Donaldson Coal Pty Limited

ABEL UNDERGROUND MINE PART 3A ENVIRONMENTAL ASSESSMENT

Appendix I

Air Quality Assessment

AIR QUALITY ASSESSMENT:
ABEL UNDERGROUND COAL MINE

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Prepared for
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1 INTRODUCTION

This report has been prepared by Holmes Air Sciences on behalf of Donaldson Coal Pty Ltd. It provides an air quality assessment for the proposed Abel Underground Coal Mine which is planned to be developed in an area extending southwards from John Renshaw Drive towards George Booth Drive (see **Figure 1**). The area is located within Exploration Lease 5497 (EL5497), which has a surface area of 4950 ha.

The overall approach to the assessment follows the "*Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*" (**DEC, 2005**). It is based on the use of an air dispersion model, which has been used with estimated emissions and local meteorological data to predict dust concentration and deposition levels arising from the proposal. After making appropriate allowances for existing levels of dust the predicted values have been compared with the assessment criteria published by the NSW Department of Environment and Conservation (DEC).

The modelling assessment is a level 2 assessment as defined by the DEC's assessment procedures.

2 LOCAL SETTING

As noted above, the area where the mine's surface facilities are to be developed is located within the disturbed land at the southern end of the Donaldson Open Cut. The surrounding non-mining land is either bushland or cleared land used for farming and residential use. The terrain varies from gently undulating to moderately steep slopes in the southern part of the underground mining area.

3 PROJECT DESCRIPTION

The proposed underground mine, to be known as the Able Underground Mine (Abel Mine), will produce 4.5 million tonnes of ROM coal per annum over a 20 year period. The coal from the Able Mine will be processed at the Bloomfield Coal Preparation Plant which will process a total of 6.5 million tonnes of ROM coal (coal processed being made up of coal from the Abel Mine, the Donaldson Open Cut Mine, the Tasman Mine and the Bloomfield Mine). The required changes to Bloomfield's CHPP to accommodate the Abel coal and the use of the Bloomfield CHPP in general, form part of the project subject to this Environmental Assessment and are assessed in this report.

The surface facilities of the mine will be located on the northern side of John Renshaw Drive within a 16 ha section of the Donaldson Open Cut Coal Mine where the coal has been extracted but not backfilled. The mine entries will be in the open cut highwall with a number of tunnels (roadways) driven below John Renshaw Drive to connect the surface area with the mining areas. Coal produced from the mine will be stockpiled within the surface area then transported to the existing Bloomfield Coal Handling and Preparation Plant (CHPP) by either trucks or conveyor for processing. Product coal will be loaded and despatched using the existing Bloomfield infrastructure.

Beyond the nominated surface area, no surface facilities other than small scale items such as monitoring boreholes and possibly goaf methane drainage plants will be required within the Abel Mine lease area for the first few years of the mines operating life.

The resource contains approximately 90 million tonnes of in-situ coal with a depth of cover greater than 30 m and a seam thickness greater than 1.8m. Depth of mining is between 30 m and 365 m with an average of 175 m.

It is estimated that approximately 60 million tonnes of run-of-mine coal will be recovered during the life of the mine. Following construction, output will increase in stages until full production is reached approximately 5 years later. Full production levels will be sustained for the next 10-12 years followed by a period of stepped reductions in production level.

There has been previous coal mining activity within the EL area. A number of mines have worked the Borehole seam which is located about 250 m above the Upper Donaldson seam.

4 AIR QUALITY ASSESSMENT CRITERIA

The project will result in the liberation of a number of classes of particulate matter (PM) described as total suspended particulate matter (TSP)[1], particulate matter with equivalent aerodynamic diameters 10 μm or less (PM_{10})[2] and particles with equivalent aerodynamic diameters of 2.5 μm and less ($PM_{2.5}$). These emissions would occur primarily as fugitive dust from the surface facilities and in the mine ventilation air.

There will also be emissions from vehicles and underground equipment. These emissions will include carbon monoxide (CO) and minor quantities of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). In practice these gaseous emissions will be minor and at levels that will not give rise to environmental impacts. For this reason these pollutants are not considered further in this report. The focus of the report is on the assessment of impacts due to dust.

4.1 Particulate matter

Table 1 and **Table 2** summarise the air quality goals that are relevant to this study. The air quality goals relate to the total dust burden in the air and not just the dust from the project. In other words, consideration of background levels needs to be made when using these goals to assess impacts. The assessment criteria are designed to protect human health.

[1] TSP is particulate matter suspended in the air and measured using a high volume sampler operated according to AS2724.3-1984. The size range of particles is indeterminate and depend on the measurement conditions. TSP is usually taken to comprise particles in the size range up to 0 to 50 μm. Particles larger than 50 μm are generally too large to remain suspended in the air for long enough to be considered as air pollutants.

[2] A particle is said to have an equivalent aerodynamic diameter of x μm if its dynamical behavior in the atmosphere is the same as a sphere of diameter x and with density 1 g/cm^3.

Table 1. Air quality standards/goals for particulate matter concentrations (Source: DEC, 2005)

POLLUTANT	STANDARD / GOAL	AVERAGING PERIOD	AGENCY
Total suspended particulate matter (TSP)	90 µg/m^3	Annual mean	National Health and Medical Research Council (NSW DEC, 2005)
Particulate matter < 10 µm (PM_{10})	50 µg/m^3	24-hour maximum	NSW DEC (2005) (assessment criteria)
	30 µg/m^3	Annual mean	NSW DEC (2005) (long-term reporting goal)
	50 µg/m^3	(24-hour average, 5 exceedances permitted per year)	National Environment Protection Measure (NEPC, 1998)

µg/m^3 – micrograms per cubic metre
µm - micrometre

4.2 Dust deposition

In addition to health impacts, airborne dust also has the potential to cause nuisance impacts by depositing on surfaces and possibly vegetation/crops. **Table 2** shows the maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective. The criteria for dust fallout levels are set to protect against nuisance impacts (**NSW EPA, 2001**).

Table 2. DEC criteria for dust (insoluble solids) fallout

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

5 EXISTING AIR QUALITY

Monitoring programs to characterise the meteorological conditions and existing air quality have been in place since late 1999 as part of the Donaldson Open Cut Air Quality Management Plan (AQMP). There was however a gap of four months in the data from January 2000 until May 2000 when monitoring recommenced. It has remained relatively uninterrupted since that time. The data analysed in this report is from May 2000. **Figure 1** shows the locations of the meteorological station and air quality monitors. The air quality monitoring plan comprises eleven dust deposition gauges, one TSP monitor and one PM_{10} monitor. In addition, the DEC's PM_{10} monitor at Beresfield provides useful information on regional PM_{10} concentrations.

The monitoring data includes the effects of all emission sources that were active at the time of the monitoring. This includes the effect of emissions from mining at

Bloomfield and the effect of emissions from the Bloomfield Coal Handling and Preparation Plant (CHPP). In the modelling (see later) emissions from the CHPP and the associated stockpiles have been included as new sources. Strictly, only the increased emissions due to coal from the Abel Project will be new emissions. This will mean that the assessment double counts the effect of some of the emissions, namely the existing emissions. This is because the effect of these is already included in the monitoring data. The advantage of including the CHPP emissions in the modelling is that it allows that CHPP to be considered as an integral part of the project, which will be the case. The effect of the double counting is small and will be conservative (i.e. will exaggerate impacts) and so the approach has been taken to be compatible with the DEC's assessment procedures as set out in their approve dmethods (**DEC, 2005**).

5.1 Dust deposition monitoring

The results of the dust deposition monitoring are summarised in **Table 3** and **Table 4**. **Table 3** shows the annual average dust deposition values recorded throughout the monitoring network from 2000 to 2005 (inclusive). **Table 4** shows the most recent 12 months of data (at the time of writing) leading up to and including April 2006. A table showing a complete list of all dust deposition data collected at each gauge since May 2000 can be found in **Appendix A**.

Gauges D1, D2, D3, D4, D5A and D10 provide data for the area potentially affected by the Abel project. Gauges D6, D7, D8, D9 and D11 are too far from the project area to be representative of conditions there, but do provide information on air quality conditions in the general area. The only annual averages that exceed the DEC criterion for dust fallout are at DG8 in 2001 and 2002. These high averages were caused by a few elevated monthly readings that were not attributable to mining activity and do not indicate poor air quality.

Table 3. Annual average dust deposition from 2000 to 2006

Year	Annual average dust deposition rate (g/m²/month)										
	DG1	DG2	DG3	DG4	DG5A	DG6	DG7	DG8	DG9	DG10	DG11
2000*	1.5	0.7	1.1	0.9	1.0	0.7	3.0	2.6	0.7	0.8	-
2001	1.0	1.0	1.8	0.8	0.9	0.9	2.7	4.7	1.0	1.6	1.3
2002	1.3	1.0	2.4	1.0	0.9	1.1	1.7	4.0	1.1	0.9	1.5
2003	0.9	0.7	1.1	1.0	0.6	1.3	1.4	2.3	1.2	1.2	1.9
2004	1.3	0.8	2.1	1.2	0.8	1.7	1.1	3.7	1.5	2.5	1.3
2005	1.1	1.8	1.5	1.3	1.1	1.8	1.4	2.8	1.4	1.6	1.7
2006*	1.1	1.1	1.5	0.9	1.2	1.8	1.0	2.0	0.9	1.6	1.6

** The annual averages calculated for 2000 and 2006 are not for complete years. The value for 2000 includes data from May 2000 (when monitoring began) to December 2000, while the value for 2006 includes data from January to April 2006 only as this was all that was available at the time of writing.*

Table 4. Dust deposition monitoring for the 12-month period to April 2006

Month	Monthly dust deposition rate (g/m²/month)										
	DG1	DG2	DG3	DG4	DG5A	DG6	DG7	DG8	DG9	DG10	DG11
May-05	0.7	8.6#	1.1	0.8	0.7	0.8	0.9	4.4	1.2	0.8	1.1
Jun-05	1.3	0.8	1.2	1.2	0.8	1.2	1.2	1.3	1.5	2.5	0.9
Jul-05	1.0	0.5	0.5	0.7	0.4	1.6	0.7	1.2	0.8	4.3	1.1
Aug-05	0.6	0.6	0.8	1.0	0.8	0.9	0.7	1.0	0.9	1.0	0.9
Sep-05	0.6	0.7	0.8	0.7	0.7	1.2	1.3	1.3	1.0	0.9	1.1
Oct-05	0.8	0.9	1.3	0.9	0.8	1.4	1.2	1.9	1.3	1.1	1.3
Nov-05	+	2.3	2.3	2.0	1.7	1.2	2.0	3.2	1.6	1.4	2.2
Dec-05	1.9	3.2	2.3	3.3	2.6	3.4	2.3	+	1.3	2.1	3.9
Jan-06	1.0	2.1	2.7	1.0	2.3	3.5	+	2.7	1.1	+	1.5
Feb-06	2.2	1.0	0.9	1.2	1.1	1.7	1.1	2.9	*	2.3	1.8
Mar-06	0.7	0.6	2.3	0.7	0.6	0.9	1.0	1.4	0.7	0.8	1.5
Apr-06	0.6	0.7	1.1	0.8	0.6	1.1	0.8	1.0	1.0	1.8	1.5
Annual Average	**1.0**	**1.8**	**1.4**	**1.2**	**1.1**	**1.6**	**1.2**	**2.0**	**1.1**	**1.7**	**1.6**

** Funnel broken (vandals?)*
 # Insects and bird droppings reported
+ Invalid due to excess bird droppings
Data supplied by Metford Laboratories

Measured dust deposition levels were generally low and all gauges have recorded deposition levels less than the DEC's annual average assessment criterion of 4 g/m²/month in the twelve months up to and including April 2006.

In May 2005, DG2 measured a monthly deposition level of 8.6 g/m²/month, which is much higher than at any time since monitoring began in May 2000. The reading of 8.6 g/m²/month was associated with contamination of the sample by insects and bird droppings. This is not indicative of poor air quality. DG8 recorded the highest annual average deposition rate of 2 g/m²/month. None of the higher readings (May and Nov 2005) are attributable to mining activity.

Overall, dust deposition levels appear to be at satisfactory levels and an increment of up to 2 g/m²/month in the annual average dust (insoluble solids) deposition levels would be acceptable under the DEC's assessment procedures.

5.2 Dust concentration data

Measurements of PM_{10} and TSP concentrations made at sites referred to as Beresfield and Blackhill (see **Figure 1**) from May 2000, are presented in **Figure 2**. Although there have been numerous occasions (27 occasions) when the 24-hour average PM_{10} concentration at Beresfield has exceeded the DEC's criteria of 50 μg/m³, there has been only one such occasion in the past 12 months (December 2005). Similarly, since May 2000 there have been eight occasions when 24-hour average PM_{10} concentration has exceeded 50 μg/m³ at the Blackhill monitor, but none of these has occurred in the last 12 months.

The annual average PM10 concentration (running mean) at Beresfield exceeded the DEC 30 μg/m3 criterion for a period running from late 2002 to the end of 2003, but has been below the criterion since that time. The annual average PM10 concentration at Blackhill has not exceeded the criterion since monitoring commenced in May 2000. The annual average TSP concentration at Blackhill has also been lower than the DEC 90 μg/m3 criterion since monitoring commenced.

Although emissions from mining at Donaldson and Bloomfield will theoretically contribute to concentrations of PM_{10} and TSP at these Beresfield and Blackhill sites, modelling (see later) indicates that the contributions are likely to be small and are unlikely to have caused, or contributed significantly to, the measured exceedances. The highest concentrations measured are clearly not related to emissions from mining because they occur at both the Beresfield and Blackhill sites on the same days (see **Figure 2**). The location of the mines (between the two monitoring sites) makes it impossible for emissions from the mines to contribute to both monitors simultaneously and even when averaged over a 24-hour period it is highly unlikely that emissions would cause high concentrations at two sites on opposite sides of the mines. The mostly likely explanation for the elevated levels is regional air pollution caused by bushfire smoke or regional dust storms of sufficient scale to affect both monitoring sites.

Thus, as with dust deposition, PM_{10} and TSP concentrations are satisfactory at present, but emission sources of PM_{10} that might affect air quality in the Beresfield area, should be carefully controlled to ensure that the area continues to comply with the DEC annual and 24-hour criteria of PM_{10}. The Abel project is unlikely to contribute significantly to the PM_{10} burden in the Beresfield area (see model results in **Section 9**).

6 METEOROLOGICAL CONDITIONS

6.1 Wind speed and wind direction

A meteorological station has been operated since 1999 as part of the Donaldson Project environmental monitoring program. The weather station is located on the mine site but is unavoidably affected by the trees. Therefore, the weather station's exposure does not comply with Australian Standard 2923-1987, which specifies the requirements for the exposure of weather stations used to collect wind speed and wind direction data for modelling. For this reason, the modelling work has been undertaken using data from the nearby DEC meteorological station at Beresfield (see **Figure 1**). It is nevertheless interesting to compare the meteorological conditions recorded onsite with the conditions recorded at the DEC monitoring site.

Wind roses prepared from the DEC's weather station for the period 1 August 2005 to 31 July 2005 at Beresfield are shown in **Figure 3**. Seasonal and annual wind roses for the same period from the Donaldson Mine's meteorological station are presented in **Figure 4**. The two sites show a similar distribution of winds, but the Donaldson site shows a much higher frequency of light winds. This is not unexpected given the shielding effect of the vegetation on the mine site. The winds at Beresfield also appear to be rotated slightly, approximately 20 degrees or so clockwise, relative to the mine site data.

The wind roses show that over the year the most common winds are from the west, west-northwest and east-southeast and southeast. Westerlies are most common in the winter and the southeasterlies in the summer. Autumn and spring show an intermediate pattern between that which applies in the summer and the winter.

Given the better exposure of the Beresfield site it is more appropriate to use the DEC data for modelling.

6.2 Temperature and rainfall

Bureau of Meteorology data from the East Maitland Bowling Club provide a longer record of data than is available from either the Donaldson or DEC weather stations, and the Bureau of Meteorology's data set is useful for parameters such as temperature and rainfall. The Bureau of Meteorology's data are shown in **Table 5**.

Temperatures are typical of the NSW Central Coast. January is the warmest month with a mean daily maximum temperature of 30.7 °C and July is the coolest with a mean daily minimum temperature of 5.8 °C.

Rainfall data, in particular the number of rain days that can be expected per year, is of particular importance in estimating dust emissions from wind erosion. Over approximately 82 years of records, there have been approximately 84.7 rain days per year. This figure has been used in compiling the dust emissions estimates (see **Section 8**).

Table 5. Bureau of Meteorology data from East Maitland Bowling Club

Climate averages for Station: 061034 EAST MAITLAND BOWLING CLUB Commenced: 1902; Last record: 1994; Latitude (deg S): -32.7483; Longitude (deg E): 151.5833; State: NSW

Element	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	No. of years	Percentage complete
Mean daily maximum temperature - deg C	30.7	29.6	27.7	24.3	20.1	17.1	16.5	18.6	21.9	25.3	28.3	30.1	24.2	91.3	83
Mean no. of days where Max Temp >= 40.0 deg C	1.3	0.5	0.3	0	0	0	0	0	0	0	0	0.5	2.5	3.3	91
Mean no. of days where Max Temp >= 35.0 deg C	5.8	6.5	2.3	0	0	0	0	0	0.3	0.7	3.7	2.5	21.7	3.3	91
Mean no. of days where Max Temp >= 30.0 deg C	11.8	12.8	10.8	2.7	0	0	0	0	1.7	4.3	9.3	9.5	62.8	3.3	91
Highest daily Max Temp - deg C	41.1	42.8	40	33.3	29.4	23.9	22.8	28.3	35.6	38.3	39.4	40	42.8	3.3	93
Mean daily minimum temperature - deg C	17.6	17.6	15.7	12.3	8.9	7	5.8	6.8	8.9	11.8	14.3	16.4	11.9	91.3	83
Mean no. of days where Min Temp <= 2.0 deg C	0	0	1	0	3.7	7.3	8.3	2.7	0.7	0	0	0	23.6	3.3	91
Mean no. of days where Min Temp <= 0.0 deg C	0	0	0.3	0	0.3	3.7	3	0.7	0	0	0	0	7.9	3.3	91
Lowest daily Min Temp - deg C	7.2	11.1	-6.7	3.9	0	-2.8	-2.9	0	0.6	4.4	5	7.8	-6.7	3.3	88
Mean 9am wind speed - km/h	6.9	8.5	6.3	5.8	4.7	6.7	13	6.9	7.8	7.2	9.7	5.7	7.5	2.1	60
Mean monthly rainfall - mm	89	94.1	96.5	87.4	70.3	84.2	58.1	52.2	54.8	65.5	61.6	81.3	894.9	85.4	93
Median (5th decile) monthly rainfall - mm	70.4	74.6	82.8	60.8	42.9	47.1	38.9	38.1	42.7	52.2	49.8	64.3	886.3	79	
9th decile of monthly rainfall - mm	169.5	202.2	209.7	182.8	189.3	189.6	137.4	111.3	127.8	153.6	127.5	171.5	1197.6	79	
1st decile of monthly rainfall - mm	18.2	10.8	19.8	18	8.5	13.1	7.3	7.5	6.4	7.7	8.5	11.6	564.6	79	
Mean no. of raindays	7.9	7.8	7.7	7.7	6.7	7.5	6.6	6.2	6.2	7.4	6.5	6.4	84.7	80.8	88
Highest monthly rainfall - mm	430.2	455.8	263.6	454.7	328.5	554.2	237.2	440.1	217.3	279.4	201.8	300		85.4	93
Lowest monthly rainfall - mm	0	0	0	0	0.8	1.5	0	0.3	0	1.1	0	0		85.4	93
Highest recorded daily rainfall - mm	103.4	171.2	119	190.5	115	287.5	129.5	124.5	102.4	168	88	142.7	287.5	84.4	92

7 APPROACH TO ASSESSMENT

In August 2005, the DEC published new 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 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 closely as possible the approaches suggested by the guidelines.

The remainder of 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 $PM_{2.5}$, 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 4.68% 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. 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 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 or quarry operations 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 location of activities for the modelled scenario. 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) and also correspond with periods of poor dispersion. If these measures are not taken then the model has the potential to significantly overstate impacts.

Dust concentrations and deposition rates have been predicted over the area shown in **Figures 5** to **8**. Local terrain has been included in the modelling.

The modelling has been performed using the DEC meteorological data from Beresfield (as discussed in **Section 6.1**) and the dust emission estimates from **Section 8**. Dust emissions from wind erosion sources have been modelled for 24 hours per day in all modelling scenarios. Model predictions have been made at 432 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 nearby receptors.

The ISCST3 model input files will be provided in electronic form on request.

The model ISCST3 was used in this instance as it has been the most widely used model in NSW for assessing the dust impacts of extractive industries. AUSPLUME is the DEC's model of first choice but it has had limited use in dust modelling applications. AUSPLUME is also not able to handle the large number of sources that have to be included to realistically represent the mine and its time-varying emissions. Dust impacts and model predictions using ISCST3 are presented as contour plots in **Figures 5** to **8**.

An objective of most air dispersion models is to predict off-site pollutant levels as close as possible to levels that would be measured by conventional monitoring techniques. In situations where detailed information on existing operations are available as well as concurrent ambient air quality monitoring data, there have been opportunities to assess the performance of a model by comparing model predictions with measured values. Differences between modelled and measured values may be due to the model itself, the emission estimates or from the modelling approach. Depending on the difference between modelled and measured values, a correction to the model results may then be considered necessary to provide reliable predictions for future scenarios.

A calibration study 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 appear 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 ISCST3 model are to be conducted as part of the approval conditions for the Mt Owen Mine. At this time the results of these studies are not available.

Comparisons between ISCST3 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) ISCST3 predictions. Although the comparison between AUSPLUME and ISCST3 shows varying difference, AUSPLUME has consistently predicted almost 50% lower than uncorrected ISCST3 predictions. Thus AUSPLUME may have some advantages over ISCST3 in that it more accurately predicts 24-hour average concentrations of PM_{10}, which are known to be consistently overestimated by ISCST3.

Results from a simplified model comparison of AUSPLUME and ISCST3 suggested 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 ISCST3 than for AUSPLUME (see **Appendix C**). The difference between the models had some dependence on the meteorological conditions. Different results from the two models were largely explained by the way in which each model has interpreted plume dispersion curves.

The approach taken in this study has been to make use of a recent model calibration analysis conducted as part of an assessment for the Bengalla Mine (**Holmes Air Sciences, 2006**). This study used monitoring data around the Bengalla Mine to develop a site specific relationship between predictions and measurements of 24-hour PM_{10} concentrations. It was concluded from the Bengalla analysis that model predictions of 24-hour average PM_{10} concentrations due to the mining operations were 1.6 times greater than measured concentrations. The approach to the emission estimates and modelling for the Bengalla Mine was similar to the approach adopted for this assessment, although the meteorological conditions are likely to be different. In the absence of better data the same calibration factor has been used. That is, model results for 24-hour average PM_{10} concentrations have therefore been divided by 1.6 to account for model over-prediction.

8 ESTIMATES OF DUST EMISSIONS

8.1 The project

Dust emissions from the proposal will arise from a number of sources and activities. These include:

- The mine ventilation system;
- Loading coal to the raw coal stockpile;
- Wind erosion from stockpiles;

- Dust loss from the conveyor system;
- or
- from trucking of coal (using sealed internal haul road) instead of conveying;

- Loading coal to the Bloomfield CHPP stockpile;
- Emissions from the Bloomfield CHPP; and
- Loading coal to trains at Bloomfield.

Estimates of emissions from these sources are provided below. In estimating emissions the calculations have been carried through to showing emissions to within 1 kg. This has been done for convenience in checking the calculations. It is not intended to imply that the estimates carry this level of precision. The accuracy of the estimation methods is variable. Overall, model predictions are affected by uncertainties in the estimated emissions, uncertainties in meteorological conditions and uncertainties introduced by the way in which the model simulates dispersion. These uncertainties cannot be precisely quantified.

In estimating the emissions, it is necessary to define the boundaries of the development. This is important because the project will make use of the Bloomfield CHPP, which will also handle coal from the Bloomfield, Donaldson and Tasman mines as well as the Abel project. In assessing the emissions from the CHPP area, it has been assumed that the CHPP will process 6,500,000 t/y and that all these emissions are part of the project and the wind erosion emissions from the raw coal and product coal stockpiles are also attributable to the project. That is when estimating emissions from the CHPP and the associated ROM/raw coal and product coal stockpiles associated with the CHPP there has been no attempt to identify the contribution that arises specifically from Abel coal.

This will result in some double counting of the emissions in the sense that some of the emissions from the Bloomfield stockpile are already occurring. The emissions from the CHPP that are strictly attributable the Abel project will be that from 4.5 Mtpa not the 6.5 Mtpa. However, the CHPP is a necessary part of the Abel project and it is difficult to separate the effects of how much of the emissions are due to the Abel project. Assuming that all the stockpile and CHPP emissions are part of the project is a conservative assumption.

8.1.1 Mine ventilation system

Initially mine ventilation air will be discharged at approximately 30 m^3/s but will increase to approximately 300 m^3/s by Year 25. The concentration of particulate matter in the air is unknown and will depend on a number of factors, in particular the effectiveness of dust controls in the mine. Concentrations are unlikely to exceed 5 mg/m^3 and so an upper limit for the estimated dust emissions from the ventilation system, working at 300 m^3/s, is 47,304 kg/y [300 m^3/s x 5 x 10^{-6} kg/m^3 x 3600 s/h x 8760 h/y].

8.1.2 Loading raw coal to stockpile

Each tonne of coal loaded will generate a quantity of TSP depending on the wind speed and the moisture content. Equation 1 shows the relationship between these variables.

Equation 1

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

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

The average of $(U/2.2)^{1.3}$ in the Beresfield data is 1.51. Assuming that the coal moisture content is 4.8% (the highest value for which the equation has been validated, but less than the expected moisture content of the coal) and that the wind conditions are represented by the data from Beresfield, the emission factor is 0.0005 kg/t. Further, assuming a raw coal production rate of 4.5 Mtpa (the design capacity of the mine) the estimated TSP emission rate is 2,250 kg/y [0.0005 kg/t x 4,500,000 tpa].

8.1.3 Wind erosion from stockpiles at Abel and Bloomfield

The emission factor for wind erosion can be calculated from Equation 2 below.

Equation 2

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

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

From the Beresfield data f is 9.7% and the average number of rain days (from data collected by the Bureau of Meteorology observation site at the East Maitland Bowling Club) is 84.7 days/y over approximately 81 years of records. If the silt content of the raw coal is taken to be 10% then the TSP emission factor is estimated to be 24 kg/ha/day. Assuming the stockpile area is 1.5 ha the estimated TSP emission is 13,140 kg/y.

The stockpile area at the Bloomfield CHPP, which will handle coal from Bloomfield, Abel and other mines, will be expanded to occupy 19.72 ha comprised of 8.95 ha for the expanded ROM/raw coal stockpiles and 10.76 ha for the clean/product coal stockpiles. (These areas refer to the stockpile pad areas). The estimated TSP emissions from the stockpiles will be 172,747 kg/y [19.72 ha x 24 kg/day x 365 days/y].

8.1.4 Transporting coal from Abel to Bloomfield

8.1.4.1 Dust loss from the conveyor system

The conveyor system for transferring coal from the surface facilities to the Bloomfield CHPP will be approximately 3.7 km long and will be constructed when the production level from the Abel Mine justifies its use. Before the installation of the conveyor raw coal from the Abel Mine will be trucked (see **Section 8.1.4.2**).

Assuming that the effective width of the erodable material on the conveyor is 1.5 m the total area that could contribute to wind erosion is 0.55 ha. Assuming that the emission from this occurs at the same rate as from the stockpile (i.e. 24 kg/ha/day) the total estimated TSP emission is 4,818 kg [0.55 ha x 24 kg/ha/day x 365 days/y].

8.1.4.2 Transporting coal from ROM stockpile to Bloomfield (until conveyor is constructed)

Prior to construction of the conveyor system for transferring coal from the surface facilities to the Bloomfield CHPP raw coal will be trucked. While the conveyor will most likely be installed before raw coal production has reached 4.5 Mtpa, for assessment purposes it has been assumed that there will be a period when 4.5 Mtpa of coal will be trucked in 45 t trucks from the Abel Mine to the Bloomfield CHPP following very closely the same route used by the conveyor. Assuming that the haul road will be sealed and that each truck generates 0.2 kg/VKT, the trucking operation will result in the generation of TSP at the rate of 148,000 kg/y [(4,500,000 t / 45 t) trips/y x 0.2 kg/VKT x (2 x 3.7) km/trip].

8.1.5 Loading coal to the Bloomfield CHPP stockpile

The estimated emission from loading coal to the CHPP stockpile will be the same as the emission associated with loading to the raw coal stockpile, namely 13,140 kg/y.

8.1.6 Emissions from the Bloomfield CHPP

Emissions from CHPPs are difficult to estimate. Almost all processes occur with moisture levels that are too high to allow direct emissions of dust and many of the processes occur in an enclosed environment. However emissions of water droplets carrying coal particles will occur and these will dry and give rise to emissions of dust. Typically, the emission is estimated to be equivalent to six transfers of coal and thus the estimated TSP emission will be 19,500 kg/y [6 x 6,500,000 t/y x 0.0005 kg/t].

8.1.7 Loading coal to trains at Bloomfield

Loading Abel coal to trains at Bloomfield is estimated to produce an emission similar to the loading of raw coal to the stockpile. Conservatively assuming that 4.5 Mtpa of product coal is loaded to trains the TSP emission is estimated to be 2,250 kg/y.

8.1.8 Summary

The emissions from the major dust sources associated with the Abel project are summarised below:

•	The mine ventilation system	47,304
•	Loading coal to the raw coal stockpile	2,250
•	Wind erosion from stockpile at Abel	13,140
•	Wind erosion from stockpile at Bloomfield	172,747
•	Dust loss from the conveyor system	4,818
or		
•	Dust from trucking coal to Bloomfield via an sealed haul road	
•		148,000
•	Transferring raw coal to trucks	2,250
•	Loading coal to the Bloomfield CHPP stockpile	2,250
•	Emissions from the Bloomfield CHPP	19,500
•	Loading coal to trains at Bloomfield	2,250
•	[3]Total (with conveyor)	264,259 kg/y
•	Total (with trucking using sealed haul road)	409,691 kg/y.

8.2 Cumulative emissions

There will also be particulate matter from emissions from sources not associated with the Abel project. These will include emissions from mining at the Bloomfield and Donaldson open cut mines and the existing industrial, commercial and domestic emissions sources. In addition, there are also natural sources of particulate matter that currently liberate particulate matter to the airshed in the Newcastle/Maitland area. In practice the dominant local sources (namely Bloomfield and Donaldson open cuts) are not expected to change significantly in the near future and so the effect of emissions from the existing emission sources can be appropriately included into the assessment by taking the existing background levels and assuming that these are maintained into the future. Emissions from the Abel development will add to these.

9 ASSESSMENT OF IMPACTS

The effects of dust emissions from the project can be assessed by examining the predicted concentration and deposition levels shown in **Figures 5** to **12**. **Figures 5** to **8** show the predicted dust concentration and deposition levels with the Abel Underground Coal Mine operating at its design capacity of 4.5 Mtpa (raw coal) and the Bloomfield CHPP operating with a throughput of 6.5 Mtpa and coal being transferred from the Abel Mine raw coal stockpile to the Bloomfield CHPP by conveyor.

[3] Note: the dust emission using trucks allows for an emission due to the loading of coal to the trucks and for the dust generated either from the sealed road. The project has committed to seal the haul road if the haul road option is selected. Emissions from loading coal to the conveyor have been assumed negligible.

Figures 9 to **12** show the effects of the same operations but with the assumption that coal is transferred from the Abel Mine raw stockpile to the Bloomfield CHPP by truck rather than by conveyor. Because this represents the worst-case, the assessment focuses on this case. The results for the worst-case are discussed below.

9.1 24-hour PM_{10} concentration

Figure 9 shows the predicted maximum 24-hour average PM_{10} concentrations. It can be seen that the most affected residence is located approximately 1 km to the southeast of the surface facilities. This residence is predicted to experience a worst-case increase in 24-hour average PM_{10} concentrations of approximately 30 $\mu g/m^3$. This is less than the DEC's 50 $\mu g/m^3$ assessment criterion.

The 24-hour average PM_{10} concentrations could still exceed the assessment criterion on days when the background-level of PM_{10} are above 20 $\mu g/m^3$ at a time when emissions from the Abel project were at the highest level. This will happen from time to time, particularly when air quality is affected by bushfire smoke.

9.2 Annual average PM_{10} concentration

Figure 10 shows the predicted annual average PM_{10} concentrations. Again the most-affected residence is located approximately 1 km to the southeast of the surface facilities and is predicted to experience an increase in annual average PM_{10} concentrations of approximately 7 $\mu g/m^3$. This is less than the DEC's 30 $\mu g/m^3$ annual average assessment criterion. Annual average PM_{10} concentrations would need to exceed 23 $\mu g/m^3$ before the criterion would be exceeded. The annual average PM_{10} concentration measured at Beresfield over the twelve month period 1 August 2004 to 31 July 2005 was 19.0 $\mu g/m^3$. (This period included 319 days of valid 24-hour average PM_{10} measurements). The long-term average PM_{10} concentrations at Blackhill since monitoring commenced in May 2000 has been 19.2 $\mu g/m^3$ and the average over most recent 12 months is 14.7 $\mu g/m^3$. Based on this analysis it is unlikely that the annual average PM_{10} assessment criterion would be exceeded at the most affected residence.

9.3 Annual average TSP concentration

Figure 11 shows the predicted annual average TSP concentrations. Again the most-affected residence is located approximately 1 km to the southeast of the surface facilities and is predicted to experience an increase in annual average TSP concentrations of approximately 9 $\mu g/m^3$. This is less than the DEC's 90 $\mu g/m^3$ annual average assessment criterion. Annual average TSP concentrations would need to exceed 82 $\mu g/m^3$ before the criterion would be exceeded. The annual average TSP concentration data from Blackhill has never exceeded 50 $\mu g/m^3$ since the monitoring program commenced in May 2000. It is unlikely that the annual average TSP assessment criterion would be exceeded at the most affected residence.

9.4 Annual average dust (insoluble solids) levels

Figure 12 shows the predicted annual average dust (insoluble solids) deposition levels. Again, the most-affected residence is located approximately 1 km to the southeast of the surface facilities and is predicted to experience an increase in annual average dust (insoluble solids) deposition level of approximately 1 g/m²/month. This is less than the DEC's annual average increment of 2 g/m²/month that has been determined as an acceptable increase.

10 GREENHOUSE GAS ISSUES

Greenhouse gas inventories are calculated according to a number of different methods. The procedures specified under the Kyoto Protocol United Nations Framework Convention on Climate Change are the most common.

The protocol identifies greenhouse gases as follows:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulphur hexafluoride (SF_6).

Carbon dioxide and N_2O are formed and released during the combustion of gaseous, liquid and solid fuels. The most significant gases for the current proposal are CO_2 and N_2O, which will be liberated when fuels are burnt in diesel power equipment and in the generation of the electrical energy that will be used by the project.

Inventories of greenhouse gas emissions can be calculated using published emission factors. Different gases have different greenhouse warming effects (potentials) and emission factors take into account the global warming potentials of the gases created during combustion.

The global warming potentials assumed in the Australian Greenhouse Office (AGO) (**2005**) emission factors are as follows:

- CO_2 – 1
- CH_4 – 21
- N_2O – 310
- NO_2 – not included.

When the global warming potentials are applied to the estimated emissions then the resulting estimate is referred to in terms of CO_2-equivalent emissions.

The emission factors published by the Australian Greenhouse Office (AGO) (**2005**) have been used to convert fuel usage and electricity consumption into CO_2-equivalent emissions. The relevant emission factors are:

1. 3.0 kg CO_2-equivalent/litre for diesel usage – based on full fuel cycle analysis (see Table 3 of **AGO (2005)**)
2. 0.985 kg CO_2-equivalent/kWh of electrical energy used in NSW (estimated factor for NSW 2005 see Table 25 of **AGO (2005)**).

The project will liberate greenhouse gases as a result of the combustion of diesel to power mining equipment, the use of electrical energy and as a result of methane in the mine ventilation air. Information on fuel and electricity consumption and methane emissions for selected years is provided in **Table 6**.

It is interesting to note that a substantial fraction of the emission is due to emissions of methane in the mine ventilation air.

The estimated annual emission of CO_2-equivalent are in the range 5,807 t/y in Year 1 to 709,560 t/y in Year 25. These can be compared with the estimated total CO_2-equivalent emissions for Australia in 2003 of 550 Mt calculated using the Kyoto protocol calculation methods (**Australian Greenhouse Office (2005)** - web site).

Table 6. Estimated emission of CO2-equivalent for selected years (assuming use of conveyor to transport coal to Bloomfield CHPP)

	Unit Rates	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 15	Year 25
Mine Output (tpa)		149,406	995,387	1,953,997	2,980,850	3,713,250	4,416,120	4,416,120	4,416,120
Mining Sections		1	3	4	6	7	8	8	8
Diesel Units		2	6	8	12	14	16	18	20
Ventilating Quantity (m3/s)	30 cu m/unit	80	90	120	180	210	240	270	300
Methane Content (%)		0.00	0.05	0.10	0.15	0.20	0.25	0.35	0.50
Fan Drive (kW)		150	250	400	600	750	900	950	985
Mining Equipment (kW)	425 kW/Unit	425	1,275	1,700	2,550	2,975	3,400	3,400	3,400
Panel Conveyors (kW)	125 kW/Unit	125	375	500	750	875	1,000	1,000	1,000
Trunk Conveyors (kW)		200	300	400	500	600	700	750	800
Overland Conveyors		0	0	1,500	1,750	2,000	2,250	2,250	2,250
Lighting (kW)		5	10	15	20	20	20	20	20
Electrical Electrical Power - Mining (MWhr/y)	4,800hrs	2,040	6,120	8,160	12,240	14,280	16,320	16,320	16,320
Electrical Power - Conveying (MWhr/y)	5,280hrs	1,716	3,564	4,752	6,600	7,788	8,976	9,240	9,504
Electrical Power - Ventilation (MWhr/y)	8,112hrs	1,217	2,028	3,245	4,867	6,084	7,301	7,706	7,990
Electrical Power - CHPP (MWhr/y)	1W/tonne	149	995	1,954	2,981	3,713	4,416	4,416	4,416
Electrical Power - Lighting (MWhr/y)	3,276hrs	16	33	49	66	66	66	66	66
Total Electrical Power (MWhr/y)		**5,139**	**12,740**	**18,160**	**26,754**	**31,931**	**37,078**	**37,748**	**38,296**
Hydrocarbons - Coal Hlge Deisel (l/yr)	0.21 l/t	32,016	213,297	209,357	0	0	0	0	0
Hydrocarbons - Surf Deisel (l/yr)		5,000	6,000	7,000	8,000	9,000	10,000	10,000	10,000
Hydrocarbons - UG Deisel (l/yr)	105,000 l/unit	210,000	630,000	840,000	1,260,000	1,470,000	1,680,000	1,890,000	2,100,000
Hydrocarbons - Petrol (l/yr)	1,500 l/unit	1,500	1,500	2,250	2,250	2,250	3,000	3,750	4,500
Total CO2-equivalent emission (t/yr)		**5,807**	**36,388**	**77,828**	**157,883**	**234,572**	**325,425**	**489,915**	**753,624**
Total CO2-equivalent emission (due to emission of methane) (t/yr)		**-**	**21,287**	**56,765**	**127,721**	**198,677**	**283,824**	**447,023**	**709,560**

11 MITIGATION MEASURES

Mitigation measures that will be applied to control dust from the project are listed below:

- Stockpiles at the mine portal will be below ground level;
- Stockpiles will be fitted with water sprays;
- Conveyors will be enclosed on three sides;
- Monitoring of meteorological conditions, dust deposition and concentration levels will be continued using the current monitoring network with modifications as required by the DEC
- Regular analysis and reporting of the monitoring results will be undertaken to identify any problems should these arise; and
- Vegetation will be maintained around the mine surface facilities to mitigate visual impacts and reduce off-site transport of dust.

12 SUMMARY AND CONCLUSIONS

This report has analysed the likely air quality effects of the proposed Abel Underground Coal Mine. Because the mine is an underground operation emissions will be minor compared with an open cut mine of a similar production level.

Model predictions of the dispersion of dust emissions from the mine indicate that no residences are likely to experience any exceedances of the DEC's long-term assessment criteria for PM_{10}, TSP or dust (insoluble solids) deposition.

The DEC's 24-hour average PM_{10} assessment criterion of 50 $\mu g/m^3$ is currently exceeded from time to time particular at times when bushfire smoke is affecting air quality. This situation will continue, but emissions from the mine are not predicted to significantly affect the number of exceedances.

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APPENDIX A
ALL DUST DEPOSITION DATA
FROM MAY 2000 TO APRIL 2006 (INCLUSIVE)

Dust deposition (g/m²/month)

Month	D1	D2	D3	D4	D5A	D6	D7	D8	D9	D10	D11
May-00	0.4	0.4	-	0.7	0.9	0.6	3.6	1.6	0.5	1.8	-
Jun-00	0.7	0.5	0.5	0.7	0.8	0.4	3.8	3.2	0.5	0.7	-
Jul-00	0.4	0.4	0.5	0.7	0.8	0.5	0.8	1.5	0.4	0.4	-
Aug-00	0.9	0.6	1.0	1.2	1.1	1.0	3.4	0.7	0.7	0.6	-
Sep-00	0.8	0.9	1.1	0.9	1.3	1.0	2.2	1.0	1.0	0.8	-
Oct-00	0.4	0.6	1.1	0.9	0.9	0.8	5.3	0.9	0.6	0.5	-
Nov-00	5.2	0.7	1.4	0.8	1.0	0.4	24.1	9.4	1.1	0.6	-
Dec-00	2.8	1.4	1.9	1.3	1.1	0.8	2.1	2.5	0.9	0.9	-
Jan-01	0.7	1.7	1.4	1.8	0.7	1.3	1.1	2.4	1.1	0.6	-
Feb-01	0.9	3.1	2.0	0.5	0.9	0.7	0.7	6.7	1.3	0.5	1.0
Mar-01	0.8	2.1	1.3	0.6	0.7	0.6	0.6	5.5	0.6	0.6	1.5
Apr-01	0.8	0.7	1.3	0.5	0.7	0.4	0.3	5.1	0.7	0.6	0.8
May-01	0.2	0.2	0.4	0.4	0.3	0.3	0.6	1.8	0.6	0.8	0.9
Jun-01	0.5	0.4	0.5	1.0	1.0	0.4	0.4	8.8	0.7	0.6	0.6
Jul-01	0.5	0.3	1.8	0.5	0.8	-	16.3	4.9	0.9	0.7	0.7
Aug-01	0.4	0.4	0.8	0.8	1.0	1.7	1.0	-	1.0	1.8	1.1
Sep-01	0.7	1.0	1.7	1.1	1.7	0.7	-	6.0	1.1	1.3	1.7
Oct-01	1.1	0.6	4.6	0.9	0.7	0.9	1.2	1.9	0.9	0.6	1.7
Nov-01	0.9	1.0	1.1	1.1	0.8	1.1	6.0	5.5	1.3	1.9	2.3
Dec-01	4.9	0.9	4.2	0.9	1.3	1.9	1.2	3.1	1.2	9.7	1.8
Jan-02	0.8	1.0	1.5	1.3	1.1	1.4	1.3	1.5	1.1	0.9	1.5
Feb-02	1.1	1.1	0.9	0.3	0.4	0.5	3.1	5.1	0.5	0.5	0.9
Mar-02	1.7	2.1	1.6	0.7	0.7	0.8	1.0	18	1.0	0.9	1.7
Apr-02	1.0	0.4	1.0	0.8	0.8	0.6	0.9	10.1	0.5	0.7	1.0
May-02	0.6	0.6	6.0	0.7	0.4	1.2	0.9	3.1	0.7	0.2	1.0
Jun-02	1.4	0.4	1.7	0.6	0.5	0.8	0.6	2.1	0.6	0.5	1.0
Jul-02	0.7	0.7	-	0.8	0.8	0.7	1.2	-	1.1	0.5	1.0
Aug-02	1.3	0.8	1.4	1.2	1.1	1.2	1.5	-	1.5	0.9	1.6
Sep-02	0.5	1.2	1.1	0.8	0.5	0.7	5.1	9.3	1.6	0.6	1.0
Oct-02	2.2	1.4	5.2	1.5	1.5	1.4	1.4	3.4	-	1.5	3.1
Nov-02	2.8	1.8	3.7	1.6	0.1	1.8	2.1	3.5	2.1	2	1.9
Dec-02	2.0	-	2.5	1.5	3.0	1.5	1.8	4.1	1.6	1.2	1.9
Jan-03	2.1	1.5	2.7	1.5	1.0	1.9	2.2	2.5	1.1	1.0	1.6
Feb-03	1.4	1.1	2.6	1.1	0.9	1.2	1.7	5.9	1.2	1.0	1.5
Mar-03	0.8	0.5	1.2	1.2	0.6	2.1	1.5	3.4	-	3.6	9.5
Apr-03	0.5	1.0	0.6	1.0	0.7	0.5	1.1	8.0	-	2.0	1.0
May-03	0.5	0.4	0.6	0.2	0.2	0.6	1.3	1.6	0.5	0.8	1.2
Jun-03	0.5	0.6	0.8	0.8	0.4	0.6	0.8	0.7	0.9	0.7	0.7
Jul-03	0.3	0.4	0.4	0.6	0.4	0.5	0.7	0.5	0.5	0.5	0.7
Aug-03	0.8	0.2	0.7	1.1	0.5	1.3	1.8	2.1	1.3	0.7	0.9
Sep-03	0.6	0.7	1.1	0.7	0.8	1.7	1.4	1.3	2.5	0.9	1.3
Oct-03	-	0.9	1.4	0.9	0.7	1.9	1.0	1.4	0.6	0.8	1.3
Nov-03	2.6	0.8	1.0	1.1	0.4	1.3	1.5	1.5	-	0.8	1.3
Dec-03	1.0	1.0	1.4	1.3	1.1	1.5	1.6	2.0	1.8	0.9	1.4
Jan-04	8.5	1.5	2.1	1.5	1.3	2.6	1.4	2.2	1.7	1.5	1.7
Feb-04	1.2	1.0	1.7	1.4	0.7	3.1	1.6	2.2	-	1.5	2.3
Mar-04	0.4	0.6	6.6	1.2	0.7	1.9	1.1	12.1	4.8	1.5	1.1
Apr-04	0.6	1.0	0.8	0.8	0.6	1.9	0.8	1.4	0.9	1.2	1.1
May-04	0.2	0.9	2.2	0.9	0.8	0.7	0.9	1.4	1.2	0.9	1.5

Month	D1	D2	D3	D4	D5A	D6	D7	D8	D9	D10	D11
Jun-04	0.4	0.6	0.7	0.9	0.6	1.4	1.0	0.9	1.0	1.0	0.8
Jul-04	0.4	0.6	5.3#	0.6	0.5	2.9	1.0	1.1	0.9	0.6	1.2
Aug-04	0.5	0.5	0.5	1.3	0.7	1.1	1.1	1.4	-	1.0	1.0
Sep-04	0.6	0.6	0.8	2.2	1.0	1.0	0.9	4.4	0.9	16.7	1.1
Oct-04	0.7	0.9	1.2	0.9	0.8	1.4	1.0	10.5	1.0	1.0	0.8
Nov-04	0.8	0.7	1.3	1.9	0.7	0.9	1.0	3.0	1.1	1.1	1.6
Dec-04	2.0	1.4	3.6	1.5	1.3	2.2	3.2	7.9	1.8	5.5	2.5
Jan-05	1.2	1.0	3.7	1.6	1.4	4.0	2.3	2.7	2.6	2.5	2.8
Feb-05	1.2	1.2	1.8	1.6	1.3	2.0	1.7	-	2.3	1.5	2.3
Mar-05	1.3	0.9	1.4	0.9	0.9	3.0	1.2	7.7	-	0.8	1.3
Apr-05	1.1	0.7	0.9	0.8	0.7	0.9	1.4	3.3	1.1	0.8	0.9
May-05	0.7	8.6	1.1	0.8	0.7	0.8	0.9	4.4	1.2	0.8	1.1
Jun-05	1.3	0.8	1.3	1.3	0.8	1.2	1.2	1.3	1.5	2.5	0.9
Jul-05	1.0	0.5	0.5	0.7	0.4	1.6	0.7	1.2	0.8	4.3	1.1
Aug-05	0.6	0.6	0.8	1.0	0.8	0.9	0.7	1.0	0.9	1.0	0.9
Sep-05	0.6	0.7	0.8	0.7	0.7	1.2	1.3	1.3	1.0	0.9	1.1
Oct-05	0.8	0.9	1.3	0.9	0.8	1.4	1.2	1.9	1.3	1.1	1.3
Nov-05	-	2.3	2.3	2.0	1.7	1.2	2.0	3.2	1.6	1.4	2.2
Dec-05	1.9	3.2	2.3	3.3	2.6	3.4	2.3		1.3	2.1	3.9
Jan-06	1.0	2.1	1.7	1.0	23.	3.5	-	2.7	1.1	-	1.5
Feb-06	2.2	1.0	0.9	1.2	1.1	1.7	1.1	2.9	-	2.3	1.8
Mar-06	0.7	0.6	2.3	0.7	0.6	0.9	1.0	1.4	0.7	0.8	1.5
Apr-06	0.6	0.7	1.1	0.8	0.6	1.1	0.8	1.0	1.0	1.8	1.5

APPENDIX B
STATISTICAL SUMMARY OF METEOROLOGICAL DATA

STATISTICS FOR FILE: C:\Jobs\Abel\Met\BER0405.isc
MONTHS: All
HOURS : All
OPTION: Frequency

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	0.006677	0.006677	0.001607	0.000989	0.000124	0.000000	0.000000	0.000000	0.016073
NE	0.008531	0.007047	0.001978	0.000618	0.000000	0.000000	0.000000	0.000000	0.018175
ENE	0.006058	0.014713	0.008160	0.002596	0.000247	0.000000	0.000000	0.000000	0.031775
E	0.007295	0.018917	0.011746	0.004946	0.000865	0.000247	0.000000	0.000000	0.044016
ESE	0.009644	0.028190	0.022626	0.006306	0.000247	0.000000	0.000000	0.000000	0.067013
SE	0.017681	0.036597	0.030539	0.001360	0.000124	0.000000	0.000000	0.000000	0.086301
SSE	0.024233	0.030663	0.022750	0.006553	0.000865	0.000000	0.000247	0.000000	0.085312
S	0.026583	0.034743	0.011993	0.002102	0.000618	0.000000	0.000000	0.000000	0.076039
SSW	0.017557	0.023863	0.005811	0.001484	0.000000	0.000000	0.000000	0.000000	0.048714
SW	0.008778	0.019659	0.008408	0.002102	0.000124	0.000124	0.000000	0.000000	0.039194
WSW	0.009891	0.006182	0.001484	0.001113	0.000495	0.000124	0.000000	0.000000	0.019288
W	0.011622	0.011375	0.004204	0.002844	0.000247	0.000124	0.000000	0.000000	0.030415
WNW	0.023244	0.038081	0.038205	0.023615	0.011993	0.013477	0.004822	0.004204	0.157641
NW	0.023368	0.056009	0.031775	0.017062	0.014095	0.008160	0.002473	0.002596	0.155539
NNW	0.018422	0.023986	0.009149	0.004946	0.003586	0.001360	0.000989	0.000618	0.063056
N	0.010880	0.010015	0.001607	0.000247	0.000000	0.000000	0.000000	0.000000	0.022750
CALM									0.038699
TOTAL	0.230465	0.366716	0.212043	0.078882	0.033630	0.023615	0.008531	0.007418	1.000000

MEAN WIND SPEED (m/s) = 2.84
NUMBER OF OBSERVATIONS = 8088

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	0.002720	0.003091	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.005935
NE	0.002720	0.001484	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.004451
ENE	0.002226	0.002102	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.004451
E	0.002349	0.002967	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.005440
ESE	0.001855	0.002473	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.004575
SE	0.002473	0.003215	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005687
SSE	0.001978	0.003338	0.000495	0.000000	0.000000	0.000000	0.000000	0.000000	0.005811
S	0.002967	0.008655	0.003462	0.000000	0.000000	0.000000	0.000000	0.000000	0.015084
SSW	0.002720	0.007047	0.002596	0.000495	0.000000	0.000000	0.000000	0.000000	0.012859
SW	0.000989	0.002967	0.000495	0.000247	0.000000	0.000000	0.000000	0.000000	0.004698
WSW	0.001484	0.000989	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.002844
W	0.001113	0.001484	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.002844
WNW	0.002102	0.001731	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.004080
NW	0.003709	0.002226	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.006306
NNW	0.003091	0.001731	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004822
N	0.001855	0.002226	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004080
CALM									0.007542
TOTAL	0.036350	0.047725	0.009149	0.000742	0.000000	0.000000	0.000000	0.000000	0.101508

MEAN WIND SPEED (m/s) = 1.74
NUMBER OF OBSERVATIONS = 821

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	0.000371	0.000742	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.001236
NE	0.000000	0.000495	0.000495	0.000000	0.000000	0.000000	0.000000	0.000000	0.000989
ENE	0.000247	0.000989	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.001855
E	0.000000	0.001607	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.001978
ESE	0.000371	0.002226	0.000495	0.000000	0.000000	0.000000	0.000000	0.000000	0.003091
SE	0.000371	0.007789	0.006182	0.000000	0.000000	0.000000	0.000000	0.000000	0.014342
SSE	0.001113	0.003586	0.006058	0.000989	0.000000	0.000000	0.000000	0.000000	0.011746
S	0.000865	0.004080	0.002596	0.000247	0.000000	0.000000	0.000000	0.000000	0.007789
SSW	0.000618	0.002844	0.002473	0.000742	0.000000	0.000000	0.000000	0.000000	0.006677
SW	0.000618	0.002844	0.001855	0.000124	0.000000	0.000000	0.000000	0.000000	0.005440
WSW	0.000247	0.000495	0.000000	0.000371	0.000000	0.000000	0.000000	0.000000	0.001113
W	0.000495	0.000742	0.000495	0.000247	0.000000	0.000000	0.000000	0.000000	0.001978
WNW	0.000989	0.001236	0.000865	0.000124	0.000000	0.000000	0.000000	0.000000	0.003215
NW	0.001484	0.002720	0.001731	0.000124	0.000000	0.000000	0.000000	0.000000	0.006058
NNW	0.000247	0.001731	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.002349
N	0.000618	0.001484	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002102
CALM									0.000000
TOTAL	0.008655	0.035608	0.024728	0.002967	0.000000	0.000000	0.000000	0.000000	0.071958

MEAN WIND SPEED (m/s) = 2.70
NUMBER OF OBSERVATIONS = 582

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	0.000000	0.000495	0.000495	0.000495	0.000000	0.000000	0.000000	0.000000	0.001484
NE	0.000371	0.000618	0.000742	0.000495	0.000000	0.000000	0.000000	0.000000	0.002226
ENE	0.000000	0.000989	0.001607	0.000371	0.000000	0.000000	0.000000	0.000000	0.002967
E	0.000495	0.001236	0.003215	0.000742	0.000000	0.000000	0.000000	0.000000	0.005687
ESE	0.000000	0.002844	0.008408	0.001360	0.000000	0.000000	0.000000	0.000000	0.012611
SE	0.000495	0.007047	0.016197	0.000865	0.000000	0.000000	0.000000	0.000000	0.024604
SSE	0.000618	0.001360	0.004451	0.003462	0.000000	0.000000	0.000000	0.000000	0.009891
S	0.000371	0.000495	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.001484
SSW	0.000000	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000371
SW	0.000124	0.001113	0.000989	0.000247	0.000000	0.000000	0.000000	0.000000	0.002473
WSW	0.000495	0.000742	0.000124	0.000124	0.000000	0.000000	0.000000	0.000000	0.001484
W	0.000371	0.000865	0.000371	0.000618	0.000000	0.000000	0.000000	0.000000	0.002226
WNW	0.000371	0.001236	0.003709	0.002967	0.000000	0.000000	0.000000	0.000000	0.008284
NW	0.001360	0.005687	0.004204	0.002967	0.000000	0.000000	0.000000	0.000000	0.014219
NNW	0.000865	0.002473	0.001360	0.000371	0.000000	0.000000	0.000000	0.000000	0.005069
N	0.000371	0.000618	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.001607
CALM									0.000000
TOTAL	0.006306	0.028190	0.047107	0.015084	0.000000	0.000000	0.000000	0.000000	0.096686

MEAN WIND SPEED (m/s) = 3.36
NUMBER OF OBSERVATIONS = 782

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	0.000495	0.001607	0.000865	0.000495	0.000124	0.000000	0.000000	0.000000	0.003586
NE	0.000124	0.003091	0.000495	0.000124	0.000000	0.000000	0.000000	0.000000	0.003833
ENE	0.000247	0.008408	0.005687	0.002226	0.000247	0.000000	0.000000	0.000000	0.016815
E	0.000495	0.008531	0.007913	0.004204	0.000865	0.000247	0.000000	0.000000	0.022255
ESE	0.002844	0.016444	0.013477	0.004946	0.000247	0.000000	0.000000	0.000000	0.037957
SE	0.003338	0.007047	0.008160	0.000495	0.000124	0.000000	0.000000	0.000000	0.019164
SSE	0.003462	0.005687	0.011746	0.002102	0.000865	0.000000	0.000247	0.000000	0.024110
S	0.000618	0.001113	0.004698	0.001855	0.000618	0.000000	0.000000	0.000000	0.008902
SSW	0.000124	0.000371	0.000124	0.000247	0.000000	0.000000	0.000000	0.000000	0.000865
SW	0.000124	0.002720	0.004946	0.001484	0.000124	0.000124	0.000000	0.000000	0.009520
WSW	0.000371	0.001607	0.000989	0.000618	0.000495	0.000124	0.000000	0.000000	0.004204
W	0.002596	0.005564	0.003091	0.001978	0.000247	0.000124	0.000000	0.000000	0.013600
WNW	0.005935	0.018793	0.021761	0.018299	0.011993	0.013477	0.004822	0.004204	0.099283
NW	0.005317	0.029550	0.019288	0.012735	0.014095	0.008160	0.002473	0.002596	0.094214
NNW	0.003586	0.011128	0.004451	0.004575	0.003586	0.001360	0.000989	0.000618	0.030292
N	0.001484	0.004080	0.000742	0.000247	0.000000	0.000000	0.000000	0.000000	0.006553
CALM									0.002226
TOTAL	0.031157	0.125742	0.108432	0.056627	0.033630	0.023615	0.008531	0.007418	0.397379

MEAN WIND SPEED (m/s) = 4.05
NUMBER OF OBSERVATIONS = 3214

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	0.000618	0.000495	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.001113
NE	0.001484	0.001236	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002720
ENE	0.000618	0.001855	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.002596
E	0.001360	0.003462	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.004946
ESE	0.002473	0.003338	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005811
SE	0.004327	0.009397	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.013724
SSE	0.005687	0.011004	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.016691
S	0.004822	0.006429	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.011869
SSW	0.001855	0.001978	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.004451
SW	0.000742	0.004822	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.005687
WSW	0.001236	0.001236	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002473
W	0.002102	0.001978	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004080
WNW	0.005440	0.013229	0.011622	0.002226	0.000000	0.000000	0.000000	0.000000	0.032517
NW	0.004080	0.014590	0.006182	0.001236	0.000000	0.000000	0.000000	0.000000	0.026088
NNW	0.003833	0.006058	0.002967	0.000000	0.000000	0.000000	0.000000	0.000000	0.012859
N	0.002349	0.000989	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.003586
CALM									0.000618
TOTAL	0.043027	0.082097	0.022626	0.003462	0.000000	0.000000	0.000000	0.000000	0.151830

MEAN WIND SPEED (m/s) = 2.17
NUMBER OF OBSERVATIONS = 1228

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	0.002473	0.000247	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002720
NE	0.003833	0.000124	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003956
ENE	0.002720	0.000371	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003091
E	0.002596	0.001113	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.003709
ESE	0.002102	0.000865	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.002967
SE	0.006677	0.002102	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008778
SSE	0.011375	0.005687	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.017062
S	0.016939	0.013971	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.030910
SSW	0.012240	0.011251	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.023492
SW	0.006182	0.005193	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.011375
WSW	0.006058	0.001113	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007171
W	0.004946	0.000742	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.005687
WNW	0.008408	0.001855	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.010262
NW	0.007418	0.001236	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.008655
NNW	0.006800	0.000865	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.007666
N	0.004204	0.000618	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.004822
CALM									0.028314
TOTAL	0.104970	0.047354	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.180638

MEAN WIND SPEED (m/s) = 1.15
NUMBER OF OBSERVATIONS = 1461

FREQUENCY OF OCCURENCE OF STABILITY CLASSES

A : 10.2%
B : 7.2%
C : 9.7%
D : 39.7%
E : 15.2%
F : 18.1%

STABILITY CLASS BY HOUR OF DAY

Hour	A	B	C	D	E	F
01	0000	0000	0000	0112	0095	0130
02	0000	0000	0000	0108	0100	0129
03	0000	0000	0000	0099	0119	0119
04	0000	0000	0000	0116	0108	0113
05	0000	0000	0000	0112	0115	0110
06	0013	0011	0010	0122	0100	0081
07	0039	0032	0038	0139	0051	0038
08	0060	0036	0053	0173	0011	0004
09	0055	0046	0051	0185	0000	0000
10	0078	0047	0056	0156	0000	0000
11	0093	0061	0050	0133	0000	0000
12	0119	0051	0063	0104	0000	0000
13	0120	0054	0069	0094	0000	0000
14	0098	0074	0087	0078	0000	0000
15	0083	0078	0094	0082	0000	0000
16	0052	0067	0113	0086	0003	0016
17	0010	0023	0086	0152	0026	0040
18	0001	0002	0012	0244	0038	0040
19	0000	0000	0000	0217	0063	0057
20	0000	0000	0000	0182	0073	0082
21	0000	0000	0000	0148	0073	0116
22	0000	0000	0000	0135	0074	0128
23	0000	0000	0000	0123	0080	0134
24	0000	0000	0000	0114	0099	0124

STABILITY CLASS BY MIXING HEIGHT

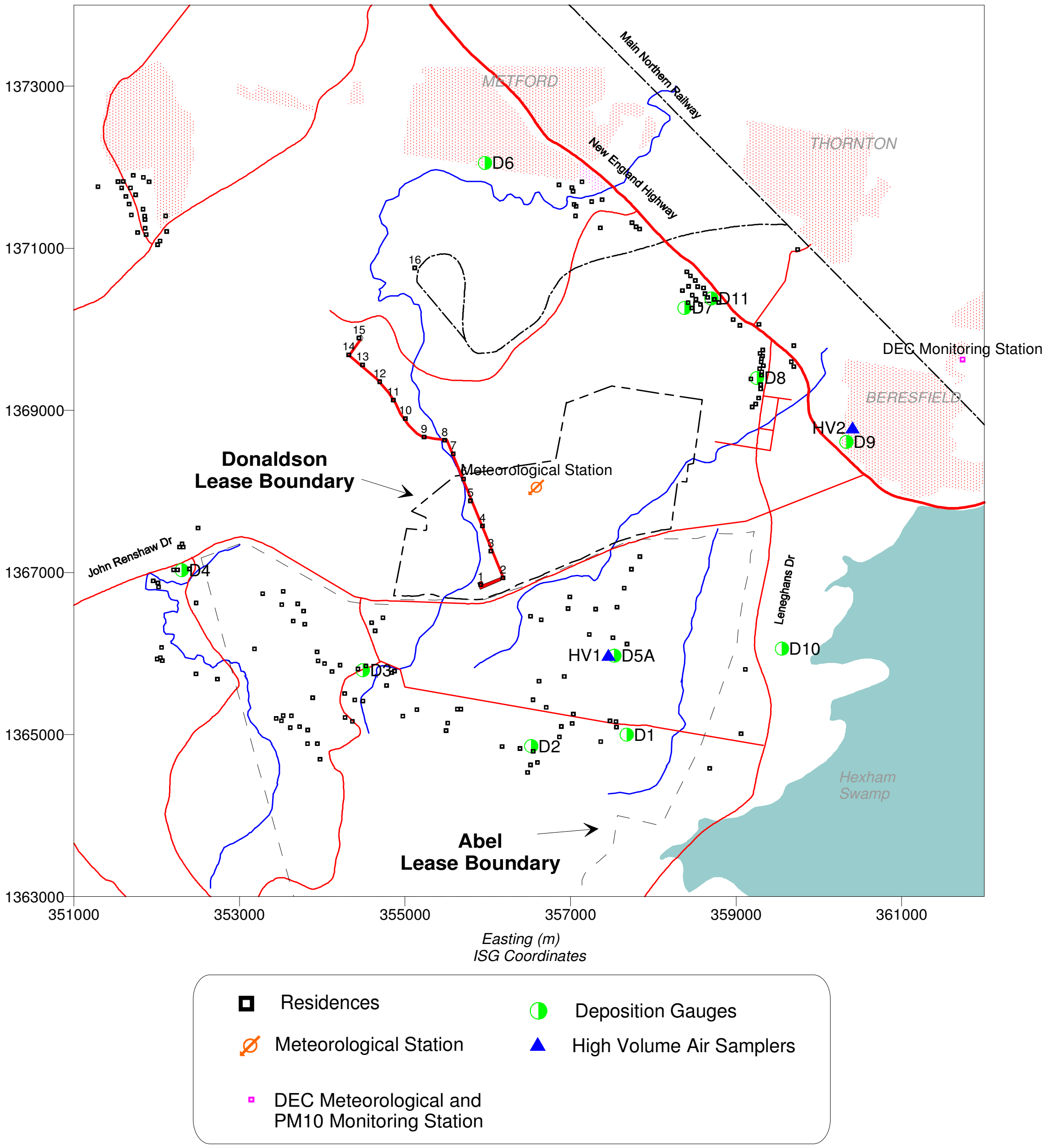
Mixing height	A	B	C	D	E	F
<=500 m	0096	0065	0086	0796	1195	1409
<=1000 m	0305	0198	0220	1350	0009	0019
<=1500 m	0420	0319	0476	0786	0024	0033
<=2000 m	0000	0000	0000	0156	0000	0000
<=3000 m	0000	0000	0000	0117	0000	0000
>3000 m	0000	0000	0000	0009	0000	0000

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	0139	0084	0019	0046	0035	0014	0000
02	0138	0088	0011	0050	0032	0018	0000
03	0131	0101	0014	0041	0033	0016	0001
04	0121	0097	0015	0045	0044	0014	0001
05	0144	0090	0012	0039	0035	0016	0001
06	0091	0121	0070	0024	0018	0013	0000
07	0093	0062	0110	0063	0006	0003	0000
08	0000	0060	0120	0157	0000	0000	0000
09	0000	0000	0086	0182	0069	0000	0000
10	0000	0000	0000	0217	0120	0000	0000
11	0000	0000	0000	0134	0203	0000	0000
12	0000	0000	0000	0086	0251	0000	0000
13	0000	0000	0000	0000	0337	0000	0000
14	0000	0000	0000	0000	0337	0000	0000
15	0000	0000	0000	0000	0337	0000	0000
16	0000	0000	0000	0000	0337	0000	0000
17	0012	0007	0000	0006	0299	0013	0000

18	0031	0031	0000	0031	0219	0024	0001
19	0057	0060	0006	0040	0147	0027	0000
20	0086	0069	0008	0058	0097	0018	0001
21	0124	0064	0011	0060	0063	0015	0000
22	0137	0062	0015	0056	0055	0012	0000
23	0143	0070	0015	0051	0045	0013	0000
24	0141	0077	0022	0047	0038	0012	0000

FIGURES



Location of project and air quality and meteorological monitoring stations

Figure 1

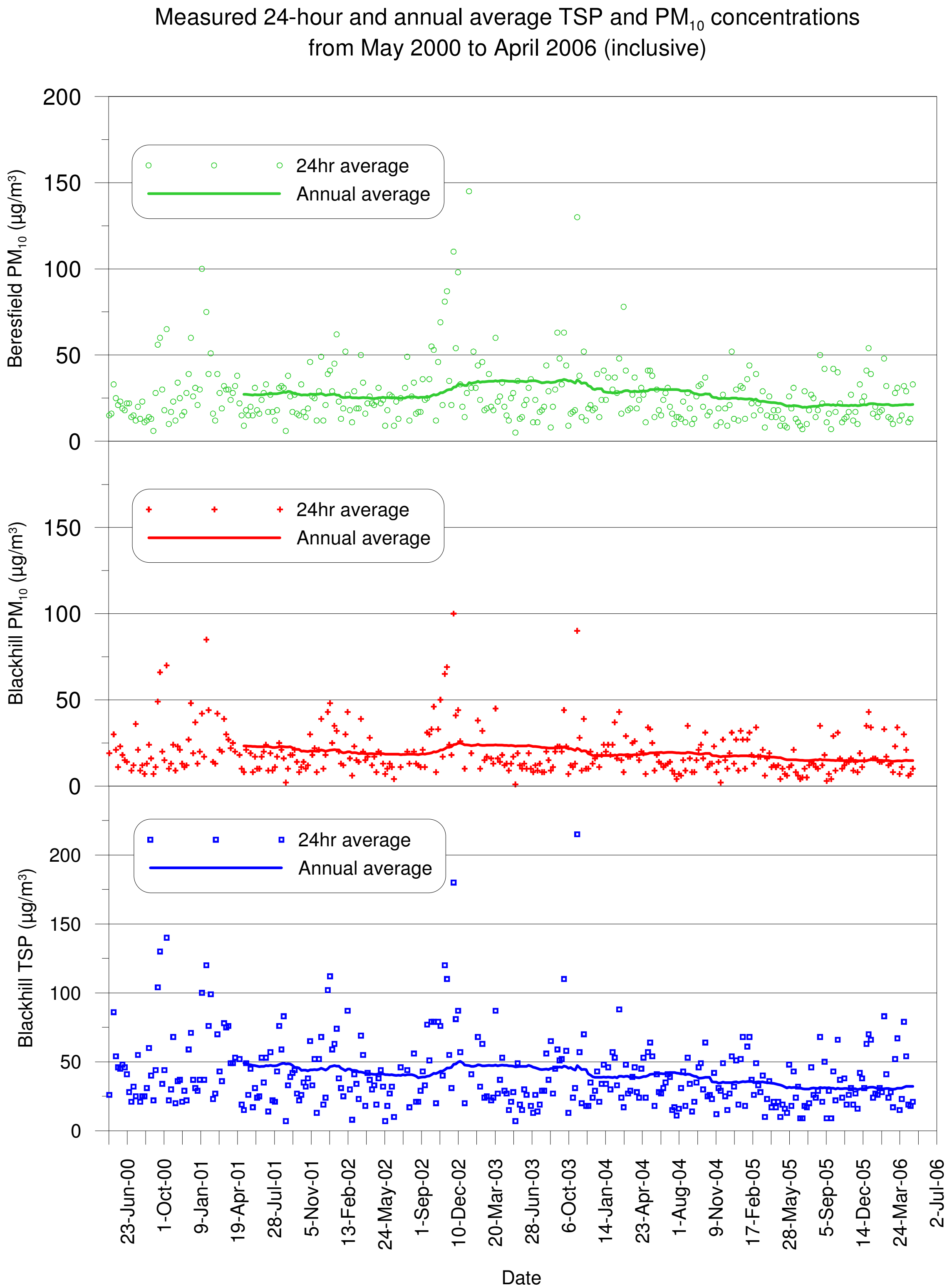
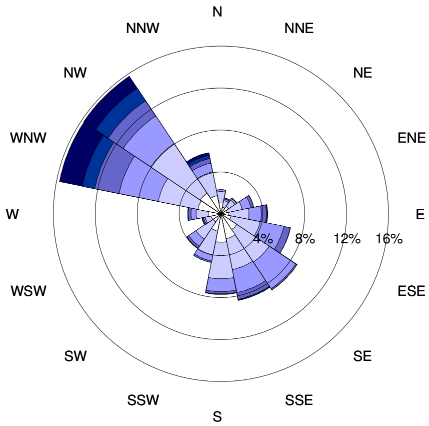
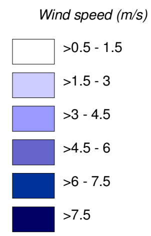

Measured 24-hour and annual average TSP and PM10 concentrations
from May 2000 to April 2006 (inclusive)
Beresfield PM10 (µg/m³)
Blackhill PM10 (µg/m³)
Blackhill TSP (µg/m³)
24hr average
Annual average
200
150
100
50
0
23-Jun-00
1-Oct-00
9-Jan-01
19-Apr-01
28-Jul-01
5-Nov-01
13-Feb-02
24-May-02
1-Sep-02
10-Dec-02
20-Mar-03
28-Jun-03
6-Oct-03
14-Jan-04
23-Apr-04
1-Aug-04
9-Nov-04
17-Feb-05
28-May-05
5-Sep-05
14-Dec-05
24-Mar-06
2-Jul-06
Date

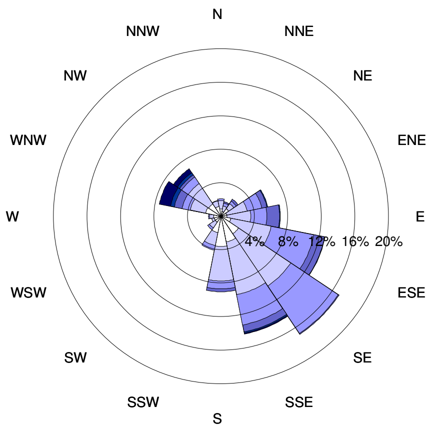
Figure 2

Annual and seasonal windroses prepared from data collected at DEC monitoring station at Beresfield (1 August 2004 to 31 July 2005)

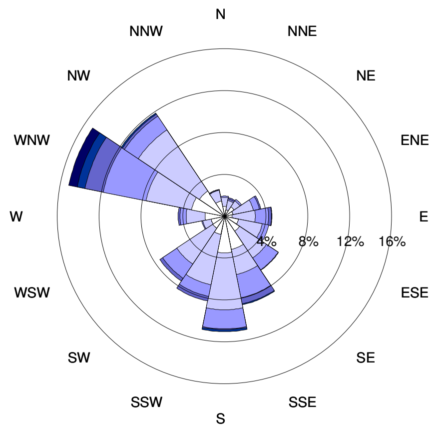


Annual
Calms = 3.9%

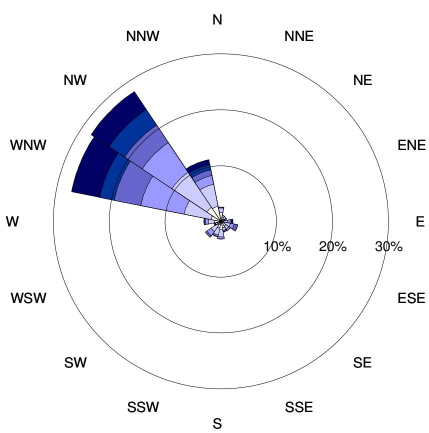




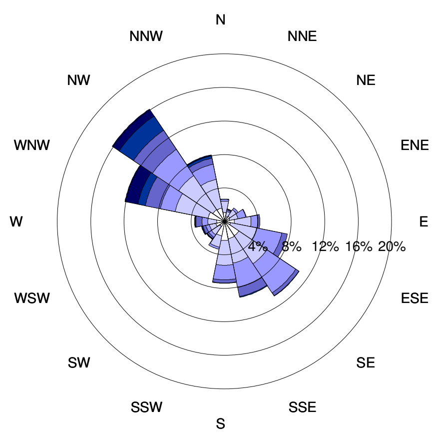
Summer
Calms = 3.1%



Autumn
Calms = 4.1%



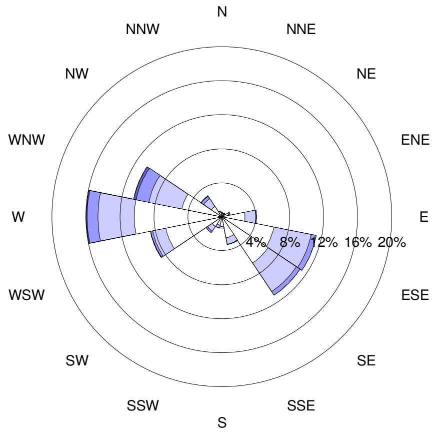
Winter
Calms = 4.8%



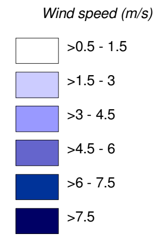
Spring
Calms = 3.3%

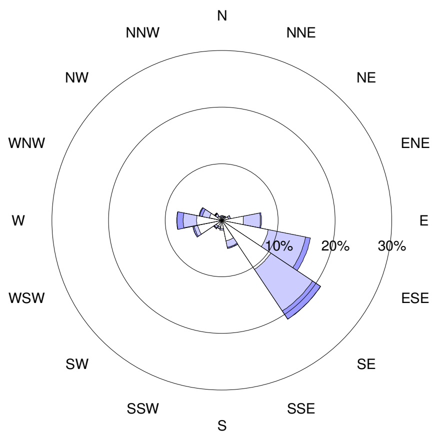
Figure 3

Annual and seasonal windroses for Donaldon (2004)

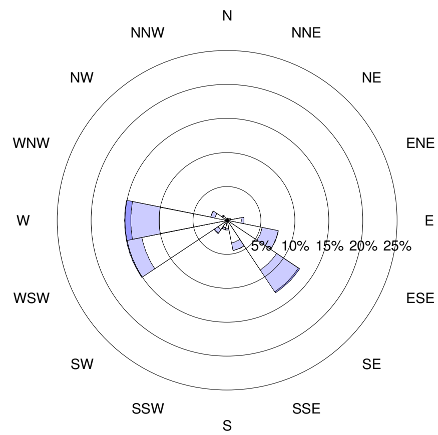


Annual
Calms = 24.1%

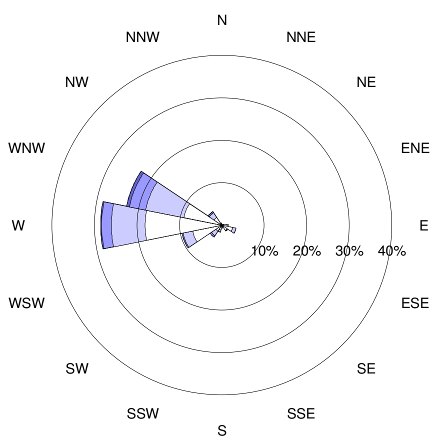




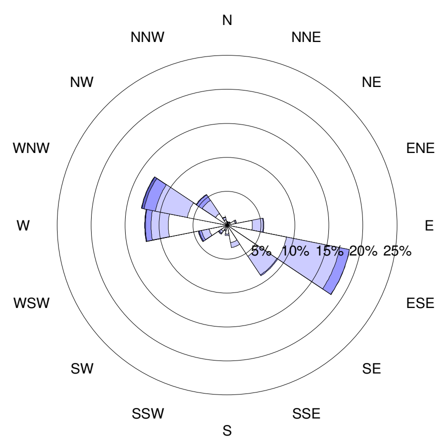
Summer
Calms = 22.3%



Autumn
Calms = 32.2%

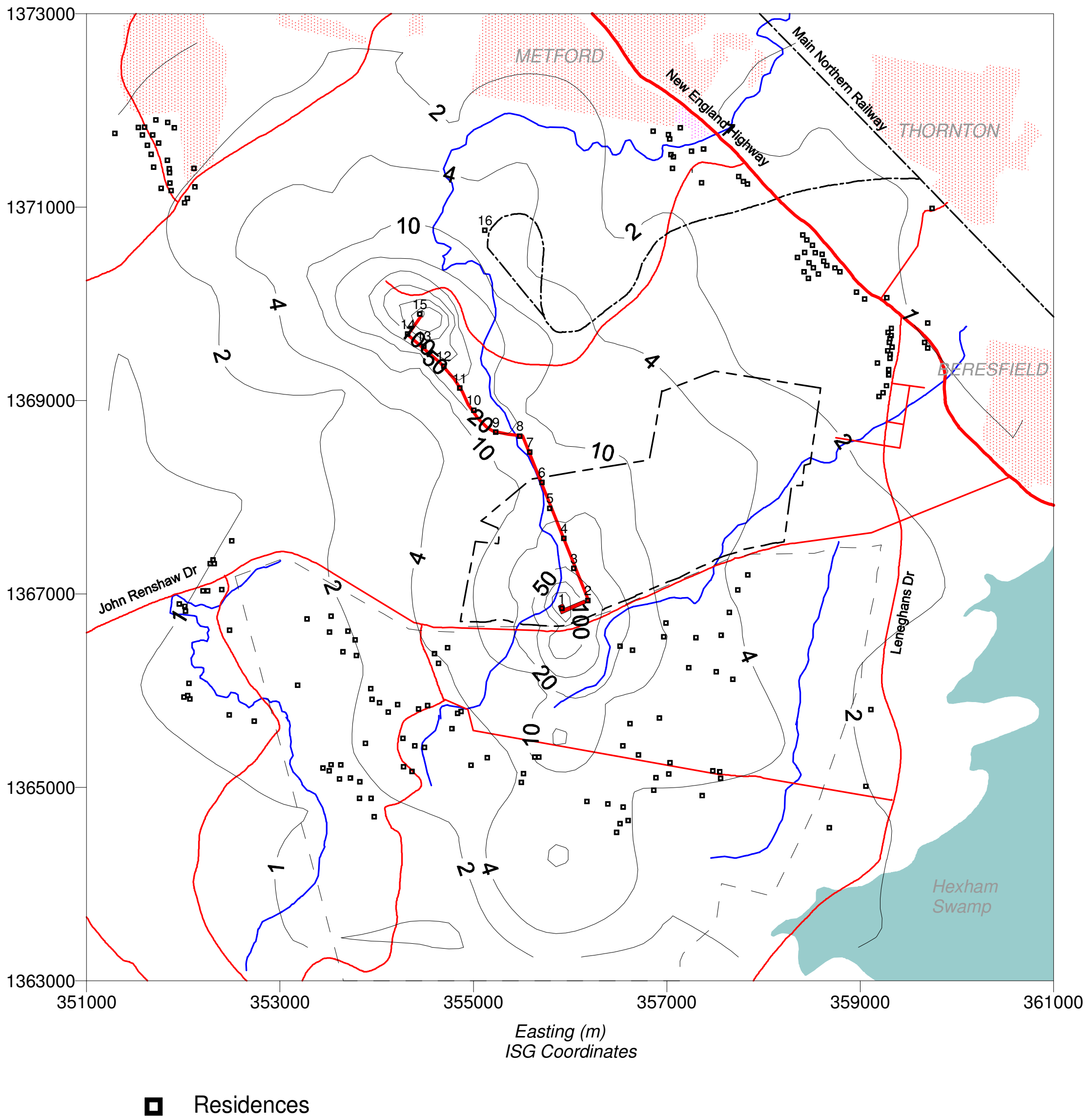


Winter
Calms = 20.7%



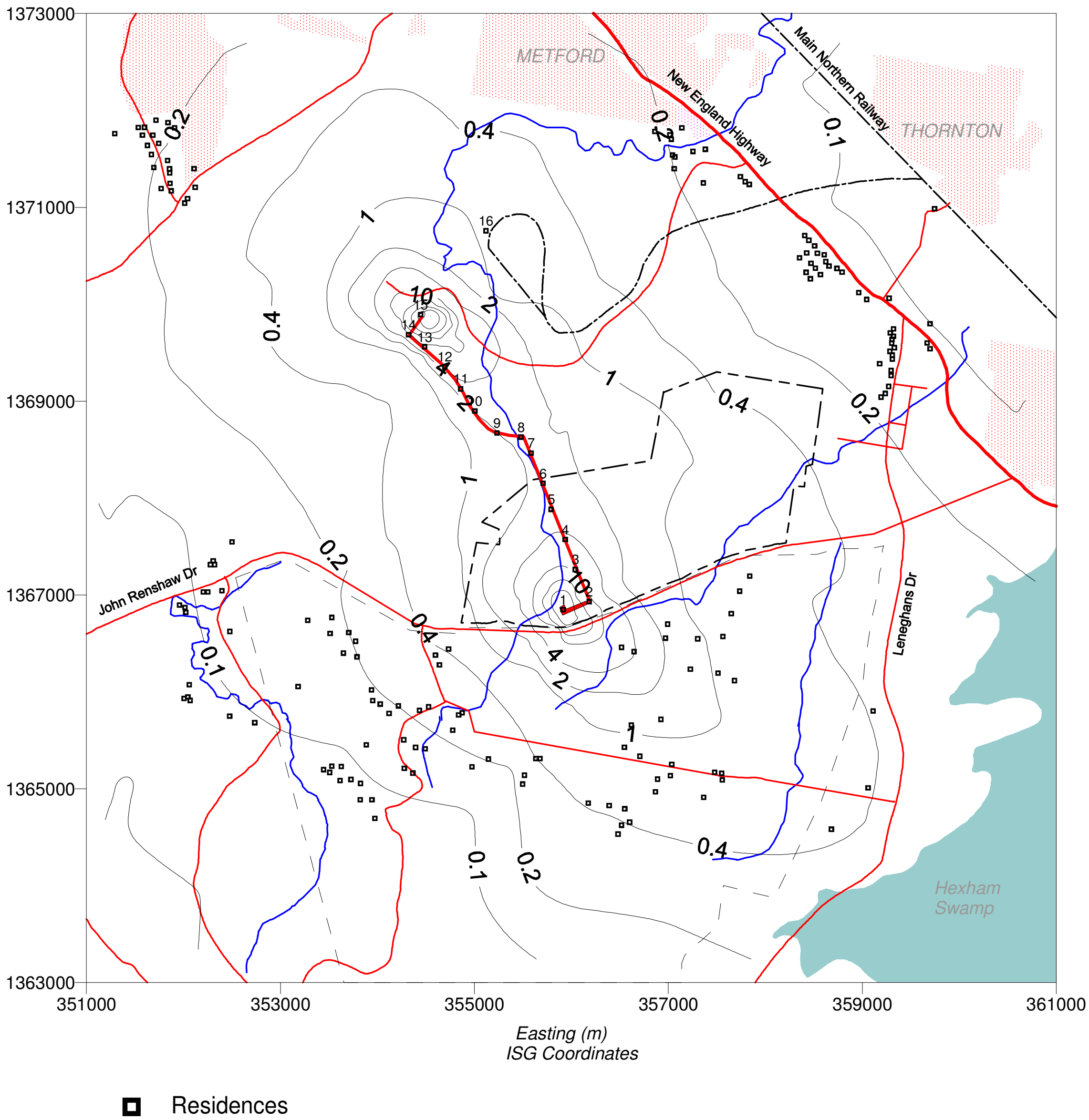
Spring
Calms = 21.1%

Figure 4



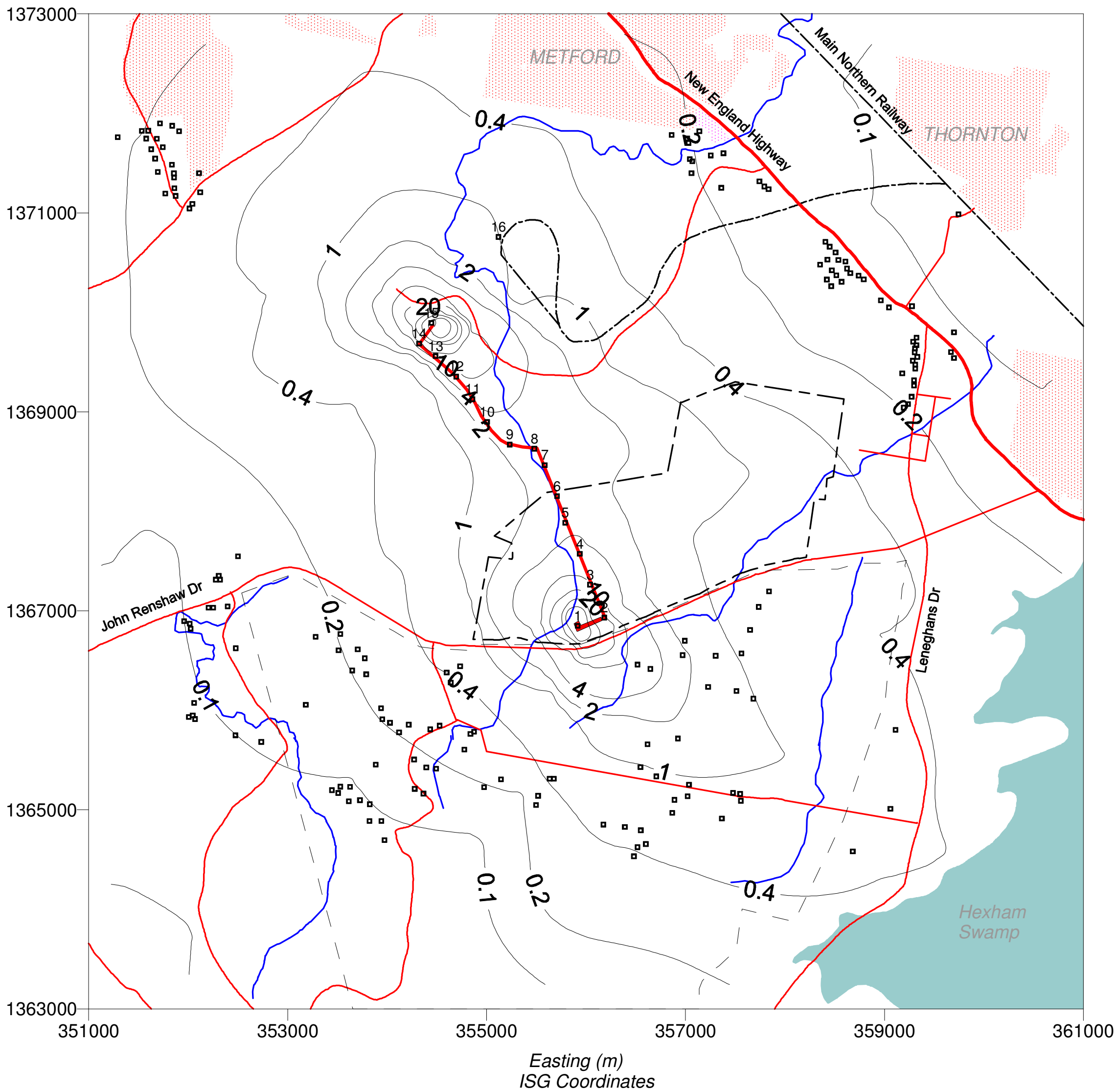
Predicted maximum 24-hour average PM_{10} concentrations due to emissions from Abel Underground Mine at 4.5 Mtpa production and assuming that Bloomfield CHPP handles 6.5 Mtpa- µg/m^3

Figure 5



Predicted annual average PM_{10} concentrations due to emissions from Abel Underground Mine at 4.5 Mtpa production and assuming that Bloomfield CHPP handles 6.5 Mtpa- µg/m^3

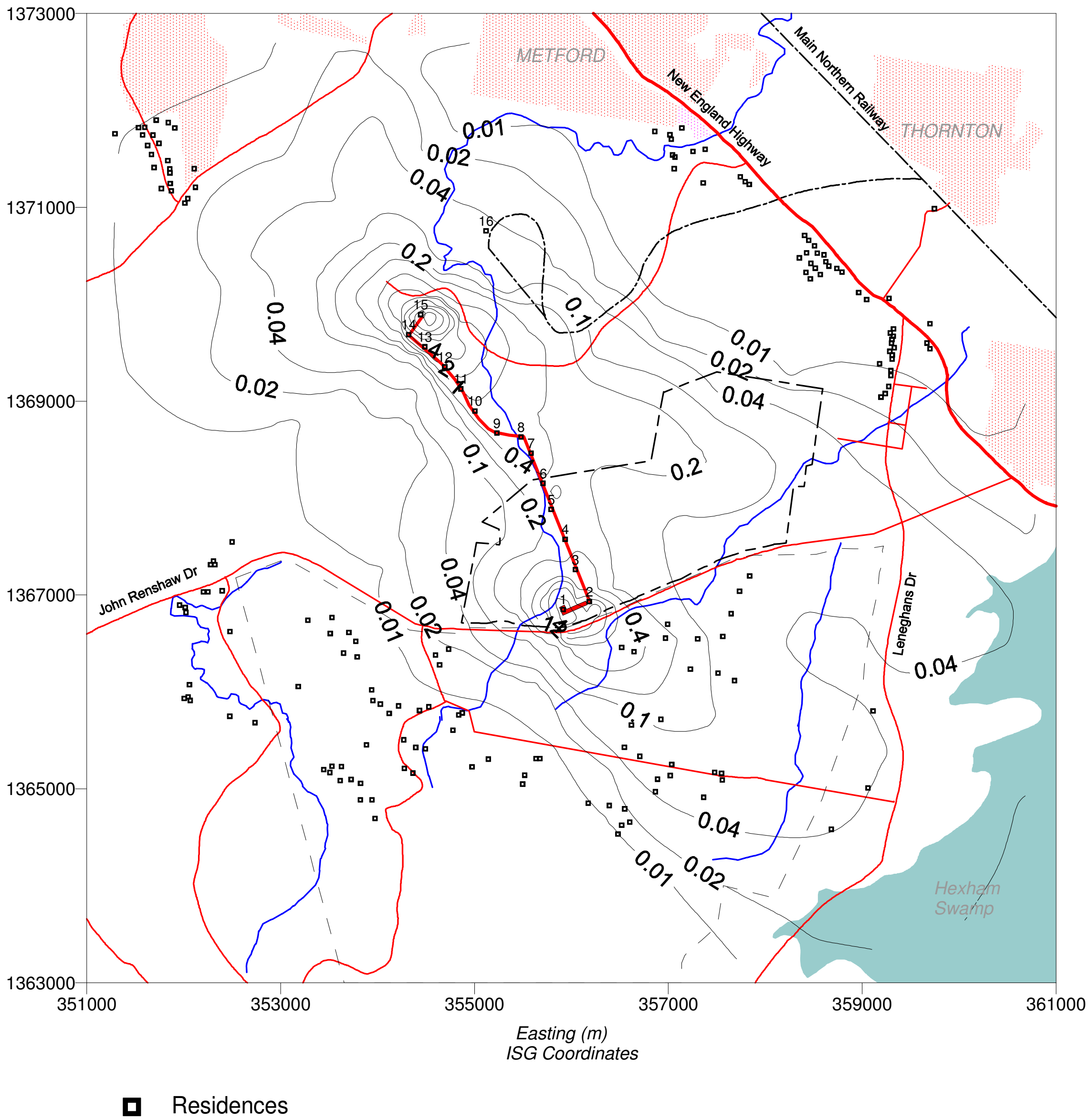
Figure 6



◘ Residences

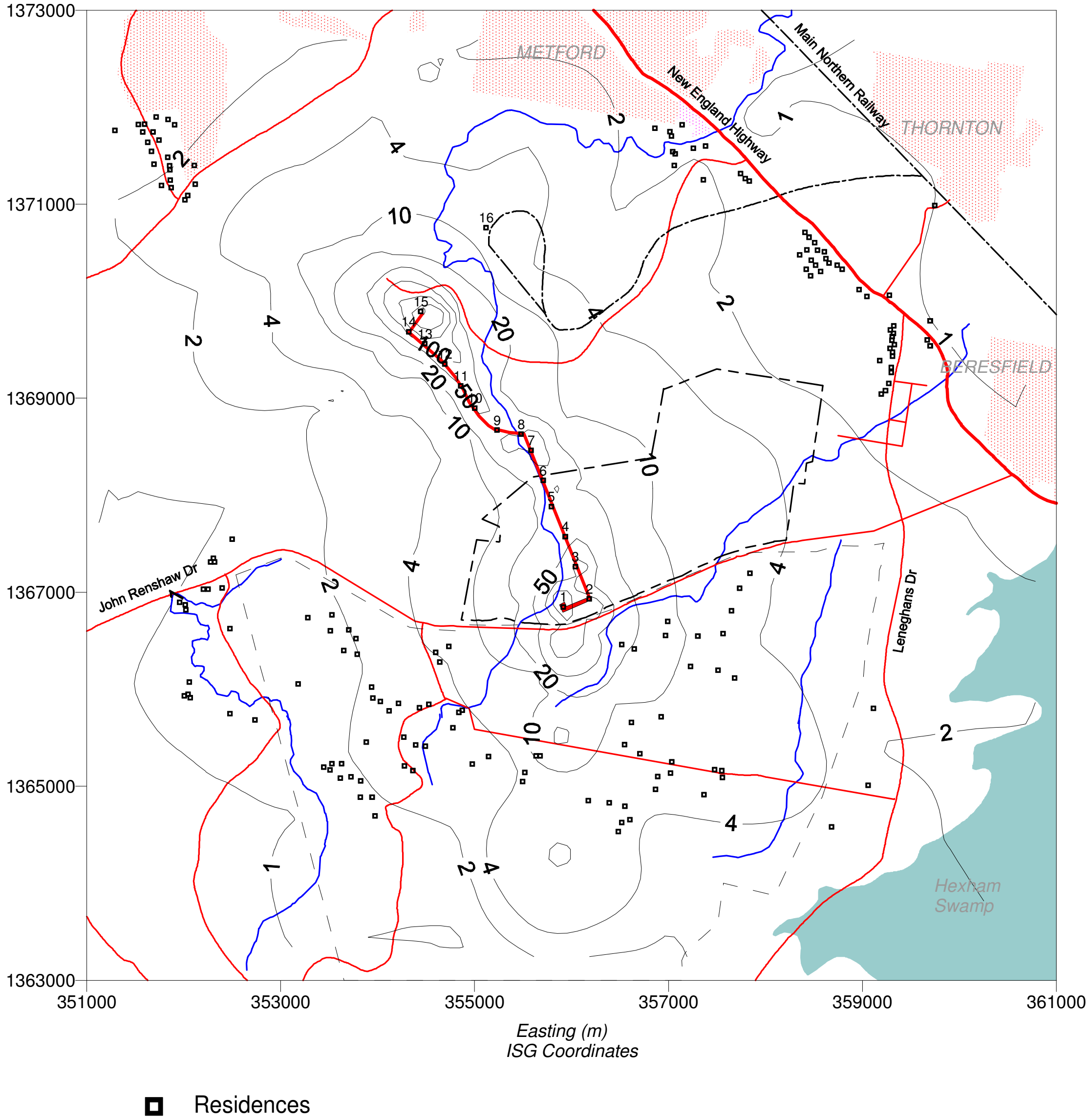
Predicted annual average TSP concentrations due to emissions from Abel Underground Mine at 4.5 Mtpa production and assuming that Bloomfield CHPP handles 6.5 Mtpa - µg/m^3

Figure 7



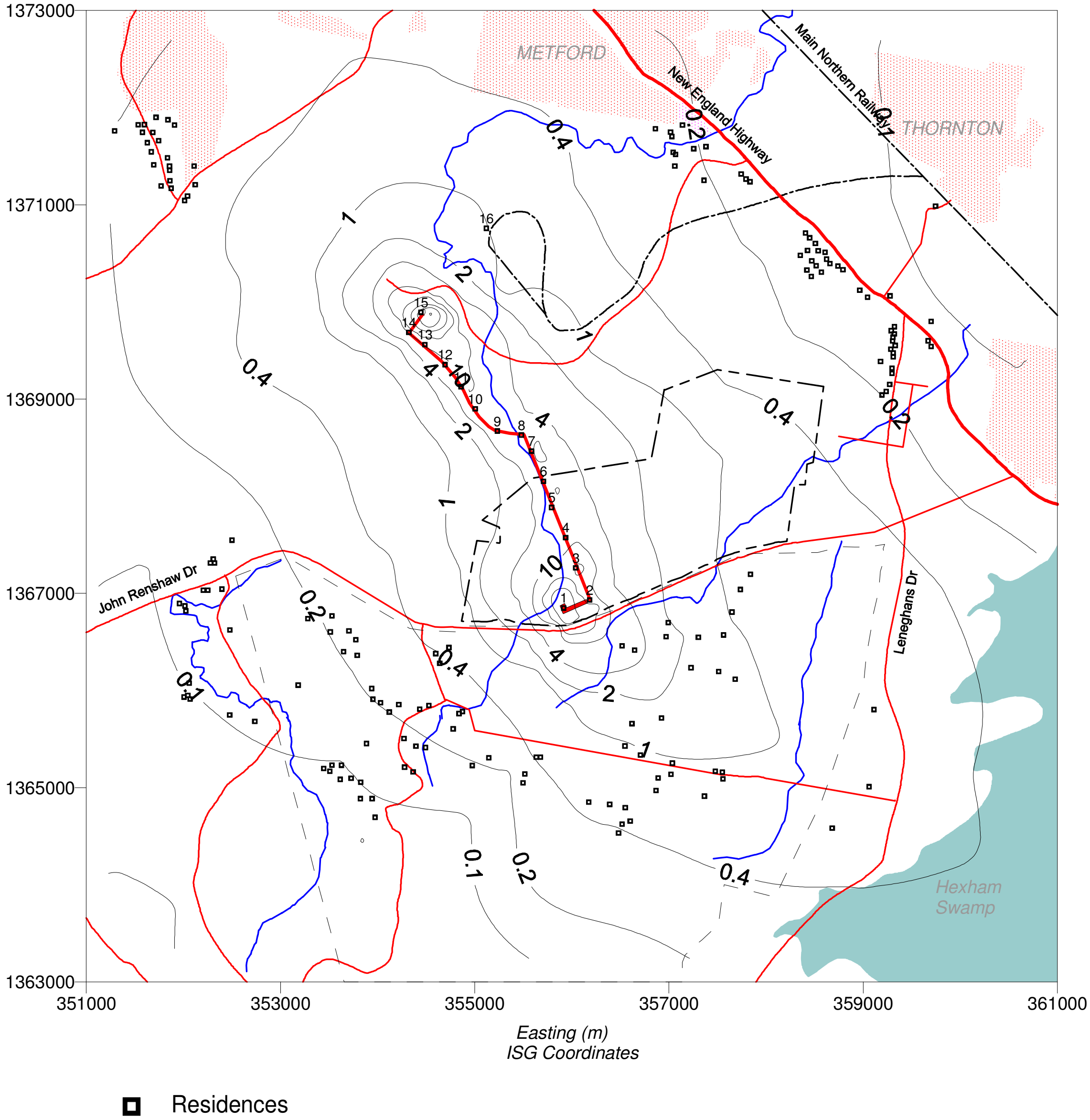
Predicted annual average dust (insoluble solids) deposition rate due to emissions from Abel Underground Mine at 4.5 Mtpa production and assuming that Bloomfield CHPP handles 6.5 Mtpa - g/m^2/month

Figure 8



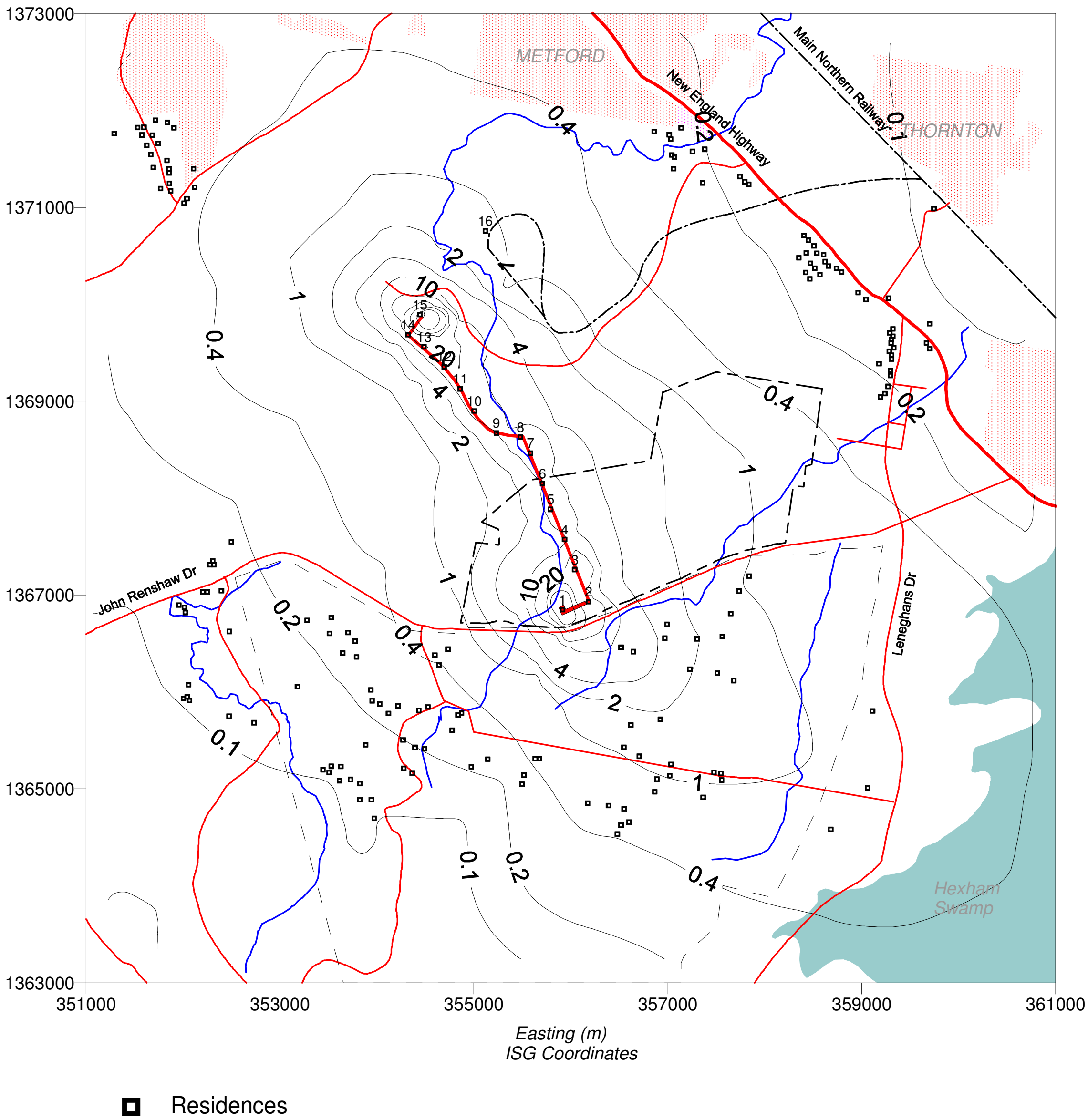
Predicted maximum 24-hour average PM_{10} concentrations due to emissions from Abel Underground Mine at 4.5 Mtpa production assuming all coal is trucked and assuming that Bloomfield CHPP handles 6.5 Mtpa - µg/m³

Figure 9



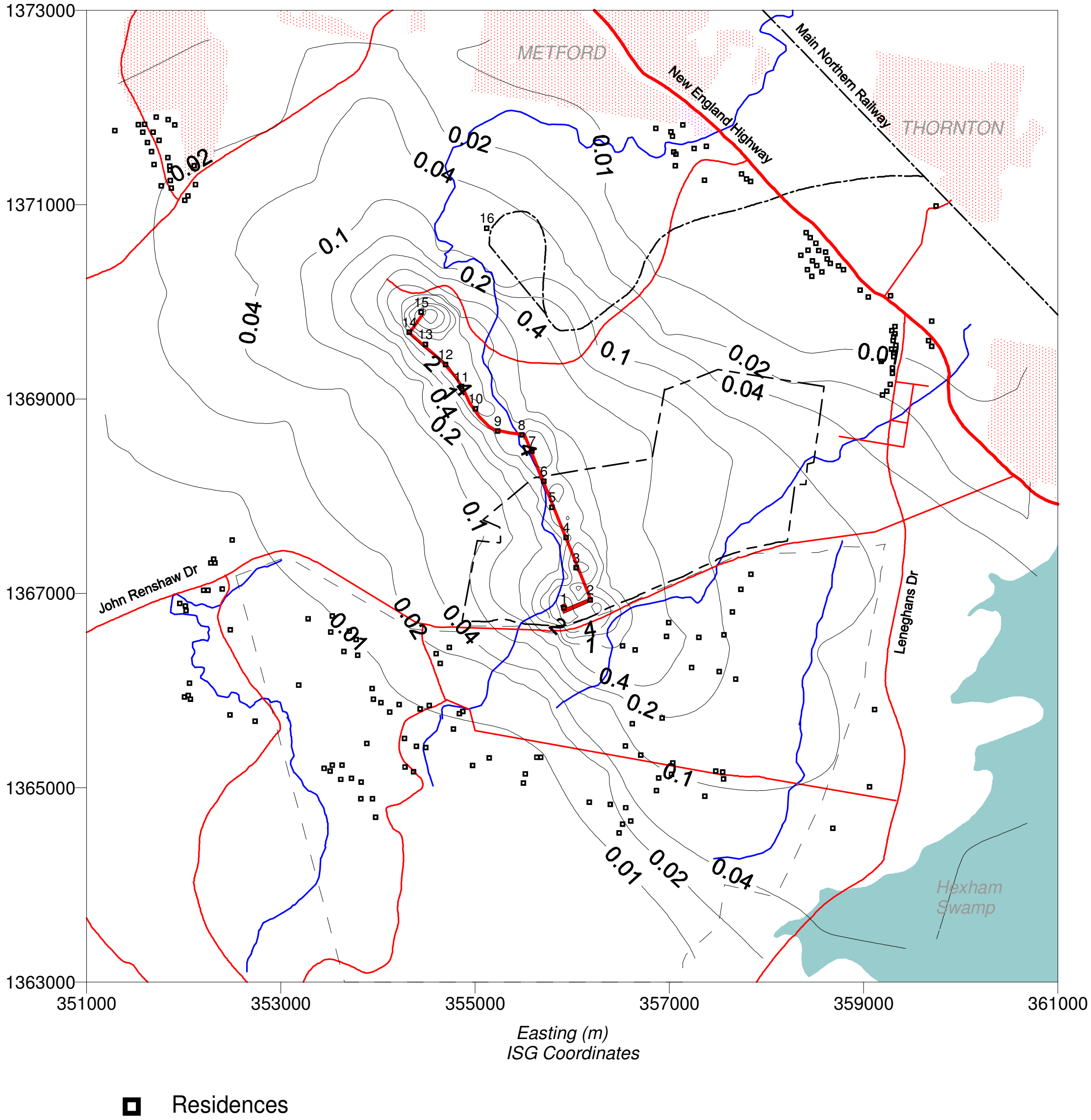
Predicted annual average PM_{10} concentrations due to emissions from Abel Underground Mine at 4.5 Mtpa production assuming all coal is trucked and assuming that Bloomfield CHPP handles 6.5 Mtpa - µg/m^3

Figure 10



Predicted annual average TSP concentrations due to emissions from Abel Underground Mine at 4.5 Mtpa production assuming all coal is trucked and assuming that Bloomfield CHPP handles 6.5 Mtpa - µg/m^3

Figure 11



Predicted annual average dust (insoluble solids) deposition rate due to emissions from Abel Underground Mine at 4.5 Mtpa production assuming all coal is trucked and assuming that Bloomfield CHPP handles 6.5 Mtpa - g/m²/month

Figure 12