APPENDIX 10

Air Quality Assessment

AIR QUALITY IMPACT ASSESSMENT:
MT ARTHUR COAL SOUTH PIT EXTENSION PROJECT

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Prepared for
Umwelt (Australia) Pty Limited

by

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1. INTRODUCTION

This report has been prepared by Holmes Air Sciences for Umwelt (Australia) Pty Limited (Umwelt). It provides an assessment of air quality impacts associated with the Mt Arthur Coal South Pit Extension Project (SPE) ("the Project"). Umwelt is preparing an Environmental Assessment (EA) for the Project.

The assessment is based on a conventional approach following the procedures outlined by the NSW Department of Environment and Conservation (DEC). The DEC guidance document is titled "Approved Methods for the Modelling and Assessment of Air Pollutants in NSW" (**DEC, 2005**).

The assessment uses a computer-based dispersion model to predict ground-level dust concentrations and deposition levels due to the SPE operations. Model predictions have been compared to relevant air quality goals to assess the effect that the Project would have on the existing air quality environment.

The extent of air quality impacts associated with the approved MAN mining area, which forms part of the Mt Arthur Coal operations, was predicted as part of the MAN Environmental Impact Statement (EIS) (**URS, 2000**). An objective of the current study was to compare the impacts of MAN including SPE with impacts presented in the original EIS in addition to predicting the project specific impacts.

In summary, the report provides information on the following:

- Proposed mining operations;
- Air quality goals relevant for this Project;
- Meteorological and climatic conditions in the area;
- Methods used to estimate dust emissions from the mine;
- Expected dispersion and dust fallout patterns due to emissions from the Project; and
- Comparisons of current predictions with EIS predictions.

2. PROJECT DESCRIPTION

The Mt Arthur Coal mine is located approximately five kilometres to the south of Muswellbrook in the upper Hunter Valley of NSW. Mt Arthur Coal are seeking approval to extend and modify activities associated with the currently approved South Pit area.

Figure 1 shows the extent of the approved MAN mining operations as well as the proposed SPE and overburden emplacement areas. Terrain in the study area is shown by **Figure 2**.

The MAN South Pit was approved as part of Mt Arthur Coal's MAN Coal Mine in 2001. The proposed SPE project will extend the existing approved South Pit further south into the Bayswater No. 3 mining lease (ML) increasing resource recovery from within Mt Arthur Coal's existing ML areas. The project will result in the recovery of an additional approximately 25 million tonnes of run-of-mine (ROM) coal over the proposed 21 year project life. The majority of overburden extracted from within the extended South Pit will be emplaced in the Bayswater

No. 2 mining area and also within the neighbouring Drayton West Pit. Coal from the SPE area will be hauled to the existing MAN coal handling and preparation plant (CHPP) for processing and transportation. There will be no changes to the existing CHPP facilities as part of the Project.

Table 1 shows the proposed material volumes and tonnages associated with the SPE area for selected years of operation. These years have formed the basis of the dispersion modelling undertaken in this study.

Table 1 : Material volumes and tonnages associated with the SPE Project

Operational year	Volume of overburden from SPE area (BCM*)	Overburden emplaced at Bayswater No. 2 (BCM)	ROM coal from SPE area (t)
MAN Year 10 / SPE Year 5	6,000,000	12,500,000	1,275,000
MAN Year 15 / SPE Year 10	7,000,000	13,700,000	1,490,000
MAN Year 21 / SPE Year 15	6,000,000	12,500,000	1,275,000

** BCM: Bank cubic metres*

Table 2 shows the material volumes and tonnages from the entire MAN site. These data represent the SPE area in addition to the material quantities prescribed in the MAN EIS. These data have been used for generating predictions to compare with the original MAN predictions.

Table 2 : Material volumes and tonnages from MAN including SPE

Operational year	Total overburden (BCM*)	Total ROM coal (t)
MAN Year 10 / SPE Year 5	67,302,000	15,356,000
MAN Year 15 / SPE Year 10	65,205,200	15,491,700
MAN Year 21 / SPE Year 15	64,535,800	14,883,900

** BCM: Bank cubic metres*

3. AIR QUALITY GOALS

Table 3 and **Table 4** summarise the current air quality assessment criteria noted by the DEC. The air quality goals relate to the total dust burden in the air and not just the dust from the project. In other words, some consideration of background levels needs to be made when using these goals to assess impacts. The estimation of appropriate background levels will be discussed further in **Section 4.3**.

Table 3 : DEC assessment criteria for particulate matter concentrations

POLLUTANT	STANDARD / GOAL	AVERAGING PERIOD	AGENCY
Total suspended particulate matter (TSP)	90 µg/m^3	Annual mean	National Health & Medical Research Council
Particulate matter < 10 µm (PM_{10})	50 µg/m^3	24-hour maximum*	DEC
	30 µg/m^3	Annual mean	DEC long-term reporting goal
	50 µg/m^3	(24-hour average, 5 exceedances permitted per year)	National Environment Protection Council

** For coal mining operations in rural areas, this goal is taken to be non-cumulative for assessment purposes, provided the mine operates with best-practice dust control measures.*

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces. **Table 4** shows the maximum acceptable increase in dust deposition over the existing dust levels. The criteria for dust fallout levels are set to protect against nuisance impacts (**DEC, 2005**).

Table 4 : DEC 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

Table 5 shows the MAN development consent air quality goals and standards. Again, these levels relate to the total dust burden in the air and not just the dust from the MAN mining area.

Table 5 : Development consent air quality standards/goals for MAN

<table>
<tr><th>POLLUTANT</th><th>STANDARD / GOAL</th><th>AVERAGING PERIOD</th><th>AGENCY</th></tr>
<tr><td>Total suspended particulate matter (TSP)</td><td>90 µg/m³</td><td>Annual mean</td><td>NHMRC</td></tr>
<tr><td rowspan="2">Particulate matter < 10 µm (PM10)</td><td>150 µg/m³</td><td>24-hour maximum (average of 99th percentile of 24-hour averages over three years)</td><td>US EPA</td></tr>
<tr><td>50 µg/m³</td><td>Annual mean</td><td>US EPA</td></tr>
<tr><td colspan="4">NSW EPA amenity based criteria for dust fallout</td></tr>
<tr><td rowspan="2">Existing dust fallout level (g/m²/month)</td><td colspan="3">Maximum acceptable increase over existing fallout levels (g/m²/month)</td></tr>
<tr><td colspan="2">Residential</td><td>Other</td></tr>
<tr><td>2</td><td colspan="2">2</td><td>2</td></tr>
<tr><td>3</td><td colspan="2">1</td><td>2</td></tr>
<tr><td>4</td><td colspan="2">0</td><td>1</td></tr>
</table>

It can be seen that the current DEC goals (from **Table 3** and **Table 4**) are now more stringent than the MAN development consent goals (**Table 5**). Most notably, the maximum 24-hour average PM_{10} goal was reduced from 150 µg/m^3 to 50 µg/m^3 and the annual average PM_{10} goal was reduced from 50 µg/m^3 to 30 µg/m^3. The decrease from 150 µg/m^3 to 50 µg/m^3 is not as stringent as it first appears as the 150 µg/m^3 relates to the total dust and the 50 µg/m^3 to project dust.

The DEC criteria for dust fallout is now a maximum increase of 2 g/m^2/month and a maximum total level of 4 g/m^2/month, consistent with the consent criteria for residential receptors.

4. EXISTING ENVIRONMENT

This section describes the dispersion meteorology and local climatic conditions in the area.

4.1 Dispersion Meteorology

The Gaussian dispersion model used for this assessment, ISCST3, requires information about the dispersion characteristics of the area. In particular, data are required on wind speed, wind direction, atmospheric stability class[1] and mixing height[2]. Two meteorological sites have been sourced for the purposes of this study.

Macquarie Generation has collected meteorological data near the mine (see **Figure 1** for location). As part of the MAN EIS, these data were processed into a form suitable for the ISCST3 dispersion model and data for the period November 1995 to October 1996 are available. However, only 81% of the data potentially available in a year were recorded whereas the DEC now specify a requirement for one year of data to be at least 90% complete for dispersion modelling purposes. Therefore, an alternative weather data set from the Macquarie Generation data has been sourced for the project specific modelling. In this study the Macquarie Generation data have, however, been used for comparing predictions made in the MAN EIS for consistency.

A meteorological station was installed by Holmes Air Sciences in July 1999 specifically for the MAN coal mine project and operations. This station is located to the south of Denman Road and in the north of the MAN mining lease boundary (see **Figure 1**). The site is referred to as McLeans Hill and the weather station logs 10-minute records of temperature, wind speed, wind direction and sigma-theta (a measure of fluctuation in the horizontal wind direction) among other parameters. Data for 2004 are available for the purposes of this study and during this year there were 8328 hours of data collected. This represents 95% data recovery.

Windroses generated from the 1995/1996 Macquarie Generation data are presented in **Figure 3**. It can be seen from this figure that, annually, the most common winds were from the SE. In winter the most common winds are from the NW while winds from the SE prevail in summer. This pattern of winds is typical of conditions in the upper Hunter Valley. The average wind speed for the 1995/1996 dataset was 3.6 m/s.

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[1] 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.

[2] 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 shows annual and seasonal windroses for McLeans Hill in 2004. The pattern of winds at this site in 2004 was very similar to that measured at the Macquarie Generation site. This may be expected given that the sites are less than two kilometres from each other and there is no significant intervening terrain. The average wind speed in 2004 was 3.3 m/s.

To use the wind data to assess dispersion, it is necessary to also have available data on atmospheric stability. For the Macquarie Generation and McLeans Hill data, a stability class was assigned to each hour of the meteorological data using sigma-theta according to the method recommended by the US EPA (**US EPA, 1986**). **Table 6** shows the frequency of occurrence of the stability categories expected in the area.

The most common stability class for both locations was determined to be D class. This would suggest that the dispersion conditions are such that dust emissions disperse rapidly for a significant proportion of the time.

Table 6 : Frequency of occurrence of stability classes in the study area

Stability Class	Macquarie Generation site (1995/1996 data)	McLeans Hill site (2004 data)
A	15.4	9.1
B	4.5	4.1
C	7.2	9.0
D	43.7	53.2
E	13.6	18.5
F	15.7	6.1
Total	100	100

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.

Given that there was over 90% data capture for a continuous year from the McLeans Hill site, these data were considered more suitable for dispersion modelling purposes than the Macquarie Generation data. The McLeans Hill data were therefore used in the dispersion modelling for the SPE Project.

Joint wind speed, wind direction and stability class frequency tables for the McLeans Hill 2004 data are provided in **Appendix A**.

4.2 Local Climatic Conditions

The Bureau of Meteorology also collects climatic information in the vicinity of the study area. A range of climatic information collected from Jerrys Plains Post Office (located approximately 20 km to the south of Mt Arthur Coal) are presented in **Table 7** (**Bureau of Meteorology, 2005**). Temperature and humidity data consist of monthly averages of 9 am and 3 pm readings. Also presented are monthly averages of maximum and minimum temperatures. Rainfall data consist of mean and median monthly rainfall and the average number of rain days per month.

Table 7 : Climate information for the study area

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Mean 9 am dry-bulb temperature (deg C)	23.3	22.7	21.3	17.9	13.5	10.5	9.2	11.3	15.2	18.9	21.1	23.1	17.3
Mean 9 am wet-bulb temperature (deg C)	19.2	19.3	17.9	14.9	11.5	8.9	7.6	8.9	11.7	14.4	16.2	18.1	14
Mean 9 am humidity (%)	67	72	71	71	77	79	78	72	65	60	59	60	69
Mean 3 pm dry-bulb temperature (deg C)	29.6	28.9	27.1	24.2	20	17.1	16.3	18.2	21.1	23.9	26.8	29	23.5
Mean 3 pm wet-bulb temperature (deg C)	21	21.1	19.6	17.1	14.5	12.2	11.1	12	13.9	16.1	17.8	19.6	16.3
Mean 3 pm relative humidity (%)	46	50	50	47	51	53	50	45	43	43	41	42	47
Mean daily maximum temperature (deg C)	31.8	30.9	29	25.3	21.2	17.9	17.3	19.4	22.8	26.2	29.3	31.4	25.2
Mean daily minimum temperature (deg C)	17.1	17.1	15	10.8	7.4	5.2	3.7	4.4	6.9	10.2	13.1	15.7	10.5
Mean rainfall (mm)	78.2	71.7	58.2	44.7	41.3	45.3	44.3	36.6	41.3	51.9	58.2	67.3	638.8
Median rainfall (mm)	65.5	46	45.7	32.5	29.9	28.8	36.3	30.5	33.8	47.6	48.9	55	644.1
Mean number of rain days	7.9	7.3	7.3	6.3	6.6	7.3	7	7	6.6	7.5	7.6	7.5	86

Climate averages for Station: 061086 JERRYS PLAINS POST OFFICE, Commenced: 1884; Last record: 2004; Latitude (deg S): -32.4972; Longitude (deg E): 150.9093; State: NSW. Source : ***Bureau of Meteorology (2005)***

Temperature data show that January is typically the warmest month with a mean daily maximum of 31.8ºC. July is the coldest month with a mean daily minimum of 3.7ºC.

Rainfall data collected at Jerrys Plains show that January is the wettest month with a mean rainfall of 78 mm over 8 rain days. Annually the area experiences, on average, 639 mm of rain.

4.3 Existing Air Quality

Air quality standards and goals refer to pollutant levels which include the contribution from specific projects and existing sources. To fully assess impacts against all the relevant air quality standards and goals (refer to **Section 3**) it is necessary to have information or estimates on existing dust concentration and deposition levels in the area in which the Project is likely to contribute to these levels.

Dust deposition and dust concentration (PM_{10}) is monitored in the study area. The location of each of the monitoring sites are shown in **Figure 5**. There are eight high volume air samplers, measuring PM_{10}, and 21 dust deposition gauges.

Mt Arthur Coal undertakes a comprehensive review of data from their air quality monitoring network on an annual basis. The most recent reviews were based on data collected in 2004 and 2005 (see **Holmes Air Sciences, 2005 and 2006a**).

4.3.1 Dust Concentration

Table 8 presents the annual average and annual maximum PM_{10} concentrations for each monitoring site in the study area for 2004 and 2005. Also shown in this table are estimates of the annual average TSP concentrations at each site, based on measured PM_{10} concentrations.

Table 8 : Summary of dust concentration data collected in 2004 and 2005

Site	Data collected (% of year)	Annual average PM_{10} ($\mu g/m^3$)	Annual average TSP ($\mu g/m^3$)*	Highest 24-hour PM_{10} ($\mu g/m^3$)	2nd highest 24-hour PM_{10} ($\mu g/m^3$)
2004 data					
Constable	100	18.9	47.3	59	47
Denman Rd West	100	17.9	44.8	48	43
South Muswellbrook	100	28.2	70.5	169 [a]	155 [c]
Sheppard Ave	100	27.5	68.8	63	60
Windmill	98	18.6	46.5	58	50
Edderton	95	14.6	36.5	40	35
Roxburgh South	100	17.3	43.3	50	49
Wire Lane	100	23.0	57.5	110 [b]	58
2005 data					
Constable	100	16.6	41.5	62.7 [d]	49.2
Denman Rd West	98	18.9	47.3	84.5 [e]	71.7 [d]
South Muswellbrook	98	22.4	56.0	60.9	59.3 [f]
Sheppard Ave	100	21.8	54.5	47.4	46.7
Windmill	100	16.3	40.8	59.6 [d]	43.0
Edderton	100	13.4	33.5	42.8	30.6
Roxburgh South	100	15.7	39.3	42.4	32.7
Wire Lane	98	19.4	48.5	57.3	42.3 [d]

* *Estimated from PM_{10} by assuming that monitored annual average PM_{10} levels will be approximately 40% of annual average TSP levels.*

[a] *ash was recorded on the filter paper. Cause unknown.*

[b] *a slight ash odour and discolouration was noted about this measurement. Cause unknown.*

[c] *red dust recorded on filter paper. Most likely cause is cars doing burnouts on the adjacent dirt road.*

[d] *bushfires in the vicinity of the mine.*

[e] *heavy grey dust on filter paper. Likely to be due to do nearby farming activity.*

[f] *heavy red/brown dust, most likely from traffic on adjacent dirt road.*

In 2004 and 2005 the annual average PM_{10} concentrations were below both the development consent goal of 50 $\mu g/m^3$ and also the current DEC assessment criterion of 30 $\mu g/m^3$ at all monitoring locations. The highest level was recorded at the South Muswellbrook site in 2004 with 28.2 $\mu g/m^3$. It can also be seen from **Table 8** that the average PM_{10} concentrations in 2004 were lower than the 2005 records at all sites except Denman Road West where a minor increase (17.9 to 18.9 $\mu g/m^3$) was reported.

Annual average TSP concentrations were derived from the PM_{10} measurements by assuming that 40% of the TSP was PM_{10}. This relationship was obtained from data collected by co-located TSP and PM_{10} monitors operated for reasonably long periods of time in the Hunter Valley (**NSW Minerals Council, 2000**). Use of this relationship indicates that annual average TSP concentrations were below both the development consent goal and DEC assessment criterion of 90 $\mu g/m^3$.

Maximum 24-hour average PM_{10} concentrations above the consent limit of 150 $\mu g/m^3$ have only been recorded at the South Muswellbrook site in 2004. Possible contamination of the samples was reported with the samples above the 150 $\mu g/m^3$ limit.

Many of the monitoring sites have recorded maximum 24-hour average concentrations above the current DEC goal of 50 $\mu g/m^3$. The most recent review of air quality monitoring data

(**Holmes Air Sciences, 2006a**) found that these maxima were generally due to widespread dust events, such as bushfires.

4.3.2 Dust Deposition

Insoluble solids data collected in 2004 and 2005 from the 21 dust deposition gauges are presented in **Table 9**.

Table 9 : Summary of dust deposition data collected in 2004 and 2005

Gauge	Insoluble solids for 2004			Insoluble solids for 2005		
	Data collected (% of year)	Annual average (g/m^2/month)	Maximum monthly deposition (g/m^2/month)	Data collected (% of year)	Annual average (g/m^2/month)	Maximum monthly deposition (g/m^2/month)
DD1	100	2.2	4	83*	2.2	3.6
DD2	100	3.7	6.9	100	**4.6**	8.2
DD3	75	3.8	6.6	100	**4.3**	11.2
DD4	100	1.7	6.3	100	1.7	2.4
DD5	67	**5.0**	14.1	100	3.0	7.3
DD6	100	1.2	1.9	100	1.8	3.8
DD7	50	**5.3**	12	92*	1.8	3.4
DD8	100	1.2	2.7	100	1.3	2.0
DD9	100	1.3	2.8	100	1.1	1.9
DD10	92	2.4	8.3	83*	1.9	3.0
DD11	33	**8.5**	20	92*	**6.0**	11.1
DD12	92	2.7	10.7	100	2.1	6.6
DD13	100	1.8	4.1	100	1.4	3.2
DD14	100	1.2	1.9	100	1.0	1.9
DD15	100	3.0	8.7	100	3.8	14.4
DD16	92	**4.9**	11.3	100	4.0	7.2
DD17	92	**4.1**	9.3	100	2.3	3.0
DD18	100	2.6	4.2	100	2.1	3.1
DD19	100	2.9	8.2	100	2.3	3.2
DD20	100	2.3	2.2	92	3.4	8.5
DD21	75	3.6	3.6	100	2.1	3.2
All sites	**-**	**3.1**	**-**	**-**	**2.6**	**-**

** Comments were attached to the monthly dust deposition data that indicated whether each record was valid or not. The data flagged as "invalid" were not included for the preparation of the table above.*

Overall, the monitoring data from **Table 9** suggest that dust deposition in the area has declined slightly from 2004 to 2005. There were still three of the 21 sites where the annual average dust deposition was above the DEC 4 g/m^2/month total deposited dust goal. These three gauges are all located on Mt Arthur Coal land and are not near to any residential receivers.

Dust deposition measurements generally reflect the influence of activities occurring very close to the monitoring site. The gauges are also particularly susceptible to contamination by bird droppings and insects for example. Thus, the average from all sites has been calculated and included in the table above to provide an indication of annual average fallout levels in the study area.

5. ESTIMATED DUST EMISSIONS

Dust emissions arise from various activities at open-cut coal mines. Total dust emissions due the proposed SPE have been estimated by analysing the activities taking place at the site during selected years of operation.

The operations which apply in each case have been combined with emission factors developed, both locally and by the US EPA, to estimate the amount of dust produced by each activity. This study draws on US EPA emission factors for mining operations that were subject to significant revisions in 2003. The emission factors applied are considered to be the most up to date methods for determining dust generation rates. The fraction of fine, inhalable and coarse particles for each activity has been taken into account for the dispersion modelling.

The assessment has considered three years of mining in the SPE area. These years are SPE Year 5, 10 and 15 which coincide approximately with MAN operations for Year 10, 15 and 21 respectively.

The operational description for the Project has been used to determine haul road distances and routes, stockpile and pit areas, activity operating hours, truck sizes and other details that are necessary to estimate dust emissions for each year.

One objective of this study was to compare the impacts of MAN including SPE with impacts presented in the original EIS. Estimated emissions from the MAN operations (that is, North Pit, Central Pit Upper and Central Pit Lower) have also been determined to allow this comparison. The approach was to take advantage of the emission calculations used in the EIS and replace emissions associated with the South Pit activities with emissions from the proposed SPE activities.

The most significant dust generating activities from the SPE operations have been identified and the dust emission estimates during the three operational years selected are presented below in **Table 10**. Also shown in **Table 10** are emissions from other MAN pits (in italics), as determined for the EIS but without the original South Pit.

Details of the dust emission calculations are presented in **Appendix B**. The estimated emissions take account of proposed air pollution controls including passive controls such as those inbuilt into the mine plan, including stockpile size and alignment and length of haul roads. Active controls such as the intensity of watering and extent of rehabilitation are also considered in the emission calculations.

Table 10 : Estimated dust emissions due to proposed mining operations

ACTIVITY	Annual TSP emission rate (kg/y)		
	SPE Year 5	SPE Year 10	SPE Year 15
OB - Stripping topsoil in SPE	5110	5110	5110
OB - Drilling in SPE	3304	4012	3304
OB - Blasting in SPE	15211	18470	15211
OB - Sh/Ex/FELs loading in SPE	29754	34713	29754
OB - Hauling to emplace from SPE	500940	584430	500940
OB - Emplacing at dumps in SPE	61987	67938	61987
OB - Dozers on O/B in SPE	117449	118503	118503
CL - Dozers ripping in SPE	204353	231858	203373
CL - Loading ROM to trucks in SPE	86130	100654	86130
CL - Hauling ROM coal to dump hopper from SPE	60032	70155	60032

ACTIVITY	Annual TSP emission rate (kg/y)		
	SPE Year 5	SPE Year 10	SPE Year 15
CL - unloading ROM coal at pile/hopper	12750	14900	12750
CL - Additional ROM rehandle pile to hopper	638	745	638
CL - Additional handling of coal at CHPP	2952	3450	2952
CL - Additional loading of product coal stockpile	231	270	231
WE - OB dumps for SPE	323617	323617	323617
WE - SPE pit	258894	258894	258894
Additional loading of coal to trains	231	270	231
EIS - Drilling Overburden - North pit	*24436*	*60872*	*61708*
EIS - Drilling Overburden - Central Pit Lower	*65731*	*35264*	*40094*
EIS - Blasting Overburden - North pit	*31789*	*75315*	*72771*
EIS - Blasting Overburden - Central Pit Lower	*85770*	*43363*	*46986*
EIS - Loading Overburden - North pit	*247135*	*574936*	*534603*
EIS - Loading Overburden - Central Pit Lower	*664794*	*333065*	*347356*
EIS - Hauling Overburden - North pit	*1739134*	*3514854*	*3026758*
EIS - Hauling Overburden - Central Pit Lower	*3994496*	*1558734*	*2569574*
EIS - Dumping Overburden - North pit	*247135*	*574936*	*534603*
EIS - Dumping Overburden - Central Pit Lower	*664794*	*333065*	*347356*
EIS - Dozers on thin interburden in pits - North pit	*60204*	*122015*	*111136*
EIS - Dozers on thin interburden in pits - Central Pit Lower	*177067*	*69228*	*100669*
EIS - Dozers on Coal - North pit	*218843*	*471178*	*418957*
EIS - Dozers on Coal - Central Pit Lower	*496662*	*217660*	*334636*
EIS - Dozers on overburden - Reshaping overburden	*23133*	*17446*	*46779*
EIS - Drilling Coal - North pit	*10213*	*33450*	*31280*
EIS - Drilling Coal - Central Pit Lower	*41607*	*22114*	*13897*
EIS - Blasting Coal - North pit	*6881*	*22262*	*21048*
EIS - Blasting Coal - Central Pit Lower	*27929*	*14977*	*9310*
EIS - Loading Coal - North pit	*2298*	*6118*	*5705*
EIS - Loading Coal - Central Pit Lower	*6661*	*3403*	*3549*
EIS - Hauling Coal - North pit	*428816*	*1188130*	*1118546*
EIS - Hauling Coal - Central Pit Lower	*1133846*	*623688*	*698082*
EIS - Dumping Coal - North pit	*2298*	*6118*	*5705*
EIS - Dumping Coal - Central Pit Lower	*6661*	*3403*	*3549*
EIS - Wind erosion - mine areas - Exposed (ex-pit)	*3390470*	*2953872*	*2227843*
EIS - Wind erosion - mine areas - Exposed (in-pit)	*463579*	*762996*	*900528*
EIS - Wind erosions stockpiles - ROM west	*1752*	*1752*	*1752*
EIS - Wind erosions stockpiles - ROM east	*1752*	*1752*	*1752*
EIS - Wind erosions stockpiles - Product west	*10512*	*10512*	*10512*
EIS - Wind erosions stockpiles - Product east	*7008*	*7008*	*7008*
EIS - Wind erosions stockpiles - Product expansion east	*31536*	*31536*	*31536*
EIS - Coal processing - Assumes 7 transfers and 70% control	*20108*	*19994*	*26574*
EIS - Loading trains – Loading	*2873*	*2856*	*3796*
EIS - Grading Roads - All roads	*168150*	*163881*	*160351*
EIS - Scrapers removing top-soil - North pit	*20032*	*27451*	*7230*
EIS - Scrapers removing top-soil - Central pit	*40064*	*27451*	*7230*
EIS - Load re-handled coal – Stockpile	*448*	*476*	*463*
EIS - Hauling re-handled coal - Stockpile to dump hopper	*5782*	*5758*	*5638*

ACTIVITY	Annual TSP emission rate (kg/y)		
	SPE Year 5	SPE Year 10	SPE Year 15
EIS - Dumping rehandled coal - Dump hopper	*448*	*476*	*463*
EIS - Hauling coal rejects - Hauling rejects	*676820*	*615740*	*445960*
Total dust due to SPE (kg)	1,683,583	1,837,990	1,683,657
Total dust due to MAN without South Pit (kg)	*15,249,668*	*14,559,108*	*14,343,291*
Total dust due to MAN including SPE (kg)	16,933,251	16,397,098	16,026,948

Key: OB= Operations on overburden, CL = Operations on coal, WE = Dust due to wind erosion, EIS = Emissions determined for the EIS (in italics)

6. APPROACH TO ASSESSMENT

In August 2005, the DEC published guidelines for the assessment of air pollution sources using dispersion models (**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. The approach taken in this assessment follows as close as possible to the approaches suggested by the guidelines.

This section is provided so that technical reviewers can appreciate how the modelling of different particle size categories was carried out.

The model used was the US EPA ISCST3 model. The model is fully described in the user manual and the accompanying technical description (**US EPA, 1995**). 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 FP (fine particles), 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 developed both within NSW and by the US EPA (see **Appendix B**).

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

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

Modelling was done using three ISC source groups with each group corresponding 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 dot points above to determine the concentration of PM_{10} and TSP.

The ISC 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 mining operations where wind speed is an important factor in determining the rate at which dust is generated.

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 ISC 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 a mine site would correspond with periods of low dust generation because wind erosion and other wind dependent emissions rates will be low. Light winds also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Mining operations were represented by a series of volume sources located according to the location of activities for the modelled scenario. **Figure 6** shows the location of the modelled sources.

Dust concentrations and deposition rates have been predicted over the extent of **Figure 1** with the mine site located approximately in the centre. Model predictions have been made at 90 discrete receptors, including residential locations, located in the study area. The location of these receptors has been chosen to provide finer resolution closer to the dust sources and nearest sensitive areas whilst still maintaining acceptable model run times.

The modelling has been performed using the meteorological data discussed in **Section 4.1** and the dust emission estimates from **Section 5**. Local terrain has been included in the modelling.

All activities have been modelled for 24 hours per day, except for blasting type activities which have been modelled only during day-time hours. **Appendix B** provides a summary of dust emissions, hours of emission and allocation of sources for each activity.

It has been apparent for a number of years that the ISC model has a tendency to overestimate 24-hour PM_{10} concentrations, while still predicting the longer term average concentrations reasonably accurately. In recent years the DEC have permitted the use of a calibration factor to correct for the tendency of ISC to over-predict 24-hour average PM_{10} concentrations. In most instances, the DEC has required site-specific calibration factor be developed from local model and monitoring results.

One of the earliest calibration studies was undertaken as part of the EIS for the Warkworth mine in the Hunter Valley (**Holmes Air Sciences, 2002**). The calibration was done by comparing the predicted maximum 24-hour average PM_{10} concentrations at the several mine operated monitors. The maximum measured PM_{10} concentrations were then determined by inspection of the monitoring data. From these investigations the average extent of over-prediction was found to be a factor of 2.6; that is, unadjusted model predictions appeared to over predict 24-hour PM_{10} concentrations by 260%. This factor was used to adjust the model predictions for the Warkworth EIS downwards to obtain a calibrated prediction of the worst-case 24-hour PM_{10} concentrations for all scenarios that were assessed.

Other studies undertaken at other locations have derived different calibration factors, both larger and smaller than 2.6. Further studies to develop a more scientifically robust methodology for dealing with the over-prediction of short-term concentrations by the ISC model are to be conducted as part of the approval conditions for the Mt Owen Mine.

Comparisons between ISC and AUSPLUME (see **Holmes Air Sciences, 2003** for example) have suggested that a correction factor is appropriate for short term (that is, 24-hour average) ISC predictions. Although the comparison between AUSPLUME and ISCS shows varying difference, AUSPLUME has consistently predicted almost 50% lower than uncorrected ISC predictions. Thus, AUSPLUME may have some advantages over ISC in that it more accurately predicts 24-hour average concentrations of PM_{10}, which are known to be consistently overestimated by ISC.

Results from a simplified model comparison of AUSPLUME and ISC showed that 1-hour average PM_{10} concentrations downwind of a source and along the plume centreline were between 2.8 and 3.5 times higher using ISC than for AUSPLUME (see Appendix C of **Holmes Air Sciences, 2006b**). The difference between the models depends on the meteorological conditions. Different results from the two models were largely explained by the way in which each model has interpreted the plume dispersion curves.

These studies, and the recently completed calibration study undertaken as part of the Mt Owen Mine's conditions of approval, have lead to a better understanding of the reasons for the over-prediction. It appears that a substantial fraction of the effect is due to the fact that the dispersion curves used in the ISC model have not been adjusted for differences in averaging times and the effects of the aerodynamic roughness. For most model runs for a particular site these will be different from the conditions where the original dispersion curves were developed.

To overcome this difficultly the ISC model has been modified to create a model that will be referred to as ISCMOD. ISCMOD is identical to ISC except that the horizontal plume spreading dispersion curves have been modified to adopt the recommendations of the American Meteorological Society's (AMS) expert panel on dispersion curves (**Hanna, 1977**) and the suggestions made by **Arya (1999)**. The suggested changes were recommended because, as the AMS panel notes, the original horizontal dispersion curves relate to an averaging time of three minutes and they recommend that these be adjusted to the one hour curves required by ISC. The change involves increasing the horizontal plume widths by a factor of 1.82 $(60 \text{ minutes} / 3 \text{ minute})^{0.2}$.

A similar adjustment has been applied to account for the local surface roughness being different at Mt Arthur Coal compared with the site where the original curves were developed. The Mt Arthur Coal mine site has been taken to have a surface roughness of 0.3 m compared with 0.03 m for the original curves. The adjustment leads to an increase in the horizontal and vertical curves by a factor of $(0.3 \text{ m}/ 0.03 \text{ m})^{0.2}$ namely 1.6.

To assess the air quality impacts of the Project, the activities associated with the SPE have been modelled alone. Contour plots have been created from the results in order to assess the likely contribution of the SPE activities to local air quality. Model predictions were then made at the each of the high volume air sampler monitoring locations (discussed in **Section 4.3.1**) with the measured levels added to the results to obtain a cumulative prediction. Predictions were then compared with the current DEC assessment criteria.

In addition, the extent of impacts of MAN including SPE have been predicted for comparison with the extent of impacts predicted in the EIS. The following approach was adopted:

- Predict the contribution of MAN operations with SPE;
- Assess the difference against MAN operations predicted in the EIS; and
- Calculate the cumulative impacts by updating the EIS cumulative impacts to reflect the modelled differences with SPE.

For consistency with the EIS, modelling for MAN with SPE used the 1995/1996 Macquarie Generation meteorological dataset.

7. ASSESSMENT OF IMPACTS

7.1 Model Results for SPE

Dust concentrations and deposition rates for the selected years of assessment have been presented as isopleth diagrams in **Figures 7** to **9**. These figures show 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.

In examining the maximum 24-hour average contour plots it should be noted that 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 for the worst day in the year. The maxima are used to show concentrations which can possibly be reached under the modelled conditions.

It should be noted that the contour plots show predicted concentrations and deposition levels due only to modelled dust sources associated with the SPE activities. That is, the predictions do not include contributions from other parts of the MAN mine, other mines or existing non-mine sources.

The air quality criteria used for deciding which areas are likely to experience air quality impacts are those specified by the DEC. The air quality criteria are listed in **Table 3** and **Table 4**.

The criteria are:

- 50 $\mu g/m^3$ for 24-hour PM_{10} for the Project considered alone;
- 30 $\mu g/m^3$ for annual average PM_{10} due to the Project and other sources;
- 90 $\mu g/m^3$ for annual TSP concentrations due to the Project and other sources;
- 2 g/m^2/month for annual average deposition (insoluble solids) due to the Project considered alone; and
- 4 g/m^2/month for annual predicted cumulative deposition (insoluble solids) due to the Project and other sources.

Figure 7 shows model predictions for SPE Year 5. Maximum 24-hour average PM_{10} concentrations are predicted to be of the order of 20 $\mu g/m^3$ or less beyond the ML boundaries. This is below the DEC's 50 $\mu g/m^3$ goal.

Annual average PM_{10} concentrations for SPE Year 5 are predicted to be 5 $\mu g/m^3$ or less beyond the ML boundaries. TSP concentrations are predicted to be less than 10 $\mu g/m^3$. Note that background concentrations need to be considered for annual average PM_{10} and TSP when comparing the model predictions with the air quality criteria.

Dust deposition for SPE Year 5 is predicted to be 1 g/m^2/month or less beyond the ML boundaries. This is below the 2 g/m^2/month goal for the Project considered alone.

Model results for SPE Years 10 and 15 (see **Figures 8** and **9** respectively) are very similar to those predicted for Year 5. This reflects the similar overburden movement and production rates expected for each of the modelled scenarios.

Table 11 summarises the model results for the high volume air sampler monitoring locations. In this assessment the monitoring locations are taken to be representative of the sensitive receptor locations. **Table 12** shows the model predictions including the addition of the measured levels from the monitoring location.

Note that measurement data from 2004 was chosen for this analysis as the data were generally higher than 2005 - that is, more conservative. Also, the data from the 2004 air quality monitoring are consistent with the year of modelled meteorology.

Table 11 : Project only predictions at selected locations

Location	Prediction due to SPE Year 5	Prediction due to SPE Year 10	Prediction due to SPE Year 15	Project only goal
Maximum 24-hour average PM_{10} concentrations ($\mu g/m^3$)				
Constable	1.6	1.8	1.6	50
Denman Rd West	2.2	2.5	2.2	50
South Muswellbrook	2.3	2.6	2.3	50
Sheppard Ave	2.5	2.8	2.5	50
Windmill	2.3	2.6	2.3	50
Edderton	5.0	5.7	5.0	50
Roxburgh South	3.3	3.7	3.3	50
Wire Lane	5.5	6.2	5.5	50
Annual average PM_{10} concentrations ($\mu g/m^3$)				
Constable	0.3	0.3	0.3	-
Denman Rd West	0.4	0.4	0.4	-
South Muswellbrook	0.1	0.1	0.1	-
Sheppard Ave	0.1	0.1	0.1	-
Windmill	0.4	0.4	0.4	-
Edderton	0.4	0.4	0.4	-
Roxburgh South	0.5	0.5	0.5	-
Wire Lane	0.2	0.2	0.2	-
Annual average TSP concentrations ($\mu g/m^3$)				
Constable	0.3	0.3	0.3	-
Denman Rd West	0.4	0.5	0.4	-
South Muswellbrook	0.1	0.1	0.1	-
Sheppard Ave	0.1	0.1	0.1	-
Windmill	0.4	0.5	0.4	-
Edderton	0.4	0.4	0.4	-
Roxburgh South	0.5	0.6	0.5	-
Wire Lane	0.2	0.2	0.2	-
Annual average dust deposition (g/m^2/month)				
Constable	0.02	0.03	0.02	2
Denman Rd West	0.05	0.06	0.05	2

Location	Prediction due to SPE Year 5	Prediction due to SPE Year 10	Prediction due to SPE Year 15	Project only goal
South Muswellbrook	0.00	0.00	0.00	2
Sheppard Ave	0.01	0.01	0.01	2
Windmill	0.05	0.05	0.05	2
Edderton	0.00	0.00	0.00	2
Roxburgh South	0.06	0.06	0.06	2
Wire Lane	0.00	0.00	0.00	2

Note: A prediction of 0.00 means less than 0.005

Table 12 : Cumulative predictions at selected locations

Location	Measured current (2004) level	Prediction due to SPE Year 5 including background	Prediction due to SPE Year 10 including background	Prediction due to SPE Year 15 including background	Cumulative goal
Annual average PM_{10} concentrations ($\mu g/m^3$)					
Constable	18.9	19.2	19.2	19.2	30
Denman Rd West	17.9	18.3	18.3	18.3	30
South Muswellbrook	28.2	28.3	28.3	28.3	30
Sheppard Ave	27.5	27.6	27.6	27.6	30
Windmill	18.6	19.0	19.0	19.0	30
Edderton	14.6	15.0	15.0	15.0	30
Roxburgh South	17.3	17.8	17.8	17.8	30
Wire Lane	23	23.2	23.2	23.2	30
Annual average TSP concentrations ($\mu g/m^3$)					
Constable	47.3	47.6	47.6	47.6	90
Denman Rd West	44.8	45.2	45.3	45.2	90
South Muswellbrook	70.5	70.6	70.6	70.6	90
Sheppard Ave	68.8	68.9	68.9	68.9	90
Windmill	46.5	46.9	47.0	46.9	90
Edderton	36.5	36.9	36.9	36.9	90
Roxburgh South	43.3	43.8	43.9	43.8	90
Wire Lane	57.5	57.7	57.7	57.7	90

At each monitoring site the predicted maximum 24-hour average PM_{10} concentrations are well below the 50 $\mu g/m^3$ goal for all future scenarios. Cumulative annual average PM_{10} and TSP concentrations are predicted to be below the 30 and 90 $\mu g/m^3$ goals respectively. Annual average dust deposition is predicted to be below the 2 g/m^2/month goal (Project only). Compliance with the 4 g/m^2/month goal (total dust fallout) is also predicted at each monitoring site when 3.1 g/m^2/month is assumed to be the typical background dust fallout level and this is added to the model predictions.

From the model results, the activities related to the SPE are predicted to contribute very little to dust levels at the monitoring locations that surround Mt Arthur Coal's operations. For example, the highest contribution from the SPE dust emissions to maximum 24-hour average PM_{10} concentrations is 6.2 $\mu g/m^3$ at the Wire Lane site. This monitoring site can be taken to be representative of the nearest residential area ("Antiene", see **Figure 1**) to the SPE area.

There are, however, some limitations to the modelling approach adopted above. The key limitation is that background concentrations at the monitoring sites have been assumed to be the same for future years. In reality, measured levels at each site may undergo variation in the future and would reflect, to some degree, the change in location and activity levels at nearby mining operations.

Given that the more conservative year of background data was selected and that the increment of the Project to off-site locations is predicted to be small, the limitation described above would not change the conclusions of this assessment.

7.2 Comparison with EIS

As discussed in **Section 3**, one objective of the current study was to examine the differences between the dust impacts of the approved MAN operations as predicted in the EIS with MAN operations that include the proposed SPE. Essentially, this section seeks to update the extent of impacts predicted in the EIS to reflect the modifications with the SPE Project. The EIS model also included dust impacts associated with the Bengalla mine to the north of Mt Arthur Coal.

The extent of impacts predicted in the EIS compared with impacts predicted for SPE are shown by **Figures 10** to **12**. These figures show the impact zone determined for the EIS and the new impact zone defined with the inclusion of SPE. For this analysis the air quality goals that applied at the time of the EIS have been referenced. Predictions of maximum 24-hour average PM_{10} are not included since this was was not modelled for the MAN EIS.

The extent of air quality impacts for SPE Year 5 is shown by **Figure 10**. Cumulative annual average PM_{10} predictions show that the new impact zone defined for the SPE modelling is close to the impact zone defined in the EIS. It is useful to note that the 45 $\mu g/m^3$ contour was taken to represent the extent of impacts. This level represents the original 50 $\mu g/m^3$ goal minus 5 $\mu g/m^3$ due to non-modelled sources. For annual average TSP, the EIS assumed that non-modelled sources contributed 10 $\mu g/m^3$.

Compared with the EIS predictions, the impacts for SPE Year 5 are predicted to be marginally lower to the northwest and marginally higher to the southeast of the operations on mine owned land. This represents the change in the distribution of dust sources around the mine site.

Annual average TSP and dust deposition levels for SPE Year 5 exhibit a similar trend to annual average PM_{10} with slight decreases to the northwest and slight increases to the southeast on mine owned land. In fact, this trend is predicted for all the modelled years (see **Figures 11** and **12**).

In areas where the extent of air quality impacts is predicted to be greater than for the EIS the new "zone of affectation" in each year with SPE would remain on mine owned land and not encroach into any new sensitive receptor areas. The differences between the EIS predictions and the SPE predictions are considered to be small and the changes to off-site air quality would be difficult to detect.

8. CONCLUSIONS

This report has assessed the air quality impacts of proposed modifications to the operation of Mt Arthur Coal mine. The proposed modifications are referred to as the South Pit Extension Project. Dispersion modelling has been used to predict off-site dust concentration and dust deposition levels due to the dust generating activities occurring on the site. The dispersion modelling took account of the local meteorology and terrain information and used dust emission estimates to predict the air quality impacts for three future mining scenarios.

Air quality monitoring data have showed that annual average PM_{10} concentrations are below the DEC's current air quality goal at the monitored locations. Concentrations of TSP were inferred from the PM_{10} concentrations but also show compliance with the current DEC goal.

Measured 24-hour average PM_{10} concentrations above the DEC's 24-hour average goal have been recorded in the past. Particulate matter concentrations arising from widespread events, such as bushfires and regional dust storms, may continue to result in elevated levels on occasions.

Results from the dispersion modelling suggested that the incremental increase to off-site dust concentrations and deposition levels due to activities associated with the SPE would be small. Activities associated with the SPE would therefore not be expected to cause current air quality goals noted by the DEC to be exceeded at the nearest sensitive receptor locations.

The assessment also compared predicted air quality impacts of the MAN mining area with the SPE Project to the original predictions in the MAN EIS. The dispersion modelling indicated that the extent of air quality impacts for MAN with SPE would be similar to the extent predicted without SPE. Based on these findings, the extent of air quality impacts with SPE is therefore taken to be acceptable.

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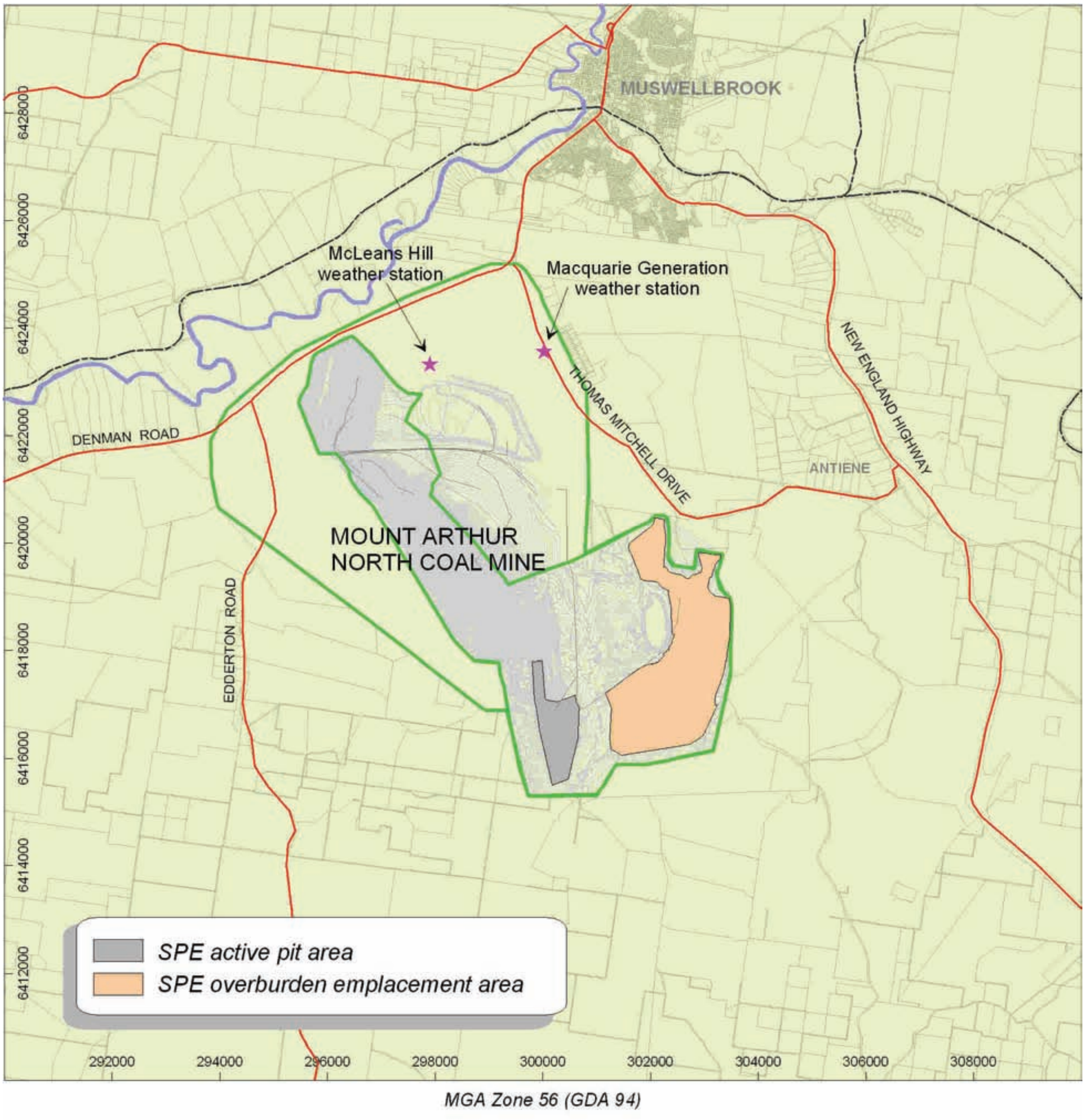
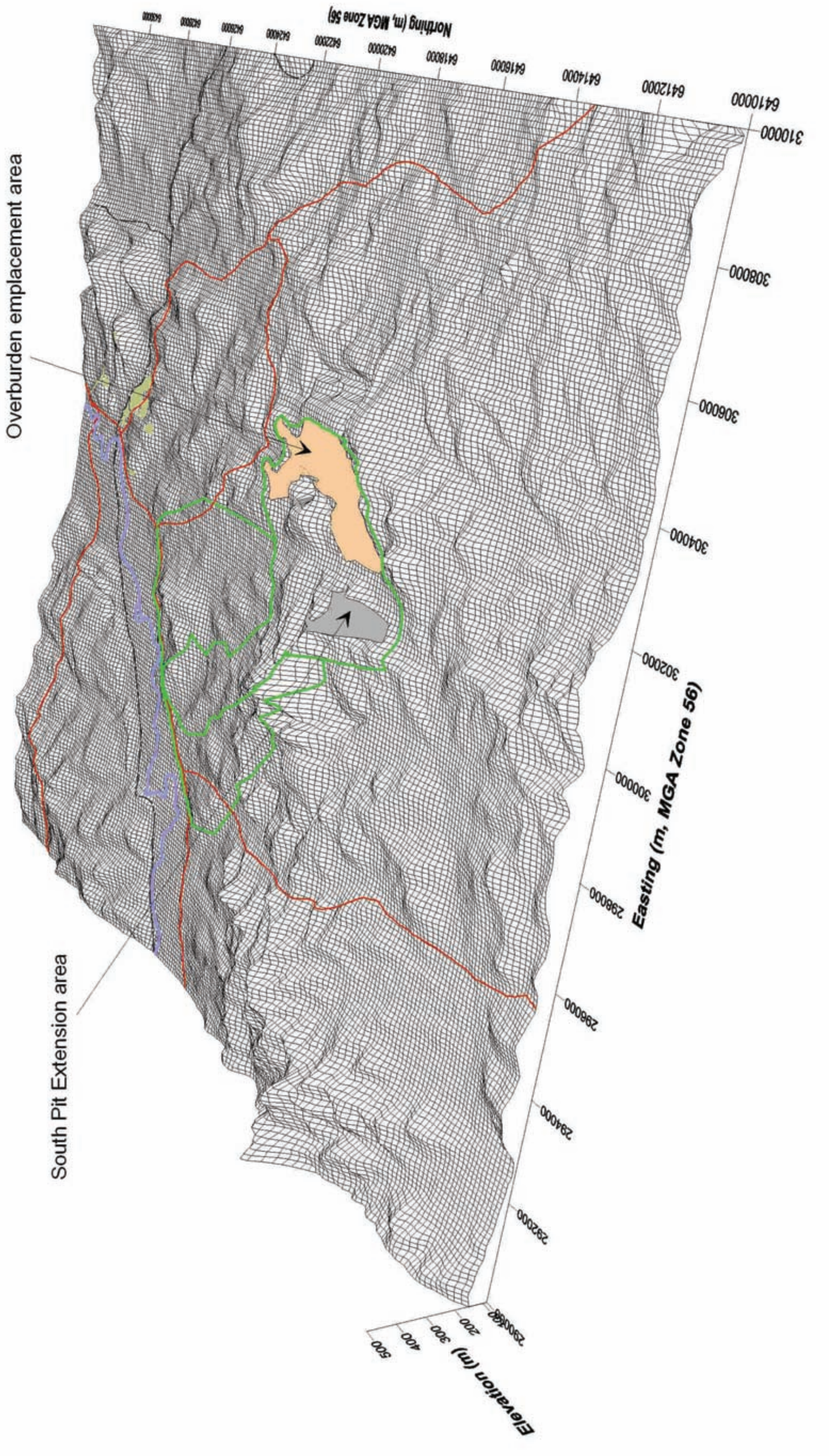
FIGURES



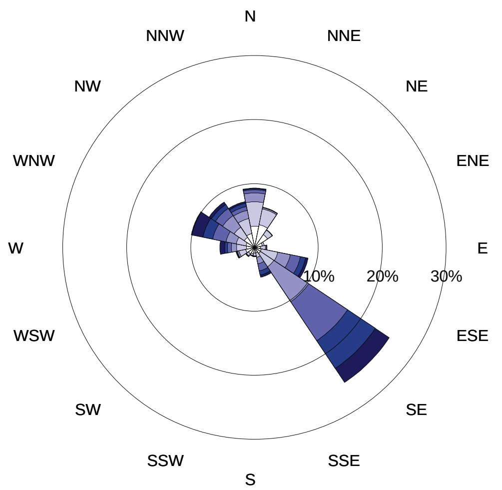
Mt Arthur Coal operations and South Pit Extension Area

FIGURE 1



Pseudo three-dimensional representation of the local terrain

Annual and seasonal windroses for MAN (Maquarie Generation data - 1995/1996)



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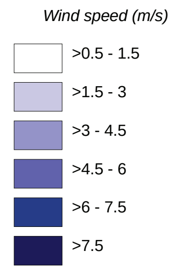

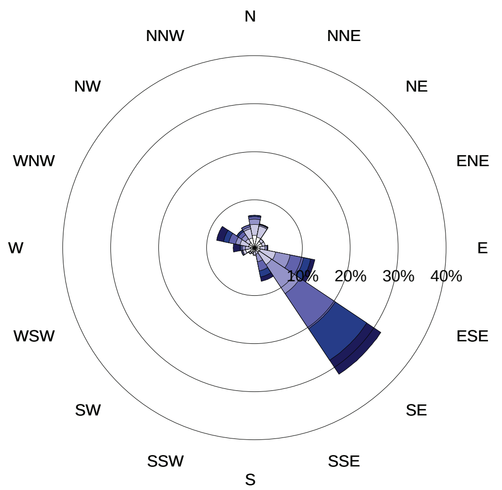

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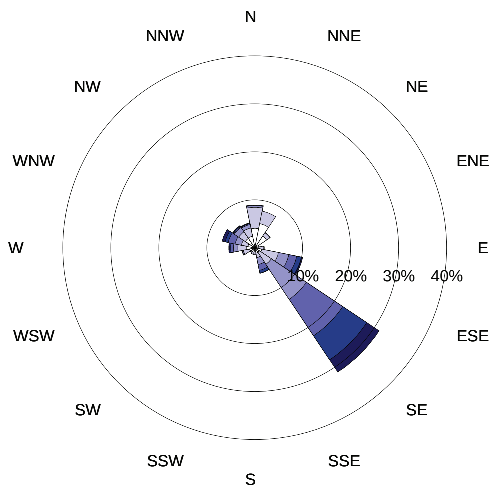

Autumn
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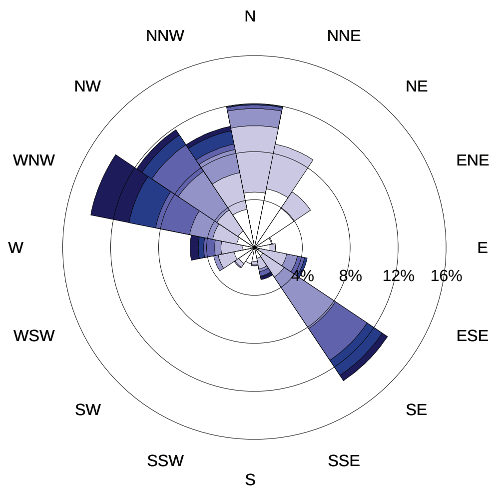

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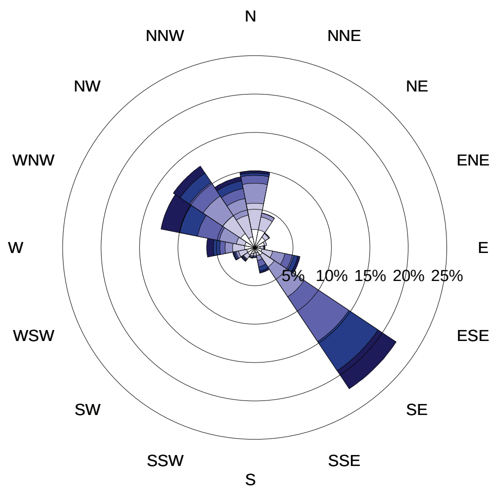

Spring
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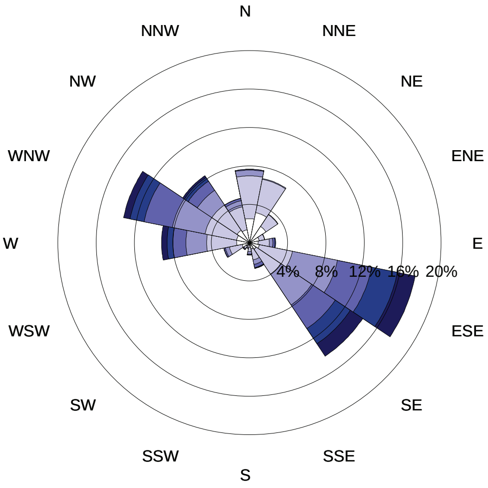
FIGURE 3

Annual and seasonal windroses for McLeans Hill (2004)



Annual
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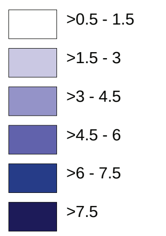

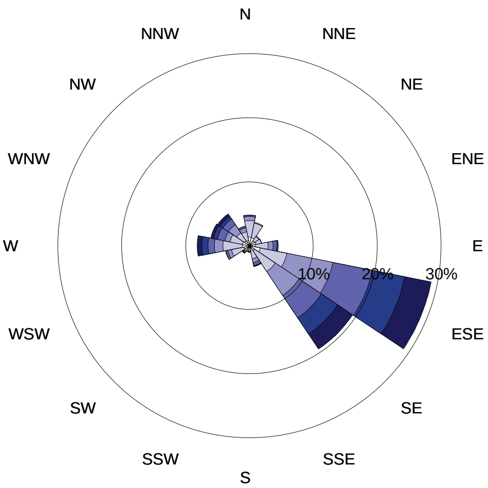

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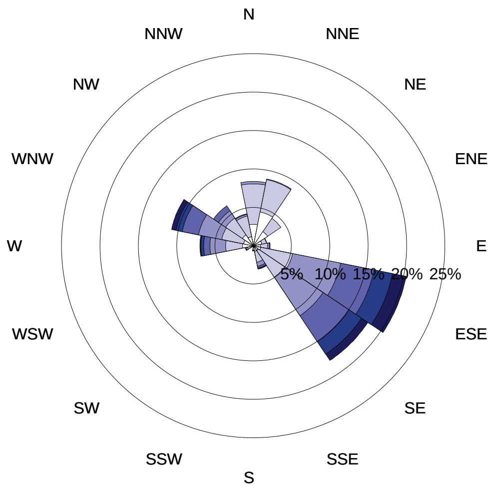

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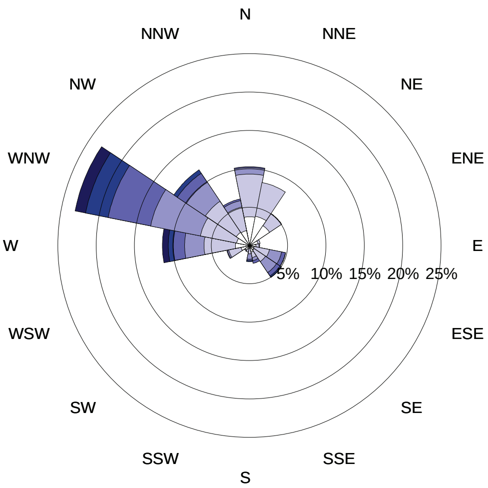
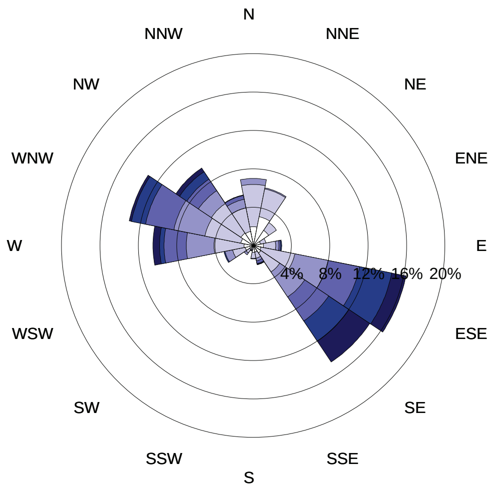
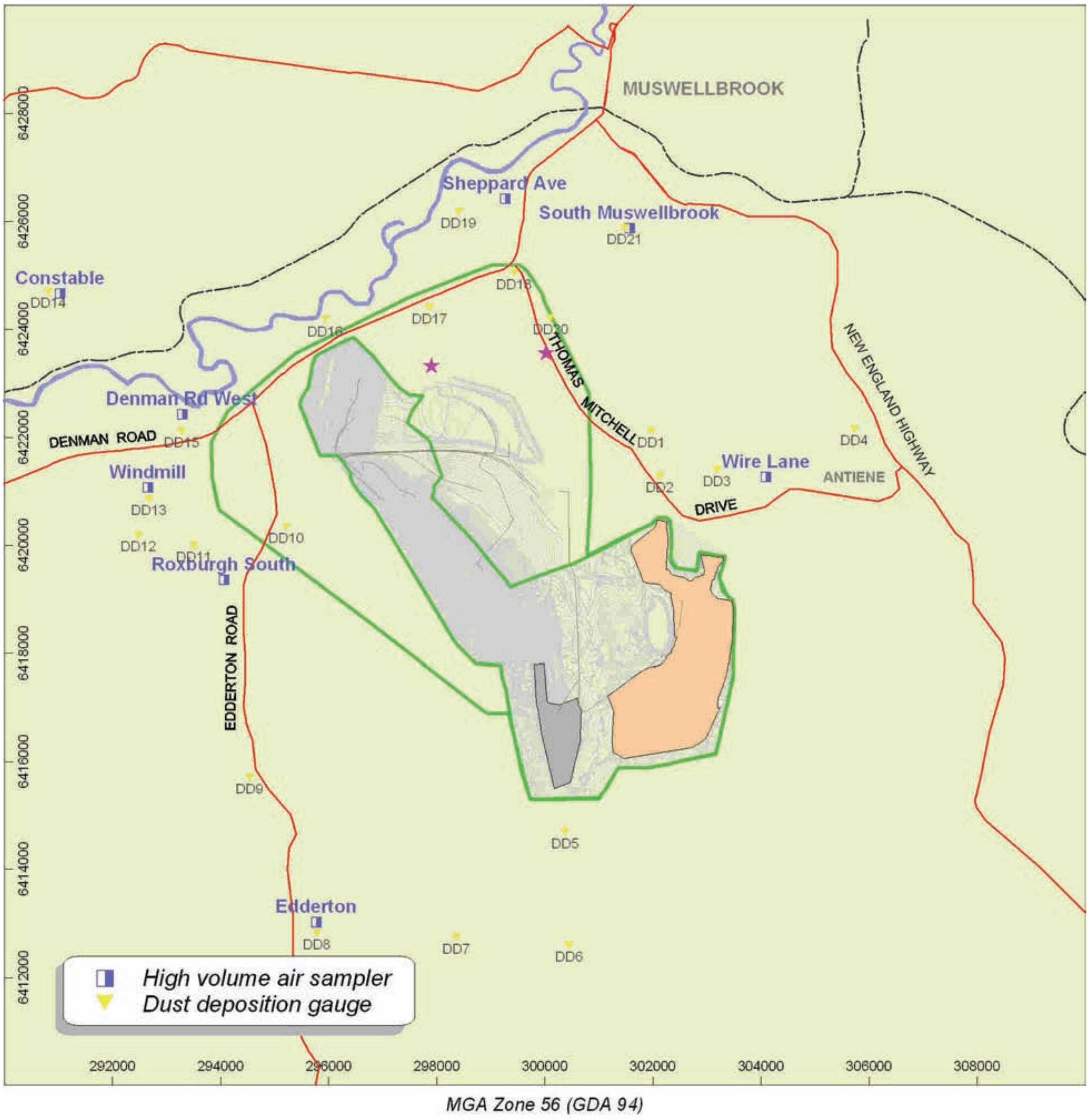


Winter
Calms = 2.0%

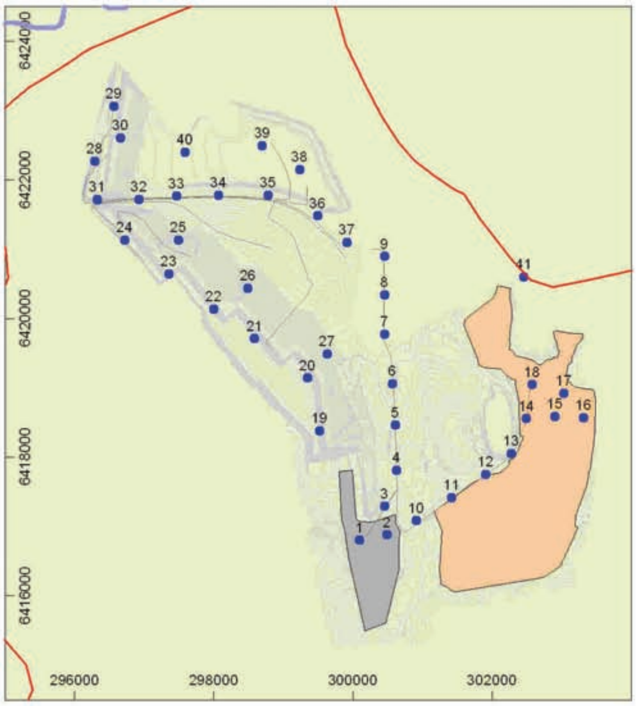


Spring
Calms = 1.9%

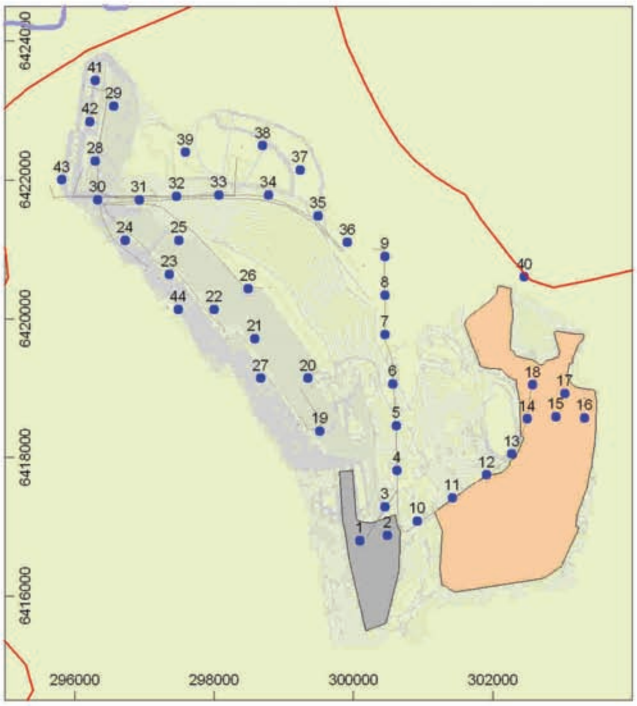
FIGURE 4



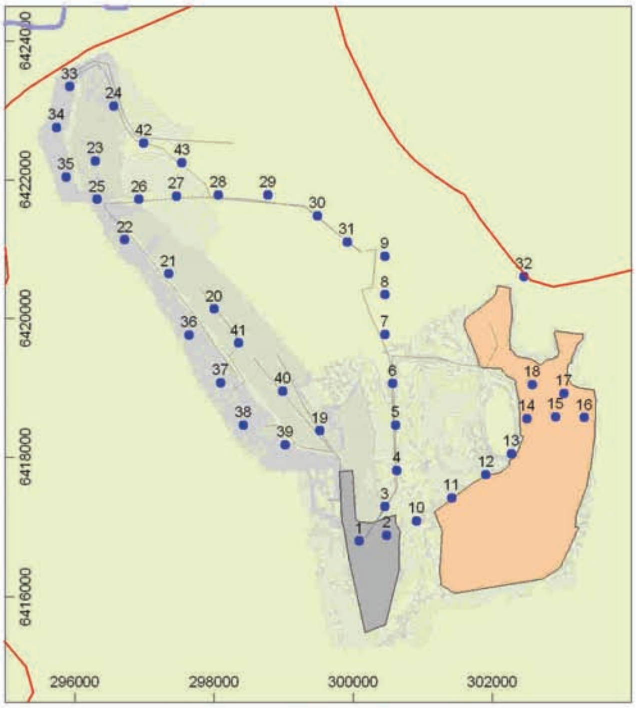
Location of air quality monitoring sites



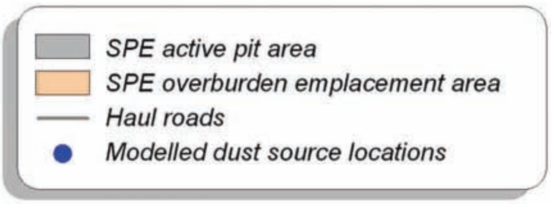
MAN year 10, SPE year 5



MAN year 15, SPE year 10

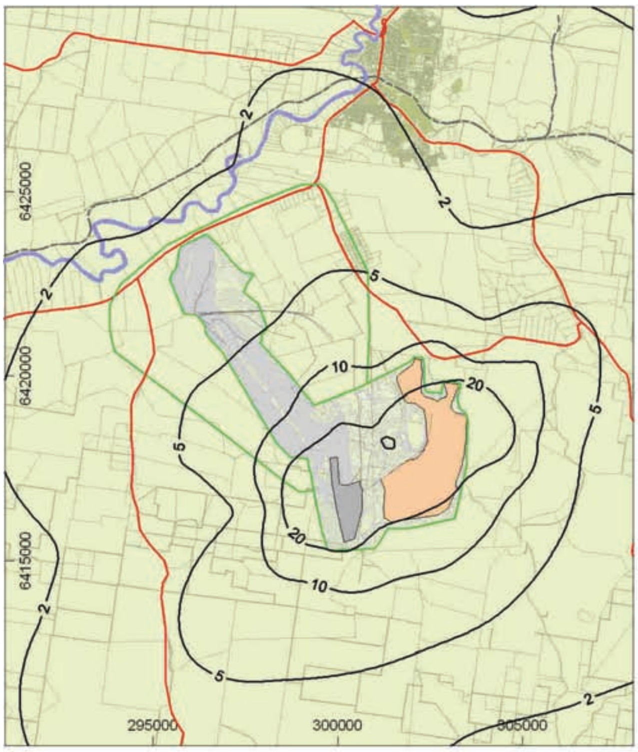


MAN year 21, SPE year 15

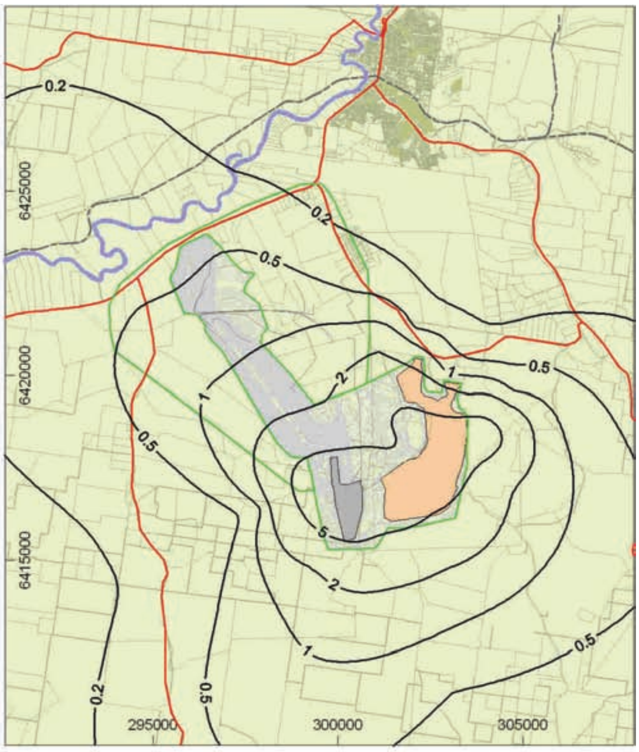


Location of modelled dust sources

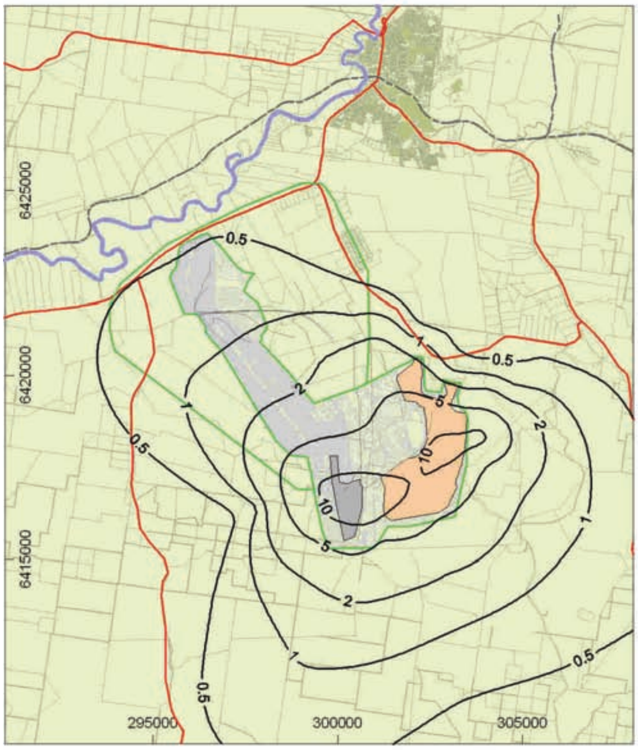
FIGURE 6



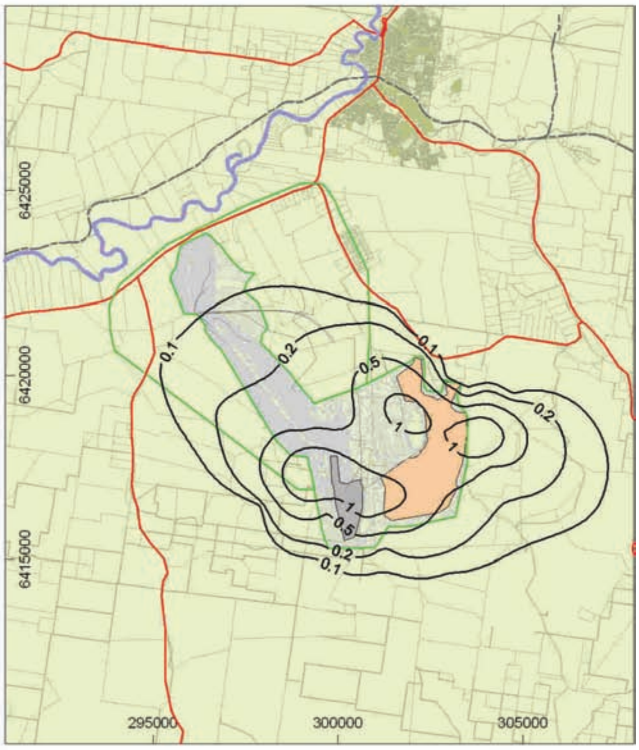
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



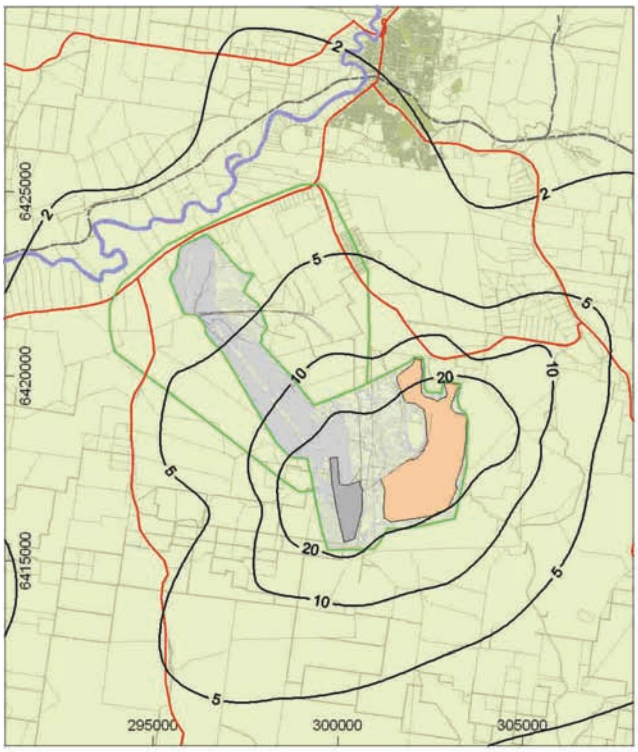
Annual average TSP - µg/m^3



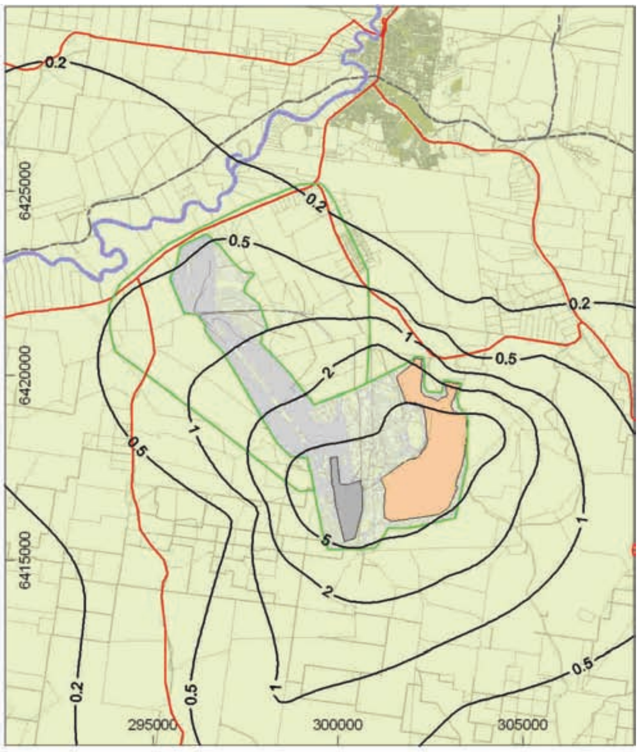
Annual average dust deposition - g/m^2/month

Dispersion model predictions for SPE Year 5

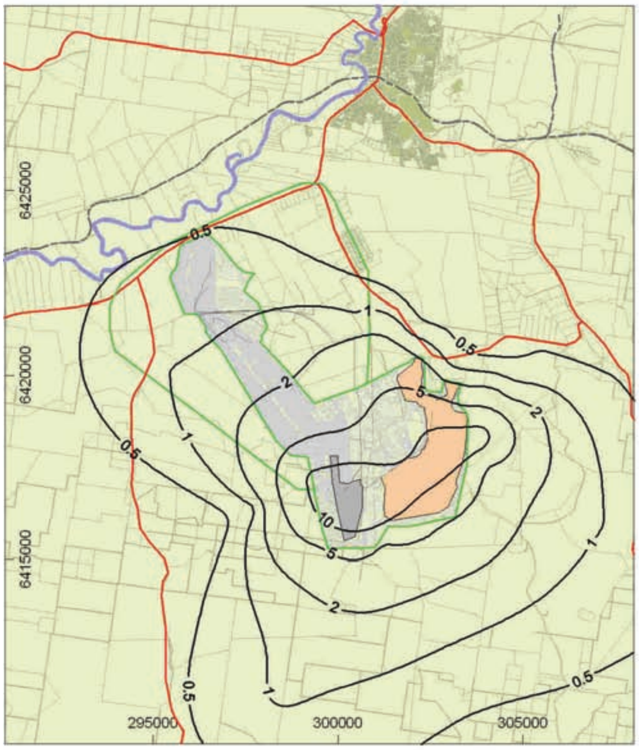
FIGURE 7



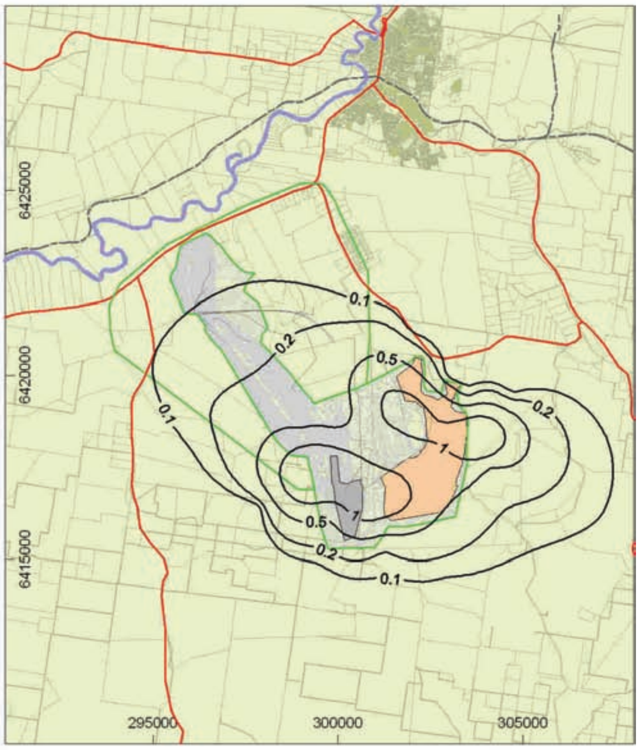
Maximum 24-hour average PM_{10} - $\mu g/m^3$



Annual average PM_{10} - $\mu g/m^3$



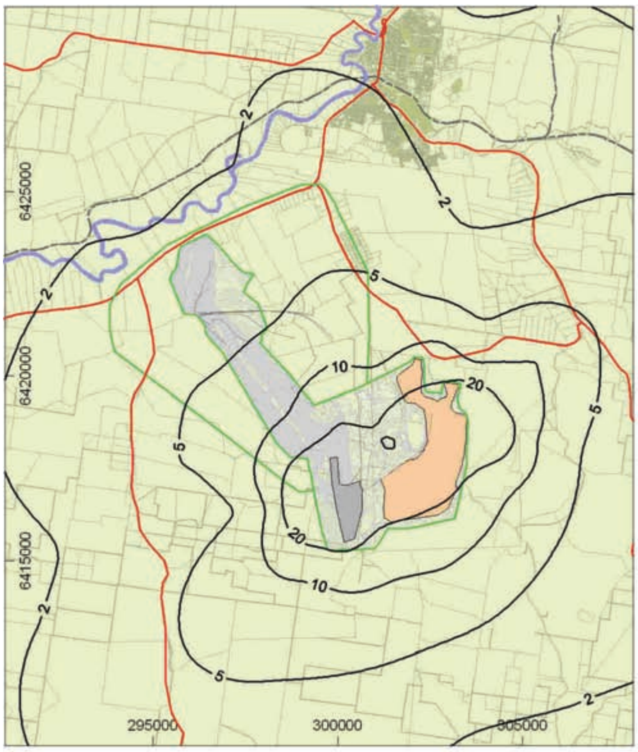
Annual average TSP - $\mu g/m^3$



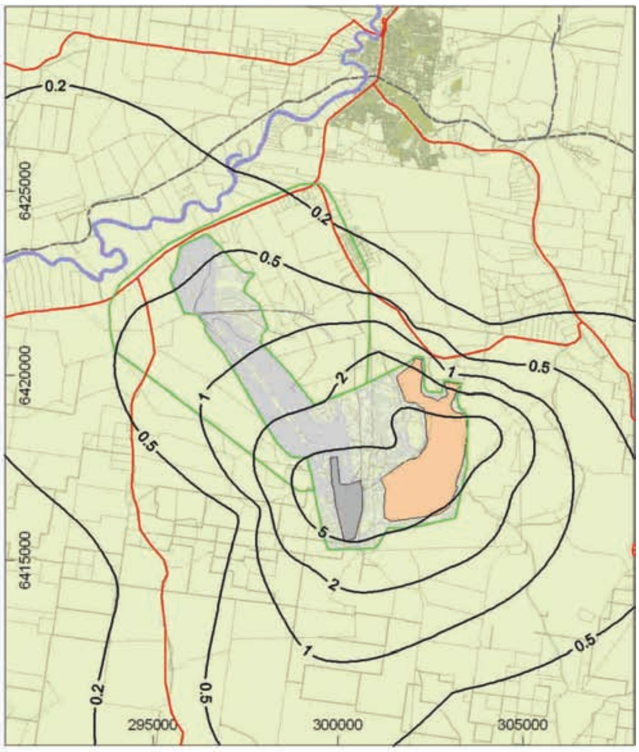
Annual average dust deposition - g/m^2/month

Dispersion model predictions for SPE Year 10

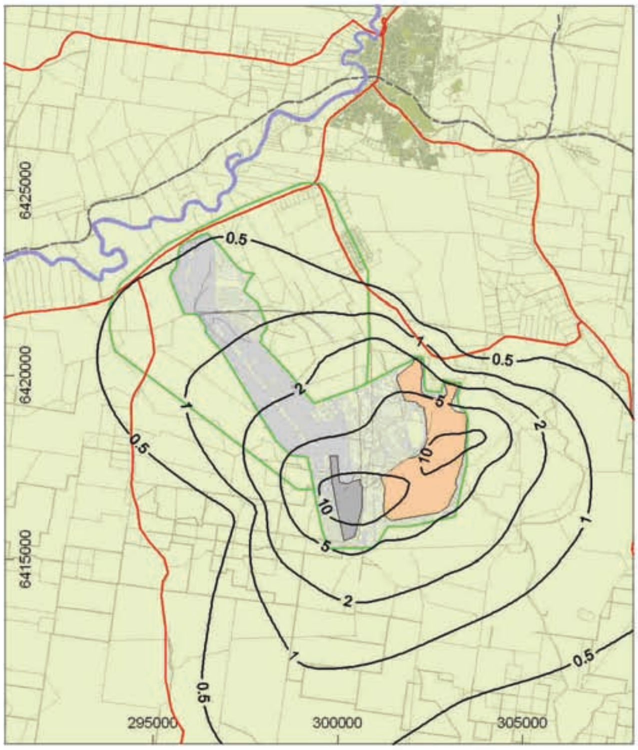
FIGURE 8



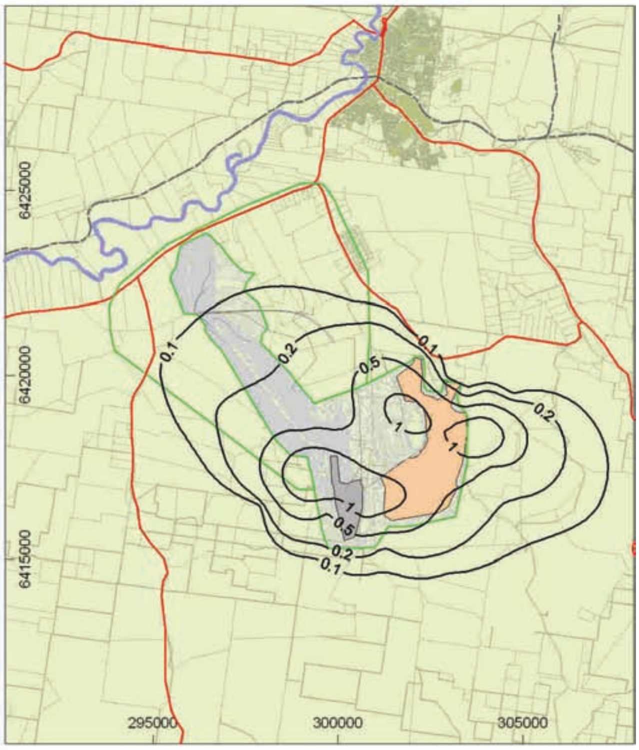
Maximum 24-hour average PM_{10} - µg/m^3



Annual average PM_{10} - µg/m^3



Annual average TSP - µg/m^3

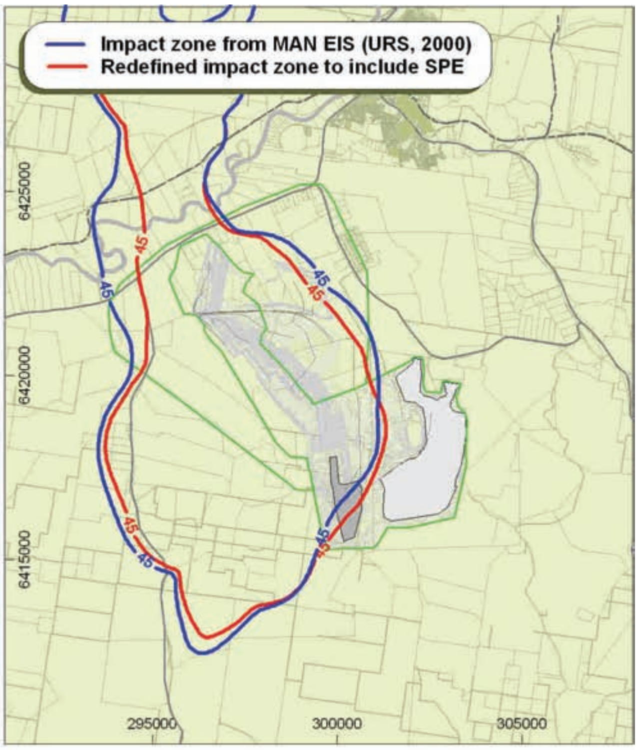


Annual average dust deposition - g/m^2/month

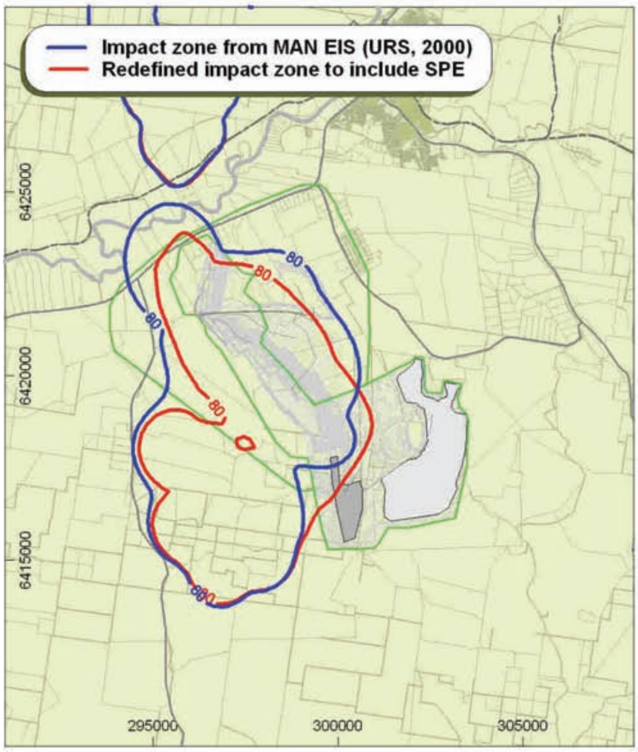
Dispersion model predictions for SPE Year 15

FIGURE 9

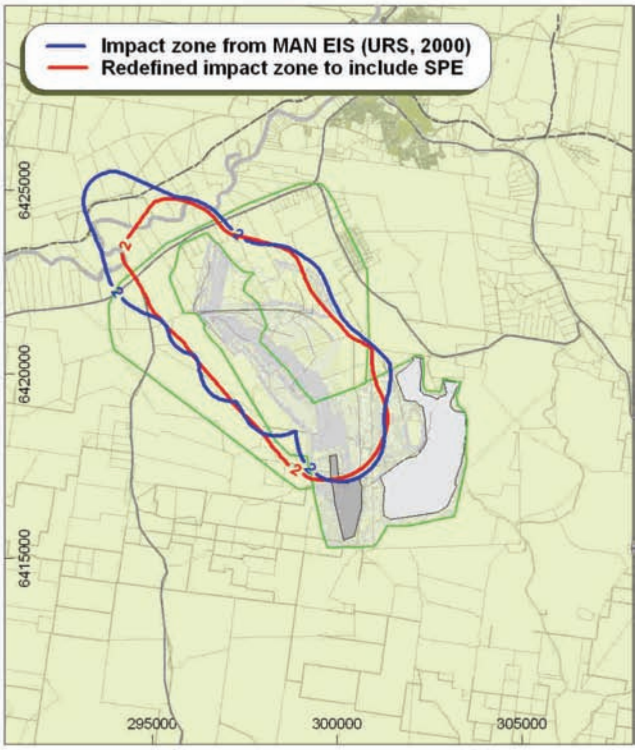
Update to MAN EIS Year 10 results to include SPE Year 5



Annual average PM_{10} - µg/m^3



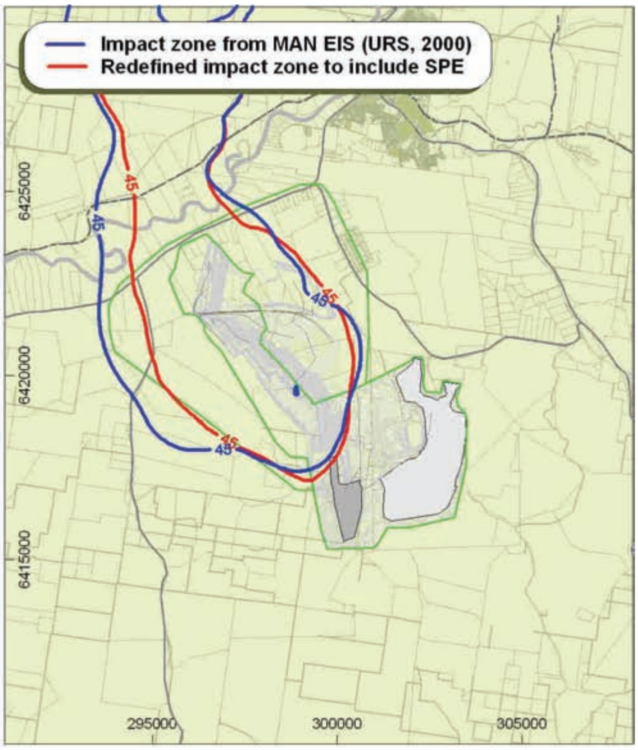
Annual average TSP - µg/m^3



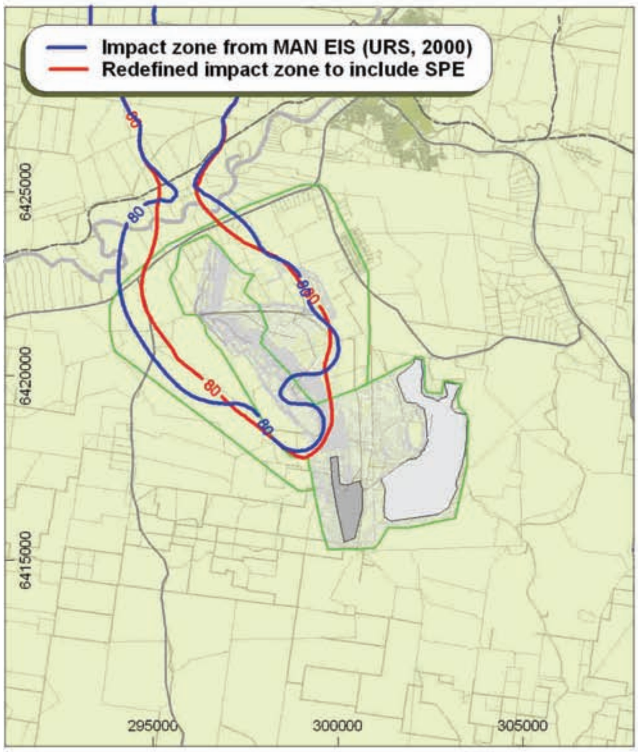
Annual average dust deposition - g/m^2/month

FIGURE 10

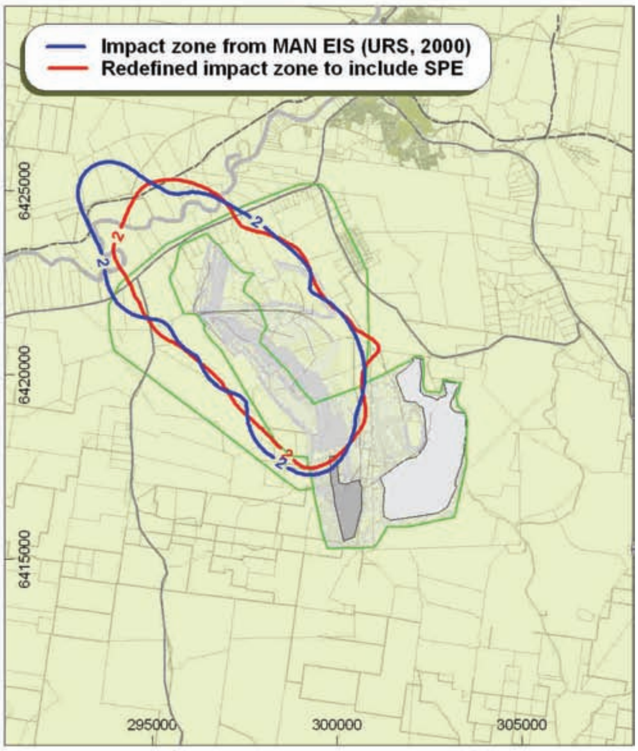
Update to MAN EIS Year 15 results to include SPE Year 10



Annual average PM_{10} - µg/m^3



Annual average TSP - µg/m^3

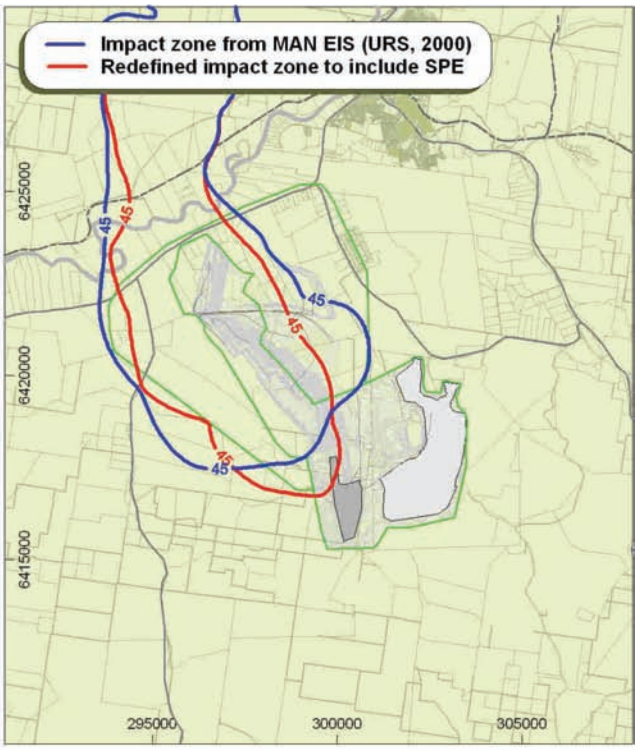


Annual average dust deposition - g/m^2/month

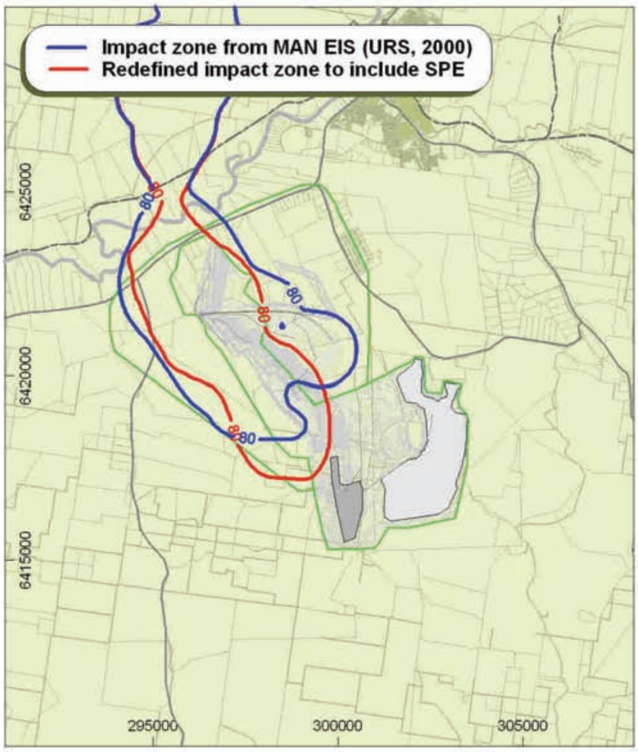
FIGURE

11

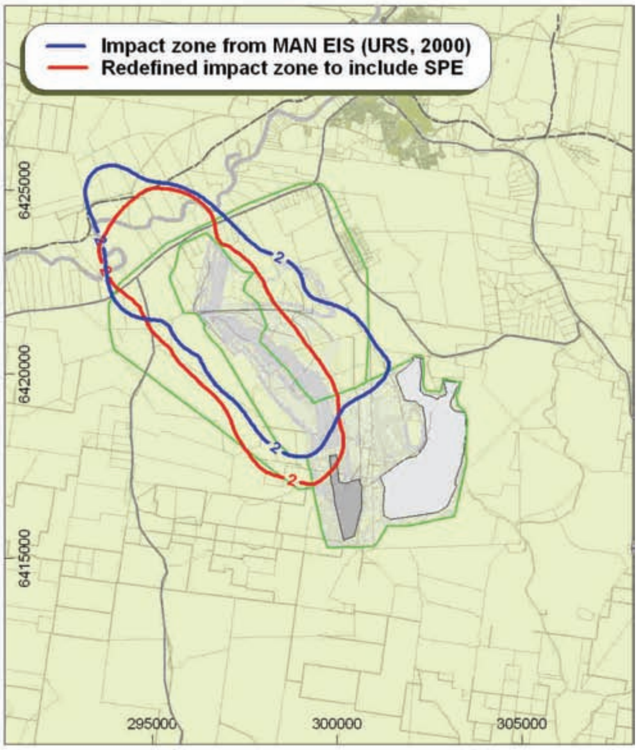
Update to MAN EIS Year 21 results to include SPE Year 15



Annual average PM_{10} - µg/m^3



Annual average TSP - µg/m^3



Annual average dust deposition - g/m^2/month

FIGURE

12

APPENDIX A
JOINT WIND SPEED, WIND DIRECTION AND STABILITY CLASS FREQUENCY TABLES

STATISTICS FOR FILE: C:\Jobs\Bengalla\metdata\McLeansH\man2004.isc
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	0.003002	0.001921	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.005043
NE	0.002041	0.001561	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.003722
ENE	0.002161	0.001801	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003963
E	0.002161	0.002041	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004203
ESE	0.002161	0.005043	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.007565
SE	0.001681	0.005283	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.007205
SSE	0.003242	0.003242	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.006724
S	0.001681	0.001321	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003002
SSW	0.000720	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001681
SW	0.001081	0.001321	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002402
WSW	0.002642	0.002522	0.000240	0.000120	0.000000	0.000000	0.000000	0.000000	0.005524
W	0.002522	0.004083	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.006724
WNW	0.003602	0.004083	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007685
NW	0.004083	0.004323	0.000600	0.000120	0.000000	0.000000	0.000000	0.000000	0.009126
NNW	0.003122	0.003842	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.006964
N	0.004083	0.001561	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.005884
CALM									0.003602
TOTAL	0.039986	0.044909	0.002281	0.000240	0.000000	0.000000	0.000000	0.000000	0.091018

MEAN WIND SPEED (m/s) = 1.58
NUMBER OF OBSERVATIONS = 758

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	0.002402	0.000841	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.003362
NE	0.000720	0.000600	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001321
ENE	0.000600	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001081
E	0.000720	0.000480	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.001441
ESE	0.000720	0.001681	0.002041	0.000120	0.000000	0.000000	0.000000	0.000000	0.004563
SE	0.000240	0.002762	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.003963
SSE	0.000480	0.001081	0.000240	0.000120	0.000000	0.000000	0.000000	0.000000	0.001921
S	0.000360	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000600
SSW	0.000240	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000360
SW	0.000000	0.000000	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000120
WSW	0.000360	0.000720	0.000240	0.000120	0.000000	0.000000	0.000000	0.000000	0.001441
W	0.000841	0.002642	0.000841	0.000120	0.000000	0.000000	0.000000	0.000000	0.004443
WNW	0.001441	0.002161	0.000360	0.000120	0.000000	0.000000	0.000000	0.000000	0.004083
NW	0.001561	0.001561	0.001441	0.000240	0.000000	0.000000	0.000000	0.000000	0.004803
NNW	0.001321	0.002161	0.000600	0.000000	0.000000	0.000000	0.000000	0.000000	0.004083
N	0.001561	0.001561	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003122
CALM									0.000600
TOTAL	0.013569	0.019092	0.007205	0.000841	0.000000	0.000000	0.000000	0.000000	0.041306

MEAN WIND SPEED (m/s) = 2.12
NUMBER OF OBSERVATIONS = 344

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	0.003722	0.002522	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.006604
NE	0.000841	0.000841	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001681
ENE	0.000240	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000480
E	0.000000	0.000961	0.000360	0.000120	0.000000	0.000000	0.000000	0.000000	0.001441
ESE	0.000120	0.001921	0.007565	0.001441	0.000000	0.000000	0.000000	0.000000	0.011047
SE	0.000480	0.002281	0.004923	0.001081	0.000000	0.000000	0.000000	0.000000	0.008766
SSE	0.000240	0.000961	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.001681
S	0.000120	0.000000	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000240
SSW	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000120
SW	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000120
WSW	0.000841	0.000720	0.000240	0.000000	0.000000	0.000000	0.000000	0.000000	0.001801
W	0.001561	0.001561	0.003362	0.001681	0.000000	0.000000	0.000000	0.000000	0.008165
WNW	0.001321	0.003362	0.007325	0.001801	0.000000	0.000000	0.000000	0.000000	0.013809
NW	0.000841	0.003362	0.005043	0.007805	0.000000	0.000000	0.000000	0.000000	0.017051
NNW	0.000841	0.002281	0.001441	0.001801	0.000000	0.000000	0.000000	0.000000	0.006364
N	0.003482	0.004203	0.000720	0.000240	0.000000	0.000000	0.000000	0.000000	0.008646
CALM									0.002161
TOTAL	0.014890	0.025216	0.031940	0.015970	0.000000	0.000000	0.000000	0.000000	0.090178

MEAN WIND SPEED (m/s) = 3.04
NUMBER OF OBSERVATIONS = 751

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	0.012248	0.021734	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.034462
NE	0.008646	0.004203	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.013208
ENE	0.003362	0.001681	0.000120	0.000120	0.000000	0.000000	0.000000	0.000000	0.005283
E	0.002281	0.003002	0.001681	0.001441	0.000600	0.000000	0.000000	0.000000	0.009006
ESE	0.002281	0.013689	0.027498	0.034822	0.027017	0.013569	0.003602	0.001321	0.123799
SE	0.001201	0.010687	0.023175	0.028338	0.019332	0.011167	0.003362	0.001321	0.098583
SSE	0.001321	0.003242	0.001801	0.003362	0.000600	0.000600	0.000000	0.000000	0.010927
S	0.000240	0.000841	0.000720	0.000480	0.000480	0.000000	0.000000	0.000000	0.002762
SSW	0.000240	0.001321	0.000480	0.000240	0.000000	0.000000	0.000000	0.000000	0.002281
SW	0.001081	0.000480	0.000480	0.000240	0.000000	0.000120	0.000000	0.000000	0.002402
WSW	0.001441	0.003002	0.001561	0.000961	0.000360	0.000000	0.000120	0.000000	0.007445
W	0.003602	0.008766	0.005043	0.009006	0.005764	0.003362	0.001201	0.000961	0.037704
WNW	0.003722	0.009606	0.014049	0.028939	0.015370	0.004083	0.001681	0.001321	0.078770
NW	0.004683	0.017051	0.009846	0.003722	0.004563	0.001201	0.000961	0.000000	0.042027
NNW	0.004923	0.012368	0.005403	0.000841	0.000240	0.000120	0.000000	0.000000	0.023895
N	0.007685	0.024135	0.004203	0.000720	0.000120	0.000000	0.000000	0.000000	0.036864
CALM									0.002281
TOTAL	0.058958	0.135807	0.096902	0.113232	0.074448	0.034222	0.010927	0.004923	0.531700

MEAN WIND SPEED (m/s) = 4.25
NUMBER OF OBSERVATIONS = 4428

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	0.008525	0.009846	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.018372
NE	0.005644	0.006724	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.012368
ENE	0.003122	0.001201	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004323
E	0.002642	0.003602	0.000720	0.000240	0.000000	0.000000	0.000000	0.000000	0.007205
ESE	0.002762	0.011167	0.008285	0.001201	0.000000	0.000000	0.000000	0.000000	0.023415
SE	0.001921	0.007925	0.008285	0.002041	0.000000	0.000000	0.000000	0.000000	0.020173
SSE	0.001321	0.002642	0.002642	0.000240	0.000000	0.000000	0.000000	0.000000	0.006844
S	0.000600	0.001321	0.001681	0.000240	0.000000	0.000000	0.000000	0.000000	0.003842
SSW	0.000240	0.000600	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000841
SW	0.000961	0.000360	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.001441
WSW	0.000961	0.002281	0.002161	0.000120	0.000000	0.000000	0.000000	0.000000	0.005524
W	0.002522	0.006484	0.011287	0.001201	0.000000	0.000000	0.000000	0.000000	0.021494
WNW	0.001801	0.011287	0.012488	0.001921	0.000000	0.000000	0.000000	0.000000	0.027498
NW	0.002522	0.003963	0.000120	0.000000	0.000000	0.000000	0.000000	0.000000	0.006604
NNW	0.002522	0.003242	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005764
N	0.005163	0.010207	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.015850
CALM									0.003722
TOTAL	0.043228	0.082853	0.048271	0.007205	0.000000	0.000000	0.000000	0.000000	0.185279

MEAN WIND SPEED (m/s) = 2.36
NUMBER OF OBSERVATIONS = 1543

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	0.002762	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003722
NE	0.002161	0.000841	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003002
ENE	0.001081	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001561
E	0.001561	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002522
ESE	0.002281	0.001561	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003842
SE	0.002161	0.002161	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004323
SSE	0.000360	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001321
S	0.001441	0.000720	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002161
SSW	0.000720	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001201
SW	0.000720	0.000360	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001081
WSW	0.001441	0.004083	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005524
W	0.002762	0.007445	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010207
WNW	0.002161	0.003482	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005644
NW	0.001321	0.000720	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002041
NNW	0.001801	0.000961	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002762
N	0.002161	0.000720	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002882
CALM									0.006724
TOTAL	0.026897	0.026897	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.060519

MEAN WIND SPEED (m/s) = 1.45
NUMBER OF OBSERVATIONS = 504

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	0.032661	0.037824	0.001081	0.000000	0.000000	0.000000	0.000000	0.000000	0.071566
NE	0.020053	0.014769	0.000480	0.000000	0.000000	0.000000	0.000000	0.000000	0.035303
ENE	0.010567	0.005884	0.000120	0.000120	0.000000	0.000000	0.000000	0.000000	0.016691
E	0.009366	0.011047	0.003002	0.001801	0.000600	0.000000	0.000000	0.000000	0.025817
ESE	0.010327	0.035062	0.045749	0.037584	0.027017	0.013569	0.003602	0.001321	0.174232
SE	0.007685	0.031100	0.037584	0.031460	0.019332	0.011167	0.003362	0.001321	0.143012
SSE	0.006964	0.012128	0.005403	0.003722	0.000600	0.000600	0.000000	0.000000	0.029419
S	0.004443	0.004443	0.002522	0.000720	0.000480	0.000000	0.000000	0.000000	0.012608
SSW	0.002281	0.003482	0.000480	0.000240	0.000000	0.000000	0.000000	0.000000	0.006484
SW	0.003963	0.002522	0.000720	0.000240	0.000000	0.000120	0.000000	0.000000	0.007565
WSW	0.007685	0.013329	0.004443	0.001321	0.000360	0.000000	0.000120	0.000000	0.027257
W	0.013809	0.030980	0.020653	0.012008	0.005764	0.003362	0.001201	0.000961	0.088737
WNW	0.014049	0.033982	0.034222	0.032781	0.015370	0.004083	0.001681	0.001321	0.137488
NW	0.015010	0.030980	0.017051	0.011888	0.004563	0.001201	0.000961	0.000000	0.081652
NNW	0.014529	0.024856	0.007445	0.002642	0.000240	0.000120	0.000000	0.000000	0.049832
N	0.024135	0.042387	0.005644	0.000961	0.000120	0.000000	0.000000	0.000000	0.073247
CALM									0.019092
TOTAL	0.197526	0.334774	0.186599	0.137488	0.074448	0.034222	0.010927	0.004923	1.000000

MEAN WIND SPEED (m/s) = 3.29
NUMBER OF OBSERVATIONS = 8328

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 9.1%
B : 4.1%
C : 9.0%
D : 53.2%
E : 18.5%
F : 6.1%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0180	0116	0051
02	0000	0000	0000	0187	0118	0042
03	0000	0000	0000	0189	0114	0044
04	0000	0000	0000	0170	0124	0053
05	0000	0000	0000	0177	0121	0049
06	0004	0000	0006	0200	0102	0035
07	0014	0006	0032	0216	0059	0020
08	0037	0033	0077	0196	0003	0001
09	0055	0046	0097	0149	0000	0000
10	0096	0051	0088	0112	0000	0000
11	0119	0031	0077	0120	0000	0000
12	0118	0037	0065	0127	0000	0000
13	0099	0034	0080	0134	0000	0000
14	0096	0033	0073	0145	0000	0000
15	0073	0036	0066	0172	0000	0000
16	0033	0028	0060	0214	0006	0006
17	0014	0009	0030	0262	0026	0006
18	0000	0000	0000	0227	0101	0019
19	0000	0000	0000	0211	0114	0022
20	0000	0000	0000	0208	0111	0028
21	0000	0000	0000	0205	0111	0031
22	0000	0000	0000	0219	0102	0026
23	0000	0000	0000	0214	0109	0024
24	0000	0000	0000	0194	0106	0047

STABILITY CLASS BY MIXING HEIGHT

Mixing height	A	B	C	D	E	F
<=500 m	0063	0048	0165	0887	1502	0486
<=1000 m	0330	0161	0280	1432	0006	0009
<=1500 m	0365	0135	0306	1293	0035	0009
<=2000 m	0000	0000	0000	0378	0000	0000
<=3000 m	0000	0000	0000	0392	0000	0000
>3000 m	0000	0000	0000	0046	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	0048	0079	0049	0066	0062	0043	0000
02	0045	0091	0038	0074	0061	0037	0001
03	0037	0097	0052	0077	0050	0034	0000
04	0044	0107	0048	0073	0045	0030	0000
05	0095	0097	0038	0061	0041	0015	0000
06	0083	0099	0098	0038	0024	0005	0000
07	0110	0059	0103	0072	0003	0000	0000
08	0000	0060	0127	0160	0000	0000	0000
09	0000	0000	0093	0176	0078	0000	0000
10	0000	0000	0000	0227	0120	0000	0000
11	0000	0000	0000	0142	0205	0000	0000
12	0000	0000	0000	0092	0255	0000	0000
13	0000	0000	0000	0000	0347	0000	0000
14	0000	0000	0000	0000	0347	0000	0000
15	0000	0000	0000	0000	0347	0000	0000
16	0000	0000	0000	0000	0347	0000	0000
17	0003	0004	0005	0009	0313	0013	0000
18	0006	0037	0054	0016	0198	0035	0001
19	0012	0050	0078	0031	0059	0109	0008
20	0016	0048	0080	0033	0054	0106	0010
21	0017	0065	0064	0033	0074	0090	0004
22	0015	0068	0051	0045	0086	0080	0002
23	0013	0081	0051	0061	0075	0065	0001
24	0035	0082	0046	0055	0073	0056	0000

APPENDIX B
ESTIMATED DUST EMISSIONS

ESTIMATED DUST EMISSIONS : MAN South Pit Extension Project

SPE Year 5

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping in SPE	5110	365	h/y	14	kg/h						
OB - Drilling in SPE	3304	5600	holes/y	0.59	kg/hole						
OB - Blasting in SPE	15211	14	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Sh/Ex/FELs loading in SPE	29754	13800000	t/y	0.00216	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Hauling to emplace from SPE	500940	13800000	t/y	0.0363	kg/t	240	t/truck load	8.712	km/return trip	1	kg/VKT
OB - Emplacing at dumps in SPE	61987	28750000	t/y	0.0022	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Dozers on O/B in SPE	117449	7018	h/y	16.7353	kg/h	10	silt content in %	2	moisture content in %		
CL - Dozers ripping in SPE	204353	10223	h/y	19.9895	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks in SPE	86130	1275000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper from SPE	60032	1275000	t/y	0.0471	kg/t	190	t/load	8.946	km/return trip	1	kg/VKT
CL - unloading ROM coal at pile/hopper	12750	1275000	t	0.01	kg/t						
CL - Additional ROM rehandle pile to hopper	638	63750	t	0.01	kg/t						
CL - Additional handling of coal at CHPP	2952	1275000	t	0.00232	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - Additional loading of product coal stockpile	231	1020000	t	0.00023	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB dumps for SPE	323617	50	ha	6472	kg/ha/y	86	Average number of raindays	10	silt content in %	17.6873	% of winds above 5.4 m/s
WE - SPE pit	258894	40	ha	6472	kg/ha/y	86	Average number of raindays	10	silt content in %	17.6873	% of winds above 5.4 m/s
Additional loading of coal to trains	231	1020000	t	0.00023	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		

SPE Year 10

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping in SPE	5110	365	h/y	14	kg/h						
OB - Drilling in SPE	4012	6800	holes/y	0.59	kg/hole						
OB - Blasting in SPE	18470	17	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Sh/Ex/FELs loading in SPE	34713	16100000	t/y	0.00216	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Hauling to emplace from SPE	584430	16100000	t/y	0.0363	kg/t	240	t/truck load	8.712	km/return trip	1	kg/VKT
OB - Emplacing at dumps in SPE	67938	31510000	t/y	0.0022	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Dozers on O/B in SPE	118503	7081	h/y	16.7353	kg/h	10	silt content in %	2	moisture content in %		
CL - Dozers ripping in SPE	231858	11599	h/y	19.9895	kg/h	5	silt content in %	6	moisture content in %		

CL - Loading ROM to trucks in SPE	100654	1490000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper from SPE	70155	1490000	t/y	0.0471	kg/t	190	t/load	8.946	km/return trip	1	kg/VKT
CL - unloading ROM coal at pile/hopper	14900	1490000	t	0.01	kg/t						
CL - Additional ROM rehandle pile to hopper	745	74500	t	0.01	kg/t						
CL - Additional handling of coal at CHPP	3450	1490000	t	0.00232	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - Additional loading of product coal stockpile	270	1192000	t	0.00023	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB dumps for SPE	323617	50	ha	6472	kg/ha/y	86	Average number of raindays	10	silt content in %	17.6873	% of winds above 5.4 m/s
WE - SPE pit	258894	40	ha	6472	kg/ha/y	86	Average number of raindays	10	silt content in %	17.6873	% of winds above 5.4 m/s
Additional loading of coal to trains	270	1192000	t	0.00023	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		

SPE Year 15

ACTIVITY	TSP emission/year	Intensity	units	Emission factor	units	Variable 1	units	Variable 2	units	Variable 3	units
OB - Stripping in SPE	5110	365	h/y	14	kg/h						
OB - Drilling in SPE	3304	5600	holes/y	0.59	kg/hole						
OB - Blasting in SPE	15211	14	blasts/y	1086	kg/blast	29000	Area of blast in square metres				
OB - Sh/Ex/FELs loading in SPE	29754	13800000	t/y	0.00216	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Hauling to emplace from SPE	500940	13800000	t/y	0.0363	kg/t	240	t/truck load	8.712	km/return trip	1	kg/VKT
OB - Emplacing at dumps in SPE	61987	28750000	t/y	0.0022	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	2	moisture content in %		
OB - Dozers on O/B in SPE	118503	7081	h/y	16.7353	kg/h	10	silt content in %	2	moisture content in %		
CL - Dozers ripping in SPE	203373	10174	h/y	19.9895	kg/h	5	silt content in %	6	moisture content in %		
CL - Loading ROM to trucks in SPE	86130	1275000	t/y	0.0676	kg/t	6	moisture content of coal in %				
CL - Hauling ROM coal to dump hopper from SPE	60032	1275000	t/y	0.0471	kg/t	190	t/load	8.946	km/return trip	1	kg/VKT
CL - unloading ROM coal at pile/hopper	12750	1275000	t	0.01	kg/t						
CL - Additional ROM rehandle pile to hopper	638	63750	t	0.01	kg/t						
CL - Additional handling of coal at CHPP	2952	1275000	t	0.00232	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	6	moisture content of coal in %		
CL - Additional loading of product coal stockpile	231	1020000	t	0.00023	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		
WE - OB dumps for SPE	323617	50	ha	6472	kg/ha/y	86	Average number of raindays	10	silt content in %	17.6873	% of winds above 5.4 m/s
WE - SPE pit	258894	40	ha	6472	kg/ha/y	86	Average number of raindays	10	silt content in %	17.6873	% of winds above 5.4 m/s
Additional loading of coal to trains	231	1020000	t	0.00023	kg/t	1.821	average of (wind speed/2.2)^1.3 in m/s	10	moisture content of coal in %		

The dust emission inventories have been prepared using the operational description of the proposed mining activities provided by Umwelt. Estimated emissions are presented for all significant dust generating activities associated with the operations. The relevant emission factors used for the study are described below.

Stripping topsoil
An emission rate of 14 kg/h has been used for stripping topsoil (SPCC, 1983).

Drilling overburden and coal
The emission factor used for drilling has been taken to be 0.59 kg/hole (US EPA, 1985 and updates).

Blasting overburden and coal
TSP emissions from blasting were estimated using the US EPA (1985 and updates) emission factor equation given in Equation 1.

Equation 1

$$\mathrm{E}_{\mathrm{TSP}} = 0.00022 \times A^{1.5} \qquad \text{kg/blast}$$

where,
A = area to be blasted in m^2

Loading material / dumping overburden
Each tonne of material loaded will generate a quantity of TSP that will depend on the wind speed and the moisture content. Equation 2 shows the relationship between these variables.

Equation 2

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

where,
E_{TSP} = *TSP emissions*
$k = 0.74$
U = wind speed (m/s)
M = moisture content (%)
[where $0.25 \leq M \leq 4.8$]

Hauling material / product on unsealed surfaces
After the application of water the emission factor used for trucks hauling overburden or ROM coal on unsealed surfaces was 1 kg per vehicle kilometre travelled (kg/VKT).

Dozers on overburden
Emissions from dozers on overburden have been calculated using the US EPA emission factor equation (**US EPA, 1985 and updates**). The equation is as follows:

Equation 3

$$E_{TSP} = 2.6 \times \frac{s^{1.2}}{M^{1.3}} \qquad \text{kg/hour}$$

where,
E_{TSP} = TSP emissions

S = silt content (%), and
M = moisture (%)

Dozers on coal
The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in Equation 4.

Equation 4

$$E_{TSP} = 35.6 \times \frac{s^{1.2}}{M^{1.4}} \qquad \text{kg/hour}$$

where,
E_{TSP} = TSP emissions
S = silt content (%), and
M = moisture (%)

Loading coal
The **US EPA (1985 and updates)** emission factor equation has been used. It is given below in Equation 5.

Equation 5

$$E_{TSP} = \frac{0.58}{M^{1.2}} \qquad \text{kg/t}$$

where,
E_{TSP} = TSP emissions
M = moisture (%)

Unloading ROM coal and re-handling
The emission factor has been taken to be 0.01 kg/t.

Loading coal to stockpiles
See equation 2.

Loading coal to trains
See equation 2.

Wind erosion
The emission factor for wind erosion is given in Equation 6 below.

Equation 6

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

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

Grading roads
Estimated of TSP emissions from grading roads have been made using the US EPA (1985 and updates) emission factor equation (Equation 7).

Equation 7

$$E_{TSP} = 0.0034 \times S^{2.5} \qquad \text{kg/VKT}$$

where,
S = speed of the grader in km/h (taken to be 8 km/h)

Summary of modelled activities, emissions and locations

A summary of dust emission estimates for each activity, activity type, location of emission sources and activity hours are provided below. Only information for SPE Year 5 is shown below but other scenarios, as well as ISCST3 model input files, can be provided on request.

The location of the sources can be obtained from **Figure 6**.

```
 -------------------------------      05-Sep-2006 16:46
  DUST EMISSION CALCULATIONS V2
 -------------------------------

 Output emissions file  : C:\Jobs\MANSPit\iscst3\SPE_y05\emiss.dat
 Meteorological file    : C:\Jobs\MANSPit\metdata\McLeansH\man2004.isc
 Number of dust sources : 41
 Number of activities   : 17
 No-blast conditions    : None
 Wind sensitive factor  : 1.821 (1.821 adjusted for activity hours)
 Wind erosion factor    : 91.757

  -----ACTIVITY SUMMARY-----
 ACTIVITY NAME : OB - Stripping in SOUTH pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 5110 kg/y
 FROM SOURCES  : 2
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 : OB - Drilling in SOUTH pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 3304 kg/y
 FROM SOURCES  : 2
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 : OB - Blasting in SOUTH pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 15211 kg/y
 FROM SOURCES  : 2
1 2
 HOURS OF DAY  :
0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 1 1 1 0 0 0 0 0 0

 ACTIVITY NAME : OB - Sh/Ex/FELs loading in SOUTH pit
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 29754 kg/y
 FROM SOURCES  : 2
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 : OB - Hauling to emplace from SOUTH pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 500940 kg/y
 FROM SOURCES  : 12
1 2 3 10 11 12 13 14 15 16 17 18
 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 : OB - Emplacing at dumps in SOUTH pit
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 61987 kg/y
 FROM SOURCES  : 5
14 15 16 17 18
 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 : OB - Dozers on O/B in SOUTH pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 117449 kg/y
 FROM SOURCES  : 5
```

```
14 15 16 17 18
 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 : CL - Dozers ripping in SOUTH pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 204353 kg/y
 FROM SOURCES  : 2
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 : CL - Loading ROM to trucks in SOUTH pit
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 86130 kg/y
 FROM SOURCES  : 2
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 : CL - Hauling ROM coal to dump hopper from SOUTH pit
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 60032 kg/y
 FROM SOURCES  : 9
1 2 3 4 5 6 7 8 9
 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 : CL - unloading ROM coal at pile/hopper
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 12750 kg/y
 FROM SOURCES  : 1
9
 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 : CL - Additional ROM rehandle pile to hopper
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 638 kg/y
 FROM SOURCES  : 1
9
 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 : CL - Additional handling of coal at CHPP
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 2952 kg/y
 FROM SOURCES  : 2
8 9
 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 : CL - Additional loading of product coal stockpile
 ACTIVITY TYPE : Wind sensitive
 DUST EMISSION : 231 kg/y
 FROM SOURCES  : 2
8 9
 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 : WE - OB dumps at SOUTH pit
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 323617 kg/y
 FROM SOURCES  : 5
14 15 16 17 18
 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 : WE - SOUTH pit
 ACTIVITY TYPE : Wind erosion
 DUST EMISSION : 258894 kg/y
 FROM SOURCES  : 2
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 : Additional loading of coal to trains
 ACTIVITY TYPE : Wind insensitive
 DUST EMISSION : 231 kg/y
 FROM SOURCES  : 1
41
 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
```