ARUP

SSD

Project Echidna

Air Quality Technical Report

Reference: Appendix J

Revision 3 | 27 October 2023

Job number 288255-02

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Executive summary

Arup Australia Pty Ltd (Arup) was engaged by the Client to undertake an air quality impact assessment for a proposed data centre building (the 'Proposal') located at 10 Eastern Creek Drive, Eastern Creek in New South Wales (the 'site') ("the Proposal" or "the subject site"). The air quality impact assessment accompanies the Environment Impact Statement (EIS) for the Proposal.

Within the site that the Proposal is located, there are other data centre facilities, namely: Building 1 and Building 1A. This air quality assessment looked at the cumulative impact of the standby generators associated with the Proposal as well as the other data centre facilities (Building 1 and Building 1A) located within the same site.

Existing Environmental Conditions

The site exhibits an industrial character with mixed commercial land use and open grass land. Nearby commercial/industrial sensitive receivers are located directly adjacent to the Proposal site, with residential sensitive receivers are located approximately 2 km away from the site.

Site-representative meteorological conditions were derived from prognostic meteorological model AERMET. Analysis of site representative meteorological data for a five year period was undertaken to determine the most representative year for typical meteorological conditions as required by the Approved Methods. The wind roses for the subject site show similar distribution patterns across the five years with prevailing south-westerly winds. Wind speed distribution and temperature characteristics also show similar patterns across the five years. Given the similarity of wind conditions across the assessed years and a comparison of background air quality data across the five years, data for 2017 have been selected for inclusion in the dispersion modelling assessment, as this best represents the general trend across the past five years.

Pollutant Impact Assessment

Construction

There is the potential for dust generation associated with the construction of the proposal. The main dust-generating activities associated with earthworks and construction of buildings would be close to the subject site boundary. Given the considerable 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. Standard 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.

Operation

A dispersion modelling assessment of the proposed 19 on-duty standby generators within the proposal's site, as well as the inclusion of cumulative impact from 20 other generators from the two adjoining data centres located within the same area has been undertaken to ascertain the air quality impacts at nearby receivers due to a justified worst case scenario where all generators would be operational (in the event of a power outage), as well as routine maintenance/testing (realistic operations). The assessment was conducted to comply with requirements of the Secretary's Environmental Assessment Requirements (SEARs).

The assessment was undertaken using AERMOD. Emissions to air from the standby generators associated with this Proposal and nearby data centres have been estimated using manufacturer's specification datasheets for indicative pieces of equipment. Predicted ground-level concentrations were assessed at identified nearby discrete sensitive receivers.

Hourly varying background concentration data were used to assess those pollutants likely to have the greatest risk of exceeding relevant impact assessment criteria such as nitrogen dioxide (NO_2), and particulate matter, this helps to avoid over conservatism. Maximum background concentration data across the year were used to assess impacts for sulfur dioxide (SO_2) and carbon monoxide (CO). In addition, incremental ground-level concentrations were also assessed for toxic pollutants such as benzene and polycyclic aromatic hydrocarbons (PAH).

A photochemical conversion for short-term concentrations (i.e. hourly average) from nitrogen oxides (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 and therefore impacts have only been assessed for short-term averaging periods.

The modelling results indicated that the predicted pollutants' ground level concentrations from the generators meet the impact assessment criteria outlined in the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (EPA, 2022)(the 'Approved Methods') at identified residential sensitive receivers. Emissions of 1-hour average oxides of nitrogen (NO_x), which convert to NO_2 in the atmosphere and 24-hour average sulfur dioxide (SO_2) and particulate matter ($PM_{2.5}$) from the generators exceed the impact assessment criteria at the nearby commercial/industrial sensitive receivers. The predicted exceedances for the 24-hour averaging period criteria assumes that a power outage occurs continuously for 24 hours. This is highly unlikely to occur in an event of loss of mains power scenario. Therefore, this is expected to provide a conservative assessment.

Exceedances of the impact assessment criteria for NO_2, SO_2 and particulate matter 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.

This is considered to result in a low risk of air quality impacts from the subject site.

Likelihood of Justified Worst-Case Scenario

Under typical conditions, power for the proposal is fed directly from the grid. A review of the Endeavour Energy *Distribution Annual Planning Report (2021)* (2021 DAPR)[2], it has been determined that the average unplanned actual system average interruption duration index (SAIDI)[3] of power outage incident is 48 minutes (total cumulative events) of unplanned outages per year per customer – based on year 2020/21 of SAIDI data. The Endeavour Energy network covers areas including Sydney's Greater West, Blue Mountains, Southern Highlands, Illawarra, South Coast and NSW Government's priority land release areas in Sydney's North West and South West.

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[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.

[2] Endeavour Energy, 2021. *Distribution Annual Planning Report*, December 2021.

[3] The SAIDI is a measure in minutes the average duration of an incident weighted by the number of customers affected by each incident. That is, if 10 customers suffer a 10-minute interruption and there are 100 customers in the region, then this would equal a SAIDI of 1 minute. Multiple incidents are added together, so if a second incident of 15 minutes affected 10 customers, then that would be added to the first incident and equal a SAIDI of 2.5 minutes.

On this basis, despite predicted exceedances of NO_2, SO_2, and $PM_{2.5}$ against the impact assessment criteria 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 an average of about 48 minutes (total cumulative events) of the year due to power outages.

Realistic Operations during Routine Maintenance

The on-duty standby generators would undergo routine maintenance and testing to make sure they are operational if required during a power outage. Routine maintenance follows a prescribed testing regime that sets the frequency and duration of testing to minimise emissions to air while undertaking all required maintenance. For the Proposal, it is anticipated that a maximum of three generators would be tested at any one time on a fortnightly basis.

Dispersion modelling has been undertaken to determine potential air quality impacts at nearby identified sensitive receivers as a result of routine maintenance. Predicted pollutant concentrations at nearby identified sensitive receivers during all maintenance or testing periods are below the impact assessment criteria for all assessed pollutants, due to less generators being operational for shorter periods of time, compared with the justified worst-case scenario. Therefore, the air quality impact risk from the routine maintenance activity would be negligible.

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 air quality impacts with these management measures in place are negligible.

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Appendices

1. Introduction

Arup Australia Pty Ltd (Arup) has been commissioned to undertake an air quality assessment of the project Echidna Data Centre at 10 Eastern Creek Drive, Eastern Creek NSW – State Significant Development (SSD) (hereafter referred to as 'the Proposal').

1.1 Proposal background

Arup is seeking development consent to construct a data centre (the 'Proposal') at 10 Eastern Creek Drive, Eastern Creek NSW, legally described as Lot 4001 DP 1243178 (the Site). The Proposal involves the construction of a two-storey data centre comprising of data halls, mechanical and electrical equipment rooms, offices, other ancillary support spaces, and external/rooftop mechanical and electrical equipment. The Site is situated within the Blacktown Local Government Area (LGA) on the corner of Eastern Creek Drive and Old Wallgrove Road.

The parcel of land is currently vacant, and the site gross floor area (GFA) is of approximately 9,000 square metres.

The design of the Proposal is based on the end-client's reference design as well as applicable Australian Standards and will deliver capacity for approximately 35.2MW of IT equipment. Utility power will be delivered via a dedicated on-site electricity substation (subject to a separate development application), with emergency backup power provided by a combination of lithium-ion battery systems and standby generators. Cooling will be delivered by highly efficient fresh air free-cooling systems to ensure energy consumption is minimised as far as practical.

The two (2) level facility will reach a building height of approximately 20m, with additional 5m if including lift shaft and all significant plant and rooftop equipment. The facility will include two (2) levels of data hall space and supporting plantrooms, and supporting administrative spaces incorporating secure entry facilities, loading dock, storage, staff offices and the like. The standby generators will occupy an external equipment yard to the east of the main building, and some mechanical equipment will be located at roof level. The site will be served from a private on-site substation, shown on Figure 1 located to the east of the proposed data centre building and subject to a separate development application.

Landscaped areas are also proposed, where mature local trees will be used to improve aesthetics and amenity for local businesses.

On-site car parking spaces will be provided for staff and visitors, including disabled and electric vehicle parking.

The location of the Proposal within the site on 10 Eastern Creek Drive is shown in Figure 1 below, shown as 'Project Echidna'.

Previous development applications for the site have gained approval for the development of data centre capacity on the site. Building 1 and Building 1A, shown in Figure 1 also have onsite stand-by generators for the purposes of continuous operation of data centres. Hence, the operational air quality assessment in this report assessed the potential cumulative impact from both the Proposal as well as existing onsite stand-by generators.

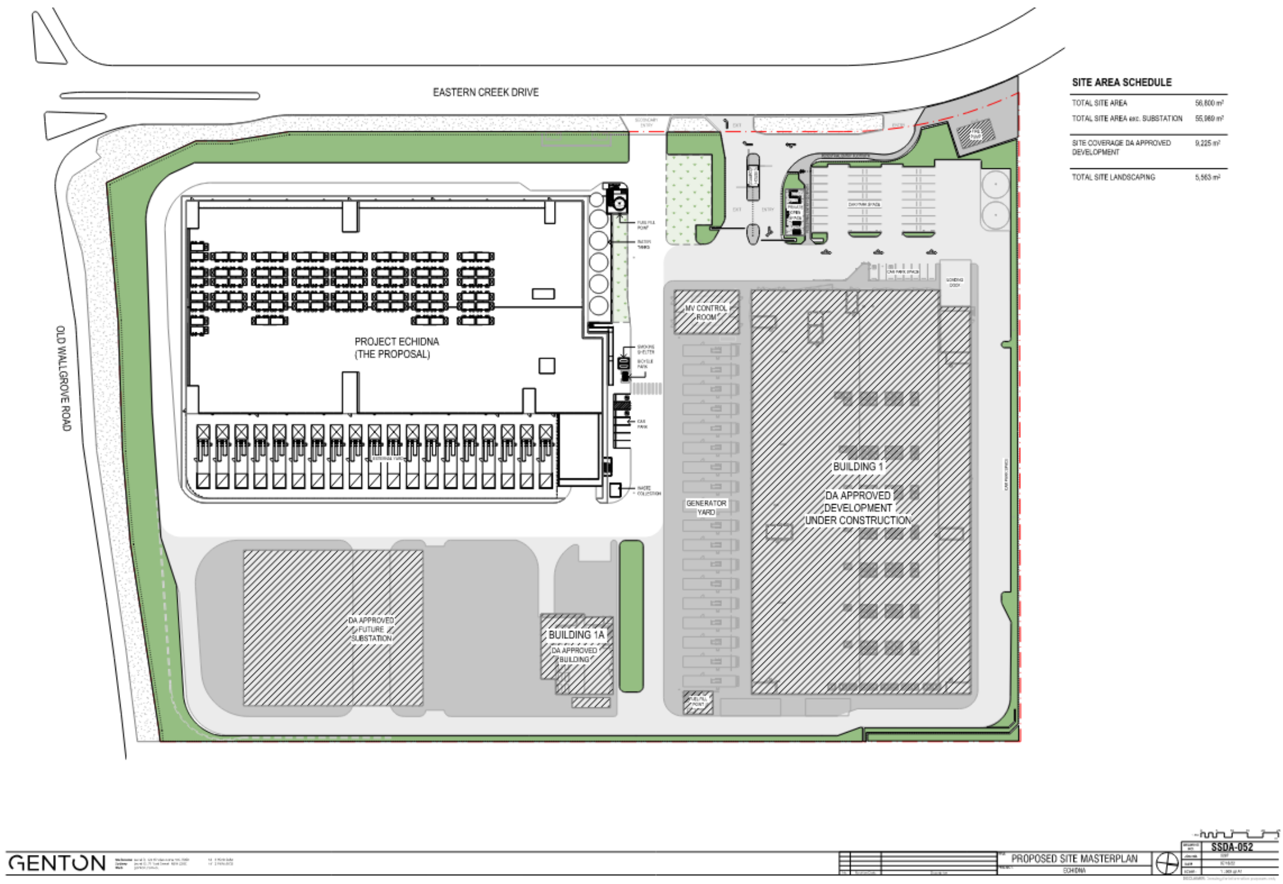


Figure 1 – Site layout

1.2 Purpose 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:

- NSW *Protection of the Environment Operations (Clean Air) Regulation 2022* (POEO)
- NSW EPA – *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (August 2022)
- NSW *Protection of the Environment Operations Act 1997* – Section 128

This assessment characterises the local meteorological and air quality conditions at the Proposal 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 (inclusive of potential cumulative impact from Building 1 and Building 1A standby generators), as a worst-case scenario as well as considering 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.

1.3 SEARs relevant to this report

Table 1 identifies the SEARs and DCP requirements which are relevant to this technical assessment.

Table 1 – SEARs requirements for Air Quality

SEARs relevant to this technical report	Where addressed in this technical report
Provide an assessment of air quality impacts, prepared in accordance with the relevant NSW Environment Protection Authority (EPA) guidelines. The assessment must address construction works and include modelling of emissions and air pollutants from predicted operations (including testing of the back-up power system) and a peak emission and air pollutant scenario, and outline the proposed mitigation, management and monitoring measures that would be implemented.	Sections 3.1, 3.2, 5.2, 5.3, 6, 7, 8, 9.

2. Policy and planning context

This Chapter presents relevant regulation, legislation and policy governing management of Air Quality it relates to the Proposal.

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 and Environment (DPE), under the Environment and Heritage 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 minimises 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 minimises 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[4] 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 standby plant operating for less than 200 hours per year.

[4] 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 2022

The NSW Protection of the Environment Operations POEO (Clean Air) Regulation 2022 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 2 Part 2 Division 3 to set the *Standard of concentrations* for *scheduled premises of general activities and plant* and Schedule 2 Part 3 to set the *Standard of concentrations for non-scheduled premises*. However, Part 5, Division 6, Clause 73 of the POEO (Clean Air) Regulation exempts emergency electricity generation comprising a stationary reciprocal internal combustion engine from the air impurities Standard of nitrogen dioxide and nitric oxide concentrations specified in Schedule 2 in relation to that plant, if the plant is used for a total of not more than 200 hours per year.

Table 2 and Table 3 below set out the standard of concentrations under the Schedule 4 and Schedule 6 of the POEO (Clean Air) Regulation.

Table 2 – Schedule 2, Part 2 Division 3 – Standards of concentration for (Group 6) scheduled premises

Air impurity	Activity or plant	Concentration
Solid Particles (Total)	Any activity/ plant	50 mg/m^3
Nitrogen dioxide (NO_2) or Nitric oxide (NO) or both nitrogen dioxide and nitric oxide, as NO_2 equivalent	Stationary reciprocating internal combustion engines	450 mg/m^3

Note: Concentration level based on reference condition of dry, 273 K, 101.3kPa and 7% O_2 content

Table 3 – Schedule 2 Part 3 – Standards of concentration for (Group C) non-scheduled premises

Air impurity	Activity or plant	Concentration
Solid particles	Any activity/ plant	100 mg/m^3
Smoke	Any activity or plant in connection with which liquid or gaseous fuel is burnt	Ringelmann 1 or 20% opacity

Note: Concentration level based on reference condition of dry, 273 K, 101.3kPa and 7% O_2 content

2.1.3 The EPA Approved Methods 2022

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* (August 2022), 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 Impact Assessment Criteria

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

Table 4 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 4 – Applicable Air Quality Impact Assessment Criteria

Pollutant	Averaging Period	Maximum Concentration, $\mu g/m^3$
Carbon Monoxide (CO)	15 minutes	100,000
	1 hour	30,000
	8-hour	10,000
Sulfur dioxide (SO_2)	1 hour	286
	24-hour	57
Nitrogen dioxide (NO_2)	1 hour	164
Benzene (representative of VOCs)	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 4 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 the cumulative impact, including 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

Justification for the proposed back-up power system and any alternatives considered

The data centre is a mission critical facility and therefore requires back up generation. The site is designed for a total of 18 low voltage 2.8MW standby generators to supply the data centre critical loads. The administrative area will also require a dedicated generator for critical and life safety loads; this will be a low voltage 600kW emergency backup generator.

Generators will operate as a standby power supply in the event of mains failure. The site power connection is from two redundant supplies fully rated to carry the entire site load.

The generators are proposed to be located outside the main building. Belly tanks will be provided locally at each packaged generator enclosure, providing minimum 24 hours of fuel storage. Fuel systems will be designed to comply with AS 1940:2017 – *Storage and handling of flammable and combustible liquids*.

Alternative energy sources to diesel fuel such as solar power and battery storage options were also investigated. Due to the high load density and relatively steady load profile of the data centre, the amount of power that could be generated from solar panels covering entire roof space would only be approximately 3.5% of the power consumed on site. Moreover, the roof is occupied by mechanical equipment which discharges air vertically and horizontally. Therefore, the available space for solar panels will only enable a very low total power output which would not offer tangible benefits to the site.

Battery storage has also been investigated and deemed ineffective to the site as there would be no excess energy to store. Whilst batteries are currently being used for short-term backup, the quantity of fuel nominated is required to provide 24 hours of autonomy time to keep the critical services provided by the data centre online in the unlikely event of an extended power outage. Providing a similar autonomy time using batteries would be prohibitive from a cost and space perspective. Batteries also create similar concerns to diesel fuel such as chemical spills and fire hazards.

As such, diesel fuel has been considered the most appropriate solution to meet the data centre demands.

Arrangement

The masterplan drawing in Figure 2 shows the proposed data centre buildings and the standby generator locations. There are three data centre facilities within the site, namely: Building 1, Building 1A and the Proposal (Project Echidna). The number of standby generators associated with each of the data centre facility is as below:

- Building 1 – A total of 19 standby generators (including one admin standby generator).
- Building 1A – A total of one standby generator.
- Project Echidna (the Proposal) – A total of 19 standby generators (including one admin standby generator).

All generators have been included in the dispersion modelling exercise to provide a cumulative assessment of all sources. 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. The admin generator at the Proposal would typically be much smaller in capacity than the main generators. In the absence of specific generator data, the admin generator is assumed to be the same as the main generator used for Building 1A.

Figure 2 shows the location of the standby generators. All generators are located outside, adjacent to the data centre buildings. 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 generators for the data centre buildings has the following capacity:

- Building 1: Generator capacity of 2.4 MWe, with a fuel consumption rate of 665 L/hr at100% load.
- Building 1A: Generator capacity of 1.6 Mwe, with fuel consumption rate of 359 L/hr at100% load.
- The Proposal (Project Echidna): Generator capacity of 2.8 MWe, with fuel consumption rate of 730 L/hr at100% load.

The diesel generator specification sheets are presented in Appendix B.

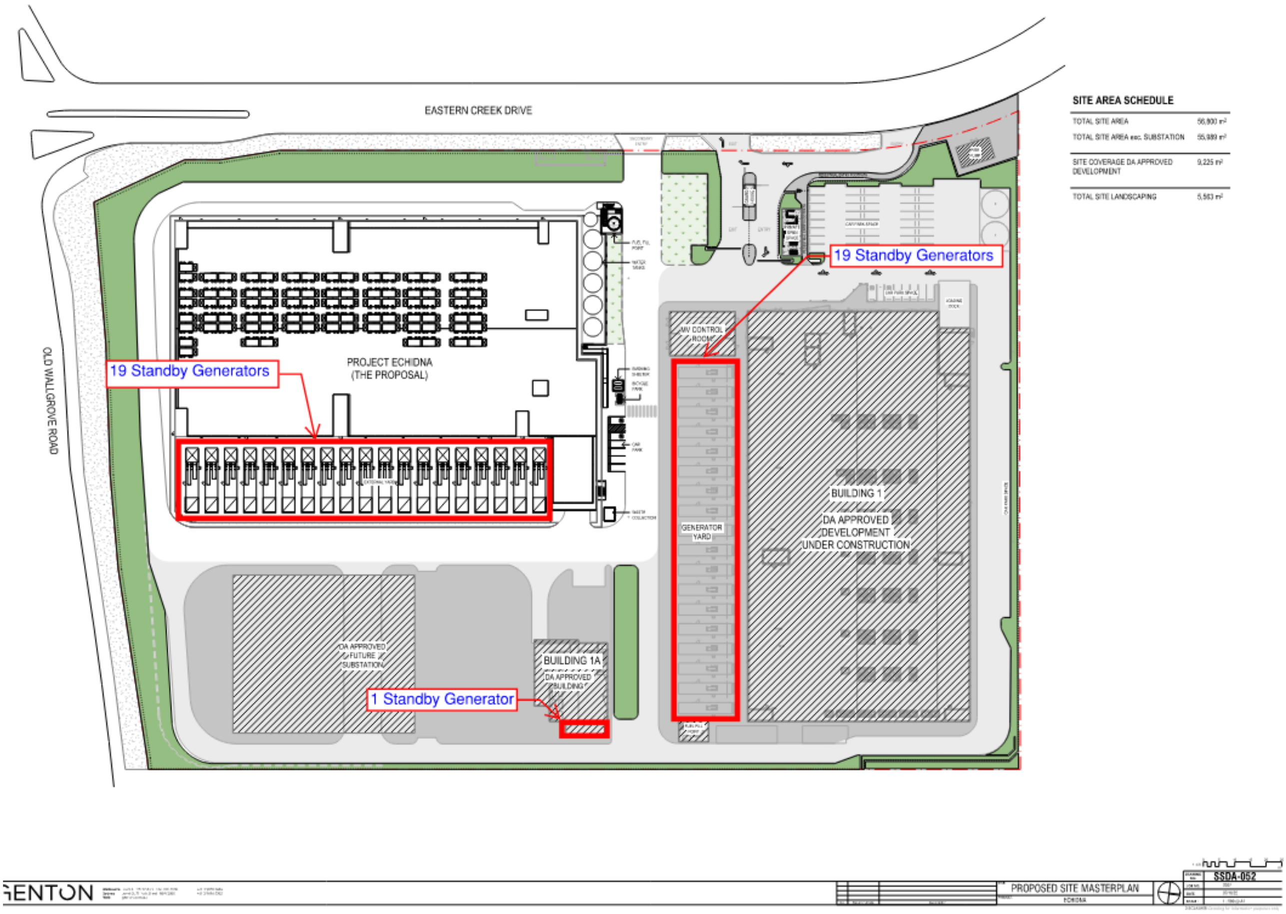


Figure 2 – Standby generators locations

Usage

Given the unlikely event of an interruption of mains power, the standby generators would switch on to provide power to each of the buildings. It is likely any loss of mains power would be resolved quickly, within a few hours and therefore even when required the generators would only operate for a short duration.

Although it is not possible to determine exactly the duration of power outage/damage over a year which would require the standby generators to be in operation, based on the Endeavour Energy *Distribution Annual Planning Report (2021)* (2021 DAPR)[5], it has been determined that the average unplanned actual system average interruption duration index (SAIDI)[6] of power outage incident is 48 minutes (total cumulative events) of unplanned outages per year per customer – based on year 2020/21 of SAIDI data (Table 5). The Endeavour Energy network covers areas including Sydney's Greater West, Blue Mountains, Southern Highlands, Illawarra, South Coast and NSW Government's priority land release areas in Sydney's North West and South West.

[5] Endeavour Energy, 2021. *Distribution Annual Planning Report*, December 2021.

[6] The SAIDI is a measure in minutes the average duration of an incident weighted by the number of customers affected by each incident. That is, if 10 customers suffer a 10-minute interruption and there are 100 customers in the region, then this would equal a SAIDI of 1 minute. Multiple incidents are added together, so if a second incident of 15 minutes affected 10 customers, then that would be added to the first incident and equal a SAIDI of 2.5 minutes.

Table 5 - SAIDI Targets vs 2020/21 Actuals

Category	SAIDI Actual (minutes)	SAIDI Target (minutes)
Urban	48.2	60.1

Maintenance routine

For standby generators to be ready to operate should an unexpected interruption to mains power occur, a regular maintenance schedule is required. A likely standby generator testing schedule is provided in Table 6. Maintenance testing of standby generators is anticipated to occur during the daytime period (the period from 7 am to 6 pm (Monday to Saturday) and 8 am to 6 pm (Sundays and public holidays[7]). The suitability of night time testing will be further confirmed during the detailed design phase of the proposal.

Table 6 - Likely standby generator testing regime

Type	Duration (min)		Building 1/1A testing			Proposal testing			Total Tests	Total Min
	Run	Cool-down	Number of gens	Gens run per test	Number of tests	Number of gens	Gens run per test	Number of tests		
Fortnightly no-load	5	0	20	3	7	19	3	7	14	70
Quarterly (70% load)	20	10	20	1	20	19	1	19	39	1170
Annual (100% load)	110	10	20	1	20	19	1	19	39	4680
Total minutes per year										9730
Total hours per year										162

It is proposed that up to three generators at a time would be tested under the fortnightly testing scenario with no load. There would be up to one generator tested at a time during the quarterly and yearly testing scenarios with 70% load and 100% load respectively. It is noted that Building 1 and 1A generators will not be tested at the same time as Proposal's generators.

The above testing schedule gives a cumulative total of 162 hours operation for all generators combined. The cumulative operation is not more than the 200-hour exemption limit in Schedule 1 Clause 17 of the NSW POEO Act 2022 (refer to Section 2.1.1), as well as Part 5, Division 6, Clause 73 of the POEO (Clean Air) Regulation 2022 (refer to Section 2.1.2), and therefore generator emissions are exempt from Schedule 2 of the Standard of Concentrations in the POEO (Clean Air) Regulation 2022. It is proposed up to three generators would be tested concurrently under the fortnightly testing scenario, however only one generator at a time would be tested under the quarterly and yearly testing scenarios.

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.

[7] NSW EPA, 2017. Noise Policy for Industry.

Emission data for this Proposal has been assessed based on indicative equipment selection for each of data centre facility as below:

- Building 1: CAT3516E generator (refer to Appendix B).
- Building 1A: MTU 12V4000G74F generator (refer to Appendix B).
- The Proposal: MTU 20V4000G94F generator (refer to Appendix B).

All other emission data for the assessed pollutants not provided in the generator specification has been based on emission information provided in Table 43 of the National Pollutant Inventory (NPI 2008)[8].

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

4. Existing environment

4.1 Local meteorology

Local meteorology conditions which can affect the dispersal of pollutants in the local area were determined. Meteorological conditions are not monitored at the subject site with the nearest Bureau of Meteorology (BoM) meteorological station at Horsley Park, approximately 4.7 km south-south-east of the subject site.

AERMET is the meteorological processor 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 site representative meteorological data and all parameters required by the dispersion model, meteorological data was purchased from Lakes Environment based on the MM5 prognostic model for the period 2016 to 2020. This data was interpolated from nearby forecasted and monitored data. Analysis of site representative meteorological data for a five year period (2016-2020) was undertaken (see Appendix C) to determine the most representative year for typical meteorological conditions as required by the Approved Methods.

The wind roses presented in Appendix C indicate that winds at the subject site show similar distribution patterns across the five years with prevailing south-westerly winds. Wind speed distribution characteristics also show similar patterns across the five years.

Given the similarity of wind conditions across the assessed years, data for 2017 have been selected for inclusion in the dispersion modelling assessment, as it best represents the general trend across recent years. 2017 was selected over a more recent year due to the correlation with background air quality data discussed in Section 4.2.

4.1.1 Windrose

Annual Average

The annual average wind rose between 1 January 2017 and 31 December 2017 is shown in Figure 3 with wind class frequency distribution in Figure 4. Based on Figure 3 and Figure 4, the following features can be observed:

- Winds are most prevalent from the south-west.
- The average wind speed is 3.4 m/s.
- Winds are least prevalent from the north-west sector with annual winds of less than 1%.
- Light winds (< 0.5 m/s) are more prevalent from the south-west sectors.
- Due to the infrequent occurrence of calm winds (5.2%), meteorological conditions are favourable for dispersion.

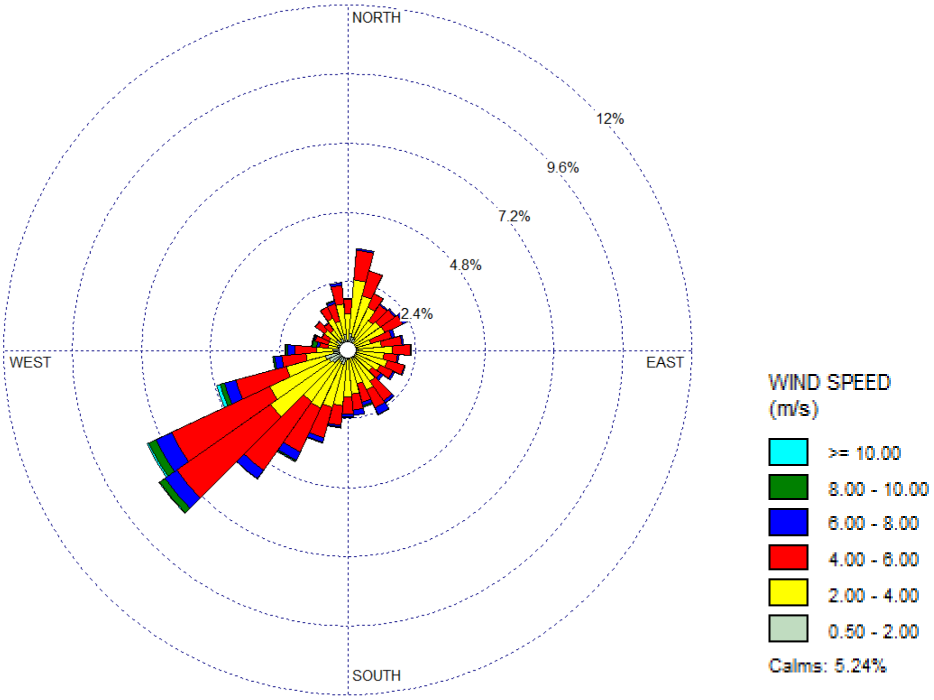


Figure 3 – Wind Rose for 2017 data

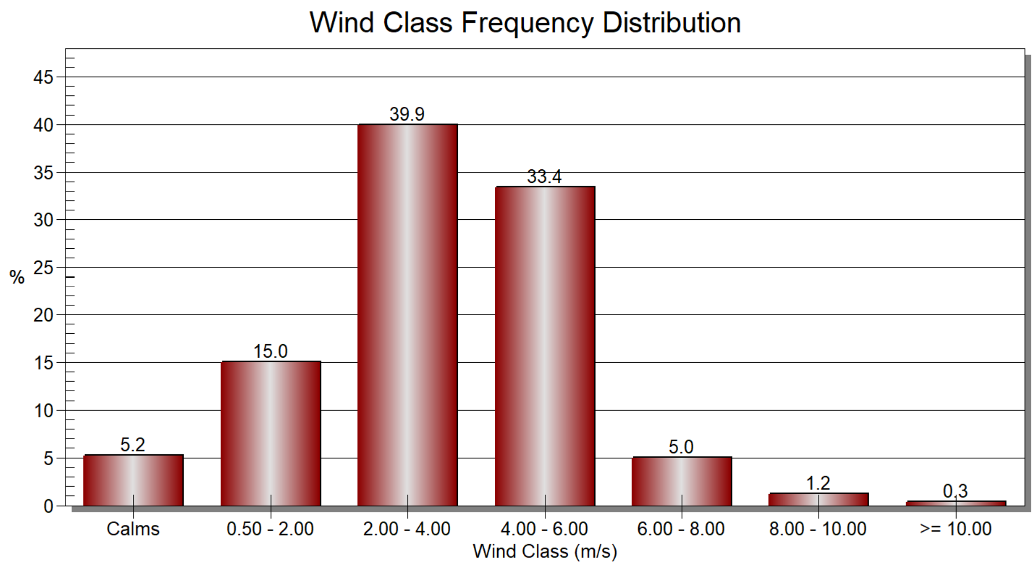
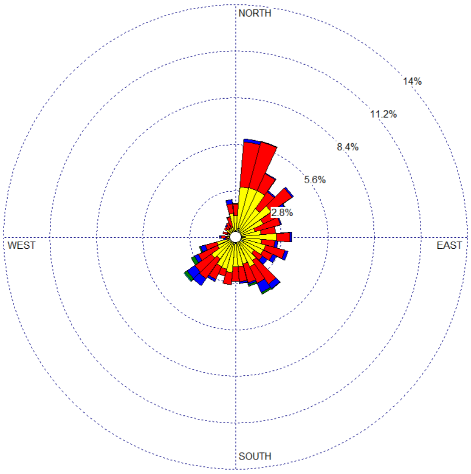


Figure 4 – Wind Class Frequency Distribution for 2017 data

Seasonal Variation

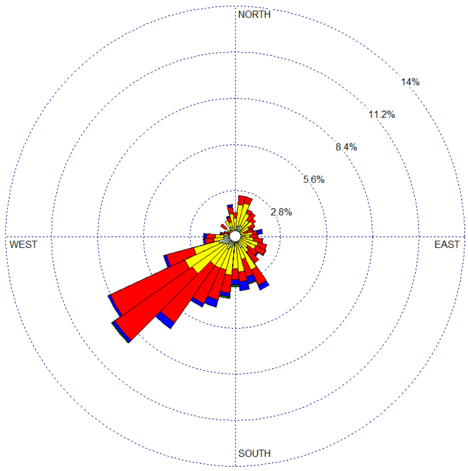
The seasonal variation wind roses for 2017 are shown in Figure 5. Based on Figure 5, the following features can be observed:

- Prevailing wind direction varies seasonally. Autumn, winter and spring seasons are dominated by south-west prevailing wind, whereas summer season is dominated by north-north-east prevailing wind.
- The incident of light wind is greatest in winter with a south-west direction.



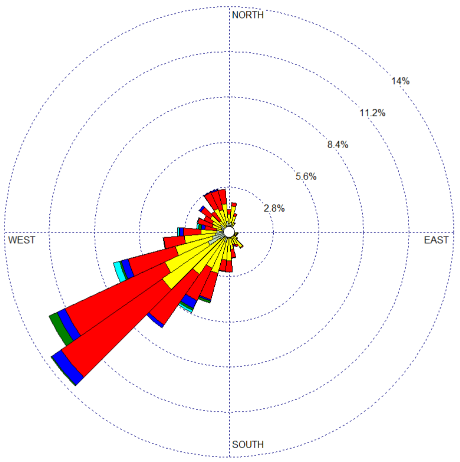
Summer Season

Average wind speed 3.5 m/s



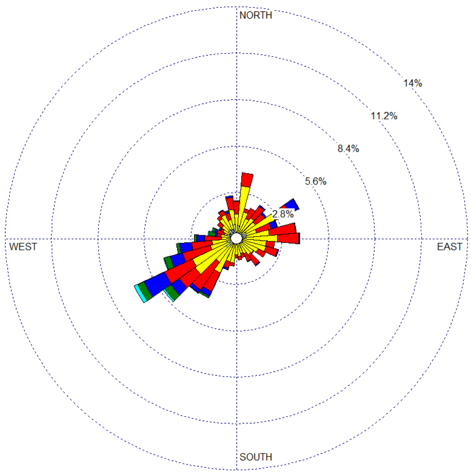
Autumn Season

Average wind speed 3.2 m/s



Winter Season

Average wind speed 3.4 m/s



Spring Season

Average wind speed 3.3 m/s

Seasonal Wind Roses

Figure 5 – Seasonal Wind Rose for 2017

4.2 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. Upon review of recent background air quality data, 2017 was selected over a more recent year due to the absence of extreme events that would have influenced monitored pollutant concentrations, such as major bush fires in late 2019 and early 2020, as well as lockdowns associated with the COVID-19 pandemic, reducing transport and some industrial emissions, in early to mid-2020 and late 2021. Background air quality data from these years is considered to be atypical. 2018 background air quality data was also affected by a considerable amount of missing data between mid-June to mid-July for the closest monitoring station. On this basis, background air quality data for 2017 is considered to be most representative of typical conditions and has been adopted for this assessment.

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, over and above other pollutants such as CO, SO_2, PAH and VOC that are also generated by standby generators in smaller quantities. To avoid over conservatism, Background method Option 2 has been used to predict ground level concentrations of NO_2 and particulate matter and Background method Option 1 has been used for predicting ground level concentrations of CO and SO_2.

Background monitoring of VOCs and PAHs is not undertaken in NSW, however, these are expected to be minimal (refer to Section 4.2.5).

4.2.1 Air quality monitoring station

The nearest air quality monitoring station (AQMS) is located at St Marys, approximately 6.7 km to the west of the subject site. The St Marys AQMS only records NO_2, O_3 and particulate matter, and is located in a mixture of predominantly residential premises and significant grassland, which is somewhat different to that of the subject site as well as the surrounding assessed receivers, located in the proximity of commercial/industrial uses and grassland. Based on this, the background air quality at St Marys would not be considered representative of the subject site and another monitoring station was investigated.

The second nearest AQMS is located at Prospect, approximately 7.1 km to the east of the subject site. The AQMS at Prospect is situated in close proximity to dense residential premises, with relatively close commercial/industrial areas. The AQMS at Prospect records all relevant pollutants, such as NO_2, SO_2, CO, O_3, PM_{10} and $PM_{2.5}$. Based on the above, background air quality monitoring at Prospect is considered more representative, than that at St Marys, to the surrounding nearby sensitive receivers subject to this assessment.

Table 7 shows the AQMS used for each pollutant and the relevant data capture for 2017.

Table 7 – 2017 background air quality data capture (Prospect)

Pollutant	Data Capture
CO	94.6%
SO_2	94.5%
NO_2	94.2%
O_3	94.6%
PM_{10}	98.9%
$PM_{2.5}$	94.7%

4.2.2 Hourly missing data interpolation

The assessment of particulate matter as well as the OLM method (conversion of NO_x to NO_2) requires hourly background data for O_3, NO_2, PM_{10} and $PM_{2.5}$. Although data capture was above 94% for each of these pollutants, 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).

4.2.3 Exclusion of exceptional air quality affecting events

While 2017 was chosen as representative of typical conditions, exceptional events still occurred which led to short-term peaks in particulate matter concentrations. An exceptional event is defined as a fire or dust occurrence that adversely affects air quality at a particular location and causes an exceedance of 24-hour average standards in excess of normal historical fluctuations and background levels and is generally directly related to: bushfire, jurisdiction authorised hazard reduction burning or continental scale windblown dust[9].

In 2017, there were 22 distinct calendar days where the daily PM_{10} standard was exceeded in NSW[10]. These exceedances were due to non-exceptional events such as local dust and particle sources, or exceptional events such as dust storms, bushfires and hazard reduction burning. Table 20 and Table A.6 of the NSW Annual Compliance Report 2017[10] details the dates with recorded exceedances. This information, along with the reported hazardous air quality levels in NSW Annual

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[9] OEH, 2018. *NSW Annual Air Quality Statement 2017*, The State of NSW and Office of Environment and Heritage. (https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/nsw-air-quality-statement-2017-180044.pdf)

[10] DPIE, 2019. *New South Wales Annual Compliance Report 2017*, National Environment Protection (Ambient Air Quality) Measure, Department of Planning, Industry and Environment. (https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/national-environment-protection-measure-ambient-air-quality-nsw-compliance-report-2017-180635.pdf)

Air Quality Statement 2017[11], have been used to filter typical 2017 PM_{10} and $PM_{2.5}$ background air quality data by removing anomalies due to the above-mentioned extraneous events, such as local dust, dust storm and hazard reduction burnings. Refer to Section 4.2.4 for more detailed charts of the filtered background air quality data used in the assessment.

4.2.4 Adopted background air quality

The maximum monitored air quality concentrations for 2017 are summarised in Table 8. The maximum monitored concentrations for CO and SO_2 in Table 8 have been adopted as background concentrations for these pollutants and have been used to determine cumulative concentrations (e.g. incremental plus background) in the assessment, whereas for NO_2, PM_{10} and $PM_{2.5}$ the hourly data presented in Figure 6 and Figure 9 have been used to provide a contemporaneous cumulative assessment.

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

Table 8 – Maximum monitored air quality concentrations

Pollutant	Averaging Period	Maximum Monitored Concentrations, µg/m³
CO	1-hour	1840.0
	8-hour	1297.9
NO_2	1-hour	112.8
SO_2	1-hour	60.3
	24-hour	26.5
O_3	1-hour	241.1
PM_{10}	24-hour	61.13
$PM_{2.5}$	24-hour	29.5

[11] OEH, 2018. *NSW Annual Air Quality Statement 2017*, The State of NSW and Office of Environment and Heritage. (https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Air/nsw-air-quality-statement-2017-180044.pdf)

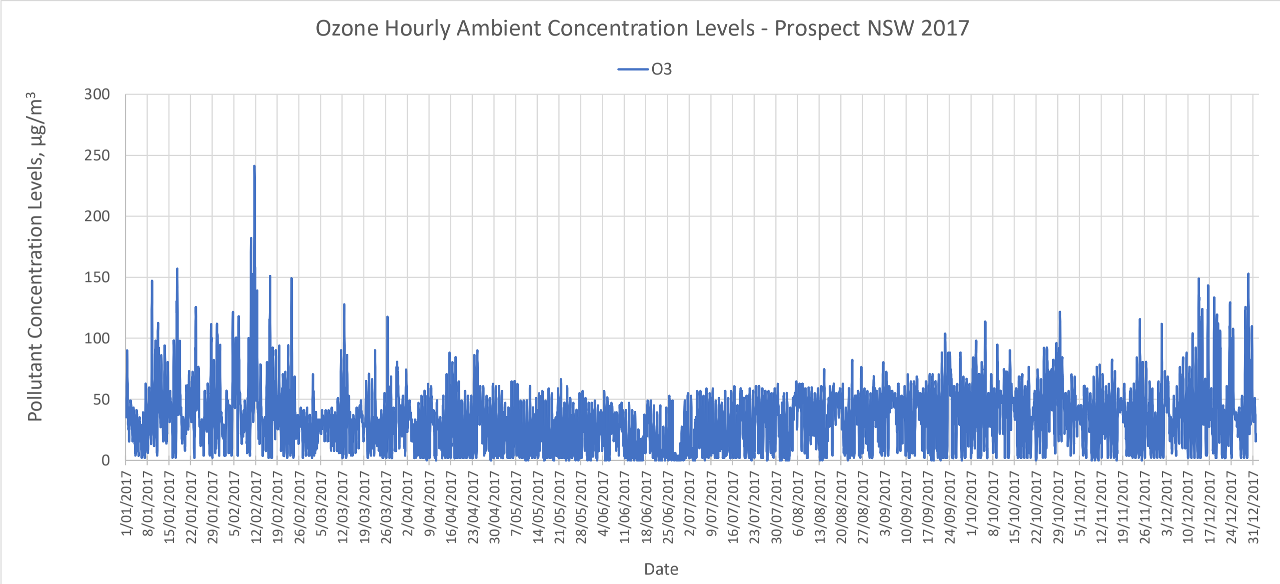

Figure 6 – Adopted hourly ozone background air quality chart

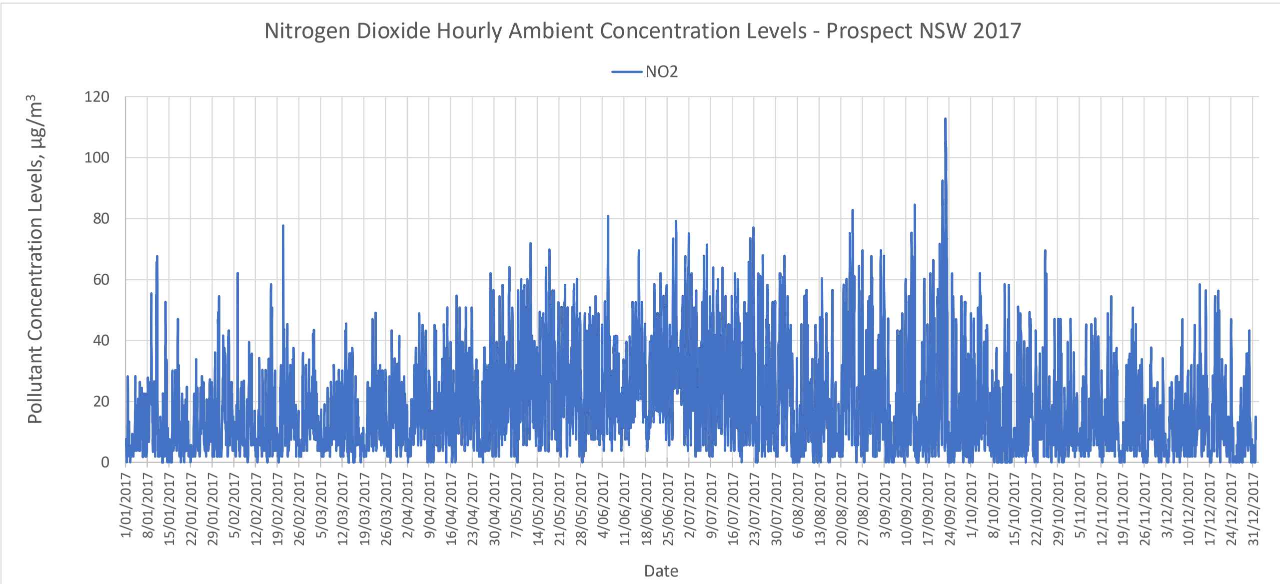

Figure 7 – Adopted hourly nitrogen dioxide background air quality chart

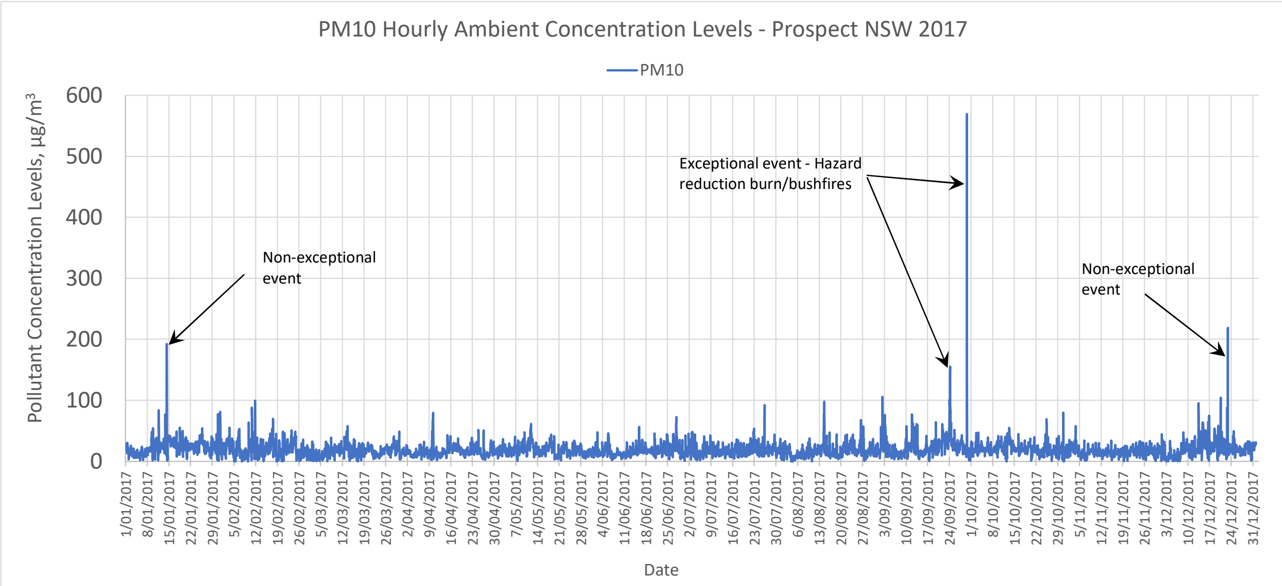

Figure 8 – Adopted hourly PM_{10} background air quality chart

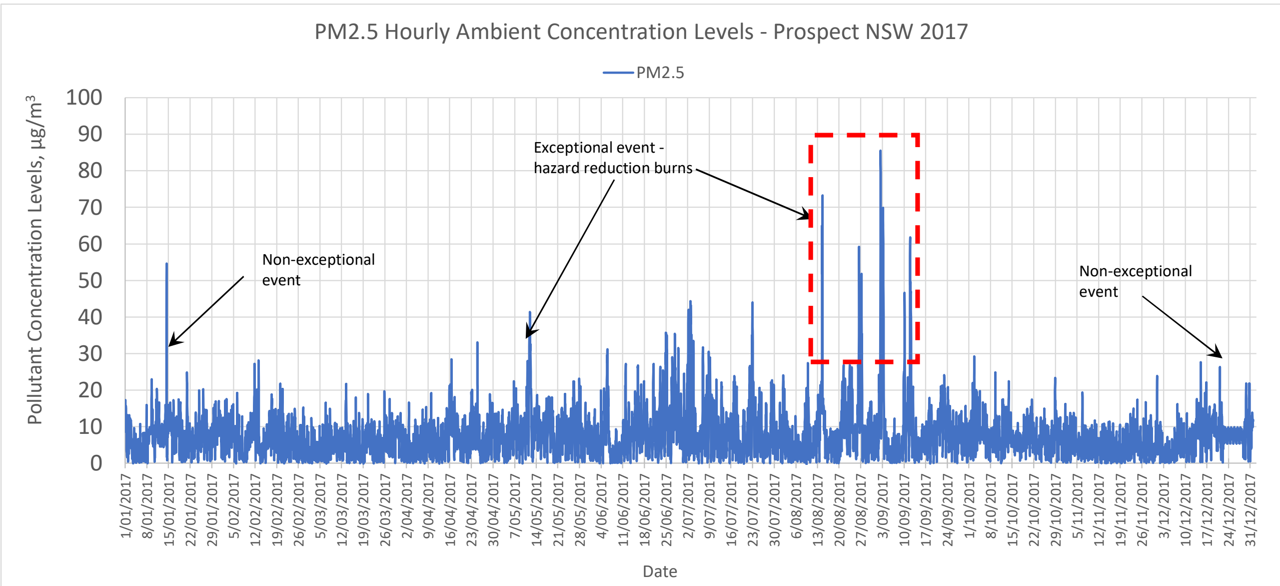

Figure 9 – Adopted hourly $PM_{2.5}$ background air quality chart

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

4.2.5 Air quality contribution from nearby industries

A review of the National Pollutant Inventory (NPI) database was undertaken to identify any industrial sites with potentially significant emissions to air within the proximity of the subject site.

There are several NPI registered industries surrounding the subject site (Erskine Park), as well as in the wider Eastern Creek and Prospect regions, located to the east of the subject site (refer to Figure 10). The contribution of these sources to local air quality in the area is expected to be captured in the air quality monitoring data from the AQMS at Prospect discussed above.

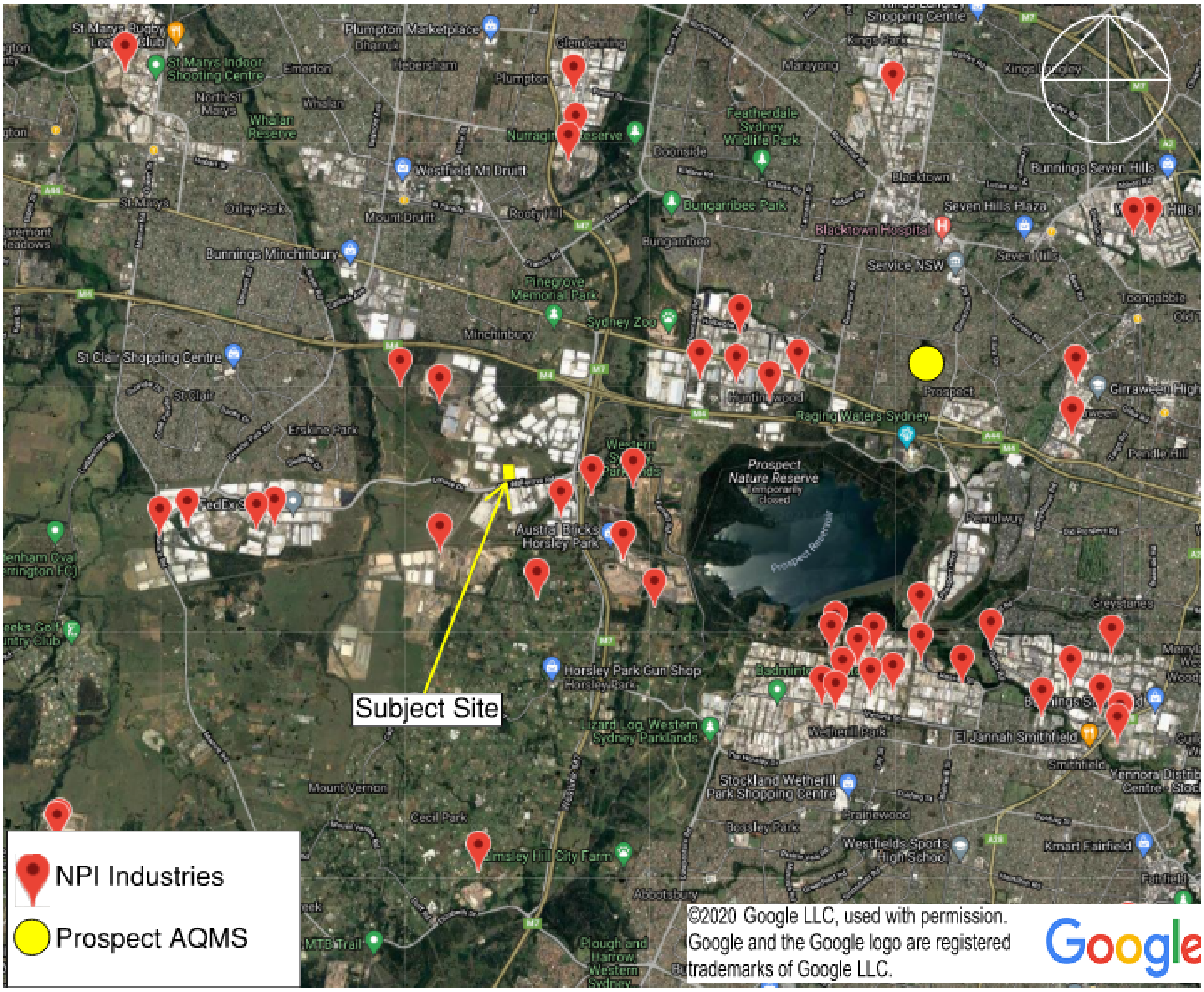

Figure 10 – Map locations of surrounding NPI listed industries

4.3 Sensitive receivers

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 subject site is located within an industrial land use. Industrial/commercial sensitive receivers are located within close proximity to the subject site, with the closest at immediately adjacent to the east. The nearest residential sensitive receivers are located approximately 1.6 km to the south of the subject site. There are residential premises located to the north and west of the subject site, at approximately 1.7 km and 2.4 km respectively. Discrete sensitive receivers have been selected to represent the nearest receivers in all directions to assist in assessing air quality impacts from the Proposal, and are summarised in Table 9 and Figure 11.

In addition, the assessment has considered a 10 km x 10 km grid to assess the location of predicted maximum ground level concentration that may not coincide with a sensitive receiver (refer to Section 5.3.2).

Table 9 – Identified nearby discrete sensitive receivers

Receiver ID (Figure 11)	Receiver Address/ Name	Receiver Type	Approximate Distance from subject site boundary (km)	X: Easting (m)	Y: Northing (m)
C1	RICOH Australia	Commercial	0.080	299798	6256703
C2	BULLVANTS	Commercial	0.058	299810	6256815
C3	FX FACTORY	Commercial	0.055	299802	6256876
C4	JAYCAR ELECTRONICS	Commercial	0.060	299855	6256989
C5	Potential Future Commercial	Commercial	0.020	299941	6256941
I1	ACR Supply South	Industrial	Immediately adjacent	300091	6256691
I2	Sydney Mainfreight Warehouse	Industrial	0.311	299987	6257248
I3	Coles CDC	Industrial	0.080	300025	6256546
R1	3 Cetus Pl, Erskine Park	Residential	2.5	297410	6256644
R2	16 Weaver St, Erskine Park	Residential	2.5	297338	6257195
R3	13 Swamphen St, Erskine Park	Residential	2.8	297238	6257990
R4	168 McFarlane Dr, Minchinbury	Residential	2.2	298982	6258956
R5	10 Agrafe Pl, Minchinbury	Residential	1.9	299728	6258796
R6	31 Farrington St, Minchinbury	Residential	1.7	300139	6258648
R7	58 Burley Rd, Horsley Park	Residential	2.0	300778	6254806
R8	146 Burley Rd, Horsley Park	Residential	1.6	300355	6255010

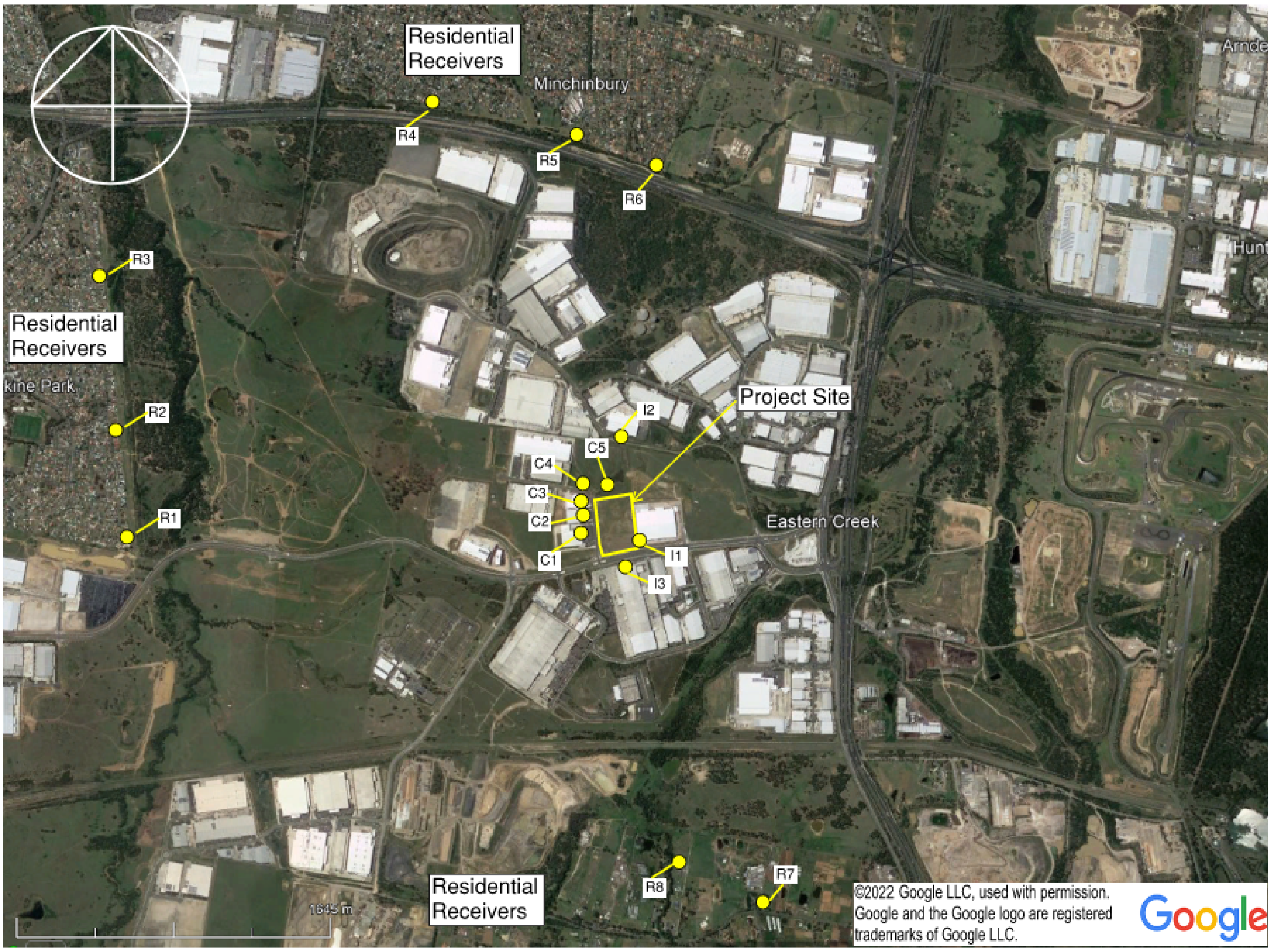

Figure 11 – Modelled nearby sensitive receiver locations

5. Methodology

This Chapter outlines the methodology used to define the existing environment 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.

5.1 Study area

The study area for the air quality assessment extends up to 5 km from the subject site in all directions. 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 x 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.

5.2 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 such as that from construction activity.

Given the scale and duration of construction, the main potential impact would be amenity-related due to the risk of dust generation and emissions to air from equipment and machinery generated by fuel combustion. Therefore, a qualitative risk-based approach has been carried out and is 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 $PM_{2.5}$.

5.3 Operational phase

The impact assessment for the operation of standby generators has been carried out using dispersion modelling to predict pollutant concentrations at nearby sensitive receivers, as well as over a larger grid domain.

5.3.1 Assessment scenarios

The following assessment 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 (100% load) under a loss of mains power situation (refer to Section 3.2).
- **Scenario 2**: Realistic operations e.g. regular generator testing where generators are tested during maintenance hours (refer to Section 3.2).

5.3.2 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[12], and is estimated to be the most widely used dispersion model internationally[13]. AERMOD is a steady-state 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 of terrain data. AERMET requires surface and upper air meteorological data input. The meteorological data used in this assessment is for the period of 1st January 2017 – 31st December 2017 (refer to Section 4.1).

AERMOD was configured as per Table 10 to assess the impact of generator emissions from the Proposal.

Table 10 – General inputs for AERMOD dispersion modelling

Parameter	Input
Meteorological Data	2017 – 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[14] was modelled to determine the average concentration impact for comparison against the impact assessment criteria.

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[12] 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.

[13] 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.

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

Prediction of less than 1-hour average concentrations

In the absence of NSW specific guidelines to convert modelled hourly concentrations to a less than 1-hour averaging period, 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. This has been 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).

Model extent

The model was run for a large grid (10 km x 10 km) at ground level, inclusive of the assessed closest sensitive receivers (refer to Section 4.3). This covers all potentially impacted nearby sensitive land uses. The extent of the model is shown in Figure 12.

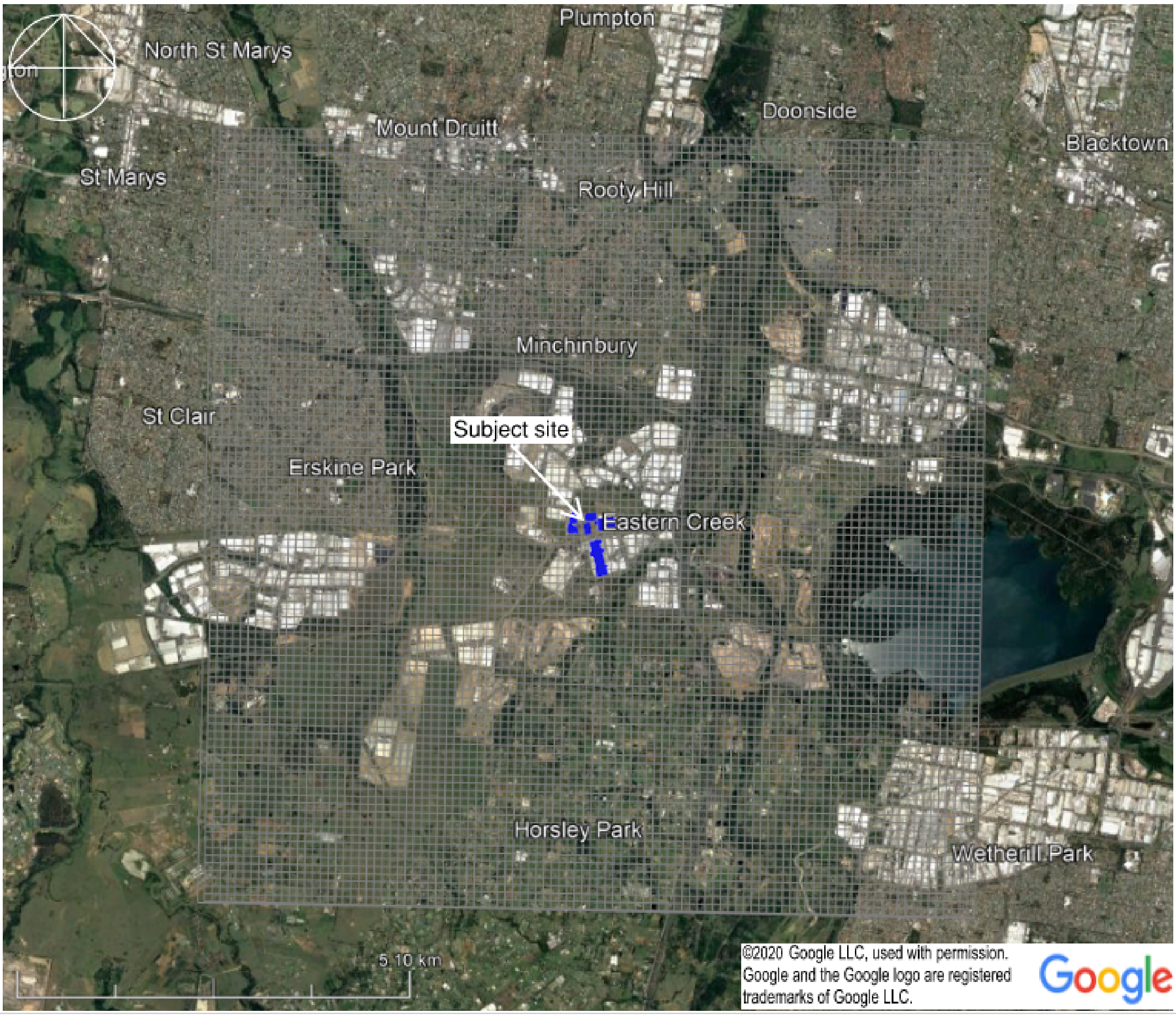

Figure 12: AERMOD model extent

Terrain effects

The subject site is located in slight sloped terrain. The gradient is steepest along the eastern border with a difference in elevation of approximately 7.5 m, reducing from 70.0 m to 62.5 m AHD. Along the western boundary the subject site grades from 69.5 m to 66.5 m AHD with a total elevation difference of approximately 3.0 m. Similarly, the subject site appears to grade from a height of approximately 68.5 m to 64.0 m AHD from west to east across the centre.

A raised plateau bordering the southern boundary of the subject site lies at 71.5 m AHD and is approximately 3.5 m above the surrounding area. A stockpile, approximately 82 m in diameter, lies close to the eastern boundary of the subject site. The top of this stockpile lies an elevation of 71.5 m AHD.

Smaller stockpiles lie to the centre and to the north of the subject site. The stock pile in the centre of the subject site is close to 51 m in breadth and 24 m in width. It stands at 4.5 m in height above ground elevation. A smaller stockpile, 80 m in length and 10 m in width lies to the north of the subject site at a height of 1 m above ground elevation (Figure 13).

Figure 13 – Site topography (Crux Surveying Australia, 2019) superposed on satellite image (Google Maps, 2019)

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 used in the model is shown in Figure 14.

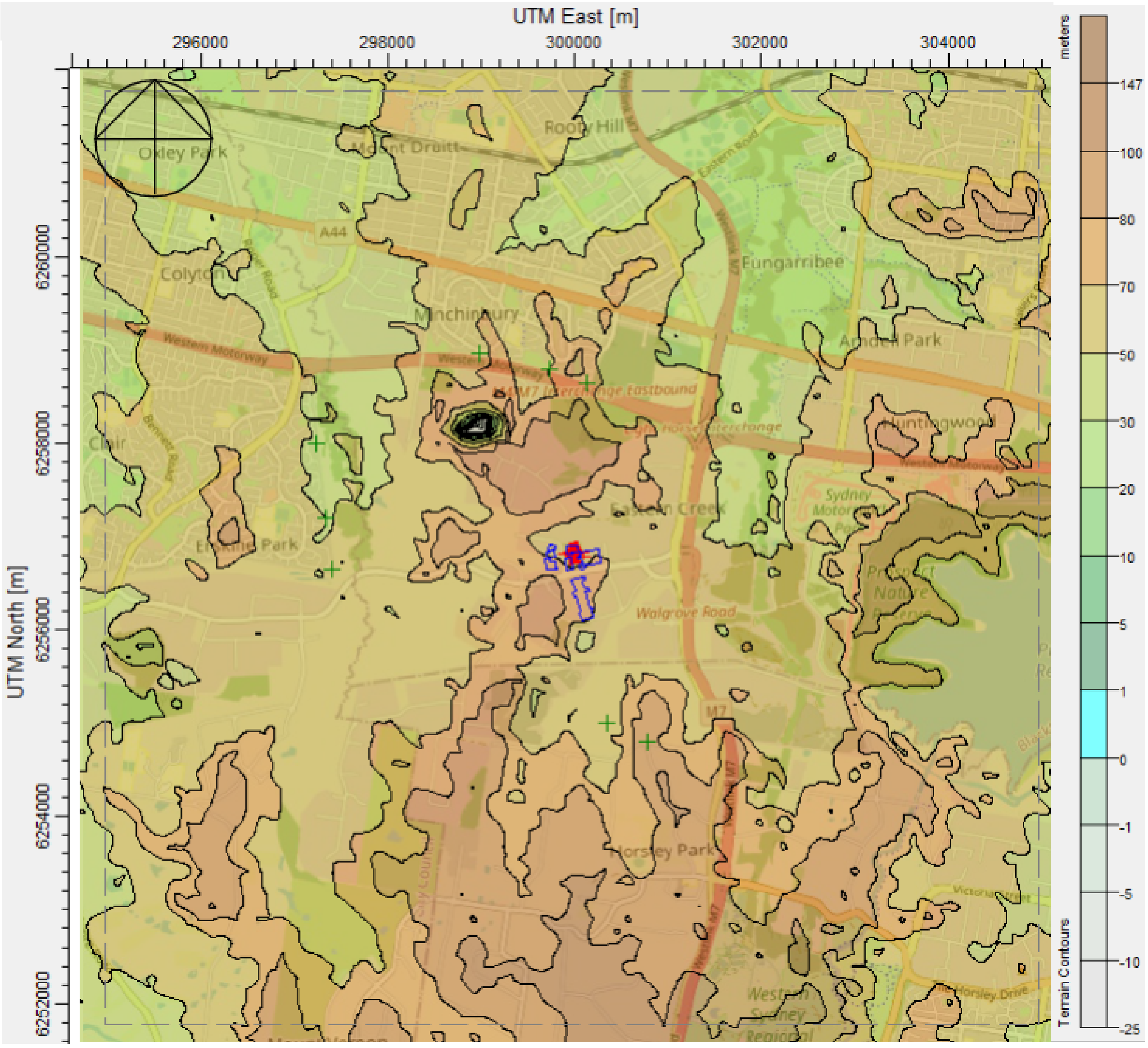

Figure 14: Modelled AERMOD topography

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 located within close proximity to the main building. The stack discharge height for Building 1 is at 30 m above ground for the 19 main generators. Building 1 has a height of 21.8 m above ground, including any roof-top parapet screens height. For Building 1A, the generator has a stack discharge height of 13.2 m next to a 13.5 m high building. The Proposal's stack discharge height is 25 m above ground level for the 19 generators. The height of the main building is 20 m above ground level, with some small areas, including the lift and stair shafts reaching a maximum height of 25 m above ground level. A building height of 20 m was modelled as this is representative of most of the building and the smaller shaft areas are unlikely to have a significant effect on air movement. On this basis, the standby generator stacks are considered wake-affected sources. As a result, the building downwash effect can lead to higher ground concentrations than would be expected in the absence of buildings, therefore buildings that may contribute to a downwash effect have been included in the dispersion model.

The surrounding buildings were also modelled as deemed relevant in potentially creating wake effect on the dispersion.

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.

Surface roughness

AERMET also requires land characteristics data for the area surrounding the subject site. The subject site is situated on a predominantly developed suburban area with a combination of grass land with trees. 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).

The non-default option of "*Adjust Surface Friction Velocity (ADJ_U*)*" was applied for consistency with the use of LOWWIND3 option in AERMOD to better resolve dispersion associated with light wind conditions, in line with the US EPA AERMOD guide.

5.3.3 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 11.

The manufacturer's specification datasheet is provided in Appendix B, which provides the emissions for particulate matter, NO_x, CO and hydrocarbon.

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)[15] 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 $PM_{2.5}$ size components.

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 specification datasheet in Appendix B. Therefore, it is 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.

Stack Characteristics and Emission Inventory

The generator exhaust stack characteristics and the associated emission inventory are summarised in Table 11.

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

Table 11 – Standby generator stack design parameters and emission inventory

Stack Parameter	Building 1 Main Generators (Admin Generator)					Building 1A Generator					Proposal Generators				
	100% Load	75% Load	50% Load	25% Load	10% Load	100% Load	75% Load	50% Load	25% Load	10% Load	100% Load	75% Load	50% Load	25% Load	10% Load
Number of generators	18 (1)					1					19				
Number of generator stack sources	18 (1)					1					19				
Height above ground (m)	30 (30)					13.2					25				
Exit internal diameter (mm)	550 (400)					400					650				
Actual discharge rates (m^3/s)[c]	9.24 (4.5)					4.5					11.1				
Exit temperature (ºC)	495 (440)					440					457				
Calculated exit velocity (m/s)	38.9 (35.8)					35.8					33.5				
CO emission (g/s)	0.608 (0.411)	0.637 (0.266)	0.608 (0.177)	0.380 (0.184)	0.197 (0.205)	0.411	0.266	0.177	0.184	0.205	0.343	0.315	0.893	0.583	0.549

Stack Parameter	Building 1 Main Generators (Admin Generator)					Building 1A Generator					Proposal Generators				
	100% Load	75% Load	50% Load	25% Load	10% Load	100% Load	75% Load	50% Load	25% Load	10% Load	100% Load	75% Load	50% Load	25% Load	10% Load
SO_2 emission (g/s)	0.075[b] (0.041[b])					0.041[b]					0.083[b]				
NO_x emission (g/s)	3.666 (6.453)	2.186 (5.000)	1.860 (2.997)	1.332 (1.402)	0.879 (0.859)	6.453	5.000	2.997	1.402	0.859	6.103	4.454	2.669	1.467	1.497
Benzene emission (g/s)	0.000268 (0.001400)	0.000268 (0.001115)	0.000134 (0.000919)	0.000246 (0.000854)	0.000322 (0.001356)	0.001400	0.001115	0.000919	0.000854	0.001356	0.001030	0.000837	0.000773	0.000772	0.002086
PAH emission (g/s)[a]	0.0000000351[a] (0.0000000189[a])					0.0000000189[a]					0.0000000386[a]				
PM emission (PM_{10} and $PM_{2.5}$) (g/s)	0.036 (0.030)	0.040 (0.026)	0.040 (0.021)	0.025 (0.024)	0.004 (0.049)	0.030	0.026	0.021	0.024	0.049	0.024	0.024	0.058	0.045	0.019
Stack location coordinates	Refer to Appendix E.														

Note:

a. 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.
b. Emission values were estimated with referenced from the NPI 2008
c. Constant flow rate under different engine loads has been assumed, in the absence of detailed information.

5.3.4 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[16] (OLM), as per 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[17],[18], which adds a level of conservatism to the assessment.

The OLM equation for calculating NO_2 is provided below:

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

Where,

ISR = In-stack NO_2/NO_x ratio

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[19]. 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 4.2.4.

[16] 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.

[17] 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

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

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

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. These include construction of an access road, pavements, culvert and other ancillary works and earthworks and construction of buildings associated with the Proposal. The closest sensitive receivers are located at 1.6 km south of the subject site boundary. 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 very low.

While the activities described above are typical for any construction site, with a low risk identified, 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 as part of the best practice.

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 all standby generators under worst case conditions, due to a loss of mains power, where all generators would run simultaneously to provide the full back up power required.

7.1.1 Nitrogen dioxide

The highest 1-hour average ground level concentrations (GLCs) for NO_2 have been predicted at each of the assessed sensitive receivers. The results are shown in Table 12, which indicate that the cumulative NO_2 GLCs (i.e. inclusive of background concentrations) are predicted to exceed the impact assessment criterion at the nearby commercial/industrial and residential receivers, with the highest concentration predicted at receiver ID C5 (potential future commercial area) by up to three-and-a-half fold.

The concentrations shown in Table 12 represent the highest 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 (refer to Section 3.2.1).

Table 12 – Predicted 100th percentile 1-hour NO_2 concentrations (Scenario 1)

Receiver ID	1-Hour Nitrogen Dioxide (NO_2) Concentration (µg/m^3)			Comply
	Incremental	Cumulative	Criteria	
C1	352.5	373.9	164	No
C2	409.8	443.1		No
C3	439.0	468.3		No
C4	509.3	550.6		No
C5	560.9	589.5		No
I1	276.5	285.9		No
I2	355.8	382.1		No
I3	257.0	285.2		No
R1	100.7	146.2		Yes
R2	89.9	132.8		Yes
R3	90.3	135.4		Yes
R4	128.2	169.5		No
R5	103.7	148.8		Yes
R6	148.1	194.6		No
R7	142.2	194.6		No
R8	155.1	204.8		No

The predicted cumulative GLCs across the modelled domain are shown as contour plots in Appendix F.

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, which are shown in Table 13.

The results show that the cumulative PM_{10} GLCs (i.e. inclusive of background concentrations) are predicted to meet the impact assessment criterion of 50 µg/m^3 at all assessed sensitive receivers. The predicted $PM_{2.5}$ GLCs are predicted to meet the impact assessment criterion of 25 µg/m^3 at all assessed sensitive receivers, except at commercial receivers ID C4 (JAYCAR Electronics) and C5 (potential future commercial area) by almost one-and-a-half folds. However, it is unlikely that standby generators would need to operate for a continuous 24-hour period in an event of loss of mains power scenario. Therefore, this is expected to provide a conservative assessment. Further, as previously discussed, the likelihood of this scenario occurring is expected to be very rare at the subject site (refer to Section 3.2.1).

Table 13 – Predicted 100th percentile 24-hour PM_{10} and $PM_{2.5}$ concentrations (Scenario 1)

Receiver ID	24-Hour Ground Level Concentrations (µg/m^3)					Comply
	PM_{10}/$PM_{2.5}$	PM_{10}		$PM_{2.5}$		
	Incremental	Cumulative	Criteria	Cumulative	Criteria	
C1	8.9	41.0	50	22.2	25	Yes
C2	11.3	44.1		22.4		Yes
C3	13.0	46.2		22.7		Yes
C4	11.4	43.7		25.8		PM_{10} = Yes $PM_{2.5}$ = No
C5	24.7	48.5		34.2		PM_{10} = Yes $PM_{2.5}$ = No
I1	3.9	38.8		22.1		Yes
I2	5.9	40.6		24.4		Yes
I3	6.0	38.9		24.0		Yes
R1	0.7	38.8		22.0		Yes
R2	0.5	38.8		22.0		Yes
R3	0.3	38.9		22.0		Yes
R4	0.6	38.8		22.1		Yes
R5	0.9	38.8		22.2		Yes
R6	0.8	39.0		22.2		Yes
R7	0.9	38.8		22.0		Yes
R8	0.8	38.8		22.0		Yes

7.1.3 All other pollutants

The predicted 100th percentile highest GLCs for all other assessed pollutants (CO, SO_2, Benzene and PAH) are summarised in Table 14 and Table 16. The results show that CO, SO_2, Benzene and PAH are predicted to be below the relevant impact assessment criteria at the assessed sensitive receivers, except for predicted 24-hour average SO_2 concentrations at some of the assessed commercial sensitive receivers (ID C2, C3 and C5). As previously mentioned, it is unlikely that standby generators would need to operate for a continuous 24-hour period in a loss of mains power scenario, therefore the approach taken provides a conservative assessment.

Table 14 – Predicted 100th percentile GLCs for 8-hour CO and 24-hour SO_2 (Scenario 1)

Receiver ID	8-Hour Ground Level Concentrations (µg/m³) CO Incremental	Cumulative	Criteria	24-Hour Ground Level Concentrations (µg/m³) SO_2 Incremental	Cumulative	Criteria	Comply
C1	198.7	1496.6	10,000	28.3	54.8	57	Yes
C2	210.4	1508.3		30.7	57.2		CO = Yes SO_2 = No
C3	245.0	1542.9		33.3	59.8		CO = Yes SO_2 = No
C4	301.2	1599.1		28.1	54.6		Yes
C5	569.4	1867.3		54.5	81.0		CO = Yes SO_2 = No
I1	104.7	1402.6		8.5	35.0		Yes
I2	153.5	1451.4		13.5	40.0		Yes
I3	128.6	1426.5		14.4	40.9		Yes
R1	15.3	1313.2		1.8	28.3		Yes
R2	13.8	1311.7		1.3	27.8		Yes
R3	12.9	1310.8		0.9	27.4		Yes
R4	20.3	1318.2		1.4	27.9		Yes
R5	23.0	1320.9		2.3	28.8		Yes
R6	22.8	1320.7		2.1	28.6		Yes
R7	24.8	1322.7		2.3	28.8		Yes
R8	36.8	1334.7		2.0	28.5		Yes

Table 15 – Predicted 100th percentile 1-hour concentrations 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	
C1	247.6	2087.6	30,000	39.0	99.3	286	0.453	29	0.00001820	0.4	Yes
C2	263.9	2103.9		45.6	105.9		0.561		0.00002123		Yes
C3	326.8	2166.8		54.5	114.8		0.599		0.00002539		Yes
C4	413.1	2253.1		67.5	127.8		0.647		0.00003145		Yes
C5	642.1	2482.1		87.1	147.4		0.607		0.00004069		Yes
I1	132.9	1972.9		19.2	79.5		0.175		0.00000896		Yes
I2	334.3	2174.3		47.6	107.9		0.364		0.00002221		Yes
I3	171.4	2011.4		29.9	90.2		0.293		0.00001393		Yes
R1	29.4	1870.4		4.8	65.1		0.044		0.00000222		Yes
R2	28.2	1870.2		4.6	64.9		0.042		0.00000213		Yes
R3	26.2	1869.2		4.2	64.5		0.038		0.00000197		Yes
R4	80.4	1924.4		11.5	71.8		0.083		0.00000535		Yes
R5	70.7	1915.7		8.6	68.9		0.065		0.00000404		Yes
R6	104.8	1950.8		13.1	73.4		0.094		0.00000613		Yes
R7	68.6	1915.6		10.1	70.4		0.094		0.00000471		Yes
R8	79.2	1927.2		12.1	72.4		0.111		0.00000566		Yes

Table 16 – Predicted 100th percentile 15-minute GLCs for CO (Scenario 1)

Receiver ID	15-min Ground Level Concentrations (µg/m^3) CO			Comply
	Incremental	Cumulative	Criteria	
C1	326.7	2754.6	100,000	Yes
C2	348.3	2776.2		Yes
C3	431.2	2859.1		Yes
C4	545.0	2972.9		Yes
C5	847.3	3275.2		Yes
I1	175.4	2603.3		Yes
I2	441.1	2869.0		Yes
I3	226.2	2654.1		Yes
R1	38.7	2468.0		Yes
R2	37.2	2467.7		Yes
R3	34.5	2466.4		Yes
R4	106.1	2539.2		Yes
R5	93.3	2527.8		Yes
R6	138.3	2574.1		Yes
R7	90.5	2527.6		Yes
R8	104.5	2543.0		Yes

7.2 Scenario 2 – Realistic operations (routine maintenance)

The on-duty standby generators would undergo routine maintenance and testing to make sure they are operational if required during a power outage. Routine maintenance follows a prescribed testing regime as shown in Section 3.2.1. For the Proposal, it is anticipated that a maximum of three generators would be tested at any one time on a fortnightly basis, under no-load. Up to one generator to be tested during the quarterly and yearly period, with 70% and 100% load respectively. The Building 1 and 1A generators will not be tested at the same time as the Proposal's generators.

The emission rates for relevant pollutants under different loads are presented in Section 5.3.3, Table 11. The air quality assessment during maintenance scenario considered the following events:

- Three generators under no-load (based on 10% load emission data) being tested concurrently. This assumes generators tested are located next to each other. It is noted that during this testing scenario, there would be up to five minutes run time per three generators tested. The approach taken in the modelling assumes that a group of three generators is tested continuously during the daytime period, this provides a level of conservatism and in reality predicted concentrations would be much lower.
- One generator under 100% or 70% load (whichever has the greatest emission under different pollutant) being tested.

7.2.1 Nitrogen dioxide

The 100th percentile NO_2 GLCs under routine maintenance at each of the assessed sensitive receivers have been predicted in Table 17, taking into consideration the worst impact from both three-tested generators (no-load) and single generator-tested (70% or 100% load).

The results show the cumulative NO_2 concentrations (i.e. inclusive of background concentrations) are all predicted to be below the impact assessment criterion, with the highest predicted concentration of 144.8 µg/m^3 at receiver ID C3 (Commercial receiver: FX Factory), which is 88 % of the NO_2 impact assessment criterion. This indicates that predicted 1-hour NO_2 concentrations at nearby sensitive receivers meet the impact assessment criteria under all routine maintenance conditions.

Table 17 – Predicted 100th percentile 1-hour NO_2 concentrations (Scenario 2)

Receiver ID	Worst 1-Hour Nitrogen Dioxide (NO_2) Concentration (µg/m^3) – Three Generators tested		Worst 1-Hour Nitrogen Dioxide (NO_2) Concentration (µg/m^3) – Single Generator tested		Criteria	Comply
	Incremental	Cumulative	Incremental	Cumulative		
C1	46.5	112.8	61.5	112.8	164	Yes
C2	33.4	112.8	68.1	124.5		Yes
C3	49.2	112.8	88.4	144.8		Yes
C4	28.7	112.8	63.4	114.2		Yes
C5	41.1	112.8	71.5	114.4		Yes
I1	42.3	112.8	81.7	112.8		Yes
I2	18.4	112.8	25.9	112.8		Yes
I3	32.2	112.8	60.1	112.8		Yes

Receiver ID	Worst 1-Hour Nitrogen Dioxide (NO_2) Concentration (µg/m^3) – Three Generators tested		Worst 1-Hour Nitrogen Dioxide (NO_2) Concentration (µg/m^3) – Single Generator tested		Criteria	Comply
	Incremental	Cumulative	Incremental	Cumulative		
R1	6.0	112.8	15.5	112.8		Yes
R2	5.4	112.8	16.3	112.8		Yes
R3	5.3	112.8	19.7	112.8		Yes
R4	6.8	112.8	20.4	112.8		Yes
R5	5.5	112.8	11.5	112.8		Yes
R6	7.4	112.8	16.0	112.8		Yes
R7	7.1	112.8	11.3	112.8		Yes
R8	9.0	112.8	15.1	112.8		Yes

Note:

- As the model is run for each hour of the year with contemporaneous background data for NO_2 and O_3, the worst case cumulative concentrations are dominated by an elevated background concentrations which occurred 8pm on 22 September 2017. The worst-case incremental concentrations are based on the hours where modelled emissions coincide with worst case meteorological conditions for each receiver. The same understanding applies to all other assessed pollutants.

7.2.2 All other pollutants

All other pollutants have been predicted to meet the relevant impact assessment criteria under the realistic operations scenario. The predicted results are summarised in Table 18 to Table 24.

- The highest predicted PM_{10} and $PM_{2.5}$ cumulative GLCs at the assessed sensitive receivers are 39.6 µg/m^3 and 23.1 µg/m^3, respectively.
- The highest predicted cumulative 8-hour, 1-hour and 15-minute CO GLCs at the assessed sensitive receivers are 1340.7 µg/m^3, 1904.5 µg/m^3, 2513.0 µg/m^3, respectively.
- The highest predicted cumulative 24-hour and 1-hour SO_2 GLCs at the assessed sensitive receivers are 32.8 µg/m^3 and 76.0 µg/m^3, respectively.
- The highest predicted incremental 1-hour benzene GLC at the assessed sensitive receivers is 0.2450 µg/m^3.
- The highest predicted incremental 1-hour PAH GLC at the assessed sensitive receivers is 0.00000736 µg/m^3.

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 significantly impact air quality at nearby sensitive receivers

Table 18 – Predicted 100th percentile 24-hour PM_{10} concentrations (Scenario 2)

Receiver ID	Worst 24-Hour $PM_{10}/PM_{2.5}$ Concentration (µg/m³) – 3 Generators tested		Worst 24-Hour PM_{10} Concentration (µg/m³) – 1 Generator tested		Criteria	Comply
	Incremental	Cumulative	Incremental	Cumulative		
C1	0.60	39.20	0.26	38.94	50	Yes
C2	0.53	39.15	0.30	38.92		Yes
C3	0.71	39.25	0.32	38.94		Yes
C4	0.79	39.16	0.37	38.96		Yes
C5	1.24	39.57	1.15	39.27		Yes
I1	0.41	38.78	0.19	38.76		Yes
I2	0.37	38.80	0.17	38.77		Yes
I3	0.41	38.77	0.22	38.76		Yes
R1	0.02	38.75	0.01	38.75		Yes
R2	0.02	38.76	0.01	38.76		Yes
R3	0.02	38.76	0.01	38.76		Yes
R4	0.03	38.76	0.01	38.76		Yes
R5	0.03	38.76	0.01	38.75		Yes
R6	0.03	38.76	0.01	38.76		Yes
R7	0.02	38.75	0.01	38.75		Yes
R8	0.04	38.75	0.02	38.75		Yes

Table 19 – Predicted 100th percentile 24-hour $PM_{2.5}$ concentrations (Scenario 2)

Receiver ID	Worst 24-Hour $PM_{10}/PM_{2.5}$ Concentration (µg/m³) – 3 Generators tested		Worst 24-Hour $PM_{2.5}$ Concentration (µg/m³) – 1 Generator tested		Criteria	Comply
	Incremental	Cumulative	Incremental	Cumulative		
C1	0.60	21.99	0.26	21.98	25	Yes
C2	0.53	22.07	0.30	22.02		Yes
C3	0.71	22.10	0.32	22.03		Yes
C4	0.79	22.38	0.37	22.16		Yes
C5	1.24	23.07	1.15	22.55		Yes
I1	0.41	21.99	0.19	21.98		Yes
I2	0.37	22.15	0.17	22.04		Yes
I3	0.41	21.99	0.22	21.98		Yes
R1	0.02	21.98	0.01	21.98		Yes
R2	0.02	21.98	0.01	21.98		Yes
R3	0.02	21.98	0.01	21.98		Yes
R4	0.03	22.00	0.01	21.99		Yes
R5	0.03	21.99	0.01	21.98		Yes

Receiver ID	Worst 24-Hour PM_{10}/$PM_{2.5}$ Concentration (µg/m^3) – 3 Generators tested		Worst 24-Hour $PM_{2.5}$ Concentration (µg/m^3) – 1 Generator tested		Criteria	Comply
	Incremental	Cumulative	Incremental	Cumulative		
R6	0.03	21.99	0.01	21.98		Yes
R7	0.02	21.98	0.01	21.98		Yes
R8	0.04	21.98	0.02	21.98		Yes

Table 20 – Predicted 100th percentile GLCs for 8-hour CO (Scenario 2)

Receiver ID	8-Hour Ground Level Concentrations (µg/m³) – 3 Generators tested		8-Hour Ground Level Concentrations (µg/m³) – 1 Generator tested		Criteria	Comply
	Incremental	Cumulative	Incremental	Cumulative		
C1	43.1	1341.0	9.1	1307.0	10,000	Yes
C2	36.3	1334.2	10.8	1308.7		Yes
C3	26.7	1324.6	12.9	1310.8		Yes
C4	22.5	1320.4	13.8	1311.7		Yes
C5	39.1	1337.0	42.8	1340.7		Yes
I1	16.3	1314.2	8.0	1305.9		Yes
I2	6.9	1304.8	6.5	1304.4		Yes
I3	19.1	1317.0	8.2	1306.1		Yes
R1	0.4	1298.3	0.2	1298.1		Yes
R2	0.3	1298.2	0.3	1298.2		Yes
R3	0.5	1298.4	0.2	1298.1		Yes
R4	0.6	1298.5	0.4	1298.3		Yes
R5	0.7	1298.6	0.3	1298.2		Yes
R6	0.5	1298.4	0.4	1298.3		Yes
R7	0.5	1298.4	0.3	1298.2		Yes
R8	0.9	1298.8	0.4	1298.3		Yes

Table 21 – Predicted 100th percentile GLCs for 24-hour SO_2 (Scenario 2)

Receiver ID	24-Hour Ground Level Concentrations (µg/m³) – 3 Generators tested		24-Hour Ground Level Concentrations (µg/m³) – 1 Generator tested		Criteria	Comply
	Incremental	Cumulative	Incremental	Cumulative		
C1	2.6	29.1	0.9	27.4	57	Yes
C2	2.3	28.8	0.8	27.3		Yes
C3	1.8	28.3	0.6	27.1		Yes
C4	2.1	28.6	0.7	27.2		Yes
C5	6.3	32.8	2.1	28.6		Yes
I1	1.0	27.5	0.4	26.9		Yes
I2	0.9	27.4	0.3	26.8		Yes
I3	1.1	27.6	0.4	26.9		Yes
R1	0.0	26.5	0.0	26.5		Yes
R2	0.0	26.5	0.0	26.5		Yes
R3	0.0	26.5	0.0	26.5		Yes
R4	0.0	26.5	0.0	26.5		Yes
R5	0.0	26.5	0.0	26.5		Yes
R6	0.1	26.6	0.0	26.5		Yes
R7	0.0	26.5	0.0	26.5		Yes
R8	0.1	26.6	0.0	26.5		Yes

Table 22 – Predicted 100th percentile 1-hour concentrations for CO and SO_2 (Scenario 2)

Receiver ID	CO					SO_2					Comply
	1-Hour Ground Level Concentrations (µg/m³) – 3 Generators tested		1-Hour Ground Level Concentrations (µg/m³) – 1 Generator tested		Criteria	1-Hour Ground Level Concentrations (µg/m³) – 3 Generators tested		1-Hour Ground Level Concentrations (µg/m³) – 1 Generator tested		Criteria	
	Incremental	Cumulative	Incremental	Cumulative		Incremental	Cumulative	Incremental	Cumulative		
C1	64.5	1904.5	15.9	1855.9	30,000	9.7	70.0	3.3	63.6	286	Yes
C2	54.6	1894.6	22.2	1862.2		8.3	68.6	2.8	63.1		Yes
C3	54.8	1894.8	29.3	1869.3		8.3	68.6	2.9	63.2		Yes
C4	45.6	1885.6	28.3	1868.3		7.1	67.4	2.8	63.1		Yes
C5	41.9	1881.9	45.5	1885.5		15.7	76.0	5.4	65.7		Yes
I1	34.5	1874.5	12.5	1852.5		5.2	65.5	1.8	62.1		Yes
I2	23.8	1863.8	14.8	1854.8		5.2	65.5	1.7	62.0		Yes
I3	30.1	1870.1	24.6	1864.6		4.5	64.8	2.5	62.8		Yes
R1	2.5	1843.5	1.1	1842.1		0.4	60.7	0.1	60.4		Yes
R2	2.5	1844.5	1.3	1843.3		0.4	60.7	0.1	60.4		Yes
R3	2.2	1845.2	1.6	1844.6		0.3	60.6	0.2	60.5		Yes
R4	3.8	1847.8	3.0	1847.0		1.0	61.3	0.4	60.7		Yes
R5	2.6	1847.6	1.6	1846.6		0.4	60.7	0.2	60.5		Yes
R6	3.5	1849.5	2.1	1848.1		0.7	61.0	0.2	60.5		Yes
R7	3.2	1850.2	2.1	1849.1		0.5	60.8	0.2	60.5		Yes
R8	3.7	1851.7	3.2	1851.2		0.6	60.9	0.3	60.6		Yes

Table 23 – Predicted 100th percentile 15-minute and 10-minute GLCs for CO and SO_2 (Scenario 2)

Receiver ID	CO					Comply
	15-min Ground Level Concentrations (µg/m³) – 3 Generators tested		15-min Ground Level Concentrations (µg/m³) – 1 Generator tested		Criteria	
	Incremental	Cumulative	Incremental	Cumulative		
C1	85.1	2513.0	21.0	2448.9	100,000	Yes
C2	72.0	2499.9	29.3	2457.1		Yes
C3	72.3	2500.2	38.6	2466.5		Yes
C4	60.1	2488.0	37.3	2465.2		Yes
C5	55.2	2483.1	60.0	2487.9		Yes
I1	45.5	2473.4	16.4	2444.3		Yes
I2	31.4	2459.3	19.5	2447.4		Yes
I3	39.7	2467.6	32.4	2460.3		Yes
R1	3.3	2432.5	1.5	2430.7		Yes
R2	3.3	2433.9	1.7	2432.2		Yes
R3	2.9	2434.8	2.0	2433.9		Yes
R4	5.1	2438.2	3.9	2437.1		Yes
R5	3.4	2437.9	2.1	2436.5		Yes
R6	4.7	2440.5	2.8	2438.6		Yes
R7	4.2	2441.3	2.8	2439.9		Yes
R8	4.9	2443.3	4.3	2442.7		Yes

Table 24 – Predicted 100th percentile 1-hour concentrations for Benzene and PAH (Scenario 2)

Receiver ID	Benzene			PAH			Comply
	1-Hour Ground Level Concentrations (µg/m³) – 3 Generators tested	1-Hour Ground Level Concentrations (µg/m³) – 1 Generator tested	Criteria	1-Hour Ground Level Concentrations (µg/m³) – 3 Generators tested	1-Hour Ground Level Concentrations (µg/m³) – 1 Generator tested	Criteria	
	Incremental	Incremental		Incremental	Incremental		
C1	0.2450	0.0411	29	0.00000453	0.00000154	0.4	Yes
C2	0.2074	0.0755		0.00000384	0.00000128		Yes
C3	0.2081	0.0998		0.00000385	0.00000135		Yes
C4	0.1731	0.0963		0.00000331	0.00000130		Yes
C5	0.1591	0.1336		0.00000736	0.00000251		Yes
I1	0.1312	0.0390		0.00000243	0.00000085		Yes
I2	0.0905	0.0392		0.00000243	0.00000081		Yes
I3	0.1142	0.0837		0.00000211	0.00000113		Yes
R1	0.0094	0.0038		0.00000017	0.00000006		Yes
R2	0.0096	0.0044		0.00000018	0.00000006		Yes
R3	0.0084	0.0053		0.00000016	0.00000007		Yes
R4	0.0146	0.0061		0.00000048	0.00000016		Yes
R5	0.0098	0.0053		0.00000020	0.00000007		Yes
R6	0.0134	0.0070		0.00000035	0.00000012		Yes
R7	0.0120	0.0071		0.00000022	0.00000010		Yes
R8	0.0141	0.0111		0.00000026	0.00000015		Yes

7.3 POEO (Clean Air) Regulation – Standard of Concentrations

Clause 73 of the POEO (Clean Air) Regulation 2022 exempts emergency electricity generation comprising a stationary reciprocal internal combustion engine from the air impurities Standard of nitrogen dioxide and nitric oxide concentrations specified in Schedule 2 in relation to that plant, if the plant is used for a total of not more than 200 hours per year.

Based on the likely maintenance schedule outlined in Table 6, the Proposal is considered as non-scheduled premises, the Proposal shall comply with the Schedule 2 Part 3 of the Standard of Concentrations for non-scheduled premises.

Table 3 below shows that the generator emissions for particles associated with the Proposal are below the Standard of Concentration of 100 mg/m^3.

Table 25 – POEO (Clean Air) Regulation Schedule 2 Part 3 – Standards of concentrations assessment

Air impurity	Activity or plant	Standard of Concentration, mg/m^3	The Proposal's per-Generator Emissions[a], mg/m^3				
			100% load	75% load	50% load	25% load	10% load
Solid particles	Any activity/ plant	100[b]	11	12	42	51	29

Note:

a. The Proposal's generator emissions above are based on the mg/Nm^3 generator emission data of MTU 20V4000G94F in Appendix B, assumed as dry, 273K, 101.3kPa and 12.5% O_2 content, which were then converted into 7% O_2 content as per the POEO (Clean Air) Regulation requirements.

b. Standard of emission concentration under dry, 273K, 101.3kPa, 7% O_2 conditions.

8. Environmental management measures

This section describes the measures to mitigate against, monitor and manage any potential 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 26 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, however specific mitigation or management measures are proposed for the operational phase to minimise the air quality impact during maintenance.

Table 26 – 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 shall 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 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 • When the air quality, suppression and management measures need to be applied, who is responsible, and how effectives will be assessed • Community notification and complaint handling procedures, as required.	Contractor	Pre-construction/Construction

ID	Impacts	Mitigation	Responsibility	Timing
AQ2	Risks to air quality during construction from vehicle and machinery emissions	The following management measures shall 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	Selection of USEPA tier II generators with low emissions (in particular NO_x) generator equipment. 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	Selection of USEPA tier II generators with low emissions (in particular NO_x) generator equipment. 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 27.

Table 27 – 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 26. 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 26. 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 26.	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 26.	Low	N/A

10. References

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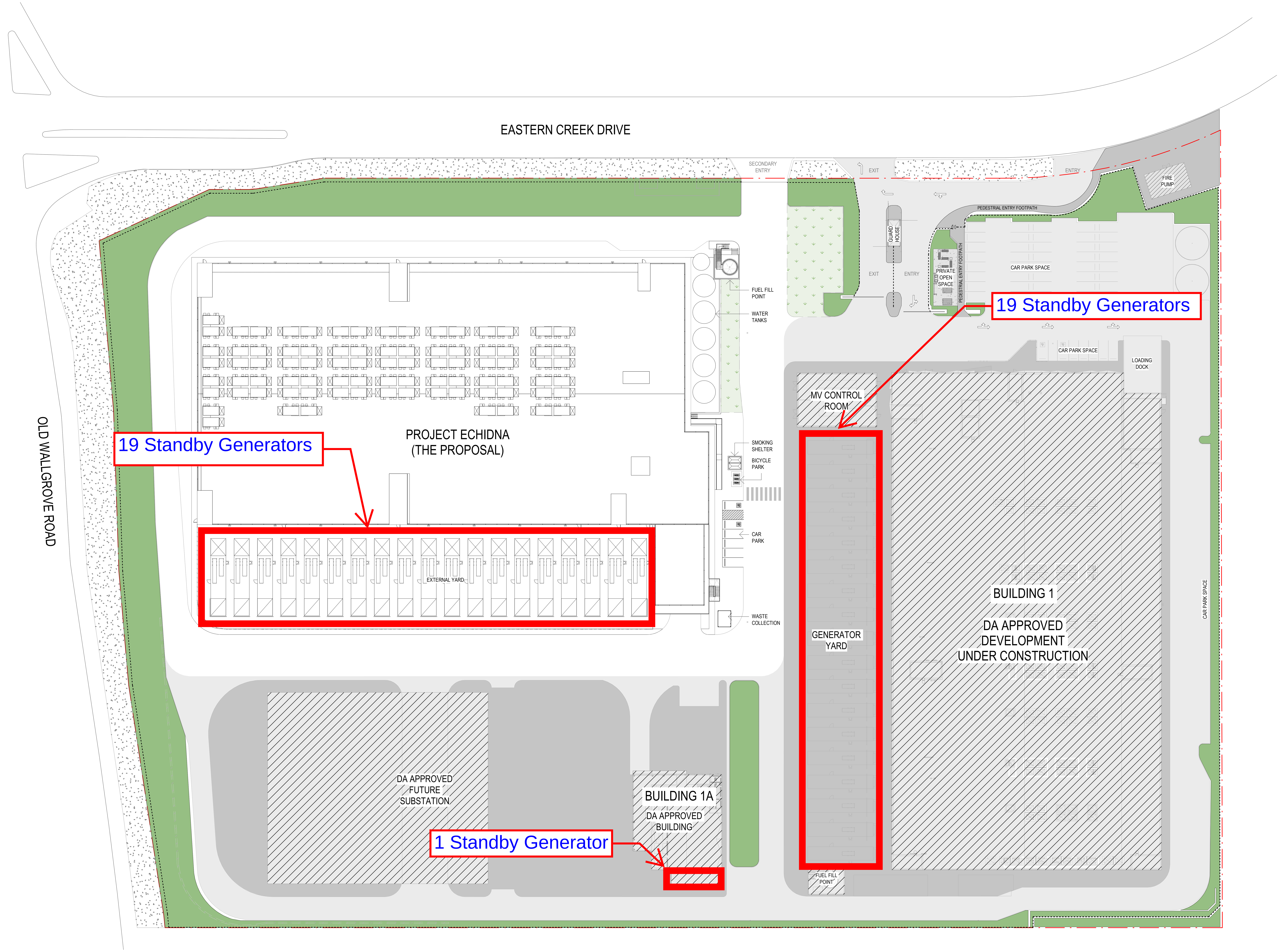
Appendix A

Masterplan drawing



SITE AREA SCHEDULE

TOTAL SITE AREA	56,800 m²
TOTAL SITE AREA exc. SUBSTATION	55,989 m²
SITE COVERAGE DA APPROVED DEVELOPMENT	9,225 m²
TOTAL SITE LANDSCAPING	5,563 m²

GENTON
Melbourne Level 3, 125 Flinders Lane VIC 3000 +61 3 9078 3686
Sydney Level G, 71 York Street NSW 2000 +61 2 9696 5002
Web genton.com.au

1 : 500 0 5 10 15 20 25 m

No.	Revision Date	Description

TITLE. PROPOSED SITE MASTERPLAN
PROJECT. ECHIDNA

DRAWING NO.	SSDA-052
JOB NO.	2207
DATE	07/18/22
SCALE :	1 : 500 @ A1

Appendix B

Standby generator specification

Building 1

3516E Diesel Generator Sets
Electric Power

CAT®

Package Performance

Performance	Standby		Mission Critical		Prime	
Engine Speed	1500 rpm		1500 rpm		1500 rpm	
Frequency	50 Hz		50 Hz		50 Hz	
Gen set power rating with fan	2400 ekW		2400 ekW		2180 ekW	
Gen set power rating with fan @ 0.8 power factor	3000 kVA		3000 kVA		2725 kVA	
Emissions	Tier 2 (EPA ESE)		Tier 2 (EPA ESE)		Tier 2 (EPA ESE)	
Performance number	EM4775-04		EM4781-02		EM4787-02	
Fuel Consumption						
100% load with fan – L/hr (gal/hr)	664.7	(175.6)	664.7	(175.6)	617.2	(163.0)
75% load with fan – L/hr (gal/hr)	528.3	(139.6)	528.3	(139.6)	491.4	(129.8)
50% load with fan – L/hr (gal/hr)	355.9	(94.0)	355.9	(94.0)	329.1	(86.9)
25% load with fan – L/hr (gal/hr)	203.5	(53.7)	203.5	(53.7)	189.6	(50.1)
Cooling System						
Radiator air flow restriction (system) – kPa (in. water)	0.12	(0.48)	0.12	(0.48)	0.12	(0.48)
Radiator air flow – m³/min (cfm)	2878	(101635)	2878	(101635)	2878	(101635)
Engine coolant capacity – L (gal)	179.0	(47.3)	179.0	(47.3)	179.0	(47.3)
Radiator coolant capacity – L (gal)	202.0	(53.4)	202.0	(53.4)	202.0	(53.4)
Total coolant capacity – L (gal)	381.0	(100.7)	381.0	(100.7)	381.0	(100.7)
Inlet Air						
Combustion air inlet flow rate – m³/min (cfm)	204.5	(7219.9)	204.5	(7219.9)	195.7	(6910.1)
Exhaust System						
Exhaust stack gas temperature – °C (°F)	494.7	(922.4)	494.7	(922.4)	493.1	(919.6)
Exhaust gas flow rate – m³/min (cfm)	554.4	(19577.5)	554.4	(19577.5)	524.8	(18531.2)
Exhaust system backpressure (maximum allowable) – kPa (in. water)	7.0	(28.1)	7.0	(28.1)	7.0	(28.1)
Heat Rejection						
Heat rejection to jacket water – kW (Btu/min)	835	(47475)	835	(47475)	809	(46088)
Heat rejection to exhaust (total) – kW (Btu/min)	2652	(150817)	2652	(150817)	2487	(141419)
Heat rejection to aftercooler – kW (Btu/min)	755	(42937)	755	(42937)	680	(38666)
Heat rejection to atmosphere from engine – kW (Btu/min)	165	(9395)	165	(9395)	161	(9175)
Heat rejection from alternator – kW (Btu/min)	104	(5914)	104	(5914)	79	(4498)
Emissions* (Nominal) - Full Load						
NOx mg/Nm³ (g/hp-h)	1877.3	(4.10)	1877.3	(4.10)	1658.6	(3.68)
CO mg/Nm³ (g/hp-h)	309.1	(0.68)	309.1	(0.68)	345.2	(0.77)
HC mg/Nm³ (g/hp-h)	12.7	(0.03)	12.7	(0.03)	13.1	(0.03)
PM mg/Nm³ (g/hp-h)	15.4	(0.04)	15.4	(0.04)	18.7	(0.05)
Emissions* (Potential Site Variation) - Full Load						
NOx mg/Nm³ (g/hp-h)	2252.7	(4.92)	2252.7	(4.92)	1990.4	(4.41)
CO mg/Nm³ (g/hp-h)	556.3	(1.22)	556.3	(1.22)	621.4	(1.38)
HC mg/Nm³ (g/hp-h)	16.9	(0.04)	16.9	(0.04)	17.4	(0.04)
PM mg/Nm³ (g/hp-h)	21.5	(0.06)	21.5	(0.06)	26.2	(0.07)

**mg/Nm³ levels are corrected to 5% O_2. Contact your local Cat dealer for further information*

Building 1A

Application data [1]

Engine

Manufacturer	*mtu*
Model	12V4000G74F
Type	4-cycle
Arrangement	12V
Displacement: l	57.2
Bore: mm	170
Stroke: mm	210
Compression ratio	16.4
Rated speed: rpm	1500
Engine governor	ECU 9
Max power: kWm	1575
Air cleaner	dry

Fuel system

Maximum fuel lift: m	5
Total fuel flow: l/min	16

Fuel consumption [2]	l/hr	g/kwh
At 100% of power rating:	358.6	189
At 75% of power rating:	276.1	194
At 50% of power rating:	189.8	200

Liquid capacity (lubrication)

Total oil system capacity: l	260
Engine jacket water capacity: l	160
Intercooler coolant capacity: l	40

Combustion air requirements

Combustion air volume: m^3/s	1.8
Max. air intake restriction: mbar	50

Cooling/radiator system

Coolant flow rate (HT circuit): m^3/hr	56
Coolant flow rate (LT circuit): m^3/hr	30
Heat rejection to coolant: kW	580
Heat radiated to charge air cooling: kW	260
Heat radiated to ambient: kW	75
Fan power for electr. radiator (40°C): kW	38

Exhaust system

Exhaust gas temp. (after turbocharger): °C	440
Exhaust gas volume: m^3/s	4.5
Maximum allowable back pressure: mbar	85
Minimum allowable back pressure: mbar	30

Standard and optional features

System ratings (kW/kVA)

Generator model	Voltage	fuel consumption optimized					
		without radiator			with mechanical radiator		
		kWel	kVA*	AMPS	kWel	kVA*	AMPS
Leroy Somer LSA52.3 S5 (Low voltage Leroy Somer standard)	380 V	1424	1780	2704	1376	1720	2613
	400 V	1424	1780	2569	1376	1720	2483
	415 V	1424	1780	2476	1376	1720	2393
Marathon 743RSL7090 (Low voltage Marathon)	380 V	1392	1740	2644	1368	1710	2598
	400 V	1368	1710	2468	1368	1710	2468
	415 V	1320	1650	2295	1320	1650	2295
Marathon 744RSL7091 (Low voltage Marathon oversized)	380 V	1392	1740	2644	1368	1710	2598
	400 V	1368	1710	2468	1368	1710	2468
	415 V	1320	1650	2295	1320	1650	2295
Marathon 1020FDH7095 (Medium volt. marathon)	11kV	1416	1770	93	1368	1710	90
Leroy Somer LSA53.2 VL6 (Medium volt. Leroy Somer)	11 kV	1416	1770	93	1376	1720	90

* cos phi = 0.8

Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	12V4000G74F				
Application Group	3D				
Legislative body	Fuel-consumption optimized				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN^3 values base on residual oxygen value of [%]	5				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	1575	1181	788	394	158
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1500	1500	1500	1500	1500
Engine speed relative	[-]	1	1	1	1	1
NOX+HC1 mass flow	kg/h	23.73	18.4	11.11	5.35	3.57
NOX-Emissions specific	g/kWh	14.75	15.24	13.69	12.81	19.58
CO-Emissions specific	g/kWh	0.94	0.81	0.81	1.68	4.67
HC1-Emissions specific	g/kWh	0.32	0.34	0.42	0.78	3.09
NOX+HC1-Emissions specific	g/kWh	15.06	15.58	14.11	13.6	22.67
PM-Emissions specific (Meas.)	g/kWh	0.069	0.078	0.096	0.218	1.121
NOX-Emissions (based on 5% O2)	mg/m3N	5733	5850	5052	4206	4858
NOX+HC1-Emissions (based on 5% O2)	mg/m3N	5851	5975	5202	4454	5597
CO-Emissions (based on 5% O2)	mg/m3N	349.2	301.2	289.2	531.6	1119.9
HC1-Emissions (based on 5% O2)	mg/m3N	117.7	125.2	150.4	248.1	739.2
PM-Emissions (based on 5% O2)	mg/m3N	25.7	28.7	33.9	69	268.7

PDF	Name	Project no. AWS PAC	Size A4
Configurator	Theiss, Sandro (TVMG)	Order no. AWS PAC	
Approver1	Kneifel, Alexander (TSLE)	EDS-ID 1151-10.02.2022	
Approver2	Kollwer, Michael (TSF)		
Approver3			
Approver4			
User	APACchange	Title Emission data sheet	
Engine model 12V4000G74F			

Description of Revision | Frequency

Data generated by EDS Creator version 1.0 and uniplot.
Ref.-dataset: 412TA_001_bearbeitet.nc.nc2 for 1377 in EDS platfrom.

Emissionstage: **Fuel-consumption optimized**

Emissionstage basis: **Fuel-consumption optimized**

Sheet of

Configuration-ID: 1377

Documentation: Penske Project

A Rolls-Royce solution

Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	20V4000G94F				
Application Group	3D				
Legislative body	NEA Singapore for ORDE				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN^3 values base on residual oxygen value of [%]	Measured				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	3090	2317	1545	772	309
Power relative	[-]	1	0.75	0.5	0.25	0.1
Engine speed	1/min	1501	1501	1501	1501	1500
Engine speed relative	[-]	1	1	1	1	1
NOX-Emissions specific	g/kWh	7.11	6.92	6.22	6.84	17.44
CO-Emissions specific	g/kWh	0.4	0.49	2.08	2.72	6.4
HC1-Emissions specific	g/kWh	0.12	0.13	0.18	0.36	2.43
NMHC-Emissions specific	g/kWh	0.12	0.13	0.18	0.35	
NOX+HC1-Emissions specific	g/kWh	7.23	7.05	6.4	7.21	19.87
NOX+NMHC-Emissions specific	g/kWh	7.22	7.05	6.4	7.2	
PM-Emissions specific (Meas.)	g/kWh	0.028	0.037	0.134	0.209	0.227
NOX-Emissions (based on O2 meas)	mg/m3N	1695	1440	1193	1029	1397
NOX+HC1-Emissions (based on O2 meas)	mg/m3N	1723	1467	1228	1083	1588
NOX+NMHC-Emissions (based on O2 meas)	mg/m3N	1722	1467	1227	1082	

PDF	Name	Project no. AWS	Size A4
Configurator	Lenhof, Torsten (TARC)	Order no. AWS	
Approver1	Kreifel, Alexander (TSLE)	EDS-ID 1655-08.07.2022	
Approver2	Kollwer, Michael (TV)		
Approver3			
Approver4			
User	APAC\chenge	Title Emission data sheet	
Engine model 20V4000G94F			

Description of Revision | Frequency

Data generated by EDS Creator version 1.0 and uniplot.
Ref.-dataset: 420122_364_NEA_G94F_D2.nc for 294 in EDS platfrom.

Emissionstage: **NEA Singapore for ORDE**

Emissionstage basis: **NEA Singapore for ORDE**

Sheet of

Configuration-ID: **294**

Documentation

CO-Emissions (based on O2 meas)	mg/m3N	92	99.2	391.8	401.5	502.7
HC1-Emissions (based on O2 meas)	mg/m3N	27.7	27	34.7	53.3	190.9
PM-Emissions (based on O2 meas)	mg/m3N	6.5	7.5	25.1	30.9	17.8

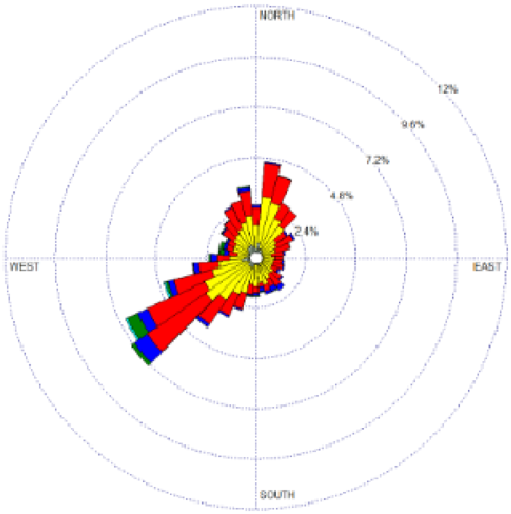
PDF	Name	Project no. **AWS**
Configurator	Lenhof, Torsten (TARC)	Order no. **AWS**
Approver1	Kneifel, Alexander (TSLE)	Size **A4**
Approver2	Kolwer, Michael (TV)	EDS-ID **1655-08.07.2022**
Approver3		
Approver4		
User	APAC\cherge	
Engine model **20V4000G94F**		Title **Emission data sheet**

Description of Revision	Frequency
Data generated by EDS Creator version 1.0 and uniplot. Ref.-dataset: 420122_364_NEA_G94F_D2.nc for 294 in EDS platfrom.	

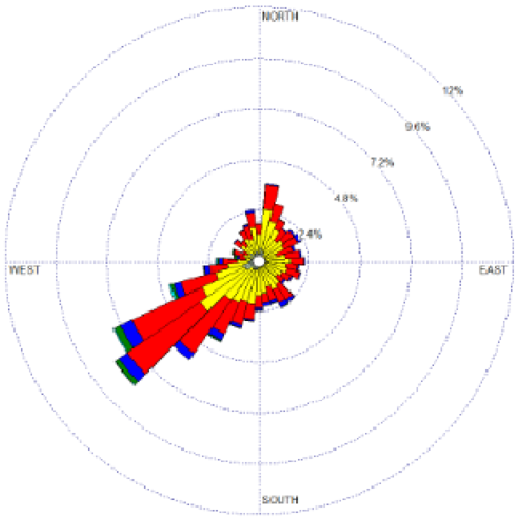
		Emissionstage **NEA Singapore for ORDE**	Sheet
Configuration-ID **294**	Documentation	Emissionstage basis **NEA Singapore for ORDE**	of

Appendix C

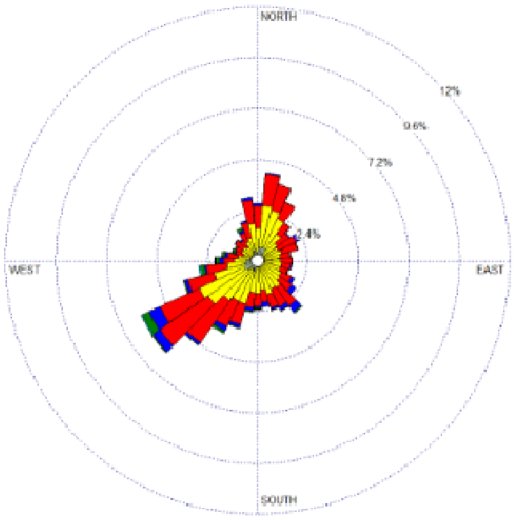
Local meteorological conditions for year 2016-2020



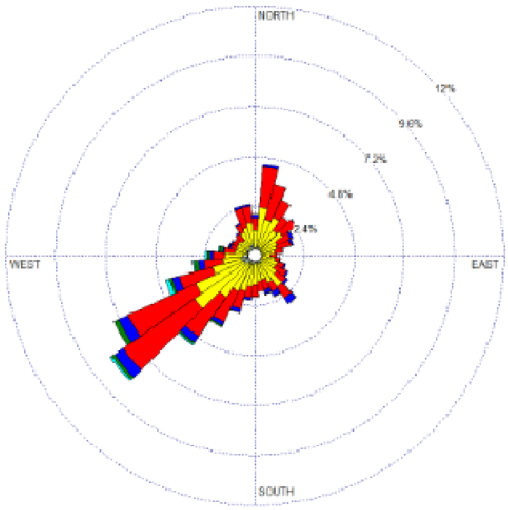
Year 2016



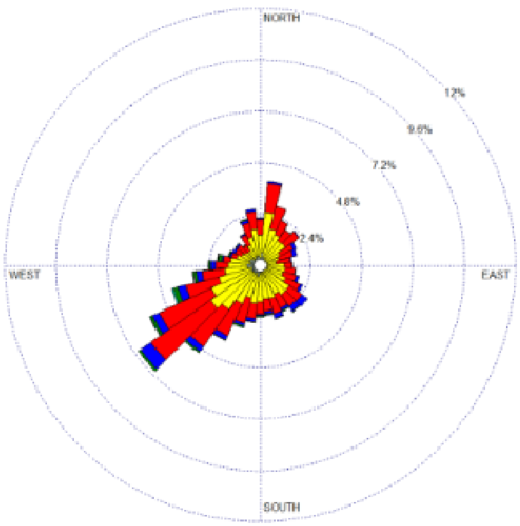
Year 2017



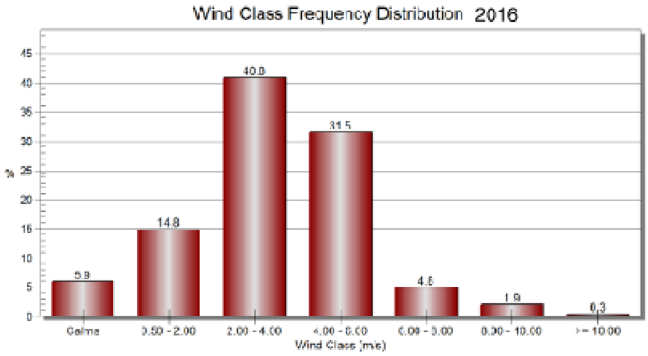
Year 2018

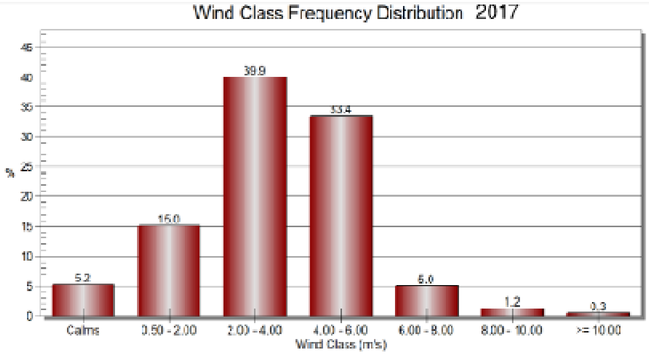


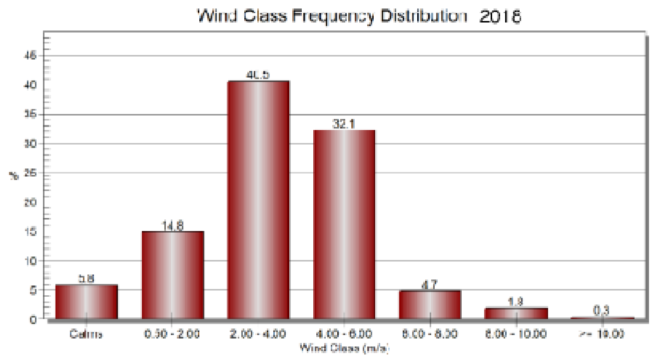
Year 2019

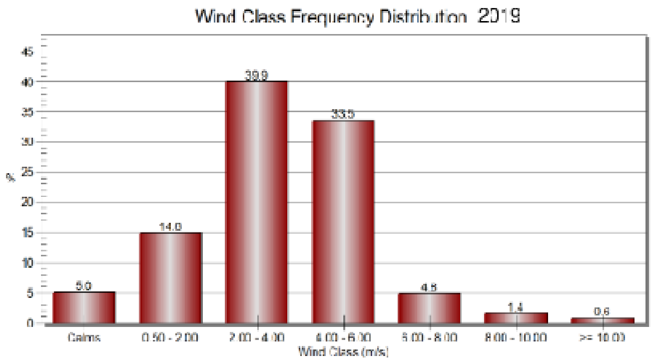


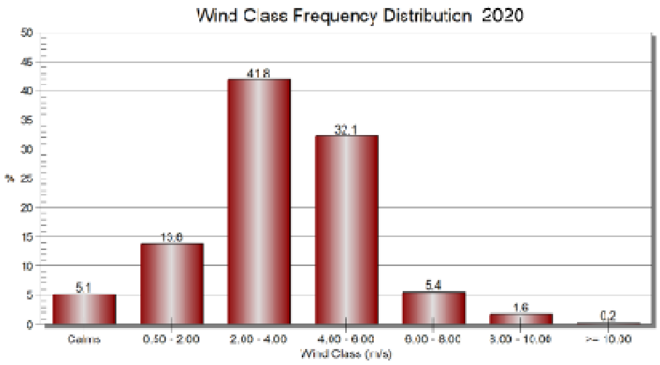
Year 2020


Wind Class Frequency Distribution 2016
%
Calms
0.50 - 2.00
2.00 - 4.00
4.00 - 6.00
6.00 - 8.00
8.00 - 10.00
>= 10.00
Wind Class (m/s)


Wind Class Frequency Distribution 2017
%
Calms
0.50 - 2.00
2.00 - 4.00
4.00 - 6.00
6.00 - 8.00
8.00 - 10.00
>= 10.00
Wind Class (m/s)


Wind Class Frequency Distribution 2018
%
Calms
0.50 - 2.00
2.00 - 4.00
4.00 - 6.00
6.00 - 8.00
8.00 - 10.00
>= 10.00
Wind Class (m/s)

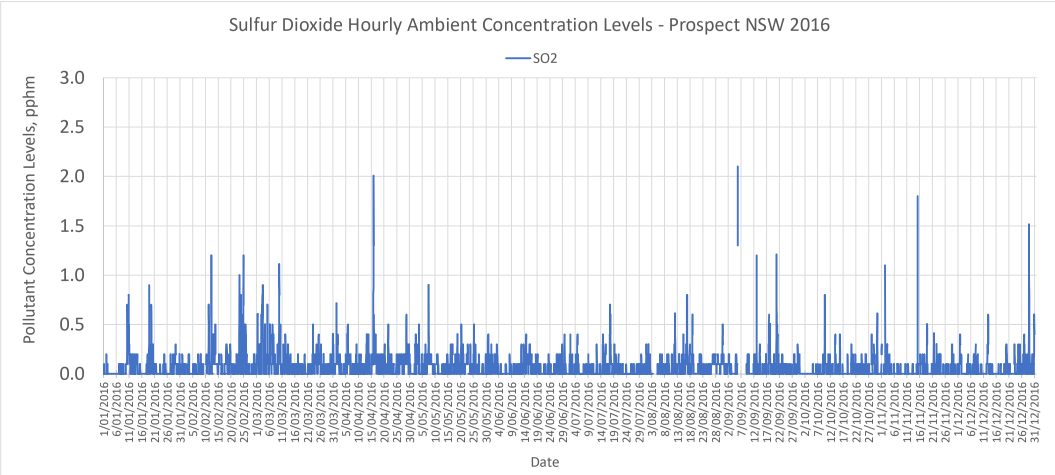

Wind Class Frequency Distribution 2019
%
Calms
0.50 - 2.00
2.00 - 4.00
4.00 - 6.00
6.00 - 8.00
8.00 - 10.00
>= 10.00
Wind Class (m/s)

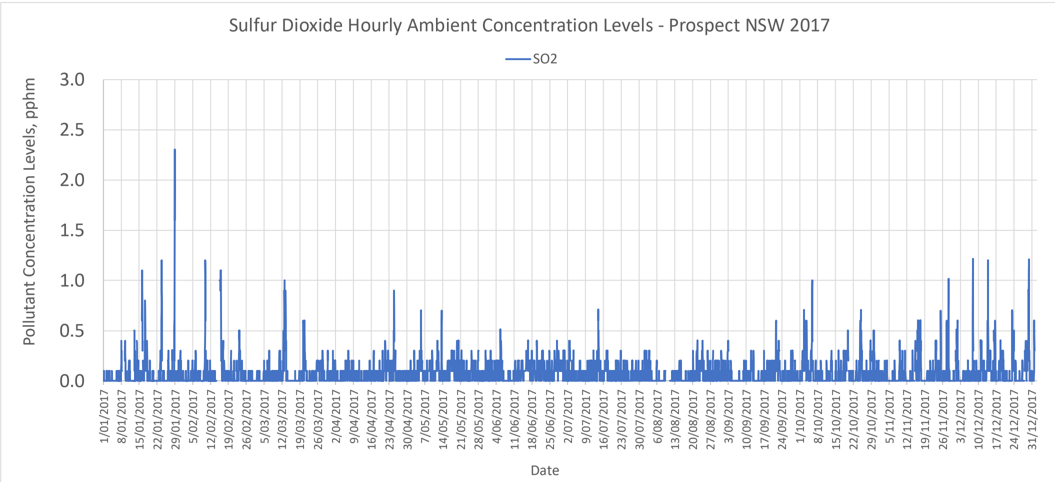

Wind Class Frequency Distribution 2020
%
Calms
0.50 - 2.00
2.00 - 4.00
4.00 - 6.00
6.00 - 8.00
8.00 - 10.00
>= 10.00
Wind Class (m/s)

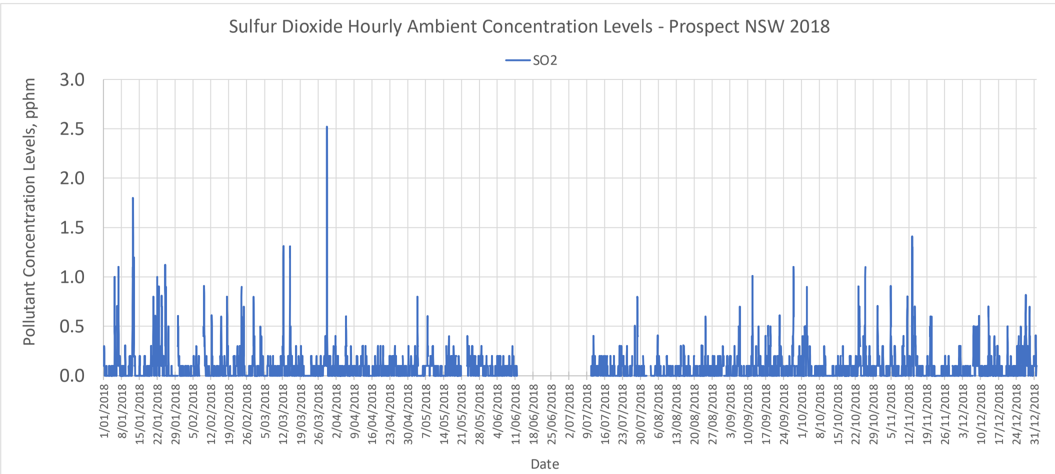
Appendix D

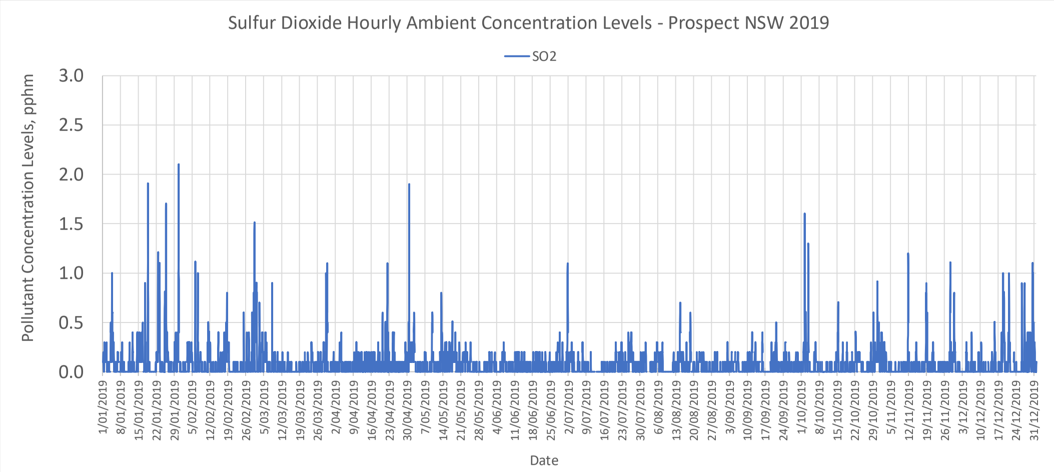
Background air quality for year 2016-2020

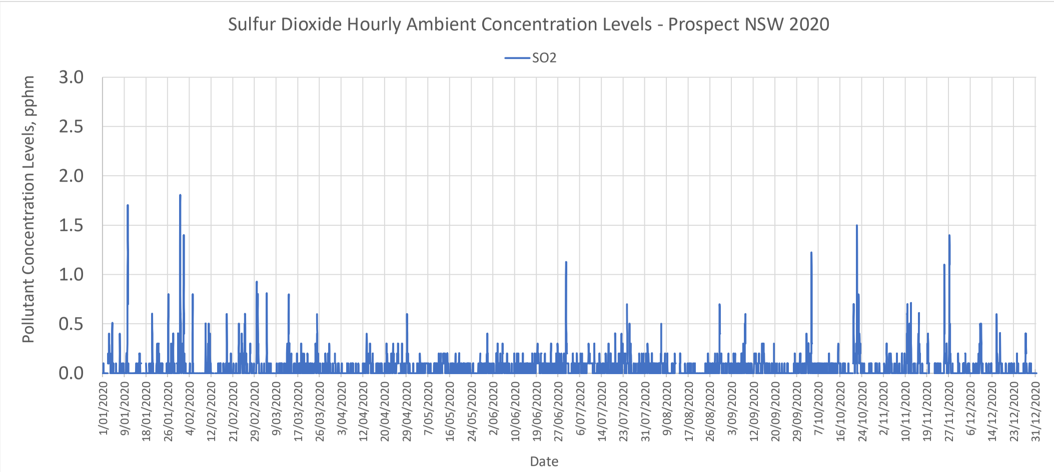
Sulfur Dioxide



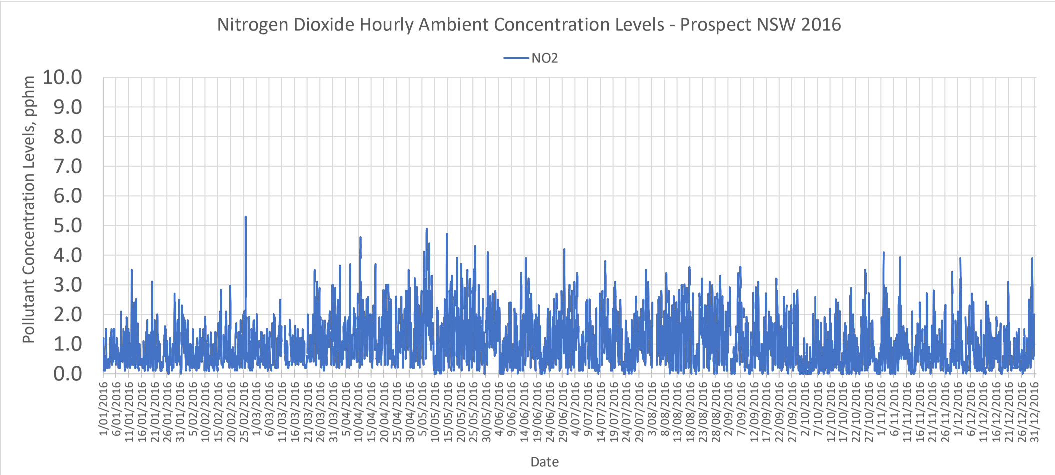


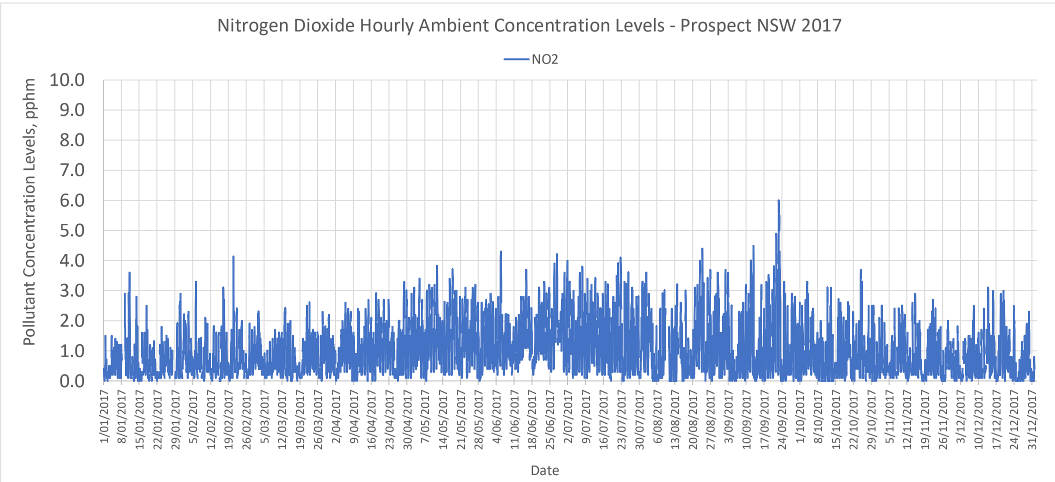


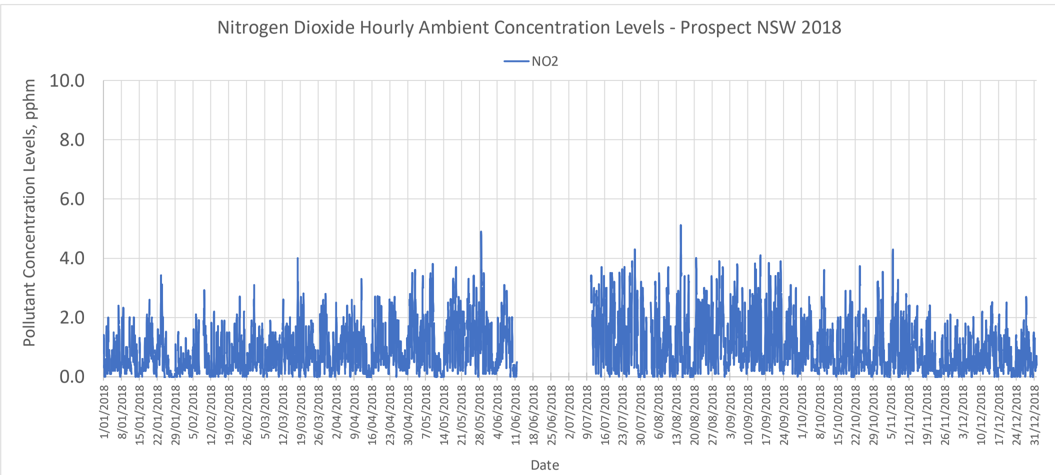

Sulfur Dioxide Hourly Ambient Concentration Levels - Prospect NSW 2019
SO2
Pollutant Concentration Levels, pphm
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Date

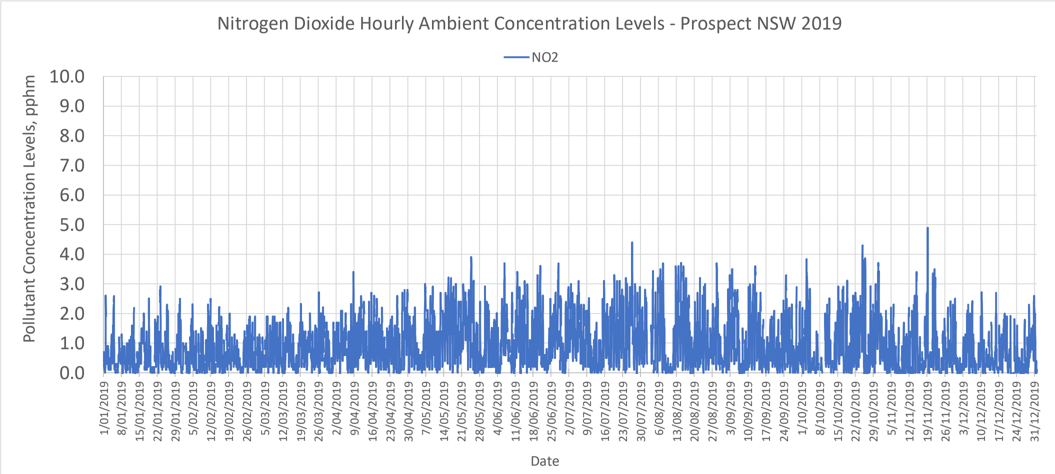

Sulfur Dioxide Hourly Ambient Concentration Levels - Prospect NSW 2020
SO2
Pollutant Concentration Levels, pphm
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Date

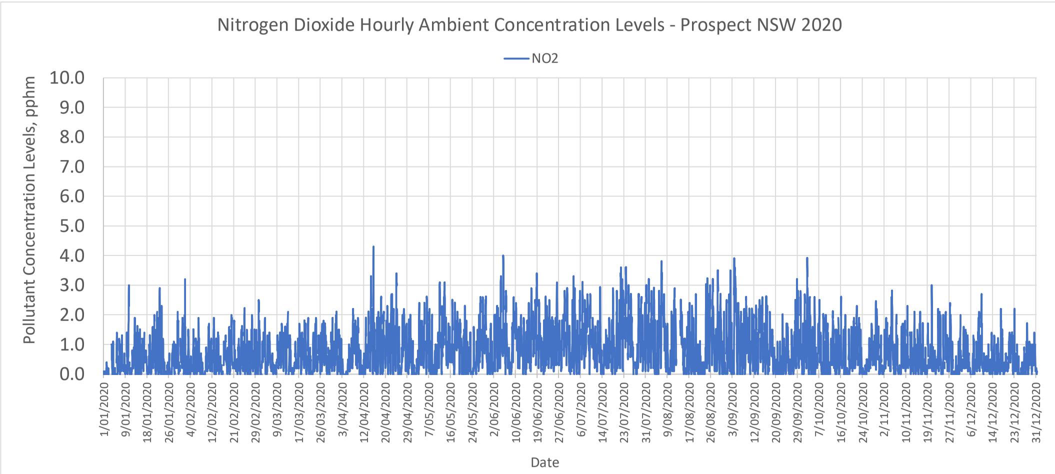
Nitrogen Dioxide



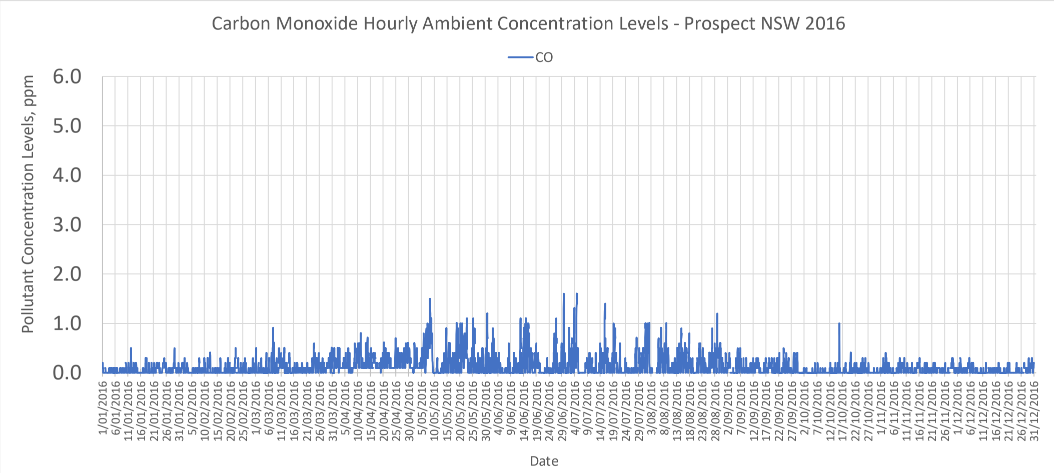


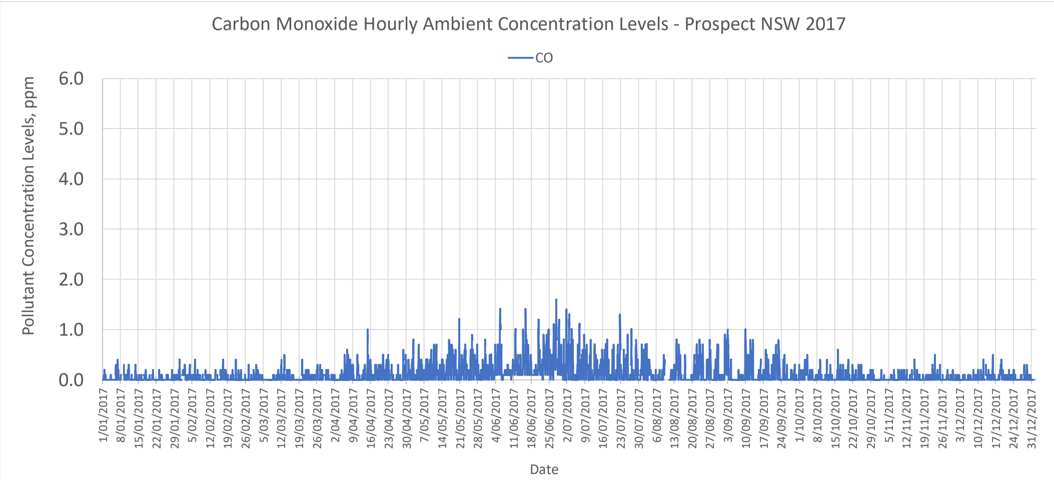


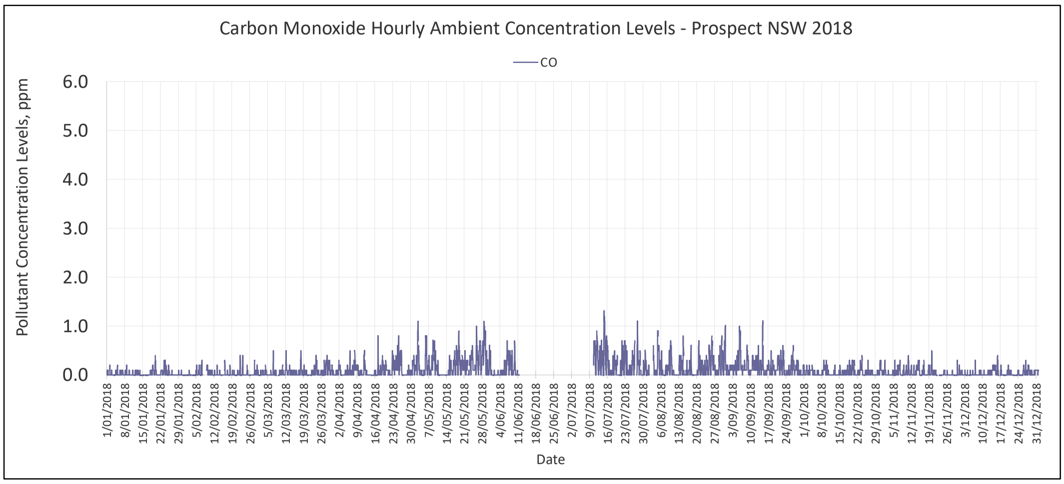

Nitrogen Dioxide Hourly Ambient Concentration Levels - Prospect NSW 2019
NO2
Pollutant Concentration Levels, pphm
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/01/2019
8/01/2019
15/01/2019
22/01/2019
29/01/2019
5/02/2019
12/02/2019
19/02/2019
26/02/2019
5/03/2019
12/03/2019
19/03/2019
26/03/2019
2/04/2019
9/04/2019
16/04/2019
23/04/2019
30/04/2019
7/05/2019
14/05/2019
21/05/2019
28/05/2019
4/06/2019
11/06/2019
18/06/2019
25/06/2019
2/07/2019
9/07/2019
16/07/2019
23/07/2019
30/07/2019
6/08/2019
13/08/2019
20/08/2019
27/08/2019
3/09/2019
10/09/2019
17/09/2019
24/09/2019
1/10/2019
8/10/2019
15/10/2019
22/10/2019
29/10/2019
5/11/2019
12/11/2019
19/11/2019
26/11/2019
3/12/2019
10/12/2019
17/12/2019
24/12/2019
31/12/2019
Date

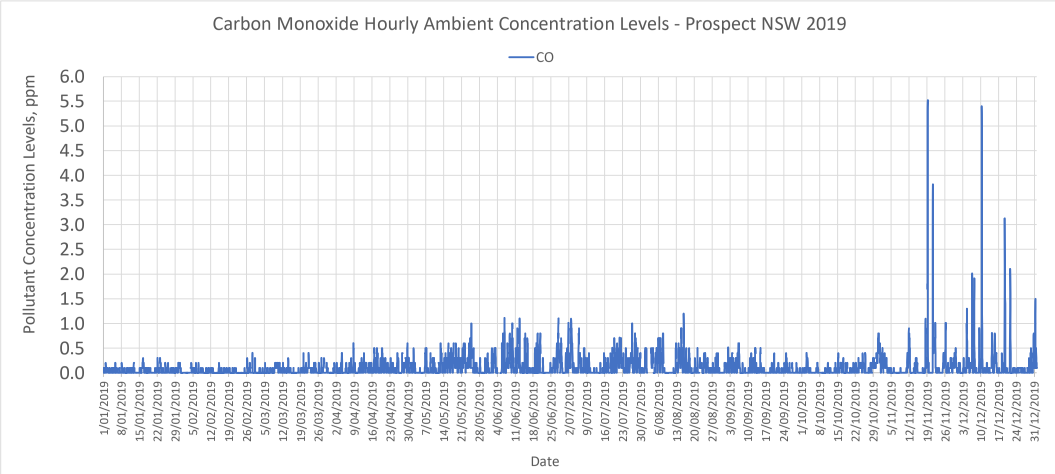

Nitrogen Dioxide Hourly Ambient Concentration Levels - Prospect NSW 2020
NO2
Pollutant Concentration Levels, pphm
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1/01/2020
9/01/2020
18/01/2020
26/01/2020
4/02/2020
12/02/2020
21/02/2020
29/02/2020
9/03/2020
17/03/2020
26/03/2020
3/04/2020
12/04/2020
20/04/2020
29/04/2020
7/05/2020
16/05/2020
24/05/2020
2/06/2020
10/06/2020
19/06/2020
27/06/2020
6/07/2020
14/07/2020
23/07/2020
31/07/2020
9/08/2020
17/08/2020
26/08/2020
3/09/2020
12/09/2020
20/09/2020
29/09/2020
7/10/2020
16/10/2020
24/10/2020
2/11/2020
10/11/2020
19/11/2020
27/11/2020
6/12/2020
14/12/2020
23/12/2020
31/12/2020
Date

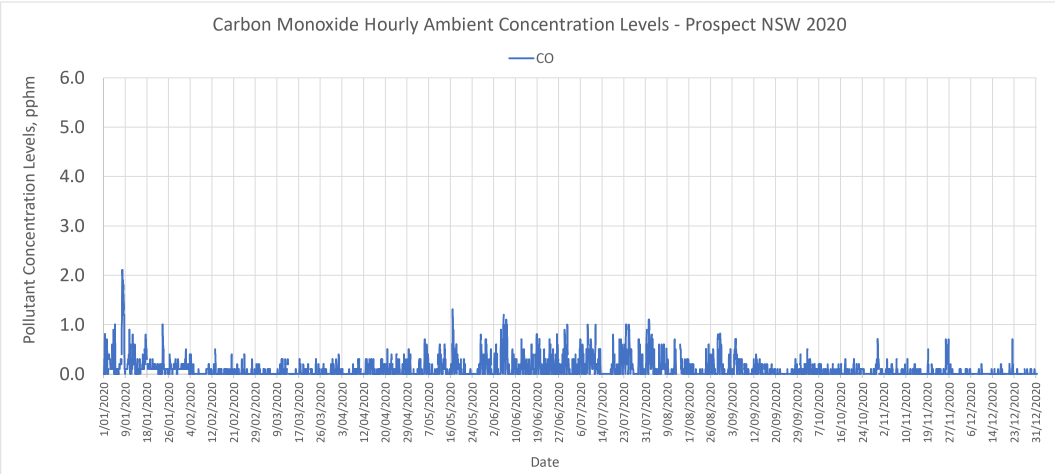
Carbon Monoxide



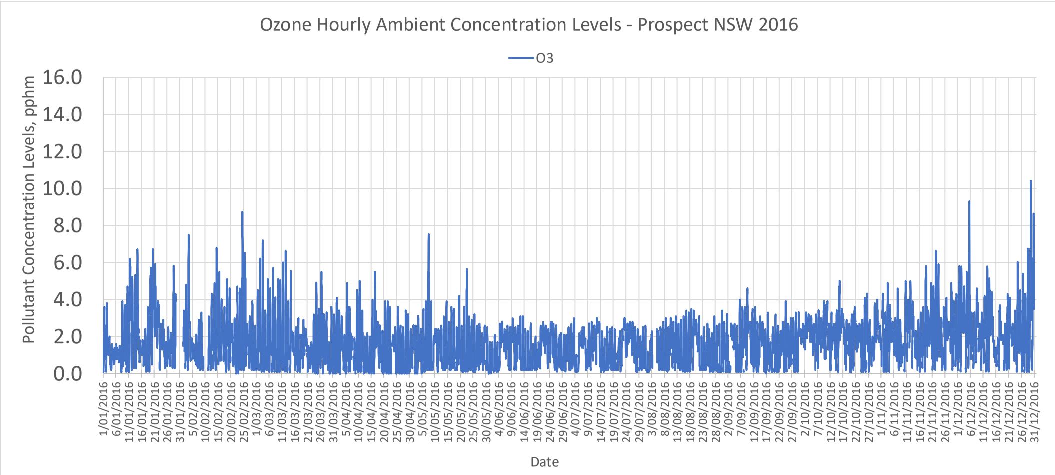


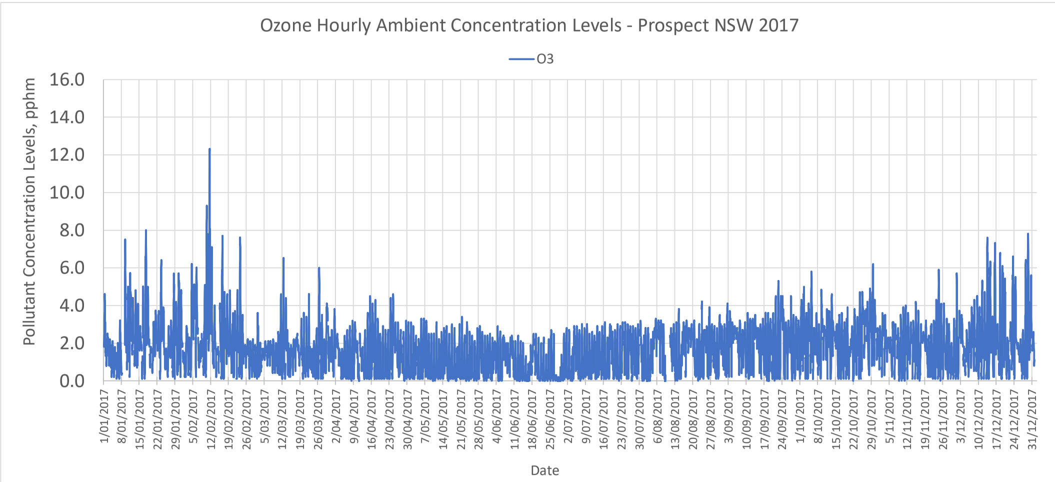


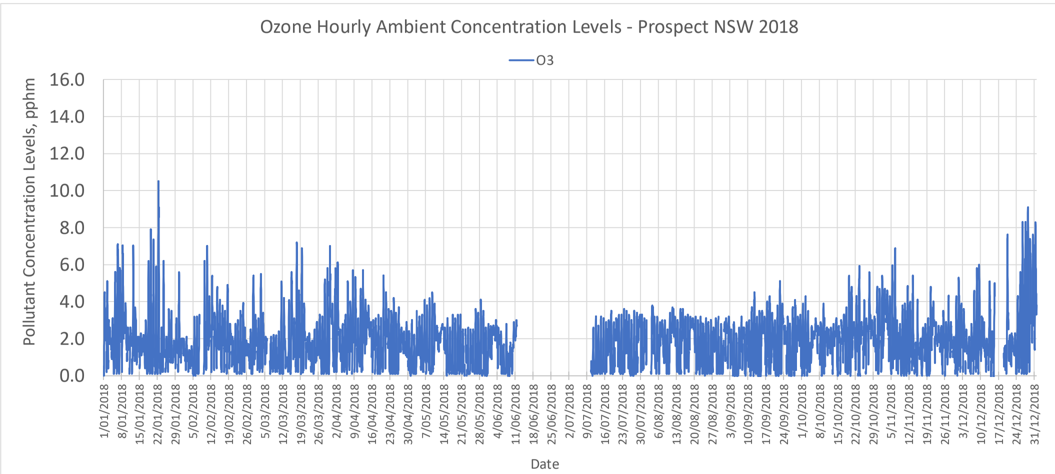

Carbon Monoxide Hourly Ambient Concentration Levels - Prospect NSW 2019
CO
Pollutant Concentration Levels, ppm
Date

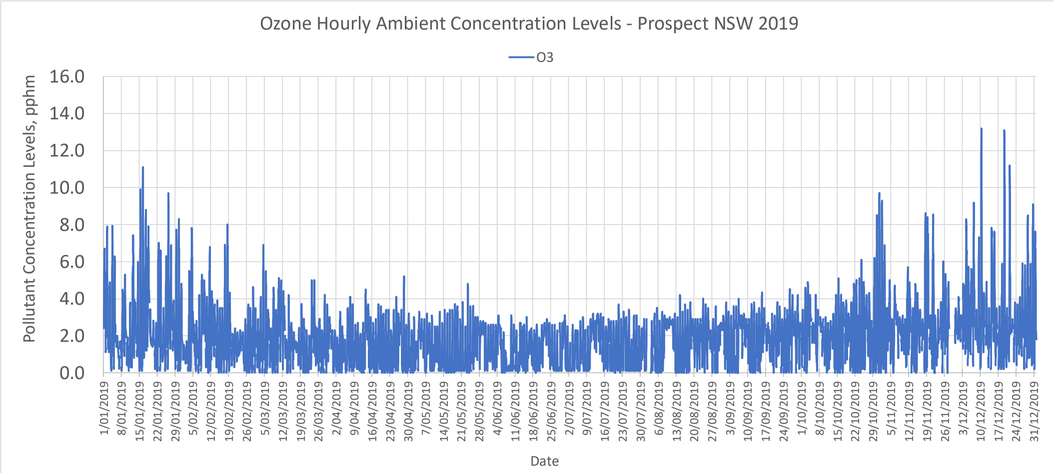

Carbon Monoxide Hourly Ambient Concentration Levels - Prospect NSW 2020
CO
Pollutant Concentration Levels, pphm
Date

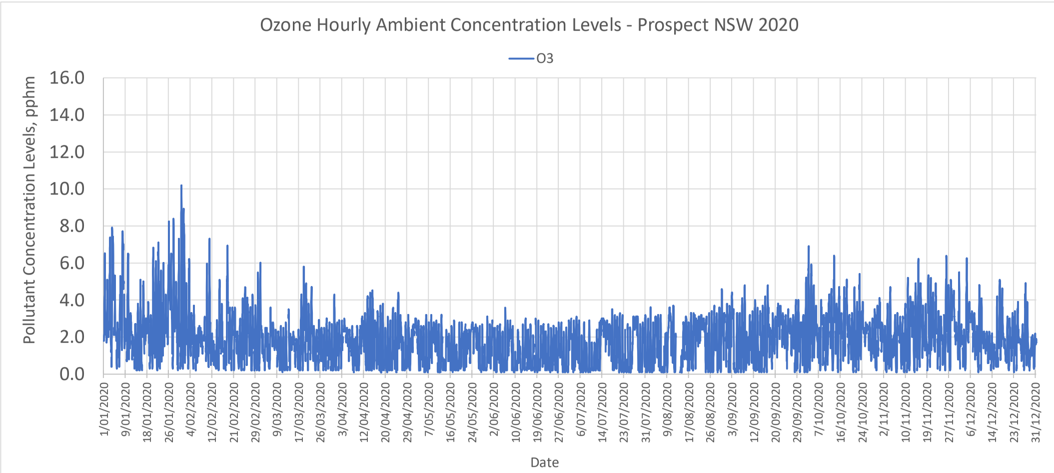
Ozone


Ozone Hourly Ambient Concentration Levels - Prospect NSW 2016
O3
Pollutant Concentration Levels, pphm
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Date

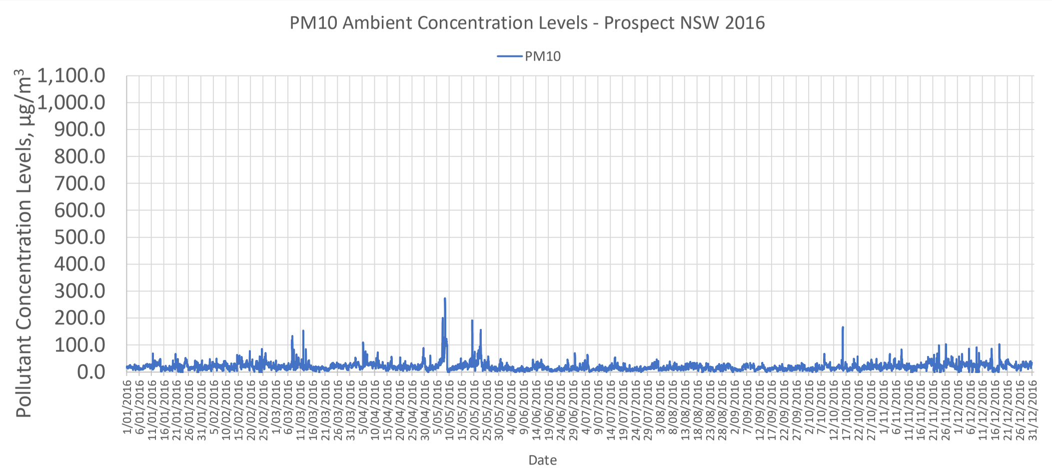

Ozone Hourly Ambient Concentration Levels - Prospect NSW 2017
O3
Pollutant Concentration Levels, pphm
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Date

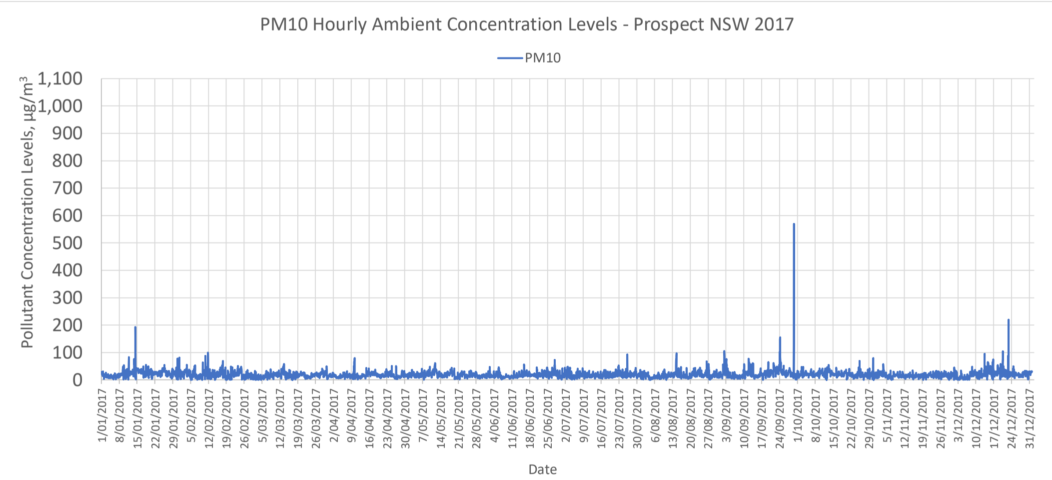

Ozone Hourly Ambient Concentration Levels - Prospect NSW 2018
O3
Pollutant Concentration Levels, pphm
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Date

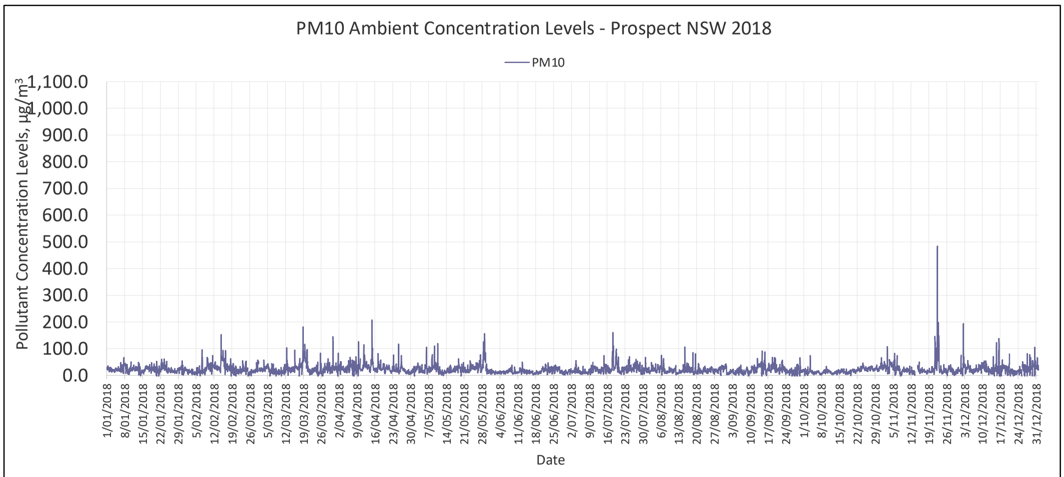

Ozone Hourly Ambient Concentration Levels - Prospect NSW 2019
O3
Pollutant Concentration Levels, pphm
Date

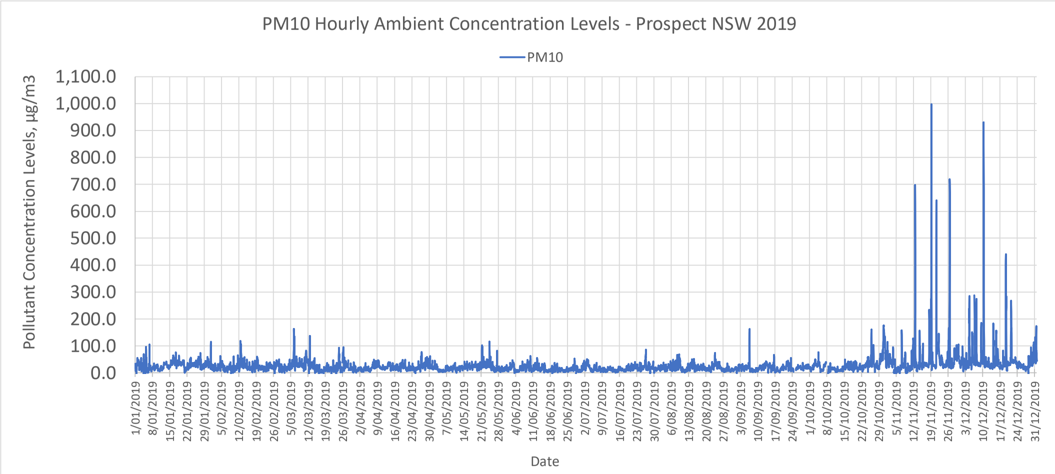

Ozone Hourly Ambient Concentration Levels - Prospect NSW 2020
O3
Pollutant Concentration Levels, pphm
Date

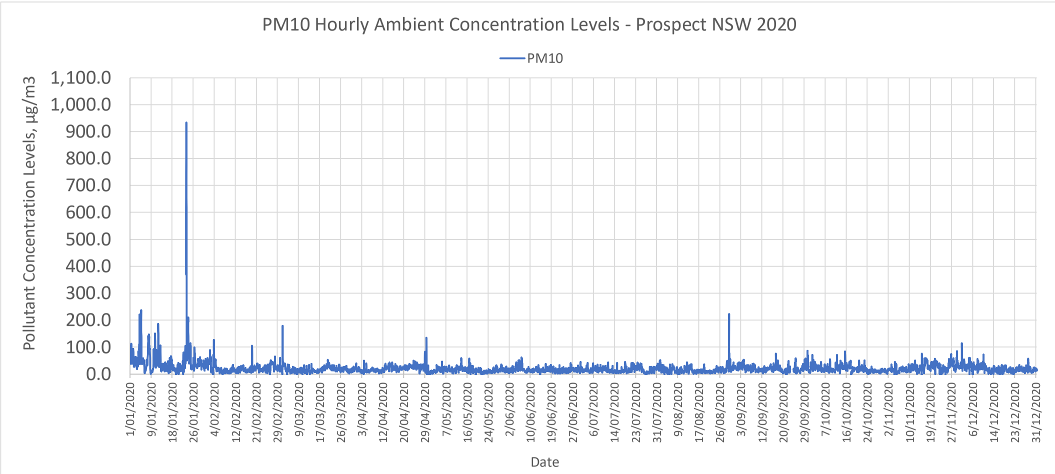
Particulate Matter PM10



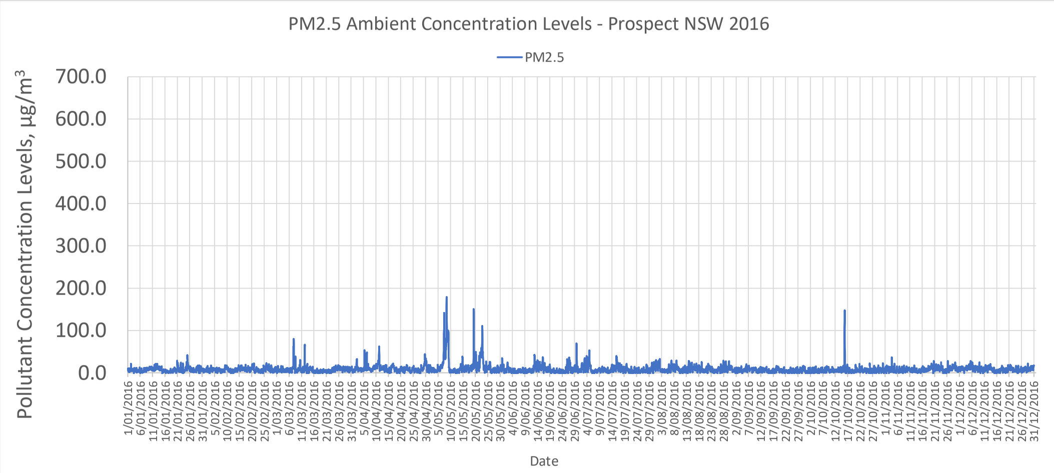


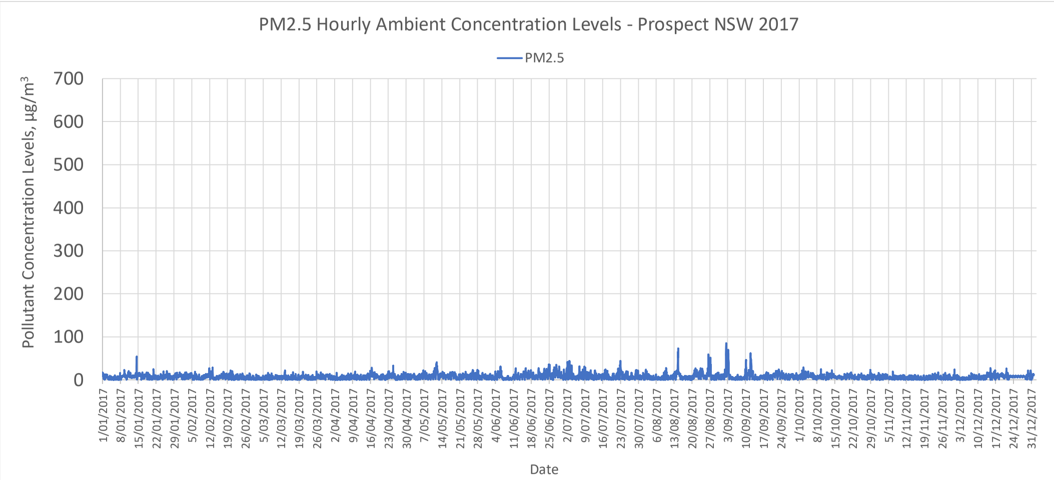


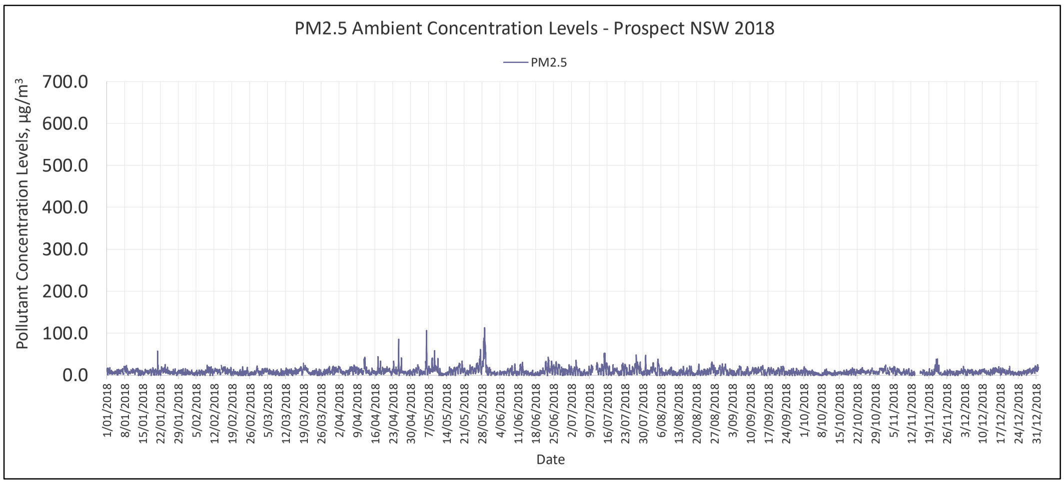

PM10 Hourly Ambient Concentration Levels - Prospect NSW 2019
PM10
Pollutant Concentration Levels, µg/m3
Date

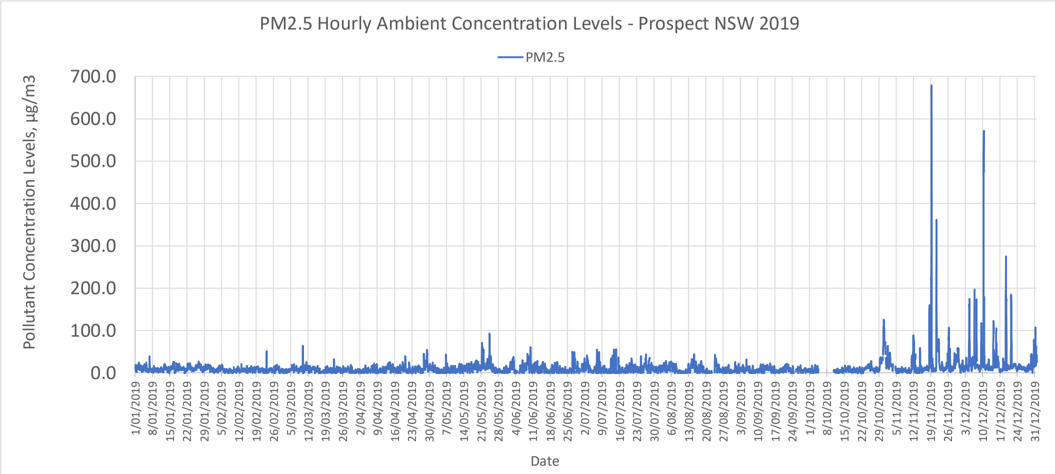

PM10 Hourly Ambient Concentration Levels - Prospect NSW 2020
PM10
Pollutant Concentration Levels, µg/m3
Date

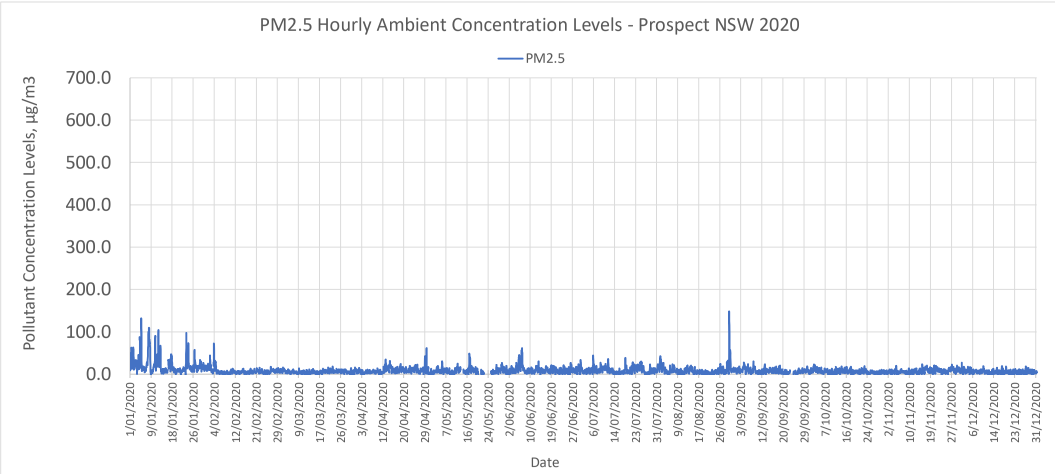
Particulate Matter $PM_{2.5}$








PM2.5 Hourly Ambient Concentration Levels - Prospect NSW 2019
PM2.5
Pollutant Concentration Levels, µg/m3
Date


PM2.5 Hourly Ambient Concentration Levels - Prospect NSW 2020
PM2.5
Pollutant Concentration Levels, µg/m3
Date

Appendix E

Modelled generator stacks coordinates

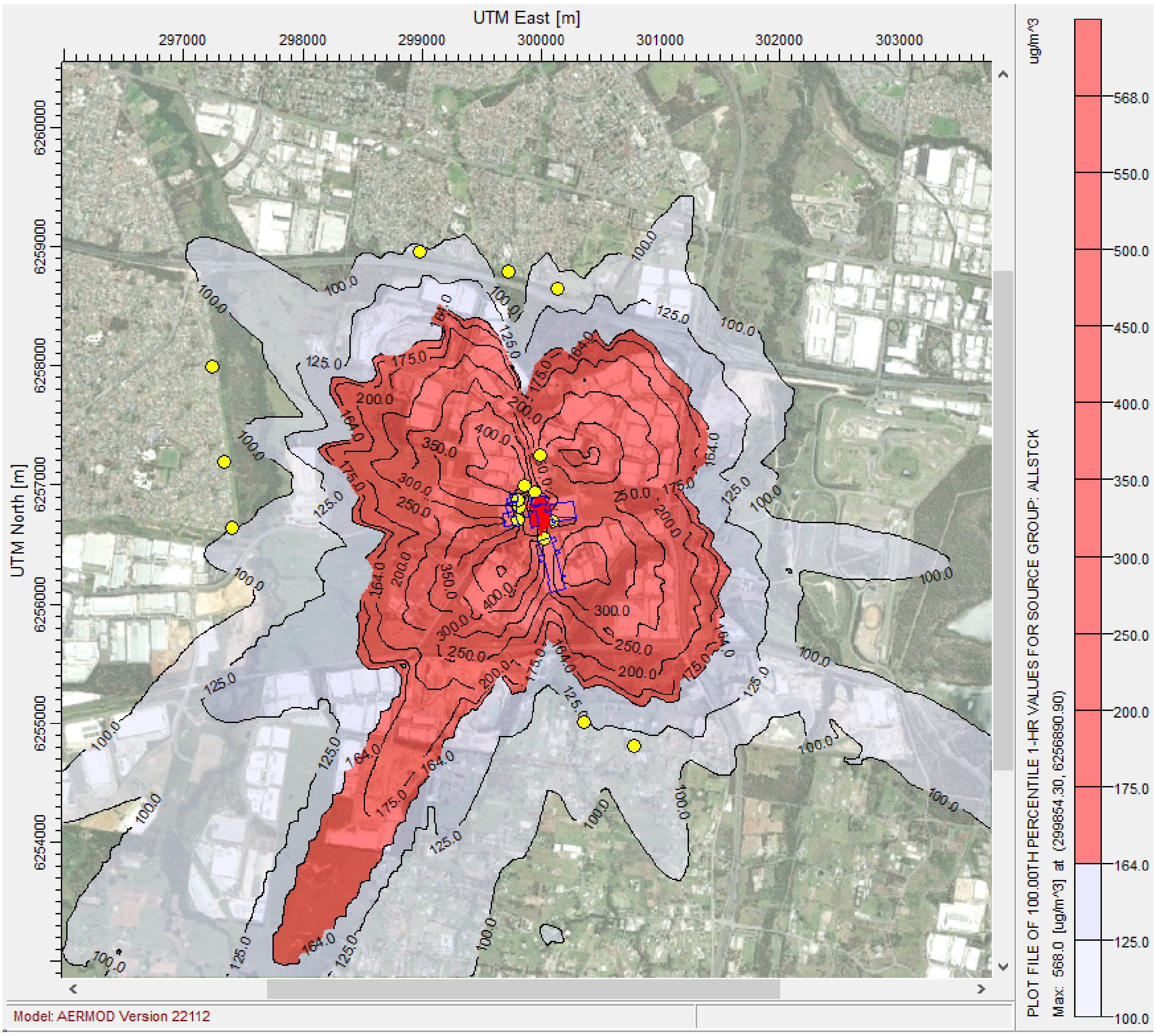
Stack ID	Stack Coordinate X: Easting (m)	Y: Northing (m)	Stack Height (m) (above Sea Level)
Building 1			
Stack 1	299940.8	6256818.7	30
Stack 2	299946.4	6256819.4	30
Stack 3	299952.3	6256820.1	30
Stack 4	299958.0	6256820.9	30
Stack 5	299963.7	6256821.5	30
Stack 6	299969.2	6256822.2	30
Stack 7	299974.9	6256822.9	30
Stack 8	299980.7	6256823.6	30
Stack 9	299986.3	6256824.4	30
Stack 10	299991.9	6256825.1	30
Stack 11	299997.7	6256825.8	30
Stack 12	300003.3	6256826.6	30
Stack 13	300009.0	6256827.3	30
Stack 14	300014.7	6256828.0	30
Stack 15	300020.3	6256828.8	30
Stack 16	300026.0	6256829.4	30
Stack 17	300031.8	6256830.2	30
Stack 18	300037.4	6256830.8	30
Stack 19	299935.2	6256817.9	30
Building 1A			
Stack 1	300054.3	6256790.9	13.2
Proposal			
Stack 1	299996.1	6256654.4	25
Stack 2	299995.3	6256660.5	25
Stack 3	299994.5	6256666.7	25
Stack 4	299993.7	6256672.9	25
Stack 5	299992.9	6256679.0	25
Stack 6	299992.2	6256685.1	25
Stack 7	299991.4	6256691.3	25
Stack 8	299990.6	6256697.4	25
Stack 9	299989.8	6256703.5	25
Stack 10	299989.0	6256709.6	25
Stack 11	299988.3	6256715.7	25
Stack 12	299987.4	6256721.9	25
Stack 13	299986.7	6256728.0	25
Stack 14	299985.9	6256734.1	25

Stack ID	Stack Coordinate X: Easting (m)	Y: Northing (m)	Stack Height (m) (above Sea Level)
Stack 15	299985.1	6256740.4	25
Stack 16	299984.4	6256746.5	25
Stack 17	299983.5	6256752.5	25
Stack 18	299982.8	6256758.6	25
Stack 19	299982.1	6256764.9	25

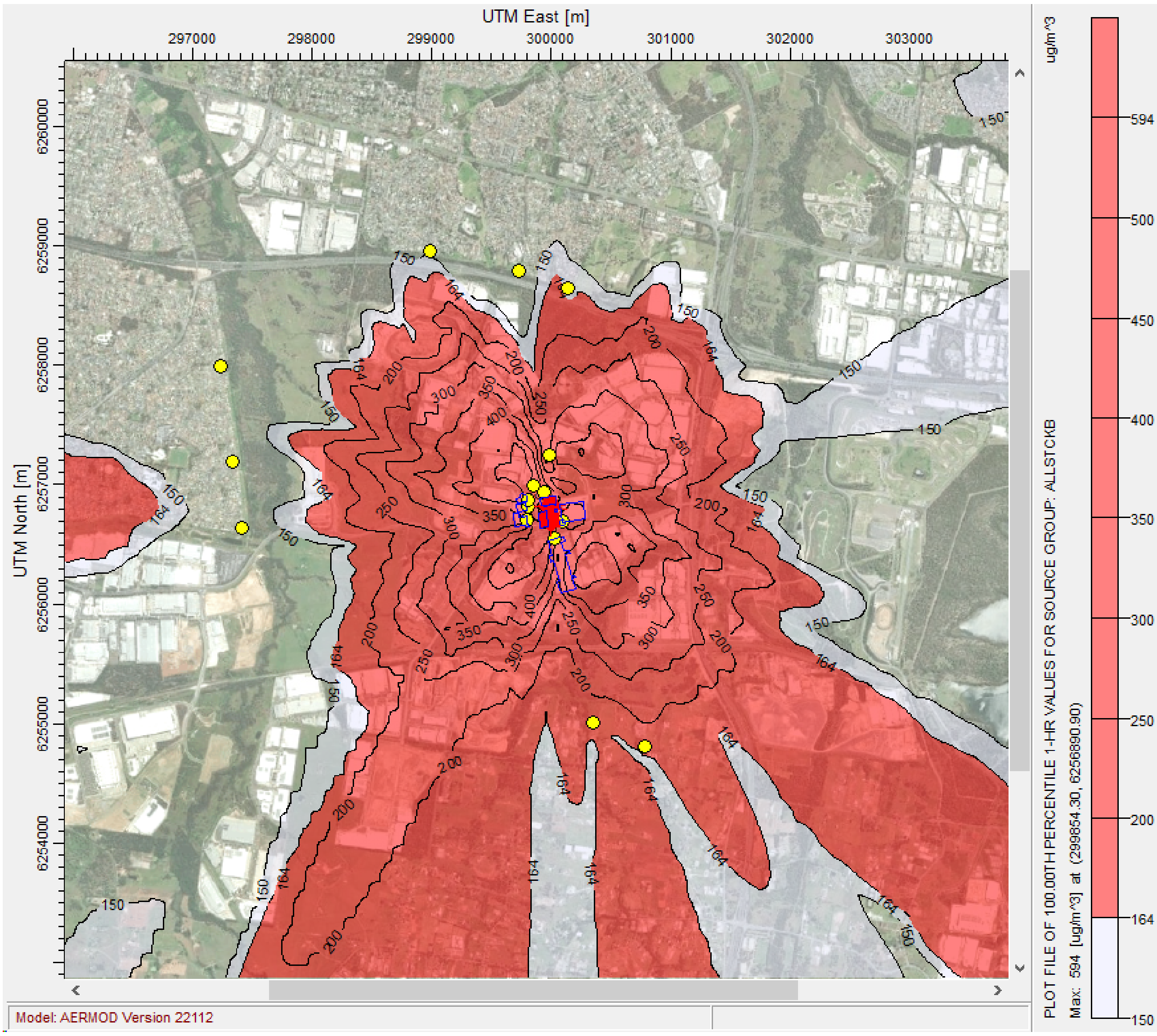
Appendix F

Predicted generator emissions – Dispersion modelling contours (Scenario 1)

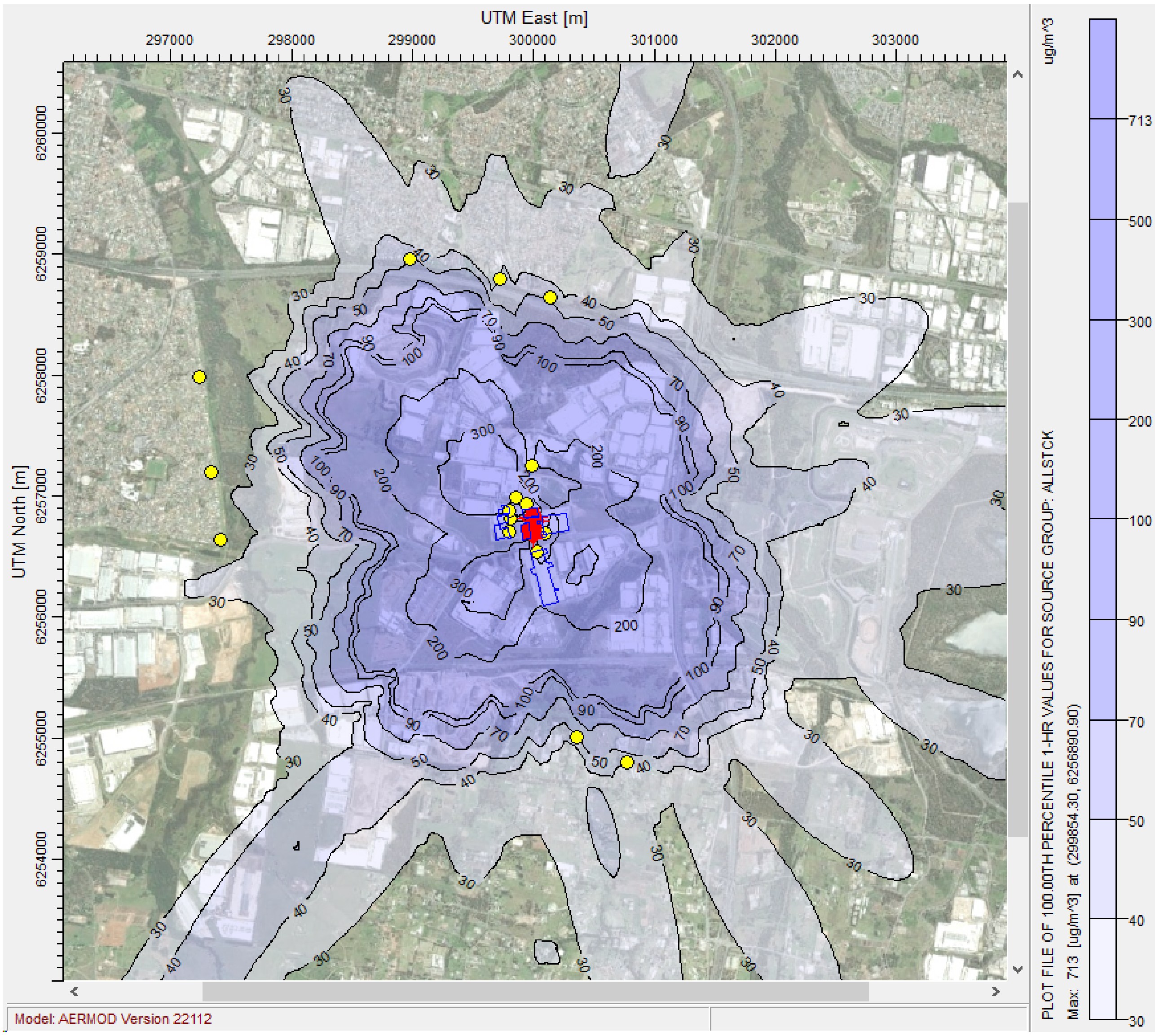
F.1 NO_2 (1-hour average) - Incremental



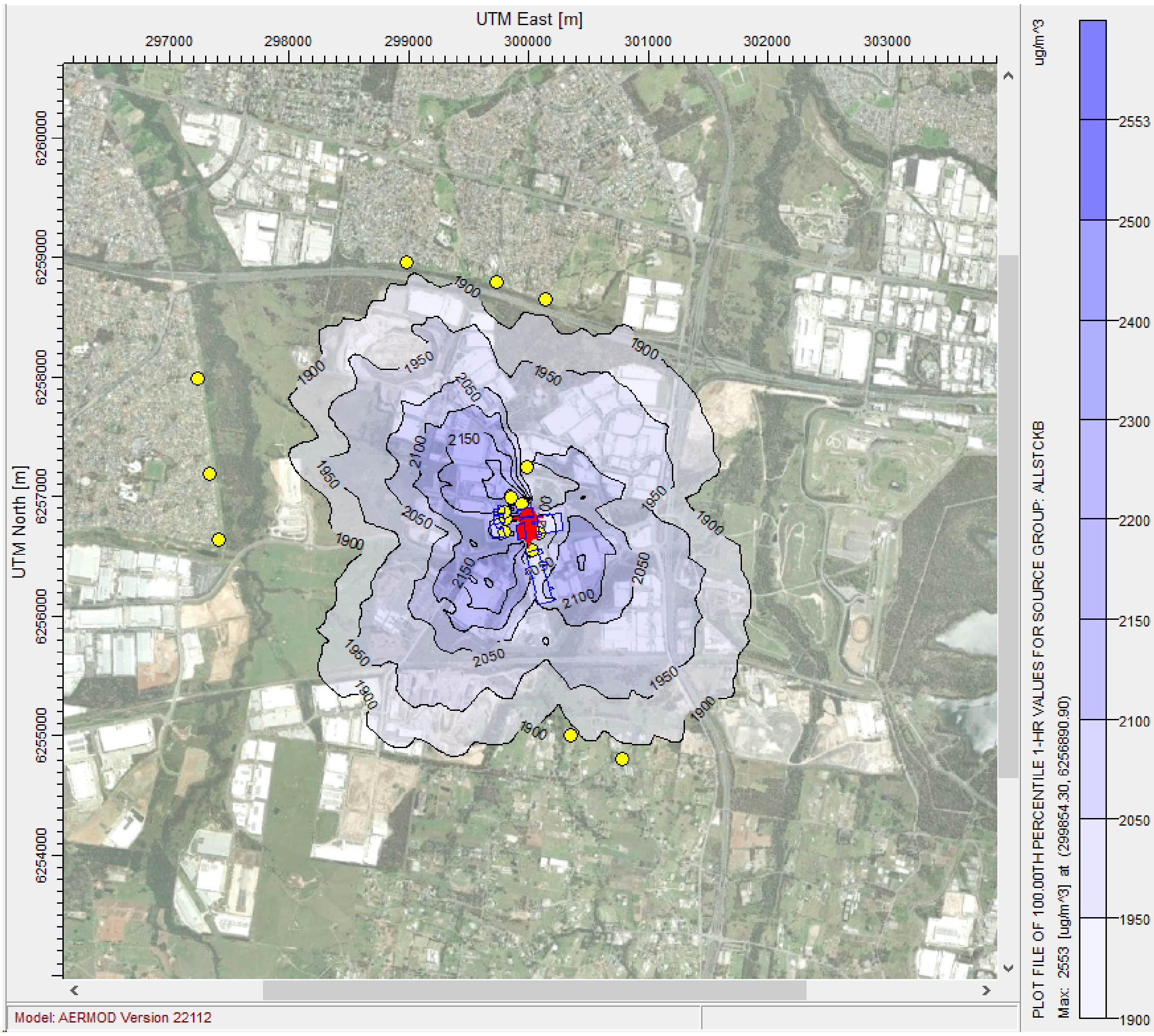
F.2 NO_2 (1-hour average) - Cumulative



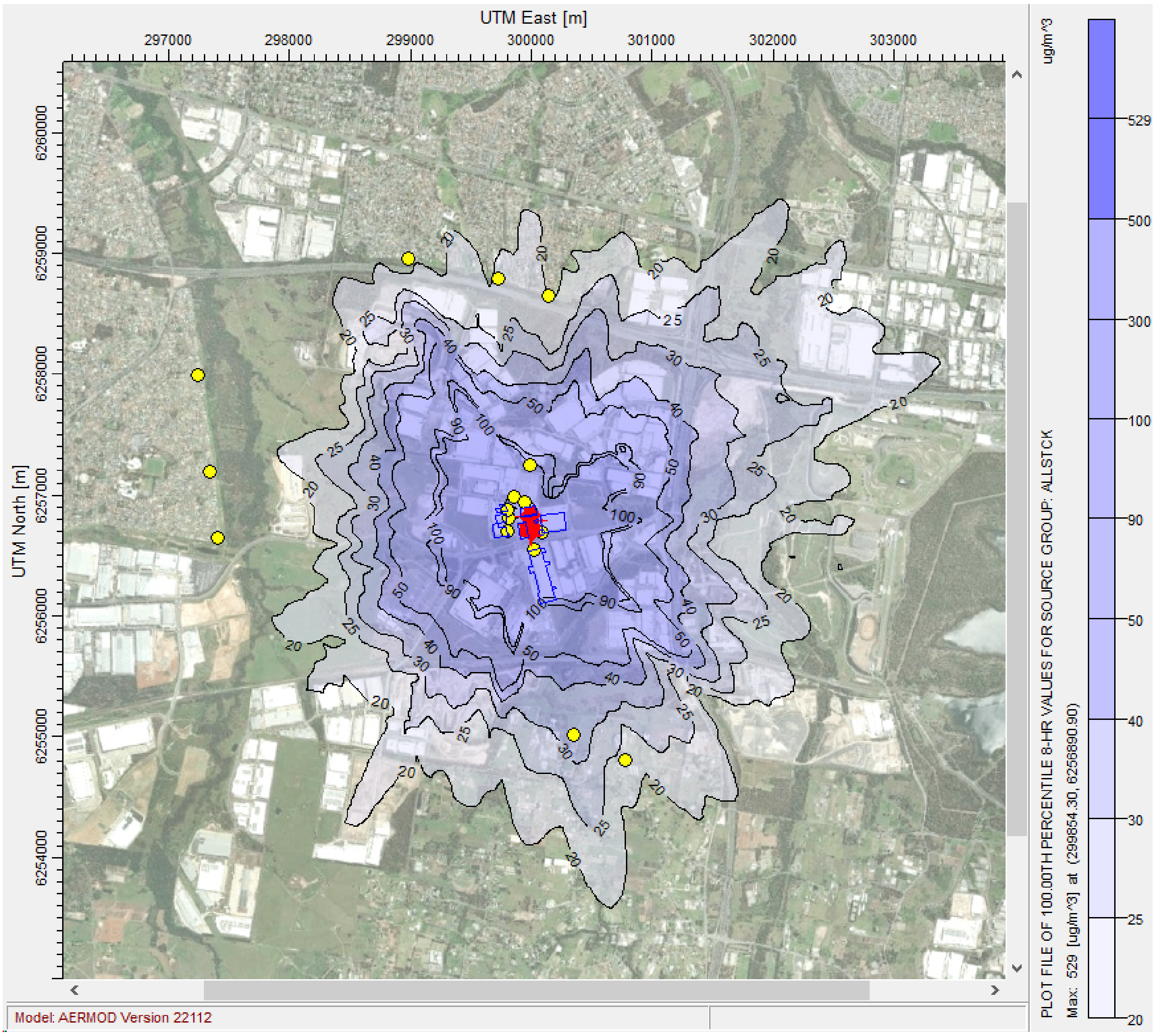
F.3 CO (1-hour average) - Incremental



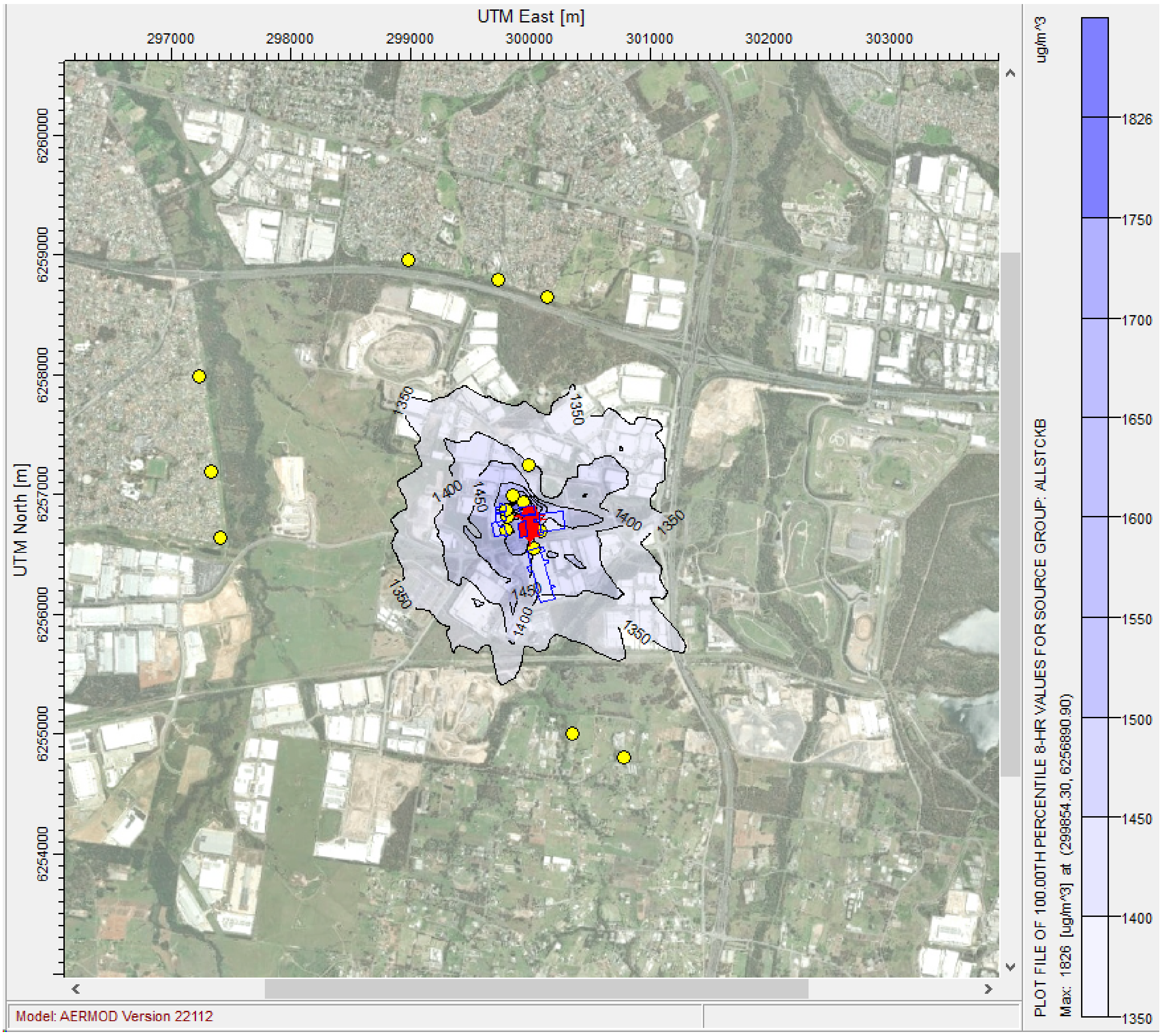
F.4 CO (1-hour average) - Cumulative



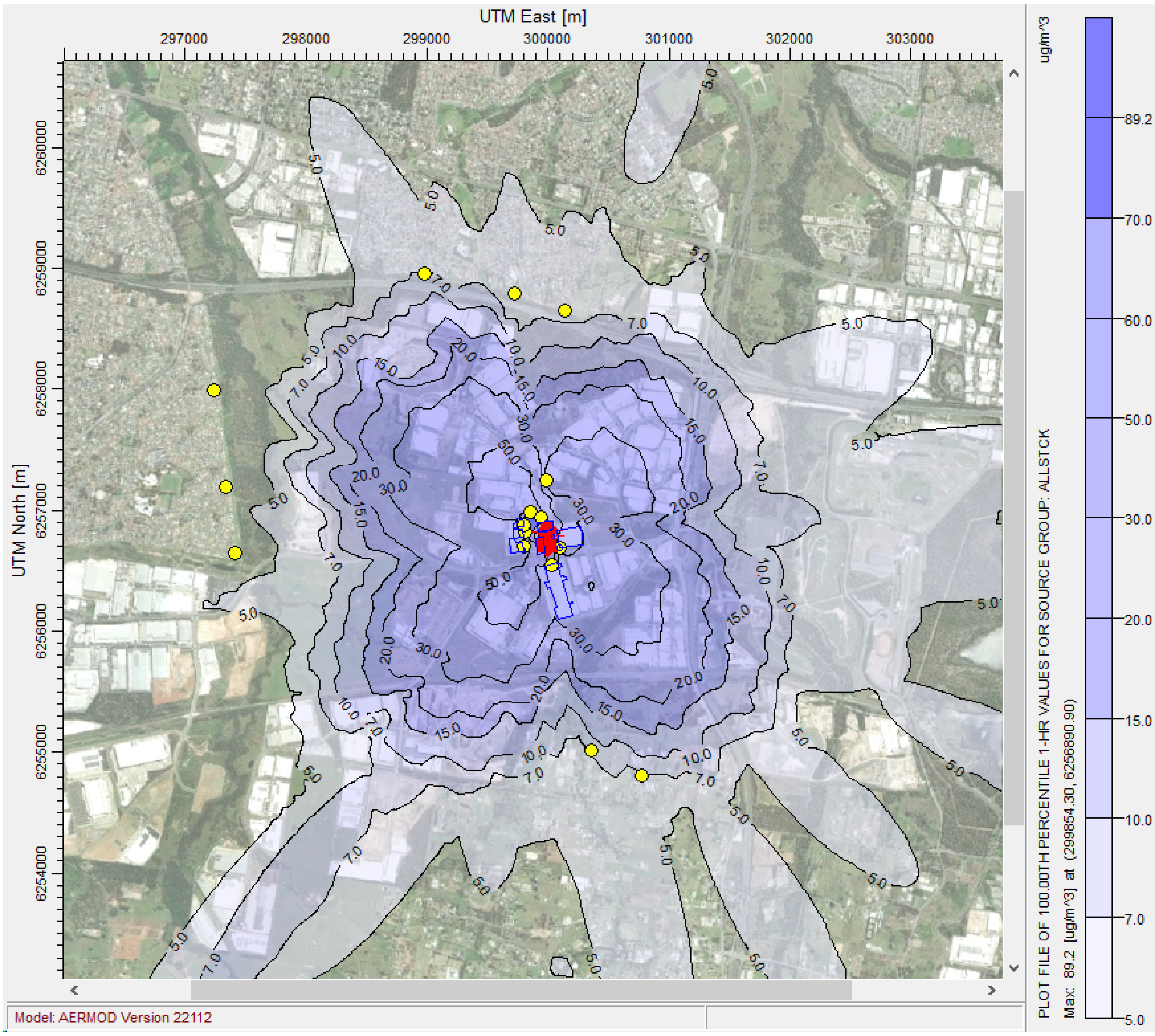
F.5 CO (8-hour average) - Incremental



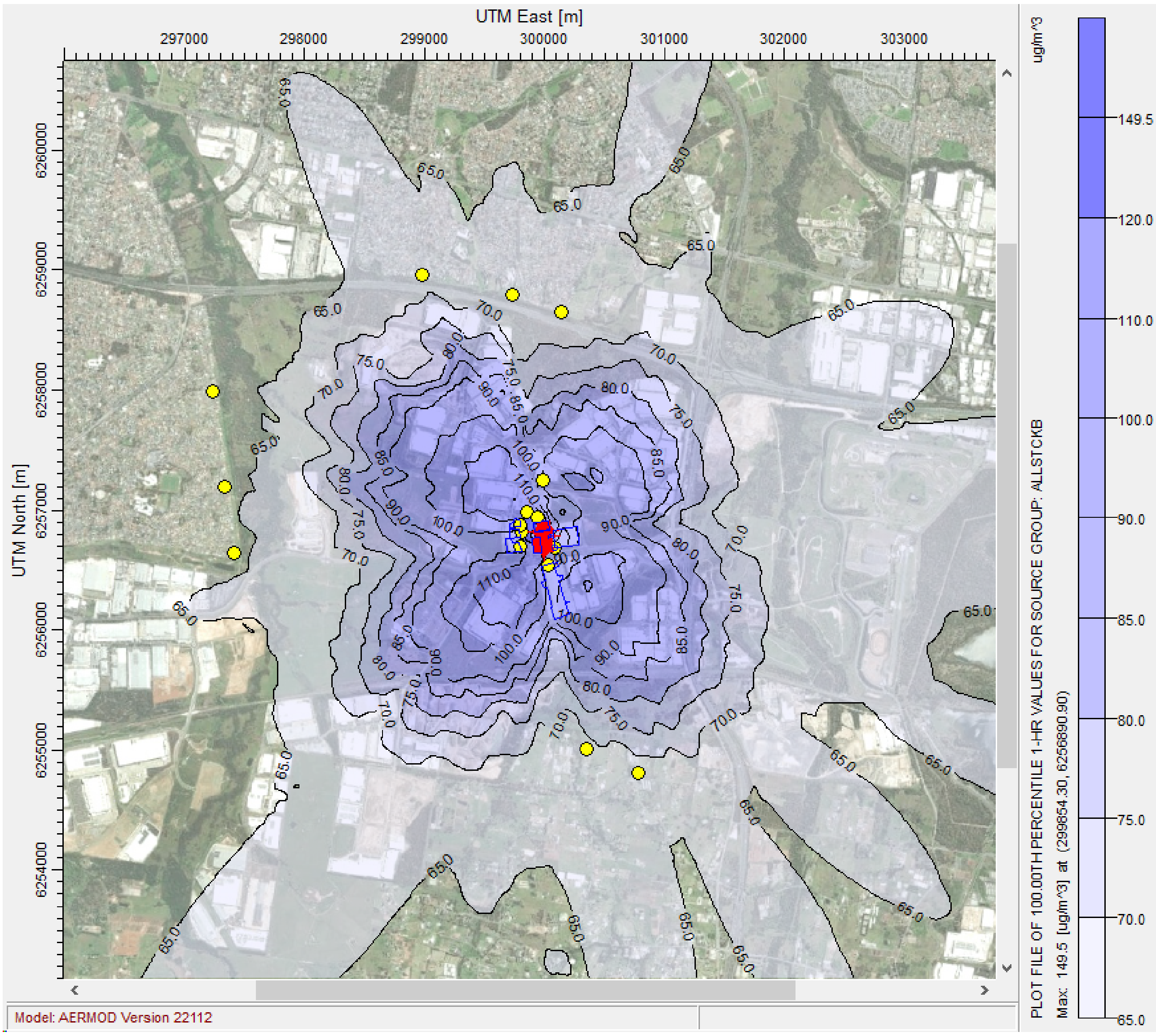
F.6 CO (8-hour average) - Cumulative



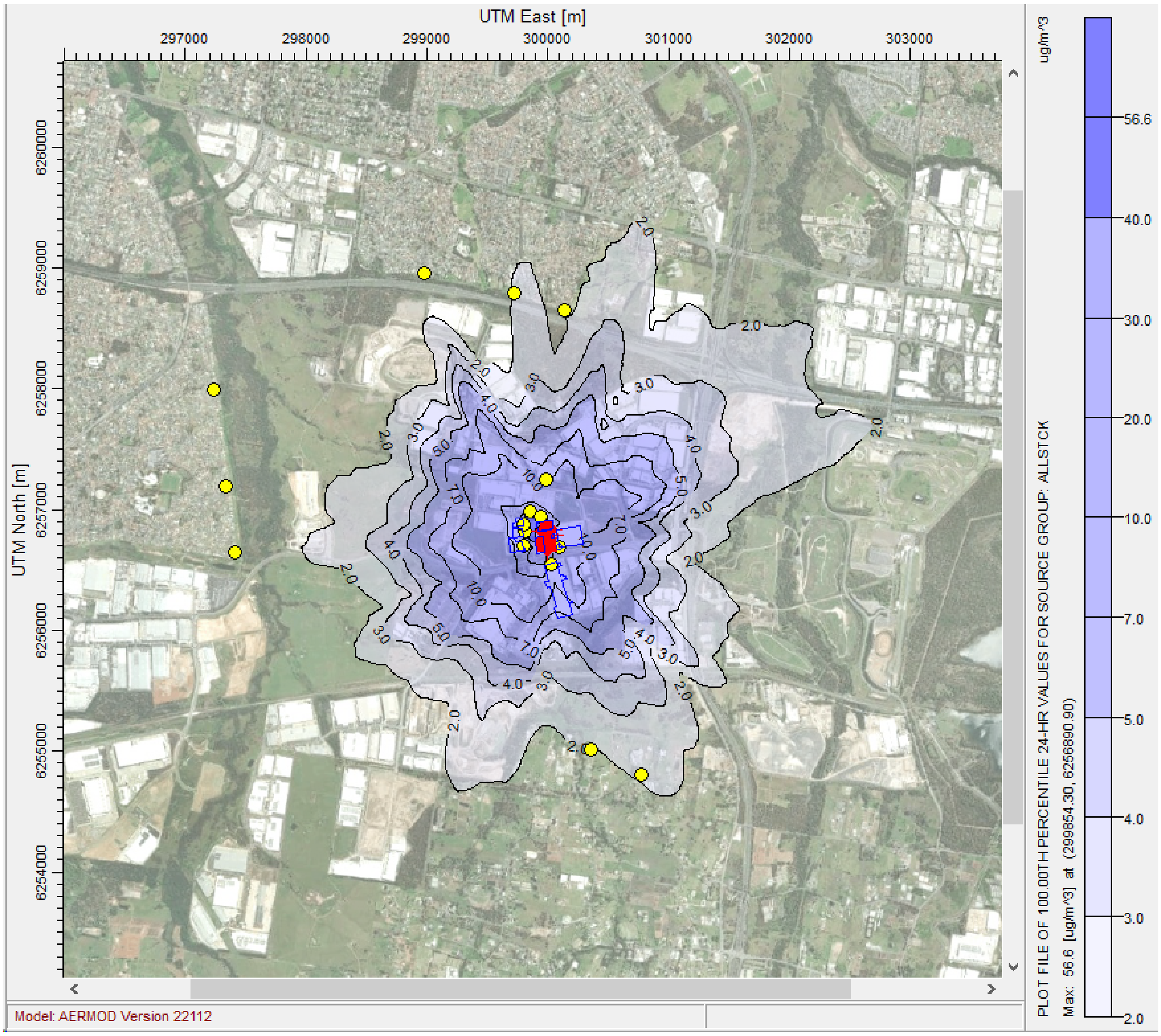
F.7 SO_2 (1-hour average) - Incremental



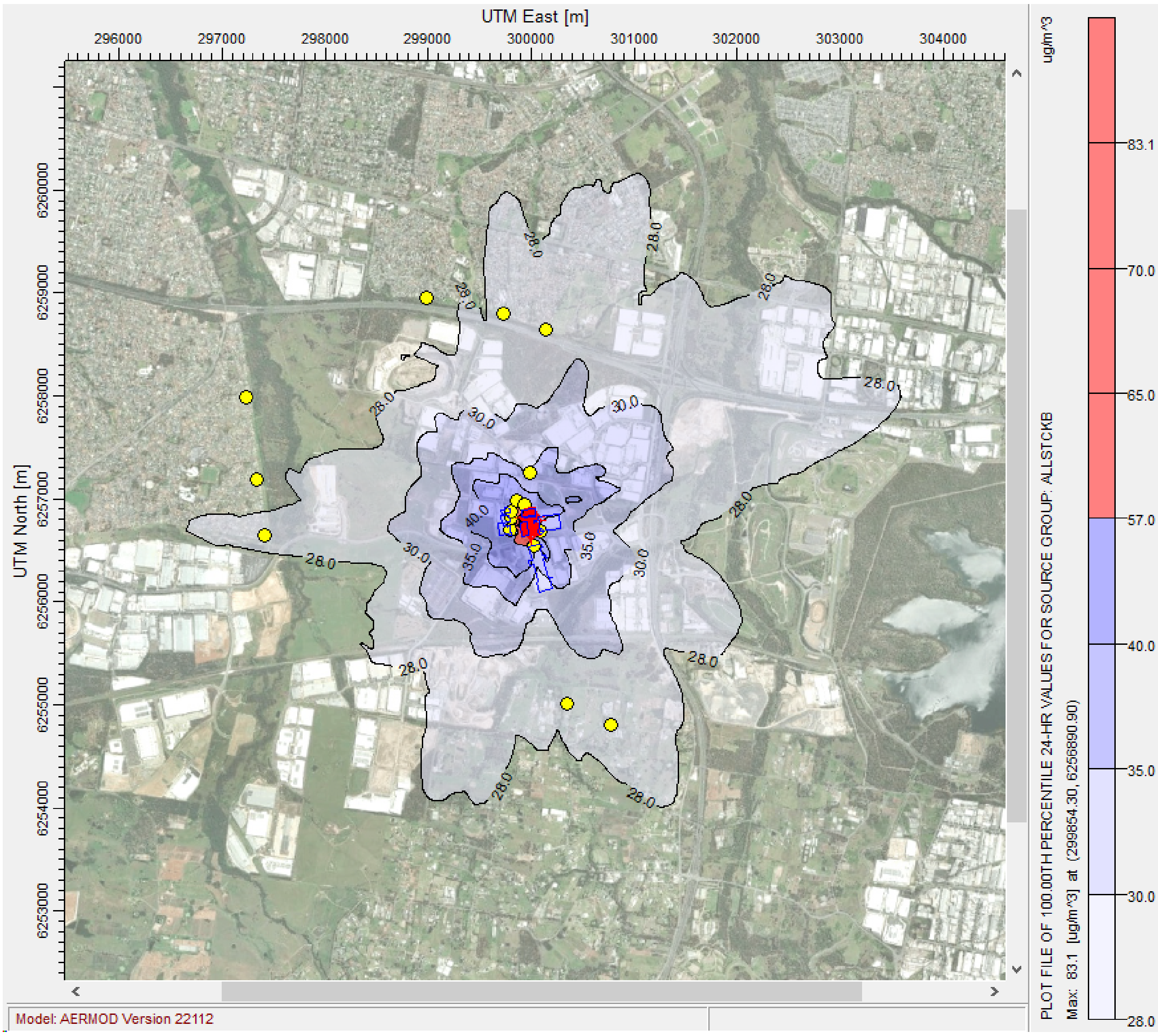
F.8 SO_2 (1-hour average) - Cumulative



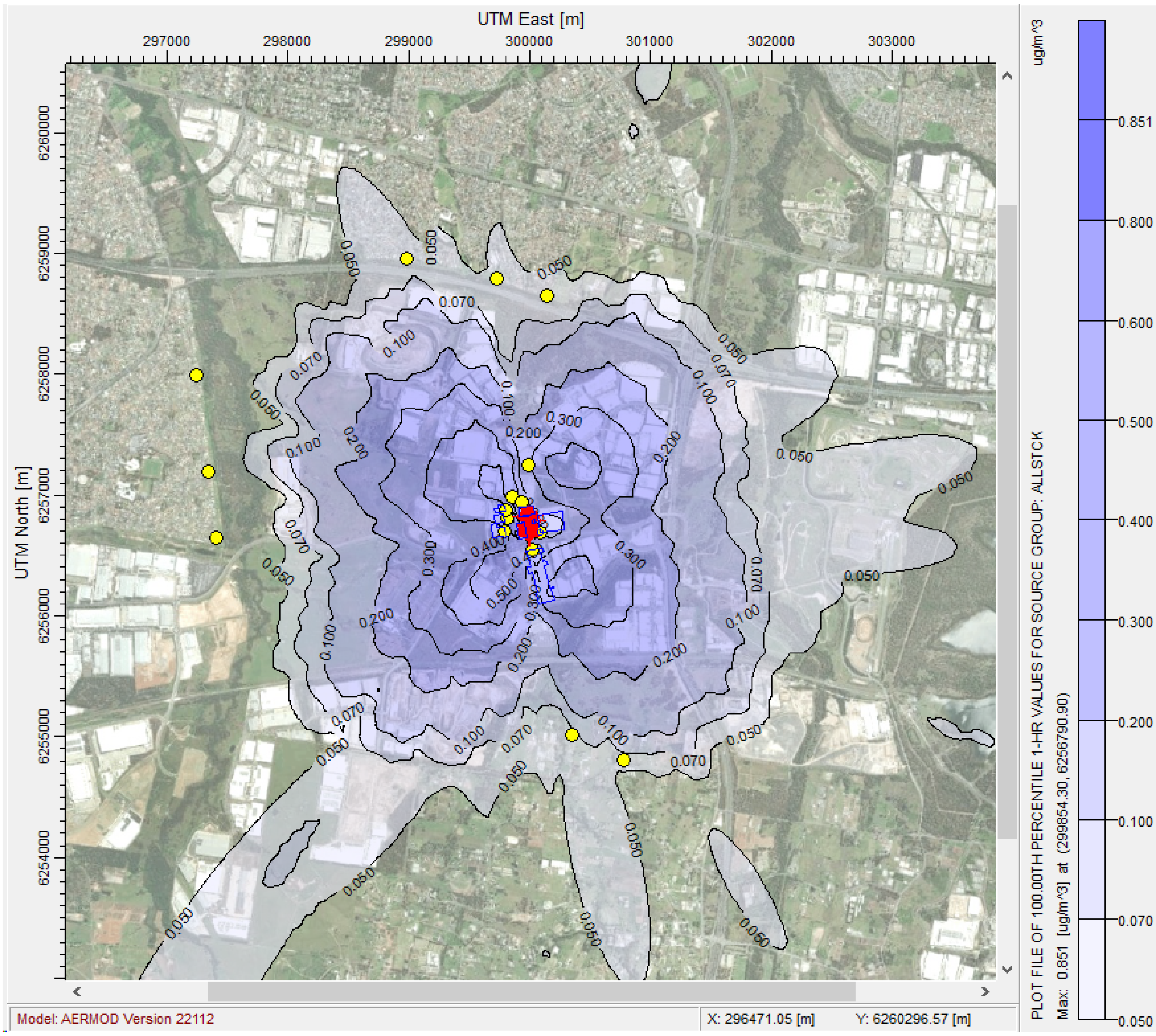
F.9 SO_2 (24-hour average) - Incremental



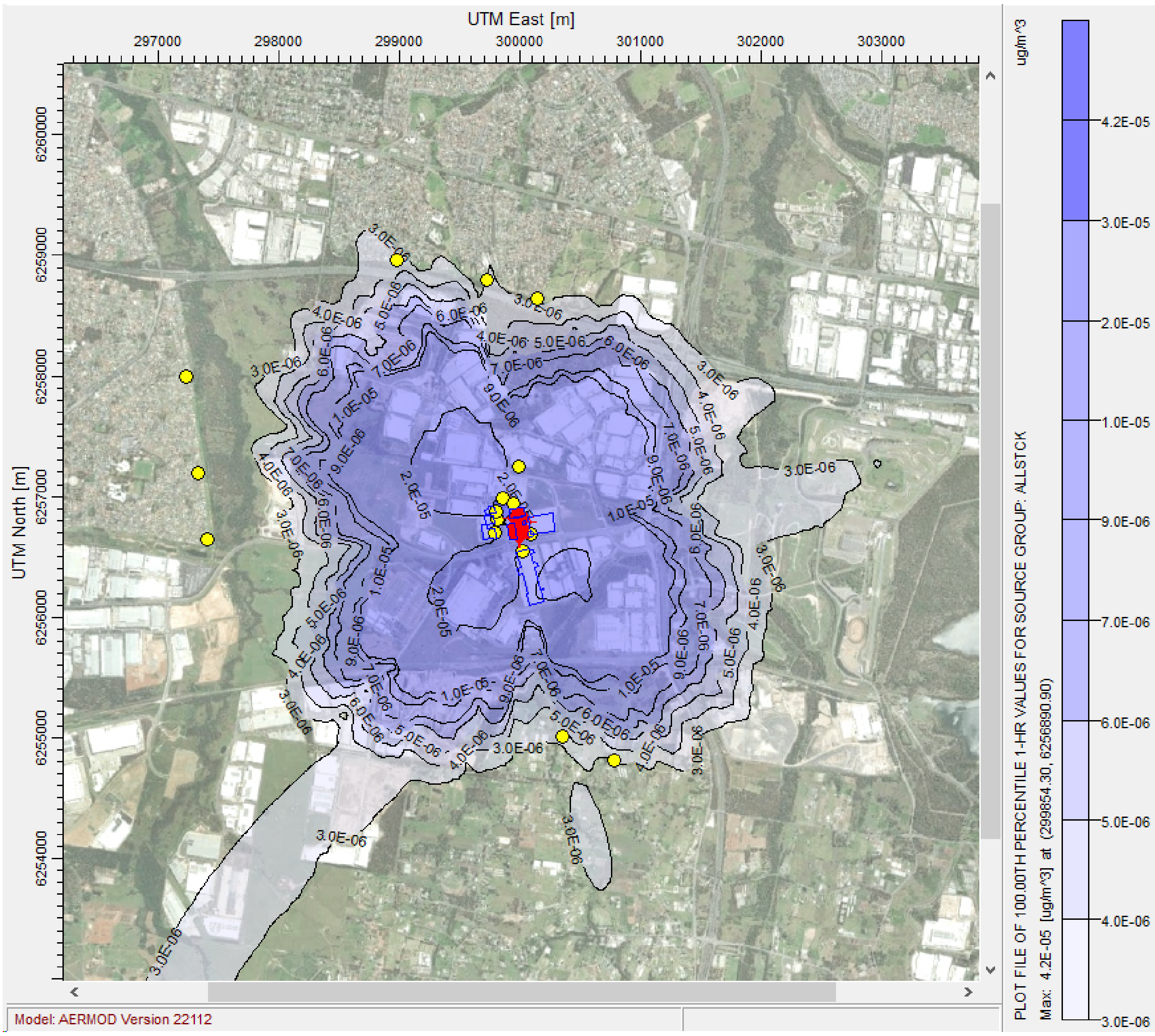
F.10 SO_2 (24-hour average) - Cumulative



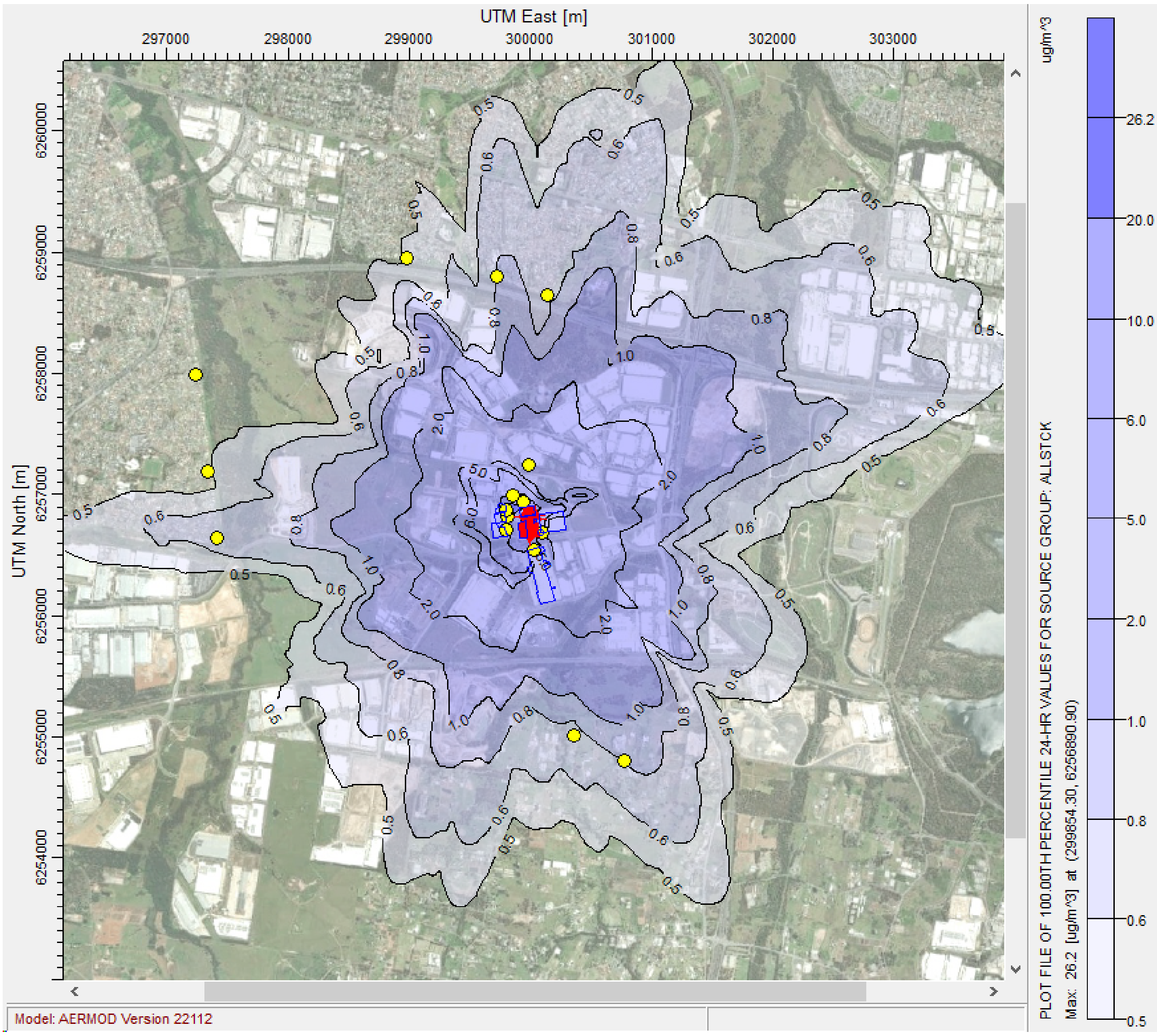
F.11 Benzene (1-hour average) - Incremental



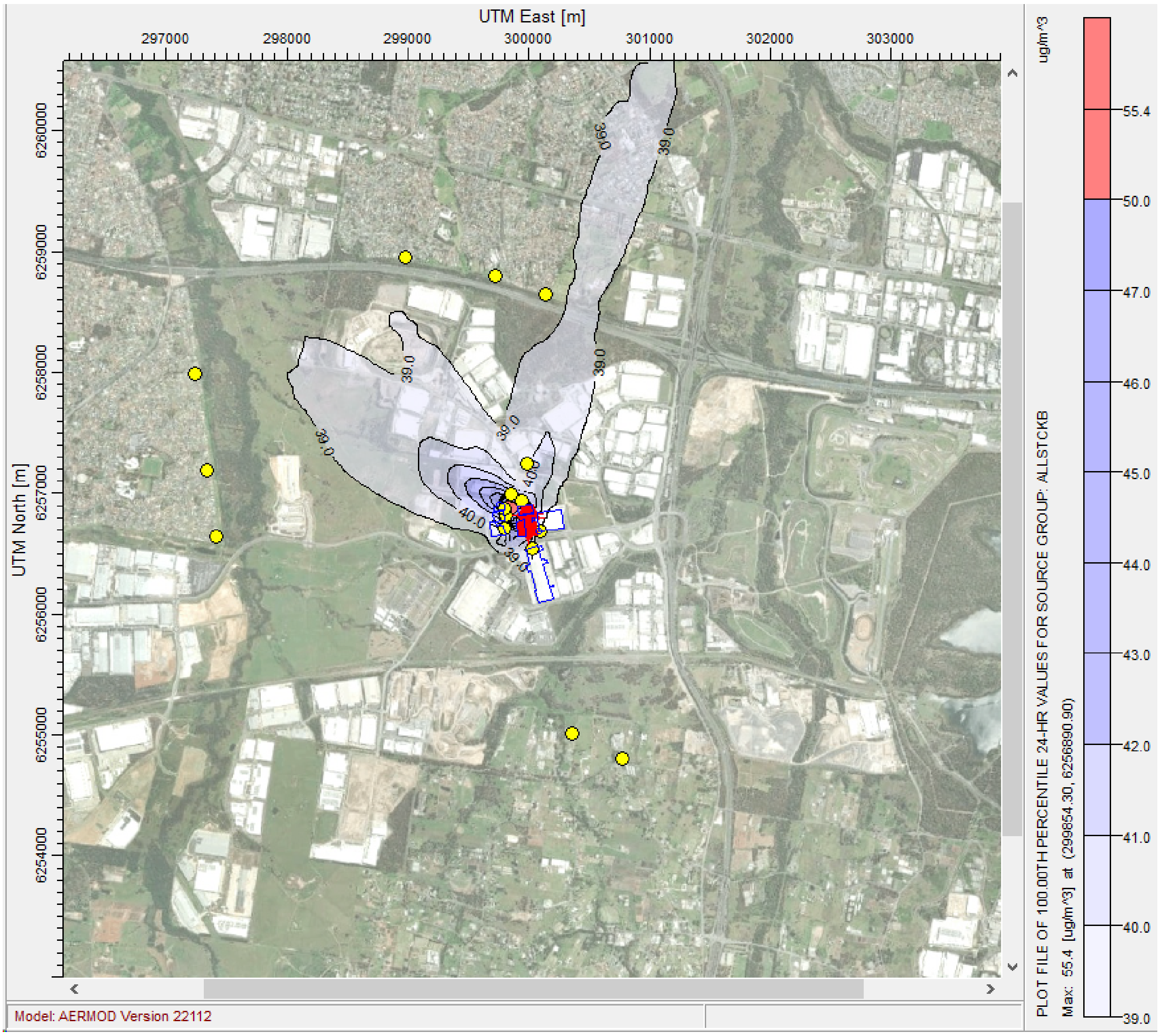
F.12 PAH (1-hour average) - Incremental



F.13 PM_{10} /$PM_{2.5}$ (24-hour average) – Incremental



F.14 PM10 (24-hour average) – Cumulative



F.15 $PM_{2.5}$ (24-hour average) – Cumulative