APPENDIX 4

Air Quality Assessment

REPORT

AIR QUALITY IMPACT ASSESSMENT: KOORAGANG COAL TERMINAL STAGE 4 PROJECT FOURTH DUMP STATION AND FOURTH SHIPLOADER

Umwelt (Australia) Pty Limited

Job No: 3321

21 October 2009

A PEL Company

PROJECT TITLE:	**AIR QUALITY IMPACT ASSESSMENT KOORAGANG COAL TERMINAL STAGE 4 PROJECT FOURTH DUMP STATION AND FOURTH SHIPLOADER**
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DOCUMENT CONTROL			
VERSION	**DATE**	**PREPARED BY**	**REVIEWED BY**
DRAFT v1	23.07.09	Fardausur Rahaman	Kerry Holmes
DRAFT v2	03.09.09	Fardausur Rahaman	Kerry Holmes
DRAFT v3	06.10.09	Fardausur Rahaman	
FINAL	21.10.09	Fardausur Rahaman	Jane Barnett

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1 INTRODUCTION

In 2006 an assessment was carried out to determine the air quality impacts of an increase in throughput capacity at the Port Waratah Coal Services (PWCS) Kooragang Coal Terminal (KCT) from 77 million tonnes per annum (Mtpa) to 120 Mtpa (**Holmes Air Sciences, 2006a**). Approval for this increase was granted in 2007. PWCS propose to modify this approval to enable the construction of a fourth dump station and fourth ship loader in order to increase efficiency of throughput at the KCT through the benefit of additional 'sprint capacity'. The purpose of this report is to quantitatively assess the potential air quality impacts of the Stage 4 Project.

Emissions of dust will be the main air quality issue and the assessment is based on the use of a computer-based dispersion model to predict ground-level dust concentrations and deposition levels in the vicinity of the KCT. To assess the effect that the dust emissions would have on existing air quality, the dispersion model predictions have been compared to relevant air quality criteria and predicted dust levels associated with the approved KCT operations.

The assessment has been undertaken in accordance with the Director-General's environmental assessment requirements (DGRs). The assessment is based on a conventional approach following the procedures outlined by the NSW Department of Environment, Climate Change and Water (DECCW) in their guideline document titled "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (**NSW DEC, 2005**).

2 PROJECT DESCRIPTION

Figure 2.1 shows the study area and location of the KCT. The nearest residential areas are Fern Bay located approximately 1.7 kilometres to the east, Stockton North located approximately 1.5 kilometres to the south-east, and Mayfield located approximately 1.7 kilometres to the south-west of KCT (refer to **Figure 2.1**)

The KCT receives, assembles and loads coal onto ships for export to customers around the world. Since Stage 1 of the facility was completed in 1984 a continuous expansion program has been implemented. The program has seen the KCT throughput capacity increase from an initial 21 Million tonnes per annum (Mtpa) to 41 Mtpa at the completion of Stage 2 to a planned 77 Mtpa at the completion of Stage 3. In 2007, approval was obtained to increase the throughput to a nominal 120 Mtpa through the optimisation of existing and approved KCT infrastructure.

Stage 1 of the development included one dump station, two half-length stockpile pads (referred to as Pad A and Pad B) and one shipping berth (K4). A second dump station was added for Stage 2 as well as the use of full-length Pad A and Pad B stockpiles and a second shipping berth (K5). Stage 3 of the development included three dump stations, four full length stockpile pads (Pads A, B, C and D) and four shipping berths (K4, K5, K6 and K7).

As part of the Stage 4 Project, a fourth dump station and a fourth ship loader is proposed to be constructed and operated at the KCT. The Stage 4 Project would involve minor changes to the approved footprint of the KCT through this additional coal handling infrastructure. The KCT operates 24 hours per day, seven days per week.

The potential dust generating activities associated with the KCT include:

- material unloading/loading points;
- stacking and reclaiming to and from coal stockpiles, and
- wind erosion from coal stockpiles.

Importantly, the proposed Stage 4 Project will not alter the approved stockpile areas, the major source of dust generation associated with the KCT. The Stage 4 Project will introduce an additional material unloading/loading point at the KCT.

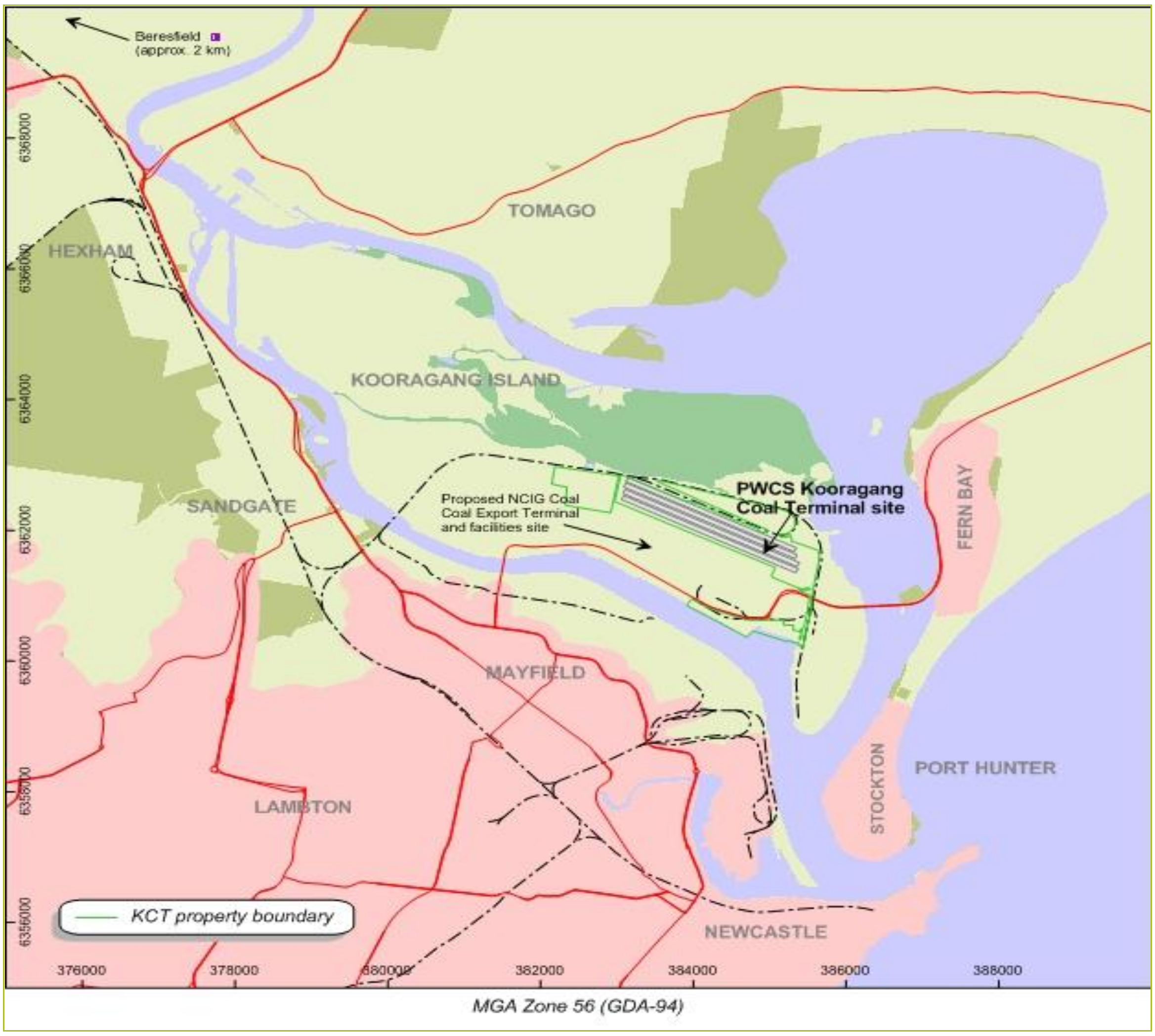

Figure 2.1: Location of study area

3 AIR QUALITY CRITERIA

Table 3.1 and **Table 3.2** summarise the air quality assessment criteria that are relevant to this study. The air quality criteria relate to total dust in the air at a specific location and not just the dust from the KCT. In other words, some consideration of background levels needs to be made when using these criteria to assess impacts.

Table 3.1: DECCW assessment criteria for particulate matter concentrations

Pollutant	Criteria	Averaging Period	Agency
Total suspended particulate matter (TSP)	90 $\mu g/m^3$	Annual mean	NHMRC[1]
Particulate matter <10 μm (PM_{10})	50 $\mu g/m^3$	24-hour maximum	DECCW
	30 $\mu g/m^3$	Annual mean	DECCW
	50 $\mu g/m^3$	(24-hour average, 5 exceedances permitted per year)	NEPM[2]

1 National Health and Medical Research Council
2 National Environment Protection Measure

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 3.2** shows the maximum acceptable increase in dust deposition over the existing dust levels. These criteria for dust fallout levels are set to protect against nuisance impacts (**NSW DEC, 2005**).

Table 3.2: DECCW assessment criteria for dust fallout

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

4 EXISTING ENVIRONMENT

This section describes the dispersion meteorology, local climatic conditions and existing dust levels in the area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, AUSPLUME, requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[a] and mixing height[b]. Meteorological data collected in the study area are discussed below.

Meteorological information has been made available for this study by the Steel River Industrial Estate on the southern side of the Hunter River (south arm) (approximately 1 km from the KCT). Steel River operates a weather station (see **Figure 4.1** for location) which collects 10-minute records of temperature, wind speed, wind direction and sigma-theta (a measure of the fluctuation of the horizontal wind direction). These data have been prepared into a form suitable for the AUSPLUME dispersion model.

Annual and seasonal windroses prepared from data collected in 2001 are shown in **Figure 4.2.** It can be seen from the windroses that, annually, the most common winds are from the WNW and NW. Winds from the east are also common, but to a lesser extent. In the summer months winds from the east indicate the direction of the sea-breeze while winds in winter are predominantly from the WNW. Wind patterns from year to year have been found to be quite similar at this site, especially in summer and winter (**Holmes Air Sciences, 2006b**).

Wind data from Beresfield, Newcastle and Wallsend were examined in a previous assessment (**Holmes Air Sciences, 2006b)**. These data were collected by the DECCW in 2000. All of these sites exhibit some similarities to each other, to various extents. For example, all sites indicate that winds from the NW are common. Wallsend is perhaps the most different, with winds from the SW occurring most often.

Meteorological data have also been collected by PWCS at the KCT (**Zib 2006**) (see **Figure 4.1** for location). Data are collected at this station on a continuous basis. **Figure 4.3** shows the annual and seasonal windroses from data collected between 2004 and 2005. The patterns of winds from this site are consistent with the winds measured at the Steel River site.

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

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

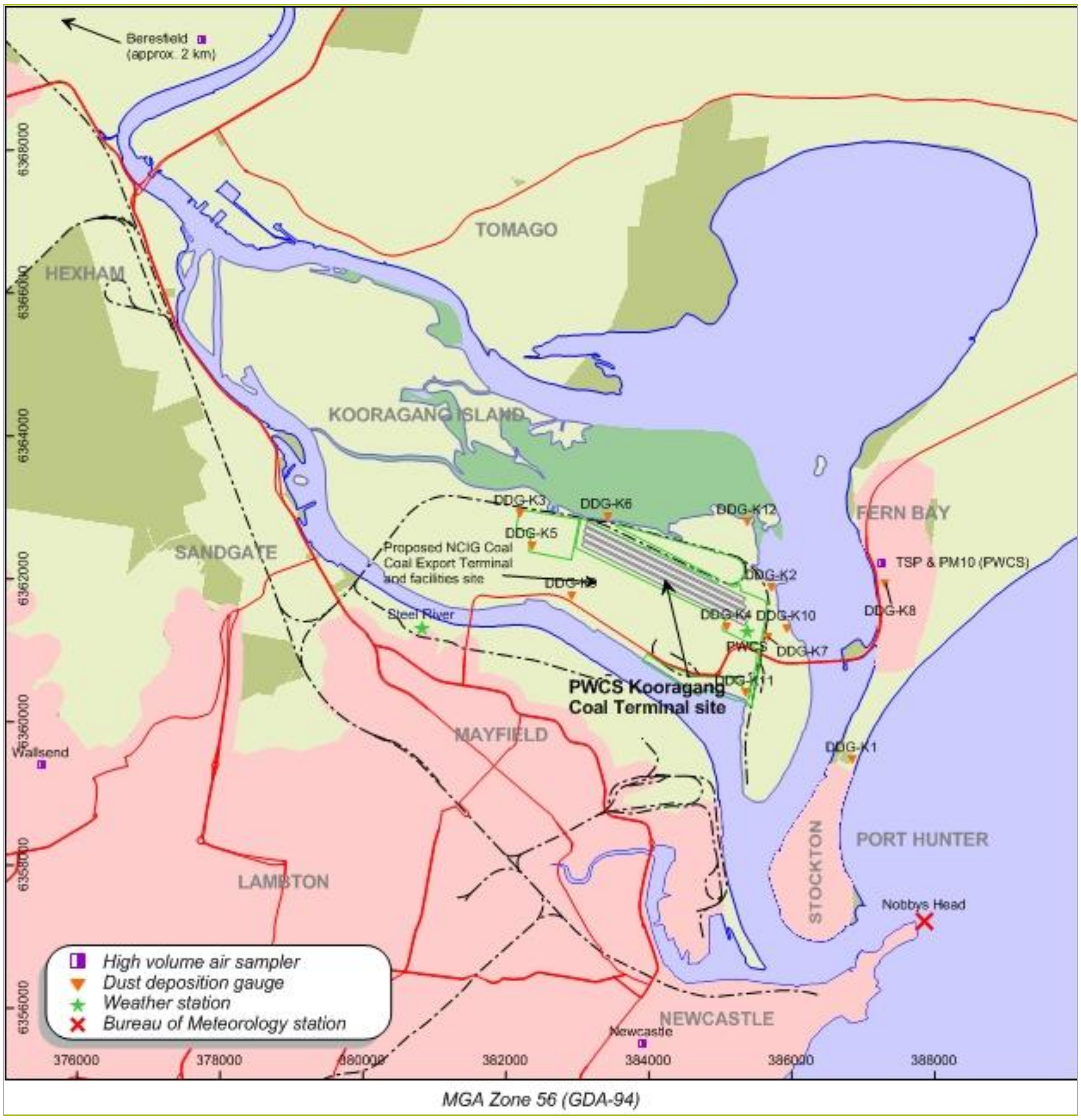

Figure 4.1: Monitoring locations

The subtle differences in the wind patterns measured at each of the meteorological monitoring sites could be explained by differences in either the topography or landuse in which the meteorological station is located.

To use the wind data to assess dispersion it is necessary to also have available data on atmospheric stability. A stability class was calculated for each hour of the meteorological data using sigma-theta according to the method recommended by the United States Environmental Protection Agency (**US EPA, 1986**).

Mixing height was determined using a scheme defined by **Powell** (**1976**) for day-time conditions and an approach described by **Venkatram** (**1980**) for night-time conditions. These two methods provide a good estimate of mixing height in the absence of upper air data.

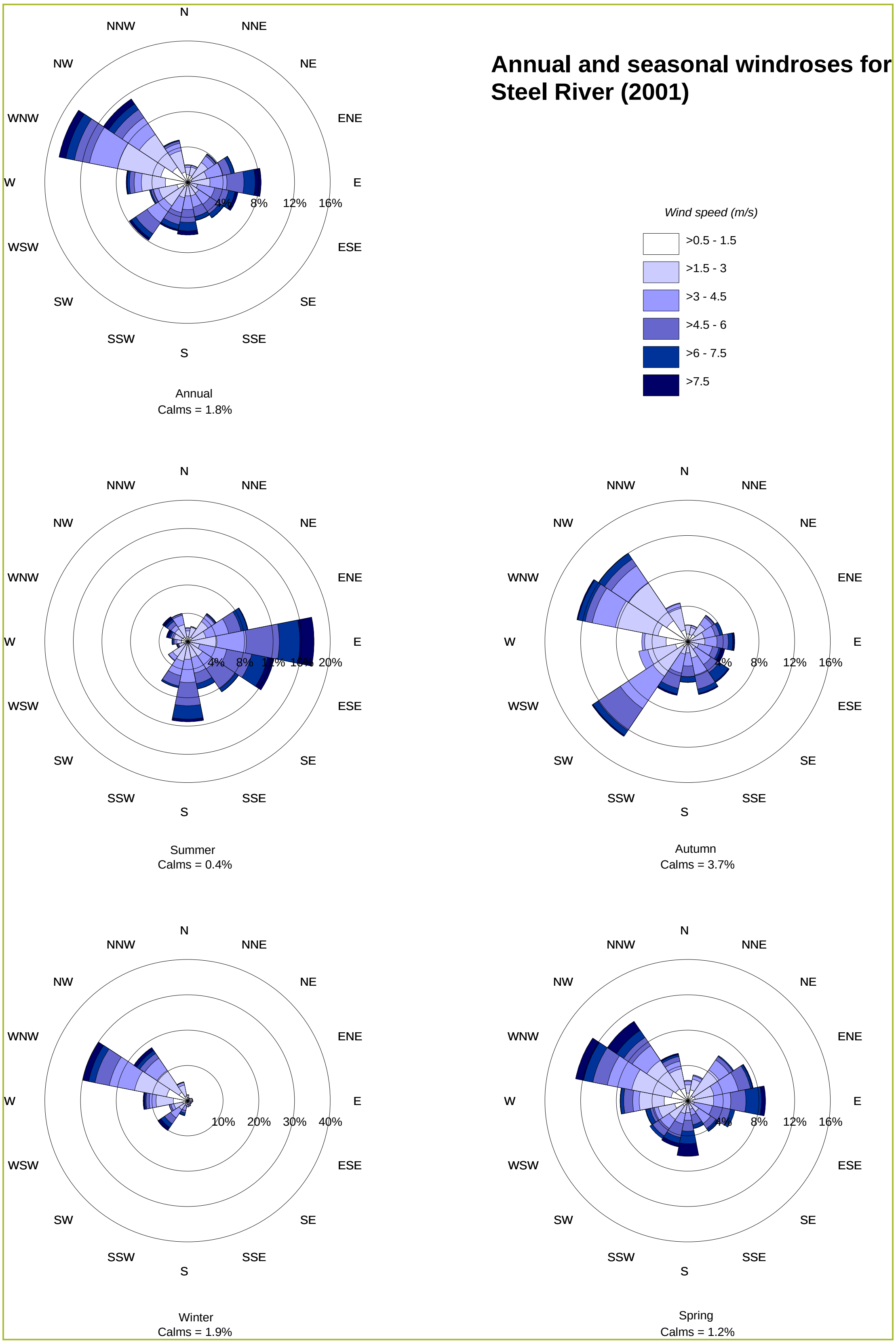

Figure 4.2: Annual and seasonal windroses for Steel River

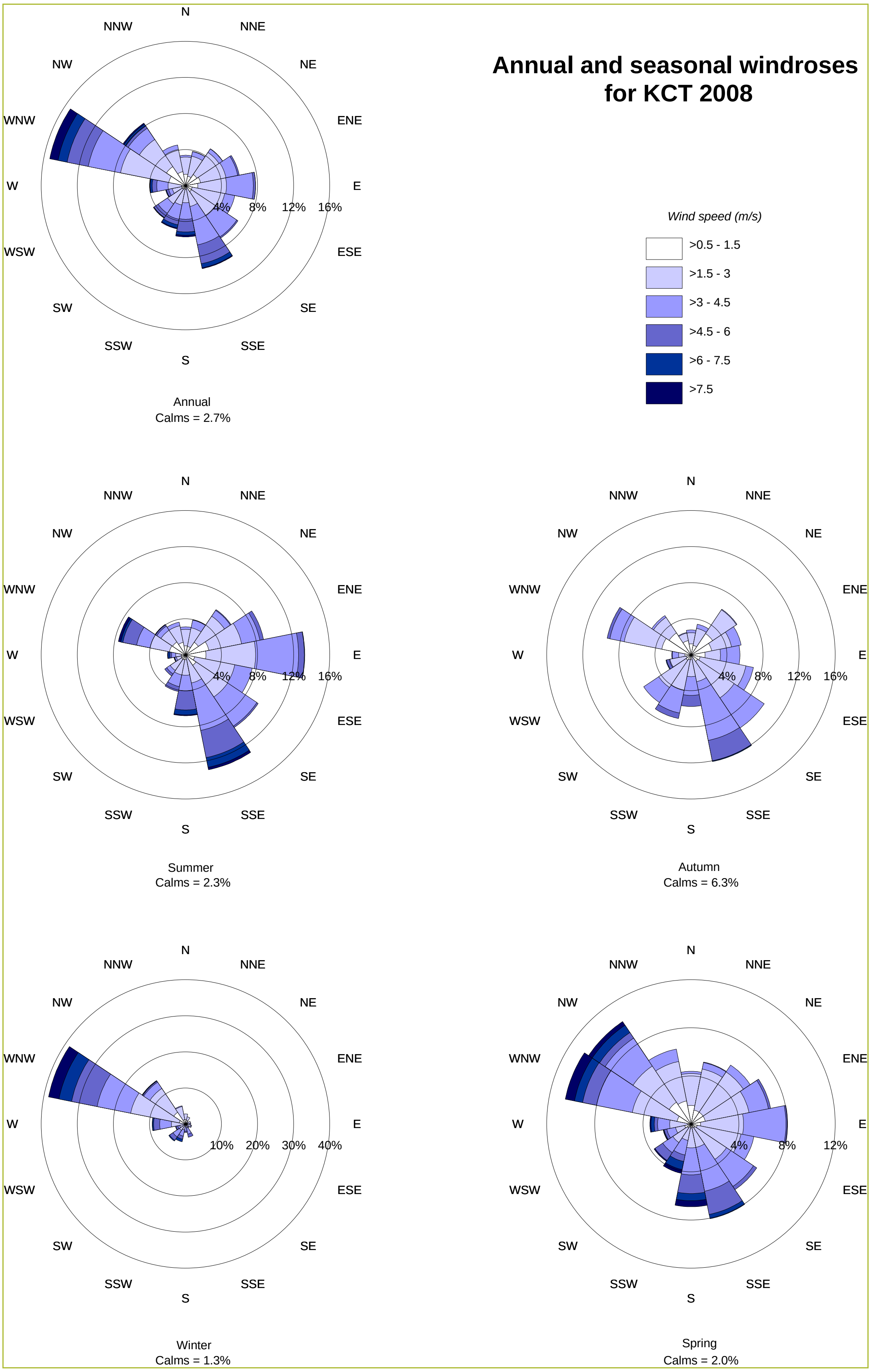

Figure 4.3: Annual and seasonal windroses for KCT (2008)

Table 4.1 shows the frequency of occurrence of the stability categories in the area for the modelled year. The most common stability occurrences at the Steel River site were calculated to be D class stabilities (54%) which suggests that dust emissions will disperse rapidly for a significant proportion of the time.

Table 4.1: Percentage of occurrence of stability classes

Stability class	Percentage of occurrence
A	2.8
B	2.1
C	5.5
D	53.9
E	28.5
F	7.2

Given the proximity of the Steel River site to the key receiver areas surrounding KCT, these data are considered to contain meteorological conditions that are representative of the conditions experienced at the KCT. The 2001 data were used in the dispersion modelling as this dataset had the highest data capture. Modelling with the Steel River data provides consistency with the approach adopted for the NCIG air quality study (**Holmes Air Sciences, 2006b**) and previous PWCS air quality assessment (**Holmes Air Sciences 2006a)**. These data also shows similar wind patterns when compared to the data collected at the KCT in 2008 (**Figure 4.3**). It is noted that the KCT meteorological data has a higher percentage of calms and higher average wind speed when compared to that of Steel River meteorological data. Hence use of Steel River meteorological data will provide a more conservative estimation of particulate emissions from the KCT activity as most of the activities are wind dependent (see **Table B1**).

Joint wind speed, wind direction and stability class frequency tables for the Steel River 2001 data are presented in **Appendix A**.

4.2 Local Climatic Conditions

The Bureau of Meteorology collects climatic information from Nobbys Head Signal Station at Newcastle (refer to **Figure 4.1**). A range of meteorological data collected from this station are presented in **Table 4.2** (**Bureau of Meteorology, 2009**). The station has been collecting meteorological information since 1862.

Temperature data show that January is typically the warmest month with a mean daily maximum of 25.5°C. July is the coldest month with a mean daily minimum of 8.4°C. Rainfall data collected at Nobbys Head show that March is the wettest month with a mean rainfall of 120 millimetres (mm). Annually the area experiences, on average, 1,140 mm of rain per year.

Table 4.2: Climate information for Nobbys Signal Station

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Mean maximum temperature (°C)	25.5	25.4	24.7	22.8	20.0	17.5	16.7	18.0	20.2	22.1	23.5	24.9	21.8
Mean minimum temperature (°C)	19.2	19.3	18.2	15.3	12.0	9.7	8.4	9.2	11.4	14.0	16.1	18.0	14.2
Mean rainfall (mm)	89.0	108.4	120.3	116.9	117.7	117.4	94.9	74.8	73.5	73.3	70.4	81.5	1140.0
Mean number of clear days	6.3	5.3	6.4	7.4	6.9	7.5	9.7	10.8	9.3	7.4	5.5	6.3	88.8
Mean number of cloudy days	12.4	11.9	11.7	10.7	11.9	11.7	9.5	8.3	9.0	12.1	12.2	11.7	133.1
Mean 9am temperature (°C)	21.9	21.8	20.8	18.1	14.6	12.0	10.9	12.1	15.0	17.9	19.5	21.1	17.1
Mean 9am relative humidity (%)	77	80	79	78	79	79	77	73	70	68	72	75	75
Mean 9am wind speed (km/h)	20.9	20.9	20.8	21.6	23.6	26.6	26.5	25.8	25.2	23.8	23.3	21.7	23.4
Mean 3pm temperature (°C)	23.3	23.4	22.9	21.3	18.8	16.5	15.9	16.9	18.5	19.8	20.9	22.4	20.0
Mean 3pm relative humidity (%)	72	74	72	66	64	64	59	56	59	64	68	71	66
Mean 3pm wind speed (km/h)	33.4	32.7	30.6	28.1	26.2	28.4	29.1	30.6	34.2	34.4	35.4	35.3	31.5

Climate averages for station 061055 Newcastle Nobbys Signal Station. Commenced 1862; Last record: 2009; Latitude (deg S) 32.9185; Longitude (deg E): 151.7985; State: NSW
Source: Bureau of Meteorology

4.3 Existing Air Quality

Air quality standards and goals refer to total dust levels which include the KCT and other existing sources. To fully assess impacts against all the relevant air quality standards and goals (see **Section 3**) it is necessary to have information on, or estimates of, existing dust concentration and deposition levels in the surrounding area.

This section summarises air quality monitoring data collected by the DECCW and PWCS in 2001 (modelling year) and 2008.

4.3.1 DECCW Monitoring

The DECCW operate air quality monitoring stations at Beresfield, Newcastle and Wallsend (refer **Figure 4.1** for locations). These three sites measure concentrations of PM_{10} by tapered element oscillating microbalance (TEOM) however, no total suspended particulates (TSP) measurements are made. Monitoring data from the three DECCW monitoring locations in the vicinity of Newcastle for 2001 and 2008 are shown below in **Table 4.3**.

Annual average PM_{10} was below the DECCW air quality criterion of 30 $\mu g/m^3$ in both years. Maximum 24-hour average PM_{10} concentrations have been above the DECCW 50 $\mu g/m^3$ criterion on several occasions at all three monitoring locations in 2008. On 1st July, 16th September and 31st December, all three monitoring station recorded higher PM_{10} concentrations (**Figure 4.4**). These may be due to regional events. Bushfires and dust storms can contribute to very high PM_{10} concentrations.

Neither TSP concentrations nor dust deposition are measured by the DECCW in the Newcastle area. Monitoring data from areas in the Hunter Valley where co-located TSP and PM_{10} monitors have been operated for reasonably long periods of time indicate that long term average PM_{10} concentrations are approximately 40% of the corresponding long-term TSP concentration (**NSW Minerals Council, 2000**) A value of 55 $\mu g/m^3$ for annual average TSP could be derived from the annual average PM_{10} (22 $\mu g/m^3$) assuming that 40% of the TSP is PM_{10}.

Table 4.3: Annual average PM_{10} monitoring data in the Newcastle area (2001 and 2008)

Month	Beresfield (µg/m³)		Newcastle (µg/m³)		Wallsend (µg/m³)	
	2001	2008	2001	2008	2001	2008
Goal	**50**	**30**	**50**	**30**	**50**	**30**
Jan-08	21	19	24	25	22	17
Feb-08	19	17	19	18	20	13
Mar-08	19	20	26	19	19	15
Apr-08	21	15	18	18	18	13
May-08	17	21	14	21	15	16
Jun-08	22	15	23	15	16	10
Jul-08	18	19	17	19	13	14
Aug-08	21	17	14	16	15	14
Sep-08	20	20	16	26	16	20
Oct-08	30	18	15	24	15	17
Nov-08	22	18	22	23	18	16
Dec-08	30	20	33	24	27	18
Annual Ave	**21.7**	**18.3**	**20.1**	**20.6**	**17.8**	**15.1**

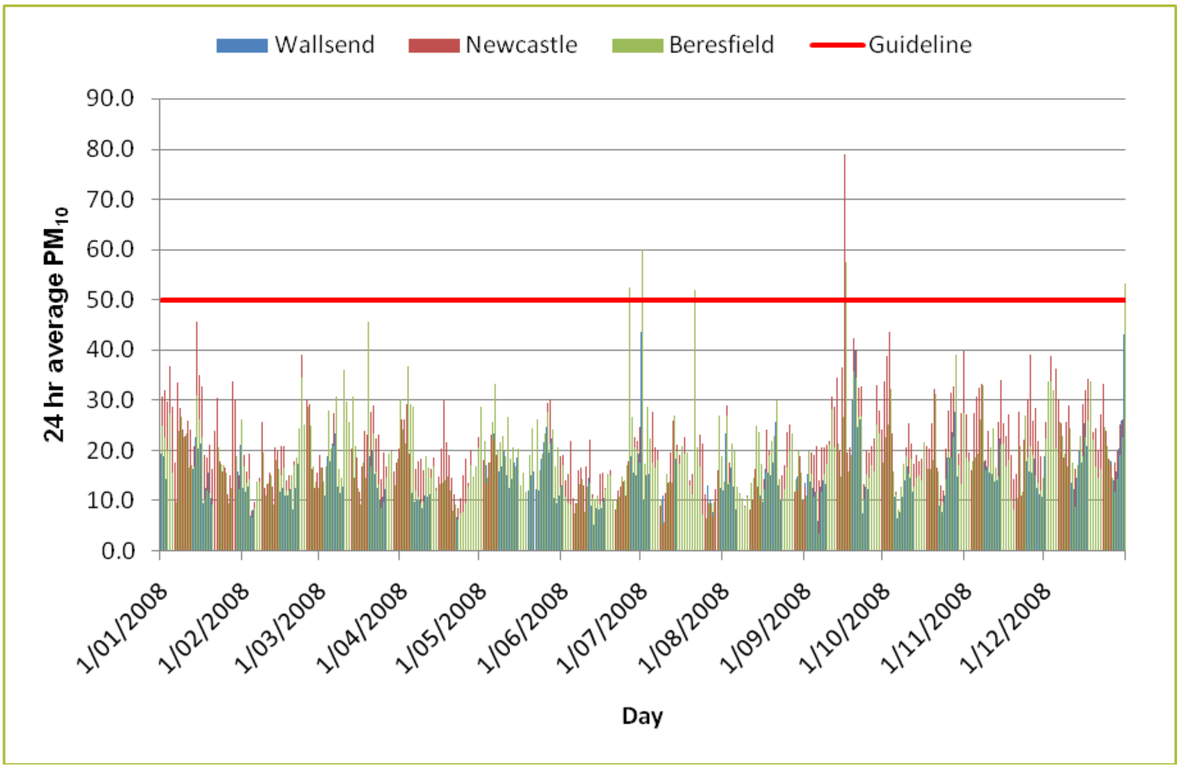

Figure 4.4: 24 hour average PM_{10} concentration (µg/m³) at DECCW monitoring stations.

4.3.2 PWCS Monitoring

PWCS monitor TSP, PM_{10} and dust deposition within the key receiver areas surrounding the KCT. There are currently two high volume air samplers located at Fern Bay and 12 dust deposition gauges surrounding the site. Among the high volume air samplers, one sampler (K2) measures TSP, the other sampler (K3) measures PM_{10}. **Figure 4.1** shows the monitoring locations.

Table 4.4 summarises the dust concentration and deposition data collected in the surrounding areas of Fern Bay and Stockton.

Table 4.4: Summary of PWCS air quality monitoring

Year	Annual average TSP ($\mu g/m^3$) (HVAS K2 – Fern Bay)	Annual average PM_{10} ($\mu g/m^3$) (HVAS K3– Fern Bay)	Annual average dust deposition ($g/m^2/month$)	
			DDG K1 – Stockton	DDG K8 – Fern Bay
2001 (modelling year)	41	21	1.3	1.3
2008 (recent year)	45	19	1.9	2.1
DECCW Guideline	**90**	**30**	**4**	**4**

Figure 4.5 and **Figure 4.6** show the measured 24-hour average PM_{10} and TSP concentrations as a time series graph for the 2008 monitoring period. It can be seen from these graphs that there have been two days (23rd May and 31st December) in 2008 when the measured 24-hour average PM_{10} concentration exceeded the 50 $\mu g/m^3$ criterion specified by the DECCW. On 31st December HVAS recorded a PM_{10} concentration of 51 µg/m³. On 23rd May HVAS recorded an extremely high PM_{10} concentration of 87 µg/m³. The reason for this extremely high PM_{10} concentration on this particular day is unknown. Analysis of 2001 data also showed several exceedances in December (**Holmes Air Sciences, 2006**). Bushfires and dust storms can contribute to very high and short term PM_{10} concentrations.

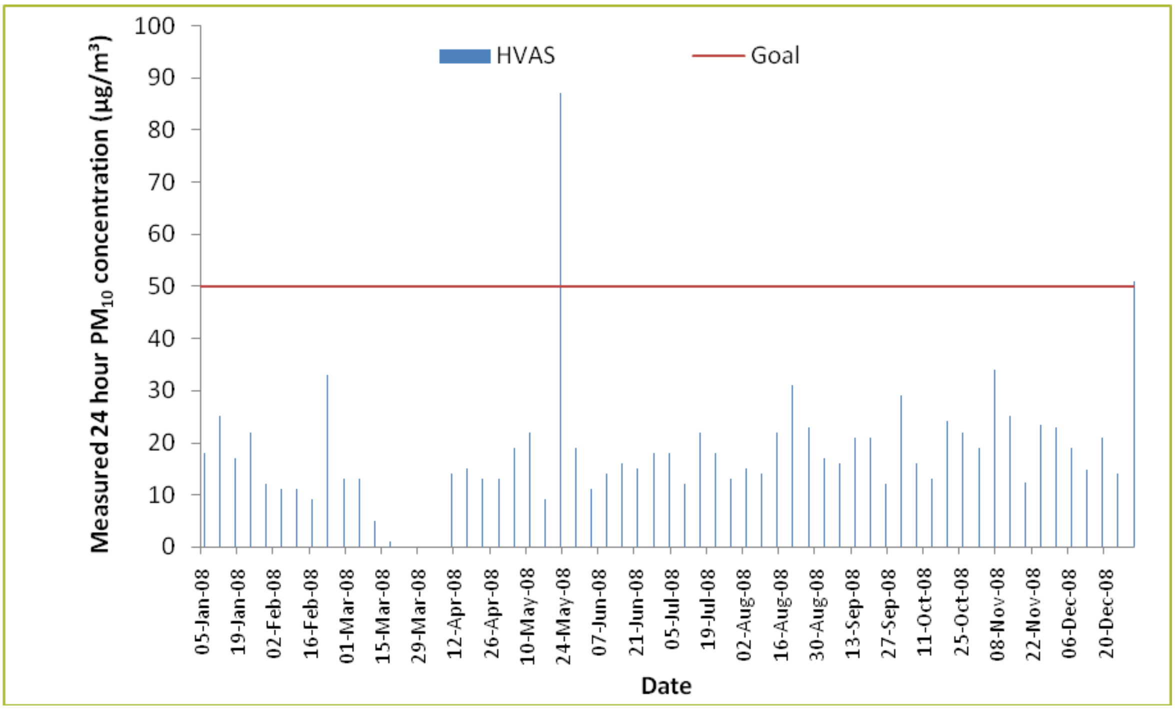

Figure 4.5: Measured 24 hour PM_{10} concentration at Fern Bay

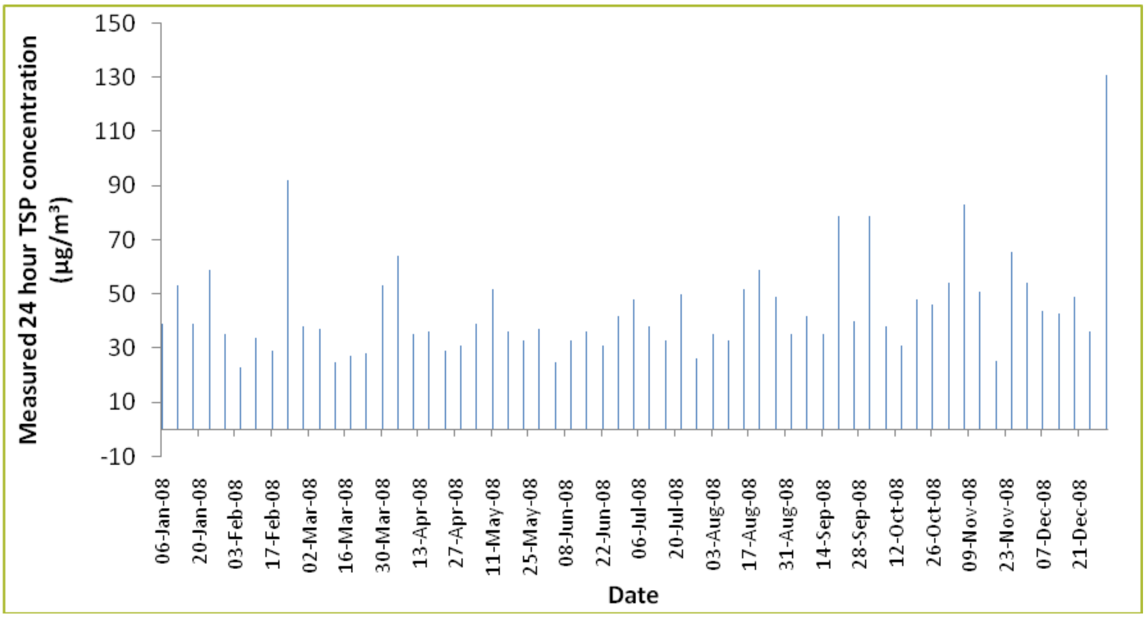

Figure 4.6: Measured 24-hour TSP concentration at Fern Bay

DDG-K1 and DDG-K8 are located at Stockton and Fern Bay respectively (see **Figure 4.1**). These gauges were considered to be the most appropriate of all 12 gauges for establishing background dust deposition levels at key receiver locations. The other 10 gauges are located much closer to the KCT operations and would not necessarily be representative of the broader, regional dust deposition levels in the area. These gauges are maintained by PWCS for environmental management purposes.

The annual average total dust deposition at DDG-K1 and DDG-K8 were below the DECCW criterion of 4 g/m^2/month. The measurement reports showed that many of these monthly samples were contaminated. Contamination was usually due to bird droppings, insects and/or seeds. Those contaminated samples have been excluded from the averages of the reported dust deposition. The average dust deposition for 2008 was 1.6 g/m^2/month for DDG-K1 and 1.9 g/m^2/month for DDG-K8.

4.3.3 Summary of Existing Air Quality

In summary, based on the monitoring data of 2001 and 2008, it has been assumed that the following background concentrations apply in the vicinity of the KCT.

- Annual average TSP of 45 µg/m^3;
- Annual average PM_{10} of 21 µg/m^3; and
- Annual average total dust deposition of 2.0 g/m^2/month.

In addition, the DECCW guidelines require an assessment against 24-hour PM_{10} concentrations. Given that exceedances of the DECCW's 24-hour average PM_{10} criterion have been recorded in this area, this assessment examines the increment of the KCT operations and adopts the approach that the proposal should not cause any additional exceedances of the 50 µg/m^3 criterion at the nearest residences.

5 EMISSIONS INVENTORY

The approach to this assessment has been to model the dust emissions from the KCT at full approved operations of up to 120 Mtpa throughput, including the proposed Stage 4 infrastructure.

This approach provides for the assessment of potential dust impacts associated with the KCT in its entirety, whilst highlighting the contribution of the proposed Stage 4 infrastructure to total predicted dust emissions for ongoing KCT operations.

Dust emissions will arise from a range of activities associated with the KCT. Total dust emissions have been estimated by analysing the activities taking place at the site for operations with 120 Mtpa throughput rate and with the additional dump station, transfer station and ship loader associated with the Stage 4 operational. The operations which apply in each case have been combined with emission factors developed, both locally and by the US Environment Protection Authority (EPA), to estimate the amount of dust produced by each activity.

The proposed infrastructure associated with Stage 4 Project will incorporate dust management controls, including enclosure of conveyors and transfer points as outlined further in **Section 6**.

Operations have been discussed with PWCS in order to determine material quantities, equipment locations, stockpile locations and areas, activity operating hours and other details that are necessary to estimate dust emissions.

The most significant dust generating activities from the operations have been identified and the dust emission estimates are presented below in **Table 5.1**. Details of the calculations of the dust emissions are provided in **Appendix B**.

Table 5.1: Estimated emission data used in modelling study

ACTIVITY	Annual TSP (kg/y)	
	Approved operations[1]	Additional dump and new transfer station
	120 Mtpa scenario	120 Mtpa scenario
Trains unloading to unloading station[1]	11,702	11,702
1st transfer between unloading station and stockpiles[1]	11,702	11,702
2nd transfer between unloading station and stockpiles[2]	11,702	11,702
Stacking to coal stockpiles	39,006	39,006
Reclaiming coal from stockpiles	33,077	33,077
1st transfer between stockpile and shiploader[2]	9,923	9,923
2nd transfer between stockpile and shiploader[2]	9,923	9,923
New transfer between stockpile and ship loader[2]	0	2,481
Transfer to additional buffer bins (enclosed)	0	0
3rd transfer between stockpile and shiploader	33,077	33,077
Loading coal to ships	9,923	9,923
Wind erosion from stockpiles and exposed areas	197,722	197,722
Diesel train exhausts	894	894
Annual throughput (t)	**120,000,000**	**120,000,000**
TOTAL DUST (kg)	**368,650**	**371,132**

1 Activity takes places underground – control factor applied for emission calculation purposes
2 Activity within an enclosed building – control factor applied for emission calculation purposes

The estimates from **Table 5.1** suggest that the annual dust emissions from the KCT would increase from 369 t to 371 t with the additional infrastructure associated with the Stage 4 Project. As highlighted in **Table 5.1** the additional transfer station is the only additional modelled dust source associated with the Stage 4 Project. It can be seen that the emissions from the new transfer station are significantly less than those from the other transfer stations. This is due to the fact that only one of the four streams of conveyers will pass through the new station.

Material handling (loading, unloading and transfer) and wind erosion from stockpiles and exposed areas are the most significant potential dust generating activities at the site (refer to **Table 5.1**). Importantly for this assessment the major dust source associated with the KCT, wind erosion from stockpile areas, will remain unchanged for current approved KCT operations as part of the Stage 4 Project.

For material handling, the US EPA emission factor (see **Appendix B**) is dependent on the wind speed as well as the material moisture content. The emission factor gives a dust emission in units of kilograms per tonne (kg/t) of material moved, that is the dust emission will be proportional to the amount of material handled. No direct allowance for dust control measures can be taken into account with this emission factor however emission factors published by the National Pollutant Inventory (NPI) (**NPI, 2001**) prescribe some control factors – for example, 70% control for enclosure of transfer points. This level of control was considered appropriate for inclusion in the emission calculations.

The US EPA emission factor for wind erosion from exposed areas and stockpiles relates to an emission in kilograms per hectare per day. Emissions are dependent on the material silt content, the number of raindays per year and the frequency of strong winds. The effect of control measures, such as the watering of stockpiles, cannot be directly determined from the application of this emission factor. No control factors were applied to wind erosion activities. This is a conservative approach that effectively overestimates emissions from this source.

In summary, the available dust emission factors have some limitations for applications with specific dust control measures. There are however some general control factors that can be applied to the emission factors in order to reflect the use of these controls.

Another source of dust for this project will be that generated from activities required in constructing the fourth dump station and fourth ship loader, predominantly the earthworks involved in preparing the building surface. There are a number of activities involved in this process but the main sources are likely to be the use of equipment such as dozers and haul trucks as well as wind erosion from exposed areas. The use of a water cart on-site during the construction phase will aid in reducing these emissions significantly.

Each of these activities (e.g. dozers) will be carried out for a short period of time over the modelling period. The proposed construction will result in minimal dust emissions and while there may be an increase in the dust deposition level for short term periods within the site, it is highly unlikely that dust emission from the construction activities will cause an increase in the particulate levels in nearby residential areas. Hence dust emissions from the construction activities have not been included in this modelling.

Details on the dust control measures in place at KCT are outlined below.

6 DUST CONTROL MEASURES

The controls that are implemented at the KCT can be summarised in three broad categories:

1. **Engineering controls** such as covering and enclosing conveyors and transfer points, dust collection systems and water sprays;
2. **Planning controls** (which increase the separation between dust emission sources at the KCT and sensitive areas); and
3. **Operational controls** which can vary operations when adverse meteorological conditions occur.

The specific dust control measures at KCT include:

- Use of automated sprays on coal stockpiles linked to meteorological monitoring station at KCT;
- Monitoring of moisture levels in the coal stockpiles;
- Minimising drop heights from stackers;
- Train unloading in a building enclosure, with the hopper designed for dust containment;
- Enclosure of conveyors and transfer points;
- Enclosure of buffer bins;
- Replacing traditional chutes with "soft-flow" chutes at the transfer points for more efficient movement of coal and reduced dust emissions;
- Clean up of coal spillage with water washing;
- Belt cleaners to reduce "carry-back" dust from coal on the conveyors;
- Use of water sprays on stockpiles and transfer points; and
- Sealed access roads with water washing or sweeping.

As noted above, the available dust emissions factors are limited in the detail to which these measures can be included. In this regard, the estimated annual emissions shown in **Table 5.1** are considered to be conservative (that is, a higher estimation than with detailed control measures implemented).

7 APPROACH TO ASSESSMENT

In August 2005 the DECCW published guidelines for the assessment of air pollution sources using dispersion models (**NSW DEC, 2005)**. The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data to be used in dispersion models, the way in which emissions should be estimated and the relevant air quality criteria for assessing the significance of predicted concentration and deposition rates from the proposal. This assessment has been undertaken in general accordance with the DECCW guidelines.

Off-site dust concentration and dust deposition levels due to the KCT have been predicted using AUSPLUME. AUSPLUME (Version 6.0) is an advanced Gaussian dispersion model developed on behalf of the Victorian EPA (**VEPA, 1986**) and is based on the US EPA's Industrial Source Complex (ISC) model. It is widely used throughout Australia and is regarded as a "state-of-the-art" model. AUSPLUME is the model required for use by the DECCW unless Project characteristics dictate otherwise (**NSW DEC, 2005**).

The modelling has been based on the use of three particle-size categories: 0 to 2.5 μm - referred to as $PM_{2.5}$ or fine particles (FP), 2.5 to 10 μm - referred to as CM (coarse matter) and 10 to 30 μm - referred to as the Rest. Emission rates of TSP have been calculated using emission factors derived from **US EPA (1985)** and **NERDDC (1988)** work (see **Appendix B**).

The distribution of particles has been derived from measurements in the **SPCC (1986)** study. The distribution of particles in each particle size range is as follows:

- $PM_{2.5}$ (FP) is 4.7% of the TSP;
- $PM_{2.5-10}$ (CM) is 34.4% of TSP; and
- PM_{10-30} (Rest) is 60.9% of TSP.

Modelling was done using three AUSPLUME source groups. Each group corresponded to a particle size category. Each source in the group was assumed to emit at the full TSP emission rate and to deposit from the plume in accordance with the deposition rate appropriate for particles with an aerodynamic diameter equal to the geometric mean of the limits of the particle size range, except for the $PM_{2.5}$ group, which was assumed to have a particle size of 1 μm. The predicted concentration in the three plot output files for each group were then combined according to the weightings in the above dot points to determine the concentration of PM_{10} and TSP.

The AUSPLUME model also has the capacity to take into account dust emissions that vary in time, or with meteorological conditions. This has proved particularly useful for simulating emissions on dust generating industries where wind speed is an important factor in determining the rate at which dust is generated.

For the current study the operations were represented by a series of volume sources located according to the site layout. **Figure 7.1** shows the location of the modelled dust sources. Estimates of emissions for each source were developed on an hourly time step taking into account the activities that would take place at that location. Thus, for each source, for each hour, an emission rate was determined which depended upon the level of activity and the wind speed. It is important to do this in the AUSPLUME model to ensure that long-term average emission rates are not combined with worst-case dispersion conditions which are associated with light winds. Light winds at KCT would correspond with periods of low dust generation (because wind erosion and other wind dependent emissions rates will be low) and also correspond with periods of poor dispersion. If these measures are not taken the model has the potential to significantly overstate impacts.

Dust concentrations and deposition rates have been predicted in the vicinity of the KCT. Receptor heights have been obtained from information on the local terrain.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. All dust sources have been modelled assuming 24-hour per day operations.

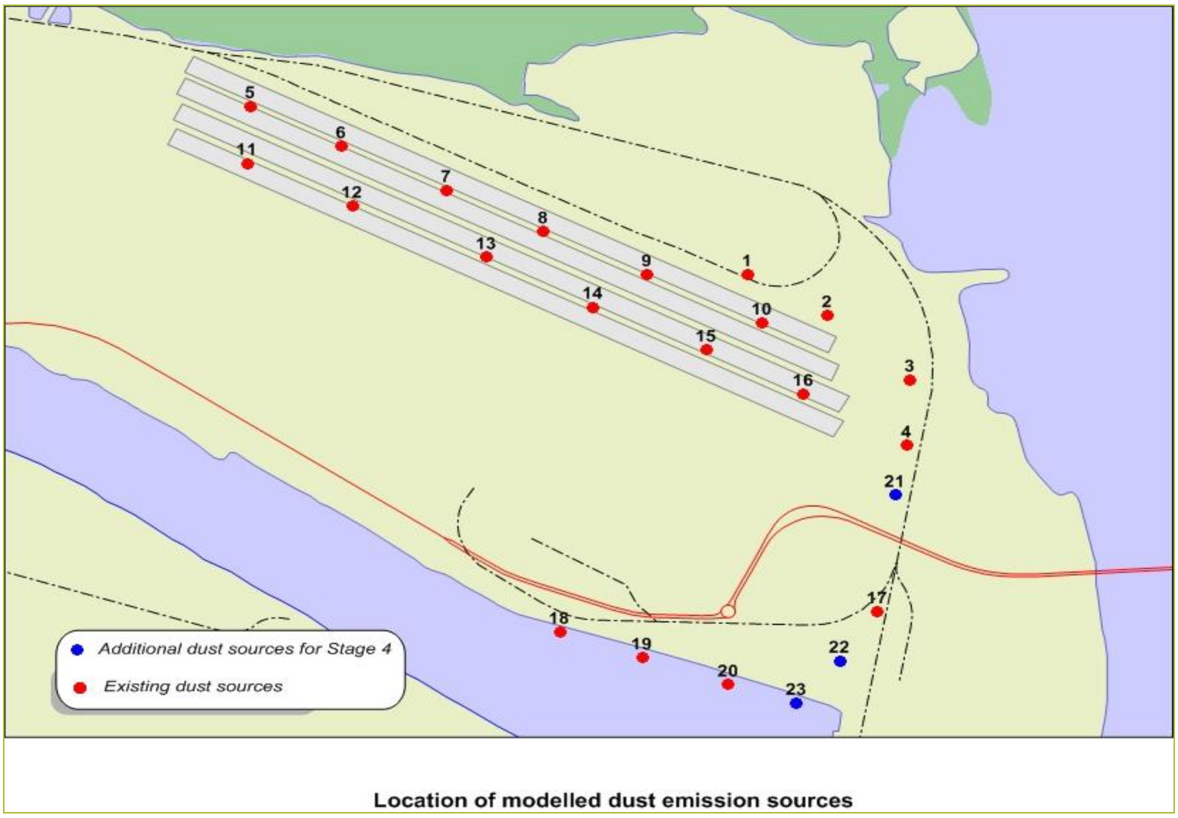

Figure 7.1: Location of modelled dust sources

8 ASSESSMENT OF IMPACTS

8.1 Preamble

This section provides an interpretation of the predicted dust concentrations and deposition levels.

Dust concentrations and deposition rates due only to emissions from the KCT operating at 120 Mtpa and the Stage 4 Project have been presented as isopleth diagrams in **Figure 8.1**, showing the following:

1. Predicted maximum 24-hour average PM_{10} concentration;
2. Predicted annual average PM_{10} concentration;
3. Predicted annual average TSP concentration; and
4. Predicted annual average dust deposition.

The maximum 24-hour average contour plots do not represent the dispersion pattern for any particular day, but show the highest predicted 24-hour average concentration that occurred at each location. The maxima are used to show concentrations which can possibly be reached under the modelled conditions.

Dust concentrations and deposition rates due only to emissions from the KCT operating without the fourth loader and transfer station is shown **Figure 8.2** (**Holmes Air Sciences 2006a**). It can be observed from **Figure 8.1** and **Figure 8.2** that changes in dust concentration and deposition rates at the nearby sensitive receptors in Fern Bay, Stockton and Mayfield due to the inclusion of the Stage 4 project are insignificant.

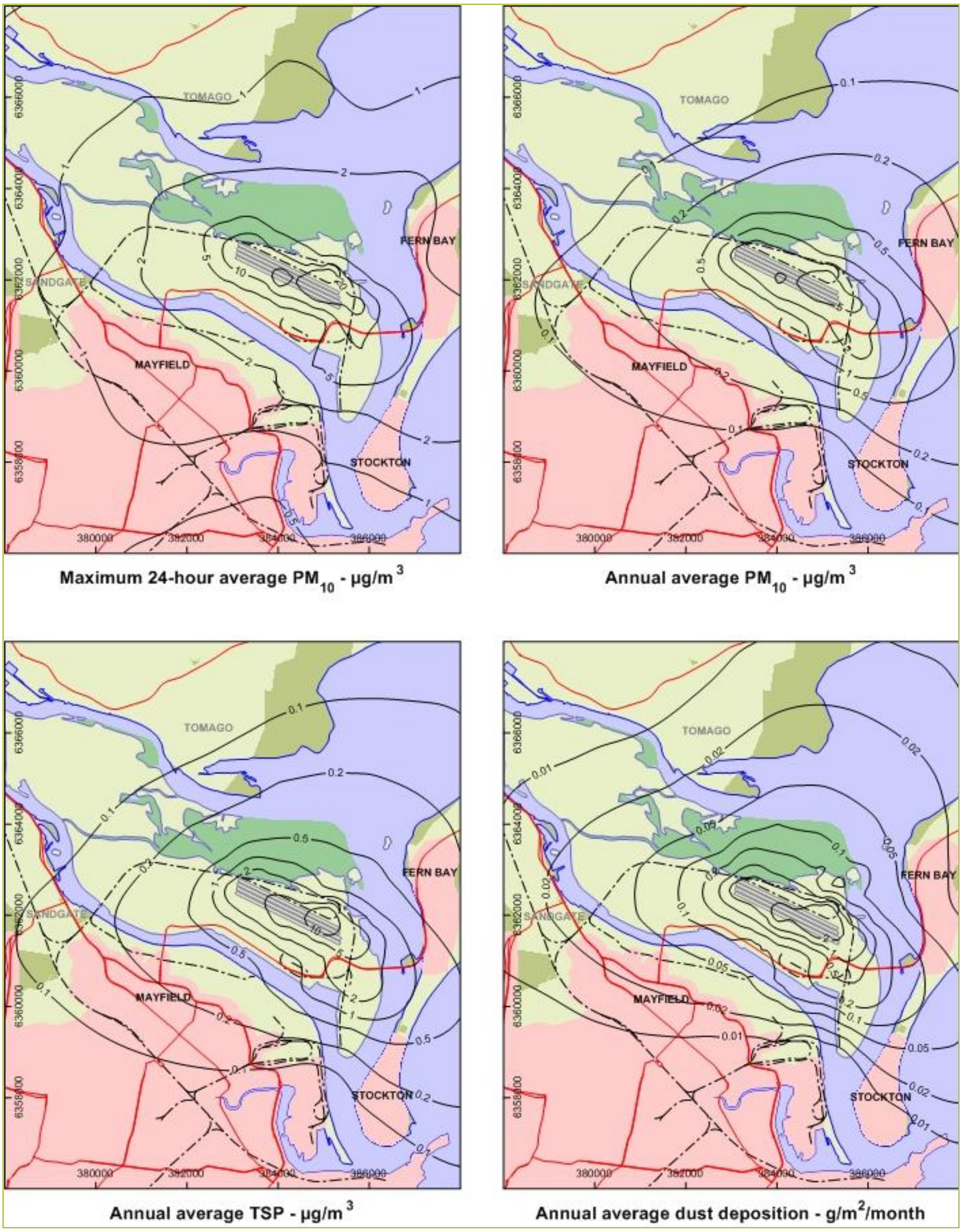

Figure 8.1: Model predictions for KCT operating at 120 Mtpa with additional Stage 4 Infrastructure (Source: Holmes Air Science 2006a)

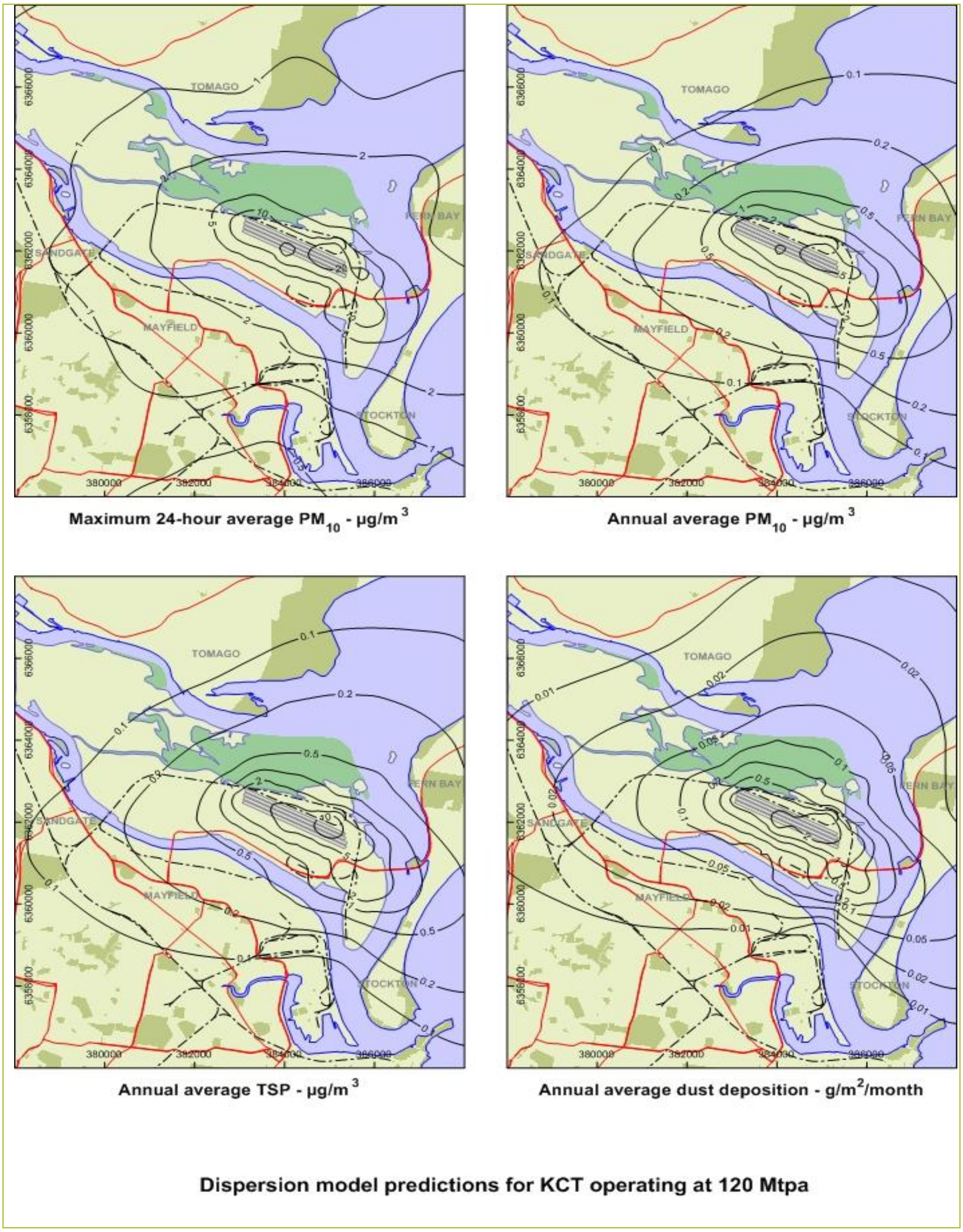

Figure 8.2: Model predictions for KCT operating at 120 Mtpa without additional Stage 4 Infrastructure (Source: Holmes Air Science 2006a)

8.2 Assessment of Impacts

Figure 8.1 include plots showing the predicted maximum 24-hour average PM_{10} concentrations. At the residential area of Fern Bay to the east of the site, the predicted concentration is of the order of 2 $\mu g/m^3$.

The maximum 24-hour average prediction represents the worst day due to emissions from the KCT. The nearest residential areas are approximately 2 km from the major site dust sources. The predicted concentration is well below the DECCW 50 $\mu g/m^3$ criterion at the nearest residential areas and at industrial receptors on Kooragang Island. Cumulative 24-hour average PM_{10} impacts are discussed in detail in **Section 8.3**

Predicted annual average PM_{10} concentrations due to the KCT operations are less than 2 $\mu g/m^3$ off-site and less than 0.5 $\mu g/m^3$ at the nearest residential areas of Mayfield to the southwest, Fern Bay and Stockton to the east. Taking into account an average PM_{10} background concentration of 21 $\mu g/m^3$, the predicted concentrations are well below the air quality criterion (30 $\mu g/m^3$) at the nearest residential areas.

Predicted annual average TSP concentrations are shown in **Figure 8.1**. The model predictions show annual average TSP concentrations are less than 0.5 $\mu g/m^3$ at the nearest residential areas. Taking account of an average TSP background concentration of 45 $\mu g/m^3$, the predicted cumulative PM_{10} concentrations are well below the air quality criterion (90 $\mu g/m^3$) at the nearest residential areas.

Figure 8.1 also includes the predicted annual average dust deposition. The contribution to dust deposition levels is predicted to be low at less than 0.05 g/m^2/month at Fern Bay. The predicted concentration is well below the DECCW criteria of 2 g/m^2/month (incremental). Taking into account an average background dust deposition rate of 2 g/m^2/month, the predicted cumulative dust deposition rates are well below the air quality criteria (4 g/m^2/month) at the nearest residential areas.

8.3 Cumulative 24-hour average PM10

The conventional approach to the assessment of air quality impacts is to add the predicted incremental impact of the operation to background levels and to compare the result with the relevant air quality criteria. This approach is referred to as a cumulative assessment and for annual averages; this approach has been adopted (see **Section 8.2**).

Assessment of cumulative 24-hour average PM_{10} air quality impacts is often complicated as there may be many occasions when background concentrations are already above the 24-hour average air quality criterion.

For a more refined analysis, the DECCW recommends (**NSW DEC, 2005**) that there should be no *additional* exceedances of the 50 $\mu g/m^3$ criterion. To undertake this analysis the dispersion model results need to be combined with contemporaneous hourly PM_{10} monitoring data. The hourly PM_{10} monitoring data were available from the Beresfield site, to the west of the KCT (**Figure 4.1**). The Beresfield site was chosen for this assessment as hourly TEOM data were available for the modelled meteorological year, that is, 2001. Also, the annual average PM_{10} concentration in 2001 (22 $\mu g/m^3$) was very similar to the annual average PM_{10} concentration measured at Fern Bay (21 $\mu g/m^3$) in 2001. A comparison of the observed PM_{10} concentration at Beresfield in 2001 and 2008 is shown in **Table 8.1.** The observed PM_{10} concentration (maximum, minimum and average) in 2001 is higher compared to that in 2008. Hence use of 2001 observed PM_{10} concentration for cumulative assessment would be a conservative approach to this assessment.

Table 8.1: Comparison of 2001 and 2008 PM_{10} monitoring data at Beresfield

Year	Maximum	Minimum	Average
2001	82	4.8	22
2008	60	3.6	18

The approach to address potential cumulative PM_{10} impacts is summarised below:

- re-run the AUSPLUME dispersion model for three sensitive receptor locations in the area;
- predict 24-hour average PM_{10} concentrations at the three sensitive receptor locations and match the predictions with contemporaneous TEOM PM_{10} monitoring data from the Beresfield monitoring station;
- tabulate results of 24-hour average PM_{10} concentrations at each location showing highest background with corresponding increment from the KCT and highest predicted increment with corresponding background; and
- assess the model predictions in the context of other existing and proposed operations in the area.

The three sensitive receptor locations used for this assessment are shown in **Figure 8.3**. These receptor locations have been chosen to represent the nearest residential areas of Mayfield, Stockton and Fern Bay.

Sensitive receptor locations chosen for the assessment

Figure 8.3: Sensitive receptor locations for cumulative PM_{10} assessment.

Figure 8.4 shows a time series of the background 24-hour average PM_{10} as well as the increment from the modelled sources at the three receptor locations. It can be seen from this figure that the measured background levels at Beresfield were above the 50 $\mu g/m^3$ goal on five days in 2001. The exceedances were generally in the warmer months, towards the end of the year. This is consistent with the air quality monitoring data collected by PWCS in areas surrounding the KCT and is generally associated with extreme events such as bushfires. There were also a few occasions when measured concentrations were between 40 and 50 $\mu g/m^3$. The predicted increment from the KCT at all three receptor locations represents a small fraction of background levels (refer to **Figure 8.4**).

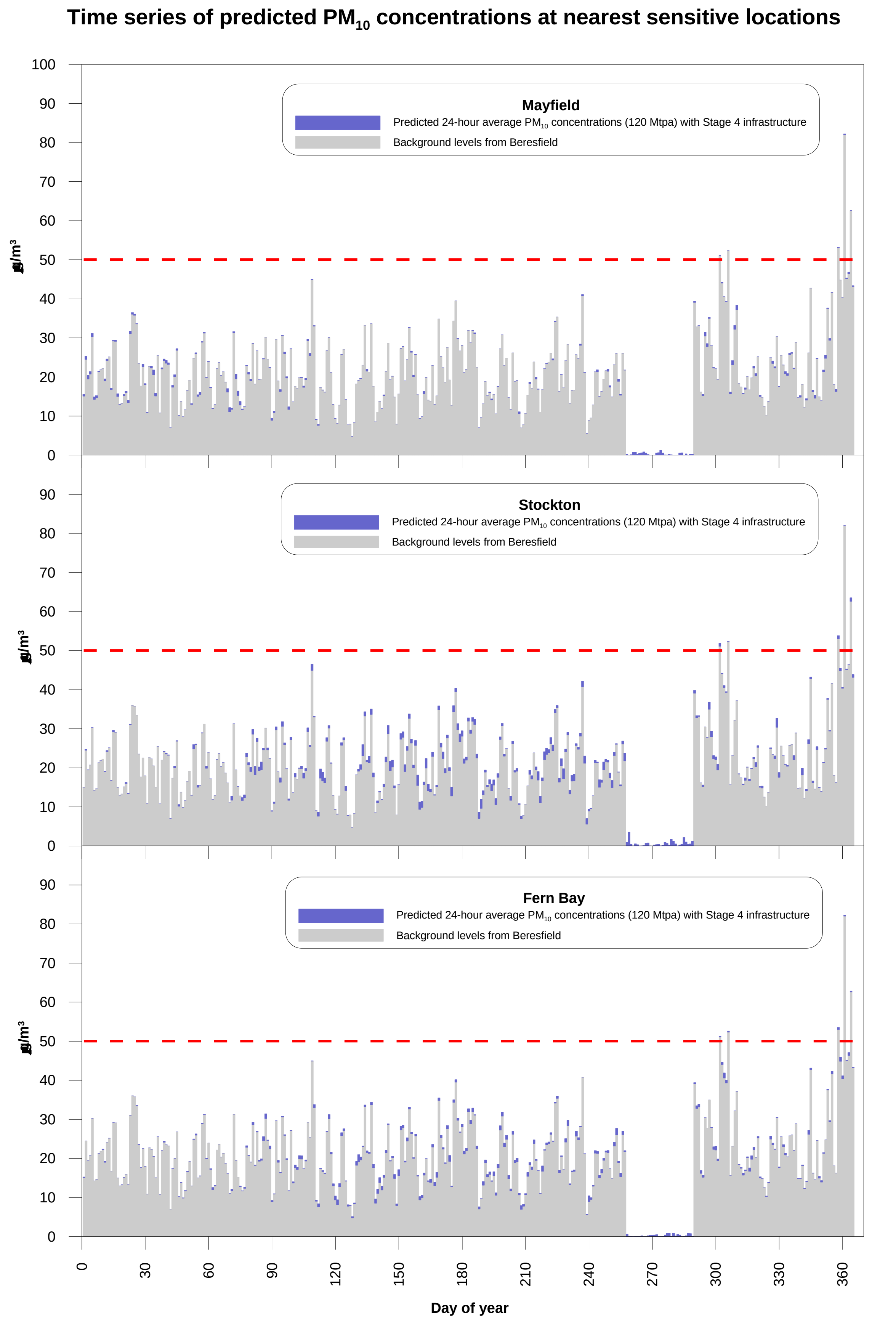

Figure 8.4: Time series of predicted PM_{10}.concentration at nearest sensitive locations

Table 8.2 summarises the dispersion model results for 24-hour average PM_{10} concentrations at the selected sensitive receptor locations. The top 10 background levels and predicted PM_{10} increments are shown.

Table 8.2 : Summary of dispersion model results for PM_{10} at sensitive receptors

Date	Background levels ranked			Model predictions ranked			
	Beresfield PM_{10} – RANKED	Increment from KCT	TOTAL cumulative impact	Date	Beresfield PM_{10}	Increment from KCT - RANKED	TOTAL cumulative impact
Mayfield receptor ($\mu g/m^3$)							
27/12/2001	82.0	0.21	82.2	3/02/2001	20.5	1.30	21.8
30/12/2001	62.6	0.00	62.6	1/10/2001	No data	1.24	1.2
24/12/2001	53.0	0.16	53.2	14/03/2001	19.5	1.22	20.7
2/11/2001	52.3	0.00	52.3	6/11/2001	37.2	1.18	38.4
29/10/2001	51.1	0.00	51.1	15/03/2001	15.2	1.16	16.4
29/12/2001	46.4	0.48	46.8	11/03/2001	11.1	1.09	12.2
28/12/2001	45.1	0.31	45.4	4/11/2001	23.1	1.08	24.2
19/04/2001	44.9	0.03	44.9	22/10/2001	30.5	1.00	31.5
25/12/2001	44.8	0.00	44.8	5/11/2001	32.2	1.00	33.2
30/10/2001	44.0	0.22	44.3	3/01/2001	19.5	0.95	20.4
Stockton receptor ($\mu g/m^3$)							
27/12/2001	82.0	0.00	82.0	16/09/2001	No data	3.61	3.6
30/12/2001	62.6	0.95	63.5	13/05/2001	23.0	2.91	26.0
24/12/2001	53.0	0.80	53.8	08/06/2001	15.5	2.68	18.2
2/11/2001	52.3	0.01	52.4	16/08/2001	17.2	2.56	19.8
29/10/2001	51.1	0.86	52.0	12/06/2001	19.9	2.44	22.4
29/12/2001	46.4	0.03	46.4	25/11/2001	30.4	2.39	32.7
28/12/2001	45.1	0.25	45.3	08/07/2001	9.6	2.38	12.0
19/04/2001	44.9	1.65	46.5	23/04/2001	17.3	2.38	19.7
25/12/2001	44.8	0.68	45.5	26/05/2001	19.3	2.35	21.6
30/10/2001	44.0	0.22	44.3	24/06/2001	12.8	2.26	15.0
Fern Bay receptor ($\mu g/m^3$)							
27/12/2001	82.0	0.29	82.3	11/05/2001	19.1	1.83	21.0
30/12/2001	62.6	0.25	62.8	10/09/2001	26.0	1.70	27.7
24/12/2001	53.0	0.53	53.5	23/06/2001	19.2	1.50	20.8
2/11/2001	52.3	0.26	52.6	30/05/2001	15.6	1.50	17.1
29/10/2001	51.1	0.22	51.3	28/08/2001	8.9	1.49	10.4
29/12/2001	46.4	0.73	47.1	18/08/2001	28.4	1.41	29.8
28/12/2001	45.1	0.08	45.1	6/08/2001	16.7	1.38	18.1
19/04/2001	44.9	0.11	45.0	31/10/2001	40.6	1.34	41.9
25/12/2001	44.8	1.05	45.9	1/05/2001	8.1	1.32	9.4
30/10/2001	44.0	0.55	44.6	22/08/2001	25.7	1.28	27.0

** 0.00 means less than 0.005*

It can be seen from **Table 8.2** that, by this methodology, there are no instances whereby the predicted increment from the KCT causes the total cumulative impact to be above 50 $\mu g/m^3$. This assessment cannot, however, dismiss the possibility of a scenario where the background is close to the goal, say 49 $\mu g/m^3$, with an additional contribution from the KCT of around 2 or 3 μg/m³. The occurrence of any exceedance such as this would be when the background PM_{10} concentrations are already close to the criterion.

The annual average PM_{10} and TSP concentrations from the KCT are considerably lower than the air quality criteria. This allows for some variation to the assumed background levels without changing the conclusions of the assessment.

Therefore, the cumulative impacts of the KCT in relation to the 24 hour PM_{10} criterion are taken to be acceptable.

8.4 Odour Impact Assessment

8.4.1 Odour criteria

The DECCW Approved Methods include ground-level concentration (glc) criterion for complex mixtures of odorous air pollutants. They have been refined by the DECCW to take account of population density in the area. **Table 8.3** lists the odour glc criterion to be exceeded not more than 1% of the time, for different population densities.

The difference between odour goals is based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level there will be a wide range of responses in the population exposed to the odour. In a densely populated area there will therefore be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area.

The PWCS area can be considered as urban. Therefore, as shown in **Table 8.3,** the relevant impact assessment criterion for the facility is 2 ou **(NSW DEC, 2005)**.

Table 8.3: Impact Assessment Criteria for the Assessment of Odourous air pollutants

Population of affected community	Impact Assessment Criteria for Complex Mixtures Odorous Air Pollutants (OU, nose-response-time average, 99th percent
≤ ~2	7
~10	6
~30	5
~125	4
~500	3
Urban (2000) and/or schools and hospitals	2

8.4.2 Estimation of odour emissions

The KCT operates a small sewage treatment plant within the site, which acts as the main and only source of odour. The design/setup of this plant is quite simple with only one processing tank and several balance ponds. The main source of odour from this operation is the processing tank. Since no odour measurement data are available, odour emissions from the processing tank were estimated using odour measurement data from conventional sewage treatment plant (**Holmes Air Sciences, 2004**). As a conservative approach, the highest specific odour emission rate of 4.29 ou.m³/s/m² from the conventional sewage treatment plant sources (listed in **Table 8.4**) was used in estimating odour emission from the processing tank.

Table 8.4: Measured odour emission rate from a conventional sewage treatment plant

Odour source	Specific odour emission rate ($ou.m^3/s/m^2$)
Inlet works	4.29
Oxidation ditch	0.23
Secondary clarifier	0.03
Sludge lagoon	0.62
Biosolids Stockpile	0.05

Table 8.5: Estimated emission from the KCT sewage treatment plant

Source name	Area (m^2)	Specific odour emission rate ($ou.m^3/s/m^2$)	Nose response odour emission rate ($ou.m^3/s$)*
Processing tank	28.27	4.29	279

* A peak to mean ratio of 2.3 was applied as a conservative approach. Definition and selection of peak to mean ratio has been provided in **Appendix C.**

Table 8.5 shows the estimated emission from the sewage treatment plant located at the KCT. Using the highest emission rate, the total specific odour emission from the activities related to this plant is 4.29 $ou.m^3/s/m^2$, which is very small when compared to a typical waste treatment plant (range between 1500 to 2000 $ou.m^3/s/m^2$). The odour emission rate from this sewage treatment plant is too low to create any impact in the surrounding areas of the KCT.

It can be concluded that odour emissions from the sewage treatment plant located at KCT will not cause any odour nuisance.

9 CONCLUSIONS

This report has assessed the air quality impacts associated with the proposed new dump station, transfer station and ship loader at the PWCS KCT associated with the Stage 4 Project. Dispersion modelling has been used to assess the impact of dust emissions on the local air quality. It is concluded that air quality impacts are at acceptable levels and that air quality criteria would not be exceeded at sensitive receptors due to this operation.

The KCT operations employ a large range of dust control measures and safeguards to ensure that off-site air quality is not adversely affected. The available emission factors are somewhat limited in the amount of detail that can be included for activities with very specific dust control measures. Thus, the estimated dust emissions were taken to be conservative (that is, are a higher estimation than with detailed control measures assumed).

The modelling indicated that the contribution of dust emissions from the additional infrastructure associated with the proposed Stage 4 Project are small and existing dust concentrations and deposition levels will remain below relevant DECCW criteria at surrounding residential locations. The project will not cause cumulative dust concentration or dust deposition levels to exceed relevant criteria, except under extreme circumstances when regional dust levels are already very close to the criteria. These circumstances may include dust storms or bushfires.

Air quality monitoring data have indicated that existing short-term dust concentrations are above air quality criteria on occasions. Particulate matter concentrations arising from non-project related sources, such as bushfires and dust storms, may continue to result in elevated levels on occasions.

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APPENDIX A

JOINT WIND SPEED, WIND DIRECTION AND STABILITY CLASS FREQUENCY TABLE

Steel Rive data - 2001
STATISTICS FOR FILE: C:\Jobs\NCIG\metdata\SteelRiver\sr2001.aus
MONTHS: All
HOURS : All
OPTION: Frequency

PASQUILL STABILITY CLASS 'A'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000571	0.001256	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.001941
NE	0.000342	0.001142	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.001712
ENE	0.000342	0.001142	0.000685	0.000000	0.000000	0.000000	0.000000	0.000000	0.002169
E	0.000114	0.000571	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
ESE	0.000342	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001826
SE	0.000000	0.000571	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000799
SSE	0.000228	0.000571	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
S	0.000228	0.000685	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
SSW	0.000114	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000342
SW	0.000457	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001027
WSW	0.000913	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001256
W	0.000913	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001370
WNW	0.000913	0.002169	0.000000	0.000114	0.000000	0.000000	0.000000	0.000000	0.003196
NW	0.000913	0.001484	0.000228	0.000114	0.000000	0.000000	0.000000	0.000000	0.002740
NNW	0.001826	0.001598	0.000114	0.000114	0.000000	0.000000	0.000000	0.000000	0.003653
N	0.001370	0.001712	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003082
CALM									0.000342
TOTAL	0.009589	0.015982	0.001941	0.000342	0.000000	0.000000	0.000000	0.000000	0.028196

MEAN WIND SPEED (m/s) = 1.92
NUMBER OF OBSERVATIONS = 247

PASQUILL STABILITY CLASS 'B'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000114	0.001027	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.001256
NE	0.000114	0.000457	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
ENE	0.000000	0.001256	0.000685	0.000000	0.000000	0.000000	0.000000	0.000000	0.001941
E	0.000000	0.000799	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.001027
ESE	0.000000	0.000571	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
SE	0.000000	0.000685	0.000228	0.000228	0.000000	0.000000	0.000000	0.000000	0.001142
SSE	0.000228	0.000571	0.000228	0.000114	0.000000	0.000000	0.000000	0.000000	0.001142
S	0.000114	0.000228	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000685
SSW	0.000114	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000457
SW	0.000000	0.000913	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
WSW	0.000114	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000571
W	0.000457	0.000457	0.000114	0.000000	0.000000	0.000000	0.000000	0.000000	0.001027
WNW	0.000571	0.001370	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.002511
NW	0.000342	0.001142	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.001941
NNW	0.000228	0.002626	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.003425
N	0.000228	0.000685	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
CALM									0.000000
TOTAL	0.002626	0.013584	0.004224	0.000342	0.000000	0.000000	0.000000	0.000000	0.020776

MEAN WIND SPEED (m/s) = 2.46
NUMBER OF OBSERVATIONS = 182

PASQUILL STABILITY CLASS 'C'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000342	0.000913	0.000457	0.000228	0.000000	0.000000	0.000000	0.000000	0.001941
NE	0.000000	0.001712	0.000685	0.000000	0.000000	0.000000	0.000000	0.000000	0.002397
ENE	0.000114	0.001484	0.001142	0.000114	0.000000	0.000000	0.000000	0.000000	0.002854
E	0.000000	0.000342	0.001712	0.000342	0.000000	0.000000	0.000000	0.000000	0.002397
ESE	0.000000	0.000799	0.002626	0.001370	0.000000	0.000000	0.000000	0.000000	0.004795
SE	0.000114	0.000685	0.002283	0.001256	0.000000	0.000000	0.000000	0.000000	0.004338
SSE	0.000228	0.001027	0.001941	0.001142	0.000000	0.000000	0.000000	0.000000	0.004338
S	0.000114	0.000685	0.001941	0.000342	0.000000	0.000000	0.000000	0.000000	0.003082
SSW	0.000000	0.000685	0.000228	0.000114	0.000000	0.000000	0.000000	0.000000	0.001027
SW	0.000000	0.001598	0.000913	0.000571	0.000000	0.000000	0.000000	0.000000	0.003082
WSW	0.000000	0.000913	0.000457	0.000571	0.000000	0.000000	0.000000	0.000000	0.001941
W	0.000457	0.001484	0.001027	0.000342	0.000000	0.000000	0.000000	0.000000	0.003311
WNW	0.001256	0.001598	0.002055	0.000685	0.000000	0.000000	0.000000	0.000000	0.005594
NW	0.000457	0.003311	0.001027	0.000342	0.000000	0.000000	0.000000	0.000000	0.005137
NNW	0.001142	0.003539	0.000799	0.000342	0.000000	0.000000	0.000000	0.000000	0.005822
N	0.000685	0.001370	0.001027	0.000114	0.000000	0.000000	0.000000	0.000000	0.003196
CALM									0.000000
TOTAL	0.004909	0.022146	0.020320	0.007877	0.000000	0.000000	0.000000	0.000000	0.055251

MEAN WIND SPEED (m/s) = 3.20
NUMBER OF OBSERVATIONS = 484

PASQUILL STABILITY CLASS 'D'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.003767	0.002968	0.000913	0.000342	0.000000	0.000000	0.000000	0.000000	0.007991
NE	0.002626	0.005822	0.002626	0.001484	0.000913	0.000114	0.000000	0.000000	0.013584
ENE	0.000913	0.006507	0.004795	0.006621	0.003767	0.000457	0.000000	0.000000	0.023059
E	0.000799	0.004795	0.006164	0.017466	0.012671	0.005822	0.000799	0.000000	0.048516
ESE	0.000571	0.002854	0.010616	0.013584	0.007420	0.002511	0.000799	0.000114	0.038470
SE	0.000342	0.005708	0.009932	0.010731	0.005251	0.000571	0.000000	0.000000	0.032534
SSE	0.000457	0.007306	0.010274	0.009475	0.004110	0.000457	0.000114	0.000000	0.032192
S	0.001484	0.006735	0.010845	0.013356	0.009703	0.003311	0.001027	0.000228	0.046689
SSW	0.001142	0.006393	0.011530	0.012785	0.005594	0.001941	0.000000	0.000000	0.039384
SW	0.001256	0.007192	0.009018	0.011986	0.005822	0.002854	0.000000	0.000114	0.038242
WSW	0.003425	0.007078	0.003311	0.002169	0.001484	0.000228	0.000114	0.000000	0.017808
W	0.008219	0.010616	0.004566	0.004452	0.002397	0.001027	0.000228	0.000000	0.031507
WNW	0.011187	0.017352	0.013584	0.014041	0.009817	0.004110	0.002968	0.000685	0.073744
NW	0.007078	0.018721	0.014612	0.008904	0.007648	0.003539	0.001598	0.001712	0.063813
NNW	0.003196	0.010160	0.006735	0.001941	0.000913	0.000342	0.000000	0.000000	0.023288
N	0.001941	0.002854	0.001027	0.000342	0.000000	0.000000	0.000000	0.000000	0.006164
CALM									0.001712
TOTAL	0.048402	0.123059	0.120548	0.129680	0.077511	0.027283	0.007648	0.002854	0.538699

MEAN WIND SPEED (m/s) = 4.34
NUMBER OF OBSERVATIONS = 4719

PASQUILL STABILITY CLASS 'E'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.002283	0.003082	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.005594
NE	0.002055	0.009817	0.004795	0.000571	0.000000	0.000000	0.000000	0.000000	0.017237
ENE	0.002169	0.006393	0.011187	0.002283	0.000000	0.000000	0.000000	0.000000	0.022032
E	0.000457	0.013927	0.010616	0.001256	0.000000	0.000000	0.000000	0.000000	0.026256
ESE	0.000342	0.003196	0.005936	0.000913	0.000000	0.000000	0.000000	0.000000	0.010388
SE	0.001027	0.004224	0.002397	0.000571	0.000000	0.000000	0.000000	0.000000	0.008219
SSE	0.001027	0.003082	0.000457	0.000114	0.000000	0.000000	0.000000	0.000000	0.004680
S	0.000913	0.002626	0.002397	0.000799	0.000000	0.000000	0.000000	0.000000	0.006735
SSW	0.000799	0.005708	0.005479	0.000799	0.000000	0.000000	0.000000	0.000000	0.012785
SW	0.002854	0.012671	0.013014	0.002740	0.000000	0.000000	0.000000	0.000000	0.031279
WSW	0.003881	0.009475	0.002283	0.000000	0.000000	0.000000	0.000000	0.000000	0.015639
W	0.007877	0.012329	0.002397	0.000457	0.000000	0.000000	0.000000	0.000000	0.023059
WNW	0.008333	0.025000	0.015982	0.002397	0.000000	0.000000	0.000000	0.000000	0.051712
NW	0.007420	0.016210	0.006735	0.001484	0.000000	0.000000	0.000000	0.000000	0.031849
NNW	0.003196	0.005708	0.000457	0.000114	0.000000	0.000000	0.000000	0.000000	0.009475
N	0.001941	0.001370	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.003767
CALM									0.004452
TOTAL	0.046575	0.134817	0.084817	0.014498	0.000000	0.000000	0.000000	0.000000	0.285160

MEAN WIND SPEED (m/s) = 2.63
NUMBER OF OBSERVATIONS = 2498

PASQUILL STABILITY CLASS 'F'

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.000913	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001370
NE	0.001712	0.001370	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003082
ENE	0.001142	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001370
E	0.001484	0.001598	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003082
ESE	0.000571	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001027
SE	0.001142	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001484
SSE	0.000685	0.000228	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000913
S	0.000913	0.000571	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001484
SSW	0.001712	0.000457	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002169
SW	0.002055	0.002283	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004338
WSW	0.003995	0.002511	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006507
W	0.007192	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008676
WNW	0.008447	0.001826	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010274
NW	0.004452	0.003767	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008219
NNW	0.002397	0.000913	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003311
N	0.002511	0.000342	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002854
CALM									0.011758
TOTAL	0.041324	0.018836	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.071918

MEAN WIND SPEED (m/s) = 1.22
NUMBER OF OBSERVATIONS = 630

ALL PASQUILL STABILITY CLASSES

Wind Speed Class (m/s)

WIND SECTOR	0.50 TO 1.50	1.50 TO 3.00	3.00 TO 4.50	4.50 TO 6.00	6.00 TO 7.50	7.50 TO 9.00	9.00 TO 10.50	GREATER THAN 10.50	TOTAL
NNE	0.007991	0.009703	0.001826	0.000571	0.000000	0.000000	0.000000	0.000000	0.020091
NE	0.006849	0.020320	0.008676	0.002055	0.000913	0.000114	0.000000	0.000000	0.038927
ENE	0.004680	0.017009	0.018493	0.009018	0.003767	0.000457	0.000000	0.000000	0.053425
E	0.002854	0.022032	0.018950	0.019064	0.012671	0.005822	0.000799	0.000000	0.082192
ESE	0.001826	0.009361	0.019521	0.015868	0.007420	0.002511	0.000799	0.000114	0.057420
SE	0.002626	0.012215	0.015068	0.012785	0.005251	0.000571	0.000000	0.000000	0.048516
SSE	0.002854	0.012785	0.013014	0.010845	0.004110	0.000457	0.000114	0.000000	0.044178
S	0.003767	0.011530	0.015525	0.014498	0.009703	0.003311	0.001027	0.000228	0.059589
SSW	0.003881	0.013813	0.017237	0.013699	0.005594	0.001941	0.000000	0.000000	0.056164
SW	0.006621	0.025228	0.022945	0.015297	0.005822	0.002854	0.000000	0.000114	0.078881
WSW	0.012329	0.020776	0.006050	0.002740	0.001484	0.000228	0.000114	0.000000	0.043721
W	0.025114	0.026826	0.008105	0.005251	0.002397	0.001027	0.000228	0.000000	0.068950
WNW	0.030708	0.049315	0.032192	0.017237	0.009817	0.004110	0.002968	0.000685	0.147032
NW	0.020662	0.044635	0.023059	0.010845	0.007648	0.003539	0.001598	0.001712	0.113699
NNW	0.011986	0.024543	0.008676	0.002511	0.000913	0.000342	0.000000	0.000000	0.048973
N	0.008676	0.008333	0.002511	0.000457	0.000000	0.000000	0.000000	0.000000	0.019977
CALM									0.018265
TOTAL	0.153425	0.328425	0.231849	0.152740	0.077511	0.027283	0.007648	0.002854	1.000000

MEAN WIND SPEED (m/s) = 3.46
NUMBER OF OBSERVATIONS = 8760

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 2.8%
B : 2.1%
C : 5.5%
D : 53.9%
E : 28.5%
F : 7.2%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0125	0188	0052
02	0000	0000	0000	0129	0179	0057
03	0000	0000	0000	0126	0179	0060
04	0000	0000	0000	0105	0189	0071
05	0000	0000	0000	0131	0175	0059
06	0003	0005	0012	0161	0151	0033
07	0011	0007	0024	0220	0089	0014
08	0012	0020	0046	0287	0000	0000
09	0025	0018	0054	0268	0000	0000
10	0038	0024	0056	0247	0000	0000
11	0045	0022	0072	0226	0000	0000
12	0041	0025	0068	0231	0000	0000
13	0035	0026	0050	0254	0000	0000
14	0022	0019	0048	0276	0000	0000
15	0008	0013	0033	0311	0000	0000
16	0006	0000	0017	0320	0021	0001
17	0001	0003	0004	0275	0073	0009
18	0000	0000	0000	0192	0154	0019
19	0000	0000	0000	0158	0174	0033
20	0000	0000	0000	0141	0189	0035
21	0000	0000	0000	0123	0200	0042
22	0000	0000	0000	0136	0182	0047
23	0000	0000	0000	0136	0179	0050
24	0000	0000	0000	0141	0176	0048

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0019	0028	0065	1183	2393	0624
<=1000 m	0134	0097	0249	1544	0029	0002
<=1500 m	0094	0057	0170	1694	0076	0004
<=2000 m	0000	0000	0000	0225	0000	0000
<=3000 m	0000	0000	0000	0069	0000	0000
>3000 m	0000	0000	0000	0004	0000	0000

MIXING HEIGHT BY HOUR OF DAY

Hour	0000 to 0100	0100 to 0200	0200 to 0400	0400 to 0800	0800 to 1600	1600 to 3200	Greater than 3200
01	0070	0167	0028	0053	0033	0014	0000
02	0068	0165	0031	0048	0039	0014	0000
03	0079	0157	0032	0051	0033	0013	0000
04	0090	0161	0033	0036	0032	0013	0000
05	0129	0134	0026	0043	0024	0009	0000
06	0087	0136	0099	0017	0016	0010	0000
07	0118	0057	0115	0075	0000	0000	0000
08	0000	0058	0127	0180	0000	0000	0000
09	0000	0000	0089	0192	0084	0000	0000
10	0000	0000	0000	0233	0132	0000	0000
11	0000	0000	0000	0136	0229	0000	0000
12	0000	0000	0000	0092	0273	0000	0000
13	0000	0000	0000	0000	0365	0000	0000
14	0000	0000	0000	0000	0365	0000	0000
15	0000	0000	0000	0000	0365	0000	0000
16	0000	0000	0000	0000	0365	0000	0000
17	0008	0026	0006	0017	0305	0003	0000
18	0022	0099	0017	0024	0190	0013	0000
19	0033	0158	0031	0036	0073	0034	0000
20	0038	0172	0022	0053	0058	0022	0000
21	0057	0171	0028	0043	0046	0019	0001
22	0063	0160	0021	0067	0037	0017	0000
23	0066	0159	0029	0051	0042	0018	0000
24	0064	0153	0032	0065	0035	0016	0000

APPENDIX B

Estimated Emissions

B.1 ESTIMATED DUST EMISSIONS : PWCS KOORAGANG COAL TERMINAL

B.1.1 Loading, unloading and transferring material

The dust emission from this activity will depend on wind speed according to the **US EPA (1985 and updates)** emission factor equation. This means that the emissions will vary with wind speed. The actual emission is given by Equation 1.

Equation 1

$$E_{TSP} = k \times 0.0016 \times \left(\frac{\left(\frac{U}{2.2}\right)^{1.3}}{\left(\frac{M}{2}\right)^{1.4}} \right) \quad kg/t$$

where,

$E_{TSP} = TSP\ emissions$

$k = 0.74$

$U = wind\ speed (m/s)$

$M = moisture\ content (\%)$

$[where\ 0.25 \le M \le 4.8]$

In cases where transfer points include some form of enclosure a reduction to emissions of 70% (Table 3 of **NPI, 2001**) has been used.

B.1.2 Wind erosion from exposed areas and stockpiles

The emission factor for wind erosion is given in Equation 2 below.

Equation 2

$$E_{TSP} = 1.9 \times \left(\frac{s}{1.5}\right) \times \left(\frac{365 - p}{235}\right) \times \left(\frac{f}{15}\right) \quad kg/ha/day$$

Where,
s = silt content (%)
p = number of raindays per year, and
f = percentage of the time that wind speed is above 5.4 m/s

B.1.3 Diesel train exhausts

The emission factor was taken to be 0.034 kg/h for a locomotive in notch 1 (**Lilley, 1996**)

Table B.1: Estimated emission for 120 Mtpa operations

ACTIVITY (120 Mtpa)	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Trains unloading to unloading station	11702	120000000	t/y	0.00010	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	8	moisture content (%)	-	bcm
1st transfer between unloading station and stockpiles	11702	120000000	t/y	0.00010	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	8	moisture content (%)	-	bcm
2nd transfer between unloading station and stockpiles	11702	120000000	t/y	0.00010	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	8	moisture content (%)	-	bcm
Stacking to coal stockpiles	39006	120000000	t/y	0.00033	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	8	moisture content (%)	-	bcm
Reclaiming coal from stockpiles	33077	120000000	t/y	0.00028	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)	-	bcm
1st transfer between stockpile and shiploader	9923	120000000	t/y	0.00008	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)	-	bcm
2nd transfer between stockpile and shiploader	9923	120000000	t/y	0.00008	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)	-	bcm
New transfer between stockpile and shiploader	2481	30000000	t/y	0.00008	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)	-	bcm
Transfer to buffer bins (enclosed)	0										
3rd transfer between stockpile and shiploader	33077	120000000	t/y	0.00028	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)	-	bcm
Loading coal to ships	9923	120000000	t/y	0.00008	kg/t	1.912	average of (wind speed/2.2)^1.3 in m/s	9	moisture content (%)	-	bcm

ACTIVITY (120 Mtpa)	TSP (kg/y)	Intensity	Units	Emission factor	Units	Variable 1	Units	Variable 2	Units	Variable 3	Units
Wind erosion from stockpiles and exposed areas	197722	96	ha	2057.8	kg/ha/y	133	Average number of raindays	4	silt content in %	16.9064	% of winds above 5.4 m/s
Diesel train exhausts	894	8760	h/y	0.034	kg/h	4	No locos				

A summary of dust emission estimates for each activity, activity type, location of emission sources and activity hours are provided below.

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-------------------------------      23-Jul-2008 12:32
  DUST EMISSION CALCULATIONS V2
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 Output emissions file  : C:\Jobs\PWCS_KCT\ausplume\120_new\emiss_120new.src
 Meteorological file    : C:\Jobs\PWCS_KCT\metdata\SteelRiver\sr2001.aus
 Number of dust sources : 23
 Number of activities   : 13
 No-blast conditions    : None
 Wind sensitive factor  : 1.912 (1.912 adjusted for activity hours)
 Wind erosion factor    : 89.468

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : Trains unloading to unloading station
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 11702 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : 1st transfer between unloading station and stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 11702 kg/y
 FROM SOURCES  : 1
2
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : 2nd transfer between unloading station and stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 11702 kg/y
 FROM SOURCES  : 2
3 4
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Stacking to coal stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 39006 kg/y
 FROM SOURCES  : 12
5 6 7 8 9 10 11 12 13 14 15 16
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Reclaiming coal from stockpiles
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 33077 kg/y
 FROM SOURCES  : 12
5 6 7 8 9 10 11 12 13 14 15 16
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : 1st transfer between stockpile and shiploader
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 9923 kg/y
 FROM SOURCES  : 2
3 4
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : 2nd transfer between stockpile and shiploader
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 9923 kg/y
 FROM SOURCES  : 1
17
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : New transfer between stockpile and shiploader
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 2481 kg/y
 FROM SOURCES  : 1
```

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21
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1


 ACTIVITY NAME : Transfer to buffer bins (enclosed)
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 0 kg/y
 FROM SOURCES  : 1
17
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : 3rd transfer between stockpile and shiploader
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 33077 kg/y
 FROM SOURCES  : 1
22
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Loading coal to ships
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 9923 kg/y
 FROM SOURCES  : 4
18 19 20 23
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Wind erosion from stockpiles and exposed areas
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 197722 kg/y
 FROM SOURCES  : 12
5 6 7 8 9 10 11 12 13 14 15 16
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1

 ACTIVITY NAME : Diesel train exhausts
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 1191 kg/y
 FROM SOURCES  : 1
1
 HOURS OF DAY  :
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
```