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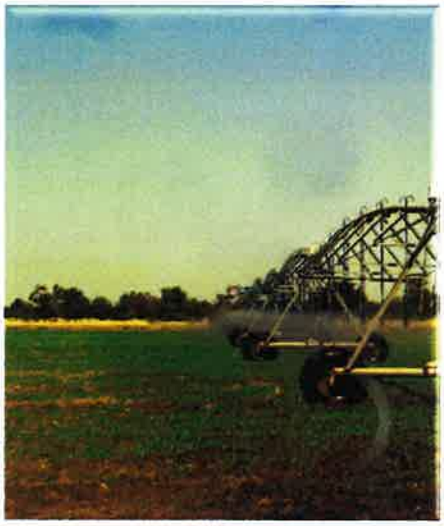

"Pearlman" Quarry

Soil and Water Management Plan

Quarry Solutions Pty Ltd

PO Box 903, Oxenford QLD 4210

August 2019

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DOCUMENT CONTROL

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Revision History

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0	August 2019	Hayley Greenham (SMK Consultants)	Initial Issue

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1 Introduction

SMK Consultants have been engaged by Quarry Solutions to prepare a Soil and Water Management Plan (SWMP). The SWMP is to accompany an Environmental Impact Statement (EIS) in support of a development application for a quarry to be located on "Tikitere".

A SWMP is the formal plan designed to control erosion and sedimentation on a building site. It details the specific methods of erosion and sediment control that will be used to meet the specific site conditions at the various stages of construction and operation. This assessment has been prepared in accordance with 'Managing Urban Stormwater: Soils and Construction, Vol. 1, 4th Edition' (Landcom, 2004) (the 'Blue Book').

The primary part of the SWMP is the provision of a sediment basin for the collection of sand, silt and other sediments generated from within the area to be disturbed. In this case, the quarry operation will involve clearing of the land within the entire footprint and then development of the quarry site in stages. As a result of the clearing, the site will be exposed to erosion and therefore generation of sediment. The sediment is deemed a pollutant if it reaches watercourses and therefore must be contained within the site.

These SWMP is intended to provide a design for the require sediment pond system, based on the intended site operations. In this case, it is intended to capture sediment from the rainfall runoff within the quarry footprint. The quarry is regarded as a source of sediments because of the large expanse of bare earth that will occur once cleared.

After initial work is completed to clear the whole site of native vegetationh, quarry activities will start from below natural surface to allow draining of quarry to an internal sump for each staged section. Sediment will be controlled within the work area with runoff from within the quarry contained. Ponds will collect runoff and sediment from each stage until quarry floor level is below natural surface.

Sediment Ponds are to remain in the same location for both construction and operation. Quarry staging has been designed to have the same area as each watershed catchment, thus allowing sediment pond 1 and sediment pond 2 to service both Stage 1 and 2 of the operation phase. The stages are outlined on the Erosion and Sediment Control Operation Plan included as Appendix 2.

Most of the cleared area will be exposed for periods of more than 6 months with the exception of stage 1, where this area will be self-draining within the quarry area. All newly cleared areas are a potential source of sheet erosion.

Most of the area associated with the quarry will be bare earth apart from a gravelled haul road for trucks to cart gravel and rock to a stockpile off site. At least three quarters of the quarry area will be cleared for longer than 6 months. These cleared areas have been included in the catchment due to the potential to yield sediment. The sediment and settling ponds on site are designed to be below ground level all runoff water stored on site and not released. During the year, the water from these ponds is used by watercarts in application of water to all roads and quarry areas for dust suppression. Any suspended solids in the runoff water will be recycled onto all road surfaces.

1.1 Soil and Water Management Principles

The principal objective of surface water management at the Pearlman Quarry is to reduce the potential for transport of sediment offsite into the nearby drainage lines and Tackinbri Creek, and the flow-on impact of sedimentation on receiving waters. This is a standard objective of erosion and sedimentation designs and controls, and is achieved by implementing the following principles:

- Directing sediment-laden runoff into designated sediment retention basins;
- Diverting 'clean water' runoff unaffected by the operations away from disturbed areas and offsite; and
- Maintaining sediment control structures to ensure that the designed capacities are maintained for optimum settling of sediments.

1.2 Site Description

This site is in an area undulating with hills, 10 kilometres south west of the town of North Star. The proposed development is located 2.6 kilometres from the Tackinbri Creek, which is a tributary of the Whalan Creek, and flows to the Barwon-Darling River system. Tackinbri Creek is contained within the wider Border Rivers catchment area. The subject area drains to the south-west.

The proposed development will include a sediment pond to capture direct runoff from the site. If runoff from the site were to exceed the sediment pond capacity, the flow would have to travel approximately 2.7 kilometres along a slope of less than 0.5 % fall before it could enter the creek. Predicted water velocity across the 2.7 kilometres of landscape between the sediment pond and the creek would be less than 0.1 m/s. Under these velocity conditions, silt deposition would occur. The area between the sediment pond and the creek is generally cropped and also contains areas of grass and other forbes. The grass and forbes would provide appropriate filtration of the sediment laden water to minimise potential silt impacts that may degrade water quality in the river.

Cultivation of this area after the overflow event would incorporate the silt into the topsoil. The quarry will involve below ground excavation. Once quarry operations commence, the sediment pond will be required to capture and settle runoff from the Quarry. The quarrying activity will result in the quarry face and immediate surround being below ground. If active onsite processing continues, the catchment area would be limited to these above ground working and stockpile areas. Once quarrying ceases, the surface areas would be remediated. As time progresses the catchment for the sediment pond will reduce.

The following figure presents an aerial image of the property "Tikitere" and the proposed Pearlman quarry footprint containing a significant basalt resource. The plan shows the contour lines within the area. All silt generated as a result of rainfall runoff within the quarry area will be captured and settled within active areas of the quarry or sediment ponds. It is therefore considered that there is minimal risk of sediment and silt entering the Tackinbri Creek.

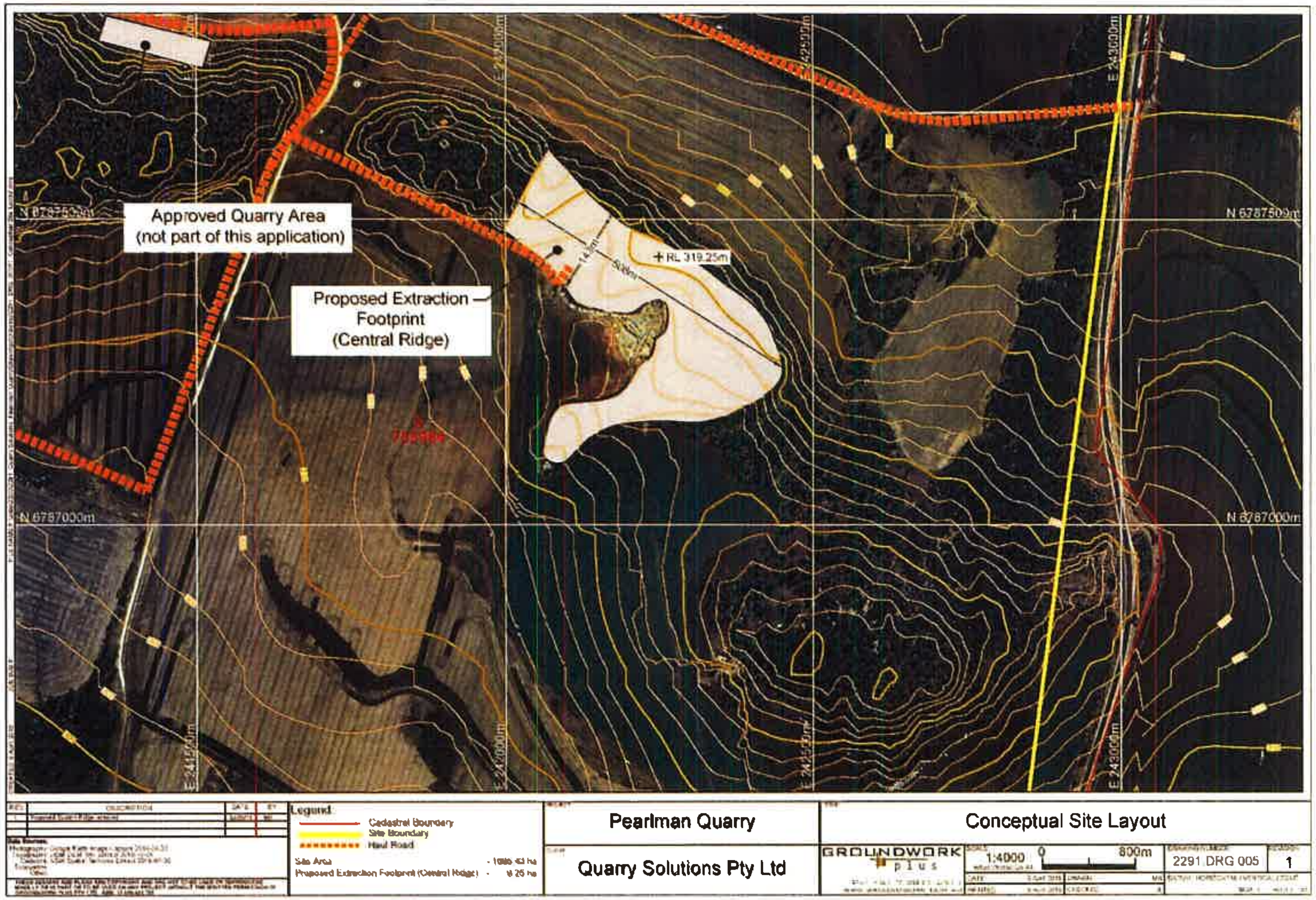


Figure 1: Pearlman Quarry Footprint

2 Factors to be Considered

Constraints are classified as either:

- on-site, i.e. relating to soils, landforms, ecology, pollutants and hydrology occurring on the site of the proposed or approved activities; or
- downstream, i.e. relating to aquatic ecosystem sensitivity and the social and aesthetic values of the community.

Based on the identified constraints and opportunities, best management practices (BMPs) have been developed for the site to minimise the potential degradation of soil and water resources and/or other aesthetic/environmental assets while maximising the achievement of outcomes in accordance with principles of Ecologically Sustainable Development (ESD). The recommended constraints to be addressed by the Blue Book are discussed in the sections below. These are in addition to the project-specific constraints discussed elsewhere in the EIS.

2.1 Flooding

This site is in an area undulating with hills, 10 kilometres south west of the town of North Star. Due to the nature of the site being situated on a hill, the site will not be affected by flood. All sediment ponds are located on the downstream of potential runoff from the existing hill and prevent the entrance of flood water and other overland flow water. The sediment ponds are located outside of any potential flood areas. In general terms, assessments should identify the 2-year ARI flood event (50% AEP). However, flooding from external areas is not considered an issue and will not be examined.

2.2 Riparian Lands

Waterfront Lands (formally known as Riparian Lands under the Rivers and Foreshores Improvement Act 1948) are those vegetated lands within 40 metres of waterbodies such as rivers, creeks, estuaries, lakes and wetlands. Development on riparian lands is constrained:

- to protect and enhance the social, economic, cultural, spiritual and heritage values of waterfront land for Aboriginal groups and the wider community; and
- to avoid or minimise land degradation, including soil erosion, compaction, geomorphic instability, contamination, acidity, waterlogging, salinity hazards and decline of native vegetation.

The proposed Quarry footprint is not within 40m of a river, creek, estuary, lake or wetland as defined by the Act. As discussed in the previous section there is minimal risk of sediment and silt entering the Tackinbri Creek.

2.3 Erosion (Rainfall Erosivity & Soil Erodibility)

2.3.1 Rainfall Data & Erosivity

The **rainfall erosivity factor (R),** is a measure of the ability of rainfall to cause erosion. This is a state-wide variable dependent on the total energy within a rainfall event. It is the product of two components, namely:

- total energy; and
- maximum 30-minute intensity for each storm.

The intensity for a 30-min storm event is used in this calculation. Generally, this variable fluctuates across the state per the rainfall intensity that could be expected for the 30-min storm at a particular location. High intensity rain results in high erosion whilst low intensity rain results in low erosion. Erosivity factors for the site can be obtained from Appendix B of the Blue Book.

The Rainfall Erosivity Factor (R) for this site is 1420 with a 2 year 6 hr storm of 7.6 mm/hr.

The proposed quarry site is considered to have a Low Erosion Hazard as shown in the below figure which is an extract from Figure 4.6 of the Blue Book. In comparison, the R-factor varies from up to 7000 along the mid North Coast of the State and approximately 700 in western parts of the state at 700.

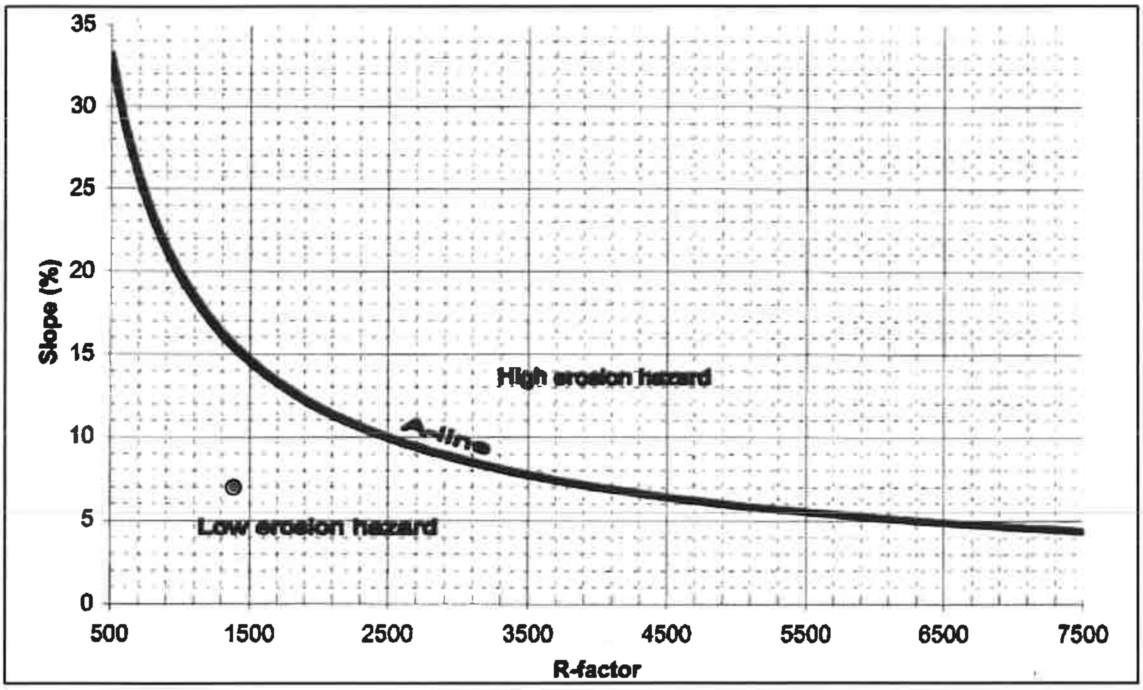


Figure 2: Assessment of Potential Erosion Hazard (Source: Figure 4.6 of the 'Blue Book').

The total quantity of rainfall over a 5-day period is an important factor in sizing of ponds and allowing the runoff to deposit sediment.

The EPA default is a minimum design of capture for a 90th percentile, 5-day rainfall depth (mm).

The 90th Percentile Rainfall Event for Moree, being the nearest data site to the subject site, is 36.3mm. This is the value used in the following calculations.

The following parameters are based on the Bureau of Meteorology's Intensity Frequency Table for the site (see Appendix 1). The **Rainfall Intensity for a 2 year 6-hour storm is 7.6 mm/hr.** Also, the Rainfall Intensities for the 1, 5, 10, 20, 50 and 100 year can be obtained from the IFD Table for use in the calculation of the peak flow.

Volumetric Runoff coefficient for the site is determined from the soil type found and the total rainfall for the 5 day 90th percentile event.

Table F1 in Appendix F of the Blue Book lists the Soil Hydrologic Groups and rates their ability to absorb water. Sands have high infiltration rates and heavy clays have low infiltration rates and therefore high runoff potential. The predominant soil type on the site is self-mulching Black Vertosols (Black Earths) and Brown Dermosols (Chocolate Soils/Brown Clays). This could be classed as **Soil Hydrologic Group D** and will have a high runoff potential.

Table F1 Effect of Ksat and profile infiltration rates on Soil Hydrologic Group

Soil Hydrologic Group	Typical infiltration rate (mm/hr)		K_{sat} (mm/hr)	Rate of infiltration	Runoff potential
	Saturated steady state	Dry soil			
A	25	>250	>120	moderate to very rapid	very low
B	13	200	10-120	moderate to rapid [1]	low to moderate
C	6	125	1-10	slow to moderate [2]	moderate to high
D	3	75	<1	very slow [3]	high

1. Includes soils where the subsoil structure grade is moderate or strong or where the texture is coarser than silty clay.
2. Includes moderately permeable surface soils underlaid by silty clays or silty clay loams with weak sub-angular or angular blocky structures; it includes permeable surface soils overlying massive clays or silty clays.
3. Includes soils where depth is limited by a hardpan, rock, high watertable, or other confining layer.

Figure 3: Effect of Ksat and profile infiltration rates on Soil Hydrologic Group (Source: Table F1 of the 'Blue Book').

Table F2 Appendix F of the manual gives the **runoff coefficient for the site as 0.64 for the sites design rainfall depth of 36.3mm**.

Table F2. Runoff coefficients (Cv) for volumetric data in disturbed catchments (adapted from USDA, 1996)

Soil Hydrologic Group	Design Rainfall depth (mm)							Runoff potential
	<20	21-25	26-30	31-40	41-50	51-60	61-80	
A	0.01	0.05	0.08	0.15	0.22	0.28	0.37	very low
B	0.10	0.19	0.25	0.34	0.42	0.48	0.57	low to moderate
C	0.25	0.35	0.42	0.51	0.58	0.63	0.70	moderate to high
D	0.39	0.50	0.56	0.64	0.69	0.74	0.79	high

Figure 4: Runoff Coefficients (Cv) for Volumetric Data in Disturbed Catchments (Source: Table F2 of the 'Blue Book').

2.3.2 Soil Erodibility

The Soil Erodibility Factor (K) is a measure of the susceptibility of individual soil particles to detachment and transport by rainfall and runoff. Soil texture is the principal component affecting soil erodibility, but structure, organic matter and permeability also contribute.

Three classes of soil are considered:

- Type D - Fine material (<0.005mm). Classed as dispersible material that will not settle unless flocculated.
- Type C – Coarse grained (33% or less < 0.02mm and 66% or More > 0.02mm). Will settle easily in a sediment retention pond.
- Type F – Fine grained (66% or More < 0.02mm and 33% or Less > 0.02mm). Will require a much longer residence time in the pond to settle.

This quarry consists of clay dominant material which will be cleared of vegetation. Exceptions to this will be haul roads and the internal self-draining quarry (Stages 1-4).

Therefore, the site could be regarded as soil Type F. The soils are regarded as Non-Dispersive.

To accommodate soil Types D and F section 6.3.4 (d) suggests a 5-day rainfall depth can be adopted as standard in the design of the settling zone.

3 Catchment Areas (A, B, C, D)

The total quarry footprint is 9.25 hectares. This has been separated into the 4 catchment areas (A, B, C & D) as shown on the attached plans. The sediment and settlement ponds associated with these catchments are depicted on the plans at the end of this report. All catchments are designed to be equal in area, so a single pond calculation has been calculated for all sediment ponds.

The design event selected is a five (5) day 90th percentile storm where the total runoff for this five-day period is held onsite to allow settlement of sediment to below the maximum discharge threshold of 50 mg/L total suspended solids as required by NSW legislation. Storms in excess of this design event, may discharge from the site. The sediment ponds are considered to capture the first flush from the disturbed area which will contain the majority of sediments. Additional runoff from the catchment is deemed to contain an acceptable level of sediment due to the large dilution levels that will occur.

The catchment area discharge points are shown on the attached plans. The discharge points collect rainfall runoff water from the areas shown on the plan and each Catchment A,B,C,D will be stored in Sediment Basin 1, 2 ,3 and 4 respectively. The surface area contributing to each discharge point is 2.31 hectares.

3.1 Design Pond Size for Type D or F Soil

Design Settling Zone Volume required for this same catchment is 537 m^3 and the Sediment Storage Volume is 268 m^3. The Design Total Basin Volume then should then be 805 m^3 (see Appendix 1).

Table 1: Total Basin Volume

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
A	0.64	36.3	2.31	537	268	805
B	0.64	36.3	2.31	537	268	805
C	0.64	36.3	2.31	537	268	805
D	0.64	36.3	2.31	537	268	805

Minimum pond dimensions based on above minimum basin volume with 1.5m water depth and 5:1 batters is shown below. Length to width ratio used was 5:1 L/W ratio.

Table 2: Minimum Pond Dimensions

	L (m)	W (m)	Area (m^2)
Top	45	21	945
Bottom	30	6	180

Volume	**844 m^3**

3.2 Discharge

Quarry Solutions have indicated that 150m^3/day of water will be used for dust suppression during the operation of the Pearlman Quarry. Due to the assumed used of water for dust suppression purposes exceeding the volume of water to be captured the site is not expected to have any discharges.

3.3 Water Balance

Quarry Solutions have indicated that 150m^3/day of water will be used for dust suppression during the operation of the Pearlman Quarry. The following tables provides a water balance for a 90th percentile wet year, 50th percentile median year and 10th percentile dry year. The water balances indicate the site will have a water deficit based on the assumed water use for dust suppression. The estimated water deficit required to maintain these dust suppression measures is 47.60ML in a 10th percentile dry year.

If the proposed development is approved, the use of water obtained from the sediment ponds for dust suppression on the site would be considered exempt from a separate water use approval under Clause 35 (a) of the *Water Management (General) Regulation 2018*. This exemption applies to any person for the use of water for any purpose as authorised by a development consent under the *environmental Planning and Assessment Act 1979.*

Table 3: Annual Water Balance (90th Percentile Wet Year) - Sediment Pond Storage (ML)

Month	90th Percentile Wet Year Rainfall (mm)	Hard Area Runoff	Soft Area Runoff	Pond Area Runoff	Pond Evaporation	Dust Suppression	Monthly Balance	Cumulative Storage Requirement
Jan	115.04	2.13	0.00	0.12	0.30	4.65	-2.71	0.00
Feb	92.80	1.71	0.00	0.09	0.25	4.20	-2.64	0.00
Mar	73.44	1.36	0.00	0.07	0.24	4.65	-3.46	0.00
Apr	32.40	0.60	0.00	0.03	0.16	4.50	-4.03	0.00
May	39.95	0.74	0.00	0.04	0.17	4.65	-4.04	0.00
Jun	56.70	1.05	0.00	0.06	0.12	4.50	-3.51	0.00
Jul	49.83	0.92	0.00	0.05	0.09	4.65	-3.76	0.00
Aug	34.87	0.64	0.00	0.03	0.09	4.65	-4.06	0.00
Sep	50.38	0.93	0.00	0.05	0.13	4.50	-3.65	0.00
Oct	60.95	1.13	0.00	0.06	0.17	4.65	-3.63	0.00
Nov	103.23	1.91	0.00	0.10	0.23	4.50	-2.72	0.00
Dec	95.13	1.76	0.00	0.10	0.26	4.65	-3.06	0.00
Total	**804.73**	**14.87**	**0.00**	**0.80**	**2.21**	**54.75**	**-41.29**	**0.00**

Table 4: Annual Water Balance (Median Rainfall) - Sediment Pond Storage (ML)

Month	50th Percentile Wet Year Rainfall (mm)	Hard Area Runoff	Soft Area Runoff	Pond Area Runoff	Pond Evaporation	Dust Suppression	Monthly Balance	Cumulative Storage Requirement
Jan	76.3	1.4	0.0	0.1	0.3	4.65	-3.5	0.0
Feb	61.6	1.1	0.0	0.1	0.2	4.20	-3.2	0.0
Mar	48.7	0.9	0.0	0.0	0.2	4.65	-3.9	0.0
Apr	21.5	0.4	0.0	0.0	0.2	4.50	-4.2	0.0
May	26.5	0.5	0.0	0.0	0.2	4.65	-4.3	0.0
Jun	37.6	0.7	0.0	0.0	0.1	4.50	-3.9	0.0
Jul	33.1	0.6	0.0	0.0	0.1	4.65	-4.1	0.0
Aug	23.1	0.4	0.0	0.0	0.1	4.65	-4.3	0.0
Sep	33.4	0.6	0.0	0.0	0.1	4.50	-4.0	0.0
Oct	40.4	0.7	0.0	0.0	0.2	4.65	-4.0	0.0
Nov	68.5	1.3	0.0	0.1	0.2	4.50	-3.4	0.0
Dec	63.1	1.2	0.0	0.1	0.3	4.65	-3.7	0.0
Total	**534.0**	**9.9**	**0.0**	**0.5**	**2.2**	**54.8**	**-46.56**	**0.0**

Table 5: Annual Water Balance (10th Percentile Rainfall) - Sediment Pond Storage (ML)

Month	10th Percentile Wet Year Rainfall (mm)	Hard Area Runoff	Soft Area Runoff	Pond Area Runoff	Pond Evaporation	Dust Suppression	Monthly Balance	Cumulative Storage Requirement
Jan	68.7	1.3	0.0	0.1	0.3	4.65	-3.6	0.0
Feb	55.4	1.0	0.0	0.1	0.2	4.20	-3.4	0.0
Mar	43.9	0.8	0.0	0.0	0.2	4.65	-4.0	0.0
Apr	19.4	0.4	0.0	0.0	0.2	4.50	-4.3	0.0
May	23.9	0.4	0.0	0.0	0.2	4.65	-4.4	0.0
Jun	33.9	0.6	0.0	0.0	0.1	4.50	-4.0	0.0
Jul	29.8	0.6	0.0	0.0	0.1	4.65	-4.2	0.0
Aug	20.8	0.4	0.0	0.0	0.1	4.65	-4.3	0.0
Sep	30.1	0.6	0.0	0.0	0.1	4.50	-4.0	0.0
Oct	36.4	0.7	0.0	0.0	0.2	4.65	-4.1	0.0
Nov	61.7	1.1	0.0	0.1	0.2	4.50	-3.5	0.0
Dec	56.8	1.1	0.0	0.1	0.3	4.65	-3.8	0.0
Total	**480.7**	**8.9**	**0.0**	**0.5**	**2.2**	**54.8**	**-47.60**	**0.0**

4 Surface Water Monitoring

The following parameters consider all facets of water control and monitoring associated with the proposed construction and operation of the Pearlman Quarry.

4.1 Water quality

The proposed sediment pond will collect runoff from within the above ground working area of the quarry. No chemicals associated with vehicles or crushing and sieving machinery material will be disposed of within the sediment pond. Fuel used on the site would be stored in sealed tanks and only used in designated refuelling areas that are isolated from the drainage network through bunding. The pond will primarily capture silty water. Any water used for dust suppression should be assessed in terms of water quality to ensure it is suitable for the proposed use (eg. salinity levels should be considered).

4.2 Surface and groundwater impacts

Potential impacts on surface water as a result of the construction and operational phases of the project include:

- Pollution of surface water through:
    - Increased turbidity of surface waters due to sediment loss and erosion from stockpiles, haul roads or other disturbed areas.
    - Impurities, incidental minerals or other leachates from the disturbed rocks and soil.
    - Elevated salinity levels, as quarrying can disrupt saline aquifers or allow salt to be leached from freshly shattered overburden.
    - Stormwater runoff from plant and equipment areas, fuel storage areas, chemical spills and uncontrolled surface runoff.
- Increased risk of erosion on slopes through increased flow rates.

The site will need to operate as a bare earth area to avoid vegetative contamination of the gravel material. No ground cover will be present and therefore artificial erosion control or silt capture devices will need to be deployed on an as required basis. Such systems will include the sediment pond and a system of diversion drains to capture and manage the flow of runoff into the pond system at suitable velocities that avoid additional erosion within the quarrying sites.

The following mitigation measures should be adopted onsite to ensure protection of surface water quality:

- Maintenance of vegetated buffer zones between the quarry site and watercourses within the region, to enable natural filtration of surface water in the event of a sediment pond overflow

- Siting of the quarry site above the 1 in 100 average recurrence interval flood level, to minimise the risk of the quarry site being inundated in the event of a major flood;
- Minimising the disturbed area by working in sections to reduce the exposure area and stabilising disturbed land as soon as possible to minimise erosion.
- Use drains, diversion banks or bund walls to direct clean stormwater away from disturbed areas, working areas and stockpiles.
- Use diversion drains, and contour drains to capture and slow down water in sloped areas, and use stones or vegetation to stabilise drains in these high velocity areas.
- Ensure that the storage and use of hazardous and dangerous materials occurs in accordance with relevant legislation, and ensuring spillages are contained.
- Minimise gradients of access tracks, and maintain table drains.
- Placing hay bales, silt fences or other suitable control devices in drainage lines within the site to reduce onsite erosion where possible.

The implementation of the appropriate mitigation measures in accordance with the above recommendations and best practice management techniques are considered sufficient to avoid potential contamination of offsite surface waters.

Based on the available information it is considered that using groundwater under an existing groundwater licence would be the most appropriate backup option for the dust mitigation measures throughout the operation of the quarry. There would be therefore be no increase to the existing licensed entitlements. No additional extraction will ensure that the Quarry does not adversely impact on the drawdown of sourced and/or adjacent aquifer(s).

The available setback from surface water and potential GDE's is substantial providing a sufficient barrier between the Quarry. The provision of suitable drainage and sediment controls will prevent erosion and ensure runoff does not contaminate offsite areas, including waterways and GDE's.

The storage and/or use of hazardous materials which may be used on site will occur in accordance with *National Code of Practice for the Storage and Handling of Workplace Dangerous Goods (2001).* The appropriate storage and handling will ensure such materials do not pose an unacceptable risk in respect to the pollution of groundwater.

5 Conclusions and Recommendations

All dirty water collected on site will be directed to the sediment pond or quarry pits. The water collected will be utilised for dust suppression throughout operations. As seen in the water balance, there will be limited water collected in the sediment pond and as such it is expected additional water will be required to maintain dust mitigation measures.

Quarry Solutions should implement all erosion and sediment controls measures as outlined within this report and included within the attached erosion and sediment control plans to ensure the development does not cause the pollution of water in accordance with Section 120 of the *Protection of the Environment Operation Act 1997*. The proposed mitigation measures, if implemented, are considered sufficient to avoid the potential for impacts to offsite surface and groundwater from the proposed development.

Appendix 1: Calculations

Location

Label: PEARLMAN QUARRY

Latitude: -29 [Nearest grid cell: 28.9875 (S)]

Longitude:150.2 [Nearest grid cell: 150.2125 (E)]

Table 6: Bureau of Meteorology IFD Table

	Annual Exceedance Probability (AEP)						
Duration	63.2%	50%#	20%*	10%	5%	2%	1%
1 min	125	142	197	236	275	327	369
2 min	109	124	174	209	242	285	318
3 min	100	114	160	191	222	262	293
4 min	93.9	107	149	178	207	245	274
5 min	88.4	101	140	167	194	230	258
10 min	69.0	78.4	109	130	151	180	204
11 min	66.2	75.2	104	124	145	173	196
15 min	57.2	65.0	90.1	108	126	150	170
20 min	49.2	55.9	77.6	92.8	108	130	146
25 min	43.3	49.3	68.4	81.9	95.5	114	129
30 min	38.8	44.2	61.4	73.5	85.8	103	116
45 min	30.0	34.1	47.4	56.9	66.3	79.2	89.4
1 hour	24.7	28.1	39.0	46.8	54.6	65.1	73.5
1.5 hour	18.5	21.1	29.3	35.1	40.9	48.7	54.9
2 hour	15.1	17.1	23.7	28.4	33.1	39.4	44.4
3 hour	11.2	12.7	17.5	20.9	24.4	29.0	32.7
4.5 hour	8.31	9.40	12.9	15.4	17.9	21.4	24.1
6 hour	6.73	7.60	10.4	12.4	14.4	17.2	19.4
9 hour	5.02	5.65	7.70	9.15	10.6	12.7	14.4
12 hour	4.08	4.59	6.24	7.42	8.62	10.3	11.7
18 hour	3.06	3.44	4.67	5.54	6.45	7.75	8.81
24 hour	2.49	2.80	3.80	4.53	5.27	6.34	7.21
30 hour	2.12	2.38	3.25	3.87	4.51	5.43	6.18
36 hour	1.86	2.09	2.85	3.41	3.98	4.79	5.44
48 hour	1.50	1.69	2.32	2.78	3.25	3.91	4.44
72 hour	1.10	1.24	1.72	2.06	2.42	2.90	3.29
96 hour	0.874	0.988	1.37	1.64	1.93	2.31	2.61
120 hour	0.723	0.819	1.13	1.36	1.60	1.91	2.16
144 hour	0.616	0.698	0.963	1.15	1.35	1.62	1.83
168 hour	0.534	0.606	0.832	0.988	1.16	1.39	1.57

Table 7: Frequency Factor Determination

TABLE 5.1 - Frequency Factors FF_Y for Rational Method in Eastern New South Wales

Frequency Factors FF_Y	Zone in Figure 5.2: A Below 500m	A Above 500m	B Below 500m	B Above 500m	C Below 500m	C Above 500m	D Below 500m	D Above 500m	E Below 500m	E Above 500m	F Below 500m	F Above 500m
FF_1	0.67	0.50	0.62	0.57	0.62	0.89	0.43	0.37	0.38	0.52	0.66	0.69
FF_2	0.81	0.66	0.74	0.70	0.78	0.92	0.58	0.53	0.54	0.64	0.74	0.77
FF_5	0.92	0.85	0.88	0.86	0.90	0.95	0.80	0.77	0.78	0.82	0.87	0.89
FF_{10}	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
FF_{20}	1.07	1.14	1.12	1.14	1.10	1.05	1.20	1.25	1.26	1.21	1.15	1.10
FF_{50}	*	1.32	*	1.33	*	1.17	1.54	1.74	1.71	1.62	1.39	1.26
FF_{100}	*	1.46	*	1.50	*	1.24	1.80	2.20	2.14	1.78	1.60	1.34

Zones Below 500m	FF_{50}	FF_{100}
A	$FF_{50} = 1.90 - \frac{0.366\ I_{12,50}}{I_{12,2}}$	$FF_{100} = 2.45 - \frac{0.588\ I_{12,50}}{I_{12,2}}$
B	$FF_{50} = 1.99 - \frac{0.366\ I_{12,50}}{I_{12,2}}$	$FF_{100} = 2.57 - \frac{0.588\ I_{12,50}}{I_{12,2}}$
C	$FF_{50} = 1.97 - \frac{0.366\ I_{12,50}}{I_{12,2}}$	$FF_{100} = 2.54 - \frac{0.588\ I_{12,50}}{I_{12,2}}$

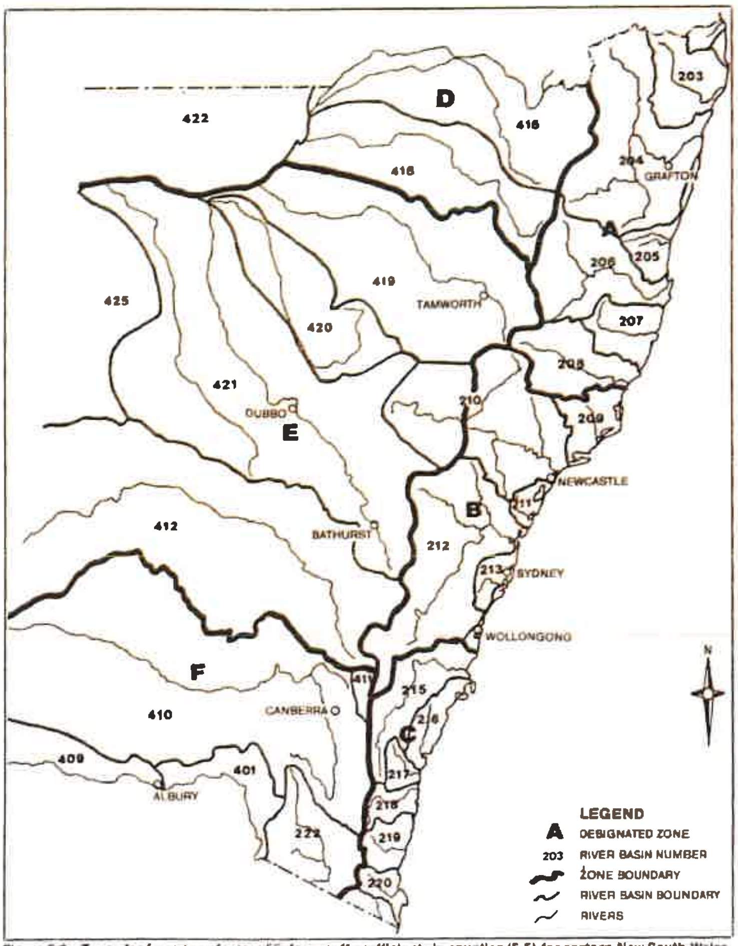


Figure 5.2 - Zones for frequency factors FF_Y for runoff coefficients in equation (5.5) for eastern New South Wales.

Site Data Sheet

Site name: Pearlman Quarry

Site location: 10 km South West of Township of North Star, NSW

Co-ordinates: MGA Zone 56 E 242208 N 6787390

Precinct: Moree

Description of site: The proposed quarry will drain within itself to internal sumps, but sediment capture is required for the land clearing. Proposed Land clearing sections approximate area of 9.25ha.

Table 8: Site Area

Site area	Site				Remarks
	A	B	C	D	
Total catchment area (ha)	2.31	2.31	2.31	2.31	Includes pads, roads and sheds
Disturbed catchment area (ha)	2.31	2.31	2.31	2.31	

Table 9: Soil Analysis

Soil Landscape	Black soil plains. Soil type CH or CL with gravel road base as covering (SG sandy Gravel)				DIPNR mapping (if relevant) Sections 6.3.3(c), (d) & (e)
Soil Texture Group	F	F	F	F	

Table 10: Rainfall Data

Design rainfall depth (days)	5	5	5	5	See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	90	90	90	90	See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	36.3	36.3	36.3	36.3	See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	7.6	7.6	7.6	7.6	See IFD chart for the site
Rainfall erosivity (R-factor)	1420	1420	1420	1420	Automatic calculation from above data

Comments: Area to be cleared is assumed to be clay dominant. Therefore, it has been estimated that the soil type to be Type F. Basin was designed for both soil types as at the time of calculation soil type was unknown.

Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Q_Y = 0.00278 \times C_{10} \times F_Y \times I_{y,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c)

= $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

= 0.18 Hours (Rural)

= 10.89 Minutes (Rural)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Table 11: Peak Flow Calculations 1

Site	A (ha)	tc (mins)	Rainfall Intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
A	2.31	11	66.2	104	124	145	173	196	0.9
B	2.31	11	66.2	104	124	145	173	196	0.9
C	2.31	11	66.2	104	124	145	173	196	0.9

D	2.31	11	66.2	104	124	145	173	196	0.9

Table 12: Peak Flow Calculations 2

ARI years	Frequency Factor (F_Y)	Peak Flows				Comment
		A (m^3/s)	B (m^3/s)	C (m^3/s)	D (m^3/s)	
$1_{yr, tc}$	0.43	0.165	0.165	0.165	0.165	
$5_{yr, tc}$	0.8	0.481	0.481	0.481	0.481	
$10_{yr, tc}$	1	0.717	0.717	0.717	0.717	
$20_{yr, tc}$	1.2	1.006	1.006	1.006	1.006	
$50_{yr, tc}$	1.54	1.540	1.540	1.540	1.540	
$100_{yr, tc}$	1.8	2.039	2.039	2.039	2.039	

Volume of Sediment Basins: *Type C* Soils (Not Used)

Basin volume = settling zone volume + sediment storage volume

Settling Zone Volume

The settling zone volume for Type C soils is calculated to provide capacity to allow the design particle (e.g. 0.02 mm in diameter) to settle in the peak flow expected from the design storm (e.g. 0.25-year ARI). The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle. Peak flow/discharge for the 0.25-year, ARI storm is given by the Rational Formula:

Q tc, 0.25 = 0.5 x [0.00278 x C10 x Fy x I 1yr, tc x A] (m3/sec)

where:

Q tc,0.25	=	flow rate (m3/sec) for the 0.25 ARI storm event
C10	=	runoff coefficient (dimensionless for ARI of 10 years)
Fy	=	frequency factor for 1 year ARI storm
I 1 yr,tc	=	average rainfall intensity (mm/hr) for the 1-year ARI storm
A	=	area of catchment in hectares (ha)

Basin surface area (A) = area factor x Qtc, 0.25 m2

Particle settling velocities under ideal conditions (Section 6.3.5(e))

Particle Size	Area Factor
0.100	170
0.050	635
0.020	4100

Volume of settling zone = basin surface area x depth (Section 6.3.5(e)(ii))

Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 100 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.5(e)(iv)), in which case the "Detailed Calculation" spreadsheets should be used.

Table 13: Total Basin Volume

Site	$Q_{tc, 0.25}$ (m^3/s)	Area factor	Basin surface area (m^2)	Depth of settling zone (m)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)	Minimum Basin shape		
								L:W Ratio	Length (m)	Width (m)
A	0.082	4100	337	0.6	202	202	405	5	41.1	8.2
B	0.082	4100	337	0.6	202	202	405	10	58.1	5.8
C	0.082	4100	337	0.6	202	202	405	10	58.1	5.8
D	0.082	4100	337	0.6	202	202	405	10	58.1	5.8

Volume of Sediment Basins: Type D and Type F Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for Type F and Type D soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

V = 10 x Cv x A x Ry-%ile, x-day (m3)

where:

10 = a unit conversion factor

Cv = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

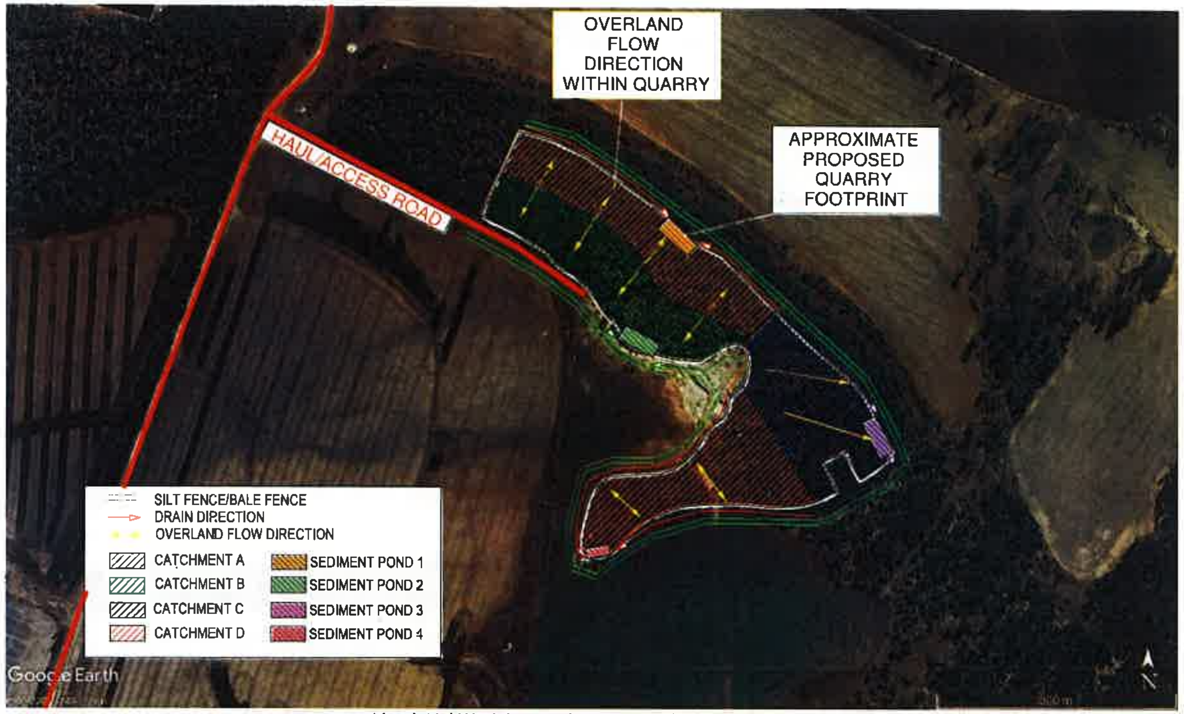
Sediment Storage Zone Volume

In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)), in which case the "Detailed Calculation" spreadsheets should be used.

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
A	0.64	36.3	2.31	537	268	805
B	0.64	36.3	2.31	537	268	805
C	0.64	36.3	2.31	537	268	805
D	0.64	36.3	2.31	537	268	805

Note: These "Standard Calculation" spreadsheets relate only to low erosion hazard lands as identified in figure 4.6 where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreadsheets should be used on high erosion hazard lands as identified by figure 4.6 or where the designer chooses to run the RUSLE in calculations.

Appendix 2: Erosion and Sediment Control Plans



After Initial Work is complete to open the site, quarry activities will start from below natural surface to allow draining of quarry to an internal sump for each staged section. Sediment will be controlled within the work area with no run-off produced.

NOTES:

- The contractor is responsible for all erosion protection and sediment control during the contract.
- The contractor is to ensure all construction areas are to remain in a bare state for the minimum amount of time possible.
- During the time that these areas are left exposed, all efforts must be taken to ensure the subject area is not eroded
- Any topsoil that is to be stripped is to be placed in a designated top soil stockpile
- Any top soil stockpiles are to be placed on suitably higher ground and a silt fence is to be built surrounding the stockpile
- Stockpiles are to have one access only and are to be rehabilitated on construction completion
- Location of silt fences and truck shake down areas were designed using the provided data and proposed access at the time of report. Should lot conditions change or access routes change, the above plan should be amended to suit.
- Silt traps/fences/shakedowns are to be checked weekly and after rain events
- Dust is to be minimised during construction with watering of the site when required
- No clear drainage line was evident from the provided survey, therefore silt fences have been used to control sediment from overland flow
- Sediment fences are to be monitored and sediment is to be removed once it builds up to a height of 300mm from top of upslope side.
- All sediment and erosion devices are to remain until all construction works are completed
- It is up to the contractor to manage sediment and erosion control to suit the varying stages of construction and make sure all placement of devices and management of devices is up to best practice guidelines.

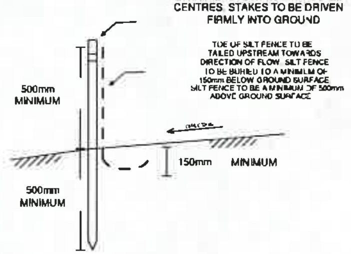
Minimum Sediment Pond Dimensions:
(Based on Catchment Area of 2.31ha, 1.5m of water depth, 5:1 batters and length to width ratio of 5:1)

	L (m)	W (m)	Area (m²)
Top	45	21	945
Bottom	30	6	180

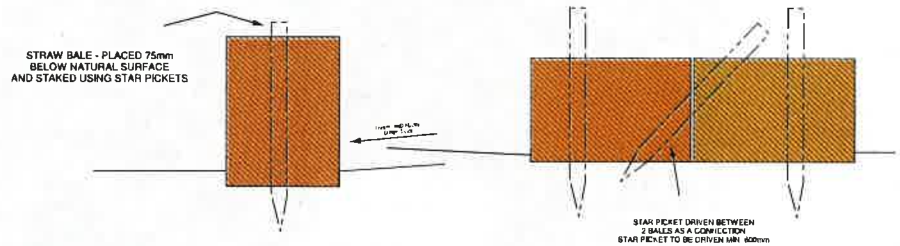
Volume	844 m³

SEDIMENT POND SIZING

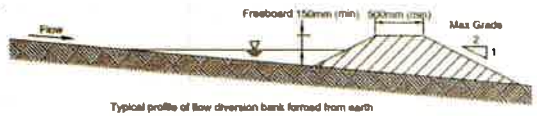
Catch drains are designed to be open channels to collect runoff and sediment and desposit to sediment controls.



STANDARD SILT FENCE DETAIL

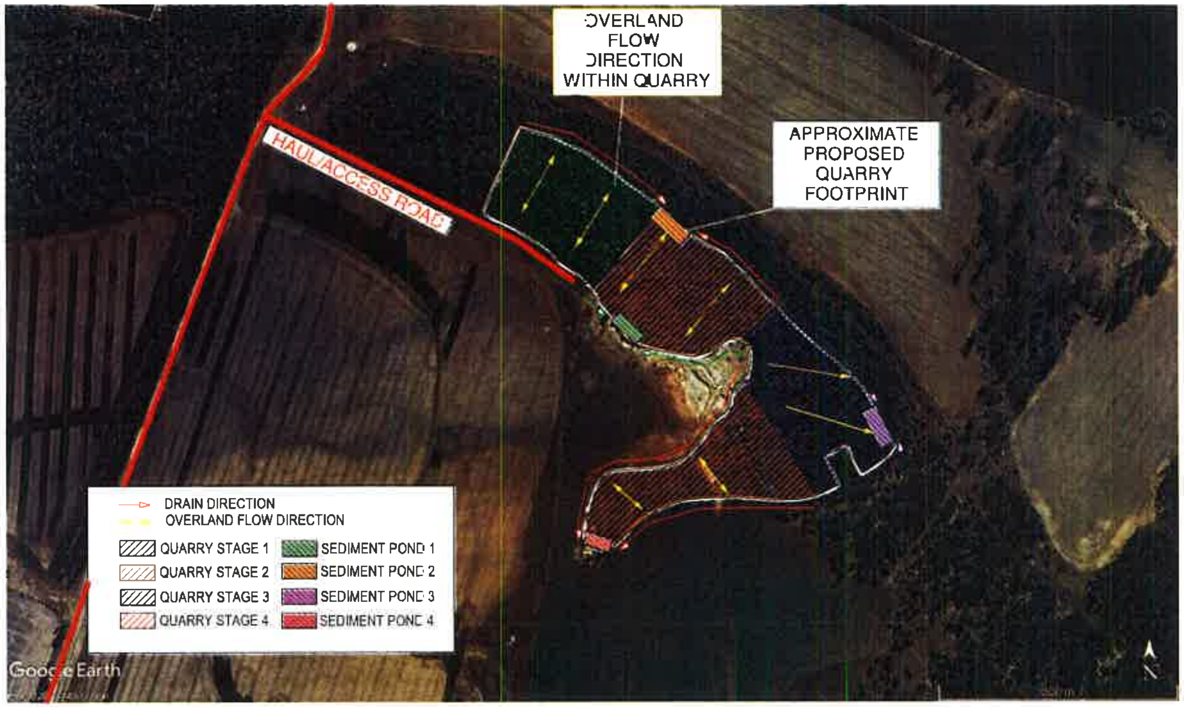


STRAW BALE FENCE



CATCH DRAIN TYPICAL SECTION

SCALES: HORIZ NOT TO SCALE, VERT	A3	SMK CONSULTANTS surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT: ALAN PEARLMAN	DESCRIPTION: LAYOUT PLAN FOR SEDIMENT AND STORMWATER CONTROL DURING CONSTRUCTION	PLAN REVISION:	DATE	SHEET No. 1 of 1
DATUM: LOCAL			PROJECT: PROPOSED PEARLMAN QUARRY		A FIRST ISSUE	09-08-2019	JOB No. 17-172
SURVEYED -; DESIGNED SMK CONSULTANTS; CHECKED PETER TAYLOR	CONTOUR INTERVAL -				B REVISED	15-08-2019	COMPUTER FILE
					C REVISED	19-08-2019	Pearlman Quarry Stormwater and Erosion Control Planning



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- The contractor is responsible for all erosion protection and sediment control during the contract.
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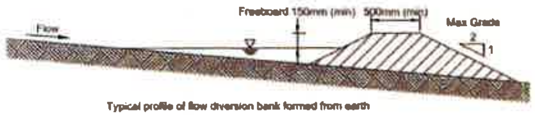
- Any top soil stockpiles are to be placed on suitably higher ground and a silt fence is to be built surrounding the stockpile
- Stockpiles are to have one access only and are to be rehabilitated on construction completion
- Location of silt fences and truck shake down areas were designed using the provided data and proposed access at the time of report. Should lot conditions change or access routes change, the above plan should be amended to suit.
- Silt traps/fences/shakedowns are to be checked weekly and after rain events
- Dust is to be minimised during construction with watering of the site when required
- No clear drainage line was evident from the provided survey, therefore silt fences have been used to control sediment from overland flow
- Sediment fences are to be monitored and sediment is to be removed once it builds up to a height of 300mm from top of upslope side.
- All sediment and erosion devices are to remain until all construction works are completed
- It is up to the contractor to manage sediment and erosion control to suit the varying stages of construction and make sure all placement of devices and management of devices is up to best practice guidelines.

Catch drains are designed to be open channels to collect runoff and sediment and desposit to sediment controls.



CATCH DRAIN TYPICAL SECTION

Minimum Sediment Pond Dimensions:
(Based on Catchment Area of 2.31ha, 1.5m of water depth, 5:1 batters and length to width ratio of 5:1)

	L (m)	W (m)	Area (m²)
Top	45	21	945
Bottom	30	6	180

Volume	844 m³

SEDIMENT POND SIZING

SEDIMENT POND USAGE DURING OPERATION

After Initial Work is complete to open the site, quarry activities will start from below natural surface to allow draining of quarry to an internal sump for each staged section. Sediment will be controlled within the work area with no run-off produced. Ponds will collect runoff and sediment from each stage until quarry floor level is below natural surface.

Sediment Ponds are to remain in the same location for both construction and operation. Quarry Staging has been designed to have the same area as each watershed catchment, thus allowing sediment pond 1 and sediment pond 2 to service both Stage 1 and 2 of the operation phase.

SCALES: HORIZ NOT TO SCALE; VERT; DATUM: LOCAL; SURVEYED; DESIGNED SMK CONSULTANTS; CHECKED PETER TAYLOR; CONTOUR INTERVAL	A3	**SMK CONSULTANTS** surveying - irrigation - environmental PO BOX 774 MOREE 2400 PHONE (02) 67 521021	CLIENT: ALAN PEARLMAN; PROJECT: PROPOSED PEARLMAN QUARRY	DESCRIPTION: LAYOUT PLAN FOR SEDIMENT AND STORMWATER CONTROL DURING OPERATION

PLAN REVISION:		DATE
A	FIRST ISSUE	09-08-2019
B	REVISED	15-08-2019
C	REVISED	19-08-2019

SHEET No. 1 of 1

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Report

Air Quality Impact Assessment

Pearlman's Quarry

Quarry Solutions Pty Ltd

14 Aug, 2019

Rev 1 (Final)

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Report Details

Air Quality Impact Assessment - Pearlman's Quarry

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Prepared For

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History

Date	Revision	Comments
12 Aug, 2019	0	Issue for Client Review
14 Aug, 2019	1	Final Issue

Endorsements

Function	Signature	Name and Title	Date
Prepared by	[signature]	Grant Brown Environmental Scientist (Air Quality)	14 Aug, 2019
Checked by	[signature]	Dr Carl Fung Lead Consultant - Process Engineering and Sustainability, CAQP (*CASANZ*)	14 Aug, 2019
Authorised for Release by	[signature]	Dr Rod Bennison Lead Environmental Scientist	14 Aug, 2019

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FIGURES

APPENDICES

1. INTRODUCTION

Advitech Pty Limited (trading as Advitech Environmental) was engaged by Groundwork Plus Pty Ltd (Groundwork Plus) on behalf of Quarry Solutions Pty Ltd (Quarry Solutions). Groundwork Plus are compiling several Environmental Impact Statements for Quarry Solutions, which intends to supply the Australian Rail Track Corporation with extractive materials for the construction of the Melbourne to Brisbane Inland Rail project. The Pearlman's Quarry proposal is considered Designated Development under Part 4 of the Environmental Planning and Assessment Act 1979 (EP&A Act). As such, this Air Quality Impact Assessment (AQIA) supports the Environment Impact Statement (EIS) completed in accordance with the Planning Secretary's environmental assessment requirements (EAR 1331). It should be noted that this report was prepared by Advitech Pty Limited for Quarry Solutions ('the customer') in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

2. BACKGROUND AND OBJECTIVES

2.1 Project Background

Quarry Solutions propose to develop and operate a hard rock quarry operation on the property 'Tikitere', located approximately 70 km north east of Moree (a site map is provided in **Figure 1**). The property has historically been used for mixed cultivation and grazing operations. The Pearlman's Quarry is one of several possible sources of ballast material for the Inland Rail project. The quarry proposes to extract up to 490,000 tonnes of material per annum over a five year period.

While the proposed area includes an area of 9.25 ha, a number of existing tracks are present through this area. Overall, the proposed clearing will only impact on 8.79 ha of existing native vegetation.

2.2 Site Description

The proposed Pearlman's Quarry is located in the New England North West region within New South Wales, approximately 70 km north east of Moree and 45 km south of Boggabilla. The township of North Star is approximately 10 km north. The approximate area of the proposal site is 1695 hectares, with 9.25 hectares comprising the extraction area and 7.00 hectares comprising the stockpile area (see **Figure 1**). The quarry lies on Lot 5 DP755984 on land zoned RU1 Primary Production within Gwydir Shire Council. Two kilometres east of the proposed quarry, on a separate lot, but still apart of the Pearlman's property, the Camurra Boggabilla Railway line runs north-south through the property.

Another quarry facility (known as Tikitere quarry) operated by Quarry Solutions Pty Ltd is located on the same site, approximately 500 m from the proposed Pearlman Quarry. To properly account for cumulative particulate impacts associated with the two closely situated quarry facilities, Advitech has also modelled particulate emissions from the Tikitere quarry.

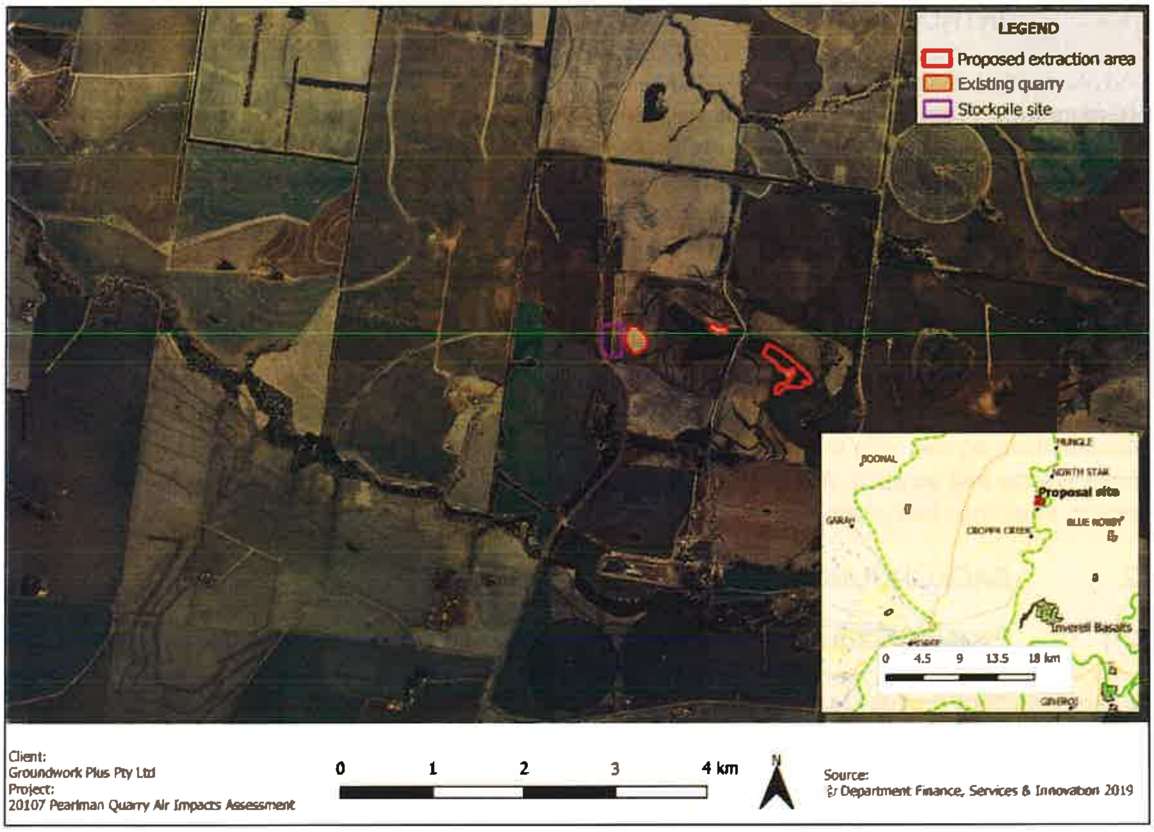


Figure 1: Site Location (Regional Context)

2.3 Project Description

The proposed quarry/extraction operations are as follows:

1. The proposed quarry will extract 490,000 metric tonnes of material per annum.
2. The hours of operation will be 12 hours Monday to Friday and 6 hours on Saturday.
3. The quarry is expected to operate for a period of 5 years delivering product to the Inland Rail Project between 2019 and 2024.
4. The quarry will be subject to typical daily and weekly extraction activities such as blasting, winning, crushing and stockpiling of material as well as removing prepared product and transporting it.
5. The extracted material will be delivered primarily to supply ballast materials for Australian Governments Inland Rail project. Blue metal products will also be extracted from the quarry to supply the local council.
6. Approximately 80% of the product is expected to be transported using the access road and onto the Croppa Creek Road, with the remaining 20% transported via rail. The extracted material will be delivered off-site.

The facility proposes to have capacity to operate 6 days per week excluding Sundays and public holidays. The operating hours will be between 6 am - 6 pm on weekdays, between 6 am - 1 pm on Saturdays and closed on Sundays and Public Holidays. The process is such that aside from mined basalt material, no other material will need to be removed from the site. The site layout and indicative quarry extraction area is presented in **Figure 2**.

Figure 2: Conceptual Site Layout (Source Groundwork Plus)

2.4 Secretary's Environmental Assessment Requirements

This report will be appended to an Environmental Impact Statement (EIS) which must comply with the requirements of Clause 6 and 7 of the Environmental Planning and Assessment Regulation 2000, and which addresses environmental considerations identified in the Planning Secretary's Environmental Assessment Requirements (SEARs) (EAR 1331) relevant to air quality. The SEARs notes the following requirements for air quality assessment including:

- An assessment of the likely air quality impacts of the development in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW. The assessment is to give particular attention to potential dust impacts on any nearby private receivers due to construction activities, the operation of the quarry and/or road haulage.

2.5 Sensitive Receivers

The nearest potentially affected residences are shown on **Figure 3**. The residences are located in North Star, along Croppa Creek Road, Boonery Park Road, Birrahlee Road and Oaklands Road. The area surrounding the development site can be described as an established rural setting. **Table 1** provides the locations for each sensitive receiver. \

Figure 3: Sensitive Receivers

Table 1: Sensitive Receivers

Receiver ID	Address	Easting UTM[a] (m)	Northing UTM[a] (m)	Receiver Type
R1	1137 Croppa Creek Road	238781	6787014	Private Residence
R2	473 Birrahlee Road	236533	6788442	Private Residence
R3	1176 Oaklands Road	240870	6790201	Private Residence
R4	1835 Croppa Creek Road	242536	6792303	Private Residence
R5	391 Boonery Park Road (Lot 1 DP1080910)	238055	6783704	Private Residence
R6	1216 Croppa Creek Road	244994	6784834	Private Residence
R7	391 Boonery Park Road (Lot 54 DP751116)	238228	6784000	Private Residence
R8	141 Boonery Park Road	241172	6783672	Private Residence
R9	391 Boonery Park Road (Lot 1 DP751134)	235878	6785140	Private Residence

[a] - Universal Transverse Mercator (UTM) coordinate System based on the WGS84 Datum.

3. AIR QUALITY GUIDELINES

The NSW Environment Protection Authority (EPA) specify the impact assessment criteria in the publication *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*, 2016 (refer **Section** 8, *Reference 1*). The relevant sections from this publication are reproduced below in **Table 2** which presents the ground level concentration (GLC) criteria for each applicable air pollutant.

Table 2: NSW EPA Impact Assessment Criteria

Pollutant	NSW EPA Design Criteria	Units	Averaging Time
TSP[a]	90	µg/m³	Annual
PM_{10}[b]	50	µg/m³	24 hours
	25	µg/m³	Annual
$PM_{2.5}$[c]	25	µg/m³	24 hours
	8	µg/m³	Annual
Deposited Dust[d]	2[e]	g/m²/month	Annual
	4[f]		

[a] Total suspended particulates.
[b] Particulate materials with an aerodynamic diameter less than 10 µm.
[c] Particulate materials with an aerodynamic diameter less than 2.5 µm.
[d] Dust is assessed as insoluble solids as defined by AS 3580.10.1.
[e] Maximum increase in deposited dust level.
[f] Maximum total deposited dust level.

4. METEOROLOGICAL DATA

To determine the most representative 12 month calendar period, required for modelling air emissions from the Pearlman Quarry, historical Bureau of Meteorology (BOM) climate data at the Moree Airport Automatic Weather Station (AWS) (053115) was reviewed in **Table 3**. Historical BOM wind roses at Moree Airport from 2012 - 2017 have been presented in **Appendix III.**

Table 3: Bureau of Meteorology (BoM) Climate Data History for Moree Airport (053115)

Year	Temperature (°C)				Rainfall (mm)	
	Maximum year average	Difference from long term average	Minimum year average	Difference from long term average	Yearly total	Percentage of long term average
2012	26.4	-0.4	11.9	-0.6	633.2	109%
2013	27.6	+0.8	12.5	0.0	499.4	86%
2014	28.1	+1.3	13.7	+1.2	354.8	61%
2015	27.1	+0.3	13.1	+0.6	521.8	90%
2016	27.1	+0.3	13.5	+1.0	527.2	90%
2017	28.2	+1.4	13.4	+0.9	512.4	88%

A review of BOM climate and wind rose data suggests the years with the least deviation from long term average climate statistics are years 2012 and 2015. As a result of the review of climatic data (refer to **Table 3**) and wind rose data (refer to **Appendix III**), this report has adopted the 2015 year for air dispersion modelling purposes.

4.1 CALMET

Air dispersion modelling requires the creation of a three dimensional (3D) CALMET meteorological data file that represents the weather and climate for the region (domain) modelled. In brief, CALMET is a meteorological model that develops hourly (or sub-hourly) wind and other meteorological fields on a 3D gridded modelling domain. Associated two dimensional fields such as mixing height, surface characteristics, and dispersion properties are also included in the file produced by CALMET. The final time varying wind field thus reflects the influences of local topography and land uses.

Compilation of a 2015 three dimensional (3D) meteorological data file for the Moree area representative of the proposed site was obtained from the following data sources:

- Fifth-Generation NCARIPenn State Mesoscale Prognostic Model (MM5) for 2015;
- NSW DECC 2007 Land Use NSW; and
- Terrain data set with SRTM1 30 m resolution topography data.

MM5 is a widely-used three-dimensional numerical meteorological model which contains non-hydrostatic dynamics and a variety of physics options. Extensive comparison between MM5 outputs and observed weather data has validated its use for application in the preparation of 3D CALMET weather files. MM5 is capable of simulating a variety of meteorological phenomena such as tropical cyclones, severe convective storms, sea-land breezes, and terrain forced flows such as mountain valley wind systems.

The generated 3D meteorological file used in this report was developed using no observations mode in CALMET. After comparison of the local observational data with regional observational data, Advitech considered the local data not suitable for meteorological modelling. Therefore, the CALMET model was undertaken in 'No Obs' mode using prognostic MM5 data.

The MM5 wind field was used as an initial guess in CALMET which was subsequently used to generate its wind. The initial wind was then adjusted to account for the kinematic and thermal effects of terrain and land use on wind.

Figure 4 shows the frequency of wind speed and direction for each season during the 2015 calendar year extracted from the CALMET generated file.

The CALMET seasonal wind roses predict that the predominant winds are from a northeast direction in summer and spring months and a northeast and southwest direction in the autumn, winter months.

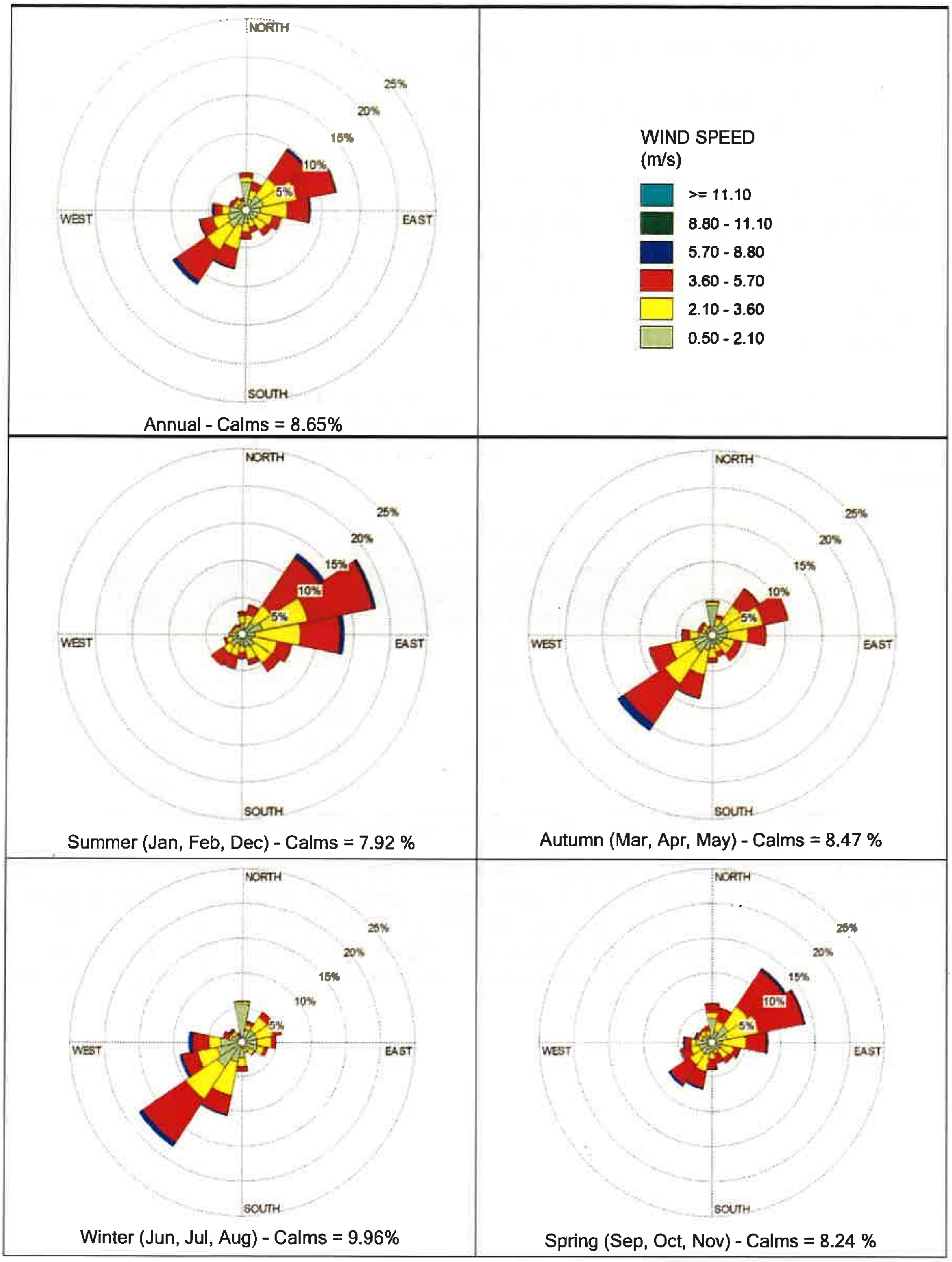


Figure 4: CALMET 2015 Pearlman Quarry Site Seasonal Wind Roses

5. MODELLING APPROACH/METHODOLOGY

5.1 Background Air Quality (Particulates)

Assessment of background air quality data has been undertaken for the airshed surrounding the proposed Pearlman quarry operation.

The QLD Department of Environment and Science (DES) operate an air quality monitoring program that collects accurate real-time measurements of ambient level pollutants at a number of monitoring sites across Queensland (refer **Section 8**, *Reference 2*). Given the absence of background air quality data for 2015 in the North Star region, the nearest monitoring location with high quality data is located at Jondaryan, Queensland and was applied for the purpose of the assessment. Jondaryan is located approximated 220 km north-north-east of the Pearlman Quarry and was selected based on its location, elevation, similar land use and data availability for 2015.

A Level 1 assessment of particulate background concentrations has been prepared for the pollutants listed in **Table 4** for the 2015 monitoring year to correspond with the meteorological data. The Level 1 assessment has assumed a worst-case background concentration by using the maximum reported value.

Table 4: Background Air Quality

Pollutant	Background Concentration	Units	Averaging Time
TSP	36.78	µg/m³	Annual
PM_{10}	Varies	µg/m³	24 Hours
	18.39	µg/m³	Annual
$PM_{2.5}$	Varies	µg/m³	24 Hours
	5.82	µg/m³	Annual

[a] Assumed from annual average PM_{10} background concentration (TSP = 2 x PM_{10}).

The maximum reported PM_{10} background concentration for the 2015 monitoring period was 83.7 µg/m³ respectively, which is above the NSW EPA impact assessment criteria. As such, a Level 2 contemporaneous assessment of the PM_{10} background concentration is required to understand the cumulative impact of the proposed development. **Figure 5** displays the PM_{10} 24-hour average background concentrations for 2015 and indicates an exceedance of the NSW EPA impact assessment criteria.

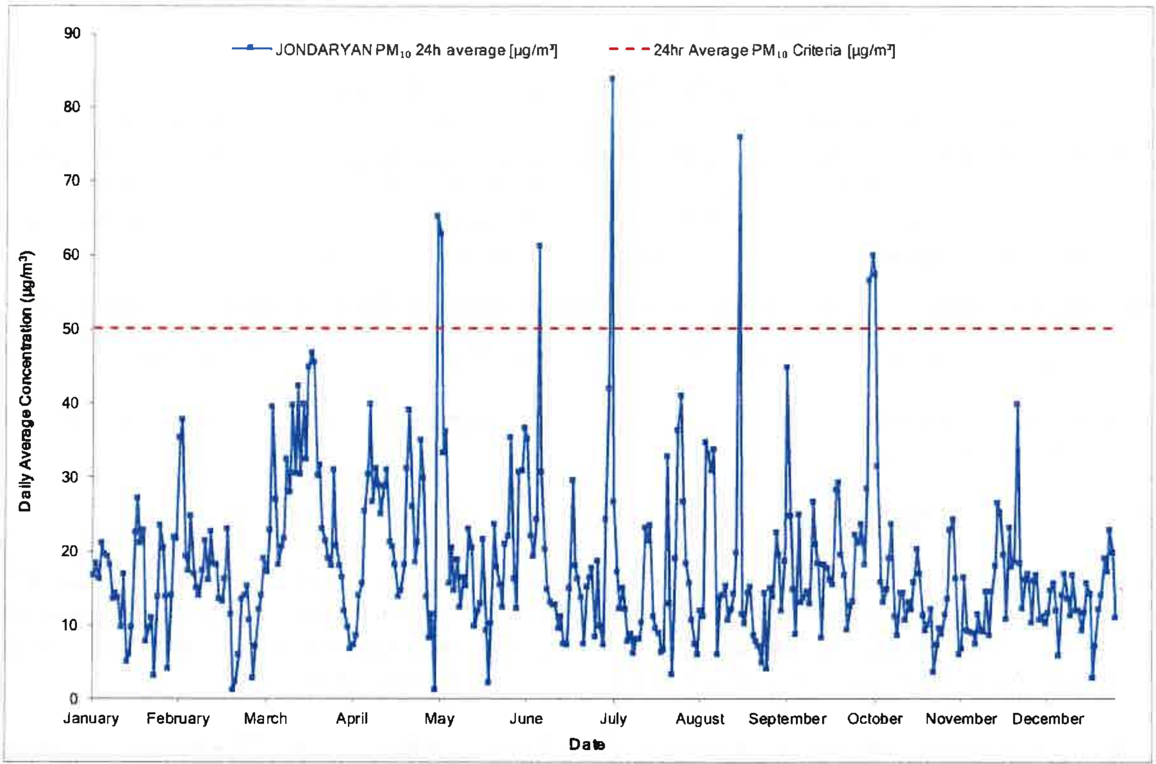


Figure 5: Daily Particulate Matter Concentrations for Jondaryan 2015

5.2 Meteorological Model Configuration

Table 5 details the parameters used in the meteorological modelling to drive the CALMET model. The nearest BOM observational station at Moree Airport AWS is 68 km south-south-west of the subject site.

After comparison of the local observational data with regional observational data, Advitech considered the local data not suitable for meteorological modelling. Therefore, the CALMET model was undertaken in 'No Obs' mode using prognostic MM5 data.

Table 5: CALMET Meteorological Parameters used in this Report

Identifier	Descriptor	Comment
MM5	Grid spacing	4 km
	Year of analysis	2015
	Time step	hourly
CALMET (v 6.4.0)	Meteorological grid domain	15 km x 15 km
	Meteorological grid origin (SW corner)	233867 m, 6780620 m
	Meteorological grid resolution	0.15 km
	TERRAD value	5 km
	Cell Face Heights	0, 20, 40, 80, 160, 320, 640, 1000, 1500, 2000, 2500, 3000

5.3 Dispersion Modelling Configuration

CALPUFF is an advanced non-steady-state meteorological and air quality modelling system. The model advects 'puffs' of material emitted from modelled sources, simulating the dispersion and transformation processes along the way. The model has been adopted by the U.S. Environmental Protection Agency (U.S. EPA) in its guideline on air quality models. CALPUFF uses the 3D wind fields generated by CALMET with the primary output files from CALPUFF processed in CALPOST to produce time based concentration or deposition fluxes evaluated at selected receiver locations.

Particulate concentrations were simulated for a regular Cartesian receiver grid covering a 15 km by 15 km computational domain, set within the CALMET modelling domain with a grid resolution of 0.15 km.

Section 5.5 outlines the assumptions made for the AQIA. **Appendix I** contains example CALMET and CALPOST input files.

5.4 Modelling Scenarios

The Pearlman quarry operations are to proceed as per the project description outlined in **Section 2.3.** The maximum export modelling ('worst case') scenario has been undertaken on the assumptions presented in **Section 5.5** and **Section 5.5.2**. An additional modelling scenario is also presented to represent the 'average export' with assumptions presented in **Section 5.5.3**.

Dispersion modelling has been undertaken for the entire 2015 calendar year. All modelling scenarios were conservatively assumed to be operating at the annual operating limit of 490,000 metric tonnes. Dispersion modelling was also undertaken to include the existing quarry on the same site (Tikitere Quarry) to address potential cumulative impacts. Assumptions for this existing quarry are outlined in **Section 5.5.4**

5.5 Assumptions

Assumptions used in the computation of GLCs and deposition for particulates using the CALPUFF dispersion model are listed below:

5.5.1 General

The following assumptions have been applied to the dispersion modelling of the Pearlman and Tikitere quarries. Any assumptions which are specific to various scenarios are listed in **Section 5.5.2** to **Section 5.5.4**.

- Options within CALPUFF modelling reflect the *NSW OEH Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System guidelines* (refer **Section** 8, *Reference 3*).
- Appropriate emission factors from the Emission Estimation Technique (EET) Manual for Mining - Version 3.1 (refer **Section 8**, *Reference 4*) and AP-42 Air Pollutant Emission Factors 1 (refer **Section 8**, *Reference 8*) have been applied to all quarry emission sources.
- *The operating times for Pearlman Quarry are* as follows:
  - Monday to Friday: 6 am to 6 pm.
  - Saturday: 6 am to 1 pm.
  - Sundays and Public Holidays: Closed.

- The Pearlman Quarry extraction area is as per Conceptual Final Landform document provided by GroundWork Plus (refer to **Figure 2**). The quarry area is estimated at 92,500 m^2.
- The annual average extraction rate for the Pearlman Quarry operation is 1,781 tonnes of material per day. To account for fluctuations Advitech has conservatively modelled emissions-to-air on the basis of 1,818 metric tonnes of material per day.
- For dust deposition modelling, a geometric mass mean diameter (GMMD) of 12.8 µm for TSP and 7 µm for PM_{10} with geometric standard deviation (GSD) of 1.7 µm for TSP and 1.3 µm for PM_{10} respectively was applied (refer **Section** 8, *Reference 5*).
- A $PM_{2.5}$ to PM_{10} ratio of 0.15 and 0.1 has been applied to material handling and wheel generated emission sources respectively (refer **Section** *8, Reference 10).*
- Wheel generated dust from haul trucks within the quarry extraction area were modelled as multiple volume sources in CALPUFF. Each volume source has a separation distance of less than one quarter of the distance to the nearest residential receiver (i.e. 300 m). Particulate emissions were equally divided between volume sources.
- The number of vehicle kilometres travelled is calculated on the unpaved haul route separating the extraction area and the stockpiling area (Haul Road 'A') and the road from the stockpiling area out to Croppa Creek Road (Haul Road 'B') (refer to **Figure 2**).
- The haul road connecting the stockpiling area to Croppa Creek Road (Haul Road 'B') will be used less frequently (i.e. 20% less) than the extraction area to stockpile haul road. This is to account for some of the extracted material leaving the site via rail (refer **Section** 8, Reference 6).
- The entire aforementioned quarry extraction area is assumed to be blasted. The implemented blasting frequency was conservatively assumed at one hour of blasting per day. This assumption grants the blasting operators the flexibility to undertake blasting activities any day of the year rather than confining them to a particular day per week or per month. As advised by Groundwork Plus, the maximum blast frequency is likely to occur once per fortnight. The blasting parameters were based on the blast design parameters provided by Groundwork Plus (refer **Section** 8, Reference 7).

5.5.2 Maximum Export Scenario

- During peak demand it is possible up to 132 laden trucks (i.e. a total of 264 vehicle movements) per day may exit the quarry. To accommodate maximum exports to road during these periods, Advitech has modelled emissions-to-air based on this maximum export scenario.
- Emission control factors (i.e. water sprays) have been applied to the following equipment:
  - Drill rig (refer **Section 8**, *Reference 4*);
  - Primary and secondary jaw crusher (refer **Section 8**, *Reference 8*); and
  - Vibrating screen (refer **Section 8**, *Reference 8*).
- Level 2 watering (i.e. >2 litres/m^2/h) 75% control factor applied on the main internal export haul road exiting the site to Croppa Creek Road. Level 1 watering (i.e. 2 litres/m^2/h) 50% control factor on all other internal haul roads.

5.5.3 Average Export Scenario

- The scenario is designed to model emissions-to-air based on an average export scenario. In this scenario 43 laden trucks (i.e. a total of 86 vehicle movements) per day were modelled exporting extracted materials to road.
- Emission control factors (i.e. water sprays) have been applied to the following equipment:
  - Drill rig (refer **Section 8**, *Reference 4*);
  - Primary and secondary jaw crusher (refer **Section 8**, *Reference 8*); and
  - Vibrating screen (refer **Section 8**, *Reference 8*).
- Level 1 watering (i.e. 2 litres/m²/h) 50% control factor on all internal haul roads.

5.5.4 Cumulative Modelling (Tikitere Quarry)

The existing Tikitere Quarry at 1135 Croppa Creek Road, North Star was modelled using the following assumptions:

- Quarry operations have been modelled based on year 2021 maximum extraction rate of 1,333 metric tonnes of basalt material per day. This equates to an annual extraction rate of 400,000 t/year (refer **Section** 8, Reference 11).
- Plant equipment and emission control factors identical to that used in the Pearlman Quarry.
- The operating times for site quarry activities are as follows:
  - Monday to Friday: 6 am to 6 pm. Saturday 6 am to 1 pm.
  - Sundays and Public Holidays: Closed.
- The number of vehicle kilometres travelled (2.8 km per one-way trip) is calculated on the unpaved haul route between the extraction areas and the main road, i.e. Croppa Creek Road.
- Level 1 watering (i.e. 2 litres/m²/h) control factor on all internal haul roads.

5.6 Emission Sources

The activities associated with the proposed operations with the potential to generate dust are:

- Blasting and drilling operations within the proposed quarry extraction area;
- Operation of front-end loader and excavator within the extraction area;
- Operation of the grader, primary crusher, secondary crusher and screen;
- Wind erosion from stockpiled quarry materials; and
- Dust generated by haul truck movements along internal access roads, from the extraction area to the stockpile and from the stockpile to Croppa Creek Road.

Details of each emission source are given in **Table 6** and **Table 7**. The emission factors and estimates are based on Emission Estimation Technique (EET) Manual for Mining - Version 3.1 (refer **Section 8**, *Reference 4*) and AP-42 Air Pollutant Emission Factors 1 (refer **Section 8**, *Reference 8*). Emissions from these manuals are based on typical emission for coal mining, metalliferous mining operations and crushed stone processing. The emission factors have been applied to the quarry operation and can be considered as a conservative estimate.

Table 6: Maximum Scenario Emission Sources

Emitter Identifier	Emitter Name	Emission Factor			Modelled days (Days)	Modelled Working hours (hours/day)[1]	Emission Rate(g/s)[2]			Modelled Location[3]		
		TSP	PM_{10}	Units			TSP	PM_{10}	$PM_{2.5}$	Easting (m)	Northing (m)	Ground Elevation (m)
Grader	Grader	0.19	0.085	kg/VKT[8]	275	11	0.109	0.049	0.007	242324	6787253	325
Drill	Drill	0.59	0.310	kg/hole	275	11	0.012	0.006	0.001	242348	6787250	331
Excav	Excavator	0.03	0.012	kg/t	275	11	1.263	0.606	0.091	242076	6787500	322
FEL	Front end loader	0.0014	0.00067	kg/t	275	11	0.178	0.084	0.013	240220	6787566	301
Crush1	Jaw Crusher	0.0006	0.0003	kg/t	275	11	0.030	0.014	0.003	242137	6787469	321
Crush2	Secondary Crusher	0.0006	0.0003	kg/t	275	11	0.030	0.014	0.003	242115	6787480	320
Screen	Screen	0.0011	0.00037	kg/t	275	11	0.056	0.019	0.001	242115	6787461	319
Erosion	Wind Erosion from stockpiles	0.40	0.20	kg/ha/hr	365	24	1.028	0.514	0.077	240220	6787566	301
Blast[4]	Blasting	0.81	0.422	kg/blast	275	1	0.226	0.117	0.018	242345	6787261	331
HRA1-HRA13[5]	Wheel generated dust from truck movements[7]	2.88	0.777	kg/VKT[8]	275	11	11.347	3.063	0.460	Varies	Varies	Varies
HRB1-HRB10[6]		2.88	0.777	kg/VKT[8]	275	11	13.808	3.728	0.559	Varies	Varies	Varies

Notes:
[1] - Weekday operating hours based on 6 am to 6 pm. With 1 hour of downtime per day. Saturday operating hours based on 6 am to 1 pm. No operations on Sunday. Actual operating hours are likely to be less.
[2] - Shaded cells indicate emission controls (i.e. water sprays) applied. Refer to **Section 5.5.2.**
[3] - Plant equipment location is based on the centre of the quarry extraction footprint.

Additional Notes:
[4] - Blasting is assumed to occur at 2 pm on every operational day to enable the flexibility of choosing any day of the month for blasting.
[5] - Haul Road A modelled with Level 1 watering mitigation control factor.
[6] - Haul Road B modelled with Level 2 watering mitigation control factor.
[7] - Kilometres travelled by haul trucks estimated from Google Earth satellite imagery. Wheel generated dust from haul trucks were modelled as a volume source in CALPUFF. Each volume source has a separation distance of 300 metres.
[8] - Vehicle Kilometres Travelled.

Table 7: Average Export Scenario Emission Sources

Emitter Identifier	Emitter Name	Emission Factor			Modelled days (Days)	Modelled Working hours (hours/day)[1]	Emission Rate(g/s)[2]			Modelled Location[3]		
		TSP	PM_{10}	Units			TSP	PM_{10}	$PM_{2.5}$	Easting (m)	Northing (m)	Ground Elevation (m)
Grader	Grader	0.19	0.085	kg/VKT[8]	275	11	0.109	0.049	0.007	242324	6787253	325
Drill	Drill	0.59	0.310	kg/hole	275	11	**0.012**	**0.006**	**0.001**	242348	6787250	331
Excav	Excavator	0.03	0.012	kg/t	275	11	1.263	0.606	0.091	242076	6787500	322
FEL	Front end loader	0.0014	0.00067	kg/t	275	11	0.178	0.084	0.013	240220	6787566	301
Crush1	Jaw Crusher	0.0006	0.0003	kg/t	275	11	**0.030**	**0.014**	**0.003**	242137	6787469	321
Crush2	Secondary Crusher	0.0006	0.0003	kg/t	275	11	**0.030**	**0.014**	**0.003**	242115	6787480	320
Screen	Screen	0.0011	0.00037	kg/t	275	11	**0.056**	**0.019**	**0.001**	242115	6787461	319
Erosion	Wind Erosion from stockpiles	0.40	0.20	kg/ha/hr	365	24	1.028	0.514	0.077	240220	6787566	301
Blast[4]	Blasting	0.81	0.422	kg/blast	275	1	0.226	0.117	0.018	242345	6787261	331
HRA1-HRA13[5]	Wheel generated dust from truck movements[7]	2.88	0.777	kg/VKT[8]	275	11	**11.347**	**3.063**	**0.460**	Varies	Varies	Varies
HRB1-HRB10[6]		2.88	0.777	kg/VKT[8]	275	11	**9.205**	**2.485**	**0.373**	Varies	Varies	Varies

Notes:
[1] - Weekday operating hours based on 6 am to 6 pm. With 1 hour of downtime per day. Saturday operating hours based on 6 am to 1 pm. No operations on Sunday. Actual operating hours are likely to be less.
[2] - Shaded cells indicate emission controls (i.e. water sprays) applied. Refer to **Section 5.5.2.**
[3] - Plant equipment location is based on the centre of the quarry extraction footprint.
Additional Notes:
[4] - Blasting is assumed to occur at 2 pm on every operational day to enable the flexibility of choosing any day of the month for blasting.
[5] - Haul Road A modelled with Level 1 watering mitigation control factor.
[6] - Haul Road B modelled with Level 1 watering mitigation control factor.
[7] - Kilometres travelled by haul trucks estimated from Google Earth satellite imagery. Wheel generated dust from haul trucks were modelled as a volume source in CALPUFF. Each volume source has a separation distance of 300 metres.
[8] - Vehicle Kilometres Travelled.

6. DISPERSION MODELLING RESULTS

6.1 Maximum Export Modelling Scenario

The predicted cumulative concentrations at selected sensitive receivers of the annual average PM_{10}, $PM_{2.5}$ and TSP for the Pearlman and Tikitere quarries are presented in **Table 8**.

The subsequent modelling of particulate impacts on sensitive receivers are shown in **Section 6.1.1** to **Section 6.1.4**. Contour plots for each assessment criteria are presented in **Appendix II.**

6.1.1 Annual Average PM_{10}, $PM_{2.5}$, TSP

Table 8: Predicted Cumulative Annual Average PM_{10}, $PM_{2.5}$ and TSP at Sensitive Receivers during maximum export

Receiver	Predicted Annual Average PM_{10} +Tikitere+ Background (µg/m³)	Predicted Annual Average $PM_{2.5}$ + Tikitere+ Background (µg/m³)	Predicted Annual Average TSP + Tikitere+ Background (µg/m³)
Background[1]	18.3	5.8	36.3
R1	20.50	6.13	42.22
R2	18.70	5.86	37.46
R3	19.18	5.93	39.07
R4	18.78	5.88	37.77
R5	18.64	5.85	37.34
R6	18.76	5.87	37.77
R7	18.72	5.86	37.59
R8	18.58	5.84	37.19
R9	18.66	5.85	37.33

[1] - Background particulate concentrations obtained from the QLD DES monitoring station at Jondaryan

Table 8 presents the predicted cumulative 100th percentile annual average PM_{10}, $PM_{2.5}$ and TSP for sensitive receivers respectively for the maximum export scenario. The annual PM_{10}, $PM_{2.5}$ and TSP impact assessment criteria are not exceeded at any sensitive receiver.

6.1.2 24 Hour Average PM_{10}

The predicted concentrations at selected sensitive receivers of the 24-hour average PM_{10} maximum increment for the Pearlman Quarry are presented in **Table 9**.

Table 9: Maximum Impact of 24 Hour Average PM_{10}

Receiver	Pearlman Quarry Maximum Predicted Increment (µg/m³)	Maximum Background Concentration (µg/m³)[1]	Tikitere Quarry Calculated Increment (µg/m³)	Total (µg/m³)
R1	16.61	45.6 (20/03/2015)	3.70	**65.91**
R2	9.91		2.37	**57.88**
R3	8.70		3.27	**57.57**
R4	5.23		1.21	**52.04**
R5	5.21		1.85	**52.66**
R6	11.58		2.07	**59.25**
R7	5.95		2.17	**53.72**
R8	4.73		1.38	**51.71**
R9	5.86		1.93	**53.39**

Notes:
[1] - The background concentration of 83.8 µg/m³ (refer to **Figure 5**) has been discounted as it is above the impact assessment criteria of 50 µg/m³. Therefore, the next highest value under the criteria (45.6 µg/m³) was used.

The exceedances at nearby sensitive receivers of the 24-hour average PM_{10} concentration presented in **Table 9** are a result of an elevated background PM_{10} concentration. A Level 2 contemporaneous impact and background assessment is required to determine any additional exceedances as a result of the proposed operation.

A summary of the 24-hour average PM_{10} contemporaneous impact and background assessment (Level 2 Assessment) for identified sensitive receivers are presented in **Table 10.**

Nine exceedances displayed in **Table 10** have been discounted due to a background concentration greater than the impact assessment criteria. There are no additional exceedances of the 24 hour PM_{10} impact assessment criteria at nearby sensitive receivers. It should be noted that there is one predicted cumulative value equivalent to the guideline criteria value (i.e. 50 µg/m³), however as it is not above the criteria this is not considered an exceedance.

Table 10: Summary of the 24 Hour Average PM_{10} Contemporaneous Impact and Background

Date	PM_{10} 24-hour average (µg/m³)[1]					Date	PM_{10} 24-hour average (µg/m³)				
	Highest Background	Calculated Increment - Existing Tikitere Quarry	Predicted Increment - Proposed Pearlman Quarry	Receiver	Total		Background	Calculated Increment - Existing Tikitere Quarry	Predicted Increment - Proposed Pearlman Quarry	Receiver	Total
5/07/2015	**83.8**	0.5	1.6	R6	**85.6**	15/07/2015	7.9	3.8	16.6	R1	28.8
20/08/2015	**75.9**	1.3	4.8	R1	**82.0**	29/09/2015	13.1	5.1	13.8	R1	32.0
4/05/2015	**65.1**	0.2	1.9	R6	**67.2**	27/05/2015	12.3	2.1	11.6	R6	26.0
5/05/2015	**62.7**	1.3	6.0	R1	**70.0**	27/02/2015	2.7	4.1	11.3	R1	18.1
9/06/2015	**61.2**	0.7	2.6	R6	**64.5**	10/07/2015	12.0	2.4	9.9	R2	24.3
6/10/2015	**59.9**	3.3	7.4	R3	**70.6**	16/04/2015	31.0	4.0	9.4	R1	44.4
7/10/2015	**57.3**	0.4	0.6	R2	**58.3**	03/11/2015	22.8	1.4	9.3	R1	33.5
5/10/2015	**56.6**	1.1	5.7	R6	**63.4**	28/05/2015	20.8	1.7	8.7	R3	31.2
20/03/2015	45.6	0.8	3.6	R1	50.0	26/05/2015	15.4	1.4	8.6	R6	25.4
21/03/2015	45.5	0.7	1.1	R1	47.3	26/08/2015	7.7	3.8	7.9	R1	19.4
6/09/2015	44.8	0.3	1.8	R1	46.9	29/08/2015	21.9	2.1	7.7	R1	31.7
19/03/2015	44.7	1.0	3.1	R4	48.8	10/08/2015	30.7	4.0	7.7	R1	42.4
15/03/2015	42.2	0.6	0.5	R1	43.3	30/09/2015	22.1	2.3	7.5	R1	31.9
4/07/2015	41.9	0.5	2.4	R1	44.8	06/10/2015	**59.9**	3.3	7.4	R3	**70.6**
30/07/2015	40.9	0.6	2.3	R2	43.8	20/05/2015	21.5	1.7	7.3	R6	30.5

Notes:
1 - No predicted 24 hour average PM_{10} recorded at any sensitive receiver.
2 - Highlighted fields indicate predicted exceedance discounted as 24 hour average PM_{10} was already at the NSW EPA impact criteria.

6.1.3 24 Hour Average $PM_{2.5}$

The predicted concentrations at selected sensitive receivers of the 24-hour average $PM_{2.5}$ for the proposed operation are presented in **Table 11**. A maximum 24-hour $PM_{2.5}$ background concentration of 19.4 µg/m³ has been applied (refer to **Table 4**) to determine if further assessment is required.

Table 11: Predicted Maximum 24 Hour Average $PM_{2.5}$ at Sensitive Receivers

Receiver	Pearlman Quarry Maximum Predicted Increment (µg/m³)	Maximum Background Concentration (µg/m³)[1]	Tikitere Quarry Predicted Increment (µg/m³)	Total (µg/m³)
R1	2.49		0.55	22.44
R2	1.49		0.36	21.25
R3	1.3		0.49	21.19
R4	0.78		0.18	20.36
R5	0.78	19.4 µg/m³ (17/07/2015)	0.28	20.46
R6	1.74		0.31	21.45
R7	0.89		0.32	20.61
R8	0.71		0.21	20.32
R9	0.88		0.29	20.57

Notes:
[1] - The background concentration of 36.3 µg/m³ (refer to **Figure 5**) has been discounted as it is above the impact assessment criteria of 25 µg/m³. Therefore, the next highest value under the criteria (19.4 µg/m³) was used.

No additional exceedances at nearby sensitive receivers of the 24-hour average $PM_{2.5}$ concentration presented in **Table 11** were recorded. Therefore, further analysis of 24-hour average $PM_{2.5}$ concentration is not required.

6.1.4 Dust Deposition

The predicted annual average dust deposition rates at selected sensitive receivers for the proposed operation are presented in **Table 12**.

Table 12: Predicted Cumulative Dust Deposition at Sensitive Receivers

Receiver	Subject Site Maximum Predicted Increment (g/m²/month)	Impact Assessment Criteria
R1	0.1	
R2	0.0	
R3	0.0	
R4	0.0	
R5	0.0	2 g/m²/month
R6	0.0	
R7	0.0	
R8	0.0	
R9	0.0	

There are no exceedances of the maximum increase in deposited dust level criteria of 2 g/m^2/month at nearby sensitive receivers. According to the NSW EPA guidance, mitigation measures or emission controls that reduce emissions are not required.

6.2 Average Export Modelling Scenario

The scenario is designed to model emissions-to-air based on an 'average export' to roads scenario. Details of modelling set up and scenario assumptions are presented in **Section 5.5.3**.

The subsequent modelling of particulate impacts on sensitive receivers are shown in **Section 6.2.1** to **Section 6.2.4**. Contour plots for each assessment criteria are presented in **Appendix II.**

6.2.1 Annual Average PM_{10}, $PM_{2.5}$, TSP

The predicted cumulative concentrations at selected sensitive receivers of the annual average PM_{10}, $PM_{2.5}$ and TSP for the proposed operation with emission controls are presented in **Table 13**.

Table 13: Predicted Cumulative Annual Average PM_{10}, $PM_{2.5}$ and TSP at Sensitive Receivers during average export

Receiver	Predicted Annual Average PM_{10}+ Tikitere+ Background (µg/m^3)	Predicted Annual Average $PM_{2.5}$ + Tikitere+ Background (µg/m^3)	Predicted Annual Average TSP + Tikitere+ Background (µg/m^3)
Background[1]	18.3	5.8	36.6
R1	20.50	6.13	42.26
R2	18.69	5.86	37.46
R3	19.16	5.93	39.05
R4	18.76	5.87	37.73
R5	18.63	5.85	37.31
R6	18.73	5.87	37.71
R7	18.71	5.86	37.55
R8	18.57	5.84	37.17
R9	18.65	5.86	37.32

[1] - Background particulate concentrations for PM_{10} and $PM_{2.5}$ obtained from the QLD DES monitoring station at Jondaryan.

Table 13 presents the predicted cumulative 100th percentile annual average PM_{10}, $PM_{2.5}$ and TSP for sensitive receivers respectively for the average export scenario. An annual average background PM_{10}, $PM_{2.5}$ and TSP concentration has been applied (refer to **Table 4**) to determine if further assessment is required.

The annual average PM_{10}, $PM_{2.5}$ and TSP impact assessment criteria are not exceeded at any sensitive receivers. According to the NSW EPA guidance, no additional assessment of annual average PM_{10}, $PM_{2.5}$ and TSP is required.

6.2.2 24 Hour Average PM_{10}

The predicted concentrations at selected sensitive receivers of the 24-hour average PM_{10} maximum increment for the proposed operation are presented in **Table 14**.

Table 14: Maximum Impact of 24 Hour Average PM_{10}

Receiver	Pearlman Quarry Maximum Predicted Increment (µg/m³)	Maximum Background Concentration (µg/m³)	Tikitere Quarry Calculated Increment (µg/m³)	Total (µg/m³)
R1	15.23	45.6 µg/m³ (20/03/2015)	5.09	**65.92**
R2	8.76		3.24	**57.6**
R3	6.71		4.22	**56.53**
R4	4.31		1.51	**51.42**
R5	4.49		2.32	**52.41**
R6	9.69		3.08	**58.37**
R7	5.15		2.69	**53.44**
R8	4.38		1.74	**51.72**
R9	5.13		2.49	**53.22**

Notes:
[1] - The background concentration of 83.8 µg/m³ (refer to **Figure 5**) has been discounted as it is above the impact assessment criteria of 50 µg/m³. Therefore, the next highest value under the criteria (45.6 µg/m³) was used.

The exceedances at nearby sensitive receivers of the 24-hour average PM_{10} concentration presented in **Table 14** are a result of an elevated background PM_{10} concentration. A Level 2 contemporaneous impact and background assessment is required to determine any additional exceedances as a result of the proposed operation.

A summary of the 24-hour average PM_{10} contemporaneous impact and background assessment (Level 2 Assessment) for identified sensitive receivers are presented in **Table 15.**

Nine exceedances displayed in **Table 15** have been discounted due to a background concentration greater than the impact assessment criteria. There are no additional exceedances of the 24 hour PM_{10} impact assessment criteria at nearby sensitive receivers.

Table 15: Summary of the 24 Hour Average PM_{10} Contemporaneous Impact and Background

Date	PM_{10} 24-hour average (µg/m³)[1]					Date	PM_{10} 24-hour average (µg/m³)				
	Highest Background	Calculated Increment - Existing Tikitere Quarry	Predicted Increment - Proposed Pearlman Quarry	Receiver	Total		Background	Calculated Increment - Existing Tikitere Quarry	Predicted Increment - Proposed Pearlman Quarry	Receiver	Total
5/07/2015	**83.8**	0.5	1.6	R6	**85.9**	15/07/2015	7.9	3.8	15.2	R1	26.9
20/08/2015	**75.9**	1.3	4.8	R1	**82.0**	29/09/2015	13.1	5.1	12.7	R1	30.9
4/05/2015	**65.1**	0.4	1.5	R6	**67.0**	27/02/2015	2.7	4.1	10.6	R1	17.4
5/05/2015	**62.7**	1.3	5.7	R1	**69.7**	27/05/2015	12.3	3.1	9.7	R6	25.1
9/06/2015	**61.2**	0.8	2.4	R6	**64.4**	10/07/2015	12.0	3.2	8.8	R2	24.0
6/10/2015	**59.9**	4.2	6.7	R3	**70.8**	16/04/2015	31.0	4.0	8.8	R1	43.8
7/10/2015	**57.3**	0.4	0.6	R1	**58.3**	3/11/2015	22.8	1.4	8.7	R1	32.9
5/10/2015	**56.6**	1.5	4.7	R6	**62.8**	25/07/2015	32.7	0.9	7.1	R1	40.7
20/03/2015	45.6	0.8	3.5	R1	49.9	26/08/2015	7.7	3.8	7.1	R1	18.6
21/03/2015	45.5	0.7	1.1	R1	47.3	29/05/2015	21.9	2.1	7.1	R1	31.1
6/09/2015	44.8	0.3	1.8	R1	46.9	26/05/2015	15.4	2.2	7.0	R6	24.6
19/03/2015	44.7	1.3	2.7	R4	48.7	10/08/2015	30.7	4.0	7.0	R1	41.7
15/03/2015	42.2	0.6	0.5	R1	43.3	30/09/2015	22.1	2.3	6.8	R1	31.2
4/07/2015	41.9	0.6	2.4	R1	44.9	6/10/2015	**59.9**	4.2	6.7	R3	**70.8**
30/07/2015	40.9	0.6	2.2	R1	43.7	14/12/2015	16.7	0.9	6.7	R1	24.3

Notes:
[1] - No predicted 24 hour average PM_{10} recorded at any sensitive receiver.
[2] - Highlighted fields indicate predicted exceedance discounted as 24 hour average PM_{10} was already at the NSW EPA impact criteria.

6.2.3 24 Hour Average $PM_{2.5}$

The predicted concentrations at selected sensitive receivers of the 24-hour average $PM_{2.5}$ for the proposed operation are presented in **Table 11**. A maximum 24-hour $PM_{2.5}$ background concentration of 24.0 µg/m³ has been applied (refer to **Table 4**) to determine if further assessment is required.

Table 16: Predicted Maximum 24 Hour Average $PM_{2.5}$ at Sensitive Receivers

Receiver	Pearlman Quarry Maximum Predicted Increment (µg/m³)	Maximum Background Concentration (µg/m³)[1]	Tikitere Quarry Predicted Increment (µg/m³)	Total (µg/m³)
R1	2.28	19.4 µg/m³ (17/07/2015)	0.76	22.44
R2	1.31		0.49	21.2
R3	1.01		0.63	21.04
R4	0.65		0.23	20.28
R5	0.67		0.35	20.42
R6	1.45		0.46	21.31
R7	0.77		0.4	20.57
R8	0.66		0.26	20.32
R9	0.77		0.37	20.54

Notes:
[1] - The background concentration of 36.3 µg/m³ (refer to **Figure 5**) has been discounted as it is above the impact assessment criteria of 25 µg/m³. Therefore, the next highest value under the criteria (19.4 µg/m³) was used.

No additional exceedances at nearby sensitive receivers of the 24-hour average $PM_{2.5}$ concentration presented in **Table 16** were recorded. Therefore, further analysis of 24-hour average $PM_{2.5}$ concentration is not required.

6.2.4 Dust Deposition

The predicted annual average dust deposition rates at selected sensitive receivers for the proposed operation are presented in **Table 17**.

Table 17: Predicted Cumulative Dust Deposition at Sensitive Receivers

Receiver	Subject Site Maximum Predicted Increment (g/m²/month)	Impact Assessment Criteria
R1	0.1	2 g/m²/month
R2	0.0	
R3	0.0	
R4	0.0	
R5	0.0	
R6	0.0	
R7	0.0	
R8	0.0	
R9	0.0	

There are no exceedances of the maximum increase in deposited dust level criteria of 2 g/m^2/month at nearby sensitive receivers. According to the NSW EPA guidance, mitigation measures or emission controls that reduce emissions are not required.

6.3 Discussion

The particulate dispersion modelling indicates that air quality impacts (i.e. airborne dust) from the proposed Pearlman Quarry will not cause additional exceedances of the PM_{10}, $PM_{2.5}$ or TSP impact assessment criteria at sensitive receivers for the two scenarios presented in this report. The dispersion modelling indicates that elevated particulate impacts at Receivers R1, R2, R3, and R6 are the result of elevated background dust concentrations.

7. CONCLUSIONS AND RECOMMENDATIONS

Advitech modelled two scenarios to assess the potential particulate impacts to sensitive receivers for the proposed Pearlman Quarry; one detailing a maximum export to roads scenario and the other detailing average export to roads scenario. The results of the CALPUFF modelling indicate that the operation of the Pearlman Quarry will result in incremental increases in particulate matter or dust deposition at surrounding sensitive receivers. However, these increases are predicted not to result in any additional exceedances of the NSW EPA assessment criteria for TSP, PM_{10}, $PM_{2.5}$ or dust deposition. The air quality impact assessment has also considered emissions to air from the adjacent Tikitere Quarry. As advised by Groundwork Plus, the Tikitere Quarry is scheduled to close at the end of 2021. It is expected that air quality will improve after year 2021 due to the cessation of air emissions from this quarry.

An assessment of cumulative air quality impacts indicates that quarry operations will be below NSW EPA guidelines. Any exceedances that may occur will be likely attributed to elevated background concentrations rather than significant incremental contribution from the proposed quarry development.

To mitigate the potential particulate impacts from the quarry operations, Advitech recommends the following measures to be implemented:

- An air quality management plan (AQMP) to ensure effective management and measurement of particulate emissions.
- Enforce a maximum speed of 40 km/hr on unsealed haul and internal roads.
- Apply water sprays on trafficable areas (approx. rate 2 $L/m^2/hr$) as required during normal operations.
- Increase water sprays (greater than 2 $L/m^2.hr$) during periods of peak export to roads.
- Apply water sprays or other suitable alternative on processing plant and equipment to maintain material in a moistened state.

8. REFERENCES

1. NSW EPA, 2016. *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales.*
2. QLD DES, Air Quality Monitoring Network accessed via https://data.qld.gov.au/dataset/air-quality-monitoring-2015 on 5 August 2019.

3. NSW OEH, 2011. *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia'.*

4. Department of Sustainability, Environment, Water, Population and Communities, 2012. *Emission Estimation Technique (EET) Manual for Mining - Version 3.1.*

5. Midwest Research Institute, 2006. *Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emission Factors.*

6. Groundwork Plus consultants supplied information, drawings and plans.

7. Groundwork Plus, 2019. 2291_181109_Advitech GP Tikitere AQIA NIA Info Request.

8. Air Control Techniques, P.C., 2003. *Background document for Revised AP-42 Section 11.19.2, Crushed Stone Processing and Pulverised Mineral Processing.* Retrieved from https://www3.epa.gov/ttn/chief/ap42/ch11/bgdocs/b11s1902.pdf on 06 June 2019.

9. Dyno Nobel, 2010. *Blasting and Explosives Quick Reference Guide.* Retrieved from https://www.dynonobel.com/apac/~/media/Files/Dyno/ResourceHub/Brochures/APAC/Explosives%20Engineers%20Guide.pdf on 06 June 2019.

10. United States Environmental Protection Agency. *AP 42, Chapter 13: Miscellaneous Sources,* Volume 1, Fifth Edition.

11. Groundwork Plus, 2019 2291_DA1_305_006_Brief to Advitech Noise and Dust.

12. Bureau of Meteorology Climate Statistics accessed via http://www.bom.gov.au/climate/data/ on July 4.

APPENDIX I: Example CALPUFF Input File

```
CALPUFF.INP      2.0             File version record
Pearlman Quarry


---------------- Run title (3 lines) ------------------------------------------

                    CALPUFF MODEL CONTROL FILE
                    --------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names

--------------
Default Name  Type          File Name
------------  ----          ---------
CALMET.DAT    input    ! METDAT = C:\20107\Pearlman\calmet.dat
!
    or
ISCMET.DAT    input    * ISCDAT =                *
    or
PLMMET.DAT    input    * PLMDAT =                *
    or
PROFILE.DAT   input    * PRFDAT =                *
SURFACE.DAT   input    * SFCDAT =                *
RESTARTB.DAT  input    * RSTARTB=                *
-------------------------------------------------------------------------------
CALPUFF.LST   output   ! PUFLST = lvl2w296trrev4
_calpuff_dry.lst !
CONC.DAT      output   ! CONDAT = lvl2w296trrev4_calpuff.con !
DFLX.DAT      output   ! DFDAT = lvl2w296trrev4_calpuff.dry !
WFLX.DAT      output   * WFDAT = *

VISB.DAT      output   * VISDAT = *
TK2D.DAT      output   * T2DDAT = *
RHO2D.DAT     output   * RHODAT = *
RESTARTE.DAT  output   * RSTARTE=                *
-------------------------------------------------------------------------------
Emission Files
--------------
PTEMARB.DAT   input    * PTDAT  =                *
VOLEMARB.DAT  input    ! VOLDAT = C:\20107\Pearlman\lvl 2
watering\lvl2watering_Rev4_dry.DAT!
BAEMARB.DAT   input    * ARDAT  =                *
LNEMARB.DAT   input    * LNDAT  =                *
-------------------------------------------------------------------------------
Other Files
-----------
OZONE.DAT     input    * OZDAT  =                *
VD.DAT        input    * VDDAT  =                *
CHEM.DAT      input    * CHEMDAT=                *
AUX           input    * AUXEXT =                *
```



```
(Extension added to METDAT filename(s) for files
 with auxiliary 2D and 3D data)
H2O2.DAT      input    * H2O2DAT=                *
NH3Z.DAT      input    * NH3ZDAT=                *
HILL.DAT      input    * HILDAT=                *
HILLRCT.DAT   input    * RCTDAT=                *
COASTLN.DAT   input    * CSTDAT=                *
FLUXBDY.DAT   input    * BDYDAT=                *
BCON.DAT      input    * BCNDAT=                *
DEBUG.DAT     output   * DEBUG =                *
MASSFLX.DAT   output   * FLXDAT=                *
MASSBAL.DAT   output   * BALDAT=                *
FOG.DAT       output   * FOGDAT=                *
RISE.DAT      output   * RISDAT=                *
-------------------------------------------------------------------------------
All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to
UPPER CASE
         T = lower case      ! LCFILES = T !
         F = UPPER CASE
NOTE: (1) file/path names can be up to 132 characters in
length


Provision for multiple input files
----------------------------------

     Number of Modeling Domains (NMETDOM)
                                        Default: 1        !
NMETDOM =   1   !

     Number of CALMET.DAT files for run (NMETDAT)
                                        Default: 1        !
NMETDAT = 1 !

     Number of PTEMARB.DAT files for run (NPTDAT)
                                        Default: 0        ! NPTDAT
=   0   !

     Number of BAEMARB.DAT files for run (NARDAT)
                                        Default: 0        ! NARDAT
=   0   !

     Number of VOLEMARB.DAT files for run (NVOLDAT)
                                        Default: 0        !
NVOLDAT =   0   !

!END!

-------------
Subgroup (0a)
-------------

  Provide a name for each CALMET domain if NMETDOM > 1
  Enter NMETDOM lines.
                                  a,b
```

```
Default Name             Domain Name
------------             ------------
 none                  * DOMAIN=     *    *END*


  The following CALMET.DAT filenames are processed in sequence
  if NMETDAT > 1

  Enter NMETDAT lines, 1 line for each file name.

                                           a,c,d
Default Name  Type           File Name
------------  ----           ---------
 none         input     * METDAT=  *     *END*
-------------
    a
     The name for each CALMET domain and each CALMET.DAT file
is treated
     as a separate input subgroup and therefore must end with
an input
                group(terminator.
    b
     Use DOMAIN1= to assign the name for the outermost CALMET
domain.
     Use DOMAIN2= to assign the name for the next inner CALMET
domain.
     Use DOMAIN3= to assign the name for the next inner CALMET
domain, etc.
      --------------------------------------------------------
------------
      |   When inner domains with equal resolution (grid-cell
size)      |
      |   overlap, the data from the FIRST such domain in the
list will  |
      |   be used if all other criteria for choosing the
controlling     |
      |   grid domain are inconclusive.
|
      --------------------------------------------------------
------------
    c
     Use METDAT1= to assign the file names for the outermost
CALMET domain.
     Use METDAT2= to assign the file names for the next inner
CALMET domain.
     Use METDAT3= to assign the file names for the next inner
CALMET domain, etc.
    d
     The filenames for each domain must be provided in
sequential order

-------------
Subgroup (0b)
-------------

  The following PTEMARB.DAT filenames are processed if NPTDAT>
0
```



```
  (Each file contains a subset of the sources, for the entire
simulation)

Default Name  Type          File Name
------------  ----          ---------
 none         input       * PTDAT=      *    *END*


-------------
Subgroup (0c)
-------------

  The following BAEMARB.DAT filenames are processed if NARDAT>
0
  (Each file contains a subset of the sources, for the entire
simulation)

Default Name  Type          File Name
------------  ----          ---------
 none         input       * ARDAT=      *    *END*


-------------
Subgroup (0d)
-------------

  The following VOLEMARB.DAT filenames are processed if
NVOLDAT>0
  (Each file contains a subset of the sources, for the entire
simulation)

Default Name  Type          File Name
------------  ----          ---------
 none         input       * VOLDAT=     *    *END*

--------------------------------------------------------------
------------------

INPUT GROUP: 1 -- General run control parameters
--------------

    Option to run all periods found
    in the met. file     (METRUN)   Default: 0        ! METRUN
= 1 !

         METRUN = 0 - Run period explicitly defined below
         METRUN = 1 - Run all periods in met. file

     Starting date:    Year   (IBYR)  --    No default   !
IBYR = 2011 !
                       Month  (IBMO)  --    No default   !
IBMO = 1 !
                       Day    (IBDY)  --    No default   !
IBDY = 1 !
     Starting time:    Hour   (IBHR)  --    No default   !
IBHR = 0 !
```

```
                         Minute (IBMIN) --     No default    !
IBMIN = 0 !
                         Second (IBSEC) --     No default    !
IBSEC = 0 !

     Ending date:        Year   (IEYR)  --     No default    !
IEYR = 2012 !
                         Month  (IEMO)  --     No default    !
IEMO = 1 !
                         Day    (IEDY)  --     No default    !
IEDY = 1 !
     Ending time:        Hour   (IEHR)  --     No default    !
IEHR = 0 !
                         Minute (IEMIN) --     No default    !
IEMIN = 0 !
                         Second (IESEC) --     No default    !
IESEC = 0 !

     (These are only used if METRUN = 0)

     Base time zone:          (ABTZ)  --     No default    !
ABTZ = UTC+1000 !
      (character*8)
     The modeling domain may span multiple time zones.  ABTZ
defines the
     base time zone used for the entire simulation.  This must
match the
     base time zone of the meteorological data.
     Examples:
         Los Angeles, USA           = UTC-0800
         New York, USA              = UTC-0500
         Santiago, Chile            = UTC-0400
         Greenwich Mean Time (GMT)  = UTC+0000
         Rome, Italy                = UTC+0100
         Cape Town, S.Africa        = UTC+0200
         Sydney, Australia          = UTC+1000

     Length of modeling time-step (seconds)
     Equal to update period in the primary
     meteorological data files, or an
     integer fraction of it (1/2, 1/3 ...)
     Must be no larger than 1 hour
     (NSECDT)                       Default:3600     ! NSECDT
=  3600  !
                                    Units: seconds

     Number of chemical species (NSPEC)
                                    Default: 5       ! NSPEC
= 3 !

     Number of chemical species
     to be emitted  (NSE)           Default: 3       ! NSE =
2 !

     Flag to stop run after
     SETUP phase (ITEST)            Default: 2       ! ITEST
=  2  !
```



```
     (Used to allow checking
     of the model inputs, files, étc.)
           ITEST = 1 - STOPS program after SETUP phase
           ITEST = 2 - Continues with execution of program
                       after SETUP

     Restart Configuration:

        Control flag (MRESTART)       Default: 0       !
MRESTART =  0   !

           0 = Do not read or write a restart file
           1 = Read a restart file at the beginning of
               the run
           2 = Write a restart file during run
           3 = Read a restart file at beginning of run
               and write a restart file during run

        Number of periods in Restart
        output cycle (NRESPD)         Default: 0       ! NRESPD
=  0   !

           0 = File written only at last period
          >0 = File updated every NRESPD periods

     Meteorological Data Format (METFM)
                                      Default: 1       ! METFM
=  1   !

           METFM = 1 - CALMET binary file (CALMET.MET)
           METFM = 2 - ISC ASCII file (ISCMET.MET)
           METFM = 3 - AUSPLUME ASCII file (PLMMET.MET)
           METFM = 4 - CTDM plus tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)
           METFM = 5 - AERMET tower file (PROFILE.DAT) and
                       surface parameters file (SURFACE.DAT)

     Meteorological Profile Data Format (MPRFFM)
            (used only for METFM = 1, 2, 3)
                                      Default: 1       ! MPRFFM
=  1   !

           MPRFFM = 1 - CTDM plus tower file (PROFILE.DAT)
           MPRFFM = 2 - AERMET tower file (PROFILE.DAT)

     PG sigma-y is adjusted by the factor (AVET/PGTIME)**0.2
     Averaging Time (minutes) (AVET)
                                      Default: 60.0    ! AVET =
60. !
     PG Averaging Time (minutes) (PGTIME)
                                      Default: 60.0    ! PGTIME
= 60. !

     Output units for binary concentration and flux files
     written in Dataset v2.2 or later formats
     (IOUTU)                          Default: 1       ! IOUTU
```

```
= 1   !
        1 = mass       -  g/m3 (conc) or g/m2/s (dep)
        2 = odour      -  odour_units (conc)
        3 = radiation  -  Bq/m3 (conc) or Bq/m2/s (dep)


     Output Dataset format for binary concentration
     and flux files (e.g., CONC.DAT)
     (IOVERS)                         Default: 2       ! IOVERS
= 2   !
        1 = Dataset Version 2.1
        2 = Dataset Version 2.2


!END!


-------------------------------------------------------------
-----------------

INPUT GROUP: 2 -- Technical options
--------------


     Vertical distribution used in the
     near field (MGAUSS)                   Default: 1     !
MGAUSS =  1   !
        0 = uniform
        1 = Gaussian

     Terrain adjustment method
     (MCTADJ)                              Default: 3     !
MCTADJ =  3   !
        0 = no adjustment
        1 = ISC-type of terrain adjustment
        2 = simple, CALPUFF-type of terrain
            adjustment
        3 = partial plume path adjustment

     Subgrid-scale complex terrain
     flag (MCTSG)                          Default: 0     !
MCTSG =  0   !
        0 = not modeled
        1 = modeled

     Near-field puffs modeled as
     elongated slugs? (MSLUG)              Default: 0     !
MSLUG =  0   !
        0 = no
        1 = yes (slug model used)

     Transitional plume rise modeled?
     (MTRANS)                              Default: 1     !
MTRANS =  1   !
        0 = no  (i.e., final rise only)
        1 = yes (i.e., transitional rise computed)
```



```
     Stack tip downwash? (MTIP)            Default: 1     !
MTIP =  1  !
        0 = no  (i.e., no stack tip downwash)
        1 = yes (i.e., use stack tip downwash)

     Method used to compute plume rise for
     point sources not subject to building
     downwash? (MRISE)                     Default: 1     !
MRISE =  1  !
        1 = Briggs plume rise
        2 = Numerical plume rise

     Method used to simulate building
     downwash? (MBDW)                      Default: 1     !
MBDW = 1 !
        1 = ISC method
        2 = PRIME method

     Vertical wind shear modeled above
     stack top (modified Briggs plume rise)?
     (MSHEAR)                              Default: 0     !
MSHEAR =  0  !
        0 = no  (i.e., vertical wind shear not modeled)
        1 = yes (i.e., vertical wind shear modeled)

     Puff splitting allowed? (MSPLIT)      Default: 0     !
MSPLIT =  0  !
        0 = no (i.e., puffs not split)
        1 = yes (i.e., puffs are split)

     Chemical mechanism flag (MCHEM)       Default: 1     !
MCHEM = 0 !
        0 = chemical transformation not
            modeled
        1 = transformation rates computed
            internally (MESOPUFF II scheme)
        2 = user-specified transformation
            rates used
        3 = transformation rates computed
            internally (RIVAD/ARM3 scheme)
        4 = secondary organic aerosol formation
            computed (MESOPUFF II scheme for OH)
        5 = user-specified half-life with or
            without transfer to child species
        6 = transformation rates computed
            internally (Updated RIVAD scheme with
            ISORROPIA equilibrium)
        7 = transformation rates computed
            internally (Updated RIVAD scheme with
            ISORROPIA equilibrium and CalTech SOA)

     Aqueous phase transformation flag (MAQCHEM)
     (Used only if MCHEM = 6, or 7)        Default: 0     !
MAQCHEM = 0 !
        0 = aqueous phase transformation
            not modeled
        1 = transformation rates and wet
```

```
            scavenging coefficients adjusted
            for in-cloud aqueous phase reactions
            (adapted from RADM cloud model
             implementation in CMAQ/SCICHEM)

     Liquid Water Content flag (MLWC)
     (Used only if MAQCHEM = 1)            Default: 1      !
MLWC =  1   !
        0 = water content estimated from cloud cover
            and presence of precipitation
        1 = gridded cloud water data read from CALMET
            water content output files (filenames are
            the CALMET.DAT names PLUS the extension
            AUXEXT provided in Input Group 0)

     Wet removal modeled ? (MWET)          Default: 1      !
MWET = 0 !
        0 = no
        1 = yes

     Dry deposition modeled ? (MDRY)       Default: 1      !
MDRY = 1 !
        0 = no
        1 = yes
        (dry deposition method specified
         for each species in Input Group 3)


     Gravitational settling (plume tilt)
     modeled ? (MTILT)                     Default: 0      !
MTILT =  0   !
        0 = no
        1 = yes
        (puff center falls at the gravitational
         settling velocity for 1 particle species)

     Restrictions:
         - MDRY  = 1
         - NSPEC = 1  (must be particle species as well)
         - sg    = 0  GEOMETRIC STANDARD DEVIATION in Group 8
is
                      set to zero for a single particle
diameter

     Method used to compute dispersion
     coefficients (MDISP)                  Default: 3      !
MDISP =  3   !

        1 = dispersion coefficients computed from measured
values
            of turbulence, sigma v, sigma w
        2 = dispersion coefficients from internally calculated
            sigma v, sigma w using micrometeorological
variables
            (u*, w*, L, etc.)
        3 = PG dispersion coefficients for RURAL areas
(computed using
```



```
            the ISCST multi-segment approximation) and MP
coefficients in
            urban areas
        4 = same as 3 except PG coefficients computed using
            the MESOPUFF II eqns.
        5 = CTDM sigmas used for stable and neutral
conditions.
            For unstable conditions, sigmas are computed as in
            MDISP = 3, described above.  MDISP = 5 assumes
that
            measured values are read

     Sigma-v/sigma-theta, sigma-w measurements used? (MTURBVW)
     (Used only if MDISP = 1 or 5)         Default: 3      !
MTURBVW =  3   !
        1 = use sigma-v or sigma-theta measurements
            from PROFILE.DAT to compute sigma-y
            (valid for METFM = 1, 2, 3, 4, 5)
        2 = use sigma-w measurements
            from PROFILE.DAT to compute sigma-z
            (valid for METFM = 1, 2, 3, 4, 5)
        3 = use both sigma-(v/theta) and sigma-w
            from PROFILE.DAT to compute sigma-y and sigma-z
            (valid for METFM = 1, 2, 3, 4, 5)
        4 = use sigma-theta measurements
            from PLMMET.DAT to compute sigma-y
            (valid only if METFM = 3)

     Back-up method used to compute dispersion
     when measured turbulence data are
     missing (MDISP2)                      Default: 3      !
MDISP2 =  3   !
     (used only if MDISP = 1 or 5)
        2 = dispersion coefficients from internally calculated
            sigma v, sigma w using micrometeorological
variables
            (u*, w*, L, etc.)
        3 = PG dispersion coefficients for RURAL areas
(computed using
            the ISCST multi-segment approximation) and MP
coefficients in
            urban areas
        4 = same as 3 except PG coefficients computed using
            the MESOPUFF II eqns.

     [DIAGNOSTIC FEATURE]
     Method used for Lagrangian timescale for Sigma-y
     (used only if MDISP=1,2 or MDISP2=1,2)
     (MTAULY)                              Default: 0      !
MTAULY =  0   !
        0 = Draxler default 617.284 (s)
        1 = Computed as Lag. Length / (.75 q) -- after SCIPUFF
       10 < Direct user input (s)             -- e.g., 306.9


     [DIAGNOSTIC FEATURE]
     Method used for Advective-Decay timescale for Turbulence
```

```
     (used only if MDISP=2 or MDISP2=2)
     (MTAUADV)                          Default: 0     !
MTAUADV =  0  !
        0 = No turbulence advection
        1 = Computed (OPTION NOT IMPLEMENTED)
       10 < Direct user input (s)   -- e.g., 800


     Method used to compute turbulence sigma-v &
     sigma-w using micrometeorological variables
     (Used only if MDISP = 2 or MDISP2 = 2)
     (MCTURB)                           Default: 1     !
MCTURB =  1  !
        1 = Standard CALPUFF subroutines
        2 = AERMOD subroutines

     PG sigma-y,z adj. for roughness?      Default: 0     !
MROUGH =  0  !
     (MROUGH)
        0 = no
        1 = yes

     Partial plume penetration of          Default: 1     !
MPARTL =  1  !
     elevated inversion modeled for
     point sources?
     (MPARTL)
        0 = no
        1 = yes

     Partial plume penetration of          Default: 1     !
MPARTLBA =  1  !
     elevated inversion modeled for
     buoyant area sources?
     (MPARTLBA)
        0 = no
        1 = yes

     Strength of temperature inversion     Default: 0     !
MTINV =  0  !
     provided in PROFILE.DAT extended records?
     (MTINV)
        0 = no (computed from measured/default gradients)
        1 = yes

     PDF used for dispersion under convective conditions?
                                        Default: 0     !
MPDF =  0  !
     (MPDF)
        0 = no
        1 = yes

     Sub-Grid TIBL module used for shore line?
                                        Default: 0     !
MSGTIBL = 0  !
     (MSGTIBL)
        0 = no
```



```
        1 = yes

     Boundary conditions (concentration) modeled?
                                           Default: 0     !
MBCON = 0  !
     (MBCON)
        0 = no
        1 = yes, using formatted BCON.DAT file
        2 = yes, using unformatted CONC.DAT file

     Note:  MBCON > 0 requires that the last species modeled
            be 'BCON'.  Mass is placed in species BCON when
            generating boundary condition puffs so that clean
            air entering the modeling domain can be simulated
            in the same way as polluted air.  Specify zero
            emission of species BCON for all regular sources.

     Individual source contributions saved?
                                           Default: 0     !
MSOURCE = 0  !
     (MSOURCE)
        0 = no
        1 = yes


     Analyses of fogging and icing impacts due to emissions
from
     arrays of mechanically-forced cooling towers can be
performed
     using CALPUFF in conjunction with a cooling tower
emissions
     processor (CTEMISS) and its associated postprocessors.
Hourly
     emissions of water vapor and temperature from each
cooling tower
     cell are computed for the current cell configuration and
ambient
     conditions by CTEMISS. CALPUFF models the dispersion of
these
     emissions and provides cloud information in a specialized
format
     for further analysis. Output to FOG.DAT is provided in
either
     'plume mode' or 'receptor mode' format.

     Configure for FOG Model output?
                                           Default: 0     !
MFOG =  0    !
     (MFOG)
        0 = no
        1 = yes  - report results in PLUME Mode format
        2 = yes  - report results in RECEPTOR Mode format


     Test options specified to see if
     they conform to regulatory
     values? (MREG)                        Default: 1     !
```

```
MREG =  0   !

        0 = NO checks are made
        1 = Technical options must conform to USEPA
            Long Range Transport (LRT) guidance
                       METFM    1 or 2
                       AVET     60. (min)
                       PGTIME   60. (min)
                       MGAUSS   1
                       MCTADJ   3
                       MTRANS   1
                       MTIP     1
                       MRISE    1
                       MCHEM    1 or 3 (if modeling SOx, NOx)
                       MWET     1
                       MDRY     1
                       MDISP    2 or 3
                       MPDF     0 if MDISP=3
                                1 if MDISP=2
                       MROUGH   0
                       MPARTL   1
                       MPARTLBA 0
                       SYTDEP   550. (m)
                       MHFTSZ   0
                       SVMIN    0.5 (m/s)


!END!

--------------------------------------------------------------
-----------------

INPUT GROUP: 3a, 3b -- Species list
-------------------

-------------
Subgroup (3a)
-------------

  The following species are modeled:
! CSPEC = PM10 !         !END!
! CSPEC = PM2.5 !         !END!
! CSPEC = TSP !          !END!

                                                     Dry
OUTPUT GROUP
    SPECIES          MODELED          EMITTED       DEPOSITED
NUMBER
     NAME        (0=NO, 1=YES)    (0=NO, 1=YES)     (0=NO,
(0=NONE,
   (Limit: 12                                        1
=COMPUTED-GAS         1=1st CGRUP,
    Characters                                       2
=COMPUTED-PARTICLE    2=2nd CGRUP,
    in length)                                       3=USER-
SPECIFIED)      3= etc.)
```



```
!       PM10=       1,                1,            2,
0   !
!      PM2.5=       1,                0,            0,
0   !
!        TSP=       1,                1,            2,
0   !

!END!

  Note:  The last species in (3a) must be 'BCON' when using
the
         boundary condition option (MBCON > 0).  Species BCON
should
         typically be modeled as inert (no chem transformation
or
         removal).


-------------
Subgroup (3b)
-------------
  The following names are used for Species-Groups in which
results
  for certain species are combined (added) prior to output.
The
  CGRUP name will be used as the species name in output files.
  Use this feature to model specific particle-size
distributions
  by treating each size-range as a separate species.
  Order must be consistent with 3(a) above.



--------------------------------------------------------------
-----------------


INPUT GROUP: 4 -- Map Projection and Grid control parameters
--------------

     Projection for all (X,Y):
     -------------------------

     Map projection
     (PMAP)                     Default: UTM    ! PMAP = UTM !

         UTM :  Universal Transverse Mercator
         TTM :  Tangential Transverse Mercator
         LCC :  Lambert Conformal Conic
          PS :  Polar Stereographic
          EM :  Equatorial Mercator
        LAZA :  Lambert Azimuthal Equal Area

     False Easting and Northing (km) at the projection origin
     (Used only if PMAP= TTM, LCC, or LAZA)
     (FEAST)                    Default=0.0     ! FEAST  =
0.000  !
```

```
     (FNORTH)                    Default=0.0      ! FNORTH =
0.000  !

     UTM zone (1 to 60)
     (Used only if PMAP=UTM)
     (IUTMZN)                    No Default       ! IUTMZN = 56
!

     Hemisphere for UTM projection?
     (Used only if PMAP=UTM)
     (UTMHEM)                    Default: N       ! UTMHEM = S !
         N   :  Northern hemisphere projection
         S   :  Southern hemisphere projection

     Latitude and Longitude (decimal degrees) of projection
origin
     (Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
     (RLAT0)                     No Default       ! RLAT0 = 0N
!
     (RLON0)                     No Default       ! RLON0 = 0E
!

         TTM :  RLON0 identifies central (true N/S) meridian
of projection
                RLAT0 selected for convenience
         LCC :  RLON0 identifies central (true N/S) meridian
of projection
                RLAT0 selected for convenience
         PS  :  RLON0 identifies central (grid N/S) meridian
of projection
                RLAT0 selected for convenience
         EM  :  RLON0 identifies central meridian of
projection
                RLAT0 is REPLACED by 0.0N (Equator)
         LAZA:  RLON0 identifies longitude of tangent-point of
mapping plane
                RLAT0 identifies latitude of tangent-point of
mapping plane

     Matching parallel(s) of latitude (decimal degrees) for
projection
     (Used only if PMAP= LCC or PS)
     (XLAT1)                     No Default       ! XLAT1 = 0N
!
     (XLAT2)                     No Default       ! XLAT2 = 0N
!

         LCC :  Projection cone slices through Earth's surface
at XLAT1 and XLAT2
         PS  :  Projection plane slices through Earth at XLAT1
                (XLAT2 is not used)

     ----------
     Note:  Latitudes and longitudes should be positive, and
include a
              letter N,S,E, or W indicating north or south
latitude, and
```



```
              east or west longitude.  For example,
              35.9  N Latitude  =  35.9N
              118.7 E Longitude = 118.7E

     Datum-region
     ------------

     The Datum-Region for the coordinates is identified by a
character
     string.  Many mapping products currently available use
the model of the
     Earth known as the World Geodetic System 1984 (WGS-84).
Other local
     models may be in use, and their selection in CALMET will
make its output
     consistent with local mapping products.  The list of
Datum-Regions with
     official transformation parameters is provided by the
National Imagery and
     Mapping Agency (NIMA).

     NIMA Datum - Regions(Examples)
     ------------------------------------------------------------
---------------------
     WGS-84    WGS-84 Reference Ellipsoid and Geoid, Global
coverage (WGS84)
     NAS-C     NORTH AMERICAN 1927 Clarke 1866 Spheroid, MEAN
FOR CONUS (NAD27)
     NAR-C     NORTH AMERICAN 1983 GRS 80 Spheroid, MEAN FOR
CONUS (NAD83)
     NWS-84    NWS 6370KM Radius, Sphere
     ESR-S     ESRI REFERENCE 6371KM Radius, Sphere

     Datum-region for output coordinates
     (DATUM)                     Default: WGS-84    ! DATUM =
WGS-84 !


METEOROLOGICAL Grid:

     Rectangular grid defined for projection PMAP,
     with X the Easting and Y the Northing coordinate

            No. X grid cells (NX)      No default     ! NX =
100 !
            No. Y grid cells (NY)      No default     ! NY =
100 !
         No. vertical layers (NZ)      No default     ! NZ =
11 !

           Grid spacing (DGRIDKM)      No default     !
DGRIDKM = 0.15 !
                                       Units: km

               Cell face heights
                   (ZFACE(nz+1))       No defaults
```

```
                                   Units: m
 ! ZFACE = 0,20,40,80,160,320,640,1000,1500,2000,2500,3000 !

            Reference Coordinates
           of SOUTHWEST corner of
                 grid cell(1, 1):

            X coordinate (XCRIGKM)      No default      !
XORIGKM = 233.867 !
            Y coordinate (YCRIGKM)      No default      !
YORIGKM = 6780.62 !
                                      Units: km


COMPUTATIONAL Grid:

     The computational grid is identical to or a subset of the
MET. grid.
     The lower left (LL) corner of the computational grid is
at grid point
     (IBCOMP, JBCOMP) of the MET. grid.  The upper right (UR)
corner of the
     computational grid is at grid point (IECOMP, JECOMP) of
the MET. grid.
     The grid spacing of the computational grid is the same as
the MET. grid.

        X index of LL corner (IBCOMP)      No default      !
IBCOMP = 1 !
                  (1 <= IBCCMP <= NX)

        Y index of LL corner (JBCOMP)      No default      !
JBCOMP = 1 !
                  (1 <= JBCCMP <= NY)


        X index of UR corner (IECOMP)      No default      !
IECOMP = 100 !
                  (1 <= IECCMP <= NX)

        Y index of UR corner (JECOMP)      No default      !
JECOMP = 100 !
                  (1 <= JECCMP <= NY)


SAMPLING Grid (GRIDDED RECEPTORS):

     The lower left (LL) corner of the sampling grid is at
grid point
     (IBSAMP, JBSAMP) of the MET. grid.  The upper right (UR)
corner of the
     sampling grid is at grid point (IESAMP, JESAMP) of the
MET. grid.
     The sampling grid must be identical to or a subset of the
computational
     grid.  It may be a nested grid inside the computational
```



```
grid.
     The grid spacing of the sampling grid is DGRIDKM/MESHDN.

        Logical flag indicating if gridded
        receptors are used (LSAMP)          Default: T      !
LSAMP = T !
        (T=yes, F=no)

        X index of LL corner (IBSAMP)       No default      !
IBSAMP = 1 !
         (IBCOMP <= IBSAMP <= IECOMP)

        Y index of LL corner (JBSAMP)       No default      !
JBSAMP = 1 !
         (JBCOMP <= JBSAMP <= JECOMP)


        X index of UR corner (IESAMP)       No default      !
IESAMP = 100 !
         (IBCOMP <= IESAMP <= IECOMP)

        Y index of UR corner (JESAMP)       No default      !
JESAMP = 100 !
         (JBCOMP <= JESAMP <= JECOMP)


       Nesting factor of the sampling
        grid (MESHDN)                       Default: 1      !
MESHDN = 1 !
        (MESHDN is an integer >= 1)

!END!


-------------------------------------------------------------
-----------------


INPUT GROUP: 5 -- Output Options
--------------

*
     FILE                       DEFAULT VALUE
VALUE THIS RUN
     ----                       -------------
--------------

   Concentrations (ICON)            1                !
ICON = 1 !
   Dry Fluxes (IDRY)                1                !
IDRY = 1 !
   Wet Fluxes (IWET)                1                !
IWET = 0 !
   2D Temperature (IT2D)            0                !
IT2D = 0 !
   2D Density (IRHO)                0                !
IRHO = 0 !
```

```
   Relative Humidity (IVIS)            1                    !
IVIS = 0 !
    (relative humidity file is
     required for visibility
     analysis)
   Use data compression option in output file?
   (LCOMPRS)                          Default: T            !
LCOMPRS = T !

    0 = Do not create file, 1 = create file


    QA PLOT FILE OUTPUT OPTION:

       Create a standard series of output files (e.g.
       locations of sources, receptors, grids ...)
       suitable for plotting?
       (IQAPLOT)                      Default: 1            !
IQAPLOT = 0 !
         0 = no
         1 = yes

    DIAGNOSTIC PUFF-TRACKING OUTPUT OPTION:

       Puff locations and properties reported to
       PFTRAK.DAT file for postprocessing?
       (IPFTRAK)                      Default: 0            !
IPFTRAK =  0   !
         0 = no
         1 = yes, update puff output at end of each timestep
         2 = yes, update puff output at end of each sampling
step

    DIAGNOSTIC MASS FLUX OUTPUT OPTIONS:

       Mass flux across specified boundaries
       for selected species reported?
       (IMFLX)                        Default: 0            !
IMFLX =  0  !
         0 = no
         1 = yes (FLUXBDY.DAT and MASSFLX.DAT filenames
                  are specified in Input Group 0)

       Mass balance for each species
       reported?
       (IMBAL)                        Default: 0            !
IMBAL =  0  !
         0 = no
         1 = yes (MASSBAL.DAT filename is
              specified in Input Group 0)


    NUMERICAL RISE OUTPUT OPTION:

       Create a file with plume properties for each rise
       increment, for each model timestep?
```



```
      This applies to sources modeled with numerical rise
      and is limited to ONE source in the run.
      (INRISE)                        Default: 0            !
INRISE =  0  !
         0 = no
         1 = yes (RISE.DAT filename is
                  specified in Input Group 0)


   LINE PRINTER OUTPUT OPTIONS:

      Print concentrations (ICPRT)    Default: 0            !
ICPRT =  1   !
      Print dry fluxes (IDPRT)        Default: 0            !
IDPRT =  0   !
      Print wet fluxes (IWPRT)        Default: 0            !
IWPRT =  0   !
      (0 = Do not print, 1 = Print)

      Concentration print interval
      (ICFRQ) in timesteps            Default: 1            !
ICFRQ =  1   !
      Dry flux print interval
      (IDFRQ) in timesteps            Default: 1            !
IDFRQ =  1   !
      Wet flux print interval
      (IWFRQ) in timesteps            Default: 1            !
IWFRQ =  1   !

      Units for Line Printer Output
      (IPRTU)                         Default: 1            !
IPRTU =  3   !
                        for              for
                   Concentration     Deposition
           1 =        g/m**3          g/m**2/s
           2 =       mg/m**3         mg/m**2/s
           3 =       ug/m**3         ug/m**2/s
           4 =       ng/m**3         ng/m**2/s
           5 =     Odour Units

      Messages tracking progress of run
      written to the screen ?
      (IMESG)                         Default: 2            !
IMESG =  2   !
         0 = no
         1 = yes (advection step, puff ID)
         2 = yes (YYYYJJJHH, # old puffs, # emitted puffs)


     SPECIES (or GROUP for combined species) LIST FOR OUTPUT
OPTIONS

                 ---- CONCENTRATIONS ----    ------ DRY FLUXES
------   ------ WET FLUXES ------    -- MASS FLUX --
   SPECIES
   /GROUP          PRINTED?  SAVED ON DISK?   PRINTED?  SAVED ON
DISK?   PRINTED?  SAVED ON DISK?    SAVED ON DISK?
```

```
-------      ------------------------
------------------------    ------------------------
---------------
!          PM10=   0,            1,            0,            1,
0,            0,           0   !
!         PM2.5=   0,            1,            0,            1,
0,            0,           0   !
!           TSP=   0,            1,            0,            1,
0,            0,           0   !
  Note:  Species BCON (for MBCON > 0) does not need to be
saved on disk.


     OPTIONS FOR PRINTING "DEBUG" QUANTITIES (much output)

       Logical for debug output
       (LDEBUG)                                   Default: F
! LDEBUG = F !

       First puff to track
       (IPFDEB)                                   Default: 1
! IPFDEB =  1  !

       Number of puffs to track
       (NPFDEB)                                   Default: 1
! NPFDEB =  1  !

       Met. period to start output
       (NN1)                                      Default: 1
! NN1 =  1   !

       Met. period to end output
       (NN2)                                      Default: 10
! NN2 =  10  !

!END!


-------------------------------------------------------------
------------------


INPUT GROUP: 6a, 6b, & 6c -- Subgrid scale complex terrain
inputs
-------------------------


---------------
Subgroup (6a)
---------------
       Number of terrain features (NHILL)         Default: 0
! NHILL =  0   !

       Number of special complex terrain
       receptors  (NCTREC)                        Default: 0
! NCTREC =  0   !

       Terrain and CTSG Receptor data for
```



```
       CTSG hills input in CTDM format ?
       (MHILL)                                    No Default
! MHILL =  2   !
       1 = Hill and Receptor data created
           by CTDM processors & read from
           HILL.DAT and HILLRCT.DAT files
       2 = Hill data created by OPTHILL &
           input below in Subgroup (6b);
           Receptor data in Subgroup (6c)

       Factor to convert horizontal dimensions  Default: 1.0
! XHILL2M = 1.0 !
       to meters (MHILL=1)

       Factor to convert vertical dimensions    Default: 1.0
! ZHILL2M = 1.0 !
       to meters (MHILL=1)

       X-origin of CTDM system relative to      No Default
! XCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

       Y-origin of CTDM system relative to      No Default
! YCTDMKM = 0 !
       CALPUFF coordinate system, in Kilometers (MHILL=1)

! END !

---------------
Subgroup (6b)
---------------

                          1 **
     HILL information


HILL         XC        YC        THETAH   ZGRID   RELIEF
EXPO 1     EXPO 2    SCALE 1    SCALE 2   AMAX1     AMAX2
 NO.         (km)      (km)      (deg.)    (m)       (m)
(m)         (m)       (m)       (m)       (m)       (m)
----        ----      ----      ------    -----     -----
------     ------    ------    ------    -----     -----

---------------
Subgroup (6c)
---------------

    COMPLEX TERRAIN RECEPTOR INFORMATION

                      XRCT         YRCT         ZRCT
XHH
                      (km)         (km)          (m)
                     ------       -----        ------
----


-------------------
```

```
1
     Description of Complex Terrain Variables:
          XC, YC  = Coordinates of center of hill
          THETAH  = Orientation of major axis of hill
(clockwise from
                    North)
          ZGRID   = Height of the  0  of the grid above mean
sea
                    level
          RELIEF  = Height of the crest of the hill above the
grid elevation
          EXPO 1  = Hill-shape exponent for the major axis
          EXPO 2  = Hill-shape exponent for the major axis
          SCALE 1 = Horizontal length scale along the major
axis
          SCALE 2 = Horizontal length scale along the minor
axis
          AMAX    = Maximum allowed axis length for the major
axis
          BMAX    = Maximum allowed axis length for the major
axis

          XRCT, YRCT = Coordinates of the complex terrain
receptors
          ZRCT    = Height of the ground (MSL) at the complex
terrain
                    Receptor
          XHH     = Hill number associated with each complex
terrain receptor
                    (NOTE: MUST BE ENTERED AS A REAL NUMBER)

   **
     NOTE: DATA for each hill and CTSG receptor are treated as
a separate
           input subgroup and therefore must end with an input
group terminator.
```

```
INPUT GROUP: 7 -- Chemical parameters for dry deposition of
gases
--------------

      SPECIES     DIFFUSIVITY      ALPHA STAR      REACTIVITY
MESOPHYLL RESISTANCE     HENRY'S LAW COEFFICIENT
       NAME        (cm**2/s)
(s/cm)                (dimensionless)
     -------    -----------     -----------     ----------
--------------------     ----------------------


!END!
```

```
INPUT GROUP: 8 -- Size parameters for dry deposition of
particles
--------------

     For SINGLE SPECIES, the mean and standard deviation are
used to
     compute a deposition velocity for NINT (see group 9)
size-ranges,
     and these are then averaged to obtain a mean deposition
velocity.

     For GROUPED SPECIES, the size distribution should be
explicitly
     specified (by the 'species' in the group), and the
standard deviation
     for each should be entered as 0.  The model will then use
the
     deposition velocity for the stated mean diameter.

      SPECIES      GEOMETRIC MASS MEAN        GEOMETRIC
STANDARD
       NAME            DIAMETER                  DEVIATION
                       (microns)                 (microns)
      -------      -------------------
------------------

!        PM10 =          6.8,        1.28 !
!         TSP =         11.8,        1.78 !

!END!
```

```
INPUT GROUP: 9 -- Miscellaneous dry deposition parameters
--------------

     Reference cuticle resistance (s/cm)
     (RCUTR)                          Default: 30    !  RCUTR
= 30.0 !
     Reference ground resistance  (s/cm)
     (RGR)                            Default: 10    !    RGR
= 10.0 !
     Reference pollutant reactivity
     (REACTR)                         Default: 8     ! REACTR
= 8.0 !

     Number of particle-size intervals used to
     evaluate effective particle deposition velocity
     (NINT)                           Default: 9     !   NINT
=  9  !
```

```
     Vegetation state in unirrigated areas
     (IVEG)                          Default: 1      !  IVEG
=  1   !
        IVEG=1 for active and unstressed vegetation
        IVEG=2 for active and stressed vegetation
        IVEG=3 for inactive vegetation

!END!

-------------------------------------------------------------------------------
-----------------


INPUT GROUP: 10 -- Wet Depcsition Parameters
---------------


                      Scavenging Coefficient -- Units: (sec)**
(-1)

       Pollutant      Liquid Precip.       Frozen Precip.
       ---------      --------------       --------------

!END!

-------------------------------------------------------------------------------
-----------------


INPUT GROUP: 11a, 11b -- Chemistry Parameters
---------------------


---------------
Subgroup (11a)
---------------

     Several parameters are needed for one or more of the
chemical transformation
     mechanisms.  Those used for each mechanism are:
                                          M                 B
                                          A  B  R  R  R     C  B
N
                                       B  V  C  N  N  N  M  K  C
O     D
                                       C  M  G  K  I  I  I  H  H  K
F  V  E
                                    M  K  N  N  N  T  T  T  2  2  P
R  C  C
                                    O  O  H  H  H  E  E  E  O  O  M
A  N  A
     Mechanism (MCHEM)              Z  3  3  3  3  1  2  3  2  2  F
C  X  Y
     --------------------
```



```
     --------------------------------------------
     0 None                    .  .  .  .  .  .  .  .  .  .  .
.  .  .
     1 MESOPUFF II             X  X  .  .  X  X  X  X  .  .  .
.  .  .
     2 User Rates              .  .  .  .  .  .  .  .  .  .  .
.  .  .
     3 RIVAD                   X  X  .  .  X  .  .  .  .  .  .
.  .  .
     4 SOA                     X  X  .  .  .  .  .  .  .  .  X
X  X  .
     5 Radioactive Decay       .  .  .  .  .  .  .  .  .  .  .
.  .  X
     6 RIVAD/ISORRPIA          X  X  X  X  X  X  .  .  X  X  .
.  .  .
     7 RIVAD/ISORRPIA/SOA      X  X  X  X  X  X  .  .  X  X  X
X  .  .


     Ozone data input option (MOZ)      Default: 1              !
MOZ =  1   !
     (Used only if MCHEM = 1, 3, 4, 6, or 7)
        0 = use a monthly background ozone value
        1 = read hourly ozone concentrations from
            the OZONE.DAT data file

     Monthly ozone concentrations in ppb (BCKO3)
     (Used only if MCHEM = 1,3,4,6, or 7 and either
        MOZ = 0, or
        MOZ = 1 and all hourly O3 data missing)
                                        Default: 12*80.
     !  BCKO3 = 80.00, 80.00, 80.00, 80.00, 80.00, 80.00,
80.00, 80.00, 80.00, 80.00, 80.00, 80.00 !

     Ammonia data option (MNH3)         Default: 0              !
MNH3 =  0   !
     (Used only if MCHEM = 6 or 7)
        0 = use monthly background ammonia values (BCKNH3) -
no vertical variation
        1 = read monthly background ammonia values for each
layer from
            the NH3Z.DAT data file

     Ammonia vertical averaging option (MAVGNH3)
     (Used only if MCHEM = 6 or 7, and MNH3 = 1)
        0 = use NH3 at puff center height (no averaging is
done)
        1 = average NH3 values over vertical extent of puff
                                        Default: 1              !
MAVGNH3 =  1   !

     Monthly ammonia concentrations in ppb (BCKNH3)
     (Used only if MCHEM = 1 or 3, or
               if MCHEM = 6 or 7, and MNH3 = 0)
                                        Default: 12*10.
     !  BCKNH3 = 10.00, 10.00, 10.00, 10.00, 10.00, 10.00,
10.00, 10.00, 10.00, 10.00, 10.00, 10.00 !
```

```
     Nighttime SO2 loss rate in %/hour (RNITE1)
     (Used only if MCHEM = 1, 6 or 7)
     This rate is used only at night for MCHEM=1
     and is added to the computed rate both day
     and night for MCHEM=6,7 (heterogeneous reactions)
                                        Default: 0.2        !
RNITE1 = .2 !

     Nighttime NOx loss rate in %/hour (RNITE2)
     (Used only if MCHEM = 1)
                                        Default: 2.0        !
RNITE2 = 2.0 !

     Nighttime HNO3 formation rate in %/hour (RNITE3)
     (Used only if MCHEM = 1)
                                        Default: 2.0        !
RNITE3 = 2.0 !

     H2O2 data input option (MH2O2)     Default: 1          !
MH2O2 =  1   !
     (Used only if MCHEM = 6 or 7, and MAQCHEM = 1)
        0 = use a monthly background H2O2 value
        1 = read hourly H2O2 concentrations from
            the H2O2.DAT data file

     Monthly H2O2 concentrations in ppb (BCKH2O2)
     (Used only if MQACHEM = 1 and either
        MH2O2 = 0 or
        MH2O2 = 1 and all hourly H2O2 data missing)
                                        Default: 12*1.
     !  BCKH2O2 = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00, 1.00, 1.00, 1.00 !


 --- Data for SECONDARY ORGANIC AEROSOL (SOA) Options
     (used only if MCHEM = 4 or 7)

     The MCHEM = 4 SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)
          VOC / NOX ratio (after reaction)         (VCNX)

     The MCHEM = 7 SOA module uses monthly values of:
          Fine particulate concentration in ug/m^3 (BCKPMF)
          Organic fraction of fine particulate     (OFRAC)

     These characterize the air mass when computing
     the formation of SOA from VOC emissions.
     Typical values for several distinct air mass types are:

        Month    1    2    3    4    5    6    7    8    9
10   11   12
                Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep
Oct  Nov  Dec

     Clean Continental
```



```
        BCKPMF   1.   1.   1.   1.   1.   1.   1.   1.   1.
1.   1.   1.
        OFRAC  .15  .15  .20  .20  .20  .20  .20  .20  .20
.20  .20  .15
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.
50.  50.  50.

     Clean Marine (surface)
        BCKPMF  .5   .5   .5   .5   .5   .5   .5   .5   .5
.5   .5   .5
        OFRAC  .25  .25  .30  .30  .30  .30  .30  .30  .30
.30  .30  .25
        VCNX    50.  50.  50.  50.  50.  50.  50.  50.  50.
50.  50.  50.

     Urban - low biogenic (controls present)
        BCKPMF  30.  30.  30.  30.  30.  30.  30.  30.  30.
30.  30.  30.
        OFRAC  .20  .20  .25  .25  .25  .25  .25  .25  .20
.20  .20  .20
        VCNX     4.   4.   4.   4.   4.   4.   4.   4.   4.
4.   4.   4.

     Urban - high biogenic (controls present)
        BCKPMF  60.  60.  60.  60.  60.  60.  60.  60.  60.
60.  60.  60.
        OFRAC  .25  .25  .30  .30  .30  .55  .55  .55  .35
.35  .35  .25
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.
15.  15.  15.

     Regional Plume
        BCKPMF  20.  20.  20.  20.  20.  20.  20.  20.  20.
20.  20.  20.
        OFRAC  .20  .20  .25  .35  .25  .40  .40  .40  .30
.30  .30  .20
        VCNX    15.  15.  15.  15.  15.  15.  15.  15.  15.
15.  15.  15.

     Urban - no controls present
        BCKPMF 100. 100. 100. 100. 100. 100. 100. 100. 100.
100. 100. 100.
        OFRAC  .30  .30  .35  .35  .35  .55  .55  .55  .35
.35  .35  .30
        VCNX     2.   2.   2.   2.   2.   2.   2.   2.   2.
2.   2.   2.

     Default: Clean Continental
     !  BCKPMF = 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00,
1.00, 1.00, 1.00, 1.00, 1.00 !
     !  OFRAC  = 0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20,
0.20, 0.20, 0.20, 0.20, 0.15 !
     !  VCNX   = 50.00, 50.00, 50.00, 50.00, 50.00, 50.00,
50.00, 50.00, 50.00, 50.00, 50.00, 50.00 !

 --- End Data for SECONDARY ORGANIC AEROSOL (SOA) Option
```

```
     Number of half-life decay specification blocks provided
in Subgroup 11b
     (Used only if MCHEM = 5)
     (NDECAY)                                   Default: 0
! NDECAY =  0   !

!END!

---------------
Subgroup (11b)
---------------

     Each species modeled may be assigned a decay half-life
(sec), and the associated
     mass lost may be assigned to one or more other modeled
species using a mass yield
     factor. This information is used only for MCHEM=5.

     Provide NDECAY blocks assigning the half-life for a
parent species and mass yield
     factors for each child species (if any) produced by the
decay.
     Set HALF_LIFE=0.0 for NO decay (infinite half-life).

                               a             b
        SPECIES          Half-Life   Mass Yield
         NAME              (sec)       Factor
        -------          ---------   ----------

     *  SPEC1    =     3600.,         -1.0    *     (Parent)
     *  SPEC2    =      -1.0,          0.0    *     (Child)
   *END*

--------
    a
     Specify a half life that is greater than or equal to zero
for 1 parent species
     in each block, and set the yield factor for this species
to -1
    b
     Specify a yield factor that is greater than or equal to
zero for 1 or more child
     species in each block, and set the half-life for each of
these species to -1

     NOTE: Assignments in each block are treated as a separate
input
           subgroup and therefore must end with an input group
terminator.
           If NDECAY=0, no assignments and input group
terminators should appear.

--------------------------------------------------------------
-----------------
```



```
INPUT GROUP: 12 -- Misc. Dispersion and Computational
Parameters
---------------

     Horizontal size of puff (m) beyond which
     time-dependent dispersion equations (Heffter)
     are used to determine sigma-y and
     sigma-z (SYTDEP)                            Default: 550.
! SYTDEP = 5.5E02 !

     Switch for using Heffter equation for sigma z
     as above (0 = Not use Heffter; 1 = use Heffter
     (MHFTSZ)                                    Default: 0
! MHFTSZ =  0   !

     Stability class used to determine plume
     growth rates for puffs above the boundary
     layer (JSUP)                                Default: 5
! JSUP =  5   !

     Vertical dispersion constant for stable
     conditions (k1 in Eqn. 2.7-3)  (CONK1)      Default: 0.01
! CONK1 = .01 !

     Vertical dispersion constant for neutral/
     unstable conditions (k2 in Eqn. 2.7-4)
     (CONK2)                                     Default: 0.1
! CONK2 = .1 !

     Factor for determining Transition-point from
     Schulman-Scire to Huber-Snyder Building Downwash
     scheme (SS used for Hs < Hb + TBD * HL)
     (TBD)                                       Default: 0.5
! TBD = .5 !
        TBD < 0   ==> always use Huber-Snyder
        TBD = 1.5 ==> always use Schulman-Scire
        TBD = 0.5 ==> ISC Transition-point

     Range of land use categories for which
     urban dispersion is assumed
     (IURB1, IURB2)                              Default: 10
! IURB1 =  10  !
                                                          19
! IURB2 =  19  !

     Site characterization parameters for single-point Met
data files ---------
     (needed for METFM = 2,3,4,5)

        Land use category for modeling domain
        (ILANDUIN)                               Default: 20
! ILANDUIN =  20  !

        Roughness length (m) for modeling domain
        (Z0IN)                                   Default: 0.25
```

```
! ZOIN = .25 !

        Leaf area index for modeling domain
        (XLAIIN)                                Default: 3.0
! XLAIIN = 3.0 !

        Elevation above sea level (m)
        (ELEVIN)                                Default: 0.0
! ELEVIN = .0 !

        Latitude (degrees) for met location
        (XLATIN)                                Default: -999.
! XLATIN = -999. !

        Longitude (degrees) for met location
        (XLONIN)                                Default: -999.
! XLONIN = -999. !

     Specialized information for interpreting single-point Met
data files -----

        Anemometer height (m) (Used only if METFM = 2,3)
        (ANEMHT)                                Default: 10.
! ANEMHT = 10.0 !

        Form of lateral turbulance data in PROFILE.DAT file
        (Used only if METFM = 4,5 or MTURBVW = 1 or 3)
        (ISIGMAV)                               Default: 1
! ISIGMAV =  1  !
            0 = read sigma-theta
            1 = read sigma-v

        Choice of mixing heights (Used only if METFM = 4)
        (IMIXCTDM)                              Default: 0
! IMIXCTDM =  0  !
            0 = read PREDICTED mixing heights
            1 = read OBSERVED mixing heights

     Maximum length of a slug (met. grid units)
     (XMXLEN)                                   Default: 1.0
! XMXLEN = 1.0 !

     Maximum travel distance of a puff/slug (in
     grid units) during one sampling step
     (XSAMLEN)                                  Default: 1.0
! XSAMLEN = 1.0 !

     Maximum Number of slugs/puffs release from
     one source during one time step
     (MXNEW)                                    Default: 99
! MXNEW =  99   !

     Maximum Number of sampling steps for
     one puff/slug during one time step
     (MXSAM)                                    Default: 99
! MXSAM =  99   !
```



```
     Number of iterations used when computing
     the transport wind for a sampling step
     that includes gradual rise (for CALMET
     and PROFILE winds)
     (NCOUNT)                                   Default: 2
! NCOUNT =  2   !

     Minimum sigma y for a new puff/slug (m)
     (SYMIN)                                    Default: 1.0
! SYMIN = 1.0   !

     Minimum sigma z for a new puff/slug (m)
     (SZMIN)                                    Default: 1.0
! SZMIN = 1.0   !

     Maximum sigma z (m) allowed to avoid
     numerical problem in calculating virtual
     time or distance.  Cap should be large
     enough to have no influence on normal events.
     Enter a negative cap to disable.
     (SZCAP_M)                                  Default:
5.0e06 ! SZCAP_M = 5.0E06 !

     Default minimum turbulence velocities sigma-v and sigma-w
     for each stability class over land and over water (m/s)
     (SVMIN(12) and SWMIN(12))

                    ----------  LAND  ----------
---------  WATER  ----------
        Stab Class :  A    B    C    D    E    F         A
B    C    D    E    F
                     ---  ---  ---  ---  ---  ---        ---
---  ---  ---  ---  ---
     Default SVMIN : .50, .50, .50, .50, .50, .50,      .37,
.37, .37, .37, .37, .37
     Default SWMIN : .20, .12, .08, .06, .03, .016,     .20,
.12, .08, .06, .03, .016

           ! SVMIN = 0.500, 0.500, 0.500, 0.500, 0.500, 0.500,
0.370, 0.370, 0.370, 0.370, 0.370, 0.370!
           ! SWMIN = 0.200, 0.120, 0.080, 0.060, 0.030, 0.016,
0.200, 0.120, 0.080, 0.060, 0.030, 0.016!

     Divergence criterion for dw/dz across puff
     used to initiate adjustment for horizontal
     convergence (1/s)
     Partial adjustment starts at CDIV(1), and
     full adjustment is reached at CDIV(2)
     (CDIV(2))                                  Default:
0.0,0.0  ! CDIV = .0, .0 !

     Search radius (number of cells) for nearest
     land and water cells used in the subgrid
     TIBL module
     (NLUTIBL)                                  Default: 4
! NLUTIBL =  4  !
```

```
     Minimum wind speed (m/s) allowed for
     non-calm conditions. Also used as minimum
     speed returned when using power-law
     extrapolation toward surface
     (WSCALM)                                 Default: 0.5
! WSCALM = .5 !

     Maximum mixing height (m)
     (XMAXZI)                                 Default: 3000.
! XMAXZI = 3000.0 !

     Minimum mixing height (m)
     (XMINZI)                                 Default: 50.
! XMINZI = 20.0 !

     Default wind speed classes --
     5 upper bounds (m/s) are entered;
     the 6th class has no upper limit
     (WSCAT(5))                    Default    :
                                   ISC RURAL : 1.54, 3.09,
5.14, 8.23, 10.8 (10.8+)

                              Wind Speed Class :  1     2
3     4     5
                                                 ---   ---
---   ---   ---
                                    ! WSCAT = 1.54, 3.09,
5.14, 8.23, 10.80 !

     Default wind speed profile power-law
     exponents for stabilities 1-6
     (PLX0(6))                     Default    : ISC RURAL
values
                                   ISC RURAL : .07, .07,
.10, .15, .35, .55
                                   ISC URBAN : .15, .15,
.20, .25, .30, .30

                               Stability Class :  A     B
C     D     E     F
                                                 ---   ---
---   ---   ---   ---
                                    ! PLX0 = 0.07, 0.07,
0.10, 0.15, 0.35, 0.55 !

     Default potential temperature gradient
     for stable classes E, F (degK/m)
     (PTG0(2))                     Default: 0.020, 0.035
                                      ! PTG0 = 0.020,
0.035 !

     Default plume path coefficients for
     each stability class (used when option
     for partial plume height terrain adjustment
     is selected -- MCTADJ=3)
     (PPC(6))                  Stability Class :  A     B
C     D     E     F
```



```
                                          Default  PPC : .50,  .50,
.50,  .50,  .35,  .35
                                                         ---   ---
---   ---   ---   ---
                                          !  PPC = 0.50, 0.50,
0.50, 0.50, 0.35, 0.35 !

     Slug-to-puff transition criterion factor
     equal to sigma-y/length of slug
     (SL2PF)                                 Default: 10.
! SL2PF = 10.0 !

     Puff-splitting control variables ------------------------

       VERTICAL SPLIT
       --------------

       Number of puffs that result every time a puff
       is split - nsplit=2 means that 1 puff splits
       into 2
       (NSPLIT)                              Default:   3
! NSPLIT =  3  !

       Time(s) of a day when split puffs are eligible to
       be split once again; this is typically set once
       per day, around sunset before nocturnal shear develops.
       24 values: 0 is midnight (00:00) and 23 is 11 PM
(23:00)
       0=do not re-split    1=eligible for re-split
       (IRESPLIT(24))                        Default:  Hour 17 =
1
       !  IRESPLIT =
0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,1,0,0,0,0,0,0 !

       Split is allowed only if last hour's mixing
       height (m) exceeds a minimum value
       (ZISPLIT)                             Default: 100.
! ZISPLIT = 100.0 !

       Split is allowed only if ratio of last hour's
       mixing ht to the maximum mixing ht experienced
       by the puff is less than a maximum value (this
       postpones a split until a nocturnal layer develops)
       (ROLDMAX)                             Default: 0.25
! ROLDMAX = 0.25 !


       HORIZONTAL SPLIT
       ----------------

       Number of puffs that result every time a puff
       is split - nsplith=5 means that 1 puff splits
       into 5
       (NSPLITH)                             Default:   5
! NSPLITH =  5  !

       Minimum sigma-y (Grid Cells Units) of puff
```

```
        before it may be split
        (SYSPLITH)                      Default:  1.0
! SYSPLITH = 1.0 !

        Minimum puff elongation rate (SYSPLITH/hr) due to
        wind shear, before it may be split
        (SHSPLITH)                      Default:  2.
! SHSPLITH = 2.0 !

        Minimum concentration (g/m^3) of each
        species in puff before it may be split
        Enter array of NSPEC values; if a single value is
        entered, it will be used for ALL species
        (CNSPLITH)                      Default:  1.0E-07
! CNSPLITH = 1.0E-07 !

      Integration control variables ------------------------

        Fractional convergence criterion for numerical SLUG
        sampling integration
        (EPSSLUG)                       Default:   1.0e-04
! EPSSLUG = 1.0E-04 !

        Fractional convergence criterion for numerical AREA
        source integration
        (EPSAREA)                       Default:   1.0e-06
! EPSAREA = 1.0E-06 !

        Trajectory step-length (m) used for numerical rise
        integration
        (DSRISE)                        Default:   1.0
! DSRISE = 1.0 !

        Boundary Condition (BC) Puff control variables
-------------------------

        Minimum height (m) to which BC puffs are mixed as they
are emitted
        (MBCON=2 ONLY).  Actual height is reset to the current
mixing height
        at the release point if greater than this minimum.
        (HTMINBC)                       Default:   500.
! HTMINBC = 500.0 !

        Search radius (km) about a receptor for sampling
nearest BC puff.
        BC puffs are typically emitted with a spacing of one
grid cell
        length, so the search radius should be greater than
DGRIDKM.
        (RSAMPBC)                       Default:   10.
! RSAMPBC = 10.0 !

        Near-Surface depletion adjustment to concentration
profile used when
        sampling BC puffs?
        (MDEPBC)                        Default:   1
```



```
! MDEPBC =  1  !
          0 = Concentration is NOT adjusted for depletion
          1 = Adjust Concentration for depletion

!END!


-------------------------------------------------------------------------------
-----------------

INPUT GROUPS: 13a, 13b, 13c, 13d -- Point source parameters
--------------------------------

---------------
Subgroup (13a)
---------------

      Number of point sources with
      parameters provided below       (NPT1)   No default   ! NPT1
= 0 !

      Units used for point source
      emissions below                 (IPTU)   Default: 1   !
IPTU =   1  !
           1 =        g/s
           2 =       kg/hr
           3 =       lb/hr
           4 =     tons/yr
           5 =     Odour Unit * m**3/s  (vol. flux of odour
compound)
           6 =     Odour Unit * m**3/min
           7 =     metric tons/yr
           8 =     Bq/s  (Bq = becquerel = disintegrations/s)
           9 =     GBq/yr

      Number of source-species
      combinations with variable
      emissions scaling factors
      provided below in (13d)         (NSPT1) Default: 0   !
NSPT1 =  0  !

      Number of point sources with
      variable emission parameters
      provided in external file       (NPT2)   No default   !
NPT2 =  0  !

      (If NPT2 > 0, these point
      source emissions are read from
      the file: PTEMARB.DAT)

!END!

---------------
Subgroup (13b)
---------------
                                          a
```

POINT SOURCE: CONSTANT DATA

```
b           c
  Source       X          Y        Stack     Base      Stack
Exit  Exit     Bldg.  Emission
   No.     Coordinate Coordinate Height Elevation Diameter
Vel.  Temp.   Dwash    Rates
             (km)       (km)        (m)       (m)        (m)
(m/s) (deg. K)
```

a
Data for each source are treated as a separate input subgroup
and therefore must end with an input group terminator.

SRCNAM is a 12-character name for a source
(No default)

X is an array holding the source data listed by the column headings
(No default)

SIGYZI is an array holding the initial sigma-y and sigma-z (m)
(Default: 0.,0.)

FMFAC is a vertical momentum flux factor (0. or 1.0) used to represent the effect of rain-caps or other physical configurations that reduce momentum rise associated with the actual exit velocity.
(Default: 1.0 -- full momentum used)

ZPLTFM is the platform height (m) for sources influenced by an isolated structure that has a significant open area between the surface and the bulk of the structure, such as an offshore oil platform. The Base Elevation is that of the surface (ground or ocean), and the Stack Height is the release height above the Base (not above the platform). Building heights entered in Subgroup 13c must be those of the buildings on the platform, measured from the platform deck. ZPLTFM is used only with MBDW=1 (ISC downwash method) for sources with building downwash.
(Default: 0.0)

b
0. = No building downwash modeled

1. = Downwash modeled for buildings resting on the surface
2. = Downwash modeled for buildings raised above the surface (ZPLTFM > 0.)
NOTE: must be entered as a REAL number (i.e., with decimal point)

c
An emission rate must be entered for every pollutant modeled.
Enter emission rate of zero for secondary pollutants that are modeled, but not emitted. Units are specified by IPTU (e.g. 1 for g/s).

Subgroup (13c)

Subgroup (13c)

BUILDING DIMENSION DATA FOR SOURCES SUBJECT TO DOWNWASH

```
      Source(a)
 No.       Effective building height, width, length and X/Y
offset (in meters)
           every 10 degrees.  LENGTH, XBADJ, and YBADJ are
only needed for
           MBDW=2 (PRIME downwash option)
```

a
Building height, width, length, and X/Y offset from the source are treated as a separate input subgroup for each source and therefore must end with an input group terminator. The X/Y offset is the position, relative to the stack, of the center of the upwind face of the projected building, with the x-axis pointing along the flow direction.

Subgroup (13d)

POINT SOURCE: VARIABLE EMISSIONS DATA[a]

Use this subgroup to describe temporal variations in the emission rates given in 13b. Factors entered multiply the rates in 13b.
Skip sources here that have constant emissions. For more elaborate variation in source parameters, use PTEMARB.DAT and NPT2 > 0.

IVARY determines the type of variation, and is source-specific:

```
     (IVARY)                                 Default: 0
          0 =       Constant
          1 =       Diurnal cycle (24 scaling factors: hours 1-24)
          2 =       Monthly cycle (12 scaling factors: months 1-12)
          3 =       Hour & Season (4 groups of 24 hourly scaling factors,
                              where first group is DEC-JAN-FEB)
          4 =       Speed & Stab. (6 groups of 6 scaling factors, where
                              first group is Stability Class A,
                              and the speed classes have upper
                              bounds (m/s) defined in Group 12
          5 =       Temperature   (12 scaling factors, where temperature
                              classes have upper bounds (C) of:
                              0, 5, 10, 15, 20, 25, 30, 35, 40,
                              45, 50, 50+)
```

[a] Data for each species are treated as a separate input subgroup and therefore must end with an input group terminator.

INPUT GROUPS: 14a, 14b, 14c, 14d -- Area source parameters

Subgroup (14a)

```
     Number of polygon area sources with
     parameters specified below (NAR1)       No default  !
NAR1 = 0 !

     Units used for area source
     emissions below             (IARU)       Default: 1  !
IARU =   1  !
          1 =       g/m**2/s
          2 =      kg/m**2/hr
          3 =      lb/m**2/hr
          4 =     tons/m**2/yr
          5 =     Odour Unit * m/s  (vol. flux/m**2 of odour
compound)
          6 =     Odour Unit * m/min
          7 =     metric tons/m**2/yr
          8 =     Bq/m**2/s  (Bq = becquerel =
disintegrations/s)
          9 =     GBq/m**2/yr

     Number of source-species
     combinations with variable
     emissions scaling factors
     provided below in (14d)        (NSAR1) Default: 0  !
NSAR1 =  0  !

     Number of buoyant polygon area sources
     with variable location and emission
     parameters (NAR2)                       No default  !
NAR2 =  0   !
     (If NAR2 > 0, ALL parameter data for
     these sources are read from the file: BAEMARB.DAT)

!END!
```

Subgroup (14b)

```
                                       a
          AREA SOURCE: CONSTANT DATA
          ----------------------------
                                                          b
Source            Effect.    Base      Initial     Emission
 No.              Height   Elevation   Sigma z      Rates
                   (m)        (m)        (m)
-------           ------   -------    --------    ---------

--------
    a
     Data for each source are treated as a separate input
subgroup
     and therefore must end with an input group terminator.
    b
     An emission rate must be entered for every pollutant
modeled.
     Enter emission rate of zero for secondary pollutants that
are
```



```
     modeled, but not emitted.  Units are specified by IARU
     (e.g. 1 for g/m**2/s).
```

Subgroup (14c)

```
          COORDINATES (km) FOR EACH VERTEX(4) OF EACH POLYGON
          ---------------------------------------------------
-----
Source
a
 No.       Ordered list of X followed by list of Y, grouped by
source
------
------------------------------------------------------------

--------
    a
     Data for each source are treated as a separate input
subgroup
     and therefore must end with an input group terminator.
```

Subgroup (14d)

```
                                               a
         AREA SOURCE: VARIABLE EMISSIONS DATA
         ------------------------------------

     Use this subgroup to describe temporal variations in the
emission
     rates given in 14b.  Factors entered multiply the rates
in 14b.
     Skip sources here that have constant emissions.  For more
elaborate
     variation in source parameters, use BAEMARB.DAT and NAR2
> 0.

     IVARY determines the type of variation, and is source-
specific:
     (IVARY)                                Default: 0
          0 =       Constant
          1 =       Diurnal cycle (24 scaling factors: hours
1-24)
          2 =       Monthly cycle (12 scaling factors: months
1-12)
          3 =       Hour & Season (4 groups of 24 hourly
scaling factors,
                                   where first group is DEC-
JAN-FEB)
          4 =       Speed & Stab. (6 groups of 6 scaling
factors, where
                                   first group is Stability
Class A,
                                   and the speed classes have
```

```
upper
                                          bounds (m/s) defined in
Group 12
            5 =        Temperature    (12 scaling factors, where
temperature
                                          classes have upper bounds
(C) of:
                                          0, 5, 10, 15, 20, 25, 30,
35, 40,
                                          45, 50, 50+)


--------
    a
     Data for each species are treated as a separate input
subgroup
     and therefore must end with an input group terminator.

-------------------------------------------------------------------------------
-----------------

INPUT GROUPS: 15a, 15b, 15c -- Line source parameters
----------------------------

---------------
Subgroup (15a)
---------------

     Number of buoyant line sources
     with variable location and emission
     parameters (NLN2)                              No default
!  NLN2 =  0   !

     (If NLN2 > 0, ALL parameter data for
      these sources are read from the file: LNEMARB.DAT)

     Number of buoyant line sources (NLINES)        No default
! NLINES = 0 !

     Units used for line source
     emissions below                (ILNU)          Default: 1
!  ILNU =   1  !
            1 =        g/s
            2 =       kg/hr
            3 =       lb/hr
            4 =     tons/yr
            5 =     Odour Unit * m**3/s  (vol. flux of odour
compound)
            6 =     Odour Unit * m**3/min
            7 =     metric tons/yr
            8 =     Bq/s  (Bq = becquerel = disintegrations/s)
            9 =     GBq/yr

     Number of source-species
     combinations with variable
```



```
     emissions scaling factors
     provided below in (15c)        (NSLN1) Default: 0  !
NSLN1 =  0  !

     Maximum number of segments used to model
     each line (MXNSEG)                             Default: 7
! MXNSEG = 7 !

     The following variables are required only if NLINES > 0.
They are
     used in the buoyant line source plume rise calculations.

        Number of distances at which                Default: 6
! NLRISE = 6 !
        transitional rise is computed

        Average building length (XL)                No default
! XL =  !
                                                    (in
meters)

        Average building height (HBL)               No default
! HBL =  !
                                                    (in
meters)

        Average building width (WBL)                No default
! WBL =  !
                                                    (in
meters)

        Average line source width (WML)             No default
! WML =  !
                                                    (in
meters)

        Average separation between buildings (DXL)  No default
! DXL =  !
                                                    (in
meters)

        Average buoyancy parameter (FPRIMEL)        No default
! FPRIMEL =  !
                                                    (in m**
4/s**3)

!END!

---------------
Subgroup (15b)
---------------

          BUOYANT LINE SOURCE: CONSTANT DATA
          ----------------------------------

a
Source      Beg. X      Beg. Y      End. X     End. Y
```

```
Release    Base         Emission
 No.     Coordinate  Coordinate  Coordinate Coordinate  Height
Elevation      Rates
            (km)        (km)        (km)       (km)       (m)
(m)
------   ----------  ----------  ---------  ----------
------   ---------   ---------

--------

   a
    Data for each source are treated as a separate input
subgroup
    and therefore must end with an input group terminator.

   b
    An emission rate must be entered for every pollutant
modeled.
    Enter emission rate of zero for secondary pollutants that
are
    modeled, but not emitted.  Units are specified by ILNTU
    (e.g. 1 for g/s).

---------------
Subgroup (15c)
---------------
                                                          a
         BUOYANT LINE SOURCE: VARIABLE EMISSIONS DATA
         ----------------------------------------------

    Use this subgroup to describe temporal variations in the
emission
    rates given in 15b.  Factors entered multiply the rates
in 15b.
    Skip sources here that have constant emissions.

    IVARY determines the type of variation, and is source-
specific:
    (IVARY)                              Default: 0
           0 =       Constant
           1 =       Diurnal cycle (24 scaling factors: hours
1-24)
           2 =       Monthly cycle (12 scaling factors: months
1-12)
           3 =       Hour & Season (4 groups of 24 hourly
scaling factors,
                                   where first group is DEC-
JAN-FEB)
           4 =       Speed & Stab. (6 groups of 6 scaling
factors, where
                                   first group is Stability
Class A,
                                   and the speed classes have
upper
                                   bounds (m/s) defined in
Group 12
           5 =       Temperature   (12 scaling factors, where
```



```
temperature
                                   classes have upper bounds
(C) of:
                                   0, 5, 10, 15, 20, 25, 30,
35, 40,
                                   45, 50, 50+)

--------
   a
    Data for each species are treated as a separate input
subgroup
    and therefore must end with an input group terminator.

-------------------------------------------------------------
----------------

INPUT GROUPS: 16a, 16b, 16c -- Volume source parameters
---------------------------

---------------
Subgroup (16a)
---------------

    Number of volume sources with
    parameters provided in 16b,c (NVL1)      No default   !
NVL1 = 0 !

    Units used for volume source
    emissions below in 16b         (IVLU)     Default: 1   !
IVLU =   1  !
          1 =         g/s
          2 =        kg/hr
          3 =        lb/hr
          4 =      tons/yr
          5 =      Odour Unit * m**3/s  (vol. flux of odour
compound)
          6 =      Odour Unit * m**3/min
          7 =      metric tons/yr
          8 =      Bq/s  (Bq = becquerel = disintegrations/s)
          9 =      GBq/yr

    Number of source-species
    combinations with variable
    emissions scaling factors
    provided below in (16c)        (NSVL1)    Default: 0   !
NSVL1 =  0  !

    Number of volume sources with
    variable location and emission
    parameters                     (NVL2)     No default   !
NVL2 =   32   !

    (If NVL2 > 0, ALL parameter data for
```

```
      these sources are read from the VOLEMARB.DAT file(s) )

!END!

-----------------
Subgroup (16b)
-----------------
                                                        a
               VOLUME SOURCE: CONSTANT DATA
               ------------------------------

b
         X              Y          Effect.     Base      Initial
Initial     Emission
       Coordinate  Coordinate   Height   Elevation  Sigma y
Sigma z      Rates
          (km)         (km)        (m)        (m)        (m)
(m)
       ----------  ----------   ------    ------    --------
--------   --------

--------
     a
       Data for each source are treated as a separate input
subgroup
       and therefore must end with an input group terminator.

     b
       An emission rate must be entered for every pollutant
modeled.
       Enter emission rate of zero for secondary pollutants that
are
       modeled, but not emitted.  Units are specified by IVLU
       (e.g. 1 for g/s).

-----------------
Subgroup (16c)
-----------------
                                                        a
              VOLUME SOURCE: VARIABLE EMISSIONS DATA
              ---------------------------------------

       Use this subgroup to describe temporal variations in the
emission
       rates given in 16b.  Factors entered multiply the rates
in 16b.
       Skip sources here that have constant emissions.  For more
elaborate
       variation in source parameters, use VOLEMARB.DAT and NVL2
> 0.

       IVARY determines the type of variation, and is source-
specific:
       (IVARY)                              Default: 0
            0 =       Constant
            1 =       Diurnal cycle (24 scaling factors: hours
1-24)
```



```
            2 =       Monthly cycle (12 scaling factors: months
1-12)
            3 =       Hour & Season (4 groups of 24 hourly
scaling factors,
                                     where first group is DEC-
JAN-FEB)
            4 =       Speed & Stab. (6 groups of 6 scaling
factors, where
                                     first group is Stability
Class A,
                                     and the speed classes have
upper
                                     bounds (m/s) defined in
Group 12
            5 =       Temperature   (12 scaling factors, where
temperature
                                     classes have upper bounds
(C) of:
                                     0, 5, 10, 15, 20, 25, 30,
35, 40,
                                     45, 50, 50+)


--------
     a
       Data for each species are treated as a separate input
subgroup
       and therefore must end with an input group terminator.

-------------------------------------------------------------------------
-----------------

INPUT GROUPS: 17a & 17b -- Non-gridded (discrete) receptor
information
-----------------------

-----------------
Subgroup (17a)
-----------------

       Number of non-gridded receptors (NREC)  No default  !
NREC = 9 !

!END!

-----------------
Subgroup (17b)
-----------------
                                                      a
           NON-GRIDDED (DISCRETE) RECEPTOR DATA
           ------------------------------------

                   X            Y          Ground
Height   b
Receptor       Coordinate   Coordinate   Elevation   Above
```

Ground No.		(km)	(km)	(m)	(m)
1	! X =	238.781,	6787.014,	287,	1.5! !END!
2	! X =	236.533,	6788.442,	281,	1.5! !END!
3	! X =	240.870,	6790.201,	278,	1.5! !END!
4	! X =	242.536,	6792.303,	281,	1.5! !END!
5	! X =	238.055,	6783.704,	284,	1.5! !END!
6	! X =	244.994,	6784.834,	305,	1.5! !END!
7	! X =	238.228,	6784.000,	290,	1.5! !END!
8	! X =	241.172,	6783.672,	288,	1.5! !END!
9	! X =	235.878,	6785.140,	283,	1.5! !END!

[a] Data for each receptor are treated as a separate input subgroup and therefore must end with an input group terminator.

[b] Receptor height above ground is optional. If no value is entered, the receptor is placed on the ground.

APPENDIX II: Contour Plots

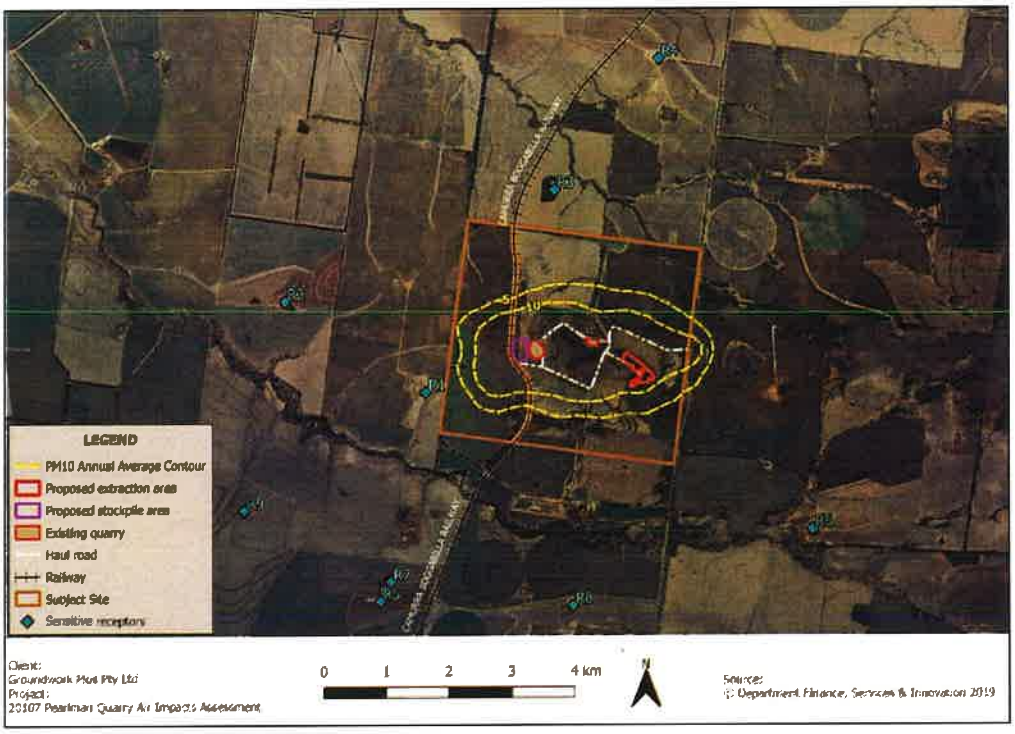


Figure 6: 100th Percentile Annual Average PM_{10} Concentration (Maximum Export Scenario) (Contour labels = 5, 10 µg/m³)

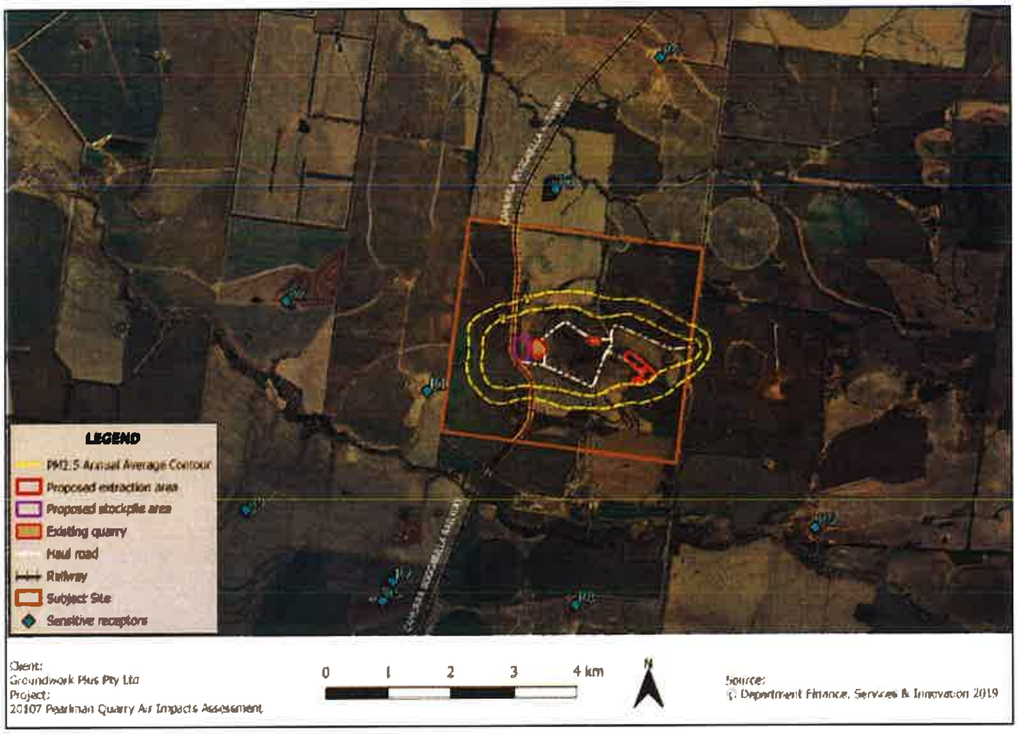


Figure 7: 100th Percentile Annual Average $PM_{2.5}$ Concentration (Maximum Export Scenario) (Contour labels = 1, 2 µg/m³)

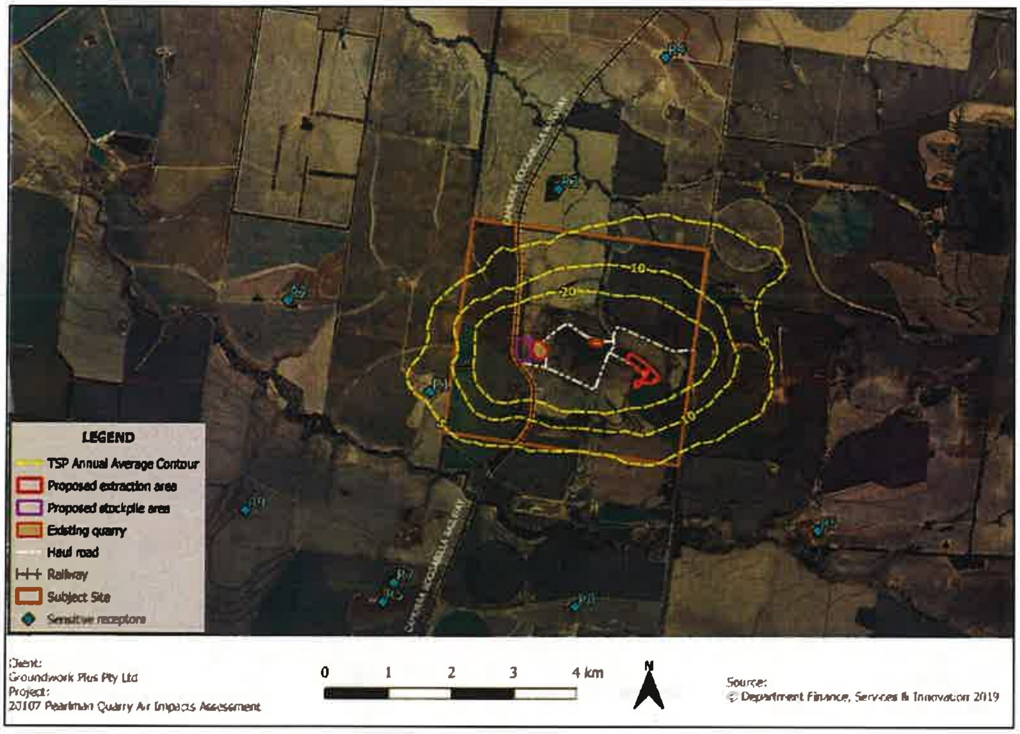


Figure 8: 100th Percentile Annual Average TSP Concentration (Maximum Export Scenario) (Contour labels = 5, 10, 20 µg/m³)

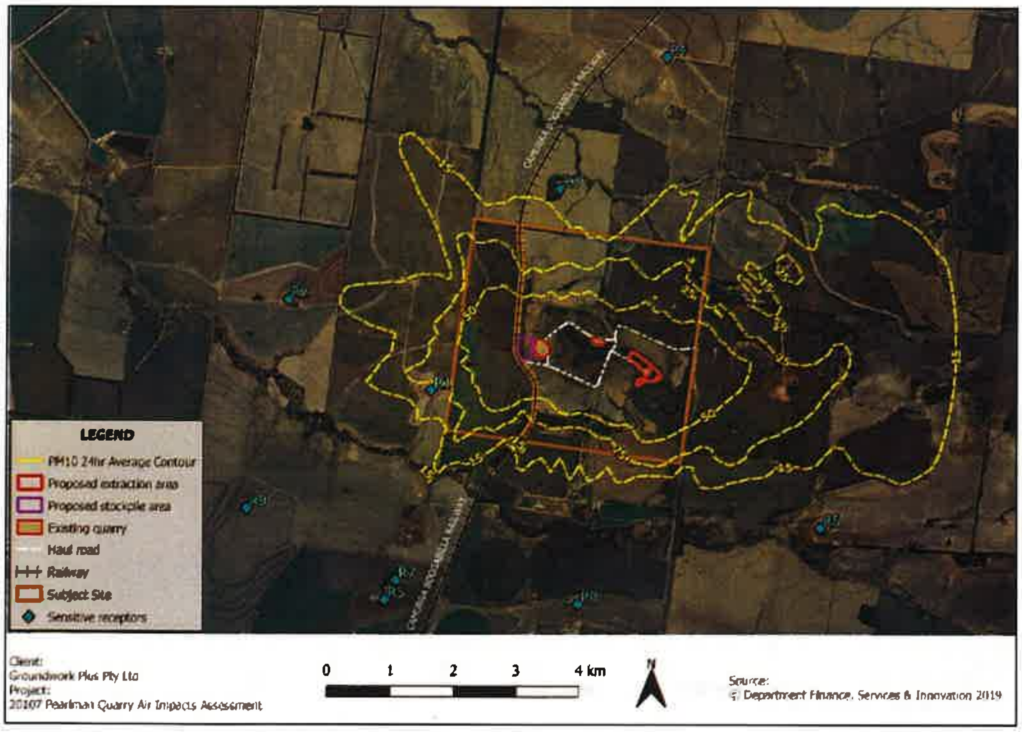


Figure 9: 100th Percentile 24-hr Average PM_{10} Concentration (Maximum Export Scenario) (Contour labels = 15, 25, 50 µg/m³)

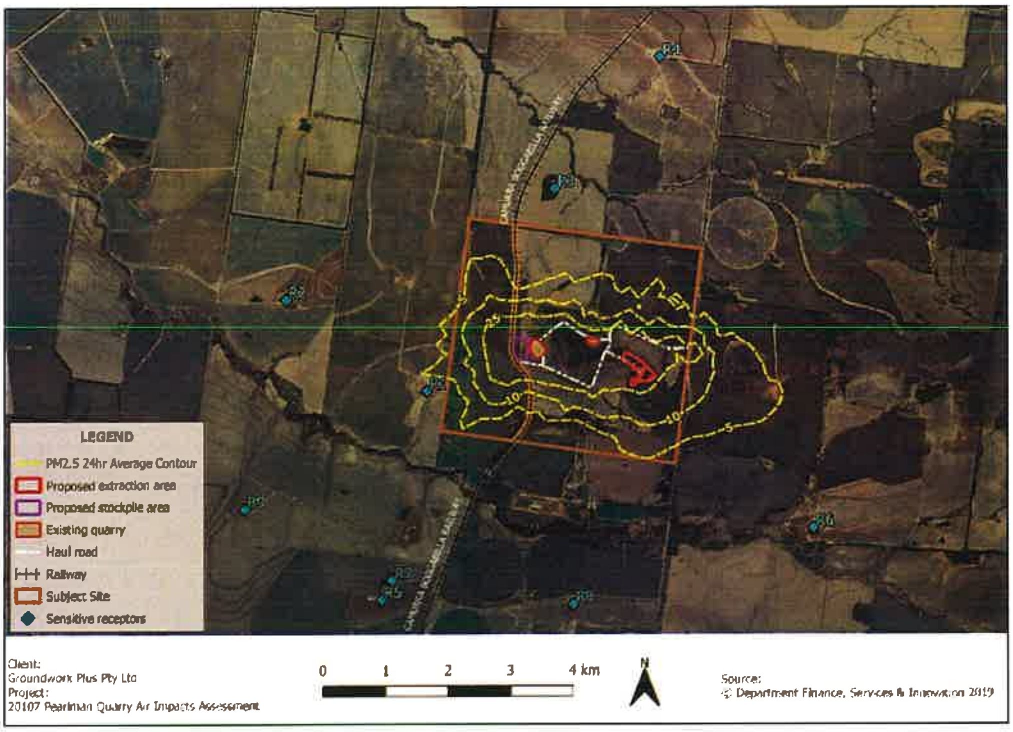


Figure 10: 100th Percentile 24-hr Average $PM_{2.5}$ Concentration (Maximum Export Scenario) (Contour labels = 5, 10, 25 µg/m³)

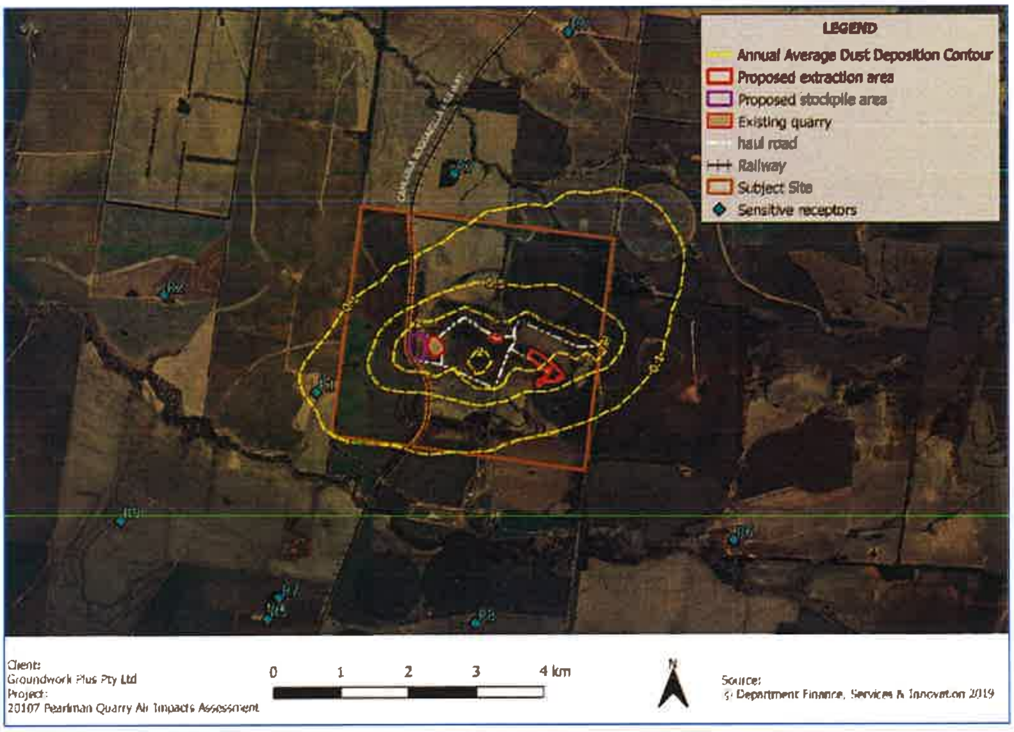


Figure 11: 100th Percentile Annual Average Incremental Dust Deposition Rate (Maximum Export Scenario) (Contour labels = 0.1, 0.5, 2 g/m²/month)

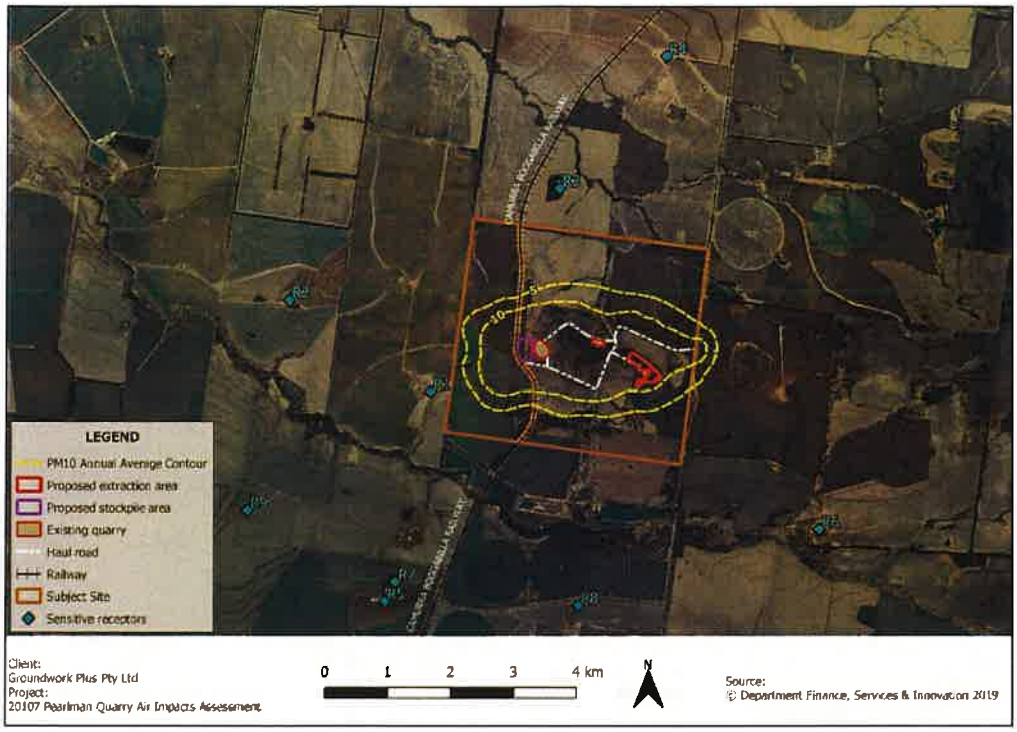


Figure 12: 100th Percentile Annual Average PM_{10} Concentration (Average Export Scenario) (Contour labels = 5, 10 µg/m³)

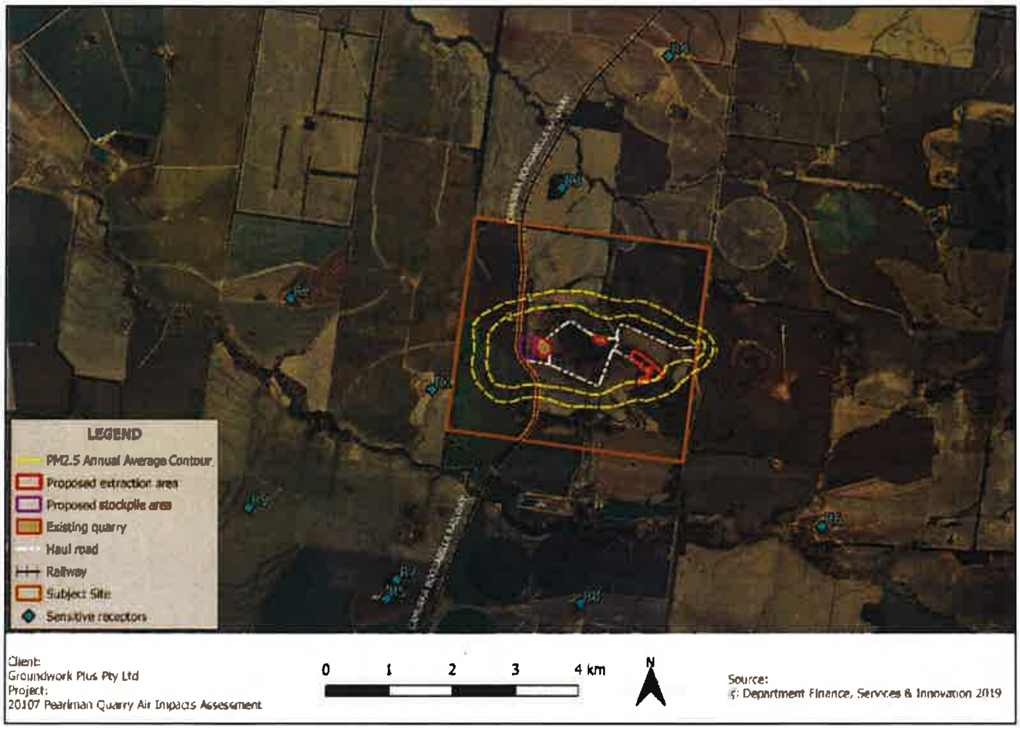


Figure 13: 100th Percentile Annual Average $PM_{2.5}$ Concentration (Average Export Scenario) (Contour labels = 1, 2 µg/m³)

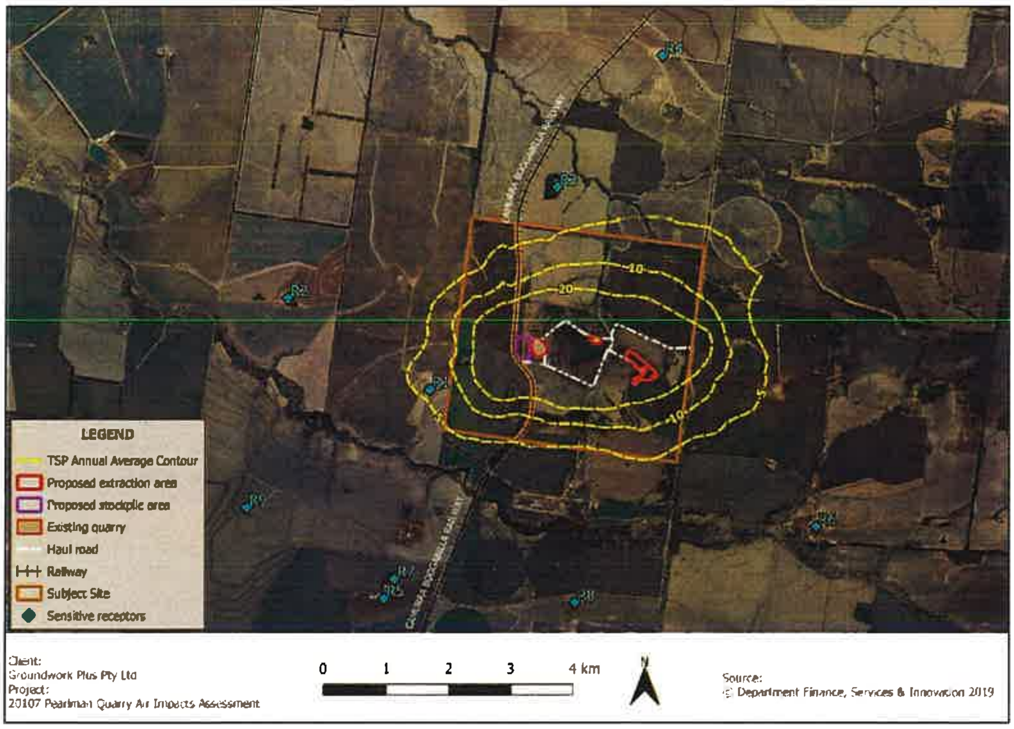


Figure 14: 100th Percentile Annual Average TSP Concentration (Average Export Scenario) (Contour labels = 5, 10, 25 μg/m³)

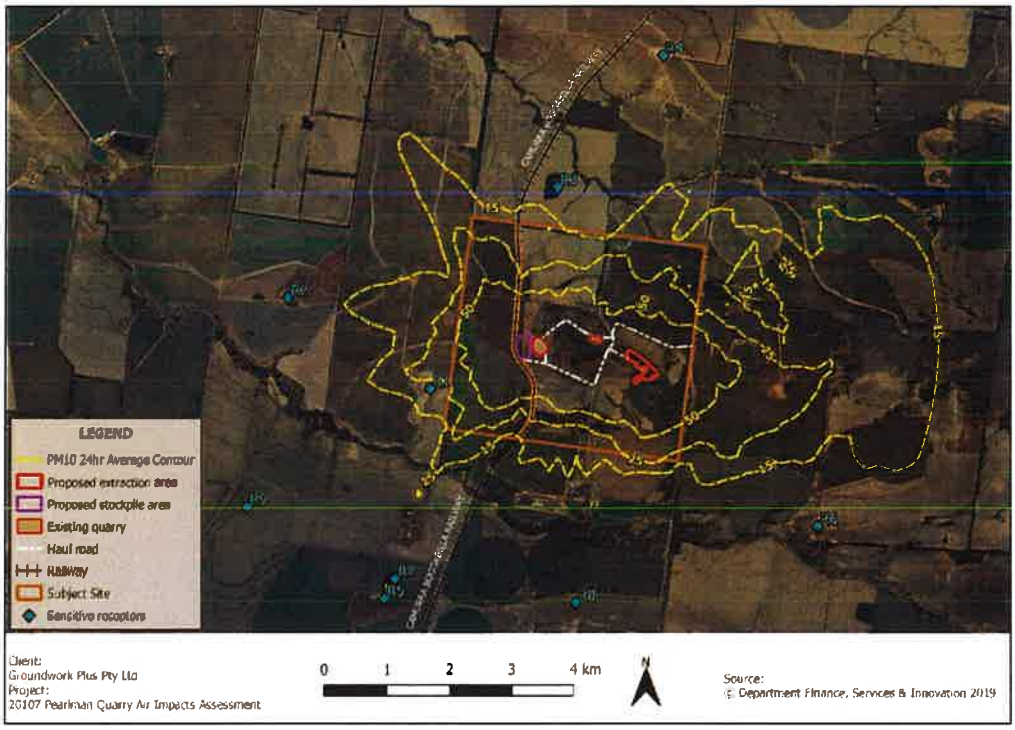


Figure 15: 100th Percentile 24-hr Average PM_{10} Concentration (Average Export Scenario) (Contour labels = 15, 25, 50 μg/m³)

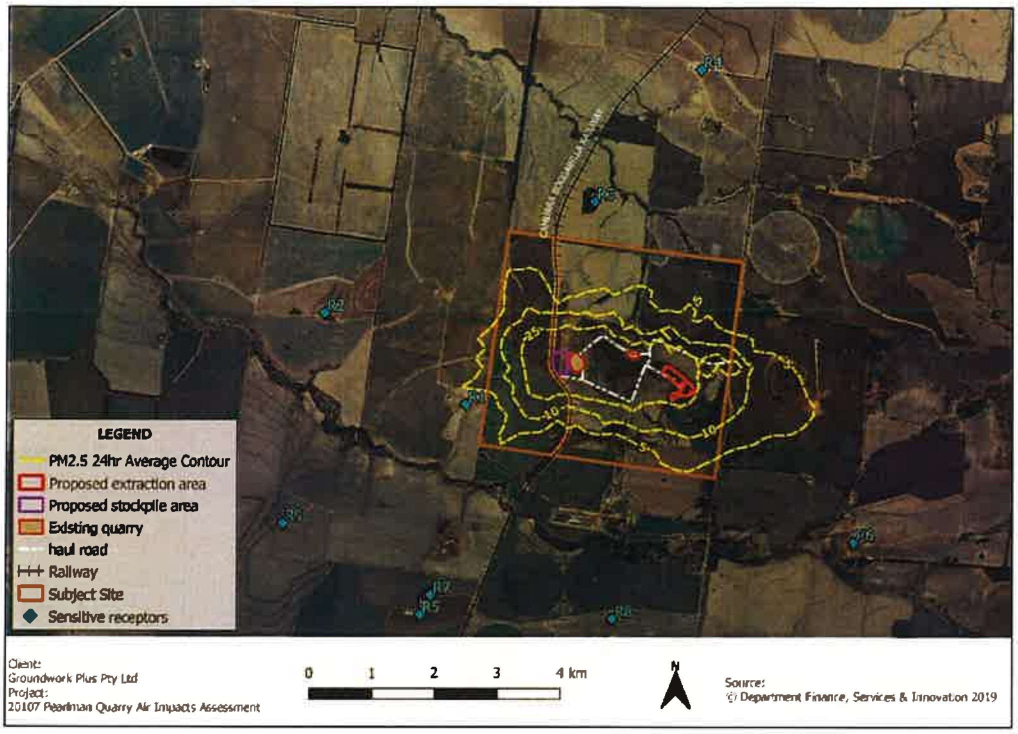


Figure 16: 100th Percentile 24-hr Average $PM_{2.5}$ Concentration (Average Export Scenario) (Contour labels = 5, 10, 25 µg/m³)

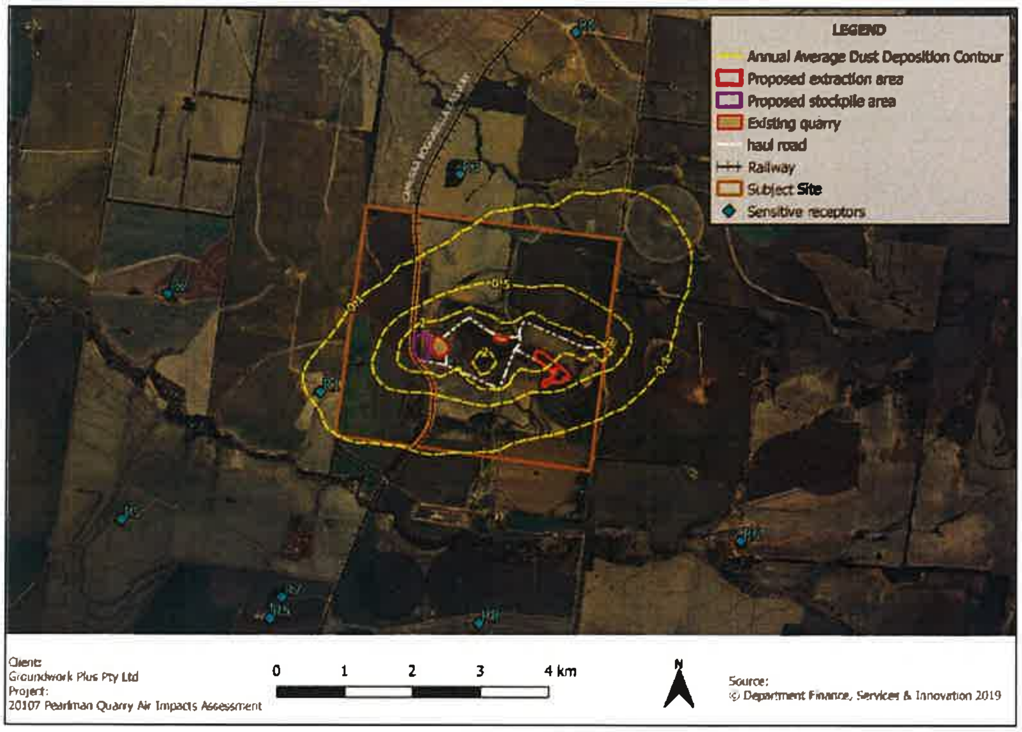
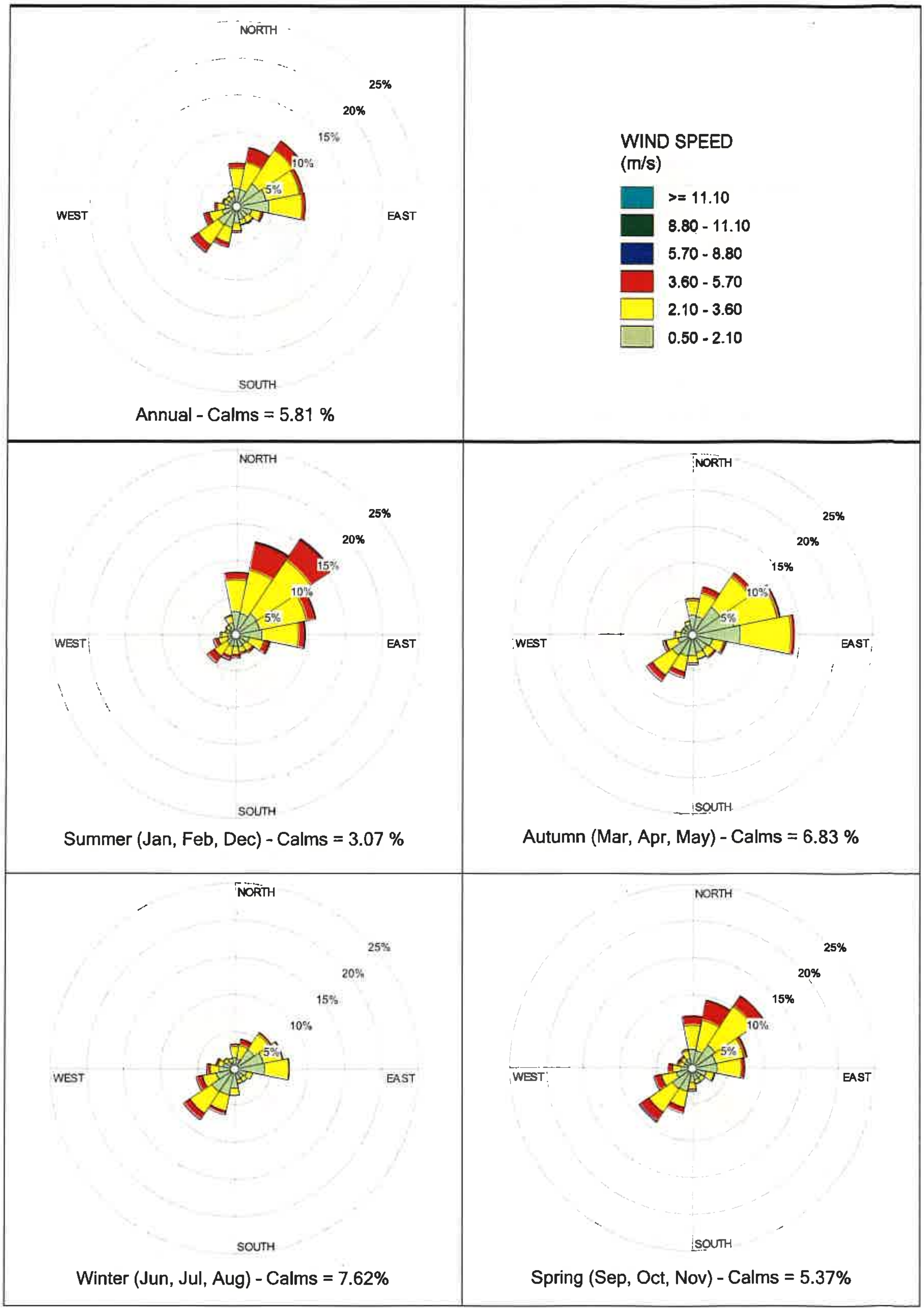


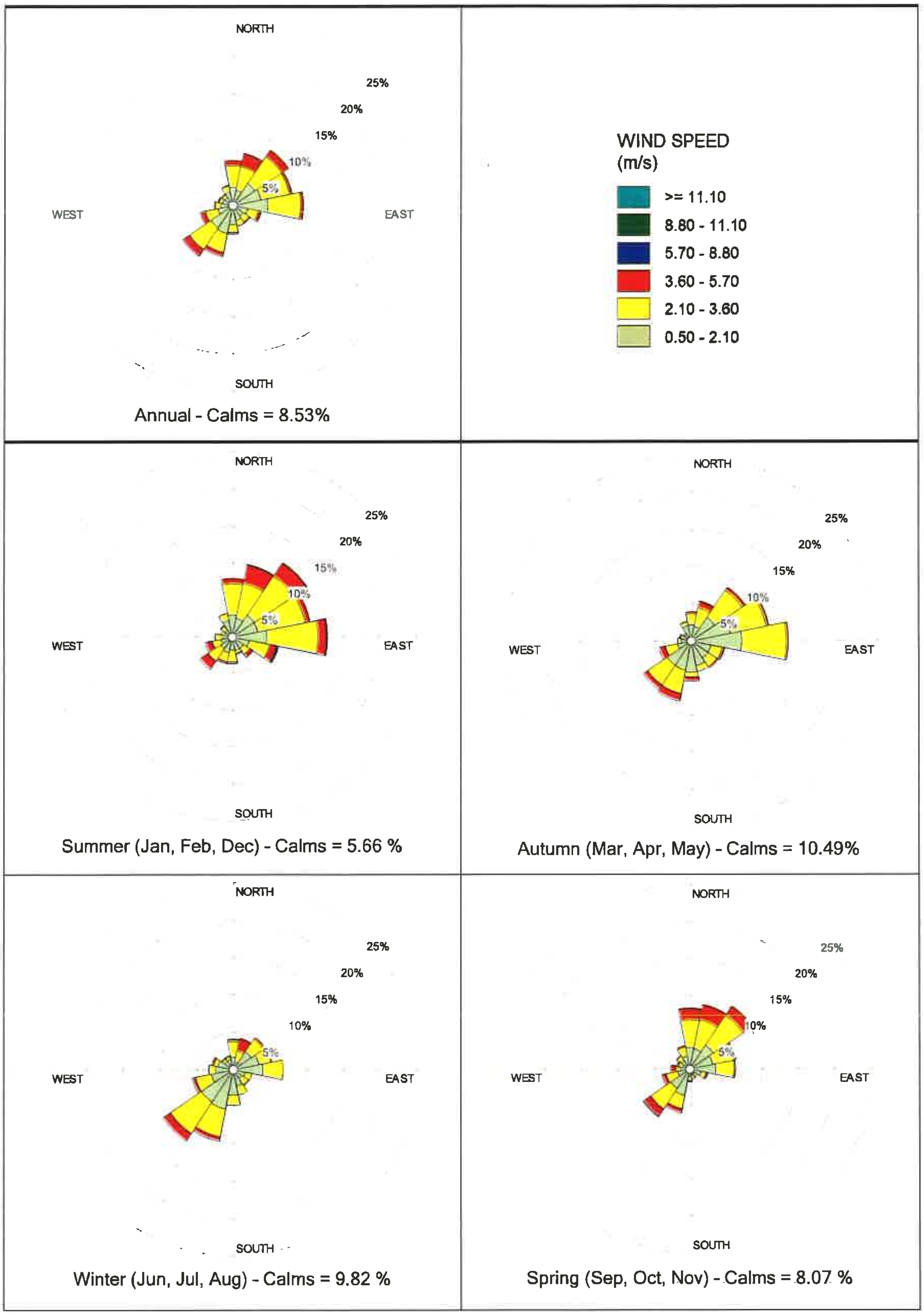
Figure 17: 100th Percentile Annual Average Incremental Dust Deposition Rate (Maximum Export Scenario) (Contour labels = 0.1, 0.5, 2 g/m²/month)

APPENDIX III: Moree Annual Wind Roses

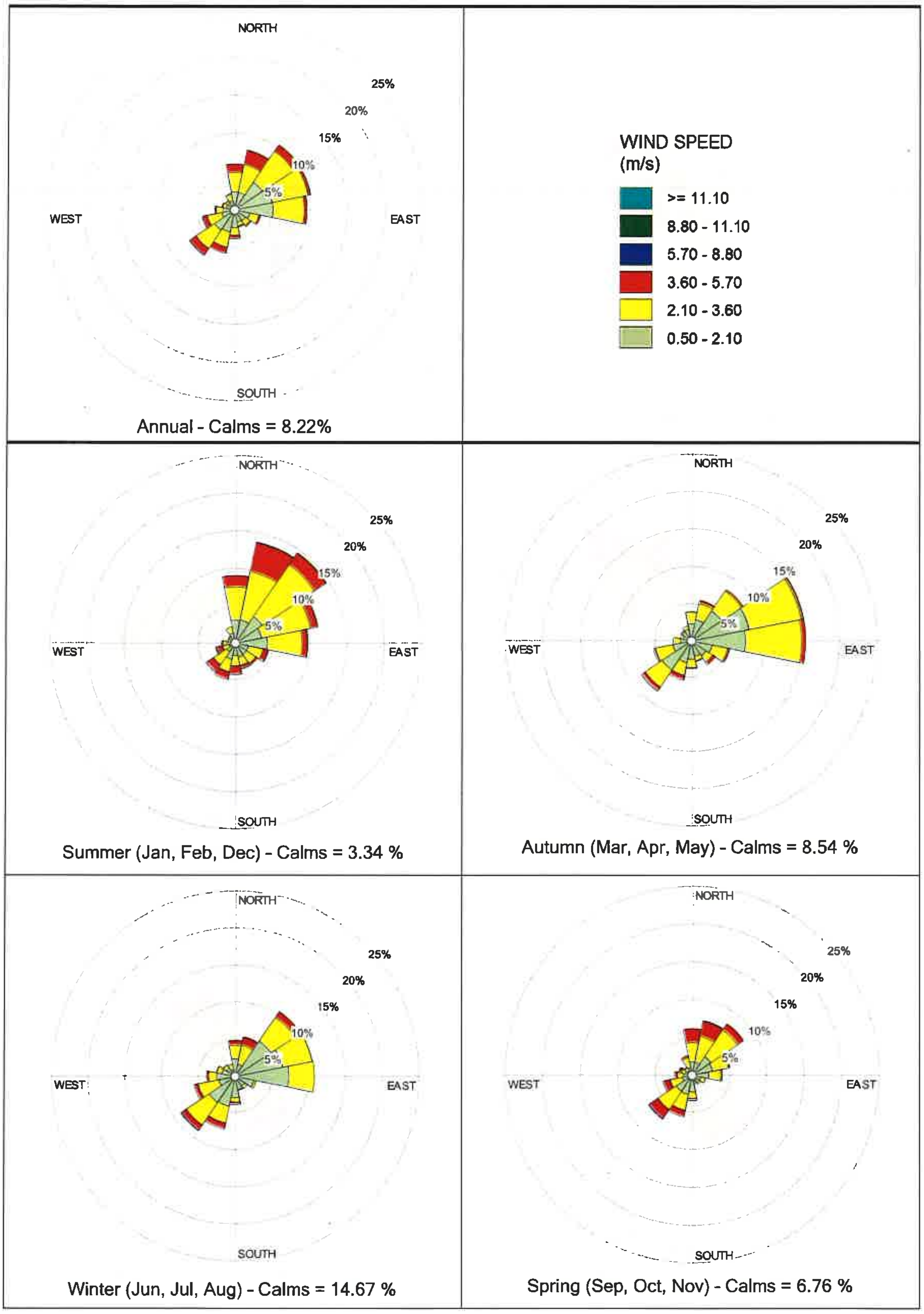
Moree AWS (60801) 2012 - 2017 Annual and Seasonal Wind Roses



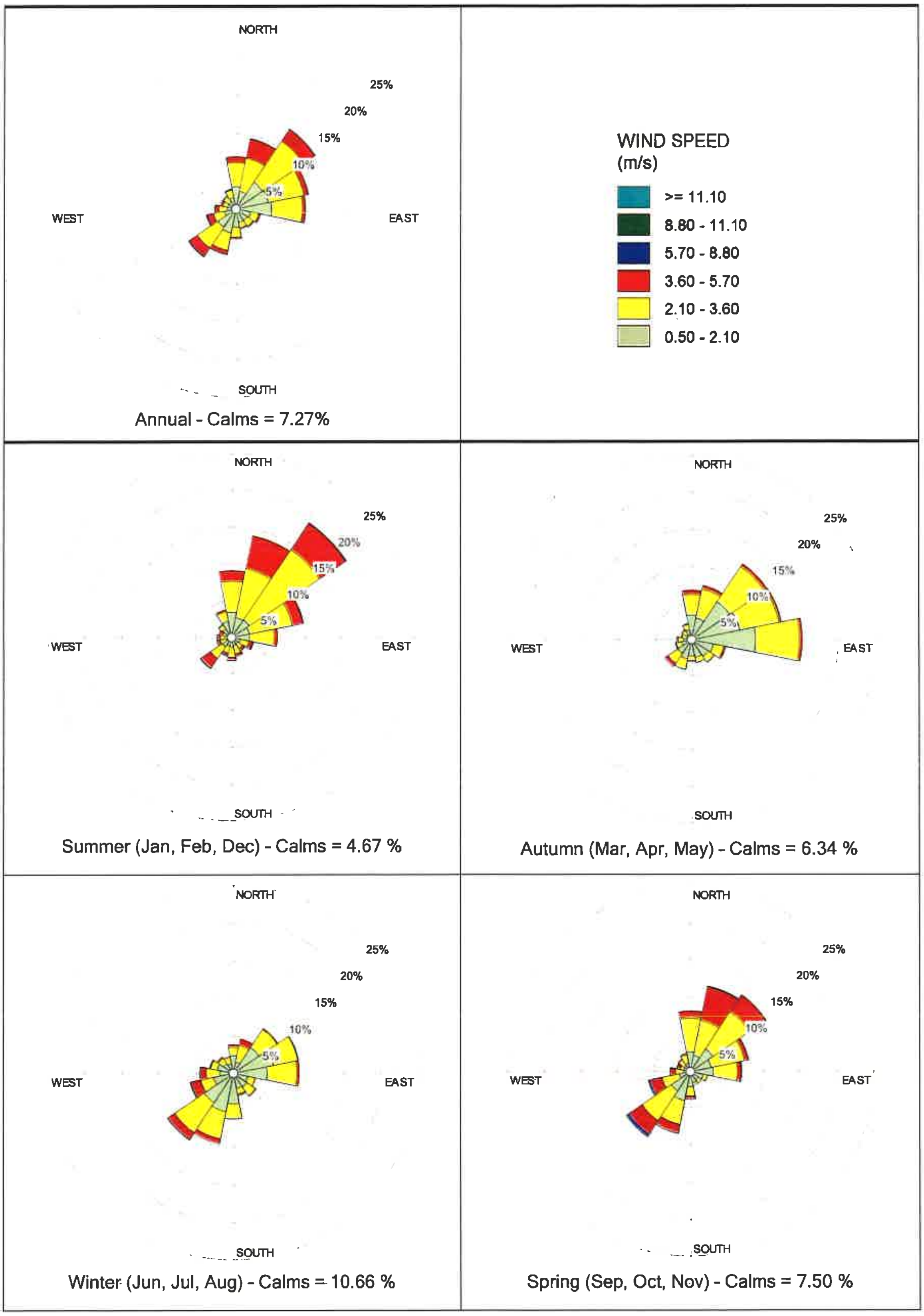
Moree AWS (60801) 2012 Annual and Seasonal Wind Roses



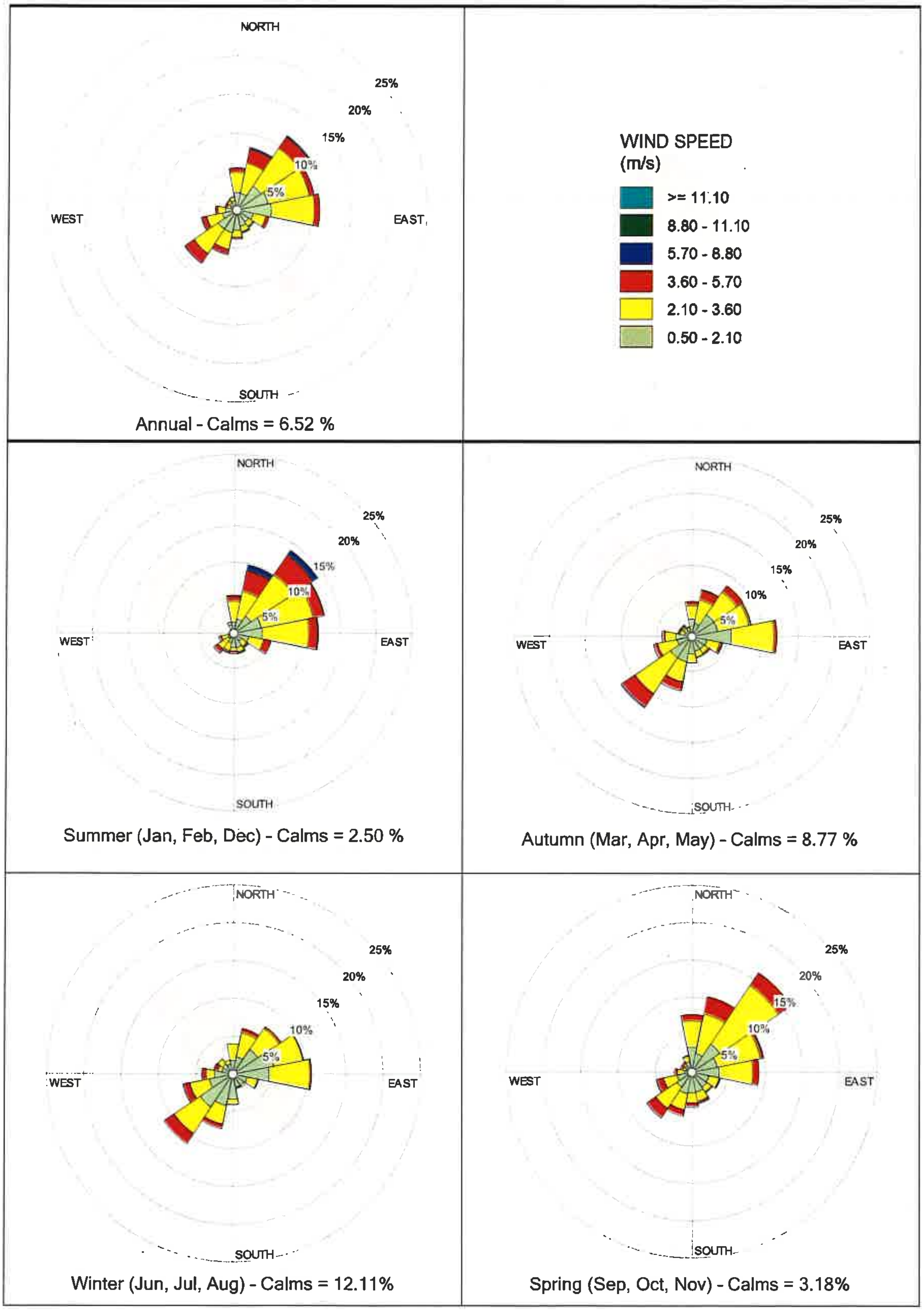
Moree AWS (60801) 2013 Annual and Seasonal Wind Roses



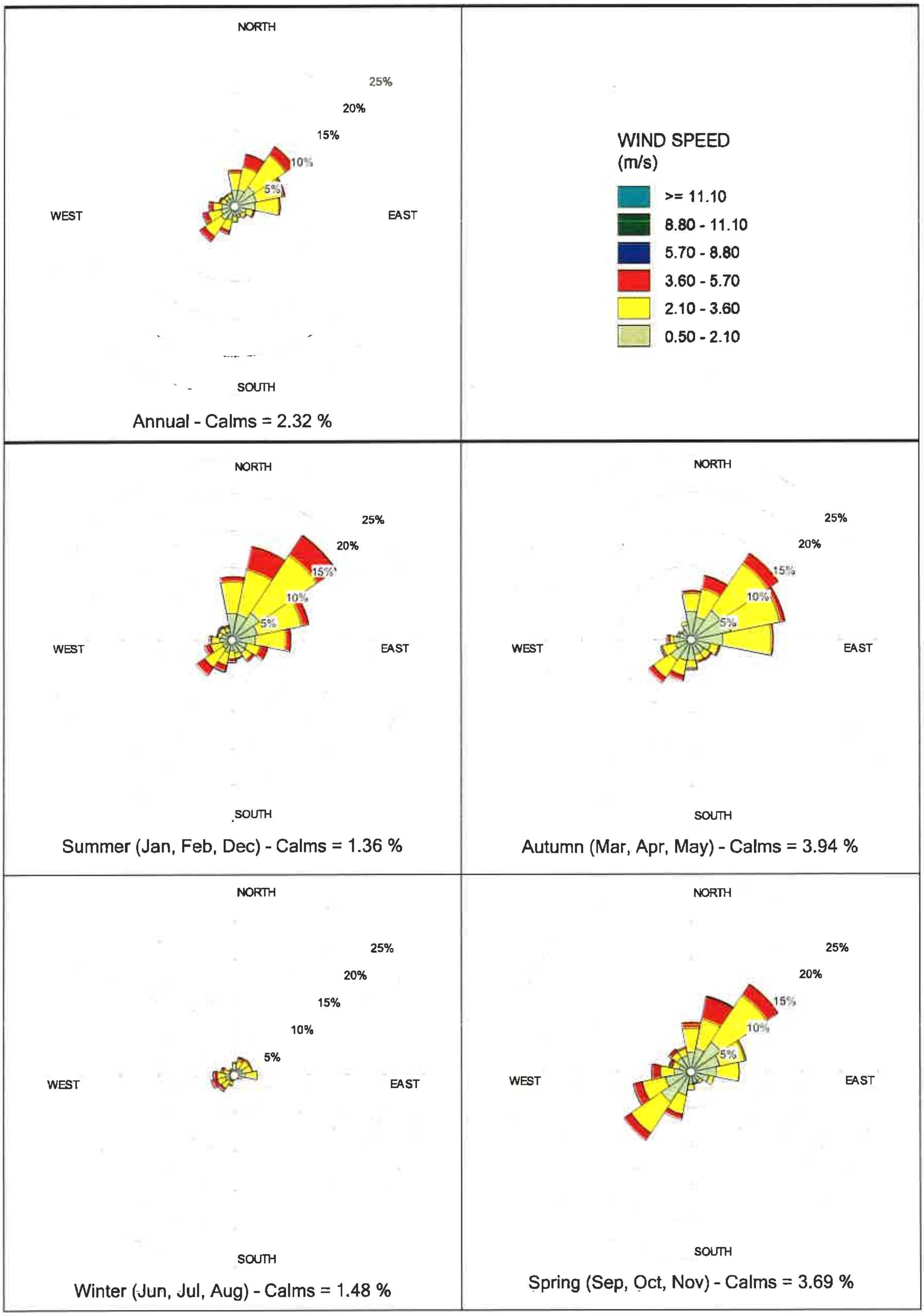
Moree AWS (60801) 2014 Annual and Seasonal Wind Roses



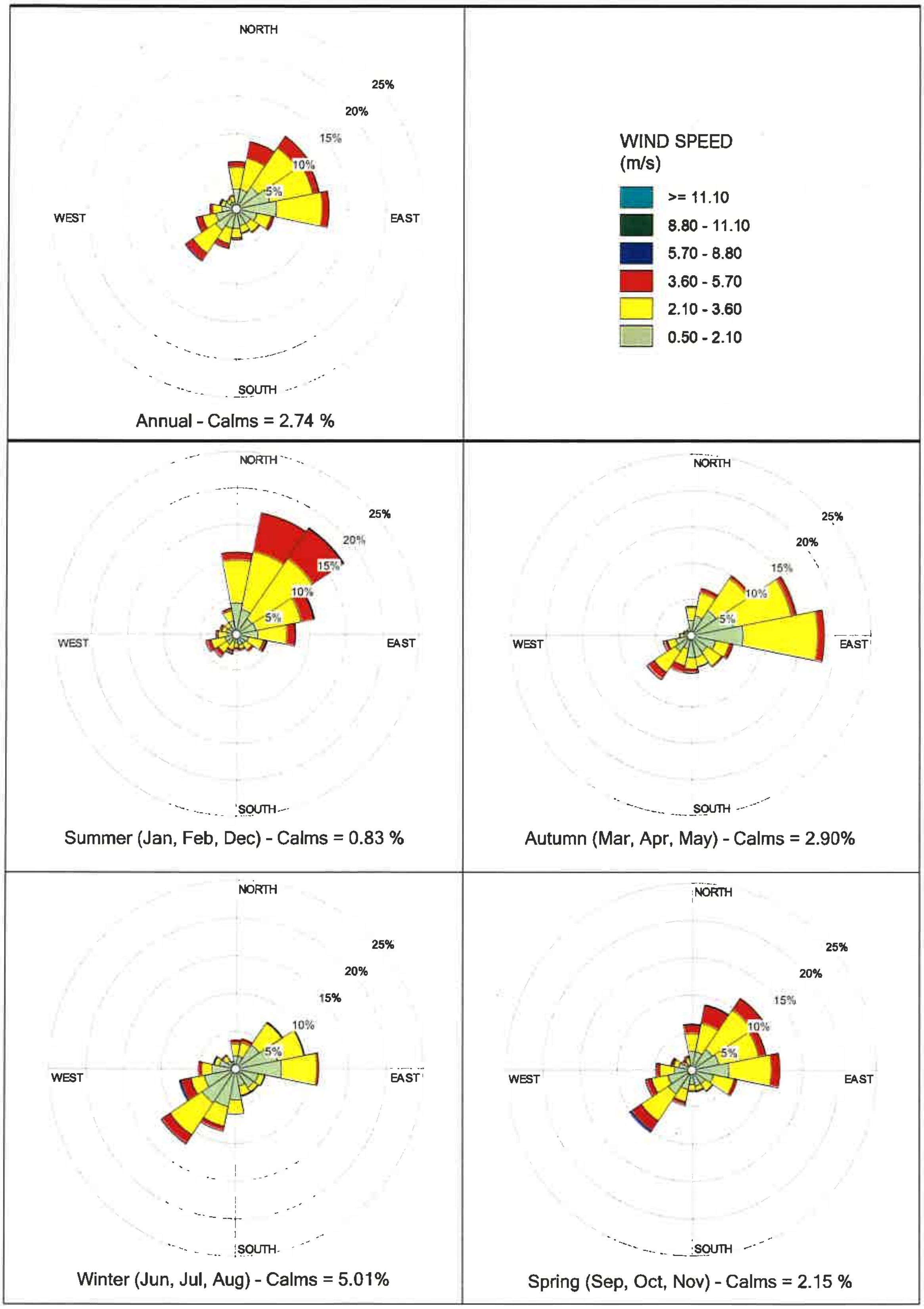
Moree AWS (60801) 2015 Annual and Seasonal Wind Roses



Moree AWS (60801) 2016 Annual and Seasonal Wind Roses



Moree AWS (60801) 2017 Annual and Seasonal Wind Roses



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Report

Noise Impact Assessment

Pearlmans Quarry

Quarry Solutions

12 August, 2019

Rev 0 (Final)

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Since 1988

the advitech group

Report Details

Noise Impact Assessment - Pearlmans Quarry

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Endorsements

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EXECUTIVE SUMMARY

Advitech Environmental was engaged to prepare an assessment of potential noise impacts associated with the development of the proposed Pearlman Quarry. The development is proposed to service bulk construction material requirements of the proposed North Star section of the Inland Rail project and would also service the Newell Highway project which involves key upgrades between Moree and Goondiwindi. The operation may produce up to 490ktpa of quarried material per annum.

Project Noise Trigger Levels for adjacent receiving environments were reviewed, and the assessment adopted the most stringent criteria for the project area. Modelling indicates that noise levels associated with the project are expected to meet these criteria, provided crushing plant and hard rock crushing activities are restricted to the day period. Stockpile maintenance and loading of trucks may be undertaken during the evening and night period (including the early morning period prior to 7:00) without expectation of adverse impact.

While adverse operational, construction and blasting impacts are not expected, this activity may be audible at some locations given the characteristics of the receiving environment. It is thus recommended that measures be put in place to ensure the timely and effective response to any concerns raised by adjacent receivers.

Road traffic noise associated with product haulage is not expected at residential receivers adjacent to the haulage routes. Impacts of 2dB(A) above the criteria may be observed at the North Star Public School under average haulage conditions. Mitigation and management of traffic associated with the proposed development should be implemented with the intention to reduce this minor impact and cumulative traffic noise impacts associated with future developments in the area.

Cumulative impacts associated with the operation of existing quarries within the project were assessed against the operational noise criteria. Assessment indicates that simultaneous quarry operations will comply with the established PNTL provided that crushing operations are restricted to the day period. Stockpile maintenance and loading of trucks may be undertaken during the evening and night period (including the early morning period prior to 7:00) without expectation of adverse impact.

Impacts associated with the operation of existing quarries on site during construction of the proposed quarry were assessed against the construction noise criteria. The results of modelling indicate that cumulative noise emissions from construction and existing quarrying activities are likely to be below NMLs for all receivers adjacent to the site.

Cumulative blast impacts may be effectively managed through a program of consultation with any other quarries within development area that are undertaking blasting, to ensure that blasting is not undertaken at the same time.

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APPENDICES

1. INTRODUCTION

Advitech Pty Limited (trading as Advitech Environmental) was engaged by Goundwork Plus Pty Ltd (Groundwork Plus) on behalf of Quarry Solutions Pty Ltd (Quarry Solutions) to undertake an assessment of potential noise impacts associated with the construction, operation and traffic noise for a proposed quarry at Croppa Creek, North Star, NSW. The proposed quarry operation is located on Lot 5 DP755984 1135 Croppa Creek Road, NSW. The proposed operation is referred to as the Pearlman Quarry herein. It should be noted that Pearlman quarry with be operating in conjunction with a pre-existing operational quarry on Lot 5 DP755984.

It should be noted that this report was prepared by Advitech Pty Limited for Groundwork Plus ("the customer") in accordance with the scope of work and specific requirements agreed between Advitech and the customer. This report was prepared with background information, terms of reference and assumptions agreed with the customer. The report is not intended for use by any other individual or organisation and as such, Advitech will not accept liability for use of the information contained in this report, other than that which was intended at the time of writing.

2. BACKGROUND AND OBJECTIVES

Quarrying activities at 1135 Croppa Creek Road associated with Pearlman quarry would involve the construction and operation of:

- a hard rock quarry to the east of the site;
- an internal haul road;
- site access from the east of the site; and
- a stockpile to the west of the site.

The existing operational quarries at this site are identified as a hard rock quarry and a gravel pit that has been previously worked. These sites are approximately 1000m apart and are located towards the centre of the Lot 5 DP755984. As mentioned above, this report will assess the noise and vibration impacts associated with the construction and operation of an additional hard rock quarry to the east of Lot 5 DP755984. The general arrangement of the project is provided in **Figure 1**.

The expansion of quarry sites on Lot 5 DP755984 would service construction of the Inland Rail project, currently under design and assessment by the Australian Rail and Track Corporation (ARTC). Aspects of the Noise Impact Assessment for the Inland Rail project (ARTC NIA) are referenced as part of this assessment.

The quarry will have a proposed yield of 490ktpa. The proposed operating hours are 6:00am to 18:00pm, Monday to Saturday. This assumes 10 hours of quarrying activities per day, with an allowance of 2 hours for maintenance activities. Potential requirements may exist for extended work hours to service short term increases in demand from the Inland Rail construction activity. This may involve 24-hour operations during some stages of the development.

2.1 Description of the Proposed Operations

Operations would involve the extraction (including explosive blasting), processing (crushing and sizing) and despatch of hard rock material. Where required, blasting would be undertaken between the hours of 9:00 and 17:00pm, Monday to Saturday. A review of proposed site activities was undertaken to establish an inventory of significant noise generating plant and processes. These include:

- Pre-blast drilling (where blasting is required);
- Excavation of material and transport (within the quarry) to a crushing plant;
- Operation of a crushing plant to size and screen the material;
- Operation of haulage trucks delivering material from the extraction area to stockpiles;
- Reclaim of stockpiled material for loading into trucks and trains;
- Haulage of quarried material from the site via road.

Advitech Environmental understands that the following mobile plant will be used within the operation:

- Drilling rig;
- Mobile crushing plant;
- Front End Loader(s) (FEL);
- Excavator(s);
- Dump Truck(s)
- Water-cart and grader;
- Dozer;
- Light service vehicles.

The mobile plant will be utilised for excavation of material from the quarries, management of the crushing plant, loading of heavy vehicles, and clearance of vegetation (ahead of the quarry shell, as required).

While production is likely to be variable, the assessment assumes that the quarry would generate an average of up to 92 heavy vehicle movements per day (46 laden trucks per day). During peak demand periods, it has been projected that up to 264 heavy vehicle movements may be generated per day (132 laden trucks per day). Peak demand periods are unlikely to occur on a prolonged basis, but flexibility is required so that service requirements to the Inland Rail project can be met. The peak periods will be offset by wet weather days and lower demand periods which may generate less material deliveries.

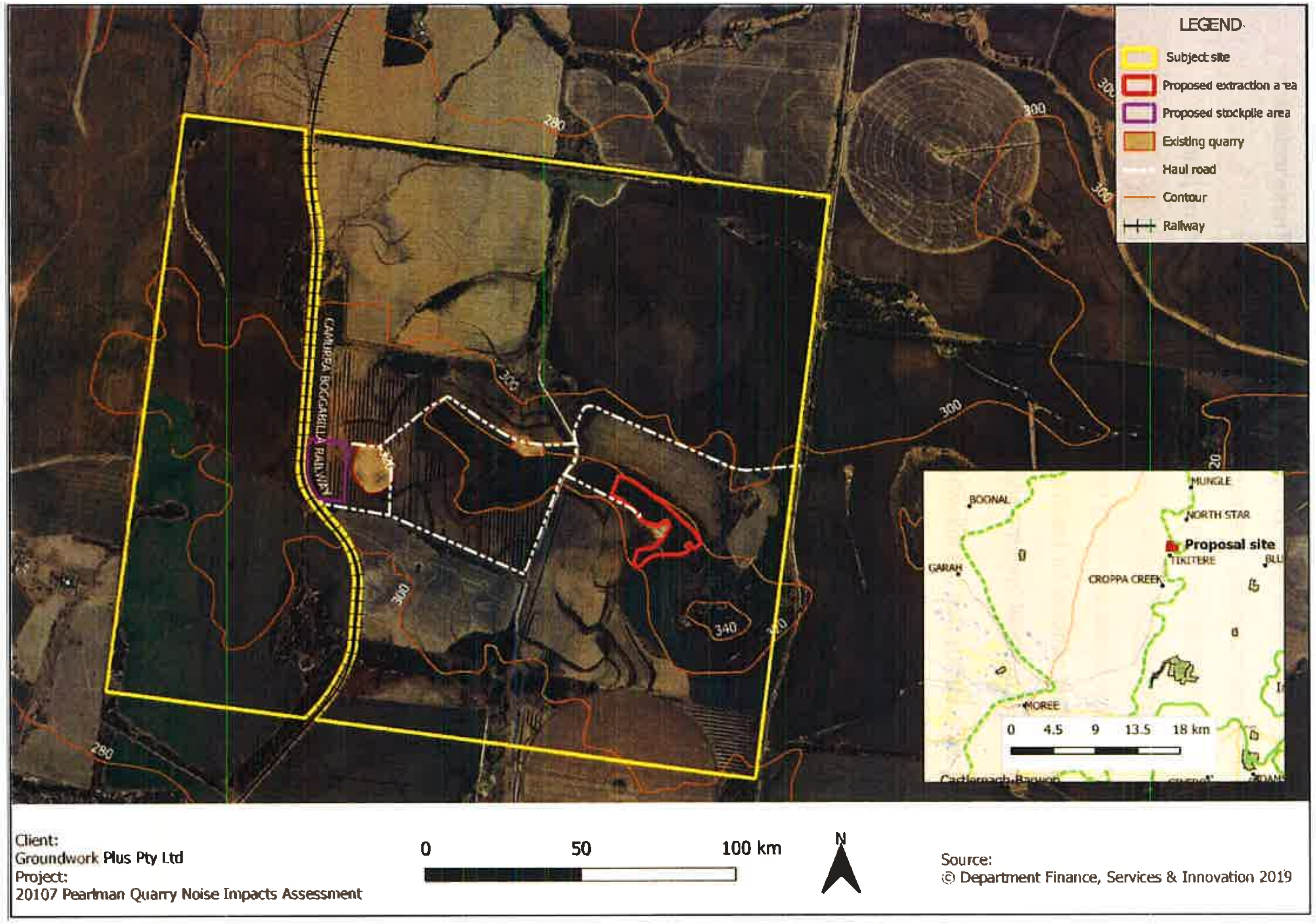


Figure 1:Conceptual Quarry Development Plan

3. METHODOLOGY

3.1 Assessment Requirements

The Secretary's Environmental Assessment Requirements (SEARs) (EAR 1331) establish the following requirements for:

- Noise: including a quantitative assessment of potential:
  - construction and operational noise and off-site transport noise impacts of the development in accordance with the *Interim Construction Noise Guideline, NSW Industrial Noise Policy* and *NSW Road Noise Policy* respectively;
  - reasonable and feasible mitigation measures to minimise noise emissions; and
  - monitoring and management measures;
- Blasting and vibration:
  - proposed hours, frequency, methods and impacts; and
  - an assessment of the likely blasting and vibration impacts of the development, having regard to the relevant ANZEC guidelines and paying particular attention to impacts on people, buildings, livestock, infrastructure and significant natural features.

3.2 Assessment Methodology

The methodology adopted to address the requirements established by the SEARs includes:

- An assessment of the existing environment, including:
  - identification of potentially sensitive receivers adjacent to the operation;
  - efforts to characterise the existing noise environment, identify relevant receiver types and establish Project Noise Trigger Levels (PNTL) for the assessment of potential impacts. Given the absence of significant ambient noise and the rural character of the proposed development site, minimum Rating Background Levels (RBLs) were assumed in lieu of a site specific (long term) assessment of background noise levels;
  - analysis of prevailing meteorology: to identify significant meteorological conditions that may influence the way that impacts associated with the development may manifest;
- Calculation of noise levels that may be generated by the development, including:
  - identification of significant operational and meteorological scenarios that may have potential to generate different levels of noise;
  - development of a noise model using Bruel and Kjaer Predictor software (ISO9613 calculation methodology) to derive predicted noise levels associated with the development at adjacent sensitive receivers;
  - determination of premises-based contributions from the development, using descriptors established by the relevant guidelines;
- Assessment of results, including:
  - recommendations for noise criteria that may be written into a development consent;
  - comparison of noise predictions against these criteria, and evaluation of potential impacts; and

- recommendations for management of potentially adverse or residual impacts.

3.3 Guidelines and Standards Referenced by this Assessment

The assessment was performed with reference to the following guidelines, policies and standards:

- AS1055:2018 Acoustics - Description and measurement of environmental noise;
- AS 2436 Guide to noise and vibration control on construction, demolition and maintenance sites;
- AS2187.2-2006 Explosives - Storage and Use Part 2: Use of Explosives;
- Noise Policy for Industry (NPfI). EPA, 2017;
- Interim Construction Noise Guideline (ICNG), EPA. 2008;
- Road Noise Policy (RNP). EPA, 2011;
- Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration (ANZEC, 1990); and
- Assessing Vibration: a technical guideline (EPA, 2006).

4. THE EXISTING ENVIRONMENT

4.1 Sensitive Receivers

Identification of potentially sensitive receivers was initially undertaken via cross referencing of:

- Aerial imagery;
- The Geocoded National Address File (G-NAF) (an open source national database of address points), maintained by the Federal Department of Industry, Innovation and Science;
- Limited ground truthing during field inspection.

Two distinct receiving environments were identified within the study area, including:

- Isolated receivers located in rural areas adjacent to the proposed quarry site; and
- Receivers in more densely populated areas at North Star, adjacent to the proposed haulage route for material exported from the site.

These receiving environments are described further below and in **Figure 2**.

4.1.1 Noise Environments Adjacent to the Quarry

Table 1 identifies noise sensitive receptors adjacent to the proposed development site. The nearest residence that is not associated with the proposed development (Receptor 1) is located approximately 1500m south west of the proposed stockpile site associated with hard rock quarry. The next closest receiver group (receivers 2 to 9) are located further to the west, north, south southeast, and south of the proposed operations.

Table 1: Details of sensitive noise receivers

Receiver ID	Address (Residences)	Distance from Site (m)	Direction
R1	1137 Croppa Creek Road	1500	W
R2	473 Birrahlee Road	3700	W
R3	1176 Oaklands Road	2200	N
R4	1835 Croppa Creek Road	4300	N
R5	391 Boonery Park Road (Lot 1 DP1080910)	3400	SSW
R6	1216 Croppa Creek Road	3400	ESE
R7	391 Boonery Park Road (Lot 54 DP751116)	3400	S
R8	141 Boonery Park Road	3500	S
R9	391 Boonery Park Road (Lot 1 DP751134)	4200	SSW

4.1.2 Noise Environments Adjacent to the Haul Route

Analysis was undertaken to identify receivers within 600m of the proposed haulage route, in line with guidance established in the RNP. This study area contains approximately 53 receivers, including:

- Isolated rural receivers adjacent to (and predominantly affected by) Croppa Creek Road
- Isolated rural receivers adjacent to (and predominantly affected by) IB Bore Road;
- Receivers located outside the township of North Star exposed to traffic noise from North Star Road; and
- Receivers located within the township of North Star exposed to traffic noise from both Edward Street and the North Star Road. This catchment is shown in **Figure 2.**

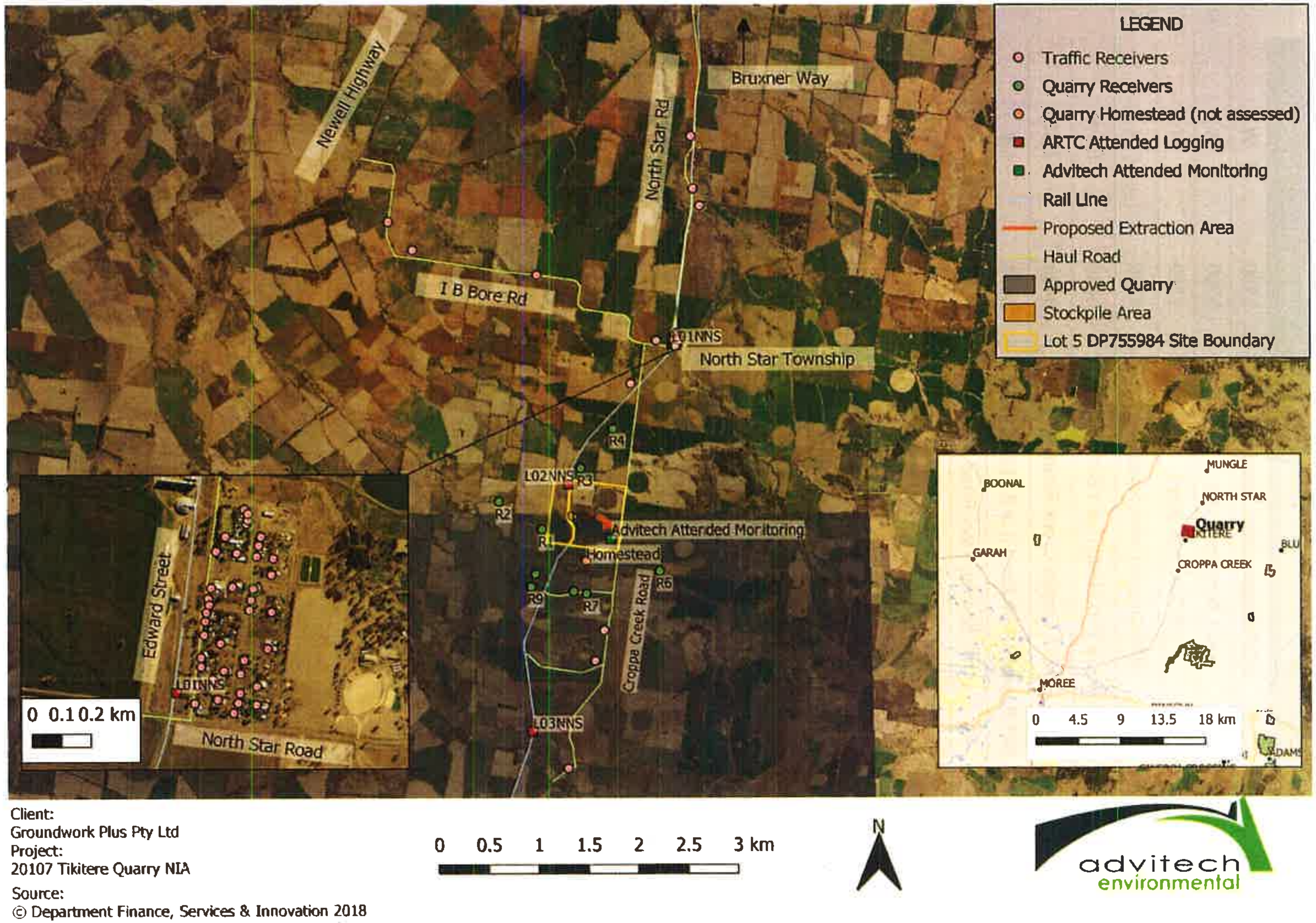


Figure 2: Sensitive receiver locations

4.2 Assessment Existing Noise Levels

During a site inspection on 8 January, 2019, site based environmental noise monitoring was undertaken to evaluate noise levels and predominant sources in receiving environments adjacent to the development site. The identified monitoring location was considered representative of typical receiver locations in the local environment.

As stated in **Section 2**, the ARTC NIA conducted for the construction and operation of the Inland Rail from North Star to Narrabri has been used as a reference to support attended noise monitoring results measured by Advitech Environmental, as it shares monitoring locations in a close vicinity to the proposed quarry operation.

Three monitoring locations (L01NNS, L02NNS and L03NNS) in close proximity to Lot 5 DP755984 and the township of North Star were identified, including:

- L01NNS, located at chainage 757km, within the township of North Star and predicted to be heavily influenced by road traffic noise,
- L02NNS, located at chainage 749km, within the site boundary; and
- L03NNS, located at chainage 734km, adjacent to the locality of Croppa Creek, approximately 10kms South of the site boundary.

A summary of results from both site based (Advitech Environmental) and regional (ARTC NIA) noise monitoring are presented in **Table 2**. The corresponding attended monitoring locations are displayed in **Figure 2.**

Table 2: Details of background monitoring

Source	Location	Date	Measured noise level dB(A)			Observations and instantaneous noise sources
			L_{90}	L_{10}	L_{Aeq}	
Advitech Environmental	South east boundary of site	8/1/2019 11:47	31	38	34	Birds, Wind gusts, Farm activities, road maintenance, road traffic
		8/1/2019 16:22	37	49	38	Wind gusts, Birds, distant road noise
ARTC NIA	L03NNS	1/3/2016 13:14	31	44	43	Birds 30-60; Wind noise 30-45;Road noise 33-39
	L03NNS	1/3/2016 13:31	33	48	46	Birds 30-60; Wind noise 30-40; Road noise 40-57
	L02NNS	1/3/2016 11:21	27	47	43	Road noise 30-35; Birds 28-30; Wind noise 35-57; Insects 30-35
	L02NNS	1/3/2016 11:38	25	43	40	Road noise 25-30; Wind noise 35-57; Insects 30-35
	L01NNS	1/3/2016 9:50	39	52	51	Road noise 44-65; Birds 38-52; Insects 36-38;Silo operations 45-48
	L01NNS	1/3/2016 10:09	41	55	55	Road noise 45-70; Birds, 40-60; Insects 35-45; Silo operations 45-52

4.3 Assessment of Prevailing Meteorology

The NPfI identifies that meteorological conditions may enhance noise propagation from industrial sites to distant sensitive receivers. The guide provides two options for the assessment of these impacts:

- a simple method, which adopts worst case noise enhancing conditions;
- a more detailed analysis of prevailing meteorology, to identify whether enhancing conditions occur with sufficient frequency to be considered a feature of the local environment:
  - where enhancing conditions occur with sufficient frequency, noise enhancing meteorological parameters should be adopted by the noise modelling;
  - where enhancing conditions are not a feature of the environment, modelling should adopt the standard meteorological parameters.

Definitions of the standard and enhancing conditions established by the NPfI are reproduced in **Table 3**. The NPfI indicates that where a wind or stability condition may occur for more than 30% of the time during any assessment period (day, evening or night) of any season, then the parameters for noise enhancing conditions should be adopted as part of the assessment.

Table 3: Standard and noise-enhancing meteorological conditions

Meteorological Condition	Meteorological Parameters
Standard conditions	Day/evening/night: stability categories A-D with wind speed up to 0.5 m/s at 10 m AGL.
Noise-enhancing conditions	Daytime/evening: stability categories A-D with light winds (up to 3 m/s at 10 m AGL) Night-time: stability categories A-D with light winds (up to 3 m/s at 10 m AGL) and/or stability category F with winds up to 2 m/s at 10 m AGL.

The nearest Bureau of Meteorology (BoM) Automatic Weather Station (AWS) is located at Moree Airport, approximately 65km south west of the proposed development site. Monitoring records from Spring 2016 through to Winter 2017 were analysed to identify whether any prevailing wind patterns may be considered a feature of this environment.

The results presented in **Table 4** indicate that none of the prevailing winds are observed for more than 30% of the time during any season. Prevailing winds are therefore not considered significant feature of this environment, and standard meteorological conditions were adopted for the assessment of potential gradient wind impacts. Seasonal wind-roses are provided in **Appendi14.AI**.

Table 4: Frequency of most dominant prevailing winds (+/-22.5deg, <3m/s)

Season	Day	Evening	Night
Spring	SE (7%), E, S, SW (6%)	NE (3%), E, SE, S (2%)	NE (3%), E, SE (2%)
Summer	SE (5%), E, SE (4%)	E, SE, S (1%)	E, SE, S (1%)
Autumn	S, SW (10%), SE (9%)	NE, E (3%), N, SE, S (2%)	NE (3%), E, SE (2%)
Winter	E (10%), NE, (9%), SE (8%)	NE, E, SE (5%)	NE, E (3%), N, SE (2%)

The AWS at Moree Airport does return observations that would enable assessment of atmospheric stability and temperature inversion frequency; however, previous experience suggests that these phenomena have potential to be a feature in rural environments. On this basis, the parameters for noise enhancing conditions are conservatively adopted in noise modelling.

4.4 Assessment of Existing Road Traffic

Data relating to the most recent existing traffic volume analyses in the study area was adapted from AADT data provided by the Gwydir Shire Council (GWC), and a traffic impact assessment conducted for the existing quarry by SMK Consulting Pty Ltd (SMK TIA). This existing traffic volume data is assumed to incorporate haulage movements generated by the existing quarry on the proposal site. An adapted summary of traffic volume data relevant to the study area (Croppa Creek Road, IB Bore Road, Bruxner and North Star Road / Edward Street) is provided in below in **Table 5**. Unattended noise monitoring results for existing levels of ambient and background noise within the township of North Star have been adapted for the ARTC NIA and are presented in **Table 6.**

Table 5: Existing road traffic

Road	Date of Observation[2]	Average Daily Traffic (ADT)	Current Heavy Vehicle Movements per Day
Croppa Creek Road	July 2019	161	50 (31%)
Croppa Moree Road	July 2019	158	32 (20%)
IB Bore Road	March 17	18	2 (14%)
Bruxner Highway	July 2019	194	31 (16%)
North Star Road / Edward Street	July 2019	159	27 (17%)

Note 1: Data provided by GWC

Note 2: Data provided by SMK Consulting

Note 2: Most recent date of observation used for analysis of existing road traffic

Table 6: ARTC unattended monitoring (extract table 2.3)

Location	L_{A90} RBL noise levels			L_{Aeq} ambient noise levels		
	Day	Evening	Night	Day	Evening	Night
LO1NNS[1]	39	39	41	49	50	50

5. ASSESSMENT CRITERIA

5.1 Project Trigger Noise Levels

The ARTC NIA also undertook assessment of longer term unattended monitoring results at the two locations adjacent to the proposed development site. These results are reproduced in **Table 7**.

Table 7: ARTC unattended monitoring (extract table 2.3)

Location	L_{A90} RBL noise levels			L_{Aeq} ambient noise levels		
	Day	Evening	Night	Day	Evening	Night
LO2NNS	19	23	32	46	43	41
LO3NNS	27	30	35	45	47	45

The operator attended (**Table 2**) and unattended monitoring results (**Table 7**) indicate that receiving environmental adjacent to the proposed development site may be considered representative of the rural receiver type identified by the NPfI.

5.2 Assessment of PNTL

The NSW Noise Policy for Industry (NPfI) presents a methodology for determining Project Noise Trigger Levels (PNTL) for industrial development. Ambient and background noise measurements are used to determine PNTL relevant to the proposed development. Assessment in **Table 8** establishes the RBL for the project based on the pool of RBLs available.

Table 8: Assessment of RBLs relevant to the assessment

RBL Dataset	Day	Evening	Night
Assessed RBL L02NNS	19	23	32
Assessed RBL L03NNS	27	30	35
Minimum RBL NPfI	35	30	30
Adopted RBL	35	30	30

The NPfI minimum RBL were adopted for the day, evening and night periods. While marginally higher RBLs were reported in the ARTC NIA for the night period, the minimum level was conservatively adopted so as to avoid having a less stringent limit at night that during the evening period. **Table 9** provides an analysis of both the Intrusiveness and Amenity noise levels for the purposes of establishing a PNTL for the proposed development. Section 2 of the NPfI establishes that the lower of the Amenity and Intrusiveness noise levels should be adopted as the PNTL for the development.

Table 9: Assessment of PNTL in adjacent receiving environment (dB(A))

Metric	Day	Evening	Night
Rating Background Level	35	30	30
Project Intrusiveness Criteria	40	35	35
Recommended Amenity Level	50	45	40
Project Amenity Criteria	48[1]	43[1]	38[1]
Project Trigger Noise Level	40	35	35

Note 1: Project amenity level established as level equal to the Recommended Amenity Noise Levels for Rural receivers minus 5dB(A) plus 3dB(A) to convert from a period level to a 15-minute level, in accordance with guidance established in Fact Sheet F of the NPfI.

The Project Intrusiveness Criterion is the more stringent of the two criteria and is thus adopted as the PNTL for the development.

5.3 Maximum Noise Level Triggers

The NPfI provides updated guidance relating to the assessment of maximum noise level events that carry potential to cause sleep disturbance. In this context, potential for sleep disturbance is considered in terms of events that may induce awakenings or cause disturbance to sleep stages. The guide establishes the following requirements:

Where the subject development night-time noise levels at a residential location exceed:

- *$L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater, and/or*

- *L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater,*

... a detailed maximum noise level event assessment should be undertaken.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the rating background noise level, and the number of times this happens during the night-time period. As approval for 24-hour operations is sought, assessment of potential maximum noise level events forms part of this assessment. The Maximum Noise Level Triggers adopted as part of this assessment are provided in **Table 10**.

Table 10: Maximum Noise Level Triggers (MNLT)

Metric	MNLT
$L_{Aeq,15minute}$	40 dB(A)
L_{AFMax}	52dB(A)

5.4 Construction Noise Criteria

The NSW *Interim Construction Noise Guideline* (ICNG) (2009) provides guidance on managing construction works to minimise noise. Equipment and site activities during construction are likely to be similar to those occurring during operation of the quarry. However, it's likely that equipment will be operating at (or close to) natural surface levels during initial excavation of the quarry workings and associated stockpile areas. This means that higher noise levels may be expected relative to operational noise levels, which may benefit from attenuation by the quarry pit.

The Noise Management Levels (NMLs) relevant to construction noise are typically slightly higher than for operations noise, as the construction activity typically represents a shorter-term impact. **Table 11** summarises the NMLs relevant to the proposed development. It is noted that the NMLs are not statutory criteria above which impacts are deemed to be non-compliant, but the level at which reasonable and feasible management measures would be required.

Table 11: Construction Noise Management Levels, $L_{Aeq,15\ minute}$

Receiver Type	Construction Hours	Management Level ($L_{Aeq,\ (15\ min)}$)	
Residential Receivers	Monday to Friday: 7am to 6pm Saturday: 8am to 1pm	Noise Affected NML (RBL + 10 dB)	45 dB(A)
		Highly Noise Affected NML	75 dB(A)
	Outside recommended standard hours	Noise Affected NML (RBL + 5 dB)	40 dB(A)

5.5 Road Traffic Noise Criteria

The NSW RNP (2011) provides a framework for the management of noise issues associated with road traffic from existing roads, new road projects, road redevelopment projects and new traffic-generating developments. The primary aim of the RNP is to provide assessment criteria for road traffic noise based on protecting amenity and wellbeing.

The criterion adopted for this assessment is provided in **Table 12** and **Table 13**. This is based on review of existing receiving environments, and description of road types established in the RNP. Contributions from road traffic generated by the proposed development may be compared against management levels (or existing traffic noise levels) to evaluate potential project related impacts.

Table 12: Road traffic noise assessment criteria for residential land uses

Road Category	Type of Project / Land Use	Assessment Criteria - dB(A) Day 7am - 10pm	Night 10pm - 7am
Local Roads	Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq,(1hour)}$ 55 (external)	$L_{Aeq,(1hour)}$ 50 (external)
Freeway / arterial / sub-arterial roads	Existing residences affected by additional traffic on existing freeways / arterial / sub-arterial roads generated by land use developments	$L_{Aeq,(15hour)}$ 60 (external)	$L_{Aeq,(9hour)}$ 55 (external)

Table 13: Road traffic noise assessment criteria for non-residential land uses

Land Use	Assessment Criteria Day	Night	Additional Considerations
School Classroom	$L_{Aeq,1hour}$ 40dB (internal, when in use)	n/a	In the case of buildings used for education or health care, noise level criteria for spaces other than classrooms and wards may be obtained by interpolation from the 'maximum' levels shown in Australian Standard 2107:2000 (Standards Australia 2000)
Open Space (Active Use)	$L_{Aeq,15hour}$ 60dB(A) (external)	n/a	Active recreation is characterised by sporting activates

5.6 Ground Vibration and Air-blast Overpressure Criteria

The NSW EPA recommends that impacts associated with blasting be assessed in accordance the Australian and New Zealand Environment Council (ANZEC 1990) *Technical basis for guidelines to minimise annoyance due to blasting overpressure and vibration*. The guideline establishes the following criteria to minimise annoyance associated with blasting:

- Air-blast Overpressure:
  - the recommended peak maximum level for air blast overpressure at sensitive receivers is 115 dB(Lin); and
  - the maximum air blast overpressure level should not exceed 115 dB(Lin) during more than 5% of blasts in any 12 month period, and should never exceed 120 dB(Lin);
- Ground Vibration:
  - the recommended maximum peak particle velocity (PPV) value of 5 mm/s; and
  - the maximum PPV should not exceed 5mm/s during more than 5% of blasts in any 12 month period, and should never exceed 10 mm/s; and
- Timing:
  - blasting should be restricted to the hours 9:00 to 15:00pm, Monday to Saturday; and
  - blasting should not take place on Sundays or public holidays.

These criteria represent thresholds for the assessment of potential impacts at residential receivers adjacent to the proposed development. Australian Standard AS2187.2-2006 provides outline methods for evaluating potential ground vibration and air blast overpressure impacts.

6. ASSESSMENT OF OPERATIONAL NOISE LEVELS

6.1 Operational Activities

A model of operational noise impacts was constructed using the ISO9613 calculation method within the Predictor-Lima software package. The proposed operation is comprised of a number of noise generating activities, including:

- Drilling to prepare the quarry for blasting;
- Operation of the quarry, crushing plant, stockpiling and reclaim at quarry areas;
- Haulage of material in heavy vehicles along internal hauls routes within the site;
  - noise generated by heavy vehicle haulage from the quarry areas to the rail loading point (wholly contained within the boundary of the site)
  - noise generated by heavy vehicle haulage along public roads (i.e. during delivery to end users) is addressed in **Section 8**, as part of the road traffic noise assessment.

A summary of Sound Power Level (SWL) for plant utilised during these operational phase activities are shown in **Table 14.** Given that the configuration of the quarrying plant will not be determined until the approval is in place, assumptions relating to equipment and power levels were determined on the basis of the production rates that are sought. Where information was not available directly from the proponent, SWL data were sourced from a library of representative plant, and cross referenced against existing assessment of similarly sized quarrying operations.

Table 14: Operational stage noise sources

Scenario	Description of Utilisation	Plant	SWL, dB(A)	Total SWL for Scenario, dB(A)
Pre-blast Drilling	Drilling rig operating to drill blast pattern	Drill Rig	117	117
Quarrying Operations	Including extraction, crushing and sizing operations	Jaw Crusher	124	127
		Secondary Crusher	118	
		Screen	116	
		Excavator	108	
		Front End Loader	108	
		Dozer	116	
		Dump truck	112	
		Water Truck	109	
		Grader	113	
		Generator / Site Power	96	
Truck loading and Haulage	Loading and movement of heavy vehicles between quarry & stockpile areas , and on internal haul roads	Road Registered Heavy Vehicle (Truck & Dog)	109	112 (116 L_{AMax})
		Front End Loader	108	

The operational noise model assumes:

- Progressive extraction from benches within a formed pit. The floor of the pit is located at an RL of approximately 320m AHD;
- Crushing and screen plant centrally located within the pit;
- Pre-blast drilling takes place at natural ground level ahead of the pit, but does not occur during the evening or night period;
- Material is reclaimed from temporary stockpiles adjacent to screening sizing plant, and transported to a formed stockpile area approximately 1300m west of the pit; and
- Product is hauled from the site along an internal haul route, then onto Croppa Creek Road.

The operational model results presented in **Table 15** assume that operation occurs in isolation from existing quarry operations outlined in **Section 2.** Detailed assessment of cumulative impacts associated with existing quarry operations are outlined in **Section 10.**

6.2 Meteorological Scenarios

This operational configuration was modelled using enhancing meteorological parameters, following analysis of prevailing meteorology presented in **Section 4.2**. This includes:

- assessment under daytime (standard) conditions:
  - stability category D with 0.5m/s winds from the NE, E, S and NW: to evaluate propagation towards the various receiver locations;
- assessment under (enhancing) conditions which may occur during the evening and night:
  - light drainage winds (2m/s) that may be observed under stable atmospheric conditions (Pasquil Gifford Stability Class F). Drainage winds were assumed to occur in a NE to SW direction.

6.3 Noise Level Predictions

A summary of predicted $L_{Aeq,15minute}$ noise levels at the nearest sensitive receivers associated with operation of the proposed quarry (including simultaneous pre-blast drilling, quarrying and stockpiling activities) is provided in **Table 15**.

Table 15: Worst case noise impact predictions $L_{Aeq,15minute}$ dB(A)

	Predicted $L_{Aeq,15minute}$				PNTL (D /E / N)	Above PNTL?
	Day		Evening / Night			
Receiver	Calm	Enhancing	Calm	Enhancing	$L_{Aeq,15minute}$	
R1	32	32	34	34	40 / 35 / 35	No
R2	<30	<30	< 30	< 30	40 / 35 / 35	No
R3	31	31	31	31	40 / 35 / 35	No
R4	34	34	**36**	34	40 / 35 / 35	Yes Evening / Night
R5	33	33	34	34	40 / 35 / 35	No
R6	30	30	32	32	40 / 35 / 35	No
R7	<30	<30	31	31	40 / 35 / 35	No
R8	35	35	**36**	**36**	40 / 35 / 35	Yes Evening / Night

Receiver	Predicted $L_{Aeq,15minute}$ Day Calm	Day Enhancing	Evening / Night Calm	Evening / Night Enhancing	PNTL (D /E / N) $L_{Aeq,15minute}$	Above PNTL?
R9	32	32	33	33	40 / 35 / 35	No

The results of modelling indicate that predicted operational noise levels will be below the PNTL at all receiver locations during the day period. Results indicate that noise contributions above the PNTL at receivers R4 and R8 are likely if the quarry operates during the evening and night period. In all instances, operation of the crushing plant and hard rock crushing activities are the dominant contributor.

6.4 Maximum Noise Level Predictions

Assessment of predicted noise levels associated with short-term high-level events (L_{AMax}) with potential to cause sleep disturbance at adjacent sensitive receivers are provided in **Table 16**. Loading of material into train wagons, hoppers or truck bodies was identified as the activity most likely to generate peak noise events. Modelling results presented in **Table 16** indicate that maximum noise levels are not expected to exceed the MNTL of 52dB(A) at received adjacent to the proposed development, and further assessment of impacts is not undertaken.

Table 16: Maximum noise level predictions, activities outside daytime hours (L_{AMax} dB(A))

Receiver	Prediction L_{AMAX} Calm	Prediction L_{AMAX} Enhancing	Criteria (Night) L_{Amax}	Above MNLT?
R1	40	40	52	No
R2	<30	<30	52	No
R3	<30	<30	52	No
R4	<30	<30	52	No
R5	<30	<30	52	No
R6	<30	<30	52	No
R7	<30	<30	52	No
R8	<30	<30	52	No
R9	<30	<30	52	No

Assessment presented in **Table 16** indicates that L_{AMax} peak events are not expected to exceed the L_{Amax} criteria of 52dB(A), and would thus comply with the $L_{Aeq,15minute}$ MNTL of 40dB(A). On this basis, assessment is limited to analysis of emissions against prediction of L_{AMax} values.

7. ASSESSMENT OF CONSTRUCTION NOISE LEVELS

7.1 Construction Activities

The operational noise model was also used to evaluate emissions associated with preliminary earthworks and construction activities. Review indicates that construction activities with potential to generate noise impacts may include:

- Site access upgrades at the site access and Croppa Creek Road, and construction of internal access roads between the site access and quarry;
- Earthworks associated with establishment of the stockpile pad; and
- Operation of quarrying plant (drilling rig, crushing plant) at natural surface levels prior to cutting of working faces and pit development.

A summary of Sound Power Level (SWL) for plant utilised during these construction phase activities are shown in **Table 17.** Assumptions relating to equipment and power levels were determined based on the information provided by the proponent (construction hours and plant itinerary). Working SWL for initial crushing operations at natural level are based on the summation of crushing and excavation plant discussed in **Table 17.** Noise level predictions are presented in **Table 18**, and adopt the following assumptions:

- Day period meteorological conditions from the operational noise model are adopted for this analysis;
- All items of plant operate simultaneously;
- All noise generating plant is located at natural ground level; and
- While works are assumed to take place only during standard work hours, assessment against the NML for non-standard hours is also presented to enable assessment of potential impacts should Out of Hours Works (OOHW) be required.

The construction model results presented in **Table 18** assume that construction occurs in isolation from existing quarry operations outlined in **Section 2.** Detailed assessment of cumulative impacts associated with existing quarry operations are outlined in **Section 10.**

Table 17: Construction Noise Sources

Construction Phase	Plant Description	A-wt Level	Activity SWL, dB(A)
Construction of internal access road and intersection works	Grader	113	115
	Roller	106	
	Water cart	109	
Construction of stockpile pad and sediment pond	Grader	113	119
	Dozer	116	
	Front end loader	108	
	Excavator	108	
Initial Pit Development Works at Natural Surface Level	Drill Rig	117	125
	Crushing Plant and Excavator	124	

7.2 Noise Level Predictions

A summary of predicted $L_{Aeq,15minute}$ noise levels at the nearest sensitive receivers associated with proposed construction works is provided in **Table 18**.

Table 18: Worst case construction noise levels $L_{Aeq,15minute}$ dB(A)

Receiver	Site Access	Stockpile Pad	Quarry Development	NML (Standard / OOHW)	Above NML?
R1	<30	36	33	45 / 40	No
R2	<30	<30	<30	45 / 40	No
R3	<30	<30	39	45 / 40	No
R4	<30	<30	36	45 / 40	No
R5	<30	<30	34	45 / 40	No
R6	<30	<30	31	45 / 40	No
R7	<30	<30	31	45 / 40	No
R8	<30	<30	36	45 / 40	No
R9	<30	<30	33	45 / 40	No

The results of modelling indicate that noise emissions from construction activities are likely to be below NMLs for all receivers adjacent to the site. Levels are predicted to approach the NML at R3 where quarry development (crushing) activities are taken outside of standard work hours. On this, basis, it is recommended that any crushing activities at natural surface level be restricted to standard work hours (7:00 to 18:00) to ensure NML are achieved.

8. ASSESSMENT OF ROAD TRAFFIC NOISE

8.1 Road Traffic Generated by the Development

Heavy vehicle movements generated by the development are evaluated against the criteria established in the RNP. Assessment of road traffic noise is based on the following assumptions:

- Receivers are exposed to an existing level of road traffic noise, and additional movements generated by the proposed development have potential to increase existing levels of impact;
  - this may require assessment against both absolute and relative increase noise limits;
- Assessment of noise levels associated with:
  - Both average and peak quarry related traffic movements along Croppa Creek Road, Croppa Moree Road, Bruxner Highway, North Star Road / Edward Street and IB Bore Road (**Table 19**);
- Vehicle speeds are assumed to follow signposted limits of:
  - 100km/h on Croppa Creek Road, IB Bore Road and North Star Road / Edward Street on approaches to North Star;
  - 60km/h on road sections within the town limits of North Star
  - 40km/h within the North Star school zone.

Table 19 (overleaf) specifies existing and predicted traffic within the area of the proposed development.

Table 19: Proposed quarry related traffic movements

Road	Existing Average Daily Traffic (ADT)	Predicted Additional Heavy Vehicle Movements	Predicted Average Daily Traffic (ADT)	Proportion Heavy Vehicles %
	Average Daily Movements			
Croppa Creek Road	161	74	235	53
Croppa Moree Road	158	18	176	29
I B Bore Road	18	18	36	56
Bruxner Highway	194	55	249	35
North Star Road / Edward Street	159	55	214	38
	Peak Demand Movements			
Road	**Existing Average Daily Traffic (ADT)**	**Predicted Additional Heavy Vehicle Movements**	**Predicted Peak Daily Traffic (ADT)**	**Proportion Heavy Vehicles %**
Croppa Creek Road	161	211	372	70
Croppa Moree Road	158	53	211	40
I B Bore Road	18	53	71	77
Bruxner Highway	194	158	352	54
North Star Road / Edward Street	159	158	317	58

8.1.1 Road Traffic Noise Model Validation

A road traffic noise model was constructed within the Predictor environmental noise modelling software package using the Calculation of Road Traffic Noise (CoRTN) method. A summary of the modelling assumptions is included in **Table 20**.

Table 20: Operational noise model parameters

Parameter	Details
Traffic Volumes (Existing)	Refer to **Table 5**
Traffic Volumes (Proposed)	Refer to **Table 19**
Traffic Speed	Posted Speeds (100km/h outside town limits, 60km/h within, 40km/h School Zone))
Modelling Method	CoRTN (Predictor v8.11)
Split Height Sources	Cars (RL+0.5m) Trucks (RL+1.5m) Truck Exhaust RL(+3.6m)
Road Surface Corrections	None applied, assume standard asphalt surface
Ground Absorption	0.75 (rural areas)
Receiver Locations	1m from building Height RL +1.5m
Facade Correction	+2.5dB at 1m from building

A model based on existing traffic conditions was constructed in order to validate predictions against available measurement data. Results from the noise model were compared to unattended measurements logger data provided in the ARTC NIA and any variations between the levels were analysed. Variations between the measured and modelled results are deemed to be acceptable if the levels are within ± 2 dBA.

A comparison of the measured and modelled results is shown in **Table 21**. The predicted results and measured results have an acceptable average variance within 2 dBA. Model calibration depends on a variety of inputs including the road surface, average traffic volumes, vehicle types and speed, ground absorption and any obstacles obstruction the sound transmission path. The model was subsequently used to characterise existing levels of road traffic noise across the study area, and evaluate potential impacts associated with the proposed development.

Table 21: Validation of road traffic noise model

Scenario	Measured L_{Aeq} at L01NNS (Day /Evening / Night)	Model Prediction (Day / Evening / Night)
Existing road traffic noise ($L_{Aeq,period}$) adjacent to North Star Road / Edward Street	49dB(A) / 50dB(A)/ 50dB(A) (from **Table 7**)	51dB(A) / 49dB(A) / 48dB(A)

8.2 Existing Road Traffic Noise Levels

A model representative of current conditions was developed to characterise existing levels of road traffic noise at receivers adjacent to the proposed haul route. The existing levels of road traffic noise are important to understand as it enables evaluation of not just absolute road traffic noise levels against limits, but also assessment of any relative increase that may be experienced. Following guidance established in the RNP, relative increase criteria are not applicable to those receivers predominantly affected by noise from local roads. As the roads for all haulage routes have been identified as sub-arterial road, the relative increase criteria will also be assessed at all receivers.

A summary of predicted noise levels at the most sensitive receivers along each section of the proposed haul route is provided in **Table 22.** A more detailed summary of existing traffic noise levels for receivers is presented in **Appendix III**.

Table 22: Existing traffic noise levels and criteria

Catchment	Receiver	Existing Level dB(A)	Road Type	Criteria Level dB(A)[2]	Count of Receivers Above Criteria
Day Period					
Croppa Creek Road	781 Croppa Creek Road	43	Sub-arterial	$L_{Aeq,(15 hour)}$ 60	0
Croppa Moree Road	4011 Croppa Moree Road	48	Sub-arterial	$L_{Aeq,(15 hour)}$ 60	0
I B Bore Road	2279 I B Bore Road	44	Sub-arterial	$L_{Aeq,(15 hour)}$ 60	0
North Star Road	7114 North Star Road	48	Sub-arterial	$L_{Aeq,(15 hour)}$ 60	0
North Star Town	3 Edward Street	51	Sub-arterial	$L_{Aeq,(15 hour)}$ 60	0
North Star School	31 - 37 Edward Street	49	n/a	40[1] (50 external)[1]	n/a

Catchment	Receiver	Existing Level dB(A)	Road Type	Criteria Level dB(A)[2]	Count of Receivers Above Criteria
Day Period					
Night Period					
Croppa Creek Road	781 Croppa Creek Road	39	Sub-arterial	$L_{Aeq,(9\ hour)}$ 60	0
Croppa Moree Road	4011 Croppa Moree Road	44	Sub-arterial	$L_{Aeq,(9\ hour)}$ 60	0
I B Bore Road	2279 I B Bore Road	40	Sub-arterial	$L_{Aeq,(9\ hour)}$ 60	0
North Star Road	7114 North Star Road	44	Sub-arterial	$L_{Aeq,(9\ hour)}$ 60	0
North Star Town	3 Edward Street	48	Sub-arterial	$L_{Aeq,(9\ hour)}$ 60	0

Note 1: Screening external noise criteria of internal + 10dB adopted in order to evaluate potential impacts based on external noise levels. A 10dB difference between internal and external noise levels was adopted based on guidance provided in Section 2.5.4 of the RNP.

Note 2: Criteria based on external levels unless stated otherwise.

Analysis presented in **Table 22** indicates that all receivers adjacent experience noise levels well below the relevant criteria during both the day and night period.

8.3 Road Traffic Noise Level Prediction

Further analysis was undertaken to evaluate changes in noise levels associated with traffic generated by the proposed development for both average daily movements and movements associated with peak demand. For brevity, a summary of predicted noise levels for average and peak heavy vehicle movements have been provided for select sensitive receivers along the haul route in **Table 23**.

Table 23: Assessment of predicted traffic noise levels and criteria

	Existing Level dB(A)	Predicted Level dB(A)	Predicted Level dB(A)	Increase dB(A)		Criteria Level dB(A)	Criteria Exceedance
		Average	Peak	Average	Peak		
	43	47	50	4	7	60	0
	48	50	52	2	4	60	0
	44	46	50	2	6	60	0
	48	52	54	4	6	60	0
	51	52	57	1	6	60	0
	49	52	56	3	7	40 (50 external)	1
				Average	Peak		
	39	41	43	2	4	55	0

	Existing Level dB(A)	Predicted Level dB(A)	Predicted Level dB(A)	Increase dB(A)		Criteria Level dB(A)	Criteria Exceedance
		Average	Peak	Average	Peak		
	44	45	46	1	2	55	0
	40	42	44	2	4	55	0
	44	46	47	2	3	55	0
	48	49	50	1	2	55	0

Note: Criteria based on external levels unless stated otherwise.

Review of modelling results indicates:

- All noise receivers are below the relevant criteria when assessing the existing road noise levels;
- One receiver (School) is predicted to exceed the criteria by 2dB(A) under average quarry haulage operations and 6dB(A) under periods during peak demand requiring 264 heavy vehicle movements per day. When assessing road noise impacts associated with average or peak quarry operations, noise levels may increase at all other receivers but will continue to be below the criteria; and
- Noise levels at receivers within the North Star township along Edward St and David St are expected to increase by less than 5dB(A) under average quarry haulage operations.

Detailed results presented in **Appendix III** identify those receivers that may experience impacts as a result of the proposed development. While increase in traffic noise levels above the criteria outlined in the RNP are not expected at residential receivers, the following recommendations are provided to minimise adverse road noise associated with the increase in noise levels at sensitive receivers and potential minor exceedances at North Star Public School:

- Consultation with residents adjacent to the Haul Route;
- Developing an effective traffic management plan to ensure that drivers:
  - adhere to sign-posted speed limits (40km/h through school zone);
  - maintain and operate vehicles in a manner that does not generate excessive noise;
  - schedule haulage of product to maximise periods of respite;
  - have a mechanism for monitoring adherence to the plan and responding to complaints;
- Where practical, utilise larger capacity vehicles to minimise the number of movements; and
- Operation of vehicles at speeds below signposted speeds (i.e. at 50km/h) in built up areas may provide opportunities to reduce levels of impact.

9. ASSESSMENT OF BLAST IMPACTS

Australian Standard AS2187.2-2006 provides outline methods for evaluating potential ground vibration and air blast overpressure impacts associated with explosive blasting. A quantitative assessment of potential impacts has been prepared on the basis of minimum separation distances to the nearest sensitive receiver from the proposed blast location (2,800m to the north west) and preliminary blast design information. Impacts at more distant receiver locations are assumed to be acceptable where air blast and ground vibration levels comply with limits at these assessment locations.

9.1 Estimating Overpressure Levels

Appendix J7 of *AS2187.2-2006 Explosives - Storage and use. Part 2: Use of explosives* provides the following method for evaluating potential airblast overpressure levels:

$$P = K_a \left(\frac{R}{Q^{1/3}} \right)^a$$

Where: P is air pressure (Pa);
R is the distance between charge and point of measurement (m);
Q is maximum instantaneous charge (charge mass per delay) (kg);
K_a,is the site constant; and
a is the site exponent.

Additional detail contained in Clause J7.3 of AS2187.2:2006 provides the following values for the site constant and site exponent for confined blasthole charges:

K_a = range between 10 to 100;
a = -1.45

Equation J5.1 in AS2187.2:2006 allows for the expression of overpressure impacts in decibels:

$$SPL = 10 \times \log_{10} \left(\frac{P}{P_0} \right)^2$$

Where: P is estimated overpressure level (μPa); and
P_0 is the reference pressure of 20 μPa.

9.1.1 Assessment of Overpressure Impacts

A summary of air blast overpressure impacts based on preliminary blast design information is presented in **Table 24**. The results indicate that, based on observed separation distances, air blast overpressure levels are unlikely to exceed the human annoyance criteria presented in the ANZEC guideline at the nearest sensitive receiver.

Table 24: Assessment of air blast impacts at nearest receiver

Scenario	Sep Distance	Hole Diameter	MIC	Air blast Overpressure	Limit
1	2800m	89mm	67kg	92dB	115dB
2		102mm	88kg	93dB	

9.2 Estimating Ground Vibration Impact

Appendix J7 of *AS2187.2-2006 Explosives - Storage and use. Part 2: Use of explosives* provides the following method for evaluating potential ground vibration levels:

$$V = K_g \left(\frac{R}{Q^{1/2}} \right)^{-B}$$

Where: V is ground vibration as vector peak particle velocity (mm/s);
R is the distance between charge and point of measurement (m);
Q is maximum instantaneous charge (charge mass per delay) (kg); and
K_g, B are constants related to site and rock properties for estimation purposes.

Discussion presented in Clause J7.3 of AS2187.2:2006 states that, in the absence of site specific constants the following values may be used to estimate vibration levels (50% probability of exceedence) in average conditions:

$K_g = 1140$
$B = -1.6$

In the absence of detailed understanding of site specific vibration propagation characteristics, the constants for average conditions are applied to this assessment.

9.2.1 Assessment of Ground Vibration Impacts

A summary of assessed ground vibration impacts is presented in **Table 25.** The results indicate that, based on the observed separation distances, ground vibration levels are unlikely to exceed the criteria for human annoyance at sensitive receivers adjacent to the blast site.

Table 25: Assessment ground vibration impacts

Scenario	Sep Distance	Hole Diameter	MIC	Ground Vibration PPV	Limit
1	2800m	89mm	67kg	<0.2mm/s	5mm/s
2		102mm	88kg	<0.2mm/s	

9.2.2 Mitigation of Blast Impacts

While the assessment indicates blasting activities are likely to comply with the relevant criteria, impacts may be perceived by sensitive receivers adjacent to the site. AS2187.2-2006 provides guidance on methods to manage blasting in such a way as to minimise ground vibration and overpressure impacts, including:

- Reducing the maximum instantaneous charge and us of appropriate delays;
- Establishing blast times in accordance with prevailing meteorological conditions;
- Optimising blast design; and
- Orienting blasts away from receivers (where possible).

To comply with the ANZEC 1990 *Technical basis for guidelines to minimise annoyance due to blasting overpressure and vibration* guideline, it is recommended that blasting should be restricted to:

- the hours 9:00 to 15:00pm, Monday to Saturday; and
- should not take place on Sundays or public holidays.

It is also recommended that provisions are made for notifying neighbours of planned blasts, and monitoring of overpressure and ground vibration of blasts as they occur. This should aid in the establishment of mechanisms to modify blast designs, and respond to any complaints as may be required.

10. ASSESSMENT OF CUMULATIVE IMPACTS

While analysis presented in **Sections 6** to **9** provides assessment of specific project related impacts, potential exists for cumulative impacts associated with existing operating quarries within the development footprint. Cumulative impacts for this development were assessed using information adapted from an operational noise impact assessment for Tikitere quarry conducted by Advitech in 2018 (Advitech Tikitere NIA). This noise impact assessment modelled and assessed the impacts associated with the operation of both a gravel quarry and a hard rock quarry on Lot 5 DP755984.

10.1 Operational Impacts

Assessment presented in **Section 6** indicates that while noise levels associated with the proposed development may approach and exceed management levels at the nearest sensitive receivers during the night period, levels of impact well below the criteria are generally expected during the day period. A model of cumulative noise impacts was constructed using the methodology outlined in **Section 6** to assess the significance of existing operations on the proposed quarry development.

Additional noise sources were included in the model to characterize existing gravel and hard rock quarry operations outlined in **Figure 1**. Noise sources associated with product haulage and train loading were also added to the model. The SWL data for these additional sources was derived from the Advitech Tikitere NIA and is displayed in **Table 26**

Table 26: Operational stage noise sources

Plant Description	Description of Utilisation	SWL, dB(A)
Hard Rock Quarry	Including extraction and crushing, sizing and stockpiling	123
Gravel Pit Quarry	Including excavations, and screening / sizing plant (without crushing)	110
Product Haulage	Rear Dump Truck(s) between quarry areas and rail loading point	112
Train Loading	Front end loader for train loading/material stockpile	108 (116 L_{AMax})

A summary of predicted $L_{Aeq,15minute}$ noise levels at the nearest sensitive receivers associated with cumulative quarry operations (including simultaneous pre-blast drilling, quarrying and stockpiling activities) is provided in **Table 27**.

Table 27: Cumulative operational quarry impacts, dB(A)

	Predicted $L_{Aeq,15minute}$					
	Day		Night		PNTL (D /E / N)	
Receiver	Calm	Enhancing	Calm	Enhancing	$L_{Aeq,15minute}$	Above PNTL?
R1	35	35	**37**	**37**	40 / 35 / 35	Yes Evening/Night
R2	<30	<30	<30	<30	40 / 35 / 35	No
R3	33	33	35	33	40 / 35 / 35	No
R4	34	34	**36**	34	40 / 35 / 35	Yes Evening/Night (calm)
R5	33	33	35	35	40 / 35 / 35	No
R6	30	30	32	32	40 / 35 / 35	No
R7	30	30	32	32	40 / 35 / 35	No
R8	35	35	**37**	**37**	40 / 35 / 35	Yes Evening/Night
R9	32	32	33	33	40 / 35 / 35	No

The results of modelling indicate that predicted cumulative operational noise levels will be below the PNTL at all receiver locations during the day period. Results indicate that noise contributions above the PNTL at several receivers are likely if simultaneous quarry operations occur during the evening and night period.

Cumulative impacts associated with short term high level events (L_{AMax}) with potential to cause sleep disturbance at adjacent sensitive receivers was not assessed as no additional noise sources associated with the process of loading material into train wagons, hoppers or truck bodies are predicted to occur during the assessment period. Modelling results presented in **Table 16** indicate that maximum noise levels are not expected to approach the L_{Amax} of 52dB(A) at receivers adjacent to the proposed development. This provides capacity for introduction of additional noise sources into these receiving environments, without expectation of potential for adverse cumulative impacts.

10.2 Construction Impacts

A model of cumulative noise impacts was constructed using the methodology outlined in **Section 7** to assess the significance simultaneous construction and operational activities at the site. Noise sources associated with existing quarry operations were incorporated into the construction model scenarios outlined in **Section 7**. The SWL data for these additional sources was derived directly from the Advitech Tikitere NIA and is displayed in **Table 26**

A summary of predicted $L_{Aeq,15minute}$ noise levels at the nearest sensitive receivers associated cumulative impacts from proposed construction works and existing quarry operations is provided in **Table 30**.

Table 28: Predicted cumulative noise impacts, dB(A)

Receiver	Site Access	Stockpile Pad	Quarry Development	NML (Standard / OOHW)	Above NML?
R1	35	39	37	45 / 40	No
R2	<30	<30	<30	45 / 40	No
R3	31	32	39	45 / 40	No
R4	<30	<30	36	45 / 40	No
R5	<30	30	35	45 / 40	No
R6	<30	<30	32	45 / 40	No
R7	<30	<30	32	45 / 40	No
R8	<30	30	36	45 / 40	No
R9	<30	<30	33	45 / 40	No

The results of modelling indicate that cumulative noise emissions from construction and existing quarrying activities are likely to be below NMLs for all receivers adjacent to the site. Levels are predicted to approach the NML at R3 where quarry development (crushing) activities are taken outside of standard work hours and at R1 when stockpile development activities are taken outside of standard work hours. On this, basis, it is recommended that construction works be restricted to standard work hours (7:00 to 18:00) to ensure NML are achieved.

10.3 Road Traffic Noise Impacts

Road traffic noise associated with product haulage from the proposed development is not expected to exceed the road traffic noise criteria at sensitive receivers (with the exception of North Star public school) when assessed under the RNP. It is understood that the existing quarry within the development site have been utilising the inland rail in conjunction with haul routes used for the assessment of the proposed quarry.

The existing traffic volume data (**Table 5**) is expected to account for haulage movements generated by the existing quarry on the proposal site, providing a representative foundation for the modelling of additional road traffic noise impacts associated with Pearlman quarry. Traffic volume counts for I B Bore road were adopted from the most recent data (March 2017) provided in the SMK TIA for the existing quarry, which do not encompass movements from the existing quarry. A worst case modelling scenario was undertaken for the three receivers along I B Bore Road assuming existing traffic volumes of 80 heavy vehicles per day to account for potential movements generated by the existing quarry. Using this assumption, it is predicted that no additional receivers will be above the criteria when assessed against average and peak demand heavy vehicle movements generated by the Pearlman quarry. Analysis of road traffic noise comparing the existing traffic volumes **Table 5** and predicted traffic volumes from the existing quarry (80 heavy vehicle movements per day) is displayed below.

Table 29: Comparison of existing traffic volumes from 2017 with predicted volumes from existing quarry

Catchment	Receiver	Existing Level dB(A)	Predicted Average Movements dB(A)	Predicted Peak Movements dB(A)	Above Criteria?
Day Period		**Original / Worst case**	**Original / Worst case**	**Original / Worst case**	
I B Bore Road	578 I B Bore Road	30 / 41	35 / 42	39 / 43	No
	751 I B Bore Road	31 / 42	36 / 43	40 / 44	No
	2279 I B Bore Road	44 / 45	47 / 48	50 / 50	No
Night Period					
I B Bore Road	578 I B Bore Road	< 30 / < 30	< 30 / 34	30 / 35	No
	751 I B Bore Road	< 30 /< 30	< 30 / 35	31 / 36	No
	2279 I B Bore Road	40 / 40	42 / 42	44 / 44	No

It is noted in the ARTC NIA that the construction of the inland rail may constitute higher traffic noise levels associated with an increase in heavy vehicle movements. Although it is predicted that there is capacity for introduction of additional noise sources into these receiving environments without expectation of potential for adverse cumulative impacts, mitigation and management of traffic associated with the proposed development should be implemented with the intention to reduce potential cumulative traffic noise impacts associated with future developments in the area.

10.4 Blasting Impacts

Unlike operational and construction phase impacts (which are typically continuous in nature), management of potential cumulative blast impacts may be effectively managed through a program of consultation with any other quarries within development area that are undertaking blasting, to ensure that blasting is not undertaken at the same time.

11. DISCUSSION AND RECOMMENDATIONS

11.1 Assessment Conditions and Criteria

Analysis of background noise monitoring indicates that the receiving environmental adjacent to the proposed development site is rural in nature, influenced predominantly by environmental and distant transportation sources. In all cases, the PNTL were established in terms of the Intrusiveness Criteria. For the purposes of evaluating potential impacts, it is recommended at that the PNTL be adopted as the assessment criteria for the development.

Review of prevailing meteorology indicates that there are no wind conditions observed more than 30% of the time during any season. Data was not available to evaluate the potential significance of temperature inversions at this location, so conservative assumptions were adopted and enhancing meteorological parameters were applied to the assessment.

12. ASSESSMENT OF IMPACTS AND RECOMMENDATIONS FOR MANAGEMENT

12.1.1 Operational Noise

Review of noise modelling indicates that the proposed and existing operations will generate offsite noise levels below the PNTL at all receivers during the day period. Contributions at several receivers (R1, R4 and R8) may exceed the evening and night period PNTL but are expected to be well below the day period criteria level. In all cases the primary contribution to offsite noise levels is associated with operation of crushing plant at the proposed and existing hard rock quarry. To achieve PNTL during the evening and night period, it is recommended that crushing and processing activities is restricted to the day period (7:00 to 18:00). Stockpile maintenance and loading of trucks may be undertaken during the evening and night period (including the early morning period prior to 7:00) without expectation of adverse impact.

12.1.2 Maximum Noise Levels

Materials' handling within the quarry was identified as the activity with greatest potential to generate maximum noise level impacts. It is important to note that these impacts may only manifest where quarrying or stockpiling operations are required to take place during the night period. Notwithstanding, review of modelling results indicates that L_{AMax} noise levels at adjacent sensitive receivers will be less than the Maximum Noise Trigger Level. Adverse impacts are not expected, and detailed assessment of potential impact was not undertaken.

12.1.3 Construction Noise

The results of modelling indicate that noise emissions from construction activities are likely to be below NMLs for all receivers adjacent to the site. Levels are predicted to approach the NML at receiver R3 and receiver R1 when stockpile development and quarry development activities are taken outside of standard work hours in conjunction with existing operations. On this, basis, it is recommended that any crushing activities at natural surface level (during construction period) be restricted to standard work hours (7:00 to 18:00) to ensure NML are achieved.

12.1.4 Road Traffic Noise

Assessment indicates that residential receivers along the proposed haulage route are not likely to experience levels above the recommended noise limits due to proposed quarry operations. Minor exceedances (up to 2dB) may be experienced at North Star school during the day period.

Given the potential for cumulative noise impacts associated with the development of the Inland rail, the following recommendations are provided to minimise adverse road noise impacts:

- Consultation with residents adjacent to the Haul Route;
- Developing an effective traffic management plan to ensure that drivers:
  - adhere to sign-posted speed limits (40km/h through school zone);
  - maintain and operate vehicles in a manner that does not generate excessive noise;
  - schedule haulage of product to maximise periods of respite;
  - contains a mechanism for monitoring adherence to the plan, and for responding to complaints;
- Where practical, utilise larger capacity vehicles to minimise the number of movements; and
- Operation of vehicles at speeds below signposted speeds (i.e. at 50km/h) in built up areas may provide opportunities to reduce levels of impact.

12.1.5 Blasting Impacts

Assessment of the resource indicates that blasting may be required as part of the extraction process. Criteria for both ground vibration and overpressure were adopted from the ANZEC guidelines for the purposes of assessing blast impacts. Assessment of preliminary blast design indicates that compliance with these guideline values is likely. Notwithstanding, it is recommended that monitoring of blasts be undertaken until such time that compliance can be demonstrated. It is also recommended that a strategy for notifying neighbours of planned blasts be developed and implemented, and a method for receiving, investigating and responding to complaints is provided.

12.1.6 Summary of Recommendations

Assessment indicates that the proposed quarry operations will comply with the established PNTL, and that the PNTL may be adopted as appropriate criteria for the proposed development. It is likely that the development will be audible at some receivers, and it is suggested that the above recommendations be put in place to minimise the noise impacts at the surrounding sensitive receivers. It is additionally recommended that systems are put in place to monitor and respond to potential concerns from adjacent sensitive receivers.

13. CONCLUSION

Advitech Environmental was engaged to prepare an assessment of potential noise impacts associated with the development of the proposed Pearlman Quarry. The development is proposed to service bulk construction material requirements of the proposed North Star section of the Inland Rail project and would also service the Newell Highway project which involves key upgrades between Moree and Goondiwindi. The operation may produce up to 490ktpa of quarried material per annum.

Project Tigger Noise Levels for adjacent receiving environments were reviewed, and the assessment conservatively adopted the most stringent criteria for the project area. Modelling indicates that noise levels associated with the project are expected to meet these criteria.

While adverse operational, construction and blasting impacts are not expected, this activity may be audible at some locations given the characteristics of the receiving environment. It is thus recommended that measures be put in place to ensure the timely and effective response to any concerns raised by adjacent receivers.

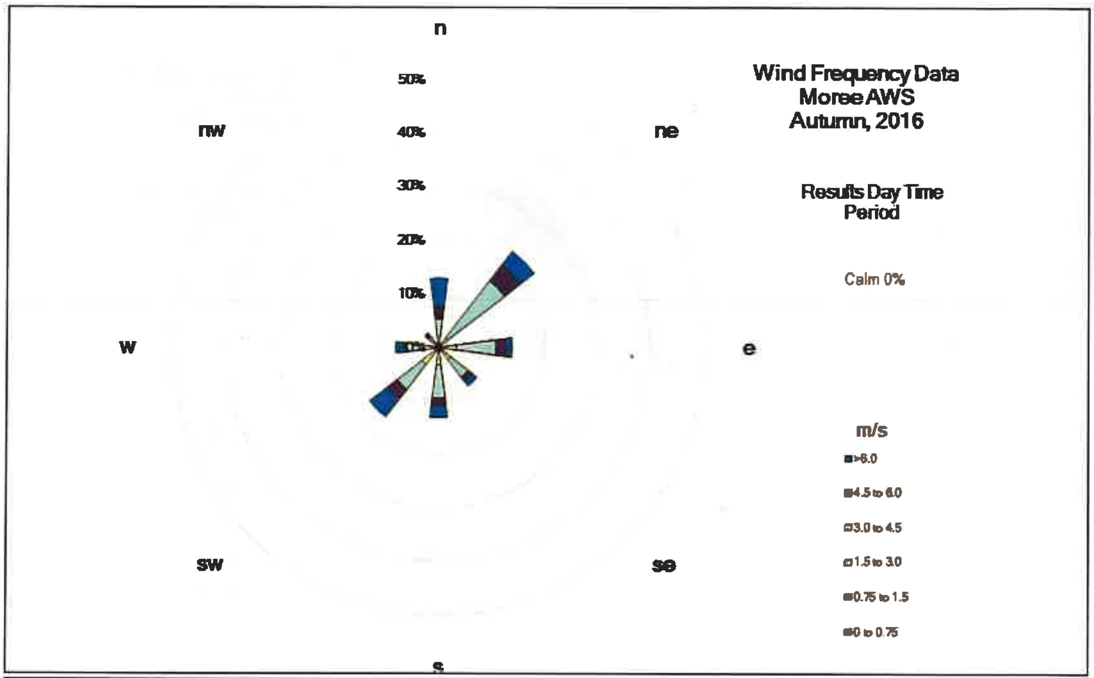
Road traffic noise associated with product haulage is not expected at residential receivers adjacent to the haulage routes. Impacts above the criteria may be observed at the North Star Public School Mitigation and management of traffic associated with the proposed development should be implemented with the intention to reduce cumulative traffic noise impacts associated with future developments in the area.

14. REFERENCES

The following information was used in the preparation of this report:

1. Advitech Pty Limited (2018), *Noise Impact Assessment for Tikitere Quarry,* report dated February, 2018;
2. Australia and New Zealand Environment Council (1990), *Technical basis for guidelines to minimise annoyance due to blasting overpressure and ground vibration*, Australia and New Zealand Environment Council
3. AS1055:2018 Acoustics - *Description and measurement of environmental noise General Procedures*
4. AS 2436 *Guide to noise and vibration control on construction, demolition and maintenance sites.*
5. AS2187.2-2006 Explosives - *Storage and Use Part 2: Use of Explosives*
6. ARTC NSW Inland Rail Programme, *Narrabri to North Star Project, Technical Report 5: Noise & Vibration Assessment*, report dated October, 2017;
7. AS 1055.1-1997: Acoustics - *Description and measurement of environmental noise General procedures.*
8. Bies, DA & Hansen, CH (2009). Engineering Noise Control: Theory and Practice (4th Edition), Spon Press;
9. NSW Environment Protection Authority (2000). *NSW Industrial Noise Policy*, NSW Environment Protection Authority, Sydney;
10. NSW Environment Protection Authority (2006). *Assessing Vibration: a technical guideline*, NSW Environment Protection Authority, Sydney;
11. NSW Environment Protection Authority (2008). *Interim Construction Noise Guideline*, NSW Environment Protection Authority, Sydney;
12. NSW Environment Protection Authority (2011). *Road Noise Policy*, NSW Environment Protection Authority, Sydney;
13. NSW Environment Protection Authority (2017). *NSW Noise Policy for Industry*, NSW Environment Protection Authority, Sydney;
14. SMK Consultants Pty Ltd (2018). *Tikitere Quarry Traffic Impact Assessment*, SMK Consultants Pty Ltd, Moree
15. UK Department of Environment, Food and Rural Affairs (2005), *Update of noise database for prediction of noise on construction and open sites,* UK Department of Environment, Food and Rural Affairs, Norwich.

APPENDIX I: Seasonal Wind Roses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Wind Frequency Data
Moree AWS
Autumn, 2016
Results Day Time Period
Calm 0%
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1.5 to 3.0
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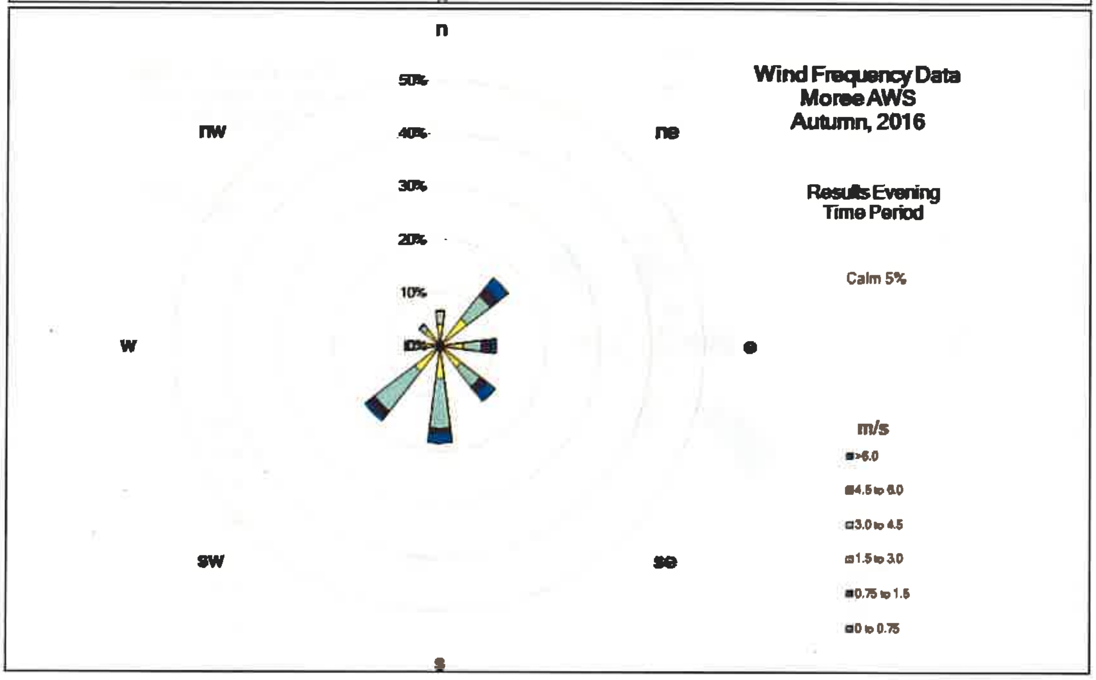
0 to 0.75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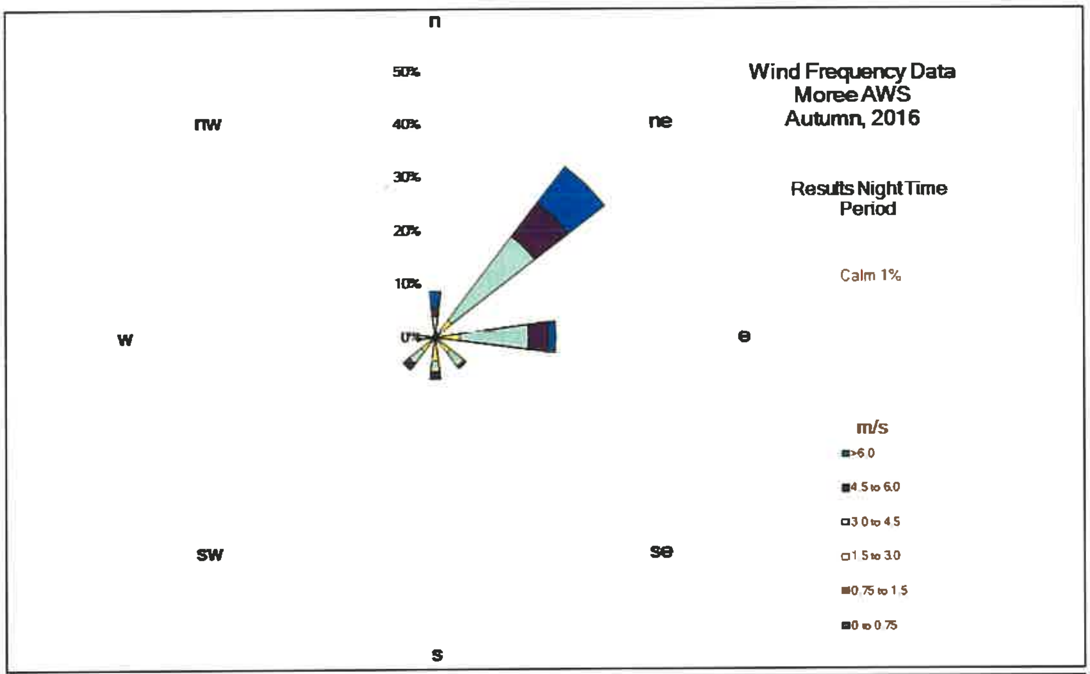
1.5 to 3.0
0.75 to 1.5
0 to 0.75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Results Night Time
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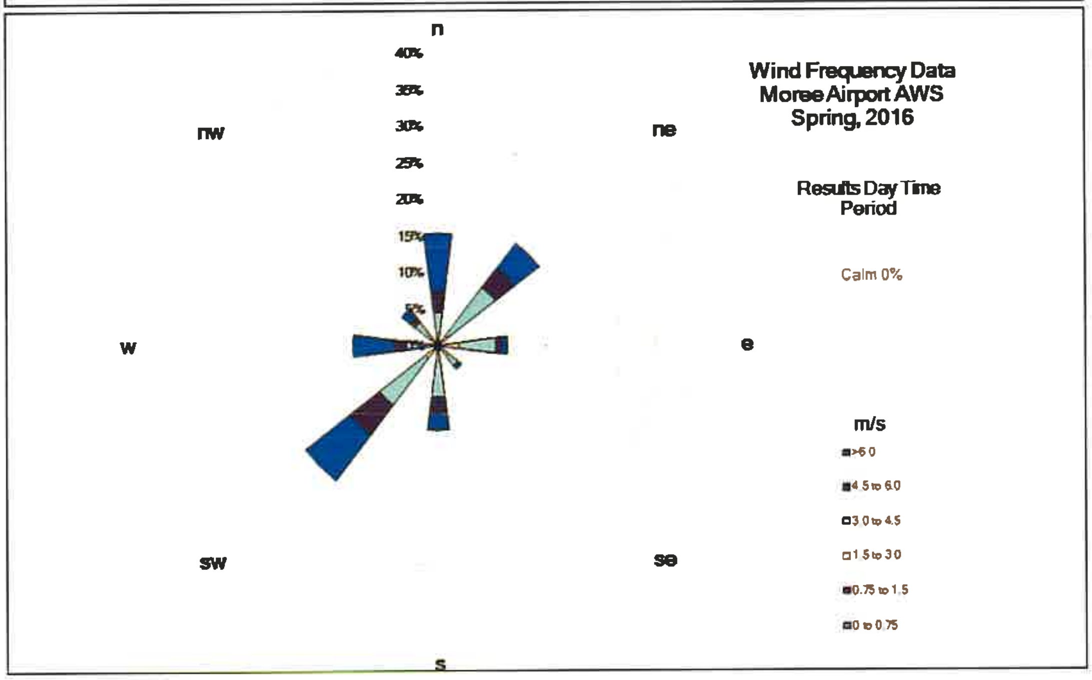
3.0 to 4.5
1.5 to 3.0
0.75 to 1.5
0 to 0.75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Wind Frequency Data
Moree Airport AWS
Spring, 2016
Results Day Time
Period
Calm 0%
m/s
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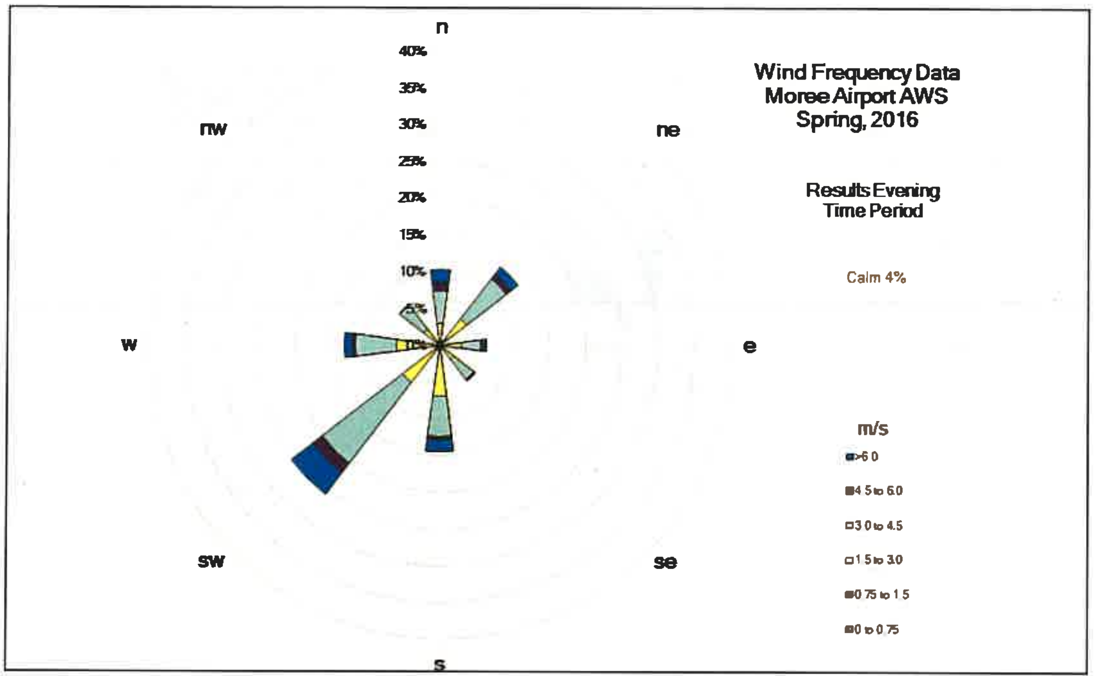
3.0 to 4.5
1.5 to 3.0
0.75 to 1.5
0 to 0.75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Wind Frequency Data
Moree Airport AWS
Spring, 2016
Results Evening Time Period
Calm 4%
m/s
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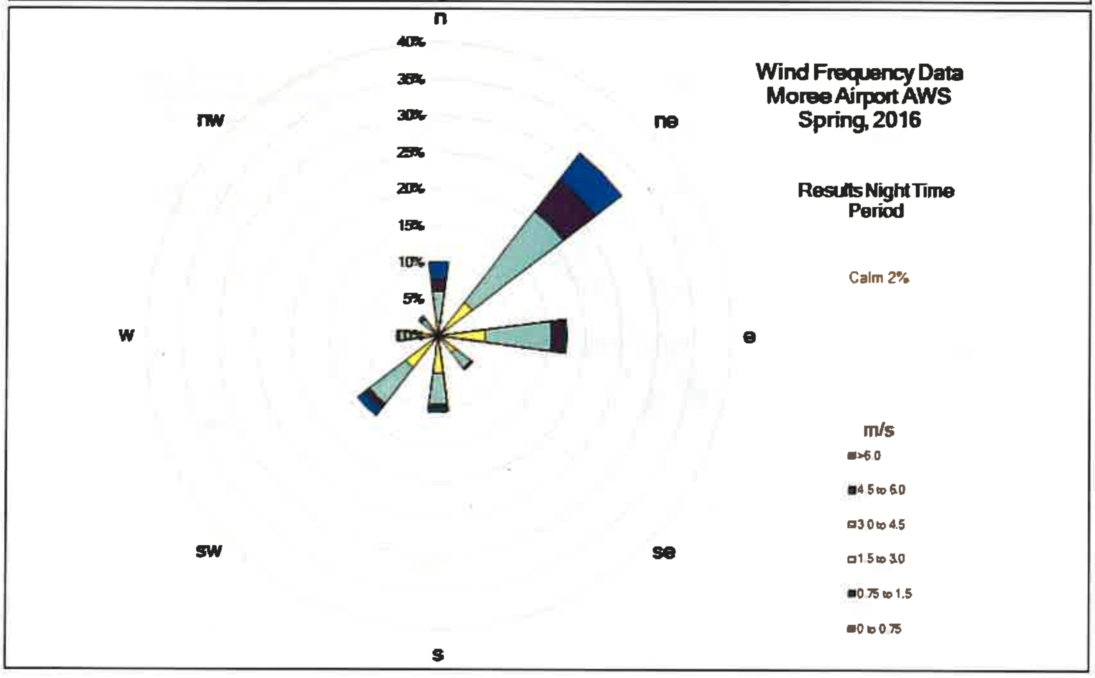
3 0 to 4.5
1 5 to 3.0
0 75 to 1.5
0 to 0.75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Wind Frequency Data
Moree Airport AWS
Spring, 2016
Results Night Time Period
Calm 2%
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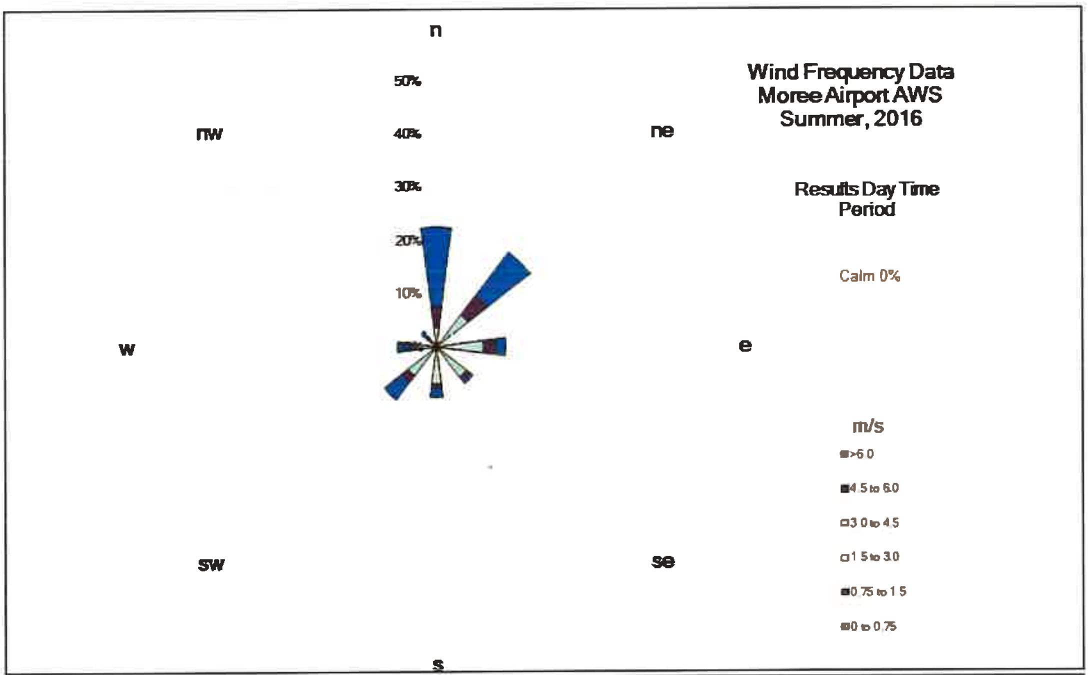
3 0 to 4.5
1 5 to 3.0
0 75 to 1.5
0 to 0.75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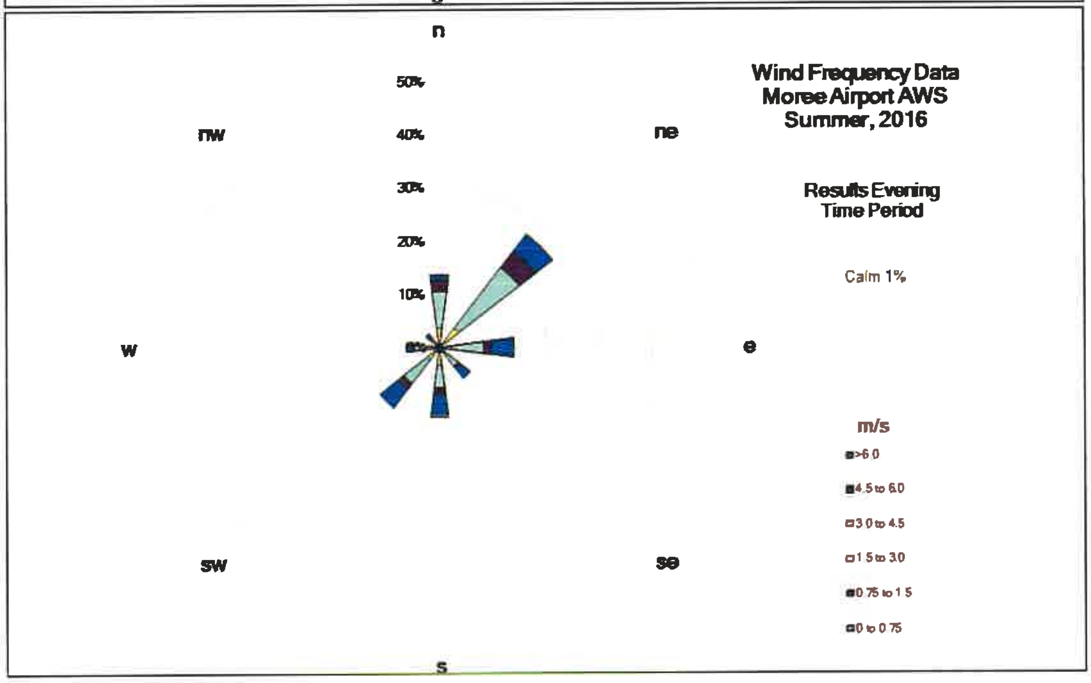
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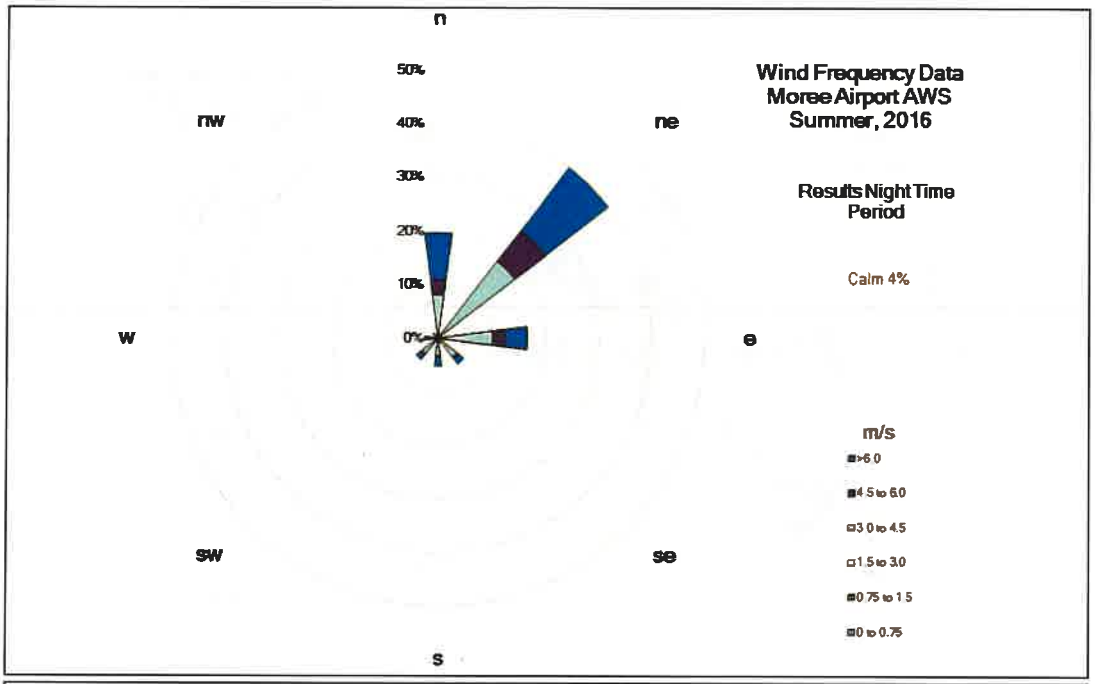

Wind Frequency Data
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0.75 to 1.5
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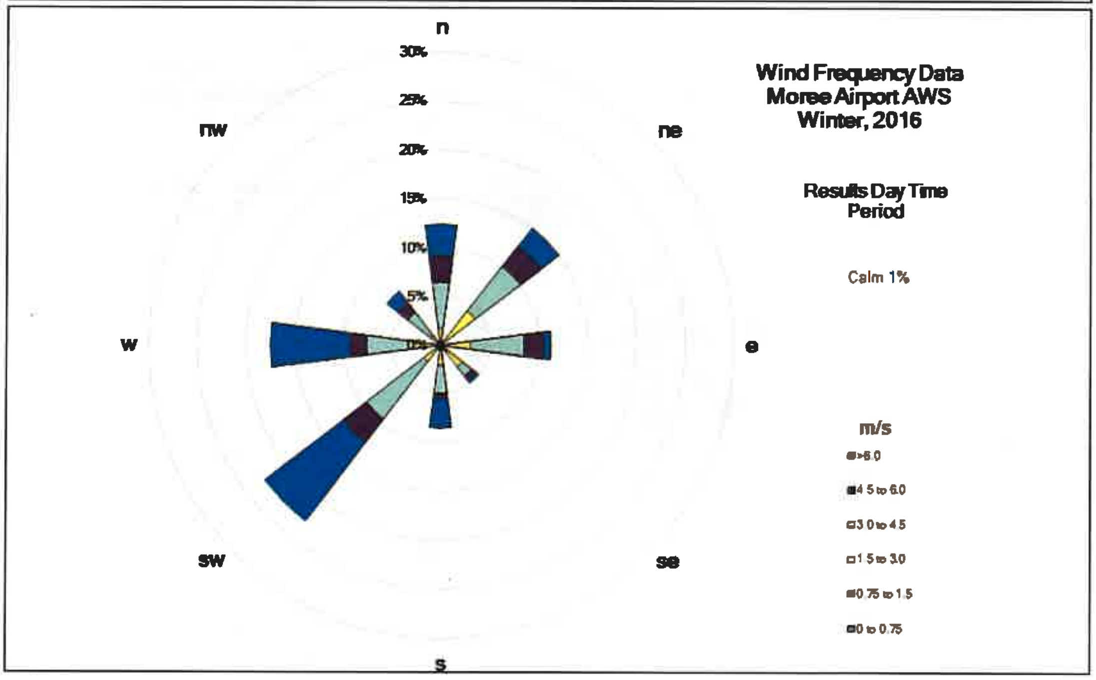

Wind Frequency Data
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Winter, 2016
Results Day Time Period
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m/s
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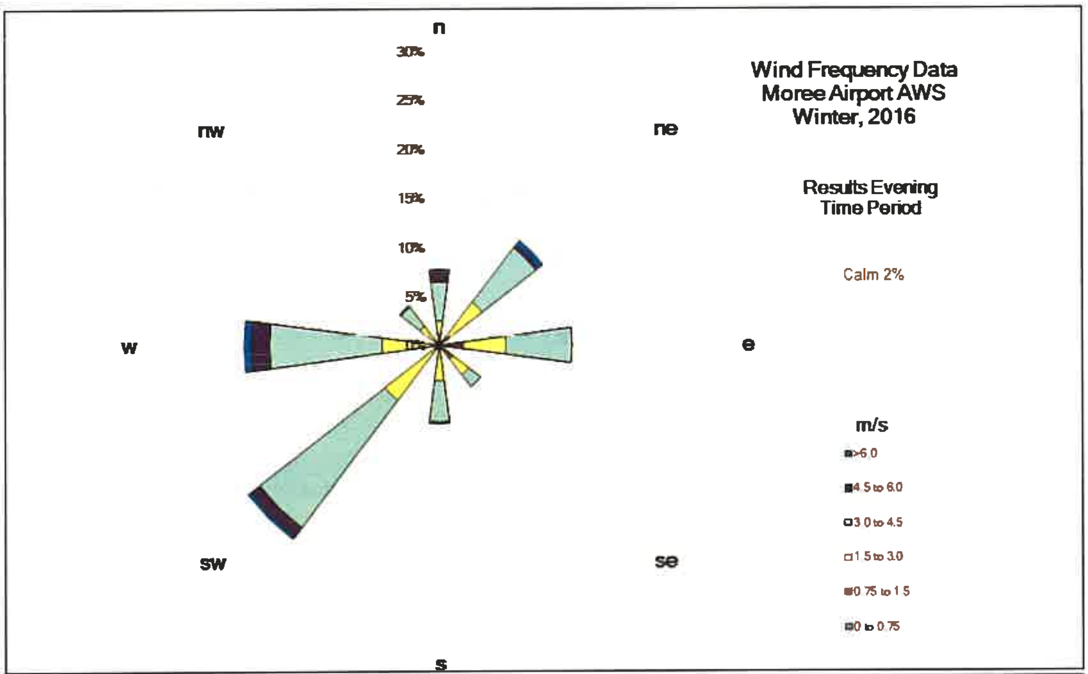
1.5 to 3.0
0.75 to 1.5
0 to 0.75



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Wind Frequency Data
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Results Evening
Time Period
Calm 2%
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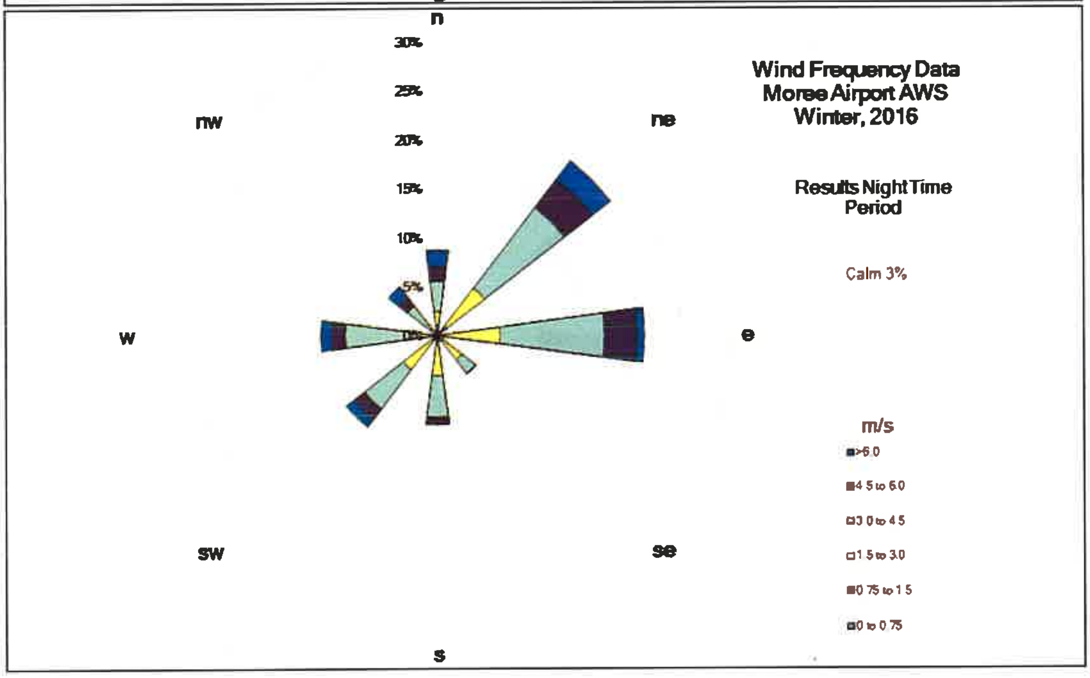

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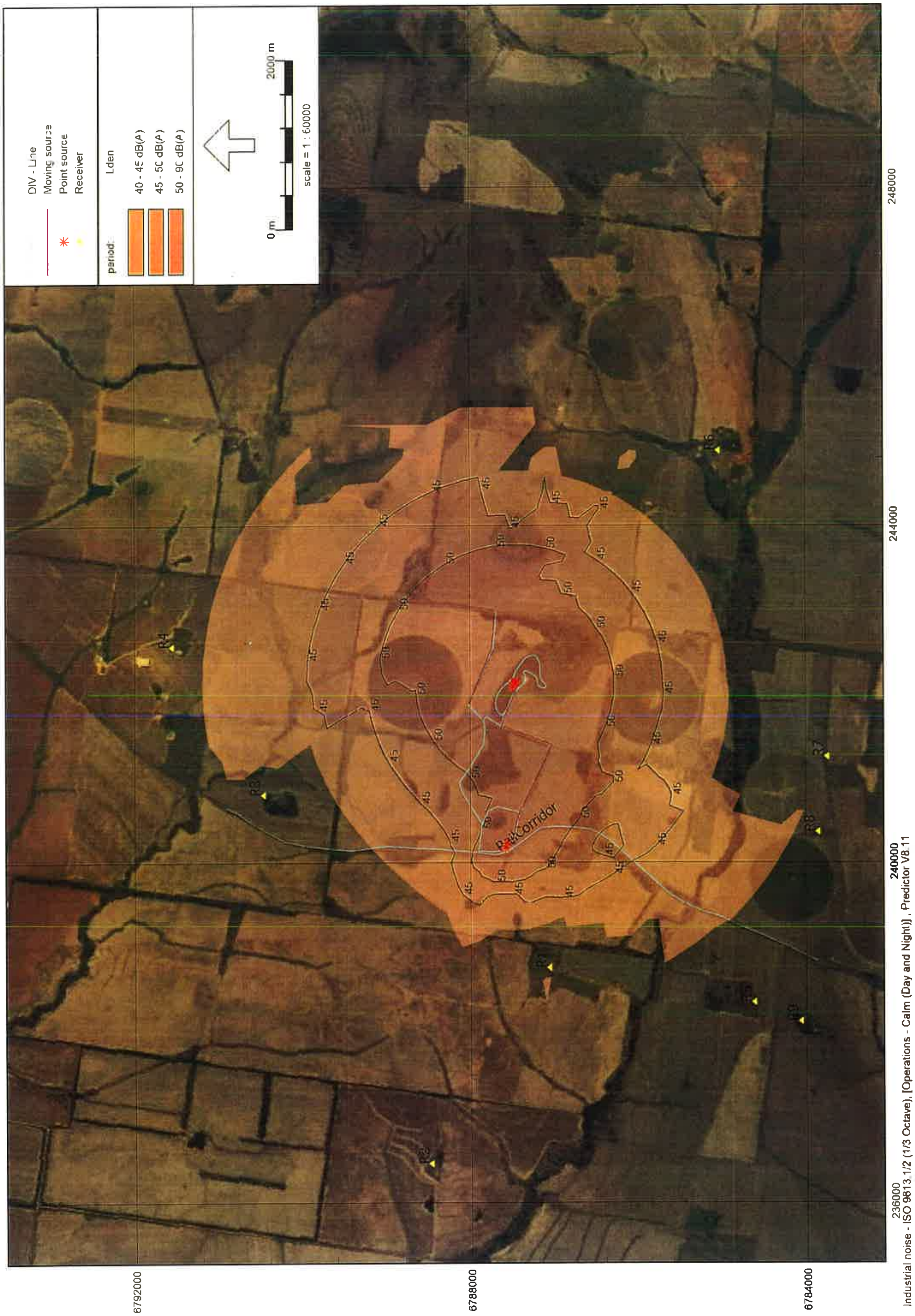
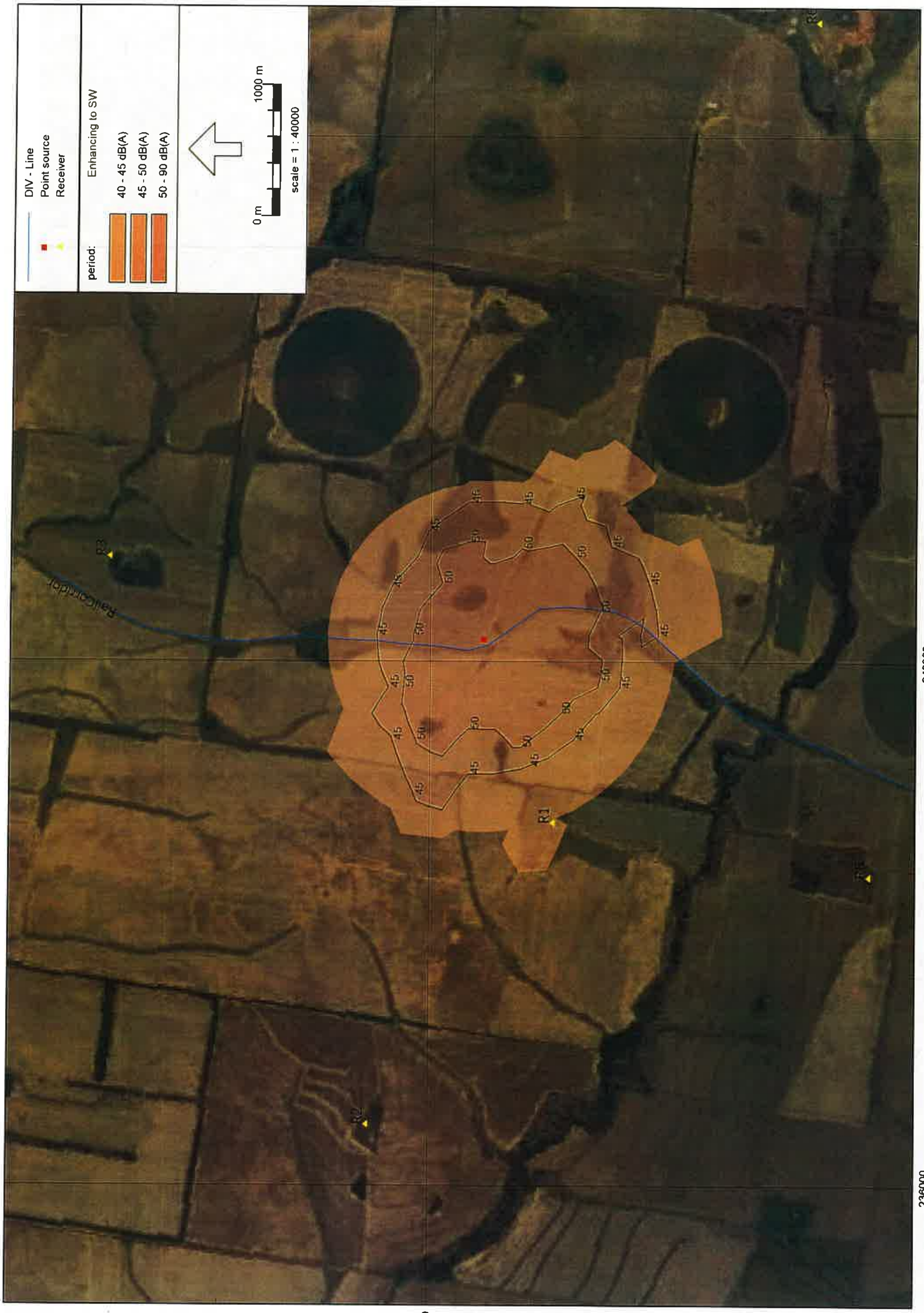
APPENDIX II: Noise Level Contours

Quarry Operations - Day (Calm) Advitech Pty Ltd

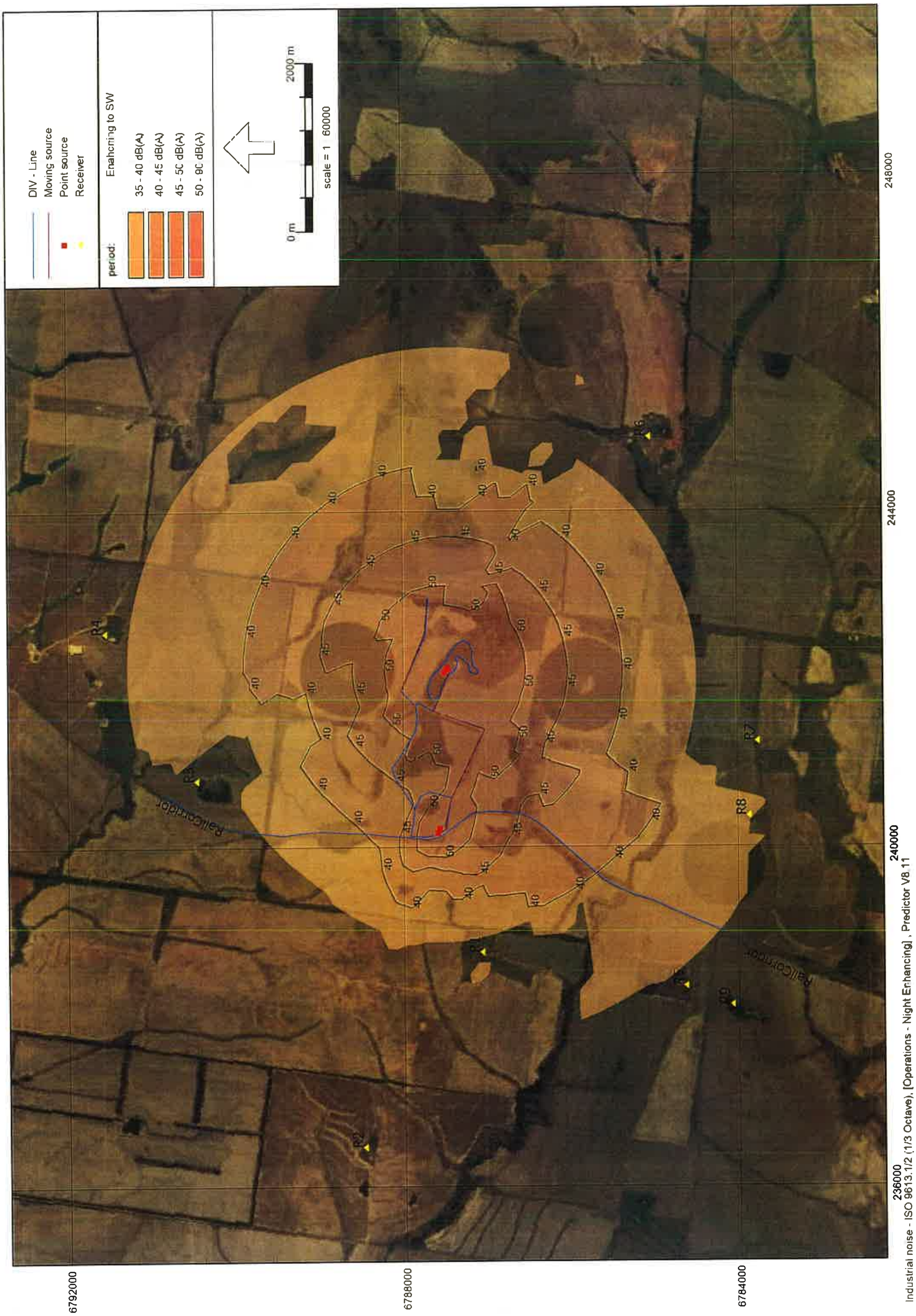




Industrial noise - ISO 9613.1/2 (1/3 Octave), [Operations - Lmax Model (Enhancing)] ; Predictor V8.11

Quarry Operations - Enhancing Conditions (Night)

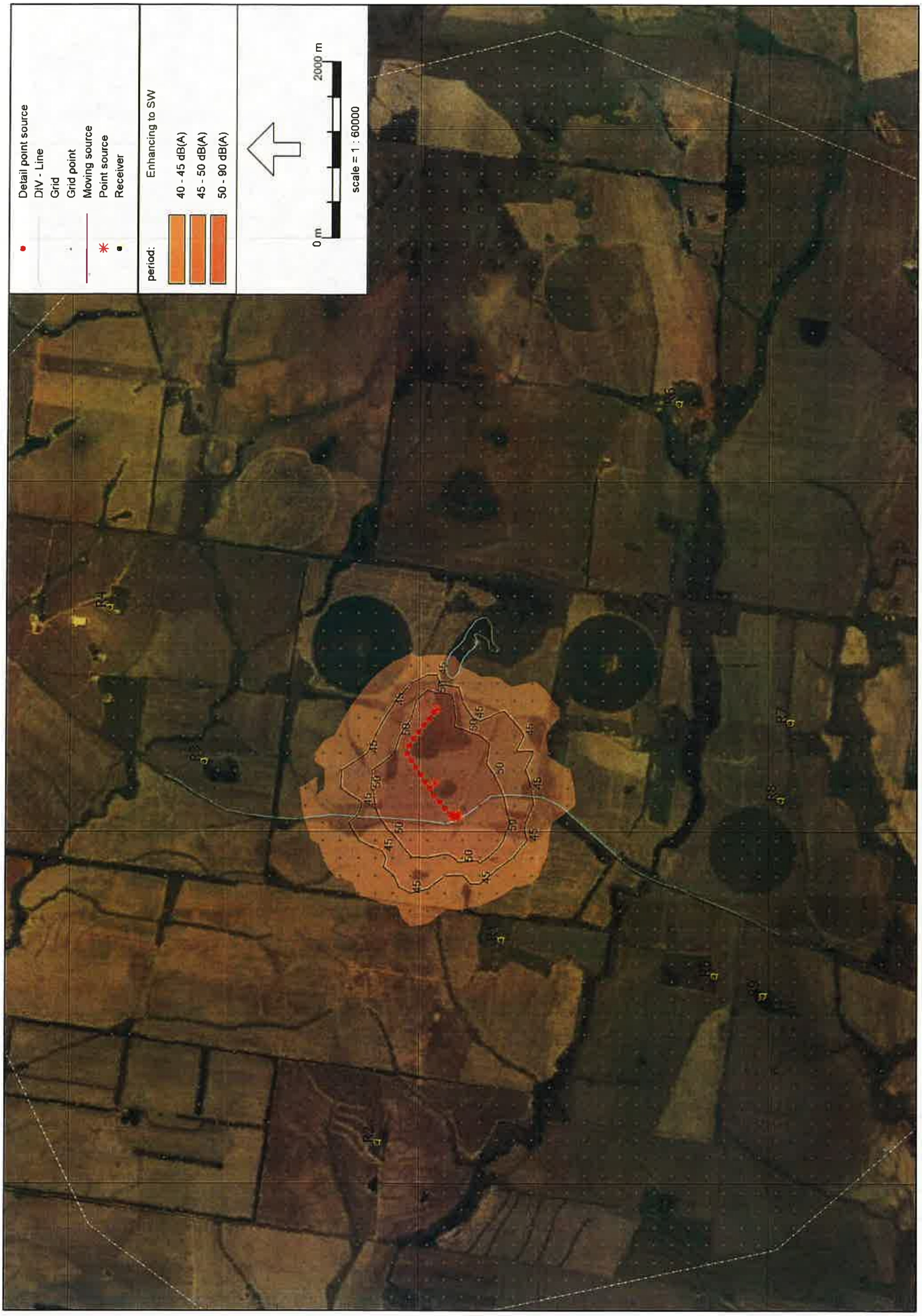
Advitech Environmental Pty Ltd



Cumulative Construction - Initial Quarry Footprint (Calm) Advitech Pty Ltd

Industrial noise - ISO 9613.1/2 (1/3 Octave), [Cumulative - Construction (Initial Quarry) Enhancing] , Predictor V8.11

Cumulative Construction - Site Access (Calm) Advitech Pty Ltd


Detail point source
DIV - Line
Grid
Grid point
Moving source
Point source
Receiver
period:
Enhancing to SW
40 - 45 dB(A)
45 - 50 dB(A)
50 - 90 dB(A)
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scale = 1 : 60000
248000
244000
240000
236000
6792000
6788000
6784000
Industrial noise - ISO 9613.1/2 (1/3 Octave), [Cumulative - Construction (Stockpile) Enhancing] , Predictor V8.11

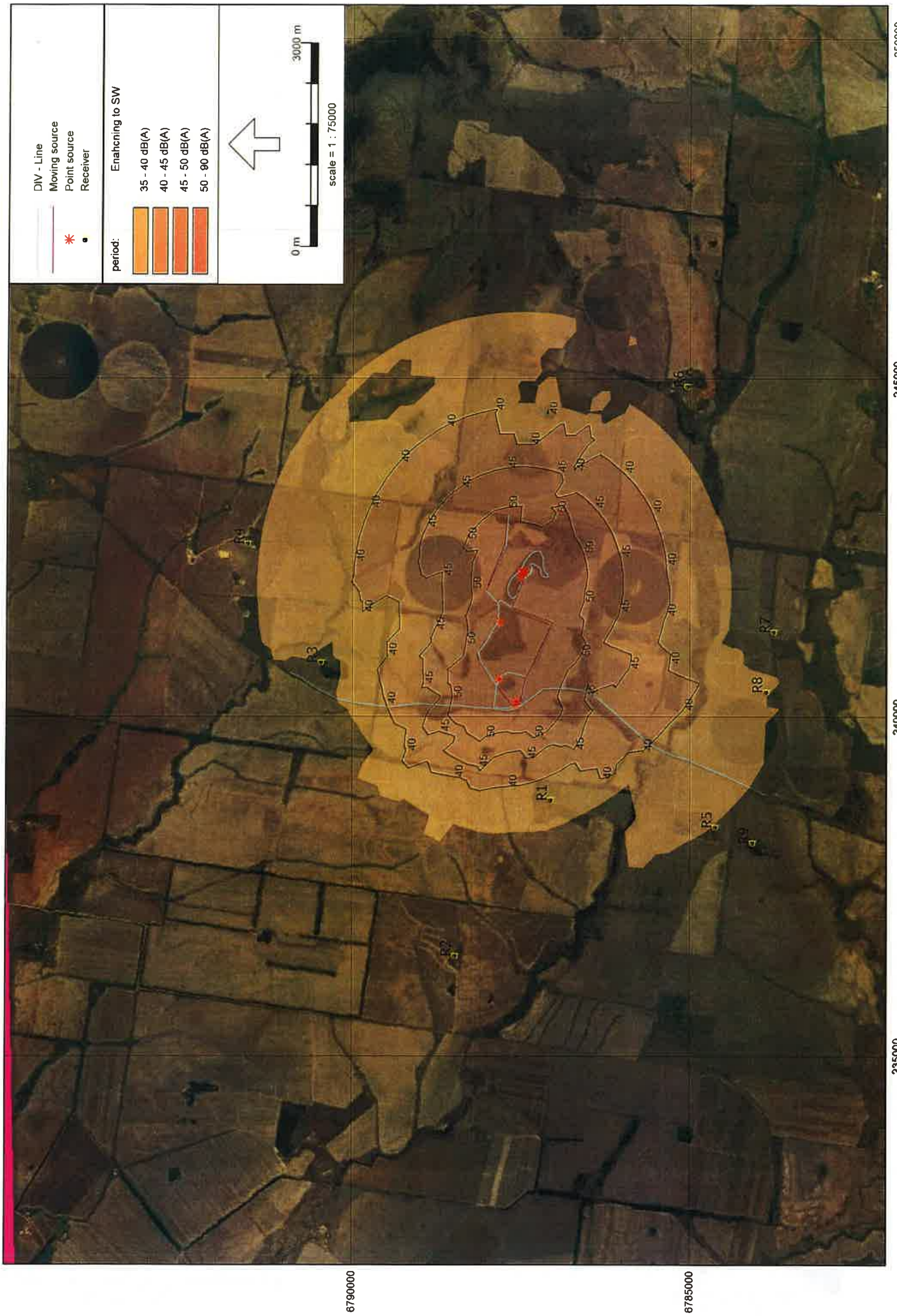
Cumulative Day Operations (Calm)

Advitech Environmental Pty Ltd

Industrial noise - ISO 9613.1/2 (1/3 Octave), [Cumulative - Calm (Day and Night)] , Predictor V8.11

Cumulative Operations Night (Enhancing Conditions)

Advitech Pty Ltd



Industrial noise - ISO 9613.1/2 (1/3 Octave), [Cumulative - Night Enhancing] , Predictor V8.11

advitech environmental

APPENDIX III: Traffic Noise Level Affected Receivers

Table 30: Existing road noise levels at sensitive traffic noise receivers

Address	Catchment	Existing dB(A)		Criteria dB(A)		Exceedance	
		Day	Night	Day	Night	Day	Night
1 David Street	Township	51	47	60	55	Nil	Nil
10 Cleveland Street	Township	52	49	60	55	Nil	Nil
10 David Street	Township	48	44	60	55	Nil	Nil
10-12 Wilby Street	Township	47	44	60	55	Nil	Nil
11 David Street	Township	49	46	60	55	Nil	Nil
13 David Street	Township	47	43	60	55	Nil	Nil
13 Edward Street	Township	48	45	60	55	Nil	Nil
15 Edward Street	Township	47	44	60	55	Nil	Nil
17 Edward Street	Township	48	44	60	55	Nil	Nil
19 David Street	Township	46	43	60	55	Nil	Nil
19 Edward Street	Township	50	46	60	55	Nil	Nil
195 Croppa Creek Road	Croppa Creek	40	36	60	55	Nil	Nil
2 Wilby Street	Township	51	47	60	55	Nil	Nil
20-22 Wilby Street	Township	46	42	60	55	Nil	Nil
21 David Street	Township	46	42	60	55	Nil	Nil
21 Edward Street	Township	51	48	60	55	Nil	Nil
21768 Bruxner Way	Bruxner Hwy	41	37	60	55	Nil	Nil
21930 Bruxner Way	Bruxner Hwy	44	40	60	55	Nil	Nil
23 David Street	Township	45	42	60	55	Nil	Nil
23 Edward Street	Township	53	49	60	55	Nil	Nil
24 David Street	Township	47	43	60	55	Nil	Nil
25 Edward Street	Township	53	49	60	55	Nil	Nil
26 Wilby Street	Township	45	41	60	55	Nil	Nil
27 David Street	Township	45	42	60	55	Nil	Nil
2-8 Cleveland Street	Township	53	50	60	55	Nil	Nil
28 David Street	Township	48	44	60	55	Nil	Nil
29 David Street	Township	45	41	60	55	Nil	Nil
29 Edward Street	Township	51	49	60	55	Nil	Nil
3 David Street	Township	49	45	60	55	Nil	Nil
3 Edward Street	Township	51	48	60	55	Nil	Nil
31 David Street	Township	45	41	60	55	Nil	Nil
32-34 Wilby Street	Township	45	41	60	55	Nil	Nil
33-35 David Street	Township	44	40	60	55	Nil	Nil
36 David Street	Township	47	43	60	55	Nil	Nil
38 David Street	Township	46	42	60	55	Nil	Nil

Address	Catchment	Existing dB(A)		Criteria dB(A)		Exceedance	
		Day	Night	Day	Night	Day	Night
3824 Getta Getta Road	Township	47	43	60	55	Nil	Nil
4 David Street	Township	49	45	60	55	Nil	Nil
5 David Street	Township	48	44	60	55	Nil	Nil
5 Edward Street	Township	48	47	60	55	Nil	Nil
578 I B Bore Road	I B Bore Rd	30	--	60	55	Nil	Nil
7 Edward Street	Township	48	45	60	55	Nil	Nil
7056 North Star Road	North Star Rd	42	38	60	55	Nil	Nil
7114 North Star Road	North Star Rd	48	44	60	55	Nil	Nil
751 I B Bore Road	I B Bore Rd	31	--	60	55	Nil	Nil
781 Croppa Creek Road	Croppa Creek	36	32	60	55	Nil	Nil
781 Croppa Creek Road	Croppa Creek	43	39	60	55	Nil	Nil
9 David Street	Township	47	44	60	55	Nil	Nil
2107 Croppa Creek Road	Croppa Creek	39	35	60	55	Nil	Nil
4011 Croppa Moree Road	Croppa Moree Rd	48	44	60	55	Nil	Nil
2279 I B Bore Road	I B Bore Rd	44	40	60	55	Nil	Nil
31-37 Edward Street	School	49	46	50[1]	--	Nil	Nil
9-11 Edward Street	Township	48	47	60	55	Nil	Nil

Note[1]: 50db(A) external 40dB(A) internal.

Table 31: Predicted road noise levels at sensitive traffic noise receivers (average daily movements)

Address	Catchment	Predicted dB(A)		Criteria dB(A)		Exceedance		Increase	
		Day	Night	Day	Night	Day	Night	Day	Night
1 David Street	Township	54	48	60	55	Nil	Nil	3	1
10 Cleveland Street	Township	56	51	60	55	Nil	Nil	4	2
10 David Street	Township	51	46	60	55	Nil	Nil	3	2
10-12 Wilby Street	Township	51	45	60	55	Nil	Nil	4	1
11 David Street	Township	53	47	60	55	Nil	Nil	4	1
13 David Street	Township	50	45	60	55	Nil	Nil	3	2
13 Edward Street	Township	53	47	60	55	Nil	Nil	5	2
15 Edward Street	Township	52	46	60	55	Nil	Nil	5	2
17 Edward Street	Township	52	46	60	55	Nil	Nil	4	2
19 David Street	Township	50	44	60	55	Nil	Nil	4	1
19 Edward Street	Township	53	48	60	55	Nil	Nil	3	2
195 Croppa Creek Road	Croppa Creek	44	38	60	55	Nil	Nil	4	2
2 Wilby Street	Township	55	49	60	55	Nil	Nil	4	2
20-22 Wilby Street	Township	49	44	60	55	Nil	Nil	3	2
21 David Street	Township	49	44	60	55	Nil	Nil	3	2
21 Edward Street	Township	54	49	60	55	Nil	Nil	3	1
21768 Bruxner Way	Bruxner Hwy	44	39	60	55	Nil	Nil	3	2
21930 Bruxner Way	Bruxner Hwy	47	41	60	55	Nil	Nil	3	1
23 David Street	Township	49	43	60	55	Nil	Nil	4	1
23 Edward Street	Township	57	51	60	55	Nil	Nil	4	2
24 David Street	Township	50	44	60	55	Nil	Nil	3	1
25 Edward Street	Township	56	50	60	55	Nil	Nil	3	1
26 Wilby Street	Township	48	43	60	55	Nil	Nil	3	2
27 David Street	Township	49	43	60	55	Nil	Nil	4	1
2-8 Cleveland Street	Township	57	51	60	55	Nil	Nil	4	1
28 David Street	Township	51	46	60	55	Nil	Nil	3	2
29 David Street	Township	48	43	60	55	Nil	Nil	3	2
29 Edward Street	Township	54	50	60	55	Nil	Nil	3	1
3 David Street	Township	52	46	60	55	Nil	Nil	3	1
3 Edward Street	Township	55	49	60	55	Nil	Nil	4	1
31 David Street	Township	48	43	60	55	Nil	Nil	3	2
32-34 Wilby Street	Township	48	42	60	55	Nil	Nil	3	1
33-35 David Street	Township	47	42	60	55	Nil	Nil	3	2
36 David Street	Township	50	45	60	55	Nil	Nil	3	2
38 David Street	Township	49	44	60	55	Nil	Nil	3	2
3824 Getta Getta Road	Township	50	45	60	55	Nil	Nil	3	2
4 David Street	Township	52	46	60	55	Nil	Nil	3	1
5 David Street	Township	51	46	60	55	Nil	Nil	3	2
5 Edward Street	Township	52	48	60	55	Nil	Nil	4	1
578 I B Bore Road	I B Bore Rd	35	27	60	55	Nil	Nil	5	--
7 Edward Street	Township	52	46	60	55	Nil	Nil	4	1
7056 North Star Road	North Star Rd	45	39	60	55	Nil	Nil	3	1
7114 North Star Road	North Star Rd	51	46	60	55	Nil	Nil	3	2
751 I B Bore Road	I B Bore Rd	36	27	60	55	Nil	Nil	5	--

Address	Catchment	Predicted dB(A)		Criteria dB(A)		Exceedance		Increase	
		Day	Night	Day	Night	Day	Night	Day	Night
781 Croppa Creek Road	Croppa Creek	39	34	60	55	Nil	Nil	3	2
781 Croppa Creek Road	Croppa Creek	47	41	60	55	Nil	Nil	4	2
9 David Street	Township	51	45	60	55	Nil	Nil	4	1
2107 Croppa Creek Road	Croppa Creek	43	37	60	55	Nil	Nil	4	2
4011 Croppa Moree Road	Croppa Moree Rd	50	45	60	55	Nil	Nil	2	1
2279 I B Bore Road	I B Bore Rd	47	42	60	55	Nil	Nil	3	2
31-37 Edward Street	School	52	47	50[1]	--	Nil	Nil	3	1
9-11 Edward Street	Township	52	48	60	55	Nil	Nil	4	1

Note[1]: 50db(A) external 40dB(A) internal.

Table 32: Predicted road noise levels at sensitive traffic noise receivers (peak daily movements)

Address	Catchment	Predicted dB(A)		Criteria dB(A)		Exceedance		Increase	
		Day	Night	Day	Night	Day	Night	Day	Night
1 David Street	Township	57	50	60	55	Nil	Nil	6	3
10 Cleveland Street	Township	59	53	60	55	Nil	Nil	7	4
10 David Street	Township	54	47	60	55	Nil	Nil	6	3
10-12 Wilby Street	Township	53	47	60	55	Nil	Nil	6	3
11 David Street	Township	55	49	60	55	Nil	Nil	6	3
13 David Street	Township	53	46	60	55	Nil	Nil	6	3
13 Edward Street	Township	56	49	60	55	Nil	Nil	8	4
15 Edward Street	Township	56	48	60	55	Nil	Nil	9	4
17 Edward Street	Township	56	48	60	55	Nil	Nil	8	4
19 David Street	Township	52	46	60	55	Nil	Nil	6	3
19 Edward Street	Township	57	50	60	55	Nil	Nil	7	4
195 Croppa Creek Road	Croppa Creek	47	40	60	55	Nil	Nil	7	4
2 Wilby Street	Township	57	51	60	55	Nil	Nil	6	4
20-22 Wilby Street	Township	52	46	60	55	Nil	Nil	6	4
21 David Street	Township	52	46	60	55	Nil	Nil	6	4
21 Edward Street	Township	58	51	60	55	Nil	Nil	7	3
21768 Bruxner Way	Bruxner Hwy	47	41	60	55	Nil	Nil	6	4
21930 Bruxner Way	Bruxner Hwy	49	43	60	55	Nil	Nil	5	3
23 David Street	Township	52	45	60	55	Nil	Nil	7	3
23 Edward Street	Township	60	53	60	55	Nil	Nil	7	4
24 David Street	Township	53	46	60	55	Nil	Nil	6	3
25 Edward Street	Township	59	52	60	55	Nil	Nil	6	3
26 Wilby Street	Township	51	45	60	55	Nil	Nil	6	4
27 David Street	Township	51	45	60	55	Nil	Nil	6	3
2-8 Cleveland Street	Township	60	53	60	55	Nil	Nil	7	3
28 David Street	Township	54	47	60	55	Nil	Nil	6	3
29 David Street	Township	51	45	60	55	Nil	Nil	6	4
29 Edward Street	Township	57	52	60	55	Nil	Nil	6	3
3 David Street	Township	55	48	60	55	Nil	Nil	6	3
3 Edward Street	Township	57	50	60	55	Nil	Nil	6	2
31 David Street	Township	51	45	60	55	Nil	Nil	6	4
32-34 Wilby Street	Township	51	44	60	55	Nil	Nil	6	3
33-35 David Street	Township	50	43	60	55	Nil	Nil	6	3
36 David Street	Township	53	47	60	55	Nil	Nil	6	4
38 David Street	Township	52	46	60	55	Nil	Nil	6	4
3824 Getta Getta Road	Township	53	46	60	55	Nil	Nil	6	3
4 David Street	Township	54	48	60	55	Nil	Nil	5	3
5 David Street	Township	54	47	60	55	Nil	Nil	6	3
5 Edward Street	Township	54	49	60	55	Nil	Nil	6	2
578 I B Bore Road	I B Bore Rd	39	30	60	55	Nil	Nil	9	--
7 Edward Street	Township	54	48	60	55	Nil	Nil	6	3
7056 North Star Road	North Star Rd	48	41	60	55	Nil	Nil	6	3
7114 North Star Road	North Star Rd	54	47	60	55	Nil	Nil	6	3
751 I B Bore Road	I B Bore Rd	40	31	60	55	Nil	Nil	9	--

Address	Catchment	Predicted dB(A)		Criteria dB(A)		Exceedance		Increase	
		Day	Night	Day	Night	Day	Night	Day	Night
781 Croppa Creek Road	Croppa Creek	42	36	60	55	Nil	Nil	6	4
781 Croppa Creek Road	Croppa Creek	50	43	60	55	Nil	Nil	7	4
9 David Street	Township	53	47	60	55	Nil	Nil	6	3
2107 Croppa Creek Road	Croppa Creek	46	39	60	55	Nil	Nil	7	4
4011 Croppa Moree Road	Croppa Moree Rd	52	46	60	55	Nil	Nil	4	2
2279 I B Bore Road	I B Bore Rd	50	44	60	55	Nil	Nil	6	4
31-37 Edward Street	School	56	50	50[1]	--	Nil	Nil	7	4
9-11 Edward Street	Township	54	49	60	55	Nil	Nil	6	2

Note[1]: 50db(A) external 40dB(A) internal.

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"Pearlman" Quarry

Traffic Impact Assessment

Quarry Solutions Pty Ltd

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August 2019

SMK

CONSULTANTS

surveying – irrigation – environmental – planning

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Revision History

Version Number	Date	Authority	Details
0	August 2019	Hayley Greenham (SMK Consultants)	Initial Issue

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1 Introduction

SMK Consultants Pty Ltd have been engaged by Quarry Solutions Pty Ltd (Quarry Solutions) to provide a Traffic Impact Assessment (TIA) for the proposed "Pearlman Quarry". The assessment has been prepared in accordance with requirements under the *Environmental Planning and Assessment Act 1979* to consider the environmental impact of a development proposal. In this instance, the environment considered is the road network servicing the proposed development.

1.1 Purpose

The purpose of this assessment is to assess the haul routes to be used by a development application for a 490,000-tonne hard rock quarry on the property of "Tikitere" 1135 Croppa Creek Road, North Star in the Gwydir Shire Council local government area.

1.2 Aims and Objectives

This assessment aims to identify the likely impact of the proposed heavy vehicle traffic upon the road network of the region. Impacts considered include impacts to the road network itself (road condition), the functionality of the road network (road safety and traffic volumes) and amenity impacts of changes to the road network (traffic noise). The assessment also outlines traffic considerations with regard to the design of the proposed quarry (adequacy of on-site parking provision, internal traffic circulation and site access to the public road network).

Plans of road upgrades are not included in this assessment but may be required as a part of operational works or negotiated through conditions of approval.

1.3 Scope of Works

The scope of works for this Traffic Impact Assessment (TIA) includes the following:

- Determine potential haulage routes with special considerations for any school zones, school bus routes, residential areas or potential risk locations;
- Assessment of the surrounding environment, existing conditions and road safety;
- Assessment of existing private property driveways and farm access points;
- Liaison with Gwydir Shire Council and Moree Plains Shire Council in relation to existing road traffic numbers;
- Assessment of likely impacts associated with road haulage;
- Any mitigation measures required to minimise road impacts, e.g. dust and noise suppression;
- Calculation of expected contribution rate; and
- Inclusion of Traffic Management Plan and Truck Driver Code of Practice as prepared by Groundwork Plus.

2 Existing Conditions

2.1 Development Site

The development site is approximately 9.25 hectares on Lot 5 in DP755984. The site is located within the Gwydir Shire local government area. The public roads proposed to be utilised as the haulage route are located within both the Gwydir and Moree Plains Local Government areas. The locality of the proposed development site is shown in Figure 1.

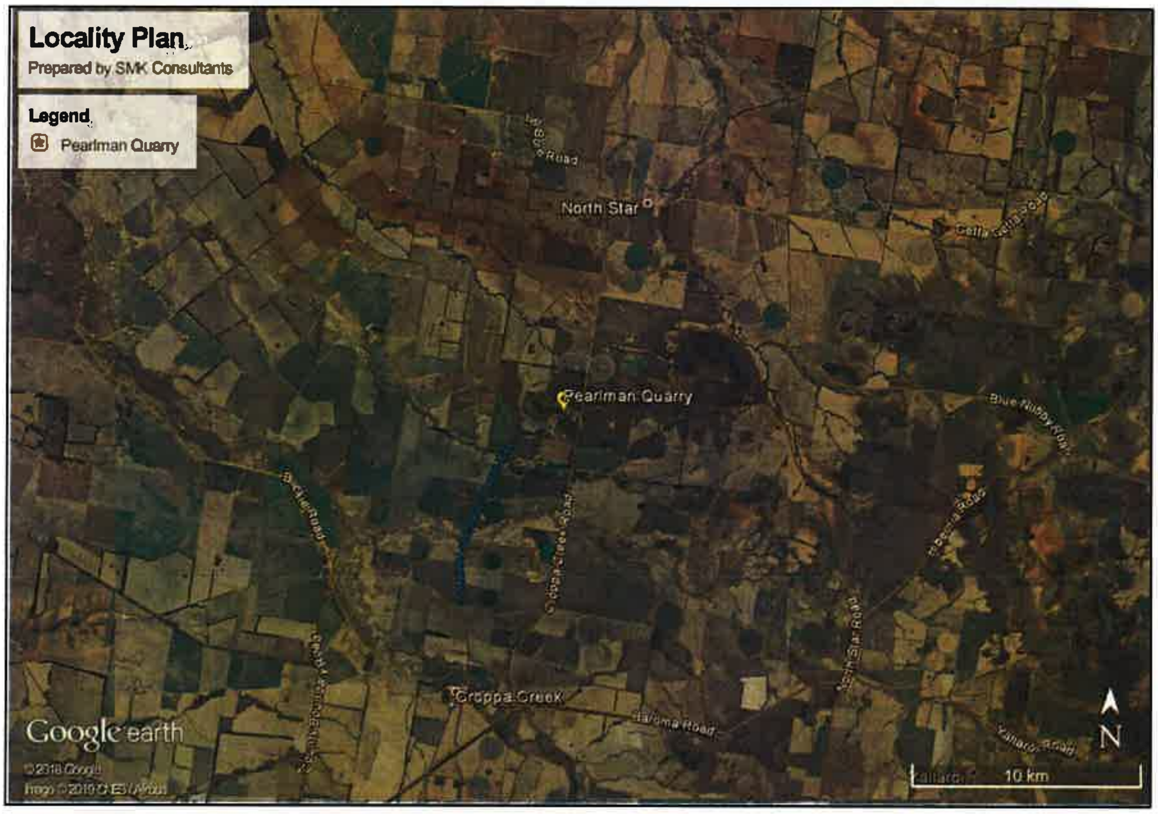


Figure 1: Quarry Site Locality Plan

The layout of the proposed development site is presented in the site plans included as Appendix 1.

2.2 Access Suitability

2.2.1 Access from Croppa Creek Road to Pearlman Quarry

The proposal includes utilising an existing access to the property. The current state of the existing access is shown in Figure 2. The access was constructed in early 2019 as part of the Tikitere Quarry development. The access was designed for heavy vehicle traffic and is currently in good condition.

Figure 2: Existing Property Access to the proposed Pearlman Quarry
(Location: 243013m E; 6787542m S)

2.2.2 Safety and Efficiency of Access

The sign posted speed limit on Croppa Creek Road is 100 km/h. Intersection performance is dependent upon adequate horizontal and vertical sight distance for all entering traffic (Department of Main Roads Chapter 13 Road Planning and Design Manual Intersections at Grade, 2006). It is therefore necessary to undertake a check of the available sight distance to assess whether or not it can operate under safe parameters. The types of sight distance that must be provided in the design of all intersections include:

- Approach Sight Distance (ASD)
- Safe Intersection Sight Distance (SISD)
- Minimum Gap Sight Distance (MGSD)

Intersections should be designed to provide the more conservative value of SISD or MGSD for all vehicle movements that may be required to give way to other vehicles at the intersection. Details regarding how the sight distances are applied are provided in the following sections.

Approach Site Distances (ASD)

Provision of ASD for cars:

- The minimum level of sight distance which must be available on the minor road approaches to all intersections to ensure that drivers are aware of the presence of an intersection;

- For major road approaches where practical, drivers should see the pavement markings within the intersection and should be achieved where practicable. However, the provision of ASD on the major road may have implications (e.g. costs, impact on adjacent land and features) in which case Stopping Site Distance (SSD) is the minimum sight distance that should be achieved on the major road approaches to the intersection and within the intersection;
- Numerically equal to normal car SSD – which is defined as the distance travelled by a vehicle between the time the driver receives a stimulus signifying a need to stop, and the time at which the vehicle comes to rest; and
- Varying the SSD may include the object height used in its calculation. ASD is measured from a driver's eye height (1.1m) to 0.0m, which ensures that a driver is able to see any line marking and kerbing at the intersection whereas SSD is measured from 1.1m to 0.2m (a nominal object height).

Provision of ASD for trucks:
ASD for trucks should be provided at intersections to ensure that trucks approaching the intersection, at the 85th percentile operating speed of trucks, are able to stop safely. ASD for trucks on the intersection approaches should be measured from the truck driver eye height (2.4m) to the pavement level at the stop or holding line (0.0m).

Approach sight distance for trucks are numerically the same as the SSD values for trucks provided in the Austroads Document Guide to Road Design – Part 3: Geometric Design. ASD is applied as shown in Figure 3.

$$\mathrm{ASD} = \frac{\mathrm{R_T} \times \mathrm{V}}{3.6} + \frac{V^2}{254 \times (d + [0.01 \times a])}$$

Where:

- ASD = Application Sight Distance
- R_T = Reaction Time (s) = 2.0s
- V = Operating (85%ile) speed (Km/h) = 40km/h
- d = Coefficient of deceleration = 0.22
- a = Longitudinal grade (% + uphill, - downhill) = 0.0%

$$\mathrm{ASD} = \frac{2.0 \times 40}{3.6} + \frac{40^2}{254 \times (0.22 + [0.01 \times 0])}$$

ASD = 50.85m

The available ASD is in excess of the required ASD (50.85m) as shown below in Figures 5 and 6. The Approach Sight Distance of the access road geometric design is therefore satisfactory.

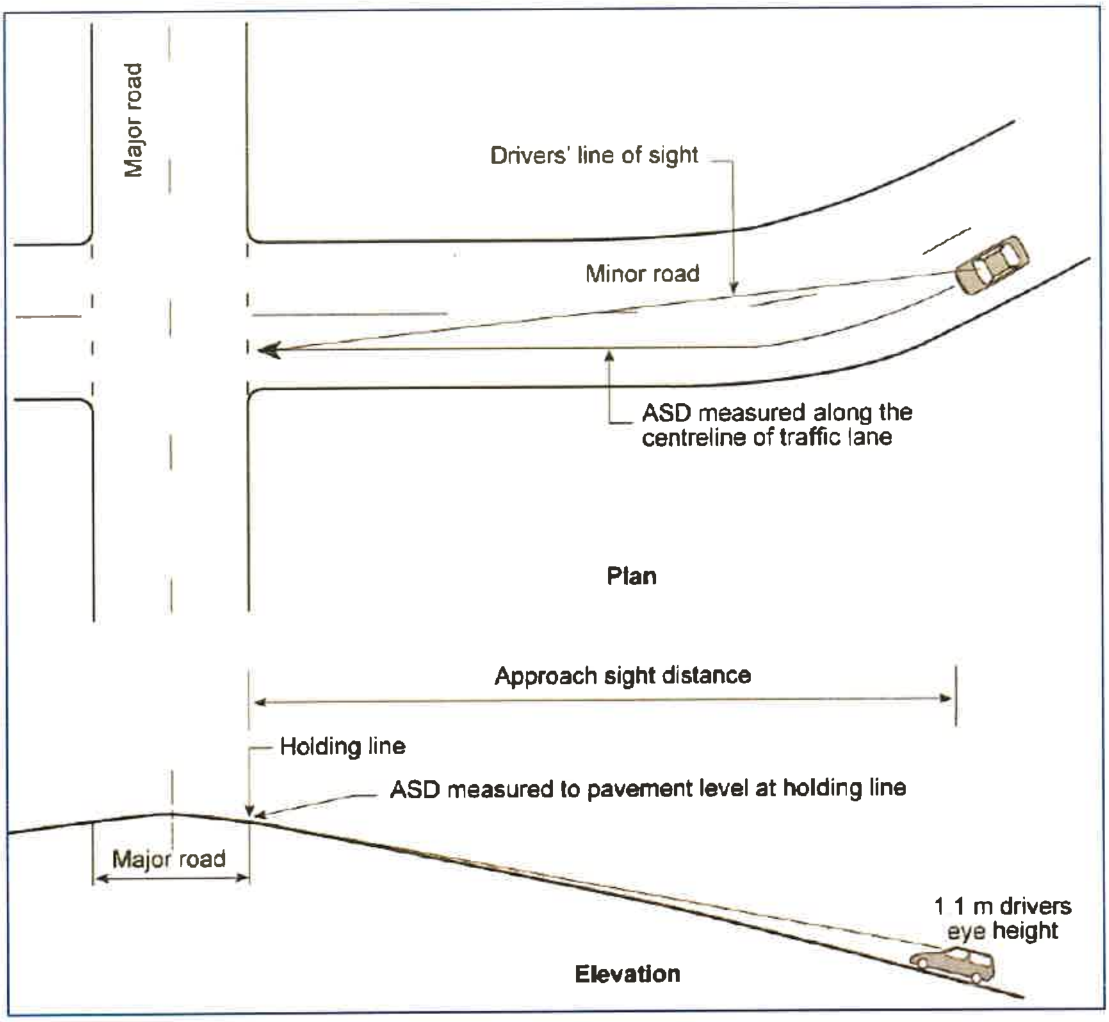


Figure 3: Application of ASD (Source Figure 3.1. AGRD04A/09).

Safe Intersection Sight Distance (SISD)

SISD refers to the distance required for the driver of a vehicle, on the non-terminating road, to observe a vehicle entering from a minor road, decelerate and stop prior to a point of collision. In this context, it is the minimum sight distance which should be provided on the major road of the intersection. SISD:

- Is viewed between two points to provide inter-visibility between drivers and vehicles on the major road and minor road approaches. It is measured from a driver eye height of 1.1 m above the road to points 1.25 m above the road which represents drivers seeing the upper part of cars. Figure 3.2 illustrates the longitudinal section for the two cases representing inter-visibility; one for drivers on the major road and the second for a driver waiting in the minor road for an opportunity to enter the major road;
- Assumes that the driver on the minor road is situated at a distance of 5.0 m (minimum of 3.0 m) from the lip of the channel or edge line projection of the major road. SISD allows for a 3 s observation time for a driver on the priority legs of the intersection to

detect the problem ahead, (e.g. car from minor road stalling in through lane) plus the SSD;

- Provides sufficient distance for a vehicle to cross the non-terminating movement on two-lane two-way roads, or undertake two-stage crossings of dual carriageways, including those with design speeds of 80 km/h or more;
- Should also be provided for drivers of vehicles stored in the centre of the road when undertaking a crossing or right-turning movement;
- Enables approaching drivers to see an articulated vehicle, which has properly commenced a manoeuvre from a leg without priority, but its length creates an obstruction; and
- Is measured along the carriageway from the approaching vehicle to the conflict point, the line of sight having to be clear to a point 5.0 m (3.0 m minimum) back from the holding line or stop line on the side road.

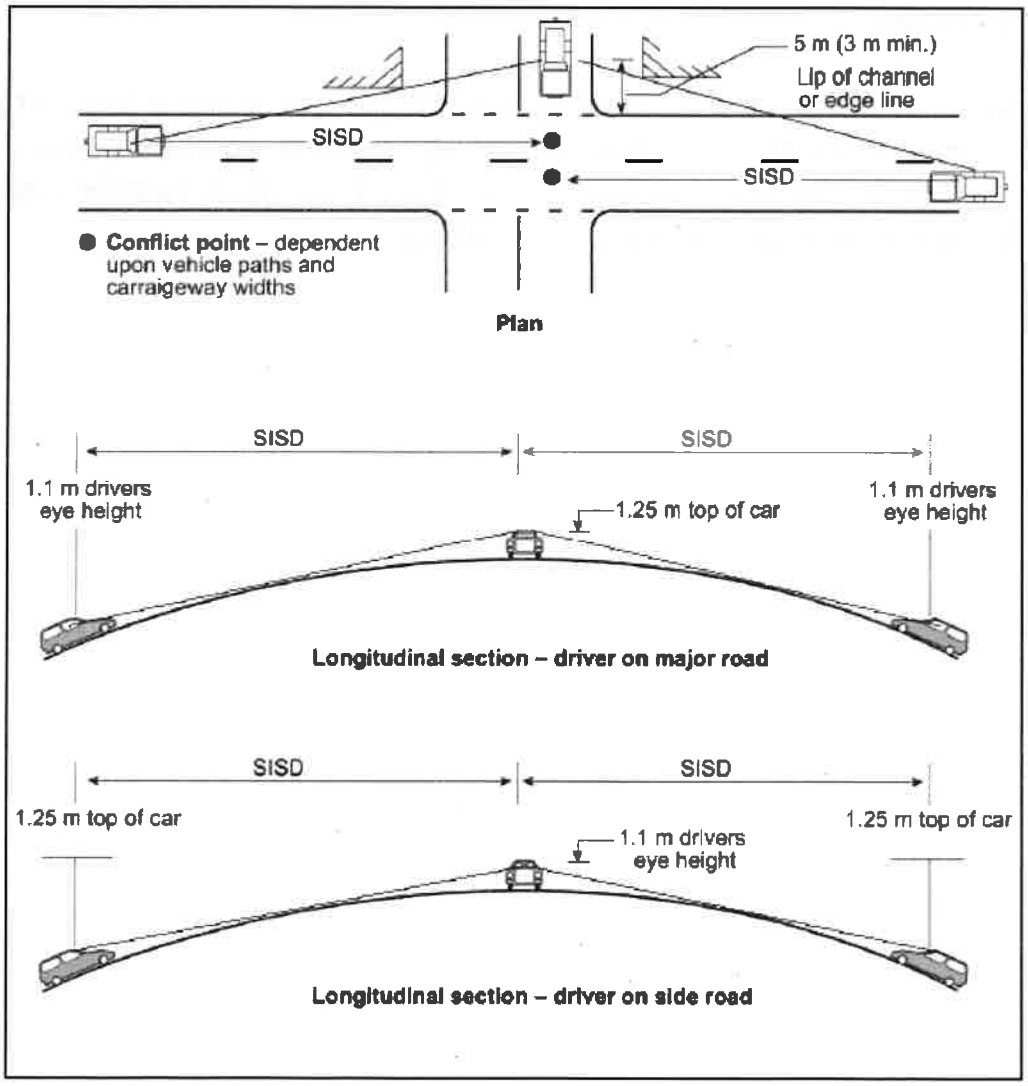


Figure 4: Application of SISD (Source Figure 3.1. AGRD04A/09)

The Safe Intersection Sight Distance (SISD) for the access intersection has been calculated as:

$$\text{SISD} = \frac{\text{D}_\text{T} \times \text{V}}{3.6} + \frac{V^2}{254 \times (d + [0.01 \times a])}$$

Where:

- SISD = Safe Intersection Sight Distance
- D_T = Decision Time (s) = Observation Time (s) + Reaction Time (s) = 5.0s
- V = Operating (85%ile) speed (Km/h) = 100km/h
- d = Coefficient of deceleration = 0.22
- a = Longitudinal grade (% + uphill, - downhill) = 0.0%

$$\text{SISD} = \frac{5.0 \times 100}{3.6} + \frac{100^2}{254 \times (0.22 + [0.01 \times 0])}$$

SISD = 317.84m

The available SISD is well in excess of the required SISD (317.84m) as shown below in Figures 5 and 6. There are no objects or vegetation obscuring the view (in either direction) of a truck parked 3-5m back from the intersection. The existing access road geometric design is deemed satisfactory in terms of Safe Intersection Sight Distance.

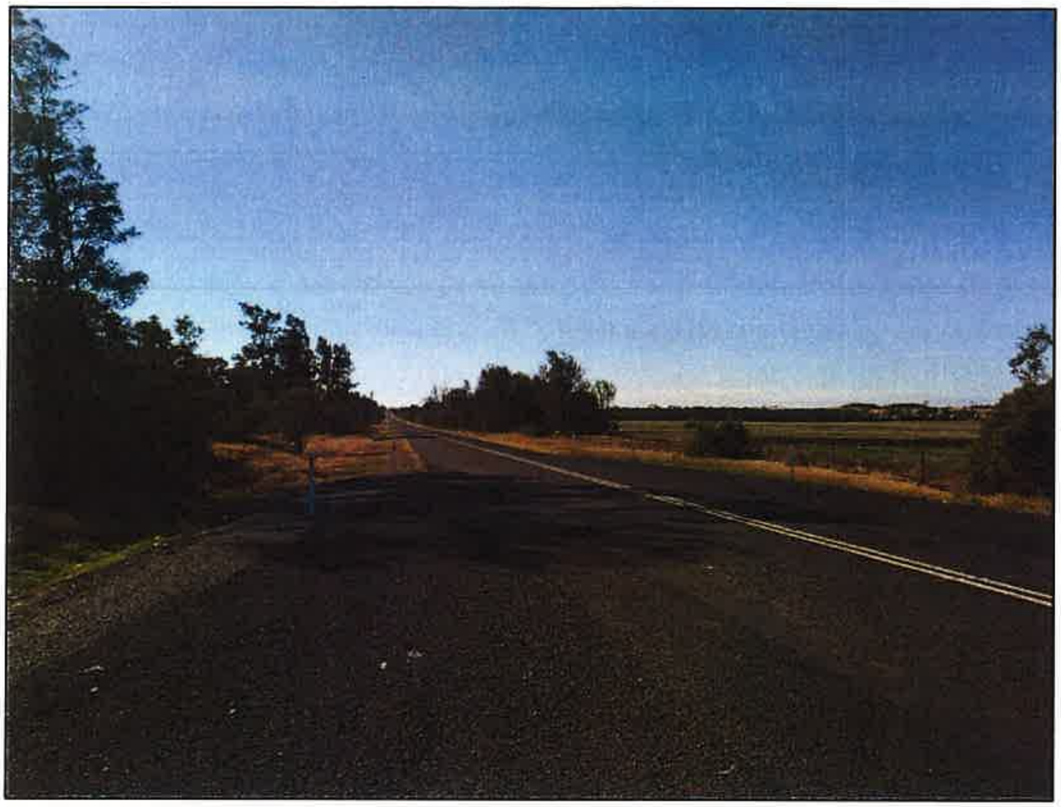


Figure 5: Sight Distance facing north along Croppa Creek Road. Sight distance >600metres.

Figure 6: Sight Distance facing south along Croppa Creek Road. Sight distance >400metres.

Minimum Gap Sight Distance (MGSD)

MDSD is based on distances corresponding to the critical acceptance gap that drivers are prepared to accept when undertaking a crossing or turning manoeuvre at intersections. More information on gap acceptance theory in relation to intersection capacity is provided in the *Austroads Guide to Traffic Management Part 3: Traffic Studies and Analysis.*

The MGSD required for the driver of an entering vehicle to see a vehicle in the conflicting streams in order to safely undertake a desired manoeuvre is dependent upon the:

- length of the gap being sought (critical acceptance gap time t_a) and;
- observation angle to approaching traffic.

As the intersection has been appropriately designed and constructed for heavy vehicles, including road trains, sighting angles will be well within these restrictions.
The critical acceptance gap time varies according to:

- the type of manoeuvre – left-turn/right-turn/crossing of traffic
- the width of carriageway – increased time required for greater widths
- whether the major road has a one-way or two-way traffic flow, requiring increased time required to look both ways.

The estimated values for MGSD, with t_a factors extracted from Table 3.5 of the *Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections*, are presented below in Table 1.

Table 1: Table of Minimum Gap Sight Distances (in metres) for various speeds

Critical gap acceptance time (t_a) (secs)	85th percentile speed of approaching vehicle (km/h)										
	10	20	30	40	50	60	70	80	90	100	110
4	11	22	33	44	55	67	78	89	100	111	122
5	14	28	42	55	69	83	97	111	125	139	153
6	17	33	50	67	83	100	117	133	150	167	183
7	19	39	58	78	97	117	136	155	175	194	214
8	22	44	67	89	111	133	155	178	200	222	244
9	25	50	75	100	125	150	175	200	225	250	275
10	28	56	83	111	139	167	194	222	250	278	305

Based on Table 1 the assessed values for MGSD (in metres) for the Croppa Creek Road and Pearlman Quarry access road intersection have been calculated with a t_a of 10 seconds, to give the most conservative values. These were 278 metres for both left and right turns out (turning into traffic travelling at 100km/h). These values are both within the available sight distances (Figure 5 and Figure 6) and are therefore deemed satisfactory.

2.2.1 Internal Traffic Circulation

All traffic would enter and exit the site from Croppa Creek Road. Internal roads are either gravelled or graded on natural surface to provide all-weather access to the Quarry sites. Internal roads are private roads within the property of Tikitere. No public access is available.

2.2.2 Parking Supply

The development site is located within a rural property which does not have access to public transport, and therefore is only accessible via private vehicle. For industries it is recommended that parking spaces be provided in accordance with the following rate: 1 parking space per 2 staff employed. Ample parking is available on site to accommodate vehicles of staff, in addition to visitors to the site. Parking will be available adjacent to the site office.

2.2.3 Operating Hours

The approved operating hours are included in Table 2. The loading of trucks to haul product can occur between 6.00am-6.00pm Monday to Friday and 6.00am-1.00pm Saturday, with no haulage to occur on Sundays or public holidays.

Table 2: Hours of Operation

Activity	Monday to Friday	Saturday	Sunday and Public Holidays
Loading of trucks to haul product.	6.00am to 6.00pm	6.00am to 1.00pm	Nil
Light vehicle traffic associated with employees, or light service vehicles entering or leaving the site.	24 hours a day		
Maintenance of plant and equipment including repairs/alterations to processing equipment and unloaded test runs.	6.00am to 6.00pm	Nil	Nil
Drilling	7.00am to 6.00pm	Nil	Nil
Blasting	9.00am to 3.00pm	Nil	Nil
Operation of associated equipment within the confines of the excavated quarry area.	7.00am to 6.00pm	7.00am to 1.00pm	Nil
Operation of loaders, excavators, trucks, screening & crushing equipment within the property.	7.00am to 6.00pm	7.00am to 1.00pm	Nil
Exceptional circumstances – all crushing, loading and product haulage activities within the site to enable manufacture and delivery of high priority ARTC projects only.	24 hours with written notification and approval from Gwydir Shire Council and the Environment Protection Authority.		

2.3 Haulage Routes

The Pearlman quarry intends to supply quarry materials to the general market which at this time includes the Inland Rail Project, associated RMS road projects and other general construction projects in the market area that might occur as a result of the additional economic investment in the region. As such, the location and distance to client delivery points cannot be specified at this time.

The potential exists for the full annual extraction volume may be transported on the local road network. Because of this, impacts to individual sections of roads cannot be calculated and it is more appropriate to assume transport of material via sealed and unsealed local roads. A precautionary approach has been adopted as part of existing agreements with the Gwydir Shire for a contribution of $0.8/tonne moved from the quarry site as a contribution for maintenance of the local road network.

The monetary contribution will work in conjunction with the voluntary measures in the Traffic Management Plan (such as the implementation of GPS tracking for trucks and school buses which is an industry leading practice adopted by Quarry Solutions and endorsed by RMS) to mitigate and minimise potential traffic impacts whilst facilitating delivery of the region building infrastructure for the Inland Rail and associated RMS projects that will bring substantial economic stimulus and benefit to the region. The system will include tracking of loads and the weight of material moved from the quarry on local roads.

Daily production and haulage from this site may vary, however the maximum output from the Quarry will remain limited to 490,000 tonnes over a 12-month period.

2.3.1 Potential Haulage Route

The proposed haulage route from the development site will utilise internal roads before entering Croppa Creek Road and proceeding either north or south as required to provide material to various projects.

The extent of this assessment, shown in Figure 7, is limited to the major components of the surrounding road network likely to be impacted by the development including the following roads and intersections. Beyond the immediate network, the numbers of additional trips associated with the development and their impact are considered to be minimal and less than 5% of total trips. Impacted road infrastructure may include:

- Croppa Moree Road,
- Croppa Creek Road,
- North Star Road,
- I B Bore Road,
- Bruxner Way,
- Buckie Road,
- Tucka Tucka Road,
- Tumba Road,
- Boonery Park Road, and
- Crooble Road.

For clarification purposes, road names are based on NSW Land and Property Service data base referred to as Six Maps.

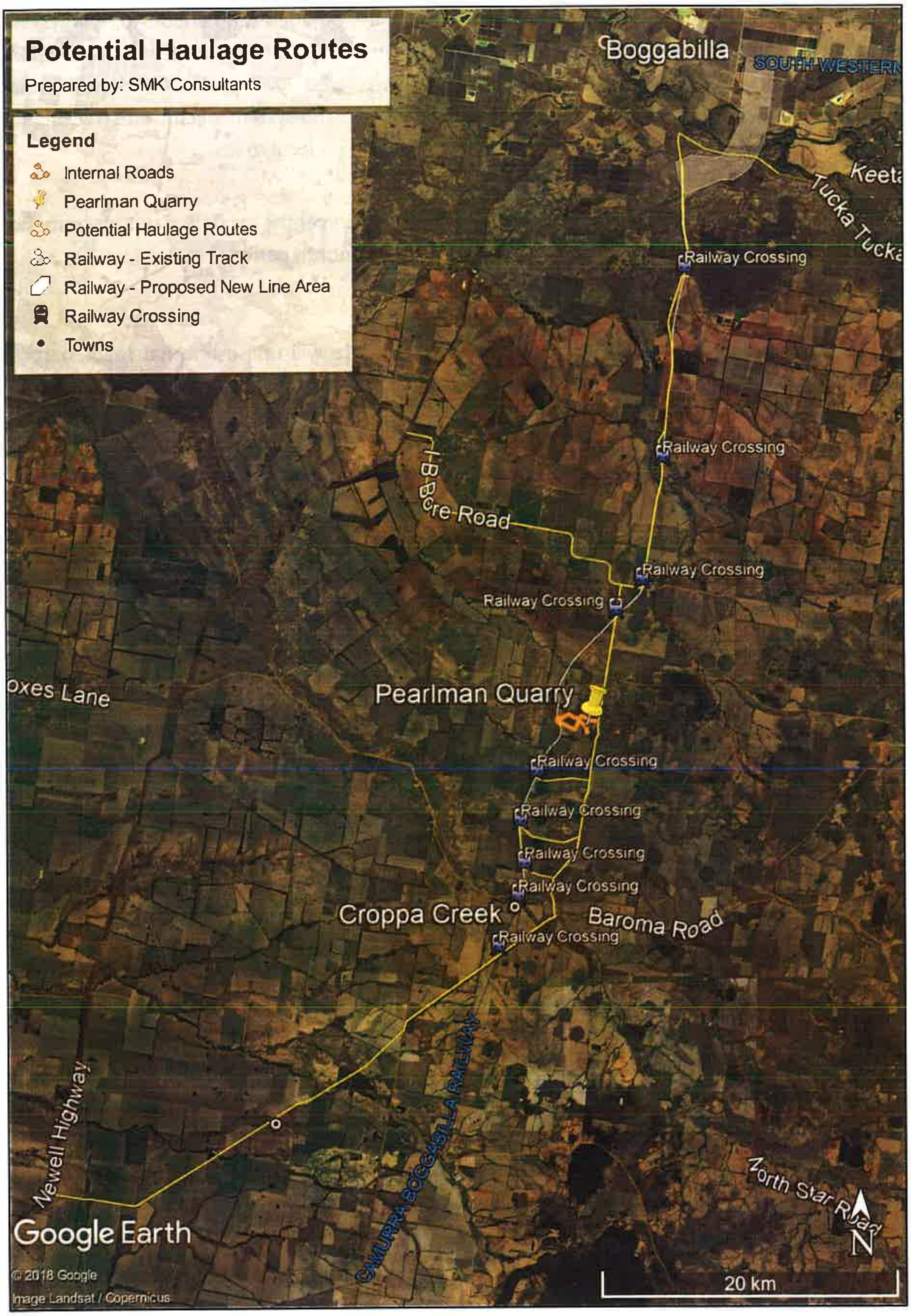


Figure 7: Inland Railway Haulage Route

2.4 Existing Road Network

2.4.1 Road Condition Assessment

Between the 25th, 26th and 30th of October 2018, SMK Consultants conducted a visual pavement inspection of the following roads:

- Croppa Creek-Moree Road (from Croppa Creek to the Crooble Road intersection)
- Croppa Creek Road (Croppa Creek-North Star)
- North Star Road
- I B Bore Road
- Buckie Road
- Bruxner Way
- Tucka Tucka Road
- Tumba Road
- Boonery Park Road
- Crooble Road
- Newell Highway

On the 20th of June 2019, Mark Carrigan and Hayley Greenham from SMK Consultants conducted a visual pavement inspection of the following roads:

- Croppa Creek-Moree Road (from the Crooble intersection to the Newell Highway intersection)

Both inspections were completed over a number of hours in fine and clear weather conditions. The road was driven in both directions and a handheld GPS unit was used to record locations of damage or deficiency. Coordinates are provided in GDA94 format. No destructive geotechnical investigation of the existing pavements was undertaken as part of this investigation.

The photos included as Appendix 3 are generally presented in order as taken along the designated haulage route and are considered representative of the road condition at the time of each inspection.

Note: RA – Rural Address, W - Road Width. All road names have been obtained from SixMaps.

Croppa Moree Road (SR5)

Croppa Moree Road is a bitumen sealed two-way road maintained by both the Gwydir Shire Council (GSC) and Moree Plains Shire Council (MPSC). The road services the farming community and several other smaller arterial roads. The road is trafficable in all weather conditions apart from times of extreme flood events. The section that may potentially be impacted by the quarry involves 36.5 kilometres in length (24.8 kilometres within the MPSC and 11.7 kilometres within the GSC) with the following characteristics:

- The average road width is 6.7 metres with a minimum of 6.5 metres of sealed pavement.
- Culvert width is generally >12 metres, with the narrowest culvert width (11.5 metres) located approximately 600 metres south of the T-intersection with Buckie Road.
- Much of the road has no line markings, with the only exception being the first 13.5km from the Newell Highway turn off. A combination of shoulder line marking, and centerline marking is evident for this western 13.5km section.
- There are table drains either side.
- The road is generally raised above surrounding natural surface.
- Croppa Moree Road is a B-double and Road Train (with conditions[1]) approved route.
- Croppa Moree Road is part of a school bus route.
- ADT Data is available on this road which is summarised in Table 3.

Croppa Moree Road is currently generally in a good condition. There are isolated seal repairs, very minor rutting and some edge break. A single pipe culvert (width 10.1m) has collapsed approximately 400 metres east of the Croppa-Moree Road/ County Boundary Road / Strangford Road intersection within the Gwydir Shire (GPS: E 231002, S 6767395). The collapse has resulted in a significant pothole in the road that needs repair.

Croppa Creek Road (SR7)

Croppa Creek Road is a bitumen sealed two-way road maintained by the GSC. The road services the farming community and several other smaller arterial roads. The road is trafficable in all weather conditions apart from times of extreme flood events. The section to be potentially impacted by the quarry involves 23.1 kilometres in length with the following characteristics:

- The average road width is 6.86 metres with a minimum of 6.2 metres of sealed pavement.
- Culvert width is generally >10 metres, with the narrowest culvert width (9.6 metres for a twin pipe) located approximately 85 metres to the south of RA 1835.
- There is no line marking.
- There are table drains either side.
- The road is generally raised above surrounding natural surface.
- The road is relatively straight with few bends over undulating terrain.
- Croppa Creek Road is part of a school bus route.
- ADT Data is available on this road which is summarised in Table 3.

[1] The operator of a Type 1 A-double road train must hold National Heavy Vehicle Accreditation Scheme (NHVAS) maintenance management accreditation for the vehicle. The vehicle must have a tri-axle dolly and the tri-axle dolly must be fitted with certified Road Friendly Suspension (RFS). The minimum extreme axle spacing must be at least 26.5m.

Croppa Creek Road is currently in a good condition. However, there is consistent edge break (minor) along the length of the road with areas of vegetation growing through the shoulder. Various sections have edge drop with longitudinal cracking. In the areas where it is getting worse it has been patched with bitumen. There were a few potholes as a result of cracking and shoving of the sealed pavement. This may have occurred as a result of prolonged dry conditions.

At the southern end of this road, a section of approximately 700m in length starting from 850m from the southern intersection with Myall Downs road, has some delamination of the bitumen seal from the subgrade. The delamination has created corrugations in the bitumen. Historically, this has been an issue resulting from springs on this hill section which soak the foundation of the road and make road construction difficult. The bitumen seal appears to hold onto the subgrade, but corrugations are present. An extensive period of wet weather may result in deterioration of this section of road as a result of isolated failures due to a soakage of subgrade materials.

North Star Road

North Star Road is a bitumen sealed two-way road maintained by both the GSC and MPSC. The road services the farming community and several other smaller arterial roads. The road is trafficable in all weather conditions apart from times of extreme flood events. The section to be potentially impacted by the quarry involves 23.2 kilometres in length (2.8 kilometres within the MPSC and 20.4 kilometres within the GSC) with the following characteristics:

- The average road width is 6.0 metres with a minimum of 4.8 metres of sealed pavement.
- Culvert width is generally >10 metres.
- There is no line marking.
- There are table drains either side.
- The road is generally raised above surrounding natural surface.
- North Star Road is considered to include Edward Street as it is known within North Star village.
- Edward Street contains a school zone.
- North Star Road is part of a school bus route.
- ADT Data is available on this road which is summarised in Table 3.

I B Bore Road (SR9)

I B Bore Road is maintained by both the GSC and MPSC. It commences at the southern end of North Star village. The first section of 1.49 kilometres is bitumen sealed. The remaining section between Croppa Creek Road and the Newell Highway consists of a gravel road. The section to be potentially impacted by the quarry involves 22.1 kilometres in length (3.1 kilometres within the MPSC and 19 kilometres within the GSC). This section of road would be utilised by quarry traffic as a haulage route to the Newell Highway. This section to be impacted has the following characteristics:

- The average road width is 6.0 metres with a minimum of 4.8 metres of formed gravel road.
- Gravel depth was visually assessed as variable
- Culvert width is generally >8.6 metres, with the narrowest culvert width (8.1 metres) located at a drainage line approximately 1.7 kilometres west of the T-intersection with Croppa Creek Road (GPS Zone 56J: E 243448, N 6798019).
- The road is relatively flat with several significant bends.
- There is no line marking.
- There are table drains either side.
- The road is generally raised above surrounding natural surface.
- I B Bore Road is a B-double and Road Train (with conditions) approved route.
- I B Bore Road is part of a school bus route.
- ADT Data is available on this road which is summarised in Table 3.

At the time of the site inspection (October 2018), I B Bore Road was considered to be in moderate condition with areas of rutting and corrugation more prevalent in corners and near access points. The depth of gravel in some sections of this road is minimal. Such sections will be prone to impact from heavy vehicles as the weight of the trucks is being supported by the clay subgrade only. This road is considered a dry weather road only as a result of a lack of gravel pavement in some of the western sections.

Buckie Road

The section of Buckie Road assessed by SMK Consultants is a bitumen sealed two-way road maintained by the GSC between Croppa Creek village and Croppa-Moree Road. This section of road would provide access to the railway. The road to the west connects Croppa Creek with the Newell Highway. This western section is a gravel road only with some sections having a relatively thin layer of gravel.

The bitumen sealed section of road is trafficable in all weather conditions apart from times of extreme flood events. The section that may be used by quarry traffic is the section to the east of Croppa Creek connecting Croppa Moree Road with the village. The potential haulage route is contained within the GSC area and involves 2.0 kilometres in length with the following characteristics:

- The average road width is 6.8 metres with a minimum of 5.4 metres of sealed pavement.
- Culvert width is generally >14 metres, with the narrowest culvert width (12.2 metres) located to the west of the Railway Crossing.
- The road is relatively flat and straight.

- There is no line marking.
- There are table drains either side.
- The road is generally raised above surrounding natural surface.
- Buckie Road contains a school zone and is part of a school bus route.
- Buckie Road is a B-double and Road Train (with conditions) approved route.
- There were no available traffic counts for this road.

Bruxner Way

Bruxner Way is a bitumen sealed two-way road maintained by both the GSC and MPSC. The road is trafficable in all weather conditions apart from times of extreme flood events. The section to be potentially impacted by the quarry is contained within the MPSC area and involves 9.7 kilometres in length with the following characteristics:

- The average road width is 7.8 metres with a minimum of 7.1 metres of sealed pavement.
- Culvert width is generally >11.8 metres, with the narrowest culvert width (10.8 metres) located to the south of RA 21930.
- The road is relatively flat and straight.
- There is no line marking.
- There are table drains either side.
- The road is generally raised above surrounding natural surface.
- Bruxner Way is a B-double and Road Train (with conditions) approved route.
- ADT Data is available on this road between Boggabilla and Tucka Tucka Road which recorded 190.57 ADT in 2013 with 12.3% heavy vehicles.
- These volumes are within the capacity of the existing >7 metres sealed pavement width generally provided along Bruxner Way.

Bruxner Road is currently in moderate condition. The old bitumen sealed road has had a thin layer of new sealed put on which is flaking off the old layer.

Tucka Tucka Road

Tucka Tucka Road is a bitumen sealed two-way road maintained by both the GSC and MPSC. The section to be potentially impacted by the quarry is contained within the MPSC area and involves 5.5 kilometres in length.

Tumba Road

Tumba Road is a single lane 4-metre-wide black dirt track controlled by the GSC. The section to be potentially impacted by the quarry involves 4.4 kilometres in length. The road has been formed with slight table drains above natural surface. There is a single culvert servicing a drainage line located approximately 1.2 kilometres from the Croppa Creek Road intersection. The culvert width is 12.1 metres.

Boonery Park Road

Boonery Park Road involves two one-lane tracks maintained by the GSC. One track is a formed gravel road for all-weather use whilst the other is an unformed dirt track. The road services a number of rural dwellings. The section to be potentially impacted by the quarry involves 3.7 kilometres in length with the following characteristics:

- Generally, a 3.4-metre-wide gravel road and a 3.8 metre wide dirt track.
- The gravel road is generally raised above the surrounding natural surface with table drains.
- The gravel road is benefited by two single culverts. Culvert 1 (239109mE; 6783624mS) was 10 metres wide; Culvert 2 (241633mE; 6783757mS) was 7.5 metres wide and blocked.
- There is no line marking.
- There were no available traffic counts for this road.

The intersection between Croppa Creek Road and Boonery Park Road is located near a crest with some visibility issues for traffic flow along Croppa Creek Road.

Crooble Road

Crooble Road is a gravel two-way road maintained by both the GSC and MPSC. The section to be potentially impacted by the quarry is contained within the GSC area and involves 4.3 kilometres in length.

Newell Highway

The Newell Highway is a national highway (A39) with the following characteristics in the vicinity of the development:

- Generally, a 10-metre-wide sealed pavement with 3.3 metre lanes, centre lines and edgelines.
- The Newell Highway is a B-double and road train approved route in the section between Moree and Narrabri.
- ADT Data is available on this road which is summarised in Section 2.6 and Table 3.

Summary

Potential haulage routes include sealed and unsealed roads considered in good to moderate condition at the time of assessments. The identified roads were therefore considered suitable for use by quarry traffic under the intended management proposals. Several matters of note need to be considered for road use, mainly:

1. **Floodways**

Floodways by nature will have water over them at various times. Heavy vehicles crossing floodways when under-water or when still wet will accelerate road wear. Haulage of materials from the quarry should cease during flood events. (Any flood would normally cause a cessation of works)

2. **Bitumen seal to access points and intersections**

Most of the wear and tear to the edges of the road is at access points and intersections to side roads and property access points. This is to be expected. This damage is mainly associated with older access points. Some local maintenance schedule may be required to improve these localised points.

3. **Wet Weather**

Many of the local road connections between the primary bitumen sealed roads and highways are gravel roads only. Sections of gravel along these roads is considered thin (<100mm) which is not ideal to support heavy traffic (grain trucks and quarry trucks). Wet weather will require a modification of haul routes or stoppage of trucks over these lightly gravelled roads to avoid significant damage, unless additional gravel is applied.

2.5 Current and proposed roadworks and traffic management works

The Newell Highway is currently undergoing upgrades in various sections from Narrabri through to Goondiwindi. The project "Newell Highway Upgrade Mungle Back Creek to Boggabilla" commenced in August 2018 and is expected to be completed by the end of 2021. The Proponent intends to support this infrastructure project and additional Newell Highway upgrades through the supply of materials from the proposed Quarry.

The Gwydir Shire Council are undertaking a causeway replacement at Postmans Gully along the North Star Road commencing in August 2019 and expected to complete this by the end of October 2019. Council is also undertaking road rehabilitation along a 2 kilometre section of North Star Road scheduled for September/October.

The Moree Plains Shire Council have advised that construction works are scheduled from October 2019 until February 2020 along the Croppa Moree Road. They have also applied a speed restriction on a narrow section of road on the Bruxner Way. This will remain in force until the section can be widened.

There are no other current or scheduled roadworks or traffic management works, apart from routine maintenance, which will be affected by the development.

2.6 Traffic Volumes

Available traffic data for identified haulage roads are presented in Table 3. Data was provided by the Gwydir Shire Council, Moree Plains Shire Council and Roads and Maritime Services.

Table 3: Available Traffic Data for Key Haulage Roads

Road	Date of Observation	Average Daily Traffic (ADT)	Heavy Vehicles
Croppa Creek Road	March 2011	143	29.5 (20%)
	Dec/Jan 2017	138.0	28 (20.3%)
	July 2019	161	50 (31%)
I B Bore Road	October 2014	32	6.39 (19.9%)
	March 2017	18	2.43 (13.5%)
North Star Road	September 2011	330	51.45 (15.6%)
	June/July 2013	788.43	644.54 (82%)
	March 2014	240	49.3 (20.5%)
	March 2017	297	55.69 (18.8%)
	July 2019	159	27 (17%)
Bruxner Way	June/July 2013	190.57	23.49 (12%)
	July 2019	194	31.04 (16%)
Croppa Moree Road	September 2014	153	23.9 (15.6%)
	March/April 2015	142.86	37.14 (26%)
	March/April 2017	106	21.10 (19.9%)
	July 2019	158	31.6 (20%)
Newell Highway	2015	3,911	1,329.74 (34%)
	2016	3,858	1,234.56 (32%)
	2017	4,051	1,336.83 (33%)
	2018	3,852	1,271.16 (33%)
	2019	3,825	1,185.75 (31%)

Note: Heavy Vehicles = Class 3 and above.

No data was available for Crobble Road, Buckie Road, Tucka Tucka Road, Tumba Road or Boonery Park Road.

Annual Average Daily Traffic (AADT) is available for the Newell Highway (Site: T0146). The counter recorded 3,911 AADT (34% heavy vehicles) in 2015, 3,858 AADT (32% heavy vehicles) in 2016, 4,051 AADT (33% heavy vehicles) in 2017, 3,852 AADT (33% heavy vehicles) in 2018 and 3,825 AADT (31%) to date in 2019. This information is presented in Figure 8.

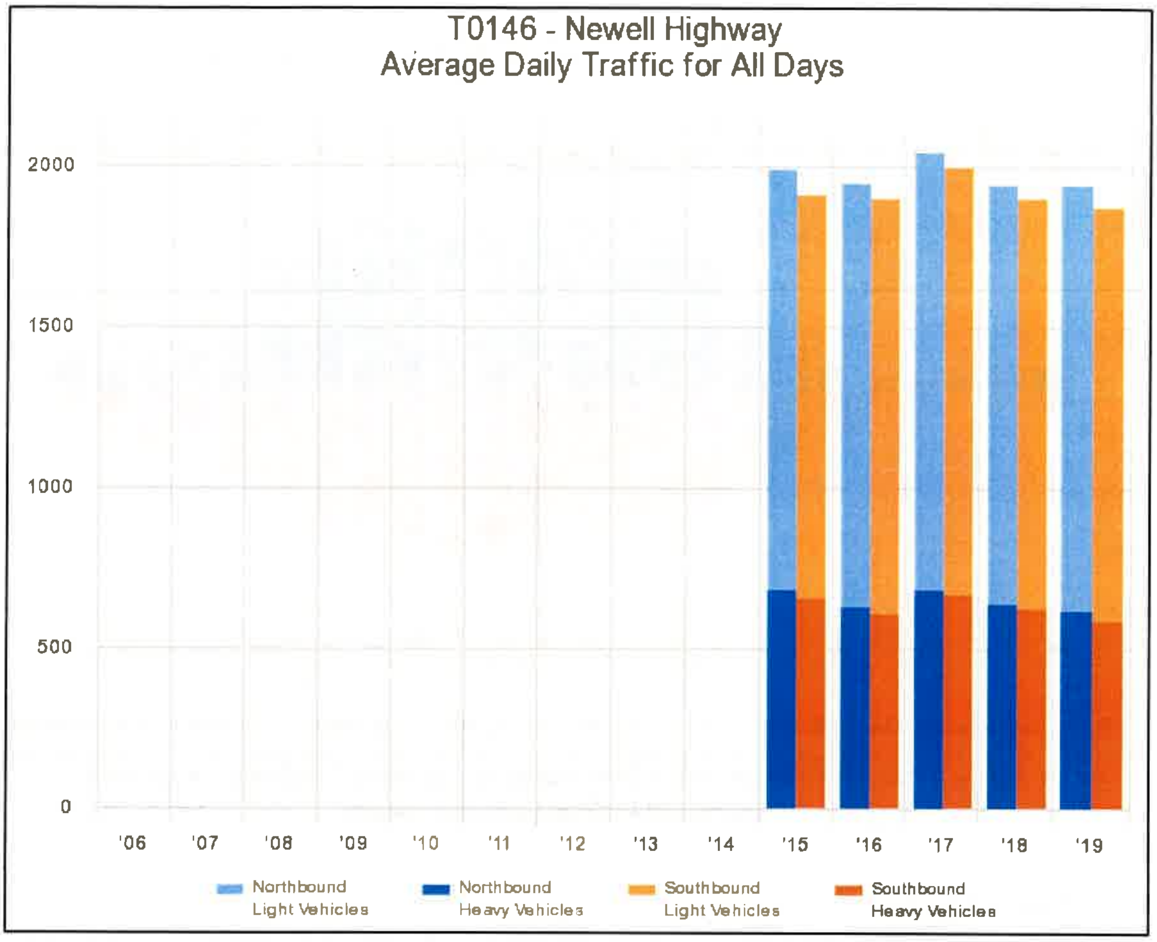


Figure 8: Annual Average Daily Traffic Distribution of the Newell Highway, Boggabilla. Source: RMS Traffic Volume Viewer (Site: T0146).

Hourly traffic flow data is also available for the Newell Highway (Site: T0146) as shown in Figure 9. The data shows that the traffic distribution is reasonably even throughout the day.

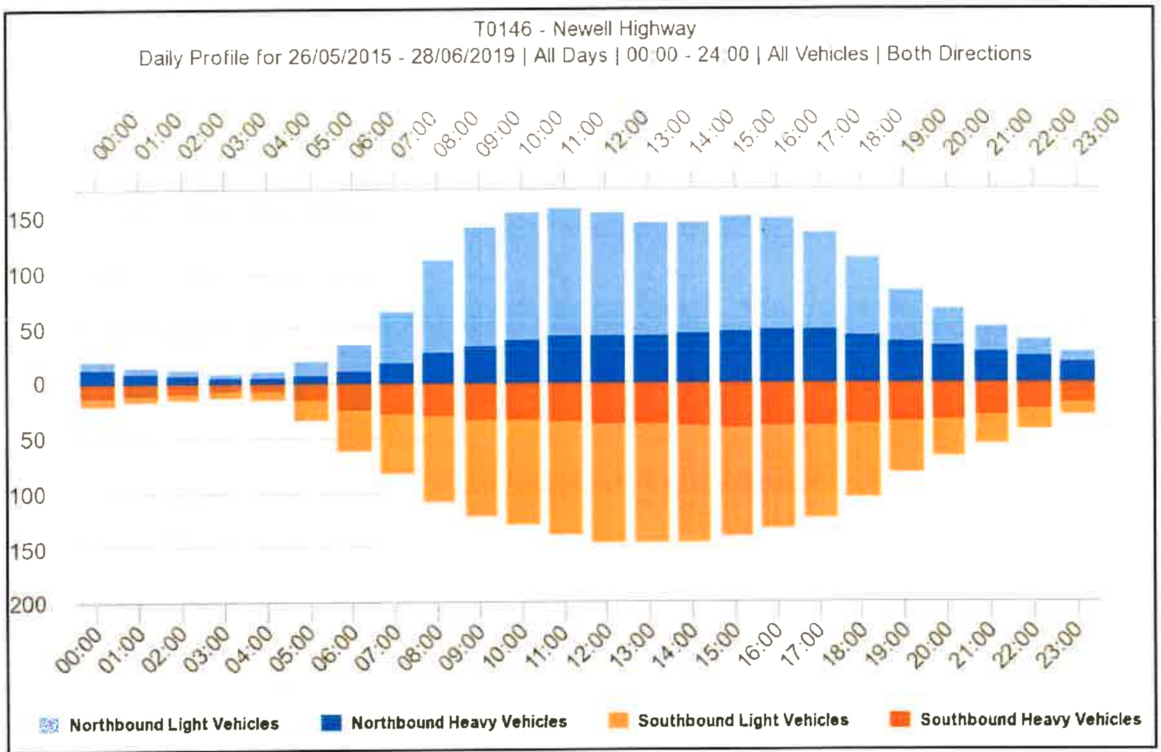


Figure 9: Hourly Average Traffic Distribution of the Newell Highway, Boggabilla. Source: RMS Traffic Volume Viewer.

2.7 Traffic Safety

The NSW Centre for Road Safety provides crash statistics for all reportable accidents to occur within both the Gwydir Shire and Moree Plains Shire areas from 2013-2017. Mapping of reportable accidents is presented in Figure 10. Figure 10 indicates that a low number of traffic incidents occur on rural roads in the vicinity of the development site. This is likely to be a result of low traffic density of these roads. By contrast, roads with higher traffic densities (such as the Newell Highway) experienced a greater number of collisions during this time period.

From 2013 to 2017, one (1) minor reportable incident occurred on Croppa Creek Road. No other reportable incidents occurred on any rural roads in close proximity to the development site. Given the lack of traffic incidents within the region, it is unlikely that any particular section of roads in the vicinity of the Pearlman Quarry presents a traffic hazard.

The Newell Highway is expected to be utilised as a transport route for the proposed Quarry in supplying materials to the Newell Highway Project. A number of incidents occurred on this section of the Newell Highway from 2013 to 2017. These incidents occurred at different locations along the highway, it appears that no particular locations along the highway present a hazard to road safety.

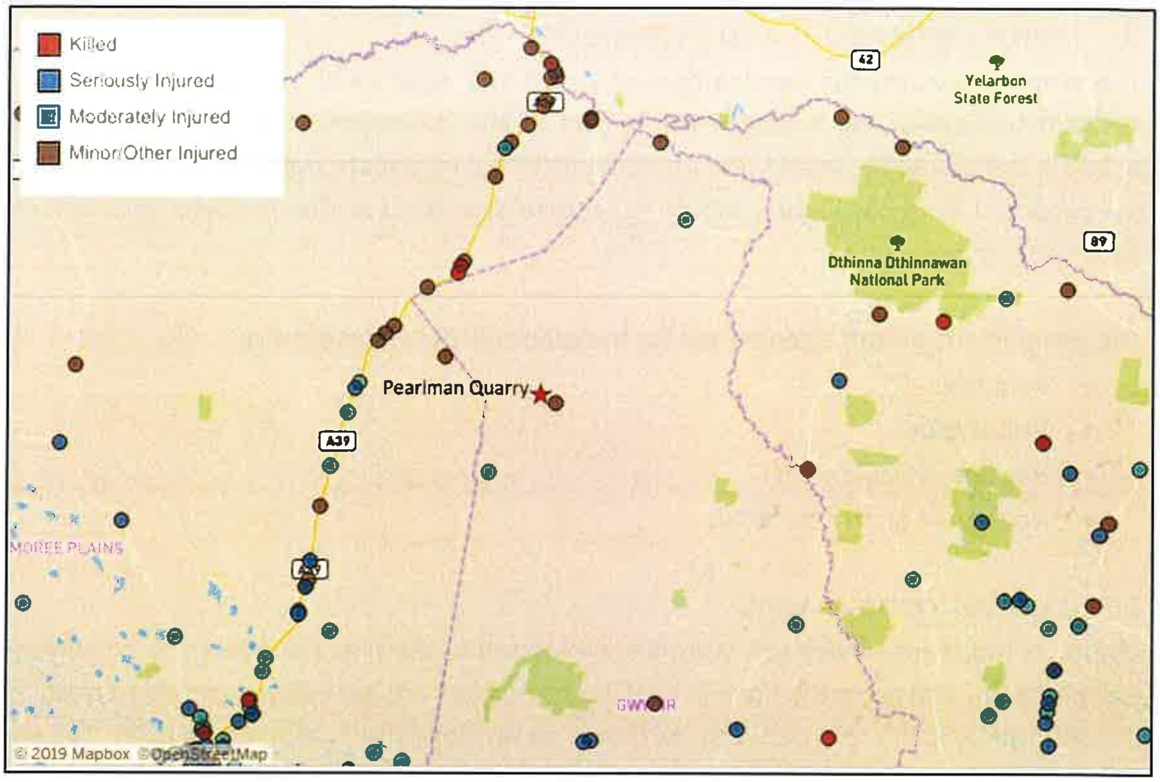


Figure 10: Reportable Crash Statistics, 2013-2017

2.8 Proposed Developments in the Vicinity

The GSC and MPSC were contacted via email on the 26th of July 2019 with a request for any proposed traffic generating developments within the vicinity of the Quarry. Moree Plains Shire Council advised that there were no known development proposals. The Gwydir Shire Council advised that the Myola Feedlot, located approximately 9 kilometres south of the proposed development site along Croppa Creek Road has recently been approved to expand from the existing 20,000 head capacity to 35,000 head. This would include an increase in heavy vehicle traffic movements once the expansion is completed. There are some other existing feedlots and small quarries located in the wider area, however the heavy vehicle traffic associated with these developments is considered to have been included within the existing traffic data.

3 Traffic Generation and Distribution

The proposal involves the development of a hard rock quarry with a production capacity of 490,000 tonne/year. To establish the impact of the development on the adjacent road network and assess the need for improvements to accommodate traffic generated based on the proposed Pearlman Quarry, traffic generation as a result of the proposed development have been determined.

The components of traffic generation for the proposed development are:

- Staff trips
- Visitor trips
- Haulage of equipment
- Haulage of quarry materials

3.1 Light Vehicle Movements

Due to its remoteness; very few visitors are expected to the site, assumed to be on average one per week, and generally none in peak hours. Visitors are generally expected to travel to the site with a 50/50 split between north and south along the Croppa Creek Road. The site will have 5-6 full time equivalent (FTE) staff and will therefore utilise 2 light vehicles per day.

3.2 Heavy Vehicle Movements

The proposed development seeks to develop a 490,000 tonne/year hard-rock quarry to support the construction of large infrastructure projects in the local area. The traffic generated by the development will include heavy-vehicle traffic carrying materials, and light vehicles transporting employees, visitors and service personnel.

Road traffic would be considered to distribute evenly north and south from the existing Quarry access on Croppa Creek Road and further distribute evenly among the various potential haulage routes.

The following assumptions have therefore been made with regard to traffic calculations:

- 490,000 tonne (100%) will be hauled utilising the road network.
- Haulage vehicles will typically be truck & dog configurations.
- The General Mass Limit (GML) is 55.95 tonnes for truck & dog configurations. A 38-tonne haulage capacity per trip has been assumed.
- Hours of operation for loading of trucks to haul material are 6.00am to 6.00pm. However, given loading times it is assumed that trucks will only be operational for 11 hours a day.
- There will be 50 working weeks/year.
- There will be 5.5 working day/week.
- Movement is one-way (i.e. a truck entering and leaving is considered two movements).

Table 4 outlines the anticipated numbers of truck movements that are predicted to be generated by the proposed development.

Table 4: Inland Railway - Heavy Vehicle Movements (Peak)

Traffic Calculations	
Tonnes Processed	490,000 tonnes/year
	9,800 tonnes/week
	1,782 tonnes/day
Trucks	12,895 trucks/year
	258 trucks/week
	47 trucks/day
Truck Movements	25,790 truck movements/year
	516 truck movements/week
	94 truck movements/day

Note: These figures have been rounded up to the nearest whole number. These calculations do not include the use of Double Road Trains – Prime Mover Hauling Unit's. These vehicles may be used on occasion and would reduce the number of truck movements calculated above.

When operating at peak capacity, the Quarry is predicted to produce a maximum average traffic volume of 9 truck movements every hour during operating hours. Actual traffic generation is likely to be less than this.

4 Traffic Management

Quarry Solutions recognises the need for safe, responsible and efficient transport of quarry materials in the interest of public benefit and safety. To ensure the quarry is managed in accordance with best practices, all staff and drivers must adhere to the Traffic Management Plan and Drivers Code of Conduct, provided as Appendix 2. These documents have been adopted by Quarry Solutions for other existing operations in the region.

One of the primary management tools to be implemented at the Pearlman Quarry is the installation of GPS monitoring devices on haulage trucks managed by Quarry Solutions. Each GPS monitoring unit is installed on the truck. A GPS 'fob' or 'key' is assigned to an individual driver as per the Driver Induction Procedure. The driver logs on to the GPS monitoring unit on the truck prior to commencing each shift. The GPS monitoring unit tracks the vehicle location, speed, exceedance of speed limits and harsh vehicle movement and braking as well as mapping the location of any potential incident or infringement to assist in future investigations. In the event of an incident or infringement (e.g. exceedance of speed limit) alerts are sent immediately by email and 'phone app' to the Quarry Manager, Operations Manager, Transport Manager and General Manager. All alerts provide detailed information including, date, time, nature of the infringement, driver name, truck registration and type and the location of the event.

The key safety benefits as a result of the GPS monitoring system include the ability to:

- Track the location of individual trucks;
- Monitor speed;
- Manage fatigue of the driver;
- Link the driver to the truck on any given day;
- Link the truck in relation to school buses either travelling in the same or opposite direction to the truck; and
- (Optional subject to bus driver agreements) Provide truck drivers with an alarm when school buses are travelling towards the truck (The purpose of this is that the trucks are notified of school bus locations as they approach a truck or the bus stops, allowing truck drivers to maximise safety options when school buses are operating on haul routes.)

4.1 Public Transport

4.1.1 School Bus Routes and Bus Stop Locations

School Bus routes from Croppa Creek Public School (CCPS) and North Star Public School (NSPS) travel along Croppa Creek Road, Croppa Moree Road, North Star Road and I B Bore Road. Under the current bus routes, the CCPS bus travels as far north as the intersection between Croppa Creek Road and Baroma Downs Road, and as far south as the intersection between Croppa Moree Road and the County Boundary Road. The NSPS route currently reaches as far south as Bonny Ridge, as far north as Scotts Road off the North Star Road and as far west as Nullin Nulla along I B Bore Road. Under the current bus routes, no school buses pass the proposed access to the Pearlman Quarry.

School buses are on the road shortly before and after school hours, Monday to Friday during the school term. To ensure limited disruption to school buses within the vicinity of the development, Quarry Solutions will offer to install GPS monitoring units on all local school buses using the haulage route where permission is provided. Each GPS monitoring unit fitted to a school bus enables tracking and interaction with the GPS monitoring unit in each truck. The GPS monitoring system is configured to send an alert to a truck driver traveling in the same direction as a school bus when the truck comes within 500 metres of the school bus. The alert is in the form of a beep audible only to the truck driver and not the school bus driver. Being alerted of the nearby school bus the truck driver is to reduce speed and be alert and maintain a minimum 50-metre separation distance to the school bus. If the 50-metre separation distance is encroached an alert is generated, and the infringement will be investigated. If the school bus stops the truck is also to stop and not pass the school bus. If the truck does pass the school bus an alert is generated, and the infringement will be investigated. The GPS tracking system is intelligent and alerts a truck traveling in the opposite direction of a school bus when it is approaching the school bus, but the alert will not be triggered when the truck passes the school bus in the opposite direction.

This means that each and every school bus stop on the haulage route does not need to be mapped as the GPS monitoring system provides 'live' data on the whereabouts of each school bus and truck.

The school zones will also be included within the GPS monitoring system to monitor the trucks speed as they pass through the school zones. Figures 11 and 12 below indicate the school zones within Croppa Creek and North Star area that would be designated as part of the geofence.

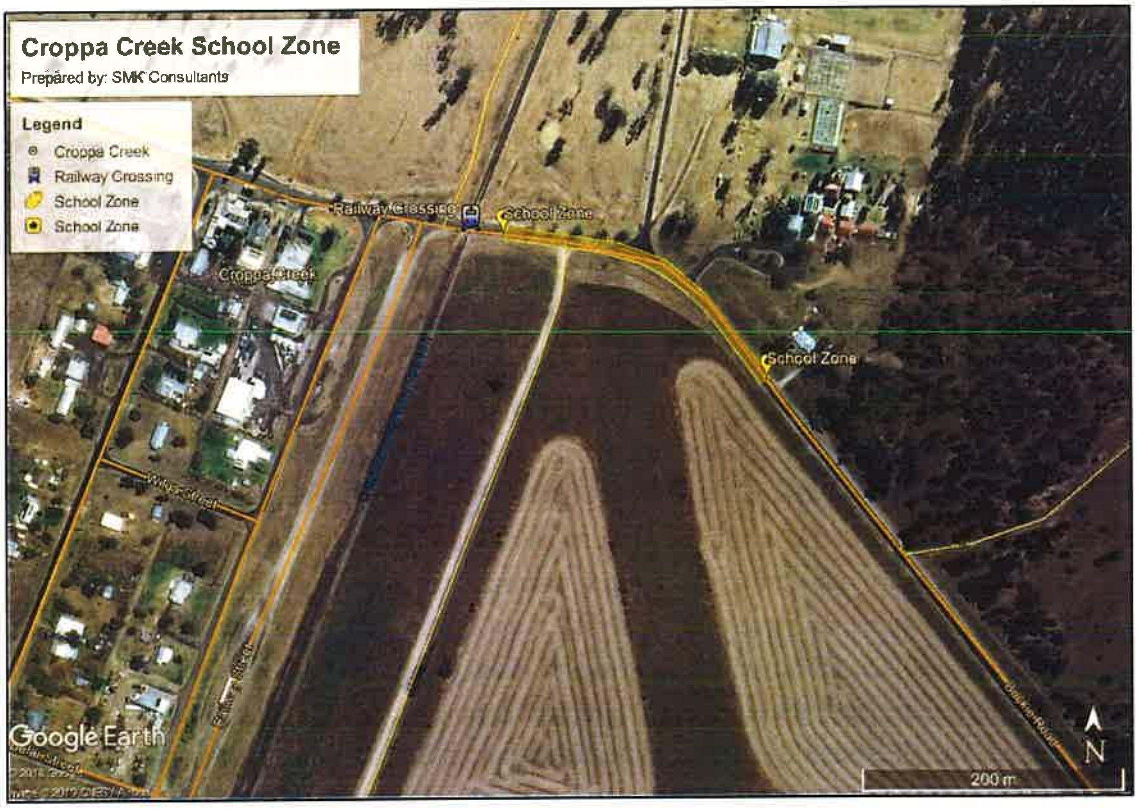


Figure 11: Croppa Creek School Zone

Figure 12: North Star School Zone

5 Impact on Road Network

5.1 Impact on Traffic Volumes

The Pearlman Quarry is located in a rural region, in which high traffic volumes and traffic congestion are not significant issues throughout the majority of the year. Peak traffic volumes on the road network are typically experienced in association with periods of harvest.

5.2 Impacts on Road Condition

The potential haulage route includes sealed and unsealed roads considered in good to moderate condition with minor pavement damage, considered suitable to support the existing and predicted heavy vehicle traffic. These roads pass through rural areas, and do not have high crash frequencies. Therefore, the potential for adverse safety impacts as a result of road condition is minimal.

It should be noted that the weather can significantly affect road conditions on unsealed roads and as such it would be recommended that in such conditions the use of non-sealed roads be avoided if possible.

Council Engineers have recommended that trucks using narrower unsealed roads, use some discretion in their travel path. Trucks that continually "tram-line" along the centre of the road will cause more significant damage than if the trucks can vary their path from the road centre line where possible. Trucks continually "tram-lining" the centre of the road will compact two wheel tracks in softer sections of the road and road deterioration will occur. This is to be avoided where possible.

The development is subject to both the Gwydir Shire Council "Section 94 Development Contribution Plan No.1 – Traffic Generating Development" (April 2011) (DCP) and the Moree Plains Shire Council "Section 94 Development Contribution Plan – Traffic Generating Development" (April 2016). The contribution plans allow the Councils to levy contributions from traffic generating developments under Section 7.11 (previously Section 94) of the *Environmental Planning and Assessment Act 1979*. These contributions are typically utilised to cover the costs of maintenance, repair and reconstruction of roads as a result of damage caused by heavy vehicles generated by the development.

Quarry Solutions met with John Coulton (Mayor) and Alex Eddy (Manager Engineering Services) from the Gwydir Shire Council on the 10th of July, 2019 to discuss the contribution fee as outlined below in Section 5.6. Lila Fisher (Projects and Development Manager) from the Moree Plains Shire Council was advised of the proposed contribution rate on the 22nd of August, 2019.

The payment of contribution fees is therefore considered sufficient to compensate the Councils for any impacts on existing road condition as a result of the proposed development.

5.3 Impact on Traffic Safety

The existing site access has appropriate sight distances and has been designed to accommodate for heavy vehicle traffic. The site access therefore does not pose a traffic hazard to Croppa Creek Road as a result of poor visibility or poor road quality. No significant safety concerns are known to occur with regards to Croppa Creek Road or surrounding rural roads servicing the development site.

The purpose of the development is to provide materials for various infrastructure projects aimed at reducing heavy vehicle traffic and improving the safety and efficiency of existing road infrastructure.

5.4 Impact on Traffic Noise and Dust Production

The proposed development will result in a net increase in traffic volumes on the public road network. Therefore, the development will increase traffic noise and dust production throughout the local road network.

The closest residences to the haulage route have been identified in Table 5, as well as the potential amenity impacts.

Table 5: Residents located along the designated haulage route

Address	Distance to road	Sealed / Unsealed	Potential issue
"Werchillibar" 578 IB Bore Road, North Star	>400m	Sealed	
751 IB Bore Road, North Star	>400m	Unsealed	
1069 IB Bore Road, North Star	>400m	Unsealed	
1863 IB Bore Road, North Star	>400m	Sealed	
2279 IB Bore Road, North Star	<400m	Sealed	
2107 Croppa Creek Road, North Star	>400m	Sealed	
1835 Croppa Creek Road, North Star	>400m from Croppa Creek,	Sealed	
	<100m to the private portion of Bushes Access Road	Unsealed	Dust if private road used. Otherwise no concerns.

Address	Distance to road	Sealed / Unsealed	Potential issue
1176 Oaklands Road, North Star	>400m from Bushes Access Road	Unsealed	
141 Boonery Park Road, North Star	<100m to Boonery Park Road	Unsealed	Dust if Boonery Park Road used. Otherwise no concerns.
	>400m from Croppa Creek Road	Sealed	
781 Croppa Creek Road, North Star	<400m from Croppa Creek Road	Sealed	
Feedlot on Croppa Creek, Road	>400m from Croppa Creek Road	Sealed	
Tumba Road	No residents	Unsealed	
367 Croppa Creek Road, North Star	>400m from Croppa Creek Road	Sealed	
195 Croppa Creek Road, North Star	>400m from Croppa Creek Road	Sealed	
	>400m from Plevna Road	Unsealed	
4011 Croppa Moree Road, Croppa Creek	<100m from Croppa Moree Road	Sealed	Noise if road haulage goes south to Croppa Creek.
Buckie Road, Croppa Creek (1 house with silos north of the road)	<400m from Buckie Road	Sealed	
“Yunburra” 286 Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	
“Wallam” 283 Croppa Moree Road, Moree	<400m from Croppa Moree Road	Sealed	Noise if road haulage extends along Croppa Moree Road.
“Yambin” 622 Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	
“North Yambin” 793 Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	

Address	Distance to road	Sealed / Unsealed	Potential issue
"Tantaranna" 994 Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	
"Oodnadatta" 1263 Croppa Moree Road, Moree	<400m from Croppa Moree Road	Sealed	Noise if road haulage extends along Croppa Moree Road.
"Kirkland" 1651 Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	
"Warayama" 1792 Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	
"Kintyre" Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	
"Glenelg" Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	
"Elgin" 2032 Croppa Moree Road, Moree	>400m from Croppa Moree Road	Sealed	
"Bonnie Downs" 161 Strangford Road, Moree	>400m from Croppa Moree Road	Sealed	
Residents and Businesses in North Star Town	<100m from North Star Road	Sealed	Noise if road haulage goes through North Star.
7056 North Star Road North Star	<400m from North Star Road	Sealed	
7114 North Star Road North Star	<100m from North Star Road	Sealed	Noise if road haulage goes north to Bruxner Highway.
7409 North Star Road North Star	<400m from North Star Road	Sealed	
21930 Bruxner Way Boggabilla	<400m from highway	Sealed	
3954 Tucka Tucka Road Boggabilla	<400m from road	Sealed	

`Assumptions:
House >400m from sealed road are not a concern for noise and dust.
House <400m from unsealed road may have a concern about dust.
House <100m from sealed road may have a concern about noise.
House <100m from unsealed road may have concern about noise and dust.

Quarry Solutions have advised that they will contact the residences of the above-mentioned rural dwellings prior to operation to discuss acceptable mitigation measures and resolve concerns related to noise and dust impacts. Quarry Solutions include the implementation of dust and noise mitigation measures in accordance with the Environmental Management Plan. Dust management measures in all trafficable areas on site will include:

- Enforce a maximum speed of 40 km/hr on internal roads.
- Keep trafficable areas as clean as possible.
- Maintain road surfaces in good condition.
- Use water sprays on trafficable areas (approx. rate 2L/m^2/hr).

When transporting materials, the following dust management measures will be implemented:

- Ensure loads are appropriately contained and covered prior to leaving the site.
- Clear spillages from side rails, tailgates and draw bars of trucks (following loading and tipping).
- Securely fix tailgates of all material transport vehicles prior to loading to prevent material.

Dust is not considered to be an issue on the bitumen sealed roads. Gravel and dirt roads are expected to generate dust for a brief period after each heavy vehicle.

When transporting materials, the following noise management measures will be implemented:

- Heavy vehicle traffic being limited to the hours of 6am-6pm in accordance with the conditions of consent.
- Enforce a maximum speed of 40 km/hr on internal roads.
- Operate well-maintained plant, vehicles and equipment, and ensure all plant, vehicles and equipment are serviced in accordance with, or more frequently than, manufacturers' specifications.
- Avoid unnecessary revving of engines.
- Ensure that any extraneous noises are rectified.
- Avoid the use of compression braking on product delivery trucks in residential areas.
- The Quarry operator is able to monitor truck driver behaviour through the GPS monitoring system.

Provided the Operator manages dust and noise effectively and addresses the concerns of sensitive rural receptors the potential for heavy vehicle traffic to adversely impact the amenity of rural areas within the vicinity of the freight routes to be utilised by the Pearlman Quarry is considered minimal.

5.5 Cumulative Impacts with Neighbouring Developments

Potential cumulative impacts are those which are generated by the combined impacts on the local environment as a consequence of the project together with other developments of a similar nature. In this instance, the assessment of cumulative impacts considers the impacts of existing and proposed extractive industry development in the local area.

There is an existing approved large-scale quarry located on the same property known as the 'Tikitere Quarry'. The Tikitere Quarry is a 500,000-tonne hard rock quarry with a similar quality of aggregate and the same haul roads as the proposed Pearlman Quarry. The Tikitere Quarry is also operated by Quarry Solutions and has approval to operate until the 4th of March 2024. However, the available resource is expected to be exhausted within 3 years. If the Pearlman quarry receives approval, it will be operated in conjunction with the Tikitere Quarry by the Proponent. This period of overlap is considered to be a maximum of 2 years within the 10 year horizon of the quarry operations.

No other quarry sites or development have been identified by Council or others.

The worst-case scenario identified, in regard to cumulative traffic impacts, would be likely to occur where both quarries are operating at full capacity, thus generating maximum daily truck traffic.

The cumulative operational traffic volumes have therefore been based on the worst-case scenario of simultaneous operation. The proposed traffic volumes for full operation of both the Pearlman Quarry and Tikitere Quarry traffic has been included in Table 6. These assumptions are based on the proposed annual limit for the Pearlman Quarry and the existing annual limit for the Tikitere Quarry, and that both quarries would utilise similar truck units for haulage of materials:

- 990,000 tonne/year of material will be hauled utilising the road network.
- Haulage vehicles will typically be truck & dog configurations.
- The General Mass Limit (GML) is 55.95 tonnes for truck & dog configurations. A 38-tonne haulage capacity per trip has been assumed.
- Hours of operation for loading of trucks to haul material are 6.00am to 6.00pm. However, given loading times it is assumed that trucks will only be operational for 11 hours a day.
- There will be 6 working days/week.
- There will be 50 working weeks/year.
- Movement is one-way (i.e. a truck entering and leaving is considered two movements).

Table 6: Combined Average Heavy Vehicle Movements from the Pearlman Quarry and Tikitere Quarry

Traffic Calculations	
Tonnes Processed	990,000 tonnes/year
	19,800 tonnes/week
	3,300 tonnes/day
Trucks	26,053 trucks/year
	522 trucks/week
	87 trucks/day
Truck Movements	52,106 truck movements/year
	1,044 truck movements/week
	174 truck movements/day

Note: These figures have been rounded up to the nearest whole number. These calculations do not include the use of Double Road Trains – Prime Mover Hauling Unit's. These vehicles may be used on occasion and would reduce the number of truck movements calculated above.

In the event the two Quarries are operational, they are predicted to produce a combined average traffic volume of 16 truck movements every hour during operating hours. However, exact truck numbers vary throughout the day and may be higher during peak times.

The net result of both quarries operating at the same time will be an increase in the frequency of trucks meeting each other while travelling in different directions along the potential haulage route and Croppa Creek Road. The issue of damage to the edge of the bitumen and the road shoulder would be exacerbated over a shorter period of time. However, attempts will be made to coordinate the even distribution of trucks dispatched from each quarry to prevent additional loading to the softer parts of the road when passing is required.

Truck frequency is expected to be restricted during parts of the day with school attendance and movement of the school bus to and from Croppa Creek and North Star.

It is also expected the cumulative traffic impact of both quarries will be more profound during harvest periods, as the region relies heavily on agriculture. However, baseline traffic data for the area, as provided by the Gwydir Shire Council and Moree Plains Shire Council, does not appear to account for harvest periods so exact numbers of trucks during this time is unknown.

Both Quarries would be operated by Quarry Solutions and as such the truck drivers would be engaged in active communication whilst operational to coordinate the even distribution of trucks and ensure that the transport of materials occurs both safely and efficiently. Requirements for active communication between truck drivers should be included in the Driver Code of Conduct and/or Traffic Management Plan for both Quarries.

No existing significant safety concerns are known to occur for surrounding rural roads servicing the area.

5.6 Calculation of Expected Development Contribution Rate

The method of calculating contribution rates is typically based on the reconstruction costs, average road maintenance costs and the length of road likely to be used by vehicles associated with the development. The impact is based on the Equivalent Standard Axle (ESA) loading on the road per vehicle as a proportion of the total loadings on the road. This is then converted to a total cost per tonne (1,000 kilograms) per kilometre. The designated haulage route typically forms the length of road upon which the contribution will be levied. Where the designated haulage route involves the use of more than one road then each road should be treated separately in terms of the road maintenance contribution. Therefore, the total contribution payable for the development would be the sum of all the calculated contribution rates for all the individual roads on the designated haulage route/s.

Given the Proponent intends to supply to various markets the exact haulage route cannot be determined at this time. This makes it difficult to calculate the appropriate contribution rate using the methods included in the Gwydir and Moree Plains Shires Guidelines. For the ease of administration for both the Operator and Council, Quarry Solutions would like to propose the following contribution rates:

- Gwydir Shire Council – 80c/tonne
- Moree Plains Shire Council – 50c/tonne

This contribution rate would be payable on every tonne out the gate regardless of the trip length or road type.

It is considered that the proposed tonnage rate is higher than with similar developments in the region and significantly exceeds the minimum required contribution fees in accordance with Council's DCP – Traffic Generating Developments.

It should also be noted that transparency of outgoing materials and haulage routes can be maintained utilising the Quarry Solutions GPS monitoring system to ensure the estimated contribution rate is consistent with actual usage.

6 Conclusion and Recommendations

SMK Consultants were commissioned by Quarry Solutions Pty Ltd to prepare a Traffic Impact Assessment in support of a development application for the proposed "Pearlman Quarry", a 490,000 tonne/year hard rock quarry to be located on the property of Tikitere. This Traffic Impact Assessment has considered the potential impacts of the proposed Pearlman Quarry upon traffic on site and within the wider region.

The existing site access and internal roads within Tikitere are considered suitable for both truck and dog combinations and road trains to support the construction and operational traffic associated with the proposed development. Any new internal roads to be constructed in association with the proposed development should be constructed in accordance with relevant standards to ensure that the site will be operated and maintained at a high standard.

It has been concluded that the proposed development would result in a net increase in traffic generation from the subject site, but that this traffic increase would not significantly impact upon road safety or general amenity within the region if the intended mitigation measures are adopted. Road condition of designated routes to be utilised by the Operator will be reviewed during haulage campaigns. The intention of road use contributions made under Section 94 Development Contributions Plan will be utilised by Councils to repair damage and maintain roads that are impacted by the development proposal. The proposed contribution to the Gwydir Shire Council is estimated to be $392,000 for the total production of 490,000 tonnes per annum.

Quarry Solutions has indicated that they will commit to:

- Paying all heavy haulage contribution fees within 30 days from the end of the month.
- Continued liaison with the community along the haulage route.
- Fitting GPS tracking devices in all heavy vehicles operated by the Quarry.
- They would also recommend GPS tracking be fitted in all heavy vehicles associated with traffic generating developments.
- Comply with all the conditions of approval as issued by Gwydir Shire Council.

Overall, the impact of the proposed development upon the road network is considered to be manageable if the intended management and mitigation protocols are adopted. The traffic potential additional truck movements will result in increases in road use and the presence of trucks on the road, however, the provisions of Section 94 contributions aim to ensure that the local road network is maintained if contributions are utilised for road maintenance works.

7 Limitations

This Traffic Impact Assessment ("report"):

- Has been prepared by SMK Consultants Pty Ltd ("SMK Consultants") for Quarry Solutions Pty Ltd ("Quarry Solutions");
- Should be read in full, and no summary, conclusion or other section of the report may be used or relied on in isolation or taken as representative of the report as a whole;
- May be provided to other third parties but such third parties' use of or reliance on the report is at their sole risk; and
- May only be used for the purpose as stated in Section 1.1 of the report (and must not be used for any other purpose).

SMK Consultants and its employees otherwise expressly disclaim responsibility to any person other than Quarry Solutions arising from or in connection with this report.

No representation or warranty, express or implied is made as to the relevance, accuracy, completeness or fitness for purpose of this document in respect of any particular user's circumstances. Users of this document should satisfy themselves concerning its application to and where necessary seek expert advice in respect of their situation.

The services undertaken by SMK Consultants in conjunction with preparing this report:

- Were limited to those specifically detailed in Section 1.3 of this report; and
- Were undertaken in accordance with current professional practices and by reference to relevant environmental regulatory authority and industry standards, guidelines and assessment criteria in existence as at the date of this report.

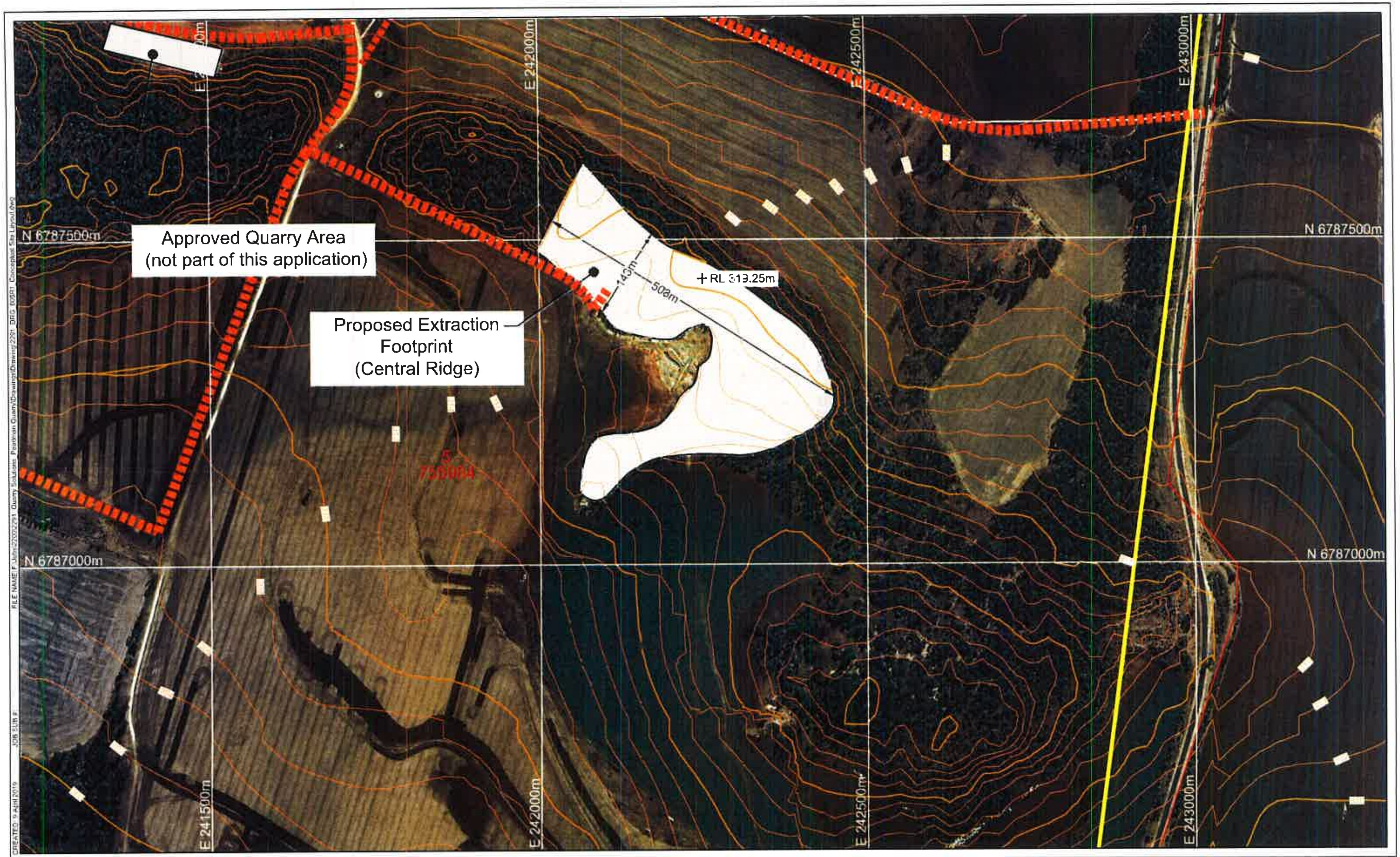
The opinions, conclusions and any recommendations included in this report are based on assumptions made by SMK Consultants when undertaking the services mentioned above and preparing the report as specified throughout this report. SMK Consultants expressly disclaims responsibility for any error in, or omission from, the report arising from or in connection with any of the assumptions being incorrect.

Subject to the paragraphs in this section of the report, the opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the time of preparation of this report and are relevant until such as the site conditions or relevant legislation changes, at which time, SMK Consultants expressly disclaims responsibility for any error in, or omission from, this report arising from or in connection with those opinions, conclusions and recommendations.

SMK Consultants has prepared this report on the basis of information provided by Quarry Solutions, Gwydir Shire Council, Moree Plains Shire Council and Roads and Maritime Services among others, which SMK Consultants has not independently verified or checked ("unverified information") beyond the agreed scope of work. SMK Consultants expressly disclaims responsibility in connection with the unverified information, including (but not limited to) errors in, or omissions from, the report, which were caused or contributed to by errors in, or omissions from, the unverified information.

Inspections undertaken in respect of this report are limited to visual inspections only and are constrained by the particular site conditions, such as site access or vegetation. The results of the road condition assessment are limited to the date of the site inspection. The suitability of the roads for purpose should be determined by Quarry Solutions prior to each trip.

Appendix 1 – Site Plans



REV	DESCRIPTION	DATE	BY
1	Proposed Eastern Ridge removed	04/04/19	MR

Data Sources:
Photography: Google Earth Image Capture 2018-06-22
Topography: LiDar DEM 5m Extract 2018-10-04
Cadastre: NSW Spatial Services Extract 2018-07-30
Ecosystem:
Other:

THESE DESIGNS AND PLANS ARE COPYRIGHT AND ARE NOT TO BE USED OR REPRODUCED WHOLLY OR IN PART OR TO BE USED ON ANY PROJECT WITHOUT THE WRITTEN PERMISSION OF GROUNDWORK PLUS PTY LTD. ABN: 13 609 422 791

Legend:
Cadastral Boundary
Site Boundary
Haul Road

Site Area - 1695.43 ha
Proposed Extraction Footprint (Central Ridge) - 9.25 ha

PROJECT: Pearlman Quarry

CLIENT: Quarry Solutions Pty Ltd

TITLE: Conceptual Site Layout

GROUNDWORK plus
PH: +61 7 3871 0411
WWW.GROUNDWORK.COM.AU

SCALE 1:4000 When Printed On A4 — 0 800m

DATE 9 April 2019 DRAWN MR
PRINTED 9 April 2019 CHECKED JL

DRAWING NUMBER 2291.DRG.005 REVISION 1

DATUM HORIZONTAL / VERTICAL / ZONE MGA / AHD / 56

FILE NAME F:\Jobs\2291 Quarry Solutions Pearlman Quarry\Drawings\Drawing\2291 DRG 005R1 Conceptual Site Layout.dwg JOB SUB #: CREATED: 9 April 2019

Appendix 2 – Traffic Management Plan

GROUNDWORK plus

Pearlman Quarry

Traffic Management Plan

Prepared for:

Quarry Solutions Pty Ltd

QuarrySolutions

Date:
August 2019

File Ref:
2291.410.001

Document Control

Project/ Report Details

Document Title:	Pearlman Quarry Traffic Management Plan
Principal Author:	Jim Lawler
Client:	Quarry Solutions Pty Ltd
Ref. No.	2291.410.001

Document Status

Issue	Description	Date	Author	Reviewer
1	Pearlman Quarry Traffic Management Plan	13th August 2019	Rowan McKay	Jim Lawler

Distribution Record

Recipient	
Quarry Solutions	1e
Gwydir Shire Council	1e

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Table of Contents

1.0 INTRODUCTION

The Pearlman Quarry is located at 1135 Croppa Creek Road, North Star being described as Lot 5 & 17 DP755984. Quarry Solutions Pty Ltd (Quarry Solutions) recognises the need for safe, responsible and efficient transport of quarry materials in the interest of public benefit and safety. Quarry Solutions have prepared this Traffic Management Plan (TMP) in accordance with the development consent (DC) issued by Gwydir Shire Council for the Pearlman Quarry. The TMP supports and forms part of the Environmental Management Plan (EMP) for the Pearlman Quarry. The TMP is required in accordance with the following conditions of development consent:

Traffic Management Plan and Driver Code of Practice

Prior to commencement of quarry operations, the applicant shall submit a Traffic Management Plan and Truck Driver Code of Practice for assessment and approval by Council. The plan shall document:

a. *The road maintenance program; and*
b. *Surrounding environment, existing conditions and road safety;*
c. *Existing private property driveways and farm access points;*
d. *Dust suppression methods including water supply management, monitoring, reporting, source, licencing and drought;*
e. *Noise suppression methods including monitoring and reporting;*
f. *Road inspection activities to be implemented for the life of the quarry;*
g. *Approved haulage routes highlighting specific locations for consideration such as school zones, school bus routes, residential areas or potential risk locations (including map);*
h. *Induction process for staff and sub-contractors outlining clear expectation and consequences for any breach of the code;*
i. *Instruction on all operational and safety requirements related to the quarry operations.*

The quarry is to operate in accordance with the approved Traffic Management Plan and Truck Driver Code of Practice.

It is also understood that the development consent prohibits haulage of material on the Local or State road network without amendment to the conditions of consent and approval of a Traffic Impact Assessment and resolution of relevant heavy haulage contributions to Local or State road authorities.

2.0 SITE DESCRIPTION

The Pearlman Quarry is located at 1135 Croppa Creek Road North Star, which is located approximately 10 kilometres south of North Star and 12 Kilometres north of Croppa Creek. The property "Tikitere" is owned by Alan Trevor Pearlman (the applicant), encompasses an area of 1698.5 hectares and consists of Lot 5 and 17 in DP 755984. The Pearlman Quarry is situated on Lot 5 DP 755984 (1266Ha). The property of "Tikitere" is bordered by Tackinbri Creek in the south, the Croppa Creek Road to the east, Bushes Access Rd to the north and the property "Strathaine" on the western side. The property holding is currently occupied by a homestead, various agricultural buildings, internal farm roads and irrigation infrastructure. The property is predominantly cleared of vegetation to allow for cropping, however areas of remnant vegetation remain along low ridge lines, fence lines, riparian areas and volcanic protrusions. The Pearlman Quarry has access to the Croppa Creek Road, a sealed public road, which runs along the eastern boundary of the property and is approximately 2.2 kilometres from the Primary Quarry site.

The offsite haulage route includes the use of Croppa Creek Rd, I B Bore Road and the Newell Highway. Along this route there are a number of farm access points included in the following locations;

- Croppa Creek Rd – 5 farm access points.
- I B Bore Rd – 22 farm access points.

All drivers will be provided with a map showing these locations during site onboarding. Due care will be taken by the haulage drivers when approaching these areas. Any near misses or safety concerns will be reported, investigated and corrective actions implemented as necessary (refer to **Sections 7 and 8**).

3.0 APPROVED HAULAGE ROUTE

Once the haulage routes for the quarry are approved the subsequent haulage plans will be appended to this document.

4.0 TRAFFIC MANAGEMENT MEASURES

The following traffic management measures will be implemented for on-site haulage:

1. Dust suppression on site will be in accordance with the Pearlman Quarry EMP.
2. An incident/complaints register will be maintained in accordance with the Pearlman Quarry EMP.
3. All drivers will be required to comply with the legislated road rules, including driver fatigue requirements and separation distances to other vehicles. Weighbridge records will keep accurate records of the amount of quarry materials transported by each vehicle. The weighbridge management software will be configured in a manner which will not issue a 'docket' to a driver if the vehicle weight exceeds the limits prescribed by the Heavy Vehicle (Mass, Dimension and Loading) National Regulation 2013. Haulage of quarry materials from the site will be limited to the approved hours of operation under the development consent. The weighbridge management software will be configured in a manner which will not issue a 'docket' to a driver outside of the approved hours of operation.
4. All drivers will be required to sign on to the Electronic Daily Prestart Management System at the weighbridge each morning or on first entry into the site.
5. In accordance with the development consent, all laden trucks operating on, entering and leaving the site are to have their loads covered and be cleaned of materials that may fall on the road.
6. Implement a Driver Induction Procedure (refer **Attachment 1 – Driver Induction Procedure**), which is summarised as follows:

   Prior to commencing work a Driver will be subject to the Quarry Solutions Driver Induction through the 'Checklist of Cartage Subcontractor Documentation' Form. Item D3 of the Checklist requires the Quarry Solutions site induction to occur. The Quarry Manager will be responsible for the site induction and will inform the Driver of the following details:
   - *The approved transport route for the quarry (if applicable)*
   - *The approved hours of operation of the quarry*
   - *The Community Engagement, Complaints and Incidents Procedure of the Environmental Management Plan*
   - *The procedures for interaction with school buses and the GPS monitoring system*
   - *The terms of the Driver Code of Conduct*
   - *The 'two strikes and you're out' policy regarding the Driver Code of Conduct*
   - *The Driver Code of Conduct will be enforced through random inspections prior to issuing a 'docket' from the weighbridge or through review in response to a complaint; and*
   - *Occupational, Health and Safety briefing information for the site*
7. Implement and enforce compliance with a Driver Code of Conduct (**Attachment 2 – Driver Code of Conduct**). Compliance with the Driver Code of Conduct will be enforced by a '*Two strikes and you're out*' policy administered by the Quarry Manager and reviewed by the General Manager in accordance with the Community Engagement and Complaints Procedure outlined in the Environmental Management Plan.
8. Installation of GPS monitoring devices on haulage trucks managed by Quarry Solutions (refer **Attachment 3 – Quarry Solutions IVMS GPS Release Form**). Each GPS monitoring unit is installed on the truck. A GPS 'fob' or 'key' is assigned to an individual driver as per the Driver Induction Procedure. The driver logs on to the GPS monitoring unit on the truck prior to commencing each shift. The GPS monitoring unit tracks the vehicle location, speed, exceedance of speed limits and harsh vehicle movement and braking as well as mapping the location of any potential incident or infringement to assist in future investigations. In the event of an incident or infringement (e.g. exceedance of speed limit) alerts are sent immediately by email and 'phone app' to the Quarry Manager, Operations Manager, Transport Manager and General Manager. All alerts provide detailed information including, date, time, nature of the infringement, driver name, truck registration and type and the location of the event.

The following additional traffic management measures will be implemented for external haulage if approved by Council:

9. All drivers must use the approved haulage route.
10. Installation of the GPS monitoring unit on all local school buses using the haulage route where permission is provided. Each GPS monitoring unit fitted to a school bus enables tracking and interaction with the GPS monitoring unit in each truck. The GPS monitoring system is configured to send an alert to a truck driver traveling in the same direction as a school bus when the truck comes within 500m of the school bus. The alert is in the form of a beep audible only to the truck driver and not the school bus driver. Being alerted of the nearby school bus the truck driver is to reduce speed and be alert and maintain a minimum 50m separation distance to the school bus. If the 50m separation distance is encroached an alert is generated and the infringement will be investigated. If the school bus stops the truck is also to stop and not pass the school bus. If the truck does pass the school bus an alert is generated and the infringement will be investigated. The GPS tracking system is intelligent and alerts a truck traveling in the opposite direction of a school bus when it is approaching the school bus, but the alert will not be triggered when the truck passes the school bus in the opposite direction.
11. All heavy vehicles travelling to and from the quarry are to be driven at no more than 80km / Hr during school times.

12. A heavy vehicle traveling to a from the quarry, following a School Bus, must not overtake the school bus and therefore must remain behind the school bus until the school bus pulls off the road.
13. To comply with the Australian Road Rules relating to School Bus Speed Zones, a heavy vehicle travelling to and from the quarry must reduce the speed to 40km / hr when a school bus is pulling over and has the flashing lights on. This requirement also applies to heavy vehicles travelling in the opposite direction to the school bus.

5.0 TRUCK NOISE MANAGEMENT MEASURES

The following truck noise management measures will be implemented by Quarry Solutions and enforced through the Driver Code of Conduct:

1. Require drivers to comply with the approved hours of operation stated in the development consent.
2. Require drivers to appropriately cover/secure loads.
3. Require drivers to comply with posted speed limits on all roads.
4. Require drivers to only use horn when appropriate do to so.
5. Require drivers to limit engine brake noise in residential areas.
6. Require drivers to reduce truck speed in residential areas, at road works and when passing stationary vehicles.
7. Preference to rely upon modern trucks with Euro 5 and Euro 6 compliant engines
8. Preference to rely upon modern trucks with airbag suspension

General operational noise management measures will be in accordance with the Pearlman Quarry EMP. Monitoring and reporting of noise emissions will be in accordance with the conditions of consent and/or Environment Protection Licence. For further information refer to the Pearlman Quarry EMP.

6.0 COMMUNITY ENGAGEMENT AND COMPLIANTS PROCEDURE

Refer to the Pearlman Quarry EMP for the community engagement, complaints and incident procedure which applies to all aspects of the quarry.

7.0 CORRECTIVE ACTION

The Quarry Manager shall take appropriate action to rectify problems or any identified deficiencies in accordance with the requirements of the Pearlman Quarry EMP.

8.0 CONTINGENCY PLAN

In the event of unpredicted impacts, the Quarry Manager shall investigate the potential cause in accordance with the Pearlman Quarry EMP. The Quarry Manager shall undertake appropriate action to rectify any identified deficiencies in the management measures immediately. The Quarry Manager may request the services of a specialist consultant to investigate and to give advice to assist in resolving the unpredicted impacts.

9.0 AUDITING AND REVIEW

The Quarry Manager shall review this management plan and its management measures to confirm their effectiveness and investigate ways to improve environment performance over time plan at least once every year at the time of completing the Annual Review as required by the development consent. Auditing and review will also include inspections of the haulage route to ensure that this management is fit for purpose to maintain safety to workers and the community. Inspections of the haulage route will also take place following the investigation of a complaint or a reported safety concern.

10.0 SUMMARY

Quarry Solutions recognises the need for safe, responsible and efficient transport of quarry materials in the interest of public benefit and safety. Quarry Solutions, through the Driver Induction Procedure will ensure that all truck drivers commit to the Driver Code of Conduct which will be strictly administered by the Quarry Manager and General Manager. The implementation of the measures outlined in this TMP will manage impacts to the community from haulage of quarry materials from the Pearlman Quarry.

attachments

Attachment 1

Quarry Solutions Driver Induction Procedure

QuarrySolutions

CHECKLIST OF CARTAGE SUBCONTRACTOR DOCUMENTATION

Subcontractor Name:		***Phone No:***	
Contact Name:		***Job No:***	***Date:***
No of Trucks:	***No of Trailers:***	***No of Drivers:***	

✓		***ITEM***	***STATUS / COMMENTS***
	A.	***Subcontractor Systems Checklist***	
	A1	Complete 14-B1-04 Subcontractor Checklist	
	B.	***Vehicle Registrations***	
	B1	Current Registration Certificate for trucks and trailers	
	B2	Maintenance Records for trucks and trailers	
	B3	Maintenance Schedule for trucks and trailers	
	B4	Registration Labels visually inspected	
	C.	***Vehicle Inspections***	
	C1	Current Heavy Vehicle Safety Inspection for trucks and trailers	
	C2	Quarry Solutions / SEE Civil Vehicle Inspection	
	D.	***Driver Inductions and Licencing***	
	D1	Current Heavy Vehicle Drivers Licences	
	D2	Pacific Complete Inductions	
	D3	Quarry Solutions/SEE Civil Site Inductions	

Review & Approval BY Quarry Solutions PTY LTD
When approved include in SEE IMS A7 Procurement, 7.2 Approval Records for each Subcontractor

A =	ACCEPTED	All works may commence
P =	PROVISIONAL ACCEPTANCE	Only some aspects of the works may commence
N =	NOT ACCEPTED	No work may commence

QUARRY SOLUTIONS **USE ONLY** – ***REVIEW STATUS RECORDS***

Date reviewed	***A,P or N***	***Comments***	***Reviewed by***	***Signature***

Attachment 2

Quarry Solutions Driver Code of Conduct

QuarrySolutions

Driver Code of Conduct

Tikitere Quarry

Quarry Solutions Pty Ltd ABN - 13 133 700 848
24a Ozone St Chinderah NSW 2487 – Ph. 0266 712 300

Quarry Solutions Pty Ltd recognises the need for safe, responsible and efficient transport of quarry materials in the interest of public benefit and safety. Any truck driver who enters or leaves the Pearlman Quarry is expected to respect the community in which they drive, and adopt the following code of conduct.

Objective

Work together to maximise safety in road haulage and minimise the impact of trucks on other road users and the surrounding communities

Drivers Code of Conduct

1. Acknowledge this Driver Code of Conduct is enforced as a 'Two Strikes and you're out' policy
2. Report any complaints, incidents or reports to the Quarry Manager
3. When transporting material use only the approved Tikitere Quarry Haulage Route
4. Present to the Quarry Site Office to sign on to the Daily Toolbox on first entry into the quarry
5. Abide by QS Drug & Alcohol Policy by presenting to work with 0.00 BAC
6. Adhere to Site Operating Conditions for Traffic Management and Noise Restrictions and Operating Hours
7. Strictly comply with all traffic rules and regulations
8. Report all incidents and accidents no matter how minor
9. Ensure there is no loading over registered gross mass
10. Appropriately cover and secure loads before leaving the quarry site
11. Ensure drawbars, tailgates, rails and duals are clear of rocks before leaving the quarry site
12. Maintain appropriate signage to enable identification by road users in the event of a complaint
13. Comply with all posted speed limits on all roads
14. Comply with the School Zones and follow the bus interaction guidelines on Fleet Office IVMS
15. Always drive in a manner that is in accordance with road conditions
16. Only use horn only when appropriate to do so
17. Be aware that we start early and not all the community start as early as we do
18. Decrease truck speeds to minimise dust and noise around private dwellings, road works, men on the ground and stationery vehicles
19. Reduce engine brake noise to respect the community through which they are driving
20. In the event of an environmental incident, make sure every endeavour is taken to contain and minimise environmental harm
21. Respect the environment by not littering
22. Encourage professional and appropriate use of two-way radios
23. Remain calm and courteous when in contact with other road users and members of the public
24. Acknowledge courteous acts by others

Non-compliance with this code of conduct under the 'Two strikes and you're out policy' will result in a review by QS Management and may result in a refusal to load out from QS Sites in future. Compliance will be assessed in the event of a complaint, incident or emergency and may also be subject to random inspection prior to issue of a 'docket' from the weighbridge.

Attachment 3

Quarry Solutions IVMS GPS Release Form

GPS Transfer Authority

SEE Civil Pty Ltd
Quarry Solutions Pty Ltd
24A Ozone Street Chinderah NSW 2487
Ph: 02 6671 2300

The Fleet Office IVMS1 GPS Tracking System

Complete the form below to transfer ownership of the IVMS1 unit from Quarry Solutions to your nominated company.

IVMS Unit ID: ______________________________

Company Name: ______________________________

Vehicle Rego: ______________________________

Vehicle Make: ______________________________

Vehicle Model: ______________________________

Vehicle Unit Number: ______________________________

By signing below, you acknowledge that Quarry Solutions will have the capability to track the movements of your vehicle. The tracker will only be activated once the vehicle enters a Quarry Solutions site and only authorised personnel will be able to track vehicle movements for the following 14-hour period.

Name: ______________________________

Signature: ______________________________

Position: ______________________________

This form MUST be completed and returned to the Quarry Manager. You may then install your IVMS1 unit following the supplied instructions. This from will be forwarded to The Fleet Office and they will be in contact to link up your IVMS unit to the network. All IVMS units are to be hard wired with no isolation switch. All trucks will be audited for compliance. Trucks which are found to have an isolation switch will be deemed to be non-compliant.

For further information visit www.thefleetoffice.com.au

GPS Transfer Authority

SEE Civil Pty Ltd
Quarry Solutions Pty Ltd
24A Ozone Street Chinderah NSW 2487
Ph: 02 6671 2300

Quarry Solutions IVMS Specifications

The aim of this brief is to outline the IVMS specifications for SEE Civil & Quarry Solutions. Subcontractors must ensure all drivers operating on these sites are informed of the below specifications to comply with our requirements.

Detailed Specification

Fatigue management – The devices are to alert a driver (Light vehicles only) when he/she is approaching 2 hours of continuous driving. This is done in cab by actioning a series of short beeps/light flashes in the cab. A report will also be sent to say the driver has been warned. If the driver exceeds 2 hours of continuous driving, the buzzer/light will continuously sound. A report will be sent to confirm this. The alarm can be silenced by changing driver, or will stop at the end of a 2-hour rest period. Note: the engine must be switched off to count as a rest period.

Speeding – All reports from the trackers are sent to our Google Maps API where they are checked against gazetted speed limits. A report will only be sent if the driver exceeds the speed limit by 10% for a period of longer than 10 seconds. All school zones must be adhered to.

Harsh driving – The devices have 3 way accelerometers which measures acceleration in any axis. They are programmed to send a report if the force in any given direction exceeds 17kph/sec.

Roll Over – In the event that an asset rolls over (Tilts more than 90 degrees) the device will send a report.

Seat Belt – If a driver exceeds a speed of 10kph for longer than one minute without a seatbelt being worn a report is sent.

Driver ID – A driver is expected to sign in before starting the vehicle, this is done by holding the ID key against the reader. When a driver does this, the indicator light in the vehicle will turn green and a single long beep will be given. The driver then has 5 mins to start the vehicle. If the vehicle is turned off for any reason, the driver will have 60 seconds to re-start the vehicle before needing to use the ID key again. If a driver fails to use the ID key and starts the vehicle, a buzzer will sound continuously until such a time that a driver signs in, and a report is sent.

Emergency Duress – A button or toggle switch with cover is placed in easy reach of the driver. In the case of an emergency, the driver can depress the button and a report will be instantly sent. If the button is pressed again the alert is cancelled and a report to this effect is also sent. Whilst the button is depressed the light and buzzer will continuously sound/flash at a rate of 4 times per second.

School Bus Interaction – (Trucks Only) When a Truck approaches a bus from behind and gets within 500m, the buzzer will sound and the light will flash at a rate of 1 x per sec. This acts as a warning that the bus is in front of the vehicle. If the truck gets closer and enters within 50m of the bus, the alarm/light will go to solid buzz/light at this point a "Too close to bus" alert will be sent via email to those you wish to receive it. When heading in opposite directions and the Truck/Bus get within 500m of each other, the buzzer will sound/light flash at a rate of 4 x per second. There is no further alert when the Bus and Truck get closer as they will have to pass each other. As soon as the 2 vehicles pass the buzzer/light will silence.

Summary - These rules are subject to change; all script changes must be done in consultation with The Fleet Office.

Appendix 3 – Road Condition Assessment: Haulage Route Photos

Croppa-Moree Road (June 2019)

Figure 13 – Newell Highway Intersection with Croppa-Moree Road (View North)
(GPS: E 789696, N 6754883) W:9.2m

Figure 14 - Newell Highway Intersection with Croppa-Moree Road (View South)
(GPS: E 789696, N 6754883) W:8.5m

Figure 15 – Croppa-Moree Road Intersection with the Newell Highway
(GPS: E 789696, N 6754883) W:9.2m

Figure 16 – Culvert Twin Pipe
(GPS: E 789696, N 6754883) CW: 12.10 W:8.5m

Figure 17 – Service Access (Telstra Repeater Tower) RA63
(GPS: E 790305, N 6754829) W: 7m

Figure 18 – Triple Property Access (North)
(GPS: E 209724, S 9754576) W: 7m

Figure 19 – Triple Property Access "Wallam" (North)
(GPS: E 209724, S 9754576) W: 7m

Figure 20 – Triple Property Access "Yunburra" (South)
(GPS: E 209724, S 9754576) W: 7m

Figure 21 – Section Change: End of Shoulder Line Marking
(GPS: E 210808, S 6754450) W: 8.4m

Figure 22 – Vegetation growing through the bitumen (mainly westbound lane)

Figure 23 – Property Access "Yambin" RA622
(GPS: E 213012, S 6754323) W: 8.2m

Figure 24 - Single Pipe Culvert
(GPS: E 213026, S 6754353) CW: 12 W: 8.5m

Figure 25 – Single Pipe Culvert
(GPS: (GPS: E 213955, S 6754961) CW: 10 W: 7.9m

Figure 26 - Section Change: Addition of Shoulder Line Marking
(GPS: E 213955, S 6754961) W: 7.9m

Figure 27 – Dual Property Access "North Yambin" RA793
(GPS: E 214434, S 6755281) W: 9m

Figure 28 – Section Change
(GPS: E 216107, S 6756432) East W: 7.6m West W: 8.5m

Figure 29 – Property Access "Tantaranna" RA994
(GPS: E 216107, S 6756432) W: 7.3m

Figure 30 – Section Change: End of Shoulder Line Marking
(GPS: E 217197, S 6757137) W: 7.7m

Figure 31 – Property Access RA626
(GPS: E 217808, S 6757554) W: 7.6m

Figure 32 - Stockpile Access
(GPS: E 218021, S 6757683)

Figure 33 - Section Change – Floodway
(GPS: E 218021, S 6757683) East W: 8.7m, West W: 7.4m

Figure 34 - Floodway (No Line Marking)
(GPS: E 218248, S 6757831) Length: 309m

Figure 35 – Twin Box Culvert (Floodway)
(GPS: E 218248, S 6757831) CW: 12.40m, W: 9.10m

Figure 36 - Section Change - End of Floodway
(GPS: E 218248, S 6757831) East RW: 7.3m, West RW: 9.2m

Figure 37 - Property Access "Oonadatta" RA1263
(GPS: E 218472, S 6758001) W: 7.1m

Figure 38 - Travelling Stock Route Access
(GPS: E 218472, S 6758001)

Figure 39 – Section Change – End of Centre Line Marking
(GPS: E 219881, S 6758961) W: 7m

Figure 40 – Unofficial Property Access
(GPS: E 219881, S 6758961) W: 7m

Figure 41 - Wongabindie Road (SR132)
(GPS: E 220359, S 6759281) W: 7m

Figure 42 – Westbound Traffic has a Depression on the Southern Edge of the Road
(GPS: E 220359, S 6759281) W: 7m

Figure 43 – Unofficial Property Access
(GPS: E 220465, S 6759345)

Figure 44 - Twin Box Culvert - Patchwork and minor rutting above
(GPS: E 221555, S 6760081) CW: 10.2m W: 7.3m

Figure 45 – Rutting and Patching
(GPS: E 221555, S 6760081)

Figure 46 – Edge Drop
(GPS: E 221555, S 6760081)

Figure 47 - Property Access "Kirkland" RA1651
(GPS: E 222155, S 6760081) W: 7m

Figure 48 – Unofficial Property Access
(GPS: E 222167, S 6760496)

Figure 49 – Rutting and Patchwork
(GPS: E 222167, S 6760496)

Figure 50 - Property Access "Warayama" RA1792
(GPS: E 222725, S 6760879) W: 7m

Figure 51 - Property Access "Kintyre" – Located on a Bend
(GPS: E 223469, S 6761391) W: 7.2m

Figure 52 – Single Pipe Culvert
(GPS: E 224434, S 6761722) CW: 10m W: 7.4m

Figure 53 – Pothole above Single Pipe Culvert
(GPS: E 224434, S 6761722) CW: 10m W: 7.4m

Figure 54 – Double Property Access "Glenelg" – Approx. 300m Sight Distance to West
(GPS: E 224433, S 6761752) W: 7.2m

Figure 55 – Property Access "Elgin" RA2032
(GPS: E 224933, S 6762105) W: 7.1m

Figure 56 - Unofficial Property Access
(GPS: E 224933, S 6762105) W: 7.1m

Figure 57 – Floodway
(GPS: E 225312, S6762328) L: 65.3m W: 9.25m

Figure 58 - Edge Drop on Floodway
(GPS: E 225312, S6762328) L: 65.3m W: 9.25m

Figure 59 - Cracking on Floodway
(GPS: E 225312, S6762328) L: 65.3m W: 9.25m

Figure 60 - Floodway Twin Box Culvert
(GPS: E 225312, S6762328) L: 65.3m W: 9.25m

Figure 61 - Section Change
(GPS: E 225312, S6762328) East W: 7.2m, West W: 8.1m

Figure 62 – Single Pipe Culvert
(GPS: E 225578, S 6762489) CW: 9.8m W: 7.2m

Figure 63 – Moderate Rutting
(GPS: E 225578, S 6762489)

Figure 64 – Section Change
(GPS: E 225737, S 6762616) East W: 6.2m, West W: 7.2m

Figure 65 - Bogamildi Road Intersection
(GPS: E 225764, S 6762616) East) W: 7.2m, West W: 6.35m

Figure 66 - Bogamildi Road (SR 237)
(GPS: E 225764, S 6762616) W: 5.8m

Figure 67 - Croppa-Moree Road - Bogamildi Road Intersection
(GPS: E 225764, S 6762616) W: 7.05m

Figure 68 – Gil Gil Creek Road – Croppa Moree Road Intersection
(GPS: E 226403, S 6763002) West W: 7.1m East W: 7.05m

Figure 69 - Gil Gil Creek Road – Croppa Moree Road Intersection SR129
((GPS: E 226403, S 6763002) West W: 7.1m East W: 7.05m

Figure 70 - Gil Gil Creek Road – Croppa Moree Road Intersection SR129
(GPS: E 226403, S 6763002) W: 5.8m

Figure 71 - Single Pipe Culvert
(GPS: E 226403 S 6763002) CW: 10.10m W: 7.1m

Figure 72 - Section Change
(GPS: E 226801 S 6763289) W: 7m; no width change

Figure 73- Section Change
(GPS: E 228317 S 6764373) East W: 8.1m, West W: 6.1m

Figure 74 - Section Change
(GPS: E 228317 S 6764373) East W: 7.2m, West W: 8.1m

Figure 75 - Croppa-Moree Road and Parallel Stockpile Entrance Approaching Intersection (GPS: E 230536 S 6766552)

Figure 76 - Croppa-Moree Road T-Junction with County Boundary Road (GPS: E 230536 S 6766552) West of Intersection W: 8.4m

Figure 77 - Croppa-Moree Road T-Junction with County Boundary Road
(GPS: E 230536 S 6766552) West of Intersection W: 8.4m

Figure 78 – County Boundary Road
(GPS: E 230536 S 6766552) Gravel Road W: 6.2m

Figure 79 - Croppa-Moree Road T-Junction with County Boundary Road
(GPS: E 230536 S 6766552) Change from Moree Plains Shire to Gwydir Shire

Figure 80 – Croppa Moree Road
(GPS: E 230536 S 6766552)

Figure 81 – Single Pipe Culvert
(GPS: E 230536 S 6766552) CW: 12.4m W: 7.1m

Figure 82 - Single Pipe Culvert
(GPS: E 230684 S 6767141) CW: 10.4m W: 6m

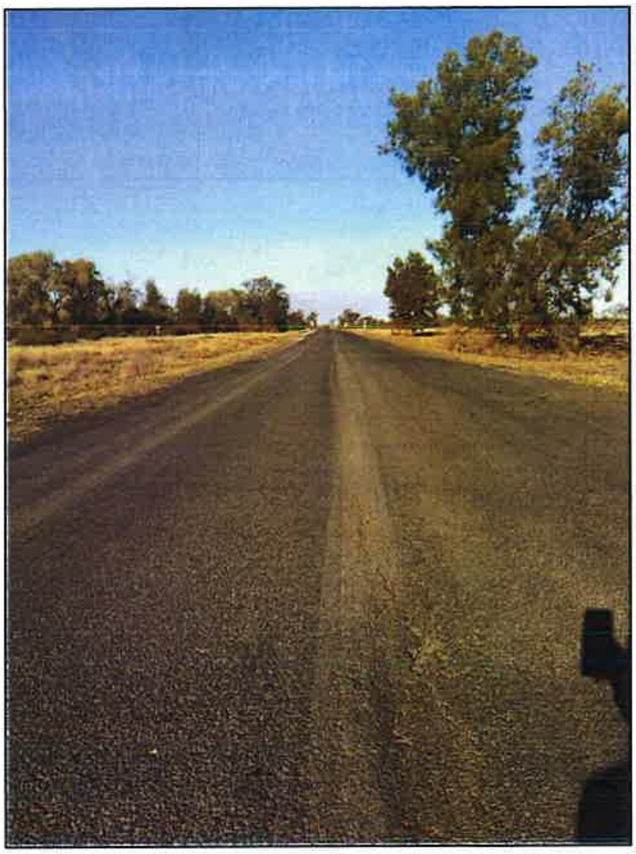

Figure 83 - Croppa-Moree Road - Cracking down centre of road
(GPS: E 230684 S 6767141) W: 6m

Figure 84 - Croppa-Moree - Rutting on road.
(GPS: E 230684 S 6767141) W: 6m

Figure 85 – Four Way Intersection
(GPS: E 230684 S 6767141) W: 6m

Figure 86 – Croppa-Moree Road Four Way Intersection
(GPS: E 230684 S 6767141) W: 6m

Figure 87 - Croppa-Moree Road Four Way Intersection
(GPS: E 230684 S 6767141) W: 6m

Figure 88 - Croppa-Moree Road Four Way Intersection – Strangford Road (SR195)
(GPS: E 230684 S 6767141) W: 6m

Figure 89 - Croppa-Moree Road Four Way Intersection – County Boundary Road to Tulloona
(GPS: E 230684 S 6767141) W: 6.3m

Figure 90 - Croppa-Moree Road Four Way Intersection – Moderate drop
(GPS: E 230684 S 6767141) W: 6m

Figure 91 – Four Way Intersection: Strangford, County Boundary Road and Croppa-Moree Road
(GPS: E 230684 S 6767141) W: 6m

Figure 92 - Approach of Four Way Intersection (Croppa Creek Side)
(GPS: E 230684 S 6767141) W: 6.7m

Figure 93 - Vegetation growth through bitumen shoulders causing edge break
(GPS: E 231002 S 6767395) W: 6m

Figure 94 - Significant Pot Hole through to Culvert
(GPS: E 231002, S 6767395)

Figure 95 – Single Pipe Culvert – Collapsed with Spider Cracking on Road
(GPS: E 231002, S 6767395) CW: 10.1m W: 6.6m

Figure 96 - Crest
(GPS: E 231667, S 6767903)

Figure 97 – Causeway – Expansion Joint
(GPS: E 231879, S 6768062) W: 7.2m (narrow) Length: 40m

Figure 98 - Causeway
(GPS: E 231879, S 6768062)

Figure 99 – Single Box Culvert
(GPS: E 231958 S 6768126) CW: 9.6m RW: 6.75

Figure 100 - Patchwork Above Single Box Culvert
(GPS: E 231958 S 6768126) CW: 9.6m RW: 6.75

Figure 101 - Crest
(GPS: E 233765 S 6769493) W: 6.9m

Figure 102 - Dual Property Access – Unnofficial
(GPS: E 233765 S 6769493) W: 6.9m

Figure 103 – Minor Edge Break at Dual Property Access
(GPS: E 233765 S 6769493) W: 6.9m

Figure 104 – Triple Pipe Culvert
(GPS: E 233765 S 6769493) CW: 12.6 W: 7m

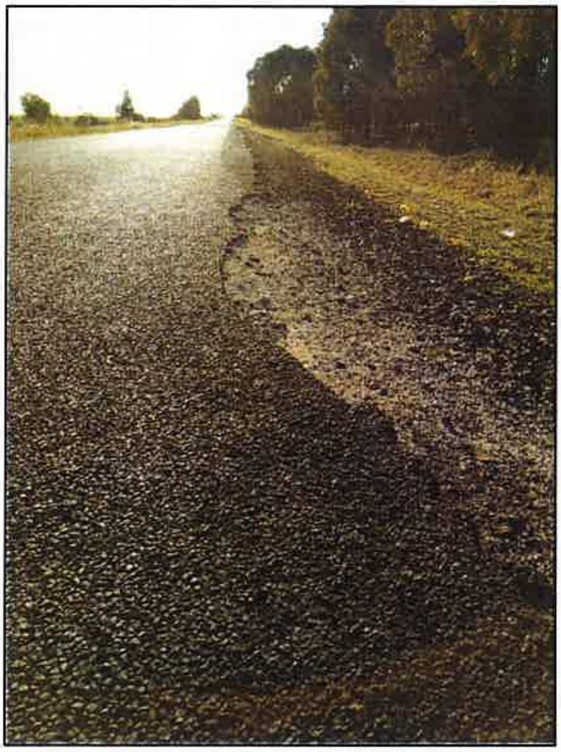

Figure 105 – Edge drop + Edge Break – Reduced Road Width
(GPS: E 233765 S 6769493) W: 6.1m

Figure 106 - Triple Pipe Culvert
(GPS: E 235519 S 6770828) CW: 10.1 W: 7m

Figure 107 – Patchwork and Rutting above Triple Pipe Culvert
(GPS: E 235519 S 6770828) CW: 10.1 W: 7m

Figure 108 – Property Access - Unofficial
(GPS: E 233519 S 6770828) W: 7m

Figure 109 – Crest
(GPS: E 233519 S 6770828) W: 7m

Figure 110 - Single Pipe Culvert
(GPS: E 233519 S 6770828) CW: 10.2 W: 7m

Figure 111 – Patchwork above Single Pipe Culvert
(GPS: E 233519 S 6770828)

Figure 112 – Single Pipe Culvert – Head Wall Damage
(GPS: E 233519 S 6770828) CW: 12.9m W: 7m

Figure 113 – Rilling above Single Pipe Culvert
(GPS: E 233519 S 6770828)

Figure 114 - Crest
(GPS: E 233519 S 6770828)

Figure 115 – Triple Pipe Culvert
(GPS: E 233519 S 6770828) CW: 10.2m W: 7.5m

Figure 116 - Triple Pipe Culvert (Rutting and Rilling above Culvert)
(GPS: E 233519 S 6770828) CW: 10.2m W: 7.5m

Figure 117 – Property Access "Yamboon" (SR156) (Minor Edge Break)
(GPS: E 233519 S 6770828) W: 7m

Figure 118 – Floodway – Patched – Speed Limit 65km/h
(GPS: E 236528 S 6771621) Length: 39.85m W: 9m

Figure 119 Floodway – Patched – Speed Limit 65km/h
(GPS: E 236528 S 6771621) Length: 39.85m W: 9m

Figure 120 – Patchwork
(GPS: E 236528 S 6771621)

Figure 121 - Patchwork
(GPS: E 236528 S 6771621)

Figure 122 – Triple Pipe Culvert
(GPS: E 236528 S 6771621) CW: 10.25m W: 7m

Croppa-Moree Road (October 2018)

Figure 123 – Croppa Moree Road Railway Crossing
(GPS: E 236754, N 6771745) W:6.6m

Figure 124 - Croppa Moree Road Railway Crossing
(GPS: E 236754, N 6771745) W:6.6m

Figure 125 - Property Access "Ercildoune" and "Talahassee" RA3604
(GPS: E 236884, N 6771843) W:6.6m

Figure 126 – Edge Drop
(GPS: E 236981, N 6771917) W:6.6m

Figure 127 – Culvert Quad Pipe
(GPS: E 236981, N 6771917) CW: 12.2 W:6.6m

Figure 128 – Culvert Single Pipe
(GPS: E 237421, N 6772250) CW: 12.4m W:7.1m

Figure 129 – Culvert Single Pipe
(GPS: E 237691, N 6772461) CW: 12.6 W:6.9m

Figure 130 - Floodway
(GPS: E 238010, N 6772699) W: 9m L: 36m

Figure 131 – Culvert Single Pipe
(GPS: E 238831, N 6773324) CW: 11.5m W:6.5m

Figure 132 – Causeway
(GPS: E 239457, N 6773826) W:6.95m L:34m

Figure 133 – Intersection Croppa Moree Road / Bristol Lane
(GPS: E 239488, N 6773847) W:6m

Figure 134 – Road Damage (Pothole)
(GPS: E 239554, N 6773893)

Figure 135 – Culvert Twin Pipe
(GPS: E 239987, N 6774207) CW: 10.4 W:6.3m

Figure 136 – Property Access "Belmore" RA4011
(GPS: E 240141, N 6774306) W:6.4m

Figure 137 – Belmore Bridge (Narrow)
(GPS: E 240283, N 6774306) W:6.6m

Figure 138 – T Intersection Croppa Moree Road / Croppa Creek Road
(GPS: E 240514, N 6774510) W:6.45m (Croppa Moree Road) W: 8m (Croppa Creek Road)

Croppa Creek Road (October 2018)

Figure 139 – Culvert Twin Pipe, Headwall Lifting Off Pipes
(GPS: E 244107, N 6795956) CW: 10m W: 6.4m

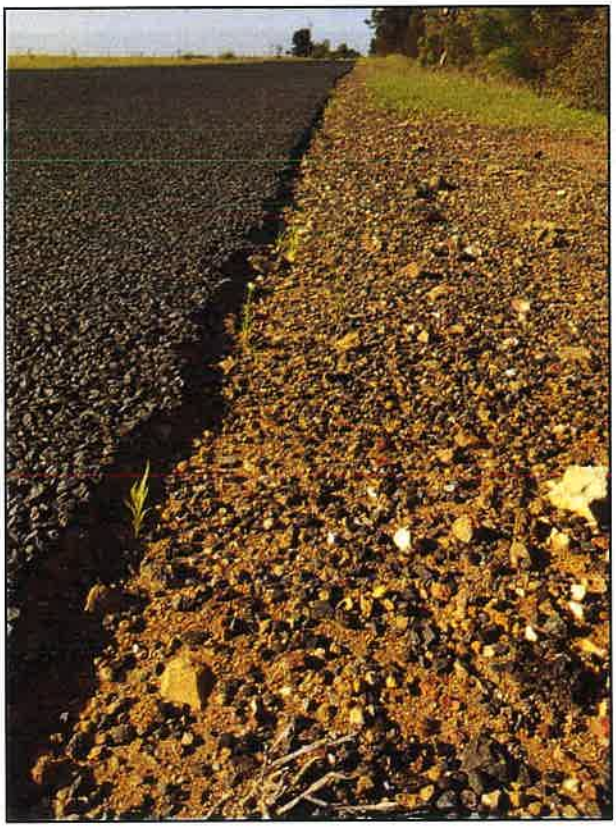

Figure 140 – Edge Drop
(GPS: E 244107, N 6795956)

Figure 141 – Culvert Single Pipe
(GPS: E 244088, N 6795806) CW: 10m W: 6.4m

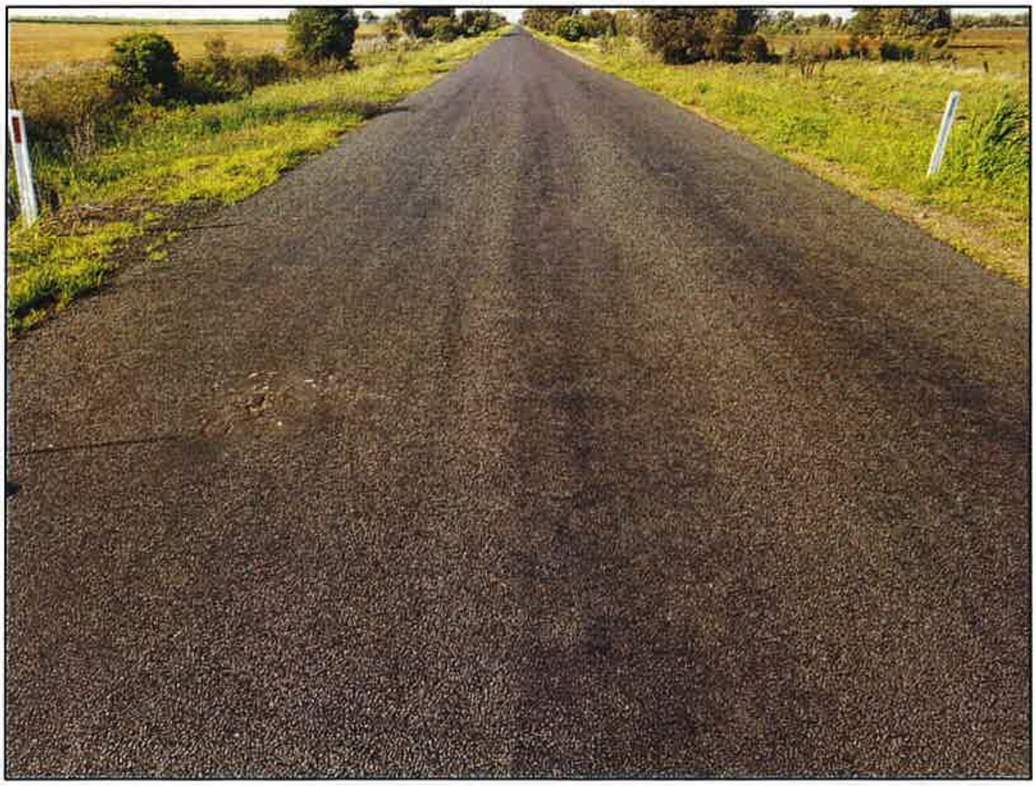

Figure 142 – Culvert Single Pipe
(GPS: E 244050, N 6795519) CW: 10.3m W: 6.3m

Figure 143 - Culvert Quad Pipe
(GPS: E 244010, N 6795231) CW: 9.9m W: 6.5m

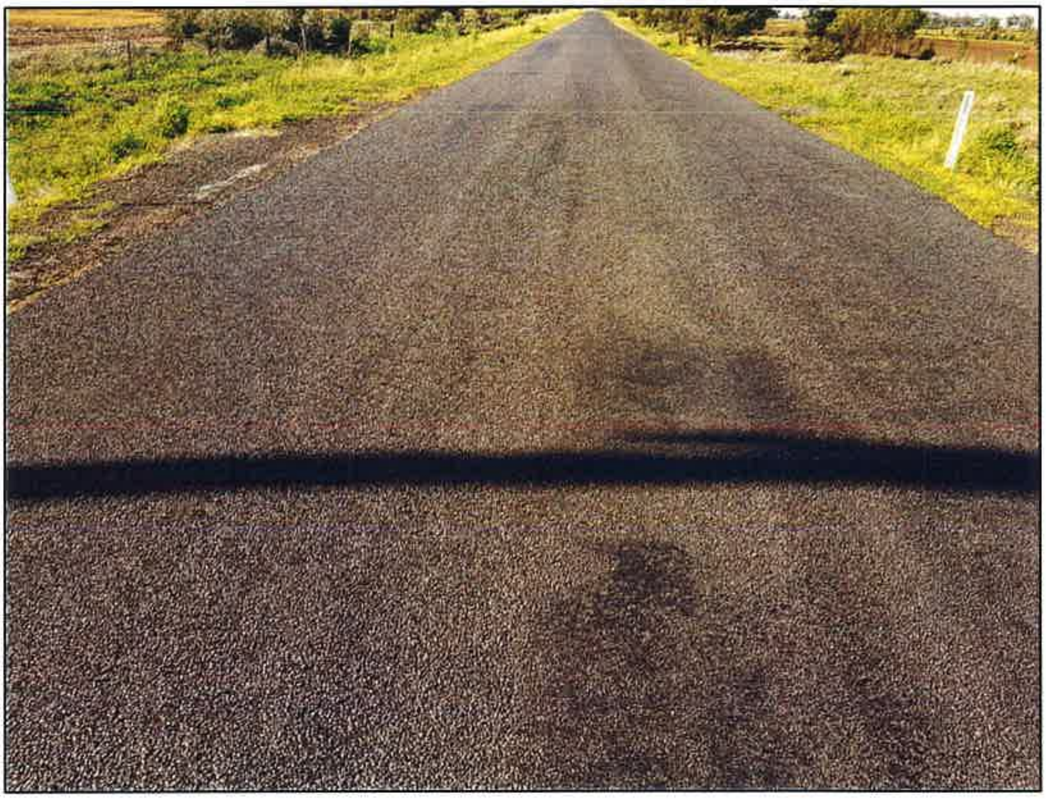

Figure 144 - Culvert Quad Pipe
(GPS: E 244010, N 6795231) CW: 9.9m W: 6.5m

Figure 145: Property Access "Alma Downs" RA2107
(GPS: E 243963, N 6798477) W: 6.25m

Figure 146 – Culvert Single Pipe (Minor edge drop)
(GPS: E 243943, N 6794708) CW: 10m W: 6.2m

Figure 147 – Railway Crossing
(GPS: E 243936, N 6794656) W: 7m

Figure 148 – Culvert Triple Pipe
(GPS: E 243923, N 6794560) CW: 12.6m W: 6.4m

Figure 149 – Culvert Tripe Pipe
(GPS: E 243818, N 6793760) CW: 9.9m W: 6.4m

Figure 150 – Minor edge break with vegetation growing through shoulder
(GPS: E 243818, N 6793760)

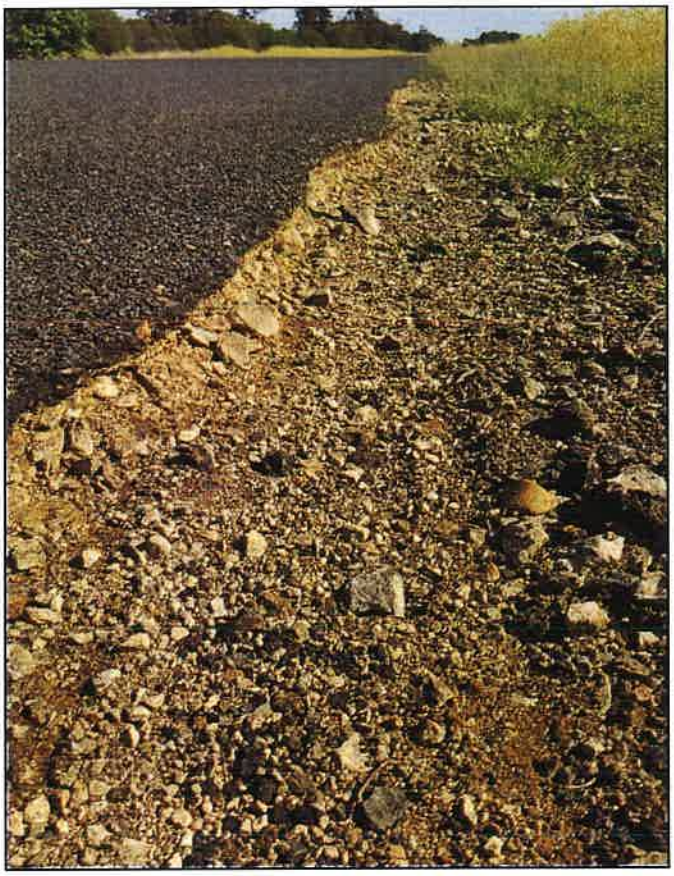

Figure 151 – Edge drop with longitudinal cracking
(GPS: E 243755, N 6793282)

Figure 152 – Culvert Single Pipe
(GPS: E 243755, N 6793282) CW: 11.5m W: 6m

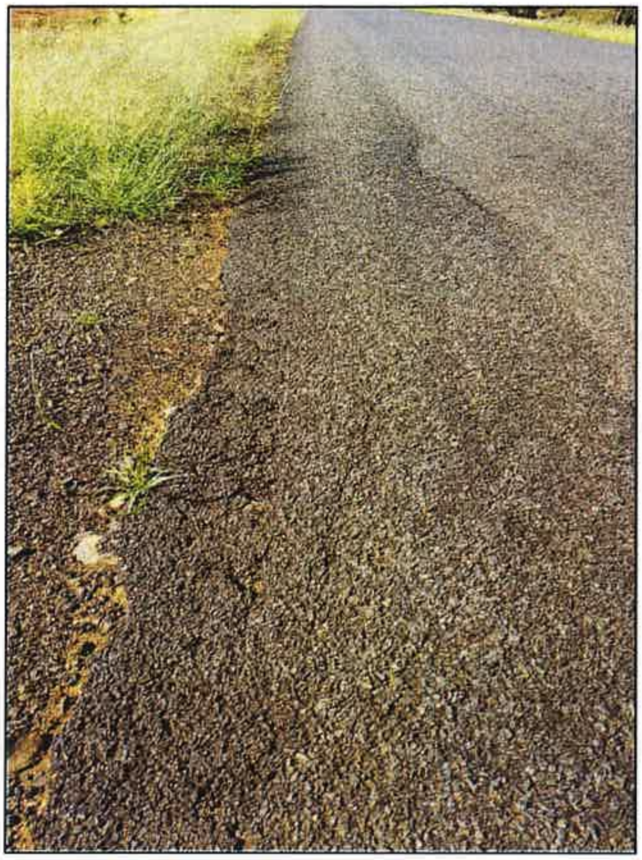

Figure 153 – Patched edge work
(GPS: E 243651, N 6792465)

Figure 154 – Potholes, cracking and shoving
(GPS: E 243651, N 6792465)

Figure 155 – Property Access "Windridge" RA1835
(GPS: E 243609, N 6792161) W:6.5m

Figure 156 – Culvert Twin Pipe
(GPS: E 243601, N 6792067) CW: 9.6 W:6.4m

Figure 157 – Culvert Twin Pipe
(GPS: E 243540, N 6791633) CW: 10m W:6.6m

Figure 158 – Property Access "Minilya"
(GPS: E 243458, N 6791084) W:7.8m

Figure 159 – Mungle Creek Floodway (pavement uneven)
(GPS: E 243385, N 6790462) W:6.9m

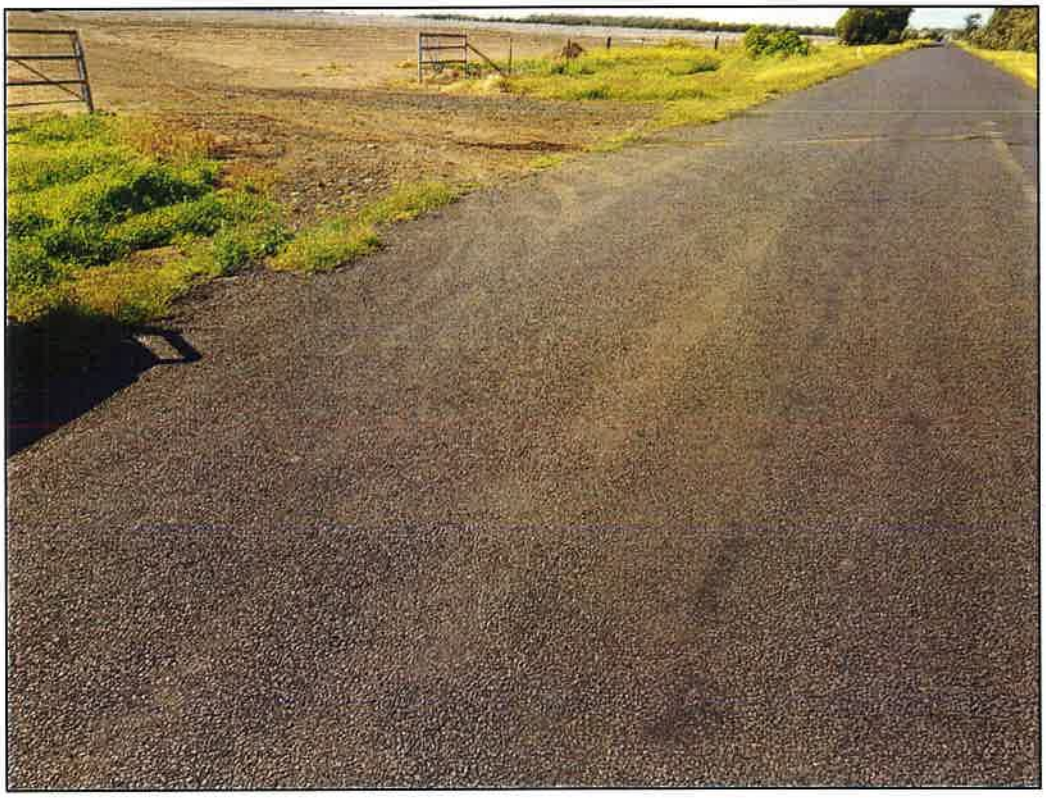

Figure 160 – Property Access
(GPS: E 243307, N 6789881) W:6.8m

Figure 161 – Culvert Single Pipe
(GPS: E 243280, N 6789671) CW:12 W:7m

Figure 162 – Property Access "Bonnyridge" and "Straithaine" RA1545
(GPS: E 243220, N 6789274) W:6.5m

Figure 163 – Floodway
(GPS: E 243175, N 6788850) W:6.8m

Figure 164 – Property Access "Yannarie" RA1216
(GPS: E 242811, N 6786050) W:7m

Figure 165 – Culvert Single Pipe
(GPS: E 242776, N 6785789) CW:12 W:7m

Figure 166 – Culvert Twin Pipe
(GPS: E 242768, N 6785708) CW:11.5m W:6.7m

Figure 167 - Culvert Twin Pipe - Blocked
(GPS: E 242768, N 6785708) CW:11.5m W:6.7m

Figure 168 - Culvert Twin Pipe
(GPS: E 242732, N 6785454) CW:14.4m W:7.7m

Figure 169 – Property Access "Tikitere" RA1135 & RA1137
(GPS: E 242708, N 6785242) W:7.2m (Croppa Creek Road) W:5.5 (Tikitere Access)

Figure 170 – Floodway and Unofficial Property Access (east)
(GPS: E 242674, N 6784911) W:6.4m

Figure 171 – Travelling Stock Route adjacent to Croppa Creek Road
(GPS: E 242622, N 6784485)

Figure 172 – Boonery Park Road Intersection with Croppa Creek Road (Crest visibility issues)
(GPS: E 242513, N 6783682) W:7.2m (Croppa Road) W:4.7m (Boonery Road)

Figure 173 – Culvert Quad Pipe
(GPS: E 242466, N 6783163) CW:11.4m W:7.6m

Figure 174 - Culvert Quad Pipe
(GPS: E 242466, N 6783163) CW:11.4m W:7.6m

Figure 175 – Property Access "Tullin Tulla" RA116
(GPS: E 242455, N 6783047) W:7.3m

Figure 176 – Bridge
(GPS: E 242452, N 6783005) W:6.7m

Figure 177 - Bridge
(GPS: E 242452, N 6783005) W:6.7m

Figure 178 – Culvert Single Pipe
(GPS: E 242386, N 6782591) CW:11.2m W:7m

Figure 179 – Property Access RA781
(GPS: E 242242, N 6781714) W:7.2m

Figure 180 – Localised edge break, vegetation growing through shoulder
(GPS: E 242242, N 6781714)

Figure 181 – Double Property Access "Tullin Tulla" (East)
(GPS: E 242067, N 6780434) W:6.8m

Figure 182 – Double Property Access "Myola" RA651 (West)
(GPS: E 242067, N 6780434) W:6.8m

Figure 183 – Tumba Road Intersection with Croppa Creek Road (localised edge break)
(GPS: E 241989, N 6779852) W:6.6m

Figure 184 – Culvert Single Pipe
(GPS: E 240764, N 6779468) CW: 12.1 W:4.3m

I B Bore Road (October 2018)

Figure 185 – Newell Intersection Facing North
(GPS: E 229341, N 6806580) W:6.8m (IB Bore)

Figure 186 – Newell Intersection Facing South
(GPS: E 229341, N 6806580) W:6.8m (IB Bore)

Figure 187 – I B Bore Road (Minor Corrugation)
(GPS: E 229341, N 6806580)

Figure 188 – Gravel Wearing Thin to Dirt
(GPS: E 229568, N 6806544) W:6.8m

Figure 189 – Culvert Single Pipe
(GPS: E 229974, N 6806477) CW:8.7m W:5m

Figure 190 – Culvert Twin Pipe
(GPS: E 230823, N 6806321) W:5.0m CW:8.7m

Figure 191 – Property Access RA165
(GPS: E 230905, N 6806279) W:5.7m Corners Corrugated

Figure 192 – Corrugation (typical to bends)
(GPS: E 230905, N 6806279)

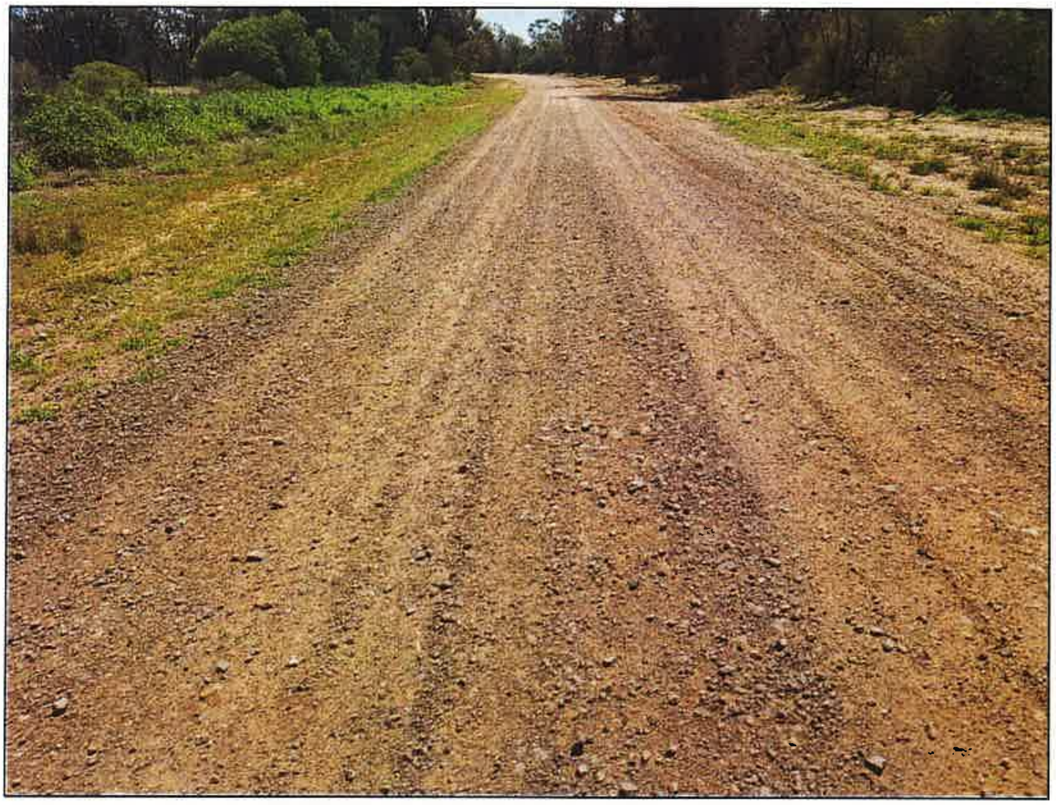

Figure 193 – Shire Border MPSC and GSC
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Figure 201 – Property Access
(GPS: E 230688, N 6802508) W:6.3m

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Figure 203 – Property Access
(GPS: E 230796, N 6802253) W:6.2m

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Figure 210 – Culvert Single Pipe
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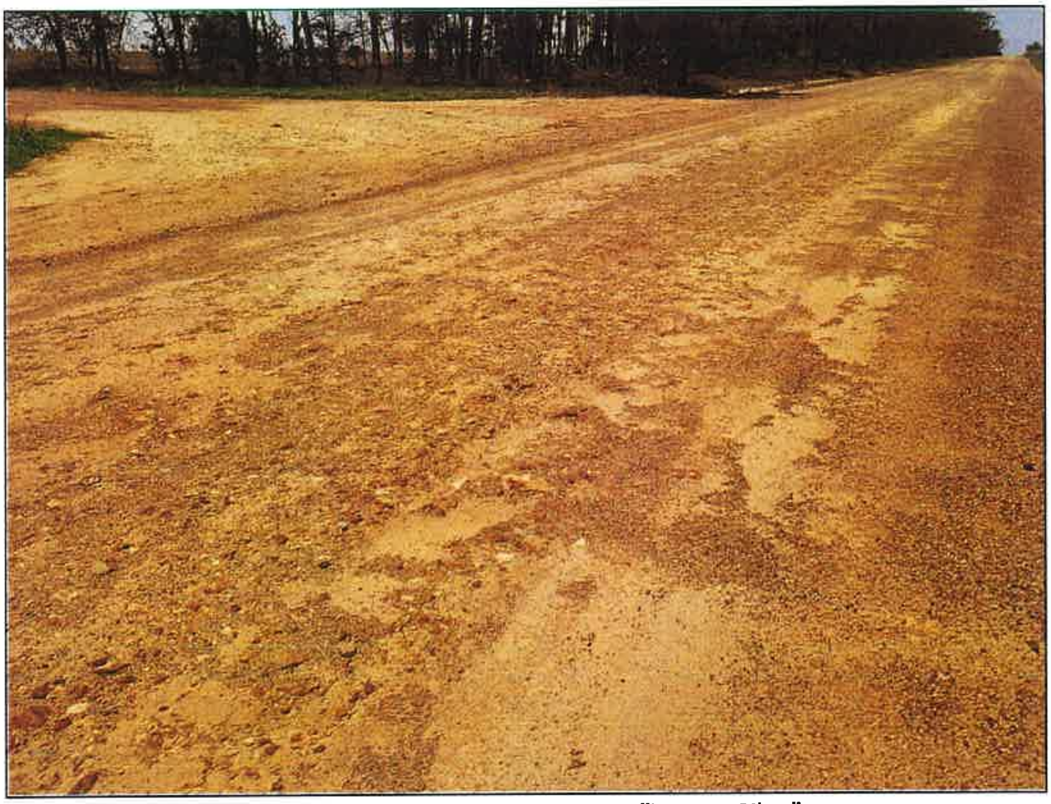

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Figure 215 – Property Access
(GPS: E 232978, N 6801247) W:6.5m

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Figure 222 – Property Access "Nulla Nulla" RA1069
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Figure 224 – Culvert Single Pipe
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Figure 226 – Property Access
(GPS: E 236253, N 6800799) W:8.0m

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Figure 248 – Culvert Single Pipe
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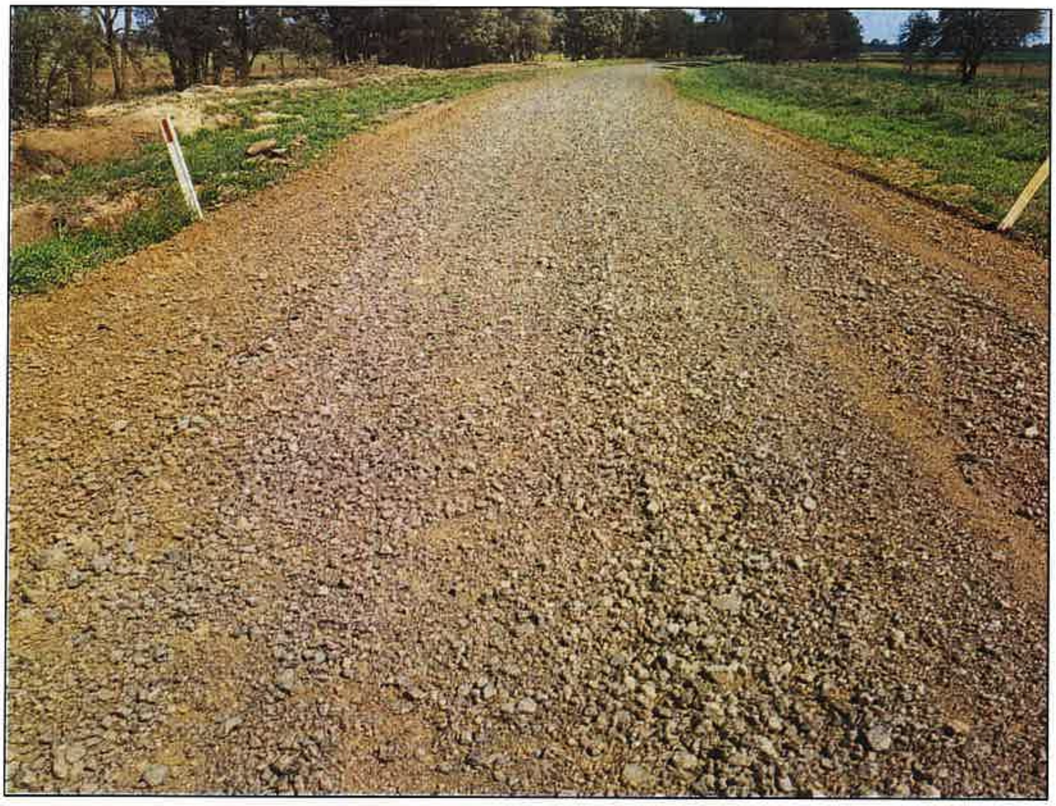

Figure 249 – Culvert Single Pipe
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Figure 250 – Culvert Twin Pipe
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Buckie Road (October 2018)

Figure 252 – Culvert Single Box
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North Star Road (October 2018)

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Figure 277 – Railway Crossing
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Figure 280 – Speed Change (School Zone 40km/h)
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Figure 286 – Double Rural Access (east)
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Figure 287 - Double Rural Access (west)
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Figure 293 – Culvert Single Pipe
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Figure 294 – Property Access "Bibalah" RA7056
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Figure 295 – Culvert Single Pipe
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Figure 296 – Double Property Access (east)
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Figure 297 – Old Railway Crossing (sealed)
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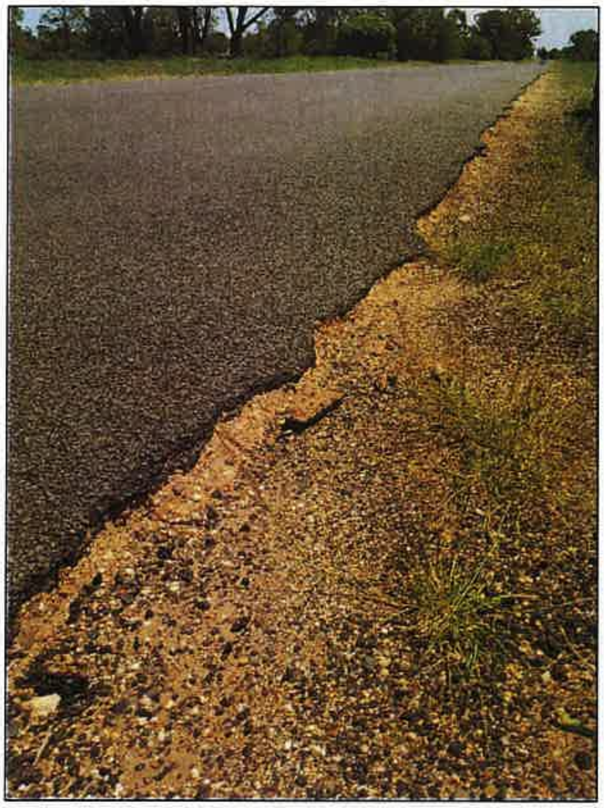

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Bruxner Way (October 2018)

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Figure 321 – Shire Boundary
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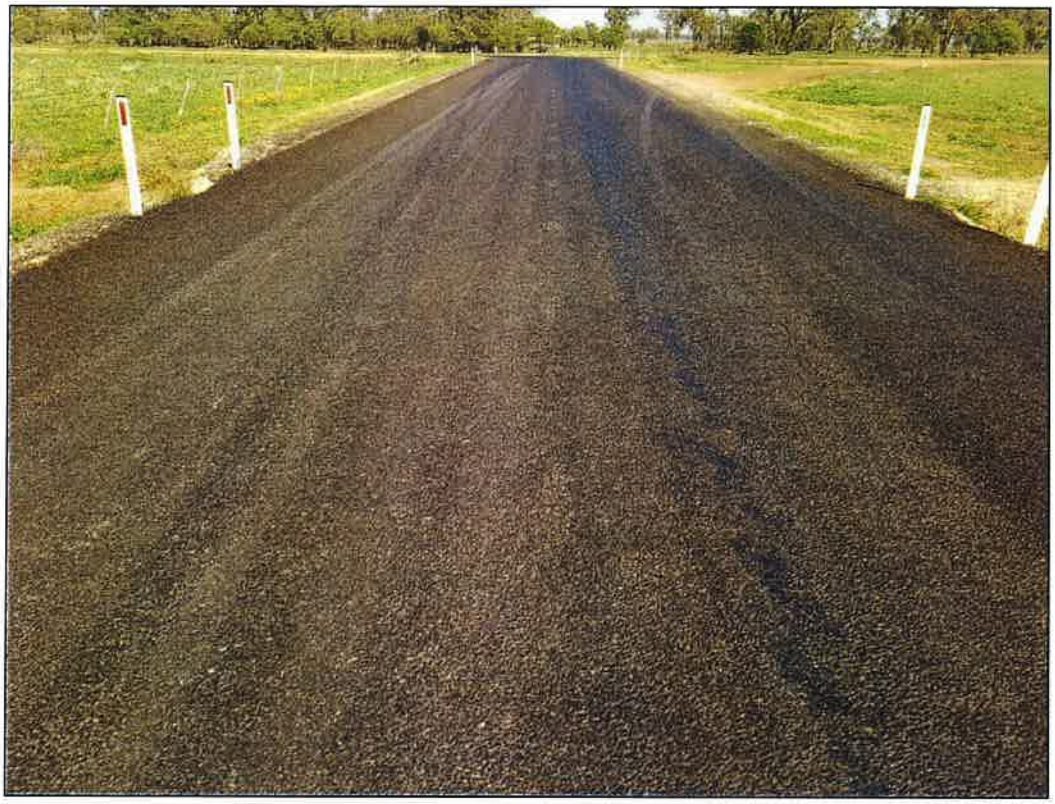

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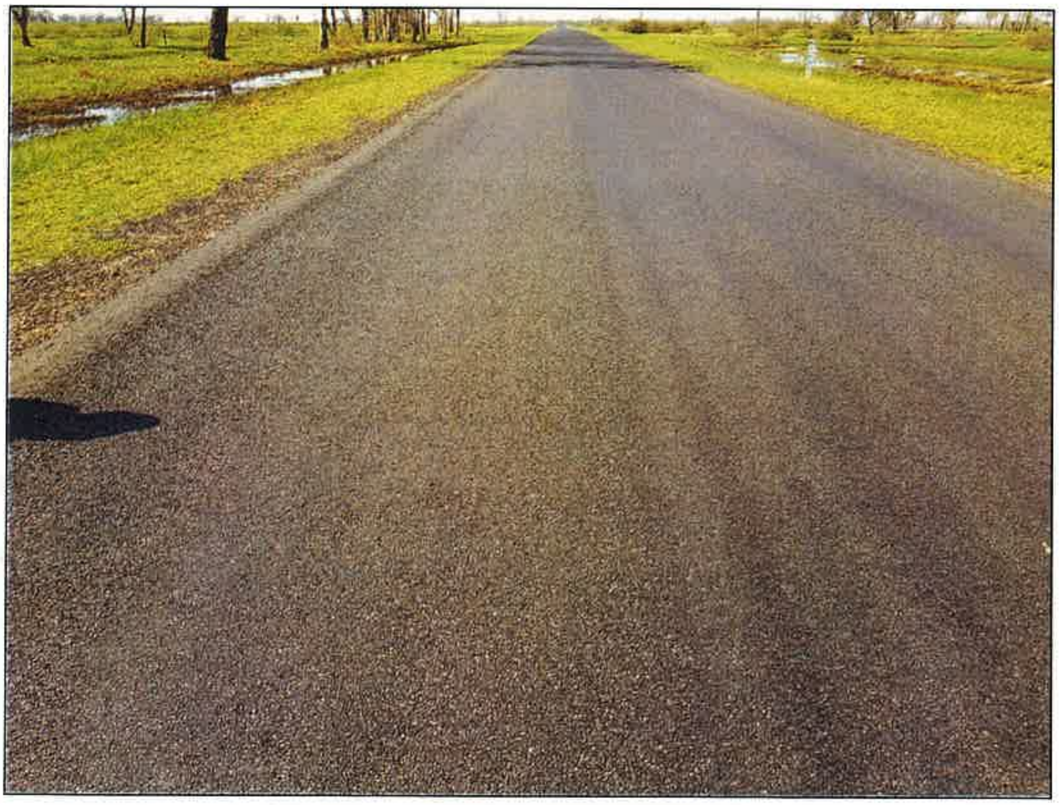

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Figure 338 – Property Access (East)
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Figure 339 – Floodway (section change)
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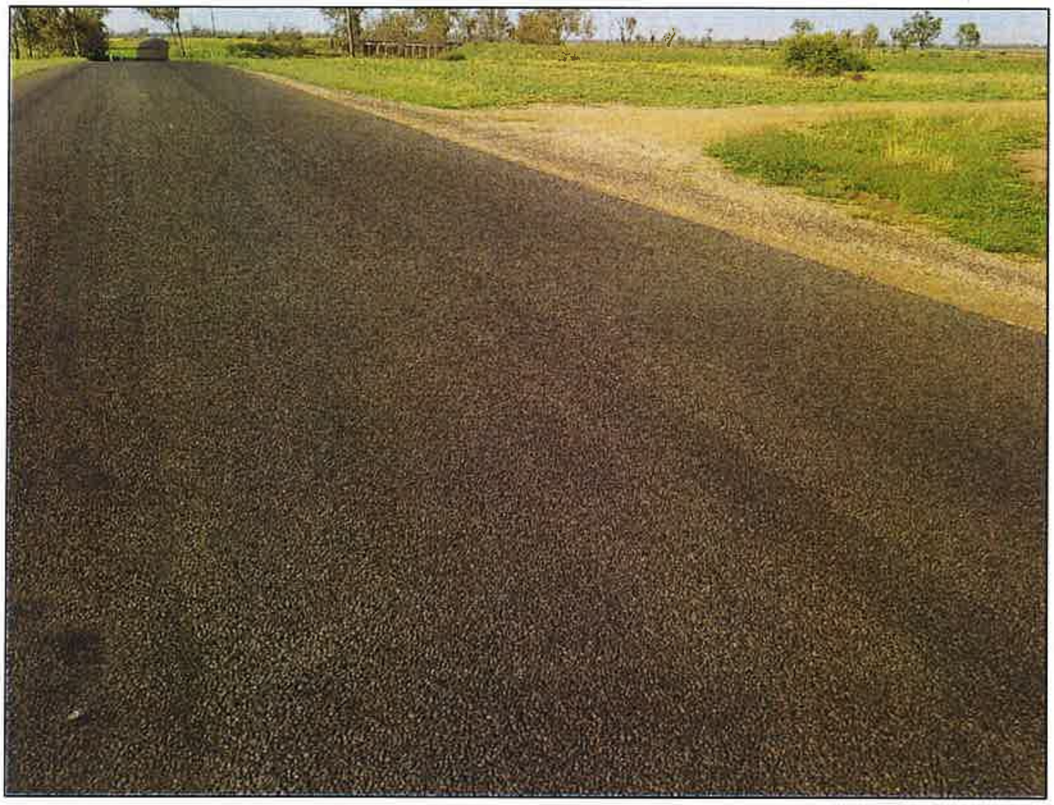

Figure 340 – Property Access (Railway Crossing approx 50m west)
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Boonery Park Road (October 2018)

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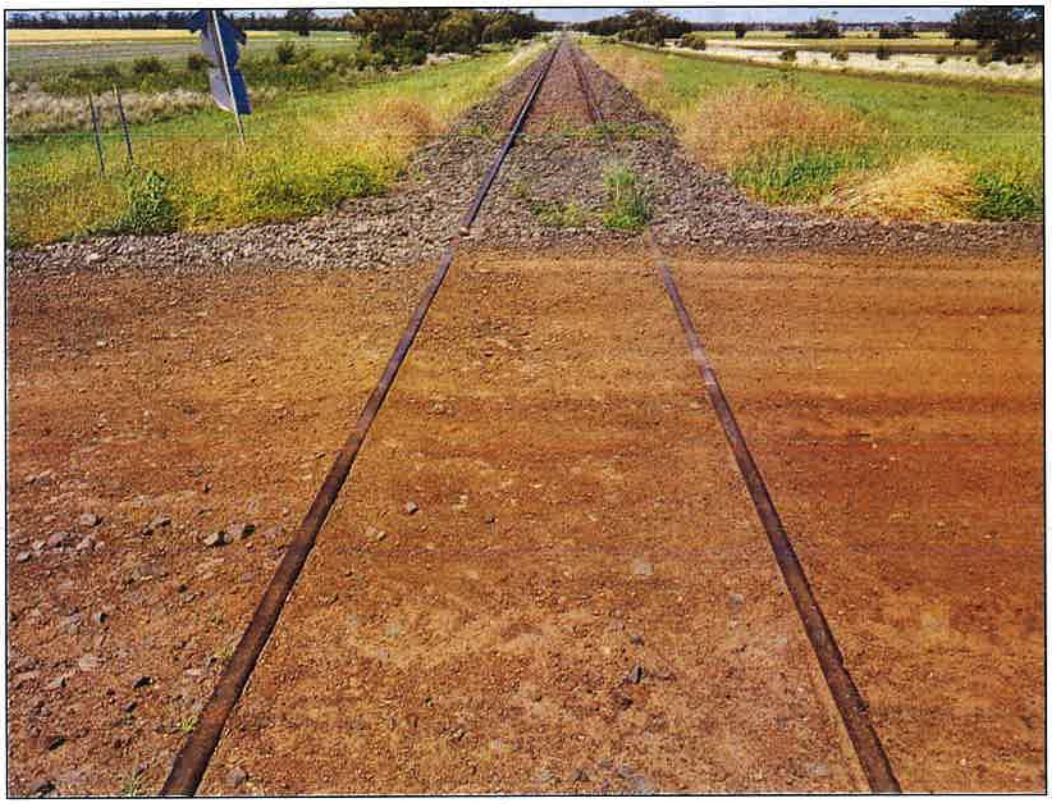

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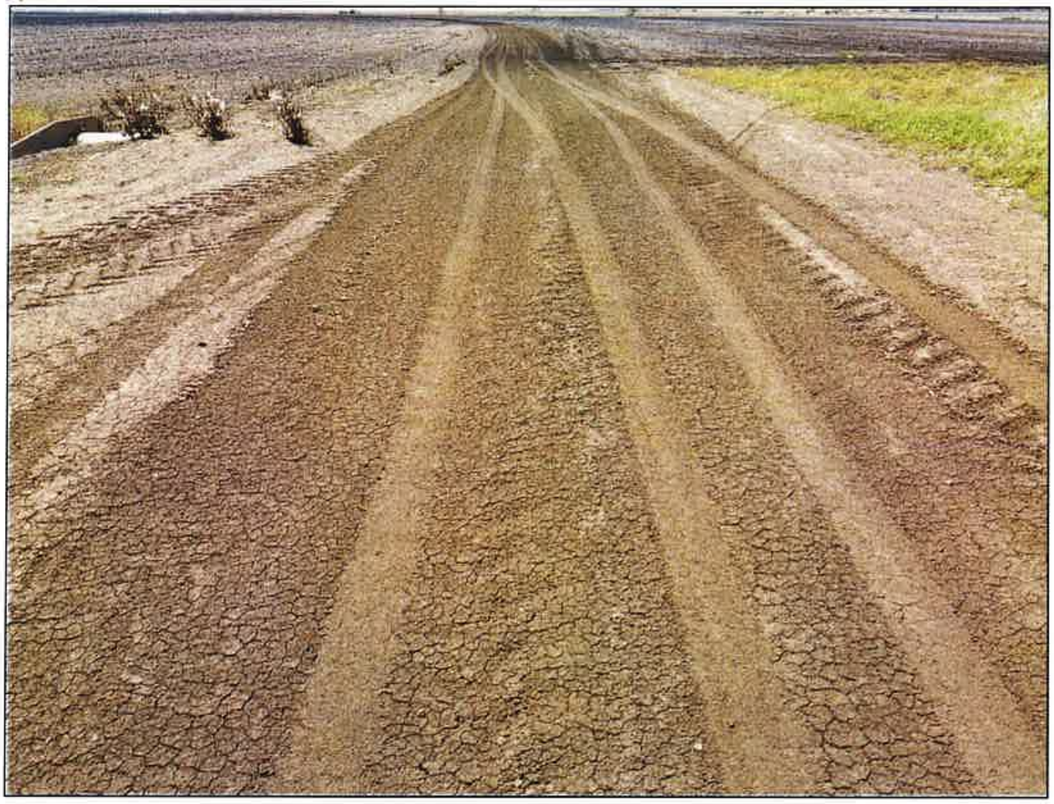

Figure 356 – Tumba Road Culvert Single Pipe
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GROUNDWORK plus

Resources, Environment, Land Use Planning

Inland Rail Project: Preliminary Resource Investigation – Tikitere

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Executive Summary

As part of a preliminary resource investigation conducted in central NSW following the proposed Inland Rail route from Narromine to Inglewood, preliminary drilling and field mapping has identified key sites hosting modest sized resources of commercial interest. These resources include basalt, such as that occurring on the property known as "Tikitere", approximately 10km south east of the town of North Star. The total resources available at Tikitere are shown below in **Table 1- Inferred Resources**.

Table 1 – Inferred Basalt Resources - Tikitere

Area	Basalt Volume (m^3) (*in situ*)	Comments and calculation constraints
Tikitere West	340,000	Based on drilling data and local LIDAR derived topographic data. Constrained to conceptual pit design. Subject to proposed Development Application by landowner.
Tikitere East	1,737,000	Based on drilling data and local LIDAR derived topographic data. Aerial photograph interpretation used in areas of no drilling.
Total	**2,077,000**	

Key Findings

- **Tikitere Site**
    - The site consists of a significant high-quality basalt resource which forms a prominent hill (Tikitere West) and east west trending ridge line (Tikitere East). The basalt forming the hill at Tikitere West has previously been drilled to a depth of 29m without hitting basement and is interpreted as being a localised volcanic vent of limited horizontal extent (200m x 80m). The ridge line of Tikitere East is interpreted to be a remnant basalt flow averaging 5-6m thick and extending for about 1,600m long by 150m wide.
    - The low elevations, resource distributions, weathering profile and confining topography of the Tikitere East Resource is well suited to simple lateral quarrying progressions effectively slicing the targeted elevated resource from the surrounding agricultural plains. The Tikitere West Resource will need to be to be mined using conventional benching techniques to access the resource at depth.
    - A modest amount of further resources could be better defined to the east where outcrop of basalt has been identified but remains untested by drilling.

Key Recommendations

- It is recommended to collect a bulk sample from Tikitere East for materials testing to confirm preliminary geological observations. Whilst the risk of geological non-compliance is considered low in the target material, completing this work would confirm the suitability of the material for the production of specification materials.

1. Introduction

Groundwork Plus was commissioned by Quarry Solutions to conduct a collaborative investigation to gather sufficient information to recommend key sites of interest to service the material needs of the anticipated Inland Rail Project. Drilling was completed over two days beginning 17th of July 2018 and was jointly supervised by Terry Woods of Quarry Solutions and Troy Lowien of Groundwork Plus. A total of forty (40) percussion drill holes were completed over the site by an air track top hammer rig during this time with samples retrieved at each site for further analysis and digitisation into logs. Brief reconnaissance style geological mapping of the site was also completed to inform hole locations and confirm the broad nature and distribution of the rock types on site.

Plate 1 – Atlas Copco (Epiroc) T35 tophammer rig drilling on Tikitere East ridge line. Thin veneer of residual basaltic soil and basalt cobbles can be seen pushed up in foreground.

2. Key Site Details

Locations:	**Tikitere Site** – Lot5 DP755984. Situated 13km south of North Star on Croppa Creek Road.
Land Use:	The site is currently used for agricultural activities.
Landform:	Hilly rise and ridge line to 330m AHD surrounded by gently undulating agricultural plains
Site Geology:	Volcanic plug (basaltic) and residual basalt flow overlying sandstone to argillite sedimentary rock.
Vegetation:	Patches of remnant vegetation on hills.

3. Investigations

The results of this report relate to a recent investigative drilling conducted in central NSW with the object to identify potential quarry resources and nominate sites to service the anticipated Inland Rail Project. The Inland Rail Project requires a broad range of quarry materials including significant fill, pavement, sealing and ballast products to be sourced along the breadth of the proposed line which is not yet finalised. Accordingly, sites were chosen following a desktop review conducted by Groundwork Plus in consultation with Quarry Solutions and accessed opportunistically with the permission and co-operation of the land owner. Final determination of the site, subsequent drill hole locations and resource sampling and logging was conducted by a suitably qualified geologist (Troy Lowien – Groundwork Plus) and overseen from an operational perspective by a representative of Quarry Solutions (Terry Woods).

Investigation of the **Tikitere Site** was conducted over an isolated hill rising 20m above the surrounding plain (Tikitere West) and an adjacent 1.6km long ridge line (Tikitere East). Both sites show surficial distinctly to slightly weathered basalt cobbles but little outcrop available to mark geological contacts. Previous investigations were carried out on the hill at Tikitere West in 2017 to support a Development Application by the land owner for a quarry at the site. This investigation involved drilling of three (3) cored and twelve (12) percussion holes to depths of up to 30m.

Recent investigative drilling consisted of forty (40) percussion holes in total comprising fifteen (15) on the hill at Tikitere West and twenty five (25) percussion holes along the ridge line of Tikitere East. Material was retrieved at one (1) metre intervals to be stored in chip trays for later logging. All drill collars were surveyed using a hand-held GPS unit, including the collars of holes drilled in 2017 to confirm their locations, refer **Figure 1 - DRILLHOLE LOCATION.**

Reconnaissance geological mapping was also carried out to confirm the rock types and extents of the geological units on site.

The results of the investigation are discussed in Section 4 and the percussion drill-hole logs are attached in **APPENDIX 1 – PERCUSSION DRILL HOLE PHOTOGRAPHS AND LOGS**.

Figure 1 – Drillhole Location Plan (see Figure 3 for Tikitere West detail)

4. Results of Investigations

The resource estimates are based on the results of the very preliminary site inspections possible combined with the information returned from all percussion drill-holes completed in this and previous investigations. The material encountered was geologically logged pursuant to Australian Standard AS1726-1993: Geotechnical Site Investigations. Estimated material strength, degree of weathering, degree of alteration, rock structure, foliation intensity, and general rock type were recorded. The percussion drill-hole logs are attached in **APPENDIX 1 – PERCUSSION DRILL HOLE PHOTOGRAPHS AND LOGS**.

The details of the drilling are listed below:

Contractor: Ron Sothern Drilling
Holes Drilled: 40 Percussion Holes (TR01 to TR40)
Total Meters Drilled: 225m
Drill Hole Inclination: Linear holes drilled at -90°
Drilling Date: July 2018
Hole Size: 89mm
Drilling Style: Top hole hammer

In general the drilling conditions encountered across the site were good. Drill penetration rates were recorded and varied across the site, however, averaged approximate 0.6 m/min. This suggests that the target rock has high potential for use as high quality quarried products.

4.1 Results

The geology of the site is dominated by remnant basaltic flows which overlie older sedimentary rocks (sandstone, siltstone) and minor low-grade metamorphic rocks (meta-sandstone), refer **Figure 2 – Site Geology**.

Tikitere West.

The basalt at TIkitere West forms a prominent hill, approximately 200m long by 80m wide, which rises to about 20m above the surrounding plain. Previous drilling concentrated on the central area of the hill, with some holes being drilled up to a depth of 29m without intersecting the underlying sandstone. Recent drilling was focussed on delineating the peripheral extents of the basalt and revealed a steeply dipping contact with the sandstone, dipping towards the centre of the hill, which intersects the ground surface just above the toe of the hill, refer **Figure 3 - Tikitere West Geology**. Measurements of columnar jointing orientations in a small cutting on the north west side of the hill (**Plate 2**) support the inference of a steeply dipping contact. This basalt hill has been interpreted to be a small, localised magmatic vent, which is also supported by the occurrence of a basaltic pumice breccia at the southern end of the hill (**Plate 3**).

Figure 2 – Site Geology

Figure 3 – Tikitere West - Geology Plan (top) and Cross Section (bottom).

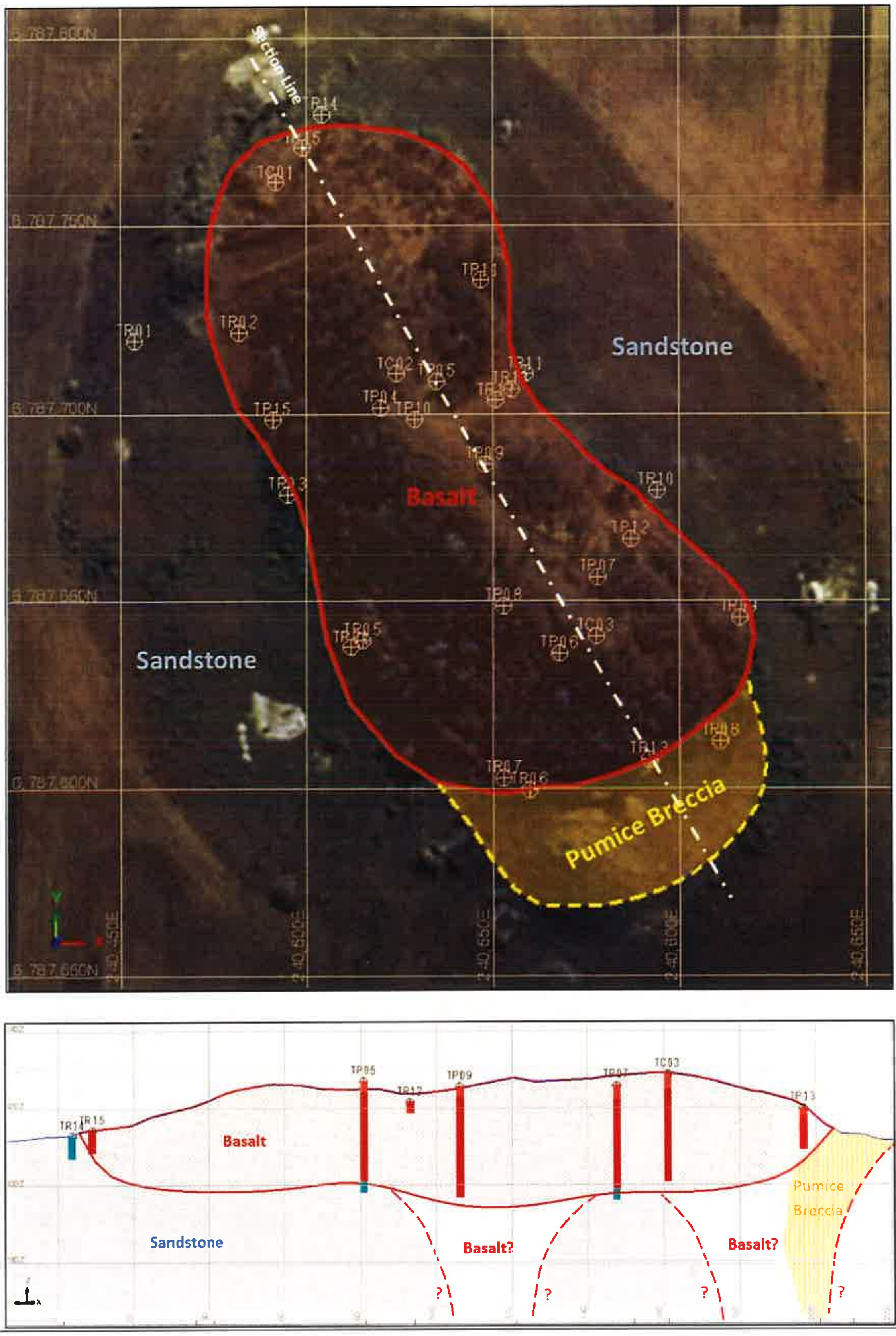


Plate 2 – Cutting on north-west side of Tikitere West hill showing orientation of columnar jointing.

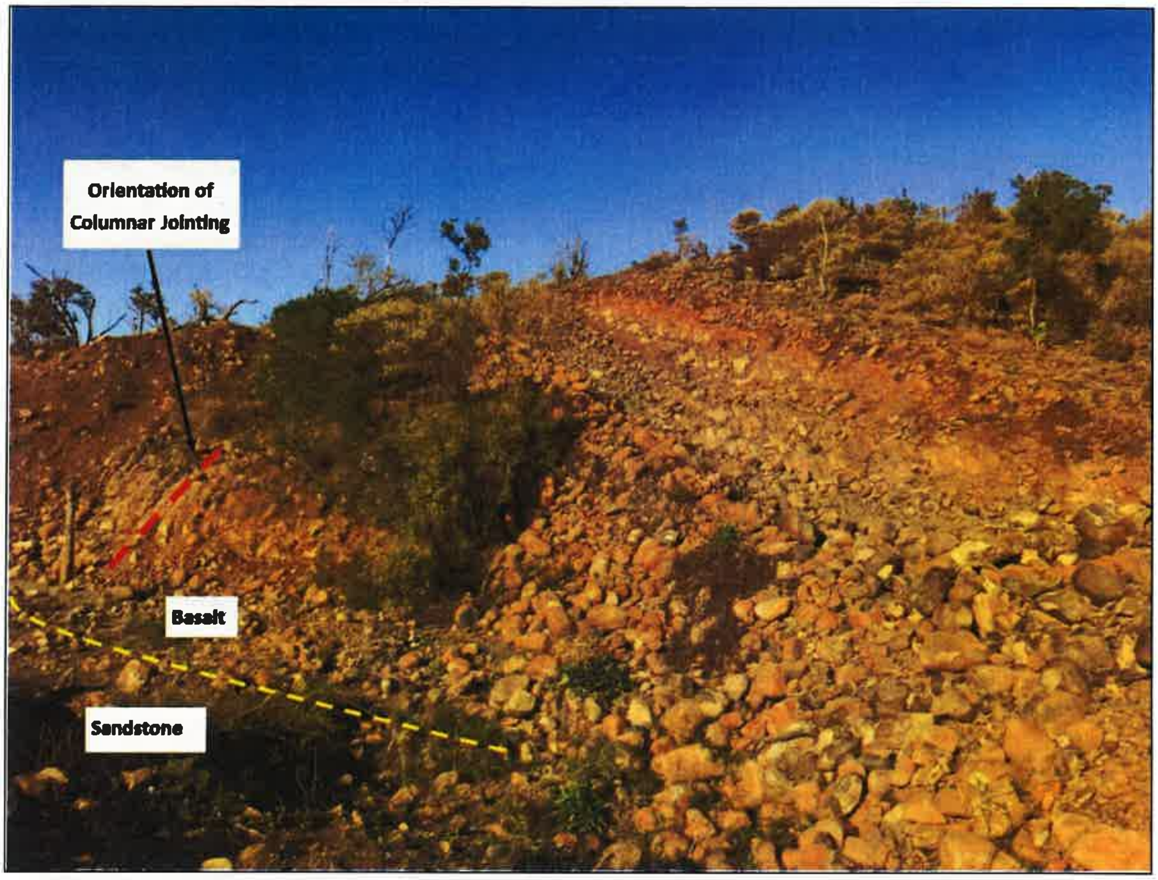


Plate 3 – (Top) Outcrop of pumice breccia on southern margin of Tikitere West hill. (Bottom) Close up of pumice breccia.

The residual soil and overburden are thin (<0.5 m) to non-existent across the hill, with good quality basalt intersected close to surface and continuing to the contact with the sandstone.

The basalt is consistent, sparsely vesicular with no observable amygdule or significant hosted smectite-chlorite segregations. As such it is predicted to produce a broad range of quarry products including fill, pavements, sealing and asphalt aggregate and ballast.

Tests carried out on samples from the previous investigation indicate the basalt meets and exceeds specifications for rail ballast as required by the ARTC **(refer Table 2).**

Table 2– Laboratory Test Results (after Greenham 2017)

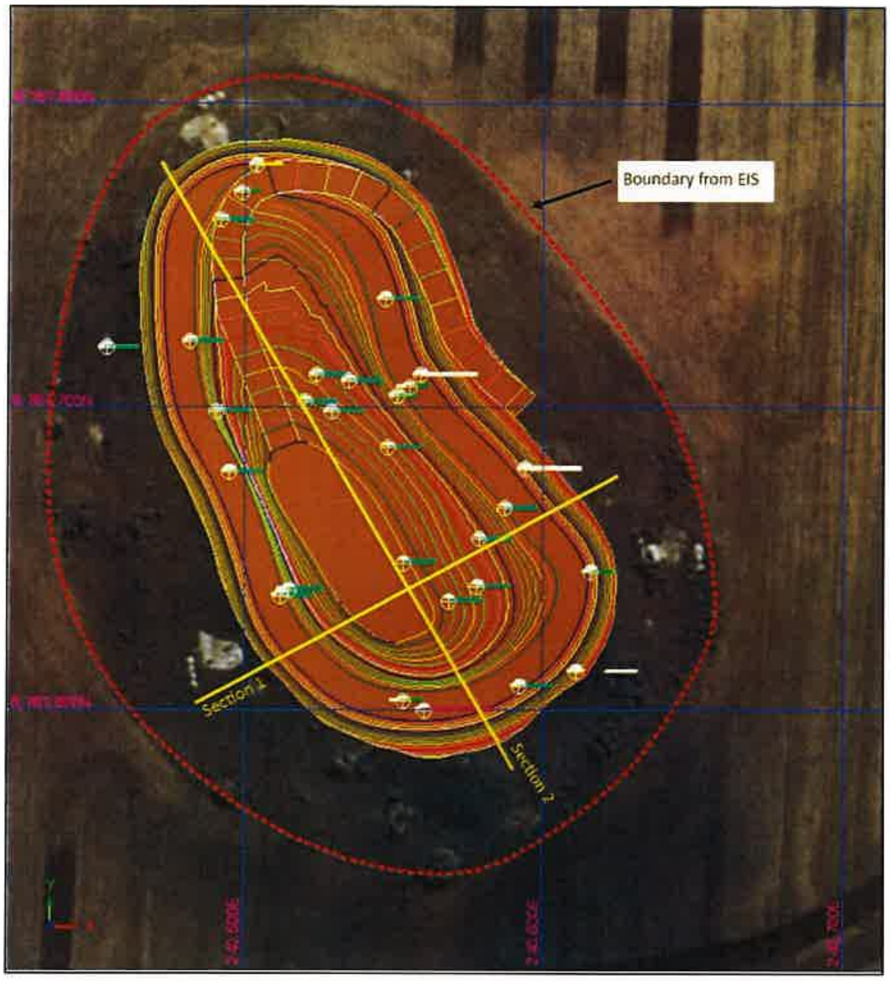
Laboratory Test	ARTC – ETA – 04-01 Ballast Specification	Sample 1	Sample 2	Sample 3
Bulk Density (kg/m3)	**min 1200**	2800	2880	2900
Particle Density (kg/m3)	**min 2500**	2800	2830	2840
Aggregate Crushing Value	**max 25%**	16.7	8.2	8.6
Wet Attrition Value	**max 6%**	2.7	2.5	3.3
LA Values	**max 25%**	12	11	13
Weak Particles	**max 5%**	0.1	0.1	0.2
Particle Density (SSD) (t/m3)	**>1.2 t/m3**	2.83	2.83	2.84
Water Absorption (%)		0.7	0.7	0.7
Wet Strength (13.2 -9.5mm) (kN)	**>175 kN**	221	239	357
Dry Strength (13.2-9.5mm) (kN)		246	265	372
Wet/Dry Strength Variation (13.2-9.5mm) (%)	**<25%**	10	10	4
Degradation Factor		84	84	
UCS kPa		230	337	268
Mill Abrasion Value		4.8	4	
Mill Abrasion Number		36	31	

The base of the basalt was modelled in 3D using geological modelling software with the basal contact being projected no more than 10m below the end of drill holes which finished in basalt. A conceptual pit design was created that enables full extraction of the modelled resource (**Figures 4 and 5**). The pit was designed using batter angles of 45° and 75° in the sandstone and basalt respectively, and maximum bench height of 15m. Volumes of Sandstone and basalt within the pit design are shown in **Table 3**.

Table 3 - Tikitere West Conceptual Pit Volumes

Material	**Volume (m^3)**
Basalt	340,000
Sandstone	55,000
Total	**395,000**

Figure 4 – Tikitere West - Plan and oblique views of drill holes and conceptual pit design.



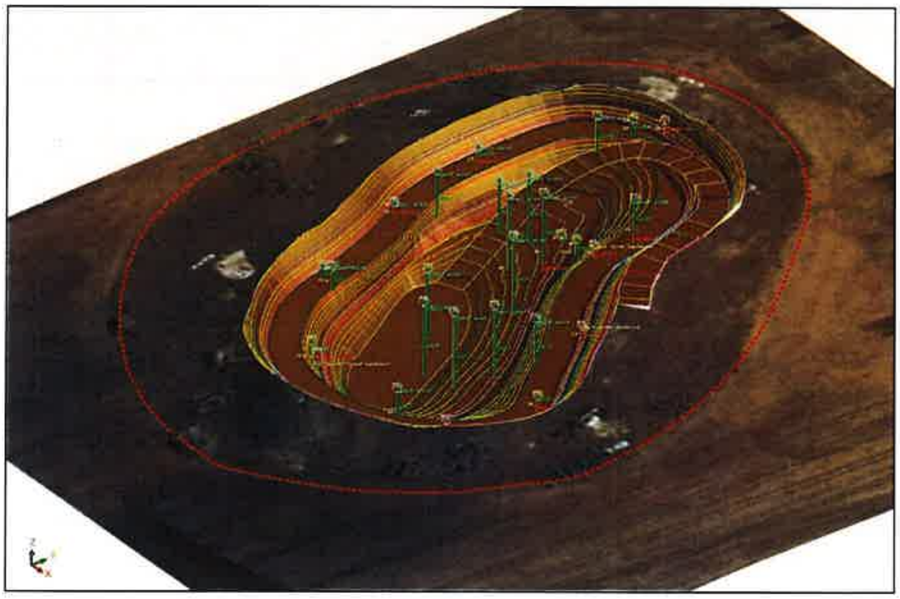
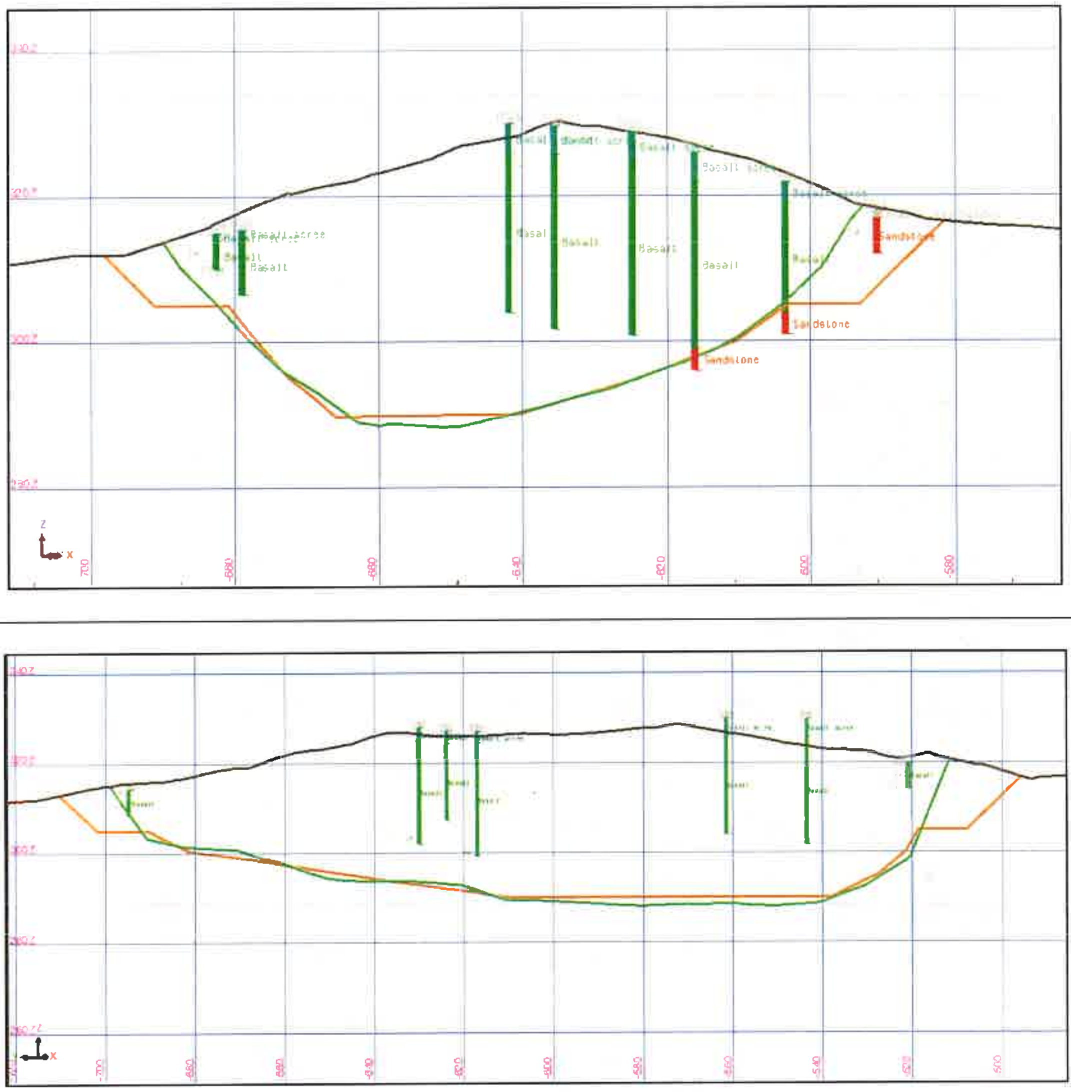


Figure 5 – Tikitere West – Section 1 (top) and Section 2 (bottom) showing base of basalt (green) and pit design (orange)



Tikitere East.

The basalt at TIkitere East forms an east-south-east trending ridge line, approximately 1,600m long by 150m wide, which rises to about 10m above the surrounding plain. Another smaller, north-east trending ridge line lies further to the east, approximately 480m long by 80m wide, which was not tested by drilling in this investigation (**refer Figure 2**). An area of low grade metamorphosed sandstone occurs adjacent to the smaller basalt ridge. This meta-sandstone is very hard and resistant to weathering and forms a localised rise.

This investigation was focussed on drilling along the axis of the main ridge line to test the depth to the contact with the underlying sandstone, with some holes drilled on the edges of the ridge line to determine contact morphology. Holes were also stepped out into the surrounding plain to test for basalt occurring below cover / residual soils.

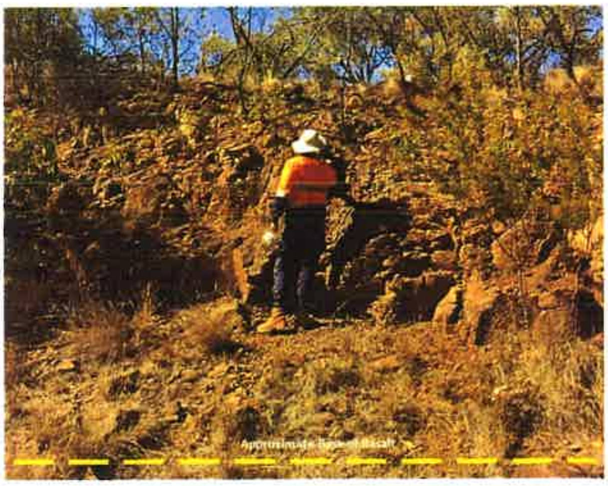
Drilling encountered reasonably consistent basalt thickness along the ridge line, with some holes showing up to 8m of basalt (**Plate 4**). Average thickness of basalt is around 7m for the western ridge line and 5m for the central ridge line. Although it wasn't drilled, it is estimated the basalt of the eastern ridge is also around 5m average thickness.

Plate 4 – Rock Chips from TR18 drilled on western basalt ridge. Shows 8m of slightly to distinctly weathered basalt followed by 2m of sandstone. Top of hole on left.

A small 50m by 50m area of the central basalt ridge has been excavated by the landowner and serves as a window into the shape and form of the basalt-sandstone contact. The contact can be traced around the periphery of the pit and forms a relatively planar feature (**Plate 5**).

The quality of the basalt on the ridges appears to be slightly less than that of Tikitere West. Likely because flows are less massive than vents and are more susceptible to weathering processes. There is more abundant ferruginous staining on joint surfaces logged in the rock chips, and drilling penetration was marginally faster. There were also some areas that displayed more intense weathering at the base of the basalt, which can be a common occurrence for mafic lava flows. However, the basalt of the ridge lines is still considered of good quality and should meet the specifications for rail ballast.

Plate 5 – Photos of pit walls in the central basalt ridge.



Modelling of the basalt-sandstone contact based on drilling results and aerial photo interpretation was undertaken and enabled a reasonably accurate estimate of basalt thickness and volume (**refer Figure 6 – Tikitere East Basalt Thickness**). Estimated volumes are shown in **Table 4**, using a 50m buffer zone to the property boundary.

Table 4 - Tikitere East Basalt Volumes

Basalt	**Volume (m^3)**
Western Ridge	1,040,000
Central Ridge	515,000
Eastern Ridge	182,000
Total	**1,737,000**

Figure 6 – Tikitere East - Basalt Thickness

6. Recommendations

While data suggests that the quality of the basalt resource is high at the Tikitere West site, it is recommended to collect a bulk sample from Tikitere East for materials testing to confirm preliminary geological observations. Whilst the risk of geological non-compliance is considered low in the target material, completing this work would confirm the suitability of the material for the production of material complying with ARTC specifications.

7. References

Grennham, H. 2017 – Environmental Impact Statement – Tikitere Quarry. Report no 17-146 SMK Consultants.

8. Important Information

Your attention is drawn to the document – 'Important Information about your Report'. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be and to present you with recommendations on how to minimise the risks associated with the geotechnical criteria for this project. The document is not intended to reduce the level of responsibility accepted by Groundwork Plus, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing. We would be pleased to answer any questions about this important information from the reader of this report. Further information on **UNDERSTANDING YOUR REPORT** is presented in **APPENDIX 2**.

appendices

Appendix 1

PERCUSSION DRILL HOLE PHOTOGRAPHS AND LOGS

GROUNDWORK plus
ABN 13 664 427 791 5 Maynview Street, Milton, Qld 4064 Ph: 07 3871 0411 Fax: 07 3871 0021

Client: Quarry Solutions
Drill Type: Percussion
Project: Narrabri to Inglewood
Date: 17 July 2018
Logged by: Troy Lowien
Job: 2033_220

Hole Numbers:

TR01

0.0 - 1.0m
Slightly weathered basaltic scree and soil.

1.0 - 2.0m
Distinctly weathered ferruginous fine grained quartzose sandstone.

2.0 - 3.0m
Distinctly weathered fine grained quartzose sandstone.

TR02

0.0 - 1.0m
Slightly weathered basaltic scree and soil.

1.0 - 3.0m
Slightly weathered basalt. Ferruginous staining.

3.0 - 4.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

4.0 - 6.0m
Distinctly weathered ferruginous fine grained quartzose sandstone.

TR03

0.0 - 2.0m
Slightly weathered basaltic scree and soil.

2.0 - 5.0m
Distinctly weathered fine grained quartzose sandstone.

TR04

0.0 - 1.0m
Slightly weathered basaltic scree and soil.

1.0 - 5.0m
Slightly weathered basalt. Ferruginous staining.

TR05

0.0 - 1.0m
Slightly weathered basaltic scree and soil.

1.0 - 2.0m
Slightly weathered basalt with ferruginous staining.

2.0 - 9.0m
Slightly weathered to fresh basalt with ferruginous staining. Higher strength.

TR06

0.0 - 3.0m
Distinctly weathered basaltic scoria breccia.

3.0 - 5.0m
Distinctly weathered basaltic scoria breccia with sandstone.

GROUNDWORK plus
ABN 13 604 422 791 6 Mayneview Street Milton, Qld 4064 Ph 07 3871 0411 Fax 07 3871 0021

Client: Quarry Solutions
Drill Type: Percussion
Project: Narrabri to Inglewood
Date: 17 July 2018
Logged by: Troy Lowien
Job: 2033_220

Hole Numbers:

TR07

E.O.H
6.0m

0.0 - 1.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining

1.0 - 5.0m
Slightly weathered basalt. Ferruginous staining.

5.0 - 6.0m
Slightly weathered to fresh basalt with ferruginous staining. Higher strength.

TR08

E.O.H
6.0m

0.0 - 1.0m
Slightly weathered basalt scree and distinctly weathered basaltic scoria breccia with sandstone.

1.0 - 6.0m
Distinctly weathered basaltic scoria breccia with sandstone.

TR09

E.O.H
6.0m

0.0 - 2.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

2.0 - 6.0m
Distinctly weathered fine grained quartzose sandstone

TR10

E.O.H
6.0m

0.0 - 1.0m
Distinctly weathered ferruginous fine grained quartzose sandstone with minor basalt scree.

1.0 - 6.0m
Distinctly weathered ferruginous fine grained quartzose sandstone.

TR11

E.O.H
5.0m

0.0 - 1.0m
Distinctly weathered ferruginous fine grained quartzose sandstone with minor basalt scree.

1.0 - 5.0m
Distinctly weathered ferruginous fine grained quartzose sandstone.

TR12

E.O.H
3.0m

0.0 - 3.0m
Slightly weathered basalt. Ferruginous staining.

CHIP TRAY PHOTOGRAPHY

Client: Quarry Solutions
Drill Type: Percussion
Project: Narrabri to Inglewood
Date: 17 July 2018
Logged by: Troy Lowien
Job: 2033_220

GROUNDWORK plus
ABN 13 509 422 731 6 Mayneview Street Milton Qld 4064 Ph: 07 3871 0411 Fax: 07 3871 0021

Hole Numbers:

TR13

E.O.H
6.0m

0.0 - 3.0m
Slightly weathered basalt. Ferruginous staining.

3.0 - 6.0m
Slightly weathered to fresh basalt with ferruginous staining. Higher strength.

TR14

E.O.H
6.0m

0.0 - 2.0m
Distinctly weathered ferruginous fine grained quartzose sandstone with minor basalt scree.

2.0 - 6.0m
Distinctly weathered ferruginous fine grained quartzose sandstone.

TR15

E.O.H
6.0m

0.0 - 1.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

1.0 - 6.0m
Slightly weathered basalt. Ferruginous staining.

TR16

E.O.H
5.0m

0.0 - 1.0m
Slightly weathered basaltic scree and soil.

1.0 - 5.0m
Slightly weathered basalt. Ferruginous staining.

TR17

E.O.H
6.5m

0.0 - 1.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

1.0 - 6.0m
Slightly weathered basalt. Ferruginous staining.

6.0 - 6.5m
Extremely weathered fine grained quartzose sandstone.

TR18

E.O.H
10.0m

0.0 - 2.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

2.0 - 3.0m
Slightly weathered basalt. Ferruginous staining.

3.0 - 7.0m
Slightly to distinctly weathered basalt. Lower strength. Ferruginous staining.

7.0 - 8.0m
Distinctly to extremely weathered basalt.

8.0 - 10.0m
Distinctly to extremely weathered fine grained quartzose sandstone.

Client: Quarry Solutions
Drill Type: Percussion
Project: Narrabri to Inglewood
Date: 17 July 2016
Logged by: Troy Lowien
Job: 2033_220

Hole Numbers:

TR19

0.0 - 2.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining

2.0 - 5.0m
Slightly weathered basalt. Ferruginous staining.

5.0 - 6.0m
Distinctly weathered fine grained quartzose sandstone

TR20

0.0 - 2.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

2.0 - 6.0m
Slightly weathered basalt. Ferruginous staining.

TR21

0.0 - 2.0m
Slightly weathered to fresh basalt with ferruginous staining. Higher strength.

2.0 - 4.0m
Slightly weathered basalt. Ferruginous staining.

4.0 - 8.5m
Slightly weathered to fresh basalt with ferruginous staining. Higher strength.

8.5 - 9.0m
Extremely weathered ferruginous fine grained quartzose sandstone

TR22

0.0 - 3.5m
Distinctly weathered basalt. Lower strength. Ferruginous staining

3.5 - 6.0m
Extremely weathered fine grained quartzose sandstone.

TR23

0.0 - 1.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

1.0 - 6.0m
Slightly weathered basalt. Ferruginous staining.

TR24

0.0 - 2.0m
Slightly weathered basalt. Ferruginous staining.

2.0 - 6.5m
Slightly to distinctly weathered basalt. Ferruginous staining. Lower strength.

6.5 - 8.0m
Distinctly weathered fine grained quartzose sandstone.

GROUNDWORK plus
ABN 13 609 422 791 5 Mayneview Street Milton Qld 4064 Ph 07 3871 0411 Fax 07 3871 0021

CHIP TRAY PHOTOGRAPHY

Client: Quarry Solutions
Drill Type: Percussion
Project: Narrabri to Inglewood
Date: 17 July 2018
Logged by: Troy Lowien
Job: 2033_220

Hole Numbers:

TR25

E.O.H 6.0m

0.0 - 1.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

1.0 - 5.0m
Slightly weathered basalt. Ferruginous staining.

5.0 - 6.0m
Slightly to distinctly weathered basalt. Ferruginous staining. Lower strength.

TR26

E.O.H 6.0m

0.0 - 0.5m
Residual basaltic soil.

0.5 - 1.0m
Extremely weathered basalt.

1.0 - 6.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

TR27

E.O.H 5.0m

0.0 - 0.5m
Residual basaltic soil.

0.5 - 3.0m
Distinctly weathered fine grained quartzose sandstone and meta sandstone.

3.0 - 5.0m
Distinctly weathered fine grained quartzose sandstone.

TR28

E.O.H 4.0m

0.0 - 4.0m
Distinctly weathered slightly ferruginous fine grained quartzose sandstone.

TR29

E.O.H 4.0m

0.0 - 1.5m
Residual soil.

1.5 - 4.0m
Extremely weathered fine grained quartzose sandstone and soil.

TR30

E.O.H 5.0m

0.0 - 0.5m
Residual soil.

0.5 - 5.0m
Extremely weathered fine grained quartzose sandstone and soil.

GROUNDWORK plus

Client: Quarry Solutions

Drill Type: Percussion

Project: Narrabri to Inglewood

Date: 17 July 2018

Logged by: Troy Lowien

Job: 2033_220

Hole Numbers:

TR31

E.O.H
6.0m

0.0 - 1.5m
Residual soil.

1.5 - 6.0m
Extremely weathered fine grained quartzose sandstone and soil.

TR32

E.O.H
6.0m

0.0 - 1.5m
Residual soil.

1.0 - 6.0m
Extremely weathered ferruginous fine grained quartzose sandstone.

TR33

E.O.H
4.0m

0.0 - 4.0m
Extremely weathered ferruginous fine grained quartzose sandstone.

TR34

E.O.H
6.0m

0.0 - 1.0m
Extremely weathered basalt.

1.0 - 3.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

3.0 - 6.0m
Slightly weathered basalt. Ferruginous staining.

TR35

E.O.H
9.0m

0.0 - 5.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

5.0 - 7.5m
Slightly weathered basalt. Ferruginous staining.

7.5 - 9.0m
Extremely weathered fine grained quartzose sandstone.

TR36

E.O.H
7.0m

0.0 - 1.0m
Extremely weathered basalt.

1.0 - 3.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

3.0 - 5.5m
Slightly weathered basalt. Ferruginous staining.

5.5 - 7.0m
Extremely weathered ferruginous fine grained quartzose sandstone.

Client: Quarry Solutions | **Drill Type**: Percussion
Project: Narrabri to Inglewood | **Date**: 17 July 2018 | **Logged by**: Troy Lowien
Job: 2033_220

Hole Numbers:

TR37

E.O.H
6.0m

0.0 - 1.0m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

1.0 - 2.0m
Slightly weathered basalt. Ferruginous staining.

2.0 - 3.5m
Distinctly weathered basalt. Lower strength. Ferruginous staining.

3.5 - 6.0m
Distinctly weathered slightly ferruginous fine grained quartzose sandstone and minor chert.

TR38

E.O.H
3.0m

0.0 - 0.5m
Extremely weathered basaltic scree.

0.5 - 3.0m
Extremely weathered fine grained quartzose sandstone.

TR39

E.O.H
1.0m

0.0 - 0.5m
Residual soil.

0.5 - 1.0m
Extremely weathered fine grained quartzose sandstone.

TR40

E.O.H
3.0m

0.0 - 1.0m
Residual soil.

1.0 - 3.0m
Extremely weathered ferruginous fine grained quartzose sandstone.

Appendix 2

UNDERSTANDING YOUR REPORT

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL REPORT

These notes have been collated by Groundwork Plus. They are designed to help you in the interpretation of your Report.

Geological studies are commissioned to gain information about environmental conditions on and beneath the surface of a site. The more comprehensive the study, the more reliable the assessment is likely to be, but remember, any such assessment is to a greater or lesser extent based on professional opinions about conditions that cannot be seen or tested. Accordingly, no matter how much data is accumulated, risks created by unanticipated conditions will always remain. Work with your geological consultant to manage known and unknown risks. Part of that process should already have been accomplished, through the risk allocation provisions you and your geological professional discussed and included in your contract's general terms and conditions. This document is intended to explain some of the concepts that may be included in your agreement and to pass along information and suggestions to help you manage your risk.

Beware Of Change; Keep Your Geological Professional Advised

The design of a geological study considers a variety of factors that are subject to change. Changes can undermine the applicability of a reports findings, conclusions, and recommendations. Advise your geological professional about any changes as you become aware of them. Geological professionals cannot accept responsibility or liability for problems that occur because a report fails to consider conditions that did not exist when the study was designed. Ask your geological professional about the types of changes you should be particularly alert to. Some of the most common include:

- modification of the proposed development or ownership group;
- sale or other property transfer;
- replacement of or additions to the financing entity;
- amendment of existing regulations or introduction of new ones; or
- changes in the use or condition of adjacent property.

Should you become aware of any change, do not rely on an existing geological report. Advise your geological professional immediately; follow the professional's advice.

Prepare To Deal with Unanticipated Conditions

The findings, recommendations, and conclusions of a report typically are based on a review of historical information, interviews, a site 'walkover' and other forms of non-invasive research. When site subsurface conditions are not sampled in any way, the risk of unanticipated conditions is higher than it would otherwise be.

While borings, installation of monitoring wells, and similar invasive test methods can help reduce the risk of unanticipated conditions, do not overvalue the effectiveness of testing. Testing provides information about actual conditions only at the precise locations where samples are taken and only when they are taken. Your geological professional has applied that specific information to develop a general opinion about environmental conditions. Actual conditions in areas not sampled may differ (sometimes sharply) from those predicted in a report. For example, a site may contain an unregistered underground storage tank that shows no surface trace of its existence. Even conditions in areas that were tested can change, sometimes suddenly, due to any number of events, not the least of which include occurrences at adjacent sites. Recognize too, that even some conditions in tested areas may go undiscovered, because the tests or analytical methods used were designed to detect only those conditions assumed to exist.

Manage your risks by retaining your geological professional to work with you as the project proceeds. Establish a contingency fund or other means to enable your geological professional to respond rapidly, in order to limit the impact of unforeseen conditions. To help prevent any misunderstanding, identify those empowered to authorize changes and the administrative procedures that should be followed.

Do Not Permit Any Other Party to Rely On The Report

Geological professionals design their studies and prepare their reports to meet the specific needs of the clients who retain them, in light of the risk management methods that the client and geological professionals agree to, and the statutory, regulatory, or other requirements that apply. The study designed for a developer may differ sharply from one designed for a lender, insurer, public agency or even another developer. Unless the report specifically states otherwise, it was developed for you and only you. Do not unilaterally permit any other party to rely on it. The report and the study underlying it may not be adequate for another party's needs and you could be held liable, for shortcomings your geological professional was powerless to prevent or anticipate. Inform your geological professional when you know or expect that someone else - a third-party will want to use or rely on the report. Do not permit third-party use or reliance until you first confer with the Geological professional who prepared the report. Additional testing, analysis, or study may be required and in any event, appropriate terms and conditions should be agreed to so both you and your geological professional are protected from third-party risks. Any party who relies on a geological report without the express written permission of the professional who prepared it and the client for whom it was prepared may be solely liable for any problems that arise.

Avoid Misinterpretation of the Report

Design professionals and other parties may want to rely on the report in developing plans and specifications. They need to be advised, in writing, that their needs may not have been considered when the study's scope was developed and even if their needs were considered, they might misinterpret geological findings, conclusions, and recommendations. Commission your geological professional to explain pertinent elements of the report to others who are permitted to rely on it and to review any plans, specifications or other instruments of professional service that incorporate any of the report's findings, conclusions, or recommendations. Your geological professional has the best understanding of the issues involved, including the fundamental assumptions that determined the study's scope.

Give Contractors Access to the Report

Reduce the risk of delays, claims, and disputes by giving contractors access to the full report, providing that it is accompanied by a letter of transmittal that can protect you by making it unquestionably clear that: I) the study was not conducted and the report was not prepared for purposes of bid development and 2) the findings, conclusions and recommendations included in the report are based on a variety of opinions, inferences, and assumptions and are subject to interpretation. Use the letter to also advise contractors to consult with your geological professional to obtain clarifications, interpretations, and guidance (a fee may be required for this service) and that-in any event, they should conduct additional studies to obtain the specific type and extent of information each prefers for preparing a bid or cost estimate. Providing access to the full report, with the appropriate caveats, helps prevent formation of adversarial attitudes and claims of concealed or differing conditions. If a contractor elects to ignore the warnings and advice in the letter of transmittal, it would do so at its own risk. Your geological professional should be able to help you prepare an effective letter.

Do Not Separate Documentation from the Report

Geological reports often include supplementary documentation, such as maps and copies of regulatory files, permits, registrations, citations, and correspondence with regulatory agencies. If subsurface explorations were performed, the report may contain final boring logs and copies of laboratory data. If remediation activities occurred on site, the report may include; copies of daily field reports, waste manifests and information about the disturbance of subsurface materials, the type and thickness of any fill placed on site and fill placement practices, among other types of documentation. Do not separate supplementary documentation from the report. Do not permit any other party to redraw or modify any of the supplementary documentation for incorporation into other professionals' instruments of service.

Realize That Recommendations May Not Be Final

The technical recommendations included in a geological report are based on assumptions about actual conditions and so are preliminary or tentative. Final recommendations can be prepared only by observing actual conditions as they are exposed. For that reason, you should retain your geological professional to observe construction and/or remediation activities on site, to permit rapid response to unanticipated conditions. The geological professional who prepared the report cannot assume responsibility or liability for the report's recommendations if that professional is not retained to observe relevant site operations.

Understand That Geotechnical Issues Have Not Been Addressed

Unless geotechnical engineering was specifically included in the scope of professional service, a report is not likely to relate any findings, conclusions, or recommendations about the suitability of subsurface materials for construction purposes, especially when site remediation has been accomplished through the removal, replacement, encapsulation, or chemical treatment of on- site soils. The equipment, techniques, and testing used by geotechnical engineers differ markedly from those used by Geological professionals; their education, training, and experience are also significantly different. If you plan to build on the subject site, but have not yet had a geotechnical engineering study conducted, your Geological professional should be able to provide guidance about the next steps you should take. The same firm may provide the services you need.

Read Responsibility Provisions Closely

Geological studies cannot be exact; they are based on professional judgement and opinion. Nonetheless, some clients, contractors, and others assume geological reports are, or certainly should be, unerringly precise. Such assumptions have created unrealistic expectations that have led to wholly unwarranted claims and disputes. To help prevent such problems, geological professionals have developed a number of report provisions and contract terms that explain who is responsible for what and how risks are to be allocated. Some people mistake these for 'exculpatory clauses', that is, provisions whose purpose is to transfer one party's rightful responsibilities and liabilities to someone else. Read the responsibility provisions included in a report and in the contract you and your Geological professional agreed to.