5. Air quality dispersion modelling

5.1 The model

Atmospheric dispersion modelling was conducted to predict the maximum ground level concentrations of dust (TSP and PM_{10}) resulting from emissions to air from the WRF. Dust deposition rates were also predicted. The predicted ground level concentrations (GLC) and dust deposition rates were then assessed against the relevant criteria.

Dispersion modelling of emissions to air requires the selection of an appropriate model and then the selection of three general types of input. These are:

- Hourly site-specific or site representative meteorological data for a period of not less than one year. The meteorological data file used in this assessment is discussed in Section 2.
- Source characterisation (which includes emission rate inventory and source geometry) as detailed in Section 4.
- Model configuration – in which the various model settings are selected to best characterise the physical processes specific to this site and to make best use of the available emissions and meteorological data.

The source characterisation and model configuration are detailed below under relevant section headings.

Ausplume version 6.0 is a regulatory approved dispersion model and was used in this assessment. The use of Ausplume at this site is considered very conservative, with the steep terrain and heavy vegetation between the source and nearby receivers. Dust and odour emissions would require additional energy to be dispersed up the hill and therefore in this instance the predictions to the north of the site may be conservative.

5.2 Source characterisation

5.2.1 Mobile and Fixed Plant

Processing and mobile equipment, such as the crushers, screens, loaders, haul trucks and an excavator have been modelled as individual 'volume' sources using the corresponding emission rates and characteristics presented in Table 7 and Table 10. The details of modelled sources are provided in Table 11.

Table 11 – Dust source Characteristics

Source	Horizontal Spread (m)	Vertical Spread (m)	Source Height (m)
Screen	2.8	3.5	5
Crusher	2.8	3.5	5
Loader	1.2	1.5	3
Excavator	1.2	1.5	3
Dump truck (dumping)	1.2	1.5	3
Reclaimer	1.2	1.5	3
Bulldozer	1.2	1.5	3

The significant dust generating activities will be located in the outdoor processing and stockpiling area indicated in Figure 14 below. Dust from trucks entering and exiting the site has been assumed to be emitted from the access road from the weighbridge into the vehicle turning and backing area.

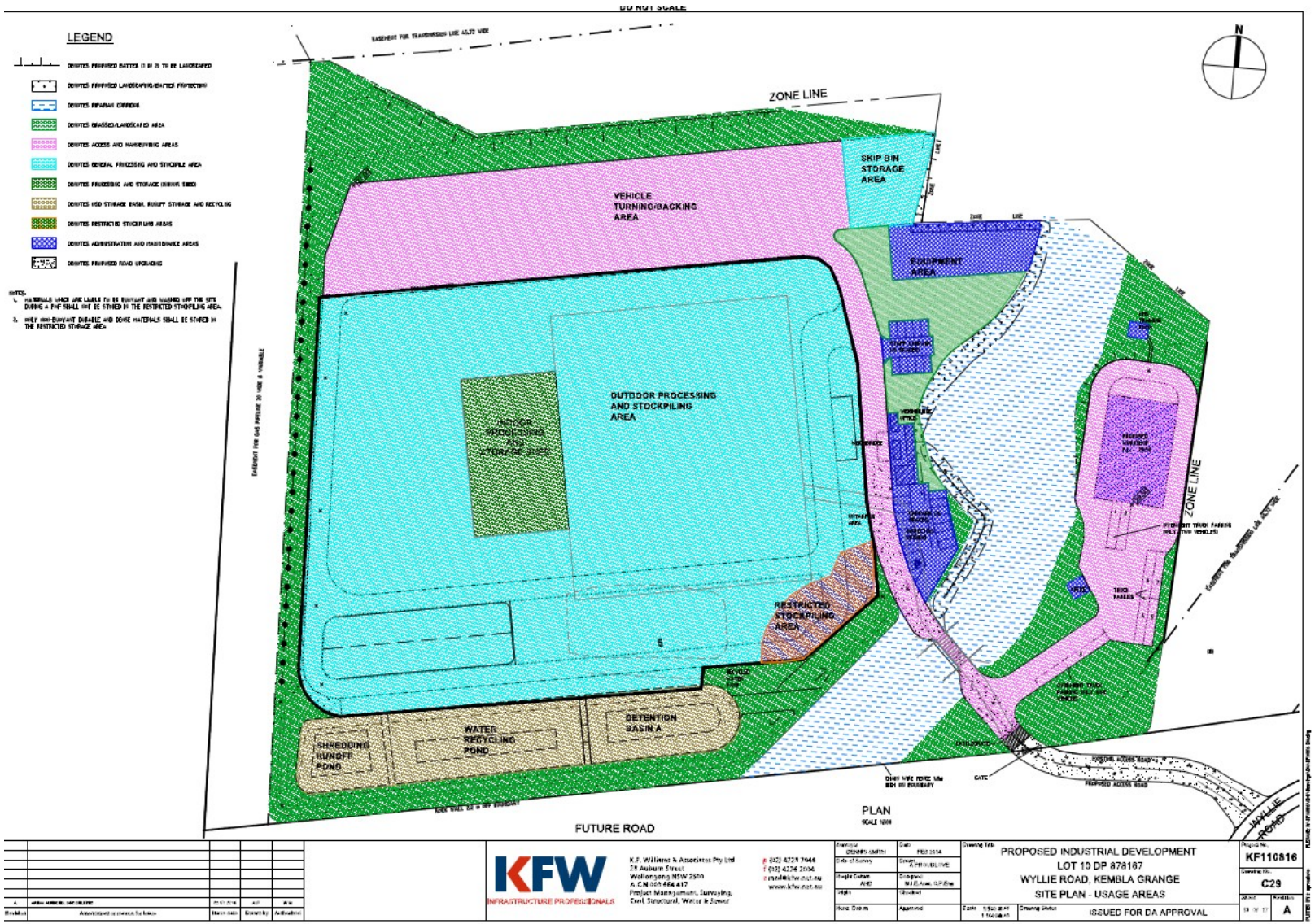

Figure 14 – Locations of emission sources

5.3 Dust Deposition

Dust deposition parameters have been set[5] as provided in Table 12. No site specific data was provided however due to the range of materials to be processed at the site dust particle parameters are believed to be conservative.

Table 12 – Dust Deposition Parameters

Fraction No.	Mass Fraction	Particle Size (micron)	Particle Density (g/cm^3)
1	0.052	1.8	2.6
2	0.140	4.0	2.6
3	0.223	8.0	2.6
4	0.322	17.0	2.6
5	0.263	31.0	2.6

5.4 Model Configuration

Key components of the Ausplume model configuration used in this assessment are as follows:

- Ground level concentrations (GLC) were predicted over a 2 km by 2 km receptor grid, with a grid resolution of 100 m.
- Dry depletion was included in the PM_{10}, $PM_{2.5}$ and TSP and dust deposition model runs.
- Irwin's 'Rural' wind profile exponents were used.
- Horizontal dispersion was parameterised according to equations for the Pasquill-Gifford curves.
- A roughness height of 0.8 m ('Rolling Rural') was used to represent the land features that surround the site. This is the dense forest and steep escapement to the north of the site

Further detail on the Ausplume configuration can be found in the Ausplume output file attached in Appendix A.

5.4.1 Odour Peak to mean calculations

The *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* states that peak to mean values are applied to the emissions from the sources in order to estimate the peak concentration. Peak to mean values are required as the evaluation of odour impacts requires the estimation of short or peak concentrations on the time scale of less than one second. Dispersion model predictions however are typically valid for averaging periods of 1 hour and longer. Thus in order to predict peak concentrations a ratio between extreme short term concentration and longer-term averages were used as defined in the *Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales* (refer Table 6.1). The far field peak to mean values were applied to the area and point sources at the site.

5.4.2 Building ventilation

As discussed in Section 4.2 the significant odour sources will be enclosed in a building maintained at negative air pressure. At this stage there is no detailed information on the ventilation system. As a conservative measure, GHD has modelled all odour sources at the

[5] Based on data provided in the NSW Minerals Council Technical Paper: Particulate Matter and Mining Interim Report, 2000.

building location assuming no enclosure in place. Two mitigation options have also been assessed and are as follows:

- All air from the enclosed building is released into the atmosphere via a stack.
- All air within the building will be directed through an odour control system for treatment prior to being released into the surrounding environment via a stack.

Once more details of the building ventilation and odour control system (if needed) are known, a more detailed assessment can be undertaken to determine appropriate sizing and flow rates.

6. Assessment of impacts

6.1 Dust

A summary of the predicted results from dispersion modelling are presented in Table 13 for the 5 identified receivers.

Maximum predicted ground level concentrations and deposition rates at the five receivers have been added to the adopted background levels to determine the cumulative impact, which can then be compared against the NSW assessment criteria and are discussed below. Exceedances above the assessment criteria have been bolded in red.

GHD are not aware of any formal complaints regarding dust emissions from the current site operations.

6.1.1 PM_{10}

Results show that the predicted 24 hour PM_{10} dust concentration of 74.6 $\mu g/m^3$ at Receiver 1 (Fairloch Avenue) will exceed the criteria of 50 $\mu g/m^3$ without mitigation. The predicted dust levels also exceed the criteria at Receiver 3 and 5.

In order to meet the criteria mitigation options have been assessed in Section 6.2.

All other receivers are predicted to be within the PM_{10} criteria.

6.1.2 TSP

The predicted TSP concentrations meet the relevant criteria at all receivers.

6.1.3 Dust deposition

The predicted dust deposition levels meet the relevant criteria at all receivers.

Table 13 – Maximum predicted dust impact at sensitive receivers

Pollutant	Averaging Period	Units	Maximum Predicted Incremental Impact	Adopted Back-ground Level	Cumulative Impact	Criteria
Receiver 1: 57 Fairloch Avenue, Farmborough Heights						
PM_{10}	24-hour	µg/m^3	53.3	21.3	**74.6**	50
$PM_{2.5}$	24-hour	µg/m^3	16.6	6.6	23.2	-
PM_{10}	Annual	µg/m^3	4.2	21.3	25.5	30
TSP	Annual	µg/m^3	12.9	42.6	55.5	90
Dust deposition	Annual	g/m^2/month max. total	1.3	2	3.3	4
Receiver 2: Ian McLennan Park						
PM_{10}	24-hour	µg/m^3	24.1	21.3	45.4	50
$PM_{2.5}$	24-hour	µg/m^3	7.6	6.6	14.2	-
PM_{10}	Annual	µg/m^3	1.3	21.3	22.6	30
TSP	Annual	µg/m^3	3.8	42.6	46.4	90
Dust deposition	Annual	g/m^2/month max. total	0.2	2	2.2	4
Receiver 3: Macedonian Orthodox Church						
PM_{10}	24-hour	µg/m^3	37.9	21.3	**59.2**	50
$PM_{2.5}$	24-hour	µg/m^3	11.8	6.6	18.4	-
PM_{10}	Annual	µg/m^3	1.7	21.3	23.0	30
TSP	Annual	µg/m^3	5.1	42.6	47.7	90
Dust deposition	Annual	g/m^2/month max. total	0.3	2	2.3	4
Receiver 4: Kingston Lodge						
PM_{10}	24-hour	µg/m^3	6.8	21.3	28.1	50
$PM_{2.5}$	24-hour	µg/m^3	2.2	6.6	8.8	-
PM_{10}	Annual	µg/m^3	0.4	21.3	21.7	30
TSP	Annual	µg/m^3	1.2	42.6	43.8	90
Dust deposition	Annual	g/m^2/month max. total	0.05	2	2.05	4
Receiver 5: Rural Fire Service						
PM_{10}	24-hour	µg/m^3	38.8	21.3	**60.1**	50

Pollutant	Averaging Period	Units	Maximum Predicted Incremental Impact	Adopted Back-ground Level	Cumulative Impact	Criteria
$PM_{2.5}$	24-hour	µg/m^3	12.1	6.6	18.7	-
PM_{10}	Annual	µg/m^3	3.8	21.3	25.1	30
TSP	Annual	µg/m^3	11.4	42.6	54.0	90
Dust deposition	Annual	g/m^2/month max. total	1.1	2	2.1	4

6.2 Dust mitigation

Dust emissions from the site are predicted to potentially exceed the NSW assessment criteria without mitigation. An analysis of dust emission rates shows that the haul trucks are the primary source of dust. In order to reduce these dust emissions, mitigation in the form of watering the access roads has been assessed. Level 2 watering (>2L/m^2/hr) of the access road (from the site office into the site) and truck turning/backing area has been assessed as a mitigation option and most likely to provide the necessary mitigation. Crushing activities were also found to be a large contributor to dust emissions. Wet suppression systems (such as spray nozzles) although not assessed, can further reduce dust levels from crushing operations[6].

Predicted dust emissions with mitigation at the sensitive receivers are presented in Table 14. Figure 15 shows the maximum predicted 24-hour PM_{10} ground level concentration (GLC) contours for WRF operations with mitigation and Figure 16 shows the maximum predicted annual TSP ground level concentration (GLC) contours for WRF operations with mitigation.

[6] Based on data provided in the US EPA AP-42 Mineral Products Industry Section 11.19.2 (2003)

Table 14 – Maximum predicted dust impact at sensitive receivers with mitigation measures

Pollutant	Averaging Period	Units	Maximum Predicted Incremental Impact	Adopted Back-ground Level	Cumulative Impact	Criteria
Receiver 1: 57 Fairloch Avenue, Farmborough Heights						
PM_{10}	24-hour	µg/m^3	28.5	21.3	49.8	50
$PM_{2.5}$	24-hour	µg/m^3	8.9	6.6	15.5	-
PM_{10}	Annual	µg/m^3	2.2	21.3	23.5	30
TSP	Annual	µg/m^3	6	42.6	48.6	90
Dust deposition	Annual	g/m^2/month max. total	0.6	2	2.6	4
Receiver 2: Ian McLennan Park						
PM_{10}	24-hour	µg/m^3	12.5	21.3	33.8	50
$PM_{2.5}$	24-hour	µg/m^3	4	6.6	10.6	-
PM_{10}	Annual	µg/m^3	0.7	21.3	22.0	30
TSP	Annual	µg/m^3	1.8	42.6	44.4	90
Dust deposition	Annual	g/m^2/month max. total	0.1	2	2.1	4
Receiver 3: Macedonian Orthodox Church						
PM_{10}	24-hour	µg/m^3	19.3	21.3	40.6	50
$PM_{2.5}$	24-hour	µg/m^3	6.1	6.6	12.7	-
PM_{10}	Annual	µg/m^3	0.9	21.3	22.2	30
TSP	Annual	µg/m^3	2.4	42.6	45.0	90
Dust deposition	Annual	g/m^2/month max. total	0.2	2	2.2	4
Receiver 4: Kingston Lodge						
PM_{10}	24-hour	µg/m^3	3.5	21.3	24.8	50
$PM_{2.5}$	24-hour	µg/m^3	1.2	6.6	7.8	-
PM_{10}	Annual	µg/m^3	0.2	21.3	21.5	30
TSP	Annual	µg/m^3	0.5	42.6	43.1	90
Dust deposition	Annual	g/m^2/month max. total	0.02	2	2.02	4
Receiver 5: Rural Fire Service						

Pollutant	Averaging Period	Units	Maximum Predicted Incremental Impact	Adopted Back-ground Level	Cumulative Impact	Criteria
PM_{10}	24-hour	$\mu g/m^3$	20.6	21.3	41.9	50
$PM_{2.5}$	24-hour	$\mu g/m^3$	6.5	6.6	13.1	-
PM_{10}	Annual	$\mu g/m^3$	2	21.3	23.3	30
TSP	Annual	$\mu g/m^3$	5.2	42.6	47.8	90
Dust deposition	Annual	g/m^2/month max. total	0.5	2	2.5	4

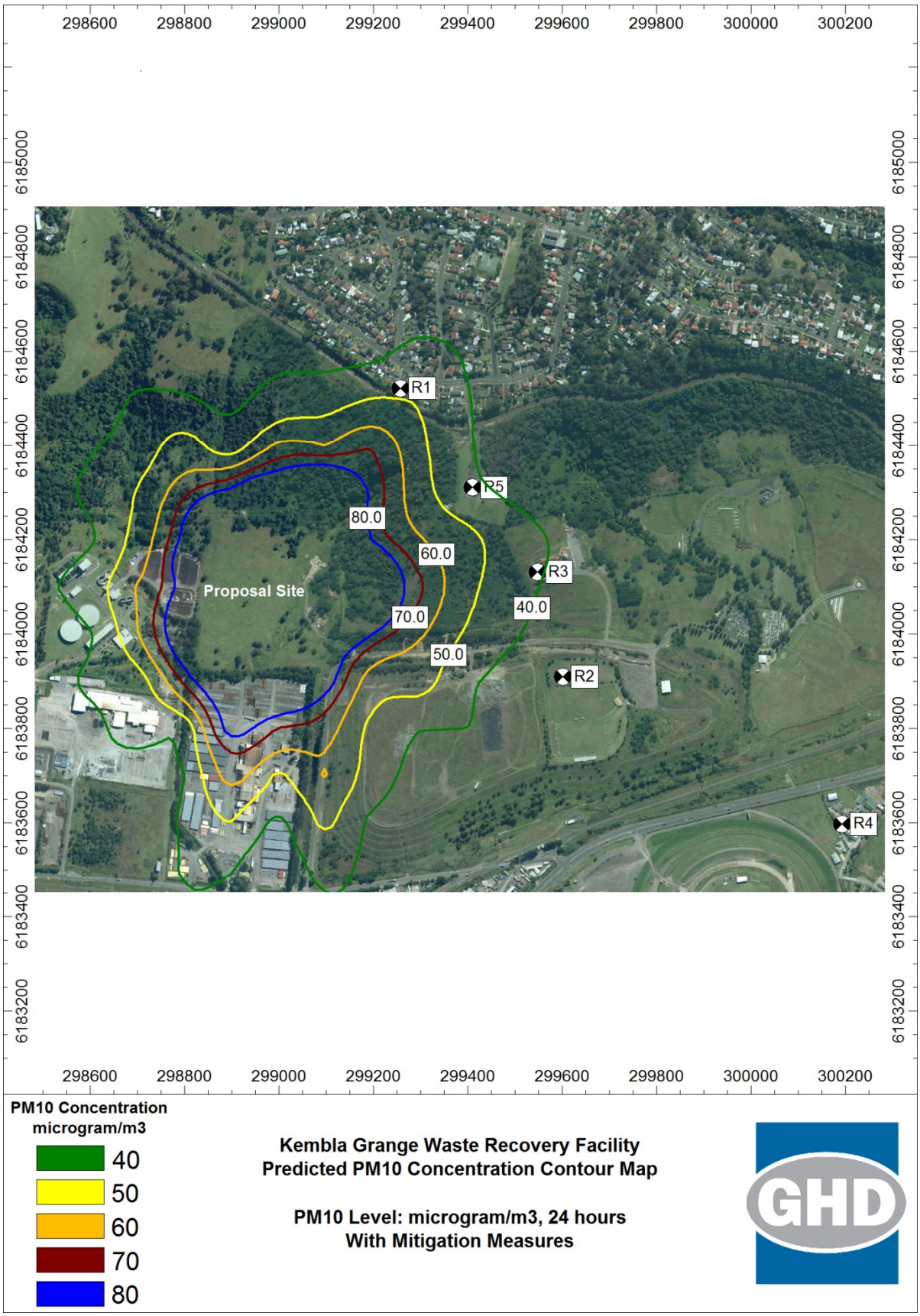

Figure 15 – Predicted – Cumulative PM_{10} 24-hour Average Concentration (with mitigation) $\mu g/m^3$

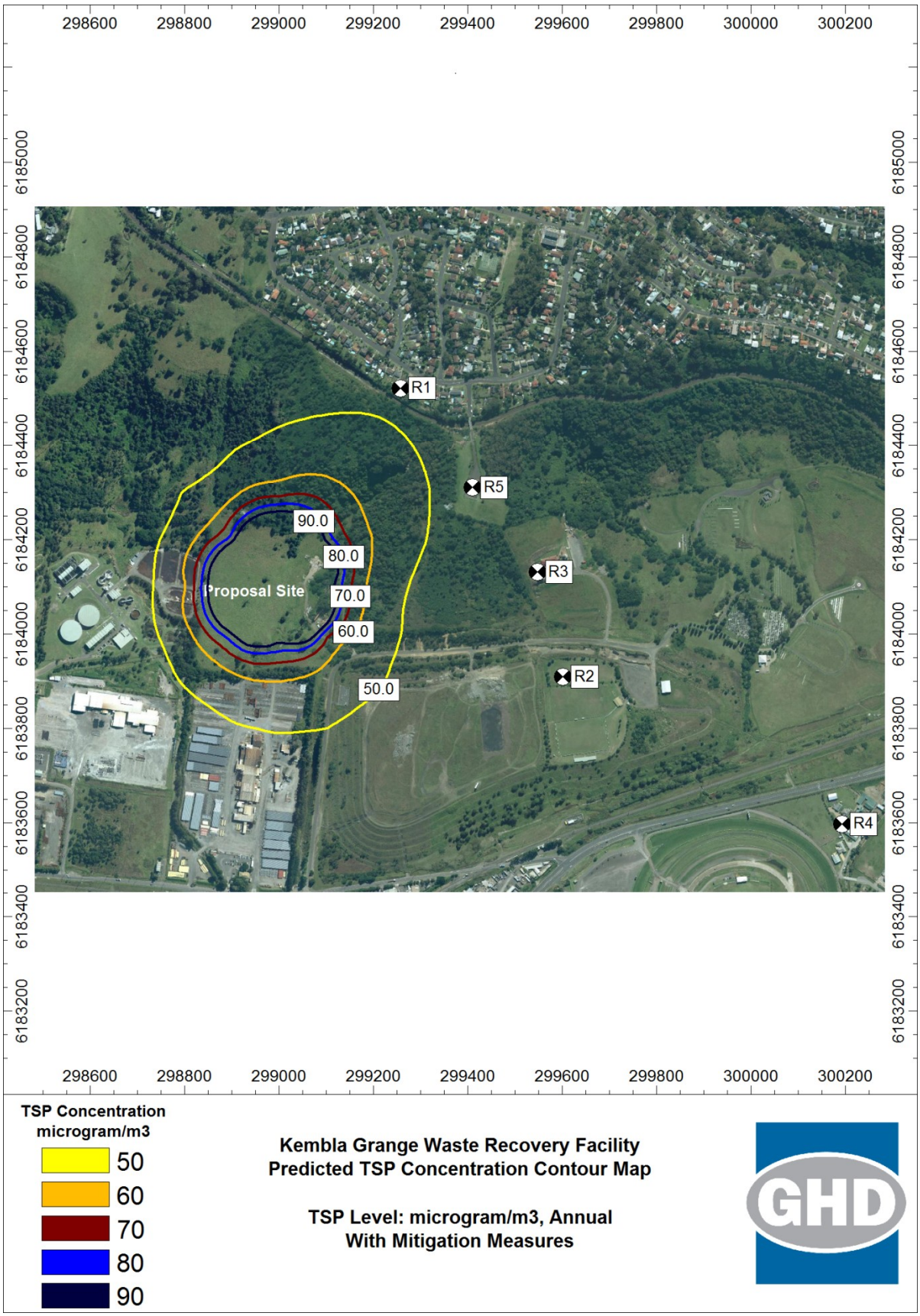

Figure 16 – Predicted – Cumulative TSP Annual Average Concentration (with mitigation) µg/m³

6.3 Odour

6.3.1 Predicted peak impact as discrete receivers

All odour sources have been assumed to be located as per Figure 14, with no building ventilation or emission controls in place. This is considered a worst-case scenario.

For the nominated discrete receptors near the site i.e. closest residents on Fairloch Avenue Road and church on Wyllie Road (see Figure 3) the predicted peak 99th percentile (1-hour average) odour levels were assessed.

The highest predicted concentrations are at 57 Fairloch Avenue which is approximately 400 m from the proposal. Slightly lower concentrations would be expected at the church on Wyllie Road.

The compliance to the 2 OU criterion is to be taken as the 88th highest value in the top 100 values for the receptor. The 88th highest value for each receptor is given in Table 15. The predicted odour impact exceeds the criteria at R1 (residences on Fairloch Avenue) and R5 (church on Wyllie Road)

The predicted levels at the receivers on Fairloch Avenue are considered conservative considering the ground based emission sources and the heavily vegetated hill behind the site. A plot of the predicted peak 99th percentile odour impact from the site is shown in Figure 17.

In order to meet the criteria mitigation options have been assessed in Section 6.4.

Table 15 – Predicted peak odour impact at receptors (OU) – no mitigation

Residence	R1	R2	R3	R4	R5
Proposal (OU)	**2.55**	1.08	1.48	0.42	**2.1**
Criteria (OU)	2	2	2	2	2

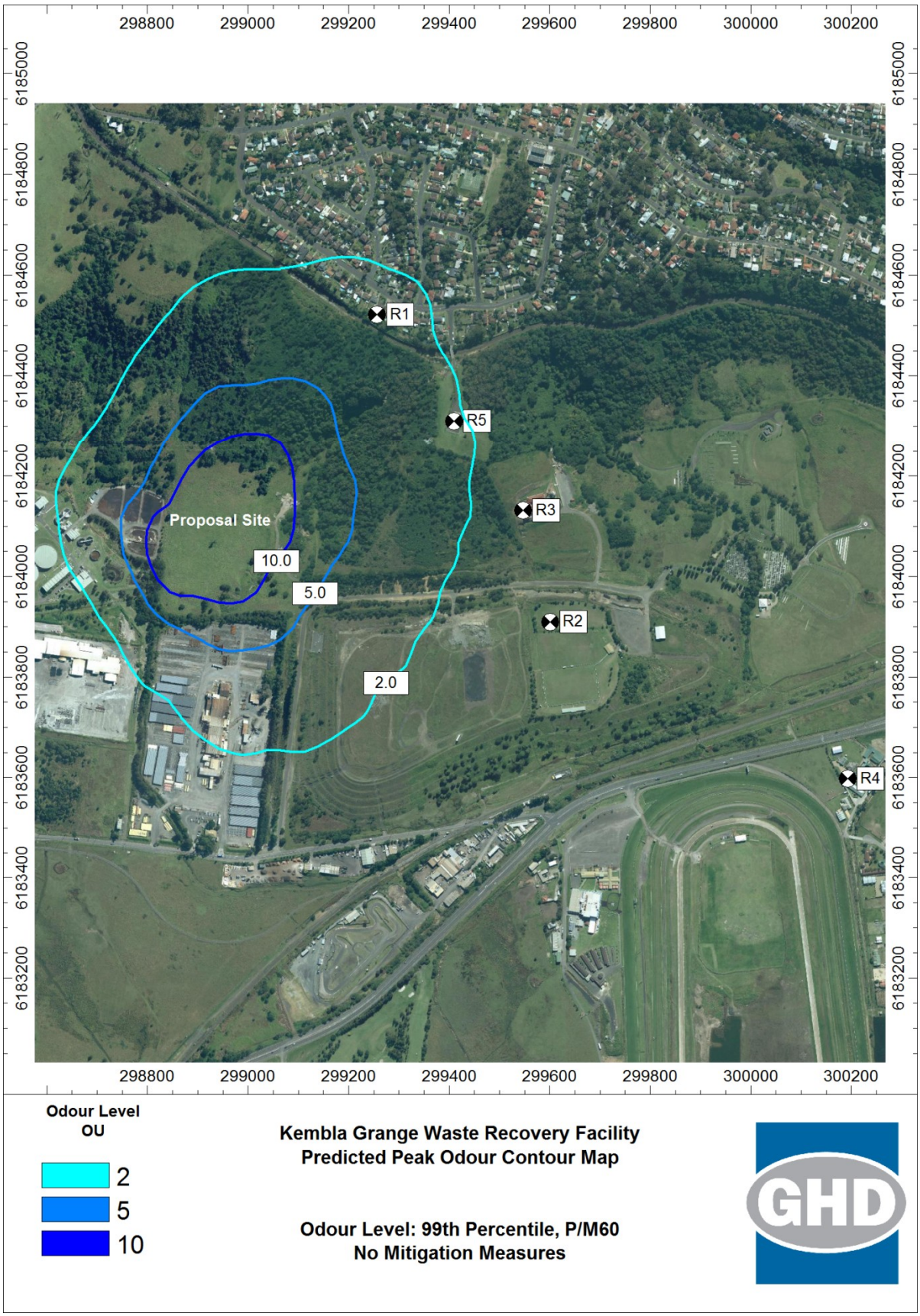

Figure 17 – Predicted Peak Odour Contour Map, OU

6.4 Odour Mitigation

Odour emissions from the site are predicted to exceed the NSW assessment criteria without mitigation. The largest odour contributors from the site are the activities proposed to be enclosed within the building. The following two scenarios have been assessed:

- All air from the ventilated enclosed building is released untreated into the atmosphere via a stack
- All air within the building will be directed through an odour control system for treatment prior to being released into the surrounding environment via a stack.

GHD has assumed that the total air flow rate through the WRF ventilation system would be approximately 45,000 m^3 per hour. This represents three building air exchanges (approximate building volume is 15,000 m^3) that flow through the odour control system and then exhaust stack or directly through an exhaust stack. The parameters assumed in this assessment are presented in Table 16. The actual building ventilation requirements will need to be confirmed during the design stage.

The odour control system has been assumed to have an efficiency of 90%. That means that 90% of all odour is removed prior to the air being discharged into the atmosphere. 90% odour removal efficiency is a level that is readily achieved by many odour control systems such as a biofilter. An odour removal efficiency of less than 90% may be appropriate and can be verified based on the building ventilation design.

Table 16 – Odour control system parameters

Parameter	AWT Building
Building height	10 m
Stack height above roof line	2 m
Exit velocity	6.25 m/s
Exit temperature	35 degrees C
Stack diameter	2 m
Building dimensions	30 m x 50 m
Building downwash algorithm	PRIME
Odour control system efficiency	90%

The odour emission inventory for the two mitigation scenarios is presented in Table 17 and Table 18.

Table 17 – Emission inventory for building with exhaust stack for untreated air

Source description	Emitting surface area (m^2)	SOER (OUm/s)	OER (OUm^3/s)	Percentage of OER (%)
Operating Hours				
Green waste stockpile – Receival	92	4.0	366	3.5
Shredder		-	5,741	55
Matured stockpile	429	0.6	250	2.4

Leachate pond	780	0.3	234	2.2
Building stack			3845	36.8
Total			**10436**	**100.0**
Non-Operating Hours				
Green waste stockpile – Receival	92	4.0	366	7.8
Matured stockpile	429	0.6	250	5.3
Leachate pond	780	0.3	234	5
Building stack			3845	81.9
Total			**4329**	**100.0**

Table 18 – Emission rate inventory for building with odour control system

Source description	Emitting surface area (m^2)	SOER (OUm/s)	OER (OUm^3/s)	Percentage of OER (%)
Operating Hours				
Green waste stockpile – Receival	92	4.0	366	5.2
Shredder		-	5,741	82.3
Matured stockpile	429	0.6	250	3.6
Leachate pond	780	0.3	234	3.4
Odour control system (90% efficiency)			385	5.5
Total				**100.0**
Non-Operating Hours				
Green waste stockpile – Receival	92	4.0	366	29.6
Matured stockpile	429	0.6	250	20.2
Leachate pond	780	0.3	234	19
Odour control system (90% efficiency)			385	31.2
Total			**4329**	**100.0**

6.4.1 Predicted peak impact as discrete receivers

The predicted odour impact at receivers for the two scenarios is presented below. The results in Table 19 assume that the building is maintained at negative air pressure with all untreated air being released through a stack on the roof as per Table 16. Results show compliance with the criteria at all receivers. Odour contours are provided in Figure 18.

Table 19 – Predicted peak odour impact at receptors (OU) – with building ventilation system

Residence	R1	R2	R3	R4	R5
Proposal (OU)	1.06	0.56	0.67	0.28	0.92
Criteria (OU)	2	2	2	2	2

The results in Table 20 assume that the building is maintained at negative pressure and all air is directed through an odour control system for treatment prior to being released into the surrounding environment. Results show compliance with the criteria at all receivers. Odour contours are provided in Figure 19. Given that the predicted odour impact complies with the criteria without treatment of ventilated air, an odour control system may only be required if the measured odour levels once operational exceed the predicted odour levels.

Table 20 – Predicted peak odour impact at receptors (OU) – with ventilation and biofilter

Residence	R1	R2	R3	R4	R5
Proposal (OU)	0.54	0.27	0.35	0.12	0.49
Criteria (OU)	2	2	2	2	2

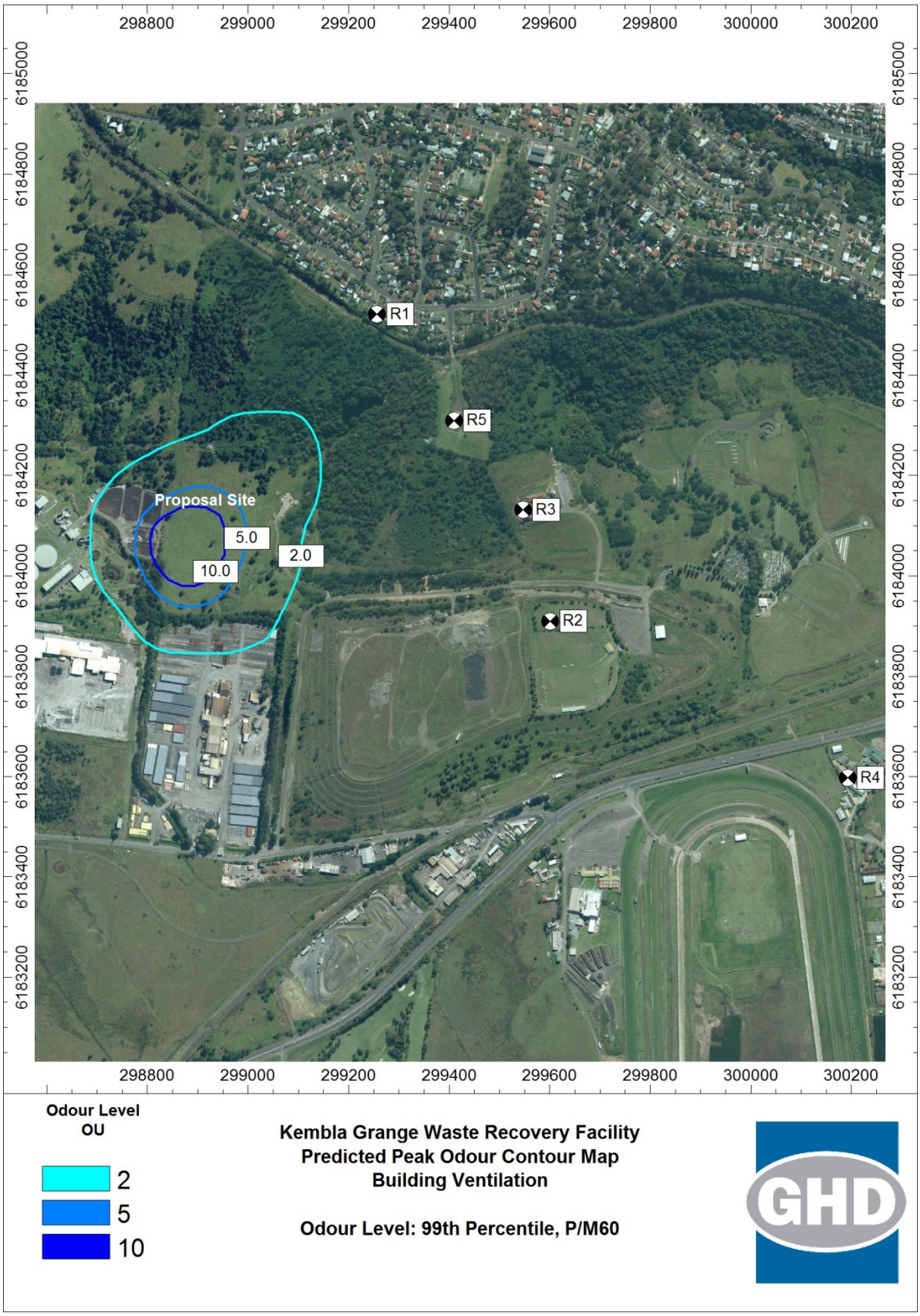

Figure 18 – Predicted Peak Odour Contour Map, OU with building ventilation

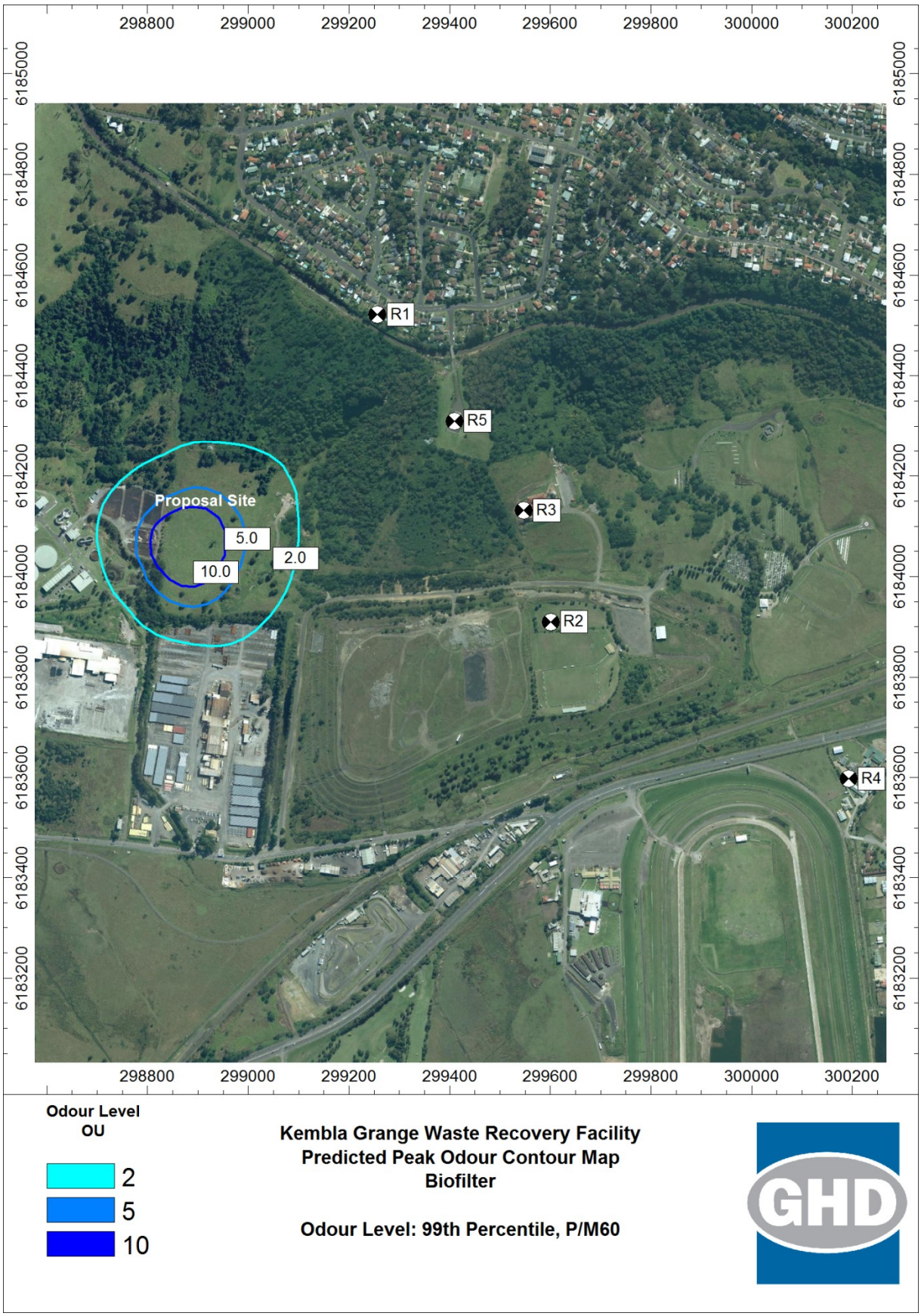

Figure 19 – Predicted Peak Odour Contour Map, OU with building ventilation and biofilter

7. Management and mitigation

7.1 Access Roads

Dust dispersion modelling identified trucks operating on unsealed surfaces are the primary source of dust. In order to control the primary source of dust, and to meet the project criteria, Level 2 (>2L/m^2/hr) water spraying should be undertaken on the unsealed access road from the site office into the site. This should be undertaken during daytime weather conditions that assist dust dispersion (dry and windy) towards receivers.

7.2 General Dust Mitigation measures

While general site operations are not expected to exceed air quality goals at nearby private receptors, the following mitigation measures are recommended.

- Water material prior to it being loaded for haulage, where appropriate.
- Aim to minimise the size of storage piles where possible.
- Limit cleared areas of land and clear only when necessary to reduce fugitive dust emissions.
- Control on-site traffic by designating specific routes for haulage and access and limiting vehicle speeds to below 25 km/hr.
- All trucks hauling material should be covered before exiting the site and should maintain a reasonable amount of vertical space between the top of the load and top of the trailer.
- Material spillage on sealed roads should be cleaned up as soon as practicable.
- A rumble-strip at the interface of the sealed road and the unsealed access road should be considered.
- Excavating operations conducted in areas of low moisture content material should be suspended during high wind speed events or water sprays should be used.

7.3 Odour mitigation measures

The odour modelling shows that odour emissions from the site without odour controls in place have the potential to exceed the 2 OU odour criteria at the nearby sensitive receivers. GHD has assessed two options for odour management onsite, and recommend that a ventilation system be designed that keeps the building under negative pressure at all times during operation. The air should be discharged in a manner that suitably disperses odour.

One suitable option to further reduce the odours from the site is an odour control system that is designed to treat all air from the building ventilation system. The flow rate and stack properties dictate how the odour will disperse once discharged.

The odour control systems assessed in Section 6.4 demonstrate compliance with the 2 OU criterion at all receivers.

The following odour mitigation measures are recommended:

- Design and installation of an appropriate building ventilation system at negative pressure at all times during operation
- A site odour management plan be developed prior to commissioning
- Validation sampling of odour from any key odour discharge points after commissioning
- If required, treat all air in an odour control system prior to discharge

8. Conclusion

An operational air quality impact assessment has been undertaken with consideration given to the *Approved methods for the modelling and assessment of pollutants in NSW* (DEC, 2005).

The results of the air quality impact assessment for the operation of the proposed WRF have led to the following conclusions:

- Based on the assumptions made in this assessment, predicted odour levels from proposed green waste composting without mitigation do not comply with the 2 OU criteria.
- Based on the assumptions made in this assessment, predicted odour levels from the proposed green waste composting will comply with the criteria if the WRF building is kept at negative pressure and all air is released into the atmosphere via a stack.
- Design and implementation of an odour control system will further reduce odour emissions from the building and any discharged odours will be less offensive than untreated emissions.
- Based on the assumptions made in this assessment, 24-hour PM_{10} concentration levels (without mitigation) from site operations are not expected to comply with the adopted criteria at private Receiver R1. Annual average PM_{10} and TSP concentration levels, as well as monthly deposition rates are expected to readily comply with the adopted dust criteria.
- Dust mitigation measures in the form of Level 2 water sprays on the access roads and truck turning and backing areas are predicted to reduce dust emissions resulting in compliance with the adopted criterion at all private receivers.
- Weather conditions that cause maximum dust impact are generally consistent winds in the direction of the nearest sensitive receivers throughout the daytime period outside of rain events.
- Trucks on unsealed surfaces were identified as the most significant source of dust emissions on the site and provide the greatest contribution to off-site dust impact. Therefore, during times of consistent adverse weather conditions (dry and winds), operations of these items should be reduced, or water sprays should be used in order to minimise potential impacts.
- The application of standard dust mitigation measures will also assist to minimise potential impacts from general site operations.

Appendices

Appendix A - Sample Ausplume output file

1 _____

KemblaG

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Concentration or deposition Concentration
Emission rate units OUV/second
Concentration units Odour_Units
Units conversion factor 1.00E+00
Constant background concentration 0.00E+00
Terrain effects None
Smooth stability class changes? No
Other stability class adjustments ("urban modes") None
Ignore building wake effects? No
Decay coefficient (unless overridden by met. file) 0.000
Anemometer height 10 m
Roughness height at the wind vane site 0.300 m
Use the convective PDF algorithm? No
Averaging time for sigma-theta values 60 min.

DISPERSION CURVES

Horizontal dispersion curves for sources <100m high Sigma-theta
Vertical dispersion curves for sources <100m high Pasquill-Gifford
Horizontal dispersion curves for sources >100m high Briggs Rural
Vertical dispersion curves for sources >100m high Briggs Rural
Enhance horizontal plume spreads for buoyancy? Yes
Enhance vertical plume spreads for buoyancy? Yes
Adjust horizontal P-G formulae for roughness height? Yes
Adjust vertical P-G formulae for roughness height? Yes
Roughness height 0.800m
Adjustment for wind directional shear None

PLUME RISE OPTIONS

Gradual plume rise? Yes
Stack-tip downwash included? Yes
Building downwash algorithm: PRIME method.
Entrainment coeff. for neutral & stable lapse rates 0.60,0.60
Partial penetration of elevated inversions? No
Disregard temp. gradients in the hourly met. file? No

and in the absence of boundary-layer potential temperature gradients
given by the hourly met. file, a value from the following table
(in K/m) is used:

Wind Speed	Stability Class					
Category	A	B	C	D	E	F
1	0.000	0.000	0.000	0.000	0.020	0.035

2	0.000	0.000	0.000	0.000	0.020	0.035
3	0.000	0.000	0.000	0.000	0.020	0.035
4	0.000	0.000	0.000	0.000	0.020	0.035
5	0.000	0.000	0.000	0.000	0.020	0.035
6	0.000	0.000	0.000	0.000	0.020	0.035

WIND SPEED CATEGORIES
Boundaries between categories (in m/s) are: 1.54, 3.09, 5.14, 8.23, 10.80

WIND PROFILE EXPONENTS: "Irwin Rural" values (unless overridden by met. file)

AVERAGING TIMES
1 hour

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1 _____

KemblaG

SOURCE CHARACTERISTICS

_____

STACK SOURCE: BIOFT

X(m)	Y(m)	Ground Elev.	Stack Height	Diameter	Temperature	Speed
298931	6184103	0m	12m	2.00m	35C	6.3m/s

_____ Effective building dimensions (in metres) _____

Flow direction	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°	110°	120°
Effective building width	38	45	51	55	58	59	58	54	50	55	57	59
Effective building height	10	10	10	10	10	10	10	10	10	10	10	10
Along-flow building length	55	58	58	58	55	51	46	38	30	38	45	51
Along-flow distance from stack	-27	-28	-28	-28	-27	-25	-22	-19	-15	-19	-23	-26
Across-flow distance from stack	0	0	0	0	1	1	1	1	1	1	1	1

Flow direction	130°	140°	150°	160°	170°	180°	190°	200°	210°	220°	230°	240°
Effective building width	58	55	51	45	38	30	38	45	51	55	58	59
Effective building height	10	10	10	10	10	10	10	10	10	10	10	10
Along-flow building length	55	58	59	57	55	50	55	58	59	58	55	51
Along-flow distance from stack	-28	-29	-30	-30	-28	-26	-29	-30	-30	-30	-29	-26
Across-flow distance from stack	1	1	1	1	1	0	0	0	0	0	-1	-1

Flow direction	250°	260°	270°	280°	290°	300°	310°	320°	330°	340°	350°	360°
Effective building width	58	55	50	55	57	58	58	56	51	45	38	30
Effective building height	10	10	10	10	10	10	10	10	10	10	10	10
Along-flow building length	45	38	30	38	45	51	55	58	59	58	55	50
Along-flow distance from stack	-23	-20	-15	-19	-23	-26	-27	-28	-29	-28	-27	-24
Across-flow distance from stack	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0

Emission rates by stability and wind speed, in OUV/second:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability B:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability C:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability D:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability E:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
Stability F:	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02

No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: G4

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
298931	6184057	0m	4	0m	4m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	298931	6184057	2	298947	6184057
3	298946	6184040	4	298931	6184040

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00
Stability B:	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00
Stability C:	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00
Stability D:	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00	2.17E+00
Stability E:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00
Stability F:	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00	1.79E+00

No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: POND

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
298858	6184023	0m	5	0m	0m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	298858	6184023	2	298854	6184006
3	298858	6184004	4	298882	6184004
5	298882	6184023			

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s):	< 1.5	1.5_ 3.1	3.1_ 5.1	5.1_ 8.2	8.2_10.8	>10.8
Stability A:	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00	1.11E+00

Stability B: 1.11E+00 1.11E+00 1.11E+00 1.11E+00 1.11E+00 1.11E+00
Stability C: 1.11E+00 1.11E+00 1.11E+00 1.11E+00 1.11E+00 1.11E+00
Stability D: 1.11E+00 1.11E+00 1.11E+00 1.11E+00 1.11E+00 1.11E+00
Stability E: 9.20E-01 9.20E-01 9.20E-01 9.20E-01 9.20E-01 9.20E-01
Stability F: 9.20E-01 9.20E-01 9.20E-01 9.20E-01 9.20E-01 9.20E-01

No gravitational settling or scavenging.

INTEGRATED POLYGON AREA SOURCE: RAWGW

X0(m)	Y0(m)	Ground El	No. Vertices	Ver. spread	Height
298876	6184057	0m	4	0m	4m

Integrated Polygon Area Source Vertice Locations (in metres)

No.	X	Y	No.	X	Y
1	298876	6184057	2	298880	6184057
3	298880	6184039	4	298876	6184039

Emission rates by stability and wind speed, in OUV/second per square metre:

Wind speeds (m/s): < 1.5 1.5_ 3.1 3.1_ 5.1 5.1_ 8.2 8.2_10.8 >10.8
Stability A: 1.33E+01 1.33E+01 1.33E+01 1.33E+01 1.33E+01 1.33E+01
Stability B: 1.33E+01 1.33E+01 1.33E+01 1.33E+01 1.33E+01 1.33E+01
Stability C: 1.33E+01 1.33E+01 1.33E+01 1.33E+01 1.33E+01 1.33E+01
Stability D: 1.33E+01 1.33E+01 1.33E+01 1.33E+01 1.33E+01 1.33E+01
Stability E: 1.10E+01 1.10E+01 1.10E+01 1.10E+01 1.10E+01 1.10E+01
Stability F: 1.10E+01 1.10E+01 1.10E+01 1.10E+01 1.10E+01 1.10E+01

No gravitational settling or scavenging.

VOLUME SOURCE: SHREDD

X(m)	Y(m)	Ground Elevation	Height	Hor. spread	Vert. spread
298879	6184063	0m	3m	1m	1m

Emission rates by hour of day in OUV/second:

1 0.00E+00	2 0.00E+00	3 0.00E+00	4 0.00E+00
5 0.00E+00	6 0.00E+00	7 1.32E+04	8 1.32E+04
9 1.32E+04	10 1.32E+04	11 1.32E+04	12 1.32E+04
13 1.32E+04	14 1.32E+04	15 1.32E+04	16 1.32E+04
17 1.32E+04	18 1.32E+04	19 0.00E+00	20 0.00E+00
21 0.00E+00	22 0.00E+00	23 0.00E+00	24 0.00E+00

No gravitational settling or scavenging.

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RECEPTOR LOCATIONS

DISCRETE RECEPTOR LOCATIONS (in metres)

No.	X	Y	ELEVN	HEIGHT	No.	X	Y	ELEVN	HEIGHT
1	299257	6184522	0.0	2.0					

METEOROLOGICAL DATA : Met for 299,193mE 6,184,118mN from CALMET output job

1 Peak values for the 100 worst cases (in Odour_Units)
Averaging time = 1 hour

Rank	Value	Time Recorded hour,date	Coordinates (* denotes polar)
1	7.90E+00	07,10/08/09	(299257, 6184522, 2.0)
2	7.36E+00	07,06/05/09	(299257, 6184522, 2.0)
3	5.63E+00	07,24/06/09	(299257, 6184522, 2.0)
4	3.88E+00	07,12/05/09	(299257, 6184522, 2.0)
5	3.50E+00	07,04/05/09	(299257, 6184522, 2.0)
6	3.48E+00	07,19/08/09	(299257, 6184522, 2.0)
7	3.40E+00	18,06/07/09	(299257, 6184522, 2.0)
8	3.18E+00	07,01/05/09	(299257, 6184522, 2.0)
9	3.06E+00	07,05/06/09	(299257, 6184522, 2.0)
10	2.91E+00	07,06/07/09	(299257, 6184522, 2.0)
11	2.61E+00	07,09/05/09	(299257, 6184522, 2.0)
12	2.45E+00	18,13/05/09	(299257, 6184522, 2.0)
13	2.21E+00	07,02/05/09	(299257, 6184522, 2.0)
14	1.96E+00	07,18/06/09	(299257, 6184522, 2.0)
15	1.81E+00	07,26/05/09	(299257, 6184522, 2.0)
16	1.75E+00	07,07/05/09	(299257, 6184522, 2.0)
17	1.71E+00	07,06/06/09	(299257, 6184522, 2.0)
18	1.71E+00	07,15/06/09	(299257, 6184522, 2.0)
19	1.71E+00	07,18/08/09	(299257, 6184522, 2.0)
20	1.68E+00	07,12/06/09	(299257, 6184522, 2.0)
21	1.66E+00	07,17/08/09	(299257, 6184522, 2.0)
22	1.53E+00	07,17/05/09	(299257, 6184522, 2.0)
23	1.41E+00	07,29/07/09	(299257, 6184522, 2.0)
24	1.39E+00	18,27/05/09	(299257, 6184522, 2.0)
25	1.35E+00	07,08/08/09	(299257, 6184522, 2.0)
26	1.13E+00	18,13/07/09	(299257, 6184522, 2.0)
27	1.08E+00	07,28/03/09	(299257, 6184522, 2.0)
28	1.02E+00	07,19/07/09	(299257, 6184522, 2.0)

29	1.02E+00	07,23/06/09	(299257, 6184522, 2.0)
30	9.21E-01	22,27/11/09	(299257, 6184522, 2.0)
31	8.94E-01	02,19/05/09	(299257, 6184522, 2.0)
32	8.93E-01	05,10/08/09	(299257, 6184522, 2.0)
33	8.90E-01	03,19/10/09	(299257, 6184522, 2.0)
34	8.84E-01	02,10/08/09	(299257, 6184522, 2.0)
35	8.83E-01	02,14/07/09	(299257, 6184522, 2.0)
36	8.80E-01	03,21/03/09	(299257, 6184522, 2.0)
37	8.33E-01	23,06/05/09	(299257, 6184522, 2.0)
38	8.31E-01	07,06/09/09	(299257, 6184522, 2.0)
39	8.29E-01	02,17/04/09	(299257, 6184522, 2.0)
40	8.10E-01	07,27/05/09	(299257, 6184522, 2.0)
41	7.87E-01	01,28/12/09	(299257, 6184522, 2.0)
42	7.77E-01	23,22/06/09	(299257, 6184522, 2.0)
43	7.69E-01	18,02/08/09	(299257, 6184522, 2.0)
44	7.53E-01	17,06/07/09	(299257, 6184522, 2.0)
45	7.42E-01	22,12/04/09	(299257, 6184522, 2.0)
46	7.40E-01	05,14/12/09	(299257, 6184522, 2.0)
47	7.32E-01	21,22/06/09	(299257, 6184522, 2.0)
48	7.32E-01	07,16/07/09	(299257, 6184522, 2.0)
49	7.30E-01	01,12/05/09	(299257, 6184522, 2.0)
50	7.30E-01	04,21/01/09	(299257, 6184522, 2.0)
51	7.16E-01	06,27/06/09	(299257, 6184522, 2.0)
52	7.16E-01	22,29/09/09	(299257, 6184522, 2.0)
53	7.14E-01	05,19/08/09	(299257, 6184522, 2.0)
54	7.00E-01	03,05/06/09	(299257, 6184522, 2.0)
55	6.99E-01	07,29/05/09	(299257, 6184522, 2.0)
56	6.87E-01	03,12/05/09	(299257, 6184522, 2.0)
57	6.67E-01	21,19/03/09	(299257, 6184522, 2.0)
58	6.66E-01	03,18/01/09	(299257, 6184522, 2.0)
59	6.64E-01	05,27/06/09	(299257, 6184522, 2.0)
60	6.58E-01	01,04/11/09	(299257, 6184522, 2.0)
61	6.32E-01	06,01/05/09	(299257, 6184522, 2.0)
62	6.27E-01	05,24/06/09	(299257, 6184522, 2.0)
63	6.27E-01	05,20/12/09	(299257, 6184522, 2.0)
64	6.25E-01	03,28/03/09	(299257, 6184522, 2.0)
65	6.21E-01	04,24/06/09	(299257, 6184522, 2.0)
66	6.09E-01	04,28/03/09	(299257, 6184522, 2.0)
67	6.04E-01	07,28/07/09	(299257, 6184522, 2.0)
68	6.02E-01	01,30/09/09	(299257, 6184522, 2.0)
69	6.01E-01	01,18/11/09	(299257, 6184522, 2.0)
70	6.01E-01	05,07/05/09	(299257, 6184522, 2.0)
71	5.97E-01	03,29/12/09	(299257, 6184522, 2.0)
72	5.81E-01	05,09/04/09	(299257, 6184522, 2.0)
73	5.77E-01	23,23/06/09	(299257, 6184522, 2.0)
74	5.76E-01	04,16/08/09	(299257, 6184522, 2.0)
75	5.75E-01	07,09/08/09	(299257, 6184522, 2.0)
76	5.70E-01	03,28/06/09	(299257, 6184522, 2.0)
77	5.64E-01	03,06/05/09	(299257, 6184522, 2.0)
78	5.63E-01	24,12/05/09	(299257, 6184522, 2.0)
79	5.62E-01	04,14/04/09	(299257, 6184522, 2.0)
80	5.61E-01	05,02/06/09	(299257, 6184522, 2.0)

81	5.56E-01	07,29/04/09	(299257, 6184522, 2.0)
82	5.54E-01	07,14/04/09	(299257, 6184522, 2.0)
83	5.52E-01	23,23/04/09	(299257, 6184522, 2.0)
84	5.49E-01	19,08/08/09	(299257, 6184522, 2.0)
85	5.46E-01	08,27/05/09	(299257, 6184522, 2.0)
86	5.43E-01	07,28/05/09	(299257, 6184522, 2.0)
87	5.37E-01	06,12/05/09	(299257, 6184522, 2.0)
88	5.35E-01	08,11/07/09	(299257, 6184522, 2.0)
89	5.35E-01	20,06/10/09	(299257, 6184522, 2.0)
90	5.35E-01	08,05/04/09	(299257, 6184522, 2.0)
91	5.34E-01	22,15/07/09	(299257, 6184522, 2.0)
92	5.28E-01	08,06/07/09	(299257, 6184522, 2.0)
93	5.20E-01	18,23/07/09	(299257, 6184522, 2.0)
94	5.16E-01	18,01/05/09	(299257, 6184522, 2.0)
95	5.15E-01	22,29/12/09	(299257, 6184522, 2.0)
96	5.12E-01	08,04/06/09	(299257, 6184522, 2.0)
97	5.11E-01	08,07/07/09	(299257, 6184522, 2.0)
98	5.07E-01	21,06/04/09	(299257, 6184522, 2.0)
99	5.05E-01	04,04/05/09	(299257, 6184522, 2.0)
100	5.04E-01	04,25/05/09	(299257, 6184522, 2.0)

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		Name	Signature	Name	Signature	Date
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4	P Pandey	E Smith		E Milton		10/07/2014

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