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Penrith Waste Services Pty Ltd
PO Box 262
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Mulgoa Landfill Proposed Flare
Air Quality Assessment

Attention: Harry Singh

1 Introduction

SLR Consulting Australia Pty Ltd (SLR) has been engaged by Penrith Waste Services (PWS) to conduct an Air Quality Assessment (AQA) for a proposed landfill flare at Mulgoa Landfill (the Project), located at 842 Mulgoa Road, Mulgoa, NSW (the Site). This assessment has been prepared to accompany the submission of a development application (DA) for the Project.

This letter report provides a brief summary of the proposed operations, associated air emissions and predicted air quality impacts relevant to the proposed flare only. For details regarding the Site location, sensitive receptor identification and modelling methodology, please refer to Mulgoa Landfill Expansion, Air Quality Impact Assessment (SLR Consulting Pty Ltd, 2021, draft pending) conducted for the same Site.

2 Proposed Flare Operations

The proposed flare will be a ceramic-lined ground flare used to combust landfill gas coming from the Mulgoa Landfill collection system. A schematic representation of the proposed flare is shown in Figure 1 and details of the flare parameters are provided in Table 1.

Figure 1 Flare layout

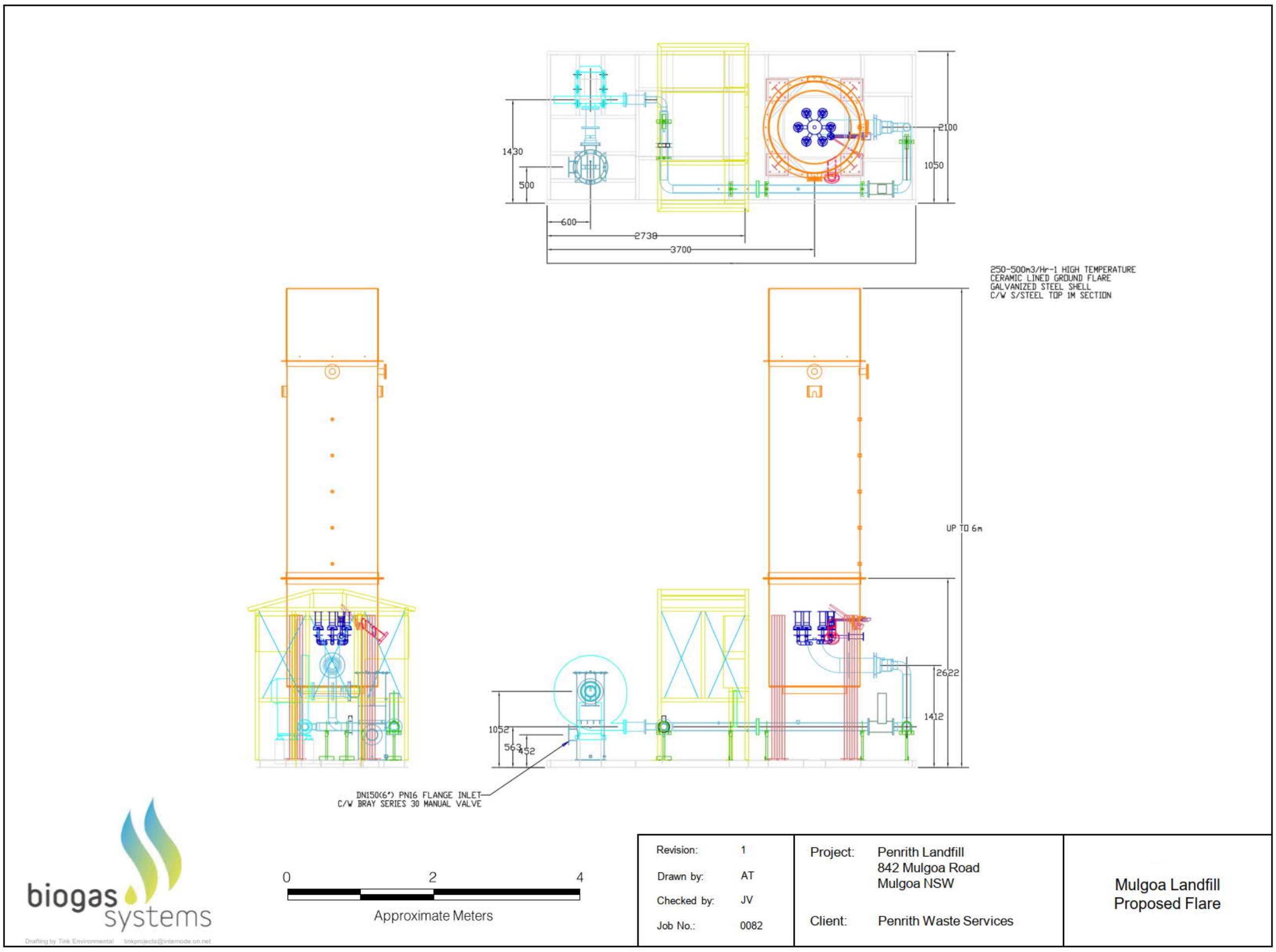


Table 1 Stack Parameters used in the Modelling Study

Parameter	Data
Easting, Northing (m)	283,777, 6,256,223
Height (m)	6
Diameter (m)	1
Design Capacity (m^3/h)	500
Exit velocity (m/s)	10
Temperature (^{O}C)	1,000

3 Pollutants of Concern

The key air pollutants that will be emitted from the combustion of landfill gas in the proposed flare are:

- Oxides of nitrogen (NO_X): NO_X is a mixture of gases that are composed of nitrogen and oxygen. Two of the most toxicologically significant compounds are nitric oxide (NO) and nitrogen dioxide (NO_2). Other gases belonging to this group are nitrous oxide (N_2O) and nitrogen pentoxide (N_2O_5). The majority of NO_X (90 to 95%$_{(v/v)}$) generated by the combustion of fossil fuels is in the form of NO, with NO_2 contributing the remaining 5 to 10%$_{(v/v)}$ along with traces of N_2O. The NO reacts in the atmosphere to form NO_2 as the plume travels downwind.
- Carbon monoxide (CO): CO forms due to incomplete combustion of carbon in fuels (e.g. petrol, wood, coal, natural gas).

Sulfur dioxide (SO_2) will also be emitted from the flare due to the combustion of sulfur-containing compounds in the landfill gas, such as hydrogen sulfide (H_2S), methyl mercaptan (CH_3SH) and other reduced sulfur compounds. There will also be trace emissions of volatile organic compounds (VOCs), particulate matter and metals from the flare. However, as shown in Table 2, estimated emissions for these pollutants are significantly lower than NO_X and CO emissions. Thus, if no off-site exceedances of air quality criteria are predicted for the key pollutants listed above, further detailed assessment of SO_2 and other trace emissions is not warranted.

3.1 NO to NO_2 Conversion

NO_X emissions from combustion sources generally consist of only around 10% NO_2 and 90% NO. The NO will convert to NO_2 in the environment, in the presence of ozone and sunlight, however the reaction converting NO to NO_2 has a conversion rate that takes place over several hours and results in increased NO_2 concentrations further down plume (where the plume is significantly diluted), not close to the source.

For this assessment, it has been conservatively assumed that 30% of NO_X emitted from the combustion sources has been converted to NO_2 by the time the plumes reach the identified sensitive receptor locations (approximately 570 m away).

3.2 Estimated Emission Rates

The emission rates for pollutants identified in Section 3 were calculated based on the maximum flowrate and relevant landfill gas combustion emission factors sourced from the National Pollutant Inventory Emission Estimation Technique Manual for Combustion in Boilers (Department of Environment and Energy, 2011), as referenced in Section 5.2 of the National Pollutant Inventory Emission Estimation Technique Manual for Municipal Solid Waste Landfills (V2.0). The calculated emission rates are presented in Table 2.

As noted in Section 3, NO_X and CO emission rates are significantly higher compared to the other pollutants presented in Table 2. Thus if no off-site exceedances of air quality criteria are predicted for these key pollutants, further detailed assessment of SO_2 and other trace emissions is not warranted.

Table 2 Estimated Emission Rates

Pollutant	Emission Factor (kg/MJ of landfill gas)	Calculated Emission Rate (g/s)
NO_X	1.8×10^{-5}	0.05
CO	3.08×10^{-6}	0.01
PM_{10}	1.08×10^{-6}	0.003
$PM_{2.5}$	1.08×10^{-6}	0.003
SO_2	$3.2 \times 10^{-8\#}$	0.0001

Note 1- Emission factors sourced from Table 19 of the NPI EETM for Combustion in Boilers (Department of Environment and Energy, 2011)
Note 2- Caloric value of landfill gas has been estimated to be 18.75 MJ/N.m^3 (Warken ISE, 2007)
#Based on default sulfur content of 50% in landfill gas (Department of Environment and Energy, 2011)

4 Air Quality Criteria

The NSW EPA air quality assessment criteria relevant to the proposed operations at the Site set out in the 'Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales' (NSW EPA, 2017), hereafter referred to as 'Approved Methods', for NO_2 and CO are shown in Table 3.

Table 3 Impact Assessment Criteria

Pollutant	Averaging Time	Concentration
NO_2	1 Hour	246 µg/m^3
	Annual	62 µg/m^3
CO	1 Hour	30 mg/m^3, 30,000 µg/m^3
	8 Hours	10 mg/m^3, 10,000 µg/m^3

Source Approved Methods, (NSW EPA, 2017)

5 Background Air Quality

For the purposes of assessing potential cumulative off-site air quality impacts, an estimation of the background ambient air quality concentrations is required. The nearest Air Quality Monitoring Station (AQMS) operated by the Department of Planning, Industry and Environment (DPIE) measuring continuous NO_2 and CO concentrations is located at St Marys approximately 10 km to the east of the Site.

As shown in Table 4 the last five (5) years of monitoring data was analysed and the maximum concentrations for each relevant averaging period for all years was selected as conservative background pollutant concentrations. It is also observed that no exceedances for the relevant NO_2 and CO criteria were recorded at the St Marys AQMS for the last five (5) years.

Table 4 Summary of Ambient NO_2 and CO Data - St Marys AQMS (2016 – 2020)

Pollutant	NO_2		CO	
Averaging Period	Maximum 1-hour (µg/m³)	Annual (µg/m³)	Maximum 1-hour (µg/m³)	Maximum 8-hour (µg/m³)*
2016	86.1	7.0	2,000	1,875
2017	75.9	8.1	2,000	1,375
2018	75.9	9.6	1,625	1,375
2019	67.7	7.6	6,875	3,500
2020	69.7	7.4	2,625	2,250
Maximum All Years	86.1	9.6	6,875	3,500
Criterion	246	62	30,000	10,000

*Based on rolling 8-hour average

6 Air Quality Assessment

SLR performed meteorological modelling using a combination of the TAPM and CALMET models in order to generate a site-representative three-dimensional meteorological dataset for the calendar year of 2019. This dataset was then used as an input to the US EPA's CALPUFF (Version 6.267) dispersion model. Emissions from the proposed flare were modelled as a point source using the stack parameters and emission rates presented in Table 1 and Table 2.

Further details regarding the selection of the representative meteorological year and modelling methodology is presented in Mulgoa Landfill Expansion, Air Quality Impact Assessment (SLR Consulting Pty Ltd, 2021, draft pending).

As identified in Section 3 the following pollutants were modelled from the flare:

- NO_2
- CO

6.1 Dispersion Modelling Results

6.1.1 Nitrogen Dioxide

A summary of the incremental and cumulative maximum 1-hour and annual average NO_2 concentrations predicted at the identified nearest sensitive receptors for proposed operations are presented in Table 5. The cumulative predictions include the estimated background concentrations shown in Table 4.

The modelling results presented in Table 5 show that the cumulative maximum 1-hour and annual average NO_2 concentrations predicted at all identified receptors comply with the NSW EPA's 1-hour criterion of 246 µg/m³ and annual average criterion of 62 µg/m³. The incremental impacts predicted as a result of the proposed flare operations are negligible compared to the estimated background levels and the relevant ambient air quality assessment criteria.

The cumulative maximum 1-hour and annual average NO_2 concentrations are presented as contour plots in Figure 2 and Figure 3 respectively.

6.1.2 Carbon Monoxide

A summary of the incremental and cumulative maximum 1-hour and maximum 8-hour average CO concentrations predicted at the identified nearest sensitive receptors for proposed operations are also presented in Table 5. The cumulative predictions include the estimated background concentrations shown in Table 4.

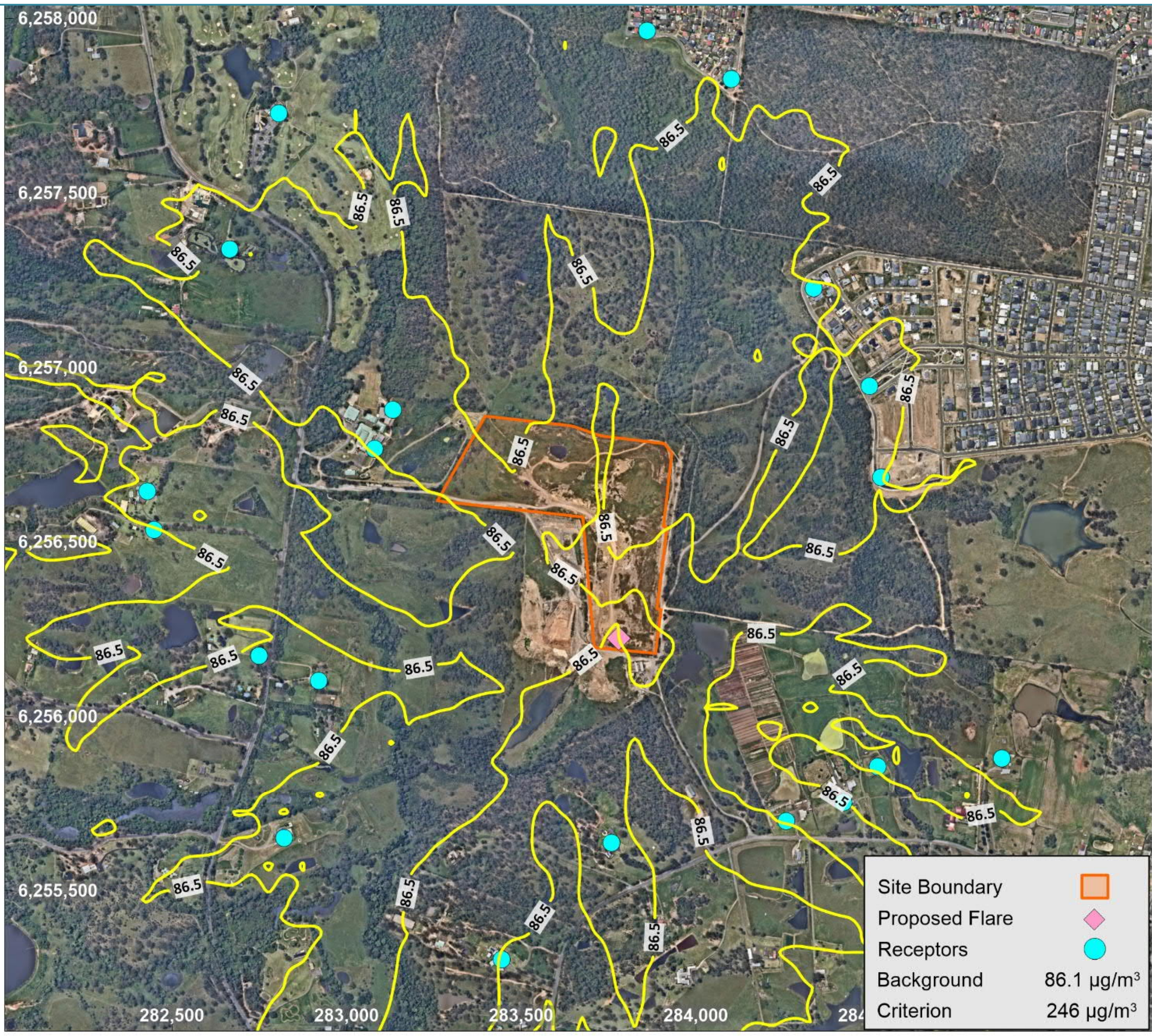
The modelling results presented in Table 5 show that the cumulative maximum 1-hour and maximum 8-hour average CO concentrations predicted at all identified receptors comply with the NSW EPA's 1-hour criterion of 30,000 µg/m^3 and 8-hour criterion of 10,000 µg/m^3. The incremental impacts predicted as a result of the proposed flare operations are negligible compared to the estimated background levels and the relevant ambient air quality assessment criteria.

The cumulative maximum 1-hour and maximum 8-hour average CO concentrations are presented as contour plots in Figure 4 and Figure 5 respectively.

Table 5 Predicted NO_2 and CO Concentrations at Surrounding Sensitive Receptors

Receptor ID	NO_2				CO			
	Incremental (µg/m³)		Cumulative (µg/m³)		Incremental (µg/m³)		Cumulative (µg/m³)	
	Maximum 1-Hour Average	Annual Average	Maximum 1-Hour Average	Annual Average	Maximum 1-Hour Average	Maximum 8-Hour Average	Maximum 1-Hour Average	Maximum 8-Hour Average
R1	0.5	0.003	86.6	9.56	0.31	0.05	6900.3	3500.0
R2	0.9	0.003	87.0	9.56	0.50	0.08	6900.5	3500.1
R3	0.5	0.002	86.6	9.56	0.26	0.07	6900.3	3500.1
R4	0.3	0.002	86.4	9.56	0.15	0.04	6900.1	3500.0
R5	0.2	0.002	86.3	9.56	0.12	0.05	6900.1	3500.0
R6	0.4	0.003	86.5	9.56	0.21	0.04	6900.2	3500.0
R7	0.4	0.002	86.5	9.56	0.22	0.03	6900.2	3500.0
R8	0.7	0.002	86.8	9.56	0.37	0.06	6900.4	3500.1
R9	0.4	0.003	86.5	9.56	0.25	0.04	6900.2	3500.0
R10	0.2	0.001	86.3	9.56	0.11	0.05	6900.1	3500.1
R11	0.5	0.001	86.6	9.56	0.31	0.04	6900.3	3500.0
R12	0.4	0.001	86.5	9.56	0.24	0.03	6900.2	3500.0
R13	0.4	0.001	86.5	9.56	0.21	0.05	6900.2	3500.1
R14	0.2	0.001	86.3	9.56	0.10	0.03	6900.1	3500.0
R15	0.3	0.002	86.4	9.56	0.19	0.04	6900.2	3500.0
R16	0.6	0.003	86.7	9.56	0.36	0.06	6900.4	3500.1
R17	0.2	0.002	86.3	9.56	0.11	0.03	6900.1	3500.0
R18	0.2	0.002	86.3	9.56	0.11	0.03	6900.1	3500.0
R19	0.4	0.002	86.5	9.56	0.20	0.04	6900.2	3500.0
R20	0.5	0.002	86.6	9.56	0.26	0.05	6900.3	3500.0
Guideline	-	-	246	62	-	-	30,000	10,000

Figure 2 Cumulative Maximum 1-hour NO_2 Concentrations



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Project Number:	620.13653
Dispersion Model:	CALPUFF
Modelling Period:	2019
Projection:	GDA 1994 MGA Zone 56
Date:	26/05/2021

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Cumulative Impact

Pollutant	NO_2	Averaging Period	1-Hour	Unit	µg/m³

Figure 3 Cumulative Annual Average NO_2 Concentrations

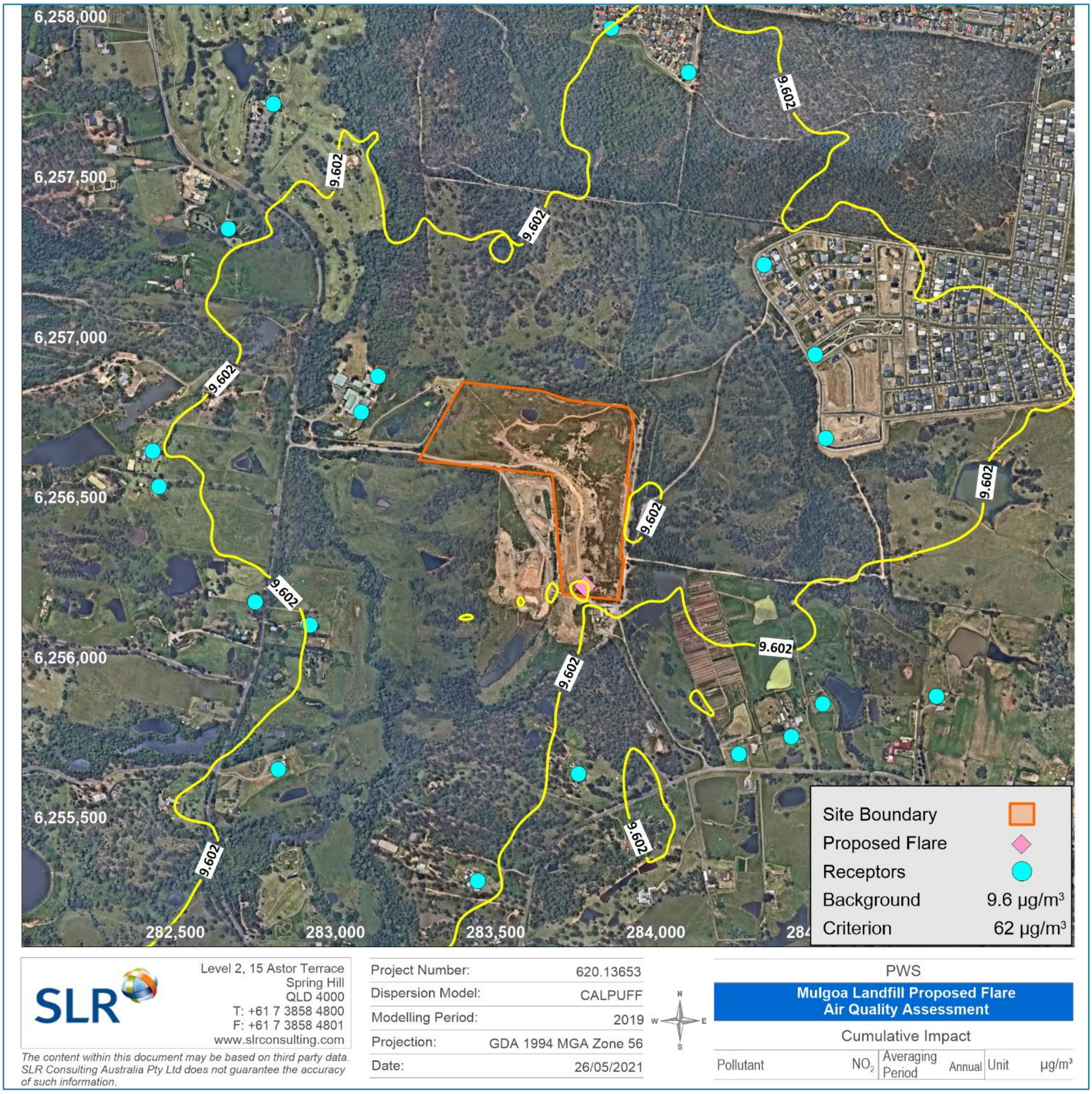


Figure 4 Cumulative Maximum 1-hour CO Concentrations

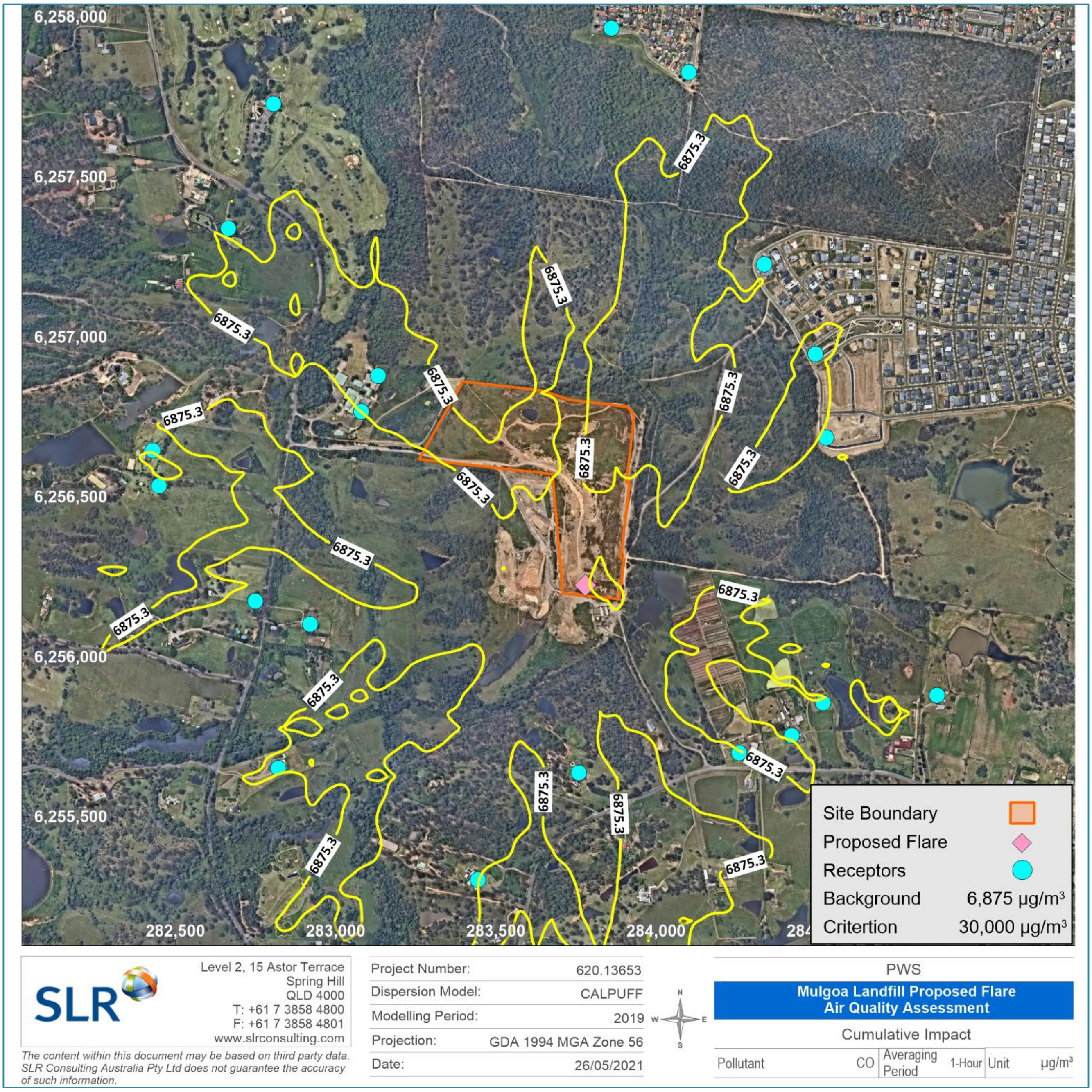
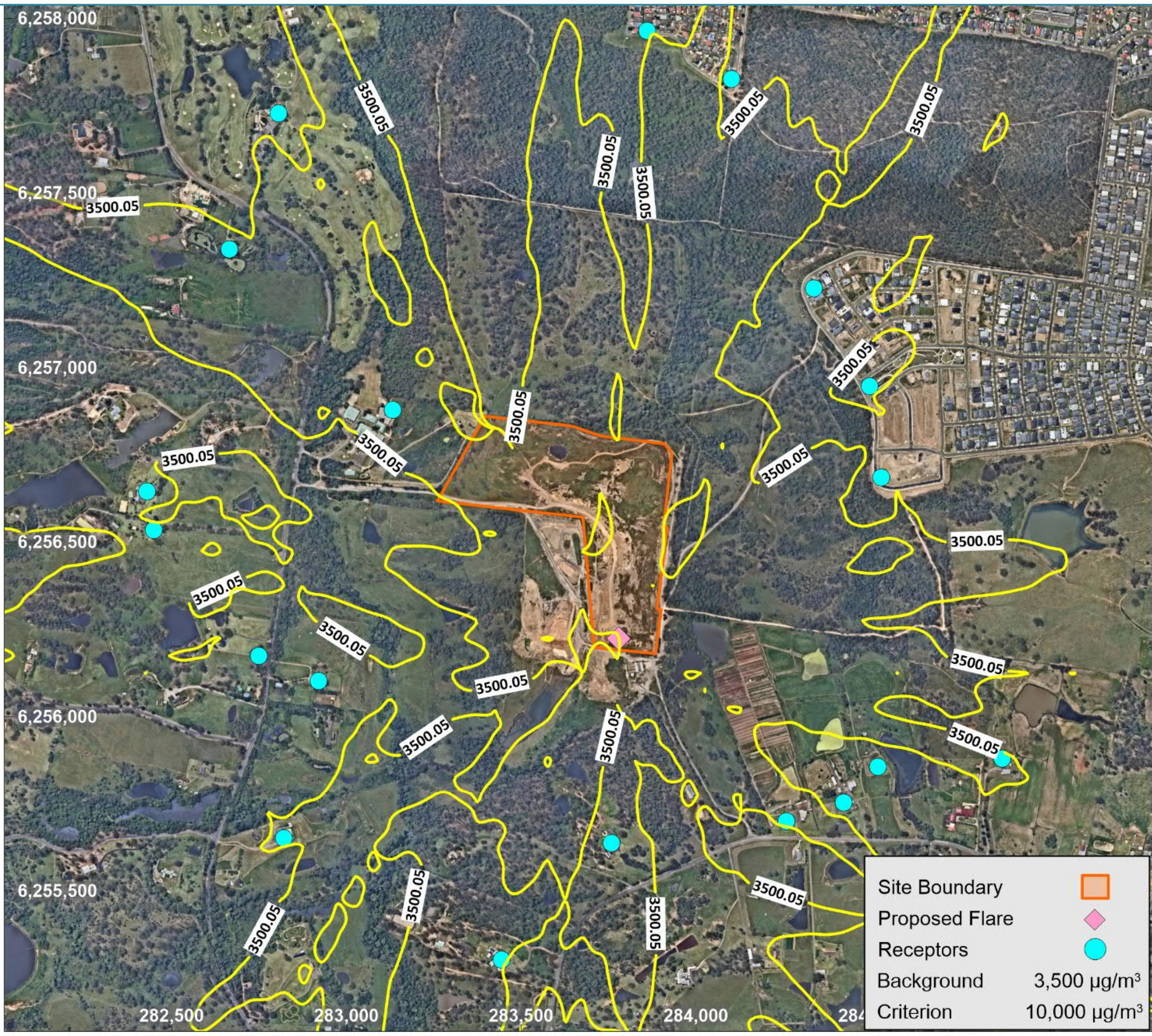


Figure 5 Cumulative Maximum 8-hour Average CO Concentrations



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Air Quality Assessment
Cumulative Impact

Pollutant	CO	Averaging Period	8-Hour	Unit	µg/m³

7 Conclusion

SLR was engaged by PWS to conduct an Air Quality Assessment for a proposed landfill flare at Mulgoa Landfill, located at 842 Mulgoa Road, Mulgoa. This assessment has been prepared to accompany the submission of a DA for the Project.

SLR performed air pollution dispersing modelling to assess potential air quality impacts from the proposed flare at identified neighbouring sensitive receptors. Results from modelling study show the following –

- Predicted maximum 1-hr NO_2 concentrations are below the NSW EPA's maximum allowable 1-hr NO_2 criterion of 246 µg/m^3 at all identified receptors.
- Predicted annual average NO_2 concentrations are below the NSW EAP's annual average criterion of 62 µg/m^3 at all identified receptors.
- Predicted maximum 1-hr CO concentrations are below the NSW EPA's maximum allowable 1-hr CO criterion of 30,000 µg/m^3 at all identified receptors.
- Predicted maximum 8-hr CO concentrations are below the NSW EPA's maximum allowable 8-hr CO criterion of 10,000 µg/m^3 at all identified receptors.

Based on the modelling results, it is concluded that potential air quality impacts are not a constraint for the Project.

8 References

Department of Environment and Energy. (2011). *NPI Emission Estimation Technique Manual for Combustion in Boilers.* Australian Government.

NSW EPA. (2017, January). Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales. Prepared by NSW Environment Protection Authority, which is part of the NSW Office of Environment and Heritage (OEH). Retrieved from http://www.environment.nsw.gov.au/resources/air/ammodelling05361.pdf

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Warken ISE. (2007). *Potential for Greenhouse Gas Abatment from Waste Management and Resource Recovery Activities in Australia.*

Yours sincerely

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Checked/
Authorised by: KL