APPENDIX I

Air Quality Impact Assessment

Pacific Environment Limited

Consulting • Technologies • Monitoring • Toxicology

REPORT

AIR QUALITY ASSESSMENT FOR THE MODIFICATION OF THE OUTER HARBOUR DEVELOPMENT OF PORT KEMBLA

Port Kembla Port Corporation c/o AECOM

Job No: **7731**

31 May 2013

PROJECT TITLE: Air Quality Assessment for the Modification of the Outer Harbour Development of Port Kembla

JOB NUMBER: 7731

PREPARED FOR: Port Kembla Port Corporation c/o AECOM

APPROVED FOR RELEASE BY: J. Cox

DISCLAIMER & COPYRIGHT: This report is subject to the copyright statement located at www.pacific-environment.com © Pacific Environment Operations Pty Ltd ABN 86 127 101 642

DOCUMENT CONTROL

VERSION	DATE	PREPARED BY	REVIEWED BY
D1	24.05.2013	R. Kan	J. Cox
D2	27.05.2013	R. Kan	J. Cox
D3	30.05.2013	R. Kan/J.Cox	J. Cox
R1	31.05.2013	R. Kan/J.Cox	J. Cox

Pacific Environment Operations Pty ABN 86 127 101 642

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

Unit 1, 22 Varley Street
Yeerongpilly, Qld 4105
Ph: +61 7 3004 6460

ADELAIDE
35 Edward Street, Norwood SA 5067
PO Box 3187, Norwood SA 5067
Ph: +61 8 8332 0960
Fax: +61 7 3844 5858

PERTH
Level 1, Suite 3
34 Queen Street, Perth WA 6000
Ph: +61 8 9481 4961
Fax: +61 7 3844 5858

SYDNEY
Suite 1, Level 1, 146 Arthur Street
North Sydney, NSW 2060
Ph: +61 2 9870 0900
Fax: +61 2 9870 0999

MELBOURNE
Suite 62, 63 Turner Street, Port Melbourne VIC 3207
PO Box 23293, Docklands VIC 8012
Ph: +61 3 9681 8551
Fax: +61 3 9646 3408

GLADSTONE
Suite 2, 36 Herbert Street, Gladstone QLD 4680
Ph: +61 7 4972 7313
Fax: +61 7 3844 5858

EXECUTIVE SUMMARY

In March 2011, Port Kembla Port Corporation (PKPC) was granted Concept Plan Approval for the long-term master plan for the Outer Harbour (the Outer Harbour Development), and Major Project Approval for Stage 1 of the development under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This entailed the expansion of port side and landside facilities in the Outer Harbour of the Port.

PKPC is now seeking to modify its approval to accommodate an increase in the bulk cargo throughput handled at Port Kembla from 4.25 million tonnes per annum to 16 million tonnes per annum (the Project).

This air quality assessment follows the procedures outlined by the NSW EPA in its document titled "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (**EPA, 2005**) (referred to hereafter as Approved Methods).

Twenty one receptors were selected for the assessment. Estimation of air emissions from port operations (as modified) including ships, trains, trucks, CHEs and fugitive dust was completed for three scenarios: Major Projects (Stage 1), Concept Plan (Typical) and Concept Plan (Worst Case). Dispersion modelling was conducted to predict the ground level concentrations (glcs) for all relevant pollutants.

Dispersion modelling results indicate that for the Concept Plan Typical scenario and the Stage 1 scenario, the only residences that may exceed the EPA impact criteria for particulate matter due to the Project-alone and the cumulative assessment are the closest residences south of the site. There are no exceedances of the SO_2 and CO criteria as a result of the Project-alone or cumulatively. There is potential for ten residences to exceed the 1-hour average NO_2 criterion for the Concept Plan Worst Case scenario when the Project is considered cumulatively. No residences are predicted to exceed the 1-hour average NO_2 criterion for Stage 1 or Concept Plan Typical scenarios.

For the Concept Plan Worst Case scenario, a number of residences potentially exceed the EPA dust impact criteria. The main contribution for dust emissions is from the hauling of material on internal sealed roads. A conservative silt loading was applied to determine emissions from hauling on sealed roads for the Concept Plan Worst Case scenario. A sensitivity analysis of the silt loading factor indicated that with a lower silt loading, the predicted particulate concentrations at the receptors are reduced significantly.

PKPC propose to monitor the site specific silt loading factor for the internal roads once Stage 1 is operational. This will enable more accurate estimation of dust emissions from haulage on internal roads at the site prior to the implementation of Stage 2 and Stage 3.

A cumulative assessment of 24-hour average PM_{10} concentrations at the most affected receptor locations was completed at the most affected receptor locations. This concluded that there is potential for a number of exceedances of the 24-hour average PM_{10} impact assessment criterion during both Stage 1 and the Concept Plan Typical scenarios. As noted previously, the predicted concentrations are extremely sensitive to the assumed silt loading on the sealed roads within the site, and PKPC propose to collect data on the silt loading to provide more certainty in any future dispersion modelling. The air quality management plan committed to be developed under current approval and statement of commitments will be designed to minimise the potential for exceedances at the residences.

Potential impacts from construction were assessed qualitatively. The potential impacts from construction are expected to be managed in accordance with the current Construction Management Plan. The existing construction has not resulted in any recorded exceedances in monitoring data, or complaints from the residences.

Generally, the predictions presented in this report incorporate a level of conservatism due to worst case assumptions and the inherent conservative nature of dispersion modelling.

CONTENTS

FIGURES

TABLES

1 INTRODUCTION

In March 2011, Port Kembla Port Corporation (PKPC) was granted Concept Plan Approval for the long-term master plan for the Outer Harbour (the Outer Harbour Development), and Major Project Approval for Stage 1 of the development under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This entailed the expansion of port side and landside facilities in the Outer Harbour of the Port.

The Concept Plan outlines the progressive development of the Outer Harbour over a 25-30 year period, to be constructed in a series of three stages. As currently approved, the Outer Harbour Development would comprise dredging and reclamation for the creation of multi-purpose and container terminals within the Outer Harbour which would be capable of receiving Panamax sized vessels. The multi-purpose terminal would consist of three berths for the import and export of bulk cargo (4.25 million tonnes per annum) and general cargo (2 million tonnes per annum). The container terminal would consist of four berths with a combined throughput of up to 1.2 million twenty-foot equivalent units (TEUs) per annum.

The Concept Plan includes construction and operation of infrastructure associated with the port development, including land-side terminal facilities, upgrades to the existing freight rail infrastructure to the Outer Harbour and construction of a new road link from Christy Drive to Foreshore Road.

The Major Project encompasses construction and operation of Stage 1 of the Concept Plan. The key elements of Stage 1 include dredging and reclamation for the footprint of the total development (except the northern area of the multi-purpose terminal and the swing basin), construction and operation of one new multi-purpose terminal berth and construction of the first container berth. Associated infrastructure upgrades contained in the Major Project approval include rail infrastructure improvements in the South Yard and the construction of a portion of the new road link from Christy Drive.

Stages 2 and 3 of the Concept Plan would be subject to separate applications for approval at a later date.

In September 2011, approval was granted by the Planning Assessment Commission for a Cement Grinding Mill proposed by Cement Australia to be located on the western side of the central portion of the multi-purpose terminal. Construction of Stage 1 and the Cement Grinding Mill commenced in 2012. This construction is ongoing and includes the following elements:

- Initial reclamation of seven hectares of the central portion of the multi-purpose terminal operational area.
- Commencement of construction of the Cement Grinding Mill on the initial reclamation area.
- Access roads to service the multi-purpose terminal and Cement Grinding Mill have been designed for construction in 2013/2014.
- Stockpiling of material for the purposes of future reclamation works.
- Detailed design for the first multi-purpose berth and associated dredging and reclamation.

Due to growing customer demand and greater recognition of the strategic role of the Port as detailed in the Draft NSW Freight and Ports Strategy (**TfNSW, 2012**), PKPC is now seeking to modify its approval to accommodate an increase in the bulk cargo throughput handled at Port Kembla from 4.25 million tonnes per annum to 16 million tonnes per annum (the Project). This will be assessed and determined in accordance with Section 75W of the EP&A Act, and the Minister for Planning and Infrastructure (or his delegate) will be the approval authority for the proposed modification.

1.1 Objectives of the study

This assessment forms the technical report to cover air quality for the proposed modification. In December 2012, PKPC received Director-General's environmental assessment requirements (DGRs) relating to the proposed modification. The DGRs specify the following:

"Air Quality – including but not limited to:

- *A revised air quality assessment addressing changes in dust deposition, total suspended particulates and other atmospheric pollutants of concern for local and regional air quality, arising from fugitive and point sources (e.g. locomotives, wagons, ship exhausts, stockpiles, loading and unloading cargo, scrubbers) consequent to the proposed modification. The assessment is to take into account the 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW (DEC, 2005)'; and*
- *Potential increases in the intensity and duration of any odour from dredge spoil consequent to increased dredge volumes, and proposed odour control."*

This assessment follows the procedures outlined by the NSW EPA in its document titled "*Approved Methods for the Modelling and Assessment of Air Pollutants in NSW*" (**EPA, 2005**) (referred to hereafter as Approved Methods).

A detailed review of the air quality assessment completed for the previous Environmental Assessment (**AECOM, 2010a**) was undertaken prior to any additional emission estimation/dispersion modelling being completed to determine if a qualitative approach was suitable. This was done in accordance with the Director Generals Requirements (DGR's) comments and it concluded that a detailed dispersion modelling assessment was required, as presented in this document.

The pollutants assessed in the previous assessment included odour, nitrogen dioxide (NO_2), carbon monoxide (CO), sulphur dioxide (SO_2) and particulates. The same contaminants have been assessed in this report. A qualitative assessment of emissions from construction is also included.

The potential impacts on dust-sensitive industries in Port Kembla Port have been considered. Cumulative impacts of the proposed modification with current industrial operations in Port Kembla and various urban sources in the Illawarra region has been considered through the use of contemporary background air monitoring data. The potential for cumulative impacts with the operations at the Cement Grinding Mill, which is scheduled to be operational in 2014 is also included in the cumulative assessment.

2 PROJECT DESCRIPTION

2.1 Introduction

The Project Site is located within the Wollongong Local Government Area in the Outer Harbour of Port Kembla. It is located in the vicinity of the Blue Scope Steel Works and other associated heavy industrial activities which form the industrial area of Port Kembla. As discussed previously, the Cement Grinding Mill is currently under construction within the Stage 1 footprint of the Project. A schematic depicting for the site layout for the Stage 1 Plan is illustrated in **Figure 2.1**.

As detailed in **Section 1.1**, the Project has the potential to release odour, nitrogen dioxide (NO_2), carbon monoxide (CO) and sulphur dioxide (SO_2) and particulates. Particulates 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 ($PM_{2.5}$). A summary of the activities associated with the Project and the potential air emissions is provided in **Table 2.1**.

Table 2.1: Air emissions and activity source

Activity	Pollutant
Ships at berth	SO_2, NO_2, CO, $PM_{2.5}$, PM_{10}, TSP
Trains(unloading and in sidings)	SO_2, NO_2, CO, $PM_{2.5}$, PM_{10}, TSP
Cargo handling equipment (cranes, front end loaders, etc.)	SO_2, NO_2, CO, $PM_{2.5}$, PM_{10}, TSP
Trucks (wheel generated emissions on sealed roads)	$PM_{2.5}$, PM_{10}, TSP
Trucks (fuel usage)	SO_2, NO_2, CO, $PM_{2.5}$, PM_{10}, TSP
Loading material to ships (transfer stations and loaders)	$PM_{2.5}$, PM_{10}, TSP
Construction	Odour, $PM_{2.5}$, PM_{10}, TSP

2.2 The Proposed Modification

Due to growing customer demand and greater recognition of the strategic role of the Port as detailed in the Draft NSW Freight and Ports Strategy (**TfNSW, 2012**), PKPC is now seeking to modify its approval to accommodate an increase in the bulk cargo throughput handled at Port Kembla from 4.25 million tonnes per annum to 16 million tonnes per annum (the Project). All additional bulk cargo volumes would be moved by rail. To facilitate this increase in bulk trade, this modification includes:

- Increase in the bulk cargo capacity to 16 million tonnes per annum through the first multi-purpose berth.
- Amendments to the dredging and reclamation footprint between the multi-purpose and container terminals to cater for the larger Cape-size vessels and Super Post-Panamax size vessels.
- Increased number of ship movements to cater for increased bulk volumes and more efficient movement of cargo.
- An enlarged operational land area for the multi-purpose terminal to support the increase in cargo volumes.
- Covered conveyors and construction of storage sheds to enable the movement of dry bulk product between trains, trucks and terminals.
- Increased train movements to facilitate delivery of larger volumes of bulk cargo, resulting in an additional nine trains per day accessing the Port (totalling 13 bulk trains per day).
- Additional rail and supporting infrastructure to facilitate increased train movements, including two bulk loops, two bulk unloaders and sidings.
- Changes to road infrastructure in the vicinity of the Outer Harbour to accommodate increased train movements, including the changes at the railway level crossing on Old Port Road.
- An increase in the volume of material temporarily stockpiled for land reclamation purposes at the Outer Harbour from 100,000 cubic metres to 360,000 cubic metres across two sites.
- A slight increase in construction traffic due to the increase in construction activity under Stage 1.
- A revised alignment of the Salty Creek extension on a more direct route through the reclamation area.

There would be no change to the approved capacity for general cargo or container cargo at the Outer Harbour.

To enable a larger throughput, both the Concept Plan and Major Project approvals would require modification. Overall, the method of construction, layout and operation of the Outer Harbour development would remain similar to that outlined in the existing approvals. The majority of changes to the development are related to the Major Project (Stage 1) to allow for increased capacity at the first multi-purpose berth for a total throughput of 16 million tonnes per annum. The changes to Stage 1 have some implications for Stages 2 and 3 of the development, though these are relatively minor.

2.3 Proposed Operations

Once fully operational in 2037, the Concept Plan for the Outer Harbour Development would comprise two new areas of reclaimed land, one multi-purpose terminal area dedicated to handling dry bulk, break bulk and general cargo, and the other terminal area dedicated to handling containers.

A schematic depicting for the site layout for the Concept Plan is illustrated in **Figure 2.1**.

2.3.1 Multi-purpose terminals

2.3.2 Rail traffic

The system to transfer goods from trains to ships would occur as follows:

- Trains would pass through one of the two enclosed bulk unloader facilities on the eastern side of the bulk loops and bottom-dump product onto an unloading conveyor system as carriages pass through the enclosed conveyor facility.
- Material would be transferred via the unloading conveyor system into appropriate sheds, where they would be stockpiled before being exported.
- When an appropriate vessel is berthed, material would be transferred from sheds to the ships for export via a separate loading conveyor system.

2.3.3 Road traffic

Stage 1 operational road traffic approved under the original application was capped at 70 movements per hour (including those generated by the CGM). Under this modification, operational traffic movements would increase to 78 movements per hour, comprising the 70 approved movements, and eight additional employee vehicle movements per hour.

2.3.3.1 Extension of new access road

The original application outlined the construction of a new road to access the multi-purpose terminals. Stage 1 construction of the road encompassed the portion of the road that would run south from Christy Drive, parallel with existing rail sidings, before turning east to provide access to the central part of the terminal.

To facilitate access to the expanded area of the multi-purpose terminal, the modification proposes to extend the construction of this road further south during Stage 1. The road would run the length of the multi-purpose terminal before connecting with Foreshore Road in the south. This access road connection to Foreshore Road was originally proposed to occur in Stage 3 of construction, but would now occur in Stage 1. Additional easterly extensions off this road would be constructed further south along this road, as required to provide access to the southern portion of the multi-purpose terminal.

2.3.4 Multi-purpose terminals

Ships berthing at the multi-purpose terminal would be loaded and unloaded by either ship or land based cranes or by specialist loader/ unloader plant established on the wharf. Dry bulk imports generally be moved directly from the ship to ta truck via hopper with trucks exiting the terminal immediately after loading. Break bulk would be transferred to and from ships using cranes and would be temporarily stored in cargo sheds located adjacent to the new road link that would extend from Christy Drive to Foreshore Road or on the terminal if non-weather sensitive.

2.3.5 Container terminals

The container terminal would commence operation progressively over Stages 2 and 3 of the Concept Plan. As such it is likely that the container terminals would be split into two separate facilities, the western and eastern facilities. Each of the facilities would accommodate two berths.

Containers would be loaded and unloaded via rail-mounted quayside cranes, initially purpose built mobile harbour cranes might be utilised. Containers would be stacked up to eight containers high along the length of the container terminals. Shuttle carriers would transfer containers between the unloading point and the container stacks. Up to ten rail mounted gantries would be positioned above the container stacks to reposition containers as required and load/ unload trains. Forklifts or reach stackers would move between the container stacks and a truck loading point to the south of the container stacks, within the Concept Plan footprint.

The majority of containers (90 per cent) would be transported from the Outer Harbour by rail to or from markets in Sydney and interstate. A small proportion of containers (10 per cent) and cargo within containers would be transported by road. It is possible that containers may be transported to an 'inland Port', such as an intermodal terminal, prior to being distributed to their ultimate destinations in Sydney and other markets.

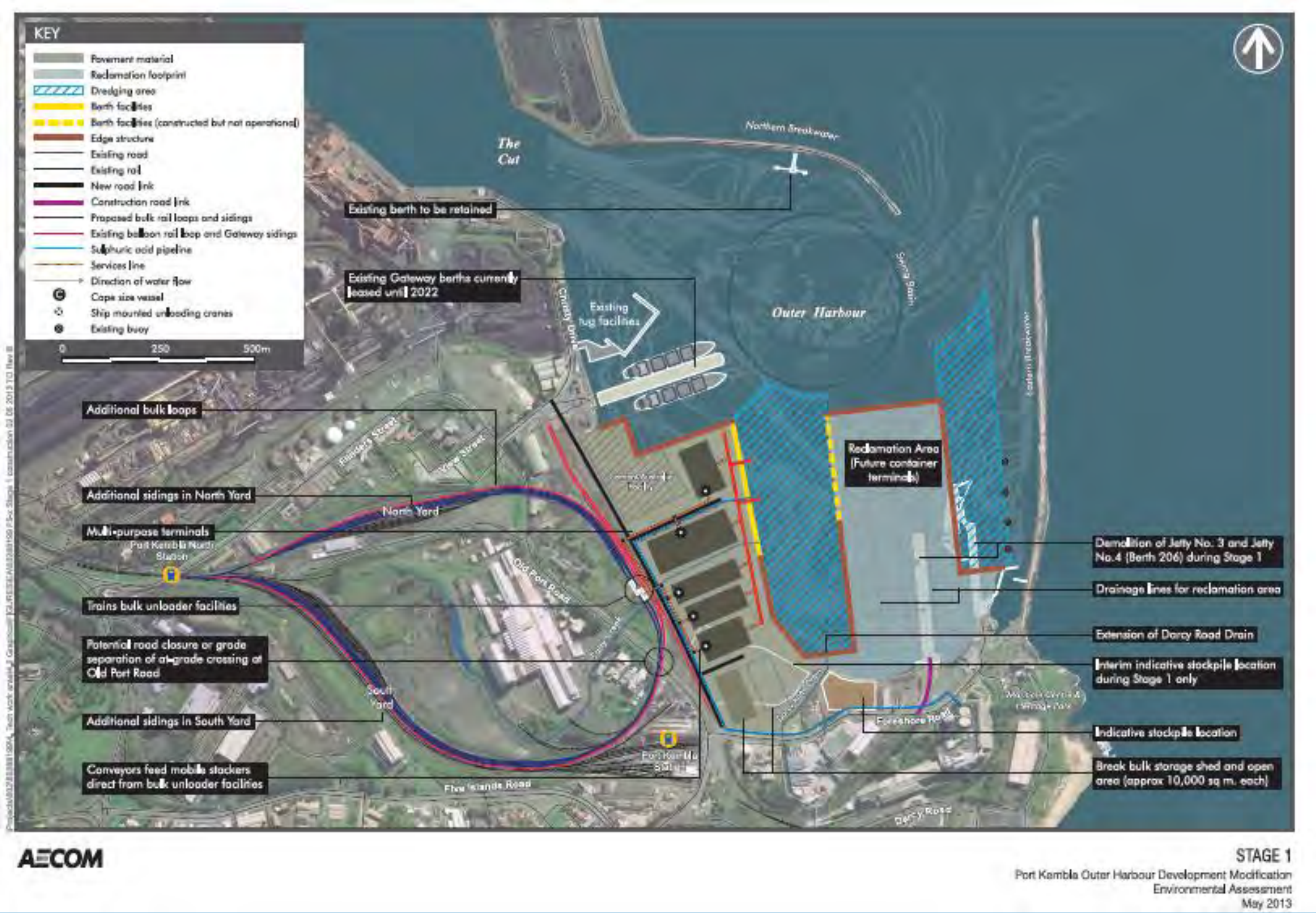


Figure 2.1: Site Layout – Stage 1 Plan

Figure 2.2: Site Layout – Concept Plan

3 LOCAL SETTING

The PKOH is located in the Illawarra region of NSW, approximately 80 kilometre south of Sydney. Illawarra is the fourth largest major population centre of NSW and Port Kembla is Australia's ninth largest port.

Port Kembla is located approximately five kilometres south of the Wollongong CBD. The port area encompasses coal and grain handling facilities, steel works, a fertiliser manufacturer, ship loading facilities, motor vehicle import and processing facilities, and various dry bulk and bulk liquid handling facilities. A railway line and main arterial road provide access to the port area. Residential premises are also located within one kilometre of the port. Existing land use within the local area includes industrial, mixed commercial and residential. The location of the Project and surrounding areas is shown in **Figure 3.1**.

There are a number of receptors (e.g. dwellings) in the vicinity of the Project, as shown in **Figure 3.1** and listed in **Table 3.1**. Non-residential receptors were included in this assessment to identify the receptors which may require management measures.

Port Kembla is located on a coastal strip with a steep escarpment approximately eight kilometres to the west of the port. The escarpment is a major influence on meteorology and air quality in the region. It can steer or deflect winds, changing the apparent direction at the surface. It can also lead to the decoupling of winds above and below the escarpment. As a result an inversion can form at the top of the escarpment, limiting the dispersion of pollutants in the Illawarra region.

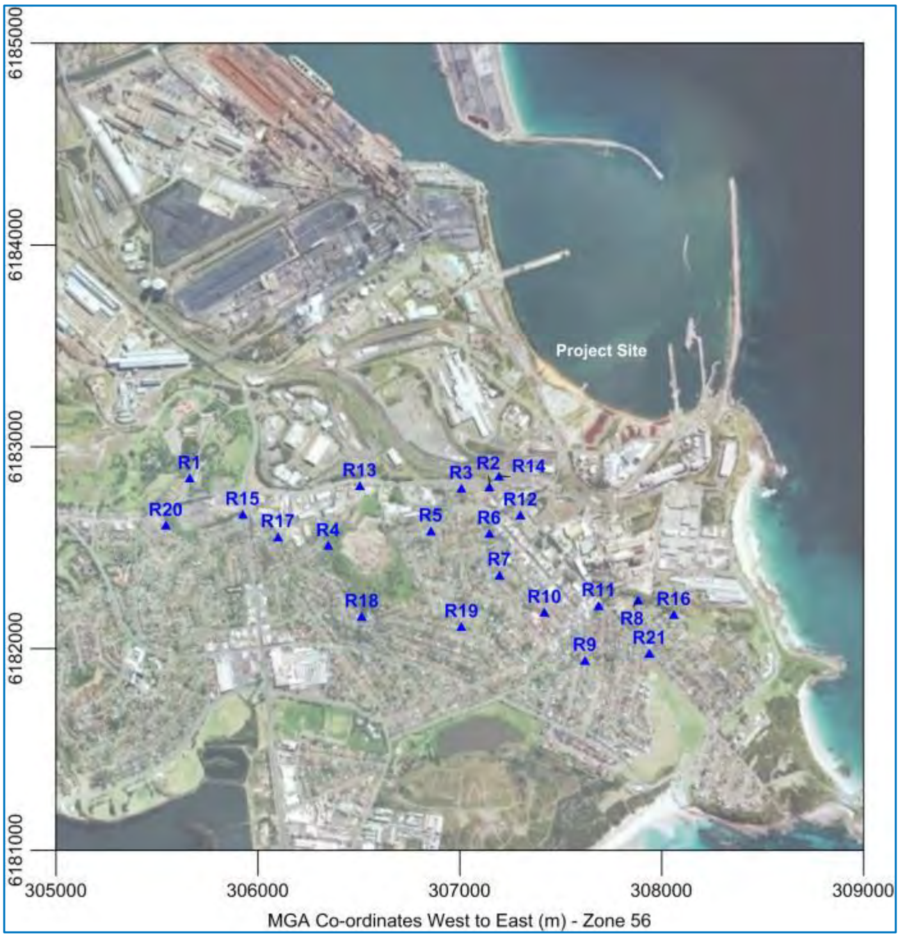


Figure 3.1: Project site and receptors

Table 3.1: Relevant Receptor List

Receptor ID	Receptor Type	Easting (m)	Northing (m)
R1	Residential	305662	6182844
R2	Residential	307148	6182800
R3	Residential	307007	6182794
R4	Residential	306348	6182510
R5	Residential	306856	6182583
R6	Residential	307146	6182571
R7	Residential	307196	6182364
R8	Residential	307883	6182239
R9	Residential	307620	6181942
R10	School	307420	6182180
R11	Church	307689	6182213
R12	Commercial	307300	6182662
R13	Industrial	306505	6182807
R14	Industrial	307194	6182855
R15	Residential	305924	6182665
R16	Residential	308060	6182169
R17	Residential	306100	6182554
R18	Residential	306515	6182159
R19	Residential	307009	6182109
R20	Residential	305545	6182611
R21	Pre-school	307940	6181977

4 AIR POLLUTANTS AND ASSESSMENT CRITERIA

4.1 Introduction

Port activities described in **Section 2.1** have the potential to generate emissions in the form of particulate matter, NO_2, CO and SO_2.

The health effects of each of these pollutants are discussed in **Section 4.2** and the sources of emissions from the operations of the Project are presented in **Section 7**.

The following sections provide information on the air quality criteria used to assess the impact of emissions. To assist in interpreting the significance of predicted concentration and deposition levels some background discussion is also provided.

4.2 Air Quality Issues and Effects

4.2.1 Particulate Matter

Particulate matter has the capacity to affect health and to cause nuisance effects, and is categorised by size and/or by chemical composition. The potential for harmful effects depends on both. The particulate size ranges are commonly described as:

- TSP – refers to all suspended particles in the air. In practice, the upper size range is typically 30 µm to 50 µm.
- PM_{10} – refers to all particles with equivalent aerodynamic diameters of less than 10 µm, that is, all particles that behave aerodynamically in the same way as spherical particles with diameters less than 10 µm and with a unit density. PM_{10} are a sub-component of TSP.
- $PM_{2.5}$ – refers to all particles with equivalent aerodynamic diameters of less than 2.5 µm diameter (a subset of PM_{10}). These are often referred to as the fine particles and are a sub-component of PM_{10}.
- $PM_{2.5-10}$ – defined as the difference between PM_{10} and $PM_{2.5}$ mass concentrations. These are often referred to as coarse particles.

Evidence suggests that health effects from exposure to airborne particulate matter are predominantly related to the respiratory and cardiovascular systems. The human respiratory system has in-built defensive systems that prevent larger particles from reaching the more sensitive parts of the respiratory system. Particles larger than 10 μm, while not able to affect health, can soil materials and generally degrade aesthetic elements of the environment. For this reason air quality goals make reference to measures of the total mass of all particles suspended in the air, this is referred to as TSP. In practice particles larger than 30 to 50 μm settle out of the atmosphere too quickly to be regarded as air pollutants. The upper size range for TSP is usually taken to be 30 μm.

Both natural and anthropogenic processes contribute to the atmospheric load of particulate matter. Coarse particles ($PM_{2.5-10}$) are derived primarily from mechanical processes resulting in the suspension of dust, soil, or other crustal[a] materials from roads, farming, mining and dust storms. Coarse particles also include sea salts, pollen, mould, spores, and other plant parts. Mining dust is likely to be composed of predominantly coarse particulate matter (and larger).

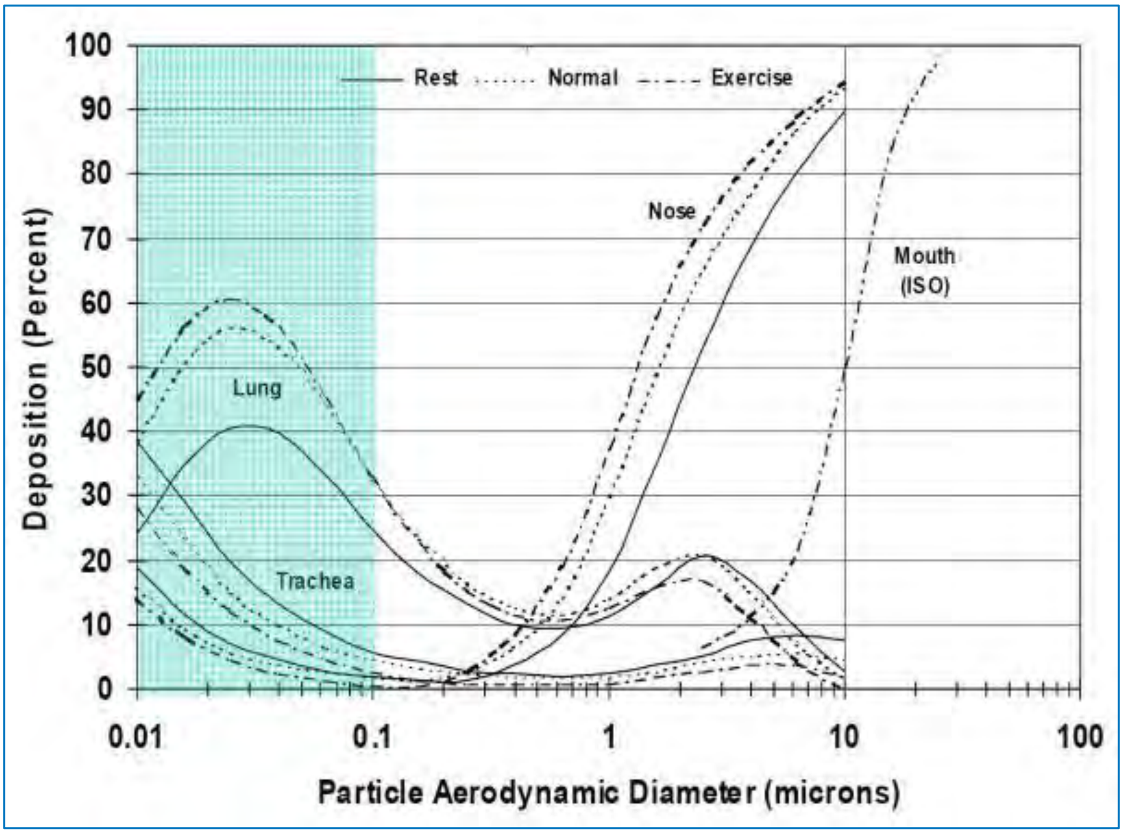
Fine particles or $PM_{2.5}$ are derived primarily from combustion processes, such as vehicle emissions, wood burning, coal burning for power generation and natural processes such as bush fires. Fine particles also consist of transformation products, including sulphate and nitrate particles, and secondary organic aerosol from volatile organic compound emissions. $PM_{2.5}$ may penetrate beyond the larynx and into the thoracic respiratory tract and evidence suggests that particles in this size range are more harmful than the coarser component of PM_{10}.

The size of particles determine their behaviour in the respiratory system, including how far the particles are able to penetrate, where they deposit, and how effective the body's clearance mechanisms are in removing them. This is demonstrated in **Figure 4.1**, which shows the relative deposition by particle size within various regions of the respiratory tract. Additionally, particle size is an important parameter in determining the residence time and spatial distribution of particles in ambient air and are key considerations in assessing exposure.

In addition to health impacts, airborne dust also has the potential to cause nuisance effects by depositing on surfaces, including vegetation. Larger particles do not tend to remain suspended in the atmosphere for long periods of time and will fallout relatively close to source. Dust fallout can soil materials and generally degrade aesthetic elements of the environment and are assessed for nuisance or amenity impacts.

---

[a] Crustal dust refers to dust generated from materials derived from the earth's crust.



Source: **Phalen et al, 1991**

Figure 4.1: Particle Deposition within the Respiratory Track

4.2.2 Oxides of Nitrogen (NO_x)

Oxides of nitrogen (NO_x) are produced when fossil fuels are combusted in internal combustion engines (e.g. motor vehicles, mine equipment). 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 NO_2 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 to 95 per cent of NO and five to 10 per cent 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 i.e.:

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

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:

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

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

4.2.3 Carbon Monoxide (CO)

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 symptoms are generally not reported until relatively high ambient atmospheric concentrations are reached.

4.2.4 Sulphur Dioxide (SO_2)

Sulphur dioxide belongs to the family of sulphur oxide gases (SO_x). These gases are formed when for instance fuel containing sulphur (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 sulphur 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 per cent of what it was less than 10 years ago.

4.3 EPA Impact Assessment Criteria

The NSW EPA *Approved Methods* (**EPA, 2005**) provides impact assessment criteria for air pollutants. These criteria are consistent with the National Environment Protection Measures for Ambient Air Quality (referred to as the Ambient Air-NEPM) (**NEPC, 1998a**). However, the EPA's criteria includes averaging periods, which are not included in the Ambient Air-NEPM, and also references other measures of air quality, namely dust deposition and TSP.

Table 4.1 summaries the air quality impact assessment criteria that are relevant to this study. The criteria relate to the cumulative impact and not just the emissions from the Project. In other words, consideration of background levels needs to be made when using these goals to assess impacts.

Table 4.1: EPA air quality impact assessment criteria

Pollutant	Averaging Period	Unit	Criteria
PM_{10}	24-hour	µg/m³	50
	Annual	µg/m³	30
TSP	Annual	µg/m³	90
Dust deposition	Annual (increment)	g/m²/month	2
	Annual (cumulative)	g/m²/month	4
NO_2	1-hour	µg/m³	246
	Annual	µg/m³	62
SO_2	10-minute	µg/m³	712
	1-hour	µg/m³	570
	24-hour	µg/m³	228
	Annual	µg/m³	60
CO	15-minute	mg/m³	100
	1-hour	mg/m³	30
	8-hour	mg/m³	10

In May 2003, NEPC released a variation to the NEPM (**NEPC, 2003**) to include advisory reporting standards for $PM_{2.5}$. The variation includes a protocol setting out monitoring and reporting requirements for particles as $PM_{2.5}$. The advisory reporting standards for $PM_{2.5}$ are a maximum 24-hour average of 25 µg/m³ and an annual average of 8 µg/m³. It is noted that the Ambient Air-NEPM $PM_{2.5}$ advisory reporting standards are not impact assessment criteria. The aim of the reporting standards was to gather sufficient data nationally to facilitate the review of the Air Quality NEPM which is currently underway.

Notwithstanding the above, in the absence of any other relevant standard/goal, the advisory reporting standards have been used in this report for comparison against dispersion modelling results.

Table 4.2: Advisory reporting standards for $PM_{2.5}$

Pollutant	Averaging Period	Unit	Criteria
$PM_{2.5}$(	24-hour	µg/m³	25
	Annual	µg/m³	8

5 EXISTING ENVIRONMENT

5.1 Meteorology

The nearest available Bureau of Meteorology (BoM) monitoring sites are Albion Park and Bellambi. The Bellambi BoM station is located 11 kilometres north of the site and the Albion Park BoM station is located 13km southwest of the site.

EPA also operates a meteorological station at Wollongong approximately six kilometres northwest of the site. Data from the EPA Wollongong station were used in the air dispersion modelling for the site as it is the closest to the site. The long term climatic information for the Albion Park BoM station is presented in **Section 5.2**.

5.2 Local Climatic Conditions

A range of climatic information collected at Albion Park is presented in **Table 5.1**. Temperature and humidity data consist of monthly averages of 9am and 3pm readings. Monthly daily averages of maximum and minimum temperatures are also provided. Rainfall data consist of mean monthly rainfall and the average number of rain days per month.

The annual average maximum and minimum temperatures recorded at Albion Park are 22.4 °C and 11.4°C respectively. On average, January is the hottest month, with an average maximum temperature of 26.8°C. July and August are the coldest months, with average minimum temperature of 6.3°C.

The annual average relative humidity reading collected at 9am from the Albion Park station is 67 per cent and at 3pm the annual average is 59 per cent. The month with the highest relative humidity on average is March with 9am averages of 76 per cent and the month with the lowest relative humidity is August 3.00 pm averages of 49 per cent.

Rainfall data collected at the Albion Park station shows that February is the wettest month, with an average rainfall of 151.0 mm over nine rain days. The average annual rainfall is 889.1 mm with an average of 80.9 rain days.

Table 5.1: Monthly climate statistics for Albion Park

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9am Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	22.5	22.0	20.2	19.2	15.8	13.0	12.5	14.0	17.1	19.0	19.7	21.4	18.0
Humidity	68	74	76	68	69	73	68	61	57	58	67	66	67
3pm Mean Dry-bulb and Wet-bulb Temperatures (°C) and Relative Humidity (%)													
Dry-bulb	24.8	24.5	23.5	21.3	18.8	16.7	16.2	17.3	19.3	20.4	21.6	23.5	20.7
Humidity	63	67	64	61	58	57	54	49	53	58	63	61	59
Daily Maximum Temperature (°C)													
Mean	26.8	26.3	25.1	23.1	20.3	18.1	17.5	18.9	21.4	22.7	23.7	25.3	22.4
Daily Minimum Temperature (° C)													
Mean	16.7	17.2	15.3	12.0	8.5	6.9	6.3	6.3	8.3	10.6	13.4	14.9	11.4
Rainfall (mm)													
Mean	69.6	151.0	102.2	71.6	63.2	73.7	61.3	28.7	41.2	79.3	82.7	63.8	889.1
Rain days (Number)													
Mean	7.4	9.0	7.8	7.0	5.3	6.4	5.3	4.2	5.1	7.4	8.4	7.6	80.9

Source: BOM (2013) Climate averages for Station: 068241; Commenced: 1999; Latitude: 34°33'50"S; Longitude: 150°47'24"E

5.3 Existing Air Quality

Air quality criteria and standards refer to pollutant levels that include the contribution from specific projects and existing sources. To fully assess impacts against all the relevant air quality standards and goals it is necessary to have data on existing dust concentration and deposition levels in the area in which the Project is likely to contribute to these levels.

EPA operates two monitoring sites in the vicinity of the Project. Wollongong is one of the closest set of publicly available PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO data, located approximately 6 km northwest of the Project site. In addition, PM_{10} and NO_2 data is available from Kembla Grange located approximately 7 km west of the site. 24-hour average data for both sites were obtained from 2007 to 2012. Hourly average data from the Wollongong site were obtained from EPA for 2012.

5.3.1 Particulate Matter

The EPA Wollongong site measures PM_{10} and $PM_{2.5}$ and the EPA Kembla Grange site measures PM_{10} only.

5.3.1.1 PM_{10}

A summary of the annual average PM_{10} data from the EPA monitoring sites is presented in **Table 5.2.**

Table 5.2: Summary of annual average PM_{10} from EPA monitoring sites

Date	Wollongong	Kembla Grange
	Annual average PM_{10} (µg/m³)	
2007	20	19
2008	18	18
2009	24	24
2010	18	18
2011	17	17
2012	18	18
Average	***19***	***19***

Monitoring results show that there have been no exceedances of the EPA annual average assessment criterion of 30 µg/m³ at either monitoring site between 2007 and 2012. The average annual PM_{10} at the Wollongong and Kembla Grange monitoring site between 2007 and 2012 is 19 µg/m³.

The day to day variability in ambient levels of 24-hour average PM_{10} concentrations for the same period at the Wollongong monitoring site is shown in **Figure 5.1**. Exceedances of the EPA assessment criterion of 50 µg/m³ are seen in 2009, where it was a particularly dry year with severe dust storms. Both monitors recorded concentrations above 1000 µg/m³ on 23 September 2009 and was removed from the data presented in **Figure 5.1**. Severe dust storms and bushfires were recorded throughout the state from 23 to 25 September 2009 (**BOM, 2013a**). In addition, there were exceedances of the 24-hour average PM_{10} criterion in 2007 and 2008 at the Wollongong site.

There were a total of 27 exceedances of the 24-hour average PM_{10} at the Kembla Grange site between 2007 and 2012. The general trend of the data at Kembla Grange is similar to the Wollongong site. However, it is noted that the monitor is located at the Kembla Grange racecourse and therefore maybe influenced by the activities at the racecourse.

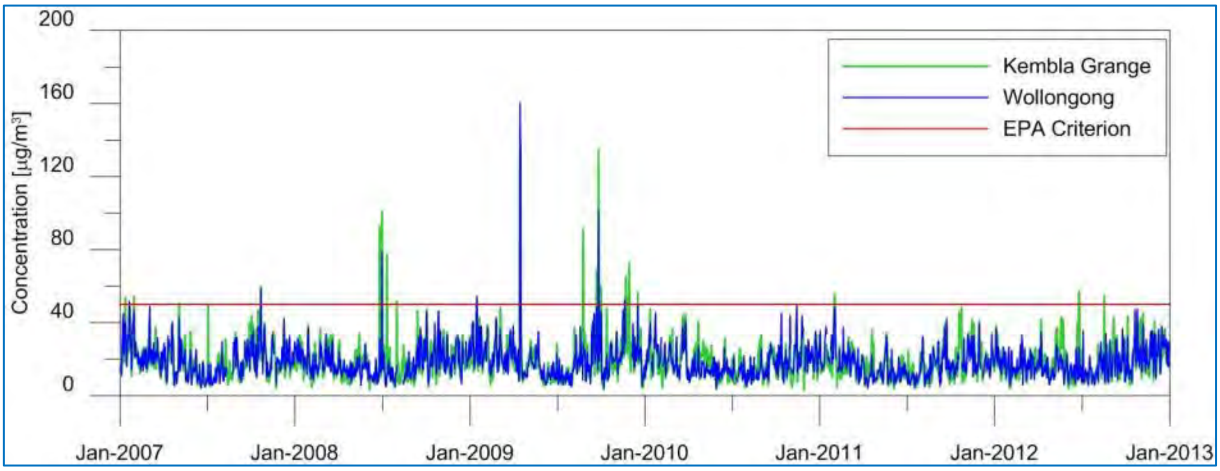


Figure 5.1: EPA Wollongong 24-hour PM_{10} concentrations (µg/m³)

5.3.1.2 $PM_{2.5}$ Concentrations

EPA operates a Beta Attenuation Mass monitoring $PM_{2.5}$ in Wollongong. A summary of the annual average $PM_{2.5}$ data at the EPA Wollongong site are presented in **Table 5.3.** There are no exceedances of the annual average $PM_{2.5}$ advisory reporting standard of 8 µg/m³ at the Wollongong site, however levels have been recorded close to the operating standard in 2009.

Table 5.3: Summary of annual average $PM_{2.5}$ from EPA Wollongong monitoring site

Date	Wollongong Annual average $PM_{2.5}$ (µg/m³)
2007	6
2008	5
2009	7
2010	5
2011	5
2012	5
Average	5

The 24-hour average $PM_{2.5}$ concentrations for 2007 to 2012 at the Wollongong monitoring site are shown in **Figure 5.2**. Similar to the 24-hour average PM_{10} data, exceedances of the EPA assessment criterion of 25 µg/m³ are seen in 2009. Seasonal variation of $PM_{2.5}$ can also be seen where concentrations are higher during winter where there is higher usage of wood fires.

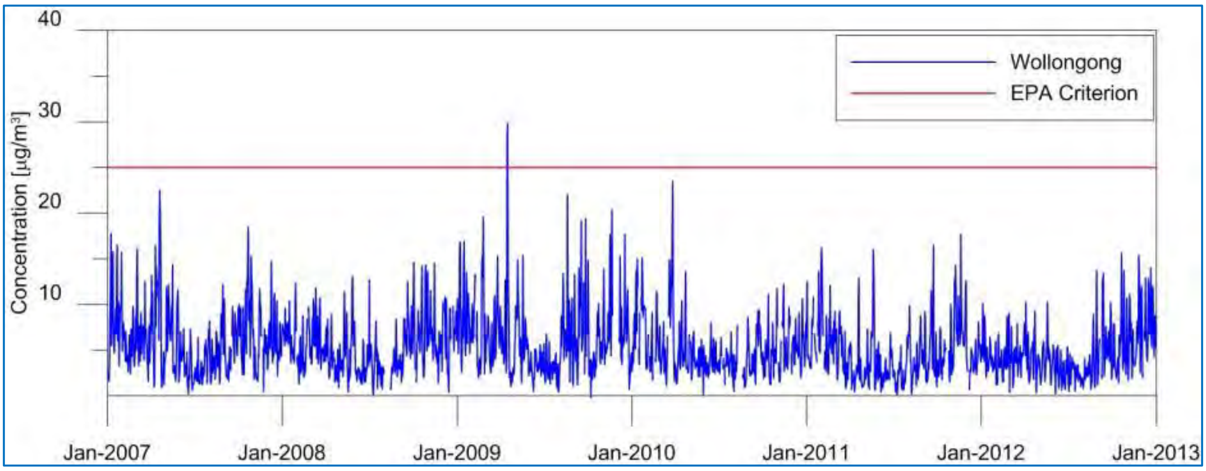


Figure 5.2: EPA Wollongong 24-hour $PM_{2.5}$ concentrations (µg/m³)

5.3.2 NO_2 concentrations

Figure 5.3 presents the 1-hour average NO_2 concentration data collected at the EPA Wollongong site. The recorded concentrations are well below the EPA impact assessment criterion of 246 µg/m³ at both sites. The annual average NO_2 concentration at Wollongong is 16 µg/m³. The maximum hourly concentration recorded at the Wollongong site in 2012 is 100 µg/m³.

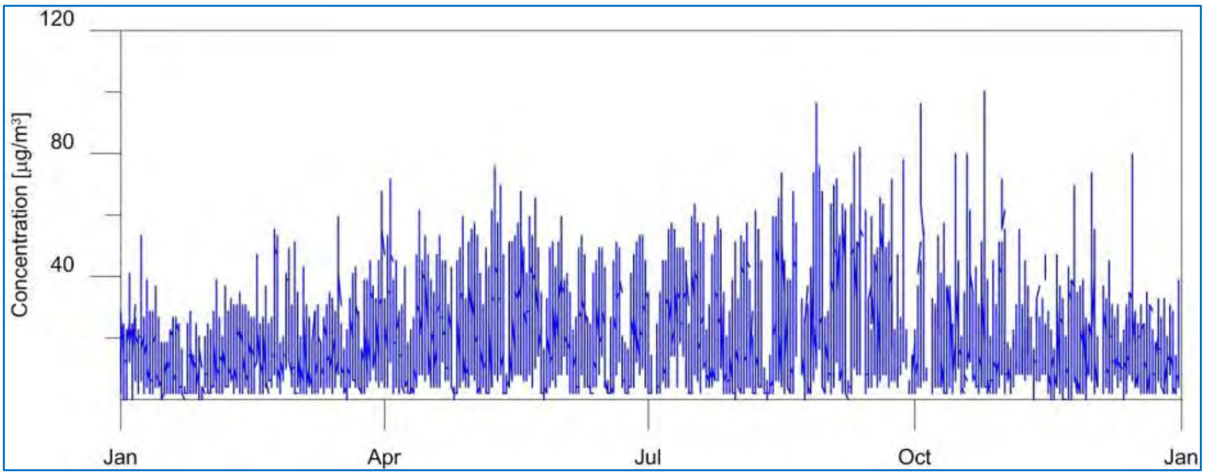


Figure 5.3: 24-hour average NO_2 concentrations measured at EPA Wollongong station (January 2007 to December 2012)

5.3.3 SO_2 concentrations

Figure 5.4 presents the 24-hour average SO_2 concentration data collected at the EPA Wollongong site. The recorded concentrations are significantly below the EPA impact assessment criterion of 570 µg/m³. The maximum hourly concentrations recorded at the Wollongong site in 2012 is 49 µg/m³. The 24-hour average and annual average SO_2 concentration based on data from 2007 to 2012 is 20 µg/m³ and 1.4 µg/m³, respectively. This is well below the 24-hour average criterion of 228 µg/m³ and the annual average SO_2 criterion of 60 µg/m³.

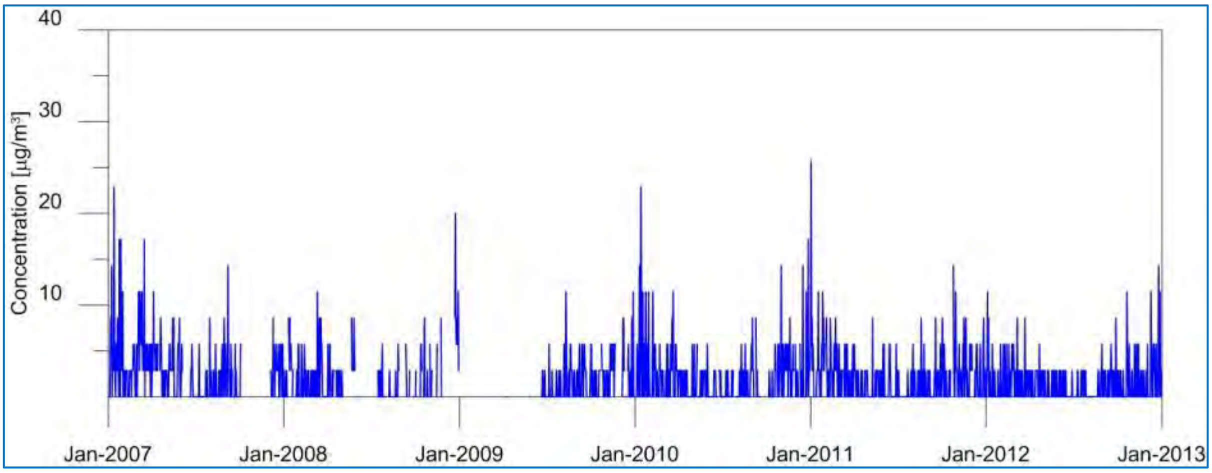


Figure 5.4: 24-hour average SO_2 concentrations measured at EPA Wollongong station (January 2007 to December 2012)

5.3.4 CO concentrations

Figure 5.5 presents the maximum 1-hour CO concentration data collected at the EPA Wollongong site in 2012. **Figure 5.5** shows that CO concentrations measured at the Wollongong site are well below the 1-hour average impact assessment criterion of 10 mg/m³. The maximum value recorded was 2.1 mg/m³ which occurred in July. The maximum rolling 8-hour average CO concentration was 1.5 mg/m³.

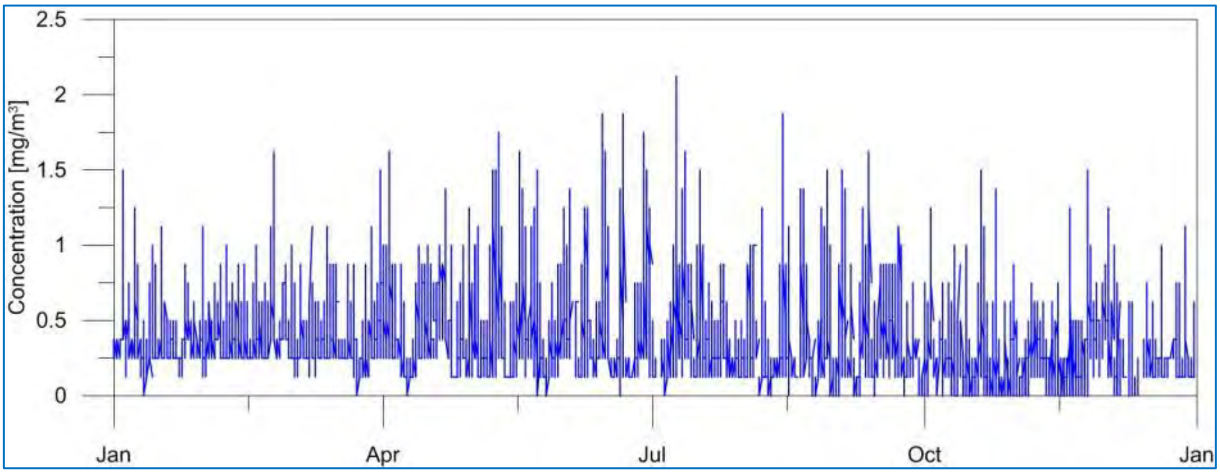


Figure 5.5: Hourly CO concentrations measured at EPA Wollongong monitoring station - 2012

5.3.5 On-site Monitoring

5.3.5.1 Introduction

Environment Protection Licence No. 20164 (the EPL) was issued to PKPC for the premises located at Christy Drive, Port Kembla where the fill was to be stockpiled for use in the reclamation works for the Outer Harbour Development. As part of the EPL conditions, one high volume air sampler (HVAS) and four dust deposition gauges (DDG) were installed at the site for the initial construction works. Currently, the construction operations are in the rock/fill receival and stockpiling stage. The existing monitoring network consists of three DDGs and a HVAS.

The locations of the existing monitors and the monitors during the reclamation works for Stage 1 are provided in **Figure 5.6**. The full monitoring datasets are provided in **Appendix A**.

In addition to the regulatory DDGs and HVAS, the Construction Phase Air Quality Management Plan also includes real-time proactive air quality management system. A series of continuous PM_{10} monitors (DustTraks) are used on-site in combination with a meteorological station and a series of triggers designed to alert the site to the potential for off-site impacts. Whilst the continuous PM_{10} monitors are not an approved method for ambient monitoring, they can provide a good indication of ambient dust levels for proactive management. As the data collected do not comply with Australian Standards, and are used for management purposes only, they are not discussed further.

Figure 5.6: Location of monitors on-site

5.3.5.2 High Volume Air Sampler (HVAS)

The location of the HVAS monitor is provided in **Figure 5.6**. The HVAS began operation in September 2011 and the data were provided to March 2013. **Table 5.4** shows that the HVAS site has recorded an average across the monitoring period of 24 µg/m^3. The only full year of data was 2012 with an average of 24 µg/m^3. The data from the HVAS indicates that the dust levels at the residences to the southwest of the site are below the EPA annual average PM_{10} criterion of 30 µg/m^3.

In addition, there has only been one recorded exceedance of the 24-hour average PM10 criterion of 50 µg/m^3. A concentration of 85.5 µg/m^{3}was recorded on 5 September 2012. The monitoring report (**Clearsafe, 2102**) noted that further visual analysis was conducted by the laboratory subsequent to reported result. The further analysis reported the filter composition as follows: coal - 40%; soot - 30%; mineral matter - 20%; vegetation – 10%. The composition of the sample combined with light north wind readings throughout the day suggests the source of the dust is from other activities conducted in the vicinity of the Site.

Table 5.4: HVAS annual average PM_{10} concentrations

Year	PM_{10} Concentration ($\mu g/m^3$)
2011	23
2012	24
2013	25
Average	**24**

5.3.5.3 *Dust Deposition Gauges*

The dust deposition monitoring from the Stage 1A of the reclamation works are summarised in **Table 5.5**.

The averages at all sites for the monitoring period are well below the EPA assessment criterion of 4 g/m²/month, except for DG1. The average dust deposition level at DG1 (background site) was 7.9 g/m²/month.

Table 5.5: Annual average dust deposition concentrations – Stage 1A Reclamation Works

Date	DG1	DG2	DG3	DG4	DG5
			(g/m²/month)		
Sep-11	15.9	1.7	1.1	0.8	1.8
Oct-11	10.8	2.8	1.5	1.7	1.9
Nov-11	5.7	1.9	1.6	1.8	0.7
Dec-11	5.5	3.8	2.4	1.3	0.6
Jan-12	7.5	6.2	4.2	2.3	1.3
Feb-12	4.3	1.6	1.0	1.1	0.3
Mar-12	4.8	1.2	1.0	3.7	1.8
Apr-12	8.6	2.6	1.4	4.4	0.9
May-12	7.6	2.0	0.8	1.6	2.7
Average	**7.9**	**2.6**	**1.7**	**2.1**	**1.3**

The existing dust deposition gauges are located on-site and are summarised in **Table 5.6**. The average at DDG2 and DDG3 is 2.0 g/m²/month and 2.1 g/m²/month, respectively which is below the EPA assessment criterion of 4 g/m²/month. DDG1 is the background site but measured much higher dust deposition levels compared with DDG2 and DDG3. The average dust deposition level at DDG1 is 6.9 g/m²/month.

The data suggests that the background site (DDG1 and DG1) is heavily influenced by other industrial activities in the area.

Table 5.6: Annual average dust deposition concentrations – current locations

Date	DDG1	DDG2	DDG3
		(g/m²/month)	
Aug-12	10.8	0.9	2[1]
Sep-12	7.5	1.4	2.2
Oct-12	6.5	1.5	1.6
Nov-12	6.7	2.9	1.6
Dec-12	5.9	1.7	1.5
Jan-13	7.8	2.2	2.8
Feb-13	5.2	3.3	2.2
Mar-13	4.6	1.9	2.5
Apr-13	6.9	1.8	2.9
Average	**6.9**	**2.0**	**2.2**

[1] Only 18 days were sampled at DDG3 for August.

6 METHODOLOGY

This section is provided so that technical reviewers can appreciate how the modelling was completed.

6.1 Modelling System

AERMOD was chosen as the most suitable model due to the source types, location of nearest receivers and nature of local topography. AERMOD is the US-EPA's recommended steady-state plume dispersion model for regulatory purposes. AERMOD replaced the Industrial Source Complex (ISC) model for regulatory purposes in the US in December 2006 as it provides more realistic results. AUSPLUME, a steady state Gaussian plume dispersion model developed by the Victorian EPA and frequently used in Australia for simple near-field applications is based on ISC, which has now been replaced by AERMOD. AERMOD has previously been demonstrated to provide better comparison between predicted and measured concentrations in the Port Kembla area (**Moriarty, Roddis and Scorgie, 2009**).

It is noted that the previous air quality assessment was completed with AUSPLUME (**AECOM, 2010a**), using meteorological data from July 2006 to June 2007. These factors, combined with the increase in operations, makes in impractical to make any direct comparisons between the modelling results.

A significant feature of AERMOD is the Pasquill-Gifford stability based dispersion is replaced with a turbulence-based approach that uses the Monin-Obukhov length scale to account for the effects of atmospheric turbulence based dispersion.

The AERMOD system includes AERMET, used for the preparation of meteorological input files and AERMAP, used for the preparation of terrain data.

Terrain data were sourced from NASA's Shuttle Radar Topography Mission (SRTM) Data (3 arc-second (~90m) resolution) and processed within AERMAP to create the necessary input files.

AERMET requires surface meteorological data as input. Surface data were sourced from the EPA Wollongong meteorological station. Appropriate values for three surface characteristics are required for AERMET as follows:

- Surface roughness, which is the height at which the mean horizontal wind speed approaches zero, based on a logarithmic profile.
- Albedo, which is an indicator of reflectivity of the surface.
- Bowen ratio, which is an indicator of surface moisture.

Values of surface roughness, Bowen ratio and albedo were determined based on a review of aerial photography for a radius of 3 km centred on the site. Default values for urban were chosen for the majority of the area with water chosen for the northeast section.

6.2 Dispersion Meteorology

Annual and seasonal windroses for the EPA Wollongong station are shown in **Figure 6.1**. The predominant wind direction on an annual basis is from the southwest with a small percentage from the northeast. The predominant wind direction in autumn and winter are the same as the annual. The predominant wind direction in summer and spring is from the northeast, with a smaller percentage from the southwest.

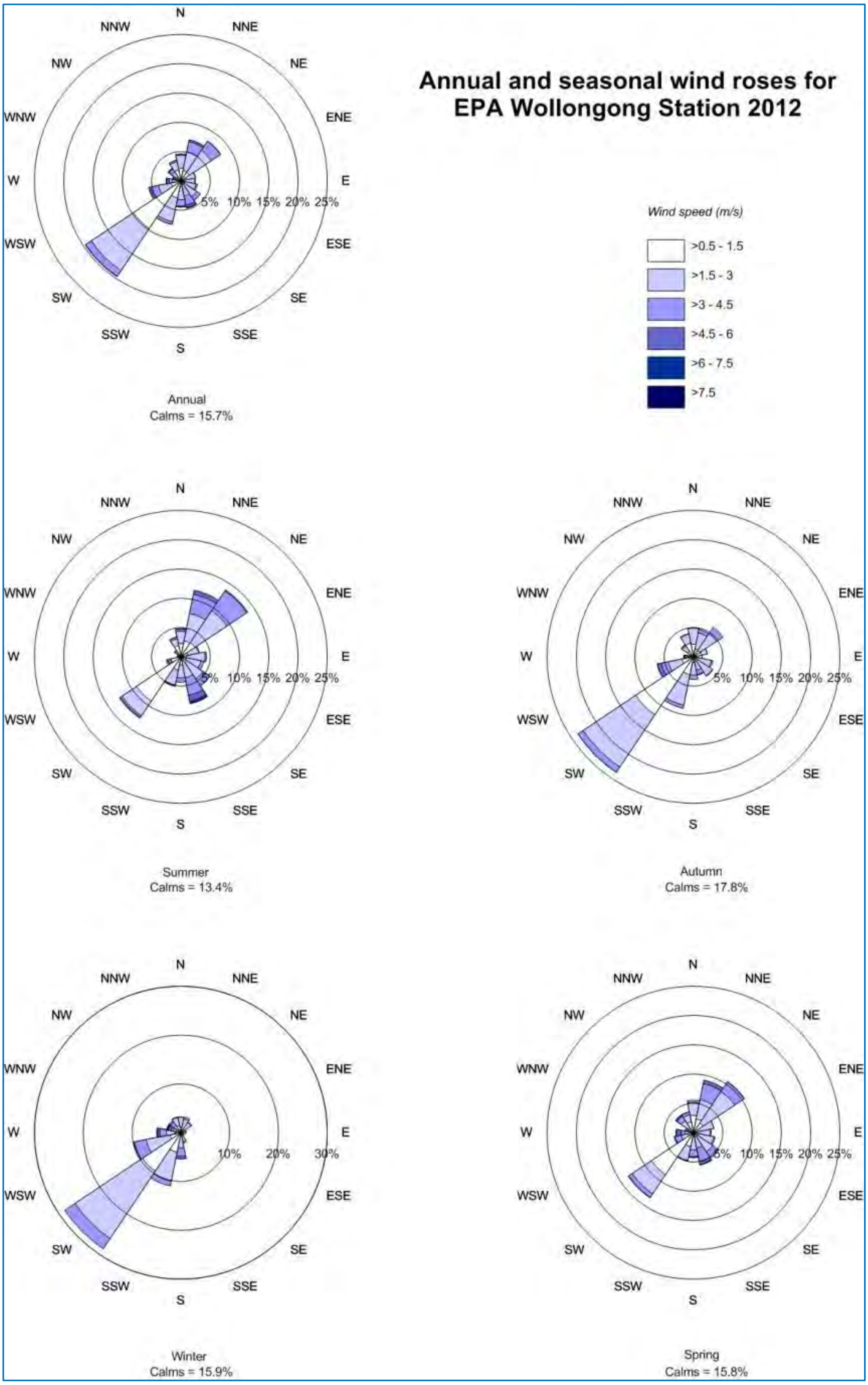


Figure 6.1: Windroses for EPA Wollongong Station 2012

7 EMISSION ESTIMATION

Estimates of emissions for each source were developed on an hourly time step, taking into account the representative activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. For the current study, the train operations were modelled as point sources and all other operations were represented by a series of volume sources located according to the location of activities for the modelled scenarios (see **Figure 7.1** to **Figure 7.2**). All activities have been modelled for 24 hours per day. This is considered to be a conservative approach, for example, trains operations will generally occur for less than one hour per train, but the modelling has assumed 24-hour operations to ensure that the worst-case conditions that could result in the highest predicted glcs are captured.

Three scenarios have been modelled in this assessment and the assumptions for each scenario are detailed in **Table 7.1**. A sensitivity analysis on the effects of silt loading was also completed for the Concept Plan Worst Case scenario and presented in **Section 8.4.1**.

Table 7.1: Air Dispersion Modelling Scenarios

Scenario ID	Assumptions
Concept Plan – Worst Case	– All terminals in operation including multi-purpose terminal (bulk and general purpose) and container terminal – Seven berths in operation simultaneously – Two bulk trains unloading at the same time – One bulk train in the bulk holding sidings – One container train unloading and then held in siding – One general cargo train unloading and then held in siding – Silt loading of 9.7 g/m^2 at the entrance adjacent to Christy Drive (approximately 300 m) and a silt loading of 4.9 g/m^2 for all other internal roads
Concept Plan – Typical case	– All terminals in operation including multi-purpose terminal (bulk and general purpose) and container terminal – Four berths in operation simultaneously (one at the bulk cargo berth, one at the general purpose berth and two at the container berth) – Two bulk trains unloading at the same time – One bulk train in the bulk holding sidings – One container train unloading and then held in siding – One general cargo train unloading and then held in siding – Silt loading of 0.6 g/m^2 at all internal roads
Major Project – Stage 1	– Multi-purpose terminal in operation – One berth for bulk cargo – Two bulk trains unloading at the same time – One bulk train in the bulk holding sidings – Silt loading of 9.7 g/m^2 at the entrance adjacent to Christy Drive (approximately 300 m) and a silt loading of 4.9 g/m^2 for all other internal roads

Emissions of particulates, NO_x, SO_2 and CO were developed based on operational descriptions and layout plan drawings provided by PKPC. Individual emission inventories were developed for fugitive dust emissions and emissions from fuel consumption by operational equipment including ships, trains, trucks and cargo handling equipment (CHE).

Detailed calculations are provided in **Appendix B** which provides information on the equations and emission factors used, the basic assumptions about material properties (e.g. moisture content, silt content etc.), information on the way in which equipment would be used to undertake different operations and the quantities of materials that would be handled in each operation.

Activities outside the site boundary including truck movements on public roads, train movements on the wider network, ships arriving in port and ship manoeuvring are not included in the inventories. Emissions from construction activities are also not included in this assessment as it was assessed in the previous EA (**AECOM, 2010a**). As presented in **Section 5.3**, on-going monitoring of air quality in the vicinity of the initial Stage 1 construction works has demonstrated there have been no adverse impacts on local air quality due to the construction operations. A qualitative assessment of the construction operations is presented in **Section 9**.

7.1 Fugitive Dust Emissions

The information used for developing the inventory for fugitive dust emissions has been based on the operational descriptions and layout plan drawings and used to determine haul road distances and routes, equipment areas, activity operating hours, truck sizes and other details that are necessary to estimate dust emissions.

Table 7.2 to **Table 7.4** summarise the quantities of TSP, PM_{10} and $PM_{2.5}$ estimated to be released by each activity of the Project for all modelled scenarios.

Hauling on sealed internal roads is the major contributor to fugitive dust emissions. The emission equation for sealed roads requires a silt loading factor and generic silt loadings for industrial facilities are provided in the US EPA AP-42 (**US EPA, 1985 and updates**). The average silt loading for iron and steel production facilities is 9.7 g/m^2. The Project is not an iron and steel production facility but is however located in the vicinity of a steelworks. Therefore, internal roads away from the steelworks were considered to have a silt loading 50 per cent less than the US EPA value.

A silt loading of 9.7 g/m^2 at the entrance adjacent to Christy Drive (approximately 300 m) and a silt loading of 4.9 g/m^2 for all other internal roads was used in the Concept Plan Worst Case and Stage 1 scenarios.

This approach is considered to be very conservative as the Project is likely to have significantly less dust emissions compared to a steelworks which has multiple dust-generating activities at significantly higher dust loads than the Project. The majority of the bulk material operations where there is potential for fugitive dust are enclosed and for the Concept Plan Typical Scenario, a lower silt loading of 0.6 g/m^2 was used. This is the silt loading provided by the US EPA for public roads with less than 500 vehicles per day. Lower silt loading values are typically applied to more heavily trafficked roads.

An analysis on the sensitivity of the silt loading value on dust emissions due to the Project was completed for the Concept Plan Worst Case scenario. As shown in **Table 7.2** to **Table 7.4**, this results in the emissions from fugitive dust emissions for the Concept Plan Worst Case scenario being the same as the Concept Plan Typical Case scenario. The shaded cells identify the emissions that have been recalculated with a lower silt loading. An analysis of the changes in predicted concentrations at the receptors is presented in **Section 8.4.1**.

Table 7.2: Estimated TSP emissions for the Project (kg TSP/year)

ACTIVITY	Concept Plan – Worst Case		Concept Plan - Typical	Major Project – Stage 1
	As modelled	Sensitivity	As modelled	As modelled
	(kg/y)			
Unloading material in bulk unloader (coal)	376	376	376	376
Unloading material in bulk unloader (iron ore/bauxite)	400	400	400	400
Unloading of coal/iron ore/bauxite on stockpiles	Stockpiles enclosed within warehouse therefore emissions assumed to be negligible			
Dozers on stockpiles				
Hauling of bulk cargo (near Christy Road)	41,989	3,337	3,337	41,989
Hauling of bulk cargo (internal)	18,622	2,780	2,780	18,622
Transfer stations (coal)	2,578	2,578	2,578	2,578
Transfer stations (iron ore/bauxite)	2,286	2,286	2,286	2,286
Hauling of container cargo (near Christy Road)	41,495	3,297	3,297	-
Hauling of container cargo (internal)	95,694	14,288	14,288	-
Loading material to ships (coal)	1,432	1,432	1,432	1,432
Loading material to ships (iron ore/bauxite)	1,524	1,524	1,524	1,524
Hauling of general cargo (near Christy Road)	29,466	2,341	2,341	-
Hauling of general cargo (internal)	13,068	1,951	1,951	-
TOTAL	**248,930**	**36,591**	**36,591**	**69,207**

Table 7.3: Estimated PM_{10} emissions for the Project (kg PM_{10}/year)

ACTIVITY	Concept Plan – Worst Case		Concept Plan - Typical	Major Project – Stage 1
	As modelled	Sensitivity	As modelled	As modelled
	(kg/y)			
Unloading material in bulk unloader (coal)	178	178	178	178
Unloading material in bulk unloader (iron ore/bauxite)	189	189	189	189
Unloading of coal/iron ore/bauxite on stockpiles	Stockpiles enclosed within warehouse therefore emissions assumed to be negligible			
Dozers on stockpiles				
Hauling of bulk cargo (near Christy Road)	8,060	640	640	8,060
Hauling of bulk cargo (internal)	3,574	534	534	3,574
Transfer stations (coal)	1,219	1,219	1,219	1,219
Transfer stations (iron ore/bauxite)	1,081	1,081	1,081	1,081
Hauling of container cargo (near Christy Road)	7,965	633	633	-
Hauling of container cargo (internal)	18,368	2,743	2,743	-
Loading material to ships (coal)	677	677	677	677
Loading material to ships (iron ore/bauxite)	721	721	721	721
Hauling of general cargo (near Christy Road)	5,656	449	449	-
Hauling of general cargo (internal)	2,508	375	375	-
TOTAL	**50,198**	**9,439**	**9,439**	**15,700**

Table 7.4: Estimated $PM_{2.5}$ emissions for the Project (kg $PM_{2.5}$/year)

ACTIVITY	Concept Plan – Worst Case		Concept Plan - Typical	Major Project – Stage 1
	As modelled	Sensitivity	As modelled	As modelled
	(kg/y)			
Unloading material in bulk unloader (coal)	22	22	22	22
Unloading material in bulk unloader (iron ore/bauxite)	24	24	24	24
Unloading of coal/iron ore/bauxite on stockpiles	Stockpiles enclosed within warehouse therefore emissions assumed to be negligible			
Dozers on stockpiles				
Hauling of bulk cargo (near Christy Road)	1,950	155	155	1,950
Hauling of bulk cargo (internal)	865	129	129	865
Transfer stations (coal)	185	185	185	185
Transfer stations (iron ore/bauxite)	164	164	164	164
Hauling of container cargo (near Christy Road)	1,927	153	153	-
Hauling of container cargo (internal)	4,444	664	664	-
Loading material to ships (coal)	103	103	103	103
Loading material to ships (iron ore/bauxite)	109	109	109	109
Hauling of general cargo (near Christy Road)	1,368	109	109	-
Hauling of general cargo (internal)	607	91	91	-
TOTAL	**11,767**	**1,906**	**1,906**	**3,421**

7.2 Emissions from Ships

The US EPA developed a document detailing air emissions from port-related activities titled 'Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories' (**US EPA, 2009**). While the ships are being loaded at port, the main engines are off and only the auxiliary engines are operating. PKPC has advised that auxiliary boilers are also switched off while the ships are at port.

Based on a study by the Australian Maritime College (**Goldsworthy, 2012**), marine distillate with 0.5% sulphur content accounts for 15% of fuel used in auxiliary engines in Australia. The main fuel use is residual oil. Emissions from ships were estimated using the emission factors from the US EPA document, 'Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories' (**US EPA, 2009**). Emission factors are pro-rated consisting of 85% residual oil and 15% marine distillate.

The emissions from the consumption of fuel by the auxiliary engines at berth have been estimated based on emission factors from the US EPA port-related emission inventories and are presented in **Table 7.5**. There is no emission factor for TSP and therefore the emission factor for TSP was assumed to be the same as for PM_{10}. This is consistent with the methodology used in the previous air quality assessment (**AECOM, 2010a**).

Table 7.5: Emission factors for auxiliary engines - ships

Pollutant	Emission Factor (kg/kWh)
NO_x	0.0146
CO	0.0011
$PM_{2.5}$	0.0012
PM_{10}	0.0013
TSP	0.0013
SO_2	0.0105

The proposed Project will accommodate three types of ships including Cape sized, Panamax and Super Post Panamax. The fuel usage for the auxiliary engines within the three types of ships is summarised in **Table 7.6**. The fuel usages were provided by the AECOM Ports and Marine team (provided by email on 2 May 2013) based on a review of studies by The Port of Los Angeles (**TPLA, 2011**) and the California Environmental Protection Agency (**CEPA, 2005**).

Table 7.6: Fuel usage by ship type

Ship Type	Fuel Usage (kW)
Cape	1,000
Panamax	500
Super Post Panamax	1,100

The number of ships at each berth and the time of each ship at berth were provided by PKPC. The estimated emissions from the auxiliary engine of ships at berth for each scenario are provided in **Table 7.7**. Detailed calculations for emissions from ships are provided in **Appendix B**.

Table 7.7: Estimated emissions from ships at berth

Pollutant	Concept Plan – Worst Case (seven berths)	Concept Plan – Typical (four berths)	Major Project – Stage 1 (one berth)
		(kg/y)	
NO_x	234,884	162,713	59,049
CO	17,721	12,276	4,455
$PM_{2.5}$	18,776	13,007	4,720
PM_{10}	20,492	14,196	5,152
TSP	20,492	14,196	5,152
SO_2	169,171	117,191	42,529

7.3 Emissions from Locomotives

Emissions from the passing locomotives may result in short-term peaks of pollutants (less than a couple of minutes) before dispersing to concentrations that would be very unlikely to cause exceedances of air quality assessment criteria, considering for most pollutants the averaging period for the criteria is 1-hour or longer. However, for idling trains, emissions may be present for longer periods, depending on the time spent idling.

For all scenarios, a conservative assumption of one train sitting in each of the three holding sidings for the multi-purpose and container terminal was assumed. Each exhaust is modelled as a point source described by the dimensions presented in **Table 7.8**. The dimensions adopted for this assessment are based on the previous air assessment for PKPC (**AECOM, 2010a**).

Table 7.8: Assumed vent and emission parameters

Pollutant	Emission Factor (kg/kWh)
Exhaust Release Height	3 m
Vent Diameter	0.3 m
Exhaust Temperature	200°C
Exit Velocity	10 m/s

Emissions from diesel locomotives vary across different locomotive classes. Emissions also vary according to related parameters such as power output, fuel consumption and notch setting. Fuel consumption data are available for 81 and 90 class locomotives (**Lilley, 1996**). The fuel consumption by notch setting for 81 class locomotives have been assumed for this assessment and is summarised in **Table 7.9**.

Table 7.9: Fuel consumption by notch setting

Pollutant	Fuel consumption rate (kg/h)
Idle	11.9
1	46.1
2	72.4
3	154.1
4	197.8
5	269.3
6	331.9
7	451.6
8	514.8

Fuel-based emission factors for uncontrolled diesel locomotives are also available from the NPI Manual for Railway Yard Operations (**NPI, 2008),** however, a more detailed method of using specific emission rates for locomotives based on notch settings have been adopted for this assessment. The emissions for each notch settings are from the Tier 1 emission factors from the European Environment Agency (**EEA, 2009**) and are presented in **Table 7.10**. SO_2 emissions from locomotives are very low and therefore not considered further.

Table 7.10: Tier 1 emission factors for locomotives

Pollutant	Emission Factor (kg/tonne)
NO_x	52.4
CO	10.7
$PM_{2.5}$	1.37
PM_{10}	1.44
TSP	1.52

The number of locomotives, the notch settings and the time in each notch setting for the locomotive movement on-site were provided by AECOM rail engineers. The estimated emissions from the locomotives for each scenario are provided in **Table 7.11**.

Table 7.11: Estimated emissions from locomotives

Pollutant	Concept Plan – Worst Case	Concept Plan - Typical	Major Project – Stage 1
		(kg/y)	
NO_x	47,600	47,600	17,905
CO	9,720	9,720	3,656
$PM_{2.5}$	1,245	1,245	468
PM_{10}	1,308	1,308	492
TSP	1,381	1,381	519

7.4 Emissions from Vehicles

Section 7.1 accounts for fugitive dust emissions generated by trucks on sealed roads within the site boundary. Other sources of emissions from trucks on site include products of combustion from fuel usage.

The relevant National Pollutant Inventory (NPI) emission factors (**NPI, 2008**) for very-Heavy Goods Vehicles (very-HGV) are presented in **Table 7.12**. There is no emission factor for TSP and therefore the emission factor for TSP was assumed to be the same as for PM_{10}.

Table 7.12: Emission Factors for Very-HGV (kg/m³)

NO_x	CO	SO_2	$PM_{2.5}$	PM_{10}	TSP
22	8.5	0.017	1.1	1.2	1.2

Fuel consumption for articulated trucks from the Australian Bureau of Statistics of 58 L/100 km (**ABS, 2013**) was used to estimate emissions from trucks on-site. The distanced travelled on-site was measured off the sealed roads on the layout plans. The estimated emissions from fuel usage by trucks for each scenario are provided in **Table 7.13**.

Table 7.13: Estimated emissions from trucks

Pollutant	Concept Plan – Worst Case	Concept Plan - Typical	Major Project – Stage 1
		(kg/y)	
NO_x	2,579	2,579	848
CO	997	997	328
$PM_{2.5}$	129	129	42
PM_{10}	141	141	46
TSP	141	141	46
SO_2	2	2	1

7.5 Emissions from Cargo Handling Equipment

Diesel powered CHEs are also used for various operations on-site. These include forklifts, mobile cranes and low loaders.

The US EPA port-related emission inventories provide average fuel consumption from CHEs (**US EPA, 2009**). The number of CHEs and the average fuel consumption from each type of CHE is summarised in **Table 7.14**.

Table 7.14: Summary of cargo handling equipment

Equipment Item	Number of Equipment Items		Power usage (hp/equipment item)
	Concept Plan	Major Project – Stage 1	
Forklifts	2	2	274
Mobile Cranes	4	2	127
Low Loaders[1]	2	2	131

[1] Assume tractor is pulling low loader and therefore fuel usage is for a tractor.

The emissions from the consumption of fuel by the CHEs have been estimated based on emission factors from the US EPA port-related emission inventories and are presented in **Table 7.15**. There is no emission factor for TSP and therefore the emission factor for TSP was assumed to be the same as for PM_{10}.

Table 7.15: Emission factors for cargo handling equipment

Pollutant	Emission Factor (g/hph)
NO_x	0.3
CO	0.1
$PM_{2.5}$	0.01
PM_{10}	0.01
TSP	0.01
SO_2	0.16

The number of ships at each berth and the time of each ship at berth were provided by PKPC. The estimated emissions from the auxiliary engine of ships at berth for each scenario are provided in **Table 7.16**.

Table 7.16: Estimated emissions from cargo handling equipment

Pollutant	Concept Plan – Worst Case	Concept Plan - Typical	Major Project – Stage 1
		(kg/y)	
NO_x	3,464	3,464	2,796
CO	1,155	1,155	932
$PM_{2.5}$	115	115	93
PM_{10}	115	115	93
TSP	115	115	93
SO_2	1,847	1,847	1,491

7.6 Source Locations

The location of the sources for the concept plan is provided in **Figure 7.1** and the source parameters are summarised in **Table 7.17**. The release height for the ships was kept as per previous air assessment (**AECOM, 2010a**).

Table 7.17: Source parameters for concept plan

Source ID	Activity	Type	Release height (m)
1	Train	Stack	3
2	Train	Stack	3
3	Train	Stack	3
4	Train	Stack	3
5	Train	Stack	3
6	Train	Stack	3
7	Train	Stack	3
8	Train Unloading	Volume	2
9	Truck	Volume	2
10	Truck	Volume	2
11	Truck	Volume	2
12	Truck	Volume	2
13	Truck	Volume	2
14	Truck	Volume	2
15	Truck	Volume	2
16	Truck	Volume	2
17	Truck	Volume	2
18	CHE	Volume	2
19	CHE	Volume	2
20	CHE	Volume	2
21	CHE	Volume	2
22	CHE	Volume	2
23	CHE	Volume	2
24	CHE	Volume	2
25	CHE	Volume	2
26	CHE	Volume	2
27	CHE	Volume	2
28	Ship	Volume	35
29	Ship	Volume	35
30	Ship	Volume	35
31	Ship	Volume	35
32	Ship	Volume	35
33	Ship	Volume	35
34	Ship	Volume	35
35	Ship	Volume	35
36	Transfer stations	Volume	2
37	Transfer stations	Volume	2
38	Transfer stations	Volume	2
39	Transfer stations	Volume	2

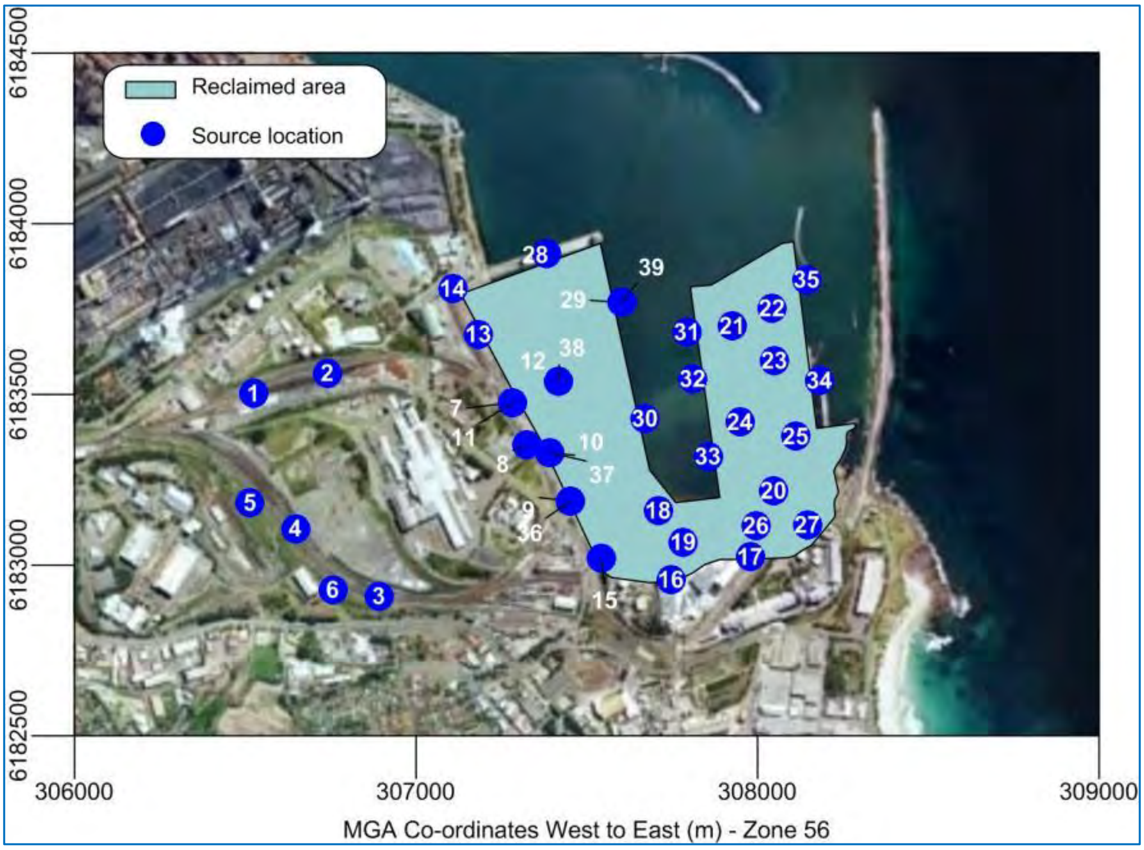


Figure 7.1: Location of sources – concept plan

The location of the sources for the major project Stage 1 is provided in **Figure 7.2** and the source parameters are summarised in **Table 7.18**.

Table 7.18: Source parameters for major project (Stage 1)

Source ID	Activity	Type	Release height (m)
1	Train	Stack	3
2	Train	Stack	3
3	Train	Stack	3
4	Train	Stack	3
5	Train	Stack	3
6	Train Unloading	Volume	2
7	Truck	Volume	2
8	Truck	Volume	2
9	Truck	Volume	2
10	Truck	Volume	2
11	Truck	Volume	2
12	Truck	Volume	2
13	CHE	Volume	2
14	CHE	Volume	2
15	Ship	Volume	35
16	Transfer stations	Volume	2
17	Transfer stations	Volume	2
18	Transfer stations	Volume	2
19	Transfer stations	Volume	2

Figure 7.2: Location of sources – major project (Stage 1)

7.7 Conversion of NO_x to NO_2

NO_2 is primarily a result of fuel combustion (i.e. motor vehicles and industry). Exceedances of the 1-hour NO_2 standard were common in Sydney during the 1980's, they have not been exceeded there since 1988 and levels in the Illawarra and Lower Hunter are even lower (**DECCW, 2010**). As discussed in **Section 5.3.2**, NO_2 monitoring at Wollongong near the site is significantly below the standard.

To determine the NO_2 concentrations at the receptors, the Approved Methods provides a number of approaches. For this assessment the Ozone Limiting Method (OLM) was used. The OLM assumes that at any given receptor location, the amount of NO that is converted to NO_2 by this reaction is proportional to the ambient O_3 concentration. If the O_3 concentration is less than the NO concentration, the amount of NO_2 formed by this reaction is limited. If the O_3 concentration is greater than or equal to the NO concentration, all the NO is assumed to be converted to NO_2. This is described by **Equation 1** below.

Equation 1

$$NO_{2_{pred}} = \left[0.1 \times NO_{x_{pred}}\right] + MIN\left[\left(0.9 \times NO_{x_{pred}}\right) \; or \; \left(\left(\frac{46}{48}\right) \times O_{3_{bkgd}}\right)\right] + NO_{2_{bkgd}}$$

Where:

$[NO_2]_{pred}$	= predicted NO_2 concentration (µg/m^3)
$[NO_x]_{pred}$	= model predicted NO_x concentration (µg/m^3)
MIN	= the minimum of the two quantities within the brackets
$[O_3]_{bkgd}$	= ambient O_3 concentration (µg/m^3)
(46/48)	= molecular weight of NO_2 divided by the molecular weight of O_3

$[NO_2]_{bkgd}$ = background concentration of NO_2 ($\mu g/m^3$)

In the equation above, the predicted NO_x concentration is multiplied by 10 per cent to account for the assumed thermal conversion of NO_x to NO_2. The remaining 90 per cent of the modelled NO_x (assumed to be NO) is challenged by the background O_3 concentration to determine the quantity of NO that is converted to NO_2.

It is important to note that O_3 only forms when there are sufficient concentrations of NO and volatile organic compounds (VOCs), adequate sunlight, and high enough temperatures to allow the photochemical reactions to occur. Elevated O_3 concentrations occur when dispersion of the resulting pollution is constrained by meteorological conditions and local topography.

AERMOD has an option for the OLM method and hourly O_3 monitoring data collected at the EPA Wollongong site for 2012 were used as input for the OLM.

7.8 Emissions from Neighbouring Facilities

7.8.1 Cement Grinding Mill

Cement Australia Pty Ltd obtained Project Approval (Application No. 10_0102) for a Cement Grinding Mill to be constructed on part of the Stage 1 footprint of the Outer Harbour Development. Project Approval for the Cement Grinding Mill was issued on 8 September 2011. A modification to the product mix of the Cement Grinding Mill was approved on 22 June 2012. This is now under construction, with operations anticipated to commence in 2014.

When in operation, the Cement Grinding Mill has the potential to release emissions of particulates, SO_2, NO_2 and CO.

The air quality assessment for the Cement Grinding Mill (**PAEHolmes, 2010**) indicates that maximum predicted particulate levels at a residential receptor as a result of the operations of the grinding mill is at R2 (labelled as R8 in the PAEHolmes report). The maximum predicted NO_2, SO_2 and CO concentrations was at R4 (labelled as R6 in the PAEHolmes report). The maximum predicted concentrations at a residential receptor are as summarised in **Table 7.19**.

Table 7.19: Maximum predicted concentrations at sensitive receivers due to Cement Grinding Mill operations

Pollutant	Averaging Period	Unit	Maximum Predicted Impact	Criteria
PM_{10}	24-hour	µg/m³	5.1	50
	Annual	µg/m³	0.7	30
TSP	Annual	µg/m³	1.1	90
Dust deposition	Annual	g/m²/month	0.1	4
NO_2	1-hour	µg/m³	9.8	246
	Annual	µg/m³	0.2	62
SO_2	10-minute	µg/m³	5.4	712
	1-hour	µg/m³	3.8	570
	24-hour	µg/m³	0.5	228
	Annual	µg/m³	0.1	60
CO	15-minute	mg/m³	0.5	100
	1-hour	mg/m³	0.4	30
	8-hour	mg/m³	0.1	10

The maximum predicted concentrations due to the Cement Grinding Mill operations were conservatively added to the predicted concentrations in this assessment to assess the cumulative concentrations from the two facilities.

7.8.2 Other Industries

The Project is located in the vicinity of the Blue Scope Steel Works and other associated heavy industrial activities which form the industrial area of Port Kembla. These industries are currently in operation and their contributions to local air quality are captured by the existing air quality monitoring networks such that they are represented in the background levels in the Port Kembla air shed. The background levels used for the cumulative assessment are discussed in **Section 7.9**.

7.9 Background Air Quality for Assessment Purposes

To assess the predicted concentrations at sensitive receivers against the relevant air quality impact assessment criteria, it is necessary to consider the existing background concentrations and levels for the area in which the Project would operate. The existing background levels account for other sources including domestic, commercial and existing industries in the Port Kembla area.

Based on the review of air quality data available since the start of 2007 (**Section 5.3**), the background levels are adopted for this assessment are summarised in **Table 7.20**.

There are no TSP (or dust deposition) data collected in the area, However, TSP concentrations can be broadly estimated from the PM_{10} measurements by assuming that 40 per cent of the TSP is PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**). There are no such data available for the Illawarra(?).

Therefore, based on an annual average PM_{10} concentration of 19 µg/m³, the annual average TSP background concentration would be approximately 48 µg/m³. This is a conservative estimate of background TSP concentration and accounts for 53 per cent of the annual TSP criterion.

The annual average quantity of deposited dust contributed by these other sources has been set at 2.2 g/m²/month. This was determined based on the dust deposition criterion and assumption that the ratio of background/criterion for TSP and dust deposition is the same. This is consistent with the air quality assessment for the Cement Grinding Mill (**PAEHolmes, 2010**).

Table 7.20: Background levels for cumulative assessment

Pollutant	Averaging Period	Unit	Background for Cumulative Assessment	Reference in Report
PM_{10}	24-hour	µg/m³	Varies daily	**Section 8.4.1**
	Annual	µg/m³	19	**Section 5.3.1.1**
$PM_{2.5}$	Annual	µg/m³	5	**Section 5.3.1.2**
TSP	Annual	µg/m³	48	-
Dust deposition	Annual	g/m²/month	2.2	-
NO_2	1-hour	µg/m³	Varies hourly	**Section 8.6.1**
	Annual	µg/m³	16	**Section 5.3.2**
SO_2	1-hour	µg/m³	49	**Section 5.3.3**
	24-hour	µg/m³	20	**Section 5.3.3**
	Annual	µg/m³	1.4	**Section 5.3.3**
CO	1-hour	mg/m³	2.1	**Section 5.3.4**
	8-hour	mg/m³	1.5	**Section 5.3.4**

8 Impact Assessment

8.1 Introduction

The EPA impact assessment criteria are those specified in the EPA Approved Methods. These have been applied in the assessment process following the practices used in contemporary approvals for projects in NSW.

The concentrations and deposition levels are present for the Project alone and cumulatively. The cumulative assessment includes predicted concentrations from the Project plus the Cement Grinding Mill (refer to **Section 7.8**) plus existing background concentrations, which includes the contribution from existing industries (refer to **Section 7.9**).

The EPA impact assessment criteria are provided in **Section 4.3**.

8.2 Model predictions

Dust concentrations and deposition levels for the modelled scenarios are presented as contour plots (see **Sections 8.3**, **8.4** and **8.4.1**). Predicted NO_2, CO and SO_2 concentrations are presented in **Section 8.6** to **Section 8.9**. The model predictions have been presented for the following:

- Predicted maximum 24-hour average PM_{10} concentration.
- Predicted annual average PM_{10} concentration.
- Predicted annual average TSP concentration.
- Predicted annual average dust deposition.
- Predicted maximum 24-hour average $PM_{2.5}$ concentration.
- Predicted annual average $PM_{2.5}$ concentration.
- Predicted maximum1-hour average NO_2 concentration.
- Predicted annual average NO_2 concentration.
- Predicted maximum1-hour and 24-hour average SO_2 concentration.
- Predicted annual average SO_2 concentration.
- Predicted maximum1-hour and 8-hour average CO concentration.

Dispersion model predictions have been made for three scenarios of the Project operation as outlined in **Table 7.1.** Contour plots of particulate concentrations and deposition levels show the areas that are predicted to be affected by dust at different levels. It is important to note that the isopleth figures are presented to provide a visual representation of the predicted impacts. To produce the isopleths it is necessary to make interpolations between prediction points, and as a result the isopleths may not always match exactly with predicted impacts at any specific location. The actual predicted particulate concentrations/levels at nearby receptors are presented in tabular form, with private receptors that are predicted to experience levels above the EPA's impact assessment criteria highlighted in bold.

Non-residential receptors were included in this assessment to identify the receptors which may require management measures.

8.3 Annual Average Particulate Predictions

8.3.1 PM_{10}

A summary of the predicted annual average PM_{10} concentrations at each of the individual receptors is provided in **Table 8.1**.

There are no privately owned receptors that are predicted to experience annual average PM_{10} concentrations above the assessment criteria, due to emissions from the Project-only or from the cumulative assessment for the Stage 1 and Typical Scenario.

The only receptors predicted to experience annual average concentrations above the assessment criteria due to emissions from the Project-only are R2 and R14 for the Concept Plan Worst Case scenario. It is noted that R14 is an industrial/commercial receptor.

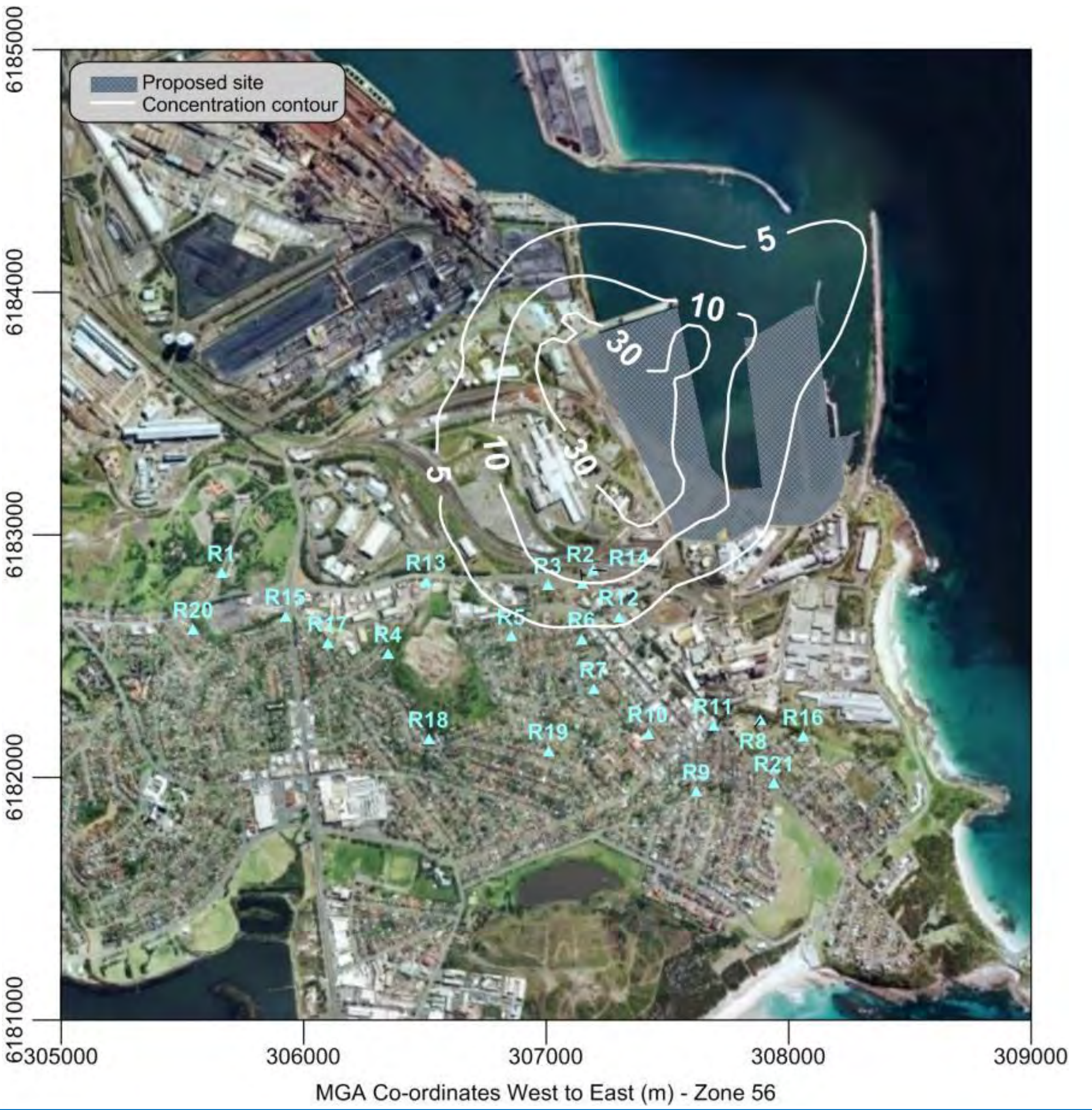
The cumulative assessment shows that in the Concept Plan Worst Case scenario, the receptors predicted to exceed the annual average concentration include R2, R3, R5, R6, R7, R12 and R14. It is noted that R12 and R14 are commercial/ industrial premises.

Figure 8.1 to **Figure 8.6** show the predicted annual average PM_{10} concentrations due to the operations of the Project alone and the cumulative assessment for all modelled scenarios.

Table 8.1: Annual Average PM_{10} Concentrations (µg/m³)

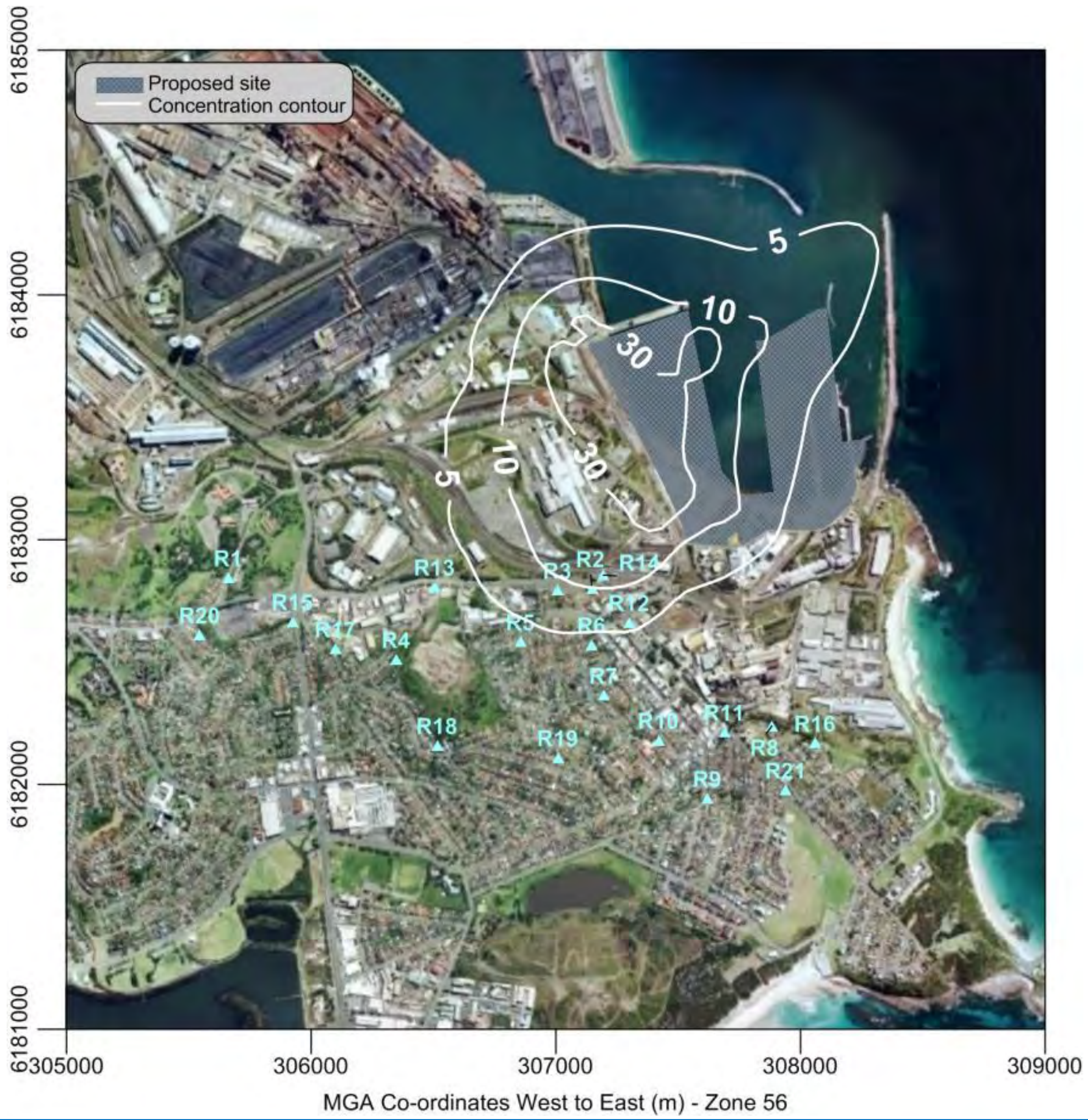
Receptor ID	Project Only: Major Project - Stage 1	Project Only: Concept Plan – Typical	Project Only: Concept Plan – Worst Case	Cumulative: Major Project - Stage 1	Cumulative: Concept Plan – Typical	Cumulative: Concept Plan – Worst Case
	Annual Average PM_{10} (µg/m³) *Assessment criteria = 30 µg/m³*					
R1	1	1	2	20	20	22
R2	10	9	**38**	30	28	**57**
R3	9	7	30	28	26	**50**
R4	2	2	6	22	21	26
R5	4	3	13	24	23	**33**
R6	5	4	18	24	24	**37**
R7	3	4	13	23	23	**33**
R8	1	2	6	21	21	26
R9	1	2	5	21	21	25
R10	2	2	6	21	22	26
R11	2	2	7	21	22	27
R12[1]	5	6	23	25	26	**43**
R13[1]	3	2	9	23	22	29
R14[1]	12	10	**46**	**31**	30	**65**
R15	1	1	4	21	21	23
R16	1	1	4	21	21	24
R17	1	1	5	21	21	24
R18	2	2	6	22	21	26
R19	2	2	7	22	22	26
R20	1	1	2	20	20	22
R21	1	1	4	21	21	24

[1] Commercial/Industrial receptors



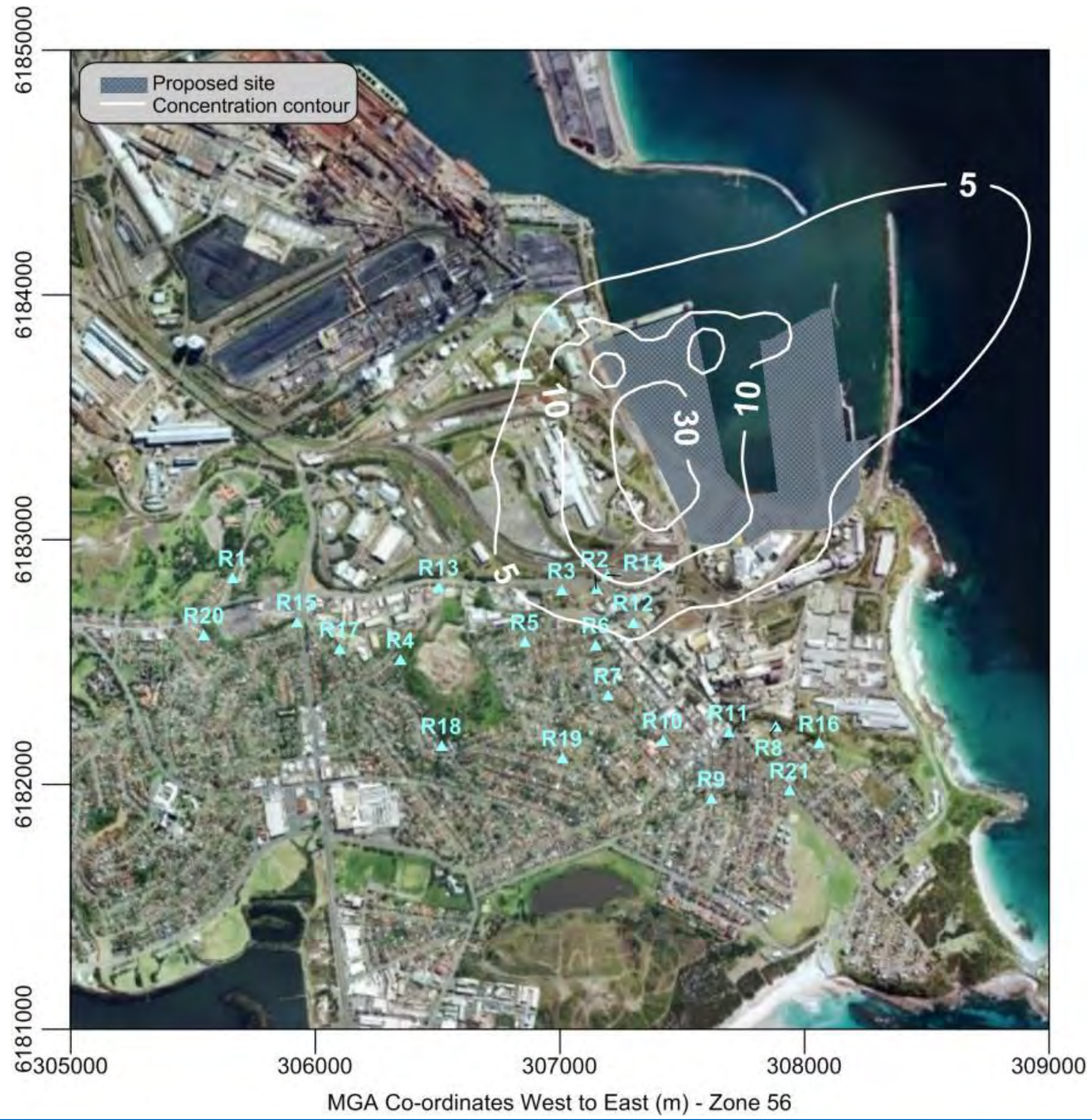
Species: PM10	Averaging Time: Annual	Percentile: Average	Scenario: Stage 1	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.1: Predicted annual average PM_{10} concentrations due to emissions from the Project alone – Stage 1



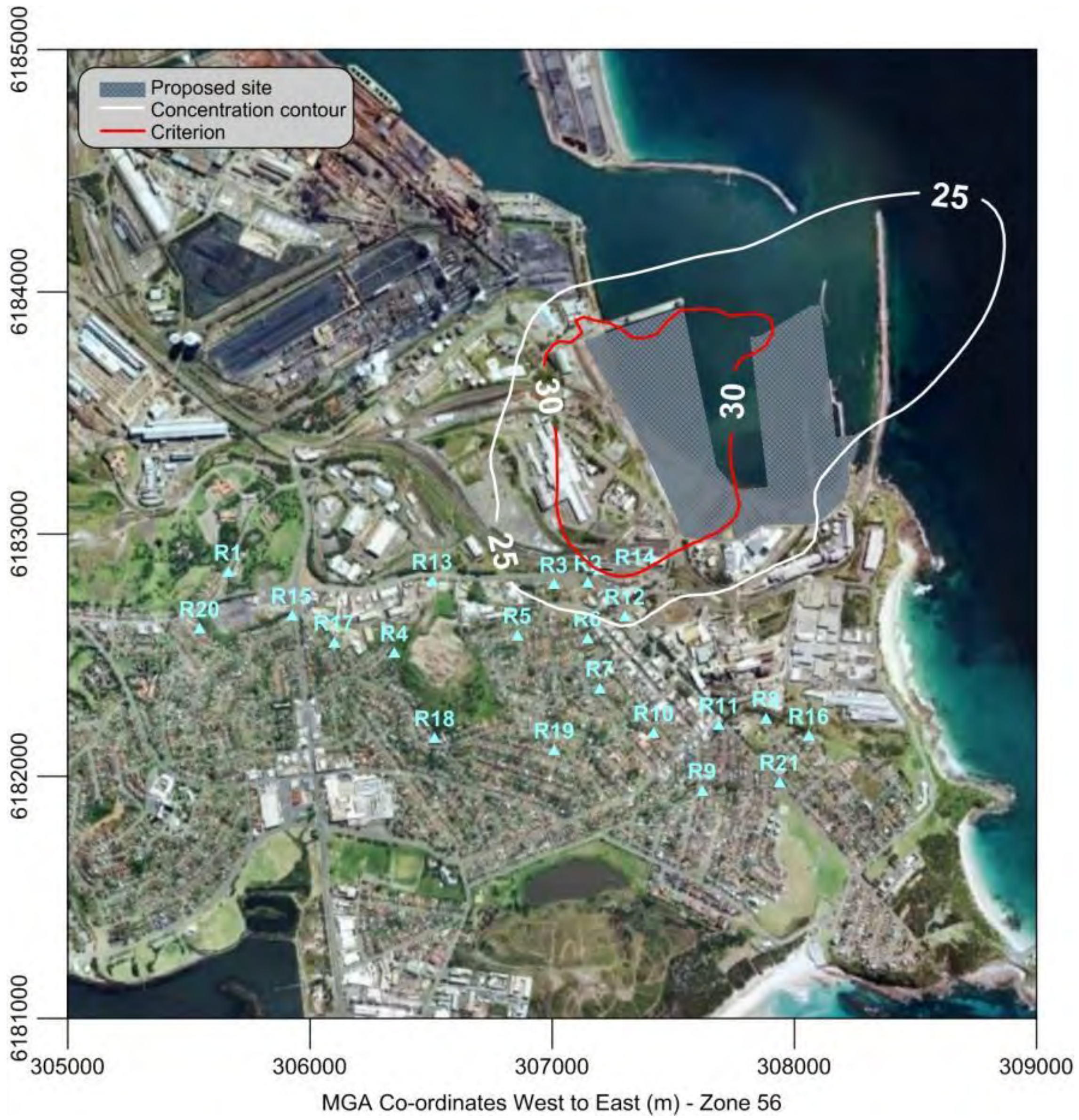
Species: PM10	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Stage 1	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** 30 µg/m³	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.2: Predicted cumulative annual average PM_{10} concentrations due to emissions from all sources – Stage 1



Species: PM10	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Typical – 4 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.3: Predicted annual average PM_{10} concentrations due to emissions from the Project alone – Concept Plan (Typical)



Species: PM10	Averaging Time: Annual	Percentile: Average	Scenario: Concept Plan (Typical – 4 Berths)	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** 30 µg/m³	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.4: Predicted cumulative annual average PM_{10} concentrations due to emissions from all sources – Concept Plan (Typical)

Species: PM10	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Worst Case – 7 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.5: Predicted annual average PM_{10} concentrations due to emissions from the Project alone – Concept Plan (Worst Case)

Species: PM10	Averaging Time: Annual	Percentile: Average	Scenario: Concept Plan (Worst Case – 7 Berths)	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** 30 µg/m³	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.6: Predicted annual average PM_{10} concentrations due to emissions from the all sources – Concept Plan (Worst Case)

8.3.2 TSP

A summary of the predicted annual average TSP concentrations at each of the individual receptors is provided in **Table 8.2**.

There are no residential receptors that are predicted to experience annual average PM_{10} concentrations above the assessment criteria, due to emissions from the Project-only or from the cumulative assessment for the Stage 1 and Concept Plan Typical scenario.

The only receptors predicted to experience annual average concentrations above the assessment criteria due to emissions from the Project-only are R2, R3 and R14 for the Concept Plan Worst Case scenario. It is noted that R14 is an industrial/commercial receptor.

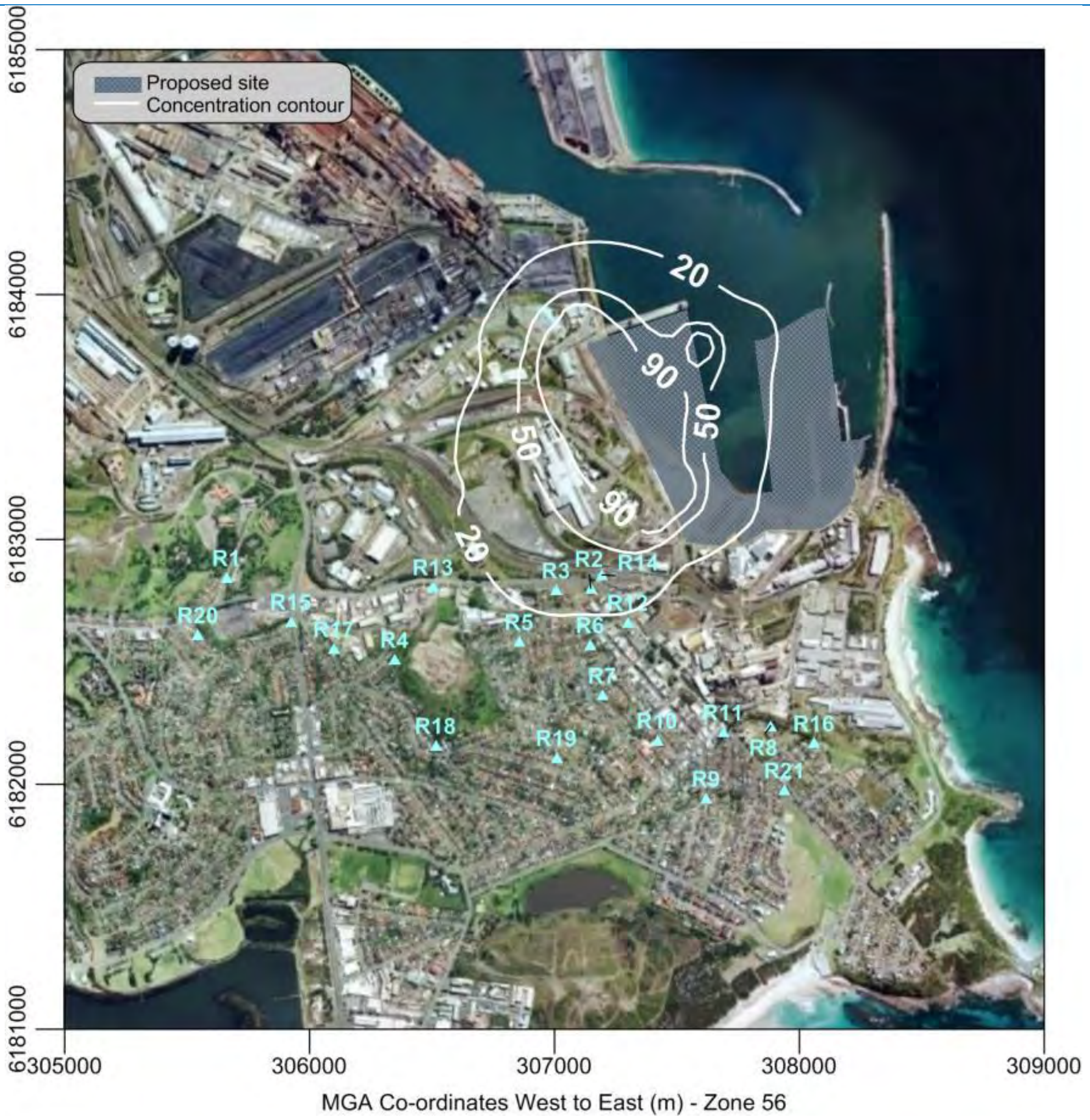
The cumulative assessment shows that in the Concept Plan Worst Case scenario, the receptors predicted to exceed the annual average concentration are R2, R3, R5, R6, R7, R12 and R14. It is noted that R12 and R14 are industrial/commercial premises.

Figure 8.7 to **Figure 8.12** shows the predicted annual average TSP concentrations due to the operations of the Project alone and the cumulative assessment for all modelled scenarios.

Table 8.2: Annual Average TSP Concentrations (µg/m³)

Receptor ID	Project Only			Cumulative		
	Major Project - Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Major Project - Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	Annual Average TSP (µg/m³) *Assessment criteria = 90 µg/m³*					
R1	2	1	6	51	50	55
R2	31	22	**133**	80	71	**182**
R3	28	17	**108**	77	66	**157**
R4	6	3	21	55	52	70
R5	12	8	46	61	56	**95**
R6	15	11	63	63	60	**112**
R7	10	8	44	58	56	**92**
R8	4	3	18	53	52	67
R9	4	3	17	53	52	65
R10	5	4	20	53	52	68
R11	5	4	23	54	53	71
R12[1]	17	15	83	66	63	**132**
R13[1]	9	5	31	58	54	80
R14[1]	37	27	**163**	85	76	**212**
R15	4	2	12	52	51	60
R16	3	2	14	52	51	62
R17	5	3	16	53	51	64
R18	6	4	21	54	52	69
R19	5	4	22	54	53	71
R20	2	1	6	51	50	55
R21	3	2	14	52	51	62

[1] Commercial/Industrial receptors

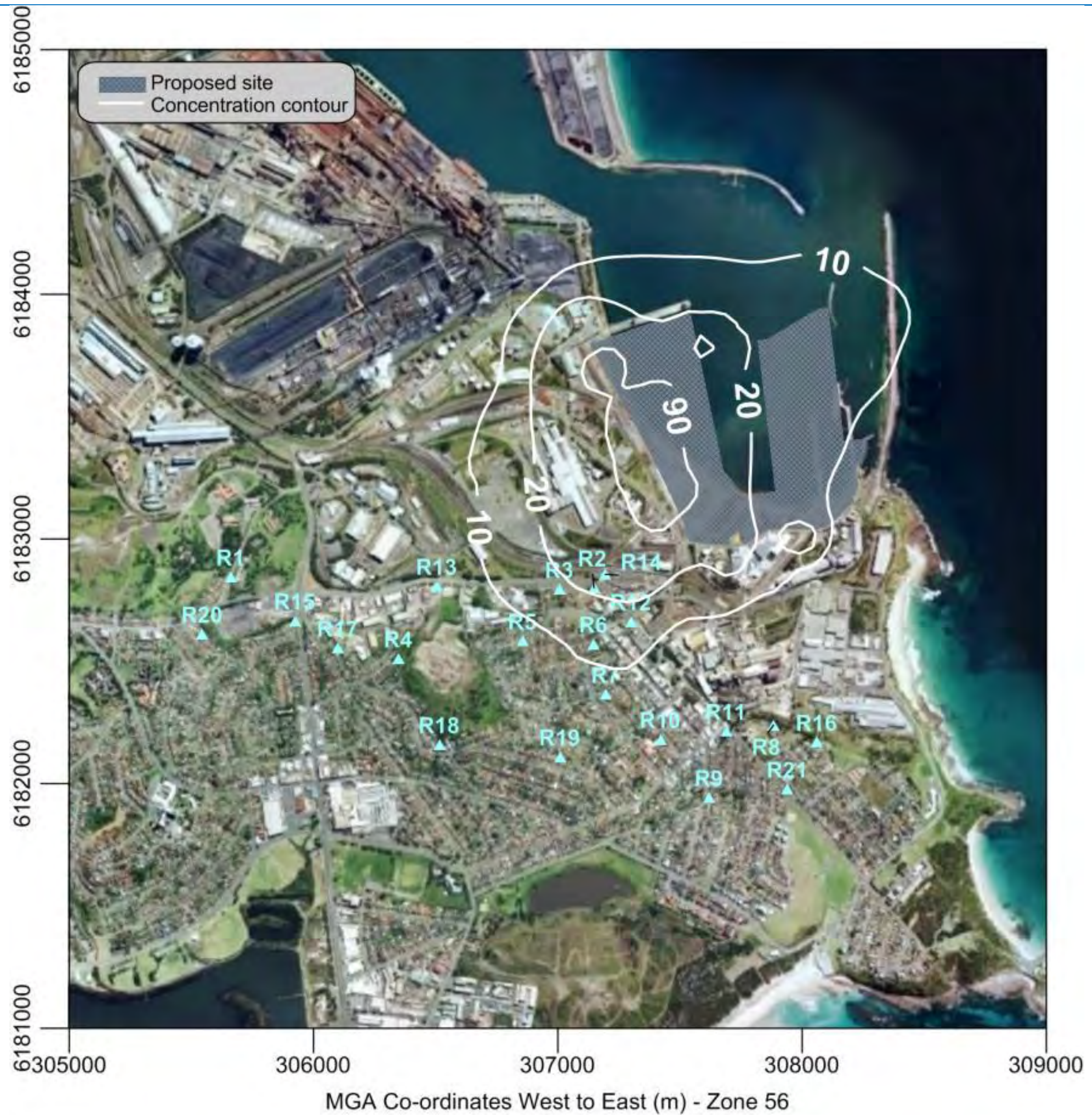


Species: TSP	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Stage 1	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.7: Predicted Annual average TSP concentrations due to emissions from the Project alone –

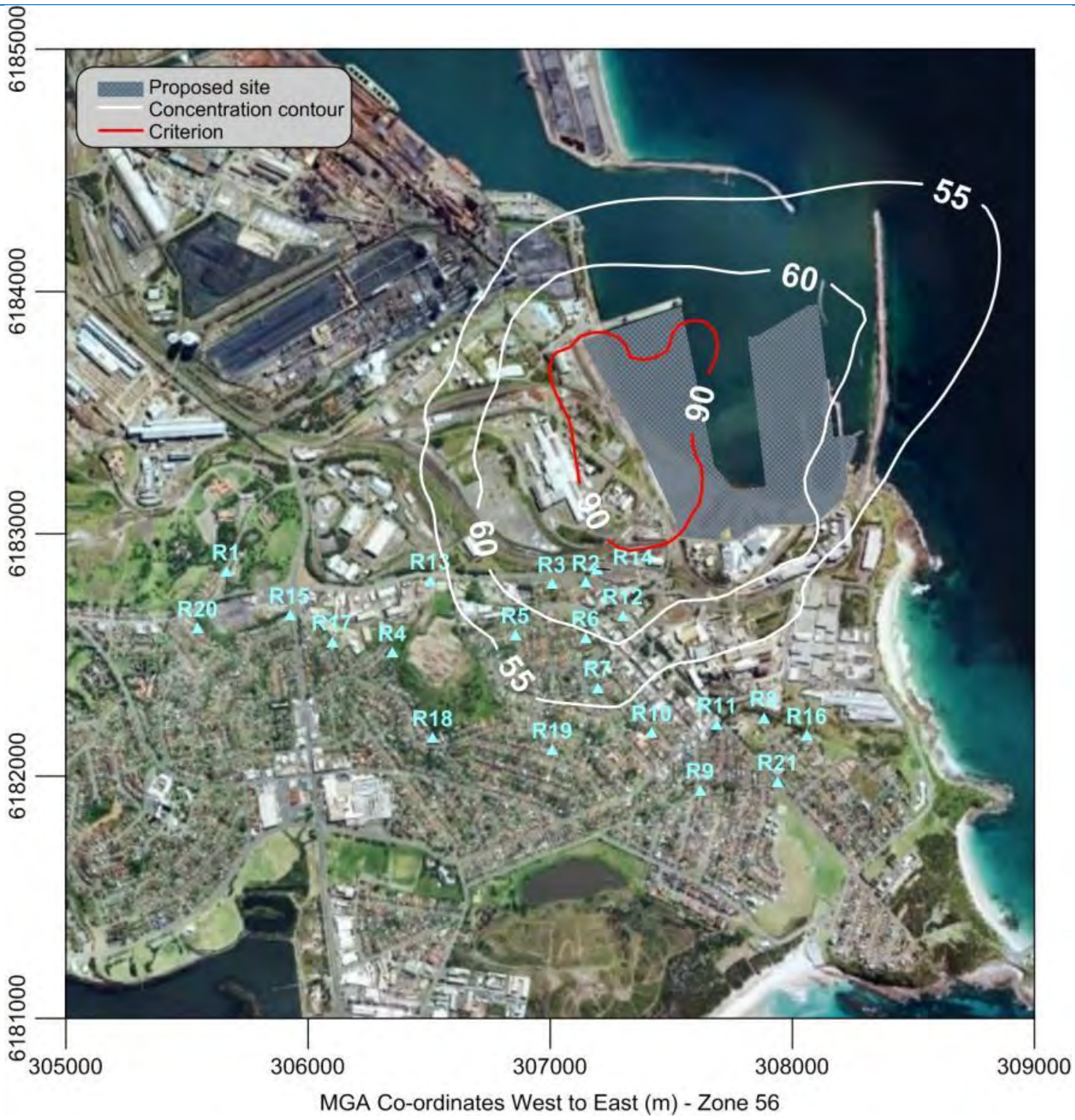
Species: TSP	Averaging Time: Annual	Percentile: Average	Scenario: Stage 1	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** 90 µg/m³	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.8: Predicted cumulative annual average TSP concentrations due to emissions from the all sources – Stage 1



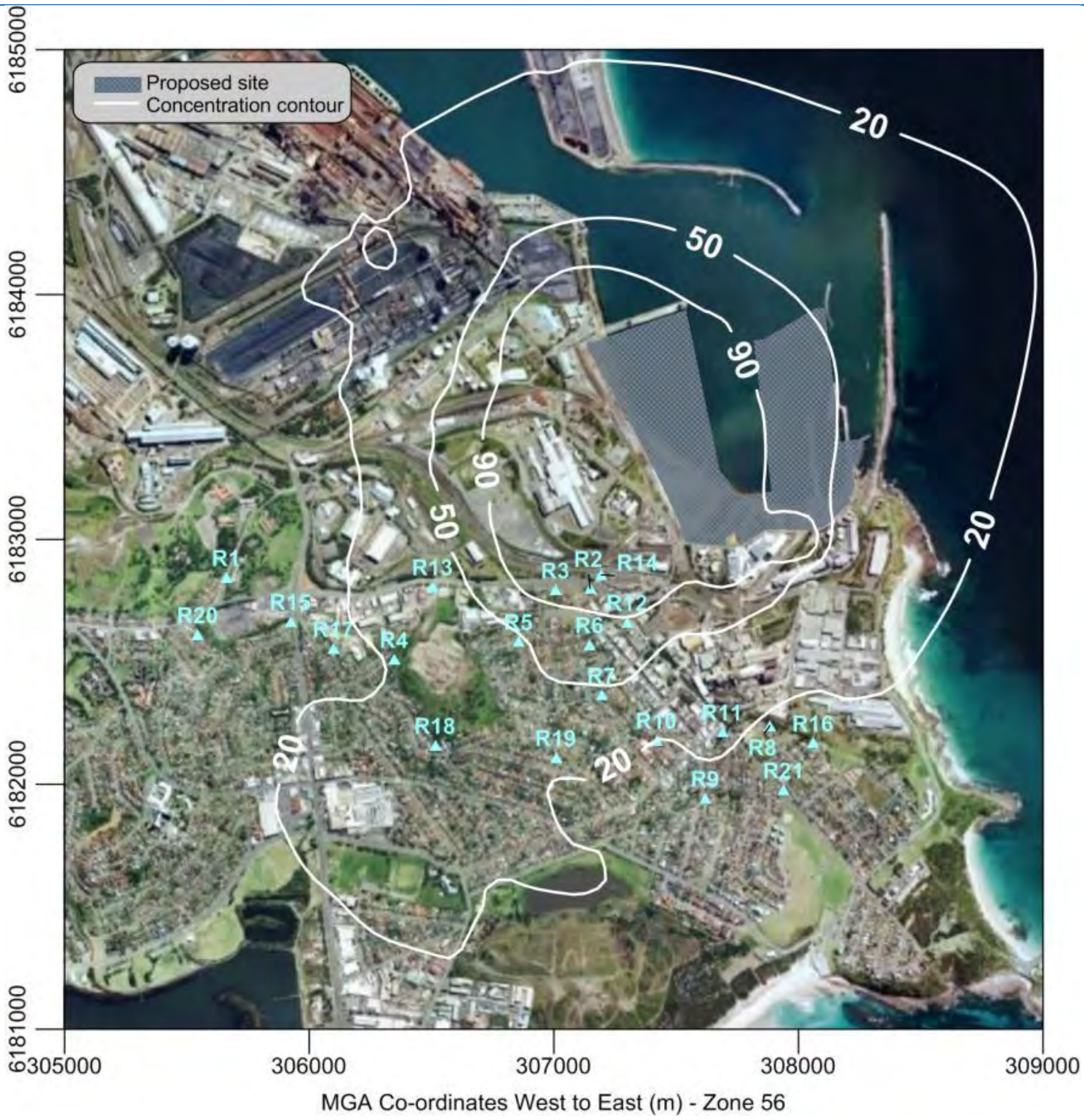
Species: TSP	Averaging Time: Annual	Percentile: Average	Scenario: Concept Plan (Typical – 4 Berths)	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.9: Predicted annual average TSP concentrations due to emissions from the Project alone – Concept Plan (Typical)



Species: TSP	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Typical – 4 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** 90 µg/m³	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.10: Predicted cumulative annual average TSP concentrations due to emissions from the all sources – Concept Plan (Typical)



Species: TSP	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Worst Case – 7 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.11: Predicted annual average TSP concentrations due to emissions from the Project alone – Concept Plan (Worst Case)

Species: TSP	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Worst Case – 7 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** 90 µg/m³	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.12: Predicted cumulative annual average TSP concentrations due to emissions from the all sources – Concept Plan (Worst Case)

8.3.3 Dust Deposition

A summary of the predicted dust deposition levels at each of the individual receptors is provided in **Table 8.3**.

There are no residential receptors that are predicted to experience annual average dust deposition levels above the assessment criteria, due to emissions from the Project-only or from the cumulative assessment for the Stage 1 and Concept Plan Typical scenario.

The only receptors predicted to experience annual average concentrations above the assessment criterion due to emissions from the Project-only are R2, R3, R12 and R14 for the Concept Plan Worst Case scenario. It is noted that R12 and R14 are industrial/commercial receptors.

The cumulative assessment shows that in the Concept Plan Worst Case scenario, the same receptors predicted to exceed the assessment criterion.

Figure 8.13 to **Figure 8.18** shows the predicted annual average dust deposition levels due to the operations of the Project alone and the cumulative assessment for all modelled scenarios.

Table 8.3: Annual Average Dust Deposition Levels (g/m²/month)

Receptor ID	Project Only			Cumulative		
	Major Project - Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Major Project - Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	Annual Average Dust Deposition (g/m²/month) *Assessment criteria = 4 g/m²/month (cumulative) = 2 g/m²/month (incremental)*					
R1	0.1	0.0	0.2	2.4	2.3	2.5
R2	0.9	0.7	**3.7**	3.2	3.0	**6.0**
R3	0.7	0.5	**2.9**	3.0	2.8	**5.2**
R4	0.2	0.1	0.6	2.5	2.4	2.9
R5	0.3	0.2	1.3	2.6	2.5	3.6
R6	0.4	0.3	1.7	2.7	2.6	4.0
R7	0.3	0.2	1.1	2.6	2.5	3.4
R8	0.2	0.1	0.7	2.5	2.4	3.0
R9	0.1	0.1	0.5	2.4	2.4	2.8
R10	0.2	0.1	0.7	2.5	2.4	3.0
R11	0.2	0.2	0.8	2.5	2.5	3.1
R12[1]	0.5	0.4	**2.4**	2.8	2.7	**4.7**
R13[1]	0.3	0.2	0.9	2.6	2.5	3.2
R14[1]	1.0	0.8	**4.6**	3.3	3.1	**6.9**
R15	0.1	0.1	0.3	2.4	2.4	2.6
R16	0.1	0.1	0.6	2.4	2.4	2.9
R17	0.1	0.1	0.4	2.4	2.4	2.7
R18	0.1	0.1	0.5	2.4	2.4	2.8
R19	0.1	0.1	0.6	2.4	2.4	2.9
R20	0.1	0.0	0.2	2.4	2.3	2.5
R21	0.1	0.1	0.5	2.4	2.4	2.8

[1] Commercial/Industrial receptors

Species: Dust Deposition	Averaging Time: Annual	Percentile: Average	Scenario: Stage 1	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** g/m²/month	**Assessment criterion:** 2 g/m²/month	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.13: Predicted Annual average dust deposition concentrations due to emissions from the Project alone – Stage 1

Species: Dust Deposition	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Stage 1	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** g/m²/month	**Assessment criterion:** 4 g/m²/month	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.14: Predicted cumulative annual average dust deposition concentrations due to emissions from the all sources – Stage 1

Species: Dust Deposition	Averaging Time: Annual	Percentile: Average	Scenario: Concept Plan (Typical – 4 Berths)	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** g/m²/month	**Assessment criterion:** 2 g/m²/month	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.15: Predicted annual average dust deposition concentrations due to emissions from the Project alone – Concept Plan (Typical)

Species: Dust Deposition	Averaging Time: Annual	Percentile: Average	Scenario: Concept Plan (Typical – 4 Berths)	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** g/m²/month	**Assessment criterion:** 4 g/m²/month	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.16: Predicted cumulative annual average dust deposition concentrations due to emissions from the all sources– Concept Plan (Typical)

Species: Dust Deposition	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Worst Case – 7 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** g/m²/month	**Assessment criterion:** 2 g/m²/month	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.17: Predicted annual average dust deposition concentrations due to emissions from the Project alone – Concept Plan (Worst Case)

Species: Dust Deposition	Averaging Time: Annual	Percentile: Average	Scenario: Concept Plan (Worst Case – 7 Berths)	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** g/m²/month	**Assessment criterion:** 4 g/m²/month	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.18: Predicted cumulative annual average dust deposition concentrations due to emissions from the all sources– Concept Plan (Worst Case)

8.3.4 Annual $PM_{2.5}$

A summary of the predicted $PM_{2.5}$ project only and cumulative annual average concentrations at each of the individual receptors is provided in **Table 8.4**.

There are no privately owned receptors that are predicted to experience annual average $PM_{2.5}$ concentrations above the advisory reporting standard, due to emissions from the Project-only in the Stage 1 and Concept Plan Typical scenario. There are two privately owned receptors (R2 and R3) that are predicted to exceed the advisory reporting standard when including background concentrations or cumulative sources. R14 (a commercial/industrial receptor) is also predicted to exceed the advisory reporting standard.

For the Concept Plan Worst Case scenario, the residential receptors predicted to experience annual average concentrations above the assessment criteria due to emissions from the Project-only are R2, R3 and R12. When combined with background concentrations and cumulative sources, ten receptors (R2, R3, R5, R6, R7, R10, R11, R12, R13 and R14) are predicted to exceed the annual average advisory reporting standard. R12, 13 and R14 are commercial/industrial receptors.

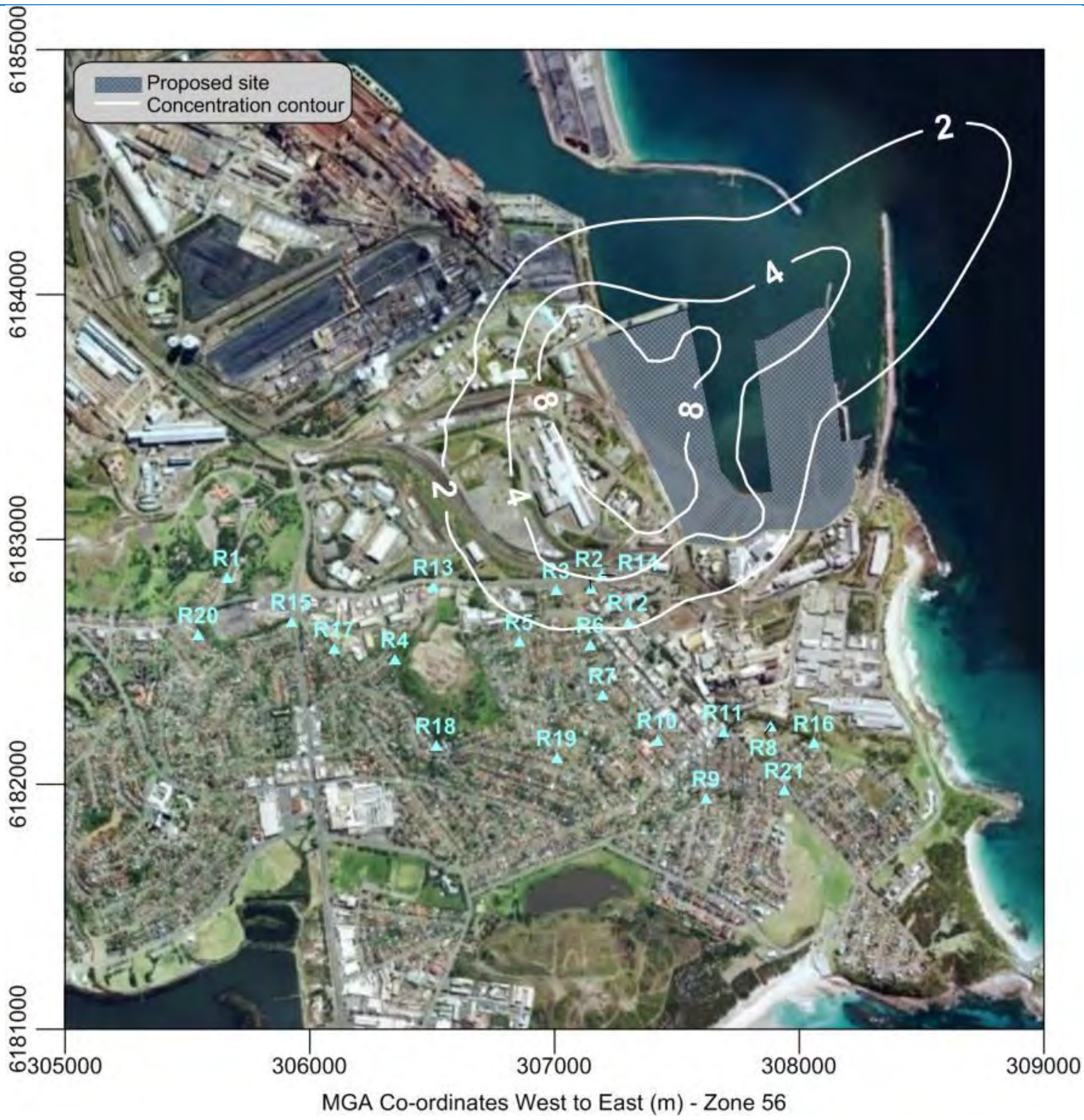
The majority of the $PM_{2.5}$ emissions are due to fuel consumption from ships and hauling.

Figure 8.19 to **Figure 8.24** shows the predicted annual average $PM_{2.5}$ concentrations due to the operations of the Project alone and the cumulative assessment for all modelled scenarios.

Table 8.4: Annual Average $PM_{2.5}$ Concentrations ($\mu g/m^3$)

Receptor ID	Project Only			Cumulative		
	Major Project - Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Major Project - Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	Annual Average $PM_{2.5}$ ($\mu g/m^3$) *Assessment criteria = 8 $\mu g/m^3$*					
R1	0	0	1	6	6	6
R2	4	4	**14**	**9**	**9**	**19**
R3	3	3	**11**	**9**	**9**	**17**
R4	1	1	3	6	7	8
R5	2	2	5	7	7	**11**
R6	2	2	7	7	8	**12**
R7	1	2	6	7	7	**11**
R8	1	1	3	6	7	8
R9	1	1	3	6	7	8
R10	1	1	3	6	7	**9**
R11	1	1	3	6	7	**9**
R12[1]	2	3	**9**	8	8	**14**
R13[1]	1	1	4	7	7	**9**
R14[1]	4	5	**17**	**10**	**10**	**22**
R15	1	1	2	6	6	7
R16	1	1	2	6	6	8
R17	1	1	2	6	6	8
R18	1	1	3	6	7	8
R19	1	1	3	6	7	**9**
R20	0	0	1	6	6	6
R21	1	1	2	6	6	8

[1] Commercial/Industrial receptors

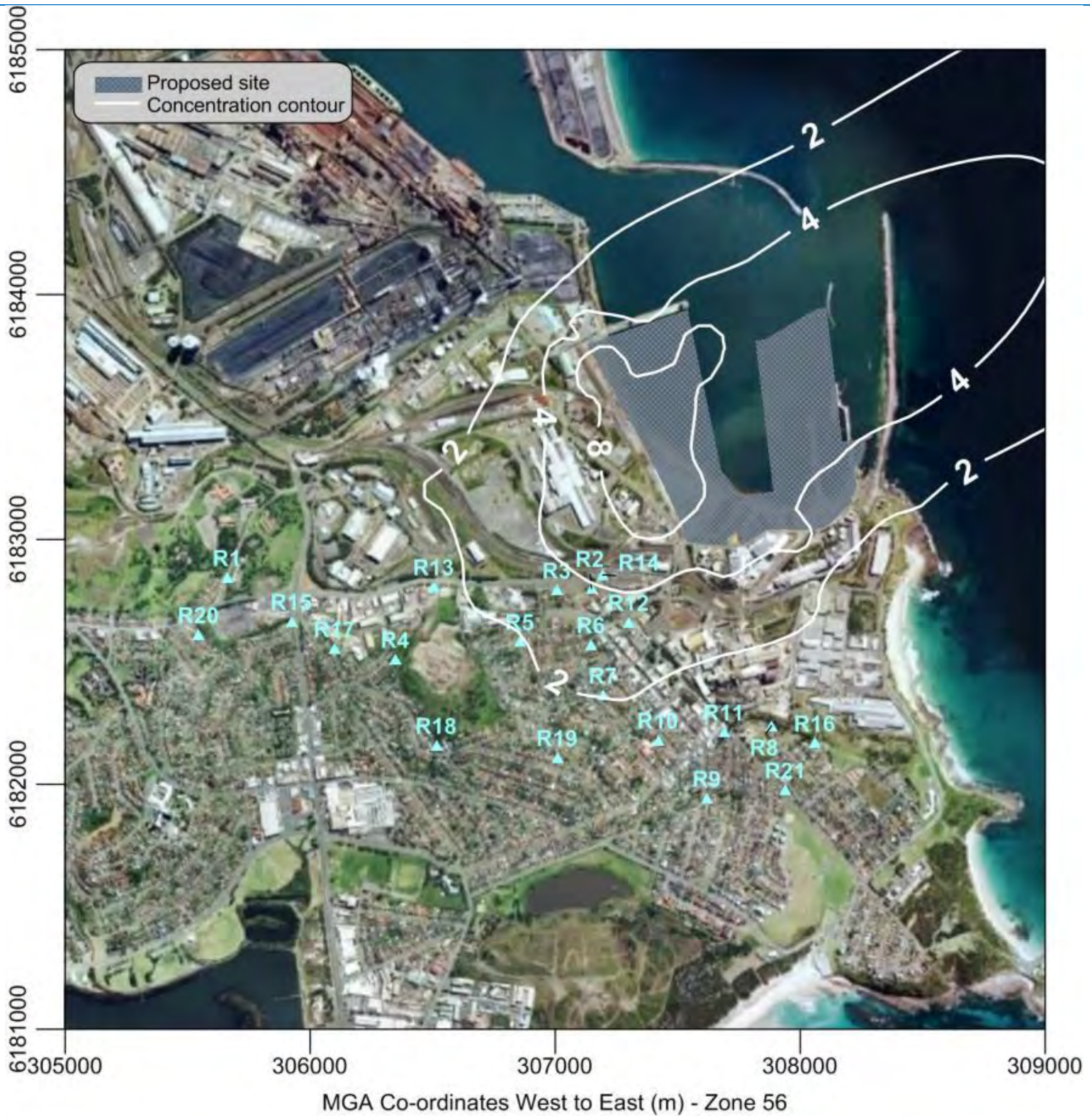


Species: PM2.5	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Stage 1	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.19: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project alone – Stage 1

Species: PM2.5	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Stage 1	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m3	**Assessment criterion:** 8 µg/m3	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.20: Predicted cumulative annual average $PM_{2.5}$ concentrations due to emissions from the all sources– Stage 1

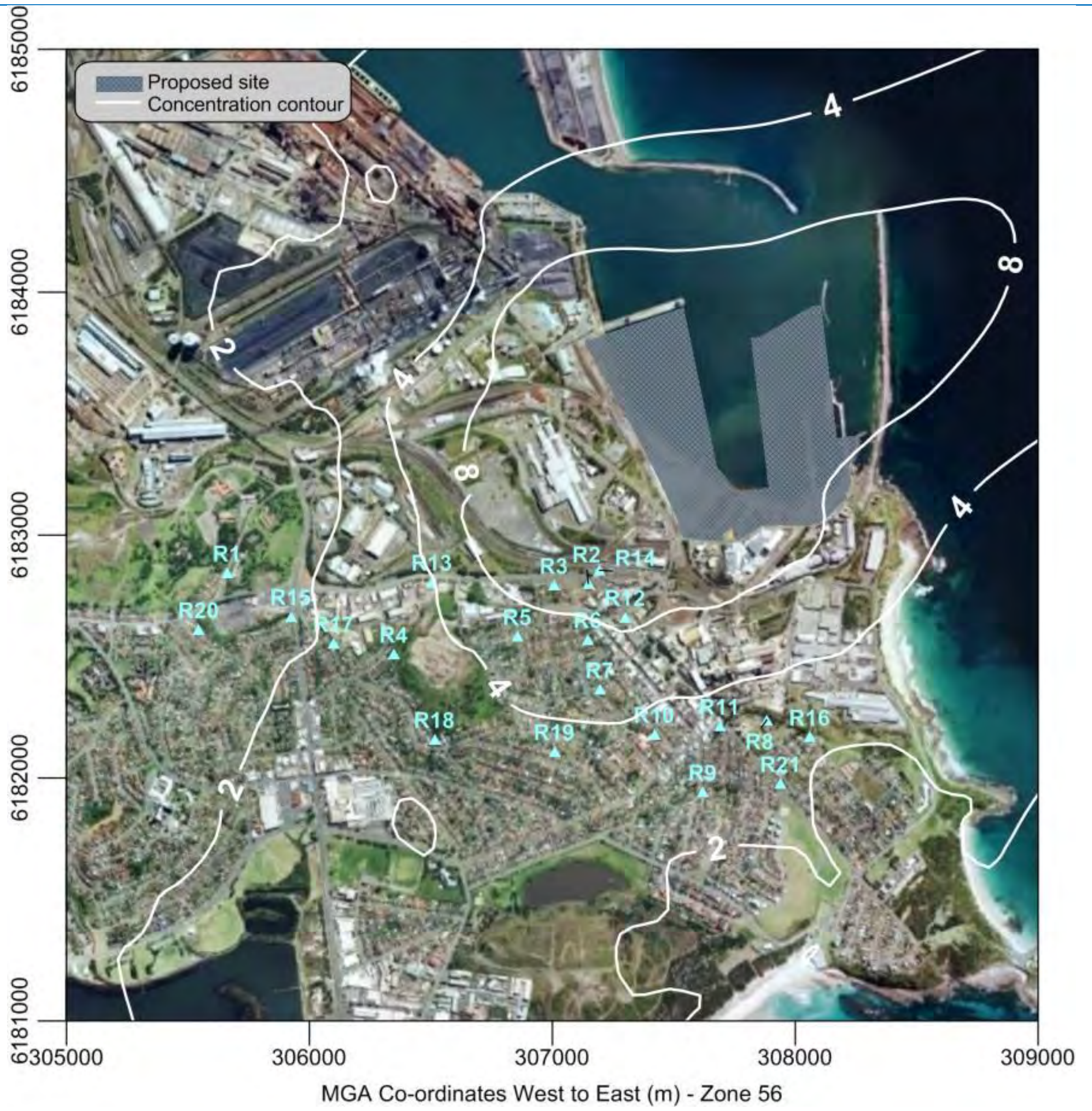


Species: $PM_{2.5}$	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Typical – 4 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.21: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project alone – Concept Plan (Typical)

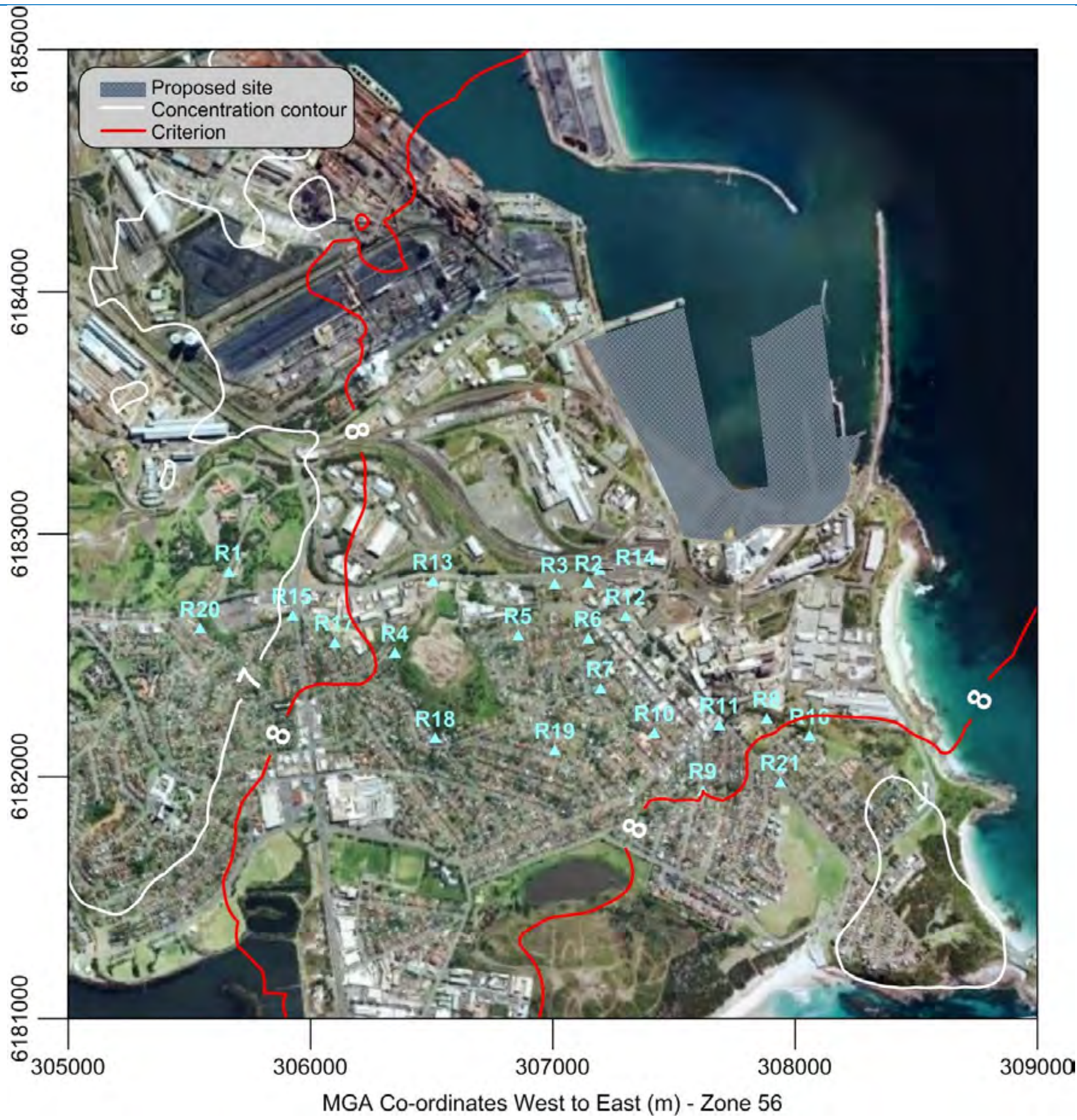
Species: PM$_{2.5}$	Averaging Time: Annual	Percentile: Average	Scenario: Concept Plan (Typical – 4 Berths)	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** 8 µg/m³	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.22: Predicted cumulative annual average PM$_{2.5}$ concentrations due to emissions from the all sources – Concept Plan (Typical)



Species: PM2.5	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Worst Case – 7 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.23: Predicted annual average $PM_{2.5}$ concentrations due to emissions from the Project alone – Concept Plan (Worst Case)



Species: PM2.5	**Averaging Time:** Annual	**Percentile:** Average	**Scenario:** Concept Plan (Worst Case – 7 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** 8 µg/m³	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.24: Predicted cumulative annual average $PM_{2.5}$ concentrations due to emissions from the all sources – Concept Plan (Worst Case)

8.4 24-hour average PM_{10}

A summary of the maximum predicted 24-hour average PM_{10} concentrations at each of the individual receptors due to the Project-alone is provided in **Table 8.5**. Predicted exceedances of the 24-hour average EPA criterion of 50 µg/m³ are shown in bold.

Model predictions show that for the Stage 1 scenario, three residences (R2, R3 and R12), are predicted to experience 24-hour average PM_{10} concentrations above the EPA impact assessment criterion of 50 µg/m³. R12 and R14 also exceeded the 24-hour average PM_{10} impact assessment criterion for the Concept Plan Typical scenario. It is noted that receptors R2, R3 and R12 are located with 500 m of the operations of the site. R12 and R14 are commercial/industrial receptors

For the Concept Plan Worst Case scenario, 14 residences (R2, R3, R5, R6, R7, R9, R10, R11, R12, R13, R14, R17, R18 and R19) are predicted to experience 24-hour average PM_{10} concentrations above the EPA impact assessment criterion of 50 µg/m³. R12 – R14 are commercial/industrial receptor.

A summary of the number of days over 50 µg/m³ is presented in **Table 8.6**. For the Stage 1 and Concept Plan Typical operations, there is only one day greater than 50 µg/m³. It is important to that that the predicted PM_{10} concentrations are significantly lower for the Concept Plan Typical scenario where a silt loading of 0.6 g/m² was used for sealed haul roads (compared with the silt loading of 9.7 g/m² at the entrance adjacent to Christy Drive (approximately 300 m) and a silt loading of 4.9 g/m² for all other internal roads used in the Stage 1 and Concept Plan Worst Case . This demonstrates the sensitivity of the silt loading factor on the air dispersion modelling, particularly on 24-hour average PM_{10} concentrations. An analysis on the sensitivity of the silt loading value on dust concentrations from the Project was completed for the Concept Plan Worst Case scenario and is provided in **Section 8.4.1**.

The 24-hour average PM_{10} contours presented in **Figure 8.25** to **Figure 8.27** do not represent a single worst case day, but rather represent the potential worst case 24-hour average PM_{10} concentration that could be reached at any particular location across the entire modelling year. The isopleth for the 24-hour average criterion of 50 µg/m³ is shown in red.

Table 8.5: Predicted maximum 24-hour average PM_{10} concentration due to the Project alone

Receptor ID	Major Project - Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	24-hour Average PM_{10} (µg/m³) *Assessment criteria = 50 µg/m³*		
R1	8	7	22
R2	**57**	48	**203**
R3	**62**	47	**187**
R4	16	14	46
R5	36	30	**110**
R6	40	37	**145**
R7	32	34	**116**
R8	14	18	49
R9	21	15	**80**
R10	20	11	**57**
R11	25	22	**106**
R12[1]	**54**	**55**	**197**
R13[1]	20	17	**56**
R14[1]	**57**	**60**	**224**
R15	14	12	38
R16	8	15	31
R17	15	12	**51**
R18	24	16	**67**
R19	16	21	**58**
R20	9	8	22
R21	12	16	44

[1] Commercial/Industrial receptors

Table 8.6: Summary of days over 50 µg/m³ for Project Alone

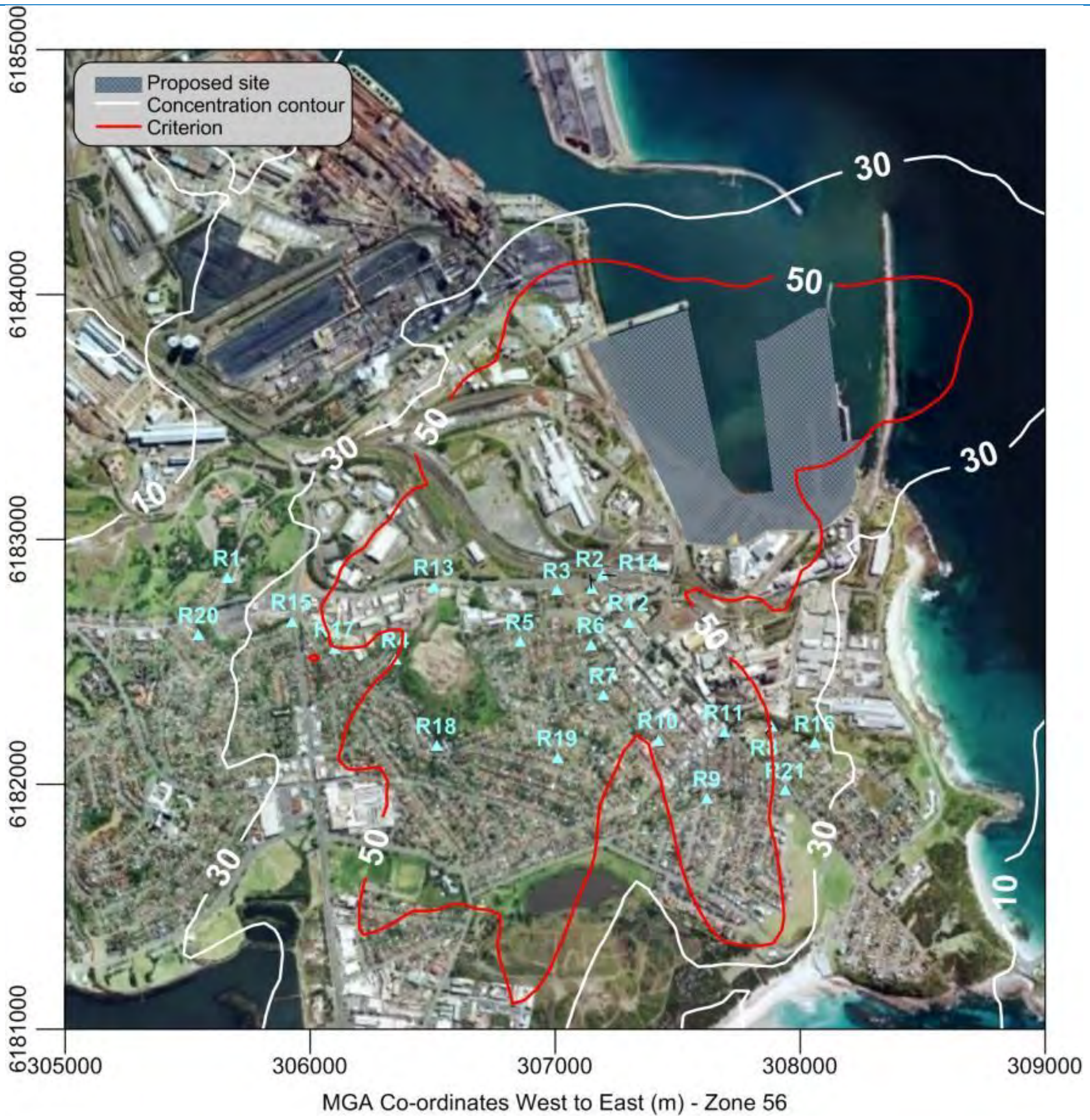
Receptor ID	Maximum predicted 24-hr PM_{10} Concentration (Project alone)	Predicted Days Over 50 µg/m³
Major Project (Stage 1)		
R2	**57**	1
R3	**62**	1
R5	36	0
R6	40	0
R7	32	0
R12	**54**	1
Concept Plan (Typical) Scenario		
R2	48	0
R3	47	0
R5	30	0
R6	37	0
R7	34	0
R12	55	1
Concept Plan (Worst Case) Scenario		
R2	**203**	96
R3	**187**	69
R5	**110**	19
R6	**145**	39
R7	**116**	11
R12	**197**	54

Species: PM10	**Averaging Time:** 24-hour	**Percentile:** Maximum	**Scenario:** Stage 1	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.25: Predicted 24-hour average PM_{10} concentrations due to emissions from the Project alone – Stage 1

Species: PM10	**Averaging Time:** 24-hour	**Percentile:** Maximum	**Scenario:** Concept Plan (Typical – 4 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.26: Predicted 24-hour average PM_{10} concentrations due to emissions from the Project alone – Concept Plan (Typical)



Species: PM10	**Averaging Time:** 24-hour	**Percentile:** Maximum	**Scenario:** Concept Plan (Worst Case – 7 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.27: Predicted 24-hour average PM_{10} concentrations due to emissions from the Project alone – Concept Plan (Worst Case)

8.4.1 Sensitivity Analysis of Silt Loading on Sealed Roads

The sensitivity of the silt loading factor for sealed internal roads on the air dispersion modelling results, particularly for 24-hour average PM_{10} is discussed in **Section 8.4**. A silt loading of 9.7 g/m^2 at the entrance adjacent to Christy Drive (approximately 300 m) and a silt loading of 4.9 g/m^2 for all other internal roads was used in the Stage 1 and Concept Plan Worst Case. As discussed in **Section 7.1**, a silt loading of 9.7 g/m^2 is considered to be very conservative for the site as this is the average factor for an iron and steel production facility (**US EPA, 1985 and updates**).

A sensitivity analysis was completed based on the Concept Plan Worst Case scenario with a silt loading of 0.6 g/m^2. This is the silt loading from US EPA for public roads with less than 500 vehicles a day. During the Concept Plan Worst Case, the site will have an average of approximately 500 vehicles per day. The rationale for using this silt loading in the sensitivity analysis was that as the operations at the Site is not considered to be very dusty, the roads are likely to have a silt loading similar to public sealed roads.

The results of the sensitivity analysis when compared to the base case for the Concept Plan Worst Case scenario are shown in **Table 8.7, Table 8.8** and **Table 8.9**.

The TSP and dust deposition results indicate a reduction of 77% to 85% at the receptors. For PM_{10}, the reduction for annual average concentration at the receptors is between 61% and 76%, and the reduction for 24-hour average concentration at the receptors is between 33% and 79%.

As discussed in **Section 4.2.1**, fine particulates (i.e. $PM_{2.5}$) are generally emitted from products of combustion. Emissions from the fuel usage of the ships at berth account for more than 50% of the total $PM_{2.5}$ emissions from Concept Plan Worst Case scenario. Therefore, the effect of reducing fugitive dust emissions from hauling on sealed roads is less for PM2.5 emissions than for PM_{10} and TSP emissions. The reduction in $PM_{2.5}$ impacts at the receptors is between 11% and 69%.

There are no residences predicted to exceed the annual average $PM_{2.5}$, PM_{10}, TSP and dust deposition criterion when the silt loading for the haul roads is reduced to 0.6 g/m^2. There is a marginal exceedance of the 24-hour average PM_{10} criterion at R2 based on the sensitivity scenario. There are two privately owned receptors (R2 and R6) that are predicted to experience 24-hour average $PM_{2.5}$ concentrations above the 24-hour advisory reporting standard. It is noted that the worst case scenario assumes a conservative 7 ships at berth at the same time, the chances of this happening will be low

The results of the sensitivity analysis indicate that dust from the site can be managed by reducing the silt loading on the internal haul roads at the site. This can be achieved by ensuring the road is swept on a regular basis.

It is recommended that PKPC obtain the site specific silt loading factor for the internal roads once Stage 1 is operational. This will enable more accurate estimation of dust emissions from haulage on internal roads at the site prior to the implementation of Stage 2 and Stage 3 and help inform any management measures, should they be required.

Table 8.7: Sensitivity analysis TSP and dust deposition – Concept Plan Worst Case

Receptor ID	Annual Average TSP (µg/m³) *Criterion = 90 µg/m³*			Annual Average Dust Deposition (g/m²/month) *Criterion = 2 g/m²/month*		
	Worst Case - Base	Worst Case - Sensitivity	% Reduction	Worst Case - Base	Worst Case - Sensitivity	% Reduction
R1	6	1	83%	0.2	0.0	81%
R2	**133**	23	83%	**3.7**	0.7	81%
R3	**108**	18	84%	**2.9**	0.5	82%
R4	21	4	83%	0.6	0.1	81%
R5	46	8	83%	1.3	0.2	81%
R6	63	11	82%	1.7	0.3	81%
R7	44	8	81%	1.1	0.2	79%
R8	18	4	80%	0.7	0.2	78%
R9	17	3	81%	0.5	0.1	79%
R10	20	4	80%	0.7	0.1	79%
R11	23	4	81%	0.8	0.2	80%
R12[1]	83	15	82%	**2.4**	0.5	80%
R13[1]	31	5	84%	0.9	0.2	81%
R14[1]	**163**	28	83%	**4.6**	0.9	81%
R15	12	2	83%	0.3	0.1	81%
R16	14	3	79%	0.6	0.1	77%
R17	16	3	83%	0.4	0.1	81%
R18	21	4	82%	0.5	0.1	80%
R19	22	4	80%	0.6	0.1	79%
R20	6	1	83%	0	0	81%
R21	14	3	80%	0	0	78%

[1] Commercial/Industrial receptors

Table 8.8: Sensitivity analysis PM_{10} – Concept Plan Worst Case

Receptor ID	Annual Average PM_{10} (µg/m³) *Criterion = 30 µg/m³*			24-hour Average PM_{10} (µg/m³) *Criterion = 50 µg/m³*		
	Worst Case - Base	Worst Case - Sensitivity	% Reduction	Worst Case - Base	Worst Case - Sensitivity	% Reduction
R1	2	1	68%	22	8	61%
R2	**38**	9	75%	**203**	**52**	74%
R3	30	7	76%	**187**	48	74%
R4	6	2	68%	46	15	67%
R5	13	4	70%	**110**	32	71%
R6	18	5	71%	**145**	44	69%
R7	13	4	68%	**116**	36	69%
R8	6	2	64%	49	23	52%
R9	5	2	65%	**80**	16	79%
R10	6	2	61%	**57**	14	75%
R11	7	2	66%	**106**	24	77%
R12[1]	23	7	72%	**197**	**57**	71%
R13[1]	9	3	71%	**56**	20	64%
R14[1]	**46**	11	75%	**224**	**64**	71%
R15	4	1	68%	38	14	64%
R16	4	2	61%	31	21	33%
R17	5	1	68%	**51**	14	72%
R18	6	2	67%	**67**	19	72%
R19	7	2	64%	**58**	26	54%
R20	2	1	66%	22	8	62%
R21	4	2	64%	44	21	52%

[1] Commercial/Industrial receptors

Table 8.9: Sensitivity analysis $PM_{2.5}$ – Concept Plan Worst Case

Receptor ID	Annual Average $PM_{2.5}$ (µg/m³) *Criterion = 8 µg/m³* Worst Case - Base	Worst Case - Sensitivity	% Reduction	24-hour Average $PM_{2.5}$ (µg/m³) *Criterion = 25 µg/m³* Worst Case - Base	Worst Case - Sensitivity	% Reduction
R1	1	0	46%	12	7	39%
R2	**14**	4	67%	**72**	**28**	62%
R3	**11**	4	68%	**73**	25	66%
R4	3	1	49%	21	13	40%
R5	5	2	55%	**44**	18	58%
R6	7	3	57%	**46**	**26**	44%
R7	6	3	53%	**41**	22	47%
R8	3	2	44%	**27**	19	31%
R9	3	1	46%	**31**	9	69%
R10	3	2	39%	21	13	41%
R11	3	2	46%	**38**	13	67%
R12[1]	**9**	4	60%	**64**	24	62%
R13[1]	4	2	54%	22	12	43%
R14[1]	**17**	5	69%	**83**	**30**	64%
R15	2	1	49%	16	8	49%
R16	2	1	40%	21	19	11%
R17	2	1	49%	23	10	56%
R18	3	1	48%	**29**	15	49%
R19	3	2	44%	**29**	19	34%
R20	1	1	43%	11	7	40%
R21	2	1	43%	25	17	31%

[1] Commercial/Industrial receptors

8.4.2 Cumulative 24-hour average PM_{10} concentrations

8.4.2.1 Introduction

It is difficult to accurately predict cumulative 24-hour PM_{10} concentration using dispersion modelling due to the difficulties in resolving (on a day-to-day basis) the varying intensity, duration and precise locations of activities at industrial sites, weather conditions at the time of the activity, or a combination of activities.

Difficulties in predicting cumulative 24-hour concentrations are compounded by the day-to-day variability in ambient dust levels and the spatial and temporal variation in any other anthropogenic activity and natural events e.g. industrial activity, dust storms, bushfires etc. Experience shows that in many cases the worst-case 24-hour average PM_{10} concentrations are strongly influenced by other sources in an area, such as bushfires and dust storms, which are essentially unpredictable. Industrial operations in the Port Kembla area also have the potential to contribute to elevated 24-hour average PM_{10} concentrations, however, they are likely to be more localised. The variability in 24-hour average PM_{10} concentrations can be clearly seen in the data collected at the EPA monitors (see **Section 5.3.1.1**).

The EPA Approved Methods describe two methods for assessing cumulative air quality impacts (see Section 11.2 **DEC, 2005**).

The Level 1 assessment (suitable for a screening assessment) requires that the highest predicted concentration from a proposal is added to the highest observed concentration in a data set which provides measurements of PM_{10} concentrations representative of conditions at the site being assessed.

The second method, a Level 2 assessment, and each individual dispersion model exceedance is added to the corresponding measured background concentration. The maximum measured 24-hour average PM_{10} concentration in 2012 at Wollongong EPA was 48 µg/m³.

Eight receptors (R2, R3, R5, R6, R7, R12, R13 and R14) were selected for cumulative analysis based on their proximity to these operations, and the magnitude of their Project-only predictions (see **Section 8.4**). It is noted R12, R13 and R14 are commercial/industrial premises.

Table 8.10 presents a summary of the following for Stage 1 and the Concept Plan Typical scenarios:

- The maximum predicted concentration due to the Project-alone.
- The maximum cumulative concentrations when adding the maximum predicted concentration to the maximum measured concentration. Note that an additional concentration of 5 $\mu g/m^3$ has been included to account for the contribution from the Cement Grinding Facility.
- The number of additional exceedances of the impact assessment criteria of 50 $\mu g/m^3$.

It is apparent from the Concept Plan – Worst Case scenario that based on the current assumptions, there is significant potential for this to result in exceedances of the criteria, and as such no further assessment has been made.

Table 8.10 shows that there is potential for a number of exceedances of the 24-hour average PM_{10} impact assessment criteria during both Stage 1 and the Concept Plan Typical scenarios. As demonstrated in **Section 8.4.1**, the predicted concentrations are extremely sensitive to the assumed silt loading on the sealed roads within the site, and it is recommended that PKPC collect data on the silt loading to provide more certainty in any future dispersion modelling.

Table 8.10: Summary of 24-hour average PM_{10} concentrations ($\mu g/m^3$)

ID	Stage 1 Maximum predicted	Stage 1 Maximum cumulative	Stage 1 No. of days > 50 $\mu g/m^3$	Concept Plan - Typical Maximum predicted	Concept Plan - Typical Maximum cumulative	Concept Plan - Typical No. of days > 50 μ/m^3
R2	57	76	43	48	78	39
R3	62	92	38	47	76	26
R5	36	65	10	30	60	11
R6	40	64	15	37	67	16
R7	32	63	9	34	63	8
R12	54	73	15	55	75	21
R13	20	55	7	17	55	5
R14	57	86	52	60	90	47

8.5 24-hour Average $PM_{2.5}$

A summary of the maximum predicted 24-hour average $PM_{2.5}$ concentrations at each of the individual receptors is provided in **Table 8.11**.

For the Stage 1 and Concept Plan Typical scenario, there are no privately owned receptors that are predicted to experience 24-hour average $PM_{2.5}$ concentrations above the 24-hour advisory reporting standard, due to emissions from the Project-only.

For the Concept Plan Worst Case scenario, 12 residences (R2, R3, R5, R6, R7, R8, R9, R11, R12, R17, R18 and R19) are predicted to experience 24-hour average PM_{10} concentrations above the EPA impact assessment criterion of 25 $\mu g/m^3$.

Figure 8.28 to **Figure 8.30** present contour plots for the predicted maximum 24-hour average $PM_{2.5}$ concentrations for the Project-only for each modelled scenario.

The 24-hour $PM_{2.5}$ contours do not represent a single worst case day, but rather represent the potential worst case 24-hour average $PM_{2.5}$ concentration that could be reached at any particular location across the entire modelling year. The isopleth for the 24-hour average criterion of 25 $\mu g/m^3$ is shown in red.

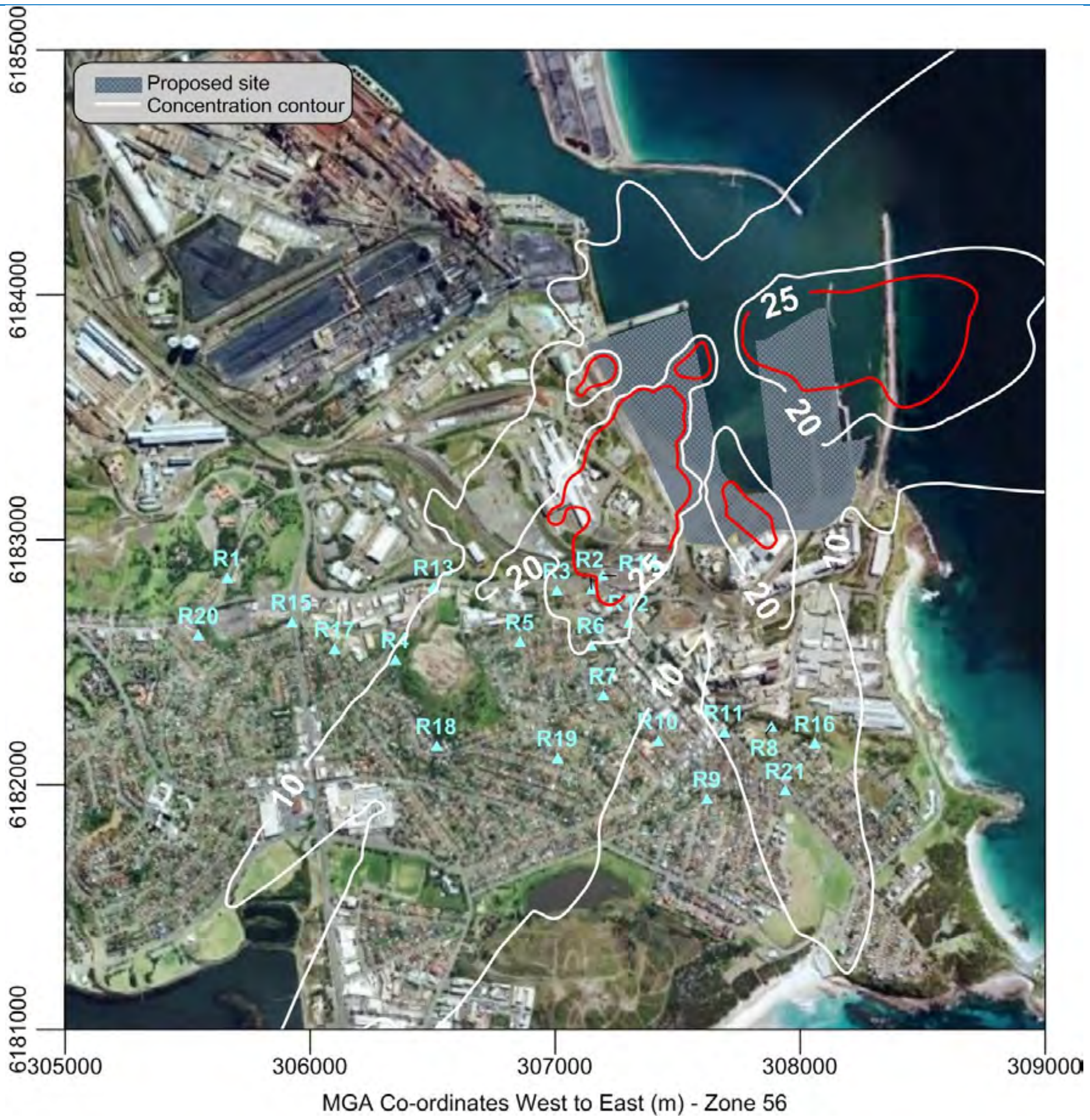
Table 8.11: Maximum Predicted Project-only 24-hour Average $PM_{2.5}$ Concentrations (µg/m³)

Receptor ID	Major Project - Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	24-hour Average $PM_{2.5}$ (µg/m³) *Assessment criteria = 25 µg/m³*		
R1	4	6	12
R2	20	21	**72**
R3	**27**	23	**73**
R4	9	11	21
R5	18	17	**44**
R6	12	20	**46**
R7	12	15	**41**
R8	9	14	**27**
R9	8	7	**31**
R10	7	9	21
R11	10	11	**38**
R12[1]	19	21	**64**
R13[1]	8	9	22
R14[1]	21	25	**83**
R15	6	7	16
R16	6	14	21
R17	6	7	23
R18	12	11	**29**
R19	6	14	**29**
R20	4	5	11
R21	8	13	25

[1] Commercial/Industrial receptors

Species: PM2.5	Averaging Time: 24-hour	Percentile: Maximum	Scenario: Stage 1	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.28: Predicted 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project alone – Stage 1



Species: PM2.5	**Averaging Time:** 24-hour	**Percentile:** Maximum	**Scenario:** Concept Plan (Typical – 4 Berths)	**Location:** Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.29: Predicted 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project alone – Concept Plan (Typical)

Species: PM2.5	Averaging Time: 24-hour	Percentile: Maximum	Scenario: Concept Plan (Worst Case – 7 Berths)	Location: Port Kembla
Model Used: AERMOD 8.2	**Units:** µg/m³	**Assessment criterion:** N/A	**Met Data:** AERMET 2012	**Plot:** R Kan

Figure 8.30: Predicted 24-hour average $PM_{2.5}$ concentrations due to emissions from the Project alone – Concept Plan (Worst Case)

8.6 Nitrogen Dioxide

A summary of the predicted NO_2 concentrations at each of the individual receptors is provided in **Table 8.12**. There are no exceedances of the 1-hour or annual average NO_2 criterion at the privately owned receptors as result of the Project alone.

Table 8.12: Maximum Predicted Project-only NO_2 Concentrations (µg/m³)

Receptor ID	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	1-hour Average NO_2 (µg/m³) *Assessment criteria = 246 µg/m³*			Annual Average NO_2 (µg/m³) *Assessment criteria = 62 µg/m³*		
R1	74	146	187	1	2	2
R2	120	150	244	4	9	11
R3	159	163	236	4	8	10
R4	100	158	193	2	5	5
R5	125	138	202	3	6	7
R6	100	124	200	3	6	8
R7	117	136	183	2	6	7
R8	72	117	160	1	4	5
R9	69	129	190	1	3	5
R10	86	125	179	2	4	6
R11	65	140	201	1	4	5
R12[1]	147	166	209	3	7	9
R13[1]	98	164	217	2	6	7
R14[1]	110	157	**256**	5	10	12
R15	90	128	187	1	3	3
R16	67	117	160	1	3	4
R17	95	146	193	1	4	4
R18	104	121	168	2	4	5
R19	84	113	164	2	4	5
R20	71	133	178	1	2	2
R21	61	106	145	1	3	4

[1] Commercial/Industrial receptors

8.6.1 Cumulative NO_2 Concentrations

Table 8.13 presents the results of the cumulative assessment of NO_2 including the predicted concentrations from the Project, the Cement Grinding Mill (under construction) (refer to **Section 7.8.1**) and background (refer to **Section 7.9**). Hourly monitoring from the EPA Wollongong site was used as background for the 1-hour average cumulative assessment.

In the major project (Stage1) and the Concept Plan Typical scenario, no receptors are predicted to experience annual average concentrations above the assessment criteria due to emissions from the cumulative assessment.

For the Concept Plan Worst Case scenario, ten receptors are predicted to exceed the 1-hour average NO_2 criterion. Note that R12, R13 and R14 are commercial/industrial receptors. The main contributor of NO_2 emissions are ships at berth and the Concept Plan Worst Case scenario conservatively assumes that seven ships at berth simultaneously. There is a low probability of this happening and normal operations is expected to be closer to the Concept Plan Typical scenario.

As discussed previously, predicted concentrations from the Cement Grinding Mill are based on the maximum predicted from the operations and as such are considered conservative. Therefore actual NO_2 concentrations are expected to be lower than has been estimated.

Table 8.13: Cumulative NO_2 Concentrations (µg/m³)

Receptor ID	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	1-hour Average NO_2 (µg/m³) *Assessment criteria = 246 µg/m³*			Annual Average NO_2 (µg/m³) *Assessment criteria = 62 µg/m³*		
R1	111	180	221	16	17	18
R2	201	216	**277**	20	24	26
R3	197	207	**274**	20	24	25
R4	138	192	245	17	20	21
R5	175	186	233	18	22	23
R6	179	200	**259**	18	22	24
R7	155	206	**255**	18	21	23
R8	148	182	221	17	19	20
R9	133	212	**271**	17	19	20
R10	154	188	**252**	17	20	22
R11	123	212	**278**	17	19	21
R12[1]	159	213	**262**	19	23	25
R13[1]	137	196	**248**	18	22	22
R14[1]	190	204	**281**	21	25	28
R15	153	167	207	17	19	19
R16	138	194	240	17	19	20
R17	142	187	221	17	19	20
R18	158	188	207	17	20	21
R19	165	203	229	17	20	21
R20	111	154	209	16	17	18
R21	140	174	205	17	19	20

[1] Commercial/Industrial receptors

8.8 Carbon Monoxide

A summary of the predicted CO concentrations at each of the individual receptors is provided in **Table 8.14**. The predicted concentrations at all receptors are well below the CO impact assessment criteria.

Table 8.14: Maximum Predicted Project-only CO Concentrations (mg/m³)

Receptor ID	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	1-hour Average CO (mg/m³) *Assessment criteria = 30 mg/m³*			8-hour Average CO (mg/m³) *Assessment criteria = 62 mg/m³*		
R1	0.01	0.02	0.02	0.002	0.005	0.005
R2	0.02	0.02	0.02	0.008	0.011	0.012
R3	0.03	0.03	0.03	0.011	0.012	0.013
R4	0.01	0.02	0.02	0.004	0.008	0.009
R5	0.02	0.02	0.02	0.009	0.011	0.011
R6	0.01	0.01	0.02	0.005	0.007	0.010
R7	0.01	0.01	0.02	0.005	0.007	0.010
R8	0.01	0.01	0.01	0.005	0.006	0.008
R9	0.01	0.01	0.02	0.003	0.005	0.007
R10	0.01	0.01	0.01	0.003	0.005	0.007
R11	0.01	0.01	0.02	0.003	0.005	0.007
R12[1]	0.02	0.02	0.02	0.006	0.008	0.010
R13[1]	0.01	0.03	0.03	0.004	0.012	0.013
R14[1]	0.02	0.02	0.02	0.010	0.011	0.011
R15	0.01	0.01	0.02	0.005	0.008	0.008
R16	0.01	0.01	0.01	0.003	0.005	0.007
R17	0.01	0.02	0.02	0.003	0.009	0.010
R18	0.01	0.01	0.01	0.007	0.008	0.009
R19	0.01	0.01	0.01	0.003	0.006	0.008
R20	0.01	0.01	0.02	0.002	0.004	0.005
R21	0.01	0.01	0.01	0.004	0.005	0.007

[1] Commercial/Industrial receptors

8.8.1 Cumulative CO Concentrations

Table 8.15 presents the results of the cumulative assessment of CO including the predicted concentrations from the Project, the Cement Grinding Mill (refer to **Section 7.8.1**) and background (refer to **Section 7.9**). There are no exceedances of the 1-hour or 8-hour average CO criterion at the privately owned receptors from the cumulative assessment.

As discussed previously, predicted concentrations from the Cement Grinding Mill are conservative and therefore actual CO concentrations are expected to be lower than has been estimated.

Table 8.15: Cumulative CO Concentrations (μg/m³)

Receptor ID	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	1-hour Average CO (mg/m³) *Assessment criteria = 30 mg/m³*			8-hour Average CO (mg/m³) *Assessment criteria = 62 mg/m³*		
R1	3	3	3	2	2	2
R2	3	3	3	2	2	2
R3	3	3	3	2	2	2
R4	3	3	3	2	2	2
R5	3	3	3	2	2	2
R6	3	3	3	2	2	2
R7	3	3	3	2	2	2
R8	3	3	3	2	2	2
R9	3	3	3	2	2	2
R10	3	3	3	2	2	2
R11	3	3	3	2	2	2
R12[1]	3	3	3	2	2	2
R13[1]	3	3	3	2	2	2
R14[1]	3	3	3	2	2	2
R15	3	3	3	2	2	2
R16	3	3	3	2	2	2
R17	3	3	3	2	2	2
R18	3	3	3	2	2	2
R19	3	3	3	2	2	2
R20	3	3	3	2	2	2
R21	3	3	3	2	2	2

[1] Commercial/Industrial receptors

8.9 Sulphur Dioxide

A summary of the predicted SO_2 concentrations at each of the individual receptors is provided in **Table 8.16**. There are no exceedances of the 1-hour, 24-hour or annual average SO_2 criterion at the privately owned receptors as result of the Project alone.

Table 8.16: Maximum Predicted Project-only SO_2 Concentrations (μg/m³)

Receptor ID	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	1-hour Average SO_2 (μg/m³) *Assessment criteria = 570 μg/m³*			24-hour Average SO_2 (μg/m³) *Assessment criteria = 228 μg/m³*			Annual Average SO_2 (μg/m³) *Assessment criteria = 60 μg/m³*		
R1	47	67	91	5	9	12	0	1	1
R2	98	104	152	19	26	41	2	4	5
R3	93	98	145	25	28	32	1	3	4
R4	58	68	100	11	15	19	1	1	2
R5	74	79	121	20	23	31	1	2	3
R6	82	88	126	14	30	43	1	3	4
R7	72	81	113	12	27	40	1	3	4
R8	45	76	106	15	26	36	1	2	3
R9	52	81	115	5	11	16	0	2	3
R10	64	83	111	8	18	27	1	2	3
R11	41	88	126	7	14	19	1	2	3
R12[1]	92	100	134	16	28	42	1	4	5
R13[1]	70	80	107	6	13	19	1	1	2
R14[1]	107	112	160	21	27	43	2	4	5
R15	51	65	91	5	9	12	0	1	1
R16	42	76	105	11	28	39	1	2	2
R17	51	66	93	4	9	14	0	1	1
R18	52	62	97	12	15	25	1	2	2
R19	55	69	99	8	23	34	1	2	3
R20	41	60	86	5	8	11	0	1	1
R21	38	68	94	13	24	33	1	2	2

[1] Commercial/Industrial receptors

8.9.1 Cumulative SO_2 Concentrations

Table 8.17 presents the results of the cumulative assessment of SO_2 including the predicted concentrations from the Project, the Cement Grinding Mill (refer to **Section 7.8.1**) and background (refer to **Section 7.9**). There are no exceedances of the SO_2 impact criteria at the receptors for all scenarios modelled.

As discussed previously, predicted concentrations from the Cement Grinding Mill are conservative and therefore actual SO_2 concentrations are expected to be lower than has been estimated.

Table 8.17: Cumulative SO_2 Concentrations (µg/m³)

Receptor ID	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case	Stage 1	Concept Plan – Typical	Concept Plan – Worst Case
	1-hour Average SO_2 (µg/m³) *Assessment criteria = 570 µg/m³*			24-hour Average SO_2 (µg/m³) *Assessment criteria = 228 µg/m³*			Annual Average SO_2 (µg/m³) *Assessment criteria = 60 µg/m³*		
R1	99	119	143	25	29	32	2	2	2
R2	150	156	204	39	46	62	3	5	6
R3	145	150	198	45	48	52	3	4	6
R4	110	120	152	31	35	39	2	3	3
R5	126	132	174	40	43	51	3	4	5
R6	134	141	178	34	50	63	3	5	6
R7	124	133	165	32	47	60	3	4	5
R8	98	129	158	35	47	56	2	3	4
R9	105	133	168	25	31	37	2	3	4
R10	116	135	163	28	38	47	2	4	5
R11	94	140	178	27	34	40	2	3	4
R12[1]	145	152	187	36	48	62	3	5	7
R13[1]	123	132	159	27	33	39	2	3	4
R14[1]	160	164	213	41	47	63	3	5	7
R15	104	118	143	25	29	32	2	2	3
R16	94	129	158	31	48	59	2	3	4
R17	104	119	145	24	29	34	2	2	3
R18	105	115	150	32	36	45	2	3	4
R19	107	121	151	29	43	54	2	3	4
R20	94	112	138	25	28	31	2	2	2
R21	90	121	147	33	44	53	2	3	4

[1] Commercial/Industrial receptors

9 CONSTRUCTION

The main air pollution (and amenity) issues at construction sites are dust deposition (soiling), visible dust plumes, elevated PM_{10} concentrations due to dust-generating activities, and emissions from diesel-powered construction equipment. Odorous emissions may also occur as results of dredging operations. Sensitive receptors (e.g. residential dwellings) close to the site will be most sensitive to construction dust and odour.

As discussed previously, the most recent Condition of Consent for the Major Projects – Stage 1 requires odour monitoring during dredging operations. A construction management plan was also required which includes ambient dust monitoring during the construction stage (refer to **Section 5.3.5**). These management measures will continue to be implemented during the construction for this modification.

The proposed construction operations for the site have not changed significantly since the previous air quality assessment and therefore were not assessed quantitatively in this assessment.

Although there is an increase in dredged volume, it is not expected to be a source of odour from the site. Additionally, as required by the existing Project Approval (see **Section 10**) field screening of odour during dredging will identify any potential odour impacts and be managed as required.

Stockpiling is currently approved to take place in two locations on the southern foreshore of the Outer Harbour:

- West of Darcy Road drain – approved under the original application for handling up to 100,000 cubic metres of material at any one time.
- East of Darcy Road drain – approved in June 2012 under a CEMP submitted to DP&I for handling up to 60,000 cubic metres of material at any one time.

PKPC submitted another modification application in July 2012 to increase the combined total volume of these stockpiles to 360,000 cubic metres. This application was subsequently withdrawn prior to approval, and the request to increase stockpile capacity to 360,000 cubic metres is now included under this modification.

The modification proposes that the area to the west of Darcy Road drain is to become operational during Stage1, as an extension of the multi-purpose terminal. For this reason, the western stockpiling area would be an interim stockpile during Stage 1, prior to the construction and operation of the southern portion of the multi-purpose terminal. The area east of Darcy Road drain would remain available to use for construction material stockpiling purposes after completion of the southern portion of the multi-purpose terminal.

There is a proposed increase in the volume of material temporarily stockpiled for land reclamation; this will also increase the total stockpile area from the previous assumption of 1.5 ha to 3 ha. Whilst this does increase the potential emissions from wind erosion, the sources of imported fill material used for reclamation would comprise waste materials from other industries (including coal washery refuse) and VENMs from other civil construction projects (including interburden rock and quarry overburden material), depending on the availability of material. Due to either high moisture contents, and/or physical size or the material, it is considered the material has a very low potential for wind erosion. In addition, water-sprays will be used to further minimise the potential for wind erosion.

The maximum predicted dust concentrations at the worst impacted receptor in the AECOM air assessment (**AECOM, 2010a**) for the Major Project construction scenario is shown in **Table 9.1**. The results are well below their respective EPA criteria. As discussed in **Section 5.3.5**, air quality monitoring is already taking place in the vicinity of the current construction operations, and no exceedances of the relevant assessment criteria have been recorded.

Table 9.1: Maximum predicted concentrations from construction operations

Pollutant	Unit	Averaging Time	Predicted concentration	Criterion
PM_{10}	$\mu g/m^3$	24-hour	8	50
TSP	$\mu g/m^3$	Annual	1.2	90
Dust deposition	$g/m^2/month$	Annual	0.13	2

Source: **AECOM, 2010a**

It is therefore considered that the increase in stockpile area is unlikely to result in any additional exceedances of the EPA criteria at the receptors. Additionally, PKPC has committed to appropriate dust control measures on stockpiles as part of the management measures for the previous air assessment.

As discussed in **Section 5.3.5**, the PKPC EPL requires on-going monitoring of construction activities to ensure potential impact on residential receptors are managed. The on-site monitoring indicates that there have been no exceedances of the air quality criteria since the commencement of construction, except at DG1 and DDG1 (refer to **Section 5.3.5**). Data from DG1 and DDG1 is significantly higher than other on-site monitors which may be an influence of other industrial activities in the area and not representative of the impacts from the construction works on site.

There have been no complaints regarding dust impacts from the nearby residences on the construction works implemented to date. PKPC will continue to monitor construction activities on-site to ensure that any potential impacts on nearby residences are minimised.

10 MANAGEMENT AND MITIGATION

10.1 Introduction

This section provides details on the proposed Management and Mitigation measures to be implemented. It is acknowledged that there are existing Statement of Commitments and Approvals for the Concept Plan and Major Project (Stage 1). Any changes or additions to this existing framework are identified below.

10.2 Construction

10.2.1 General

During construction, the following requirements, as stated in the existing Project Approval MP08_249 will be complied with:

> **Dust Control**
> C1. The Proponent shall construct the project in a manner that minimises dust emissions from construction sites, including wind-blown and traffic-generated dust. All construction activities shall be undertaken with the objective of preventing visible emissions of dust from construction sites and the Proponent shall, unless otherwise agreed by the Director General, implement a range of mitigation measures, which may include but is not limited to:
>
> a) covering of truck loads, except during loading and unloading;
>
> b) road sweeping, vehicle speed limits, truck washes and shaker grids at site exits;
>
> c) unloading of fill trains through a below track system;
>
> d) the sealing of trafficable areas and areas susceptible to windblown dust impacts; including the use of stockpile veneers and the watering of dusty areas; and
>
> e) the cessation of relevant works, as appropriate.
>
> The Proponent shall evaluate other dust control mitigations measures, including barriers, internal storage of fine construction materials (less than 3mm), exhaust emission controls and the use of mains electricity. These management measures shall be incorporated into the Construction Air Quality Management Plan.
>
> **Odour Monitoring**
> C2. During dredging activities, the Proponent shall monitor for odours using field screening. The results of olfactory determination of the degree and extent of odour shall be recorded together with a description of concurrent operational activities. Reports shall be kept on the premises and made available to the Director General on request.

A Construction Environmental Management Plan (CEMP) has been prepared and the Construction Air Quality Management Plan which forms a component of this will be updated.

10.2.2 Fill receival and stockpiling activities

Air quality management measures to be implemented for fill receival and stockpiling activities include:

- use of water carts and/or sprinklers to suppress dust
- installation of a shaker grid to prevent drag out of dust from the OHD site onto the Port Kembla Gateway paved area
- speed limit of 40 km/h for all vehicles on site
- hydromulching of the stockpile surface to establish a stabilising grass cover or other type of sealing

- real time dust monitoring during material haulage and stockpile construction activities with automated alarms when trigger levels are exceeded.

10.3 Operation

10.3.1 Stage 1

The fugitive dust management measures to be implemented for the Project, and incorporated into the dispersion modelling, are summarised below:

- Unloading material from trains in bulk unloader – enclosed/storage sheds
- Unloading bulk cargo at Multi-Purpose Berth – indoors
- Hauling on sealed roads – regular sweeping/cleaning to lower silt loading
- Conveyors and transfer stations – enclosed/storage sheds

The dispersion modelling has shown that the predicted particulate concentrations are very sensitive to the assumed silt loading on the sealed roads. As such PKPC will obtain site-specific silt loadings, in accordance with the US EPA AP-42 Appendix C.

Project Approval MP08_249 for Stage 1 contains General Environmental Standards and Designs Conditions that PKPC will continue to comply with. With respect to air quality the following conditions apply:

> B1. The Proponent shall not permit any offensive odour, as defined under section 129 of the Protection of the Environment Operations Act 1997, to be emitted beyond the boundary of the site.

In addition, an Operation Environmental Management Plan (OEMP) is required to be developed to detail environmental management practices and procedures to be followed during operation. This includes a requirement to detail how the project will managed to meet the relevant standards for air quality and a specific Operation Air /quality Management Plan:

> D7. As part of the Operation Environmental Management Plan for the project required under condition D6 of this approval, the Proponent shall prepare and implement the following:
>
> a) an Operation Air Quality Management Plan to outline measures to minimise and manage impacts from the operation of the project on local air quality. The Plan shall be prepared and include, but not necessarily be limited to:
>
> > i) identification of all major sources of particulate matter emissions that may occur as result of the operation of the project;
> >
> > ii) identification of air quality objectives consistent with concept plan approval (08_0249);
> >
> > iii) description of the procedures to manage the particulate matter emissions from the sources identified, including minimising open stockpiles of materials and the utilisation of enclosed material handling practices;
> >
> > iv) procedures for monitoring particulate matter emissions from the project, consistent with the Ambient Dust Monitoring program required under concept plan approval (08_0249);
> >
> > v) protocols for regular maintenance of plant and equipment, to minimise the potential for particulate matter emissions; and
> >
> > vi) description of procedures to be undertaken if any non-compliance is detected.

With respect to air quality, PKPC has committed to the following. Any changes from the previous Statement of Commitments are in **bold** font:

An Air Quality Management Plan will be prepared for inclusion in the CEMP and OEMP for each stage of the Concept Plan. The AQMP will include a requirement for on-going dust monitoring during the construction of Stage 1 of the project (for further details refer to Major Project SoC – **Table 20-2**).

PKPC will prepare an AQMP and mitigation measures will include but not be limited to:

- Transport loads and materials will be covered to avoid generating wind-blown dust.
- Site surfaces will be wetted down during dry weather including excavation sites, haul roads, spoil stockpiles and other exposed areas.
- Vehicular access will be confined to designated access roads.
- Shaker pad facilities will be provided for construction trucks and machinery leaving site.
- Instantaneous dust monitoring will be undertaken at the site boundary. Regular checks on exhaust emissions from construction equipment, trucks, plant and machinery will be undertaken.
- Construction site speed limits will be implemented.

The AQMP will include a dust monitoring program designed to assess the impact of particulate emissions from construction works undertaken as part of the Stage 1. Monitoring will be undertaken in accordance with Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales.

Site specific mitigation measures for the management of particulate emissions during construction and operation of each of the stages of the Concept Plan will be included in AQMPs. Mitigation measures to be included in the AQMP for Stage 1 are detailed below:

PKPC will ensure that the AQMP includes appropriate site specific mitigation measures for the management of particulate emissions during the operation of the proposed development such as:

- Sealing roads and areas susceptible to windblown dust impacts.
- Covering of transport loads.
- Instantaneous dust monitoring at the boundary of the site most affected by dust impacts.
- Reclaimed areas for future terminal development to be covered with suitable compacted materials to ensure fugitive dust emissions are minimised.
- **PKPC will obtain a site specific silt loading factor for the internal road once Stage 1 is operational, and will be used to inform any management measures, if required, to reduce particulate emissions from internal roads.**

PKPC will assess future operations at the development site on a case by case basis, for potential impacts on the local air shed, with consideration of the regional and local pollution findings of this Air Quality Impact Assessment.

10.3.2 Concept Plan

Pacific Environment recommends further analysis and atmospheric dispersion modelling will be undertaken for Stages 2 and 3 of Concept Plan. The reporting of this modelling will be included in separate project applications for Stage 2 and 3 of the Concept Plan. This will include use of a site specific silt loading factor for the internal road determined during Stage 1 operations.

In addition PPKC are committed to preparing a Shore Side Power Feasibility Report, as required by the existing Approval:

Prior to the completion of the reclamation phase in Stage 1 the Proponent shall prepare a Shore Side Power (cold ironing) Feasibility Report, in consultation with OEH, for shore side power at each berth. The assessment shall be undertaken by an appropriately qualified person(s) and shall include, but not limited to:

a) a discussion of best management practice for Shore Side Power, including any relevant international standards;

b) consideration of all feasible and reasonable measures that could be adopted at the berths, including the consideration and quantification of air quality and noise benefits; and

c) potential options and future recommendations.

PKPC will also investigate other options/technologies to reduce combustion emissions from ships, trains, trucks and yard equipment.

12 CONCLUSIONS

Pacific Environment has completed an Air Quality Impact Assessment for the proposed modifications to Concept Plan and Major Project (Stage 1) for the Port Kembla Outer Harbour Development.

PKPC is seeking to modify its approval to accommodate an increase in the bulk cargo throughput handled at Port Kembla from 4.25 million tonnes per annum to 16 million tonnes per annum.

Estimation of air emissions from port operations (as modified) including ships, trains, trucks, CHEs and fugitive dust was completed for three scenarios: Major Projects (Stage 1), Concept Plan (Typical) and Concept Plan (worst case).

Dispersion modelling was conducted to predict the ground level concentrations (glcs) for all relevant pollutants. It is noted that the previous air quality assessment was completed with AUSPLUME (**AECOM, 2010a**), using meteorological data from July 2006 to June 2007. These factors, combined with the increase in operations, makes in impractical to make any direct comparisons between the modelling results.

Cumulative impacts were also considered, taking into account the proposed Cement Grinding Mill, as well as existing background concentrations which includes existing emissions from other industrial sources in Port Kembla. Model predictions at selected receptors were compared with applicable air quality criteria. Predictions equal to or below the criteria indicate an acceptable air quality impact.

Dispersion modelling results indicate that for the Stage 1 and Concept Plan Typical scenario, the only residences that may exceed the EPA impact criteria for particulate matter due to the Project-alone and the cumulative assessment are the closest residences south of the site (R2 and R3). There are no exceedances of the SO_2 and CO criteria as a result of the Project-alone or cumulatively.

There is potential for nine residences to exceed the 1-hour average NO_2 criterion for the Concept Plan Typical scenario when the Project is considered cumulatively.

Wheel-generated dust from trucks, ship exhausts and rail l exhaust emissions are the key source types driving the predicted concentrations from the development for particulates and NO_2.

For the Concept Plan Worst Case scenario, a number of residences potentially exceed the EPA dust impact criteria. The main contribution for dust emissions is from the hauling of material on internal sealed roads. A conservative silt loading of 9.7 g/m^2 and 4.9 g/m^2 was applied to the haul roads. A sensitivity analysis of the silt loading factor indicated that with a silt loading of 0.6 g/m^2, the annual average dust concentrations at majority of the sensitive receptors are reduced to a level below the EPA impact assessment criteria due to the Concept Plan Worst Case scenario. For 24-hour average PM_{10}, one residence (R2) is predicted to exceed the EPA impact assessment criterion of 50 µg/m^3 due to the Project alone. Two residences (R2 and R6) are predicted to marginally exceed the EPA 24-hour $PM_{2.5}$ impact assessment criterion due to the Project alone.

Pacific Environment recommends that PKPC measure the site specific silt loading factor for the internal roads once Stage 1 is operational. This will enable more accurate estimation of dust emissions from haulage on internal roads at the site prior to the implementation of Stage 2 and Stage 3.

A cumulative assessment of 24-hour average PM_{10} concentrations at the most affected receptor locations was completed. The analysis included eight receptors (R2, R3, R5, R6, R7, R12, R13 and R14) based on their proximity to these operations, and the magnitude of their Project-only predictions. It is noted R12, R13 and R14 are commercial/industrial premises. This concluded that there is potential for a number of exceedances of the 24-hour average PM_{10} impact assessment criterion during both Stage 1 and the Concept Plan Typical scenarios. The predicted concentrations are extremely sensitive to the assumed silt loading on the sealed roads within the site, and it is recommended that PKPC collect data on the silt loading to provide more certainty in any future dispersion modelling. The air quality management plan committed to be developed under current approval and statement of commitments will be designed to minimise the potential for exceedances at the residences.

Potential impacts from construction were assessed qualitatively. The potential impacts from construction are expected to be managed in accordance with the current Construction Management Plan. The existing construction has not resulted in any exceedances or complaints at the residences.

Generally, the predictions presented in this report incorporate a level of conservatism due to worst case assumptions and the inherent conservative nature of dispersion modelling. As a result, it is expected that actual ground level concentrations would be lower during the normal operation of the Project.

13 REFERENCES

ABS (2013)

Survey of Motor Vehicle Use, Australian Bureau of Statistics website *http://www.abs.gov.au/ausstats/abs@.nsf/mf/9208.0*

AECOM (2010a)

"Air Quality Impact Assessment – Port Kembla Outer Harbour Development", prepared for Port Kembla Port Corporation.

AECOM (2010b)

"Port Kembla Outer Harbour Development. Revised Submissions Report. Appendix F" prepared by AECOM for Port Kembla Port Corporation. 27 October 2010.

BoM (2013a)

Monthly Weather Review, Bureau of Meteorology website http://www.bom.gov.au/climate/mwr/

BoM (2013)

Climatic Averages Australia, Bureau of Meteorology website *http://www.bom.gov.au/climate/averages/*

CEPA (2005)

"Appendix C - 2005 Oceangoing Ship Survey Summary of Results" prepared by California Environmental Protection Agency Air Resources Board. September 2005.

Clearsafe (2012)

"PKPC Monthly EPA Submission September 2012" dated 8th October 2012.

DECCW (2010)

"Current Air Quality in New South Wales". NSW Department of Environment, Climate Change and Water. August 2010.

EEA (2009)

"EMEP/EEA Emission Inventory Guidebook 2009", June 2009 *http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009*

EPA (2005)

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

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.

Moriarty J, Roddis D and Scorgie Y (2009)

"Comparison In Performance Between Calmet/Calpuff And The US-EPA AERMOD Atmospheric Dispersion Models Using A Major Australian Coastal Industry Case Study" Proceedings of International Clean Air & Environment Conference – Perth, September 2009.

NSW Minerals Council (2000).

"Technical Paper – Particulate Matter and Mining Interim Report".

NPI (2008)

"Emission estimation technique manual for Combustion engines Version 3.0", June 2008.

PAEHolmes (2010)

"Air Quality Assessment for the Proposed Grinding Mill Facility Located in the Outer Harbour of Port Kemla." Prepared for Cement Australia.

Phalen R.F, R.G. Cuddihy, G.L. Fisher, O.R. Moss, R.B. Schlessinger, D.L. Swift, H. C. Yeh (1991) "Main Features of the Proposed NCRP Respiratory Tract Model," *Radiat. Protect. Dosim. 38:179-184* (1991).

TPLA (2005) "The Port of Los Angeles Inventory of Air Emissions for Calendar Year 2010" prepared by Starcrest Consulting Group for The Port of Los Angeles. July 2011.

US EPA (1985) "Compilation of Air Pollutant Emission Factors", AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711

US EPA (2009) "Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories – Final Report", Prepared by ICF International for the US EPA, April 2009

Appendix A MONITORING REPORTS

Table A.1: On-site HVAS PM_{10} monitoring data (µg/m³)

Date	PM_{10} (µg/m³)	Date	PM_{10} (µg/m³)
1/09/2011	13	11/05/2012	30.5
7/09/2011	13.8	17/05/2012	16
13/09/2011	24.6	6/08/2012	15.5
19/09/2011	49.1	12/08/2012	24
25/09/2011	24.4	18/08/2012	11.8
1/10/2011	10.7	24/08/2012	10.2
7/10/2011	20.8	30/08/2012	21.2
13/10/2011	15.2	5/09/2012	85.5
19/10/2011	34.1	11/09/2012	32.1
25/10/2011	13.9	17/09/2012	17.6
31/10/2011	16.2	23/09/2012	31.7
6/11/2011	39.3	29/09/2012	17.5
12/11/2011	36.7	5/10/2012	27
18/11/2011	16.8	11/10/2012	6.7
24/11/2011	18.4	17/10/2012	23.8*
30/11/2011	39.5	23/10/2012	17.0*
6/12/2011	13.4	29/10/2012	19
12/12/2011	26.8	4/11/2012	17
18/12/2011	18.9	10/11/2012	18.1
24/12/2011	13	16/11/2012	13.4
30/12/2011	17.8	22/11/2012	34.2
5/01/2012	34.9	28/11/2012	9.8
11/01/2012	21.5	4/12/2012	26.7
17/01/2012	28.9	10/12/2012	24.6
23/01/2012	34.2	16/12/2012	43.6
29/01/2012	24.3	22/12/2012	32.3
5/02/2012	7.2	28/12/2012	41.5
11/02/2012	21.5	3/01/2013	24.5
16/02/2012	30.1	9/01/2013	34.2
22/02/2012	13.9	15/01/2013	32.4
25/02/2012	19.9	21/01/2013	30
28/02/2012	30.8	27/01/2013	18.2
5/03/2012	17.2	2/02/2013	9.8
11/03/2012	21.2	8/02/2013	40.6
17/03/2012	15.9	14/02/2013	12.1
23/03/2012	20.7	20/02/2013	14.4
29/03/2012	25.3	26/02/2013	34.5
5/04/2012	42.6	4/03/2013	16.7
12/04/2012	11	10/03/2013	25.8
17/04/2012	15	16/03/2013	32
5/05/2012	10.9		

* Noted as interim results in report.

Appendix B ESTIMATION OF EMISSIONS

The emission inventories have been prepared using the operational description of the proposed port activities provided by the proponent.

Estimated emissions are presented for all activities generating significant air emissions associated with the operations. The relevant emission factors used for the study are described below. Activities have generally been modelled for 24 hours per day.

Wind sensitive activities are assumed to be proportional to the third power of wind speed. Wind sensitive activities include transfer stations, unloading of bulk product from trains and loading of bulk product to ships.

B.1 FUGITIVE DUST EMISSIONS

Loading material / dumping bulk material

Each tonne of material loaded will generate a quantity of dust that will depend on the wind speed and the moisture content. Emissions from transfer stations, unloading bulk product from trains and loading bulk product to ships were estimated using the AP-42 13.2.4 Aggregate Handling and Storage Piles (**US EPA, 2006**) emission factor equation given in **Equation 1**.

Equation 1

$$E = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) (kg|t)$$

Where,

k = 0.74 for TSP, 0.35 for PM_{10} and 0.053 for $PM_{2.5}$

U – wind speed (m/s)

M – moisture content (%)

The moisture content has been taken to be approximately 6.9% for coal and 6.6% for iron ore and bauxite. The moisture content is the mean value provided in AP-42 13.2.4 Aggregate Handling and Storage Piles (**US EPA, 2006**).

70% control is assumed for the transfer stations and the unloading from trains as the operations are enclosed.

Hauling material on sealed surfaces

The emission estimate of wheel generated dust presented in the EA is based the US EPA AP-42 13.2.1 Paved Roads (**US EPA, 2011**) emission factor for paved surfaces at industrial sites shown below:

$$E = k(sL)^{0.91}(W \times 1.1023)^{1.02}(kg|VKT)$$

Where:

k = 3.23 for TSP, 0.62 for PM_{10} and 0.15 for $PM_{2.5}$

s = silt loading of road surface (%)

W = mean vehicle weight (t)

The adopted silt loading (s) for the entrance of the site (near Christy Drive) was 9.7 g/m^2 from US EPA AP-42 13.2.1 Paved Roads (**US EPA, 2011**) for iron and steel production facilities. As the site is not an iron and steel production facility, therefore a 50% reduction of silt loading for internal roads. Due to the sensitivity of the silt loading on the dust concentrations at the residences the Concept Plan Typical scenario and sensitivity analysis for the worst case scenario used a silt loading of 0.6 g/m^2 which is the ubiquitous baseline for a public paved road with less than 500 vehicles per day.

The mean vehicle weight used in the emissions estimates is an average of the loaded and unloaded gross vehicle mass, to account for one empty trip and one loaded trip. The trucks used in the assessment shown below.

	Capacity (t)	Full (GVM) (t)	Empty (t)	For Inventory (t)
Bulk Material	35	55.5	20.5	38
General Purpose	25	38	13	25.5
Container Cargo	35	55.5	20.5	38

The inventories for the three scenarios are provided below. Fugitive dust emissions are the same for the Concept Plan Typical and Worst Case scenarios.

Table B.2: TSP Emission Estimates for Major Project (Stage 1)

	ACTIVITY	TSP emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Variable 6	units
Trains	Unloading material in bulk unloader (coal)	376	7,000,000	t/y	0.00018	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							70	% control
	Unloading material in bulk unloader (iron ore/bauxite)	400	7,000,000	t/y	0.00019	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							70	% control
Multi-Purpose Berth (Bulk Cargo)	Unloading of coal/iron ore/bauxite on stockpiles		**within warehouse therefore assume emissions negligible**														0	% control
	Dozers on stockpiles		**within warehouse therefore assume emissions negligible**														0	% control
	Hauling of bulk cargo (near Christy Road)	41,989	60,714	v ehicles/yr	0.69159	kg/v ehicle	35.0	payload (tonnes)	38.0	Av erage v ehicle mass in tonnes	1	km/return trip	1.15	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of bulk cargo (internal)	18,622	60,714	v ehicles/yr	0.30671	kg/v ehicle	35.0	payload (tonnes)	38.0	Av erage v ehicle mass in tonnes	1	km/return trip	0.61	kg/VKT	4.85	g/m2 silt loading	0	% control
	Transfer stations (coal)	2,578	8,000,000	t/y	0.00018	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %	6	Number of transfer points					70	% control
	Transfer stations (iron ore/bauxite)	2,286	8,000,000	t/y	0.00019	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %	5	Number of transfer points					70	% control
Ships	Loading material to ships (coal)	1,432	8,000,000	t/y	0.00018	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							0	% control
	Loading material to ships (iron ore/bauxite)	1,524	8,000,000	t/y	0.00019	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							0	% control

Table B.3: PM_{10} Emission Estimates for Major Project (Stage 1)

	ACTIVITY	PM10 emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Variable 6	units
Trains	Unloading material in bulk unloader (coal)	178	7,000,000	t/y	0.00008	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							70	% control
	Unloading material in bulk unloader (iron ore/bauxite)	189	7,000,000	t/y	0.00009	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							70	% control
Multi-Purpose Berth (Bulk Cargo)	Unloading of coal/iron ore/bauxite on stockpiles		**within warehouse therefore assume emissions negligible**														0	% control
	Dozers on stockpiles		**within warehouse therefore assume emissions negligible**														0	% control
	Hauling of bulk cargo (near Christy Road)	8,060	60,714	v ehicles/yr	0.13275	kg/v ehicle	35.0	payload (tonnes)	38.0	Av erage v ehicle mass in tonnes	1	km/return trip	0.22	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of bulk cargo (internal)	3,574	60,714	v ehicles/yr	0.05887	kg/v ehicle	35.0	payload (tonnes)	38.0	Av erage v ehicle mass in tonnes	1	km/return trip	0.12	kg/VKT	4.85	g/m2 silt loading	0	% control
	Transfer stations (coal)	1,219	8,000,000	t/y	0.00008	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %	6	Number of transfer points					70	% control
	Transfer stations (iron ore/bauxite)	1,081	8,000,000	t/y	0.00009	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %	5	Number of transfer points					70	% control
Ships	Loading material to ships (coal)	677	8,000,000	t/y	0.00008	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							0	% control
	Loading material to ships (iron ore/bauxite)	721	8,000,000	t/y	0.00009	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							0	% control

Table B.4: $PM_{2.5}$ Emission Estimates for Major Project (Stage 1)

	ACTIVITY	PM2.5 emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Variable 6	units
Trains	Unloading material in bulk unloader (coal)	22	7,000,000	t/y	0.00001	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							75	% control
	Unloading material in bulk unloader (iron ore/bauxite)	24	7,000,000	t/y	0.00001	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							75	% control
Multi-Purpose Berth (Bulk Cargo)	Unloading of coal/iron ore/bauxite on stockpiles		**within warehouse therefore assume emissions negligible**														0	% control
	Dozers on stockpiles		**within warehouse therefore assume emissions negligible**														0	% control
	Hauling of bulk cargo (near Christy Road)	1,950	60,714	v ehicles/yr	0.03212	kg/v ehicle	35.0	payload (tonnes)	38.0	Av erage v ehicle mass in tonnes	1	km/return trip	0.05	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of bulk cargo (internal)	865	60,714	v ehicles/yr	0.01424	kg/v ehicle	35.0	payload (tonnes)	38.0	Av erage v ehicle mass in tonnes	1	km/return trip	0.03	kg/VKT	4.85	g/m2 silt loading	0	% control
	Transfer stations (coal)	185	8,000,000	t/y	0.00001	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %	6	Number of transfer points					70	% control
	Transfer stations (iron ore/bauxite)	164	8,000,000	t/y	0.00001	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %	5	Number of transfer points					70	% control
Ships	Loading material to ships (coal)	103	8,000,000	t/y	0.00001	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							0	% control
	Loading material to ships (iron ore/bauxite)	109	8,000,000	t/y	0.00001	kg/t	0.9	av erage of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							0	% control

Pacific Environment Limited

Table B.5: TSP Emission Estimates for Concept Plan (Worst Case and Typical)

	ACTIVITY	TSP emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Variable 6	units
Trains	Unloading material in bulk unloader (coal)	376	7,000,000	t/y	0.00018	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							70	% control
	Unloading material in bulk unloader (iron ore/bauxite)	400	7,000,000	t/y	0.00019	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							70	% control
Multi-Purpose Berth (Bulk Cargo)	Unloading of coal/iron ore/bauxite on stockpiles		within warehouse therefore assume emissions negligible														0	% control
	Dozers on stockpiles		within warehouse therefore assume emissions negligible														0	% control
	Hauling of bulk cargo (near Christy Road)	41,989	60,714	vehicles/yr	0.69159	kg/vehicle	35.0	payload (tonnes)	38.0	Average vehicle mass in tonnes	1	km/return trip	1.15	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of bulk cargo (internal)	18,622	60,714	vehicles/yr	0.30671	kg/vehicle	35.0	payload (tonnes)	38.0	Average vehicle mass in tonnes	1	km/return trip	0.61	kg/VKT	4.85	g/m2 silt loading	0	% control
	Transfer stations (coal)	2,578	8,000,000	t/y	0.00018	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %	6	Number of transfer points					70	% control
	Transfer stations (iron ore/bauxite)	2,286	8,000,000	t/y	0.00019	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %	5	Number of transfer points					70	% control
Container Terminals			Small amounts of dust from cranes and forklifts accounted for in equipment tab															
	Hauling of container cargo (near Chrsity Road)	41,495	60,000	vehicles/yr	0.69159	kg/vehicle	35.0	payload (tonnes)	38	Average vehicle mass in tonnes	0.6	km/return trip	1.15	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of container cargo (internal)	95,694	60,000	vehicles/yr	1.59490	kg/vehicle	35.0	payload (tonnes)	38	Average vehicle mass in tonnes	2.6	km/return trip	0.61	kg/VKT	4.85	g/m2 silt loading	0	% control
Ships	Loading material to ships (coal)	1,432	8,000,000	t/y	0.00018	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							0	% control
	Loading material to ships (iron ore/bauxite)	1,524	8,000,000	t/y	0.00019	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							0	% control
Multi-Purpose Berth (General purpose)		Small amounts of dust from cranes and forklifts accounted for in equipment tab															0	% control
	Hauling of general cargo (near Christy Road)	29,466	64,000	vehicles/yr	0.46040	kg/vehicle	25.0	payload (tonnes)	25.5	Average vehicle mass in tonnes	0.6	km/return trip	0.77	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of general cargo (internal)	13,068	64,000	vehicles/yr	0.20418	kg/vehicle	25.0	payload (tonnes)	25.5	Average vehicle mass in tonnes	0.5	km/return trip	0.41	kg/VKT	4.85	g/m2 silt loading	0	% control

Table B.6: PM_{10} Emission Estimates for Concept Plan (Worst Case and Typical)

	ACTIVITY	PM10 emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Variable 6	units
Trains	Unloading material in bulk unloader (coal)	178	7,000,000	t/y	0.00008	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							70	% control
	Unloading material in bulk unloader (iron ore/bauxite)	189	7,000,000	t/y	0.00009	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							70	% control
Multi-Purpose Berth (Bulk Cargo)	Unloading of coal/iron ore/bauxite on stockpiles		within warehouse therefore assume emissions negligible														0	% control
	Dozers on stockpiles		within warehouse therefore assume emissions negligible														0	% control
	Hauling of bulk cargo (near Christy Road)	8,060	60,714	vehicles/yr	0.13275	kg/vehicle	35.0	payload (tonnes)	38.0	Average vehicle mass in tonnes	0.6	km/return trip	0.22	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of bulk cargo (internal)	3,574	60,714	vehicles/yr	0.05887	kg/vehicle	35.0	payload (tonnes)	38.0	Average vehicle mass in tonnes	0.5	km/return trip	0.12	kg/VKT	4.85	g/m2 silt loading	0	% control
	Transfer stations (coal)	1,219	8,000,000	t/y	0	kg/t	1	average of (wind speed/2.2)^1.3 in m/s	7	moisture content of coal in %	6	Number of transfer points					70	% control
	Transfer stations (iron ore/bauxite)	1,081	8,000,000	t/y	0	kg/t	1	average of (wind speed/2.2)^1.3 in m/s	7	moisture content of iron ore/bauxite in %	5	Number of transfer points					70	% control
Container Terminals			Small amounts of dust from cranes and forklifts accounted for in equipment tab															
	Hauling of container cargo (near Chrsity Road)	7,965	60,000	vehicles/yr	0.13275	kg/vehicle	35.0	payload (tonnes)	38	Average vehicle mass in tonnes	0.6	km/return trip	0.22	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of container cargo (internal)	18,368	60,000	vehicles/yr	0.30614	kg/vehicle	35.0	payload (tonnes)	38	Average vehicle mass in tonnes	2.6	km/return trip	0.12	kg/VKT	4.85	g/m2 silt loading	0	% control
Ships	Loading material to ships (coal)	677	8,000,000	t/y	0.00008	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							0	% control
	Loading material to ships (iron ore/bauxite)	721	8,000,000	t/y	0.00009	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							0	% control
Multi-Purpose Berth (General purpose)		Small amounts of dust from cranes and forklifts accounted for in equipment tab															0	% control
	Hauling of general cargo (near Christy Road)	5,656	64,000	vehicles/yr	0.08837	kg/vehicle	25.0	payload (tonnes)	25.5	Average vehicle mass in tonnes	0.6	km/return trip	0.15	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of general cargo (internal)	2,508	64,000	vehicles/yr	0.03919	kg/vehicle	25.0	payload (tonnes)	25.5	Average vehicle mass in tonnes	0.5	km/return trip	0.08	kg/VKT	4.85	g/m2 silt loading	0	% control

Table B.7: $PM_{2.5}$ Emission Estimates for Concept Plan (Worst Case and Typical)

	ACTIVITY	PM2.5 emission (kg/y)	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units	Variable 4	units	Variable 5	units	Variable 6	units
Trains	Unloading material in bulk unloader (coal)	22	7,000,000	t/y	0.00001	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							75	% control
	Unloading material in bulk unloader (iron ore/bauxite)	24	7,000,000	t/y	0.00001	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							75	% control
Multi-Purpose Berth (Bulk Cargo)	Unloading of coal/iron ore/bauxite on stockpiles		**within warehouse therefore assume emissions negligible**														0	% control
	Dozers on stockpiles		**within warehouse therefore assume emissions negligible**														0	% control
	Hauling of bulk cargo (near Christy Road)	1,950	60,714	vehicles/yr	0.03212	kg/vehicle	35	payload (tonnes)	38.0	Average vehicle mass in tonnes	0.6	km/return trip	0.05	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of bulk cargo (internal)	865	60,714	vehicles/yr	0.01424	kg/vehicle	35	payload (tonnes)	38	Average vehicle mass in tonnes	0.5	km/return trip	0.03	kg/VKT	4.9	g/m2 silt loading	0	% control
	Transfer stations (coal)	185	8,000,000	t/y	0.00001	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %	6	Number of transfer points					70	% control
	Transfer stations (iron ore/bauxite)	164	8,000,000	t/y	0.00001	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %	5	Number of transfer points					70	% control
Container Terminals			**Small amounts of dust from cranes and forklifts accounted for in equipment tab**															
	Hauling of container cargo (near Chrsity Road)	1,927	60,000	vehicles/yr	0.03212	kg/vehicle	35	payload (tonnes)	38.0	Average vehicle mass in tonnes	0.6	km/return trip	0.05	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of container cargo (internal)	4,444	60,000	vehicles/yr	0.07407	kg/vehicle	35	payload (tonnes)	38	Average vehicle mass in tonnes	2.6	km/return trip	0.03	kg/VKT	4.9	g/m2 silt loading	0	% control
Ships	Loading material to ships (coal)	103	8,000,000	t/y	0.00001	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.9	moisture content of coal in %							0	% control
	Loading material to ships (iron ore/bauxite)	109	8,000,000	t/y	0.00001	kg/t	0.9	average of (wind speed/2.2)^1.3 in m/s	6.6	moisture content of iron ore/bauxite in %							0	% control
Multi-Purpose Berth (General purpose)		**Small amounts of dust from cranes and forklifts accounted for in equipment tab**															0	% control
	Hauling of general cargo (near Christy Road)	1,368	64,000	vehicles/yr	0.02138	kg/vehicle	25.0	payload (tonnes)	25.5	Average vehicle mass in tonnes	0.6	km/return trip	0.04	kg/VKT	9.7	g/m2 silt loading	0	% control
	Hauling of general cargo (internal)	607	64,000	vehicles/yr	0.00948	kg/vehicle	25.0	payload (tonnes)	25.5	Average vehicle mass in tonnes	0.5	km/return trip	0.02	kg/VKT	4.85	g/m2 silt loading	0	% control

B.2 EMISSIONS FROM SHIPS

Air emissions from fuel consumption by the auxiliary engines while ships are at berth were estimated using the following equation:

$$E = Q \times H \times EF$$

where:

E	=	Emissions of from fuel combustion	(kg/year)
Q	=	Estimated fuel usage	(kW)[1]
H	=	Estimated hours at berth per year	(hours/year)
EF	=	Emission factor for fuel combustion	(kg/kWh)[2]

[1] kW = kilowatts.

[2] kg/kWh = kilograms of pollutant per kilowatt hour.

Based on a study by the Australian Maritime College (**Goldsworthy, 2012**), marine distillate with 0.5% sulphur content accounts for 15% of fuel used in auxiliary engines in Australia. The main fuel use is residual oil. Emissions from ships were estimated using the emission factors from the US EPA document, 'Current Methodologies in Preparing Mobile Source Port-Related Emission Inventories' (**US EPA, 2009**). Emission factors are pro-rated consisting of 85% residual oil and 15% marine distillate.

The inventories for the three scenarios are provided below. Information on fuel usage by ship type, the number of ships per berth and the hours at berth was provided by AECOM.

STAGE 1 OPERATIONS
SHIP EMISSIONS INVENTORY

PKOHD Ships

APUs of Ships

Ship Type	Power (kW)
Cape	1,000

Ship Type	Bulk Cargo
Cape	1

Emission Factor for Auxiliary Engine

Substance	Emission factor for RO (2.7% S) kg/kwh	Emission factor for MGO (0.5% S) kg/kwh	Total Emission Factor kg/kwh
Nox	0.0147	0.0139	0.0146
CO	0.0011	0.0011	0.0011
PM2.5	0.00132	0.00029	0.0012
PM10	0.00144	0.00032	0.0013
SO2	0.012	0.002	0.011

Multi-Purpose Berth (Bulk Cargo)

Number of berths	1	
Number of ships =	270	ships/year
Time at Berth =	15	hrs/ship
	4050	hrs/year

Auxilary power engines

Auxiliary Power =	1000	kW

Substance	Emission factor kg/kwh	Emissions from Engines kg/year	Total g/s
Nox	0.0146	59,049	1.87
CO	0.0011	4,455	0.14
PM2.5	0.0012	4,720	0.15
PM10	0.0013	5,152	0.16
TSP		5,152	0.16
SO2	0.011	42,529	1.35

END

CONCEPT PLAN OPERATIONS - OPERATIONAL
SHIP EMISSIONS INVENTORY

PKOHD Ships

APUs of Ships

Ship Type	Power (kW)
Cape	1,000
Panamax	500
Super Post Panamax	1,100

Ship Type	Bulk Cargo	General Purpose	Containers
Cape	1		
Panamax		1	1
Super Post Panamax			1

Emission Factor for Auxiliary Engine

	Emission factor for RO (2.7% S)	Emission factor for MGO (0.5% S)	Total Emission Factor
Substance	kg/kwh	kg/kwh	kg/kwh
Nox	0.0147	0.0139	0.0146
CO	0.0011	0.0011	0.0011
PM2.5	0.00132	0.00029	0.0012
PM10	0.00144	0.00032	0.0013
SO2	0.012	0.002	0.011

Multi-Purpose Berth (Bulk Cargo)

Number of berths 1
Number of ships = 270 ships/year/berth
Time at Berth = 15 hrs/ship
4050 hrs/year/berth

Auxilary power engines
Auxillary Power = 1000 kW/total number of berths

	Emission factor	Emissions from Engines	Total
Substance	kg/kwh	kg/year	g/s
Nox	0.0146	59,049	1.87
CO	0.0011	4,455	0.14
PM2.5	0.0012	4,720	0.15
PM10	0.0013	5,152	0.16
TSP		5,152	0.16
SO2	0.0105	42,529	1.35

Multi-Purpose Berth (General purpose)

Number of berths 1
Number of ships = 100 ships/year/berth
Time at Berth = 27 hrs/ship
2700 hrs/year/berth

Auxilary power engines
Auxillary Power = 500 kW/total number of berths

	Emission factor	Emissions from Engines	Total
Substance	kg/kwh	kg/year	g/s
Nox	0.0146	19,683	0.62
CO	0.0011	1,485	0.05
PM2.5	0.0012	1,573	0.05
PM10	0.0013	1,717	0.05
TSP		1,717	0.05
SO2	0.011	14,176	0.45

Container Berth

Number of berths 2.00
Number of ships = 300 ships/year/berth
Time at Berth = 12 hrs/ship
3600 hrs/year/berth

Auxilary power engines
Auxillary Power = 1600 kW/total number of berths

	Emission factor	Emissions from Engines	Total
Substance	kg/kwh	kg/year	g/s
Nox	0.0146	83,981	2.66
CO	0.0011	6,336	0.20
PM2.5	0.0012	6,713	0.21
PM10	0.0013	7,327	0.23
TSP		7,327	0.23
SO2	0.011	60,486	1.92

END

CONCEPT PLAN - WORST CASE
SHIP EMISSIONS INVENTORY

PKOHD Ships

APUs of Ships

Ship Type	Power (kW)
Cape	1,000
Panamax	500
Super Post Panamax	1,100

Ship Type	Bulk Cargo	General Purpose	Containers
Cape	1		
Panamax		2	3
Super Post Panamax			1

Emission Factor for Auxiliary Engine

	Emission factor for RO (2.7% S)	Emission factor for MGO (0.5% S)	Total Emission Factor
Substance	kg/kwh	kg/kwh	kg/kwh
Nox	0.0147	0.0139	0.0146
CO	0.0011	0.0011	0.0011
PM2.5	0.00132	0.00029	0.0012
PM10	0.00144	0.00032	0.0013
SO2	0.012	0.002	0.0105

Multi-Purpose Berth (Bulk Cargo)

Number of berths 1
Number of ships = 270 ships/year/berth
Time at Berth = 15 hrs/ship
4050 hrs/year/berth

Auxilary power engines

Auxillary Power = 1000 kW/total number of berths

	Emission factor	Emissions from Engines	Total
Substance	kg/kwh	kg/year	g/s
Nox	0.0146	59,049	1.87
CO	0.0011	4,455	0.14
PM2.5	0.0012	4,720	0.15
PM10	0.0013	5,152	0.16
TSP		5,152	0.16
SO2	0.0105	42,529	1.35

Multi-Purpose Berth (General purpose)

Number of berths 2
Number of ships = 100 ships/year/berth
Time at Berth = 27 hrs/ship
2700 hrs/year/berth

Auxilary power engines

Auxillary Power = 1000 kW/total number of berths

	Emission factor	Emissions from Engines	Total
Substance	kg/kwh	kg/year	g/s
Nox	0.0146	39,366	1.25
CO	0.0011	2,970	0.09
PM2.5	0.0012	3,147	0.10
PM10	0.0013	3,434	0.11
TSP		3,434	0.11
SO2	0.011	28,353	0.90

Container Berth

Number of berths 4
Number of ships = 300 ships/year/berth
Time at Berth = 12 hrs/ship
3600 hrs/year/berth

Auxilary power engines

Auxillary Power = 2600 kW/total number of berths

	Emission factor	Emissions from Engines	Total
Substance	kg/kwh	kg/year	g/s
Nox	0.0146	136,469	4.33
CO	0.0011	10,296	0.33
PM2.5	0.0012	10,909	0.35
PM10	0.0013	11,906	0.38
TSP		11,906	0.38
SO2	0.011	98,289	3.12

End

B.3 EMISSIONS FROM LOCOMOTIVES

Air emissions from trains were estimated using the following equation:

$$E = Q \times H \times N \times EF$$

where:

E	=	Emissions of from fuel combustion	(kg/year)
Q	=	Estimated fuel usage by notch setting per train	(kg/h)[1]
H	=	Estimated time in notch setting	(min/h)[2]
N	=	Number of trains per year	
EF	=	Emission factor for fuel combustion	(kg/tonne)[3]

[1] kg/h = kilogram per hour.

[2] min/h = minutes/hour

[3] kg/kWh = kilograms of pollutant per tonne of fuel used.

Emissions from diesel locomotives vary across different locomotive classes. Emissions also vary according to related parameters such as power output, fuel consumption and notch setting. Fuel consumption data are available for 81 and 90 class locomotives (**Lilley, 1996**). Information on the number of trains, notch settings and time spent in each notch setting was provided by AECOM.

The emissions from trains for the Project were estimated with Tier 1 emission factors from the European Environment Agency (**EEA, 2009**). The inventories for emissions from trains for the three scenarios are provided below. Train operations are the same for the Concept Plan Typical and Worst Case scenario.

STAGE 1 OPERATIONS
TRAIN EMISSIONS INVENTORY

Fuel Consumption of Locomotives

Notch	Fuel usage (kg/h)	Fuel usage (tonne/h)
idle	11.9	0.012
1	46.1	0.046
2	72.4	0.072
3	154.1	0.154
4	197.8	0.198
5	269.3	0.269
6	331.9	0.332
7	451.6	0.452
8	514.8	0.515

Multi-Purpose Berth – 13.2 trains per day (bulk freight and assuming dumper)		
Train Movement	Throttle Level & Time Normal Operations	No. of Locos
Train enters holding siding in North Yard	Throttle 1 – 5 minutes	4
Train idles in holding siding in North Yard	Idle - 20 minutes	2
Train moves into unloading bays and unloads	Throttle 1 - 40 minutes	2
Train idles in holding siding in South Yard	Idle - 20 minutes	2
Train leaves via Balloon Loop and South Yard	Throttle 1 – 5 minutes	2

Train Movements - Multi-purpose berth (bulk cargo)

Movement	Trains/day	Throttle Level	Time (min)	Total Fuel tonne/Day
Train enters holding siding in North Yard	13	1	5	0.20
Train idles in holding siding in North Yard	13	idle	20	0.10
Train moves into unloading bays and unloads	7	1	40	0.43
Train idles in holding siding in South Yard	13	idle	20	0.10
Train leaves via Balloon Loop and South Yard	13	1	5	0.10
			Total	0.9

Substance	Emission factor kg/tonne	Emissions kg/year	Total g/s	Total kg/y
Nox	52.4	17,905	0.6	17,905
CO	10.7	3,656	0.116	3,656
PM2.5	1.37	468	0.015	468
PM10	1.44	492	0.016	492
TSP	1.52	519	0.01647	519

CONCEPT PLAN - WORST CASE & OPERATIONAL
TRAIN EMISSIONS INVENTORY

[illegible]

Fuel Consumption of Locomotives

Notch	Fuel usage (kg/h)	Fuel usage (tonne/h)
Idle	11.9	0.012
1	46.1	0.046
2	72.4	0.072
3	154.1	0.154
4	197.8	0.198
5	269.3	0.269
6	331.9	0.332
7	451.6	0.452
8	514.8	0.515

Multi-Purpose Berth (Bulk Cargo)

Multi-Purpose Berth – 13.2 trains per day (bulk freight and assuming dumper)

Train Movement	Throttle Level & Time Normal Operations	No. of Locos
Train enters holding siding in North Yard	Throttle 1 – 5 minutes	4
Train idles in holding siding in North Yard	Idle - 20 minutes	2
Train moves into unloading bays and unloads	Throttle 1 - 40 minutes	2
Train idles in holding siding in South Yard	Idle - 20 minutes	2
Train leaves via Balloon Loop and South Yard	Throttle 1 – 5 minutes	2

Train Movements - Multi-purpose berth (bulk cargo)

Movement	Trains/day	Throttle Level	Time (min)	Total Fuel tonne/Day
Train enters holding siding in North Yard	13	1	5	0.20
Train idles in holding siding in North Yard	13	Idle	20	0.10
Train moves into unloading bays and unloads	7	1	40	0.43
Train idles in holding siding in South Yard	13	Idle	20	0.10
Train leaves via Balloon Loop and South Yard	13	1	5	0.10
			Total	0.9

Substance	Emission factor kg/tonne	Emissions kg/year	Total g/s	Total kg/y
Nox	52.4	17,905	0.6	17,905
CO	10.7	3,656	0.116	3,656
PM2.5	1.37	468	0.015	468
PM10	1.44	492	0.016	492
TSP	1.52	519	0.01647	519

[illegible]

Multi-Purpose Berth – 1 train per day (general purpose)

Train Movement	Throttle Level & Time Normal Operations / Normal Operations	No. of Locos
Train enters holding siding in North Yard	Throttle 1 – 5 minutes	2
Train idles in unloading siding adjacent to multi-purpose berth while unloading	Idle - 20 minutes	2
	Shut down - 2 hour 40 minutes	2
Train shunt & reform in holding siding in North Yard	Notch 1 – 30 minutes	2
Train leaves holding siding and exit via Balloon Loop and South Yard	Throttle 1 – 5 minutes	2

Movement	Trains/day	Throttle Level	Time (min)	Total Fuel tonne/Day
Train enters holding siding in North Yard	1	1	5	0.008
Train idles in unloading siding adjacent to multi-purpose berth while unloading	1	Idle	20	0.008
	1	Shutdown	160	0.000
Train shunt & reform in holding siding in North Yard	1	1	30	0.046
Train leaves holding siding and exit via Balloon Loop and South Yard	1	1	5	0.008
			Total	0.07

Substance	Emission factor kg/tonne	Emissions kg/year	Total g/s	Total kg/y
Nox	52.4	1,327	0.042	1,327
CO	10.7	271	0.009	271
PM2.5	1.37	35	0.0011	35
PM10	1.44	36	0.0012	36
TSP	1.52	39	0.00122	39

Container Berths

Container Berths – 16 trains per day		
Train Movement	Throttle Level & Time Normal Operations	No. of Locos
Train enters holding siding in South Yard	Idle – 20 minutes	2
Train idles in container berth sidings and returns to holding siding in South Yard to reform before exiting	Idle - 20 minutes	2
	Shut down - 1 hour 40 minutes	2
Train shunt & reform in holding siding in South Yard	Throttle 1 – 20 minutes	2
Train idles in holding siding in South Yard	Throttle 1 – 20 minutes	2
Train leaves from exit siding in South Yard	Throttle 1 – 5 minutes	4

Movement	Trains/day	Throttle Level	Time (min)	Total Fuel tonne/Day
Train enters holding siding in South Yard	16	Idle	20	0.13
Train idles in container berth sidings and returns to	16	Idle	20	0.13
holding siding in South Yard to reform before exiting	16	Shutdown	100	0.00
Train shunt & reform in holding siding in South Yard	16	1	20	0.49
Train idles in holding siding in South Yard	16	1	20	0.49
Train leaves from exit siding in South Yard	16	1	5	0.25
			Total	1.5

	Emission factor	Emissions	Total	Total
Substance	kg/tonne	kg/year	g/s	kg/y
Nox	52.4	28,368	0.9	28,368
CO	10.7	5,793	0.184	5,793
PM2.5	1.37	742	0.024	742
PM10	1.44	780	0.025	780
TSP	1.52	823	0.02609	823

EV8

B.4 EMISSIONS FROM VEHICLES

Emissions from products of combustion from trucks travelling on site were estimated with the following equation.

$$E = Q \times D \times EF$$

where:

E	=	Emissions of from fuel combustion	(kg/year)
Q	=	Estimated fuel usage	(m^3/km)[1]
D	=	Estimated kilometres travelled per year	(km/year)
EF	=	Emission factor for fuel combustion	(kg/m^3)[2]

1 m^3/km = cubic meter consumed per kilometre travelled.

2 kg/m^3 = kilograms of pollutant per cubic meter of fuel consumed.

Fuel consumption for articulated trucks from the Australian Bureau of Statistics of 58 L/100 km (**ABS, 2013**) was used to estimate emissions from trucks on-site. The inventories for the three scenarios are provided below. Information on the number of trucks and the distance travelled at each terminal was provided by AECOM. Vehicle usage is the same for the Concept Plan Typical and Worst Case scenarios.

STAGE 1 OPERATIONS
TRUCK EMISSIONS INVENTORY

PKOHD Trucks			
Multi-Purpose Berth (Bulk Cargo)			

Type of Vehicles =	very HGV (Heavy goods vehicles)		
Fuel Type =	Diesel		
Number of trucks =	60,714	/year	
	166	/day	
	7	/hour	
On-site road distance (2way) =	1.1	km	550 m one way
Distance travelled in year =	66,785	km/y	
Fuel usage =	58	L/100 km	from ABS 2012 for
	0.00058	m3/km	

Met AQS	Emission factor	Emissions	Total
Substance	**kg/m3**	**kg/year**	**g/s**
Nox	22	848	0.027
CO	8.5	328	0.010
PM2.5	1.1	42	0.0013
PM10	1.2	46	0.0015
TSP	1.2	46	0.0015
SO2	0.017	0.7	0.00002

END			

CONCEPT PLAN - WORST CASE & OPERATIONAL TRUCK EMISSIONS INVENTORY

PKOHD Trucks

Multi-Purpose Berth (Bulk Cargo)

Type of Vehicles =	very HGV (Heavy goods vehicles)		
Fuel Type =	Diesel		
Number of trucks =	60,714	/year	
	166	/day	
	7	/hour	
On-site road distance (2way) =	1.1	km	550 m one way
Distance travelled in year =	66,785	km/y	
Fuel usage =	58	L/100 km	from ABS 2012 fo
	0.00058	m3/km	

Met AQS Substance	Emission factor kg/m3	Emissions kg/year	Total g/s
Nox	22	848	0.027
CO	8.5	328	0.010
PM2.5	1.1	42	0.0013
PM10	1.2	46	0.0015
TSP	1.2	46	0.0015
SO2	0.017	0.7	0.00002

Multi-Purpose Berth (General purpose)

Type of Vehicles =	very HGV (Heavy goods vehicles)		
Fuel Type =	Diesel		
Number of trucks =	64,000	/year	
	175	/day	
	7	/hour	
On-site road distance (2way) =	1.1	km	550 m one way
Distance travelled in year =	70,400	km/y	
Fuel usage =	58	L/100 km	from ABS 2012 fo
	0.00058	m3/km	

Met AQS Substance	Emission factor kg/m3	Emissions kg/year	Total g/s
Nox	22	894	0.028
CO	8.5	345	0.011
PM2.5	1.1	45	0.0014
PM10	1.2	49	0.0015
TSP	1.2	49	0.0015
SO2	0.017	0.7	0.00002

Container Berths

Type of Vehicles =	very HGV (Heavy goods vehicles)		
Fuel Type =	Diesel		
Number of trucks =	60,000	/year	
	164	/day	
	7	/hour	
On-site road distance (2way) =	3.2	km	1.6 km one way
Distance travelled in year =	66,000	km/y	
Fuel usage =	58	L/100 km	from ABS 2012 fo
	0.00058	m3/km	

Met AQS Substance	Emission factor kg/m3	Emissions kg/year	Total g/s
Nox	22	838	0.027
CO	8.5	324	0.010
PM2.5	1.1	42	0.0013
PM10	1.2	46	0.0014
TSP	1.2	46	0.0014
SO2	0.017	0.6	0.00002

END

B.5 EMISSIONS FROM CARGO HANDLING EQUIPMENT

Emissions from products of combustion from CHEs on site were estimated with the following equation.

$$E = \frac{Q \times EF}{1000}$$

where:

E	=	Emissions of from fuel combustion	(kg/year)
Q	=	Estimated fuel usage	(hp)[1]
EF	=	Emission factor for fuel combustion	(g/hp-hr)[2]

[1] hp = horsepower.

[2] g/hp-hr = grams of pollutant per horsepower hour.

The US EPA port-related emission inventories provide average fuel consumption from CHEs (**US EPA, 2009**). The emissions from the consumption of fuel by the CHEs have been estimated based on emission factors from the US EPA port-related emission inventories. The number of equipment items in operation for each stage of the Project was provided by AECOM.

STAGE 1 OPERATIONS

EQUIPMENT EMISSIONS INVENTORY

PKOHD Equipments

Equipment list	STAGE 1	Average HP from Table 4-4 USEPA 2009 Mobile-source port related inventories	Total HP
Mobile crane	2	274	548
Forklifts	2	127	254
Low loader	2	131	262
	Total	532	1064

Assume Tier 4 for 2012-2013 equipment

Hours of operation 8760 hr/yr

Met AQS Substance	Emission factor g/hp-hr	Emissions g/year	Total g/s	Total kg/yr
Nox	0.3	2,796,192	0.09	2,796
CO	0.1	932,064	0.03	932
PM2.5	0.01	93,206	0.00	93
PM10	0.01	93,206	0.00	93
TSP				93
SO2	0.16	1,491,302	0.0473	1,491

End

CONCEPT PLAN - WORST CASE & OPERATIONAL
EQUIPMENT EMISSIONS INVENTORY

PKOHD Equipments				

Equipment list	Stage 1	Stage 2-3	Average HP from Table 4-4 USEPA 2009 Mobile-source port related inventories	Total HP
Mobile crane	2		274	548
Forklifts	2	2	127	508
Low loader	2		131	262
		Total	532	1318

Assume Tier 4 for 2012-2013 equipment

Hours of operation 8760 hr/yr

Met AQS	Emission factor	Emissions	Total	Total
Substance	**g/hp-hr**	**g/year**	**g/s**	**kg/yr**
Nox	0.3	3,463,704	0.11	3,464
CO	0.1	1,154,568	0.04	1,155
PM2.5	0.01	115,457	0.00	115
PM10	0.01	115,457	0.00	115
TSP				115
SO2	0.16	1,847,309	0.0586	1,847

End				