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Air Quality Impact Assessment

SIMTA

SYDNEY INTERMODAL TERMINAL ALLIANCE

Impact Assessment Report

11 / 06 / 2013

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AIR QUALITY IMPACT ASSESSMENT

SIMTA MOOREBANK INTERMODAL TERMINAL FACILITY – CONCEPT PLAN APPROVAL

Hyder Consulting

Job No: **7095**

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ES1 EXECUTIVE SUMMARY

This air quality assessment has been prepared to address the Director-General's Requirements for environmental assessment for the Transitional Part 3A Concept Plan approval.

When fully operational, the capacity of the SIMTA site would be 1,000,000 TEU and sources of emissions to air would include diesel locomotives used for container transport, trucks distributing containers (and their cargo) and ancillary equipment such as reach stackers and forklifts involved in handling and warehousing of container contents.

Dispersion modelling predictions are used to determine compliance with impact assessment criteria for the key transport-related pollutants (nitrogen dioxide (NO_2) and particulate matter (PM)).

The results of the modelling predictions for NO_2 indicate that the NO_2 concentrations are lower than the relevant impact assessment criteria for all averaging periods at all residential receptors.

PM modelling predictions were made for operation of the site, and compared against air quality indicators for PM_{10} and $PM_{2.5}$. The modelling indicates that maximum predicted incremental 24-hour PM concentrations are lower than the relevant impact assessment criteria for all averaging periods and size fractions at all residential receptors. The analysis also indicates that the SIMTA proposal would not result in any additional exceedances of the impact assessment criteria for PM_{10} or advisory reporting standards for $PM_{2.5}$.

During construction of the first stage of the SIMTA proposal, it is unlikely that the existing occupants of the DNSDC will remain, however the potential impact of the SITMA proposal on employees and contractors is considered, as well as residential dwellings on the existing School of Military Engineering (SME) site. Both sites are expected to be vacated prior to full SIMTA operations, however in the unlikely event this doesn't occur, it is not expected that air quality goals would be exceeded across either site.

An assessment of traffic related impacts on air quality indicates that any change to air quality as a result of the SIMTA proposal on traffic along the M5 would be negligible. Along Moorebank Avenue the increase in pollutant concentrations from the SIMTA proposal is between 1% and 3% of the assessment criteria.

It is noted that a worst-case scenario was modelled, in terms of emission rates and operational conditions. As a result, all predictions in the assessment should be viewed as conservatively high, with levels expected to be lower than those modelled during normal operations of the SIMTA proposal.

The regional impacts of the SIMTA proposal were determined by comparing its marginal effects on emissions from road vehicles (articulated trucks only) and railway locomotives on the Port-Botany-Moorebank corridor. The assessment shows an overall net reduction in emissions of NO_x and PM as a result of the SIMTA proposal.

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1 INTRODUCTION

The Sydney Intermodal Terminal Alliance (SIMTA) proposes to develop the Defence National Storage and Distribution Centre (DNSDC) on Moorebank Avenue, Moorebank into an intermodal terminal facility and warehouse/distribution facility, which will offer container storage and warehousing solutions with direct rail access to Port Botany (SIMTA proposal).

Pacific Environment (formally PAEHolmes) has been engaged by SIMTA to prepare an Air Quality Impact Assessment (AQIA) as part of the Concept Plan approval, sought under the Part 3A transitional provisions contained within Schedule 6A of the *Environmental Planning and Assessment Act* 1979 (EP&A Act).

1.1 Scope of Work

The Director-General's Requirements for assessment (DGRs) have been issued for the SIMTA proposal and include a requirement to assess air quality impacts as a key issue, as follows:

- "*air pollutants, including an assessment of the potential air pollution sources and atmospheric pollutants of concern for local and regional air quality;*
- *direct and indirect greenhouse gas emissions*[a]*; and*
- *taking into account Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*"

To address the DGRs an Air Quality Impact Assessment was been prepared in accordance with the NSW Environmental Protection Agency (EPA) "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (**NSW DEC, 2005**), based on the following scope of work:

- Provide a detailed description of the ambient environment, including background pollutant concentrations, prevailing meteorological conditions and nearby sensitive receptorsb.
- Quantify emissions to air for the operation of the SIMTA proposal for various activities and equipment.
- Assess the potential impacts associated with the operation of the SIMTA proposal based on regulatory dispersion model predictions and existing background pollutant concentrations.
- Undertake a qualitative assessment of the potential impacts associated with various stages of construction at the site.
- Consider the broader regional impacts of the SIMTA proposal, in terms of improved freight handling in Sydney.

[a] Note an assessment of GHG emissions is addressed in the main section of the EA.

[b] Defined as locations were people are likely to work or reside.

2 PROJECT DESCRIPTION

The Sydney Intermodal Terminal Alliance (SIMTA) is a consortium of Qube Logistics and Aurizon. The SIMTA Moorebank Intermodal Terminal Facility (SIMTA proposal) is proposed to be located on the land parcel currently occupied by the Defence National Storage and Distribution Centre (DNSDC) on Moorebank Avenue, Moorebank, south west of Sydney. SIMTA proposes to develop the DNSDC occupied site into an intermodal terminal facility and warehouse/distribution facility, which will offer container storage and warehousing solutions with direct rail access to Port Botany. Construction of the rail connection from the SIMTA site to the Southern Sydney Freight Line (SSFL) will be undertaken as part of the first stage of works for the SIMTA proposal.

When fully operational, the ultimate capacity of the SIMTA site would be 1,000,000 TEU. The SIMTA site and Rail Corridor are shown in **Figure 2.1**.

2.1 Local Setting

The SIMTA site is located in the Liverpool Local Government Area. It is 27 kilometres west of the Sydney CBD, 17 kilometres south of the Parramatta CBD, 5 kilometres east of the M5/M7 Interchange, 2 kilometres from the main north-south rail line and future Southern Sydney Freight Line (SSFL), and 0.6 kilometres from the M5 motorway.

The SIMTA site, approximately 83 hectares in area, is currently operating as a Defence storage and distribution centre. The SIMTA site is legally identified as Lot 1 in DP1048263 and zoned as General Industrial under Liverpool City Council LEP 2008. The parcels of land to the south and south west that would be utilised for the proposed rail link are referred to as the rail corridor. The proposed rail corridor covers approximately 65 hectares and adjoins the Main Southern Railway to the north. The rail line is approximately 2.5 kilometres in length and includes two connections to the SSFL, one south and one north, see **Figure 2.1**.

The proposed rail corridor is owned by third parties, including the Commonwealth of Australia, RailCorp, private owners and Crown Land held by the Department of Primary Industries, and would link the SIMTA site with the Southern Sydney Freight Line. Existing uses include vacant land, existing rail corridors (East Hills Railway and Main Southern Railway), extractive industries and a waste disposal facility. The rail corridor is intersected by Moorebank Ave, Georges River and Anzac Creek. Native vegetation cover includes woodland, forest and wetland communities in varying condition. The proposed rail corridor is zoned partly 'SP2 Infrastructure (Defence and Railway)' and partly 'RE1 - Public Recreation'. The surrounding Commonwealth lands are zoned 'SP2 Infrastructure (Defence)'.

The site is relatively flat and lies at an elevation of between 14-16 metres Australian Height Datum (AHD). A low hill on the eastern side of the site rises to about 22 metres AHD. There are no creeks or rivers on the site, but the site is adjacent to Anzac Creek and lies within a large loop of the Georges River (approximately 800 metres to the west).

There are a number of residential areas around the site, including Moorebank to the north-east, Wattle Grove to the east, Casula to the west, and Liverpool to the north-west. The location of the site in relation to these residential areas is shown in **Figure 2.2**, including some nominal discrete residential receptors locations chosen for assessment.

The DNSDC is currently operating on the SIMTA site. In order for the DNSDC to more effectively and efficiently deliver support to the Australian Defence Force, there is a need to consolidate the existing warehousing and maintenance functions at Moorebank (http://www.defence.gov.au/jlc/infrastructure/sites/moorebank.html).

To this end, Defence is proposing to relocate the DNSDC from the SIMTA site to the north of the SIMTA site as part of the Defence Logistics Transformation Program. The DNSDC re-location site is shown in **Appendix A**.

Construction in planned to be completed in late 2014. This timeframe would mean that staged construction of the SIMTA proposal would occur concurrently with the relocation of the DNSDC from the SIMTA site.

On the opposite side of Moorebank Avenue, the Department of Defence operates the School of Military Engineering (SME), which includes existing residential dwellings for Defence personnel. It is anticipated that the SME site would be vacated by 2017. The potential air quality impacts on both the SME and DNSDC are considered.

2.2 Overview of the Concept Plan

The Concept Plan of the SIMTA proposal comprises four key components:

- Rail corridor.
- Intermodal terminal.
- Warehouse and distribution facilities (including Freight Village).
- Ancillary Terminal Facilities.

These components are described in brief below.

Rail Corridor

The proposed rail link is proposed to connect to the Southern SSFL, approximately 500 metres south of Casula railway station and would include the following infrastructure:

- Culvert crossing of Anzac Creek.
- A crossing under Moorebank Avenue in proximity to the existing grade-separated crossing which supports the existing East Hills Railway Corridor.
- A rail bridge over the Georges River.

The indicative rail alignment is shown on **Figure 2.1**.

Intermodal Terminal

The intermodal terminal is proposed to be located on the western part of the site, adjacent to Moorebank Avenue and away from the nearest residential properties. Key elements include:

- Five rail tracks of approximately 650 to 1,200 metres in length, including four permanent and one temporary siding.
- Container hardstand located on both sides of the rail tracks to be used for container sorting and storage.
- Terminal administration offices and ancillary operational facilities of approximately 2,100 m^2

The intermodal terminal is proposed to operate 24 hours a day, 7 days a week to enable continuous receipt and dispatch of freight, accommodating a wide range of servicing demands. It will be serviced by world class and leading practice intermodal facilities including:

- Automatic gantry systems
- Modern container handling equipment
- Modern control tower and support facilities

- State-of-the-art rolling stock

<u>Warehouse and Distribution Facilities</u>

Approximately 300,000 m^2 of warehouses with ancillary offices are proposed to be constructed to the east of the intermodal terminal. The proposed warehouses are to be sited and designed to provide a physical barrier between the intermodal terminal and the nearest residential properties to assist with mitigating the potential acoustic and visual impacts of the rail activities. These warehouses include:

- Intermodal Terminal Warehouse and Distribution Facilities (Terminal Warehouses) – approximately 100,000 m^2 of warehouse floor space will be located immediately adjacent to the intermodal terminal. These buildings will be designed for cross-dock operations and are anticipated to be occupied by large logistics operators dispatching goods in short turn-around times and with limited freight break-down.
- Large Format Warehouse and Distribution Facilities - approximately 200,000 m^2 of warehouse floor space will be located on the eastern part of the SIMTA site, east of the Terminal Warehouse facilities. These buildings will have perimeter loading docks and are anticipated to be occupied by logistics operators who require larger areas for operations, hold stock for longer periods and/or undertake larger amounts of freight-breakdown before dispatching.

Each of the warehouses will be serviced by the central internal road system.

<u>Ancillary Terminal Facilities</u>

It is anticipated that a total floor space of approximately 8,000 m^2 will be provided for ancillary terminal facilities and are likely to include:

- Site management and security offices.
- Retail and business service centre, potentially including a convenience store, banking facilities and post office.
- Meeting rooms/conference facilities available for hire by individual tenants.
- Sleeping facilities for drivers.
- A café/restaurant.

A centralised staff car parking area provided adjacent to the ancillary facilities will enable separation of heavy vehicle movements from private vehicle movements, particularly around the intermodal terminal warehouses.

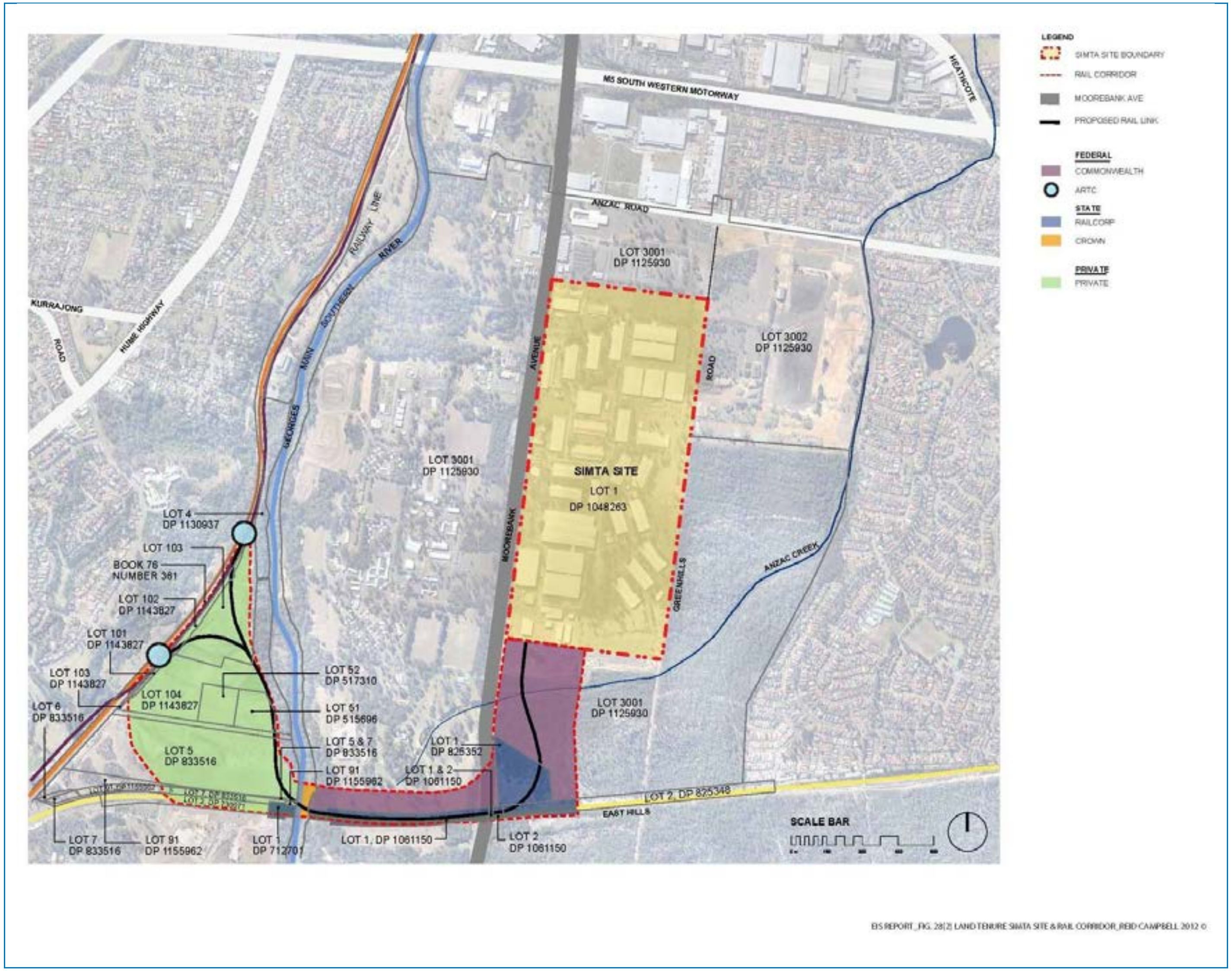

Figure 2.1: SIMTA Site and Rail Corridor and Rail Line Alignment

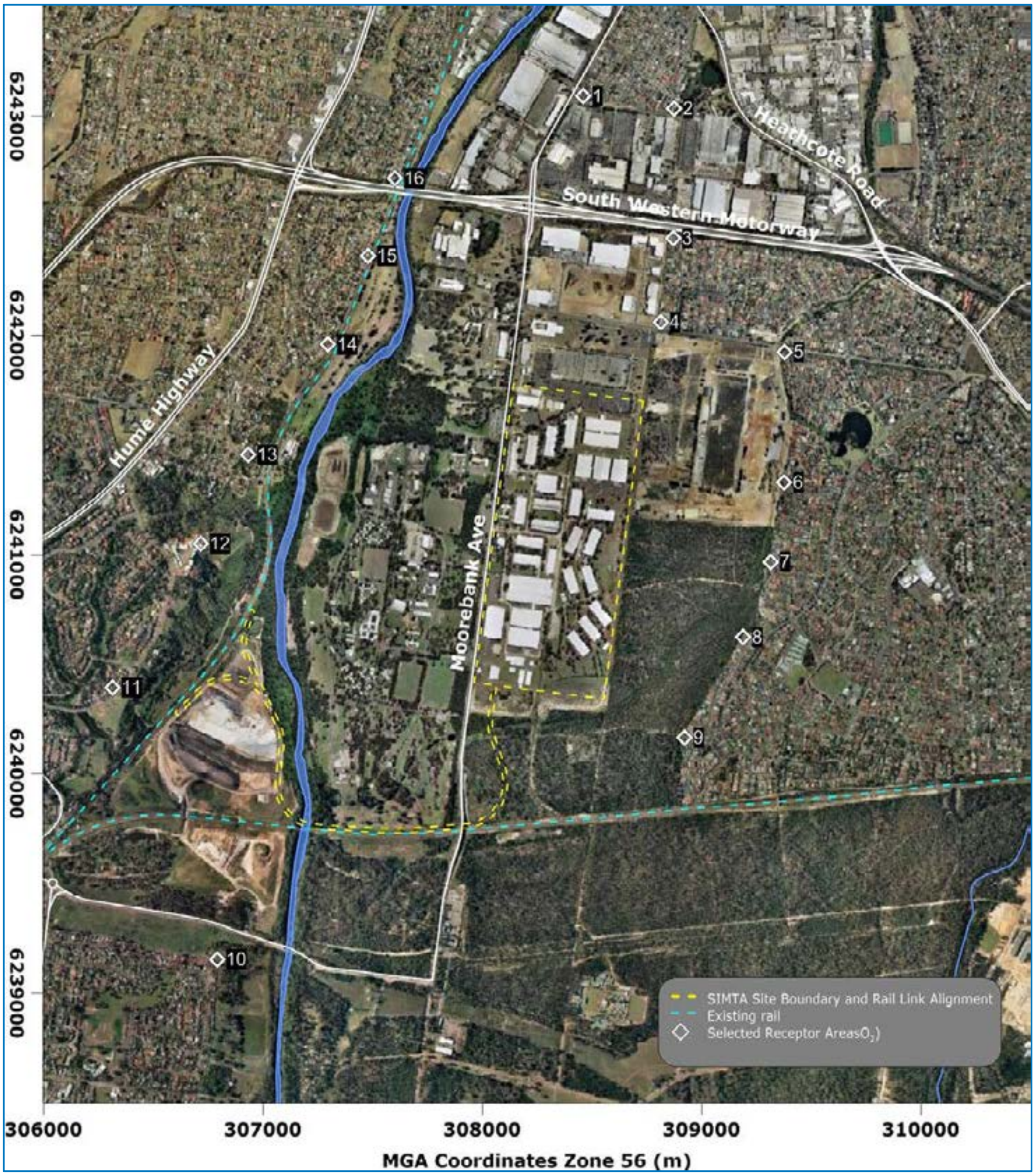

Figure 2.2: Local Setting and Sensitive Receptor Areas

3 AIR POLUTANTS AND ASSESSMENT CRITERIA

From an air quality perspective, it is important to consider the air pollutants that are likely to be emitted during the operation of the SIMTA proposal. The SIMTA proposal will operate as a fully automated terminal with the unloading and loading of trucks and trains via an automated electric gantry system. Other equipment used for the transfer of the containers within the terminal, including reach stackers, will have hybrid engines, designed to meet noise criteria during operation of the site. Smaller LPG forklifts would operate within the warehousing complexes.

The key pollutants will be those associated with diesel vehicle exhaust; namely diesel locomotives used for container transport to and from the port, and diesel trucks distributing containers (and their cargo) to their final destinations. Additional emissions associated with warehousing of cargo would occur from other container handling equipment plus LPG forklifts used for distributing cargo.

Pollutants released from fossil fuel consumption include airborne particulate matter (PM), oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2) and organic compounds. The focus of this assessment is on PM and NO_X, as these are considered to be the most important pollutants in terms of health impacts and the likelihood of air quality criteria being exceeded.

During construction, fugitive dust emissions can also be expected from the site.

3.1 Particulate Matter

Particulate matter has the capacity to affect health and to cause nuisance effects, and is usually characterised by size and/or by chemical composition. The potential for harmful effects depends on both characteristics. The most common particle size metrics are:

- TSP –refers to all suspended particles in the air. In practice, the upper limit of the size range is typically 30 µm to 50 µm. Particles larger than 30 to 50 µm settle out of the atmosphere too quickly to be regarded as air pollutants.
- PM_{10} – refers to all particles with equivalent aerodynamic diameters of less than 10 µm, that is, all particles that have the same aerodynamic behaviour as spherical particles with diameters of less than 10 µm and with a unit density. PM_{10} is a sub-component of TSP.
- $PM_{2.5}$ – refers to all particles with equivalent aerodynamic diameters of less than 2.5 µm diameter. These are often referred to as 'fine' particles. $PM_{2.5}$ is a sub-component of PM_{10}.

$PM_{2.5-10}$ – defined as the difference between the PM_{10} and $PM_{2.5}$ mass concentrations. These are often referred to as 'coarse' particles. Evidence suggests that the health effects from exposure to PM are predominantly related to the respiratory and cardiovascular systems. The size of particles determines their behaviour in the respiratory system, including how far the particles are able to penetrate, where they deposit, and how effective the body's clearance mechanisms are in removing them.

This is demonstrated in **Figure 3.1**, which shows the relative deposition by particle size within various regions of the respiratory tract. $PM_{2.5}$ may penetrate beyond the larynx and into the thoracic respiratory tract and evidence suggests that particles in this size range are more harmful than the coarser component of PM_{10}.

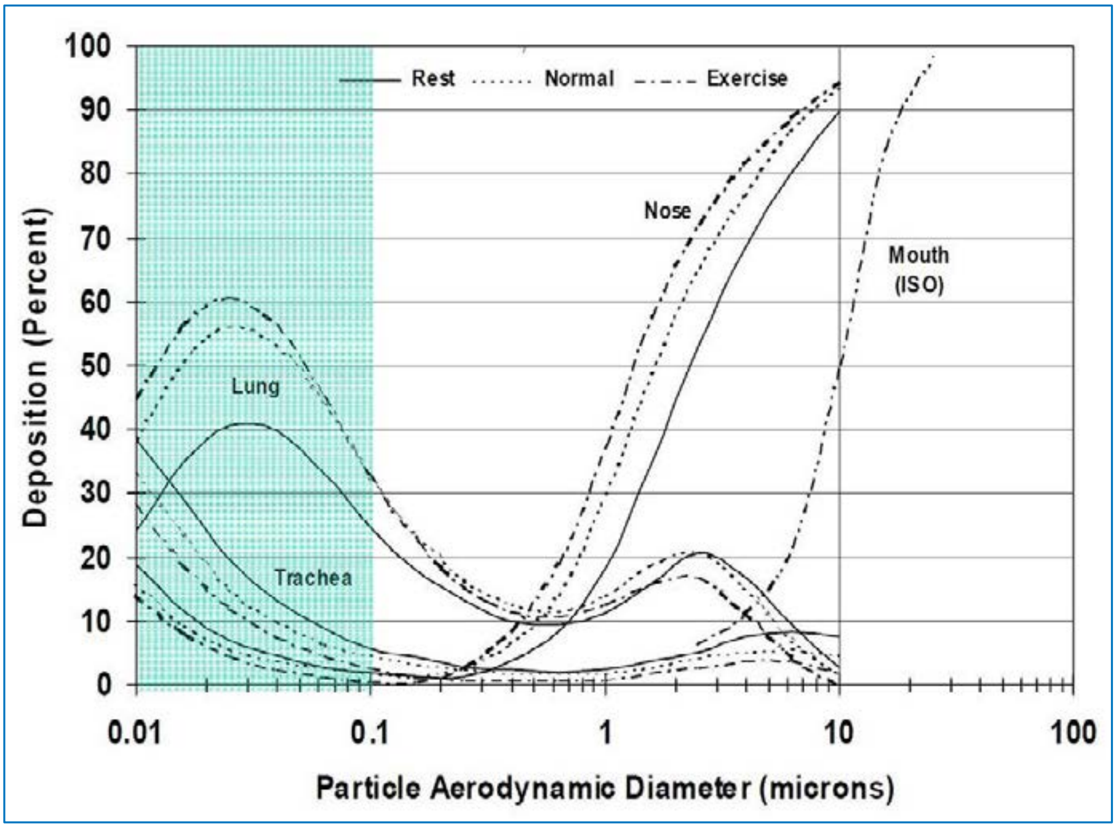

Figure 3.1: Particle Deposition within the Respiratory Track (Source: Chow, 1995)

Additionally, particle size is an important parameter in determining the residence time and spatial distribution of particles in ambient air; key considerations in assessing exposure.

Particles larger than 10 μm, whist relatively unimportant in terms of health, can soil materials and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particles suspended in the air (TSP).

Both natural and anthropogenic processes contribute to the atmospheric PM load. Coarse particles ($PM_{2.5-10}$) are derived primarily from mechanical processes resulting in the suspension of dust, soil, or other crustal[c] materials from roads, farming, mining, dust storms, and so forth. Coarse particles also include sea salts, pollen, mould, spores, and other plant parts. Fine particles are derived primarily from combustion processes, such as vehicle emissions, wood burning, coal burning for power generation, and natural processes such as bush fires. Fine particles also consist of transformation products (known as 'secondary particles'), including sulphate and nitrate particles, and secondary organic aerosol from volatile organic compound emissions.

3.2 Oxides of Nitrogen

Oxides of nitrogen are produced when fossil fuels are combusted in internal combustion engines (such as motor vehicles). Nitrogen oxides (NO_x) emitted by fossil fuel combustion are comprised mainly of nitric oxide (NO) and nitrogen dioxide (NO_2). NO_2 is the regulated component. NO is much less harmful to humans than NO_2, and is not generally considered a risk at the concentrations normally found in

c Crustal dust refers to dust generated from materials derived from the earth's crust.

urban environments. Concern with NO is related more to its transformation to NO_2 and its role in the formation of photochemical smog.

The main acute health outcomes identified in epidemiology studies are increased respiratory disease and its symptoms. The evidence for the chronic effects of long-term exposure to NO_2 is limited. As with acute exposure, the critical health outcomes with chronic exposure include respiratory disease and associated symptoms, and associated changes in lung function. Individuals with asthma and other chronic lung disease and cardiovascular diseases are recognised as being particularly vulnerable. Other susceptible populations include infants, children and the elderly (>65 years of age) (**NEPM 2010**).

The dominant mechanism for short-term conversion of NO to NO_2 is through oxidation with atmospheric ozone (O_3) as an exhaust plume travels from source.

$$NO + O_3 \equiv NO_2 + O_2$$ Equation 1

Therefore, to predict the ground-level concentration of NO_2 it is important to account for the transformation of NO_x to NO_2. The transformation of NO_x to NO_2 in this report is derived using the US EPA's Ozone Limiting Method (OLM), which assumes that all the available ozone in the atmosphere will react with the NO in the plume until either all the O_3 or all the NO is used up.

Using the OLM, NO_2 concentrations are derived as follows:

$$[NO_2]_{total} = \{0.1 \times [NO_x]_{predicted}\} + MIN\{(0.9) \times [NO_x]_{predicted}\ or\ ({}^{46}/_{48}) \times [O_3]_{background}\} + [NO_2]_{background}$$ Equation 2

The OLM is generally considered a conservative approach, and is therefore appropriate for this assessment (**Tikvart, 1996**).

3.3 Carbon Monoxide

Carbon monoxide (CO) is produced from incomplete combustion of fuels, where carbon is only partially oxidised instead of being fully oxidised to form carbon dioxide. CO can be harmful to humans because its affinity for haemoglobin is more than 200 times greater than that of oxygen. When it is inhaled it is taken up by the blood and therefore reduces the capacity of the blood to transport oxygen, although this process is reversible. Symptoms of CO intoxication are lassitude and headaches. These symptoms are generally not apparent until relatively high ambient atmospheric concentrations are reached.

The emission rates for CO from diesel exhaust are lower than those for NO_x. However, the air quality criteria for CO are higher than those for NO_x (NO_2). Therefore, if the SIMTA proposal complies with the NO_x criteria, it will also comply with the CO criteria.

3.4 Sulfur Dioxide (SO_2)

Sulfur dioxide is formed when, for instance, fuel containing sulfur (mainly coal and oil) is burned. The major health concerns associated with exposure to high concentrations of SO_2 include effects on breathing, respiratory illness, alterations in pulmonary defences, and aggravation of existing cardiovascular disease. SO_2 is a major precursor to acid rain, which is associated with the acidification of lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility.

Emissions of SO_2 from diesel exhaust have progressively declined in Australia as increasingly stringent sulfur fuel standards have been introduced. Under the Fuel Quality Standards Act (2000) the maximum sulphur content of diesel fuel is now 10 ppm, which is just 2% of what it was less than 10 years ago. Therefore, SO_2 is not considered to be a key pollutant for this assessment.

3.5 Volatile Organic Compounds

Volatile organic components (VOCs) refer to a collection of various compounds several of which are air toxics, including benzene, 1,3-butadiene, toluene and xylenes. Air toxics are present in the air in low concentrations. However, characteristics such as toxicity or persistence mean that they can be hazardous to human, plant or animal life.

There is evidence that cancer, birth defects, genetic damage, immuno-deficiency, respiratory and nervous system disorders can be linked to exposure to occupational levels of air toxics. Organic hydrocarbons also include reactive organic compounds which play a role in the formation of photochemical smog. Diesel exhaust emissions can contain carcinogenic organic hydrocarbons such as benzene and polycyclic aromatic hydrocarbons (PAHs), but the concentrations of these pollutants are typically too low to cause air quality impacts. It is unlikely that any significant impacts would arise due to VOC emissions from the site, given buffer distances from significant activity to receptor locations.

3.6 Lead

Lead concentrations in ambient air, which were predominantly produced by motor vehicles, have fallen greatly since the introduction of the ban on lead in petrol in 2002. The primary source of lead in air at the regional scale has been eliminated and lead is no longer considered an issue in air assessments for infrastructure projects.

3.7 Ozone

Ozone is a secondary pollutant formed in a chemical reaction when emissions of NO_x and VOCs react in the presence of sunlight (as follows):

$$NO + VOCs \xrightarrow{sunlight} NO_2 + O_2 \xrightarrow{sunlight} NO + O_3 \qquad \text{Equation 3}$$

Ozone is the principal component of photochemical smog, which is typically formed several hours after the precursors (NO_x and VOCs) are emitted. This means that the highest concentrations of ozone normally occur on summer afternoons in areas downwind of major sources of the precursors. Ground-level ozone continues to be a problem in Sydney during summer months. Unlike many other pollutants, ozone levels in Sydney are not decreasing and may actually be on a slight upward trend (**NSW DECCW, 2009**). At ground level, elevated ozone concentrations can cause health and environmental problems. As well as affecting vegetation growth and damaging materials such as rubber, fabric, masonry, and paint, it can also reduce visibility. Ozone can affect the human cardiac and respiratory systems, irritating the eyes, nose, throat, and lungs (**QLD EPA, 2010**).

3.8 Air Quality Criteria and Standards

The NSW EPA prescribes ambient impact assessment criteria which as outlined in their 'Approved Methods for Modelling and Assessment of Air Pollutants in NSW' (**NSW DEC, 2005**). The impact assessment criteria refer to the total pollutant load in the environment, and impacts from new sources of these pollutants must be added to existing background levels for compliance assessment.

In June 1998 the National Environment Protection Council of Environment Ministers agreed to set uniform standards for ambient air quality to apply to all States and Territories. These standards are contained in the National Environment Protection Measure (NEPM) for ambient air quality. The NEPM set standards for ambient levels of 'criteria pollutants' to be achieved within 10 years of commencement, and aim to protect the community against the detrimental health impacts of air pollution. In July 2003 a variation to the NEPM was made to extend its coverage to $PM_{2.5}$ and set 'Advisory Reporting Standards' for averaging periods of one day and one year. It is important to note that the $PM_{2.5}$ advisory reporting standards were established to assess monitoring data representative of average population, and are not used for compliance or impact assessment for specific projects. **Table 3.1** summarises the air quality goals that are relevant to this study.

The health-based assessment criteria used by the EPA have, to a large extent, been developed by reference to epidemiological studies undertaken in urban areas with large populations where the primary pollutants are the products of combustion (**National Environment Protection Council** [**NEPC**], **1998a**; **NEPC**, **1998b**).

Table 3.1: Air quality standards / goals for particulate matter concentrations

Pollutant	Standard	Averaging Period	Source
PM_{10}	50 µg/m³	24-Hour	NSW DEC (2005) (assessment criteria)
	30 µg/m³	Annual	NSW DEC (2005) (assessment criteria)
	50 µg/m³	24-Hour	NEPM (allows five exceedances per year)
$PM_{2.5}$	25 µg/m³	24-Hour	NEPM Advisory Reporting Standard
	8 µg/m³	Annual	NEPM Advisory Reporting Standard
Nitrogen dioxide	246 µg/m³ (0.12 ppm)	1-Hour	NSW DEC (2005) (assessment criteria)
	62 µg/m³ (0.03 ppm)	Annual	NSW DEC (2005) (assessment criteria)
Ozone	0.1 ppm	1-Hour	NSW DEC (2005) (assessment criteria)
	0.08 ppm	4-Hour	NSW DEC (2005) (assessment criteria)
Carbon monoxide	10 mg/m³ (9 ppm)	8-Hour	NSW DEC (2005) (assessment criteria)
Sulfur dioxide	570 µg/m³ (0.2 ppm)	1-Hour	NSW DEC (2005) (assessment criteria)
	228 µg/m³ (0.08 ppm)	24-Hour	NSW DEC (2005) (assessment criteria)
	60 µg/m³ (0.02 ppm)	Annual	NSW DEC (2005) (assessment criteria)
Organic Compounds / Air Toxics			
Benzene	0.029 mg/m³	1-Hour	NSW DEC (2005) (assessment criteria)
PAH as benzo(a)pyrene	0.0004 mg/m³	1-Hour	NSW DEC (2005) (assessment criteria)
1,3-butadiene	0.04 mg/m³	1-Hour	NSW DEC (2005) (assessment criteria)

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 3.2** shows the dust deposition criteria set out in the EPA Approved Methods (**NSW DEC, 2005**).

Table 3.2: NSW OEH criteria for dust (insoluble solids) fallout

Pollutant	Averaging period	Maximum increase in deposited dust level	Maximum total deposited dust level
Deposited dust	Annual	2 g/m²/month	4 g/m²/month

4 EXISTING ENVIRONMENT

4.1 Meteorology

Dispersion modelling for this assessment uses Ausplume v6.0, a Gaussian plume model developed by the Victorian EPA. Ausplume is the approved model for the majority of applications in NSW, where coastal effects or complex terrain are of no concern. Default options specified in the Technical User Manual (**VIC EPA, 2000**) were used in accordance with the NSW EPA Approved Methods (**NSW DEC, 2005**).

Ausplume requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[d] and mixing height[e].

The NSW EPA has listed requirements for meteorological data that are used for air dispersion modelling in their *Approved Methods* (**DEC, 2005**). The requirements are as follows:

- Data must span at least one year.
- Data must be at least 90% complete.
- Data must be representative of the area in which emissions are modelled.

The NSW EPA monitoring station at Liverpool includes a weather station, collecting information on temperature, wind speed, wind direction and sigma-theta (a measure of the fluctuation of wind direction) at hourly intervals. Given the close proximity to the site (~ 3 km to the north-west) and absence of significant intervening terrain, the data from Liverpool will be representative of conditions experienced at the SIMTA site.

The Bureau of Meteorology (BoM) also operates an automatic weather station at Bankstown Airport, approximately 7 km north-east of the proposed SIMTA site.

Figure 4.1 presents the annual wind roses for the Liverpool EPA site and the Bankstown Airport BoM site for 2009 and 2008, respectively. Data for the BoM site are presented for 2008 as 2009 was missing significant portions of information on temperature and wind speed. The wind distribution pattern for both sites is similar, with more pronounced directions dominating at Liverpool. The meteorological data collected at the Liverpool EPA site were missing small pockets of data. To provide a more complete dataset, the Liverpool meteorological data were supplemented with data from the Bankstown Airport site, resulting in 99% data recovery for the meteorological data used for dispersion modelling. There were no data available from either dataset for the period 13 to 16 November 2009.

Figure 4.2 presents the annual and seasonal wind roses for the Liverpool dataset that has been supplemented with the Bankstown data.

On an annual basis, it can be seen that winds can occur from most directions, with winds from the northern, south-western and eastern quadrants. There are few winds from the north-northeast and south.

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[d] In dispersion modelling, stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford stability class assignment scheme, as used in this study, there are six stability classes A through to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

[e] The term mixing height refers to the height of the turbulent layer of air near the earth's surface into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

The prevailing wind directions during summer are from the north-northwest through to the east-northeast (clockwise). In winter the wind distribution pattern shifts to lighter winds that are predominantly from the southwest and west-southwest. Spring is a transition between summer and winter, while in autumn the prevailing winds originate from the north-northwest and north.

The percentage of calm conditions in the area (that is, when winds are less than or equal to 0.5 m/s) is around 11.2% and the mean wind speed is 2.1 m/s.

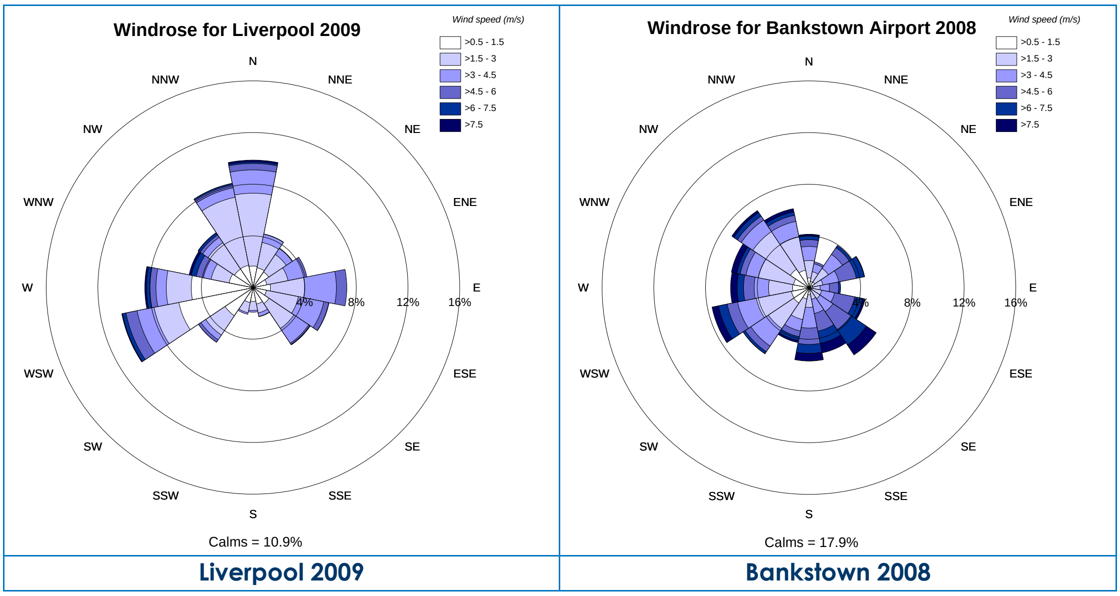

Figure 4.1: Annual wind roses for Liverpool (2009) and Bankstown Airport (2008)

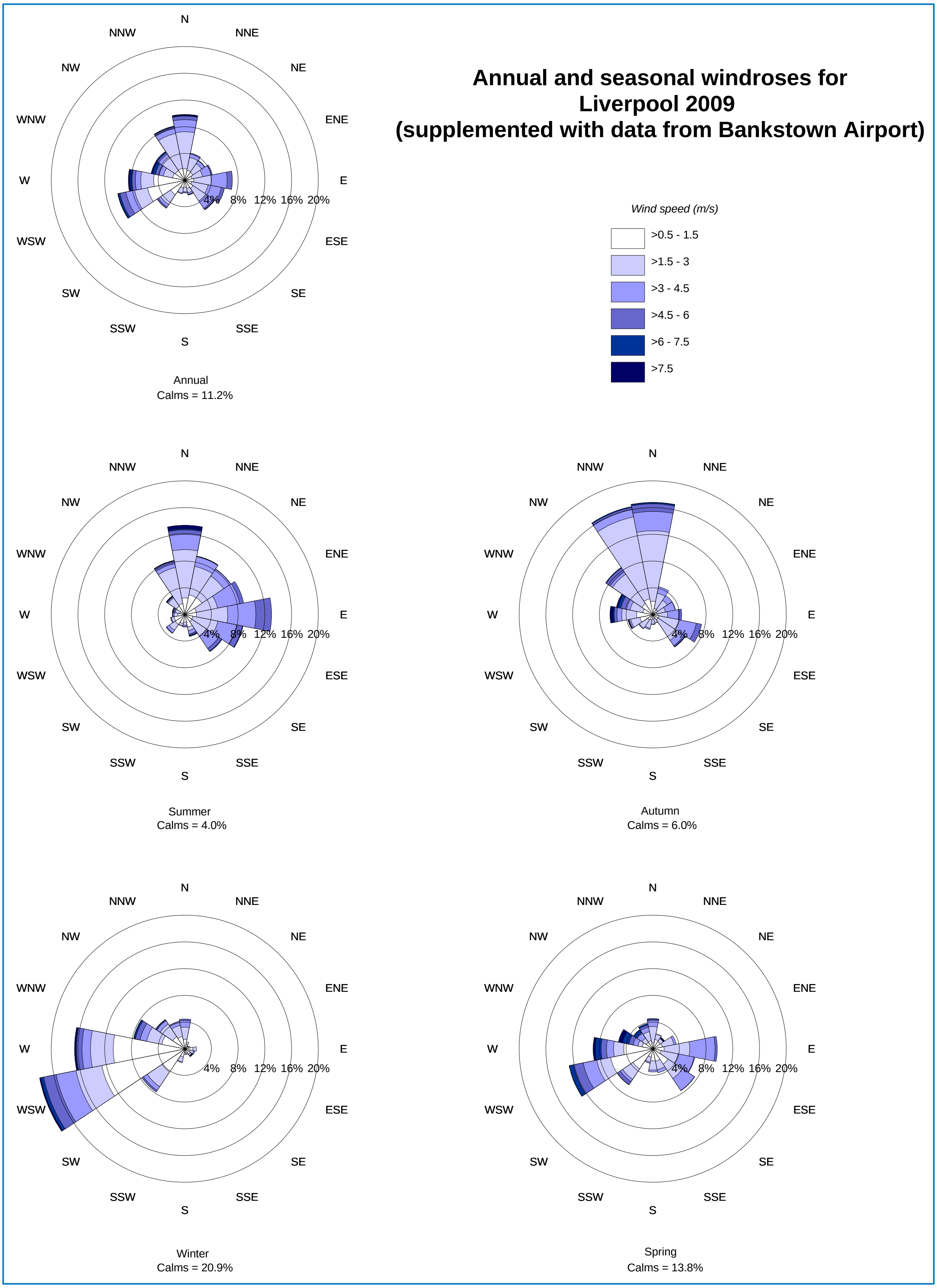

Figure 4.2: Annual and seasonal windroses for Liverpool 2009

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. Hourly sigma-theta data were also used for stability estimates using the method recommended by the USEPA (**USEPA, 2000**). **Table 4.1** shows the frequency of occurrence of the stability categories expected in the area.

The most common stability class in the area is determined to be F class using sigma-theta methods for determining stability class. It is under these conditions that emissions will disperse poorly.

Table 4.1 : Frequency of occurrence of stability classes in the study area

Stability Class	Liverpool 2009
A	18.4%
B	8.3%
C	11.3%
D	19.5%
E	10.4%
F	32.1%
Total	**100%**

Joint wind speed, wind direction and stability class frequency tables for the meteorological input file are provided in **Appendix B**. Mixing height was determined using a scheme defined by **Powell** (**1976**) for daytime conditions and an approach described by **Venkatram**, (**1980**) for night-time conditions. These two methods provide a good estimate of mixing height in the absence of upper air data.

4.1.1 Local Climatic Conditions

The Bureau of Meteorology also records climatic information at Bankstown Airport. These data provide information on the long-term average values of climatic elements such as temperature, humidity, rainfall and the number of rain days per year.

Table 4.2 presents temperature, humidity and rainfall data collected at Bankstown Airport between 1968 and 2010. Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of rain days per month.

Temperature data show that January is typically the warmest month, with a mean maximum of 28.1°C. July is the coldest month with a mean minimum of 5.1°C.

Rainfall data collected at Bankstown Airport show that February is the wettest month with a mean rainfall of 108.5 mm over 11.0 rain days. Annually the area experiences, on average, 869.3 mm of rain.

Table 4.2: Climate information for Bankstown Airport

Statistic Element	January	February	March	April	May	June	July	August	September	October	November	December	Annual
9 am Mean Dry-bulb and Wet-bulb Temperatures (°C), Relative Humidity (%), Wind speed (km/h)													
Mean 9am temperature (Degrees C) for years 1968 to 2010	22	22	20	17	14	11	10	12	15	18	19	21	17
Mean 9am relative humidity (%) for years 1968 to 2010	72	77	77	75	79	80	78	70	64	62	67	67	72
Mean 9am wind speed (km/h) for years 1968 to 2010	8	7	7	7	7	7	7	9	10	11	10	9	8
3 pm Mean Dry-bulb and Wet-bulb Temperatures (°C), Relative Humidity (%), Wind speed (km/h)													
Mean 3pm temperature (Degrees C) for years 1968 to 2010	27	26	25	23	20	17	16	18	20	22	24	26	22
Mean 3pm relative humidity (%) for years 1968 to 2010	54	57	55	54	55	55	50	44	45	48	52	51	52
Mean 3pm wind speed (km/h) for years 1968 to 2010	21	19	18	15	13	14	14	18	20	21	22	23	18
Mean Maximum Temperature (°C)													
Mean maximum temperature (Degrees C) for years 1968 to 2012	28	28	26	24	20	18	17	19	22	24	25	27	23
Mean Minimum Temperature (°C)													
Mean minimum temperature (Degrees C) for years 1968 to 2012	18	18	16	13	10	7	5	6	9	12	14	17	12
Rainfall (mm)													
Mean rainfall (mm) for years 1968 to 2012	91	108	100	85	70	74	46	48	45	61	79	68	872
Raindays (Number)													
Mean number of days of rain for years 1800 to 3000	11	11	11	9	10	9	8	7	8	10	11	10	115

Climate averages for Station: 066137 Bankstown Airport, Commenced: 1968; Last record: 2012. Latitude (deg S): -33.92; Longitude (deg E): 150.99; State: NSW. Source: Bureau of Meteorology website

4.2 Ambient Air Quality

Air quality standards and goals are used to assess the total pollutant levels in the environment, including the contributions from specific projects as well as existing sources. To fully assess impacts against all the relevant air quality standards and goals it is necessary to have information on the background concentrations to which a project is likely to contribute.

The NSW EPA operates a number of monitoring stations in Sydney, including a monitoring site at Liverpool located at the council depot on Rose Street. This Liverpool EPA site is approximately 3 km north-west of the proposed SIMTA site, and the data from the site have been used to provide an indication of existing ambient air quality for the area around Moorebank.

4.2.1 Particulate Matter

PM_{10} and $PM_{2.5}$ are monitored at Liverpool by the EPA using a Tapered Element Microbalance (TEOM). A statistical summary of PM_{10} concentrations measured at Liverpool from 2007 – 2012 is presented in **Table 4.3** and in **Table 4.4** for $PM_{2.5}$.

The annual average PM_{10} concentrations at Liverpool are consistently below the EPA's annual average PM_{10} criterion of 30 $\mu g/m^3$. The annual average measured in 2009 is higher due to the large number of regional dust storm events in this year. The annual average $PM_{2.5}$ concentrations at Liverpool are generally below the NEPM advisory reporting standard of 8 $\mu g/m^3$, although in 2012 the advisory reporting standard was exceeded.

Additional information is presented for 2009, consistent with the meteorological modelling period for assessment. A time-series of the 24-hour average PM_{10} and $PM_{2.5}$ concentrations recorded at the Liverpool site during 2009 is presented in **Figure 4.3**.

There were a number of occasions during 2009 when elevated 24-hour PM_{10} concentrations occurred as a result of regional dust storms. The most significant of these occurred on 23 September 2009 when 24-hour PM_{10} concentrations were some of the highest ever recorded in Sydney, with concentrations over 1,500 $\mu g/m^3$ recorded at Liverpool.

When considering background pollutant concentrations for assessment purposes it is sensible to exclude these anomalous events, and the approach recommended by the NSW EPA in their Approved Methods is to demonstrate that no additional exceedances of the criteria would occur as a result of the SIMTA proposal.

The dates of other regional dust storms that are known to have impacted dust concentrations in Sydney include the 15 and 16 April, 26 September and 28 and 29 November 2009. **Figure 4.3** shows a plot of the 24-hour average PM_{10} concentration recorded at the Liverpool site during 2009, with the regional dust storms removed from the dataset. With these days excluded, there were three other occasions when the air quality goal of 50 $\mu g/m^3$ was exceeded. This occurred at Liverpool on 5 March 2009, on 22 November and on 27 November 2009, when 24-hour PM_{10} levels were 51 $\mu g/m^3$, 61 $\mu g/m^3$ and 52 $\mu g/m^3$, respectively. During the last week of November 2009 much of the State experienced strong westerly winds and isolated dust storms.

Table 4.3 : Summary of EPA PM_{10} monitoring data for Liverpool

Month	Measured PM_{10} concentrations by TEOM (µg/m³)											
	2007		2008		2009		2010		2011		2012	
	Average	Maximum 24-hour average	Average	Maximum 24-hour average	Average	Maximum 24-hour average	Average	Maximum 24-hour average	Average	Maximum 24-hour average	Average	Maximum 24-hour average
Jan	25	40	20	31	21	32	23	37	20	38	20	40
Feb	18	25	15	30	17	33	17	25	20	46	15	27
Mar	19	32	17	26	19	34	19	36	16	31	17	24
Apr	21	39	14	30	23	**177**	16	30	12	18	18	33
May	23	**53**	20	32	23	40	17	27	-	-	22	39
Jun	13	23	14	27	18	33	15	27	-	-	15	26
Jul	14	36	17	39	16	27	15	26	13	19	16	30
Aug	16	31	14	29	23	39	13	26	18	37	20	37
Sep	19	37	22	40	79	**1580**	16	32	22	46	22	38
Oct	26	44			18	43	15	24	18	33	24	43
Nov	16	32	20	**54**	31	**109**	18	41	22	69	24	39
Dec	17	24	20	34	21	41	18	30	16	22	24	37
Annual average	***19***	***-***	***18***	***-***	***26***	***-***	***17***	***-***	***18***	***-***	***20***	***-***
Annual maximum	***-***	***53***	***-***	***54***	***-***	***1580***	***-***	***41***	***-***	***69***	***-***	***43***

Table 4.4 : Summary of EPA $PM_{2.5}$ monitoring data for Liverpool

Month	Measured $PM_{2.5}$ concentrations by TEOM (µg/m³)											
	2007		2008		2009		2010		2011		2012	
	Average	Maximum 24-hour average	Average	Maximum 24-hour average	Average	Maximum 24-hour average	Average	Maximum 24-hour average	Average	Maximum 24-hour average	Average	Maximum 24-hour average
Jan	10	21	7	14	8	15	7	15	6	15	6	11
Feb	7	11	5	12	10	20	5	12	6	11	5	11
Mar	7	15	6	10	7	13	7	22	5	10	6	10
Apr	10	23	5	17	7	40	7	18	4	15	-	-
May	10	18	9	16	8	18	8	14	7	29	12	25
Jun	5	14	6	15	7	20	7	15	5	15	10	20
Jul	6	18	8	17	6	13	7	14	6	16	10	20
Aug	-	-	5	12	9	15	6	13	8	16	10	20
Sep	7	16	7	12	19	268	6	16	7	22	10	24
Oct	8	15	-	-	6	15	5	11	7	16	-	-
Nov	6	15	6	32	9	25	6	21	8	38	9	17
Dec	6	12	7	12	6	12	5	9	4	7	9	13
Annual average	**7**	**-**	**6**	**-**	**8**	**-**	**6**	**-**	**6**	**-**	**9**	**-**
Annual maximum	**-**	**23**	**-**	**32**	**-**	**268**	**-**	**22**	**-**	**38**	**-**	**25**

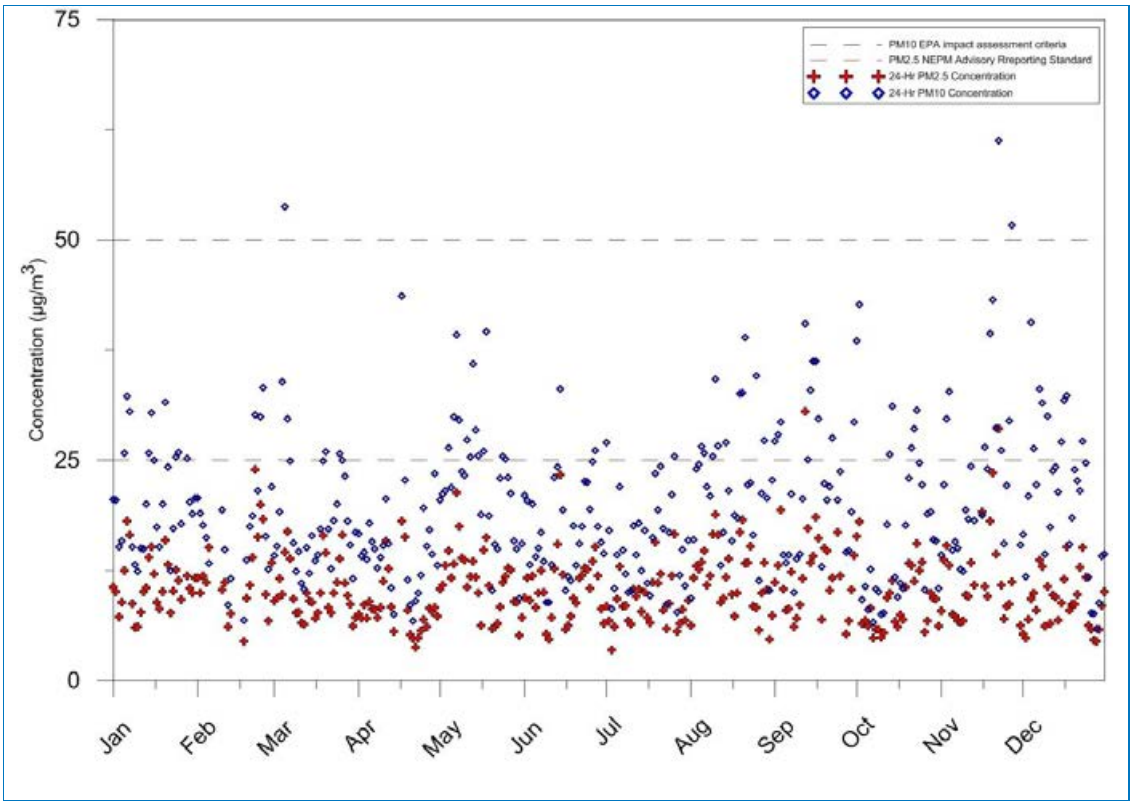

Figure 4.3: 24-Hour PM_{10} concentrations (µg/m³) – Excluding known dust storms

4.2.2 Nitrogen Dioxide

A statistical summary of the data collected between 2007 and 2012 is presented in **Table 4.5**. The data presented in **Table 4.5** indicate that there have been no exceedances of criteria for the annual average NO_2 concentration (0.03 ppm) or the maximum 1-hour average NO_2 concentration (0.12 ppm).

The highest 1-hour average NO_2 concentration recorded at Liverpool was 0.053 ppm, which is less than half the EPA criterion.

A plot of the 1-hour average NO_2 concentration recorded at the Liverpool site during 2009 is presented in **Figure 4.4**. The data indicates that for the majority of the year (>95%) the ambient concentrations are less than 20% of the air quality goal.

Table 4.5 : Summary of EPA NO_2 monitoring data for Liverpool

Month	Measured NO_2 concentrations (pphm)											
	2007		2008		2009		2010		2011		2012	
	Average	Maximum 1-hour average	Average	Maximum 1-hour average	Average	Maximum 1-hour average	Average	Maximum 1-hour average	Average	Maximum 1-hour average	Average	Maximum 1-hour average
Jan	0.9	3.5	0.7	2.1	0.8	4.8	0.9	4.1	0.6	3	0.5	3.5
Feb	1	3	0.9	2.4	0.8	2.4	1	2.8	0.7	3	0.7	3.2
Mar	1.1	4.4	1	2.9			1.2	4.7	0.6	2.6	0.7	2.5
Apr	1.4	5.3	1.1	3.2	1	4	1.3	5.3	0.8	3.8	1	3.4
May	1.6	5.1	1.5	4.2	1	3.6	1.5	4.1	1	3.4	1.2	3.1
Jun	1.2	3	1.3	3.3	1	2.8	1.3	2.9	1	3	1.2	3.1
Jul	1.3	3	1.4	3.2	1.1	3.3	1.3	3.3	1.2	3.4	1.1	3.3
Aug	1.3	4	1.2	4.1	1.2	3.8	1.1	3.6	1.6	3.8	1.1	3.3
Sep	1.2	3.2	1.3	4	1.1	5.3	1.1	4.2	1.2	4	1	3.8
Oct	1.3	5.2			1	4.2	1	3.3	1.1	4.6	0.9	4.6
Nov	0.9	3.3	0.9	4.6	1	4.3	0.9	2.8	0.9	3.2	0.7	3.1
Dec	0.9	3.3	0.9	3.1	0.9	3.5	0.7	2.3	0.6	2.2	0.5	3.5
Annual average	**1.2**	**-**	**1.1**	**-**	**1.0**	**-**	**1.1**	**-**	***1.0***	**-**	***0.8***	**-**
Annual maximum	**-**	**5.3**	**-**	**4.6**	**-**	**5.3**	**-**	**5.3**	**-**	***4.6***	**-**	***4.6***

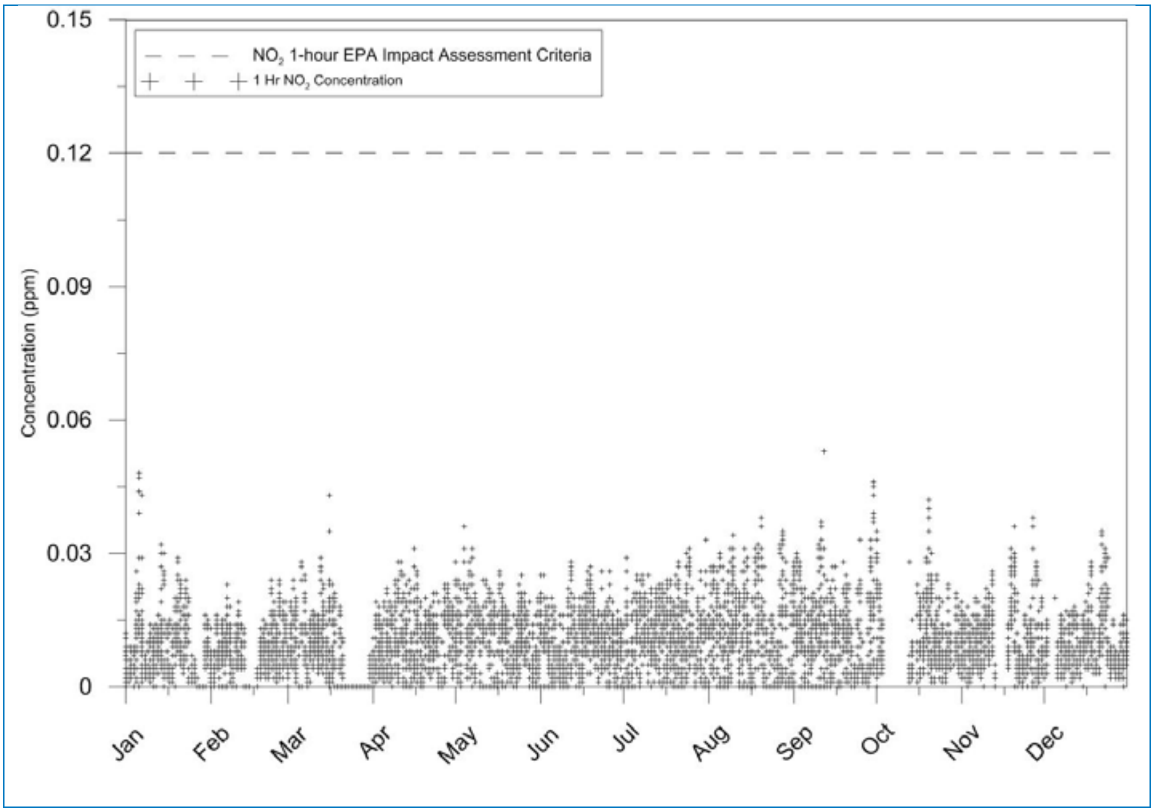

Figure 4.4: 1-hour NO_2 concentrations (ppm)

4.2.3 Carbon Monoxide

A plot of the 8-hour average CO concentrations recorded at the Liverpool site during 2009 is presented in **Figure 4.5**. The data indicate that ambient concentrations of CO are generally very low, and for the majority of the year (>90%) are less than 10% of the air quality goal.

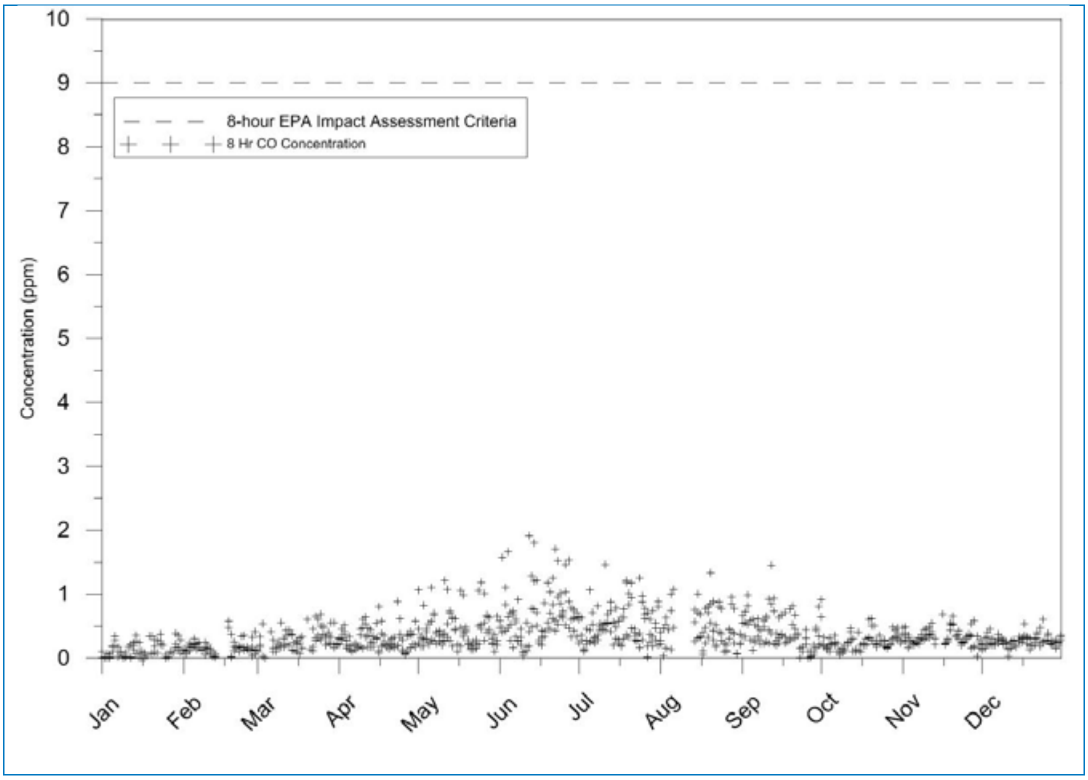

Figure 4.5: 8-hour CO concentrations (ppm)

4.2.4 Ozone

Figure 4.6 presents the 1-hour and 4-hour average ozone (O_3) concentration for Liverpool in 2009. It can be seen that for both averaging periods the EPA goal is exceeded on occasion. The maximum 1-hour average O_3 concentration was 0.15 ppm, and for the 4-hour averaging period the maximum concentration as 0.09 ppm. The O_3 concentrations display seasonal variation, with the higher concentrations observed during the summer months.

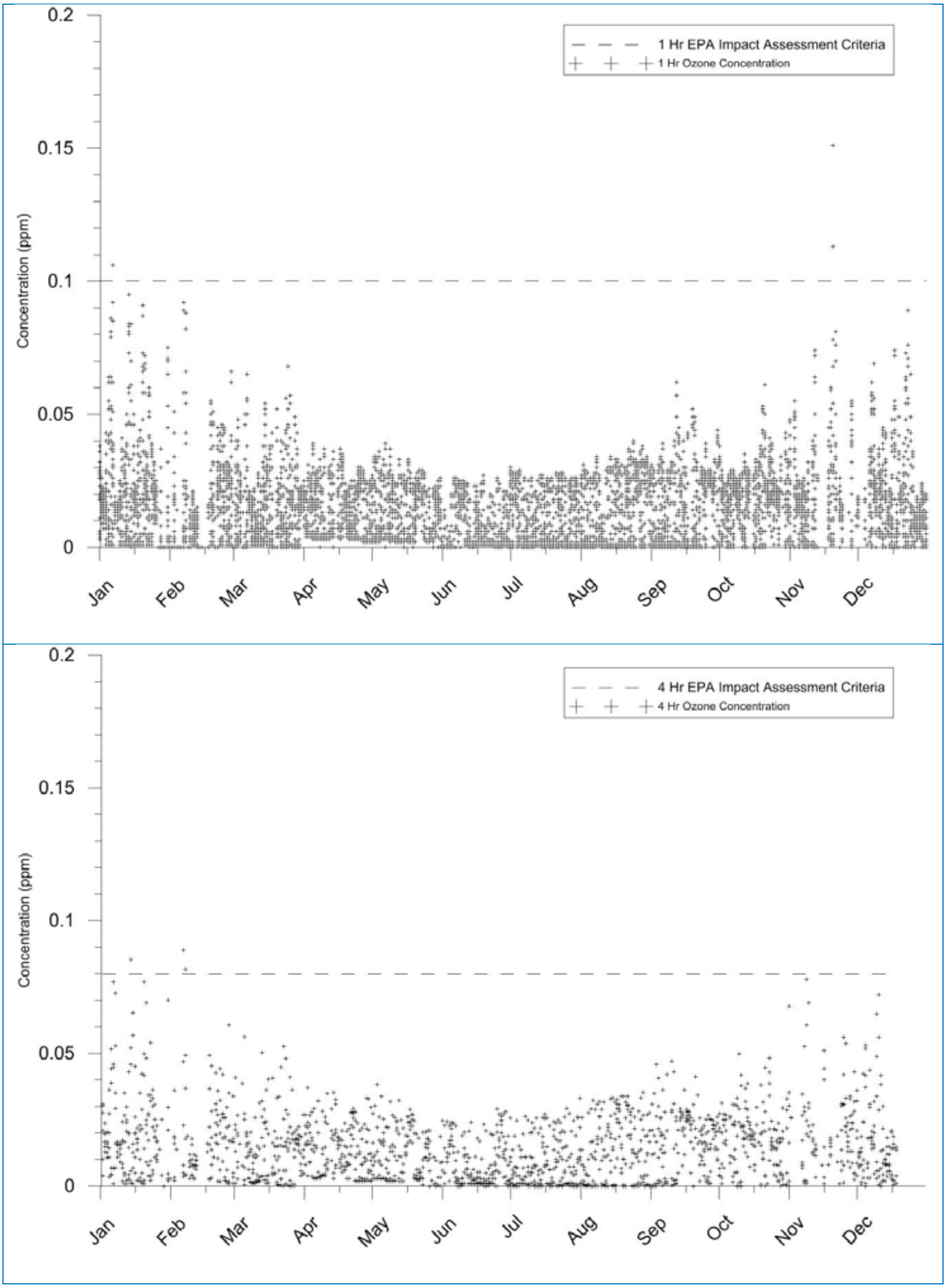

Figure 4.6: 1-hour and 4-hour O_3 concentrations (ppm)

5 IMPACT ASSESSMENT

5.1 Construction Phase Impacts

Construction of the SIMTA proposal will be staged, with an indicative staging plan provided in **Table 5.1**. Due to the staged nature of SIMTA proposal, construction impacts for the overall Concept Plan are not assessed quantitatively.

Table 5.1: Indicative construction staging plan

Stage	Scope	Timing
Stage 1 – *Construction of the intermodal terminal and rail link*	Stage 1 shall include: Construction of the rail link between the SIMTA site and the SSFL. Construction of hardstand for container storage. Possible construction of a control tower. Construction of a truck maintenance shed. Construction of access driveways, freight truck loading area and internal circulation roads required to service the intermodal terminal. Provision / upgrade of stormwater infrastructure and utility services required to service the intermodal terminal. Landscaping to Moorebank Avenue boundary. Possible construction of some warehousing.*	Construction commencement: End - 2014 Completion: Mid-2015
Stage 2 – *Construction of warehouses and distribution facilities*	Stage 2 shall construct the central portion of the intermodal terminal warehousing and distribution facilities and the south-eastern portion of the Large Format Warehousing and Distribution Facilities, including: Circulation roads required to service the proposed warehouses. Staff and visitor car parking spaces required to service the proposed warehouses. Landscaping treatments within the development areas. Provision / upgrade of stormwater infrastructure and utility services required to service the Stage 2 warehouses.	Commencement: Subject to market demand Completion: Mid-2019
Stage 3 – *Extension of the intermodal terminal and completion of warehouses and distribution facilities*	Stage 3 (the final stage) shall include: Extension of the intermodal terminal from 650 metres to 1,200 metres in length. Construction of the remaining warehouse and distribution facilities. Construction of the ancillary terminal facilities in the north-east corner of the site. Completion of the circulation roads. Staff and visitor car parking spaces required to service the additional warehouses. Completion of the landscaping treatments. Provision / upgrade of stormwater infrastructure and utility services requires to service the additional warehouses.	Completion: Mid-2022

The air quality impacts from each stage of construction would be assessed and managed separated under the Construction Environmental Management Plan (CEMP) developed at each Stage outlined in **Table 5.1**.

The CEMP would outline the air quality and dust management procedures required for the construction phase, and would:

- Identify procedures for controlling / managing dust.
- Define roles, responsibilities and reporting requirements.
- Define the dust control inspection regime.
- Identify potential contingency measures for dust control where standard measures are deemed ineffective.

The principal emissions during the construction of the SIMTA proposal will be dust from activities including:

- Vegetation clearing / earthmoving during site preparation and road and rail construction.
- Handling (loading / unloading) of spoil material.
- Handling (loading / unloading) of fill material, soils, aggregate, ballast.
- Demolition of existing structures.
- Movement of heavy plant and machinery within the site on unsealed areas.
- Wind erosion from exposed surfaces.

Emissions from these activities can be effectively controlled through good site environmental practice and commonly applied dust management measures, including the following measures which would be considered as part of the CEMP.

5.1.1 Clearing, Site Preparation and Excavation

Emissions from site clearing, vegetation removal, topsoil clearing and excavation, particularly during dry and windy conditions, can be effectively controlled by increasing the moisture content of the soil / surface.

Other controls that will be considered are:

- Modifying working practices by limiting clearing, stripping and spoil handling during periods of adverse weather (hot, dry and windy conditions).
- Limiting the extent of clearing of vegetation and topsoil to the designated footprint required for construction and appropriate staging of any clearing.

5.1.2 Rail Link

Dust generated during the construction of the rail link and Georges River railway bridge should be controlled as follows:

- Modifying working practices by limiting clearing, stripping and spoil handing during periods of adverse weather (hot, dry and windy conditions).
- Limiting the extent of vegetation removal and topsoil to the designated footprint required for the rail corridor.
- Using water sprays during rail construction for dusty activities such as ballast dumping and compacting.

5.1.3 Demolition of Existing Structures

During periods of adverse weather (hot, dry and windy conditions), consideration should be given to modify or cease demolition activities. Special consideration, including boundary monitoring will need to be given to the demolition of buildings containing asbestos.

5.1.4 Access Road Construction

The use of earth moving equipment can be a significant source of dust, and emissions should be controlled through the use of water sprays during road construction. During periods of adverse weather (hot, dry and windy conditions), and fugitive dust can be seen leaving the site, work practices should be modified, for example by limiting scraper / grader activity.

5.1.5 Haulage and Heavy Plant and Equipment

Vehicles travelling over paved or unpaved surfaces tend to produce wheel generated dust and can result in dirt track-out on paved surfaces surrounding the work areas. Mitigation measures include:

- All vehicles on-site should be confined to a designated route with speed limits enforced.
- Trips and trip distances should be controlled and reduced where possible, for example by coordinating delivery and removal of materials to avoid unnecessary trips.
- Dirt track-out should be managed using shaker grids and / or wheel cleaning. Dirt that has been tracked onto sealed roads should be cleaned as soon as practicable.
- During periods of adverse weather (hot, dry and windy conditions) and dust can be seen leaving the works site the use of a water truck (for water spraying of travel routes) should be used.

5.1.6 Wind Erosion

Wind erosion from exposed ground should be limited by avoiding unnecessary vegetation and topsoil clearing and limiting to the minimum footprint required. Wind erosion from temporary stockpiles can be limited by minimising the number of work faces on stockpiles and through temporary stabilisation (compaction of surface, water sprays, seeding, veneering).

5.2 Operational Phase Emission Estimates

Emission estimates for the operation of the SIMTA proposal are made for diesel locomotives used for container transport and for trucks distributing containers (and their cargo). The SIMTA proposal will operate as a fully automated terminal with the unloading and loading of trucks and trains via an automated electric gantry system. Other equipment such as reach stackers willl have hybrid engines, however LPG forklifts[f] would operate within the warehousing complexes.

5.2.1 Introduction

The development of air emissions inventories require detailed activity data for a site (number of trucks, fleet composition, distances travelled, times in mode, equipment types, fuel usage). This activity data is then used to derive emission estimates, based on published emission factors, for each activity.

[f] Battery operated forklifts may be used, however LPG are assessed for conservative worst case emissions.

Emission estimates generally take the form:

$$E_i = A \times EF_i \times \left(\frac{100 - ER_i}{100}\right)$$ Equation 4

Where:

E_i	=	Emission of substance *i*
A	=	Activity rate
EF_i	=	Emission factor of substance *i*
ER_i	=	Emission-reduction potential for substance *i*

Emission factors, activity data and emission estimates for each pollutant assessed for Moorebank are provided in the following sections.

5.2.2 Truck Emissions

Road traffic emissions were calculated using the aggregated emission factors developed by the NSW EPA for the 2008 Greater Metropolitan Region (GMR) emissions inventory (**Jones, 2012**). The method for calculating hot running emissions involves the use of base 'composite' emission factors for various vehicle types (in this case articulated trucks (AT) and rigid trucks (RT)), with the emission factor for each vehicle type taking into account vehicle-kilometres travelled (VKT) by age (and associated emission factors by sub-type). Five road types (residential, arterial, commercial arterial, commercial highway, highway/freeway), are specified in the emissions inventory.

In the development of the emission factors EPA has taken various real-world effects into consideration, including the deterioration in emissions performance with mileage, the effects of tampering or failures in emission-control systems, and the use of ethanol in petrol. For each case, the base emission factor is defined for a VKT-weighted average speed (the base speed) associated with the corresponding road type. Correction factors – in the form of 6^{th}-order polynomial functions - are then applied to the base emission factors taking into account the actual speed on a road (**Jones, 2012**).

The data show that some types of road – notably arterial roads – are associated with higher emissions for a given average speed than others. At present, calculations can only be made for specific years (2008, 2011, 2016, 2021 and 2026), due to the fleet data only being included for these years.

The activity data needed for emissions estimation are:

- Assessment year.
- Road type, grade and length (km).
- Daily traffic volume and traffic mix (%).
- Average speed (km/h).

For the purposes of this assessment 2016 is the year chosen for assessment. This is the closest available GMR emissions inventory year to the proposed SIMTA proposal commencement (2014). This is the year when additional network capacity, in the form of intermodal terminals, is projected to be needed (Hyder, 2012). A summary of the other activity data assumed for emission estimates is provided in **Table 5.2**Error! Reference source not found..

Table 5.2 : Activity Data for Emission Estimates

Road Link	Road Type	Grade (%)	Length (km)	Daily Traffic (vpd)	Mix (%)	Speed (km/h)
Moorebank Avenue (Site Exit to M5)	Commercial arterial	0%	2.2	3,561 (Full SIMTA)	40 % RT 60 % AT	60
Onsite Roadway			0.8		100 % AT	10

It is noted that the daily traffic data refer to SIMTA proposal trucks movements only, and emission estimates are only provided for the increase in truck movements as a result of the SIMTA facility. Total cumulative traffic associated with the SIMTA proposal is assessed separated in **Section 7** for Moorebank Avenue and the M5 and compared with a no development scenario. The boundary of the emission estimates for SIMTA only truck movements is the junction of Moorebank Avenue and the M5. Traffic along Moorebank Avenue to the north of the M5 is addressed in **Section 7**. It is estimated that, when fully developed, the SIMTA proposal would result in a reduction in truck movements between Botany and Moorebank east of Moorebank Avenue (**Hyder 2012**). It is assumed that truck movements west of Moorebank Avenue would be comparable, with and without the SIMTA proposal proceeding.

Truck movements are taken from the traffic section of the EIS and are based on a number of assumptions, as follows:

- 400,000 TEU would be processed within the SIMTA facility, leaving 600,000 TEU that would generate AT movements.
- 600,000 TEU is equivalent to 363,636 containers (1 container = 1.65 TEU).
- 400,000 TEU is equivalent to 242,424 containers (1 container = 1.65 TEU).
- 85% of trucks are processed on weekdays, with the remaining 15% processed on Saturdays.
- Each AT is assumed to carry 1.3 containers on average (based on a mix of semi-trailers and b-doubles).
- Each container holds 12.66 tonnes of cargo and each RT would carry 10 tonnes of cargo.
- The daily percentage split in truck movements between AT and RT is 60/40.
- The full operation of the SIMTA site is not projected to occur until after 2022. However, the 2016 has been retained as the assessment year. Choosing an earlier year for estimation of traffic emissions is conservative because improvements in fuel and changes to fleet composition would tend to lead to lower emission estimates for later years.

A summary of the emission estimates for the pollutants assessed are presented in **Table 5.3**.

Table 5.3 : On Road Truck Emission Estimates

Scenario	Road Link	NO_x		PM_{10}	
		tonnes/year	grams/sec	tonnes/year	grams/sec
1,000,000 TEU	Moorebank Avenue	15.56	0.49	0.75	0.024
	On-site roadway	10.87	0.34	0.46	0.015

5.2.3 Emissions from Rail Transport

Emissions are calculated using the amount of fuel consumed and fuel-specific emission factors from the US (**USEPA, 2009a**; **USEPA, 2009b**). The US EPA Tier 3 Line Haul Emission Factors (kg/kL) were used in this assessment. It is understood that the locomotives used for the SIMTA site will be able to meet or improve on the US EPA Tier 2 and 3 emissions standards. It is also understood that the locomotives used for the SIMTA site will feature automatic shut-down when idling for extended periods. Unlike traditional locomotives which have long re-start processes, the proposed locomotives will be able to be re-started quickly. Idling has therefore not been considered as part of this assessment.

A spreadsheet summarising the calculation of rail emissions for the 2008 GMR inventory was supplied to Pacific Environment by NSW EPA (**Agapides, 2012**). The EPA spreadsheet contained activity data in gross tonne-kilometres for all trains in the GMR (31,940,182 tonne-km) during 2008, as well as total diesel consumption by freight (128,836,774 litres) during the same period. Given that most of the rail diesel consumption in NSW relates to the haulage of freight and that passenger trains are predominantly electrified, it was therefore assumed that the gross tonne-km value related to freight trains only, giving a single average unit fuel consumption value of 4.03 litres per thousand gross tonne-km for freight trains. This is very similar to values reported in the literature (**Pacific National, 2006**; **ARTC, 2010**).

Emissions estimates for rail transportation require activity data in the form of fuel consumption. An estimate of the diesel fuel consumption is made based on the average fuel consumption value of 4.03 litres per thousand gross tonne-km.

The fuel consumption for trains has been estimated based on the gross tonnes transported on an annual basis, as shown in **Table 5.4**, based on the following assumptions:

- The split of empty and full TEU was provided by Hyder, as shown in **Table 5.4**, and one container is equal to 1.65 TEU.
- Container weight is comprised of cargo (12.66 tonnes) and the container (2.5 tonnes).
- Wagon weight is assumed as 30 tonnes.
- It is assumed that two locomotives would be used per train, and that there are 68 TEU per train. Locomotive weight is assumed to be 180 tonnes.

The emission factors and estimated emission rates are provided **Table 5.5**, calculated based on the fuel consumption data presented in **Table 5.4**.

5.2.1 Emissions from other onsite equipment

Other equipment involved in the handling, distributing and warehousing of containers and cargo includes:

- 15 x electric rail mounted gantry cranes.
- 6 x diesel-electric (hybrid) reach stackers.
- 6 x diesel-electric (hybrid) large forklifts.
- 40 x LPG forklifts.

The SIMTA proposal will operate as a fully automated terminal with the unloading and loading of trucks and trains through an automated and electric rail mounted gantry (RMG) crane system. RMG cranes are therefore not considered as an emission source in this assessment. It is understood that to meet noise limits the reach stackers and large forklifts are required to be diesel-electric hybrids. However, in the absence of suitable emission factors (or emission reductions) for these, we have assumed, as a worst case, that this equipment would be diesel powered. The emission factors are taken from the US EPA Tier 3 non-road diesel emissions standards.

Emissions estimates for LPG forklifts used for the SIMTA proposal are based on equipment used at a similar facility at Enfield (**SKM, 2005**). The emission factor is taken on the National Pollution Inventory (NPI) Emission Estimation Manual for Combustion Engines (**Environment Australia, 2003**). It is noted that this document was updated in June 2008 and the emission factor units for LPG forklifts has changed, however the updated emission factor does not significantly change the emission estimates, and in the absence of operational data required for the updated factors (i.e. fuel consumption, activity data), it was appropriate to retain these emission factors. A summary of the emission estimates and assumptions, including activity data for these sources is provided in **Table 5.6**.

Table 5.4: Diesel Consumption in Locomotives

TEU Category	TEU Number	Container Weight (t/y)	Wagon Weight (t/y)	Locomotive Weight (t/y)	Total Weight (t/y)	tonnes/y/ km	Fuel consumption (l/1000-t-km)	Total Fuel (l/y/km)
Import Full	500,000	4,593,939	9,090,909	2,647,059	16,331,907	16,331,907	4.03	65,878
Export Full	125,000	1,148,485	2,272,727	661,765	4,082,977	4,082,977		16,469
Export Empty	375,000	568,182	6,818,182	1,985,294	9,371,658	9,371,658		37,802
							Total	**120,150**

Table 5.5: Emission Estimates for Locomotives

	NO_x	PM_{10}
ES EPA Tier 3 Emission Factor (g/l)	27.2	0.44
Emission Rate (g/km/y)	3,267,969	52,816
Emission Rate (g/km/s)	0.1	0.002

Table 5.6: Emissions Estimates for onsite equipment

Source	NOx Emission Factor	PM Emission Factor	Intensity	Load Factor	NOx Emission Rate for SITMA (g/s)	PM Emission Rate for SIMTA (g/s)
Electric Gantry Cranes	N/A	N/A	N/A	N/A	N/A	N/A
Reach Stacker	2.98 g/hp-hr	0.15 g/hp-hr	6 x 320 hp	0.2	0.32	0.02
Large Container Forklifts	2.98 g/hp-hr	0.15 g/hp-hr	6 x 345 hp	0.2	0.34	0.02
LPG forklifts in warehouses	3.3 g/hp-hr	0.72 g/hp-hr	40 x 50 hp	0.2	0.37	0.08

5.3 Approach to the Assessment

Emissions from road and rail are simulated using a series of volume sources, positioned at regular intervals along the following routes:

- Trucks travelling onsite.
- Trucks travelling along Moorebank Avenue from site to M5.
- Trains entering and leaving the site along the rail corridor.
- Trains travelling along the SSFL just north of the M5.

The line source locations are shown by the blue line in **Figure 5.1**. The initial lateral dimension of the sources (sigma y) (required to define the initial plume dimension for subsequent dispersion) are assigned according to the number of volume source allocated to a particular route length. The initial vertical dimension of the source (sigma z) is assigned a value of 0.23 based on a nominal plume height of 1 m and assumed to be released at 3.2 m. The emission estimates presented in **Table 5.3** and **Table 5.5** are apportioned evenly across the simulated volume sources for each travel route.

Emissions from other on-site equipment are positioned across the warehousing area at regular intervals. The source locations for other equipment are shown by the red dots in **Figure 5.1** and the emissions estimates presented in **Table 5.6** are apportioned evenly across the each source group.

Rail transport emission sources are split into links of 1 km in length, and the total emissions in g/s/km assigned evenly along each 1 km link. Road transport is represented by two sources, for the on-site roadway and Moorebank Avenue, and the total emissions in g/s/km are assigned evenly along each source.

Figure 5.1: Location of line /simulated volume sources for modelling

6 MODELLING RESULTS

6.1 Incremental NO_2 Concentrations

The incremental NO_2 concentrations (assuming 100% NO_x to NO_2 conversion) at the selected receptor areas are presented in **Table 6.1**.

The maximum predicted 1-hour NO_2 (conservatively assuming 100% NO_x to NO_2 conversion) at the residential receptors assessed is 118 µg/m³, approximately 48% of the impact assessment criteria (246 µg/m³). The maximum predicted annual average NO_2 (assuming 100% NO_x to NO_2 conversion) at a residential receptor is 7.6 µg/m³, approximately 12% of the impact assessment criteria (62 µg/m³).

Table 6.1: Incremental NO_2 Modelling Results (100% NO_x to NO_2) – Full SIMTA site

Receptor Area	Predicted NO_2 Concentration (µg/m3) (assuming 100% conversion)	
	1-hour maximum	Annual average
R1	58.9	2.7
R2	48.9	2.6
R3	57.6	4.2
R4	68.1	5.2
R5	60.5	4.0
R6	69.0	5.1
R7	72.4	5.6
R8	76.9	5.4
R9	86.1	4.7
R10	118.2	1.5
R11	42.9	1.8
R12	49.2	2.2
R13	99.7	4.0
R14	98.4	7.6
R15	108.7	7.3
R16	106.8	6.5

Contour plots for the predicted ground level concentrations (GLCs) for annual average NO_2 concentrations for full SIMTA site operations are shown in **Figure 6.1**. It is noted that 100% conversion of the NO_x to NO_2 has been assumed for plotting of the contours.

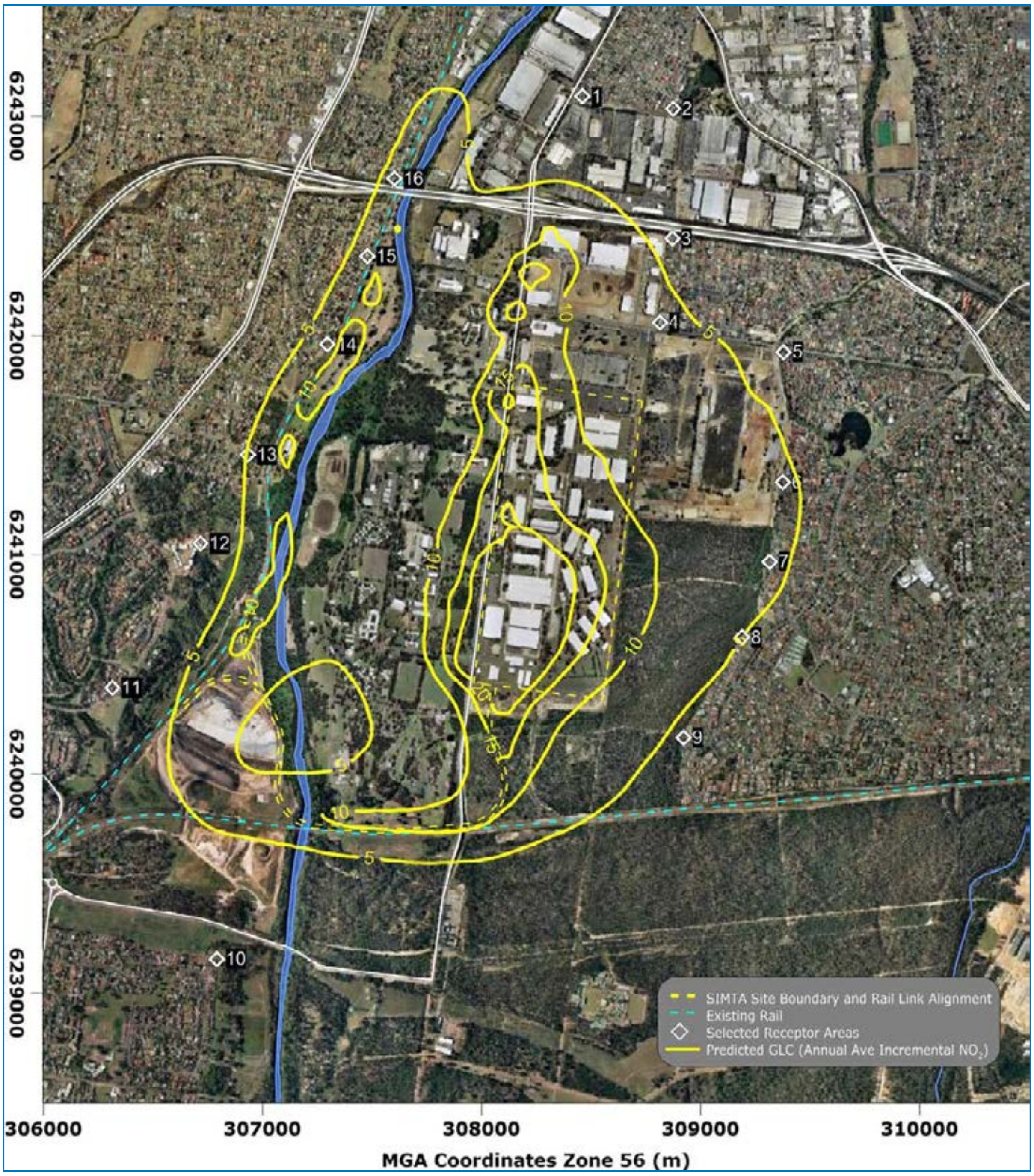

Figure 6.1: Predicted annual average incremental NO_2– 1,000,000 TEU

6.2 Cumulative NO_2 Concentrations

The cumulative NO_2 concentrations are presented in **Table 6.2** for NO_2 predictions using the Ozone Limiting Method (OLM) conversion method and incorporating hourly background for 1-hour NO_2.

The cumulative predictions for NO_2 at the receptor areas are all well below the impact assessment criteria for 1-hour (246 µg/m^3) and annual average (62 µg/m^3).

Table 6.2: Cumulative NO_2 Modelling Results – Full SIMTA site

Receptor Area	Cumulative NO_2 Concentration (µg/m^3) (using OLM)	
	1-hour maximum	Annual average
R1	109	17
R2	109	16
R3	109	17
R4	109	17
R5	109	17
R6	109	17
R7	109	17
R8	109	17
R9	109	17
R10	109	16
R11	121	17
R12	125	17
R13	125	18
R14	125	19
R15	125	19
R16	125	19

Contour plots for the cumulative ground level concentrations (GLCs) for annual average NO_2 for full SIMTA site operations are shown **Figure 6.2**. The contours include a background NO_2 level of 16 µg/m^3 [g] and account to NO to NO_2 conversion using OLM.

[g] A constant background for NO_2 and O_3 will result in slightly different predictions compared to those presented in Table 6.2 which are based on hourly varying 1-hour predictions paired with hourly varying background.

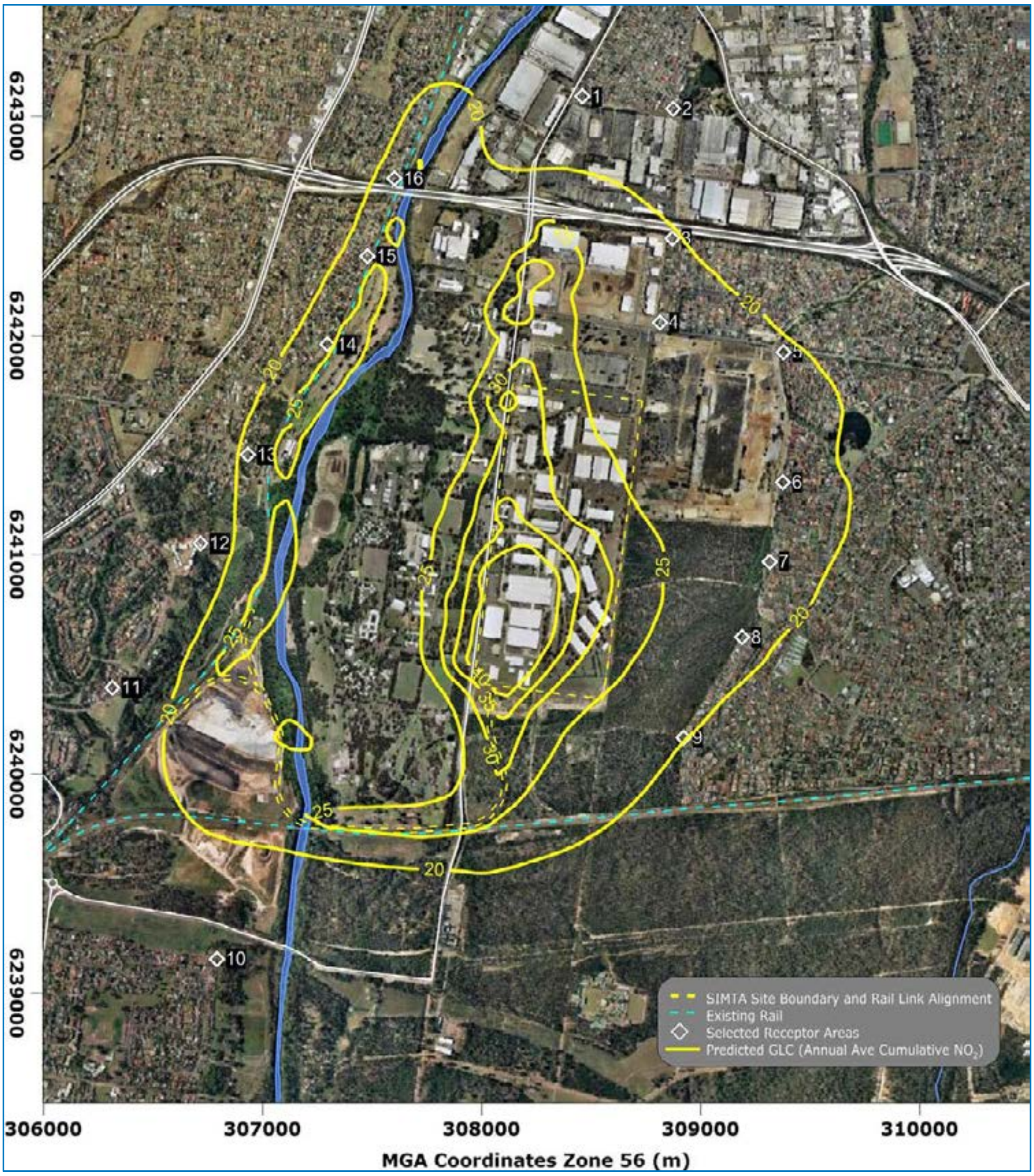

Figure 6.2: Predicted annual average Cumulative NO_2– 1,000,000 TEU

6.3 Incremental Particulate Matter (PM) Concentrations

The incremental PM concentrations at the selected receptor areas are presented in **Table 6.3**.

The maximum predicted incremental 24-hour PM at a residential receptor is 1.4 µg/m^3 or 3% of the impact assessment criterion for PM_{10} (50 µg/m^3). The maximum predicted annual average PM at a residential receptor is 0.2 µg/m^3, approximately 1% of the impact assessment criterion (30 µg/m^3).

Table 6.3: Incremental PM Modelling Results – Full SIMTA site

Receptor Area	Predicted Incremental PM Concentration (µg/m^3)	
	24-hour maximum	Annual average
R1	0.5	0.1
R2	0.3	0.1
R3	0.5	0.1
R4	0.7	0.1
R5	0.5	0.1
R6	0.9	0.2
R7	1.1	0.2
R8	1.3	0.2
R9	1.4	0.2
R10	0.6	0.1
R11	0.6	0.1
R12	1.0	0.2
R13	1.2	0.2
R14	1.2	0.2
R15	1.1	0.2
R16	0.9	0.2

Contour plots for the predicted GLCs for annual average PM_{10}/$PM_{2.5}$ for full site operations are shown in **Figure 6.3**.

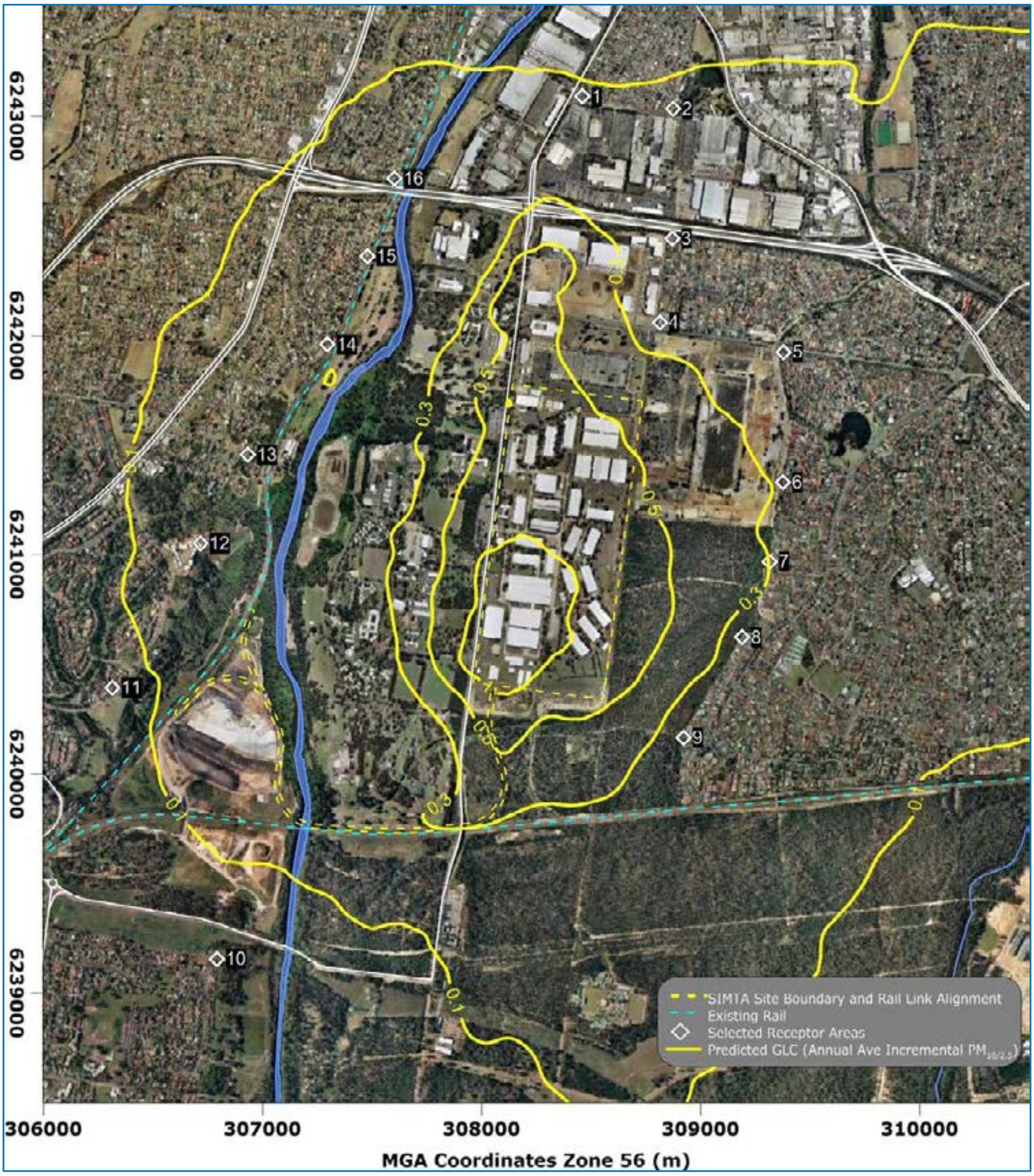

Figure 6.3: Predicted annual average incremental $PM_{10}/PM_{2.5}$– 1,000,000 TEU

6.4 Cumulative Particulate Matter (PM) Concentrations

The predicted cumulative concentrations are presented in **Table 6.4**, for PM_{10} and $PM_{2.5}$. Cumulative concentrations are presented for PM_{10} and $PM_{2.5}$ by adding the daily background value for each size fraction to the predicted increment from the SIMTA proposal.

It is noted that elevated background concentrations above the impact assessment criteria were removed from the dataset (refer to discussion in **Section 4.2.1**). The analysis shows that the SIMTA proposal would not result in any additional exceedances of the impact assessment criteria for PM_{10} or advisory reporting standards for $PM_{2.5}$. The cumulative concentrations presented in **Table 6.4** are clearly driven by the existing background.

Table 6.4: Cumulative PM Modelling Results – Full SIMTA site

Receptor Area	Predicted Cumulative PM Concentration (µg/m³)			
	PM_{10}		$PM_{2.5}$	
	24-hour maximum	Annual average	24-hour maximum	Annual average
R1	43.7	18.6	23.9	10.2
R2	43.7	18.6	23.9	10.2
R3	43.7	18.6	23.9	10.2
R4	43.7	18.6	23.9	10.3
R5	43.7	18.6	23.9	10.3
R6	43.7	18.7	23.9	10.3
R7	43.8	18.7	23.9	10.3
R8	43.9	18.7	24.0	10.3
R9	44.1	18.7	24.1	10.3
R10	43.7	18.6	24.2	10.2
R11	43.7	18.6	24.0	10.3
R12	43.7	18.7	24.0	10.3
R13	43.7	18.7	24.0	10.3
R14	43.8	18.7	24.0	10.4
R15	43.7	18.7	24.0	10.3
R16	43.7	18.7	24.0	10.3

6.5 Additional Cumulative Impacts Associated with the Proposed Moorebank Intermodal Company Ltd Terminal

The one million TEU operations is representative of a cumulative scenario whereby freight demand capacity for the catchment area is considered.

This may take the form of the full SIMTA site operations or combined operations with the proposed Moorebank Intermodal Company Ltd (MICL) Terminal Project at the adjacent SME site, to reach a combined total of 1,000,000 TEU.

The locations of the sources of emissions would change (distributed across a wider area for example) however the overall scale of impact would be the same. The location of the SIMTA and MICL terminal sites are shown in **Appendix A**.

6.6 Overview of Impacts on DNSDC and SME sites

Both the DNSDC and SME sites are expected to be vacated prior to full SIMTA operations, however the potential impacts on each site are considered in the event that either site hasn't vacated.

The predicted incremental ground-level concentrations at the two sites are shown **Table 6.5**. The values shown do not include the background, and the NO_2 concentrations assume 100% conversion of NO to NO_2.

The predicted incremental increases in ground-level concentrations at the two sites are comparable in magnitude to the predictions at the residential receptors, and are well below the relevant impact assessment criteria. Based on the cumulative analysis presented in the preceding sections, it is not expected that air quality goals would be exceeded across either the DNSDC or SME sites.

Table 6.5: Predicted GLCs across the DNSDC and SME site – full operations

Site	GLC Range (Incremental)			
	1-Hour NO_2	**Annual NO_2**	**24-Hour PM**	**Annual PM**
DNSDC	100 - 200 µg/m³	5 - 10 µg/m³	0.5 – 2.5 µg/m³	0.1 –0.5 µg/m³
SME	100 - 200 µg/m³	5 - 10 µg/m³	0.5 – 2.5 µg/m³	0.1 –0.5 µg/m³

7 ASSESSMENT OF AIR QUALITY IMPACTS FROM TRAFFIC

In response to comments received from the Department of Planning and Infrastructure, further assessment is presented for cumulative traffic movements predicted to occur at the time of implementation of the SIMTA proposal, including cumulative impacts on residential receivers located closest to the M5.

To fulfil this requirement, air quality modelling results are presented for two future traffic scenarios, with and without the SIMTA proposal.

7.1 Overview of approach

The Caline4 dispersion model has been used to estimate the concentration of oxides of nitrogen and particulate matter that are likely to result due to road traffic emissions from both the M5 and Moorebank Avenue. This model is an upgrade of Caline3 the most recent US EPA approved model, and is a steady state Gaussian model which can determine concentrations at receptor locations downwind of "at grade", "fill", "bridges" and "cut section" highways located in relatively uncomplicated terrain. The model is applicable for any wind direction, roadway orientation and receptor location.

The approach to the assessment is to identify worst case conditions which comprise 1-hour traffic flow, combined with the poorest dispersion conditions, equivalent to atmospheric inversions with very light winds.

The position of the receptors with respect to the road is also a factor when determining “worst-case” conditions along a roadway. Predictions are therefore made at various distances from each roadway.

7.2 Emission estimates for traffic

Traffic volumes were taken from **Hyder (2012)**. In the absence of hourly varying traffic data, traffic flows have been assumed to be constant along both the M5 and Moorebank Avenue. Average weekday traffic volumes with and without the proposed development have been used for each of the roadways. It was assumed that 10% of the average daily traffic volume represented peak hour conditions.

For the NO_2 1-hour predictions this peak flow has been used to represent a worst case. However, for 24-hour average PM_{10} and annual average PM_{10} and NO_2, this is likely to lead to overly conservative predictions and therefore a more even spread of traffic throughout the day has been assumed. Traffic volumes, fleet mix and other assumptions for each scenario are summarised in **Table 7.1**. The total average weekday traffic volume for the M5 motorway was estimated to be 109,400 vehicles without the development and 110,600 vehicles with the development. For Moorebank Avenue these values were estimated to be 17,400 and 23,400 vehicles, respectively.

Vehicle emission data from PIARC[h] (**PIARC, 2004**) were adjusted to reflect the NSW vehicle fleet. The modified tables include emissions of NO_x and PM_{10} by age and type of vehicle. The ages of vehicles are categorised into seven periods which correspond to the introduction of emission standards. The types of vehicle are categorised into light and heavy vehicle groups. Proportions of traffic within each age category for 2016 have been extrapolated from NSW traffic registration data from the Australian Bureau of Statistics Motor Vehicle Census (**ABS, 2005**). No future improvements in vehicle technology or fuel standards have been included in the emission estimates. Vehicle emission rates are summarised in **Table 7.2**.

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[h] *The acronym PIARC refers to the Permanent International Association of Road Congress. While this body is now known as the World Road Association, the PIARC acronym has been retained.*

Table 7.1: Modelling assumptions

Parameter	No SIMTA proposal		With SIMTA proposal	
	1-hour predictions	24-hour and annual predictions	1-hour predictions	24-hour and annual predictions
M5 Motorway				
Hourly traffic	10,940	4,560	11,060	4,610
Heavy vehicle percentage	10%	10%	10%	10%
Vehicle Speed	40 km/h	80 km/h	40 km/h	80 km/h
Moorebank Avenue (South)				
Hourly traffic	1,740	725	2,340	975
Heavy vehicle percentage	6%	6%	16%	16%
Vehicle Speed	60 km/h	60 km/h	60 km/h	60 km/h
Moorebank Avenue (North)				
Hourly traffic	3,325	1,385	3,421	1,425
Heavy vehicle percentage	10%	10%	12%	12%
Vehicle Speed	60 km/h	60 km/h	60 km/h	60 km/h

Table 7.2: Estimated peak hour traffic emissions – (g/km/v)

Model scenarios	Nitrogen Oxides			Particulate Matter		
	M5 Motorway	Moorebank Ave (Sth)	Moorebank Ave (Nth)	M5 Motorway	Moorebank Ave	Moorebank Ave (Nth)
No Development						
Peak hour	1.40	0.94	1.17	0.10	0.06	0.07
Non-peak hour	1.21	0.94	1.17	0.07	0.06	0.07
With Development						
Peak hour	1.40	1.52	1.29	0.10	0.10	0.08
Non-peak hour	1.21	1.52	1.29	0.07	0.10	0.08

7.3 Impact assessment

Nitrogen oxides are initially emitted as a mixture of nitric oxide (NO) and other oxides of nitrogen (NO_x), which are oxidised to NO_2. At the point of emission the mixture is generally about 5% NO_2 by mass. However, while the maximum concentrations of total NO_x generally occur during peak hour, this is not necessarily the case for NO_2. An extensive monitoring program undertaken by the NSW RTA (**RTA, 1997**) indicates that during peak hour the percentage NO_2 at 10 m from the roadway edge is likely to be about 5%. The conversion rate from nitric oxide to NO_2 at other times of the day may be significantly higher than this although the total NO_x levels may be significantly lower than peak hour levels. It is necessary therefore to assume some intermediate value for a worst-case assessment.

Modelling results are summarised in **Table 7.3, Table 7.4** and **Table 7.5** for scenarios with and without the SIMTA proposal. A conversion rate of 20% has been assumed for distances of 10 m or more.

It is clear from the modelling results presented in in **Table 7.3** that there is a negligible change in air quality as a result of the SIMTA proposal both at 20m and 200m from the M5.

Table 7.3: Predicted increases in ground-level concentrations due to vehicle emissions on the M5 Motorway

Distance from roadway	Pollutant and averaging time	No SIMTA proposal	With SIMTA proposal	Assessment criterion
20 m	Maximum 1-hour average NO_2 (µg/m^3)	157	158	246
	Annual average NO_2 (µg/m^3)	14	14	62
	Maximum 24-hour average PM_{10} (µg/m^3)	10	10	50
	Annual average PM_{10} (µg/m^3)	4	4	30
200 m	Maximum 1-hour average NO_2 (µg/m^3)	54	54	246
	Annual average NO_2 (µg/m^3)	4.6	4.7	62
	Maximum 24-hour average PM_{10} (µg/m^3)	3.2	3.2	50
	Annual average PM_{10} (µg/m^3)	1.3	1.3	30

Modelling results from traffic along Moorebank Avenue south of the M5, with and without SIMTA proposal are presented in in **Table 7.3**. Although results are presented at distance of 20m and 200m, there are no private residential dwellings closer than 600m from Moorebank Avenue (south of the M5). There are some residential dwellings within the SME that are located at approximately 200m from Moorebank Avenue. The modelling predictions indicate that at 200m, the predicted ground level concentrations would increase as a result of the SIMTA proposal, however the incremental increase are a minor percentage of the air quality goals. For 1 hour NO_2 the increase from the SIMTA proposal is 3% of the assessment criteria, while for annual average, the increase is 1%. For both 24-hour and annual average PM_{10} the increase from the SIMTA proposal is 1% of the assessment criteria. It is also noted that of the predicted increase of 6,000 vehicles per day along Moorebank Avenue, approximately 43% are comprised of truck movements associated with the SIMTA proposal, which are also assessed in previous sections.

Modelling results from traffic along Moorebank Avenue north of the M5 are provided in **Table 7.5**. Given that residences along the northern section of Moorebank Avenue are approximately 10 m from the kerb, predictions have been made at this distance, as well as at 100 m and 200 m to cover a range of distances.

The modelling predictions indicate that at 10m, the predicted ground level concentrations would increase as a result of the SIMTA proposal, however the incremental increase are a minor percentage of the air quality goals. For 1 hour NO_2 the increase from the SIMTA proposal is 3% of the assessment criteria, while for annual average, the increase is 1%. For both 24-hour and annual average PM_{10} the increase from the SIMTA proposal is less than 2% of the assessment criteria.

Table 7.4: Predicted increases in ground-level concentrations due to vehicle emissions on Moorebank Avenue

Distance from roadway	Pollutant and averaging time	No SIMTA proposal	With SIMTA proposal	Assessment criterion
20 m	Maximum 1-hour average NO_2 (µg/m^3)	26	52	246
	Annual average NO_2 (µg/m^3)	2.5	5.1	62
	Maximum 24-hour average PM_{10} (µg/m^3)	1.8	4.3	50
	Annual average PM_{10} (µg/m^3)	0.7	1.7	30
200 m	Maximum 1-hour average NO_2 (µg/m^3)	7.0	14	246
	Annual average NO_2 (µg/m^3)	0.7	1.4	62
	Maximum 24-hour average PM_{10} (µg/m^3)	0.5	1.2	50
	Annual average PM_{10} (µg/m^3)	0.2	0.5	30

Table 7.5: Predicted increases in ground-level concentrations due to vehicle emissions on Moorebank Avenue (North)

Distance from roadway	Pollutant and averaging time	No SIMTA proposal	With SIMTA proposal	Assessment criterion
10 m	Maximum 1-hour average NO_2 (µg/m^3)	56	63	246
	Annual average NO_2 (µg/m^3)	5.4	6.0	62
	Maximum 24-hour average PM_{10} (µg/m^3)	5.6	6.5	50
	Annual average PM_{10} (µg/m^3)	2.3	2.6	30
100 m	Maximum 1-hour average NO_2 (µg/m^3)	25	28	246
	Annual average NO_2 (µg/m^3)	2.4	2.7	62
	Maximum 24-hour average PM_{10} (µg/m^3)	1.9	2.2	50
	Annual average PM_{10} (µg/m^3)	0.8	0.9	30
200 m	Maximum 1-hour average NO_2 (µg/m^3)	17	18	246
	Annual average NO_2 (µg/m^3)	1.5	1.7	62
	Maximum 24-hour average PM_{10} (µg/m^3)	1.2	1.4	50
	Annual average PM_{10} (µg/m^3)	0.5	0.6	30

8 REGIONAL AIR QUALITY IMPACTS

8.1 Background

The procedure for assessing the impacts of a transport development on local air quality essentially determines the risk of adverse effects on human health, as assessed by comparison with health-based air quality criteria. However, developments may also lead to changes in the overall emissions on a larger geographical scale, and hence contribute to air quality impacts at the regional level. Such regional impacts on air quality are difficult to quantify in practice, as in principle they require extensive transport and air quality modelling. The usual approach is therefore to estimate the change in total pollutant emissions from the transport network as a proxy for regional air quality.

Ideally, total emissions are calculated for the transport network with and without the development, but again for larger networks this can be difficult and time-consuming. A simpler alternative is to calculate the *marginal* impacts on emissions for the transport modes and main routes affected by the development, and this approach has been adopted here.

8.2 Method

The regional impacts of the SIMTA proposal were determined by comparing its marginal effects on emissions from road vehicles (articulated trucks only) and railway locomotives on the Port-Botany-Moorebank corridor. It was assumed that the distribution of freight from the Moorebank facility would take the same form before and after the SIMTA proposal, and was therefore excluded from the calculations.

Freight is currently transported between Port Botany and Moorebank by road, and predominantly on the M5 motorway. For the purpose of the regional assessment it was assumed that with the SIMTA proposal in place this freight would be transported by rail. The pollutants included in the calculations were NO_x, PM_{10} and CO_2. All calculations were undertaken for the 1 million TEU scenario and for the calendar year 2016. The scale of the effect of the SIMTA proposal was also evaluated by comparing the results with the total emissions in Sydney.

8.2.1 Change in road transport emissions

The annual reduction in road transport emissions associated with the SIMTA proposal was calculated using Equation 5.

$$\Delta E_{road,i} = \Delta VKM \times e_i \times 10^{-6} \qquad \text{Equation 5}$$

Where:

$\Delta E_{road,i}$ = change in annual road transport emissions of pollutant i (tonnes)

ΔVKM = change in annual vehicle-kilometres (for articulated trucks)

e_i = articulated truck emission factor for pollutant i (grams per vehicle-kilometre)

The emission factors for articulated trucks were taken from the NSW GMR emissions inventory **(Jones, 2012)** (see Section 5.2.2). These emission factors are dependent upon average trip speed. The average speed for trucks on the M5 was estimated to be 72 km/h. Morning and evening peak period speeds on the M5 (34 km/h and 54 km/h respectively) were obtained from the RTA[i]. The off-peak speed was

[i] Annual Speed and Traffic Volume Data in Sydney. http://www.rta.nsw.gov.au/publicationsstatisticsforms/downloads/travelspeeds_sydney_metro_area.html

assumed to be 100 km/h. The value of 72 km/h was calculated as weighted average for a 12-hour period, assuming that each peak period covered three hours.

The estimated annual reduction in road transport of approximately 13 million vehicle-kilometres was based on Table 21 of the Economic Analysis for the Part 3A Concept Phase Approval **(Urbis, 2011)**.

8.2.2 Change in rail transport emissions

The increase in annual rail emissions associated with SIMTA proposal was calculated using Equation 6:

$$\Delta E_{rail,i} = \Delta GTK \times FC \times e_i \times 10^{-6}$$ Equation 6

Where:

$\Delta E_{rail,i}$ = change in annual rail transport emissions of pollutant i (tonnes)

ΔGTK = change in annual gross tonne-kilometres (see Section 5.2.3)

FC = unit fuel consumption (litres per gross tonne-kilometre)

e_i = fuel-specific emission factor for pollutant i (grams per litre)

The fuel consumption per gross tonne-km was taken from the NSW EPA **(Agapides, 2012)**, and the fuel-specific emission factors for Tier 3 locomotives were taken from **USEPA (2009a, 2009b)** (see Section 5.2.3).

The estimated annual increase in rail transport of approximately 332,000 train-km was taken from Section 7.3 of the Economic Analysis for the Part 3A Concept Phase Approval (Urbis, 2011). The information presented in Section 5.2.3 was used to calculate the weight of an individual train (2,221 tonnes), and this was multiplied by the 332,000 train-km to given a total annual value for gross tonne-km of around 737 million.

8.3 Results

The results of the regional assessment for 1 million TEU in 2016 are given in **Table 8.1**. The analysis shows there would be reductions in emissions of NO_x, PM_{10} and CO_2 associated with the transfer of freight from road to rail. The absolute net effects (i.e. ignoring the direction of the change) were placed into context by comparing them with emissions from all sources in Sydney in 2008, as presented in the emissions inventory for the NSW GMR **(NSW EPA, 2012)**. The results of this comparison are shown in **Table 8.2**. For CO_2 a value for NSW was used, taken from the National Greenhouse Gas Inventory web site[j]. It can be seen that the changes in emissions resulting from the SIMTA proposal would be negligible when considered at the regional level. It can therefore be concluded with confidence that the impacts on regional air quality will also be negligible.

Table 8.1: Effects of SIMTA proposal on emissions in 2016 (based on 1 million TEU)

Pollutant	Changes in emissions (tonnes/year)		
	Road	Rail	Net overall
NO_X	-85.2	+80.9	-4.3
PM_{10}	-2.76	+1.31	-1.45
CO_2	-17,487	+8,014	-9,473

[j] http://ageis.climatechange.gov.au/SGGI.aspx#

Table 8.2: Effects of SIMTA proposal compared with emissions in Sydney

Pollutant	Emissions (tonnes/year)		
	Absolute net effect of SIMTA development	Emissions in Sydney in 2008	Effect of SIMTA proposal as a proportion of emissions in Sydney
NO_X	4.3	74,722	0.006%
PM_{10}	1.45	20,443	0.007%
CO_2	9,473	1.13×10^8 [(a)]	0.008%

Note: [(a)] For NSW.

9 MONITORING

The results of the modelling for the operation of the SIMTA proposal suggests that there is a low risk of adverse air quality impacts on surrounding residential areas. Nevertheless, the proponent is committed to an ongoing campaign based air quality monitoring program during the initial phases of both construction and operation of the SIMTA site.

An overview of the proposed monitoring is provided in **Table 9.1**. The final locations would be subject to agreement with landowners and site suitability but should be representative of the potentially worst impacted residential receivers.

Monitoring data would be compared and correlated against the nearby EPA monitoring site at Liverpool.

Table 9.1: Proposed Ambient Air Quality Monitoring

Aspect	Indicator	Method	Target	Frequency of Measurement	Monitoring Point	Discharge Point	Reference
				Construction			
Nuisance Dust	Dust Deposition	EPA Approved Method AM-19	< 4 g/m²/month at sensitive receivers (as an annual average)	Monthly	Nominated Sensitive Receivers	Construction areas	EPA Environment Protection Licence
Air Emissions	PM_{10}	Light Scattering Real Time instrument	< 50 µg/m³ (max 24-hr ave) and < 30 µg/m³ (annual ave)	Campaign monitoring for 1-2 weeks on a quarterly basis	Nominated Sensitive Receivers	Terminal and warehouse areas and rail corridor.	EPA Environment Protection Licence
				Operation			
Air Emissions	PM_{10}	Light Scattering Real Time instrument	< 50 µg/m³ (max 24-hr ave) and < 30 µg/m³ (annual ave)	Campaign monitoring for 1-2 weeks on a quarterly basis. To be implemented once the terminal is operating and reviewed after 1 year.	Nominated Sensitive Receivers	Terminal and warehouse areas and rail corridor.	EPA Environment Protection Licence
	Nitrogen Dioxide	Passive Diffusion Badges	< 246 µg/m³ (max 1-hr ave) and < 62 µg/m³ (annual ave)	Campaign monitoring for 1-2 weeks on a quarterly basis. To be implemented once the terminal is operating and reviewed after 1 year.	Nominated Sensitive Receivers	Terminal and warehouse areas and rail corridor.	EPA Environment Protection Licence

10 CONCLUSIONS

The results of the modelling predictions for NO_2 for the SIMTA proposal indicate that the NO_2 concentrations are lower than the relevant impact assessment criteria for all averaging periods at all residential receptors.

The modelling indicates that maximum predicted incremental 24-hour PM concentrations are lower than the relevant impact assessment criteria for all averaging periods and size fractions at all residential receptors. The analysis also indicates that cumulatively, the SIMTA proposal would not result in any additional exceedances of the impact assessment criteria for PM_{10} or advisory reporting standards for $PM_{2.5}$.

An assessment of traffic related impacts on air quality indicates that any change to air quality as a result of the SIMTA proposal on traffic along the M5 would be negligible. Along Moorebank Avenue, both north and south of the M5, the increase in pollutant concentrations from the SIMTA proposal is between 1% and 3% of the assessment criteria.

It is noted that a worst-case scenario was modelled, in terms of emission rates and operational conditions. As a result, all predictions in the assessment should be viewed as conservatively high, with levels expected to be lower than those modelled during normal operations of the SIMTA proposal.

The regional impacts of the SIMTA proposal were determined by comparing its marginal effects on emissions from road vehicles (articulated trucks only) and railway locomotives on the Port-Botany-Moorebank corridor. The assessment shows that reductions in emissions for NO_x and PM would be expected. The absolute net effects were placed into context by comparing them with emissions from all sources in Sydney in 2008. The changes in emissions resulting from the SIMTA proposal would be negligible when considered at the regional level. It can therefore be concluded with confidence that the impacts on regional air quality will also be negligible.

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Appendix A: LOCATION OF SIMTA AND MCIL INTERMODAL SITES

SIMTA and MICL sites

Appendix B: WIND DIRECTION AND STABILITY CLASS TABLES FOR LIVERPOOL 2009

STATISTICS FOR FILE: Z:\Ajobs 5100-5199\5114 Moorebank SIMTA PROPOSAL\DECCW Data\liverpool_2.aus
MONTHS: All
HOURS : All
OPTION: Counts

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	00000048	00000058	00000000	00000000	00000000	00000000	00000000	00000000	00000106
NE	00000058	00000047	00000000	00000000	00000000	00000000	00000000	00000000	00000105
ENE	00000030	00000065	00000000	00000000	00000000	00000000	00000000	00000000	00000095
E	00000030	00000065	00000000	00000000	00000000	00000000	00000000	00000000	00000095
ESE	00000028	00000067	00000000	00000000	00000000	00000000	00000000	00000000	00000095
SE	00000033	00000057	00000000	00000000	00000000	00000000	00000000	00000000	00000090
SSE	00000021	00000015	00000000	00000000	00000000	00000000	00000000	00000000	00000036
S	00000028	00000017	00000000	00000000	00000000	00000000	00000000	00000000	00000045
SSW	00000020	00000017	00000000	00000000	00000000	00000000	00000000	00000000	00000037
SW	00000039	00000017	00000000	00000000	00000000	00000000	00000000	00000000	00000056
WSW	00000052	00000012	00000000	00000000	00000000	00000000	00000000	00000000	00000064
W	00000077	00000050	00000000	00000000	00000000	00000000	00000000	00000000	00000127
WNW	00000059	00000024	00000000	00000000	00000000	00000000	00000000	00000000	00000083
NW	00000060	00000031	00000000	00000000	00000000	00000000	00000000	00000000	00000091
NNW	00000052	00000063	00000000	00000000	00000000	00000000	00000000	00000000	00000115
N	00000061	00000110	00000000	00000000	00000000	00000000	00000000	00000000	00000171
CALM					00000179				
TOTAL	00000696	00000715	00000000	00000000	00000000	00000000	00000000	00000000	00001590

MEAN WIND SPEED (m/s) = 1.49
NUMBER OF OBSERVATIONS = 1590

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	00000002	00000007	00000014	00000000	00000000	00000000	00000000	00000000	00000023
NE	00000001	00000010	00000012	00000000	00000000	00000000	00000000	00000000	00000023
ENE	00000001	00000010	00000039	00000000	00000000	00000000	00000000	00000000	00000050
E	00000004	00000030	00000043	00000000	00000000	00000000	00000000	00000000	00000077
ESE	00000001	00000025	00000031	00000000	00000000	00000000	00000000	00000000	00000057
SE	00000005	00000032	00000041	00000000	00000000	00000000	00000000	00000000	00000078
SSE	00000006	00000016	00000011	00000000	00000000	00000000	00000000	00000000	00000033
S	00000001	00000014	00000007	00000000	00000000	00000000	00000000	00000000	00000022
SSW	00000003	00000020	00000003	00000000	00000000	00000000	00000000	00000000	00000026
SW	00000008	00000013	00000004	00000000	00000000	00000000	00000000	00000000	00000025
WSW	00000018	00000015	00000011	00000000	00000000	00000000	00000000	00000000	00000044
W	00000016	00000013	00000017	00000000	00000000	00000000	00000000	00000000	00000046
WNW	00000003	00000016	00000009	00000000	00000000	00000000	00000000	00000000	00000028
NW	00000005	00000027	00000009	00000000	00000000	00000000	00000000	00000000	00000041
NNW	00000005	00000038	00000013	00000000	00000000	00000000	00000000	00000000	00000056
N	00000002	00000046	00000043	00000000	00000000	00000000	00000000	00000000	00000091
CALM					00000000				
TOTAL	00000081	00000332	00000307	00000000	00000000	00000000	00000000	00000000	00000720

MEAN WIND SPEED (m/s) = 2.72
NUMBER OF OBSERVATIONS = 720

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	00000000	00000006	00000009	00000001	00000000	00000000	00000000	00000000	00000016
NE	00000000	00000003	00000006	00000001	00000000	00000000	00000000	00000000	00000010
ENE	00000000	00000000	00000031	00000013	00000000	00000000	00000000	00000000	00000044
E	00000001	00000012	00000112	00000064	00000000	00000000	00000000	00000000	00000189
ESE	00000001	00000017	00000093	00000032	00000000	00000000	00000000	00000000	00000143
SE	00000002	00000013	00000042	00000007	00000000	00000000	00000000	00000000	00000064
SSE	00000000	00000000	00000003	00000001	00000000	00000000	00000000	00000000	00000004
S	00000001	00000000	00000002	00000000	00000000	00000000	00000000	00000000	00000003
SSW	00000001	00000004	00000004	00000000	00000000	00000000	00000000	00000000	00000009
SW	00000003	00000014	00000018	00000009	00000000	00000000	00000000	00000000	00000044
WSW	00000015	00000017	00000038	00000038	00000000	00000000	00000000	00000000	00000108
W	00000015	00000017	00000019	00000023	00000000	00000000	00000000	00000000	00000074
WNW	00000007	00000016	00000022	00000032	00000000	00000000	00000000	00000000	00000077
NW	00000001	00000019	00000016	00000012	00000000	00000000	00000000	00000000	00000048
NNW	00000000	00000037	00000013	00000009	00000000	00000000	00000000	00000000	00000059
N	00000000	00000019	00000044	00000020	00000000	00000000	00000000	00000000	00000083
CALM					00000000				
TOTAL	00000047	00000194	00000472	00000262	00000000	00000000	00000000	00000000	00000975

MEAN WIND SPEED (m/s) = 3.80
NUMBER OF OBSERVATIONS = 975

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	00000000	00000039	00000028	00000000	00000000	00000001	00000000	00000000	00000068
NE	00000000	00000021	00000029	00000000	00000000	00000003	00000000	00000001	00000054
ENE	00000000	00000007	00000042	00000001	00000000	00000000	00000000	00000000	00000050
E	00000007	00000042	00000050	00000004	00000000	00000000	00000000	00000000	00000103
ESE	00000002	00000025	00000045	00000007	00000002	00000000	00000000	00000000	00000081
SE	00000003	00000021	00000028	00000009	00000004	00000001	00000000	00000001	00000067
SSE	00000000	00000002	00000007	00000003	00000003	00000001	00000000	00000000	00000016
S	00000000	00000001	00000002	00000001	00000000	00000000	00000000	00000000	00000004
SSW	00000001	00000000	00000000	00000000	00000000	00000000	00000000	00000000	00000001
SW	00000024	00000061	00000014	00000010	00000001	00000000	00000000	00000000	00000110
WSW	00000084	00000095	00000062	00000040	00000024	00000006	00000000	00000000	00000311
W	00000048	00000030	00000032	00000021	00000027	00000018	00000003	00000000	00000179
WNW	00000006	00000021	00000024	00000018	00000037	00000017	00000002	00000001	00000126
NW	00000000	00000071	00000019	00000010	00000016	00000002	00000000	00000000	00000118
NNW	00000004	00000122	00000035	00000014	00000009	00000001	00000000	00000000	00000185
N	00000004	00000111	00000051	00000026	00000010	00000007	00000005	00000000	00000214
CALM					00000006				
TOTAL	00000183	00000669	00000468	00000164	00000133	00000057	00000010	00000003	00001693

MEAN WIND SPEED (m/s) = 3.45

NUMBER OF OBSERVATIONS = 1693

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	00000010	00000026	00000004	00000000	00000000	00000000	00000000	00000000	00000040
NE	00000001	00000015	00000000	00000000	00000000	00000000	00000000	00000000	00000016
ENE	00000001	00000020	00000001	00000000	00000000	00000000	00000000	00000000	00000022
E	00000015	00000039	00000002	00000000	00000000	00000000	00000000	00000000	00000056
ESE	00000010	00000032	00000005	00000000	00000000	00000000	00000000	00000000	00000047
SE	00000011	00000035	00000005	00000001	00000000	00000000	00000000	00000000	00000052
SSE	00000004	00000008	00000001	00000000	00000000	00000000	00000000	00000000	00000013
S	00000008	00000008	00000002	00000000	00000000	00000000	00000000	00000000	00000018
SSW	00000013	00000008	00000004	00000000	00000000	00000000	00000000	00000000	00000025
SW	00000038	00000029	00000001	00000000	00000000	00000000	00000000	00000000	00000068
WSW	00000079	00000018	00000004	00000000	00000000	00000000	00000000	00000000	00000101
W	00000063	00000024	00000002	00000000	00000000	00000000	00000000	00000000	00000089
WNW	00000008	00000019	00000000	00000000	00000000	00000000	00000000	00000000	00000027
NW	00000007	00000033	00000000	00000001	00000000	00000000	00000000	00000000	00000041
NNW	00000014	00000133	00000005	00000000	00000000	00000000	00000000	00000000	00000152
N	00000006	00000088	00000019	00000000	00000000	00000000	00000000	00000000	00000113
CALM					00000023				
TOTAL	00000288	00000535	00000055	00000002	00000000	00000000	00000000	00000000	00000903

MEAN WIND SPEED (m/s) = 1.82
NUMBER OF OBSERVATIONS = 903

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	00000072	00000034	00000000	00000000	00000000	00000000	00000000	00000000	00000106
NE	00000062	00000041	00000000	00000000	00000000	00000000	00000000	00000000	00000103
ENE	00000060	00000039	00000000	00000000	00000000	00000000	00000000	00000000	00000099
E	00000057	00000037	00000000	00000000	00000000	00000000	00000000	00000000	00000094
ESE	00000047	00000051	00000000	00000000	00000000	00000000	00000000	00000000	00000098
SE	00000071	00000039	00000000	00000000	00000000	00000000	00000000	00000000	00000110
SSE	00000077	00000017	00000000	00000000	00000000	00000000	00000000	00000000	00000094
S	00000050	00000021	00000000	00000000	00000000	00000000	00000000	00000000	00000071
SSW	00000062	00000020	00000000	00000000	00000000	00000000	00000000	00000000	00000082
SW	00000113	00000020	00000000	00000000	00000000	00000000	00000000	00000000	00000133
WSW	00000247	00000014	00000000	00000000	00000000	00000000	00000000	00000000	00000261
W	00000186	00000034	00000000	00000000	00000000	00000000	00000000	00000000	00000220
WNW	00000080	00000027	00000000	00000000	00000000	00000000	00000000	00000000	00000107
NW	00000078	00000034	00000000	00000000	00000000	00000000	00000000	00000000	00000112
NNW	00000082	00000068	00000000	00000000	00000000	00000000	00000000	00000000	00000150
N	00000076	00000106	00000000	00000000	00000000	00000000	00000000	00000000	00000182
CALM					00000761				
TOTAL	00001420	00000602	00000000	00000000	00000000	00000000	00000000	00000000	00002783

MEAN WIND SPEED (m/s) = 1.06
NUMBER OF OBSERVATIONS = 2783

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	00000132	00000170	00000055	00000001	00000000	00000001	00000000	00000000	00000359
NE	00000122	00000137	00000047	00000001	00000000	00000003	00000000	00000001	00000311
ENE	00000092	00000141	00000113	00000014	00000000	00000000	00000000	00000000	00000360
E	00000114	00000225	00000207	00000068	00000000	00000000	00000000	00000000	00000614
ESE	00000089	00000217	00000174	00000039	00000002	00000000	00000000	00000000	00000521
SE	00000125	00000197	00000116	00000017	00000004	00000001	00000000	00000001	00000461
SSE	00000108	00000058	00000022	00000004	00000003	00000001	00000000	00000000	00000196
S	00000088	00000061	00000013	00000001	00000000	00000000	00000000	00000000	00000163
SSW	00000100	00000069	00000011	00000000	00000000	00000000	00000000	00000000	00000180
SW	00000225	00000154	00000037	00000019	00000001	00000000	00000000	00000000	00000436
WSW	00000495	00000171	00000115	00000078	00000024	00000006	00000000	00000000	00000889
W	00000405	00000168	00000070	00000044	00000027	00000018	00000003	00000000	00000735
WNW	00000163	00000123	00000055	00000050	00000037	00000017	00000002	00000001	00000448
NW	00000151	00000215	00000044	00000023	00000016	00000002	00000000	00000000	00000451
NNW	00000157	00000461	00000066	00000023	00000009	00000001	00000000	00000000	00000717
N	00000149	00000480	00000157	00000046	00000010	00000007	00000005	00000000	00000854
CALM									00000969
TOTAL	00002715	00003047	00001302	00000428	00000133	00000057	00000010	00000003	00008664

MEAN WIND SPEED (m/s) = 2.13
NUMBER OF OBSERVATIONS = 8664

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 18.4%
B : 8.3%
C : 11.3%
D : 19.5%
E : 10.4%
F : 32.1%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0084	0072	0205
02	0000	0000	0000	0074	0059	0228
03	0000	0000	0000	0073	0075	0213
04	0000	0000	0000	0083	0067	0211
05	0000	0000	0000	0080	0073	0208
06	0017	0006	0006	0073	0062	0197
07	0075	0030	0031	0085	0032	0108
08	0156	0066	0062	0048	0003	0026
09	0198	0054	0079	0030	0000	0000
10	0201	0063	0067	0030	0000	0000
11	0186	0090	0064	0021	0000	0000
12	0196	0069	0074	0022	0000	0000
13	0179	0070	0089	0023	0000	0000
14	0144	0076	0117	0024	0000	0000
15	0121	0072	0140	0028	0000	0000
16	0087	0076	0128	0049	0009	0012
17	0026	0040	0097	0093	0032	0073
18	0004	0008	0021	0169	0053	0106
19	0000	0000	0000	0151	0064	0146

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 20 0000 0000 0000 0105 0065 0191
 21 0000 0000 0000 0104 0060 0197
 22 0000 0000 0000 0089 0066 0206
 23 0000 0000 0000 0079 0056 0226
 24 0000 0000 0000 0076 0055 0230

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STABILITY CLASS BY MIXING HEIGHT
--------------------------------
Mixing height    A    B    C    D    E    F
   <=500 m    0290 0107 0144 0321 0849 2674
  <=1000 m    0722 0260 0306 0606 0018 0036
  <=1500 m    0578 0353 0525 0616 0036 0073
  <=2000 m    0000 0000 0000 0102 0000 0000
  <=3000 m    0000 0000 0000 0043 0000 0000
   >3000 m    0000 0000 0000 0005 0000 0000

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MIXING HEIGHT BY HOUR OF DAY
----------------------------
      0000  0100  0200  0400  0800  1600  Greater
       to    to    to    to    to    to   than
Hour  0100  0200  0400  0800  1600  3200  3200
 01   0193  0073  0017  0039  0034  0005  0000
 02   0205  0078  0016  0025  0031  0006  0000
 03   0193  0093  0006  0034  0029  0006  0000
 04   0198  0077  0014  0040  0024  0008  0000
 05   0211  0080  0009  0031  0022  0008  0000
 06   0165  0105  0061  0015  0009  0006  0000
 07   0122  0063  0107  0067  0001  0001  0000
 08   0000  0072  0127  0162  0000  0000  0000
 09   0000  0000  0103  0183  0075  0000  0000
 10   0000  0000  0000  0242  0119  0000  0000
 11   0000  0000  0000  0142  0219  0000  0000
 12   0000  0000  0000  0092  0269  0000  0000
 13   0000  0000  0000  0000  0361  0000  0000
 14   0000  0000  0000  0000  0361  0000  0000
 15   0000  0000  0000  0000  0361  0000  0000
 16   0000  0000  0000  0000  0361  0000  0000
 17   0013  0008  0001  0003  0333  0003  0000
 18   0060  0046  0007  0013  0224  0010  0001
 19   0115  0070  0017  0013  0132  0014  0000
 20   0166  0076  0015  0013  0077  0014  0000
 21   0175  0075  0012  0023  0063  0013  0000
 22   0191  0071  0016  0024  0048  0011  0000
 23   0209  0066  0013  0030  0035  0008  0000
 24   0214  0062  0014  0031  0033  0007  0000
```