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Kariong Sand and Soil Supplies – Proposed Development

Air Quality Impact Assessment

Addressee(s):	Jackson Environment & Planning Pty Ltd
Report Reference:	18.1021.FR2V4
Date:	30 June 2020

Quality Control

Study	Status	Prepared by	Checked by	Authorised by
INTRODUCTION	Final	Northstar Air Quality	GCG, JEP	MD
THE PROJECT	Final	Northstar Air Quality	GCG, JEP	MD
LEGISLATION, REGULATION AND GUIDANCE	Final	Northstar Air Quality	GCG, JEP	MD
EXISTING CONDITIONS	Final	Northstar Air Quality	GCG, JEP	MD
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CONSTRUCTION PHASE AIR QUALITY	Final	Northstar Air Quality	GCG, JEP	MD
OPERATIONAL PHASE AIR QUALITY	Final	Northstar Air Quality	GCG, JEP	MD
MITIGATION AND MONITORING	Final	Northstar Air Quality	GCG, JEP	MD
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Report Status

Northstar References		Report Status	Report Reference	Version
Year	Job Number	(Draft: Final)	(R*x*)	(V*x*)
18	1021	F	R2	V4
Based upon the above, the specific reference for this version of the report is:				**18.1021.FR2V4**

Final Authority

This report must by regarded as draft until the above study components have been each marked as final, and the document has been signed and dated below.

Martin Doyle **30th June 2020**

Non-Technical Summary

Jackson Environment & Planning Pty Ltd has engaged Northstar Air Quality Pty Ltd on behalf of Mrs Sue Davis to perform an air quality impact assessment for the proposed development of a designated State Significant Development (SSD8860), namely Kariong Sand and Soil Supplies site (the project) located at 90 Gindurra Road, Somersby NSW (the project site).

A previous version of the air quality impact assessment was submitted to support the Environmental Impact Statement for the project. Following a number of submissions from NSW Environment Protection Authority, NSW Department of Health, and the community, an updated air quality impact assessment has been prepared to respond to those submissions. The revised air quality impact assessment is presented within this document.

In summary, submissions on the previous air quality impact assessment indicated that stakeholders were concerned about the following:

- the cumulative impacts associated with the project and other sources of particulate matter in the area;
- the assessment of potential maximum daily discharges of particulate matter based on maximum achievable production rates;
- the requirement for additional information / clarification to justify the calculated emission rates;
- further analysis of modelled meteorological conditions;
- the employment of best practice particulate control measures to minimise emissions;
- the requirement for air quality monitoring as part of the project;
- potential health impacts of silica dust; and
- potential impacts of odour from stockpiled waste materials.

A full and detailed response to each of the issues above is presented within this report. Importantly, and in summary:

- the potential impacts associated with existing and proposed developments in the immediate area have been addressed;
- an updated dispersion modelling scenario, reflecting maximum potential daily material processing rates and the associated increase in vehicle movements has been subject to assessment;
- additional information / clarification has been provided in the report to allow replication of emission rate calculations;
- an updated meteorological modelling assessment adopting observational data has been performed, and a subsequent updated dispersion modelling approach adopted to assess the impact of emissions on the surrounding environment;
- additional particulate control measures have been adopted by the proponent in response to community concerns regarding dust. These additional control measures include:
  - the construction of buildings around crushing and grinding/mulching operations with water sprays to suppress dust; and,

  - the construction of a building to enclose the tip and spread area on three sides and the inclusion of water misting sprays to reduce dust emissions further.

  The additional measures have been included in the updated dispersion modelling assessment.

- an air quality monitoring program incorporating continuous measurement of particulate matter is proposed;
- an assessment of the impacts of respirable crystalline silica indicate that increases due to the project may be up to 10 percent of the relevant criterion as an absolute maximum, based on worst case assumptions; and
- impacts associated with odour will not be an issue as the project will not accept odorous materials.

A range of emissions control measures (including those additional measures adopted and outlined above) would be implemented as part of the project operation and these are discussed in detail in the main body of the report. It is considered that the measures adopted represent best practice dust control, including:

- Sorting and processing operations are conducted within a controlled environment in the Secondary Sorting Warehouse, with accompanying misting systems for dust control;
- Enclosure of the tipping and spreading bays, with misting systems for dust control during tipping;
- Enclosure of the grinding and mulching operations, with accompanying misting systems to avoid dust generation;
- Misting systems on outdoor storage bays for landscaping and civil supply materials to avoid dust being generated;
- Additional management controls to cease operations on the site on windy days;
- Sweeping, watering down and maintenance of all hard surfaces and roadways to keep surfaces clean to avoid dust being generated on dry, hot days.

The control measures which are adopted have been demonstrated to ensure that the environmental objectives are achieved. These measures would be implemented through an Air Quality Management and Monitoring Plan and in line with environmental best practice.

A risk-based assessment of the potential construction phase air quality impacts indicates that the implementation of a range of mitigation measures would be required to ensure that the risks (both health and amenity) to the surrounding community would be low or not significant.

The updated air quality impact assessment has considered worst case operational parameters, including material processing rates at absolute maximum throughout, and an increase in vehicle traffic bringing materials to site.

The results of the assessment, with the incorporation of a range of particulate matter control measures, indicate that all adopted air quality criteria will be achieved at all surrounding sensitive receptor locations.

It is recommended that air quality monitoring is performed to provide the community and EPA with assurance that the site can be operated with the best practice measures outlined in the report and without giving rise to unacceptable air quality impacts, implemented through an Air Quality Management and Monitoring Plan. As part of this recommendation, an air quality validation assessment can be considered to ensure the facility is complying with conditions of consent prior to increasing production above 100,000 tonnes per annum, and furthermore, once the facility increases production over 150,000 tonnes per annum. This measure will provide the community and regulatory authorities with confidence that the facility is being operated in a manner consistent with the predictions in this study, and the health of the community and the environment is protected at all times.

The results of the air quality impact assessment indicate that the granting of Development Consent for the project should not be rejected on the grounds of air quality.

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Units Used in the Report

All units presented in the report follow the International System of Units (SI) conventions, unless derived from references using non-SI units. In this report, units formed by the division of SI and non-SI units are expressed as a negative exponent, and do not use the solidus (/) symbol. For example:

- 50 micrograms per cubic metre is presented as 50 $\mu g \cdot m^{-3}$ and not 50 $\mu g/m^3$; and,
- 0.2 kilograms per hectare per hour is presented as 0.2 $kg \cdot ha^{-1} \cdot hr^{-1}$ and not 0.2 kg/ha/hr.

Common Abbreviations

Abbreviation	Term
ABS	Australian Bureau of Statistics
AHD	Australian height datum
AQIA	air quality impact assessment
AQMS	air quality monitoring station
BoM	Bureau of Meteorology
CO	carbon monoxide
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPE	Department of Planning and Environment
DPIE	Department of Planning, Industry and Environment
EETM	emission estimation technique manual
EPA	Environmental Protection Authority
kW	kilowatt
$mg \cdot m^{-3}$	milligram per cubic metre of air
$\mu g \cdot m^{-3}$	microgram per cubic metre of air
NCAA	National Clean Air Agreement
NEPM	National Environment Protection Measure
NO	nitric oxide
NO_X	oxides of nitrogen
NO_2	nitrogen dioxide
O_3	ozone
OEH	NSW Office of Environment and Heritage
PM	particulate matter
PM_{10}	particulate matter with an aerodynamic diameter of 10 µm or less
$PM_{2.5}$	particulate matter with an aerodynamic diameter of 2.5 µm or less
RCS	respirable crystalline silica
SEE	Statement of Environmental Effects
TAPM	The Air Pollution Model
TSP	total suspended particulates
US EPA	United States Environmental Protection Agency
VKT	vehicle kilometre travelled
VOC	volatile organic compound

1. INTRODUCTION

Jackson Environment & Planning Pty Ltd has engaged Northstar Air Quality Pty Ltd (Northstar) on behalf of Mrs Sue Davis to perform an air quality impact assessment (AQIA) for the proposed development of the Kariong Sand and Soil Supplies site (the project) located at 90 Gindurra Road, Somersby NSW (the project site).

This AQIA forms part of the Environmental Impact Statement (EIS) prepared to accompany the development application for the project under Part 4 of the *Environmental Planning and Assessment Act* 1979. The project will be assessed as a State Significant Development under Division 4.36 of the *Environmental Planning and Assessment Act* 1979 and Schedule 1 of the *State Environmental Planning Policy (State and Regional Development)* 2011.

The AQIA presents an assessment of the impacts of the proposed operations at the project site, associated with both the construction phase and operational phase of the development. Potential construction impacts have been assessed using a risk-based assessment methodology, and appropriate construction control measures proposed to manage that risk. Potential operational impacts have been predicted using a quantitative dispersion modelling approach, and the predicted incremental change in air quality in the area surrounding the project site is presented in addition to an assessment of compliance with relevant air quality criteria associated with cumulative impacts.

1.1 Assessment Requirements

Secretary's Environmental Assessment Requirements (SEARs 8660) have been provided for the project by the NSW Department of Planning and Environment (DPE [now Department of Planning, Industry and Environment DPIE]). The SEARs also included specific requirements outlined by NSW EPA. These requirements are outlined in **Table 1**.

NSW EPA has also provided a general list of requirements which have been adopted as part of this assessment. These broad requirements are reproduced in **Table 2** and have been given due consideration within the performance of this assessment. The section of the report where each general requirement has been addressed is provided in **Table 2**.

Folloiwng review of the EIS during the Public Exhibition period (February to March 2019), comments were received from agencies and the public. During an adequacy review in February 2020, NSW DPE provided additional comments. Responses to these comments are also outlined in **Table 1**.

Table 1 Requirements for the Air Quality Assessment

Agency	Requirement / comment	Response / where addressed
DPE (SEARs)	• A quantitative assessment of the potential air quality, dust and odour impacts of the development in accordance with relevant Environment Protection Authority guidelines	This report / Section 7
	• The details of buildings and air handling systems and strong justification for any material handling, processing or stockpiling external to a building	Section 2
	• Details of proposed mitigation, management and monitoring measures.	Section 2 Section 8
NSW EPA	• Identify all sources of air emissions from the development.	Section 2.4
	• Provide details of the project that are essential for predicting and assessing air impacts including: – The quantities and physio-chemical parameters (eg concentration, moisture content, bulk density, particle sizes etc) of materials to be used, transported, produced or stored – An outline of procedures for handling, transport, production and storage – The management of solid, liquid and gaseous waste streams with potential for significant air impacts.	 Section 5.2.3, Appendix C Section 2 Section 2
Comments on EIS from Public Exhibition (February to March 2019)		
NSW EPA – Waste Compliance	• Review of the Air Quality Impact Assessment (AQIA) revealed inadequacies regarding the meteorological data and the modelling relied upon. The EPA requires the proponent to revise the AQIA to include: – cumulative impact of emissions from facilities and sources nearby to the proposed development site in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (January 2017). – a scenario that reflects the maximum daily discharge of particle emissions calculated based on the maximum achievable production rates for receiving, processing and dispatching material. – additional information regarding the assumed average operational characteristics for each source. Where possible, sufficient information should be provided for each source to enable the calculation of an emission rate in grams per second. – additional meteorological data options such as those generated using CALMET run in various modes (no-observation, hybrid).	 Section 1.2.1 Section 4.5 Section 1.2.1 Section 5.2.3 Section 1.2.1 Appendix C Section 1.2.1 Section 5.2.1 Section 5.2.2

Agency	Requirement / comment	Response / where addressed
NSW Health	Epidemiological studies have been unable to identify a threshold below which exposure to particulate matter air pollution (PM) is not associated with health effects. Therefore, any increase in exposure must be assumed to have an adverse impact, even at levels below the assessment criteria. If the project is approved, the proponent should be required to employ best practice measures to minimise PM emissions (both $PM_{2.5}$ and the coarse particle fraction of PM_{10}) from all sources to ensure that any risk from PM is as low as reasonably practicable. We defer to the EPA's assessment of the appropriateness of the model, validity of the assumptions underlying the air quality modelling and estimated impacts on particulate pollution. It is noted that Figures 8 and 9 and Table 6 clearly demonstrate increased particulate levels exceeding the PM_{10} 24 hour criteria, beyond the property boundaries. This may have implications for the future use of these lands by the owners of adjacent properties. Table 21 shows the incremental impact of operations on PM_{10}, for Receptor R3. The second part of the table (the right hand side) shows increased particulate levels, with fewer days below 10mcg/m3 and 20mcg/m3. While no additional exceedances are identified, there will be more days with higher levels of particulates.	Section 1.2.2

Agency	Requirement / comment	Response / where addressed
Central Coast Council	The Air Quality Impact Assessment dated 17 December 2018 prepared by Northstar Air Quality ('the Report') has been reviewed and has been generally prepared in accordance with the NSW EPAs Guidelines for Air Pollutants. The Report provides a quantitative assessment of potential dust and odour impacts, details of proposed mitigation, management and monitoring measures of both the construction and operational phases of the development. During the operational phase of the development the fact that only non-putrescible waste will be stored and processed on the site reduces the risk of offensive odours. The Report compares the expected particulate pollutants with the National Environment Protection (Ambient Air Quality) Measure ('Ambient Air Quality NEPM') and NSW EPA Guidelines. The application of water on haul roads and stockpiles, modifying activities in windy conditions, 3 sided enclosure around stockpiles, covering loads with tarps, keeping travels routes paved and partial enclosure of the secondary screening area will be used as controls. In any case this will form part of the operational environmental management plan of the site of which the NSW EPA are the appropriate regulatory authority ('ARA'). Fugitive dust emissions during the construction phase of the development are considered the highest risk. It is anticipated that > 50 heavy vehicle movements would be required each day to service the site, during peak periods of construction. These movements along with earthworks are considered the highest contributors to fugitive dust emissions. A number of mitigation measures are proposed in the Report to control dust emissions including communications, site management, monitoring, preparing and maintaining site, operating vehicle and plant, operations and waste management. Council will be the ARA during the construction phase of the development. Conditions have been applied.	No response required
Public submission – Save Somersby form letter	Offensive smell caused by stockpiling of industrial waste.	Section 1.2.3
	The risk of asbestos becoming airborne with earthworks on the property (It has been noted in their own report that asbestos has already been located on site.)	Section 1.2.3
DPIE Adequacy Review Comments February 2020		
DPIE	The AQIA only considers two potential sources in the cumulative impact assessment. The site is located in the Somersby Industrial Park in which few other existing and proposed waste management facilities locate. These facilities might be additional source of emissions to those identified in the AQIA and needs to be included in the cumulative impact assessment.	Section 1.3

Agency	Requirement / comment	Response / where addressed
	The AQIA adopted AERMOD atmospheric dispersion model, not CALMET modelling as the EPA requested in its submission to the original EIS.	Section 1.3

Table 2 NSW Environment Protection Authority general requirements for an AQIA

Issue	Requirement	Addressed
The Project	• Identify all sources of air emissions from the development.	Section 2.4
	• Provide details of the project that are essential for predicting and assessing air impacts including:	
	– The quantities and physio-chemical parameters (eg concentration, moisture content, bulk density, particle sizes etc) of materials to be used, transported, produced or stored	Section 5.2.3, Appendix C
	– An outline of procedures for handling, transport, production and storage	Section 2
	– The management of solid, liquid and gaseous waste streams with potential for significant air impacts.	Section 2
The Location	• Describe the topography and surrounding land uses. Provide details of the exact locations of dwellings, schools and hospitals. Where appropriate provide a perspective view of the study area such as the terrain file used in dispersion models.	Section 4.1, Section 4.3
	• Describe surrounding buildings that may affect plume dispersion.	N/A
	• Provide and analyse site representative data on the following meteorological parameters: – Temperature and humidity – Rainfall, evaporation and cloud cover – Wind speed and direction – Atmospheric stability class – Mixing height – Katabatic air drainage – Air re-circulation	Appendix B

Issue	Requirement	Addressed
The Environmental Issues	Describe baseline conditions • Provide a description of existing air quality and meteorology, using existing information and site representative ambient monitoring data. This description should include the following parameters – TSP – PM_{10} – $PM_{2.5}$	Section 4.2
	Assess impacts • Identify all pollutants of concern and estimate emissions by quantity (and size for particles), source and discharge point.	Section 2.4 Section 4.5
	• Estimate the resulting ground level concentrations of all pollutants. Where necessary (eg potentially significant impacts and complex terrain effects), use an appropriate dispersion model to estimate ambient pollutant concentrations. Discuss choice of model and parameters with the EPA.	Section 6 Section 7 NSW EPA (Jacqueline Ingham, Waste Operations) was contacted on 1 Nov 2017. No response other than receipt of communication has been received.
	• Describe the effects and significance of pollutant concentration on the environment, human health, amenity and regional ambient air quality standards or goals.	Section 7
	• Describe the contribution that the development will make to regional and global pollution, particularly in sensitive locations.	Section 7
	• For potentially odorous emissions provide the emission rates in terms of odour units (determined by techniques compatible with EPA procedures). Use sampling and analysis techniques for individual or complex odours and for point and diffuse sources, as appropriate.	Section 2.4
	Describe management and mitigation measures • Outline specifications of pollution control equipment (including manufacturer's performance guarantees where available) and management protocols for both point and fugitive emissions. Where possible, this should include cleaner production processes.	Section 5.2.4 Section 8

Further to the above, the policies, guidelines and plans which have been referenced during the performance of the AQIA include:

- Protection of the Environment Operations (Clean Air) Regulation 2002.
- Approved Methods for the Modelling and Assessment of Air Quality in NSW (NSW EPA, 2017).
- Approved Methods for the Sampling and Analysis of Air Pollutants in NSW (DEC, 2006).
- Technical Framework: Assessment and Management of Odour from Stationary Sources in NSW (NSW DEC, 2006).
- Technical Notes: Assessment and Management of Odour from Stationary Sources in NSW (NSW DEC, 2006).

1.2 Review of Air Quality Impact Assessment – March 2019

1.2.1 NSW Environment Protection Authority

A previous version of this AQIA (ref: 18.1021.FR1V1 dated 18th June 2018) was submitted to DPE (as of July 2019 officially titled DPI&E, although for continuity reference is made in this report to DPE) and subject to detailed review by NSW EPA. In March 2019, NSW EPA provided a number of comments on the AQIA which are summarised below. How each of these issues have been addressed in this updated AQIA is also presented below, with the reference to the appropriate section of the report provided.

> *"cumulative impact of emissions from facilities and sources nearby to the proposed development site in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (January, 2017)."*

Following consultation with NSW EPA, an approach to assess cumulative impacts with neighbouring sources was established and this is discussed in **Section 4.5**

> *"a scenario that reflects the maximum daily discharge of particle emissions calculated based on the maximum achievable production rates for receiving, processing and dispatching material."*

Following discussions with the proponent, a scenario which reflects the potential maximum operations has been developed. For materials processing, the maximum potential throughput based on the operating capacity of the equipment onsite has been calculated. For delivery and dispatch of materials to and from the site, the quantity of B-Double vehicles has been assumed to be double that of an 'average' day. Further details are provided in **Section 5.2.3**.

It is noted that additional emissions controls have been proposed by the proponent since the submission of the previous AQIA and these have been adopted and included in dispersion modelling (refer to **Section 2.3** **Section 5.2.3** and **Section 5.2.4**).

> *"additional information regarding the assumed average operational characteristics for each source. Where possible, sufficient information should be provided for each source to enable the calculation of an emission rate in grams per second."*

Additional clarification (i.e. hours of operation per source per day) is provided in the emissions inventories which allows the calculation of $g \cdot s^{-1}$ emission rate to be calculated.

> *"additional meteorological data options such as those generated using CALMET run in various modes (no-observation, hybrid)."*

Due to various complexities in characterising local meteorology and limitations in the models currently available and approved for use in NSW, two alternative approaches were adopted in the earlier iteration of the report:

- Method 1: TAPM without observations; and
- Method 2: TAPM without observations

Following receipt of the comments from the EPA, an additional meteorological modelling approach was adopted using the WRF meteorological model, the output of which was used as input to the CALMET model [Method 3]:

- Method 3: WRF / CALMET

Similar to the analysis of the performance of Methods 1 and 2, the analysis of the generated meteorological data from Method 3 did not compare well with observations of wind speed and direction at Gosford AWS.

The results of Methods 1, 2 and 3 each provided elements of agreement with the observations at Gosford, although no one method provided a good overall agreement with those observations.

Based on the findings summarised above, it was decided to adopt a further alternative meteorological (and dispersion) modelling approach which utilised a greater proportion of observational rather than modelled data:

- Method 4: AERMET

For Method 4, the US EPA AERMET model was used using observations from Gosford AWS as surface data, and upper air data was derived from measurements at Williamtown AWS and Gosford AWS. Subsequent to that meteorological modelling exercise, data was used as input to US EPA AERMOD to model dispersion of emissions. AERMOD is the EPA Victoria approved model and is routinely used in NSW across a range of industry types, including materials recycling facilities.

A detailed discussion of the meteorological and dispersion modelling approach adopted within this assessment is presented in **Section 5.2.1** and **Section 5.2.2**.

1.2.2 NSW Department of Health

During the exhibition period, NSW Department of Health (DoH) also provided comments associated with the AQIA to the DPE. A summary of the DoH comments and a brief response is provided below.

> *"Epidemiological studies have been unable to identify a threshold below which exposure to particulate matter air pollution (PM) is not associated with health effects. Therefore, any increase in exposure must be assumed to have an adverse impact, even at levels below the assessment criteria. If the project is approved, the proponent should be required to employ best practice measures to minimise PM emissions (both $PM_{2.5}$ and the coarse particle fraction of PM_{10}) from all sources to ensure that any risk from PM is as low as reasonably practicable."*

A detailed discussion of measures to be employed as part of the project operation to minimise particulate (dust) emissions is provided in **Section 5.2.4**. Since the provision of the previous AQIA, the proponent has committed to a number of additional particulate control measures including:

- The covering of all crushing, and wood grinding/chipping operations, in addition to the (previously included) use of water sprays on these activities to reduce dust; and,
- The erection of a 3-sided and roofed shed with water mists to allow the tipping and spreading of incoming materials to be shielded from the wind.

> *"We defer to the EPA's assessment of the appropriateness of the model, validity of the assumptions underlying the air quality modelling and estimated impacts on particulate pollution. It is noted that Figures 8 and 9 and Table 6 clearly demonstrate increased particulate levels exceeding the PM_{10} 24 hour criteria, beyond the property boundaries. This may have implications for the future use of these lands by the owners of adjacent properties.*
>
> *Table 21 shows the incremental impact of operations on PM_{10}, for Receptor R3. The second part of the table (the right hand side) shows increased particulate levels, with fewer days below 10 $\mu g/m^3$ and 20 $\mu g/m^3$. While no additional exceedances are identified, there will be more days with higher levels of particulates."*

The air quality criteria are set by NSW EPA and are outlined in **Section 3**. As required to comply with current guidance, these criteria were adopted and provide the basis for this assessment. Further to that requirement, an assessment of all applicable emission control measures has been presented in **Section 5.2.4** to evaluate how best practice emission controls have been implemented to minimise emissions at source.

The dispersion modelling associated with 24-hour impacts has been based on worst-case operational assumptions (e.g. maximum potential materials processing rates, increased number of vehicles delivering materials) and as such provides a worst-case assessment of the potential impacts associated with the project.

> *"Should the project proceed, comprehensive monitoring of noise emissions and air quality is required to ensure that the project goals are met and that the health and amenity of the community are not negatively affected. We support the need for continuous real time monitoring of air quality and noise impacts, and the implementation of management strategies that are consistent with best practice, clearly quantifiable, measurable, auditable and enforceable. Methods for determining compliance must be to the satisfaction of the appropriate regulator.*
>
> *Noting the undertaking to provide PM_{10} monitoring stations at the property boundary, the applicant should identify and utilise sampling sites which can be left in situ for extended periods to enable comprehensive assessment of both noise and air quality impacts."*

Continuous air quality (and meteorological) monitoring is proposed to be performed at an appropriate location surrounding the project site following project approval. The specific location at which monitoring would be performed would be outlined in an Air Quality Management and Monitoring Plan (AQMMP) for the site.

The data would be reviewed regularly with summaries provided to the community, indicating the concentrations measured at the location, and at surrounding NSW OEH Air Quality Monitoring Stations (AQMS) to enable the concentrations to be placed into context, with consideration of regional particulate events such as bush fire smoke and dust storms.

Importantly, particulate concentrations would also be measured prior to the project operation to provide a 'baseline', noting that particulate concentrations in the area will not solely be a result of the project. More information regarding the proposed monitoring program is presented in **Section 8.2.2**.

1.2.3 Public Submissions

During the exhibition period, a number of public submissions were made to DPE regarding the AQIA. In summary, these submissions related to concerns regarding:

- Potential health impacts associated with silica dust;
- The risk of asbestos becoming airborne with earthworks on the property; and,
- Potential for odour associated with stockpiling of industrial waste.

Silica dust is generally an occupational air quality issue, although given the level of community concern has been included as a pollutant of concern within this AQIA. An appropriate criterion and background concentration have been selected with model results compared against this criterion. Results can be seen in **Section 7**. Insignificant impacts are predicted at all sensitive receptors and in areas surrounding the site.

The preliminary site investigation (Clearsafe, 2020) found that non-friable asbestos cement (AC) were identified on ground surfaces within the north-eastern section of the site, adjacent to the buildings and also in the central section of the site. Clearsafe (2020) determined that the site was suitable for the proposed development subject to the following recommendations:

- An appropriate Asbestos Management Plan should be implemented prior to any development to manage the identified non-friable ACM.
- The Asbestos Management Plan should include detailed inspection and remediation prior to any future development.
- Asbestos removal should be undertaken in accordance with an Asbestos Removal Scope of Works / Remedial Action Plan prepared by a Licensed Asbestos Assessor or Competent Person.
- Asbestos removal works should be undertaken by a licensed asbestos removal contractor.
- Subsequent to licensed asbestos removal work, a Clearance Certificate must be issued by a Licensed Asbestos Assessor or Competent Person prior to reoccupation.
- Construction works should include an Unexpected Finds Protocol (UFP) to provide recommended actions for the identification of any further ACM on the ground surfaces or within excavations.
- The Site must be managed such that the ground surfaces are at all times free of visible ACM. Any identified ACM must be managed in accordance with the UFP.

- Prior to demolition, the onsite buildings and structures should be assessed for hazardous materials including but not limited to asbestos and lead paint. All asbestos containing materials within the buildings and structures at the site must be removed prior to demolition in accordance with Safe Work Australia Codes of Practice.

Should the above be implemented, the risk of asbestos being present on ground surfaces such that it would become airborne, is negligible.

No putrescible waste will be received at the site. Odour is not considered to be an issue associated with the project (refer to **Section 2.4.2**).

1.3 Review of Air Quality Impact Assessment – March 2020

The issues outlined in **Section 1.2** were addressed in an updated AQIA (ref: 18.1021.FR1V3 dated 18th December 2019). DPE have provided additional comments on that updated AQIA:

> *"The AQIA only considers two potential sources in the cumulative impact assessment. The site is located in the Somersby Industrial Park in which few other existing and proposed waste management facilities locate. These facilities might be additional source of emissions to those identified in the AQIA and needs to be included in the cumulative impact assessment."*

The NSW Government Major Projects website has been reviewed which includes one facility (Stop Waste Materials Recycling Facility) which was not specifically discussed in the previous AQIA. It was not previously discussed as:

- no information was available with which to assess the potential cumulative impacts; and,
- the facility would be located at a distance of approximately 1.5 km from the project site, and the risk of cumulative impacts being experienced is likely to be low.

> *"The AQIA adopted AERMOD atmospheric dispersion model, not CALMET modelling as the EPA requested in its submission to the original EIS."*

NSW EPA requested that additional investigation into the generation of appropriate meteorological conditions was performed. That request also included a suggestion that CALMET (the meteorological pre-processor for CALPUFF) was run in various modes. That suggestion was taken, and multiple meteorological model runs were performed, but the meteorology of the area could not be appropriately characterised using a range of modelling approaches.

An alternative approach was taken which uses observational (measured) data rather than modelled data. However, to adopt this approach required changing the model previously adopted.

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2. THE PROJECT

The following provides a description of the project and the emissions of air pollutants which would be anticipated as a result of the activities being performed at the project site during the construction and operational phases.

2.1 Project Background

The project site is currently operated as a soil and sand recycling business, located at 90 Gindurra Road, Somersby, NSW. Recycled sand and soil material is sold for landscaping. The site's current development approval and infrastructure constrains the amount of material that can be accepted and processed (screened and sorted) at the site. The site currently has development consent as a 'Sand and Metal Recycling Facility', which was originally approved under DA 15337 on 28 February 1992. The current consent permits the receiving of soil and sand, screening and landscaping material storage in outdoor concrete block bays and machinery parking at the front of the site. There are some structures on the site.

The site does not have an Environment Protection Licence under the *Protection of the Environment Operations Act* 1997.

The Kariong Sand and Soil Supplies development will involve the construction and operation of a best practice recycling and landscape supplies facility that will enable the receipt of up to 200,000 tonnes of sand, soil and building materials each year. The project will transform the site into a state-of-the-art facility turning sand, soil and building materials into 100% recycled building and landscaping supplies. The facility aims to produce a number of building and landscape products, providing them for re-use mainly in the Central Coast region.

The proposed development will seek to expand the current facility into a best-practice recycling plant that will assist the Central Coast in achieving the NSW Government's target of an 80% recycling rate for construction and demolition waste by 2021.

The project will involve the development of a largely undeveloped industrial site, to enable the facility to be used to receive, process and recycle construction and demolition waste, as well as supply building and landscape supplies for local projects. All waste materials will be received and processed indoors, to minimise impacts on the environment and neighbours.

The front part that will be visible from Gindurra Rd will be the landscaping supply operations, including landscaping along the road frontage and landscape storage bays behind the setback area. A fully enclosed warehouse where sorting and recycling operations will be conducted will be visible from the front of the site. Along the eastern boundary, a noise barrier and a native landscape buffer will be planted to avoid noise impacts on nearly rural dwellings, and to provide an aesthetically pleasing interface between the edge of the Somersby Industrial Estate and nearby rural zone lots and dwellings.

Waste processing and recycling operations for selected materials, including crushing and mulching will be done on the southern section of the site, where processing will also be done in dedicated buildings to avoid any impacts on nearby land uses. These operations are to be conducted at maximum distance from any sensitive receptors. The southern section of the site will be retained as bushland to provide a natural buffer between the development and other residential areas more than a kilometre away from the southern boundary of the site.

Advanced water capture, rainwater harvesting, water treatment and dust suppression systems will be integrated in all buildings and outdoor areas to prevent dust being formed. The site will also include an advanced membrane filtration plant to enable much of the water captured from the site to be fully reused across the site for operational uses. The site will also include a water pond treatment system for treating stormwater runoff, and an emergency spill pond for capture, testing and management of contaminated water for sewer discharge or off-site treatment. The site will also include its own weather monitoring station, air, noise, and water monitoring equipment to confirm compliance with consent and licence conditions. The site will be fully serviced with fire suppression systems.

A summary of the relevant site design features is described in **Section 2.3**.

2.2 Environmental Setting

The project site is located in Lot 4 in deposited plan (DP) 227279. The location of the project site is illustrated in **Figure 1** and relates to the parcel of land that will be subject to the development consent.

The project site is located to the north of the suburb of Kariong, on the western edge of land zoned as IN1 (general industrial), with primary production (RU1) and rural lands (RU2), to the north and east, respectively. Lands zoned as infrastructure (SP2) and special infrastructure (SP1) are located to the immediate south. Land zoned as low density residential areas (R2) are located over 1 kilometre (km) from the project site boundary to the south and south east. The project site is located approximately 130 metres (m) from the M1 Pacific Motorway (F3 Freeway). A sandstone quarry operated by Gosford Quarries is located approximately 250 m to the east of the project site.

There are a number of residential properties located within a 1.5 km radius of the site in addition to a number of industrial and educational land uses. The closest privately-owned residence is located approximately 125 m to the east of the project site boundary. Further details of these 'sensitive receptor' locations are provided in **Section 4.1**.

Figure 1 Regional project setting

2.2 Overview and Purpose

The proposed development will allow a larger range and quantity of material to be received and processed at the project site. In addition to sand and soil products, such as virgin excavated natural materials (VENM) and excavated natural materials (ENM), the site will receive timber, metal and building waste. Concrete and bricks will be crushed to produce a recycled aggregate. Timber and woody stumps will be shredded to produce a landscaping mulch.

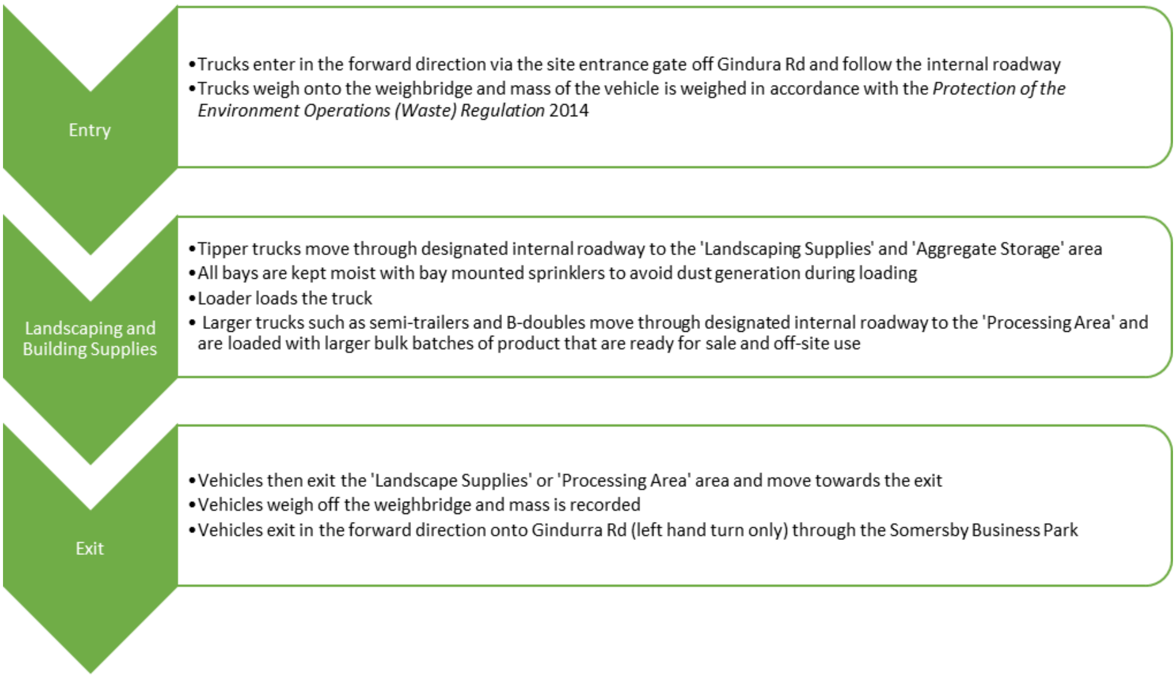
2.3 Specific Operational Details

2.3.1 Existing Operations

Current operations, which involves the receipt, storage and sale of up to 10,000 tpa of landscape supplies including items such as pebbles, bricklayers sand, plasterers sand, washed paving sand, soil mixes, pine mulches, timber mulches and other landscaping material, will be continued. It is noted that the 10,000 tpa is not included in the waste receival, processing and storage total of up to 200,000 tpa for which development consent is sought.

This assessment has considered the cumulative impact of these existing operations in addition to those of the waste receival, processing and storage operations.

A flow diagram of the existing landscaping supplies process is provided below (source: JEP, 2019).



2.3.2 The Project

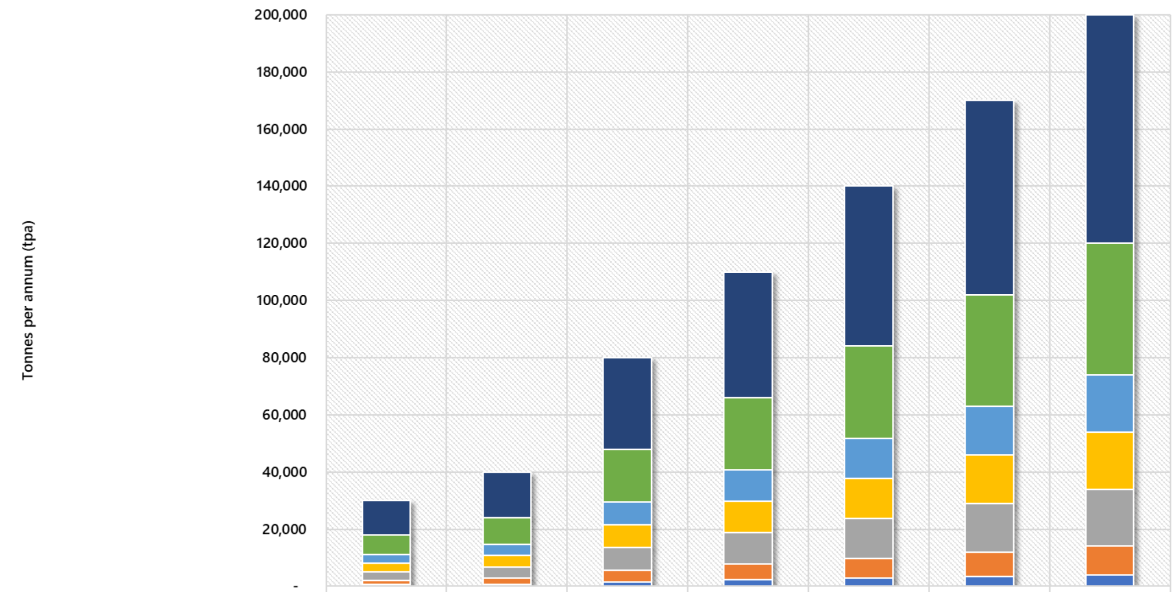
Waste

Waste received at the project site is envisaged to include a range of material types including:

- Virgin excavated natural material (VENM);
- Excavated natural material (ENM);
- Concrete, tiles and masonry;
- Timber (including rootballs and stumps);
- Mixed building waste;
- Metal; and,
- Asphalt.

The tonnages of each material type anticipated to be received over the first seven years of operation is presented in **Figure 2**. The maximum quantity of material to be received at the site in any year would be 200,000 tonnes (t). Based on the forecast demand estimates would not be achieved until year 7 (2025).

Figure 2 Anticipated waste receipt – 2019 to 2025



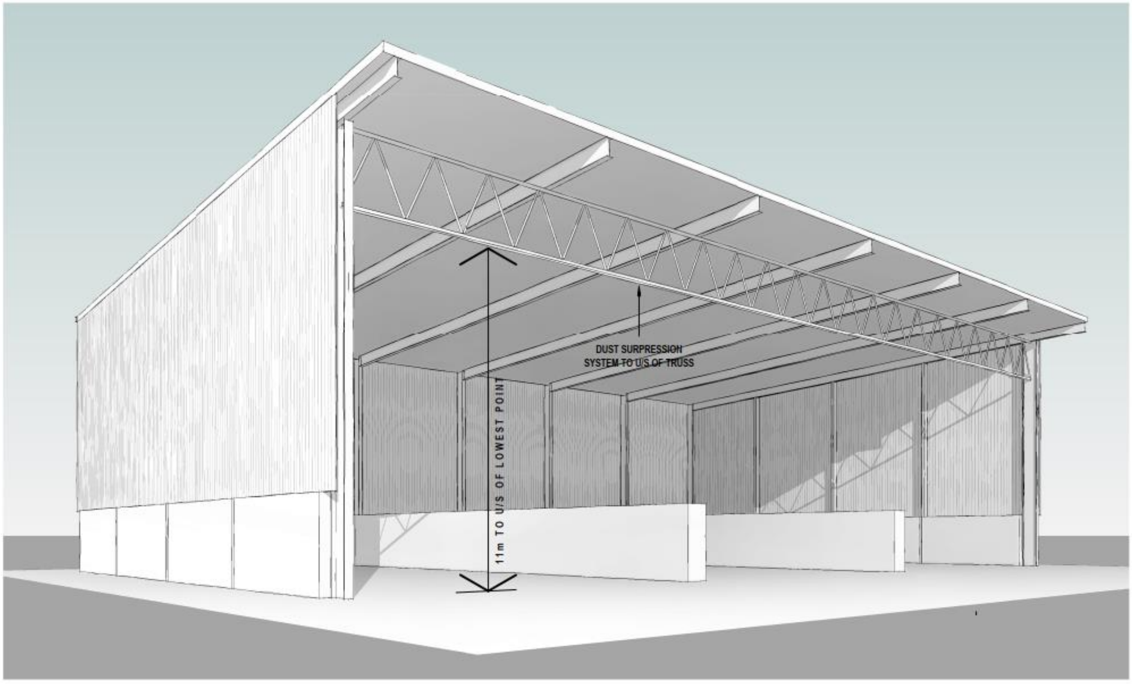
	2019	2020	2021	2022	2023	2024	2025
Excavated Natural Material (soil)	12,000	16,000	32,000	44,000	56,000	68,000	80,000
Concrete / tiles / masonry	6,900	9,200	18,400	25,300	32,200	39,100	46,000
Timber	3,000	4,000	8,000	11,000	14,000	17,000	20,000
Asphalt	3,000	4,000	8,000	11,000	14,000	17,000	20,000
Virgin Excavated Natural Material (VENM) (soil)	3,000	4,000	8,000	11,000	14,000	17,000	20,000
Mixed building waste	1,500	2,000	4,000	5,500	7,000	8,500	10,000
Metal	600	800	1,600	2,200	2,800	3,400	4,000

Data source: (Jackson Environment and Planning, 2018)

Waste receival

Waste would be delivered in B-Doubles (except metal and timber), semi-trailers (except metal and timber) or rigid trucks, which are all weighed on the weighbridge. Materials would then tipped and spread in a three sided and covered shed (refer **Figure 3**) fitted with a water misting system for dust control during the tipping process within the ‘waste receival area’. Materials would be visually inspected by trained staff and compliant material then moved by front end loader (FEL) to the storage bay associated with the relevant material. Non-compliant material would be removed and stored in a separate area prior to subsequent removal off-site for further treatment and/or disposal.

Figure 3 Tip and spread bays with dust misting system



Source: Macari + Associates. Drawing number: 17017 SSD A 01 012 6

Concrete block storage bay walls within the 'waste storage area' will be 3 m in height and storage piles will be managed to not exceed the wall height. Clean building timbers may be separated and stored within the landscaping supplies area for sale, with no further processing necessary.

Storage areas within the 'waste receival area' are proposed to be covered by a three-sided building with water mists/sprays operating across the open face to minimise particulate emissions, primarily associated with tipping and spreading of material.

A general concept layout is presented in **Figure 6** and for a more detailed overview please refer to the main EIS documentation.

Processing

As required, material would be moved by FEL from the 'waste storage area' to the 'processing area' (refer **Figure 6**) where material would be sorted by an excavator. Clean materials free of contamination will be either stored or processed further by crushing, screening or chipping/shredding:

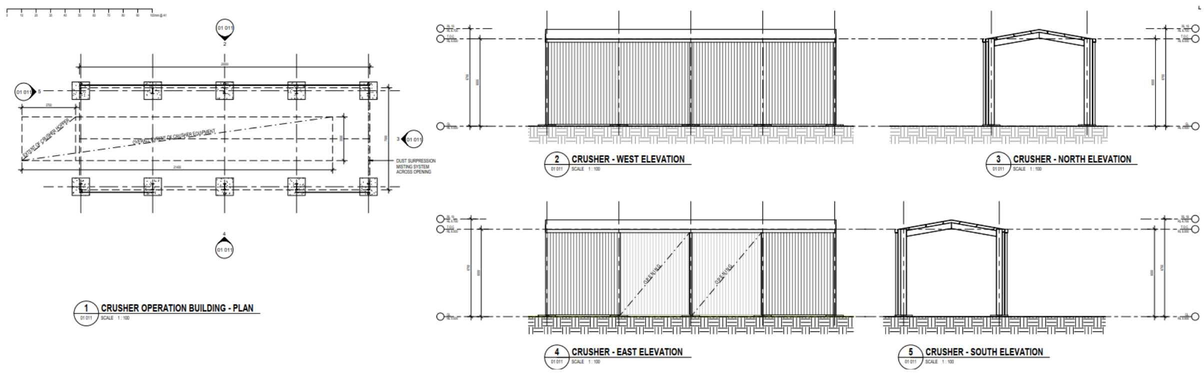
- Crushing: e.g. asphalt and concrete, tiles, masonry;
- Screening: e.g. VENM, ENM; and,
- Chipping / shredding: e.g. timber.

The processed material would then be transferred by excavator to the 'material blending area' as required.

Mixed building waste would be subject to a primary sorting process using a grab excavator with the recyclable material sent into the relevant waste stream. Any residual waste which requires further sorting to remove physical contamination to produce clean streams of recoverable materials would be transferred by FEL to the fully enclosed 'secondary sorting warehouse' which has its own additional water misting system for dust control.

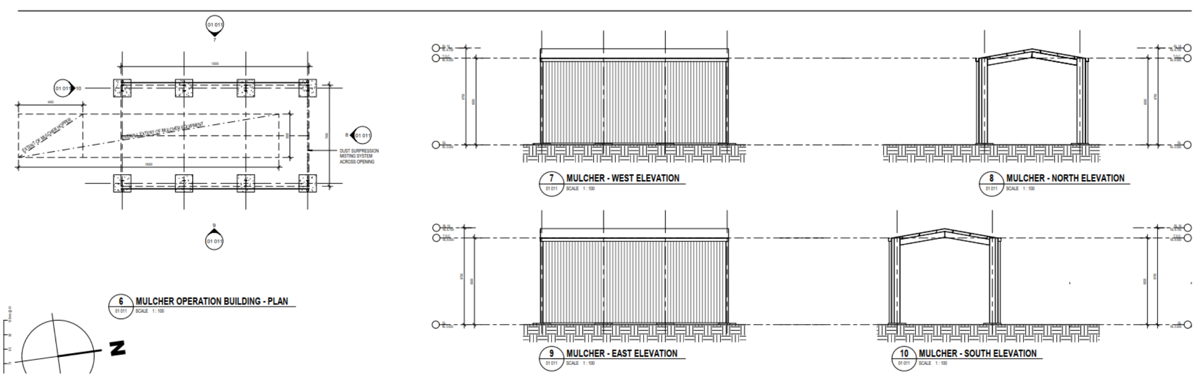
The 'processing area' would be hardstand and constructed of recycled concrete aggregate and recycled asphalt. The area would need to accommodate the operation of a mobile crusher, mobile screening plant, mobile shredder and up to three FEL. The crusher and shredder would be located within covered buildings (fitted with water sprays to suppress dust) with hopper loading being external to the building to enable adequate access (see **Figure 4** and **Figure 5**).

Figure 4 Crusher enclosure with dust misting system



Source: Macari + Associates. Drawing number: 17017 SSD A 01 011 3

Figure 5 Grinder/mulcher enclosure with dust misting system



Source: Macari + Associates. Drawing number: 17017 SSD A 01 011 3

Residual material not processed through the 'processing area' would be transferred by FEL to the 'secondary sorting warehouse' which will be located at the north-eastern edge of the project site. The FEL will enter the warehouse from the south, and deposit residual waste materials into a concrete-block holding bay. Waste materials will be loaded to an electric feed hopper and conveyor which will screen fine soils in the loads and the recovered fines will be diverted to a hooklift bin. Remaining materials will pass through a trommel screen to separate small and coarser concrete and masonry aggregate followed by a magnet for the separation of ferrous metals and an elevated picking line will be used to remove timber, plastics, concrete/aggregate and non-ferrous metals by hand. A wind-sifter will be used to remove lighter material prior to entering the picking line. Once sorted, material will either be redirected back into the appropriate storage bay/area of the project site or stored for removal offsite to a licensed landfill facility. The building will be fitted with a water misting system to supress any dust during the processing operation.

Storage

Following processing / blending, materials would be moved by FEL to the relevant storage area within the 'landscape supplies area' or 'aggregate storage bays' of the project site (refer **Figure 6**). All storage areas (in the 'landscape supplies area' and 'aggregate storage bays'), with the exception of storage piles of material which have been processed or blended immediately prior, would be constructed as 3-sided bins. All storage areas will be fitted with water sprays on the bay walls to maintain a suitable level of moisture on the pile surfaces, to avoid any dust being generated on dry, hot and/or windy days.

Waste and product transport

Vehicles delivering waste materials would enter the site via Gindurra Road, access the weighbridge and continue along the eastern boundary of the site to the 'waste receival area'. Following tipping of the load within the three-sided shed, vehicles would continue around the road loop, back over the weighbridge and exit the site onto Gindurra Road (left hand turn only to the west – no vehicles are to turn right into the smaller local roads). The length of the 'long' road loop from the gate to the 'waste receivals area' and back to the gate is approximately 750 m.

Generally, vehicles accessing the project site to pick up product would access the site via Gindurra Road, access the weighbridge and use the shorter road loop into, and around, the 'product supplies area'. The length of the 'short' road loop from the gate to the 'product supplies area' and back to the gate is approximately 400 m.

In some circumstances, vehicles accessing the project site to pick up loads of VENM, asphalt, ENM and concrete may pick up loads directly from the 'processing area' and utilise the 'long' road loop.

Products purchased and sold as part of the existing landscape supplies business (refer **Section 2.3.1**) would be delivered and removed from the project site using the 'short' road loop.

All roads would be paved. They will be constructed of recycled crushed concrete and crushed used asphalt and in accordance with the NSW EPA's *Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage 2010*. These surfaces will be regularly swept and cleaned to ensure no dust is generated from these surfaces on dry, hot and/or windy days.

Hours of operation

Deliveries of waste materials and product sales would be between the hours of 7:00 am and 6:00 pm (07:00-18:00) Monday to Saturday. No waste deliveries or product sales would occur on Sundays.

Processing of waste would be limited to weekdays (Monday to Friday) between the hours of 8:00 am and 5:00 pm (08:00-17:00).

Workforce

Up to 20 employees are anticipated to be required to service the project site after year seven, once 200,000 tpa of material is received, processed and sold.

A flow diagram of the proposed recycling operations is provided overleaf (source: JEP, 2020).

Entry

- Trucks enter in the forward direction via the site entrance gate off Gindura Rd and follow the internal roadway
- Trucks weigh onto the 26m weighbridge and mass of the vehicle is weighed in accordance with the *Protection of the Environment Operations (Waste) Regulation* 2014
- Driver is interviewed to confirm contents of load and materials can be permitted on site, and surface of contents of truck is inspected to ensure presence of compliant materials only

Inspection and unloading

- Trucks move through designated internal roadway to the Tip and Spread Waste Receival Building'
- Trucks tip into waste inspection area in the Tip and Spread Waste Receival Building
- Any dust is controlled with ceiling mounted misting system
- Loader / excavator spreads load to a depth of approximately 100mm
- Any hazardous items or contamination is removed by operational staff and stored in skip bins in the building
- Materials are loaded via front end loader into an appropriate concrete bay within the 'Waste Storage Area'
- All bays will be fitted with sprinklers for dust control when required

Exit

- Vehicles then exit the 'Tip and Spread Receival Building' area and move towards the exit
- Vehicles weigh off the weighbridge and mass is recorded
- Vehicles exit in the forward direction onto Gindurra Rd (left hand turn only) through the Somersby Business Park

Primary Sorting and Processing

- Waste materials are moved from waste storage bunkers into the 'Processing Area' via front end loader, as required.
- Concete / masonry is processed in the Crusher Building. The sorted products are removed to the Products Storage Area
- Wood and timber is processed in the Mulcher Building, with the mulch product removed to the Products Storage Area
- Clean soil will be tested and transferred to a product storage bay for sale
- Crusher and Mulcher building fitted with internal water sprays for dust control

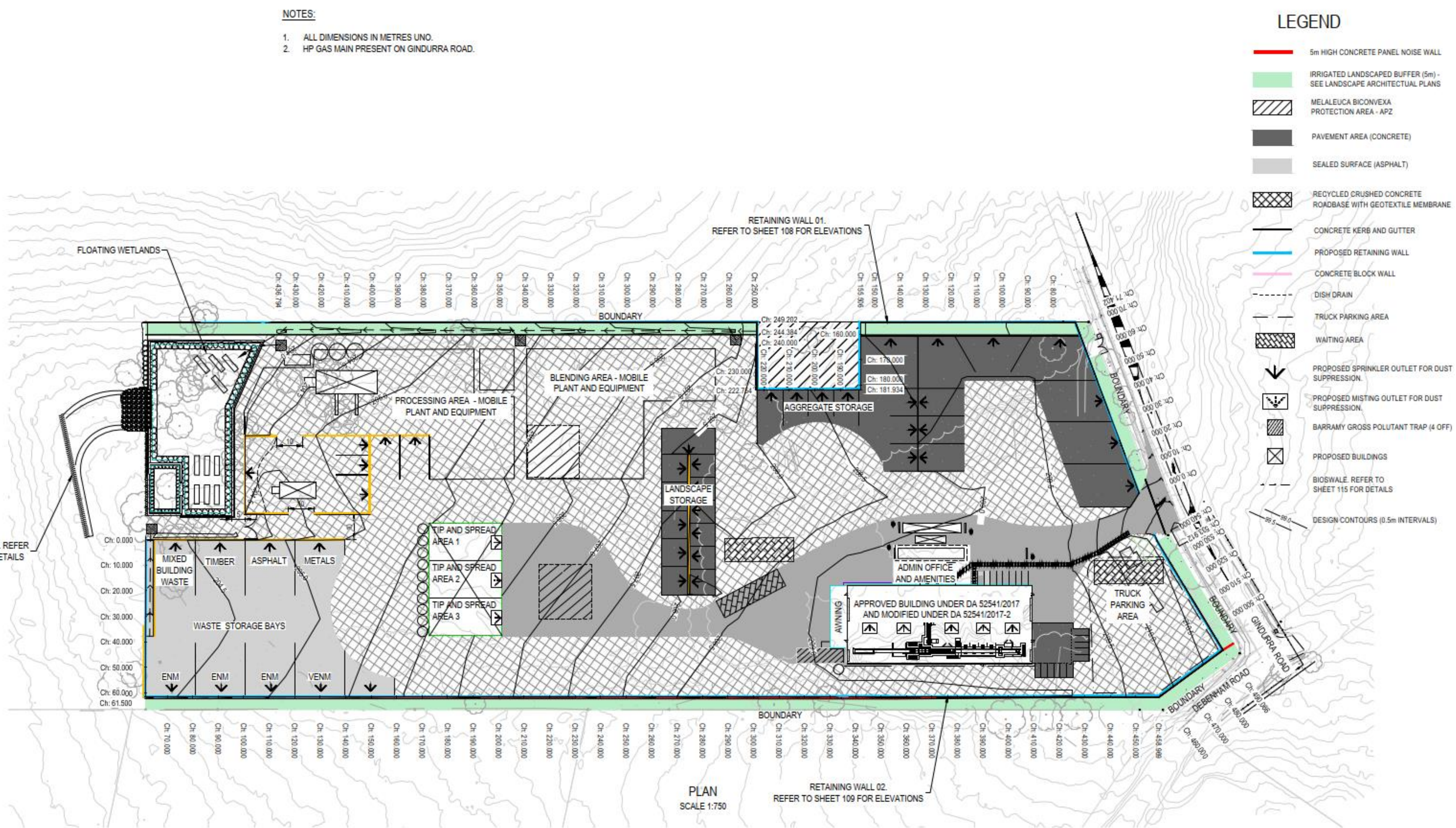
Secondary Sorting Warehouse

- Mixed building waste is transferred from the Waste Storage Area via front end loader to the 'Secondary Sorting Warehouse'. The front end loader then exits from the building in the forward direction
- Waste materials are loaded into an electric feed hopper and then onto a conveyor, which will then screen fine soils for separation into a hooklift bin
- Remaining materials pass onto a trommel screen for separation of masonry and aggregate, then a magnet for the separation of ferrous / steel materials
- Materials drop onto a conveyor, onto an elevated picking line with six persons to sort and deposit separated timber, plastics, concrete / aggregate and non-ferrous materials. Prior to entry onto the conveyor, a blower will be used to separate light materials, such as paper and cardboard. This will be directed to a hooklift bin for disposal
- Remaining materials will be deposited into chutes and into separate hooklift bins beneath the sorting line
- The material remaining after the picking line will be directed to a hook lift bin for disposal at a licenced landfill facility
- Sorted hooklift bins of plastics, cardboard, ferrous and non-ferrous materials will be transferred off-site for further recycling
- Timber and concrete / aggregate will be transferred to the Waste Storage Bays, awaiting processing
- Warehouse is fully fitted out with a misting system for dust control

Product Blending Manufacturing and Sale of product

- Recovered materials from the Processing Area will be stored in separate piles within the dedicated Product Blending Area. Here, materials will be blended as needed to manufacture specific products for building and landscaping applications
- Products, once blended, will be stored in separate piles and sampled / tested to confirm compliance with an appropriate EPA Resource Recovery Order
- Products will then be moved by front end loader to the 'Landscape Storage Bays' or the 'Aggregate Storage Bays', awaiting sale. Bays are fitted with sprinklers to ensure dust control at all times
- Recovered metals will be removed off-site for recycling

Figure 6 General concept layout



Source: Sustainability Workshop 'Proposed Kariong Sand and Soil Supplies Facility – SSD 8660', job 197 sheet 107

2.4 Identified Potential for Emissions to Air

2.4.1 Construction Phase

Construction of the project would involve the removal of existing structures and services on the project site, and the construction of new structures and services.

Jackson Environment and Planning (2017) *Kariong Sand and Soil Supplies – SEAR's Preliminary Environmental Assessment Report* (Jackson Environment and Planning, 2017) states the following:

> *"The complete development would require: installation of security fencing; construction of a hardstand area for processing material; construction of storage bays for processed material; construction of on-site roads suitable for large vehicles; construction of a truck parking area; construction of an office, maintenance workshop and weighbridge.*
>
> *The main operational area will be divided into two main areas; one for receiving and processing incoming material, and another area for storage of final product and sale of material to landscape supplies customers. It is anticipated that a total final area of the developed operational area on the site will be approximately 39,000 m^2.*
>
> *The update of the site will be conducted in two stages. The first stage will be construction work at the front of the site, involving demolition of the existing buildings, construction of a front office and workshop, front parking areas and install the security fencing. The second stage involves clearing of vegetation, earthworks to facilitate on-site drainage, construction of on-site roads, construction of a hardstand area, construction of a stormwater management system, construction of a noise barrier and construction of product storage bays."*

Further construction works are proposed following the Public Exhibition of the EIS for SSD8660, including construction of buildings and misting systems for additional dust suppression associated with the grinder and mulcher in the operational area, and the tip and spread bay area.

Correspondingly, an indicative list of plant and equipment that may be used during the construction of the project includes:

- Cranes;
- Earth moving vehicles;
- Pre-mixed concrete agitator trucks;
- Light vehicles;
- Drills;
- Pneumatic hand or power tools;
- Commercial vans; and
- Cherry pickers.

The methodology used in the construction phase air quality assessment is discussed in **Section 5.1** and detailed in **Appendix E**. The assessment of the potential impacts upon local air quality resulting from construction activities is presented in **Section 6**.

The construction phase activities to be performed as enabling works for the project are anticipated to have the potential to generate short-term emissions of particulates (i.e. 'construction dust'). Generally, these are associated with uncontrolled (or 'fugitive') emissions and may typically be experienced by neighbours as amenity impacts, such as dust deposition and/or visible dust plumes, rather than associated with health-related impacts.

Localised engine exhaust emissions from construction machinery and vehicles may also be experienced, but given the scale of the proposed works, fugitive dust emissions would have the greatest potential to give rise to downwind air quality impacts and construction vehicle emissions are not considered further in this AQIA, although the construction mitigation recommendations (see **Section 6.5**) includes measures to minimise these potential impacts.

2.4.2 Operational Phase

The processes which may result in the emission of pollutants to air in the operational phase include:

- Movement of vehicles around the project site on paved road surfaces;
- Unloading of waste materials in the tip and spread building, and purchased materials associated with the existing landscape supplies business;
- Movement of material around the site using front end loaders;
- Material processing (crushing / screening / shredding / blending) in the processing area buildings and screening / sorting in the secondary sorting warehouse;
- Loading trucks with product material;
- Wind erosion of storage areas; and
- Emissions from vehicle and equipment exhaust.

All waste received at the project site would be classified as non-putrescible. Although timber would be received, processed (to mulch) and stored at the project site, it is not likely that the material would be retained at the project site for a sufficient period of time to decay and become odorous. Furthermore, the product is of no commercial value as a mulch product if it does begin to decay and therefore the material will be managed and stored to reduce the potential for decay. Importantly, no composting is proposed as part of the project site operations.

The odour from raw timber products and shredded / chipped material would be minor. A review of odour emissions data and hedonic tone descriptors associated with raw timber and shredded/chipped wood materials indicates that odour from these sources would generally be described as exhibiting neutral hedonics and by a standard odour descriptor as 'earthy'. The final product is often used as a medium in biofilters (used to reduce odour from odorous processes) and intrinsically has a residual and minor woodchip odour. For context, a well operated and appropriately sized biofilter with odorous gas flowing through should typically not result in any discernible odour at around 10 m.

A minor odour may therefore be experienced in close proximity to the stockpiles of material, although given that the raw timber stockpile, the shredded material processing area and product stockpile are to be located approximately 200 m, 270 m and 185 m, respectively from the nearest residence, the potential for odour impacts is considered to be insignificant.

Although no odour complaints would be anticipated to be received, an odour complaints procedure would be implemented as part of the AQMMP and the complaint log would form part of the ongoing environmental management of the site.

A number of air quality management measures are to be employed as part of the project to minimise the generation and off-site transport of particulate matter as part of the AQMMP. A discussion of these measures, and how they relate to best practice, is presented in **Section 5.2.3** and **Section 5.2.4**.

Emissions associated with the transport, unloading, handling, processing and storage of materials at the project site have been considered to be associated with potential emissions to air of particulate matter only. The relevant legislation and regulation of particulates are identified in **Section 3**, and the assessment of the potential impacts upon local air quality resulting from those activities is presented in **Section 6**.

3 LEGISLATION, REGULATION AND GUIDANCE

3.1 Federal Air Quality Standards

3.1.1 National Environment Protection (Ambient Air Quality) Measure

The *National Environment Protection (Ambient Air Quality) Measure* (Ambient Air Quality NEPM) was promulgated in July 1998 and established ambient air quality standards for six key pollutants across Australia and provides a standard method for monitoring and reporting on air quality. Air quality standards and performance monitoring goals for the six key air pollutants include:

- Carbon monoxide (CO);
- Lead (Pb);
- Nitrogen dioxide (NO_2);
- Particles (particulate matter with an aerodynamic equivalent diameter of 10 microns (µm) or less (PM_{10});
- Photochemical oxidants, as ozone (O_3); and,
- Sulphur dioxide (SO_2).

The Ambient Air Quality NEPM was varied in July 2003 to include advisory reporting standards for fine particulate matter with an aerodynamic equivalent diameter of 2.5 microns (µm) or less ($PM_{2.5}$) and in February 2016 (NEPC, 2016), introducing varied standards for PM_{10} and $PM_{2.5}$. The air quality standards and goals as set out in the (revised) Ambient Air Quality NEPM for the pollutants considered within this assessment are presented in **Table 3**.

Table 3 National Environment Protection (Ambient Air Quality) Measure standards and goals

Pollutant	Averaging period	Criterion	Allowable exceedances per year
Particulates (as PM_{10})	1 day	50 $\mu g \cdot m^{-3}$	None
	1 year	25 $\mu g \cdot m^{-3}$	None
Particulates (as $PM_{2.5}$)	1 day	25 $\mu g \cdot m^{-3}$	None
	1 year	8 $\mu g \cdot m^{-3}$	None

3.1.2 National Clean Air Agreement

The National Clean Air Agreement (NCAA) was agreed by Australia's Environment Ministers on 15 December 2015. The NCAA establishes a framework and work plans for the development and implementation of various policies aimed at improving air quality across Australia.

Regarding air quality standards with relevance to this report, the Initial Work Plan sets an objective to vary the Ambient Air Quality NEPM regarding PM_{10} and $PM_{2.5}$ standards.

Of relevance to the standards adopted as the relevant benchmarks for the performance of the project, the previous standards were augmented by an annual average PM_{10} concentration standard of 25 µg·m^{-3}, and the advisory reporting standards for $PM_{2.5}$ considered as standards. It is further likely that the 24-hour average PM_{10} concentration standard will be made more stringent from the current value of 50 µg·m^{-3} in time, although it is currently not possible to determine the revised standard for that metric.

3.2 NSW Air Quality Standards – Particulates

State air quality guidelines adopted by the NSW EPA are published in the *'Approved Methods for the Modelling and Assessment of Air Quality in NSW'* (the Approved Methods (NSW EPA, 2017)) which has been consulted during the preparation of this assessment report.

The Approved Methods lists the statutory methods that are to be used to model and assess emissions of criteria air pollutants from stationary sources in NSW. Section 7.1 of the Approved Methods clearly outlines the impact assessment criteria for the project.

The criteria listed in the Approved Methods are derived from a range of sources (including NHMRC, NEPC, DoE and WHO).

The criteria specified in the Approved Methods are the defining ambient air quality criteria for NSW. The standards adopted to protect members of the community from health impacts in NSW are presented in **Table 4**.

Table 4 NSW EPA air quality standards and goals

Pollutant	Averaging period	Criterion		Notes
		µg·m^{-3} (a)		
Particulates (as PM_{10})	24 hours	50		Numerically equivalent to the AAQ NEPM(b) standards and goals.
	1 year	25		
Particulates (as $PM_{2.5}$)	24 hours	25		
	1 year	8		
Particulates (as TSP)	1 year	90		
		g·m^{-2}·month^{-1}	g·m^{-2}·month^{-1}	
Deposited dust	1 year	2(c)	4(d)	Assessed as insoluble solids as defined by AS 3580.10.1

Notes: (a): micrograms per cubic metre of air
(b): National Environment Protection (Ambient Air Quality) Measure
(c): Maximum increase in deposited dust level
(d): Maximum total deposited dust level

3.3 Other Air Quality Standards – Silica

Respirable crystalline silica (RCS) is the portion of airborne crystalline silica that can enter the lungs and potentially cause silicosis. It generally affects workers in occupations such as mining, glass manufacturing and foundry work after long-term exposure.

The NSW EPA do not provide air quality criteria for RCS, although the Victorian EPA (VIC EPA) do include a criterion for respirable crystalline silica (as $PM_{2.5}$) as 3 $\mu g \cdot m^{-3}$ (annual average) in their State Environmental Planning Policy (SEPP) Protocol for Environmental Management: Mining and Extractive Industries (PEM) (VIC EPA, 2007). This criterion has in turn been adopted from the California EPA Office for Environmental Health Hazard Assessment Reference Exposure Levels.

This criterion is referenced in this assessment and calculates RCS by adjusting annual average $PM_{2.5}$ modelling results pro-rata to account for the determined maximum free silica content of the extracted material (Safe Work Australia quote a silica content of 67%(w/w) for natural sandstone1).

Based upon the above, the impact assessment criteria presented in **Table 5** have been applied to this AQIA.

Table 5 Impact assessment criteria adopted in this AQIA

Pollutant	Averaging period	Criterion
Particulates (as TSP)	1 year	90 $\mu g \cdot m^{-3}$
Particulates (as PM_{10})	24 hours	50 $\mu g\ m^{-3}$
	1 year	25 $\mu g\ m^{-3}$
Particulates (as $PM_{2.5}$)	24 hours	25 $\mu g\ m^{-3}$
	1 year	8 $\mu g\ m^{-3}$
Silica (as $PM_{2.5}$)	Annual	3 $\mu g\ m^{-3}$
Deposited dust	1 year (as monthly average)	2 $g \cdot m^{-2} \cdot month^{-1}$ (a) 4 $g \cdot m^{-2} \cdot month^{-1}$ (b)

Notes: (a): Maximum increase in deposited dust level
(b): Maximum total deposited dust level

[1] https://www.safeworkaustralia.gov.au/silica

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4. EXISTING CONDITIONS

4.1 Surrounding Land Sensitivity

4.1.1 Discrete Receptor Locations

Air quality assessments typically use a desk-top mapping study to identify 'discrete receptor locations', which are intended to represent a selection of locations that may be susceptible to changes in air quality. In broad terms, the identification of sensitive receptors refers to places at which humans may be present for a period representative of the averaging period for the pollutant being assessed (see also **Section 3** and **Table 5** for a discussion on how this consideration has been applied to the adopted impact assessment criteria). Typically, these locations are identified as residential properties although other sensitive land uses may include schools, medical centres, places of employment, recreational areas or ecologically sensitive locations.

It is important to note that the selection of discrete receptor locations is not intended to represent a fully inclusive selection of all sensitive receptors across the study area. The location selected should be considered to be representative of its location, and may be reasonably assumed to be representative of the immediate environs. In some instances, several viable receptor locations may be identified in a small area, for example a school neighbouring a medical centre. In this instance, the receptor closest to the potential sources to be modelled would generally be selected and would be used to assess the risk to other sensitive land uses in the area. It is further noted that in addition to the identified 'discrete' receptor locations, the entire modelling area is gridded with 'uniform' receptor locations (see **Section 4.1.2**) that are used to plot out the predicted impacts, and as such the accidental non-inclusion of a location sensitive to changes in air quality does not render the AQIA invalid, or otherwise incapable of assessing those potential risks.

To ensure that the selection of discrete receptors for the AQIA are reflective of the locations in which the population of the area surrounding the project site reside, population density data has been examined. Population density data based on the 2016 census have been obtained from the Australian Bureau of Statistics (ABS) for a 1 square kilometre (km^2) grid, covering mainland Australia (ABS, 2017). Using a Geographical Information System (GIS), the locations of sensitive receptor locations have been confirmed with reference to their population densities.

For clarity, the ABS use the following categories to analyse population density ($persons \cdot km^{-2}$):

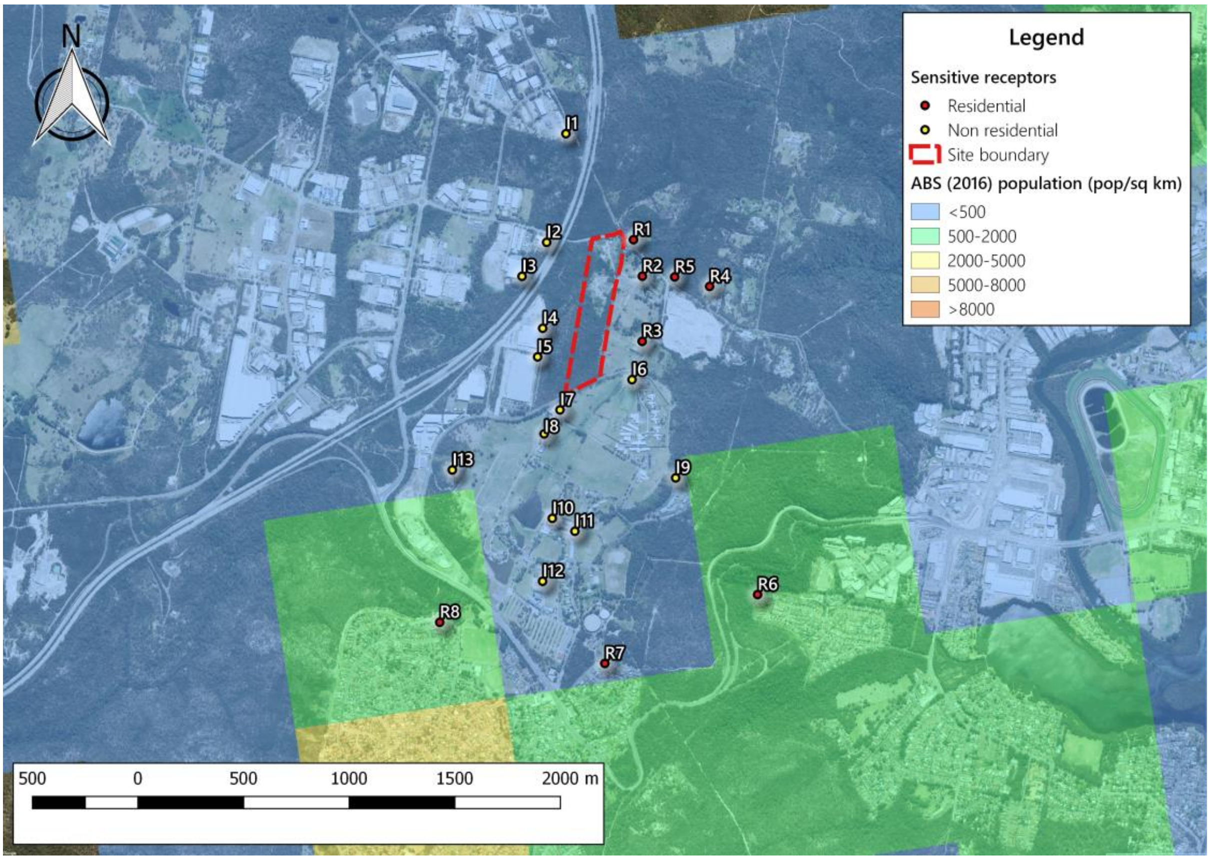
- Very high >8,000
- High >5,000
- Medium >2,000
- Low >500
- Very low <500
- No population 0

Using ABS data in a GIS, the population density of the area surrounding the project site are presented in **Figure 7**. The project site is located in an area of very low (<500 persons·km^{-2}), low (500 to 2000 persons·km^{-2}) and medium (2000 to 5000 persons·km^{-2}).

A number of residential locations, industrial locations and educational receptor location have been identified and these receptors adopted for use within this AQIA are presented in **Table 6**. **Figure 7** identifies that the receptors selected are located in directions which correspond to surrounding populated areas and are therefore appropriate.

The nearest identified schools to the project site are Parklands Community Preschool (I10) and Ngaruki Gulgul Central School (I13) which are located approximately 600 m from the project site boundary, and around 950 m from site activities. These sensitive receptor locations have been specifically included within the assessment.

Figure 7 Population density and sensitive receptors surrounding the project site



Note: Areas with no colour represents a 1 km^2 grid cell with zero population

Table 6 represents the discrete receptor locations that have been identified as part of this study (see **Figure 7**). The table is not intended to represent a definitive list of sensitive land uses, but a cross section of available locations that are used to characterise larger areas, or selected as they represent more sensitive locations which may represent people who are more susceptible to changes in air pollution than the general population.

Table 6 Discrete sensitive receptor locations used in the study

Rec	Location	Location (m, Australian Map Grid, zone 56)		Land Use	Land Use Zoning
		Easting	Northing		
Residential receptor locations					
R1	242 Debenham Road South, Somersby	342,001	6,301,422	Residential	Rural Landscape
R2	10 Acacia Road, Somersby	342,046	6,301,251	Residential	Primary Production
R3	32 Acacia Road, Somersby	342,050	6,300,944	Residential	Primary Production
R4	198 Debenham Road South, Somersby	342,365	6,301,208	Residential	Rural Landscape
R5	252 Debenham Road South, Somersby	342,199	6,301,250	Residential	Rural Landscape
R6	10 Singleton Point Road, Clare	342,616	6,299,761	Residential	Low Density Residential
R7	26 Old Mount Penang Road, Kariong	341,898	6,299,425	Residential	Low Density Residential
R8	95 Mitchell Drive, Kariong	341,113	6,299,606	Residential	Low Density Residential
Non-residential receptor locations					
I1	244 Debenham Road North, Somersby	341,673	6,301,916	Industrial	Rural Landscape
I2	58 Gindurra Road, Somersby	341,590	6,301,403	Industrial	General Industrial
I3	44 Gindurra Road, Somersby	341,476	6,301,241	Industrial	General Industrial
I4	2 Wella Way, Somersby	341,578	6,300,998	Industrial	General Industrial
I5	33 Kangoo Road, Somersby	341,556	6,300,863	Industrial	General Industrial
I6	3 Central Coast Highway, Kariong	342,005	6,300,763	Correctional Centre	Infrastructure
I7	3 Central Coast Highway, Kariong	341,666	6,300,615	Education	Infrastructure
I8	1A Central Coast Highway, Kariong	341,593	6,300,501	Education	Special Activities
I9	3 Central Coast Highway, Kariong	342,219	6,300,304	Correctional Centre	Infrastructure
I10	1A Central Coast Highway, Kariong	341,638	6,300,104	Education	Special Activities
I11	1A Central Coast Highway, Kariong	341,746	6,300,045	Education	Special Activities
I12	10 Festival Drive, Kariong	341,597	6,299,807	Education	Special Activities
I13	1A Central Coast Highway, Kariong	341,161	6,300,324	Education	Special Activities

4.1.2 Uniform Receptor Locations

Additional to the sensitive receptors identified in **Section 4.1.1**, a grid of uniform receptor locations has been used in the AQIA to allow presentation of contour plots of predicted impacts.

4.2 Air Quality

The air quality experienced at any location will be a result of emissions generated by natural and anthropogenic sources on a variety of scales (local, regional and global). The relative contributions of sources at each of these scales to the air quality at a location will vary based on a wide number of factors including the type, location, proximity and strength of the emission source(s), prevailing meteorology, land uses and other factors affecting the emission, dispersion and fate of those pollutants.

When assessing the potential impact of any particular source of emissions on the air quality at a location, the impact of all other sources of an individual pollutant should also be assessed. This 'background' air quality will vary depending on the pollutants to be assessed, and can often be characterised by using representative air quality monitoring data.

A detailed description of the air quality environment surrounding the project site is presented in **Appendix A**.

A summary of the background air quality adopted for use within this AQIA is presented in **Table 7**.

Table 7 Background air quality data adopted for use within the AQIA

Pollutant	Averaging Period	Maximum Concentration	Criterion from Table 4	Source
TSP	Annual	32.8 $\mu g{\cdot}m^{-3}$	90 $\mu g{\cdot}m^{-3}$	Estimated on a TSP:PM_{10} ratio of 2.2 : 1 [1]
PM_{10}	24 hours	58.6 $\mu g{\cdot}m^{-3}$	50 $\mu g{\cdot}m^{-3}$	Wyong AQMS 2015 [1,2]
	Annual	14.9 $\mu g{\cdot}m^{-3}$	25 $\mu g{\cdot}m^{-3}$	
$PM_{2.5}$	24 hours	13.2 $\mu g{\cdot}m^{-3}$	25 $\mu g{\cdot}m^{-3}$	Wyong AQMS 2015 [1]
	Annual	5.2 $\mu g{\cdot}m^{-3}$	8 $\mu g{\cdot}m^{-3}$	
Silica	Annual	0.7 $\mu g{\cdot}m^{-3}$	3 $\mu g{\cdot}m^{-3}$	Somersby Sand AQIA (SLR, 2012)
Dust deposition	Annual	2 $g{\cdot}m^{2}{\cdot}month^{-1}$	4 $g{\cdot}m^{2}{\cdot}month^{-1}$	Difference in NSW OEH maximum allowable and incremental impact criterion

Note: 1) Justification for the use of data from Wyong provided in **Appendix A**

2) Discussion of existing exceedance of criterion discussed in **Appendix A**

Table 7 and **Appendix A** indicates that concentrations of particulate matter (24-hour average PM_{10}) exceeded the relevant air quality criteria as detailed in **Table 4** in 2015 (on 6 May 2015). The NSW Air NEPM Compliance Report for 2015 (NSW OEH, 2015) indicated that the exceedance on 6 May 2015 was an 'exceptional' event and was due to a dust storm which affected PM_{10} concentrations at the Wyong site and in a wider area, from Albury to Sydney and to Tamworth.

The AQIA has been performed to assess the contribution of the project to the air quality of the surrounding area. A full discussion of how the project impacts upon the air quality, including the contribution during such 'exceptional events' is presented in **Section 6**.

4.3 Topography

The elevation of the project site is approximately 190 m to 210 m Australian Height Datum (AHD). No significant topographical features are present between the project site and the nearest sensitive receptor locations. The wider area does contain more significant features as shown in **Figure 8**, although these would not impact significantly upon the transport and dispersion of pollutants between the project site and receptors.

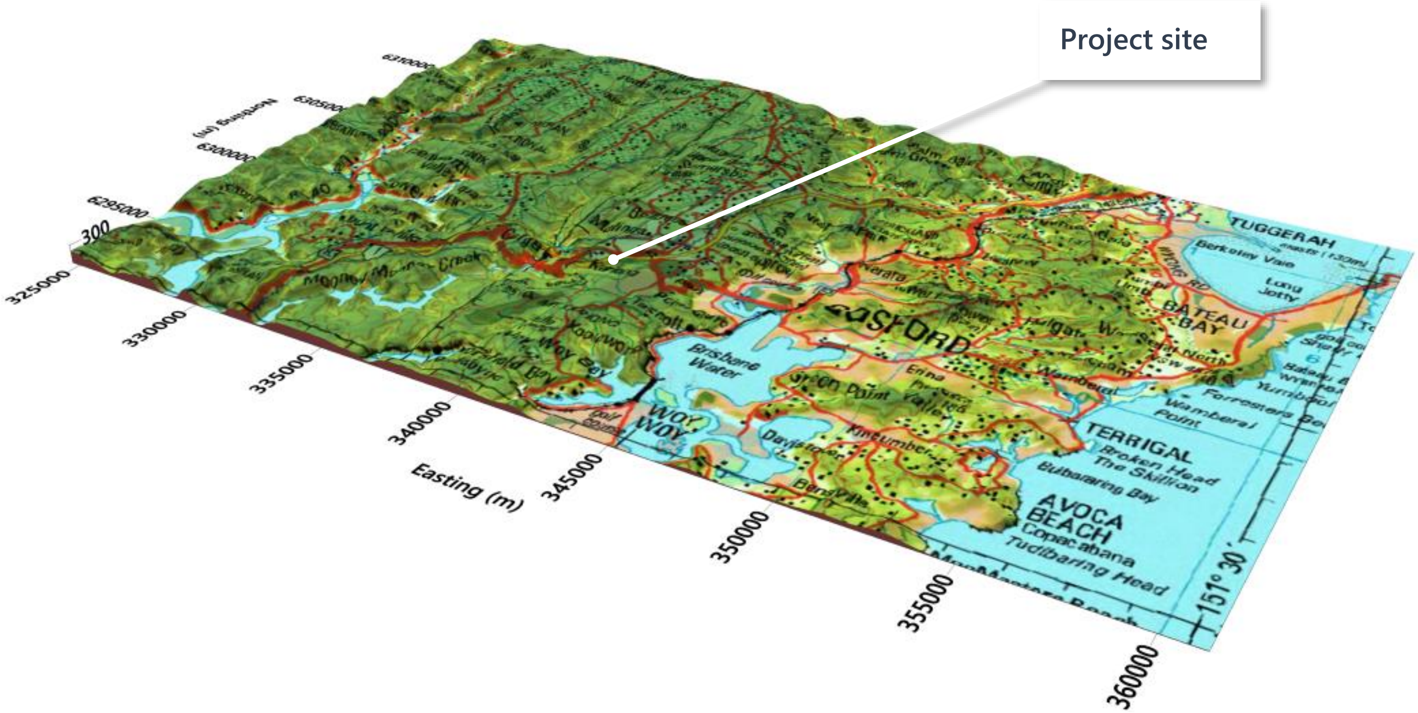
4.4 Meteorology

The meteorology experienced within an area can govern the generation (in the case of wind dependent emission sources), dispersion, transport and eventual fate of pollutants in the atmosphere. The meteorological conditions surrounding the project site have been characterised using data collected by the Australian Government Bureau of Meteorology (BoM) at a number of surrounding Automatic Weather Stations (AWS).

To provide a characterisation of the meteorology which would be expected at the project site, a detailed meteorological modelling and evaluation exercise has also been performed (see also **Section 1.2** for context).

A summary of the inputs and outputs of the meteorological modelling assessment is presented in **Appendix B**.

Figure 8 3-dimensional representation of topography surrounding project site



4.5 Potential Sources of Cumulative Impacts

A number of existing and proposed operations which may contribute to the local particulate matter environment are located in the area surrounding the project site. A review of activities licenced by NSW EPA through the POEO environmental protection licensing (EPL) scheme, surrounding operations under Central Coast Council consent, and a review of projects proposed to be operated in the area has been performed.

Through review of those operations and through discussion with NSW EPA, the following operations have been considered in relation to potential cumulative impacts:

- Gosford Quarries, 1 Acacia Road Somersby – existing operation located approximately 250 m to the east of the project site (refer **Section 4.5.1**); and,
- Proposed Somersby Resource Recovery Facility (SSD 18_9265) located approximately 20 m to the north of the project site (refer **Section 4.5.2**).

Other operations identified through an initial review are located at distances over 650 m from the project site and given the results of the assessment presented in **Section 7** are not likely to result in cumulative impacts of any significance and have therefore not been considered further.

4.5.1 Gosford Quarries

Gosford Quarries performs sandstone block extraction at 1 Acacia Road, Somersby, located approximately 250 m to the east of the project site. No EPL has been issued by NSW EPA for this operation and it is therefore determined that the quarry operates under the extraction limit of 30,000 tpa outlined in Clause 19 of Schedule 1 of the POEO Act 1997 (extractive activities). The quarry operates under Development Consent provided by Council.

No information is available through Council relating to the operations being performed at the quarry. An emissions inventory has been estimated which assumes a 30,000 tpa extraction rate, sandstone block cutting, loading to vehicles, transport from the quarry on unpaved roads (with control by watering) and wind erosion. This inventory provides an estimation of PM_{10} emissions to be 503 $kg{\cdot}yr^{-1}$, with 75 % of those emissions being associated with material haulage on unpaved roads and 21 % associated with wind erosion.

Comparison of those annual average PM_{10} emissions with the project indicates that they may represent approximately 26 % of those emitted by the project.

No information is available to allow calculation of the potential maximum daily activity rates at the quarry, or subsequent assessment of the potential impacts of that operation on the surrounding area on that timescale.

No dispersion modelling of the quarry has been performed, and the potential impacts associated with the quarry are discussed qualitatively in **Section 7**.

4.5.2 Proposed Somersby Resource Recovery Facility (SSD 18_9265)

In March 2018, NSW DPE received a request for SEARs associated with a proposed resource recovery facility (RRF) to be located at 83 Gindurra Road, Somersby, approximately 20 m to the north of the project site boundary.

The Applicant (Bingo Recycling Pty Ltd) is seeking approval to construct and operate an RRF with an annual throughput of up to 500,000 tpa of waste, with capacity for storage of up to 40,000 t at any one time. Based on the information provided in the request for SEARs document (Arcadis, 2018), waste is anticipated to primarily comprise construction and demolition waste, commercial and industrial waste, green waste, soils and timber waste from the Greater Sydney Area, primarily the Central Coast to Newcastle areas.

The RRF would comprise a fully enclosed processing shed incorporating processing equipment and stockpile, storage and handling areas, loading areas, vehicular access and parking, weighbridges and wheel wash stations, a site office, and associated amenities.

Material would be brought to the facility, processed into recyclables and then sold to the end user for further processing. The residual, non-reusable materials would be transferred to a licensed landfill site or alternative residual waste processing facility (Arcadis, 2018).

Dust suppression measures proposed to be included as part of the development include full enclosure of all operations, an in-ground wheel wash prior to the exit weighbridge and dust suppression systems including misting systems (Arcadis, 2018).

The RRF is proposed to be operational for 24 hours per day, seven days per week.

An indicative layout of the proposed Somersby RRF as provided in (Arcadis, 2018) is presented in **Figure 9**.

SEARs were issued by DPE in May 2018 and at the time of writing (June 2019), no EIS has been submitted by the Applicant.

Based on the information presented within (Arcadis, 2018) the operations performed as part of the RRF are likely to represent best practice for the industry, for a site which is 'new build'. The use of hardstand across the site, operation of all activities within an enclosed building and use of dust suppression measures is likely to result in minor and manageable impacts at surrounding receptor locations. The potential for cumulative impacts is therefore likely to be low.

Given that no further information has been provided by the Applicant at this stage, the potential for cumulative impacts cannot be quantified, although should the facility be operated in accordance with best practice, and as outlined above, these impacts are likely to be minimal. For clarity, no quantification of cumulative impacts has been performed as part of this assessment.

Figure 9 Somersby Resource Recovery Facility – layout (indicative)

Source: (Arcadis, 2018)

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5. METHODOLOGY

5.1 Construction Phase Activities

Construction phase activities have the potential to generate short-term emissions of particulates. Generally, these are associated with uncontrolled (or 'fugitive') emissions and are typically experienced by neighbours as amenity impacts, such as dust deposition and visible dust plumes, rather than associated with health-related impacts. Localised engine exhaust emissions from construction machinery and vehicles may also be experienced, but given the scale of the proposed works, fugitive dust emissions would have the greatest potential to give rise to downwind air quality impacts.

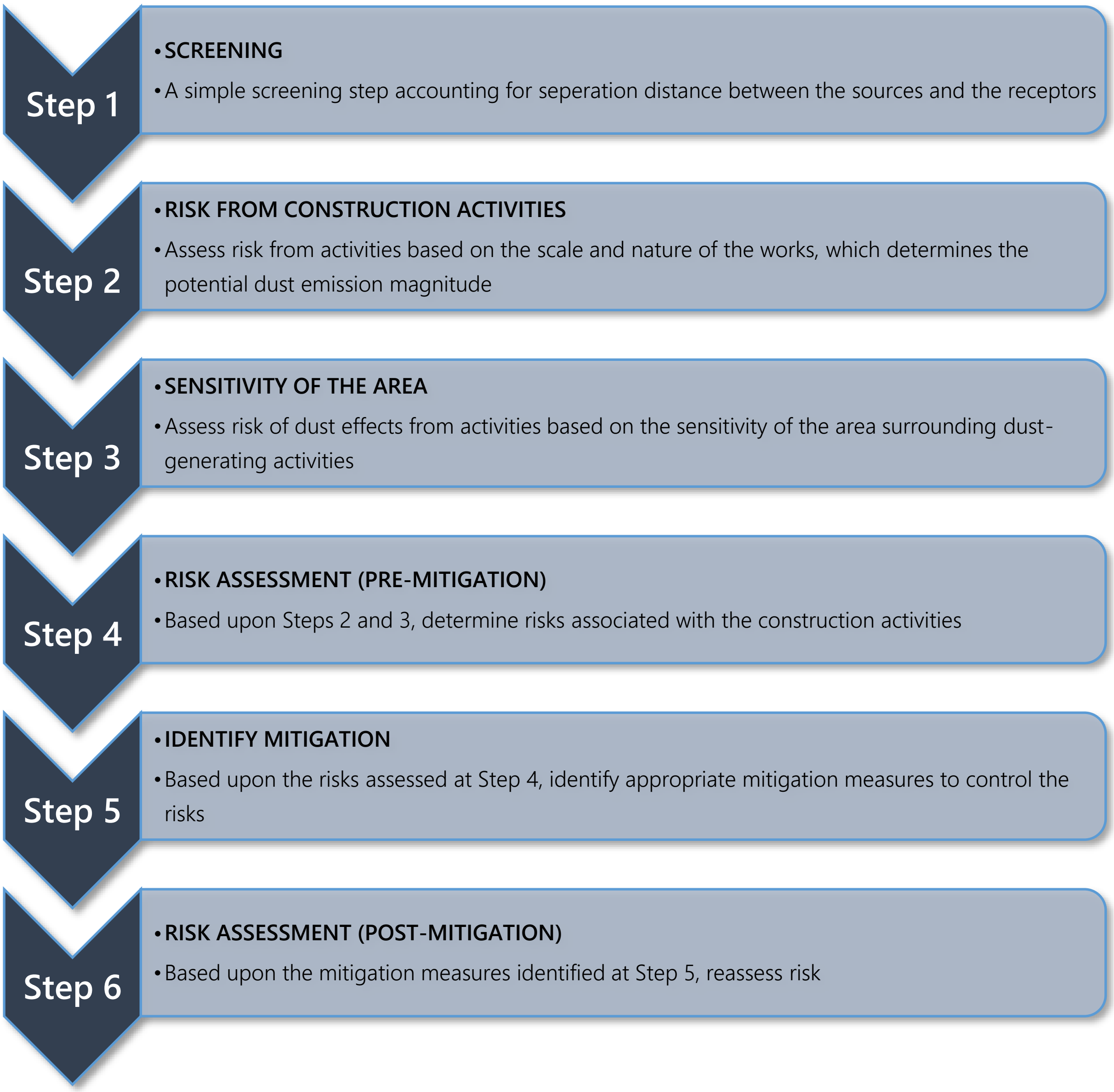
Modelling of dust from construction projects is generally not considered appropriate, as there is a lack of reliable emission factors from construction activities upon which to make predictive assessments, and the rates would vary significantly depending upon local conditions and the construction management practices employed. In lieu of a modelling assessment, the construction phase impacts associated with the project have been assessed using a risk-based assessment procedure. The advantage of this approach is that it determines the activities that pose the greatest risk, which allows the Construction Environmental Management Plan (CEMP) to focus controls to manage that risk appropriately, and reduce the impact through proactive management.

For this risk assessment, Northstar has adapted a methodology presented in the *IAQM Guidance on the Assessment of Dust from Demolition and Construction* developed in the United Kingdom by the Institute of Air Quality Management (Institute of Air Quality Management, 2016)[2]. Reference should be made to **Appendix D** for the methodology.

Briefly, the adapted method uses a six-step process for assessing dust impact risks from construction activities, and to identify key activities for control, as illustrated in **Figure 10**.

[2] www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf

Figure 10 Construction phase impact risk assessment methodology



5.2 Operational Phase Activities

5.2.1 Meteorological Data Processing

Further to the description of prevailing meteorology discussed in **Section 4.4**, and discussed in more detail in **Appendix B**, the meteorology used in the AQIA has been processed to provide inputs suitable for dispersion modelling (refer **Section 5.2.2**).

The meteorological (and dispersion) modelling approach taken within this current assessment represents a revision to the approach adopted in the previous AQIA submitted to support the EIS (the previous AQIA).

The decision to alter the modelling approach was taken following performance of an extensive meteorological modelling exercise where outputs associated with a range of approaches was shown to provide poor agreement with observational data. A summary of the three meteorological modelling approaches taken are presented in **Table 8**, with results for two of those approaches (Method 1 and Method 2) having been provided in the previous AQIA and also replicated in **Figure 11** and **Figure 12**.

In response to NSW EPA comments on the previous AQIA relating to meteorological data, an additional meteorological modelling exercise was performed, using WRF meteorological model output as input to CALMET. The results are also presented in **Figure 11** and **Figure 12** (Method 3).

The three approaches to meteorological modelling are briefly outlined in **Table 8**.

Table 8 Approaches to meteorological modelling

Presented in previous AQIA		Method 3
Method 1	Method 2	
TAPM modelling extracted at the project site with no data assimilation	TAPM modelling extracted at the project site with data assimilated from observations of wind speed and direction from Gosford AWS	WRF modelling, used as input to CALMET extracted at the project site with no data assimilation

Annual wind speed and direction predictions (as wind roses) at Gosford AWS and those associated with each of the three modelling methods, extracted at Gosford AWS, are presented in **Figure 11**. Presented in **Figure 12** are the resulting wind roses predicted at the project site.

None of the meteorological modelling approaches taken results in full replication of observed wind conditions. Method 1 replicates the wind conditions in the northern quadrants with reasonable accuracy but provides poor replication in southern quadrants. Method 2 could be considered to represent the opposite situation. Method 3 results in reasonably good replication of wind conditions in the eastern but not western quadrant.

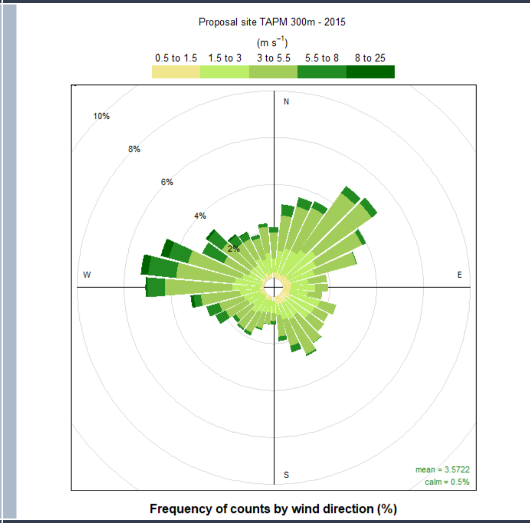
Figure 11 Observed and modelled wind roses – Gosford AWS 2015

Figure 12 Modelled wind roses – project site 2015

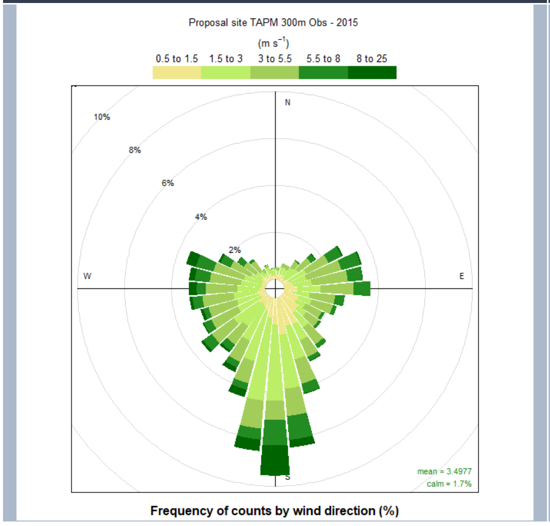
Observations

None

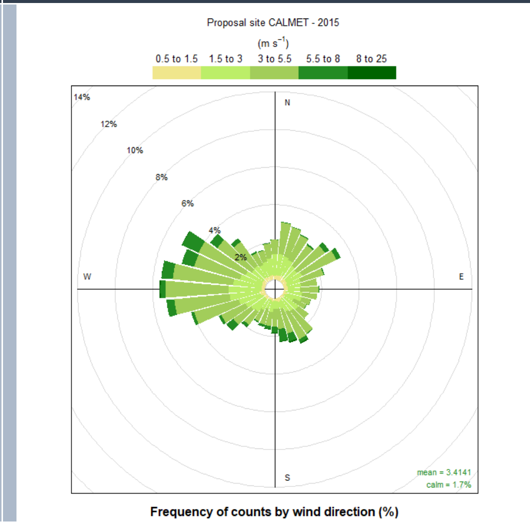
Method 1



Method 2



Method 3



Given that neither of the three meteorological modelling approaches resulted in adequate characterisation of observed wind conditions, the decision was made to use observational data (including that from Gosford AWS) rather than modelled data to use as input to the dispersion model. This has resulted in a change in the dispersion model used and further detail is provided in **Section 5.2.2** and **Appendix B**. This is also referred to as Method 4.

It is acknowledged that the approach using observational data from Gosford AWS does not provide a site-specific meteorological dataset, however in the absence of a validated modelled dataset or site specific observations with which to validate that modelled data, the use of observations from Gosford AWS is considered to be appropriate in this instance. The proponent proposes to install a meteorological monitoring station following project approval and these data can be used within a reassessment of wind conditions and potential impacts should this be required.

It is noted that the meteorological modelling and dispersion modelling approaches presented in the previous AQIA predicted compliance with the required air quality criteria. The additional modelling approach presented within this current AQIA also predicts compliance. The range of approaches taken and scenarios assessed provides a comprehensive assessment of air quality.

5.2.2 Dispersion Modelling

A dispersion modelling assessment has been performed using the US EPA approved AERMOD atmospheric dispersion model. The modelling was previously performed in CALPUFF 2-dimensional (2-D) mode. The results of the previous modelling exercise are presented in **Appendix E** in the interests of transparency.

AERMOD is the US EPA's recommended steady-state plume dispersion model for regulatory purposes. AERMOD is designed to handle a variety of pollutant source types, including surface and buoyant elevated sources, in a wide variety of settings such as rural and urban as well as flat and complex terrain. AERMOD represents an advanced new-generation model, which requires additional meteorological and land use inputs to provide more refined predictions.

The AERMOD system is composed of two pre-processors that generate the input files required by the AERMOD dispersion model: AERMET (for the preparation of meteorological data) and AERMAP (for the preparation of terrain data). Terrain data for the modelling domain was sourced from NASA's Shuttle Radar Topography Mission (SRTM) data. This data set provided a high-resolution topography at 3 arc-second (~90 m) grid spacing. In applying the AERMET meteorological processor to prepare the meteorological data for the AERMOD model, appropriate values for three surface characteristics need to be determined: surface roughness length, albedo, and Bowen ratio.

An assessment of the impacts of the operation of activities at the project site has been performed which characterises the likely day-to-day operation of the project site, approximating average operational characteristics which are appropriate to assess against longer term (annual average) criteria. A scenario reflecting the potential maximum throughput of the project site has also been generated to allow assessment against shorter term (24-hour) criteria for particulate matter (for further information refer to **Section 5.2.3** and **Appendix C**).

The modelling scenarios provide a prediction of the air quality impacts of the operation of activities at the project site. Added to these impacts are background air quality concentrations (where available and discussed in **Section 4.2** and **Appendix A**) which represent the air quality which may be expected within the area surrounding the project site, without the impacts of the project itself.

The following provides a description of the determination of appropriate emissions of air pollutants resulting from the operation of the project.

For clarity, emissions have been estimated for the proposed project (200,000 tpa) and includes a further 10,000 tpa of material deliveries and sales which occur as part of the existing operations at the site. All further references to a 200,000 tpa operations includes this existing 10,000 tpa operation which is not part of the current approval but has been modelled to provide an assessment of cumulative impacts.

5.2.3 Emissions Estimation

The estimation of emissions from a process is typically performed using direct measurement or through the application of factors which appropriately represent the processes under assessment. This assessment has adopted emission factors for materials handling processes, movement of trucks on paved site roads, crushing and screening and wind erosion contained within the US EPA AP-42 emission factor compendium (USEPA, 2006) to represent the emission of particulate matter resulting from the operations occurring at the project site as described in **Section 2.4**.

A full description of the emission sources included in the assessment for each scenario, and the emission factors and assumptions adopted are presented in **Appendix C**.

The assumptions outlined in **Table 9** have been used in the development of the particulate emissions inventory for the project and clearly show the conservative nature of the assumptions adopted in the assessment of peak maximum daily emissions. Note that this assessment considers worst case scenario conditions when the site is sorting, processing and recycling at the maximum possible rate of production. Assumptions used to inform the worst-case scenario operating conditions are given as footnotes to **Table 9**.

Table 9 Assumptions adopted within the particulate matter assessment

Parameter[6]	Units	Annual average (per annum)	Peak maximum (per day)[1]
Material receival rate	tonnes	200,000	877.0 [2]
Material processing rate	tonnes	200,000	Screen – 1,280 [3] Crush – 640 [3] Grind/shred – 224 [3]
Material despatch rate	tonnes	200,000	877.0 [2]
Existing landscape supplies business – receivals and sales	Tonnes	10,000	32.1 (per day)[4]
Silt loading of paved roads	$g \cdot m^{-2}$	0.6[5]	

Notes: 1: Operational days per year - 365 days minus Sundays = 312 days per year

2: Peak daily maximum taken to be the average daily delivery for all vehicles except B-Double deliveries which are taken to be double on peak days – equates to an equivalent of 273,682 t per year delivery/despatch

3: Maximum potential hourly processing rate (200 $t \cdot hr^{-1}$ for screens (x2), 100 $t \cdot hr^{-1}$ for crusher, 35 $t \cdot hr^{-1}$ for grinder/shredder) multiplied by working hours per day (8) and utilisation rate of 80%. Equivalent to 668,928 t of processing per annum.

4: Peak daily maximum taken to be the average daily throughput (365 days minus Saturdays and Sundays per annum = 260 days per year)

5: Ubiquitous baseline for normal conditions on roads with <500 annual average daily traffic flow (USEPA, 2011)

6: No values for material moisture content, silt content or wind speed required as default values used within the assessment.

5.2.4 Emissions Controls

Emissions controls will be employed at the project site. These controls include:

- Sorting and processing operations conducted within a controlled environment in the Secondary Sorting Warehouse, with accompanying misting systems for dust control;
- Enclosure of the tipping and spreading bays, with misting systems for dust control during tipping;
- Enclosure of the crushing and grinding/mulching operations, with accompanying misting systems to avoid dust generation;
- Misting systems on outdoor storage bays for landscaping and civil supply materials to avoid dust being generated;
- Additional controls to cease operations on the site on windy days;
- Sweeping, application of moisture and maintenance of all hard surfaces and roadways to keep surfaces clean to avoid dust being generated on dry, hot days.

The application of some of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the project operation. Where there are quantifiable and justifiable reductions, these have been included in the dispersion modelling assessment. Some controls to be applied during project operation do result in emissions reductions, yet the magnitude of reduction is either not well characterised in the literature or rely heavily on human intervention (e.g. cessation of activities in certain wind conditions). The assessment has been performed to clearly show that compliance with the air quality criteria is not reliant on such control measures, but these measures will act to further reduce predicted offsite impacts.

The sources of emissions resulting from project operation are associated with road haulage, materials handling, materials processing and wind erosion. The emissions control measures proposed to be employed are discussed below, and where additional measures may be available but are not proposed to be implemented, these are discussed, and justification is provided.

It is noted that all the control measures which are available for a particular emissions source may not be suitable for implementation at the project site. Consideration has been given to factors which may constrain the implementation of each particulate control measure, namely the regulatory requirements, environmental impacts, safety implications and compatibility with current processes and future development (including economic viability). These factors have been considered in reference to the constraints evaluation adopted for the NSW EPA *DustStop* Pollution Reduction Program.

Road haulage

Options for the control of dust emissions from (unpaved) haul roads fall into the following three categories:

- Vehicle restrictions that limit the speed, weight or number of vehicles on the road.
- Surface improvement by measures such as (a) paving or (b) adding gravel or slag to a dirt road.
- Surface treatment such as watering or treatment with chemical dust suppressants.

By nature of the layout of the site, vehicles would generally be travelling at speeds well below those experienced on public roads. It is anticipated that the vehicle speed limit within the project site would be 30 $km \cdot hr^{-1}$ and as such, could result in an emission reduction of up to 85%, although this reduction factor is associated with unpaved roads (Katestone Environmental Pty Ltd, 2011). The predictive emission factor used in the quantification of particulate emissions from paved roads (USEPA, 2011) is applicable to vehicle speeds from 1 $km \cdot hr^{-1}$ to 88 $km \cdot hr^{-1}$ and no reduction factor for lower speeds is available. Lower vehicle speeds on paved roads would result in unquantifiably lower emissions.

All site roads would be constructed of recycled crushed concrete and crushed used asphalt and in accordance with the NSW EPA's *Specification for Supply of Recycled Material for Pavements, Earthworks and Drainage 2010*.

All site roads would be subject to regular watering, with (USEPA, 2011) indicating that water flushing at a rate of 0.48 $gal \cdot yd^{-2}$ (2.2 $L \cdot m^{-2}$) would result in emissions reductions of between 30% and 70%. For the purposes of this assessment, the lower (conservative) reduction factor of 30% has been adopted. Road surfaces will also be swept to keep surfaces clean and to avoid dust generation.

In summary, three broad emission control strategies can be employed to minimise particulate emissions from road haulage operations. As discussed above, the project would implement control measures within each of those categories, by limiting the speed of vehicles, paving the road surface, and watering the road surface (refer **Table 10**).

Table 10 Emission reduction methods and particulate control efficiencies - haulage

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Vehicle restrictions that limit the speed of vehicles on the road.	☑	-	Not quantifiable
Surface improvement by paving	☑	-	Emissions reductions over unpaved roads calculated through emission factor
Surface treatment - watering	☑	30	(USEPA, 2011) - application rate of 2.2 $L \cdot m^{-2} \cdot hr^{-1}$ (0.48 $gal \cdot yd^{-2}$)
Surface treatment – road sweeping	☑	-	Effect variable and not quantifiable

The project would employ best practice emission controls on haul roads

Materials handling

The handling of materials at the project site relates to materials being unloaded and loaded, and transferred by FEL from one area of the project site to another. Although the available information relating to best practice emission controls relates to the coal mining industry (Katestone Environmental Pty Ltd, 2011), the broad control techniques can generally be applied to any industry.

Options for the control of dust emissions from materials handling activities are as follows:

Loading / unloading

- Minimising the drop height from vehicles;
- Application of water via sprays or mists;
- Modification of activities in windy conditions;
- Loading materials to a 3-sided enclosure (bins or larger building);
- Covering loads with a tarpaulin;
- Limit load sizes to ensure material is not above the level of truck sidewalls; and,
- Enclosure with control device.

Operation of front end loader

- Minimising travel speeds and distances; and,
- Keep travel routes and materials moist.

Materials brought to site will be unloaded inside a 3-sided building, with water mists on the open side of the building. The building will be approximately 8.5 m high at the lowest side, rising to approximately 11 m at the open face. Within the building will be located three 3-sided enclosures where material will be tipped and spread, as shown in **Figure 3**.

The drop height of incoming material from vehicles would be minimised as far as possible, although the design of the various vehicles that would typically use the site (i.e. B-Doubles, tippers and semi-trailers) does not permit the implementation of a specified drop height of material from the vehicle (i.e. the tray and tip height of the vehicles is fixed). The drop height could be minimised by dropping material onto a built-up surface such as a stockpile, although stockpiles would likely be cleared as soon as practicable.

A visual assessment of dust lift-off during material handling activities would be undertaken whilst those activities are being performed. Where visible dust is generated as a result of those activities, additional control measures would be implemented (such as the direct application of water sprays in addition to the water mists used within the building), or the intensity of the activity would be reduced (reducing the particulate emission load). Non-critical site activities could also be ceased to reduce the overall site particulate emission and the hierarchy of the activities to be ceased would be determined by the site manager and the procedure implemented in the AQMMP.

All product loads leaving the site would be covered, and with loads not above the level of the sidewalls in accordance with NSW Roads and Maritime Services requirements[3].

As discussed regarding road haulage (see **Road haulage** above), all site roads are to be paved and regularly watered which would reduce wheel-generated particulate emissions from FEL moving between parts of the project site. The FEL would also be required to adhere to mandatory site speed limits, although would likely be moving at a lower speed than trucks given the vehicle type and loads being carried.

Full enclosure of materials handling activities (outside of the tipping and spreading area) is not proposed. The area covered by the stockpiles (in which materials are to be deposited to and loaded from [sorted materials and product]) and the distance which FEL would be required to move materials to/from makes the use of full enclosure impractical. The area of land which would be required to be covered to enclose all stockpiles and transport routes between them (not including haul roads) would be greater than 10,000 m^2. The capital expenditure for such an enclosure would increase the overall cost of the project substantially. The emissions controls proposed for the project (refer **Table 11**) act to reduce particulate emissions, with some of these reductions being included within the dispersion modelling assessment. Some have not been included either due to the unquantifiable nature of the emission reduction (e.g. covering loads), or due to their 'as required' use (e.g. application of water).

3 http://www.rms.nsw.gov.au/roads/safety-rules/demerits-offences/uncovered-loads.html

Table 11 Emission reduction methods and particulate control efficiencies – materials handling

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Enclosure of the tipping and spreading area	☑	70	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011)
Minimising the drop height from vehicles	☑	30	Adopted as far as practicable. Reduction associated with a drop height reduction from 3 m to 1.5 m (Katestone Environmental Pty Ltd, 2011)
Application of water	☑	50	Water sprays within tipping and spreading building. Watering as required. Table 4 of (NPI, 2012)
Modification of activities in windy conditions	☑	-	As required. Not quantified
Loading materials to a 3-sided enclosure	☑	30	Table 4 of (NPI, 2012)
Covering loads with a tarpaulin	☑	-	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	☑	-	Not quantified
Full enclosure with control device (filtration)	☒	90-100	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011) Would increase the cost of the project substantially
Minimising travel speeds and distances	☑	-	Not quantified
Keep travel routes and materials moist	☑	50	Table 4 of (NPI, 2012)
Surface treatment – sweeping of paved areas	☑	-	Effect variable and not quantifiable
Ceasing crushing, screening and grinding activities (and loading) when wind speeds >25 $km \cdot hr^{-1}$	☑	-	Not quantified in AQIA but would result in removal of emissions source

Considering the relevant constraints, the project would employ best practice emission controls for materials handling

Materials processing

The processing of materials at the project site relates to the crushing, screening and shredding of material in the 'processing area' and sorting and screening in the 'secondary sorting warehouse'. Although the available information relating to best practice emission controls generally relates to the coal mining industry (Katestone Environmental Pty Ltd, 2011), the broad control techniques can generally be applied to any industry.

Options for the control of dust emissions from materials processing are as follows:

- Application of water;
- Modification of activities in windy conditions; and
- Enclosure, or enclosure with control device.

Crushing and grinding operations will be partially enclosed and water will be applied. Given that the processes will not be fully enclosed, an emission control efficiency appropriate to the level of enclosure has been applied. Water will be applied to screening operations.

A visual assessment of dust lift-off during materials processing would be undertaken whilst those activities are being performed. Where visible dust is generated as a result of those activities, additional control measures would be implemented (such as the increased application of water sprays), or the intensity of the activity would be reduced (reducing the particulate emission load). Non-critical site activities could also be ceased to reduce the overall site particulate emission and the hierarchy of the activities to be ceased would be determined by the site manager, and implemented through the AQMMP.

The activities being performed within the 'secondary sorting warehouse' will be partially enclosed, as these operations are proposed to be performed within an existing building at the project site. The proponent has indicated that the doors on the 'secondary sorting warehouse' will be kept closed whenever possible, with the door on the northern side kept almost permanently closed and only opened for maintenance/emergencies. The door on the southern side will only be opened to allow the transport of material into and out of the building. Given that the process will not be fully enclosed, an emission control efficiency appropriate to the level of enclosure has been applied.

The emissions controls proposed for the project (refer **Table 12**) act to reduce particulate emissions, with some of these reductions being included within the dispersion modelling assessment. Some have not been included either due to the unquantifiable nature of the emission reduction (e.g. modification of activities).

Table 12 Emission reduction methods and particulate control efficiencies – material processing

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Application of water	☑	91.6 (screen) 77.7 (crush) 50 (shred)	Control efficiency adopted from (USEPA, 2006) Control efficiency adopted from (USEPA, 2006) Table 4 of (NPI, 2012)
Ceasing crushing, screening and grinding activities (and loading) when wind speeds >25 $km{\cdot}hr^{-1}$	☑	-	Not quantified in AQIA but would result in removal of emissions source
Enclosure	☑	70	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011) For activities within 'secondary sorting warehouse' and all crushing and shredding/grinding activities
Full enclosure with control device (filtration)	☒	90-100	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011) Would increase the cost of the project substantially

Considering the relevant constraints, the project would employ best practice emission controls for materials processing

Wind erosion

Wind erosion at the project site would be associated with stockpiles of raw and processed materials. Although the available information relating to best practice emission controls generally relates to the coal mining industry (Katestone Environmental Pty Ltd, 2011), the broad control techniques can generally be applied to any industry.

Options for the control of dust emissions from wind erosion sources are as follows:

- Application of water through bay mounted misting or surface sprays;
- Application of chemical wetting agents;
- Surface crusting agents;
- Coverage of stockpiles with a tarp in high winds;
- Vegetative wind breaks or wind screens / fences;
- 3-sided enclosures around stockpiles;
- Reduction in stockpile heights;
- Pile shaping and orientation;
- Modification of activities in windy conditions; and
- Enclosure with control device.

All material which is brought to the project site would be unloaded within a 3-sided shed with water sprays/mists applied to reduce wind erosion during unloading activities. Three-sided bins are proposed for all storage activities (other than piles generated from processing which would be short term) to reduce wind erosion during storage. No surface crusting agents or chemical wetting agents are proposed for any stockpile at the project site given that materials are not proposed to be stored over the long-term. Stockpile heights would be minimised to an extent as they would be limited by the height of the 3-sided bins. No material would be loaded above the height of the storage bins.

No vegetative wind-breaks or screens are proposed as these would hinder the movement of vehicles and FEL to the stockpiles. Piles cannot be effectively shaped or oriented, given that they would be 3-sided bins.

Transient stockpiles of material within the processing area would be kept to a minimum and loaded to the relevant product stockpile in the landscape supplies area. Long-term storage of processed materials outside of 3-sided bins is not proposed.

As previously discussed, a visual assessment of dust lift-off during materials processing would be performed whilst those activities are being performed and implemented through the AQMMP. Where visible dust is generated as a result of those activities, additional control measures would be implemented (such as the increased application of water sprays), or the intensity of the activity would be reduced (reducing the particulate emission load). This would result in the quantity of material being stockpiled outside of the 3-sided bins to be reduced.

Water sprays would also be implemented should visible dust lift-off be observed from materials storage bins and piles. Given that the 3-sided bins act to significantly reduce wind erosion (by up to 75% (Katestone Environmental Pty Ltd, 2011)), the constant application of water sprays is not considered to be required but would be available should circumstances require their use. Given their intermittent use, the application of water sprays has not been assumed as a control within the dispersion modelling exercise of annual average emissions but has been applied in the assessment of maximum 24-hr impacts, given that the maximum impacts would likely be experienced on days of higher wind speeds.

Full enclosure of materials storage areas is not proposed. The area covered by the materials stockpiles makes the use of full enclosure impractical. The area of land which would be required to be covered to enclose all stockpiles and ensure that FEL could access those piles to pick up / deposit loads would be greater than 3,000 m^2 (for 3-sided bins alone). The capital expenditure for such an enclosure would increase the overall cost of the project substantially. The emissions controls proposed for the project (refer **Table 13**) act to reduce particulate emissions, with some of these reductions being included within the dispersion modelling assessment. Some have not been included either due to the intermittent nature of the application.

Stockpiles of waste materials in the designated waste storage area will be limited to 3 m in height. Visual height guidance will be provided by the 3 m height of the concrete block bays.

Stockpiles of inert material such as concrete, brick, soil etc. will be limited to a maximum of 5 m in height in the processing and blending areas. Height poles to the exact length (5 m) will provide on-site guidance for stockpile management.

Stockpiles of organic material such as timber and mulch will be limited to a maximum of 3 m in height in the processing and blending areas. Height poles to the exact length (3 m) will provide on-site guidance for stockpile management.

Stockpiles of all processed products, aggregates and landscaping supplies will be limited to 3 m in height. Height guidance will be provided by the 3 m height of the concrete block bays.

Table 13 Emission reduction methods and particulate control efficiencies – wind erosion

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Application of water	☑	50 (in 24-hr assessment)	As required Table 4 of (NPI, 2012)
Application of chemical wetting agents	☒	80-99	Materials stored short-term (Katestone Environmental Pty Ltd, 2011)
Surface crusting agents	☒	95	Materials stored short-term (Katestone Environmental Pty Ltd, 2011)
Coverage of stockpiles with a tarp in high winds	☒	99	Area of >3,000 m^2 too large to cover (Katestone Environmental Pty Ltd, 2011)
Vegetative wind breaks or wind screens / fences	☒	30 - 80	Would hinder vehicle movements (Katestone Environmental Pty Ltd, 2011)
3-sided enclosures around stockpiles	☑	75	(Katestone Environmental Pty Ltd, 2011)
Reduction in stockpile heights	☑	30	Stockpiles limited in height (Katestone Environmental Pty Ltd, 2011)
Pile shaping and orientation	☒	<60	Materials stored in 3-sided bins (Katestone Environmental Pty Ltd, 2011)
Modification of activities in windy conditions	☑	-	As required. Not quantified

Emission control method	Adoption	Control efficiency (%)	Reference / Notes
Enclosure with control device	☒	90-100	Table 4 of (NPI, 2012) (Katestone Environmental Pty Ltd, 2011) Would increase the cost of the project substantially

Considering the relevant constraints, the project would employ best practice emission controls for sources of wind erosion

A summary of the emissions reductions measures that would be adopted as part of the project operation is presented in **Table 14**. All of these measures will result in the reduction of particulate matter emissions when implemented although not all have an associated and defensible emission control efficiency (%) which can be adopted within this AQIA.

Table 14 Summary of emission reduction methods adopted as part of project operation

Emission control method	Control efficiency (%)
Road Haulage	
Vehicle restrictions that limit the speed of vehicles on the road.	Not quantified
Surface improvement by paving	Assessed through emission factor
Surface treatment - watering	30
Surface treatment - sweeping	Not quantified
Materials Handling	
Enclosure of the tipping and spreading area	70
Minimising the drop height from vehicles	30
Application of water	50
Ceasing crushing, screening and grinding activities (and loading) when wind speeds >25 $km \cdot hr^{-1}$	Not quantified
Loading materials to a 3-sided enclosure	30
Covering loads with a tarpaulin	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	Not quantified
Minimising travel speeds and distances	Not quantified
Keep travel routes and materials moist	50
Materials Processing	
Application of water	91.6 (screen) 77.7 (crush) 50 (shred)
Enclosure of crushing and grinding/shredding activities and activities within 'secondary sorting warehouse'	70
Ceasing crushing, screening and grinding activities when wind speeds >25 $km \cdot hr^{-1}$	Not quantified

Emission control method	Control efficiency (%)
Wind Erosion	
Application of water	50
Stockpiles limited in height	30
3-sided enclosures around stockpiles	75
Modification of activities in windy conditions	Not quantified

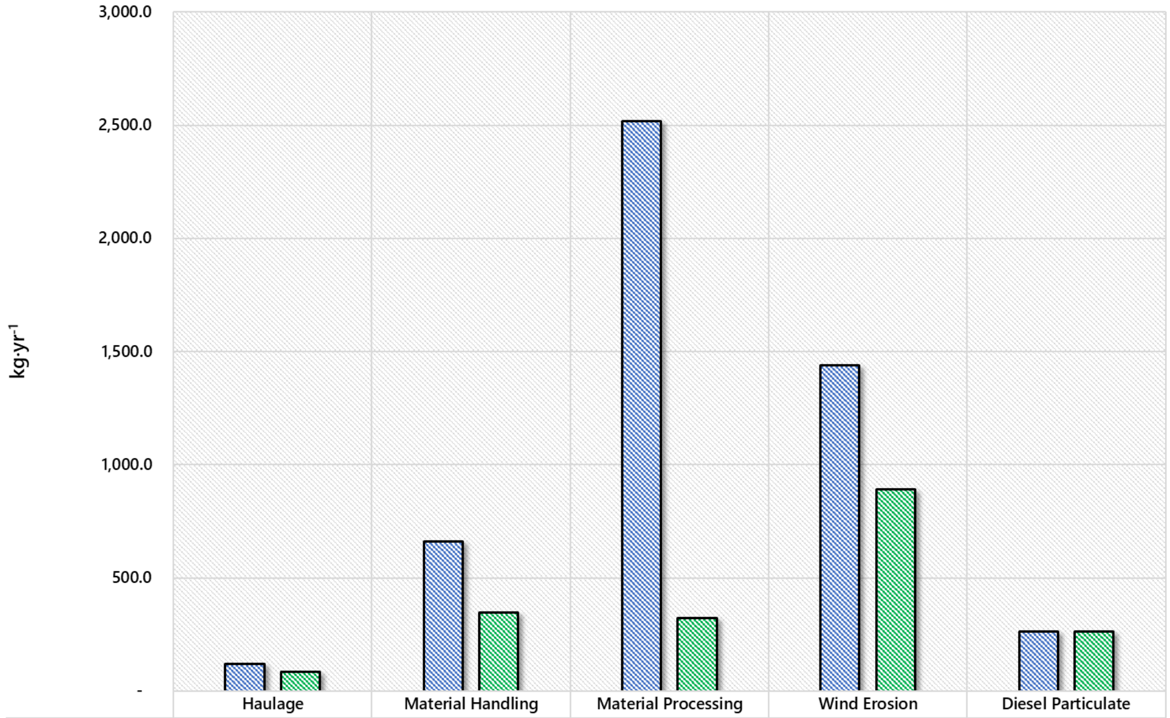
Based on the foregoing and the information provided in **Appendix C**, the distribution of controlled particulate emissions across broad emissions categories is presented in **Figure 13** for PM_{10} (annual average scenario). Distributions for TSP and $PM_{2.5}$ are presented in **Appendix C** for both the annual average and peak 24-hour scenarios. The peak 24-hour scenario represents emissions under worst case operating conditions.

The approach adopted within this assessment in the assessment of wind erosion distributes emissions according to the wind speed across the site in each hour with zero wind erosion occurring during periods when the hourly wind speed is lower than the threshold wind velocity ($\leq 5.2\ m \cdot s^{-1}$) and emissions are increased by the cube of the wind speed during hours when the wind speed is greater than the threshold wind velocity ($> 5.2\ m \cdot s^{-1}$).

The USEPA (USEPA, 1998) approach assumes a constant emission across all hours, which in lower wind speeds (with associated poorer dispersion conditions) can result in unrealistic impacts at receptors.

The exposed areas adopted in the assessment which are available to be eroded by the wind have been assumed to be the full areas of the stockpile area. In reality, the area available for wind erosion at any one moment in time will be limited to those areas being or having been recently disturbed. That is, fresh particulate matter does not generally become available due to the action of the wind itself, but is made available by activities being performed on an area. However, a worst-case assessment has been performed which assumes a constant supply of particles for wind erosion.

Figure 13 Calculated uncontrolled & controlled annual PM_{10} emissions



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled PM10	120.7	661.5	2,517.0	1,439.9	264.6
Controlled PM10	84.5	346.5	323.9	891.4	264.6

Note: The emissions presented above (and in **Appendix C**) and associated results in **Section 6** reflect a 200 ktpa scenario. Wind erosion emissions are associated with observed wind speeds (from Gosford AWS).

6. CONSTRUCTION PHASE AIR QUALITY ASSESSMENT

As described in (Jackson Environment and Planning, 2017) and (Jackson Environment and Planning, 2018) the construction and enabling works for the project would involve two stages:

- The first stage will be construction work at the front of the site, involving demolition of some of the existing buildings, construction of a front office and workshop, front parking areas and installation of the security fencing. This stage has been approved by Central Coast Council and is currently under construction. Only impacts associated with the second stage are considered within this AQIA.
- The second stage involves clearing of vegetation, earthworks to facilitate on-site drainage, construction of on-site roads, construction of a hardstand area, construction of a stormwater management system, construction of a noise barrier, construction of product storage bays, construction of the three-sided waste tipping and spreading shed, construction of the crusher and grinder enclosures, and the installation of processing equipment in the processing area and secondary sorting warehouse.

The development and grading of the site will require both cut and fill, and the volumes have been derived from cut and fill estimates produced by Cardno, which are presented in **Table 15**

Table 15 Cut and fill estimates – construction phase

Activity	Cut volume (m^3)	Fill volume (m^3)	Balance volume (m^3)
Building pad	5	2,800	-2,795
Site roads	310	3,730	-3,420
Existing stockpiles	18,090	0	18,090
Total	18,405	6,530	11,875

The net balance equates to approximately 12,000 m^3 (rounded up) of material cut from the site as a result of the construction phase activities, and principally generated through the regrading of the existing stockpiles. That volume of cut material however will not be exported directly from the site and will be recycled as product (depending upon type and quality).

The footprint of the project site which is to be affected is estimated as: approximately 39,000 m^2, or 3.9 hectares (ha), in area.

The assumed supply route around the site during construction works may be up to 1 km as a loop to the southern extent of the processing area and back to the site entrance on Gindurra Road. It is anticipated that >50 heavy vehicle movements would be required each day to service the site, during peak periods of construction activities.

For the purposes of the assessment, the route for construction traffic to/from the site is assumed to be (i) along Gindurra Road to the left, along Wisemans Ferry Rd then onto Pacific Highway or the Central Coast Highway. No construction vehicles are to turn right and enter onto Debenham Rd.

6.1 Step 1: Screening Based on Separation Distance

The screening criteria applied to the identified sensitive receptors are whether they are located in excess of:

- 350 m from the boundary of the site.
- 500 m from the site entrance.
- 50 m from the route used by construction vehicles on public roads.
- Track-out is assumed to affect roads up to 100 m from the site entrance.

Table 16 presents the identified discrete sensitive receptors, with the corresponding estimated screening distances as compared to the screening criteria.

Table 16 Construction phase impact screening criteria distances

Rec	Location	Land Use	Screening Distance (m approx.)		
			Boundary (350m)	Site Entrance (500m)	Const. route (50m)
R1	242 Debenham Road South, Somersby	Residential	35	125	20
R2	10 Acacia Road, Somersby	Residential	80	190	20
R3	32 Acacia Road, Somersby	Residential	20	420	280
R4	198 Debenham Road South, Somersby	Residential	420	520	20
R5	252 Debenham Road South, Somersby	Residential	260	350	20
R6	10 Singleton Point Road, Clare	Residential	>1,000	>1,000	250
R7	26 Old Mount Penang Road, Kariong	Residential	>1,000	>1,000	255
R8	95 Mitchell Drive, Kariong	Residential	>1,000	>1,000	190
I1	244 Debenham Road North, Somersby	Industrial	500	500	20
I2	58 Gindurra Road, Somersby	Industrial	190	290	20
I3	44 Gindurra Road, Somersby	Industrial	260	440	140
I4	2 Wella Way, Somersby	Industrial	105	440	290
I5	33 Kangoo Road, Somersby	Industrial	105	640	540
I6	3 Central Coast Highway, Kariong	Correctional Centre	150	>1,000	40
I7	3 Central Coast Highway, Kariong	Education	55	>1,000	680
I8	1A Central Coast Highway, Kariong	Education	175	>1,000	660
I9	3 Central Coast Highway, Kariong	Correctional Centre	600	>1,000	750
I10	1A Central Coast Highway, Kariong	Education	600	>1,000	470
I11	1A Central Coast Highway, Kariong	Education	640	>1,000	490
I12	10 Festival Drive, Kariong	Education	>1,000	>1,000	180
I13	1A Central Coast Highway, Kariong	Education	600	>1,000	340

With reference to **Table 16**, a number of sensitive receptors are noted to be within the screening distance boundaries and therefore require further assessment as summarised in **Table 17**.

Table 17 Application of Step 1 screening

Construction Impact	Screening Criteria	Step 1 Screening	Comments
Demolition	350 m from boundary 500 m from site entrance	Screened	Demolition to occur in Stage 1 – not relevant to this AQIA
Earthworks	350 m from boundary 500 m from site entrance	Not screened	Receptors identified within the screening distance
Construction	350 m from boundary 500 m from site entrance	Not screened	
Track-out	100 m from site entrance	Screened	No receptors identified within the screening distance
Construction Traffic	50 m from roadside	Not screened	Receptors identified within the screening distance

6.2 Step 2: Risk from Construction Activities

Based upon the above assumptions and the assessment criteria presented in **Appendix D**, the dust emission magnitudes are as presented in **Table 18**.

Table 18 Construction phase impact categorisation of dust emission magnitude

Activity	Detail	Dust Emission Magnitude
Demolition	*screened at Step 1*	*screened at Step 1*
Earthworks and enabling works	>10,000 m^2 earthworks area	large
Construction	<25,000 m^3 building volume[(a)]	small
Track-out	*screened at Step 1*	*screened at Step 1*
Construction traffic routes	>10,000 m^2 earthworks area	large

Note (a) Includes construction of noise barrier, material storage bins, 3-sided tip and spread shed, and crusher and grinder enclosures. Secondary Processing Warehouse will be re-purposed and requires minor fit-out only.

6.3 Step 3: Sensitivity of an Area

6.3.1 Land Use Value

Based on the criteria listed in **Appendix D**, the land use value of the area surrounding the site is concluded to be *high* for health impacts and for dust soiling, based upon the following assumption:

- The receptor locations include residential properties where people may reasonably be expected to be present for eight to 24-hours.

Medium land use values are also identified in the area immediately surrounding the site in locations where people are anticipated to be employed (as opposed to residing).

Given that the highest sensitivity land uses would tend to define the level of control required to minimise impacts, it is considered that these sensitivity land uses are appropriately considered for both health and dust soiling effects. This value is used to derive *the sensitivity of the area*.

6.3.2 Sensitivity of an Area

Using the classifications shown in **Appendix D**, the sensitivity of the surrounding area to (i) health effects and (ii) dust soiling may be identified.

The assumed existing background annual average PM_{10} concentrations (as measured at Wyong in 2015) are reported in **Section 4.2**. As presented in **Table 7** the annual average PM_{10} concentration as measured at Wyong in 2015 was 14.9 µg m^{-3}, which provides the sensitivity of the area as *low* for dust health impacts.

The sensitivity of the area to dust soiling effects is assessed as a function of land use value, number of receptors and the distance to the site boundary. For this assessment, the sensitivity to dust soiling effects is assessed as being *high*, which seems intuitive given the proximity of receptors to the site boundary.

6.4 Step 4: Risk (Pre-Mitigation)

Given the dust emission magnitudes for the various construction phase activities as shown in **Section 6.2** (Step 2) and the sensitivity of the identified receptors as determined in **Section 6.3**, the resulting risk of air quality impacts (without mitigation) is as presented in **Table 19**.

Table 19 Risk of air quality impacts from construction activities

Impact	Sensitivity of Area	Dust Emission Magnitude					Preliminary Risk				
		Demolition	Earthworks	Construction	Track-out	Const. Traffic	Demolition	Earthworks	Construction	Track-out	Const. Traffic
Human Health	low	n/a	large	small	n/a	large	n/a	low	negl	n/a	low
Dust Soiling	high	n/a	large	small	n/a	large	n/a	high	low	n/a	high

The preliminary risk assessment summarised in **Table 19** indicates that with no mitigation measures there is a *low risk* of human health effects associated with construction phase activities. These are associated with emissions from earthworks and from construction traffic.

Table 18 indicates that there is a *high risk* of adverse dust soiling (amenity) impacts if no mitigation measures were to be applied to control emissions, in relation to earthworks and construction traffic. There is also a low impact associated with construction.

This preliminary risk assessment is used to identify appropriate construction-phase mitigation controls to be applied to those activities during the construction phase.

6.5 Step 5: Identified Mitigation

Table 20 lists the relevant mitigation measures identified, and have been presented as follows:

- **N** = not required (although they may be implemented voluntarily).
- **D** = desirable (to be considered as part of the CEMP, but may be discounted if justification is provided).
- **H** = highly recommended (to be implemented as part of the CEMP, and should only be discounted if site-specific conditions render the requirement invalid or otherwise undesirable).

The following measures are recommended as *highly recommended* (H) or *desirable* (D) by the IAQM methodology for a *low* risk site for earthworks, construction and construction traffic. A detailed review of the recommendations would be performed once details of the construction phase are available.

For clarity, these management measures are associated with construction activities. Specific mitigation and management measures to reduce particulate matter emissions during operations are outlined in **Section 5.2.4**.

Table 20 Site-Specific Management Measures

Recommended Mitigation Measure		Risk & Recommendation
1	Communications	High
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	**H** to be implemented
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	**H** to be implemented
1.2	Display the head or regional office contact information.	**H** to be implemented

Recommended Mitigation Measure		Risk & Recommendation
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	**H** to be implemented
2	**Site Management**	**High**
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	**H** to be implemented
2.2	Make the complaints log available to the local authority when asked.	**H** to be implemented
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	**H** to be implemented
2.4	Hold regular liaison meetings with other high-risk construction sites within 500 m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes.	**H** to be implemented
3	**Monitoring**	**High**
3.1	Undertake daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary.	**H** to be implemented
3.2	Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and make an inspection log available to the local authority when asked.	**H** to be implemented
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	**H** to be implemented
3.4	Agree dust deposition, dust flux, or real-time continuous monitoring locations with the relevant regulatory bodies. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences.	**H** to be implemented
4	**Preparing and Maintaining the Site**	**High**
4.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	**H** to be implemented
4.2	Erect solid screens or barriers around dusty activities or the site boundary that they are at least as high as any stockpiles on site.	**H** to be implemented
4.3	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	**H** to be implemented
4.4	Avoid site runoff of water or mud.	**H** to be implemented
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	**H** to be implemented

Recommended Mitigation Measure		Risk & Recommendation
4.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below	**H** to be implemented
4.7	Cover, seed or fence stockpiles to prevent wind erosion	**H** to be implemented
4.8	Conduct regular sweeping of paved areas to reduce soiling and potential for dust generation on hot, dry windy days	**H** to be implemented
4.9	Apply surface moisture / water to all paved areas on dry, hot windy days to avoid dust generation	**H** to be implemented
5	Operating Vehicle/Machinery and Sustainable Travel	High
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	**H** to be implemented
5.2	Ensure all vehicles switch off engines when stationary - no idling vehicles	**H** to be implemented
5.3	Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable	**H** to be implemented
5.4	Impose and signpost a maximum-speed-limit of 25 $km \cdot h^{-1}$ on surfaced and 15 $km \cdot h^{-1}$ on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate	**H** to be implemented
5.4	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	**H** to be implemented
5.5	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	**H** to be implemented
6	Operations	High
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems	**H** to be implemented
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate	**H** to be implemented
6.3	Use enclosed chutes and conveyors and covered skips	**H** to be implemented
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	**H** to be implemented
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	**H** to be implemented

Recommended Mitigation Measure		Risk & Recommendation
7	Waste Management	High
7.1	Avoid bonfires and burning of waste materials.	**H** to be implemented
8	Measures Specific to Demolition	n/a
9	Measures Specific to Construction	Low
9.1	Avoid scabbling (roughening of concrete surfaces) if possible	**D** to be considered
9.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	**D** to be considered
10	Measures Specific to Track-Out	n/a
11	Specific Measures to Construction Traffic (adapted)	High
11.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	**H** to be implemented
11.2	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	**H** to be implemented
11.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	**H** to be implemented
11.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	**H** to be implemented
11.5	Record all inspections of haul routes and any subsequent action in a site log book.	**H** to be implemented

Notes D = desirable (to be considered), H = highly recommended (to be implemented), N = not required (although can be voluntarily implemented)

6.6 Step 6: Risk (Post-Mitigation)

For almost all construction activity, the adapted methodology notes that the aim should be to prevent significant effects on receptors through the use of effective mitigation and experience shows that this is normally possible.

Given the limited size of the site, residual impacts associated with fugitive dust emissions from the project construction activities would be anticipated to be '*low*' or '*not significant*'.

7. OPERATIONAL PHASE AIR QUALITY ASSESSMENT

The methodology used to assess operational phase impacts is discussed in **Section 4.5**. This section presents the results of the dispersion modelling assessment and uses the following terminology:

- Incremental impact – relates to the concentrations predicted as a result of the operation of the project in isolation.
- Cumulative impact – relates to the concentrations predicted as a result of the operation of the project PLUS the background air quality concentrations discussed in **Section 4.2**.

The results are presented in this manner to allow examination of the likely impact of the project in isolation and the contribution to air quality impacts in a broader sense.

The dispersion modelling results presented in the following sections indicate that the proposed project will meet all NSW EPA air quality standards and goals, even under worst case scenario conditions.

In the presentation of results, the tables included shaded cells which represent the following:

Model prediction	Pollutant concentration / deposition rate less than the relevant criterion	**Pollutant concentration / deposition rate equal to, or greater than the relevant criterion**

7.1 Particulate Matter - Annual Average TSP, PM_{10}, $PM_{2.5}$ and silica

The predicted annual average particulate matter concentrations (as TSP, PM_{10} and $PM_{2.5}$) resulting from the proposed operations at the project site are presented in **Table 21**.

In the interests of transparency, the change in predicted concentrations at each receptor when compared to those presented in the previous AQIA is presented in **Appendix E**.

The results indicate that predicted incremental concentrations of TSP, PM_{10} and $PM_{2.5}$ at receptor locations are low (<5% of the annual average TSP criterion, <5% of the annual average PM_{10} criterion and <6% of the $PM_{2.5}$ criterion).

The addition of existing background concentrations (refer **Section 4.2**) results in predicted concentrations of annual average TSP being less than 42%, annual average PM_{10} being less than 65% and annual average $PM_{2.5}$ being less than 71% of the relevant criteria at the nearest receptors.

Adjustment of the annual average $PM_{2.5}$ modelling results to account for the potential worst-case silica content of processed materials (67%, refer **Section 3.3**) results in a predicted incremental RCS concentration at the worst affected receptor of 0.28 $\mu g{\cdot}m^{-3}$ (0.4 $\mu g{\cdot}m^{-3}$ x 67%) which represents >10 % of the criterion. Even with the addition of a background concentration of 0.7 $\mu g{\cdot}m^{-3}$, the maximum RCS concentration is less than one third of the Victorian EPA and the California EPA Office for Environmental Health Hazard Assessment annual average criterion of 3 $\mu g{\cdot}m^{-3}$. These results clearly indicate that the project will not negatively impact on the health of the community, even at the closest residential receptor.

The predicted concentrations presented above are shown to be minor and even with the addition of a contribution from the Gosford Quarries operation next door (which is likely to be approximately 26% of those emitted by the project), cumulative impacts would still be well below the respective annual average criteria.

Table 21 Predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations

Receptor	Annual Average Concentration (µg·m⁻³)								
	TSP			PM_{10}			$PM_{2.5}$		
	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact	Incremental Impact	Background	Cumulative Impact
R1	3.7	32.8	36.5	1.0	14.9	15.9	0.4	5.2	5.6
R2	4.3	32.8	37.1	1.2	14.9	16.1	0.4	5.2	5.6
R3	2.1	32.8	34.9	0.7	14.9	15.6	0.2	5.2	5.4
R4	1.3	32.8	34.1	0.3	14.9	15.2	0.1	5.2	5.3
R5	2.1	32.8	34.9	0.6	14.9	15.5	0.2	5.2	5.4
R6	0.1	32.8	32.9	<0.1	14.9	15.0	<0.1	5.2	5.3
R7	0.2	32.8	33.0	<0.1	14.9	15.0	<0.1	5.2	5.3
R8	0.2	32.8	33.0	<0.1	14.9	15.0	<0.1	5.2	5.3
I1	0.4	32.8	33.2	0.1	14.9	15.0	<0.1	5.2	5.3
I2	1.2	32.8	34.0	0.4	14.9	15.3	0.1	5.2	5.3
I3	1.1	32.8	33.9	0.3	14.9	15.2	0.1	5.2	5.3
I4	2.0	32.8	34.8	0.7	14.9	15.6	0.2	5.2	5.4
I5	1.3	32.8	34.1	0.4	14.9	15.3	0.1	5.2	5.3
I6	0.9	32.8	33.7	0.3	14.9	15.2	0.1	5.2	5.3
I7	0.8	32.8	33.6	0.2	14.9	15.1	0.1	5.2	5.3
I8	0.6	32.8	33.4	0.2	14.9	15.1	0.1	5.2	5.3
I9	0.3	32.8	33.1	0.1	14.9	15.0	<0.1	5.2	5.3
I10	0.3	32.8	33.1	0.1	14.9	15.0	<0.1	5.2	5.3
I11	0.3	32.8	33.1	0.1	14.9	15.0	<0.1	5.2	5.3
I12	0.2	32.8	33.0	0.1	14.9	15.0	<0.1	5.2	5.3
I13	0.3	32.8	33.1	0.1	14.9	15.0	<0.1	5.2	5.3
Criterion	-	90		-	25		-	8	

No contour plots of annual average TSP, PM_{10} or $PM_{2.5}$ are presented, given the minor predicted contribution from the operations at the project site at the nearest relevant sensitive receptors.

7.2 Particulate Matter – Annual Average Dust Deposition Rates

Table 22 presents the annual average dust deposition predicted as a result of the operations at the project site.

In the interests of transparency, the change in predicted concentrations at each receptor when compared to those presented in the previous AQIA is presented in **Appendix E**.

Table 22 Predicted annual average dust deposition

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Incremental Impact	Background	Cumulative Impact
R1	0.3	2.0	2.3
R2	0.3	2.0	2.3
R3	0.2	2.0	2.2
R4	0.1	2.0	2.1
R5	0.1	2.0	2.1
R6	<0.1	2.0	2.1
R7	<0.1	2.0	2.1
R8	<0.1	2.0	2.1
I1	<0.1	2.0	2.1
I2	0.1	2.0	2.1
I3	0.1	2.0	2.1
I4	0.2	2.0	2.2
I5	0.1	2.0	2.1
I6	0.1	2.0	2.1
I7	<0.1	2.0	2.1
I8	<0.1	2.0	2.1
I9	<0.1	2.0	2.1
I10	<0.1	2.0	2.1
I11	<0.1	2.0	2.1
I12	<0.1	2.0	2.1
I13	<0.1	2.0	2.1
Criterion	2.0	-	4.0

An assumed background dust deposition of 2 g·m^{-2}·month^{-1} is presented in **Table 22**, although comparison of the incremental concentration with the incremental criterion of 2 g·m^{-2}·month^{-1} is also valid (as discussed within **Section 3**). In either case, the resulting conclusions drawn are identical. Annual average dust deposition is predicted to meet the criteria at all receptors surrounding the project site where the predicted impacts are 15 % of the incremental criterion at receptor locations. The addition of a minor increment associated with the Gosford Quarries operation would not alter this conclusion, and the impact is likely to be represented by the adopted background deposition level of 2 g·m^{-2}·month^{-1}.

No contour plot of annual average dust deposition is presented, given the minor predicted contribution from the operations at the project site at the nearest sensitive receptors.

7.3 Particulate Matter - Maximum 24-hour Average

Table 23 presents the maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations predicted to occur at the nearest residential receptors as a result of the operations at the project site only. No background concentrations are included within this table.

In the interests of transparency, the change in predicted concentrations at each receptor when compared to those presented in the previous AQIA is presented in **Appendix E**.

Table 23 Predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum incremental 24-hour average concentration ($\mu g \cdot m^{-3}$)	
	PM_{10}	$PM_{2.5}$
R1	9.8	2.9
R2	9.2	2.7
R3	13.0	2.8
R4	4.6	1.3
R5	5.7	1.4
R6	1.8	0.4
R7	2.5	0.7
R8	2.1	0.5
I1	2.5	0.5
I2	9.4	1.8
I3	4.6	1.1
I4	9.8	2.4
I5	9.7	1.8
I6	11.7	2.2
I7	6.5	1.4
I8	6.0	1.2
I9	3.0	0.6
I10	2.8	0.8
I11	4.5	0.9
I12	2.1	0.6
I13	3.1	0.9

At the receptor where the maximum impact is expected to occur (for PM_{10} - receptor R3, 32 Acacia Road, Somersby, and for $PM_{2.5}$ – receptor R1, 242 Debenham Road South, Somersby) operation of the project would contribute up to 26% of the 24-hour PM_{10} criterion and up to 12% of the 24-hour $PM_{2.5}$ criterion.

The predicted maximum 24-hour average PM_{10} and $PM_{2.5}$ concentrations resulting from the operation of the project, with background included are presented in **Table 24** and **Table 25** respectively.

Results are presented for the receptor at which the highest incremental impacts have been predicted (receptor R3 for PM_{10} and receptor R1 – 242 Debenham Road South, Somersby, refer **Table 23**). The left side of the tables show the predicted concentration on days with the highest background, and the right side shows the total predicted concentration on days with the highest predicted incremental concentrations.

Table 24 Summary of contemporaneous impact and background – PM_{10} Receptor R3

Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
06/05/2015	1.4	58.6	60.0	16/07/2015	13.0	8.8	21.8
26/11/2015	3.2	41.7	44.9	02/06/2015	10.6	11.4	22.0
17/10/2015	0.6	36.8	37.4	05/06/2015	10.0	10.3	20.3
06/10/2015	0.5	34.3	34.8	05/07/2015	7.6	10.8	18.4
27/11/2015	<0.1	33.7	33.8	27/05/2015	6.5	10.3	16.8
02/01/2015	0.4	33.2	33.6	26/05/2015	6.1	11.0	17.1
19/11/2015	0.2	33.1	33.3	11/05/2015	5.7	12.6	18.3
25/11/2015	0.3	32.9	33.2	09/05/2015	5.0	10.2	15.2
12/12/2015	<0.1	32.9	33.0	12/06/2015	4.9	0.0	4.9
07/10/2015	0.3	32.6	32.9	31/05/2015	4.8	7.6	12.4
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the project.			

One exceedance of the 24-hour average impact assessment criterion for PM_{10} is predicted although **no additional exceedances** are shown to eventuate because of the operation of the project. The predicted exceedance (highlighted in **Table 24**) is driven by the background air quality (i.e. existing sources) and is not contributed to by the proposed operations at the project site.

No exceedance of the 24-hour average $PM_{2.5}$ impact assessment criterion is predicted as a result of the project operations.

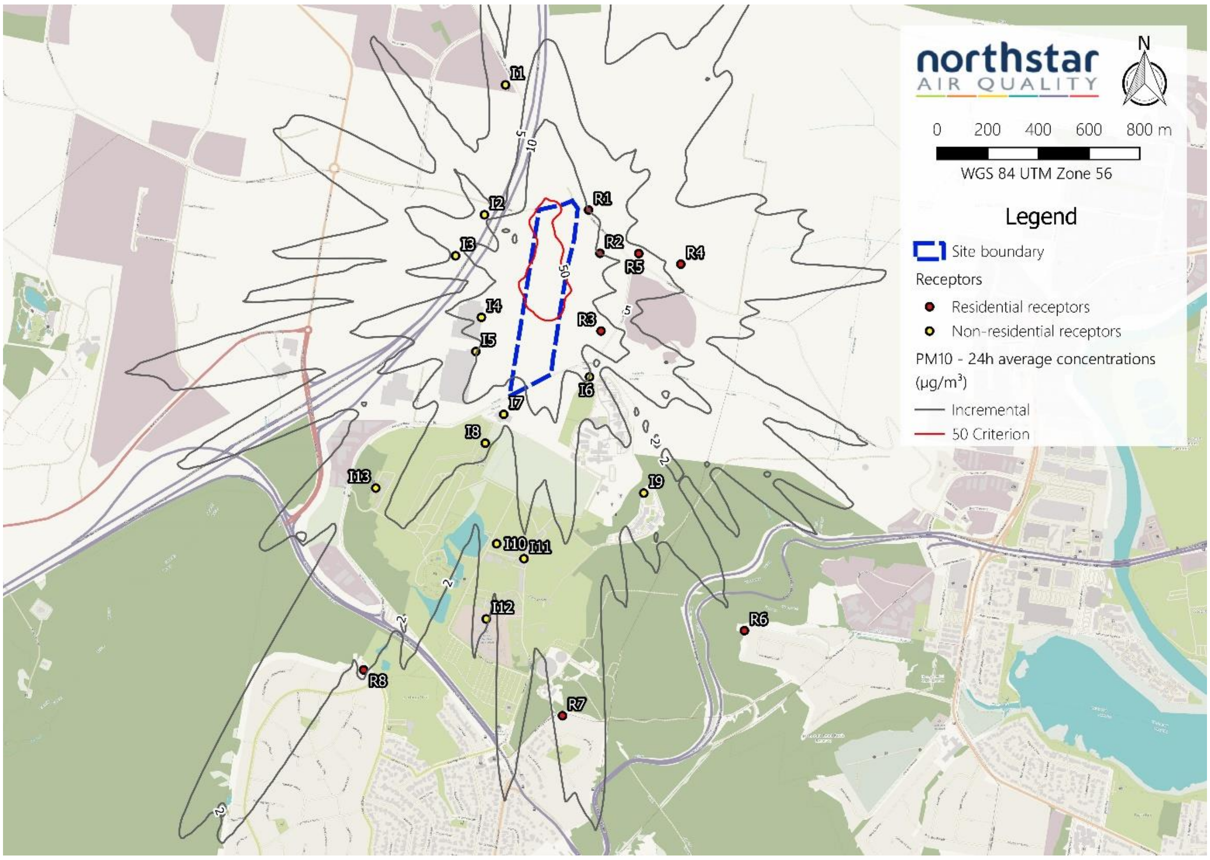
Addition of an appropriate increment associated with the Gosford Quarry operation is difficult, although assuming that maximum 24-hr emissions would also be 26% of the project site (as assumed for annual average emissions), and also assuming coincidental maximum impacts, the addition of approximately 3.4 $\mu g \cdot m^{-3}$ of PM_{10} (13.0 $\mu g \cdot m^{-3}$ x 26%) or 0.7 $\mu g \cdot m^{-3}$ of $PM_{2.5}$ (2.9 $\mu g \cdot m^{-3}$ x 26%) is unlikely to result in significant cumulative impacts which would result in additional exceedances occurring.

Table 25 Summary of contemporaneous impact and background – $PM_{2.5}$ Receptor R1

Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)			Date	24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)		
	Incremental Impact	Background	Cumulative Impact		Incremental Impact	Background	Cumulative Impact
09/03/2015	0.5	13.2	13.7	17/05/2015	2.9	4.1	7.0
20/11/2015	0.2	13.1	13.3	10/06/2015	2.5	6.6	9.1
12/03/2015	0.2	12.1	12.3	20/06/2015	2.0	4.8	6.8
21/08/2015	<0.1	11.7	11.8	16/05/2015	2.0	4.5	6.5
01/01/2015	0.1	11.2	11.3	07/07/2015	1.9	4.5	6.4
07/10/2015	<0.1	10.8	10.9	10/07/2015	1.9	5.1	7.0
10/03/2015	0.3	10.6	10.9	14/06/2015	1.9	7.4	9.3
17/10/2015	0.4	10.4	10.8	26/06/2015	1.7	4.8	6.5
20/12/2015	<0.1	10.6	10.7	24/05/2015	1.6	5.4	7.0
14/12/2015	0.1	10.4	10.5	13/06/2015	1.6	2.7	4.3
These data represent the highest Cumulative Impact 24-hour PM_{10} predictions (outlined in red) as a result of the operation of the project.				These data represent the highest Incremental Impact 24-hour PM_{10} predictions (outlined in blue) as a result of the operation of the project.			

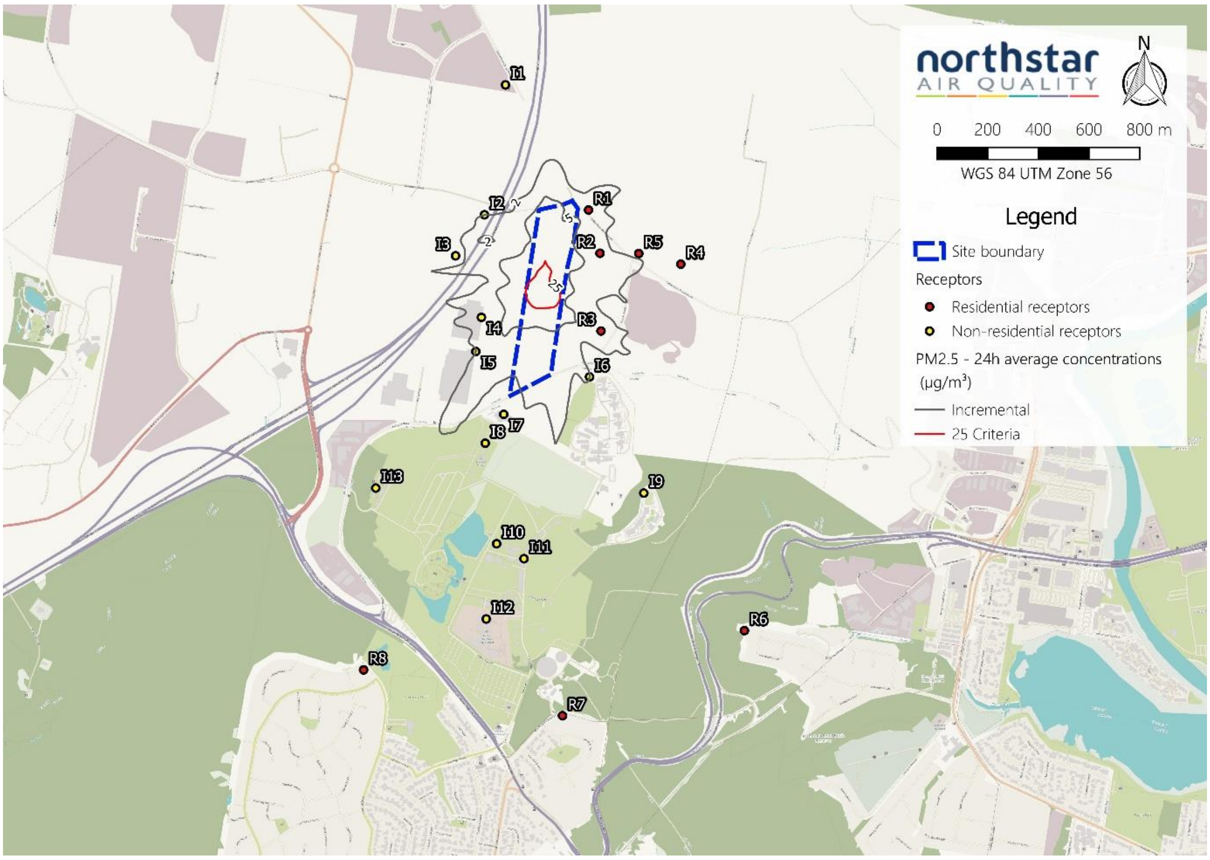
Contour plots of the incremental contribution of the proposed operations at the project site to the 24-hour average PM_{10} and $PM_{2.5}$ concentrations are presented in **Figure 14** and **Figure 15**.

Figure 14 Incremental 24-hour PM_{10} concentrations



Note 1: Criterion = 50 µg·m^{-3} (cumulative)

Figure 15 Incremental 24-hour $PM_{2.5}$ concentrations



Note 1: Criterion = 25 µg·m^{-3} (cumulative)

8. MITIGATION AND MONITORING

8.1 Construction Phase

Based on the findings of the construction phase air quality assessment, even with no mitigation measures there is a *low risk* of human health effects associated with construction phase activities. These are associated with emissions from earthworks and from construction traffic.

There is a *high risk* of adverse dust soiling (amenity) impacts if no mitigation measures were to be applied to control emissions, in relation to earthworks and construction traffic. There is also a low impact associated with construction.

A range of mitigation and management measures are presented in **Section 6.5**, which would result in the risks associated with construction to be reduced to *'low'* or *'not significant'*.

8.2 Operational Phase

8.2.1 Mitigation

Based on the findings of the operational phase air quality impact assessment, it is considered that the particulate control measures proposed to be implemented will be sufficient to ensure that exceedances of all particulate criteria would not be experienced as a result of the project operation.

It is noted that since the provision of the previous AQIA, the proponent has proposed a range of further particulate control measures including:

- The construction and use of enclosures on crushing and grinding/shredding operations with accompanying water sprays for dust suppression; and,
- The construction and use of a three-sided shed in which all materials would be tipped and sorted. This shed also incorporates the use of misting sprays to further mitigate particulate generation and wind erosion.

No additional exceedances of the 24-hour $PM_{2.5}$ or PM_{10} criteria are predicted as a result of the proposed activities at the project site. Whilst dispersion modelling predicts that one exceedance of the 24-hour PM_{10} criterion is likely at nearby residential locations, on that instance the incremental impact from the project operation resulting in the exceedance is very low with the background (non-project) concentration of 58.6 $\mu g \cdot m^{-3}$ already in exceedance of the 50 $\mu g \cdot m^{-3}$ criterion. The operations at the project site would not have contributed significantly during that day of exceedance.

A number of mitigation measures are proposed to be implemented as part of the project. Where defensible quantification of the control efficiencies afforded by these measures can be determined, these have been applied within the assessment. Additional measures may also be applied during certain wind conditions and although these measures have not been included within dispersion modelling (apart from stockpile watering during the assessment of maximum 24-hr impacts), they would act to further reduce the generation of particulate.

It is important to note that this assessment does not rely on unquantified emissions control efficiencies to achieve compliance with the environmental objectives, rather these unquantified emissions control efficiencies would act to further reduce impacts and provide further assurances that the objectives will be complied with.

The mitigation measures which will be used as part of the project operation are summarised in **Table 26**. These will be identified and implemented in the AQMMP.

Table 26 Summary of emission reduction methods adopted as part of project operation

Emission control method	Control efficiency (%)
Road Haulage	
Vehicle restrictions that limit the speed of vehicles on the road.	Not quantified
Surface improvement by paving	Assessed through emission factor
Surface treatment - watering	30
Surface treatment - sweeping	Not quantified
Materials Handling	
Enclosure of the tipping and spreading area	70
Minimising the drop height from vehicles	30
Application of water	50
Ceasing crushing, screening and grinding activities (and loading) when wind speeds >25 $km \cdot hr^{-1}$	Not quantified
Loading materials to a 3-sided enclosure	30
Covering loads with a tarpaulin	Not quantified
Limit load sizes to ensure material is not above the level of truck sidewalls	Not quantified
Minimising travel speeds and distances	Not quantified
Keep travel routes and materials moist	50
Materials Processing	
Application of water	91.6 (screen) 77.7 (crush) 50 (shred)
Enclosure of crushing and grinding/shredding activities and activities within 'secondary sorting warehouse'	70
Ceasing crushing, screening and grinding activities when wind speeds >25 $km \cdot hr^{-1}$	Not quantified

Emission control method	Control efficiency (%)
Wind Erosion	
Application of water	50
Stockpiles limited in height	30
3-sided enclosures around stockpiles	75
Modification of activities in windy conditions	Not quantified

Results of the dispersion modelling exercise indicate that all air quality criteria can be achieved at all surrounding residential and non-residential land uses with the controls adopted, which are considered to represent best practice.

8.2.2 Monitoring

The predictions presented in this AQIA indicate that there would be no additional exceedances of the adopted air quality criteria due to project operation. However, based on the level of community concern associated with the project, it is recommended that a campaign of air quality monitoring is performed, to provide the EPA and community with assurance that the site can be operated with the best practice measures outlined in the report without giving rise to unacceptable air quality impacts.

The design of the air quality monitoring programme would be fully documented within the AQMMP for the project site, the development of which is likely to be a condition of consent for the project. In the interests of providing sufficient information at this time to provide a broad structure of an air quality monitoring programme the following is noted:

- Continuous air quality monitoring would be performed at an appropriate location surrounding the project site before and during the project operation;
- As a minimum, measurements of PM_{10} would be made;
- A meteorological monitoring station would be installed to allow assessment of particulate concentrations and wind speeds/directions to assist in the assessment of any complaints received by the site;
- The meteorological monitoring would also assist in the refinement of site controls (e.g. application of water sprays, progressive cessation of operations);
- Review of the data obtained pre-development would allow a 'baseline' to be determined and would allow and concentrations measured post-development to be placed into context.

As part of this recommendation, an air quality validation assessment can be considered to ensure the facility is complying with conditions of consent prior to increasing production above 100,000 tpa, and furthermore, once the facility increases production over 150,000 tpa. This measure will provide the community and regulatory authorities with confidence that the facility is being operated in a manner consistent with the predictions in this study, and the health of the community and the environment is protected at all times.

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9. CONCLUSION

Jackson Environment & Planning Pty Ltd has engaged Northstar Air Quality Pty Ltd on behalf of Mrs Sue Davis to perform an air quality impact assessment for the proposed development of a designated State Significant Development (SSD8860), namely Kariong Sand and Soil Supplies site (the project) located at 90 Gindurra Road, Somersby NSW (the project site).

A previous version of the air quality impact assessment was submitted to support the Environmental Impact Statement for the project. Following a number of submissions from NSW Environment Protection Authority, NSW Department of Health, and the community, an updated air quality impact assessment has been prepared to respond to those submissions. The revised air quality impact assessment is presented within this document.

In summary, submissions on the previous air quality impact assessment indicated that stakeholders were concerned about the following:

- the cumulative impacts associated with the project and other sources of particulate matter in the area;
- the assessment of potential maximum daily discharges of particulate matter based on maximum achievable production rates;
- the requirement for additional information / clarification to justify the calculated emission rates;
- further analysis of modelled meteorological conditions;
- the employment of best practice particulate control measures to minimise emissions;
- the requirement for air quality monitoring as part of the project;
- potential health impacts of silica dust; and
- potential impacts of odour from stockpiled waste materials.

A full and detailed response to each of the issues above is presented within this report. Importantly, and in summary:

- the potential impacts associated with existing and proposed developments in the immediate area have been addressed;
- an updated dispersion modelling scenario, reflecting maximum potential daily material processing rates and the associated increase in vehicle movements has been subject to assessment;
- additional information / clarification has been provided in the report to allow replication of emission rate calculations;
- an updated meteorological modelling assessment adopting observational data has been performed, and a subsequent updated dispersion modelling approach adopted to assess the impact of emissions on the surrounding environment;
- additional particulate control measures have been adopted by the proponent in response to community concerns regarding dust. These additional control measures include:
    - the construction of buildings around crushing and grinding/mulching operations with water sprays to suppress dust; and,

    - the construction of a building to enclose the tip and spread area on three sides and the inclusion of water misting sprays to reduce dust emissions further.

  The additional measures have been included in the updated dispersion modelling assessment.

- an air quality monitoring program incorporating continuous measurement of particulate matter is proposed;
- an assessment of the impacts of respirable crystalline silica indicate that increases due to the project may be up to 10 % of the relevant criterion as an absolute maximum, based on worst case assumptions; and
- impacts associated with odour will not be an issue as the project will not accept odorous materials.

A range of emissions control measures (including those additional measures adopted and outlined above) would be implemented as part of the project operation and these are discussed in detail in the main body of the report. It is considered that the measures adopted represent best practice dust control, including:

- Sorting and processing operations are conducted within a controlled environment in the Secondary Sorting Warehouse, with accompanying misting systems for dust control;
- Enclosure of the tipping and spreading bays, with misting systems for dust control during tipping;
- Enclosure of the grinding and mulching operations, with accompanying misting systems to avoid dust generation;
- Misting systems on outdoor storage bays for landscaping and civil supply materials to avoid dust being generated;
- Additional management controls to cease operations on the site on windy days;
- Sweeping, watering down and maintenance of all hard surfaces and roadways to keep surfaces clean to avoid dust being generated on dry, hot days.

The control measures which are adopted have been demonstrated to ensure that the environmental objectives are achieved. These measures would be implemented through an Air Quality Management and Monitoring Plan and in line with environmental best practice.

A risk-based assessment of the potential construction phase air quality impacts indicates that the implementation of a range of mitigation measures would be required to ensure that the risks (both health and amenity) to the surrounding community would be low or not significant.

The updated air quality impact assessment has considered worst case operational parameters, including material processing rates at absolute maximum throughout, and an increase in vehicle traffic bringing materials to site.

The results of the assessment, with the incorporation of a range of particulate matter control measures, indicate that all adopted air quality criteria will be achieved at all surrounding sensitive receptor locations.

One exceedance of the 24 hr PM_{10} criterion is noted, although this was due to an 'exceptional' event (a dust storm which affected PM_{10} concentrations at the Wyong site and in a wider area, from Albury to Sydney and to Tamworth). Significantly, the project is demonstrated not to contribute to any additional exceedances of the air quality criteria.

It is recommended that air quality monitoring is performed to provide the community and EPA with assurance that the site can be operated with the best practice measures outlined in the report and without giving rise to unacceptable air quality impacts, implemented through an Air Quality Management and Monitoring Plan. As part of this recommendation, an air quality validation assessment can be considered to ensure the facility is complying with conditions of consent prior to increasing production above 100,000 tonnes per annum, and furthermore, once the facility increases production over 150,000 tonnes per annum. This measure will provide the community and regulatory authorities with confidence that the facility is being operated in a manner consistent with the predictions in this study, and the health of the community and the environment is protected at all times.

The results of the air quality impact assessment indicate that the granting of Development Consent for the project should not be rejected on the grounds of air quality.

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APPENDIX A

Background Air Quality

Air quality monitoring is performed by the NSW Office of Environment and Heritage (OEH) at three air quality monitoring station (AQMS) within a 50 km radius of the project site. Details of the monitoring performed at these AQMS is presented in **Table A1** with the location of the stations being illustrated in **Figure A1**.

Table A1 Details of closest AQMS surrounding the project site

Site Name	Distance from Project site (km)	Commissioned	Particulate measurements performed
Wyong	19.8	2012	PM_{10}, $PM_{2.5}$
Macquarie Park	41.9	2017	PM_{10}, $PM_{2.5}$
Lindfield	42.6	1994	PM_{10}

Air quality is not monitored at the project site and therefore air quality monitoring data measured at a representative location has been adopted for the purposes of this assessment.

Given that concentrations of PM_{10} and $PM_{2.5}$ are measured at the Wyong AQMS since 2012, and that AQMS is the closest to the project site, the use of air quality data collected as Wyong has been used for the purposes of this assessment. Data collected at Macquarie Park does not cover a sufficient time period, and data collected at Lindfield does not include $PM_{2.5}$ data. Furthermore, the environment surrounding the Wyong AQMS is similar to that surrounding the project site (non-urban, away from major sources of particulate emissions, similar population density).

Figure A1 Meteorological and air quality monitoring surrounding the project site

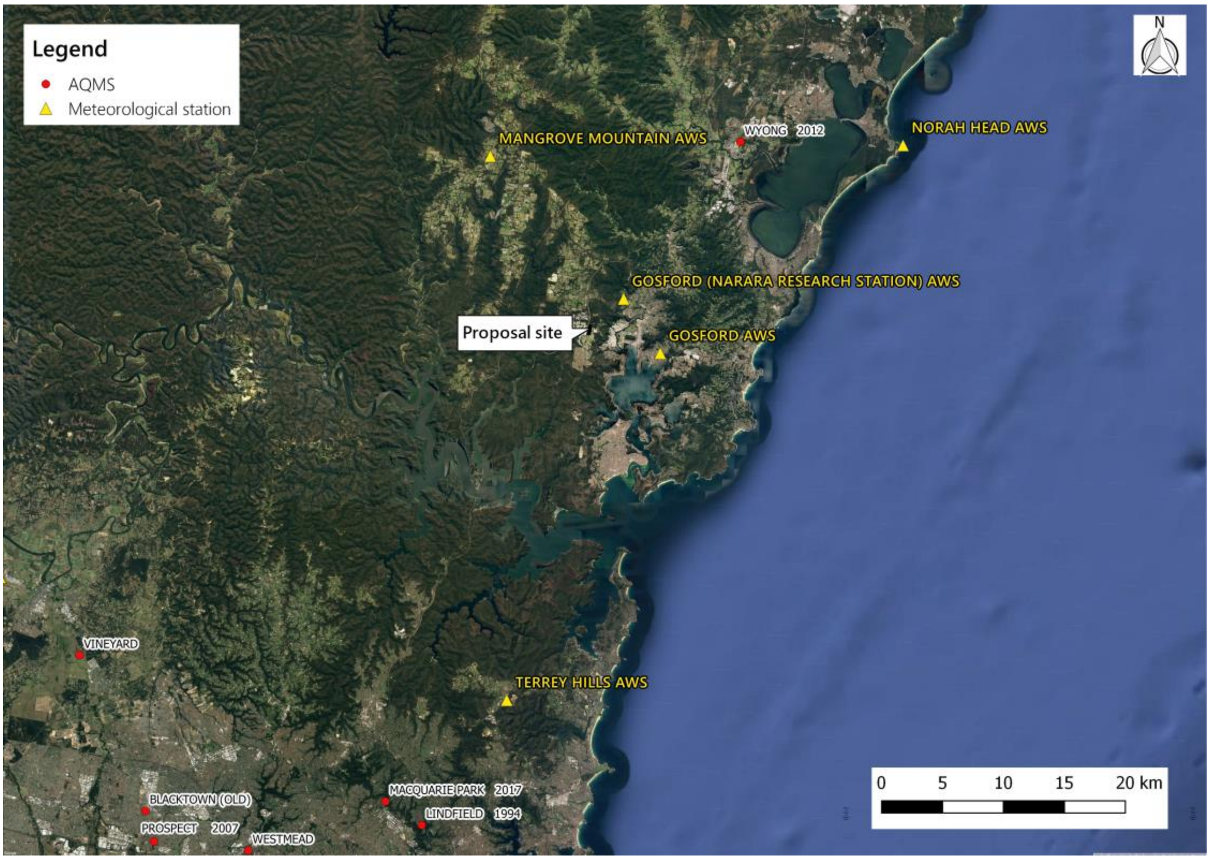


Table A2 presents statistics for PM_{10} and $PM_{2.5}$ monitoring at the Wyong AQMS in 2015.

For the reasons discussed above, PM_{10} and $PM_{2.5}$ monitoring data from the Wyong AQMS for the year 2015 have been used as a representation of the background conditions at the project site.

Table A2 PM$_{10}$ and PM$_{2.5}$ statistics for Wyong AQMS, 2015

Year	2015	2015
Pollutant	PM$_{10}$	PM$_{2.5}$
Averaging Period	24-hour	24-hour
Data Points (number)	361	355
Mean (µg·m^{-3})	14.9	5.2
Standard Deviation (µg·m^{-3})	6.8	2.1
Skew[1]	*+1.6*	*+0.9*
Kurtosis[2]	*+5.0*	*+0.9*
Minimum (µg·m^{-3})	3.1	1.4
Percentiles (µg·m^{-3})		
1	4.7	1.7
2	5.7	2.0
3	6.3	2.2
5	7.3	2.4
10	8.2	2.8
25	10.2	3.7
50	13.0	4.8
75	18.3	6.4
90	24.4	8.0
95	26.8	9.1
97	29.3	9.7
98	32.9	10.6
99	33.9	11.4
Maximum 1 (µg·m^{-3})	58.6	13.2
Maximum 2 (µg·m^{-3})	41.7	13.1
Maximum 3 (µg·m^{-3})	36.8	12.1
Data Capture (%)	98.9	97.3

Notes: **1:** Skew represents an expression of the distribution of measured values around the derived mean. Positive skew represents a distribution tending towards values higher than the mean, and negative skew represents a distribution tending towards values lower than the mean. Skew is dimensionless.

2: Kurtosis represents an expression of the value of measured values in relation to a normal distribution. Positive skew represents a more peaked distribution, and negative skew represents a distribution more flattened than a normal distribution. Kurtosis is dimensionless.

Figure A2 24-hour average PM_{10} measurements, Wyong 2015

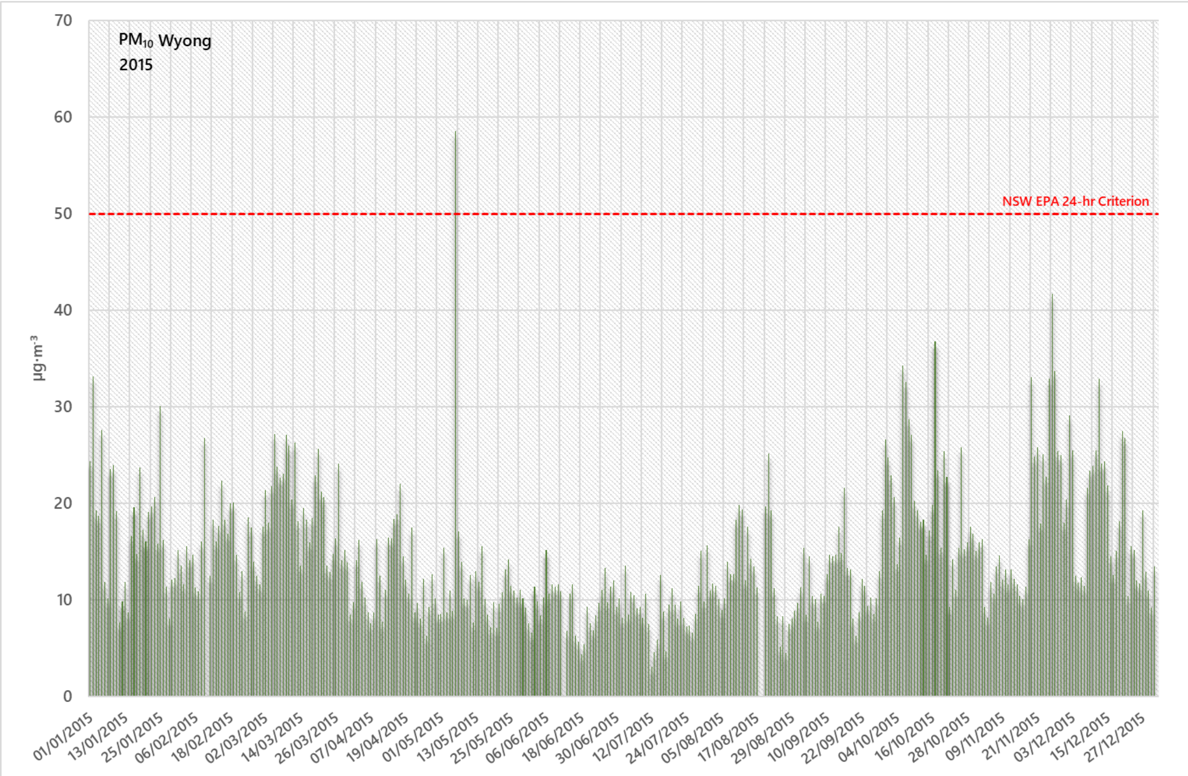
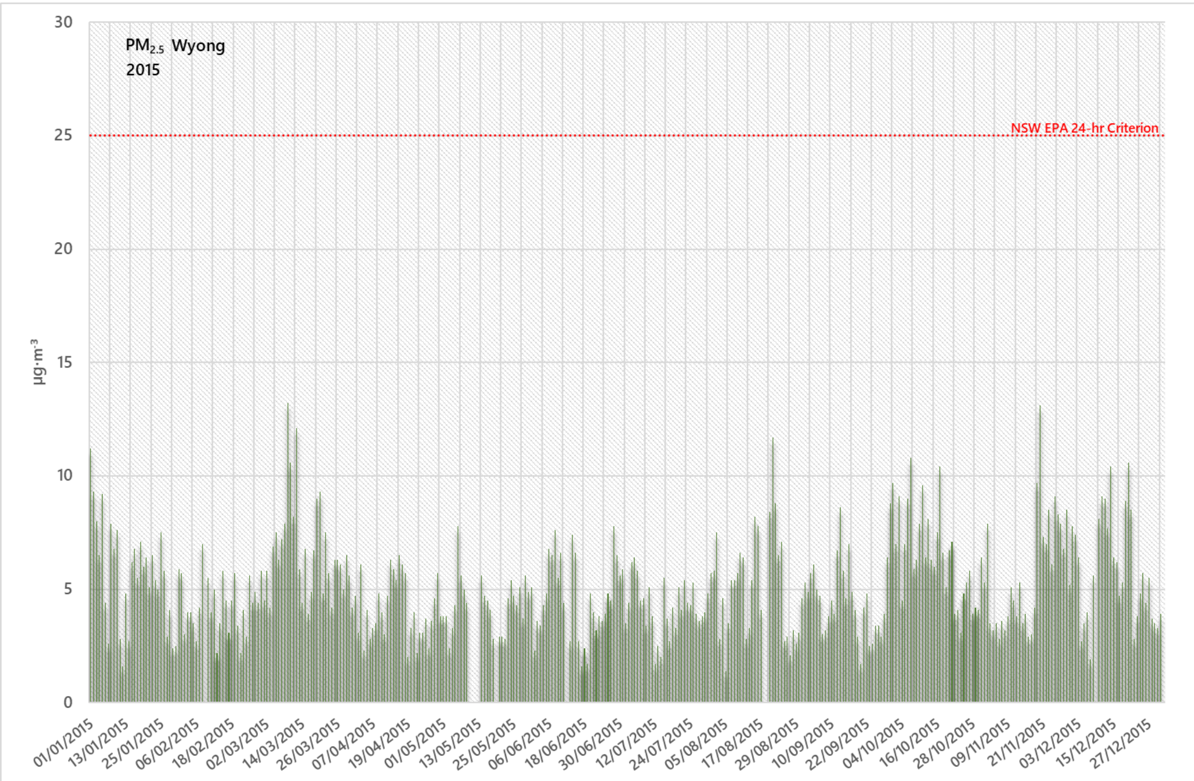
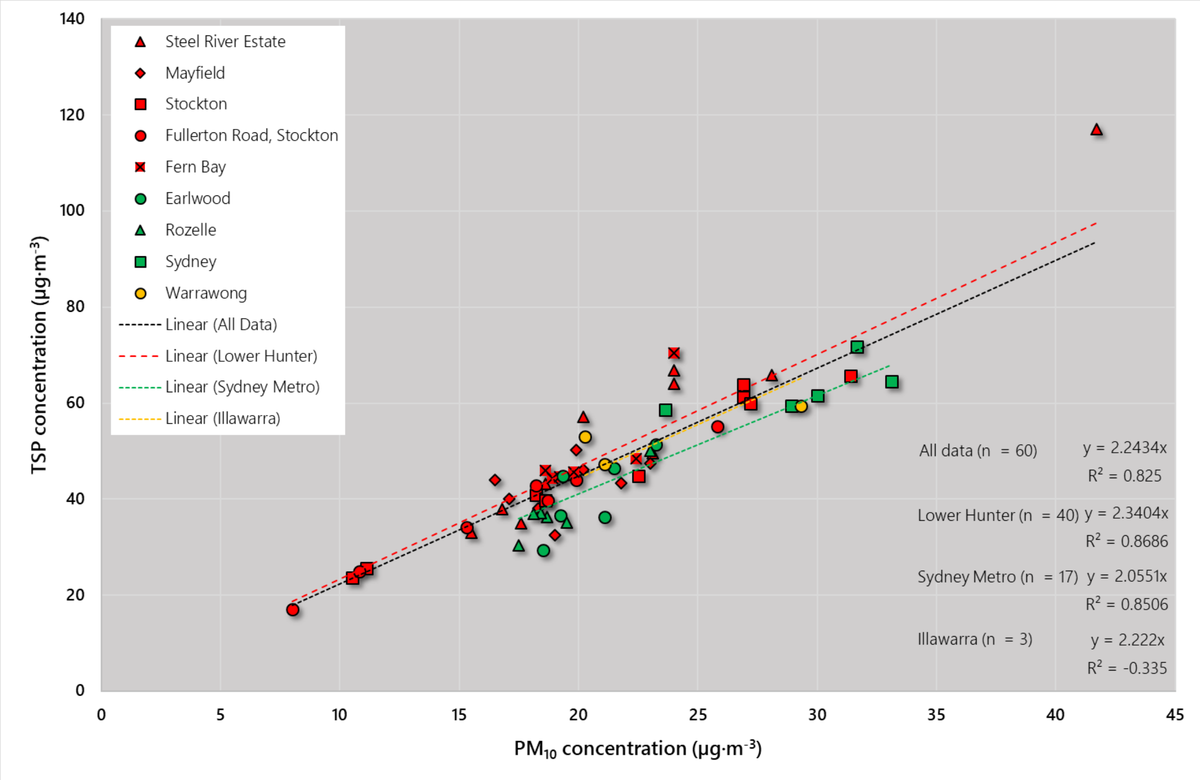


Figure A3 24-hour average $PM_{2.5}$ measurements, Wyong 2015



Concentrations of TSP are not measured by the NSW OEH at any AQMS surrounding the project site. An analysis of co-located measurements of TSP and PM_{10} in the Lower Hunter (1999 to 2011), Illawarra (2002 to 2004), and Sydney Metropolitan (1999 to 2004) regions is presented in **Figure A4**. The analysis concludes that, on the basis of the measurements collected in all regions between 1999 to 2011, the derivation of a broad TSP:PM_{10} ratio of 2.2 : 1 (i.e. PM_{10} represents ~45% of TSP) is appropriate. In the absence of any more specific information, this ratio has been adopted within this AQIA.

Figure A4 Co-located TSP and PM_{10} measurements, Lower Hunter, Sydney Metro and Illawarra



Similarly, no dust deposition data is available for the area surrounding the project site. The incremental impact criterion of 2 g·m^{-2}·month^{-1} as outlined within the Approved Methods has been adopted which effectively provides a background deposition level of 2 g·m^{-2}·month^{-1} (the total allowable deposition being 4 g·m^{-2}·month^{-1}).

Monitoring of respirable crystalline silica (RCS) is generally not conducted in the ambient environment as it is generally considered to be an occupational health issue. No monitoring data for silica is available in the area surrounding the project site. An AQIA performed on behalf of Hanson for the expansion of the Somersby Sand Quarry (SLR, 2012) adopted an annual average background silica concentration of 0.7 µg·m^{-3} which was based on data collected in Victoria. A study in the United Kingdom (Stacey, Thorpe, & Butler, 2018) measured RCS concentrations in both urban and rural environments with concentrations in urban areas being typically less than 0.3 µg·m^{-3} and in rural areas the median concentration measured was 0.02 µg·m^{-3}.

For the purposes of this assessment, a background RCS concentration of 0.7 μg·m^{-3} has been adopted which may be viewed as conservative.

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APPENDIX B

Meteorological Data Analysis

A summary of the relevant monitoring sites is provided in **Table B1** and also displayed in **Figure A1**.

Table B1 Details of the meteorological monitoring surrounding the project site

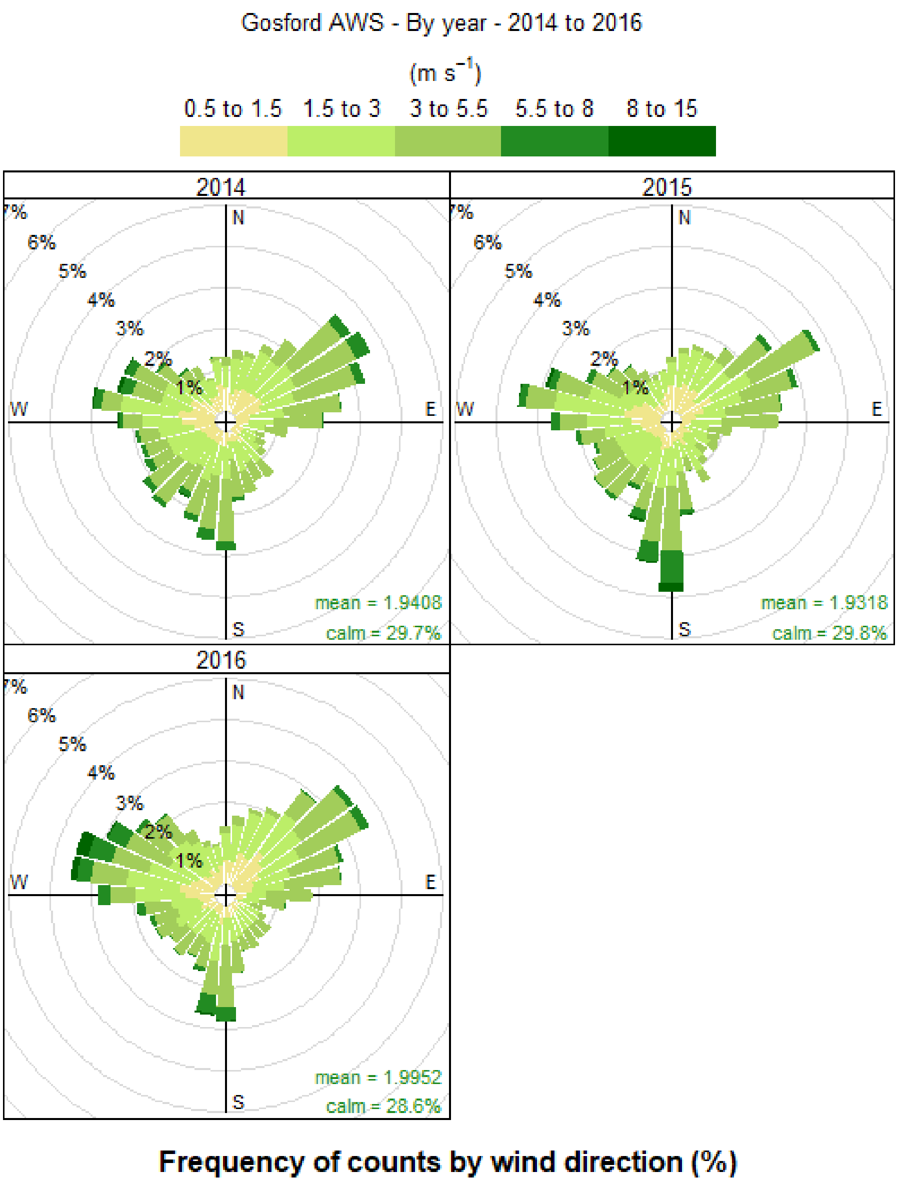
Site Name	Approximate Location (Latitude, Longitude)	
	˚S	˚E
Gosford AWS – Station # 61425	33.44	151.36
Gosford Narara AWS – Station # 61087	33.39	151.33
Mangrove Mountain AWS – Station # 61375	33.29	151.21

Meteorological conditions at Gosford AWS have been examined to determine a 'typical' or representative dataset for use in dispersion modelling. Annual wind roses for the most recent years of data (2014 to 2016) are presented in **Figure B1**. It is noted that Gosford AWS began monitoring in 2013.

The wind roses indicate that from 2014 to 2016, winds at Gosford AWS show north-westerly, north-easterly and southerly components to the wind direction.

The majority of wind speeds experienced at the Gosford AWS between 2014 and 2016 are generally in the range 1.5 metres per second ($m{\cdot}s^{-1}$) to 5.5 $m{\cdot}s^{-1}$ with the highest wind speeds (greater than 8 $m{\cdot}s^{-1}$) occurring from southerly and north-westerly directions. Winds of this speed are rare and occur during 0.4 % of the observed hours during the years. Calm winds (<0.5 $m{\cdot}s^{-1}$) prevail and occur more than 29 % of hours across the years.

Figure B1 Annual wind roses 2014 to 2016, Gosford AWS



Given the similarities in the wind distribution across the years examined, data for the year 2015 has been selected for further assessment. Presented in **Figure B2** are the annual wind rose for the 2014 to 2016 period and the year 2015 and in **Figure B3** the annual wind speed distribution for Gosford AWS. These figures indicate that the distribution of wind speed and direction in 2015 is very similar to that experienced across the longer-term period.

It is concluded that conditions in 2015 may be considered to provide a suitably representative dataset for use in dispersion modelling.

Figure B2 Annual wind roses 2014 to 2016, and 2015 Gosford AWS

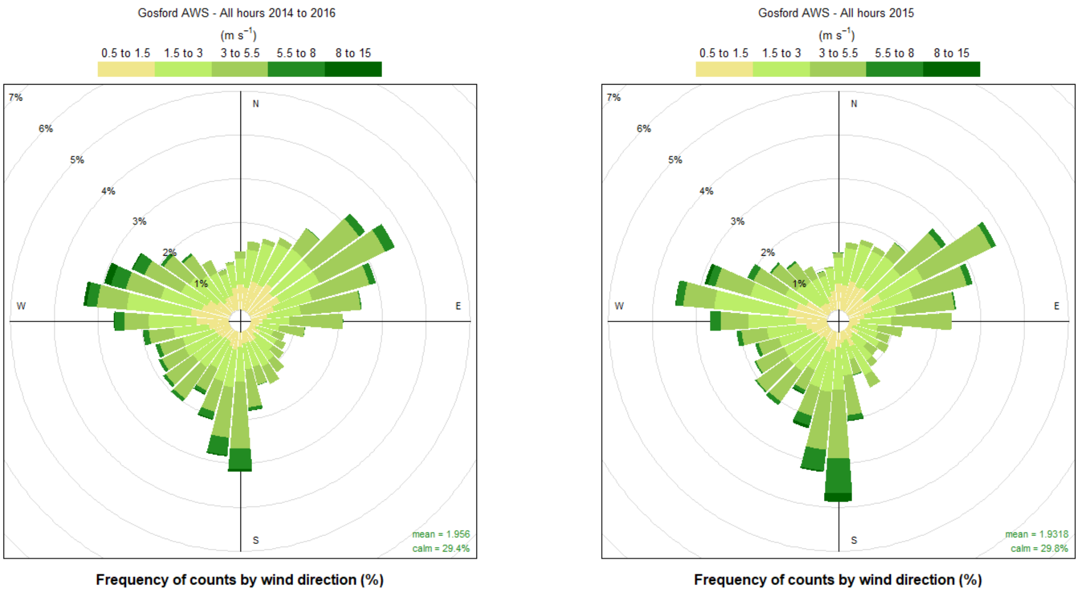
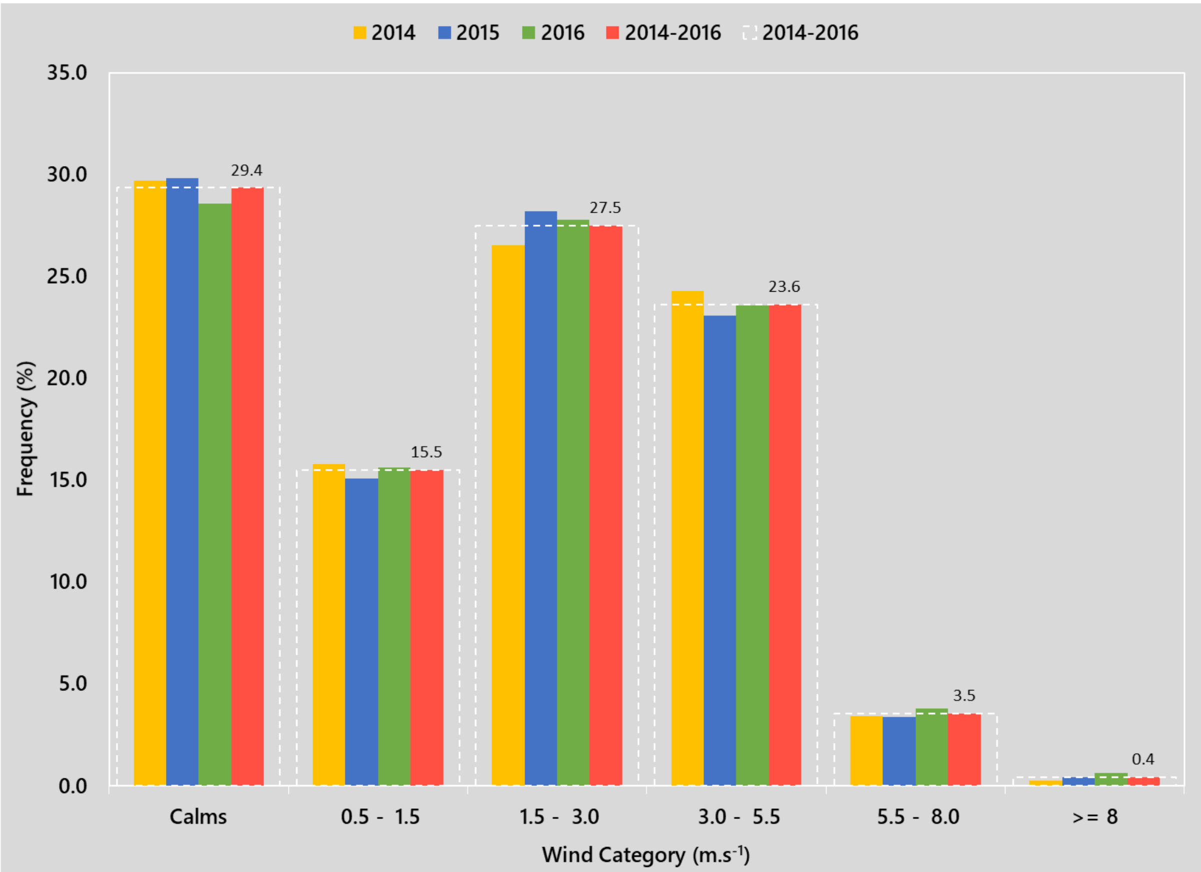


Figure B3 Annual wind speed distribution Gosford AWS



Meteorological Processing

The BoM data adequately covers the issues of data quality assurance, however it is limited by its location compared to the project site. To address these uncertainties, a multi-phased assessment of the meteorological data has been performed.

As previously discussed, three alternative approaches to meteorological data modelling (TAPM and WRF) failed to appropriately replicate observational data and an alternative approach utilising observational meteorological data has been taken (Method 1, 2 and 3). The dispersion modelling approach using the AERMOD dispersion model is discussed in detail in **Section 5.2.2** (Method 4).

AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain.

AERMOD requires the input of two meteorological files:

- a 'surface' data file of hourly boundary layer parameter estimates; and,
- a 'profile' data file of multiple-level observations of wind speed and direction, temperature, and standard deviation of the fluctuating components of the wind.

AERMET, a regulatory component of the AERMOD modelling system, organises available meteorological data, calculates the boundary layer parameters required by AERMOD and generates the two AERMOD ready meteorological data files.

Hourly surface observations from appropriate data sources and twice-daily upper air soundings and data from a site-specific meteorological measurement program can be processed in AERMET.

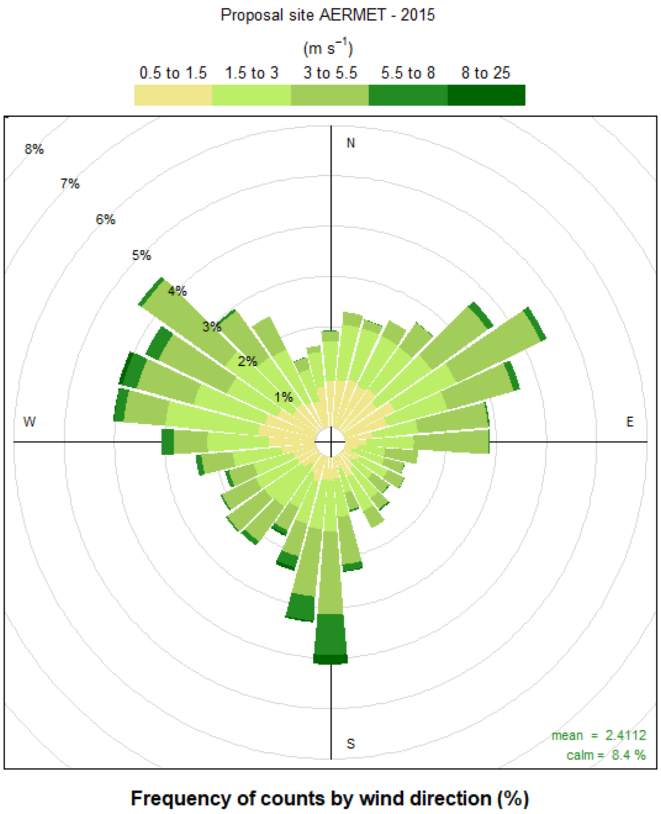
The required 'surface' and 'profile' data files were generated by AERMET using observational meteorological data from the US National Oceanic and Atmospheric Administration (NOAA), Bureau of Meteorology (BoM), and World Meteorological Association (WMO) as presented in **Table B2**.

Table B2 Meteorological observations used for this study

Input type	Source	Distance from project site	Format
Hourly surface observations	WMO - Williamtown RAAF Station Identifier 94776	87 km	ISHD
Upper air soundings	WMO - Williamtown RAAF Station Identifier 94776	87 km	FSL
Site specific meteorological measurements	BOM - Gosford AWS #61425 Sydney Airport AMO (Total cloud cover only) #66037	6 km 53 km	Non-standard format

Observational data were processed using AERMET to produce the wind rose presented in **Figure B4** and the temperature, mixing height and wind speed distribution presented in **Figure B5**.

Figure B4 Annual wind speed distribution – project site 2015

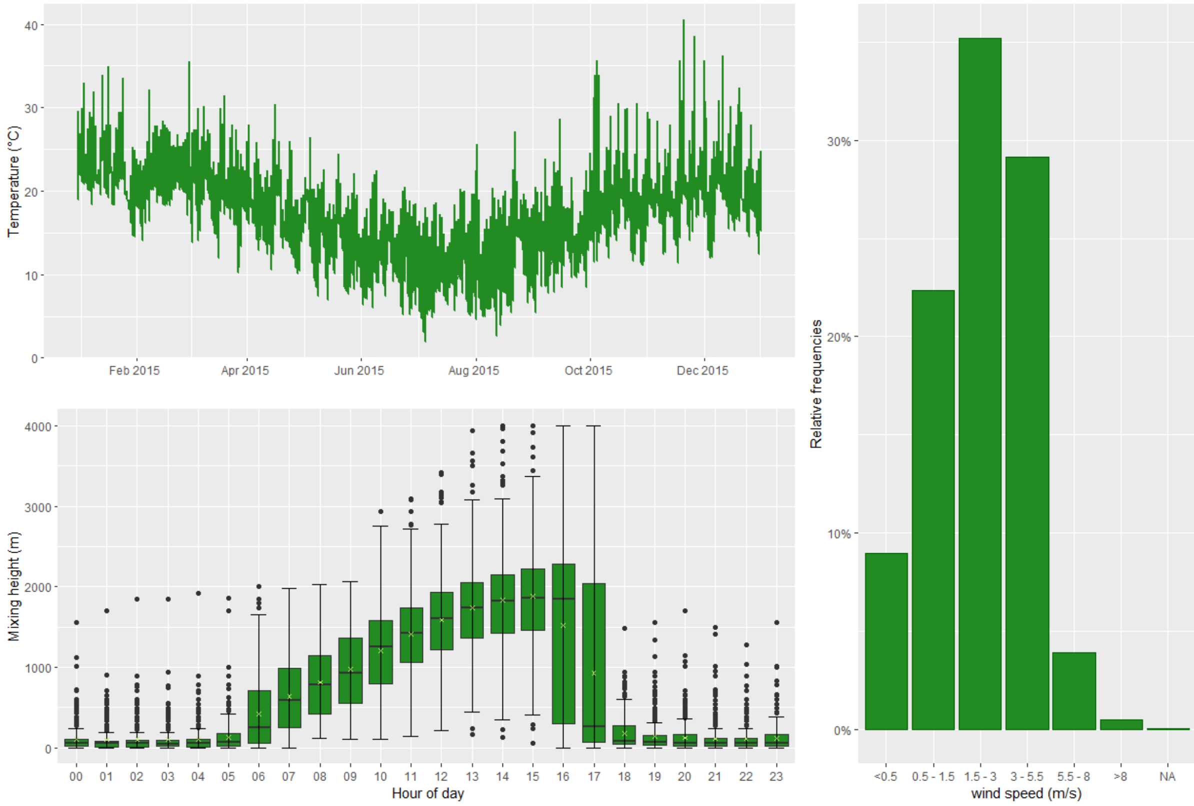


Given that wind speed and direction data were taken primarily from Gosford AWS, the wind rose presented in **Figure B4** closely resembles that from Gosford AWS.

Although the data do not represent site specific conditions (i.e. at the project site), no data is available to allow an assessment of that meteorological environment. As discussed in **Section 8.2.2**, the proponent will install a meteorological monitoring station at the project outset, and it is recommended that the dispersion modelling exercise is repeated using site specific meteorology after the first full year of measurements have been made (following appropriate validation).

As previously discussed, three alternative approaches to meteorological data modelling failed to appropriately replicate observational data and the approach outlined above has sought to adopt observational data.

Figure B5 Annual temperature, mixing height and wind speed distribution – project site 2015



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APPENDIX C

Emissions Estimation

The assumptions outlined in **Table C1** have been used in the development of the particulate emissions inventory for the project.

Table C1 Assumptions adopted within the particulate matter assessment

Parameter[6]	Units	Annual average (per annum)	Peak maximum (per day)[1]
Material receival rate	tonnes	200,000	877.0 [2]
Material processing rate	tonnes	200,000	Screen – 1,280 [3] Crush – 640 [3] Grind/shred – 224 [3]
Material despatch rate	tonnes	200,000	877.0 [2]
Existing landscape supplies business – receivals and sales	tonnes	10,000	32.1 (per day)[4]
Silt loading of paved roads	$g \cdot m^{-2}$	0.6[5]	

Notes: 1: Operational days per year - 365 days minus Sundays = 312 days per year

2: Peak daily maximum taken to be the average daily delivery for all vehicles except B-Double deliveries which are taken to be double on peak days – equates to an equivalent of 273,682 t per year delivery/despatch

3: Maximum potential hourly processing rate (200 $t \cdot hr^{-1}$ for screens (x2), 100 $t \cdot hr^{-1}$ for crusher, 35 $t \cdot hr^{-1}$ for grinder/shredder) multiplied by working hours per day (8) and utilisation rate of 80%. Equivalent to 668,928 t of processing per annum.

4: Peak daily maximum taken to be the average daily throughput (365 days minus Saturdays and Sundays per annum = 260 days per year)

5: Ubiquitous baseline for normal conditions on roads with <500 annual average daily traffic flow (USEPA, 2011)

6: No values for material moisture content, silt content or wind speed required as default values used within the assessment.

Emissions resulting from the loading of materials, transfer of materials (except for road transport), and the loading of crushers, screens and the shredder have been estimated using the US EPA AP-42 emission factor for material transfer in crushed stone processing and mineral processing industries (USEPA, 2006) with emission factors of:

- 0.0015 $kg \cdot t^{-1}$ for TSP;
- 0.00055 $kg \cdot t^{-1}$ for PM_{10}; and,
- 0.00008 $kg \cdot t^{-1}$ for $PM_{2.5}$.

The $PM_{2.5}$ emission factor assumes a $PM_{2.5}/PM_{10}$ ratio of 0.14 which is taken from similar activities within the USEPA AP-42 for Crushed Stone Processing (USEPA, 2006).

Emissions arising from the movement of heavy vehicles on unpaved site roads have been estimated using the US EPA AP-42 emission factor for paved roads (USEPA, 2011) as outlined below.

$$E = k\,(sL)^{0.91} \times (W)^{1.02}$$

Where:

E = Emission factor ($g \cdot VKT^{-1}$)

k = particle size multiplier (dimensionless) for TSP = 3.23, for PM_{10} = 0.62, for $PM_{2.5}$ = 0.15

sL = road surface silt loading ($g \cdot m^{-2}$)

W = Mean vehicle weight (tonnes)

Emissions resulting from the crushing and screening of materials at the project site have been estimated using the US EPA AP-42 emission factor for crushed stone processing (USEPA, 2006). The emission factor for uncontrolled tertiary crushing:

- 0.0027 $kg \cdot t^{-1}$ for TSP
- 0.0012 $kg \cdot t^{-1}$ for PM_{10} and
- 0.00012 $kg \cdot t^{-1}$ for $PM_{2.5}$

have been adopted. Application of emissions controls (watering) result in these emissions being controlled by 77.7 % (USEPA, 2006) with controlled emissions being:

- 0.0006 $kg \cdot t^{-1}$ for TSP
- 0.00027 $kg \cdot t^{-1}$ for PM_{10} and
- 0.00005 $kg \cdot t^{-1}$ for $PM_{2.5}$

For screening uncontrolled emissions rates of:

- 0.0125 $kg \cdot t^{-1}$ for TSP
- 0.0043 $kg \cdot t^{-1}$ for PM_{10} and
- 0.00043 $kg \cdot t^{-1}$ for $PM_{2.5}$

have been adopted. Application of emissions controls (watering, or throughput of wetted material from the crusher) result in these emissions being controlled by 91.6 % (USEPA, 2006) with controlled emissions being:

- 0.0011 $kg \cdot t^{-1}$ for TSP
- 0.00037 $kg \cdot t^{-1}$ for PM_{10} and
- 0.000025 $kg \cdot t^{-1}$ for $PM_{2.5}$

Emissions resulting from the shredding of timber have been estimated using an emission factor from the Government of Canada, emissions estimation calculator for wood products operation (Environment and Climate Change Canada, 2015). The adopted uncontrolled emission factors are:

- 0.118 $kg \cdot ODT^{-1}$ for TSP
- 0.091 $kg \cdot ODT^{-1}$ for PM_{10} and
- 0.008 $kg \cdot ODT^{-1}$ for $PM_{2.5}$

with ODT being Oven Dry Tonne (0 % moisture). Given that seasoned timber to be received at the site would be higher than 0 % moisture content (seasoned timber has typically 9 % to 14 % moisture content), no adjustment for the dry weight has been performed, which represents a worst case.

The NPI mining manual EET specifies a value of 0.2 kg·ha^{-1}·hr^{-1} (PM_{10}) for wind erosion for all sources excepting coal stockpiles. This factor is considered approximate as it does not take into account variations in the climate of an area or the soil or ore type. Within this assessment, PM_{10} emissions for all stockpiles and exposed areas were parameterised using the form of Shao (2000) as:

$$Ewind = 5.2 \times 10^{-7}\, WS^3 \left(1 - \left(\frac{WS_T}{WS_{10}}\right)^2\right) \quad \text{for } WS_T > WS_{10}$$

$$Ewind = 0 \qquad \text{for } WS_T \leq WS_{10}$$

Where:

WS_T is the threshold for wind erosion in m·s^{-1}, taken to be 5.2 m·s^{-1};

WS_{10} is the wind speed at 10 m height; and,

$Ewind$ is the PM_{10} emissions (g·m^{-2}·s^{-1})

Using this equation with hourly calculated wind speeds for the project site (refer **Appendix B**) an annual PM_{10} emission of 1,410.6 kg·ha^{-1}·yr^{-1} (uncontrolled) is obtained. This is significantly higher than the US EPA AP-42 emission factor for Western surface coal mining of 425 kg·ha^{-1}·yr^{-1} (assuming PM_{10} is 50% of TSP). However, the adopted factor allows variability in emissions within the dispersion model, avoiding emissions during periods of low dispersion when winds would not be strong enough to result in wind erosion, and including emissions during stronger winds when wind erosion would occur, and dispersion would be greater.

TSP emissions have been calculated assuming that PM_{10} represents 50% of TSP and $PM_{2.5}$ emissions have been calculated assuming that they represent 10 % of PM_{10} emissions.

In addition to the emissions of process related particulate matter, recent studies have shown that emissions of fine particulate matter resulting from diesel combustion can significantly contribute to the fine particulate matter emissions profile of a site. To appropriately quantify these emissions, information contained within the NSW EPA report "*Reducing Emissions from Non-road Diesel Engines*" (NSW EPA, 2014) has been reviewed. It has been assumed that all emissions from diesel combustion are fine particulate (i.e. $PM_{2.5}$) emissions. The assumptions adopted within the assessment, including the emission factors is presented in **Table C2**. The full emissions inventory is presented below.

Table C2 Assumptions adopted within the diesel particulate matter assessment

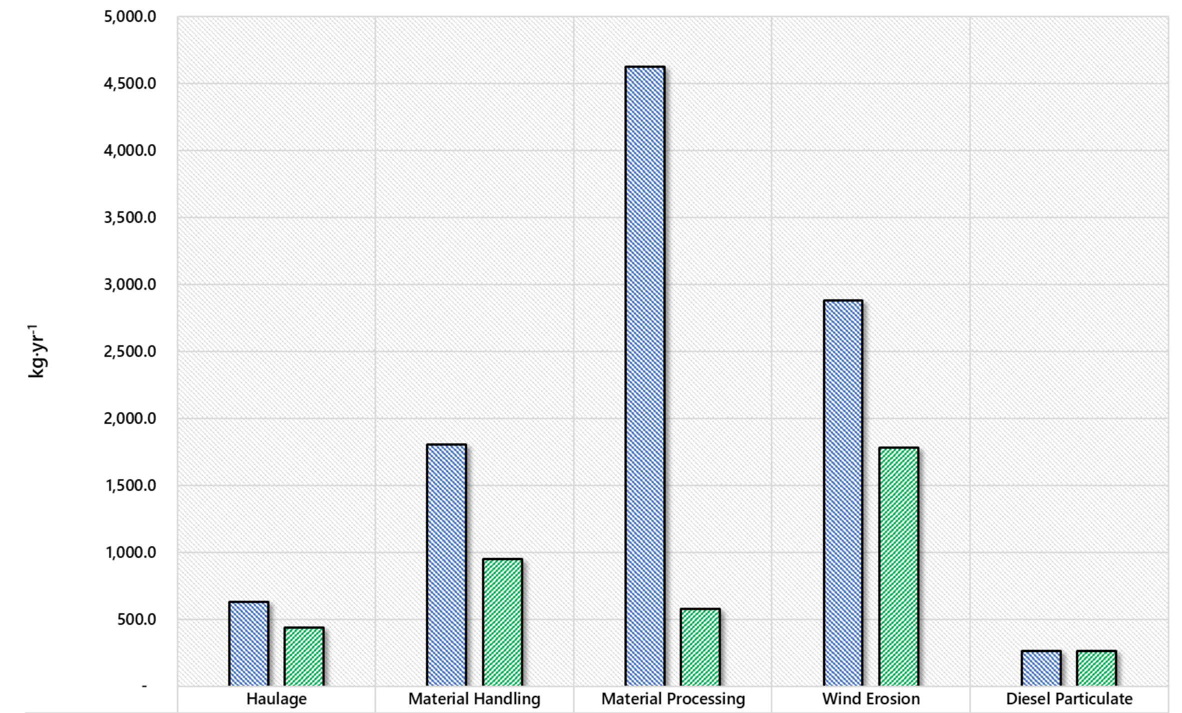
Equipment	kW rating	Operating hours[4]	Load factor[1]	$PM_{2.5}$ emission factor ($g \cdot kWh^{-1}$)[2]
Crusher	140	2,860	0.59	0.2
Screen x2	151	2,860	0.59	0.2
Shredder	37	2,860	0.59	0.2
Front end loader 1	143	2,860	0.59	0.2
Front end loader 2	143	2,860	0.59	0.2
Front end loader 3	143	2,860	0.59	0.2
Front end loader 4	143	2,860	0.59	0.2
Excavator	143	2,860	0.59	0.2
Vehicle	**$VKT \cdot year^{-1}$**		**$PM_{2.5}$ emission factor ($g \cdot VKT^{-1}$)[3]**	
All haulage vehicles – annual average	15,694		0.584	
All haulage vehicles – based on 24-hr peak	17,000			

Notes: 1: From Table D1 of (NSW EPA, 2014)
2: From Table 5 of (NSW EPA, 2014)
3: 1996 Australian Design Rule (ADR) 70/00 in (NSW EPA, 2013)
4: Note that operational hours of all equipment assumed to be 11 hrs per day, 52 weeks per year, 5 days per week to represent total worst case for both annual and 24-hr peak scenario

Emissions controls will be employed at the project site as discussed in **Section 5.2.3**. The application of these controls results in quantifiable reductions in the quantity of particulate matter being emitted as part of the project operation. A description of each emission reduction method to be employed as part of the project is presented in **Section 8**.

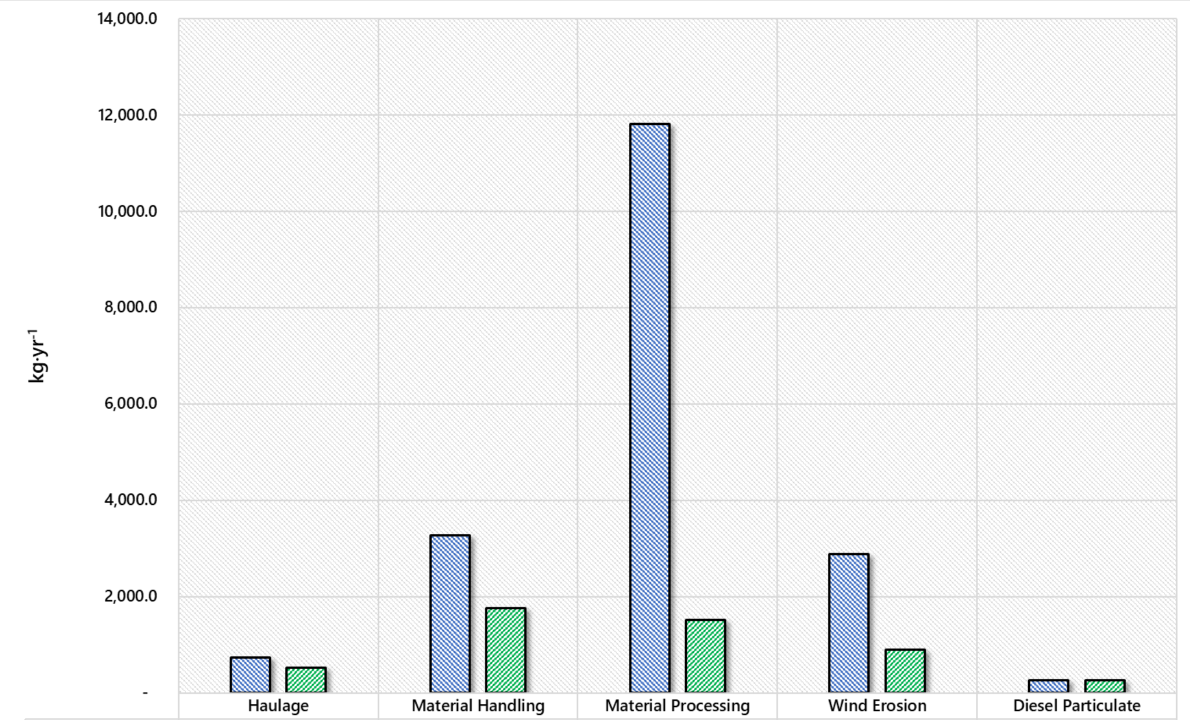
Based on the foregoing, the distribution of particulate emission across broad emissions categories is presented in **Figure C1** (TSP) **Figure C2** (PM_{10}) and **Figure C3** ($PM_{2.5}$).

Figure C1 Calculated uncontrolled & controlled annual TSP emissions



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled TSP	628.8	1,804.2	4,627.2	2,879.8	264.6
Controlled TSP	440.2	949.4	579.8	1,782.7	264.6

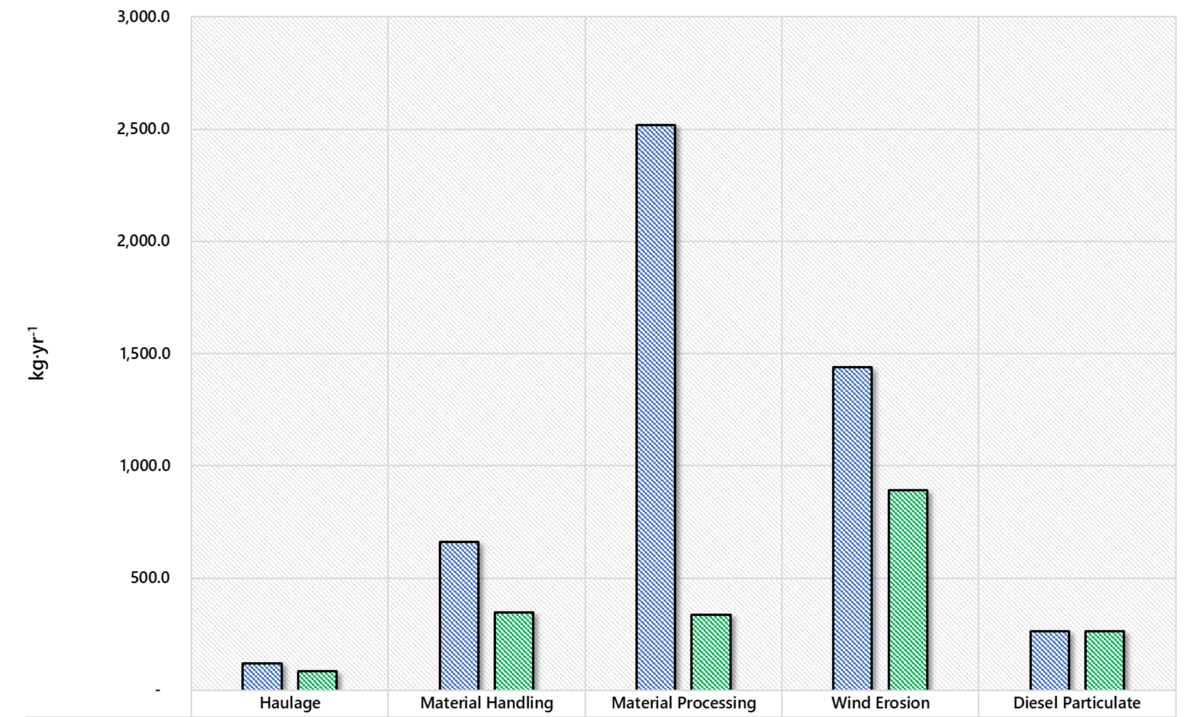
Annual average scenario



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled TSP	740.0	3,277.8	11,821.4	2,879.8	265.4
Controlled TSP	518.0	1,762.2	1,512.3	891.4	265.4

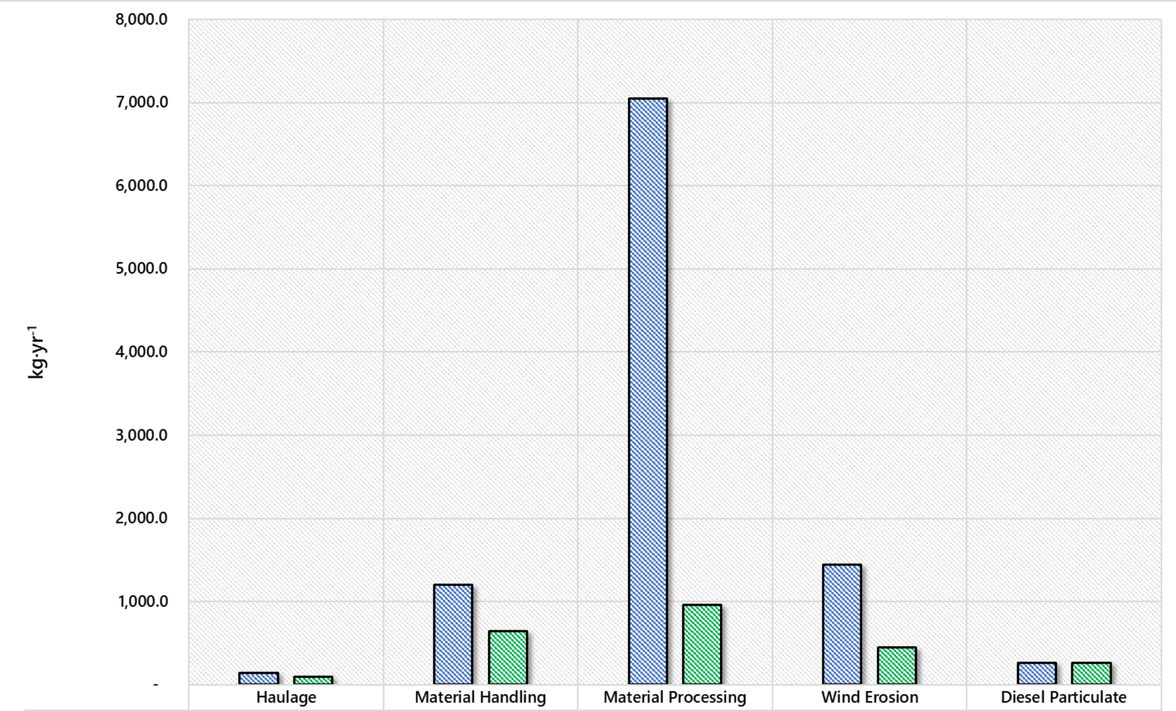
Equivalent annual totals from peak 24-hr scenario

Figure C2 Calculated uncontrolled & controlled annual PM_{10} emissions



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled PM10	120.7	661.5	2,517.0	1,439.9	264.6
Controlled PM10	84.5	348.1	336.8	891.4	264.6

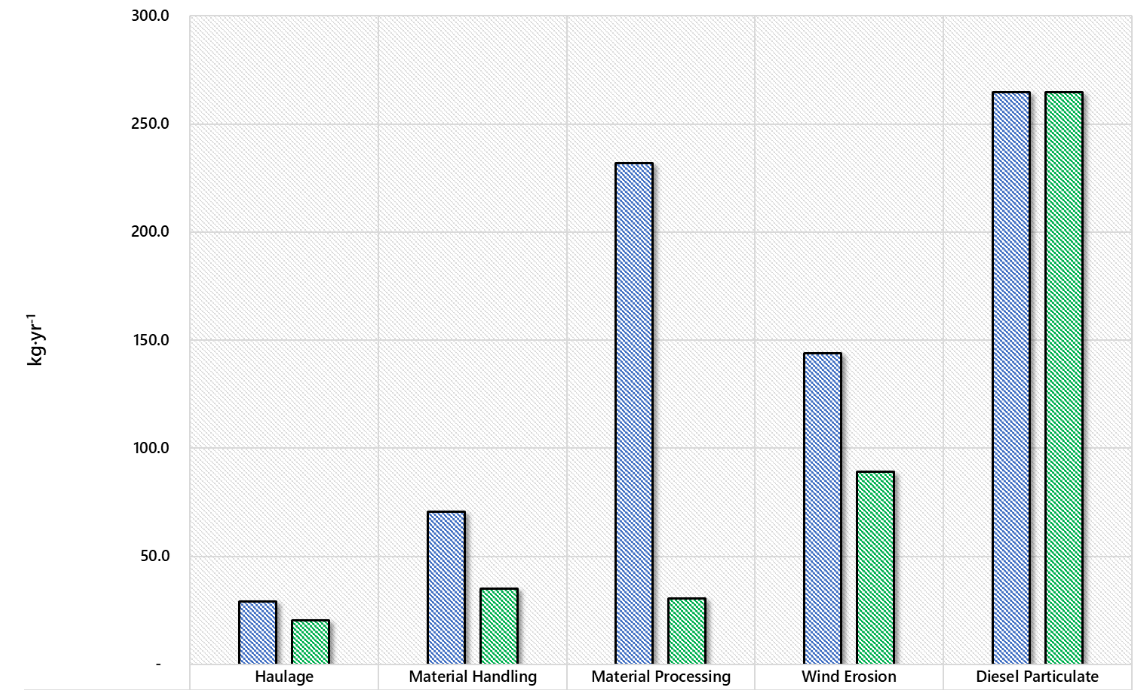
Annual average scenario



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled PM10	142.0	1,201.8	7,047.5	1,439.9	265.4
Controlled PM10	99.4	646.2	963.6	445.7	265.4

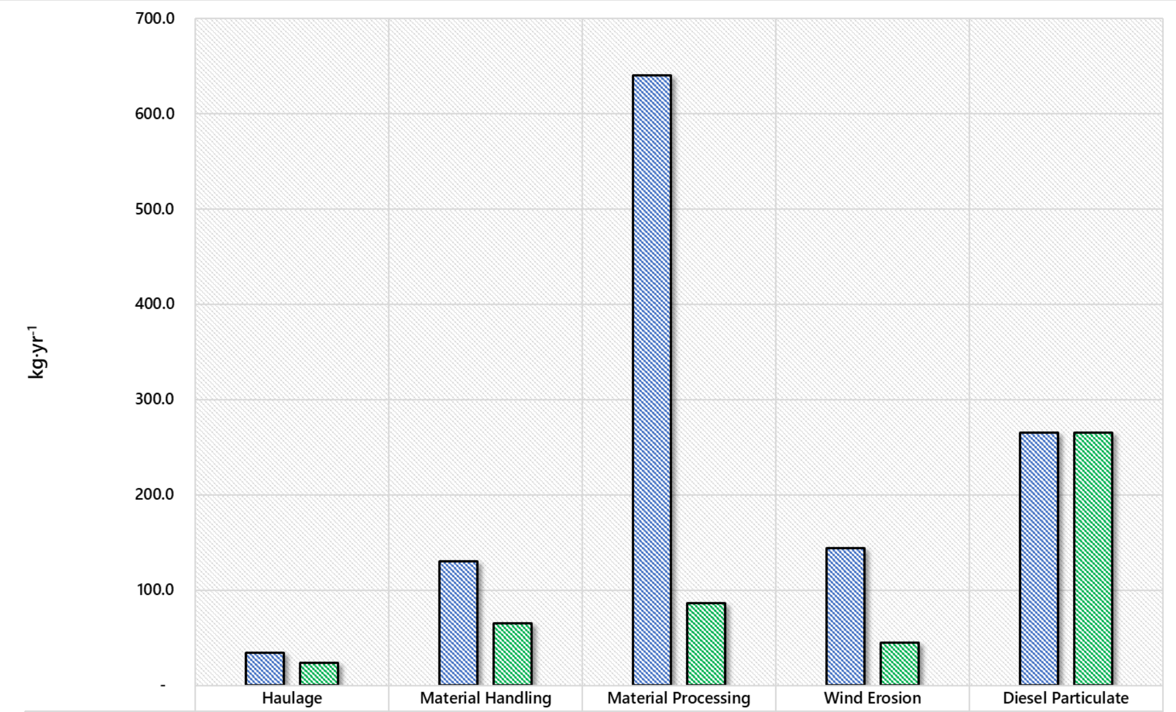
Equivalent annual totals from peak 24-hr scenario

Figure C3 Calculated uncontrolled & controlled annual $PM_{2.5}$ emissions



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled PM2.5	29.2	70.5	231.9	144.1	264.6
Controlled PM2.5	20.4	35.2	30.7	89.1	264.6

Annual average scenario



	Haulage	Material Handling	Material Processing	Wind Erosion	Diesel Particulate
Uncontrolled PM2.5	34.4	130.0	640.7	144.1	265.4
Controlled PM2.5	24.1	65.5	86.8	44.6	265.4

Equivalent annual totals from peak 24-hr scenario

Emissions Inventory

1- Annual Average

2- Peak 24-hr

Note that activity rates are provided as the equivalent annual quantity associated with the peak 24-hr activity.

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
ENM													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	2,758	VKT	11	Watering at 2.2 $L \cdot m^{-2}$	30	93.0	17.9	4.3
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	80,000	t	11	Tipping in shed Water sprays	70 50	18.0	6.6	0.7
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	80,000	t	11	Loading to 3-sided enclosure	30	84.0	30.8	3.1
Material loaded to screen	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	80,000	t	9			120.0	44.0	4.4
Screening	0.0125	0.0043	0.00043	$kg \cdot t^{-1}$	AP42 -11.19.2 Screening	80,000	t	9	Watering	91.6	84.0	28.9	2.9
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg \cdot t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	76,000	t	9	Watering	91.6	9.6	3.5	0.5
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	76,000	t	11	Loading to 3-sided enclosure	30	40.0	14.6	1.4
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	76,000	t	11			114.0	41.8	4.2
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	2,025	VKT	11	Watering at 2.2 $L \cdot m^{-2}$	30	65.1	12.5	3.0
VENM													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	690	VKT	11	Watering at 2.2 $L \cdot m^{-2}$	30	23.3	4.5	1.1

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11	Tipping in shed Water sprays	70 50	4.5	1.7	0.2
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11	Loading to 3-sided enclosure	30	10.5	3.9	0.4
Material loaded to screen	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	9			30.0	11.0	1.1
Screening	0.0125	0.0043	0.00043	$kg \cdot t^{-1}$	AP42 -11.19.2 Screening	20,000	t	9	Watering	91.6	21.0	7.2	0.7
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg \cdot t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	20,000	t	9	Watering	91.6	2.5	0.9	0.1
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11	Loading to 3-sided enclosure	30	10.6	3.8	0.4
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11			30.0	11.0	1.1
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	506	VKT	11	Watering at 2.2 $L \cdot m^{-2}$	30	16.3	3.1	0.8
Asphalt													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	690	VKT	11	Watering at 2.2 $L \cdot m^{-2}$	30	23.3	4.5	1.1
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11	Tipping in shed Water sprays	70 50	4.5	1.7	0.2

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate (kg·yr⁻¹)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11	Loading to 3-sided enclosure	30	10.5	3.9	0.4
Material loaded to crusher	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	9			30.0	11.0	1.1
Crushing	0.0027	0.0012	0.00012	$kg{\cdot}t^{-1}$	AP42 -11.19.2 Tertiary Crushing	20,000	t	9	Watering Enclosure	77.7 70	3.6	1.6	0.2
Screening	0.0125	0.0043	0.00043	$kg{\cdot}t^{-1}$	AP42 -11.19.2 Screening	20,000	t	9	Watering	91.6	21.0	7.2	0.7
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	20,000	t	9	Watering	91.6	2.5	0.9	0.1
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11	Loading to 3-sided enclosure	30	10.5	3.9	0.4
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11			30.0	11.0	1.1
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	506	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	16.3	3.1	0.8
Metal													
Receival of loads (rigid trucks)	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	247	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	6.3	1.2	0.3
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	4,000	t	11	Tipping in shed Water sprays	70 50	0.9	0.3	0.0

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg{\cdot}yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	4,000	t	11	Loading to 3-sided enclosure	30	2.1	0.8	0.1
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	4,000	t	11			6.0	2.2	0.2
Material picked up and taken offsite for recycling	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	44	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	2.6	0.5	0.1
Timber etc													
Receival of loads (rigid trucks)	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	1,235	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	31.6	6.1	1.5
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11	Tipping in shed Water sprays	70 50	4.5	1.7	0.2
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	20,000	t	11	Loading to 3-sided enclosure	30	10.5	3.9	0.4
Material chipped by shredder	0.12	0.09	0.01	$kg{\cdot}ODT^{-1}$	https://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=2101C0ED-1&offset=15&toc=hide	18,000	t	9	Watering Enclosure	50 70	318.6	245.7	21.6
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	18,000	t	9	Watering Enclosure	91.6 70	4.1	1.5	0.2
Chipped material moved by FEL to storage area in Landscape supplies area	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	18,000	t	11	Loading to 3-sided enclosure	30	9.5	3.5	0.3

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	18,000	t	11			27.0	9.9	1.0
SALE and offsite by tipper truck	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	657	VKT	11	Watering at 2.2 $L \cdot m^{-2}$	30	16.8	3.2	0.8
Concrete / tiles / masonry													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	1,586	VKT	11	Watering at 2.2 $L \cdot m^{-2}$	30	53.5	10.3	2.5
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	46,000	t	11	Tipping in shed Water sprays	70 50	10.4	3.8	0.4
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	46,000	t	11	Loading to 3-sided enclosure	30	24.2	8.9	0.9
Material loaded to crusher	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	46,000	t	9			69.0	25.3	2.5
Crushing	0.0027	0.0012	0.00012	$kg \cdot t^{-1}$	AP42 -11.19.2 Tertiary Crushing	46,000	t	9	Watering Enclosure	77.7 70	8.3	3.7	0.4
Screening	0.0125	0.0043	0.00043	$kg \cdot t^{-1}$	AP42 -11.19.2 Screening	46,000	t	9	Watering	91.6	48.3	16.6	1.7
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg \cdot t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	41,400	t	9	Watering	91.6	5.2	1.9	0.3
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	41,400	t	11	Loading to 3-sided enclosure	30	21.7	8.0	0.8

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg{\cdot}yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	41,400	t	11			62.1	22.8	2.3
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	1,147	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	36.9	7.1	1.7
Mixed building waste													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	345	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	11.6	2.2	0.5
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t	11	Tipping in shed Water sprays	70 50	2.3	0.8	0.1
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t	11	Loading to 3-sided enclosure	30	5.3	1.9	0.2
Primary sorting with grab excavator	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
Back into other waste streams	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	4,600	t	11			6.9	2.5	0.3
Residual waste stored in separate bunker	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	16,000	t	11	Loading to 3-sided enclosure	30	8.4	3.1	0.3
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	16,000	t	11			24.0	8.8	0.9

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Residual picked up and taken offsite for disposal by B-Double	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	175	VKT	11	Watering at 2.2 L/m2	30	10.4	2.0	0.5
Landscape supplies business													
Landscape supplies business (add. 10,000 tpa IN, 10,000tpa OUT)	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	3,084	VKT	11	Watering at 2.2 L/m2	30	33.2	6.4	1.5
Unload - existing landscape supplies business	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
Load - existing landscape supplies business	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
Secondary Processing Warehouse (and associated activities)													
Front end loader on residual waste for transfer to warehouse	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
Unloading to hopper	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	11	Enclosure Watering	70 50	2.3	0.8	0.1
Screening	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	10,000	t	9	Enclosure Watering	70 50	18.8	6.5	0.6
Trommel	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	10,000	t	9	Enclosure Watering	70 50	18.8	6.5	0.6
Loading to hooklift bins	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	9	Enclosure Watering	70 50	2.3	0.8	0.1

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Transfer back to main site	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
WIND EROSION													
Wind erosion	2,821.2	1,410.6	141.1	kg·ha^{-1}·yr^{-1}	Shao (2000)	01.3 (tip) 0.84 (blend, process, store) 0.62 (prod., l/scape store) Total 1.59	ha	24	3-sided enclosure, water sprays (tip) none (blend, process, store) 3-sided enclosure and water sprays (prod., l/scape store)	75, 70 75	1,782,7	891.4	89.1
DIESEL EMISSIONS													
Diesel emissions (total)	Various (see **Table C2**) and **Section 5.2.3**										264.6	264.6	264.6

Note: Paved roads emission factor represents a site average.

3-sided enclosure not included on stockpiles in processing area

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg{\cdot}yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
ENM													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	3,252	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	122.5	23.5	5.7
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	108,959	t	11	Tipping in shed Water sprays	70 50	24.5	9.0	0.9
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	108,959	t	11	Loading to 3-sided enclosure	30	114.4	41.9	4.2
Material loaded to screen	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	9			124.8	45.8	4.6
Screening	0.0125	0.0043	0.00043	$kg{\cdot}t^{-1}$	AP42 -11.19.2 Screening	83,200	t	9	Watering	91.6	87.4	30.1	3.0
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	83,200	t	9	Watering	91.6	10.5	3.8	0.6
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	11	Loading to 3-sided enclosure Water sprays	30 50	43.7	16.0	1.6
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	11			124.8	45.8	4.6
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	2,025	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	65.1	12.5	3.0
VENM													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	814	VKT	11	Watering at 2.2 $L{\cdot}m^{-2}$	30	30.6	5.9	1.4

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	27,262	t	11	Tipping in shed Water sprays	70 50	6.1	2.2	0.2
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	27,262	t	11	Loading to 3-sided enclosure	30	14.3	5.2	0.5
Material loaded to screen	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	9			124.8	45.8	4.6
Screening	0.0125	0.0043	0.00043	$kg \cdot t^{-1}$	AP42 -11.19.2 Screening	83,200	t	9	Watering	91.6	87.4	30.1	3.0
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg \cdot t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	83,200	t	9	Watering	91.6	10.5	3.8	0.6
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	11	Loading to 3-sided enclosure Water sprays	30 50	43.7	16.0	1.6
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	11			124.8	45.8	4.6
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	506	VKT	11	Watering at 2.2 $L \cdot m^{-2}$	30	16.3	3.1	0.8
Asphalt													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	814	VKT	11	Watering at 2.2 L·m-2	30	30.6	5.9	1.4
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	27,262	t	11	Tipping in shed Water sprays	70 50	6.1	2.2	0.2

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	27,262	t	11	Loading to 3-sided enclosure Water sprays	30 50	14.3	5.2	0.5
Material loaded to crusher	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	9			124.8	45.8	4.6
Crushing	0.0027	0.0012	0.00012	$kg \cdot t^{-1}$	AP42 -11.19.2 Tertiary Crushing	83,200	t	9	Watering Enclosure	77.7 70	15.0	6.7	0.7
Screening	0.0125	0.0043	0.00043	$kg \cdot t^{-1}$	AP42 -11.19.2 Screening	83,200	t	9	Watering	91.6	87.4	30.1	3.0
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg \cdot t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	83,200	t	9	Watering	91.6	10.5	3.8	0.6
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	11	Loading to 3-sided enclosure Water sprays	30 50	43.7	16.0	1.6
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	11			124.8	45.8	4.6
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	506	VKT	11	Watering at 2.2 L·m-2	30	16.3	3.1	0.8
Metal													
Receival of loads (rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	247	VKT	11	Watering at 2.2 L·m-2	30	6.3	1.2	0.3
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	5,661	t	11	Tipping in shed Water sprays	70 50	1.3	0.5	0.0

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg{\cdot}yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	5,661	t	11	Loading to 3-sided enclosure Water sprays	30 50	3.0	1.1	0.1
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	5,661	t	11			8.5	3.1	0.3
Material picked up and taken offsite for recycling	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	88	VKT	11	Watering at 2.2 L·m-2	30	5.2	1.0	0.2
Timber etc													
Receival of loads (rigid trucks)	0.051	0.010	0.002	$kg{\cdot}VKT^{-1}$	AP42 – 13.2.1 Paved Roads	1,235	VKT	11	Watering at 2.2 L·m-2	30	31.6	6.1	1.5
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	28,339	t	11	Tipping in shed Water sprays	70 50	6.4	2.3	0.2
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	28,339	t	11	Loading to 3-sided enclosure Water sprays	30 50	14.9	5.5	0.5
Material chipped by shredder	0.12	0.09	0.01	$kg{\cdot}ODT^{-1}$	https://www.ec.gc.ca/inrp-npri/default.asp?lang=En&n=2101C0ED-1&offset=15&toc=hide	58,240	t	9	Watering Enclosure	50 70	1030.8	795.0	69.9
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg{\cdot}t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	58,240	t	9	Watering Enclosure	91.6 70	13.1	4.8	0.7

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Chipped material moved by FEL to storage area in Landscape supplies area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	58,240	t	11	Loading to 3-sided enclosure Water sprays	30 50	30.6	11.2	1.1
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	58,240	t	11			87.4	32.0	3.2
SALE and offsite by tipper truck	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	657	VKT	11	Watering at 2.2 L·m-2	30	16.8	3.2	0.8
Concrete / tiles / masonry													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	1,870	VKT	11	Watering at 2.2 L·m-2	30	70.4	13.5	3.3
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	62,617	t	11	Tipping in shed Water sprays	70 50	14.1	5.2	0.5
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	62,617	t	11	Loading to 3-sided enclosure Water sprays	30 50	32.9	12.1	1.2
Material loaded to crusher	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	9			124.8	45.8	4.6
Crushing	0.0027	0.0012	0.00012	$kg \cdot t^{-1}$	AP42 -11.19.2 Tertiary Crushing	83,200	t	9	Watering Enclosure	77.7 70	15.0	6.7	0.7
Screening	0.0125	0.0043	0.00043	$kg \cdot t^{-1}$	AP42 -11.19.2 Screening	83,200	t	9	Watering	91.6	87.4	30.1	3.0
Material stacked to storage pile	0.0015	0.00055	0.00008	$kg \cdot t^{-1}$	AP42 - 11.19.2 Conveyor Transfer	83,200	t	9	Watering	91.6	10.5	3.8	0.6

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM$_{10}$	PM$_{2.5}$	Unit							TSP	PM$_{10}$	PM$_{2.5}$
Material moved to Landscape supplies bunkers for sale by FEL	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	11	Loading to 3-sided enclosure Water sprays	30 50	43.7	16.0	1.6
Material loaded to vehicles	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	83,200	t	11			124.8	45.8	4.6
SALE and offsite by tipper truck and semi	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	1,147	VKT	11	Watering at 2.2 L·m-2	30	36.9	7.1	1.7
Mixed building waste													
Receival of loads (B-Double, semi trailers or rigid trucks)	0.051	0.010	0.002	kg·VKT^{-1}	AP42 – 13.2.1 Paved Roads	406	VKT	11	Watering at 2.2 L·m-2	30	15.3	2.9	0.7
Tipping of material in unloading bay in waste receival area	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	13,592	t	11	Tipping in shed Water sprays	70 50	3.1	1.1	0.1
Material moved by FEL to storage bay	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	13,592	t	11	Loading to 3-sided enclosure Water sprays	30 50	7.1	2.6	0.3
Primary sorting with grab excavator	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	13,592	t	11			20.4	7.5	0.7
Back into other waste streams	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.19.2 Mineral products industry - material transfer	6,252	t	11			9.4	3.4	0.3

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate ($kg \cdot yr^{-1}$)		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Residual waste stored in separate bunker	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	16,000	t	11	Loading to 3-sided enclosure Water sprays	30 50	8.4	3.1	0.3
Material loaded to vehicles	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	16,000	t	11			24.0	8.8	0.9
Residual picked up and taken offsite for disposal by B-Double	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	350	VKT	11	Watering at 2.2 L/m2	30	20.9	4.0	1.0
Landscape supplies business													
Landscape supplies business (add. 10,000 tpa IN, 10,000tpa OUT)	0.051	0.010	0.002	$kg \cdot VKT^{-1}$	AP42 – 13.2.1 Paved Roads	3,084	VKT	11	Watering at 2.2 L/m2	30	33.2	6.4	1.5
Unload - existing landscape supplies business	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
Load - existing landscape supplies business	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.19.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
Secondary Processing Warehouse (and associated activities)													
Front end loader on residual waste for transfer to warehouse	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
Unloading to hopper	0.0015	0.0006	0.00006	$kg \cdot t^{-1}$	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	11	Enclosure Watering	70 50	3.1	1.1	0.1

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Screening	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	10,000	t	9	Enclosure Watering	70 50	25.5	8.8	0.9
Trommel	0.0125	0.0043	0.00043	kg·t^{-1}	AP42 -11.19.2 Screening	10,000	t	9	Enclosure Watering	70 50	25.5	8.8	0.9
Loading to hooklift bins	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	9	Enclosure Watering	70 50	3.1	1.1	0.1
Transfer back to main site	0.0015	0.0006	0.00006	kg·t^{-1}	AP42 - 11.18.2 Mineral products industry - material transfer	10,000	t	11			15.0	5.5	0.6
WIND EROSION													
Wind erosion	2,821.2	1,410.6	141.1	kg·ha^{-1}·yr^{-1}	Shao (2000)	01.3 (tip) 0.84 (blend, processing, storage) 0.62 (product, landscape storage) Total 1.59	ha	24	3-sided enclosure, water sprays (tip) water sprays (blend, processing, storage) 3-sided enclosure and water sprays (product, landscape storage)	75, 70, 50 50 75,50	891.4	445.7	44.6
DIESEL EMISSIONS													

Emission source	Emission factor				Source	Activity rate	Unit	Op. hours per day	Control method	Control efficiency (%)	Controlled emission rate (kg·yr^{-1})		
	TSP	PM_{10}	$PM_{2.5}$	Unit							TSP	PM_{10}	$PM_{2.5}$
Diesel emissions (total)	Various (see Table C2) and Section 5.2.3										264.6	264.6	264.6

APPENDIX D

Construction Phase Risk Assessment Methodology

Provided below is a summary of the risk assessment methodology used in this assessment. It is based upon IAQM (2016) *Guidance on the assessment of dust from demolition and construction* (version 1.1) and adapted by Northstar Air Quality.

Adaptions to the Published Methodology Made by Northstar Air Quality

The adaptions made by Northstar Air Quality from the IAQM published methodology are:

- **PM_{10} criterion:** an amended criterion representing the annual average PM_{10} criterion relevant to Australia rather than the UK;
- **Nomenclature:** a change in nomenclature from "receptor sensitivity" to "land use value" to avoid misinterpretation of values attributed to "receptor sensitivity" and "sensitivity of the area" which may be assessed as having different values;
- **Construction traffic:** the separation of construction vehicle movements as a discrete risk assessment profile from those associated with the 'on-site' activities of demolition, earthworks and construction. The IAQM methodology considers five risk profiles of: "demolition", "earthworks", "construction" and "track-out". The adaption by Northstar Air Quality introduces a fifth risk assessment profile of "construction traffic" to the existing four risk profiles; and,
- **Tables:** minor adjustments in the visualisation of some tables.

Step 1 – Screening Based on Separation Distance

The Step 1 screening criteria provided by the IAQM guidance suggests screening out any assessment of impacts from construction activities where sensitive receptors are located:

- more than 350 m from the boundary of the site;
- more than 50 m from the route used by construction vehicles on public roads; and,
- more than 500 m from the site entrance.

This step is noted as having deliberately been chosen to be conservative and would require assessments for most developments.

Step 2 – Risk from Construction Activities

Step 2 of the assessment provides "dust emissions magnitudes" for each of the dust generating activities; demolition, earthworks, construction, and track-out (the movement of site material onto public roads by vehicles) and construction traffic.

The magnitudes are: Large; Medium; or Small, with suggested definitions for each category as follows:

Dust Emission Magnitude Activities

Activity	Large	Medium	Small
Demolition			
- total building volume*	• >50,000 m^3	• 20,000 m^3 to 50,000 m^3	• <20,000 m^3
- demolition height	• > 20m AGL	• 10 m and 20 m AGL	• <10 m AGL
- onsite crushing	• yes	• no	• no
- onsite screening	• yes	• no	• no
- demolition of materials with high dust potential	• yes	• yes	• no
- demolition timing	• any time of the year	• any time of the year	• wet months only
Earthworks			
- total area	• >10,000 m^2	• 2,500 m^2 to 10,000 m^2	• <2,500 m^2
- soil types	• potentially dusty soil type (e.g., clay, which would be prone to suspension when dry due to small particle size	• moderately dusty soil type (e.g., silt),	• soil type with large grain size (e.g., sand
- heavy earth moving vehicles	• >10 heavy earth moving vehicles active at any time	• 5 to 10 heavy earth moving vehicles active at any one time	• <5 heavy earth moving vehicles active at any one time
- formation of bunds	• >8m AGL	• 4m to 8m AGL	• <4m AGL
- material moved	• >100,000 t	• 20,000 t to 100,000 t	• <20,000 t
- earthworks timing	• any time of the year	• any time of the year	• wet months only
Construction			
- total building volume	• 100,000 m^3	• 25,000 m^3 to 100,000 m^3	• <25,000 m^3
- piling	• yes	• yes	• no
- concrete batching	• yes	• yes	• no
- sandblasting	• yes	• no	• no
- materials	• concrete	• concrete	• metal cladding or timber
Track-out (within 100 m of construction site entrance)			
- outward heavy vehicles movements per day	• >50	• 10 to 50	• <10
- surface materials	• high potential	• moderate potential	• low potential
- unpaved road length	• >100m	• 50m to 100m	• <50m

Activity	Large	Medium	Small
Construction Traffic (from construction site entrance to construction vehicle origin)			
Demolition traffic - total building volume	• >50,000 m^3	• 20,000 m^3 to 50,000 m^3	• <10,000 m^3
Earthworks traffic - total area	• >10,000 m^2	• 2,500 m^2 to 10,000 m^2	• <2,500 m^2
Earthworks traffic - soil types	• potentially dusty soil type (e.g., clay, which would be prone to suspension when dry due to small particle size	• moderately dusty soil type (e.g., silt),	• soil type with large grain size (e.g., sand
Earthworks traffic - material moved	• >100,000 t	• 20,000 t to 100,000 t	• <20,000 t
Construction traffic - total building volume	• 100,000 m^3	• 25,000 m^3 to 100,000 m^3	• <25,000 m^3
Total traffic - heavy vehicles movements per day when compared to existing heavy vehicle traffic	• >50% of heavy vehicle movement contribution by Proposal	• 10% to 50% of heavy vehicle movement contribution by Proposal	• <10% of heavy vehicle movement contribution by Proposal

Step 3 – Sensitivity of the Area

Step 3 of the assessment process requires the sensitivity of the area to be defined. The sensitivity of the area takes into account:

- The specific sensitivities that identified land use values have to dust deposition and human health impacts;
- The proximity and number of those receptors locations;
- In the case of PM_{10}, the local background concentration; and
- Other site-specific factors, such as whether there are natural shelters such as trees to reduce the risk of wind-blown dust.

Land Use Value

Individual receptor locations may be attributed different land use values based on the land use of the land, and may be classified as having high, medium or low values relative to dust deposition and human health impacts (ecological receptors are not addressed using this approach).

Essentially, land use value is a metric of the level of amenity expectations for that land use.

The IAQM method provides guidance on the land use value with regard to dust soiling and health effects and is shown in the table below. It is noted that user expectations of amenity levels (dust soiling) is dependent on existing deposition levels.

IAQM Guidance for Categorising Land Use Value

Value	High Land Use Value	Medium Land Use Value	Low Land Use Value
Health effects	• Locations where the public are exposed over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). *Examples: Residential properties, hospitals, schools and residential care homes.*	• Locations where the people exposed are workers, and exposure is over a time period relevant to the air quality objective for PM_{10} (in the case of the 24-hour objectives, a relevant location would be one where individuals may be exposed for eight hours or more in a day). *Examples: Office and shop workers, but would generally not include workers occupationally exposed to PM_{10}.*	• Locations where human exposure is transient. *Examples: Public footpaths, playing fields, parks and shopping street.*

Value	High Land Use Value	Medium Land Use Value	Low Land Use Value
Dust soiling	• Users can reasonably expect a high level of amenity; or • The appearance, aesthetics or value of their property would be diminished by soiling, and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods as part of the normal pattern of use of the land. *Examples: Dwellings, museums, medium and long term car parks and car showrooms.*	• Users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or • The appearance, aesthetics or value of their property could be diminished by soiling; or • The people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land. *Examples: Parks and places of work.*	• The enjoyment of amenity would not reasonably be expected; or • Property would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or • There is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land. *Examples: Playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads.*

Sensitivity of the Area

The assessed land use value (as described above) is then used to assess the *sensitivity of the area* surrounding the active construction area, taking into account the proximity and number of those receptors, and the local background PM_{10} concentration (in the case of potential health impacts) and other site-specific factors.

Additional factors to consider when determining the sensitivity of the area include:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local meteorological data which accurately represent the area; and if relevant, the season during which the works would take place;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document

Sensitivity of the Area - Health Impacts

For high land use values, the method takes the existing background concentrations of PM_{10} (as an annual average) experienced in the area of interest into account, and professional judgement may be used to determine alternative sensitivity categories, taking into account the following:

- any history of dust generating activities in the area;
- the likelihood of concurrent dust generating activity on nearby sites;
- any pre-existing screening between the source and the receptors;
- any conclusions drawn from analysing local / seasonal meteorological data;
- any conclusions drawn from local topography;
- duration of the potential impact, as a receptor may become more sensitive over time; and
- any known specific receptor sensitivities which go beyond the classifications given in the IAQM document.

IAQM Guidance for Categorising the Sensitivity of an Area to Dust Health Effects

Land Use Value	Annual Mean PM_{10} Concentration ($\mu g{\cdot}m^{-3}$)	Number of Receptors[a]	Distance from the Source (m)[b]				
			<20	<50	<100	<200	<350
High	>30	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	26 – 30	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	22 – 26	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	≤22	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low	Low
	-	1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Note: (a) Estimate the total within the stated distance (e.g. the total within 350 m and not the number between 200 and 350 m), noting that only the highest level of area sensitivity from the table needs to be considered. In the case of high sensitivity areas with high occupancy (such as schools or hospitals) approximate the number of people likely to be present. In the case of residential dwellings, just include the number of properties.

(b) With regard to potential 'construction traffic' impacts, the distance criteria of <20m and <50m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

Sensitivity of the Area - Dust Soiling

The IAQM guidance for assessing the sensitivity of an area to dust soiling is shown in the table below

IAQM Guidance for Categorising the Sensitivity of an Area to Dust Soiling Effects

Land Use Values	Number of receptors[a]	Distance from the source (m)[b]			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Medium	Low	Low	Low
Low	>1	Low	Low	Low	Low

Note: (a) Estimate the total number of receptors within the stated distance. Only the highest level of area sensitivity from the table needs to be considered.

(b) With regard to potential 'construction traffic' impacts, the distance criteria of <20m and <50m from the source (roadside) are used (i.e. the first two columns only). Any locations beyond 50m may be screened out of the assessment (as per Step 1) and the corresponding sensitivity is negligible'.

Step 4 - Risk Assessment (Pre-Mitigation)

The matrices shown for each activity determine the risk category with no mitigation applied.

Risk of dust impacts from earthworks

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Earthworks**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from construction activities

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Construction**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from demolition activities

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Demolition**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible

Risk of dust impacts from trackout (within 100m of construction site entrance)

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Trackout**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Risk of dust impacts from construction traffic (from construction site entrance to origin)

Sensitivity of Area	Pre-Mitigated Dust Emission Magnitude (**Construction Traffic**)		
	Large	Medium	Small
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

Step 5 – Identify Mitigation

Once the risk categories are determined for each of the relevant activities, site-specific management measures can be identified based on whether the site is a low, medium or high risk site.

The identified mitigation measures are presented as follows:

- **N** = not required (although they may be implemented voluntarily)
- **D** = desirable (to be considered as part of the CEMP, but may be discounted if justification is provided);
- **H** = highly recommended (to be implemented as part of the CEMP, and should only be discounted if site-specific conditions render the requirement invalid or otherwise undesirable).

The table below presents the complete mitigation table, not that assessed as required for any specific project or activity:

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
1	Communications			
1.1	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	N	H	H
1.1	Display the name and contact details of person(s) accountable for air quality and dust issues on the site boundary. This may be the environment manager/engineer or the site manager.	H	H	H
1.2	Display the head or regional office contact information.	H	H	H
1.3	Develop and implement a Dust Management Plan (DMP), which may include measures to control other emissions, approved by the relevant regulatory bodies.	D	H	H
2	Site Management			
2.1	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	H	H	H
2.2	Make the complaints log available to the local authority when asked.	H	H	H
2.3	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	H	H	H
2.4	Hold regular liaison meetings with other high-risk construction sites within 500 m of the site boundary, to ensure plans are coordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/ deliveries which might be using the same strategic road network routes.	N	N	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
3	Monitoring			
3.1	Undertake daily on-site and off-site inspections where receptors (including roads) are nearby, to monitor dust, record inspection results, and make the log available to the local authority when asked. This should include regular dust soiling checks of surfaces such as street furniture, cars and window sills within 100m of site boundary.	D	D	H
3.2	Carry out regular site inspections to monitor compliance with the dust management plan / CEMP, record inspection results, and make an inspection log available to the local authority when asked.	H	H	H
3.3	Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.	H	H	H
3.4	Agree dust deposition, dust flux, or real-time continuous monitoring locations with the relevant regulatory bodies. Where possible commence baseline monitoring at least three months before work commences on site or, if it a large site, before work on a phase commences.	N	H	H
4	Preparing and Maintaining the Site			
4.1	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	H	H	H
4.2	Erect solid screens or barriers around dusty activities or the site boundary that they are at least as high as any stockpiles on site.	H	H	H
4.3	Fully enclose site or specific operations where there is a high potential for dust production and the site is active for an extensive period.	D	H	H
4.4	Avoid site runoff of water or mud.	H	H	H
4.5	Keep site fencing, barriers and scaffolding clean using wet methods.	D	H	H
4.6	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below	D	H	H
4.7	Cover, seed or fence stockpiles to prevent wind erosion	D	H	H
5	Operating Vehicle/Machinery and Sustainable Travel			
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H	H	H
5.2	Ensure all vehicles switch off engines when stationary - no idling vehicles	H	H	H
5.3	Avoid the use of diesel or petrol-powered generators and use mains electricity or battery powered equipment where practicable	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
5.4	Impose and signpost a maximum-speed-limit of 25 km·h^{-1} on surfaced and 15 km·h^{-1} on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided, subject to the approval of the nominated undertaker and with the agreement of the local authority, where appropriate	D	D	H
5.4	Produce a Construction Logistics Plan to manage the sustainable delivery of goods and materials.	N	H	H
5.5	Implement a Travel Plan that supports and encourages sustainable travel (public transport, cycling, walking, and car-sharing)	N	D	H
6	**Operations**			
6.1	Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g. suitable local exhaust ventilation systems	H	H	H
6.2	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/ mitigation, using non-potable water where possible and appropriate	H	H	H
6.3	Use enclosed chutes and conveyors and covered skips	H	H	H
6.4	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate	H	H	H
6.5	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.	D	H	H
7	**Waste Management**			
7.1	Avoid bonfires and burning of waste materials.	H	H	H
8	**Measures Specific to Demolition**			
8.1	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	D	D	H
8.2	Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition, high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground.	H	H	H
8.3	Avoid explosive blasting, using appropriate manual or mechanical alternatives.	H	H	H
8.4	Bag and remove any biological debris or damp down such material before demolition.	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
8.5	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	N	D	H
8.6	Use Hessian, mulches or trackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	N	D	H
8.7	Only remove the cover in small areas during work and not all at once	N	D	H
9	Measures Specific to Construction			
8.1	Avoid scabbling (roughening of concrete surfaces) if possible	D	D	H
8.2	Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a particular process, in which case ensure that appropriate additional control measures are in place	D	H	H
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N	D	H
8.4	For smaller supplies of fine power materials ensure bags are sealed after use and stored appropriately to prevent dust	N	D	D
10	Measures Specific to Track-Out			
10.1	Use water-assisted dust sweeper(s) on the access and local roads to remove, as necessary, any material tracked out of the site.	D	H	H
10.2	Avoid dry sweeping of large areas.	D	H	H
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D	H	H
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H	H	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D	H	H
10.6	Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.	N	H	H
10.7	Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable).	D	H	H
10.8	Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	N	H	H
10.9	Access gates to be located at least 10 m from receptors where possible.	N	H	H
11	Specific Measures to Construction Traffic (adapted)			
5.1	Ensure all on-road vehicles comply with relevant vehicle emission standards, where applicable	H	H	H

Identified Mitigation		Unmitigated Risk		
		Low	Medium	High
8.3	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	N	D	H
10.3	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	D	H	H
10.4	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	H	H	H
10.5	Record all inspections of haul routes and any subsequent action in a site log book.	D	H	H

Step 6 – Risk Assessment (post-mitigation)

Following Step 5, the residual impact is then determined.

The objective of the mitigation is to manage the construction phase risks to an acceptable level, and therefore it is assumed that application of the identified mitigation would result in a *low* or *negligible* residual risk (post mitigation).

APPENDIX E

Comparison of Model Results

The following tables provide the incremental results of the current dispersion modelling assessment and the results provided within the previous AQIA. No interpretation of these results is provided.

Table E1 Change in predicted annual average TSP, PM_{10} and $PM_{2.5}$ concentrations

Receptor	Annual Average Concentration (µg·m^{-3})								
	TSP			PM_{10}			$PM_{2.5}$		
	Current	Previous	% change	Current	Previous	% change	Current	Previous	% change
R1	3.7	1.3	+186%	1.0	0.7	+50%	0.4	0.2	+80%
R2	4.3	1.8	+137%	1.2	1.0	+17%	0.4	0.2	+107%
R3	2.1	1.5	+40%	0.7	0.9	-21%	0.2	0.2	+3%
R4	1.3	0.3	+339%	0.3	0.2	+75%	0.1	0.1	+22%
R5	2.1	0.7	+200%	0.6	0.4	+39%	0.2	0.1	+97%
R6	0.1	<0.1	+48%	<0.1	<0.1	0%	0.0	<0.1	-86%
R7	0.2	<0.1	+56%	<0.1	<0.1	0%	0.0	<0.1	-83%
R8	0.2	<0.1	+74%	<0.1	<0.1	0%	0.0	<0.1	-82%
I1	0.4	0.1	+329%	0.1	0.1	0%	<0.1	<0.1	0%
I2	1.2	0.6	+108%	0.4	0.4	-5%	0.1	0.1	+41%
I3	1.1	0.5	+130%	0.3	0.4	-16%	0.1	0.1	+21%
I4	2.0	1.1	+86%	0.7	0.7	-6%	0.2	0.1	+110%
I5	1.3	0.7	+88%	0.4	0.5	-20%	0.1	0.1	+33%
I6	0.9	0.4	+136%	0.3	0.3	-4%	0.1	0.1	-3%
I7	0.8	0.2	+286%	0.2	0.1	+126%	0.1	<0.1	-21%
I8	0.6	0.1	+487%	0.2	0.1	+70%	0.1	<0.1	-41%
I9	0.3	0.1	+190%	0.1	0.1	0%	<0.1	<0.1	0%
I10	0.3	<0.1	+211%	0.1	<0.1	-15%	<0.1	<0.1	0%
I11	0.3	<0.1	+173%	0.1	<0.1	-24%	<0.1	<0.1	0%
I12	0.2	<0.1	+117%	0.1	<0.1	-42%	<0.1	<0.1	0%
I13	0.3	0.1	+224%	0.1	<0.1	-14%	<0.1	<0.1	0%
Criterion	90		-	25		-	8		-

Table E2 Change in predicted annual average dust deposition

Receptor	Annual Average Dust Deposition ($g \cdot m^{-2} \cdot month^{-1}$)		
	Current	Previous	% change
R1	0.3	0.4	-18%
R2	0.3	0.4	-17%
R3	0.2	0.2	-13%
R4	0.1	0.1	-22%
R5	0.1	0.2	-30%
R6	<0.1	<0.1	0%
R7	<0.1	<0.1	0%
R8	<0.1	<0.1	0%
I1	<0.1	<0.1	0%
I2	0.1	0.1	1%
I3	0.1	0.1	-11%
I4	0.2	0.2	-10%
I5	0.1	0.1	-6%
I6	0.1	0.1	-38%
I7	<0.1	0.1	-58%
I8	<0.1	<0.1	0%
I9	<0.1	<0.1	0%
I10	<0.1	<0.1	0%
I11	<0.1	<0.1	0%
I12	<0.1	<0.1	0%
I13	<0.1	<0.1	0%
Criterion	2.0		-

Table E2 Change in predicted maximum incremental 24-hour PM_{10} and $PM_{2.5}$ concentrations

Receptor	Maximum incremental 24-hour average PM_{10} concentration ($\mu g \cdot m^{-3}$)		% change	Maximum incremental 24-hour average $PM_{2.5}$ concentration ($\mu g \cdot m^{-3}$)		% change
	Current	Previous		Current	Previous	
R1	9.8	7.9	+24%	2.9	1.6	+80%
R2	9.2	9.8	-6%	2.7	1.5	+80%
R3	13.0	15.6	-17%	2.8	2.5	+11%
R4	4.6	4.7	-3%	1.3	1.5	-15%
R5	5.7	6.9	-18%	1.4	1.5	-4%
R6	1.8	0.5	+262%	0.4	0.1	+252%
R7	2.5	0.4	+522%	0.7	0.1	+642%
R8	2.1	0.3	+606%	0.5	0.1	+352%
I1	2.5	1.9	+34%	0.5	0.4	+18%
I2	9.4	5.7	+65%	1.8	0.8	+129%
I3	4.6	10.6	-56%	1.1	1.4	-24%
I4	9.8	12.3	-20%	2.4	1.7	+38%
I5	9.7	6.6	+47%	1.8	1.3	+38%
I6	11.7	5.4	+117%	2.2	1.1	+98%
I7	6.5	1.9	+240%	1.4	0.4	+245%
I8	6.0	1.0	+498%	1.2	0.3	+285%
I9	3.0	1.1	+174%	0.6	0.2	+218%
I10	2.8	0.7	+305%	0.8	0.2	+312%
I11	4.5	0.7	+539%	0.9	0.2	+351%
I12	2.1	0.5	+325%	0.6	0.1	+527%
I13	3.1	0.5	+516%	0.9	0.2	+361%
Criterion	50		-	25		-