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THE AUSTRAL BRICK CO PTY LTD

PROPOSED PLANT 2 UPGRADE – SSD 9601

780 WALLGROVE ROAD, HORSLEY PARK, NSW

REVISED AIR QUALITY IMPACT ASSESSMENT

RESPONSE TO AGENCY SUBMISSIONS

DOCUMENT CONTROL

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KEY ACRONYMS

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
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cumulative Impacts	Incremental impacts from the upgraded Plant 2 facility + impacts from Plant 1 + impacts from Horsley Park WMF + background concentrations from the Prospect monitoring station)
DA	Development Application
DOEE	Department of the Environment and Energy
DOP&E	Department of Planning and Environment
EET	Emission Estimation Technique
EIS	Environmental Impact Statement
EP&A Act	Environmental Planning and Assessment Act, 1979
EPL	Environmental Protection Licence
ETBPP	Environmental Technology Best Practice Programme
HF	Hydrogen Fluoride
g/sec	Emission rate in grams per second
$g/m^2/month$	Units for deposited dust levels, grams per meter square per month
GHG	Greenhouse gas
Incremental	Impacts from the upgraded Plant 2 facility
Level 2	A refined dispersion modelling technique using site-specific input data
LGA	Local Government Area
m^2	square metres
m/sec	metres per second
m^3/hr	cubic metre per hour
Mt	Million tonnes
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure – Ambient Air Quality
NGAF	National Greenhouse Account Factors
NOx	Oxides of Nitrogen
NO_2	Nitrogen dioxide
NSW – EPA	New South Wales Environment Protection Authority
NSW – OEH	New South Wales Office of Environment and Heritage
Plant 1	Austral Bricks Plant 1, Horsley Park, NSW
Plant 2	Austral Bricks Plant 2, Horsley Park, NSW
Plant 3	Austral Bricks Plant 3, Horsley Park, NSW
PM	Particulate matter
PM_{10}	Particulate matter with an equivalent diameter of 10 microns or less
$PM_{2.5}$	Particulate matter with an equivalent diameter of 2.5 microns or less
POEO	Protection of the Environment Operations Act 1997

SEARs	Secretary Environmental Assessment Requirements
SEE	Statement of Environmental Effects
SOx	Sulfur oxides
SO_2	Sulfur dioxide
SO_3	Sulfuric acid mist and sulfur trioxide as SO_3
SRC	Sigma Research Corporation (now Exponent)
SRTM	Shuttle Radar Topography Mission
SSD	State Significant Development
TAPM	The Air Pollution Model
tpa	tonnes per annum
TSP	Total Suspended Particulates
tCO_2-e	Tonnes of CO_2 equivalent
$\mu g/m^3$	micrograms per cubic metre
US-EPA	United States Environmental Protection Agency
UTM	Universal Transverse Mercator
VOCs	Volatile Organic Compounds
WMF	Horsley Park Waste Management Facility
WSP	Western Sydney Parklands

EXECUTIVE SUMMARY

Introduction

The Austral Brick Co Pty Ltd (Austral Bricks) are proposing planned upgrades to the existing brick manufacturing plant no 2 (Plant 2) at their Horsley Park premises located at 780 Wallgrove Road, Horsley Park, NSW. Current operations at the Plant 2 site produce up to 80 million bricks per annum and are licensed under the Environmental Protection Licence (EPL) No: 546.

The proposed upgrade is categorised as a State Significant Development (SSD), which is to be accompanied by an Environmental Impact Statement (EIS) suitable for submission to the Department of Planning and Environment (NSW- DOP&E) for seeking approval.

An air quality impact assessment report (AUG18138.2) accompanying the EIS was submitted to DPIE for public exhibition. Comments were issued by the EPA and DPIE for the air quality assessment, which have been addressed in this revised air quality assessment report.

Comments from the EPA were broadly based on performance of the proposed Plant 2 scrubber for reducing HF discharge concentrations and that it is not in-line with best practice measures; inclusion of Plant 3 emissions as a part of the background environment; technical issues with dispersion modelling and estimated fugitive dust emission rates. Comments from the DPIE were related to the gas consumption details and its consequence on the corresponding greenhouse gas emissions.

Specifics of the Proposed Upgrade

A key objective of upgrading the existing Plant 2 site is to implement best practice measures and to increase efficiencies associated with the operations. The upgrade is also being planned to improve fuel consumption and the environmental performance, specifically air pollutant emissions discharged to the atmosphere from the brick kiln. The upgrade will not change any of the key brick manufacturing operations and nor the production rates, which will remain unchanged at 80 million bricks per annum, post upgrade.

With respect to air quality, the proposed upgrade will comprise the following works, which are aimed at lowering / improving the emissions profile:

- *New Kiln*: The two (2) existing kilns for Plant 2 will be replaced by a new kiln, which would improve fuel consumption and the emissions profile.
- *Scrubber to minimise acid gas emissions:* The upgraded Plant 2 kiln would comprise a dry lime fluorine cascade scrubber, which is aimed at Hydrogen Fluoride (HF) concentrations. EPA in their comments have expressed about the effectiveness of the scrubber. In response to the EPAs comments, Austral Bricks have agreed to lower the maximum HF discharge concentration at the upgraded Plant 2 kiln stack to 20 mg/m^3 from the originally assessed 45 mg/m^3, which translates to a 55% improvement in HF emissions discharged to the atmosphere. The revised HF concentration is also in-line with best practice measures implemented by Austral Bricks as most of the Austral Bricks' plants that have end-of-pipe HF abatement technologies have a maximum discharge concentration of 20 mg/m^3.
- *Increase in stack height:* The proposed upgrade also includes increasing the stack height of the existing Plant 2 kiln from 16m to 35m. Increasing the stack height would facilitate better dispersion of pollutants and minimise building wake effects that can potentially disrupt / impact the plume dispersion.

Assessment Methodology

The assessment methodology adopted in this revised assessment has been modified, where required to address the EPA comments.

To determine potential air quality impacts from the planned upgrades, air dispersion modelling was conducted using the US-EPA non-steady state CALPUFF dispersion model. Meteorological model governing the pollutant dispersion was developed using the combination of TAPM and CALMET models with site-representative observations from the BoM Automatic Weather Station (AWS) at Horsley Park, integrated into the CALMET model.

The overall air quality impact assessment was conducted in accordance with the Level 2 impact assessment requirements specified in the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (Approved Methods) published by the NSW-EPA, January 2017.

Emissions from the Upgraded Plant 2 Operations

Emissions from the upgraded Plant 2 operations have been estimated for the following sources:

- Proposed upgraded Plant 2 kiln exhaust stack; and
- Fugitive dust emissions generated from various operational activities at the upgraded Plant 2 site.

With respect to emissions from the upgraded Plant 2 kiln, pollutant emission rates have been estimated based on the kiln supplier provided design concentrations (i.e. maximum in-stack concentrations expected from the upgraded kiln post commissioning) and the corresponding volumetric flow rates. For HF, the emission rates were based on the revised discharge concentration of 20 mg/m^3. It is expected that the actual discharge concentrations from the exhaust kiln stack will not exceed the design concentrations at any given time. Furthermore, the design concentrations provided to Airlabs also comply with the relevant emission limits / concentration standards referenced from the POEO Clean Air Regulation. Stack parameters critical to pollutant dispersion, such as exit velocity, discharge temperature, stack dimensions (height and diameter) have been provided to Airlabs.

Fugitive dust emission rates have been quantified through the application of emission factors listed in the Emission Estimation Technique (EET) manuals. Dust control measures currently implemented by the Plant 2 operations have been taken into account for developing the fugitive dust emissions inventory.

Air Quality Goals

Air quality goals / limits to assess potential impacts from the proposal were referenced from the Approved Methods. As there is no considerable change in the brick manufacturing operations, the pollutants identified in the EPL 546 for Plant 2 operations have been considered to be the pollutants of interest.

As per the Approved Methods, modelled maximum cumulative concentrations have been predicted at the nearest sensitive receptor for all of the assessed pollutants (TSP, PM_{10}, $PM_{2.5}$, HF, SO_2, NO_2 and deposited dust levels), with the exception of SO_3, for which the maximum incremental impacts (i.e. Plant 2 only) have been predicted at or beyond the Plant 2 site boundary.

HF impacts in this revised assessment were also predicted at agricultural receptors that are potentially susceptible to fluoride impacts. The specialised land-use HF impact assessment criteria specified in the Approved Methods was applied exclusively for these agricultural receptors, and the general-land use assessment criteria applied to the other receptors.

Characterisation of Existing Air Quality

Characterisation of the existing air quality levels / background air quality concentrations is essential in determination of cumulative air pollution concentrations. To characterise the existing air quality levels for the cumulative assessment, reference was drawn to the following sources:

- Ambient air quality levels recorded at the Prospect monitoring station operated and managed by NSW-OEH
- Point and fugitive dust emissions generated from the existing Plant 1 operations, which is adjacent to the Plant 2 site.
- Point source emissions from the two (2) kiln stacks at Plant 3 – Point 6 (Swindell) and Point 7 (Ceric).

- Fugitive dust emissions from the existing Horsley Park Waste Management Facility (WMF).

Stack emissions from the existing Plant 1 and Plant 3 operations were obtained from historical stack emission test reports, where in the maximum measured concentration between 2017-2019 was considered for the background air quality characterisation, with the exception of the Point 7 (Ceric) kiln stack. Development Consent has been granted to commission a scrubber on Point 7 (Ceric) kiln stack, which will ensure that the maximum HF discharge concentration will not exceed 45 mg/m^3. Fugitive dust emissions for Plant 1 were estimated using emission factors from EET manuals, an approach similar to estimating fugitive dust emissions from the upgraded Plant 2 operations.

To account for emissions from the Horsley Park WMF, information was obtained from site-specific air quality assessment available on the public domain.

Model Predictions

Modelling shows that all the assessed pollutants comply with the relevant assessment criteria at all the identified sensitive receptors at all times. Furthermore, the incremental contribution of the upgraded Plant 2 operations to the overall cumulative predicted air quality levels is minimal, which is attributed to the improvements proposed by Brickworks.

Greenhouse Gas

Scope 1 and Scope 2 greenhouse gas (GHG) emissions were quantified for fuel (diesel, natural gas) combustion and on-site electricity consumption using emission factors published in the National Greenhouse Account Factors workbook for the 2017-18 period. The Plant 2 facility annual emissions are minimal, where in the contribution to state and national GHG emissions are approximately 0.03% and 0.008% respectively. The proposed upgrades to the Plant 2 kiln would result in a highly efficient plant which would substantially lower the gas used per brick and subsequently lower the corresponding GHG emissions released per brick.

Conclusion

Dispersion modelling shows that the impacts from the upgraded Plant 2 operations would comply with the ambient air quality limits. Furthermore, modelling shows that the improvements proposed by Brickworks ensure contribution from the Plant 2 operations to the overall cumulative air quality will be minimal and not affect sustainability of the local airshed.

1. INTRODUCTION

Airlabs Environmental Pty. Ltd. (Airlabs) was commissioned by Willowtree Planning on behalf of The Austral Brick Co Pty Ltd to undertake an air quality impact assessment for the proposed upgrade to the existing brickmaking plant (known as Plant 2) located at 780 Wallgrove Road, Horsley Park, NSW.

An air quality impact assessment (AQIA) report (Airlabs Ref: AUG18138.2) (hereafter 'the original air quality assessment') supporting the Plant 2 upgrade application was issued to Willowtree Planning on 04 April 2019. The AQIA, which formed a part of the Environmental Impact Statement (EIS) was submitted to the NSW Department of Planning, Industry and Environment (DPIE) for public exhibition which ended on 05 November 2019. Submissions were received by DPIE during the exhibition from the NSW – Environment Protection Authority (EPA) and DPIE with respect to air quality management from the Plant 2 upgrade.

This revised air quality assessment report (NOV19210.1) (hereafter 'revised air quality assessment report') provides a Response to Submissions (RTS) made by the EPA and DPIE with respect to air quality matters relating to the Plant 2 upgrade.

Comments raised by the agencies and the corresponding response prepared by Airlabs to those comments are summarised in Section 2 of this revised air quality assessment report.

A brief overview of the proposed upgrade of the Plant 2 facility is presented below.

Plant 2 currently operates as a face brick plant with an annual output of 80 million bricks per annum. The existing brick kiln and associated equipment were commissioned in the late 1960's but are in a good working condition and could operate for over 20 years, as there haven't been significant changes in the brick manufacturing technology. However, it is understood that the current kiln loses heat and requires large amounts of gas to run and moreover, to further improve the environmental performance with specific regards to air pollutant emissions discharged from the kiln, this upgrade is being planned.

Another key objective of the upgrade is to implement best practices and increase efficiencies associated with the operation. The proposal seeks consent for the upgrade works which will ensure the production of bricks can continue to meet the operational needs of Brickworks.

Proposed upgrade works to the existing Plant 2 facility comprises the following features:

- A new kiln to replace the existing Plant 2 kiln.
- Commissioning of a new scrubber for the Plant 2 kiln to reduce acid gas emissions generated, mainly Hydrogen Fluoride (HF) from the brick manufacturing operations. Comments issued by the EPA upon submission of the original air quality assessment report (AUG18138.2) raised concerns about the efficiency of the proposed scrubber and that the proposed maximum discharge concentration of 45 mg/m^3 for Hydrogen Fluoride (HF) did not necessarily align with best practice measures. This issue has since been addressed in this revised air quality assessment. Additional details of the scrubber performance are provided in **Section 4.1**.
- Developing a new 3,500 m^2 building for additional kiln car storage (fired product) and relocating the existing de-hacker into this area to create easy access for forklifts.
- A 1,600 m^2 building for consolidated additives area and regularisation of building.
- New footings for relocated clay bins and conveyor system.
- Extending existing clay storage building by 1,000 m^2 for additional undercover stockpile area; and
- New footings for existing scrubber.

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 State Significant Development (SSD) pursuant to *Schedule 2 Part 5 of the State Environmental Planning Policy* (State and Regional

Development) 2011, as the proposal has a capital investment value of more than $10 million and forms part of the *Western Sydney Parklands*.

As per Section 78A (8A) of the EP&A Act, a development application for a State Significant Development is to be accompanied by an Environmental Impact Statement (EIS).

The revised air quality assessment has been prepared in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, EPA, 2016 (hereafter 'the Approved Methods'). As per Section 9 of the Approved Methods, 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 **1**, Section **3** and Section **4**
- Description of the activities carried out on the site – Section **3** and Section **4**
- Emissions inventory – Section **10**
- Meteorological data – Section **11**
- Background air quality data – Section **9**
- Dispersion modelling – Section **12**, Section **13**
- Bibliography – Section **16**

As the proposal is an SSD, Secretary Environmental Assessment Requirements (SEARs) have been issued by the NSW Department of Planning & Environment (DOP&E) (SSD 9601, 16 November 2018) for the EIS and the air quality and greenhouse gas assessment. The SEARs issued with respect to air quality and greenhouse gas 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 and Greenhouse Gas

SEARs issued for Air Quality and Greenhouse Gas (SSD: 9601)	Sections of the Assessment Report Addressing the Relevant SEARs
Air Quality	
- a comprehensive air quality impact assessment (AQIA) of all potential point source and fugitive air emissions (including odour) and dust impacts from the development, including details of air quality impacts on private properties in accordance with relevant Environment Protection Authority guidelines;	All sections
- details of mitigation, management and monitoring measures for preventing and / or minimising both point and fugitive emissions; and	Section **4**, Section **10**
- an assessment of the effectiveness of the proposed air quality mitigation measures.	Section **13**
Greenhouse Gas	
- a quantitative assessment of the potential Scope 1 and 2 greenhouse gas emissions of the development, and a qualitative assessment of the potential impacts of these emissions on the environment; and	Section **14**
- a detailed description of the measures that would be implemented on site to ensure that the development is energy efficient.	

2. COMMENTS ISSUED BY AGENCIES

Comments issued by the EPA and DPIE with respect to air quality matters relating to the Plant 2 upgrade and the sections where these comments have been addressed are summarised in **Table 2** and **Table 3** respectively.

Table 2: Comments issued by the EPA – November 2019

Comments issued by the EPA – SSD 9601, 04 November 2019	Sections of the Revised Assessment Report Addressing the Comments
Efficiency of proposed scrubber not demonstrated	
The AQIA states that the proposed improvements of the fluorine cascade scrubber would offer a 45-65 % control efficiency in reducing HF emissions.	Concerns raised by the EPA regarding performance of the cascade scrubber have been addressed jointly by Airlabs and Austral Bricks. A discussion on the revised performance of the cascade scrubber is presented in **Section 4.1.**
The Best Practice HF Mitigations Options report provided by Ramboll prepared for the PRP investigating HF emissions at Austral Bricks Plants 1, 2 and 3 identified that under current international best practice cascade absorbers can achieve 90-99 % HF emission reduction.	
Previous stack testing measurements of HF (attached memo in AQIA) reported a maximum HF concentration of 68 mg/m^3, with an average concentration of 50.6 mg/m^3 (N = 15). Based on the manufacturer design specifications of a maximum HF concentration of 45 mg/m^3, the EPA calculates a maximum efficiency of 34 % and average efficiency of 11 %.	
The EPA expects the proposed scrubber for the Plant 2 kiln to achieve 90-99 % performance efficiency. The EPA advises the efficiencies stated in the AQIA are below expected performance efficiencies. The EPA recommends the expected performance of the proposed fluorine cascade scrubber be designed to meet international best practice (90-99 %).	
The EPA **recommends** the AQIA be revised to benchmark the kiln and scrubber emission design performance and control efficiency with best practice.	
The EPA **recommends** that the scrubber be redesigned to align with best practice and the redesign should be included in the revised AQIA.	
Proposed upgraded Plant 2 emissions below the Protection of the Environment Operations (Clean Air) Regulation 2010 ("Clean Air Regulation") standards of concentration	
The AQIA presents the manufacturer design specifications for concentrations of pollutants emitted from the proposed Plant 2 Kiln upgrade in Table 14. Table 14 indicates that the pollutants Total suspended particles ("TSP"), nitrogen oxide NOx (as NO_2 equivalent) and Flourine (F_2) (as HF equivalent) would be below the Group 6 standard of concentrations for the scheduled activity (ceramic works). The AQIA	Airlabs agree to this comment that emission limits cannot be provided by the EPA until the air quality assessment has been adequately

Comments issued by the EPA – SSD 9601, 04 November 2019	Sections of the Revised Assessment Report Addressing the Comments
states that actual discharge concentrations from the exhaust kiln are not expected to exceed the design specifications.	updated to include demonstrations of the expected scrubber performance efficiency. Details of the scrubber performance efficiency are presented in **Section 4.1** of this revised air quality assessment report.
The EPA advises that the proposed upgrade of the kiln at Plant 2, including the scrubber, indicates compliance with the Clean Air Regulation standards of concentrations.	
However, the EPA **recommends** the emission limits cannot be provided until the AQIA has been adequately updated to include demonstrations of the expected scrubber performance efficiency.	
Offsite hydrogen fluoride (HF) impacts below Impact Assessment Criteria (IAC)	
Predicted incremental impacts (Plant 2 upgrade only) at all identified receptors are below the HF Impact Assessment Criteria (IAC) for generalised land use of 2.9 µg/m³. The maximum incremental 24-hour concentration, predicted at receptor 7 to the immediately east of the site, is 1.48 µg/m³, which constitutes a significant amount (51%) of the 24-hour IAC.	To address this comment, Airlabs have identified a set of agricultural receptors, mainly to the south of the Plant 2 facility and applied the more stringent specialised land-use HF assessment criteria at these receptors. As it is unknown what type of produce is grown at these receptors, it has been assumed that all of these receptors are sensitive to fluoride. Additional details are presented in **Section 7.2**.
The cumulative impacts (assumed to be only sourced from Plant 1 and Plant 2 emissions) are predicted to be below the IAC for generalised land use at all receptors. The maximum cumulative 24-hour concentration, predicted at receptor 8 east of the site is 1.59 µg/m³, which constitutes a significant amount (54.9%) of the 24-hour IAC of 2.9 µg/m³.	
The EPA advises that the HF IAC from the Approved Methods for Modelling and Assessment of Air Pollutants in NSW (Approved Methods) for "general land use" has been used in the AQIA and offsite HF concentrations at all identified receptors are predicted to be below this IAC. However, a more stringent IAC exists for specialised land use, which includes all areas with vegetation sensitive to fluoride. Whilst the AQIA has stated that the surrounding land use is largely grazing/pastoral land, it has not adequately demonstrated that the general land use IAC is appropriate.	
The EPA advises that had the specialised land use IAC been used, it would have been exceeded at two identified receptors (7 and 8) on a 24-hour basis, one identified receptor (1) on a 7-day basis and two identified receptors (1 and 7) on a 90-day basis.	

Comments issued by the EPA – SSD 9601, 04 November 2019	Sections of the Revised Assessment Report Addressing the Comments
The EPA **recommends** the proponent provide a detailed land use and vegetation assessment to evaluate current and potential future land uses and vegetation that may be sensitive to fluoride.	
Dispersion modelling issues	
Plant 3 not modelled	
The cumulative impacts have only included HF emissions from Plants 1 and 2 and not Plant 3.	Contribution from the Plant 3 operations comprising point source emissions from the two (2) kiln stacks – EPA I.D. Point 6 (Swindell) and EPA I.D. Point 7 (Ceric) have been included and presented in the Existing Air Quality section (**Section 9**)
The EPA advises that emissions from Plant 3 should have been included in dispersion modelling and assessment of cumulative impacts offsite.	
The EPA **recommends** the AQIA should be revised to include Plant 3 emissions in dispersion modelling.	
Average emissions rather than maximum emissions from Plant 1	
Average emissions from Plant 1 were included in dispersion modelling and assessment of offsite impacts rather than maximum emissions.	For all the modelled pollutants except HF, maximum measured pollutant emissions from the kiln stack at Plant 1 (EPA I.D. 4) between 2017-2019 have been used in the revised air quality assessment. Austral Bricks is committing to install a scrubber on Plant 1 Kiln by 31st Dec 2020. Hence, HF concentration of 20 µg/m^3 have been applied for the Plant 1 Kiln. Additional details are presented in the Existing Air Quality section (**Section 9**)
The EPA advises that the Approved Methods requires that maximum measured emission rate to be used in the absence of available data to describe emission rate distribution.	
The EPA **recommends** the AQIA should be revised to include maximum emissions from Plant 1 in dispersion modelling.	
Use of CALMET data for long-term assessment of meteorological conditions	
The AQIA has presented the long-term site-representative meteorological data using CALMET model generated data instead of meteorological data collected at a meteorological monitoring station as preferred and outlined in the Approved Methods. The choice of 2017 for dispersion modelling was	EPA's recommendations have been adhered to in this revised air quality assessment and the following methodology has been adopted:

Comments issued by the EPA – SSD 9601, 04 November 2019	**Sections of the Revised Assessment Report Addressing the Comments**
based on CALMET generated data comparison rather than site-representative meteorological data from a monitoring station. The EPA advises that there are significant differences between the observed (BoM) meteorological data and the modelled (CALMET) meteorological data (Figure 13 of the AQIA). The EPA notes that the licence requires weather monitoring onsite, including rainfall, temperature, wind speed and direction, and advises that site-specific meteorological data (if >90 % complete) is preferred above site representative. The EPA advises that the presentation of CALMET generated long-term meteorological data only does not adequately establish that this data describes the expected meteorological conditions at the site. The EPA **recommends** additional information be provided on long-term site-representative meteorological data collected from a monitoring station and a detailed discussion on the prevailing meteorological conditions at the site including an analysis of wind speed and direction, stability class, ambient temperature and mixing height. The EPA **recommends** an adequate justification of the use of 2017 for dispersion modelling compared to the long-term site-representative meteorological data collected from a monitoring station be provided.	• Airlabs have been informed by Austral Bricks that quality assurance / quality control checks have not been conducted at the on-site monitoring station and cannot confirm if the data is error free. • Therefore, for the revised assessment, site-representative meteorological data was obtained from the BoM Automatic Weather Station at Horsley Park, NSW. • As per the comments provided by the EPA and as per the Approved Methods, at least one (1) year of site-representative data (i.e. BoM AWS data at Horsley Park) has been used and corelated against a longer-duration dataset of at least five (5) years to be considered acceptable. • Selected year has been used in the dispersion modelling to characterise the meteorology at the site. • Details of the meteorological model selection year is presented in **Appendix B.**
Building wake effects	
Section 11 of the AQIA states building wake effects on plume dispersion have been included in the modelling for the Plant 2 kiln stack. The EPA advises that it is unclear in the AQIA if building wake effects have been included for emissions from Plant 1.	Airlabs can confirm that existing Plant 1 kiln stack, the two (2) kiln stacks at Plant 3 -Point 6 (Swindell) and Point 7 (Ceric) and the upgraded Plant 2 kiln stack are all wake-affected sources. The Building Profile Input Program (BPIP) –

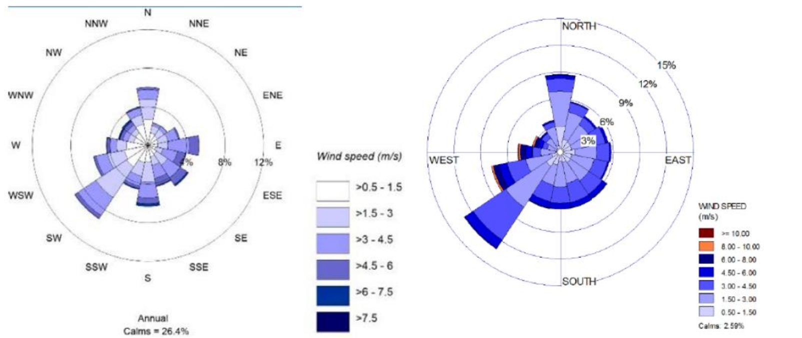
<table>
<tr><th>Comments issued by the EPA – SSD 9601, 04 November 2019</th><th>Sections of the Revised Assessment Report Addressing the Comments</th></tr>
<tr><td>The EPA recommends the AQIA clarify if building wake effects for Plant 1 have been included in dispersion modelling and justify whether Plant 1 kiln is a wake-affected or wake-free point source.</td><td>PRIME algorithm has been used to model building wake effects for all the wake-affected sources.</td></tr>
<tr><td colspan="2">Inconsistencies with previous modelling meteorology</td></tr>
<tr><td>The EPA notes that the 2018 AQIA (Pacific Environment, section 4.3) shows different wind fields and a much higher % of calms than the AQIA report modelling the proposed Plant 2 upgrade (see Figure below).


Figure: 2018 Pacific Environment meteorological data (Left) and 2019 Airlabs Environmental meteorological data (Right).</td><td rowspan="4">Airlabs would like to inform the EPA that technical inaccuracies were identified in the CALMET model developed in the original air quality assessment report (AUG18138.2). The inaccuracies related to the percentage of calms predicted by CALMET. This has since been addressed in the revised meteorological model developed by Airlabs and a detailed discussion on the validity of meteorological model output has been presented.

Additional information on long-term site-representative meteorological data collected from the BoM AWS at Horsley Park has been presented in Appendix B.</td></tr>
<tr><td>The EPA advises that the significant inconsistencies of meteorological data by the same proponent is questionable and that the significant difference in the percentages of calm would influence the dispersion of emissions, potentially changing the results and conclusions of the assessment.</td></tr>
<tr><td>The EPA recommends that a revised AQIA be prepared that demonstrates the meteorological data used for dispersion modelling adequately describes the expected meteorological patterns at the site.</td></tr>
<tr><td>The EPA recommends that additional information be provided on long-term site-representative meteorological data collected from one or more monitoring stations and a detailed discussion on the prevailing meteorological conditions at the site include an analysis of wind speed and direction, stability</td></tr>
</table>

Comments issued by the EPA – SSD 9601, 04 November 2019	Sections of the Revised Assessment Report Addressing the Comments
class, ambient temperature and mixing height, to demonstrate that the meteorological data produced by the model is appropriate for use in dispersion modelling.	
The EPA calculations are outlined below. However, the EPA advises that these issues should not influence the emissions from the kiln and the proposed kiln upgrade and scrubber installation.	
Significant issues with fugitive emissions calculations	
The EPA advises that the offsite impacts from particulates (TSP, PM_{10} and $PM_{2.5}$) cannot be assessed from the AQIA due to numerous issues in the emissions inventories for Plants 1 and 2. These issues are itemised below:	
Not enough information to evaluate emissions inventory.	
Table 12 provides the estimated fugitive emissions at Plant 1 however not enough information is provided to recalculate these emissions values. Missing information includes control factors applied, load weight of haul trucks, weight of trucks, distance travelled, silt content and moisture content.	Additional information – including all variables and equations needed to calculate fugitive dust emissions from Plants 1, 2 and 3 have been provided in **Appendix A.**
Table 16 provides the estimated fugitive emissions at Plant 2, however as for Plant 1, insufficient information is provided to recreate the emissions from the various activities included in the emissions inventory.	
The EPA **recommends** that all information and variables needed to calculate the emissions from all activities in Tables 12 and 16 should be provided.	
Incorrect total emissions calculated	
In Table 12, the sum of emissions from all sources listed equals 16,225 kg/yr for TSP, however Table 12 provides a total of 3,649 kg/yr. As the AQIA has not provided sufficient information to assess the particulate fugitive emissions, it is unclear which total is correct and what emission rates have been used in the dispersion modelling to assess offsite impacts.	Airlabs would like to inform EPA that typographical errors have been identified in **Table 14** of the original air quality assessment report (AUG18138.2). Due to the typographical errors, the sum total of all the fugitive dust sources for Plant 1 does not match the corresponding reported total emissions.
The EPA **recommends** a correct emissions inventory be provided and that if total emissions has been significantly underestimated, a revised AQIA with more realistic dispersion modelling be provided.	

<table>
<tr><th>Comments issued by the EPA – SSD 9601, 04 November 2019</th><th>Sections of the Revised Assessment Report Addressing the Comments</th></tr>
<tr><td></td><td>Airlabs would also like to inform the EPA that the typographical error was limited to the report only (and not model files) and has no implications on the model predictions.

Additional information – including all variables and equations needed to calculate the emissions has been provided in Appendix A.</td></tr>
<tr><td colspan="2">Inconsistent emissions from same activity between Plant 1 and Plant 2</td></tr>
<tr><td>Plant 1 has a total emission of TSP of 16,225 kg/yr (calculated from the sum of individual activities, see above issue) from a production of 65 million bricks, while Plant 2 has a total emission of TSP of 7,882.7 kg/yr from a production of 80 million bricks. Given the increased production and quantity at Plant 2, it is incongruous that the fugitive emissions from Plant 1 are higher.</td><td rowspan="5">Airlabs inform EPA that typographical errors have been identified in Table 14 and Table 20 of the original air quality assessment report (AUG18138.2), which incorrectly shows that the sum of TSP emissions from all fugitive sources for Plant 1 (Table 14) are considerably higher than the corresponding emissions for Plant 2 (Table 20), even though the production rate for Plant 1 being less than Plant 2. This typographical error has been since corrected in the revised air quality assessment.

Airlabs would also like to inform the EPA that the typographical error was limited to the report only (and not model files) and has no implications on the model predictions.

Additional information – including all variables and equations needed to calculate the emissions has been provided in Appendix A.</td></tr>
<tr><td>Additionally, individual activity emissions between the two plants are vastly different. For example, Plant 1 haulage emissions are 13,435 kg/yr (TSP) while Plant 2 haulage emissions are 29.8 kg/yr (TSP).</td></tr>
<tr><td>The EPA advises that no evaluation of the impacts from particulates has been conducted based on the multiple issues outlined above.</td></tr>
<tr><td>The EPA recommends the emissions inventories for Plants 1 and 2 be corrected and all information and variables used to calculate the emissions be provided.</td></tr>
<tr><td>The EPA recommends a revised AQIA should include dispersion modelling and particulate (TSP, PM_{10} and $PM_{2.5}$) impact assessments using the correct fugitive emissions inventories.</td></tr>
</table>

Comments issued by the EPA – SSD 9601, 04 November 2019	Sections of the Revised Assessment Report Addressing the Comments
Additional issues noted	
AQIA states there are no standards specific to brick manufacturing. The EPA advises that the standards for ceramic works in Schedule 3 of the POEO Clean Air Regulation apply as the facility is licensed under the scheduled activity of ceramic works (and others).	The revised air quality assessment references the standards for ceramic works in Schedule 3 of the POEO Clean Air Regulation. For SO_2, the design concentrations from the Plant 2 upgrade would be compared against the corresponding limits set in the licence. Please refer to **Table 18** for additional details.
Table 14 in the AQIA references the *POEO Clean Air Regulations* standards of concentrations to evaluate the proposed emissions of SO_2 and sulfuric acid mist for the proposed Plant 2 upgrade. However, the licence sets a lower concentration limit at Point 5 for SO_2 of 400 mg/m3 which should be used for the evaluation of SO_2 emissions for the proposal.	
As the AQIA demonstrates that this EPL concentration can be met however, the use of the incorrect standard is a minor issue.	

Table 3: Comments issued by the DPIE – November 2019

Comments issued by the DPIE – SSD 9601, 15 November 2019	Sections of the Revised Assessment Report Addressing the Comments
Attachment 1 – Department Comments	
The Department notes the purpose of the proposed development is to improve the environmental performance of the facility with respect to heat loss and gas usage. The Department requests the RTS identify the type of gas used as a fuel and where the gas is sourced. Furthermore, the EIS states the kiln upgrade will reduce gas energy used per brick unit by 30% and Greenhouse Gas (GG) emissions by approximately 40%. The RTS should quantify the current amount of gas energy consumed and GG emissions along with the anticipated gas consumption and GG emissions of the upgraded Plant 2 facility	This comment has been addressed in **Section 14.3** of this revised assessment report.

3. FACILITY OVERVIEW

3.1 Facility Location

The Plant 2 upgrade site (subject site) is identified as 780 Wallgrove Road, Horsley Park, NSW (Lot 7 in Deposited Plan 1059698). The entire site is 82 hectares (ha) in area and is considered to be the main brick manufacturing site for the Austral Brick Company.

The subject site comprises two significant existing brick manufacturing facilities (Plant 1 and Plant 2), including existing stockpiles of clay used in the brick manufacturing operations. The subject site is largely cleared of vegetation as the land has been historically used for quarrying and brick manufacturing operations.

The Horsley Park Waste Management Facility (the Horsley Park WMF), is located immediately to the south of Plant 1 and to the west of Plant 2. As per information sourced from the public domain, the Horsley Park WMF is licensed to receive up to 430,000 tonnes per annum (tpa) of non-putrescible waste. The facility accepts waste directly from commercial entities and from council customers and comprises a large open area with void space for landfilling and resource recovery. The overall facility covers 43 ha, which includes the weighbridge, a designated area of 2 ha for storage of recovered material such as concrete, soils, timber and steel and land that is still to be excavated to create landfill space.

Adjoining to the west of the Plant 1 site is the M7 Motorway, which links the M2, M4 and M5 motorways. Surrounding development predominantly to the north and north-east of the Plant 2 site comprises industrial facilities used for warehousing and distribution purposes and other extractive industries.

An aerial overview of the subject site showing Plant 2 along with Plant 1 and the Horsley Park WMF are illustrated in **Figure 1**.

3.2 Licensing Details

Existing brick manufacturing operations at Plant 1 and Plant 2 are managed under the Environmental Protection Licence (EPL) No: 546, which also includes Plant 3 operations, located on Old Wallgrove Road, Horsley Park. The three (3) brick manufacturing operations, are collectively referred to as 'Austral Brick, Plants 1, 2 & 3' in the EPL. A spatial overview of Plant 1, 2 and 3 operations is shown in **Figure 2**.

According to EPL No: 546, the licence for Plants 1, 2 & 3 permits for:

- Annual ceramic production of >200,000 tonnes.
- > 5- 100 tonnes of annual volume of waste generated or stored
- Crushing, grinding or separating of >500,000 – 2, 000, 000 tonnes on an annual basis.
- Land-based extractive activity (extract, process or store) >500,000 – 2, 000, 000 tonnes on an annual basis.
- Mining for minerals - >500,000 – 2, 000, 000 tonnes on an annual basis.

The EPL provides information on the monitoring points across Plant 1, 2 and 3 to measure air emissions generated from the brick manufacturing process, including the pollutants that are to be monitored and their monitoring frequencies, details of which are summarised in **Table 4**.

Table 4: Air Monitoring Details – EPL 546 (Plant 1, 2 and 3)

Parameter	Plant 1	Plant 2	Plant 3
Number of monitoring points	1	1	2
EPA identification	Point 4	Point 5	Point 6 (Swindell), Point 7 (Ceric)
Pollutants to be monitored	Cadmium, Fluorine, Hydrogen chloride, Hydrogen fluoride, Hydrogen sulfide, Mercury, Nitrogen oxides, Oxygen, Solid particles, Sulfuric acid mist and sulfur trioxide, Sulfur dioxide, Type 1 and 2 substances, Volatile organic compounds	Hydrogen fluoride, Nitrogen oxides, Total solid particulates	Cadmium, Dioxins and furans, Fluorine, Hydrogen chloride, Hydrogen fluoride, Hydrogen sulfide, Mercury, Nitrogen oxides, Oxygen, Sulfuric acid mist and sulfur trioxide, Sulfur dioxide, Total solid particulates, Type 1 and 2 substances, Volatile organic compounds
Monitoring frequency	Quarterly – all pollutants except Hydrogen fluoride, Nitrogen oxides, Total solid particulates which are to be monitored yearly	Yearly	Quarterly – all pollutants except Hydrogen fluoride, Nitrogen oxides, Total solid particulates which are to be monitored yearly

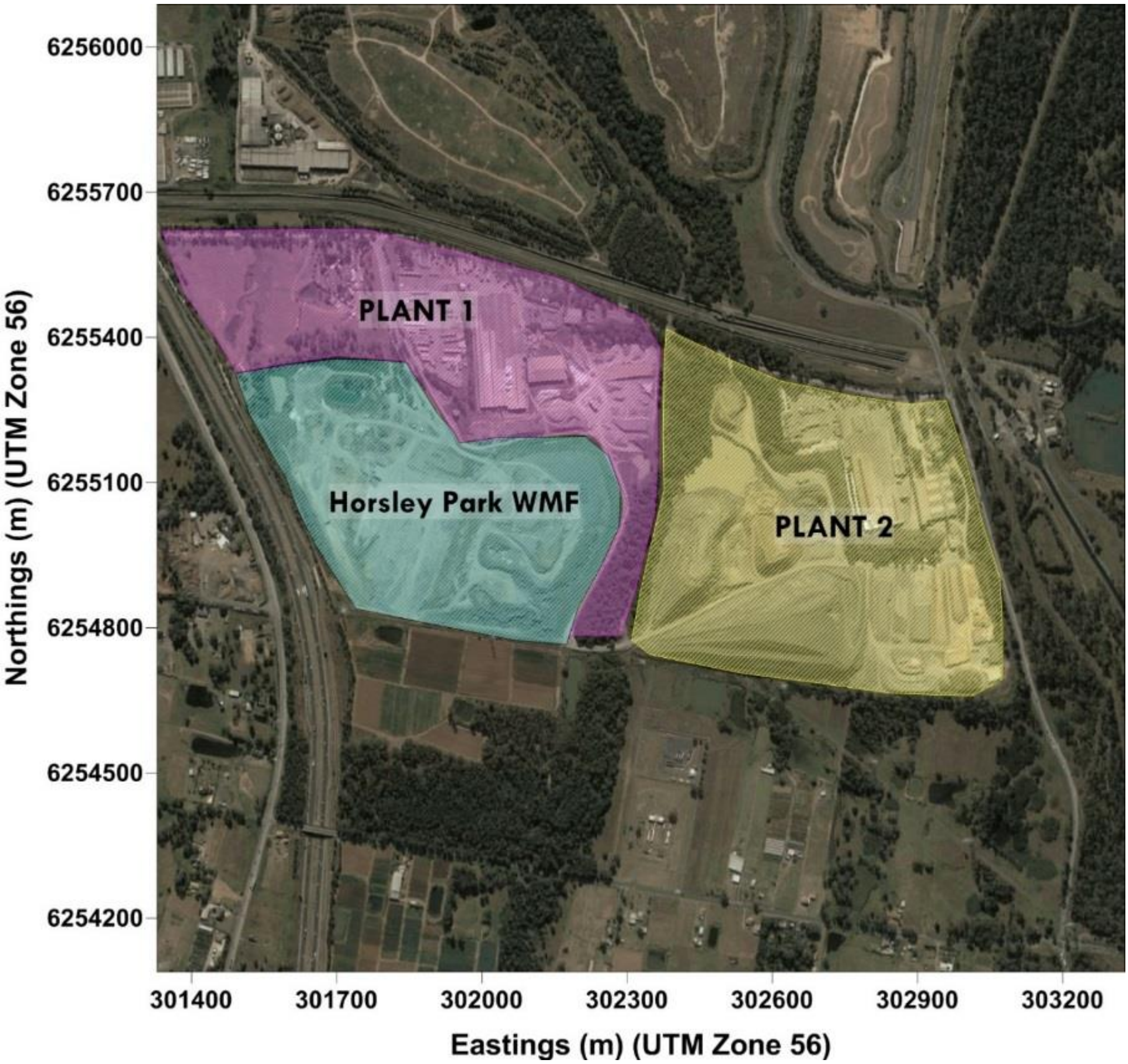
Section L3 of the EPL 546 provides the in-stack concentration limit for pollutants released from the Point 5 Stack for Kiln Number 5 at Plant 2. The concentration limits are specified in **Table 5.**

It is noted that concentration limits have been provided for sulfuric acid mist and sulfur trioxide; and sulfur dioxide, though these pollutants are not required to be monitored as shown in **Table 4.**

Table 5: In-Stack Concentration Limits for Point 5 in EPL 546 (Plant 2)

Pollutant	Units of Measure	100th percentile Concentration Limit	Reference Conditions	Averaging Period
Hydrogen fluoride	mg/m^3	50	Dry, 273 K, 101.3 kPa	1-hour or minimum duration in the test method
Total solid particles	mg/m^3	100	Dry, 273 K, 101.3 kPa	1-hour or minimum duration in the test method
Nitrogen oxides	mg/m^3	2,000	Dry, 273 K, 101.3 kPa	1-hour or minimum duration in the test method
Sulfuric acid mist and sulfur trioxide (as SO_3)	mg/m^3	100	Dry, 273 K, 101.3 kPa	1-hour or minimum duration in the test method
Sulfur dioxide (SO_2)	mg/m^3	400	Dry, 273 K, 101.3 kPa	1-hour or minimum duration in the test method

Figure 1: Aerial Overview of Plant 2 and Surrounds



4. PROPOSAL DETAILS

Austral Bricks are proposing to carry out upgrade works to the existing brick manufacturing operations at the Plant 2 site, to achieve optimal efficiency outcomes in line with best practice measures and to increase efficiencies associated with the operations. The upgrade is also being planned to improve fuel consumption and environmental performance, specifically in relation to air pollutant emissions discharged to the atmosphere from the Plant 2 kiln stack (EPA I.D. 5).

The purpose of the upgrade is not to change the operations, or the brick production capacity but to address the key issues identified above. As-such, it is noted that post upgrade, the annual output for Plant 2 will remain unchanged at 80 million bricks per annum, and so are the operational hours, with the upgraded kiln operating 24 hours, 365 days of the year.

As per the scoping report prepared by Willowtree Planning (Willowtree Planning, 2018), the following objectives have been identified as forming the basis of the proposed Plant 2 upgrade works:

- Design the site to achieve a viable economic return.
- Ensure minimal environmental and amenity impact.

- Ensure ongoing compliance with all operational legislative requirements.
- Provide for an employment-generating land use; and
- Ensure development is compatible with surrounding development and the local and regional context.

Specific aspects of the upgrade planned for the Plant 2 kiln comprise the following:

- A new kiln to replace the existing Plant 2 kiln. Annual capacity remains unchanged at 80 million bricks per annum.
- Implementation of end-of-pipe solutions (treating kiln gas stream prior to release to atmosphere), comprising a dry lime fluorine cascade scrubber to reduce Hydrogen fluoride (HF) concentrations – a key pollutant released from the brick manufacturing operations. The rationale for choosing cascade scrubber and its effectiveness in reducing HF concentrations are discussed in detail in the following section.
- New production building of around 13,250 m^2 to provide extended kiln car storage area and relocated extruder and dehacker.
- Re-roofing of the existing production building.
- New footings for relocated clay bins and for the scrubber.
- Construction of new fire access road.
- Provision of onsite detention basin.
- Supporting ancillary works; and
- Minor demolition works to facilitate the same.

The overall objective of the upgrade is to improve the environmental, health and safety and sustainability performance of the existing brickworks operation.

A site plan of the proposed upgrade as provided to Airlabs is shown in **Figure 2**.

4.1 Proposed Improvements Specific to Air Quality

One of the main purposes of upgrading the Plant 2 kiln is to improve the emissions discharged to the atmosphere from the kiln. Airlabs have undertaken air quality assessments and stack emissions monitoring historically for Austral Bricks and are cognisant of the concerns raised by the EPA regarding emissions generated from the Plant 2 kiln, especially Hydrogen fluoride (HF) concentrations, which is a key pollutant released from brick manufacturing facilities. Other pollutants, over the years, have largely remained in compliance with the corresponding limits imposed in EPL 546.

Therefore, this upgrade aims to improve the level of emissions released to the atmosphere, especially Hydrogen fluoride, and in order to achieve this, a range of improvements / mitigation measures have been proposed by Brickworks, which are discussed below:

- **New Kiln**: The two (2) existing kilns for Plant 2 will be replaced by a new kiln, which would improve fuel consumption and the emissions profile.
- **Scrubber to minimise acid gas emissions**: The upgraded Plant 2 kiln would comprise a dry lime fluorine cascade scrubber, which is aimed at reducing acid gas emissions, mainly HF. An overview on the rationale for selecting a cascade scrubber and its expected effectiveness in reducing HF concentrations is provided below:
    - Exceedances of HF limits at EPA I.D. 5 (Plant 2) and Point 7 (Ceric – Plant 3) have been reported to the EPA in the 2015-16 annual returns. Subsequently, a Pollution Reduction

program (PRP) was initiated, which required an investigation into the emissions of fluorine (including HF) and exploration of options to reduce HF concentrations.

  - To this extent, two (2) specialist studies were undertaken – *an assessment of ground-level concentrations of HF resulting from Plant 1, 2 and 3 kiln emissions determined through air dispersion modelling* (Pacific Environment Limited, May 2018) and a report *summarising range of best practice HF mitigation measures* (Ramboll, May 2018).
  - The report prepared by Ramboll recommended investing in HF end-of-pipe emission mitigation measures for new kilns, replacements or plants with significant plant life remaining (>10 years). The report specifically suggested dry scrubbing using lime mixture as an adsorbent agent to be in-line with best practice HF emission end-of-pipe solution.
  - As-such, a fluorine cascade absorber was chosen by Austral Bricks as the end-of-pipe HF mitigation measure for the upgraded Plant 2 kiln. The absorption material comprised limestone ($CaCO_3$) chippings.

- Workings of the proposed cascade scrubber system is presented below:
  - The absorption material – limestone chippings would be located in a silo on top of the absorber.
  - The absorption material then trickles vertically out of the storage silo past the horizontally aligned cascades in the reaction chamber.
  - In doing so, the pollutants flow through the absorption materials and react with the limestone chippings. The saturated limestone chippings are collected in the unit hopper and removed continuously or intermittently with a screw conveyor.
  - The reacted surface of the limestone chippings is abraded in the rotating screen drum / peeling drum. The limestone chippings which now can be reused again, are then transported back to the storage silo via a pneumatic transport system.
  - A simplified schematic of a typical cascade scrubber is shown in **Figure 3**.

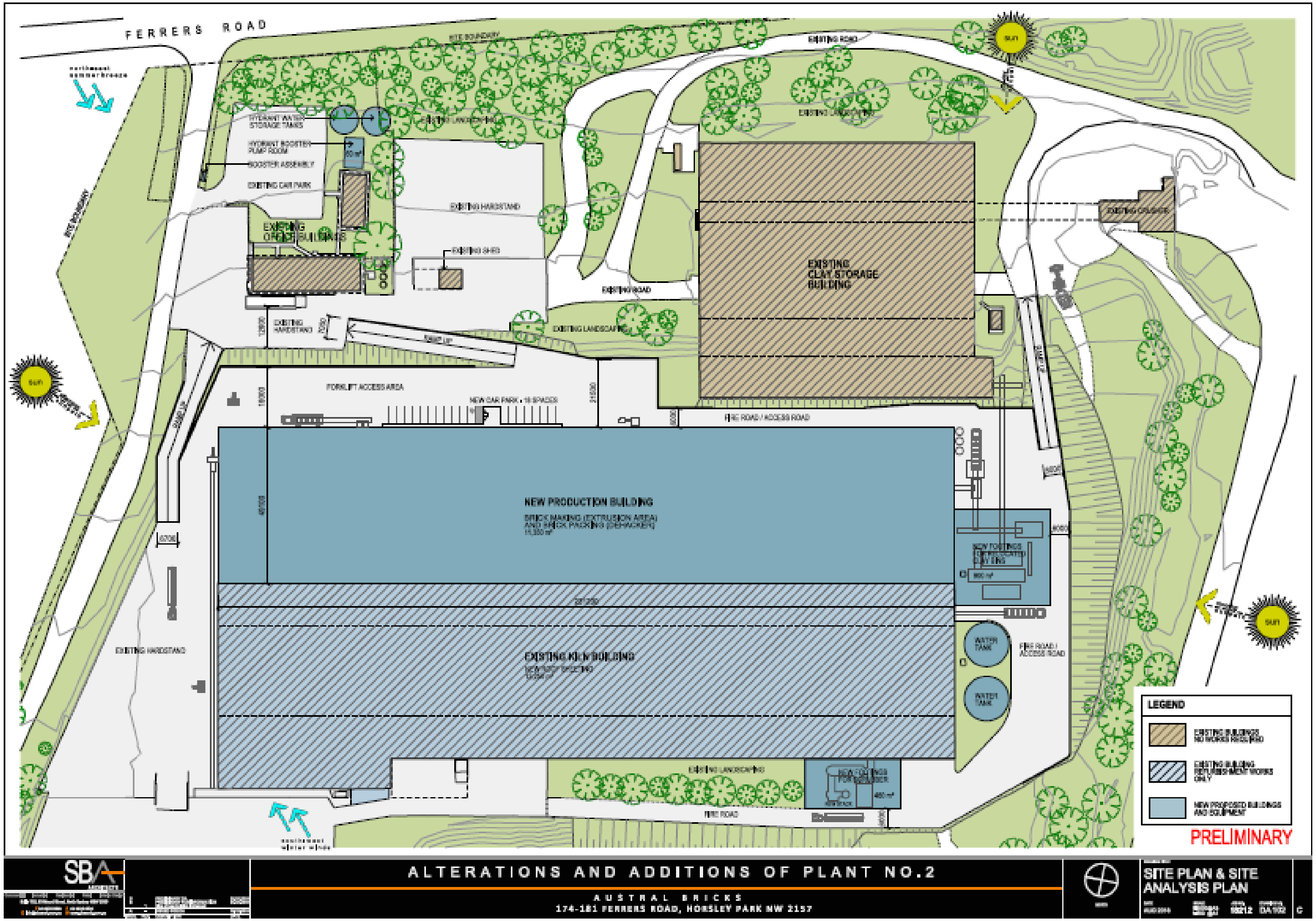
- A brief commentary about the expected HF emission reduction efficiency of the cascade scrubber is presented below:
  - Assessment of HF impacts from the upgraded Plant 2 kiln stack in the original air quality assessment report (AUG18138.2) was based on a maximum discharge concentration of 45 mg/m^3.
  - The EPA in their comments note that the Ramboll HF Mitigation Options review identified that between 90-99% HF emission reduction can be achieved through the use of cascade-type bed adsorber / dry scrubber using limestone ($CaCO_3$) and that the use of 45 mg/m^3 in the original air quality assessment (AUG18138.2) was below expected performance of the cascade scrubber. The EPA recommended the expected performance of the cascade scrubber be designed to meet international best practice (90-99%) and that the expected emissions from the redesigned scrubber be included in the revised AQIA.
  - To that effect, Austral Bricks undertook an investigation to further improve the HF removal efficiency of the cascade scrubber and informed Airlabs that the improved cascade scrubber would now be able to contain the maximum HF discharge concentration to 20 mg/m^3 as opposed to the initially assessed 45 mg/m^3. Moreover, upon comparison with the concentration limits (refer **Table 5**), the revised discharge concentration of 20 mg/m^3 from the scrubber would be 60% lower than the current licence limit of 50 mg/m^3.
  - Austral Bricks have expressed their reservation with regards to specifying a definitive HF reduction efficiency owing to the uncertainties associated with the raw gas

concentrations, and therefore, are willing to commit to limit the HF discharge concentrations from the upgraded Plant 2 kiln stack to a maximum of 20 mg/m^3.

- Airlabs concur with the reservations expressed by Austral Bricks about emphasising on reduction efficiencies. As an example, historical stack monitoring data shows that HF concentrations measured at Plant 2 site (prior to the upgrade) ranged from 45 mg/m^3 up to 120 mg/m^3. When these concentrations are compared to the proposed discharge concentration of 20 mg/m^3, the reduction efficiencies range from 55% - 83%. It is acknowledged that these reduction efficiencies are not in the range that is expected with cascade scrubbers as noted in the Ramboll HF Mitigation Options review.
- However, Airlabs would like to draw reference to Austral Bricks' Wollert plant at Wollert, VIC. As per information provided to Airlabs and as noted from the Ramboll report, HF emissions at the Wollert kiln are controlled through a dry cascade scrubber, which limits the maximum HF discharge concentration to a maximum of 20 mg/m^3, which is similar to the proposed discharge concentration for the upgraded Plant 2 cascade scrubber.
- The effectiveness of the cascade scrubber at the Wollert kiln was tested in December 2015 and Airlabs were provided a copy of the report (Ektimo, 2015).
- From the test report, it is evident that the inlet HF concentration at the Wollert East kiln was 220 mg/m^3 and the corresponding concentration at the exit was 18 mg/m^3, which shows a 92% reduction efficiency for the cascade scrubber. Nonetheless, the exit concentration of 18 mg/m^3 is comparable to the corresponding concentration of 20 mg/m^3 for the upgraded Plant 2 cascade scrubber.
- This demonstrates that the HF reduction efficiencies are majorly dependent on the concentration of fluorine in raw materials and the process.
- Most of Austral Bricks' plants that have end-of-pipe HF abatement technologies, have a maximum discharge concentration of 20 mg/m^3, which include facilities at Golden Grove in South Australia and facilities in Bellevue, Cardup and Malaga, all of which are located in WA. As the upgraded Plant 2 would also have similar discharge concentrations, it is considered to be in-line with best practice measures implemented by Austral Bricks.
- Furthermore, Airlabs and Austral Bricks opine that to achieve compliance with licence limits 100% of the time, it is important that limits are set at a reasonable level which can be achieved at all times, notwithstanding the variability associated with the raw materials and process.
- Therefore, drawing reference from the above discussion, the assessment of HF impacts from the upgraded Plant 2 kiln stack in this revised air quality assessment is based on the revised maximum discharge concentration of 20 mg/m^3.

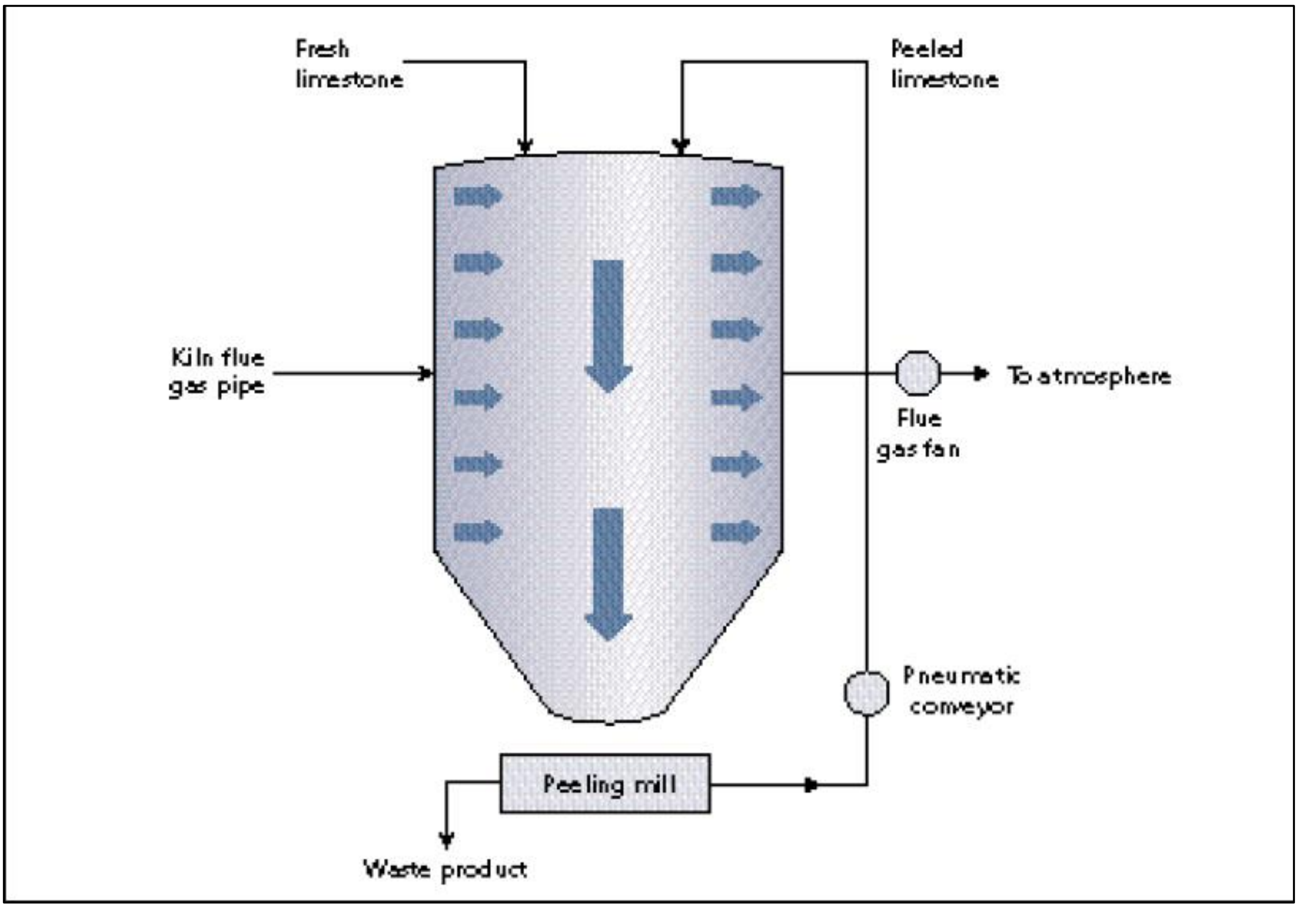
- **Increase in stack height**: In addition to commissioning a cascade scrubber, Austral Bricks are also proposing to increase the stack height of the existing Plant 2 kiln (i.e. Point No: 5) from 16m to 35m. Increasing the stack height would facilitate better dispersion of pollutants and minimise building wake effects that can potentially disrupt / impact the plume dispersion.

Figure 2: Overall Site Plan of the Proposed Plant 2 Upgrade



Source: Willowtree Planning, March 2019

Figure 3: Typical Schematic of a Fluorine Cascade Scrubber



Source: ETBPP (1999)

5. ASSESSMENT OBJECTIVE

This objective of this revised air quality impact assessment is to address the comments raised by the EPA and DPIE, which have been itemised in **Table 2** and **Table 3** respectively.

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: 9601, issued 16 November 2018)
- 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)
- National Greenhouse Accounts Factors – Australian National Greenhouse Accounts – 2018, Department of the Environment and Energy, July 2018

6. ASSESSMENT STRUCTURE

A Level 2 impact assessment has been conducted to quantify operational impacts from the proposed Plant 2 upgrade works. As per the Approved Methods, a Level 2 assessment is a refined dispersion modelling technique using site-specific input data.

For cumulative impact determination, the assessment has also quantified impacts from the existing Plant 1 operations adjoining the Plant 2 facility and the Horsley Park WMF, whose proximity to the Plant 2 can be observed in **Figure 1**.

EPA in their comments (**Table 2**) about dispersion modelling issues note that impacts from Plant 3 have not been accounted for in the original air quality assessment (AUG18138.2). Plant 3, which is located approximately 3km west of the subject site (Plant 2) has two kiln stacks – Point 6 (Swindell) and Point 7 (Ceric) and forms an integral part of the EPL 546.

Point source emissions – i.e. kiln stack emissions from Point 6 and Point 7 have been now included in the revised air quality assessment. Fugitive dust emissions from existing operations at Plant 3 have been excluded as there is considerable separation distance between the source (i.e. Plant 3) and the receiving environment, and therefore, the likelihood of fugitive dust emissions generated from Plant 3 operations having a discernible impact on the sensitive receptors considered for this assessment is very low.

In summation – for pollutants released from the kiln, contribution from Plant 1kiln stack (Point 4) and Plant 3 kiln stacks (Point 6 and Point 7) have been included for determination of cumulative concentrations in addition to corresponding ambient concentrations recorded at the at the nearest / representative ambient air quality monitoring stations. Whereas, for determination of cumulative impacts from fugitive dust sources, emissions from the adjoining Plant 1 operations and the Horsley Park WMF in addition to corresponding ambient concentrations measured at the monitoring station have been considered.

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

- A detailed review of the planned upgrades for Plant 2 was undertaken through consultation with Brickworks.
- Key pollutants of concern were identified based on the EPL and the planned upgrades.
- 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 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.
- Estimating pollutant emission rates from the upgraded kiln and associated operations.
- Modelling the estimated pollutant emission rates from the proposal and predicting incremental impacts at the identified sensitive receptors / outside the facility site boundary depending on the requirements prescribed in the Approved Methods.
- To predict cumulative pollutant concentrations where required, the following sources were taken into consideration:
    - Ambient air quality levels recorded at the nearest / representative National Environment Protection (Ambient Air Quality) Measure (Ambient Air Quality NEPM) monitoring station managed by the Office of Environment & Heritage (OEH) air monitoring network.
    - Point source and fugitive dust emissions from the existing Austral Bricks Plant 1 facility.
    - Point source emissions from the kiln stacks at existing Austral Bricks Plant 3 facility.
    - Fugitive dust emissions from the existing Horsley Park WMF.
- Predicted incremental (upgraded Plant 2) and cumulative (sum total of impacts from the Plant 2 upgrade + background levels from OEH monitoring station + impacts from Plant 1 and Plant 3 + impacts from Horsley Park WMF) pollutant concentrations were compared against the relevant assessment criteria to determine compliance.
- For estimating cumulative particulate (PM_{10} and $PM_{2.5}$) concentrations, a Level 2 contemporaneous assessment was undertaken in accordance with the Approved Methods. Daily measured background levels recorded at the ambient air quality monitoring station were paired with the corresponding model predicted impacts for the proposed upgrade along with impacts predicted from the existing Plant 1 and Plant 3 operations and the Horsley Park WMF at each of the identified sensitive receptors.
- Presentation of modelled pollutant concentrations in the form of tables and concentration isopleths.
- Preparation of assessment report.

7. STUDY AREA AND SURROUNDS

7.1 Existing Land Use and Topography

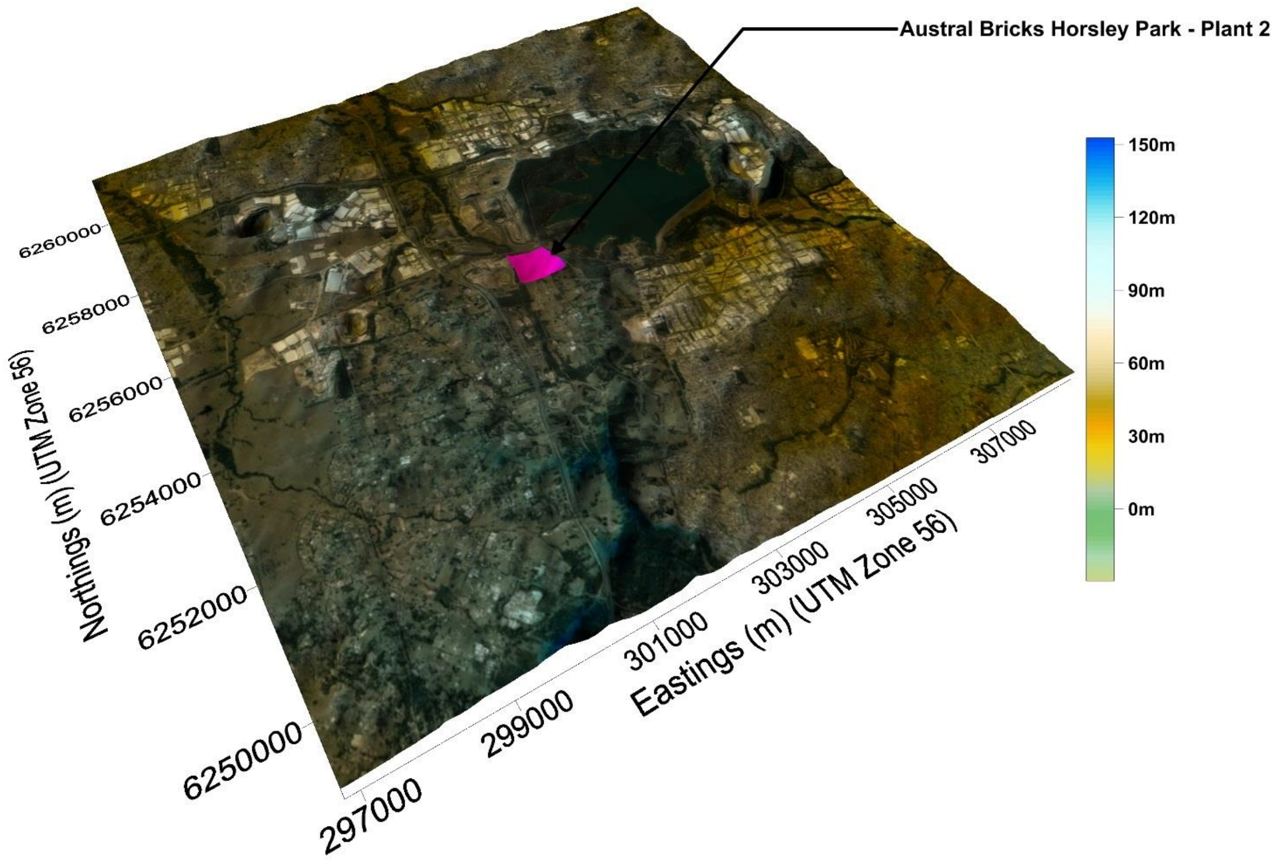
The subject site is located within the Fairfield City Council Local Government Area (LGA) and forms part of the Western Sydney Parklands (WSP), which is a 27km urban park corridor running north from Quakers Hill, south to Leppington accounting for approximately 5,280 hectares of land and as per the WSP *Plan of Management 2030*, the site is clearly delineated as 'Austral Bricks'.

Land-use surrounding the facility is predominantly rural-residential along with grazing / pastoral lands, predominantly to the south of the subject site. Existing residential development in the immediate surrounds is quite spread out and scattered, which is typically indicative of low-medium density rural residential developments.

The Prospect Reservoir and its associated infrastructure is to the immediate east of the facility, whereas the existing Plant 1 operations and the Horsley Park WMF (refer **Figure 1**) are to the immediate west. Plant 3 is to the further east (approximately 2 km) and is separated by the M7 Motorway.

The local topography surrounding the facility is largely undulating with elevations typically ranging from 60m – 90m at the facility and the immediate surrounding areas. Elevations gradually increase towards the south, south-west of the facility, as observed from the 3-dimenstional representation of the topographical features presented over a 12km x 12km domain, as shown in **Figure 4**.

Figure 4: Topographical Features Surrounding the Plant 2 Facility



7.2 Sensitive Receptors

To predict air quality impacts from the upgraded Plant 2 facility, a set of sensitive receptors closest to the facility have been identified. Model predicted incremental (impacts from Plant 2 alone) and cumulative impacts have been determined at each of the identified sensitive receptors and compared against the assessment criteria to assess compliance.

To assess compliance for HF emissions released form the kiln stack, model predicted cumulative concentrations at the nearest sensitive receptor are compared against the assessment criteria provided in the Approved Methods. Specifically, for HF, the Approved Methods have two (2) sets of assessment criteria – one for general land use and another for specialised land-use, which includes all area with vegetation sensitive to fluoride impacts.

The EPA in their comments note that the HF impacts predicted at all of the identified sensitive receptors in the original air quality assessment report (AUG18138.2) were compared against the general land-use criteria and not the specialised land-use criteria.

To address this comment, Airlabs have identified a set of agricultural receptors (including pastoral / grazing land), mainly to the south of the Plant 2 facility and applied the specialised land-use criteria exclusively for these receptors. As it is unknown what type of produce is grown at these receptors, it has been assumed that all of these receptors are sensitive to fluoride and therefore, the more stringent specialised land-use impact assessment criteria have been applied at these receptors.

For the remaining receptors, the general land-use criteria have been adopted.

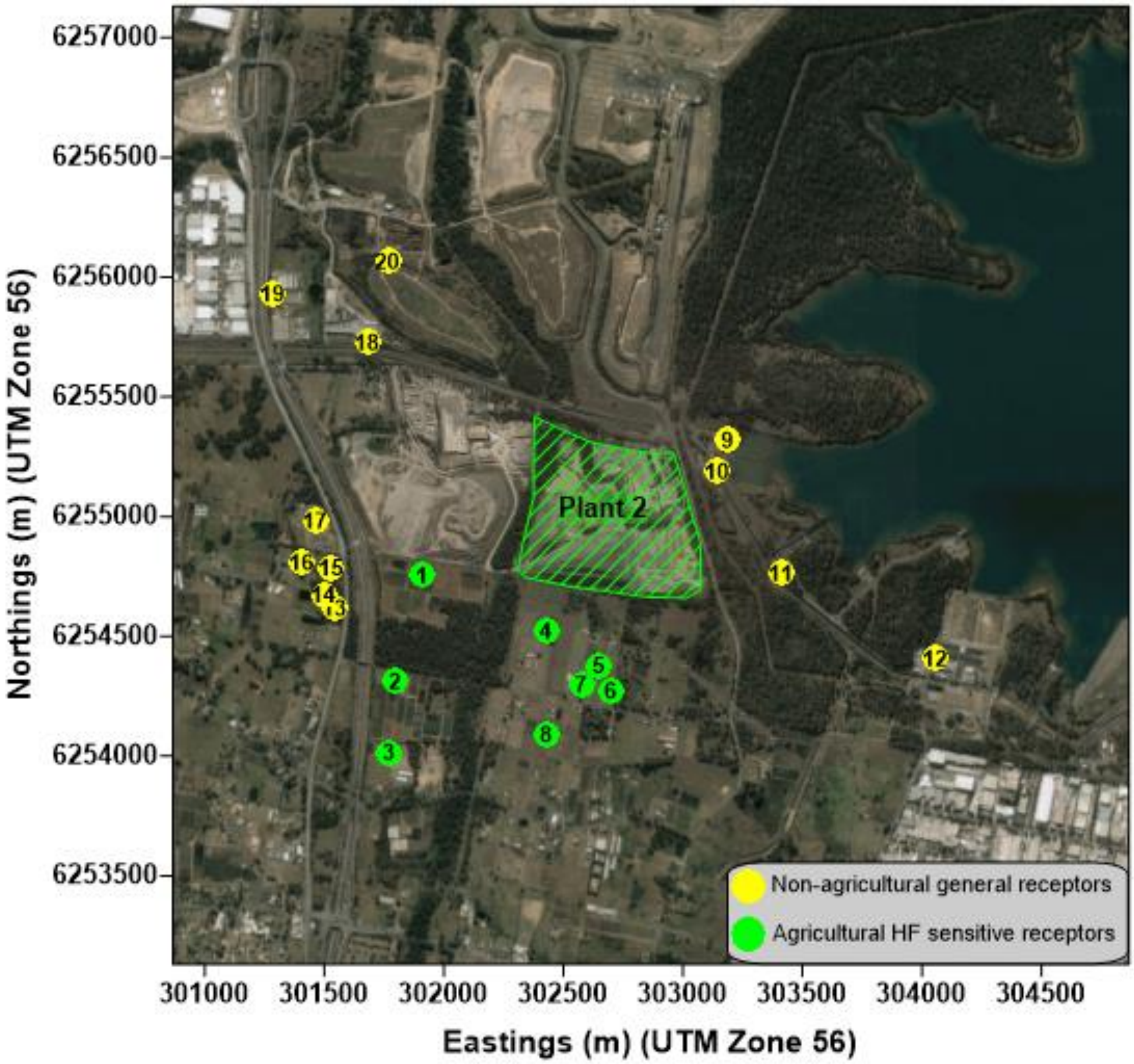
Details of the HF general land-use and specialised land-use assessment criteria are provided in the following section.

Spatial distribution of the identified sensitive receptors (including fluoride sensitive agricultural receptors) selected for the revised air quality impact assessment is illustrated in **Figure 5** and **Table 6**.

Table 6: Details of Identified Sensitive Receptors

Receptor I.D.	Eastings (m) (UTM Zone 56)	Northings (m) (UTM Zone 56)	Classification with respect to HF
R1	301911	6254754	Agricultural receptors – sensitive to fluoride – applied the specialised land-use HF assessment criteria
R2	301799	6254311	
R3	301773	6254015	
R4	302429	6254521	
R5	302651	6254377	
R6	302700	6254271	
R7	302576	6254297	
R8	302432	6254090	
R9	303189	6255318	Non-agricultural receptors – applied the general land-use HF assessment criteria
R10	303146	6255188	
R11	303414	6254763	
R12	304058	6254406	
R13	301546	6254616	
R14	301500	6254673	
R15	301531	6254786	
R16	301407	6254809	
R17	301465	6254981	
R18	301681	6255726	
R19	301287	6255930	
R20	301767	6256065	

Figure 5: Location of the Identified Sensitive Receptors



8. REGULATORY GUIDELINES

8.1 Key Pollutants of Concern

As per EPL No. 546, the stack for the Plant 2 operations is formally identified by EPA Identification No: 5 (Point 5).

According to section *L3 – Concentration Limits* of the EPL, air concentration limits have been issued for Point 5 for the following pollutants:

- Hydrogen fluoride (HF)
- Total solid particles (TSP)
- Nitrogen oxides (NOx)
- Sulfuric acid mist and sulfur trioxide (as SO_3); and
- Sulfur dioxide (SO_2)

The purpose of the upgrade is to improve fuel consumption and the environmental performance; however, the upgrade is not aimed at changing / modifying the operational process nor the production outputs.

As there is no change in the operational parameters of the upgraded Plant 2 kiln, it is reasonable to assume that the aforementioned pollutants listed out in the EPL for the existing Plant 2 operations, would still be considered as the key pollutants of concern.

Therefore, with respect to air quality, the performance of the upgraded Plant 2 kiln would be determined based on assessing the impacts for these identified pollutants.

Based on Airlabs' understanding of the brick manufacturing operations at Plant 2, the main sources that would release the identified pollutants of concern include:

- Exhaust emissions generated from the Plant 2 kiln discharged to the atmosphere through the upgraded Point 5 stack.
- Fugitive dust / particulate matter (PM) emissions generated from various operational activities at Plant 2 including material handling (loading / unloading / conveying) activities, crushing and milling operations, wind erosion of exposed areas and material stockpiles, and wheel generated dust from heavy vehicle haulage on unsealed surfaces with a gravel finish.

Airborne particulate matter typically consists of dust 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 affect amenity.

For the air quality assessment, impacts from all the particulate size fractions i.e. TSP, PM_{10} and $PM_{2.5}$ along with deposited dust levels have been assessed.

8.2 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 ($PM_{2.5}$)

8.3 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 the identified pollutants of concern, namely HF, NO_X, SO_3, SO_2 and particulates (incl. TSP, PM_{10}, $PM_{2.5}$ and deposited dust) 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 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).

As per the cumulative impact assessment guidelines provided in the Approved Methods, point and fugitive source emissions from the upgraded Plant 2 and non-project related sources (which include background levels referenced from the nearest NEPM monitoring station + impacts from Plant 1 and Plant 3 + impacts from Horsley Park WMF) 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 principal and individual air toxic pollutants, the model predicted concentrations are to be reported as 99.9^{th} percentile (Level 2 assessment) incremental (i.e. proposed facility only) impacts at or beyond the proposed facility site boundary. The only individual air toxic pollutant included in this assessment, is sulfuric acid, representing sulfuric acid mist and sulfur trioxide (SO_3) emissions.

8.4 Impact Assessment Criteria

The impact assessment criteria referenced from the Approved Methods for the identified pollutants are summarised in **Table 7**.

Table 7: Adopted Air Quality Impact Assessment Criteria for the Identified Pollutants

Pollutant	Assessment Criteria	Averaging Period	Assessment	Reporting Percentiles
TSP	90 µg/m³	Annual	Cumulative	n.a.
PM_{10}	50 µg/m³	24-hours	Cumulative	100th percentile
	25 µg/m³	Annual	Cumulative	n.a.
$PM_{2.5}$	25 µg/m³	24-hours	Cumulative	100th percentile
	8 µg/m³	Annual	Cumulative	n.a.
Hydrogen fluoride (HF) – general land-use assessment criteria [(a)]	0.5 µg/m³	90-days	Cumulative	100th percentile
	0.84 µg/m³	30-days	Cumulative	100th percentile
	1.7 µg/m³	7-days	Cumulative	100th percentile
	2.9 µg/m³	24-hours	Cumulative	100th percentile
Hydrogen fluoride (HF) – specialised land-use assessment criteria [(b)]	0.25 µg/m³	90-days	Cumulative	100th percentile
	0.4 µg/m³	30-days	Cumulative	100th percentile
	0.8 µg/m³	7-days	Cumulative	100th percentile
	1.5 µg/m³	24-hours	Cumulative	100th percentile
Sulfur dioxide (SO_2)	712 µg/m³	10-minutes	Cumulative	100th percentile
	570 µg/m³	1-hour	Cumulative	100th percentile
	228 µg/m³	24-hours	Cumulative	100th percentile
	60 µg/m³	Annual	Cumulative	n.a.
Nitrogen dioxide (NO_2)	246 µg/m³	1-hour	Cumulative	100th percentile
	62 µg/m³	Annual	Cumulative	n.a.
Sulfuric acid *(representing sulfuric acid mist and sulfur trioxide emissions)*	18 µg/m³	1-hour	Incremental	99.9th percentile, at or beyond Plant 2 facility boundary
Deposited dust levels	2 g/m²/month – maximum increase in deposited dust level	Annual	Incremental	n.a.
	4 g/m²/month – maximum total deposited dust level	Annual	Cumulative	n.a.

(a) General land-use HF assessment criteria applied for non-agricultural sensitive receptors – R9-R20

(b) Specialised land-use HF assessment criteria applied to agricultural receptors – R1-R8

9. EXISTING AIR QUALITY

Characterisation of the existing air quality levels / background air quality concentrations is essential in determination of cumulative air pollution concentrations and subsequently determining compliance with ambient air quality assessment criteria (refer **Table 7**).

9.1 Existing Sources of Air Emissions

The Plant 2 site is located within an 82-ha area at 780 Wallgrove Road, Horsley Park, NSW. This land parcel is also the site for the existing Plant 1 operations along with associated stockpile areas and hardstand areas, as shown in **Figure 1**.

Brick manufacturing operations at Plant 1 are largely similar in nature to the operations at Plant 2, and as observed from the facility licensing details (refer **Table 4**), pollutants released from the Plant 2 kiln stack are also emitted by the existing Plant 1 operations. Therefore, point and fugitive dust emissions from the existing Plant 1 operations have been included for the cumulative impact assessment.

The Horsley Park WMF which is a waste management facility is located immediately to the south of Plant 1 and to the west of Plant 2. The waste management facility is licensed to receive up to 430,000 tpa of non-putrescible waste. It is expected that the operations at the WMF would generate particulate matter emissions and therefore have been included in the assessment for the cumulative impact assessment of particulates.

EPA in their comments noted that the original air quality assessment (AUG18138.2) did not include emissions from Plant 3 and recommended that emissions from Plant 3 site are to be included for the assessment of cumulative impacts. As-such, in this revised air quality assessment, emissions from the two (2) Plant 3 kiln stacks – Point 6 (Swindell) and Point 7 (Ceric) have been considered for the cumulative impact assessment. Fugitive dust emissions generated from Plant 3 operations however have been excluded for the cumulative assessment, as there is considerable separation distance between the source (i.e. Plant 3 site) and the nearest sensitive receptors identified for the revised assessment (refer **Figure 5** and **Table 6**), which considerably limits the potential for fugitive dust emissions from Plant 3 having an adverse impact on the overall cumulative particulate concentrations.

In addition to the aforementioned localised sources, ambient air quality levels have also been included in cumulative assessment (referenced from the NEPM monitoring station at Prospect, which is operated and managed by the NSW-OEH).

The following sections provide additional details on the background concentrations recorded at the Prospect monitoring station along with pollutant emission rates and the source parameters estimated from Plant 1, Plant 3 and Horsley Park WMF operations for the cumulative impact assessment.

9.2 Monitoring Data from the OEH Prospect Station

The Prospect air quality monitoring station (Lat: 33^{0} 47^{1} 41^{11} South, Long: 150^{0} 54^{1} 45^{11} East) has been operational since February 2007 and measures ambient concentrations of the following pollutants – ozone (O_3), oxides of nitrogen (NO, NO_2 and NOx), sulfur dioxide (SO_2), carbon monoxide (CO), visibility, $PM_{2.5}$, PM_{10} along with providing data on wind speed, direction and sigma-theta and ambient temperature, relative humidity and solar radiation.

The station is approximately 5.3km north-east of the Plant 2 facility on the other side of the Prospect Reservoir. Background concentrations measured in 2017 at the Prospect air quality monitoring station for particulates, NO_2 and SO_2 are discussed below. For contemporaneous assessment it is imperative that the selected year for estimating background concentration matches with the modelled meteorological year. The justification for selecting 2017 as the modelled meteorological year is presented in the meteorological modelling section of this report (refer **Section 11**).

Particulate Concentrations

Daily observations of the particulate concentrations (PM_{10} and $PM_{2.5}$) for the calendar year 2017 have been downloaded from the OEH website and analysed.

Timeseries representation of the daily observed PM_{10} and $PM_{2.5}$ concentrations are presented in **Figure 6** and **Figure 7** respectively. Statistics for the top five (5) days of 24-hour average PM_{10} and $PM_{2.5}$ levels recorded at the Prospect monitoring station are summarised in **Table 8** and **Table 9** respectively.

As observed from **Figure 6** and **Table 8** , the daily varying 24-hour average PM_{10} concentrations recorded during 2017 showed one (1) exceedance of the assessment criteria of 50 $\mu g/m^3$, recorded on 24 September. A further investigation was conducted on the exceedance and as per information presented in the NSW Air Quality Statement for 2017 (*Clearing the Air – NSW Air Quality Statement, 2017*), the exceedance was categorised 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*' and therefore, this exceedance was excluded from the cumulative assessment.

Annual average PM_{10} concentrations were below the relevant criterion of 25 $\mu g/m^3$ for the reviewed period.

With respect to 24-hour average $PM_{2.5}$ concentrations, as observed from **Figure 7** and **Table 9**, there were three (3) individual exceedances of the assessment criteria of 25 $\mu g/m^3$ recorded in 2017. The exceedances were observed on 14 August, 02 September and 03 September, all of which were attributed to *Exceptional Events* as per the NSW Air Quality Statement for 2017. Consequently, these three (3) exceedances were excluded from the contemporaneous assessment.

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

Table 8: Statistics for Top Five (5) Days of Daily Varying 24-Hour PM_{10} Concentrations Recorded at Prospect Monitoring Station in 2017

Date	24-Hour Average PM_{10} Concentration (μg/m³), Prospect 2017	Rank	Comments
24/09/2017	61.1	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 Prospect.
02/09/2017	40.2	2	Included in contemporaneous assessment.
25/01/2017	38.8	3	Included in contemporaneous assessment
22/12/2017	37.9	4	Included in contemporaneous assessment
12/09/2017	37.6	5	Included in contemporaneous assessment

Table 9: Statistics for Top Five (5) Days of Daily Varying 24-Hour $PM_{2.5}$ Concentrations Recorded at Prospect Monitoring Station in 2017

Date	24-Hour Average $PM_{2.5}$ Concentration (μg/m³), Prospect 2017	Rank	Comments
02/09/2017	30.1	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 Prospect.
03/09/2017	29.3	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 Prospect.
14/08/2017	26.6	3	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 Prospect.
02/07/2017	24.3	4	Included in contemporaneous assessment
12/09/2017	22.5	5	Included in contemporaneous assessment

Figure 6: 24-Hour Average PM10 Concentrations – OEH Monitoring Station at Prospect – 2017

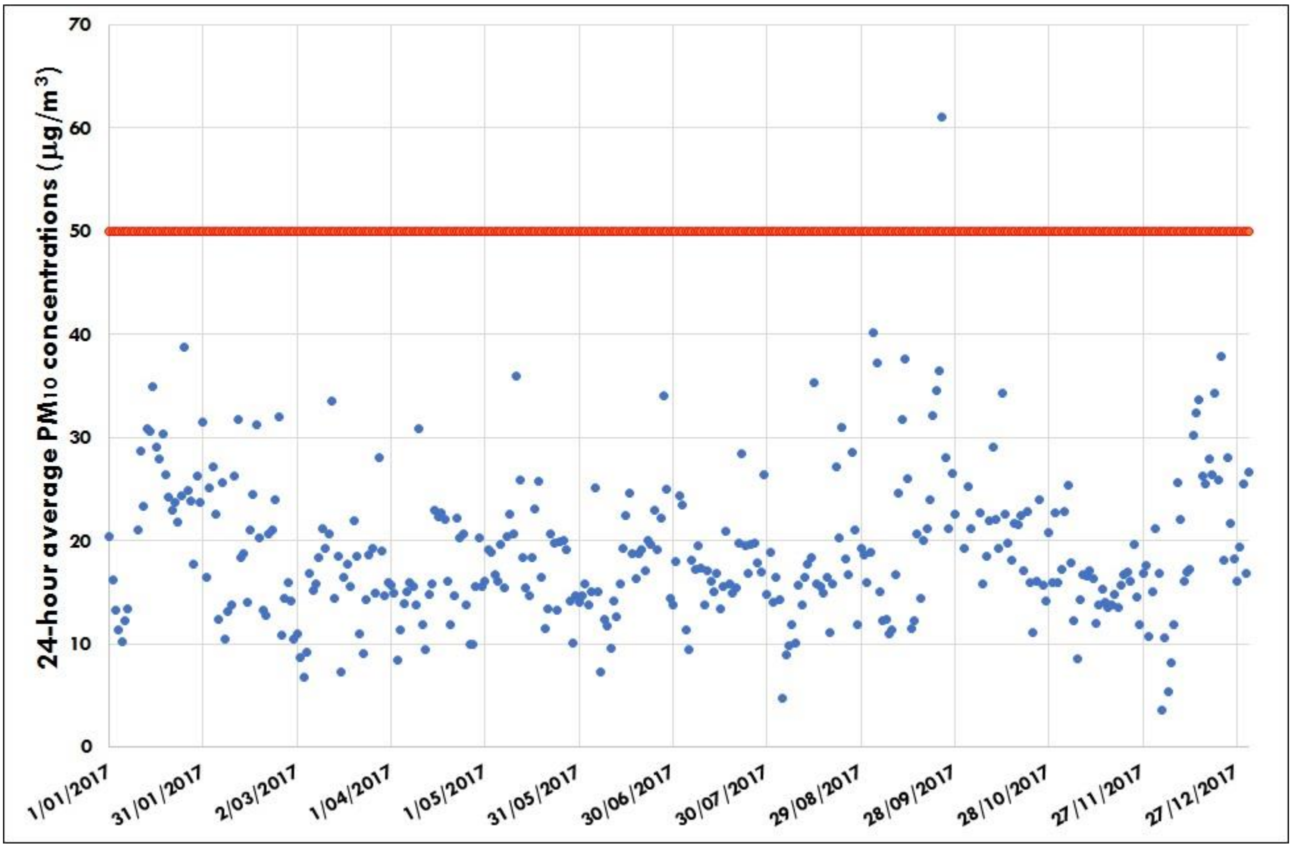
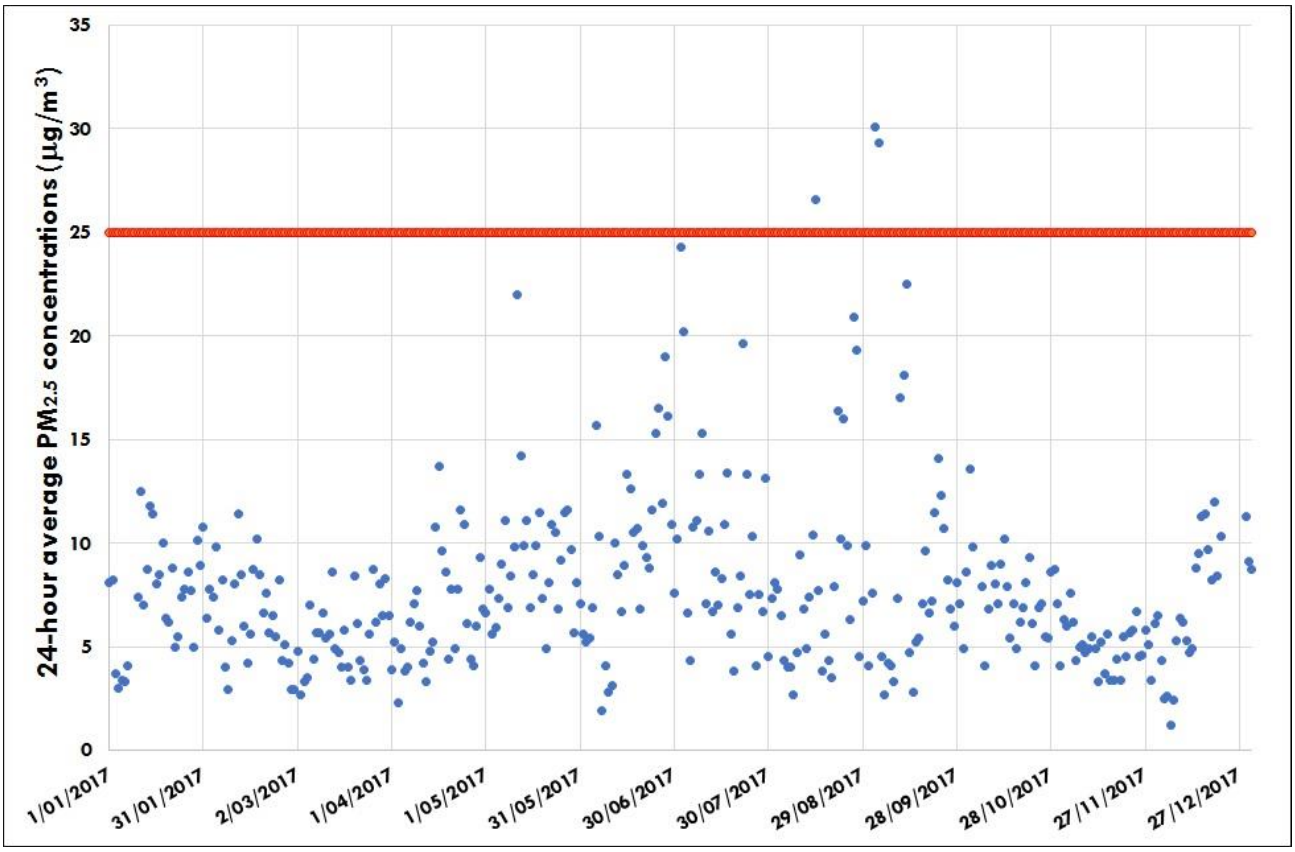


Figure 7: 24-Hour Average PM2.5 Concentrations – OEH Monitoring Station at Prospect – 2017



Nitrogen dioxide (NO_2) and Sulfur dioxide (SO_2) Concentrations

Statistics for the NO_2 and SO_2 ambient concentrations recorded at the Prospect station in 2017 are summarised in **Table 10.**

Measured NO_2 and SO_2 concentrations comply with the relevant assessment criteria (refer **Table 7**) and no exceedances have been reported for the 2017 calendar year.

Table 10: Summary of NO_2 and SO_2 Ambient Concentrations Recorded at Prospect Monitoring Station in 2017

Pollutant	Averaging Period	Measured Concentration at OEH Station - Prospect, 2017	Notes
Nitrogen dioxide (NO_2)	1-hour	123 µg/m^3	Maximum 1-hour measured at Prospect – 2017
	24-hour	59.45 µg/m^3	Maximum 24-hour measured at Prospect – 2017
	Annual	20.07 µg/m^3	Annual average, Prospect – 2017
Sulfur dioxide (SO_2)	1-hour	65.8 µg/m^3	Maximum 1-hour measured at Prospect – 2017
	24-hour	11.4 µg/m^3	Maximum 24-hour measured at Prospect – 2017
	Annual	2.0 µg/m^3	Annual average, Prospect – 2017

9.2.1 Background Concentrations from the Prospect Station Adopted for the Cumulative Assessment

A summary of the background concentrations measured in 2017 at the Prospect station for the cumulative assessment is summarised in **Table 11.**

Table 11: Background Air Quality Concentrations Adopted for the Cumulative 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 the Prospect monitoring station in 2017
	Annual	18.9 µg/m^3	Annual average PM_{10} value measured at Prospect monitoring station in 2017
$PM_{2.5}$	24-hours	Daily Varying	Assessed contemporaneously with daily varying $PM_{2.5}$ background levels measured at the Prospect monitoring station in 2017

Pollutant	Averaging Period	Adopted Background Concentration	Description
	Annual	7.6 µg/m³	Annual average $PM_{2.5}$ value measured at Prospect monitoring station in 2017
TSP	Annual	47.4 µg/m³	No monitoring data available, therefore TSP background concentration from the below assumption *TSP = Annual average PM_{10} / 0.4* Based on assumption that the PM_{10} particle size mass fraction is typically of the order of 40% of TSP mass.
Deposited Dust	Annual	2 g/m²/month	Conservative assumption based on similar projects undertaken by Airlabs

9.3 Emissions from the Adjacent Plant 1 Facility

As shown in **Figure 1**, the Austral Bricks Plant 1 facility is located immediately to the west of the Plant 2 site.

At the time of undertaking this assessment, Airlabs were informed that the production capacity at Plant 1 is approximately 62 million bricks per annum.

Brick manufacturing operations at Plant 1 are managed under EPL 546, which also regulates the operations for Plant 2 and Plant 3 facilities. As noted in **Table 4**, Plant 1 has one (1) point source / kiln exhaust stack (Point 4), which emits pollutants into the atmosphere.

Measured pollutant concentrations at the Point 4 kiln along with kiln stack parameters were obtained from tests over a two (2) year period between 2017-2019.

In the original air quality assessment (AUG18138.2), EPA noted that average emissions from Plant 1 were included in the dispersion modelling rather than considering maximum measured emissions.

Therefore, in this revised assessment, the maximum measured pollutant concentrations at Plant 1 over a two (2) year period between 2017-2019 were used for determining pollutant emission rates from Plant 1. The volumetric flow rates and stack temperatures were based on an average of readings measured between 2018-19.

With respect to HF, as an outcome of the PRP, EPA added a *Scrubber Installation Program* to EPL 546 (comprising a scrubber rollout with annual installation until all operational kilns have end-of-pipe emission mitigation installed – including any kiln upgrades), as a result of which, Austral Bricks have decided to install a dry scrubber at the Plant 1 kiln stack, which will be adequately sized to limit the HF kiln stack discharge concentration to a maximum of 20 mg/m³. As per information provided to Airlabs by Austral Bricks, the scrubber at Plant 1 would be commissioned– around December 2020, approximately one (1) year from the time of preparing this revised assessment report. Therefore, taking into consideration the planned upgrade, it is prudent that the HF emission rate from the existing Plant 1 kiln stack is referenced from the planned upgrade rather than considering historical maximum measured concentrations.

Maximum measured pollutant concentrations between 2017-19 along with volumetric flow details obtained from the stack emissions monitoring data and the calculated pollutant mass emission rates used in the cumulative assessment are summarised in **Table 12**.

Point 4 source parameters as referenced from the above test reports are presented in **Table 13.**

Table 12: Measured Pollutant Concentrations and Emission Rates – Plant 1

Pollutant	Maximum Measured Discharge Concentration between 2017-19	Units	Average Volumetric Flow (Nm^3/sec) Measured between 2018-19 expressed at Reference Conditions	Modelled Emission Rates from Plant 1 Kiln Stack (g/sec) for Cumulative Assessment
TSP	54	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	13.5	0.73
PM_{10}	32	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	13.5	0.43
$PM_{2.5}$ (a)	27	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	13.5	0.36
HF (b)	20	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	13.5	0.27
SO_2	360	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	13.5	4.86
NOx as NO_2	110	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	13.5	1.49
Sulfuric acid mist and sulfur trioxide (as SO_3)	47	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	13.5	0.63

(a) $PM_{2.5}$ concentrations are not measured in the monitoring program. As-such, $PM_{2.5}$ concentrations have been estimated assuming that they are approximately 50% of the measured TSP concentrations.

(b) A new scrubber with a maximum HF discharge concentration of $20mg/m^3$ will be commissioned at Plant 1 by December 2020.

Table 13: Plant 1 Stack (Point 4) Parameters

Parameter	Value
Stack I.D.	Point 4
Type of release	Point Source
Location – Easting (m)	302023
Location – Northing (m)	6255241
Stack height (m) from ground level	30
Stack diameter (m)	1.6
Stack exit temperature (K)	469.6 (average of measured exit temperature between 2018-2019)
Stack exit velocity (m/sec)	12.6 (average of measured exit velocities between 2018-2019)

In addition to emissions released from the point source at Plant 1, fugitive dust emissions were also quantified for the existing brick manufacturing associated operations at the Plant 1 site. Fugitive emissions were quantified for the following activities:

- Material handling (incl. loading / unloading and conveying)
- Crushing, milling and grinding operations
- Wind erosion – exposed areas and material stockpiles
- Heavy vehicle haulage on gravel surfaces.

Particulate emission rates for TSP, PM_{10} and $PM_{2.5}$ size fractions for the overmentioned activities were quantified based on production rates / throughputs provided to Airlabs and with the aid of Emissions Estimation Technique (EET) manuals. Details of the EET manuals used in estimating fugitive dust emissions are provided in **Section 10.2**.

Inventory of the estimated annual TSP, PM_{10} and $PM_{2.5}$ emissions rates from the existing Plant 1 operations are summarised in **Table 14**.

It is noted that EPA in their comments mentioned that not enough information was provided to recalculate fugitive dust emissions from the Plant 1 site. The EPA also make a note that the fugitive dust emissions estimated for Plant 1 are higher than the corresponding emissions for Plant 2, given that the production capacity of Plant 1 is lower than Plant 2.

Airlabs have identified typographical errors in the original air quality assessment report (AUG18138.2), which led to the EPA observation that Plant 1 emissions are considerably higher than the corresponding Plant 2 emissions. The typographical errors have since been rectified by Airlabs and the corrected emissions inventory is presented in **Table 14**.

Additionally, the crushing and mill building emissions for Plant 1 have been revised, which are now in-line with the controls proposed by Austral Bricks.

Detailed calculations of the estimated fugitive dust emissions from Plant 1 operations are presented in **Appendix B**.

Table 14: Estimated Annual Fugitive Dust Emission Rates – Plant 1

Activity	Quantity	Units	Modelled Annual Emission Rates (kg/year)		
			TSP	PM_{10}	$PM_{2.5}$
Front end loader on raw material stockpiles	215,000 [(a)]	tpa	18.5	8.8	1.3
Haul truck unloading raw materials	215,000 [(a)]	tpa	18.5	8.8	1.3
Loading raw materials into the crusher unit	215,000 [(a)]	tpa	18.5	8.8	1.3
Crushing operations	215,000 [(a)]	tpa	129.0	58.1	10.8
Conveying to mill building	215,000 [(a)]	tpa	5.6	2.6	0.4
Mill building operations (incl. grinding)	215,000 [(a)]	tpa	35.5	11.9	6.0
Conveying to brick kiln	215,000 [(a)]	tpa	5.6	2.6	0.4
Wind erosion – exposed areas and stockpiles	2.8	ha	619.4	309.7	46.5
Heavy vehicle haulage on gravel finish surface	215,000 [(a)]	tpa	2,691.3	575.7	57.6
Total			**3,542**	**987**	**126**

(a) Production capacity at the existing Plant 1 site is 62 million standard brick equivalents (SBE) per annum. As per information provided to Airlabs, 115 million SBE roughly translates to 400,000 tpa. Based on this information, the Plant 1 material quantities were calculated to be 215,000 tpa.

9.4 Emissions from the Adjacent Horsley Park WMF Facility

In addition to accounting emissions from the existing Plant 1 facility, the operations at the nearby Horsley Park Waste Management Facility have also been taken into account for the cumulative impact assessment. As shown in **Figure 1**, the Horsley Park WMF facility is located to the south of Plant 1 and to the west of the Plant 2 site.

Based on information provided on the public domain, the Horsley Park WMF is a licensed waste management facility which receives up to 430,000 tpa of non-putrescible waste and comprises a large open area with void space for landfilling and resource recovery.

Operations at the Horsley Park WMF have the potential to generate particulate matter / dust emissions from various operations such as stockpiling and handling of waste and wind erosion of exposed areas and stockpiles, and therefore, this facility has been considered for the cumulative impact assessment.

To estimate emissions from the Horsley Park WMF, Airlabs undertook a search on the public domain and identified a Statement of Environmental Effects undertaken in 2015 for the Horsley Park Waste Management Facility (AECOM (a), 2015). The SEE was a part of a proposal to immobilise contaminated soil. The SEE comprises assessment of air quality impacts from the proposal and this information was used to inform fugitive dust emissions. It is noted that no other documentation pertaining to air quality / dust emissions from the Horsley Park WMF were available to Airlabs at the time of preparing this assessment.

Potential sources of dust emissions from the Horsley Park WMF and their corresponding emission rates were referenced from the following publicly available assessment report:

- *Air Quality Impact Assessment for the Horsley Park Waste Management Facility Contaminated Soil Stabilisation*, AECOM Australia, June 2015 (AECOM (b), 2015) (hereafter 'the AECOM 2015 air quality assessment')

According to the AECOM 2015 air quality assessment, the main sources of particulate / dust emissions included:

- Environmental enclosure stack
- External material handling and stockpiles.

The assessment mentions that the particulate emissions from the enclosure stack would be reduced by 98% through the use of HEPA filters. As the HEPA filters offer considerable reduction in particulate emissions, this source has been excluded from the cumulative assessment and the sources considered include – external material handling and stockpiles.

Particulate emission rates expressed in g/sec, as referenced from the AECOM 2015 air quality assessment, are summarised in **Table 15**. Location of the below sources were referenced from the AECOM 2015 air quality assessment.

Table 15: Estimated Fugitive Dust Emission Rates – Horsley Park WMF (AECOM, 2015)

Activity	Modelled Emission Rates (g/sec) – AECOM 2015		
	TSP	PM_{10}	$PM_{2.5}$
Material handling [(a)]	0.19	0.15	0.01
Stockpile wind erosion [(b)]	0.07	0.04	0.005

(a) Material handling emissions based on unmitigated and mitigated emission rate expressed per stockpile (g/sec /stockpile) in the AECOM 2015 air quality assessment, and the number of unmitigated and mitigated hours and the total number of external stockpiles.

(b) Stockpile wind erosion emission rates determined based on unmitigated and mitigated emission rate expressed per stockpile (g/m^2/sec), the number of unmitigated and mitigated hours and the total number of external stockpiles.

9.5 Emissions from the Existing Plant 3 Facility

EPA in their comments note that the original air quality assessment report (AUG18138.2) did not include emissions from Plant 3 operations as a part of characterising the existing / background concentrations. To address this comment, Airlabs have included the contribution from the existing Plant 3 facility, which is located at a distance of approximately 3 km from the Plant 2 site.

Plant 3 operations are currently licensed under EPL 546 and comprise two (2) brick kiln stacks – Point 6 (Swindell) and Point 7 (Ceric). Maximum measured pollutant concentrations at Point 6 (Swindell) and Point 7 (Ceric) kiln stacks measured between 2017-2019 have been determined from the stack emission test reports and used in the dispersion model to predict contribution from Plant 3 kiln stacks. Impacts from the Plant 3 kiln stacks have been predicted at the sensitive receptors identified in the revised assessment.

The volumetric flow rates and stack temperatures for both Point 6 (Swindell) and Point 7 (Ceric) kiln stacks were based on an average of readings measured between 2018-19.

With respect to HF, as an outcome of the PRP and the *Scrubber Installation Program*, Airlabs have been informed by Austral Bricks that a Development Application (DA 131/2019) was lodged with the Fairfield City Council proposing installation and use of a fluorine cascade scrubber on the Point 7 (Ceric) kiln.

As per the Statement of Environmental Effects (Willowtree Planning, 2019) and the Council issued Assessment Report on 24 May 2019, an approval has been granted by the Council for commissioning of a dry scrubber to the existing Point 7 (Ceric) kiln stack, which will ensure that the HF EPL requirements of 50 mg/m^3 are achieved. It is also noted that the EPA did not raise any concerns / objections on the HF discharge concentration post scrubbing, provided the EPL limits were achieved.

Based on the design specification of the scrubber for Point 7 (Ceric) kiln stack, Austral Bricks is confident that the new scrubber at will limit the HF concentration to 45 mg/m^3 at all times, which is below the prescribed HF EPL limit of 50 mg/m^3.

As-such, the maximum HF discharge concentration adopted for the Point 7 (Ceric) kiln stack in the cumulative assessment is 45 mg/m^3.

No end-of-pipe scrubber solutions are proposed for the Point 6 (Swindell) within next 12 months, and therefore the maximum measured concentration has been referenced for the cumulative assessment.

Fugitive dust emissions generated from the brick manufacturing operations at the Plant 3 facility have not been included in the cumulative assessment, as there is considerable separation distance (approximately 3 km) between the Plant 2 and Plant 3. The likelihood of fugitive dust emissions generated from Plant 3 operations having a discernible impact on the sensitive receptors considered in the assessment is very low.

It is noted that background particulate levels observed at the ambient monitoring station in the vicinity (the Prospect monitoring station) will also be included in the cumulative assessment.

Therefore, with respect to the existing Plant 3 operations, only the pollutants released from the two (2) kiln stacks – Point 6 (Swindell) and Point 7 (Ceric) have been considered for the cumulative assessment.

Maximum measured pollutant concentrations between 2017-19 along with volumetric flow details obtained from the stack emissions monitoring data and the calculated pollutant mass emission rates used in the cumulative assessment from the Point 6 (Swindell) and Point 7 (Ceric) kiln stacks are summarised in **Table 16**.

Point 6 (Swindell) and Point 7(Ceric) kiln stack parameters used in the dispersion model are presented in **Table 17**

Table 16: Measured Pollutant Concentrations and Emission Rates – Plant 3 Point 6 (Swindell) and Point 7(Ceric) Kiln Stacks

Pollutant	Maximum Measured Discharge Concentration between 2017-19	Units	Average Volumetric Flow (Nm^3/sec) Measured between 2018-19 expressed at Reference Conditions	Modelled Emission Rates from Plant 3 Kiln Stack (g/sec) for Cumulative Assessment
Point 6 - Swindell				
TSP	18	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	12.6	0.23
PM_{10}	12	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	12.6	0.15
$PM_{2.5}$ (a)	9	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	12.6	0.11
HF (b)	60	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	12.6	0.75
SO_2	213	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	12.6	2.68
NOx as NO_2	91	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	12.6	1.14
Sulfuric acid mist and sulfur trioxide (as SO_3)	51	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	12.6	0.64
Point 7 - Ceric				
TSP	70	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	15.1	1.05
PM_{10}	39	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	15.1	0.59

Pollutant	Maximum Measured Discharge Concentration between 2017-19	Units	Average Volumetric Flow (Nm^3/sec) Measured between 2018-19 expressed at Reference Conditions	Modelled Emission Rates from Plant 3 Kiln Stack (g/sec) for Cumulative Assessment
$PM_{2.5}$ (a)	35	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	15.1	0.53
HF (c)	45	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	15.1	0.68
SO_2	130	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	15.1	1.96
NOx as NO_2	120	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	15.1	1.81
Sulfuric acid mist and sulfur trioxide (as SO_3)	47	mg/Nm^3, corrected to 273K, dry and 101.325 kPa	15.1	0.71

(a) $PM_{2.5}$ concentrations are not measured in the monitoring program. As-such, $PM_{2.5}$ concentrations have been estimated assuming that they are approximately 50% of the measured TSP concentrations.

(b) No end-of-pipe scrubber solutions are proposed for the Point 6 – Swindell stack. Therefore, considering the maximum measured concentration

(c) HF discharge concentration referenced from the Council approval and supporting documentation for commissioning a new scrubber at the Point 7 – Ceric kiln.

Table 17: Plant 3 Point 6 (Swindell) and Point 7(Ceric) Kiln Stack Parameters

Parameter	Value
Point 6 - Swindell	
Stack I.D.	Point 6
Type of release	Point Source
Location – Easting (m)	298909
Location – Northing (m)	6255296
Stack height (m) from ground level	23.9
Stack diameter (m)	1.4
Stack exit temperature (K)	459.4 (average of measured exit temperature between 2018-2019)
Stack exit velocity (m/sec)	14.0 (average of measured exit velocities between 2018-2019)
Point 7 - Ceric	
Stack I.D.	Point 7
Type of release	Point Source
Location – Easting (m)	298906
Location – Northing (m)	6255296
Stack height (m) from ground level	25
Stack diameter (m)	1.4
Stack exit temperature (K)	459.5 (average of measured exit temperature between 2018-2019)
Stack exit velocity (m/sec)	16.6 (average of measured exit velocities between 2018-2019)

10. UPGRADED PLANT 2 SITE EMISSIONS

This section quantifies the emissions generated from the upgraded Plant 2 operations. Emissions have been estimated for the following sources:

- Proposed upgraded Plant 2 kiln exhaust stack; and
- Fugitive dust emissions generated from various operational activities at the upgraded Plant 2 site.

10.1 Emissions from the Upgraded Plant 2 Kiln

As mentioned in the *Proposal Details* section (**Section 4**), one of the main objectives of this upgrade is to improve the environmental performance – specifically the air pollutant emissions discharged to the atmosphere from the brick kiln. To achieve this, Austral Bricks have proposed to implement mitigation measures which include a fluorine cascade scrubber for reducing HF concentrations and to increase the stack height from the existing 16m to 35m to facilitate better dispersion. These measures are in addition to commissioning of a new kiln for Plant 2.

Based on comments received by the EPA, Austral Bricks have agreed to lower the maximum HF discharge concentration from 45 mg/m^3 to 20 mg/m^3. The rationale for selecting the 20 mg/m^3 has been discussed in **Section 4.1**. Modelled HF emission rates from the upgraded Plant 2 kiln stack have been determined from the revised concentration and corresponding volumetric flow details provided to Airlabs.

Expected pollutant discharge concentrations (hereafter 'design concentrations') from the upgraded Plant 2 kiln stack as provided to Airlabs are summarised in **Table 18**.

Airlabs have been advised by Austral Bricks that once the upgraded Plant 2 kiln is operational, actual discharge concentrations from the exhaust kiln stack are not expected to exceed the design concentrations presented in **Table 18**.

The design concentrations have also been compared against the concentration standards specified in the NSW-EPA Protection of the Environment Operations (POEO) Clean Air Regulation 2010 (the Clean Air Regulation). Reference has been made to *Group 6* standards as these standards are applicable for those facilities whose operations and the corresponding licence conditions have been issued after 01 September 2005.

Based on comments from the EPA, Group 6 concentration limits for the assessed pollutants have been referenced from the standards listed for ceramic works in *Schedule 3 – Standards of concentration for scheduled premises: activities and plant used for specific purposes,* as the facility is licensed under the scheduled activity of ceramic works (and others).

For SO_2, as EPL 546 provides a lower / stringent limit than the corresponding limit set in the *POEO Clean Air Regulations*, discharge concentrations have been compared against the limits prescribed in EPL 546.

Pollutant emission rates from the upgraded Plant 2 kiln are summarised in **Table 18** along with the stack parameters presented in **Table 19**.

Table 18: Pollutant Discharge Concentrations and corresponding Stack Emissions from the Upgraded Plant 2 Kiln

Pollutant	Design Concentration (as provided to Airlabs)	Units	Corresponding Group 6 Standard of Concentration – POEO Clean Air Regulation 2010, Schedule 4	Compliance with Clean Air Regulation Standard of Concentration	Estimated Mass Emission Rate (g/sec) (b)
TSP	34	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	50 mg/m^3	Yes	0.86
PM_{10}	28	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	n.d.	n.d.	0.71
$PM_{2.5}$	17 (a)	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	n.d.	n.d.	0.43
HF	20	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	50 mg/m^3	Yes	0.51
SO_2	150	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	400 mg/m^3 (c)	Yes	3.81
NOx as NO_2	100	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	350 mg/m^3	Yes	2.54
Sulfuric acid mist	50	mg/Nm^3 corrected to 273K, dry and 101.325 kPa	100 mg/m^3	Yes	1.27

(a) Design concentrations for $PM_{2.5}$ were not provided. As-such, $PM_{2.5}$ concentrations have been estimated assuming that they are approximately 50% of the design TSP concentrations.

(b) Mass emission rate calculated based on provided design concentration and corresponding volumetric flow rate of 25.4 Nm^3/sec

n.d. – no data

(c) – SO_2 concentrations compared against the licence limit specified in EPL 546

Table 19: Upgraded Plant 2 Kiln Stack Parameters

Parameter	Value	Units
Location – Easting (X)	302801	m
Location – Northing (Y)	6255028	m
Height above ground level	35	m
Stack diameter at exit	2.0	m
Design exit velocity	15	m/sec
Stack temperature at exit	467	Kelvin
Operational hours	Continuous (24 hours, 365 days)	

10.2 Fugitive Dust Emissions from the Operational Activities at the Upgraded Plant 2 Site

Sources associated with the brick manufacturing operations at the upgraded Plant 2 site that have the potential to generate fugitive dust emissions have been quantified through the application of emission factors listed in Emission Estimation Technique (EET) manuals. Fugitive dust emissions have been quantified for the following sources:

- Loader activities on raw materials stockpile
- Truck unloading raw materials
- Loading raw material to the crusher unit
- Crushing operations
- Transfer / conveying crushed materials to the mill building
- Milling operations (incl. grinding)
- Material transfer / conveying to the new brick kiln
- Wind erosion emissions from the stockpiles on-site
- Heavy vehicle haulage on gravel surfaces

Fugitive dust emissions for the various size fractions – TSP, PM_{10} and $PM_{2.5}$ for each of the aforementioned sources were quantified 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 11.9 Western Surface Coal Mining*, United States Environmental Protection Agency (US-EPA 1998)
- 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 13.2.2 Unpaved Roads*, United States Environmental Protection Agency (US-EPA 2011).

Particulate matter (TSP, PM_{10} and $PM_{2.5}$) emission rates presented in **Table 20** have been quantified based on the emission factors corresponding to specific operational activities referenced from the above EET manuals, the current brick annual production rate of 80 million bricks per annum (it is noted that the production capacity would remain unchanged post upgrade works), the extents of exposed areas and stockpiles and estimation of vehicle kilometres travelled.

The EPA in their comments have mentioned that not enough information was provided to recalculate fugitive dust emissions from the Plant 2 site. The EPA also make a note that the fugitive dust emissions estimated for Plant 2 site are lower than the corresponding emissions for Plant 1 site, considering that the production capacity of Plant 1 is lower than Plant 2.

Airlabs have identified typographical errors in the original air quality assessment report (AUG18138.2), which led to the EPA observation that Plant 1 emissions are considerably higher than the corresponding Plant 2 emissions. The typographical errors have since been rectified by Airlabs and the corrected emissions inventory is presented in **Table 20**.

Furthermore, it is noted that since bulk of fugitive emission inventory comprises of wind erosion and wheel generated dust, the emissions inventory of the two facilities may not scale linearly with production capacities, as the trip length of vehicle haulage and footprint of exposed area/stockpiles may differ significantly.

Additionally, the crushing and mill building emissions for Plant 2 have been revised, which are now in-line with the controls proposed by Austral Bricks.

Detailed calculations of the estimated fugitive dust emissions from Plant 2 operations are presented in **Appendix B**.

Table 20: Estimated Annual Fugitive Dust Emission Rates from the Upgraded Plant 2 Site

Activity	Quantity	Units	Modelled Annual Emission Rates (kg/year)		
			TSP	PM_{10}	$PM_{2.5}$
Front end loader on raw material stockpiles	280,000 (a)	tpa	24.1	11.4	1.7
Haul truck unloading raw materials	280,000 (a)	tpa	24.1	11.4	1.7
Loading raw materials into the crusher unit	280,000 (a)	tpa	24.1	11.4	1.7
Crushing operations	280,000 (a)	tpa	168.0	75.6	14.0
Conveying to the mill building	280,000 (a)	tpa	7.2	3.4	0.5
Mill building operations (incl. grinding)	280,000 (a)	tpa	46.2	15.5	7.8
Conveying to the new brick kiln	280,000 (a)	tpa	7.2	3.4	0.5
Wind erosion – inactive and active stockpiles	21.1	ha	5,280.7	2,640.3	396.0
Heavy vehicle haulage on gravel surfaces	280,000 (a)	tpa	2,161.5	462.4	46.2
Total			**7,743**	**3,235**	**470**

(a) Production capacity for the upgraded Plant 2 would remain unchanged at 80 million standard brick equivalents (SBE) per annum. As per information provided to Airlabs, 115 million SBE roughly translates to 400,000 tpa. Based on this information, the material quantities for the upgraded Plant 2 site were calculated to be 280,000 tpa.

10.3 Fugitive Dust Emissions – Construction Phase

It is expected that there would be dust emissions generated during the construction phase of the upgrade works to the Plant 2 site. 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 has not been undertaken. 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 low. 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 21: 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 and therefore have been excluded from the assessment.

10.4 Odour Emissions

As per the SEARs issued (SSD 9601) (refer **Table 1**), any potential odour emissions generated from the proposal need to be assessed.

However, upon reviewing the proposed upgrades and improvements for the Plant 2 facility, no significant odour generating sources have been identified and therefore odour emissions have not been quantified as a part of this assessment.

11. METEOROLOGICAL MODELLING

11.1 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.

EPA in their comments raised concerns about the model predicted meteorological outputs in the original air quality assessment (AUG18138.2) and usage of CALMET outputs to demonstrate long-term site representativeness and selection of model year, rather than using site-representative meteorological data from a monitoring station. All of these comments have been addressed in this revised air quality assessment report and the approach adopted by Airlabs to characterise the meteorology at the site is as follows:

- Austral Bricks operate and manage an on-site weather station at the Plant 2 premises. However, Airlabs have been informed by Austral Bricks that quality assurance / quality control checks have not been conducted at the on-site monitoring station and cannot confirm if the data is error free.
- It is Airlabs' opinion that use of quality controlled meteorological data that has more than 99% data availability from a Bureau of Meteorology (BoM) Automatic Weather Station (AWS) located approximately 2.5 km from the Plant 2 facility is more appropriate than an uncontrolled site-specific meteorological dataset with lesser data availability.
- As-such, reference was drawn to the nearest site-representative meteorological monitoring station, which is the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) At Horsley Park (Station No: 067119), which is approximately 2.5 km from the Plant 2 site.
- As per the comments issued by the EPA and according to the Approved Methods, in the absence of site-specific data for a Level 2 impact assessment, at least one year of site-representative data must be used and this data should be corelated against longer-duration site-representative meteorological database of at least five (5) years to be deemed acceptable.
- In accordance with the Approved Methods, five (5) years of meteorological data recorded at the BoM Horsley Park AWS between 2013-2017 was collected and processed. The 2017 calendar year was selected based on analysis of five (5) years of trends in data recorded at the BoM Horsley Park AWS. Details of the selection of meteorological modelling year is presented in **Appendix B**.
- Meteorological modelling for the 2017 calendar year was conducted using TAPM and CALMET models.
- Analysis of the CALMET generated meteorological data at the Plant 2 site location was undertaken to demonstrate that the meteorological data used in the dispersion model adequately describes the expected patterns at the site.

Additional details of the TAPM and CALMET model configurations are provided in the following sections:

11.2 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).

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

TAPM simulation was run for the selected model year – 2017 and was setup using four (4) nested 25 x 25 grids, (30km, 10km, 3km and 1km) centred on latitude 33^{0}, 49.5' south, longitude 150^{0}, 52' east. Twenty-five (25) vertical levels were simulated with the lowest level being 10m and the highest level being 8km.

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 22**.

Table 22: TAPM Model Configuration

Parameter	Value
Year of Analysis	2017
Grid Centre Coordinates (latitude, Longitude) (degree)	-33 deg -49.500 min, 150 deg 52.002 min
Number of grids (spacing)	4 (30km, 10km, 3km, 1km)
Grid dimensions (nx, ny, nz)	25, 25, 25

11.3 CALMET

CALMET (version 6.4.0) was used to derive meteorological fields at 250m resolution over a 12km x 12km modelling domain centred over the Plant 2 site. CALMET modelling was undertaken for the 2017 calendar year using the Hybrid Mode approach (Prognostic Model Data + Observations from BoM Horsley Park AWS)

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 23**.

Table 23: CALMET Model Configuration

Parameter	Value
Year of Analysis	2017
No. X Grid Cells (NX), No. Y Grid Cells (NY)	49,49
Grid spacing (DGRIDKM) (km)	0.25
XORIG (km), YORIG (km)	296.700, 6249.000
No. of Vertical Levels (NZ)	10
Meteorological Data Option	NOOBS=1 (Use surface and overwater stations, Use MM4/MM5/3D for upper air data)
Upper Air and Surface Data	TAPM generated MM4/MM5/3D for upper air data and surface observations from BoM Horsley Park
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 12km x 12km 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 Plant 2 facility has been presented in **Figure 4**.

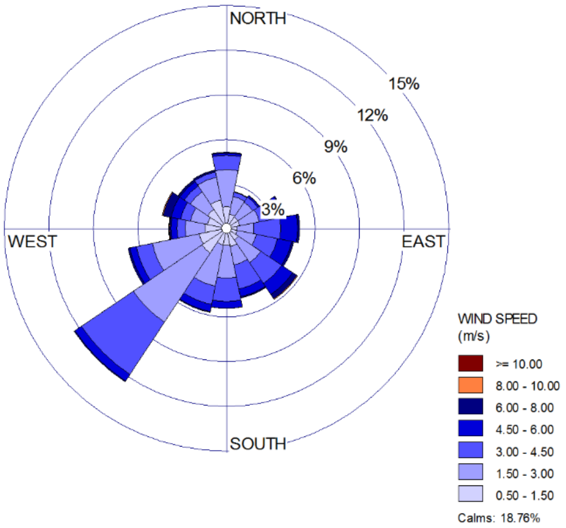
11.4 CALMET Model Outputs

Hourly wind speeds and direction for the 2017 calendar year were extracted from the CALMET output at the centre of the Plant 2 site and are visually presented in the form of annual and seasonal wind roses in **Figure 8**.

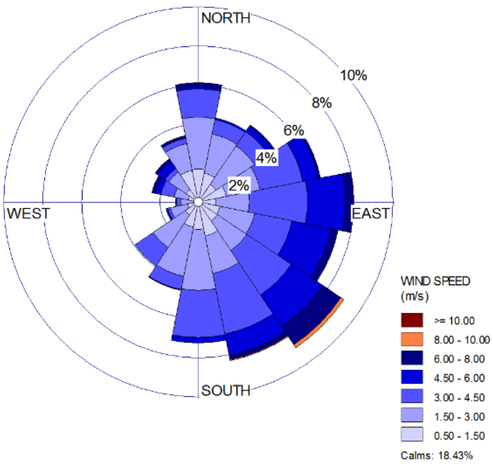
Annual wind roses for the 2017 calendar year shows winds predominantly from the south-west – which are prevalent for about 12% of the year. Less frequent, stronger winds are also experienced from the east and south-east component. The average CALMET predicted wind speed for the 2017 calendar year was 2.2 m/sec and calm conditions (wind speeds less than 0.5 m/sec) prevalent for 18.8% of the time, as seen from the frequency distribution chart in **Figure 9**.

Seasonal variability in wind speed and direction is noticed in the CALMET seasonal predictions for 2017. Winds are most common from the south-west during autumn and winter, whereas, a strong south-easterly component is noticed during summer along with low frequency of winds from the west. During spring season, wind distribution is a lot more varied.

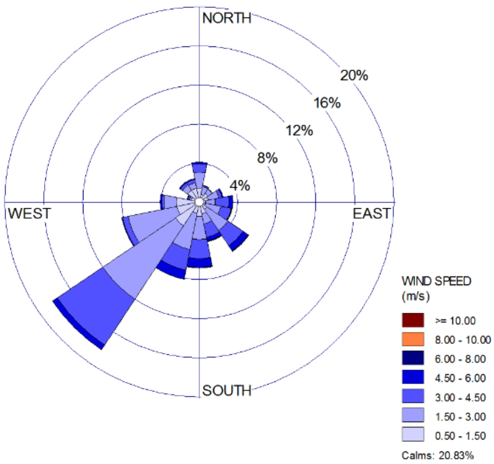
Figure 8: Annual and Seasonal CALMET Predicted Wind Roses - 2017



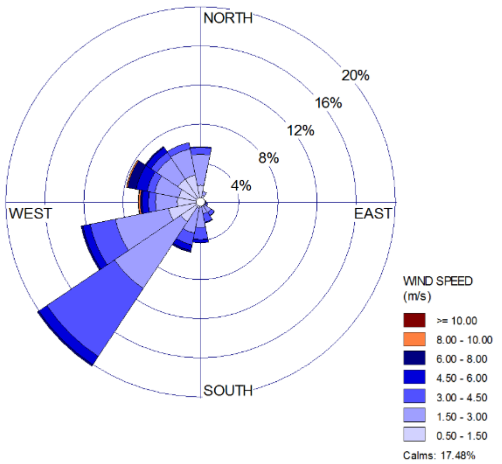
Annual



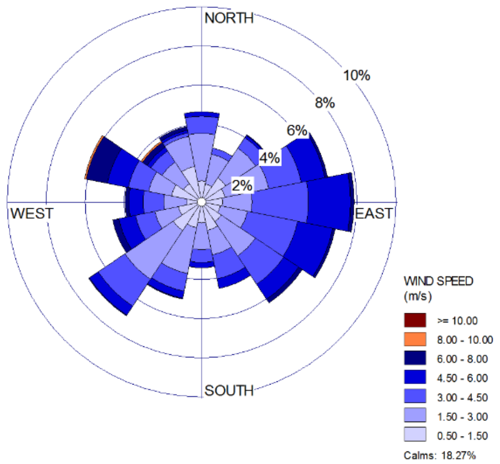
Summer



Autumn

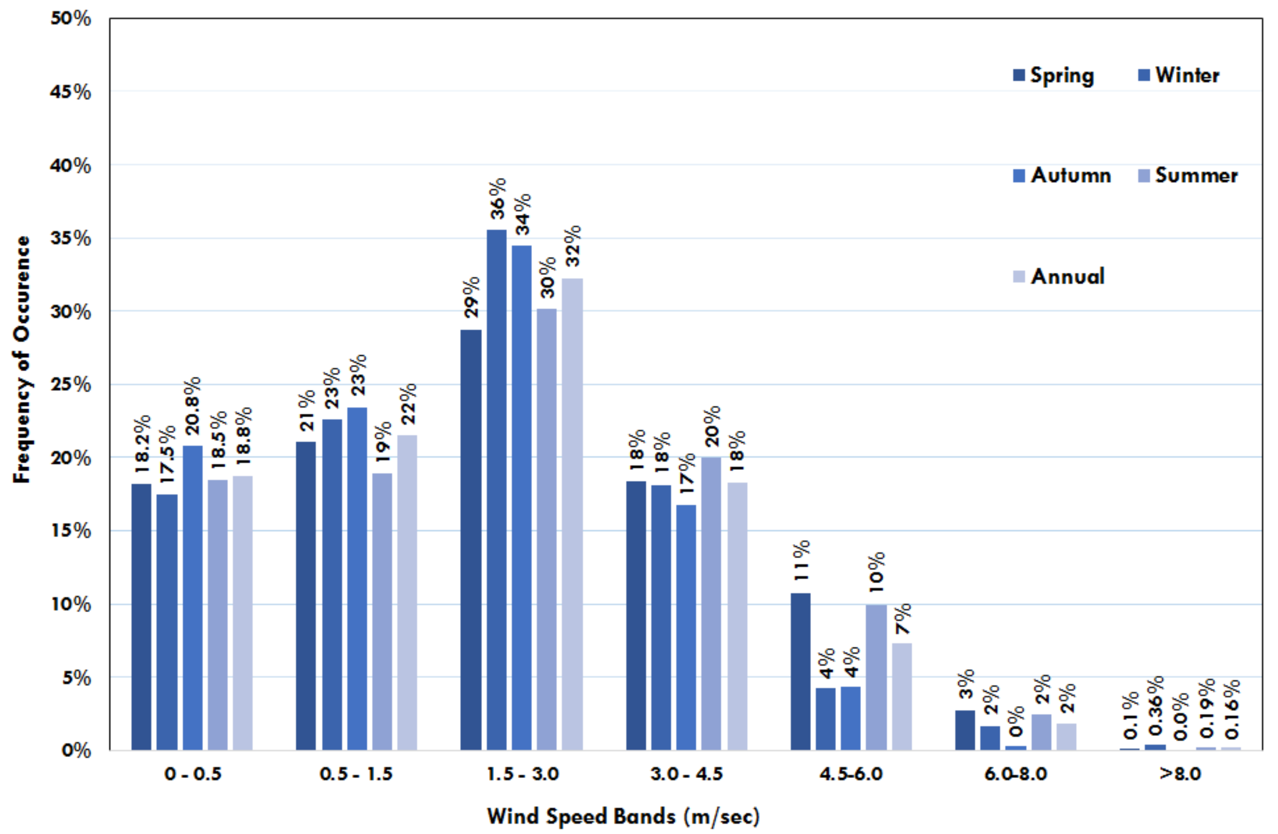


Winter



Spring

Figure 9: CALMET 2017 Wind Speed Frequency Distribution – Annual and Seasonal



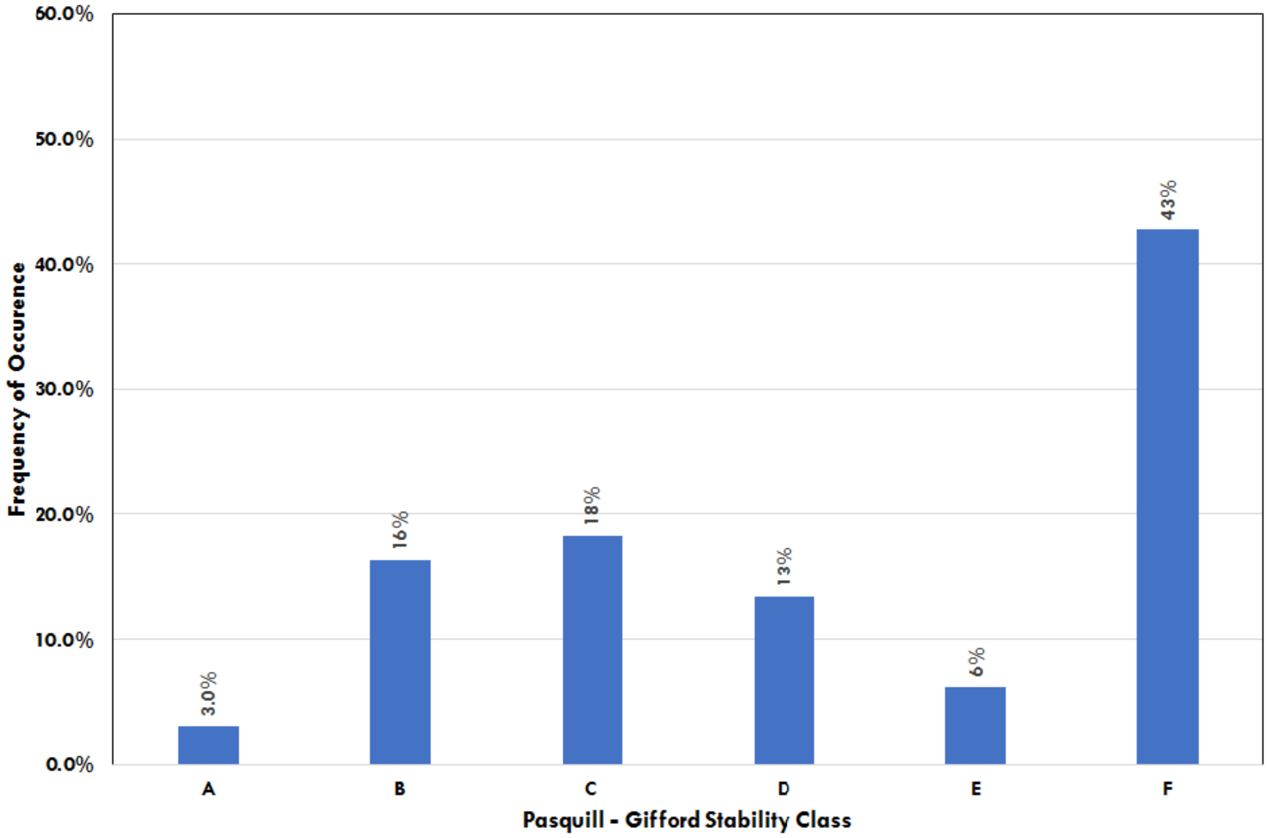
Additional analysis of the modelled meteorology is presented below:

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 10**. A higher frequency (43%) of stability class F was predicted by CALMET, which can potentially lead to poor dispersion conditions.

Figure 10: Frequency of Stability Class - 2017 CALMET

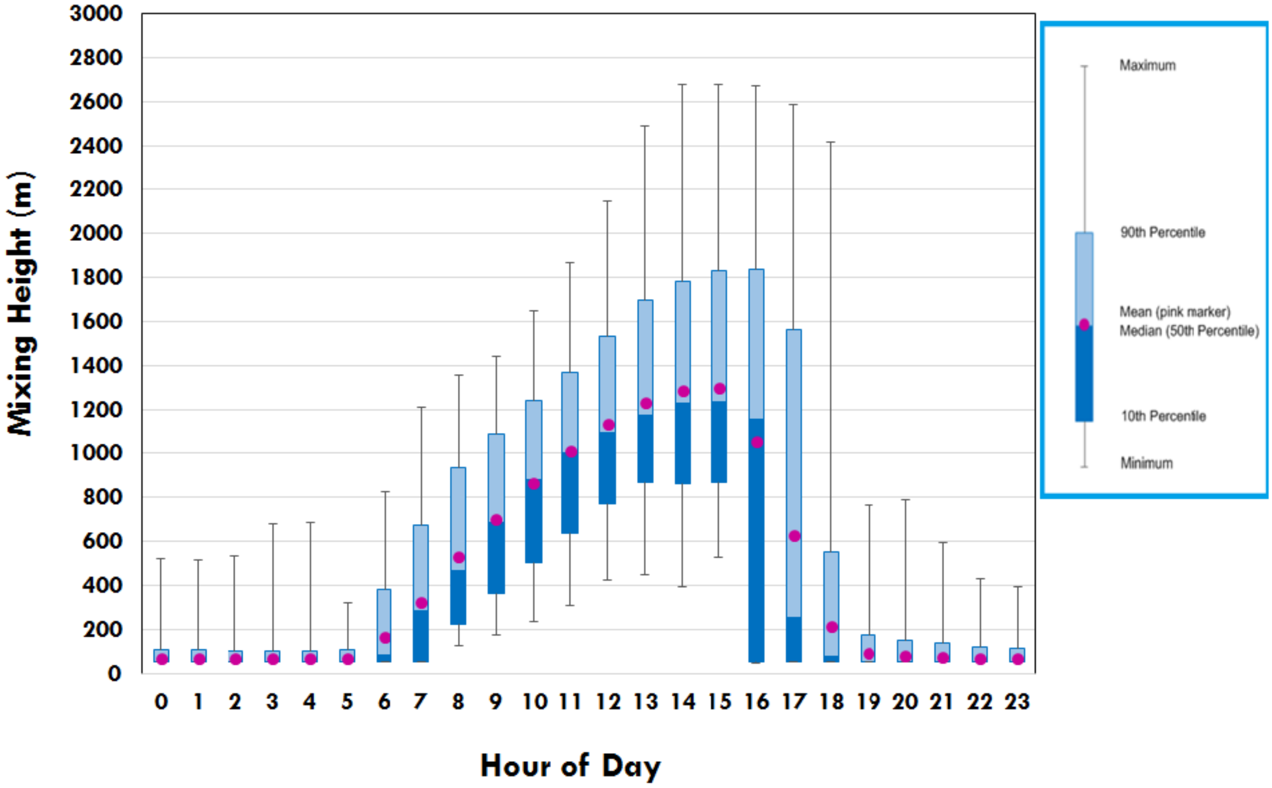


The mixing height quantifies the vertical height of mixing in the atmosphere and is a modelled parameter that cannot be measured directly. The mixing height decreases in the late afternoon, particularly after sunset, due to the change from surface heating from the sun to a net heat loss overnight. Low 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 11** for the modelled year - 2017.

Figure 11 shows the mixing height as a function of the hour of the day at the Plant 2 site. 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.

Figure 11: CALMET Predicted Diurnal Variations in Mixing Heights – 2017



12. OVERVIEW OF DISPERSION MODELLING

To determine air quality impacts from the upgraded Plant 2 kiln along with associated fugitive dust emissions (refer **Section 10**) and the existing sources of air emissions in the immediate vicinity (refer **Section 9**), air dispersion modelling was conducted 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 similar to the CALMET model domain, with a computational grid spanning 12km x 12km and a grid resolution of 250m centred at the Plant 2 site location. The sampling grid was set at approximately 4.5km x 4.5km, with a resolution of 50m (using a nesting factor of 5).

The impact of building wake effects on plume dispersion has been included in the modelling for buildings and structures located around the Plant 2 kiln stack. The heights and locations of these structures were entered into the Building Profile Input Program (BPIP) utility using the PRIME algorithm. The wind direction specific building dimensions calculated by BPIP for the Plant 2 kiln stack at their corresponding heights were then entered into the CALPUFF model.

EPA in their comments sought clarification if building wake effects were included for the Plant 1 site. Airlabs can confirm that the existing Plant 1 kiln stack, the two (2) kiln stacks at Plant 3 -Point 6 (Swindell) and Point 7 (Ceric) and the upgraded Plant 2 kiln stack are all wake-affected sources, and therefore, the Building Profile Input Program (BPIP) – PRIME algorithm has been used to model building wake effects for the Plant 1 kiln stack and Plant 3 – Point 6 (Swindell) and Point 7 (Ceric) kiln stacks.

Ground level concentrations were predicted at the identified sensitive receptors (refer **Table 6**) and for individual air toxics (i.e. sulfuric acid concentrations) the 99.9th percentile incremental concentrations were predicted at or beyond the Plant 2 site boundary, in accordance with the reporting requirements of the modelled concentrations outlined in the Approved Methods .

Fugitive dust sources for the Plant 2 operations (**Table 20**) and the corresponding sources from the existing Plant 1 operations (**Table 14**) and the Horsley Park WMF (**Table 15**) were all represented in the CALPUFF model as a series of volume-sources. Fugitive dust sources from Plant 1 and Plant 2 were all considered to be active from 6AM to 6PM, seven (7) days of the week, except for wind erosion sources, which were assigned a continuous rate of release.

Emissions from the upgraded Plant 2 kiln stack (**Table 18**) and the existing Plant 1 kiln stack (**Table 12**) and Plant 3 kiln stacks (**Table 16**) were all modelled as a continuous release (24 hours, 365 days) point source.

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).

13. DISPERSION MODELLING RESULTS

13.1 Incremental Impacts – Plant 2 Upgrade Only

Predicted ground level concentrations of all modelled pollutants from the upgraded Plant 2 project (incremental concentrations) are discussed below. Incremental concentrations discussed in this section are a consequence of the following sources:

- Point source emissions from the upgraded Plant 2 kiln exhaust stack
- Fugitive dust emissions generated from the identified operational activities at the upgraded Plant 2 site.

Model predicted HF ground-level incremental concentrations are a result of the revised maximum discharge concentration of 20 mg/m^3 and increasing the stack height to 35m from the existing 16m. As HF is the key pollutant amongst the assessed, model predicted maximum incremental ground level concentrations at the identified sensitive receptors have been exclusively presented in **Table 24**.

Maximum model predicted incremental ground level concentrations for all the other pollutants are summarised in **Table 25**.

Modelling shows that the incremental HF concentrations predicted at all sensitive receptors comply with the relevant impact assessment criteria for all averaging periods. It is noted that the impact assessment criteria are relevant for cumulative concentrations, however, for the sake of comparison and to demonstrate the contribution of the Plant 2 emissions in isolation, the incremental concentrations have been compared against the assessment criteria.

Additionally, upon EPA's directions, agricultural receptors which are assumed to be susceptible to fluoride emissions have been identified and incremental impacts have been predicted at these receptors. HF ground-level concentrations at agricultural receptors have been compared against the specialised land-use assessment criteria, which is more stringent than the general land-use assessment criteria.

From the results presented in **Table 24**, it is noted that incremental HF concentrations predicted at the agricultural receptors are also well below the specialised land-use assessment criteria, which is more stringent than the general land-use criteria. Maximum model predicted HF incremental concentration of all agricultural sensitive receptors for all averaging periods is less than 30% of the corresponding assessment criteria, which quantifies the improvements proposed by Austral Bricks – capping the HF discharge concentration from the Plant 2 kiln stack to 20 mg/m^3 and increasing the stack height to 35m from the current 16m.

Overall, from the model predictions, it is observed that the incremental HF concentrations due to the upgraded Plant 2 kiln stack are well below their respective assessment criteria, at all the identified receptors, including those that are considered to be sensitive to fluoride impacts.

Modelling shows that incremental concentrations predicted at the identified sensitive receptors for all the other pollutants are well below their respective assessment criteria, which demonstrates the low incremental effects from the upgraded Plant 2 kiln.

Incremental particulate modelling results presented in **Table 25** are a result of the point and fugitive dust sources inventoried from the Plant 2 site.

With respect to SO_3 (sulfuric acid mist and sulfur trioxide expressed as SO_3) concentrations, the Approved Methods specifies that ground level concentrations are to be reported as the 99.9^{th} percentile 1-hour average incremental concentration predicted at or beyond the Plant 2 site boundary, and subsequently, this value has been extracted, which is around 78% of the corresponding impact assessment criteria.

Concentration isopleths, illustrating spatial variation in the predicted incremental HF concentrations are illustrated in **Appendix C**.

Table 24: Predicted Incremental HF Impacts at Identified Sensitive Receptors – Specialised Land-Use and General Land-Use

Model Predicted Maximum (100th Percentile) HF Incremental Concentrations (µg/m³) at Agricultural / Fluoride Sensitive Receptors				
Averaging Period	90-days	30-days	7-days	24-hours
Impact Assessment Criteria (µg/m³) – Specialised Land-Use	0.25	0.4	0.8	1.5
R1	0.07	0.10	0.17	0.38
R2	0.04	0.05	0.11	0.23
R3	0.06	0.07	0.12	0.38
R4	0.04	0.04	0.09	0.20
R5	0.05	0.06	0.11	0.24
R6	0.04	0.04	0.06	0.20
R7	0.05	0.06	0.09	0.31
R8	0.04	0.05	0.09	0.31
Max of R1-R8	*0.07*	*0.10*	*0.17*	*0.38*
Max of R1-R8 – Percentage of Impact Assessment Criteria	*28%*	*25%*	*21%*	*25%*
Model Predicted Maximum (100th Percentile) HF Incremental Concentrations (µg/m³) at Non-Agricultural / General Land-Use Sensitive Receptors				
Averaging Period	90-days	30-days	7-days	24-hours
Impact Assessment Criteria (µg/m³) – General Land-Use	0.5	0.84	1.7	2.9
R9	0.05	0.07	0.10	0.28
R10	0.05	0.07	0.14	0.28
R11	0.03	0.03	0.08	0.15
R12	0.06	0.08	0.12	0.28
R13	0.06	0.07	0.11	0.31
R14	0.05	0.07	0.14	0.29
R15	0.05	0.06	0.10	0.31
R16	0.06	0.08	0.12	0.42
R17	0.08	0.10	0.12	0.42
R18	0.09	0.11	0.16	0.54
R19	0.10	0.13	0.18	0.42
R20	0.05	0.06	0.09	0.26
Max of R9-R20	*0.10*	*0.13*	*0.18*	*0.54*
Max of R9-R20 – Percentage of Impact Assessment Criteria	20%	15%	11%	19%

Table 25: Summary of Predicted Incremental (Plant 2 Upgrade Only) Impacts – All Pollutants Excluding HF

Model Predicted Maximum (100th Percentile) Incremental Concentrations (µg/m³) at Identified Sensitive Receptors													
Pollutant	TSP	PM_{10}		$PM_{2.5}$		SO_2				NO_2 (a)		SO_3	Deposited Dust
Averaging Period	Annual	24-hours	Annual	24-hours	Annual	10-minutes	1-hour	24-hours	Annual	1-hour	Annual	1-hour	Annual
Impact Assessment Criteria (µg/m³)	90	50	25	25	8	712	570	228	60	246	62	18	2 (Max increase)
R1	0.46	1.67	0.35	0.46	0.09	21	11	3	0.29	7	0.19	3.53	0.06
R2	0.20	1.17	0.20	0.34	0.05	30	16	2	0.16	11	0.11	2.94	0.03
R3	0.17	1.01	0.18	0.38	0.06	40	21	3	0.34	14	0.22	3.84	0.02
R4	0.61	2.00	0.44	0.41	0.09	28	15	1	0.20	10	0.14	2.69	0.06
R5	0.77	2.80	0.63	0.52	0.13	29	15	2	0.24	10	0.16	3.37	0.07
R6	0.62	2.37	0.54	0.44	0.11	16	8	1	0.14	5	0.09	2.15	0.06
R7	0.63	2.41	0.53	0.44	0.11	47	25	2	0.21	17	0.14	2.76	0.06
R8	0.30	1.29	0.28	0.26	0.07	17	9	2	0.17	6	0.12	2.40	0.03
R9	0.92	2.22	0.74	0.43	0.15	18	9	2	0.21	6	0.14	2.77	0.13
R10	1.48	3.34	1.10	0.63	0.21	20	11	2	0.20	7	0.13	3.08	0.22
R11	1.25	4.78	1.13	0.88	0.21	29	15	1	0.12	10	0.08	2.51	0.15
R12	0.15	1.12	0.21	0.26	0.06	18	9	2	0.24	6	0.16	2.86	0.02
R13	0.20	1.21	0.20	0.37	0.06	21	11	2	0.23	7	0.15	2.79	0.03
R14	0.18	1.15	0.18	0.33	0.05	21	11	2	0.21	7	0.14	3.12	0.02

Model Predicted Maximum (100th Percentile) Incremental Concentrations (µg/m³) at Identified Sensitive Receptors													
Pollutant	TSP	PM_{10}		$PM_{2.5}$		SO_2				NO_2 (a)		SO_3	Deposited Dust
Averaging Period	Annual	24-hours	Annual	24-hours	Annual	10-minutes	1-hour	24-hours	Annual	1-hour	Annual	1-hour	Annual
Impact Assessment Criteria (µg/m³)	90	50	25	25	8	712	570	228	60	246	62	18	2 (Max increase)
R15	0.22	1.22	0.20	0.34	0.06	39	21	2	0.29	14	0.19	3.08	0.03
R16	0.18	0.88	0.17	0.41	0.06	32	17	3	0.35	12	0.23	3.75	0.02
R17	0.20	1.01	0.19	0.40	0.07	73	39	3	0.37	26	0.25	6.09	0.02
R18	0.20	0.91	0.18	0.47	0.07	98	52	4	0.44	35	0.30	9.52	0.01
R19	0.13	0.60	0.12	0.36	0.06	87	46	3	0.42	31	0.28	7.95	0.01
R20	0.11	0.41	0.10	0.22	0.04	40	21	2	0.21	14	0.14	3.79	0.01
Max of R1-R20	*1.48*	*4.78*	*1.13*	*0.88*	*0.21*	*98*	*52*	*4*	*0.44*	*35*	*0.30*	*14 (b)*	*0.22*
Max of R1-R20 – Percentage of Impact Assessment Criteria	*1.6%*	*9.6%*	*4.5%*	*3.5%*	*2.6%*	*13.7%*	*9.1%*	*1.8%*	*0.7%*	*14.1%*	*0.5%*	*77.8%*	*10.8%*

(a) To predict ground level NO_2 concentrations, it has been conservatively assumed that all the NOx released is converted to NO_2 (100% NOx to NO_2 conversion). This approach is listed in Section 8.1.1 of the Approved Methods

(b) The value presented is the maximum (reported as 99.9th percentile) 1-hour average sulfuric acid concentration predicted at or beyond the Plant 2 site boundary as per the Approved Methods

13.2 Assessment of Cumulative Impacts

Cumulative model predictions for HF is presented in **Table 26** and all the other remaining pollutants are presented in **Table 27**. The presented cumulative concentrations are a sum total of the following sources:

- Incremental impacts from Plant 2
- Impacts from the existing Plant 1 operations – point and fugitive
- Impacts from the existing Horsley Park WMF – fugitive
- Impacts from the existing Plant 3 operations – point sources (Point 6 – Swindell and Point 7 – Ceric); and
- Background concentrations from the Prospect monitoring station (refer **Table 11**)

With respect to cumulative HF concentrations, no exceedances of the impact assessment criteria are reported at any of the identified sensitive receptors – including agricultural receptors.

From the model predictions at the agricultural receptors, the 90-day averaging period HF is considered the most critical pollutant, whereby, the maximum cumulative concentration predicted across all the agricultural receptors, is approximately 64% of the assessment criteria, followed by the 30-day averaging period HF, where the maximum across all the sensitive receptors is 43% of the assessment criteria. It is to be noted that these ground-level cumulative HF concentrations have been compared against the specialised land-use assessment criteria, which is a lot more stringent than the general land-use criteria. Moreover, as noted in **Section 7.2**, it is unknown as to the type of produce that is grown at these receptors, and therefore, it has been assumed that all of these receptors are sensitive to fluoride impacts. Therefore, the cumulative HF model predictions are slightly on the conservative side mainly due to the unknown nature of the agricultural produce and the application of the stringent assessment criteria across all of the agricultural receptors.

For the non-agricultural receptors, the 90-day average maximum HF cumulative concentration predicted across all the receptors is less than 35% of the assessment criteria, and the maximum 30-day and 24-hour averaging period concentrations are less than 25% of the respective assessment criteria.

These results in conjunction with the low incremental effects expected from the upgraded Plant 2 kiln stack infer that the potential for adverse HF impacts from the modelled sources in the receiving environment is low. Moreover, the modelling results are reflective of the improvements proposed by Austral Bricks, which includes the upgrades at Plant 2 (limiting the maximum HF concentration to 20 mg/m^3), upgrades at Plant 1 (limiting the maximum HF concentration to 20 mg/m^3) and upgrades at Plant 3 Ceric kiln stack (limiting the maximum HF concentration to 45 mg/m^3).

The following observations can be made from the cumulative concentrations presented for the other pollutants in **Table 27**.

- Cumulative concentrations of all the modelled pollutants are in compliance with the relevant assessment criteria at all the receptors.
- With respect to gases, the 1-hour average NO_2 cumulative concentration has the highest impact when compared to the assessment criteria. The maximum 1-hour average cumulative NO_2 ground level concentration predicted at receptor R19, is approximately 66.3% of the assessment criteria, whereas the maximum annual average concentration is predicted at receptor R1, which is approximately 33% of the assessment criteria.
- Cumulative SO_2 concentrations for all averaging periods are well below their respective assessment criteria and therefore do not warrant a detailed discussion.

- SO_3 (sulfuric acid mist and sulfur trioxide expressed as SO_3) concentrations are to be reported as incremental and therefore, have been excluded from the cumulative impact assessment.
- Cumulative model predictions of particulate matter (TSP, PM_{10} and $PM_{2.5}$) concentrations for all averaging periods are in compliance with the impact assessment criteria at all the identified sensitive receptors.
- It is noted that the maximum 24-hour average cumulative PM_{10} concentration is predicted at receptor R11, which is 86% of the assessment criteria, whereas the highest annual average of all the sensitive receptors predicted at receptor R1, is approximately 81% of the assessment criteria.
- With respect to $PM_{2.5}$ impacts, it is evident from the model predictions that the highest cumulative 24-hour average $PM_{2.5}$ concentrations of all the modelled receptors is 24.94 $\mu g/m^3$ (at receptor R1) and is approaching the assessment criteria of 25 $\mu g/m^3$. A similar observation has been made with the annual average $PM_{2.5}$ cumulative concentrations, whereby the highest annual average of all the receptors is 99.2% (at receptor R1) of the assessment criteria.
- It is noted that a Level 2 contemporaneous assessment was undertaken to predict the 24-hour average PM_{10} and $PM_{2.5}$ cumulative concentrations, where the daily varying model predicted concentrations at each receptor were paired with the corresponding daily varying background concentrations, which included contribution from the following – Plant 1 (point and fugitive), Horsley Park WMF (fugitive), Plant 3 kiln stacks (point) and the ambient concentrations measured at the Prospect monitoring station.
- As the 24-hour and annual average cumulative $PM_{2.5}$ concentrations are approaching their respective assessment criteria at receptor R1, a source contribution exercise was conducted to understand the effect of Plant 2 emissions on the overall cumulative concentrations. Source contribution exercise for $PM_{2.5}$ impacts was also conducted at receptor R4, which is closest to the Plant 2 site.
- For the source contribution exercise, 24-hour average $PM_{2.5}$ concentrations from each of the modelled facilities (Plant 2, Plant 1, Horsley Park WMF, Plant 3) were extracted on the day of predicted maximum cumulative concentration at the worst impacted receptor R1. Contributions of each facility were extracted from the model output on the day when the maximum cumulative concentration was predicted. The corresponding ambient concentration on that day was also noted. Through this exercise, contribution from the Plant 2 facility was determined and is illustrated in **Figure 12**.
- For the source contribution exercise, annual average $PM_{2.5}$ concentrations from each of the modelled facilities at receptor R1 was noted along with the annual average ambient background concentrations and compared against the corresponding cumulative concentration at receptor R1 to ascertain the contribution of Plant 2.
- The findings of the source contribution exercise for receptor R1 are illustrated in **Figure 12** (for the $PM_{2.5}$ 24-hour average) and **Figure 13** ($PM_{2.5}$ annual average). From the pie-charts, it is noted that the major contributor is the ambient background concentrations measured at the Prospect monitoring station, followed by contribution from localised sources – which include point and fugitive emissions from Plant 1, fugitive emissions from the Horsley Park WMF and point source emissions from the two (2) kiln stacks at Plant 3 – Point 6 (Swindell) and Point 7 (Ceric). Contribution from Plant 2 operations (point and fugitive) at the worst impacted receptor R1 is very low.
- A source contribution analysis for 24-hour and annual average cumulative $PM_{2.5}$ concentrations at the receptor which is closest to Plant 2 – R4 has been conducted and presented in **Figure 14** and **Figure 15** respectively. A similar observation to the worst impacted receptor is made, which shows the minimal contribution from the Plant 2 facility operations.

Table 26: Predicted Cumulative HF Impacts at Identified Sensitive Receptors – Specialised Land-Use and General Land-Use

Model Predicted Maximum (100th Percentile) HF Cumulative Concentrations (µg/m³) at Agricultural / Fluoride Sensitive Receptors				
Averaging Period	90-days	30-days	7-days	24-hours
Impact Assessment Criteria (µg/m³) – Specialised Land-Use	0.25	0.4	0.8	1.5
R1	0.16	0.17	0.25	0.49
R2	0.09	0.11	0.16	0.41
R3	0.11	0.13	0.20	0.50
R4	0.09	0.10	0.14	0.33
R5	0.11	0.13	0.17	0.45
R6	0.10	0.11	0.15	0.38
R7	0.14	0.16	0.27	0.51
R8	0.09	0.10	0.19	0.39
Max of R1-R8	*0.16*	*0.17*	*0.25*	*0.49*
Max of R1-R8 – Percentage of Impact Assessment Criteria	*64%*	*43%*	*31%*	*33%*
Model Predicted Maximum (100th Percentile) HF Cumulative Concentrations (µg/m³) at Non-Agricultural / General Land-Use Sensitive Receptors				
Averaging Period	90-days	30-days	7-days	24-hours
Impact Assessment Criteria (µg/m³) – General Land-Use	0.5	0.84	1.7	2.9
R9	0.13	0.15	0.23	0.52
R10	0.11	0.14	0.24	0.46
R11	0.08	0.10	0.11	0.34
R12	0.16	0.20	0.33	0.60
R13	0.13	0.15	0.22	0.49
R14	0.11	0.14	0.23	0.45
R15	0.10	0.12	0.17	0.37
R16	0.10	0.12	0.19	0.51
R17	0.12	0.13	0.20	0.55
R18	0.15	0.17	0.24	0.63
R19	0.17	0.21	0.33	0.72
R20	0.10	0.12	0.18	0.41
Max of R9-R20	*0.17*	*0.21*	*0.33*	*0.72*
Max of R9-R20 – Percentage of Impact Assessment Criteria	*34%*	*25%*	*19%*	*25%*

Model predicted cumulative concentration isopleths for Hydrogen fluoride (HF), PM_{10}, $PM_{2.5}$ and NO_2 are presented in **Appendix C.**

Table 27: Summary of Model Predicted Cumulative Concentrations – All Pollutants

Model Predicted Maximum (100th Percentile) Cumulative Concentrations (µg/m³) at Identified Sensitive Receptors											
Pollutant	TSP	PM_{10}		$PM_{2.5}$		SO_2				NO_2 (a)		Deposited Dust
Averaging Period	Annual	24-hours	Annual	24-hours	Annual	10-minutes	1-hour	24-hours	Annual	1-hour	Annual	Annual
Impact Assessment Criteria (µg/m³)	90	50	25	25	8	712	570	228	60	246	62	4 (Max total)
R1	49.08	42.63	20.29	24.94	7.94	233	124	19	3.35	141	20.63	2.22
R2	47.88	40.87	19.39	24.43	7.74	167	89	15	2.70	135	20.38	2.04
R3	47.69	40.74	19.23	24.36	7.72	217	115	17	2.82	143	20.47	2.08
R4	48.40	41.69	19.68	24.63	7.78	196	104	16	2.68	135	20.38	2.04
R5	48.39	41.93	19.76	24.63	7.81	227	121	17	2.92	141	20.47	2.09
R6	48.17	41.30	19.62	24.53	7.77	167	89	18	2.68	132	20.37	2.03
R7	48.26	41.33	19.66	24.49	7.80	184	98	20	3.01	140	20.49	2.13
R8	47.84	40.74	19.35	24.37	7.73	170	90	17	2.68	131	20.37	2.04
R9	48.50	41.84	19.87	24.62	7.83	171	91	17	2.81	134	20.44	2.08
R10	49.05	42.60	20.22	24.78	7.88	167	89	15	2.72	137	20.41	2.06
R11	48.73	42.90	20.15	24.83	7.85	164	87	15	2.51	134	20.31	2.03
R12	47.67	40.53	19.22	24.26	7.73	181	96	19	3.04	135	20.52	2.16
R13	48.16	41.40	19.60	24.55	7.79	174	93	16	2.84	134	20.46	2.10
R14	48.17	41.52	19.61	24.58	7.78	165	88	15	2.73	136	20.41	2.06

Model Predicted Maximum (100th Percentile) Cumulative Concentrations (µg/m³) at Identified Sensitive Receptors												
Pollutant	TSP	PM_{10}		$PM_{2.5}$		SO_2				NO_2 (a)		Deposited Dust
Averaging Period	Annual	24-hours	Annual	24-hours	Annual	10-minutes	1-hour	24-hours	Annual	1-hour	Annual	Annual
Impact Assessment Criteria (µg/m³)	90	50	25	25	8	712	570	228	60	246	62	4 (Max total)
R15	48.46	42.13	19.84	24.82	7.83	202	108	16	2.78	139	20.44	2.07
R16	48.27	41.83	19.69	24.74	7.80	215	114	17	2.78	141	20.46	2.07
R17	48.80	42.46	20.14	24.92	7.88	233	124	16	2.75	155	20.46	2.14
R18	48.94	42.37	20.09	24.79	7.87	250	133	17	2.87	162	20.52	2.21
R19	47.82	40.98	19.30	24.42	7.72	268	143	18	2.76	163	20.48	2.09
R20	47.83	40.84	19.34	24.42	7.70	202	107	15	2.41	144	20.29	2.02
Max of R1-R20	*49.08*	*42.90*	*20.29*	*24.94*	*7.94*	*268*	*143*	*20*	*3.35*	*163*	*20.63*	*2.22*
Max of R1-R20 – Percentage of Impact Assessment Criteria	*54.5%*	*85.8%*	*81.2%*	*99.8%*	*99.2%*	*37.7%*	*25.0%*	*8.7%*	*5.6%*	*66.3%*	*33.3%*	*55.4%*

(a) To predict ground level NO_2 concentrations, it has been conservatively assumed that all the NOx released is converted to NO_2 (100% NOx to NO_2 conversion). This approach is listed in Section 8.1.1 of the Approved Methods

Figure 12: Source Contribution Pie-Chart – Cumulative 24-hour Average Maximum $PM_{2.5}$ Concentration at Worst Impacted Receptor-R1

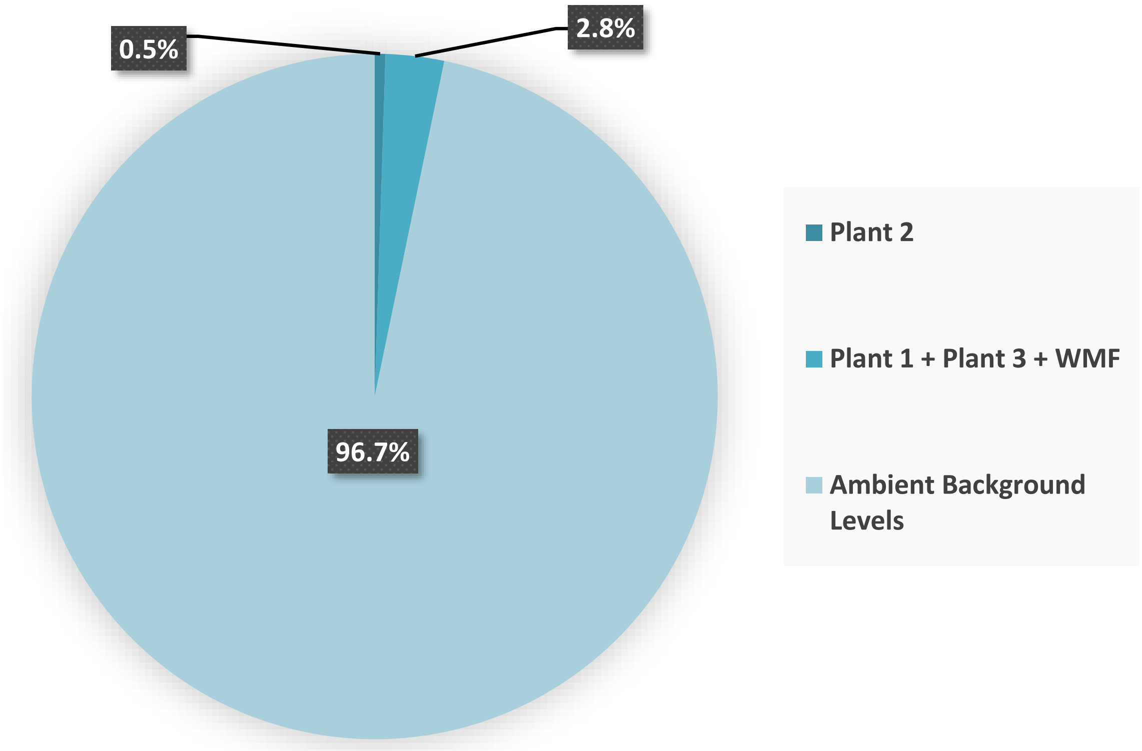


Figure 13: Source Contribution Pie-Chart – Cumulative Annual Average $PM_{2.5}$ Concentration at Worst Impacted Receptor-R1

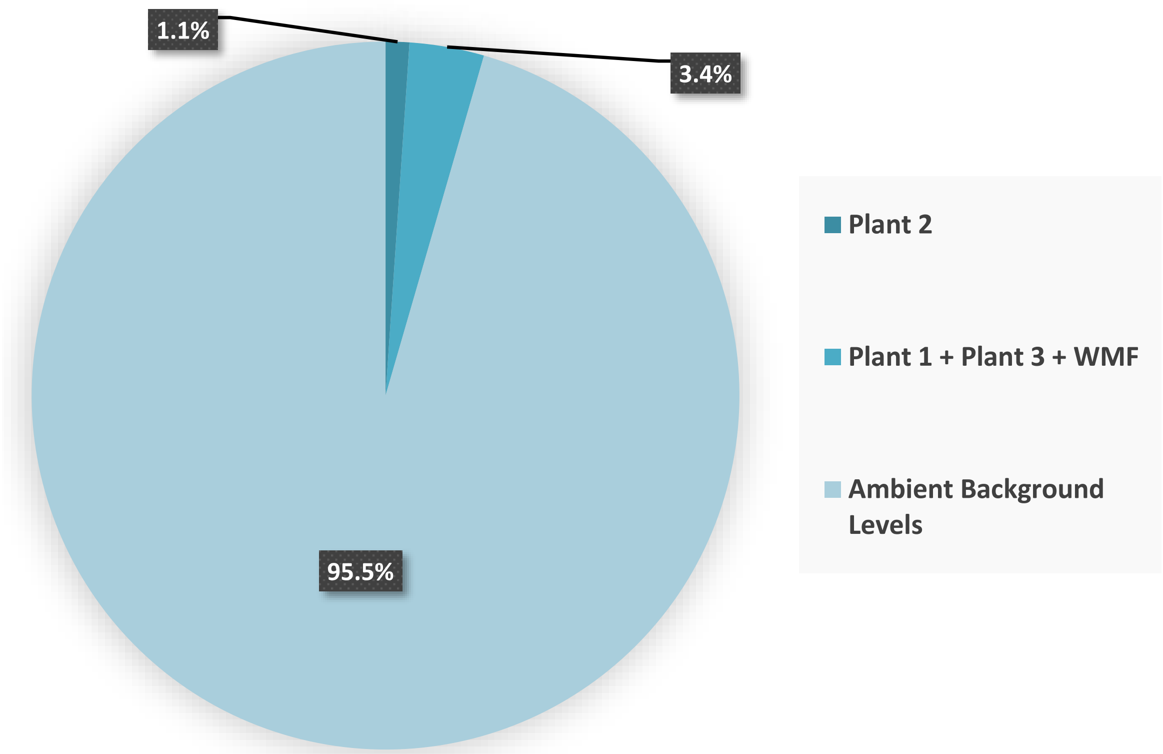


Figure 14: Source Contribution Pie-Chart – Cumulative 24-hour Average Maximum $PM_{2.5}$ Concentration at Receptor Closest to Plant 2-R4

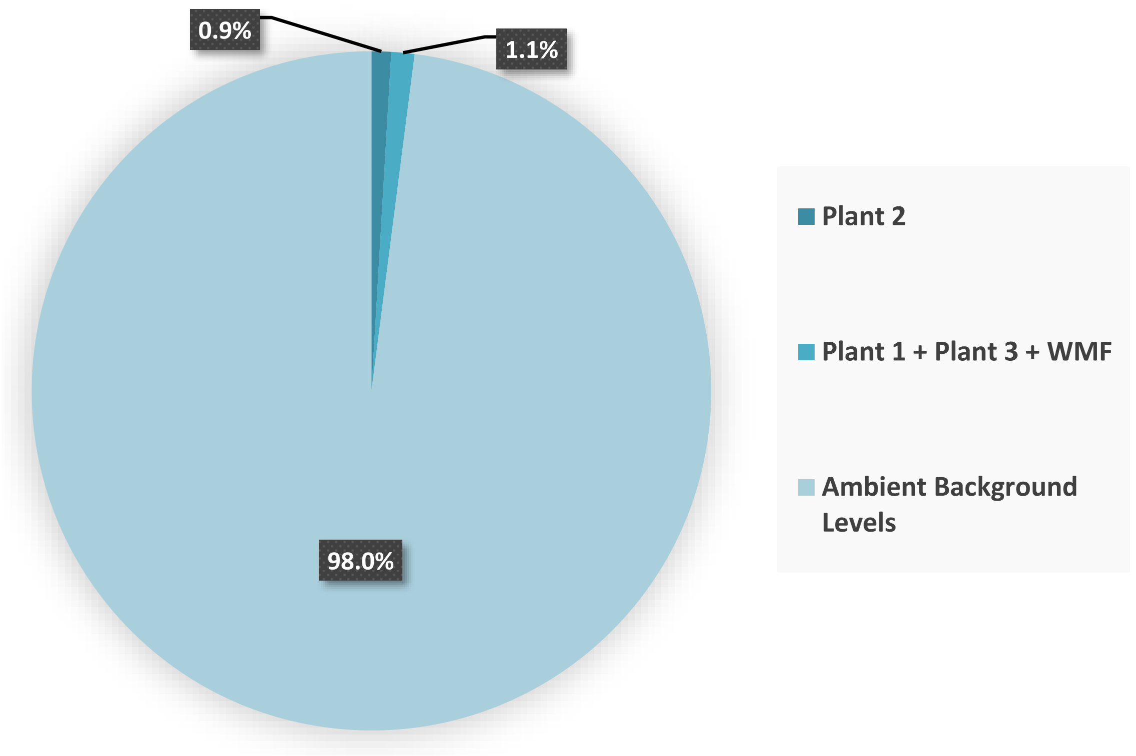
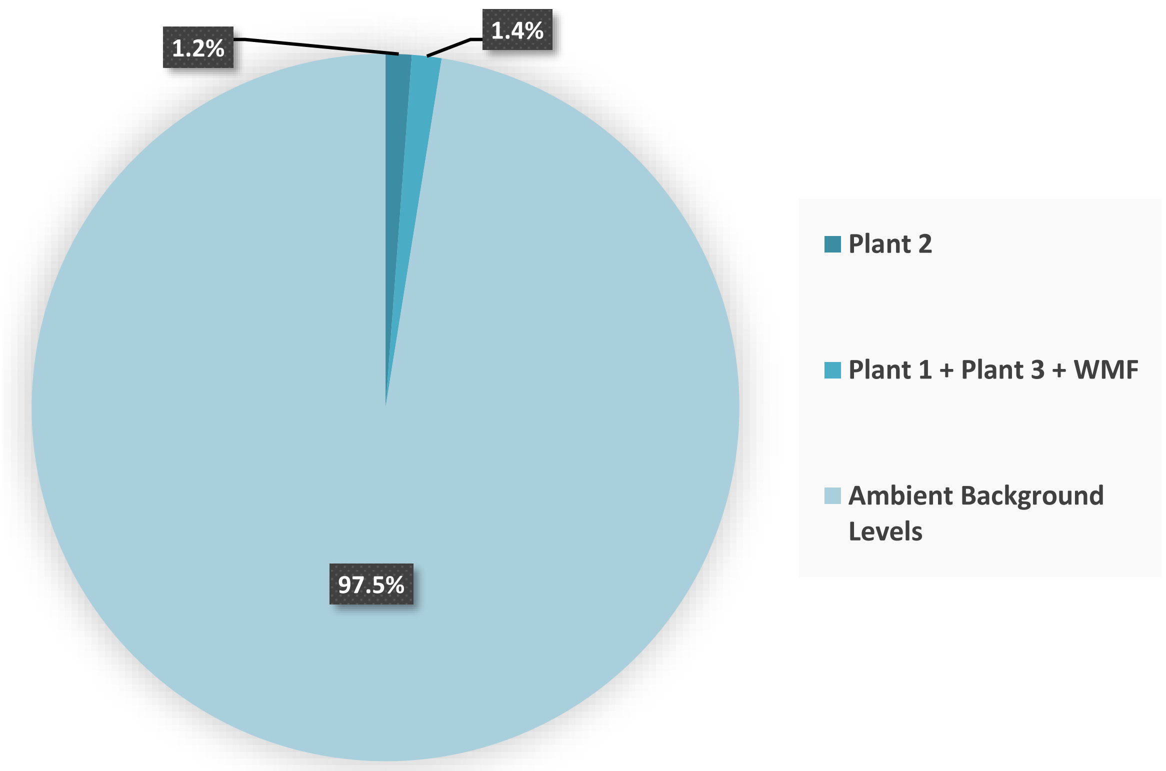


Figure 15: Source Contribution Pie-Chart – Cumulative Annual Average $PM_{2.5}$ Concentration at Receptor Closest to Plant 2-R4



14. GREENHOUSE GAS ASSESSMENT

Determination of greenhouse gas (GHG) emissions has been undertaken in accordance with:

- The World Resources Institute / World Business Council for Sustainable Development (WRI/WBCSD) *The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard Revised Edition* (WRI/WBSCD, 2004) (hereafter 'the GHG protocol')
- *National Greenhouse Account Factors July 2018*, Department of the Environment and Energy, (hereafter 'NGAF 2018')
- *State and Territory Greenhouse Gas Inventories 2016*, Australia's National Greenhouse Accounts, Department of the Environment and Energy, February 2018 (2016 State and Territory Inventory)

14.1 Overview of GHG Emissions

NGAF 2018 defines three (3) scopes for different emission categories based on whether the emissions generated are 'direct' or 'indirect' emissions. As per NGAF 2018 direct emissions *are produced from sources within the boundary of an organisation as a result of the organisations' activities*, whereas indirect emissions *are emissions generated in the wider economy as a consequence of an organisation's activities, but which are physically produced by the activities of another organisation*.

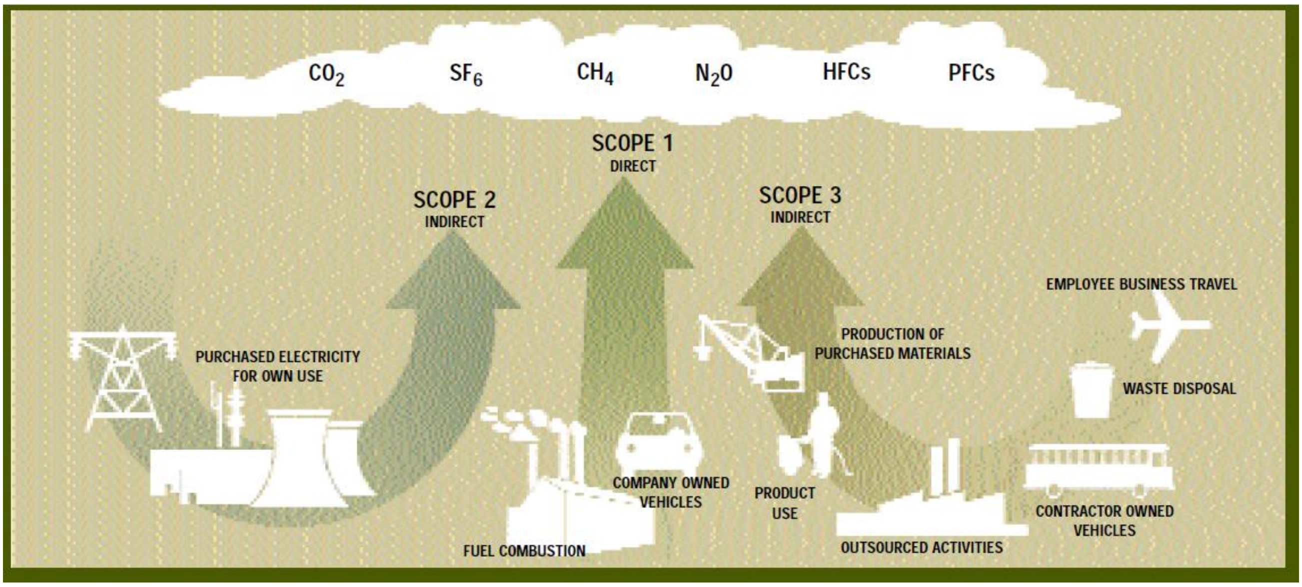
The 'scopes' of emissions (scope 1, 2 and 3) are defined for GHG reporting and are summarised below and presented in **Figure 16**.

The three (3) scopes are:

- **Scope 1**, which covers direct emissions from sources within the boundary of an organisation, such as fuel use, energy use, manufacturing process activity, mining activity, on-site waste disposal etc.
- **Scope 2**, which covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organisation; and
- **Scope 3**, which includes all other indirect emissions that are a consequence of an organisation's activities but are not from sources owned or controlled by the organisation

According to the GHG protocol, Scope 3 is an optional reporting category that allows for the treatment of all other indirect emissions. Scope 3 emissions are a consequence of the activities of the company but occur from sources not owned or controlled by the company. Some examples of scope 3 activities are extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services. Moreover, the SEARs issued for the greenhouse gas assessment (refer **Table 1**) do not specify scope 3 emissions, and as-such quantification of the indirect scope 3 GHG emissions has been excluded from this assessment.

Figure 16: Overview of Scope 1, 2 and 3 GHG Emissions



Source: The Greenhouse Gas Protocol, WRI/WBSCD, 2004

14.2 GHG Emission Estimates

GHG emissions from a facility can be calculated using published emission factors. As per NGAF 2018, emission factors are used to calculate GHG emissions by multiplying a given quantity of GHG emitted per unit of energy or fuel or a similar measure with the activity data. Estimated GHG emissions are referred to in terms of carbon dioxide equivalent (CO_2-e).

Scope 1 and 2 GHG emissions from the Plant 2 upgrade have been quantified for:

- On-site combustion of diesel fuel and natural gas – Scope 1 emissions
- On-site consumption of electricity – Scope 2 emissions.

Natural gas is the principal fuel used at the site, which would be mains sourced natural gas. Quantities of natural gas and electricity projected to be used during the first year of operations at the upgraded Plant 2 site have been provided to Airlabs and are summarised in **Table 28**.

Table 28: Projected Estimates of Natural Gas and Electricity Consumption for the First Year of the Upgraded Plant 2 Facility

Parameter	Value	Units
Natural Gas	475,637	GJ/annum
Electricity usage	13,560.77	MWh/annum

Estimated annual Scope 1 and 2 GHG emissions, expressed in tonnes of CO_2-e (t CO_2-e/annum) for the first year of operation at the upgraded Plant 2 site are presented in **Table 29**.

Table 29: Annual Scope 1 and 2 GHG Emissions from the Plant 2 Upgrade

Scope	Annual Emissions (t CO_2-e/annum)	Source of Emissions
Scope 1 GHG emissions	31,835.7	Natural gas consumption and other emissions (incl. calcination, scrum oil, die oil, waste oil, diesel oil)
Scope 2 GHG emissions	11,391.1	Electricity consumption
Total Scope 1 and 2 GHG emissions	43,226.8	All sources

The total estimated annual operational GHG emissions from the upgraded Plant 2 facility are expected to be approximately 43,302.4 tonnes of carbon dioxide equivalent (CO2-e).

In order to further understand the impacts on a larger scale, the total emissions have been compared against state (NSW) and national (Australia) GHG emissions.

Reference has been drawn to the *State and Territory Greenhouse Gas Inventories 2016 – Australia's National Greenhouse Accounts* compiled by the Department of the Environment and Energy, February 2018 (DOEE, 2018)

According to the estimates presented in the 2016 State and Territory inventory, the annual GHG emissions for NSW and Australia in 2016 were 131.6 Mt CO_2-e and 524 Mt CO_2-e. The Plant 2 facility annual emissions contribute to approximately 0.03% and 0.008% of the state and national GHG emissions respectively.

The contribution of the upgraded Plant 2 emissions to the state and national GHG emissions is relatively minimal as observed from comparing the estimated emissions with the state and national inventories. This low footprint is a result of Austral Bricks' energy management policy which aims to continually improve energy efficiency and invest in plant upgrades to achieve step change efficiency improvements.

Details on how the kiln upgrade will reduce gas quantities used and consequently lower GHG emissions is discussed in the following section.

14.3 Proposed Improvements and their Impacts on Gas Consumption and GHG Emissions

As per information provided to Airlabs, the proposed Plant 2 upgrade will make available to the NSW market a best practice energy efficiency kiln with capacity for 80 million standard brick equivalents (SBEs) per year.

The upgraded plant is expected to use over 40% less energy than the existing plant. This upgraded configuration will enable Austral Bricks business to produce the proposed SBEs from a highly efficient plant, reducing the NSW average energy use per brick produced.

A comparison of energy use and greenhouse gases to previous years is best compared on a per brick production basis. For the 2017-18 financial year (FY), approximately 28 million SBEs were produced for which 335,693 GJ of natural gas was consumed, which provides an approximate gas usage per brick of 12 MJ/brick SBE. On the contrary, the upgraded Plant 2 kiln is expected to produce 80 million brick SBE in its first year of operation and approximately 475,637 GJ of natural gas would be required, which reduces the gas usage per brick to 6 MJ/brick SBE, thereby providing a 50% reduction in gas usage estimates when compared to the existing kiln. As the gas usage is substantially reduced, the corresponding GHG emissions would also be reduced.

Based on the above estimates, it is inferred that the proposed upgrades for Plant 2 will result in a highly efficient plant which would substantially lower the gas used per brick and subsequently lower the corresponding GHG emissions released.

Gas usage and estimated GHG emissions (t CO_2-e/annum) for the 2017-18 FY and for the first year of operation of the upgraded Plant 2 are tabulated in **Table 30**.

It is noted that, due to market conditions, the 2017-18 FY production rates for Plant 2 were below the full capacity of the plant.

Table 30: Energy Usage and Greenhouse Gas Emission Comparison – Plant 2 Existing for FY 2017-18 and First Year of Upgraded Plant 2 Facility.

Parameter	Units	Estimates for 2017-18 FY – Plant 2 Existing	Projected Estimates for the First Year of Operation – Upgraded Plant 2	Reduction Achieved due to Upgrade
Brick Production Rates	SBE	28,152,000	80,000,000	
Natural Gas Usage Rates	GJ/annum	335,693	475,637	
Gas usage per brick	MJ/SBE	12	6	50% reduction
Electricity Consumption	kWh/annum	6,154,526	13,560,777	
Electricity usage per brick	kWh/SBE	0.22	0.17	26% reduction
Greenhouse Gas Emissions				
Scope 1 Natural Gas GHG Emissions	t CO_2-e/annum	17,255	24,448	
Scope 2 Electricity GHG Emissions	t CO_2-e/annum	5,170	11,391	
Other GHG Emissions (Calcination, scrum guard, dye oil, waste oil, diesel)	t CO_2-e/annum	2,600	7,388	
Total Emissions – Scope 1 + Scope 2 + Other	t CO_2-e/annum	25,025	43,227	
Total Emissions per thousands of brick SBE	$\frac{\mathrm{t\ CO_2-e/annum}}{thousands\ of\ bricks\ SBE}$	0.89	0.54	49% reduction

15. CONCLUSION

An air quality impact assessment report (AUG18138.2) supporting the Plant 2 upgrade application was issued to Willowtree Planning in April 2019. The report formed a part of the EIS, which was submitted to DPIE for public exhibition. Comments were issued by the EPA and DPIE with respect to air quality management from the Plant 2 upgrade, which have been addressed in this revised air quality assessment report.

Comments from the EPA were broadly categorised into the following – performance of the proposed Plant 2 scrubber for reducing HF discharge concentrations; inclusion of Plant 3 emissions as a part of the background environment; technical issues with dispersion modelling and estimated fugitive dust emission rates.

As a response to EPAs concerns on the effectiveness of the scrubber with respect to reducing HF concentrations, Austral Bricks have agreed to lower the maximum HF discharge concentration at the upgraded Plant 2 kiln stack to 20 mg/m^3 from the originally assessed 45 mg/m^3. The revised HF concentration is also in-line with best practice measures implemented by Austral Bricks as most of the Austral Bricks' plants that have end-of-pipe HF abatement technologies have a maximum discharge concentration of 20 mg/m^3. Therefore, the HF emissions from the upgraded Plant 2 kiln stack in this revised assessment have been based on 20 mg/m^3. This revised discharge concentration is considered to be a notable improvement proposed by Austral Bricks for reducing HF emissions, in addition to increasing the stack height from 16m to 35m, which would facilitate better dispersion.

For characterising the background air quality concentrations, EPA required inclusion of Plant 3 emissions in addition to the localised sources identified – which include point and fugitive dust emissions from Plant 1 and fugitive dust emissions from the Horsley Park WMF. Responding to EPA's comments, Airlabs included maximum measured pollutant emissions rates between 2017-19 at the Plant 1 kiln stack (Point 4) and the two (2) Plant 3 kiln stacks – Point 6 (Swindell) and Point 7 (Ceric). For the Point 7 (Ceric) kiln stack, Austral Bricks have lodged a Development Application for installing a cascade scrubber, which would limit the maximum HF discharge concentration to a maximum of 45 mg/m^3. This discharge concentration is below the relevant EPL limit of 50 mg/m^3, satisfying the DA requirements of ensuring compliance with licence limits. Therefore, HF emissions for the Point 7 (Ceric) kiln stack were determined from the proposed maximum discharge concentration of 45 mg/m^3.

Technical issues raised by the EPA with respect to dispersion modelling and fugitive dust emission estimates have all been addressed in this revised assessment report.

To predict off-site impacts from the Plant 2 upgrade, modelling was conducted using the US-EPA non-steady state CALPUFF dispersion model.

Modelling shows that all the assessed pollutants are below / comply with the relevant assessment criteria at all the identified sensitive receptors, including receptors which are sensitive to HF impacts. Furthermore, modelling shows that the contribution of the upgraded Plant 2 operations to the overall predicted air quality levels is minimal, which is a direct consequence of the improvements proposed by Austral Bricks.

Scope 1 and 2 GHG emissions generated from the Plant 2 operations are low when compared to the state and national greenhouse gas inventories, with the operations contributing to approximately 0.03% and 0.008% of the state and national GHG emissions respectively. The upgraded Plant 2 kiln result in a highly efficient plant which would substantially lower the gas used per brick and subsequently lower the corresponding GHG emissions released.

Overall, the findings from the dispersion modelling show low-level impacts from the upgraded Plant 2 operations.

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APPENDIX A

Fugitive Dust Emissions Inventory Background

Fugitive Dust Emissions – Existing Plant 1 Operations and Upgraded Plant 2 Operations

Fugitive dust emissions (TSP, PM_{10} and $PM_{2.5}$) for the existing Plant 1 facility and the upgraded Plant 2 site have been estimated based on site-specific operational activities provided by Austral Bricks and utilising emission factors from emission estimation technique (EET) manuals listed below:

- 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 11.9 Western Surface Coal Mining*, United States Environmental Protection Agency (US-EPA 1998)
- 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 13.2.2 Unpaved Roads*, United States Environmental Protection Agency (US-EPA 2011).

Particulate emissions from the Horsley Park WMF facility have been refenced from the AECOM 2015 air quality assessment and have been discussed in **Section 9.4**.

Dust generating activities along with corresponding emission factor and key variables used to estimate annual TSP, PM_{10} and $PM_{2.5}$ emissions at both existing Plant 1 site and the upgraded Plant 2 site are summarised in **Table A.1**.

Dust control efficiencies adopted in developing the emissions inventory for both Plant 1 and Plant 2 operations are summarised in **Table A.2**.

Table A.1: Emission Factors and Key Variables for Estimating Dust (TSP, PM_{10} and $PM_{2.5}$) Emissions – Plant 1 Existing Operations and Upgraded Plant 2 Operations

Activity	Emission Factor	Key Variables and Assumptions	Source of Emission Factor
Front end loader on raw material stockpiles	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	$k_{TSP} = 0.74$ $k_{PM10} = 0.35$ $k_{PM2.5} = 0.053$ U – mean wind speed, CALMET 2017 mean wind speed – 2.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Haul truck unloading raw materials	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	$k_{TSP} = 0.74$ $k_{PM10} = 0.35$ $k_{PM2.5} = 0.053$ U – mean wind speed, CALMET 2017 mean wind speed – 2.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Loading raw materials into the crusher unit	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	$k_{TSP} = 0.74$ $k_{PM10} = 0.35$ $k_{PM2.5} = 0.053$ U – mean wind speed, CALMET 2017 mean wind speed – 2.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Crushing operations	$E_{TSP} = 0.0006\ kg/t$ $E_{PM10} = 0.00027\ kg/t$ $E_{PM2.5} = 0.00005\ kg/t$	Controlled crushing – water sprays and enclosed operations	AP-42, Chapter 11.19.2 – Crushed Stone Processing and Pulverised Mineral Processing
Conveying to mill building	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	$k_{TSP} = 0.74$ $k_{PM10} = 0.35$ $k_{PM2.5} = 0.053$ U – mean wind speed, CALMET 2017 mean wind speed – 2.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Mill building operations (incl. grinding)	$E_{TSP} = 0.0011\ kg/t$ $E_{PM10} = 0.00037\ kg/t$ $E_{PM2.5} = 0.00005\ kg/t$	No specific emission factors available for activities inside the mill building. Therefore, used the controlled screening emission factor. It is to be noted that minimal dust emissions would be generated from operations inside the mill building, as the raw material would be mixed with water and additivities which would considerably limit the potential for fugitive dust emissions and all of the operations would be inside the building – enclosed operations. EET manual does not provide emission factors for $PM_{2.5}$ size fraction. Therefore, assumed that $PM_{2.5}$ would be 50% of TSP	NPI – EETM for Mining and Processing of Non-Metallic Minerals Version 2.1

Activity	Emission Factor	Key Variables and Assumptions	Source of Emission Factor
Conveying to brick kiln	$E = k(0.0016)\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}$	k_{TSP} = 0.74 k_{PM10} = 0.35 $k_{PM2.5}$ = 0.053 U – mean wind speed, CALMET 2017 mean wind speed – 2.2 m/sec M – moisture content – 13% for the raw material to be processed as provided by Austral Bricks	AP-42, Chapter 13.2.4 – Aggregate Handling and Storage Piles
Wind erosion – exposed areas and stockpiles	E_{TSP} = 850 kg/ha/yr E_{PM10} = 425 kg/ha/yr $E_{PM2.5}$ = 63.75 kg/ha/yr	No emission factors provided for PM_{10} and $PM_{2.5}$ size fractions. To determine PM_{10} and $PM_{2.5}$ emission factors, reference was made to the PM_{10}/TSP and $PM_{2.5}$/TSP ratios specified within the AP-42, *Chapter 13.2.5 – Industrial Wind Erosion.*	AP-42, Chapter 11.9 – Western Surface Coal Mining
Heavy vehicle haulage on gravel finish surface	$E = k\ (s/12)^a (W/3)^b$	k_{TSP} = 4.9 a_{TSP} = 0.7 b_{TSP} = 0.45 k_{PM10} = 1.5 a_{PM10} = 0.9 b_{PM10} = 0.45 $k_{PM2.5}$ = 0.15 $a_{PM2.5}$ = 0.9 $b_{PM2.5}$ = 0.45 s – surface material silt content (%), assumed to be 2.0% as the road surface would have a low silt gravel / aggregate finish. W – Average vehicle weight assumed to be 45 tonnes Haul truck payload capacity – 40 tonnes / trip-load Return trip length – Plant 1 ~ 2.1km/trip Return trip length – Plant 2 – Path 1 ~ 1.6 km/trip Return trip length – Plant 2 – Path 2 ~ 1.0 km/trip	AP-42, Chapter 13.2.2 – Unpaved Roads

Table A.2: Fugitive Dust Control Measures and Quantifiable Emission Reduction Factors

Fugitive Dust Control Measure	Emission Reduction Efficiency	Source
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
Water sprays on stockpiles	50%	National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Mining, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012
Wind breaks from taller stockpiles and vegetation to reduce wind erosion emissions	30%	National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Mining, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012
Water sprays on crusher	50%	National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Mining, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012
Enclosed crushing operation	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
Presence of hard "crust" on existing non-active clay stockpiles at the Plant 1 and Plant 2 site, which considerably minimise the potential for wind erosion emissions	95%	Katestone Environmental (2011), NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining, Prepared for NSW Office of Environment and Heritage, KE1006953, June 2011
Application of Level 1 watering (<2L/m^2/hour) on unsealed surfaces	50% [(a)]	National Pollutant Inventory (NPI), Emission Estimation Technique Manual for Mining, Version 3.1, Australian Government – Department of Sustainability, Environment, Water, Population & Communities, January 2012
Imposing speed restrictions (max. of 40km/hr on major haul routes)	44% [(a)]	Teralba Quarry Extensions, Air Quality Assessment, Report Prepared by SLR Consulting Pty. Ltd. for Metromix Pty. Ltd., January 2012
Application of low silt aggregate (gravel finish) on unsealed haulage routes	30% [(a)]	Katestone Environmental (2011), NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining, Prepared for NSW Office of Environment and Heritage, KE1006953, June 2011

(a) For haulage emissions, combined control efficiency applied. The combined control efficiency is multiplicative. For example, if Level 1 watering is used in conjunction with application of low silt aggregate, the resultant emissions will be (1-0.5) x (1-0.3) = 0.35 of the uncontrolled emissions (i.e. 65% combined control efficiency)

TSP, PM_{10} and $PM_{2.5}$ emission calculations for Plant 1 and Plant 2 are illustrated in **Figure A.1** through to **FigureA.6**.

Figure A.1: Annual Fugitive TSP Emission Estimates – Plant 1 Existing Operations

Activity	TSP Emissions (kg/year)	Intensity	Units	TSP Emission Factor	Units	Variable 1	Units	Variable 2	Units							Control Efficiency	Units	Operational Hours
FEL on raw material stockpiles	18.5	215,000	tonnes per annum	0.0001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Truck unloading raw materials	18.5	215,000	tonnes per annum	0.0001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Loading into crusher	18.5	215,000	tonnes per annum	0.0001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Crushing operations	129.0	215,000	tonnes per annum	0.0006	kg/t													6AM - 6PM, 7 days of the week
Conveying to mill building	5.6	215,000	tonnes per annum	0.0001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Mill building operations	35.5	215,000	tonnes per annum	0.0011	kg/t											85	% Control	6AM - 6PM, 7 days of the week
Conveying to brick kiln	5.6	215,000	tonnes per annum	0.0001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Wind erosion - stockpile set 1	33.6	0.8	hectares	850	kg/ha/yr											95	% Control	Continuous
Wind erosion - stockpile set 2	585.8	2.0	hectares	850	kg/ha/yr											65	% Control	Continuous
Heavy vehicle haulage on gravel surfaces	2691.3	215,000	tonnes per annum	0.06	kg/t	40	tonnes/each trip-load	2.1	km/trip	1.2	kg/vkt	2.0	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Total TSP Emissions (kg/year)	**3542**																	

Figure A.2: Annual Fugitive PM_{10} Emission Estimates – Plant 1 Existing Operations

Activity	PM10 Emissions (kg/year)	Intensity	Units	PM10 Emission Factor	Units	Variable 1	Units	Variable 2	Units							Control Efficiency	Units	Operational Hours
FEL on raw material stockpiles	8.8	215,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Truck unloading raw materials	8.8	215,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Loading into crusher	8.8	215,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Crushing operations	58.1	215,000	tonnes per annum	0.00027	kg/t													6AM - 6PM, 7 days of the week
Conveying to mill building	2.6	215,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Mill building operations	11.9	215,000	tonnes per annum	0.00037	kg/t											85	% Control	6AM - 6PM, 7 days of the week
Conveying to brick kiln	2.6	215,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Wind erosion - stockpile set 1	16.8	0.8	hectares	425	kg/ha/yr											95	% Control	Continuous
Wind erosion - stockpile set 2	292.9	2.0	hectares	425	kg/ha/yr											65	% Control	Continuous
Heavy vehicle haulage on gravel surfaces	575.7	215,000	tonnes per annum	0.01	kg/t	40	tonnes/each trip-load	2.1	km/trip	0.3	kg/vkt	2.0	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Total PM10 Emissions (kg/year)	**987**																	

Figure A.3: Annual Fugitive $PM_{2.5}$ Emission Estimates – Plant 1 Existing Operations

Activity	PM2.5 Emissions (kg/year)	Intensity	Units	PM2.5 Emission Factor	Units	Variable 1	Units	Variable 2	Units							Control Efficiency	Units	Operational Hours
FEL on raw material stockpiles	1.3	215,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Truck unloading raw materials	1.3	215,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Loading into crusher	1.3	215,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Crushing operations	10.8	215,000	tonnes per annum	0.00005	kg/t													6AM - 6PM, 7 days of the week
Conveying to mill building	0.4	215,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Mill building operations	6.0	215,000	tonnes per annum	0.00019	kg/t											85	% Control	6AM - 6PM, 7 days of the week
Conveying to brick kiln	0.4	215,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Wind erosion - stockpile set 1	2.5	0.8	hectares	63.75	kg/ha/yr											95	% Control	Continuous
Wind erosion - stockpile set 2	43.9	2.0	hectares	63.75	kg/ha/yr											65	% Control	Continuous
Heavy vehicle haulage on gravel surfaces	57.6	215,000	tonnes per annum	0.00	kg/t	40	tonnes/each trip-load	2.1	km/trip	0.0	kg/vkt	2.0	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Total PM2.5 Emissions (kg/year)	**126**																	

Figure A.4: Annual Fugitive TSP Emission Estimates – Upgraded Plant 2 Operations

Activity	TSP Emissions (kg/year)	Intensity	Units	TSP Emission Factor	Units	Variable 1	Units	Variable 2	Units							Control Efficiency	Units	Operational Hours
FEL on raw material stockpiles	24.1	280,000	tonnes per annum	0.00009	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Truck unloading raw materials	24.1	280,000	tonnes per annum	0.00009	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Loading into crusher	24.1	280,000	tonnes per annum	0.00009	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Crushing operations	168.0	280,000	tonnes per annum	0.0006	kg/t													6AM - 6PM, 7 days of the week
Conveying to mill building	7.2	280,000	tonnes per annum	0.00009	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Mill building operations	46.2	280,000	tonnes per annum	0.00110	kg/t											85	% Control	6AM - 6PM, 7 days of the week
Conveying to the new brick kiln	7.2	280,000	tonnes per annum	0.00009	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Wind erosion - inactive stockpile 1	29.8	0.7	hectares	850	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 2	64.4	1.5	hectares	850	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 3	107.1	2.5	hectares	850.00	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 4	166.1	3.9	hectares	850.00	kg/ha/yr											95	% Control	Continuous
Wind erosion - active stockpile 1	505.8	1.2	hectares	850.00	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 2	489.8	1.6	hectares	850.00	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 3	301.4	1.0	hectares	850.00	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 4	1645.6	3.9	hectares	850	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 5	1165.9	2.7	hectares	850.00	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 6	135.9	0.5	hectares	850.00	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 7	668.7	1.6	hectares	850.00	kg/ha/yr											50	% Control	Continuous
Heavy vehicle haulage on gravel surfaces - (Path 1 only)	1332.7	140,000	tonnes per annum	0.0486	kg/t	40	tonnes/each trip-load	1.62	km/trip	1.199	kg/vkt	2	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Heavy vehicle haulage on gravel surfaces - (Path 2 only)	828.8	140,000	tonnes per annum	0.0302	kg/t	40	tonnes/each trip-load	1.01	km/trip	1.199	kg/vkt	2	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Total TSP Emissions (kg/year)	**7743**																	

Figure A.5: Annual Fugitive PM_{10} Emission Estimates – Upgraded Plant 2 Operations

Activity	PM10 Emissions (kg/year)	Intensity	Units	PM10 Emission Factor	Units	Variable 1	Units	Variable 2	Units							Control Efficiency	Units	Operational Hours
FEL on raw material stockpiles	11.4	280,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Truck unloading raw materials	11.4	280,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Loading into crusher	11.4	280,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Crushing operations	75.6	280,000	tonnes per annum	0.00027	kg/t													6AM - 6PM, 7 days of the week
Conveying to mill building	3.4	280,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Mill building operations	15.5	280,000	tonnes per annum	0.00037	kg/t											85	% Control	6AM - 6PM, 7 days of the week
Conveying to the new brick kiln	3.4	280,000	tonnes per annum	0.00004	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Wind erosion - inactive stockpile 1	14.9	0.7	hectares	425	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 2	32.2	1.5	hectares	425	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 3	53.6	2.5	hectares	425.00	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 4	83.1	3.9	hectares	425.00	kg/ha/yr											95	% Control	Continuous
Wind erosion - active stockpile 1	252.9	1.2	hectares	425.00	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 2	244.9	1.6	hectares	425.00	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 3	150.7	1.0	hectares	425.00	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 4	822.8	3.9	hectares	425	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 5	583.0	2.7	hectares	425.00	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 6	68.0	0.5	hectares	425.00	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 7	334.3	1.6	hectares	425.00	kg/ha/yr											50	% Control	Continuous
Heavy vehicle haulage on gravel surfaces - (Path 1 only)	285.1	140,000	tonnes per annum	0.0104	kg/t	40	tonnes/each trip-load	1.62	km/trip	0.257	kg/vkt	2	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Heavy vehicle haulage on gravel surfaces - (Path 2 only)	177.3	140,000	tonnes per annum	0.0065	kg/t	40	tonnes/each trip-load	1.01	km/trip	0.257	kg/vkt	2	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Total PM10 Emissions (kg/year)	**3235**																	

Figure A.6: Annual Fugitive $PM_{2.5}$ Emission Estimates – Upgraded Plant 2 Operations

Activity	PM2.5 Emissions (kg/year)	Intensity	Units	PM2.5 Emission Factor	Units	Variable 1	Units	Variable 2	Units							Control Efficiency	Units	Operational Hours
FEL on raw material stockpiles	1.7	280,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Truck unloading raw materials	1.7	280,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Loading into crusher	1.7	280,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4									6AM - 6PM, 7 days of the week
Crushing operations	14.0	280,000	tonnes per annum	0.00005	kg/t													6AM - 6PM, 7 days of the week
Conveying to mill building	0.5	280,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Mill building operations	7.8	280,000	tonnes per annum	0.00019	kg/t											85	% Control	6AM - 6PM, 7 days of the week
Conveying to the new brick kiln	0.5	280,000	tonnes per annum	0.00001	kg/t	1.00	average (wind speed /2.2)^1.3 in (m/sec)	13.74	(moisture content /2)^1.4							70	% Control	6AM - 6PM, 7 days of the week
Wind erosion - inactive stockpile 1	2.2	0.7	hectares	63.75	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 2	4.8	1.5	hectares	63.75	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 3	8.0	2.5	hectares	63.75	kg/ha/yr											95	% Control	Continuous
Wind erosion - inactive stockpile 4	12.5	3.9	hectares	63.75	kg/ha/yr											95	% Control	Continuous
Wind erosion - active stockpile 1	37.9	1.2	hectares	63.75	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 2	36.7	1.6	hectares	63.75	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 3	22.6	1.0	hectares	63.75	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 4	123.4	3.9	hectares	63.75	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 5	87.4	2.7	hectares	63.75	kg/ha/yr											50	% Control	Continuous
Wind erosion - active stockpile 6	10.2	0.5	hectares	63.75	kg/ha/yr											65	% Control	Continuous
Wind erosion - active stockpile 7	50.1	1.6	hectares	63.75	kg/ha/yr											50	% Control	Continuous
Heavy vehicle haulage on gravel surfaces - (Path 1 only)	28.5	140,000	tonnes per annum	0.0010	kg/t	40	tonnes/each trip-load	1.62	km/trip	0.026	kg/vkt	2	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Heavy vehicle haulage on gravel surfaces - (Path 2 only)	17.7	140,000	tonnes per annum	0.0006	kg/t	40	tonnes/each trip-load	1.01	km/trip	0.026	kg/vkt	2	% silt content	54	Avg GVM (tonnes)	80.4	% Control	6AM - 6PM, 7 days of the week
Total PM2.5 Emissions (kg/year)	**470**																	

APPENDIX B

Selection of Meteorological Year

Analysis of the meteorological data recorded at the site-representative location – BoM Horsley Park AWS (AWS No: 067119) over a five (5) year period between 2013-2017 has been undertaken.

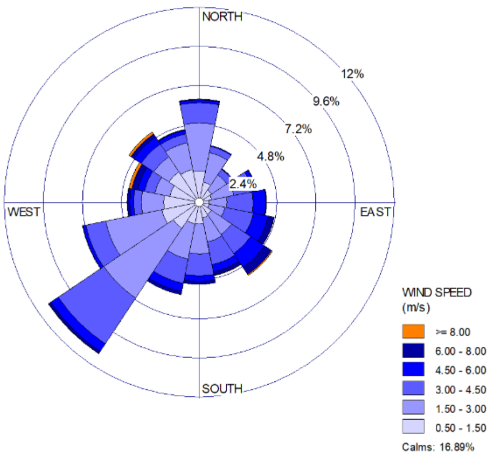
The following charts have been produced to compare the one-year site-representative data (2017) with five (5) year observations and to support the selection of the 2017 meteorological modelling year.

- Interannual (2013-2017) wind roses – BoM Horsley Park AWS.
- Interannual (2013-2017) mean maximum and mean minimum temperature profiles – BoM Horsley Park AWS
- Interannual (2013-2017) wind speed frequency distribution chart – BoM Horsley Park AWS.
- Interannual (2013-2017) percentage of calms – BoM Horsley Park AWS.

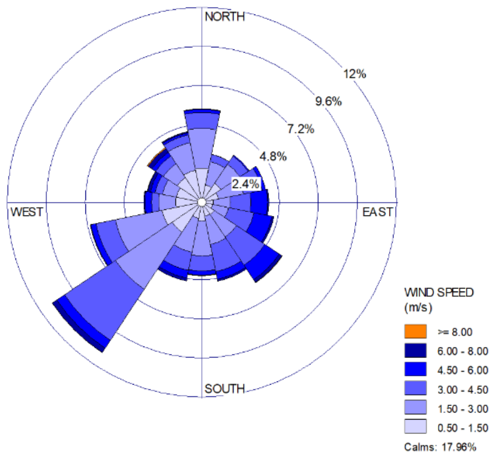
Additionally, the following metrics have been produced from the CALMET output at the centre of the Plant 2 site as these parameters are not readily measured by the BoM stations. It is to be noted that the distance between the BoM Horsley Park AWS and Plant 2 site is approximately 2.5km. As the separation distance is not large enough, the below parameters can be considered representative for the BoM location.

- 2013-17 stability class frequency distribution – extracted from the CALMET output at the centre of the Plant 2 site.
- 2013-17 mixing height frequency distribution – extracted from the CALMET output at the centre of the Plant 2 site.

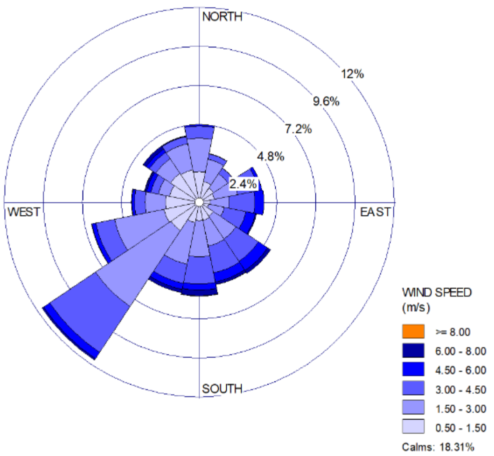
Figure B.1: Inter-Annual Wind Roses – BoM Horsley Park AWS – 2013 to 2017



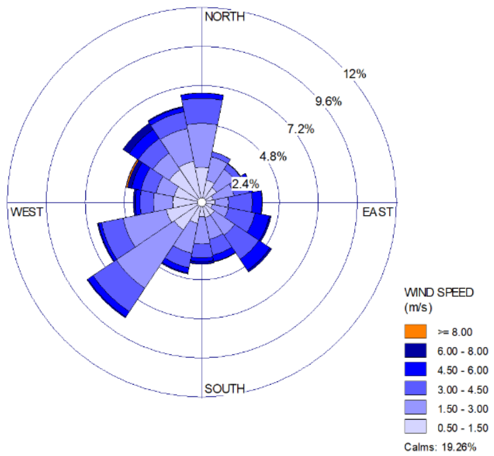
2013



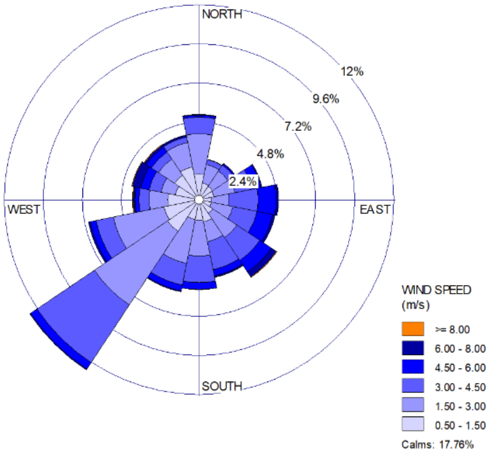
2014



2015



2016



2017

Figure B.2: Inter-Annual Mean Maximum Temperature Profile – BoM Horsley Park AWS – 2013 to 2017

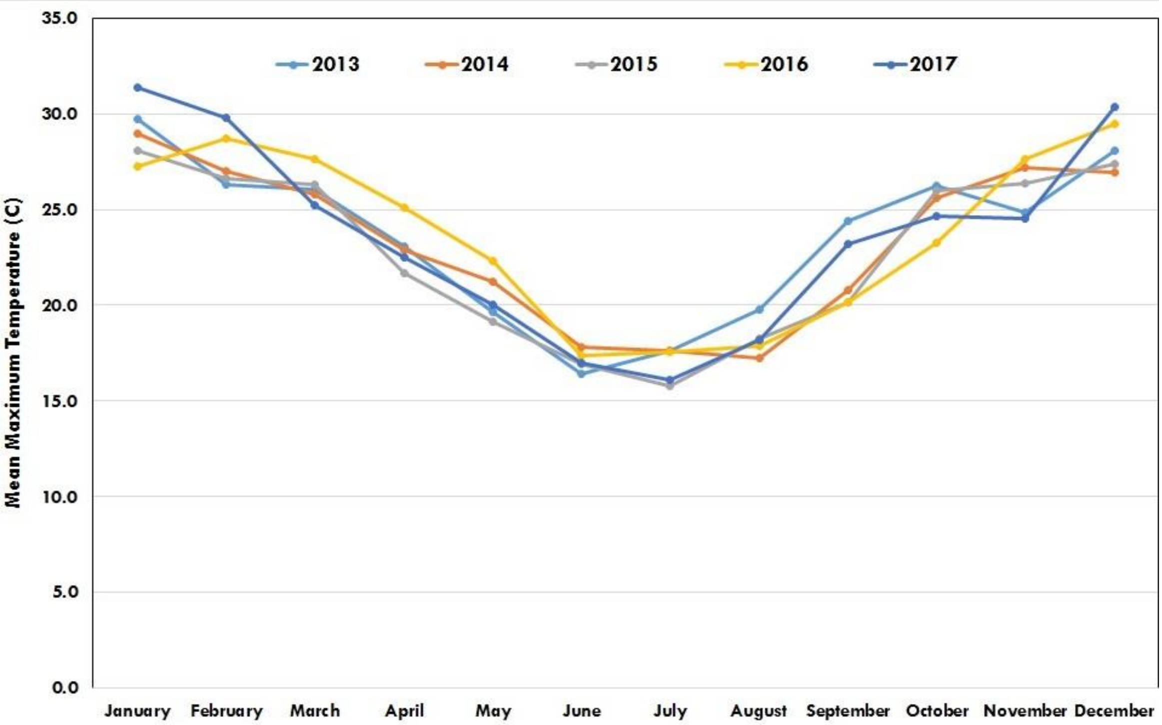


Figure B.3: Inter-Annual Mean Minimum Temperature Profile – BoM Horsley Park AWS – 2013 to 2017

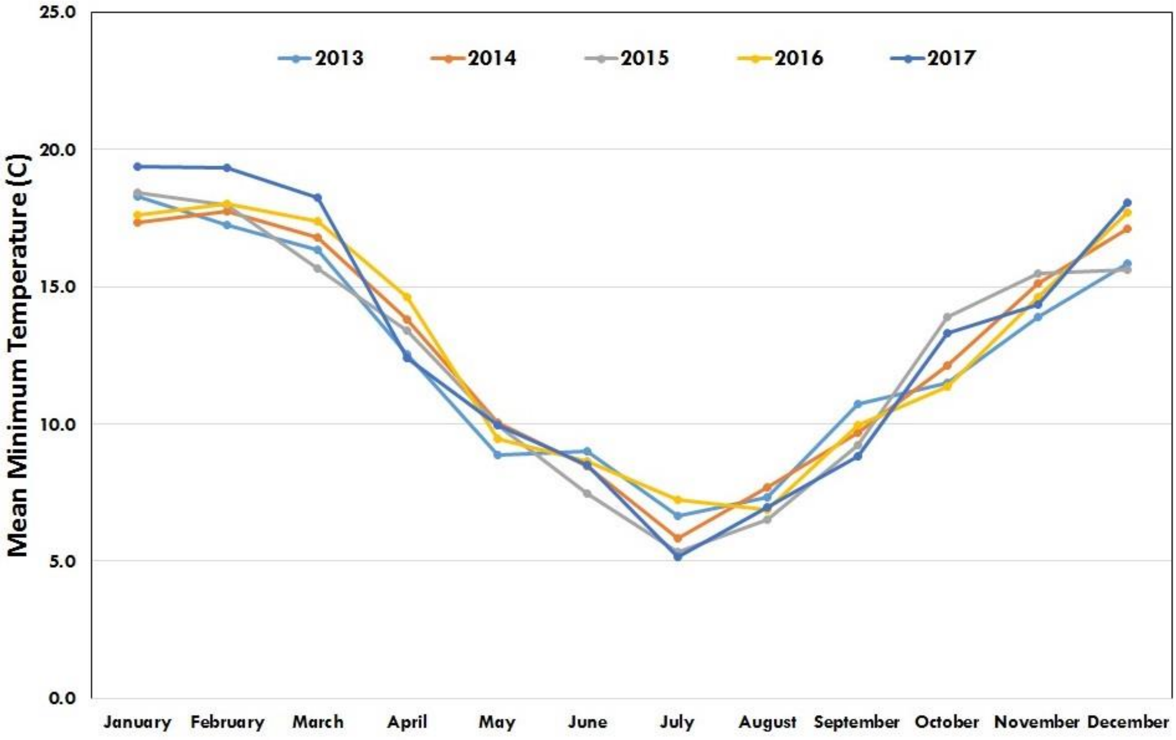


Figure B.4: Inter-Annual Wind Speed Frequency – BoM Horsley Park AWS – 2013 to 2017

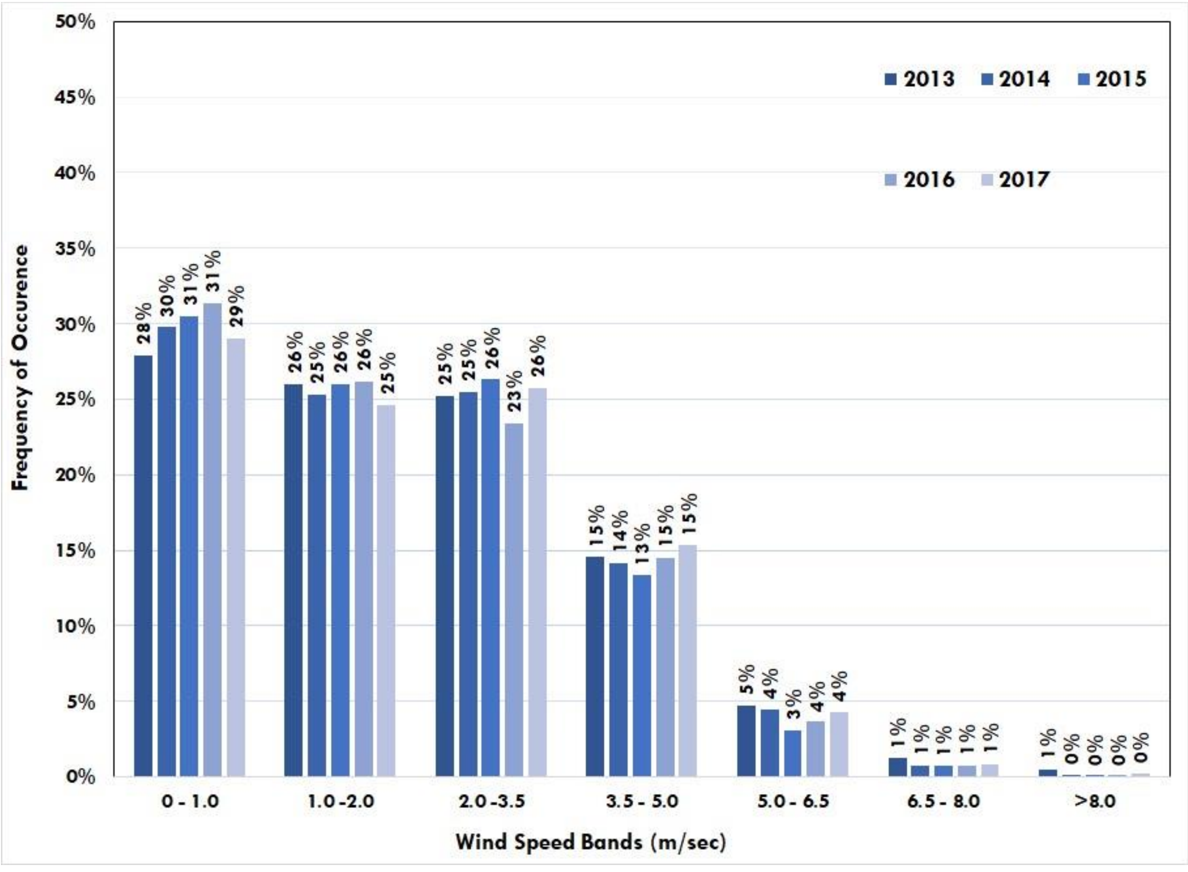


Figure B.5: Inter-Annual Calms Percentage – BoM Horsley Park AWS – 2013 to 2017

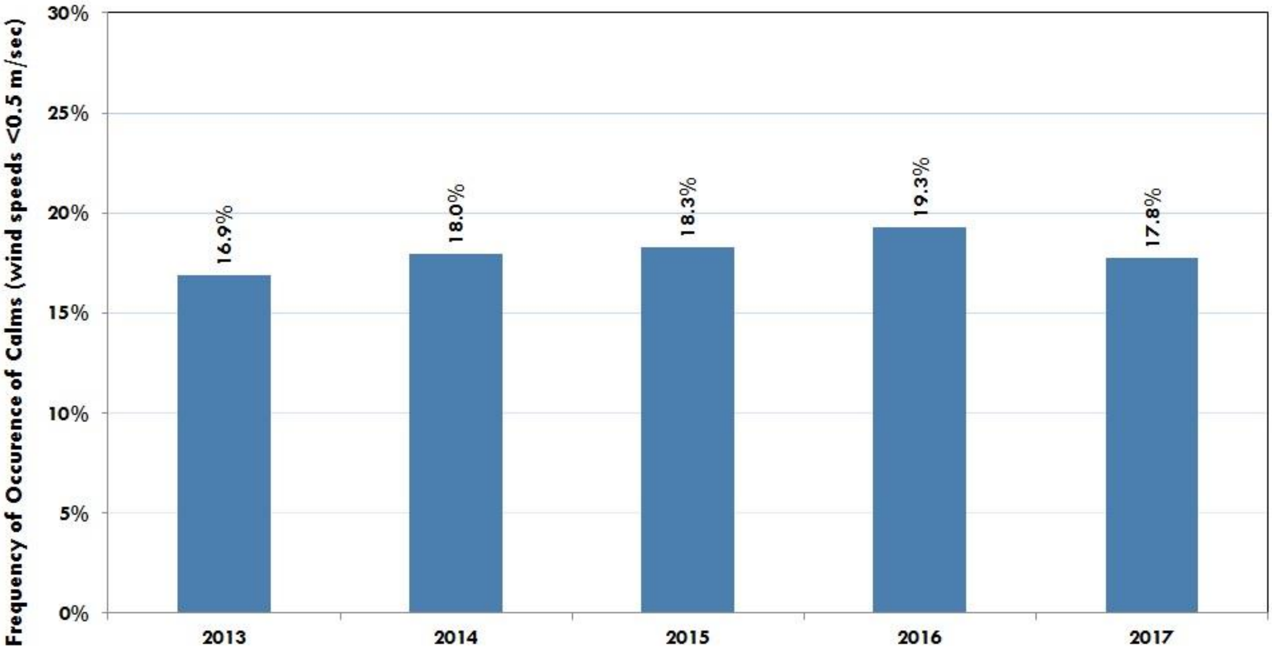


Figure B.6: Inter Annual CALMET Predicted Stability Class Frequency Distribution – extracted from the CALMET output at the centre of the Plant 2 site

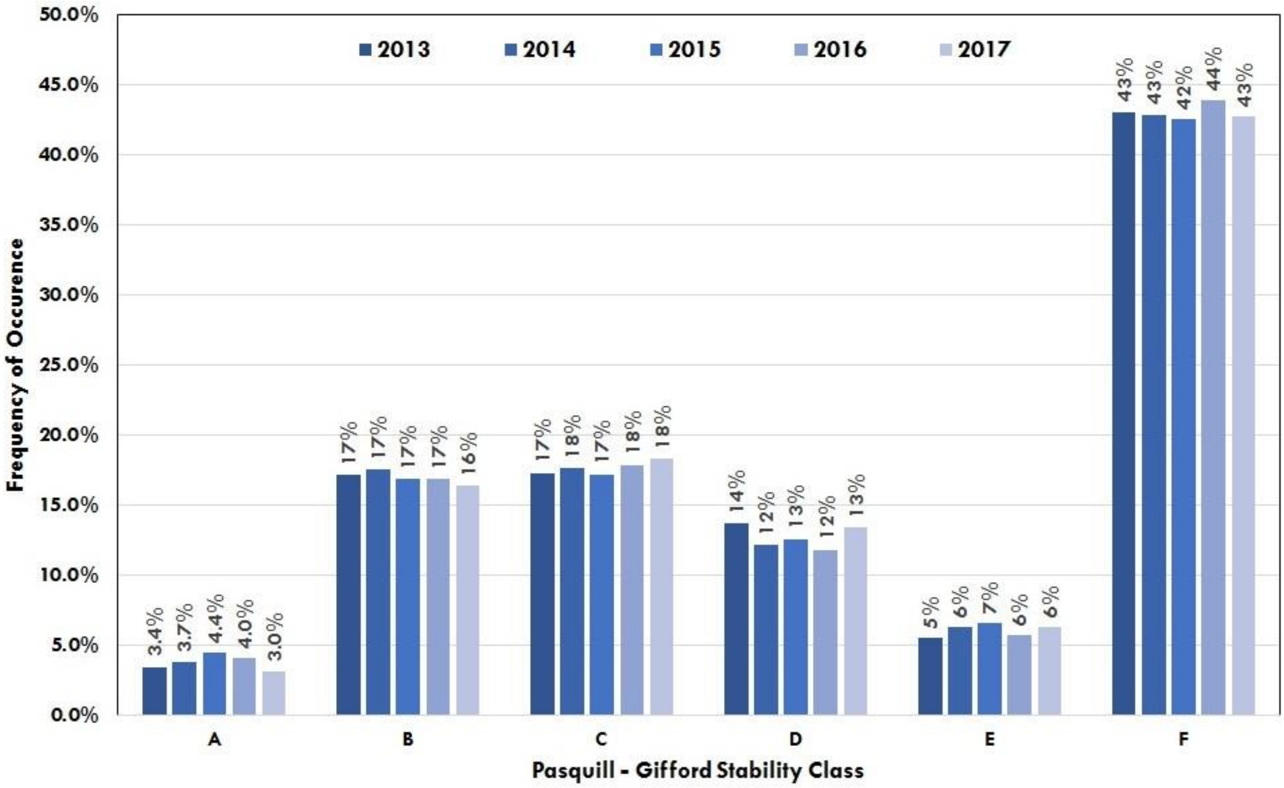
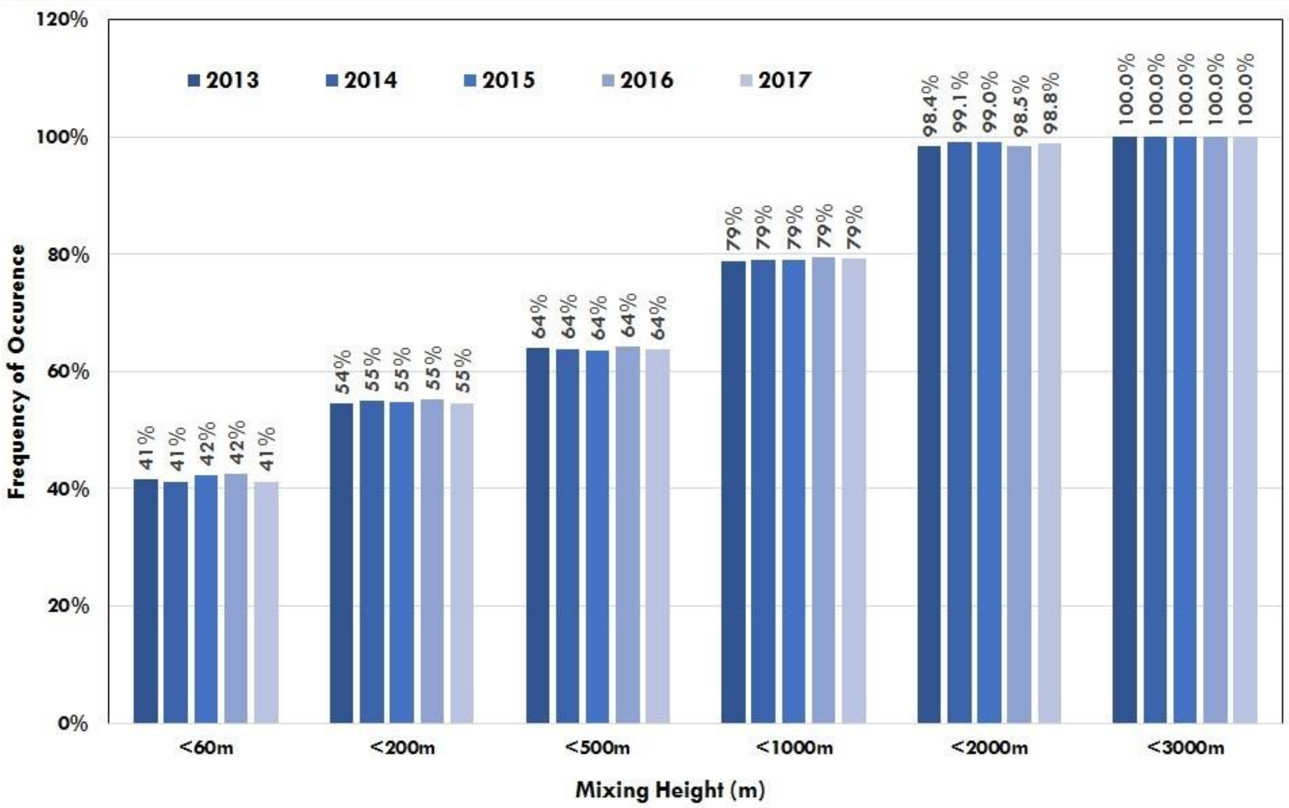


Figure B.7: Inter Annual CALMET Mixing Height Profile Frequency Distribution – extracted from the CALMET output at the centre of the Plant 2 site



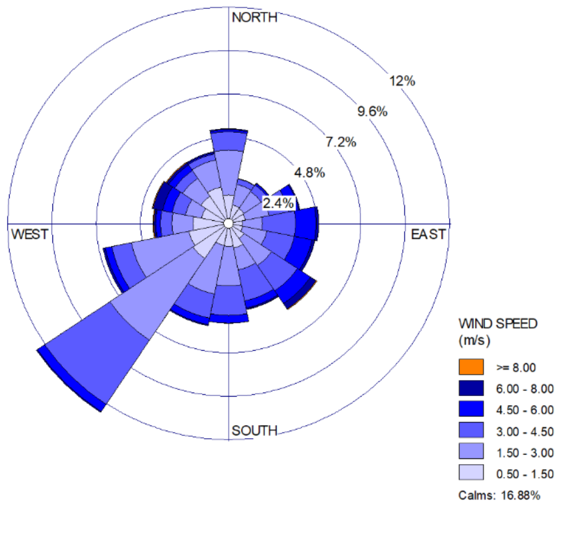
Interannual analysis presented in **Figure B.1** through to **Figure B.7** shows that there is minimal inter-annual variation in the winds measured across this period. Therefore, the 2017 calendar year is considered site representative.

To demonstrate that the CALMET output for 2017 adequately represents the expected meteorological patterns at the site, the following charts have been produced:

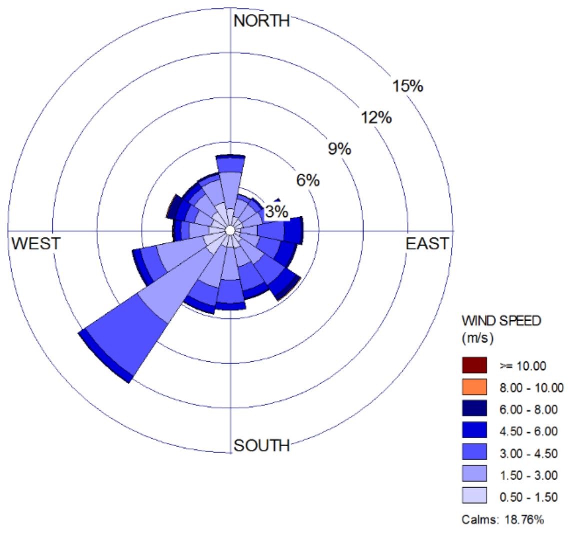
- Comparison of the 2017 annual wind roses and percentage of calms for BoM Horsley Park AWS and CALMET predicted output at the centre of the Plant 2 site.
- Comparison of the 2017 wind speed frequency distribution for BoM Horsley Park AWS and CALMET predicted output at the centre of the Plant 2 site.

Given that the separation distance between the Plant 2 site and the BoM Horsley Park AWS is 2.5km, it is reasonable to expect similar wind patterns at both sites and the information presented in **Figure B.8** and **Figure B.9** demonstrate the similarity in wind patterns, which therefore, validates the CALMET model output.

Figure B.8: Comparison of Annual Wind Roses for 2017 - BoM Horsley Park AWS Observations (Left) vs CALMET Predicted Wind Field (Right) at the centre of the Plant 2 site

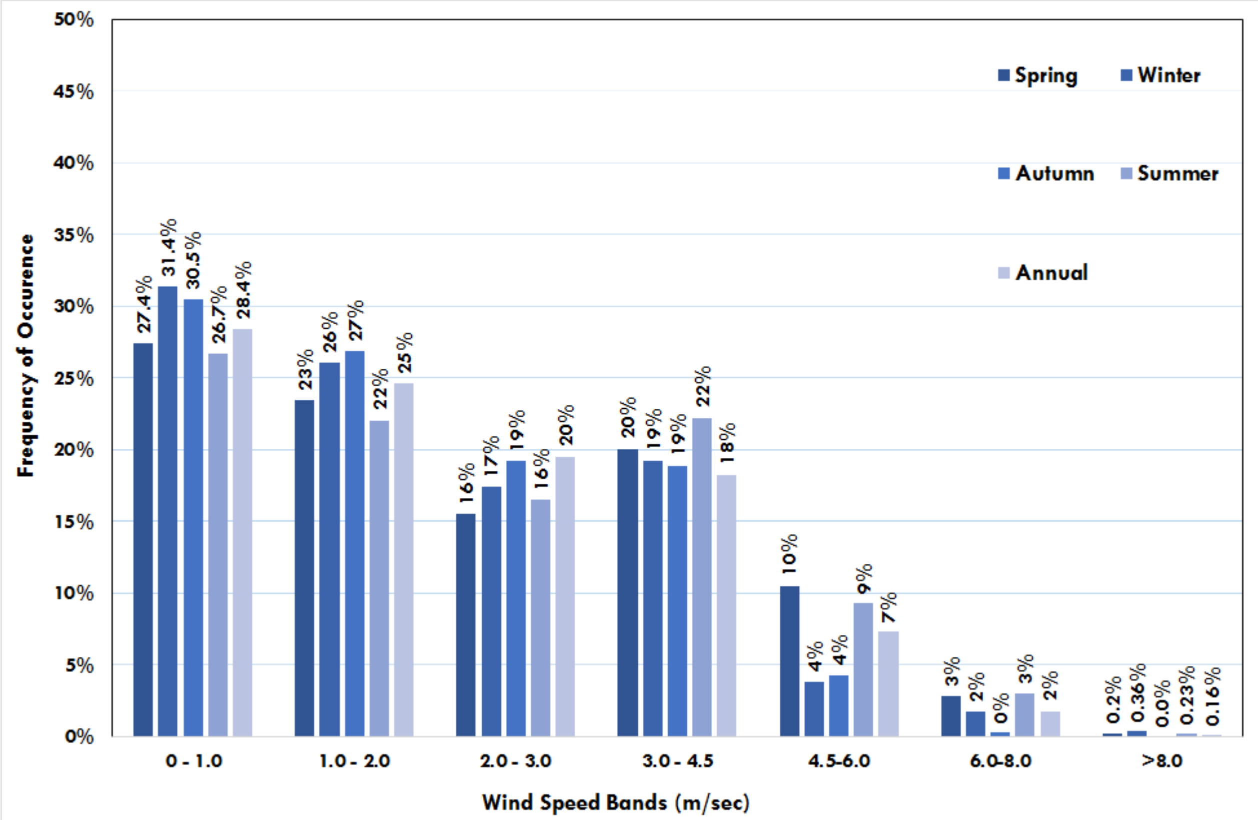


Annual Wind Rose – BoM Horsley Park, 2017

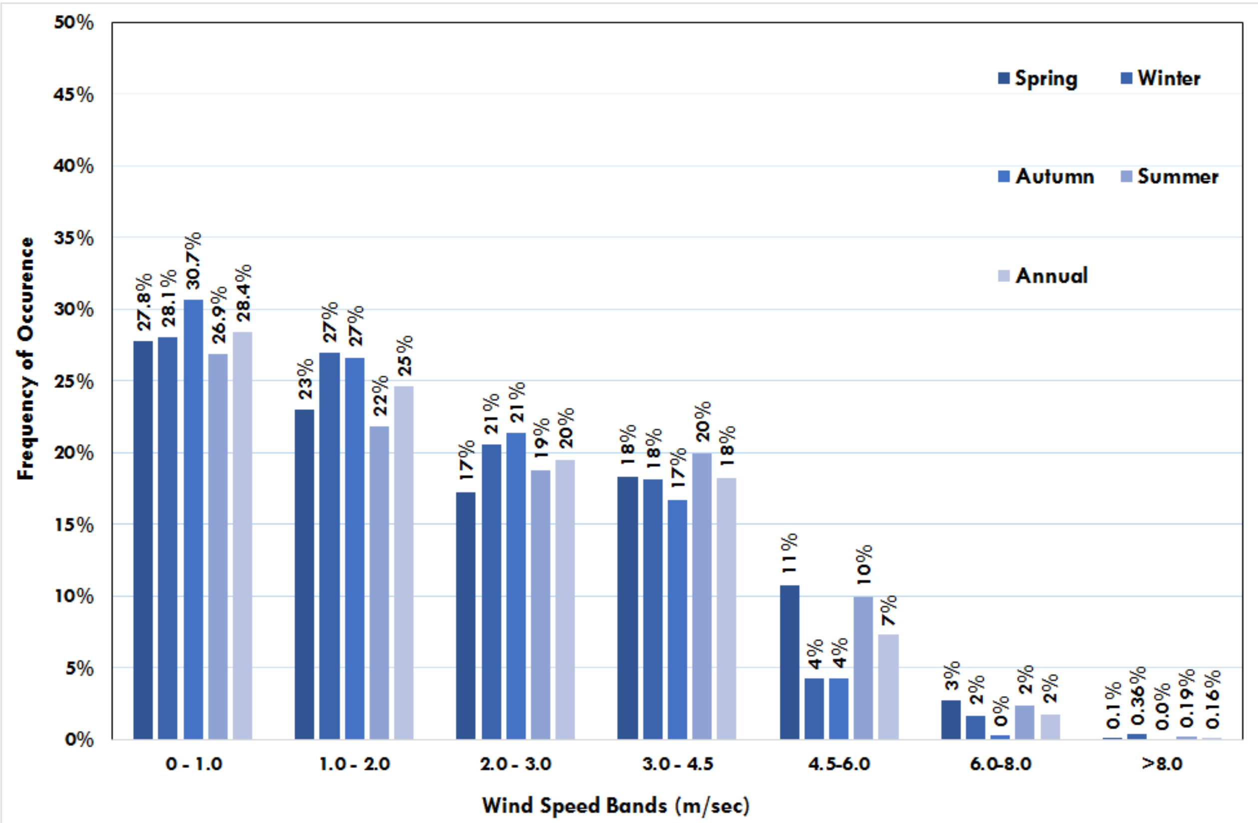


Annual Wind Rose – CALMET Predicted, 2017

Figure B.9: Comparison of 2017 Wind Speed Frequency Distribution for BoM Horsley Park AWS (Above) and CALMET predicted output (Below) at the centre of the Plant 2 site



BoM AWS Horsley Park - 2017



CALMET Predicted – 2017

APPENDIX C

Incremental and Cumulative Concentration Isopleths

Figure C.1: Incremental (Plant 2 only) 90-days average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 0.5 μg/m³ – red contour, Specialised land-use assessment criteria: 0.25 μg/m³ – blue contour)

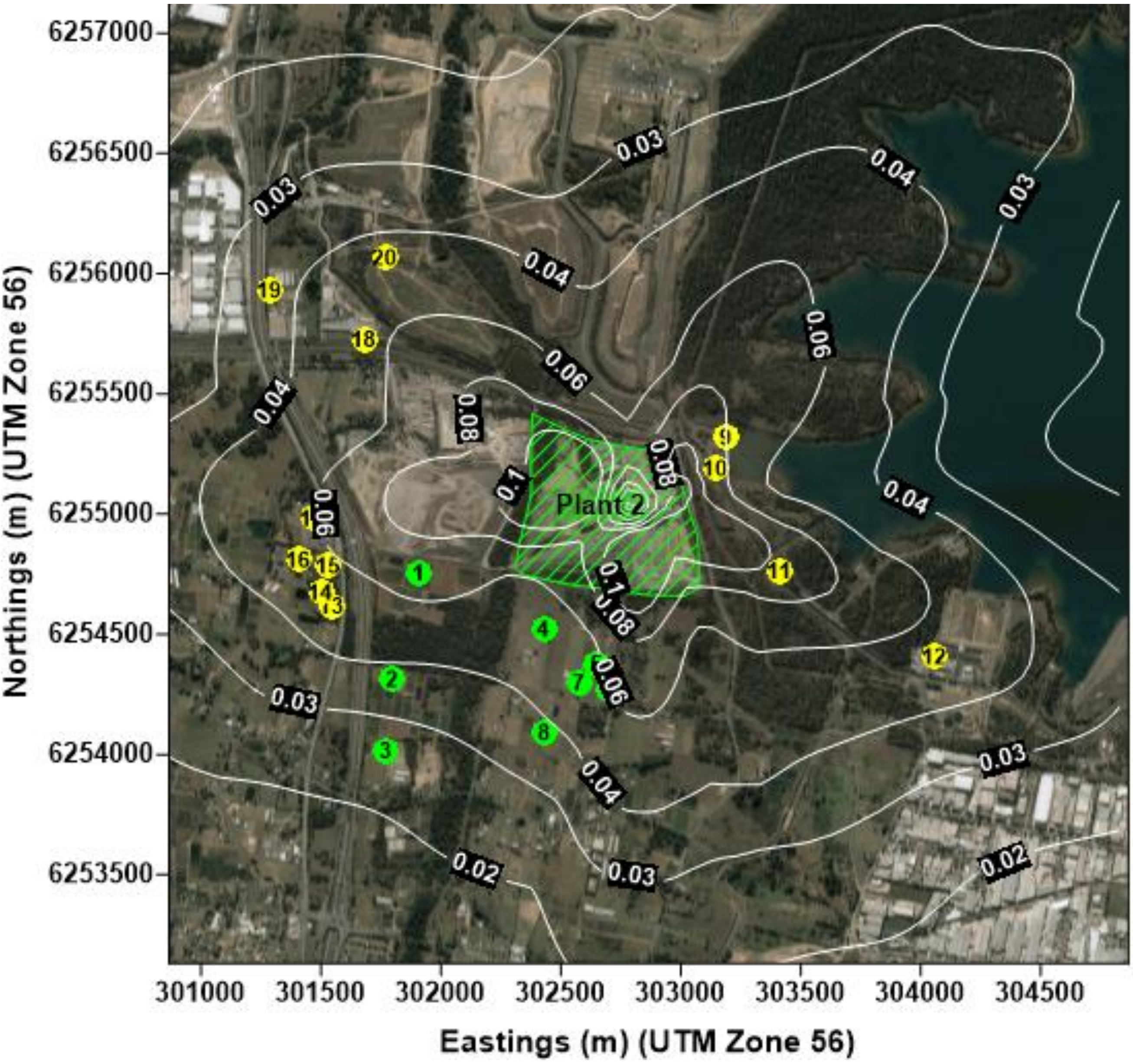


Figure C.2: Incremental (Plant 2 only) 30-days average maximum HF concentrations (µg/m³) (General land-use assessment criteria: 0.84 µg/m³ – red contour, Specialised land-use assessment criteria: 0.4 µg/m³ – blue contour)

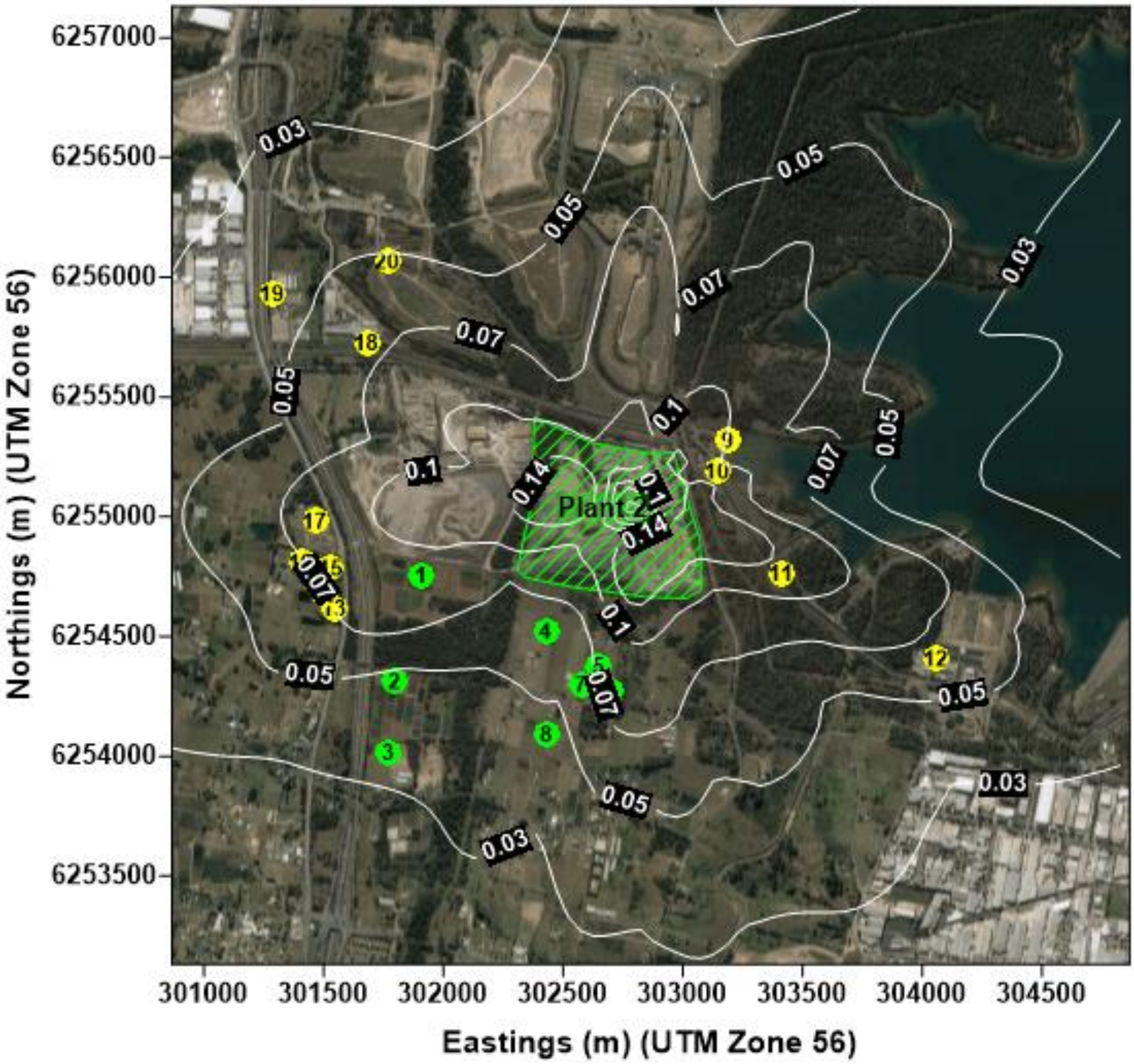


Figure C.3: Incremental (Plant 2 only) 7-days average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 1.7 μg/m³ – red contour, Specialised land-use assessment criteria: 0.8 μg/m³ – blue contour)

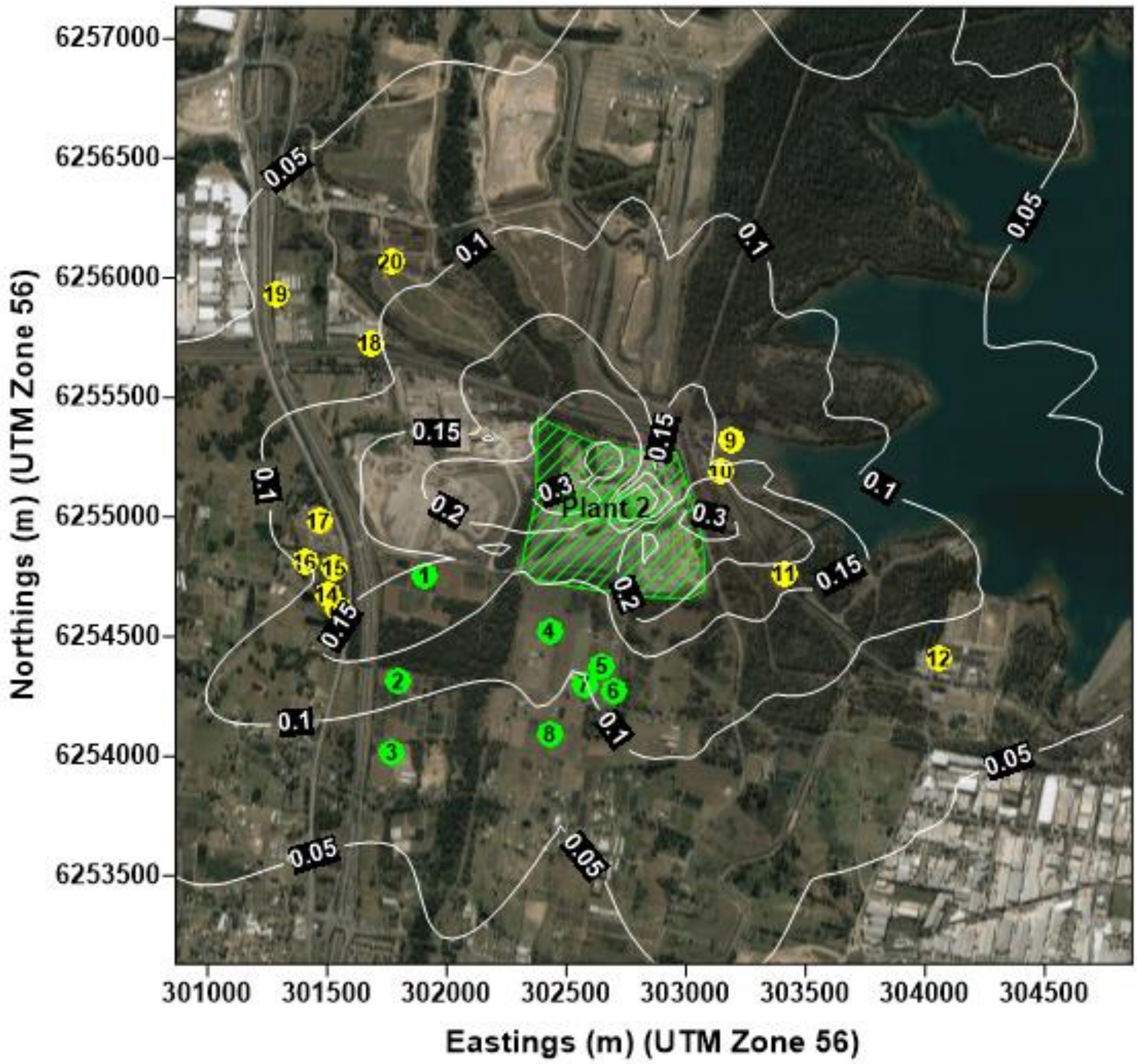


Figure C.4: Incremental (Plant 2 only) 24-hours average maximum HF concentrations (µg/m³) (General land-use assessment criteria: 2.9 µg/m³ – red contour, Specialised land-use assessment criteria: 1.5 µg/m³ – blue contour)

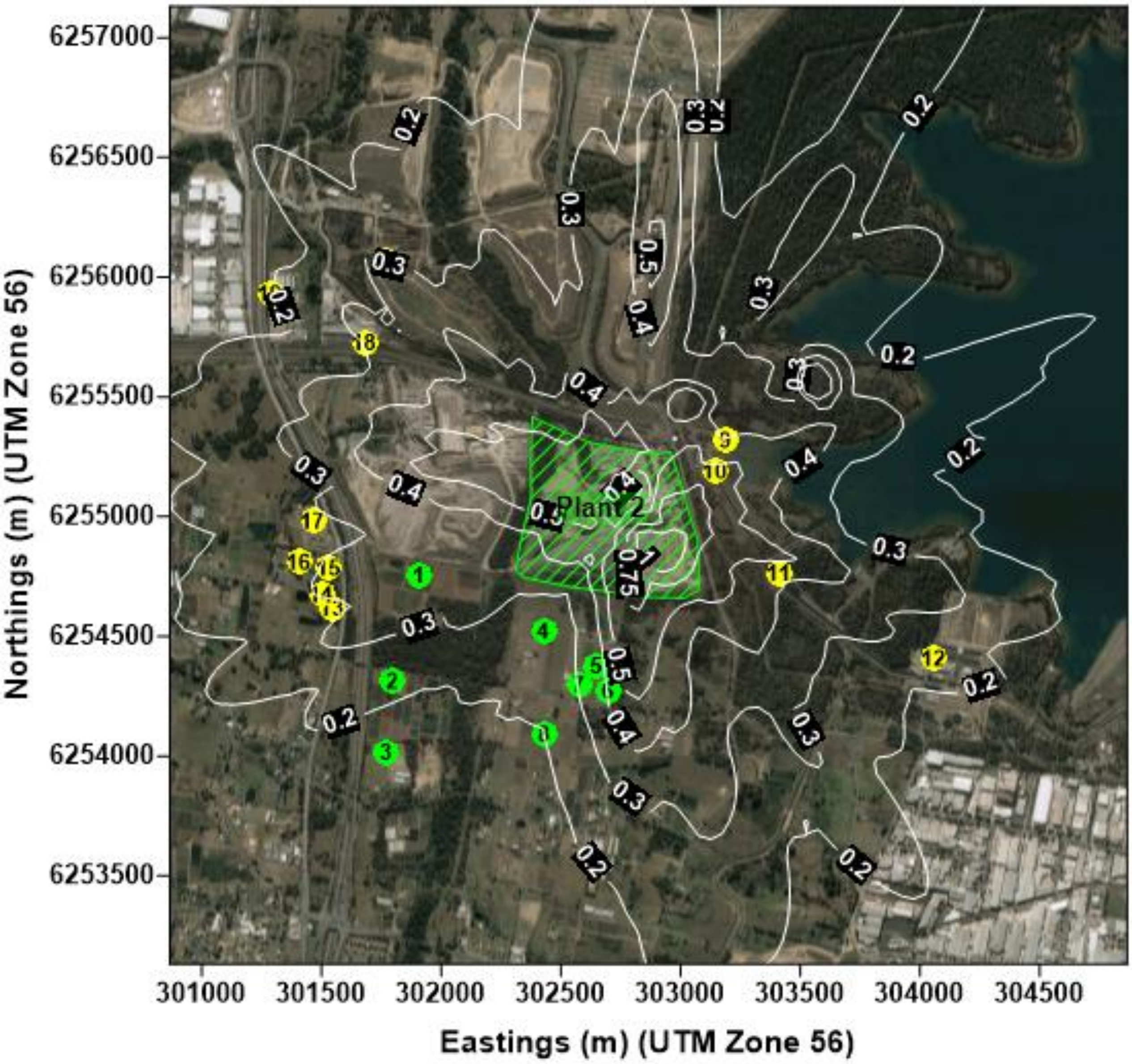


Figure C.5: Cumulative 90-days average maximum HF concentrations (µg/m³) (General land-use assessment criteria: 0.5 µg/m³ – red contour, Specialised land-use assessment criteria: 0.25 µg/m³ - blue contour)

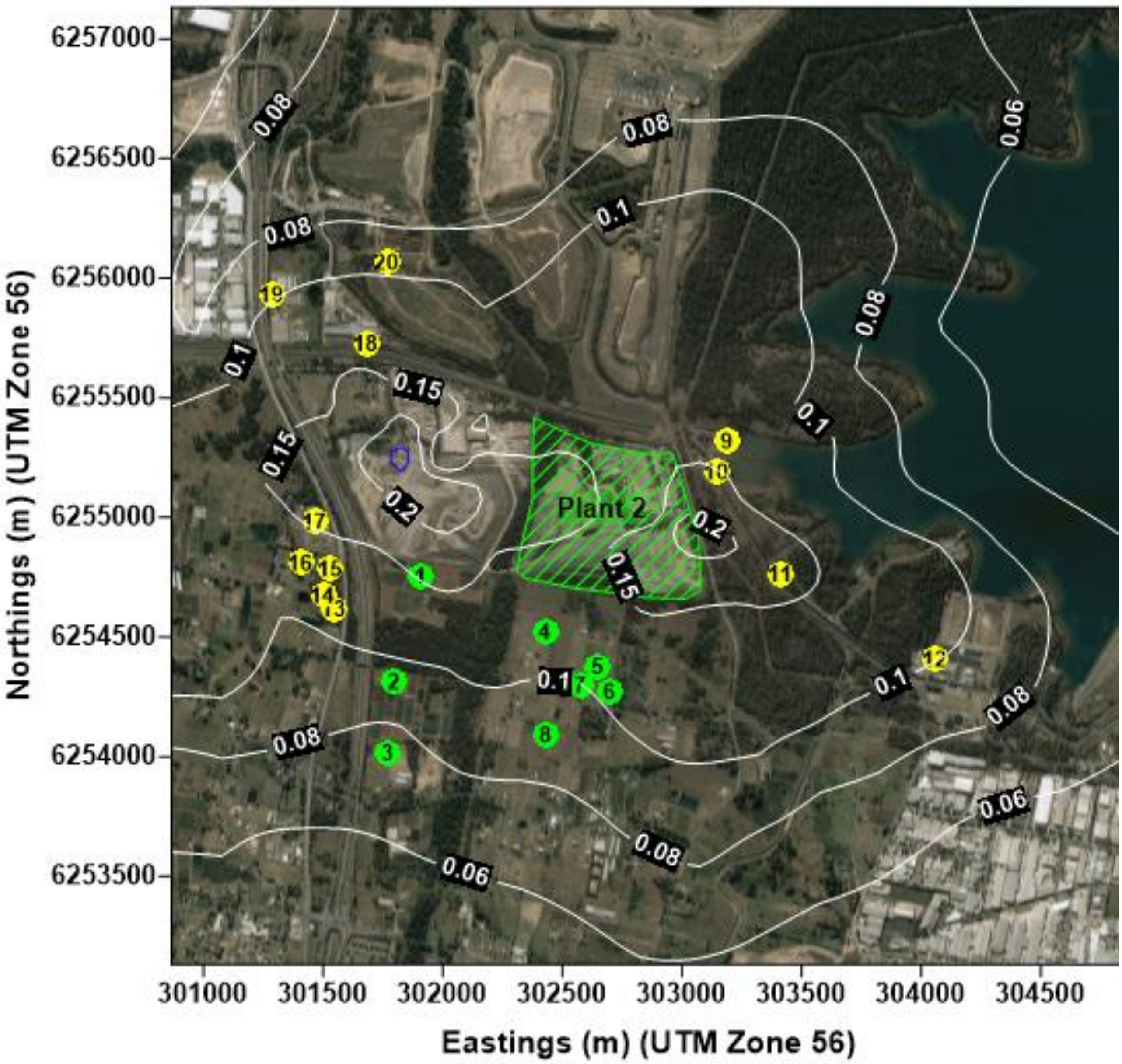


Figure C.6: Cumulative 30-days average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 0.84 μg/m³ – red contour, Specialised land-use assessment criteria: 0.4 μg/m³ - blue contour)

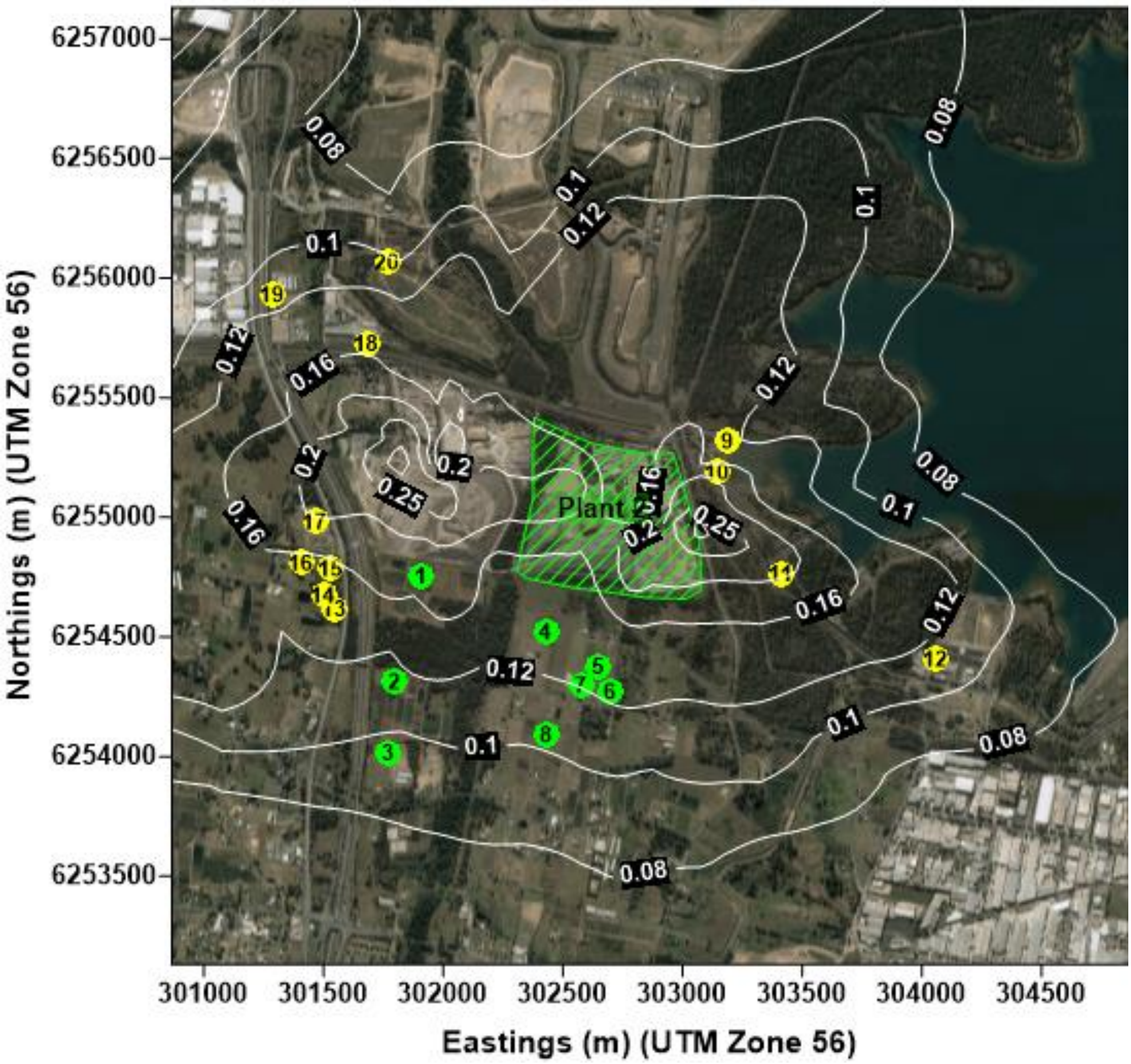


Figure C.7: Cumulative 7-days average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 1.7 μg/m³ – red contour, Specialised land-use assessment criteria: 0.8 μg/m³ - blue contour)

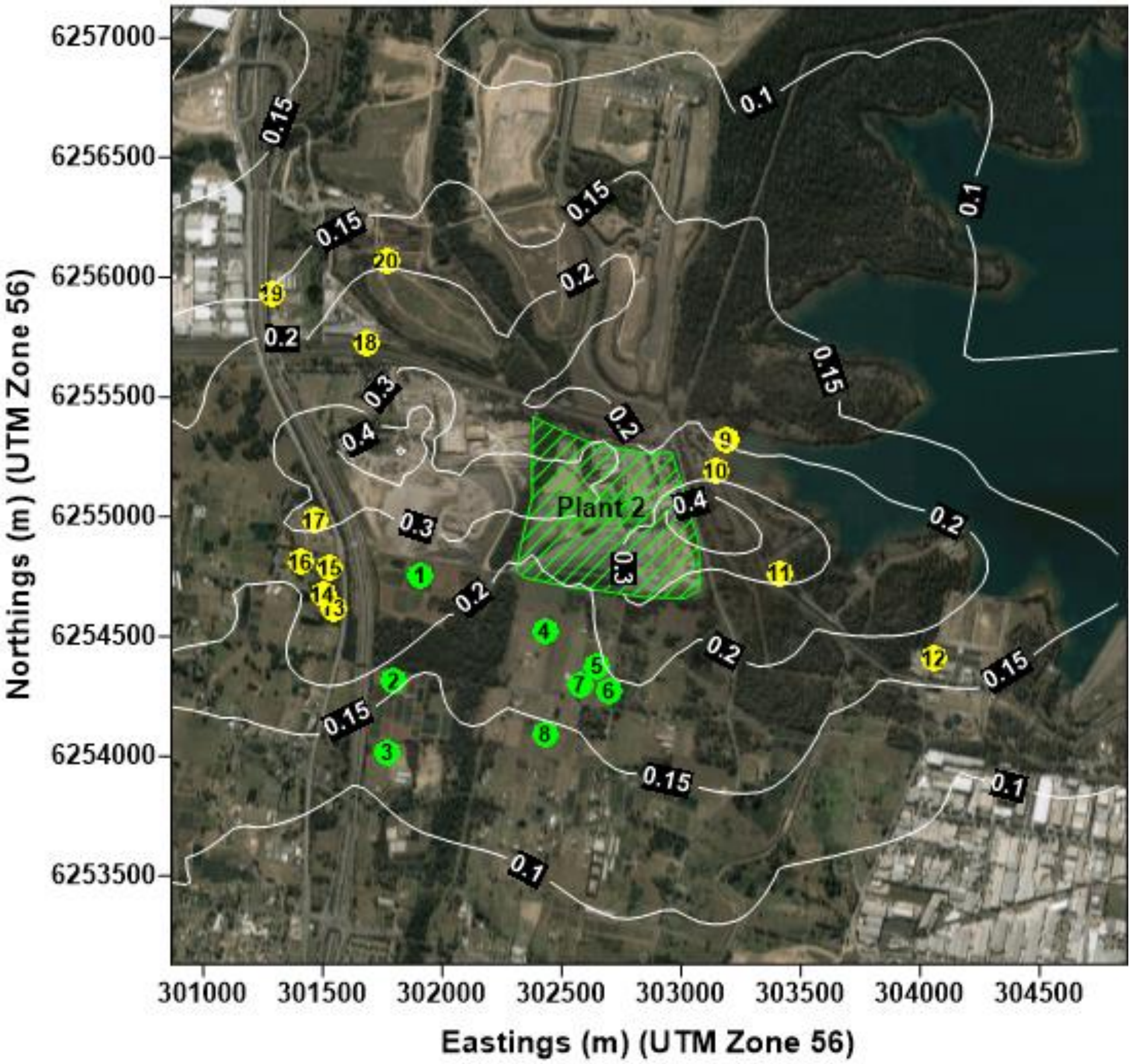


Figure C.8: Cumulative 24-hours average maximum HF concentrations (μg/m³) (General land-use assessment criteria: 2.9 μg/m³ – red contour, Specialised land-use assessment criteria: 1.5 μg/m³ - blue contour)

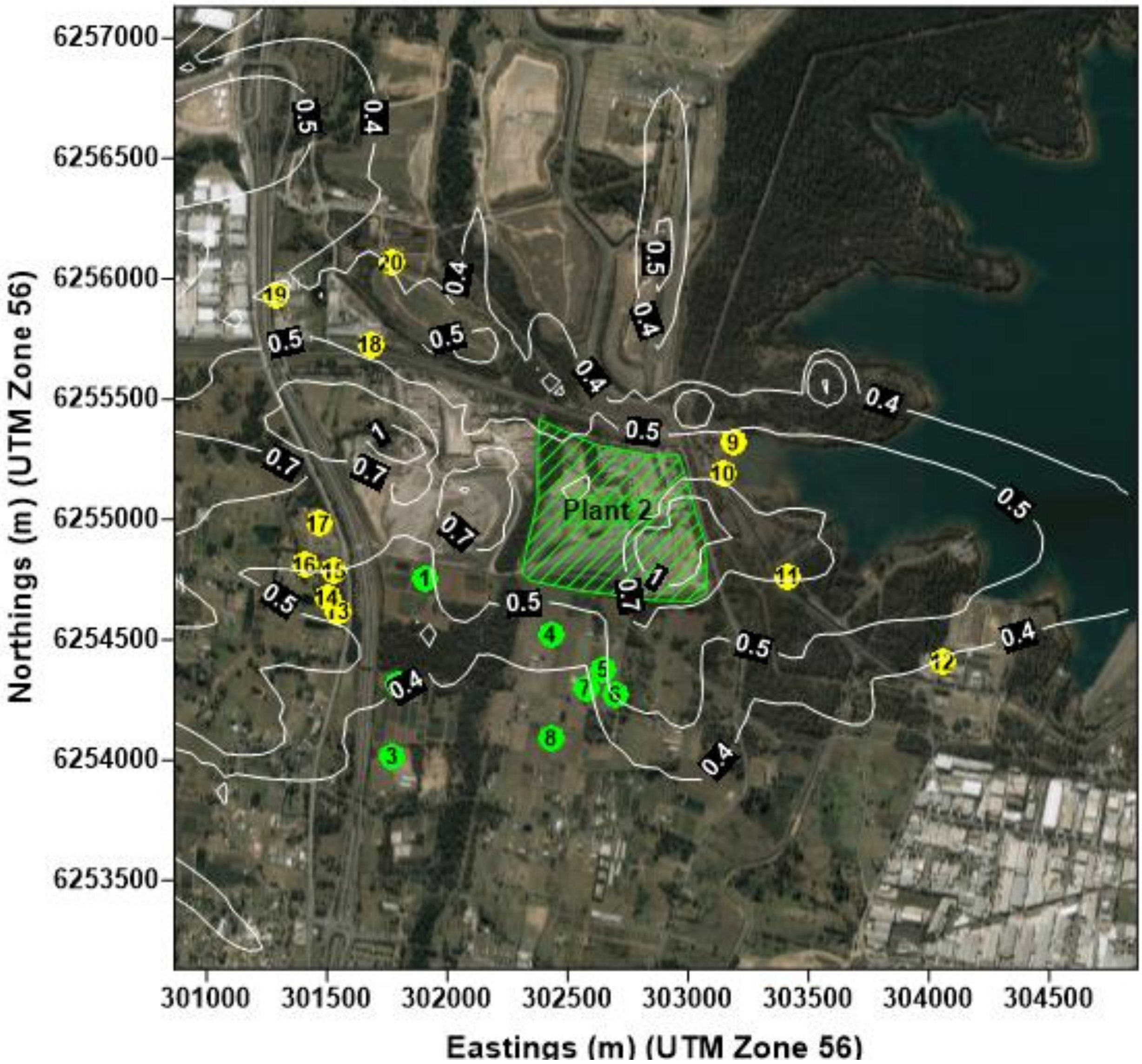


Figure C.9: Cumulative 24-hours average maximum PM_{10} concentrations ($\mu g/m^3$) (Assessment criteria: 50 $\mu g/m^3$) (Assessment criteria contour shown in red)

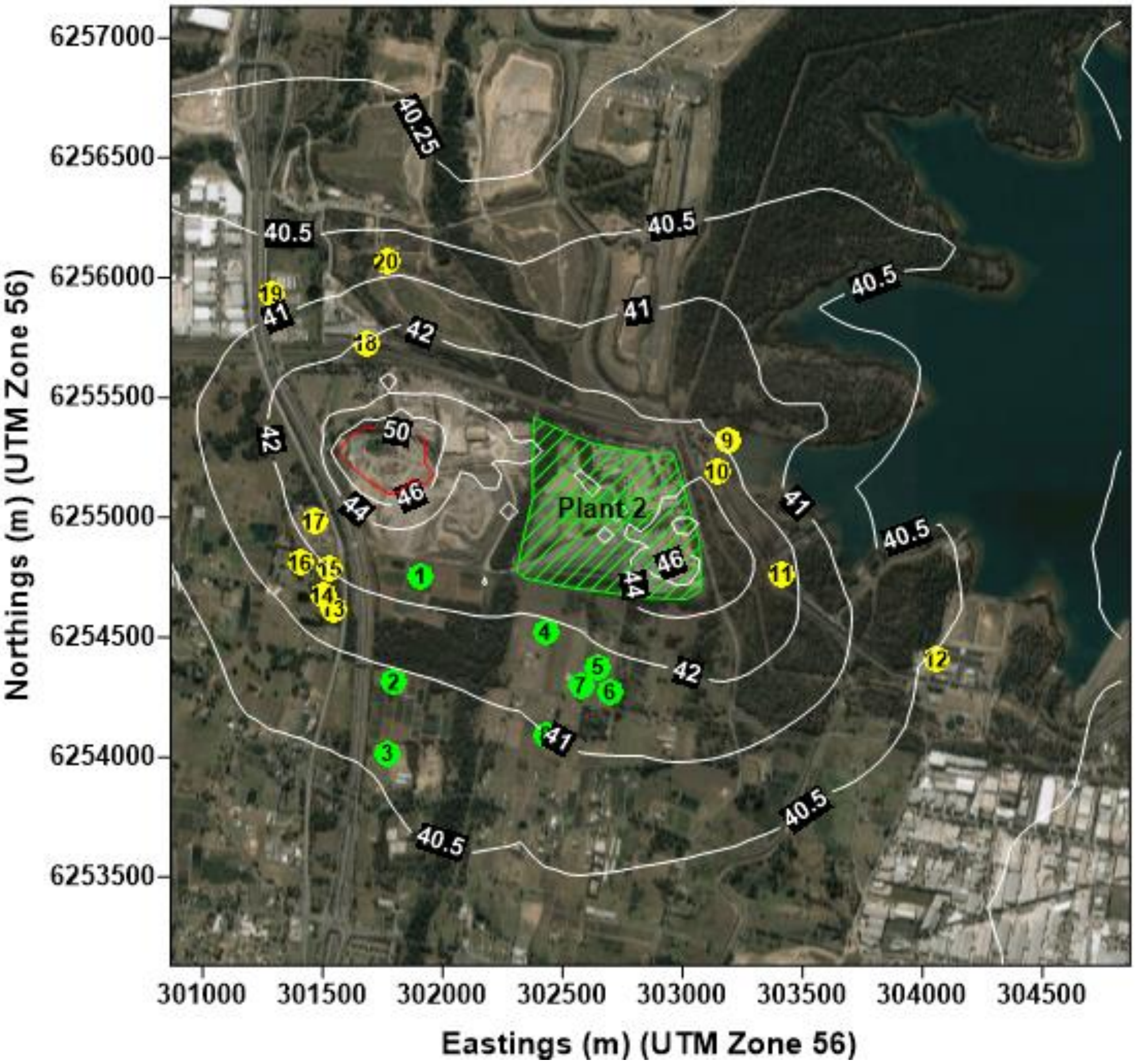


Figure C.10: Cumulative annual average PM_{10} concentrations ($\mu g/m^3$) (Assessment criteria: 25 $\mu g/m^3$) (Assessment criteria contour shown in red)

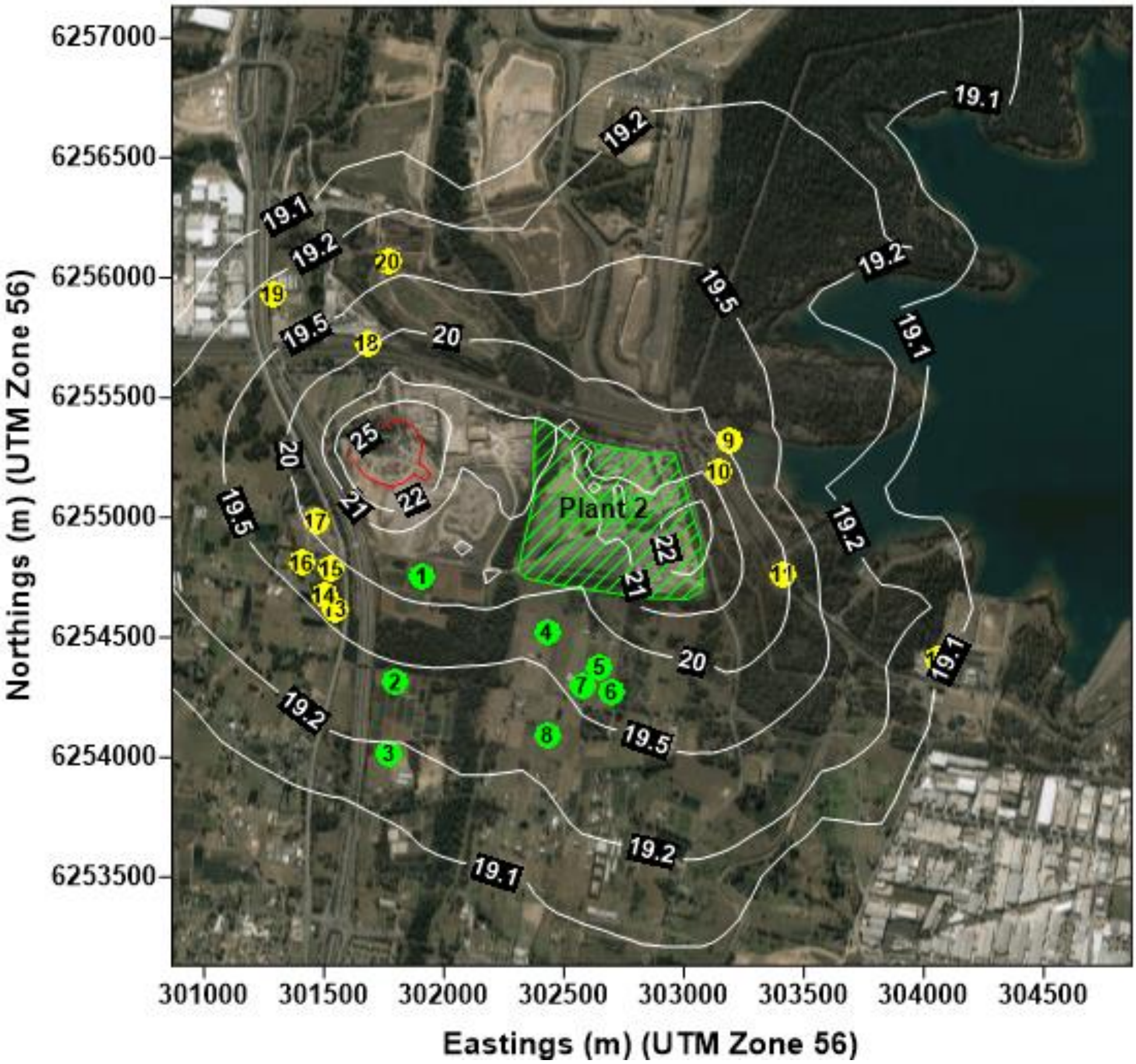


Figure C.11: Cumulative 24-hours average maximum $PM_{2.5}$ concentrations ($\mu g/m^3$) (Assessment criteria: 25 $\mu g/m^3$) (Assessment criteria contour shown in red)

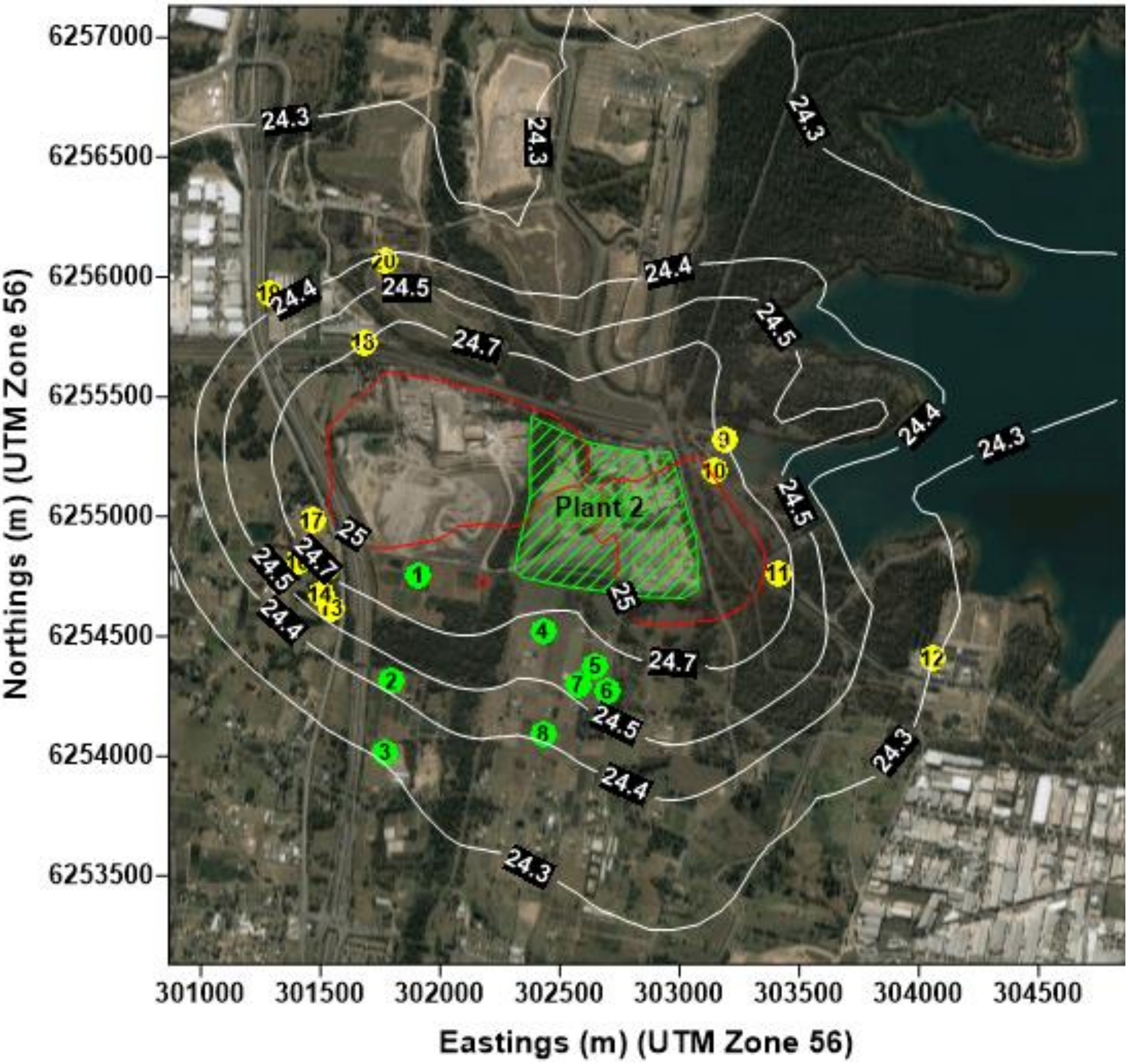


Figure C.12: Cumulative annual average $PM_{2.5}$ concentrations ($\mu g/m^3$) (Assessment criteria: 8 $\mu g/m^3$) (Assessment criteria contour shown in red)

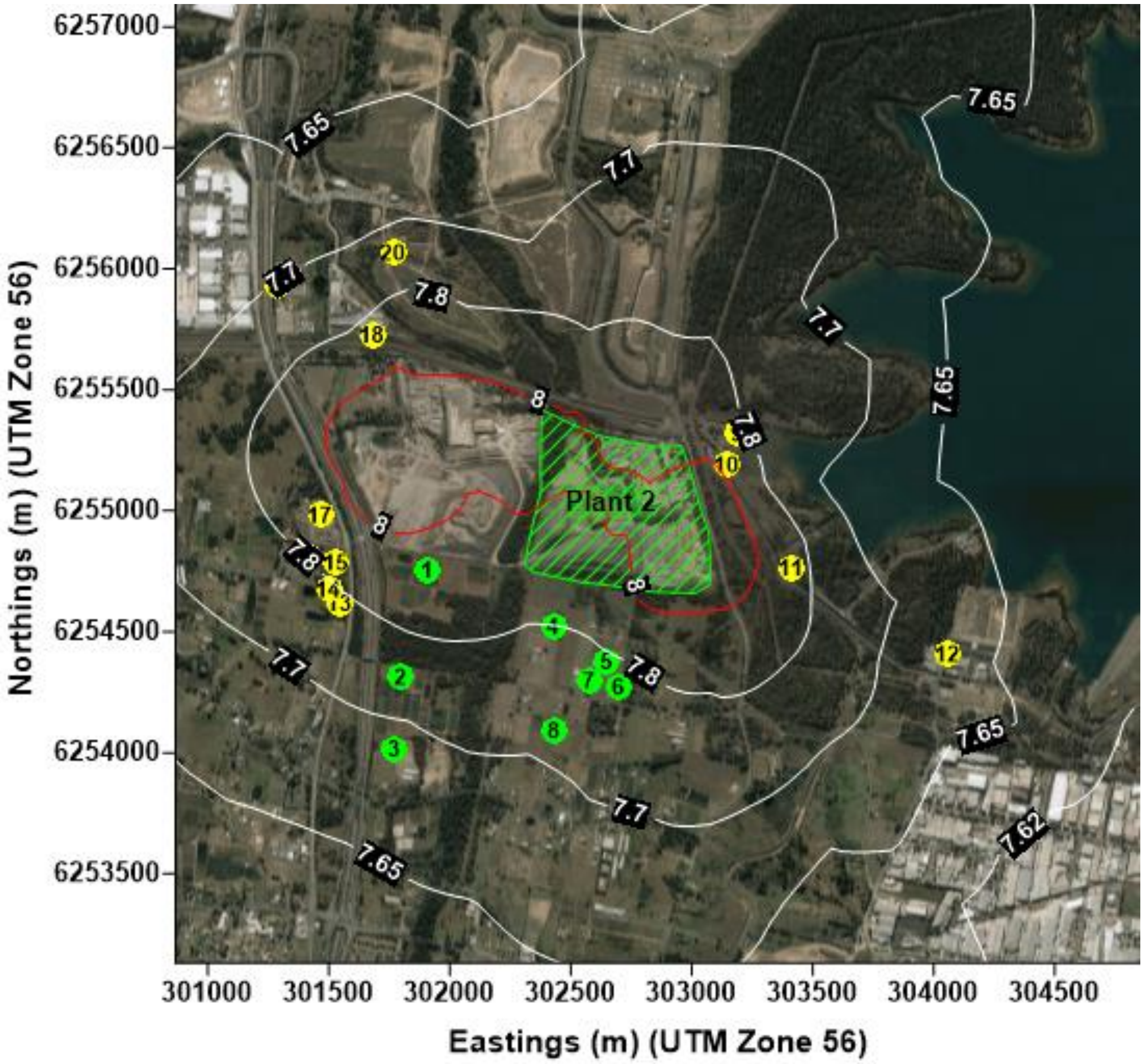


Figure C.13: Cumulative 1-hour average maximum NO_2 concentrations ($\mu g/m^3$) (Assessment criteria: 246 $\mu g/m^3$ contour shown in red)

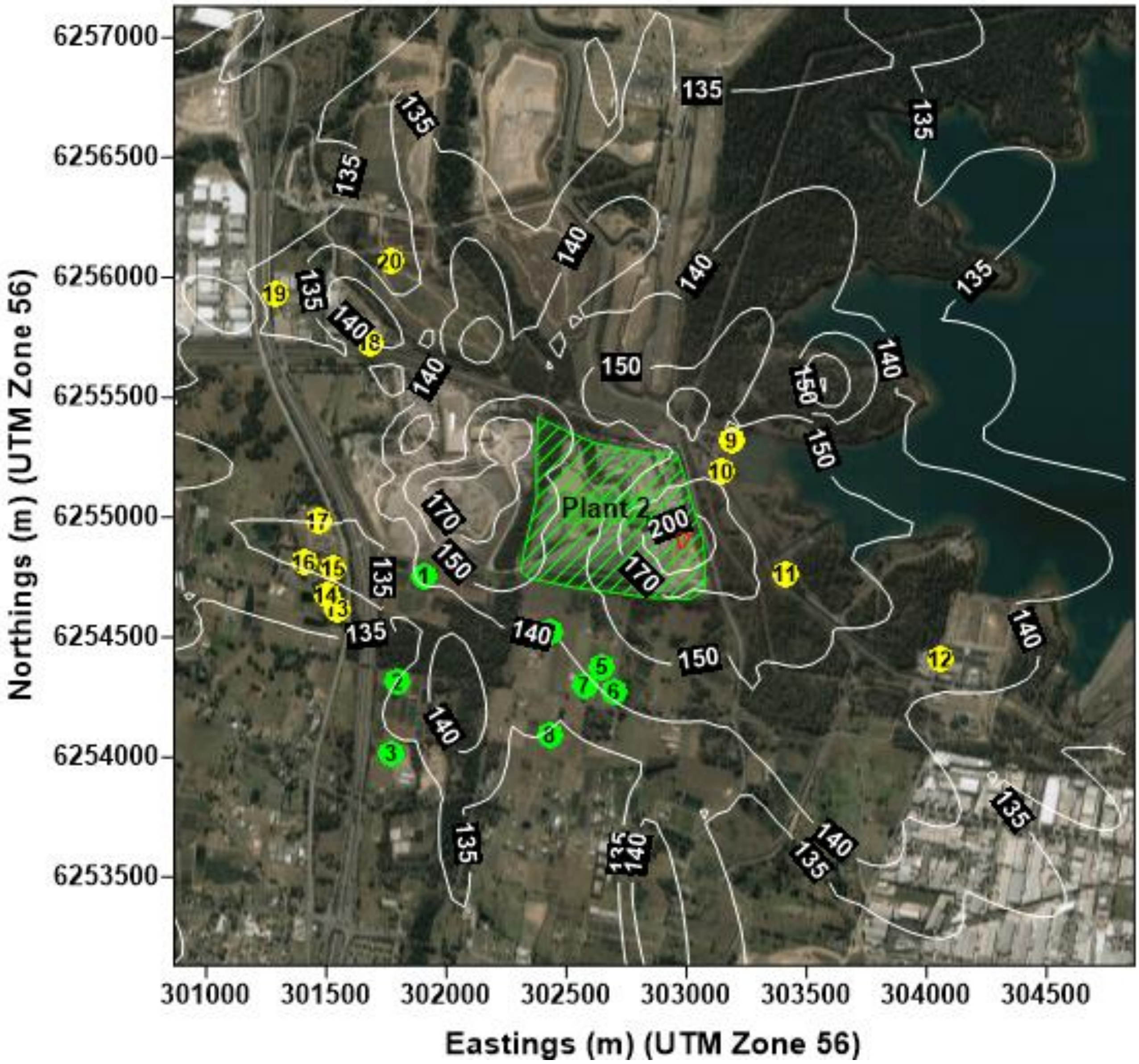


Figure C.14: Cumulative annual average maximum NO_2 concentrations ($\mu g/m^3$) (Assessment criteria: 62 $\mu g/m^3$)