Appendix D

Air Quality assessment

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AIR QUALITY IMPACT ASSESSMENT
GENESIS XERO WASTE FACILITY
MODIFICATION 7

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EXECUTIVE SUMMARY

Introduction

An air quality impact assessment has been prepared for a modification to the Genesis Xero Waste Facility at Eastern Creek (Facility), which is owned and operated by Dial a Dump Industries Pty Limited (the proponent).

Modification 7 seeks to relocate the existing access road and weighbridge and redesign the main operational areas of the site to improve traffic flow and operational efficiency. The Modification does not seek to increase the throughput of the site.

Modification 6 (Mod 6), currently under assessment by DPE, proposes to modify the project approval to alter the hours of operation and to allow greater flexibility in relation to the waste volume permitted to landfill.

Study approach

Local air quality impacts from the modification are assessed using a Level 2 assessment approach in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW EPA, 2016). Emissions are estimated for all activities and dispersion modelling is used to predict ground level concentrations at surrounding receptors. Cumulative impacts are assessed by combining the contribution from the modification with the existing ambient baseline.

Existing environment

Baseline meteorology is described with reference to the closest Bureau of Meteorology (BoM) automatic weather stations (AWS) and NSW Office of Environment and Heritage (OEH) monitoring sites. Surface observations from regional monitoring sites are included in the meteorological modelling using CALMET. Baseline air quality is described with reference to OEH monitoring sites at Prospect and St Marys and a monitoring site operated by the facility in the suburb of Minchinbury. Annual mean PM_{10} concentrations across the three sites are 61% to 76% of the impact assessment criteria, while annual mean $PM_{2.5}$ concentrations for the region are 98%-108% of the impact assessment criteria (i.e. already at or above the impact assessment). Elevated concentrations of $PM_{2.5}$ for the Western Sydney region are strongly influenced by vehicle emissions (cars, trucks and off-road equipment) and from wood heaters during winter months. Exceedances of the 24-hour average criteria occur on occasion in Western Sydney, typically associated with periods of bushfire, hazard reduction and/or dust storms (NSW EPA, 2016).

Emissions

The emissions scenario presented in this report focuses on a typical operational scenario whereby approximately 60% of material enters the recycling facility (typical range is 60%-80%) and 40% of material is directed to landfill (typical range is 20%-40%). The higher range value for landfilling is selected as a conservative worst case (as this produces more wheel generated dust for trucks entering the landfill void).

A construction phase scenario is also presented, which accounts for removal / movement of the western amenity bund, relocating all existing stockpiled material and construction of a 40 ML stormwater basin. Construction phase emissions are lower than the operation phase, however the majority of the emissions during construction are concentrated around the area of the western amenity bund and therefore the footprint of impacts will differ from typical operations at the site.

Results and conclusion

For construction phase, the predicted cumulative annual average PM_{10} concentrations comply with the impact assessment criterion at all residential receptor locations and with the addition of existing background, there are no additional exceedances of the 24-hour average PM_{10} impact assessment criterion. The cumulative annual average $PM_{2.5}$ concentrations exceed the impact assessment criterion, however this is due to an existing high baseline for the region, with the annual average background concentrations of $PM_{2.5}$ already above the impact assessment criteria. With the addition of existing background, there are no additional exceedances of the 24-hour average $PM_{2.5}$ impact assessment criterion at residential receptor locations. Cumulative annual average TSP concentrations for the construction phase comply with the impact assessment criterion at all receptor locations, while predicted dust deposition levels comply with both the incremental and cumulative impact assessment criteria at all residential receptors.

Similar results are presented for the operation phase of Modification 7. The predicted cumulative annual average PM_{10} concentrations comply with the impact assessment criterion at all residential receptor locations and there are no additional exceedances of the 24-hour average PM_{10} impact assessment criterion at residential receptor locations. The cumulative annual average $PM_{2.5}$ concentrations exceed the impact assessment criterion at all locations, however this is due to an existing high baseline for the region, with the annual average background concentrations of $PM_{2.5}$ already above the impact assessment criteria. The cumulative 24-hour average $PM_{2.5}$ concentrations result in one additional exceedance of the impact assessment criterion at one of eight residential receptor locations. This is caused by a combination of elevated background with the additional dust emissions from the modification. It is noted that the background $PM_{2.5}$ concentration on this day is already close to the impact assessment criterion (24.4 $\mu g/m^3$). Furthermore, additional statistical analysis shows that the probability or risk of any additional exceedances of the 24-hour $PM_{2.5}$ impact assessment criterion does not significantly increase, above what is already caused by background. Cumulative annual average TSP concentrations for the operation phase comply with the impact assessment criterion at all receptor locations. The predicted dust deposition complies with both the incremental and cumulative impact assessment criteria.

The worst case potential odour impact from landfilling at 2 Mtpa combined with greenwaste processing, would not result in exceedances of the odour goal of 2 OU at any residential receptor.

For the operation phase of Modification 7 there are predicted exceedances at the commercial premises located on the northern and eastern boundary of the site. This is caused by a combination of elevated background with the additional dust emissions from the modification. A number of existing and proposed dust management measures will be used to ensure exceedances are minimised.

For PM_{10} additional statistical analysis shows an increased probability or risk of additional exceedances of the 24-hour PM_{10} impact assessment criteria at these commercial receptors increases. Therefore, to better monitor the effectiveness of existing controls and ongoing performance of the site, the proponent will consider relocating the PM_{10} monitoring site in Minchinbury to a boundary location at the northern and/or eastern site boundary.

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1. INTRODUCTION

Dial A Dump Industries Pty Limited (the proponent) operates the Genesis Xero Waste Facility (the Facility) at Eastern Creek in the Blacktown Local Government Area (LGA) (Figure A1-1). The facility is at 1 Kangaroo Avenue and comprises a Resource Recovery Facility (RRF) and a general solid waste (non-putrescible) landfill (Figure A1-2).

The original project approval for the site was granted by the Minister for Planning in 2009 (MP 06_0139) under Section 75J of the NSW Environmental Planning and Assessment Act 1979 (EP&A Act). The operations commenced in 2012 and the project approval has been modified five times, most recently in March 2016.

The Facility is approved to accept up to 2 million tonnes per annum (Mtpa) of construction, demolition, commercial and industrial waste. The majority of the waste is directed to the RRF for sorting, processing and resale as products suitable for application to land such as road base. Material which is not suitable for recycling is disposed in the landfill, which is approved to accept up to 700,000 tonnes per annum (tpa) of rejects from the RRF and waste received from offsite.

The proponent seeks to modify the project approval (Modification 7) to relocate the existing access road and weighbridge and redesign the main operational areas of the site to improve traffic flow and operational efficiency.

Ramboll Australia Pty Ltd has been commissioned to prepare an air quality impact assessment (AQIA) to support the environmental assessment (EA) prepared by EMM Consulting Pty Limited (EMM) for the modification.

1.1 Overview of Modification

The purpose of the proposed modification is to allow for the following:

- Construction of a new access road (including relocation of existing weighbridges) on the northern side of the proposed Precinct Road and two additional weighbridges, to improve site access and traffic flow;
- Relocation of existing administration buildings and onsite visitor and staff car parking generally within the vicinity of the relocated and additional weighbridges;
- Relocation of above ground fuel storage tanks;
- Modified operations to include reorganisation of existing building use and storage areas combined with the construction of new associated road network to support improved operations and vehicle movements;
- Associated environmental management works to include modified stormwater management devices combined with the relocation and modification of the approved western amenity berm; and
- Realignment of the western boundary of existing Lot 1 in DP 1145808.

Modification 6 (Mod 6), currently under assessment by DPE, proposes to modify the project approval to alter the hours of operation and to allow greater flexibility in relation to the waste volume permitted to landfill.

An air quality and odour assessment has been prepared for Mod 6 (Ramboll Environ, 2017) and the interaction between the two modifications has been considered, as described in Section 2.2.

1.2 Study objectives and requirements

The AQIA has been prepared to address the Secretary's Environmental Assessment Requirements (SEARs), issued by NSW Department of Planning and Environment (DP&E) on 3 April 2017, as well as specific requirements provided by the NSW Environment Protection Authority (EPA.

Table 1-1 provides a summary of the SEARs and agency comments relevant to this study and where the requirement has been addressed in this report.

Table 1-1: Summary of SEARs for air quality

Requirement	How requirement is addressed
SEARs	
Air quality and odour, including a quantitative assessment of the potential air quality, dust and odour impacts for all phases of the proposed in accordance with relevant Environment Protection Agency guidelines.	Report prepared in accordance with the Approved Methods (refer Section 2).
NSW EPA**'s** requirement	
Detailed assessment of potential airborne emissions generated in all phases of the proposed modification works including demolition, transport and relocation of all buildings, plant, waste, construction and operations. The assessment should cover the following:	Assessment is presented for both construction phase and operational phases of the development.
Source points for all potential airborne emissions should be identified and details of the environmental controls to mitigate impacts.	Refer Section 6 for details of all emissions sources and controls considered in the assessment
Detail the process for relocating the western amenity berm and procedures to mitigate onsite and offsite impacts of wind blown particulates.	Refer Section 6 for details of all emissions sources and controls associated with the constriction phase, included relocation of the amenity berm.
The EIS should cover all potential emissions, and include but is not limit to, coarse particulates, PM_{10}, $PM_{2.5}$ and odour.	Refer to Section 2.3.
Details of plant or processes that have the potential to produce airborne emissions during any stage of the proposed modification works including onsite traffic dust and increased vehicle movements during demolition and construction.	Refer Section 6 for details of all emissions sources and controls considered in the assessment
Details of dust suppression procedures during all stages of the modification works at the premises	Refer Section 6 for details of all emissions sources and controls considered in the assessment
An odour assessment considering potential odours from all areas of the premises.	Refer to Section 6.2 and 7.3

2. STUDY APPROACH

2.1 Assessment approach

The approach to the assessment follows guidelines recommended in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* ("the Approved Methods") (NSW EPA, 2016).

Local air quality impacts are assessed using a Level 2 assessment approach (i.e. refined dispersion modelling technique using site-representative input data). The assessment approach is summarised as follows:

- Key pollutant indicators are identified, in this case dust and odour.
- Emissions are estimated for all dust generating activities associated with the facility.
- Dispersion modelling is undertaken using a regulatory dispersion model to predict ground level concentrations (GLCs) for key pollutants at nearby sensitive receptors.
- Cumulative impacts are assessed by taking into account the combined effect of facility with existing baseline air quality and/or other local sources of emissions.

2.2 Assessment scenarios

Modification 7 seeks to relocate the existing access road and weighbridge and redesign the main operational areas of the site to improve traffic flow and operational efficiency. The Modification does not seek to increase the throughput of the site.

Modification 6 (Mod 6), currently under assessment by DPE, proposes to modify the project approval to alter the hours of operation and to allow greater flexibility in relation to the waste volume permitted to landfill. An air quality and odour assessment (AQA) for Modification 6 (Ramboll Environ, 2017) assessed two hypothetical scenarios whereby the total approved waste amount (2 Mpta) is either 100% processed within the MPC or 100% directed to landfill. Although these scenarios are not likely from an operational point of view, the aim was to assess the impacts regardless of the proportion of waste processed or landfilled. The AQA found that the hypothetical 100% landfilled scenario produced the worst case emissions and potential impacts, primarily due to the increase haulage along the unsealed haul road into the landfill void.

When considered in the context of Modification 7, this worst case hypothetical 100% landfilled scenario would not change, as the redesign of the operational areas are related to material processing and recycling, and not landfilling operations (the only exception is a minor realignment of the access road). It is therefore not necessary to re-assess this scenario for Modification 7, as the results and conclusions from Mod 6 would not change.

The hypothetical 100% recycled scenario presented in Mod 6 produces less emissions than the operational scenario being considered for Modification 7 (see Section 6). It is therefore not necessary to re-assess this scenario, as the revised Modification 7 operational scenario will result in a more conservative, worst case assessment of potential impacts.

The Modification 7 emissions scenario focuses on a typical operational scenario whereby approximately 60% of material enters the Recycling Facility (typical range is 60%-80%) and 40% of material is directed to landfill (typical range is 20%-40%). The higher range value for landfilling is selected as a conservative worst case (as this produces more wheel generated dust for trucks entering the landfill void). A construction phase scenario is also presented, which accounts for removal / movement of the western amenity bund, relocating all existing stockpiled material and construction of a 40 ML stormwater basin.

The Mod 6 proposed construction and operational hours have been adopted for consideration of potential environmental impacts associated with Mod 7 proposed changes.

2.3 Pollutant indicators

The key pollutants of concern during the operation of the Genesis facility are:

- Fugitive dust / particulate matter (PM), generated during construction and operations (waste receipt, handling, processing and product dispatch).
- Odour from green waste processing, landfilling and leachate management.

The combustion of diesel in trucks and other equipment would result in combustion-related emissions including PM, oxides of nitrogen (NOx), sulfur dioxide (SO2), carbon dioxide (CO2), carbon monoxide (CO) and volatile organic compounds (VOCs).

Combustion derived PM has been included as part of the overall site emissions, as for $PM_{2.5}$ in particular it can be a relatively important component of total site emissions. Other combustion derived emissions however have not been quantitatively assessed, as they would not result in significant off-site concentrations.

The air quality indicators that have been considered in this report are summarised in Table 2-1.

Table 2-1: Air quality indicators for assessment

Emission source	Air quality indicator
Construction phase	Particulate matter (TSP[1], PM_{10}[2] and $PM_{2.5}$[3])
	Nuisance dust (dust deposition)
Waste handling, processing and product dispatch	TSP, PM_{10} and $PM_{2.5}$)
	Nuisance dust (dust deposition)
Diesel fuel combustion	PM_{10} and $PM_{2.5}$
Greenwaste processing, landfilling and leachate management	Odour

Note:
[1] Total Suspended Particulate matter
[2] Particulate matter less than 10 microns in aerodynamic diameter
[3] Particulate matter less than 2.5 microns in aerodynamic diameter

2.4 Assessment criteria

2.4.1 Particulate matter

When first regulated, airborne PM was assessed based on concentrations of "total suspended particulate matter" (TSP). In practice, this typically referred to PM smaller than about 30-50 micrometres (µm) in diameter. As air sampling technology improved and the importance of particle size and chemical composition become more apparent, ambient air quality standards have been revised to focus on the smaller particle sizes, thought to be most dangerous to human health. Contemporary air quality assessment typically focuses on "fine" and "coarse" inhalable PM, based on health-based ambient air quality standards set for PM_{10} and $PM_{2.5}$.

Air quality criteria for PM in Australia are given for particle size metrics including TSP, PM_{10} and $PM_{2.5}$. The 2016 update to the 'Approved Methods', gazetted on 20 January 2017, includes particle assessment criteria that are consistent with revised National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (National Environment Protection Council [NEPC], 1998; NEPC, 2015).

For the purpose of this report, predicted ground level concentrations (GLCs) are assessed against the NSW EPA's impact assessment criteria presented in Table 2-2.

Table 2-2: Impact assessment criteria for PM

PM metric	Averaging period	Concentration (µg/m^3)
TSP	Annual	90
PM_{10}	24 hour	50
	Annual	25
$PM_{2.5}$	24 hour	25
	Annual	8

Note: µg/m^3 = micrograms per cubic metre.

The Approved Methods specifies that the impact assessment criteria for 'criteria pollutants[1]' are applied at the nearest existing or likely future off-site sensitive receptor and compared against the 100th percentile (i.e. the highest) dispersion modelling prediction. Both the incremental and cumulative impacts need to be considered (consideration of existing ambient background concentration is required).

The Approved Methods also prescribes nuisance based goals for dust deposition, which relate to amenity type impacts such as soiling of exposed surfaces. The NSW EPA impact assessment criteria for dust deposition are summarised in Table 2-3, illustrating the maximum increase and total dust deposition rates which would be acceptable so that dust nuisance can be avoided.

Table 2-3: Dust deposition criteria

Pollutant	Maximum Increase in Dust Deposition	Maximum Total Dust Deposition Level
Deposited dust (assessed as insoluble solids)	2 g/m^2/month	4 g/m^2/month

Note: g/m^2 = grams per square metre.

2.4.2 Odour

Dynamic olfactometry is the accepted method of odour measurement and involves a sample of odorous air being presented to a panel of people with decreasing quantities of clean odour-free air. The panellists note when the smell becomes detectable and the correlation between the known dilution ratios and the panellists' responses are used to calculate the number of dilutions required to achieve the odour detection threshold. The units for odour measurement are "odour units" (ou), which, according to the method described above, are effectively "dilutions to threshold".

The odour nuisance level can be as low as 2 ou and as high as 10 ou (for less offensive odours), whereas an odour assessment criterion of 7 ou is likely to represent the level below which 'offensive' odours should not occur. The NSW EPA's *Technical framework - Assessment and management of odour from stationary sources in NSW* (NSW EPA, 2006a) recommends that, as a design criterion, no individual should be exposed to ambient odour levels of greater than 7 ou.

The Approved Methods prescribes odour goals which take into account the population density for a particular area. The most stringent odour goal of 2 ou is considered to be acceptable for the whole population and therefore appropriate for urban areas (NSW EPA, 2016).

The 2 ou odour goal should be compared against the 99th percentile of the dispersion modelling predictions. The 1-hour average dispersion modelling prediction is converted to a peak (i.e. 1-second 'nose response average') based on a peak to mean ratio of 2.3, in accordance with the Approved Methods.

[1] 'Criteria pollutants' is used to describe air pollutants that are commonly regulated and typically used as indicators for air quality. In the Approved Methods, the criteria pollutants are TSP, PM_{10}, nitrogen dioxide (NO_2), sulphur dioxide (SO_2), carbon monoxide (CO), ozone (O_3), deposited dust, hydrogen fluoride and lead.

2.5 Overview of modelling approach

The modelling for this assessment uses a combination of TAPM and CALMET/CALPUFF, as follows:

- TAPM is used to generate gridded three-dimensional upper air data for each hour of the model run period for input into CALMET.
- CALMET, the meteorological pre-processor for the dispersion model CALPUFF, calculates fine resolution three-dimensional meteorological data using a combination of surface observations and the prognostic TAPM upper air data.
- CALPUFF then calculates the dispersion of plumes within this three-dimensional meteorological field.

2.6 Cumulative impacts

Cumulative impacts are assessed by combining the contribution from the Facility with the existing ambient air quality environment, described based on baseline monitoring data for the region (refer to Section 5). The derived baseline is assumed to account for all existing emissions sources in the local airshed. In terms of potential future sources, it is noted that The Next Generation (TNG) has a current state significant development (SSD) application for an Energy from Waste (EfW) facility on land adjacent to the Genesis site. An Air Quality Assessment prepared for the application (PEL, 2015) found that emissions from the 100 m stack would be predominantly $PM_{2.5}$ and ground level concentrations would be relatively small, as follows:

- Predicted annual average of 0.2 – 0.3 µg/m³ across residential areas and at the eastern and northern site boundary.
- Predicted maximum 24-hour average of 1 – 1.5 µg/m³ across residential areas and at the eastern and northern site boundary.

Peak 24-hour average concentrations from the proposed TNG EfW facility would not occur at the same time as peak 24-hour average concentrations from the Genesis facility, due to the different meteorological conditions that produce highest concentration from tall stacks compared with ground level fugitive dust sources. Therefore, cumulative impacts for peak 24-hour average concentrations are not considered significant. Further discussion is provided in Section 7.

3. LOCAL SETTING AND ASSESSMENT LOCATIONS

3.1 Location

The facility is on a site that comprises 52 hectares (ha) at the following lots (Figure A1-2):

- Lot 1 DP 1145808; and
- Lot 8 DP 1200048.

The site address is 1 Kangaroo Avenue. It is accessed from Kangaroo Avenue. The volume of the final quarry void was estimated to be 11 million m^3.

3.2 Surrounding land use

The site is in an area being developed for commercial and industrial use under State Environmental Planning Policy (Western Sydney Employment Area) 2009. Adjacent landowners are:

- Australand, which owns and leases warehousing to the north-east;
- Hanson, which owns an asphalt batching plant to the south-east;
- NSW Department of Planning and Infrastructure, which owns vacant land to the south-west; and
- Sargents, which is developing land to the west.

The site is surrounded by Kangaroo Avenue to the east and north-east, the M4 Western Motorway to the north, Archbold Road to the west and the future Precinct Road to the south.

Further afield there is residential development in Minchinbury beyond the Western Motorway to the north and in Erskine Park beyond Archbold Road to the west, and predominantly undeveloped land containing high voltage powerlines to the west and south-west.

3.3 Sensitive receivers

The residential areas of Minchinbury are approximately 430 m north and of Erskine Park approximately 1,200 m west of the nearest site boundaries. The nearest commercial premises is adjacent to the northern boundary of the site.

Locations representative of these sensitive receivers have been identified and selected as discrete sensitive receptors, shown in Figure 3-1. Nearby residences and industrial / commercial facilities not identified as discrete sensitive receptors, can be assessed with reference to the contour plots presented in this report, which show predicted ground level concentrations of key pollutants across all areas in the vicinity of the facility.

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Sensitive Receptor Locations

FIGURE 3-1

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4. OVERVIEW OF LOCAL AND REGIONAL METEOROLOGY

4.1 Introduction

Meteorological mechanisms govern the generation, dispersion, transformation and eventual removal of pollutants from the atmosphere. To adequately characterise the dispersion meteorology of a region, information is needed on the prevailing wind regime, ambient temperature, rainfall, relative humidity, mixing depth and atmospheric stability.

Analysis of meteorology for region is presented based on the closest Bureau of Meteorology (BoM) automatic weather station (AWS) and NSW Office of Environment and Heritage (OEH) monitoring sites, as follows:

- St Marys OEH site – located approximately 6 km west of the site.
- Horsley Park Equestrian Centre AWS– located approximately 6 km southeast of the site.
- Badgerys Creek AWS – located approximately 14 km southwest of the site.
- Penrith Lakes AWS – located approximately 16.5 km west of the site.
- Bankstown Airport AWS – located approximately 19 km southeast of the site.
- Holsworthy Control Range AWS – located approximately 21.5 km southeast of the site.
- Sydney Olympic Park AWS - located approximately 22 km southeast of the site.
- Richmond RAAF AWS - located approximately 23 km northwest of the site.
- Camden Airport AWS – located approximately 29 km southwest of the site.

These locations are used as surface observation sites in the meteorological monitoring for the assessment (described in Section 4.4). It is noted that the proponent operates an on-site weather station, however the station is used for operational dust control (i.e. to trigger water sprays) and the siting makes it unsuitable for the purposes of dispersion modelling.

4.2 Prevailing winds

The 2016 annual wind rose for each surface observation site is presented in Figure 4-1. The dominant prevailing wind pattern varies across the region. At some of the observations sites, it appears that local features influence the prevailing winds (for example Sydney Olympic Park and St Marys).

Across many of the sites there is a dominant southwest component to the annual wind rose, although winds from all directions are recorded for a small percentage of time. Average wind speeds range from 2 to 3 metres per second (m/s) while the percentage occurrence of calm winds (<0.5 m/s) ranges from low at Holsworthy (7%) to high St Marys (33%).

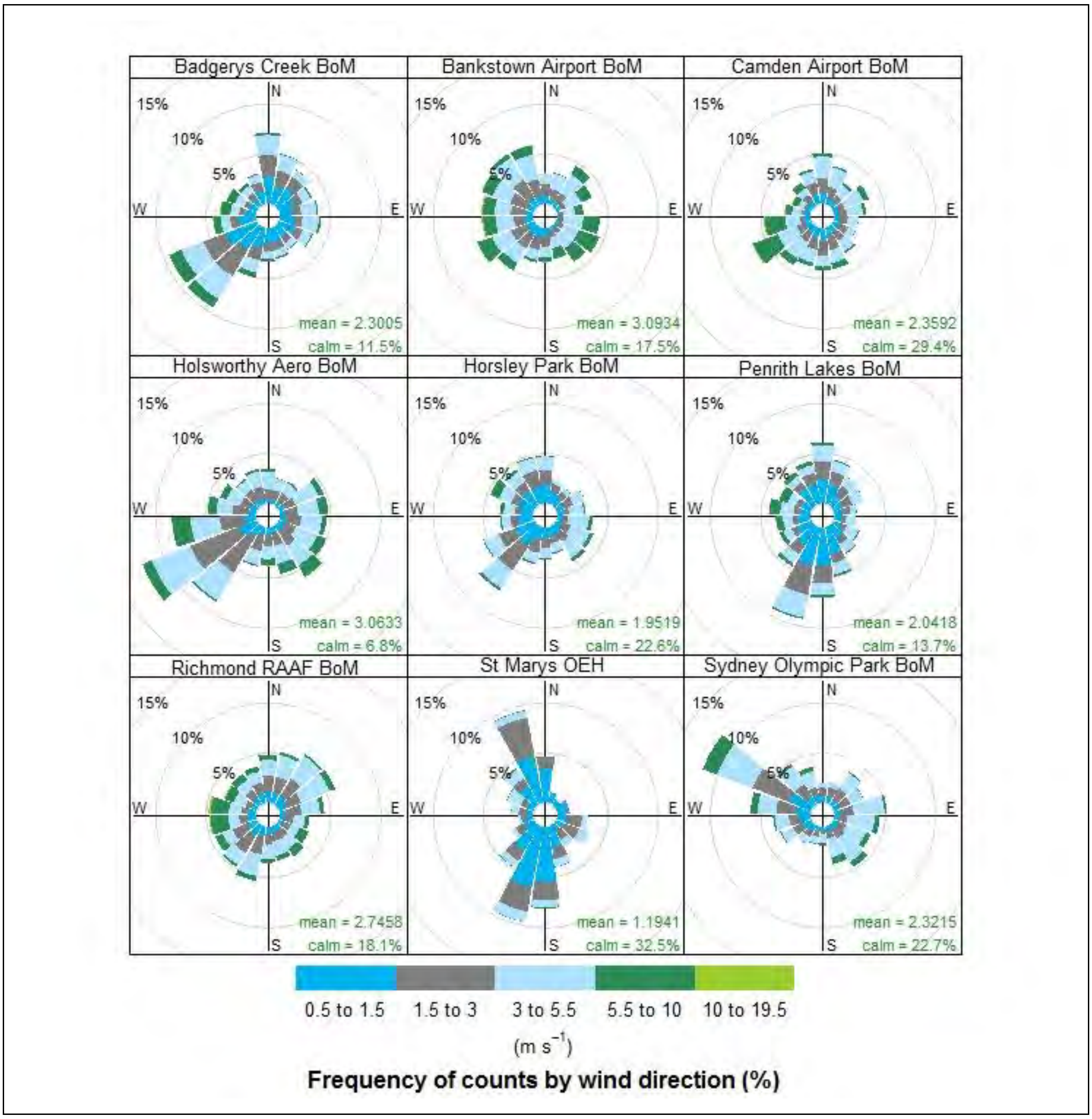
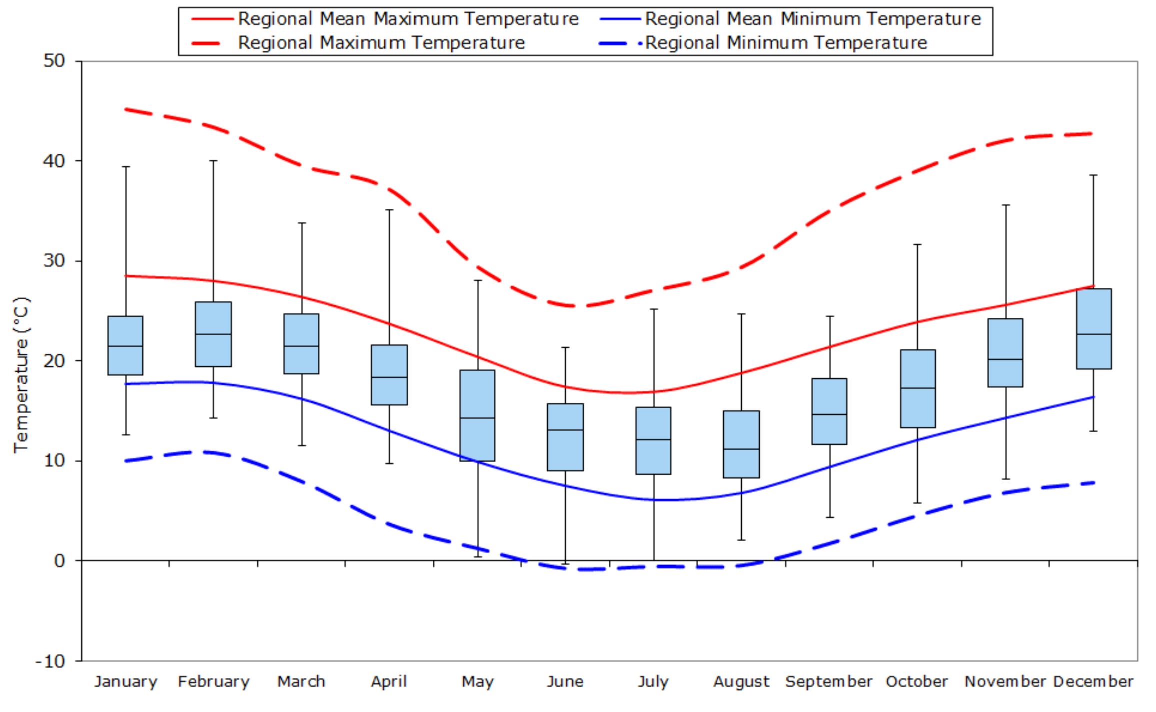


Figure 4-1: Annual wind roses for the region

4.3 Ambient temperature

The minimum, maximum, mean and upper and lower quartile temperatures for each month of the modelling year (2016) are presented as a box and whisker plot shown in Figure 4-2, based on data from BoM Prospect Reservoir long term monitoring station. The modelling year is compared with long-term records at the Prospect Reservoir and shown to correlate well with the long-term trends. The upper and lower quartile and mean temperatures for 2016 fall within the long term mean monthly maximum and minimum temperatures.



2016 data are illustrated by the 'box and whisker' plot. Boxes indicate 25th, median and 75th percentile temperature values while upper and lower whiskers indicate maximum and minimum values.

Figure 4-2: Comparison of long-term temperature records with modelling period

4.4 Meteorological modelling

Where no upper air measurements are available, CALMET can be run using prognostic upper air data (as a three-dimensional '3D.dat' file) and used to drive an 'initial guess' wind field. The model then incorporates mesoscale and local scale effects, including surface observations, to adjust the final wind field. This modelling approach is known as the "hybrid" approach (TRC, 2011) and is adopted for this assessment. TAPM was used to generate gridded upper air data for each hour of the model run period, for input into CALMET.

TAPM and CALMET model settings are described in Appendix 2, selected in accordance with recommendations in the Approved Methods and in TRC (2011).

Surface observations are included in the modelling (referred to as data assimilation) to provide real-world observations and improve the accuracy of the wind field. The surface observations are incorporated into both TAPM and CALMET modelling.

4.4.1 CALMET predicted winds

CALMET is a non-steady state model which generates a temporal and spatial varying wind field across the modelling domain. Therefore, no single wind rose is representative of the dispersion conditions used by the model, however an extract from CALMET at the Genesis site provides an indication of the dispersion conditions in the immediate vicinity of the emission source (see Figure 4-3). The windrose displays winds from all directions for a small percentage of time, with slightly higher occurrence from the south west quadrant. The annual average wind speed is 1.5 m/s while the percentage occurrence of calm winds is moderate (19%). Seasonal and diurnal windrose for CALMET are shown in Appendix 3.

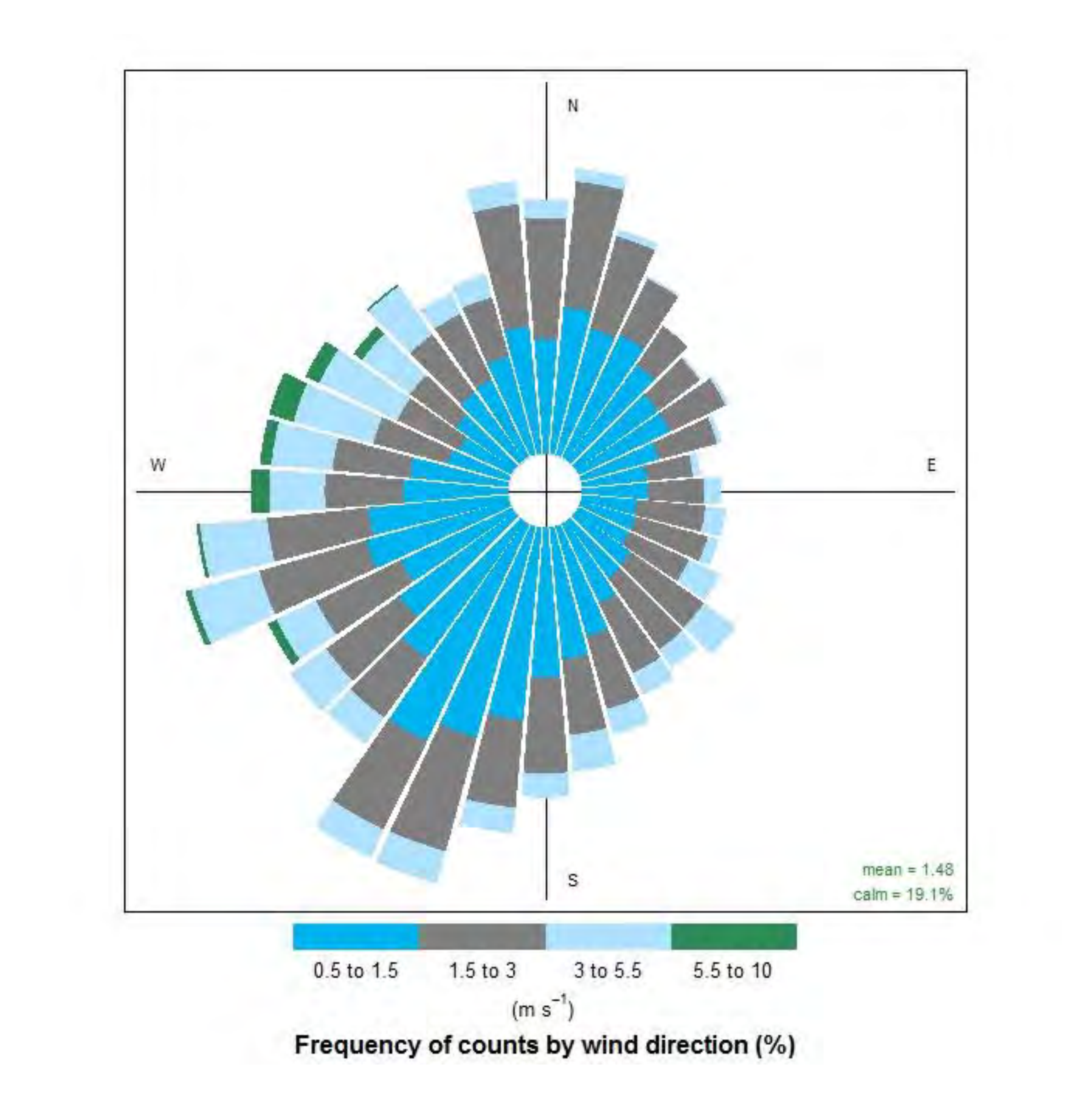


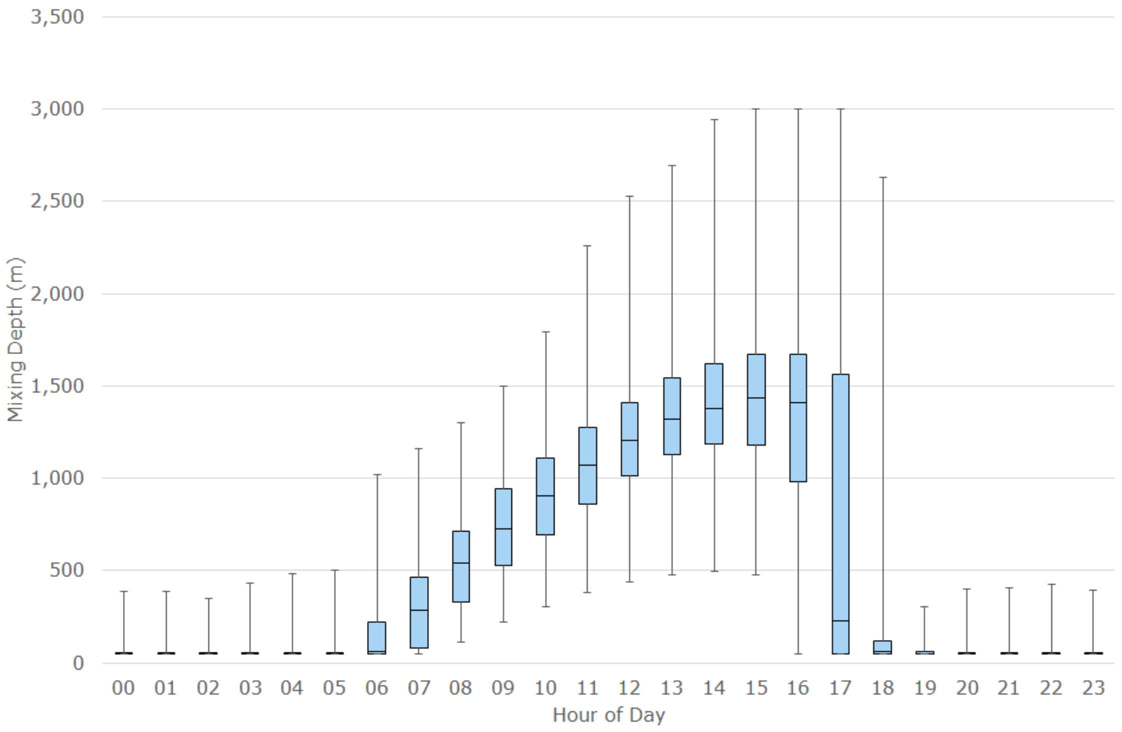
Figure 4-3: Annual wind rose – CALMET extract at the Genesis site

4.4.2 Atmospheric boundary layer heights

The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. This layer is directly affected by the earth's surface, either through the retardation of air flow due to the frictional drag of the earth's surface (mechanical mechanisms), or as result of the heat and moisture exchanges that take place at the surface (convective mixing) (Stull, 1997; Oke, 2003).

During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the mixing layer to the lowest elevated subsidence inversion. Due to radiative flux divergence, nights are typically characterised by weak to no vertical mixing and the predominance of stable conditions. These conditions are normally associated with low wind speeds and hence lower dilution potentials.

CALMET generated mixing heights are extracted at site and the average boundary layer heights by hour of the day is shown in Figure 4-4. As seen in median and upper and lower quartiles, the highest boundary layer heights are experienced during the day time hours, peaking in the mid to late afternoon. Higher day-time wind velocities and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for atmospheric dispersion of pollutants.



Lower, middle and upper box markers indicate 25th percentile, median and 75th percentile of CALMET-generated mixing height data respectively, while upper and lower whiskers indicate maximum and minimum values.

Figure 4-4: CALMET-generated diurnal variations in average boundary layer depth

4.4.3 Atmospheric stability

Atmospheric stability refers to the degree of turbulence or mixing that occurs on the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants. The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (i.e. the layer above the ground in which vertical variation of heat and momentum flux is negligible - typically about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 4-5 illustrates the diurnal variation of atmospheric stability derived from the Monin-Obukhov length calculated by CALMET. The diurnal profile at all locations illustrates that atmospheric instability increases during daylight hours as convective energy increases, while stable atmospheric conditions prevail during the night-time. The potential for atmospheric dispersion of emissions is therefore greatest during day time hours and lowest during evening through to early morning hours.

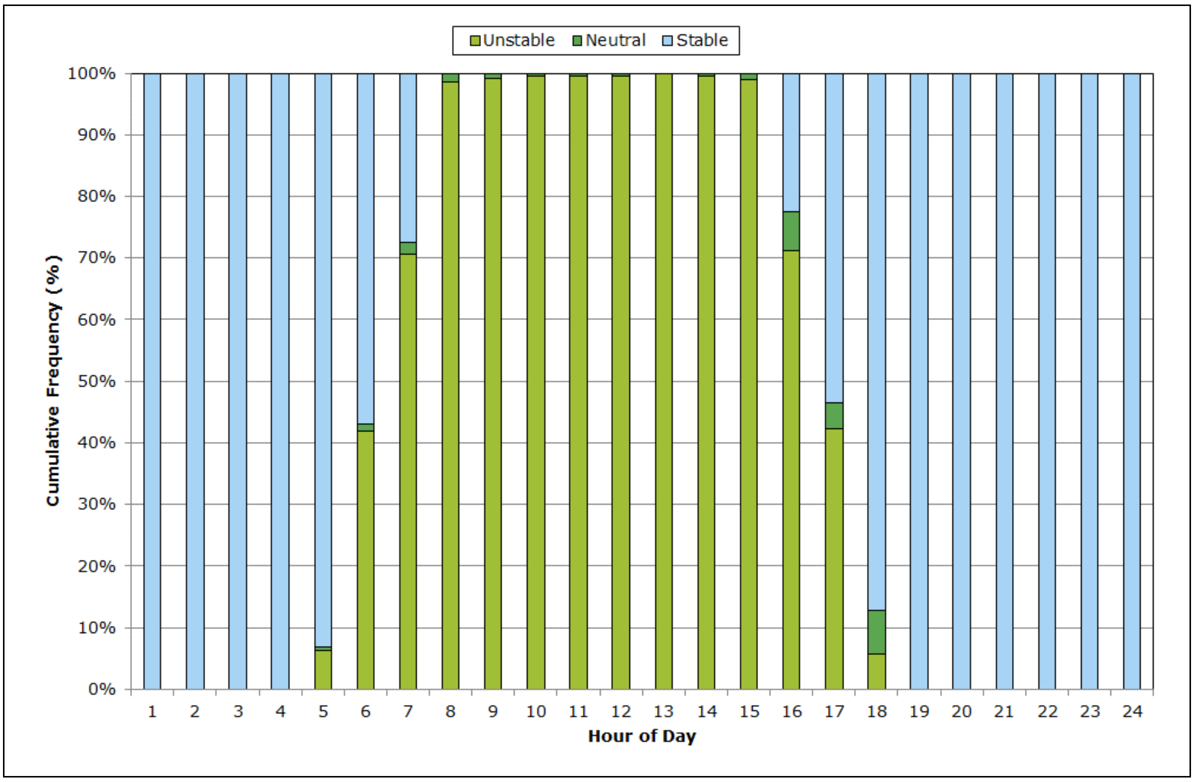


Figure 4-5: Diurnal variations in atmospheric stability derived from CALMET generated Monin-Obukhov length

5. EXISTING ENVIRONMENT

5.1 PM_{10} and $PM_{2.5}$

The Facility operates a BAM PM_{10} monitor at Minchinbury, which has been operational since mid-2012 and summary statistics for the modelling period (2016) are presented in Table 5-1. , Reference is also made to the closest OEH sites at St Marys and Prospect (within 6 km of the site). Both OEH sites measure concentrations of PM_{10} and $PM_{2.5}$ (which is not measured by the Facility), although it is noted that $PM_{2.5}$ was only added as a parameter at St Marys in March 2016.

Annual mean PM_{10} concentrations across the three sites are 61% to 76% of the impact assessment criteria, while annual mean $PM_{2.5}$ concentrations for the region are 98%-108% of the impact assessment criteria (i.e. already at or above the impact assessment criteria). Elevated concentrations of $PM_{2.5}$ for the Western Sydney region are strongly influenced by vehicle emissions (cars, trucks and off-road equipment) and from wood heaters during winter months.

A timeseries plot of the 24-hour average concentrations in Figure 5-1 shows the periods when the 24-hour average PM_{10} concentration exceeds 50 µg/m³ and in Figure 5-2 when the 24-hour average $PM_{2.5}$ concentration exceeds 25 µg/m³. Exceedances of the 24-hour average criteria in Sydney are typically associated with periods of bushfire, hazard reduction and/or dust storms (NSW EPA, 2016).

Table 5-1: 2016 summary statistics (µg/m³) for PM_{10} and $PM_{2.5}$

Metric	Statistic	Genesis	St Marys	Prospect
PM_{10}	Annual mean	15.3	16.1	18.9
	Daily maximum	125.0*	100.2	110.1
	95th percentile	27.0	29.9	33.7
	90th percentile	23.7	26.4	29.5
	Number of exceedances	2*	3	4
$PM_{2.5}$	Annual mean	-	7.8	8.7
	Daily maximum	-	93.2	84.9*
	95th percentile	-	13.7	17.8
	90th percentile	-	11.4	14.0
	Number of exceedances	-	5	5*
Note: * Not based on a full year of observations so not a true daily maximum or number of exceedances				

5.2 TSP

TSP concentrations are not measured in the vicinity of the site, however historical measurements of TSP and PM_{10} in Sydney[2] indicate that PM_{10}/TSP ratios in urban areas typically range from 0.4 to 0.5. These ratios can be applied to the PM_{10} concentration data to derive an annual average TSP concentration.

5.3 Dust deposition

Dust deposition is measured at four locations on the site and results for the previous four years are summarised in Table 5-2. The measured dust deposition across all sites and years is 1.7 g/m²/month, which is consistent with background measurements seen across much of NSW (which is typically in the range of 1 g/m²/month to 2 g/m²/month).

[2] Reported in Quarterly Air Quality Monitoring Reports - http://www.environment.nsw.gov.au/aqms/datareports.htm#quarterlies

Table 5-2: Annual average dust deposition

Site	2016	2015	2014	2013	Average
North DDG	1.1	2.9	1.9	1.3	1.6
East DDG	1.5	2.9	1.4	2.0	1.8
South DDG	1.6	1.6	1.9	1.8	1.7
West DDG	2.1	1.8	2.4	1.6	1.8
Average	1.2	1.6	2.3	1.9	1.7

5.4 Adopted background for cumulative assessment

The baseline air quality adopted for cumulative assessment is summarised in Table 5-3. Annual average concentrations are generally based on the highest of the mean concentrations presented in Table 5-1 (i.e. the Prospect monitoring site), however gaps in the daily data have been filled using both St Marys and the Facility's datasets. In the case of $PM_{2.5}$ (which isn't measured at the Facility and was only added at St Marys in March 2016) additional gaps in the daily data are estimated from the average $PM_{10}/PM_{2.5}$ ratio from the available data.

As previously described, background concentrations of $PM_{2.5}$ are already approaching or exceeding the impact assessment criteria, due to all existing sources of emissions within the airshed, and therefore assessment of impact will also be discussed in the context of the incremental increase from the proposal. For short term impacts, daily varying PM_{10} and $PM_{2.5}$ concentrations in 2016 are paired with modelling predictions for the same period.

Table 5-3: Adopted background for cumulative assessment

Pollutant	Averaging period	Adopted background value
PM_{10}	24-hour average	Daily varying
	Annual average	18.9 µg/m³
$PM_{2.5}$	24-hour average	Daily varying
	Annual average	8.6 µg/m³
TSP	Annual average	47.2 µg/m³
Dust deposition	Annual average	2 g/m²/month

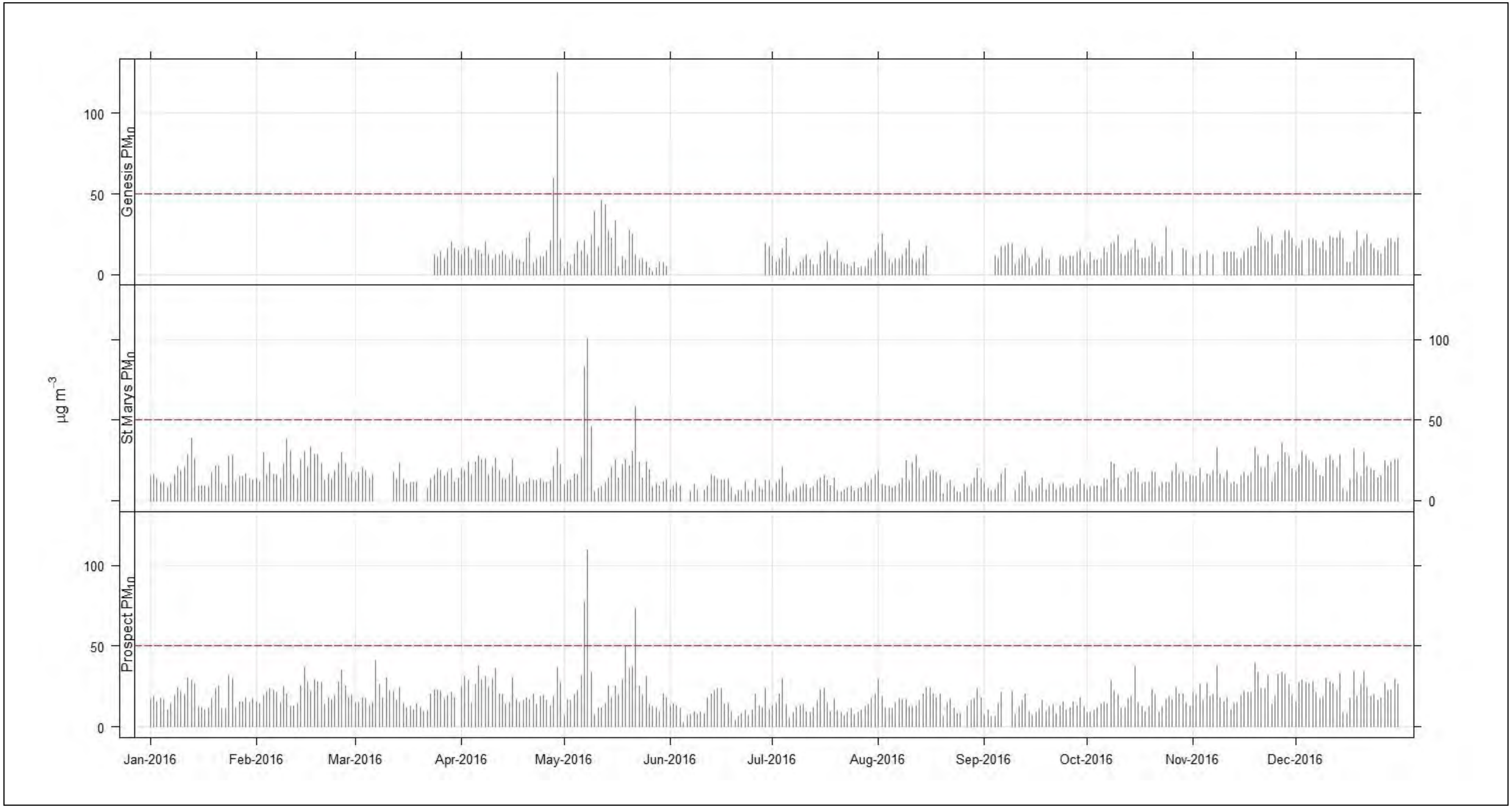


Figure 5-1: 24-hour average PM_{10} concentrations

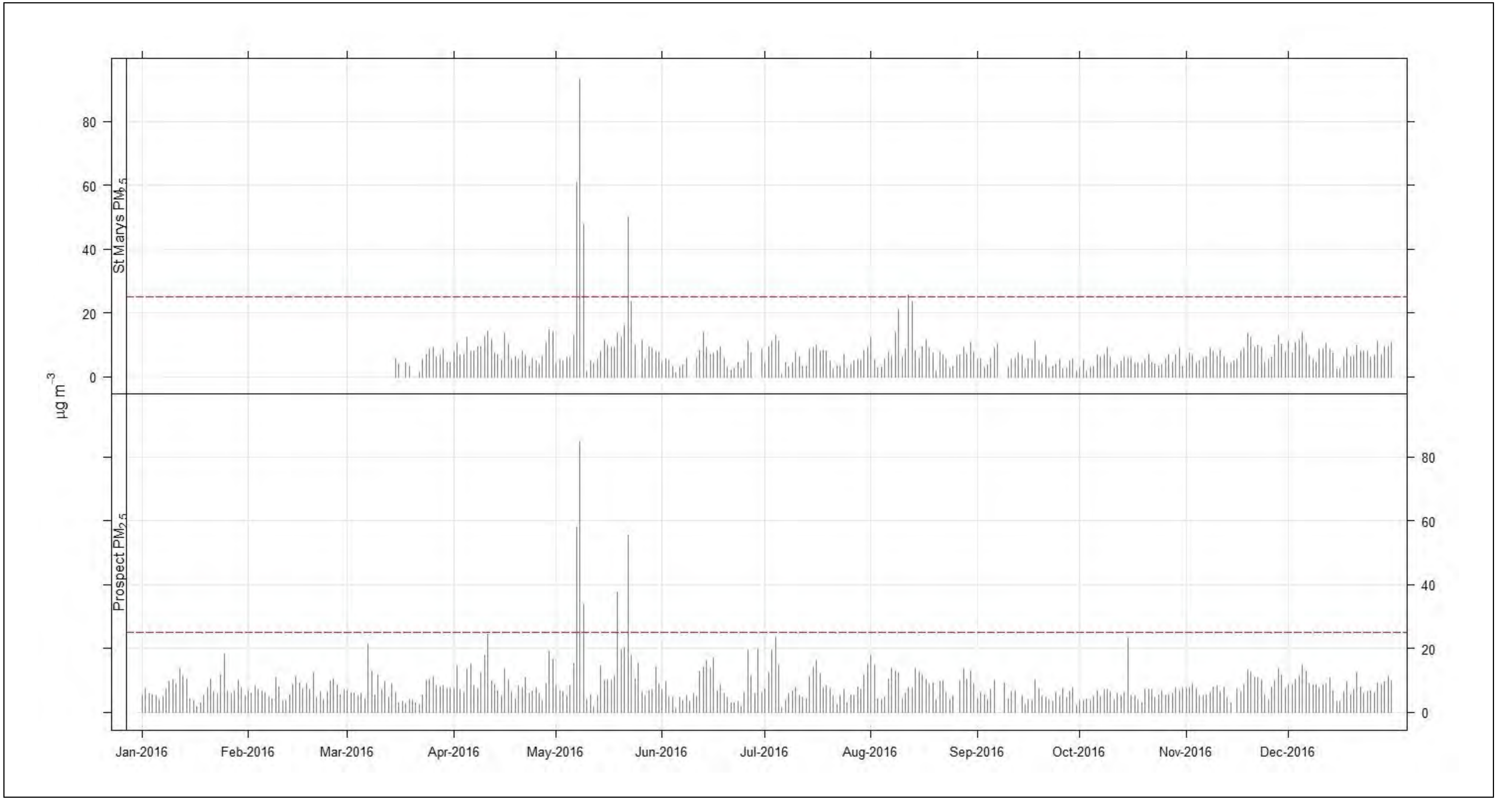


Figure 5-2: 24-hour average $PM_{2.5}$ concentrations

6. EMISSION INVENTORY

6.1 Dust emissions

Emission factors developed by the US EPA[3] have been applied to estimate the amount of dust produced by each activity (i.e. wheel generated dust, material handling / processing and wind erosion). Emissions estimates have been developed for TSP, PM_{10} and $PM_{2.5}$, with the emission estimates for TSP also used to estimate dust deposition rates.

A summary of the estimated annual emissions for construction and operation phases is presented in Figure 6-1 and compared with emissions estimates for the hypothetical scenarios considered in Mod 6 (currently under assessment by DPE).

The estimated emissions are highest for the hypothetical Mod 6 100% landfilled scenario; however, when considered in the context of Modification 7, this scenario would not change, as the redesign of the operational areas are related to material processing and recycling, and not landfilling operations (the only exception is a minor realignment of the access road).

It is therefore not necessary to re-assess this scenario for Modification 7, as the results and conclusions from Mod 6 would not change.

The estimated emissions for the hypothetical Mod 6 100% recycled scenario are lower than the operational scenario being considered for Modification 7. It is therefore not necessary to re-assess this scenario, as the revised Modification 7 operational scenario will result in a more conservative, worst case assessment of potential impacts.

Construction phase emissions are lower than the operation phase, however the majority of the emissions during construction are concentrated around the area of the western amenity bund and therefore the footprint of impacts will differ from typical operations at the site.

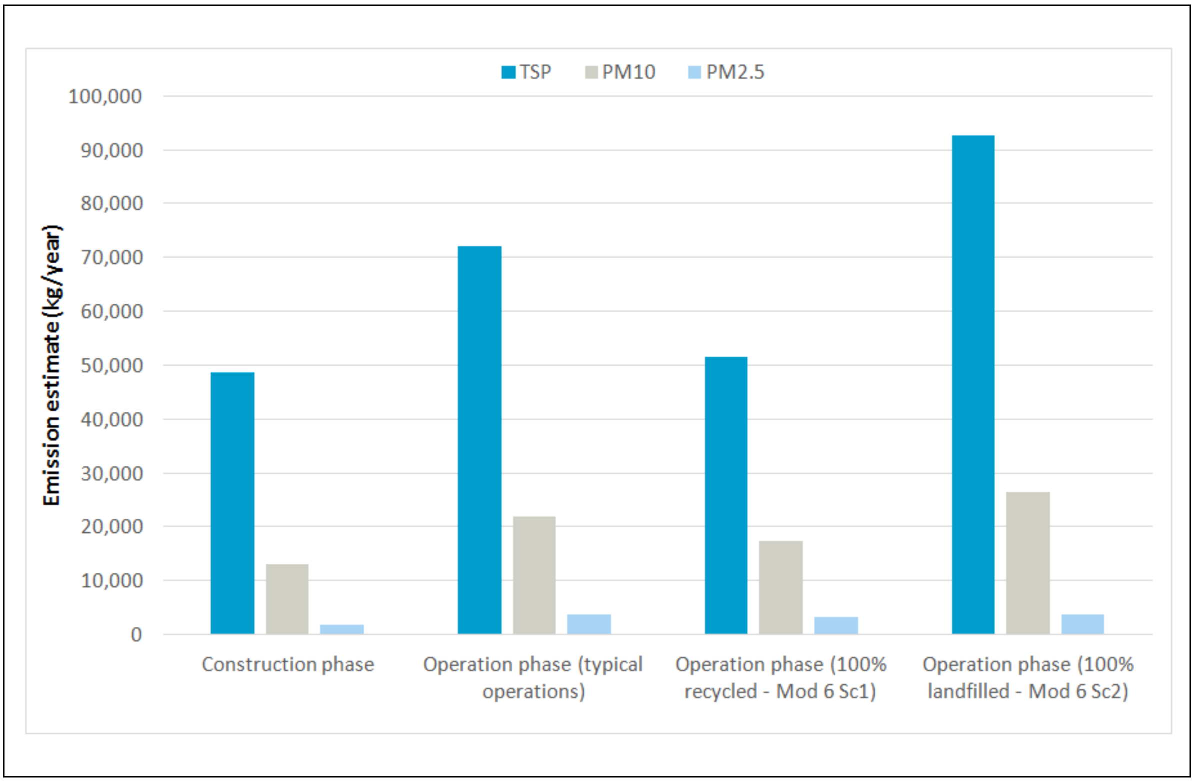


Figure 6-1: Summary of estimated emissions – Modification 6 and Modification 7

[3] US EPA AP-42 Compilation of Air Pollutant Emission Factors (US EPA, 1998b; US EPA, 2004; US EPA, 2006).

A summary of the annual TSP, PM_{10} and $PM_{2.5}$ emissions for the construction phase is presented in Table 6-1, which includes the removal / movement of the western amenity bund, relocating all existing stockpiled material and construction of a 40 ML stormwater basin. Dust controls that would be applied during construction include a water cart operating across all haulage routes and used to dampen areas where dozers / front end loaders (FEL) are pushing and spreading material. These dust controls are accounted for in the emissions estimates, assuming a control efficiency of 75% for haulage routes and 50% for dampening of material.

As described in Section 2.2, operation phase emissions are based on a typical operational scenario whereby approximately 60% of material enters the Recycling Facility (typical range is 60%-80%) and 40% of material is directed to landfill (typical range is 20%-40%). The higher range value for landfilling is selected as a conservative worst case (as this produces more wheel generated dust for trucks entering the landfill void).

A summary of the annual TSP, PM_{10} and $PM_{2.5}$ emissions for the operation phase is presented in Table 6-2. A number of dust controls are accounted for in the emissions estimates, as follows:

- Roofed enclosure of proposed waste receipt / unloading area.
- Material handling and processing within the enclosed MPC shed.
- Misting sprays within the MPC shed to dampen material as it is loaded to the hopper.
- The majority of travel routes onsite are sealed (exceptions are the haul route into the pit and within the stockpile storage area).
- Water sprays on the mobile crusher and shredder.
- Water truck operating on unsealed haul road into the pit, within the landfill and on the paved roads as needed.
- A fixed water spray system operates on the access roadway.

Some of the dust controls listed are incorporated into the emissions inventory for each relevant activity, based on control efficiencies reported in the literature. For example, all activities occurring within the shed are assigned a control efficiency of 40%. This is based on reported control efficiencies for material handling/transfer from enclosure or wind shielding, which range from 40% to 70% depending on roof/side wall wind shielding or full enclosure on all sides (Katestone, 2011). To provide a conservative (upper bound) estimate of emissions, we have adopted the lower of these reported control efficiencies. Also, to account for the mist sprays within the shed a control efficiency of 70% is assumed for waste sorting and loading the hopper (combination of 50% for watering and 40% for wind shielding). Control efficiencies for wheel generated dust are assumed to be 75% for unsealed travel routes and 70% for sealed roads.

Table 6-1: Particulate matter emissions for Construction Phase (kg/annum)

Activity	Controlled emissions (kg/annum)		
	TSP	PM_{10}	$PM_{2.5}$
Relocation of western amenity bund			
Excavator loading trucks	403	190	29
Haulage to dump location	8,252	2,228	223
Trucks unloading	403	190	29
Dozer spreading	7,854	1,705	239
Relocation of existing aggregate stockpiles			
Excavator loading trucks	38	18	3
Haulage to dump location	786	212	21
Trucks unloading	38	18	3
Loaders on stockpiles	7,854	1,705	239
Construction of basin			
Excavator loading trucks	46	22	3
Haulage to dump location	943	255	25
Trucks unloading	46	22	3
Dozer spreading	7,854	1,705	239
Relocation of existing greenwaste			
Excavator loading trucks	15	7	1
Haulage to dump location	314	85	8
Trucks unloading	15	7	1
Loaders on stockpiles	7,854	1,705	239
Exposed areas			
Wind erosion - amenity bund	3,400	1,700	255
Wind erosion - aggregate stockpile area	2,550	1,275	191
Total (kg/yr)	48,665	13,051	1,751

Table 6-2: Particulate matter emissions for Operations (kg/annum)

Activity	Controlled emissions (kg/annum)		
	TSP	PM_{10}	$PM_{2.5}$
Truck movements			
Waste trucks entering site - site access to MPC (paved)	2,483	477	115
Wheel generated dust - MPC to landfill (unpaved)	22,444	6,059	606
Product trucks leaving site - storage area to site access (paved)	1,332	256	62
Internal hauling - MPC to crushing plant/product storage	6,124	1,176	284
Internal hauling - product storage to batch plant	1,163	223	54
MPC / processing			
Trucks unloading in MPC	598	283	43
Ex/FEL sorting waste	299	141	21
Loading hopper	269	127	19
Screening in MPC	4,388	1,509	151
Transfer points	1,615	764	116
Unloading to product storage	808	382	58
Rehandle for product storage	1,615	764	116
Mobile crusher - concrete/brick for roadbase product	711	316	32
Mobile screening - sand/soil	2,633	906	91
Shredding greenwaste	284	126	13
Products			
Loading product stockpiles	808	382	58
Rehandle for batch plant	307	145	22

Activity	Controlled emissions (kg/annum)		
	TSP	PM_{10}	$PM_{2.5}$
Loading product trucks	808	382	58
Landfill			
Trucks unloading at landfill	537	254	38
Chute unload to landfill	90	42	6
Dozer pushing waste at landfill	14,706	2,764	387
Excavator/loader at landfill	66	31	5
Wind erosion			
Wind erosion - landfill	4,250	2,125	319
Wind erosion - greenwaste storage bay	510	255	38
Wind erosion - aggregate stockpile area	2,550	1,275	191
Diesel combustion - off-road	665	665	645
Diesel combustion - on-road trucks	151	151	139
Total (kg/yr)	72,213	21,980	3,686

The extent to which the US EPA emissions factors account for the diesel exhaust component of each activity varies according to the emission factor and/or monitoring method which was used in deriving the emission factor. For hauling on paved surfaces, the exhaust component is not included whereas for material processing/handling, the emission factors may include some of the diesel exhaust component. To be conservative for this assessment, we have assumed that all emission factors do not include the exhaust component and emissions from diesel combustion are included as a separate emissions source. Further details on the emission inventory development, including the assumptions, input data and emission factors used, is provided in Appendix 4.

6.2 Odour emissions

A conservative worst-case odour assessment was presented in the air quality and odour assessment for Modification 6, which considered a 100% landfilling scenario plus green waste processing and composting. One of the main challenges in accounting for an increase in odour emissions from landfilling at the 'hypothetical' increased rate, is how to appropriately scale existing odour emission data. The odour assessment for the 2008 EIS (HAS, 2008) did not have access to site specific monitoring data and instead used historical odour data from another landfill. After accounting for variations in emissions over time and across the landfill area, the historical emissions data were adjusted pro rata based on the reduced tonnages of organic waste landfilled at the Genesis facility. In other words, because most of the organic waste is recovered at modern landfills, the decomposition and resultant emissions would be much lower than for the historical monitoring data which was used. An odour assessment undertaken as part of the Independent Environmental Audit in 2015 noted some limitations in this approach and suggested a better approach would be to adjust odour emission rates based on potential fugitive gas emissions (TOU, 2015). There are insufficient data available to take this approach and, regardless, for the worst case scenario of 2 Mtpa landfilled, it was necessary to assume that no organic waste is recovered.

Site specific odour monitoring was completed onsite in 2013 for sources including the active tip face, the leachate sump/riser and the leachate treatment tanks. While these monitoring results are considered appropriate to derive emission rates for existing operations, no measurements were taken across the covered or capped areas of the landfill, although these areas of the landfill are expected to have low emissions potential. Furthermore, these measurements were taken while the MPC was operational and the organic waste volume may therefore not necessarily be representative of our worst case scenario.

To derive odour emission rates for a worst case landfilling scenario, odour emission data for other putrescible waste landfills were reviewed, with a focus on sites where relatively recent odour monitoring was conducted. A summary of these data are provided in Table 6-3.

The approach taken for the worst case assessment for Modification 6 was to use the average specific odour emissions rate (SOER, expressed as $OU.m^3/m^2/s$) from the four putrescible waste landfills presented in Table 6-3. As shown, this provides a higher SOER than measurements taken at the existing facility and is generally higher than the emission rates used in the original EIS. To provide an additional level of conservatism, the source areas, across which these SOERs are applied, were scaled from the existing site layout according to the production increase (i.e. 2/0.7 Mtpa).

Table 6-3: Review of odour emissions data and odour emission rates for modelling

Source	Specific Odour Emission Rate ($OU.m^3/m^2/s$)						
	Whytes Gully[1]	Spring Farm[2]	Woodlawn[3]	Lucas Heights[4]	SOER Average	Genesis site monitoring	Used in original EIS
Active tip face	1.115	0.424	0.7	*26-40 $OU.m^3/s$	0.7	0.4	
Daily cover	1.023	0.069		0.03	0.4		3.83
Intermediate cover	0.035	0.019	0.3	0.05	0.1		
Final cap		0.026			0.03		0.00051
Leachate storage	0.153	0.108	3.6	1.8	1.4	0.2	0.069
Greenwaste storage		1.279	*2.37 $OU.m^3/s$	4	2.6		
Compost windrow (fresh)		2.654	5.65	1.95	3.3		0.105
Compost windrow (aged/product)		0.18	0.83	0.34	0.4		

Note: * expressed as an OER ($OU.m^3/s$) and not included in the SOER average
[1] PAEHolmes, 2012
[2] Heggies, 2010
[3] GHD, 2015
[4] Pacific Environment, 2013

7. DISPERSION MODELLING RESULTS

7.1 Construction phase

7.1.1 PM_{10}

The predicted ground level concentrations (GLCs) of PM_{10} at each receptor location are presented in Table 7-1. Results are presented for the Modification 7 increment alone (construction phase), as well as cumulative which includes the addition of the existing background (described in Section 5.4).

The highest incremental annual average PM_{10} concentration at a residential receptor is 0.6 µg/m³ (R05, R07, R08). With the addition of existing background, the cumulative annual average GLCs comply with the impact assessment criterion at all residential receptor locations. The highest incremental 24-hour average PM_{10} concentration at a residential receptor is 9.0 µg/m³ (R05). With the addition of existing background, the cumulative 24-hour average GLCs comply with the impact assessment criterion at all residential receptor locations.

The highest incremental annual average PM_{10} concentration at a commercial receptor is 2.0 µg/m³ (which is effectively on the site boundary). When background is added, cumulative annual average PM_{10} concentrations are below the applicable impact assessment criterion at the commercial receptors on the facility boundary. There is a single additional exceedances of the 24-hour average impact assessment criterion at the commercial receptors right on the facility boundary (R12). This is attributed primarily to the elevated background from all other sources, rather than emissions from the construction activities.

Table 7-1: PM_{10} modelling predictions for the construction phase of Modification 7

Receptor ID	Receptor type	Modification 7 increment		Cumulative	
		24-Hour Max	Annual Ave	24-Hour Max[1]	Annual Ave
	Criteria	50 µg/m³	25 µg/m³	50 µg/m³	25 µg/m³
R01	Residential	6.2	0.5	41.2	19.3
R02		5.9	0.5	41.2	19.4
R03		5.7	0.6	41.2	19.4
R04		8.5	0.5	41.2	19.4
R05		9.0	0.6	41.2	19.5
R06		4.9	0.4	41.2	19.3
R07		8.3	0.6	41.2	19.4
R08		7.3	0.6	41.2	19.4
R09		1.2	0.1	41.5	19.0
R10		1.5	0.1	41.9	19.0
R11		1.4	0.1	41.8	19.0
R12	Commercial /industrial	23.9	2.0	50.8	20.9
R13		15.1	1.2	41.2	20.1
R14		11.5	0.6	41.2	19.5
R15		15.3	0.8	41.2	19.6
R16		19.0	0.8	41.2	19.7
R17		9.9	0.7	41.2	19.6

Note: [1] As described in Section 5, the background dataset contains four existing exceedances of the impact assessment criteria and the cumulative 24-hour average PM_{10} is therefore calculated using the 5th highest background day (excluding the background days already at or over 50 µg/m³)

7.1.2 $PM_{2.5}$

The predicted ground level concentrations (GLCs) of $PM_{2.5}$ at each sensitive receptor are presented in Table 7-2. Results are presented for the Modification 7 increment alone (construction phase), as well as cumulative which includes the addition of existing background (described in Section 5.4).

The highest incremental annual average $PM_{2.5}$ concentration at a residential receptor is 0.1 µg/m³ (R04, R05 and R07). With the addition of existing background, the cumulative annual average GLCs exceed the impact assessment criterion at all locations, however this is because the annual average background concentrations of $PM_{2.5}$ already exceed the impact assessment criterion. The highest incremental 24-hour average $PM_{2.5}$ concentration at a residential receptor is 1.2 µg/m³ (R05). With the addition of existing background, the cumulative 24-hour average GLCs comply with the applicable impact assessment criterion at all residential receptor locations.

There are also no additional exceedances of the 24-hour average impact assessment criterion at any of the commercial receptors on the site boundary.

Table 7-2: $PM_{2.5}$ modelling predictions for the construction phase of Modification 7

Receptor ID	Receptor type	Modification 7 increment		Cumulative	
		24-Hour Max	Annual Ave	24-Hour Max[1]	Annual Ave
		25 µg/m³	8 µg/m³	25 µg/m³	8 µg/m³
R01	Residential	0.8	0.1	24.5	8.7
R02		0.7	0.1	24.5	8.7
R03		0.7	0.1	24.5	8.7
R04		1.1	0.1	24.5	8.7
R05		1.2	0.1	24.5	8.7
R06		0.6	0.1	24.5	8.7
R07		1.1	0.1	24.5	8.7
R08		1.0	0.1	24.5	8.7
R09		0.1	<0.1	24.4	8.7
R10		0.2	<0.1	24.4	8.7
R11		0.2	<0.1	24.4	8.7
R12	Commercial /industrial	3.1	0.2	24.7	8.9
R13		2.0	0.2	24.6	8.8
R14		1.5	0.1	24.5	8.7
R15		2.0	0.1	24.5	8.7
R16		2.5	0.1	24.4	8.8
R17		1.3	0.1	24.4	8.7

Note: [1] As described in Section 5, the background dataset contains five existing exceedances of the impact assessment criteria and the cumulative 24-hour average $PM_{2.5}$ is therefore calculated using the 6th highest background day (excluding the background days already at or over 25 µg/m³)

7.1.3 TSP and Dust Deposition

The predicted ground level concentrations (GLCs) of TSP and dust deposition at each receptor are presented in Table 7-3. Results are presented for the Modification 7 increment alone (construction phase), as well as cumulative which includes the addition of existing background (described in Section 5.4).

The incremental increase in annual average TSP is minor and with the addition existing background, the cumulative annual average GLCs comply with the impact assessment criterion at all receptor locations.

The predicted dust deposition complies with both the incremental and cumulative impact assessment criteria at all residential and commercial receptor locations.

Table 7-3: TSP and dust deposition modelling predictions for the construction phase of Modification 7

Receptor ID	Receptor type	Modification 7 increment		Cumulative	
		TSP	Dust Depos	TSP	Dust Depos
		90 µg/m^3	2 g/m^2/month	90 µg/m^3	4 g/m^2/month
R01	Residential	1.8	0.1	49.0	2.1
R02		2.1	0.1	49.3	2.1
R03		2.1	0.1	49.3	2.1
R04		1.9	0.1	49.1	2.1
R05		2.2	0.1	49.4	2.1
R06		1.3	0.1	48.5	2.1
R07		2.0	0.1	49.2	2.1
R08		1.9	0.1	49.2	2.1
R09		0.5	<0.1	47.7	2.0
R10		0.5	<0.1	47.7	2.0
R11		0.5	<0.1	47.7	2.0
R12	Commercial /industrial	7.8	0.5	55.0	2.5
R13		4.5	0.2	51.7	2.2
R14		2.2	0.1	49.4	2.1
R15		2.6	0.2	49.8	2.2
R16		2.9	0.2	50.1	2.2
R17		2.4	0.1	49.6	2.1

7.2 Operation phase

7.2.1 PM_{10}

The predicted ground level concentrations (GLCs) of PM_{10} at each receptor location are presented in Table 7-4. Results are presented for the Modification 7 increment alone (operation phase), as well as cumulative which includes the addition of the existing background (described in Section 5.4).

The highest incremental annual average PM_{10} concentration at a residential receptor is 4.4 µg/m³ (R05). With the addition of existing background, the cumulative annual average GLCs comply with the impact assessment criterion at all residential receptor locations. The highest incremental 24-hour average PM_{10} concentration at a residential receptor is 24.2 µg/m³ (R05). With the addition of existing background, the cumulative 24-hour average GLCs comply with the impact assessment criterion at all residential receptor locations.

The highest incremental annual average PM_{10} concentration at a commercial receptor is 14.3 µg/m³ (which is effectively right on the facility boundary). When background is added, exceedances of the annual average impact assessment criterion occur at the commercial receptors on the facility boundary (shown as bold in Table 7-4).

There are a number of additional exceedances of the 24-hour average impact assessment criterion at the commercial receptors right on the facility boundary. This is caused by a combination of elevated background with the additional dust emissions from the modification. Further analysis, showing the risk of additional exceedances above background, as a result of the modification, is presented below.

Table 7-4: PM_{10} modelling predictions for the operation phase of Modification 7

Receptor ID	Receptor type	Modification 7 increment		Cumulative	
		24-Hour Max	Annual Ave	24-Hour Max[1]	Annual Ave
		50 µg/m³	25 µg/m³	50 µg/m³	25 µg/m³
R01	Residential	14.7	2.6	46.4	21.4
R02		15.5	2.8	46.5	21.7
R03		19.2	3.3	45.0	22.2
R04		23.7	4.2	46.3	23.0
R05		24.2	4.4	46.6	23.3
R06		18.9	3.0	44.8	21.9
R07		24.2	4.2	46.8	23.1
R08		23.7	4.1	46.9	23.0
R09		3.3	0.6	44.0	19.5
R10		4.1	0.7	43.7	19.6
R11		4.5	0.7	43.3	19.6
R12	Commercial /industrial	51.6	14.3	70.2	33.1
R13		45.1	11.4	69.9	30.2
R14		26.8	6.1	53.9	24.9
R15		40.9	8.1	58.0	26.9
R16		64.3	9.3	73.3	28.2
R17		42.2	6.1	71.7	24.9

Note: [1] As described in Section 5, the background dataset contains four existing exceedances of the impact assessment criteria and the cumulative 24-hour average PM_{10} is therefore calculated using the 5th highest background day (excluding the background days already at or over 50 µg/m³)

In addition to the paired-in-time cumulative analysis presented above, to provide an analysis of the statistical likelihood of compliance with the impact assessment criterion, every predicted 24-hour average concentration (366 individual concentrations) has been paired with multiple years of measured 24-hour average concentrations from the NSW OEH Prospect and St Marys sites, plus the available Genesis PM_{10} monitoring data (a total of 3,043 measurements).

Each combination of model prediction and recorded concentration (1,110,695 potential combinations) is combined, assuming that any background value from the data set could occur on any given day of the proposed operations.

For the receptors presented in Table 7-1 with one or more additional exceedance days (all commercial receptors), the frequency of cumulative 24-hour average PM_{10} concentrations was calculated and the frequency of concentrations greater than 50 µg/m³ is presented in Figure 7-1. The analysis shows that the increased probability or risk of additional exceedances of the 24-hour PM_{10} impact assessment criteria is 2-9%, equating to an additional 3 to 30 additional exceedance days above background.

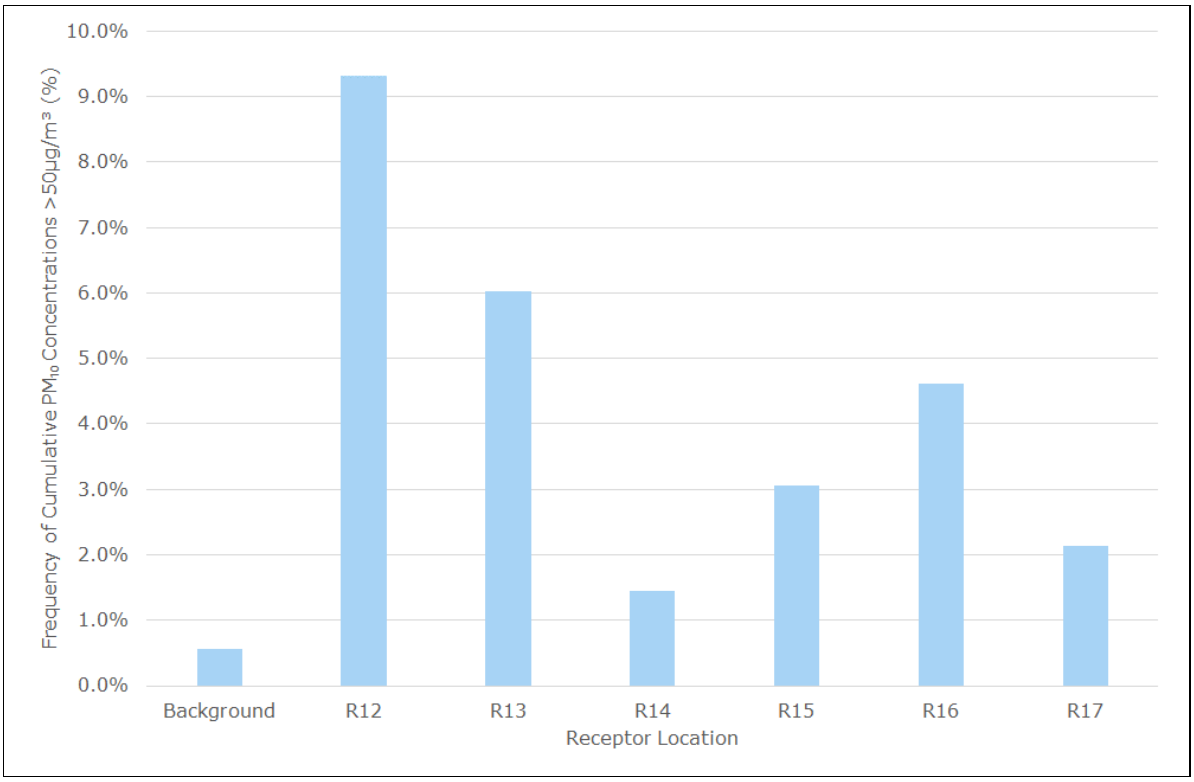


Figure 7-1: Frequency distribution of cumulative 24-hour average PM_{10} concentration

7.2.2 $PM_{2.5}$

The predicted ground level concentrations (GLCs) of $PM_{2.5}$ at each sensitive receptor are presented in Table 7-5. Results are presented for the Modification 7 increment alone (operation phase), as well as cumulative which includes the addition of existing background (described in Section 5.4).

The highest incremental annual average $PM_{2.5}$ concentration at a residential receptor is 0.8 µg/m³. With the addition of existing background, the cumulative annual average GLCs exceed the impact assessment criterion at all locations, however this is because the annual average background concentrations of $PM_{2.5}$ already exceed the impact assessment criterion.

The highest incremental 24-hour average $PM_{2.5}$ concentration at a residential receptor is 4.4 µg/m³ (R05 and R07). With the addition of existing background, the cumulative 24-hour average GLCs result in one additional exceedance of the impact assessment criterion at eight residential receptor locations. This is caused by a combination of elevated background with the additional dust emissions from the modification. It is noted that the background $PM_{2.5}$ concentration on this day is already close to the impact assessment criterion (24.4 µg/m³).

There are also two to five additional exceedances of the 24-hour average impact assessment criterion at the commercial receptors right on the facility boundary. Further analysis, showing the risk of additional exceedances above background, as a result of the modification, is presented below.

Table 7-5: $PM_{2.5}$ modelling predictions for the operation phase of Modification 7

Receptor ID	Receptor type	Modification 7 increment		Cumulative	
		24-Hour Max	Annual Ave	24-Hour Max[1]	Annual Ave
		25 µg/m³	8 µg/m³	25 µg/m³	8 µg/m³
R01	Residential	2.7	0.5	25.0	9.1
R02		2.7	0.5	25.1	9.1
R03		3.1	0.6	25.3	9.2
R04		4.3	0.8	25.8	9.4
R05		4.4	0.8	25.9	9.5
R06		3.4	0.6	25.5	9.2
R07		4.4	0.8	25.9	9.4
R08		4.2	0.8	25.8	9.4
R09		0.6	0.1	24.4	8.8
R10		0.8	0.1	24.4	8.8
R11		0.8	0.1	24.4	8.8
R12	Commercial /industrial	8.2	2.4	28.7	11.0
R13		6.9	1.9	28.1	10.6
R14		4.2	1.0	26.6	9.7
R15		6.1	1.4	27.3	10.0
R16		9.3	1.6	28.0	10.2
R17		7.3	1.1	27.2	9.7

Note: [1] As described in Section 5, the background dataset contains five existing exceedances of the impact assessment criteria and the cumulative 24-hour average $PM_{2.5}$ is therefore calculated using the 6th highest background day (excluding the background days already at or over 50 µg/m³)

Similar to the analysis conducted for PM_{10}, the frequency of additional exceedance days has been analysed for $PM_{2.5}$, for the receptors presented in Table 7-5 with one or more additional exceedance days (residential receptors R1 to R8 and commercial receptors R12 to R17).

The frequency of concentrations greater than 25 µg/m^3 from this cumulative analysis is presented in Figure 7-2. The analysis shows that for residential and commercial receptors, there is an increase in probability or risk of additional exceedances of 1.2%-1.3% and 1.3-1.7%, respectively. This equates to an additional 0.4 to 0.7 additional exceedance days for the residential receptors and an additional 0.9 to 2.1 additional exceedance days for the commercial receptors above background.

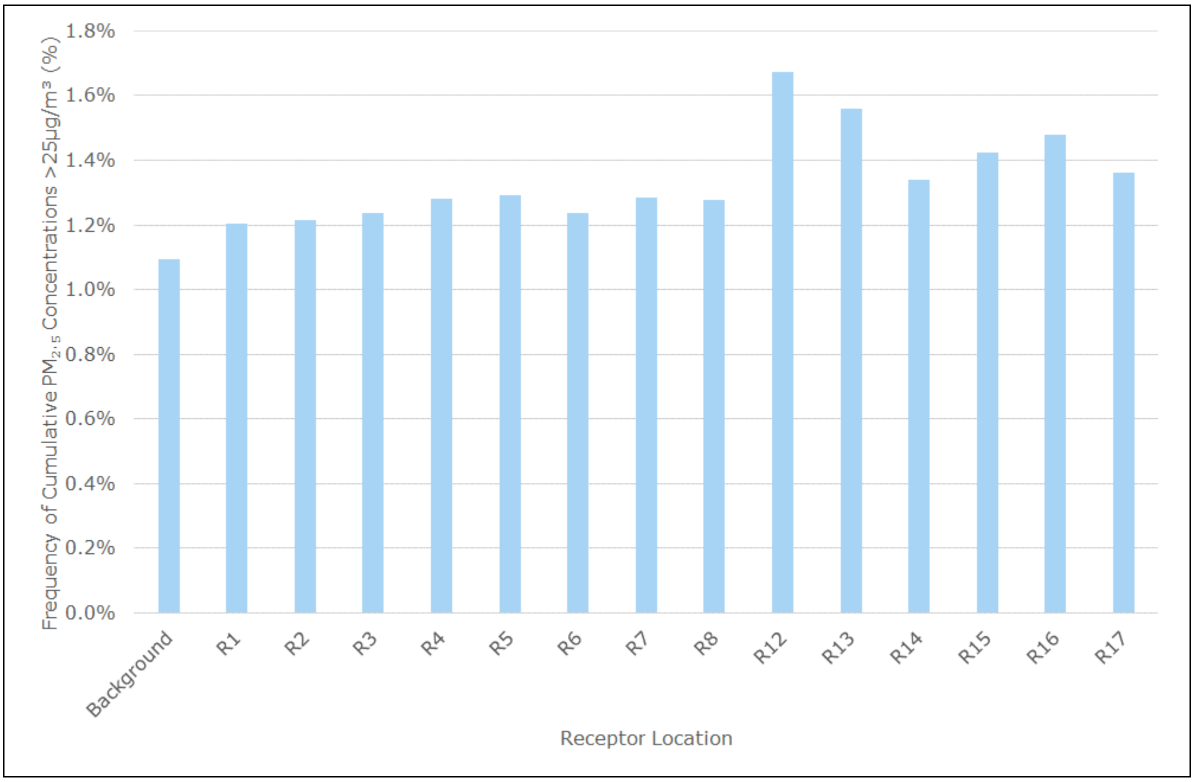


Figure 7-2: Frequency distribution of cumulative 24-hour average PM $_{2.5}$ concentration

7.2.3 TSP and Dust Deposition

The predicted ground level concentrations (GLCs) of TSP and dust deposition at each receptor are presented in Table 7-6. Results are presented for the Modification 7 increment alone (operation phase), as well as cumulative which includes the addition of existing background (described in Section 5.4).

The incremental increase in annual average TSP is relative minor at residential receptors and with the addition existing background, the cumulative annual average GLCs comply with the impact assessment criterion at all receptor locations. The predicted dust deposition complies with both the incremental and cumulative impact assessment criteria at all residential and commercial receptors.

Table 7-6: TSP and dust deposition modelling predictions for the operation phase of Modification 7

Receptor ID	Receptor type	Modification 7 increment		Cumulative	
		TSP	Dust Depos	TSP	Dust Depos
		90 µg/m³	2 g/m²/month	90 µg/m³	4 g/m²/month
R01	Residential	4.9	0.2	52.1	2.2
R02		5.4	0.2	52.6	2.2
R03		6.4	0.2	53.7	2.2
R04		7.7	0.2	54.9	2.2
R05		8.5	0.2	55.7	2.2
R06		5.4	0.2	52.6	2.2
R07		8.0	0.2	55.2	2.2
R08		7.8	0.2	55.0	2.2
R09		1.0	<0.1	48.2	2.0
R10		1.1	<0.1	48.3	2.0
R11		1.0	<0.1	48.3	2.0
R12	Commercial /industrial	39.3	1.3	86.5	3.3
R13		30.1	1.2	77.3	3.2
R14		14.0	0.5	61.2	2.5
R15		20.7	0.9	67.9	2.9
R16		26.2	1.4	73.4	3.4
R17		16.0	0.5	63.2	2.5

7.3 Odour

A theoretical worst case odour scenario was modelled, based on the hypothetical scenario for landfilling to occur up to the approved 2 Mtpa (i.e. under Modification 6 if approved). With landfilling at 2 Mtpa there would be no greenwaste processing through the MPC, however to be conservative, nominal sources associated with greenwaste storage, processing and composting were also included. It is noted that current greenwaste processing is limited to shredding, to produce various mulch products. Although not a current activity, the site is approved for greenwaste composting and this is also included as an odour source in the modelling, nominally placed within the current greenwaste storage area.

The predicted ground level concentrations (GLCs) of odour for this worst case scenario are presented in Table 7-7. All modelling predictions at residential receptors are below odour goal of 2 OU and therefore comply with the impact assessment criteria. Modelling predictions at commercial receptors are all less than 7 OU, which is considered an appropriate odour goal for this type of receptor.

It is noted that recent odour audits for the current site found that no significant odour was detected beyond the site boundary (TOU, 2015; SEMA, 2017), which further supports the outcomes of the modelling.

Table 7-7: Predicted ground level concentration of odour (99th percentile, nose response average)

Receptor ID	Receptor type	Modification 6 increment
		Odour
		2 OU
R01	Residential	<1
R02		1
R03		1
R04		<2
R05		<2
R06		1
R07		<2
R08		1
R09		<1
R10		<1
R11		<1
R12	Commercial /industrial	4
R13		3
R14		2
R15		3
R16		3
R17		3

7.4 Additional cumulative impacts from the proposed TNG EfW facility

As previously discussed, peak 24-hour average concentrations from the proposed TNG EfW facility would not occur at the same time as peak 24-hour average concentrations from the Genesis facility, due to the different meteorological conditions that produce highest concentration from tall stacks compared with ground level fugitive dust sources. Therefore, cumulative impacts for peak 24-hour average concentrations are not considered significant.

For longer term averages, cumulative impacts may occur, however based on the predicted increment from the EfW (0.2 – 0.3 µg/m^3 across residential areas and at the eastern and northern site boundary), there would be no change to the predicted cumulative results presented above. That is, the addition of emissions from the EfW would not result in any further exceedances of the annual average impact assessment criteria.

8. MANAGEMENT AND MONITORING

The principal fugitive dust emission sources during operation are:

- Movement of vehicles on travel routes and re-entrainment of dust from paved and unpaved surfaces.
- Material handling (trucks unloading, loading, screening, crushing, sorting).
- Wind erosion from exposed surfaces and stockpiles.
- Diesel vehicle exhaust from the trucks, front end loaders, excavators etc.

The existing dust controls include:

- Enclosure of all waste unloading, processing and sorting in the covered waste receipt area and within the MPC shed.
- Misting water sprays within the shed to suppress dust.
- Sealed travel routes onsite (with the exception of the pit) and use water carts and/or fixed water sprays on all travel routes and within the landfill.
- Use of water sprays on crusher.

The existing facility operates under an Operational Environmental Management Plan (OEMP) which outlines the roles, responsibilities and the tasks to be performed to ensure environmental impacts are minimised. The OEMP will be reviewed and updated, where required, for the modification.

Based on the modelling results presented in this report, the existing controls appear to be effective in preventing dust impacts in surrounding residential areas. This conclusion is supported by the existing monitoring data which demonstrate compliance with impact assessment criteria at the site boundary (dust deposition) and in the suburb of Minchinbury (PM_{10}).

It is noted that some exceedances of the impact assessment criteria are predicted at commercial receptors on the northern and eastern boundary of the site. This is caused by a combination of elevated background with the additional dust emissions from the modification.

To better monitor the effectiveness of existing controls and ongoing performance of the site, the proponent will consider relocating the PM_{10} monitoring site in Minchinbury to a boundary location at the northern and/or eastern site boundary. The four existing boundary dust deposition monitoring sites remain appropriate for the modification.

9. CONCLUSION

Local air quality impacts are assessed using a Level 2 assessment approach in accordance with the Approved Methods. Emissions are estimated for all activities and dispersion modelling is used to predict ground level concentrations at surrounding sensitive receptors. Cumulative impacts are assessed by combining the contribution from the modification with the existing ambient baseline.

A construction phase scenario is assessed, including emissions associated with the removal / movement of the western amenity bund, relocating all existing stockpiled material and construction of a 40 ML stormwater basin. Operation phase emissions are based on a likely operational scenario whereby approximately 60% of material enters the Recycling Facility (typical range is 60%-80%) and 40% of material is directed to landfill (typical range is 20%-40%). The higher range value for landfilling is selected as a conservative worst case (as this produces more wheel generated dust for trucks entering the landfill void).

For construction phase, the predicted cumulative annual average PM_{10} concentrations comply with the impact assessment criterion at all residential receptor locations and with the addition of existing background, there are no additional exceedances of the 24-hour average PM_{10} impact assessment criterion. The cumulative annual average $PM_{2.5}$ concentrations exceed the impact assessment criterion at all locations, however this is because the annual average background concentrations of $PM_{2.5}$ already exceed the impact assessment criteria. With the addition of existing background, there are no additional exceedances of the 24-hour average $PM_{2.5}$ impact assessment criterion at residential receptor locations. Cumulative annual average TSP concentrations for the construction phase comply with the impact assessment criterion at all receptor locations, while predicted dust deposition levels comply with both the incremental and cumulative impact assessment criteria at all residential receptors.

Similar results are presented for the operation phase of Modification 7. The predicted cumulative annual average PM_{10} concentrations comply with the impact assessment criterion at all residential receptor locations and there are no additional exceedances of the 24-hour average PM_{10} impact assessment criterion at residential receptor locations. The cumulative annual average $PM_{2.5}$ concentrations exceed the impact assessment criterion at all locations, however this is because the annual average background concentrations of $PM_{2.5}$ already exceed the impact assessment criteria. The cumulative 24-hour average $PM_{2.5}$ concentrations result in one additional exceedance of the impact assessment criterion at eight residential receptor locations. This is caused by a combination of elevated background with the additional dust emissions from the modification. It is noted that the background $PM_{2.5}$ concentration on this day is already close to the impact assessment criterion (24.4 µg/m³). Furthermore, additional statistical analysis shows that the probability or risk of any additional exceedances of the 24-hour $PM_{2.5}$ impact assessment criterion does not significantly increase, above what is already caused by background. Cumulative annual average TSP concentrations for the operation phase comply with the impact assessment criterion at all receptor locations. The predicted dust deposition complies with both the incremental and cumulative impact assessment criteria.

The worst case potential odour impact from landfilling at 2 Mtpa combined with greenwaste processing, would not result in exceedances of the odour goal of 2 OU at any residential receptor.

For the operation phase of Modification 7 there are predicted exceedances at the commercial premises located on the northern and eastern boundary of the site. This is caused by a combination of elevated background with the additional dust emissions from the modification. For PM_{10} additional statistical analysis shows an increased probability or risk of additional exceedances of the 24-hour PM_{10} impact assessment criteria at these commercial receptors increases. Therefore, to better monitor the effectiveness of existing controls and ongoing performance of the site, the proponent will consider relocating the PM_{10} monitoring site in Minchinbury to a boundary location at the northern and/or eastern site boundary.

The proponent has implemented dust management measures at the Site that are consistent with industry best practice and will continue to manage dust emissions to minimise any potential for off-site impacts. Existing controls have been demonstrated to be effective to-date in preventing dust impacts in surrounding residential areas, based on existing monitoring. Ongoing monitoring will continue to measure the effectiveness of dust mitigation and, if required for the Modification, allow for the Site to implemented additional reactive controls.

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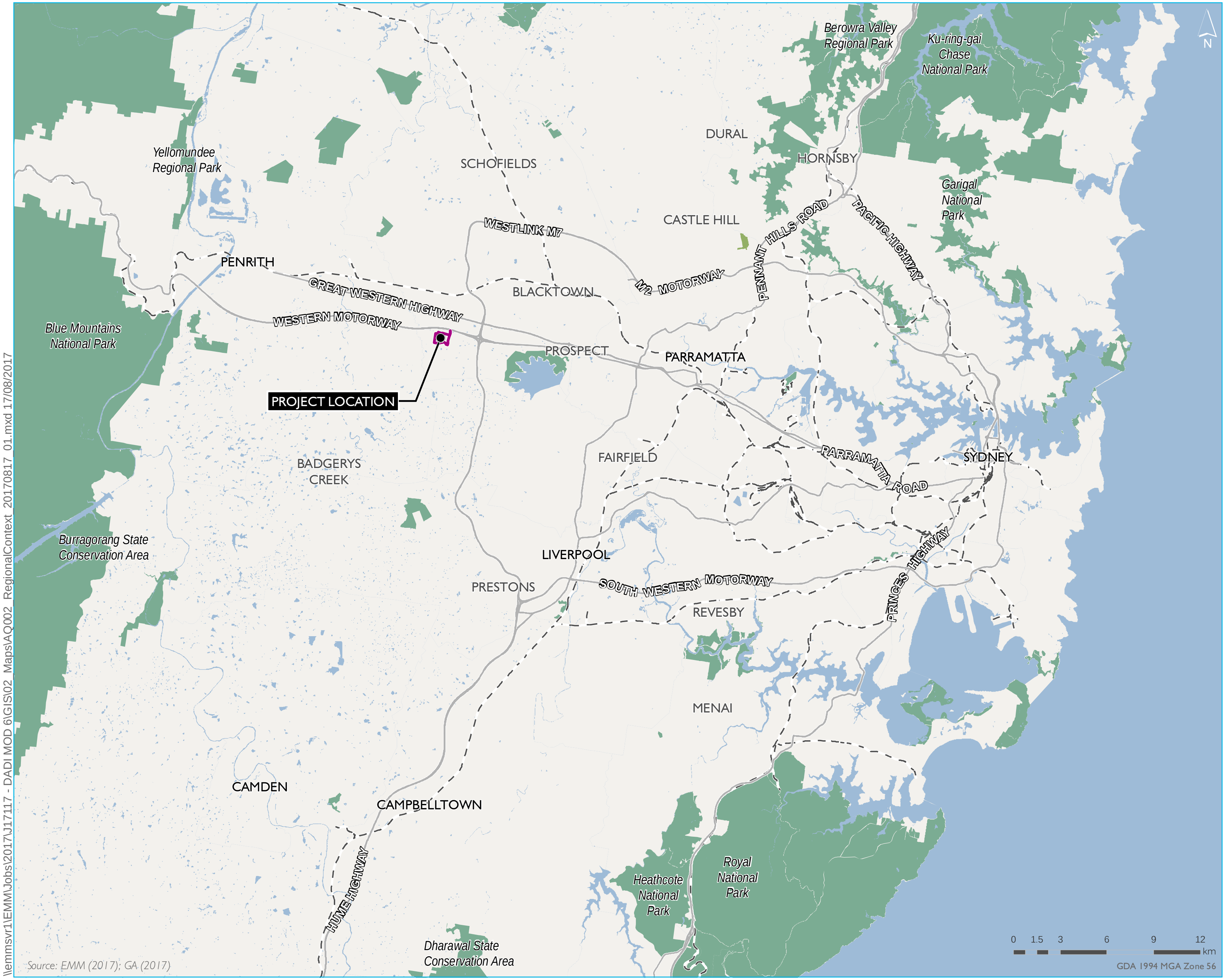
APPENDIX 1
FIGURES



KEY

- Site location
- Main roads
- Waterbodies
- NPWS reserve
- State forest

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Regional context

Genesis Zero Waste
Modification 6
Air quality impact assessment
Figure 1.1

EMM

KEY

- Site location
- Main road
- Local road
- Watercourse

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Local context

Genesis Zero Waste
Modification 6
Air quality impact assessment
Figure 1.2

EMM

APPENDIX 2
MODEL SETTINGS

Table A2-1: TAPM settings

Parameter	Setting
Model Version	TAPM v.4.0.5
Number of grids (spacing)	4 (30 km, 10 km, 3 km, 1 km)
Number of grid points	25 x 25
Vertical grids / vertical extent	30 / 8000m (~400mb)
Centre of analysis	Lat 150.824997, long -33.7999992 Easting 298655, Northing 6257892S
Year of analysis	2016
Terrain and landuse	Terrain data using NASA SRTM3 database. Default TAPM values based on land-use and soils data sets from Geoscience Australia and the US Geological Survey, Earth Resources Observation Systems (EROS) Data Center Distributed Active Archive Center (EDC DAAC).
Assimilation sites	NSW OEH - St Marys BoM - Horsley Park Equestrian Centre, Badgerys Creek AWS, Penrith Lakes AWS, Bankstown Airport, Holsworthy Control Range, Sydney Olympic Park, Richmond RAAF and Camden Airport.

Table A2-2: CALMET settings

Parameter	Setting
Grid domain	60 km x 60 km
Grid resolution	0.5 km
Number of grid points	120 x 120
Reference grid coordinate	268.900, 6228.200
Vertical grids / vertical extent	10 cell heights / 4,000m
Upper air meteorology	Prognostic 3D.dat extracted from TAPM at 1 km grid
Surface observations	NSW OEH - St Marys BoM - Horsley Park Equestrian Centre, Badgerys Creek AWS, Penrith Lakes AWS, Bankstown Airport, Holsworthy Control Range, Sydney Olympic Park, Richmond RAAF and Camden Airport.

Table A2-3: CALMET model options

Flag	Description	Recommended setting	Value used
NOOBS	Meteorological data options	0,1,2	1 - combination of surface and prognostic data
ICLOUD	Cloud Data Options – Gridded Cloud Fields	4	4 -Gridded cloud cover from Prognostic relative humidity at all levels (MM5toGrads algorithm)
IEXTRP	Extrapolate surface wind observations to upper layers	-4	-4 - similarity theory used
IFRADJ	Compute Froude number adjustment effects	1	1 - applied
IKINE	Compute kinematic effects	0	0 - not computed
BIAS (NZ)	Relative weight given to vertically extrapolated surface observations vs. upper air data	NZ * 0	NZ * 0 - layers in lower levels of model will have stronger weighting towards surface, higher levels will be have stronger weighting to upper air data
TERRAD	Radius of influence of terrain	No default (typically 5-15km)	5 km

Table A2-3: CALMET model options

Flag	Description	Recommended setting	Value used
NOOBS	Meteorological data options	0,1,2	1 - combination of surface and prognostic data
ICLOUD	Cloud Data Options – Gridded Cloud Fields	4	4 -Gridded cloud cover from Prognostic relative humidity at all levels (MM5toGrads algorithm)
RMAX1 and RMAX2	Maximum radius of influence over land for observations in layer 1 and aloft	No Default	10 km, 20km
R1 and R2	Distance from observations in layer 1 and aloft at which observations and Step 1 wind fields are weighted equally	No Default	R1 - 2 km, R2 – 5 km

Table A2-4: CALPUFF model options

Flag	Description	Value used	Description
MCHEM	Chemical Transformation	0	Not modelled
MDRY	Dry Deposition	1	Yes
MWET	Wet Deposition	0	Not modelled
MTRANS	Transitional plume rise allowed?	1	Yes
MTIP	Stack tip downwash?	1	Yes
MRISE	Method to compute plume rise	1	Briggs plume rise
MSHEAR	Vertical wind Shear	0	Vertical wind shear not modelled
MPARTL	Partial plume penetration of elevated inversion?	1	Yes
MSPLIT	Puff Splitting	0	No puff splitting
MSLUG	Near field modelled as slugs	0	Not used
MDISP	Dispersion Coefficients	2	Based on micrometeorology
MPDF	Probability density function used for dispersion under convective conditions	1	Yes
MROUGH	PG sigma y,z adjusted for z	0	No
MCTADJ	Terrain adjustment method	3	Partial Plume Adjustment
MBDW	Method for building downwash	1	ISC Method

APPENDIX 3
WIND ROSES

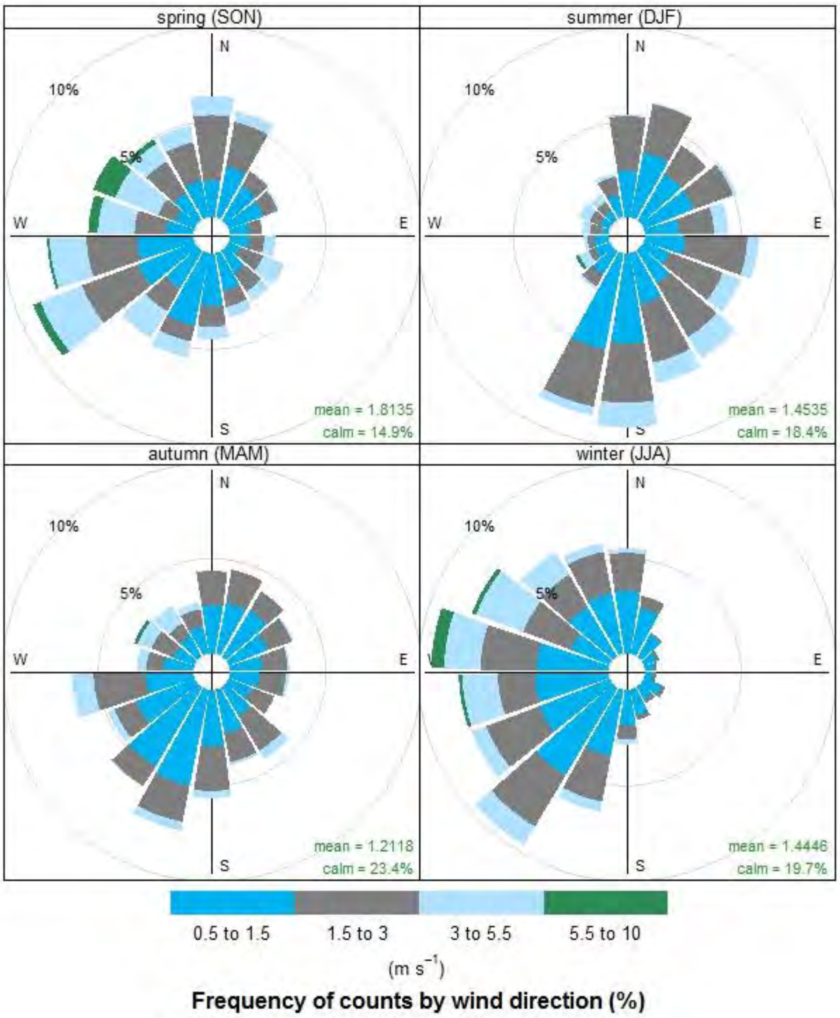


Figure A3-1: Seasonal wind rose

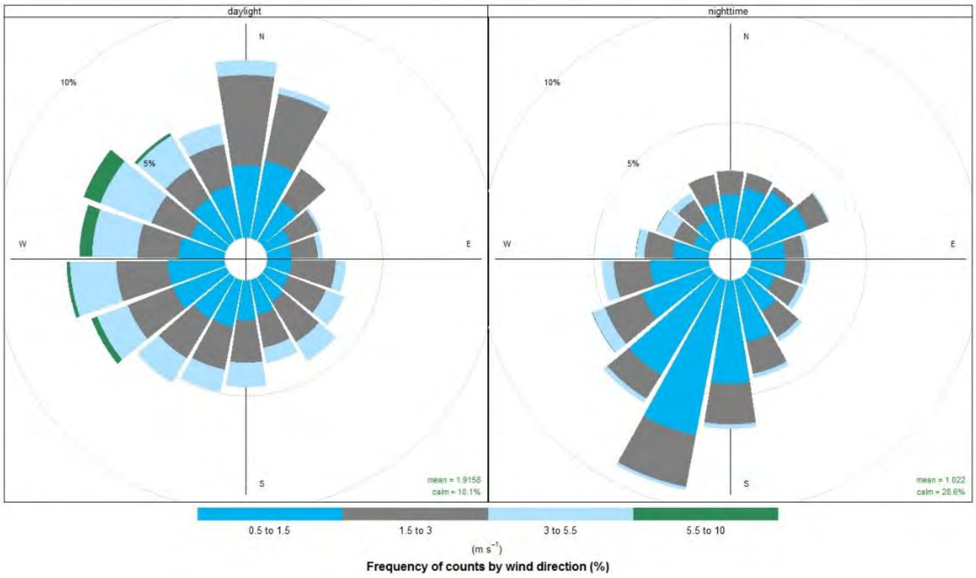


Figure A3-2: Diurnal wind rose

APPENDIX 4
EMISSIONS INVENTORY DEVELOPMENT

Dust emissions were estimated using US EPA AP-42 emission factors and predictive equations taken from the following chapters:

- Chapter 11.9 Western Surface Coal Mining.
- Chapter 13.2.2 Unpaved Roads.
- Chapter 13.2.1 Paved Roads
- Chapter 13.2.4 Aggregate Handling and Storage Piles.
- Chapter 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing.
- Chapter 13.2.5 Industrial Wind Erosion.

The material properties listed in Table A4-1 are used as input to the various emission factor equations listed in Table A4-2 to derive site specific uncontrolled emission factors for each source.

Table A4-1: Material properties

Properties	Value	Source of Information
Silt loading of paved surface % silt content for unpaved roads	- 0.6 g/m2 - 7.4 g/m2 6.4%	AP42 13.2.1 Table 13.2.1-2 - for access road based on baseline for traffic less than 500 (average daily traffic) - for other internal road based on value for municipal solid waste landfills AP42 13.2.2 Table 13.2.2-1 based on value for municipal solid waste landfills
<u>Return travel distances</u> Site access to weighbridge/MPC Internal movements Product trucks leaving site In pit unsealed road	2.1 km 0.5 km 2.4 km 2.0 km	Estimated from aerial photography
Average truck load	50 t	average for all trucks
Truck weight	45 t	Average of loaded and unloaded vehicle mass
Moisture content of raw material and product	2%	AP42 13.2.4 Table 13.2.4-1 – value for stone quarrying and processing – various limestone products
<u>Areas for wind erosion</u> Landfill Greenwaste storage Aggregate storage Soil storage area	5.0 ha 0.6 ha 3.0 ha 1.7 ha	Estimated from aerial photography

Emissions were quantified for each particle size fraction, with the TSP size fraction also used to predict dust deposition rates. Fine particles (PM_{10} and $PM_{2.5}$) were estimated using the fraction specific equations or ratios for the different particle size fractions available within the literature (shown in Table A4-2). Emissions from onsite diesel consumption are estimated as follows:

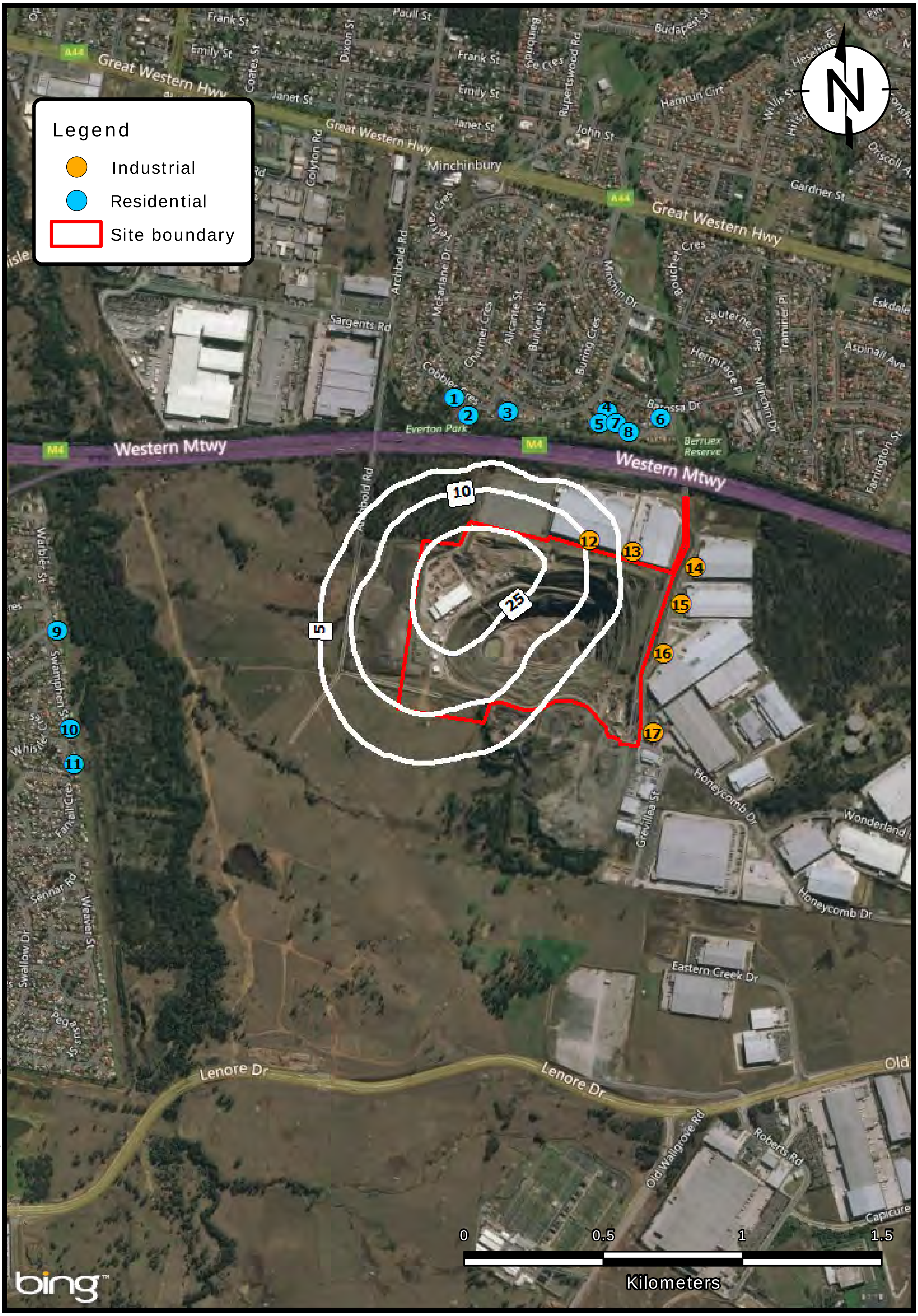
- For on-road trucks, we have assumed a truck fuel consumption of 56.9 litres per 100 km (based on the ABS survey of motor vehicle use) and emission factors of 1.2 kg/kl and 1.1 kg/kl for PM_{10} and $PM_{2.5}$ (based on NPI emission factor for heavy goods vehicle).
- For onsite equipment, (i.e. excavators, FELs, dozers, dump trucks, crushers, screens etc) a combined annual diesel consumption of 1007kL is assumed based on the reported consumption for NGERS reporting. US EPA Tier 2 emission factors (kg/kL) are assumed.

Table A4-2: Equations and emission factors

Inventory activity	Units	TSP emission factor / equation	PM_{10} emission factor / equation	$PM_{2.5}$ emission factor / equation	EF source
Material handling (loading trucks unloading trucks, loading screens etc)	kg/t	$0.74 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.35 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	$0.053 \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}}\right)$	AP42 13.2.4
Wind erosion	kg/ha/yr	0.85×1000	0.5 * TSP	0.075 * TSP	AP42 11.9 & 13.2.5
Hauling on sealed surfaces	g/VKT	$3.23\ x\ sL^{0.91} \times\ W^{1.02}$	$0.62\ x\ sL^{0.91} \times\ W^{1.02}$	$0.15\ x\ sL^{0.91} \times\ W^{1.02}$	AP43 13.2.1
Hauling on unsealed roads	kg/VKT	$\left(\frac{0.4536}{1.6093}\right) \times 4.9 * \left(\frac{s}{12}\right)^{0.7} \times \left(\frac{W\ \times\ 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 1.5 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W\ \times\ 1.1023}{3}\right)^{0.45}$	$\left(\frac{0.4536}{1.6093}\right) \times 0.15 * \left(\frac{s}{12}\right)^{0.9} \times \left(\frac{W\ \times\ 1.1023}{3}\right)^{0.45}$	AP42 13.2.2
Screening	kg/t	0.0125	0.0043	0.00043	AP42 11.19.2
Crushing	kg/t	0.0027	0.0012	0.0001	AP42 11.19.2
Dozers	kg/hr	$2.6 \times \frac{s^{1.2}}{M^{1.3}}$	$0.3375 \times \frac{s^{1.5}}{M^{1.4}}$	0.105 x TSP	AP42 11.9

Note: VKT = vehicle kilometre travelled; U = wind speed (m/s); M = moisture content (%); s = silt content (%); W = vehicle weight (t); S = speed (km/hr); ha = hectares, sL = silt loading

APPENDIX 5
CONTOUR PLOTS



RAMBOLL ENVIRON

DRAFTED BY: SF

DATE: 26/10/2017

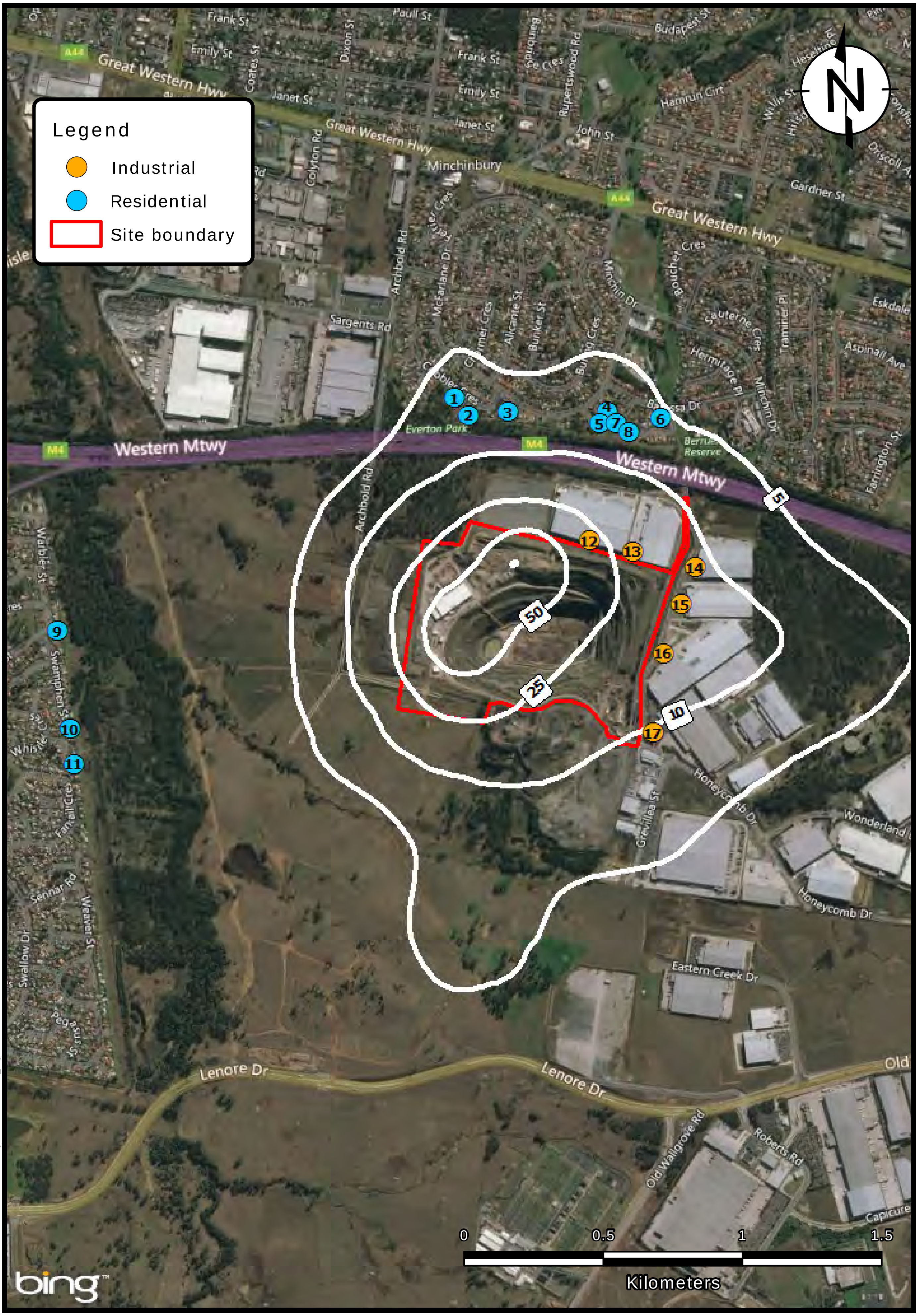
Annual Average TSP (µg/m³) Concentrations

Scenario 1 - Construction Phase

Project Only Increment

FIGURE A5-1

AS122134



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RAMBOLL ENVIRON	Maximum 24-hour Average PM_{10} ($\mu g/m^3$) Concentrations Scenario 1 - Construction Phase Project Only Increment	FIGURE A5-2
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RAMBØLL ENVIRON

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Annual Average PM_{10} ($\mu g/m^3$) Concentrations

Scenario 1 - Construction Phase

Project Only Increment

FIGURE

A5-3

AS122134

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RAMBØLL ENVIRON

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Maximum 24-hour Average $PM_{2.5}$ ($\mu g/m^3$) Concentrations
Scenario 1 - Construction Phase
Project Only Increment

FIGURE A5-4

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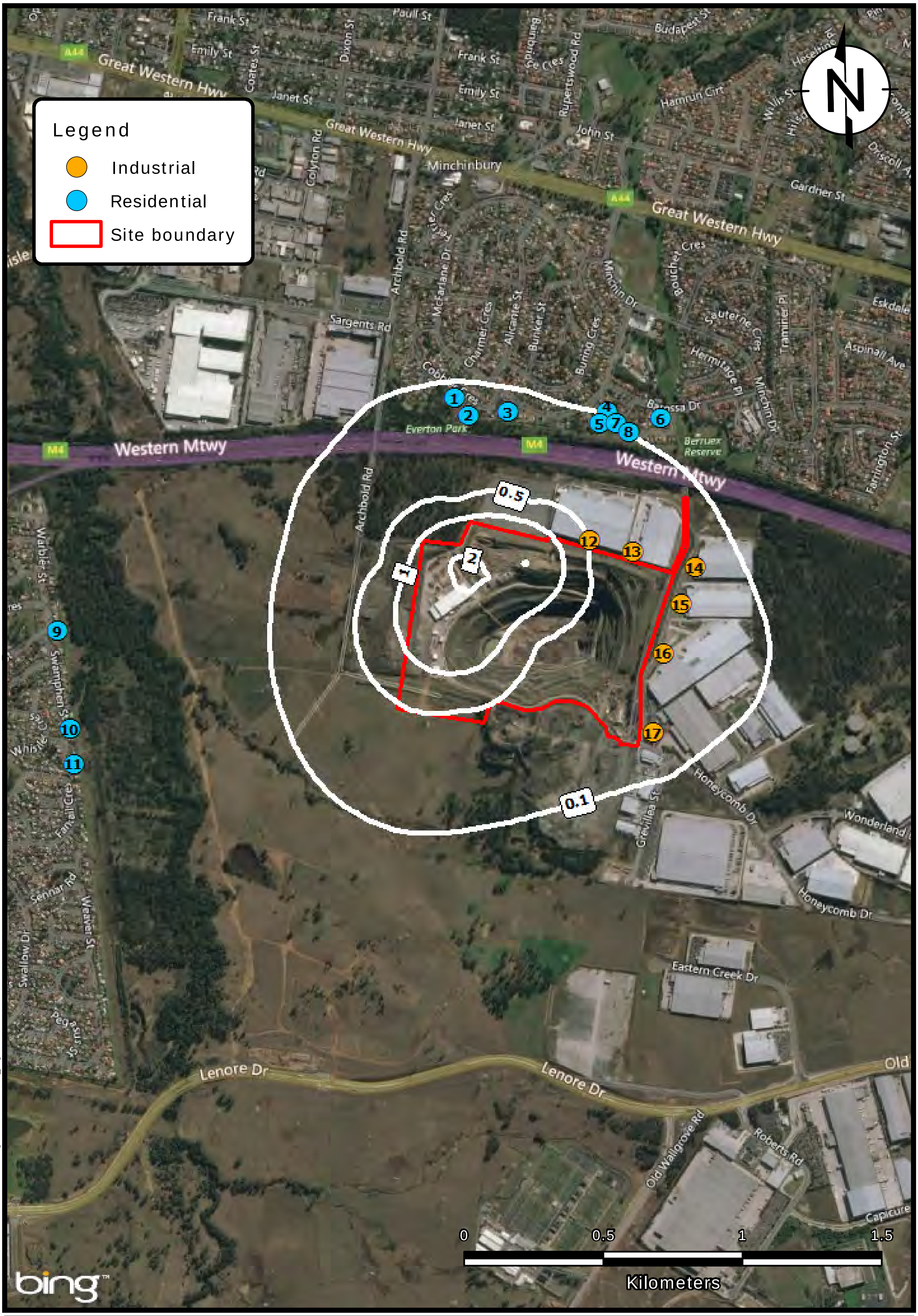
Annual Average $PM_{2.5}$ ($\mu g/m^3$) Concentrations
Scenario 1 - Construction Phase
Project Only Increment

FIGURE A5-5

AS122134



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RAMBØLL ENVIRON

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Annual Average Dust Deposition Levels (g/m^2/month)

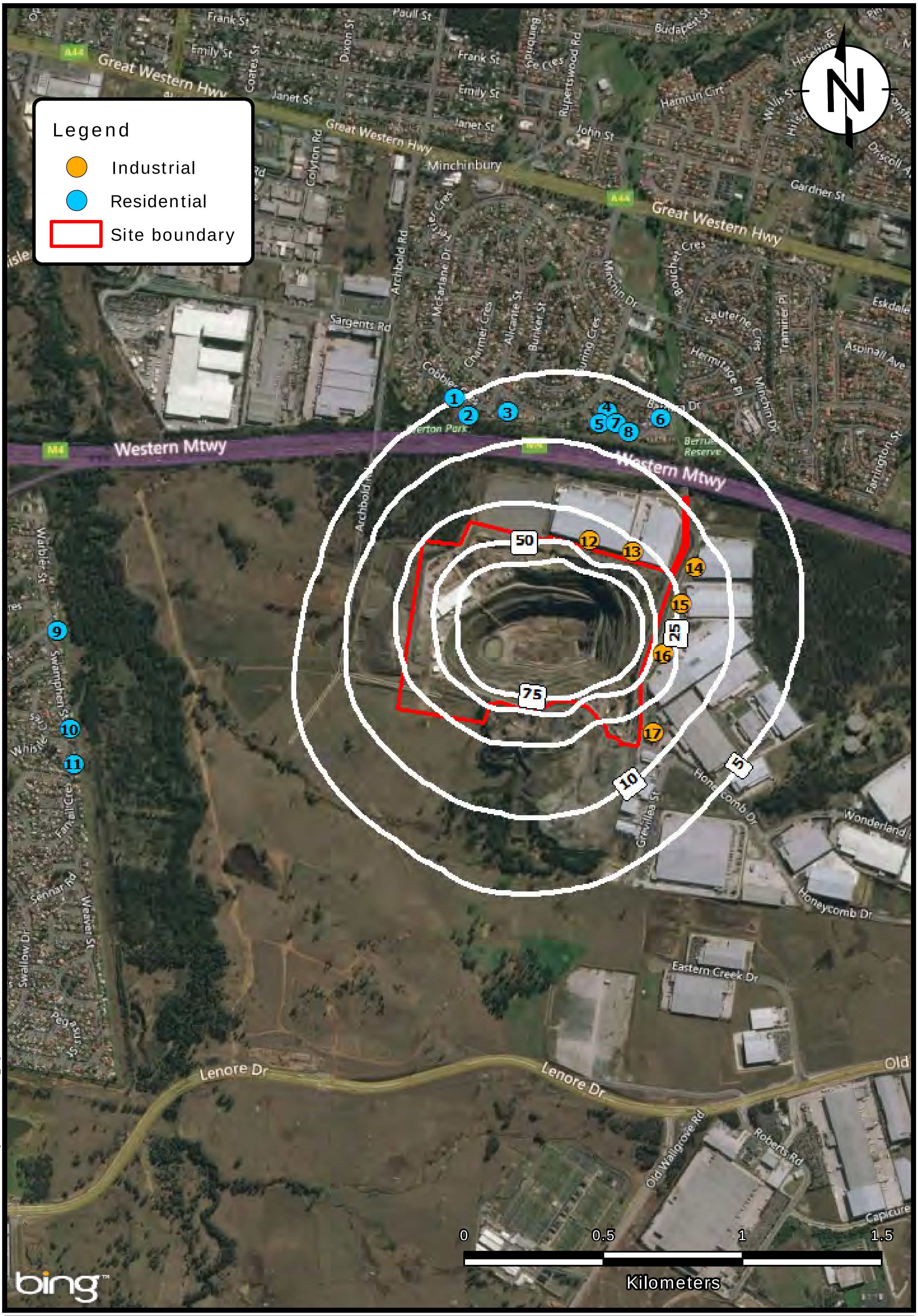
Scenario 1 - Construction Phase

Project Only Increment

FIGURE

A5-6

AS122134



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RAMBOLL ENVIRON

Annual Average TSP ($\mu g/m^3$) Concentrations
Scenario 2 - Operations Phase
Project Only Increment

FIGURE
A5-7

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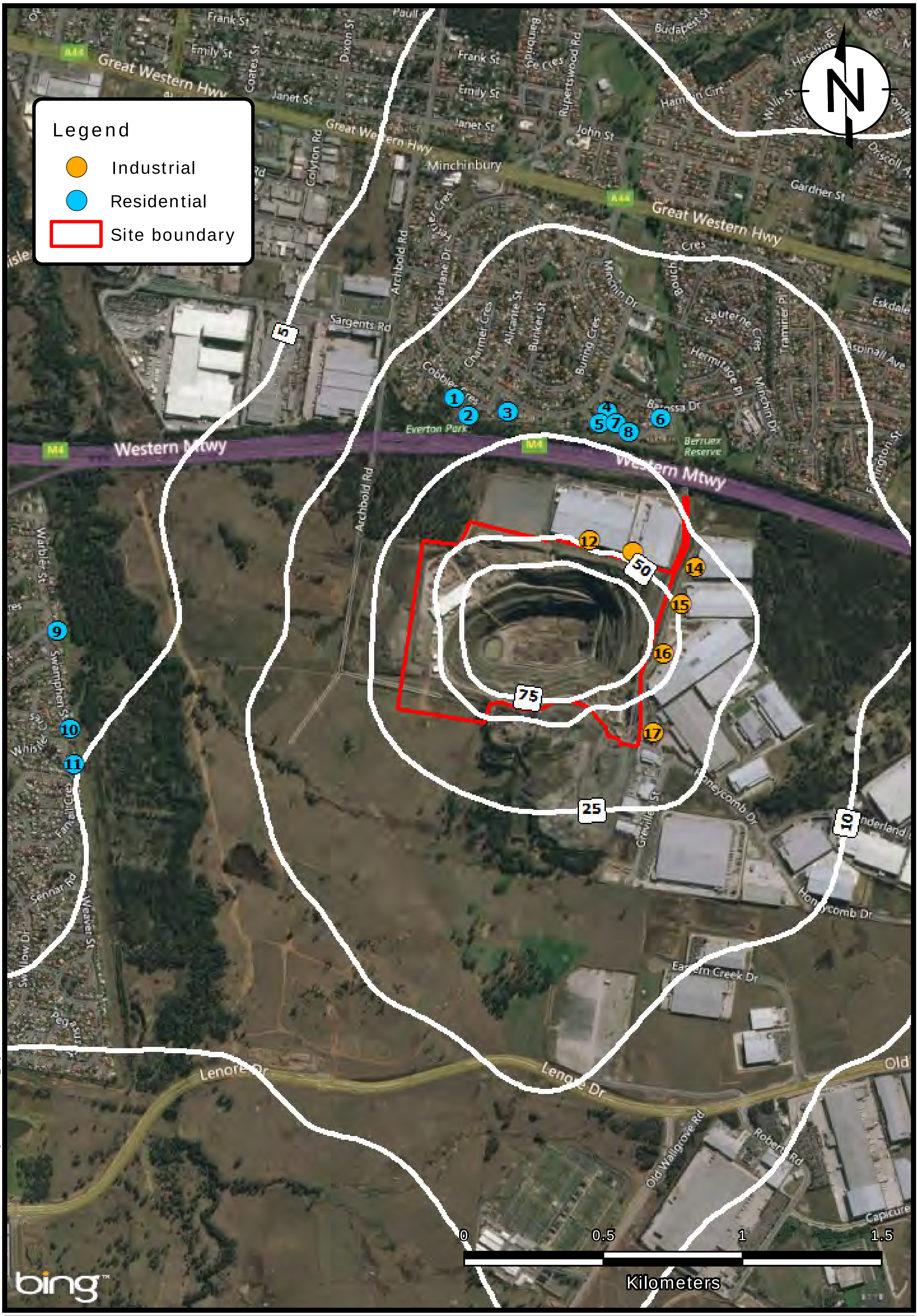
AS122134



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RAMBOLL ENVIRON

Maximum 24-hour Average PM_{10} ($\mu g/m^3$) Concentrations

Scenario 2 - Operations Phase

Project Only Increment

FIGURE A5-8

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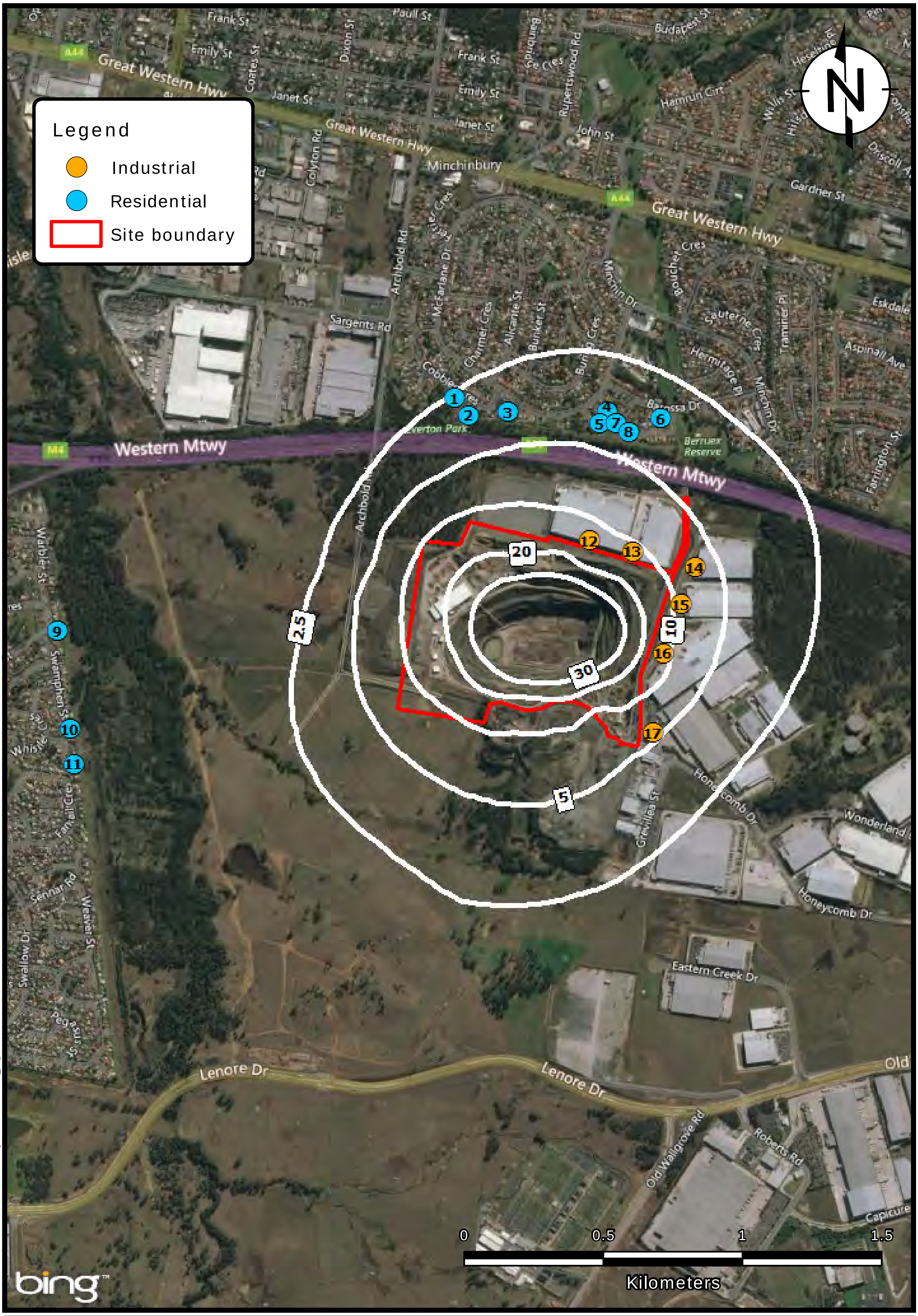

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RAMBOLL ENVIRON

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Annual Average PM_{10} ($\mu g/m^3$) Concentrations

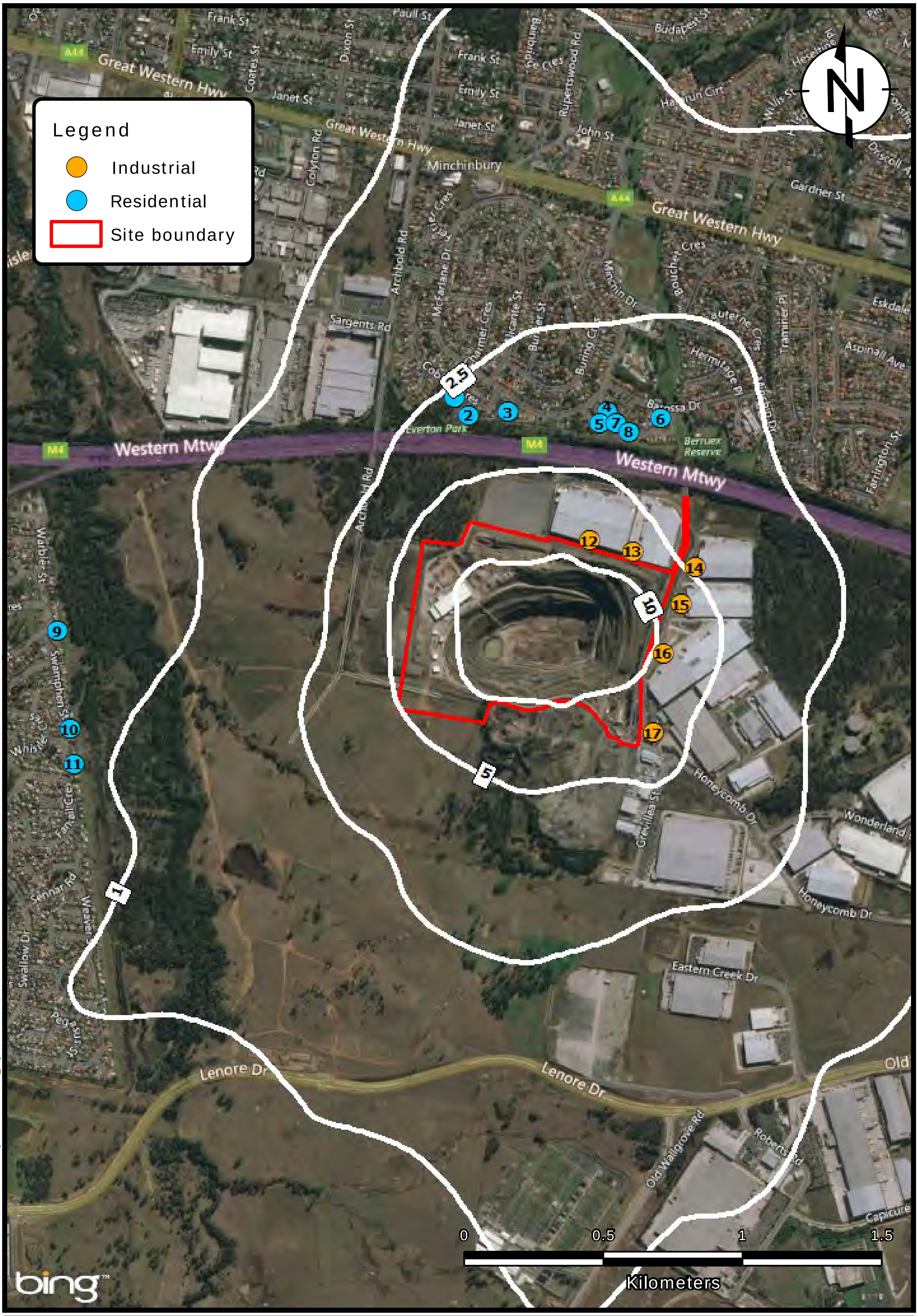
Scenario 2 - Operations Phase

Project Only Increment

FIGURE

A5-9

AS122134



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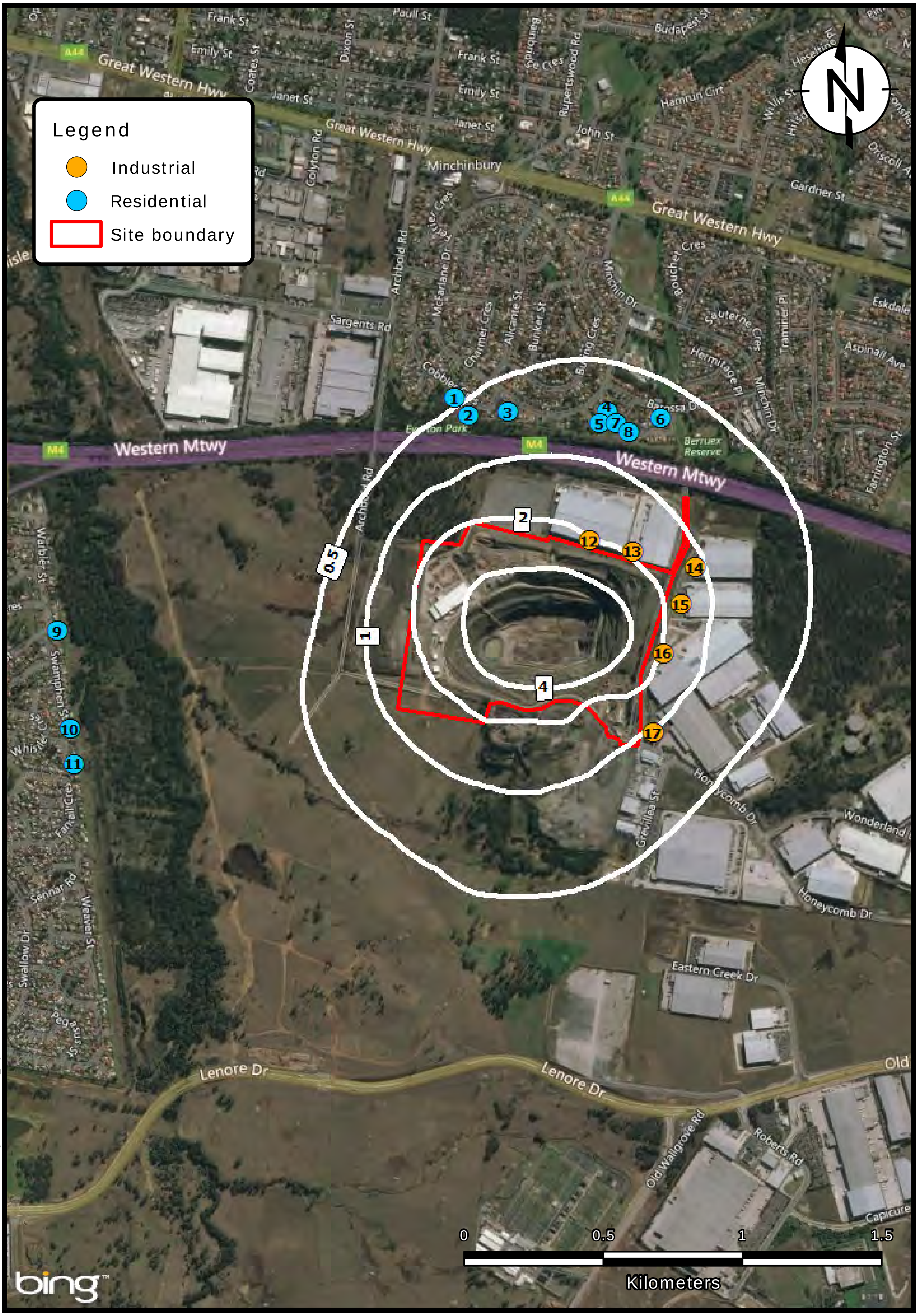
Maximum 24-hour Average $PM_{2.5}$ ($\mu g/m^3$) Concentrations
Scenario 2 - Operations Phase
Project Only Increment

FIGURE A5-10

AS122134



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RAMBOLL ENVIRON

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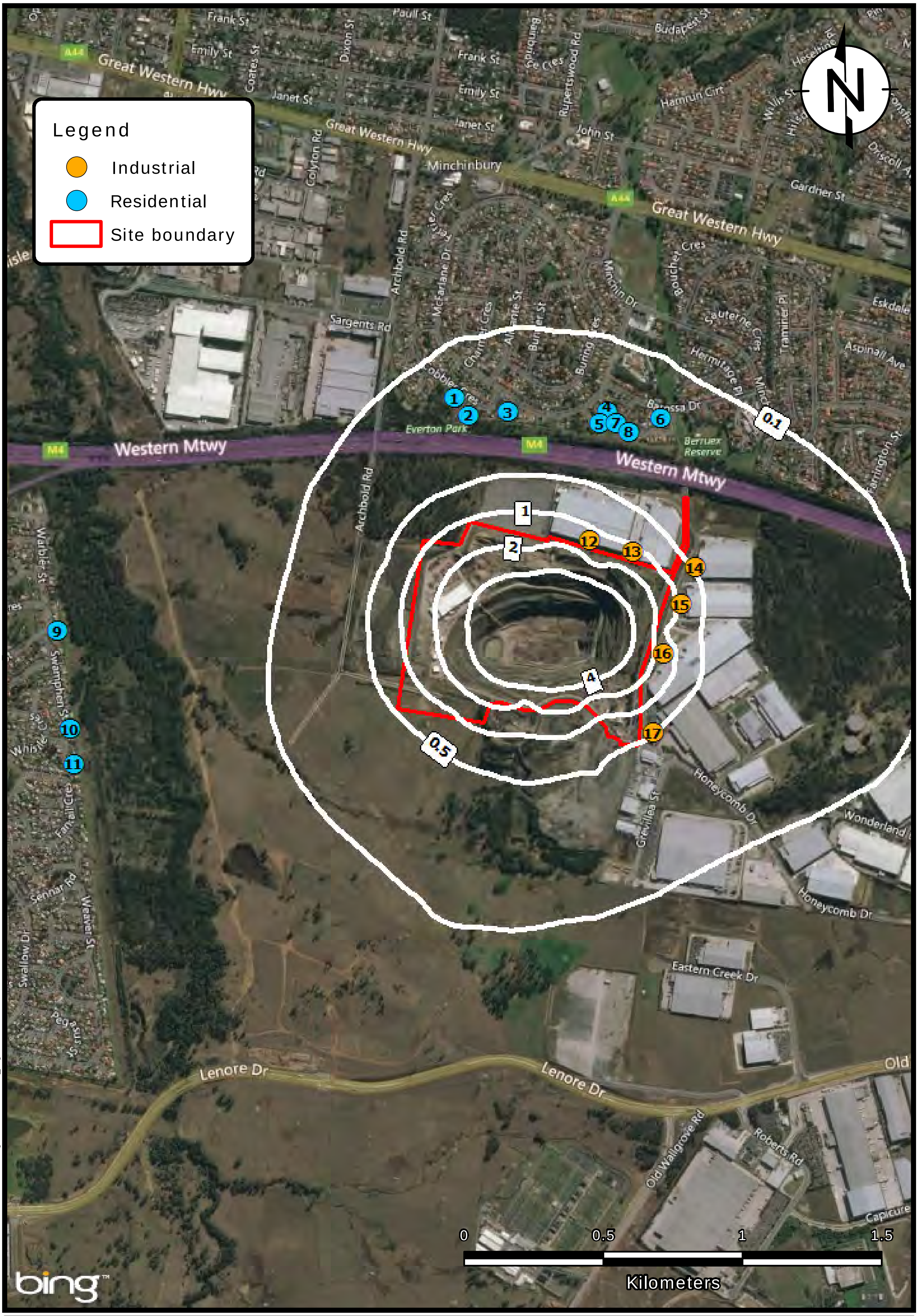
Annual Average $PM_{2.5}$ ($\mu g/m^3$) Concentrations
Scenario 2 - Operations Phase
Project Only Increment

FIGURE A5-11

AS122134



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RAMBOLL ENVIRON

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Annual Average Dust Deposition Levels (g/m^2/month)

Scenario 2 - Operations Phase

Project Only Increment

FIGURE

A5-12

AS122134