ARUP

NEXTDC Limited

NEXTDC SC2 Data Centre

Standby Generator Air Emission Assessment

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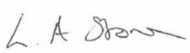
		Signature			Signed
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Executive Summary

Arup Australia Pty Ltd (Arup) was engaged by NEXTDC Limited to undertake an air quality impact assessment for a proposed new NEXTDC data centre (SC2), located at Lot 10 South Sea Islander Way, Maroochydore, QLD (hereafter referred to as 'the proposal' or 'the proposal site'). The air quality impact assessment accompanies the development application for the proposal.

This assessment looked at the air quality impact of standby generators associated with the proposal, in the event of loss of mains power, and routine maintenance testing.

Air Quality Policy

The QLD *Environment Protection (Air) Amendment Policy 2024* (EPP (Air) Amendment 2024), is the air quality legislation within the state of Queensland to assist in achieving the objective of the Queensland Government Environmental Protection Act 1994, in relation to the air environment. The EPP (Air) provides air quality objectives for relevant pollutants to the proposal, such as nitrogen dioxide (NO_2), sulfur dioxide (SO_2), carbon monoxide (CO), particulate matter (PM_{10} and $PM_{2.5}$) that need to be met at the nearby receivers. The amendment acknowledges the changes to the AAQ NEPM 2021 to ensure Queensland remains consistent with commonwealth legislation, including those air quality objectives indicators commencing on 1 January 2025 for SO_2 and $PM_{2.5}$.

Existing Environmental Conditions

The proposal site is bounded by South Sea Islander Way, Sunshine Coast Parade, Future Way and Red Bill Lane. The lands surrounding the proposal site have rapidly evolved with recently built and approved developments, including high-rise towers. The site is located within Sunshine Coast Council local government area and within the Maroochydore City Centre Priority Development Area (PDA) as part of a new central business district for the Sunshine Coast. To the east of the site is a Low Density Residential Zone governed by the Sunshine Coast Council Planning Scheme 2014. The nearby future sensitive receivers (e.g. approved-future developments relevant to this assessment) were identified through a review of aerial mapping as well as Queensland government planning information of approved-future developments. The nearby existing and approved-future developments, as well as consideration of the approved height for future development in the relevant zone has been taken into account in this assessment.

The nearest Bureau of Meteorology (BoM) station is located at Sunshine Coast Airport, approximately 6.4 km north of the proposal site. However, this station is situated in an area of relatively flat terrain, unlike the proposal site, which is surrounded by distinct topographical features to the west, including Buderim Hill and adjacent forestland. These features likely influence the local meteorological conditions at the proposal site. Therefore, site-specific meteorological conditions for 2021 were obtained using the AERMET prognostic meteorological model. The wind roses for the proposal site indicate that prevailing winds are primarily from the south-south-west to south-west, followed by winds from the south-east sector.

The nearest air quality monitoring station (AQMS) is located at Mountain Creek, approximately 3.8 km to the southeast of the proposal site, recording NO_2, O_3, PM_{10} and $PM_{2.5}$. CO and SO_2 background concentrations were sourced from South Brisbane AQMS and Lytton AQMS, which provide more conservative backgrounds. The 70th percentile background concentrations of the latest five year period available (2019-2023 for all other pollutants) have been considered, with the highest adopted as the background concentrations in this assessment. The highest 70th percentile background concentrations for all assessed pollutants.

Pollutant Impact Assessment

A dispersion modelling assessment of the proposed four standby generators within the proposal's site has been undertaken to ascertain the air quality impacts at nearby receivers due to a highly unlikely worst case scenario where all generators would be operational (emergency – in the event of a power outage). A dispersion modelling assessment for the proposal during routine maintenance testing of the standby generators has also been undertaken.

The assessment was undertaken using AERMOD. Emissions to air from the standby generators associated with the proposal have been estimated using manufacturer's specification datasheets. The highest concentrations have been predicted at the surrounding discrete receivers at ground level as well as elevated receiver heights.

Operations during Highly Unlikely Worst-Case (Power Outage) 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 emissions of oxides of nitrogen (NO_x), which convert to NO_2 in the atmosphere from the generators exceed the air quality objective at the modelled discrete receivers. The highest predicted 1-hour average NO_2 concentration exceeds the objective by 10 fold at 56 m above ground (approximately 14th floor) of the development currently under construction at 20 South Sea Islander Way, Maroochydore (R6) receiver.

Predicted PM_{10} and $PM_{2.5}$ concentrations are generally below the air quality objectives, except at some of the assessed elevated receivers. The highest predicted PM_{10} and $PM_{2.5}$ concentrations are 82 µg/m^3. While some exceedances are predicted, it is highly unlikely that standby generators would need to operate for a continuous 24-hour period in an event of loss of mains power scenario.

It is to note that the predicted concentrations represent the highest possible concentrations during a loss of mains power, with all generators operating and coinciding with worst-case meteorological conditions, which provides conservatism in the assessment. Further, the proposal is designed to operate from a 33kV utility power supply which has much higher reliability than convention utility. It is only in the event of both primary and secondary feeds failing, would back up power generation be required using the standby generators. The use of a dual redundant utility arrangement as well as the fully redundant 33 kV utility power supply increases the reliability of the utility power supply and provides additional security, which mitigates the need for the standby generators to be operational. Therefore, despite the potential for predicted exceedances of the NO_2 1-hour average air quality objective during operation of all standby generators concurrently, it is highly unlikely that this worst-case scenario would occur in a typical year. If it did occur, the standby generators are likely to only operate for far less than 0.02% of the year due to power outages, based on Energex historical data. Therefore, the air quality risks are considered to be very low.

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. The proposal's generators are proposed to be tested under a routine maintenance schedule in which up to one generator is tested up to 15 minutes at any given hour during the daytime (7am to 6pm), under 50% load or less. The proposal's generator will not be tested concurrently with the adjacent SC1 data centre generators and therefore there is no risk of cumulative impact.

Dispersion modelling has been undertaken to determine potential air quality impacts from relevant air pollutants, at nearby discrete receivers, as a result of routine maintenance. These pollutant concentrations are predicted to meet the air quality objectives at the nearby modelled discrete receivers.

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1. Introduction

Arup Australia Pty Ltd (Arup) has been commissioned to undertake an air quality assessment of the proposed new NEXTDC data centre (SC2), located at Lot 10 South Sea Islander Way, Maroochydore, QLD (hereafter referred to as 'the proposal' or 'the proposal site').

1.1 Purpose of this Report

The purpose of this report is to examine and identify the potential impact from the 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:

- Maroochydore City Centre Priority Development Area (PDA) Development Scheme
- QLD *Environmental Protection (Air) Policy 2019* (EPP (Air))
- QLD *Environmental Protection (Air) Amendment Policy 2024* (EPP Air Amendment 2024)
- QLD Guideline ESR/2015/1840 – *Application requirements for activities with impacts to air* (2021).

This assessment characterises the local meteorological and background air quality conditions at the proposal and its surroundings and provides dispersion modelling assessment of the proposed standby generators to be installed at the proposal, as a worst-case scenario (e.g. a power outage with all generators in operation) as well as a regular maintenance testing scenario.

Recommendations for mitigation measures required to minimise air quality impacts from the proposal have also been included, where necessary.

1.2 The Proposal Background

NEXTDC is an established and growing data centre developer and operator. Since its inception thirteen years ago, NEXTDC has developed multiple premium quality data centres nationally, all certified to the industry's highest standards. NEXTDC continue to grow their pipeline of world-class, next-generation data centres in Australian cities, with the latest expansion in Queensland being the SC2 facility at Lot 10, South Sea Islander Way, Maroochydore QLD 4558 Australia, directly adjacent to the existing SC1 facility. The SC2 facility is to comprise a multi-level data centre with a total capacity of 6MW IT, as well as collaboration and mission critical (MCX) office space.

1.3 Site Description

The proposal site is legally identified as Lot 10 on SP305311 and is bounded by South Sea Islander Way, Sunshine Coast Parade, Future Way and Red Bill Lane. The site is located within Sunshine Coast Council local government area and within the Maroochydore City Centre Priority Development Area (PDA) as part of a new central business district for the Sunshine Coast. The proposal site is presented in Figure 1.

In its existing state, the proposal site comprises undeveloped land utilised as an at-grade car park.

Figure 1 – Proposed site location and the proposed SC2 building locations

2. Legislation, Policies and Guidelines

This Chapter presents relevant regulation, legislation and policy governing management of air quality, to the proposal.

2.1 State Legislation and Policy

2.1.1 Environmental Protection Policy (EPP Air)

The EPP (Air) is the air quality legislation within the state of Queensland to assist in achieving the objective of the *Queensland Government Environmental Protection Act 1994*, in relation to the air environment. The EPP (Air) provides the following:

- Identification of environmental values to be enhanced or protected;
- Stating indicators and air quality objectives for enhancing or protecting the environmental values; and
- Providing a framework for making consistent, equitable and informed decisions about the air environment.

In April 2021, following a detailed assessment and consultation process, the National Environment Protection Council (NEPC) approved revisions to the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM). These updates, driven by the latest scientific findings on health impacts, involved changing standards for particulate matter ($PM_{2.5}$), ozone (O_3), nitrogen dioxide (NO_2), and sulfur dioxide (SO_2). In addition to these changes, there will be further amendments to air quality objectives and indicators which commenced on 1 January 2025, for daily $PM_{2.5}$ and 1-hour SO_2, which have been considered in this assessment.

The *Environment Protection (Air) Amendment Policy 2024* (EPP (Air) Amendment 2024), which came into effect on 29 August 2024, introduced the amendments from the AAQ NEPM to the *Environmental Protection (Air) Policy 2019* (EPP (Air)) to ensure Queensland remains consistent with commonwealth legislation.

The air quality objectives as described in the EPP (Air) Amendment 2024 for pollutants relevant to the proposal are summarised in Table 1. There are air quality objectives 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 1 – EPP (Air) Air Quality Objectives

Pollutant	Averaging Period	Air Quality Objectives, µg/m^3
Carbon Monoxide (CO)	8-hour	11,000
Nitrogen Dioxide (NO_2)	1-hour	164
Sulfur Dioxide (SO_2)	1-hour	214
	24-hour	57
Particulate Matter (PM_{10})	24-hour	50
Particulate Matter ($PM_{2.5}$)	24-hour	20

Concentrations with averaging times of 1 hour or less are to be presented using the 99.9th percentile concentration of the total site impact and background concentration, whereas concentrations with averaging times of greater than 1 hour are to be presented using the maximum concentration (100th percentile[1]) of the total site impact from dispersion modelling and background concentration.

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

2.2 Maroochydore City Centre Priority Development Scheme

The Maroochydore City Centre Priority Development Area (PDA) Development Scheme[2] was approved by the Queensland Government on 11 July 2014 and most recently amended on 15 March 2024. The declaration of Maroochydore as a PDA will support economic development, provide much needed infrastructure, and create a new central business district for the Sunshine Coast. The development scheme is the planning document that assists in planning, carrying out, promoting, coordinating and controlling the development of land in the Maroochydore city centre PDA.

All development applications within the PDA are assessed against this development scheme, with Economic Development Queensland (EDQ) being the authority responsible for evaluating applications. The proposal site is situated in the Maroochydore City Centre PDA Core Business Precinct.

The PDA-Wide criteria, as described in the Development Scheme, apply to all assessable development and proposed developments will have to demonstrate compliance. PDA-Wide criteria particularly relevant for air quality include:

2.6.7 Environment

'Development:

1. *is sensitive to environmental matters,*
2. *adequately addresses any environmentally significant matters, including any disturbance of marine plants,*
3. *seeks to incorporate tidal fish habitats and fish passage within the Maud waterway,*
4. *protects and retains ecological values, where possible,*
5. *implements planting strategies that utilise species that are predominantly endemic to the Sunshine Coast, and*
6. *achieves minimum acoustic environmental values for indoor and outdoor areas.'*

2.6.8 Community safety and development constraints

'Development:

1. *is sited, designed and constructed to avoid, mitigate, manage or otherwise overcome a development constraint,*
2. *ensures that people and property are safe from potential hazards including acid sulfate soils, flooding, coastal hazards such as storm tide inundation and erosion, with consideration for the projected impacts of climate change,*
3. *ensures the design and management of land uses avoids the attraction of wildlife that would present a risk to aviation activities associated with the Sunshine Coast airport,*
4. *ensures the design, siting, and layout of development, including development adjoining current and future transport corridors, address noise, vibration, lighting, air quality and emission impacts, and where necessary incorporate mitigation measures,*
5. *minimises adverse impacts on amenity during construction,*
6. *avoids the generation of emissions that may cause adverse impacts to human health, safety or the environment, such as: noise, vibration, emissions, odour, heat and lighting, and*
7. *Ensure the siting, design, construction and operation of development supports community safety and gives appropriate consideration to development constraints by avoiding, to the greatest extent*

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[2] Sunshine Coast Council. (2024). Maroochydore City Centre Priority Development Area Development Scheme.

practicable, then managing or mitigating adverse impacts on people, property and the environment from contaminated land'

3. Identification of Emissions Sources

3.1 Standby Generators

The primary source of emissions to air during the operational phase are the standby generators that are included for in the proposal, as an insurance policy, to absolute guarantee the need for 100% uptime if there was ever a failure of the primary and secondary power supply to the site. The proposal site is designed for a total of four standby generators to supply the data centre critical loads, with a total IT capacity target of 6 MW. 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 standby generator specification sheets for indicative equipment (MTU 16V4000G84F) are presented in Appendix A, and have been used to develop the emission inventory for this assessment.

All generators are within dedicated generator enclosures for acoustic treatment and plant positioning, which are located on Level 4 of the data centre building. 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.

3.1.1 Grid Reliability and Likelihood of Emergency Event

The proposal is a mission critical facility that if not able to operate 100% of the time could lead to catastrophic impacts for the society, organizations, and businesses that it serves. The proposal therefore as a minimum is supplied by dual redundant utility feeds using a 33kV highly reliable power utility supply arrangement. It is only in the event of both primary and secondary feeds failing, would back up power generation be required using the standby generators. A 33kV utility power supply has much higher reliability performance than a conventional utility. The use of a dual redundant utility arrangement as well as the fully redundant 33 kV utility power supply increases the reliability of the utility power supply and provides additional security, which mitigates the need for the standby generators to be operational.

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, a review of the Energex *Distribution Annual Planning Report 2024* (February 2025)[3] has been undertaken. It was determined that in 2023/24, the actual system average interruption duration index (SAIDI)[4] of power outage incidents within the Urban area was 87.1 minutes (total cumulative events) of outages per year per customer (Table 2), which equates to approximately 0.02% likelihood of occurrence in a given calendar year. Five-year (2020-2024) rolling average reliability performance for SAIDI at whole of regulated network level is approximately 77.9 minutes – based on five years of historical performance of SAIDI data.

Table 2 – Annual normalised reliability performance compared to Minimum Service Standards (MSS) Limits

Pollutant	Averaging Period	2022-23 Actual	2023-24 Actual	2021-25 MSS Limits
SAIDI (minutes)	CBD	2.59	3.49	15
	Urban	80.90	87.09	106
	Short Rural	170.63	196.14	218

3.1.2 Maintenance Routine

For standby generators to be ready to operate should an unexpected interruption to mains power occur, a regular maintenance schedule is required. The proposal generators are proposed to be tested under the following routine maintenance schedule:

[3] Energex, 20525. *Distribution Annual Planning Report 2024*, January 2025.

[4] 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.

- Up to one generator being tested up to 15 minutes at any given hour;
- Generator to be tested at 50% load or less;
- Testing to be conducted during the daytime period (7am to 6pm) only; and
- Not to be conducted concurrently with generator testing at the existing SC1 datacentre, which is less than 10m east of the proposal site.

3.1.3 Potential Impacts

Under normal operations of the data centre (when there is no routine maintenance), no air quality impacts are anticipated as the standby generators are not in operation. However, when in use, standby generators produce emissions associated with diesel combustion, mainly nitrogen oxide (NO_x), carbon monoxide (CO), particulate matter (PM) and sulfur dioxide (SO_2). The release of these emissions has the potential to impact local air quality in the surrounding area. 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.

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 proposal site. The nearest meteorological monitoring station is located at Sunshine Coast Airport automatic weather station (AWS), approximately 6.4 km to the north of the site (operated by Bureau of Meteorology). This meteorological station is located in an area surrounded by relatively flat terrain. In comparison to the proposal site, the local meteorological conditions are likely be influenced by distinct terrain features associated with the Buderim hill to the south-west.

To provide site representative meteorological data and all parameters required by the dispersion model, meteorological data was purchased from Lakes Environment based on the Weather Research and Forecast (WRF) prognostic model with 1 km grid resolution. The prognostic data was interpolated from nearby forecasted and monitored data. Analysis of meteorological data for the past five years indicated similar meteorological patterns, and therefore 2021 was selected to represent typical meteorological conditions in the area. The wind roses of the nearest Sunshine Coast Airport meteorological data and the prognostic weather model are shown in Figure 2.

In comparison of wind characteristics between the Sunshine Coast Airport AWS and the site representative prognostic data in Figure 2, it can be seen that Buderim hill to the south-west of the proposal site is creating channelling-effect to the south-westerly winds, which would result in dominant winds in this direction. Unlike those at the Sunshine Coast Airport where the wind is dominated by the high occurrence of strong winds coming through from the sea (land-sea breezes). Due to the difference above, site representative WRF meteorological data was used in the dispersion modelling assessment.

Figure 2 – Wind roses from nearest Sunshine Coast Airport weather station and the local prognostic modelled weather conditions

4.1.1 Windrose

Annual Average

The annual average wind rose between 1 January 2021 and 31 December 2021 is shown in Figure 3 with wind class frequency distribution. Based on Figure 3, the following features can be observed:

- Winds are most prevalent from the south-south-west to south-west, followed by the south-east sector.
- The average wind speed is 3.0 m/s.
- Winds are least prevalent from the west sector with annual winds of about 3%.
- Light winds (< 0.5 m/s) are more prevalent from the south-west and west-north-west sectors.
- Due to the infrequent occurrence of calm winds (2.7%), meteorological conditions are considered favourable for dispersion.

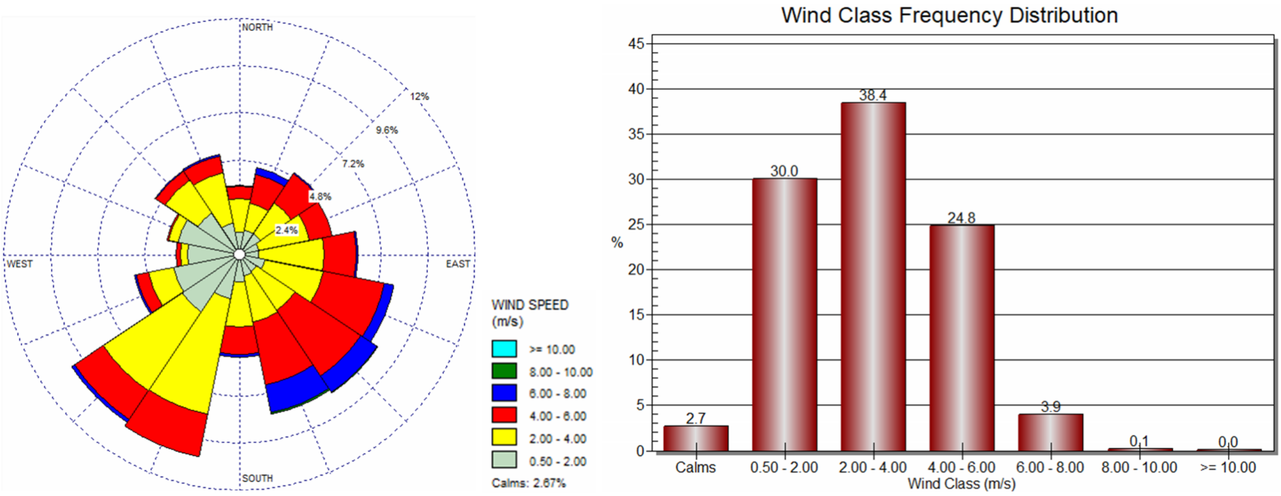
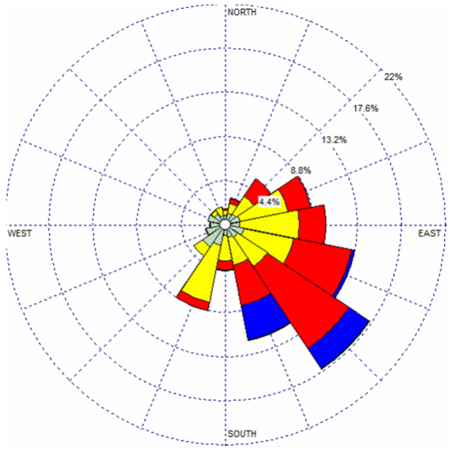


Figure 3 – Wind rose and wind class frequency distribution 2021 prognostic data

Seasonal Variation

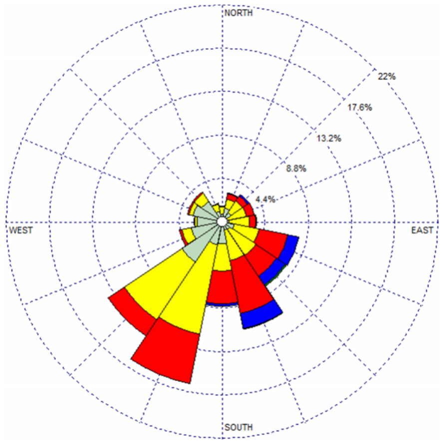
The seasonal variation wind roses for year 2021 are shown in Figure 4, the following features can be observed:

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



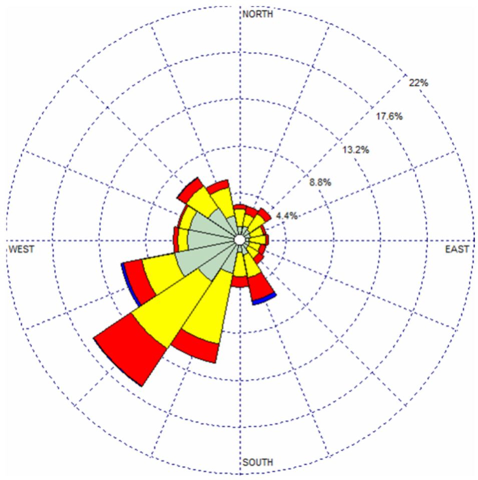
Summer Season

Average wind speed 3.32 m/s



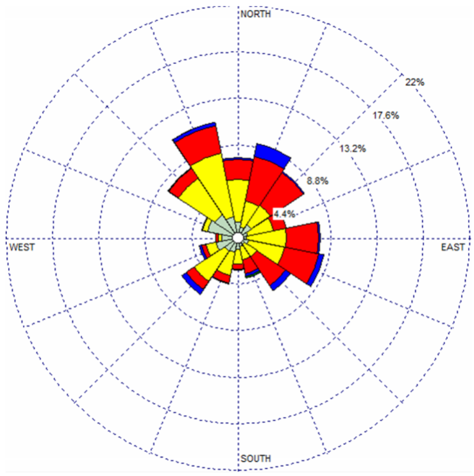
Autumn Season

Average wind speed 3.06 m/s



Winter Season

Average wind speed 2.51 m/s



Spring Season

Average wind speed 3.21 m/s

Seasonal Wind Roses

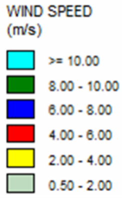


Figure 4 – Seasonal wind rose for 2021

4.1.2 Wind conditions between 7 am and 6 pm (for routine maintenance of the generators)

The operation of the standby generators relating to routine maintenance (Section 3.1.2) is limited between 7 am and 6 pm. Wind conditions during this period are shown in Figure 5. Wind patterns for this period are generally similar, though weaker winds are observed from the south-south-west to south-west and west to north-north-west arc during this time. There is also a slight shift in dominant wind direction from south-west on an annual basis to south-east for this time period. Overall average wind speed between 7 am and 6 pm is slightly higher at 3.6 m/s when compared to the annual basis of 3.0 m/s.

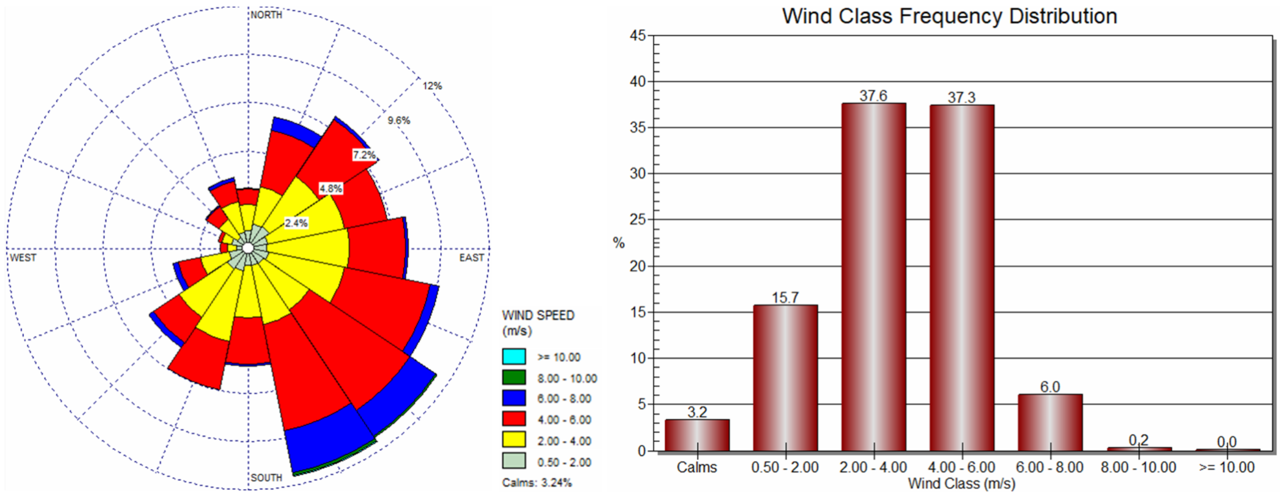


Figure 5 – Wind rose and wind class frequency distribution 2021 prognostic data (7 am to 6 pm only)

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 commercial and domestic activities, traffic and natural sources.

4.2.1 Existing Sources of Emissions

There are no significant sources of emissions to air in the local vicinity (e.g. emission reporting through the National Pollutant Inventory) with the local airshed likely dominated by typical traffic and commercial activities. An existing NEXTDC data centre (SC1) is in operation immediately adjacent to the site, but as for the proposed facility under normal operations (when routine maintenance is not occurring) this data centre would not have any impact on local air quality. It has been confirmed that the existing data centre is fed by a separate power supply to the proposed facility and that operations can be managed so that generator testing for both SC1 and SC2 do not occur at the same time. Therefore, it is highly unlikely that both facilities would contribute emissions to local air quality at the same time during normal or routine maintenance operations.

4.2.2 Air Quality Monitoring

The nearest air quality monitoring station (AQMS) is located at Mountain Creek, approximately 3.8 km to the southeast of the proposal site. The Mountain Creek AQMS is located at the Mountain Creek State Primary School, within a residential area, and at approximately 0.5 km from a major road (Sunshine Motorway). The location of this AQMS and its surrounds have similar land use context to that of the proposal site, and therefore is considered to be representative of the local air quality environment. The AQMS measures NO_2, O_3, PM_{10} and $PM_{2.5}$ which are all relevant pollutants for this assessment.

In the absence of more relevant data, monitored CO concentrations were sourced from the subsequent nearest station: South Brisbane AQMS (approximately 88 km to the southwest of the proposal site), which is located in a mixture of various commercial and residential premises. Monitored SO_2 concentrations were sourced from Lytton AQMS (approximately 83 km to the southeast of the proposal site), which is located in an industrial premises. CO and SO_2 impact levels from diesel generators are typically low, so the CO and SO_2 data at these locations have been adopted for this assessment and it is considered to likely provide a level of conservatism.

The locations of the relevant AQMS are summarised and shown in Figure 6.

Figure 6 – Locations of nearby AQMS

The 70th percentile background concentrations of the latest five year period available (2019-2023 for all other pollutants) have been considered to determine background pollutant concentrations for the proposal site. Data capture shall not be less than 75 per cent in each calendar quarter to make a valid assessment of compliance (NEPM AAQ Technical Paper No. 8). All the assessed pollutant data for the five years assessed from the above-mentioned AQMS have more than 75 per cent data availability rate.

The highest of the 70th percentile of monitored air quality background concentrations between year 2019 and 2023 are summarised in Table 3. The 70th percentile of monitored concentrations for all relevant pollutants meet the air quality objectives and have been adopted as background concentrations in determining total concentrations (e.g. incremental plus background) in the dispersion modelling assessment, for all relevant pollutants (NO_2, CO, SO_2, PM_{10} and $PM_{2.5}$).

Table 3 – 2019 – 2023 monitored air quality concentrations

Pollutant	Averaging Period	Highest 70th percentile Background Concentrations (2019-2023), µg/m³	AQMS	EPP Air Quality Objectives
CO	8-hour	203.7	South Brisbane	11,000
NO_2	1-hour	7.7	Mountain Creek	164
SO_2	1-hour	5.3	Lytton	214
	24-hour	15.9	Lytton	57
O_3	1-hour	47.9	Mountain Creek	210
PM_{10}	24-hour	17.7	Mountain Creek	50
$PM_{2.5}$	24-hour	6.4[a]	Mountain Creek	20

Note:
a. Available data from 2021 to 2023.

4.3 Sensitive Receivers

The QLD Department of Environment and Science (DES) – *Application requirements for activities with impacts to air* guideline (2021) defines sensitive places (or sensitive receivers) to include the following, as deemed relevant to this assessment:

- a dwelling, residential allotment, mobile home or caravan park, residential marina or other residential premises
- a motel, hotel or hostel
- a medical centre or hospital
- a place used as a workplace including an office for business or commercial purposes.

The proposal site is located in the Maroochydore City Centre PDA Core Business Precinct, bounded by South Sea Islander Way, Sunshine Coast Parade, Future Way, and Red Bill Lane in Maroochydore, Queensland. The site is surrounded by the PDA, except to the east, where it directly borders a Low Density Residential Zone (as shown in Figure 7) governed by the Sunshine Coast Council Planning Scheme 2014.

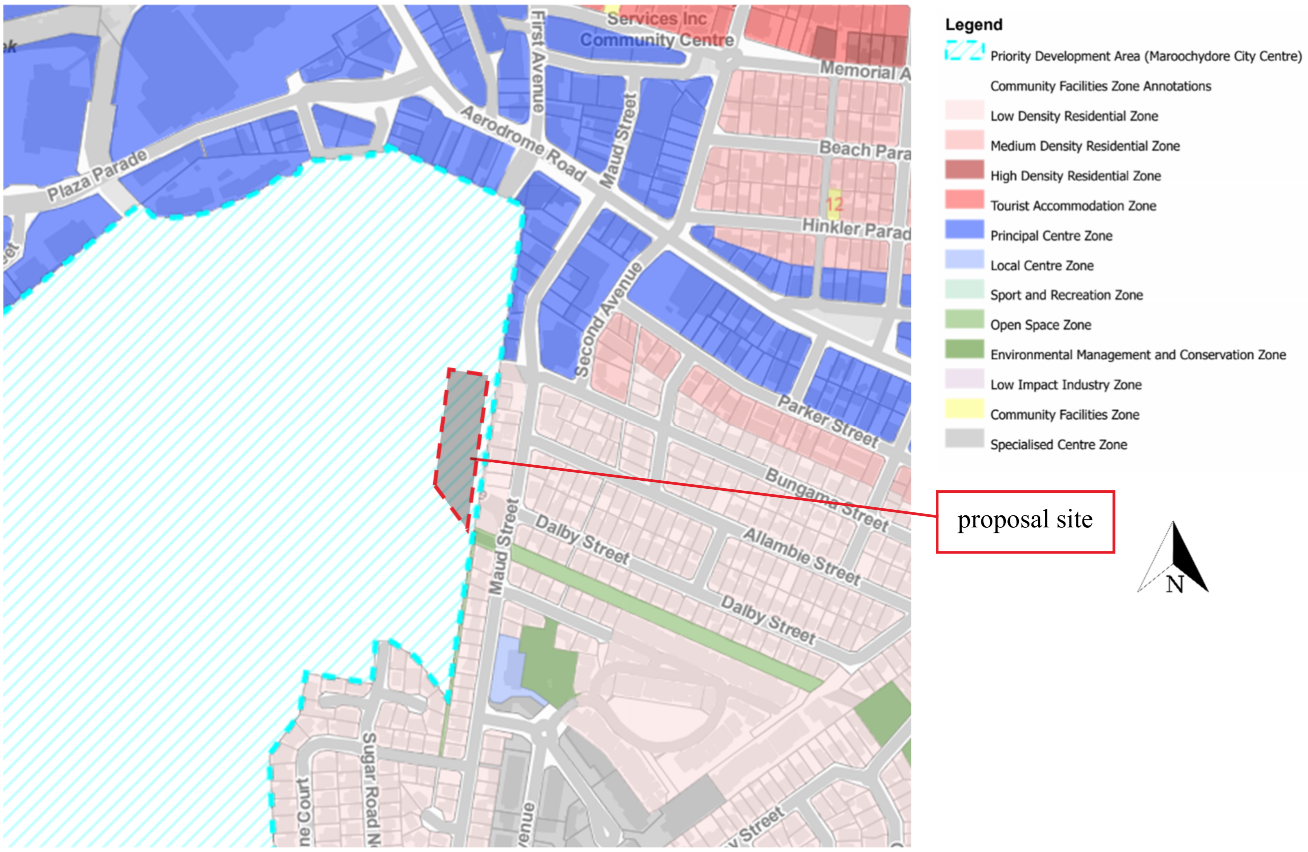


Figure 7 – Proposal site land use context *(Sunshine Coast Council Planning Scheme 2014)*

The list of identified nearby existing as well as future sensitive receivers are summarised in Table 4. The nearby future sensitive receivers (e.g. approved-future developments relevant to this assessment) were identified through a review of aerial mapping as well as Queensland government planning information of approved-future developments, and are listed below:

- Future residential - 201SP321694, Sunshine Coast Council
- Future residential - 68 Maud St, Maroochydore
- Future residential - 50SP305312, Sunshine Coast Council
- Future residential - 20 South Sea Islander Way, Maroochydore.

Table 4 – Sensitive Receivers

Receiver ID	Address	GDA 1994 MGA Zone 56 coordinates (m)		Number of Floors	Distance from the Proposal Site (m)	Modelled height (m)
		X	Y			
R1	Future residential - 201SP321694, Sunshine Coast Council	509176	7051030	15[a]	120	0 – 45
R2	Future residential - 68 Maud St, Maroochydore	509204	7051010	2	140	0 – 6
R3.1	54 First Ave Maroochydore	509120	7051380	16	130	0 – 48
R3.2		509105	7051360			
R4	Future residential - 50SP305312, Sunshine Coast Council	509210	7051300	15[a]	30	0 – 45
R5	Future residential - 20 South Sea Islander Way, Maroochydore	509170	7051260	9	20	0 – 27
R6	Future residential - 20 South Sea Islander Way, Maroochydore	509163	7051220	15	15	0 – 45
R7	50 Maud St, Maroochydore	509226	7051200	2	10	0 – 6
R8	52 Maud St, Maroochydore	509228	7051180	3	15	0 – 9
C1	40 Maud St, Maroochydore	509243	7051300	3	35	0 – 9
C2	35 Maud St, Maroochydore	509293	7051290	2	70	0 – 6
C3	44 Maud St, Maroochydore	509232	7051240	3	10	0 – 9
C4	66 Maud St, Maroochydore	509204	7051020	1	125	0 – 3

Notes:

a. Current vacant lot – building heights assumed based on 15 storey and 60m height restrictions stipulated in the Maroochydore City Centre PDA Development Scheme.

Figure 8 – Sensitive receivers assessed

5. Methodology

This Chapter outlines the methodology used to undertake the assessment of potential impacts of the proposal on air quality.

5.1 Study Area

The study area for the air quality assessment extends approximately 1km from the proposal site in all directions. The assessment has focussed on those modelled discrete sensitive receivers closest to the proposal site, however a modelling domain of 1km x 1km 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 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 highly unlikely worst-case scenario (emergency scenario during power outage) where all four generators of the proposal are in operation at 100% load to provide back-up power generation under a full loss of mains power scenario.
- **Scenario 2**: Realistic operations during regular or routine maintenance testing of the proposal, where individual generator testing (one generator) is tested for 15 minutes at any given hour during the daytime (7am to 6pm), as described in Section 3.1.2. The generator(s) routine maintenance testing will be managed by NEXTDC such that it would be tested at 50% load or less.

5.3 Dispersion Modelling

5.3.1 Model Overview/Selection

The assessment of the operation of standby generator emissions from the proposal was undertaken using AERMOD to predict pollutant concentrations at nearby sensitive receivers, as well as over a larger grid domain. The QLD DES *Application requirements for activities with impacts to air* Guideline[5] notes that AERMOD has been widely used in Australia for use in a variety of regulatory applications[6]. It is also estimated to be the most widely used dispersion model internationally[7]. 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.

At the outset of the project, preliminary modelling was undertaken using both AERMOD and CALPUFF (another internationally recognised dispersion model that is widely used in Australia) of the proposal site. The benefit of CALPUFF is that this model generally assesses impacts in coastal locations more reasonably however more appropriate for predicting concentrations in the far-field (e.g. hundreds of metres from proposal sites). The benefit of AERMOD is the assessment of impact impacts within the near-field (e.g. close proximity to proposal sites better). Given the location of high-rise sensitive receivers within very close proximity to the elevated sources at the proposal site, model outputs from AERMOD provided more reasonable results (e.g. at the expected order of magnitude) at the nearby receivers in comparison to CALPUFF. Therefore, AERMOD was selected as the most appropriate model to use for this assessment.

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[5] Queensland Government, 2024. *Application requirements for activities with impacts to air*. ESR/2015/1840. Version 5.03. Department of Environment, Science and Innovation.

[6] 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.

[7] 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.

The dispersion modelling assessment 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 2021 – 31st December 2021 (refer to Section 4.1).

Table 5 – General inputs for AERMOD dispersion modelling

Parameter	Input
Meteorological Data	Year 2021
Terrain topography	Obtained using Shuttle Radar Topography Mission (SRTM3/SRTM1) data from AERMAP at a range of 30 metres.
Grid Domain Size	1 km x 1 km
Grid Spacing	5m

5.3.2 Model Extent

The model was run for a grid (1 km x 1 km) with 5 m spacing, at an elevated level of the most impacted receiver height. This covers all potentially impacted nearby sensitive land uses. The extent of the model is shown in Figure 9.

Figure 9 – Model extent

5.3.3 Terrain Effects

The proposal site is relatively flat and the gradient is slightly steeper to the south of the site, ranging from 3 m to 4 m above mean sea level.

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 10. Figure 10 shows the location of Buderim hill in relation to the proposal site.

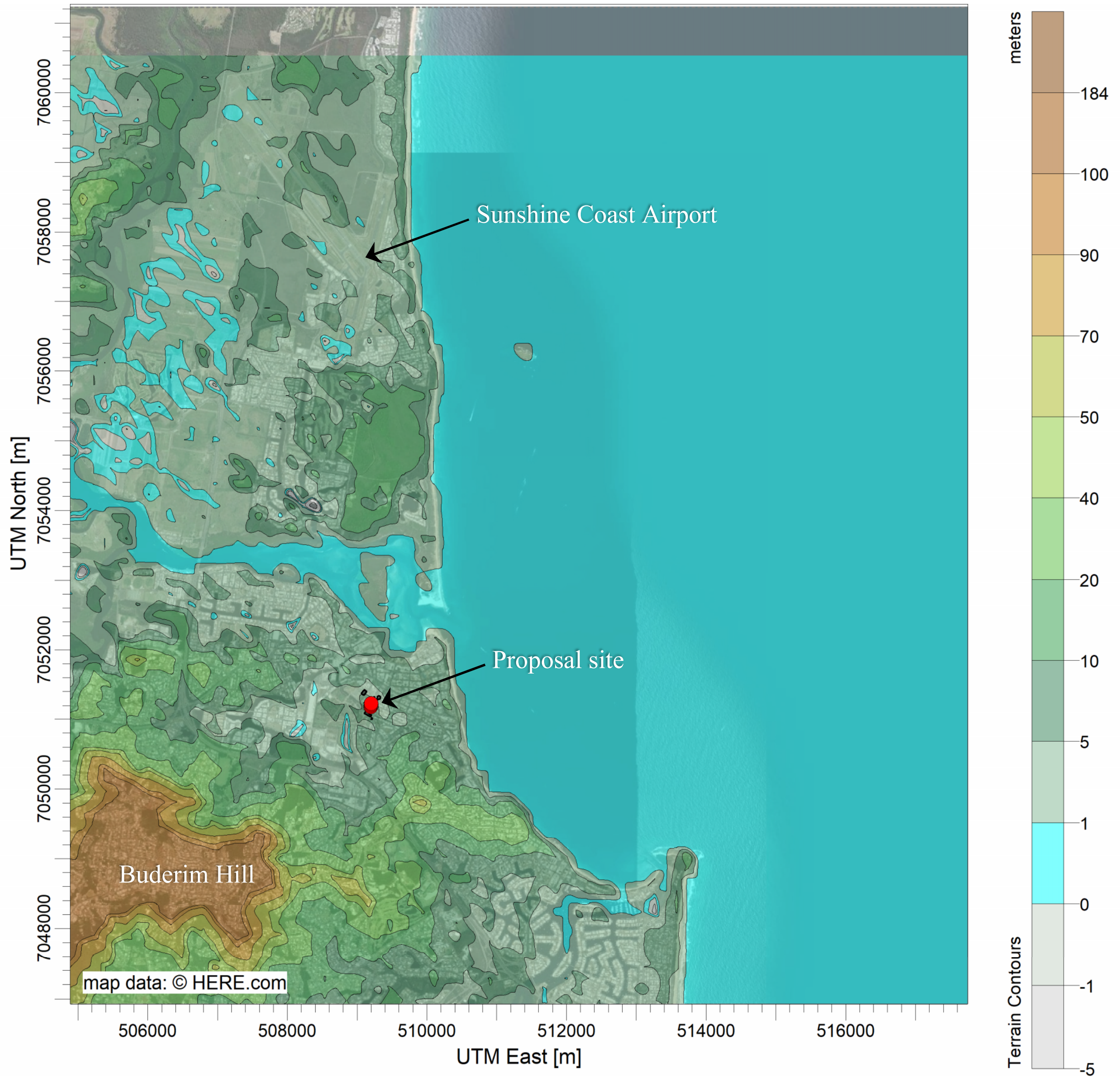

Figure 10 – Modelled topography

5.3.4 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. Typically, "*A point source is deemed to be wake affected if the stack height is less than or equal to 2.5 times the height of the building located within a distance of 5L from each release point (where L is the lesser of the height or width of the building).*"

For the operational phase (generator emissions) assessment, the data centre building have a height of 26 m above ground, including any roof-top mechanical plant, equipment and screening.

The generators are proposed to be located on the roof-top, with stack discharge height at 27 m above ground. AERMOD takes into consideration the ground terrain profile of the proposal site (refer to Section 5.3.3), and hence the actual stacks and building heights above sea levels vary depending on the ground profile.

Based on the above, 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 taken into consideration in the model. The surrounding building heights have been identified based on visual desktop inspection (Google©), as well as planning information, with 4 m floor-to-floor height assumed. Current vacant lot receivers subject to future high-rise buildings (e.g. R1 & R4), artificial buildings have also been included in the model. The identified surrounding building heights are shown in Figure 11 in 3-D view.

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.

Figure 11 – Modelled surrounding buildings

5.3.5 Modelled Discrete Receivers

The assessed discrete sensitive receivers have been modelled along the most exposed receiving building facades, in relation to the source's orientation. Each discrete location includes receiver points at individual floors, with 4m floor-to-floor height assumed. This is aimed to capture the potential air quality impact at elevated receivers, which is expected to be greater than at ground level, due to the elevated stack sources.

The modelled discrete receivers are shown in Figure 12 below, with a total of 342 discrete receiver points modelled.

Figure 12 – Modelled discrete sensitive receivers

5.3.6 Generator Stack Parameters and Emission Inventory

Modelled stack parameters were developed for this assessment using information provided by the Client for the generator equipment selection. The proposed manufacturer's specification datasheet is provided in Appendix A, which provides the emissions for particulate matter, NO_x, CO and hydrocarbon. The emission inventory for SO_2 was estimated with reference to the National Pollutant Inventory (NPI) 2008, in the absence of project specific information. Stack parameters and emission inventory are shown in Table 6 and Figure 13.

Table 6 –Standby generator stack design parameters and emission inventory

Stack Parameter	SC2 Generators			
	100% Load	75% load	50% Load	25% Load
Number of generators	4 x generators			
Height above ground (m)	27			
Exit internal diameter (mm)	400			
Actual discharge rates (m^3/s)	6.6			
Exit temperature (ºC)	490			
Calculated exit velocity (m/s)	52.5			
CO emission (g/s)	0.49	0.20	0.26	0.33
SO_2 emission (g/s) [a]	0.06	0.04	0.03	0.01
NO_x emission (g/s)	8.01	7.07	3.74	1.72
PM emission (PM_{10} and $PM_{2.5}$) (g/s)	0.033	0.046	0.062	0.092
Fuel consumption (L/hr)[b]	501.4	375.2	262.9	119.2
Stack location coordinates (X, Y)	509195, 7051184 509197, 7051198 509200, 7051212 509202, 7051229			

Note:

a. Emission values were estimated with reference from Table 43 of the National Pollutant Inventory (NPI 2008) [8]

b. The fuel consumption at 25% generator loads were based on the fuel consumption ratios at 100%, 75% and 50% loads, in the absence of generator specific information.

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

Figure 13 – Stack locations

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)[9] 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.

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 (NO), and this converts to NO_2 in the atmosphere. The EPP (Air) air quality objectives 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 Ozone Limiting Method (OLM).

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

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

evaluate the accuracy of the OLM method, and show that OLM has a tendency to overpredict the NO_2/NO_x ratios[10],[11], which adds a level of conservatism to the assessment.

The OLM equation for calculating NO_2 is provided below:

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

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[12]. On this basis, the simplified OLM equation is:

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

The ozone background concentration used in the OLM method is taken from Table 3.

5.4 Background Air Quality Data

The highest 70th percentile background air quality data shown in Section 4.2 have been adopted for this assessment. Although, the data capture for 2021 was above 75% for each of these pollutants, there were periods of missing data that need to be accounted for.

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).

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

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

[12] 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 Impacts

6.1 Scenario 1 – Highly Unlikely Worst-Case (Power Failure) Scenario

This section addresses the potential air quality impact from a highly unlikely scenario where all generators would run simultaneously (peak emissions) to provide the full back up power required. As discussed in Section 3.1.1, this scenario has a very low likelihood of occurring and would only happen if both the primary and secondary power supplies failed.

6.1.1 Nitrogen Dioxide

The highest 1-hour average concentrations for NO_2 have been predicted at each of the assessed discrete sensitive receivers at both ground level and elevated floors (where applicable). The summarised predicted results are shown in Table 7, which indicate that the cumulative NO_2 concentrations (i.e. inclusive of background concentrations) are predicted to exceed the air quality objective at some of the assessed receivers, with the highest concentration predicted at receiver ID R6 (the future residential apartment 20 South Sea Islander Way, Maroochydore) at level 14, by up to10 fold. The concentrations shown in Table 7 represent the highest possible concentrations during loss of mains power, with all generators operating and coinciding with worst-case meteorological conditions, which provides conservatism in the assessment.

Table 7 – Predicted highest 99.9th percentile1-Hour Nitrogen Dioxide (NO_2) Concentrations (Scenario 1)

Receiver ID	Floor Level	Highest 1-Hour NO_2 Concentration (µg/m^3)			Comply
		Incremental	Cumulative	Criteria	
R1	14	660.2	667.9	164	No
R2	1	121.9	129.6		Yes
R3	15	382.2	389.9		No
R4	12	1058.0	1065.7		No
R5	8	374.9	382.6		No
R6	14	1629.4	1637.1		No
R7	1	248.7	256.4		No
R8	1	171.3	179.0		No
C1	1	183.7	191.4		No
C2	1	141.9	149.6		Yes
C3	1	292.3	300.0		No
C4	GF	283.9	291.6		No

Ground-level concentrations have been assessed across the modelling domain. The predicted maximum ground-level concentration (GLC) is 381 µg/m^3, which is significantly lower than that predicted at the elevated levels shown in Table 7.

The contour plots showing the highest predicted pollutant concentrations for Scenario 1, which occur at elevated floors of nearby receivers, are provided in Appendix B. In contrast, Appendix C presents the predicted ground-level concentrations. It can be observed that the area of exceedance is less widespread at ground level compared to the elevated levels. This is expected as the stack sources are located at higher elevation, which promotes greater dispersion of the plume at it descends to ground level.

The likelihood of this scenario occurring is expected to be extremely rare at the proposal site, as the failure rates for a high reliability utility arrangement at the proposal site are expected to be significantly low. Therefore, despite the potential for predicted exceedances of the NO_2 1-hour average air quality objective at the assessed receivers during operation of all standby generators concurrently, it is highly unlikely that this worst-case scenario would occur in a typical year. If it did occur, the standby generators are likely to only operate for far less than 0.02% of the year due to power outages, based on Energex historical data (refer to Section 3.1.1). Therefore, the air quality risks are considered to be very low for Scenario 1.

In-principle mitigation measures have been discussed in Section 7 to assist in minimising the need for standby generators to operate and therefore reducing the impact from NO_x emissions.

6.1.2 Particulate Matter

The highest 100th percentile 24-hour average concentrations for PM_{10} and $PM_{2.5}$ have been predicted at each of the assessed discrete sensitive receivers, which are shown in Table 8.

The results show that the cumulative PM_{10} and $PM_{2.5}$ concentrations (i.e. inclusive of background concentrations) are predicted to generally be below the air quality objectives, except at some of the assessed elevated receivers at R6 and R4. The highest predicted PM_{10} and $PM_{2.5}$ concentrations are 82 µg/m^3 and 71 µg/m^3 respectively at level 9 of R6 receiver.

Table 8 – Predicted highest 100th percentile 24-hour PM_{10} and $PM_{2.5}$ concentrations (Scenario 1)

Receiver ID	Floor Level	Highest 24-Hour Particulate Matter Concentrations (µg/m^3)						
		$PM_{10}/PM_{2.5}$	PM_{10}		Comply	$PM_{2.5}$		Comply
		Incremental	Cumulative	Criteria		Cumulative	Criteria	
R1	14	10.6	28.3	50	Yes	17.0	20	Yes
R2	1	2.8	20.5		Yes	9.2		Yes
R3	15	7.7	25.4		Yes	14.1		Yes
R4	11	28.0	45.7		Yes	34.4		**No**
R5	8	17.0	34.7		Yes	23.4		Yes
R6	9	64.7	82.4		**No**	71.1		**No**
R7	1	7.4	25.1		Yes	13.8		Yes
R8	1	6.0	23.7		Yes	12.4		Yes
C1	1	8.8	26.5		Yes	15.2		Yes
C2	1	5.3	23.0		Yes	11.7		Yes
C3	2	11.2	28.9		Yes	17.6		Yes
C4	GF	7.5	25.2		Yes	13.9		Yes

Ground-level concentrations have been assessed across the modelling domain. The predicted PM_{10} and $PM_{2.5}$ maximum GLCs are 44.7 µg/m^3 and 33.4 µg/m^3 respectively, which is significantly lower than that predicted at the elevated levels shown in Table 8.

The contour plots showing the highest predicted pollutant concentrations for Scenario 1, which occur at elevated floors of nearby receivers, are provided in Appendix B. In contrast, Appendix C presents the predicted ground-level concentrations. As previously discussed in Section 6.1.1, it can be observed that the area of exceedance is less widespread at ground level compared to the elevated levels.

Based on the grid reliability information presented in Section 3.1.1, it is highly unlikely that standby generators would need to operate for a continuous 24-hour period in an event of loss of mains power scenario. Further, the concentrations shown in Table 8 represent the highest possible concentrations during a loss of mains power, with all generators operating and coinciding with worst-case meteorological conditions, which provides conservatism in the assessment. Therefore, these predicted exceedances are extremely unlikely to occur in reality.

6.1.3 All other pollutants

The predicted highest concentrations for all other assessed pollutants (CO and SO_2) are summarised in Table 9 to Table 11. The results show that all predicted concentrations are well below the relevant air quality objectives at the assessed sensitive receivers, at both ground as well as elevated levels.

Table 9 – Predicted highest 100th percentile concentrations for 8-hour CO (Scenario 1)

Receiver ID	Floor Level	Highest 8-Hour CO Concentration (µg/m³)			Comply
		Incremental	Cumulative	Criteria	
R1	14	152.6	356.3	11,000	Yes
R2	1	23.5	227.2		Yes
R3	15	108.7	312.4		Yes
R4	11	337.0	540.7		Yes
R5	8	124.4	328.1		Yes
R6	10	515.9	719.6		Yes
R7	1	82.2	285.9		Yes
R8	1	58.0	261.7		Yes
C1	1	73.2	276.9		Yes
C2	1	50.5	254.2		Yes
C3	2	100.8	304.5		Yes
C4	GF	71.7	275.4		Yes

Table 10 – Predicted highest 100th percentile concentrations for 24-hour SO_2 (Scenario 1)

Receiver ID	Floor Level	Highest 24-Hour SO_2 Concentration (µg/m³)			Comply
		Incremental	Cumulative	Criteria	
R1	14	6.6	11.9	57	Yes
R2	1	1.7	7.0		Yes
R3	15	4.8	10.1		Yes
R4	11	17.3	22.6		Yes
R5	8	10.6	15.9		Yes
R6	9	40.1	45.4		Yes
R7	1	4.6	9.9		Yes
R8	1	3.7	9.0		Yes
C1	1	5.4	10.7		Yes
C2	1	3.3	8.6		Yes
C3	2	7.0	12.3		Yes
C4	GF	4.6	9.9		Yes

Table 11 – Predicted highest 99.9th percentile 1-hour concentrations for SO_2 (Scenario 1)

Receiver ID	Floor Level	Highest 1-Hour SO_2 Concentration (µg/m^3)			Comply
		Incremental	Cumulative	Criteria	
R1	14	43.7	49.0	214	Yes
R2	1	5.4	10.7		Yes
R3	15	23.9	29.2		Yes
R4	12	72.0	77.3		Yes
R5	8	23.4	28.7		Yes
R6	14	112.7	118.0		Yes
R7	1	14.4	19.7		Yes
R8	2	8.9	14.2		Yes
C1	1	9.8	15.1		Yes
C2	1	6.8	12.1		Yes
C3	GF	17.5	22.8		Yes
C4	GF	16.9	22.2		Yes

6.2 Scenario 2 – Maintenance Routine

The four 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 discussed in Section 3.1.2. For the proposed site, it is anticipated that a maximum of one generator would be tested for a 15 minute period in any given hour during the daytime, under 50% (or less) load condition. It is understood that the generators associated with the existing SC1 datacentre will not be tested at the same time as the proposed SC2 generators.

The emission rates for relevant pollutants under different loads are presented in Section 5.3.6, Table 6. Based on the available emission data, the engine load (50% load or below) with the worst emission rates have been adopted in this assessment, which are:

- NO_2 and SO_2 at 50% load
- CO and particulate matter at 25% load.

The contour plots showing the highest predicted pollutant concentrations for Scenario 2, which occur at elevated floors of nearby receivers, are provided in Appendix D.

6.2.1 Nitrogen Dioxide

The highest 1-hour average NO_2 concentrations under routine maintenance of one generator (the worst case concentrations across all generator stacks are reported) at each of the assessed sensitive receivers (both at ground as well as elevated floor levels) have been predicted, and are shown in Table 12.

The results show the cumulative NO_2 concentrations (i.e. inclusive of background concentrations) are all predicted to be below the air quality objective, with the highest predicted concentration of 154.5 µg/m^3 at receiver ID R6 (future development – 20 South Sea Islander Way, Maroochydore). This indicates that predicted 1-hour NO_2 concentrations at nearby sensitive receivers meet the relevant air quality objective under the routine maintenance scenario.

Table 12 - Predicted highest 99.9th percentile 1-hour NO_2 concentrations (Scenario 2)

Receiver ID	Floor Level	Highest 1-Hour NO_2 Concentration (µg/m³)			Comply
		Incremental	Cumulative	Criteria	
R1	12	73.8	81.5	164	Yes
R2	1	18.2	25.9		Yes
R3	14	27.6	35.3		Yes
R4	0	55.5	63.2		Yes
R5	8	57.3	65.0		Yes
R6	10	146.8	154.5		Yes
R7	1	38.8	46.5		Yes
R8	1	39.6	47.3		Yes
C1	1	53.1	60.8		Yes
C2	1	36.3	44.0		Yes
C3	2	46.7	54.4		Yes
C4	GF	43.3	51.0		Yes

6.2.2 Particulate Matter

The highest 100th percentile 24-hour average concentrations for PM_{10} and $PM_{2.5}$ under routine maintenance have been predicted at each of the assessed sensitive receivers, which are shown in Table 13.

The results show the cumulative PM_{10} and $PM_{2.5}$ concentrations (i.e. inclusive of background concentrations) are all predicted to be below the air quality objectives, with the highest predicted PM_{10} and $PM_{2.5}$ concentrations of 23.6 µg/m³ and 12.3 µg/m³ respectively at receivers ID R6 (future development – 20 South Sea Islander Way, Maroochydore). This indicates that predicted 24-hour particulate matter concentrations at nearby sensitive receivers meet the air quality objectives under the routine maintenance scenario.

Table 13 – Predicted highest 100th percentile 24-hour PM_{10} and $PM_{2.5}$ concentrations (Scenario 2)

Receiver ID	Floor Level	24-Hour Highest Level Concentrations (µg/m³)						
		PM_{10}/$PM_{2.5}$	PM_{10}		Comply	$PM_{2.5}$		Comply
		Incremental	Cumulative	Criteria		Cumulative	Criteria	
R1	14	0.7	18.4	50	Yes	7.1	20	Yes
R2	1	0.1	17.8		Yes	6.5		Yes
R3	1	0.3	18.0		Yes	6.7		Yes
R4	11	1.3	19.0		Yes	7.7		Yes
R5	8	1.9	19.6		Yes	8.3		Yes
R6	9	5.9	23.6		Yes	12.3		Yes
R7	1	0.5	18.2		Yes	6.9		Yes
R8	1	0.2	17.9		Yes	6.6		Yes
C1	1	0.6	18.3		Yes	7.0		Yes
C2	1	0.4	18.1		Yes	6.8		Yes
C3	2	0.7	18.4		Yes	7.1		Yes
C4	GF	0.4	18.1		Yes	6.8		Yes

6.2.3 All other pollutants

The predicted highest 100th percentile concentrations for all other assessed pollutants (CO and SO_2) are summarised in Table 14 to Table 16. The predicted results show that the cumulative concentrations (inclusive of background concentrations) for all assessed pollutants are below the air quality objectives under all routine maintenance conditions and are therefore acceptable.

Table 14 – Predicted highest 100th percentile concentrations for 8-hour CO (Scenario 2)

Receiver ID	Floor Level	Highest 8-Hour CO Concentration (µg/m³)			Comply
		Incremental	Cumulative	Criteria	
R1	14	10.0	213.7	11,000	Yes
R2	1	1.7	205.4		Yes
R3	1	3.3	207.0		Yes
R4	10	18.6	222.3		Yes
R5	8	24.8	228.5		Yes
R6	9	65.9	269.6		Yes
R7	1	5.5	209.2		Yes
R8	1	2.5	206.2		Yes
C1	1	7.8	211.5		Yes
C2	1	4.8	208.5		Yes
C3	2	8.8	212.5		Yes
C4	GF	6.8	210.5		Yes

Table 15 – Predicted highest 100th percentile concentrations for 24-hour SO_2 (Scenario 2)

Receiver ID	Floor Level	Highest 24-Hour SO_2 Concentration (µg/m³)			Comply
		Incremental	Cumulative	Criteria	
R1	14	0.4	5.7	57	Yes
R2	1	0.1	5.4		Yes
R3	14	0.2	5.5		Yes
R4	10	0.8	6.1		Yes
R5	8	1.2	6.5		Yes
R6	9	3.7	9.0		Yes
R7	1	0.3	5.6		Yes
R8	1	0.1	5.4		Yes
C1	1	0.4	5.7		Yes
C2	1	0.2	5.5		Yes
C3	2	0.4	5.7		Yes
C4	GF	0.3	5.6		Yes

Table 16 – Predicted highest 99.9th percentile 1-hour concentrations for SO_2 (Scenario 2)

Receiver ID	Floor Level	Highest 1-Hour SO_2 Concentration (µg/m³)			Comply
		Incremental	Cumulative	Criteria	
R1	12	4.4	9.7	214	Yes
R2	1	0.4	5.7		Yes
R3	15	1.1	6.4		Yes
R4	13	4.2	9.5		Yes
R5	8	3.2	8.5		Yes
R6	10	15.9	21.2		Yes
R7	1	0.9	6.2		Yes
R8	1	0.8	6.1		Yes
C1	1	1.2	6.5		Yes
C2	1	0.8	6.1		Yes
C3	2	1.7	7.0		Yes
C4	GF	1.2	6.5		Yes

7. Mitigation and Management Measures

This section describes the measures to mitigate against, and manage any potential air quality impacts described in Section 6, with consideration to the QLD Guideline ESR/2015/1840.

7.1 Mitigation and management measures

In-principle mitigation or management measures below are recommended to assist in minimising any air quality impact from the proposal site.

- Maintenance should be undertaken as per the testing schedule in Section 3.1.2. Operation of standby generators during testing and maintenance should be minimised as far as practicable.
- Where possible, minimise back-to-back maintenance testing of generators.
- 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.

It is worth noting that measures included in the current design of the project also mitigate the need for the standby generators to operate to provide back-up power generation. The inclusion of these measures during the design phase meets the PDA-wide criteria for development to "*ensure the design, siting, and layout of development… address….. air quality and emission impacts, and where necessary incorporate mitigation measures".* These measures include:

  – The adoption of a high reliability utility power supply, which is more reliable than a conventional utility.
  – The adoption of dual redundant utility feeds to provide a secondary feed in the event of a primary power supply failure.
  – These should be maintained, or even optimised, during the late stages of project design.

Appendix A

Generator Specification

Product data: SD–NextDC B2, Stage 2B

Product data engine / cooler

Parameter	Value	UoM
Genset Model	16V4000 DS2500	
Engine	16V4000G84F	
Engine output kWb	2,185.00	kWb
Radiator	VR2350L1B30004	
Fan	170010-10P9TL38PAG @ 1.000 min-¹	
Fan Power	55.00	kWb
Radiator ambient design temperature	45.00	°C
Radiator air-to-core	52.00	°C
Net output	2,130.00	kWb

Fuel consumption at rated load

Parameter	Value	Value	Value
Load %	100%	75%	50%
Load kVA	2,500.00	1,875.00	1,250.00
Load kWe	2,000.00	1,500.00	1,000.00
Alternator η	96.12%	96.450%	96.490%
Load kWb	2,080.74	1,555.21	1,036.38
Fan loads kWb	55.00	55.00	55.00
Total Load kWb	2,135.74	1,610.21	1,091.38
Fuel consumption g/kWh	**194.84**	**193.40**	**200.00**
Fuel consumption L/H	**501.36**	**375.20**	**262.98**

Engine data

	Genset	Marine	O & G	Rail	C & I
Application	X				
Engine model	16V4000G84F				
Applicationgroup	3D				
Legislative body	Fuel-consumption optimized				
Test cycle	D2				
Fuel sulphur content [ppm]	5				
mg/mN³ values base on residual oxygen value of [%]	Measured				

Not to exceed emission values*

Cycle point	[-]	n1	n2	n3	n4	n5
Power	kW	2185	1639	1092	546	218
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	29.28	25.91	13.93	6.69	
NOX-Emissions specific	g/kWh	13.2	15.52	12.32	11.32	
CO-Emissions specific	g/kWh	0.8	0.43	0.87	2.18	
HC1-Emissions specific	g/kWh	0.2	0.29	0.43	0.93	
NOX+HC1-Emissions specific	g/kWh	13.4	15.81	12.75	12.25	
PM-Emissions specific (Meas.)	g/kWh	0.054	0.101	0.205	0.607	
NOX-Emissions (based on O2 meas)	mg/m3N	3823	4282	2826	1821	
NOX+HC1-Emissions (based on O2 meas)	mg/m3N	3879	4358	2920	1963	
CO-Emissions (based on O2 meas)	mg/m3N	221.2	114	189.2	334.9	
HC1-Emissions (based on O2 meas)	mg/m3N	56.6	75.8	94.4	141.8	
PM-Emissions (based on O2 meas)	mg/m3N	15.1	26.6	45	93.3	

Fuel Consumption

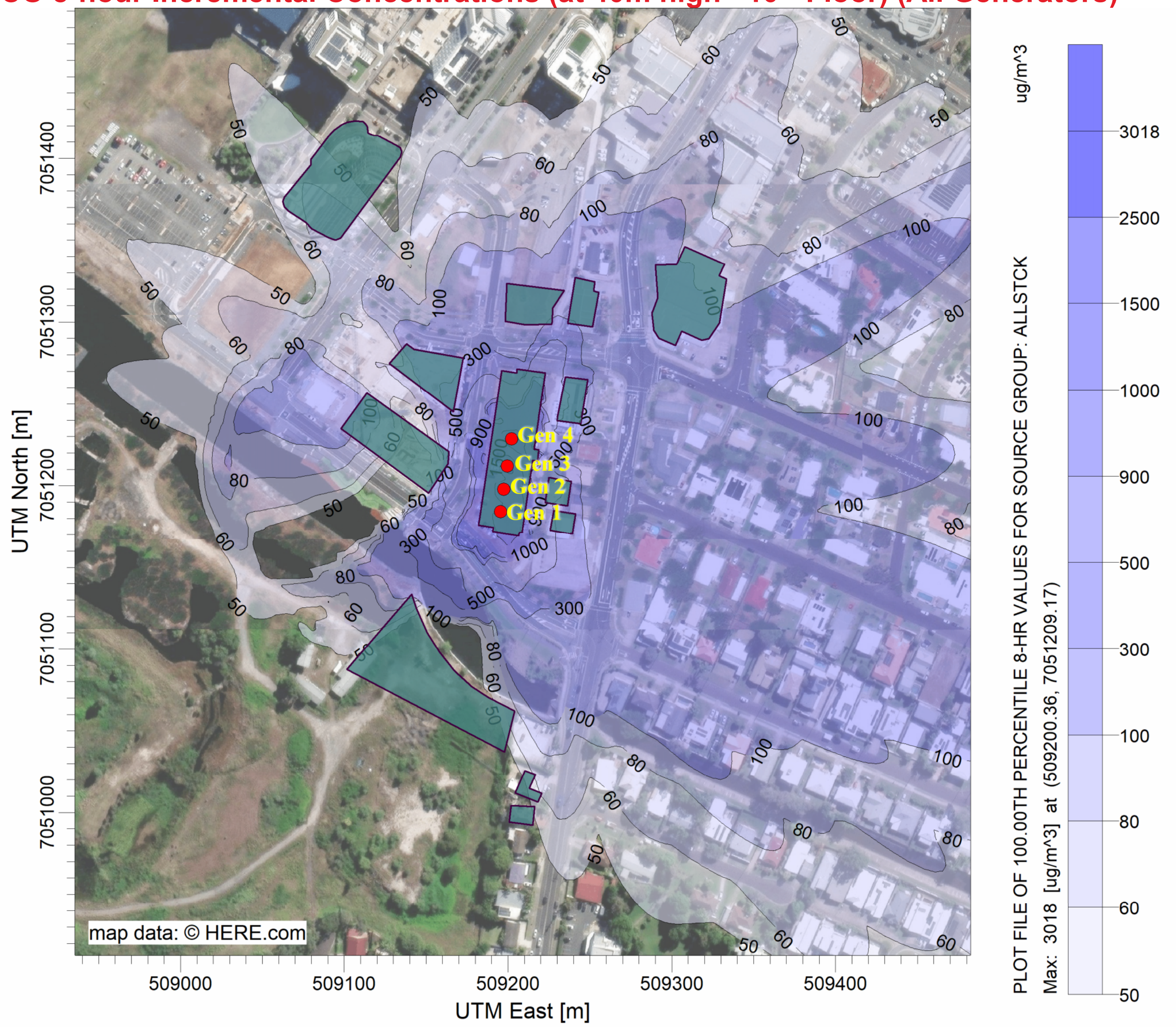
Fuel consumption at rated load

Parameter	Value	Value	Value
Load %	100%	75%	50%
Load kVA	2,500.00	1,875.00	1,250.00
Load kWe	2,000.00	1,500.00	1,000.00
Alternator η	96.12%	96.450%	96.490%
Load kWb	2,080.74	1,555.21	1,036.38
Fan loads kWb	55.00	55.00	55.00
Total Load kWb	2,135.74	1,610.21	1,091.38
Fuel consumption g/kWh	**194.84**	**193.40**	**200.00**
Fuel consumption L/H	**501.36**	**375.20**	**262.98**

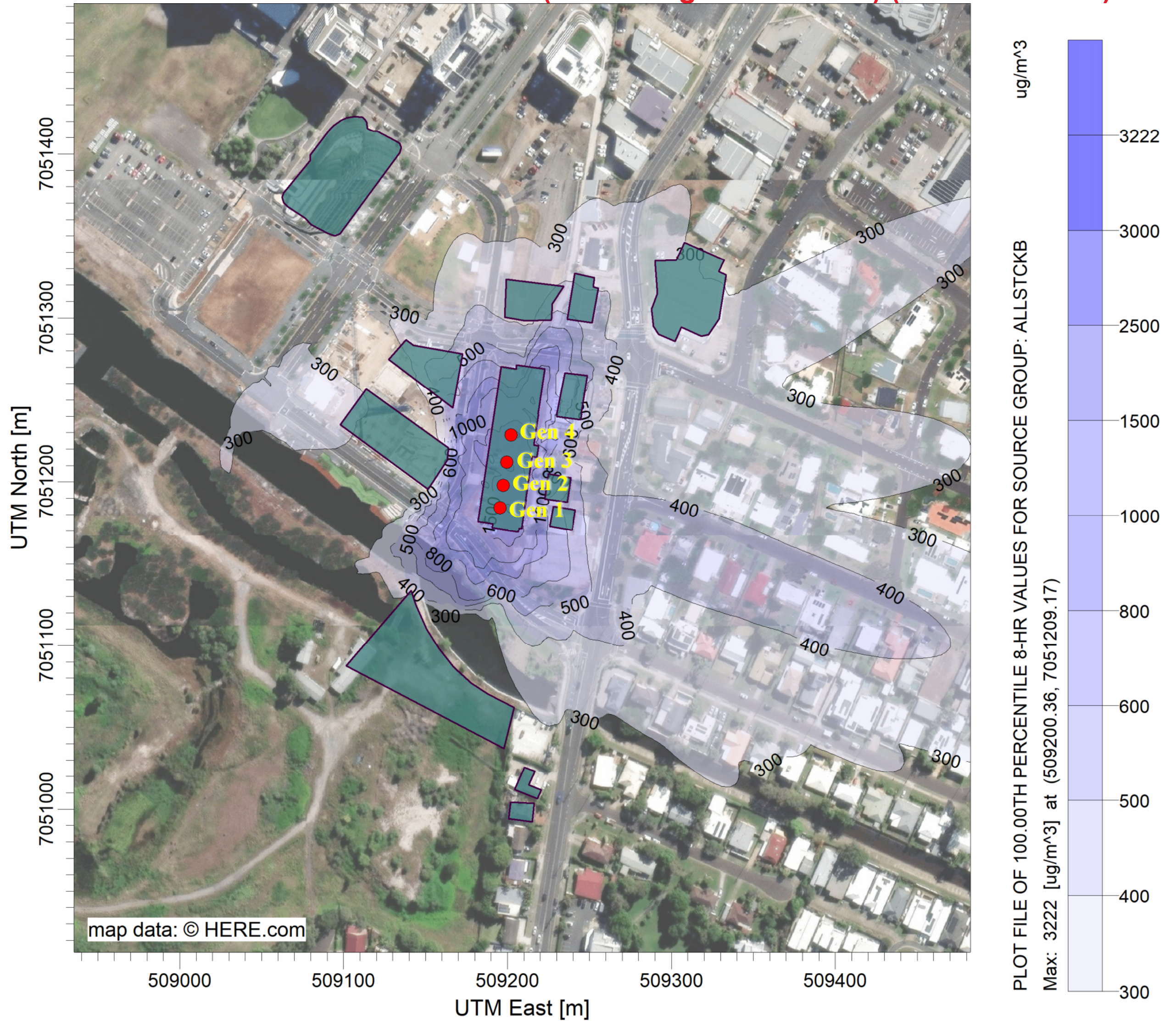
Appendix B

Predicted Concentrations at Elevation – Dispersion Modelling Contours (Scenario 1)

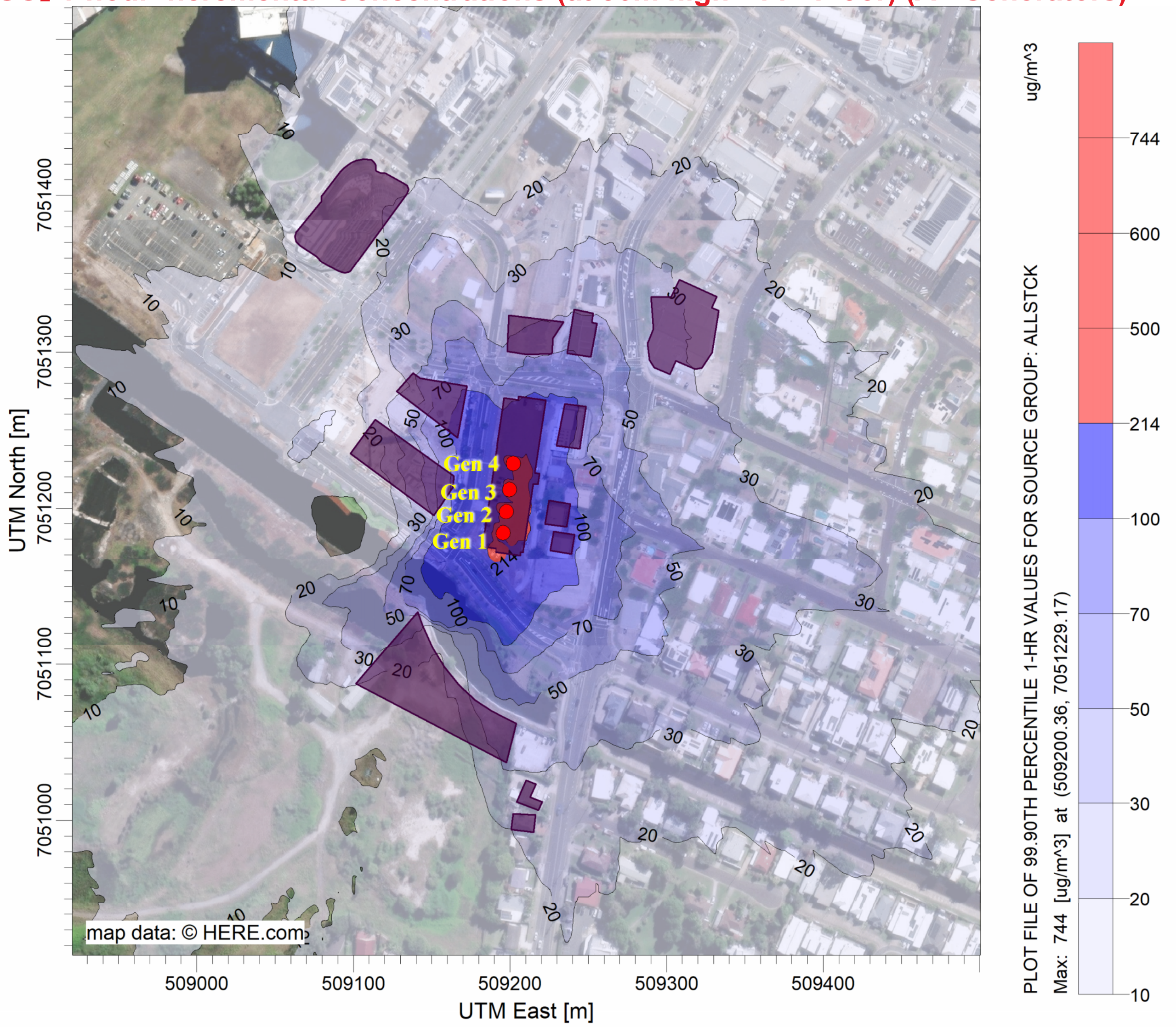
CO 8-hour Incremental Concentrations (at 40m high ~10th Floor) (All Generators)



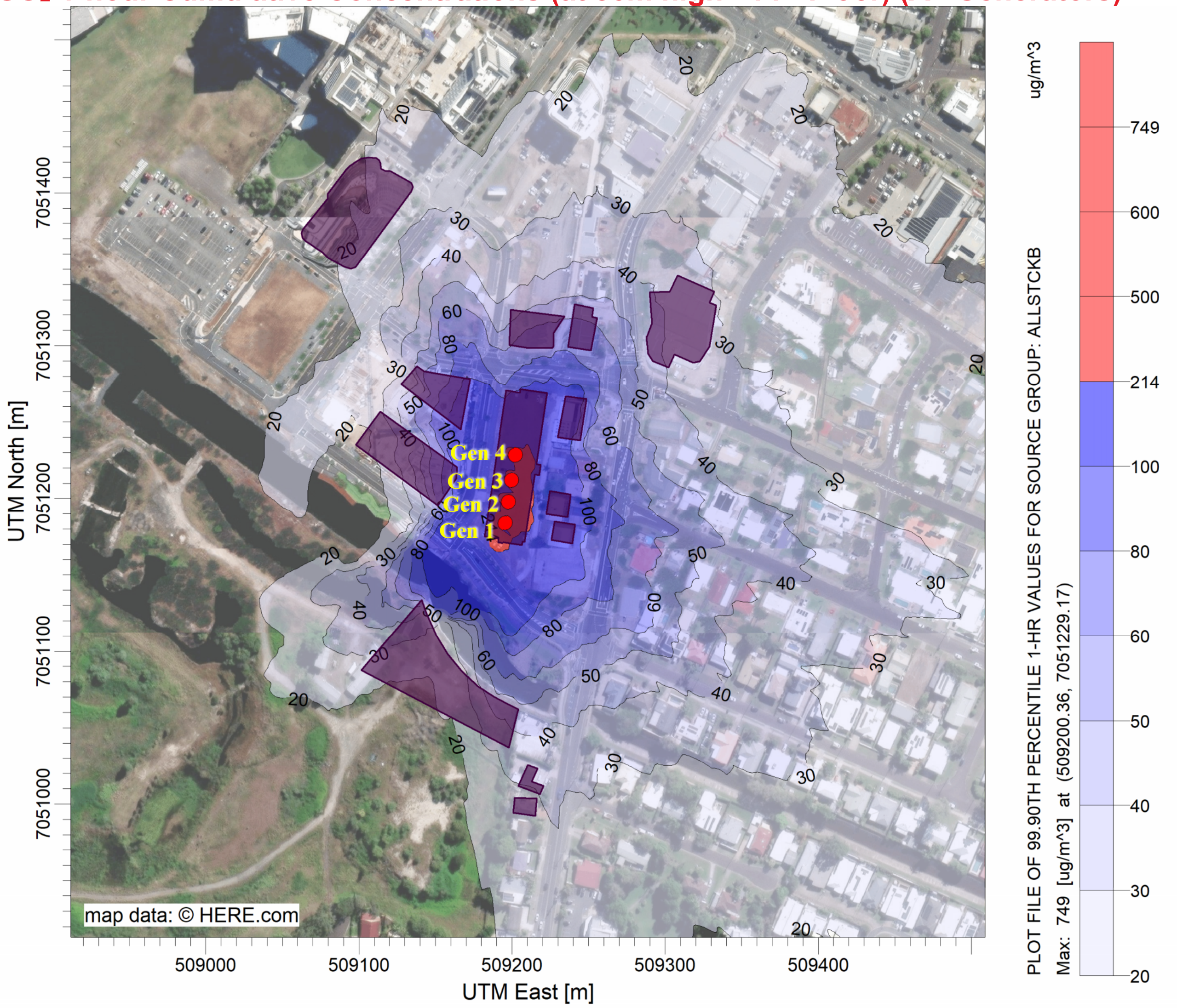
CO 8-hour Cumulative Concentrations (at 40m high ~10th Floor) (All Generators)



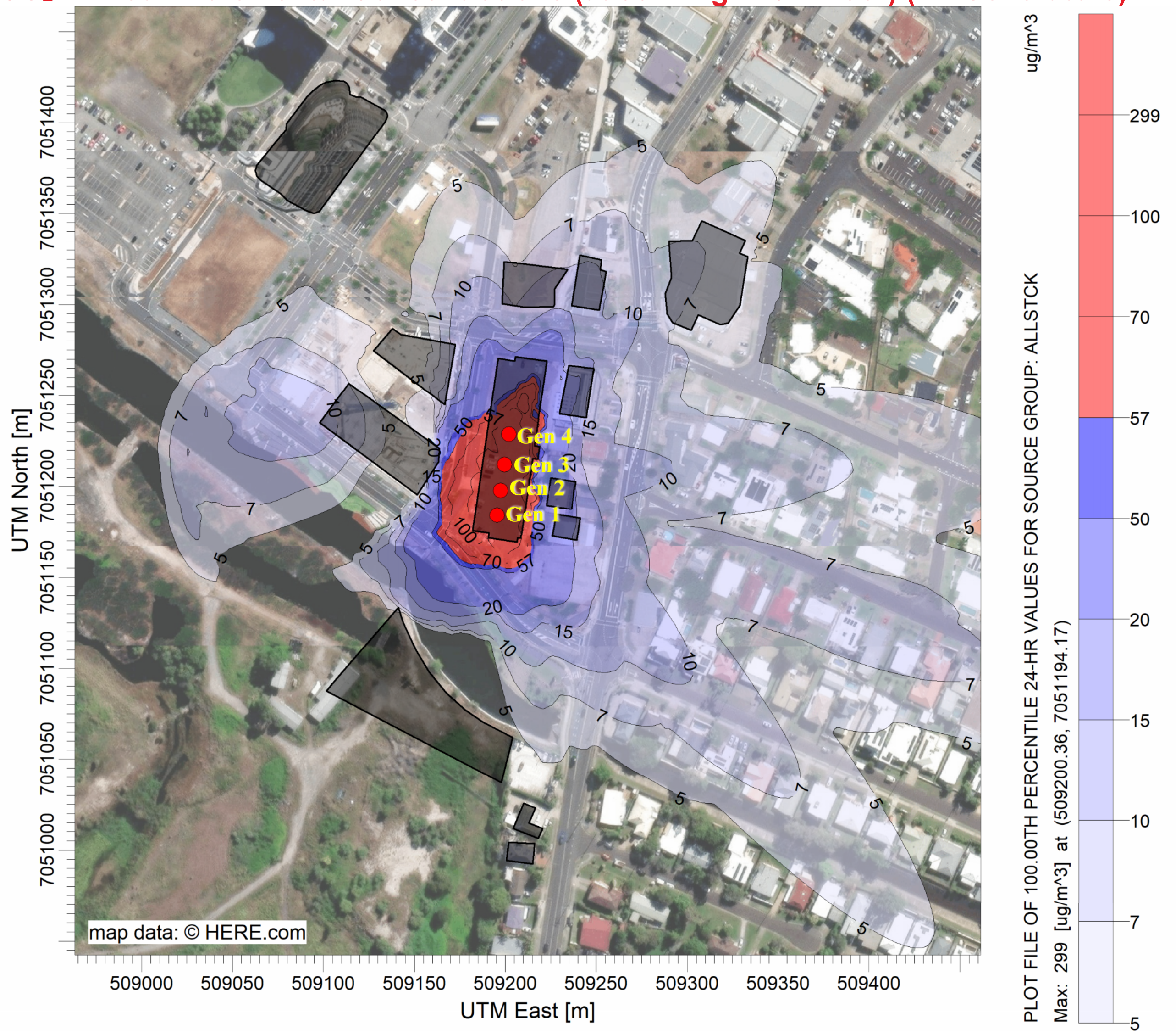
SO_2 1-hour Incremental Concentrations (at 56m high ~14th Floor) (All Generators)



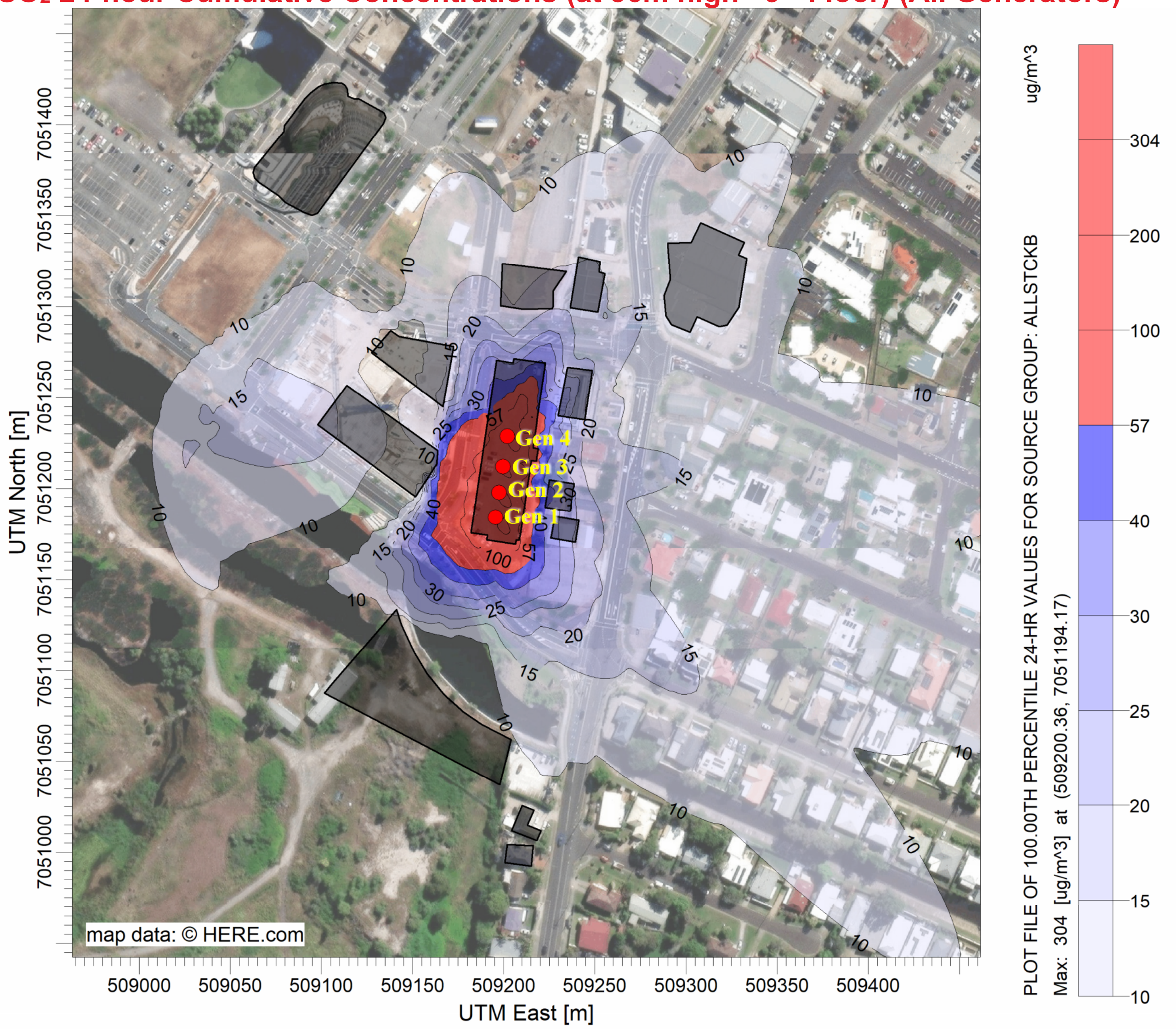
SO_2 1-hour Cumulative Concentrations (at 56m high ~14th Floor) (All Generators)



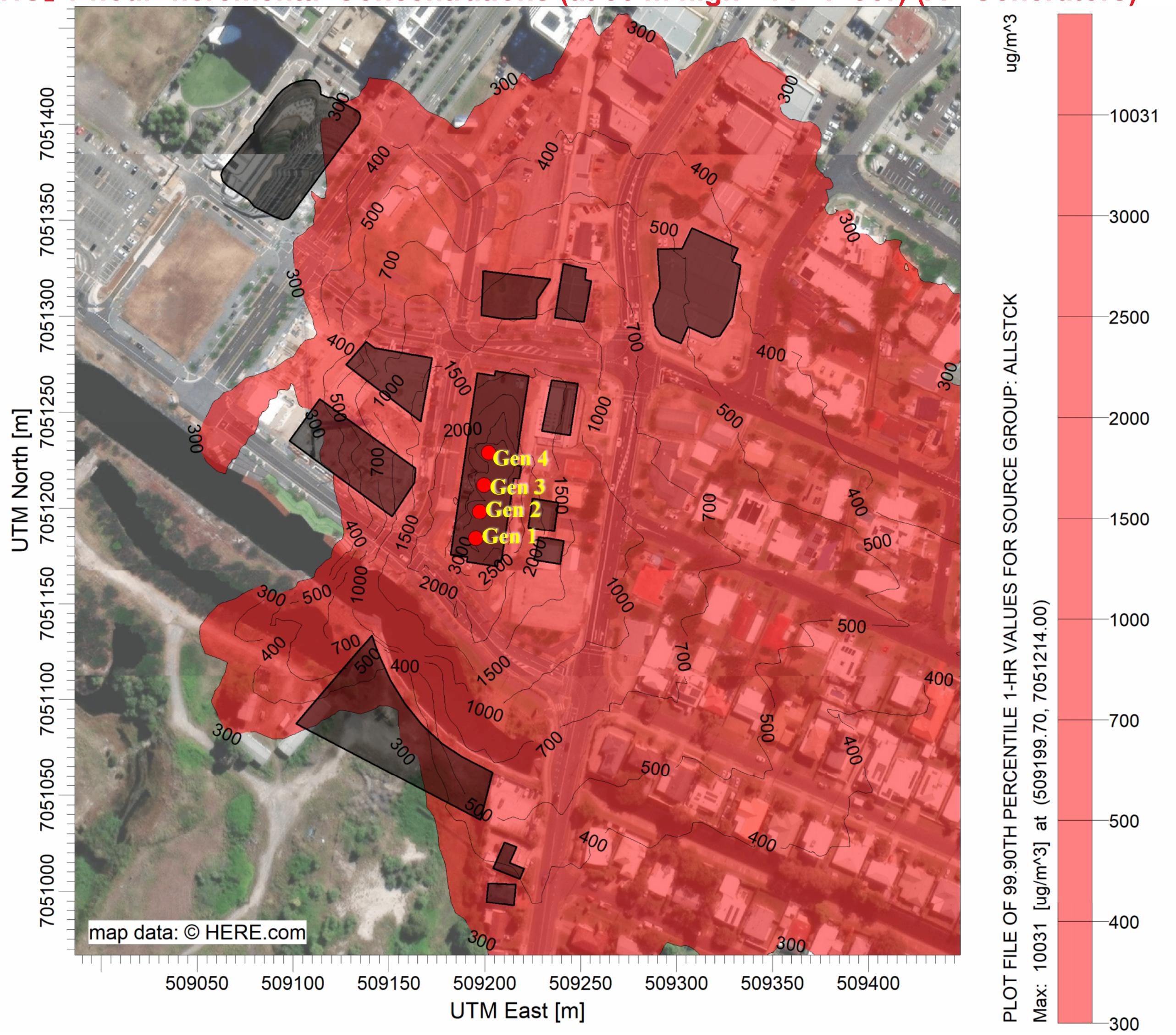
SO_2 24-hour Incremental Concentrations (at 36m high ~9th Floor) (All Generators)



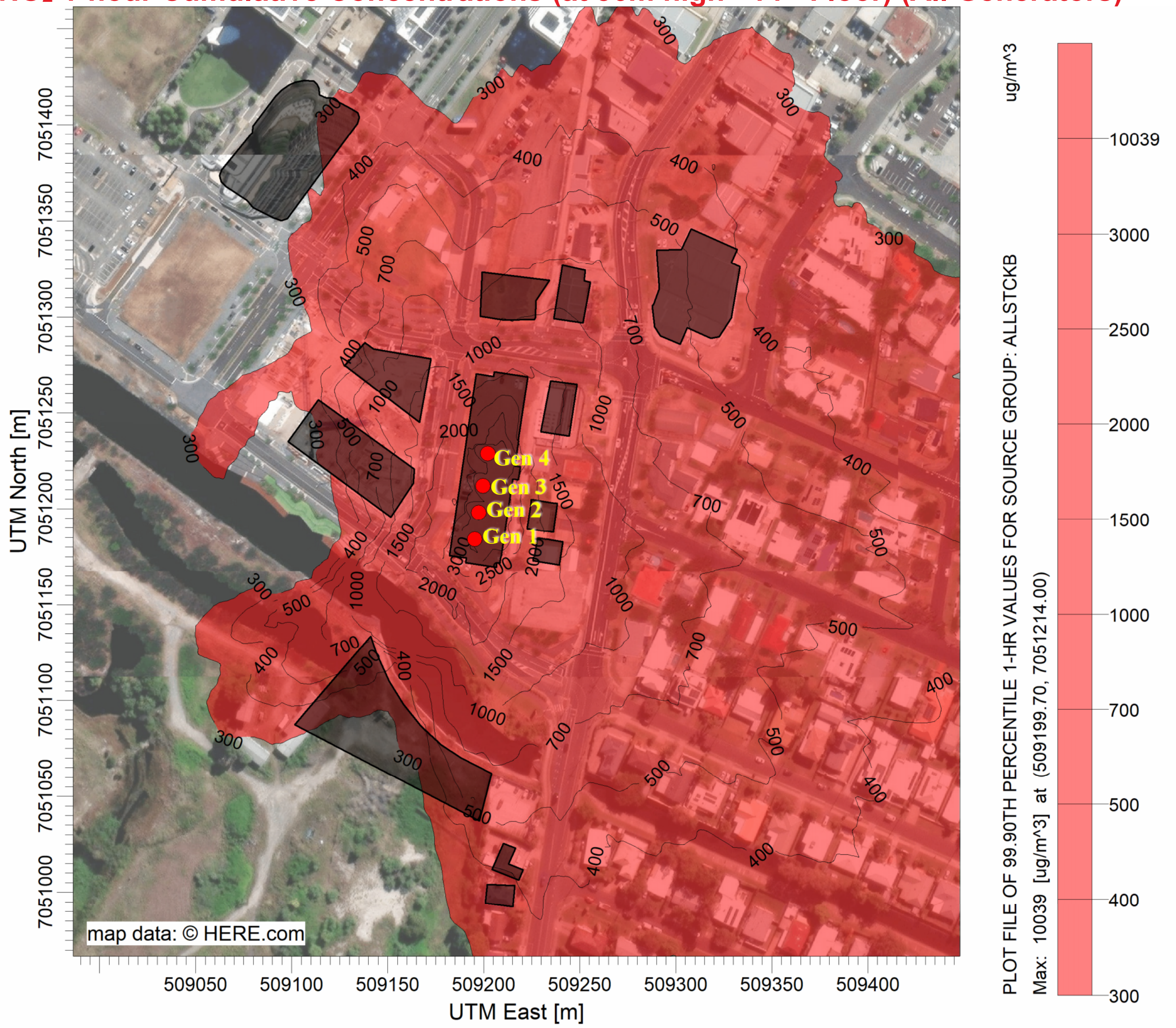
SO_2 24-hour Cumulative Concentrations (at 36m high ~9th Floor) (All Generators)



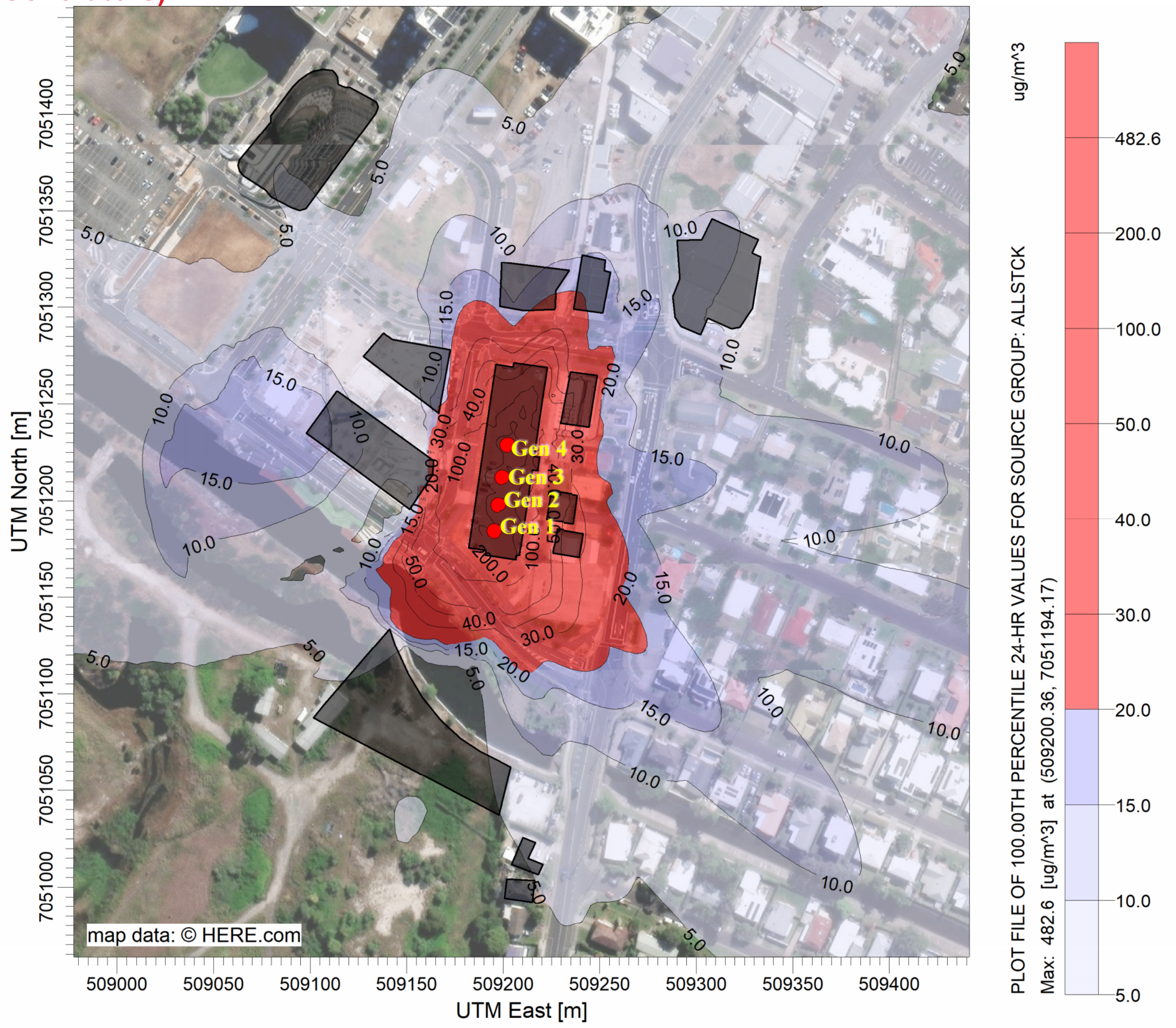
NO_2 1-hour Incremental Concentrations (at 56 m high ~14th Floor) (All Generators)



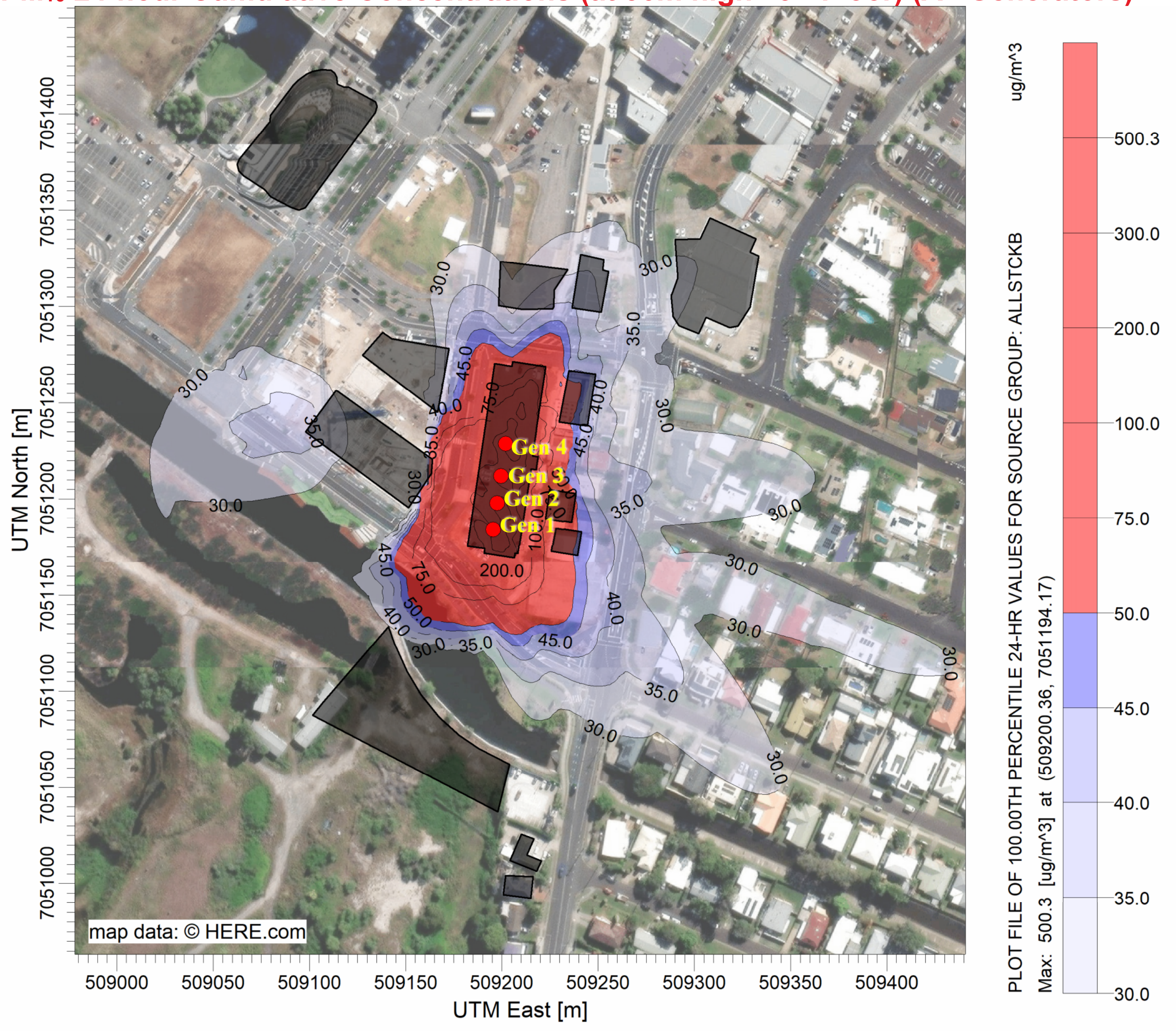
NO_2 1-hour Cumulative Concentrations (at 56m high ~14th Floor) (All Generators)



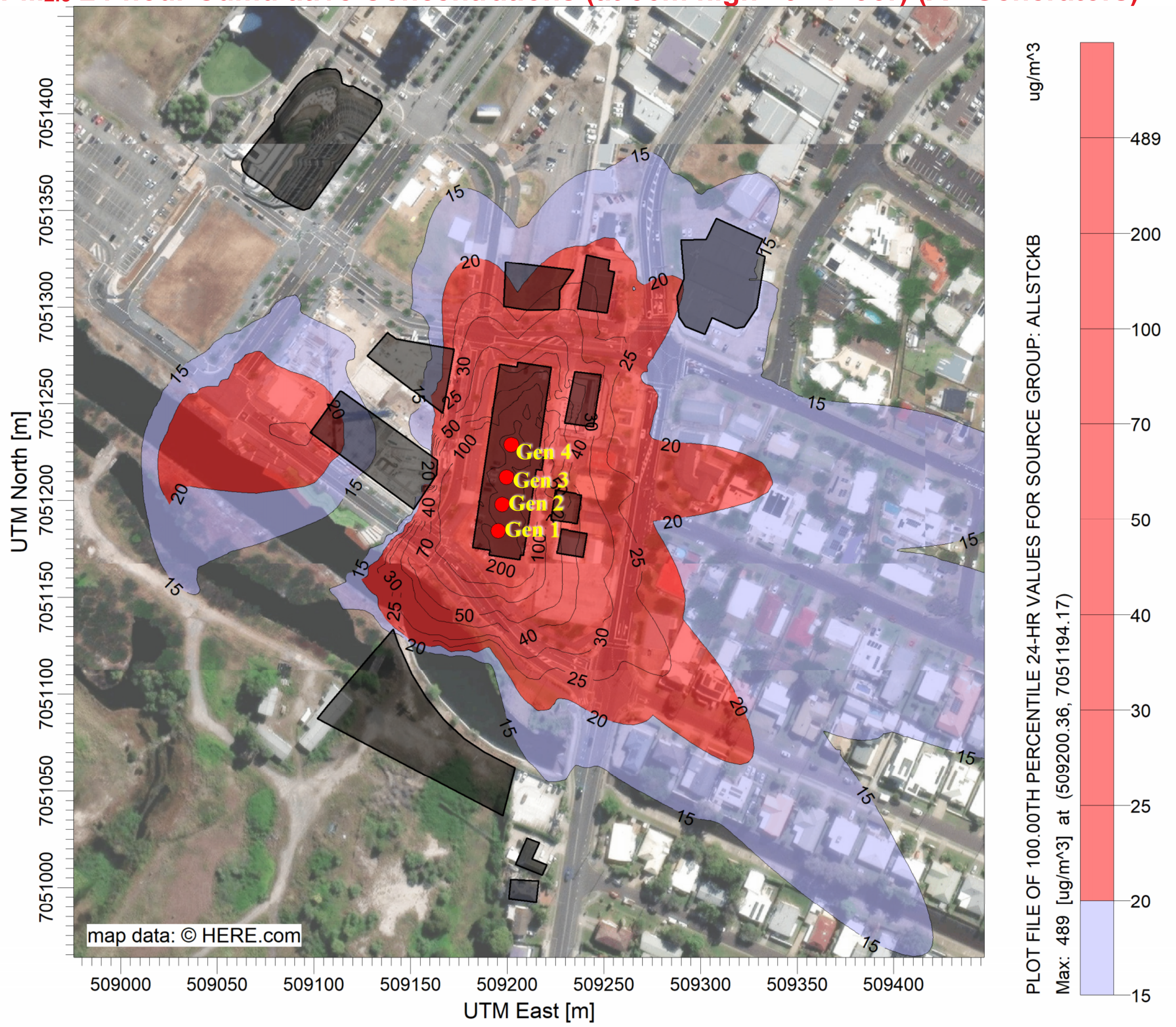
PM10 or PM2.5 24-hour Incremental Concentrations (at 36m high ~9th Floor) (All Generators)



PM_{10} 24-hour Cumulative Concentrations (at 36m high ~9th Floor) (All Generators)



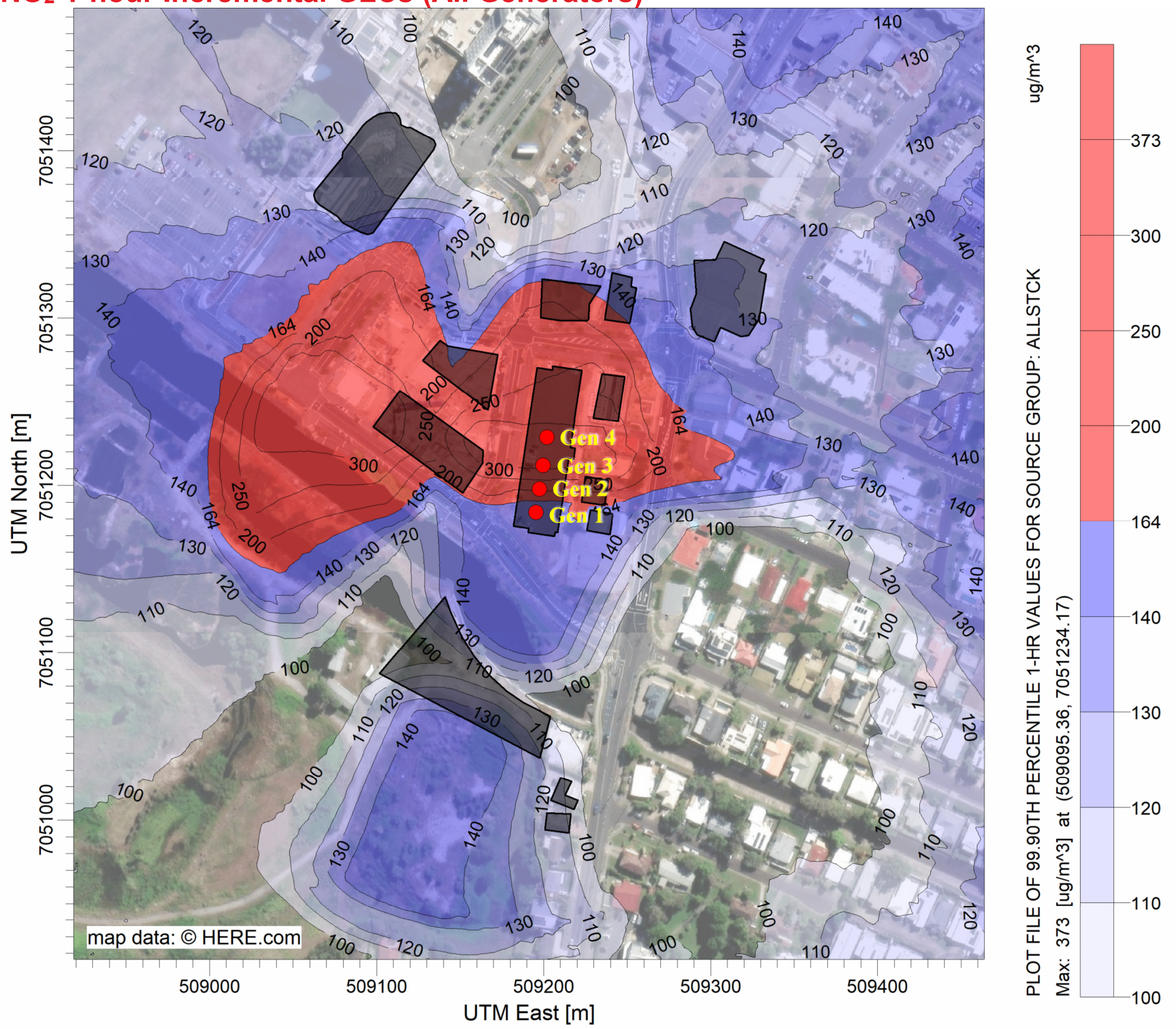
$PM_{2.5}$ 24-hour Cumulative Concentrations (at 36m high ~9th Floor) (All Generators)



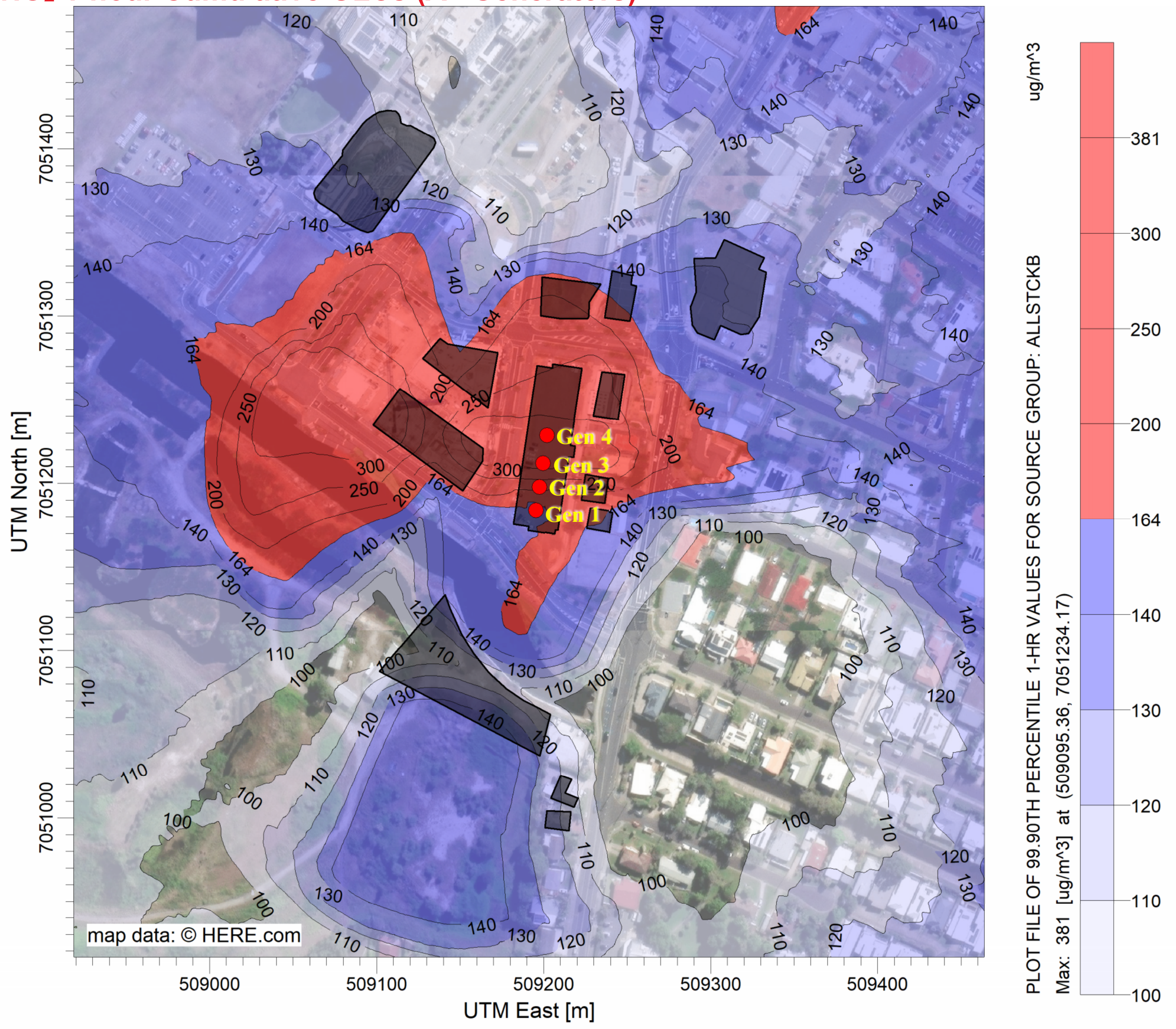
Appendix C

Predicted GLCs – Dispersion Modelling Contours (Scenario 1)

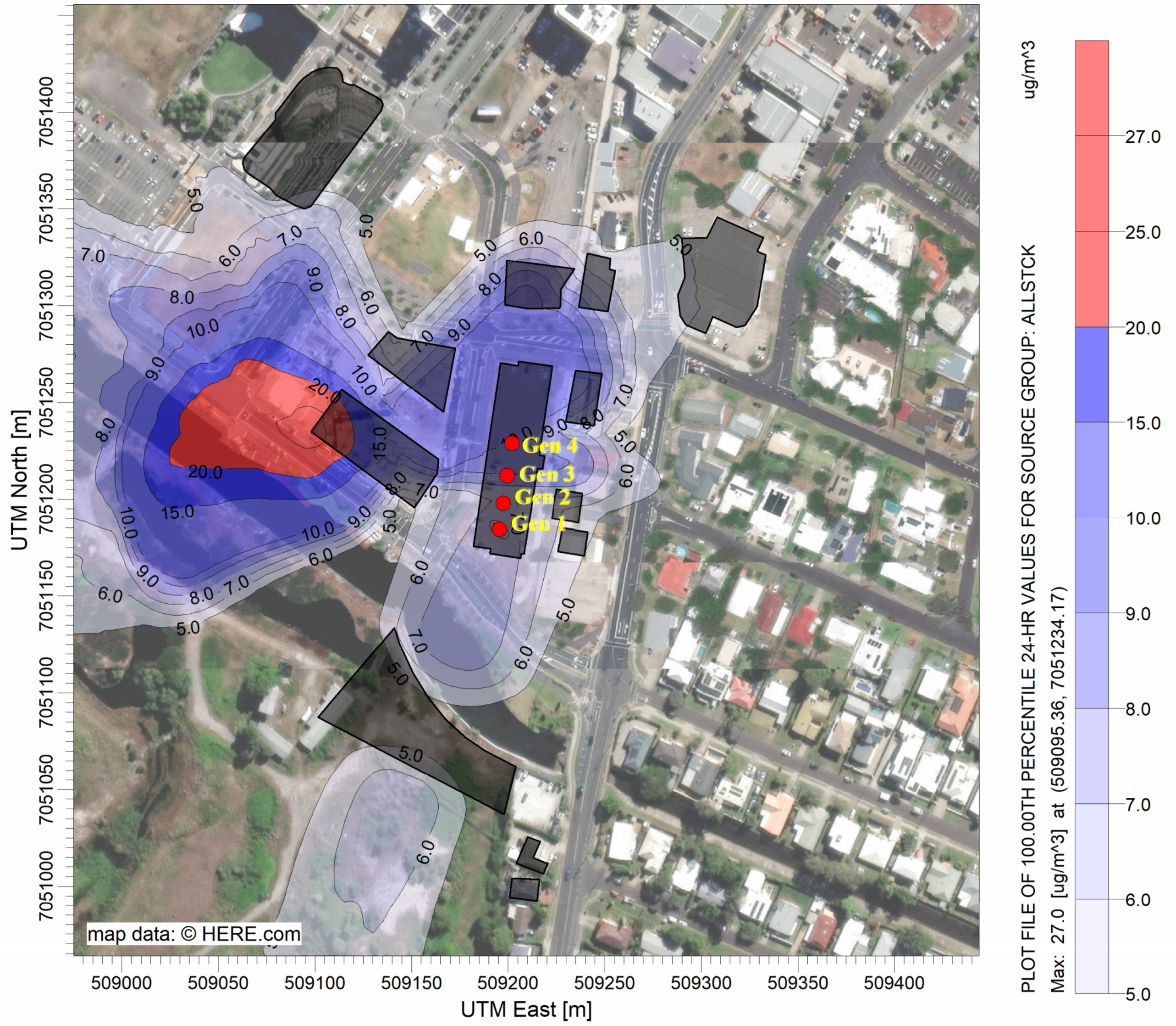
NO_2 1-hour Incremental GLCs (All Generators)



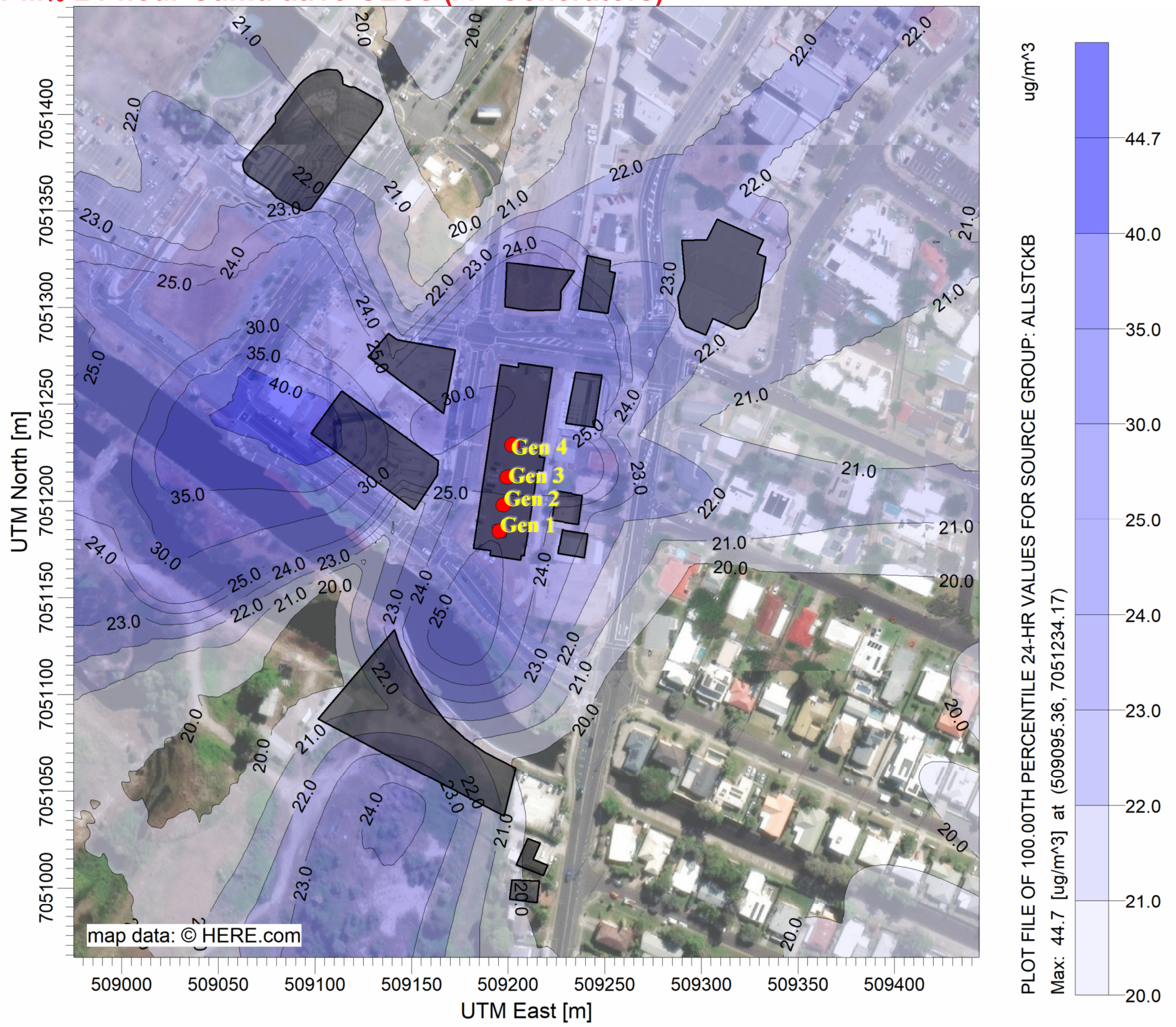
NO_2 1-hour Cumulative GLCs (All Generators)



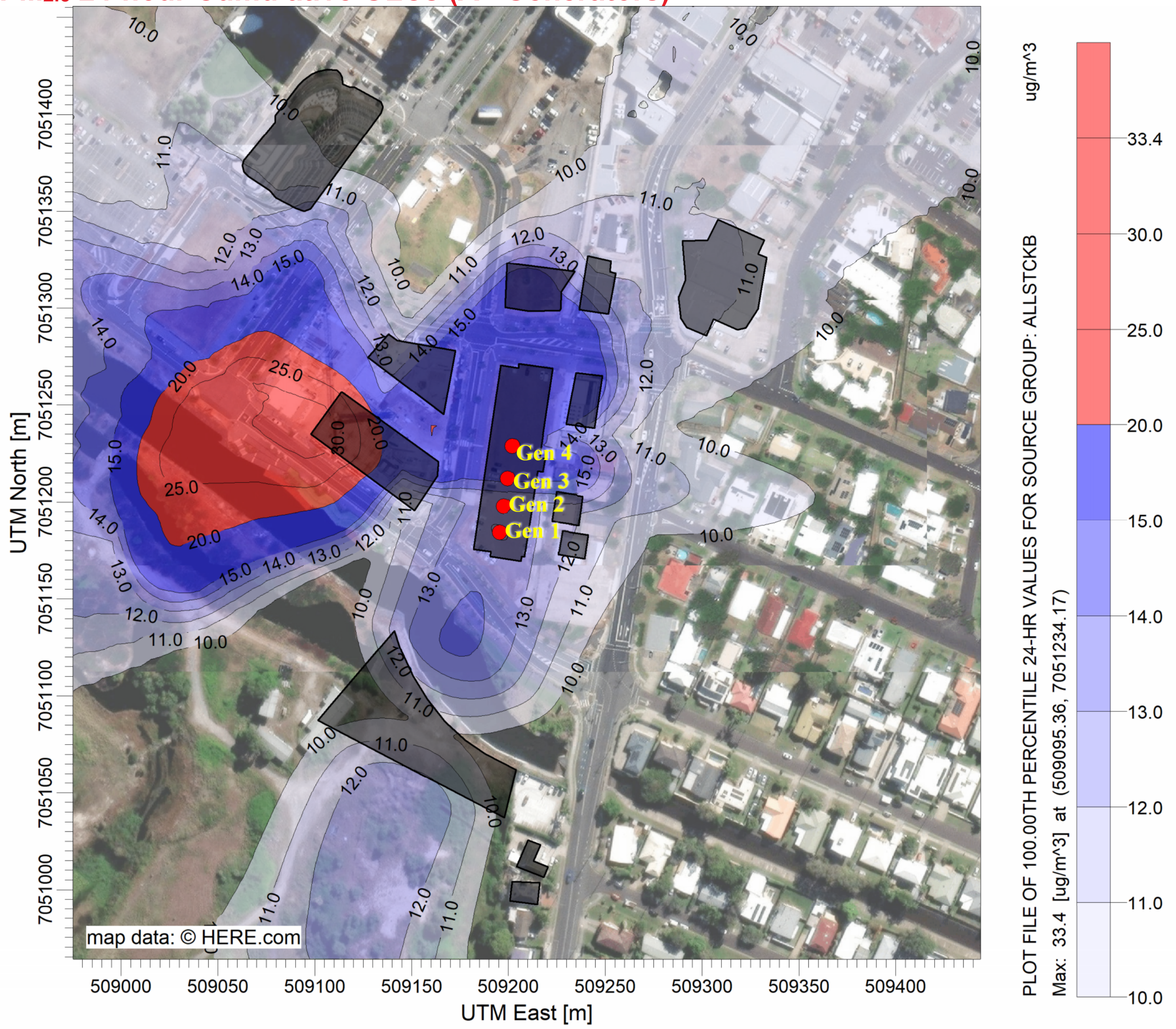
PM_{10} or $PM_{2.5}$ 24-hour Incremental GLCs (All Generators)



PM_{10} 24-hour Cumulative GLCs (All Generators)



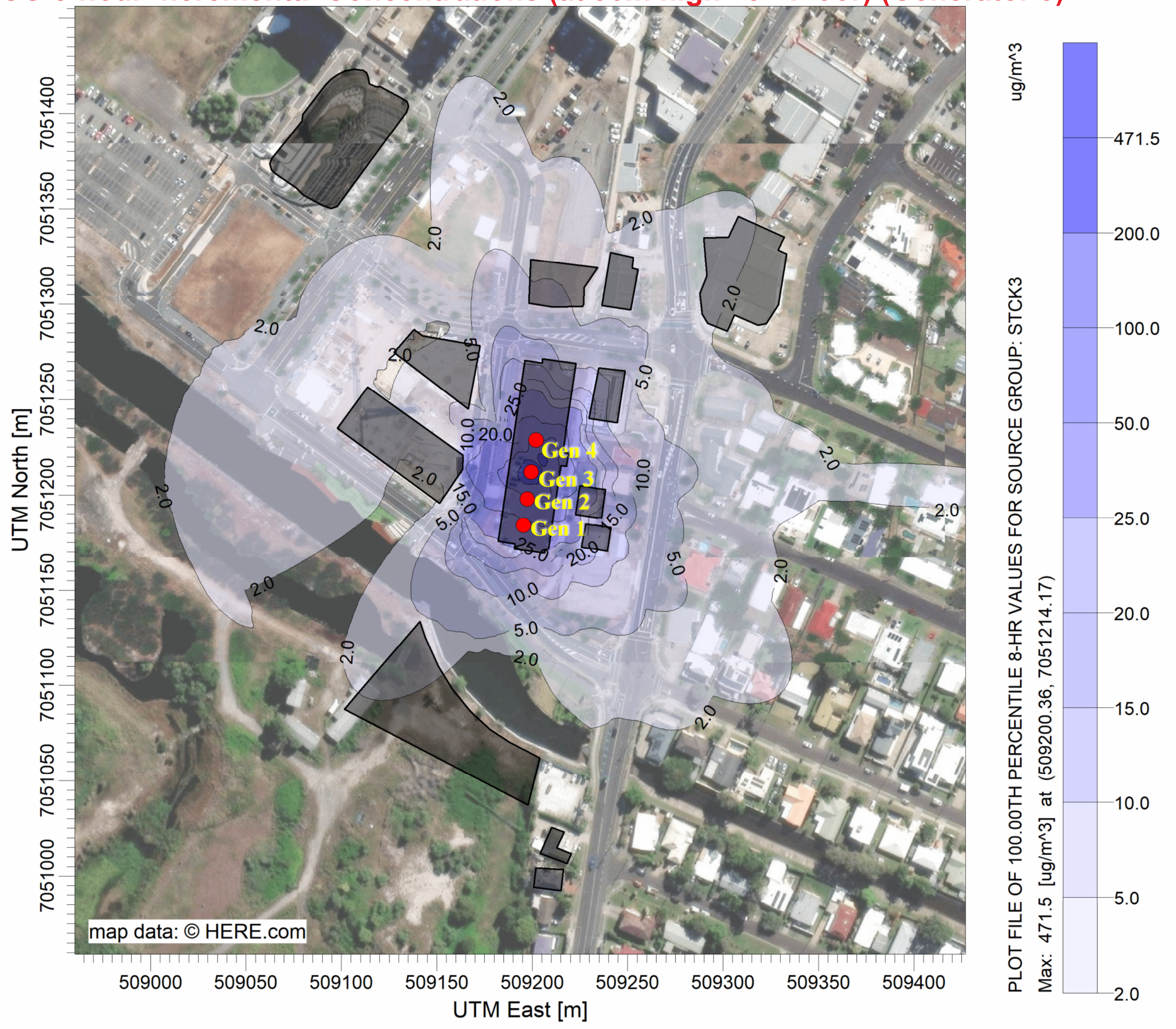
PM2.5 24-hour Cumulative GLCs (All Generators)



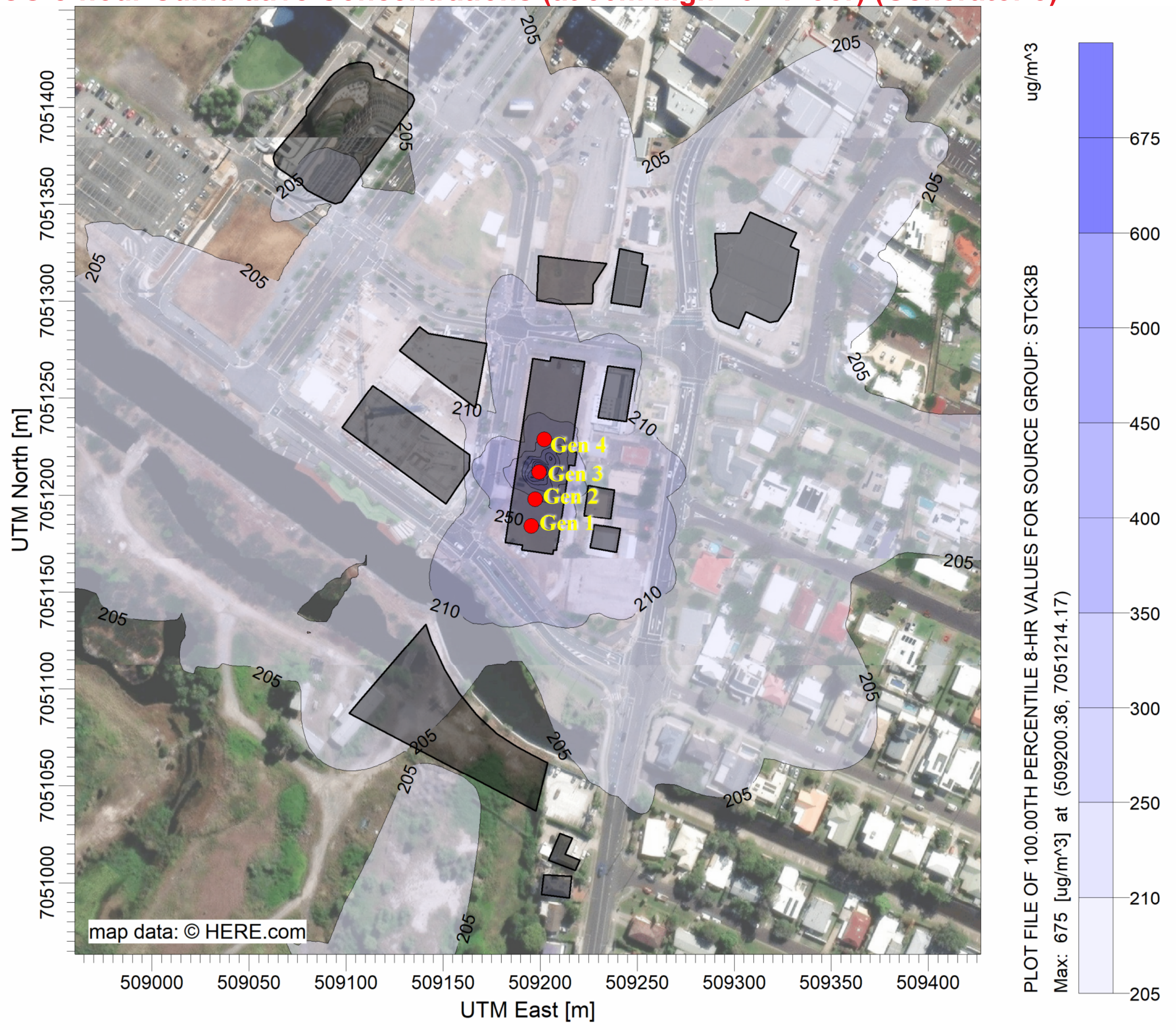
Appendix D

Predicted Concentrations at Elevation – Dispersion Modelling Contours (Scenario 2)

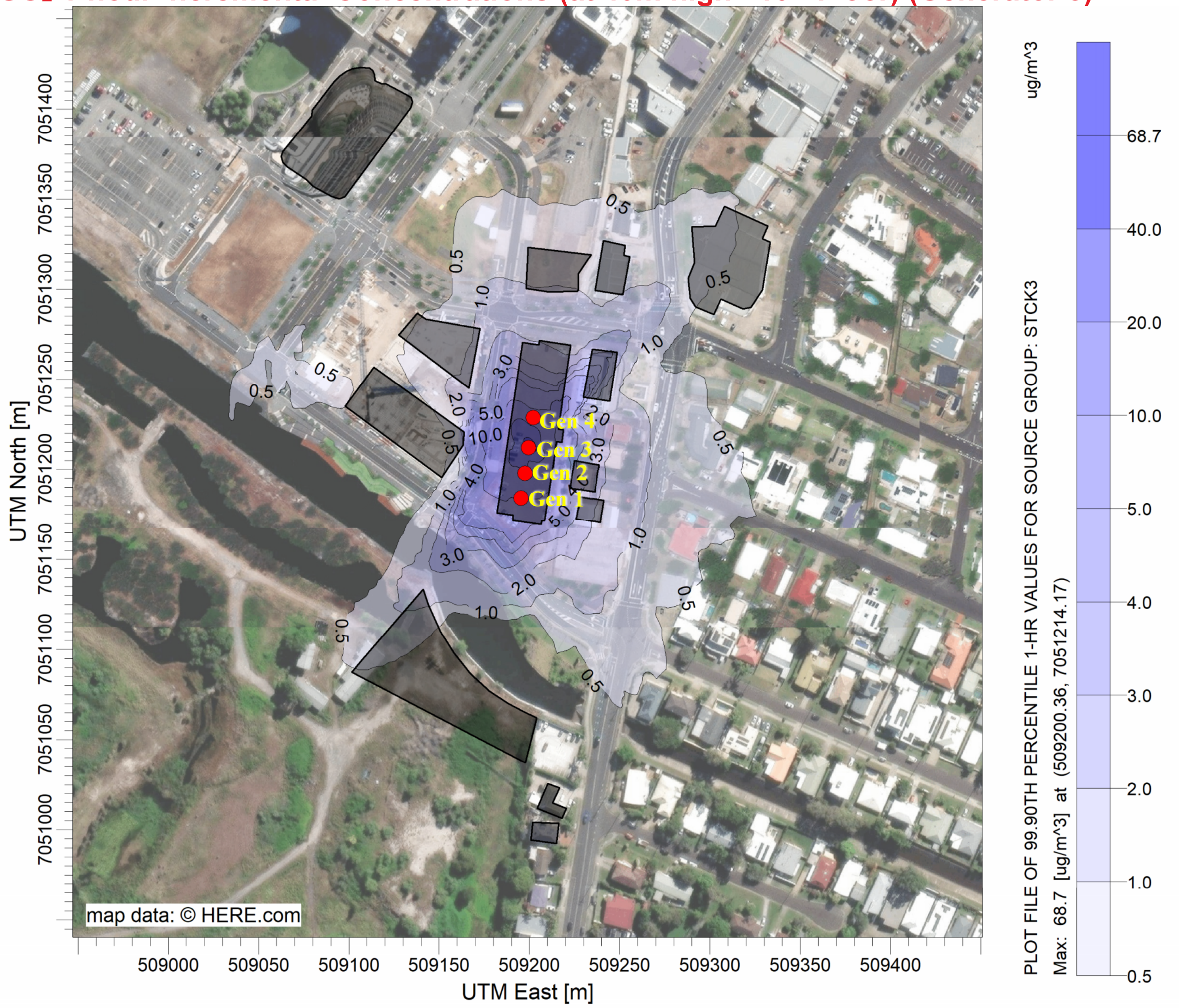
CO 8-hour Incremental Concentrations (at 36m high ~9th Floor) (Generator 3)



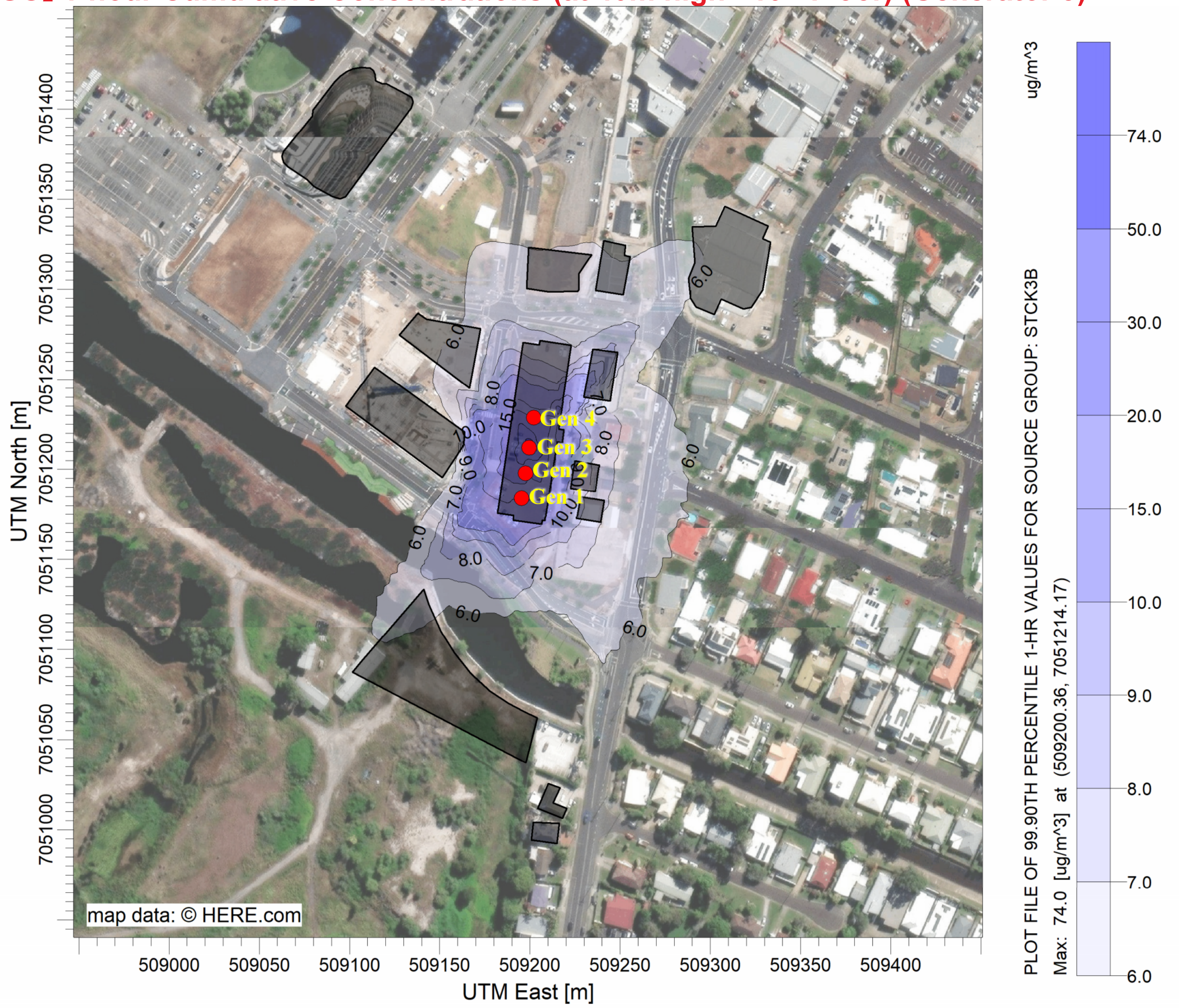
CO 8-hour Cumulative Concentrations (at 36m high ~9th Floor) (Generator 3)



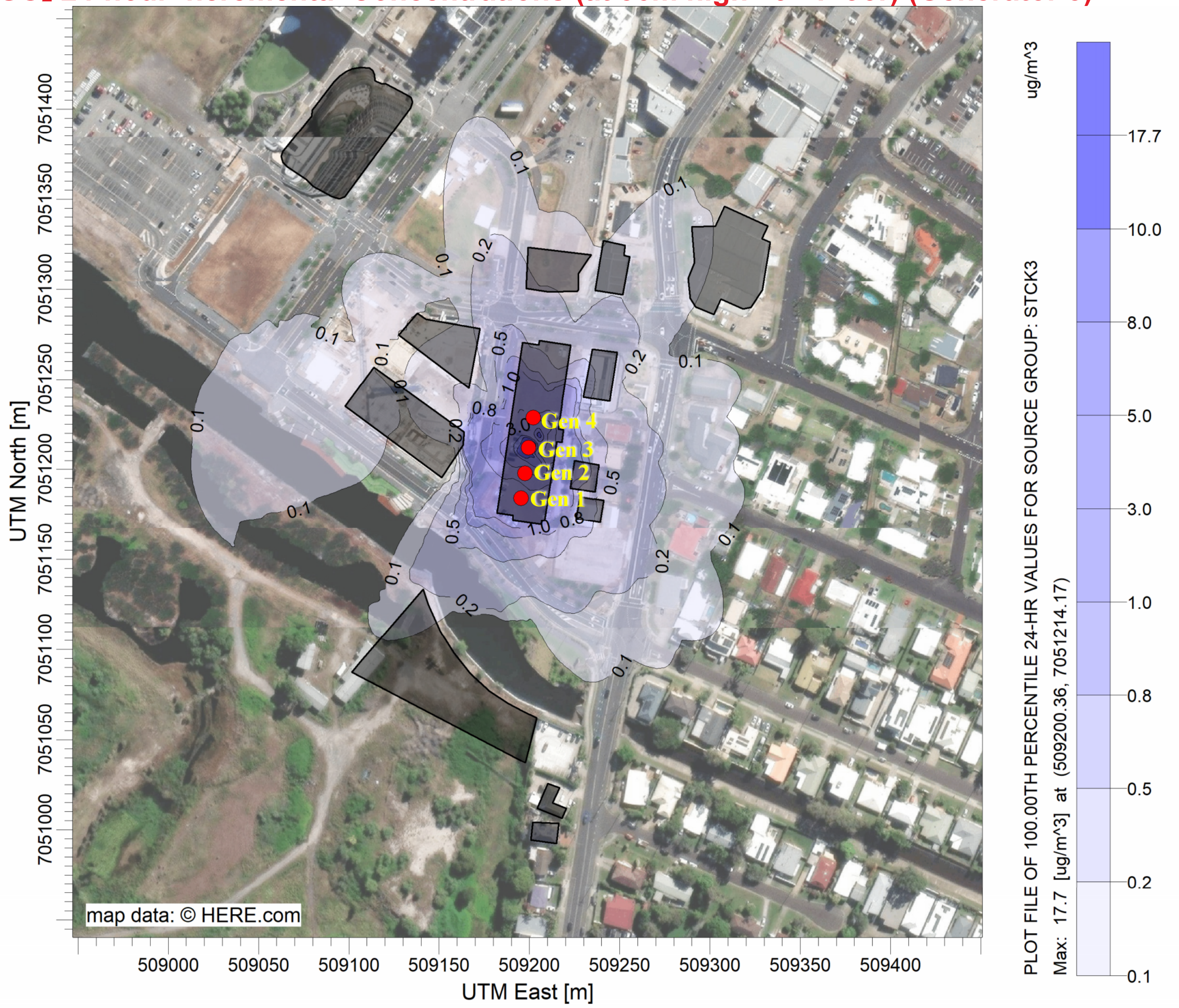
SO_2 1-hour Incremental Concentrations (at 40m high ~10th Floor) (Generator 3)



SO_2 1-hour Cumulative Concentrations (at 40m high ~10th Floor) (Generator 3)

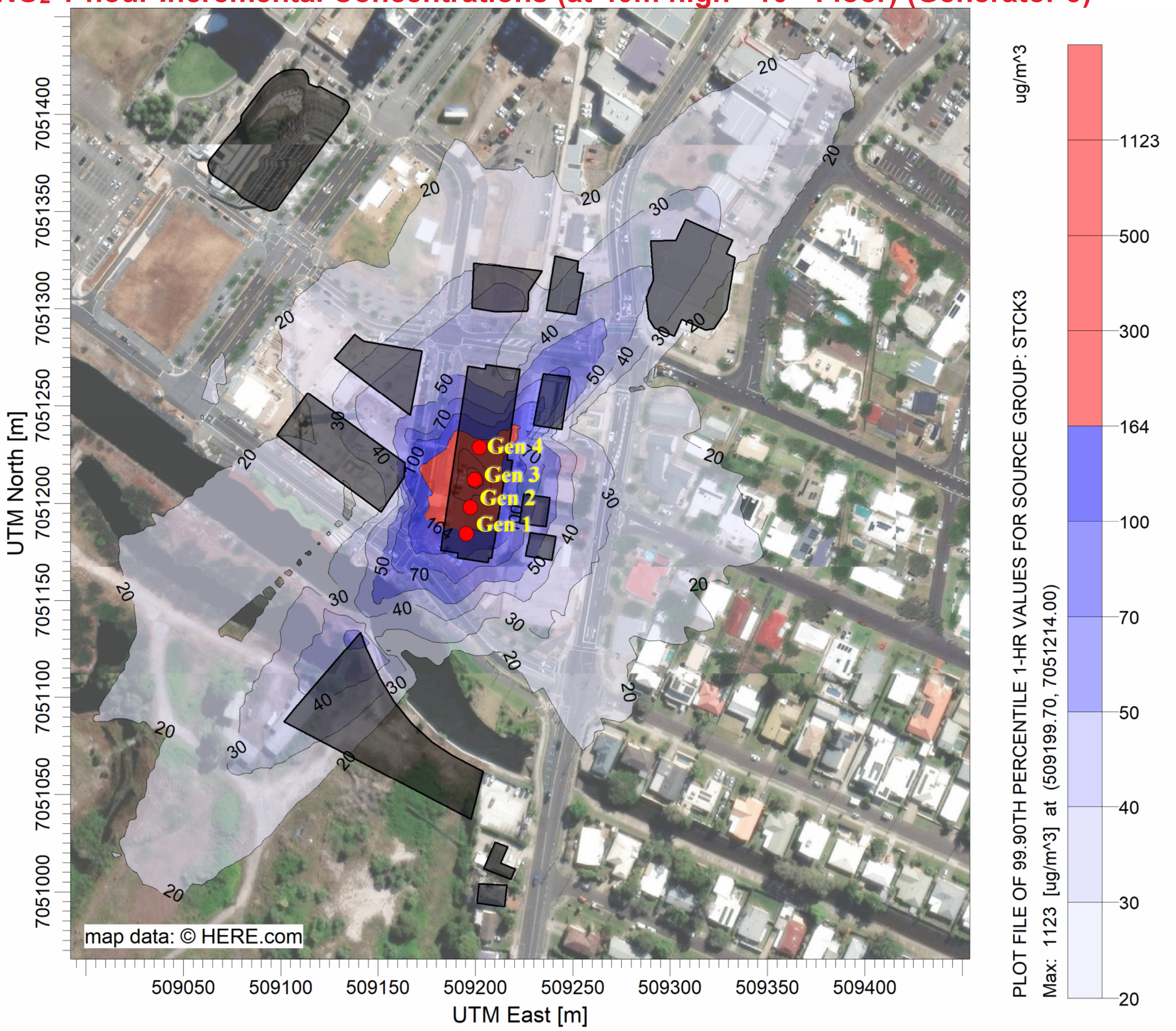


SO_2 24-hour Incremental Concentrations (at 36m high ~9th Floor) (Generator 3)

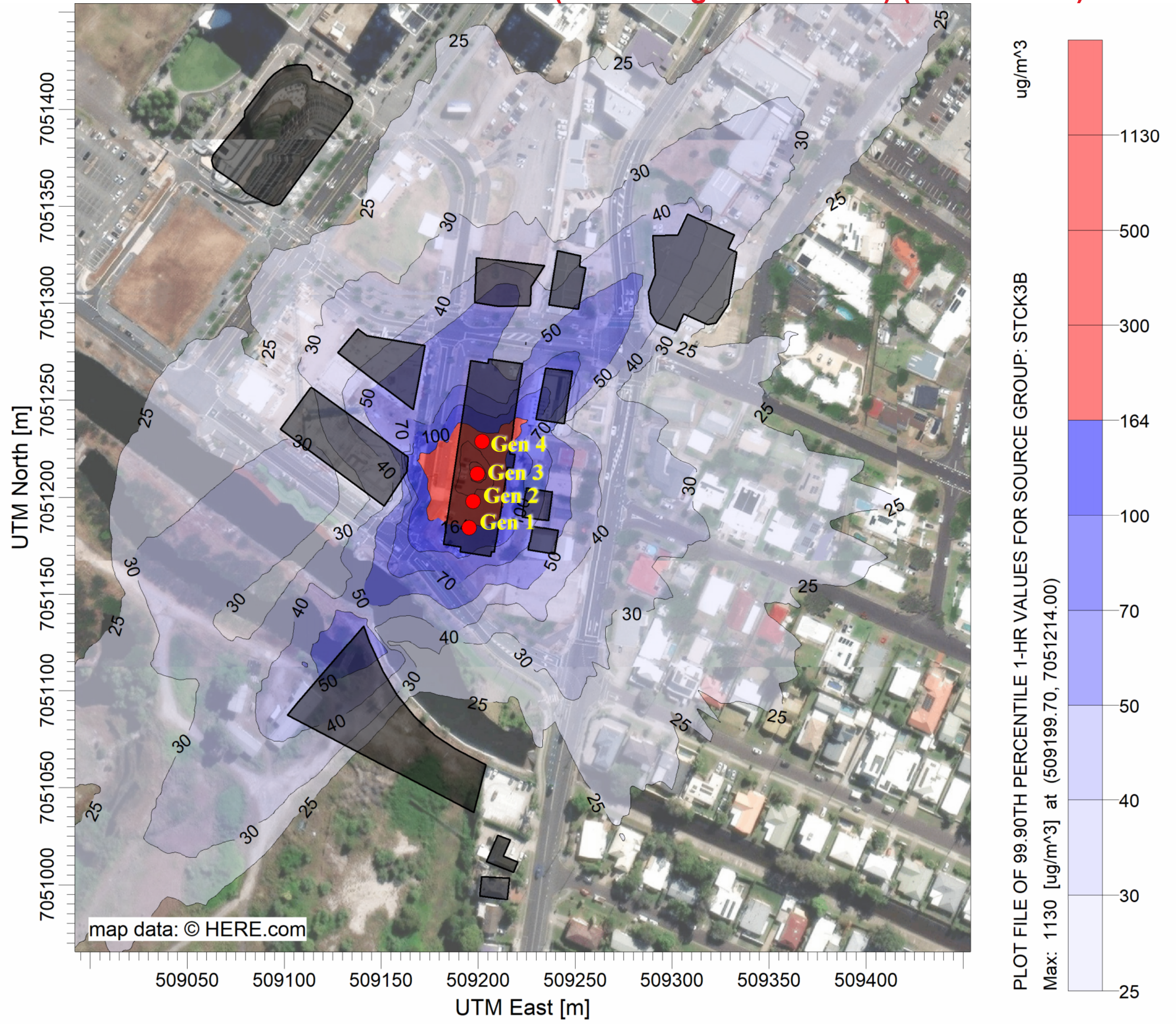


SO_2 24-hour Cumulative Concentrations (at 36m high ~9th Floor) (Generator 3)

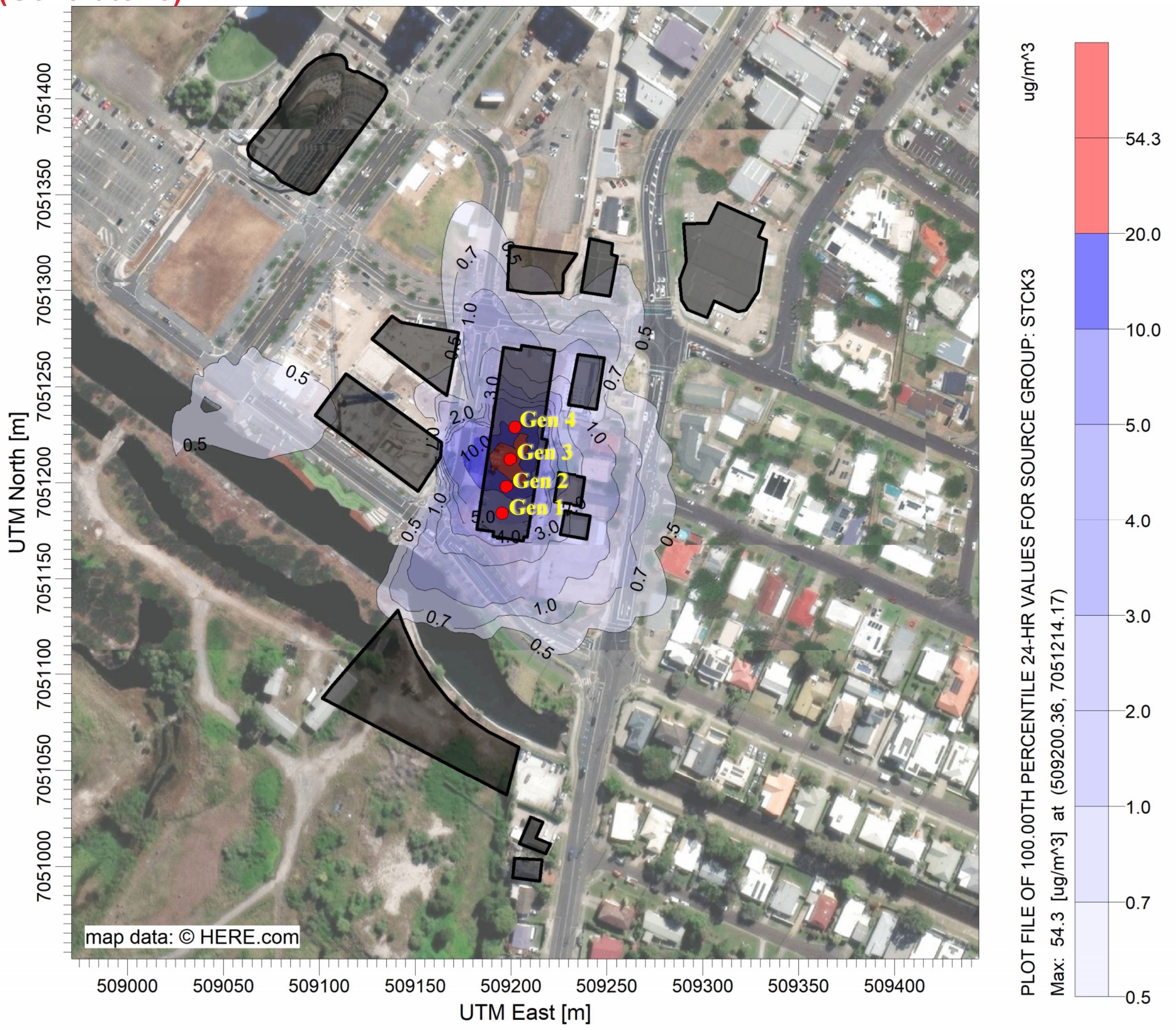
NO_2 1-hour Incremental Concentrations (at 40m high ~10th Floor) (Generator 3)



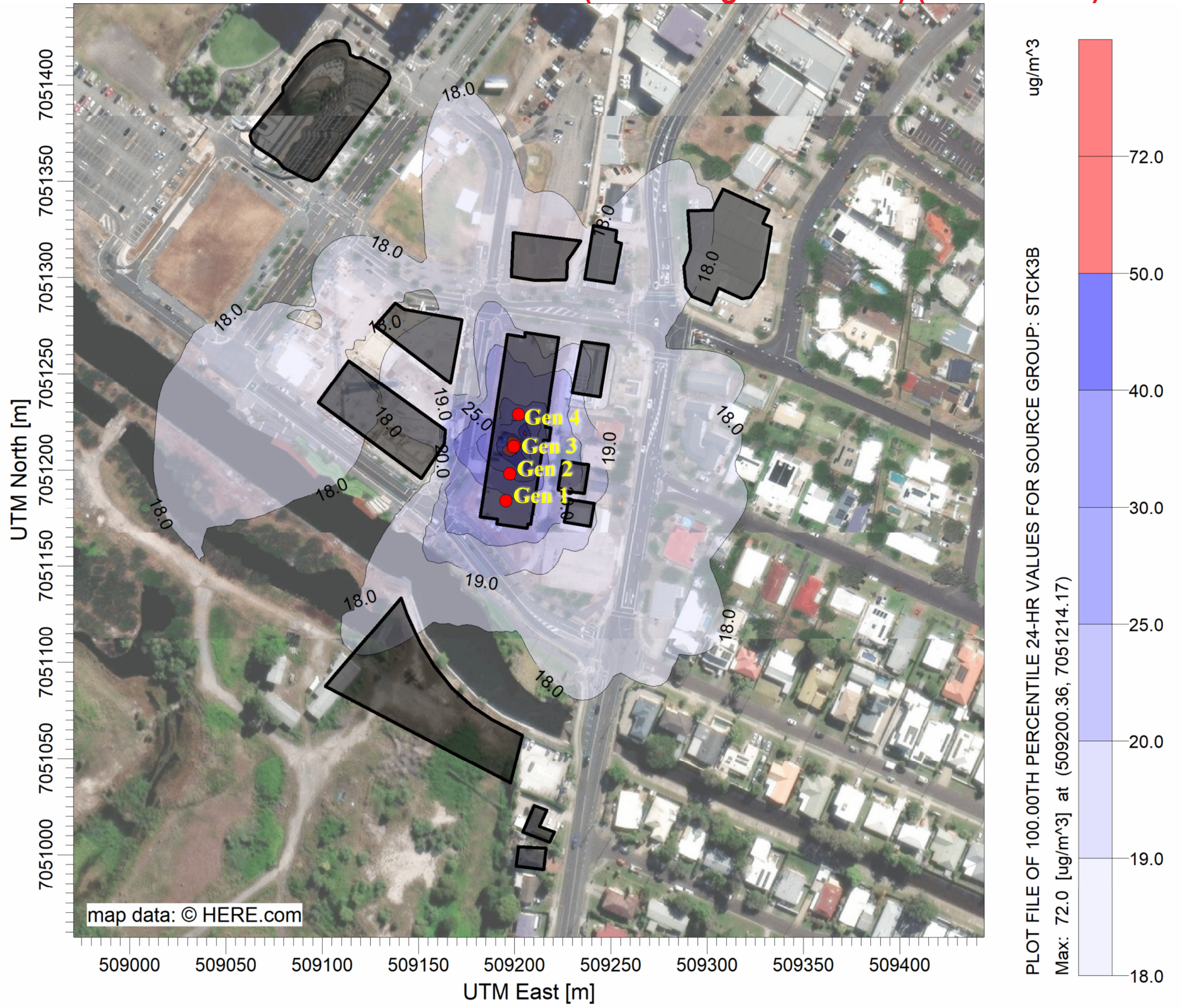
NO_2 1-hour Cumulative Concentrations (at 40m high ~10th Floor) (Generator 3)



PM10 or PM2.5 24-hour Incremental Concentrations (at 36m high ~9th Floor) (Generator 3)



PM_{10} 24-hour Cumulative Concentrations (at 36m high ~9th Floor) (Generator 3)



PM2.5 24-hour Cumulative Concentrations (at 36m high ~9th Floor) (Generator 3)