STACK MODELLING FOR TRANSPACIFIC REFINERS, RUTHERFORD

Transpacific Refiners

Job No: 6963

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A PEL Company

PROJECT TITLE: Stack Modelling for Transpacific Refiners, Rutherford

JOB NUMBER: **6963**

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DOCUMENT CONTROL

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ES1 EXECUTIVE SUMMARY

Transpacific Refiners (TPR) are investigating potential effects on ground level concentration due to changes in the stack parameters of the gas fired heater at their Rutherford refinery. Six scenarios have been modelled to incorporate all combinations of two stack heights and three exit velocities.

Dispersion modelling conducted for this assessment has been based on a modelling system using TAPM, CALMET and CALPUFF.

Initial modelling was carried out for 23 receptors in the area, which included the existing exit velocity and the two stack heights (16 m and 25 m). Further modelling was then done for five on site receptors for each of the six scenarios.

The results indicate that the largest reductions in ground level concentrations come from increasing the stack height rather than the exit velocity. The most significant of these is in the H_2SO_4 concentrations (up to 45% by increasing to 25 m alone, and 46% for increasing stack height and exit velocity).

1 INTRODUCTION

Transpacific Refiners (TPR) operate an oil refinery that processes recycled oil feedstock, located within an industrial area in Kyle Street, Rutherford. TPR wish to investigate the effects of increasing the height of the Fired Heater stack on ground level concentrations in the area.

PAEHolmes has been commissioned to conduct dispersion modelling to assess the potential impact of two different stack heights for the gas fired heater. The methodologies and results from this modelling are presented in the following.

2 IMPACT ASSESSMENT CRITERIA

The New South Wales Environment Protection Authority (EPA) provides guidance for the selection and configuration of air dispersion models, methodologies to be used to compile meteorological datasets and emissions data, and specifies the assessment criteria to be used to evaluate compliance. This guidance is the '*Approved Methods for modelling and assessment of air pollutants in New South Wales*' (**DEC, 2005**). The criteria are health-based and are consistent with the National Environment Protection Measure for Ambient Air Quality (referred to as the Ambient Air-NEPM) (**NEPC, 1998**).

Table 1 summarises the adopted air quality criteria for the six key air quality indicators that are relevant to the scope of this study. Note that Benzene has been chosen for modelling as it represents the highest proportion of total VOCs measured onsite and it has the most stringent assessment criteria.

Table 1 Ambient Air Quality Criteria relevant to the Current Study (Source: Air NEPM)

Pollutant	Averaging Period	Maximum Concentration µg/m³
PM_{10}	24 hour	50
	Annual	30
Benzene (VOCs)	1 hour	0.029
SO_2	1 hour	570
	24 hour	228
	Annual	60
NO_2	1 hour	246
	Annual	62
H_2SO_4 mist (sulphuric acid)	1 hour	0.018
H_2S	Nose response time average (99th Percentile)	3.45

Hydrogen Sulfide (H_2S) is an odorous air pollutant and is reported as a peak concentration at an approximately 1 second average. Therefore the 1 hour average ground level concentrations of H_2S are scaled with an appropriate peak-to-mean ratio from **Table 2**, which was a near field wake-affected point for all atmospheric stability classes A to F.

Table 2 Factors for estimating peak concentrations in flat terrain (Source: Approved Methods)

Source Type	Pasquil-Gifford stability class	Near field P/M60*	Far field P/M60*
Area	A, B, C, D	2.5	2.3
	E, F	2.3	1.9
Line	A-F	6	6
Surface wake-free point	A, B, C	12	4
	D, E, F	25	7
Tall wake-free point	A, B, C	17	3
	D, E, F	35	6
Wake-affected point	A-F	2.3	2.3
Volume	A-F	2.3	2.3

*Ratio of peak 1-second average concentrations to mean 1-hour average concentrations

3 DISPERSION MODELLING

The modelling has been carried out in general accordance with the '*Approved Methods'* which specify how assessments based on the use of air dispersion models should be undertaken.

Dispersion modelling conducted for this assessment has been based on a modelling system using TAPM, CALMET and CALPUFF.

TAPM is a prognostic meteorological model that generates gridded three-dimensional meteorological data for each hour of the model run period. CALMET, the meteorological pre-processor for the dispersion model CALPUFF, calculates three-dimensional meteorological data based upon observed ground and upper level meteorological data, as well as modelled data generated for example by TAPM. CALPUFF then calculates the dispersion of plumes within this three-dimensional meteorological field.

The meteorological year modelled is 2011, which was selected due to the availability of high quality meteorological at the three Bureau of Meteorology Automatic Weather stations (AWS) at Patterson, Cessnock and Williamtown RAAF. The location of the meteorological sites and CALMET and CALPUFF modelling domains are shown in **Figure 3.1**. **Table 3** summarises the data used for this dispersion modelling.

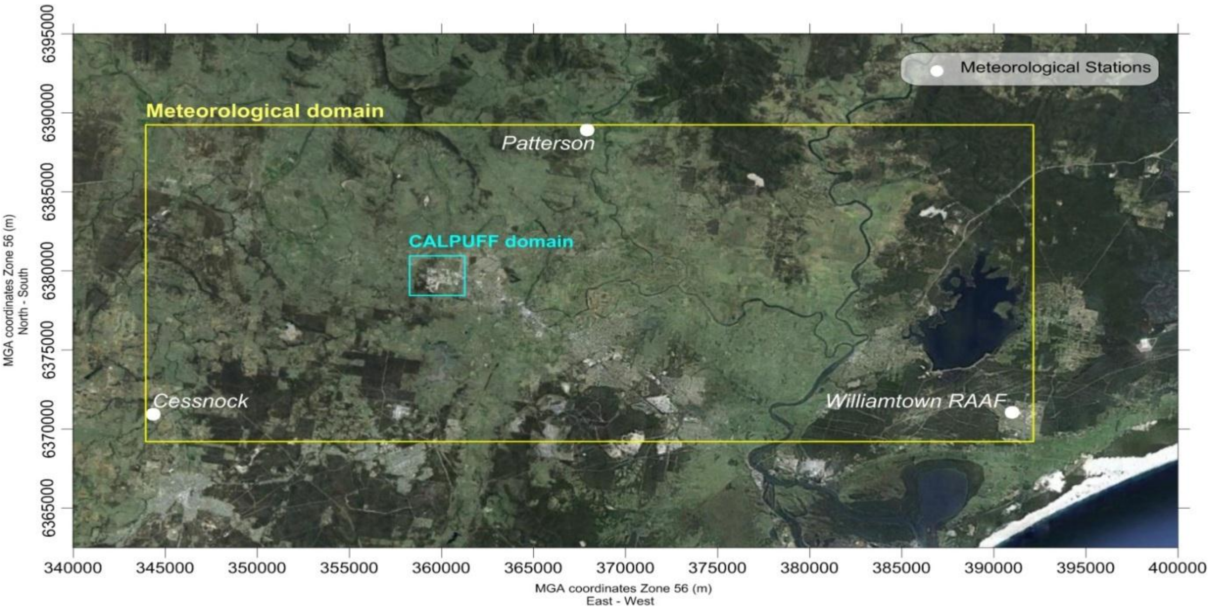


Figure 3.1: CALMET/CALPUFF modelling domains and meteorological site locations

Table 3: Meteorological Parameters used for TAPM and CALMET

TAPM (v 4.0.4)	
Number of grids (spacing)	30 km, 10 km, 3 km, 1km
Number of grid points	50 x 50 x 35
Year of analysis	January 2011 – December 2011
Centre of domain	35^{0}43.5′ S, 151^{0}35.5′ E
CALMET (v. 6.42)	
Meteorological grid domain	48 km x 20 km
Meteorological grid resolution	0.25 km
Surface meteorological stations	Williamtown RAFF AWS (BoM, Station No. 061078) - Wind speed - Cloud Amount - Wind direction - Relative humidity - Temperature - Sea Level Pressure - Cloud Height Patterson AWS (BoM, Station No. 061250) - Wind speed - Relative humidity - Wind direction - Sea Level Pressure - Temperature Cessnock Airport AWS (BoM, Station No. 061260) - Wind speed - Relative humidity - Wind direction - Sea Level Pressure - Temperature
3D.dat	Data extracted from 3 km TAPM
CALPUFF (v. 6.42)	
Computational domain	2.75 x 2.75 km
Sampling grid resolution	50m

3.1 Dispersion Meteorology

Annual and seasonal wind roses for the CALMET generated meteorological data onsite are presented in **Figure 3.2**. On an annual basis the winds are predominantly west-northwesterly. To use the wind data to assess the dispersion, it is necessary to also have data on the atmospheric stability. The frequency distribution of the estimated Pasquil-Gifford scheme stability classes are presented in **Table 4**. Overall the stability class D occurs most frequently (39%) of the time, which indicates a predominantly neutral stable atmosphere where dispersion is more efficient.

Table 4: Frequency of stability class

Stability Class	Percentage of occurrence (CALMET)
A	1%
B	5%
C	15%
D	39%
E	15%
F	25%
Total	**100%**

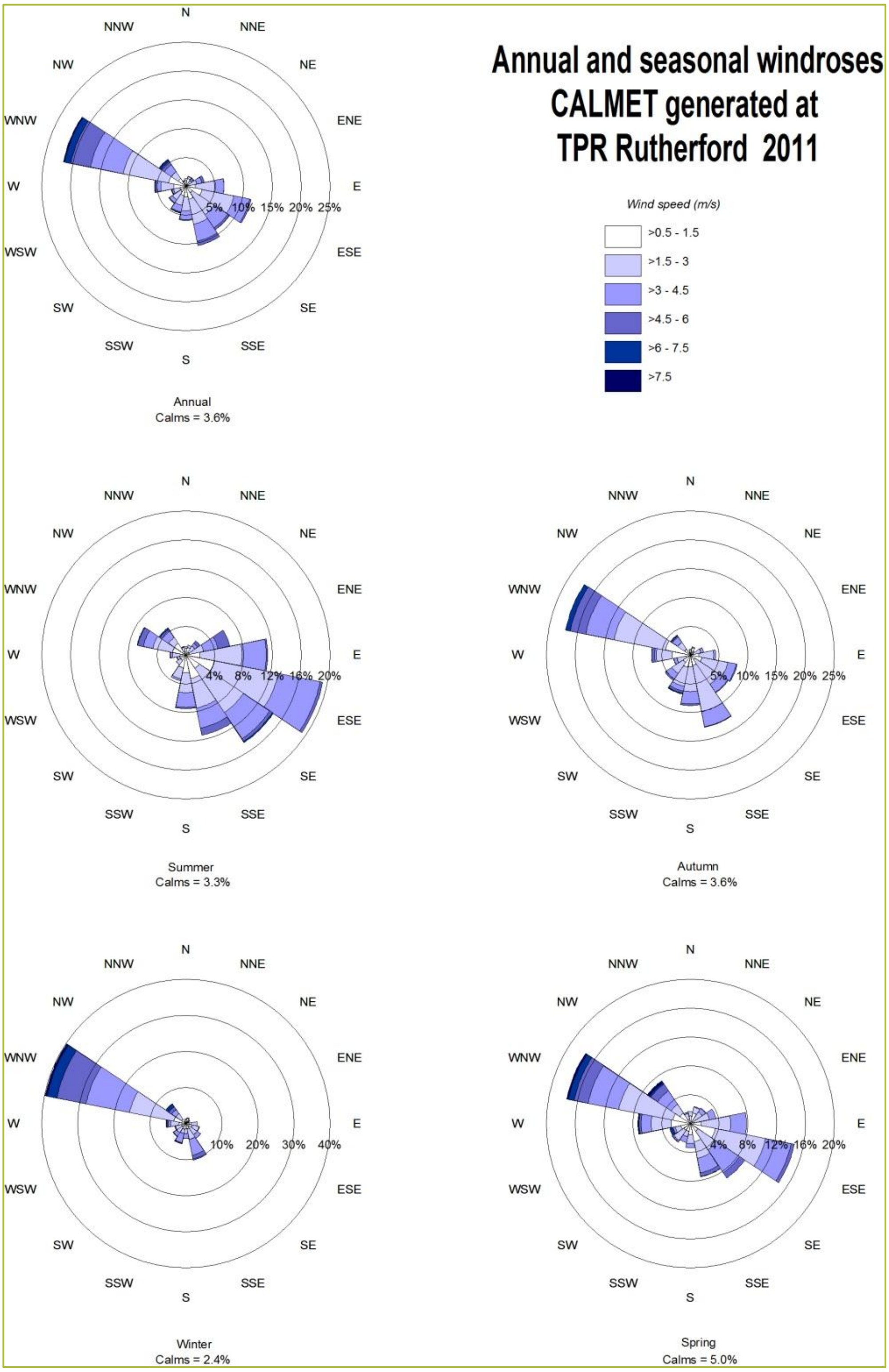


Figure 3.2: Annual and seasonal wind roses for CALMET generated meteorological data onsite

4 EMISSION ESTIMATES

New Environment Quality (newEQ) has conducted regular stack testing at the Rutherford refinery for each of the sources listed below:

- Points 2 and 3 - 0.2 and 3.0 MW gas fired boilers
- Point 5 - Light Ends Scrubber
- Point 19 - stack that serves two gas fired heaters
  - The thermal oil heater operates on natural gas and exhausts directly out of Point 19 (via in-duct monitoring point 18)
  - The Fired Heater operates on natural gas and fuel gas from the process, and exhausts to a SO_X scrubber to control potential sulphur emissions. After passing though the scrubber, emissions from the Fired Heater exhaust to point 19 (via in-duct monitoring point 1)
- Point 20 - exhaust emissions associated with operation of the reformer.

The point source locations are shown in **Figure 4.1**. Note that the point 4 flare stack is not subject to testing in this assessment.

Figure 4.1: Source locations

Table 5 summarises the characteristics of each point source. Two scenarios were modelled, one where the stack height of Point 19 is 16m and the other at 25m.

Table 5: CALPUFF Model Options used

Parameter	Point 2	Point 3	Point 5	Point 19	Point 20
Temperature (K)	470	522	295	378	1072
Exit velocity (m/s)	2.72	10.29	5.72	4.67	11.29
Diameter (m)	0.65	0.16	0.2	0.4	0.34
Height (m)	8	10	8	16/25	14
Volumetric flow rate (m^3/s)	0.90	0.68	0.18	0.59	1.03

The maximum emission rates measured at each stack source for each pollutant of interest is presented in **Table 6**. These are the emission rates that were used for the dispersion modelling.

Table 6: Maximum measured emission rates (g/s)

Pollutant	Point 2	Point 3	Point 5	Point 19	Point 20
PM_{10}	0.00211	0.00033	0.00156	0.00569	0.00130
VOCs	0.00041	0.00029	0.00018	0.00038	0.00020
Benzene	0.00016	0.00012	0.00007	0.00015	0.00008
NO_x	0.03536	0.02639	0.00037	0.07527	0.01715
SO_2	0.00128	0.00088	0.00052	0.00624	0.00058
H_2SO_4	-	-	0.00028	0.03428	-
H_2S	0.00108	0.00074	-	0.00054	0.00041

5 PREDICTED GROUND LEVEL CONCENTRATIONS

The predicted ground level concentrations for each of the six key pollutants are presented in the following sections for the relevant averaging periods.

The ground level concentrations predicted at a number of nearby receptors are presented in **Table** 6 and **Table 7**. No receptors are predicted to exceed any of the criteria of the pollutants modelled.

Table 7: Predicted ground level concentrations at nearby residences for the 16m Point 19 stack

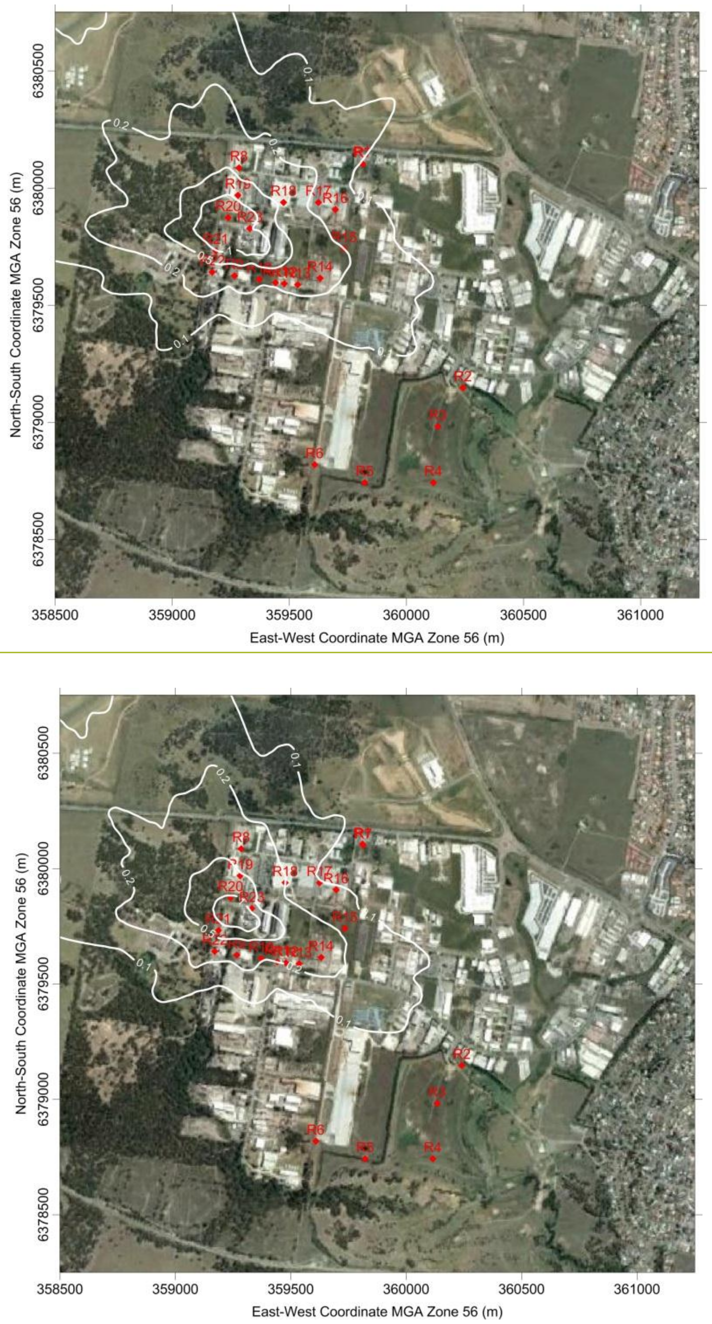
Receptor ID	Easting	Northing	H_2S	H_2SO_4 (SO_3)	SO_2			VOCs	PM_{10}		NO_x		Benzene
			99th percentile	1 hour	1 hour	24 hour	Annual	1 hour	24 hour	Annual	1 hour	Annual	1 hour
Criteria			3.45	0.018	570	228	60	-	50	30	246	62	0.029
Units			$\mu g/m^3$	mg/m^3	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	mg/m^3	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	mg/m^3
1	359332	6379827	1.20	0.0090	2.5	0.94	0.104	0.00039	1.16	0.13	38	1.61	0.00061
2	359810	6380106	0.12	0.0014	0.4	0.09	0.006	0.00006	0.10	0.01	6	0.10	0.00008
3	360241	6379147	0.09	0.0008	0.2	0.07	0.009	0.00003	0.08	0.01	3	0.15	0.00005
4	360134	6378983	0.07	0.0007	0.2	0.05	0.005	0.00003	0.06	0.01	3	0.08	0.00004
5	360115	6378743	0.03	0.0005	0.1	0.02	0.002	0.00002	0.03	0.00	2	0.03	0.00003
6	359822	6378743	0.02	0.0006	0.2	0.02	0.001	0.00003	0.03	0.00	3	0.02	0.00004
7	359608	6378819	0.02	0.0008	0.2	0.02	0.001	0.00003	0.03	0.00	3	0.02	0.00004
8	359814	6380102	0.12	0.0014	0.4	0.08	0.006	0.00006	0.09	0.01	6	0.10	0.00008
9	359285	6380087	0.37	0.0031	0.8	0.37	0.037	0.00013	0.41	0.04	13	0.58	0.00019
10	359266	6379626	0.31	0.0038	1.1	0.26	0.015	0.00018	0.32	0.02	17	0.24	0.00031
11	359372	6379611	0.28	0.0040	1.0	0.20	0.027	0.00016	0.25	0.03	16	0.43	0.00023
12	359441	6379596	0.26	0.0029	0.7	0.21	0.035	0.00011	0.25	0.04	11	0.57	0.00017
13	359479	6379592	0.27	0.0025	0.7	0.23	0.039	0.00010	0.26	0.05	10	0.62	0.00015
14	359536	6379588	0.27	0.0022	0.6	0.21	0.041	0.00009	0.25	0.05	9	0.66	0.00013
15	359631	6379615	0.28	0.0020	0.6	0.21	0.045	0.00010	0.25	0.05	10	0.72	0.00016
16	359734	6379741	0.23	0.0019	0.5	0.18	0.026	0.00009	0.20	0.03	8	0.40	0.00014
17	359696	6379908	0.19	0.0021	0.5	0.14	0.012	0.00008	0.15	0.01	8	0.19	0.00012
18	359624	6379939	0.21	0.0023	0.6	0.15	0.014	0.00009	0.16	0.02	9	0.22	0.00013
19	359475	6379939	0.37	0.0038	1.0	0.38	0.028	0.00015	0.42	0.03	15	0.42	0.00023
20	359281	6379969	0.75	0.0061	1.6	0.80	0.086	0.00024	0.88	0.10	25	1.34	0.00035
21	359239	6379874	1.29	0.0084	2.1	1.63	0.261	0.00039	1.85	0.30	34	4.01	0.00056
22	359186	6379733	0.89	0.0092	2.5	0.80	0.065	0.00040	0.92	0.08	40	1.01	0.00058
23	359171	6379642	0.35	0.0049	1.3	0.34	0.019	0.00020	0.39	0.02	20	0.30	0.00033

Table 8: Predicted ground level concentrations at nearby residences for the 25 Point 19 stack

Receptor ID	Easting	Northing	H_2S	H_2SO_4 (SO_3)	SO_2			VOCs	PM_{10}		NO_x		Benzene
			99th percentile	1 hour	1 hour	24 hour	Annual	1 hour	24 hour	Annual	1 hour	Annual	1 hour
Criteria			3.45	0.018	570	228	60	-	50	30	246	62	0.029
Units			$\mu g/m^3$	mg/m^3	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	mg/m^3	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	$\mu g/m^3$	mg/m^3
1	359332	6379827	0.97	0.0064	1.7	0.39	0.053	0.00033	0.68	0.08	27	1.00	0.00058
2	359810	6380106	0.10	0.0008	0.2	0.05	0.004	0.00005	0.05	0.01	4	0.07	0.00008
3	360241	6379147	0.09	0.0006	0.2	0.06	0.009	0.00003	0.07	0.01	3	0.15	0.00004
4	360134	6378983	0.07	0.0006	0.2	0.05	0.005	0.00003	0.06	0.01	3	0.08	0.00004
5	360115	6378743	0.03	0.0005	0.1	0.03	0.002	0.00002	0.03	0.00	2	0.03	0.00003
6	359822	6378743	0.02	0.0006	0.2	0.03	0.001	0.00003	0.03	0.00	3	0.02	0.00004
7	359608	6378819	0.02	0.0007	0.2	0.03	0.001	0.00003	0.03	0.00	3	0.02	0.00004
8	359814	6380102	0.10	0.0008	0.2	0.05	0.004	0.00005	0.05	0.01	4	0.07	0.00008
9	359285	6380087	0.35	0.0024	0.7	0.26	0.028	0.00011	0.31	0.03	11	0.47	0.00018
10	359266	6379626	0.30	0.0028	0.9	0.21	0.013	0.00016	0.27	0.02	14	0.21	0.00031
11	359372	6379611	0.27	0.0026	0.7	0.17	0.020	0.00012	0.22	0.03	11	0.35	0.00022
12	359441	6379596	0.25	0.0023	0.6	0.16	0.026	0.00009	0.20	0.03	9	0.45	0.00016
13	359479	6379592	0.24	0.0021	0.6	0.16	0.030	0.00008	0.20	0.04	9	0.52	0.00014
14	359536	6379588	0.24	0.0018	0.5	0.20	0.036	0.00008	0.24	0.04	7	0.59	0.00013
15	359631	6379615	0.26	0.0017	0.4	0.23	0.044	0.00008	0.26	0.05	7	0.70	0.00015
16	359734	6379741	0.21	0.0013	0.4	0.15	0.019	0.00007	0.17	0.02	6	0.32	0.00014
17	359696	6379908	0.16	0.0013	0.4	0.09	0.008	0.00007	0.11	0.01	6	0.14	0.00011
18	359624	6379939	0.18	0.0015	0.4	0.08	0.008	0.00008	0.10	0.01	7	0.15	0.00013
19	359475	6379939	0.31	0.0028	0.8	0.15	0.015	0.00012	0.20	0.02	12	0.27	0.00021
20	359281	6379969	0.64	0.0032	0.9	0.41	0.050	0.00019	0.51	0.06	17	0.89	0.00033
21	359239	6379874	1.19	0.0058	1.7	0.70	0.119	0.00033	1.01	0.17	27	2.29	0.00054
22	359186	6379733	0.79	0.0042	1.2	0.55	0.040	0.00031	0.69	0.05	22	0.71	0.00055
23	359171	6379642	0.33	0.0028	0.7	0.23	0.014	0.00016	0.27	0.02	12	0.24	0.00032

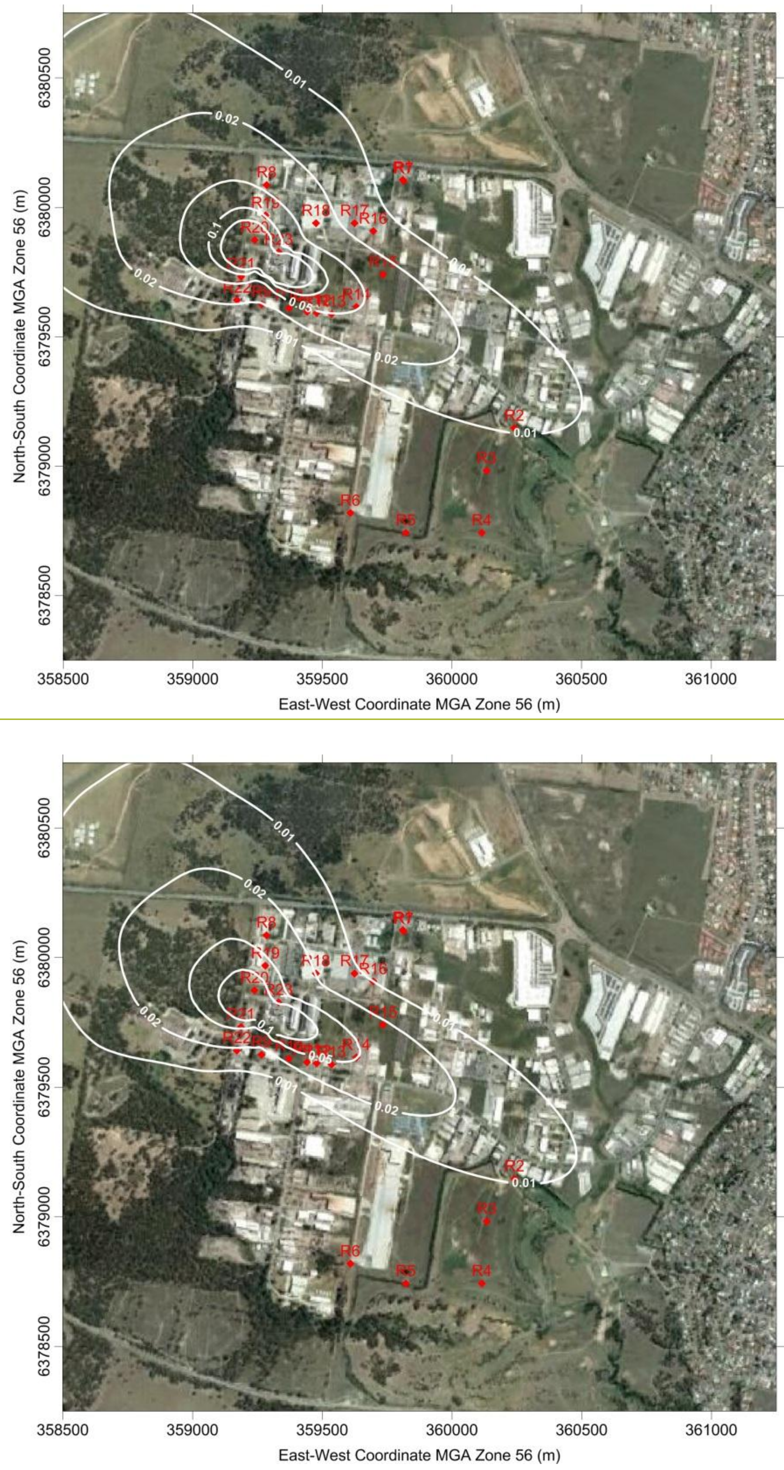
5.1 Coarse particles – PM$_{10}$

The maximum predicted 24-hour and annual ground level concentrations of PM$_{10}$ where the point 19 stacks are varied from 16 m and 25 m are presented in **Figure 5.1** and **Figure 5.2**.



Species: PM$_{10}$	**Location:** TPR	**Scenario:** Point 19 stack height (top) 16m and (bottom) 25m	**Percentile:** Maximum	**Averaging Time:** 24 hour
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** EPA = 50 µg/m^3	**Met Data:** CALMET 2011	**Plot:** K. Hill

Figure 5.1: Predicted 24-hour average ground-level concentrations of PM$_{10}$ (µg/m^3)

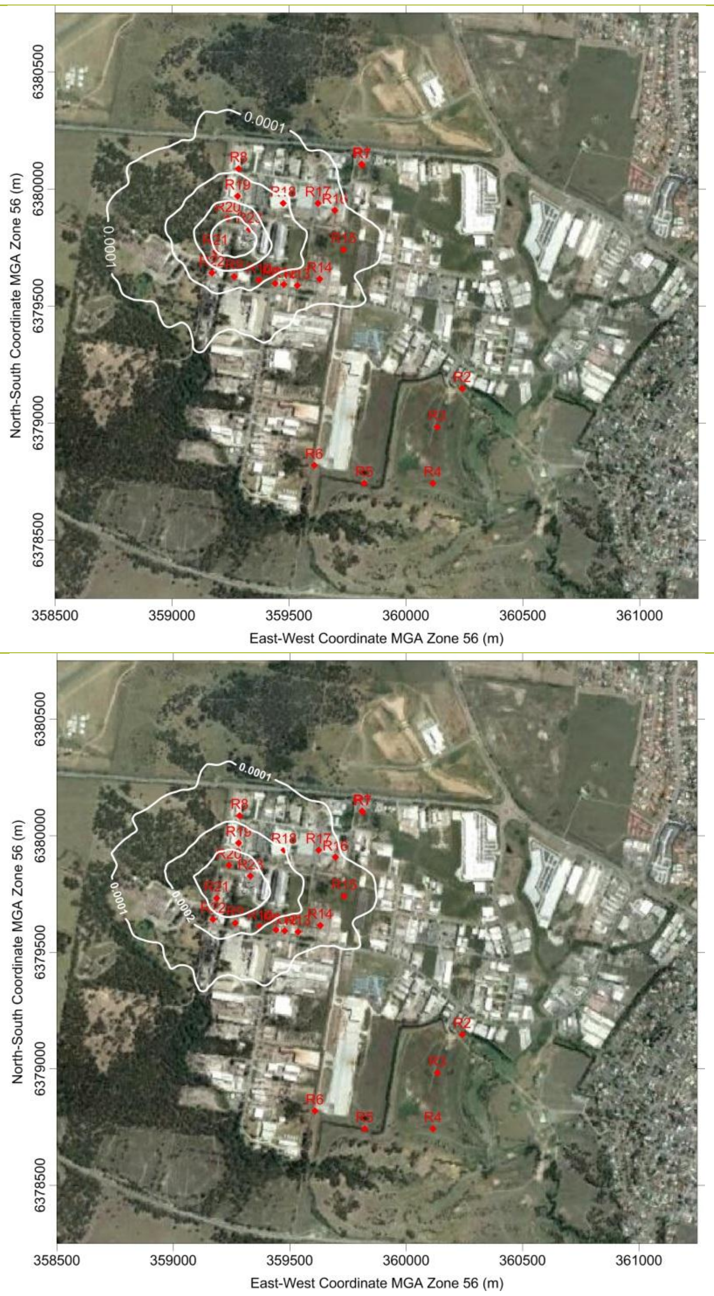


Species: PM_{10}	**Location:** TPR	**Scenario:** Point 19 stack height (top) 16m and (bottom) 25m	**Percentile:**	**Averaging Time:** Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** EPA = 30 µg/m³	**Met Data:** CALMET 2011	**Plot:** K. Hill

Figure 5.2: Predicted annual average ground-level concentrations of PM_{10} (µg/m³)

5.2 VOCs (Benzene)

The maximum predicted average 1-hour Benzene ground level concentrations where the Point 19 stacks are varied from 16 m and 25 m are compared in **Figure 5.3**.

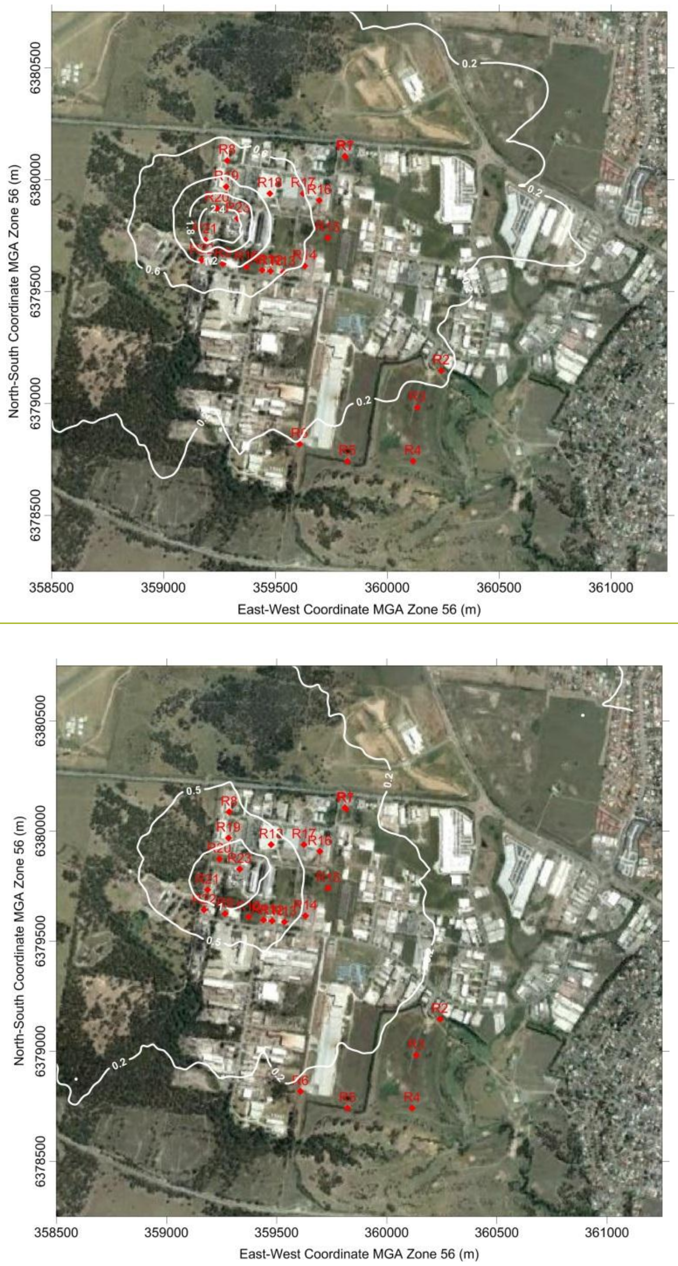


Species: VOCs (Benzene)	**Location:** TPR	**Scenario:** Point 19 stack height (top) 16m and (bottom) 25m	**Percentile:** Maximum	**Averaging Time:** 1 hour
Model Used: CALPUFF	**Units:** $\mu g/m^3$	**Guideline:** EPA = 0.29 $\mu g/m^3$	**Met Data:** CALMET 2011	**Plot:** K. Hill

Figure 5.3: Predicted 1-hour average ground-level concentrations of C_6H_6 ($\mu g/m^3$)

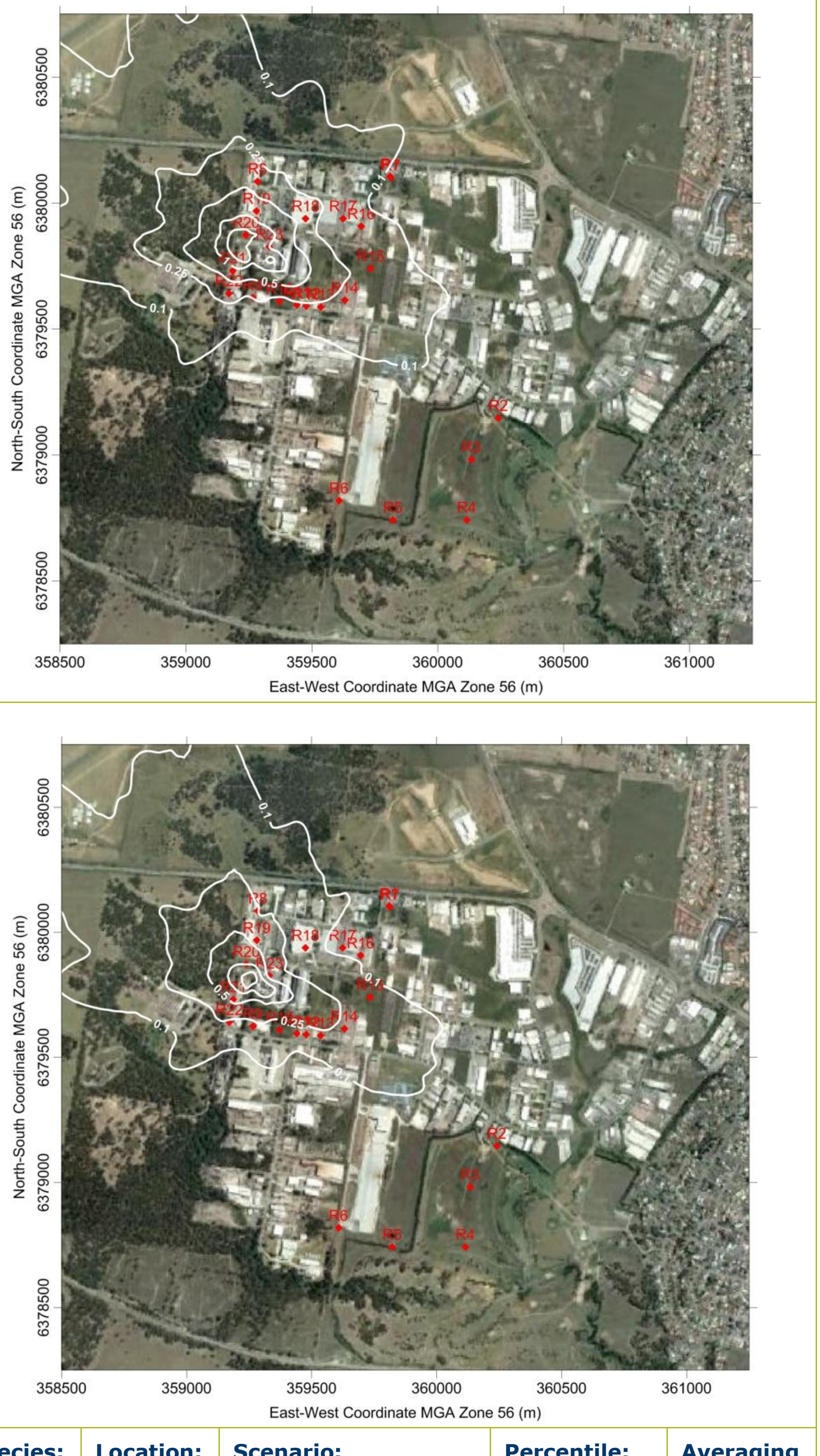
5.3 Sulphur Dioxide – SO_2

The maximum predicted 1-hour, 24-hour and annual ground level concentrations of SO_2 where the Point 19 stacks are varied from 16 m and 25 m are presented in **Figure 5.4**, **Figure 5.5** and **Figure 5.6**.



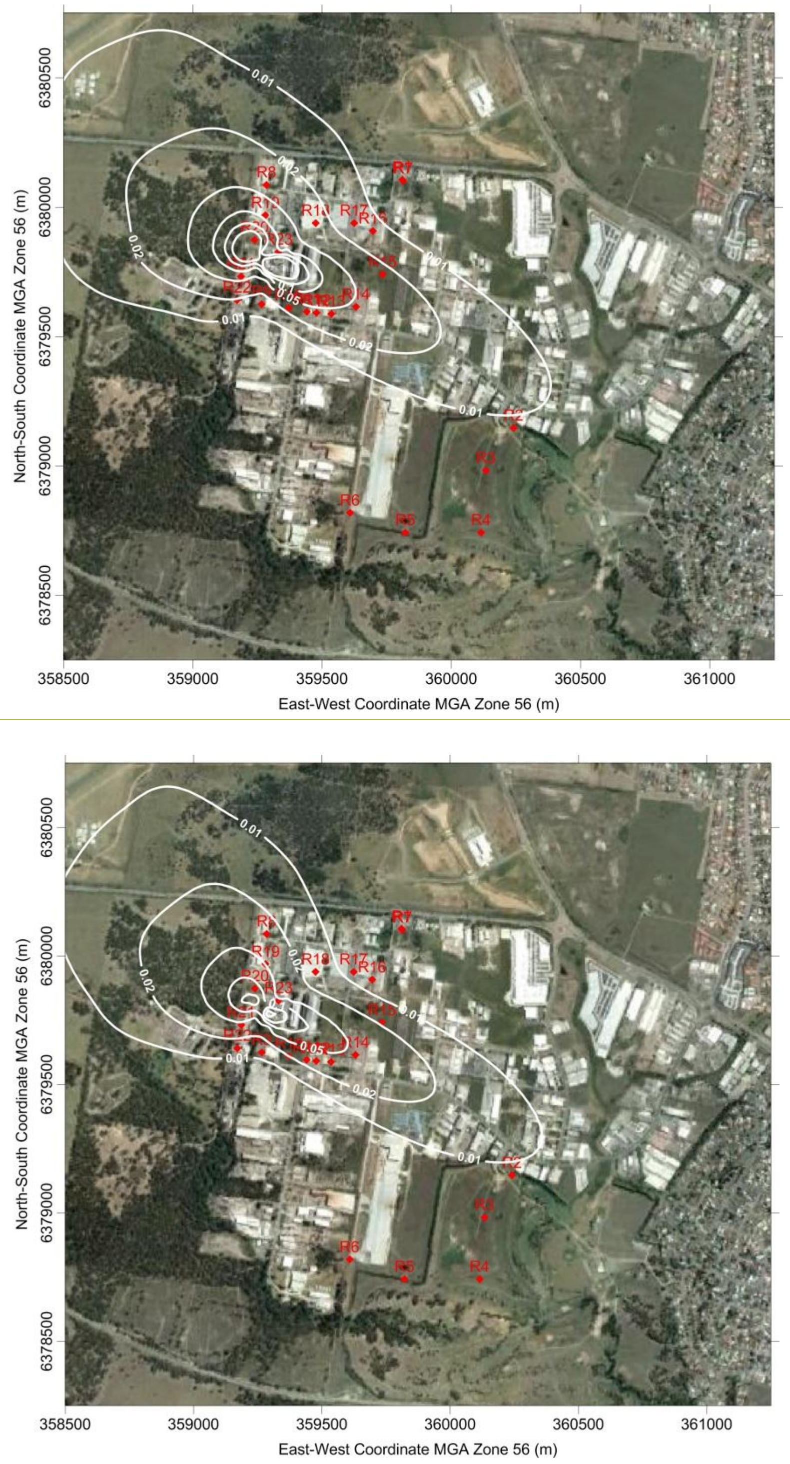
Species: SO_2	**Location:** TPR	**Scenario:** Point 19 stack height (top) 16m and (bottom) 25m	**Percentile:** Maximum	**Averaging Time:** 1 hour
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** EPA = 570 µg/m^3	**Met Data:** CALMET 2011	**Plot:** K. Hill

Figure 5.4: Predicted 1-hour average ground-level concentrations of SO_2 (µg/m^3)



Species:	Location:	Scenario:	Percentile:	Averaging Time:
SO_2	TPR	Point 19 stack height (top) 16m and (bottom) 25m	Maximum	24 hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF	µg/m³	EPA = 228 µg/m^3	CALMET 2011	K. Hill

Figure 5.5: Predicted maximum 24-hour average ground-level concentrations of SO_2 (µg/m^3)

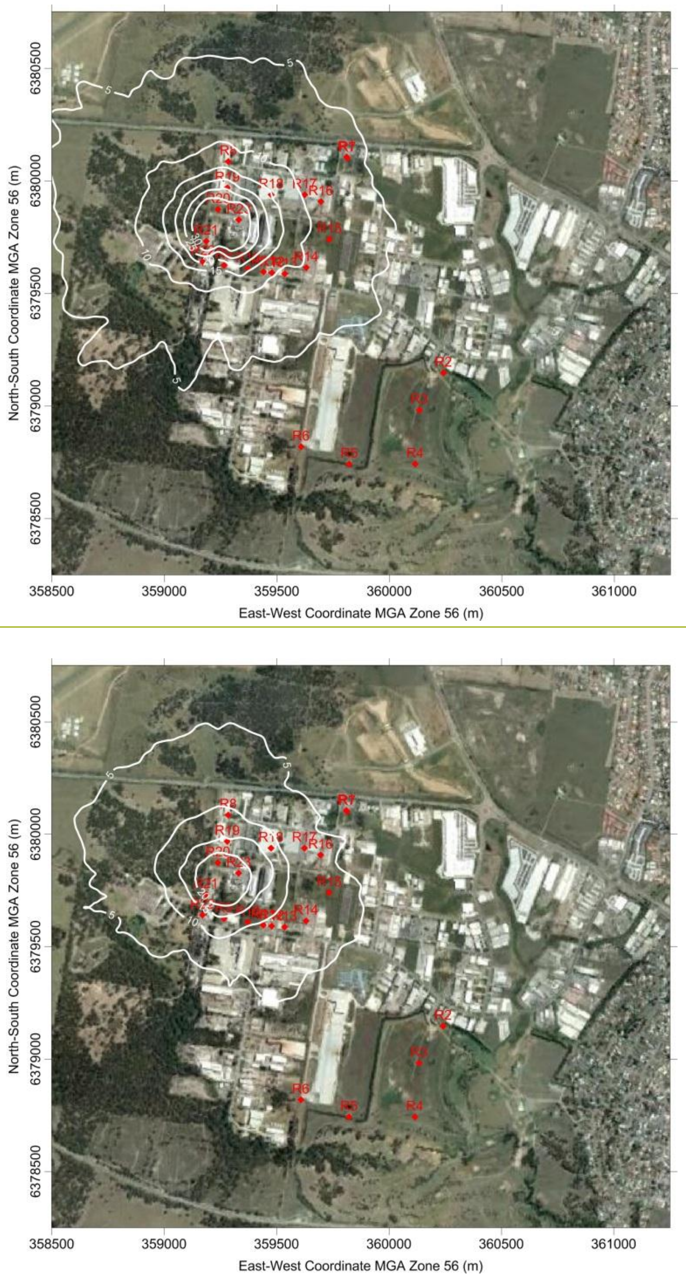


Species: SO_2	**Location:** TPR	**Scenario:** Point 19 stack height (top) 16m and (bottom) 25m	**Percentile:**	**Averaging Time:** Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** EPA = 60 µg/m^3	**Met Data:** CALMET 2011	**Plot:** K. Hill

Figure 5.6: Predicted annual average ground-level concentrations of SO_2 (µg/m^3)

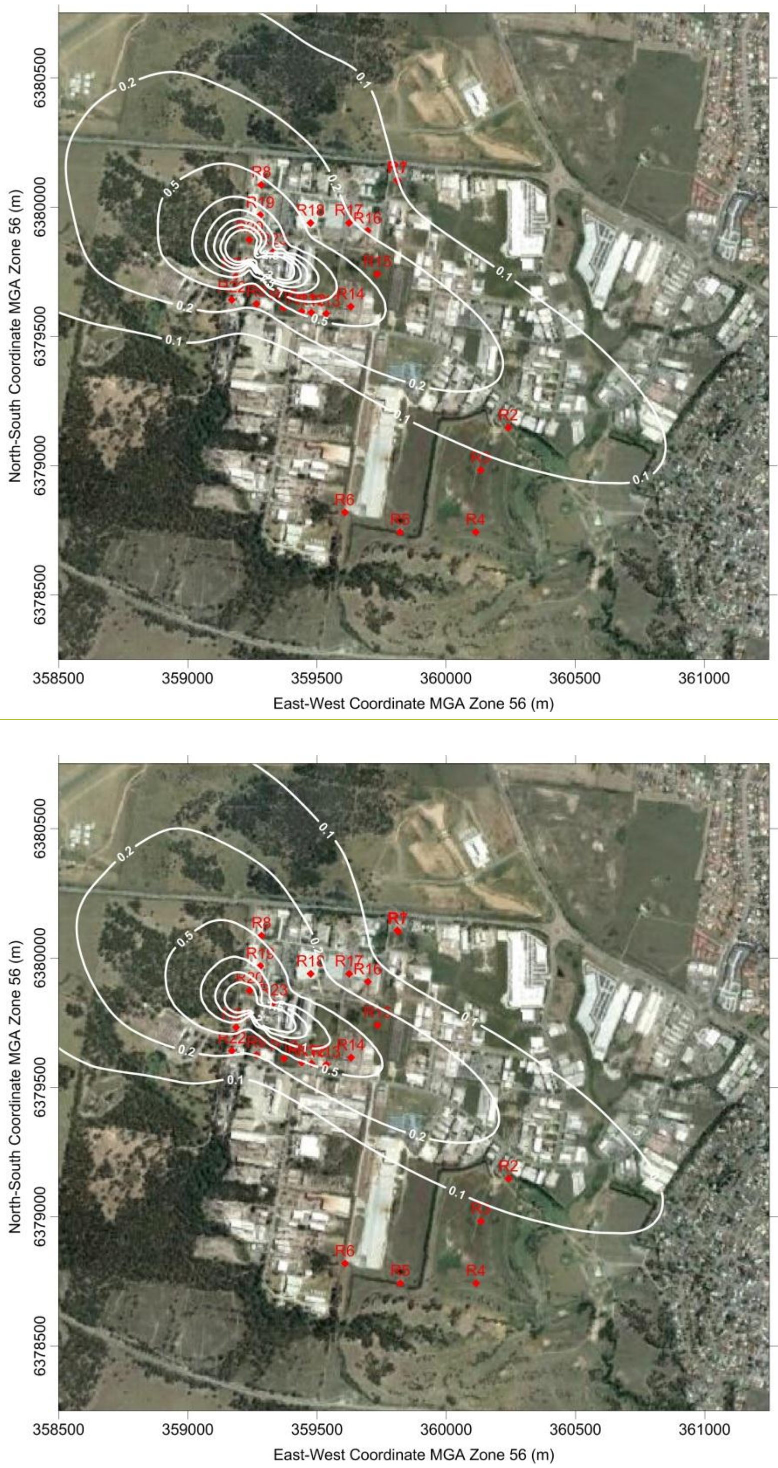
5.4 Nitrogen Dioxide – NO_2

The maximum predicted 1-hour and annual ground level concentrations of NO_2 (assuming 100% conversion of NO_x to NO_2), where the Point 19 stacks are varied from 16 m and 25 m are presented in **Figure 5.7** and **Figure 5.8**.



Species: NO_2	**Location:** TPR	**Scenario:** Point 19 stack height (top) 16m and (bottom) 25m	**Percentile:** Maximum	**Averaging Time:** 1 hour
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** EPA = 246 µg/m^3	**Met Data:** CALMET 2011	**Plot:** K. Hill

Figure 5.7: Predicted 1-hour average ground-level concentrations of NO_2 (µg/m^3)

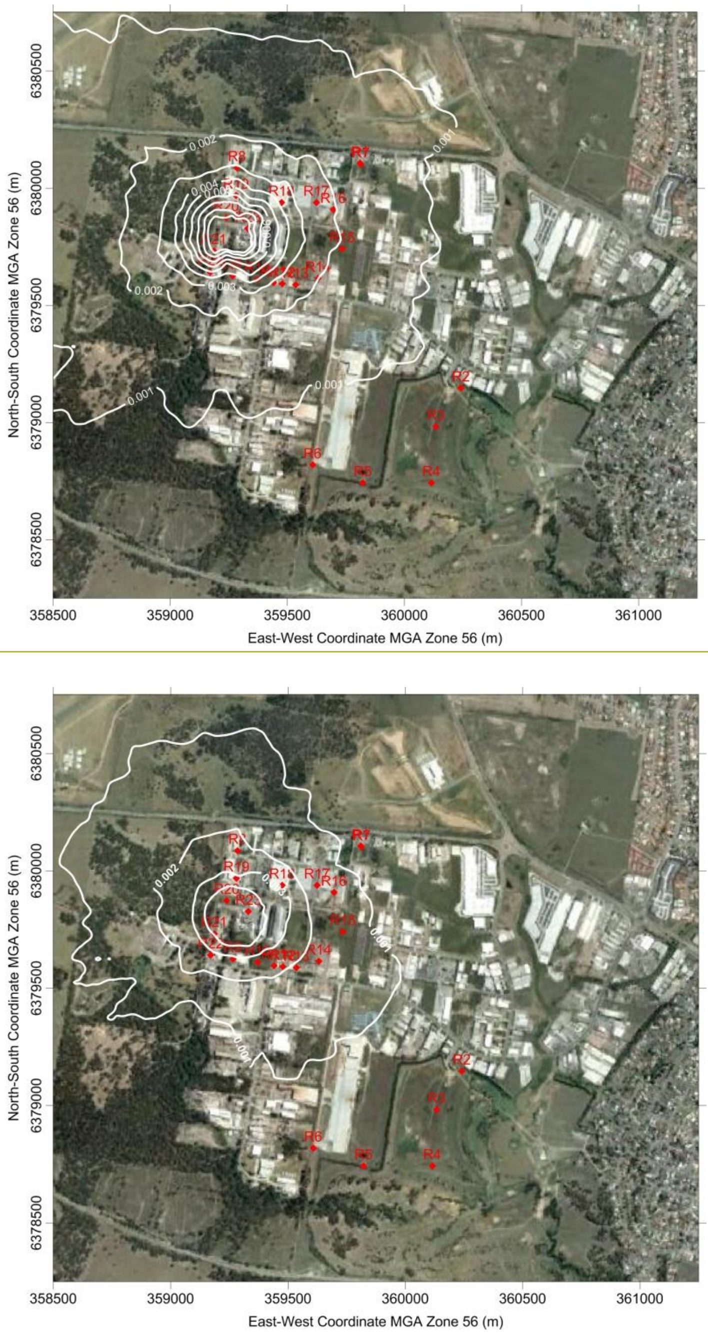


Species: NO_2	**Location:** TPR	**Scenario:** Point 19 stack height (top) 16m and (bottom) 25m	**Percentile:**	**Averaging Time:** Annual
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** EPA = 62 µg/m^3	**Met Data:** CALMET 2011	**Plot:** K. Hill

Figure 5.8: Predicted annual average ground-level concentrations of NO_2 (µg/m^3)

5.5 Hydrogen Sulphide Mist – H_2SO_4

The maximum predicted 1-hour ground level concentrations of H_2SO_4 where the Point 19 stacks are varied from 16 m and 25 m are presented in **Figure 5.9**.

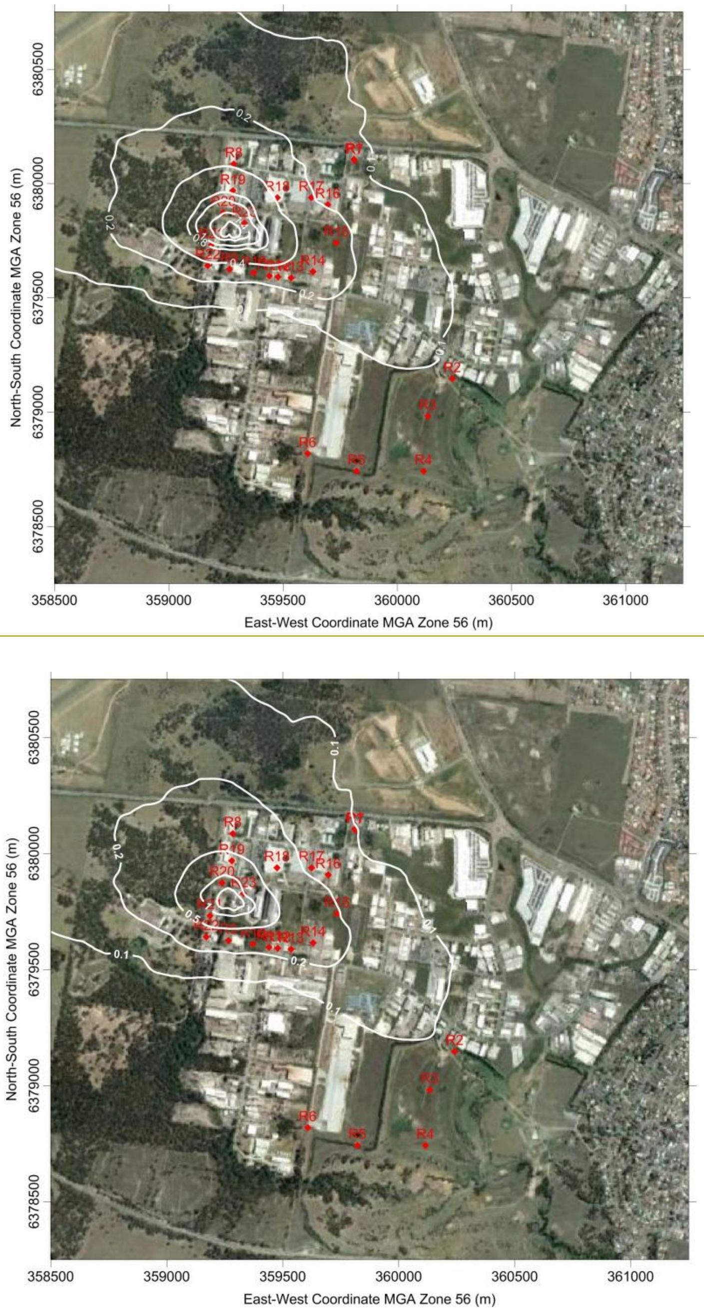


Species:	**Location:**	**Scenario:**	**Percentile:**	**Averaging Time:**
H_2SO_4	TPR	Point 19 stack height (top) 16m and (bottom) 25m	Maximum	1 hour
Model Used:	**Units:**	**Guideline:**	**Met Data:**	**Plot:**
CALPUFF	µg/m³	EPA = 0.018 µg/m³	CALMET 2011	K. Hill

Figure 5.9: Predicted 1-hour average ground-level concentrations of H_2SO_4 (µg/m³)

5.1 Hydrogen Sulfide – H_2S

The maximum predicted nose response time averaged 99th percentile ground level concentrations of H_2S where the Point 19 stacks are varied from 16 m and 25 m are presented in **Figure 5.10**.



Species: H_2S	**Location:** TPR	**Scenario:** Point 19 stack height (top) 16m and (bottom) 25m	**Percentile:** Maximum	**Averaging Time:** Nose response
Model Used: CALPUFF	**Units:** µg/m³	**Guideline:** EPA = 3.45 µg/m³	**Met Data:** CALMET 2011	**Plot:** K. Hill

Figure 5.10: Predicted nose response time-averaged ground-level concentrations of H_2S (µg/m³)

6 VARYING STACK PARAMETERS

Further investigation was carried out for five on site receptor locations. **Figure 6.1** shows the locations of these on-site receptors and the six modelling scenarios are listed below.

- Scenario 1: 16 m stack, exit velocity 4.7 m/s (current conditions)
- Scenario 2: 25 m stack, exit velocity 4.7 m/s
- Scenario 3: 16 m stack, exit velocity 7 m/s
- Scenario 4: 25 m stack, exit velocity 7 m/s
- Scenario 5: 16 m stack, exit velocity 15 m/s
- Scenario 6: 25 m stack, exit velocity 15 m/s

These scenarios were run for H_2SO_4, NO_x, H_2S and Benzene as these pollutants were those closest to the air quality goals. The results are presented in **Table 9**, and the percentage change in ground level concentrations relative to Scenario 1 are shown in **Table 10**.

For these five on-site receptors there is very little reduction gained by increasing the exit velocity. The biggest reductions come from increasing the stack height to 25 m, and the most significant of these is in the H_2SO_4 concentrations (up to 45% by increasing to 25 m alone, and 46% for increasing stack height and exit velocity).

Table 9: Ground level concentrations for each modelling scenario (µg/m^3)

Receptor ID	Easting	Northing	H_2SO_4	NO_x 1hr	H_2S	Benzene
Criteria			0.018	246	3.45	0.029
Scenario 1 - 16m stack EV 4.67 m/s						
R1	359309	6379756	0.010	38	1.37	0.0008
R2	359310	6379815	0.013	50	1.69	0.0010
R3	359268	6379824	0.014	52	1.87	0.0010
R4	359256	6379764	0.009	38	1.17	0.0011
R5	359311	6379839	0.010	42	1.30	0.0007
Scenario 2 - 25m stack EV 4.67 m/s						
R1	359309	6379756	0.006	30	1.32	0.0008
R2	359310	6379815	0.007	36	1.56	0.0010
R3	359268	6379824	0.008	38	1.86	0.0010
R4	359256	6379764	0.008	34	1.13	0.0011
R5	359311	6379839	0.007	27	1.09	0.0007
Scenario 3 - 16m stack EV 7 m/s						
R1	359309	6379756	0.010	37	1.37	0.0008
R2	359310	6379815	0.012	49	1.67	0.0010
R3	359268	6379824	0.014	51	1.87	0.0010
R4	359256	6379764	0.009	38	1.17	0.0011
R5	359311	6379839	0.009	41	1.29	0.0007
Scenario 4 - 25m stack EV 7 m/s						
R1	359309	6379756	0.006	30	1.32	0.0008
R2	359310	6379815	0.007	36	1.56	0.0010
R3	359268	6379824	0.008	38	1.86	0.0010
R4	359256	6379764	0.008	34	1.13	0.0011
R5	359311	6379839	0.007	27	1.09	0.0007
Scenario 5 - 16m stack EV 15 m/s						
R1	359309	6379756	0.010	36	1.37	0.0008
R2	359310	6379815	0.012	46	1.65	0.0010
R3	359268	6379824	0.014	52	1.87	0.0010
R4	359256	6379764	0.009	38	1.17	0.0011
R5	359311	6379839	0.009	38	1.24	0.0007
Scenario 6 - 25m stack EV 15 m/s						
R1	359309	6379756	0.006	30	1.32	0.0008
R2	359310	6379815	0.007	36	1.56	0.0010
R3	359268	6379824	0.008	38	1.86	0.0010
R4	359256	6379764	0.008	34	1.13	0.0011
R5	359311	6379839	0.007	27	1.09	0.0007

Table 10: Percentage change in concentrations relative to Scenario 1

	H_2SO_4	NO_2 1hr	H_2S	Benzene
Scenario 2 - 25m stack EV 4.67 m/s				
R1	-39%	-20%	-4%	-1%
R2	-45%	-28%	-8%	-3%
R3	-41%	-27%	0%	0%
R4	-11%	-10%	-3%	0%
R5	-32%	-37%	-17%	-5%
Scenario 3 - 16m stack EV 7 m/s				
R1	-2%	-2%	0%	0%
R2	-4%	-3%	-1%	0%
R3	-1%	-1%	0%	0%
R4	-1%	0%	0%	0%
R5	-7%	-3%	-1%	0%
Scenario 4 - 25m stack EV 7 m/s				
R1	-39%	-20%	-4%	-1%
R2	-46%	-28%	-8%	-3%
R3	-42%	-27%	0%	0%
R4	-11%	-10%	-3%	0%
R5	-33%	-37%	-17%	-5%
Scenario 5 - 16m stack EV 15 m/s				
R1	-3%	-4%	0%	0%
R2	-4%	-9%	-3%	-1%
R3	2%	1%	0%	0%
R4	2%	1%	0%	0%
R5	-12%	-10%	-5%	-1%
Scenario 6 - 25m stack EV 15 m/s				
R1	-38%	-20%	-4%	-1%
R2	-45%	-28%	-8%	-3%
R3	-41%	-26%	0%	0%
R4	-10%	-10%	-3%	0%
R5	-32%	-37%	-17%	-5%

7 CONCLUSION

The results indicate that the largest reductions in ground level concentrations come from increasing the stack height rather than the exit velocity. The most significant of these is in the H_2SO_4 concentrations (up to 45% by increasing to 25 m alone, and 46% for increasing stack height and exit velocity).

No concentrations are predicted to exceed their relevant air quality criterion at any of the receptors.

8 REFERENCES

DEC (2005)

"Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales". New South Wales EPA.

NEPC (1998)

"National Environmental Protection Measure and Impact Statement for Ambient Air Quality". National Environment Protection Council Service Corporation, Level 5, 81 Flinders Street, Adelaide SA 5000.