Oakdale East

Proposed Masonry Plant and Five Warehouses

224-398 Burley Road, Horsley Park, NSW

Air Quality Assessment

Document Control

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ABBREVIATIONS

AHD	Australian Height Datum
Airlabs	Airlabs Environmental Pty Ltd
Approved Methods	Approved Methods for the Modelling and Assessment of Air Pollutants in NSW
AWS	Automatic Weather Station
BoM	Bureau of Meteorology
CALMET	California Meteorological Model
CALPUFF	California Puff Dispersion Model
CO	Carbon monoxide
CSR Bricks	CSR Brick Manufacturing (PGH Bricks and Pavers, Horsley Park)
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cumulative impacts	Incremental impacts from proposed facility + incremental impacts from Austral Bricks Plant 3 + incremental impacts from CSR brick + background levels from St. Mary's air monitoring station
DA	Development Application
DCP	Development Control Plan
DOP&E	Department of Planning and Environment
EET	Emission Estimation Technique
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act, 1979
FEL	Front-end loader
g/sec	Emission rate in grams per second
kg/m^3	Units for density – kg per cubic metre
Incremental impacts	Impacts from the proposed facility – including masonry plant and the five (5) warehouses
Level 2	A refined dispersion modelling technique using site-specific input data
m^2	square metres
m/sec	metres per second
m^3/hr	cubic metre per hour
$mg/m^2/day$	Units for dust deposition
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure – Ambient Air Quality
NOx	Oxides of Nitrogen
NO_2	Nitrogen dioxide
NPI	National Pollutant Inventory
NSW – EPA	New South Wales Environment Protection Authority
NSW – OEH	New South Wales Office of Environment and Heritage
PAHs	Polycyclic Aromatic Hydrocarbons
Pb	Lead
Plant 3	Austral Bricks Plant 3 site
PM	Particulate matter
PM_{10}	Particulate matter with an equivalent diameter of 10 microns
$PM_{2.5}$	Particulate matter with an equivalent diameter of 2.5 microns
Proposal	Construction and operation of a masonry plant with a production capacity of 220,000 tonnes per annum and five (5) warehouses for generic warehouse and distribution uses
Proposed facility	Oakdale East project site – 224-398 Burley Road, Horsley Park, NSW
SEARs	Secretary Environmental Assessment Requirements

SOx	Sulfur oxides
SO_2	Sulfur dioxide
SRC	Sigma Research Corporation (now Exponent)
SRTM	Shuttle Radar Topography Mission
TAPM	The Air Pollution Model
tpa	tonnes per annum
TEQ	Toxic equivalent
TSP	Total Suspended Particulates
$\mu g/m^3$	micrograms per cubic metre
US-EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VOCs	Volatile Organic Compounds

EXECUTIVE SUMMARY

Introduction

Austral Masonry NSW Pty. Ltd. (Austral Masonry) and Goodman are proposing to construct and operate a masonry plant with a production capacity of 220,000 tpa and five (5) warehouses intended for generic warehousing and distribution purpose at 224-398 Burley Road, Horsley Park, NSW.

The proposed development comprising the masonry plant and the five warehouses is collectively referred to as the Oakdale East project.

Airlabs Environmental Pty. Ltd. (Airlabs) were commissioned by Goodman on behalf of Austral Masonry to conduct an air quality assessment for the proposed development.

Methodology

The proposal is categorised as a Designated Development as per the Environmental Planning and Assessment Act 1979. Secretary Environmental Assessment Requirements (SEAR No: 1255) have been issued for preparation of the Environmental Impact Statement (EIS) supporting the Development Application (DA) and the air quality assessment accompanying the EIS. The SEARs issued with respect to air quality and the sections of this report addressing those relevant SEARs are summarised below:

- a description of all potential sources of air and odour emissions.

- an air quality impact assessment in accordance with relevant Environment Protection Authority guidelines.

- a description and appraisal of air quality impact mitigation and monitoring measures.

The air quality assessment principally aims to achieve the following objectives:

- Quantifying impacts from the proposed operations at the masonry plant and the five (5) warehouses.
- Address the SEARs issued for air quality.
- Determine cumulative air quality impacts on the receiving environment, which include impacts from the proposed facility along with impacts from existing sources.

To address the SEARs and to meet the assessment objectives, a Level 2 impact assessment has been conducted in accordance with the guidelines outlined in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods), Environment Protection Authority, January 2017.

To determine impacts from the proposed masonry facility, the following tasks were undertaken:

- Identification of key pollutants from the masonry plant and the warehouses and determination of relevant impact assessment criteria referenced from the Approved Methods.
- Development of site-specific meteorology in accordance with Level 2 assessment requirements as outlined in the Approved Methods.
- Characterisation of the geographical setting of the proposed facility and the surrounding land uses and identification of residential and non-residential / industrial sensitive receptors. Modelled concentrations were predicted at the identified sensitive receptors.
- Estimating pollutant emission rates from the masonry production and the warehouses using Emission Estimation Technique (EET) Manuals.
- Modelling the estimated pollutant emission rates from the proposed facility and predicting incremental (proposed facility) impacts at the identified sensitive receptors.
- To predict cumulative pollutant concentrations where required, the following non-project related sources were taken into consideration:

  - Background ambient air quality levels from the nearest representative NEPM air quality monitoring station – The St. Mary's monitoring station managed by OEH was considered to be suitable for this assessment.
  - Point source and fugitive dust emissions generated from the existing Austral Bricks Plant 3 facility, including associated quarrying operations. The Plant 3 site is located immediately north of the proposed facility.
  - Point source and fugitive dust emissions from the operational activities at the CSR Brick Plant, including associated quarrying operations.
- Predicted cumulative concentrations were reported as a sum total of the impacts from the proposed facility along with the aforementioned non-project related sources.
- Emissions and source characteristics from Austral Bricks Plant 3 were provided to Airlabs by Austral Masonry whereas the 2016-17 emissions reported to the National Pollutant Inventory (NPI) were utilised to determine pollutant emission rates from the CSR brick manufacturing operations.
- To determine incremental (proposed facility) and cumulative impacts, air dispersion modelling was undertaken for calendar year 2017 using the CALPUFF dispersion model. Meteorological modelling was conducted using a combination of the TAPM and CALMET models.
- Incremental and cumulative impacts were predicted at the identified sensitive receptors and for individual air toxics, concentrations were predicted outside the facility site boundary, as specified in the Approved Methods.

Key Pollutants

Off-gases generated from the natural gas burner used for heating the air inside the curing chamber along with fugitive particulate matter emissions generated from various operational activities at the masonry plant and the five (5) warehouses have been identified as the main pollutants of concern from the proposed facility.

Model Predictions

From the modelling, the following observations are made:

- Model predicted incremental (proposed facility only) concentrations for all pollutants emitted from the proposed facility are observed to be well below their respective assessment criteria.
- Based on the predicted incremental impacts, particulate matter emissions (TSP, PM_{10}, $PM_{2.5}$ and deposited dust) are identified to be the key pollutant generated from the proposed facility.
- With respect to particulate emissions, the contribution from the proposed facility ranges from 0.6% of the assessment criteria (TSP annual average) to 3.2% ($PM_{2.5}$ 24-hour average) of the assessment criteria.
- For all other pollutants, such as SO_2, NO_2, CO, the maximum predicted incremental concentrations across all sensitive receptors are 0.2% or below their respective assessment criteria. As-such, it can be noted that these pollutants are not expected to significantly contribute to cumulative concentrations and therefore no additional cumulative assessment has been undertaken.
- Of all the modelled pollutants, as particulate emissions (TSP, PM_{10}, $PM_{2.5}$ and deposited dust) were identified to be the key pollutant, a cumulative assessment was undertaken.
- Modelling shows that predicted cumulative ground-level concentrations (the sum of background levels, non-project impacts and incremental impacts from the proposed facility) for TSP, PM_{10}, $PM_{2.5}$ size fractions and deposited dust levels are below their respective assessment criteria at all the identified sensitive receptors.

As compliance is achieved for all pollutants, including cumulative impacts, where required and as modelling shows that the contributions from the proposed facility are quite minimal, it can be concluded that the proposed masonry plant and warehouse operations would not affect compliance with applicable air quality assessment criteria.

1. INTRODUCTION

Airlabs Environmental Pty. Ltd. (Airlabs) was commissioned by Goodman on behalf of Austral Masonry NSW Pty. Ltd. (Austral Masonry) to undertake an air quality assessment for the proposed development of a masonry plant and five warehouses at 224-398 Burley Road, Horsley Park, NSW, that is being developed by Austral Masonry and Goodman. The proposed development comprising the masonry plant and the five warehouses is collectively referred to as the *Oakdale East* project.

The proposal comprises the construction and operation of a masonry manufacturing facility capable of producing up to 220,000 tonnes per annum (tpa) of masonry products. The products to be manufactured at the proposed facility include grey masonry block, coloured block, retaining walls and pavers. Alongside the masonry plant, five (5) warehouses intended for generic warehousing and distribution uses would also be constructed as a part of the Oakdale East project.

The Environmental Planning and Assessment Act 1979 (EP&A Act) stipulates the framework for all developments in NSW. The subject proposal is categorised as a *Designated Development* under Part 4 of the EP&A Act. As per Section 78A (8) of the EP&A Act, if the application is a designated development, it is to be accompanied by an Environmental Impact Statement (EIS) and this air quality assessment forms a part of the EIS.

This air quality assessment has been prepared in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, Environment Protection Authority (EPA), 2016 (hereafter 'the Approved Methods'). As per Section 9 of the Approved Methods, the EPA has listed out minimum requirements regarding information contained within an impact assessment report which are specified below. The relevant sections of this report which address the minimum requirements are mentioned alongside.

- Site plan – Section **2**
- Description of the activities carried out on the site – Section **2**
- Emissions inventory – Section ***7***
- Meteorological data – Section **8**
- Background air quality data – Section **11**, **Appendix B** and **Appendix C**
- Dispersion modelling – Section **9**, Section **10** and Section **11**
- Bibliography – Section **13**

As the proposal is a designated development, Secretary Environmental Assessment Requirements (SEARs) have been issued by the NSW Department of Planning & Environment (DOP&E) (SEAR No: 1255) in October 2018 for the EIS and the accompanying air quality assessment. The SEARs issued with respect to air quality and the sections of this report addressing those relevant SEARs are summarised in **Table 1**.

Table 1: Secretary Environmental Assessment Requirements issued for Air Quality – SEAR No: 1255

SEARs issued for Air Quality (SEAR No: 1255)	Sections of the Assessment Report Addressing the Relevant SEARs
- a description of all potential sources of air and odour emissions	Section ***7***
- an air quality impact assessment in accordance with relevant Environment Protection Authority guidelines; and	Section **1** to Section **12**
- a description and appraisal of air quality impact mitigation, management and monitoring measures.	Section **2.7** and Section **6.3**

2. PROJECT OVERVIEW

2.1 Facility Location

Austral Masonry are proposing to construct and operate a masonry manufacturing facility along with five (5) warehouses, located at 224-398 Burley Road, Horsley Park, NSW.

The proposed development is located on Lot 20 DP 1246626 and is referred to as the Oakdale East project. The total site area is estimated to be approximately 10.76 hectares (ha). An overall site plan of the proposed development is illustrated in **Figure 1**. Particulars of the proposed development are outlined in **Table 2**.

The proposed development would be built on the site of the existing Austral Bricks Plant 3 facility (hereafter 'the Plant 3').

Plant 3 comprises an existing brick manufacturing and associated quarrying operations. Activities at Plant 3 are regulated under the NSW Environmental Protection Licence (EPL) No: 546. Plant 1 and Plant 2, which are located approximately 2km east of the Plant 3 site at 780 Wallgrove Road, Horsley Park are also managed under EPL 546.

As per information provided to Airlabs, the proposed development – comprising the masonry plant and the five (5) warehouses would be constructed at the Plant 3 site in place of existing stockpiles, which are to the south of the brick kiln.

Table 2: Particulars of the Proposed Development

Development Area	Value	Unit
Total Site Area	108,158	m^2
New Estate Road Lot	8,535	m^2
Developable Site Area	99,623	m^2
Masonry Plant	10,430	m^2
Total Warehouse (5 Warehouses)	31,586	m^2
Total Office	4,226	m^2
Total Gross Floor Area	35,812	m^2

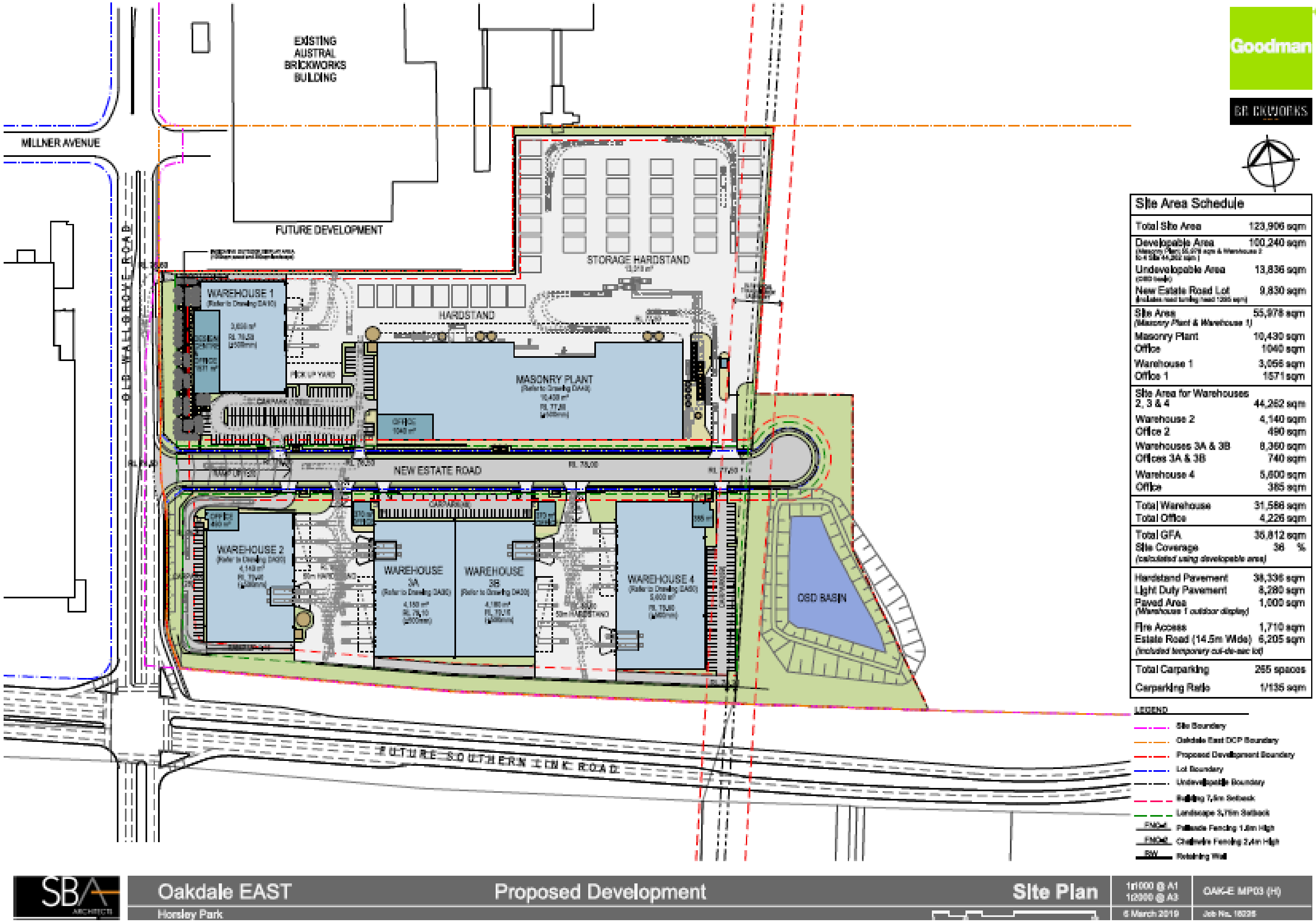
As per information available on the public domain, the proposed Oakdale East development site adjoins the Western Sydney Employment Area, located immediately to the south-west, which is being developed on land known as Lot 1 DP 106143, 327-335 Burley Road, Horsley Park, NSW as per the Development Control Plan (DCP) [1]. As per the DCP, the industrial subdivision of Lot 1 DP 106143, which will be undertaken in three (3) stages proposes the creation of 14 industrial lots and one (1) lot for the environmental conservation land, ranging from 1.5 ha to 13 ha.

According to the DCP, Lot 1 DP 106143 is currently being used as an extractive industry for the purposes of brick manufacturing and associated quarrying activities. The brick manufacturing operations at the site are currently undertaken by CSR Bricks (PGH Bricks and Pavers, Horsley Park) and as per the DCP, brick manufacturing operations will continue until the proposed subdivision reaches Stage 3. During Stage 3, decommissioning of the brick manufacturing and associated operations would commence. At this stage, Airlabs are unaware of the progress of the proposed subdivision, therefore the CSR brick manufacturing and associated quarrying operations have been considered as a part of characterising the existing air quality levels.

[1] *Development Control Plan, 327-335 Burley Road, Horsley Park*, Issued by Peter Andrews + Associates Pty. Ltd., March 2016

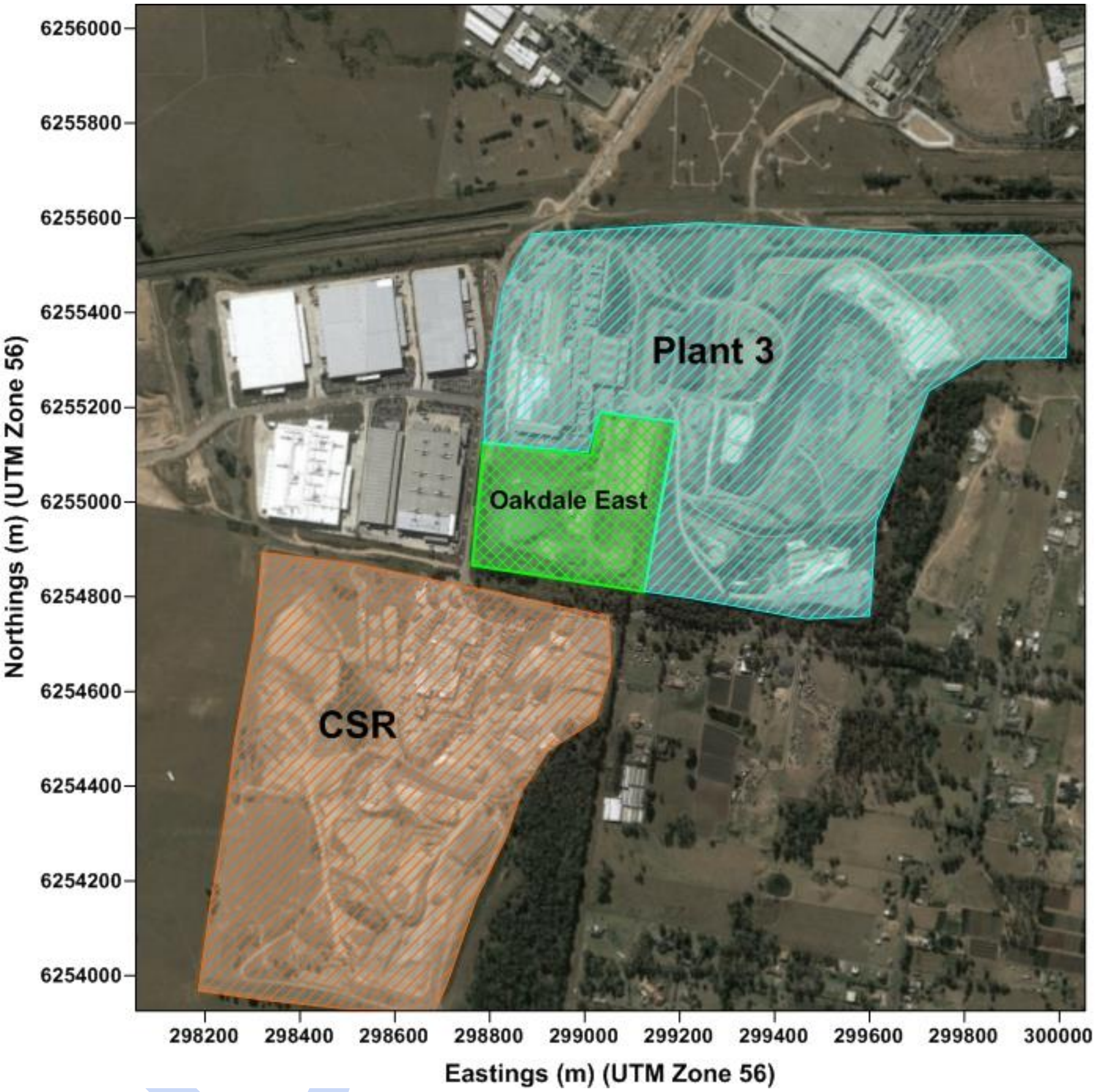
The location of the proposed development site with context to the existing Plant 3 operations and the CSR brick manufacturing and associated quarrying operations is shown in **Figure 2**

Figure 1: Overall Site Plan of the Oakdale East Project



Source: Oakdale East Master Plan Set, Goodman, 07 March 2019

Figure 2: Location of the Proposed Development in context to Austral Bricks Plant 3 and CSR Brick Manufacturing

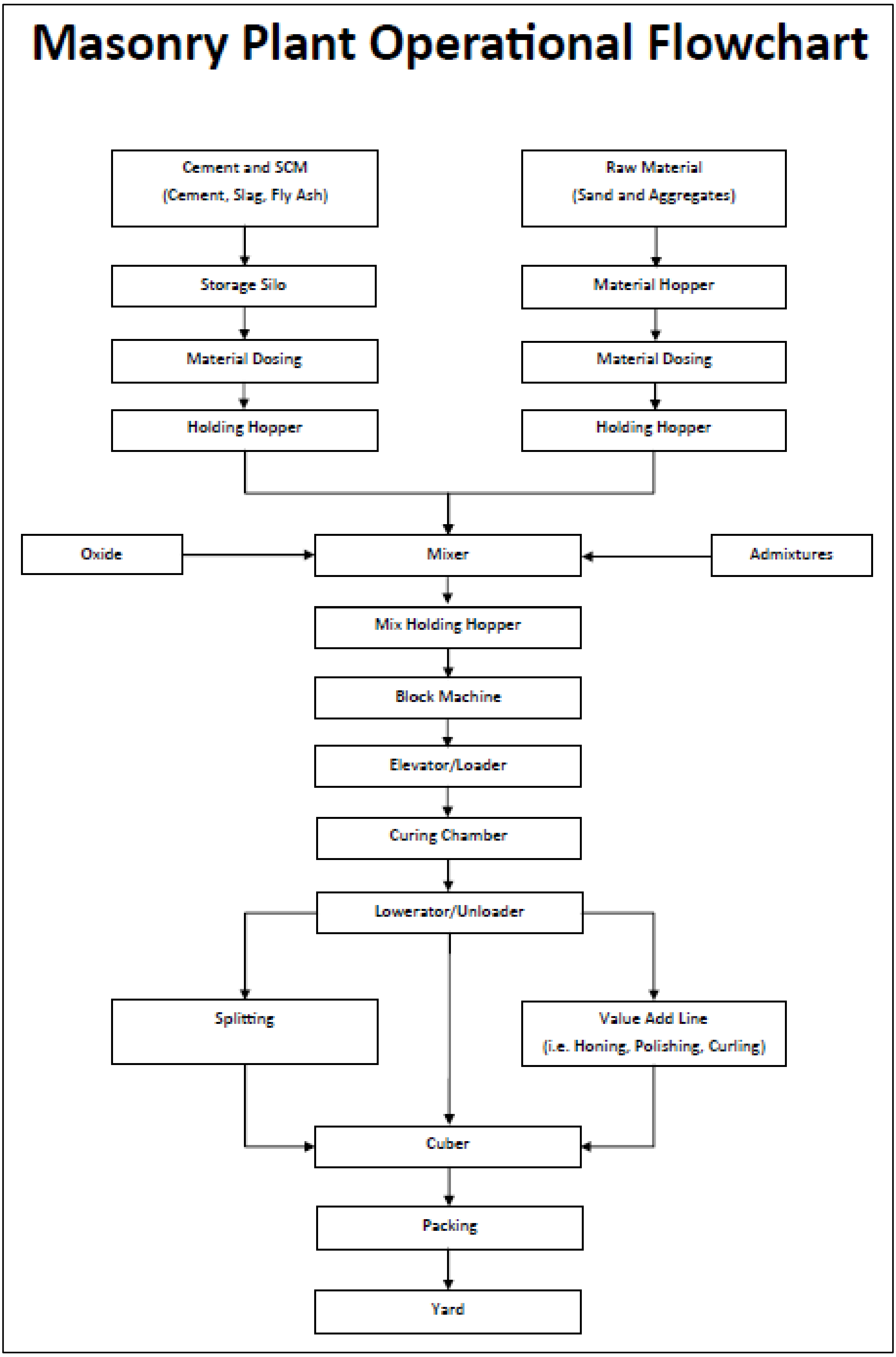


2.2 Overview of the Proposed Masonry Plant Operations

As per the information provided to Airlabs, the proposed masonry plant once fully operational is expected to produce up to 220,000 tpa of masonry products. Products that would be manufactured at the proposed facility comprise – grey block masonry, coloured block, retaining walls and pavers.

A process flow diagram of the masonry production at the proposed facility is illustrated in **Figure 3**.

Figure 3: Process Flow Diagram – Masonry Manufacturing



An overview of the masonry production process is provided below:

- Raw material including sand and aggregate and cement (incl. slag and fly ash) are delivered at the proposed facility site. The sand and aggregate materials are unloaded from delivery trucks into an underground hopper system, referred to as the drive over bins.
- The raw material unloaded into the drive-over bins is conveyed to a material hopper through enclosed conveyors.
- The cement and supplementary cementing materials such as slag and fly ash are pneumatically conveyed from the delivery trucks to the cement silos. It is understood that the cement silos will have venting filters to capture dust generated during the pneumatic filling of the silos.
- After the raw materials have been transferred to the storage silos / material hoppers, they are dosed depending on the required product and then are transferred into a holding hopper.
- From the holding hopper, the raw materials will be mixed with water, oxides and admixtures in a mixer before conveying the mix to the block machine. The mixing is an automated process, where in the desired quantities of raw materials are automatically dispensed in the preparation of the mix.
- Post mixing, the product would be held in a mix holding hopper before transferring to the block machine.
- The products would be formed into blocks / pavers via a hydraulic press, referred to as the block machine, which would be housed inside an acoustic enclosure.
- After the manufacturing of the required blocks, they are loaded onto an elevator before being transferred into the curing chamber.
- The curing chamber is a controlled environment heated room with high humidity levels. This environment will allow for hydration – chemical reaction between water and cement which causes hardening of the blocks. As per details provided by Austral Masonry, the air inside the curing chamber of the proposed facility will be heated with a gas burner and water mist would be introduced to maintain a high humid environment. It is anticipated that the maximum temperatures inside the curing chamber would be circa. 60^0C. Once the curing temperature has been reached, the blocks would be allowed to soak in the hot, moist air for a considerable period of time.
- Low NOx natural gas burner system would be used for heating up the air inside the curing chamber. Off-gases released from the combustion of natural gas would be sent out through a flue stack, which is circa. 20m high from ground level. The maximum amount of natural gas flow is expected to be around 24 cubic metres per hour (m^3/hr), which equates to approximately 16.8 kg/hr based on a natural gas density of 0.7 kg/m^3.
- After curing, the concrete products are then removed from the curing chamber and palletised. Some of the products would undergo additional processing, including polishing, honing, curling, splitting etc.
- The products would be cubed, packaged and transported (via a forklift) to the storage yard.
- Pallets will be stored externally in the storage hardstand to the east of the proposed masonry plant. There would also be a provision for internal storage of high end / high value products.
- It is expected that the process would produce a certain quantity of reject material. Reject generated from the process would be crushed into workable sizes via a crusher system which would be located adjacent to the drive over bins and re-used for the masonry production as practicable as possible.

- Airlabs have been advised that the driveways used by haul trucks for delivering raw material and transporting product material would be paved and the potential for wheel generated dust would be limited as opposed to unpaved roads.

2.3 Overview of the Proposed Warehouses

As shown in **Figure 1**, the Oakdale East project comprises construction and development of five (5) warehouses. These warehouses are intended for generic warehousing and distribution purposes. Areas schedules of each of the proposed warehouses are summarised in **Table 3**.

Table 3: Details of the Proposed Warehouses

Warehouse I.D.	Value	Unit
Warehouse 1	3,056	m^2
Warehouse 2	4,140	m^2
Warehouse 3A & 3B	8,360	m^2
Warehouse 4	5,600	m^2
Total Warehouse Area	31,586	m^2
Total Office Area (Masonry Plant Office and Offices in Warehouse 1, 2, 3A, 3B and 4)	4,226	m^2

2.4 Proposed Operational Hours

Once operational, the proposed masonry facility is assumed to operate 24 hours, 365 days per year and this has been reflected in the dispersion model. The warehouses once commissioned are expected to be operational 24 hours, seven (7) days of the week. However, for the purposes of dispersion modelling, the warehouses have been assumed to be operational, 24 hours 365 days a year.

2.5 Proposed Material Volumes – Masonry Plant

The types of raw materials and their corresponding volumes along with expected volumes of the masonry products and reject material are summarised below. The below estimates have been provided to Airlabs by Austral Masonry.

Raw Materials:

- Sand and aggregate: approx. 207,900 tpa
- Cement: approx. 23,100 tpa

Product:

- Expected annual production rate of masonry products: 220,000 tpa.

Reject:

- Reject material: approx. 11,550 tpa

2.6 Potential Sources of Air Emissions

2.6.1 Masonry Plant

Based on the process description as outlined in **Section 2.2**, sources that have the potential to generate air emissions / impact the air quality of the surrounding environment have been identified and are presented below:

- Off-gases generated from the natural gas burner used for heating the air inside the curing chamber
- Fugitive dust emissions generated from the following activities:
    - Unloading raw materials into the drive over bins.
    - Conveying / material transfer.
    - Loading reject material to the crusher unit.
    - Crushing operations.
    - Loading / transfer of crushed material to the drive over bin.
    - Paved surface vehicle haulage emissions.

2.6.2 Warehouses

Based on the intended use of the warehouses, it is unlikely that there would be any significant pollutants generated, however, for the purpose of the assessment, fugitive dust emissions generated from light and heavy vehicle haulage on the paved surfaces have been considered for the assessment.

2.7 Air Quality Control Measures – Masonry Plant and Warehouses

Although the potential for the proposed development to generate atmospheric pollutants is quite limited as observed from the process overview, Austral Masonry have integrated the following air quality control measures into their process which would reduce the extent of emissions discharged to the atmosphere:

- Using a low NOx burner for heating the air in the curing chamber, which will limit the amount of NOx emissions released.
- Conveyors used for material transfer would be enclosed, limiting the potential for windborne dust emissions.
- Raw and product material haulage surfaces for the masonry plant as well as the warehouses would be paved, limiting the potential for wheel generated dust from heavy trucks. Ongoing general maintenance of the paved surfaces would be undertaken, including periodic sweeping which would minimise the potential for wheel generated dust emissions.
- The reject material sent to the crusher unit would have a reasonably high moisture content, which would minimise dust emissions generated from the crusher.
- Airlabs have been informed that the raw material silos would have sufficient capacity to store excess material, thereby eliminating the necessity / requirement for stockpiles.
- There are no exposed areas at the proposed facility, which could generate wind-borne fugitive dust emissions.
- Imposing speed restrictions for light and heavy vehicles travelling on paved surfaces of the masonry plant and the warehouses, thereby limiting the potential for wheel generated dust emissions.

3. ASSESSMENT OBJECTIVE

This air quality assessment principally aims to achieve the following objectives:

- Quantifying air quality impacts from the proposed facility's operational activities.
- Comprehensively address the SEARs issued for the proposed facility.
- Determination of cumulative air quality impacts on the receiving environment (i.e. impacts from the proposed facility and impacts from existing sources)

The assessment has been informed by the following regulatory guideline documents:

- *Secretary Environmental Assessment Requirements* (SEARs) issued by the NSW Department of Planning & Environment (DOP&E) (SEAR No: 1255)
- *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Environment Protection Authority*, January 2017 (NSW-EPA, 2017) (hereafter 'the Approved Methods)
- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia'* (NSW-OEH, 2011)

4. ASSESSMENT METHODOLOGY

A Level 2 impact assessment has been conducted to quantify operational impacts from the Oakdale East project, which includes impacts from the masonry plant and the proposed warehouses.

According to the Approved Methods, a Level 2 assessment is a refined dispersion modelling technique using site-specific input data.

The assessment has also quantified the impacts from the nearby sources – which include the existing Plant 3 and CSR brick manufacturing operations (refer **Figure 2**) A detailed description of how these sources have been assessed is presented in **Appendix C** of this assessment report.

An overview of the air quality assessment undertaken is presented below:

- A detailed review of the proposed masonry production process was undertaken through consultation with Goodman and Austral Masonry.
- Key pollutants of concern based on production process were identified. Pollutants were also identified for the warehouses to be developed as a part of this project.
- Determination of relevant ambient air quality assessment criteria referenced from the Approved Methods for the identified pollutants of concern.
- Development of site-specific meteorology. Meteorological data was prepared in accordance with the Level 2 assessment requirements as outlined in the Approved Methods.
- Characterisation of the geographical setting of the proposed facility and the surrounding land uses and identification of sensitive receptors. Sensitive receptors representative of residential dwellings and non-residential/industrial developments have been identified.
- Pollutant emission rates from the masonry production and the warehouses were determined using Emission Estimation Technique (EET) Manuals and taking into account the air quality controls measures proposed by Austral Masonry (refer **Section 2.6**).
- Modelling the estimated pollutant emission rates from the proposed facility and predicting incremental (proposed facility) impacts on the identified sensitive receptors.
- To predict cumulative pollutant concentrations where required, the following non-project related sources were taken into consideration:

  - Background concentrations recorded at the nearest / representative National Environment Protection (Ambient Air Quality) Measure (Ambient Air Quality NEPM) monitoring stations managed by the Office of Environment & Heritage (OEH) air monitoring network.
  - Point source and fugitive dust emissions generated from the existing Austral Bricks Plant 3 facility, including associated quarrying operations.
  - Point source and fugitive dust emissions from the operational activities at the CSR Brick Plant, including associated quarrying operations.
- Predicted incremental (proposed facility) and cumulative (sum total of impacts from proposed facility + background levels from OEH monitoring station + impacts from Plant 3 + impacts from CSR Bricks) pollutant concentrations at identified sensitive receptors were compared against the relevant assessment criteria to determine compliance.
- Presentation of modelled pollutant concentrations in the form of tables and concentration isopleths.
- Preparation of assessment report.

As a part of undertaking this assessment, Airlabs contacted NSW-EPA in October 2018 and informed the assessing officer (personal communication between Airlabs and assessing officer) of the methodology adopted in determining the impacts from the proposed facility on the receiving environment. During the discussion, Airlabs personnel also informed the assessing officer of the methodology adopted in determining cumulative pollutant concentrations, which was duly acknowledged.

5. STUDY AREA AND SURROUNDS

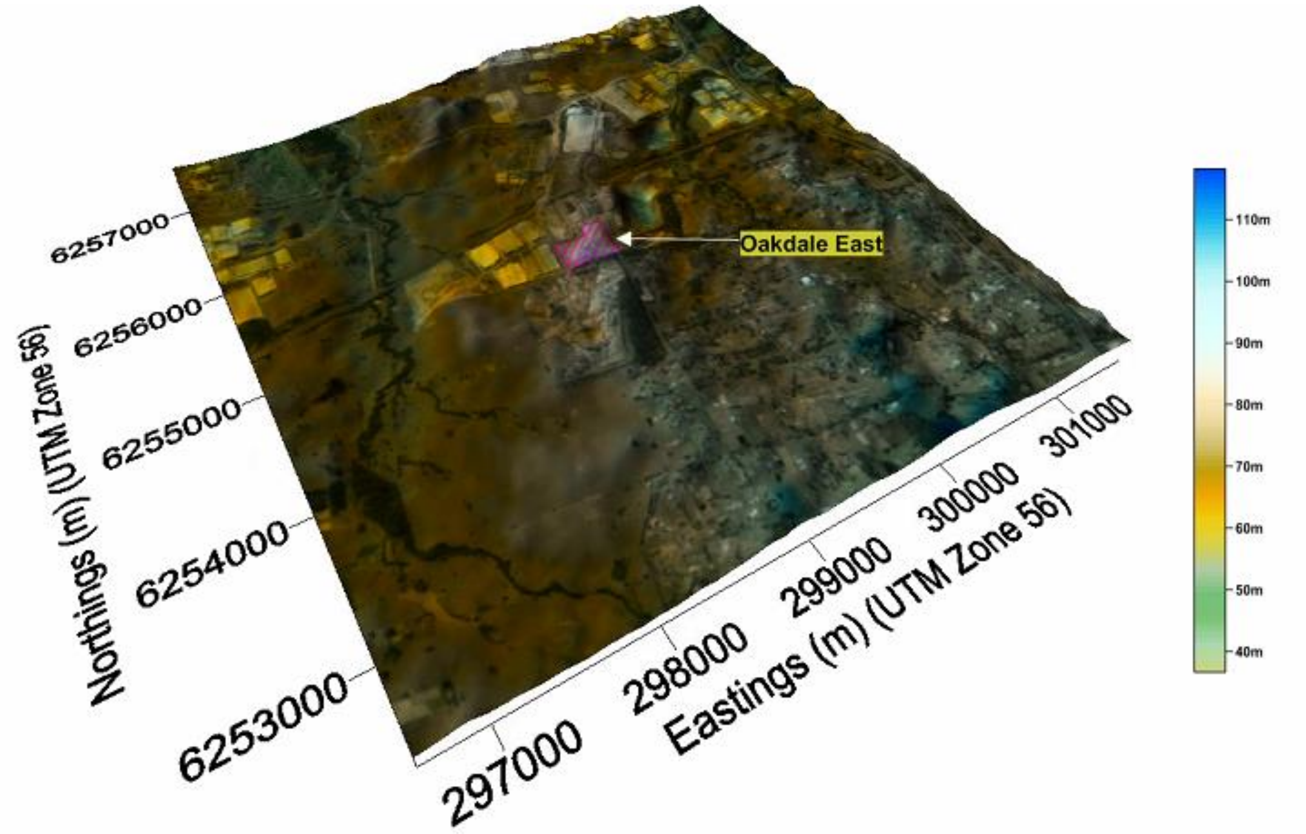
5.1 Existing Land Use and Topography

The proposed facility including the masonry plant and the five (5) warehouses would be developed within the existing Austral Bricks Plant 3 site. The CSR brick manufacturing operations is located to the immediate south of the proposed facility along with existing warehouses to the west.

The proposed facility is surrounded by scattered properties, reflective of low to medium density rural residential dwellings.

The local topography at the proposed facility is largely undulating ranging with terrain gradually increasing towards the north and to the east and south-east. A 3-dimensional representation of the topographical features surrounding the proposed facility over a 5 km x 5 km domain is illustrated in **Figure 4**.

Figure 4: Topographical Features Surrounding the Proposed Facility



5.2 Sensitive Receptors

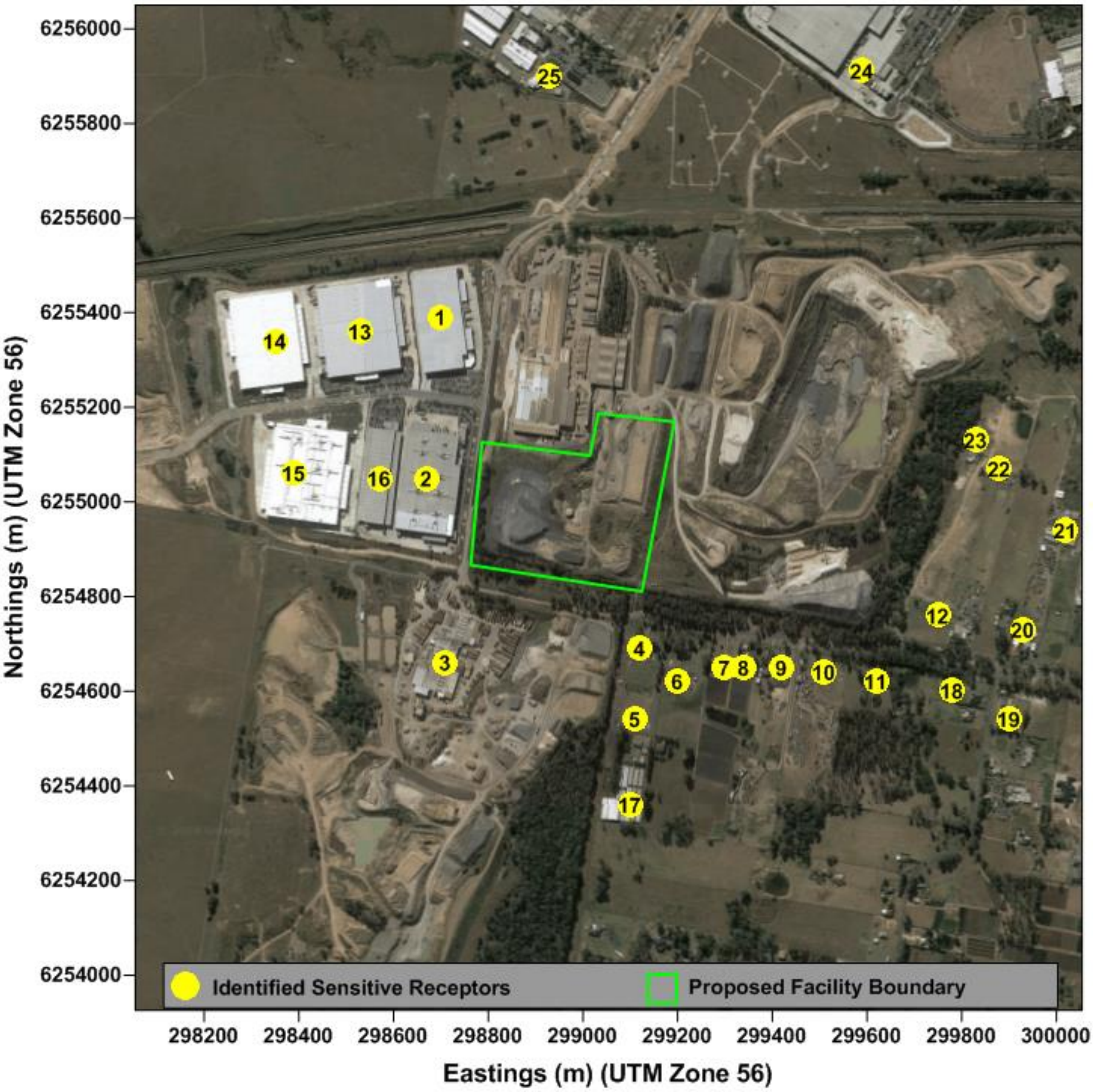
To predict air quality impacts from the proposed facility, a set of sensitive receptors closest to the proposed development have been identified. Modelled incremental (proposed facility only) and cumulative (proposed facility + background + Plant 3 + CSR) impacts have been predicted at each of the identified sensitive receptors.

Spatial distribution of the selected sensitive receptors is illustrated in **Figure 5** and the details of the receptors are summarised in **Table 4**.

Table 4: Details of Identified Sensitive Receptors

Receptor I.D.	Eastings (m) (UTM Zone 56)	Northings (m) (UTM Zone 56)
1	298700	6255391
2	298670	6255050
3	298710	6254661
4	299120	6254690
5	299110	6254541
6	299200	6254621
7	299300	6254650
8	299340	6254650
9	299420	6254650
10	299510	6254641
11	299620	6254621
12	299750	6254760
13	298530	6255360
14	298350	6255340
15	298390	6255061
16	298570	6255050
17	299100	6254360
18	299780	6254601
19	299900	6254541
20	299930	6254730
21	300020	6254940
22	299880	6255070
23	299830	6255130
24	299590	6255911
25	298930	6255900

Figure 5: Sensitive Receptors Locations



6. REGULATORY GUIDELINES

The main pollutants to be released from the masonry plant and the five (5) warehouses comprise:

- Products of incomplete combustion from burning natural gas for heating the air inside the curing chamber. Pollutants mainly include carbon monoxide (CO), oxides of nitrogen (NOx), sulfur oxides, (SOx), particulates, metals and volatile organic compounds (VOCs).
- Fugitive emissions of particulate matter generated from operational activities at the masonry plant including material handling (loading / unloading / conveying) activities, crushing of reject materials and wheel generated dust from haulage on paved surfaces.
- Fugitive emissions of particulate matter generated from light and heavy vehicle haulage on paved surfaces at the proposed warehouses.

Airborne particulate matter typically consists of particles of varying size fractions. From a health and nuisance perspective, particles are categorised primarily by size as total suspended particulates (TSP), PM_{10} and $PM_{2.5}$ and deposited dust levels.

Although, TSP is defined as the total mass of all particles suspended in air, an effective upper limit of 30 microns aerodynamic diameter is assigned. Within the TSP matter, lie two sub-categories; particulate matter with an equivalent diameter of 10 microns or less (PM_{10}) and particulate matter with an equivalent diameter of 2.5 microns or less ($PM_{2.5}$)

Dust deposition rate is the mass of particulate matter that collects over an area for a certain time period (usually monthly). Dust deposition is used as a measure of the potential for dust to affects amenity.

6.1 National Legislation

In June 1998 (revised in 2003), the National Environment Protection Council (NEPC) developed the Ambient Air Quality National Environmental Protection Measure (NEPM) which sets out uniform standards for air quality at the national levels and has included ambient air quality standards for carbon monoxide (CO), nitrogen dioxide (NO_2), photochemical oxidants (as ozone – O_3), sulfur dioxide (SO_2), lead and particulate matter with a nominal aerodynamic diameter of less than or equal to 10 microns (PM_{10}). The NEPM was revised in 2003 to include an advisory reporting goal for particulate matter with a nominal aerodynamic diameter of less than or equal to 2.5 microns ($PM_{2.5}$)

6.2 Legislation in New South Wales

In NSW, air pollution is regulated by Part 5.4 – Air Pollution of the Protection of the Environment Operations Act 1997 (POEO 1997). The impact assessment criteria for CO, lead, NO_2, O_3, SO_2 and particulates and individual air toxics are outlined in the Approved Methods.

The Approved Methods specifies air quality assessment criteria to determine whether emissions from a particular premise will comply with the appropriate environmental outcomes adopted by the EPA.

As per the Approved Methods, cumulative impact of emissions from nearby sources and existing environment need to be considered along with the emissions from the facility in concern for the following pollutants – sulfur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), particles (PM_{10}, $PM_{2.5}$), total suspended particulates (TSP), deposited dust, carbon monoxide (CO) and hydrogen fluoride (HF).

For the aforementioned pollutants, sources from the proposed facility and non-facility related sources (which include background levels referenced from the nearest NEPM monitoring station + contribution from existing Plant 3 operations + contribution from the CSR operations) are to be cumulatively assessed to determine compliance. For these pollutants, model predicted cumulative concentrations are to be presented as the 100^{th} percentile value (i.e. maximum) at the nearest sensitive receptor.

The Approved Methods also specifies assessment criteria for metals and individual VOCs which are categorised as individual air toxics. For the individual air toxic pollutants, the model predicted concentrations are to be reported as 99.9th percentile (Level 2 assessment) incremental (i.e. proposed facility only) impacts at or beyond the proposed facility site boundary.

6.3 Applicable Air Quality Assessment Criteria

Impact assessment criteria referenced from the Approved Methods for the relevant pollutants are summarised in **Table 5** and **Table 6**.

Table 5 provides the assessment criteria for sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particles (PM_{10}, $PM_{2.5}$), total suspended particulates (TSP), deposited dust and carbon monoxide (CO).

In addition to assessing health impacts, nuisance impacts are also evaluated in NSW in the form of deposited dust levels. The Approved Methods has prescribed maximum permissible dust deposition rates to regulate deposited dust levels. The limits for deposited dust levels are summarised in **Table 5**, showing the maximum increase in deposited dust levels and the total deposited dust levels.

Assessment criteria for the individual air toxics are tabulated in **Table 6**. With regards to VOCs released from the incomplete combustion of natural gas, the Emission Estimation Technique (EET) Manual (refer **Section 7.1**) used for estimating emission rates, does not speciate individual VOC compounds. As-such, an assumption has been made by Airlabs, where in the VOCs released from the natural gas burner would be equally divided into three (3) main individual VOCs – Benzene, Toluene and Xylene (i.e. one part of VOC would be equally divided into three parts comprising Benzene, Toluene and Xylene). Therefore, the assessment criteria for VOCs presented in **Table 6** are represented by Benzene, Toluene and Xylene.

Table 5: Criteria for Particulates, SO_2, NO_2, CO, Lead and Deposited Dust

Pollutant	Assessment Criteria	Averaging Period	Assessment	Reporting Percentiles
TSP	90 $\mu g/m^3$	Annual	Cumulative	n.a.
PM_{10}	50 $\mu g/m^3$	24-hours	Cumulative	100th percentile
	25 $\mu g/m^3$	Annual	Cumulative	n.a.
$PM_{2.5}$	25 $\mu g/m^3$	24-hours	Cumulative	100th percentile
	8 $\mu g/m^3$	Annual	Cumulative	n.a.
Sulfur dioxide (SO_2)	712 $\mu g/m^3$	10-minutes	Cumulative	100th percentile
	570 $\mu g/m^3$	1-hour	Cumulative	100th percentile
	228 $\mu g/m^3$	24-hours	Cumulative	100th percentile
	60 $\mu g/m^3$	Annual	Cumulative	n.a.
Nitrogen dioxide (NO_2)	246 $\mu g/m^3$	1-hour	Cumulative	100th percentile
	62 $\mu g/m^3$	Annual	Cumulative	n.a.
Carbon monoxide (CO)	100 mg/m^3	15-minutes	Cumulative	100th percentile
	30 mg/m^3	1-hour	Cumulative	100th percentile
	10 mg/m^3	8-hour	Cumulative	100th percentile
Lead (Pb)	0.5 $\mu g/m^3$	Annual	Cumulative	n.a.
Deposited dust levels	2 g/m^2/month – maximum increase in deposited dust level	Annual	Incremental	n.a.

Pollutant	Assessment Criteria	Averaging Period	Assessment	Reporting Percentiles
	4 g/m^2/month – maximum total deposited dust level	Annual	Cumulative	n.a.

Table 6: Criteria for Individual Air Toxics

Pollutant	Assessment Criteria	Averaging Period	Assessment	Reporting Percentiles
Arsenic	0.09 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Beryllium	0.004 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Cadmium	0.018 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Chromium (III)	9 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Copper	18 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Mercury	1.8 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Nickel	0.18 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Manganese	18 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Zinc	90 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Polycyclic Aromatic Hydrocarbons (PAHs)	0.4 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Polychlorinated Dioxins and Furans (TEQ)	2.0E-06 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Benzene	29 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Xylene	190 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary
Toluene	360 $\mu g/m^3$	1-hour	Incremental	99.9th percentile, at or beyond facility boundary

7. PROPOSED FACILITY EMISSIONS

Sources from the Oakdale East project that have the potential to generate atmospheric pollutants are discussed in this section. Pollutant emission rates have been quantified for:

- Off-gases generated as a result of incomplete combustion of natural gas inside the curing chamber.
- Fugitive dust emissions generated from the operational activities at the masonry plant, as identified in **Section 2.6.1**; and
- Fugitive dust emissions generated from light and heavy vehicle haulage activity on sealed roads at the proposed five (5) warehouses.

The following sections outline the approach implemented to estimated emissions for the identified sources. Air quality control measures (refer **Section 2.7**) implemented by Austral Masonry have been accounted for while developing the emissions inventory.

Additional information on the quantifiable emission reductions (especially for fugitive dust emissions) achieved as a result of the proposed air quality control measures are summarised in **Appendix A.**

7.1 Natural Gas Boiler Emissions

Austral Masonry are proposing to install a natural gas boiler to heat up the air inside the curing chamber. As per information provided to Airlabs, any off-gases generated from the incomplete combustion of natural gas would be discharged to the atmosphere through a dedicated flue duct.

A summary of the flue duct parameters including the expected amount of natural gas to be used on an annual basis is presented in **Table 7**.

Table 7: Flue Duct Parameters

Parameter	Value	Units
Location – Easting (X)	299013	m
Location – Northing (Y)	6254994	m
Height above ground level	20	m
Duct diameter (inner)	250	mm
Temperature of exhaust gases	142.7/415.7	^{0}C / Kelvin
Type of burner	Class 2/2 for EN676/EN267 Low NOx burner	
Exit velocity of exhaust gases	2.78	m/sec
Operating hours	24 hours, 365 days (~8760 hrs)	
Flow of natural gas – maximum	24	m^3/hr
Density of natural gas	0.7	kg/m^3
Estimated amount of natural gas consumption	147	tonnes per annum (tpa)

As observed in **Table 7**, the estimated amount of natural gas to be used has been calculated based on an assumption that the natural gas burner would be operating continuously (24 hours, 365 days), whilst while in reality this may not be the case, which would result in a lower usage rate and subsequently lower emissions.

To determine pollutant emission rates from the estimated annual gas consumption, reference has been drawn to the following Emission Estimation Technique (EET) Manual.

- National Pollutant Inventory (NPI), *Emission Estimation Technique Manual for Combustion in Boilers*, Version 3.6, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, December 2011 (NPI, 2011).

Estimated pollutant emission rates are summarised in **Table 8**. Estimated emission rates from the natural gas boiler presented in **Table 8** have been modelled as a continuous source – i.e. emissions would be released 24 hours, 365 days.

Table 8: Estimated Pollutant Emission Rates – Natural Gas Burner

Pollutant	Estimated Annual Emissions (kg/annum)	Notes / Assumptions
TSP	23.5	Assumed that 95% of TSP emissions are in the PM_{10} size fraction
PM_{10}	24.8	
$PM_{2.5}$	23.5	
Sulfur dioxide (SO_2)	3.5	
Nitrogen dioxide (NO_2)	158.9	Low NOx emission factor used to account for the proposed low NOx burner system. To predict NO_2 ground level concentrations, it has been assumed that all of the NOx emissions released from the flue would be converted to NO_2 (100% conversion of NOx to NO_2)
Carbon monoxide (CO)	267.8	
Lead (Pb)	0.002	
Arsenic	0.001	
Beryllium	4E-06	
Cadmium	0.004	
Chromium (III)	0.004	
Copper	0.003	
Mercury	0.001	
Nickel	0.007	
Manganese	0.001	
Zinc	0.1	
Polycyclic Aromatic Hydrocarbons (PAHs)	0.002	
Polychlorinated Dioxins and Furans (TEQ)	1.6E-08	
Benzene	5.8	As there are no speciated VOC emission factors in the EETM, total VOC emissions have been equally distributed into Benzene, Xylene and Toluene emissions
Xylene	5.8	
Toluene	5.8	

7.2 Fugitive Dust Emissions – Masonry Plant

Sources associated with the proposed masonry plant that have the potential to generate fugitive particulate matter emissions have been quantified with the aid of EET manuals.

Emissions have been quantified for TSP, PM_{10} and $PM_{2.5}$ size fractions, for the following activities:

- Unloading raw materials into the drive over bins.
- Conveying / material transfer of raw, intermediate and product materials.
- Loading reject material to the crusher unit.
- Crushing operations.
- Loading / transfer of crushed material to the drive over bin.
- Paved surface vehicle haulage emissions.

Fugitive particulate matter (TSP, PM_{10} and $PM_{2.5}$) emissions for the aforementioned activities have been determined by drawing reference to the following EET manuals.

- National Pollutant Inventory (NPI), *Emission Estimation Technique Manual for Mining*, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012 (NPI, 2012).
- AP-42 Emission Factors, *Chapter 11.19.2 Crushed Stone Processing and Pulverised Mineral Processing*, United States Environmental Protection Agency (US-EPA 2004).
- AP-42 Emission Factors, *Chapter 13.2.4 Aggregate Handling and Storage Piles*, United States Environmental Protection Agency (US-EPA 2006); and
- AP-42 Emission Factors, *Chapter 13.2.1 Paved Roads*, United States Environmental Protection Agency (US-EPA 2011).

Particulate matter (TSP, PM_{10} and $PM_{2.5}$) emission rates have been quantified based on emission factors corresponding to specific operational activities referenced from the above EET manuals, production volumes / throughputs – as mentioned in **Section 2.5** and estimation of vehicle kilometres travelled. Dust control measures (refer **Section 2.7**) proposed by Austral Masonry have been accounted for while developing the emissions inventory. Additional information on the quantifiable emission reduction factors applied in estimating the fugitive particulate emission rates are summarised in **Appendix A**.

Fugitive TSP, PM_{10} and $PM_{2.5}$ annual emission rates estimated from the operational activities at the masonry plant are summarised in **Table 9**.

Table 9: Estimated Annual Fugitive TSP, PM_{10} and $PM_{2.5}$ Pollutant Emission Rates from the Masonry Plant

Specific Operations	TSP Emissions (kg/year)	PM_{10} Emissions (kg/year)	$PM_{2.5}$ Emissions (kg/year)
Haulage of raw and product material on paved surface	541.9	104.0	25.2
Unloading raw material	57.6	27.3	4.0
Material transfer through conveyer	192.2	90.9	13.8
Loading reject to crusher	20.3	9.6	1.5
Crushing operations	13.2	5.9	1.1
Loading crushed material to drive over bin	20.3	9.6	1.5
Total Emissions	**845.5**	**247.3**	**47.1**

Each of the identified operations in **Table 9** and their corresponding emissions have been modelled as a continuous source – i.e. emissions would be released 24 hours, 365 days.

The estimated fugitive dust emissions inventory shows that haulage of raw and product material on paved surfaces followed by miscellaneous material transfer through conveyors are the major dust generating sources as far as the proposed masonry plant's operations are concerned.

7.3 Fugitive Dust Emissions – Warehouse

Based on the intended use of the five (5) proposed warehouses, vehicle haulage has been considered to be the main source of air emissions. Fugitive particulate matter emissions have been estimated for light and heavy vehicles travelling on the New Estate Road (refer **Figure 1**) to access the warehouses.

In order to estimate TSP, PM_{10} and $PM_{2.5}$ emissions from vehicular activity at the proposed warehouses, the following assumptions have been made by Airlabs. These assumptions are consistent with air quality assessments undertaken by Airlabs for generic purpose warehouses and distribution facilities.

- Light and heavy vehicles would operate continuously – i.e. 8760 hours (24 hours x 365 days)
- Total number of light and heavy vehicles travelling daily on the paved road – 1,600 vehicles per day, as provided by the Traffic Consultant.
- For each hour of the year, the ratio of passenger / light and heavy vehicles was assumed to be 70% and 30% respectively.
- The average vehicle weight (W) for passenger vehicles was considered to be 4.5 tonnes and 50 tonnes for heavy vehicles.
- The paved road surface silt loading (sl) was considered to be 0.06 g/m^2. This assumption is similar to air quality assessments undertaken for warehouses and distribution centres in the Western Sydney region (Airlabs 2016, SLR 2016).
- The average return trip on the New Estate Road was estimated to be around 350m (0.35 km/return trip).

Fugitive particulate matter (TSP, PM_{10} and $PM_{2.5}$) emissions from vehicle movements have been calculated by drawing reference to the following EET Manual:

- AP-42 Emission Factors, *Chapter 13.2.1 Paved Roads*, United States Environmental Protection Agency (US-EPA 2011).

Estimated pollutant emission rates from the proposed warehouses is summarised in **Table 10**.

Table 10: Estimated Annual Fugitive TSP, PM_{10} and $PM_{2.5}$ Pollutant Emission Rates – Warehouse Operations

Specific Operations	TSP Emissions (kg/year)	PM_{10} Emissions (kg/year)	$PM_{2.5}$ Emissions (kg/year)
Haulage emisisons from warehouse traffic	981.4	188.4	45.6
Total Emissions	**981.4**	**188.4**	**45.6**

7.4 Fugitive Dust Emissions – Construction Phase

It is expected that there would be dust emissions generated during the construction of the masonry plant and the five warehouses and associated infrastructure. However, it is expected that these activities would occur only for a limited period of time, as opposed to operational activities.

As dust emissions generated during construction phase would be temporary and short-term in nature, a quantitative assessment is not warranted. However, a brief qualitative description of construction related dust generating sources is presented below.

Construction based activities, which have a potential to generate dust emissions include:

- Earthwork operations such as excavation and topsoil stripping.
- Handling of spoil and structural fill material.
- Wind erosion from temporary exposed areas and stockpiles.
- Wheel generated dust from haulage on work areas.

Given that construction activities are progressive and transient in nature, the potential for the aforementioned activities to adversely impact the local air quality is very unlikely. Moreover, construction activities would take place sporadically over a large area which would significantly limit the potential for any adverse off-site impacts. Nonetheless, the following mitigation measures have been recommended by Airlabs to minimise dust emissions during construction activities.

Table 11: Construction Dust Mitigation Measures

Source of Dust	Mitigation Measure	Timing
General	Identify dust-generating activities and inform site personnel about location	Throughout construction
	Identify adverse weather conditions (dry and high wind blowing from dust source to sensitive receptors) and halt dust emitting activities if visible dust impacts are identified at sensitive receptors.	Throughout construction
Handling of spoil and structural fill material	Minimise drop height for material handling equipment.	Throughout construction
Wind generated dust from temporary stockpiles and exposed areas	Apply watering through water trucks or sprinklers.	As required
	Progressive staging of dust generating activities throughout the day to avoid concurrent dust emissions.	Throughout construction
	Minimise exposed area if possible.	Throughout construction
	Minimise amount of temporary material stockpiled if possible.	Throughout construction
Wheel generated dust during hauling	Restrict vehicle movement to haul routes that are watered regularly.	Throughout construction
	Cleaning of haul roads.	As required
	Speed restrictions	Throughout construction

Combustion of diesel or petrol fuels (from vehicle movements and mobile machinery) could generate emissions of particulate matter, CO, SO_2, NO_X and VOCs. Based on the relatively small amount of fuel burning during the construction phase, emissions from vehicle exhaust and mobile machinery are not likely to cause adverse impacts on surrounding sensitive receptors.

7.5 Odour Emissions

Based on a review of the process description, no significant odour generating sources associated with the masonry production have been identified. During the production process, it is probable that there could be slight odours generated which resemble odour similar to wet concrete and wet cement, but it is very unlikely that these would be considered offensive in nature and that they would have an impact on the local environment. Therefore, considering that the potential for odour emissions from the proposed facility is minimal, odour emissions have not been quantified as a part of this assessment.

8. METEOROLOGICAL MODELLING

8.1 Assessment Methodology

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. The local meteorology at the site plays a significant role in understanding the pollutant transport and dispersion mechanisms, and in order to adequately characterise the local meteorological conditions, information is needed on key parameters such as prevailing wind regime, mixing depth, atmospheric stability, ambient temperatures, rainfall and relative humidity. The following sections outline the methodology for characterising the meteorological conditions at the proposed facility.

Meteorological modelling was conducted using a combination of 'The Air Pollution Model (TAPM) (Version 4) and CALMET meteorological models.

8.2 TAPM

For this modelling assessment, the meteorological model 'The Air Pollution Model (TAPM) (Version 4.0.5)' was used to generate the prognostic output. TAPM, developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) is a prognostic model which is used to predict three-dimensional meteorological data and air pollution concentrations. TAPM allows users to generate synthetic observations by referencing in-built databases (e.g. terrain information, synoptic scale meteorological observations, vegetation and soil type etc.) which are subsequently used in generating site-specific hourly meteorological data (Hurley P.J., 2008).

Hourly meteorological observations from the nearby Bureau of Meteorology (BoM) Horsley Park Automatic Weather Station (AWS No: 067119) were assimilated into TAPM. The Horsley Park AWS is approximately 3.8 km north-west from the Oakdale East project site.

Technical details of the model equations, parameterisations, numerical methods and assimilation of observations are described in Hurley (2008).

Details of the TAPM model configuration are outlined in **Table 12**.

Table 12: TAPM Model Configuration

Parameter	Value
Year of Analysis	2013 to 2017 (01/01/2013 to 31/12/2017)
Grid Centre Coordinates (latitude, Longitude) (degree)	-33deg -49.5min, 150deg 49.5min
Number of grids (spacing)	4 (30km, 10km, 3km, 1km)
Grid dimensions (nx, ny, nz)	25, 25, 25
Data Assimilation	Yes – BoM AWS at Horsley Park (AWS: 067119) 2013 to 2017

8.3 CALMET

CALMET (version 6.4.0) was used to derive meteorological fields at 400 m resolution over a 20km x 20km modelling domain centred over the proposed facility. CALMET was run in no-observations (NOOBS = 2) mode with prognostic output from TAPM used as an input to the CALMET model.

The CALMET model settings were in general accordance with the NSW - Environment Protection Agency (NSW-EPA) (formerly Office of Environment and Heritage – OEH) '*Generic Guidance and Optimum Settings for the CALPUFF Modelling System for Inclusion into the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW, Australia*' (OEH, 2011).

Details of the CALMET model configuration are outlined in **Table 13**.

Table 13: CALMET Model Configuration

Parameter	Value
Year of Analysis	2013 to 2017
No. X Grid Cells (NX), No. Y Grid Cells (NY)	61.,61
Grid spacing (DGRIDKM) (km)	0.2
XORIG (m), YORIG (m)	293000.03, 6248841.05
No. of Vertical Levels	10
Meteorological Data Option	NOOBS=2
Upper Air and Surface Data	TAPM generated MM4/MM5/3D
Geophysical Datasets	USGS (Land-Use) & SRTM1 (Terrain)

The geophysical dataset for CALMET contains terrain and land use information for the modelling domain. For this assessment, terrain data for the CALMET grid was extracted from 1- arc second (30m) spaced elevation data obtained via NASA's Shuttle Radar Topography Mission (SRTM) in 2000 (downloaded from USGS website). The land use or land cover data for the 20km x 20km modelling domain was derived from the USGS land global land cover dataset. The geotechnical parameters for the land use classification were adopted from the default CALMET corresponding land use categories.

A 3-dimensional representation of the topographical features surrounding the proposed facility has been presented in **Figure 4**.

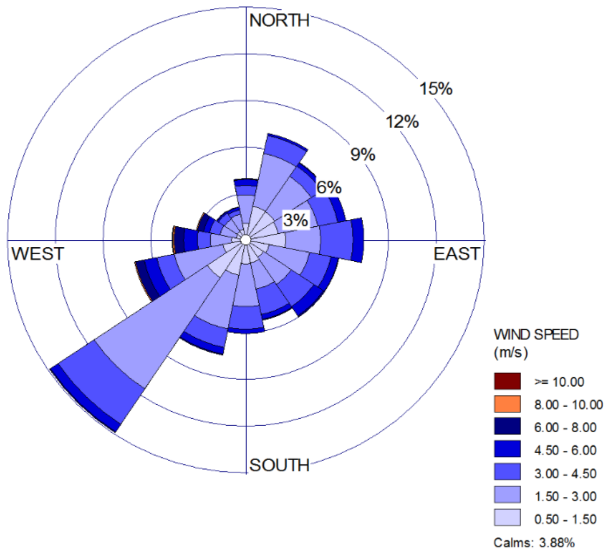
8.4 Modelled Meteorology and Inter Annual Comparison

Hourly wind speeds and direction for calendar year 2013 to 2017 were extracted from the CALMET output at the centre of the Oakdale East project site and are visually presented in the form of wind roses in **Figure 6**.

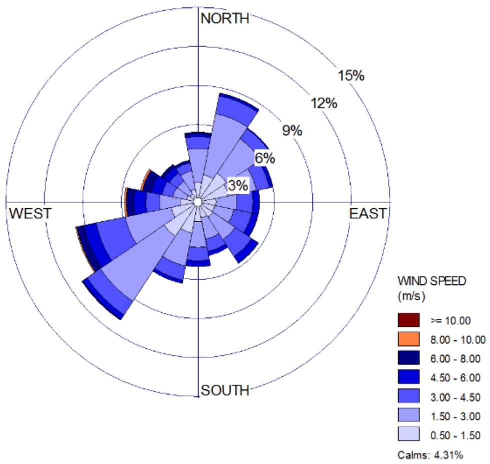
Annual wind roses for each of the modelled five years (2013 to 2017) show winds predominantly from the south-western quadrant and to a lesser extent from the north-northeast and eastern vectors. Inter-annual wind roses in **Figure 6** show good agreeability over the modelled five (5) years.

Calm wind conditions (wind speeds less than 0.5 m/sec) ranged between 4.0% to 5.5% over the modelled five years from 2013 to 2017. The range shows that there is no significant variance in the interannual percentages of calm winds and therefore corroborates the similarity between the modelled years.

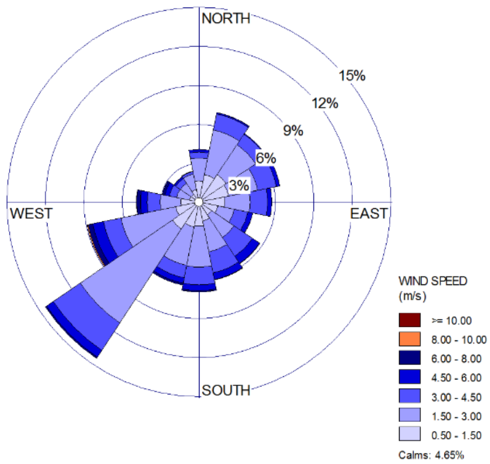
Figure 6: CALMET Predicted Wind Rose – Five Years (2013 to 2017)



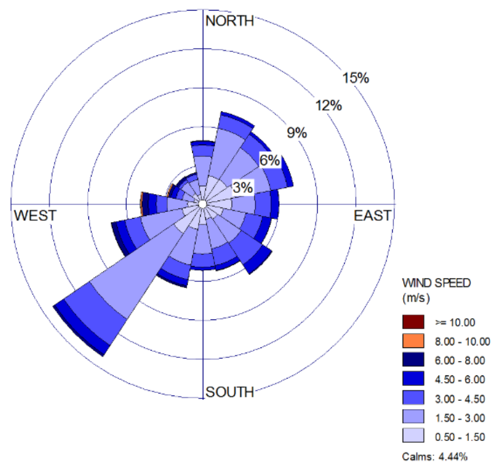
2017 - CALMET



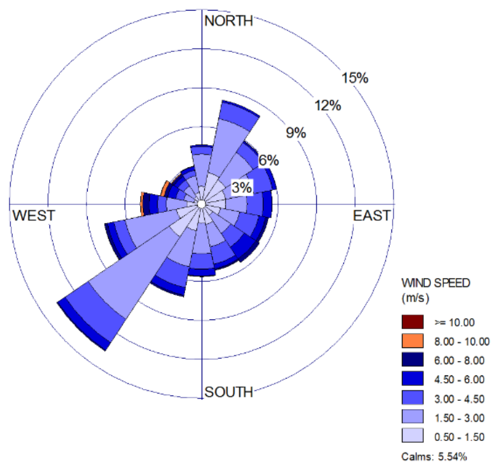
2016 - CALMET



2015 - CALMET



2014 - CALMET



2013 – CALMET

Comparison of the annual wind roses for the five modelled years (2013 to 2017) demonstrate similarity and good aggregability in the wind profile. Average wind speeds ranged between 2.2 – 2.4 m/sec across the five (5) modelled years.

Additional analysis of the modelled meteorology is discussed below.

Stability of the atmosphere is determined by a combination of horizontal turbulence caused by the wind and vertical turbulence caused by the solar heating of the ground surface. Stability cannot be measured directly; instead, it must be inferred from available data, either measured or numerically simulated.

The Pasquill-Gifford scale defines stability on a scale from A to G, with stability class A being the least stable, occurring during strong daytime sun and stability class G being the most stable condition, occurring during low wind speeds at night. For any given wind speed, the stability category may be characterised by two or three categories depending on the time of day and the amount of cloud present. In meteorological models such as CALMET, the stability classes F and G are combined.

A summary of the numerically simulated hourly stability class data using CALMET for the selected meteorological year (i.e. 2017) is presented in **Figure 7**. A higher frequency (36%) of stability class D was predicted by CALMET followed by class F (33%).

Inter annual comparison of stability class (**Figure 8**) demonstrate similarities in the predicted stability class across the five (5) modelled years.

Figure 7: Frequency of Stability Class - 2017 CALMET

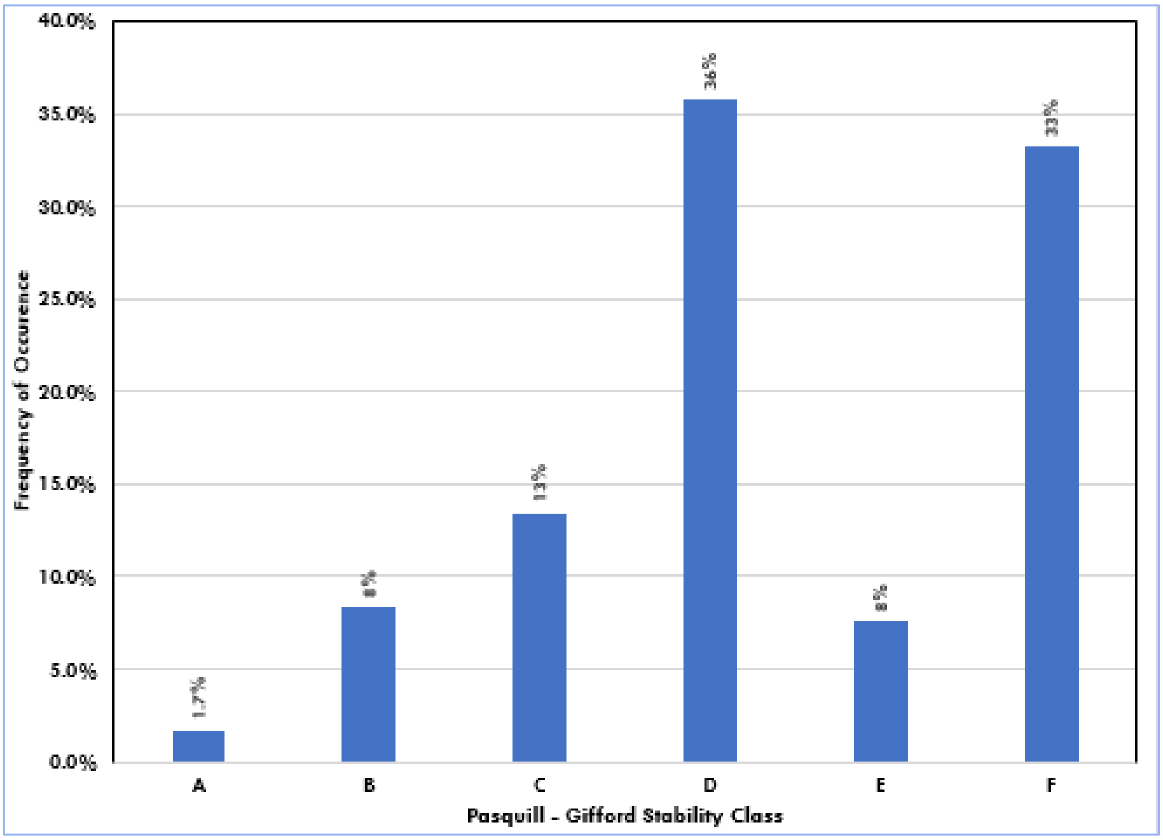
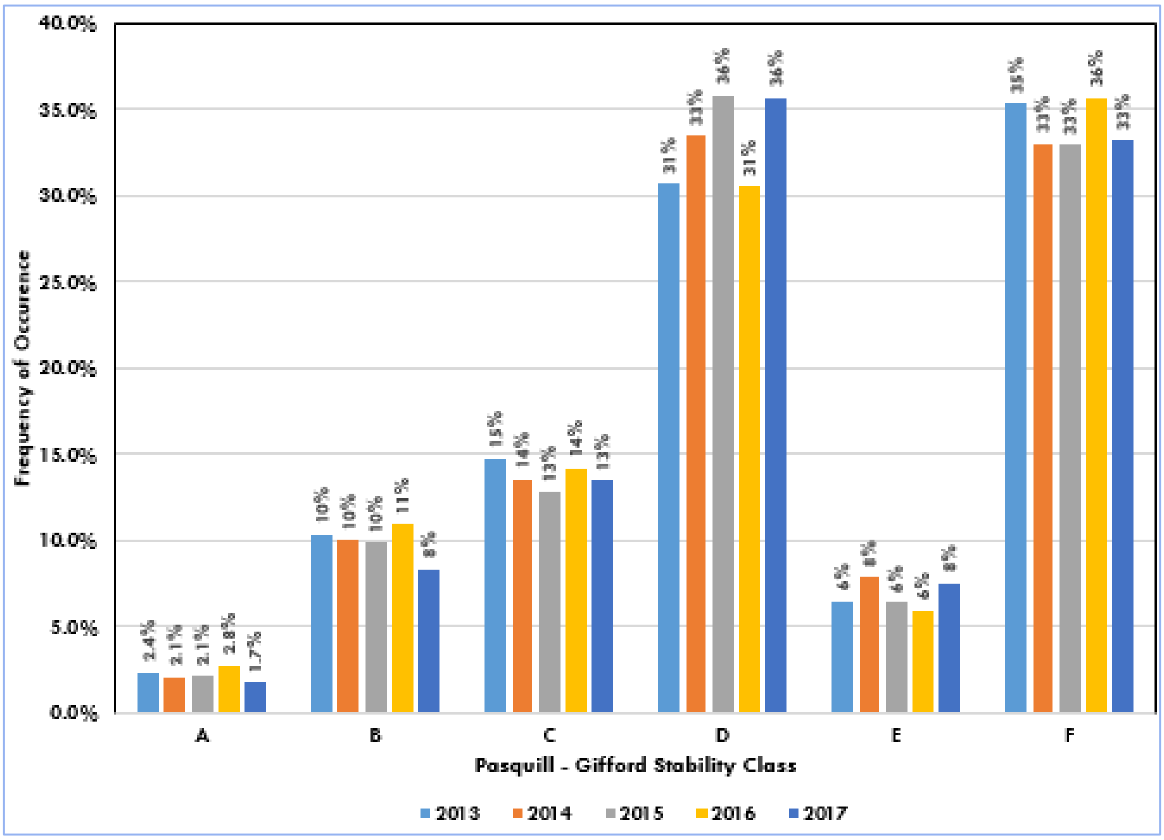


Figure 8: Comparison of Stability Class – 2013 to 2017 CALMET



The mixing height quantifies the vertical height of mixing in the atmosphere and is a modelled parameter that cannot be measured directly. The mixing height decreases in the late afternoon, particularly after sunset, due to the change from surface heating from the sun to a net heat loss overnight. Low mixing heights typically translate to stagnant air with little vertical motion, while high mixing heights allow vertical mixing and good dispersion of pollutants.

CALMET simulated hourly mixing height data is presented in **Figure 9** for the modelled year - 2017.

Figure 9 shows the mixing height as a function of the hour of the day at the proposed facility. The graph represents the typical growth of the boundary layer, whereby the mixing height is generally lowest during the night and into the early morning and highest during the late afternoon. Comparison of CALMET predicted interannual mixing heights (**Figure 10**) for 2013 – 2017 does not demonstrate any irregularities across the modelled years.

Figure 9: CALMET Predicted Diurnal Variations in Mixing Heights – 2017

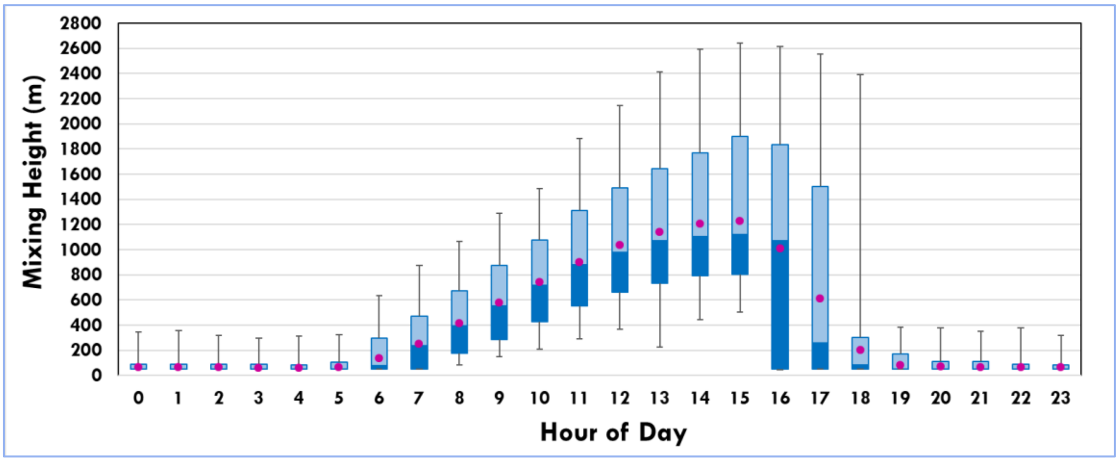
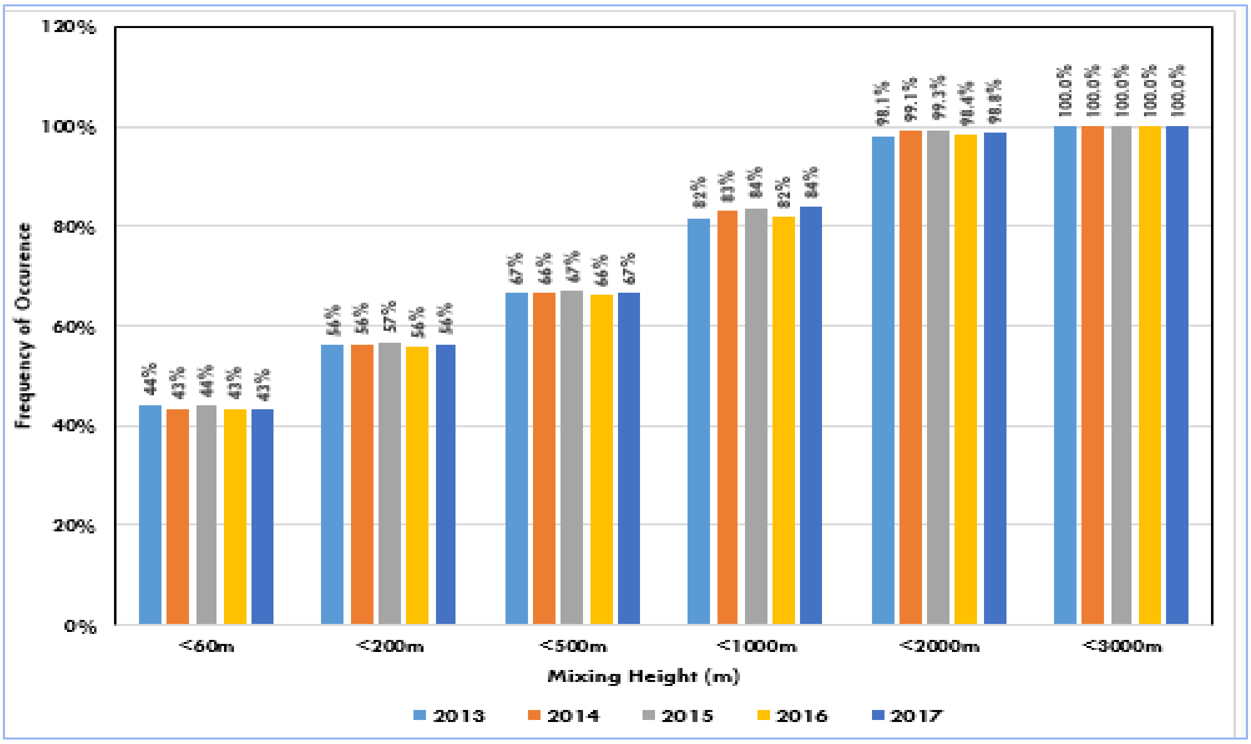


Figure 10: Comparison of Mixing heights – 2013 to 2017 CALMET

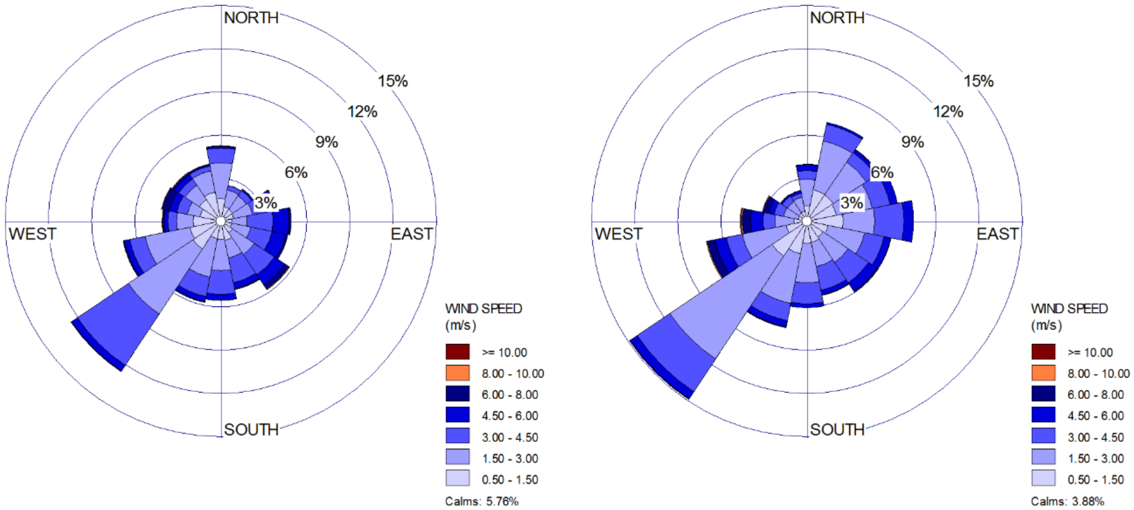


Inter annual comparison of wind profile, stability class and mixing heights shows minimal inter annual variability across the five-yearly dataset (2013-2017), and therefore the most recent calendar year - 2017 was considered to be a representative year for dispersion modelling and was selected. Furthermore, in order to assess the cumulative impacts contemporaneously with the latest available observations from the NEPM monitoring stations – year 2017 was selected for the dispersion modelling

Comparison was also made between the CALMET predicted wind data and observed wind data at the BoM Horsley Park AWS for the year 2017 (**Figure 11**).

Comparison shows good agreeability between the observed and modelled data. Slight dissimilarities in the wind profiles are attributed to local terrain features, as the AWS is approximately 3.8 km from the project site.

Figure 11: Comparison of Observed Horsley Park BoM AWS (Left) vs CALMET Predicted (Right) Wind Data – 2017



9. DISPERSION MODELLING

To determine impacts from the emissions estimated from the proposed facility's operations (refer **Section 7)** and the surrounding environment (refer **Section 11, Appendix B** and **Appendix C**), air dispersion modelling was undertaken using the US-EPA CALPUFF dispersion model.

CALPUFF is the dispersion model that calculates the dispersion of plumes within the three-dimensional (3D) meteorological field calculated by CALMET. CALPUFF is a non-steady state US-EPA approved dispersion model, which "advects" puffs of material emitted from modelled sources, simulating dispersion and transformation processes along the way. In doing so, it typically uses the wind fields generated by CALMET.

Temporal and spatial variations in the meteorological fields selected are explicitly incorporated in the resulting distribution of puffs throughout a simulation period (SRC, 2011).

The CALPUFF model domain was set up as a sub-set of the CALMET model domain, with a computational grid spanning 12-km x 12-km centred at the Oakdale East project site location. The sampling grid had a resolution of 50m (using a nesting factor of 4). Additionally, ground level concentrations were also predicted at the identified sensitive receptors (refer **Table 4**) and for individual air toxics – 99.9th percentile incremental concentrations were predicted at or beyond the facility site boundary.

Fugitive sources of dust generation associated with the proposed facility operations, including the masonry plant and the warehouses (refer **Table 9** and **Table 10**) were represented in the CALPUFF model as a series of volume-sources.

Emissions estimated from the natural gas burner (**Table 8**) were modelled as a point source.

Point source parameters were referenced from the information presented in **Table 7**. For the particulate emissions from the flue duct, dry deposition was set to zero in the dispersion model.

Point source emissions representing the flue duct and volume sources representing fugitive dust emissions were all modelled as a continuous emitting source - i.e. emissions would be released 24 hours, 365 days.

All other CALPUFF model settings were referenced from the '*Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessments of Air Pollutants in NSW, Australia*' (NSW-OEH, 2011).

10. PREDICTED IMPACTS FROM THE FACILITY (INCREMENTAL)

Model predicted ground level concentrations of pollutants released from the proposed facility (incremental impacts) are discussed below.

10.1 Predicted Incremental Impacts (Proposed Facility) – At Identified Sensitive Receptors

Predicted ground-level concentrations of pollutants with criteria applicable at sensitive receptors (i.e. Particulates, SO_2, NO_2, CO and Lead) at the worst impacted receptor are presented in **Table 14**.

It is noted that the assessment criteria (except deposited dust levels) presented in the below table are relevant for cumulative impacts, however for the sake of comparison they have been presented, nonetheless. Particulate matter concentrations (TSP, PM_{10}, $PM_{2.5}$ and deposited dust) presented below are reflective of point source emissions released from the masonry plant and the fugitive emissions released from the masonry plant as well as the proposed warehouses.

Table 14: Predicted Incremental Impacts from Proposed Facility At identified Sensitive Receptors

Pollutant	Averaging Period	Assessment Criteria (µg/m³)	Maximum (100th Percentile) Predicted Incremental Concentration (µg/m³) Across All Receptors	% of Assessment Criteria Maximum Predicted Incremental Concentrations Across All Receptors
TSP	Annual	90	0.5	0.6%
PM_{10}	24-Hour	50	1.6	3.2%
	Annual	25	0.2	0.8%
$PM_{2.5}$	24-Hour	25	0.4	1.5%
	Annual	8	0.05	0.6%
SO_2	10-Minute	712	0.02	0.003%
	1-Hour	570	0.01	0.002%
	24-Hour	228	0.003	0.001%
	Annual	60	0.0004	0.001%
NO_2	1-Hour	246	0.5	0.2%
	Annual	62	0.02	0.03%
CO	15-Minute	100,000	1.4	0.001%
	1-Hour	30,000	0.8	0.003%
	8-Hour	10,000	0.8	0.01%
Lead	Annual	0.5	5.8E-06	0.001%
Deposited Dust	Annual	2 g/m²/month (maximum increase in deposited dust levels)	0.1 g/m²/month	5.7%

From the modelling results presented in **Table 14**, the following observations are made:

- Model predicted incremental deposited dust levels at the worst impacted sensitive receptor is approximately 6% of the assessment criteria.

- For particulate emissions (TSP, PM_{10}, $PM_{2.5}$), predicted incremental impacts range from 0.6% (TSP annual average) to 3.2% ($PM_{2.5}$ 24-hour average) of the relevant assessment criteria.
- For all other pollutants – i.e. SO_2, NO_2, CO, the maximum predicted incremental concentrations across all sensitive receptors are 0.2% or below their respective assessment criteria.
- It is noted that to predict ground level NO_2 concentrations, it has been conservatively assumed that all the NOx released from the proposed facility would be converted to NO_2 (100% NOx to NO_2 conversion)

Detailed incremental results at each identified receptor for the particulate matter emissions (TSP, PM_{10}, $PM_{2.5}$ and deposited dust) released from the proposed facility (emissions from the masonry plant and the warehouses) is presented in **Table 15**.

Table 15: Predicted Incremental Particulate Matter Impacts At All Identified Sensitive Receptors

Pollutant	TSP	PM_{10}	PM_{10}	$PM_{2.5}$	$PM_{2.5}$	Deposited Dust Levels
Averaging Period	Annual	24-Hour	Annual	24-Hour	Annual	Annual
Assessment Criteria	90 µg/m³	50 µg/m³	25 µg/m³	25 µg/m³	8 µg/m³	2 g/m² /month
Receptor	Conc. (µg/m³)	Conc. (µg/m³)	Conc. (µg/m³)	Conc. (µg/m³)	Conc. (µg/m³)	Dep. Levels g/m² /month
1	0.15	0.33	0.06	0.09	0.02	0.03
2	0.54	0.90	0.19	0.23	0.05	0.11
3	0.25	0.84	0.15	0.23	0.04	0.05
4	0.32	1.58	0.18	0.38	0.04	0.11
5	0.14	0.98	0.10	0.25	0.03	0.05
6	0.15	0.91	0.10	0.23	0.02	0.07
7	0.11	0.81	0.07	0.21	0.02	0.08
8	0.09	0.72	0.05	0.18	0.01	0.07
9	0.06	0.50	0.04	0.13	0.01	0.05
10	0.04	0.36	0.03	0.09	0.01	0.03
11	0.04	0.46	0.02	0.11	0.01	0.03
12	0.04	0.34	0.02	0.08	0.01	0.03
13	0.11	0.32	0.05	0.08	0.01	0.02
14	0.07	0.25	0.03	0.07	0.01	0.01
15	0.09	0.24	0.05	0.06	0.01	0.03
16	0.24	0.49	0.10	0.13	0.03	0.06
17	0.06	0.59	0.06	0.16	0.02	0.02
18	0.03	0.51	0.02	0.12	0.01	0.02
19	0.03	0.42	0.02	0.10	0.00	0.01

Pollutant	TSP	PM_{10}	PM_{10}	$PM_{2.5}$	$PM_{2.5}$	Deposited Dust Levels
20	0.04	0.45	0.02	0.11	0.01	0.02
21	0.03	0.32	0.02	0.08	0.00	0.02
22	0.04	0.25	0.02	0.07	0.01	0.02
23	0.04	0.24	0.02	0.06	0.01	0.03
24	0.09	0.41	0.08	0.11	0.02	0.02
25	0.06	0.25	0.04	0.06	0.01	0.01

10.2 Predicted Incremental Impacts (Proposed Facility) – At or Beyond Facility Boundary

Predicted ground-level concentrations of pollutants with criteria at or beyond facility boundary (i.e. individual air toxics) are presented in **Table 16**.

Predicted impacts for all pollutants are below 0.6% of their respective assessment criteria, which demonstrates that no adverse impacts from the proposed facility are expected for individual air toxics.

Table 16: Predicted Incremental Impacts from Proposed Facility Presented At or Beyond Facility Boundary

Pollutant	Averaging Period	Assessment Criteria (µg/m³)	99.9th Percentile Predicted Incremental Concentration (µg/m³) Across All Receptors	% of Assessment Criteria Maximum (as 99.9th Percentile) Predicted Incremental Concentrations Across All Receptors
Arsenic	1-Hour	0.09	2.8E-05	0.03%
Beryllium	1-Hour	0.004	1.1E-07	0.003%
Cadmium	1-Hour	0.018	1.1E-04	0.6%
Chromium (III)	1-Hour	9	1.1E-04	0.001%
Copper	1-Hour	18	8.5E-05	0.0005%
Mercury	1-Hour	1.8	2.8E-05	0.002%
Nickel	1-Hour	0.18	2.0E-04	0.11%
Manganese	1-Hour	18	2.8E-05	0.0002%
Zinc	1-Hour	90	2.8E-03	0.003%
PAHs	1-Hour	0.4	5.7E-05	0.01%
Dioxins and Furans (as TEQ)	1-Hour	2.0E-06	4.5E-10	0.02%
Benzene	1-Hour	29	1.6E-01	0.6%
Xylene	1-Hour	190	1.6E-01	0.09%
Toluene	1-Hour	360	1.6E-01	0.05%

Concentration isopleths for selected pollutants visually illustrating the incremental impacts from the proposed facility are presented in **Figure 12** through to **Figure 17**.

Figure 12: Predicted Maximum Incremental (Proposed Facility) PM_{10} 24-Hour Average Concentration (Units: $\mu g/m^3$) (Cumulative Assessment Criteria: 50 $\mu g/m^3$)

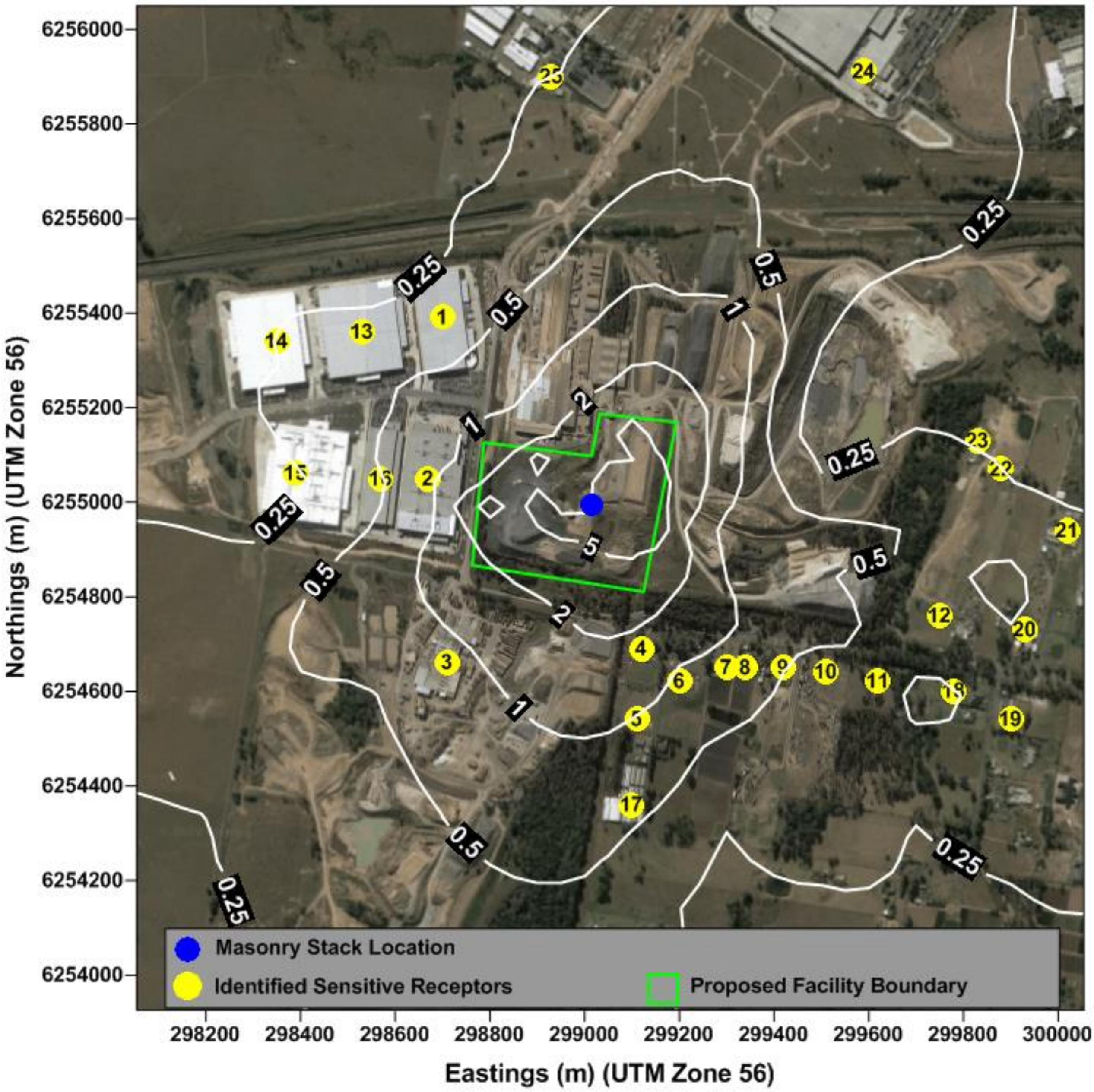


Figure 13: Predicted Incremental (Proposed Facility) PM_{10} Annual Average Concentration (Units: µg/m³) (Cumulative Assessment Criteria: 25 µg/m³)

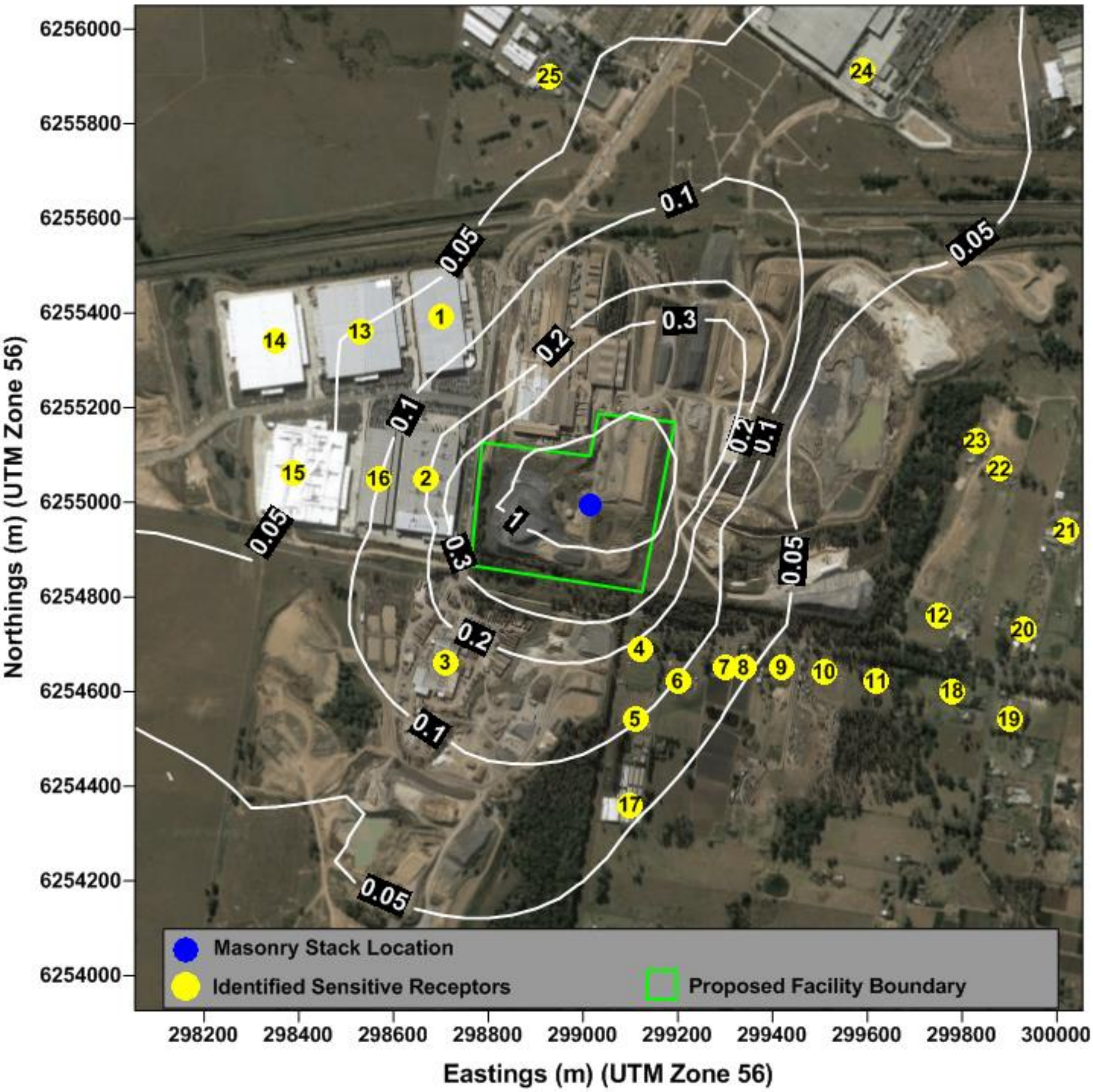


Figure 14: Predicted Maximum Incremental (Proposed Facility) $PM_{2.5}$ 24-Hour Average Concentration (Units: µg/m³) (Cumulative Assessment Criteria: 25 µg/m³)

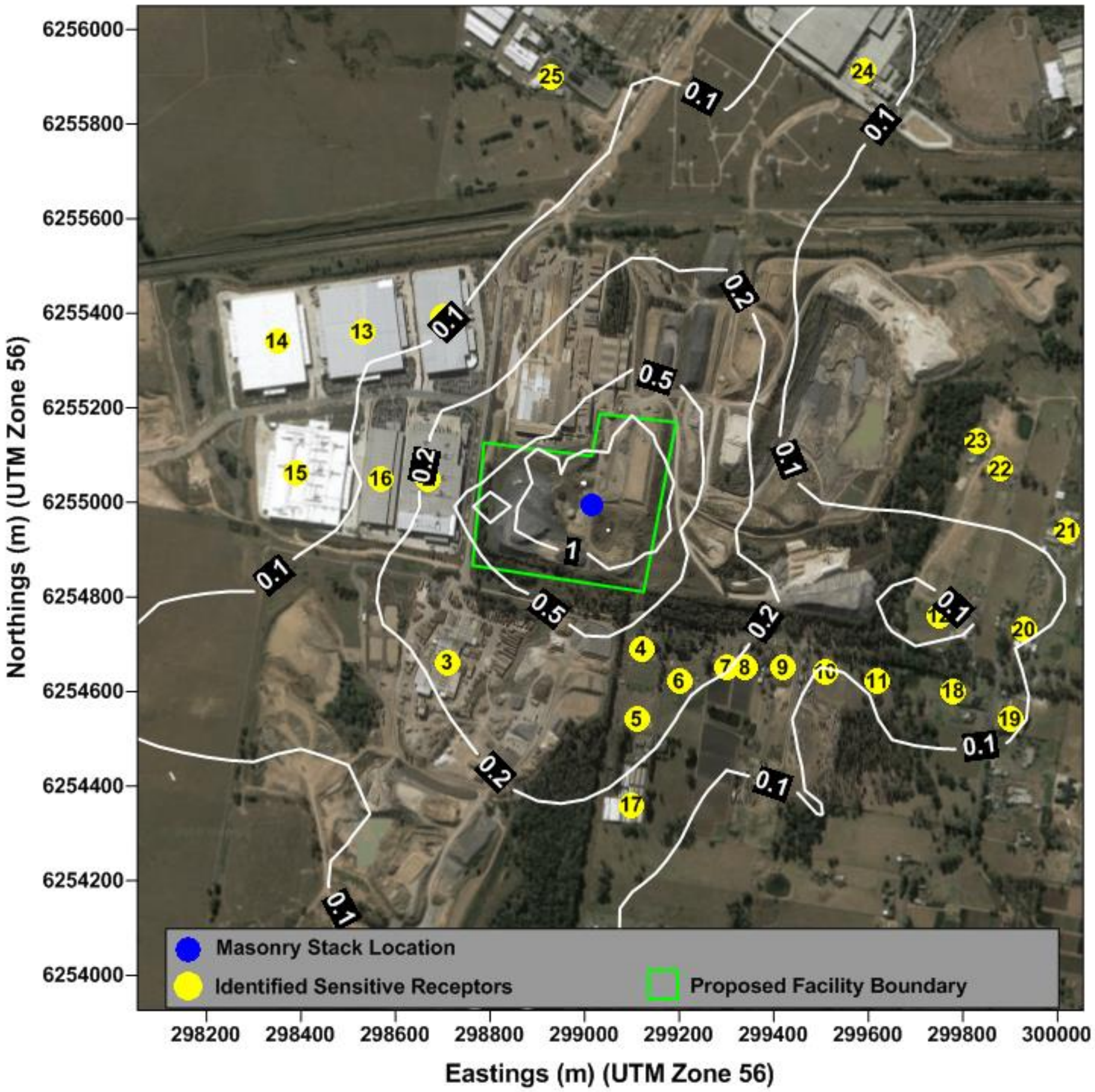


Figure 15: Predicted Incremental (Proposed Facility) $PM_{2.5}$ Annual Average Concentration (Units: µg/m³) (Cumulative Assessment Criteria: 8 µg/m³)

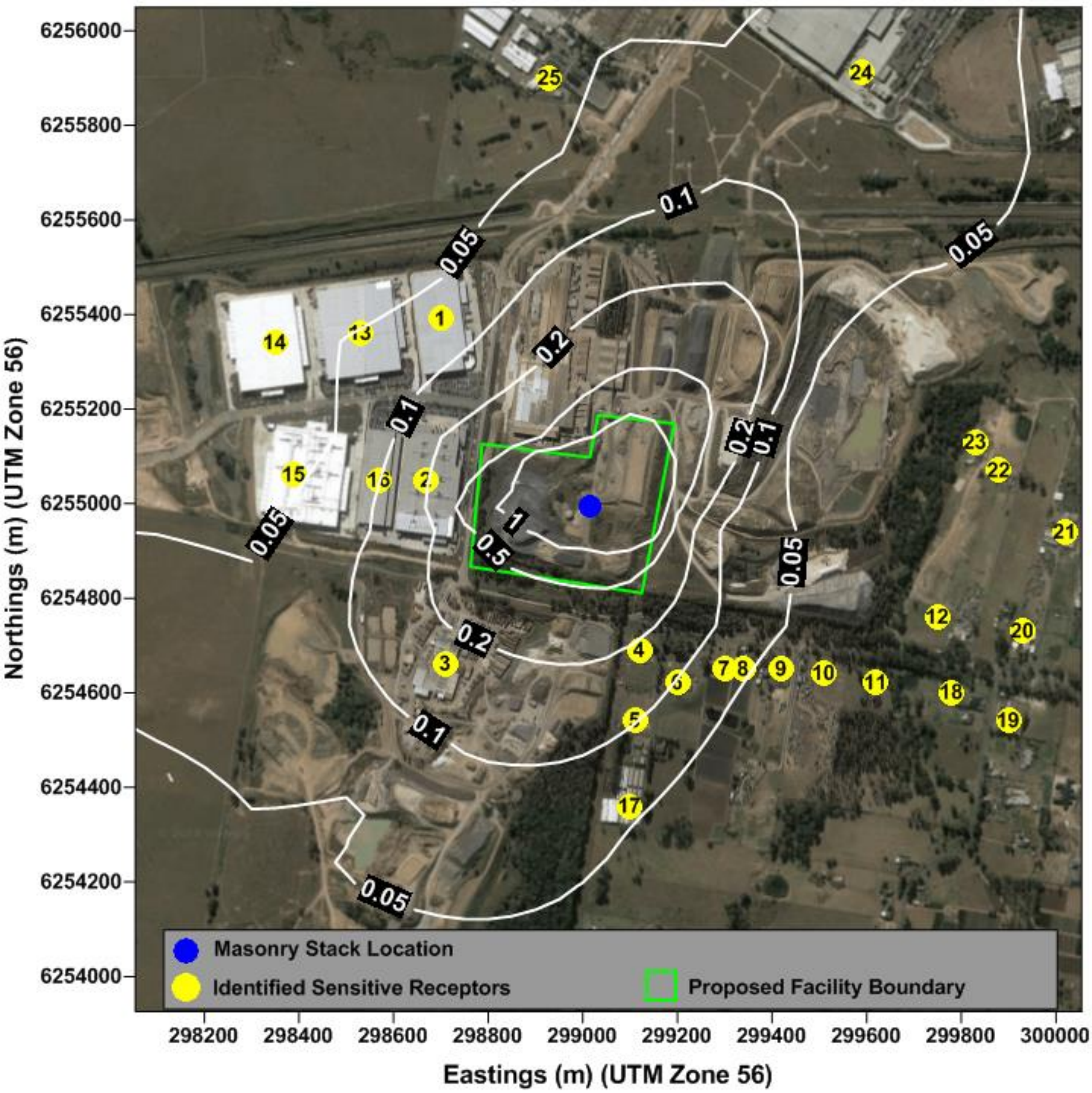


Figure 16: Predicted Incremental (Proposed Facility) TSP Annual Average Concentration (Units: µg/m³) (Cumulative Assessment Criteria: 90 µg/m³)

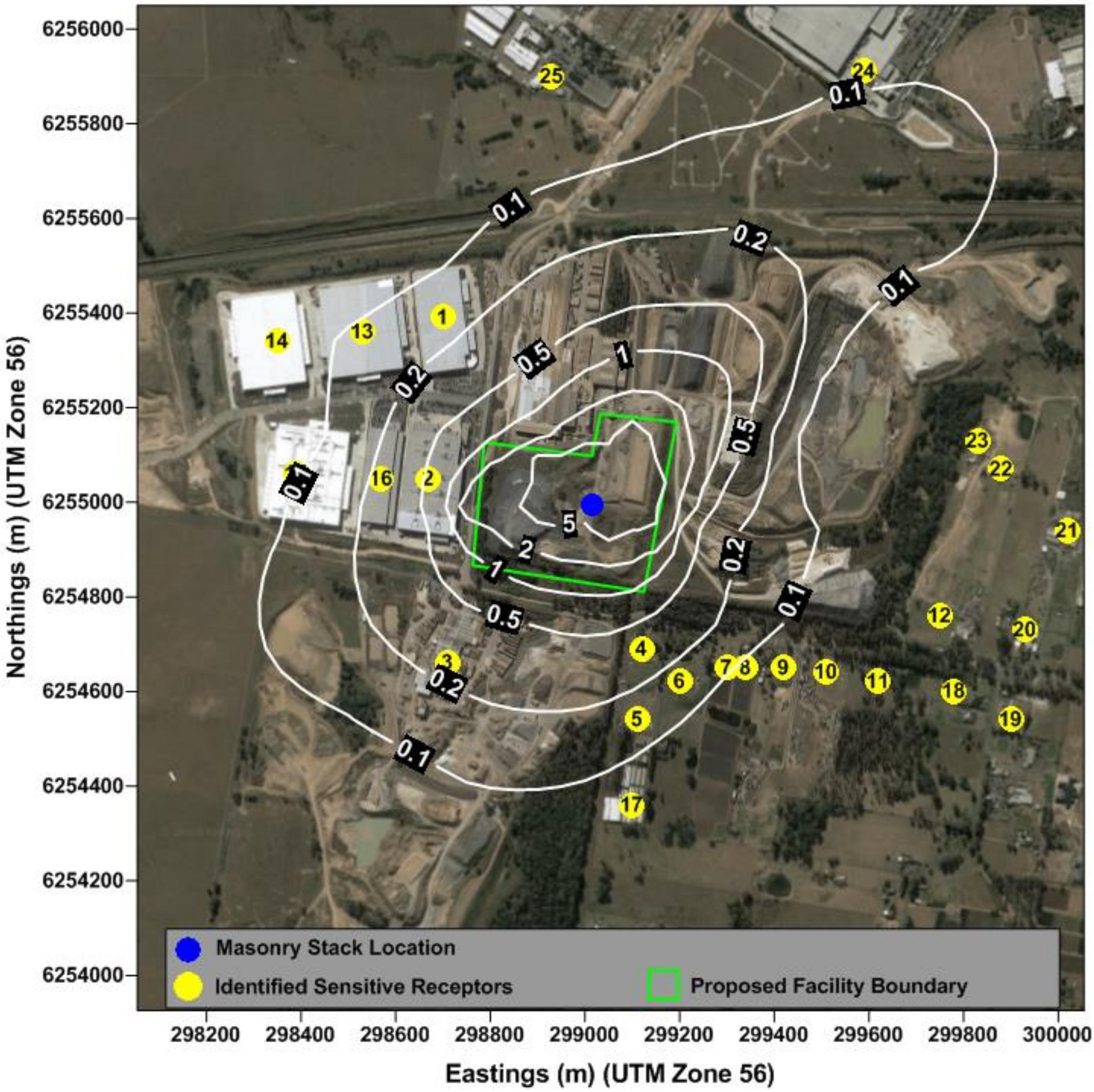
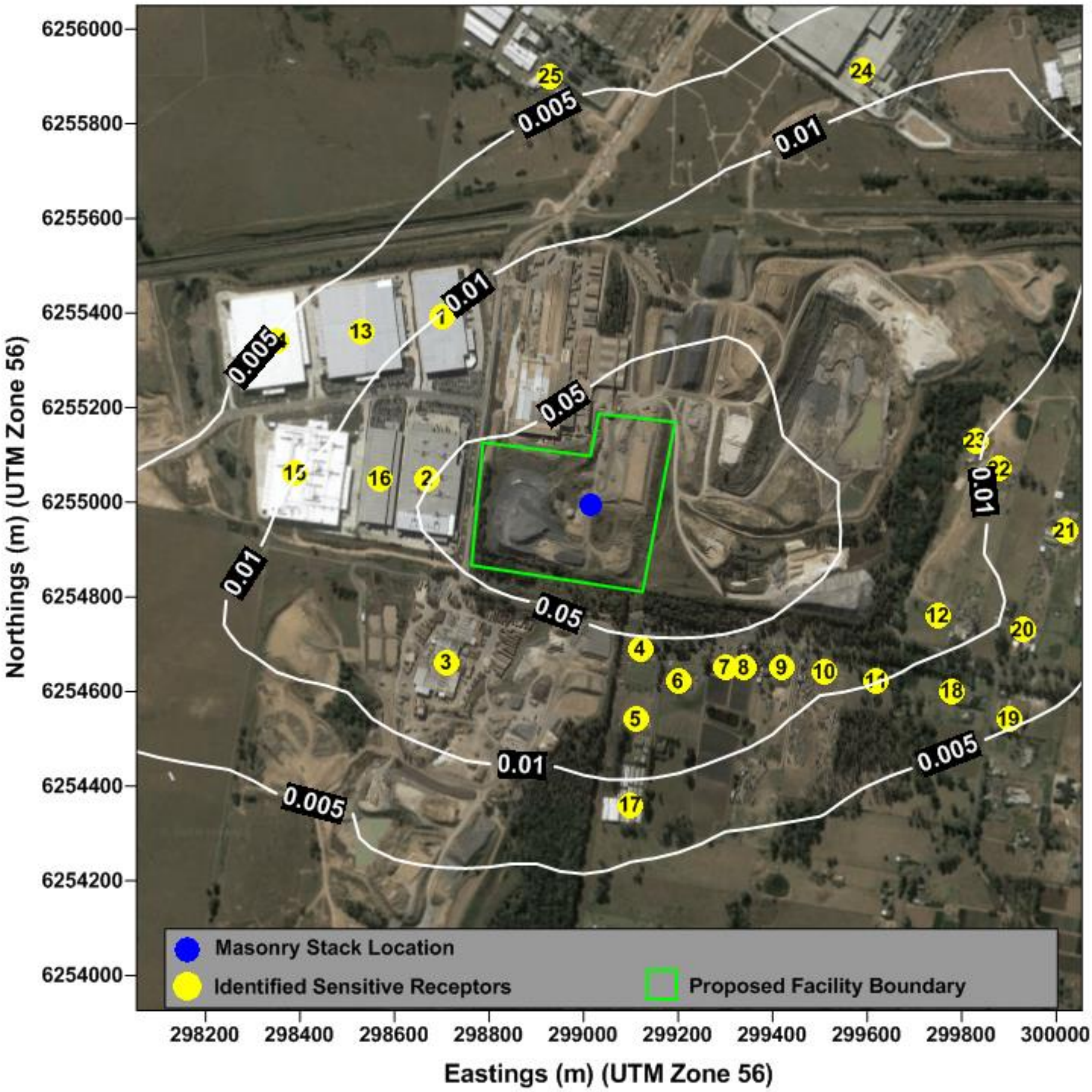


Figure 17: Predicted Incremental (Proposed Facility) Annual Average Deposited Dust Levels (Units: g/m^2/month) (Incremental Assessment Criteria: 2 g/m^2/month)



11. ASSESSMENT OF CUMULATIVE IMPACTS

As per the Approved Methods, cumulative impact of emissions from nearby sources and the background environment need to be considered along with the emissions from the facility in concern when predicting ground level concentrations for particulate matter emissions (PM_{10}, $PM_{2.5}$), TSP, NOx, SO_2, CO, lead and HF.

As noted in the Assessment Methodology (refer **Section 4**), two (2) non-project related sources of emissions in the immediate vicinity of the proposed facility have been identified. The two non-project sources comprise the following:

- Brick manufacturing and associated quarrying operations at the Austral Bricks Plant 3 site; and
- Brick manufacturing and associated quarrying operations at CSR Bricks.

The CSR brick manufacturing plant is located southwest of the proposed facility, whereas the Austral Bricks Plant 3 site is located immediately north of the proposed facility. Furthermore, it is to be noted that the masonry plant along with the proposed warehouses are being developed at the existing Austral Bricks Plant 3 site. The location of the aforementioned sources with context to the Oakdale East project has been visually illustrated in **Figure 2**.

To assess cumulative impacts, emissions for these two facilities have been accounted for and included in the cumulative assessment.

Additionally, estimates of background pollutant concentration levels (i.e. ground level concentrations that would occur in the absence of any anthropogenic emission sources) have been included in the cumulative assessment.

Reference has been drawn to the NEPM air quality monitoring station at St. Mary's, NSW (hereafter 'the St. Mary's air monitoring station'), which is approximately 6km northwest of the proposed facility. Since the monitoring station at St. Mary's is not in the immediate vicinity of any significant air emission source, the observed ground level concentration recorded at the station are deemed to be suitable as estimates of background levels.

Hence, in order to predict cumulative impacts, the following four sources have been accounted for:

- Proposed Facility (incremental impacts) (refer **Section 10**)
- Brick manufacturing and associated operations at the CSR plant (non-project impacts).
- Brick manufacturing and associated operations at the Austral Bricks Plant 3 site (non-project impacts); and
- Estimated background levels from the St. Mary's air monitoring station

Predicted cumulative concentrations presented in this assessment are a sum total of these aforementioned four sources.

Since the location of the aforementioned sources is very close to the proposed facility, the ground-level concentrations of pollutants from these sources will be both spatially and temporally varying depending on (for example) receptor location, wind direction, wind speed, and atmospheric characteristics such as stability and mixed layer depth. Hence, it was decided by Airlabs to explicitly model the emission sources from these two facilities.

Based on the results presented in previous section, it is noted that incremental impacts from the proposed facility are very low compared to their respective criterion. Of all the pollutants modelled, particulate emissions were determined to be the key pollutants emitted from the proposed facility. Predicted incremental impacts for all other pollutants were very low (generally lower than 0.2% of their respective criterion) and therefore are not expected to significantly contribute to cumulative concentrations. Therefore, assessment of cumulative impacts has been undertaken for particulates (TSP, PM_{10}, $PM_{2.5}$) and deposited dust levels only.

Estimates of background levels for particulates have been sourced from the St. Mary's air monitoring station for the most recent year to coincide with the selected meteorological model year i.e. 2017. Additional details on analysis of background levels from the Bargo air monitoring station are presented in **Appendix B**.

Modelled emission rates for the Austral Bricks Plant 3 and associated quarrying operations have been estimated based on information provided by Austral Masonry. Additional details on estimating the emission rates are presented in **Appendix C**.

No site-specific information was available for the CSR brick manufacturing and associated quarrying operations. Therefore, reference was drawn to publicly available NPI reports to estimate point and fugitive particulate matter emissions. Additional details are presented in **Appendix C**.

11.1 Predicted Cumulative Impacts

Predicted cumulative ground-level concentrations (the sum of background levels, non-project impacts and incremental impacts) at the identified sensitive receptors (**Table 4**) are presented in this section.

From the predicted incremental results (refer **Section 10**), for pollutants with assessment criteria at or beyond facility boundary (refer **Table 6**), it is noted that incremental impacts at or beyond the facility boundary are below 0.6% of their respective assessment criteria. Furthermore, it is noted that as per the Approved Methods, for these pollutants only incremental impacts are to be reported and compared against the assessment criteria. Hence, cumulative assessment has not been performed for these individual air toxic pollutants

Based on analysing modelled incremental concentrations from the proposed facility, particulate matter concentrations (TSP, PM_{10} and $PM_{2.5}$) and deposited dust levels were determined to be the key pollutants. Predicted incremental impacts for all other pollutants were very low (less than 0.2% of their respective assessment criteria).

Also, it is noted that for estimating NO_2 ground level concentrations, it was conservatively assumed that all of the NO_X emissions from the proposed facility is instantly converted to NO_2 (100% of NO_X is NO_2). Measurements of oxides of nitrogen (NO_X) emissions around Power Station plume in central Queensland (Bofinger, 1986) indicate that up to 30% of NO_X may be transformed into nitrogen dioxide (NO_2). The ratio accounts for the expectation that approximately 5%-10% of the NO_X is emitted from the source as NO_2. The remaining portion of the NO_2 is transformed from the photochemical oxidation of nitric oxide, which tends to peak at approximately 30%, ten to fifteen kilometres downwind.

Based on the above discussion, cumulative impacts have been assessed only for particulates (TSP, PM_{10}, $PM_{2.5}$) and deposited dust levels.

Predicted cumulative impacts at the worst impacted receptor are summarised in **Table 17**.

Modelling shows that for all the pollutants assessed for cumulative impacts, the predicted concentrations at the worst impacted receptor (and therefore all identified receptors) are below their respective assessment criteria.

Table 17: Predicted Maximum Cumulative PM_{10}, $PM_{2.5}$, TSP Concentrations and Deposited Dust Levels at the Worst Impacted Receptor

Pollutant	Averaging Period	Assessment Criteria (µg/m³)	Maximum Predicted Cumulative Concentration (µg/m³) Across All Receptors
PM_{10}	24-Hour	50	49.2
	Annual	25	19.2
$PM_{2.5}$	24-Hour	25	23.0
	Annual	8	7.2
TSP	Annual	90	43.9
Deposited Dust	Annual	4 g/m²/month	3.3 g/m²/month

Predicted cumulative impacts at all identified receptors are presented in **Table 18**.

It is noted that receptor no. 3 (CSR Brick Plant) have been excluded from the analysis of cumulative impact as emission sources from theses receptors have been included in the cumulative assessment.

For estimating cumulative impacts for $PM_{2.5}$ and PM_{10} size fractions, a contemporaneous assessment was conducted where in, predicted concentrations from each of the three modelled facilities (proposed facility, CSR bricks and Austral Bricks Plant 3) were added to the daily varying background levels observed at the St Mary's monitoring station for the 2017 calendar year.

As per information presented in the NSW Air Quality Statement for 2017 (*Clearing the Air – NSW Air Quality Statement, 2017*), the highest (top 1 day) observed PM_{10} 24-hour average concentration (24 September 2017) and the top 5 days of observed $PM_{2.5}$ 24-hour average concentrations recorded at the St Mary's monitoring station (11 May, 14 August, 15 August, 02 September and 03 September) were excluded from the contemporaneous assessment due to interference from exceptional events on those days. As per the Air Quality Statement, exceptional events are those related to bushfires, hazard reduction burns and dust storms. These are not counted towards the NEPM goal of '*no days above the particle standards in a year*'. Additional information of the excluded data from the contemporaneous data is presented in **Appendix B**.

Upon excluding the exceptional events, contemporaneous assessment shows that the 24-hour average PM_{10} and $PM_{2.5}$ concentrations comply with the respective assessment criteria at all the identified sensitive receptors. Compliance is also achieved for the annual average TSP, PM_{10}, $PM_{2.5}$ concentrations and deposited dust levels.

As noted in **Section 10.1**, modelling shows that the incremental particulate matter impacts attributed to emissions generated from the proposed facility is minimal, with predicted incremental concentrations ranging from 0.6% (TSP annual average) to 3.2% ($PM_{2.5}$ 24-hour average) of the relevant assessment criteria.

Therefore, taking into consideration the minimal contribution from the Oakdale East project site emissions coupled with compliance achieved for cumulative impacts, it can be inferred that no adverse air quality impacts are expected with the proposed masonry and warehousing operations.

Cumulative concentration isopleths for PM_{10}, $PM_{2.5}$, TSP and deposited dust levels are presented in **Figure 18** through to **Figure 23**.

Table 18: Predicted Maximum Cumulative PM_{10}, $PM_{2.5}$, TSP Concentrations and Deposited Dust Levels at All Identified Sensitive Receptors

Pollutant	PM_{10}		$PM_{2.5}$		TSP	Deposited Dust
Averaging Period	24-Hour	Annual	24-Hour	Annual	Annual	Monthly
Assessment Objective	50 µg/m³	25 µg/m³	25 µg/m³	8 µg/m³	90 µg/m³	4 g/m²/mth
Receptor ID	**Predicted Maximum (Rank 1) Cumulative Concentration**					
1	40.8	17.9	22.2	7.1	42.5	2.3
2	41.5	18.6	22.2	7.1	43.9	2.7
3 (CSR Bricks)	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
4	49.2	18.6	22.3	7.1	43.2	3.3
5	48.8	17.9	22.2	7.0	42.2	2.6
6	47.8	17.9	22.2	7.0	42.2	2.6
7	46.7	17.6	22.2	7.0	41.9	2.5
8	46.1	17.5	22.2	6.9	41.7	2.4
9	45.0	17.2	22.2	6.9	41.5	2.3
10	43.9	17.0	22.2	6.9	41.2	2.2
11	43.2	16.9	22.2	6.9	41.1	2.2
12	42.9	16.9	22.2	6.9	41.2	2.2
13	40.6	17.5	22.2	7.0	41.9	2.2
14	40.5	17.1	22.2	6.9	41.4	2.2
15	40.7	17.2	22.2	6.9	41.7	2.2
16	41.1	17.8	22.2	7.0	42.6	2.4
17	47.6	17.3	22.2	6.9	41.4	2.2
18	42.6	16.8	22.2	6.8	41.0	2.2
19	42.2	16.7	22.2	6.8	40.8	2.2
20	42.7	16.8	22.2	6.8	41.0	2.3
21	42.3	16.7	22.3	6.8	41.1	2.1
22	42.7	17.0	22.4	6.9	41.5	2.2
23	43.0	17.2	22.4	6.9	41.9	2.2
24	41.6	19.2	23.0	7.2	43.9	2.4
25	40.3	17.6	22.2	7.0	42.0	2.2

Figure 18: Maximum (Rank 1) Predicted Cumulative Concentrations – PM_{10} 24-Hour Average (Units: µg/m³) (Assessment Criteria 50 µg/m³)

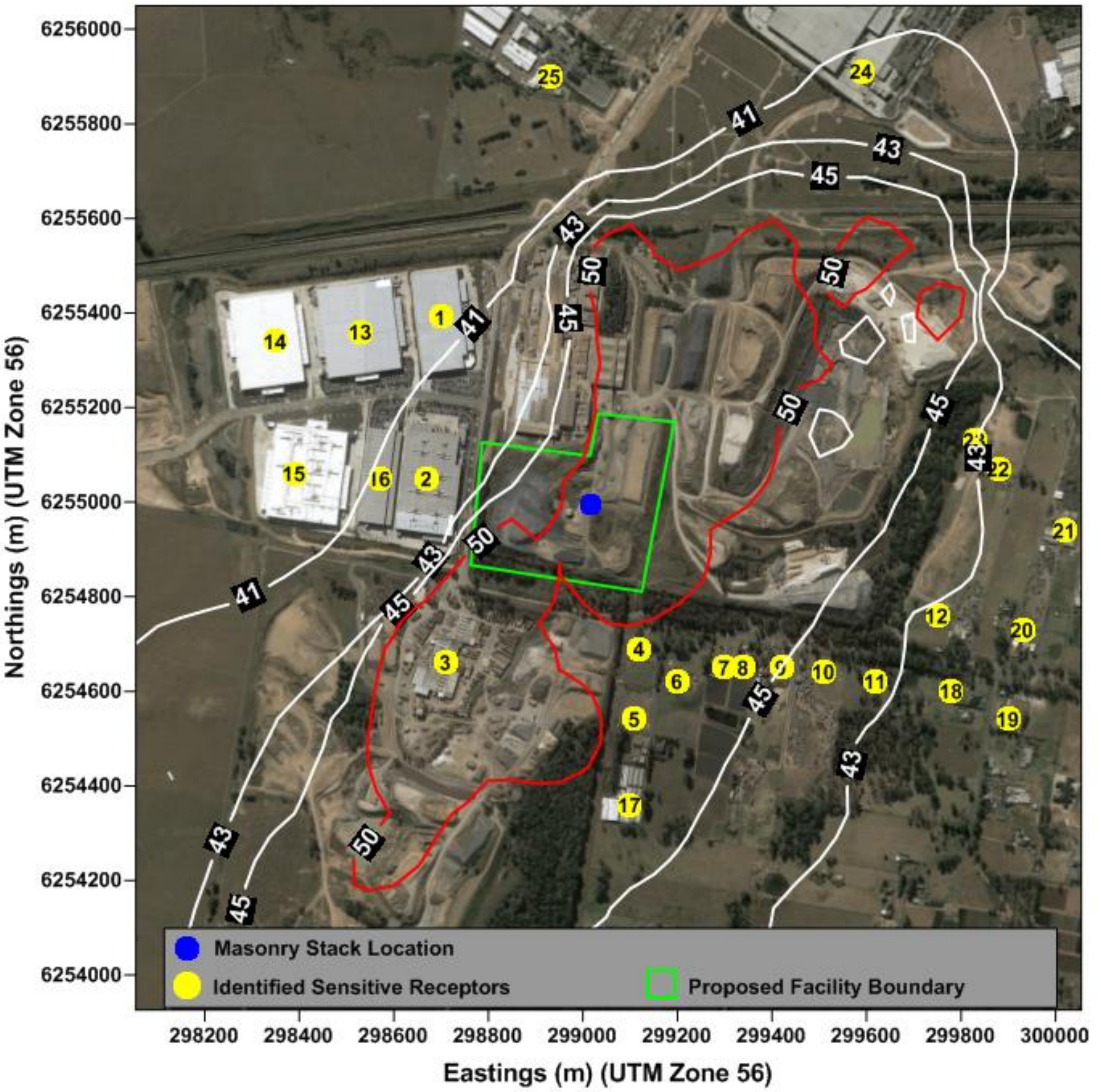


Figure 19: Predicted Cumulative Concentrations – PM_{10} Annual Average (Units: µg/m³) (Assessment Criteria: 25 µg/m³ – Red Contour)

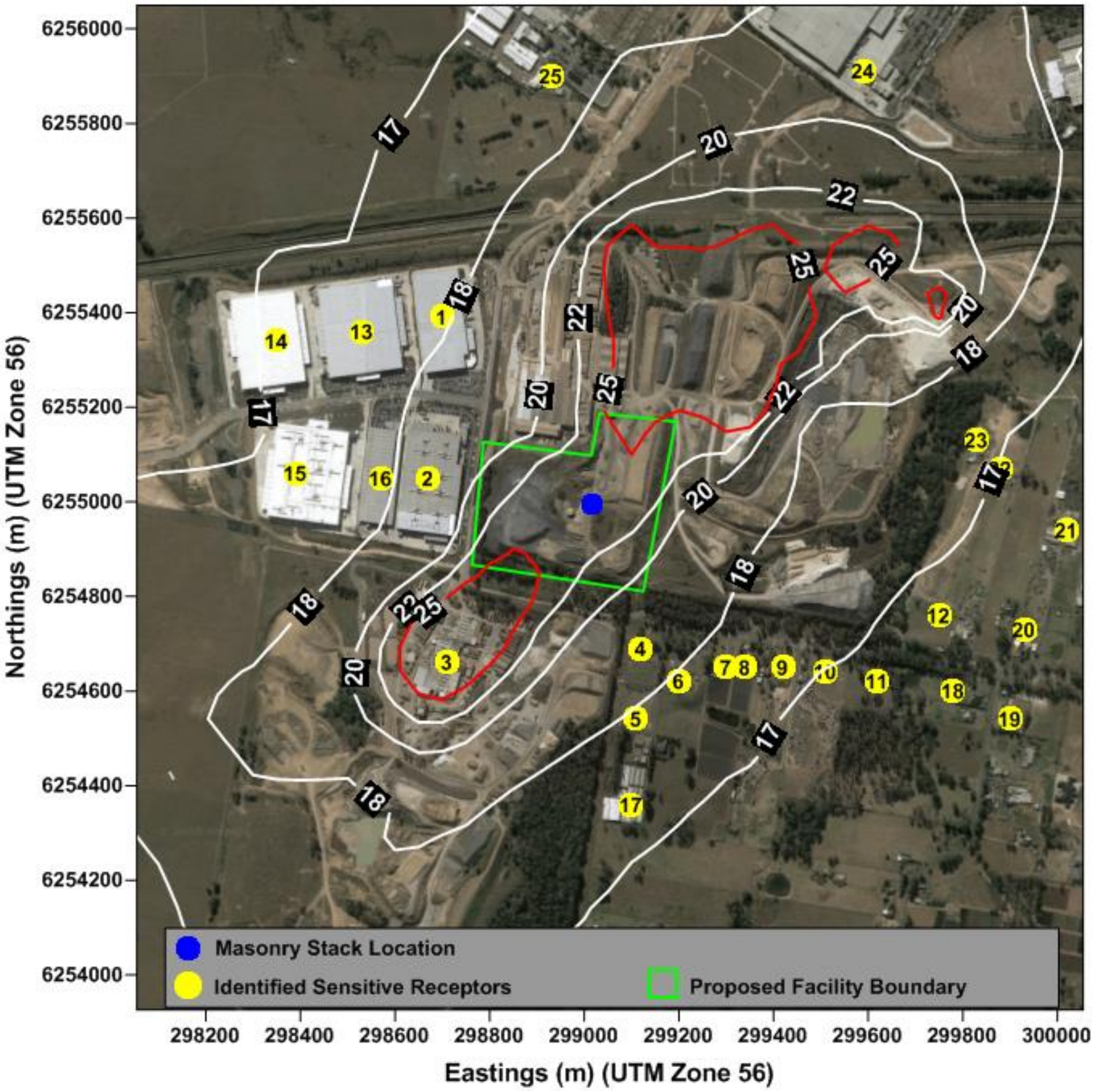


Figure 20: Maximum (Rank 1) Predicted Cumulative Concentrations – $PM_{2.5}$ 24-Hour Average (Units: µg/m^3) (Assessment Criteria: 25 µg/m^3 – Red Contour)

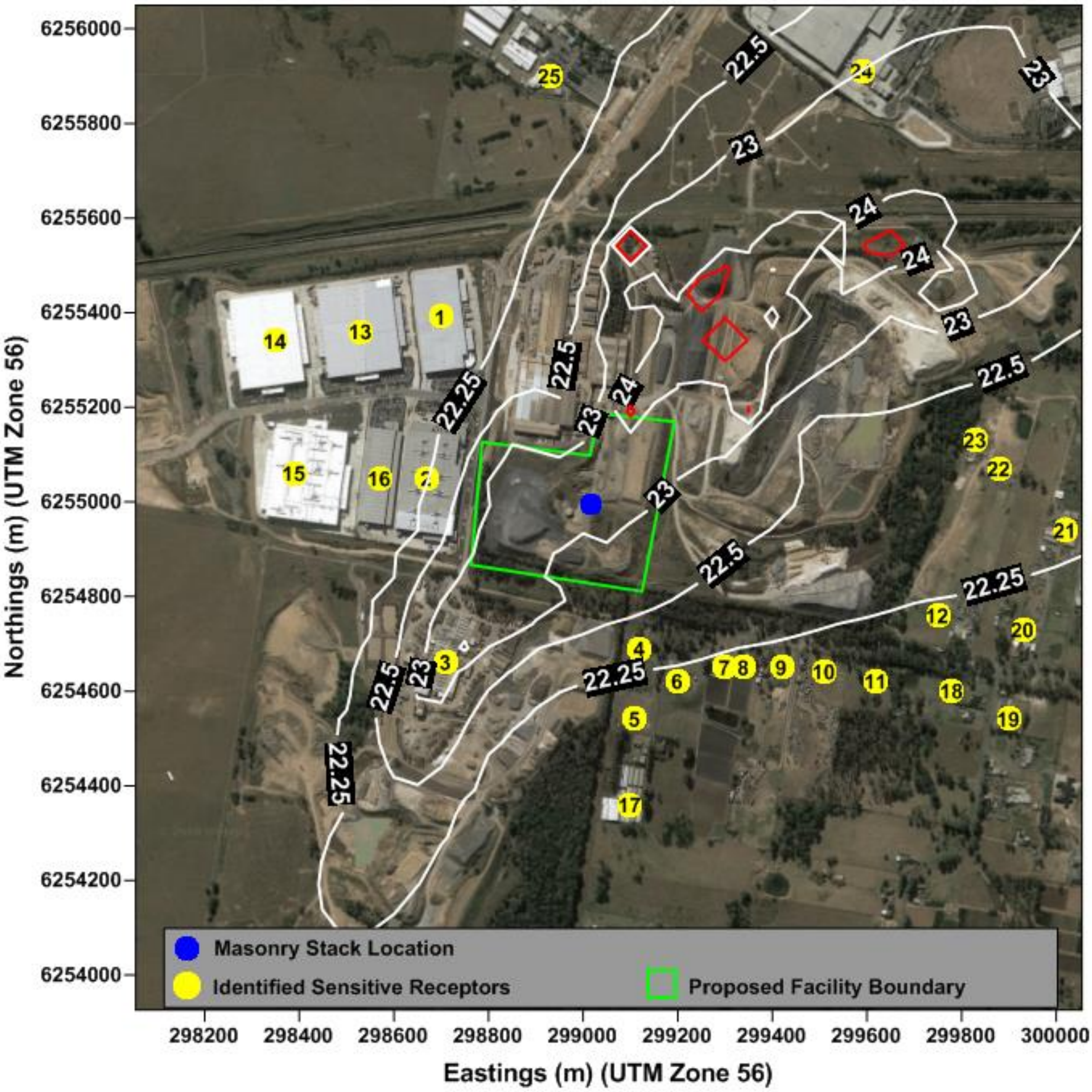


Figure 21: Predicted Cumulative Concentrations – $PM_{2.5}$ Annual Average (Units: µg/m^3) (Assessment Criteria: 8 µg/m^3 – Red Contour)

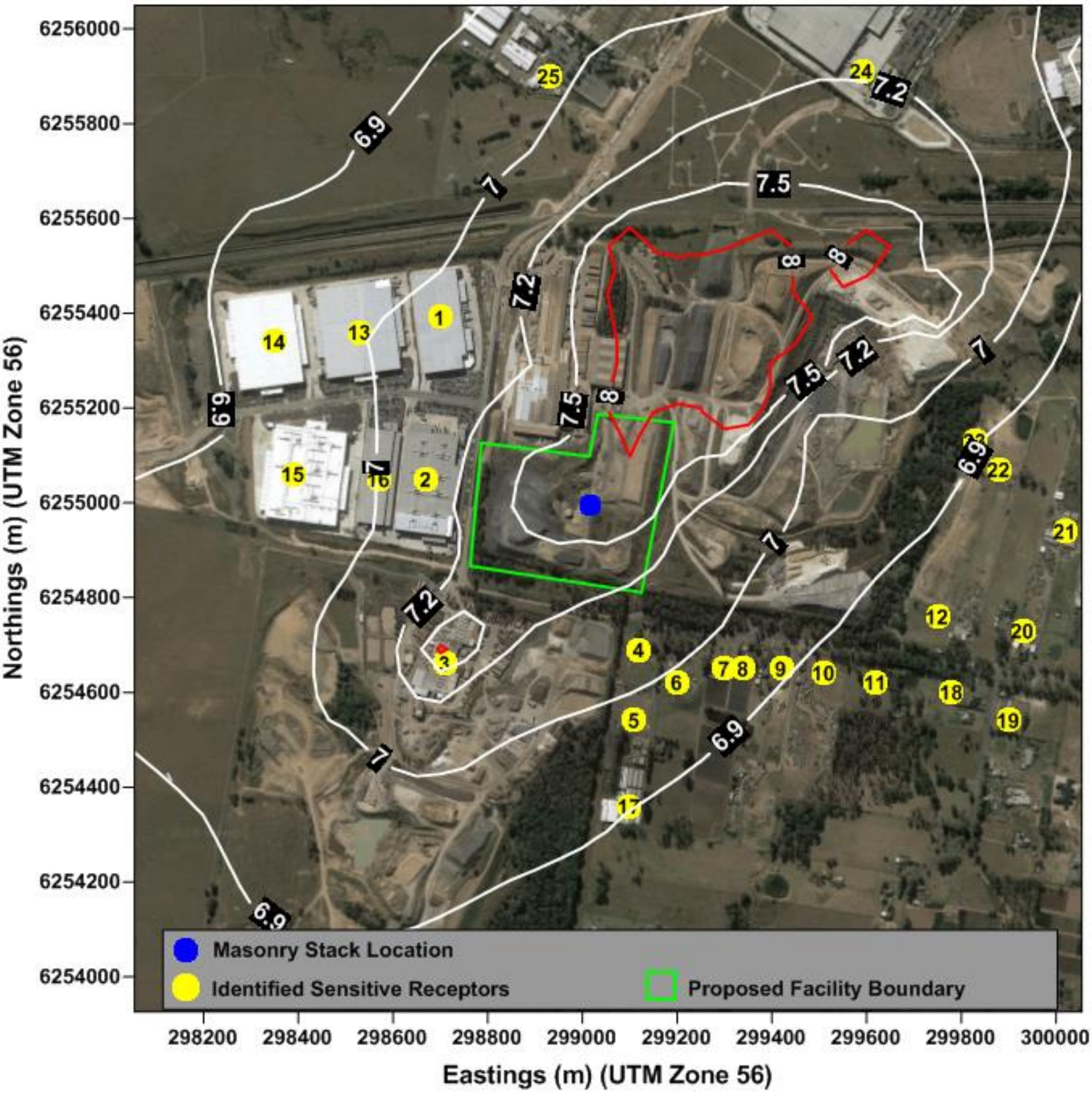


Figure 22: Predicted Cumulative Concentrations – TSP Annual Average (Units: μg/m³) (Assessment Criteria: 90 μg/m³ – Red Contour)

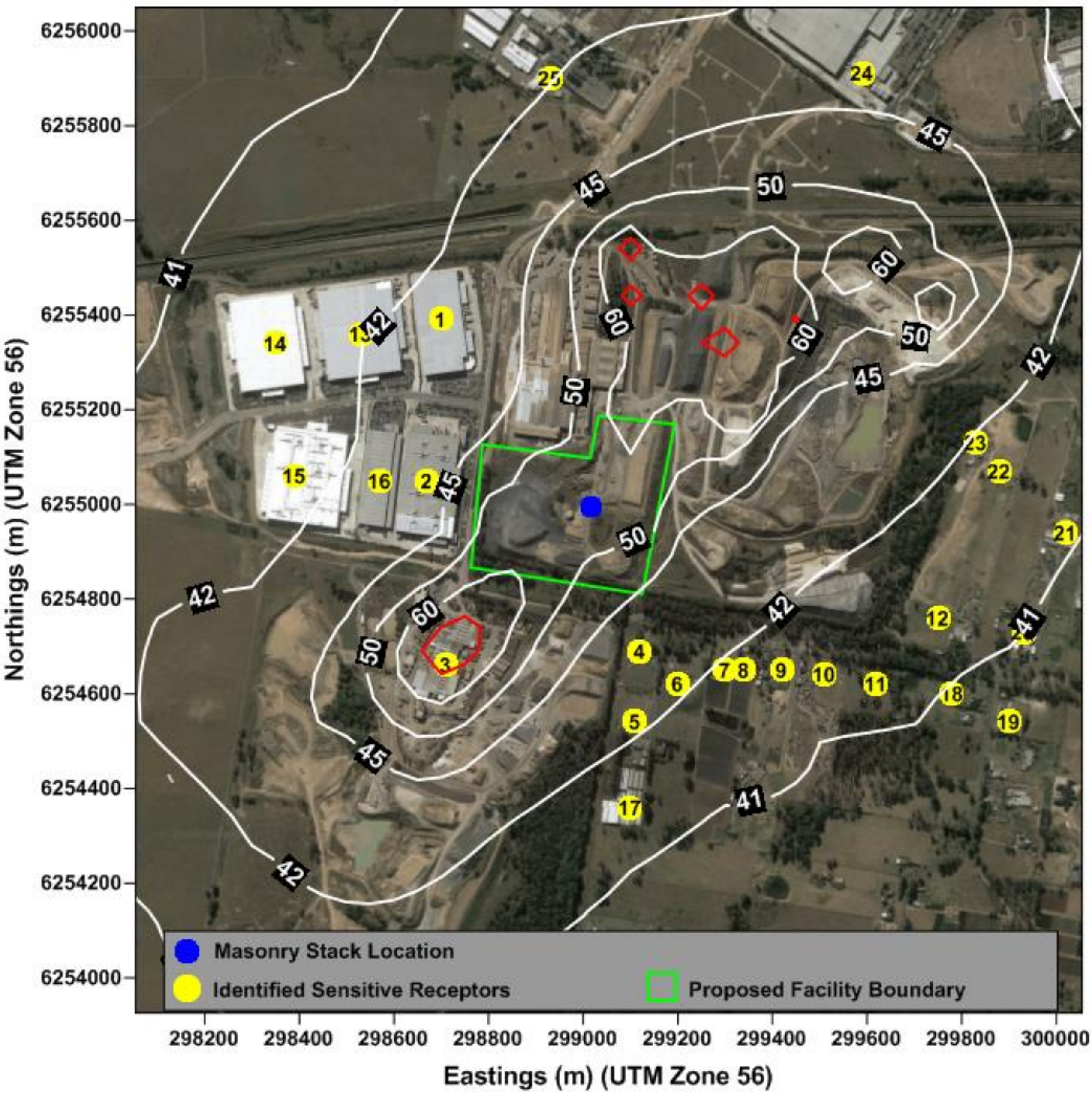
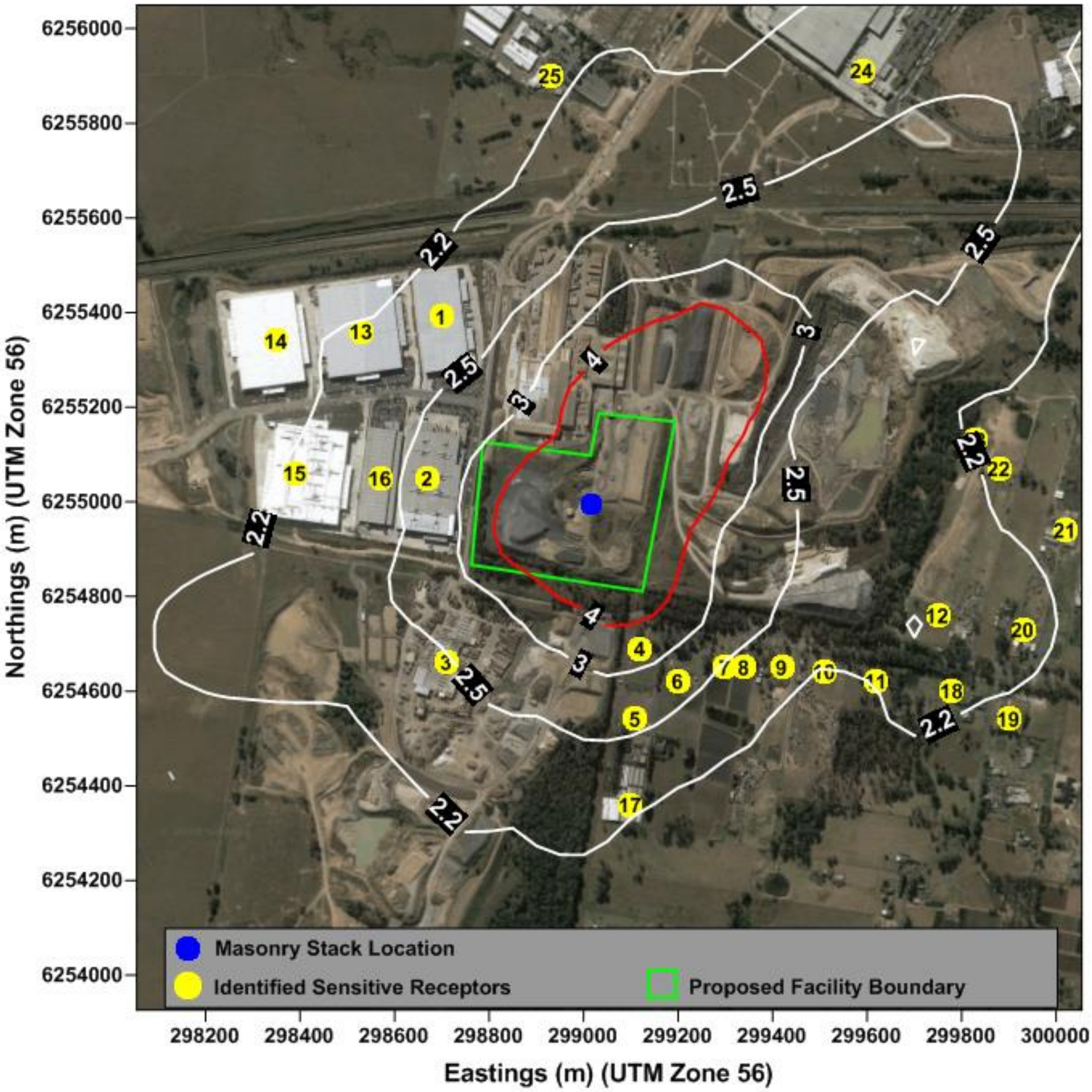


Figure 23: Maximum Predicted Cumulative Annual Average Deposited Dust Levels (Units: $g/m^2/month$) (Assessment Criteria: 4 $g/m^2/month$ – Red Contour)



12. CONCLUSION

Airlabs was commissioned by Goodman on behalf of Austral Masonry to conduct an air quality assessment for the Oakdale East project – which comprised construction and operation of a masonry plant capable of producing up to 220,000 tonnes per annum of masonry products and construction and operation of five (5) warehouses intended for generic warehousing and distribution purposes.

As the proposal is a designated development, SEARs have been issued and the air quality assessment has been prepared to address the SEARs.

Off-gas emissions generated from the natural gas burner inside the curing chamber and emissions of fugitive particulate matter from operational activities at the masonry plant and the warehouses were identified as the key sources of air emissions.

To predict impacts from the identified sources, a Level 2 air dispersion modelling assessment was conducted in accordance with the *Approved Methods for Modelling and Assessment of Air Pollutants in NSW*.

For pollutants requiring cumulative assessment, contribution from nearby sources comprising the brick manufacturing and associated quarrying operations at Austral Bricks Plant 3 and the CSR brick manufacturing operations were considered along with ambient air quality monitoring data from the NEPM air quality monitoring station at St. Mary's, NSW.

Modelling shows that the incremental impacts (emissions generated from the proposed facility alone) are quite minimal, with predicted particulate matter impacts ranging from 0.6% (TSP annual average) to 3.2% ($PM_{2.5}$ 24-hour average) of the relevant assessment criteria. For the other pollutants, including SO_2, NO_2, CO the maximum predicted incremental concentrations across all sensitive receptors are 0.2% or below their respective assessment criteria.

For individual air toxics, predicted impacts for all pollutants were found to be below 0.6% of their respective assessment criteria

Based on analysis of the predicted incremental concentrations, particulate matter emissions were considered to be the key pollutants and subsequently cumulative assessment was undertaken for the TSP, PM_{10}, $PM_{2.5}$ size fractions and deposited dust levels.

Modelling shows that for all the pollutants assessed for cumulative impacts, the predicted concentrations at all the identified receptors are in compliance with their respective assessment criteria.

Therefore, taking into consideration the minimal contribution from the Oakdale East project site coupled with compliance achieved for cumulative impacts, no adverse air quality impacts are expected with operational activities at the Oakdale East project site, including the proposed masonry and warehousing operations.

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APPENDIX A

Fugitive Particulate Matter Emission Reduction Factors

- *Proposed Masonry Plant Operations*
- *Proposed Warehousing Operations*

Table A.1: Fugitive Dust Control Measures and Quantifiable Emission Reduction Factors

Fugitive Dust Control Measure	Emission Reduction Efficiency	Notes
Enclosed conveyors	70%	National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Mining, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012
General maintenance of paved roads	50% (b)	50% control efficiency applied for general maintenance of paved road surfaces, which include periodic sweeping and preserving / maintaining the condition of the paved surface

APPENDIX B

Ambient Air Quality Characterisation

- *St. Mary's Air Quality NEPM Station*

The NSW Office of Environment and Heritage (OEH), regulates and maintains a network of air quality monitoring stations across NSW.

A NEPM air quality monitoring station at St. Mary's, NSW (approximately 6 km northwest of the proposed facility), maintained by Office of Environment and Heritage (OEH), was identified as suitable station for estimating the background levels of particulates as the station is located in a rural area without contribution from any major industries.

As emissions from the nearby industries (Austral Bricks Plant 3 and CSR Brick Plant) have been explicitly modelled and the contributions accounted for in the cumulative results, it is important that a station similar to St Mary's be used for background estimates in order to not double count the emissions from the other major industries.

Daily observations of particulate concentrations (PM_{10} & $PM_{2.5}$) for the calendar year 2017 were downloaded from the NSW EPA website.

Timeseries representation of the daily observed PM_{10} and $PM_{2.5}$ concentrations are presented in **Figure B.1** and **Figure B.2** respectively.

The statistics for the top ten (10) days of observed PM_{10} and $PM_{2.5}$ levels recorded at the St. Mary's monitoring station in 2017 are summarised in **Table B.1** and **Table B.2** respectively.

As seen from **Figure B.1 and Table B.1**, the 24-hour average PM_{10} assessment criteria of 50 µg/m^3 was exceeded for one day (24 September) in the year 2017. As per information presented in the NSW Air Quality Statement for 2017 (*Clearing the Air – NSW Air Quality Statement, 2017*), the exceedance was classified as "*Exceptional events*" i.e. those related to bushfires, hazard reduction burns and dust storms. These are not counted towards the NEPM goal of '*no days above the particle standards in a year*'.

With respect to 24-hour average $PM_{2.5}$ concentrations, as observed from **Figure B.2 and Table B.2**, there were three (3) exceedances in 2017 which were attributed to *Exceptional events*. A further investigation of the time-series also revealed that the fourth (4th) and fifth (5th) highest concentrations recorded on 14 August 2017 and 02 September 2017 were also influenced by bush fires / dust storms as these days have been classified in the 2017 NSW Air Quality Statement as *Exceptional events* at nearby NEPM monitoring stations. Consequently, these days were also excluded from the contemporaneous assessment.

For those 24-hour periods where data has been excluded for the PM_{10} and $PM_{2.5}$ size fractions, the excluded data has been replaced with the corresponding 70th percentile value for the 2017 calendar year.

Table B.1: Statistics for Top Ten Days of Observed PM_{10} Concentrations at St. Mary's in 2017

Date	24-Hour Average PM_{10} Concentration (µg/m³), St. Mary's 2017	Rank	Comments
24/09/2017	49.8	1	Excluded from the contemporaneous assessment, as categorised as *Exceptional event*. Replaced with 70th percentile value for the 24-hour average concentrations measured in 2017 at St Mary's.
15/08/2017	40.3	2	Included in contemporaneous assessment
12/09/2017	37.4	3	Included in contemporaneous assessment
03/09/2017	35.8	4	Included in contemporaneous assessment
05/10/2017	35.7	5	Included in contemporaneous assessment
15/01/2017	35.5	6	Included in contemporaneous assessment
02/09/2017	35.5	7	Included in contemporaneous assessment
23/09/2017	34.8	8	Included in contemporaneous assessment
21/08/2017	33.3	9	Included in contemporaneous assessment
11/05/2017	33.2	10	Included in contemporaneous assessment

Table B.2: Statistics for Top Ten Days of Observed $PM_{2.5}$ Concentrations at St. Mary's in 2017

Date	24-Hour Average $PM_{2.5}$ Concentration (µg/m³), St. Mary's 2017	Rank	Comments
15/08/2017	38.2	1	Excluded from the contemporaneous assessment, as categorised as *Exceptional event*. Replaced with 70th percentile value for the 24-hour average concentrations measured in 2017 at St Mary's.
03/09/2017	26	2	Excluded from the contemporaneous assessment, as categorised as *Exceptional event*. Replaced with 70th percentile value for the 24-hour average concentrations measured in 2017 at St Mary's.
11/05/2017	25.3	3	Excluded from the contemporaneous assessment, as categorised as *Exceptional event*. Replaced with 70th percentile value for the 24-hour

Date	24-Hour Average $PM_{2.5}$ Concentration (µg/m^3), St. Mary's 2017	Rank	Comments
			average concentrations measured in 2017 at St Mary's.
14/08/2017	24.3	4	Excluded from the contemporaneous assessment, as categorised as *Exceptional event*. Replaced with 70th percentile value for the 24-hour average concentrations measured in 2017 at St Mary's.
02/09/2017	23.5	5	Excluded from the contemporaneous assessment, as categorised as *Exceptional event*. Replaced with 70th percentile value for the 24-hour average concentrations measured in 2017 at St Mary's.
27/08/2017	22.2	6	Included in contemporaneous assessment
21/08/2017	21.7	7	Included in contemporaneous assessment
26/08/2017	21.3	8	Included in contemporaneous assessment
12/05/2017	20.1	9	Included in contemporaneous assessment
12/09/2017	18.6	10	Included in contemporaneous assessment

Based on the above analysis, the top 1 day of observed PM_{10} 24-hour average concentrations and top 5 days of observed $PM_{2.5}$ 24-hour average concentrations at St Marys were excluded from the daily varying background timeseries for the contemporaneous assessment

A summary of the background concentrations used for the cumulative assessment is presented in **Table B.3**.

Table B.3: Background Air Quality Levels Adopted for this Assessment

Pollutant	Averaging Period	Adopted Background Concentration	Description
PM_{10}	24-hours	Daily Varying	Assessed contemporaneously with daily varying PM_{10} background levels measured at St. Mary's air monitoring station in 2017
	Annual	16.2µg/m^3	Annual average PM_{10} value measured at St. Mary's air monitoring station in 2017
$PM_{2.5}$	24-hours	Daily Varying	Assessed contemporaneously with daily varying $PM_{2.5}$ background levels measured at St. Mary's air monitoring station in 2017

Pollutant	Averaging Period	Adopted Background Concentration	Description
	Annual	6.8 µg/m³	Annual average $PM_{2.5}$ value measured at St. Mary's air monitoring station in 2017
TSP	Annual	40.45 µg/m³	No monitoring data available, therefore TSP background concentration from the below assumption *TSP background concentration = Annual average PM_{10} concentration / 4*
Deposited Dust	Annual	2 g/m²/month	Conservative assumption based on similar projects undertaken by Airlabs

Figure B.1: 24-hour Average PM_{10} Concentration Levels (µg/m³) – St. Mary's Monitoring Station – 2017

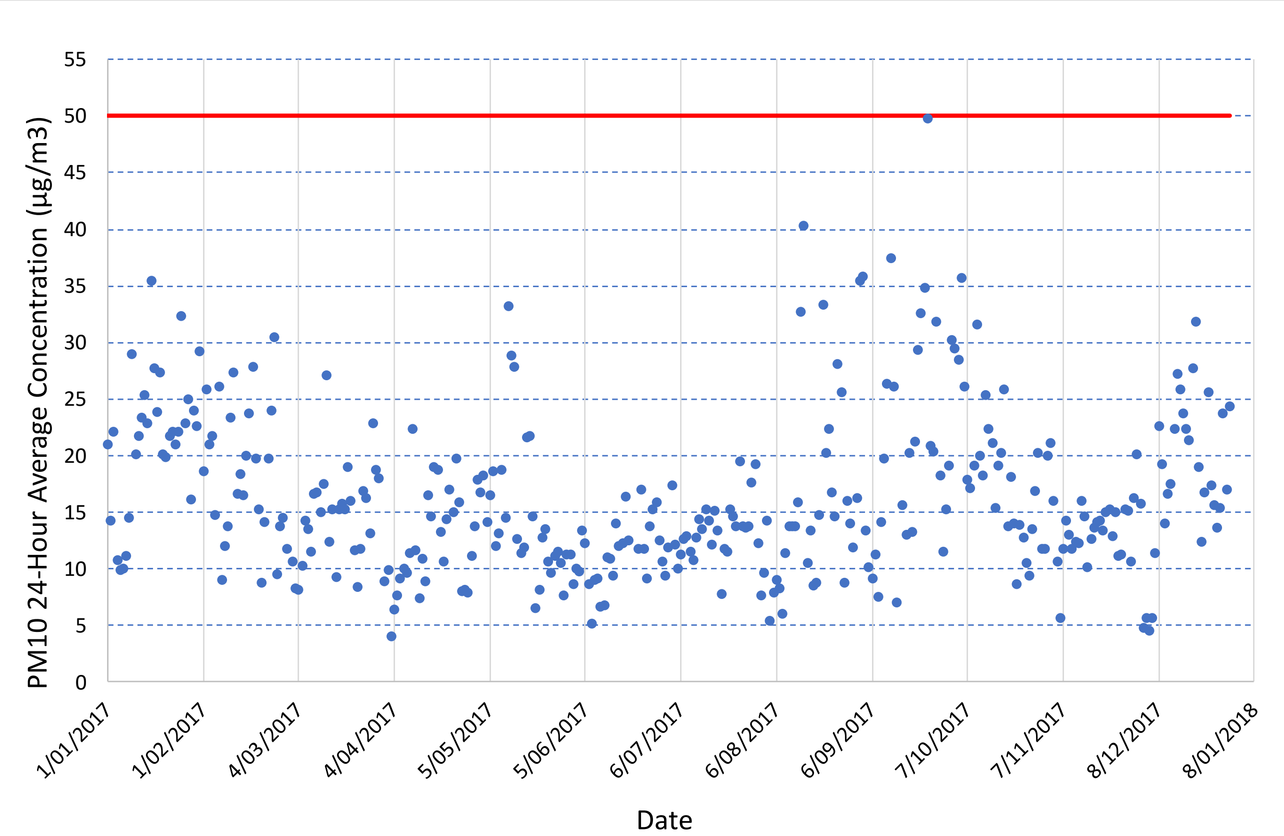
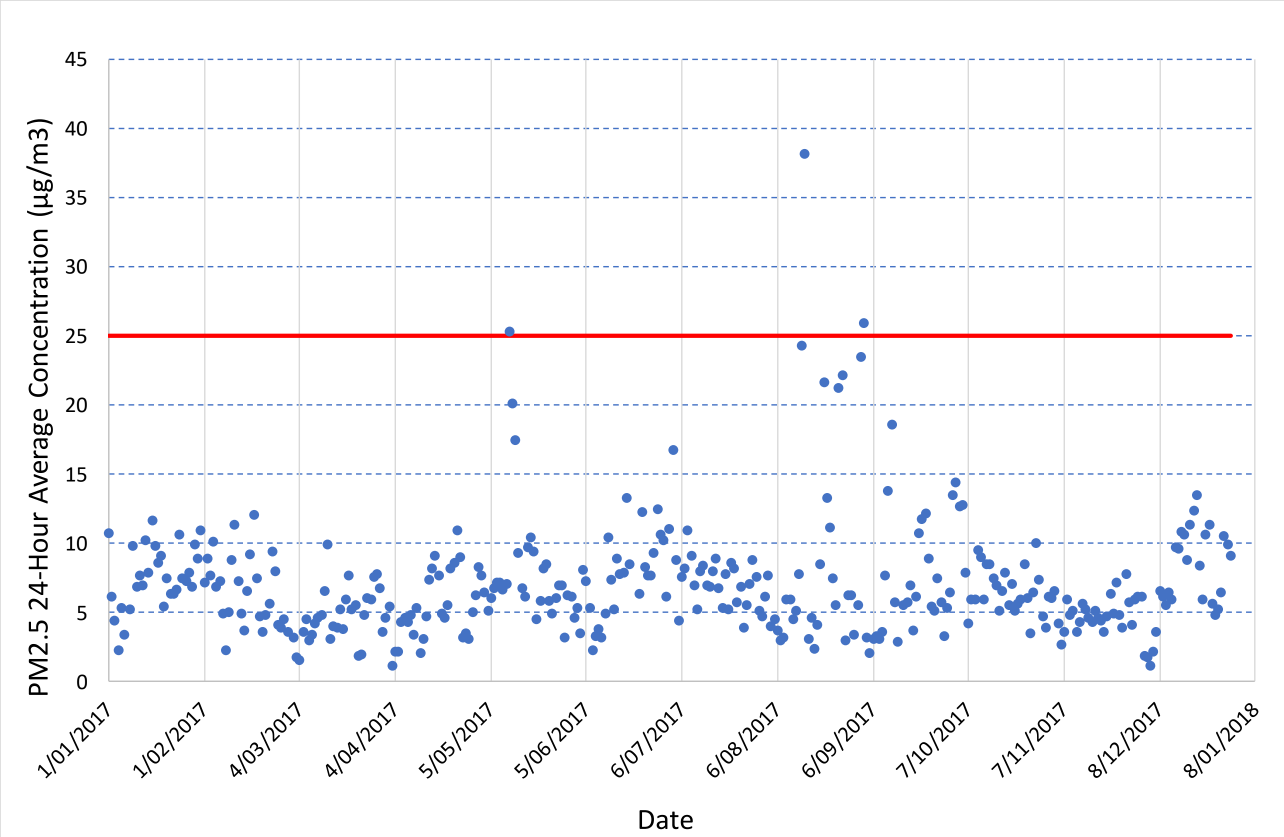


Figure B.2: 24-hour Average $PM_{2.5}$ Concentration Levels (µg/m^3) – St. Mary's Monitoring Station – 2017



APPENDIX C

Emission Estimation from Non-Project Sources

- *Modelled Emission Rates from the Austral Bricks Plant 3 and Associated Quarrying Operations*
- *Modelled Emission Rates from the CSR Brick Plant and Associated Quarrying Operations*

Austral Bricks Plant 3 Brick Manufacturing and Associated Quarrying Operations

The Austral Bricks Plant 3 site is located immediately to the north of the proposed facility. Furthermore, it is to be noted that the masonry plant along with the proposed warehouses are being developed at the existing Austral Bricks Plant 3 site.

Existing brick manufacturing operations at the Plant 3 site are managed under EPL 546. According to the EPL, Plant 3 has two (2) point sources / stacks which emit pollutants to the atmosphere – Stack for kiln number 6 known as Swindle (DP 6) and Stack for kiln number 7 known as Ceric (DP 7).

Pollutant emission rates along with parameters for the above two (2) stacks were obtained from the following reports:

- *Air Emissions Monitoring of the Plant 3 Swindle Kiln Stack (DP 6) at Austral Bricks*, Airlabs Environmental Pty. Ltd., Date of Testing: 14 March 2018, Report No: MAR18038D.1, Date of Report: 26 April 2018.
- *Air Emissions Monitoring of the Plant 3 Ceric Kiln Stack (DP 7) at Austral Bricks*, Airlabs Environmental Pty. Ltd., Date of Testing: 13 and 14 March 2018, Report No: MAR18038C.1, Date of Report: 09 May 2018.

A summary of the stack parameters along with the particulate matter emission rates as referenced from the above test reports is presented in **Table C.1**.

Table C.1: Stack Parameters and Pollutant Emission Rates – Austral Bricks Plant 3

Stack I.D.	Location (Easting, Northing)	Stack Height (m)	Dia (m)	Exit Temp (K)	Exit Vel. (m/s)	Annual Emissions (kg/year)		
						TSP	PM_{10}	$PM_{2.5}$
DP 6 – Swindle	298906, 6255296	23.9	1.42	457	18.8	11,563	9,460.8	8,514.7
DP 7 – Ceric	298909, 6255296	17	1.75	357.15	12.5	4,204.8	3,889.4	3,500.5

In addition to point source emissions, fugitive particulate matter emissions were also quantified from the associated quarrying operations at the Plant 3 site. A total of nine (9) fugitive particulate matter sources of emissions were identified and modelled to assess the impacts. Emission rates were quantified based on production rates / throughputs provided by Austral Masonry and with the aid of Emission Estimation Technique (EET) Manuals. Inventory of the TSP, PM_{10} and $PM_{2.5}$ emission rates from the Plant 3 site are summarised in **Table C.2**.

Table C.2: Fugitive Particulate Matter Emission Rates – Austral Bricks Plant 3

Activity	Quantity	Units	Modelled Annual Emission Rates (kg/year)		
			TSP	PM_{10}	$PM_{2.5}$
Truck Loading in Pit	525,000	tpa	811	384	58
Raw material haulage	22500	km	13,435	3,649	365
Truck unloading to Stockpile	405,000	tpa	626	296	45
Conveyer (Stockpile to Screening)	405,000	tpa	28	9	3
Screening	405,000	tpa	446	150	10
Crushing	405,000	tpa	243	109	20
Crushing - Fines	405,000	tpa	608	243	14
Conveyer (Crusher to Brick plant)	405,000	tpa	28	9	3
Wind Erosion (Stockpiles & Exposed areas)	25.83	ha	5,381	2,690	404
Total			**21,606**	**7,540**	**921**

CSR Brick Manufacturing (PGH Bricks and Pavers Horsley Park) and Associated Quarrying Operations

The CSR brick manufacturing plant, which manufactured clay bricks and pavers is located southwest of the proposed facility. To quantify emissions from this plant, Airlabs undertook an extensive desktop review to identify any previous air quality assessments undertaken at the CSR Plant. However, no such information was available on the public domain and therefore, reference was drawn to the annual National Pollutant Inventory (NPI) reports of the facility to quantify emissions.

Point source pollutant emission rates were available for the 2016-17 reporting year and have been used in the cumulative assessment. Point source characteristics were not included in the NPI reports (parameters such as stack height, diameter, exit velocity etc.) and therefore, the parameters were assumed to be similar to the DP 7- Ceric Kiln parameters from the Austral Bricks Plant 3 site. DP 7 – Ceric was chosen over DP 6 – Swindle, as it had a lower exit velocity and therefore considered to be a conservative assumption, as lower exit velocity leads to poor dispersion.

Source parameters along with the emission rates, as referenced from the NPI reports are presented in **Table C.3**.

Table C.3: Stack Parameters and Pollutant Emission Rates – CSR Bricks

Stack I.D.	Location (Easting, Northing)	Stack Height (m)	Dia (m)	Exit Temp (K)	Exit Vel. (m/s)	Annual Emissions (kg/year)		
						TSP	PM_{10}	$PM_{2.5}$
CSR Point	298713, 6254689	23.9	1.42	451	12.5	11,494	5,747	5,172

Similar to the Plant 3 site, fugitive particulate matter emissions were also quantified from the associated quarrying operations in addition to point source emissions. Particulate matter emission rates were referenced from the 2016-17 NPI data. Due to non-availability of site-specific information (such as specific sources generating dust emissions), the fugitive particulate matter emissions were assumed to be released from a single volume source with a source height of 4m and a length of 50m. This approach has been used by Airlabs in the past to determine impacts from sources where no site-specific information was available. Fugitive particulate matter emission rates from the CSR operations used for the cumulative assessment are summarised in **Table C.4**.

Table C.4: Fugitive Particulate Matter Emission Rates – CSR Bricks

Source I.D.	Location (Easting, Northing)	Source Type	Annual Emissions (kg/year)		
			TSP	PM_{10}	$PM_{2.5}$
CSR Fugitive	298715, 6254688	Single volume source in the middle of the CSR Bricks site with a source height of 4m and a length of 50m	10,137	3,532	93