

## Memorandum

**To** Maud Garnier, Niki Douglas  
**Date** 16 January 2026  
**Copies**  
**Reference number** 304093-21  
**From** Suk-yi Lo  
**File reference** Response to RFI\_CFD\_16Jan2026.doc  
**Subject** Technical Memo - Response to Request for Further Information (RFI) from Department of Planning, Housing and Infrastructure ('Department')

---

### Introduction

Arup has prepared this technical memo as a response to a RFI from the Department in relation to the proposed Road 1 Data Centre (SSD-80814238), located at 1-5 Khartoum Road, Macquarie Park (the Project).

Through the RFI, the Department has requested additional information to address outstanding air quality matters, summarised as follows:

*“Section 7.4(b) of the Ryde Local Environmental Plan 2014 states that development consent must not be granted to development unless the consent authority is satisfied the development will not result in a neighbouring site becoming a site that has reduced development potential.*

*The Department is currently not satisfied the development meets the requirements of Section 7.4(b) as the predicted exceedances to pollutant emissions criterion at adjoining future Build-To-Rent development sites (receivers R1 – R3) could result in reduced development potential of the site.*

*The Air Quality Impact Assessment (AQIA) in Appendix J of the EIS predicts exceedances to both the incremental and cumulative criterion for Nitrogen Dioxide at future residential receivers (Receivers R1 – R3) during routine maintenance (Scenario 2) and cumulative modelling (Scenario 3) scenarios.*

*The Department requires further consideration and implementation of at source mitigation measures be undertaken to reduce pollutant concentrations at residential receivers, including an analysis of all feasible and reasonable measures available. Any additional mitigation measures should be supported by update dispersion modelling to demonstrate compliance with the relevant pollutant criterion.”*

This technical memo provides responses to the above matters and summarises the results from the additional Computational Fluid Dynamics (CFD) modelling undertaken, taking into consideration source mitigation measures by the Applicant.

### 1. Emissions performance of generators and Selective Catalytic Reduction Equipment

The project has 19 back-up generators, as follows:

- 18 × 3 MW main back-up generators (MTU 20V4000 G94LF) to support the data centre buildings' power requirements for critical IT systems and other site infrastructure in the event of mains power loss or damage of electrical infrastructure onsite.
- One × 1 MW secondary back-up generator (MTU 16V2000 G68F) to power other incidental use of electricity such as fire pumps.

The use of high performing generators suitable for their respective purposes (MTU 20V4000 G94LF and MTU 16V2000 G68F), combined with the installation of a Selective Catalytic Reduction (SCR) system for each generator will provide a further 85% reduction of nitrogen oxides (NO<sub>x</sub>) emissions. This will ensure compliance with the relevant pollutant emissions criterion, thereby removing any minor exceedances at the R1 to R3 receiver locations and ensuring that the neighbouring site (owned by Stockland) does not have a reduced development potential (in accordance with Section 7.4 of the Ryde Local Environmental Plan 2014).

Based on the above, the updated NO<sub>x</sub> emission rates are presented in Table 1 for the MTU 20V4000 G94LF generators and in Table 2 for the MTU 16V2000 G68F generator. The other exhaust stack parameters remain unchanged from those used in the original assessment.

**Appendix A** presents the emissions performance data provided by Penske (generator supplier) for the main back-up generators post-installation of the SCR. A similar system will also be supplied for the secondary back-up generator.

**Appendix B** outlines the three scenarios with Scenario 1 representing a highly unlikely worst-case event in which all 19 generators operate simultaneously. Scenario 2 reflects normal operations, where routine maintenance testing occurs with only one generator operating at any given time during daytime hours. Scenario 3 considers the combined impact of this Project and nearby data centres. The CFD modelling focuses on the bigger source of generator emissions, i.e. the MTU 20V4000 G94LF as a worst-case for the prediction of impacts for Scenario 2 (routine maintenance of one generator).

**Table 1 – Generator exhaust stack characteristics and emission inventory for the Project (MTU 20V4000 G94LF)**

Stack Parameter	MTU 20V4000G94LF (3 MW each)			
	100% Load	75% Load	50% Load	25% Load
Number of generators	18			
Number of generator stack sources	18			
Height above ground level (m)	66.5			
Exit internal diameter (mm)	350			
Exit temperature (°C)	482			
Exit velocity (m/s)	123.7			
Pre-SCR NO <sub>x</sub> emission (g/s)	7.64	5.13	2.73	1.40
<b>Post-SCR NO<sub>x</sub> emission (g/s)</b>	<b>1.15<sup>1</sup></b>	0.77	0.41	0.21

Note: 1. Emission rate from 100% loading used for the CFD modelling

**Table 2 – Generator exhaust stack characteristics and emission inventory for the Project (MTU 16V2000 G68F)**

Stack Parameter	MTU 20V4000G94LF (1 MW each)			
	100% Load	75% Load	50% Load	25% Load
Number of generators	1			
Number of generator stack sources	1			
Height above ground level (m)	66.5			
Exit internal diameter (mm)	350			
Exit temperature (°C)	545			
Exit velocity (m/s)	35.9			
Pre-SCR NO <sub>x</sub> emission (g/s)	2.54	1.91	1.27	0.64
Post-SCR NO <sub>x</sub> emission (g/s)	0.38	0.29	0.19	0.096

## 2. Summary of additional modelling findings using CFD

This section presents the summary of additional findings using CFD modelling. Further justification of the use of CFD for the additional modelling is provided in **Appendix B**, with the technical CFD details (including new building massing for the adjacent apartment tower blocks, notated as R1 to R3) provided in **Appendix C**.

Table 3 shows the comparison between the predicted maximum cumulative (i.e inclusive of background concentration) hourly NO<sub>2</sub> concentrations from AERMOD modelling (before installation of SCR) and CFD modelling (after installation of SCR), using the 100% generator load emission rates as a worst-case assumption. The verification with the detailed CFD modelling considered a systemic approach to address the limitations of AERMOD, incorporating a minute-by-minute, long-term analysis of meteorology for informing the impact and probability of risk on a more refined basis.

**Table 3 – Comparison between AERMOD findings and detailed CFD findings for NO<sub>2</sub> (Scenario 2) – maximum cumulative concentrations**

Receptors	AERMOD-predicted maximum cumulative hourly NO <sub>2</sub> concentrations (pre-SCR)	CFD-predicted maximum cumulative hourly NO <sub>2</sub> concentrations (post-SCR)
R1	257	54.7
R2	188	54.2
R3	554	88.6
Criterion	164	

The results from Table 3 above show that if SCR is installed (with 85% reduction in emissions) onto the selected high performing generators, coupled with the modelling using the more accurate CFD model for near-field flow assessment in the complex building environment surrounding the Project, the NO<sub>2</sub> concentrations at the apartment tower blocks (R1 to R3) are below the 164 µg/m<sup>3</sup> air quality assessment criterion and therefore in compliance with the Department’s request.

For Scenario 3, the proposed Talavera Road Data Centre (SSD-63235720) project has also committed to installing SCR (85% reduction in NO<sub>x</sub> emissions). Together with the SCR installation for the Project, there is a significant reduction in local NO<sub>x</sub> emissions in the unlikely event that all existing/proposed data centres adjacent to the Project site including the Data Centre at 11-17 Khartoum Road to the northeast of the Project site, Macquarie Data Centre at 17-23 Talavera Road to the southeast of the Project site and the Talavera Road Data Centre (SSD-63235720) to the east of the Project site, maintain one of their respective generators at the same time. As such, cumulative impacts are reduced as low as reasonably practicable from the perspective of the Project through the installation of SCR, and no exceedances predicated.

### **3. Modelling Parameters**

This modelling incorporates manufacturer-guaranteed emissions performance data and testing results (**Appendix A**) for the proposed equipment to ensure that assumptions reflect realistic operational conditions.

### **Conclusion**

As demonstrated in this report and supporting information, the Project is capable of meeting all relevant air quality criteria at sensitive receivers and there are no longer any predicted exceedances, even minor ones. On that basis, the Project will not cause adverse air quality impacts and therefore air quality constraints upon the neighbouring development potential are not expected, in accordance with Section 7.4 of the Ryde Local Environmental Plan 2014.

---

## Appendix A – Manufacturer provided emissions performance data with SCR

**System overview**
**General**

**Engine data**

Engine type	MTU 20V4000 G94F	
Fuel	Diesel	
Operation mode	$\lambda > 1$	
Exhaust gas mass flow (wet)	21273	kg/h
Exhaust gas temperature	482	°C
Number of cylinders	V20	
rotating speed	1500	rpm

**Flow data**

Overall pressure drop APROVIS components	24.5	mbar
--	------	------



Performance data includes only the components shown in this document. Omitting or modifying individual components can have negative impact on the overall performance.

When the aforementioned design parameters are found to be inaccurate or require to be revised, we recommend recalculating the complete exhaust system. We do not accept any responsibility when our design is based on incorrect information.

**SCR system**

**Consisting of**

- Pos.1 Injection section
- Pos.2 Catalyst housing
- Pos. [REDACTED] Dosing system
- Pos. [REDACTED] Control cabinet


**General**

Operating temperature SCR - nominal operation	482	°C
Operating temperature SCR - continuous operation	320 - 490	°C
Urea consumption (32,5%)	44.5	l/h

**Emission data [5% O<sub>2</sub>]**

	Engine Outlet	Chimney outlet	
NO <sub>x</sub>	< 3071	< 448	mg/Nm <sup>3</sup>
NH <sub>3</sub>		< 30	mg/Nm <sup>3</sup>





**Equipment**

	Equipped	Reserve	
Number of rows SCR	2	1	pc.
Number of rows ASC	1	1	pc.



The exhaust gas temperature has an influence on the catalytic conversion rate of the SCR. If the temperature range is exceeded or falls below the temperature range during operation, the conversion rate of the SCR system is negatively affected. Exceeding the maximum operating temperature can lead to premature ageing and reduced service life or even irreparable damage to the SCR honeycombs.  
The specified operating limits for the exhaust gas temperature must be permanently respected for safe SCR operation.

**Components**

Pos.1		Injection section
Pos.2		Catalyst housing
Pos.Fehler! Verweisquelle konnte nicht gefunden werden.		Dosing system
Pos.Fehler! Verweisquelle konnte nicht gefunden werden.		Control cabinet

**Pos. 1.1 1 pc. Injection section EDS-600**

**General**

Exhaust gas temperature	482	°C
Max. operating temperature	500	°C
Max. operating pressure	0.1	barg
Pressure drop	4	mbar
Urea consumption (32,5%)	44.5	l/h



Design example

**Materials**

Injection section	Stainless steel
Flanges	Stainless steel
Surface treatment	brushed

**Dimensions etc.**

Total length	~ 2170		mm
Diameter	~ 610.0		mm
Inlet connections	600/10	EN 1092-1/01/A	DN/PN
Outlet connections	600/10	EN 1092-1/01/A	DN/PN
Weight	~ 220		kg


**Consisting of**

- Static mixers for homogeneous mixing of ammonia and exhaust gas
- Integrated measuring nozzles for
  - Pressure
  - Temperature
  - NOx



Redirections between the SCR injection section and the SCR housing must be agreed with APROVIS, as these can lead to poorer mixing of the reducing agent in the exhaust gas.

**Pos. 1.2 1 pc. Atomising lance**


For injection of urea-water-solution with compressed air


**Consisting of**

- Atomising lance with two phase nozzle

**Pos. 1.3 1 pc. Measurements on exhaust side**


For recording measured values


**Consisting of**

- 1 Temperature sensor for monitoring the temperature in the exhaust gas
- 1 Pressure transducer for measuring the pressure or pressure loss on the exhaust gas side

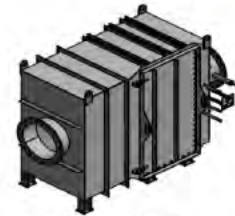


Wiring on site or by agreement

**Pos. 2.1 1 pc. Catalyst housing SCR-127x128-47x3-16x2-H**

**General**

Exhaust gas mass flow (wet)	21273	kg/h
Operating temperature SCR - nominal operation	482	°C
Operating temperature SCR - continuous operation	320 - 490	°C
Max. operating temperature	500	°C
Max. operating pressure	0.1	barg
Pressure drop	20.5	mbar



Design example

**Emission data [5% O<sub>2</sub>]**

	Engine Outlet	Chimney outlet	
NO <sub>x</sub>	< 3071	< 448	mg/Nm <sup>3</sup>
NH <sub>3</sub>		< 30	mg/Nm <sup>3</sup>

**Equipment**

	Equipped	Reserve	
Number of rows SCR	2	1	pc.
Number of rows ASC	1	1	pc.

**Materials**

Housing	Steel
Flanges	Steel
Surface treatment	priming coat

**Dimensions etc.**

L x W x H	~ 3960 x 1600 x 1700			mm
Inlet connections	600/10	axial	EN 1092-1/01/A	DN/PN
Outlet connections	600/10	axial	EN 1092-1/01/A	DN/PN
Transport weight	~ 1300			kg
Operating weight	~ 3200			kg






The exhaust gas temperature has an influence on the catalytic conversion rate of the SCR. If the temperature range is exceeded or falls below the temperature range during operation, the conversion rate of the SCR system is negatively affected. Exceeding the maximum operating temperature can lead to premature ageing and reduced service life or even irreparable damage to the SCR honeycombs.




The specified operating limits for the exhaust gas temperature must be permanently respected for safe SCR operation.

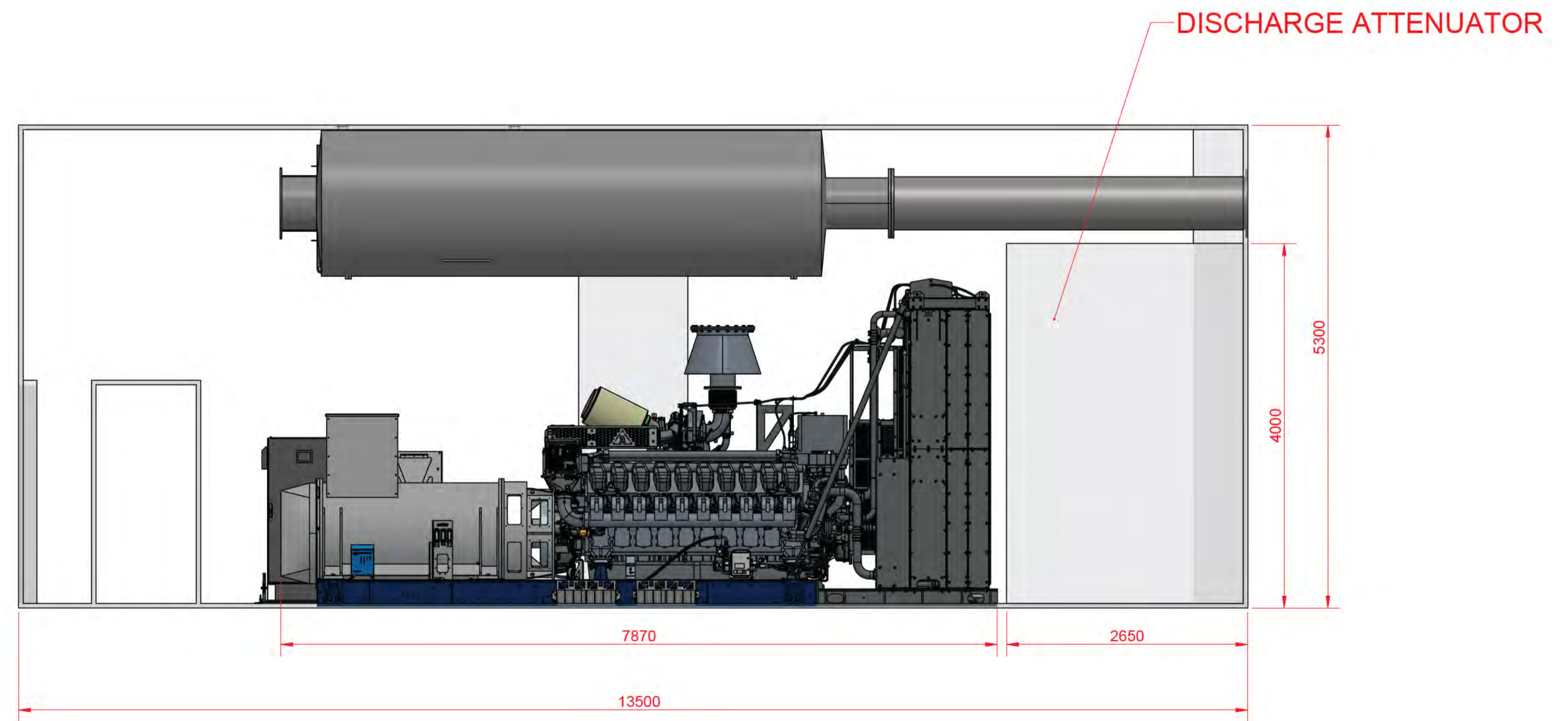
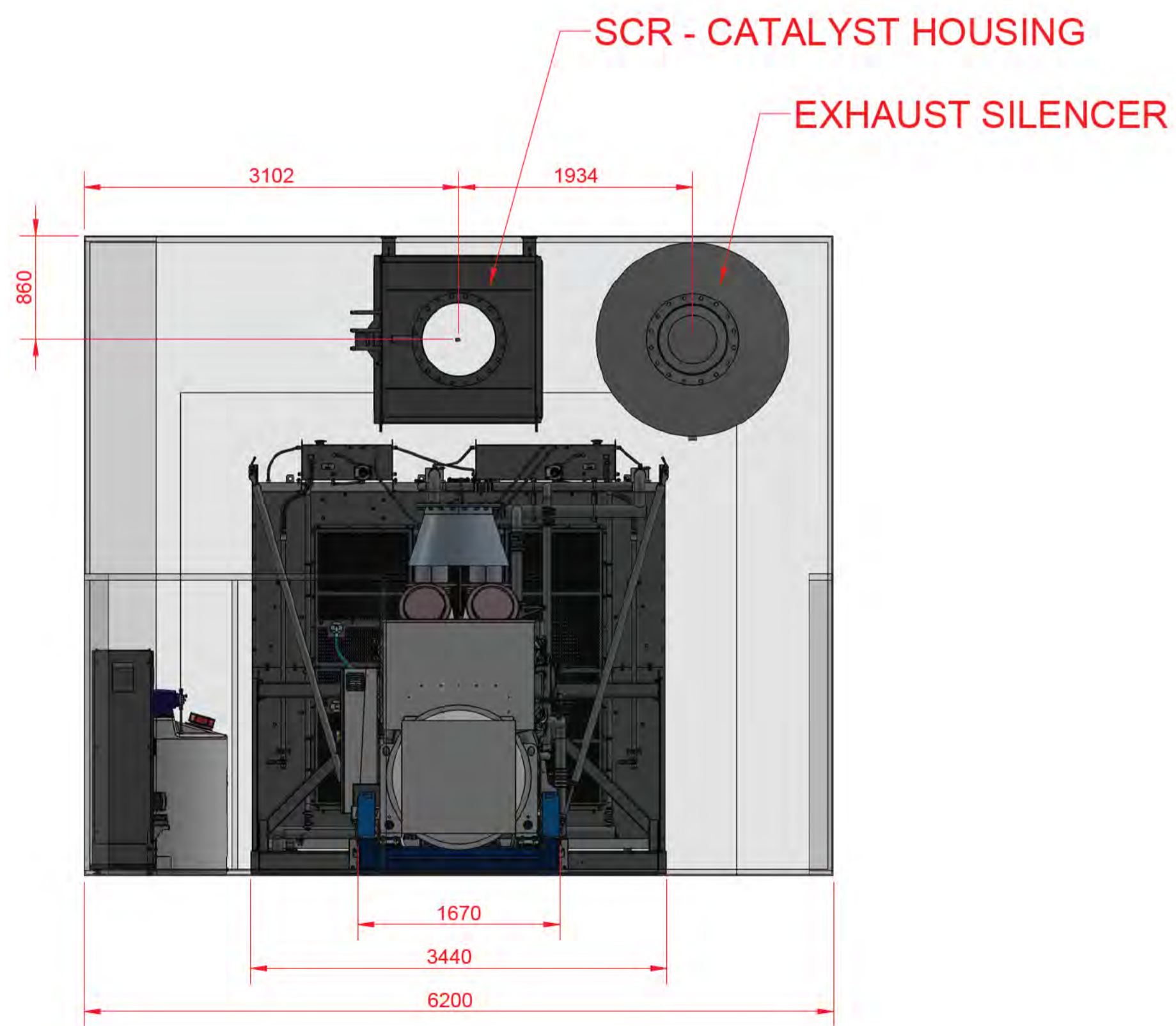
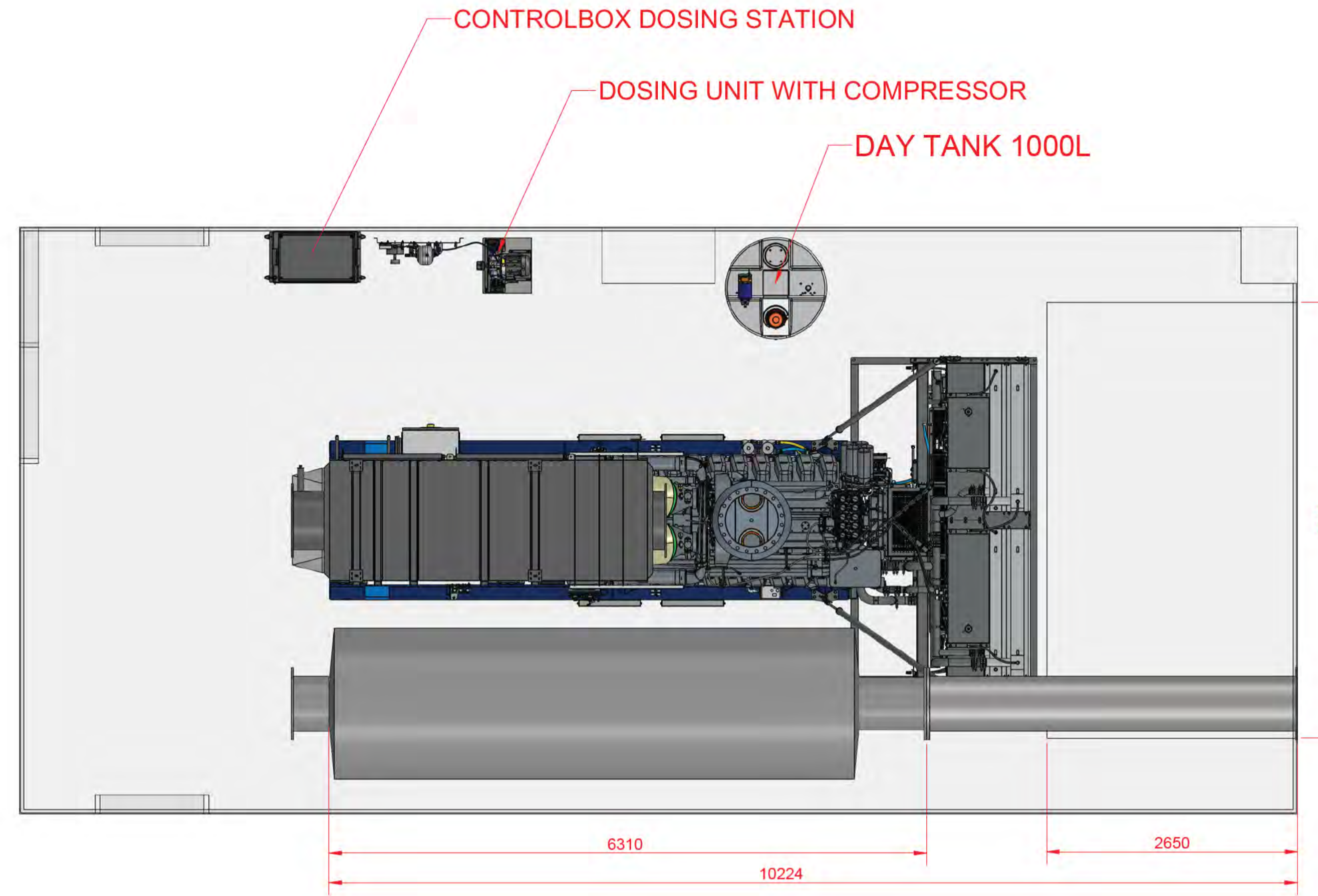
**Pos. 2.2 1 set SCR catalyst honeycombs**

Design example

-  Catalyst honeycombs will be preconditioned at the factory, integration on site. For integration engine setup must be completed as misfiring will lead to destruction of the catalysts.
-  Consisting of
  - SCR-Honeycombs
  - incl. sealing
-  Integration at commissioning  
Optional (at extra charge): Integration in factory

**Pos. 2.3 1 set ASC honeycombs**

-  Catalyst honeycombs will be preconditioned at the factory, integration on site. For integration engine setup must be completed as misfiring will lead to destruction of the catalysts.
-  Consisting of
  - Ammonia slip catalyst honeycombs
  - incl. sealing
-  Integration at commissioning  
Optional (at extra charge): Integration in factory



ISSUE	DATE	REVISION NOTES	DWN	CKD	APPD

 <b>PENSKE AUSTRALIA</b> 488 BLACKSHAW RD, ALTONA NORTH VICTORIA, 3025 ABN: 07073 690 990 P: +61 9243 9292 W: PENSKE.COM.AU	SCALE	1:40	MASS(kgs)		SHEET	A1
	PROJECT					
 Rolls Royce Power System Bergen Engines	PROJECT NUMBER					
	TITLE	20V4000 DS4000 LSA 54.2 ZL16				
 A Rolls-Royce solution	DRAWING NUMBER					
	SHEET	1	OF	1	REVISION	
COPYRIGHT- THIS DRAWING SHALL NOT BE USED FOR MANUFACTURE, PRODUCTION, PROCUREMENT OR COPIED WITHOUT THE WRITTEN PERMISSION OF PENSKE AUSTRALIA		SUPPLIER DRAWING NUMBER 8				

---

## Appendix B – Additional modelling in response to the RFI

### AERMOD dispersion modelling background

This section provides a summary of the previous dispersion modelling findings (using the AERMOD dispersion model) from the submitted State Significant Development Application (SSDA).

To support the air quality impact assessment, air dispersion modelling using AERMOD was undertaken for the usage of the back-up generators (totalling 19 units) for the Project, under the following scenarios:

- **Scenario 1:** A highly unlikely worst-case scenario (peak emission scenario) where all 19 generators of the Project are in operation (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 Project, where individual generator testing is undertaken. It has been assumed that up to one (1) generator for the Project would be tested at any given hour during the daytime (7 am to 6 pm<sup>1</sup>).
- **Scenario 3:** A cumulative assessment of the Project and the three existing/proposed adjacent data centres including the Data Centre at 11-17 Khartoum Road to the northeast of the Project site, Macquarie Data Centre at 17-23 Talavera Road to the southeast of the Project site and Talavera Road Data Centre (SSD-63235720) to the east of the Project site, assuming that realistic operations during regular or routine maintenance testing occur simultaneously, with up to one generator from each data centre site tested at any given hour during the daytime, subject to the restricted time of generator operation for the two existing adjacent data centres.

The AERMOD modelling results had shown that aside for nitrogen dioxide (NO<sub>2</sub>), all other modelled pollutants (particulate matter with aerodynamic diameter of less than 10 micron and 5 micron (PM<sub>10</sub> and PM<sub>2.5</sub>), carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>) and benzene) meet the respective air quality impact assessment criteria as provided in the NSW EPA document, *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (August 2022).

Further summary of the NO<sub>2</sub> modelling results from the SSDA report is provided in Table 3 to Table 5 below for reference. The receiver locations, as modelled in AERMOD, are provided in Figure 1.

---

<sup>1</sup> As a conservative assumption, the restricted timeframe of 7 am to 6 pm is applied to all days of the year (i.e. no differentiation between weekdays and weekends) in the dispersion modelling.



**Figure 1 – Modelled sensitive receptors (red circles) with AERMOD ID**

Hourly NO<sub>2</sub> exceedances of the assessment criterion are predicted at the future proposed residential apartment blocks planned as part of the MPark masterplan (notated as R1 to R3 to denote the three apartment blocks, with flagpole receptors included for each floor with the assumption of 3 m per floor) in all scenarios. Although there are exceedances for additional receptors in Scenario 1, power outage is considered to have a very rare occurrence (occurrence of less than 0.01% in any given year, as provided in the SSDA report) and hence the additional CFD modelling has focused on the more ‘realistic’ occurrence of Scenario 2 for NO<sub>2</sub> emissions.

**Table 4 - Summary of AERMOD modelling results for NO<sub>2</sub> (Scenario 1)**

Receptor	AERMOD ID	Floor level	1-Hour highest 100 <sup>th</sup> percentile NO <sub>2</sub> concentration (µg/m <sup>3</sup> )			Comply
			Incremental	Cumulative	Criterion	
<b>R1</b>	R1_1 to R1_39	39 <sup>th</sup> floor	2442	2457	164	No
<b>R2</b>	R2_1 to R2_34	34 <sup>th</sup> floor	1597	1625		No
<b>R3</b>	R3_1 to R3_32	32 <sup>nd</sup> floor	3234	3243		No
<b>R4</b>	R4_1 to R4_18	18 <sup>th</sup> floor	288	290		No
<b>R5</b>	R5_1 to R5_3	Ground floor	154	154		Yes
<b>R6</b>	R6_1 to R6_8	8 <sup>th</sup> floor	204	213		No
<b>R7</b>	R7	Ground level	171	180		No
<b>COM1</b>	R8	Ground level	114	139		Yes
<b>COM2</b>	R9	Ground level	149	155		Yes
<b>COM3</b>	R1	Ground level	233	246		No

Receptor	AERMOD ID	Floor level	1-Hour highest 100 <sup>th</sup> percentile NO <sub>2</sub> concentration (µg/m <sup>3</sup> )			Comply
			Incremental	Cumulative	Criterion	
COM4	R11	Ground level	141	145	164	Yes
COM5	R12	Ground level	180	184		No
COM6	R13	Ground level	230	232		No
COM7	R14	Ground level	190	194		No
CC1	R15	Ground level	120	128		Yes
CC2	R16	2 <sup>nd</sup> floor	122	124		Yes
CC3	R17	Ground level	147	150		Yes
REC1	R18	Ground level	175	181		No
HOT1	R19_1 to R19_8	5 <sup>th</sup> floor	135	145		Yes

**Table 5 - Summary of AERMOD modelling results for NO<sub>2</sub> (Scenario 2)**

Receptor	AERMOD ID	Floor level	1-hour highest 100 <sup>th</sup> percentile NO <sub>2</sub> concentration (µg/m <sup>3</sup> )			Comply
			Incremental	Cumulative	Criterion	
R1	R1_1 to R_39	39 <sup>th</sup> floor	246	257	164	No
R2	R2_1 to R2_34	34 <sup>th</sup> floor	104	188		No
R3	R3_1 to R3_32	25 <sup>th</sup> floor	545	554		No
R4	R4_1 to R4_18	9 <sup>th</sup> floor	63	72		Yes
R5	R5_1 to R5_3	Ground level	47	51		Yes
R6	R6_1 to R6_8	8 <sup>th</sup> floor	52	54		Yes
R7	R7	Ground level	71	79		Yes
COM1	R8	Ground level	43	54		Yes
COM2	R9	Ground level	58	60		Yes
COM3	R10	Ground level	63	65		Yes
COM4	R11	Ground level	41	48		Yes
COM5	R12	Ground level	68	70		Yes
COM6	R13	Ground level	68	68		Yes
COM7	R14	Ground level	85	91		Yes
CC1	R15	Ground level	47	49		Yes
CC2	R16	2 <sup>nd</sup> floor	49	49		Yes
CC3	R17	Ground level	45	47		Yes
REC1	R18	Ground level	87	92		Yes
HOT1	R19_1 to R19_8	8 <sup>th</sup> floor	45	49		Yes

**Table 6 - Summary of AERMOD modelling results for NO<sub>2</sub> (Scenario 3)**

Receptor	AERMOD ID	Floor level	1-hour highest 100 <sup>th</sup> percentile NO <sub>2</sub> concentration (µg/m <sup>3</sup> )			Comply
			Incremental + existing data centres	Cumulative	Criterion	
<b>R1</b>	R1_1 to R_39	36 <sup>th</sup> floor	451	453	164	No
<b>R2</b>	R2_1 to R2_34	34 <sup>th</sup> floor	377	405		No
<b>R3</b>	R3_1 to R3_32	24 <sup>th</sup> floor	748	748		No
<b>R4</b>	R4_1 to R4_18	Ground level	77.1	113		Yes
<b>R5</b>	R5_1 to R5_3	Ground level	73.8	73.8		Yes
<b>R6</b>	R6_1 to R6_8	7 <sup>th</sup> floor	77.4	81.1		Yes
<b>R7</b>	R7	Ground level	96.3	102		Yes
<b>COM1</b>	R8	Ground level	86.8	88.7		Yes
<b>COM2</b>	R9	Ground level	80.7	80.8		Yes
<b>COM3</b>	R10	Ground level	126	130		Yes
<b>COM4</b>	R11	Ground level	122	125		Yes
<b>COM5</b>	R12	Ground level	122	125		Yes
<b>COM6</b>	R13	Ground level	129	133		Yes
<b>COM7</b>	R14	Ground level	126	129		Yes
<b>CC1</b>	R15	Ground level	85.4	87.2		Yes
<b>CC2</b>	R16	2 <sup>nd</sup> floor	64.8	66.7		Yes
<b>CC3</b>	R17	Ground level	111	115		Yes
<b>REC1</b>	R18	Ground level	114	120		Yes
<b>HOT1</b>	R19_1 to R19_8	8 <sup>th</sup> floor	77.3	86.7		Yes

### Limitations of AERMOD

AERMOD is a commonly used dispersion model for air quality impact assessments; however, accounting for the impact of downwind buildings on dispersion poses a challenge for AERMOD. It is a steady state Gaussian-based dispersion model that assumes uniform wind conditions within each hour, where there are certain limitations<sup>2</sup> to its applicability for downwind complex building configurations and near-field dispersion distances (50 – 100 m), such as that experienced at the Project site. These limitations are especially pronounced for the nearest substantial residential apartment development (receptors R1 to R3 and their respective flagpole receptors).

<sup>2</sup> a) Lateb, M. et al., 2016. On the use of numerical modelling for near-field pollutant dispersion in urban environments – A review. Environmental Pollution, Volume 208, Part A, January 2016, Pages 271-283. b) Good Practice Guide for Atmospheric Dispersion Modelling, Published in June 2004 by the Ministry for the Environment, New Zealand. c) Woodward, H. et al, 2021. A review of the applicability of Gaussian modelling techniques to near-field dispersion (Report ADMLC-R11).

Receptors R1 to R3 are tall building clusters, where wind flow patterns are affected by the buildings, especially since the building cluster sizes are relatively large and relatively near to the emission sources of the Project. These wind flow changes are likely material in affecting the impact at the flagpole receptors.

AERMOD assumes the plume centreline travels downwind in a straight line, which is unlikely to be the case for those sensitive receptors in residential apartment towers that are not located in direct 'line of sight' plume impaction (e.g. receptors located behind or in between multiple buildings). As buildings disrupt the air flow the mean concentration field can no longer be described accurately by a single Gaussian distribution. In other words, AERMOD does not take account of the impact of the buildings downwind on dispersion in such situations and assumes that the dispersion occurs into free air. For instance, the plumes at elevated heights have the potential to 'wrap around' or 'wrap over' buildings and this may result in accumulation of pollution in the 'dead air' on the far side of the building. This means that AERMOD may not accurately predict pollutant concentrations at the flagpole receptors of R1 to R3, with potential for either under- or over-prediction depending on local flow disruptions.

To address the limitations of AERMOD modelling, CFD modelling has been used to further assess the impacts in relation to the NO<sub>2</sub> modelling results of R1 to R3 for Scenario 2. This pollutant has been selected as it is the only one exhibiting exceedances of the air quality impact assessment criterion under Scenario 2.

Further technical details of the CFD modelling are presented in Appendix C.

### **Selection of CFD modelling**

Alternative modelling has been undertaken using CFD for a more detailed near-field analysis which are beyond the capabilities of AERMOD's modelling capabilities. CFD allows for the direct simulation of site-specific flow fields and pollutant dynamics at high spatial resolution explicitly capturing the effects of obstacles and their interactions with the plume. This enables detailed analysis of the intricate interactions between emission sources, wind patterns, and turbulence effects, particularly at the near-field scale.

The following sub-sections present a summary of the reasons for selecting CFD, modelling methodology and results of the NO<sub>2</sub> CFD modelling of R1 to R3 for Scenario 2.

#### **Near-field complexity and built form considerations**

CFD was adopted in this assessment to supplement AERMOD and provide a high-resolution understanding of pollutant dispersion in the near-field urban environment of the proposed Project. While AERMOD is a common model used in NSW, its capacity to represent near-field complex urban geometry, building wake effects and stack-receptor proximity is limited. The proposed residential towers R1, R2, and R3 and the Project have significantly varying building heights and are located relatively close to each other. Under such circumstances, Gaussian plume assumptions embedded in AERMOD often over-simplify pollutant dispersion mechanisms.

CFD modelling offers a distinct advantage in this context by resolving three-dimensional flow features that are critical in near-source pollutant behaviour. Unlike Gaussian models, which rely on analytical approximations, CFD solves the Navier-Stokes equations numerically, accounting for wind-structure interactions, buoyancy, turbulence, and vertical mixing. This allows for simulation of:

- Downwash and recirculation zones around high-rise elements;

- 
- Wake effects and channelling between buildings;
  - Thermal plume rise and buoyant dispersion; and
  - Localised stagnation and re-entrainment of pollutants.

This is particularly relevant for this Project, where the architectural layout places residential towers in direct alignment with the combustion exhausts of the generators on the data centre. The use of CFD allows pollutant plumes to be traced through this environment under varying meteorological conditions, providing a nuanced understanding of risk.

#### Temporal resolution and long-term scenario mapping

While AERMOD is generally an appropriate dispersion model to use in this assessment, CFD was introduced as a targeted extension to improve resolution in near-field interactions for the receptors R1 to R3. The two approaches were applied in parallel, with CFD focusing on refining the dispersion patterns under conditions most likely to affect the proposed development.

An advantage of this supplementary CFD assessment was the ability to run simulations based on measured site-specific climate conditions. This was done by accessing meteorological data from the two nearest stations to the target site, which were Sydney Olympic Park (station ID: 066195) and Sydney Archery Centre (station ID: 066212). This data allowed for the simulation scenarios to be selected to create an operational design envelope based on realistic site wind and temperature conditions. By incorporating site-specific building geometry and aligning each CFD scenario with long-term meteorological frequencies at high temporal resolution, this approach enabled the development of a probability-weighted air quality risk framework. This was particularly useful for assessing upper-level receptors, façade alignment effects and the potential for short-lived but recurrent exposure events. The results from CFD, therefore, serve as a high-resolution complement to AERMOD outputs, providing detailed spatial and temporal context for interpreting near-field air quality impacts at the proposed development.

#### Eulerian versus Lagrangian approaches

In atmospheric dispersion modelling, besides the Gaussian approach, two other primary computational frameworks are employed, namely the Eulerian approach (the CFD used in this assessment) and Lagrangian (such as GRAL) approach. Each offers distinct methodologies suited to specific scenarios, particularly when considering factors like particle size and the influence of Brownian motion.

- Eulerian approach: This method involves solving the advection-diffusion equations on a fixed spatial grid, providing continuous concentration fields over time. The Eulerian framework is particularly adept at handling complex chemical reactions, varying meteorological conditions and spatially distributed sources. Its grid-based nature facilitates the integration of detailed boundary conditions and terrain features, making it suitable for urban-scale air quality assessments. However, the approach can be computationally intensive, especially when high spatial resolution is required<sup>3</sup>.
- Lagrangian approach: Contrastingly, the Lagrangian method tracks individual pollutant particles or parcels as they move through the atmosphere, often employing stochastic processes to

---

<sup>3</sup> Leelőssy, Á., et al. (2016). Eulerian and Lagrangian approaches for modelling of air quality. *Mathematical Problems in Meteorological Modelling*, Springer.

---

represent turbulent diffusion. This approach is advantageous for modelling dispersion from point sources over large distances and can be more computationally efficient for certain applications. Nonetheless, it may face challenges in accurately representing chemical transformations and interactions with complex urban geometries<sup>4</sup>.

The choice between these approaches often hinges on the characteristics of the pollutants being modelled. For gaseous pollutants, which consist of molecules with diameters typically less than 0.1 micrometres, Brownian motion—the random movement resulting from collisions with air molecules—plays a negligible role in their dispersion. Consequently, the stochastic particle tracking inherent in Lagrangian models offers limited additional insight for such fine-scale pollutants<sup>5</sup>. Given the objective of this study —focusing on near-field dispersion in a densely built urban environment with significant building-induced turbulence—the Eulerian approach was deemed more appropriate. Its ability to provide detailed spatial concentration fields and incorporate complex boundary conditions aligns with the requirements of accurately assessing pollutant behaviour in such settings. Furthermore, the Eulerian framework facilitates the integration of high-resolution meteorological data and detailed emission inventories, enhancing the robustness of the simulation outcomes.

---

<sup>4</sup> Trini Castelli, S. (2019). The Lagrangian approach to dispersion modeling: why we like it (and what we did with it). International Technical Meeting on Air Pollution Modelling and its Application, Springer

<sup>5</sup> Ghalati, P. F., et al. (2012). "Numerical analysis of micro-and nano-particle deposition in a realistic human upper airway." Computers in biology and medicine 42(1): 39-49.

---

## Appendix C – CFD modelling technical details

**Stockland**

# Mpark Road 1 Data Centre

## Air Quality CFD Impact Assessment

Revision 02 | 13<sup>th</sup> January 2026

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party

Job Number: 304093-21

Arup Australia Pty Ltd | ABN 76 625 912 665

**Arup Australia Pty Ltd**  
Level 5  
Sydney  
NSW, 2000  
Australia

# Document Verification

**Project title** MPark Road 1 Data Centre  
**Document title** CFD pollution impact assessment  
**Current revision** Initial Release  
**Job number** 304093-21  
**File reference**

Revision	Date	Filename	Mpark_CFD Pollution Impact_20250704.pdf		
Initial Release	4 <sup>th</sup> Jul 2025	<b>Description</b>	Initial release of CFD assessment results		
			<b>Prepared by</b>	<b>Checked by</b>	<b>Approved by</b>
		<b>Name</b>	Luke Donnelly	Erfan Keshavarzian Suk-Yi Lo	Erfan Keshavarzian
Rev. 01	16 <sup>th</sup> Dec 2025	<b>Description</b>	Mpark_CFD Pollution Impact_Rev 01_20251216.pdf		
			<b>Prepared by</b>	<b>Checked by</b>	<b>Approved by</b>
		<b>Name</b>	Luke Donnelly	Erfan Keshavarzian	Erfan Keshavarzian
Rev. 02	13 <sup>th</sup> Jan 2025	<b>Description</b>	Mpark_CFD Pollution Impact_Rev 02_20250113.pdf		
			<b>Prepared by</b>	<b>Checked by</b>	<b>Approved by</b>
		<b>Name</b>	Pallava Kodali Luke Donnelly	Erfan Keshavarzian	Suk-yi Lo
Rev. 03		<b>Description</b>			
			<b>Prepared by</b>	<b>Checked by</b>	<b>Approved by</b>
		<b>Name</b>			

# Executive Summary

Arup has been commissioned to prepare an air quality impact assessment using Computational Fluid Dynamics (CFD) for the proposed Road 1 Data Centre at 1-5 Khartoum Road, Macquarie Park, focusing on potential impacts on an adjacent residential development. This study was undertaken as a complementary assessment to the AERMOD-based air quality studies, which meet the minimum regulatory requirement for air quality assessment. The CFD approach was adopted to address limitations in AERMOD's capability to capture complex building-induced airflow effects, enabling higher-resolution insight into pollutant dispersion in the local built environment.

The CFD simulations were conducted using OpenFOAM to model the dispersion of pollutants from the rooftop generator exhausts. The simulation domain included the proposed Road 1 Data Centre, the future adjacent Talavera Road Data Centre, the three planned residential towers (notated as R1, R2, and R3), and all other existing buildings within a 500m radius of the data centres. Seventeen years of meteorological data from the two nearest Bureau of Meteorology (BoM) automatic weather stations were used to inform the selection of 16 wind scenarios, representing the full range of relevant ambient conditions.

Pollutant concentrations were assessed using 963 sensor locations placed on all façades of the three planned residential towers, representing potential receptors points. Results were compared against respective criteria provided in the *Approved Methods for the Modelling and Assessment of Air Pollutants*. The pollutants assessed included Carbon Monoxide (CO), Sulfur Dioxide (SO<sub>2</sub>), Benzene, PM<sub>2.5</sub>, PM<sub>10</sub>, and Nitrogen Dioxide (NO<sub>2</sub>). However, in alignment with previous assessments of this site, the analysis presented herein is focused around NO<sub>2</sub> as this was the pollutant with the highest exhaust concentration in relation to its respective criterion.

The scope of this assessment was limited to the combustion exhausts (flues) on Road 1 Data Centre. From this, there was no combination of wind speed, wind direction, and air temperature which was found to result in any pollution concentration exceedances across the surface of the proposed towers.

Detailed visualisations of NO<sub>2</sub> exhaust plumes are provided. No further numerical integration of climate occurrence probability was deemed necessary at this stage as there was not any measured exceedances across all tested scenarios.

# Methodology

# CFD Assessment Methodology

## Assessment domain

The subject of this assessment is the site located at 1-5 Khartoum Road, Macquarie Park, in the City of Ryde Local Government Area (LGA). To accurately simulate the dispersion of polluted exhaust air, a three-dimensional model of the target site was constructed to include all proposed developments and surrounding buildings in sufficient detail.



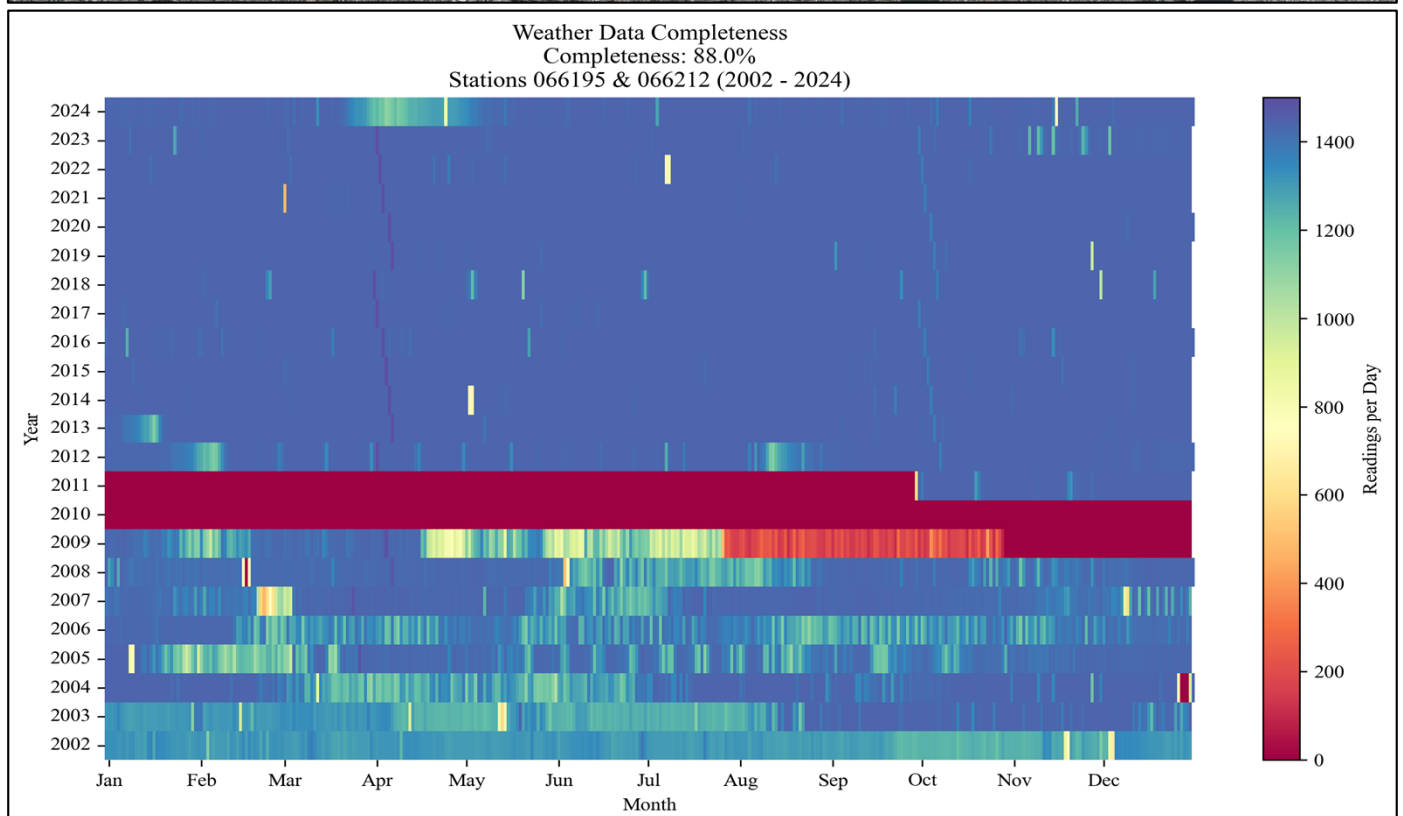
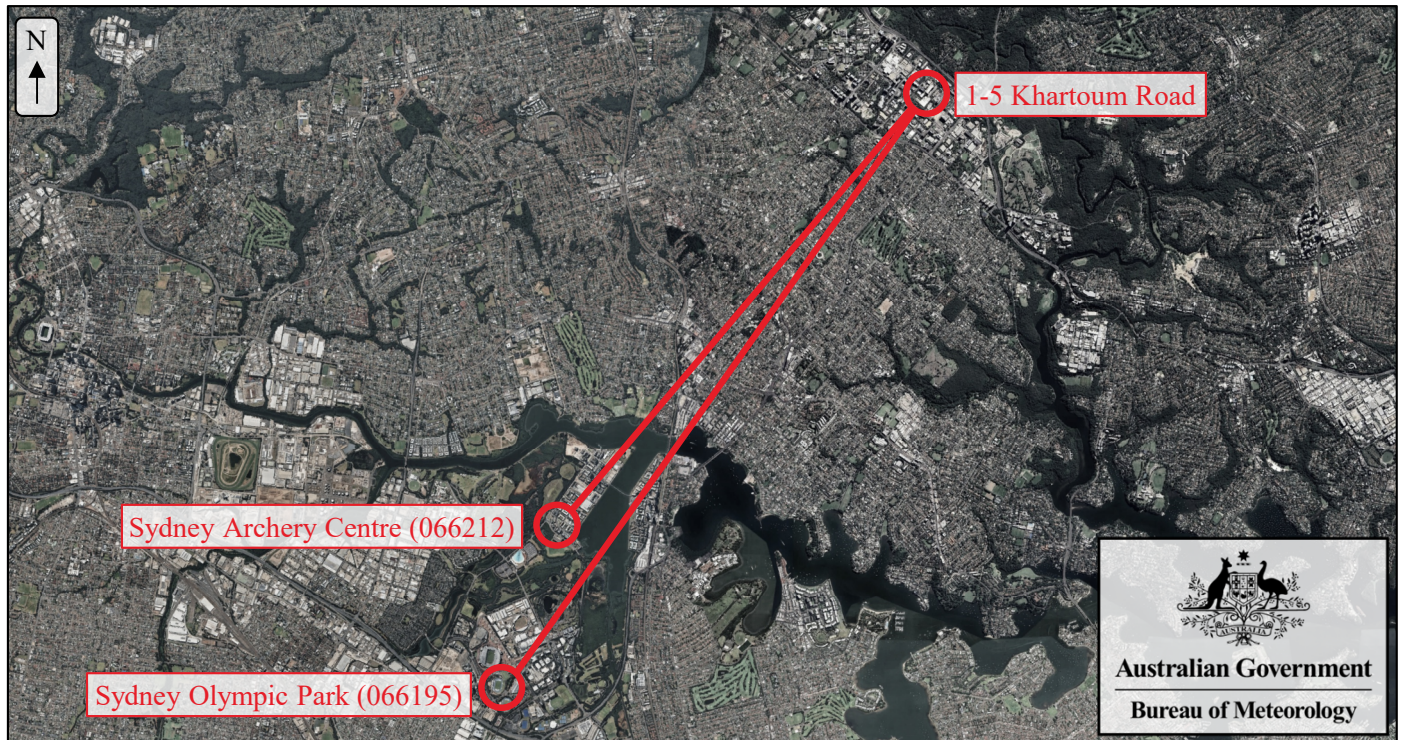
The computational domain was constructed by modelling the proposed Road 1 Data Centre, as well as the proposed towers R1, R2, and R3. All buildings within a 500m radius and the ground topography within a 600m radius were also modelled to ensure flow field accuracy at the target site. While all rooftop equipment on the data centre was represented in the model, the number of active exhaust sources was limited to three due to the relatively close distance of each flue. These 'representative' flues were spatially distributed along the full length of each building to simulate worst-case dispersion conditions.



# CFD Assessment Methodology

## Meteorological Analysis and Scenario Selection

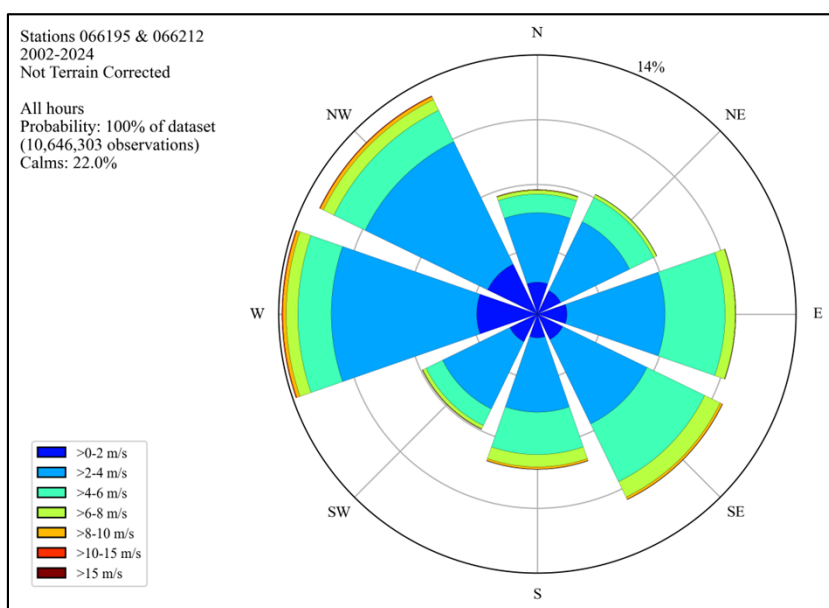
The two nearest stations to the target site are Sydney Olympic Park (station ID: 066195) and Sydney Archery Centre (station ID: 066212) which are located 9.8 km and 7.8 km from the target site respectively. The Sydney Olympic Park station was operational from 2002 to 2009, and Sydney Archery Centre started operation in 2011 and remains operational to time of reporting. After being cleaned for misreadings, these two stations offer a total of 10,646,303 observations in 1-minute intervals. This corresponds to a data acquisition completeness of 88%, though the 12% of missing data mostly comes from the time in 2009, 2010, and 2011 where no station was recording.



# CFD Assessment Methodology

## Meteorological Analysis and Scenario Selection

A detailed ambient meteorological assessment is needed to inform the number of scenarios that are required, as well as an appropriate wind speed and air temperature for each wind direction. Since the pollutant sources are located so close to the proposed towers R1, R2, and R3, it was decided that all wind directions should be simulated. When wind blows from the west, it is possible that the negative pressure on the leeward side of the buildings would be sufficiently large to draw polluted towards the towers. Pictured below is the windrose of the two nearby stations considered, which depicts the relative occurrence probability and intensity of wind speed and wind direction. This data is used to inform the scenario selection.



For each of the 8 cardinal wind directions, a low and high wind speed was chosen to create a wind design envelope encompassing all possible ambient conditions, resulting in 16 simulations in total. The low and high wind speeds were chosen based on the 5<sup>th</sup> and 95<sup>th</sup> percentile respectively of fastest wind speeds expected at the target site. The ambient air temperature was important to include as the heat difference between the exhaust air and ambient air creates buoyant forces acting on the pollutants. The air temperature was chosen as the mean coincident value for each wind scenario.

Scenario Number	Wind Direction	Wind Speed (m/s)	Air Temperature (°C)
1	N	1	19.6
2	N	5.7	22.8
3	NE	1	21.5
4	NE	5.7	24.1
5	E	1	21.6
6	E	6.2	24
7	SE	1	19.8
8	SE	6.7	20.9
9	S	1	18.3
10	S	6.7	18.7
11	SW	1	16.1
12	SW	5.1	17
13	W	1	14.4
14	W	6.2	18.3
15	NW	1	14.8
16	NW	6.2	19.9

The wind speed and direction data was extracted from stations 066195 and 066212 for the full year of 2022 (considered as representative year and consistent with AERMOD modelling). Each reading was classified based on the wind direction (cardinal N, NE, E, etc.) and wind speed (low or high) so that the pollutant concentration results of one of the 16 simulated scenarios could be mapped onto it. This created an approximate real-time time-history pollution concentration at the target site for the year 2022. From this, information about the expected probability of criteria exceedance as well as maximum expected pollutant concentration could be extracted.

# CFD Assessment Methodology

## Pollutant Exhaust Concentration and Criteria

The dispersion of pollution is monitored by including a unique passive scalar field for each of the exhaust sources for the Road 1 Data Centre included in the model. This field is normalised by setting the ambient field value to 0 and the exhaust value to 1, so that the field may be used to simulate the different exhaust and ambient concentrations of different pollutants through simple scaling and transposing. These fields are scaled based on the reported pollutant concentrations as presented in the table below.

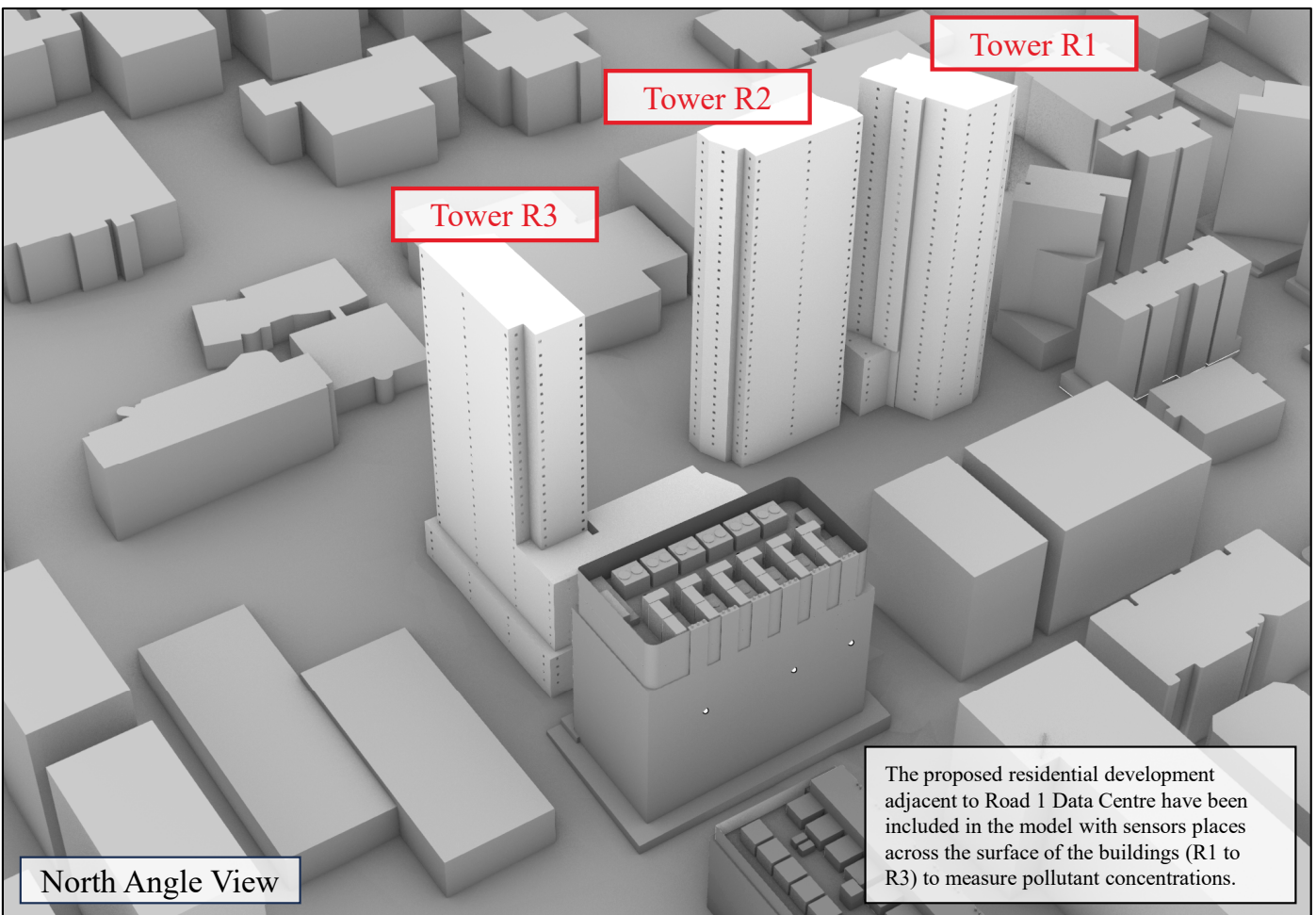
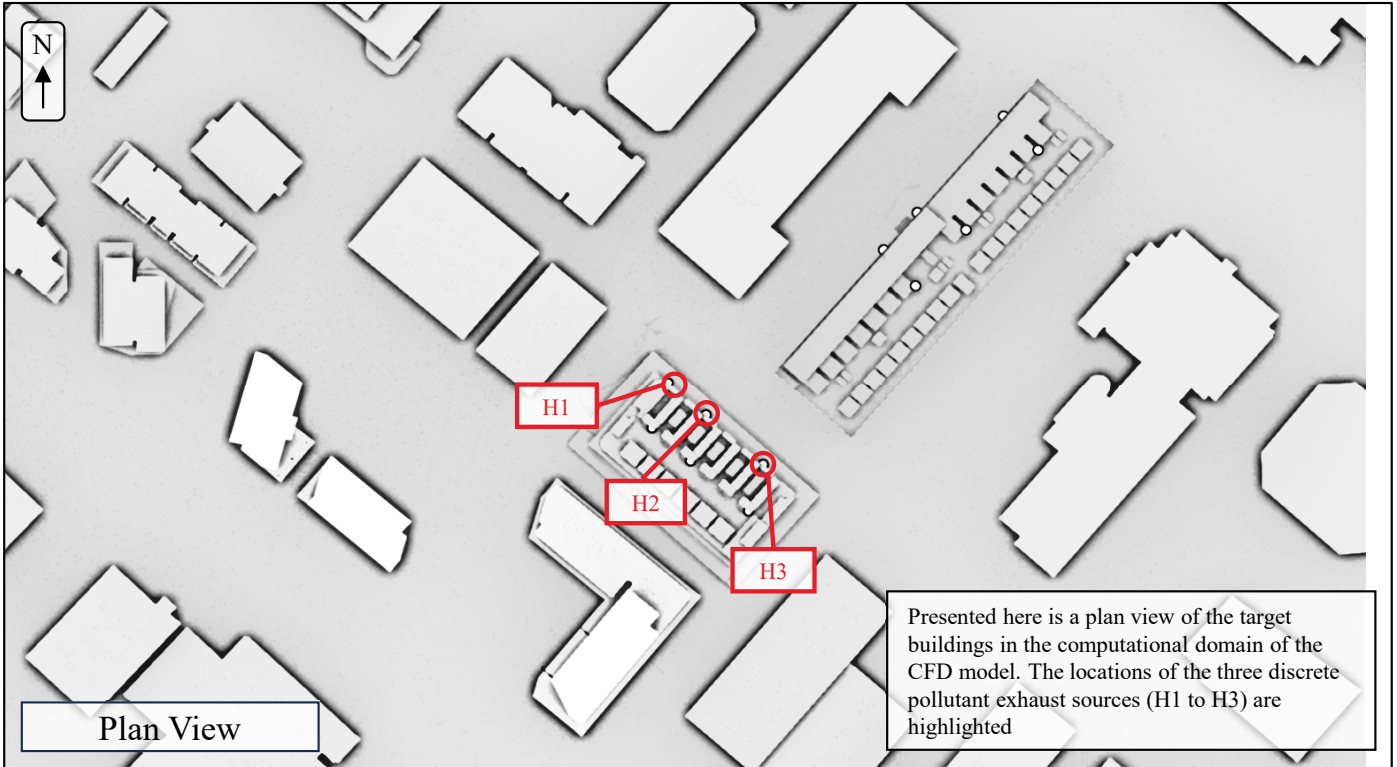
Pollutant	Road 1 Data Centre Exhaust Concentration ( $\mu\text{g}/\text{m}^3$ )
Carbon Monoxide (CO)	41,164.4
Sulfur Dioxide (SO <sub>2</sub> )	7,329.8
Nitrogen Oxides (NO <sub>x</sub> )	641,576.3
Benzene	67.3
PM <sub>10</sub>	2,268.2
PM <sub>2.5</sub>	2,268.2

There are 963 sensors placed on the three residential towers (R1 to R3) to record the pollutant concentrations across the surface of the buildings. For each simulated wind scenario, the pollutant concentrations are recorded and later factored based on the relative occurrence probability of the wind scenarios. The pollutant fields have the ambient concentration added in and are then compared with their respective criteria as presented in the following table.

Pollutant	Averaging Period	Concentration Criteria ( $\mu\text{g}/\text{m}^3$ )	Ambient Concentration ( $\mu\text{g}/\text{m}^3$ )
Carbon Monoxide (CO)	0.25 hours	100,000	1062.2
	1 hour	30,000	2645.0
	8 hours	10,000	805.0
Sulfur Dioxide (SO <sub>2</sub> )	1 hour	286	81.2
	24 hours	57	8.5
Nitrogen Dioxide (NO <sub>2</sub> )	1 hour	164	43.2
Benzene	1 hour	29	0.0
PM <sub>10</sub>	24 hours	50	25.9
PM <sub>2.5</sub>	24 hours	25	17.6

## CFD Assessment Methodology

### Exhaust Source Layout



# CFD Assessment Methodology

## Pollutant Exhaust Concentration and Criteria

The generator combustion exhausts release nitrogen oxides ( $\text{NO}_x$ ) into the air. It has been assumed that at the source, approximately 10% of the  $\text{NO}_x$  is in the form of nitrogen dioxide ( $\text{NO}_2$ ), with the remaining being mostly nitric oxide ( $\text{NO}$ ) (based on the US EPA's Ozone Limiting Method). As the exhaust gasses mix with air, the  $\text{NO}$  reacts with ambient ozone ( $\text{O}_3$ ) producing secondary  $\text{NO}_2$ . The  $\text{O}_3$  is a limiting reagent meaning the volume of secondary  $\text{NO}_2$  produced relies upon the ambient concentration of  $\text{O}_3$ . This study has utilized the following formula to estimate the final concentration of  $\text{NO}_2$  from the generator combustion exhausts, which considers both in-stack  $\text{NO}_2$  and the additional  $\text{NO}_2$  that results from the reaction of  $\text{NO}$  and  $\text{O}_3$ .

For this assessment, a photochemical conversion for short-term concentrations (i.e. hourly average) from  $\text{NO}_x$  to  $\text{NO}_2$  were determined in accordance with the US EPA's Ozone Limiting Method<sup>17</sup> (OLM), as per Section 8.1.2 of the Approved Methods. OLM assumes  $\text{NO}$  conversion to  $\text{NO}_2$  by reaction with ambient ozone. The OLM equation for calculating  $\text{NO}_2$  is provided below:

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

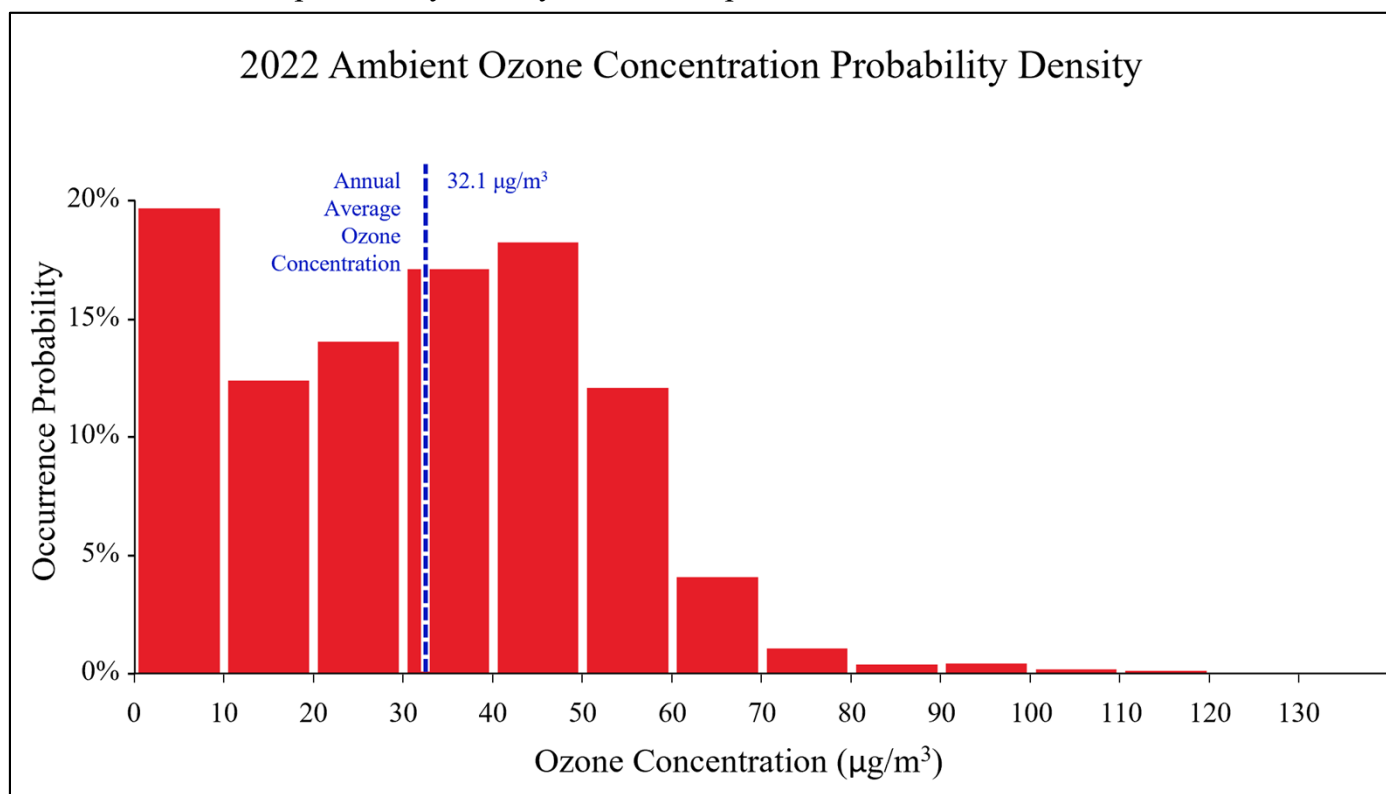
Where,

$ISR$  = In-stack  $\text{NO}_2/\text{NO}_x$  ratio

The OLM assumes a default 10% of the  $\text{NO}_x$  was initially  $\text{NO}_2$  upon release, equating to an in-stack  $\text{NO}_2/\text{NO}_x$  ratio of 0.1. This  $ISR$  is generally appropriate for combustion sources<sup>18</sup>. On this basis, the simplified OLM equation is:

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

The ambient ozone concentration for 2022 has been recorded and appended to the weather data which allows for the exhaust concentration to be scaled dynamically throughout the time domain of the assessment. The probability density of ozone is presented below.



# Results

# CFD Results

## Exhaust Plumes

The following pages present the modelled exhaust plumes from three representative generator combustion exhaust flues on the Road 1 Data Centre roof. These generators were selected to assess maintenance operating conditions, under which only one generator operates at a time. Units located at the ends and the middle of the generator row were modelled to represent potential variations in plume behaviour associated with different rooftop positions.

For each assessed case, a single generator is assumed to be operating, with the remaining generators inactive. This approach provides a representative assessment of maintenance operation scenarios without requiring modelling of every individual generator location.

Results are presented for nitrogen dioxide (NO<sub>2</sub>) only, as this pollutant was identified as the controlling species; all other assessed pollutants were predicted to remain well below their respective assessment criteria.

The exhaust plumes are defined using an NO<sub>2</sub> concentration threshold of 164 µg/m<sup>3</sup>, consistent with the adopted assessment criterion. Regions within the plume exceed this threshold, while concentrations outside the plume are below the criterion. These plume envelopes are used to identify operating scenarios that may result in elevated pollutant concentrations at nearby tower façades.

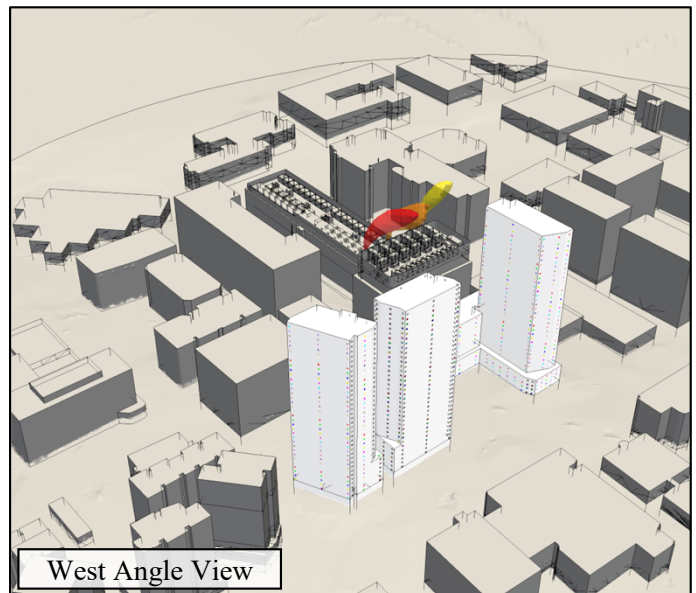
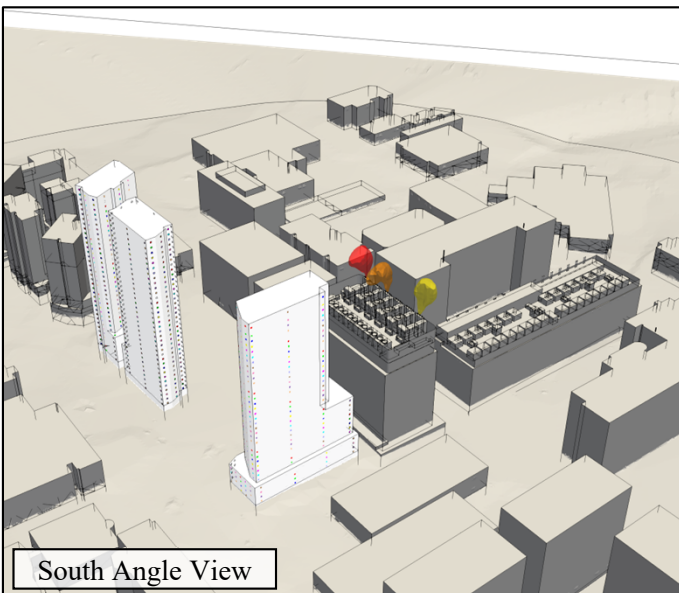
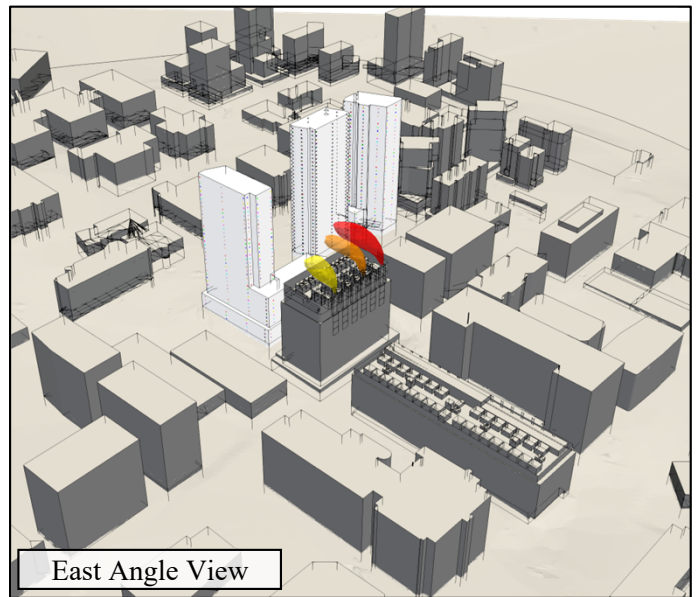
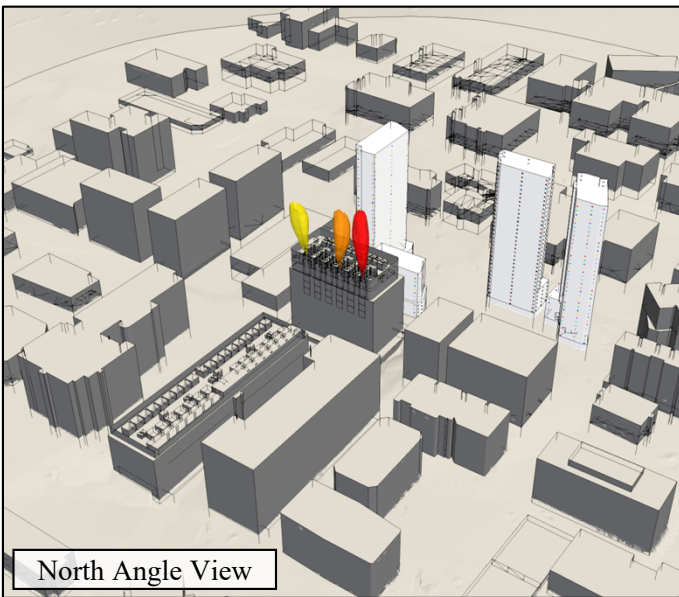
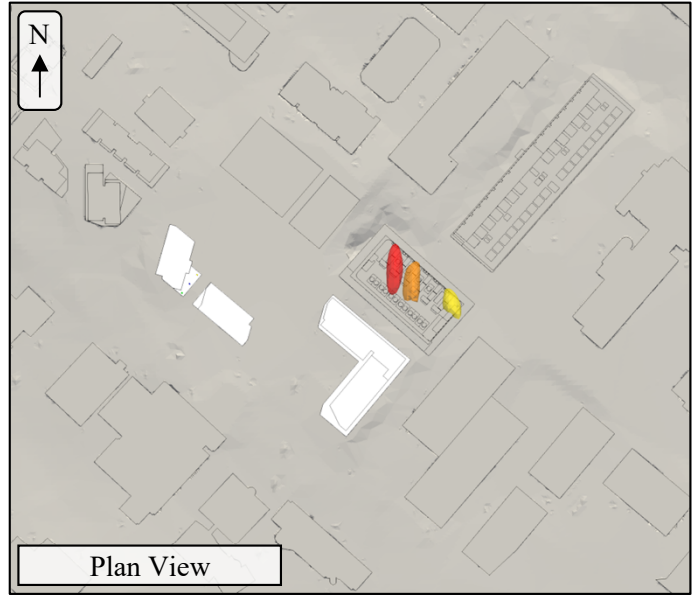
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 1

Wind Direction *North*  
 Wind Speeds *1.0 m/s (low)*  
 Air Temperature *19.6°C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



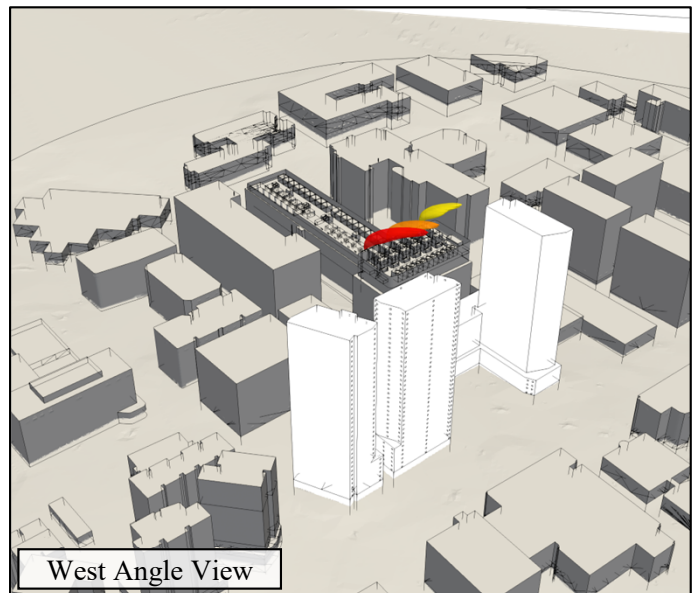
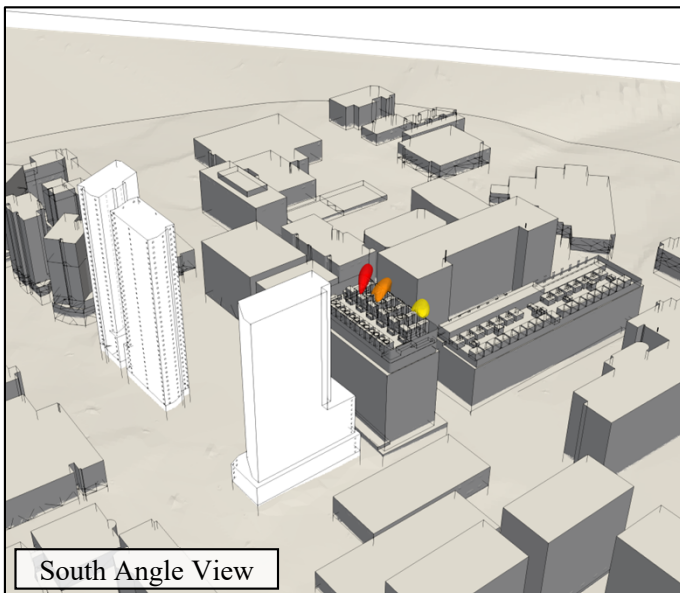
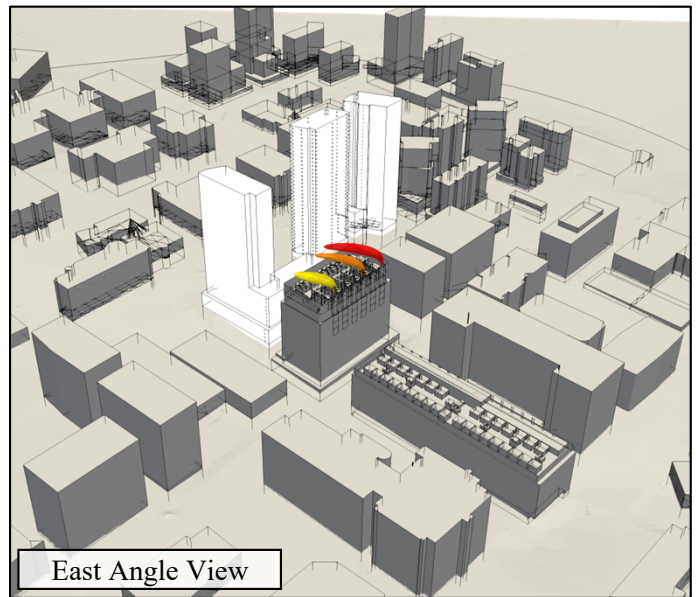
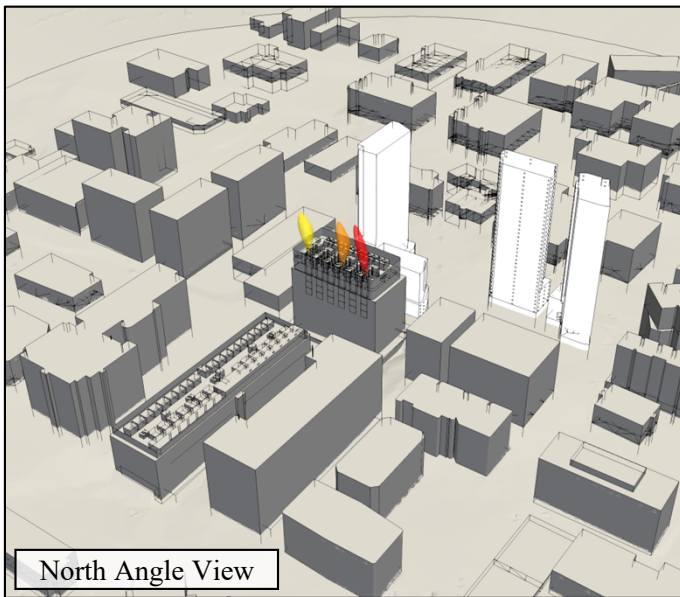
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 2

Wind Direction *North*  
Wind Speeds *5.7 m/s (high)*  
Air Temperature *22.8 °C*  
Pollutant Type *NO<sub>2</sub>*  
Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



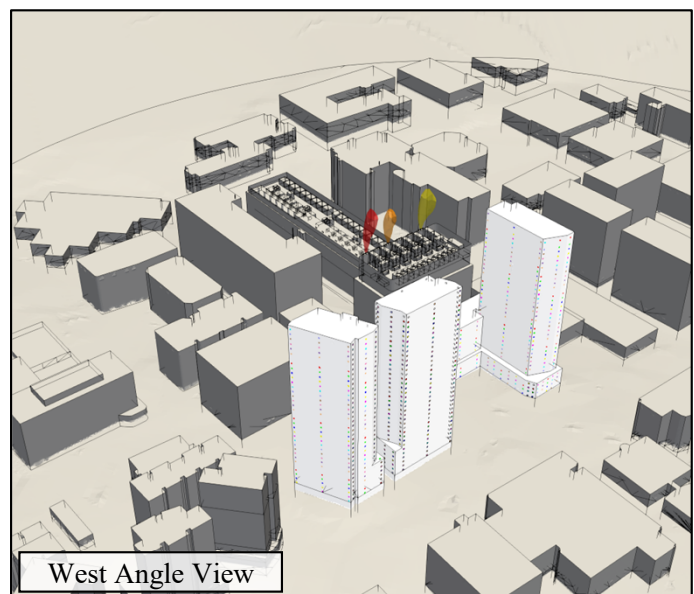
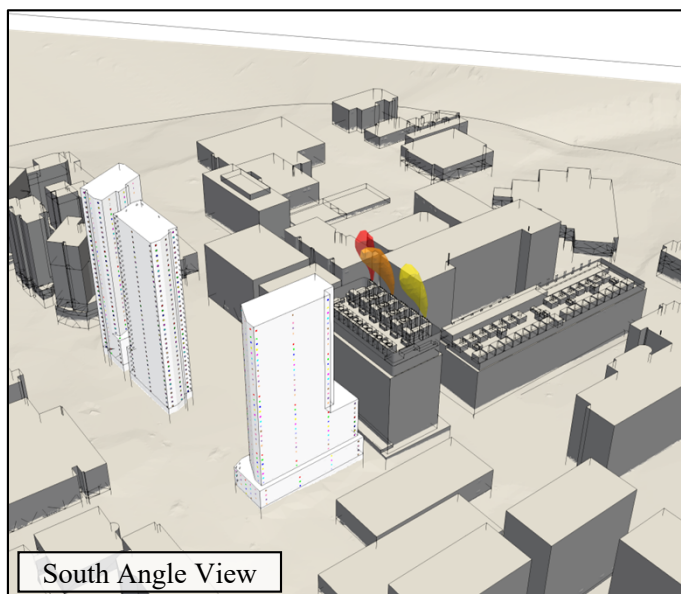
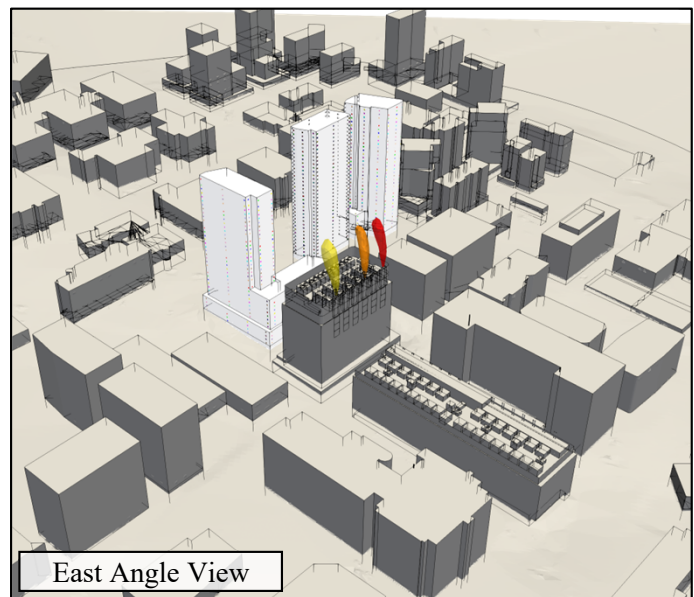
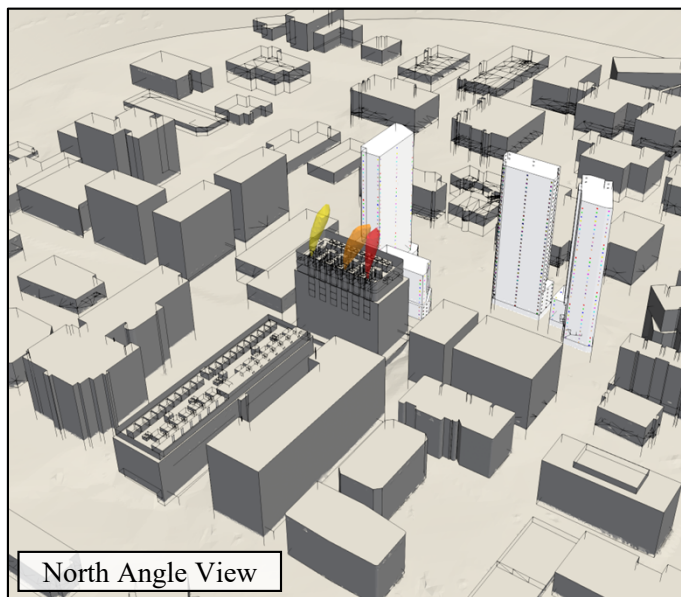
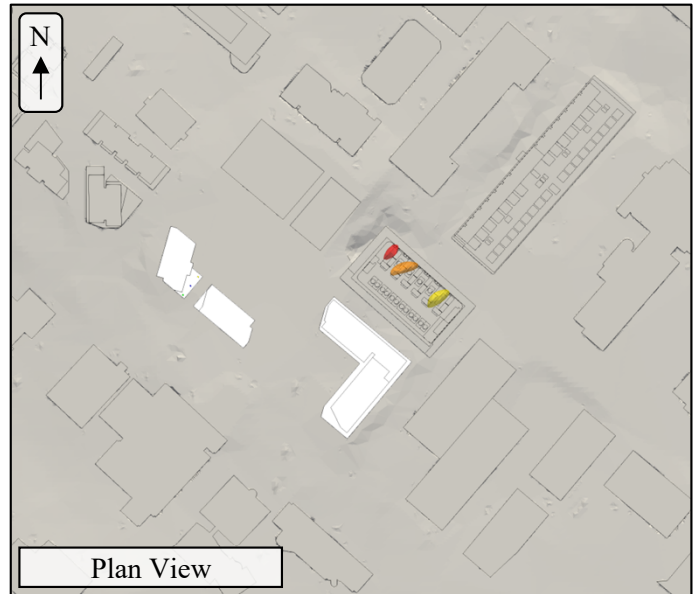
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 3

Wind Direction *Northeast*  
 Wind Speeds *1.0 m/s (low)*  
 Air Temperature *21.5°C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



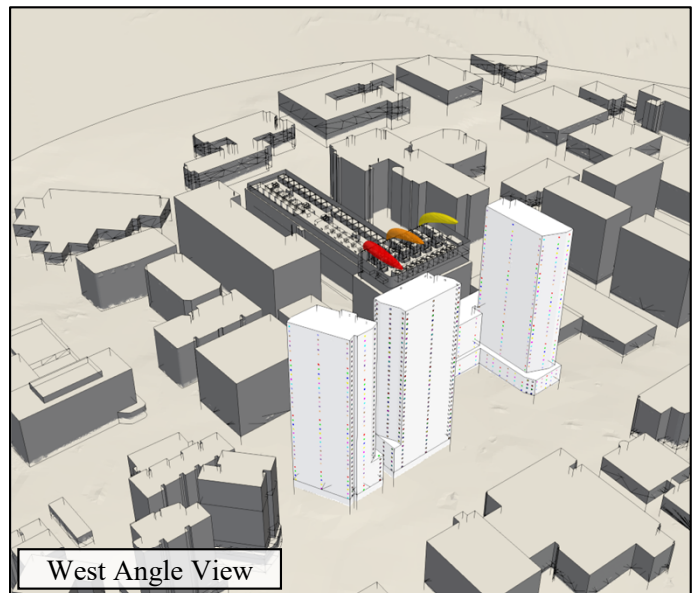
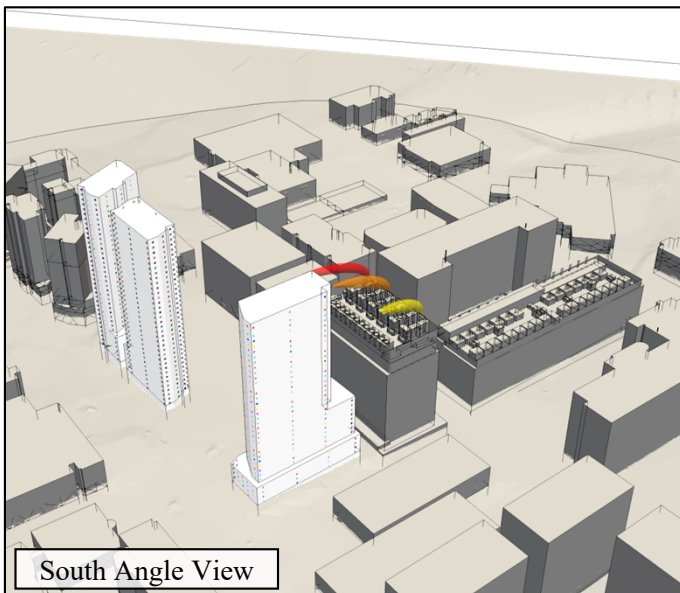
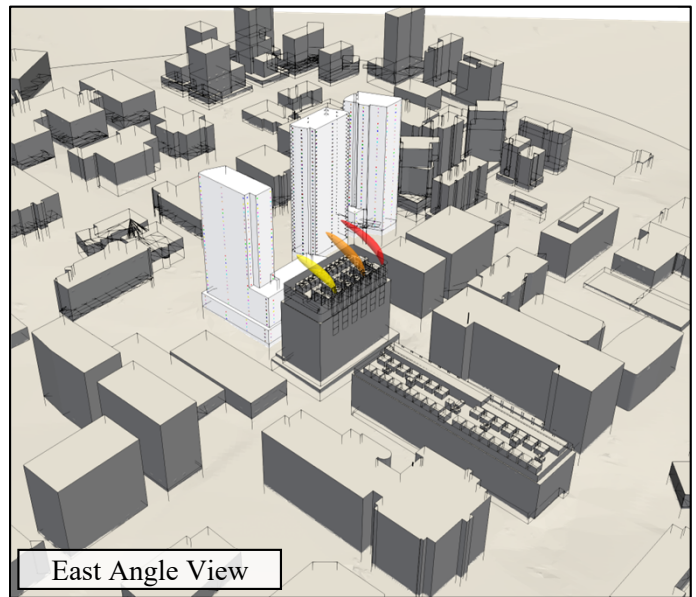
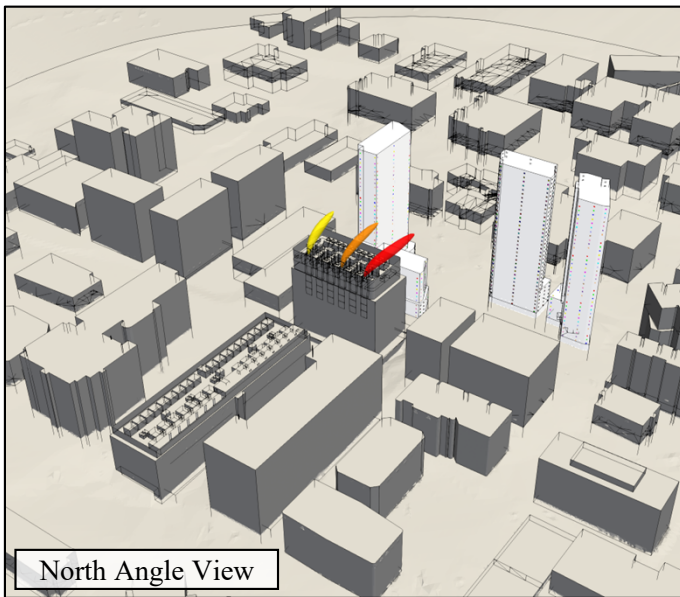
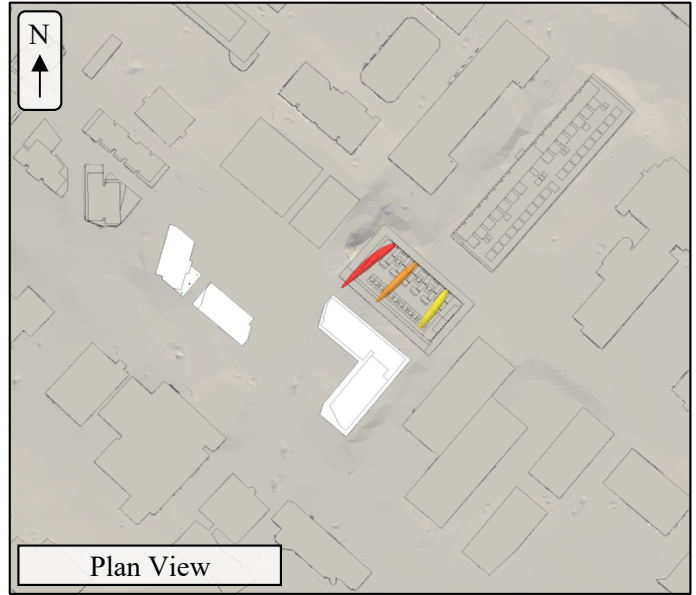
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 4

Wind Direction *Northeast*  
Wind Speeds *5.7 m/s (high)*  
Air Temperature *24.1 °C*  
Pollutant Type *NO<sub>2</sub>*  
Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



# CFD Results

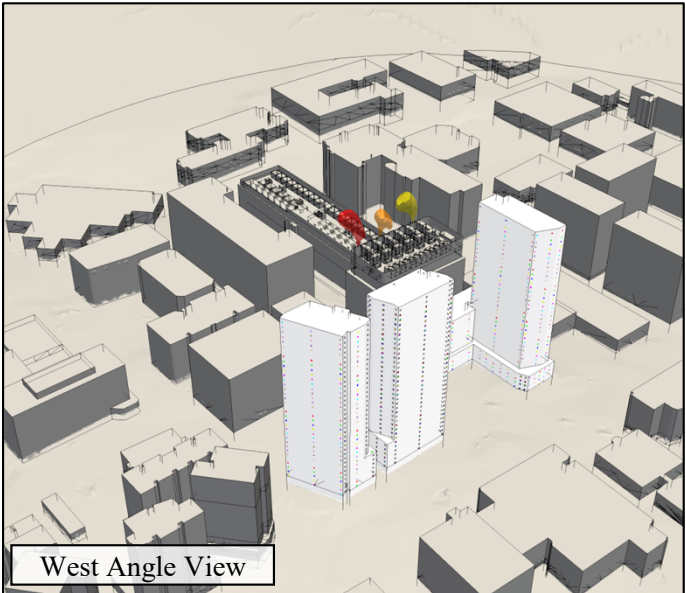
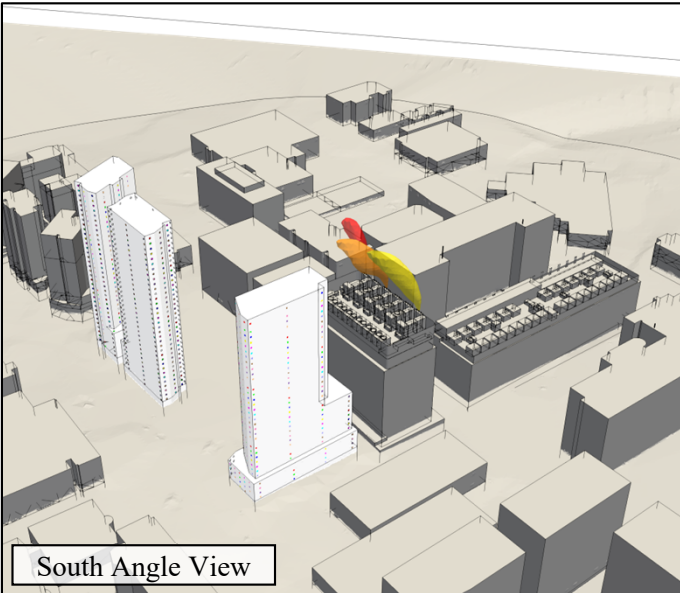
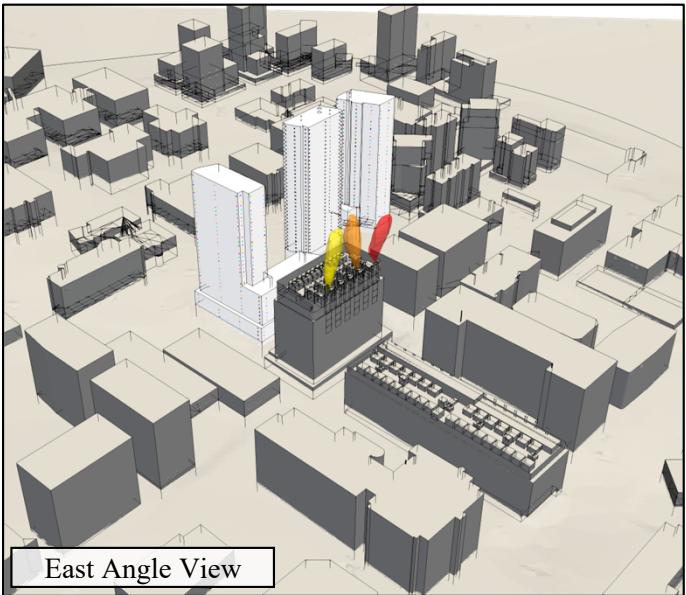
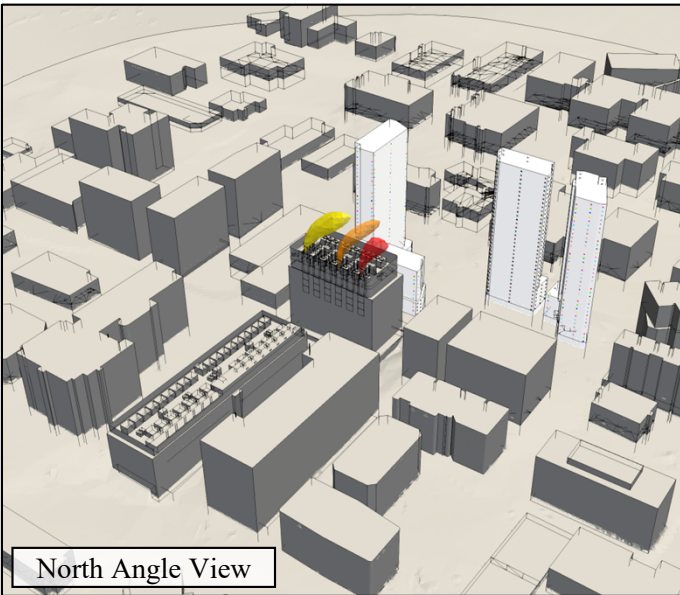
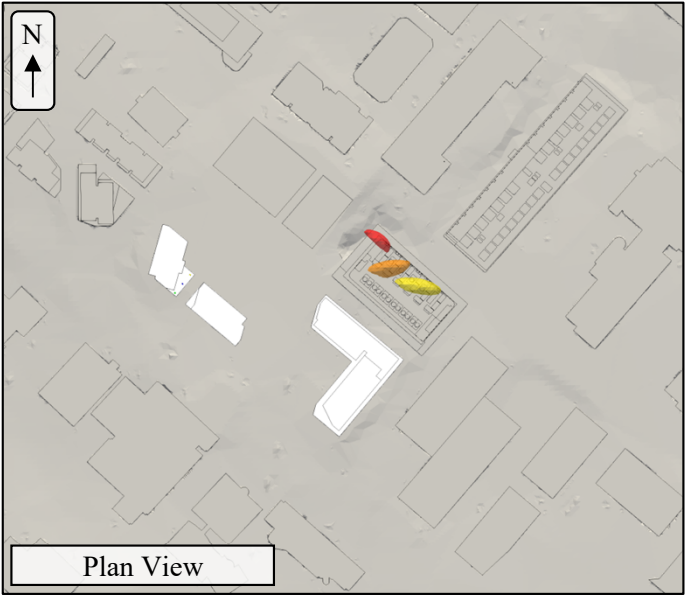
## Exhaust Plumes and Surface Contours

**Scenario 5**

Wind Direction	<i>East</i>
Wind Speeds	<i>1.0 m/s (low)</i>
Air Temperature	<i>21.6 °C</i>
Pollutant Type	<i>NO<sub>2</sub></i>
Pollutant Source	<i>Road 1 Data Centre</i>

---

- Flue 1
- Flue 2
- Flue 3



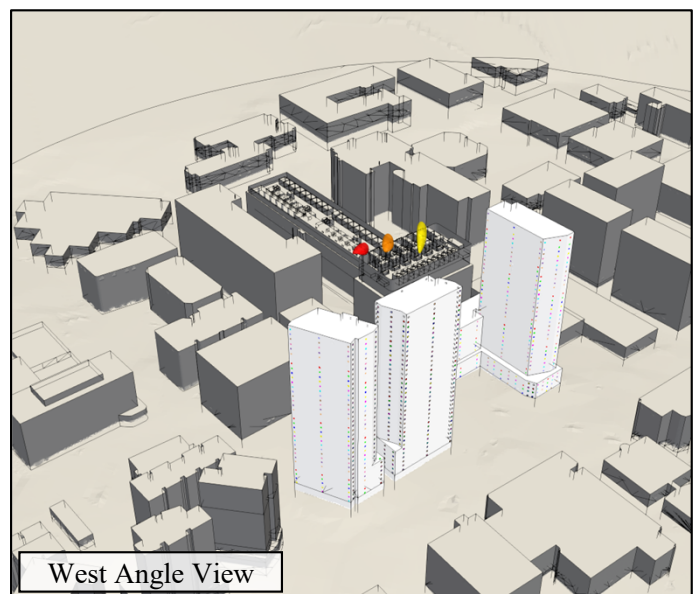
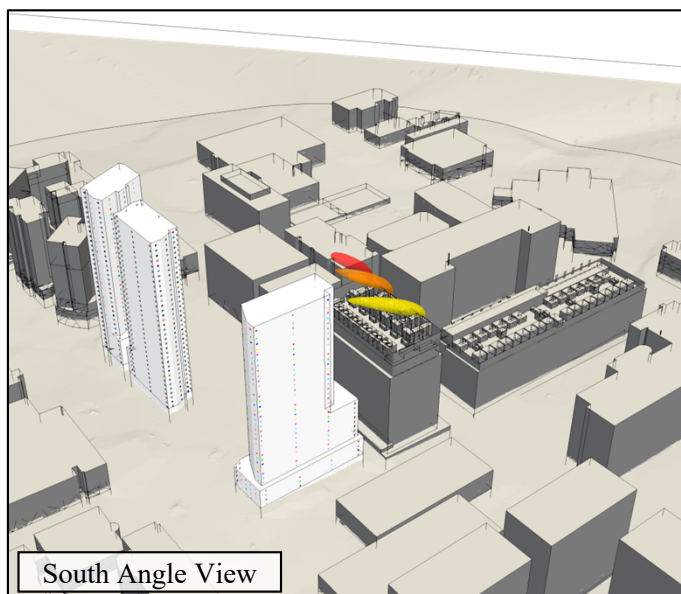
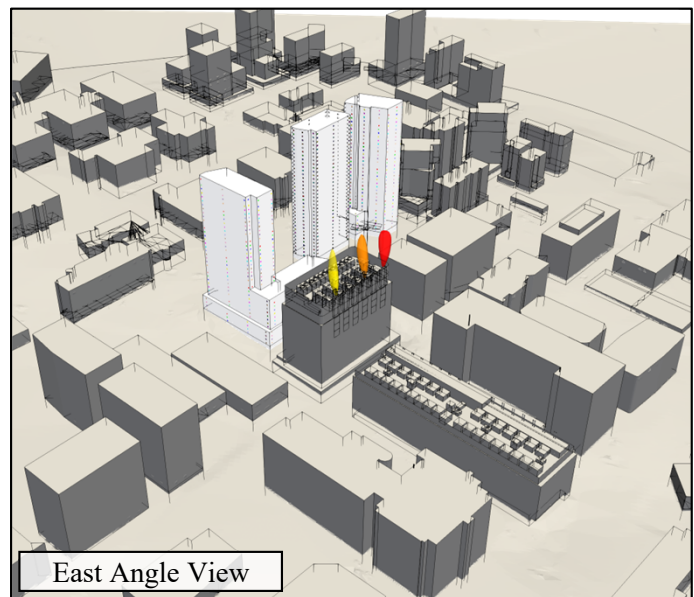
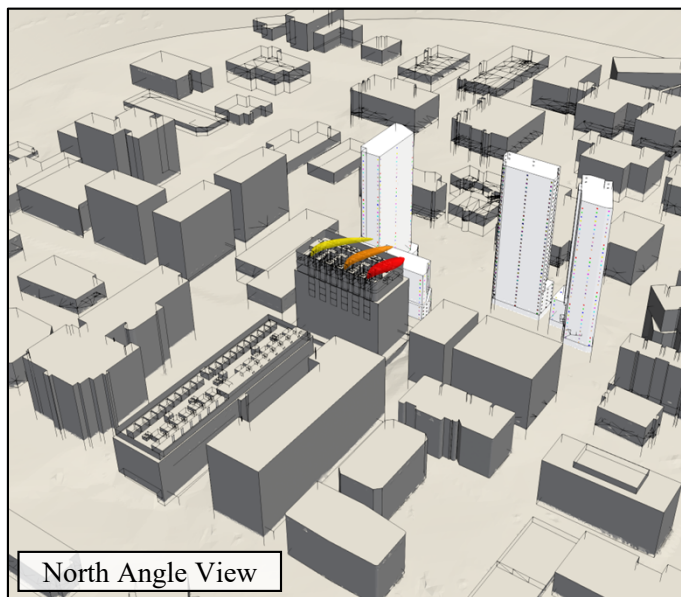
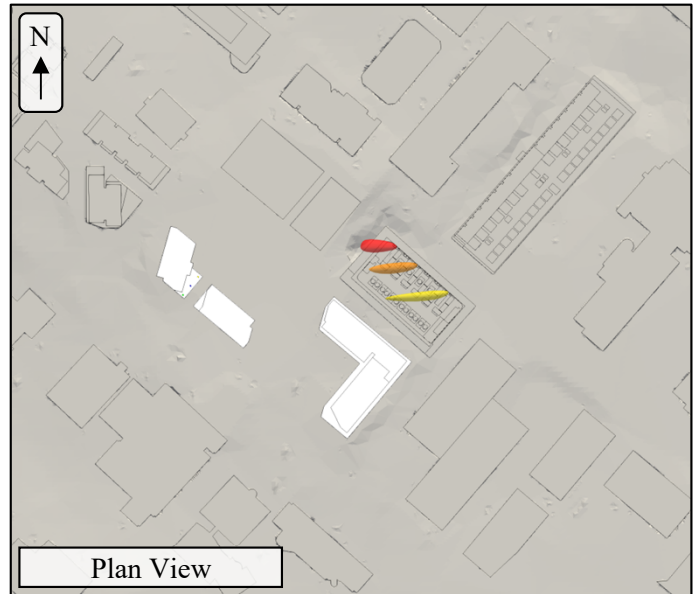
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 6

Wind Direction *East*  
 Wind Speeds *6.2 m/s (high)*  
 Air Temperature *24.0 °C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



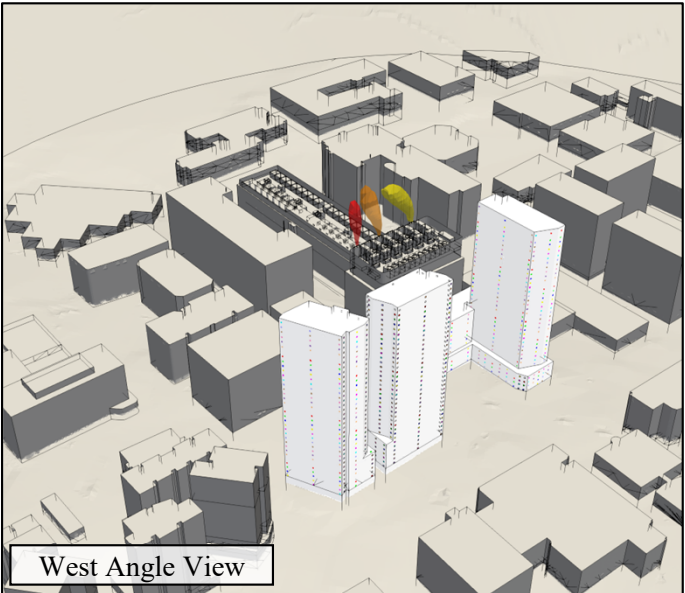
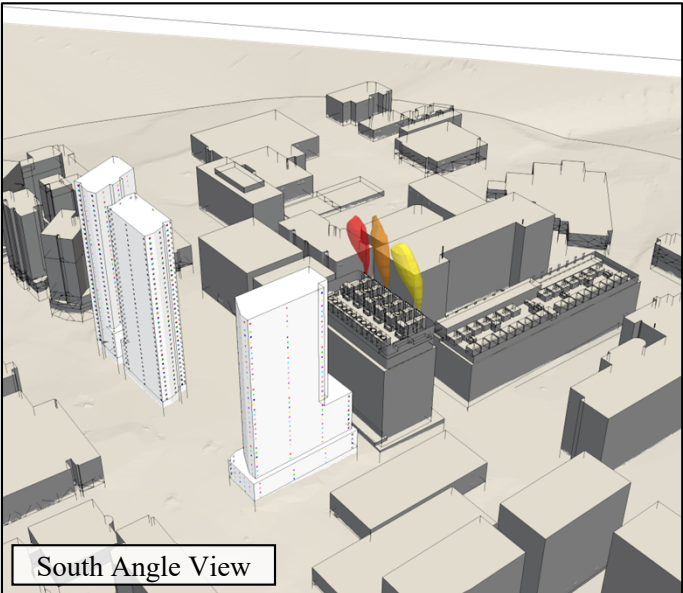
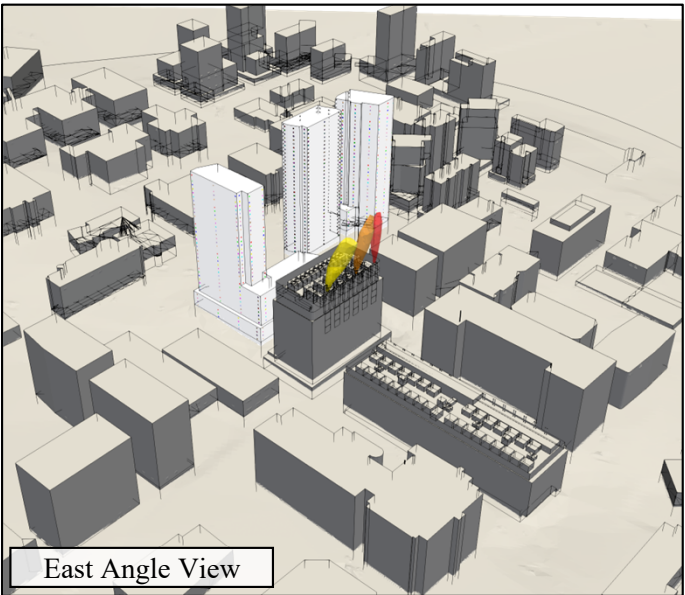
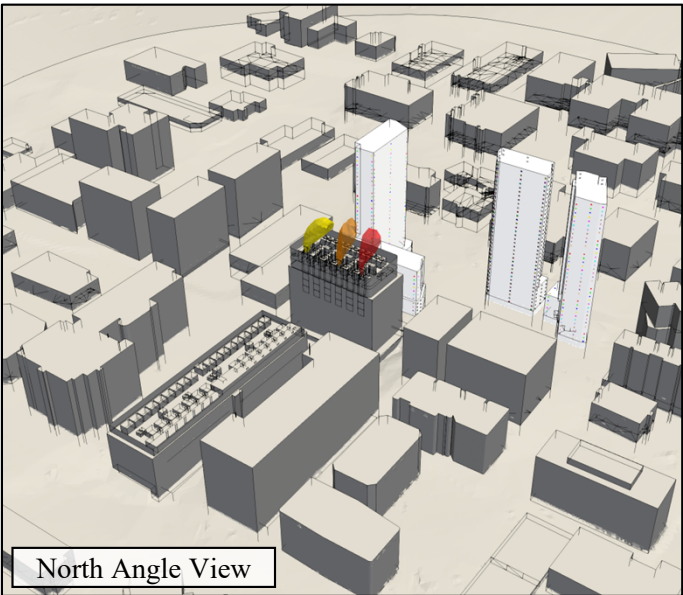
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 7

Wind Direction *Southeast*  
Wind Speeds *1.0 m/s (low)*  
Air Temperature *19.8 °C*  
Pollutant Type *NO<sub>2</sub>*  
Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



# CFD Results

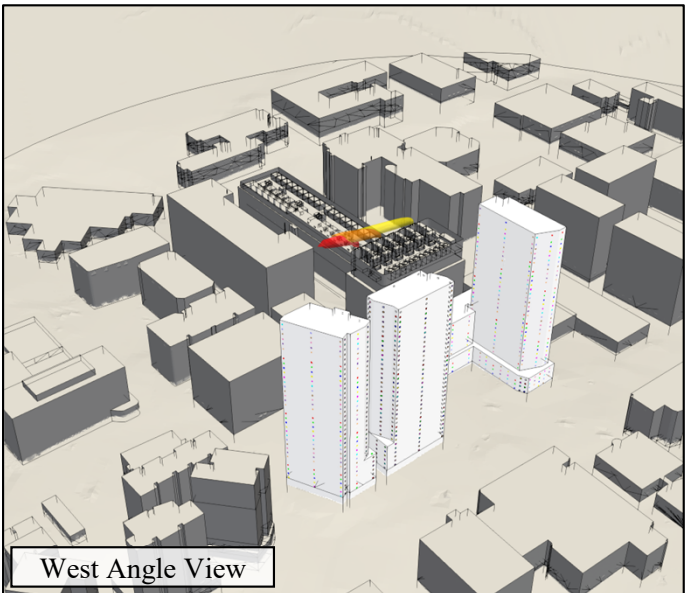
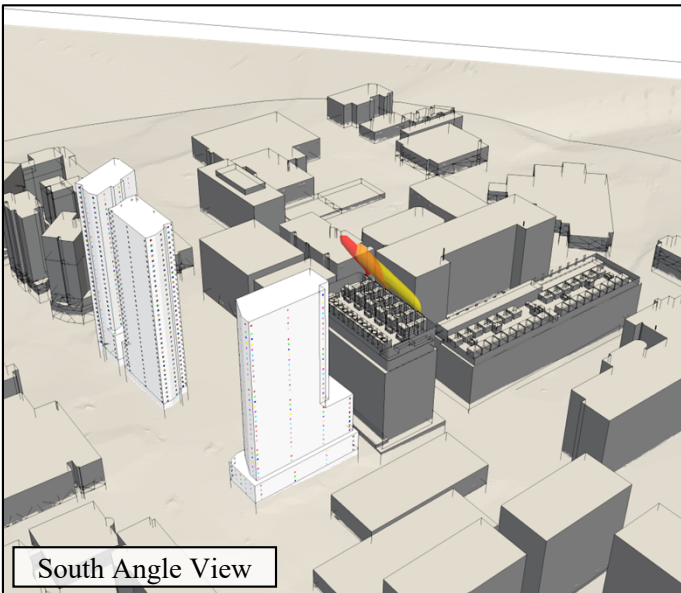
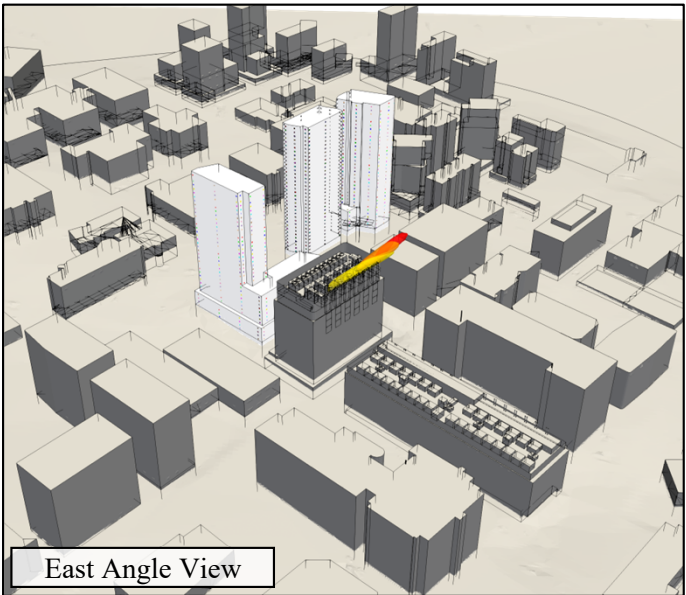
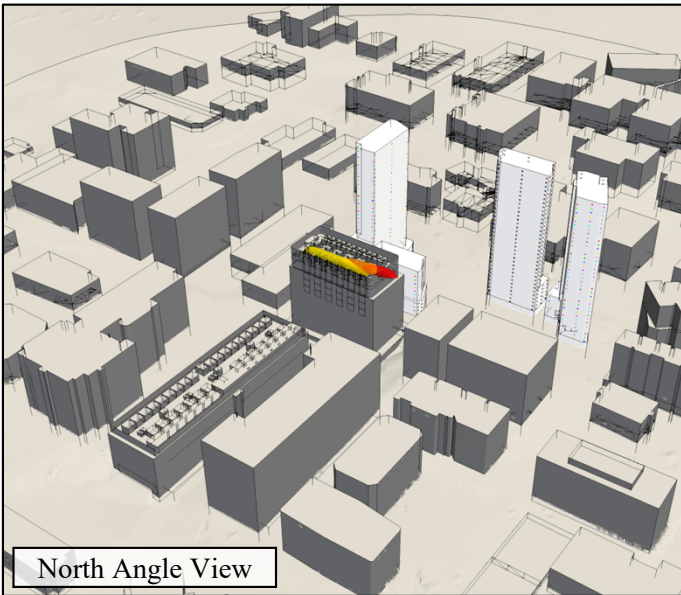
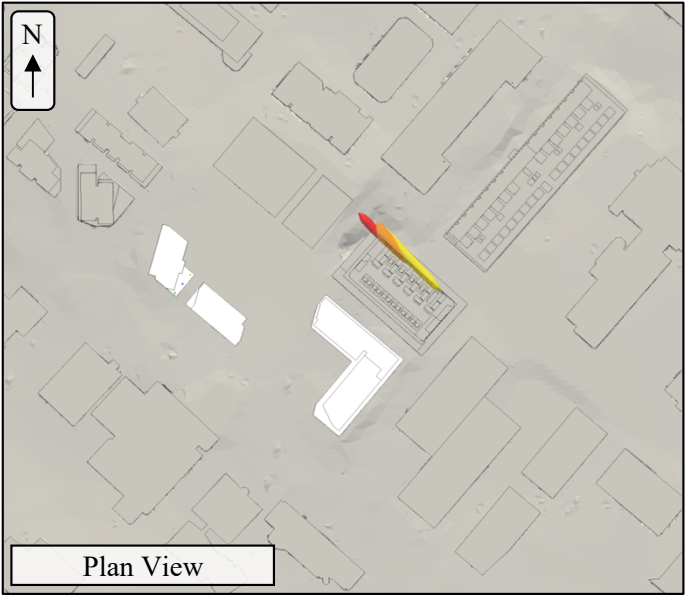
## Exhaust Plumes and Surface Contours

**Scenario 8**

Wind Direction	<i>Southeast</i>
Wind Speeds	<i>6.7 m/s (high)</i>
Air Temperature	<i>20.9 °C</i>
Pollutant Type	<i>NO<sub>2</sub></i>
Pollutant Source	<i>Road 1 Data Centre</i>

---

- Flue 1
- Flue 2
- Flue 3



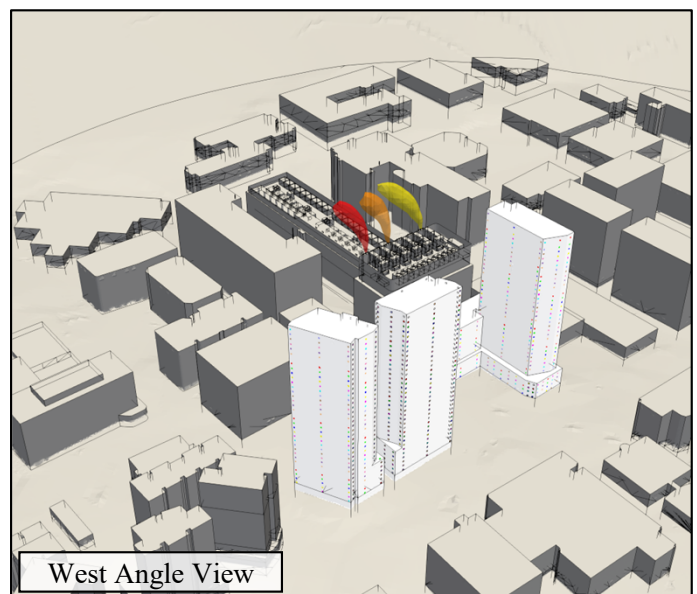
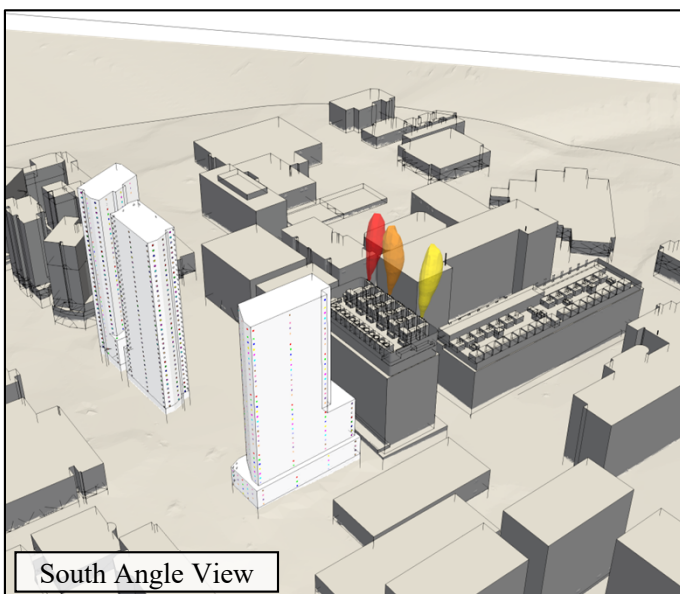
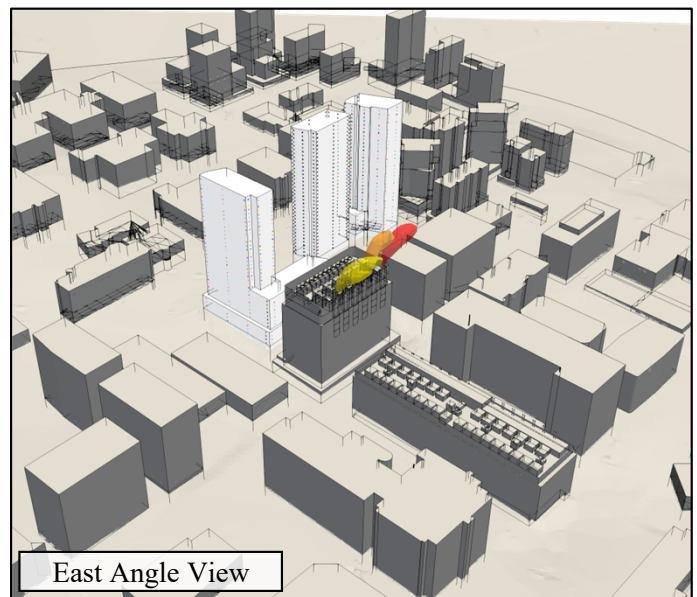
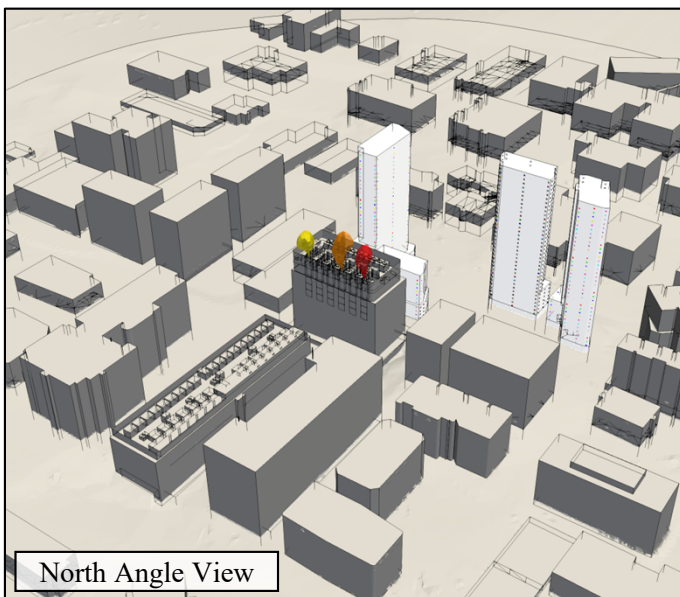
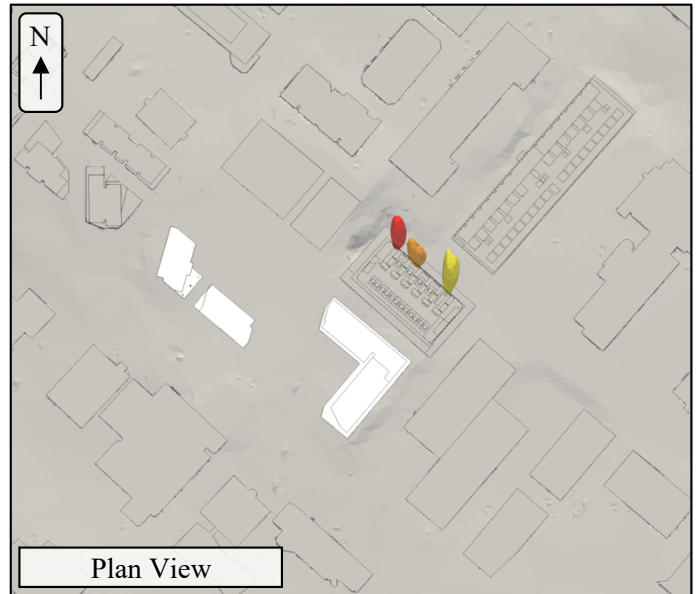
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 9

Wind Direction *South*  
 Wind Speeds *1.0 m/s (low)*  
 Air Temperature *18.3 °C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



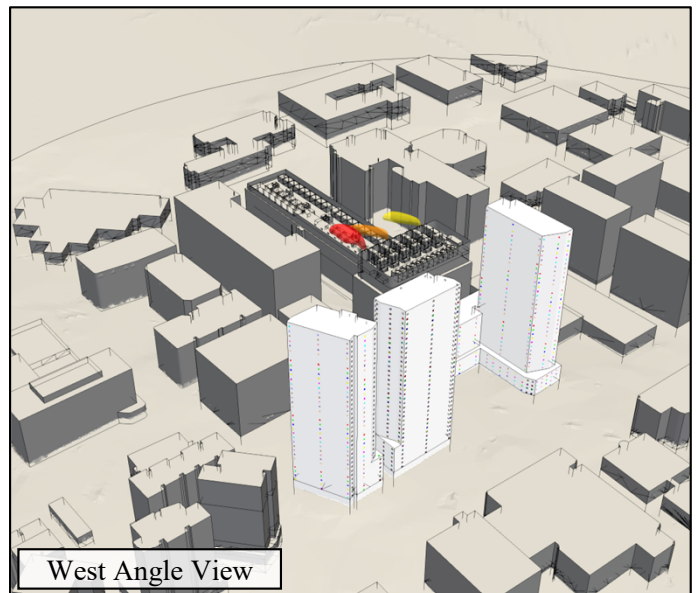
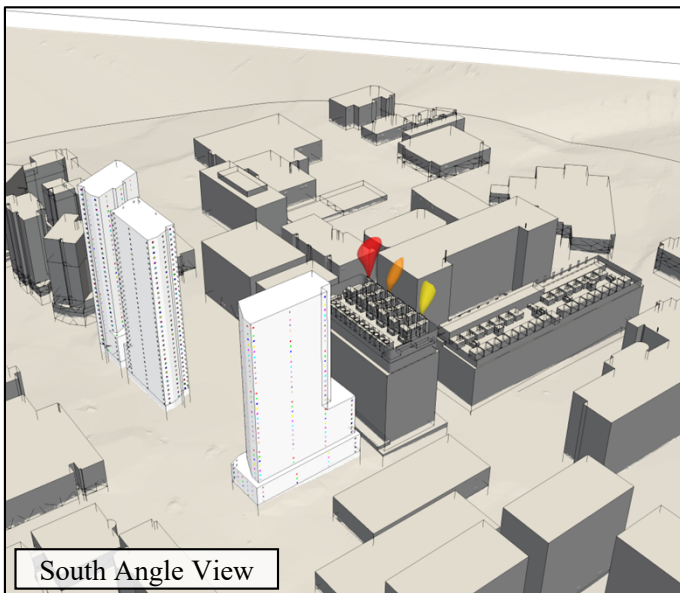
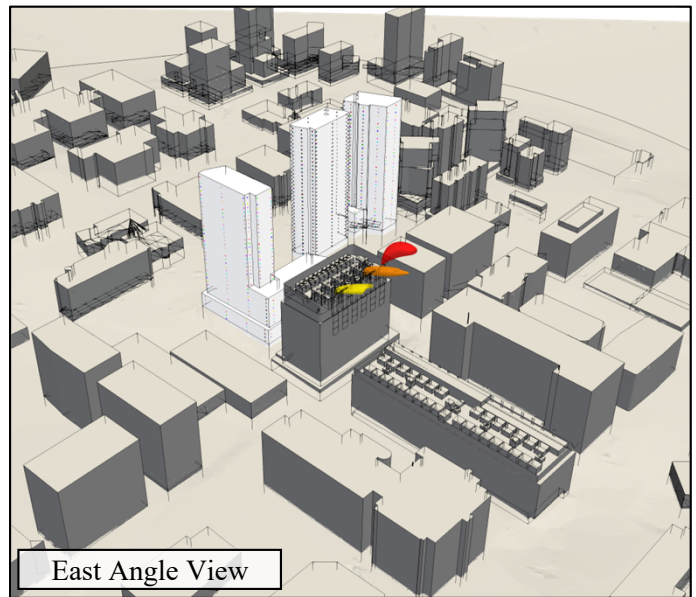
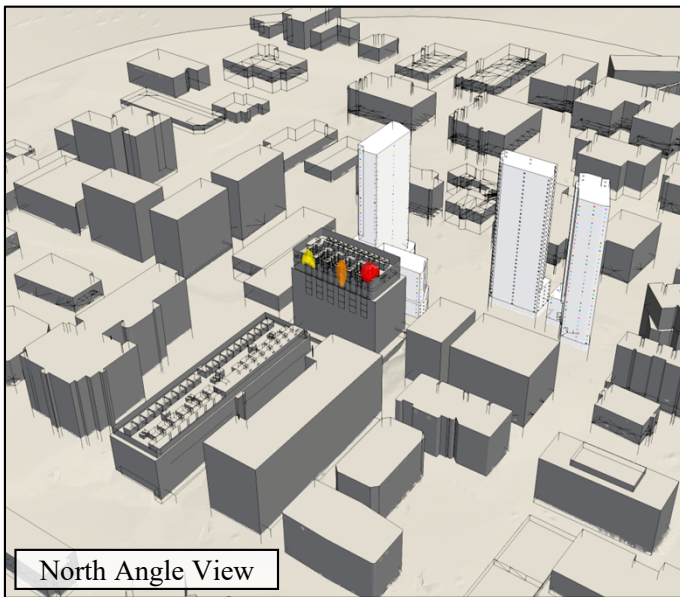
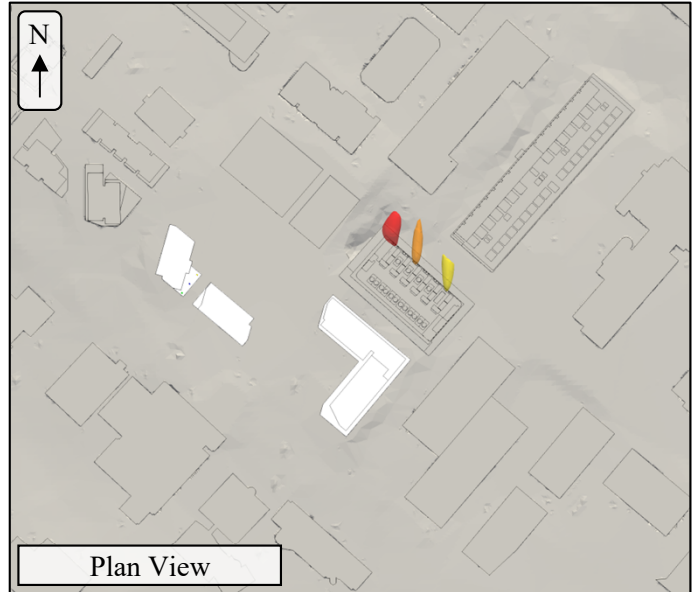
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 10

Wind Direction *South*  
 Wind Speeds *6.7 m/s (high)*  
 Air Temperature *18.7 °C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



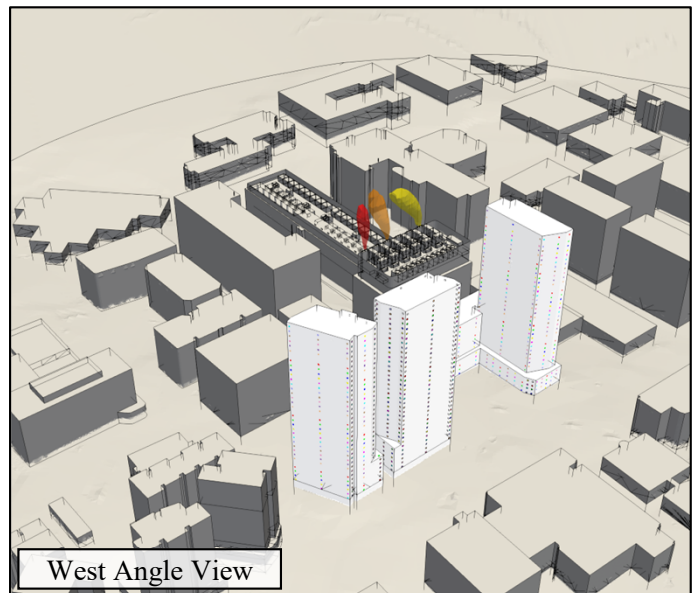
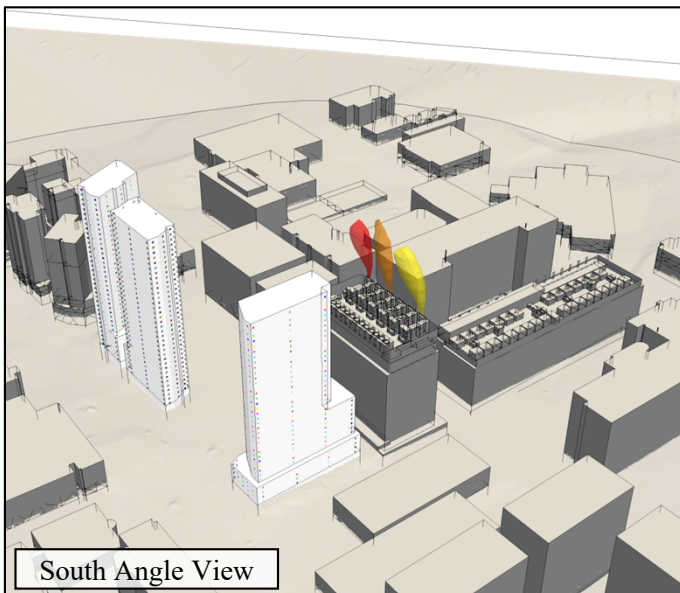
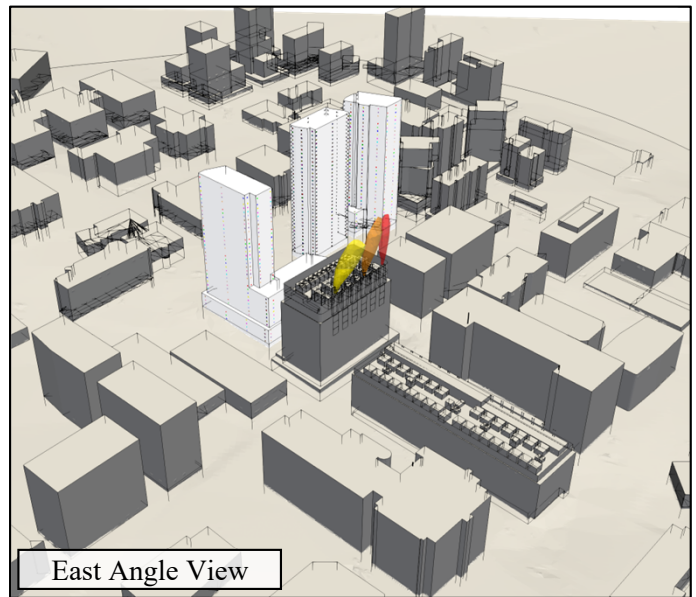
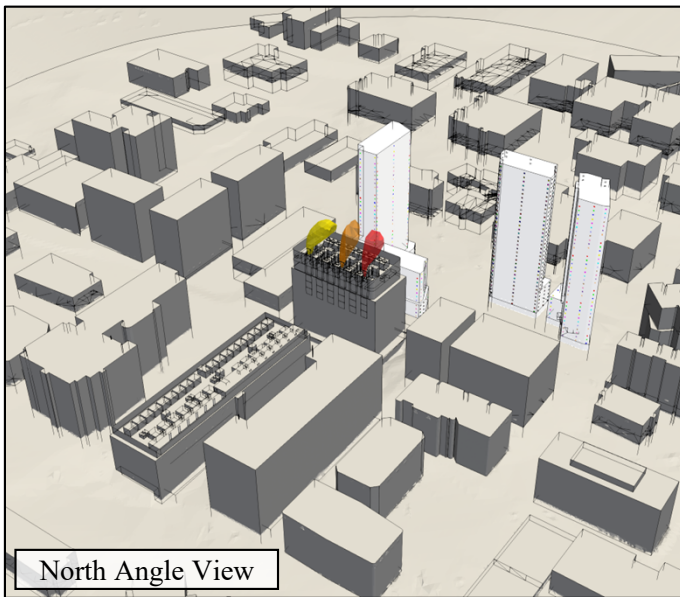
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 11

Wind Direction *Southwest*  
 Wind Speeds *1.0 m/s (low)*  
 Air Temperature *16.1 °C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



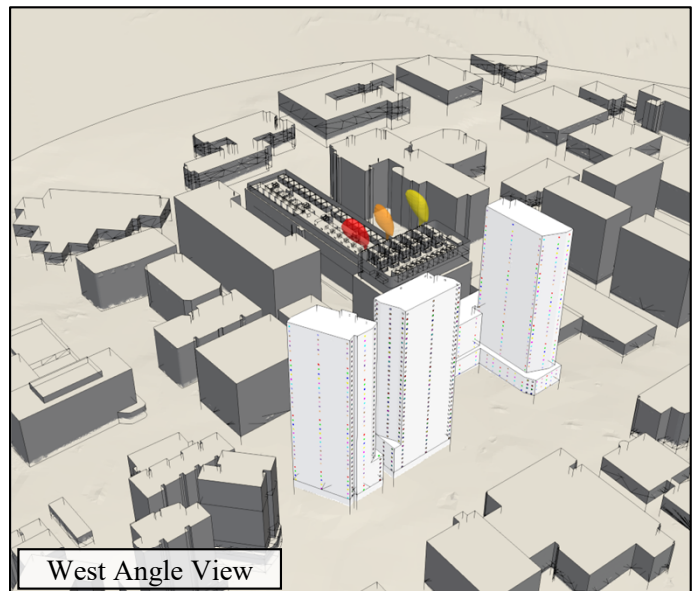
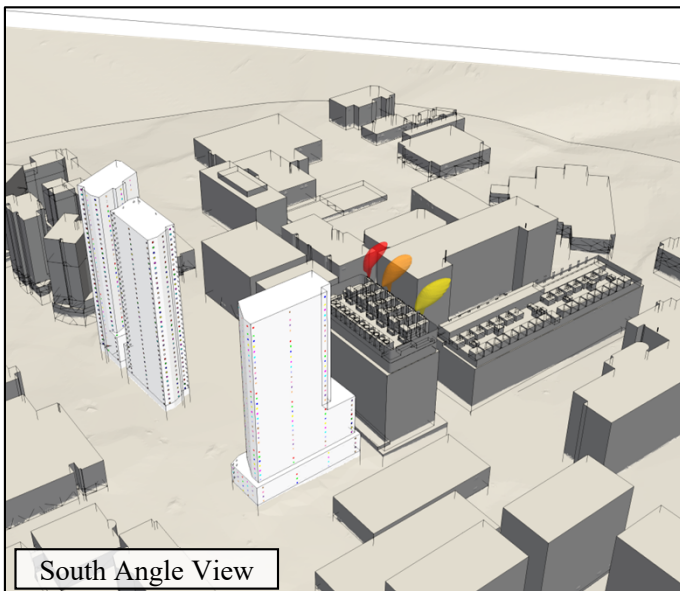
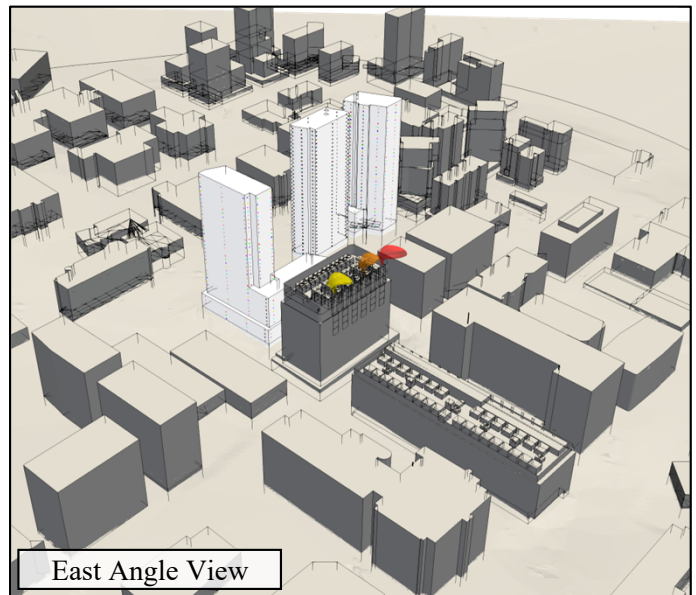
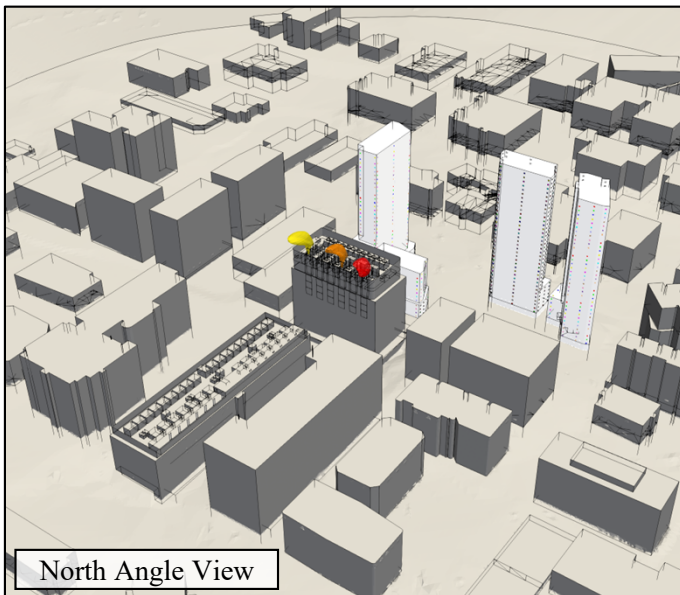
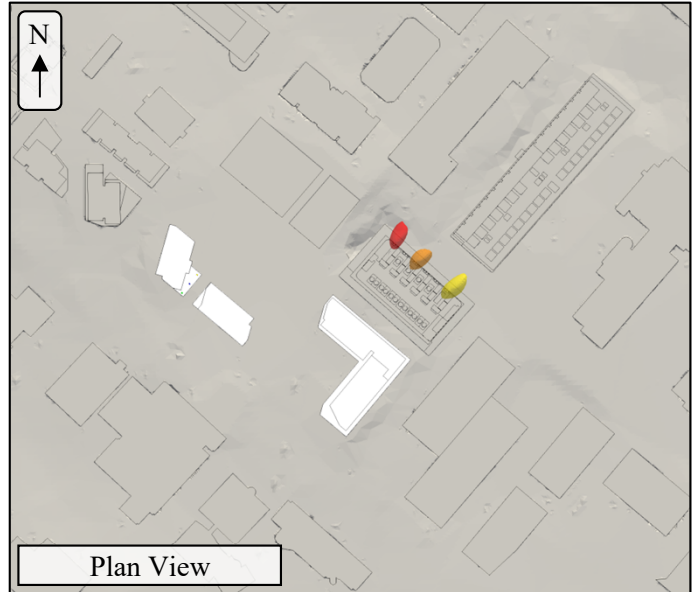
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 12

Wind Direction *Southwest*  
Wind Speeds *5.1 m/s (high)*  
Air Temperature *17.0 °C*  
Pollutant Type *NO<sub>2</sub>*  
Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



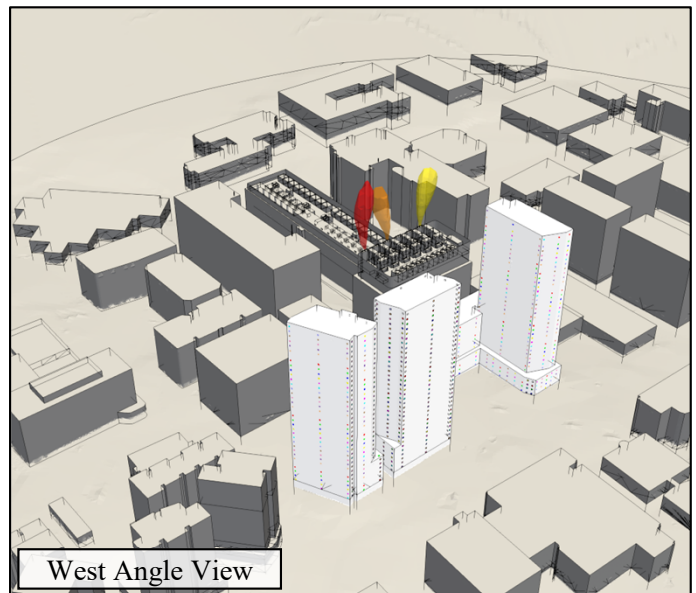
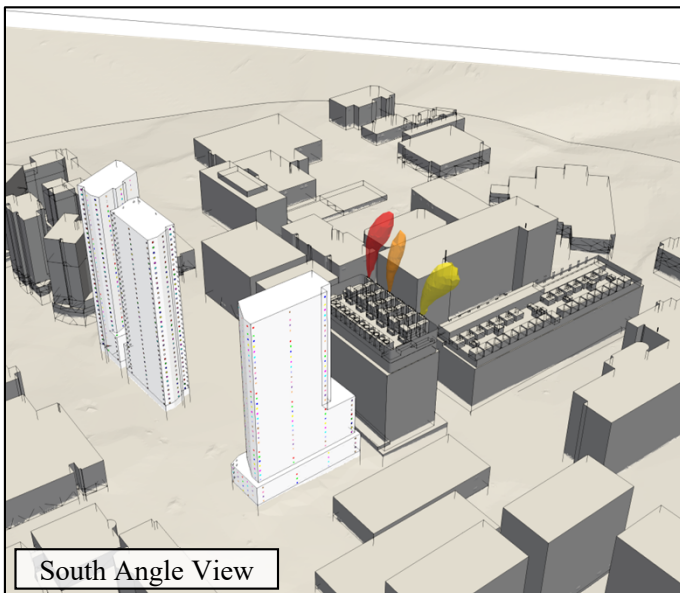
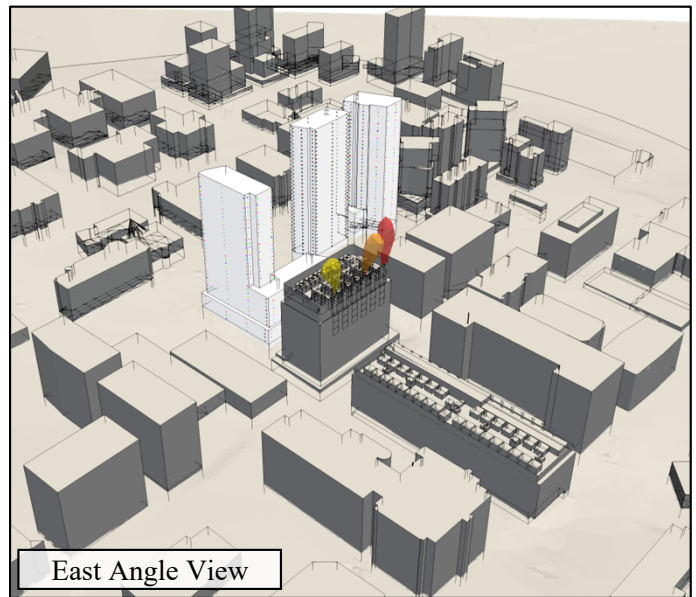
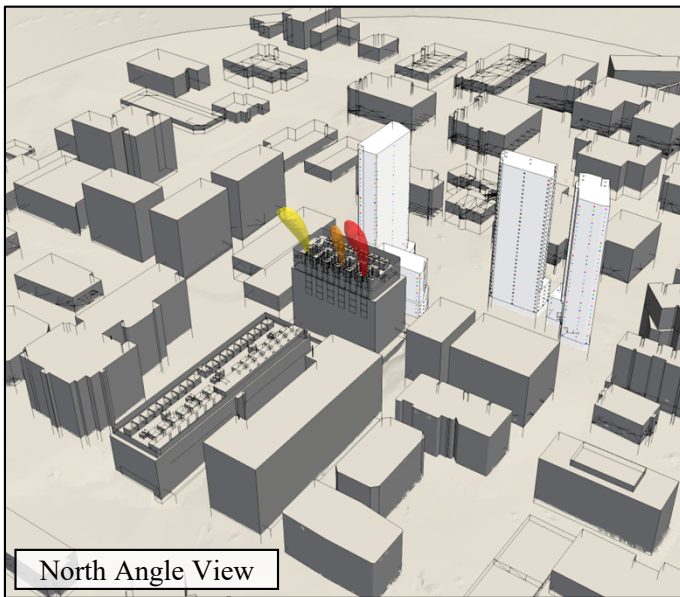
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 13

Wind Direction *West*  
 Wind Speeds *1.0 m/s (low)*  
 Air Temperature *14.4 °C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



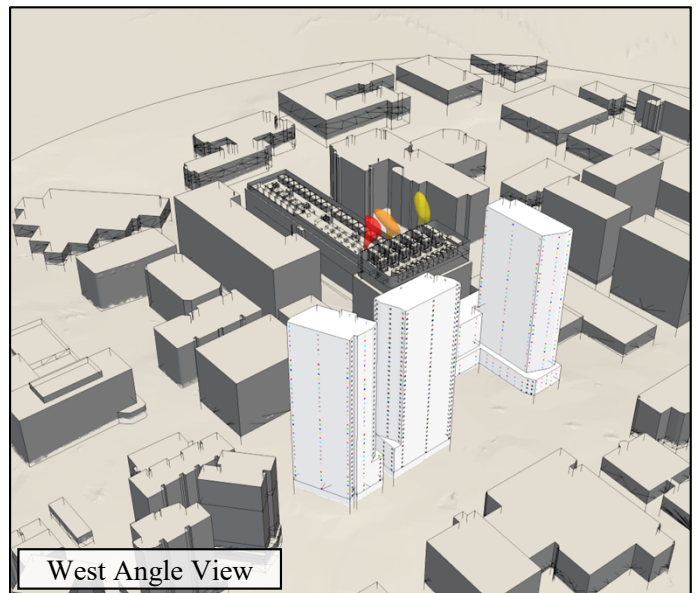
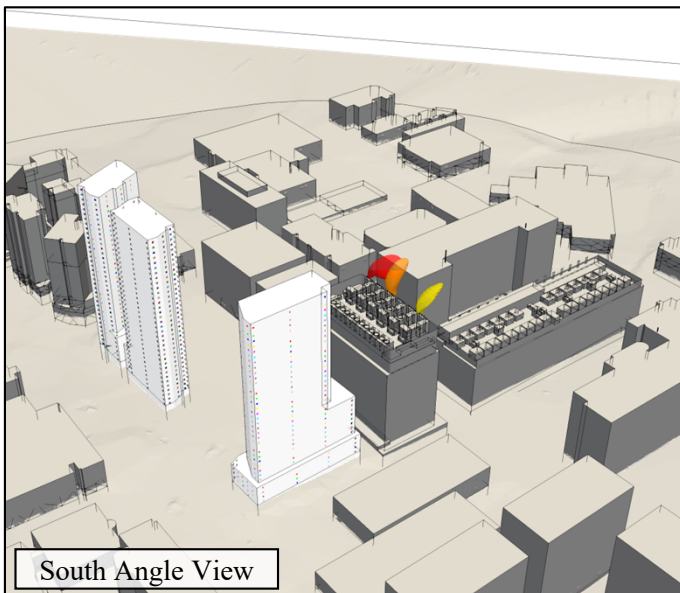
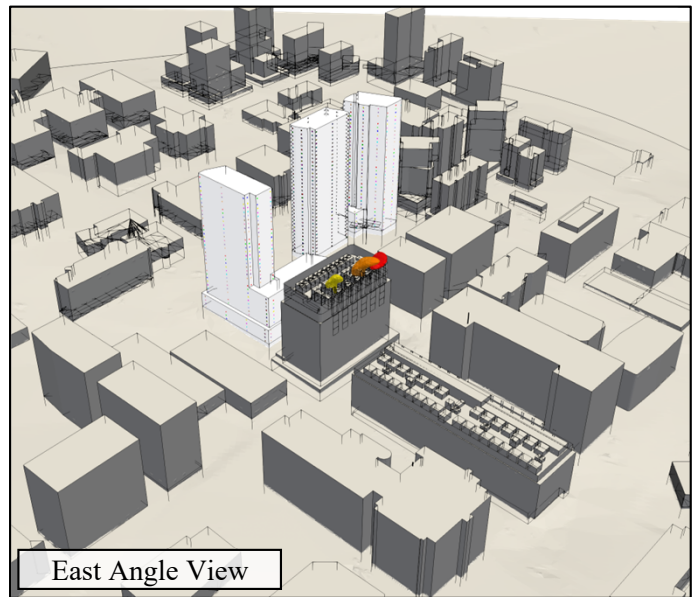
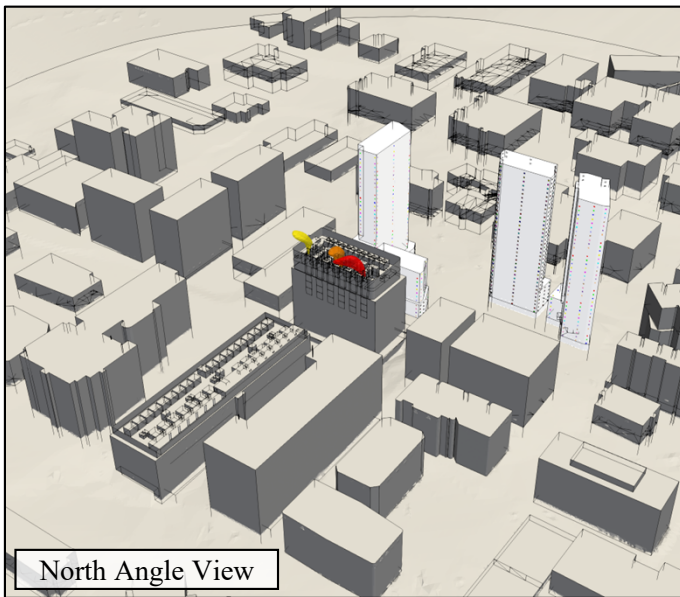
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 14

Wind Direction *West*  
Wind Speeds *6.2 m/s (high)*  
Air Temperature *18.3 °C*  
Pollutant Type *NO<sub>2</sub>*  
Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



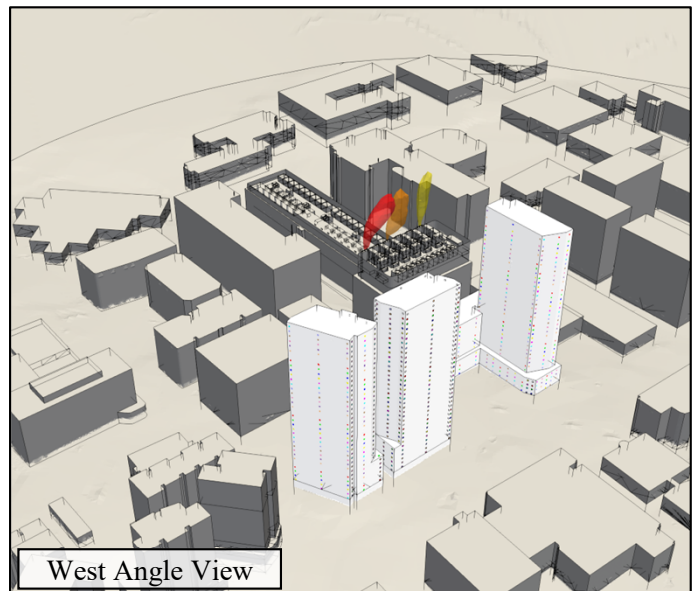
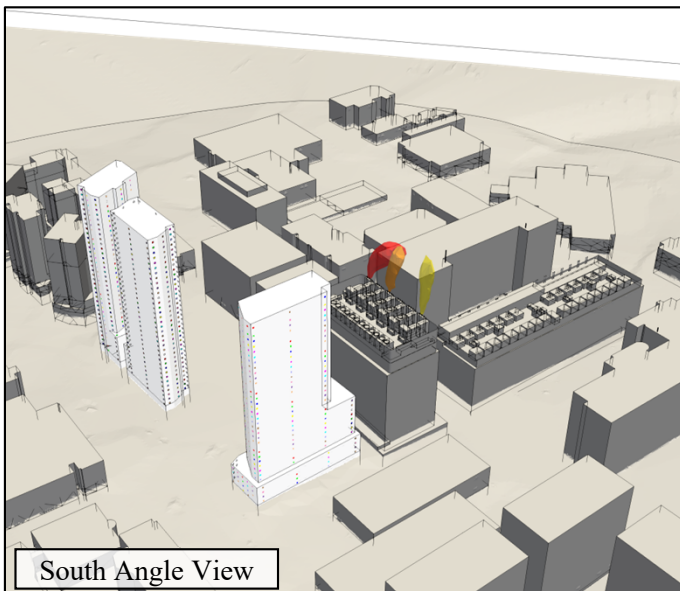
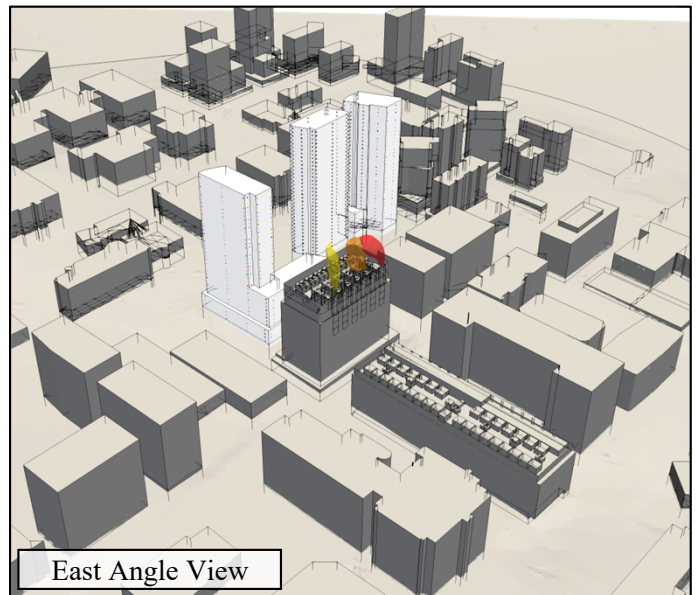
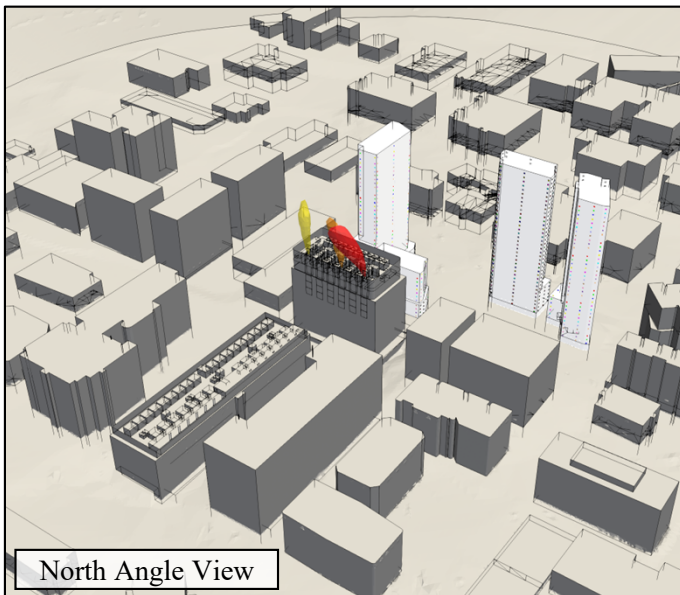
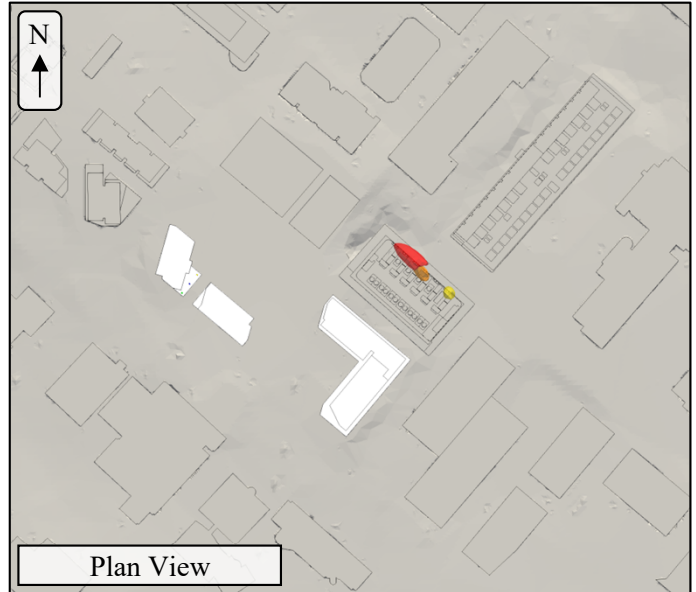
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 15

Wind Direction *Northwest*  
 Wind Speeds *1.0 m/s (low)*  
 Air Temperature *14.8 °C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



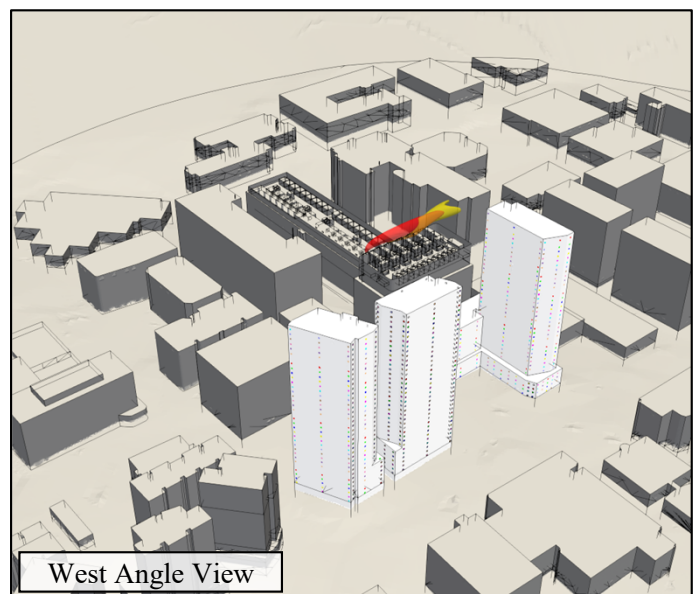
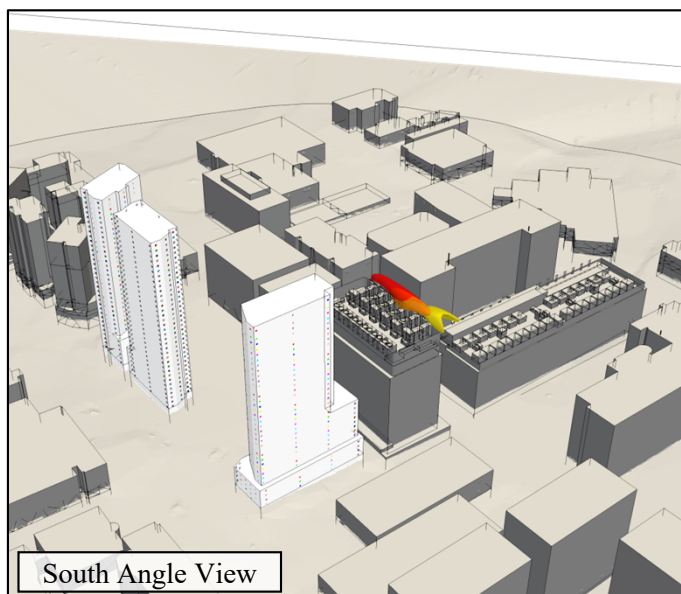
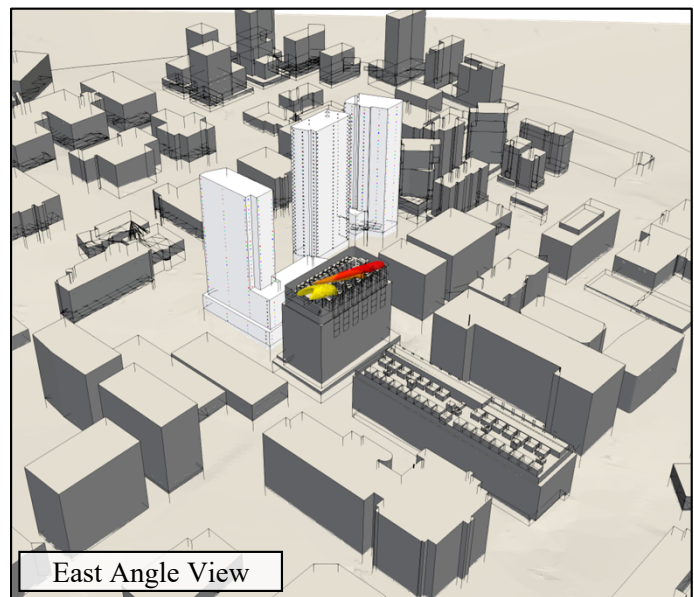
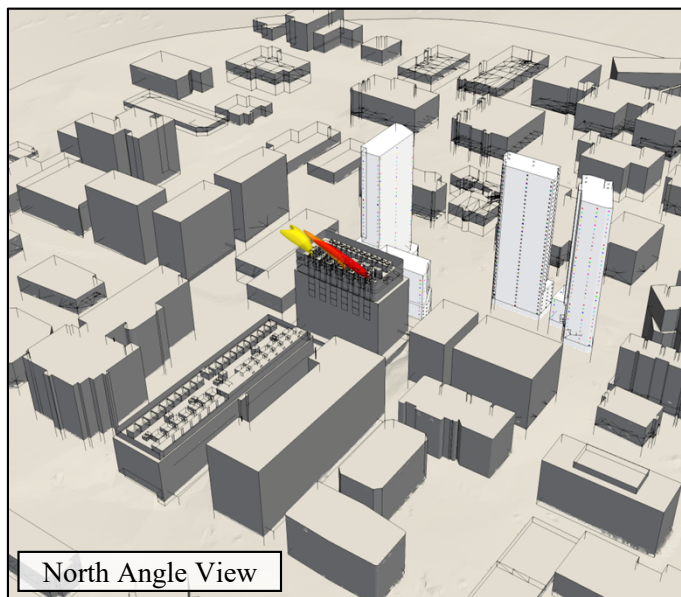
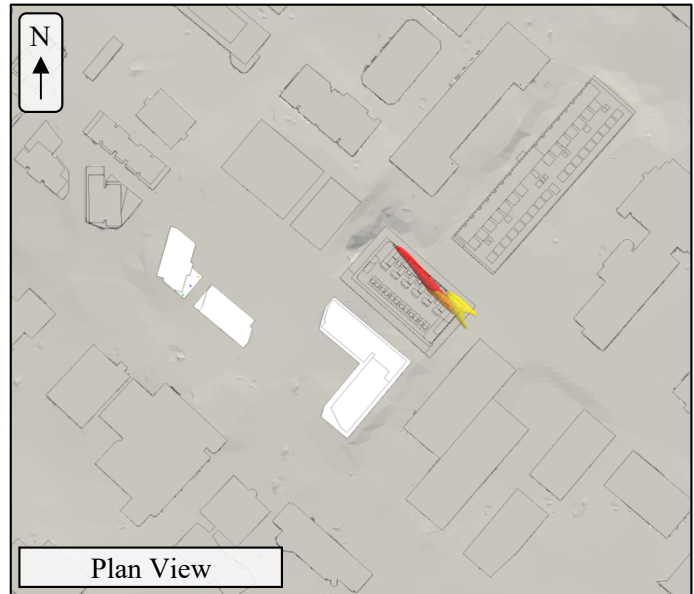
# CFD Results

## Exhaust Plumes and Surface Contours

### Scenario 16

Wind Direction *Northwest*  
 Wind Speeds *6.2 m/s (high)*  
 Air Temperature *19.9 °C*  
 Pollutant Type *NO<sub>2</sub>*  
 Pollutant Source *Road 1 Data Centre*

- Flue 1
- Flue 2
- Flue 3



# CFD Results

## Summary

# CFD Results

## Summary

- The table below shows the maximum predicted cumulative NO<sub>2</sub> concentrations at each of the residential towers.
- The CFD assessment of generator exhaust emissions from Road 1 Data Centre indicates no risk of NO<sub>2</sub> concentration exceedances at the proposed tower façades. Across the 16 assessed scenarios (eight wind directions, each evaluated at two wind speeds), exhaust plumes were not predicted to approach the towers.
- This outcome is primarily driven by the inclusion of a Selective Catalytic Reduction (SCR) system on the generator exhausts, which achieves an approximate 85% reduction in NO<sub>x</sub> emissions at the flues. As a result, predicted façade-level concentrations remain well below the adopted NO<sub>2</sub> assessment criterion under all tested conditions.
- Given the absence of plume interaction with the towers across the full range of assessed wind directions and speeds, a probabilistic integration of ambient meteorological occurrence was not undertaken, as no combination of wind direction, wind speed, or ambient temperature is expected to result in an exceedance attributable to generator operation on Road 1 Data Centre.

Location	Maximum Cumulative NO <sub>2</sub> Concentration (µg/m <sup>3</sup> )
R1	54.7
R2	54.2
R3	88.6
Criterion	164

ARUP