Confidential

Kemps Creek Data Centre

Air Quality Report

SYD05-06-07_Y-R-0007

Revision 3 | 23 July 2021

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 277863-00

Arup Australia Pty Ltd ABN 76 625 912 665

Arup
Level 5
151 Clarence Street
Sydney NSW 2000
Australia
www.arup.com

ARUP

Document verification

ARUP

Job title	Kemps Creek Data Centre	**Job number**	277863-00
Document title	Air Quality Report	**File reference**	SYD05-06-07_Y-R-0007
Document ref	SYD05-06-07_Y-R-0007		

Revision	**Date**	**Filename**	SYD05-06-07_Y-R-0007		
Revision 1	19 March 2021	**Description**	Issue 1		
			Prepared by	Checked by	Approved by
		Name	Stanley Gunawan	Lesley-Anne Stone	Chris Fay
		Signature			
Revision 2	16 April 2021	**Filename**	SYD05-06-07_Y-R-0007		
		Description	Final Issue		
			Prepared by	Checked by	Approved by
		Name	Stanley Gunawan	Lesley-Anne Stone	Chris Fay
		Signature			
Revision 3	23 July 2021	**Filename**	SYD05-06-07_Y-R-0007		
		Description	Response to DPIE adequacy review		
			Prepared by	Checked by	Approved by
		Name	Stanley Gunawan	Lesley-Anne Stone	Chris Fay
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document verification with document ✓

Executive summary

Arup Australia Pty Ltd (Arup) was engaged by the Client to undertake an air quality impact assessment for standby diesel generators associated with a proposed data centre building located at 757-769 Mamre Road, Kemps Creek in New South Wales ("the proposal" or "the subject site"). The air quality impact assessment is to accompany the Environment Impact Statement (EIS) for the proposal.

Existing Environmental Conditions

The proposal is located in a rural setting, within the vicinity of residential premises, with some schools and childcare. The closest sensitive receivers have been identified as residential properties located at approximately 315 m to the south-east of the proposal boundary.

Meteorological conditions were sourced from the nearest St Marys air quality monitoring station (AQMS), located approximately 3.7 km north of the subject site, and operated by NSW Department of Planning, Industry and Environment (DPIE). 2014 meteorological data was considered to best represent the general trend across the 5-year period studied (2013 – 2017), and has been adopted for this assessment. To provide all required meteorological parameters for dispersion modelling, AERMET-ready meteorological data using the MM5 prognostic model was purchased to determine onsite conditions for 2014. This shows that winds are most prevalent from the south-west and west-south-west, with second most prevalent direction from north-north-east direction.

Data from St Marys AQMS for 2014 has also been used to establish background pollutant concentrations for the subject site. In 2014, St Marys AQMS recorded NO_2, O_3 and PM_{10}. Data for $PM_{2.5}$, CO and SO_2 were sourced from the next closest Liverpool AQMS, also operated by DPIE.

Pollutant Impact Assessment

A dispersion modelling assessment of the proposed 62 on-duty standby generators has been undertaken to ascertain the air quality impacts on-site as well as at nearby receivers due to routine maintenance/testing (realistic operations) and a justified worst case scenario (in the event of a power outage).

The assessment was undertaken using AERMOD. Predicted ground-level concentrations were assessed at the identified nearby discrete sensitive receivers.

Hourly background concentration data were used to assess those pollutants likely to have the greatest impact such as NO_2, and particulate matter to avoid over conservatism. Whereas maximum background concentration data across the year were used to assess less impacting pollutants, such as SO_2 and CO.

A photochemical conversion for short-term concentrations (i.e. hourly average) from NO_x to NO_2 were determined in accordance with the US EPA's Ozone Limiting Method[1] (OLM), which is recognised in the NSW Approved Methods.

Justified Worst-Case Scenario

As a worst case scenario, the assessment has assumed all on-duty standby generators would be required to operate at the same time. As these generators are for standby purposes, it is assumed that they would be in operation for short periods of time only during a power outage or maintenance and therefore impacts have only been assessed for short-term averaging periods.

The modelling results indicated that the predicted ground level concentrations for carbon monoxide (CO), sulfur dioxide (SO_2), PM_{10} and $PM_{2.5}$ meet the impact assessment criteria outlined in the Approved Methods at nearby sensitive receivers. Emissions of oxides of nitrogen from the generators, which convert to NO_2 in the atmosphere, are significantly higher than for the pollutants listed above, due to the large capacity and fuel type of the proposed generators. Predicted ground level concentrations of nitrogen dioxide (NO_2) exceed the impact assessment criteria by up to three-and-a-half fold at the impacted sensitive receivers.

Exceedances of the impact assessment criteria for NO_2 are not uncommon for facilities including standby diesel generators, where all generators would be required to operate where a loss of mains power occurs. However, the likelihood of this scenario occurring is expected to be very rare at the subject site.

Likelihood of Justified Worst-Case Scenario

Under typical conditions, power for the proposal site is fed directly from the grid. A review of the Australian Energy Regulator (AER) – system average interruption duration index (SAIDI) has shown that interruptions of any kind, including power outages, would likely only occur for less than 0.05% of the time during an entire year. In addition, the Client has negotiated a high level of reliability for the utility supply to reduce risk of a power outage further at the subject site. The failure rates for a supply in the high reliability utility supply arrangement are extremely low, the last outage in Sydney was recorded in 2014 and lasted just 13 minutes. On this basis, despite predicted exceedances of the NO_2 impact assessment criteria being likely during operation of all standby generators concurrently, it is unlikely that this justified worst-case scenario would occur in a typical year. If it did occur, the standby generators are likely to only operate for a maximum of 0.05% of the year due to power outages.

Realistic Operations during Routine Maintenance

During routine maintenance, there would be a total of 197 hours per year where generators are anticipated to be tested. Schedule 1 Clause 17 (1A) of the NSW POEO Act 1997 (refer to Section 2.1.1) applies an exemption for stand-by generators that operate for less than 200 hours per year, Therefore the site is not

---

[1] Cole, H. S., & Summerhays, J. E. (1979). *A Review of Techniques Available for Estimating Short-Term NO_2 concentrations*. *J. Air Poll. Cont. Assoc., 29:8*, 812-817. doi:10:1080/00022470.1979.10470866.

classed as a scheduled premises and is exempt from meeting Standard of Concentration emissions limits outlined in Schedule 2-4 of the Protection of the Environment Operations (Clean Air) Regulation 2010. Notwithstanding this, dispersion modelling has been undertaken to determine potential air quality impacts at nearby identified sensitive receivers as a result of routine maintenance.

The predicted air quality impact at nearby identified sensitive receivers during any maintenance or testing periods is well below the impact assessment criteria for all assessed pollutants. It has been assumed that up to two generators at a time would be tested under no-load condition during daytime maintenance hours. However, up to one generator would be tested annually under 100% load condition.

On this basis, it is concluded that the operation of the standby generators during maintenance and testing activity would not adversely impact the air quality of nearby sensitive receivers.

Environment Management Measures

General air quality mitigation and management measures recommended for the proposal have been provided in Section 8 of this report. These include recommendations to control emissions to air and dust during construction, which can be incorporated in the Construction Environmental Management Plan (CEMP). These also include measures for the operator to minimise operation of the generators as far as practicable.

Residual impacts remain only in a situation where all standby generators would be required to operate during a loss of mains power. However, the likelihood of this scenario occurring is expected to be very rare at the subject site.

Contents

Tables

Figures

Appendices

1 Introduction

Arup Australia Pty Ltd (Arup) has been commissioned to undertake an air quality assessment to accompany the Environment Impact Statement (EIS) for the proposed Kemps Creek Data Centre – State Significant Development (SSD) (hereafter referred to as 'the proposal' or 'the subject site'), on behalf of the Client.

1.1 Scope of this report

The purpose of this report is to examine and identify the potential impact from the construction and operation of the proposal, on local air quality at nearby sensitive receivers. The air quality impact assessment in this report has been conducted in accordance with the following legislation, policy and guidelines:

- The National Environment Protection (Ambient Air Quality) Measure (NEPM AAQ)
- NSW *Protection of the Environment Operations (Clean Air) Regulation 2010* (POEO)
- NSW EPA – *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (January 2017)
- NSW *Protection of the Environment Operations Act 1997* – Section 128

This assessment characterises the local meteorological and air quality conditions at the proposal site and its surroundings, qualitatively assesses impact associated with the construction phase and provides a detailed dispersion modelling assessment of the proposed standby generators to be installed at the proposal, for a worst-case scenario as well as a regular testing scenario.

Recommendations for mitigation measures required to allow the proposal to meet NSW air quality standards have also been included, where necessary.

1.2 Proposal overview

1.2.1 Site context

The identified site address that is the subject of this technical report is legally defined as 757-769 Mamre Road, Kemps Creek. The entire Site comprises a total area of approximately 17.38 hectares (ha) and is subject to the applicable provisions outlined within SEPP (WSEA) 2009. Access to the Site is currently obtained via the proposed Estate Access Roads (SSD 9522), which are accessed from Mamre Road. Access into the Site is made possible via Mamre Road, which is subject to future road widening as part of the Mamre Road Widening Project (Transport for NSW).

The Site is situated approximately 40.26 km west of the Sydney CBD, 22.11 km west of Parramatta and 11.97 km southeast of Penrith. It is within close proximity to transport infrastructure routes (predominantly the bus network), as well as sharing direct links with the wider regional road network, including Mamre Road and both the M4 & M7 Motorways. All of which provide enhanced connectivity to the Subject Site and immediate vicinity, as well as the wider locality.

Additionally, the Subject Site is located within close proximity to active transport links, such as bicycle routes, providing an additional mode of accessible transport available to the Subject Site. In its existing state, the Subject Site comprises an undeveloped land portion; however, is subject to bulk earthworks and infrastructure works under a concurrent State Significant Development (SSD) Application – SSD 9522.

The Proponent is proposing to construct and operate a Data Centre on the Subject Site. The Site is located within the Penrith Local Government Area (LGA) and is zoned IN1 General Industrial under the provisions of State Environmental Planning Policy (Western Sydney Employment Area) 2009 (SEPP (WSEA) 2009). Development for the purpose of a Data Centre is permissible with consent within the IN1 General Industrial zone pursuant to the provisions outlined with Part 3, Division 3, Clause 27 of State Environmental Planning Policy (Infrastructure) 2007 (ISEPP).

The site and surrounding context are illustrated below in Figure 1.

Legend

- Proposed Site
- Lot
- SSDA 9522

Client

Job Title
Kemps Creek Data Centre

Figure Title
Site Context and Surrounding Area

Meters
0 100 200 300 400

D2	2021-03-03	ICD	LS	
Issue	Date	By	Chkd	Appd

ARUP
Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point,
Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Scale at A3	Figure Status
1:10,000	Draft
Coordinate System	
GDA 1994 MGA Zone 56	
Job No	Figure No
277863-00	Figure 01

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\Desktop\Figure_01.mxd

Aerial Imagery: DFSI, 2020

© Arup2020

1.2.2 Description of the proposed development

The Site will form part of the new Kemps Creek Warehouse, Logistics and Industrial Facilities Hub being developed as a joint venture between Frasers Property and Altis Property Partner under the recently approved SSD 9522 as of 21st December 2020.

The site layout has been developed for three data centres for a total of (3 x 48MW) 144MW capacity. Full detailed design is currently underway for two 48MW centres, with the third data centre being designated as a future build. The design of these which are based on the end-client's reference design as well as applicable Australian standards.

This air quality impact assessment is undertaken to account for the all three data centres.

1.3 SEARs and DCP requirements relevant to this report

Table 1 identifies the Secretary Environmental Assessment Requirements (SEARs) and Development Control Plan (DCP) requirements which are relevant to this technical assessment.

Table 1: SEARs and DCP requirements for Air Quality

SEARs relevant to this technical report	Where addressed in this technical report
An assessment of the air quality impacts of the development during construction and operation, prepared in accordance with the relevant Environment Protection Authority guidelines. The assessment must include:	
• Scenarios which assess construction works, realistic operations, back-up generator testing and a justified worst-case scenario	Section 6, Section 7
• An assessment of emissions from the back-up generators against the standards of concentration outlines in the Protection of the Environment Operations (Clean Air) Regulation 2010 (including, but not limited to, polycyclic aromatic hydrocarbons (PAHs) and oxides of nitrogen (NO_x) impacts)	Section 2.1.2, Section 7 Section 3.2.1 – The generators is exempt from meeting Standard of Concentration emissions limits outlined in Schedule 2-4 of the Protection of the Environment Operations (Clean Air) Regulation 2010.
• An assessment of criteria pollutants in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (EPA, 2016)	Section 2.1, Section 7
Details of any mitigation, management and monitoring measures (including for back-up generators) required to ensure compliance	Section 8, Section 9

with section 128 of the *Protection of the Environment Operations Act 1997*	
Agency (EPA) comments	
The EPA notes that an Air Quality Impact Assessment (AQIA) will be undertaken as part of the EIS to assess air quality impacts from the proposed development, with focus on emissions from the back-up generators. The proponent should ensure that the AQIA adequately assesses the impacts from the proposed collective activities (including testing of the generators) and is prepared in accordance with Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (2016)	
The air quality assessment must include: • Generator specifications, including final number, individual and total engine electrical capacity, fuel rate and emission rates/concentrations and parameters	Section 3.2.1, Appendix D
• Scenarios which assess construction works, realistic operations, regular back-up generator testing and a justified worst-case scenario of all generators in operation	Section 3.1, Section 3.2
• An assessment of emission concentrations from the back-up generators for, but not limited to polycyclic aromatic hydrocarbons (PAHs), particulates, CO, SO_2, VOCs and oxides of nitrogen (NO_x)	Section 4.3.3, Section 7
• An assessment of impacts for criteria pollutants and a discussion and evaluation of the probabilities/likelihood of exceedances for the worst-case scenario	Section 6, Section 7
• Details of generator engine performance, any mitigation, management and monitoring measures (including for back-up generators) required to ensure compliance with section 128 of the Protection of the Environment Operations Act 1997.	Section 8, Section 9, Appendix D
DCP Requirements – Section 4.3.3	
The emission of air impurities is to be controlled and limited to the standards allowed by the Protection of the Environment Operations Act 1997, to the satisfaction of Council and the Environmental Protection Authority at all times.	Section 8, Section 9
An Air Quality and Odour Assessment is required for industrial development that in the opinion of the consent authority, may have an impact on the air quality of in the region.	Section 7
An assessment of the merits of the proposal will be made at the development application stage. However, applicants should be able to demonstrate that the most efficient means of minimising emissions are being utilised.	Section 8, Section 9

2 Policy and planning context

2.1 State Legislation

2.1.1 Protection of the Environment Operations Act 1997

The NSW Protection of the Environment Operations (POEO) Act 1997 is administered by the New South Wales (NSW) Department of Planning, Industry and Environment, under the Environment, Energy and Science group. The Act is formed to protect, restore and enhance the environment in NSW and to promote public access to information and involvement in environment protection. The Act designates the NSW EPA (Environment Protection Authority) as the regulatory authority.

The following sections from Part 5.4 of the Act provide general protection conditions for air quality are relevant to the proposal:

- *Section 124*: The occupier of any premises who operated any plant in or on those premises shall operate as well as maintain the plant in a proper and efficient manner, such that it minimise the potential for air pollution.
- *Section 125*: The occupier of any premises who carries out maintenance work on any plant in or on those premises shall conduct the work in a proper and efficient manner, such that it minimise the potential for air pollution.
- *Section 128*: The occupier of any premises must not carry on any activity, or operate any plant, in or on the premises in such a manner as to cause or permit the emission at any point specified in or determined in accordance with the regulations of air impurities in excess of the standard of concentration and/or the rate prescribed by the regulations in respect of any such activity or any such plant.

  The occupier of any premises must carry on any activity, or operate any plant, in or on the premises by such practicable means as may be necessary to prevent or minimise air pollution.
- Schedule 1, Clause 17 of the Act[2] applies scheduled premises status to electricity generation by means of internal combustion engine in a metropolitan area with capacity to produce more than 30 MW of electrical power and burn rate of more than 3 MJ of fuel per second. However, Clause 17 (1A) of the Act notes that scheduled premises status does not apply if the electricity generation is utilised for emergency stand-by plant operating for less than 200 hours per year.

[2] Part 9.7, Section 327, Schedule 1, Part 1 (Premises-based activities), Clause 17 (1A) of the POEO Act 1997.

2.1.2 Protection of the Environment Operations (Clean Air) Regulation 2010

The NSW Protection of the Environment Operations POEO (Clean Air) Regulation 2010 is specifically regulated to manage air quality issues associated with various sources, such as burning activities, motor vehicles fuels, fuel usage and transfer, air impurities from activities and plant, storage of volatile organic liquids and many others.

Part 5 of the POEO (Clean Air) Regulation specifically addresses air impurities from activities and plant, and refers to Schedule 4 to set the Standard of Concentrations for scheduled premises of general activities and plant. However, Clause 57A of the POEO (Clean Air) Regulation exempts emergency electricity generation comprising a stationary reciprocal internal combustion engine from the air impurities Standard of Concentrations of nitrogen dioxide and nitric oxide specified in Schedule 4 in relation to that plant, if the plant is used for a total of not more than 200 hours per year.

2.1.3 The EPA Approved Methods 2017

As the Regulatory Authority designated by the POEO Act 1997, EPA NSW has published the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (January 2017), hereafter referred to as the Approved Methods, to provide detailed statutory methods in modelling and assessing air pollutants in the state of NSW. The Approved Methods provides methods and impact assessment criteria for assessing emissions of air pollutants from stationary sources in NSW.

2.1.4 Assessment Air Quality Criteria

Section 7.1 of the Approved Methods outlines the air pollutant impact assessment criteria. Dispersion modelling predictions (including background air quality concentrations) undertaken for a proposal should comply with these criteria. If they do not, further mitigation may be required.

Table 2 presents the relevant air quality impact assessment criteria applicable for the proposal's standby generators.

The Approved Methods set standards for various averaging periods, including annual averages. As the generators are to be used for standby purposes only and would only run for a short period or intermittently, the assessment has focussed on short-term averaging periods only. Pollutant criteria with averaging periods of longer than 24 hours have therefore been excluded from this assessment.

Table 2: Applicable Air Quality Impact Assessment Criteria

Pollutant	Averaging Period	Maximum Concentration, µg/m^3
Carbon Monoxide (CO)	15 minutes	100,000
	1 hour	30,000
	8-hour	10,000
Sulfur dioxide (SO_2)	10 minutes	712
	1 hour	570
	24-hour	228
Nitrogen dioxide (NO_2)	1 hour	246
Benzene	1 hour	29
Polycyclic Aromatic Hydrocarbon (PAH)	1 hour	0.4
PM_{10}	24 hours	50
$PM_{2.5}$	24 hours	25

The impact assessment criteria in Table 2 must be applied at the nearest existing or likely future off-site sensitive receiver, compared against both the incremental impact from modelled sources as well as background pollutant concentrations.

3 Identification of potential emissions sources

3.1 Construction phase

There is the potential for dust generation associated with the construction of the proposal, including the following activities:

- Earthworks
- Construction of new access roads
- Construction of pavements, services and hardstand

Typical construction equipment used for the proposal are likely to be:

- Scrapers
- Graders
- Loaders
- Excavators
- Pile driver
- Heavy vehicles/trucks

The above-mentioned construction equipment will emit combustion emissions (particularly NO_2, PM_{10} and $PM_{2.5}$) and are likely to generate dust as they move around the site, which may impact the surrounding air quality.

3.2 Operational phase

3.2.1 Standby generators

The masterplan drawing in Appendix A shows that the proposal is to comprise a total of three data centre buildings and two administration block buildings. The total number of standby generators on-site for the three buildings is expected to be 62 (20 generators per building plus one generator for each administration block building). The purpose of these generators is to support the buildings' power requirement for critical IT systems and other site infrastructure in the event of mains power loss or damage of electrical infrastructure on site.

Appendix A shows the location of the standby generators. All generators are located at ground level, adjacent to the data centre buildings (refer to Appendix B for elevation drawings). At this stage, the locations of the generators are indicative, however the locations assessed are expected to be largely consistent with the final developed design.

Each of the data centre generator has a capacity of 3.1 MW_e, with a fuel consumption rate of 797.4 L/hr at 100% load. The administration block building generator has a capacity of 1 MW_e, with fuel consumption rate of 272.1 L/hr at 100% load.

The indicative generator enclosure design is shown in Appendix C, and the diesel generator specification is presented in Appendix D.

Emergency operation

Data centre components do not easily tolerate power spikes due to switching from a normal to emergency power supply. When these components lose power (if only for a fraction of a second), various IT systems critical to the facility and the service it provides will be interrupted. Standby generators are needed to ensure ongoing operation if power is interrupted for more than a few minutes. As a result, supplying uninterrupted power to data centres 100% of the time is a critical aspect for their operation. Fundamentally, the function of the standby generators at the site would be to provide power when there is an unexpected interruption of mains power.

Due to the criticality of the site, the Client has negotiated a high level of reliability for the utility supply from Endeavour Energy and TransGrid's Sydney West Bulk Supply Point (BSP), to reduce risk of a power outage. The failure rates for a supply in the high reliability utility supply arrangement are extremely low. The most recent interruption for a utility power supply from Sydney West BSP was in 2014 and lasted 13 minutes. As such, emergency operation of the standby generators is not expected to contribute significantly to the total operating hours if they are required.

Maintenance routine

Maintenance testing of emergency generators is anticipated to occur during the daytime period, between 07:00am and 06:00pm (Monday to Saturday or Public Holidays) or 08:00am and 06:00pm on Sundays. The total testing regime for all 62 generators is summarised in Table 3.

The above testing schedule give a cumulative total of 197 hours operation for all 62 generators combined. The cumulative operation is not more than the 200-hour exemption limit in Schedule 1 Clause 17 (1A) of the NSW POEO Act 1997 (refer to Section 2.1.1) and therefore generator emissions are exempt from Schedule 4 of the Standard of Concentrations (refer to Section 2.1.2). It is proposed up to two generators would be tested concurrently under the bi-monthly testing scenario, however only one generator at a time would be tested under the quarterly and yearly testing scenarios. The emission impact associated with these scenarios will be discussed in Section 7.2.

Table 3: Standby Generator Annual Testing Regime

Month	Test	Duration (min)		Data Centre Gen Testing		Admin Gen Testing		Total Gens Tested	Total Mins
		Run	Cooldown	Number of tests	Gens run per test[a]	Number of tests	Gens run per test[a]		
1	Bi-monthly, no load	10	0	30	2	2	1	62	320
2	No test							62	
3	Quarterly, 70% load	30	5	60	1	2	1	62	2170
4	Bi-Monthly, no load	10	0	30	2	2	1	62	320
5	No test							62	
6	Quarterly, 70% load	30	5	60	1	2	1	62	2170
7	Bi-Monthly, no load	10	0	30	2	2	1	62	320
8	No test							62	
9	Quarterly, 70% load	30	5	60	1	2	1	62	2170
10	Bi-Monthly, no load	10	0	30	2	2	1	62	320
11	No test							62	
12	Annual, 100% load	60	5	60	1	2	1	62	4030
Total minutes per year									**11820**
Total hours per year									**197**

Note:

a. Data Centre generator testing will be conducted separately from the admin generator testing.

3.2.2 Potential impacts

While in use, standby generators produce a range of pollutants including total unburned hydrocarbons (HC), nitrogen oxide (NO_x), carbon monoxide (CO), particulate matter (PM), sulfur dioxide (SO_2) and volatile organic compounds (VOC). The release of these emissions has the potential to impact local air quality in the surrounding area. Due to the fuel type proposed e.g. diesel, the pollutant of greatest concern in relation to the use of generators is typically NO_x, as NO_x emissions are orders of magnitude greater than for other pollutants.

Emission data for this proposal has been assessed based on indicative equipment selection including the CAT C175-20 generator (data centre buildings), with capacity of up to 3.37 MWe, and CAT C18 generator (administration block building), with capacity of up to 585 kWe (refer to Appendix D).

All other emission data for the assessed pollutants not provided in the generator specification has been based on Table 43 of the National Pollutant Inventory (NPI 2008)[3].

[3] National Pollution Inventory (NPI) – *Emission estimation technique manual for Combustion engines*, Version 3.0, June 2008.

4 Methodology

This Chapter outlines the methodology used to define the baseline and undertake the assessment of potential impacts of the proposal on air quality, including definition of the study area used as the basis of the assessment.

The overall approach to the air quality impact assessment comprises:

- A review of the existing air quality conditions at, and in the vicinity of, the subject site;
- A review of the potential changes in air quality arising from the construction and operation of the proposal; and
- Formulation of mitigation measures, where appropriate, to ensure any adverse effects from air pollutants are minimised.

4.1 Study area and sensitive receivers

The study area for the air quality assessment extends up to 10 km from the subject site. The assessment in accordance with the Approved Methods has focussed on those sensitive receivers closest to the subject site, however a modelling domain of 10 km has been included to ensure that the area of maximum impact is understood and the impact for the surrounding area can be shown.

Nearby sensitive receivers were identified through a review of aerial mapping.

Air quality sensitive receivers are defined under the Approved Methods as:

"A location where people are likely to work or reside; this may include a dwelling, school, hospital, office or public recreational area. An air quality impact assessment should also consider the location of known or likely future sensitive receptors."

The nearby sensitive receivers are generally residential properties, with the nearest one located at approximately 315 m to the south-east of the subject site. Some schools and childcare are also among the other nearby sensitive receivers. The identified sensitive receivers have been summarised in Table 4 and Figure 2.

Table 4: Identified nearby discrete sensitive receivers

Receiver ID (Figure 2)	Receiver Address/ Name	Receiver Type	X: Easting (m)	Y: Northing (m)
1	797 Mamre Road, Kemps Creek	Residential	294434	6253412
2	771 Mamre Road, Kemps Creek	Residential	294610	6253567
3	772 Mamre Road, Kemps Creek	Residential	294930	6253555
4	754A Mamre Road, Kemps Creek	Residential	295116	6253612
5	784 Mamre Road, Kemps Creek	Residential	295432	6253678
6	1 Aldington Road, Kemps Creek	Residential	295849	6253923
7	Emmaus Catholic College	School	295549	6254311
8	Trinity Primary School	School	295327	6254520
9	Little Smarties Early Learning Centre	School	295142	6254276
10	2 Bakers Lane, Kemps Creek	Residential	294972	6254207
11	11 Barkers Lane, Kemps Creek	Residential	294821	6254345
12	654 Mamre Road, Kemps Creek	Residential	294667	6254684
13	573 Mamre Road, Orchard Hills	Residential	294075	6255528
14	83 Mandalong Close, Erskine Park	Childcare	294017	6255711
15	43 Mandalong Close, Erskine Park	Residential	293690	6255879
16	65 Mandalong Close, Erskine Park	Residential	293522	6255791
17	501 Mandalong Close, Erskine Park	Residential	293234	6255114
18	275 Luddenham Road, Orchard Hills	Residential	292585	6255033
19	320 Luddenham Road, Orchard Hills	Residential	292669	6254624
20	2 Comargo Lane, Luddenham	Residential	29266	6254131
21	1 Medinah Avenue, Luddenham	Residential	292994	6253788
22	9 Medinah Avenue, Luddenham	Residential	293133	6253618
23	15 Medinah Avenue, Luddenham	Residential	293258	6253490
24	25 Medinah Avenue, Luddenham	Residential	293261	6253292
25	Twin Creeks Golf (Maintenance Facility)	Recreational Area	292829	6253966
26	Twin Creeks Golf (Clubhouse)	Recreational Area	292766	6253754

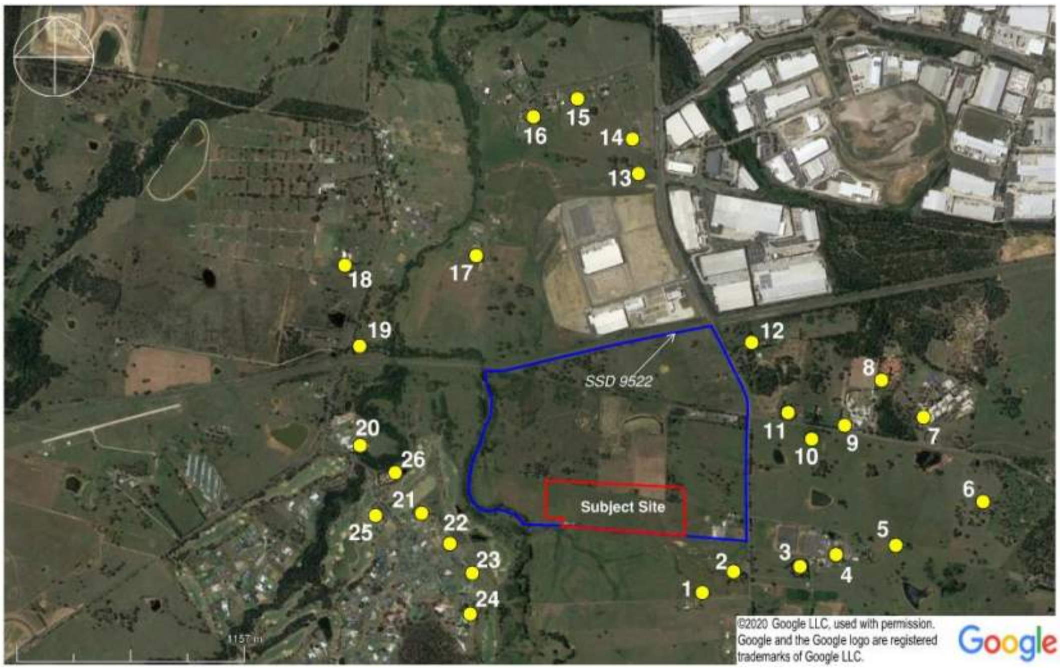


Figure 2: Identified nearby sensitive receiver locations

4.2 Construction phase

Potential local air quality impacts for the construction phase of the proposal have been identified based on experience from similar construction projects. The Approved Methods (refer to Section 2.1.3) were developed to assess emissions from stationary sources. They are therefore not appropriate to assess uncontrolled dust emission impacts.

Given the scale and duration of construction, the main potential impact would be amenity-related due to the risk of dust generation, equipment and machinery emissions generated by fuel combustion. Therefore, a qualitative risk-based approach has been carried out and addressed in Section 6.

The key factors in determining the risk of impact are the activities taking place, location of these activities onsite and the distance from sensitive receivers. In addition, it is important to consider the types of impact including amenity/nuisance concerns from the release of fugitive dust as well as health impacts associated with the release of NO_2 PM_{10} and $PM_{2.5}$.

4.3 Operational phase

The impact assessment for the operation of stand-by generators has been assessed using dispersion modelling to predict ground level pollutant concentrations at nearby sensitive receivers, as well as over a larger grid domain.

4.3.1 Modelling Scenarios

The following modelling scenarios were undertaken to determine the potential impact under the anticipated operational conditions of the standby generators.

- **Scenario 1**: A justified worst-case scenario of all generators in operation under a loss of mains power situation (refer to Section 3.2).
- **Scenario 2**: Realistic operations e.g. regular generator testing where one generator at a time would be tested during the daytime maintenance hours (refer to Section 3.2).

4.3.2 Dispersion modelling

This section describes the dispersion modelling methodology for this assessment.

Model overview

While not listed in the Approved Methods, AERMOD has been accepted in Australia for use in a variety of regulatory applications[4], and is estimated to be the most widely used dispersion model internationally[5]. AERMOD is a steady-state

[4] Pacific Environment, 2016. *Western Sydney Airport EIS – Local Air Quality and Greenhouse Gas Assessment:* Department of Infrastructure and Regional Development, ID. 9417F. Doc no. AQU-NSW-001-9417E. Rev. R2. Sydney, NSW.

[5] Pacific Environment, 2016. *Energy from Waste Facility – Air Quality and Greenhouse Gas Assessment*: The Next Generation, ID. 21292C. Doc no. AQU-NS-001-21292C. Rev. 5. Eastern Creek, NSW.

plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrain, such as the case of the proposal.

The NSW Approved Methods Section 4 requires one-year of site-specific meteorological data or site-representative meteorological data, in the absence of site-specific data, to be used for AERMOD dispersion modelling. The AERMOD system includes AERMET, used for the preparation of meteorological input files and AERMAP, used for the preparation to terrain data. AERMET requires surface and upper air meteorological data input. The meteorological data used in this assessment if over the period of 1st January 2014 – 31st December 2014 (refer to Section 4.3.3).

AERMOD was configured as per Table 5 to assess the impact of generator emissions from the proposal.

Table 5: General inputs for AERMOD dispersion modelling

Parameter	Input
Meteorological Data	2014 – refer to meteorological data section below
Terrain Topography	Obtained using Shuttle Radar Topography Mission (SRTM3/SRTM1) data from AERMAP at a range of 100 metres.
Grid Domain Size	10,000 metres x 10,000 metres
Grid Spacing	50 metres

The 100th percentile[6] was modelled to determine the average GLCs for comparison against the Approved Methods criteria.

Prediction of less than 1-hour average concentrations

In the absence of NSW specific guideline in converting pollutant's hourly data to less than 1-hour averaging concentration, reference was made to the EPA Victoria Draft Publication 1551 – *Guidance notes for using the regulatory air pollution model AERMOD in Victoria* (October 2013), which provides conversion from hourly average concentrations to 3-minute average concentration, which will be used in this case to convert hourly average concentrations to 10-minute or 15-minute average concentrations.

$$c(t) = c(t_0)\ (t_0/t)^{0.2}$$

Where:

(t) is the averaging time (minutes) of interest, and

(t_0) is the averaging time consistent with the dispersion rates (60 minutes in this case).

[6] The maximum possible concentrations over the relevant averaging period taking into account emission source and meteorological data.

Terrain effects

Terrain data was sourced from NASA’s Shuttle Radar Topography Mission (SRTM) Data (3 arc second (~30m) resolution) and processed within AERMAP to create the necessary input files for the model. The topography of the local area is shown in Figure 3. There are no significant changes in the terrain across the modelled area.

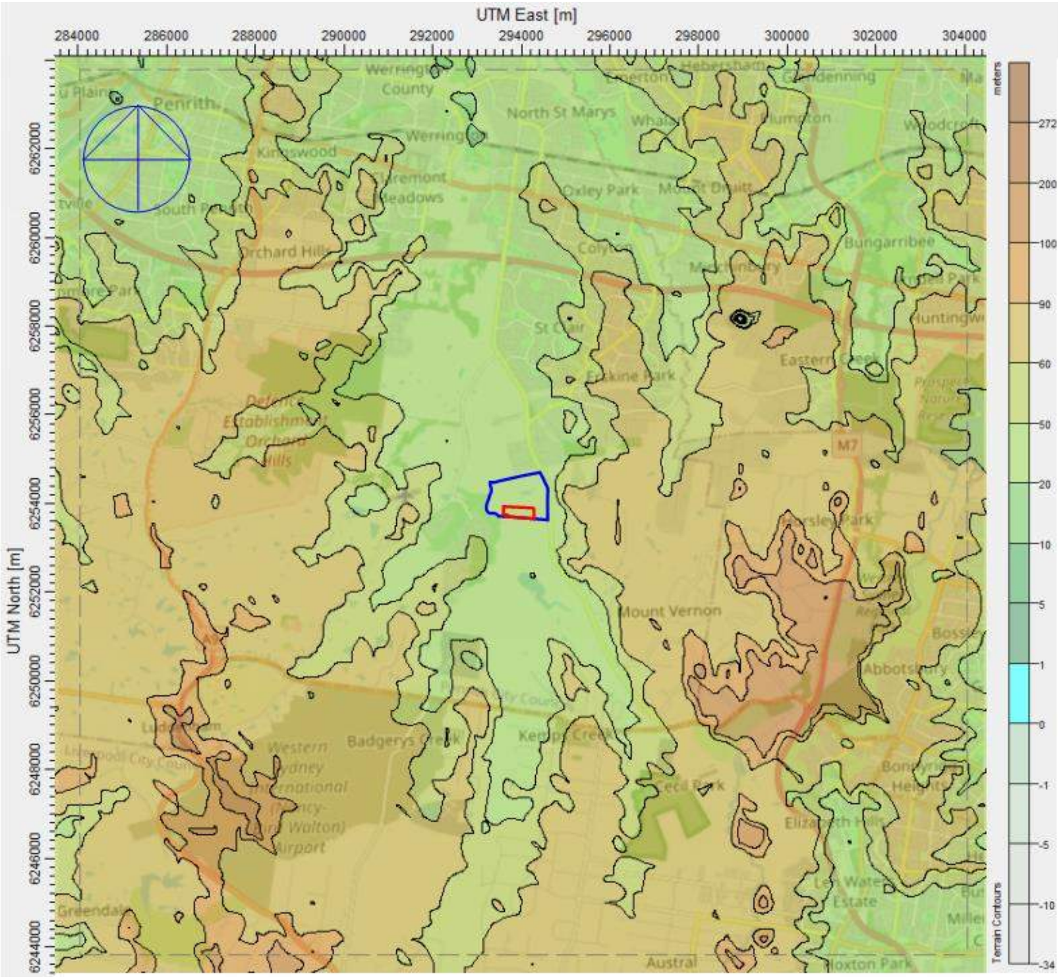


Figure 3: Local topography

The subject site slopes gently from east to west, falling towards South Creek which is located approximately 450 m west of the site’s western boundary. At the eastern boundary, the existing ground level is RL 37.2 m while at the south-west corner the existing around level id RL 35.9 m. This gives an average gradient of 0.29%.

Model extent

As well as the closest sensitive receivers (refer to Section 4.1), the model was run for a large grid (10 km x 10 km) at ground level. This covers all potentially impacted nearby sensitive land uses. The extent of the model is shown in Figure 4.

Figure 4: Model extent

Building wake effects

Buildings can have a significant effect on dispersion. If buildings are close to a stack, the plume can be entrained in the cavity zone downwind of the building. The ratio of the stack height vs. the building height can affect the magnitude of building downwash, such that if the stack extends well above the roof of the building, the downwash effect is expected to be insignificant. The Approved Methods notes that *"A point source is wake-affected if stack height is less than or equal to 2.5 times the height of buildings located within a distance of 5L (where L is the lesser of the height or width of the building) from each release point."*

The generators are proposed to be located on ground floor, next to the data centre buildings (refer to Section 3.2), with stack heights of 20 m above ground level. With the data centre building height of about 14 m, the stack sources are considered as wake-affected sources. Stronger building downwash effect can lead to higher ground concentrations than would be expected in the absence of buildings.

Therefore, the data centre buildings and administration block have been modelled as shown in Figure 5 below, building heights are as shown in Appendix B.

Building Profile Input Program – Plume Rise Model Enhancements (BPIP-PRIME) uses heights and corner locations of buildings in the vicinity of the stack release to simulate the effective height and width of the structures. The downwash algorithm calculates effective building dimensions relative to the plume, resolved down to ten-degree intervals. AERMOD then calculates the impact of these buildings on plume dispersion and consequently on ground level concentrations. Although a simplified building geometry is used, it should provide a reasonable indication of how the building may disrupt wind flow in the immediate vicinity.

Other than the proposal's data centre buildings, based on aerial observation, there are no immediate surrounding buildings that are sufficiently high or have the potential to have a significant wake effects on dispersion. Hence, surrounding buildings, other than the data centre buildings, have not been included in this modelling assessment.

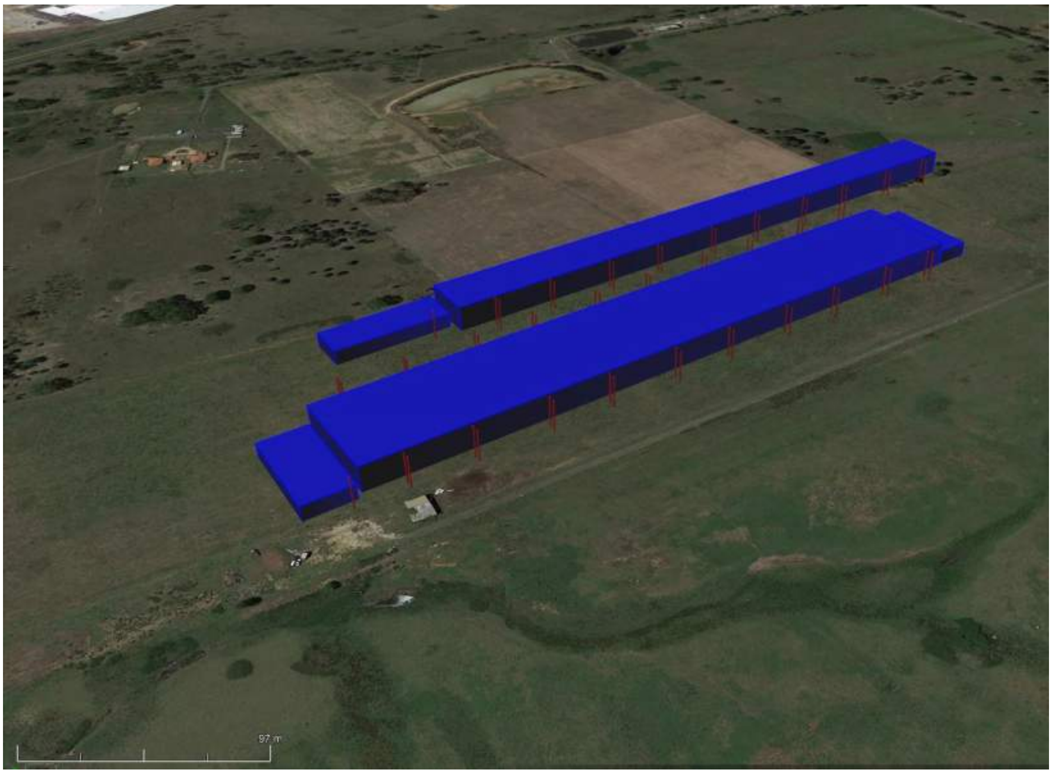


Figure 5: Modelled buildings

4.3.3 Meteorological data

Local meteorology conditions which can affect the dispersal of pollutants in the local area were also determined. A detailed assessment of meteorological conditions for the subject site is included in the air quality assessment[7] for the broader SSD 9522 site, hereafter referred to as the 'SSD 9522 AQ report'.

[7] Northstar Air Quality, 2020. *Mamre Road South Precinct, 657-769 Mamre Road, Kemps Creek: State Significant Development – Air Quality Impact Assessment*. Ref. 18.1080.FR2V14. 30 July 2020. https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-1192%2120200811T071436.173%20GMT

Meteorological conditions are not monitored at the subject site and therefore nearby meteorological stations were reviewed. The SSD 9552 AQ report assessed seven meteorological stations located within a 17 km radius from the subject site. The closest station is St Marys air quality monitoring station (AQMS), located approximately 3.7 km north of the subject site, and operated by NSW Department of Planning, Industry and Environment (DPIE) – Figure 6 shows the subject site relative to the St Marys AQMS.

St Marys AQMS is considered to be most representative of the conditions at the proposal site, due to the close proximity and lack of significant topographical features between the two locations.

The SSD 9522 AQ report studied five years (2013-2017) of meteorological data at St Marys, and concluded that data from 2014 best represented the general trend across the 5-year period studied, on the basis of the wind distributions across the years examined.

Figure 6: St Marys AQMS location

AERMET

AERMET is meteorological processor built-in within the AERMOD model. AERMET was used in this assessment to construct AERMOD-ready meteorological input data representative of the local conditions within the subject site. To provide all required meteorological parameters, AERMET-ready meteorological data using the MM5 prognostic model was purchased to determine onsite conditions for 2014.

AERMET also requires land characteristics data of that surrounding the subject site. The subject site is situated on a predominantly grass land in a rural area. The surrounding land uses to the subject site were divided into 12 sectors to determine the atmospheric turbulences values in the dispersion modelling due to the effect of surface roughness. The land use configuration was generated with the aid of AERSURFACE, via U.S. Geological Survey Enhanced National Land Cover Data (USGS NLCD), and are presented in Table 6.

Table 6: AERMET Land Use Configuration

Degrees	Season	Albedo	Bowen Ration	Surface Roughness
0-30	Summer Autumn Winter Spring	0.18	1.16	0.303
30-60		0.18	1.16	0.300
60-90		0.18	1.16	0.300
90-120		0.18	1.16	0.300
120-150		0.18	1.16	0.300
150-180		0.18	1.16	0.252
180-210		0.18	1.16	0.083
210-240		0.18	1.16	0.162
240-270		0.18	1.16	0.300
270-300		0.18	1.16	0.300
300-330		0.18	1.16	0.300
330-360		0.18	1.16	0.300

Windrose

Annual Average

The annual average wind rose between 1 January 2014 and 31 December 2014 is shown in Figure 7 with wind class frequency distribution in Figure 8. Based on Figure 7 and Figure 8, the following features can be observed:

- Winds are most prevalent from the south-west and west-south-west, about 25% of all winds. Second most prevalent wind direction is from north-north-east direction, about 15% of all winds.
- A south-west and west-south-west prevalent wind directions means that nearby sensitive receivers located to the east-north-east of the proposal are most likely to be exposed to pollution from the proposal’s standby generators.
- The average wind speed is 3.5 m/s.
- Winds are least prevalent from the north-west sector with annual winds of less than 1%.
- Light winds (< 2 m/s) are more prevalent from the north-east and west-south-west sectors.

- Due to the infrequent occurrence of calm winds in onsite, meteorological conditions are favourable for dispersion.

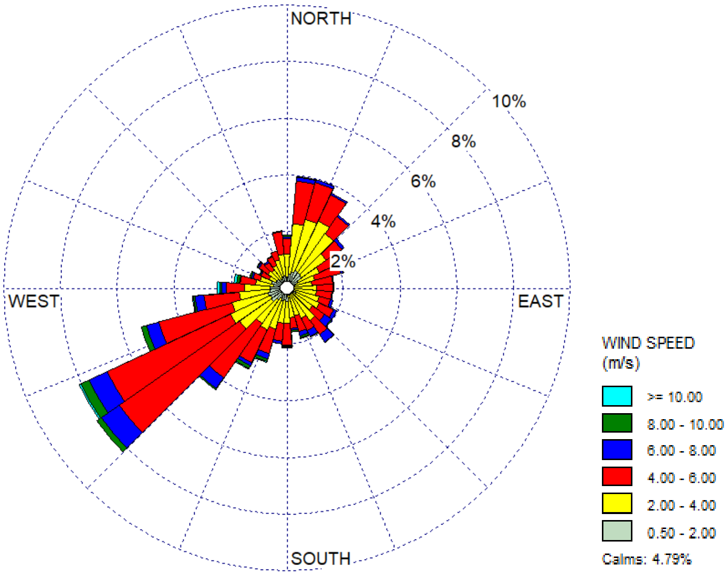


Figure 7: Wind Rose for 2014 data

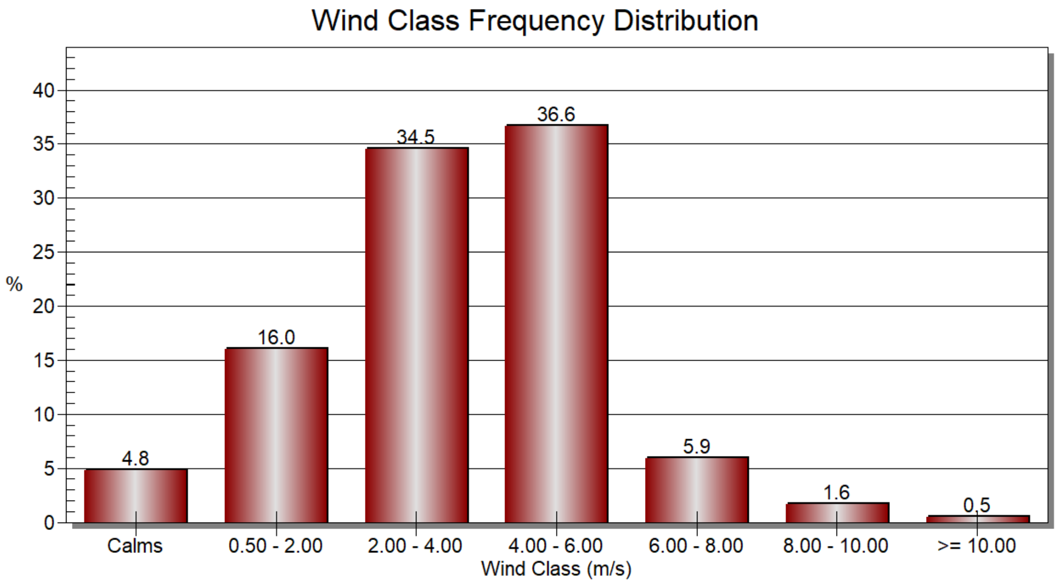
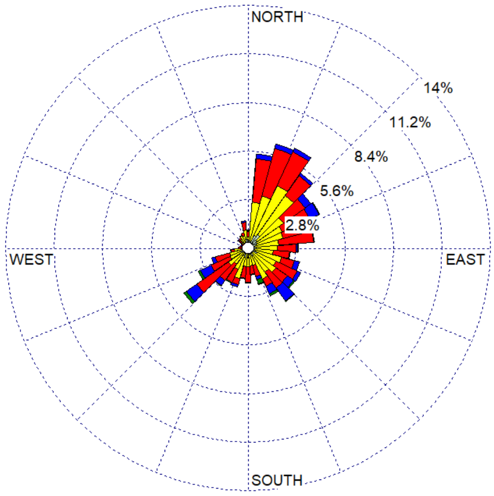


Figure 8: Wind Class Frequency Distribution for 2014 data

Seasonal Variation

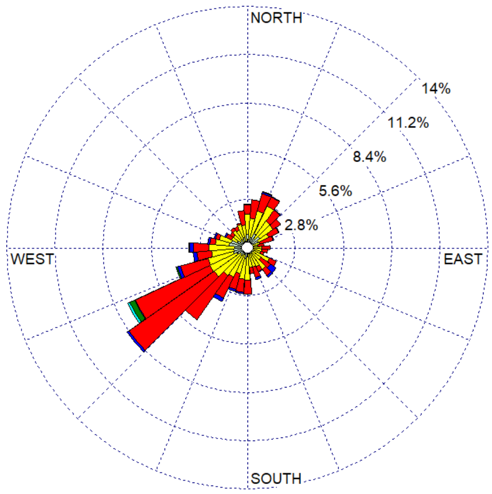
The seasonal variation wind roses for 2014 are shown in Figure 9. Based on Figure 9, the following features can be observed:

- Prevailing wind direction varies seasonally. Summer season is dominated by north-north-east prevailing wind, whereas autumn, winter and spring are dominated by west-south-west prevailing wind.
- The incident of light wind (< 2 m/s) is greatest in autumn with west-north-west direction.



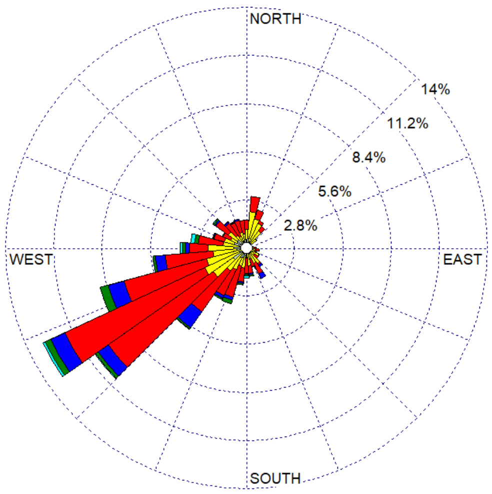
Summer Season

Average wind speed 3.5 m/s



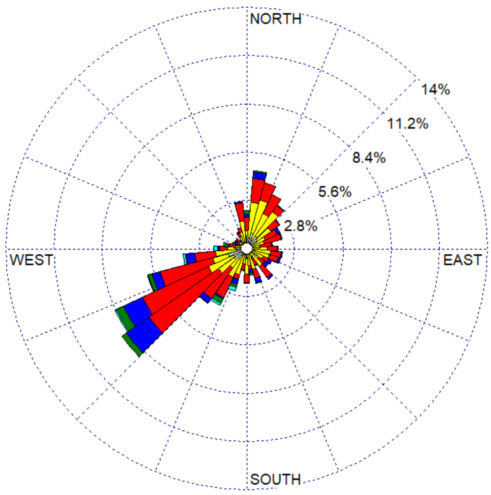
Autumn Season

Average wind speed 3.1 m/s



Winter Season

Average wind speed 3.8 m/s



Spring Season

Average wind speed 3.5 m/s

Seasonal Wind Roses

Figure 9: Seasonal Wind Rose for 2014

4.3.4 Background air quality

Existing background air quality refers to the concentration of relevant substances that are already present in the environment from various sources that may include industrial processes, commercial and domestic activities, traffic and natural sources.

The Approved Methods requires at least one year of continuous background air quality data to be used, contemporaneous with meteorological data. The assessment of air quality impacts can be undertaken using two options of background air quality data:

- *Background Option 1*: Using the maximum background concentration of the pollutant being assessed for each relevant averaging period, or
- *Background Option 2*: Using the addition of the corresponding measured background concentration to each individual dispersion model prediction (e.g. add the first hourly average dispersion model prediction to the first hourly average background concentration).

For air emissions from diesel combustion engines, typically NO_2 and particulate matter are considered to be the major pollutants of concern, compared to other pollutants such as CO, SO_2 and VOC. To avoid over conservatism, The Background Option 2 method has been used to predict ground level concentrations of NO_2 and particulate matter. Background Option 1 has been used for predicting ground level concentrations of CO and SO_2.

Background monitoring of pollutant associated with VOC is not undertaken in NSW, however, as the location of the subject site is in a rural area, away from heavy industrial premises, it is expected that VOC background concentrations would be low.

Data from St Marys AQMS for 2014 has been used to establish existing conditions for the subject site (refer to discussion in Section 4.3.3). In 2014, St Marys AQMS recorded NO_2, O_3 and PM_{10}.

In the absence of $PM_{2.5}$, CO and SO_2 data from St Marys AQMS, information was sourced from the Liverpool AQMS. Liverpool AQMS is operated by DPIE and is the closest station monitoring $PM_{2.5}$, approximately 16.5 km south-east of the subject site. Liverpool AQMS is located in the vicinity of high-density suburban area with busy transportation corridors, which is anticipated to have higher $PM_{2.5}$,CO and SO_2 background levels when compared to the subject site, which would provide a level of conservatism in the assessment. It should be noted that background SO_2 data has been taken from 2019 as no information was available for 2014.

Table 7 shows the background data adopted for each pollutant based on the nearest AQMS and relevant data capture.

Table 7: Background data adopted for air quality assessment

AQMS Location	Distance to Proposal Site, km	Year	Monitored Parameters (data capture)					
			CO	SO_2	NO_2	O_3	PM_{10}	$PM_{2.5}$
St Marys	3.7	2014	✗	✗	✓(85.4%)	✓(94.2%)	✓(98.8%)	✗
Liverpool	16.5	2014	✓(93.1%)	✓(93.6%)[a]	✗	✗	✗	✓(91.8%)

Note:

a. 2019 data with 93.6% data capture has been used in the absence of year 2014 data.

Hourly missing data interpolation

The assessment of particulate matter as well as the NO_2 OLM method requires hourly background data for ozone, NO_2, PM_{10} and $PM_{2.5}$ data from the St Marys and Liverpool AQMS. Any missing data periods were interpolated using the following methodology:

- Where less than six consecutive hours of missing data occurred, the nearest valid data point was used (i.e. the first three missing hours would be replaced with the nearest preceding value, and the last three missing values would be replaced with the following value).
- Where there was more than six consecutive hours of missing data, an average hourly value was used for the corresponding hour of missing data (i.e. the average value for a given hour of day was calculated, using the entire existing dataset, and subsequently used to fill the respective missing hour of day).

4.3.5 Emission sources

Generator stack parameters

Modelled stack parameters were developed for this assessment using information provided by the Client and manufacturer specifications for the indicative generator equipment selection. Stack design parameters per generator are summarised in Table 8.

The manufacturer’s specification datasheet is provided in Appendix D.

Table 8: Standby Generator Stack Design Parameters

Stack Parameter	Input Description for Data Centre Generators	Input Description for Administration Block Building Generator
Number of generators	60	2
Number of generator stack sources	60	2
Height above ground level (m)	20	20
Exit internal diameter (mm)	500	203
Actual discharge rates (m^3/s)	11.74	1.71
Exit temperature (°C)	460.7	571.1
Calculated exit velocity (m/s)	59.8	52.7
CO emission (g/s)	0.683	0.216
SO_2 emission (g/s)[a]	0.093	0.015
NO_x emission (g/s)	6.274	1.484
Benzene emission (g/s)	0.001279	0.000022
PAH emission (g/s)[b]	0.0000000432	0.0000000070
PM emission (PM_{10} and $PM_{2.5}$) (g/s)	0.015	0.003
Stack location coordinates	Refer to Appendix E	

Note:

a. The Sulfur Dioxide emission concentration was based on NPI Table 43 – *Emission factors for stationary large (greater than 450 Kw) diesel engines*, with maximum fuel sulfur content of 10 mg/kg (https://www.environment.gov.au/protection/fuel-quality/standards/diesel)

b. The PAH emission is based on emission factor from Table 43 of the NPI Emission Technique Manual for Combustion Engines and generator's fuel consumption specification.

Particulate matter

The emission data taken from the manufacturer's specification datasheet refers only to "particulate matter", with no reference to the size of the particulate matter. Table 43 of the National Pollutant Inventory (NPI 2008)[8] shows that emission factors of PM_{10} and $PM_{2.5}$ from large stationary diesel engines are the same. On this basis, it has been assumed that the particulate matter emission rate applies to both PM_{10} and $PM_{2.5}$.

Volatile Organic Compounds

Hydrocarbons are organic compounds composed primarily of carbon and hydrogen atoms. Many of these compounds are volatile, which can easily vaporise into the atmosphere at normal atmospheric conditions (room temperature and atmospheric pressure) and are typically referred to as volatile organic compounds (VOCs). The proportion of VOCs within the hydrocarbon emission has not been provided in the generator's product specification in Appendix D. Therefore, it is

[8] National Pollution Inventory (NPI) – *Emission estimation technique manual for Combustion engines*, Version 3.0, June 2008.

assumed that 100% of the hydrocarbon emission from the generator would be VOCs, which is expected to provide a level of conservatism.

For internal combustion engines, VOCs are often associated with primary toxic air pollutants such as benzene, ethylbenzene, toluene and xylene (BTEX). Among these pollutants, benzene is one of the major components within VOCs discharged from a diesel combustion engine. In this case, compliance with Benzene would typically result in compliance with all other VOC pollutants. The proportion of benzene or all other pollutants has not been provided in the manufacturer's specification datasheet. Reference to the NPI 2008 has therefore been made to approximate Benzene emission concentration from the proposal's diesel generator, as a proportion relative to the total VOCs.

NO_x to NO_2 conversion

The air quality model predicts concentrations of nitrogen oxides which is a mixture of NO_2 and nitric oxide (NO). Both gases react in the atmosphere, particularly with ozone. In general, the nitrogen oxides are mainly emitted as nitric oxide and this converts to NO_2 in the atmosphere. The Approved Methods impact assessment criteria have been set for NO_2, as this is the pollutant most impactful to human health, and therefore it is important that an appropriate conversion rate is used to calculate NO_2 from modelled NO_x concentrations.

For this assessment, a photochemical conversion for short-term concentrations (i.e. hourly average) from NO_x to NO_2 were determined in accordance with the US EPA's Ozone Limiting Method[9] (OLM), in accordance with Section 8.1.2 of the Approved Methods.

OLM assumes NO conversion to NO_2 by reaction with ambient ozone. The reaction is assumed to be instantaneous and irreversible and can be applied on an hourly basis. Several studies have been undertaken to evaluate the accuracy of the OLM method, and show that OLM has a tendency to overpredict the NO_2/NO_x ratios[10],[11], which adds a level of conservatism to the assessment.

The OLM equation for calculating NO_2 is provided below:

$$NO_{2\,(total)} = \left[ISR \times NO_{x\,(predict)}\right] + Minimum\left[\left\{(1 - ISR) \times NO_{x(predict)}\right\} or \left\{\left({}^{46}/_{48}\right) \times O_{3\,(bckgnd)}\right\}\right] + NO_{2\,(bckgnd)}$$

Where,

ISR = In-stack NO_2/NO_x ratio

[9] Cole, H. S., & Summerhays, J. E. (1979). *A Review of Techniques Available for Estimating Short-Term NO_2 concentrations*. *J. Air Poll. Cont. Assoc., 29:8*, 812-817. doi:10:1080/00022470.1979.10470866.

[10] Hendrick, E., Tino, V., Hanna, S., & Egan, B. (2013). *Evaluation of NO_2 predictions by the plume volume molar ratio method (PVMRM) and ozone limiting method (OLM) in AERMOD using new field observations*. J. Air & Waste Mgt. Assoc., 844-854. doi:10.1080/10962247.2013.798599

[11] Podrez, M. (2015). *An update to the ambient ratio method for 1-h NO2 air quality standards dispersion modelling*. Atm. Env., 163-170.

The OLM assumes a default 10% of the NO_x was initially NO_2 upon release, equating to an in-stack NO_2/NO_x ratio of 0.1. This ISR is generally appropriate for combustion sources[12]. On this basis, the simplified OLM equation is:

$$NO_{2\,(total)} = [0.1 \times NO_{x\,(predict)}] + Minimum[\{0.9 \times NO_{x(predict)}\}\ or\ \{(46/48) \times O_{3\,(bckgnd)}\}] + NO_{2\,(bckgnd)}$$

The adopted NO_2 and ozone background concentrations for the OLM method are detailed in Sections 4.3.4 and 5.

[12] AGL (2019). *Newcastle Power Station – Air Quality Impact Assessment*. Project No.: 0468623/AQIA/R4. Version 7.0. Revision R4. 30 October 2019.

5 Existing background air quality

Existing air quality conditions for the area were determined using nearby AQMS. The nearest AQMS is identified to be located at St Marys, approximately 3.7 km north of the proposal. St Marys AQMS in year 2014 recorded NO_2, O_3 and PM_{10}. Year 2014 $PM_{2.5}$ air quality data was sourced from Liverpool AQMS, also operated by DPIE.

The methodology for assessing the existing background concentration for this assessment was detailed in Section 4.3.4.

The maximum 2014 background air quality concentrations are summarised in Table 9. The maximum background concentration for CO and SO_2 in Table 9 has been used to assess the cumulative impact assessment, whereas for NO_2, PM_{10} and $PM_{2.5}$ the hourly data presented in Figure 10 to Figure 13 has been used to provide a contemporaneous cumulative impact assessment.

The background air quality charts for all pollutants are shown in Appendix F.

Table 9: Maximum background air quality concentrations for CO and SO_2

Pollutant	Averaging Period	Maximum Background Concentrations, µg/m^3
PM_{10}	1-hour	121.8
	24-hour	45.0
$PM_{2.5}$	1-hour	63.5
	24-hour	24.3
O_3	1-hour	196
NO_2	1-hour	58.3
CO	1-hour	2875
	8-hour	2579
SO_2	1-hour	41.9
	24-hour	12.8

Note:

SO_2 background concentration data for year 2014 is not available at Liverpool AQMS. Data was based on year 2019, as year 2020 may not be representative of typical year conditions due to the COVID-19 pandemic.

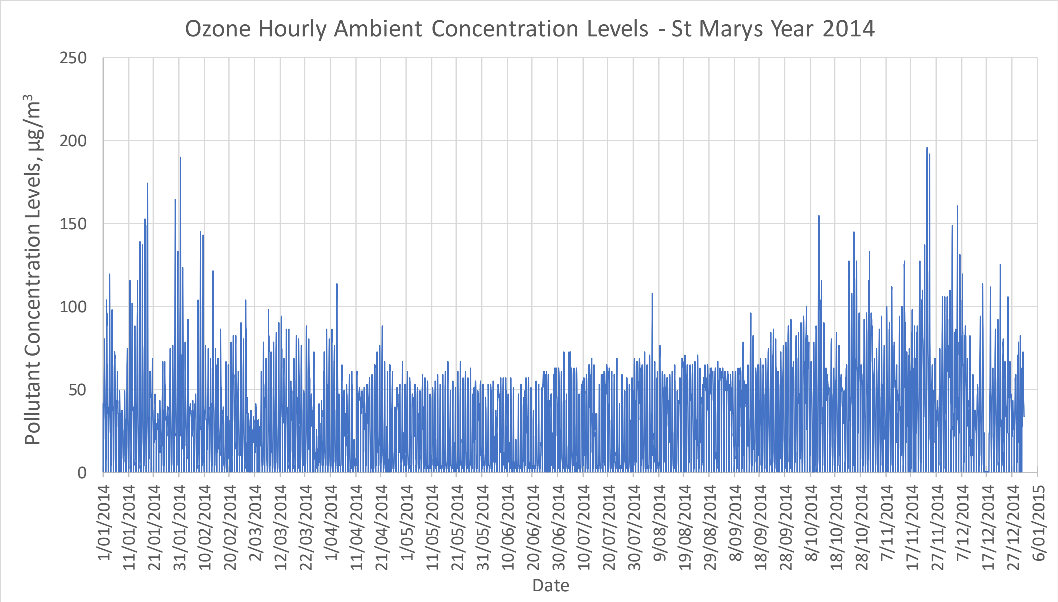


Figure 10: Adopted hourly ozone background air quality chart

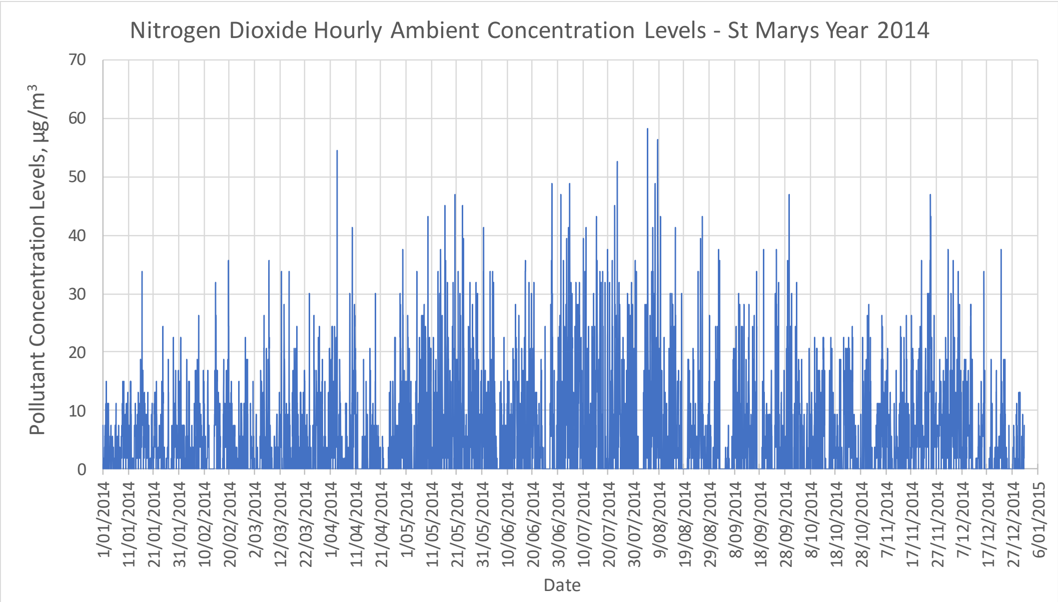


Figure 11: Adopted hourly nitrogen dioxide background air quality chart

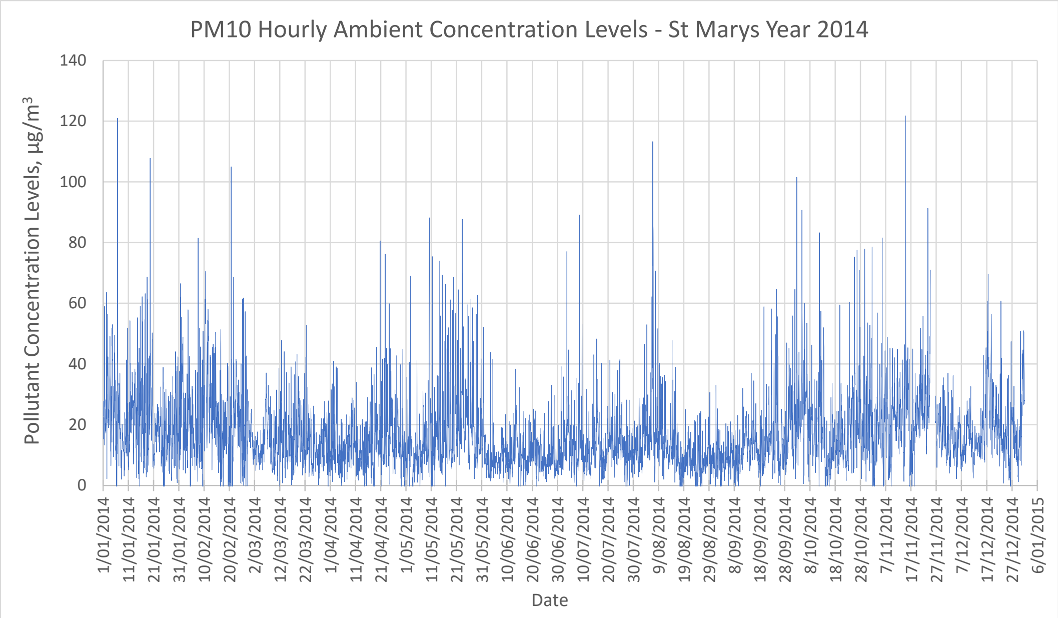


Figure 12: Adopted hourly PM_{10} background air quality chart

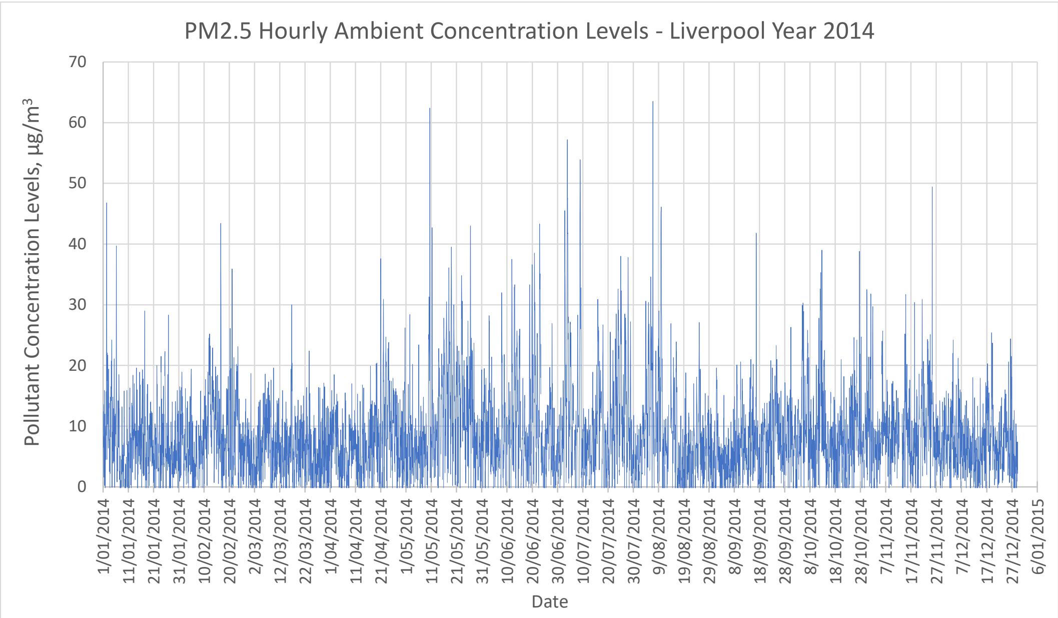


Figure 13: Adopted hourly $PM_{2.5}$ background air quality chart

Note that in the absence of publicly available 10-minute and 15-minute local background concentration for the assessed CO and SO_2 pollutants, 1-hour background concentrations have been used. Whilst it is noted that 15-minute or 10-minute background concentration may be higher than the 1-hour concentration, given the predicted cumulative impact for CO and SO_2 is generally well below the design criteria (refer to Section 7.1.3), it is unlikely that adopting the 15-minute or 10-minute background concentrations would result in significant increase to cause exceedances for these pollutants.

6 Assessment of potential construction impacts

There is the potential for dust generation associated with the construction of the proposal. In addition, exhaust emissions from construction plant, machinery and vehicles may also generate impacts on local air quality. Such emissions are associated with the combustion of fossil fuels during vehicle movement and the operation of on-site plant and construction machinery. No diesel fuelled generators are proposed for use onsite during construction.

All dust-generating activities associated with construction would occur within the subject site shown in Figure 1. Activities that would occur close to the subject site boundary are anticipated to be limited to construction of an access road, pavements, culvert and other ancillary works. The main dust-generating activities associated with earthworks and construction of buildings would be set-back from the subject site boundary. The closest sensitive receiver to the subject site boundary is approximately 300m in the south-east direction. Moreover, it is noted that winds are most prevalent from the south-west and west-south-west (refer Section 4.3.3) direction, which will mostly disperse any construction dust from the subject site away from the closest receivers.

Given the distance of sensitive receivers from potential dust generating activities at the subject site and the quantum of dust-generating activities that would be required, it is anticipated that the risk of amenity/nuisance issues and human health impacts would be **low.**

While the risk is low and the activities described above are typical for any construction site. Management measures to control the generation and spread of dust would need to be outlined in a construction environmental management plan (CEMP) for the proposal, that is then implemented onsite.

7 Assessment of potential operational impacts

7.1 Scenario 1 – Justified worst-case scenario (all generators operating in a loss of mains power situation)

This section addresses the potential air quality impact from the operation of the standby generators operating under worst case condition, due to a loss in main power, where all generators would run simultaneously to provide the full back up power required.

7.1.1 Nitrogen Dioxide

The maximum 1-hour average GLCs for NO_2 have been predicted at each of the assessed sensitive receivers. The results are shown in Table 10. The results show that the maximum cumulative NO_2 concentrations (i.e. inclusive of background concentrations) are predicted at receiver ID 11 (11 Barkers Lane, Kemps Creek), however exceedances of the impact assessment criteria are predicted at all receivers, by up to three-and-a-half fold. The predicted exceedances at nearby sensitive receivers are expected due to the conservative assumptions included in dispersion modelling to represent a justified worst-case scenario.

The concentrations shown in Table 10 represent the maximum possible concentrations during a loss of mains power, with all generators operating and coinciding with worst-case meteorological conditions. However, the likelihood of this scenario occurring is expected to be very rare at the subject site. Further discussion regarding the likelihood of exceedance is included in Section 7.1.4.

The predicted cumulative GLC concentrations across the modelled domain are shown as contour plots in Appendix G.

Table 10: Predicted 100th percentile 1-hour NO_2 GLCs (Scenario 1)

Receiver ID	1-Hour Nitrogen Dioxide (NO_2) Concentration (µg/m^3)			Comply
	Incremental	Cumulative	Criteria	
1	712.3	723.6	246	No
2	768.1	771.9		No
3	713.3	717.1		No
4	684.4	688.2		No
5	621.8	631.2		No
6	463.5	484.1		No
7	644.9	654.3		No
8	656.0	657.9		No
9	704.0	715.3		No
10	747.7	760.8		No
11	774.8	786.1		No
12	692.1	740.9		No
13	425.9	427.7		No
14	347.2	369.3		No
15	400.5	406.1		No
16	451.8	458.2		No
17	555.1	558.8		No
18	533.6	537.3		No
19	558.4	584.7		No
20	556.9	564.1		No
21	623.4	625.3		No
22	668.1	670.0		No
23	728.4	736.0		No
24	638.9	640.8		No
25	618.3	648.3		No
26	585.0	603.0		No

7.1.2 Particulate Matter

The 100th percentile 24-hour averaged GLCs for PM_{10} and $PM_{2.5}$ have been predicted at each of the assessed sensitive receivers. The results are shown in Table 11. The results show that both the cumulative PM_{10} and $PM_{2.5}$ concentrations (i.e. inclusive of background concentrations) are predicted to meet the impact assessment criteria of 50 µg/m^3 and 25 µg/m^3 respectively.

Therefore, under a justified worst-case scenario, no significant impact is predicted for particulate matter concentrations.

Table 11: Predicted 100th percentile 24-hour PM_{10} and $PM_{2.5}$ GLCs (Scenario 1)

Receiver ID	24-Hour Ground Level Concentrations (µg/m³)					Comply
	PM_{10} or $PM_{2.5}$	PM_{10}		$PM_{2.5}$		
	Incremental	Cumulative	Criteria	Cumulative	Criteria	
1	3.1	45.4	50	22.4	25	Yes
2	3.8	45.4	50	22.8	25	Yes
3	3.2	45.2	50	22.5	25	Yes
4	3.4	45.2	50	22.3	25	Yes
5	1.7	45.3	50	22.4	25	Yes
6	1.2	46.2	50	22.2	25	Yes
7	2.1	46.2	50	22.2	25	Yes
8	2.4	45.3	50	22.7	25	Yes
9	2.9	46.2	50	22.5	25	Yes
10	3.2	46.7	50	22.7	25	Yes
11	4.3	45.2	50	23.7	25	Yes
12	2.2	45.0	50	22.6	25	Yes
13	1.0	45.0	50	22.1	25	Yes
14	0.8	45.0	50	22.1	25	Yes
15	0.5	45.0	50	22.1	25	Yes
16	0.8	45.0	50	22.1	25	Yes
17	1.5	45.0	50	22.1	25	Yes
18	0.8	45.0	50	22.1	25	Yes
19	1.4	45.0	50	22.1	25	Yes
20	1.9	45.0	50	22.1	25	Yes
21	1.4	45.1	50	22.2	25	Yes
22	1.6	45.1	50	22.2	25	Yes
23	2.2	45.1	50	22.2	25	Yes
24	2.1	45.1	50	22.3	25	Yes
25	1.5	45.0	50	22.1	25	Yes
26	1.2	45.0	50	22.1	25	Yes

7.1.3 All other pollutants

The predicted 100th percentile GLCs for all other assessed pollutants are summarised in Table 12 and Table 14, for CO, SO_2, Benzene and PAH. The results show that CO, SO_2, Benzene and PAH are predicted to be well below the relevant impact assessment criteria at assessed sensitive receivers, and therefore no significant impact is predicted.

Table 12: Predicted 100th percentile 1-hour GLCs for 8-hour CO and 24-hour SO_2 (Scenario 1)

Receiver ID	8-Hour Ground Level Concentrations (µg/m³) CO			24-Hour Ground Level Concentrations (µg/m³) SO_2			Comply
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
1	349.4	2928.4	10,000	19.3	32.1	228	Yes
2	431.6	3010.6		23.7	36.4		Yes
3	409.8	2988.8		20.0	32.8		Yes
4	444.5	3023.5		21.2	34.0		Yes
5	223.9	2802.9		10.5	23.3		Yes
6	143.0	2722.0		7.2	20.0		Yes
7	290.4	2869.4		13.3	26.1		Yes
8	279.9	2858.9		14.6	27.4		Yes
9	386.2	2965.2		17.7	30.5		Yes
10	418.0	2997.0		19.9	32.6		Yes
11	363.0	2942.0		26.8	39.6		Yes
12	215.2	2794.2		13.9	26.7		Yes
13	138.1	2717.1		6.2	19.0		Yes
14	106.1	2685.1		4.8	17.6		Yes
15	61.8	2640.8		2.8	15.6		Yes
16	107.1	2686.1		5.0	17.7		Yes
17	146.5	2725.5		9.0	21.8		Yes
18	103.4	2682.4		4.8	17.5		Yes
19	163.5	2742.5		8.4	21.2		Yes
20	263.8	2842.8		12.0	24.7		Yes

Receiver ID	8-Hour Ground Level Concentrations (µg/m³) CO			24-Hour Ground Level Concentrations (µg/m³) SO_2			Comply
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
21	189.3	2768.3		9.0	21.7		Yes
22	183.5	2762.5		10.1	22.8		Yes
23	281.7	2860.7		13.7	26.5		Yes
24	260.4	2839.4		13.1	25.8		Yes
25	189.8	2768.8		9.0	21.8		Yes
26	165.1	2744.1		7.7	20.5		Yes

Table 13: Predicted 100th percentile 1-hour GLCs for all other assessed pollutants (Scenario 1)

Receiver ID	1-Hour Ground Level Concentrations (µg/m³)										Comply
	CO			SO_2			Benzene		PAH		
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	Incremental	Criteria	Incremental	Criteria	
1	701.7	3576.7	30,000	95.0	136.9	570	1.3	29	0.000044	0.4	Yes
2	768.8	3643.8		104.2	146.1		1.4		0.000048		Yes
3	704.6	3579.6		95.5	137.4		1.3		0.000044		Yes
4	664.9	3539.9		90.1	132.0		1.2		0.000042		Yes
5	597.6	3472.6		80.7	122.6		1.1		0.000038		Yes
6	429.5	3304.5		58.0	99.9		0.8		0.000027		Yes
7	623.9	3498.9		84.3	126.2		1.2		0.000039		Yes
8	663.3	3538.3		89.7	131.6		1.2		0.000042		Yes
9	687.0	3562.0		92.9	134.8		1.3		0.000043		Yes
10	736.3	3611.3		99.4	141.3		1.4		0.000046		Yes
11	765.4	3640.4		103.5	145.4		1.4		0.000048		Yes
12	690.2	3565.2		93.7	135.6		1.3		0.000044		Yes
13	383.4	3258.4		51.8	93.7		0.7		0.000024		Yes
14	296.2	3171.2		40.3	82.2		0.6		0.000019		Yes
15	377.3	3252.3		51.2	93.1		0.7		0.000024		Yes
16	411.2	3286.2		55.9	97.8		0.8		0.000026		Yes
17	529.4	3404.4		71.9	113.8		1.0		0.000033		Yes
18	502.0	3377.0		68.1	110.0		0.9		0.000032		Yes
19	526.8	3401.8		71.6	113.5		1.0		0.000033		Yes
20	525.4	3400.4		71.3	113.2		1.0		0.000033		Yes

Receiver ID	1-Hour Ground Level Concentrations (μg/m^3)										
	CO			SO_2			Benzene		PAH		Comply
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	Incremental	Criteria	Incremental	Criteria	
21	610.9	3485.9		82.8	124.7		1.1		0.000038		Yes
22	647.3	3522.3		87.7	129.6		1.2		0.000041		Yes
23	712.8	3587.8		96.7	138.6		1.3		0.000045		Yes
24	625.1	3500.1		84.8	126.7		1.2		0.000039		Yes
25	616.8	3491.8		83.7	125.6		1.1		0.000039		Yes
26	568.9	3443.9		77.1	119.0		1.1		0.000036		Yes

Table 14: Predicted 100th percentile 15-minute and 10-minute GLCs for CO and SO_2 (Scenario 1)

Receiver ID	15-min Ground Level Concentrations (µg/m³) CO			10-min Ground Level Concentrations (µg/m³) SO_2			Comply
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
1	925.9	3800.9	100,000	136.0	177.9	712	Yes
2	1014.4	3889.4		149.0	190.9		Yes
3	929.7	3804.7		136.6	178.5		Yes
4	877.4	3752.4		129.0	170.9		Yes
5	788.5	3663.5		115.5	157.4		Yes
6	566.7	3441.7		83.0	124.9		Yes
7	823.2	3698.2		120.6	162.5		Yes
8	875.2	3750.2		128.4	170.3		Yes
9	906.6	3781.6		133.0	174.9		Yes
10	971.6	3846.6		142.2	184.1		Yes
11	1009.9	3884.9		148.2	190.1		Yes
12	910.7	3785.7		134.1	176.0		Yes
13	505.9	3380.9		74.1	116.0		Yes
14	390.9	3265.9		57.7	99.6		Yes
15	497.9	3372.9		73.3	115.2		Yes
16	542.6	3417.6		80.0	121.9		Yes
17	698.5	3573.5		102.9	144.8		Yes
18	662.4	3537.4		97.5	139.4		Yes
19	695.1	3570.1		102.4	144.3		Yes
20	693.3	3568.3		102.0	143.9		Yes

Receiver ID	15-min Ground Level Concentrations (µg/m³) CO			10-min Ground Level Concentrations (µg/m³) SO_2			Comply
	Incremental	Cumulative	Criteria	Incremental	Cumulative	Criteria	
21	806.1	3681.1		118.4	160.3		Yes
22	854.2	3729.2		125.5	167.4		Yes
23	940.5	3815.5		138.3	180.2		Yes
24	824.8	3699.8		121.4	163.3		Yes
25	813.9	3688.9		119.8	161.7		Yes
26	750.7	3625.7		110.3	152.2		Yes

7.1.4 Likelihood of justified worst-case scenario and exceedances of the NO_2 impact assessment criteria

Under typical conditions, power for the subject site is fed directly from the grid. A review of the Energy Networks Australia indicate that the Australian Energy Regulator (AER) has found that a typical customer experiences around 200 minutes of outages per year[13], which means that interruptions of any kind would likely only occur for less than 0.05% of the time during an entire year. This is based on the system average interruption duration index (SAIDI) – refer to Figure 14.

It is understood that the Client has negotiated a high level of reliability for the utility supply to reduce risk of a power outage at the subject site further. The failure rates for a supply in the high reliability utility supply arrangement are extremely low, the last outage in Sydney was recorded in 2014 and lasted just 13 minutes.

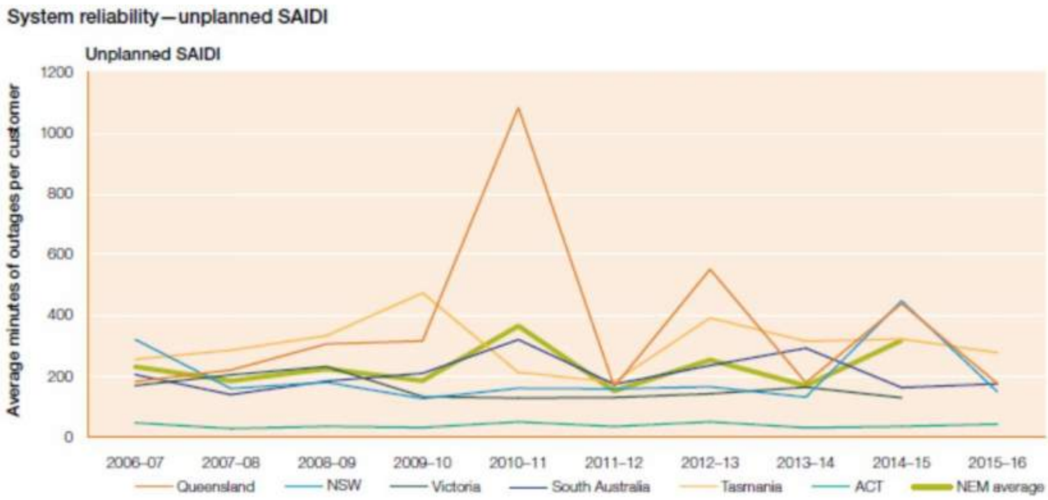


Figure 14: Australia – System reliability – unplanned SAIDI

Based on the above analysis, despite predicted exceedances of the NO_2 impact assessment criteria being likely during operation of all standby generators concurrently, it is unlikely that this justified worst-case scenario would occur in a typical year. If it did occur, the standby generators are likely to only operate for a maximum of 0.05% of the year due to power outages.

---

[13] Energy Networks Australia (2020) (https://www.energynetworks.com.au/news/energy-insider/behind-the-news-network-reliability/#:~:text=With%20regard%20to%20SAIDI%2C%20the,including%20planned%20and%20unplanned%20outages.&text=For%20the%20average%20customer%2C%20interruptions,time%20during%20the%20entire%20year) . Access 25 September 2020.

7.2 Scenario 2 – Realistic operations (routine maintenance)

This section addresses the potential air quality impact from the operation of the standby generators under routine maintenance conditions (Section 3.2.1). As detailed in Section 3.2.1, the generators will be tested under various load and combination depending on the testing regime. Generators would only ever be tested for a maximum of one hour and 5 minutes under 100% load capacity under the annual cycle. All other testing cycles, would result in lower load capacity of lesser time periods. The air quality impact during realistic operations has been assessed for the worst-case 1-hour period depending on the testing cycle applied.

7.2.1 Nitrogen Dioxide

Table 15 shows the NO_x emissions generated under each testing cycle, based on time, load capacity and number of generators, as shown in Appendix D.

Table 15: Generator's NOx emissions under different testing cycle

Frequency	Testing Load	NO_x Emission ($\mu g/m^3$)	Number of Generator being Tested Simultaneously	Total NO_x Emission per Testing ($\mu g/m^3$)
Bi-Monthly	No Load	0.939 (based on 10% load)	2	1.878
Quarterly	70%	3.460 (based on 75% load)	1	3.460
Yearly	Full Load	6.274	1	6.274

Based on Table 15, the NO_x emission for one generator at 100% load is much greater than the emission of two generators at 10% load combined (representing no-load scenario), and similarly with one generator under 70% load.

Table 15 shows that emissions from one generator under 100% load for one hour and five minutes during the annual testing cycle would result in the highest emissions from any testing scenario. The annual testing cycle is therefore considered to be the worst case scenario for realistic operations.

The 100th percentile NO_2 GLCs under routine maintenance at each of the assessed sensitive receivers have been predicted in Table 16. The predicted NO_2 concentrations are representative of single generators being tested under 100% load for 1-hour periods across daytime maintenance hours.

The results in Table 16 show the cumulative NO_2 concentrations (i.e. inclusive of background concentrations) are predicted to be well below the impact assessment criteria. The highest predicted NO_2 concentration occurs at receiver ID 23 (15 Medinah Avenue, Luddenham), with a GLC of 72.4 $\mu g/m^3$. This indicates that predicted 1-hour NO_2 concentrations at nearby sensitive receivers would meet the impact assessment criteria under all routine maintenance conditions.

Table 16: Predicted 100th percentile 1-hour NO_2 GLCs (Scenario 2)

Receiver ID	1-Hour Nitrogen Dioxide (NO_2) Concentration (µg/m^3)		Comply
	Cumulative	Criteria	
1	63.3	246	Yes
2	58.3		Yes
3	59.1		Yes
4	58.3		Yes
5	58.3		Yes
6	58.3		Yes
7	58.3		Yes
8	58.3		Yes
9	58.3		Yes
10	58.3		Yes
11	58.3		Yes
12	66.9		Yes
13	58.3		Yes
14	58.3		Yes
15	58.3		Yes
16	58.3		Yes
17	58.3		Yes
18	58.3		Yes
19	58.3		Yes
20	58.3		Yes
21	66.3		Yes
22	68.9		Yes
23	72.4		Yes
24	66.8		Yes
25	59.8		Yes
26	63.9		Yes

7.2.2 All other pollutants

As evidenced in Section 7.1, all other pollutants (including particulate matter) meet the relevant impact assessment criteria for the justified worst-case scenario and compliance with the relevant impact assessment criteria would also be maintained under the realistic operations scenario as less generators would be operational for shorter periods of time.

Overall, predicted concentrations at nearby identified sensitive receivers during maintenance and testing periods will meet all relevant impact assessment criteria for all assessed pollutants. On this basis, it is concluded that the operation of the standby generators during maintenance and testing activity would not adversely impact the air quality at nearby sensitive receivers.

8 Environmental management measures

This section describes the measures to mitigate against, monitor and manage any adverse air quality impacts described in Sections 6 and 7**.**

The dust emitting activities assessed above can be greatly reduced or eliminated by applying mitigation and management measures. It is anticipated that with the implementation of effective management measures, the environmental effect would not be significant in most cases. Table 17 outlines the air quality mitigation and management measures recommended for the subject site. These measures should be included in the Construction Environmental Management Plan (CEMP) as a specific air quality management sub-plan.

Operation of the proposal is not anticipated to significantly impact local air quality therefore no specific mitigation or management measures are proposed for the operational phase.

Table 17: Environmental management measures for Air Quality impacts

ID	Impacts	Mitigation	Responsibility	Timing
Construction				
AQ1	Risks to air quality during construction from fugitive dust	A dust and air quality management plan will be prepared and implemented as part of the proposal’s CEMP: • Potential sources of air pollution (such as dust, vehicles, odour transporting waste, plant and equipment) during construction • Air quality management objectives consistent with any relevant published EPA and/or OEH guidelines • Mitigation and suppression measures to be implemented, such as spraying or covering exposed surfaces, provision of vehicle clean down areas, covering of loads, street cleaning, use of dust screens, maintenance of plant in accordance with manufacturer's instructions • Methods to manage works during strong winds or other adverse weather conditions • A progressive rehabilitation strategy for exposed surfaces	Contractor	Pre-construction/Construction

ID	Impacts	Mitigation	Responsibility	Timing
		• When the air quality, suppression and management measures need to be applied, who is responsible, and how effectives will be assessed • A monitoring program to record whether the air quality mitigation, suppression and management measures have been applied; and assess the effectiveness of the applied measures • Community notification and complaint handling procedures		
AQ2	Risks to air quality during construction from vehicle and machinery emissions	The following management measures should be included as part of the proposal's CEMP to minimise emissions to air from construction vehicles and site machinery: • Implement a high standard of engine maintenance to minimise vehicle emissions; • Complete pre-start vehicle checklists to make sure construction vehicles are in good working order;	Contractor	Pre-construction/construction
Operation				
AQ3	Risks to air quality during maintenance of standby generators	Maintenance should be undertaken as per the testing schedule in Section 3.2.1. Operation of standby generators during testing and maintenance should be minimised as far as practicable.	Operator	Operation
AQ4	Risks to air quality during operation of standby generators in the event of a loss of mains power	In the event of a loss of mains power, all practical measures should be taken to reduce the duration of the outage to ensure that standby generators operate for the least amount of time possible.	Operator	Operation

9 Summary of residual impacts

This section provides a summary of the construction and operational risks both pre-mitigation and any residual impacts remaining after the implementation of the management measures describe in Section 8. Pre-mitigation and residual impacts are summarised in Table 18.

Table 18: Summary of pre-mitigation and residual impacts

Potential pre-mitigation adverse impact	Relevant management measures	Potential residual impact after implementation of management measures	Comment on how any residual impacts would be managed
Construction			
Low risk of dust-generation during construction effecting local air quality	Refer to AQ1 Impact Mitigation in Table 17. Best practice dust management measures included in a dust and air quality management plan developed as part of the CEMP.	Negligible	N/A
Low risk of emissions from equipment, traffic and machinery effecting local air quality	Refer to AQ2 Impact Mitigation in Table 17. Best practice emission control management measures included in an Air Quality Management Plan developed as part of the CEMP.	Negligible	N/A
Operation			
Risks to air quality during maintenance of standby generators	Refer to AQ3 Impact Mitigation in Table 17.	Negligible	N/A
Risks to air quality during operation of standby generators in the event of a loss of mains power	Refer to AQ4 Impact Mitigation in Table 17.	During a loss of mains power with all generators operating concurrently there is likely to be exceedances of the NO_2 impact assessment criteria.	As per mitigation measure A4, all practicable options should be taken to reduce the duration of the outage to minimise the release of emissions to air.

10 References

AGL, 2019. Newcastle Power Station – Air Quality Impact Assessment. Project No.: 0468623/AQIA/R4. Version 7.0. Revision R4. 30 October 2019.

Australian Government, Department of Agriculture Water and Environment, 1998. *The National Environment Protection (Ambient Air Quality) Measure*.

Cole, H. S., & Summerhays, J. E., 1979. *A Review of Techniques Available for Estimating Short-Term NO2 concentrations*. J. Air Poll. Cont. Assoc., 29:8, 812-817. doi:10:1080/00022470.1979.10470866.

Energy Networks Australia, 2020. (https://www.energynetworks.com.au/news/energy-insider/behind-the-news-network-reliability/#:~:text=With%20regard%20to%20SAIDI%2C%20the,including%20planned%20and%20unplanned%20outages.&text=For%20the%20average%20customer%2C%20interruptions,time%20during%20the%20entire%20year) . Access 25 September 2020

EPA Victoria, 1985. *Plume Calculation Procedure*.

Hendrick, E., Tino, V., Hanna, S., & Egan, B., 2013. *Evaluation of NO_2 predictions by the plume volume molar ratio method (PVMRM) and ozone limiting method (OLM) in AERMOD using new field observations*. J. Air & Waste Mgt. Assoc., 844-854. doi:10.1080/10962247.2013.798599

National Pollution Inventory, June 2008. *Emission estimation technique manual for combustion engines*, Version 3.0.

Northstar Air Quality, 2020. *Mamre Road South Precinct, 657-769 Mamre Road, Kemps Creek: State Significant Development – Air Quality Impact Assessment*. Ref. 18.1080.FR2V14. 30 July 2020. https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-1192%2120200811T071436.173%20GMT

NSW, 1997. *Protection of the Environment Operations Act 1997* – Section 128

NSW, 2010. *Protection of the Environment Operations (Clean Air) Regulation*.

NSW EPA, 2017. *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

Pacific Environment, 2016. *Department of Infrastructure and Regional Development, Western Sydney Airport EIS – Local Air Quality and Greenhouse Gas Assessment*, ID. 9417F. Doc no. AQU-NSW-001-9417E. Rev. R2. Sydney, NSW.

Pacific Environment, 2016. *Energy from Waste Facility – Air Quality and Greenhouse Gas Assessment*: The Next Generation, ID. 21292C. Doc no. AQU-NS-001-21292C. Rev. 5. Eastern Creek, NSW.

Podrez, M., 2015. *An update to the ambient ratio method for 1-h NO_2 air quality standards dispersion modelling*. Atm. Env., 163-170.

US EPA, 1995. *User's Guide for the Industrial Source Complex (ISC3) Dispersion Models*, Volume 1 and Volume 2, US EPA Office of Air Quality Planning and Standards Emissions, Monitoring, and Analysis Division Research Triangle Park, North Caroline.

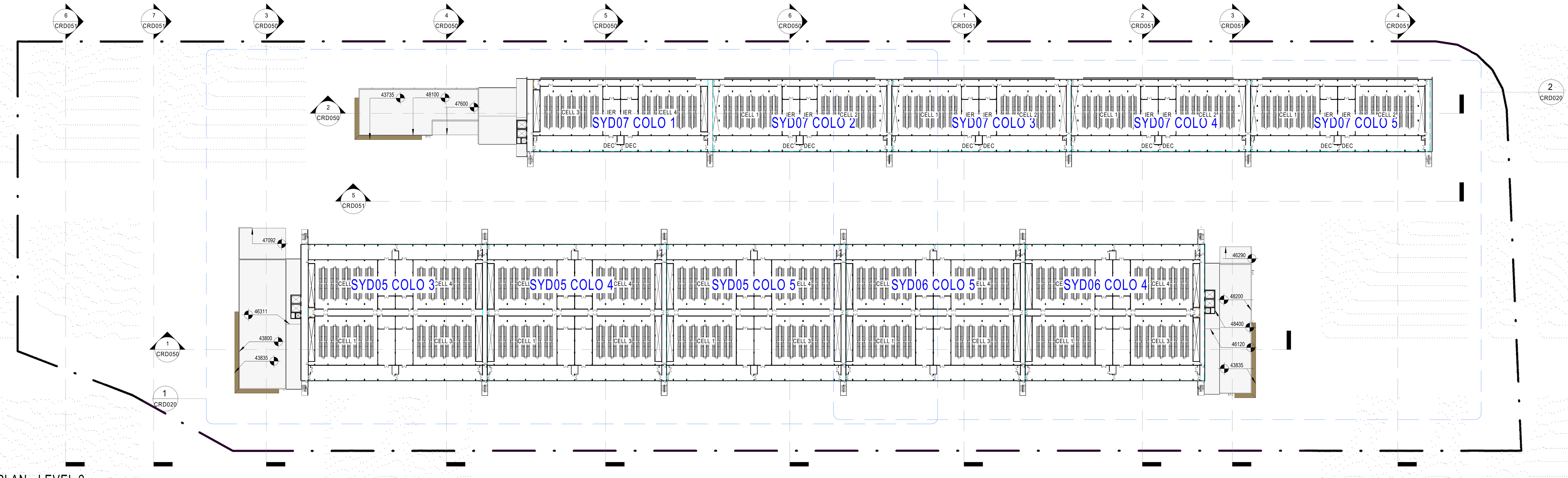
Work Safe Australia, 2013. *Workplace Exposure Standards for Airborne Contaminants* – Amended in 2019.

Appendix A

Masterplan Site Layout

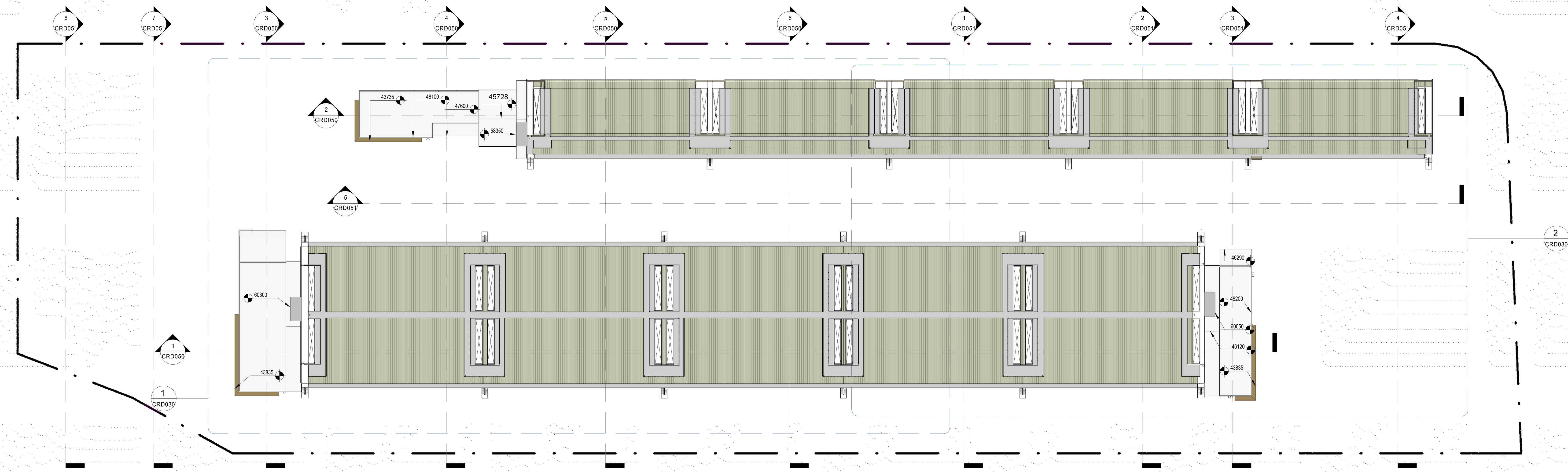
1 GA FLOOR PLAN - LEVEL 1

1 : 1000



2 GA FLOOR PLAN - LEVEL 2

1 : 1000



3 GA FLOOR PLAN - LEVEL ROOF

1 : 1000

PRELIMINARY

N

Approvals

Customer | Date

General Notes:

A. This is not an installation drawing and shows design intent information only.
B. All dimensions are in millimeters (mm) unless noted otherwise. All levels are in metres (m) unless stated otherwise.
C. Do not scale; work to figures dimensions only. This drawing shall be read in conjunction with building services documents and other relevant contract documents.
D. Equipment and plant details are not manufacturer specific. Contractor selected equipment shall meet the given constraints and long lead equipment will be coordinated based on final equipment selection.
E. All service penetrations through fire, acoustic, thermal, air and watertight compartments shall be sealed to achieve performance rating equivalent to the compartment and shall be designed to accommodate movement.
F. All services penetrations through fire rated compartments shall be fire stopped to achieve a rating equivalent to the compartment and shall be designed to accomodate thermal movement.
G. All services crossing the movement joints shall be installed to accomodate the movements as defined in the Structural Engineers Contract documentation.
H. The Contractor will produce fully coordinated installation drawings prior to installation for approval.
I. The Contractor will produce as built drawings prior to handover for approval.

Notes:

Issue	Date	Description
1	15/12/2020	ISSUE FOR COORDINATION
2	18/12/2020	ISSUE FOR COORDINATION
3	18/12/2020	ISSUE FOR STATUS UPDATE
4	11/01/2021	ISSUE FOR INFORMATION
5	14/01/2021	ISSUE FOR COORDINATION
6	19/02/2021	ISSUE FOR COORDINATION
7	19/03/2021	30% COORDINATION SET

ARUP
Arup, Level 5 Barrack Place, 151 Clarence St
Sydney, NSW, 2000
Tel +61(02)9320 9320
www.arup.com

GREENBOX
+61 2 8069 8930
LEVEL 25
25 BLIGH ST
SYDNEY NSW 2000 AUSTRALIA
GREENBOX ARCHITECTURE PTY LTD
ABN: 79 139 779 098
ISO 9001 CERTIFIED QUALITY SYSTEM

Client
PROPONENT

Project Title
SYD05-06-07
KEMPS CREEK

Key Plan

Drawing Title
GA FLOOR PLANS_1-1000

Scale at A0	1 : 1000	Drawn By	AG
Role	Architecture	Checked By	MP
Suitability	A3	Approved By	AO
Job No	200036	Rev	7

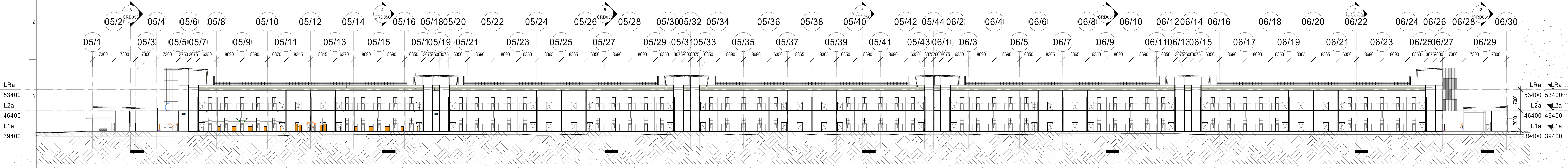
Sheet number
CRD001

Scale bar
1:1000 0 10 20 30 50m

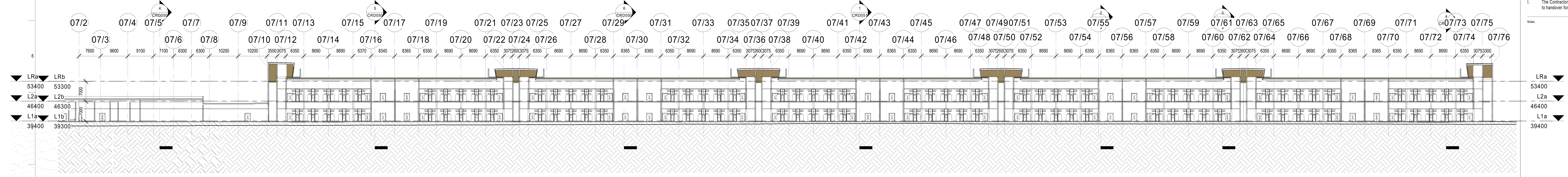
Appendix B

Buildings Sections and Elevations

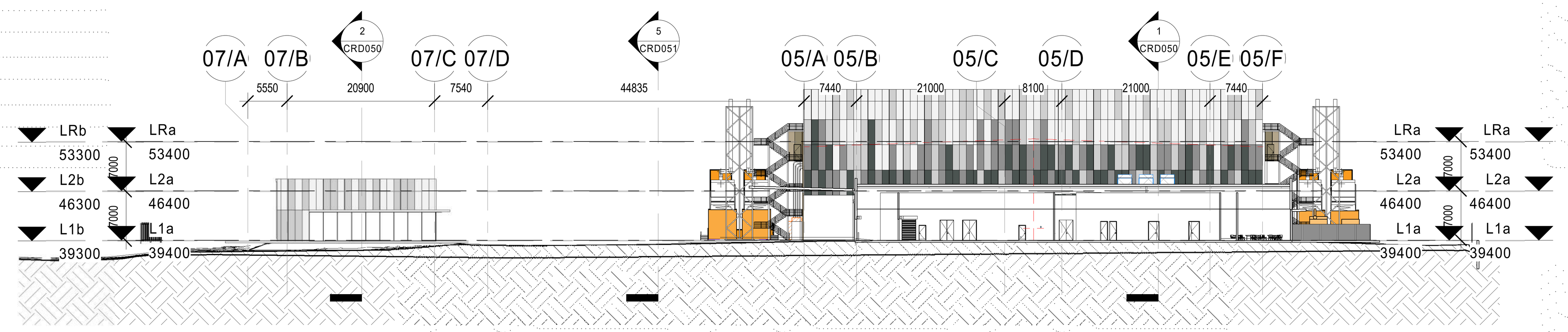
A0



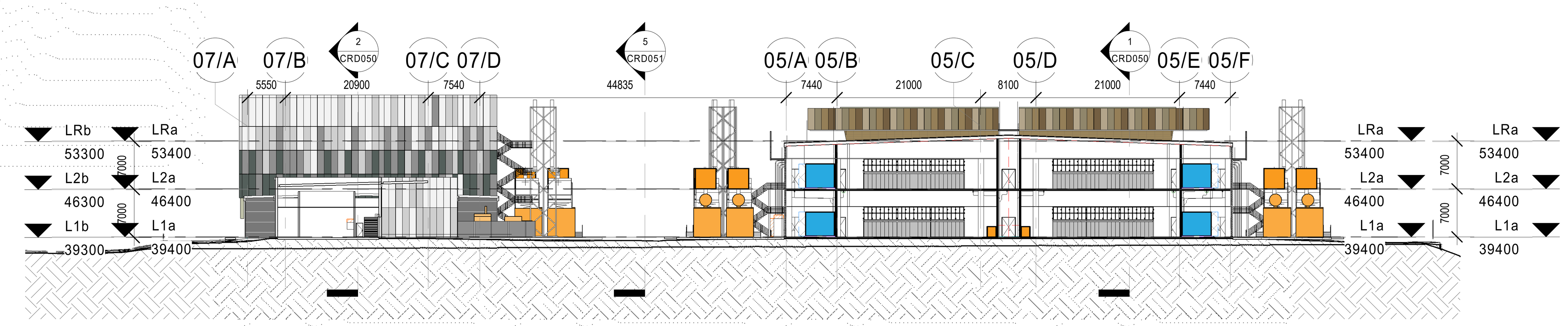
1 (CRD) GA SECTION 1
1 : 500



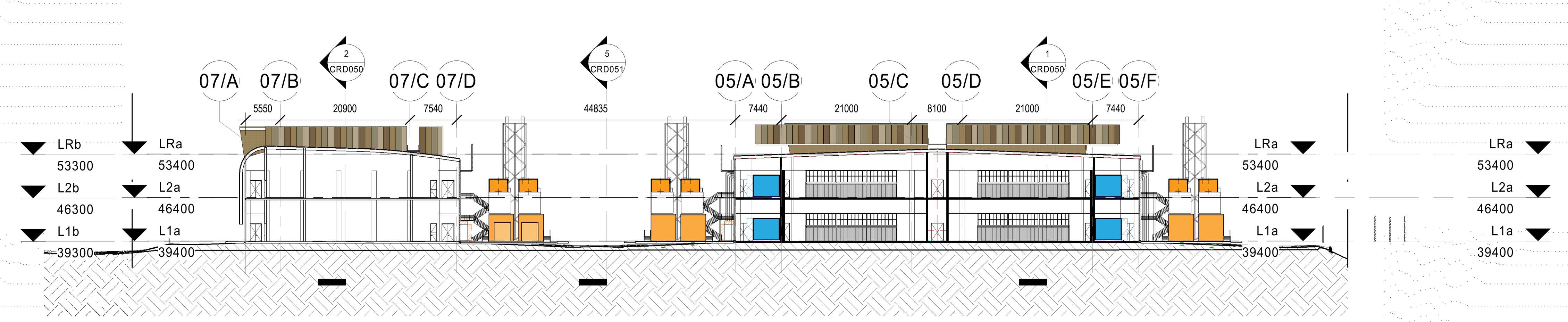
2 (CRD) GA SECTION 2
1 : 500



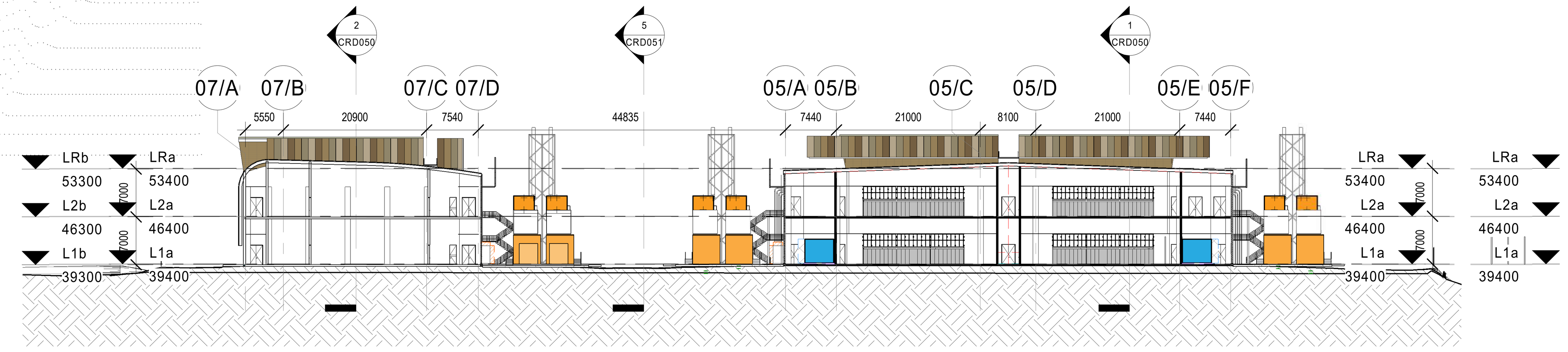
3 (CRD) GA SECTION 3
1 : 500



4 (CRD) GA SECTION 4
1 : 500



5 (CRD) GA SECTION 5
1 : 500



6 (CRD) GA SECTION 6
1 : 500

PRELIMINARY

Approvals

Customer | Date

General Notes:

A. This is not an installation drawing and shows design intent information only.
B. All dimensions are in millimeters (mm) unless noted otherwise. All levels are in metres (m) unless stated otherwise.
C. Do not scale; work to figures dimensions only. This drawing shall be read in conjunction with building services documents and other relevant contract documents.
D. Equipment and plant details are not manufacturer specific. Contractor selected equipment shall meet the given constraints and long lead equipment will be coordinated based on final equipment selection.
E. All service penetrations through fire, acoustic, thermal, air and watertight compartments shall be sealed to achieve performance rating equivalent to the compartment and shall be designed to accommodate movement.
F. All services penetrations through fire rated compartments shall be fire stopped to achieve a rating equivalent to the compartment and shall be designed to accomodate thermal movement.
G. All services crossing the movement joints shall be installed to accomodate the movements as defined in the Structural Engineers Contract documentation.
H. The Contractor will produce fully coordinated installation drawings prior to installation for approval.
I. The Contractor will produce as built drawings prior to handover for approval.

Notes:

Issue	Date	Description
1	15/12/2020	ISSUE FOR COORDINATION
2	18/12/2020	ISSUE FOR COORDINATION
3	18/12/2020	ISSUE FOR STATUS UPDATE
4	14/01/2021	ISSUE FOR COORDINATION
5	19/02/2021	ISSUE FOR COORDINATION
6	19/03/2021	30% COORDINATION SET

ARUP
Arup, Level 5 Barrack Place, 151 Clarence St
Sydney, NSW, 2000
Tel +61(02)9320 9320
www.arup.com

GREENBOX

+61 2 8069 8930

LEVEL 25
25 BLIGH ST
SYDNEY NSW 2000 AUSTRALIA

GREENBOX ARCHITECTURE PTY LTD
ABN: 79 139 779 098

ISO 9001 CERTIFIED QUALITY SYSTEM

Client
PROPONENT

Project Title
SYD05-06-07
KEMPS CREEK

Key Plan

Drawing Title
GA SECTIONS_1-500

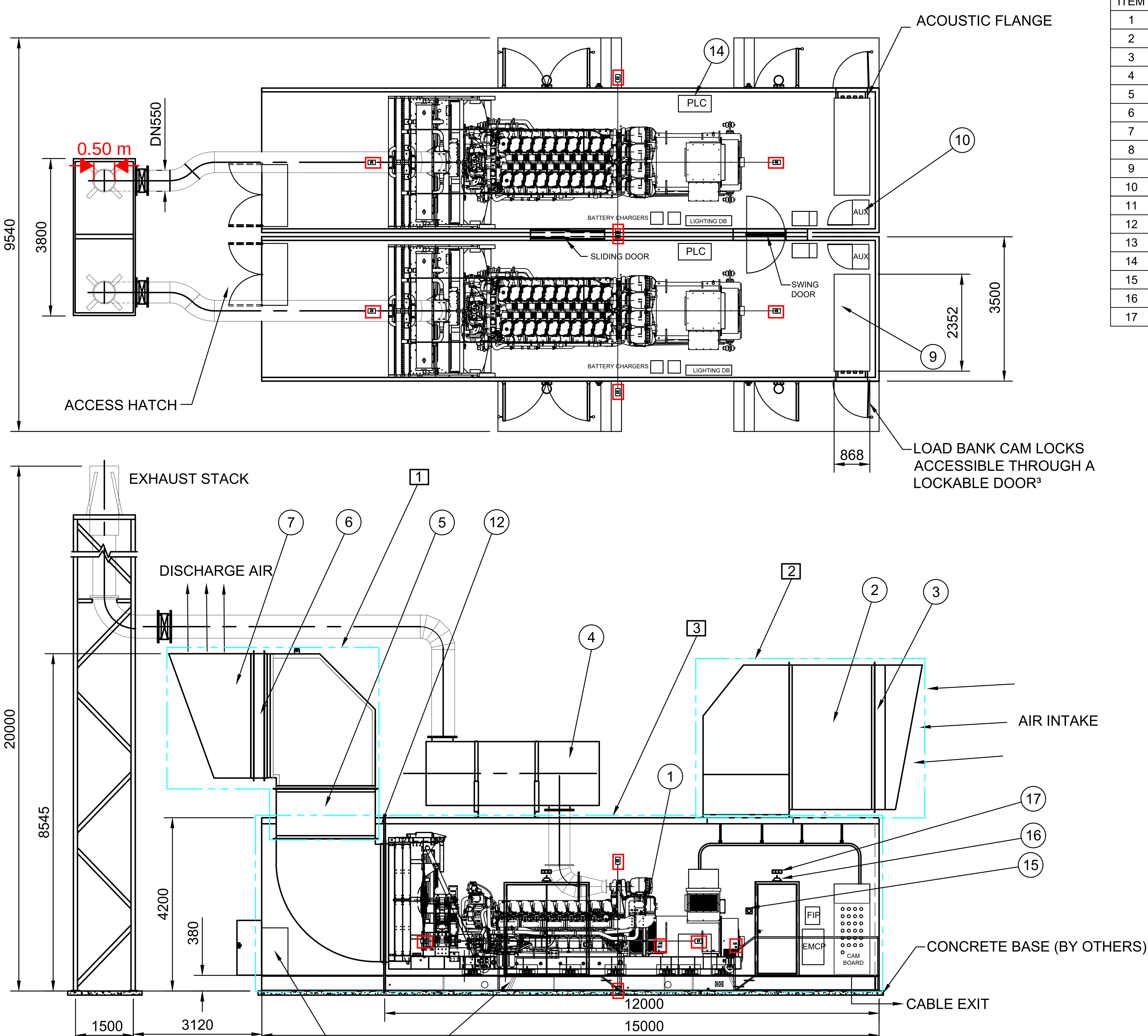
Scale at A0	1 : 500	Drawn By	AG
Role	Architecture	Checked By	MP
Suitability	A3	Approved By	AO
Job No	200036	Rev	6

Sheet number
CRD050

Scale bar
Sc. 1:500 0 5 10 15 25m

Appendix C

Preliminary Generator Set Design



ITEM	QTY	DESCRIPTION	DETAILS
1	1	C175-20 GENSET	-
2	1	INLET ATTENUATOR	A3-2100 3400 W X 3500 H
3	1	INLET MOISTURE ELIMINATOR	-
4	1	MUFFLER	BCS500
5	1	OUTLET ATTENUATOR	A13-1200 2400 W X 3300 H
6	1	OUTLET MOISTURE ELIMINATOR	-
7	1	OUTLET HOOD	-
8	1	FUEL TANK, DOUBLE SKIN	1000L
9	1	CAM BOARD	2352 W X 816 D X 2236 H
10	1	AUX BOARD	600 W X 400 D X 1400 H
11	4	LIFTING LUGS	
12	1	SUMMER VENTILATION FAN	1.0m³/sec 0.55 kW
13	1	POWER CABLE TRAY	
14	1	PLC PANEL	800 W X 400 D X 1000 H
15	2	EMERGENCY STOP	-
16	2	LIGHT FIXTURE	-
17	2	RED/YELLOW/GREEN LIGHT FIXTURE	-

NOTES

1. MATERIAL: ALL MILD STEEL U.N.O.
2. 75 dB(A) @ 1m
3. ENCLOSURE DESIGN SUITABLE FOR WIND CATEGORY REGION A2
4. ESTIMATED GROSS WEIGHT 65,000 kg

* DENOTES A TRANSPORTABLE SECTION

Appendix D

Generator Set Specification

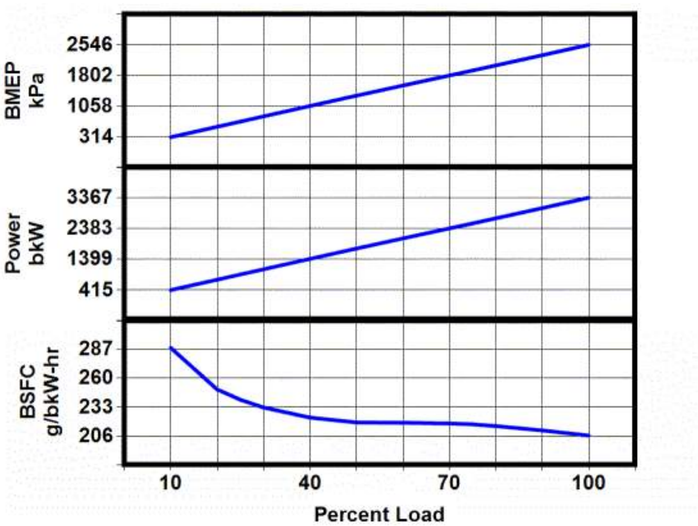
ELECTRIC POWER - Performance Data Sheet
STANDARD

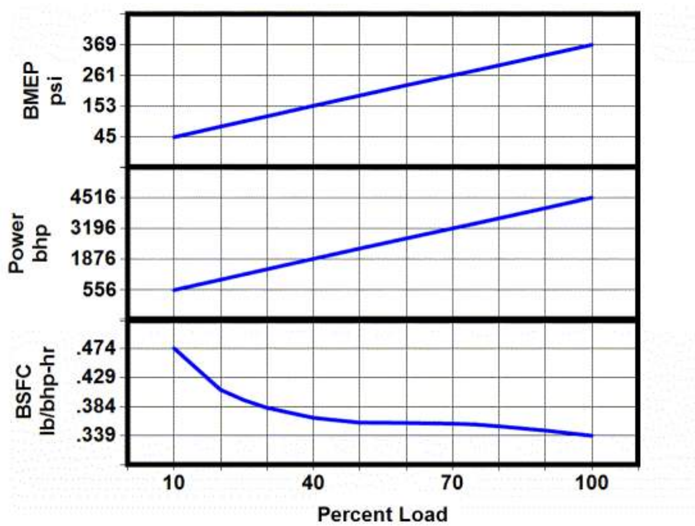
C175-20 DITA
3120 ekW/50 Hz/1500 rpm/0.8 Power Factor

Rating Type: MISSION CRITICAL STANDBY

Fuel Strategy: LOW EMISSIONS

Performance Number: EM1366-04





Metric

Gen Power ekW	Percent Load	Engine Power bkW	Engine BMEP kPa	BSFC g/bkW-hr	Fuel Rate L/hr
3120	100	3368.0	2546	206.4	817.7
2808	90	3036.0	2295	211.2	754.2
2496	80	2709.1	2048	215.2	685.9
2340	75	2547.2	1925	216.9	649.9
2184	70	2387.4	1805	217.7	611.4
1872	60	2067.2	1563	218.3	530.9
1560	50	1743.6	1318	218.6	448.5
1248	40	1413.4	1068	223.1	371.0
936	30	1080.6	817	232.6	295.6
780	25	913.8	691	239.8	257.8
624	20	747.1	565	249.4	219.2
312	10	414.9	314	288.2	140.7

English

Gen Power kVA	Percent Load	Engine Power bhp	Engine BMEP psi	BSFC lb/bhp-hr	Fuel Rate gph
3900	100	4517	369	.339	216.0
3510	90	4071	333	.347	199.2
3120	80	3633	297	.354	181.2
2925	75	3416	279	.357	171.7
2730	70	3202	262	.358	161.5
2340	60	2772	227	.359	140.3
1950	50	2338	191	.359	118.5
1560	40	1895	155	.367	98.0
1170	30	1449	118	.382	78.1
975	25	1225	100	.394	68.1
780	20	1002	82	.410	57.9
390	10	556	45	.474	37.2

Gen Power ekW	Intake Manifold Temp °C	Intake Manifold Press kPa	Intake Air Flow m³/min	Exhaust Manifold Temp °C	Exhaust Stack Temp °C	Exhaust Gas Flow m³/min
3120	50.8	297.2	305.5	634.2	460.7	704.5
2808	49.6	283.7	297.7	615.1	447.8	673.0
2496	48.5	262.7	283.2	595.2	437.5	629.9
2340	47.9	249.5	273.6	584.8	433.4	604.1
2184	47.3	232.9	261.1	574.7	431.2	573.5
1872	46.1	194.8	232.0	553.1	428.0	504.6
1560	44.9	154.1	200.2	529.5	422.9	430.8
1248	43.6	116.4	170.5	501.5	413.0	361.3
936	42.4	82.2	143.1	464.5	393.8	294.4
780	41.8	66.2	130.1	442.7	380.7	261.6
624	41.3	51.6	118.1	411.2	357.9	229.1
312	40.8	26.9	97.5	317.2	281.2	165.5

Gen Power kVA	Intake Manifold Temp °F	Intake Manifold Press in Hg	Intake Air Flow cfm	Exhaust Manifold Temp °F	Exhaust Stack Temp °F	Exhaust Gas Flow cfm
3900	123.4	88.0	10786.9	1173.5	861.2	24877.4
3510	121.4	84.0	10511.2	1139.2	838.0	23763.0
3120	119.3	77.8	10001.3	1103.3	819.6	22241.9
2925	118.2	73.9	9661.0	1084.7	812.1	21332.1
2730	117.2	69.0	9221.1	1066.4	808.2	20250.1
2340	115.0	57.7	8192.1	1027.6	802.3	17818.9
1950	112.7	45.6	7069.2	985.0	793.3	15212.1
1560	110.5	34.5	6021.7	934.7	775.4	12756.6
1170	108.4	24.4	5052.8	868.2	740.9	10395.2
975	107.3	19.6	4592.6	828.8	717.2	9236.2
780	106.4	15.3	4169.8	772.1	676.2	8091.0
390	105.5	8.0	3444.0	602.9	538.1	5844.5

© 2020 Caterpillar All Rights Reserved

C175-20 DITA
3120 ekW/50 Hz/1500 rpm/0.8 Power Factor

Rating Type: MISSION CRITICAL STANDBY

Fuel Strategy: LOW EMISSIONS

Performance Number: EM1366-04

Heat Rejection Data

Metric

Gen Power ekW	Percent Load	Rejection to Jacket Water kW	Rejection to Atmos kW	Rejection to Exhaust kW	From Oil Cooler kW
3120	100	1731.7	196.0	3033.9	439.9
2808	90	1649.3	189.6	2796.4	405.8
2496	80	1540.4	183.5	2542.4	369.0
2340	75	1476.2	180.5	2409.0	349.6
2184	70	1400.8	177.7	2267.4	329.0
1872	60	1232.3	172.1	1971.7	285.6
1560	50	1052.1	166.2	1669.2	241.3
1248	40	878.7	159.6	1392.5	199.6
936	30	714.0	152.0	1116.8	159.1
780	25	634.4	147.9	971.6	138.7
624	20	561.8	143.2	816.1	117.9
312	10	439.3	131.9	479.1	75.7

English

Gen Power kVA	Percent Load	Rejection to Jacket Water Btu/min	Rejection to Atmos Btu/min	Rejection to Exhaust Btu/min	From Oil Cooler Btu/min
3900	100	98479.9	11145.5	172533.0	25018.6
3510	90	93796.5	10784.4	159030.0	23077.7
3120	80	87602.7	10435.6	144583.0	20986.8
2925	75	83950.4	10265.2	136997.7	19884.2
2730	70	79660.5	10105.4	128947.2	18708.3
2340	60	70081.2	9786.5	112127.9	16244.6
1950	50	59833.5	9449.4	94928.1	13721.7
1560	40	49970.3	9073.9	79187.7	11351.8
1170	30	40602.5	8644.5	63508.5	9045.7
975	25	36079.9	8409.6	55254.5	7887.1
780	20	31951.5	8141.5	46408.9	6707.3
390	10	24980.9	7500.8	27245.3	4304.6

Information contained in this publication may be considered confidential. Discretion is recommended when distributing. Materials and specifications are subject to change without notice. The International System of Units (SI) is used in this publication. CAT, CATERPILLAR, their respective logos, ADEM, EUI, S•O•S, "Caterpillar Yellow" and the "Power Edge" trade dress, as well as corporate and product identity used herein, are trademarks of Caterpillar and may not be used without permission

© 2020 Caterpillar All Rights Reserved

PERFORMANCE DATA[EM1366]

Performance Number: EM1366 **Change Level: 04**

SALES MODEL:	C175-20	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,500
ENGINE POWER (BKW):	3,368.0	**HERTZ:**	50
GEN POWER WITH FAN (EKW):	3,120.0	**FAN POWER (KW):**	84.0
COMPRESSION RATIO:	15.3	**ASPIRATION:**	TA
RATING LEVEL:	MISSION CRITICAL STANDBY	**AFTERCOOLER TYPE:**	SCAC
PUMP QUANTITY:	2	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC+1AC, 2AC
FUEL TYPE:	DIESEL	**AFTERCOOLER TEMP (C):**	46
MANIFOLD TYPE:	DRY	**JACKET WATER TEMP (C):**	99
GOVERNOR TYPE:	ADEM4	**TURBO CONFIGURATION:**	PARALLEL
ELECTRONICS TYPE:	ADEM4	**TURBO QUANTITY:**	4
CAMSHAFT TYPE:	STANDARD	**TURBOCHARGER MODEL:**	GTB6251BN-48T-1.38
IGNITION TYPE:	CI	**COMBUSTION STRATEGY:**	LOW EMISSION
INJECTOR TYPE:	CR	**FUEL RATE (RATED RPM) NO LOAD (L/HR):**	70.5
FUEL INJECTOR:	4439454	**PISTON SPD @ RATED ENG SPD (M/SEC):**	11.0
REF EXH STACK DIAMETER (MM):	356		

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET
OIL AND GAS	LAND PRODUCTION	PACKAGED GENSET

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BKW	KPA	G/BKW-HR	L/HR	KPA	DEG C	DEG C	KPA	DEG C
3,120.0	100	3,368	2,546	206.4	817.7	297.2	50.8	634.2	231.7	460.7
2,808.0	90	3,036	2,295	211.2	754.2	283.7	49.6	615.1	218.2	447.8
2,496.0	80	2,709	2,048	215.2	685.9	262.7	48.5	595.2	200.1	437.5
2,340.0	75	2,547	1,925	216.9	649.9	249.5	47.9	584.8	189.3	433.4
2,184.0	70	2,387	1,805	217.7	611.4	232.9	47.3	574.7	176.3	431.2
1,872.0	60	2,067	1,563	218.3	530.9	194.8	46.1	553.1	147.4	428.0
1,560.0	50	1,744	1,318	218.6	448.5	154.1	44.9	529.5	117.4	422.9
1,248.0	40	1,413	1,068	223.1	371.0	116.4	43.6	501.5	91.6	413.0
936.0	30	1,081	817	232.6	295.6	82.2	42.4	464.5	69.0	393.8
780.0	25	914	691	239.8	257.8	66.2	41.8	442.7	58.8	380.7
624.0	20	747	565	249.4	219.2	51.6	41.3	411.2	49.3	357.9
312.0	10	415	314	288.2	140.7	26.9	40.8	317.2	32.4	281.2

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	ENGINE OUTLET WET EXH VOL FLOW RATE (0 DEG C AND 101 KPA)	ENGINE OUTLET DRY EXH VOL FLOW RATE (0 DEG C AND 101 KPA)
EKW	%	BKW	KPA	DEG C	M3/MIN	M3/MIN	KG/HR	KG/HR	M3/MIN	M3/MIN
3,120.0	100	3,368	299	227.9	305.5	704.5	19,260.0	19,954.4	262.2	240.3
2,808.0	90	3,036	286	220.2	297.7	673.0	18,764.1	19,405.1	255.0	234.6
2,496.0	80	2,709	265	208.4	283.2	629.9	17,839.1	18,422.3	242.1	223.4
2,340.0	75	2,547	251	200.9	273.6	604.1	17,219.9	17,772.5	233.6	215.8
2,184.0	70	2,387	235	190.7	261.1	573.5	16,415.3	16,935.1	222.4	205.6
1,872.0	60	2,067	197	169.1	232.0	504.6	14,534.1	14,985.0	196.6	181.9
1,560.0	50	1,744	156	147.0	200.2	430.8	12,490.1	12,870.5	169.1	156.6
1,248.0	40	1,413	118	123.9	170.5	361.3	10,607.5	10,921.1	143.8	133.4
936.0	30	1,081	84	100.6	143.1	294.4	8,888.2	9,137.8	120.6	112.2
780.0	25	914	68	89.1	130.1	261.6	8,079.6	8,298.0	109.3	101.9
624.0	20	747	53	78.0	118.1	229.1	7,336.0	7,522.4	99.2	92.8
312.0	10	415	29	56.5	97.5	165.5	6,055.4	6,175.0	81.6	77.2

Heat Rejection Data

PUMP POWER IS INCLUDED IN HEAT REJECTION BALANCE, BUT IS NOT SHOWN.

PERFORMANCE DATA[EM1366]

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXH RECOVERY TO 177C	FROM OIL COOLER	FROM 2ND STAGE AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY
EKW	%	BKW	KW	KW	KW	KW	KW	KW	KW	KW	KW
3,120.0	100	3,368	1,732	196	3,034	1,672	440	374	3,368	8,260	8,799
2,808.0	90	3,036	1,649	190	2,796	1,546	406	335	3,036	7,619	8,116
2,496.0	80	2,709	1,540	184	2,542	1,409	369	296	2,709	6,929	7,381
2,340.0	75	2,547	1,476	181	2,409	1,336	350	277	2,547	6,565	6,993
2,184.0	70	2,387	1,401	178	2,267	1,261	329	258	2,387	6,176	6,579
1,872.0	60	2,067	1,232	172	1,972	1,101	286	220	2,067	5,363	5,713
1,560.0	50	1,744	1,052	166	1,669	925	241	182	1,744	4,530	4,826
1,248.0	40	1,413	879	160	1,392	752	200	150	1,413	3,748	3,992
936.0	30	1,081	714	152	1,117	576	159	121	1,081	2,986	3,181
780.0	25	914	634	148	972	490	139	106	914	2,604	2,774
624.0	20	747	562	143	816	392	118	90.7	747	2,214	2,359
312.0	10	415	439	132	479	183	75.7	56.9	415	1,421	1,514

Sound Data

SOUND DATA REPRESENTATIVE OF NOISE PRODUCED BY THE "ENGINE ONLY"

EXHAUST: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ	800 HZ
EKW	%	BKW	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,120.0	100	3,368	128.5	94.9	113.2	107.8	109.1	111.9	112.0	113.0	116.2	115.4	113.3
2,808.0	90	3,036	127.9	94.0	113.5	106.9	108.1	111.5	110.9	111.9	115.4	113.9	112.1
2,496.0	80	2,709	126.4	94.2	112.1	106.2	107.7	111.2	110.1	111.0	114.7	112.4	111.0
2,340.0	75	2,547	125.6	93.8	110.7	105.9	107.6	110.4	109.3	110.9	114.0	111.8	110.5
2,184.0	70	2,387	124.9	92.5	109.2	105.3	107.1	108.6	108.2	110.0	113.4	111.2	110.2
1,872.0	60	2,067	123.7	92.1	108.6	104.7	105.9	106.1	107.1	109.3	113.1	110.4	109.6
1,560.0	50	1,744	122.6	90.4	108.7	105.4	104.9	106.9	108.0	109.7	111.7	110.0	109.4
1,248.0	40	1,413	121.1	90.3	104.9	105.8	104.3	105.3	107.9	109.0	110.5	108.6	107.8
936.0	30	1,081	119.5	91.9	102.2	105.3	102.4	104.7	107.9	106.3	108.7	107.6	106.6
780.0	25	914	118.8	92.8	103.2	104.3	101.5	104.2	107.8	105.3	107.8	107.0	106.2
624.0	20	747	118.2	90.9	107.3	101.3	102.5	102.8	105.6	105.4	107.2	106.4	106.2
312.0	10	415	116.4	83.9	107.5	102.7	100.8	100.4	101.6	102.5	105.3	105.5	105.0

EXHAUST: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ	10000 HZ
EKW	%	BKW	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,120.0	100	3,368	118.7	120.7	120.0	119.9	118.3	115.1	111.1	108.0	105.4	103.4	111.8
2,808.0	90	3,036	117.5	118.9	119.1	119.0	117.0	114.0	109.9	106.9	104.4	102.8	118.5
2,496.0	80	2,709	116.0	117.5	117.8	118.0	116.1	112.9	108.9	105.8	103.6	101.7	112.3
2,340.0	75	2,547	115.2	116.8	116.9	117.4	115.7	112.5	108.5	105.3	103.2	101.5	108.4
2,184.0	70	2,387	114.3	116.0	116.2	116.7	115.3	112.1	108.1	104.8	102.9	101.9	104.4
1,872.0	60	2,067	112.7	114.7	114.8	115.2	114.3	111.2	107.2	103.8	102.6	102.9	96.8
1,560.0	50	1,744	111.3	113.4	113.0	113.3	113.0	109.8	105.9	102.7	102.3	101.9	94.7
1,248.0	40	1,413	109.9	111.5	111.0	111.2	111.2	107.9	104.4	101.4	102.7	98.4	93.3
936.0	30	1,081	108.3	110.0	109.0	109.5	109.2	106.2	102.7	100.5	100.7	95.9	91.8
780.0	25	914	107.5	109.3	108.0	108.6	108.2	105.3	101.8	100.3	99.1	95.3	91.2
624.0	20	747	106.6	108.5	106.8	107.9	107.3	104.5	101.1	100.7	97.3	94.9	90.9
312.0	10	415	106.0	107.6	105.7	106.1	105.7	102.1	101.1	96.9	95.7	94.3	89.3

Sound Data (Continued)

MECHANICAL: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	OVERALL SOUND	100 HZ	125 HZ	160 HZ	200 HZ	250 HZ	315 HZ	400 HZ	500 HZ	630 HZ	800 HZ
EKW	%	BKW	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,120.0	100	3,368	126.2	90.3	99.0	97.9	103.3	102.1	110.4	110.0	111.6	112.1	113.7

2,808.0	90	3,036	126.3	90.0	99.1	97.8	102.9	102.1	109.9	109.6	111.2	111.9	113.4
2,496.0	80	2,709	125.4	89.6	97.9	97.5	102.1	102.1	109.2	109.2	110.9	111.8	113.0
2,340.0	75	2,547	124.9	89.5	97.5	97.4	101.8	102.4	109.1	109.4	110.9	111.9	112.8
2,184.0	70	2,387	124.5	89.4	96.7	97.3	101.6	102.5	108.7	109.7	110.9	111.9	112.6
1,872.0	60	2,067	124.0	89.1	96.4	97.5	101.4	102.7	107.8	110.1	110.5	111.8	112.3
1,560.0	50	1,744	123.3	88.2	96.6	97.8	100.9	102.4	107.4	109.5	110.3	111.6	112.0
1,248.0	40	1,413	122.5	87.3	97.0	98.9	100.0	102.4	106.8	108.9	110.0	111.2	110.9
936.0	30	1,081	121.9	86.3	96.4	99.5	99.4	102.8	106.3	108.8	110.2	111.2	109.9
780.0	25	914	121.7	85.8	95.4	99.1	98.7	103.1	106.4	108.8	110.7	111.7	109.9
624.0	20	747	121.8	85.2	94.1	97.9	97.7	103.1	106.7	109.2	111.6	112.7	110.7
312.0	10	415	121.9	84.9	94.0	99.2	94.6	102.5	105.6	109.2	111.5	113.4	111.5

MECHANICAL: Sound Power (1/3 Octave Frequencies)

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	1000 HZ	1250 HZ	1600 HZ	2000 HZ	2500 HZ	3150 HZ	4000 HZ	5000 HZ	6300 HZ	8000 HZ	10000 HZ
EKW	%	BKW	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)	dB(A)
3,120.0	100	3,368	114.8	114.6	114.8	115.5	114.6	113.4	111.5	112.0	113.6	112.6	119.4
2,808.0	90	3,036	114.5	114.4	114.6	115.0	114.1	113.5	111.3	111.7	113.0	112.2	121.2
2,496.0	80	2,709	114.1	114.0	114.3	114.6	113.7	112.4	110.9	110.9	112.3	111.2	118.7
2,340.0	75	2,547	113.9	114.1	114.3	114.5	113.6	112.0	110.5	110.4	112.0	110.8	116.1
2,184.0	70	2,387	113.9	114.2	114.4	114.4	113.5	111.7	110.3	110.1	111.6	110.6	113.3
1,872.0	60	2,067	113.7	114.4	114.3	114.0	113.2	111.3	109.8	109.5	111.2	111.2	108.1
1,560.0	50	1,744	112.9	114.2	113.5	113.1	112.2	110.5	109.0	108.7	110.7	110.2	106.4
1,248.0	40	1,413	112.1	112.7	112.4	112.1	111.0	109.8	108.2	107.7	110.5	107.3	104.8
936.0	30	1,081	111.4	112.6	111.9	111.3	110.1	109.2	107.3	106.9	108.7	105.1	102.7
780.0	25	914	111.2	112.6	111.6	111.1	109.8	109.0	107.0	106.6	107.3	104.5	101.9
624.0	20	747	111.6	112.3	111.3	111.1	109.7	108.9	106.3	106.1	105.6	104.2	101.7
312.0	10	415	112.5	112.7	111.8	110.6	110.1	108.4	105.8	103.8	104.0	103.4	100.3

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1500 RPM

GENSET POWER WITH FAN		EKW	3,120.0	2,340.0	1,560.0	780.0	312.0
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BKW**	**3,368**	**2,547**	**1,744**	**914**	**415**
TOTAL NOX (AS NO2)		G/HR	27,105	14,946	10,346	5,471	4,056
TOTAL CO		G/HR	4,425	6,028	4,456	2,665	2,201
TOTAL HC		G/HR	635	717	829	1,071	1,177
PART MATTER		G/HR	74.3	169.8	228.9	206.6	97.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,815.3	1,952.9	1,957.0	1,829.2	2,594.4
TOTAL CO	(CORR 5% O2)	MG/NM3	459.1	788.1	849.1	899.9	1,411.1
TOTAL HC	(CORR 5% O2)	MG/NM3	57.2	80.8	137.0	315.6	651.2
PART MATTER	(CORR 5% O2)	MG/NM3	6.5	18.9	37.6	60.3	50.2
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,371	951	953	891	1,264
TOTAL CO	(CORR 5% O2)	PPM	367	630	679	720	1,129
TOTAL HC	(CORR 5% O2)	PPM	107	151	256	589	1,216
TOTAL NOX (AS NO2)		G/HP-HR	5.99	4.36	4.41	4.45	7.26
TOTAL CO		G/HP-HR	0.98	1.76	1.90	2.17	3.94
TOTAL HC		G/HP-HR	0.14	0.21	0.35	0.87	2.11
PART MATTER		G/HP-HR	0.02	0.05	0.10	0.17	0.18
TOTAL NOX (AS NO2)		LB/HR	59.76	32.95	22.81	12.06	8.94
TOTAL CO		LB/HR	9.75	13.29	9.82	5.88	4.85
TOTAL HC		LB/HR	1.40	1.58	1.83	2.36	2.59
PART MATTER		LB/HR	0.16	0.37	0.50	0.46	0.22

RATED SPEED NOMINAL DATA: 1500 RPM

GENSET POWER WITH FAN		EKW	3,120.0	2,340.0	1,560.0	780.0	312.0
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BKW**	**3,368**	**2,547**	**1,744**	**914**	**415**
TOTAL NOX (AS NO2)		G/HR	22,587	12,455	8,621	4,559	3,380
TOTAL CO		G/HR	2,458	3,349	2,475	1,481	1,223
TOTAL HC		G/HR	478	539	623	805	885
TOTAL CO2		KG/HR	2,188	1,729	1,185	663	359
PART MATTER		G/HR	53.1	121.3	163.5	147.6	69.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	2,346.1	1,627.4	1,630.8	1,524.3	2,162.0
TOTAL CO	(CORR 5% O2)	MG/NM3	255.0	437.9	471.7	500.0	784.0

TOTAL HC	(CORR 5% O2)	MG/NM3	43.0	60.7	103.0	237.3	489.6
PART MATTER	(CORR 5% O2)	MG/NM3	4.6	13.5	26.8	43.1	35.9
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,143	793	794	742	1,053
TOTAL CO	(CORR 5% O2)	PPM	204	350	377	400	627
TOTAL HC	(CORR 5% O2)	PPM	80	113	192	443	914
TOTAL NOX (AS NO2)		G/HP-HR	4.99	3.64	3.67	3.70	6.05
TOTAL CO		G/HP-HR	0.54	0.98	1.05	1.20	2.19
TOTAL HC		G/HP-HR	0.11	0.16	0.27	0.65	1.58
PART MATTER		G/HP-HR	0.01	0.04	0.07	0.12	0.13
TOTAL NOX (AS NO2)		LB/HR	49.80	27.46	19.01	10.05	7.45
TOTAL CO		LB/HR	5.42	7.38	5.46	3.26	2.70
TOTAL HC		LB/HR	1.05	1.19	1.37	1.78	1.95
TOTAL CO2		LB/HR	4,824	3,812	2,612	1,462	791
PART MATTER		LB/HR	0.12	0.27	0.36	0.33	0.15
OXYGEN IN EXH		%	10.1	11.4	11.9	13.1	15.3
DRY SMOKE OPACITY		%	0.1	1.2	3.2	4.3	1.7
BOSCH SMOKE NUMBER			0.68	0.79	0.97	1.07	0.83

Regulatory Information

NON-CERTIFIED	1970 - 2100
THIS ENGINE RATING IS NOT EMISSIONS CERTIFIED BY ANY DOMESTIC OR FOREIGN AGENCY.	

Altitude Derate Data

ALTITUDE DERATE DATA IS BASED ON THE ASSUMPTION OF A 20 DEGREES CELSIUS(36 DEGREES FAHRENHEIT) DIFFERENCE BETWEEN AMBIENT OPERATING TEMPERATURE AND ENGINE INLET SCAC TEMPERATURE. AMBIENT OPERATING TEMPERATURE IS DEFINED AS THE AIR TEMPERATURE MEASURED AT THE TURBOCHARGER COMPRESSOR INLET.

ALTITUDE CORRECTED POWER CAPABILITY (BKW)

AMBIENT OPERATING TEMP (C)	0	5	10	15	20	25	30	35	40	45	50	55	60	NORMAL
ALTITUDE (M)														
0	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368
250	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,210	2,807	2,717	2,677	2,635	3,368
500	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,368	2,804	2,761	2,717	2,679	2,622	3,368
750	3,368	3,368	3,368	3,368	3,368	3,368	3,368	3,310	2,803	2,762	2,713	2,677	2,616	3,368
1,000	3,368	3,368	3,368	3,368	3,368	3,368	3,343	3,127	2,806	2,764	2,711	2,665	2,608	3,368
1,250	3,365	3,365	3,365	3,364	3,364	3,364	3,295	2,850	2,809	2,765	2,711	2,646	2,595	3,364
1,500	3,303	3,294	3,285	3,276	3,265	3,254	3,155	2,855	2,813	2,758	2,697	2,639	2,543	3,273
1,750	3,220	3,207	3,193	3,181	3,165	3,150	2,977	2,789	2,740	2,678	2,608	2,546	2,447	3,182
2,000	3,117	3,103	3,090	3,079	3,065	3,051	2,756	2,645	2,584	2,517	2,438	2,360	2,304	3,083
2,250	3,017	3,006	2,995	2,986	2,975	2,826	2,627	2,542	2,487	2,429	2,363	2,295	2,243	2,993
2,500	2,918	2,910	2,901	2,893	2,885	2,628	2,537	2,464	2,416	2,368	2,316	2,260	2,206	2,902
2,750	2,821	2,813	2,803	2,795	2,785	2,668	2,564	2,481	2,428	2,377	2,327	2,275	2,224	2,807
3,000	2,722	2,713	2,703	2,694	2,684	2,656	2,567	2,487	2,431	2,378	2,330	2,282	2,228	2,710
3,250	2,620	2,609	2,599	2,590	2,582	2,565	2,532	2,477	2,421	2,367	2,321	2,277	2,214	2,610
3,500	2,523	2,512	2,501	2,494	2,485	2,475	2,467	2,434	2,390	2,347	2,306	2,256	2,178	2,516
3,750	2,432	2,420	2,410	2,403	2,394	2,386	2,379	2,362	2,343	2,319	2,285	2,224	2,124	2,428
4,000	2,338	2,323	2,312	2,302	2,292	2,284	2,276	2,267	2,257	2,242	2,217	2,167	2,072	2,338
4,250	2,242	2,223	2,208	2,195	2,184	2,175	2,164	2,155	2,145	2,132	2,116	2,094	2,022	2,249
4,500	2,145	2,126	2,111	2,098	2,088	2,079	2,068	2,060	2,052	2,041	2,030	2,022	1,973	2,159

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
4577023	LL6686	4806566	GS269	-	BXR00001	
4577023	LL6685	5683573	PG325	-	TZ800100	
4577023	LL6686	5683573	PG325	-	TZ800100	

Performance Parameter Reference

Parameters Reference:DM9600-12
PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request (SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%
Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.
REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 15 deg C (59 deg F), where the density is 850 G/Liter (7.0936 Lbs/Gal).
GAS

Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.
ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.
ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.
Standard temperature values versus altitude could be seen on TM2001.
When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.
Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.
Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.
REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.
Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.
EMISSION CYCLE LIMITS:
Cycle emissions Max Limits apply to cycle-weighted averages only. Emissions at individual load points may exceed the cycle-weighted limit.
EMISSIONS DEFINITIONS:
Emissions : DM1176
EMISSION CYCLE DEFINITIONS
1. For constant-speed marine engines for ship main propulsion, including,diesel-electric drive, test cycle E2 shall be applied, for controllable-pitch propeller sets
test cycle E2 shall be applied.
2. For propeller-law-operated main and propeller-law-operated auxiliary engines the test cycle E3 shall be applied.
3. For constant-speed auxiliary engines test cycle D2 shall be applied.
4. For variable-speed, variable-load auxiliary engines, not included above, test cycle C1 shall be applied.
HEAT REJECTION DEFINITIONS:
Diesel Circuit Type and HHV Balance : DM9500
HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500
RATING DEFINITIONS:
Agriculture : TM6008
Fire Pump : TM6009
Generator Set : TM6035
Generator (Gas) : TM6041
Industrial Diesel : TM6010
Industrial (Gas) : TM6040
Irrigation : TM5749
Locomotive : TM6037
Marine Auxiliary : TM6036
Marine Prop (Except 3600) : TM5747
Marine Prop (3600 only) : TM5748
MSHA : TM6042
Oil Field (Petroleum) : TM6011
Off-Highway Truck : TM6039
On-Highway Truck : TM6038
SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 07/10/19

PERFORMANCE DATA[DM9822]

November 26, 2020

Performance Number: DM9822 **Change Level: 00**

SALES MODEL:	C18	**COMBUSTION:**	DIRECT INJECTION
BRAND:	CAT	**ENGINE SPEED (RPM):**	1,500
ENGINE POWER (BKW):	585.0	**HERTZ:**	50
GEN POWER W/O FAN (EKW):	536.0	**FAN POWER (KW):**	17.9
GEN POWER WITH FAN (EKW):	528.0	**ASPIRATION:**	TA
COMPRESSION RATIO:	14.5	**AFTERCOOLER TYPE:**	ATAAC
RATING LEVEL:	STANDBY	**AFTERCOOLER CIRCUIT TYPE:**	JW+OC, ATAAC
PUMP QUANTITY:	1	**INLET MANIFOLD AIR TEMP (C):**	49
FUEL TYPE:	DIESEL	**JACKET WATER TEMP (C):**	89
MANIFOLD TYPE:	DRY	**TURBO CONFIGURATION:**	PARALLEL
GOVERNOR TYPE:	ELEC	**TURBO QUANTITY:**	2
INJECTOR TYPE:	EUI	**TURBOCHARGER MODEL:**	S310S089-1.00
REF EXH STACK DIAMETER (MM):	152	**COMBUSTION STRATEGY:**	LOW BSFC
MAX OPERATING ALTITUDE (M):	3,353	**PISTON SPD @ RATED ENG SPD (M/SEC):**	9.2

INDUSTRY	SUBINDUSTRY	APPLICATION
ELECTRIC POWER	STANDARD	PACKAGED GENSET
OIL AND GAS	LAND PRODUCTION	PACKAGED GENSET

General Performance Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	BRAKE MEAN EFF PRES (BMEP)	BRAKE SPEC FUEL CONSUMPTN (BSFC)	VOL FUEL CONSUMPTN (VFC)	INLET MFLD PRES	INLET MFLD TEMP	EXH MFLD TEMP	EXH MFLD PRES	ENGINE OUTLET TEMP
EKW	%	BKW	KPA	G/BKW-HR	L/HR	KPA	DEG C	DEG C	KPA	DEG C
528.0	100	585	2,581	193.6	133.2	190.8	48.9	727.0	133.8	571.1
475.2	90	527	2,324	193.9	120.1	169.2	46.4	699.7	117.2	554.0
422.4	80	469	2,070	192.8	106.4	144.0	44.1	667.3	98.7	532.6
396.0	75	441	1,944	192.2	99.6	131.1	43.0	650.3	89.5	521.9
369.6	70	412	1,818	192.2	93.2	119.4	42.0	633.7	81.5	511.0
316.8	60	356	1,570	192.8	80.7	97.4	40.4	598.6	67.0	489.4
264.0	50	300	1,323	194.3	68.6	77.0	39.3	561.0	54.3	467.6
211.2	40	246	1,084	197.0	56.9	58.3	38.6	515.3	43.3	437.2
158.4	30	191	845	201.6	45.4	41.3	38.3	458.0	34.0	395.7
132.0	25	164	724	205.3	39.6	33.4	38.3	424.8	29.8	370.7
105.6	20	136	600	210.7	33.7	26.1	38.3	386.7	26.1	340.8
52.8	10	78.3	345	234.7	21.6	14.3	38.5	289.8	19.9	259.9

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	COMPRESSOR OUTLET PRES	COMPRESSOR OUTLET TEMP	WET INLET AIR VOL FLOW RATE	ENGINE OUTLET WET EXH GAS VOL FLOW RATE	WET INLET AIR MASS FLOW RATE	WET EXH GAS MASS FLOW RATE	ENGINE OUTLET WET EXH VOL FLOW RATE (0 DEG C AND 101 KPA)	ENGINE OUTLET DRY EXH VOL FLOW RATE (0 DEG C AND 101 KPA)
EKW	%	BKW	KPA	DEG C	M3/MIN	M3/MIN	KG/HR	KG/HR	M3/MIN	M3/MIN
528.0	100	585	200	184.5	34.2	102.4	2,406.9	2,520.1	33.1	29.7
475.2	90	527	178	169.9	32.2	93.5	2,246.5	2,348.6	30.9	27.8
422.4	80	469	152	153.1	29.5	83.0	2,047.9	2,138.3	28.1	25.3
396.0	75	441	139	144.8	28.1	77.6	1,944.3	2,029.0	26.7	24.1
369.6	70	412	127	136.5	26.9	73.0	1,850.0	1,929.2	25.4	23.0
316.8	60	356	104	120.2	24.4	64.0	1,670.2	1,738.7	22.9	20.8
264.0	50	300	83	104.1	22.0	55.6	1,500.9	1,559.2	20.5	18.7
211.2	40	246	64	88.7	19.8	47.6	1,342.8	1,391.1	18.3	16.7
158.4	30	191	46	73.5	17.7	39.8	1,196.7	1,235.3	16.3	15.0
132.0	25	164	38	66.0	16.7	36.0	1,127.8	1,161.5	15.3	14.2
105.6	20	136	30	58.9	15.8	32.3	1,064.3	1,093.0	14.4	13.4
52.8	10	78.3	18	47.1	14.3	25.2	963.8	982.2	12.9	12.2

Heat Rejection Data

GENSET POWER WITH FAN	PERCENT LOAD	ENGINE POWER	REJECTION TO JACKET WATER	REJECTION TO ATMOSPHERE	REJECTION TO EXH	EXH RECOVERY TO 177C	FROM OIL COOLER	FROM AFTERCOOLER	WORK ENERGY	LOW HEAT VALUE ENERGY	HIGH HEAT VALUE ENERGY

EKW	%	BKW	KW	KW	KW	KW	KW	KW	KW	KW	KW
528.0	100	585	169	84.2	504	301	71.7	91.2	585	1,346	1,434
475.2	90	527	156	78.4	454	267	64.6	77.5	527	1,213	1,292
422.4	80	469	143	74.5	396	228	57.3	62.4	469	1,075	1,145
396.0	75	441	137	71.5	368	210	53.6	55.3	441	1,006	1,072
369.6	70	412	131	69.4	342	193	50.1	48.8	412	941	1,003
316.8	60	356	119	62.9	293	162	43.4	37.2	356	815	868
264.0	50	300	107	54.1	250	134	36.9	27.2	300	692	738
211.2	40	246	94.7	47.3	206	107	30.6	18.8	246	575	613
158.4	30	191	81.5	40.6	163	78.8	24.4	11.8	191	459	489
132.0	25	164	74.4	36.7	142	65.3	21.3	8.8	164	400	426
105.6	20	136	65.3	33.9	122	51.6	18.1	6.1	136	341	363
52.8	10	78.3	42.4	30.1	79.4	23.1	11.6	2.3	78.3	218	233

Emissions Data

RATED SPEED POTENTIAL SITE VARIATION: 1500 RPM

GENSET POWER WITH FAN		**EKW**	**528.0**	**396.0**	**264.0**	**132.0**	**52.8**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BKW**	**585**	**441**	**300**	**164**	**78.3**
TOTAL NOX (AS NO2)		G/HR	5,772	5,528	4,312	2,372	1,327
TOTAL CO		G/HR	1,456	1,118	411	232	474
TOTAL HC		G/HR	6	8	20	14	30
PART MATTER		G/HR	17.6	27.1	17.2	11.5	7.4
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,765.3	4,795.7	5,394.1	5,060.2	5,173.9
TOTAL CO	(CORR 5% O2)	MG/NM3	948.8	967.5	505.2	532.6	2,101.6
TOTAL HC	(CORR 5% O2)	MG/NM3	3.2	5.8	21.7	30.3	114.2
PART MATTER	(CORR 5% O2)	MG/NM3	9.1	19.1	17.6	21.2	26.0
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,834	2,336	2,627	2,465	2,520
TOTAL CO	(CORR 5% O2)	PPM	759	774	404	426	1,681
TOTAL HC	(CORR 5% O2)	PPM	6	11	40	57	213
TOTAL NOX (AS NO2)		G/HP-HR	7.52	9.48	10.78	10.82	12.67
TOTAL CO		G/HP-HR	1.90	1.92	1.03	1.06	4.53
TOTAL HC		G/HP-HR	0.01	0.01	0.05	0.06	0.28
PART MATTER		G/HP-HR	0.02	0.05	0.04	0.05	0.07
TOTAL NOX (AS NO2)		LB/HR	12.73	12.19	9.51	5.23	2.93
TOTAL CO		LB/HR	3.21	2.46	0.91	0.51	1.05
TOTAL HC		LB/HR	0.01	0.02	0.04	0.03	0.07
PART MATTER		LB/HR	0.04	0.06	0.04	0.03	0.02

RATED SPEED NOMINAL DATA: 1500 RPM

GENSET POWER WITH FAN		**EKW**	**528.0**	**396.0**	**264.0**	**132.0**	**52.8**
PERCENT LOAD		**%**	**100**	**75**	**50**	**25**	**10**
ENGINE POWER		**BKW**	**585**	**441**	**300**	**164**	**78.3**
TOTAL NOX (AS NO2)		G/HR	5,344	5,118	3,993	2,196	1,229
TOTAL CO		G/HR	779	598	220	124	254
TOTAL HC		G/HR	3	4	11	7	16
TOTAL CO2		KG/HR	351	264	182	106	58
PART MATTER		G/HR	9.0	13.9	8.8	5.9	3.8
TOTAL NOX (AS NO2)	(CORR 5% O2)	MG/NM3	3,486.4	4,440.4	4,994.5	4,685.4	4,790.6
TOTAL CO	(CORR 5% O2)	MG/NM3	507.4	517.4	270.2	284.8	1,123.9
TOTAL HC	(CORR 5% O2)	MG/NM3	1.7	3.1	11.5	16.0	60.4
PART MATTER	(CORR 5% O2)	MG/NM3	4.7	9.8	9.0	10.9	13.3
TOTAL NOX (AS NO2)	(CORR 5% O2)	PPM	1,698	2,163	2,433	2,282	2,333
TOTAL CO	(CORR 5% O2)	PPM	406	414	216	228	899
TOTAL HC	(CORR 5% O2)	PPM	3	6	21	30	113
TOTAL NOX (AS NO2)		G/HP-HR	6.96	8.77	9.98	10.01	11.73
TOTAL CO		G/HP-HR	1.01	1.02	0.55	0.57	2.42
TOTAL HC		G/HP-HR	0.00	0.01	0.03	0.03	0.15
PART MATTER		G/HP-HR	0.01	0.02	0.02	0.03	0.04
TOTAL NOX (AS NO2)		LB/HR	11.78	11.28	8.80	4.84	2.71
TOTAL CO		LB/HR	1.72	1.32	0.48	0.27	0.56
TOTAL HC		LB/HR	0.01	0.01	0.02	0.02	0.03
TOTAL CO2		LB/HR	775	581	402	233	127
PART MATTER		LB/HR	0.02	0.03	0.02	0.01	0.01
OXYGEN IN EXH		%	7.0	8.0	9.4	12.1	15.3
DRY SMOKE OPACITY		%	0.7	0.7	0.7	0.6	0.4
BOSCH SMOKE NUMBER			0.38	0.40	0.38	0.32	0.11

Regulatory Information

NON-CERTIFIED	1970 - 2100
THIS ENGINE RATING IS NOT EMISSIONS CERTIFIED BY ANY DOMESTIC OR FOREIGN AGENCY.	

Altitude Derate Data

ALTITUDE CORRECTED POWER CAPABILITY (BKW)

AMBIENT OPERATING TEMP (C)	0	5	10	15	20	25	30	35	40	45	50	55	60	NORMAL
ALTITUDE (M)														
0	585	585	585	585	585	585	585	585	585	585	585	585	585	585
250	585	585	585	585	585	585	585	585	585	585	585	585	585	585
500	585	585	585	585	585	585	585	585	585	585	585	585	585	585
750	585	585	585	585	585	585	585	585	585	585	585	585	585	585
1,000	585	585	585	585	585	585	585	585	585	585	585	585	585	585
1,250	585	585	585	585	585	585	585	585	585	585	585	585	585	585
1,500	585	585	585	585	585	585	585	585	585	585	585	585	585	585
1,750	585	585	585	585	585	585	585	585	585	585	585	585	585	585
2,000	585	585	585	585	585	585	585	585	585	585	585	585	585	585
2,250	585	585	585	585	585	585	585	585	585	585	585	585	585	585
2,500	585	585	585	585	585	585	585	585	585	585	585	585	585	585
2,750	585	585	585	585	585	585	585	585	585	585	585	576	568	585
3,000	585	585	585	585	585	585	585	585	584	575	566	557	549	585
3,250	585	585	585	585	585	585	583	574	565	556	547	539	531	585
3,500	585	585	585	585	583	573	564	555	546	537	529	521	513	585
3,750	585	585	583	573	564	554	545	536	528	519	511	503	496	585
4,000	584	574	564	554	544	535	526	518	510	502	494	486	479	585
4,250	564	554	544	535	526	517	508	500	492	484	477	470	463	568
4,500	545	535	526	516	508	499	491	483	475	468	460	453	447	552

Cross Reference

Test Spec	Setting	Engine Arrangement	Engineering Model	Engineering Model Version	Start Effective Serial Number	End Effective Serial Number
0K8822	PP6034	2939764	GS408	-	ELL00001	
0K8822	PP6034	3823736	GS408	-	ELM00001	
0K8822	PP6034	3823737	GS408	-	ELM00001	
5643888	PP7475	5787145	GS920	-	LXE00001	
5643888	PP7475	5787145	GS625	XJ	LXE00001	
5643888	PP7475	5824149	GS625	XJ	LXE00001	

Performance Parameter Reference

Parameters Reference:DM9600-12
PERFORMANCE DEFINITIONS

PERFORMANCE DEFINITIONS DM9600
APPLICATION:
Engine performance tolerance values below are representative of a typical production engine tested in a calibrated dynamometer test cell at SAE J1995 standard reference conditions. Caterpillar maintains ISO9001:2000 certified quality management systems for engine test Facilities to assure accurate calibration of test equipment. Engine test data is corrected in accordance with SAE J1995. Additional reference material SAE J1228, J1349, ISO 8665, 3046-1:2002E, 3046-3:1989, 1585, 2534, 2288, and 9249 may apply in part or are similar to SAE J1995. Special engine rating request

(SERR) test data shall be noted.
PERFORMANCE PARAMETER TOLERANCE FACTORS:
Power +/- 3%
Torque +/- 3%
Exhaust stack temperature +/- 8%
Inlet airflow +/- 5%
Intake manifold pressure-gage +/- 10%
Exhaust flow +/- 6%
Specific fuel consumption +/- 3%
Fuel rate +/- 5%
Specific DEF consumption +/- 3%
DEF rate +/- 5%
Heat rejection +/- 5%
Heat rejection exhaust only +/- 10%
Heat rejection CEM only +/- 10%
Heat Rejection values based on using treated water.
Torque is included for truck and industrial applications, do not use for Gen Set or steady state applications.
On C7 - C18 engines, at speeds of 1100 RPM and under these values are provided for reference only, and may not meet the tolerance listed.
These values do not apply to C280/3600. For these models, see the tolerances listed below.
C280/3600 HEAT REJECTION TOLERANCE FACTORS:
Heat rejection +/- 10%
Heat rejection to Atmosphere +/- 50%
Heat rejection to Lube Oil +/- 20%
Heat rejection to Aftercooler +/- 5%
TEST CELL TRANSDUCER TOLERANCE FACTORS:
Torque +/- 0.5%
Speed +/- 0.2%
Fuel flow +/- 1.0%
Temperature +/- 2.0 C degrees
Intake manifold pressure +/- 0.1 kPa
OBSERVED ENGINE PERFORMANCE IS CORRECTED TO SAE J1995 REFERENCE AIR AND FUEL CONDITIONS.
REFERENCE ATMOSPHERIC INLET AIR
FOR 3500 ENGINES AND SMALLER
SAE J1228 AUG2002 for marine engines, and J1995 JAN2014 for other engines, reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity at the stated aftercooler water temp, or inlet manifold temp.
FOR 3600 ENGINES
Engine rating obtained and presented in accordance with ISO 3046/1 and SAE J1995 JANJAN2014 reference atmospheric pressure is 100 KPA (29.61 in hg), and standard temperature is 25deg C (77 deg F) at 30% relative humidity and 150M altitude at the stated aftercooler water temperature.
MEASUREMENT LOCATION FOR INLET AIR TEMPERATURE
Location for air temperature measurement air cleaner inlet at stabilized operating conditions.
REFERENCE EXHAUST STACK DIAMETER
The Reference Exhaust Stack Diameter published with this dataset is only used for the calculation of Smoke Opacity values displayed in this dataset. This value does not necessarily represent the actual stack diameter of the engine due to the variety of exhaust stack adapter options available. Consult the price list, engine order or general dimension drawings for the actual stack diameter size ordered or options available.
REFERENCE FUEL
DIESEL
Reference fuel is #2 distillate diesel with a 35API gravity;
A lower heating value is 42,780 KJ/KG (18,390 BTU/LB) when used at 15 deg C (59 deg F), where the density is 850 G/Liter (7.0936 Lbs/Gal).
GAS
Reference natural gas fuel has a lower heating value of 33.74 KJ/L (905 BTU/CU Ft). Low BTU ratings are based on 18.64 KJ/L (500 BTU/CU FT) lower heating value gas. Propane ratings are based on 87.56 KJ/L (2350 BTU/CU Ft) lower heating value gas.
ENGINE POWER (NET) IS THE CORRECTED FLYWHEEL POWER (GROSS) LESS EXTERNAL AUXILIARY LOAD
Engine corrected gross output includes the power required to drive standard equipment; lube oil, scavenge lube oil, fuel transfer, common rail fuel, separate circuit aftercooler and jacket water pumps. Engine net power available for the external (flywheel) load is calculated by subtracting the sum of auxiliary load from the corrected gross flywheel out put power. Typical auxiliary loads are radiator cooling fans, hydraulic pumps, air compressors and battery charging alternators. For Tier 4 ratings additional Parasitic losses would also include Intake, and Exhaust Restrictions.
ALTITUDE CAPABILITY
Altitude capability is the maximum altitude above sea level at standard temperature and standard pressure at which the engine could develop full rated output power on the current performance data set.

PERFORMANCE DATA[DM9822]

Standard temperature values versus altitude could be seen on TM2001.
When viewing the altitude capability chart the ambient temperature is the inlet air temp at the compressor inlet.
Engines with ADEM MEUI and HEUI fuel systems operating at conditions above the defined altitude capability derate for atmospheric pressure and temperature conditions outside the values defined, see TM2001.
Mechanical governor controlled unit injector engines require a setting change for operation at conditions above the altitude defined on the engine performance sheet. See your Caterpillar technical representative for non standard ratings.
REGULATIONS AND PRODUCT COMPLIANCE
TMI Emissions information is presented at 'nominal' and 'Potential Site Variation' values for standard ratings. No tolerances are applied to the emissions data. These values are subject to change at any time. The controlling federal and local emission requirements need to be verified by your Caterpillar technical representative.
Customer's may have special emission site requirements that need to be verified by the Caterpillar Product Group engineer.
EMISSION CYCLE LIMITS:
Cycle emissions Max Limits apply to cycle-weighted averages only. Emissions at individual load points may exceed the cycle-weighted limit.
EMISSIONS DEFINITIONS:
Emissions : DM1176
EMISSION CYCLE DEFINITIONS
1. For constant-speed marine engines for ship main propulsion, including,diesel-electric drive, test cycle E2 shall be applied, for controllable-pitch propeller sets
test cycle E2 shall be applied.
2. For propeller-law-operated main and propeller-law-operated auxiliary engines the test cycle E3 shall be applied.
3. For constant-speed auxiliary engines test cycle D2 shall be applied.
4. For variable-speed, variable-load auxiliary engines, not included above, test cycle C1 shall be applied.
HEAT REJECTION DEFINITIONS:
Diesel Circuit Type and HHV Balance : DM9500
HIGH DISPLACEMENT (HD) DEFINITIONS:
3500: EM1500
RATING DEFINITIONS:
Agriculture : TM6008
Fire Pump : TM6009
Generator Set : TM6035
Generator (Gas) : TM6041
Industrial Diesel : TM6010
Industrial (Gas) : TM6040
Irrigation : TM5749
Locomotive : TM6037
Marine Auxiliary : TM6036
Marine Prop (Except 3600) : TM5747
Marine Prop (3600 only) : TM5748
MSHA : TM6042
Oil Field (Petroleum) : TM6011
Off-Highway Truck : TM6039
On-Highway Truck : TM6038
SOUND DEFINITIONS:
Sound Power : DM8702
Sound Pressure : TM7080
Date Released : 07/10/19

Appendix E

Modelled Generator Stacks Coordinates

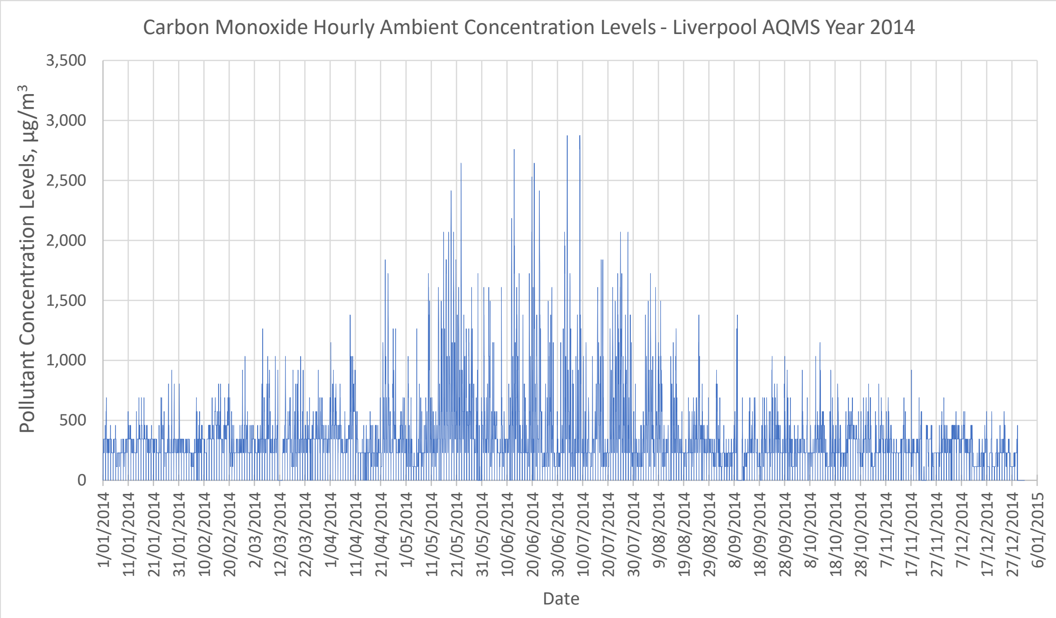
Table 19: Modelled generator stacks coordinates

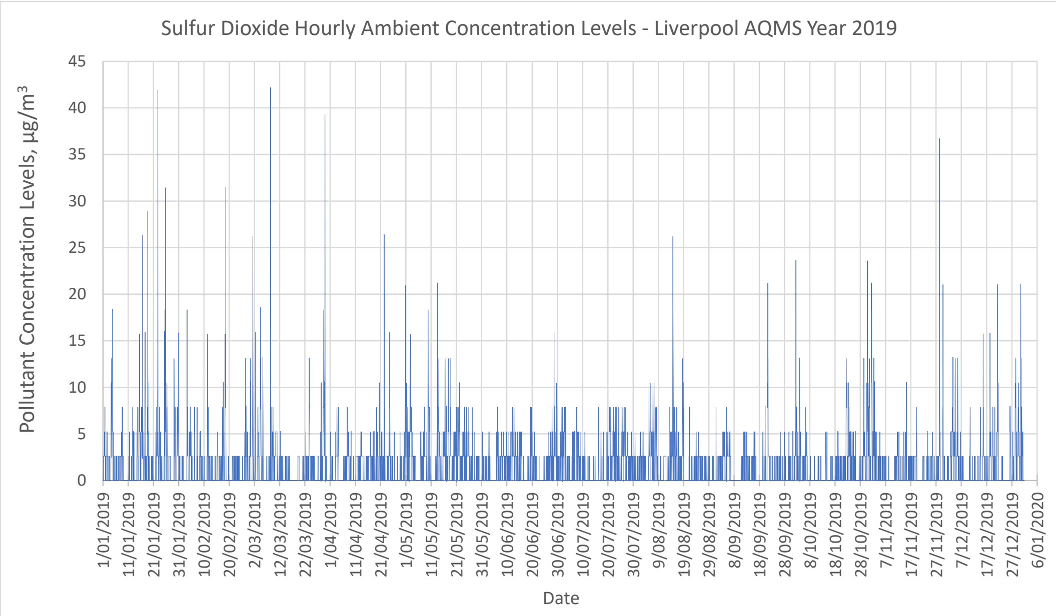
Stack ID	Stack Coordinate	
	X: Easting (m)	Y: Northing (m)
Stack 1	293776.80	6253852.14
Stack 2	293776.92	6253847.73
Stack 3	293816.37	6253851.22
Stack 4	293816.06	6253846.83
Stack 5	293775.20	6253768.85
Stack 6	293775.10	6253764.56
Stack 7	293814.41	6253767.98
Stack 8	293814.31	6253763.69
Stack 9	293862.18	6253850.37
Stack 10	293862.08	6253845.89
Stack 11	293901.97	6253849.38
Stack 12	293901.77	6253845.11
Stack 13	293860.74	6253767.04
Stack 14	293860.33	6253762.57
Stack 15	293900.00	6253766.16
Stack 16	293899.59	6253761.69
Stack 17	293947.79	6253848.36
Stack 18	293947.90	6253843.98
Stack 19	293986.95	6253847.48
Stack 20	293986.96	6253843.00
Stack 21	293945.93	6253765.14
Stack 22	293946.15	6253760.76
Stack 23	293985.61	6253764.15
Stack 24	293985.20	6253759.89
Stack 25	294032.98	6253846.35
Stack 26	294032.89	6253841.98
Stack 27	294072.35	6253845.47
Stack 28	294072.25	6253841.10
Stack 29	294030.92	6253763.24
Stack 30	294031.03	6253758.86
Stack 31	294070.49	6253762.26
Stack 32	294070.29	6253757.99
Stack 33	294118.28	6253844.45
Stack 34	294118.29	6253840.17
Stack 35	294157.75	6253843.57

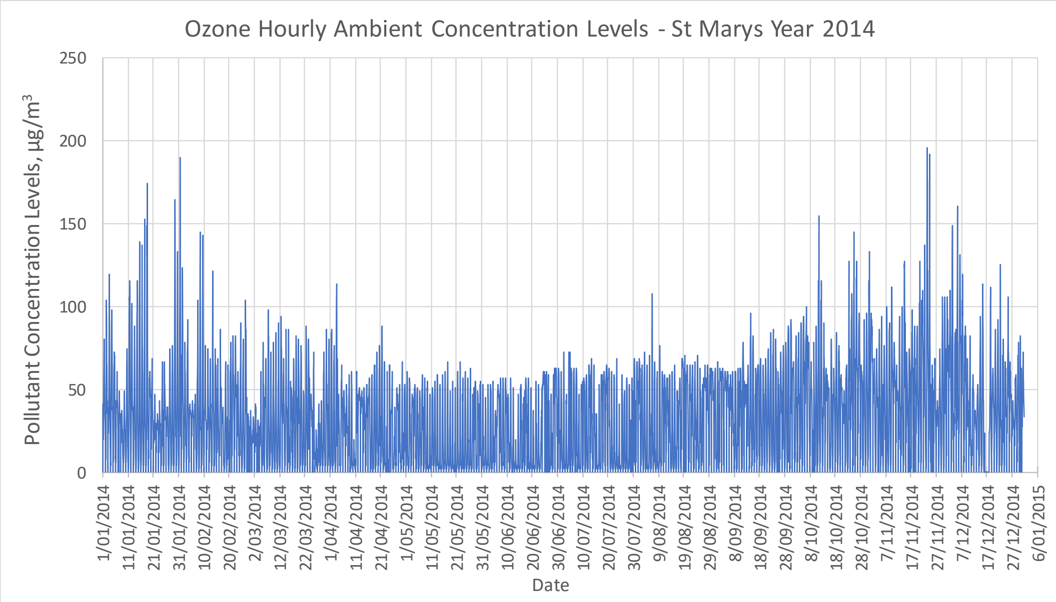
Stack ID	Stack Coordinate	
	X: Easting (m)	Y: Northing (m)
Stack 36	294157.66	6253839.19
Stack 37	294116.42	6253761.23
Stack 38	294116.43	6253756.86
Stack 39	294155.90	6253760.35
Stack 40	294155.80	6253755.98
Stack 41	293892.37	6253876.89
Stack 42	293892.37	6253872.52
Stack 43	293932.05	6253876.01
Stack 44	293932.16	6253871.63
Stack 45	293977.88	6253875.09
Stack 46	293977.67	6253870.61
Stack 47	294017.24	6253874.21
Stack 48	294017.14	6253869.73
Stack 49	294063.38	6253872.97
Stack 50	294063.39	6253868.70
Stack 51	294102.75	6253872.09
Stack 52	294102.55	6253867.83
Stack 53	294148.47	6253871.07
Stack 54	294148.16	6253866.70
Stack 55	294188.15	6253870.19
Stack 56	294187.84	6253865.82
Stack 57	294233.97	6253869.17
Stack 58	294234.19	6253864.89
Stack 59	294273.55	6253868.28
Stack 60	294273.56	6253864.01
Stack 61 (Admin Block)	293745.30	6253767.89
Stack 62 (Admin Block)	293853.31	6253885.00

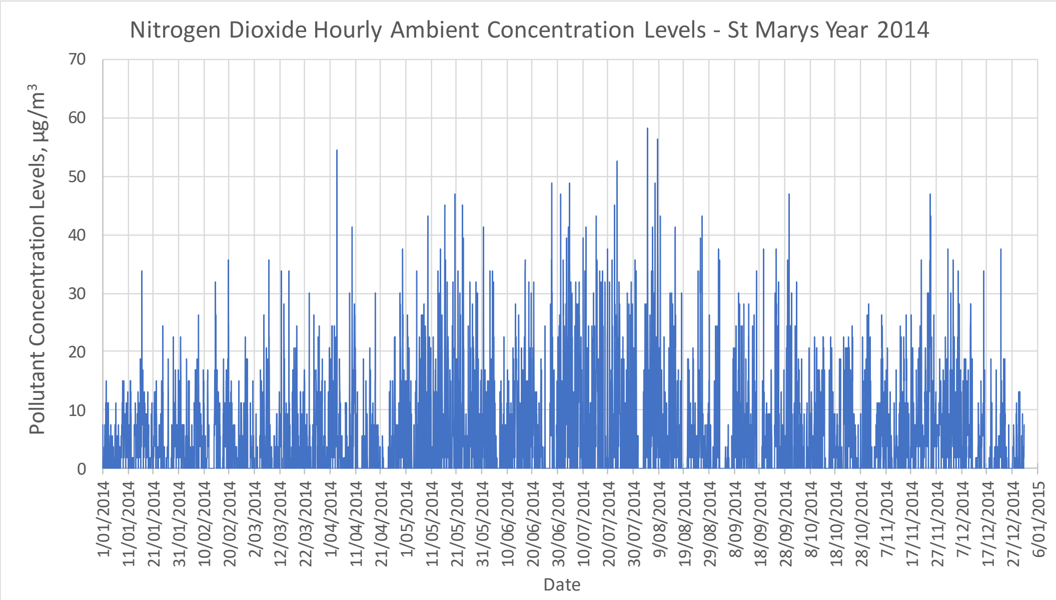
Appendix F

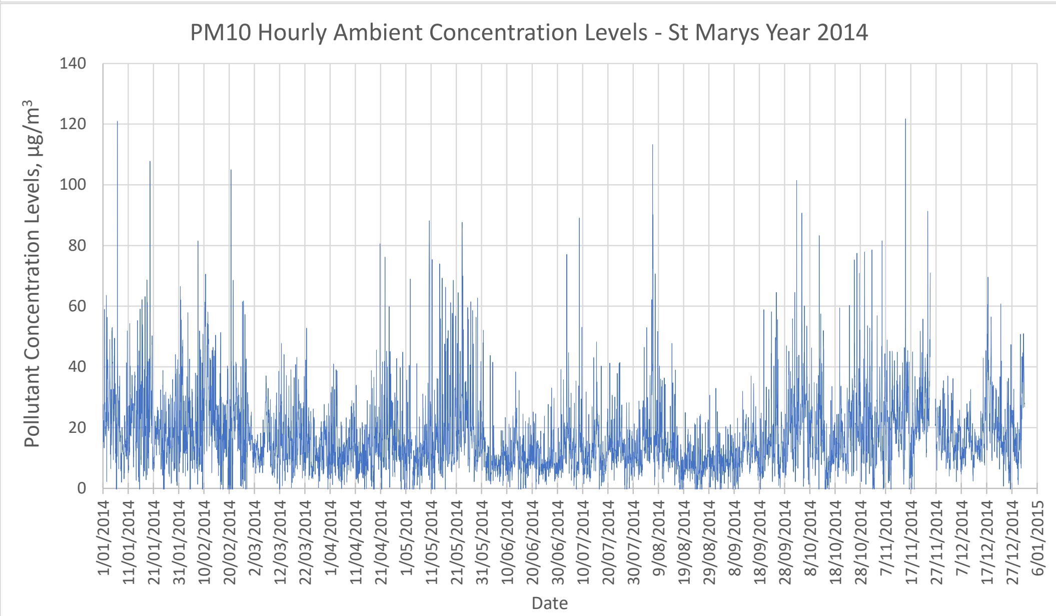
Background Air Quality Charts

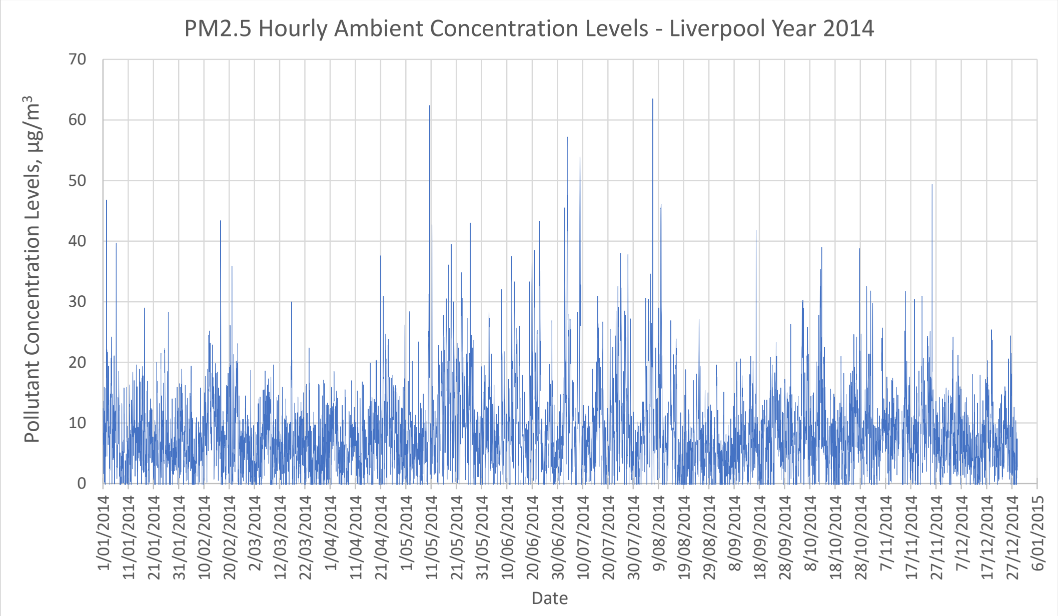

Carbon Monoxide Hourly Ambient Concentration Levels - Liverpool AQMS Year 2014
Pollutant Concentration Levels, µg/m3
3,500
3,000
2,500
2,000
1,500
1,000
500
0
1/01/2014
11/01/2014
21/01/2014
31/01/2014
10/02/2014
20/02/2014
2/03/2014
12/03/2014
22/03/2014
1/04/2014
11/04/2014
21/04/2014
1/05/2014
11/05/2014
21/05/2014
31/05/2014
10/06/2014
20/06/2014
30/06/2014
10/07/2014
20/07/2014
30/07/2014
9/08/2014
19/08/2014
29/08/2014
8/09/2014
18/09/2014
28/09/2014
8/10/2014
18/10/2014
28/10/2014
7/11/2014
17/11/2014
27/11/2014
7/12/2014
17/12/2014
27/12/2014
6/01/2015
Date


Sulfur Dioxide Hourly Ambient Concentration Levels - Liverpool AQMS Year 2019
Pollutant Concentration Levels, µg/m3
45
40
35
30
25
20
15
10
5
0
1/01/2019
11/01/2019
21/01/2019
31/01/2019
10/02/2019
20/02/2019
2/03/2019
12/03/2019
22/03/2019
1/04/2019
11/04/2019
21/04/2019
1/05/2019
11/05/2019
21/05/2019
31/05/2019
10/06/2019
20/06/2019
30/06/2019
10/07/2019
20/07/2019
30/07/2019
9/08/2019
19/08/2019
29/08/2019
8/09/2019
18/09/2019
28/09/2019
8/10/2019
18/10/2019
28/10/2019
7/11/2019
17/11/2019
27/11/2019
7/12/2019
17/12/2019
27/12/2019
6/01/2020
Date


Ozone Hourly Ambient Concentration Levels - St Marys Year 2014
Pollutant Concentration Levels, µg/m³
Date

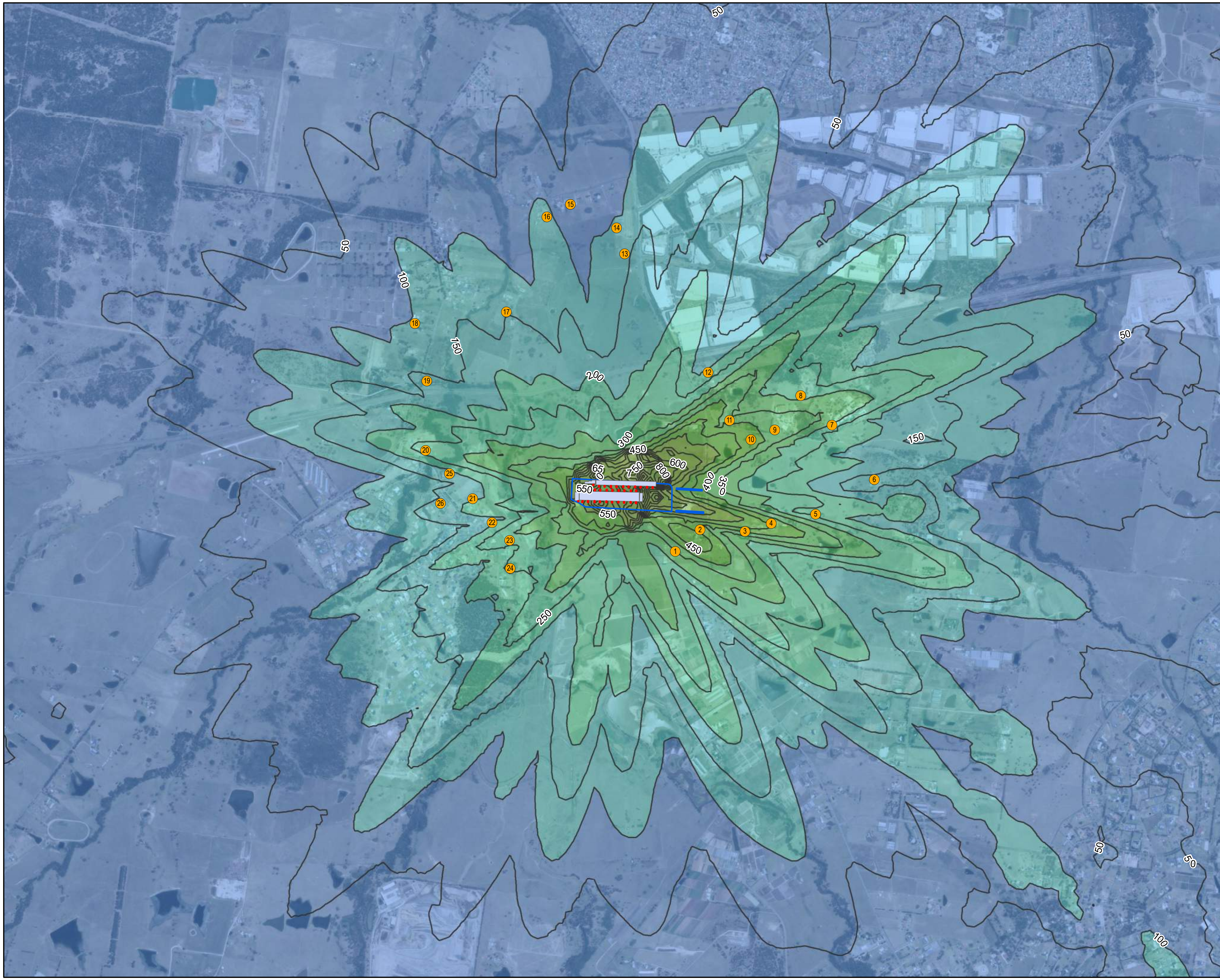

Nitrogen Dioxide Hourly Ambient Concentration Levels - St Marys Year 2014
Pollutant Concentration Levels, µg/m³
Date


PM10 Hourly Ambient Concentration Levels - St Marys Year 2014
Pollutant Concentration Levels, µg/m³
Date


PM2.5 Hourly Ambient Concentration Levels - Liverpool Year 2014
Pollutant Concentration Levels, μg/m³
Date
0
10
20
30
40
50
60
70
1/01/2014
11/01/2014
21/01/2014
31/01/2014
10/02/2014
20/02/2014
2/03/2014
12/03/2014
22/03/2014
1/04/2014
11/04/2014
21/04/2014
1/05/2014
11/05/2014
21/05/2014
31/05/2014
10/06/2014
20/06/2014
30/06/2014
10/07/2014
20/07/2014
30/07/2014
9/08/2014
19/08/2014
29/08/2014
8/09/2014
18/09/2014
28/09/2014
8/10/2014
18/10/2014
28/10/2014
7/11/2014
17/11/2014
27/11/2014
7/12/2014
17/12/2014
27/12/2014
6/01/2015

Appendix G

Predicted Generator Emissions Dispersion Modelling Contours



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration (µg/m^3)

- < 100
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Confidential

Job Title

757-769 Mamre Road, Kemps Creek

Figure Title

CO 8-hour 100th percentile predicted incremental GLC (µg/m^3)

Scale at A3	Figure Status
1:25,000	Preliminary

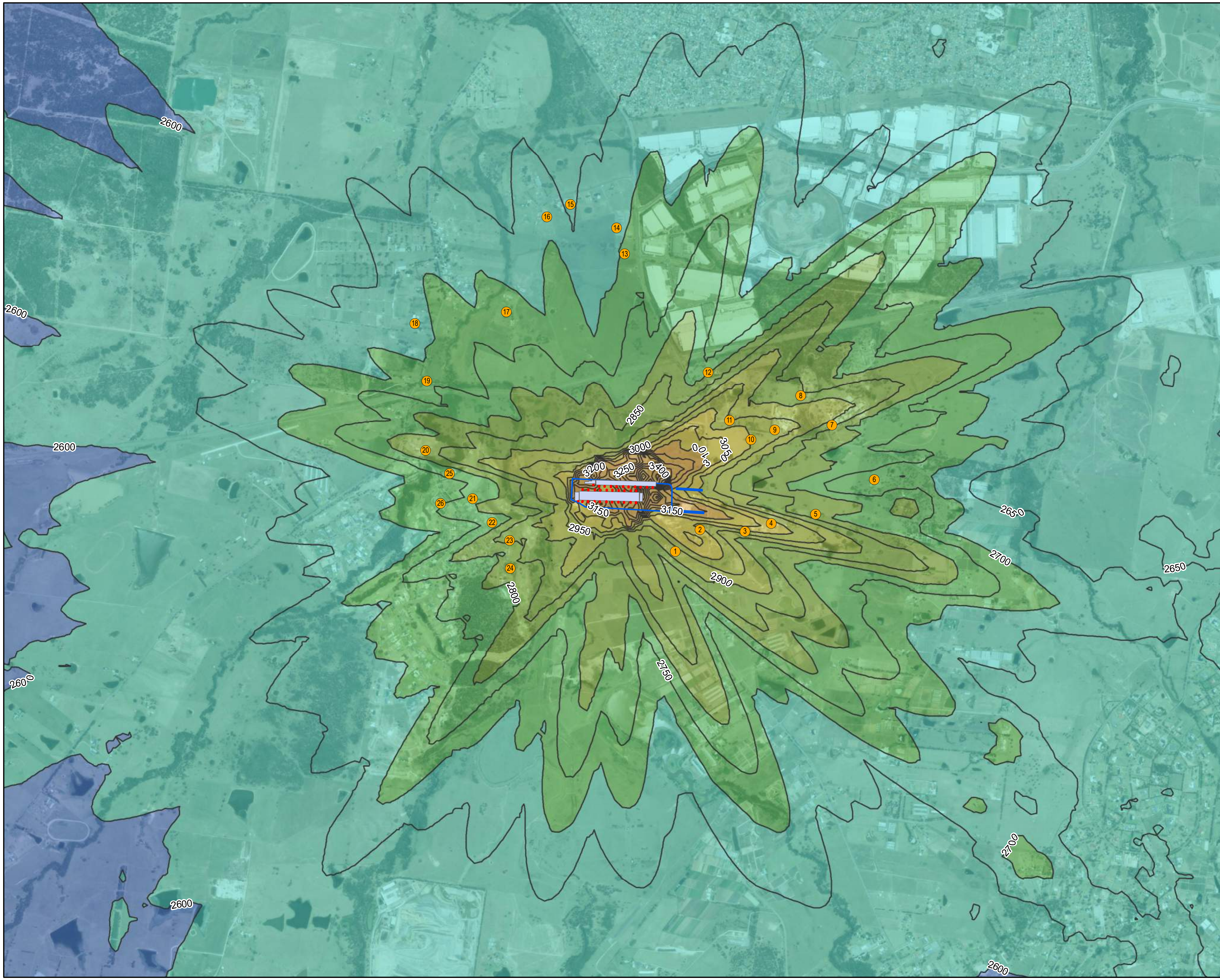
Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
277863	001

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 2,600
- 2,600 - 2,700
- 2,700 - 2,800
- 2,800 - 2,900
- 2,900 - 3,000
- 3,000 - 3,100
- 3,100 - 3,200

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres
0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
CO 8-hour 100th percentile predicted cumulative GLC ($\mu g/m^3$)

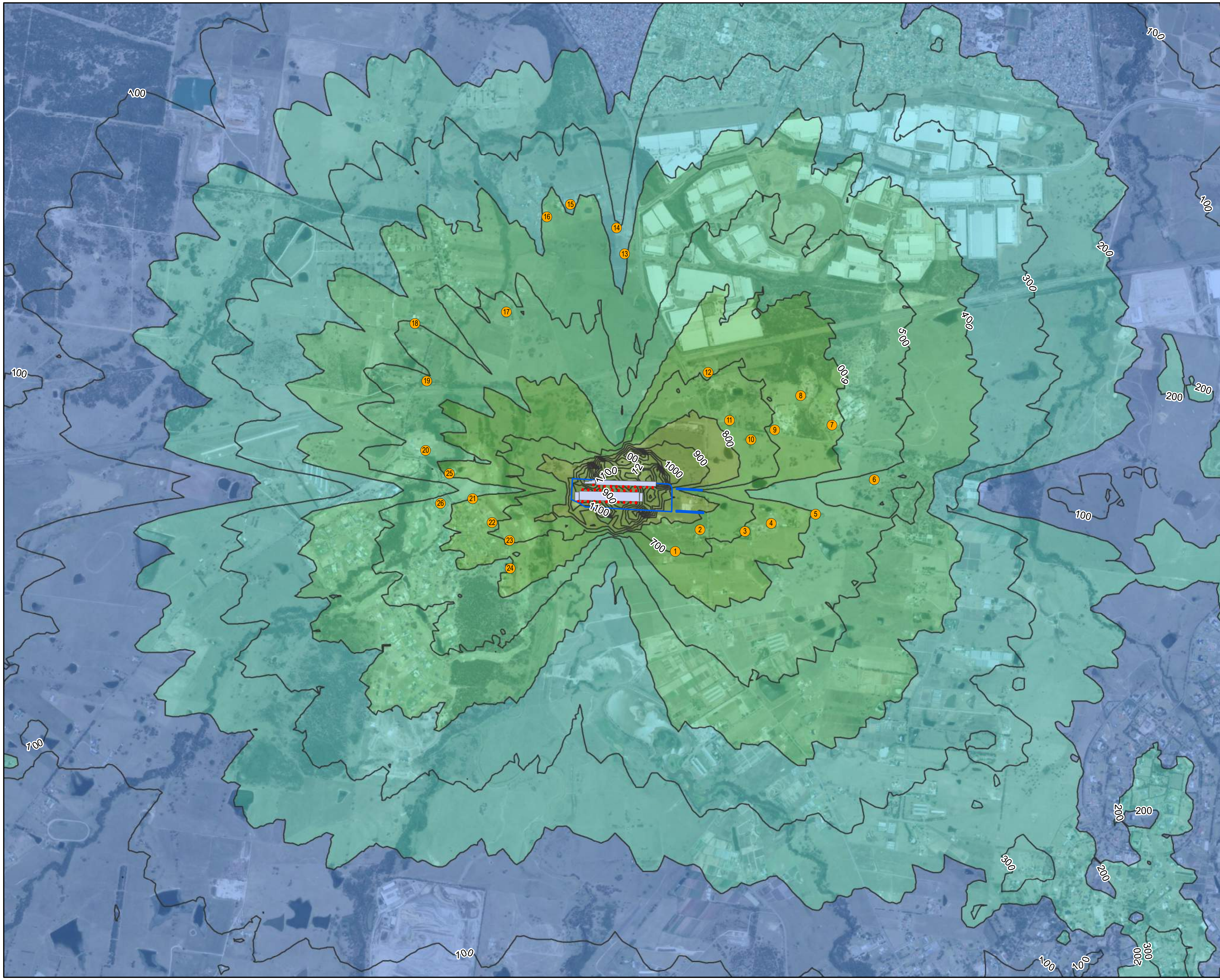
Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	002

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 200
- 200 - 400
- 400 - 600
- 600 - 800
- 800 - 1,000

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Confidential

Job Title

757-769 Mamre Road, Kemps Creek

Figure Title

CO 1-hour 100th percentile predicted incremental GLC ($\mu g/m^3$)

Scale at A3	Figure Status
1:25,000	Preliminary

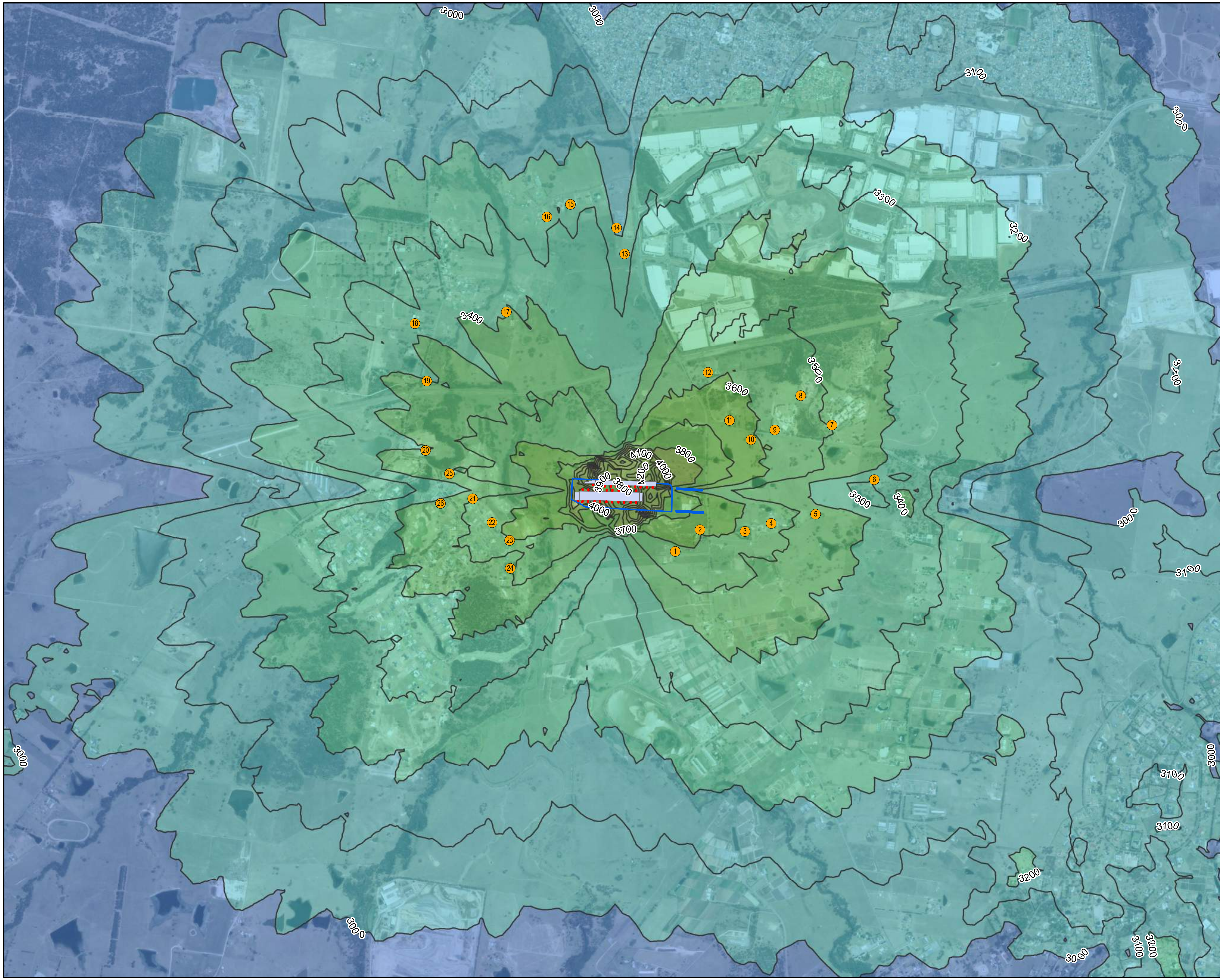
Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
277863	003

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 3,000
- 3,000 - 3,200
- 3,200 - 3,400
- 3,400 - 3,600
- 3,600 - 3,800
- 3,800 - 4,000

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres
0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
CO 1-hour 100th percentile predicted cumulative GLC ($\mu g/m^3$)

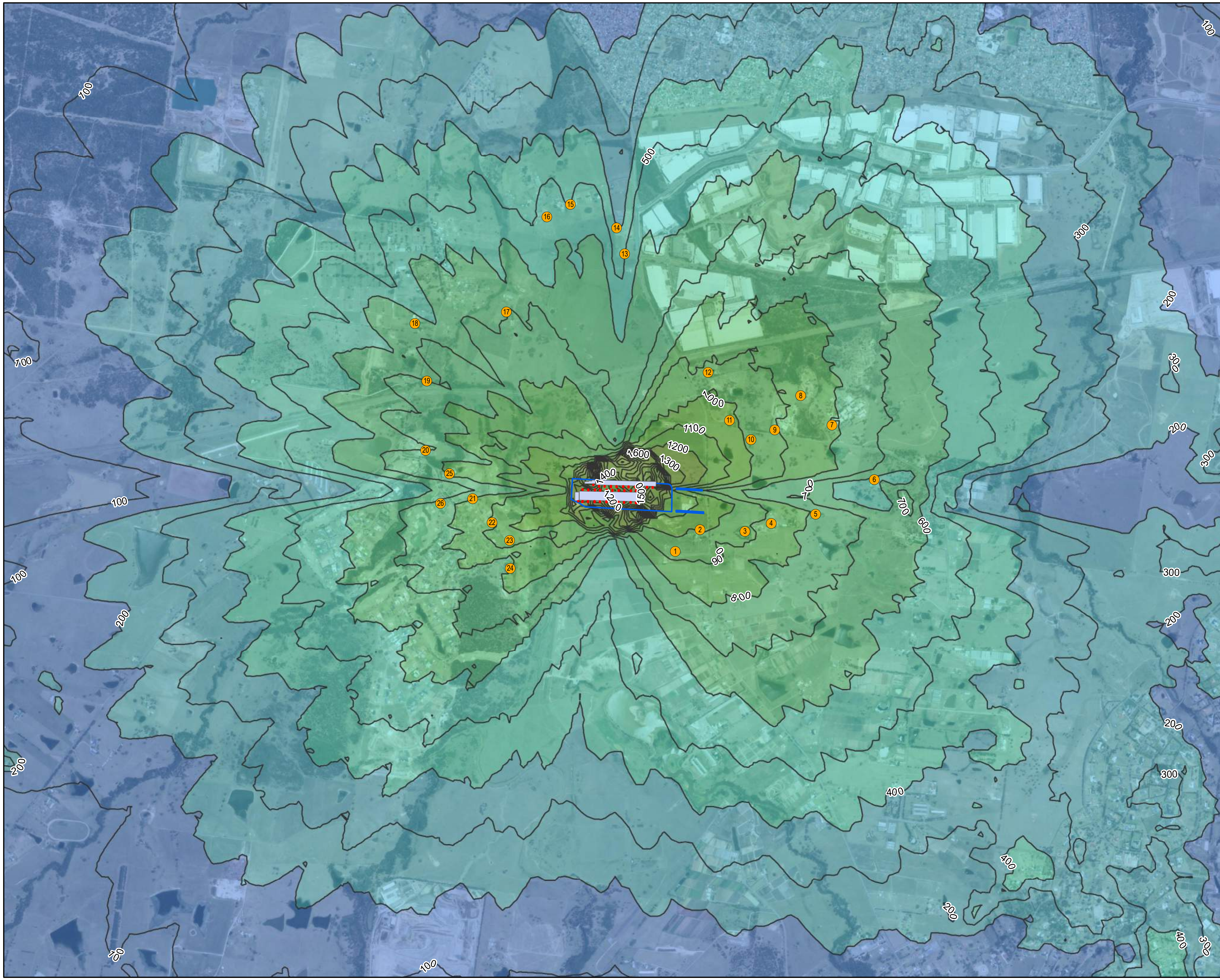
Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	004

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 200
- 200 - 400
- 400 - 600
- 600 - 800
- 800 - 1,000
- 1,000 - 1,200
- 1,200 - 1,400

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
CO 15-min 100th percentile predicted incremental GLC ($\mu g/m^3$)

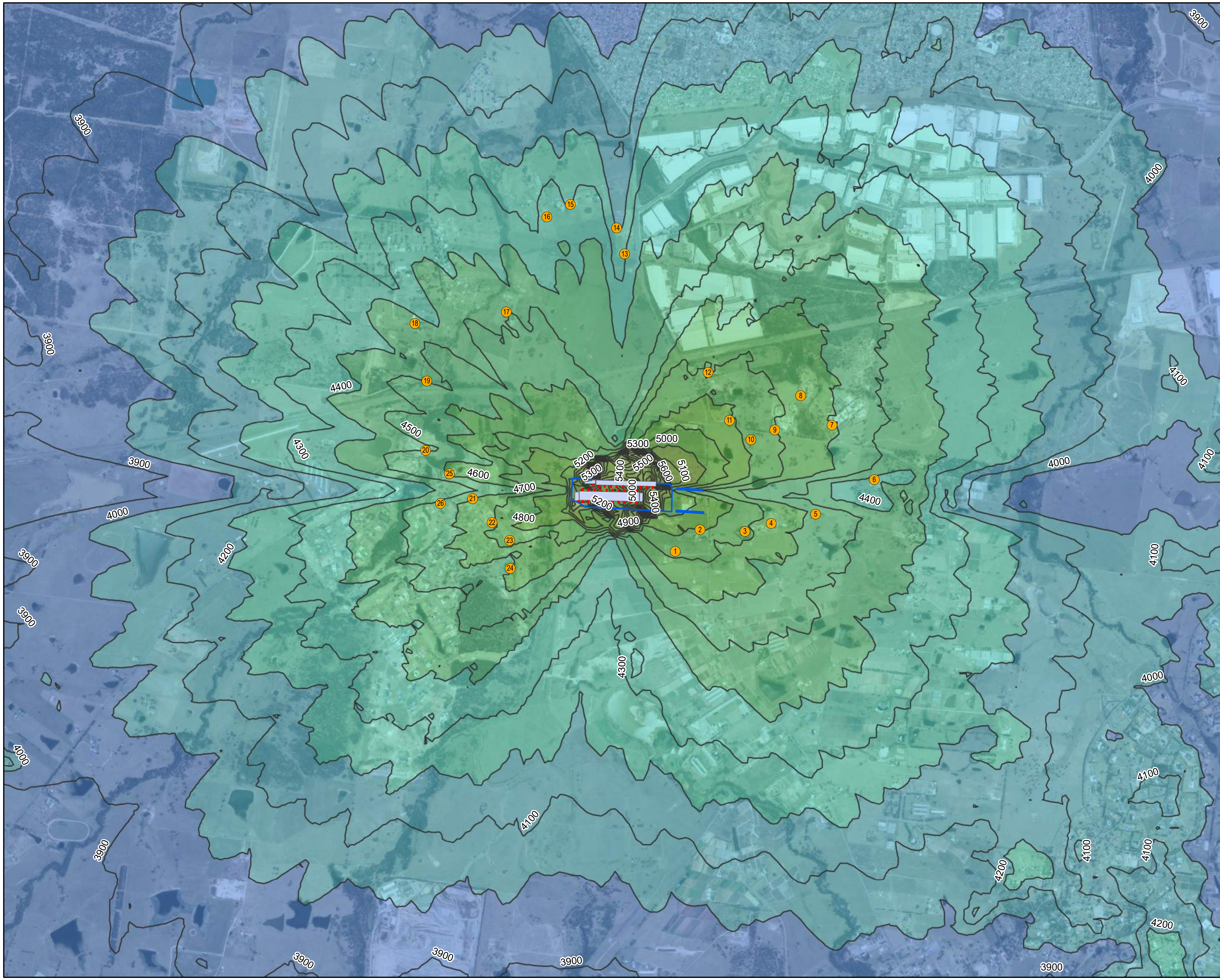
Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	005

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 4,000
- 4,000 - 4,200
- 4,200 - 4,400
- 4,400 - 4,600
- 4,600 - 4,800
- 4,800 - 5,000
- 5,000 - 5,200

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
CO 15-min 100th percentile predicted cumulative GLC ($\mu g/m^3$)

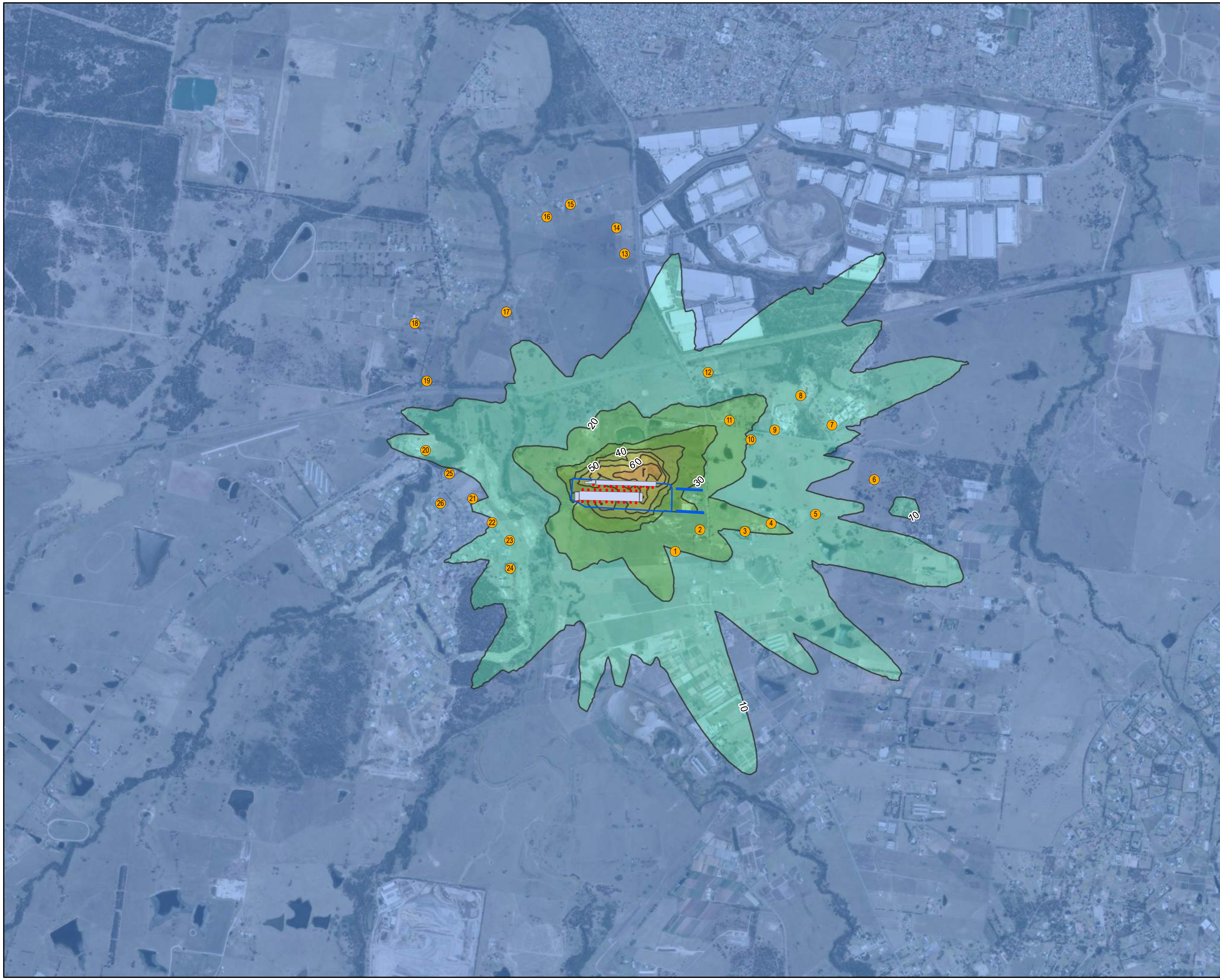
Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	006

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 10
- 10 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Confidential

Job Title

757-769 Mamre Road, Kemps Creek

Figure Title

SO_2 24-hour 100th percentile predicted incremental GLC ($\mu g/m^3$)

Scale at A3	Figure Status
1:25,000	Preliminary

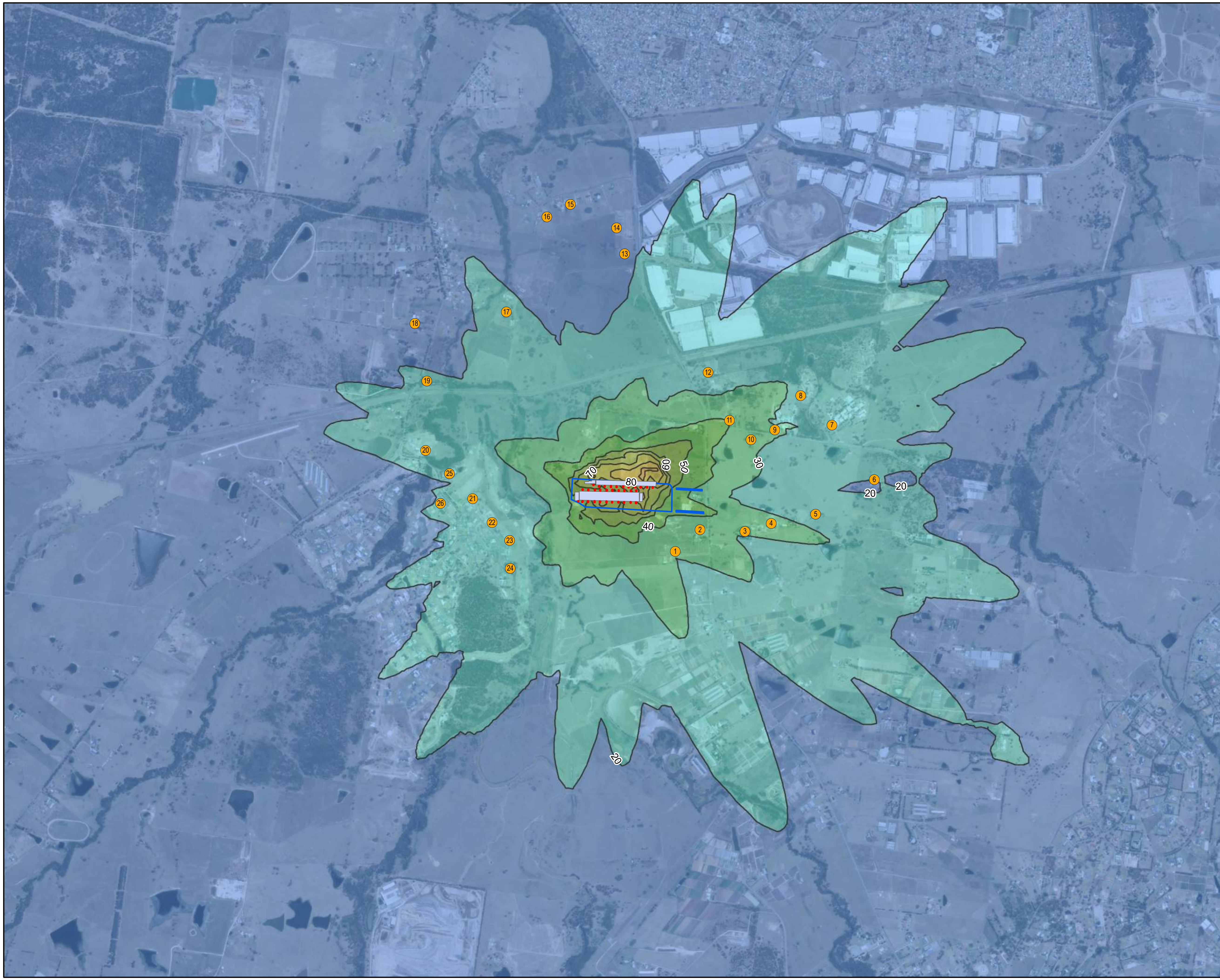
Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
277863	007

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
SO_2 24-hour 100th percentile predicted cumulative GLC ($\mu g/m^3$)

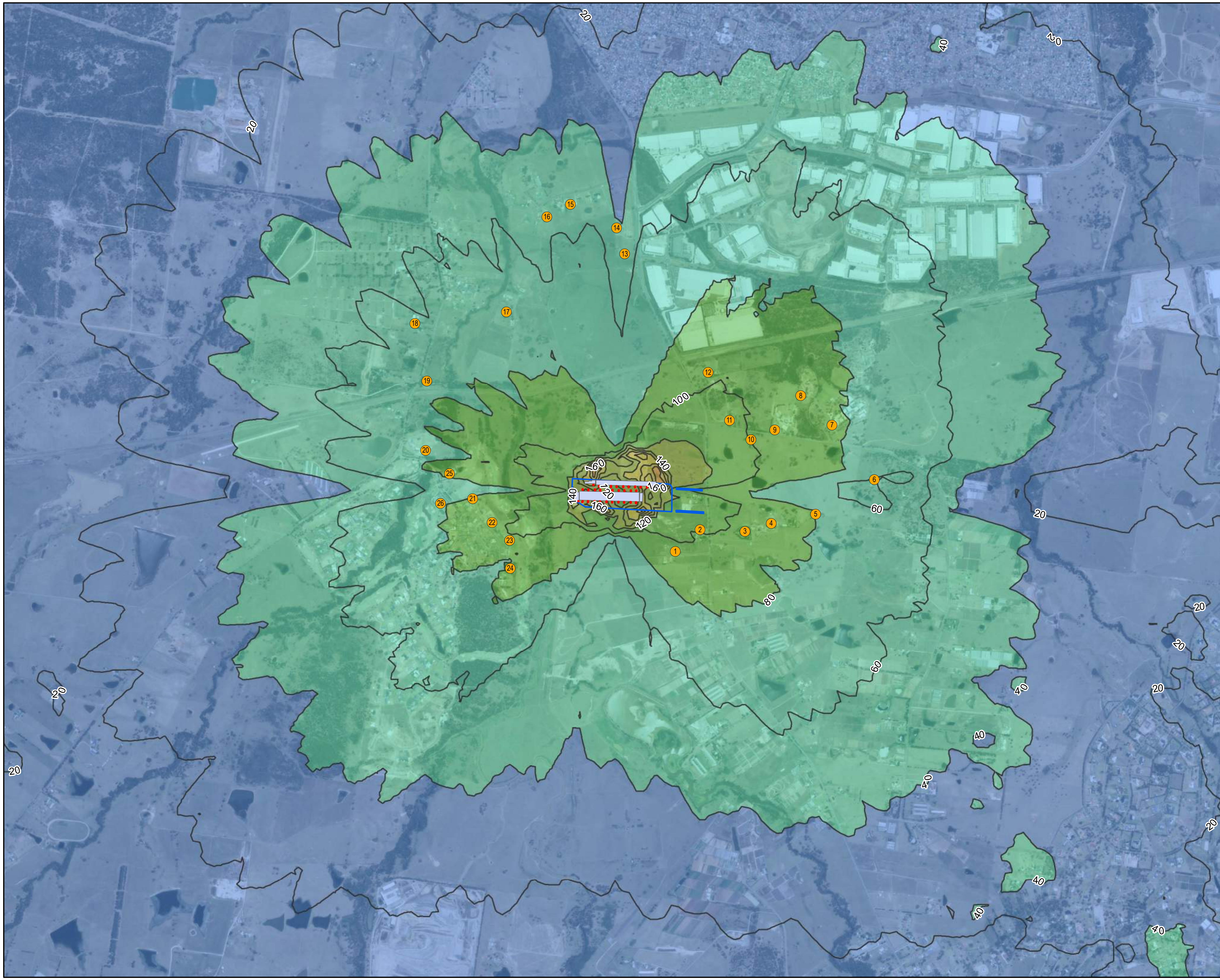
Scale at A3	Figure Status
1:25,000	**Preliminary**

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	**008**

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 40
- 40 - 80
- 80 - 120
- 120 - 160
- 160 - 200
- 200 - 240

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres
0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
SO_2 1-hour 100th percentile predicted incremental GLC ($\mu g/m^3$)

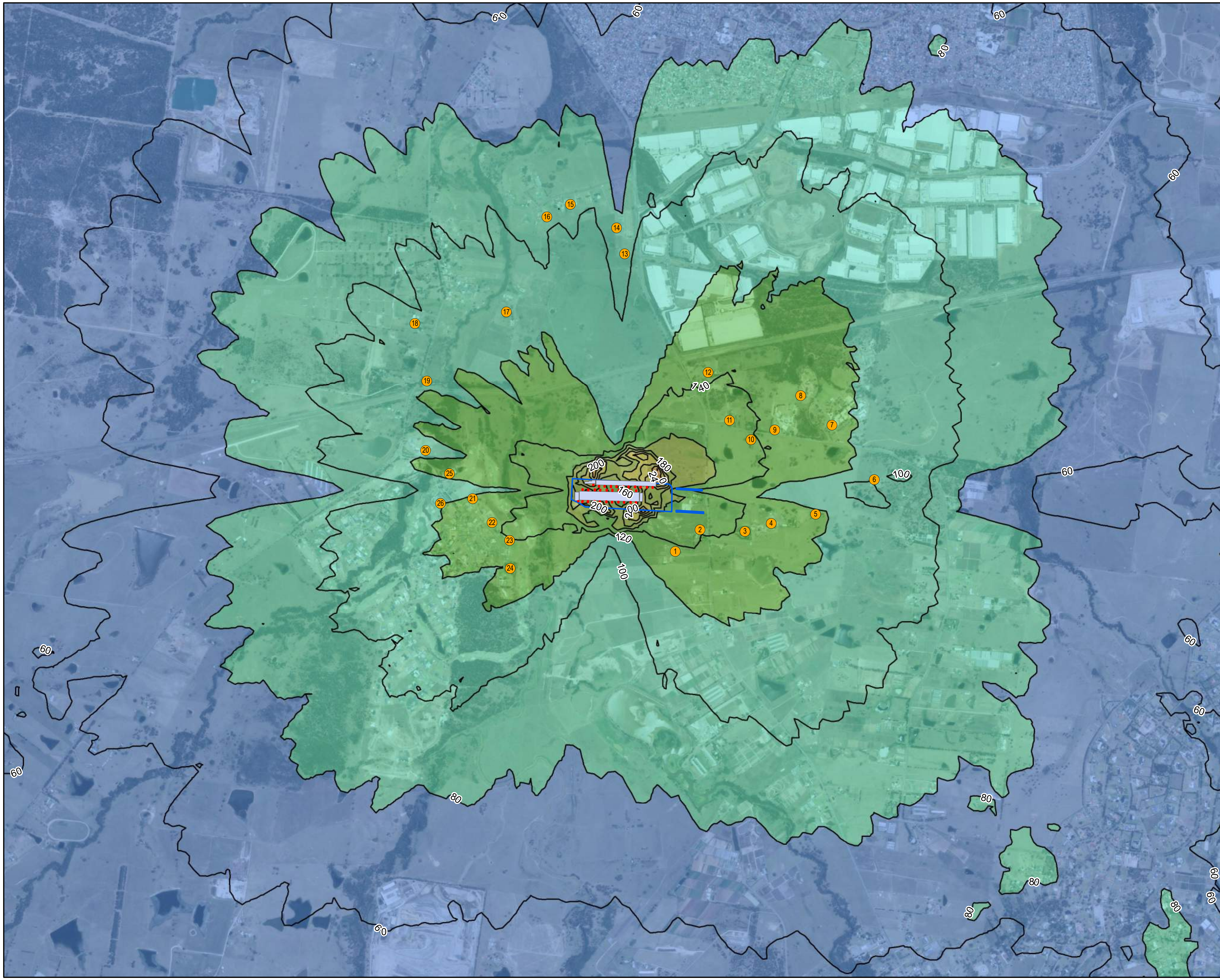
Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	009

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 80
- 80 - 120
- 120 - 160
- 160 - 200
- 200 - 240
- 240 - 280

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres
0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
SO_2 1-hour 100th percentile predicted cumulative GLC ($\mu g/m^3$)

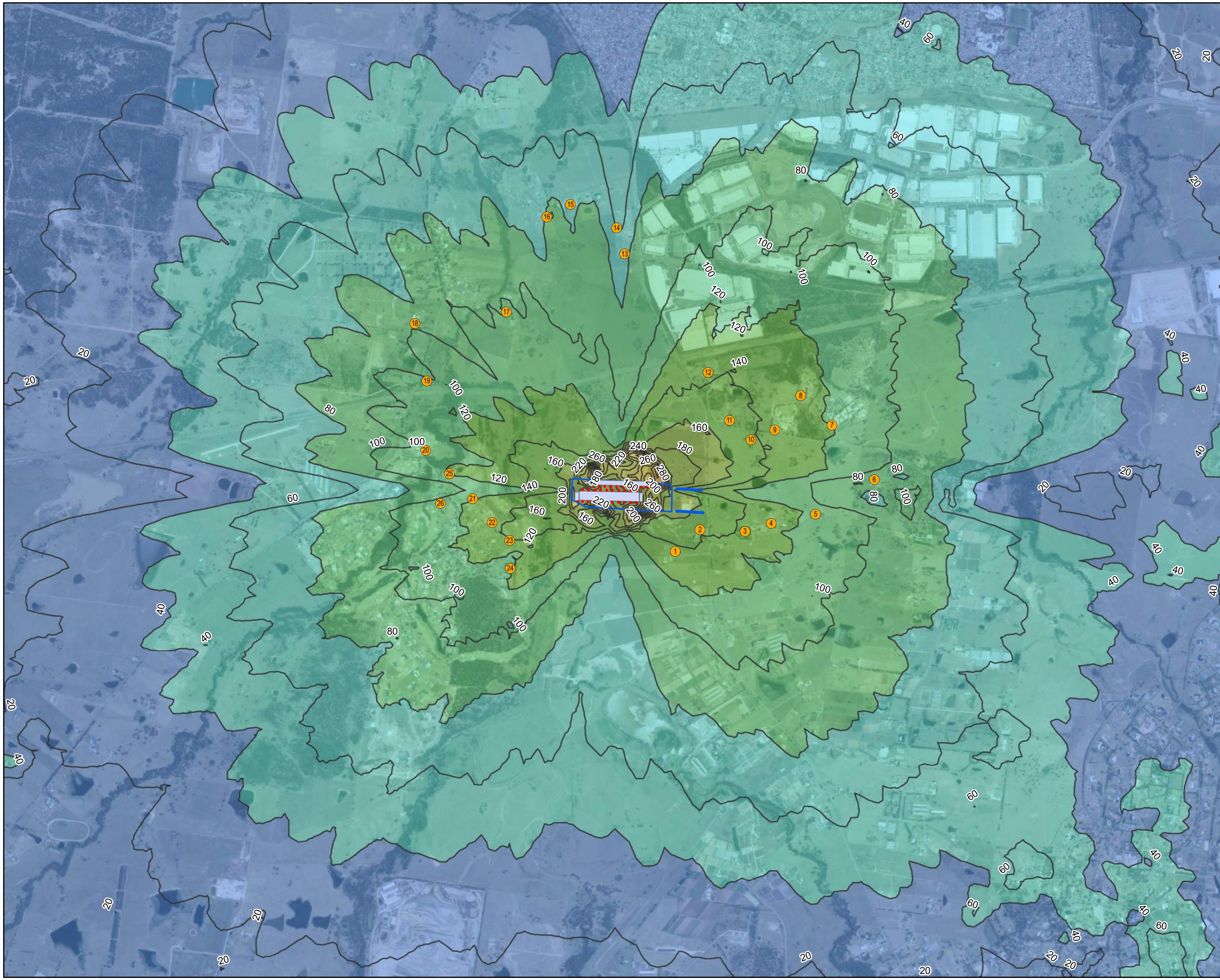
Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	010

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 40
- 40 - 80
- 80 - 120
- 120 - 160
- 160 - 200
- 200 - 240
- 240 - 280
- 280 - 320

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Confidential

Job Title

757-769 Mamre Road, Kemps Creek

Figure Title

SO_2 10-min 100th percentile predicted incremental GLC ($\mu g/m^3$)

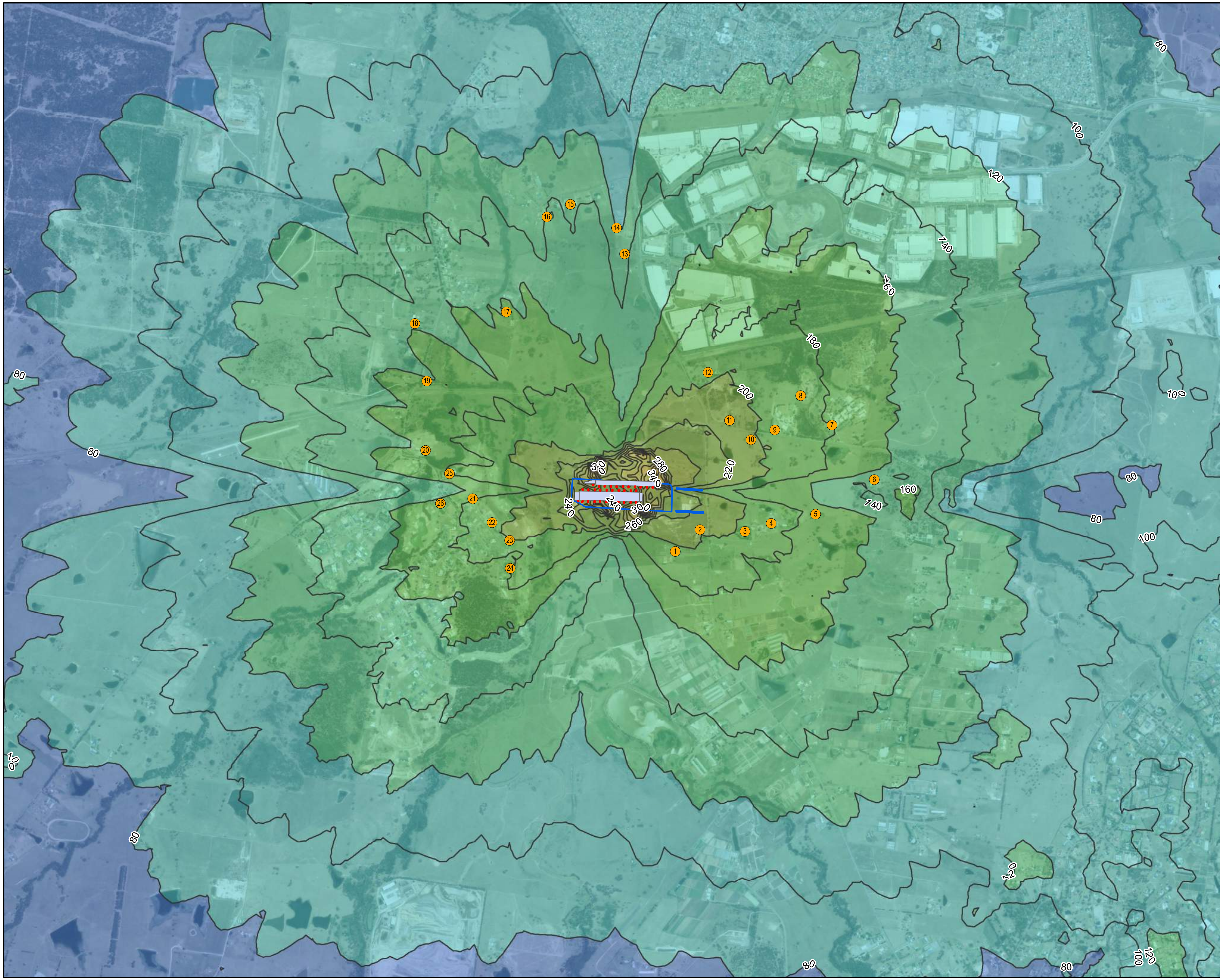
Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
277863	011

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 80
- 80 - 120
- 120 - 160
- 160 - 200
- 200 - 240
- 240 - 280
- 280 - 320
- 320 - 360
- 360 - 400

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Confidential

Job Title

757-769 Mamre Road, Kemps Creek

Figure Title

SO_2 10-min 100th percentile predicted cumulative GLC ($\mu g/m^3$)

Scale at A3	Figure Status
1:25,000	Preliminary

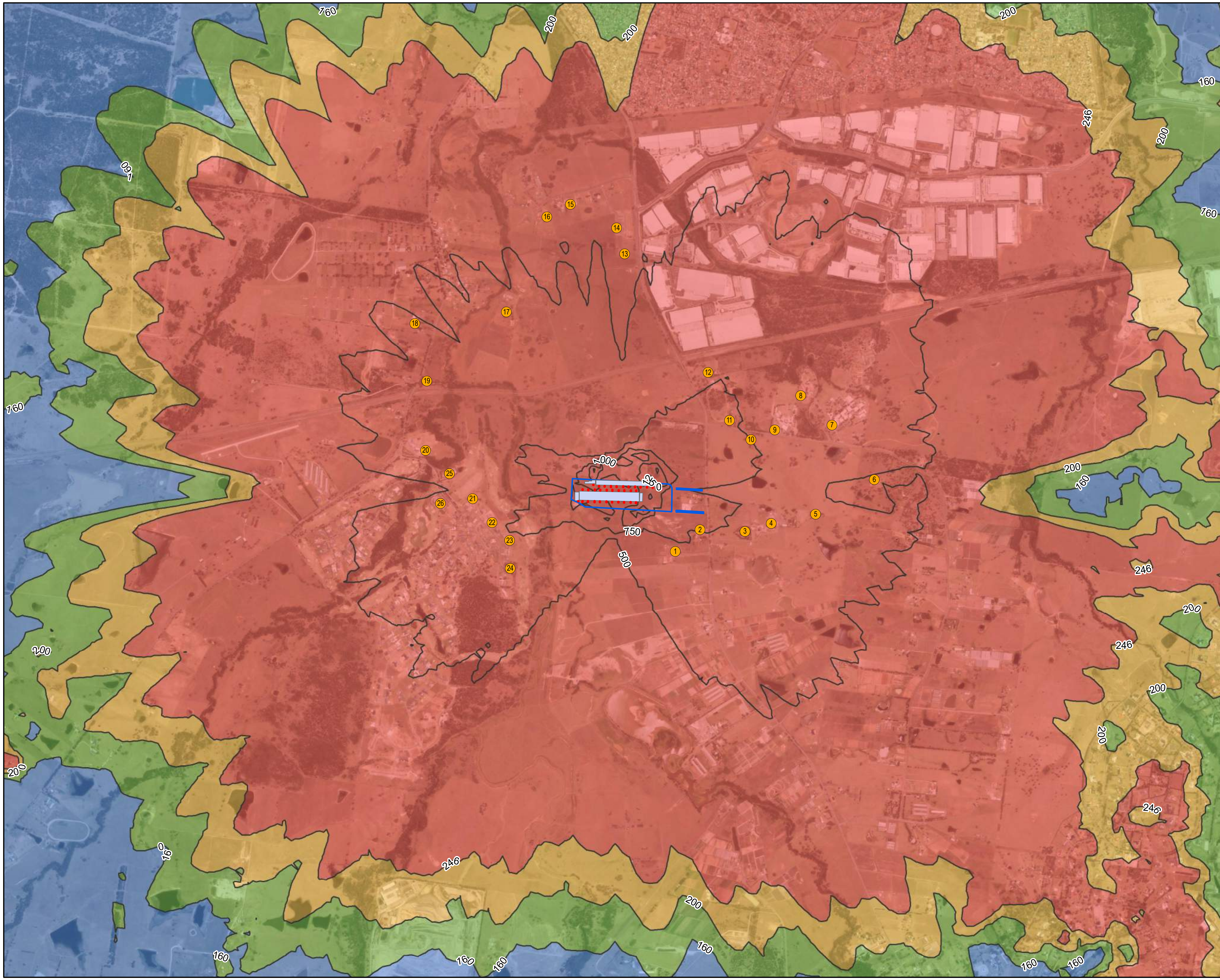
Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
277863	012

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 160
- 160 - 200
- 200 - 246
- 246 - 1,724

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres
0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
NO_2 1-hour 100th percentile predicted incremental GLC ($\mu g/m^3$)

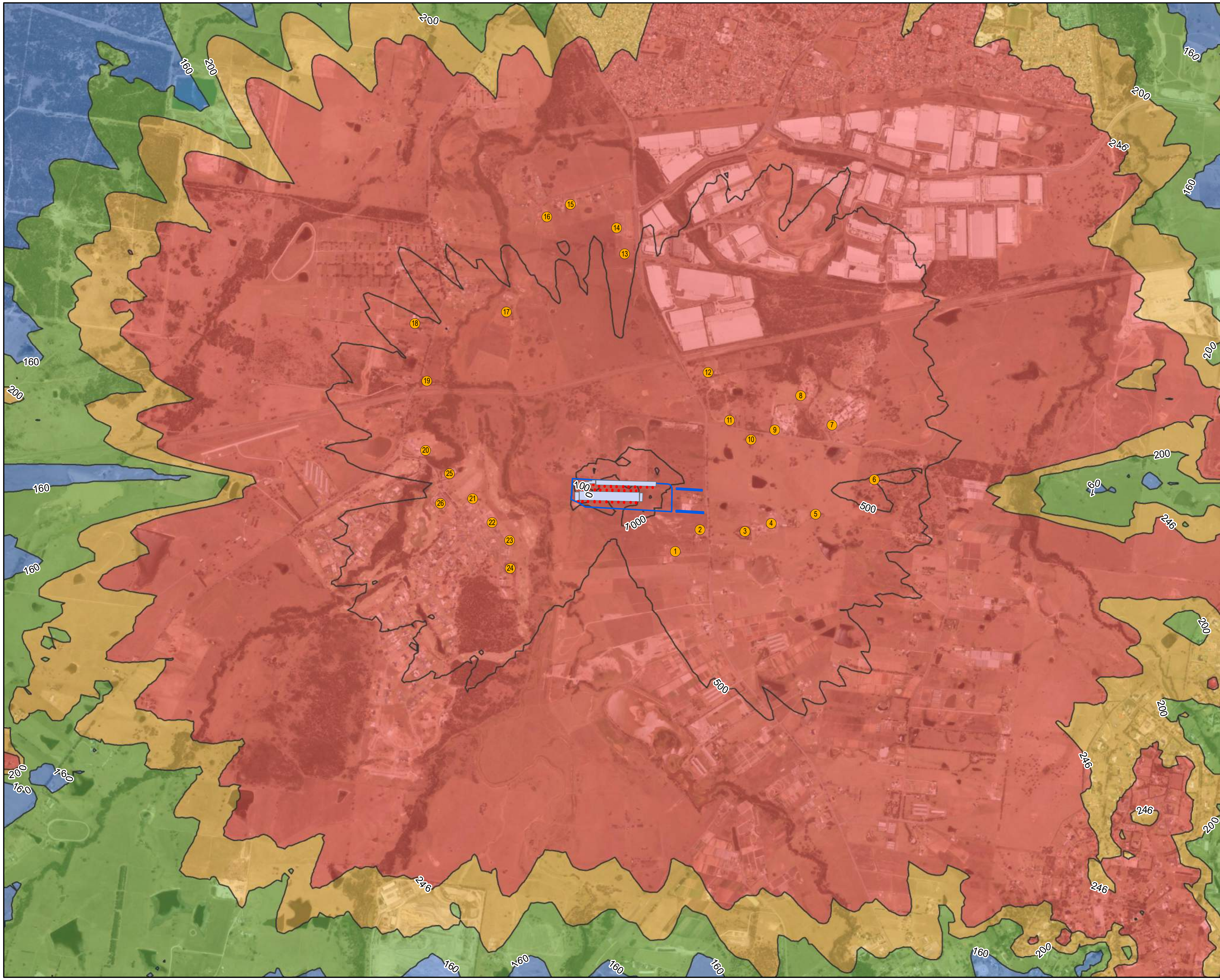
Scale at A3	Figure Status
1:25,000	**Preliminary**

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	**013**

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 160
- 160 - 200
- 200 - 246
- 246 - 1,724

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
NO_2 1-hour 100th percentile predicted cumulative GLC ($\mu g/m^3$)

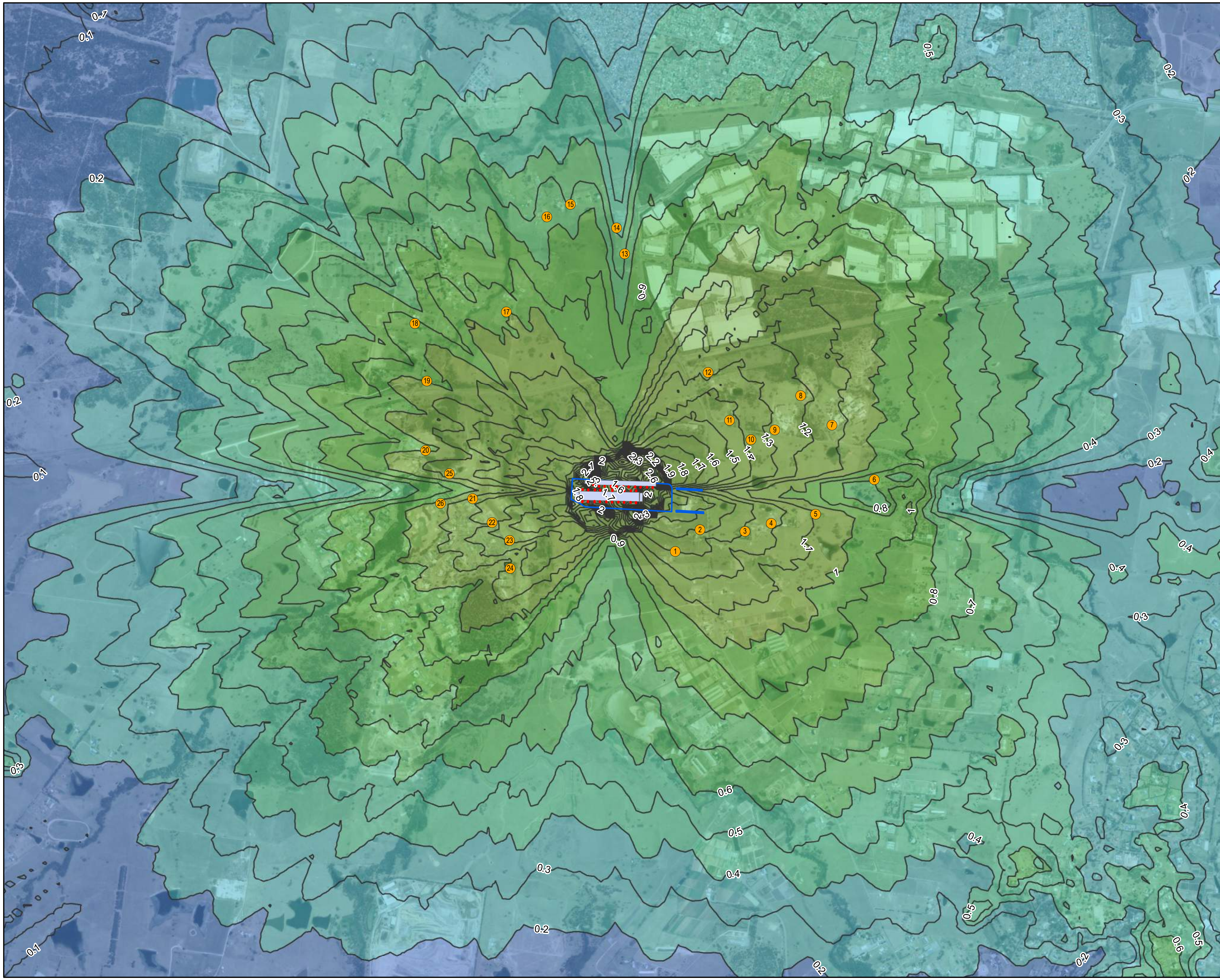
Scale at A3	Figure Status
1:25,000	**Preliminary**

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	**014**

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0
- 1.0 - 1.2

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Confidential

Job Title

757-769 Mamre Road, Kemps Creek

Figure Title

Benzene 1-hour 100th percentile predicted incremental GLC ($\mu g/m^3$)

Scale at A3	Figure Status
1:25,000	Preliminary

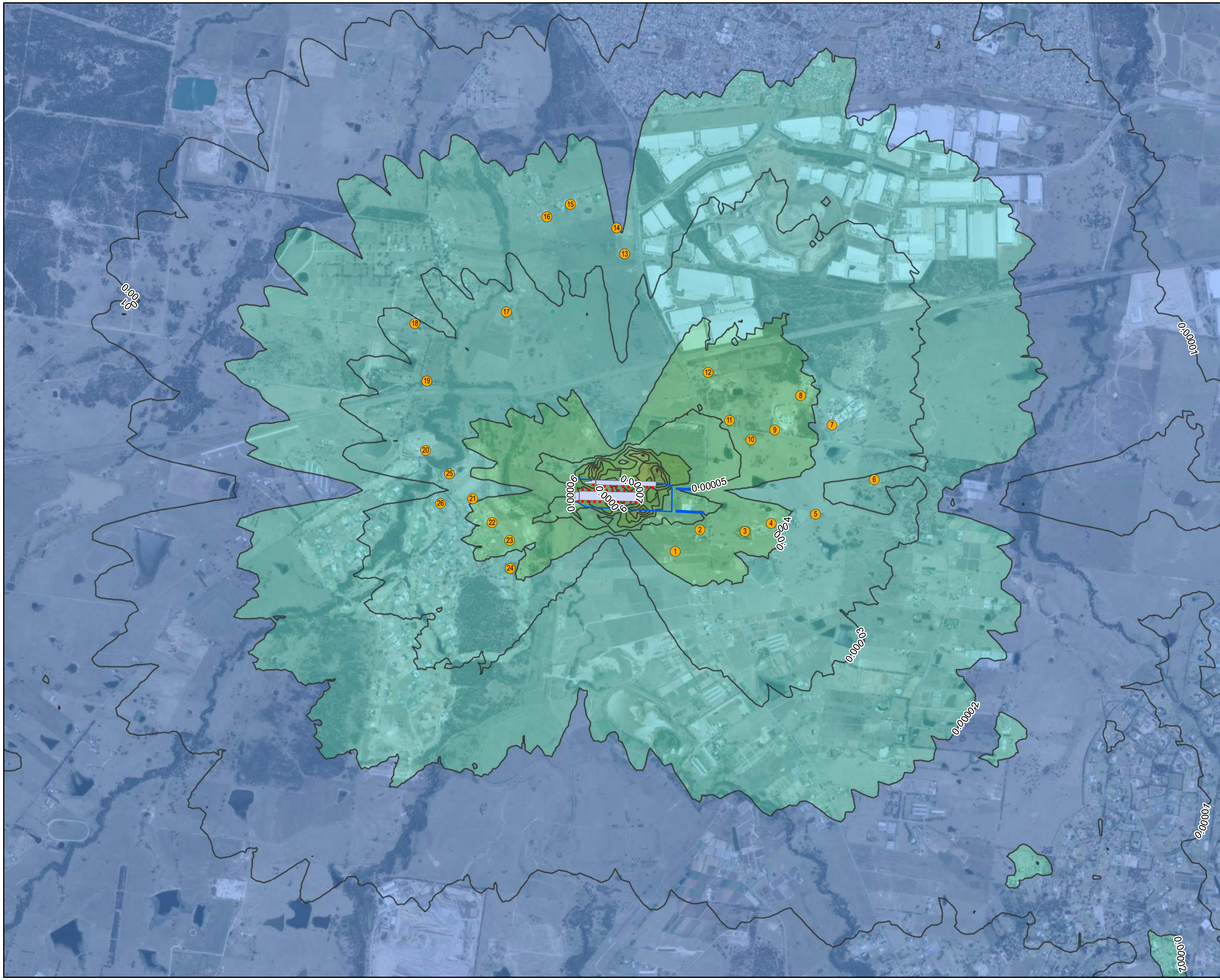
Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
277863	015

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration (µg/m^3)

- > 0.00002
- 0.00002 - 0.00004
- 0.00004 - 0.00006
- 0.00006 - 0.00008
- < 0.00008

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Confidential

Job Title

757-769 Mamre Road, Kemps Creek

Figure Title

PAH 1-hour 100th percentile predicted incremental GLC (µg/m^3)

Scale at A3	Figure Status
1:25,000	**Preliminary**

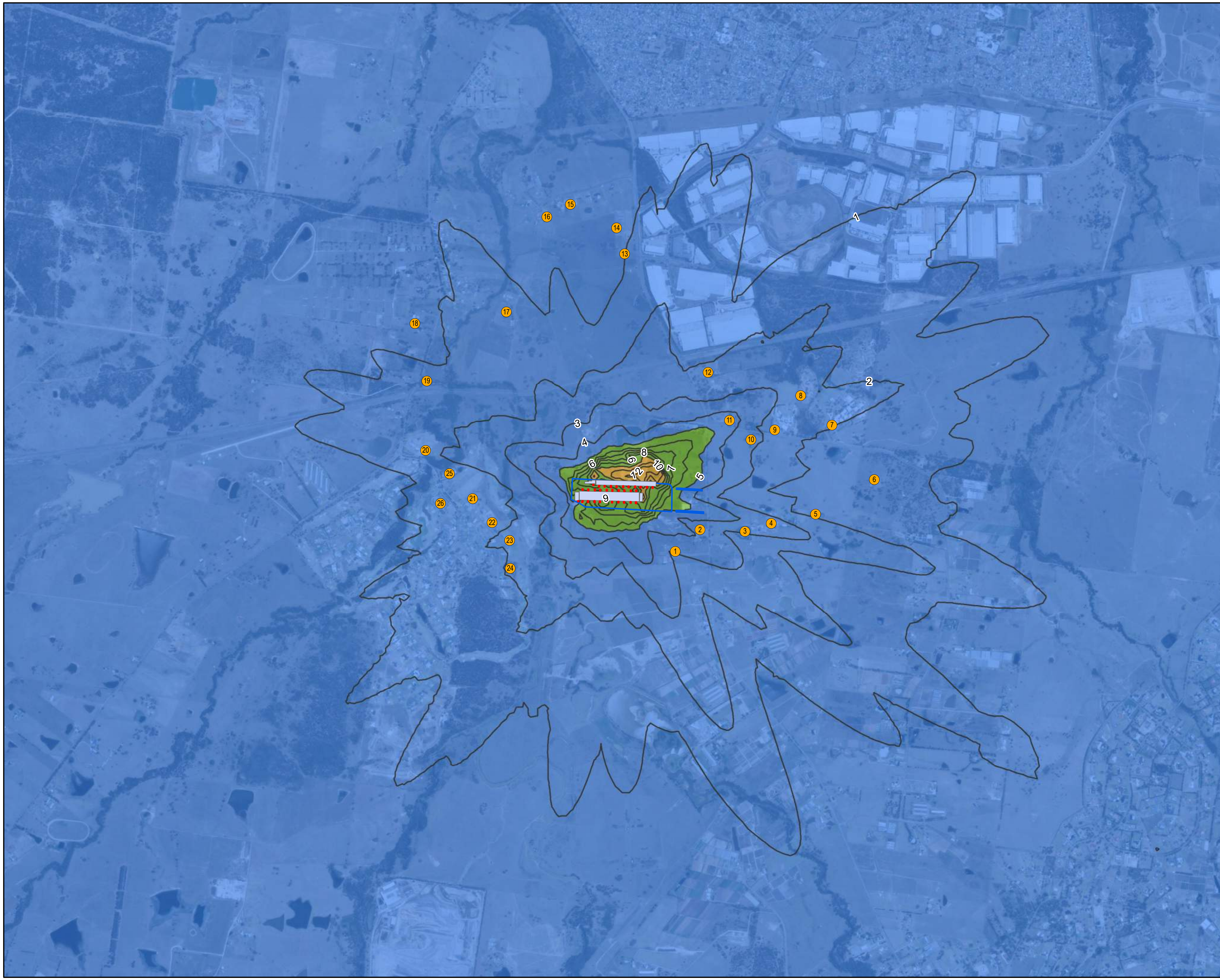
Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
277863	**016**

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- 0 - 5
- 5 - 10
- 10 - 15

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
PM_{10} 24-hour 100th percentile predicted incremental GLC ($\mu g/m^3$)

Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	017

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020

LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- 45 - 50
- 50 - 54

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres
0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
PM_{10} 24-hour 100th percentile predicted cumulative GLC ($\mu g/m^3$)

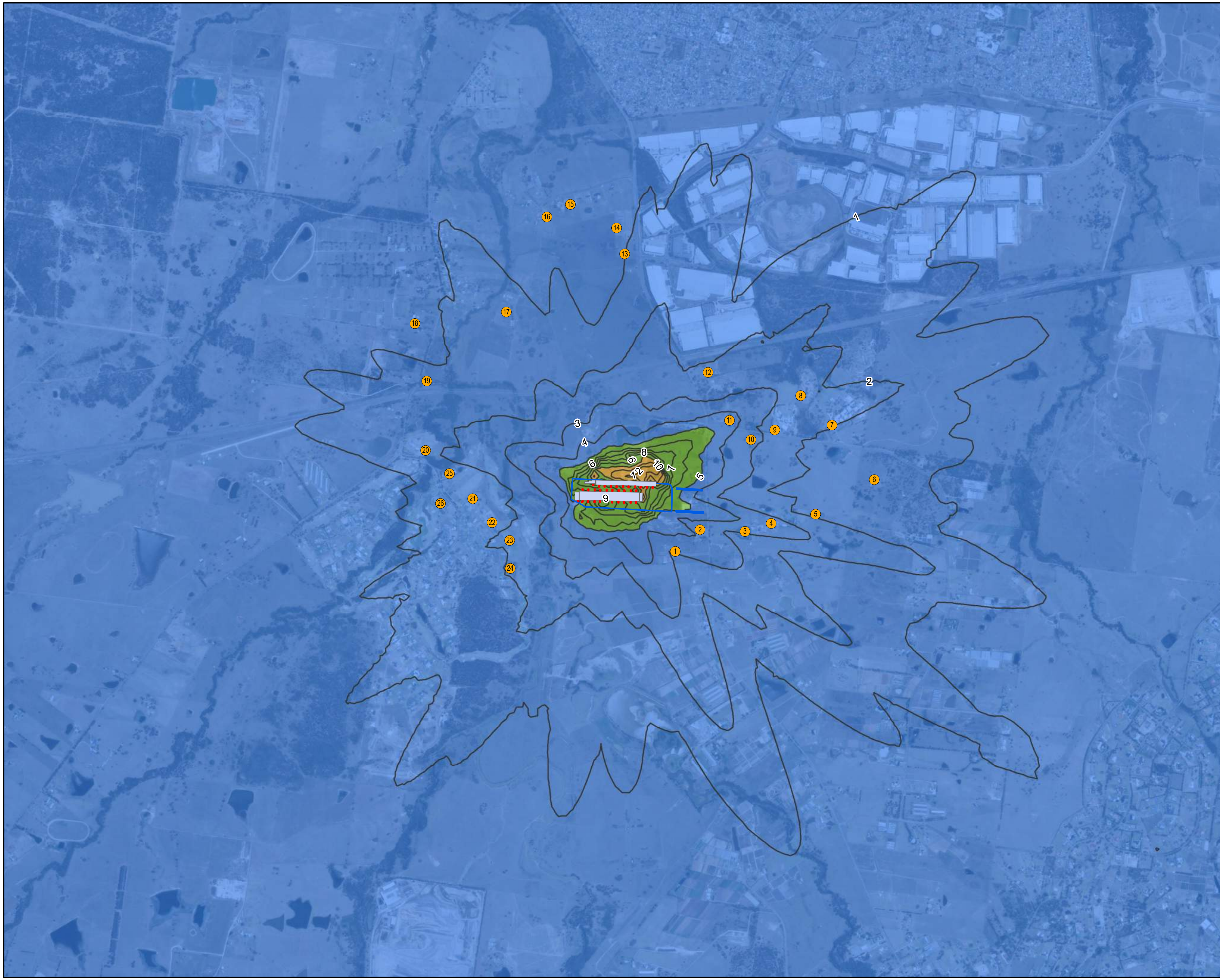
Scale at A3	Figure Status
1:25,000	Preliminary

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	018

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020



LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- < 5
- 5 - 10
- 10 - 15

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres
0 250 500 750 1,000

ARUP
Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client
Confidential

Job Title
757-769 Mamre Road, Kemps Creek

Figure Title
$PM_{2.5}$ 24-hour 100th percentile predicted incremental GLC ($\mu g/m^3$)

Scale at A3	Figure Status
1:25,000	**Preliminary**

Coordinate System
GDA 1994 MGA Zone 56

Job No	Figure No
277863	**019**

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020

LEGEND

- Generator Stacks
- Discrete Receiver
- Building Outline
- Proposed Site

Concentration ($\mu g/m^3$)

- 22 - 25
- 25 - 31

FINAL	14/04/2021	ICD	SG	LAS
Issue	Date	By	Chkd	Appd

Metres

0 250 500 750 1,000

ARUP

Level 5, Barrack Place,
151 Clarence St,
PO Box 76 Millers Point, Sydney NSW 2000
Tel +61 (2)9320 9320
www.arup.com

Client

Confidential

Job Title

757-769 Mamre Road, Kemps Creek

Figure Title

$PM_{2.5}$ 24-hour 100th percentile predicted cumulative GLC ($\mu g/m^3$)

Scale at A3	Figure Status
1:25,000	**Preliminary**

Coordinate System

GDA 1994 MGA Zone 56

Job No	Figure No
277863	**020**

J:\277000\277863-00 Data Centre\work\internal\design\gis\Map\20210413_Air_Quality_Plots_Landscape.mxd

© Arup 2020