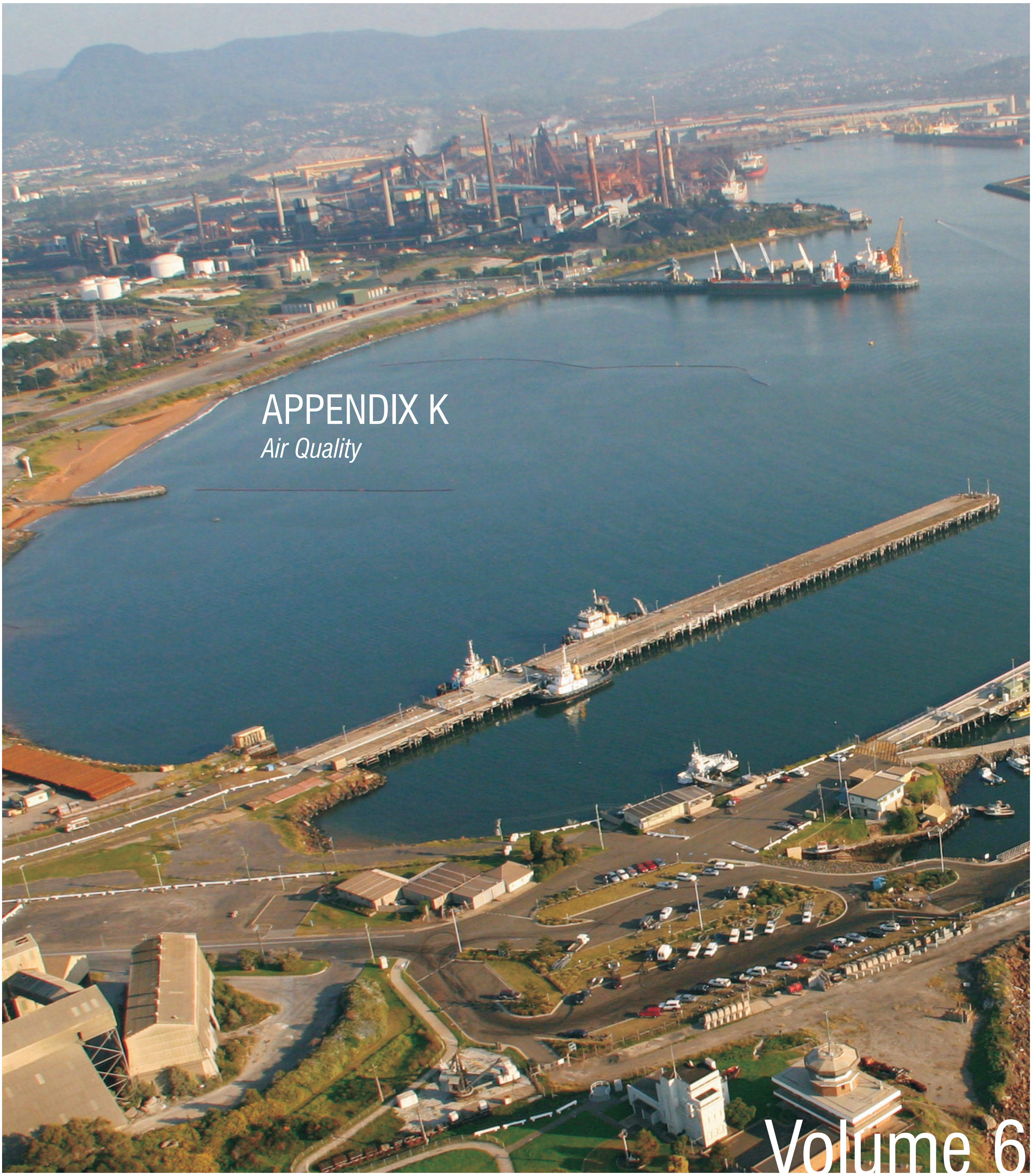
APPENDIX K
Air Quality
Volume 6

Port Kembla Port Corporation
11 February 2010

Air Quality Impact Assessment

Port Kembla Outer Harbour Development

Air Quality Impact Assessment

Port Kembla Outer Harbour Development

Prepared for

Port Kembla Port Corporation

Prepared by

AECOM Australia Pty Ltd
PO Box 73 HRMC NSW 2310 Australia
T +61 2 4911 4900 F +61 2 4911 4999 www.aecom.com
ABN 20 093 846 925

11 February 2010

60039301

Quality Information

Document	Air Quality Impact Assessment		
Ref	60039301		
Date	11 February 2010		
Prepared by	Adam Plant	Author Signature	
Reviewed by	David Rollings	Technical Peer Reviewer Signature	

Distribution

Copies	Recipient	Copies	Recipient
1	**Geoff Cornwall** Port Kembla Port Corporation PO Box 89 Port Kembla NSW 2505	1	**AECOM** File Copy

"This page has been left blank intentionally"

Contents

Tables

Body Report

Figures

Body Report

Figures Section

"This page has been left blank intentionally"

1.0 Introduction

AECOM Australia Pty Ltd (AECOM) was commissioned by Port Kembla Port Corporation (PKPC) to undertake an air quality impact assessment (AQIA) for the Port Kembla Outer Harbour Development (PKOHD). The purpose of the investigation was to identify and analyse key air quality opportunities and constraints relating to the proposed development. The report reviews the air quality issues related to the Concept Plan application and the Major Project application (Stage 1) of the Concept Plan.

The AQIA examines the likely sources of air pollution during both construction and operational phases of the project, and investigates the local and regional air quality characteristics to determine the capacity of the local airshed to absorb emissions from the proposed development.

Air dispersion modelling was undertaken to predict the likely air quality impacts that the project may have on the surrounding area. It is expected that the Concept Plan is likely to have long term impacts related primarily to moored ships and increased vehicle movements (trains and trucks), whilst the Major Project is likely to result in short term impacts related primarily to material haulage and stockpiling of fill material during the construction and long term impacts during the operation from moored ships and increased vehicle movements.

The Director-Generals Requirements (DGRs) provided by the NSW Department of Planning (DoP) (DoP reference S08/00337-1) dated 27 January 2009 lists Air Quality as a key issue to address. The DGRs provided that the Environmental Assessment (EA) must assess air pollutants, including dust and any other atmospheric pollutants of concern for "*local regional and inter-regional air quality , from fugitive and point sources, taking into account of the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW"* (DEC, 2005). In particular, the EA must assess the "*potential odour from dredge spoil and proposed odour control*".

In addition to the DGRs, an adequacy review by DoP (dated 2 November 2009) of the draft EA submitted on 1 October 2009 was undertaken. In regards to air quality issues, the review required the AQIA to expand its description and quantified assessment of the "*operation of dredging equipment and material haulage during reclamation activities*" as well as potential impacts from operations of the terminals and increased vehicle traffic. In a subsequent teleconference with DoP staff (held on 24 November 2009) an appropriate quantitative approach and modelling methodology was formulated to meet the requirements of the DGRs and adequacy review. A summary of the scope of works formulated in consultation with DoP is as follows:

- Ambient background pollutant concentrations were investigated for the area surrounding the Outer Harbour development. These levels were analysed to determine the capacity of the local airshed to absorb increased emissions whilst still complying with regulatory limits;
- Local topography, meteorology and location of sensitive receptors (both now and potentially in the future) were examined to assess how these factors may affect the development pollution envelope;
- The potential for odour emission from dredging operations was considered; and
- Quantitative air dispersion modelling was undertaken to predict the likely air quality impacts that the Concept Plan application and Major Project application (construction and operation) may have on the surrounding area. The assessment incorporated increased traffic emissions from trains, trucks and shipping vessels, emissions from dredging vessels, and bulk material handling including stockpile emissions. The modelling results were combined with ambient pollutant concentrations (where available) and compared to NSW DECC assessment criteria.

"This page has been left blank intentionally"

2.0 Assessment Background

2.1 Assessment Area

The PKOH is located in the Illawarra region of NSW, approximately 80km south of Sydney. Illawarra is the fourth major population centre of NSW and has the nation's ninth largest port. It is located on a thin coastal strip with a steep escarpment approximately 8 km 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.

Port Kembla is located approximately 5 km south of the Wollongong CBD. The port area encompasses coal and grain handling facilities, steel works, a fertiliser manufacturer and ship loading facilities. A railway line and main arterial road provide access to the port area. Residential premises are also located within 1 km of the port. Existing land use within the local area includes industrial, mixed commercial and residential.

The regional and local context of the development site is provided in **Figures F1** and **F2** respectively.

2.2 Project Description

Approval Framework

Port Kembla Port Corporation is seeking concurrent Concept Plan approval for the total development and Major Project approval for Stage 1 of the development. The Major Project sits within, and is part of, the overarching Concept Plan framework. A description of the Concept Plan and Major Project is provided below. Further discussion on the framework of the Concept Plan and Major Project is presented in Sections 5 and 6 of the Environmental Assessment report.

Concept Plan Description

The Outer Harbour development is to be constructed in three discrete stages over the next 30 years with an anticipated completion date of 2037. Concept Plan approval is being sought for the total development. Construction of the Concept Plan would be staged to meet the needs of prospective customers, to cater for growing port needs and regional development, and to increase the potential to address the needs of new industry for 30 plus years into the future.

The Concept Plan provides a framework for the progressive completion of the Outer Harbour development and comprises creation of land dedicated to port activity. The reclaimed land would be divided into two main areas, one devoted to the import and export of dry bulk, break bulk and bulk liquid cargoes (multi-purpose terminals) and one devoted to container trade (container terminals).

Once the Concept Plan is completed, the reclamation footprint of the development would extend from the existing Port Kembla Gateway jetty in the north to Foreshore Road in the south, the boat harbour to the east and existing rail sidings to the west.

Physical features of the Concept Plan include the following:

- At least 42 hectares of hard stand, to accommodate new multi-purpose terminals and new container terminals
- Dredging would be completed over a series of dredging campaigns for:
    - Berth boxes and basins between multi-purpose terminals and container terminals.
    - Basins east of the container terminals.
    - Container berth boxes and approach channels.
- 1770 metres total new berth length.
- A total of seven new berths, including:
    - Four container berths with a total length of 1,150 metres.
    - Two multi-purpose berths designed to handle dry bulk, break bulk and bulk liquid with a total berth length of 620m.
    - A multi-purpose berth at the site of the existing No. 6 Jetty.
- Retention of the existing oil berth on the northern breakwater of the Outer Harbour.

- Berthing basins and approaches with up to -16.5 metres water depth below Port Kembla Harbour Datum for new berths.
- Road and rail infrastructure to support the expansion, including:
  - New road link from Christy Drive to the multi-purpose and container terminals.
  - Rail infrastructure upgrade in the South Yard.
  - A new road link connecting Darcy Road.
  - An extension of existing sidings to connect to a rail siding on the container terminals.

PKPC is seeking Concept Plan Approval for the total development of the Outer Harbour with the understanding that separate Major Project applications would be made for approval to construct and operate facilities on the site. PKPC would construct the reclamation, road and rail infrastructure and basic services for the site as a whole. Development of specific facilities may be undertaken by PKPC or third party operators who would lease part of the site from PKPC for a specific purpose. It is initially intended that the first stage of the multi-purpose terminals, including utilities and amenities, would be developed, operated and maintained by PKPC as a common user facility.

Stage 1 would be constructed between 2010 and 2018, Stage 2 between 2014 and 2025 and Stage 3 between 2026 and 2037.

Major Project Description

Major Project Approval is being sought to construct and operate Stage 1 of the Concept Plan. Construction of the Major Project would be divided into three sub-stages, identified as Stage 1a, Stage 1b and Stage 1c. Construction elements of Stage 1 comprise demolition of No.3 and No.4 Jetties, and reclamation and dredging for the footprint of the total development, with the following exceptions:

- An area in the vicinity of the Port Kembla Gateway.
- Expansion of the current swing basin area (ship turning circle).

At the completion of Stage 1 the central portion of the multi-purpose terminals would be operational. Road and rail infrastructure to support the first multi-purpose berth would also be constructed, and would comprise:

- Upgrade of rail infrastructure in the South Yard.
- A new road link from Christy Drive to the central portion of the multi-purpose terminals.
- A temporary road to facilitate construction of the container terminals.

The Major Project application sits within, and is part of, the overarching Concept Plan. Stage 1 is proposed to be constructed between 2010 and 2018. Major Project Approval would allow PKPC to commence reclamation and dredging for the multi-purpose and container terminals and construct and commence operations for the first multi-purpose berth. Major Project Approval for Stages 2 and 3 of the Concept Plan would be subject to separate applications for Project Approval made at a later date.

2.3 Sensitive Receptor Location

Sensitive receptors are defined by the Department of Environment, Climate Change and Water (DECCW) as "*a location where people are likely to work or reside*" and should "*consider the location of known or likely future sensitive receptors*" (DEC 2005). Land uses such as residential housing, schools, hospitals, nursing homes, and recreational areas are classified as sensitive receptors. **Figure 2** shows the local context of the PKOHD where industry and housing are located on the eastern and western borders of the site. A more refined description of the sensitive receptors for the development is provided below:

- The nearest residences to the border of the project area are located approximately 400m to the south west near the corner of Five Islands Road and Military Road, with other residence in a clockwise arc from 800m to the south-south east to the west;
- Commercial and industrial areas are located on the boundary of the project area in all directions with the exception of adjacent water bodies;
- The nearest schools are Illawarra Senior College on Military Rd approximately 300m to the south west, Port Kembla Pre-School on Military Rd approximately 700m to the south and Port Kembla Public School on Gloucester Bvd approximately 1.2km to the south-south east;
- The nearest church is the Port Kembla Uniting Church located approximately 1km to the south west; and

- The nearest hospital is the Villa Maria Centre which is located approximately 6km to the west-north west, with the Illawarra Private Hospital and Victory Hospital located approximately 6.5km to the north west.

2.4 Potential Sources of Air Pollution from PKOHD

Potential sources of air pollution related to the construction and operational phases of the Concept Plan and Major Project applications are as follows:

2.4.1 General Construction

General construction operations (excluding dredging operations which are detailed later in this section) have the potential to increase short term pollution concentrations during the development. Pollutant emissions may increase due to the following operations:

- Earthworks (breaking soil); earthworks actively disturb the soil creating dust and the exposed soil is a source of windblown dust;
- Movement of vehicles over unsealed roads; vehicle movement over unsealed roads generates dust, while the road itself is a source of windblown dust;
- Raw material stockpiles; the stockpiling of raw materials required for construction needs (such as builders sand and blue metal) may increase the potential for dust caused when unloading and loading the stockpiles as well as wind generated dust; and
- Emissions from vehicle engine combustion (discussed later in this section); increased vehicle pollution (such as oxides of nitrogen, carbon monoxide and particulates) from construction includes the use of earth moving machinery (bulldozers etc), haul trucks and increased worker vehicles.

It is understood that during the Major Project construction stage a material stockpile is to be located to the south of the harbour containing material required for reclamation activities and general construction. The reclamation material is sourced from off-site locations and may contain sand stone, soil or blast furnace slag. The slag is well aged and effectively inert and as such it is assumed that it will not emit harmful vapours or other gaseous pollutants. The material will undergo a screening assessment prior to delivery on the site to ensure that the fill is suitably clean of pollutants such as heavy metals. Suitable mitigation measures should be employed to control the emission of pollutants from the stockpile. These have been discussed in **Section 7.0** and include watering of the stockpile or potentially covering it if not disturbed for large time periods.

It is assumed that ‘Best Practice’ pollution mitigation methods are employed at all times during construction to limit the potential impact on local air quality. It is envisaged that Major Project construction activities would be scheduled between the hours of 7 am and 6 pm Monday to Friday, and 8 am and 1 pm on Saturdays. Where practical, the nearest affected residents would be notified in advance of work proposed outside of these hours. Potential pollution from construction of the development will be short term and localised to the area surrounding the construction and is not expected to have long term adverse impacts on the surrounding area.

Land reclamation has the potential to expose new unsealed dirt areas to winds, increasing the potential for dust emissions from these areas. The material used for reclamation is likely to be wet sediment which limits dust emissions, with the reclamation areas sealed in the interim. It should also be noted that current areas of unsealed land that are prone to windblown dust impacts will be sealed for uses such as container storage, decreasing the potential emission of dust from these particular areas.

2.4.2 Dredge Spoil

During the Major Project construction period spoil will be dredged from selected areas of the harbour and used to fill areas that are to be reclaimed for the development. The spoil that will be dredged has the potential to emit odour and gaseous pollutants (such as hydrocarbons), with this potential increasing if dredge spoil is stockpiled above the water level. Information on the dredging operation and the potential air quality issues are discussed below.

Dredging Background

For Stage 1 (Major Project Application) a total of 4,628,049m^3 of fill will be required for the reclamation. Part of the fill will be sourced from dredging material from within the outer harbour (383,575m^3 rock, and 833,675m^3 soft sediments) while the balance (3,410,799m^3) will need to be imported from external sources. A total of 798,398m^3 of blast furnace slag will be sourced from local stockpiles, 1,000,000m^3 will come from CBD Metro and 1,612,401m^3 will be sourced from other projects around the Sydney and Shoalhaven regions. A stockpile of off-site sourced reclamation material will be located to the south of the Outer Harbour as discussed in the previous section.

Some reclamation and dredging will be undertaken as part of subsequent stages of the development (Stage 2 and Stage 3). Approximately 50,000m^3 of material would be dredged from an area in the vicinity of the existing swing basin during Stage 3 to accommodate manoeuvring of vessels in and out of the proposed Outer Harbour berths once the eastern container terminals are operational. The material would be deposited in the reclamation for the eastern portion of the container terminals during Stage 3.

Material dredged from the Outer Harbour would be encapsulated and confined within a series of engineered containment structures, or bunds, at a lower harbour depth (approximately -10m Port Kembla height datum) beneath the proposed container terminal. Bund sizing and locations within the reclamation footprint would be determined as dredging and reclamation design activities progress.

Related Air Quality Issues

Environmental testing of sediments found some sediments to be contaminated with heavy metals, Polycyclic Aromatic Hydrocarbons (PAH) and Tributyl Tin (TBT). It is proposed to permanently relocate the contaminated sediments from within the Outer Harbour dredging footprint to bunded containment areas which form part of the reclamation area, where they would be permanently contained and capped by clean fill. The contaminated soils will not be exposed to the atmosphere (they will remain within the water column) during the dredging process, therefore its movement will not result in the emission of pollutants to the atmosphere.

It has been identified that the dredging and filling process is to be conducted by methods designed to limit the exposure of the sediment to the atmosphere (including Cutter Suction Dredging, Backhoe Dredging or Grab Dredge) and does not involve any excavation or handling of dry sediments. For this reason the risk of dust, gaseous pollutants and odour emissions from the dredging activities is considered to be very low.

Any potential emission of dust, odour or gaseous pollutants from the dredge spoil is likely to occur during the construction phase only and any potential adverse impact will be short term and localised to the area surrounding the operation. In addition, recent dredging operations in the Inner and Outer Harbour have not resulted in odour complaints from the local community. As such, it is expected that the potential for nuisance odours to be emitted from the site due to dredging will be low.

2.4.3 Ship Loading

The PKOHD will involve the loading and unloading of bulk materials to and from ships, including the transfer of material from trains and trucks. As the primary use of the port facilities is for the transfer of bulk goods and containers, it is considered unlikely that such transfers will represent a potential pollutant source.

Auxiliary engines and boilers used during ship mooring are potential contributors to the local air quality. The engines and boilers from ships emit a number of pollutants including oxides of nitrogen, carbon monoxide, particulate matter (dust), sulphur dioxide and others. The content of pollutants from the moored ships auxiliary engine and boilers depends primarily on the power of the ship (kWh) and the type of fuel used (residual oil, marine diesel oil or marine gas oil).

The Concept Plan development will see an increase in moored ships in the Outer Harbour. It has been estimated that during an average year 105 ships will be moored for an average of 14 hours per day for the bulk material berth (multi-purpose berth), 50 ships will be moored for an average of 7 hours per day for the bulk cargo berths (multi-purpose berth) and 100 ships will be moored for an average of 10 hours per day for the container berths.

2.4.4 Increased Vehicle Emissions

The construction and operation phase of the development will see an increase in vehicle traffic to the area leading to a potential increase in pollutants from fossil fuel combustion (likely to be diesel from both trucks and trains). Although the increase in vehicles during the construction phase has the potential to create increases in short term pollution concentrations, it is not expected to have long term adverse impacts on the surrounding area.

The increase in vehicle emissions due to the operational phase of the development has the potential to contribute to existing and long term pollutant levels in the surrounding area.

It is estimated that there will be approximately 184,714 trucks per year (assuming an average of 21 trucks per hour) serving the port during the Concept Plan approval stage. It is estimated that that there will be a maximum of approximately 65,608 trucks per year (expected in the first year of construction) serving the port over the Major

Project (Stage 1) construction period, and 60,714 trucks per year (assuming an approximate average of 7 trucks per hour) serving the port during the Major Project operational period.

It is estimated that for the Major Project Stage 1 construction period there will be 3 trains per day unloading material in the construction stockpile area. During the Major Project operation period there will be an estimated 2 trains per day unloading at the bulk materials berth stockpiles. During the Concept Plan operation period there will be an estimated 1 train per day at the general freight berth, 2 trains per day at the bulk material berth, and 16 trains per day at the container terminal (4 trains per day per berth). Each train is expected to have 2 locomotives.

2.5 Pollutants of Concern

The above mentioned activities have the potential to contribute to various pollutant levels in the local air shed. The following sections describe the potential pollutants of concern.

Carbon Monoxide

Carbon monoxide (CO) is a colourless, odourless gas produced by the incomplete combustion of fuels containing carbon (e.g. oil, gas, coal and wood). CO is absorbed through the lungs of humans, where it reacts to reduce the blood's oxygen-carrying capacity. In urban areas, motor vehicles account for up to 90 percent of all CO emissions.

An increase in motor vehicles, plant/machinery and shipping vessels during the construction and operational phase of the PKOHD could potentially contribute to increased levels of CO.

Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a brownish gas with a pungent odour. It exists in the atmosphere in equilibrium with nitric oxide. The mixture of these two gases is commonly referred to as nitrogen oxides (NO_x). NO_x is a product of combustion processes. In urban areas, motor vehicles and industrial combustion processes are the major sources of ambient NO_x. NO_2 can cause damage to the human respiratory tract, increasing a person's susceptibility to respiratory infections and asthma. NO_2 can also cause damage to plants, especially in the present of other pollutants such as O_3 and SO_2. NO_x are also primary ingredients in the reactions that lead to photochemical smog formation.

An increase in motor vehicles, plant/machinery and shipping vessels during the construction and operational phases of the PKOHD could potentially contribute to increased levels of NO_2.

Sulfur Dioxide

Sulfur dioxide (SO_2) is a colourless gas with a sharp, irritating odour. It is formed in combustion processes through burning fossil fuel containing sulfur, in petroleum refining and smelting mineral ores. SO_2 may be oxidised in the atmosphere to form sulfuric acid, which contributes to acid rain. SO_2 affects human health by causing respiratory tract infections. People with pre-existing respiratory conditions such as asthma are most sensitive to SO_2 exposure. The simultaneous presence of airborne particulate matter can compound these effects. SO_2 and its aerosols can also damage vegetation and some materials.

An increase in motor vehicles and shipping vessels during the construction and operational phases of the PKOHD could potentially contribute to increased levels of SO_2.

Particulate Matter

Particulate matter is the term for solid or liquid particles found in the air. Some particles are large or dark enough to be seen as soot or smoke, but fine particulate matter is tiny and is generally not visible to the naked eye. Particulate matter is produced by the mechanical breakup of larger solid particles. The larger or coarse fraction can include dust from roads, agricultural processes, uncovered soil or mining operations, as well as non-combustible materials released when burning fossil fuels. Pollen grains, mould spores, and plant and insect parts can also contribute to the coarse fraction. Evaporation of sea spray can produce large particles near coasts. The smaller or fine particulates are largely formed by the oxidation of primary gases.

There are two main effects of particulate; nuisance effects and health effects. Nuisance effects are primarily due to deposited dust and the coarser fraction of total suspended particulate. Health effects are primarily due to particles in the size range less than 10 µm in diameter (PM_{10}) and particles less than 2.5 µm in diameter ($PM_{2.5}$). PM_{10} refers to the range of particulate matter that is inhalable and is able to penetrate the nose or mouth under normal breathing conditions. $PM_{2.5}$ is respirable and is able to penetrate the nasal cavity and ultimately the lungs.

Deposited dust refers to the larger fractions that fall from the air and deposit on exposed surfaces. In general, deposited dust has an aerodynamic diameter of greater than about 20 µm, however there is no sharp size cut off between these particles and the smaller particles that remain suspended in the air for long periods. Larger dust particles are generally responsible for nuisance (amenity) effects. Dust can have a range of nuisance effects including vegetation damage and surface soiling. Depending on its physical or chemical characteristics, dust may also cause surface deterioration of materials due to its abrasive or corrosive properties. If the dust composition is dangerous then it is considered a hazardous air pollutant (and may contain toxic material).

Local particulate matter levels could be contributed to by an increase in vehicle use and plant/machinery during the construction and operation phase of the development (especially if there is an increase in diesel motors), as well as from any activities that handle coal, minerals or other similar products, or that disturb soil during the construction phase. This would include the loading/unloading of ships, especially where dusty materials are being handled such as coal. Land reclamation also has the potential to expose new unsealed dirt areas to winds, increasing the potential for dust emissions from these areas.

Lead

Lead has been monitored in the Illawarra region at various sites since 1970 as a check on emissions from the operation of particular point sources as well as ambient sources. Although many heavy metals are present in the Illawarra air shed, lead will be the major focus of this qualitative assessment. The development has the potential to contribute to local lead levels if materials containing lead (e.g. concentrates for processing) are to be transferred through the port.

Toxic Air Pollutants

Toxic air pollutants, also known as hazardous air pollutants, are those pollutants that are known or suspected to cause cancer or other serious health effects, such as reproductive effects or birth defects, or adverse environmental effects. Examples of toxic air pollutants include benzene, which is found in gasoline; perchlorethylene, which is emitted from some dry cleaning facilities; and methylene chloride, which is used as a solvent and paint stripper by a number of industries. Health effects associated with these pollutants are affects on the immune system, as well as neurological, reproductive, developmental, respiratory and other health problems. Benzene is the toxic air pollutant that is typically monitored and used as an indication of the overall toxic air pollution quality.

Odour

Odour is a sensory response to the inhalation of one or more chemicals in the air we breathe. A person's perception of an odour can vary significantly depending on the sensitivity of the person, the acuteness of the person's sense of smell and the connotations that the odour bestows on that person. Odour primarily affects a person's quality of life and can have a large range of adverse effects including stress and other physical symptoms.

Odour is not monitored by state environmental agencies nor by industry; however odorous emissions do need to be taken into account in any air pollution assessment, as many air pollution complaints in residential (and sometimes industrial) areas often relate to odour. Many industries in and around the assessment area contain potential odour sources.

Odour will primarily be a pollutant of concern during the dredging operations of the construction phase of the PKOHD.

3.0 Pollutant Assessment Criteria

In NSW the DECCW Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (DEC, 2005), is the primary source of pollutant criteria. The Commonwealth National Environmental Protection (Air Toxics) Measure (Air Toxics NEPM) provides additional criteria for air quality. This assessment compares all three documents to the background data available from local monitoring stations.

As previously listed, the pollutants of potential concern investigated in this assessment included the following criteria pollutants:

- Carbon monoxide (CO);
- Nitrogen oxides (NO_x reported as NO_2);
- Sulfur dioxide (SO_2);
- Particulate matter: PM_{10} (particles less than 10 μm in diameter), $PM_{2.5}$ (particles less than 2.5 μm in diameter) and deposited dust; and
- Ozone (O_3) precursors (volatile organic compounds or VOCs).

Some toxic air pollutants were briefly examined in terms of long term trends due to limited monitoring data. The air toxics included were benzene, toluene, and xylenes.

Odour was also highlighted as a pollutant of potential concern (in terms of nuisance effects). Odour has not been monitored by any regulatory authorities in the Illawarra region, and as such no background data can be referenced. For a densely populated area such as Port Kembla, an air dispersion modelling criteria of 2 Odour Units (OU) at the nearest sensitive receptor would be appropriate. This illustrates that the criteria and expectations placed on odour emissions in the area would be strict.

In addition, the NSW EPA *Protection of the Environment Operations Act (POEO) (1997a)* requires that “offensive odours” should not be emitted by any facility or operation. Offensive odour is described as an odour which may cause harm to a person or interfere unreasonably with the comfort or repose of any person.

Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2005)

The NSW DECCW *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005), hereon referred to as the Approved Methods, lists the statutory methods for modelling and assessing emissions of air pollutants from stationary sources. **Table 1** presents the Approved Methods air quality impact assessment criteria for the air pollutants of potential concern for the PKOHD.

Table 1: NSW DECCW Approved Methods Air Quality Impact Assessment Criteria for Pollutants of Concern

Pollutant	NSW DECCW Air Quality Criteria		Averaging Period
	pphm	μg/m³	
Carbon monoxide (CO)	8,700 2,500 900	100,000 30,000 10,000	15 minutes 1 hour 8 hour
Benzene	0.009	0.029	1 hour
Nitrogen Dioxide (NO_2)	12 3	246 62	1 hour Annual
Sulfur Dioxide (SO_2)	25 20 8 2	712 570 228 60	10 minute 1 hour 24 hour Annual
PM_{10}	- -	50 30	24 hour Annual
Ozone (0_3)	10 8	214 171	1 hour 4 hours
Lead (Pb)	-	0.5	Annual
Units	**g/m².month**	**g/m².month**	
Deposited Dust	2 *	4 **	Annual

ppm: parts per million
pphm: parts per hundred million
μg / m³: micrograms per cubic metre
mg / m³: milligrams per cubic metre
* The maximum increase in deposited dust
** The maximum total deposited dust level

National Environmental Protection (Ambient Air Quality) Measure and National Environmental Protection (Air Toxics) Measure

Commonwealth *National Environmental Protection (Ambient Air Quality) Measure* (Air NEPM) and monitoring investigation levels in the Commonwealth *National Environment Protection (Air Toxics) Measure* (Air Toxics NEPM) are used to assess whether pollutant levels could harm public health.

The desired environmental outcome of the Air NEPM is ambient air quality that provides for the adequate protection of human health and well being. The goal of the Air NEPM is to achieve the standards with the allowable exceedences, as assessed in accordance with the associated monitoring protocol. The Air NEPM standards apply to air quality experienced by the general population within a region, and not to air quality in areas within the region impacted by localised air emissions such as heavily trafficked streets. The ambient air quality standards defined in the Air NEPM are listed in **Table 2**.

Table 2: Air NEPM Air Quality Standards

Pollutant	Air NEPM Standards	Averaging Period
Carbon Monoxide	9.0 ppm	8 hour*
Nitrogen Dioxide	0.12 ppm 0.03 ppm	1 hour* Annual
Sulfur Dioxide	0.20 ppm 0.08 ppm 0.02 ppm	1 hour* 24 hour* Annual
PM_{10}	50 $\mu g/m^3$	24 hour**
$PM_{2.5}$	25 $\mu g/m^3$ 8 $\mu g/m^3$	24 hour (advisory only) Annual (advisory only)
Photochemical Oxidants (as Ozone)	0.10 ppm 0.08 ppm	1 hour* 4 hour*
Lead	0.50 $\mu g/m^3$	Annual

ppm: parts per million

$\mu g / m^3$: micrograms per cubic metre

* Not to be exceeded more than one day per year

** Not to be exceeded more than five days per year

The Air Toxics NEPM provides a framework for monitoring, assessing and reporting on ambient levels of air toxics. The Air Toxics NEPM includes monitoring investigation levels for use in assessing the significance of monitored levels of air toxics with respect to human health. The monitoring investigation levels are levels of air pollution below which lifetime exposure, or exposure for a given averaging time, does not constitute a significant health risk. If these limits are exceeded in the short term, it does not mean that adverse health effects automatically occur. If the monitoring investigation levels are exceeded, then some form of further investigation by the relevant jurisdiction of the cause of the exceedence is required. The relevant monitoring investigation levels defined in the Air Toxics NEPM are listed in **Table 3**.

Table 3: Air Toxics NEPM Air Quality Monitoring Investigation levels

Pollutant	Air Toxics NEPM Monitoring Investigation Level	Averaging Period
Benzene	0.003 ppm	Annual
Toluene	1 ppm 0.1 ppm	24 hour Annual
Xlyenes (as a total of ortho, meta and para isomers)	0.25 ppm 0.2 ppm	24 hour Annual

ppm: parts per million

DECCW instrumentation is only capable of measuring levels of the *p*-xylene isomer, not total xylene. However, monitoring studies conducted in urban environments around the world have shown that *p*-xylene consistently comprises about 20 percent of the total xylene present in the atmosphere, providing the basis for an estimate of total xylene concentrations to be made.

4.0 Existing Ambient Air Quality

4.1 Surrounding Sources of Potential Air Pollution

Port Kembla is dominated by heavy and light industry, with some mixed commercial use and residential areas. Sources of air pollution identified include point sources (specifically stack sources), ground level sources such as construction sites, fugitive emission sources (for example, petroleum storage tanks, coal storage and despatch and transport corridors) and motor vehicle sources at construction sites and on transport corridors.

The site upon which the Outer Harbour development will be developed is mostly unsealed and poorly vegetated. Areas of exposed dirt are prone to wind generated dust emissions and can contribute to dust levels in the local area. The Outer Harbour development will involve the sealing of a high percentage of these dirt areas, hence reducing the potential area for wind generated dust emissions.

Significant, or potentially significant, sources of air pollution (criteria pollutants, toxic air pollutants, dust and odour) in the area surrounding the site include:

- BlueScope Steel;
- Orica;
- Incitec Limited (fertiliser manufacturer);
- GrainCorp Operations Limited;
- Port Kembla Coal Terminal;
- Port Kembla Copper; and
- Various light industrial sources (steel workshops, equipment hire etc).

4.2 Pollutant Monitoring Data

Ambient pollutant concentrations for criteria pollutants (where available) and toxic air pollutants from nearby DECCW monitoring sites were used to examine the existing ambient air quality in the assessment area.

In order to gain a general idea of the existing ambient air quality in the assessment area, reference was made to the following documents:

- *Ambient Air Quality Research Report (1996-2001); Dioxins, Organics, Polycyclic Aromatic Hydrocarbons and Heavy Metals* (2002), NSW Environment Protection Authority (EPA), Sydney; and
- *Quarterly Air Quality Monitoring Reports*, Department of Environment and Climate Change NSW, Sydney.

The DECCW monitors air quality in NSW to check compliance with ambient air quality guidelines, identify long term trends in air quality, assess the effectiveness of air quality management strategies and to disseminate information about air quality. The results are published as quarterly air quality monitoring reports. Air pollutants monitored by the DECCW in NSW include CO, O_3, NO_x (reported as NO_2), SO_2, benzene, toluene, p-xylene, PM_{10}, $PM_{2.5}$ and visibility reducing particles. Not all pollutants are measured at all monitoring sites. The Wollongong monitoring station at Gipps Street was the closest to the assessment area monitoring the appropriate pollutants and was used to interpret the air quality for relevant pollutants.

From early 1996 to August 2001 the NSW Environmental Protection Agency (EPA) conducted a study to assess the presence of air toxics on a regional scale encompassing the Sydney, Newcastle and Illawarra regions (EPA 2002). The primary aim of the program was to obtain data on the concentration of a wide range of dioxins, 11 Polycyclic Aromatic Hydrocarbons (PAHs), 12 heavy metals and 41 organic compounds. The dioxin results from the EPA study were not reviewed in the current assessment.

4.2.1 Dust Deposition Gauge Results

The results from the Dust Deposition Gauges (DDG) located to the east and west of the PKOHD from October 2001 to October 2007 have been examined in this assessment. DDG results reflect the long-term dust levels in a local area as opposed to assessing contributions from a specific activity or operation. The gauges collect dust that settles gravimetrically, and can be contributed to by a variety of sources in the local environment. DDG measure the total dust settled and does not differentiate between particulate sizes.

DDG results are assessed using the NSW DECCW Approved Methods residential amenity criteria value of 4 g/m^2.month (Insoluble Solids). The DDG results have been summarised by location and year in **Table 4**.

Table 4: Dust Deposition Gauge Results for the Outer Harbour Development October 2001 to October 2007

Year	Location	Dust Concentration (g/m^2.month)		
		Average	Maximum	Minimum
2001	East	**4.1**	**6.7**	1.4
	West	2.0	2.5	1.7
2002	East	2.8	**9.2**	0.8
	West	**4.7**	**8.3**	2.8
2003	East	2.8	**4.2**	1.5
	West	3.2	**5.5**	1.3
2004	East	2.0	**5.0**	1.2
	West	3.0	**5.7**	1.2
2005	East	3.2	**7.2**	1.1
	West	**4.3**	**12.3**	0.9
2006	East	2.2	**8.4**	0.1
	West	3.3	**5.7**	1.2
2007	East	2.2	**5.4**	0.3
	West	**4.2**	**7.5**	0.7
All Data	East	2.6	**9.2**	0.1
	West	3.7	**12.3**	0.7
	All	3.2	**12.3**	0.1
NSW DECCW Criteria		4 g/m^2.month (residential amenity)		

Bold denotes exceedence

The tabulated results shows that the dust deposition rates averaged over all monitored years for both the east and west locations were below the 4 g/m^2.month criteria. However, a review of the individual monthly results shows that from a possible 61 months of monitoring data there are 10 months for the east location and 21 months from the west location where monitoring data exceeds the NSW DECCW criteria.

The most recent data available is for 2007. The annual average for this year is below the criteria for the east location and above the criteria for the west location. The monthly results show that from a possible 10 months there are no months for the east location and 5 months from the west location that exceed the NSW DECCW criteria.

The results show that generally the DDG results from the west location are higher than those from the east location. The west location is situated closer to industrial areas which are potential sources of dust emissions.

4.2.2 Long Term Air Toxic Trends

Ambient Air Quality Research Project (EPA, 2002)

On a regional scale, the NSW EPA *Ambient Air Quality Research Project* (2002) summarises the results of five and a half years of monitoring data from the Sydney, Newcastle and Illawarra regions. There were four monitoring stations in the Illawarra region, including the Wollongong CBD. Relevant comments and trends observed from the project for PAHs, heavy metals, and organic compounds are summarised below:

Polycyclic Aromatic Hydrocarbons (PAHs)

- PAHs are a mixture of organic compounds released into the atmosphere as gases and particles during the incomplete combustion of organic material. Typical sources are motor vehicles, steel works, waste incineration, the burning of wood and coal for heating, and bushfires.
- In the EPA project the most common 11 PAHs were collated together as 'total PAHs'.
- **Table 5** presents the 24 hour average total PAHs (in ng/m^3) for Wollongong and Sydney (for comparison) for both winter and summer.

Table 5: Total PAHs as 24 hour averages (ng/m^3) winter and summer for Wollongong and Sydney (EPA, 2002)

	Wollongong		Sydney	
	Winter	**Summer**	**Winter**	**Summer**
Average	1.71	0.62	4.47	0.62
Max	9.62	1.79	17.5	1.39

- The results show that, as expected, the winter months are more conducive to higher levels of pollutants. Factors that contribute to the high levels are; less mixing in the atmosphere due to stronger and more frequent temperature inversions resulting in pollutants being trapped in a shallow layer at the ground, as well as increased use of solid fuel heaters mostly for home heating.
- The report further details that autumn and spring had lower results than winter, although not as low as summer, and that as a general rule, the annual average PAH value would be approximately one quarter to one half of the winter value.
- The data shows that Wollongong has better air quality in terms of PAHs present in the atmosphere than Sydney, especially during the winter period.
- No ambient PAH standards have been set, however guideline values for benzo(a)pyrene (BaP) have been developed. BaP is considered as a good indication for the presence of PAHs. The UK has proposed an annual average BaP goal of 0.25 ng/m^3 (from 2010) and the EU are considering a BaP goal of between 0.5 and 1.0 /m^3. The results in the EPA study show that the average BaP value for Wollongong was 0.16 and 0.03 ng/m^3 in winter and summer respectively. The average values for both seasons met the European goals. If you then apply the previously suggested ratio of one quarter to one half on the winter average, then the result would be less than 0.08 ng/m^3.

Heavy Metals

- 12 heavy metals were assessed in the EPA project, with the Illawarra monitoring stations being located at Gipps Street, Wollongong and at Albion Park.
- All metals showed low levels and were generally below recognised international standards, although direct comparison with annual goals was not possible. Copper, lead, manganese, nickel, vanadium and zinc accounted for 95% of the total metal concentration.
- **Table 6** presents the results for lead. The table shows that all results were well below ambient air quality goals.

Table 6: Concentrations of Lead and Air quality Goals (EPA, 2002)

Metal	Mean of Samples (24-hour: ng/m^3)	Range of Samples (24-hour: ng/m^3)	Ambient Air Goals (annual average: ng/m^3)	Source
Lead	29.9	3.4 - 99	500	NEPM, WHO* and DECCW

* WHO – World Health Organisation

Organic Compounds

- Only 19 of the 41 targeted organic compounds were identified in more than 1% of the samples taken. The majority of these 19 compounds were associated with motor vehicle emissions, with industry the primary source of only three of these compounds. **Table 7** presents the 19 found compounds classified by their most likely source.
- The EPA research project concluded that Wollongong CBD had 'good air quality' with respect to organic air toxic levels.
- A comparison against international goals found that no organic compounds exceeded the goals at any time. In fact, the annual average concentration of benzene was below both the UK (2003) goal of 5 parts per billion by volume (ppbV) and the European Commission (2010) long term goal of 1.5 ppbV.

Table 7: Organic compounds detected by the Ambient Air Quality Research Project (EPA, 2002) classified by likely source

Likely Source	Source Organic compound
Motor vehicles	Toluene
	Benzene
	Xylenes (para and meta)
	Xylenes (ortho)
	1,2,4-trimethylbenzene
	Ethylbenzene
	1,3-butadiene
	4-ethyltoluene
	Styrene
	1,3,5-trimethylbenzene
Ozone-depleting substances	Freon® (11, 12 and 113)
	Carbon tetrachloride
	1,1,1-trichloroethane
Industrial	Dichloromethane
	Trichloroethylene
	Tetrachloroethylene
Natural, domestic and industrial	Chloromethane

DECCW Quarterly Air Quality Monitoring Reports

The Illawarra region has three active monitoring sites; Wollongong, Kembla Grange and Albion Park South. The Wollongong CBD location on Gipps Street Wollongong was deemed the most appropriate for the assessment as both Wollongong and the PKOH are located in similar coastal environments and it is the closest monitoring station to Port Kembla at approximately 6km north (although the CBD station will be impacted less by industry than the Outer Harbour site).

Table 8 presents the results from the DECCW quarterly air quality monitoring reports for the Wollongong monitoring station.

Table 8: DECCW Air Pollutant Data for the Wollongong Monitoring Station

Pollutant	Averaging Period	Yearly data ug/m^3				Maxima ug/m^3	Average ug/m^3	Criteria ug/m^3
		2004	2005	2006	2007			
CO	1 Hr maximum	4,000	4,250	3,375	3,625	4,250	-	30,000
	8 Hr maximum	2,625	3,250	1,875	1,875	3,250	-	10,000
NO_2	1 Hr maximum	126	166	143	109	166	-	246
	Annual average	26	26	26	26	-	26	62
SO_2	1 Hr maximum	152	109	100	92	152	-	570
	24 Hr maximum	43	17	20	26	43	-	228
	Annual average	3	3	3	4	-	3	60
PM_{10}*	24 Hr maximum	48	55	62	53	62	-	50
	Annual average	18	19	20	20	-	19	30
$PM_{2.5}$**	1 Hr maximum	79	66	81	75	79	-	NA
	Annual average	10	9	9	10	-	10	8**

* PM_{10} and $PM_{2.5}$ data derived from TEOM measurements.

** Advisory criteria provided in NEPM.

- The data shows that there were no recorded exceedences of any listed air quality criteria for CO, NO_2, and SO_2 for all monitored periods.
- The PM_{10} 24 hour maximum value criteria of 50 ug/m^3 (DECCW and NEPM) was exceeded for every year except 2004. The maximum exceedence was 12 ug/m^3 in 2006 while the lowest exceedence was 3 ug/m^3 in 2007.
- The PM_{10} annual average of 30 ug/m^3 (DECCW and NEPM) was met for all monitored periods.
- The NEPM $PM_{2.5}$ criteria is advisory only, and was established as a long term objective. The $PM_{2.5}$ annual average criteria (advisory only) of 8 ug/m^3 (NEPM) was exceeded for all monitored periods. All years exceeded by 2 ug/m^3 or less.
- The most recent year monitored was 2007 and in that year values were below the calculated maxima for each parameter and 2007 results were generally lower than past years for most parameters. This shows that the air quality in recent times is good compared to past years.

4.3 Implications for the Assessment Area

Based on the information referenced in this assessment, only one major concern was identified relating to the existing air quality in and around the assessment area. Exceedences of the air quality criteria and goals were presented in the DECCW quarterly monitoring particulate matter results for both PM_{10} and $PM_{2.5}$. As the $PM_{2.5}$ criterion is advisory the assessment will focus on the PM_{10} results. There is the potential for health effects associated with this pollutant at exceedence levels. Particles smaller than 10µm have the potential to enter the human respiratory system and penetrate deeply into the lungs, causing adverse effects.

In general PM_{10} is generated by natural events such as bush fires and dust storms as well as by diesel and petrol motor vehicles and other combustion processes that burn fossil fuels, such as power generation, industrial processes and domestic solid fuel heaters. The development has the potential to include vehicle use, plant, machinery and industrial activities and hence has the potential to further contribute to the already high PM_{10} ambient levels in the region.

It is the responsibility of the development, as provided under the NSW DECCW key environmental requirements (dated 19 December 2008), to ensure that 'dust emissions are minimised or prevented' at the site. The development can limit its impact on the local PM_{10} levels by employing 'Best Practice' dust management strategies during the construction and operation phases of the development, as discussed in **Section 6.0** of this report.

Analysis and/or atmospheric dispersion modelling of pollutants, in particular $PM_{10,}$ may be required on a case by case basis for new developments to identify worst case air pollution scenarios and pollutant "hot spots". Pollutant hot spots can be used to identify local air quality impacts and areas unsuitable for highly sensitive land uses (such as childcare centres, schools and recreation areas).

5.0 Meteorology

Meteorological data was sourced from the DECCW Wollongong Monitoring Station located at the Army Barracks on Gipps Street. Continuous hourly averaged data was sourced from the DECCW to assess the wind speed and direction in the general vicinity of the development site. There are no significant topographical features between the Gipps Street station and the development site that would indicate that the station data would not be representative of the meteorological patterns in the area. Both sites are located close to the coast line, so coastal wind effects should be similar at both locations.

5.1 Wind Data

Wind rose diagrams for the Wollongong monitoring station for the period July 2006 to June 2007 for annual and seasonal data are shown in **Figures F3** to **F7**. The wind roses show the frequency of occurrence of winds by direction and strength. The bar at the top of each wind rose diagram represents winds blowing from the north (i.e., northerly winds), and so on. The length of the bar represents the frequency of occurrence of winds from that direction, and the widths of the bar sections correspond to wind speed categories, the narrowest representing the lightest winds.

General observations of the wind rose data shows:

- Annual wind patterns are dominated by winds from the south west in the morning and winds from the north east in the afternoon;
- Summer wind patterns are characterised by increasing north east winds in both the morning and afternoon;
- Autumn winds are dominated by south westerly winds in the morning and north easterly winds in the afternoon as sea breezes take effect;
- Winter winds are generally more settled than those in other seasons. Predominant winds in the morning are from the south west, with more unsettled winds in an arc clockwise from north east to west in the afternoon; and
- Spring winds in the morning are erratic and come from most directions with predominance from the south west and north east, with afternoon winds from the north east.

In general, offshore winds will dominate in the morning and onshore winds (predominantly from the north east) will dominate in the afternoon. This may have some effect on pollutant transport in the afternoon with onshore winds transporting pollutants from existing industrial sources towards inland areas.

The wind speed frequency distribution by hour for the data is presented in **Figure 1**. The data shows that winds are highest during daylight hours with a peak average speed around 1300 to 1500 (1pm to 3pm). This data shows that pollution will be dispersed by winds more effectively in the daytime than at night. This may lead to higher near field pollution concentrations during the night if 24 hour operating activities are assumed.

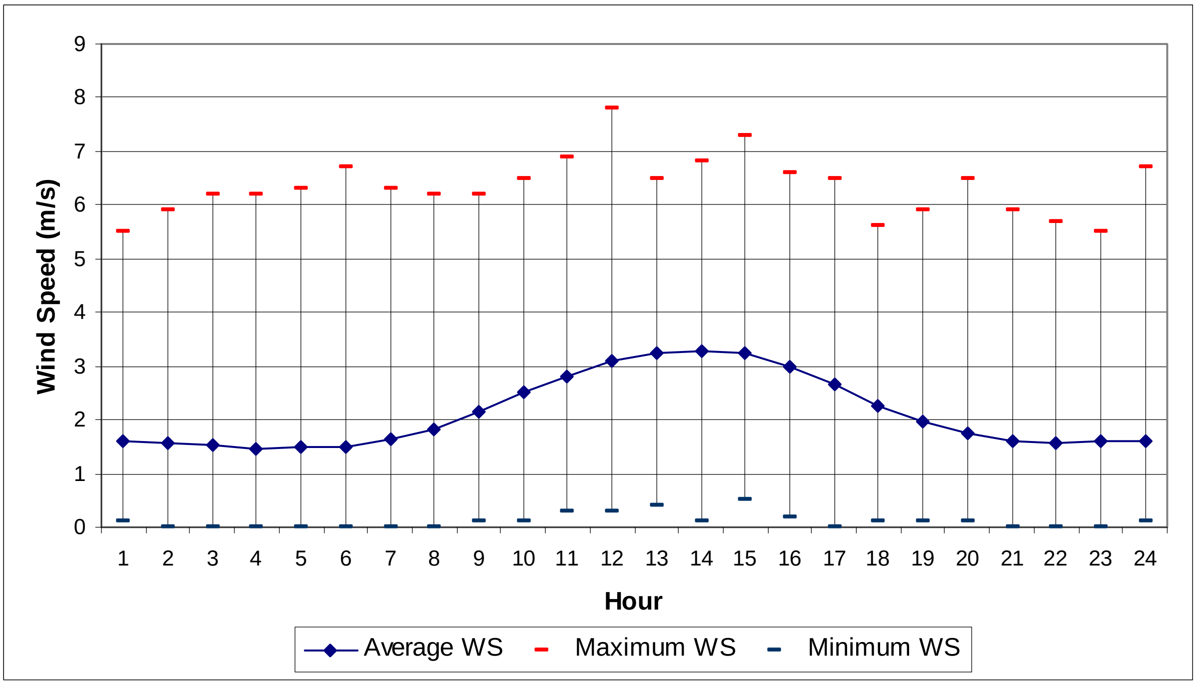

Figure 1: Hourly Wind Speed Frequency for Wollongong July 2006 - June 2007

The wind speed frequency distribution by wind speed category is provided in **Figure 2**. The data shows that there is a relatively even spread of wind speeds between 0.5 and 6 m/s, with very little winds less than 0.5 or greater than 8 m/s. No winds were recorded for wind speeds greater than 10 m/s. It should be noted that there is a very low occurrence of low wind speeds, for which the reason is unclear. The likely cause may be due to the stall speed of the wind speed sensor.

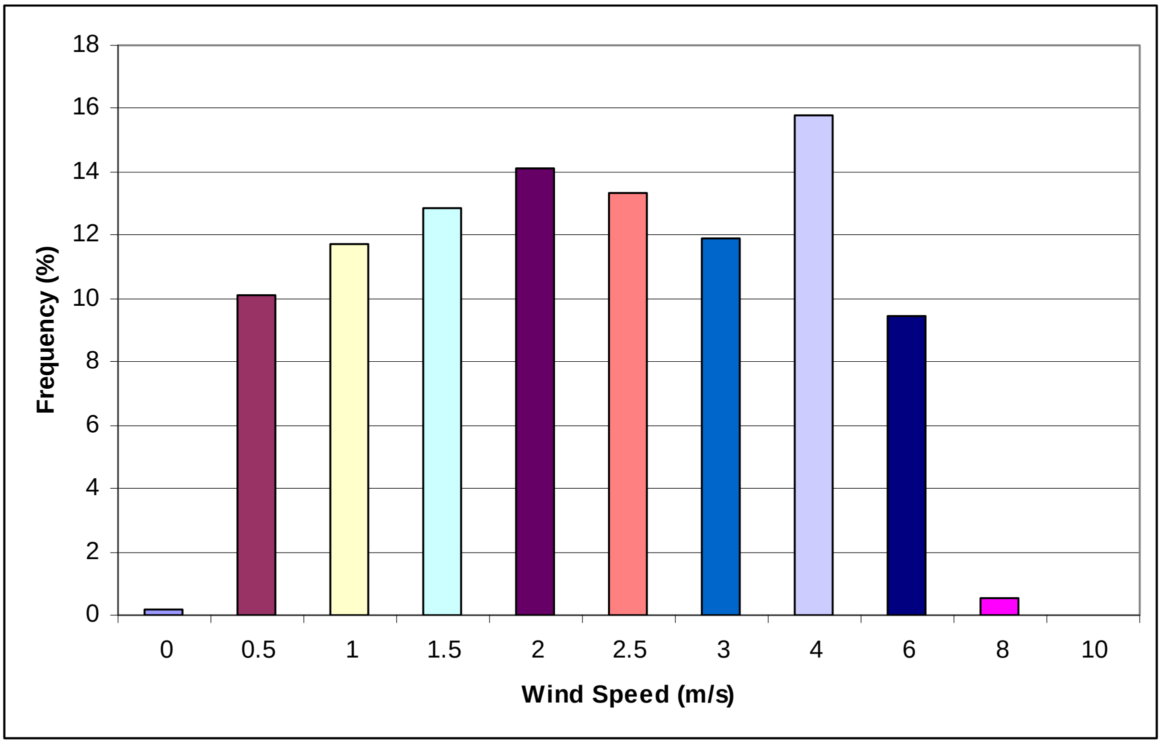

Figure 2: Wind Speed Frequency Distribution by Wind Speed Category for Wollongong July 2006 - June 2007

5.2 Stability Class

An important aspect of plume dispersion is the atmospheric turbulence level in the region of the plume. Turbulence acts to increase the cross-sectional area of the plume due to random motions, thus diluting or diffusing a plume. For traditional dispersion modelling using Gaussian plume models, categories of atmospheric stability are used in conjunction with other meteorological data to describe atmospheric conditions and thus dispersion.

The most well-known stability classification is the Pasquill-Gifford scheme, which denotes stability classes from A to F. Class A is described as highly unstable and occurs in association with strong surface heating and light winds, leading to intense convective turbulence and much enhanced plume dilution. At the other extreme, class F denotes very stable conditions associated with strong temperature inversions and light winds, which commonly occur under clear skies at night and in the early morning. Under these conditions plumes can remain relatively undiluted for considerable distances downwind. Intermediate stability classes grade from moderately unstable (B), through neutral (D) to slightly stable (E). Whilst classes A and F are strongly associated with clear skies, class D is linked to windy and/or cloudy weather, and short periods around sunset and sunrise when surface heating or cooling is small.

As a general rule, unstable (or convective) conditions dominate during the daytime and stable flows are dominant at night. This diurnal pattern is most pronounced when there is relatively little cloud cover and light to moderate winds. The frequency distribution of estimated stability classes in the Wollongong meteorological data is shown in **Figure 3**. The data shows a total of 50% of hours were either A, B or C class. This is consistent with the expected occurrence of moderately unstable conditions at such a coastal location. This should result in greater atmospheric mixing and dilution of pollutants in the region.

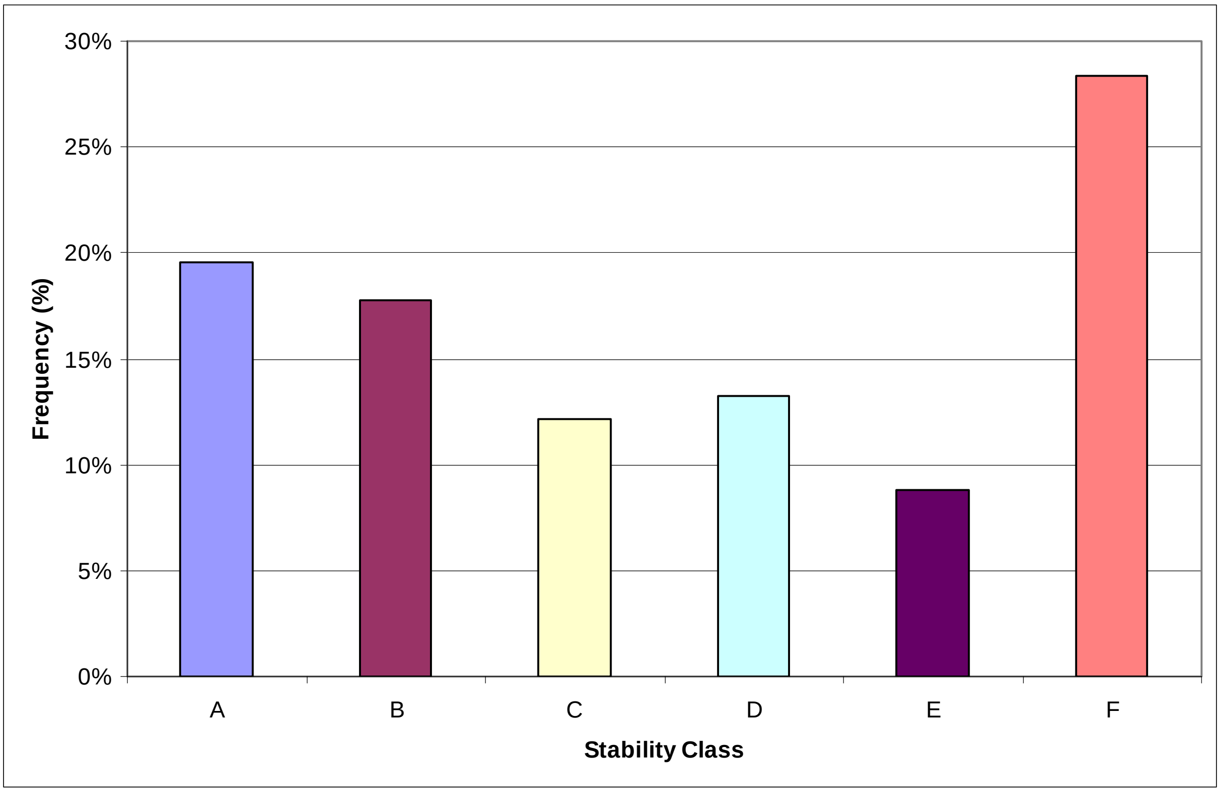

Figure 3: Frequency Distribution of Stability Class for Wollongong

6.0 Air Dispersion Modelling Methodology

Dispersion modelling was undertaken to predict the potential air quality impacts from the PKOHD Concept Plan and Major Project (Stage 1). The scenarios modelled in the AQIA are as follows:

- Scenario 1a – Major Project; Construction
- Scenario 1b – Major Project; Operation
- Scenario 2 – Concept Plan; Operation

The scope of work undertaken by AECOM to assess the potential air quality impacts from the PKOHD is as follows:

- **Development of an Emissions Inventory**. The inventory contains all emissions information required to undertake dispersion modelling. The inventory was generated using operational information supplied by PKPC and the emission factors supplied in relevant documents (Commonwealth 2008a and 2008b, EPA 1997a).
- **Dispersion Modelling**. The AUSPLUME dispersion model was used in the AQIA. Model inputs include meteorology, source characteristics, modelling scenarios and pollutant emissions data.
- **Report Preparation**. This report was prepared to present the findings of the dispersion modelling. The report outlines the methodology, assumptions, model inputs, findings and recommendations of the AQIA.

As required by the DGRs, the AQIA was conducted in accordance with the following guideline:

- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales,* Department of Environment and Conservation New South Wales (DEC) 2005, hereafter referred to as the Approved Methods.

The Approved Methods outlines the requirements for developing air dispersion modelling methodology, analysing meteorological data, and the criteria applicable when considering the potential impacts as a result of a site's operation.

The AUSPLUME prognostic air dispersion model was used in the AQIA. The model uses the Gaussian dispersion model equations to simulate the dispersion of a plume from point, area or volume sources. Mechanisms for determining the effect of terrain on plume dispersion are also provided. The dispersion of each pollutant plume is determined for each hour using conventional Gaussian model assumptions. It should be noted that Gaussian models are best used to identify pollutant concentrations at receptor locations close to emissions sources, as they can overestimate concentrations at longer distances.

Atmospheric dispersion modelling was conducted using AUSPLUME 6.0 (the latest approved version of the model) in accordance with the DECCW Approved Methods (DEC NSW, 2005). The document prescribes calculation modes for accounting for terrain effects, building wake effects, horizontal and vertical dispersion curves, buoyancy effects, surface roughness, plume rise, wind speed categories and wind profile exponents.

Input parameters used in the AUSPLUME dispersion modelling are summarised in **Table 9**.

Table 9: Summary of AUSPLUME Input Parameters

Parameter	Input
AUSPLUME Version	6.0
Modelling Domain	5 km x 5 km
AUSPLUME Modelling Grid Resolution	0.1 km
Number of Sensitive Receptors	10
Terrain Data	Not Required
Building Wake Data	Not included in model
Dispersion Algorithm	PG (urban ISC curves) & MP Coeff. (urban)
Hours Modelled	8760 hours (365 days)
Meteorological Data Period	1 July 2006 – 31 June 2007

6.1 Emissions Inventory

The emissions from ship operations and bulk material handling on site were estimated using the following National Pollution Inventory (NPI) and US EPA AP42 emission estimation technique manuals:

- Emission Estimation Technique Manual for Railway Yard Operations Version 2, June 2008 (Commonwealth 2008a).
- Emission Estimation Technique Manual for Maritime Operations Version 2, July 2008 (Commonwealth 2008b).
- Emission Estimation Technique Manual for Mining Operations Version 2.3, December 2001 (Commonwealth 2001).
- AP42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources *Large Stationary Diesel and All Stationary Dual-fuel Engines* (US EPA, October 1996).

The manuals provide emission factor equations that are applied to the operational data of the shipping to generate emission inputs for the modelling process.

The engine capacity of the dredging equipment used in the Major Project construction period has been gained from the *Royal Boskalis Westminster N.V* website (http://www.boskalis.com, accessed 22 December 2009). Royal Boskalis Westminster N.V. is a leading global services provider operating in the dredging, maritime infrastructure and maritime services sectors. The average engine capacity of the backhoe dredger (1010 kW) and grab dredger (654 kW) listed on the website were applied in the AQIA.

The emissions from truck movements on the site have been estimated using the following air quality study:

- Environment Protection Authority New South Wales (EPA) (1997a) *Metropolitan Air Quality Study: Air Emissions Inventory*.

The Metropolitan Air Quality Study (MAQS, 1997a) was undertaken to develop a computerised air emission inventory, analyse meteorological data/modelling of air movements, investigation of air chemistry and urban airshed modelling. The study provides vehicle emission rates for various types of vehicles and fuel types.

The emissions from ship operations and train movements on site were estimated using the NPI manuals (2008a and 2008b). The truck movement emissions were estimated using the EPA MAQS (1997a). Due to a lack of information regarding stack flow rates, emission concentrations etc, the ship stacks were modelled as volume sources and are likely to result in conservative predicted impacts.

The emission rates for trains in the southern railyard, train unloading siding, construction stockpile and the container terminal were based on estimated train operations for the port in regards to the time that selected throttle levels are used on-site. The fuel consumption values used below were gained from the handbook "*Train controllers guide to fuel conservation with train operation*" published by V/Line (1986). A summary of the throttle fuel consumptions applied in the AQIA are provided below:

- Idle fuel consumption of 24 L/h/locomotive;
- Throttle 5 fuel consumption of 290 L/h/locomotive (loaded trains); and
- Throttle 3 fuel consumption of 146 L/h/locomotive (unloaded trains).

The number of trains, locations and times at each throttle speed for each scenario has been provided in the following assumptions section. The assumptions listed provide more information regarding the development of the emissions inventory.

The emission rates applied in the AQIA for Scenario 1 have been included in the modelling as a variable emission rates file. The file lists the emission rate for each source for each hour of the modelling period for each pollutant, and is summarised in **Table 10**. The emission rates applied in the AQIA for Scenarios 1b and 2 are provided in **Table 11** and **Table 12** respectively.

The emission rates for each train and truck source are required to be modelled as separated volume sources, and as such the emission rates supplied are for each of the volume sources for each source. To calculate the total emission rate for a pollutant from a source, multiply the pollutant emission rate by the number of volume sources (provided in the 'No. of Volume Sources' column).

Table 10: Scenario 1a (Major Application; Construction) Modelling Emissions Inventory

Source	ID	Hour/ day	Source Type	No. of Volume Sources	Emission Rate per Volume/Area Source (g/s)				
					NO_x	CO	SO_2	PM_{10}	TSP
Dredging Ships	DR1	24	Volume	1	6.0	0.1	0.2	0.2	0.2
Trains (Stockpile)	TR7-9	24	Volume	3	0.3	0.2	0.0001	0.02	0.02
Trucks	VS20-25	11	Volume	6	0.005	0.003	0.00002	0.00004	0.00004
Construction Stockpile (Wind Erosion)	CONSTK	24	Area	NA	0	0	0	0.000003	0.000006
Construction Stockpile (Active Area)	ACTSTK	24	Area	NA	0	0	0	0.001	0.003

Table 11: Scenario 1b (Major Application; Operation) Modelling Emissions Inventory

Source	ID	Hour/ day	Source Type	No. of Volume Sources	Emission Rate per Volume/Area Source (g/s)				
					NO_x	CO	SO_2	PM_{10}	TSP
Bulk Material Ship	VS2	24	Volume	1	1.5	0.1	0.1	0.1	0.1
Trains (Railyard)	TR1-3	24	Volume	3	0.1	0.09	0.00006	0.01	0.01
Trains (Unloading Siding)	TR4-6	24	Volume	3	0.2	0.1	0.0001	0.02	0.02
Trucks	VS20-25	24	Volume	1	0.006	0.003	0.00002	0.00004	0.00004
Bulk Material Stockpile (Wind Erosion)	OPSSTK	24	Area	NA	0	0	0	0.000003	0.000006
Bulk Material Stockpile (Active Area)	ACTSTK	24	Area	NA	0	0	0	0.0009	0.002

Table 12: Scenario 2 (Concept Plan; Operation) Modelling Emissions Inventory

Source	ID	Hour / day	Source Type	No. of Volume Sources	Emission Rate per Volume/Area Source (g/s)				
					NO_x	CO	SO_2	PM_{10}	TSP
Cargo Ships	VS1-7	24	Volume	7	3.3	0.3	0.3	0.2	0.2
Trains (Railyard)	TR1-3	24	Volume	3	0.4	0.2	0.0001	0.03	0.03
Trains (Unloading Siding)	TR4-6	24	Volume	3	0.3	0.2	0.0001	0.03	0.03
Trains (Container Terminal)	VS8-15	24	Volume	8	0.6	0.4	0.0002	0.1	0.1
Trucks	VS16-25	24	Volume	10	0.01	0.008	0.00004	0.0001	0.0001
Bulk Material Stockpile (Wind Erosion)	OPSSTK	24	Area	NA	0	0	0	0.000003	0.000006
Bulk Material Stockpile (Active Area)	ACTSTK	24	Area	NA	0	0	0	0.0004	0.001

The source characteristics for each of the volume sources are provided in **Table 13**. The train sources are modelled as line sources (separated volume sources).

Table 13: Modelling Volume Source Characteristics

Sources	Horizontal Spread (m)	Vertical Spread (m)	Centre Height (m)
Dredging Ships	0.5	0.5	10
Cargo Ships	1	1	35
Trains (Railyard, Unloading Siding and Construction Stockpile)	0.5	0.5	3
Trains (Container Terminal)	47	0.47	3
Trucks	47	0.47	2

6.1.1 Comments and Assumptions

The following comments and assumptions have been made in relation to generating the emissions inventory and modelling inputs for the PKOHD AQIA:

General Assumptions

- The modelling is based on the current design for the PKOHD Concept Plan and Major Project.
- The train and truck line sources were modelled as multiple volume sources spread over the train tracks and haul roads within the PKOHD boundary. The railyard facility for the PKOHD is being considered for two locations; the northern point of the train loop to the west of the facility and the southern point of the train loop to the west of the facility. The southern railyard location is closest to sensitive receptors (residents) and as such has been modelled in the AQIA.

- The bulk material and construction stockpiles have been assumed to be at half capacity with this area subject to wind erosion dust emissions. Half capacity has been used to represent to interim nature of such stockpiles. 10% of this half area has been modelled as active in regards to applying loading and unloading dust emissions.
- The following total stockpile sizes have been used in the AQIA:
  - Construction stockpile during the Major Project construction period = 30,000 m^2;
  - Bulk material stockpile during the Major Project operations period = 22,500m^2; and
  - Bulk material stockpile during the Concept Plan operations period = 45,000m^2.
- It has been assumed that bulk material and construction stockpiles will be watered. As such dust emission reductions provided in the NPI manual for mining table 3 (Commonwealth 2001) have been applied to stockpile conveyor loading and unloading activities (50% reduction) and for trucks dumping material on stockpiles (70% reduction).
- It is assumed that demolition and construction activities are subject to appropriate routine mitigation measures and any impacts would be short term. As such they have been omitted from the modelling.
- Fill trains to the west of the PKOHD will be unloading material directly into an environmentally controlled trap beneath the rail track, it has been assumed that no pollutant emissions occur as a result of this activity.
- The MAQS emission factors for Heavy Duty diesel fuel engines (trucks) were applied in the modelling (MAQS, 1997a).
- The PM_{10} emission rates from combustion engines (trucks and ships) have been calculated using the NPI manuals (Commonwealth, 2001, 2008a and 2008b). The manuals do not provide emission factors for TSP for these sources, and as such TSP emissions from combustion sources are assumed to be equal to PM_{10} emissions in the AQIA.
- The SO_2 and PM_{10} vehicle emission rates applied in the AQIA provided by the MAQS (EPA 1997a) were based on the total vehicle fleet as individual vehicle types are not detailed. The residential/minor road emission rate category was chosen due to the ports low speed limits.
- Truck movements included in the model were averaged over the whole operating period.
- The height of the bulk and container ship stacks (35m) was based on the typical stack height from the water of the Panamax style cargo ship while berthing in ballast.
- The default NPI values for ship auxiliary power (600kW) and auxiliary boiler fuel consumption (0.0125 tonnes/hour) were applied in the modelling of bulk and container ships.
- The NPI weighted average fuel burn (marine diesel oil and marine gas oil) was applied in the modelling of dredging, bulk and container ships.
- The total hours that ships are moored have been calculated by determining the number of hours a ship is expected to be tied off at each berth and the overall time was evenly distributed over the entire year to gain the emission rate for each of the seven berths. It was not assumed that all seven berths had a ship in berth at all times during the modelling period.
- It has been assumed that ship loading activities are subject to appropriate routine mitigation measures and any impacts would be short term. As such they have been omitted from the modelling.
- A cement facility is to be located within the PKOHD boundary. The facility will be assessed under a separate planning approval process and as such has been omitted from this assessment.

Major Project Construction

- Construction activities (including truck haulage) are assumed to be operational 5 days per week (Monday to Friday) for 11 hours per day (7am to 6pm) and 1 day per week (Saturday) for 5 hours per day (8am to 1pm). Dredging operations, train movements and stockpile loading are assumed to be 24 hours per day, 7 days per week.
- Emission rates were entered into the model using a variable emission rates file to represent the varying operational times of the Major Project construction activities.
- The construction stockpile train unloading operations were modelled as a line source (separated volume sources) along the western side of the stockpile.

- The following assumptions were made in order to calculate the train fuel consumption for application with the NPI emission equations:
  - 3 trains per day with 2 locomotives per train
    - 3 hours per train at the construction stockpile
      - 0.5 hours at throttle 5 (loaded trains)
      - 2 hours at Idle
      - 0.5 hours at throttle 3 (unloaded trains)
  - No trains will be at the bulk material unloading siding or south railyard
- The number of trucks per year during the construction period is estimated to be 65,608 trucks maximum with a maximum of 23 trucks per hour at any one time (estimated during the first year of construction). The trucks will travel 1100m (550m one way) within the site per trip.
- It has been estimated that for the construction period one Backhoe Dredger and one Cutter Suction Dredger will be active 24 hours a day, 365 days per year. The dredging ships have been modelled as 1 volume source located in the middle of the dredging area with a vertical dimension of 0.5m, horizontal dimension of 0.5m and height of 10m.
- The emission rates from the dredging ships has been calculated using the NPI manual for Maritime Operations (Commonwealth 2008b).
- The engine capacity of the dredging ships used in the Major Project construction period has been gained from the *Royal Boskalis Westminster N.V* website (http://www.boskalis.com, accessed 22 December 2009). The average capacity of all the listed vessels was used in the assessment.
- The bulk material stockpile for the Major Project application has been modelled as half the area of the bulk material stockpile for the Concept Plan.
- No bulk material cargo ships or container ships have been modelled for the construction period.

Major Project Operation

- All operation activities are assumed to be 24 hours per day, 7 days per week.
- The following assumptions were made in order to calculate the train fuel consumption for application with the NPI emission equations:
  - 2 trains per day with 2 locomotives per train
    - 5 hours per train at the bulk material unloading siding
      - 0.5 hour at throttle 5 (loaded trains)
      - 4 hours at Idle
      - 0.5 hour at throttle 3 (unloaded trains)
    - 1 hour per train at the southern railyard
      - 0.5 hour at throttle 5 (loaded trains)
      - 0.5 hour at throttle 3 (unloaded trains)
- The number of trucks per year during the operations was estimated to be 60,714 travelling 1100m within the site (550m one way) per trip assuming an average of approximately 7 trucks per hour.
- It has been estimated that for the operations 105 ships per year will be moored for an average of 14 hours per day for the bulk material berth. Only one ship berth has been modelled as existing ships would be included in the measured background concentrations.
- The bulk material stockpiles have been modelled as two volume sources in the AQIA; total stockpile size for wind erosion and the active section of the stockpile (10% of total) for dust sources from loading/unloading activities.

Concept Plan Operation

- All operation activities are assumed to be 24 hours per day, 7 days per week.
- The following assumptions were made in order to calculate the train fuel consumption for application with the NPI emission equations:
  - 3 trains per day with 2 locomotives per train at the bulk material unloading siding
    - 5 hours per train at the bulk material unloading siding
      - 0.5 hours at throttle 5 (loaded trains)
      - 4 hours at Idle
      - 0.5 hours at throttle 3 (unloaded trains)
    - 1 hour per train at the railyard
      - 0.5 hours at throttle 5 (loaded trains)
      - 0.5 hours at throttle 3 (unloaded trains)
  - 16 trains per day with 2 locomotives per train at the container terminal with a maximum of 4 trains unloading at any one time and a maximum of 2 trains waiting/idling in the south railyard
    - 5 hours per train at the container terminal
      - 0.5 hour at throttle 5 (loaded trains)
      - 4 hours at Idle
      - 0.5 hour at throttle 3 (unloaded trains)
    - 1 hour per train idling in the south railyard
      - 0.5 hours at throttle 5 (loaded trains)
      - 0.5 hours at throttle 3 (unloaded trains)
- The number of trucks per year during the operations was estimated to be 184,714 travelling 1600m within the site (800m one way) on site per trip assuming an average of 21 trucks per hour.
- It has been estimated that for the operations 105 ships per year will be moored for an average of 14 hours per day for the bulk material berth, 50 ships per year will be moored for an average of 7 hours per day for the bulk cargo berths and 100 ships per year will be moored for an average of 10 hours per day for the container berths. These values have been used in conjunction with the NPI emission factors to calculate the vessel emission rates.
- The bulk material stockpiles have been modelled as two volume sources in the AQIA; total stockpile size for wind erosion and the active section of the stockpile (10% of total) for dust sources from loading/unloading activities.

6.2 Existing Air Quality

A detailed description of the existing air quality in the local area has been provided in **Section 4.0**. A summary of the pollutant data sourced from the DECCW Wollongong monitoring station which has been applied as the background concentration in the modelling is presented in **Table 14**. The maximum measured pollutant 1 hour, 8 hour and 24 hour values for 2003 to 2007 and annual averages for 2003 to 2007 have been used in the modelling. Background values below 1 hour were not available. Note that oxides of nitrogen have not been included in the table. The application of oxides of nitrogen background values has been discussed below.

The Wollongong DECCW monitoring station does not measure TSP. To allow an estimation of likely TSP background values, the TSP concentrations were calculated from the measured PM_{10} annual average using a typical ambient PM_{10} to TSP ratio of 39% i.e. 39% of TSP is PM_{10} (NSW Minerals Council, 2000).

Table 14: Background Pollutant Concentrations

Pollutant	Averaging Period	Background Value (ug/m^3)	Criteria (ug/m^3)
CO	1 Hour	4,250	30,000
	8 Hour	3,250	10,000
SO_2	1 Hour	152	570
	24 Hour	43	228
	Annual	3	60
PM_{10}*	24 Hour	62	50
	Annual	19	30
TSP**	Annual	49	90

* PM_{10} data derived from TEOM measurements.

** TSP has been calculated from the Annual PM_{10} value using a PM_{10} to TSP ratio of 39% (NSW Minerals Council, 2000).

Nitrogen oxides are produced in most combustion processes and are formed during the oxidation of nitrogen in fuel and nitrogen in the air. During high-temperature processes a variety of oxides are formed including nitric oxide (NO) and Nitrogen dioxide NO_2. Generally, at the point of emission NO will comprise the greatest proportion of the emission with 95% by volume of the NO_x. The remaining NO_x will consist of NO_2. Ultimately, however, all nitric oxides emitted into the atmosphere are oxidised to NO_2 and then further to other higher oxides of nitrogen.

The USEPA's Ozone Limiting Method (OLM) has been used to predict ground-level concentrations of NO_2. The OLM is based on the assumption that approximately 10% of the initial stack NO_X emissions are emitted as NO_2. If the ozone (O_3) concentration is greater than 90% of the predicted NO_X concentrations, all the NO_X is assumed to be converted to NO_2, otherwise NO_2 concentrations are predicted using the equation $NO_2 = 46/48 * O_3 + 0.1 * NO_X$. This method assumes instant conversion of NO to NO_2 in the plume, which overestimates concentrations close to the source since conversion usually occurs over periods of hours. This method is described in detail in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (NSW DEC, 2005).

Contemporaneous O_3 and background NO_2 data from the Wollongong DECCW Monitoring Station were used in the conversion to produce background NO_2 concentrations which have been applied in the AQIA.

As the 24 hour average PM_{10} background concentration exceeded the DECCW criteria, an alternative method was required to assess the potential fine particulate impacts. The DECCW Approved Methods (DEC, 2005) states that where existing ambient air pollutant concentrations exceed impact assessment criteria "*a licensee must demonstrate that no additional exceedences of the impact assessment criteria will occur as a result of the proposed activity*". PM_{10} emissions have been modelled contemporaneously with background PM_{10} concentrations and the number of exceedences of the criteria calculated over the modelling period. An assessment of whether any additional exceedences have occurred was undertaken.

6.3 Sensitive Receptors

The AUSPLUME modelling domain incorporates a 5 km by 5 km grid with a resolution of 0.1 km, centred over the PKOHD. Within this gridded modelling domain, discrete sensitive receptors were modelled. The DECCW considers sensitive receptors to be areas where people are likely to either live or work, or engage in recreational activities (DEC, 2005). On this basis, representative sensitive receptors were selected at 10 locations surrounding the site. The receptors were chosen from local residential and commercial buildings. Industrial buildings were not chosen as these locations are less sensitive to industrial emissions. However, these locations will still be assessed using the Ground Level Concentration (GLC) contours produced in the modelling.

A summary of the approximate sensitive receptor locations is provided below in **Table 15** and shown in **Figures 8-10**.

Table 15: Sensitive Receptor Locations

Receptor Number	Sensitive Receptor Description	Type
1	Flagstaff Rd, west of PKOHD	Commercial
2	Five Island Rd, west south west of PKOHD	Commercial
3	Five Island Rd, south west of PKOHD	Residential
4	Military Rd, south of PKOHD	Commercial
5	Military Rd, south of PKOHD	Residential
6	Marne St, south of PKOHD	Residential
7	First Ave, south of PKOHD	Residential
8	Church St, south of PKOHD	Residential
9	Keira St, south west of PKOHD	Residential
10	Holman St, west south west of PKOHD	Residential

"This page has been left blank intentionally"

7.0 Air Dispersion Modelling Results

The predicted pollutant GLCs for each scenario gained from the dispersion modelling are provided in the following sections.

7.1 Scenario 1a Results (Major Project; Construction)

The predicted Scenario 1a pollutant GLCs are provided in **Table 16** and **Table 17**. Where background data is available, the predicted cumulative pollutant GLCs (predicted GLC plus the background concentration) are shown in brackets. For PM_{10} results, the additional number of exceedences have also been listed in square brackets. Note that deposited dust results are expressed as deposition rates and not concentrations.

Table 16: Scenario 1a (Major Project; Construction) Maximum Predicted GLC at the Discrete Sensitive Receptors for PM_{10}, TSP and Dust Deposition

Receptor Number	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust Deposition (g/m^2.month)
	24 Hour	Annual	Annual	Annual
1	9 (**72**) [0]	0.5 (21)	1 (50)	0.06
2	5 (**68**) [4]	1 (22)	2 (51)	0.16
3	**78** (**130**) [30]	6 (27)	14 (63)	0.98
4	**109** (**131**) [60]	11 (**32**)	24 (73)	1.06
5	**66** (**118**) [42]	9 (29)	20 (69)	0.63
6	**76** (**91**) [21]	5 (26)	12 (61)	0.36
7	29 (**81**) [12]	4 (25)	10 (59)	0.29
8	**62** (**84**) [23]	5 (26)	12 (61)	0.48
9	**73** (**116**) [20]	4 (25)	10 (59)	0.57
10	1 (**64**) [5]	1 (22)	3 (52)	0.17
Criteria	50	30	90	2

Bold denotes exceedences of criteria

Table 17: Scenario 1a (Major Project; Construction) Maximum Predicted GLC at the Discrete Sensitive Receptors for NO_x (as NO_2) and SO_2

Receptor Number	Oxides of Nitrogen (as NO_2) (µg/m^3)		Sulfur Dioxide (SO2) (µg/m^3)			
	1 Hour	Annual	10min	1 hour	24 hour	Annual
1	103 (115)	0.9 (19)	31	22 (174)	1.7 (45)	0.1 (3.1)
2	166 (187)	1.9 (20)	44	30 (182)	1.8 (45)	0.1 (3.1)
3	229 (**286**)	6.3 (24)	83	59 (211)	5.6 (49)	0.4 (3.4)
4	183 (199)	4.1 (22)	66	46 (198)	4.9 (48)	0.4 (3.4)
5	147 (178)	3.1 (21)	54	38 (190)	3.6 (47)	0.4 (3.4)
6	125 (156)	2.2 (20)	49	35 (187)	4 (47)	0.3 (3.3)
7	97 (137)	2.0 (20)	39	27 (179)	2.5 (45)	0.2 (3.2)
8	143 (159)	2.8 (21)	44	31 (183)	3.3 (46)	0.3 (3.3)
9	137 (186)	3.1 (21)	47	33 (185)	2.4 (45)	0.2 (3.2)
10	119 (139)	1.7 (20)	33	23 (175)	1.9 (45)	0.1 (3.1)
Criteria	246	62	712	570	228	60

Bold denotes exceedences of criteria

Table 18: Scenario 1a (Major Project; Construction) Maximum Predicted GLC at the Discrete Sensitive Receptors for CO

Receptor Number	Carbon Monoxide (CO) (µg/m^3)		
	15 Minutes	1 hour	8 Hours
1	52	49 (4,299)	10 (3,260)
2	135	111 (4,361)	27 (3,277)
3	370	348 (4,598)	142 (3,392)
4	321	255 (4,505)	72 (3,322)
5	221	170 (4,420)	42 (3,292)
6	175	133 (4,383)	29 (3,279)
7	131	101 (4,351)	22 (3,272)
8	172	138 (4,388)	36 (3,286)
9	204	166 (4,416)	32 (3,282)
10	106	87 (4,337)	16 (3,266)
Criteria	100,000	30,000	10,000

Bold denotes exceedences of criteria

The modelling results show that with the exception of PM_{10} 24 hour average and NO_2 1 hour average time periods, all selected pollutants met the DECCW criteria at the discrete sensitive receptors. **Figure 8** presents the PM_{10} 24 hour average results (in isolation from background) as contour plots. NO_2 1 hour contours cannot be generated due to the conversion of NO_x to NO_2 using the DECCW OLM method.

The predicted PM_{10} GLCs show that there are likely to be additional exceedences in addition to the number of exceedences that already occur in the Wollongong air shed. There was one exceedence of the PM_{10} annual average criteria for the cumulative results (Receptor No. 4) and none for the isolated results.

The modelling predicted that the NO_2 1 hour criteria would be exceeded at one of the sensitive receptor locations (Receptor No. 3) when considered cumulatively with background NO_2 concentrations. The NEPM for Ambient Air Quality (Commonwealth, 2003) provides the goal for the maximum allowable days of exceedence for NO_2 as one day per year. For the receptor where there is predicted to be an exceedence of the criteria, there is only three hours out of the year where the concentration exceeds the limit, which is less than the allowable 24 hours (one day as listed in the NEPM). The desired environmental outcome of the Air NEPM is ambient air quality that provides for the adequate protection of human health and wellbeing and is considered as a good guideline for long term health impacts. On this basis the long term impacts of Scenario 1a (Major Project: Construction) are not expected to be adverse.

Scenario 1a includes the simultaneous operation of all expected construction activities at the port. Activities such as train and truck movements and dredging activities are likely to be of an intermittent nature, and together with equipment 'down-time' caused by maintenance, shift breaks, public holidays etc, it is considered unlikely that all construction activities would occur simultaneously during the worst case meteorological conditions required to cause the modelled maximum predicted GLCs. The predicted maximum GLCs are therefore considered conservative and the likely impact that Scenario 1a will have on the local community is expected to be less than that predicted in the modelling.

7.2 Scenario 1b Results (Major Project; Operation)

The predicted Scenario 1b pollutant GLCs are provided in **Table 19** and **Table 20**. Where background data is available, the predicted cumulative pollutant GLCs (predicted GLC plus the background concentration) are provided in brackets. For PM_{10} results, the additional number of exceedences have also been listed in square brackets. Note that deposited dust results are expressed as deposition rates and not concentrations.

Table 19: Scenario 1b (Major Project; Operation) Maximum Predicted GLC at the Discrete Sensitive Receptors for PM_{10}, TSP and Dust Deposition

Receptor Number	PM_{10} ($\mu g/m^3$)		TSP ($\mu g/m^3$)	Dust Deposition (g/m^2.month)
	24 Hour	Annual	Annual	Annual
1	1 (**64**) [4]	1 (22)	2 (51)	0.13
2	36 (**87**) [11]	2 (23)	5 (54)	0.30
3	**63** (**88**) [29]	7 (28)	14 (63)	0.62
4	35 (**87**) [12]	4 (25)	9 (58)	0.27
5	11 (**75**) [6]	3 (24)	7 (56)	0.19
6	3 (**66**) [2]	2 (23)	4 (53)	0.13
7	7 (**71**) [0]	2 (23)	4 (53)	0.12
8	27 (**79**) [6]	3 (24)	7 (56)	0.19
9	5 (**68**) [10]	3 (24)	7 (56)	0.28
10	28 (**80**) [9]	2 (23)	4 (53)	0.22
Criteria	50	30	90	2

Bold denotes exceedences of criteria

Table 20: Scenario 1b (Major Project; Operation) Maximum Predicted GLC at the Discrete Sensitive Receptors for NO_x (as NO_2) and SO_2

Receptor Number	Oxides of Nitrogen (as NO_2) (μg/m^3)		Sulfur Dioxide (SO2) (μg/m^3)			
	1 Hour	Annual	10min	1 hour	24 hour	Annual
1	64 (91)	0.5 (18)	4	3 (155)	0.2 (43.2)	0.02 (3)
2	82 (103)	1.4 (19)	6	4 (156)	0.3 (43.3)	0.03 (3)
3	98 (125)	3.0 (21)	7	5 (157)	0.3 (43.3)	0.06 (3)
4	60 (97)	1.2 (19)	5	4 (156)	0.4 (43.4)	0.05 (3)
5	50 (90)	0.9 (19)	6	5 (157)	0.3 (43.3)	0.04 (3)
6	40 (95)	0.7 (19)	7	5 (157)	0.4 (43.4)	0.03 (3)
7	48 (88)	0.6 (19)	6	4 (156)	0.3 (43.3)	0.03 (3)
8	54 (90)	1.1 (19)	5	4 (156)	0.3 (43.3)	0.04 (3)
9	64 (93)	1.8 (20)	5	4 (156)	0.3 (43.3)	0.04 (3)
10	77 (108)	1.0 (19)	5	4 (156)	0.4 (43.4)	0.03 (3)
Criteria	246	62	712	570	228	60

Bold denotes exceedences of criteria

Table 21: Scenario 1b (Major Project; Operation) Maximum Predicted GLC at the Discrete Sensitive Receptors for CO

Receptor Number	Carbon Monoxide (CO) (μg/m^3)		
	15 Minutes	1 hour	8 Hours
1	109	83 (4,333)	19 (3,269)
2	297	228 (4,478)	54 (3,304)
3	669	510 (4,760)	194 (3,444)
4	140	107 (4,357)	25 (3,275)
5	94	72 (4,322)	19 (3,269)
6	67	51 (4,301)	20 (3,270)
7	60	46 (4,296)	16 (3,266)
8	97	74 (4,324)	18 (3,268)
9	196	153 (4,403)	42 (3,292)
10	154	133 (4,383)	43 (3,293)
Criteria	100,000	30,000	10,000

Bold denotes exceedences of criteria

The modelling results show that with the exception of PM_{10} 24 hour average, all modelled pollutants met the DECCW criteria at the discrete sensitive receptors. **Figure 9** presents the PM_{10} 24 hour average results (in isolation from background) as contour plots.

The predicted PM_{10} GLCs show that there are likely to be additional 24 hour average exceedences in addition to the number of exceedences that already occur in the Wollongong air shed for all sensitive receptors. There were no exceedences of the PM_{10} annual average assessment criteria.

The Major Project operations modelling scenario is considered a worst case assessment and is likely to result in conservative estimate of likely impacts. It is assumed in the modelling that the all of the Major Project operational activities will be simultaneously active 24 hours a day for 365 days of the year. This includes the simultaneous operation of the expected maximum number of trucks, trains and ships at the port. Activities such as train, truck and ship movements are likely to be of an intermittent nature, and together with equipment 'down-time' caused by maintenance, shift breaks, public holidays etc, it is considered unlikely that all construction activities would occur simultaneously during the worst case meteorological conditions required to cause the modelled maximum predicted GLCs. The predicted maximum GLCs are therefore considered conservative and the likely impact that Scenario 1b will have on the local community is expected to be less than that predicted in the modelling.

7.3 Scenario 2 Results (Concept Plan; Operation)

The predicted Scenario 2 pollutant GLCs are provided in **Table 22** and **Table 23**. Where background data is available, the predicted cumulative pollutant GLCs (predicted GLC plus the background concentration) are provided in brackets. For PM_{10} results, the additional number of exceedences have also been listed in square brackets. Note that deposited dust results are expressed as deposition rates and not concentrations.

Table 22: Scenario 2 (Concept Plan; Operation) Maximum Predicted GLC at the Discrete Sensitive Receptors for PM_{10}, TSP and Dust Deposition

Receptor Number	PM_{10} (µg/m^3)		TSP (µg/m^3)	Dust Deposition (g/m^2.month)
	24 Hour	Annual	Annual	Annual
1	6 (**69**) [2]	1 (22)	2 (51)	0.11
2	35 (**87**) [11]	3 (24)	5 (54)	0.31
3	**92** (**117**) [62]	12 (**33**)	24 (73)	1.12
4	**57** (**109**) [35]	8 (29)	16 (65)	0.42
5	20 (**83**) [18]	6 (27)	11 (60)	0.26
6	12 (**76**) [14]	5 (25)	7 (56)	0.16
7	15 (**79**) [8]	4 (25)	7 (56)	0.15
8	38 (**90**) [17]	5 (26)	10 (59)	0.27
9	33 (**85**) [23]	5 (26)	11 (60)	0.42
10	37 (**88**) [11]	3 (23)	5 (54)	0.25
Criteria	50	30	90	2

Bold denotes exceedences of criteria

Table 23: Scenario 2 (Concept Plan; Operation) Maximum Predicted GLC at the Discrete Sensitive Receptors for NO_x (as NO_2) and SO_2

Receptor Number	Oxides of Nitrogen (as NO_2) ($\mu g/m^3$)		Sulfur Dioxide (SO2) ($\mu g/m^3$)			
	1 Hour	Annual	10min	1 hour	24 hour	Annual
1	111 (128)	3 (21)	51	42 (194)	3 (46)	0.2 (3.2)
2	199 (223)	6 (24)	66	57 (209)	5 (48)	0.4 (3.4)
3	**262** (**289**)	13 (31)	96	81 (233)	7 (50)	1.0 (4.0)
4	144 (165)	8 (26)	78	69 (221)	5 (48)	0.9 (3.9)
5	131 (152)	6 (24)	77	67 (219)	6 (49)	0.8 (3.8)
6	146 (180)	5 (23)	93	80 (232)	7 (50)	0.7 (3.7)
7	137 (173)	4 (22)	76	65 (217)	6 (49)	0.6 (3.6)
8	136 (157)	6 (24)	69	60 (212)	5 (48)	0.7 (3.7)
9	113 (160)	8 (26)	64	55 (207)	5 (48)	0.7 (3.7)
10	154 (174)	5 (23)	70	54 (206)	4 (47)	0.4 (3.4)
Criteria	246	62	712	570	228	60

Bold denotes exceedences of criteria

Table 24: Scenario 2 (Concept Plan; Operation) Maximum Predicted GLC at the Discrete Sensitive Receptors for CO

Receptor Number	Carbon Monoxide (CO) ($\mu g/m^3$)		
	15 Minutes	1 hour	8 Hours
1	304	273 (4,523)	93 (3,343)
2	915	751 (5,001)	190 (3,440)
3	1,486	1,133 (5,383)	430 (3,680)
4	545	510 (4,760)	180 (3,430)
5	614	538 (4,788)	176 (3,426)
6	733	612 (4,862)	194 (3,444)
7	549	455 (4,705)	126 (3,376)
8	458	405 (4,655)	146 (3,396)
9	436	339 (4,589)	151 (3,401)
10	487	426 (4,676)	145 (3,395)
Criteria	100,000	30,000	10,000

Bold denotes exceedences of criteria

The modelling results show that with the exception of 24 hour and annual average PM_{10} and 1 hour average NO_2, all modelled pollutants met the DECCW criteria at the discrete sensitive receptors. **Figure 10** presents the PM_{10} 24 hour average results (in isolation from background) as contour plots. NO_2 1 hour contours cannot be generated due to the conversion of NO_x to NO_2 using the DECCW OLM method.

The predicted PM_{10} GLCs show that there are likely to be additional exceedences in addition to the number of exceedences that already occur in the Wollongong air shed. There was one exceedence of the PM_{10} annual average criteria for the cumulative results (Receptor No. 3) and none for the isolated results.

The modelling predicted that the NO_2 1 hour criteria would be exceeded at one of the sensitive receptor locations (Receptor No. 3) as a result of Concept Plan operation when considered cumulatively with background NO_2 concentrations and in isolation. The NEPM for Ambient Air Quality (Commonwealth, 2003) provides the goal for the maximum allowable days of exceedence for NO_2 as one day per year. For the receptor where there is predicted to be an exceedence of the criteria, there is only twenty-one hours out of the year where the concentration exceeds the limit, which is less than the allowable 24 hours (one day as listed in the NEPM). On this basis the long term impacts of the Concept Plan Operation are not expected to be adverse.

The Concept Plan operations modelling scenario is considered a worst case assessment of the typical operational emissions and is likely to result in conservative estimate of likely impacts. It is assumed in the modelling that the all of the Concept Plan operations will be simultaneously active 24 hours a day for 365 days of the year. The scenario includes the simultaneous operation of the expected maximum number of trucks, trains and ships at the port. Activities such as train, truck and ship movements are likely to be of an intermittent nature, and together with equipment 'down-time' caused by maintenance, shift breaks, public holidays etc, it is considered unlikely that all construction activities would occur simultaneously during the worst case meteorological conditions required to cause the modelled maximum predicted GLCs. The predicted maximum GLCs are therefore considered conservative and the likely impact that Scenario 2 will have on the local community is expected to be less than that predicted in the modelling.

7.4 Limitations of Dispersion Modelling

Best efforts have been made to estimate the likely numbers and operational parameters (including fuel type and consumption etc) of ships and trucks in the AQIA. The numbers used have been based on current information and may change to reflect the detailed design of the PKOHD. The numbers used in the model are considered as conservative and as such any minor changes in the future are not likely to have a significant impact on the modelling results. If major changes are proposed in regards to pollutant emitting activities during construction or operation, then further modelling of the project incorporating these changes may be required.

Air dispersion modelling of ship emissions are typically not undertaken in Australia. Best efforts have been made to approach the modelling in a reasonable and realistic way, however there is likely to be a degree of uncertainty in the results. Ship operational details, including stack flow rate and emission concentrations, are limited and conservative assumptions have been applied during the modelling. These conservative assumptions, such as modelling ship emissions as volume sources instead of stack sources, are likely to overestimate the pollutant impacts of the PKOHD on the local community.

"This page has been left blank intentionally"

8.0 Discussion and Mitigation Measures

The analysis of the regional air shed using existing pollution data shows that with the exception of short term episodic particulate matter (short term concentrations of PM_{10} can on occasion exceed the assessment criteria), there is the capacity to increase the pollutants of concern in the air shed without exceeding relevant criteria. The analysis has shown that there may be a constraint on those operations that have the potential to emit fine particulates in the air shed during the construction and operation phases.

The meteorological data suggests that the emission of pollutants during night time may have a higher impact on the surrounding area when the winds are more stable and hence there is less dispersion of pollutants. Future operations of the multi-purpose and container terminal which form part of later stages of the Concept Plan will have to consider this night time affect when planning developments, particularly in relation to particulate emissions.

Further analysis and possibly atmospheric dispersion modelling may be required on a case to by case basis for new developments not included in this assessment to identify worst case air pollution scenarios and pollutant impact hot spots.

Major Project (Stage 1); Construction

The modelling results for the construction suggest that the NO_2 GLCs from the PKOHD are likely to exceed criteria for one discrete receptor (Receptor No. 3). The exceedence at the single receptor was for three hours during the full year and as such meets the NEPM criteria for days allowed above the assessment criteria. Operations would be expected to only cause short term, localised increases in pollutants. Due to the conservativeness of the modelling approach it is expected that the actual NO_2 impacts of the PKOHD will be less than that predicted by the modelling. Monitoring of ambient NO_2 levels may be required during the construction and an appropriate air quality mitigation plan (AQMP) should be prepared or updated based on these results. The AQMP should be integrated into the site Construction Environmental Management Plan (CEMP).

The modelling results suggest that the construction has the potential to increase short term (24 hour average) PM_{10} emissions from construction stockpiles and the increase in trains and trucks during construction. Long term PM_{10} predictions (annual average) were predicted to slightly exceed the assessment criteria at one receptor only (receptor No. 4). Operations would be expected to cause short term, localised increases in particulate matter (increased number of PM_{10} exceedences). The impacts of the construction phase can be limited by implementing site specific ‘best practice’ dust mitigation measures which should be incorporated into the site’s AQMP. Mitigation measures may include the following:

- Trucks carrying spoil, sand and/or other loose materials covered to avoid generating wind-blown dust;
- Wetting down or use of surfactant on stockpiles (where practicable);
- Wetting down of site surfaces during dry weather including excavation sites, haul roads, spoil stockpiles and other exposed areas;
- Vehicular access confined to designated access roads;
- Construction equipment, plant and machinery regularly tuned, modified or maintained to minimise visible smoke emissions;
- Construction vehicles only left idling when required for construction works;
- Construction site speed limits would be implemented; and
- Instantaneous dust monitoring at the boundary. The location of an instantaneous dust monitor (such as a TEOM) at the boundary of the site most affected by dust impacts can alert site personnel when elevated dust levels occur.

Major Project (Stage 1); Operation

The modelling results for the operation suggest that the operation has the potential to increase short term (24 hour average) PM_{10} emissions from material stockpiles and an increase in trains, trucks and ships. Long term PM_{10} predictions (annual average) were predicted to meet the criteria. Operations would be expected to cause short term localised increases in fine particulates only (increased number of PM_{10} exceedences). The impacts of the operation phase can be limited by implementing site specific 'best practice' dust mitigation measures which should be incorporated into the site's AQMP. Mitigation measures may include the following:

- Sealing roads and areas susceptible to windblown dust impacts;
- Vehicles carrying loose materials would be covered to avoid generating wind-blown dust;
- Wetting down and/or using surfactants on site surfaces, especially during dry weather, including haul roads, material stockpiles and other exposed areas;
- Instantaneous dust monitoring at the boundary of the site most affected by dust impacts to alert site personnel when elevated dust levels occur;
- Full concrete sealing of all operational areas of the Major Project terminal and
- Stabilising of reclaimed surface areas set aside for future terminal development.

Concept Plan; Operation

The modelling results for the Concept Plan suggest that the NO_2 GLCs from the operation are likely to exceed criteria for one discrete receptor (Receptor No. 3). The exceedence at the single receptor was for twenty one hours only and as such meets the NEPM criteria for days allowed above the assessment criteria. Operations would be expected to cause short term, localised increases in pollutants only. Due to the conservativeness of the modelling approach it is expected that the actual NO_2 impacts of the PKOHD will be less than that predicted by the modelling. Monitoring of ambient NO_2 levels may be required during the operations and an appropriate air quality mitigation plan (AQMP) should be prepared or updated based on these results. The AQMP should be integrated into the site Operational Environmental Management Plan (OEMP).

The modelling results for the Concept Plan suggest that the operation has the potential to increase short term (24 hour average) PM_{10} emissions from material stockpiles and an increase in trains, trucks and ships. Long term PM_{10} predictions (annual average) were predicted to slightly exceed the assessment criteria at one receptor only (Receptor No. 3). Operations would be expected to cause short term localised increases in fine particulates (increased number of PM_{10} exceedences). The impacts of the operation phase can be limited by implementing site specific 'best practice' dust mitigation measures which should be incorporated into the site's AQMP. Mitigation measures may include the following:

- Sealing roads and areas susceptible to windblown dust impacts;
- Vehicles carrying loose materials would be covered to avoid generating wind-blown dust;
- Wetting down and/or using surfactants on site surfaces, especially during dry weather, including haul roads, material stockpiles and other exposed areas;
- Instantaneous dust monitoring at the boundary of the site most affected by dust impacts can alert site personnel when elevated dust levels occur; and
- Full concrete sealing of all operational area of the Major Project terminal.

Potential Combustion Emission Mitigation Measures

Whilst direct mitigation measures (primarily relating to particulates) have been identified above, additional measures are available to minimise the emission of other pollutants such as SO_2 and NO_X. The following measures are expected to aid in the reduction of combustion related emissions over time:

- Fuel standards have and will continue to improve, which will lead to lower SO_x, NO_x and particulate emissions. In 2008 the Marine Environment Protection Committee (MEPC) of the International Maritime Organization (IMO) unanimously adopted amendments to the MARPOL Annex VI regulations to reduce harmful emissions from ships. (see http://www.imo.org/environment/mainframe.asp?topic_id=233 for details). Some of the main changes include:
    - Progressive reductions in SO_x emissions from ships, with the global sulphur cap reduced initially to 3.50% (from the current 4.50%), effective from 1 January 2012; then progressively to 0.50 %, effective from 1 January 2020.

  - Progressive reductions in NO_x emissions from marine engines.

- A Fuel Standards Consultative Committee was established under the Fuel Quality Standards Act 2000 as a formal consultation mechanism to promote uniformity in Australian fuel standards, to facilitate investment in new fuels and technology, and to be a champion for new fuel standards. From an historical perspective, fuel standards have been modified a number of times since the Fuel Quality Standards Act 2000 came into force in 2002 with the introduction of uniform fuel standards. An example of action taken on fuel standards since their inception in 2002 can be noted in the committee’s action in reducing the national standard for sulphur content in diesel. The allowable content in 2002 was set at a maximum of 500ppm, which was reduced to 50ppm in 2006 and further reduced to 10ppm in 2009. There has been no further action proposed as of the date of this report for fuel standards but given the historical trends toward further tightening of standards further improvements in fuel quality could be expected (although the scope and nature of these changes cannot be predicted at this stage).
- Berth design would include allowance for alternative marine power (AMP) for vessels (also known as cold-ironing) while at berth. The success of AMP would depend upon suitable international standards being adopted for the supply of shore-based electricity to ships and a “critical mass” of vessels to be equipped so as to receive shore power. The adoption of alternative marine power would effectively remove emissions from ship boilers whilst in berth, eliminating a significant source of NO_X and particulate emissions.
- Possible adoption of programs such as the “Green Award” to offer incentives for less polluting vessels to call at Port Kembla. A Green Award ship meets high but manageable technical and managerial requirements and confirms the high quality of the vessel. Crude oil tankers, product tankers and bulk carriers with a minimum deadweight of 20,000 ton may apply for inspection and certification.

"This page has been left blank intentionally"

9.0 Conclusion

The assessment of the PKOHD has identified potential exceedences of ambient air quality goals. Exceedences are expected to relate to short term localised particulate and NO_2 impacts from construction and operational activities.

There are no other specific characteristics shown from the meteorological data analyses that would be expected to adversely affect air pollution in the area immediately surrounding the PKOHD. On-site meteorological analysis may be required to aid in the assessment of pollutant impacts related to meteorological conditions, and may benefit future assessments of activities to be added to the harbour.

There are no significant regional exceedences of relevant air quality guidelines with the exception of 24 hour average PM_{10}. These dust levels are contributed to by natural processes such as bush fires as well as anthropogenic influences such as motor vehicles. The dust gauge results also show there are elevated deposited dust levels in the local area.

The dredge spoil managed during the Major Project (Stage 1) was highlighted as a potential source of odour from the site. Dredging operations have been designed so that the spoil is not planned to be stockpiled above the water surface and hence is therefore not expected to be a source of odour from the site.

The modelling results for the Major Project (Stage 1) construction suggest that the short term NO_2, and PM_{10} GLCs may exceed the DECCW criteria at discrete receptors close to the development boundary. NO_2 concentrations are not expected to exceed the assessment criteria for a significant proportion of the year and are considered acceptable for the construction period of the project. Dust impacts of the construction phase can be limited by implementing site specific 'best practice' dust mitigation measures which should be incorporated into the site's AQMP and CEMP.

The modelling results for the Major Project (Stage 1) operation suggest that only short term PM_{10} GLCs are likely to exceed the DECCW criteria at some discrete receptors. Dust impacts of the operation phase can be limited by implementing site specific 'best practice' dust mitigation measures which should be incorporated into the site's AQMP and OEMP.

The modelling results for the Concept Plan operation suggest that the short term NO_2, and PM_{10} GLCs may exceed the DECCW criteria at some discrete receptors. NO_2 concentrations are not expected to exceed the assessment criteria for a significant proportion of the year and are considered acceptable for the project. Dust impacts of the operation phase can be limited by implementing site specific 'best practice' dust mitigation measures which should be incorporated into the site's AQMP and OEMP.

"This page has been left blank intentionally"

10.0 References

Commonwealth Government of Australia (Commonwealth) (2001) *National Pollution Inventory Emission Estimation Technique Manual for Mining Version 2.3*, December 2001

Commonwealth of Australia (Commonwealth) (2003) *National Environmental Protection (Ambient Air Quality) Measure*.

Commonwealth of Australia (Commonwealth) (2004) *National Environment Protection (Air Toxics) Measure*.

Commonwealth of Australia (Commonwealth) (2008a) *National Pollution Inventory Emission Estimation Technique Manual for Railway Yard Operations Version 2*, June 2008

Commonwealth Government of Australia (Commonwealth) (2008b) *National Pollution Inventory Emission Estimation Technique Manual for Maritime Operations Version 2*, July 2008

Environment Protection Authority New South Wales (EPA) (1997a) *Metropolitan Air Quality Study: Air Emissions Inventory*.

Environment Protection Authority New South Wales (EPA) (1997b) *Protection of the Environment Operations Act (1997).*

Environment Protection Authority New South Wales (EPA) (2002) *Ambient Air Quality Research Report (1996-2001); Dioxins, Organics, Polycyclic Aromatic Hydrocarbons and Heavy Metals*.

NSW Department of Environment and Conservation (DEC) (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

New South Wales Minerals Council. 2000, *Particulate Matter and Mining; A NSW Minerals Council Technical Paper*, Version 3.

US EPA, October 1996, *AP42 Fifth Edition Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources Large Stationary Diesel and All Stationary Dual-fuel Engines, Supplement B*

V/Line (1986) *Train controllers guide to fuel conservation with train operation*.

"This page has been left blank intentionally"