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MT/bm
Ref: 201135_Dust Analysis Letter_Rev2
10 September 2020

Hodgson Quarries & Plant Pty Ltd
PO Box 1778
GOSFORD NSW 2756

Re: Background data analysis for dust emissions at Roberts Road Sand Quarry, 4405-4467 Old Northern Road, Maroota NSW 2756

Dear Martin,

This summary report provides further information related to dust monitoring undertaken on-site for the Roberts Road Sand Quarry located 4405-4467 Old Northern Road, Maroota NSW 2756 (Lots 1 & 2, DP 228308 and Lot 2, DP 312327).

Analysis and review of dust emission data provided by Hodgson Quarries & Plant Pty Ltd for dust emissions has been undertaken by Benbow Environmental to validate the accuracy of the high volume active sampler (HVAS) monitoring device on site for particulate matter size fractions $PM_{2.5}$ and PM_{10}.

The particle sizes of concern are $PM_{2.5}$ and PM_{10} (<2.5 and <10 microns respectively), as particles of this size are potentially dangerous to human health and the environment. These particles are persistent in the environment and affect both air quality and visibility.

BACKGROUND

During typical daily operation, dust generating activities may take place on site. These include extraction of sandstone from the quarry, loading/unloading materials on site, vehicular movements on unsealed internal roads and windblown dust from disturbed areas and stockpiles. The site employs an existing Air Quality Management Plan (AQMP) which has in place a number of controls to minimise dust generation potential during site activities.

As part of the AQMP, active air monitoring is undertaken to collect on-site emission data and ensure compliance with consent conditions (DA 267-11-99). Air quality monitoring is conducted using a HVAS, located at the office near the entry gate to the site on Roberts Road. The HVAS has been in operation since 2016 and monitor particulates within the $PM_{2.5}$, PM_{10} and TSP (Total Suspended Particulate) size fractions.

The site has recently proposed a modification application to import ENM and VENM (extracted natural materials and virgin extracted natural materials) on site to backfill spent portions of the quarry. The application of ENM and VENM to land has the potential to generate dust

emissions. An Air Quality Impact Assessment (AQIA) has been undertaken by Jacobs (IA206300) in support of the proposed modification and its impacts to local air quality.

The AQIA incorporates background air quality data to calculate the cumulative impacts to air as a result of the proposed site activities. The nearest air quality monitoring station is located in Richmond (approximately 28 km south-west of the site), and so while possibly indicative of background particulate concentrations for the general north-west area, it is not site specific and therefore insufficient for accurately estimating on-site impacts. To assess contributions from existing sources in the surrounding environment, the AQIA includes particulate measurements from other quarries and extractive operatives located near Roberts Road Quarry. Dixon Sand Penrith Pty Ltd (Dixon Sand) operate a tapered element oscillating microbalance (TEOM) at the Maroota Public School just to the southeast of their operations at the Old Northern Road Quarry. Therefore, an on-site HVAS data was used in combination with the Dixon Sand TEOM data to estimate potential impacts to local air quality as a result of the proposed modification.

However, for years 2016-2019, there is significant inconsistency in $PM_{2.5}$ and PM_{10} emissions data obtained from the on-site HVAS; particularly in regard to the ratio between the two size fractions. PM_{10} is particulate matter that is 10 micrometres or less in diameter and $PM_{2.5}$ is particulate matter that is 2.5 micrometres or less in diameter. By definition all $PM_{2.5}$ particulate is within the PM_{10} size fraction and therefor $PM_{2.5}$ must be less than PM_{10}. However unusually high proportions of $PM_{2.5}$ have been measured, in some cases exceeding PM_{10} measurements.

Consent Conditions

As per consent conditions 28 and 29 of DA 267-11-99, air quality (dust) monitoring is to be undertaken on site. Relevant conditions are presented below:

Air Quality Criteria

28. The Applicant shall take all practical steps to manage the development so that the ambient air quality goals for total suspended particles (TSP) of 90 µg/m³ (annual average), particulate matter (PM10) of 50 µg/m³ (24 hours average) and 30 µg/m³ (annual average) and the dust deposition goal of 4mg/m^2 (annual average) are not exceeded as a result of the development, when measured at any monitoring location specified in the Air Quality Management Plan.

Air Quality Management

29. The Applicant shall prepare an Air Quality Management Plan as part of the EMP. The Air Quality Management Plan shall:

(a) identify existing and potential sources of dust deposition, TSP and fine particulates (PM10 and PM2.5) and specify appropriate monitoring intervals and locations. The purpose of the monitoring is to evaluate, assess and report on these emissions and the ambient impacts with the objective of understanding the development's contribution to levels of dust deposition, TSP and fine particulates in ambient air around the site;

(b) provide a monitoring plan having regard to local meteorology and the relevant Australian Standards, identifying the methodologies to be used, including

justification for monitoring intervals, weather conditions, seasonal variations, selecting locations, periods and times of measurements;

(c) *provide details of dust suppression measures for all sources of dust from the development, ... The use of a polymer in the water to minimise dust impacts shall be investigated as part of this Plan;*

(d) *provide details of actions to ameliorate impacts if they exceed the relevant criteria; and*

(e) *provide the design of the reactive management system intended to reduce the day-to-day impacts of dust and fine particulates due to the development.*

Air Quality Criteria

The NSW EPA *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* provides guidance on the thresholds that are to be used in the AQIA for proposed developments. These are displayed below in Table 1.

It should be noted that the NSW EPA threshold limits are for total allowable emissions per 24 hour or annual averaging period; that is, the sum of potential on-site particulate emissions and the background particulate concentrations. Where heightened background particulate concentrations are present, the *Approved Methods* require a demonstration that no additional exceedances of the impact assessment criteria will occur as a result of the proposed site activities. An AQIA has been undertaken by Jacobs (IA206300) for the proposed modification and showed no additional days of exceedance.

Table 1: Relevant NSW EPA Limits for Particulates and Dust Deposition

Pollutant	Averaging Period	Concentration		Source
		µg/m^3		
$PM_{2.5}$	24 Hours	25		DoE (2016)
	Annual	8		DoE (2016)
PM_{10}	24 Hours	50		DoE (2016)
	Annual	25		DoE (2016)
Total Suspended Particulates (TSP)	Annual	90		NHMRC (1996)
		g/m^2/month	**g/m^2/month**	
Deposited Dust	Annual	2	4	NERDDC (1988)

Particle Size Distributions

Particulate distribution sizes in a given medium can vary depending on the material. Dense, coarse materials such as sand, stone or other aggregates will contain a higher concentration of PM_{10} particle sizes when compared to lighter, finer materials, such as cement, which will contain a higher concentration of $PM_{2.5}$.

The subject site and Roberts Road Sand Quarry predominantly produce graded sand, gravel and pebble products for construction projects in the greater Sydney region. Site specific particulate distribution has not been conducted on site, however ratios for $PM_{2.5}/PM_{10}$ distributions of similar dust generating activities used in calculating dust emission rates are referenced below.

- The Midwest Research Institute *Background Document for Revisions to Fine Fraction Ratios Used for AP-42 Fugitive Dust Emissions Factors* (2006) for 'Aggregate Handling and Storage Piles' gives a $PM_{2.5}/PM_{10}$ ratio of **0.15**; and
- US EPA AP-42 *Appendix B.2 Generalized Particle Size Distributions* (1996) data for 'Mechanically Generated Processed Ores and Non-metallic Minerals' gives a $PM_{2.5}/PM_{10}$ ratio of **0.35.**

For the purposes of this analysis, both US EPA ratios of 0.15 and 0.35 $PM_{2.5}/PM_{10}$ have been included in this letter as a comparison to measured levels.

DATA ANALYSIS

NSW Government Air Quality Data

$PM_{2.5}$ and PM_{10} data for 2016-2019 was obtained from NSW Government air quality monitoring stations to cross-reference on site HVAS and Dixon Sand TEOM concentrations. NSW ambient air particulate concentrations were obtained from the closest air quality monitoring stations as well as stations which are in close proximity to other sand quarry operations.

Richmond is the closest monitoring station to the Roberts Road Sand Quarry, approximately 28 km south-west of the site. Rouse Hill and St Marys monitoring stations are similarly close. Sand quarries in closest proximity to their respective monitoring station (Bargo) included Spring Farm Quarry and Nepean Quarries; these quarries are located approximately 4 km and 4.6 km respectively from the referenced station.

Air quality data for $PM_{2.5}$ and PM_{10} was obtained for years 2016-2019 from the following NSW Environment, Energy and Science monitoring stations:

- Bargo
- Camden
- Richmond
- Rouse Hill[1]
- St Marys

Note: [1] Particulate data collection from the Rouse Hill monitoring began in June 2019.

Figure 1 shows the location of the subject site compared to the referenced monitoring stations, as well as similar identified sand quarry operations. Identified quarries near Bargo and Camden monitoring stations included Spring Farm Quarry, Nepean Quarries and Benedict Sands Mittagong. A similar local quarry operation, "Dixon Sand", has also been included. Dixon Sand is approximately 1.5 km north-west of the subject site.

Figure 1: Location of the subject site in respect to the referenced air monitoring stations and identified sand quarry operations

Source: Google Earth 2020

↑N

LEGEND:

- Site Location
- Air Monitoring Station Location
- Quarry Location

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Table 2 displays the annual average $PM_{2.5}$ and PM_{10} data for 2016-2019 at all referenced monitoring stations. Emboldened, red text indicates that results exceed the NSW EPA annual limits for particulate matter.

Table 2: Annual Average Particulate Concentrations at Referenced Monitoring Stations (2016-2019)

Year	Monitoring Station Pollutant Annual Average (µg/m³)											
	$PM_{2.5}$ (NSW EPA limit 8 µg/m³)						PM_{10} (NSW EPA limit 25 µg/m³)					
	Richmond	Bargo	St Marys	Camden	Rouse Hill	Year average	Richmond	Bargo	St Marys	Camden	Rouse Hill	Year average
2016	7.92	7.30	8.13	6.47	-	7.46	15.87	14.23	16.03	14.43	-	15.14
2017	7.13	6.27	6.99	6.73	-	6.78	16.08	13.83	16.18	14.71	-	15.20
2018	**8.11**	6.76	7.66	7.22	-	7.44	18.88	16.92	19.53	17.49	-	18.21
2019	**12.89**	**10.81**	**10.08**	**11.66**	**12.71**	**11.63**	24.27	21.58	24.75	22.33	**27.61**	24.11
Total Average	**9.01**	7.78	8.22	8.02	12.71	**9.15** / **8.33**	18.77	16.64	19.12	17.24	27.61	**19.88** / **18.16**

As can be seen in Table 2, background concentrations of $PM_{2.5}$ have increased in 2019, with background concentrations exceeding the NSW EPA annual criteria for $PM_{2.5}$ emissions (8 µg/m^3) at Richmond for 2018 and all referenced stations for 2019. Additionally, PM_{10} concentrations exceeded the NSW EPA annual criteria for PM_{10} emissions (25 µg/m^3) at Rouse Hill for 2019. Remaining stations PM_{10} emissions may be considered elevated in 2019, spanning 21.58-24.75 µg/m^3.

Table 3 and Table 4 display the $PM_{2.5}$:PM_{10} ratio is also displayed total averages across all sites and total averages across all years.

Table 3: NSW Government Air Quality Monitoring Station results for annual average across all sites $PM_{2.5}$ and PM_{10} emissions (2016-2019)

Year	All sites Pollutant Annual Average (µg/m^3)		
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$:PM_{10} Ratio
2016	7.45	15.14	0.49
2017	6.78	15.20	0.45
2018	7.44	18.21	0.41
2019	11.63	24.11	0.48
Total Average	**8.33**	**18.16**	**0.46**

Table 4: NSW Government Air Quality Monitoring Station results for average site for all years of $PM_{2.5}$ and PM_{10} emissions (2016-2019)

Site	All Years Pollutant Annual Average (µg/m^3)		
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$:PM_{10} Ratio
Richmond	9.01	18.77	0.48
Bargo	7.78	16.64	0.47
St Marys	8.22	19.12	0.43
Camden	8.02	17.24	0.47
Rouse hill	12.71	27.61	0.46
Total Average	**9.15**	**19.88**	**0.46**

For all years (2016-2019) and all sites, the $PM_{2.5}$/ PM_{10} ratio is 0.46 (46%).

On-site HVAS Monitoring Data

On-site HVAS collected data for years 2016-2019 was provided by Hodgson Quarries & Plant Pty Ltd and reviewed by Benbow Environmental.

The HVAS monitors particulates within the $PM_{2.5}$, PM_{10} and TSP size fraction every six (6) days, as per the development consent conditions.

Data within this period was collated and averaged over each respective month. Table 5 displays the results for annual average $PM_{2.5}$ and PM_{10} emissions (2016-2019) obtained by the on-site HVAS. The $PM_{2.5}$:PM_{10} ratio is also displayed.

Table 5: HVAS results for annual average $PM_{2.5}$ and PM_{10} emissions (2016-2019)

Year	Pollutant Annual Average (µg/m³)		
	$PM_{2.5}$	PM_{10}	$PM_{2.5}$:PM_{10} Ratio
2016	13.78	10.32	1.34
2017	11.91	14.88	0.80
2018	11.45	18.31	0.63
2019	26.77	32.13	0.83
Total Average	15.98	18.91	0.85 / 0.90

In 2016 the $PM_{2.5}$:PM_{10} Ratio was 1.34 which by definition is not possible. $PM_{2.5}$:PM_{10} ratios for all years are significantly above the $PM_{2.5}$:PM_{10} ratios from NSW government websites.

Table 6: PM10 HVAS results & PM2.5 NSW Gov Monitoring Stations for annual average (2017-2019)

Year	Pollutant Annual Average (µg/m³)		
	NSW Gov. Monitoring $PM_{2.5}$	HVAS PM_{10}	$PM_{2.5}$:PM_{10} Ratio
	7.45	10.32	0.72
2017	6.78	14.88	0.46
2018	7.44	18.31	0.41
2019	11.63	32.13	0.36
Total Average	8.33	18.91	0.44 / 0.49

In Table 6 is shows that when HVAs PM_{10} and NSW monitoring data for $PM_{2.5}$ are compared, the ratio is as expected and therefor the HVAs PM_{10} is likely accurate.

Dixon Sand TEOM Monitoring Data

The Dixon Sand Quarry has similar operations to the subject site and TEOM monitoring for PM_{10} is conducted at a receiver for that operations. This PM10 data for 2017 was obtained from the Jacobs AQIA and 2018-2019 data was obtained from Dixon Sands website, and is summarised in Table 7. Annual average concentrations of PM_{10} is shown below. It is then compared to $PM_{2.5}$ site emissions from the HVAS site monitoring and also the NSW government monitoring sites.

Table 7: Dixon Sands TEOM results for annual average PM_{10} emissions (2017-2019)

Year	Pollutant Annual Average (µg/m³)
	PM_{10}
2017	13
2018	16
2019	16
Total Average	15

Table 8: PM10 Dixon Sands TEOM PM10 results & PM2.5 Site HVAS for annual average (2017-2019)

Year	Pollutant Annual Average (µg/m^3)		
	HVAS Site $PM_{2.5}$	Dixon Sands TEOM PM_{10}	$PM_{2.5}$:PM_{10} Ratio
2017	12	13	0.92
2018	11	16	0.70
2019	27	16	1.66
Total Average	**17**	**15**	**1.13** / **1.09**

Table 9: PM10 Dixon Sands TEOM PM10 results & PM2.5 NSW Gov Monitoring Stations for annual average (2017-2019)

Year	Pollutant Annual Average (µg/m^3)		
	NSW Gov. Monitoring $PM_{2.5}$	Dixon Sands TEOM PM_{10}	$PM_{2.5}$:PM_{10} Ratio
2017	7	15	0.46
2018	7	18	0.41
2019	12	32	0.36
Total Average	**8**	**21**	**0.38** / **0.41**

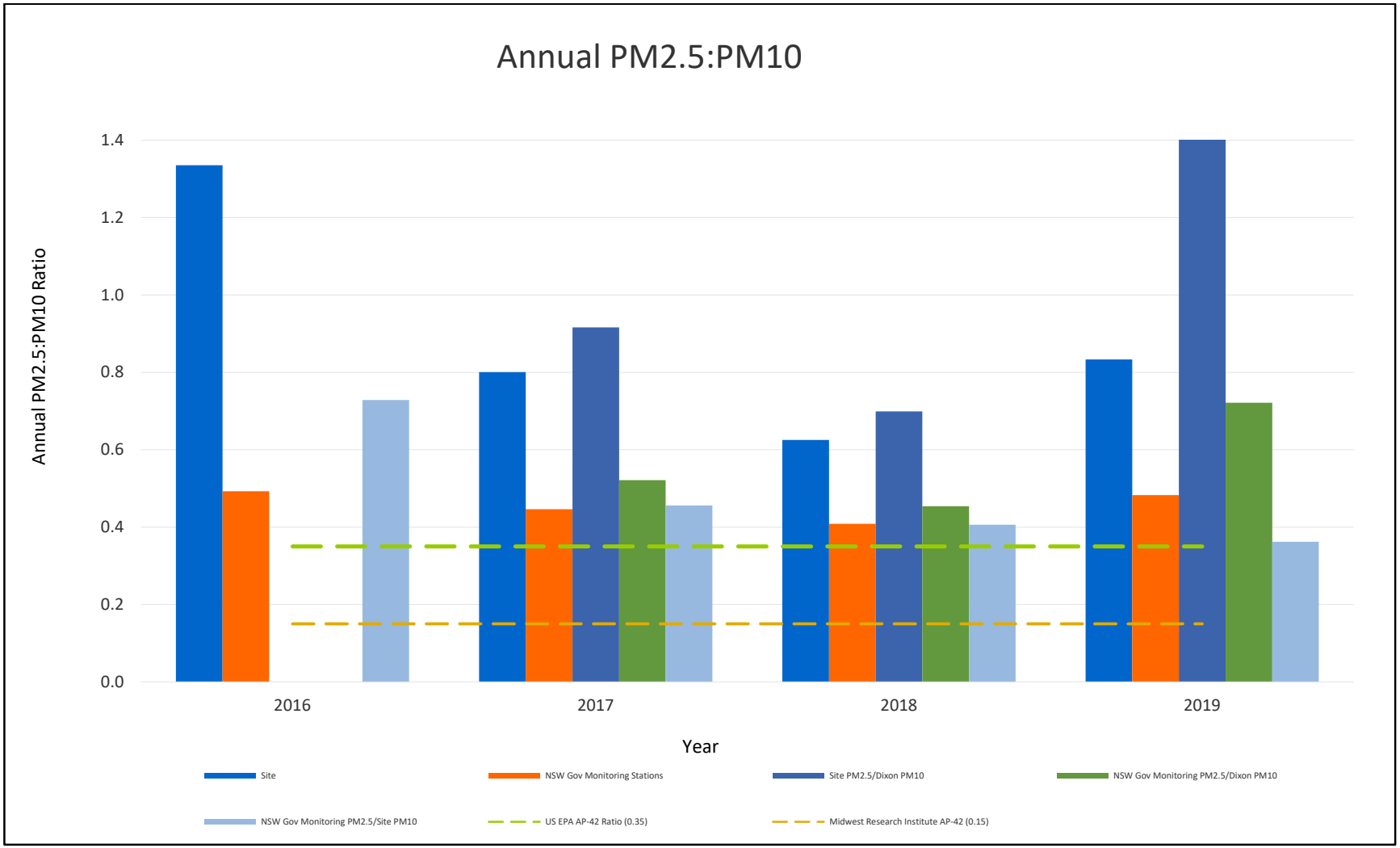
Similar to the HVAS site specific data the ratios of $PM_{2.5}$:PM_{10} , comparing the Site $PM_{2.5}$ levels to the Dixon Sands PM_{10} levels the ratio is highly elevated.

Inconsistencies with On-site Monitoring

Analysis of HVAS site data from 2016-2019 was undertaken by Benbow Environmental to ascertain the validity of the device due to the inconsistencies between site and air monitoring station data.

Figure 2 shows the $PM_{2.5}$:PM_{10} ratio between the referenced monitoring station and site collected data. The US EPA AP-42 'Mechanically Generated Processed Ores and Non-metallic Minerals' ratio of 0.35 $PM_{2.5}$/PM_{10} is displayed for reference.

Figure 2: PM2.5:PM10 ratio between all referenced monitoring stations and site data for 2016-2019



Relationship Between Site and Monitoring Station Data

As displayed in the above tables and graphs, there is a clear inconsistency in particle size fraction ratios between years at the site when compared to referenced monitoring stations. Data from years 2016-2019 at the referenced air monitoring stations had an average the $PM_{2.5}$:PM_{10} Ratio of 0.46 , whereas data collected on site for the same years fluctuated greatly; its average was almost double that of the referenced monitoring stations, at 0.85 (85%).

Further evidence for inaccurate site data included 2016, where the ratio of $PM_{2.5}$ to PM_{10} showed a 130 % difference between the size fractions; meaning that $PM_{2.5}$ concentrations were 1.3 times more than that of PM_{10} concentrations, which is an impossible result by definition.

DISCUSSION AND CONCLUSION

The PM2.5 to PM10 ratio from the HVAS between 2016-2019 is implausibly high to the extent that it is likely in error. Therefore, we consider these data unsuitable for use in assessing cumulative impacts of the proposed modification.

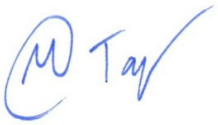
However, as the available NSW Government air quality monitoring stations for PM2.5 are very far from the subject site, these are not likely to accurately represent background levels at the relevant location either.

Nevertheless, it is clear that the background dust level of PM2.5 is an issue across NSW, with NSW government monitoring stations increasingly showing background levels exceeding the PM2.5 annual criteria.

It is not considered warranted to update/remodel the Air Quality Impact Assessment, as there is insufficient reliable information available to feasibly assess the cumulative uncertainties attributable to cumulative impacts.

Considering that the quarry is obligated in any case to eventually remediate the site by stabilizing the disturbed areas, it is advantageous in terms of reducing overall long-term dust impacts to begin carrying out this necessary remediation by bringing in clean fill (VENM/ENM) at the earliest point at which it is feasible to do so. Furthermore, because the greatest dust impacts associated with the site arise from the areas of the quarry closest to residences, these areas should be filled first, so that they will be the first parts of the site to ultimately be fully stabilized. Therefore, it is common sense to approve this activity rather than delay the start of the remediation until later in the life-cycle of the quarry.

However, dust will necessarily be generated in the process of filling areas of the site, and general background dust levels (particularly of PM2.5) are at historically high levels across NSW. As such, regardless of the probable invalidity of the sampling already undertaken on site, it is nevertheless paramount that all reasonable, feasible dust mitigation measures are implemented for not only the transport and filling of the VENM/ENM as proposed by the MOD, but also the ongoing normal operations of the quarry. The attached Air Quality Management Plan details these measures.

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