pae holmes

Air Quality Impact Assessment

SIMTA

SYDNEY INTERMODAL TERMINAL ALLIANCE

Part 3A Concept Plan Application

28 / 09 / 2011

PROJECT TITLE:	**CONCEPT PLAN PROPOSAL FOR THE SIMTA MOOREBANK INTERMODAL TERMINAL FACILITY**
JOB NUMBER:	**5114**
PREPARED FOR:	Rebecca Sommer
	HYDER CONSULTING PTY LTD
PREPARED BY:	Ronan Kellaghan
APPROVED FOR RELEASE BY:	R. Kellaghan
DISCLAIMER & COPYRIGHT:	This report is subject to the copyright statement located at www.paeholmes.com © Queensland Environment Pty Ltd trading as PAEHolmes ABN 86 127 101 642

DOCUMENT CONTROL

VERSION	DATE	PREPARED BY	REVIEWED BY
01	13.07.11	Ronan Kellaghan	Ronan Kellaghan
02	29.07.11	Ronan Kellaghan	Ronan Kellaghan
03	04.08.11	Ronan Kellaghan	Ronan Kellaghan
04	23.09.11	Ronan Kellaghan	Ronan Kellaghan
05	28.09.11	Ronan Kellaghan	Ronan Kellaghan

Queensland Environment Pty Ltd trading as
PAEHolmes ABN 86 127 101 642

SYDNEY:
Suite 203, Level 2, 240 Beecroft Road
Epping NSW 2121
Ph: +61 2 9870 0900
Fax: +61 2 9870 0999

BRISBANE:
Level 1, La Melba, 59 Melbourne Street South Brisbane Qld 4101
PO Box 3306 South Brisbane Qld 4101
Ph: +61 7 3004 6400
Fax: +61 7 3844 5858

Email: info@paeholmes.com

Website: www.paeholmes.com

ES1 EXECUTIVE SUMMARY

The Sydney Intermodal Terminal Alliance (SIMTA) is a joint venture between Stockland, Qube Logistics and QR National. 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.

An air quality impact assessment has been conducted to assess the Concept Plan for the SIMTA proposal under Part 3A of the *Environmental Planning and Assessment Act 1979*. The SIMTA proposal will function as an intermodal rail-to-truck freight terminal with a throughput of 1,000,000 TEUs (twenty foot equivalents) per annum when operating at full capacity. The SIMTA proposal will be situated on the SIMTA site formerly known as the Defence National Storage and Distribution Centre (DNSDC), on Moorebank Avenue, Moorebank. The SIMTA site is well positioned to take advantage of existing infrastructure, being 27 kilometres west of the Sydney CBD, 16 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, and 0.6 kilometres from the M5 motorway.

From an air quality perspective, the potential emissions during operation of the SIMTA proposal are primarily from diesel vehicle exhaust (locomotives, trucks and container handling equipment). During construction, fugitive dust emissions can also be expected from the site; however, construction impacts would be staged, temporary and relatively short.

An indication of existing ambient air quality and meteorology for the area has been described and characterised using data from the NSW Office of Environment and Heritage (OEH) monitoring site, approximately 3 km north-west of the proposed SIMTA site.

Final development design, layout and operational details for the SIMTA proposal have not been developed for the concept phase approval. The approach therefore adopted for this assessment is to use operational details for a similar intermodal facility at Enfield and scaled to account for an expected increase in container TEUs handled at Moorebank.

A modelling scenario for the concept plan operation of the site has been developed, based on a conceptual busiest hour of operations at the site. Pollutant emissions from the following sources have been estimated and used to predict impacts from the operation of the site:

- Locomotives idling on-site during container unloading and loading;
- Trucks travelling along Moorebank Avenue and moving and idling within the site;
- Container handling equipment (forklifts, gantry cranes) unloading / loading containers; and
- Forklifts operating within warehouse areas.

Dispersion modelling using Ausplume was used to predict potential off-site impacts from the operation of the SIMTA proposal. The results of the modelling indicate that operations at the SIMTA proposal at maximum capacity would not result in exceedances of the relevant impact assessment criteria for NO_2, for all averaging periods and at all receptors.

Particulate Matter (PM) modelling predictions were made based on the maximum operating capacity of SIMTA proposal, and compared against air quality indicators for coarse particulate (PM_{10}) and fine particulate ($PM_{2.5}$). The modelling indicates that maximum predicted incremental 24-hour PM concentrations at residences are approximately 8 µg/m^3, which equates to 16% of the impact assessment criteria for PM_{10} and 32% of the advisory reporting standard for $PM_{2.5}$.

Cumulative impact assessment shows that the addition of the PM from the SIMTA proposal to background PM_{10} does not result in an exceedance of the 24-hour or annual PM_{10} impact assessment criteria. Impact assessment criteria are not prescribed for $PM_{2.5}$, however, the addition of the PM from the SIMTA proposal to the background $PM_{2.5}$ may result in one to two additional occurrences above the 24-hour $PM_{2.5}$ NEPM advisory reporting standards. However, it is noted that the modelling is based on the busiest hour of operation at the site, and applying this for averaging periods of 24-hours and longer will result in a conservatively high prediction of impact.

In terms of impacts on regional air quality, the operation of the SIMTA proposal is expected to have a net positive impact by reducing freight transport by truck and reducing the overall emissions to airshed. The operation of the SIMTA proposal is expected to reduce the vehicle kilometres travelled (VKT) by heavy freight traffic in Sydney, reducing the demand for freight truck movements between Port Botany and Moorebank, and by substituting freight transport by truck with rail transport to and from Port Botany. Each train will transport up to 80 TEUs with a capacity for the SIMTA proposal of up to 21 train movements per day. This equates to up to 1680 TEUs per day which would otherwise be transported by truck across Sydney.

It is recommended that all feasible and reasonable measures are taken to minimise potential impacts on local and regional air quality, including:

- Consideration of advances in rolling stock servicing the SIMTA proposal.
- Consider the use of electrically powered container handling equipment in lieu of diesel equipment where possible.
- Consider the use of LPG forklifts in lieu of diesel forklifts where possible.
- Minimise truck movements through the efficient management of deliveries and dispatches.
- Minimise truck idling and queuing on-site.
- Construction dust mitigation measures should be considered as part of future Project Application construction management plans.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

The 'Sydney Intermodal Terminal Alliance' (SIMTA) (the joint venture participants being Stockland, Qube Logistics & QR National) has been formed to develop an Intermodal Terminal Facility (SIMTA proposal) and Warehouse / Distribution Facility at Moorebank.

The SIMTA proposal is for Concept Plan (CP) approval under Part 3A of the *Environmental Planning and Assessment Act 1979*. The future development of the SIMTA proposal will be undertaken in a series of stages, with the design detail being prepared to accompany future Project Applications (PAs).

PAEHolmes have been engaged to prepare an Air Quality Impact Assessment (AQIA) to form part of the Environmental Assessment (EA).

1.1 Overview

The proposed Moorebank Intermodal Terminal Facility (SIMTA proposal) will be located at the SIMTA site (formally known as the Defence National Storage and Distribution Centre (DNSDC), Moorebank Avenue, Moorebank. The CP includes a rail corridor that will link the SIMTA site with the Southern Sydney Freight Line (SSFL). The rail corridor will accommodate a 30m wide rail alignment for a rail connection from the SIMTA site to the SSFL.

The SIMTA proposal will include new rail corridor, rail siding, container storage areas, truck holding areas, warehousing and distribution facilities and ancillary requirements such as car parking.

An indicative Development Plan has been developed for the entire site for the purposes of achieving approval for the CP.

1.2 Scope of Work

The Director-General's Requirements for assessment (DGRs) have been issued and include a requirement to assess air quality impacts as a key issue.

The DGRs for Air Quality require an assessment of:

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

The objective of this assessment is to address the DGRs for Air Quality and this will be achieved by the following scope of work:

Conduct an Air Quality Impact Assessment in accordance with the NSW Office of Environment and Heritage (OEH)[1] "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (**NSW DEC, 2005**).

[1] The NSW EPA exists as a legal entity operated within the Office of Environment and Heritage (OEH) which came into existence in April 2011. OEH was previously part of the Department of Environment, Climate Change and Water (DECCW). The DECCW was also recently known as the Department of Environment and Climate Change (DECC), and prior to that the Department of Environment and Conservation (DEC). The terms NSW EPA, OEH, DECCW, DECC and DEC are interchangeable in this report.

- Provide a detailed description of the ambient receiving environment, including background pollution concentrations, prevailing meteorological conditions and nearby sensitive receptors.
- 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 pollution 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.

2 PROJECT DESCRIPTION

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.

The Intermodal Terminal Facility (SIMTA proposal) will include a rail corridor, rail siding and warehouse and distribution facility. The SIMTA proposal will function as a Port Shuttle providing an intermodal rail to truck freight terminal with a throughput of 1,000,000 TEUs (twenty foot equivalents) per annum when operating at full capacity.

The primary function of the SIMTA proposal will be the transfer of container freight to and from Port Botany by rail and to facilitate the ongoing distribution of freight throughout western and south-western industrial areas of Sydney. Operations will involve the following:

- Unloading of containers from rail onto stacks within SIMTA proposal.
- Containers will then be transported to warehouses within the intermodal centre, or onto trucks for transport off-site.
- Loading of containers onto trains for export or return to Port Botany.

The SIMTA proposal will operate 24 hours a day, seven days a week and will cater for up to 21 train movements a day. Each train is expected to carry up to 80 TEUs with a turnover cycle of two hours per train. The facility has the capacity for up to three (3) trains (approximately 640m in length) at any one time. Average time for a truck to enter the site, be directly loaded from the train and depart from the site is anticipated to take up a maximum of 30 minutes. Containers not loaded directly to a truck will be transferred to container storage areas on either side of the rail siding or a warehouse facility where each container will be broken down and the contents loaded onto smaller vehicles for delivery generally within the western and south-western industrial areas. Elsewhere on the site there will be a number of large format distribution warehouses to service tenants which benefit from proximity to the SIMTA proposal, and receive a large amount of goods from Port Botany and where the location of a distribution facility near the rail head will have an advantage over a location elsewhere.

Equipment used to move containers within the terminal and to load / unload containers will include inter-terminal vehicles (ITVs), gantry cranes, forklifts and / or reach stackers. Initially reach stackers will be utilised for TEU movement within the site, however, the installation of 5 gantries is anticipated for the SIMTA proposal to operate at full capacity.

The SIMTA site and proposed rail corridor land is presented in **Figure 2.1**. The final development layout for the site has not been determined, however, an overall Land Use Concept Plan has been developed including a rail corridor which will link the SIMTA site with the SSFL and accommodate a 30m wide rail alignment.

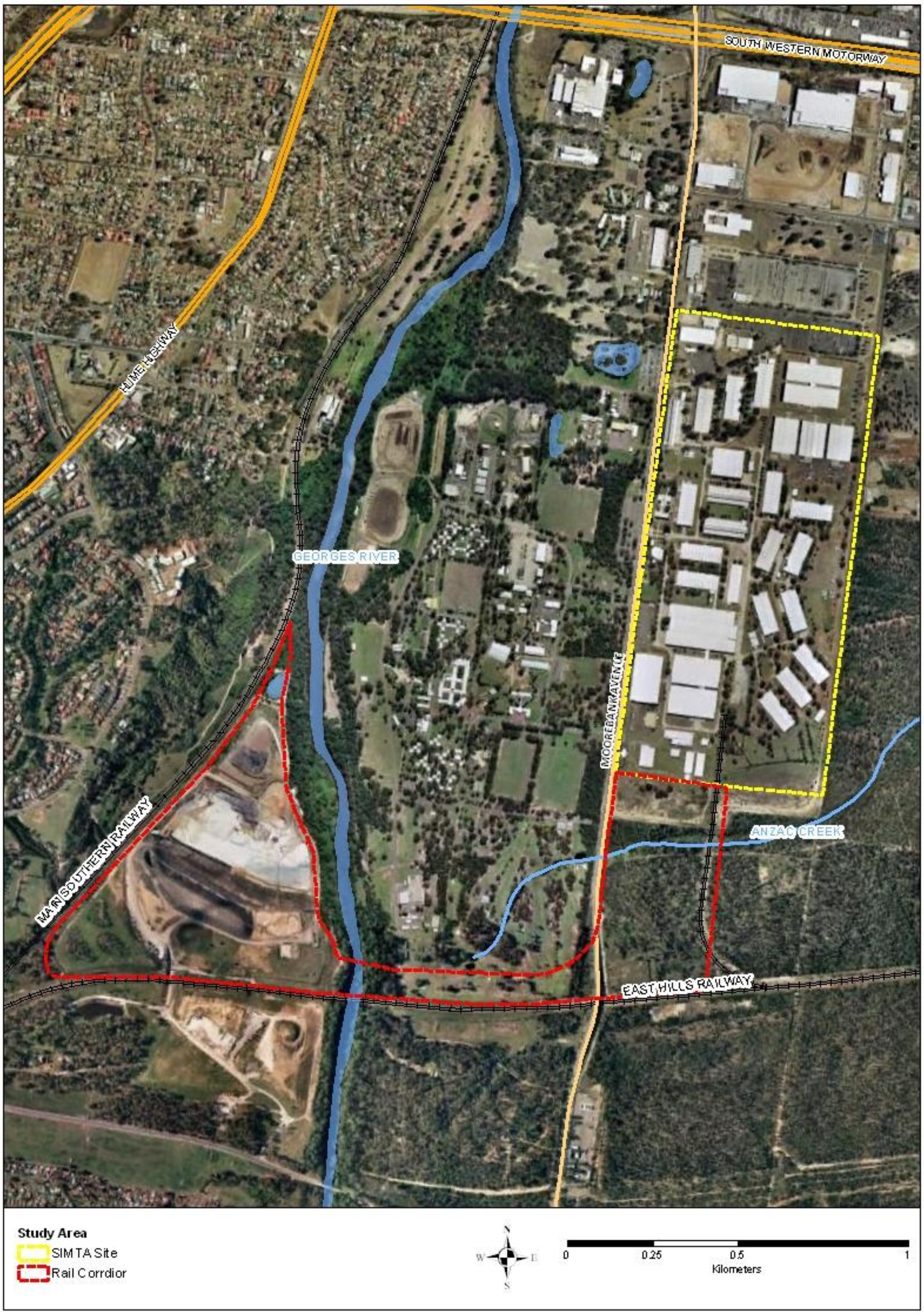


Figure 2.1: SIMTA Proposal

2.1 Local Setting

The SIMTA site is located in the Liverpool Local Government Area. It is 27 kilometres west of the Sydney CBD, 16 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, 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 corridor are referred to as the rail corridor. The proposed rail corridor covers approximately 65 hectares and adjoins the Main Southern Railway to the north. Existing land use includes vacant land, golf course, extractive industries, and a waste disposal depot. Native vegetation includes woodland, forest and wetland communities in varying condition. Georges River and Anzac Creek intersect the proposed rail corridor. The supplementary lands area to the south of the SIMTA site to the north of the existing East Hills Rail Line are part of Lot 3001 DP1125930 and Lot 1 DP1125930. To the west of the Georges River, the Glenfield Waste Disposal site comprises several lots that are currently all used for the purposes of the waste facility.

The location of the site is shown in **Figure 2.1**. The site also includes a disused rail spur that enters the site from the East Hills rail line approximately 1 kilometre to the south. Approximately 1.5 kilometres to the west is the Southern Sydney Freight Line.

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 the site lies within a large loop of the Georges River (approximately 800 metres to the west).

2.1.1 Discrete Receptor Locations

The discrete receptor locations chosen for this assessment are presented in **Table 2.1** and **Figure 2.2**. The locations are chosen as representative of the closest residential areas surrounding the site and are used to assess potential air quality impacts at these locations.

Table 2.1: Discrete Receptor Locations

Receptor ID	Description	Approximate distance and direction from nearest boundary	Easting (m MGA)	Northing (m MGA)
Receptor 1	Residential area – end of Yallum Ct	0.5 km south-east	308907	6240168
Receptor 2	Commercial property on Cnr Anzac Rd and Delvin Dr	0.2 km north	308815	6242065
Receptor 3	Residential area – end of Martindale Ct	0.5 km east	309368	6241335
Receptor 4	Residential area along Goodenough St	2 km south-west	306780	6239162
Receptor 5	Residential area along Leacocks Ln	1.5 km west	306534	6240736
Receptor 6	Residential area along Buckland Road	0.8 km west	307317	6241949
Receptor 7	Residential area along Church Rd	1.4 km north	308638	6243063

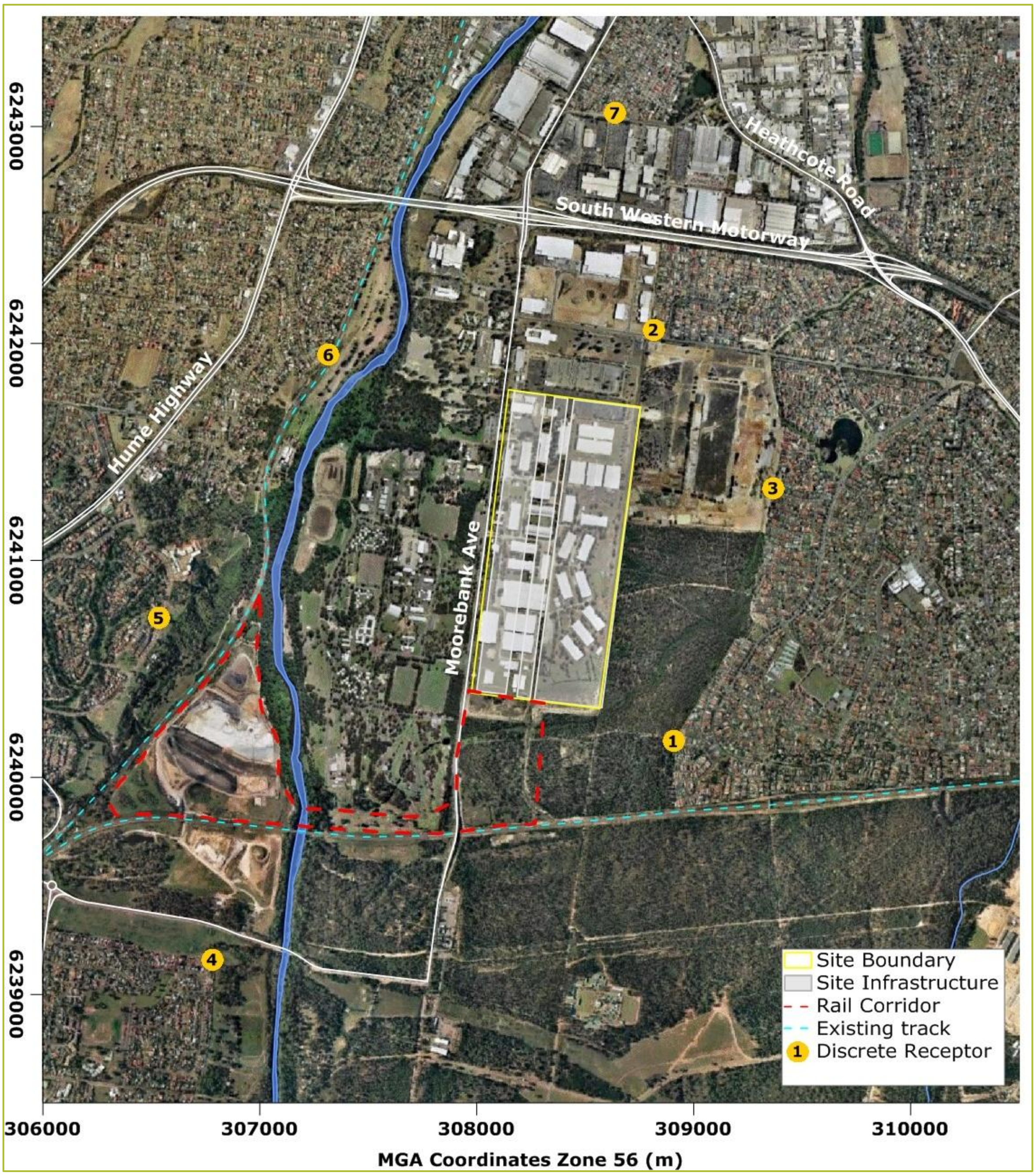


Figure 2.2: Local Setting and Discrete Receptor Locations

3 AIR QUALITY ISSUES AND EFFECTS

From an air quality perspective, it is important to consider the potential emissions that would occur during the operation of the SIMTA proposal. During operation of the SIMTA proposal, the key pollutants will be those associated with diesel vehicle exhaust, from sources including emissions from diesel locomotives idling on-site, trucks entering the site and diesel powered container handling equipment (forklifts, cranes). It is also anticipated that ancillary sources would include LPG powered forklifts within the warehouse areas, as well as light vehicle traffic (i.e. employee vehicles).

Pollutants from diesel exhaust include coarse and fine fractions of particulate matter (PM_{10} and $PM_{2.5}$), oxides of nitrogen (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2) and organic compounds. The focus of this assessment will be on the key pollutants of particulate matter (PM) and NO_x.

During construction, fugitive dust emissions can also be expected from the site; however, construction impacts would be staged and therefore relatively short lived. Construction activities will include clearing / stripping / excavation on the eastern side of the site, development of a rail link within the rail corridor to the SSFL, demolition of existing buildings and construction of a rail siding, container hardstand and new warehouse facilities. The rail link will have to cross the Georges River and would involve piling and bridge construction.

The construction air quality impacts from each stage will be assessed separately, as part of the subsequent Project Applications (PAs) for each stage of the SIMTA proposal. Construction impacts for the overall CP are not, therefore, assessed quantitatively as part of this air quality assessment and are discussed in **Section 5.1**.

3.1 Particulate Matter

Emissions of particulate matter are generally considered in three separate size fractions. These are described as total suspended particulate matter (TSP), particulate matter with equivalent aerodynamic diameters 10 μm or less (PM_{10}) and particles with equivalent aerodynamic diameters of 2.5 μm and less ($PM_{2.5}$). Goals for TSP were developed before more recent health studies suggested stronger relationships between health impacts and exposure to smaller size fractions of particulate matter, including PM_{10} and $PM_{2.5}$.

Particulate matter has the capacity to affect health and to cause nuisance effects. The extent to which health or nuisance effects occur, relates to the size and / or by chemical composition of the particulate matter. Generally the finer the particle, the greater the health effect, based on the particles ability to penetrate deep into the lungs. Particles larger than PM_{10} tend to be trapped in the nose, mouth, throat or major bronchi and are typically expelled relatively quickly from the body.

Impact assessment criteria for particulate matter provide benchmarks, which, if met, are intended to protect the community against the adverse effects of air pollutants. These criteria reflect current Australian community standards for the protection of health and protection against nuisance effects. To assist in interpreting the significance of predicted concentration some background discussion on the potential harmful effects is provided below.

The human respiratory system has in-built defensive systems that prevent particles larger than approximately 10 μm from reaching the more sensitive parts of the respiratory system. Particles with aerodynamic diameters less than 10 μm are referred to as PM_{10}. Particles larger than 10 μm, while not able to affect health, can soil materials and generally degrade aesthetic elements of the environment. In practice, particles larger than 30 to 50 μm settle out of the atmosphere too quickly to be regarded as air pollutants but are considered for their impacts on amenity.

The health-based assessment criteria used by NSW OEH (**DEC, 2005**) 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. This means that, in contrast to dust of crustal[2] origin, the particulate matter would be composed of smaller particles and would generally contain acidic and carcinogenic substances that are associated with combustion. This is particularly significant for diesel exhaust emissions which are predominantly comprised of fine ($PM_{2.5}$) and ultra-fine particulate matter (< PM_1) and can contain carcinogenic compounds such as benzene and polycyclic aromatic hydrocarbons (PAHs).

3.2 Oxides of Nitrogen

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

NO_2 is the regulated oxide of nitrogen in NSW and effects of exposure to NO_2 include irritation of the lungs and lower resistance to respiratory infections such as influenza. The effects of short-term exposure are still unclear, but continued or frequent exposure to concentrations that are typically much higher than those normally found in the ambient air may cause increased incidence of acute respiratory illness in children. Concern with NO is related to its transformation to NO_2 and its role in the formation of photochemical smog.

Typically, close to the combustion sources (i.e. trucks and locomotives), NO_2 makes up 5 to 20 per cent by weight of the total oxides of nitrogen. At the point of emission, NO_x would consist of approximately 90-95% of NO and 5-10% of NO_2, the regulated oxide. The dominant short term conversion is NO to NO_2 through oxidation with atmospheric ozone (O_3) as the plume travels from source.

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

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:

$$NO_{2\ total} = 0.1 \times NO_{x\ predicted} + MIN\ \left(0.9 \times NO_{x\ predicted}\ or\ \frac{46}{48} \times O_{3\ background}\right) + NO_{2\ background}$$

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

[2] The term crustal dust is used to refer to dust generated from materials that constitute the earth's crust.

3.3 Carbon Monoxide

Carbon monoxide is produced from incomplete combustion of fuels, where carbon is only partially oxidised instead of being fully oxidised to form carbon dioxide. Carbon monoxide 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. This process is reversible. Symptoms of carbon monoxide intoxication are lassitude and headaches. These symtoms are generally not reported until relatively high ambient atmospheric concentrations are reached.

The emission rates for CO from diesel exhausts are lower than emissions for NO_x, however, the air quality goals for CO are higher than 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 belongs to the family of sulfur oxide gases (SO_x). These gases are 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 have been progressively declining in Australia as more stringent sulfur fuel standards are brought online. Under the Fuel Quality Standards Act (2000) the current sulphur content in 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 indicator pollutant for this assessment.

3.5 Organic Hydrocarbons

Total hydrocarbons are comprised of a collection of various volatile organic components (VOCs), and several of these compounds may be toxic, 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 means 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), however, 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 VOCs emissions from the site, given buffer distances from significant activity to receptor locations of more than 500m.

3.6 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):

$$NO + VOCs \xrightarrow[\gg]{sunlight} NO_2 + O_2 \xrightarrow[\gg]{sunlight} NO + O_3$$

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 the highest concentrations of ozone normally occur on summer afternoons, in areas downwind of major sources of ozone 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**).

3.7 Air Quality Criteria and Standards

The NSW OEH prescribe 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. These 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 Ambient Air Quality NEPM was made to extend its coverage to $PM_{2.5}$ and set 'Advisory Reporting Standards' for averaging periods of 1-day and 1-year. It is important to note that the 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.

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 OEH Approved Methods (**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

The dispersion model used for this assessment, AUSPLUME, requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[3] and mixing height[4].

The OEH have 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 OEH 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 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 OEH 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.

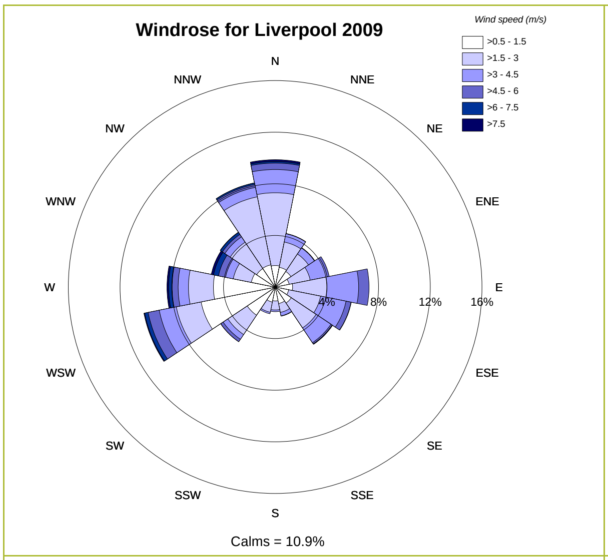
The meteorological data collected at the Liverpool OEH site were missing small pockets of data. To provide a more complete dataset, the Liverpool meteorological data were supplemented with data from the Bankstown Airport site resulting in 99% data recovery for the meteorological data used for dispersion modelling. There were no data available from either dataset for the 13 to 16 November. **Figure 4.2** presents the annual and seasonal wind roses for the Liverpool dataset that has been supplemented with the Bankstown data.

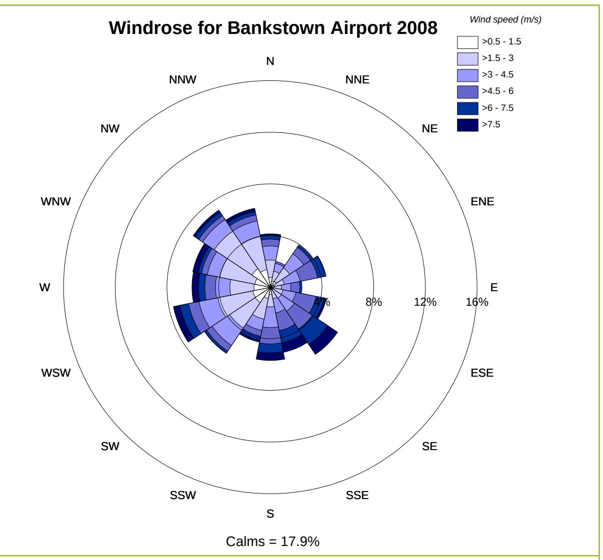
On an annual basis, it can be seen that winds can occur from most directions with winds from the northern, south-western and eastern quadrants. There are few winds from the north-northeast and south. The prevailing wind directions during summer are from the north-north-west through to the east-north-east (clockwise). In winter the wind distribution pattern shifts to lighter winds that are predominantly from the south-west and west-south-west. Spring is a transition between summer and winter while in autumn the prevailing winds originate from the north-north-west 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.

---

[3] 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.

[4] 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.





Liverpool 2009	Bankstown 2008

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

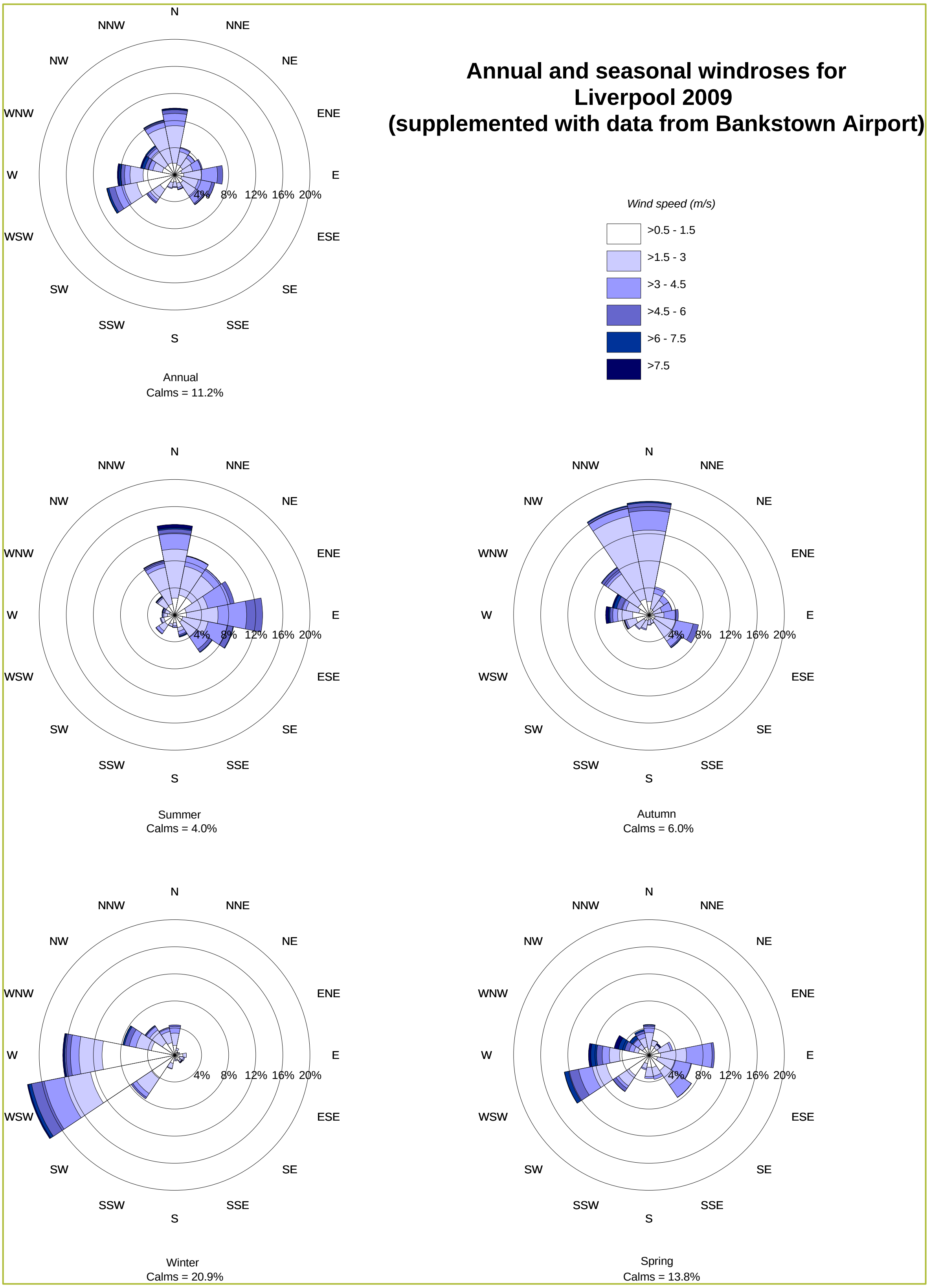


Figure 4.2: Annual and seasonal wind roses for Liverpool 2009

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 US EPA (**US EPA, 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 A**.

Mixing height was determined using a scheme defined by **Powell** (**1976**) for day-time 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 9am and 3pm 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^{o}C. July is the coldest month with a mean minimum of 5.1^{o}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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
9 am Mean Dry-bulb and Wet-bulb Temperatures (ºC), Relative Humidity (%), Wind speed (km/h)													
Dry-bulb	22.2	21.6	20.2	17.4	13.8	10.7	9.5	11.5	15.1	18.2	19.3	21.4	16.7
Wet-bulb	18.8	19.1	17.6	14.9	11.9	9.1	7.8	9.0	11.6	14.0	15.7	17.6	13.9
Humidity	72	77	77	75	79	80	78	70	64	62	67	67	72
Wind speed	8.2	7.4	6.6	6.7	6.7	6.5	6.5	8.9	10.2	10.6	9.7	9.1	8.1
3 pm Mean Dry-bulb and Wet-bulb Temperatures (ºC), Relative Humidity (%), Wind speed (km/h)													
Dry-bulb	26.8	26.4	25.0	22.6	19.5	17.0	16.4	18.0	20.2	22.1	23.5	25.9	22.0
Wet-bulb	20.2	20.4	19.0	16.7	14.3	12.2	11.2	11.7	13.4	15.4	17.1	18.9	15.9
Humidity	54	57	55	54	55	55	50	44	45	48	52	51	52
Wind speed	20.9	19.0	17.6	15.3	12.9	13.5	14.1	17.6	19.9	20.9	21.6	22.6	18.0
Mean Maximum Temperature (ºC)													
Mean	28.1	27.7	26.2	23.7	20.4	17.7	17.2	18.9	21.5	23.7	25.2	27.3	23.1
Mean Minimum Temperature (°C)													
Mean	18.1	18.1	16.1	12.7	9.6	6.6	5.1	6.0	8.6	11.8	14.2	16.6	12.0
Rainfall (mm)													
Mean	92.1	108.5	97.6	82.8	70.9	73.6	44.6	49.7	44.6	61.9	76.1	67.0	869.3
Rain days (Number)													
Mean	11.2	11.0	11.2	8.6	9.9	9.3	7.9	7.3	7.6	9.4	11.0	9.7	114.1

Climate averages for Station: 066137 Bankstown Airport, Commenced: 1968; Last record: 2010. 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 level in the environment, including the contribution 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 OEH operate a number of monitoring stations in Sydney, including a monitoring site at Liverpool, located at the council depot on Rose Street. This Liverpool OEH site is approximately 3 km north-west of the proposed SIMTA site, and these data 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 OEH using a Tapered Element Microbalance (TEOM). **Figure 4.3** shows a plot of the 24-hour average PM_{10} concentration recorded at the Liverpool site during 2009.

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 µg/m^3 recorded at Liverpool.

Obviously when considering background pollutant concentrations for assessment purposes, it is sensible to exclude these anomalous events and the approach recommended by the NSW OEH 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 µg/m^3 was exceeded. This occurred at Liverpool on 5 March 2009 and 22 and 27 November 2009 when 24-hour PM_{10} levels were 51 µg/m^3, 61 µg/m^3 and 52 µg/m^3, respectively. During the last week of November 2009, much of the state experienced strong westerly winds and isolated dust storms.

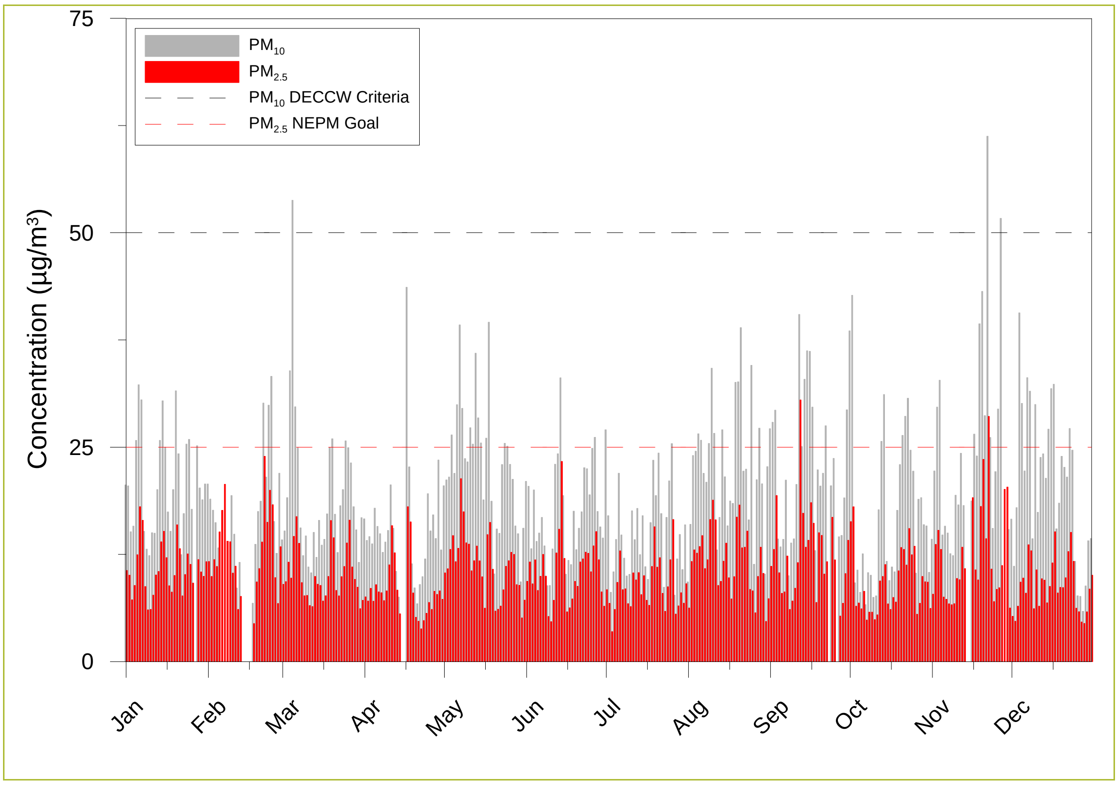


Figure 4.3: 24-Hour PM_{10} concentrations (µg/m^3) – Excluding known dust storms

The annual average statistics for PM_{10} recorded at Liverpool for 2007 onwards are presented in **Table 4.3**. The annual average PM_{10} concentrations at Liverpool are consistently below the OEH's annual average PM_{10} criteria of 30 µg/m^3. The annual average during 2009 is significantly higher due to the large number of regional dust storm events.

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

Month	Measured PM_{10} concentrations by TEOM ($\mu g/m^3$)							
	2007		2008		2009		2010[a]	
	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
Feb	18	25	15	30	17	33	17	25
Mar	19	32	17	26	19	34	20	36
Apr	21	39	14	30	23	**177**	16	30
May	23	**53**	20	32	23	40	17	27
Jun	13	23	14	27	18	33	15	27
Jul	14	36	17	39	16	27	-	-
Aug	16	31	14	29	23	39	-	-
Sep	19	37	22	40	79	**1580**	-	-
Oct	26	44			18	43	-	-
Nov	16	32	20	**54**	31	**109**	-	-
Dec	17	24	20	34	21	41	-	-
Annual average	*19*	*-*	*18*	*-*	*26*	*-*	*18*	*-*
Annual maximum	*-*	*53*	*-*	*54*	*-*	*1580*	*-*	*37*

[a] Data available to end of June 2010

4.2.2 Nitrogen Dioxide

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 indicated that for the majority of the year (>95%) the ambient concentrations are less than 20% of the air quality goal.

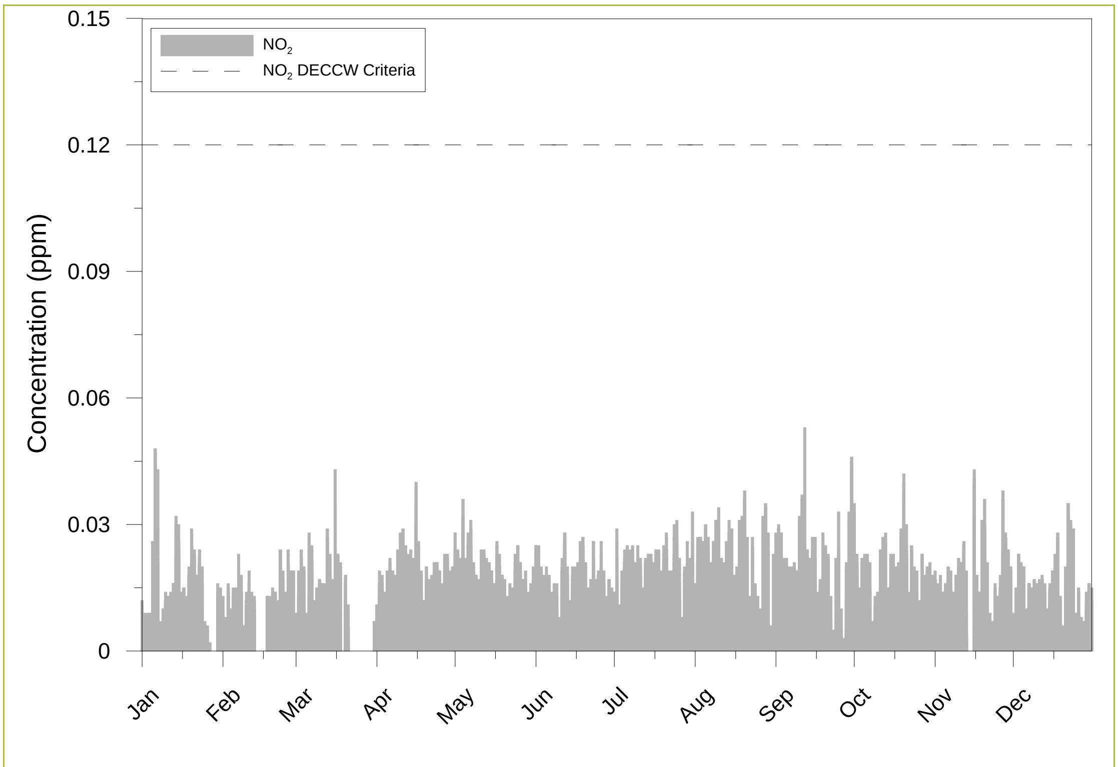


Figure 4.4: 1-hour NO_2 concentrations (ppm)

A statistical summary of the data collected from 2007 is presented in **Table 4.4**. The data presented in **Table 4.4** indicated that there have been no exceedances of OEH 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 OEH criterion.

Table 4.4 : Summary of OEH NO_2 monitoring data for Liverpool

Month	Measured PM_{10} concentrations by TEOM (ppm)							
	2007		2008		2009		2010[a]	
	Average	Maximum 1-hour average	Average	Maximum 1-hour average	Average	Maximum 1-hour average	Average	Maximum 1-hour average
Jan	0.009	0.035	0.7	0.021	0.008	0.048	0.009	0.041
Feb	0.010	0.030	0.9	0.024	0.008	0.024	0.010	0.028
Mar	0.011	0.044	1.0	0.029	0.011	0.052	0.012	0.047
Apr	0.014	0.053	1.1	0.032	0.010	0.040	0.013	0.053
May	0.016	0.051	1.5	0.042	0.010	0.036	0.015	0.041
Jun	0.012	0.030	1.3	0.033	0.010	0.028	0.013	0.029
Jul	0.013	0.030	1.4	0.032	0.011	0.033	-	-
Aug	0.013	0.040	1.2	0.041	0.012	0.038	-	-
Sep	0.012	0.032	1.3	0.040	0.011	0.053	-	-
Oct	0.013	0.052			0.010	0.042	-	-
Nov	0.009	0.033	0.9	0.046	0.010	0.043	-	-
Dec	0.009	0.033	0.9	0.031	0.009	0.035	-	-
Annual average	0.012	-	1.1	-	0.010	-	0.012	-
1-Hour maximum	-	0.053	-	0.046	-	0.053	-	0.053

a *Data available to end of June 2010*

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.

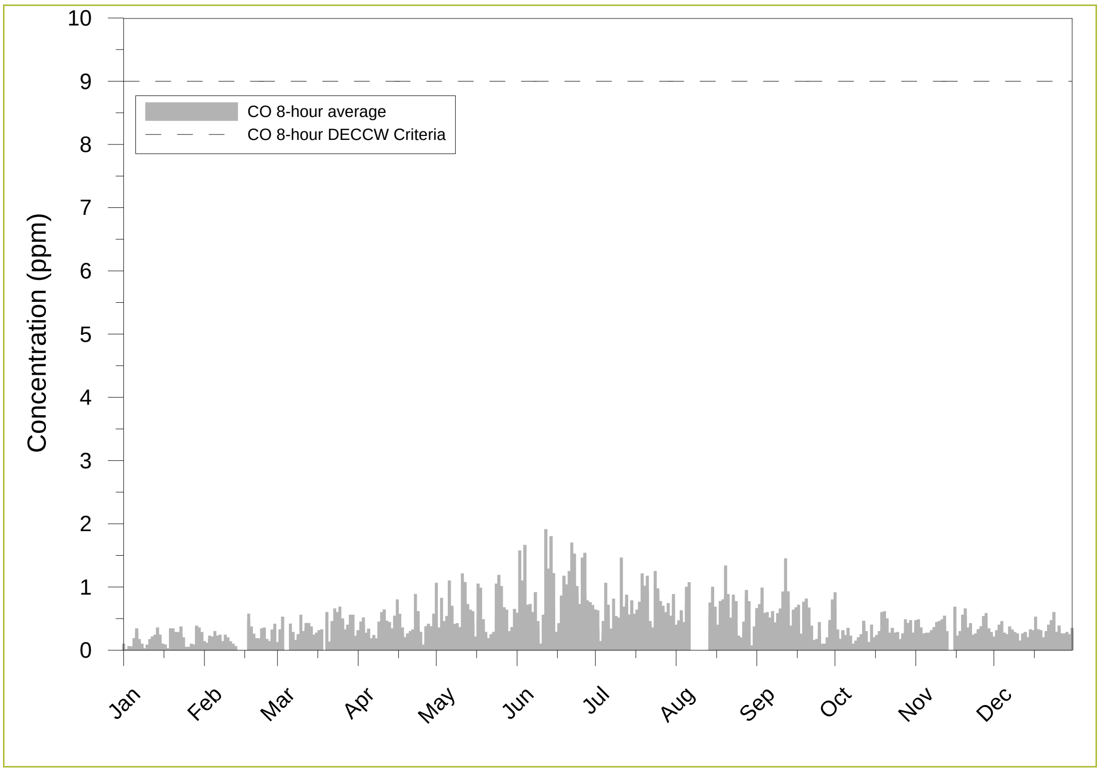


Figure 4.5: 8-Hour CO concentrations (ppm)

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 OEH 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.

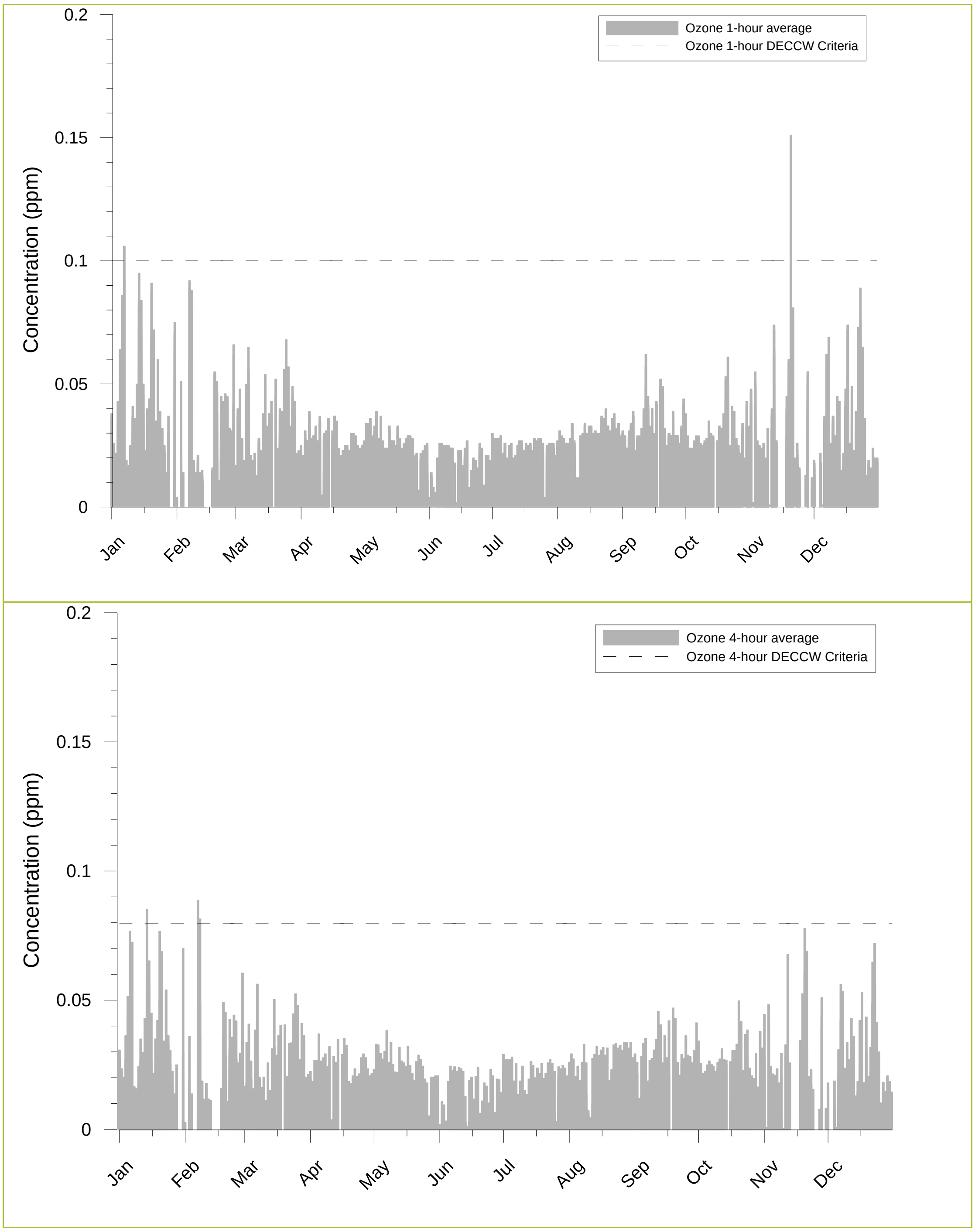


Figure 4.6: 1-Hour and 8-Hour O_3 concentrations (ppm)

5 IMPACT ASSESSMENT

From an air quality perspective it is important to consider the potential emissions that would occur when the SIMTA proposal is operational, primarily from diesel equipment operating on site. As discussed in **Section** 2, the SIMTA proposal will be staged and an indicative Development Plan has been developed for the CP approval. Final development design / layout and operational details for the SIMTA proposal, which are needed for a detailed assessment of air quality impacts, have not yet been developed.

The approach adopted for this assessment is therefore to use operational details for a similar intermodal facility at Enfield and scale the total emissions based on the ratio of throughput at both sites. The Enfield Intermodal Logistics Centre (ILC) was approved in September 2007 and construction of the facility is currently underway. The Enfield ILC is located at the former Enfield Marshalling Yards and the primary function is the transfer and storage of container freight to and from Port Botany. The operation of the Enfield ILC is expected to be very similar to the SIMTA proposal, however, the throughput (i.e. number of container TEUs handled) at Moorebank is greater, as outlined in **Table 5.1**.

Table 5.1 shows the difference in operational details at the Enfield ILC and the SIMTA proposal. The ratio of throughput at Moorebank and Enfield is used to develop a scaling factor, to allow activities at Enfield to be scaled upwards for Moorebank operations. The number of containers per annum (in twenty foot equivalents (TEUs) and the area of warehousing were the two operational parameters chosen to provide scaling factors for emission estimates from Moorebank.

Table 5.1: Comparison between Enfield ILC and SIMTA Proposal

Parameter	Enfield	Moorebank	Ratio of Moorebank /Enfield Operations
Total Site Area	60 ha	80 ha	1.3
Number of Containers per annum	300,000 TEUs	1,000,000 TEUs	3.3
Area of Warehousing	57,000 m^2	250,000 m^2	4.4

5.1 Construction Phase Impacts

The principal emissions during the construction of the SIMTA proposal will be dust and particulate matter, occurring from the activities including:

- Vegetation clearing / earthmoving during site preparation and access road construction.
- Handling of spoil material.
- Demolition of existing structures.
- Movement of heavy plant and machinery within the site on unsealed areas.
- Graders / scrapers working access road construction.
- Construction of rail link including bridge access over Georges River.
- Wind erosion from exposed surfaces.

Construction of the SIMTA proposal will be staged. Due to the staged nature of SIMTA proposal, the air quality impacts from each stage of construction will be assessed separately as part of the subsequent Project Applications for each Stage. Construction impacts for the overall Concept Plan are not, therefore, assessed quantitatively.

In general, construction impacts are expected to be controlled through good site environmental practice and commonly applied dust management measures. Prior to construction, an Environmental Management Plan will be developed which will include air quality and dust management / mitigation procedures and will:

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

The following dust mitigation measures should be considered as part of future PA construction management plans.

5.1.1 Clearing / 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:

- Modify working practices by limiting excavation during periods of high winds.
- 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 Corridor

Dust generated during the construction of the rail corridor and bridge should be controlled as follows:

- Modify working practices by limiting clearing and excavation during periods of high winds.
- Limiting the extent of vegetation removal and topsoil to the designated footprint required for the rail corridor.
- Use of water sprays during rail construction for dusty activities such as ballast dumping and compacting.

5.1.3 Demolition of Existing Structures

When conditions are dry and windy, consideration should be given to modify or cease demolition activities. Special consideration will need to be given to the demolition of buildings containing asbestos.

5.1.4 Access Route 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. Where conditions are excessively dusty and windy, and fugitive dust can be seen leaving the site, work practices should be modified 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 that has been tracked onto sealed roads should be cleaned as soon as practicable.
- When conditions are excessively dusty and windy, 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 surfaces should be controlled as part of the best practice environmental management of the site. Wind erosion from exposed ground should be limited by avoiding unnecessary vegetation clearing and complete rehabilitation as quickly as possible. Wind erosion from temporary stockpiles can be limited by minimising the number of stockpiles on-site and minimising the number of work faces on stockpiles.

5.2 Operational Phase Emission Estimates

Emissions estimates for the SIMTA proposal have been derived based on the Air Quality Impact Assessment for the Enfield ILC (**SKM, 2005**). 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. Emission estimates generally take the form:

$$E_i = A \times EF_i \times \frac{100 - ER_i}{100}$$

Where:

E_i	=	Emission of Substance i
A	=	Activity Rate
EF_i	=	Emissions 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 **Table 5.4**. Detailed activity data are not available for operations of the SIMTA proposal and the approach therefore is to use operational details for Enfield ILC during the busiest hour at the site. Operational details for Enfield are then scaled upwards to account for the increase in throughput at Moorebank. The equipment inventory presented in the assessment for Enfield ILC is shown in **Table 5.2**. For the SIMTA proposal it is assumed that a similar equipment inventory would operate on-site.

Table 5.2: Equipment Inventory for Maximum Capacity at the Enfield ILC and adopted for SIMTA proposal

Equipment	Activity data for "busiest hour"
81 Class Locomotive	3 idling
48 Class Locomotive	2 idling
Trucks (moving on-site)	24 trucks travelling 1.5 km on-site @ 20 kph
Trucks (idling on-site)	24 trucks idling
Gantry Cranes	3 x 600hp - loading/unloading
Reach Stackers	2 x 32 hp - loading/unloading
Container Forklifts	3 x 345 hp - loading/unloading
Large Forklifts	4 x 345 hp - loading/unloading
Empty Container Forklifts	6 x 200 hp - loading/unloading
Small LPG Forklifts	40 x 50 hp in warehouses
Staff Cars	300 movements / hour with average of 675 m / trip
Power Washer	1 x 50 hp

The emission factors used for the Enfield ILC air assessment are presented in **Table 5.3**.

Table 5.3: Emission Factors for sources at Enfield ILC and adopted for SIMTA proposal

Equipment	NO_x Emission Factor	PM_{10} Emission Factor	Source
Locomotives	35.6 g/L (Fuel Consumption = 14 L/hour)	1.35 g/L	Estimate based on NPI (Aggregated Emissions from Railways) and controls in USEPA420-F-97-051
Trucks (moving on-site)	16.019 g/km	0.804 g/km	2002 from M5 East AQMP (Congested Road)
Trucks (idling on-site)	16.019 g/km	0.804 g/km (assumed to be half those for moving trucks)	2002 from M5 East AQMP (Congested Road)
Gantry Cranes	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Reach Stackers	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Container Forklifts	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Large Forklifts	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Empty Container Forklifts	2.8 g/hp-hr	0.4 g/hp-hr	USEPA Tier 3
Small LPG Forklifts	3.3 g/hp-hr	0.72 g/hp-hr	Table 8, Environment Australia (2003)
Power Washer	5 g/hp-hr	0.6 g/hp-hr	USEPA Tier 2
Staff Cars	1.513 g/km	0.031 g/km	2002 from M5 East AQMP (Congested Road)

The source of the Emissions Factors were reviewed and determined to be suitable for use in the Moorebank assessment. It is noted that emission factors are regularly updated and some of the factors presented in SKM (2005) may have been updated.

For example, the National Pollution Inventory (NPI) Emission Estimation Manual for Combustion Engines was updated in June 2008, and the emission factor for LPG industrial vehicles 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 considered suitable to retain the Emission Factors used for the operation of the Enfield ILC.

5.2.1 Assumptions used for operations at SIMTA Proposal

The emission estimates for the operation of the SIMTA proposal have been derived using the operational data for the Enfield ILC, in the absence of operational data for Moorebank. The number of container TEUs handled per annum at Enfield is about 30% of the SIMTA proposal.

There are also expected to be advances in rolling stock servicing the SIMTA proposal which adds a level of conservatism to the emissions estimates.

Emissions from all activities at the SIMTA proposal, with the exception of the locomotives idling and LPG forklifts, were scaled based on the ratio of container throughput at Moorebank compared to Enfield (i.e. 3.3). The emissions from locomotives idling were not scaled on the assumption that no more than 2 trains (each with 3 locomotives) would operate on the proposed rail siding within the site for any given hour. This is a conservative worst case scenario that assumes all six locomotives would be idling continuously for any one hour period.

The emissions from LPG forklifts were scaled by the ratio of total area of warehousing at Moorebank and Enfield (i.e. 57,000 divided by 250,000).

Truck movements have been treated slightly differently for the operation of SIMTA proposal. The assessment for Enfield separated emissions from trucks on the wider road network with those from trucks moving on-site. The approach taken for this assessment is to aggregate both on-site and off-site truck movements. It is assumed that if the SIMTA proposal is operational, trucks that would normally travel along the M5 to and from Port Botany, would enter Moorebank Avenue and travel to the site. It is assumed that the total return trip distance along Moorebank Avenue and entering the site would be approximately 6 km.

The total truck movements of 80 per hour is based on the truck numbers presented for Enfield for the busiest hour of operation and scaled upwards by 3.3 to account for the increase in container TEUs. The number of truck movements per hour appears sensible based on a maximum throughput of 1,000,000 TEUs per annum. For example, if you assume 50% of the trucks are semi-trailers and 50% are b-doubles, the total trucks required to shift 1,000,000 TEUs would be 750,000. This equates to 86 trucks per hour, assuming a 24-hour, 7 days a week operation.

However, it is noted that 1,000,000 TEUs per annum is the maximum capacity of the SIMTA proposal once it is completed and in full operation.

Staff vehicles (small petrol vehicles) were not included in the emission inventory as these were identified as an insignificant source at Enfield, for both NO_x and PM_{10}, when compared to the site emission as a whole.

For the energy based emission factors (g/hp-hr) the total energy used is based on maximum rated engine power (hp), hours of operation (1) and a load factor of 0.2 (based on Table 5 of **DEWHA, 2008**). The Emission Inventory for Moorebank is presented in **Table 5.4**.

Table 5.4: Emissions Inventory for Moorebank - NO_x and PM

Source	NO_x Emission Factor	PM Emission Factor	Intensity	Number of Sources at Enfield	Total NO_x Emission Rate (Enfield) (g/s)	Total PM Emission Rate (Enfield) (g/s)	Scaled NO_x Emission Rate for Moorebank (g/s)	Scaled PM Emission Rate for Moorebank (g/s)	Scaled NO_x Emission Rate for Moorebank per Source (g/s)	Scaled PM Emission Rate for Moorebank per Source (g/s)	Source Allocation (refer Figure 6.1)
Loco 90 Class	35.6 (g/L)	1.35 (g/L)	14 (L/hour)	3	0.415	0.016	0.415	0.016	0.138	0.005	14 to 16
Loco 81 Class	35.6 (g/L)	1.35 (g/L)	14 (L/hour)	2	0.277	0.011	0.277	0.011	0.092	0.004	14 to 16
Truck idling	16.019 (g/km)	0.804 (g/km)	1.5 (km)	24	0.160	0.004	0.534	0.013	0.107	0.003	9 to 13
Container forklifts	2.8 (g/hp-hr)	0.4 (g/hp-hr)	345 (hp)	3	0.161	0.023	0.537	0.077	0.067	0.010	23 to 30
Large forklifts in warehouse areas	2.8 (g/hp-hr)	0.4 (g/hp-hr)	345 (hp)	4	0.215	0.031	0.716	0.102	0.089	0.013	23 to 30
Large forklift on empty containers	2.8 (g/hp-hr)	0.4 (g/hp-hr)	200 (hp)	6	0.187	0.027	0.622	0.089	0.078	0.011	23 to 30
Reach Stacker	2.8 (g/hp-hr)	0.4 (g/hp-hr)	320 (hp)	2	0.100	0.014	0.332	0.047	0.041	0.006	23 to 30
Gantry Crane	2.8 (g/hp-hr)	0.4 (g/hp-hr)	600 (hp)	3	0.280	0.040	0.933	0.133	0.117	0.017	23 to 30
Power Washer	5 (g/hp-hr)	0.6 (g/hp-hr)	50 (hp)	1	0.014	0.002	0.046	0.006	0.006	0.001	23 to 30
LPG forklifts in warehouses	3.3 (g/hp-hr)	0.72 (g/hp-hr)	50 (hp)	40	0.367	0.080	1.608	0.351	0.268	0.058	17 to 22
Trucks on Moorebank Avenue and moving within site	16.019 (g/km)	0.804 (g/km)	480 (VKT)	N/A	N/A	N/A	2.136	0.107	0.164	0.008	1 to 13

5.2.2 Modelling Scenarios

A modelling scenario for the Concept Plan operation of the SIMTA proposal has been developed, based on the busiest hour at the Enfield ILC and scaled according to the increased throughput. All sources are assumed to be operating at the locations shown in **Figure 5.1** for the worst case modelling hour, as follows;

- Source locations 1 - 13 - trucks travelling.
- Source locations 9 – 13 - trucks idling.
- Source locations 14 – 16 - diesel locomotives idling.
- Source locations 17 – 22 - LPG forklifts in warehouses.
- Source locations 23 – 30 – container forklifts, cranes and stackers.

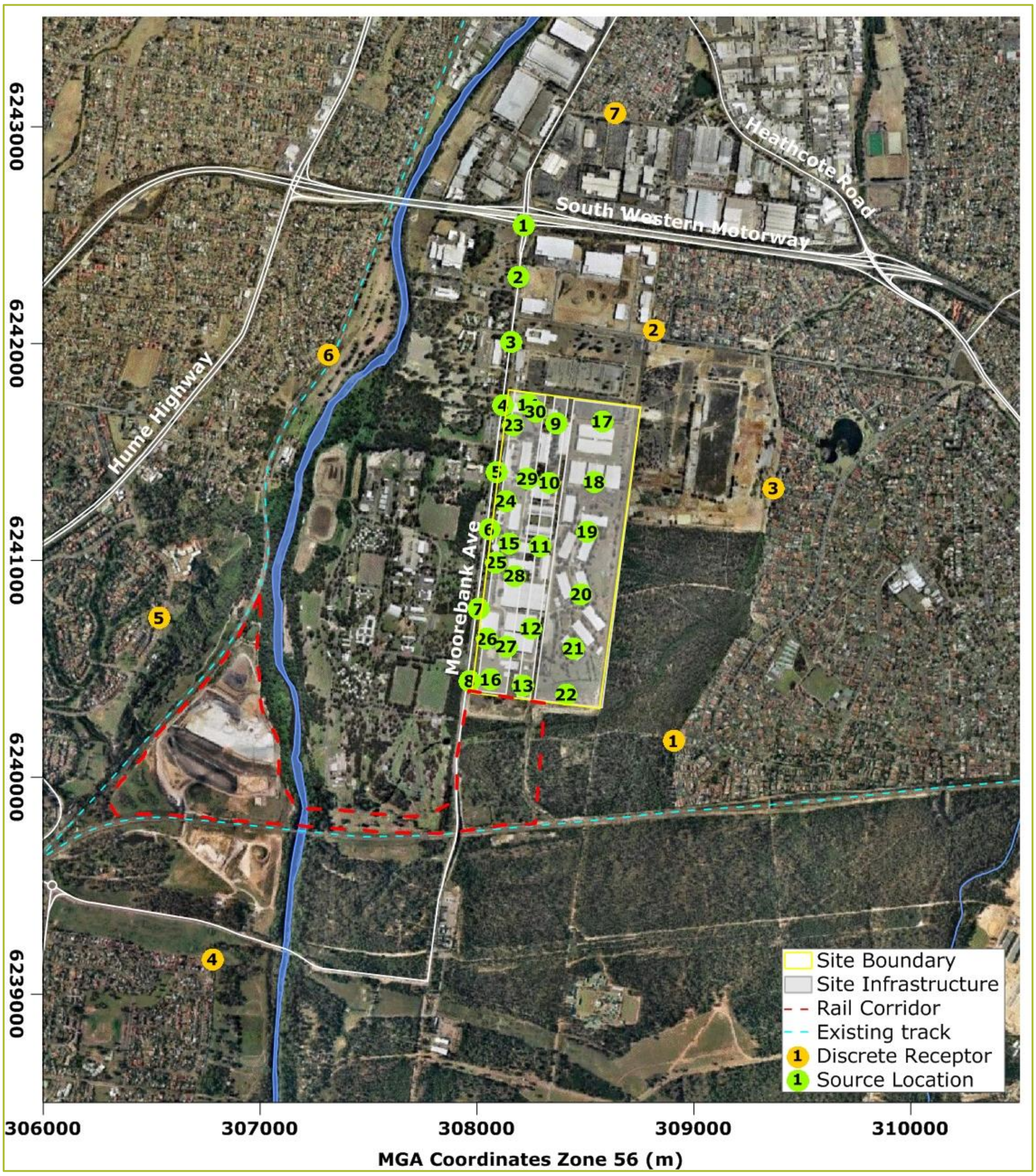


Figure 5.1: Location of sources and discrete receptors for modelling

5.3 Trains Entering and Leaving the Site

Trains will enter the SIMTA site via a rail link within the rail corridor. The exact rail alignment within the rail corridor land is yet to be determined and will be subject to a separate Project Application; however, it will connect to the SSFL to the west of the SIMTA site.

The proposed rail link will be located over 600 m from the closest residential areas to the south (along Goodenough Street) and over 300 m from the closest residential areas to the west (along Leacocks Lane). The SIMTA proposal would accommodate up to 21 train movements per day.

On the basis of these separation distances and the infrequent and transient nature of the train movements (~ one per hour), emissions from locomotives entering and leaving the site are not expected to be significant. While train movements may result in short-term peaks of pollutants (less than a few minutes), emissions would quickly disperse to concentrations that would be unlikely to cause exceedances of air quality goals, considering minimum averaging periods of 1 hour for most pollutants.

6 MODELLING RESULTS

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 Users Manual (**VIC EPA, 2000**) were used in accordance with the OEH Approved methods (**NSW DEC, 2005**).

6.1 NO_2

The results of the modelling predictions for NO_2 for the Concept Phase operation of the site are presented in **Table 6.1**. The predicted incremental NO_x from the SIMTA proposal is presented, as is the total NO_2 (OLM conversion method) using background monitoring data collected at the Liverpool monitoring site.

The results indicate that the NO_2 concentrations are less than the relevant impact assessment criteria for all averaging periods at all receptors.

Table 6.1: Predicted NO_2 Concentrations

	Predicted Incremental NO_x Concentration (µg/m^3)		Derived Total NO_2 Concentration (µg/m^3) (using OLM)	
	1-hour maximum	Annual average	1-hour maximum	Annual average
Receptor 1	218	21	124	20
Receptor 2	284	21	111	21
Receptor 3	173	18	109	20
Receptor 4	344	2	109	17
Receptor 5	151	4	145	18
Receptor 6	222	8	144	19
Receptor 7	182	7	109	17
Criteria			**246**	**62**

Time series plots of the hourly predictions of NO_x and NO_2 for each receptor are presented in **Figure 6.1**.

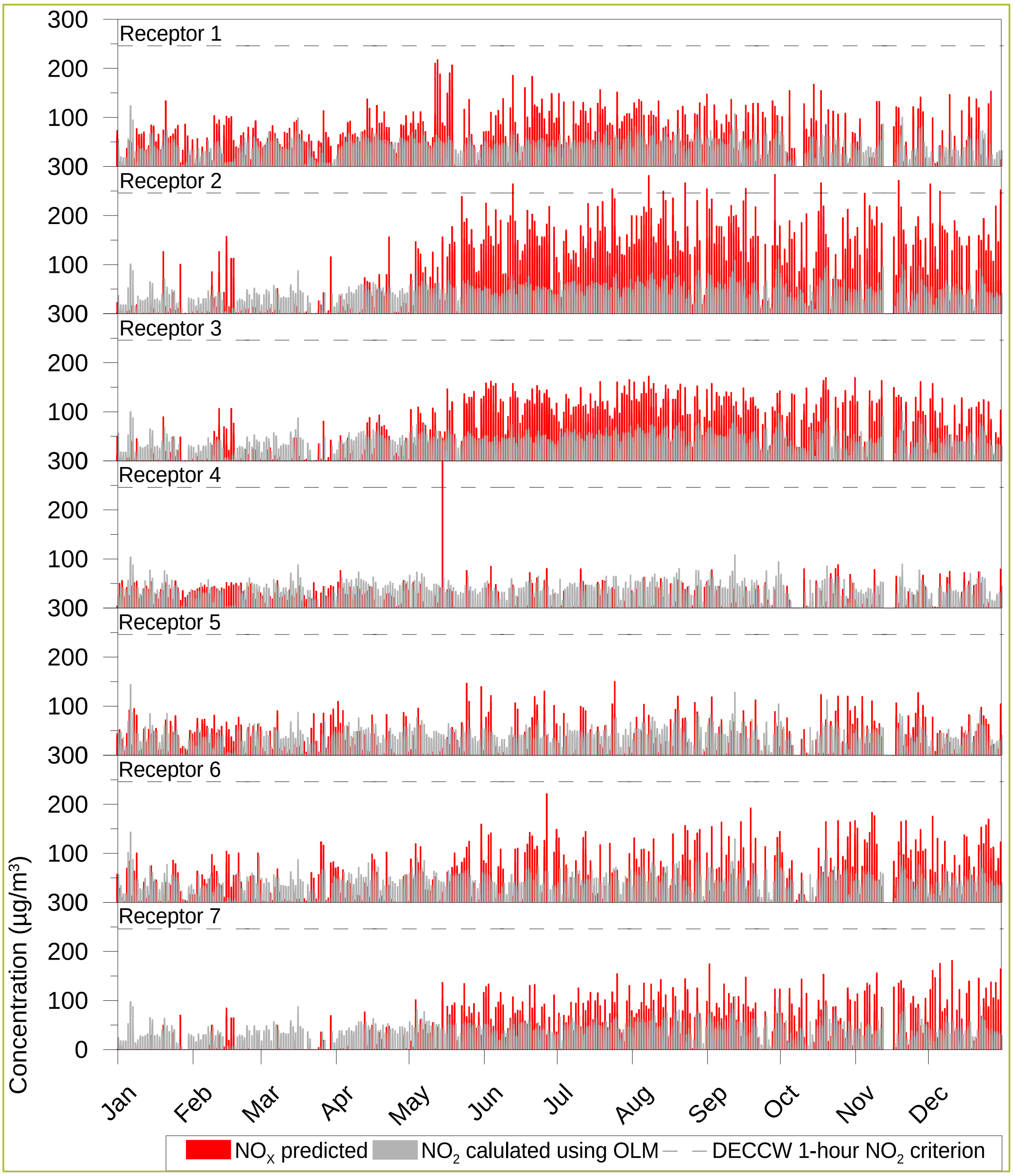


Figure 6.1: Time Series of the Predicted NO_x and NO_2 at each receptor

6.2 Particulate Matter (PM)

The results of the modelling predictions for PM for the full operation of the SIMTA proposal are presented in **Table 6.2**. The predicted incremental PM from the SITMA proposal is presented and compared to air quality criteria for PM_{10} and advisory report standards for $PM_{2.5}$. Greater than 90% of diesel exhaust emissions are in the <$PM_{2.5}$ size range (**Watson et al, 2000**), however, there are no impact assessment criteria in NSW for $PM_{2.5}$. The NSW OEH prescribes impact assessment criteria for PM_{10} only and while the Ambient Air NEPM has adopted advisory reporting standards for $PM_{2.5}$, these are not applicable for compliance or assessing impacts for new development.

The maximum predicted incremental 24-hour PM concentration is approximately 8 µg/m^3 which is 16% of the impact assessment criteria for PM_{10} and 32% of the advisory reporting standard for $PM_{2.5}$.

Table 6.2: Predicted Incremental Particulate Matter Concentrations

Receptor	24-Hour Average	Annual Average
Receptor 1	7.0	1.5
Receptor 2	7.7	1.8
Receptor 3	7.8	2.0
Receptor 4	2.1	0.3
Receptor 5	3.1	0.5
Receptor 6	3.7	0.7
Receptor 7	3.0	0.5
Impact Assessment Criteria for PM_{10}	**50**	**30**
Advisory Report Standards for $PM_{2.5}$	**25**	**8**

6.2.1 Cumulative Impacts

The results in **Table 6.2** are presented as incremental increases from the SIMTA proposal alone. To assess impacts against the relevant air quality standards and goals, it is necessary to have information on the background concentrations to which the SIMTA proposal is likely to contribute. When considering background pollutant concentrations it is sensible to exclude days when the goals are already exceeded due to, for example, dust storms or bushfires. The approach is to determine if any additional exceedances would occur as a result of the SIMTA proposal operations, as recommended in the OEH Approved Methods.

Time series plots of the predicted daily PM concentrations are presented in **Figure 6.2** to **Figure 6.8**, added to background PM_{10} concentrations for each day. The plots show that the addition of the SIMTA proposal does not result in any additional exceedances of the 24-hour PM_{10} impact assessment criteria.

It is also noted that the addition of the highest annual average PM concentrations (2.0 µg/m^3) to the background PM_{10} concentrations at Liverpool (26 µg/m^3), does not result in an exceedance of the impact assessment criteria.

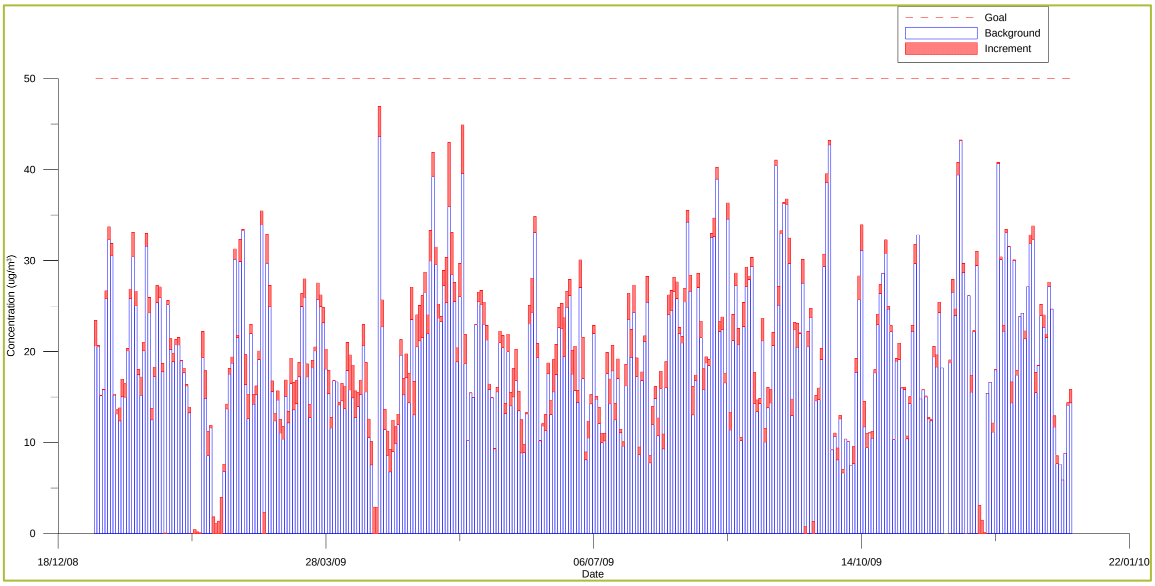


Figure 6.2: Daily Predictions for Receptor 1 with PM_{10} background

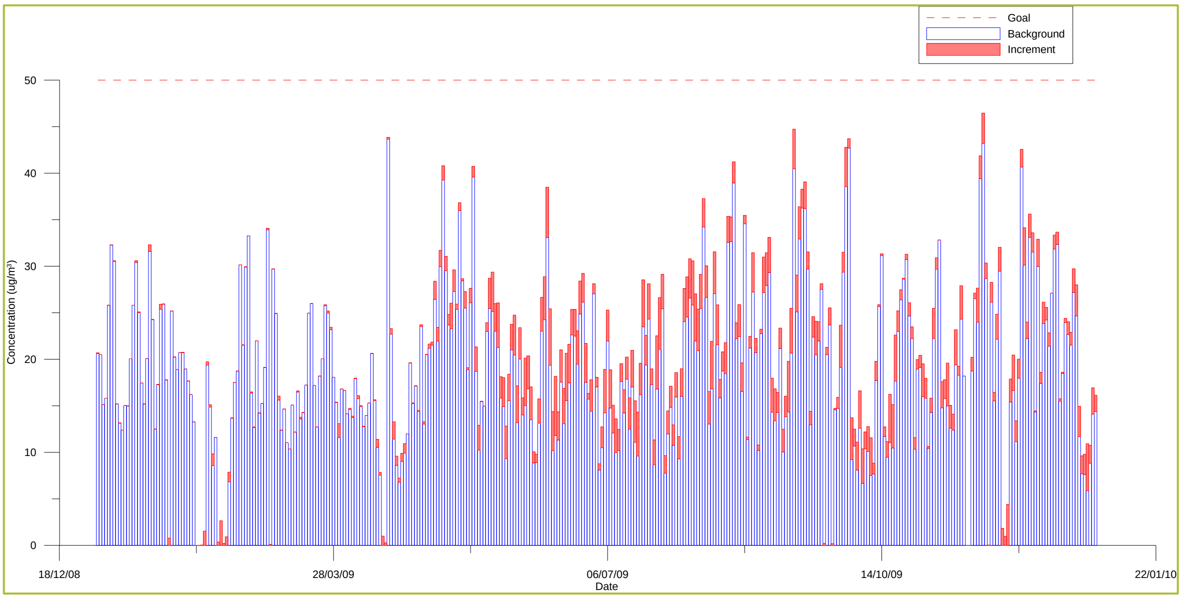


Figure 6.3: Daily Predictions for Receptor 2 with PM_{10} background

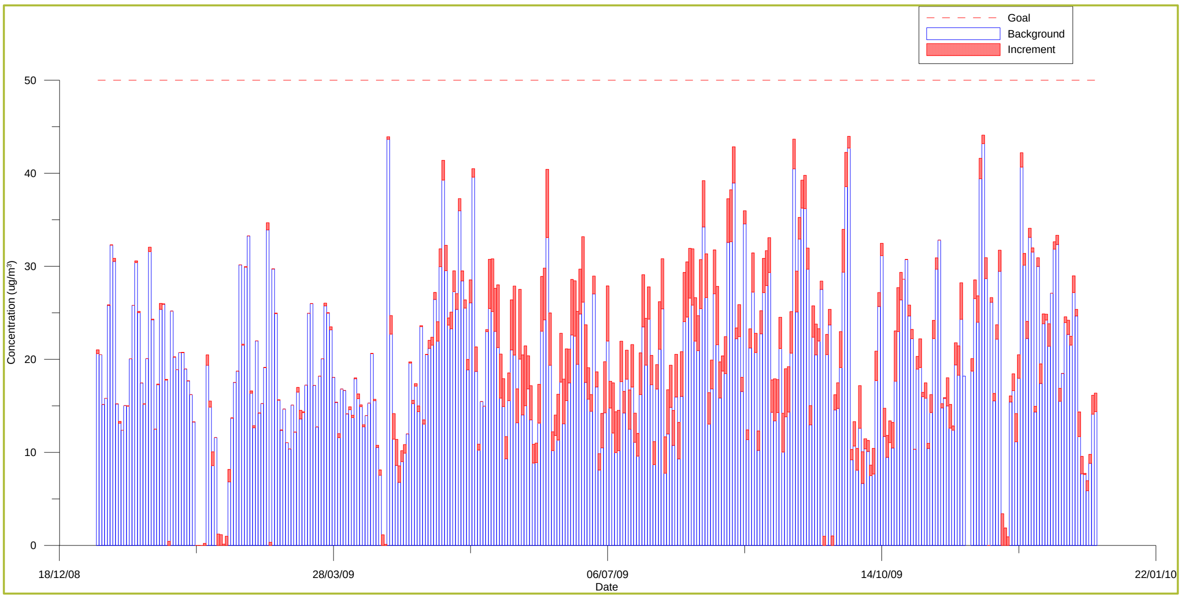


Figure 6.4: Daily Predictions for Receptor 3 with PM_{10} background

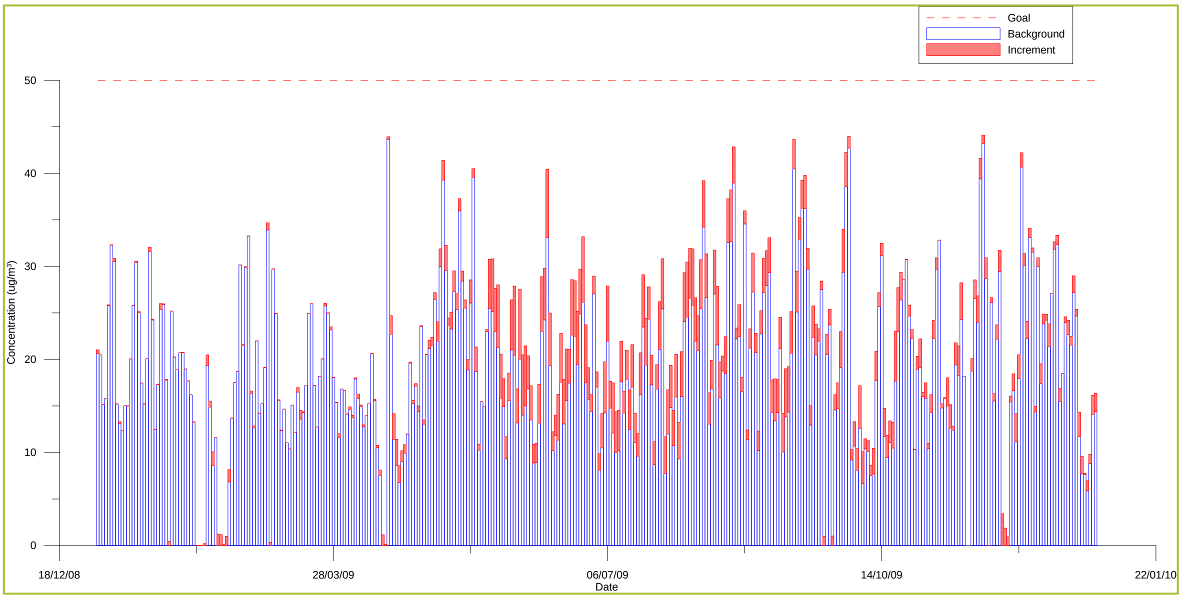


Figure 6.5: Daily Predictions for Receptor 4 with PM_{10} background

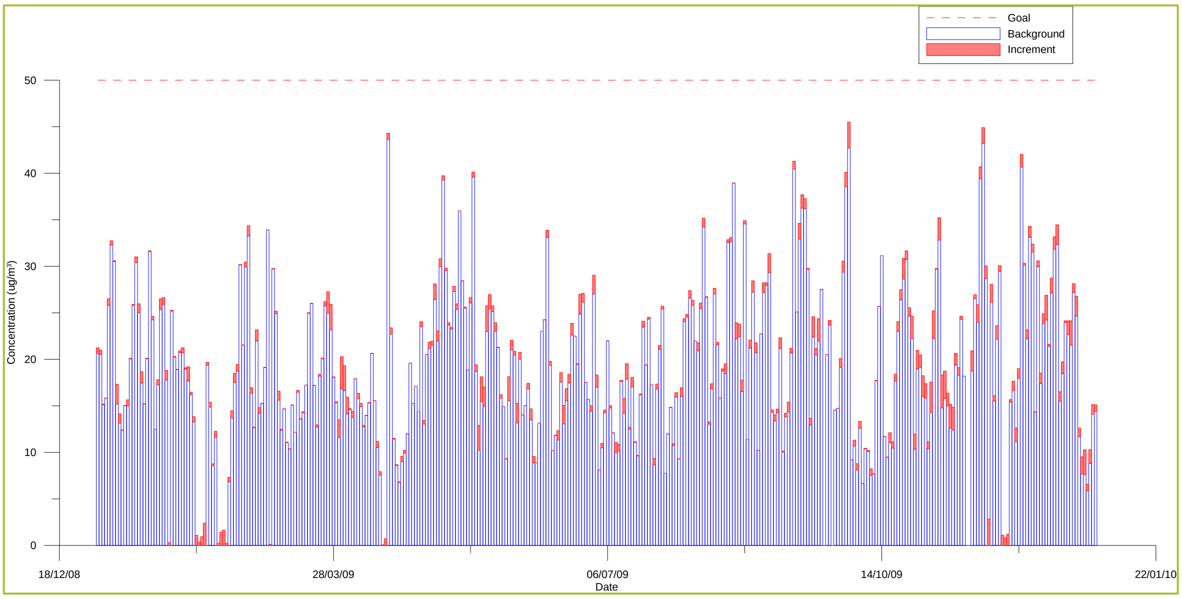


Figure 6.6: Daily Predictions for Receptor 5 with PM_{10} background

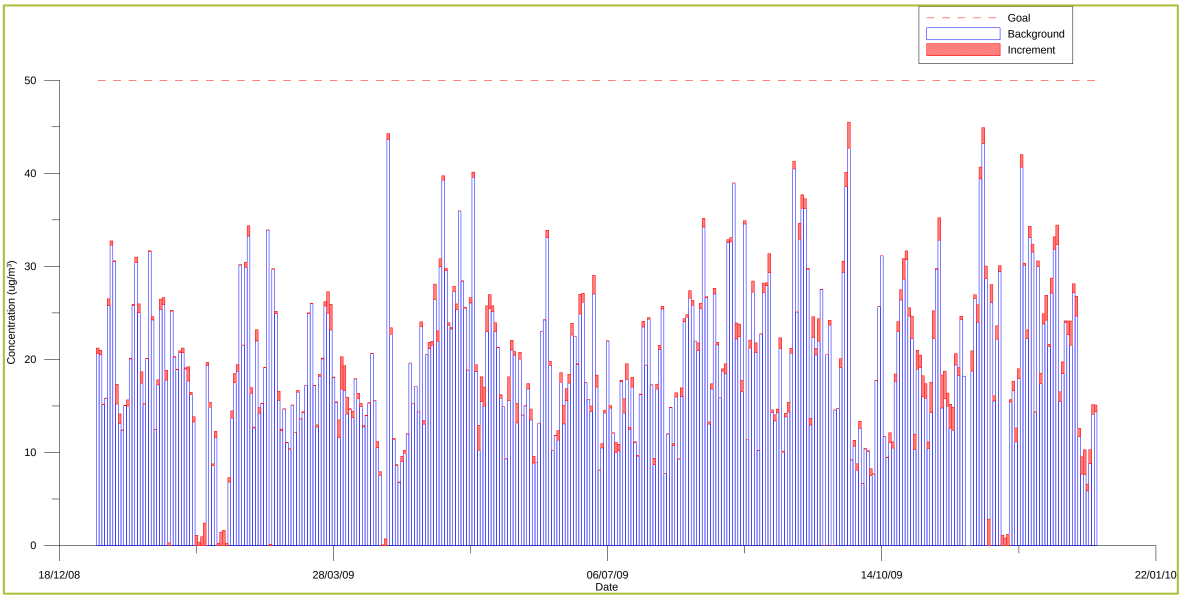


Figure 6.7: Daily Predictions for Receptor 6 with PM_{10} background

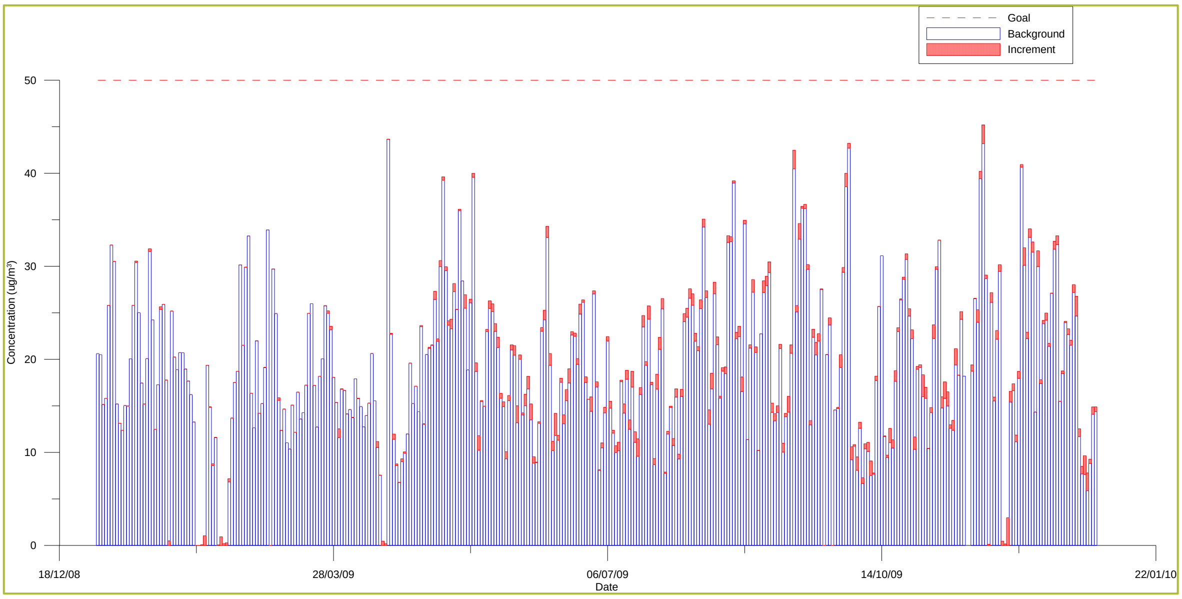


Figure 6.8: Daily Predictions for Receptor 7 with PM_{10} background

A time series of the predicted daily PM concentrations are presented in **Figure 6.9** to **Figure 6.15**, added to background $PM_{2.5}$ concentrations for each day. The plots show that the addition of the SIMTA proposal may result in additional occurrences above the 24-hour $PM_{2.5}$ advisory reporting standards. This is discussed further below.

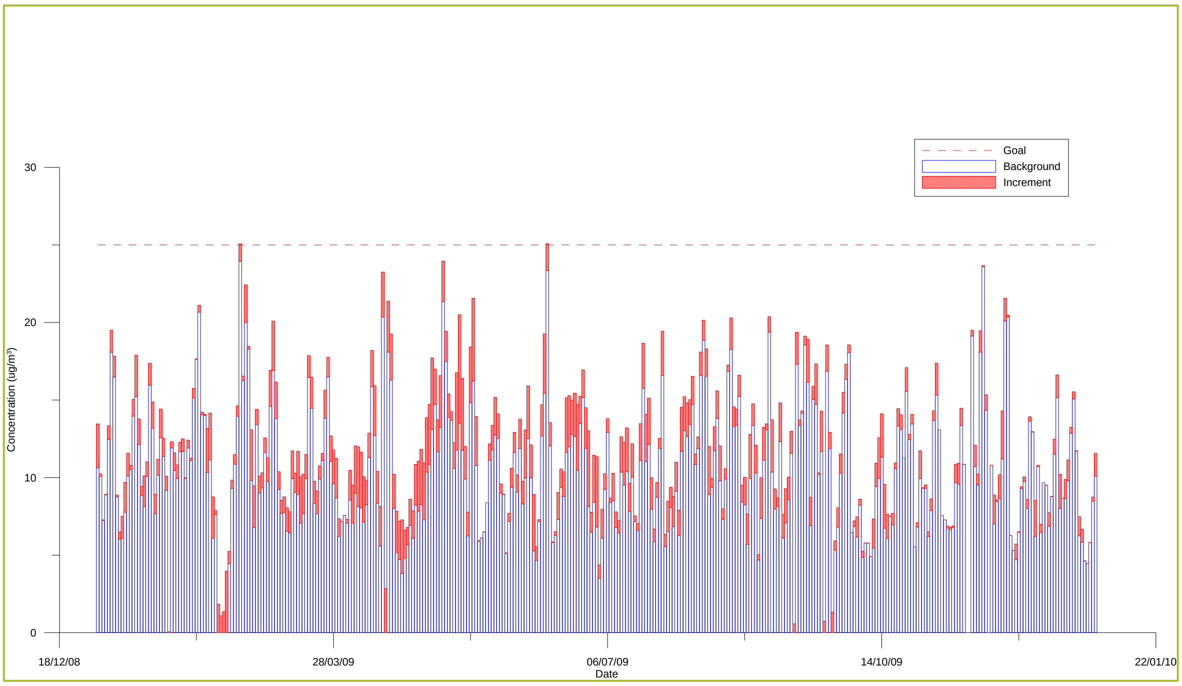


Figure 6.9: Daily Predictions for Receptor 1 with $PM_{2.5}$ background

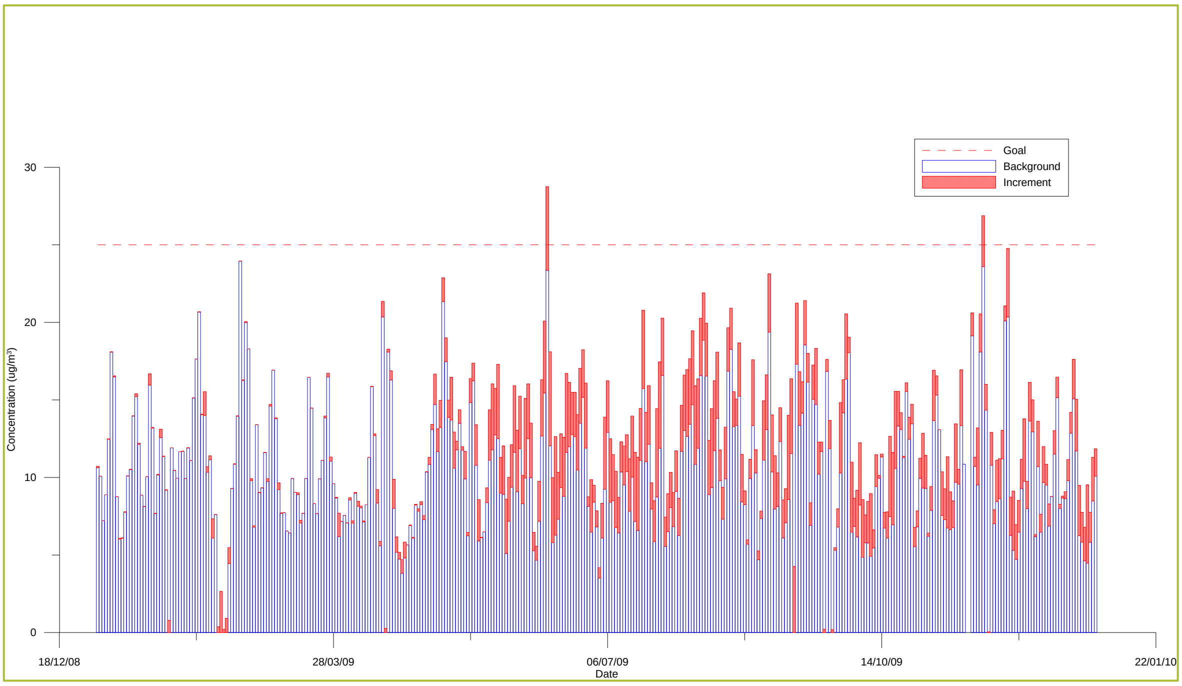


Figure 6.10: Daily Predictions for Receptor 2 with $PM_{2.5}$ background

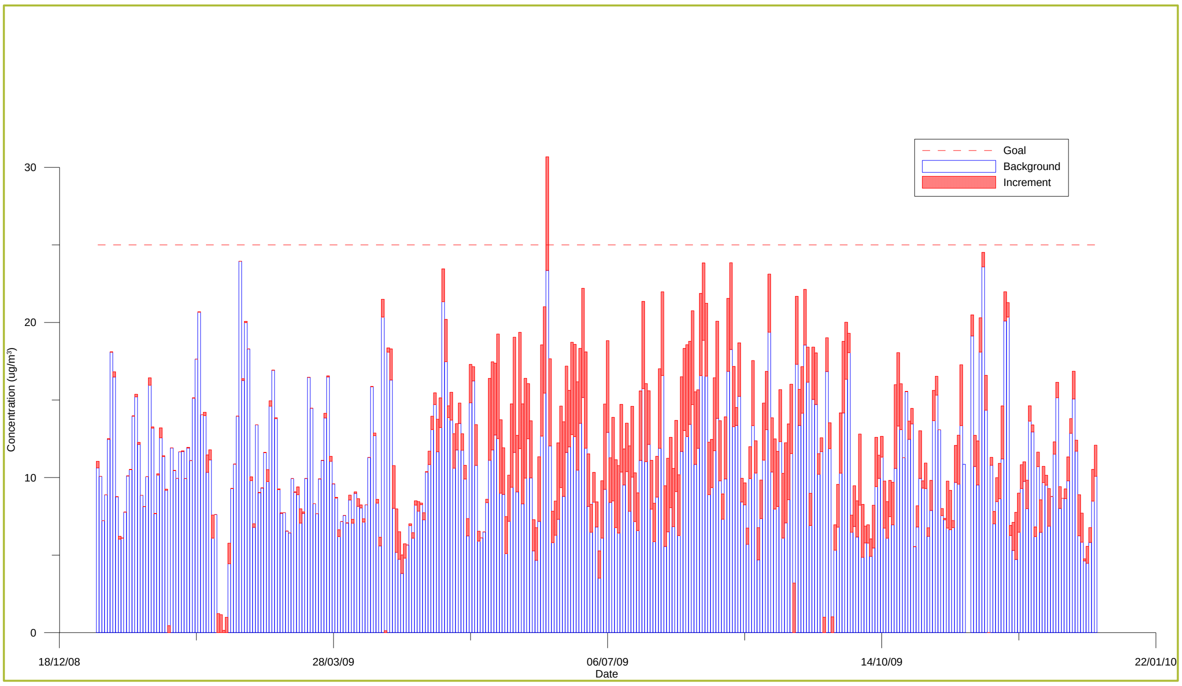


Figure 6.11: Daily Predictions for Receptor 3 with $PM_{2.5}$ background

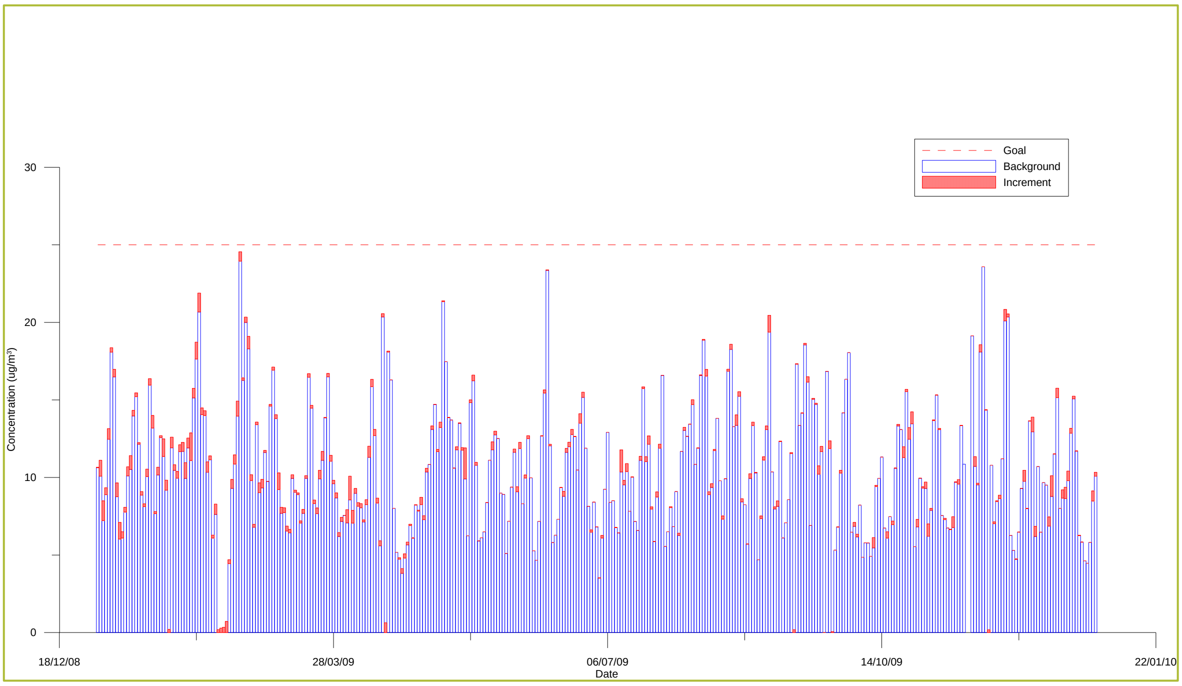


Figure 6.12: Daily Predictions for Receptor 4 with $PM_{2.5}$ background

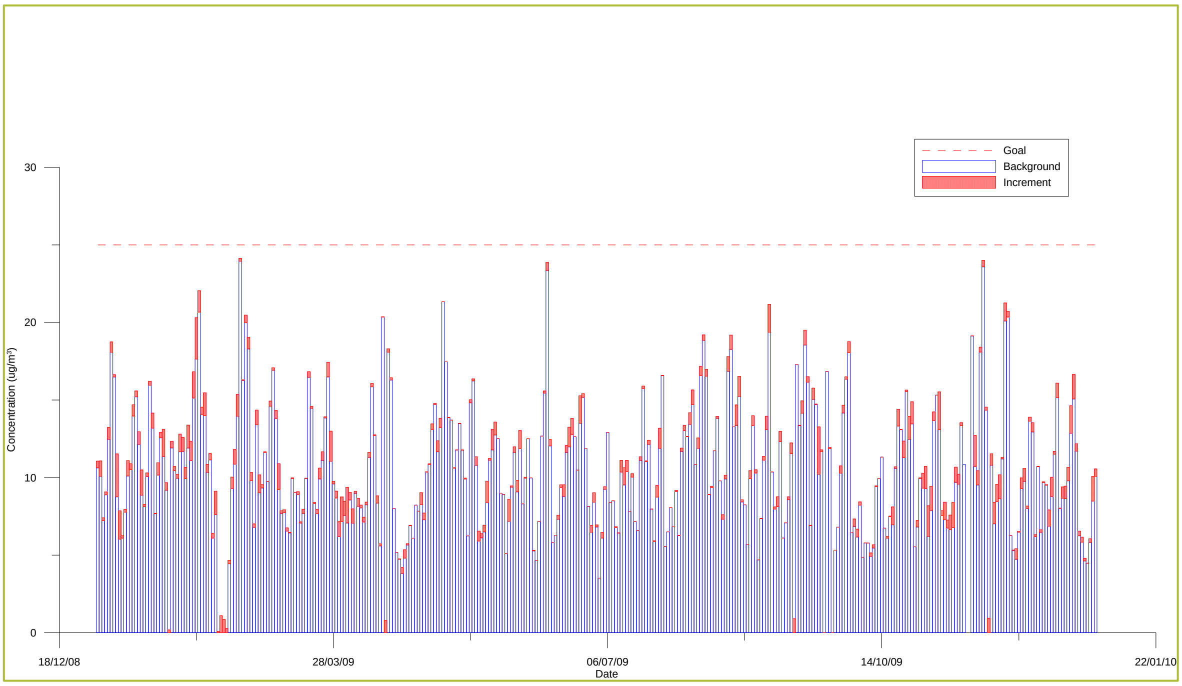


Figure 6.13: Daily Predictions for Receptor 5 with $PM_{2.5}$ background

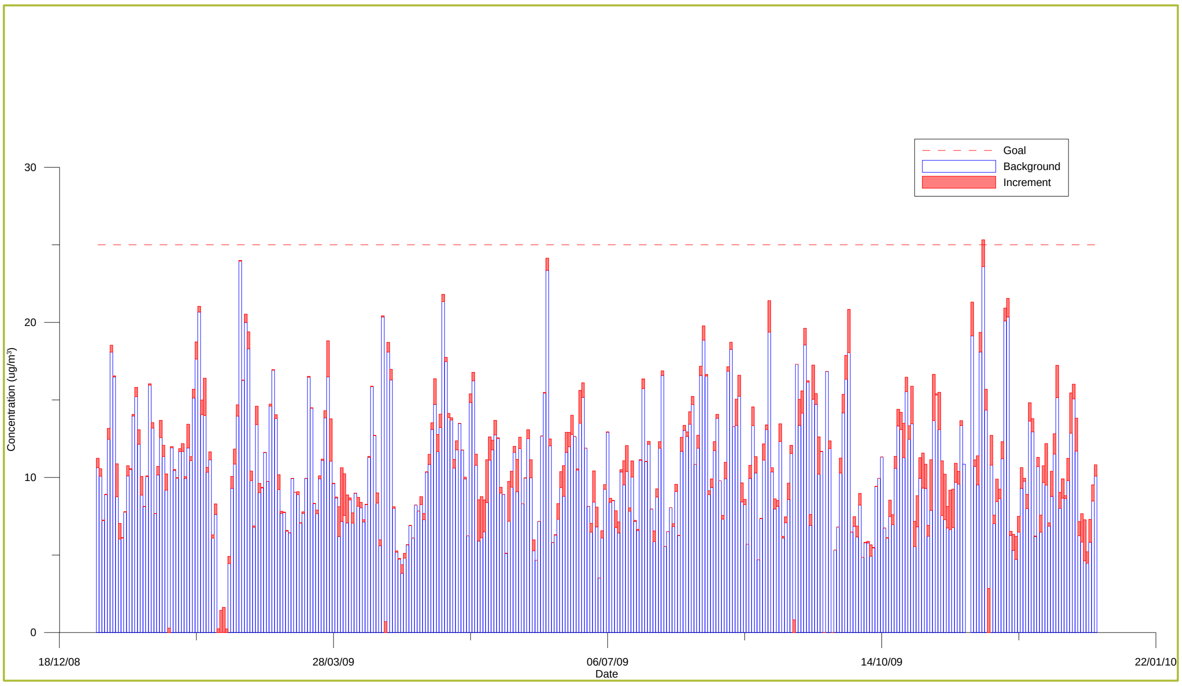


Figure 6.14: Daily Predictions for Receptor 6 with $PM_{2.5}$ background

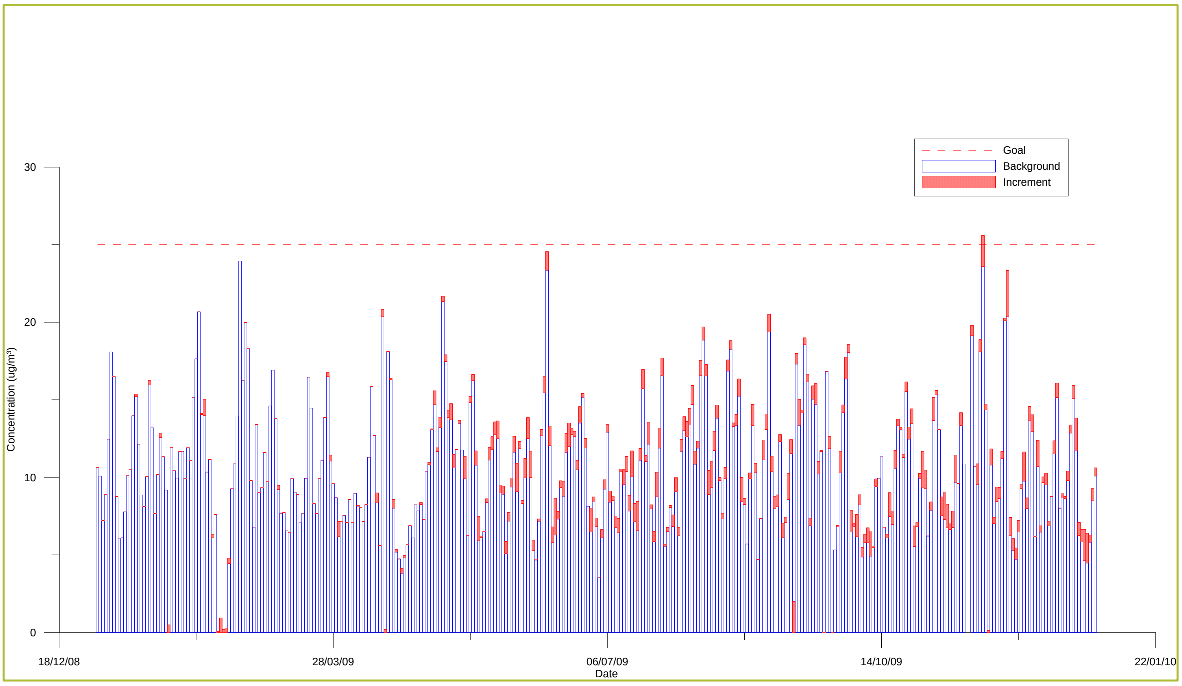


Figure 6.15: Daily Predictions for Receptor 7 with $PM_{2.5}$ background

No additional occurrences above the NEPM advisory reporting guidelines for $PM_{2.5}$ are predicted to occur at Receptor 1, Receptor 4, Receptor 5 and Receptor 6. There are two days at Receptor 2 and one day at Receptor 3 and 7 where the predictions are above the NEPM advisory reporting guideline. It is clear from the plots, however, that the additional exceedances occur on days when the background is already high. When the NEPM advisory reporting standards were set, there was insufficient information available to set a health based standard for $PM_{2.5}$.

Significant progress has been made since 2003 and the Air NEPM is currently under review in Australia. The US Environmental Protection Agency (EPA) is also currently reviewing their National Ambient Air Quality Standards (NAAQS) for criteria pollutants, including particulate matter. The latest review of the NAAQS is currently underway and the status of review is outlined in their document '*Policy Assessment for the Review of the Particulate Matter National Ambient Air Quality Standards – Second External Review Draft*', June 2010 (**US EPA, 2010**).

The current US EPA NAAQS for particulate matter, which were last reviewed in 2006, are as follows:

- PM_{10} 24-hour Average – 150 $\mu g/m^3$.
- $PM_{2.5}$ 24-hour Average – 35 $\mu g/m^3$.
- $PM_{2.5}$ Annual Average – 15 $\mu g/m^3$.

The latest review is considering a revision to the annual $PM_{2.5}$ standard in the range of 11 $\mu g/m^3$ to 13 $\mu g/m^3$ in conjunction with retaining the current 24-hour $PM_{2.5}$ standard of 35 $\mu g/m^3$. Consideration is also being given for a review of the 24-hour $PM_{2.5}$ standard down to 30 $\mu g/m^3$ in conjunction with the alternative annual standard of 11 $\mu g/m^3$.

When compared against the current US EPA goals for $PM_{2.5}$ the concept phase operation of the proposed SIMTA proposal would not result in exceedances for either averaging period at any receptor.

7 REGIONAL AIR QUALITY IMPACTS

The operation of the SIMTA proposal is expected to have a net positive impact on regional air quality and result in an overall reduction in emissions to airshed. The operation of the SIMTA proposal is expected to reduce the vehicle kilometres travelled (VKT) by heavy freight traffic in Sydney, reducing the demand for freight truck movements between Port Botany and Moorebank, and by substituting freight transport by truck with rail transport to and from Port Botany.

The SIMTA proposal is expected to handle 1,000,000 container TEUs per annum at full operating capacity. Approximately 500,000 TEUs will be delivered from Port Botany by rail, where they would be unloaded, unpacked, warehoused and then distributed by truck to destinations around Sydney. Containers will either be returned to Port Botany empty or re-loaded with export freight. Each train will transport up to 80 TEUs with a capacity for the SIMTA proposal of up to 21 train movements per day. This equates to up to 1680 TEUs per day which would otherwise be transported by truck.

Whilst we do not have sufficient details at this time for detailed analysis of activity data, (fleet profiles, origin and destination of freight / goods, total VKT, time spent idling, locomotive time in mode, average speeds), needed to quantify the improvements to regional air quality, the replacement of road freight transport by rail is expected to achieve a reduction in the mass of key pollutants including NO_x and particulate matter release into the airshed.

An additional benefit will be a reduction in heavy goods vehicle traffic using the M5 Corridor, which is operating at or near capacity in peak hours, and assist in managing projected industrial growth at Port Botany.

8 CONCLUSIONS

This air quality assessment has been prepared as part of the EA documentation to support and assess the environmental impacts of the concept plan for an Intermodal facility at the SIMTA site (formally known as the DNSDC site). As the SIMTA proposal will be constructed in several stages which are subject to future Project Application design detail, this air quality assessment has considered the overall impacts of SIMTA proposal based on operational details for a similar intermodal facility at Enfield and scaled to account for an expected increase in capacity.

Dispersion modelling was used for the Concept Plan operation of the site for key pollutants including NO_2 and particulate matter (PM).

The results of the modelling predictions for NO_2 for overall operation of the site indicate that the NO_2 concentrations are less than the relevant impact assessment criteria for all averaging periods at all receptors.

Particulate Matter (PM) modelling predictions were made for overall 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 at residences are approximately 8 $\mu g/m^3$, which equates to 16% of the impact assessment criteria for PM_{10} and 32% of the advisory reporting standard for $PM_{2.5}$. Cumulative impact assessment shows that the addition of the PM from the SIMTA proposal to background PM_{10} does not result in an exceedance of the 24-hour or annual PM_{10} impact assessment criteria.

Impact assessment criteria are not prescribed for $PM_{2.5}$, however, the addition of the PM from the SIMTA proposal to the background $PM_{2.5}$ may result in additional occurrences above the 24-hour $PM_{2.5}$ NEPM advisory reporting standards. However, it is noted that the modelling is based on the busiest hour of operation at the site, and applying this for averaging periods of 24 hours and longer will result in a conservative over prediction of impacts.

The operation of the SIMTA proposal is expected to have a net positive impact on regional air quality by reducing the overall emissions to airshed.

8.1 Recommendations

A worst case assessment of the operation of the SIMTA proposal at maximum capacity indicates that air quality goals will not be comprised at surrounding residential areas. Notwithstanding this it is recommended that all feasible and reasonable measures are taken to minimise potential impacts on local and regional air quality. These measures should include:

- Consideration of advances in rolling stock servicing the SIMTA proposal.
- Consider the use of electrically powered container handling equipment in lieu of diesel equipment where possible.
- Consider the use of LPG forklifts in lieu of diesel forklifts where possible.
- Minimise truck movements through the efficient management of deliveries and dispatches.
- Minimise truck idling and queuing on-site.
- Construction dust mitigation measures should be considered as part of future Project Application construction management plans.

9 REFERENCES

Best, P.R., Lunney, K.E., Killip, C. (2000). Averaging Time Corrections for Estimating Extreme Air Quality Statistics. Presented at the 15th International Clean Air Conference, Sydney Australia, November 2000.

DEWHA, 2008 Department of Environment, Water, Heritage and the Arts "Emission estimation technique manual for Railway yard operations" (version 2.0), June 2008.

Lilley W.E. (1996) "Quantification and dispersion modelling of diesel locomotives emissions" submitted to the Department of Geography University of Newcastle in partial fulfilment of the requirements for the degree of Bachelor of Science with Honour.

NEPC (1998). National Environmental Protection (Ambient Air Quality) Measure Environment Protection and Heritage Council, as amended 7 July 2003.

NSW DEC (2005) "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW", August 2005.

NSW DECCW (2009) NSW Department of Environment, Climate Change and Water, "Action for Air, 2009 Update".

Powell (1976) "A Formulation of Time-varying Depths of Daytime Mixed Layer and Nighttime Stable Layer for use in Air Pollution Assessment Models", Annual Report for 1976 Part 3, Battelle PNL Atmospheric Sciences, 185-189.

QLD EPA (2010) Queensland Environmental Protection Agency website accessed on http://www.derm.qld.gov.au

SKM (2005) "Intermodal Logistics Centre at Enfield. Environmental Impact Assessment – Air Quality Assessment Final" 22 June 2005.

Tikvart, J.A. (1996) Application of Ozone Limiting Method, Model Clearinghouse Memorandum NO. 107, US Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, USA.

US EPA (2000) "Meteorological Monitoring Guidance for Regulatory Modelling Applications" Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711, February 2000.

US EPA (2010) "*Policy Assessment for the Review of the Particulate Matter National Ambient Air Quality Standards – Second External Review Draft*", Office of Air Quality Planning and Standards, Health and Environmental Impacts Division, U.S. Environmental Protection Agency, Research Triangle Park, NC, June 2010.

Venkatram (1980) "Estimating the Monin-Obukhov Length in the Stable Boundary Layer for Dispersion Calculations", Boundary-Layer Meteorology, Volume 19, 481-485.

VIC EPA (2000) "Ausplume Gaussian Plume Dispersion Model – Technical User Manual" Centre for Air Quality Studies, Environmental Protection Agency. Government of Victoria, November 2000.

Watson, J.G., Chow, J.C., Pace, T.G. (2000) Fugitive Dust Emissions in Air Pollution Engineering Manual, second ed, Air and Waste Management Association ed. W.T.Davis.

APPENDIX A

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
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

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

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