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REPORT

ROCGLEN PRP – IDENTIFICATION OF ADVERSE WEATHER CONDITIONS FOR OVERBURDEN HANDLING

Whitehaven Coal Limited

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1 INTRODUCTION

Whitehaven Coal Limited (WCL) holds Environmental Protection Licence (EPL) 12870 for the Rocglen Coal Mine (Rocglen). Condition U2 (*Particulate Matter Control Best Practice Implementation - Disturbing and Handling Overburden under Adverse Weather Conditions)* requires Rocglen to alter or cease the use of equipment on overburden and the loading and dumping of overburden during adverse weather conditions. The licence must:

- Undertake daily visual dust level assessments, continuously record real-time PM10 levels and continuously measure and record real-time meteorological conditions, and
- Record changes to mining activities due to adverse weather conditions.

The purpose of this report is to define "adverse conditions" that may result in unacceptable dust levels beyond the site boundary. Trigger levels will be identified for these adverse conditions to inform a Trigger Action Response Plan (TARP) for overburden handling activities in critical locations.

1.1 Scope of Work

The following methodology is used to identify adverse conditions:

- Identify critical locations where overburden (OB) handling may result in elevated dust concentrations at or beyond the site boundary.
- Represent each location using two sources to simulate dozer and loading/unloading operations simultaneously occurring in one location. A TSP emission rate of 1,000,000 kg/y has been assumed, with loading and dumping emissions varying with wind speed according to the US EPA AP-42 emissions factor.
- Use a screening level atmospheric dispersion model to predict dust plume behaviour under various meteorological conditions (using site representative data).
- At boundary locations where the highest impacts are predicted, analyse the meteorological conditions that correspond to the highest 1-hour dust concentrations.
- Based on these "adverse" meteorological conditions, determine appropriate trigger values to inform a TARP.

2 METHODOLOGY

2.1 Critical locations

The active OB dump areas currently in operation at Rocglen are towards the northern end of the site in the middle of the northern dump, as well as in pit (in-pit dump). The western dump area is no longer in use but has the potential for some dozer activity in the future to finalise the batters in the next 12 month period.

The locations of current OB activities are shown in **Figure 1** and were determined in consultation with Rocglen. Dust sources are released from the OB dump at the location shown and the resultant dust concentration predictions are made at each of the numbered boundary locations shown.

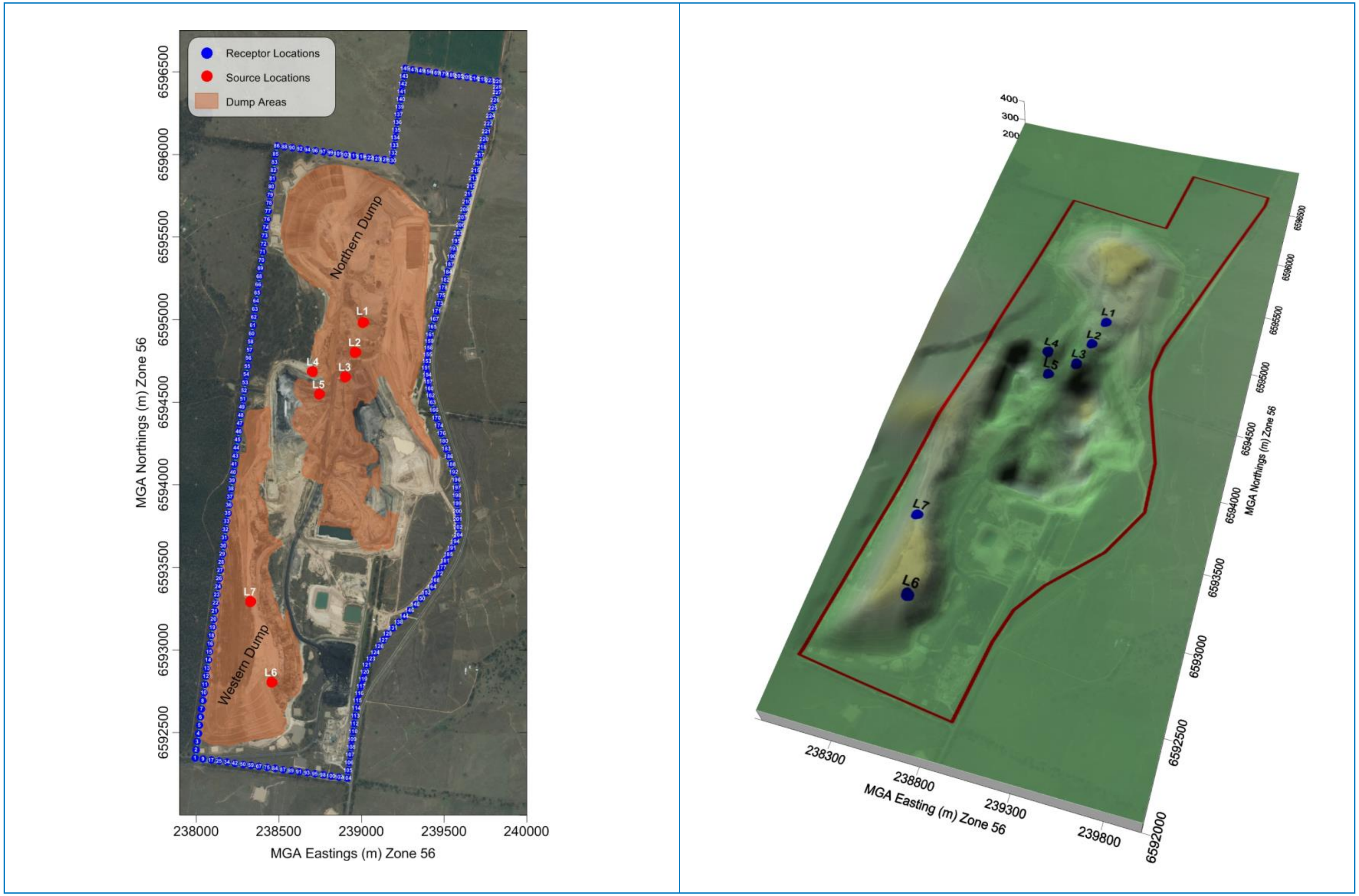

Figure 1: Overburden Activity Source Locations

2.2 Model Inputs

Overburden handling activities are assumed to include loading / unloading of OB, dozers operating on OB and wind erosion from the disturbed surfaces. Each activity is assumed to operate simultaneously and an emission rate for total suspended particulate (TSP) is assumed to be 1,000,000 kg/y from each source.

Adjustments are made to hourly emissions as follows:

- **Loading/dumping OB**. Emissions are assumed to be dependent on wind speed to account for wind dependency in the overburden handling emission factor equation and hourly emissions are adjusted for wind speed as follows (**US EPA, 1987**):

$$Emission_{adjusted} = Emission_{unadjusted} \times \left({Hourly\ Wind\ Speed}/{2.2}\right)^{1.3}$$

- **Dozers**. Emissions are independent of wind speed, as per the dozer emission factor equation.

By varying emissions in this way, “adverse conditions” will not only be influenced by the meteorological conditions under which dust disperses but also include those conditions under which higher emissions are generated at source (i.e. high wind speeds).

A meteorological modelling file was compiled using measured data from the Rocglen meteorological station ‘Glenroc’, from April 2009 to June 2012. The ‘Glenroc’ meteorological station was relocated in July 2012 so data after this time have not been included. The source and receptors heights took mine terrain into account. The scenarios modelled are as summarised in **Table 1**.

Table 1: Modelling Scenarios

Scenario ID	Dump ID	Terrain Height (m)	Distance from boundary (m)	Comments for selection
L1	Northern Emplacement	322	390	Currently dumping on elevated area. Notably dusty at present.
L2	Northern Emplacement	310	420	Currently dumping on elevated area. Notably dusty at present.
L3	Northern Emplacement	288	490	Currently dumping in-pit
L4	Northern Emplacement	294	390	Currently dumping in-pit
L5	Northern Emplacement	266	440	Currently dumping in-pit
L6	Western Emplacement	325	390	Potential overburden activity when finalising batter in next 12 month period
L7	Western Emplacement	326	210	Potential overburden activity when finalising batter in next 12 month period

3 ANALYSIS OF MODELLING RESULTS

The location of the 10 highest TSP boundary predictions for each OB activity location were, as expected, at locations closest to, or in a prevailing direction of, the active OB area. The ten boundary receptors for each OB location (shown in **Figure 2**) were selected for analysis of the meteorological conditions under which these high concentrations occur.

An hourly time series of predicted TSP concentrations at each of these top ten receptors was extracted for each scenario. The time series data were then normalised to enable the different scenarios to be directly compared with each other. The aim of normalisation of the predicted TSP concentrations across the scenarios was to enable identification of the scenarios (or locations) where the highest concentrations occur. In other words, the focus is on relative concentrations rather than actual concentrations.

Normalisation of data takes a large number of data sets that are on different scales and consolidates them to a single common scale. In this case, the activities were modelled with the same emissions and therefore the predicted levels at the receptors are not a reflection of actual levels which will be experienced, but rather how the results relate to one another. The concentrations determined from dispersion modelling have been normalised to the maximum predicted TSP concentrations for the parameter investigated (i.e. wind speed or wind direction). This enables all the data from the different scenarios to be compared on a scale of 0 to 1, across all scenarios.

It is important to note that the data were analysed separately based on wind speed and wind direction and therefore the graphs shown for wind speed and wind direction do not relate to each other.

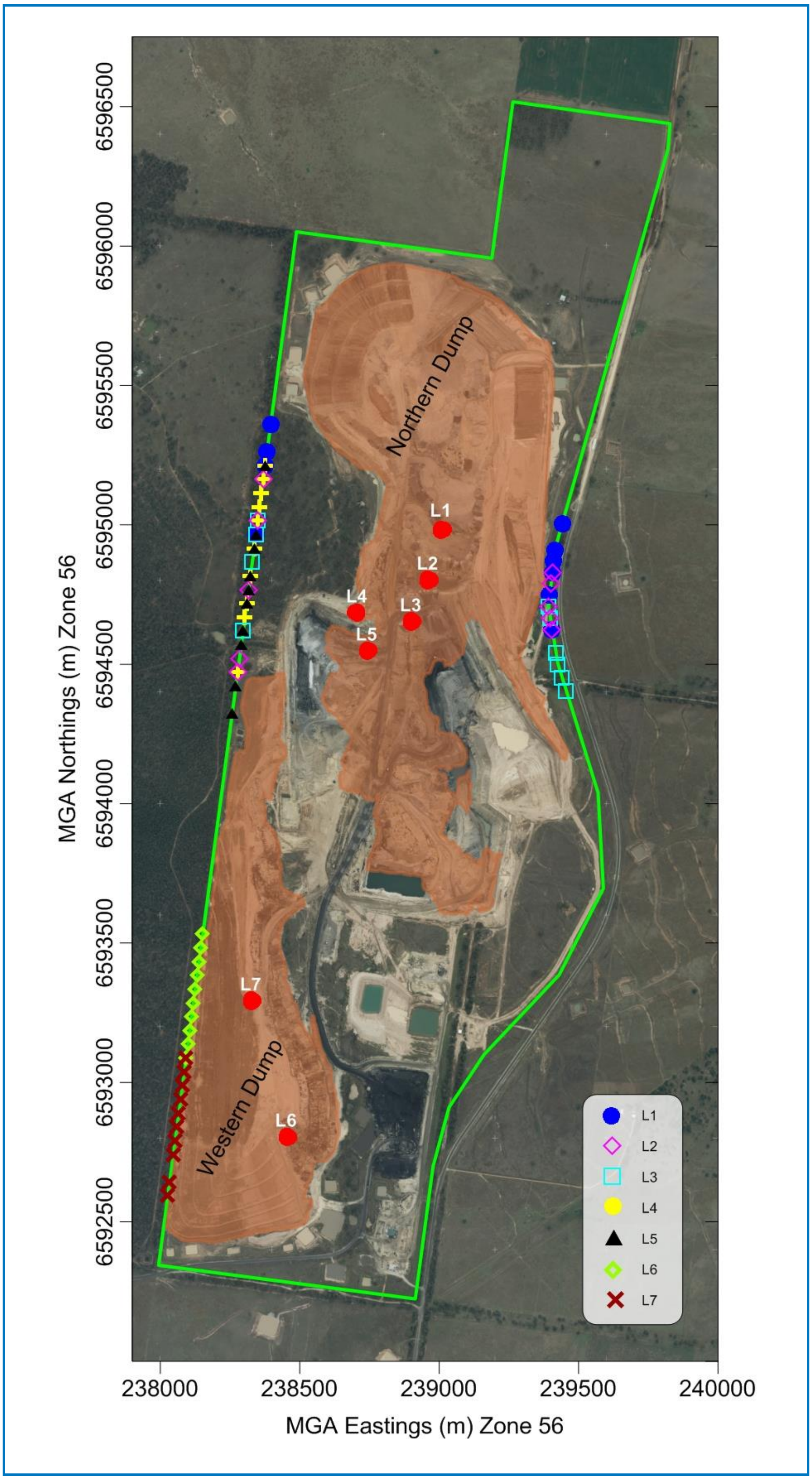

Figure 2: Location of highest boundary predictions for each OB activity location

3.1 Wind speed analysis

The normalised 1-hour TSP concentration for each hour of the year were averaged into a corresponding wind speed bin (at 0.1 m/s increments) and the results are presented in **Figure 3**, for the northern dump scenarios L1 to L5. **Figure 4** shows the results for the western dump scenarios L6 and L7. Each line shows the hourly prediction (averaged by wind speed) for each of the 10 highest boundary receptors for each scenario, as identified in **Figure 2**.

The analysis shows that the predicted TSP concentrations are relatively unchanged up to wind speeds of approximately 6 m/s. At wind speeds greater than 8 m/s there is a clear increase in predicted TSP concentrations, peaking at approximately 11 m/s.

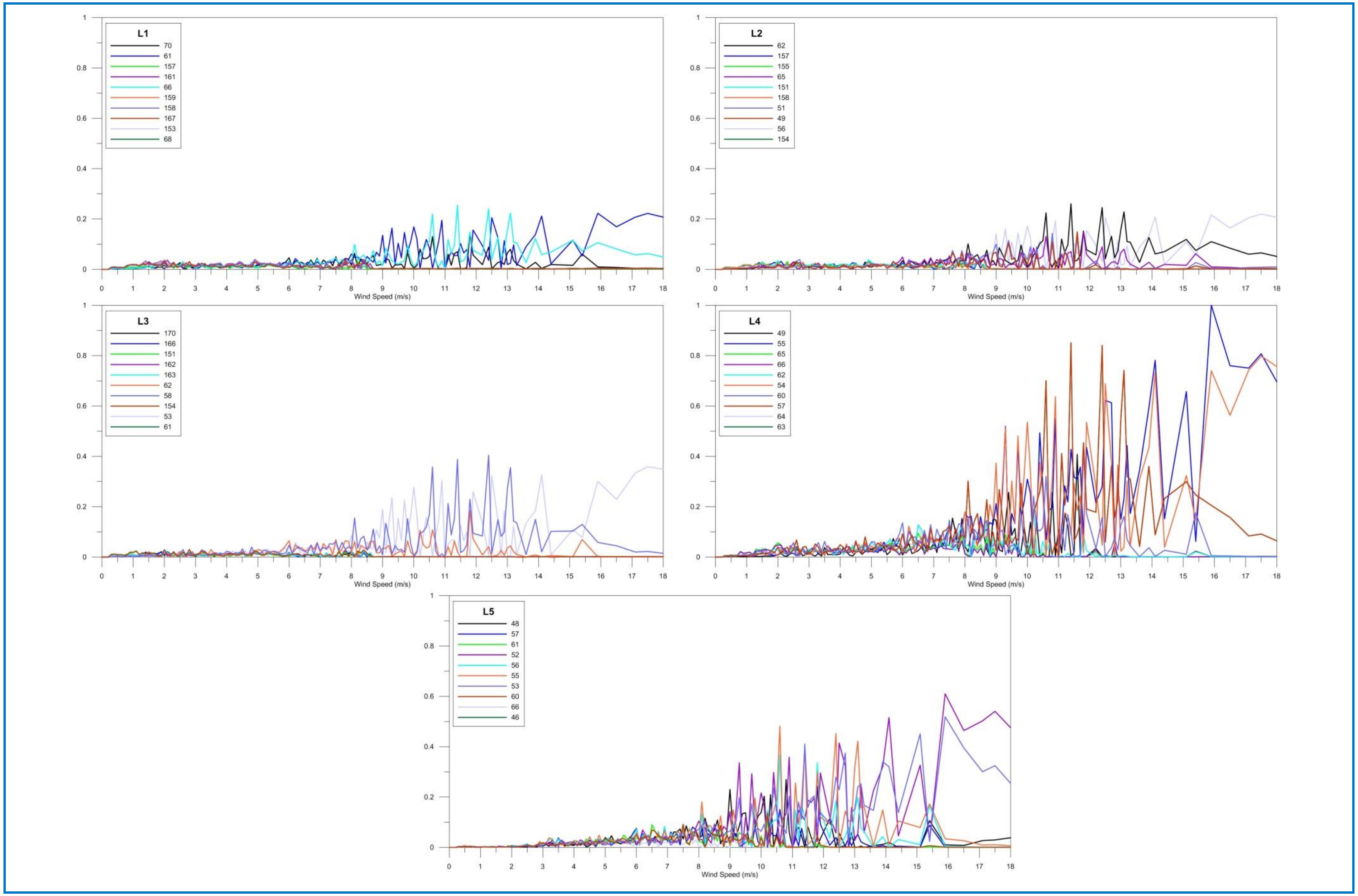

Figure 3: Normalised TSP concentration by wind speed at the northern dump (L1 to L5)

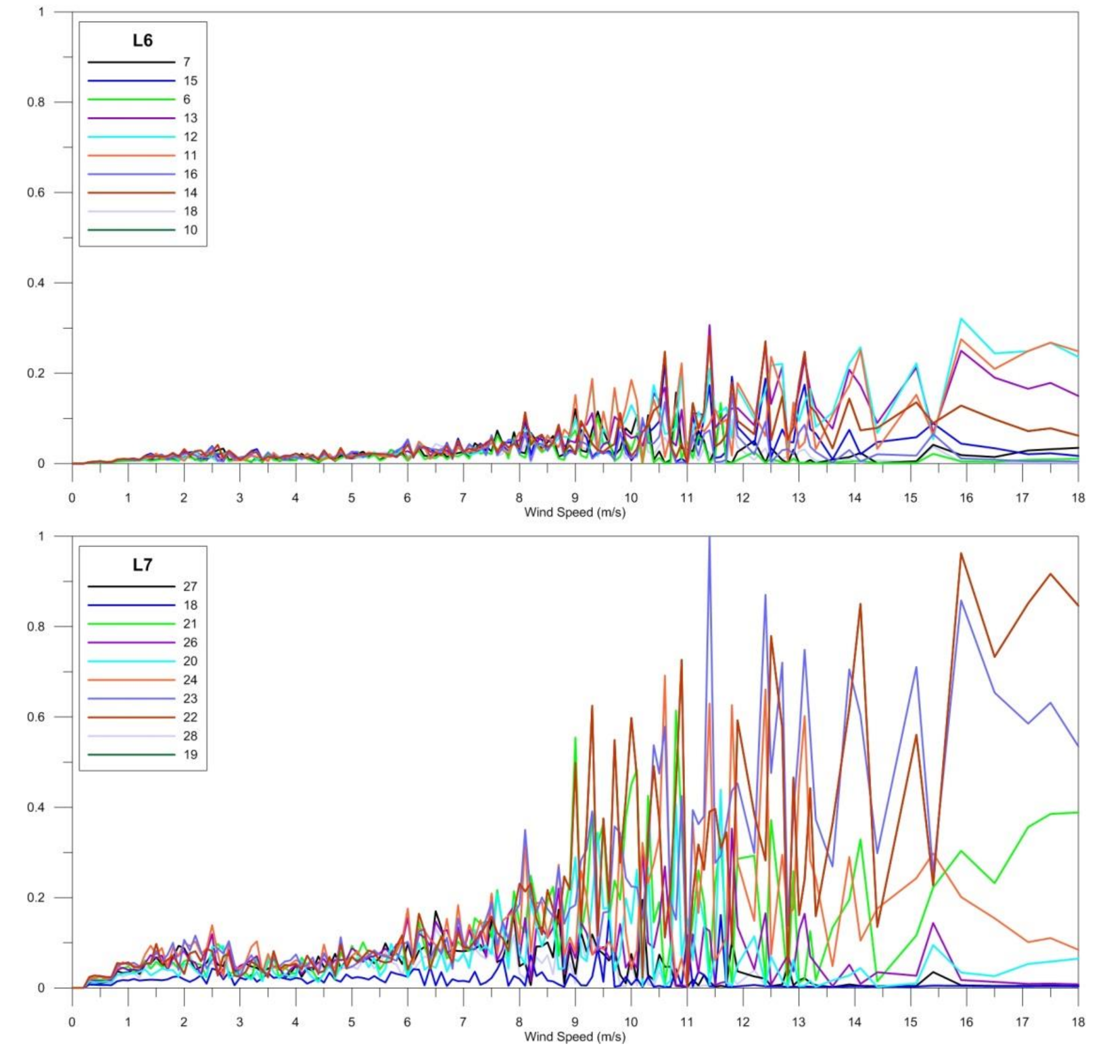

Figure 4: Normalised TSP concentration by wind speed at the western dump (L6 to L7)

3.2 Time of day analysis

An analysis of the 1-hour TSP concentrations by hour of the day is presented in **Figure 5**. This analysis has been carried out for L4 and L7, the highest predicted levels for the northern and western dump areas, respectively. A clear pattern is evident with higher concentrations at the boundaries during night-time conditions.

Hour of the day can be used as a surrogate for atmospheric stability, an indicator of turbulence or dispersive capacity. A descriptor of turbulence, known as Monin-Obukhov length (L), can be interpolated from the modelling files and used to describe whether conditions are unstable (enhanced dust dispersion) or stable (dust dispersion is suppressed). The inverse of Monin-Obukhov length (1/L) is plotted below the time of day analysis, showing highest concentration during stable conditions (when Monin-Obukhov length is positive).

What is evident from the time of day analysis is that the normalised TSP concentrations are significantly lower (< 0.2 as shown in **Figure 5**) than those presented for the wind speed analysis (up to 1, as shown in **Figure 3** and **Figure 4**). Therefore, although boundary concentrations increase during stable atmospheric conditions, they would not necessarily be considered “adverse” based on the relatively low normalised dust concentration.

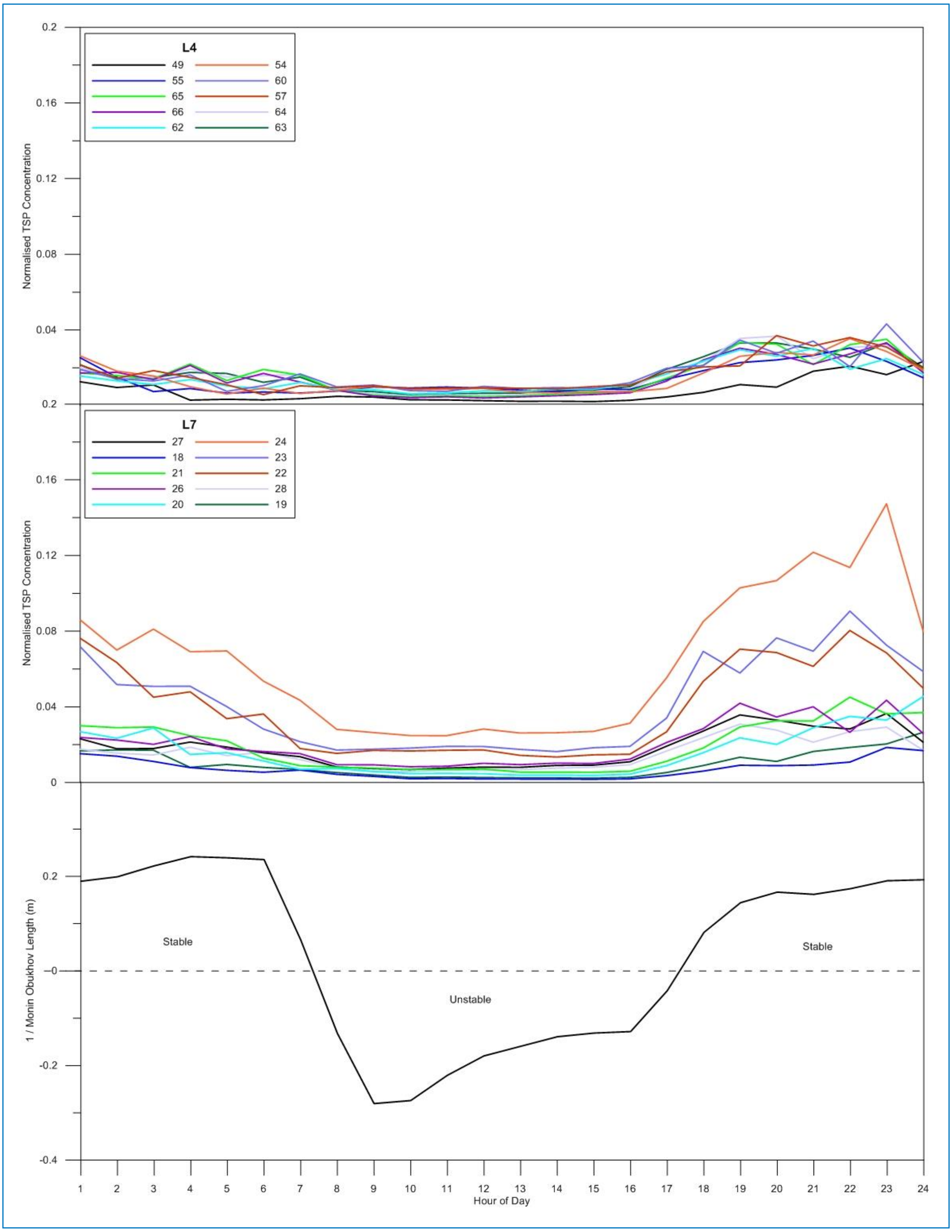

Figure 5: Normalised TSP concentrations and Monin-Obukhov length by hour of the day

3.3 Wind direction analysis

Normalised TSP concentrations for scenarios L1 to L5 are plotted against wind direction for the same top 10 boundary receptors discussed previously (**Figure 6**). The pollution rose shows the wind directions under which highest TSP concentrations at the boundary locations occur, which as expected are when winds blow from the south-southwest and southwest. The highest levels are predicted for scenario L4 with winds from the eastern quadrant. There are also elevated levels predicted at the eastern boundary for L1, L2 and L3, which are slightly closer to that boundary.

Results for the western dump locations L6 and L7 are shown in **Figure 7** and show the highest levels are predicted on the western boundary when winds are from the eastern quadrant. This is not unexpected given the close proximity of the dump area to that western boundary.

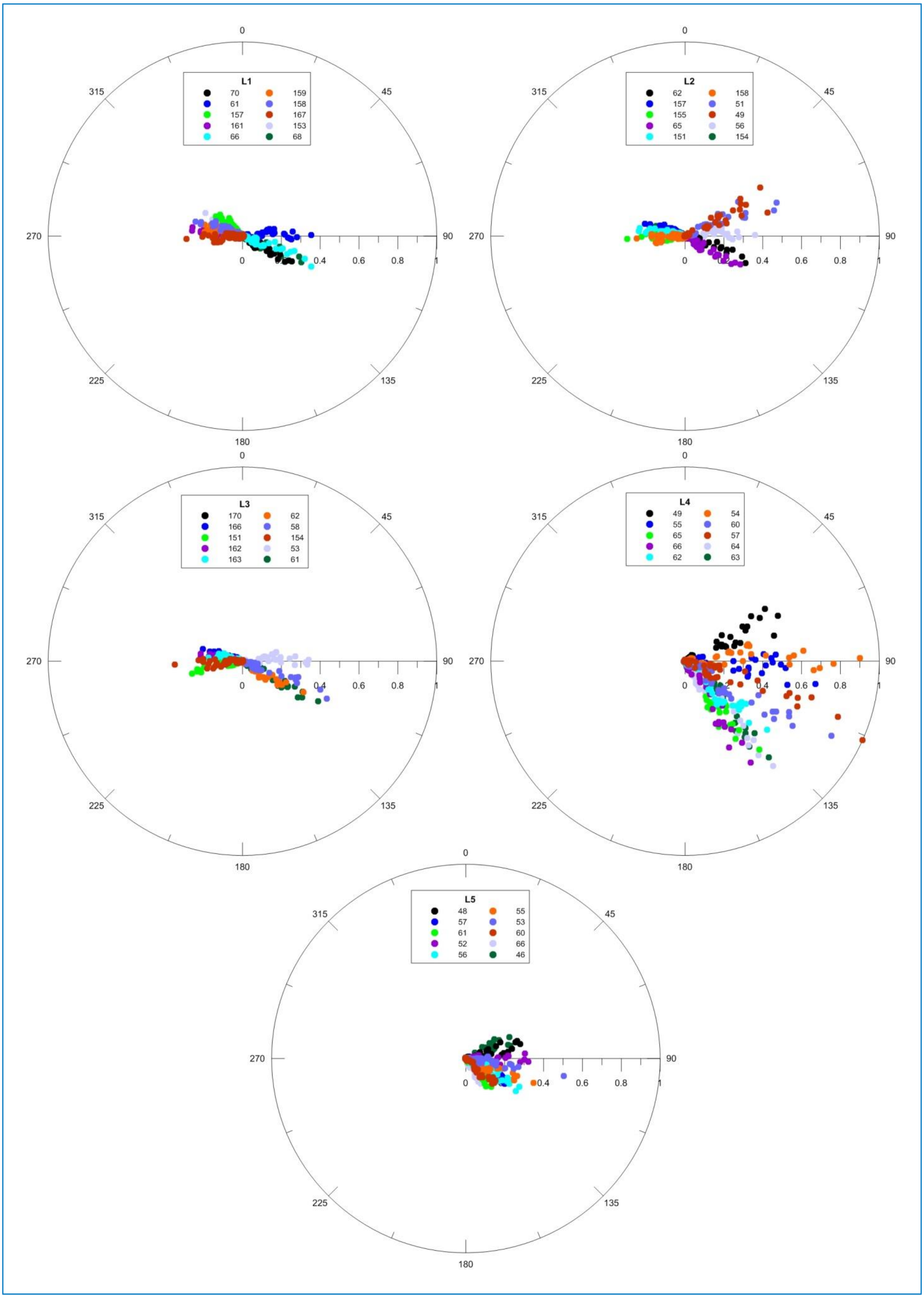

Figure 6: Normalised TSP concentrations with wind direction for the northern dump area

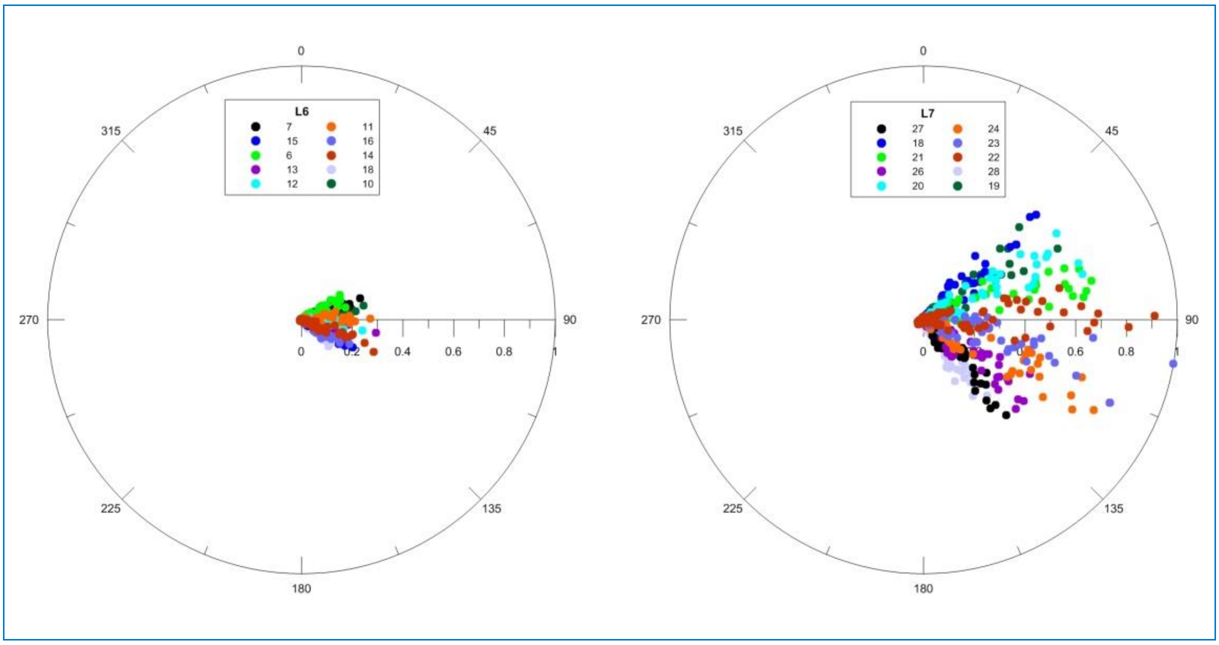

Figure 7: Normalised TSP concentrations with wind direction for the western dump area

4 DEVELOPMENT OF TRIGGER LEVELS

Based on the analysis presented above, adverse conditions for unacceptable dust levels beyond the site boundary are identified as wind speeds greater than 6 m/s. This is the case for both the northern and western OB dump areas.

The pollution roses for the northern and western overburden areas (refer to **Figure 6** and **Figure 7**) identify the wind directions where highest levels may occur are from the eastern quadrant (approximately 45° to 135°). In scenarios L1 to L3, some dust impacts are also expected at the eastern receptors when the wind direction is from the westerly direction (approximately 270°). Normalised concentrations at the eastern receptors are approximately 0.3, which is 30% of maximum predicted impacts for wind direction.

Even though concentrations may be lower at the eastern boundary, it is the wind speed that is likely to be more critical as it will determine the level of emission from loading and dumping activities on OB dump areas.

The following trigger levels are therefore defined for the Rocglen TARP:

- Investigation Level - wind speed ≥ 6 m/s
- Action Level - wind speed ≥ 8 m/s

4.1 Analysis of the frequency of "adverse conditions"

The percentage occurrence of adverse conditions at Rocglen can be inferred from the information presented in **Table 2**, based on a review of the meteorological data from 2009 to June 2012. The frequency distribution of wind speeds are presented in **Figure 8** showing how often the wind speed triggers may be reached. The wind roses show the occurrence of wind speeds for different directions (

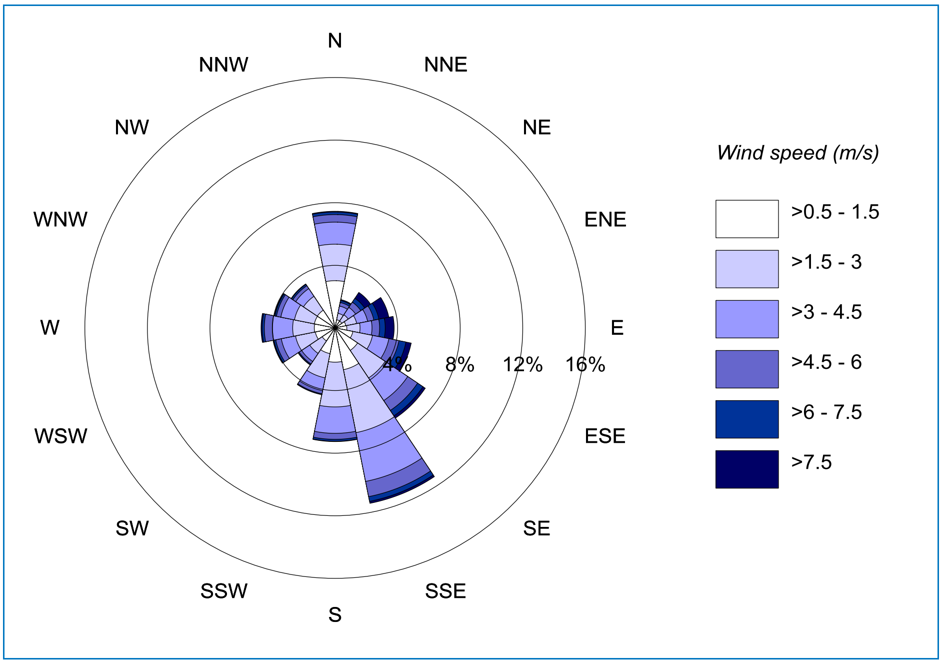

Figure 9). These plots and the data presented in **Table 2**, show that while the higher wind speeds are relatively infrequent, they are predominantly from the eastern quadrant. In other words, when the wind speed is such to activate a trigger the wind will often be from the eastern quadrant.

From the data presented in **Table 2** it can be seen that winds above 6 m/s (in any direction) occur approximately 5% of the time. Approximately 65% of those occasions the wind direction will be between 45° and 135°.

Table 2: Frequency distribution of wind speeds and direction

Wind Direction		Wind Speed (m/s)		
		< 6	>6 and < 8	> 8
>=0 - 22.5	N	21.3%	0.0%	0.0%
>22.5 - 45	NNE	2.2%	0.1%	0.0%
>45 - 67.5	NE	2.5%	0.4%	0.3%
>67.5 - 90	ENE	3.1%	0.4%	0.4%
>90 - 112.5	E	3.5%	0.5%	0.4%
>112.5 - 135	ESE	4.9%	0.6%	0.1%
>135 - 157.5	SE	7.2%	0.5%	0.0%
>157.5 - 180	SSE	12.5%	0.3%	0.0%
>180 - 202.5	S	8.2%	0.1%	0.0%
>202.5 - 225	SSW	5.6%	0.1%	0.0%
>225 - 247.5	SW	3.7%	0.1%	0.0%
>247.5 - 270	WSW	5.1%	0.1%	0.0%
>270 - 292.5	W	5.6%	0.2%	0.0%
>292.5 - 315	WNW	5.0%	0.1%	0.0%
>315 - 337.5	NW	4.6%	0.1%	0.0%
>337.5 - 360	NNW	0.0%	0.0%	0.0%
Total	**All directions**	**95%**	**4%**	**1%**

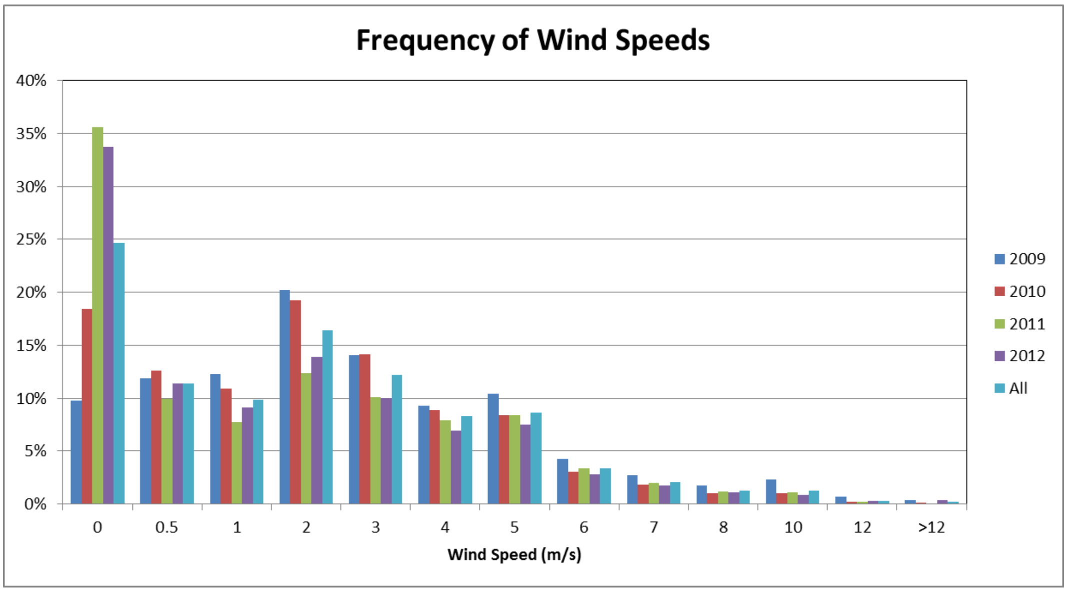

Figure 8: Frequency of wind speeds and 'Glenroc'

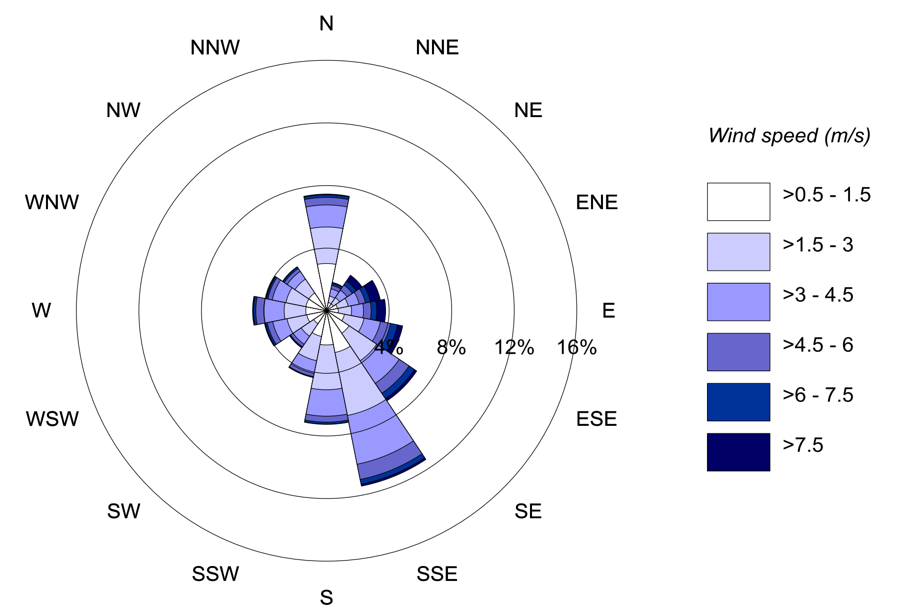

Figure 9: Windrose for all data from 2009 to 2012 at 'Glenroc'

5 REFERENCES

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