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Vehicle Examination Centre

SA 8c AVA Report

Job No: 1012429

Doc Ref: 1012429 Vehicle Examination Centre

Latest Revision: A

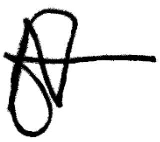
Date: 5/06/2020

Project Name:	Vehicle Examination Centre
Client:	Hip Hing
Report Title:	SA 8c AVA Report
Job Number:	1012429

Document Revision History

Revision Ref	Issue Date	Purpose of issue / description of revision
Draft	20/02/2019	SA 8c AVA Report 1st Draft
1st Issue	26/02/2019	SA 8c AVA Report for BEAM Submission
2nd Issue	05/06/2020	SC8c AVA Report addressing PlanD's comments

Document Validation (latest issue)

Prepared by	Checked by	Verified by
Albert Ng	Desmond Lee	Jonathan Yau
		

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Executive Summary

Cundall had been commissioned by Architectural Service Department (ArchSD) to carry out an Air Ventilation Assessment (AVA) for the Vehicle Examination Centre in Tsing Yi. This study is based on the design of the proposed development and existing structures surrounding the project site.

The study compares the wind ventilation performance of the latest design scheme with that of a baseline, which adopts an earlier planning design scheme provided by ArchSD. The study follows the procedures and guidelines outlined in Technical Circular No. 1/06 jointly issued by the House, Planning and Lands Bureau (HPLB) and Environment, Transport and Works Bureau (ETWB). The study is based on the methodology for an “Initial Study” where CFD is used to assess the wind performance of the design.

The study has found that the surrounding wind environment for the proposed and baseline schemes are very similar, with a slight overall improvement in the proposed scheme. This similarity can be attributed to the similar building massing, and also because of an isolated location that is tucked away in an alcove at the base of surrounding mountains to the east and north. The SVR and LVR for the baseline and proposed schemes are summarised in the table below.

	Proposed	**Baseline**
SVR	0.133	0.127
LVR	0.130	0.128

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Table of Contents

1. Introduction

1.1 This Report

This study has been prepared for BEAM Plus New Building v1.2 Provisional Assessment (PA) submission for Transport Department's Vehicle Examination Centre (VEC) to demonstrate that the criteria under SA 8c Air Ventilation Assessment is fulfilled with proposed design scheme.

1.2 Project Background

The VEC is a building of approximately 34,843 m^2 designed for the express purpose for the inspection of vehicles by the Transport Department. The building comprises of three main storeys, accommodating vehicle inspection areas, vehicular queuing and waiting spaces and carparking, with 6 support building storeys, with space for plant rooms and ancillary services including offices. The building is developed as part of a design and construct project.

Cundall has been appointed the sustainability consultant for the VEC and has been commissioned to carry out an investigation on the impact of the site on surrounding wind ventilation. This report outlines the analysis approach, results and conclusions derived from the study.

1.3 Site Location

The project site is located on Sai Tso Wan Road in Tsing Yi, as shown in Figure 1-1, and is currently used as an open carpark under a Short-Term Tenancy issued by Lands Department (LandsD). The Site occupies an area of approximately 34,843 m2 with existing elevations at about +13.5mPD to +22.2mPD.

The site sits in an enclave between Tsing Sha Highway to the south, Cheung Tsing Highway to the north and West Tsing Yi Road to the east. Further, the highways both exit from tunnels to the south-southeast and north, respectively. To the south, there are a number of industrial uses, such as a dock yard, oil terminals and a bus depot. A portion (about a quarter) of the Site is situated underneath the flyover structure of the Tsing Sha Highway.

Figure 1-1 Site Location

The Site mainly falls within the "Industrial" ("I") Zone in the approved Tsing Yi Outline Zoning Plan No. S/TY/30 (the OZP), with a very small portion (167m2) intruding into the "Green Belt" ("GB") Zone. With regard to the Notes to the OZP, "Government Use (not elsewhere specified)" is always permitted in the "I" zone. The maximum plot ratio is 9.5 and there is no building height restriction. With regard to the intrusion into the "GB" Zone, Planning Department (PlanD) advised that it can be considered as a minor adjustment of site boundary for the proposed development when detailed planning proceeds.

1.4 Building Description

Layout plans of the Project are presented in Appendix F and include the following:

- General:
    - 30 nos. of inspection lanes for different kinds of vehicles
    - Queuing and waiting area
    - Parking spaces for staff and public
    - 2 nos. chassis dynamometers (Dynos) for diesel vehicles and LPG/petrol vehicles on ground floor
    - Ancillary facilities for vehicle examination such as a track lane and test ramp for brake testing, a swept circle testing area, tilting stability test platform and two-axle weigh bridge, four posts hoists.
    - Office accommodation and ancillary plant room

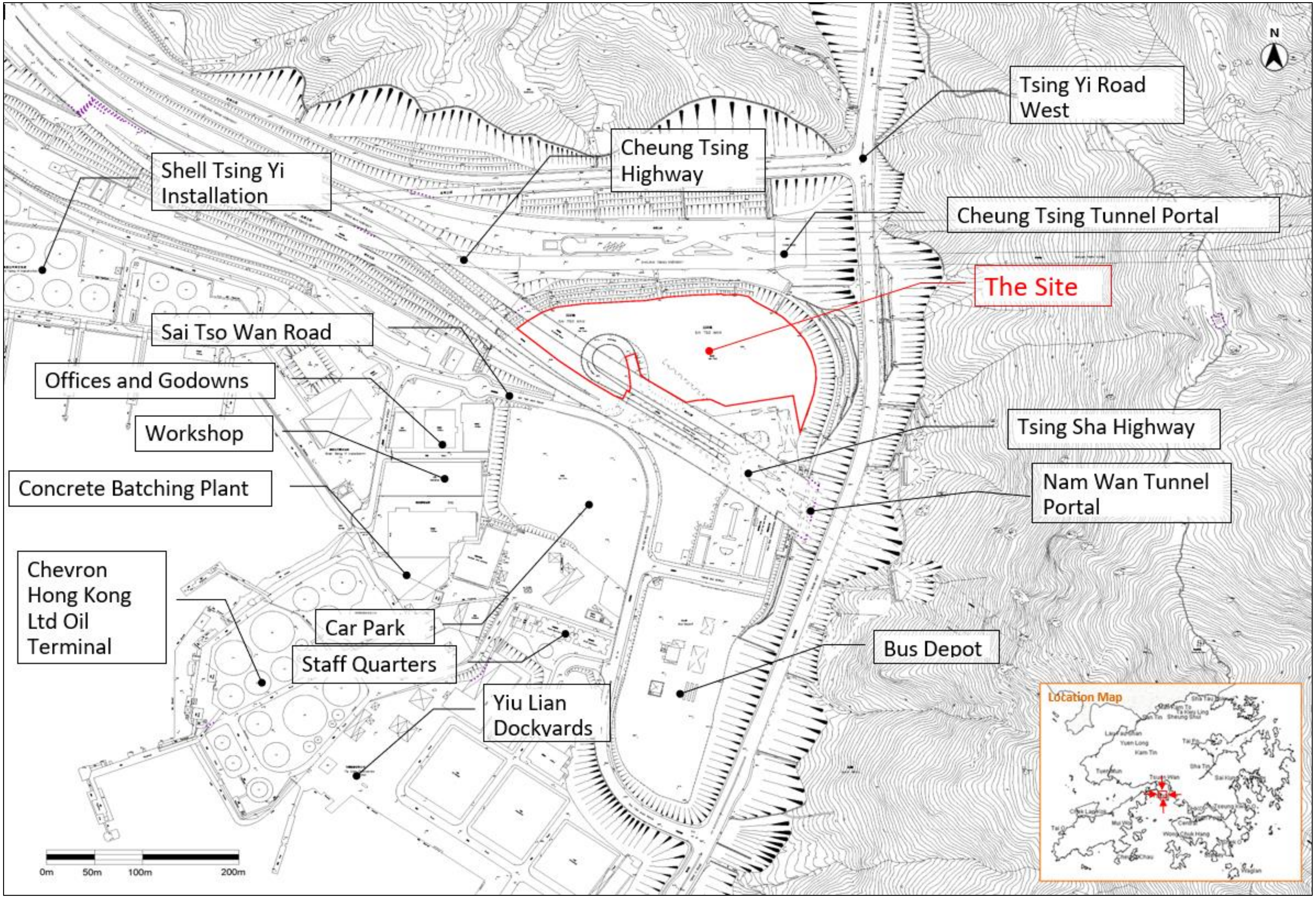


Figure 1-2 Site Location and its Environs

- External and landscape Works including landscape gardens, vertical greening and green roof etc. to suit the design of the VEC.

- External Works including underground utilities connection, fence wall installation, modification of existing ingress/ egress, additional new egress through the Tsing Sha Control Rea (TSCA) and road widening work at STW Road.

1.5 Scope of Study

This report uses Computational Fluid Dynamics (CFD) simulation for the assessment of wind velocity at pedestrian level surrounding the project site, following the methodology of “Initial Study” as set out in the Technical Circular No. 1/06 issued jointly by House, Planning and Lands Bureau (HPLB) and Environment, Transport and Works Bureau (ETWB), and its Annex A – Technical Guide for Air Ventilation Assessment for Development in Hong Kong (hereafter referred to as the “Technical Circular”).

The geometry of studied scheme is identical to proposed design.

1.6 Baseline Scheme and Proposed Scheme

A Baseline Scheme and a Proposed Scheme were selected from design options developed during planning. These are described below.

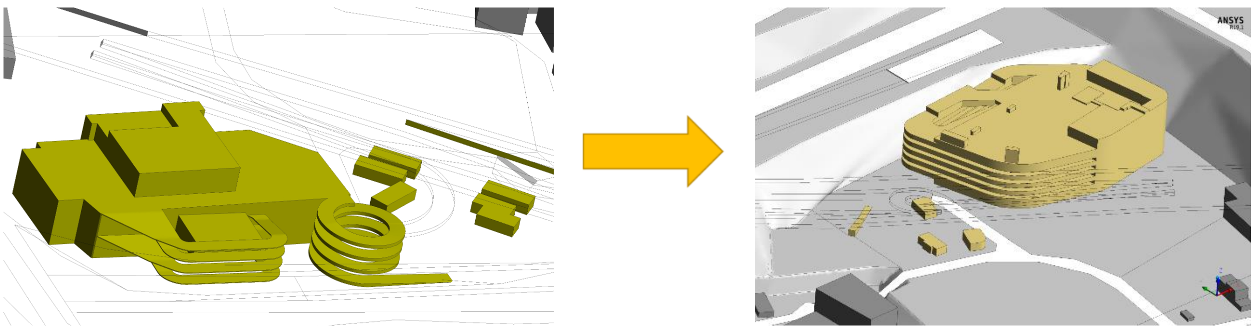
Project Planning Option (Baseline Scheme)

The Baseline Scheme adopts one of the design options developed during the early planning stages and was submitted in an earlier AVA submission to ArchSD. This design was subsequently accepted by ArchSD at the time in their assessment of the project’s impact on the wind environment of surrounding areas. Architectural drawings are provided in Appendix E.

Proposed Design (Proposed Scheme)

The Proposed Scheme is the architectural design accepted by ArchSD. This design is semi enclosed in order to maximise natural ventilation potential to remove pollutants in the inspection halls. The form of the slabs and upramps have also been modified to cater for the anticipated traffic flow in the building.

The images below illustrate the building form of Baseline Scheme and Proposed Scheme in this study.



Baseline Scheme Proposed Scheme

Figure 1-3 Building Forms of Baseline Scheme and Proposed Scheme

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2. Methodology

2.1 Initial Study Methodology

2.1.1 Assessment Standard

This study follows the methodology of “Initial Study” as set out in the Technical Guide for Air Ventilation Assessment for Developments in Hong Kong published by Housing, Planning and Lands Bureau (HPLB) and Environment, Transport and Works Bureau (ETWB) and adopted by Planning Department (PlanD).

2.1.2 CFD as Analysis Tool

The proposed method of “Initial Study” of air ventilation assessment is to compare a baseline building to the proposed design using CFD simulations. This method is accepted by the guideline and is preferred as it offers a means to visualise to assist analysis. CFD simulations compare performance under the highest frequency wind directions whose total annual frequency account for at least 75%. The results will be compared in terms of Wind Velocity Ratio to quantitatively assess whether the design case is an improvement over the base case design.

2.1.3 Velocity Ratio as a Performance Indicator

Velocity Ratio (VR) will be used as the primary indicator of wind performance for this wind environment study. VR is defined as the ratio of the wind velocity as experienced by the pedestrian at 2 meters above grade and the velocity of wind at the top of the boundary layer, which exists at a height of around 400 m to 600 m above grade, and represents wind unadulterated by terrain and structures. The VR indicates how much of the wind available to an area could be experienced and enjoyed by pedestrians on the ground, taking into account the surrounding buildings, topography and the proposed development. Two types of Velocity Ratios will be compared:

- **Site Velocity Ratio (SVR)**

  The SVR gives an idea of the wind impact to a site’s immediate vicinity. It is derived from the weighted average VRs of Perimeter Test Points, which are located on the perimeter of the site boundary.

- **Local Velocity Ratio (LVR)**

  The LVR gives an idea of the impact of the proposed development on the wind access of surrounding areas. It is derived from the weighted average VRs of Perimeter Test Points and Overall Test Points, which are located on the perimeter of the site boundary and around the site, respectively.

The VRs at each test point for each wind condition will be converted to an average weighted according to the annual frequency of the wind condition they are observed in. SVR and LVR will be derived from these. A design scheme with higher Weighted Average SVR and LVR is generally considered to have better air ventilation access.

2.2 Key Assumptions

2.2.1 Project Information

The study is based on the best information that are available at the time of study. The key information and sources are detailed as below:

Table 2-1 Summary of Key Assumptions

Items	References	Source
Architectural Drawings		
Base Case Building	Design scheme developed during Project Planning Stage	Planning Stage Scheme by ArchSD; Appendix E
Proposed Case Building	3rd AIP Architectural Package issued on 12th December 2018 by Wong Tung	Wong Tung; Appendix F
Site Information		
Map of Surrounding Area		Digital map published by Lands Department
Wind Data	Consultancy Study on Establishment of Simulated Site Wind Availability Data for Air Ventilation Assessments in Hong Kong http://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/064048.html	Planning Department

2.2.2 Site Wind Availability

The wind availability data up to 500m above ground adopted for this study is taken from the Consultancy Study on Establishment of Simulated Site Wind Availability Data for Air Ventilation Assessments in Hong Kong, which was commissioned by Planning Department in October 2010. The wind velocity profile from 10m to 500m are extracted from the wind data provided in the results from the study. Wind velocities beneath 10m are calculated using a logarithmic relationship with the wind velocity at 10m as a reference. As required in the Technical Circular for Air Ventilation Assessments, no less than 75% of the annual probable winds have been accounted for which included a total of eight wind directions. The considered wind directions sums up to **78.0%** of annual probability and the detailed annual probabilities are indicated in the table below:

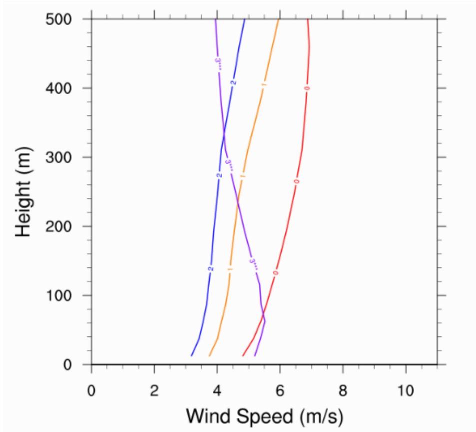
Table 2-2 Prevailing Wind Directions at 500m for AVA Study

Direction	N Degree	Wind Zone: 64,48		
		Probability of Occurrence (%)	Rank	Annual Prevailing Wind
N	0	2.1%	12	
NNE	22.5	3.9%	10	
NE	45	9.8%	4	✓
ENE	67.5	12.9%	2	✓
E	90	19.3%	1	✓
ESE	112.5	10.3%	3	✓
SE	135	6.3%	7	✓
SSE	157.5	5.9%	8	✓
S	180	6.2%	6	✓
SSW	202.5	7.3%	5	✓
SW	225	4.4%	9	
WSW	247.5	2.7%	11	
W	270	2.3%	12	
WNW	292.5	1.3%	15	
NW	315	1.6%	14	
NNW	337.5	1.4%	15	
Total		78.0%		>=75%

As indicated in the table above, the most frequent prevailing wind direction is E, which represents 19.3% of wind occurrence, followed by ENE (12.9%), ESE (10.3%) and NE (9.8%). The detailed wind availability data and corresponding wind boundary profiles are as below:

Table 2-3 Wind Availability Data and Wind Profile

	Wind direction/degree angle			
Height	22.5-112.4	112.5-202.4	202.5-292.4	292.5-22.4
500	6.85	5.92	4.86	
450	6.89	5.74	4.68	
400	6.86	5.47	4.47	
350	6.77	5.18	4.28	
300	6.63	4.93	4.12	
250	6.45	4.72	4.00	
200	6.23	4.57	3.91	
150	5.97	4.45	3.82	
100	5.64	4.30	3.69	
50	5.24	4.06	3.47	
10	4.84	3.75	3.19	



2.2.3 Area of Assessment

The "*Technical Guide for Ventilation Assessment for Developments in Hong Kong*" requires that the surrounding area of a perpendicular distance of 2H (where H is the height of the building) from the project boundary must be modelled. In this case, the proposed building height is approximately 43m (approximately 65mPD up to main roof) that 2H is equivalent to 86m. Detailed elevations are found in Appendix F.

In this project, due to the extremely low density development around the site, the study area was extended to at least 10H and up to 20H in each direction, as shown in Figure 2-1.

Figure 2-1 – Extent of Domain

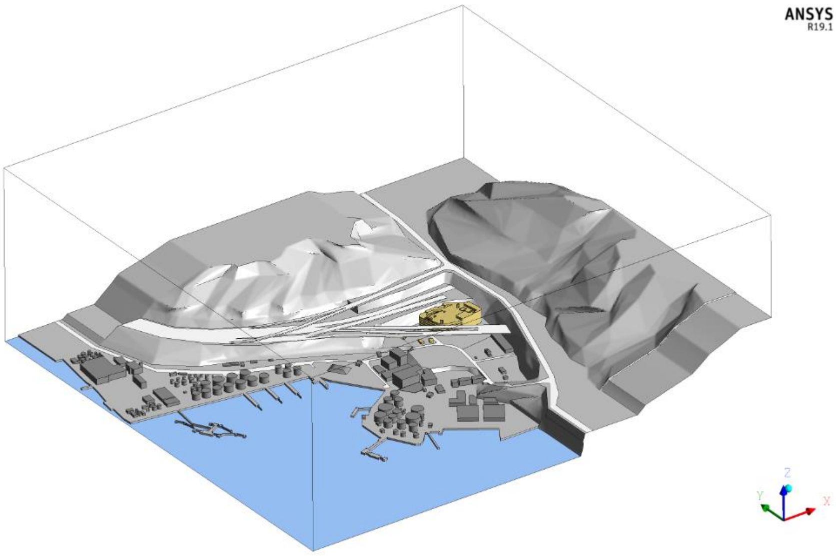


Figure 2-2 – 3D Model Showing Domain

2.2.4 CFD Model Setup

<u>CFD Software</u>

FLUENT- v19.1 has been used for the analysis.

<u>CFD Model Setup</u>

The parameters of the CFD model are as follows:

- **Domain Size:** 600x1700x1600 [m]
- **Mesh Type:** Polyhedral
- **Grid Size:** Maximum 0.5m for the proposed development, 1m for other buildings. Maximum size 20m.

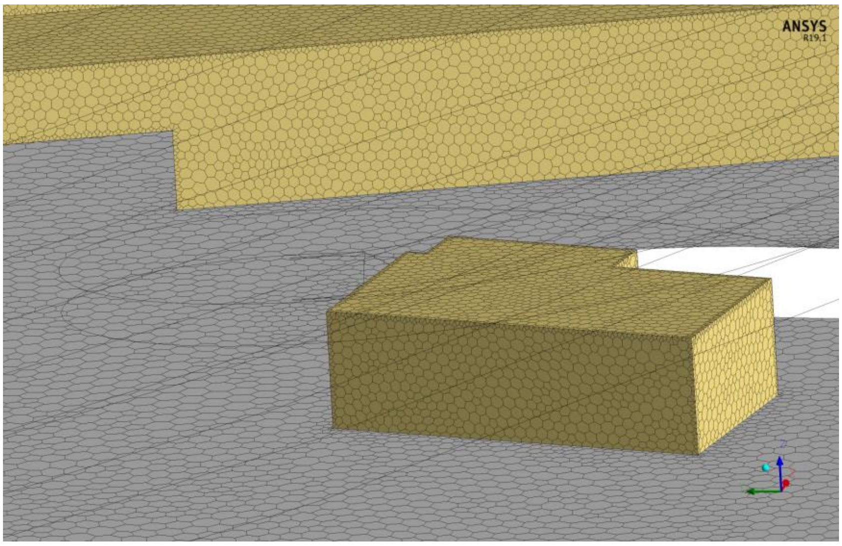


Figure 2-3 Demonstration of Meshing Setting in Study Model

- **Turbulence Model:** κ-ε standard turbulence model

- **Wind Profile**

	Wind direction/degree angle			
Height	22.5-112.4	112.5-202.4	202.5-292.4	292.5-22.4
500	6.85	5.92	4.86	
450	6.89	5.74	4.68	
400	6.86	5.47	4.47	
350	6.77	5.18	4.28	
300	6.63	4.93	4.12	
250	6.45	4.72	4.00	
200	6.23	4.57	3.91	
150	5.97	4.45	3.82	
100	5.64	4.30	3.69	
50	5.24	4.06	3.47	
10	4.84	3.75	3.19	

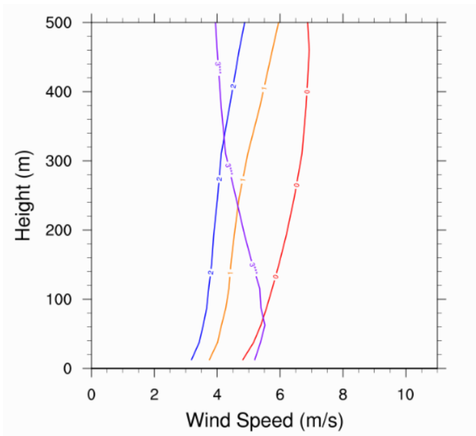


Figure 2-4 Wind Profile Adopted for Study

- **Convergence Criteria:** 0.1%

Simplification of Geometry:

Since the intention of AVA is to study wind behaviour within and around the Site for the Base Case and Proposed Case, a level of approximation and simplification of geometry are necessary for the scale of study based on professional judgement. For example:

- Buildings and flyovers will be modelled in layout block forms to represent overall massing instead of every single detail.
- Trees, fence walls, cars, minor structure etc. will not be modelled.

Images of Baseline and Proposed Building

The CFD models for baseline and proposed buildings are built based on the assumptions above. Below are the images of the model images.

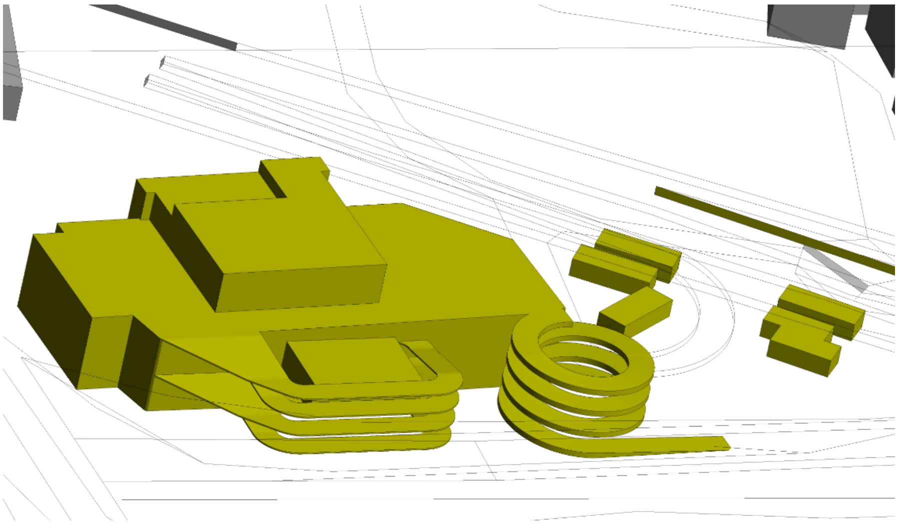


Figure 2-5 Baseline Scheme CFD Model

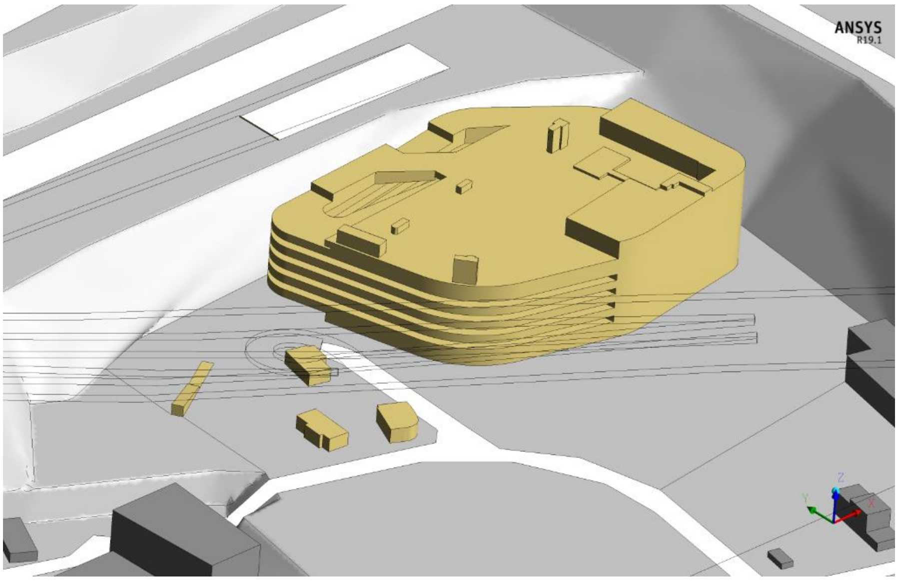


Figure 2-6 Proposed Scheme CFD Model

2.2.5 Test Points

Overall there are 80 testing points inserted in the CFD model to measure the results, consisting of Perimeter Test Points and Overall Test Points.

Table 2-4 Summary of Test Points in CFD Model

	Perimeter Test Point	Overall Test Points
Typical Requirement	30-50	50-80
Proposed	40	50

2.2.5.1 Perimeter Test Points

Perimeter Test Points are positioned on the project site boundary. They are useful to assess the effect of the project on the immediate surroundings. According to the Technical Circular, test points spaced out at around 10 m to 50 m centre to centre (or more if a larger test site is evaluated) are placed on perimeter of the project site boundary.

Test points are normally not necessary at perimeter(s) where there are no major air ventilation issues e.g. waterfront areas with ample sea breeze, inaccessible land such as green belts. Tests points must be located at the junctions of all roads leading to the project site, at main entrances to the project, and at corners of the project site.

Perimeter test points will provide data for the Site Air Ventilation Assessment. Typically, about 30 to 50 perimeter test points that are well spaced out and located will suffice. For this project, 40 perimeter test points are employed at a spacing of around 25 meters.

2.2.5.2 Overall Test Points

Overall test points are more uniformly distributed and positioned in the open spaces, on the streets and places of the project and Assessment Area where pedestrians frequently have access to. For practical reasons, around 50 to 80 test points may be adequate for typical development sites.

This group of overall test points, together with the perimeter test points, will provide data for the Local Air Ventilation Assessment. For this project, 50 overall test points are employed.

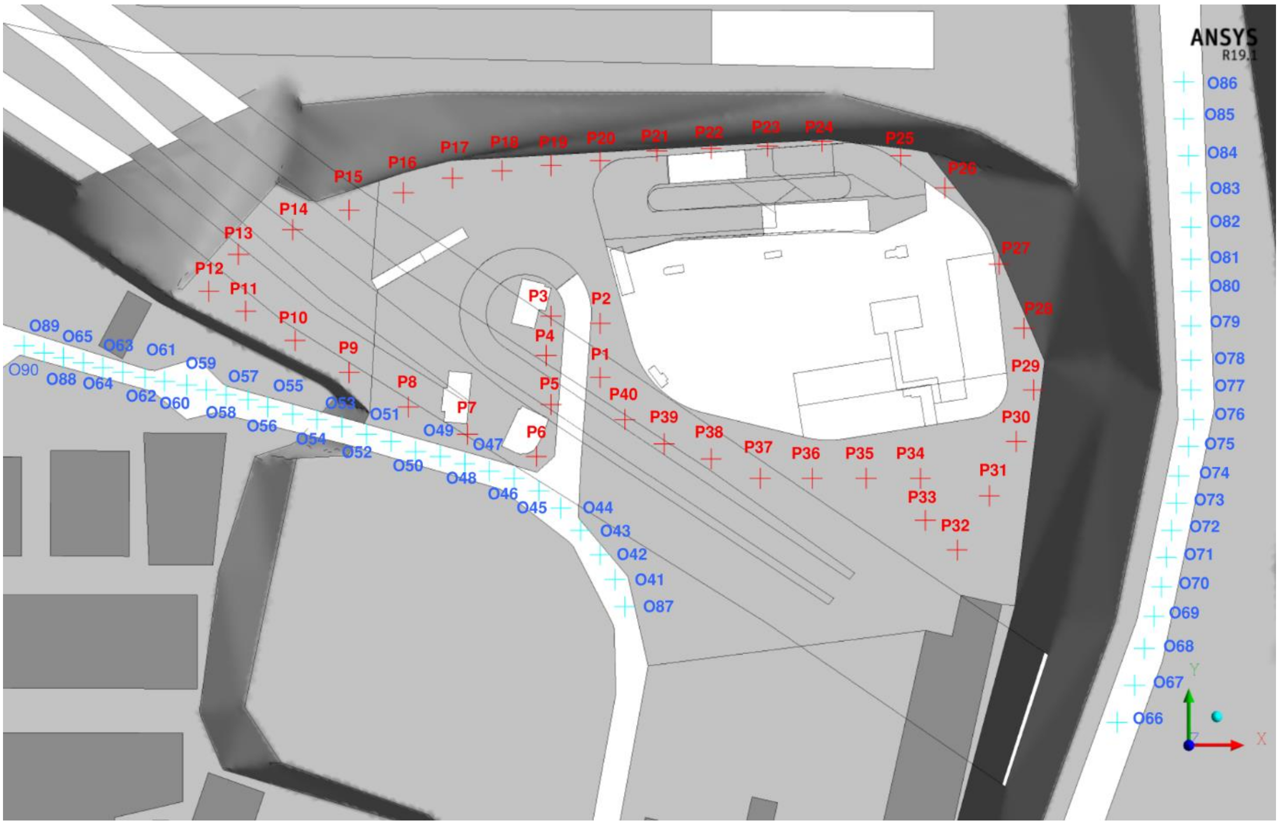


Figure 2-7 Location of Test Points

3. Results

3.1 Site Spatial Average Velocity Ratio

The Site Spatial Average Velocity Ratio (SVR) gives an indication of the impact that the building has on its immediate surroundings. The Baseline Scheme SVR is range is 0.127, with average VRs of perimeter points ranging from 0.03 to 0.3. The Proposed Scheme shows the slightly better performance in SVR with a value of 0.133, with average VRs ranging from 0.04 to 0.28. The similarity between the wind availability of both cases is largely due to the similar building massing, and also because of their unimposing scale on the surrounding buildings. The location of the building in an alcove at the base of surrounding mountains to the east and north would also limit its impact on the surrounding wind environment.

Table 3-1 Site Air Ventilation Assessment

Direction	Baseline Scheme Average VR	Proposed Scheme Average VR
SVR	**0.127**	**0.133**
Max Average VR	0.30	0.28
Min Average VR	0.03	0.04

3.2 Local Spatial Velocity Ratio

The Local Spatial Velocity Ratio (LVR) gives an indication of the impact that the building has on its greater surroundings. It is noted that the performance of both cases is similar in terms of maximum, minimum and overall weighted LVR, revealing that both cases impact to the air ventilation in their surrounding areas are very similar, despite the difference in design between the two schemes. This is due to the enclosed and isolated location of the project site. Topographical effects on wind are much stronger than those by the project building.

Table 3-2 Local Air Ventilation Assessment

Direction	Baseline Scheme Average VR	Proposed Scheme Average VR
LVR	**0.128**	**0.130**
Max Average VR	0.30	0.28
Min Average VR	0.03	0.04

3.3 CFD Study Result Summary

In accordance to the above observations, it can be concluded that the proposed design has similar effect on its surroundings to the originally planned design. Thus, the design has been optimised with respect to its impact on the ventilation access of surrounding areas. Features to enhance wind environment have been incorporated as much as possible, including permeable building design and low building profile, in order to reduce the impact of the building on its surrounding wind environment.

The full results are graphically presented in the appendices:

- Appendix A – Baseline Scheme Velocity Ratio Contour and Vector Maps
- Appendix B – Proposed Scheme Velocity Ratio Contour and Vector Maps.

The detailed numerical results are presented in:

- Appendix C – Baseline Scheme Velocity Ratios; and
- Appendix D – Proposed Scheme Velocity Ratios.

4. Conclusion

This AVA study has successfully investigated the pedestrian wind environment and has provided insight into the impact of a proposed building design on the local wind conditions through a comparison with a base case.

This study has been completed according to Technical Circular No. 1/06 issued jointly by House, Planning and Lands Bureau (HPLB) and Environment, Transport and Works Bureau (ETWB) and is found to be in compliance.

The SVR and LVR of the design case in the previous section show that the wind environments in the proposed and baseline schemes are very similar. This is largely due to the similar building massing, and also because of an isolated location that is tucked away in an alcove at the base of surrounding mountains to the east and north.

The study results have demonstrated an optimised design in which wind performance in terms of wind distribution at the pedestrian level in areas where pedestrians are expected to spend time is not affected compared to the original planned design. These improvements largely come about from design decisions made in order to enhance the wind environment for areas within the site immediately around the building, where pedestrians are expected, or in fact permitted, to go.

Appendix A – Baseline Scheme Velocity Ratio Contour and Vector Maps

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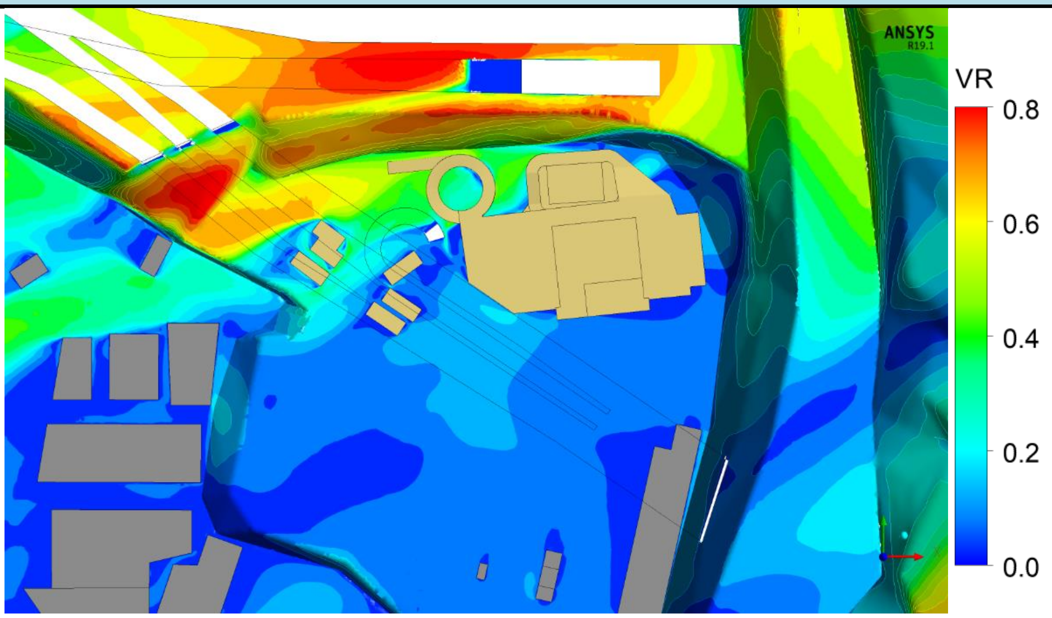
<tr><td rowspan="2">NE</td><td>
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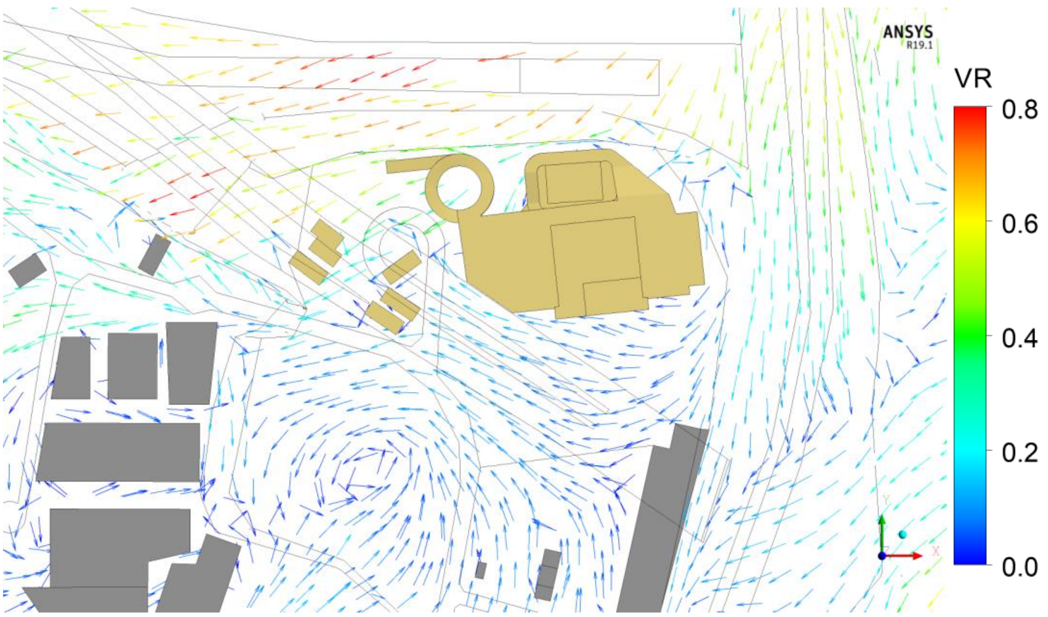
<tr><td>
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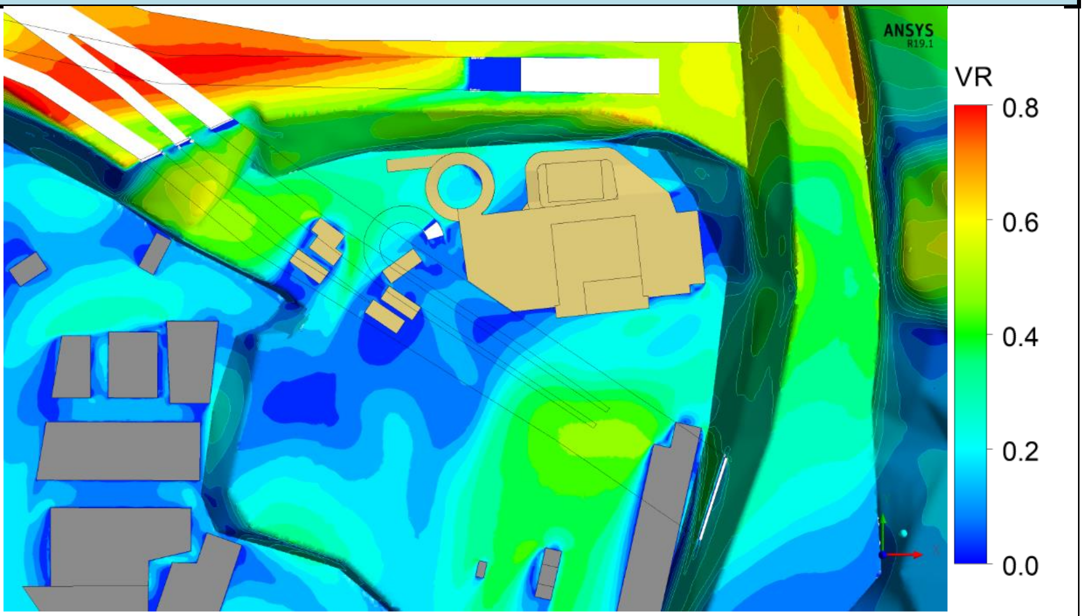
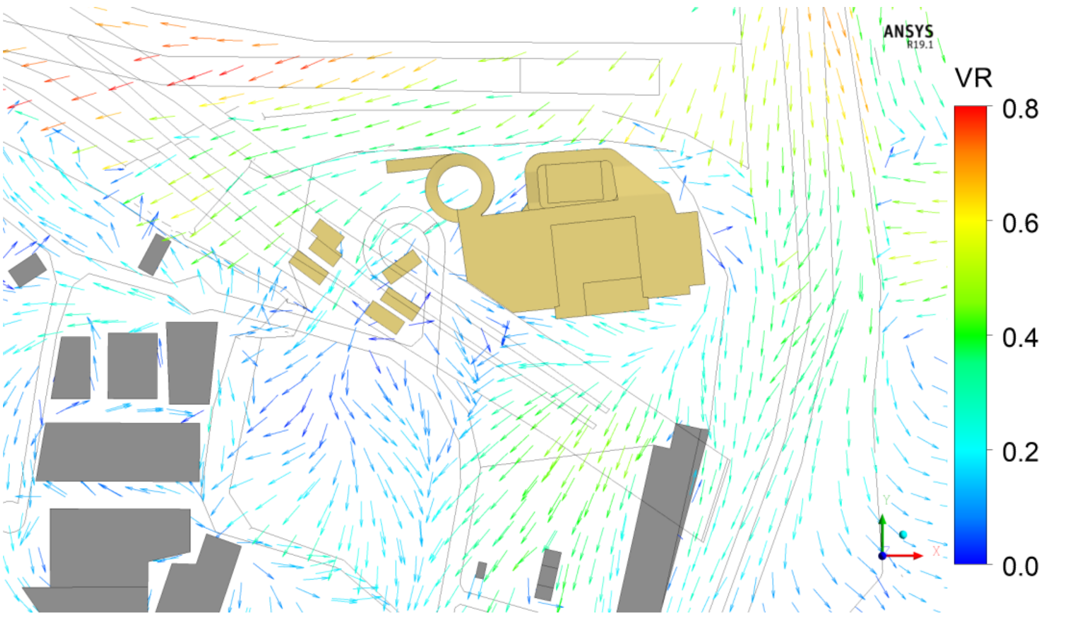
ENE	
	

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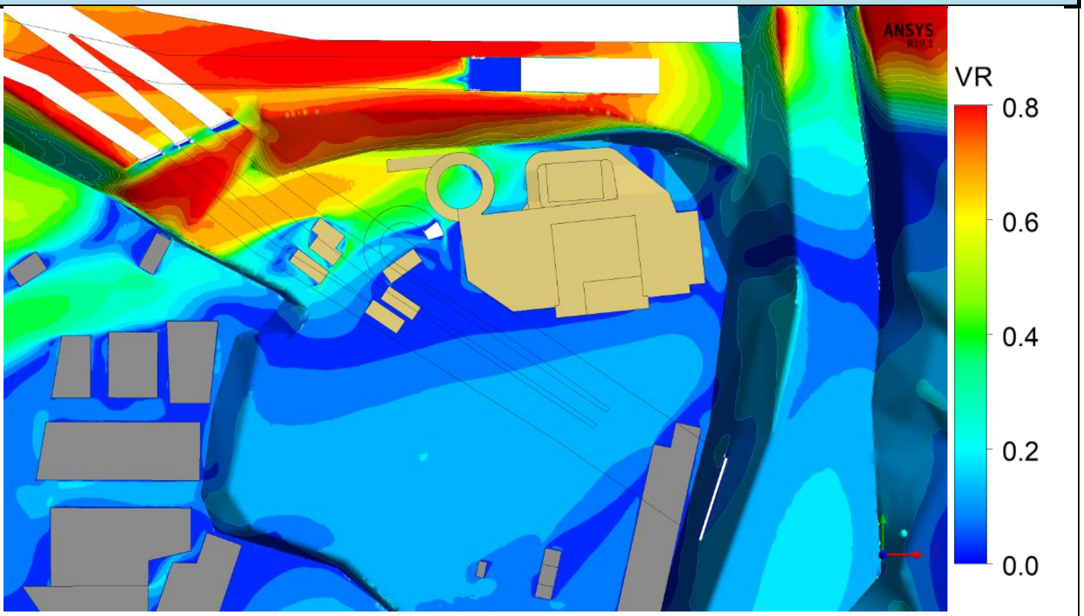
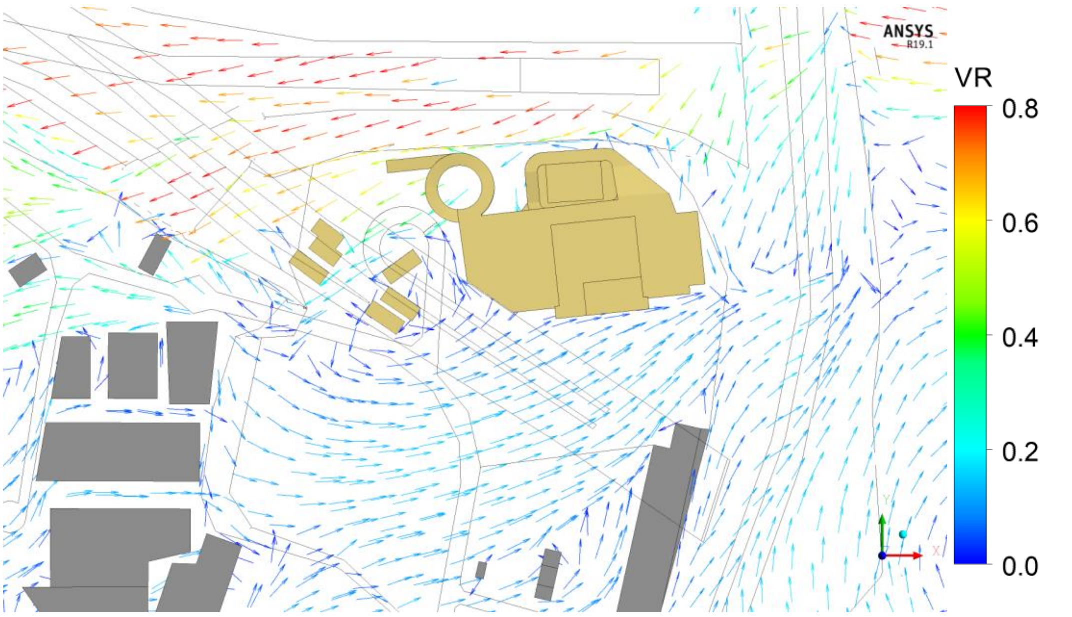
E	
	

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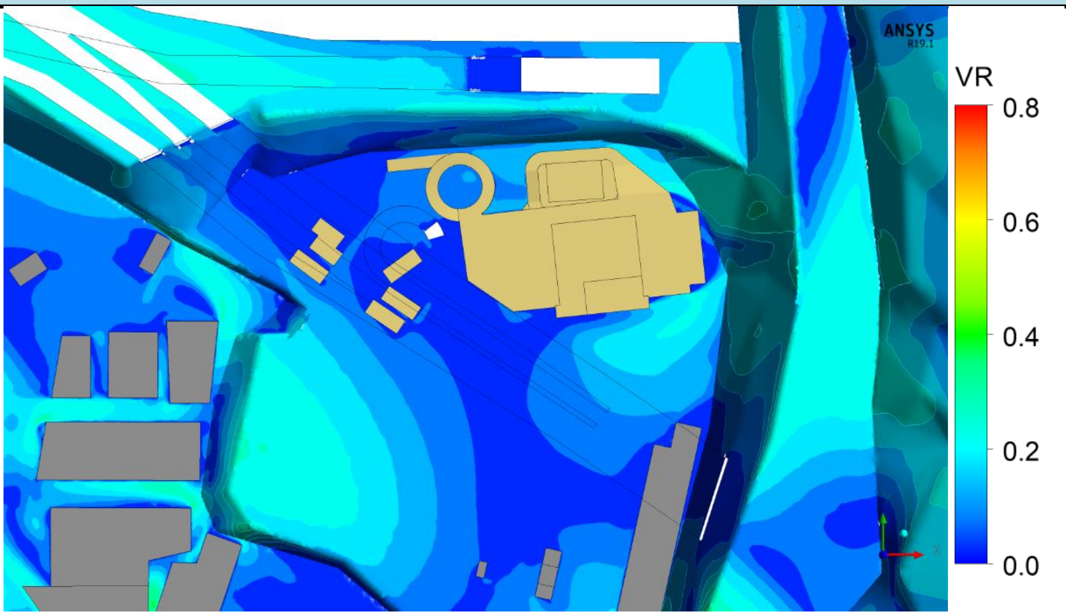
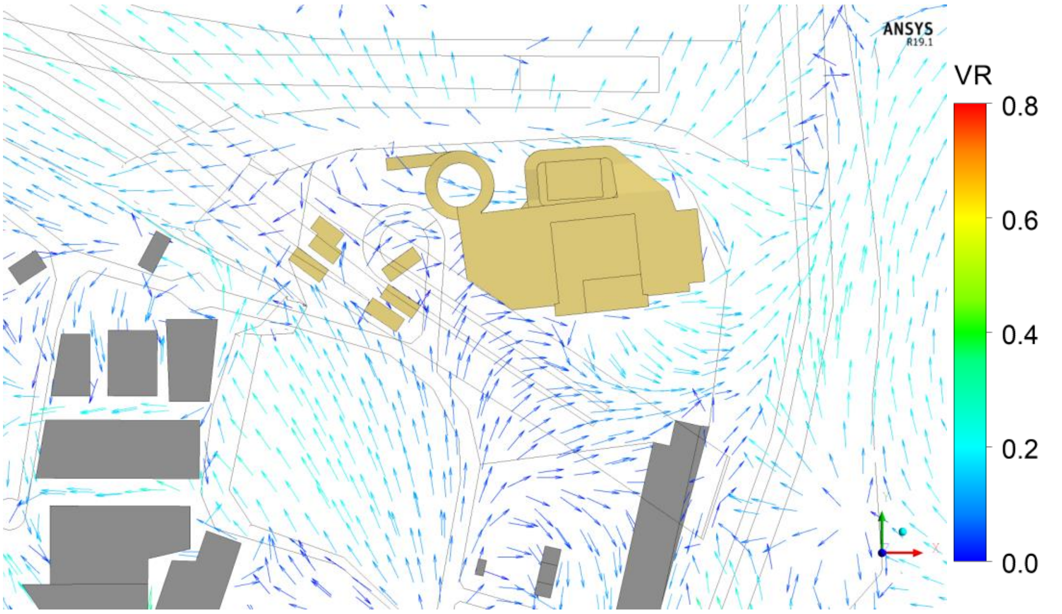
<tr><td>ESE</td><td>
</td></tr>
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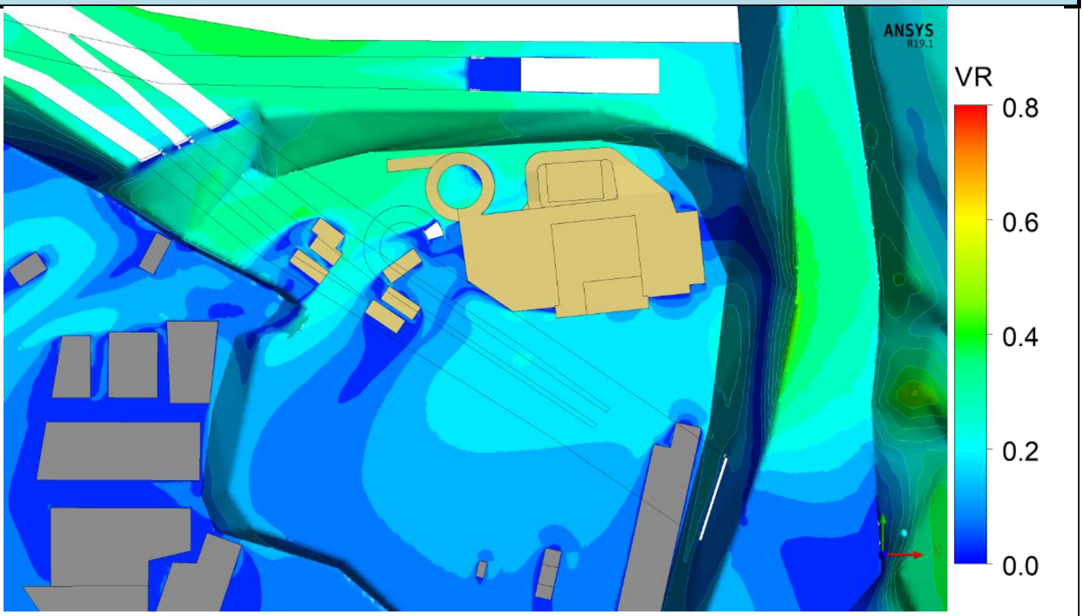
<tr><td rowspan="2">SE</td><td>
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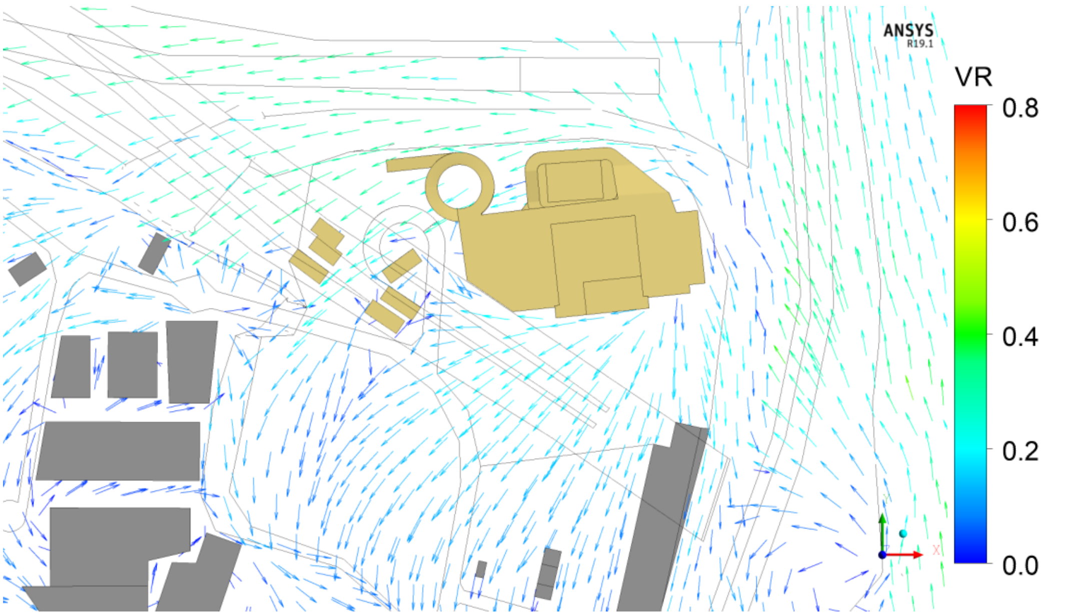
<tr><td>
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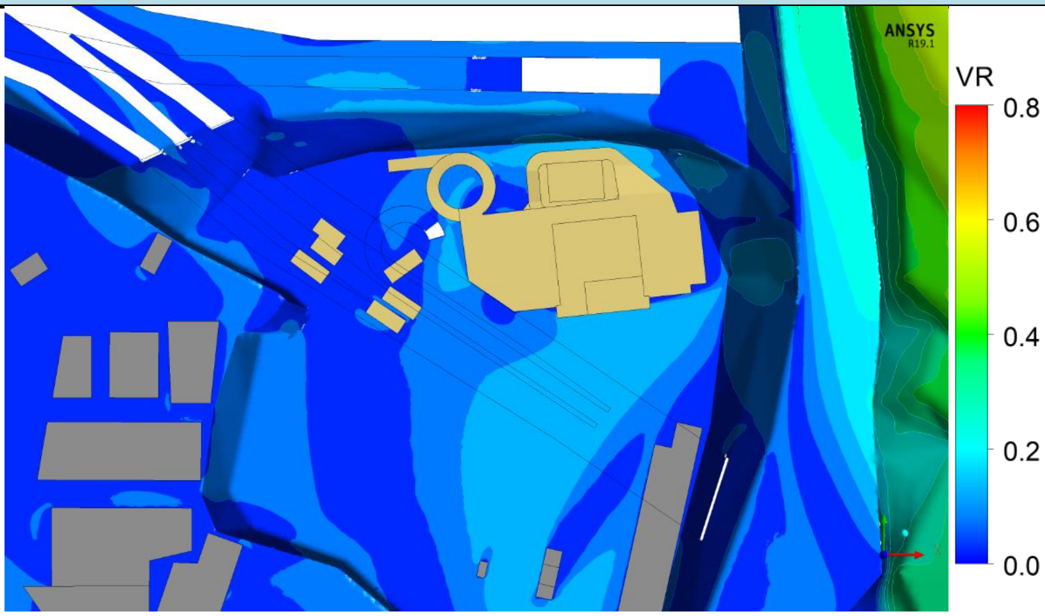
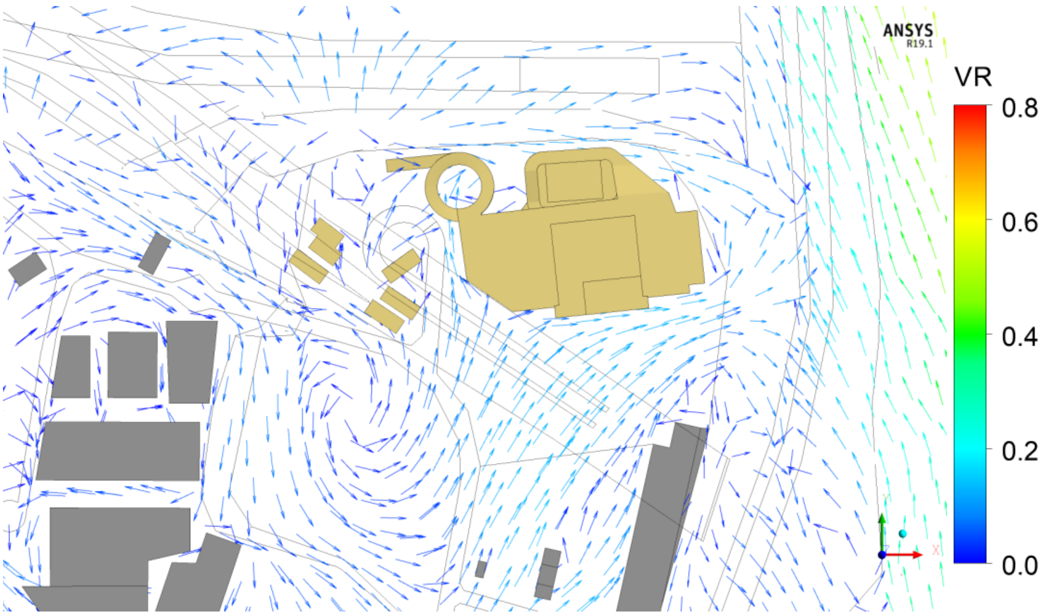
SSE	 

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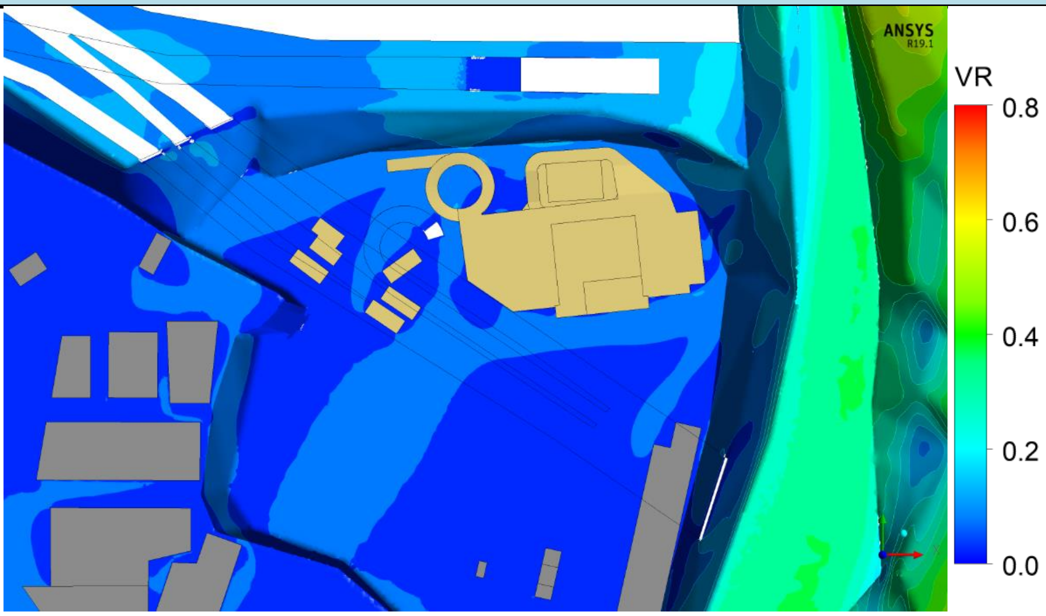
<tr><td rowspan="2">S</td><td>
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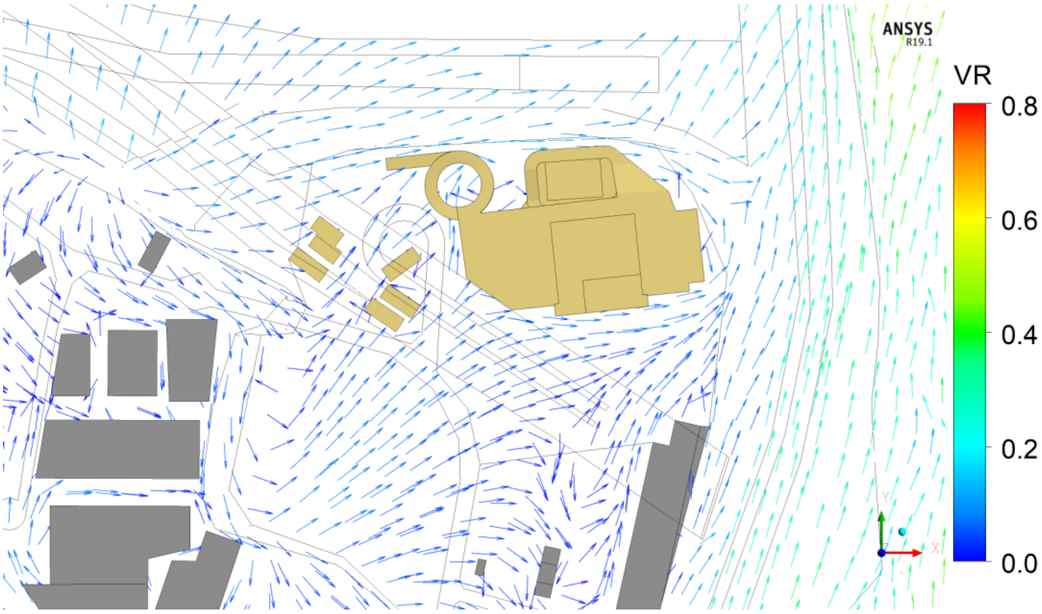
<tr><td>
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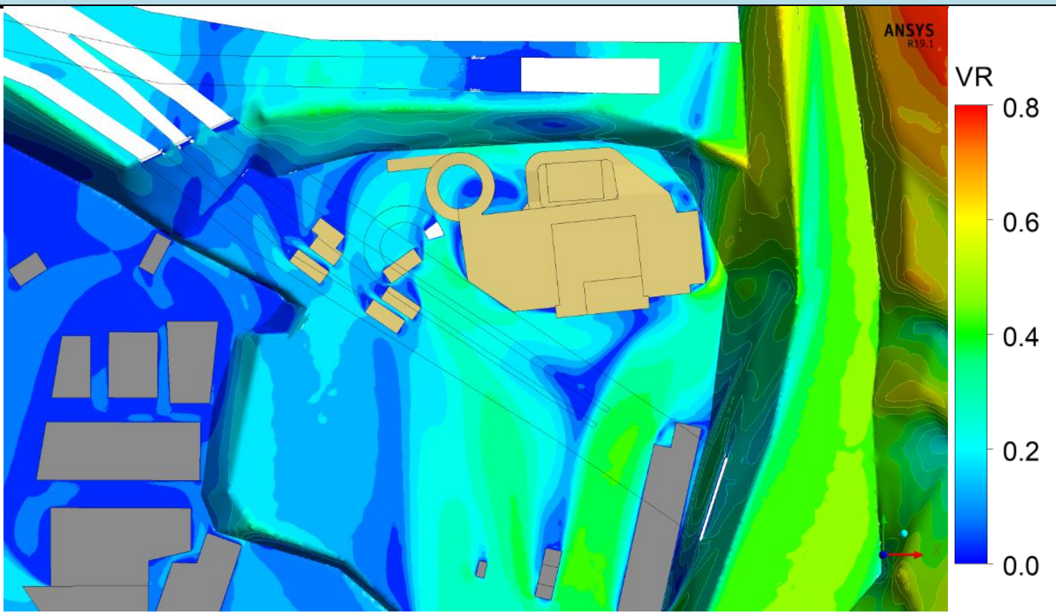
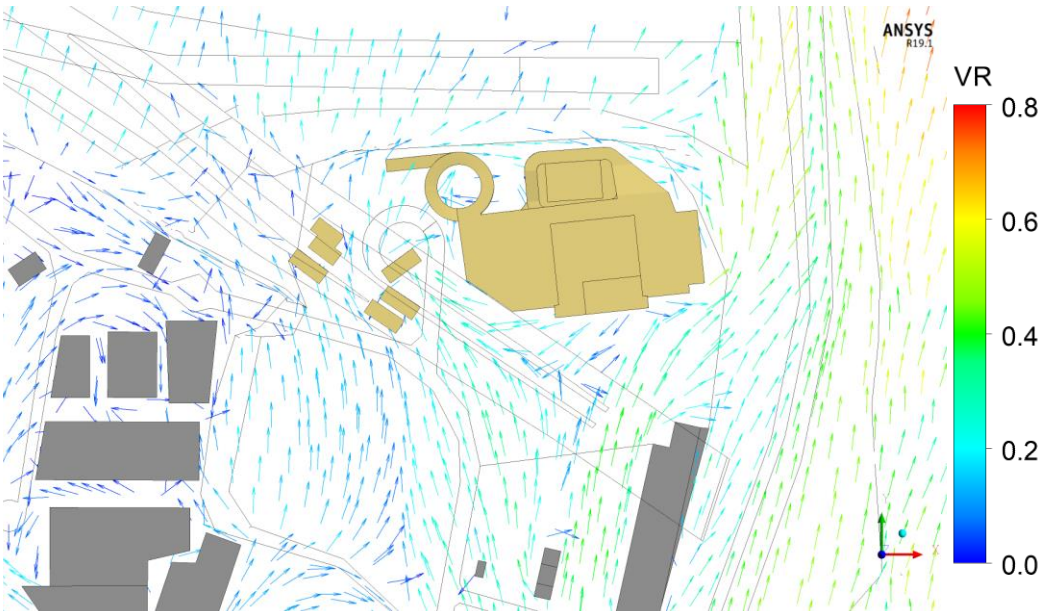
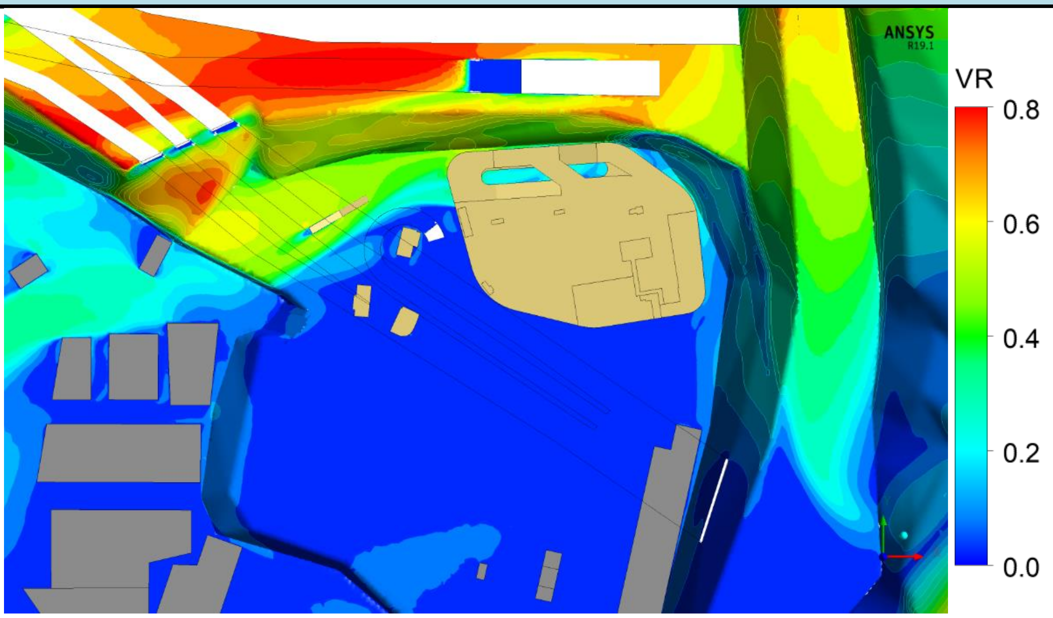
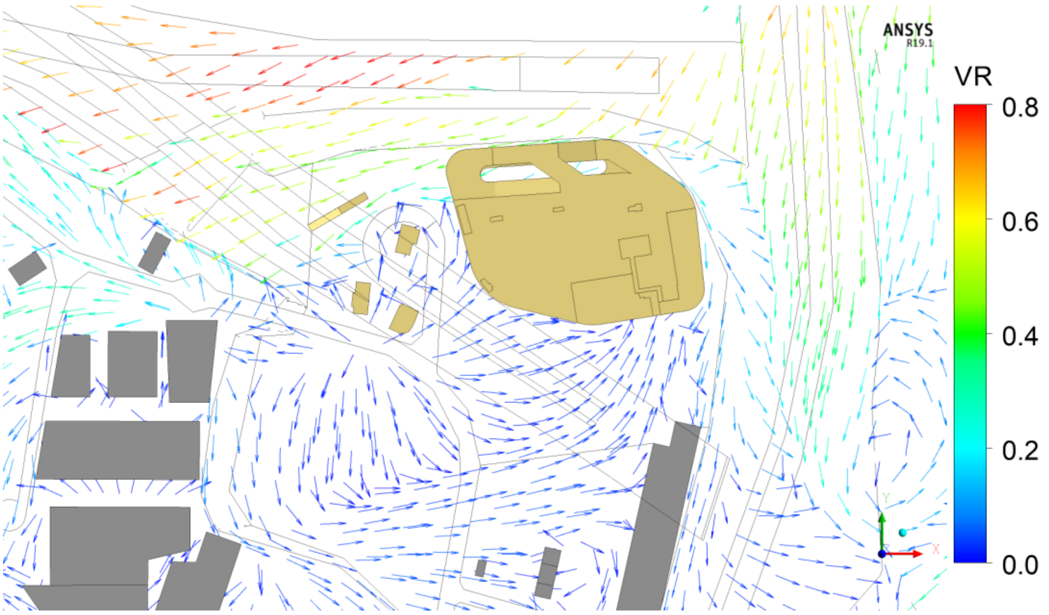
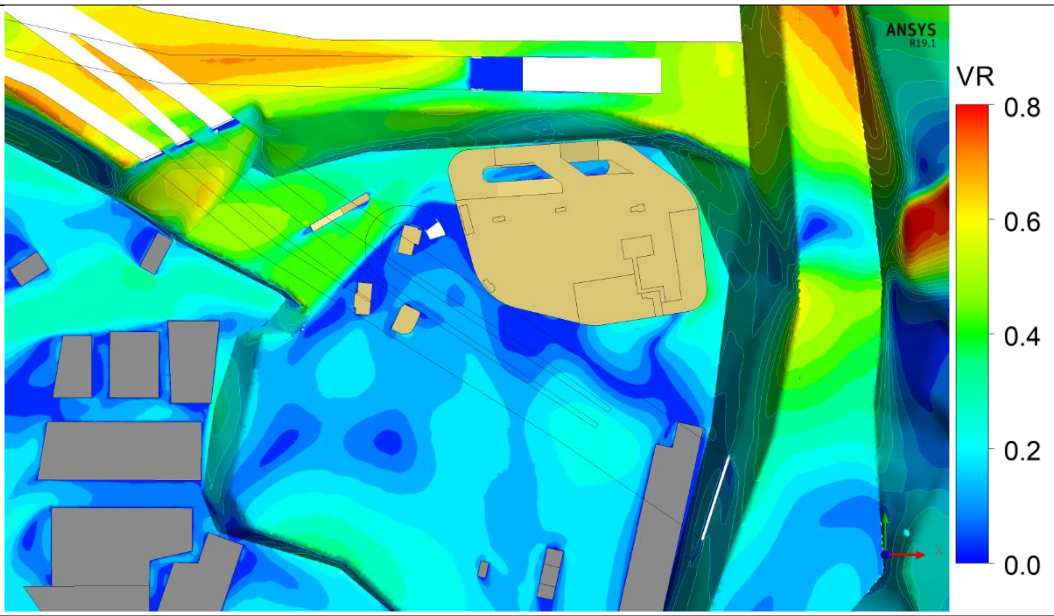
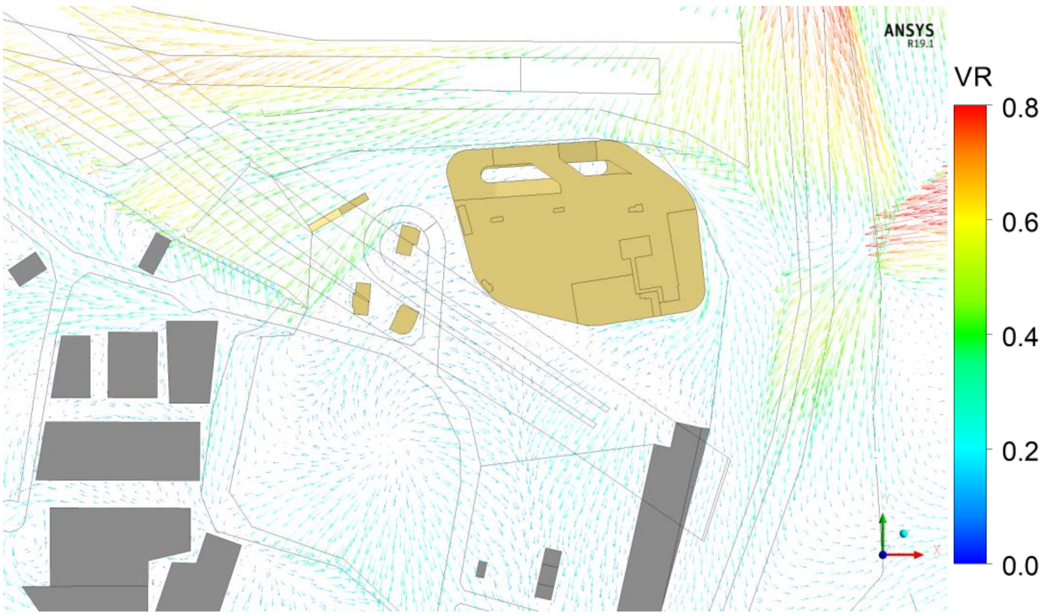
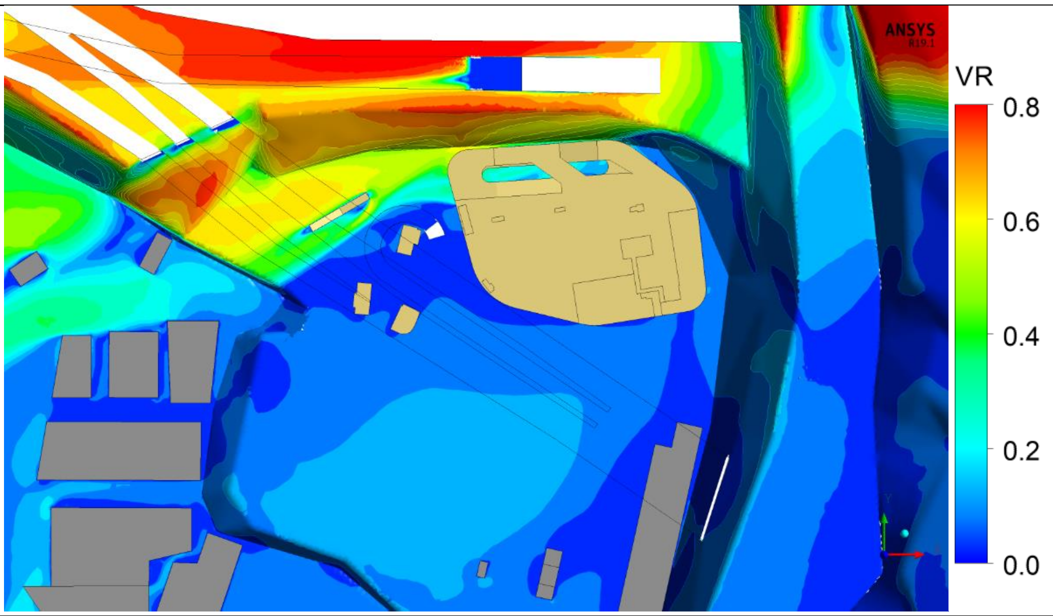
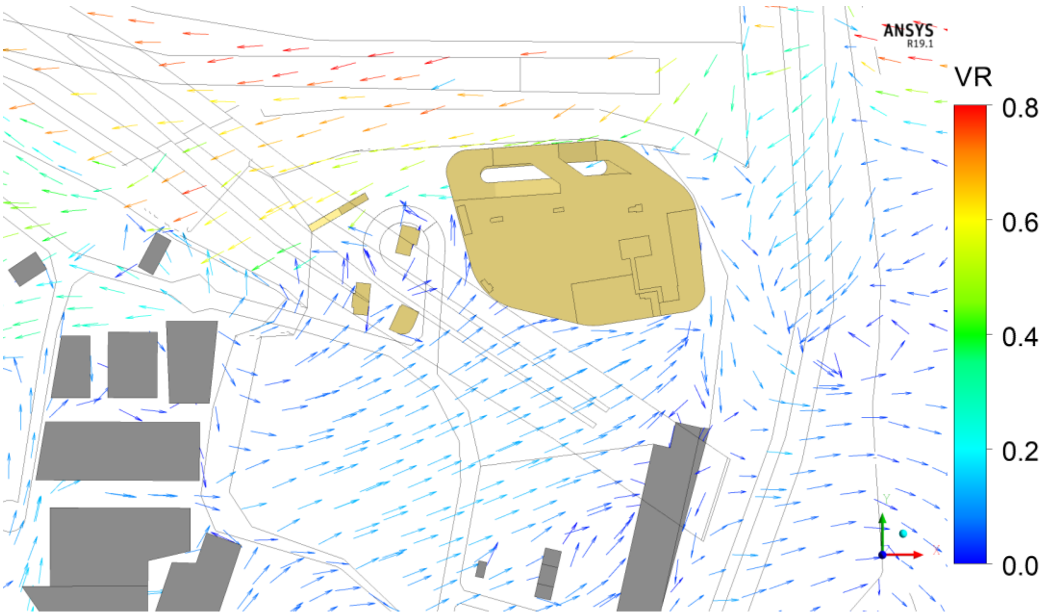
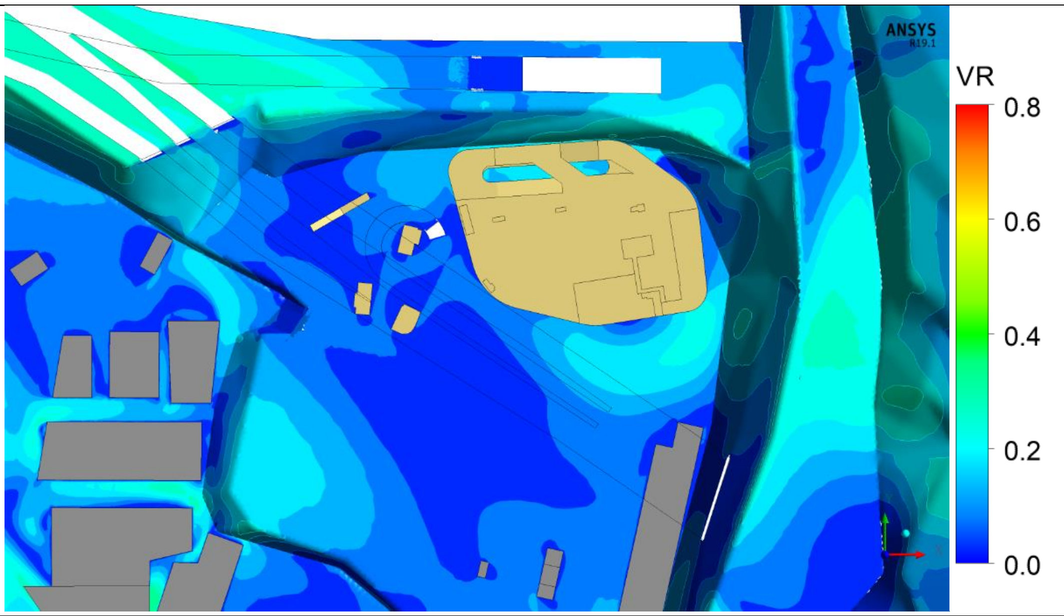
Direction	Baseline Scheme CFD Air Velocity Ratio Results – Pedestrian Level
SSW	 

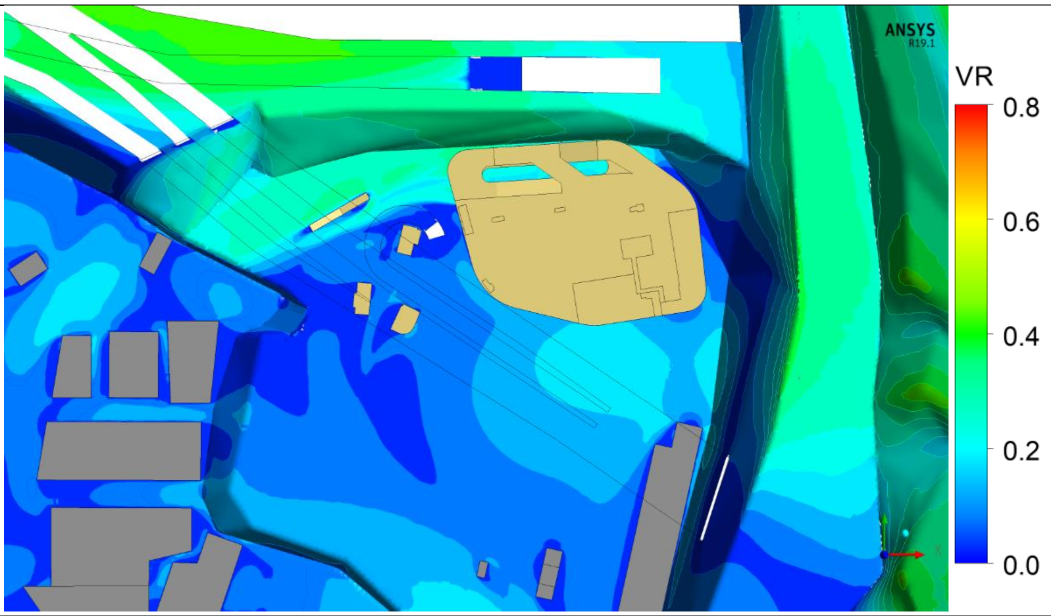
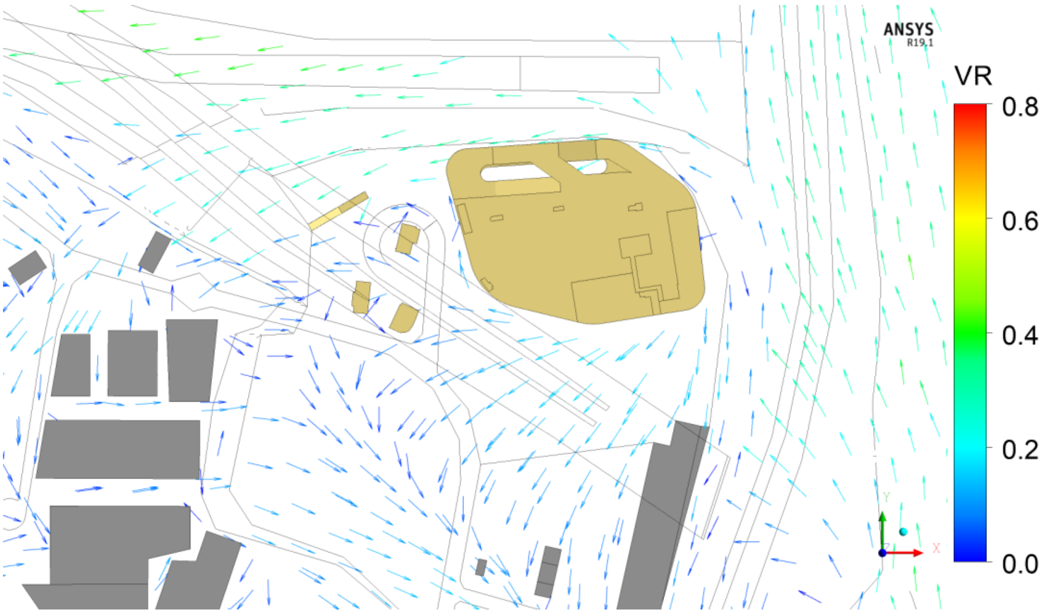
Appendix B – Proposed Scheme Velocity Ratio Contour and Vector Maps

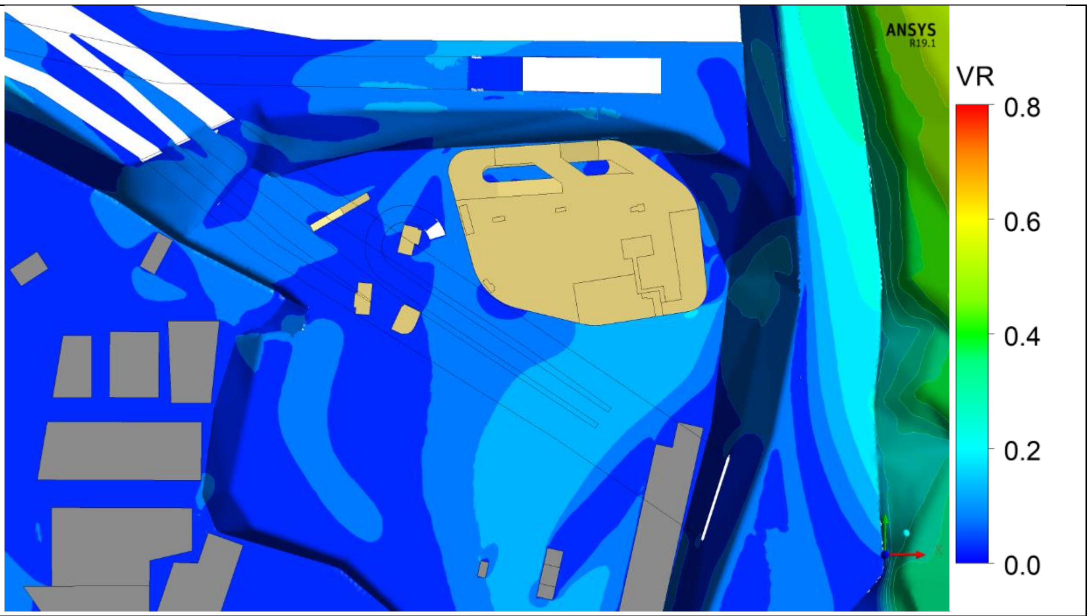
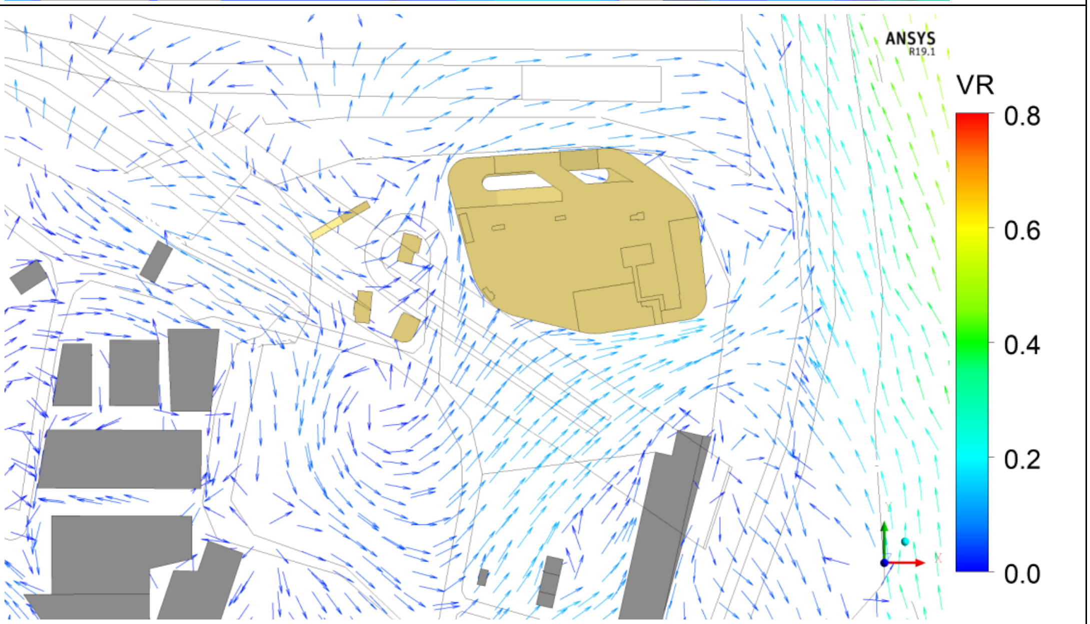
Direction	Proposed Scheme CFD Air Velocity Ratio Results – Pedestrian Level
NE	 

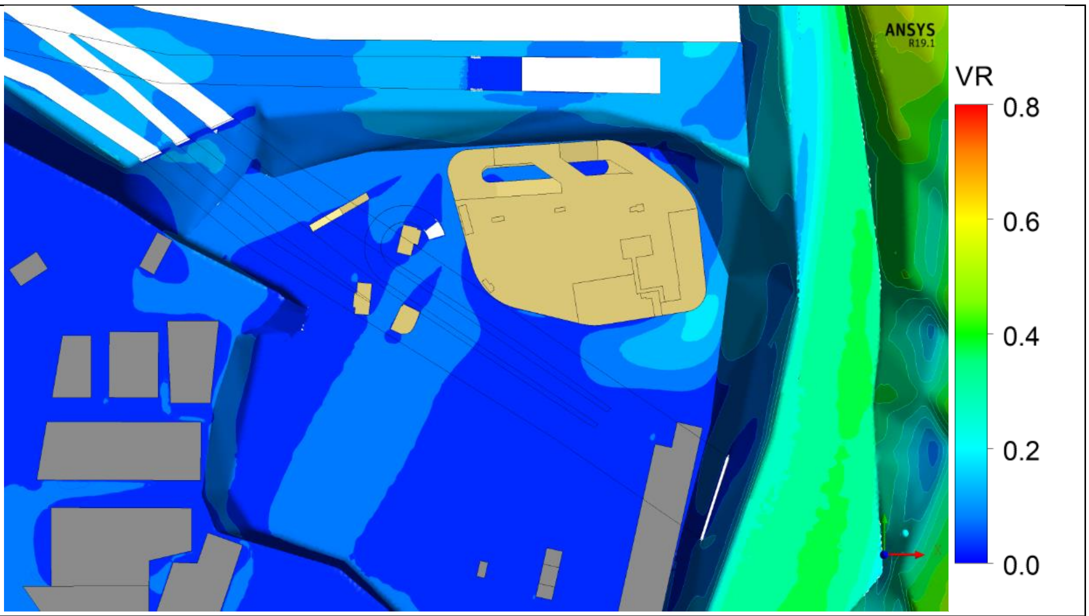
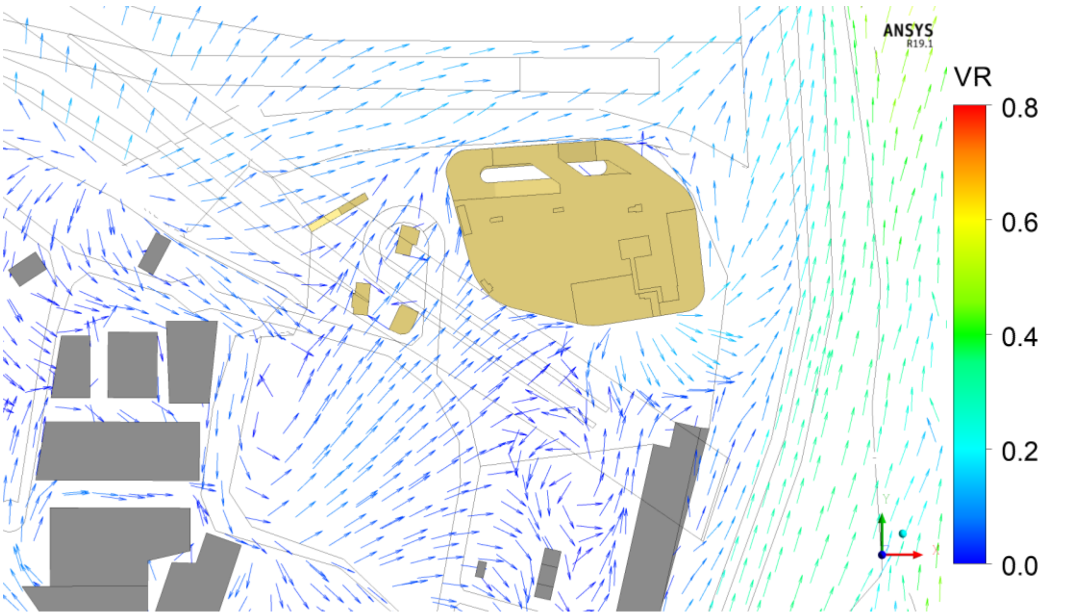
ENE	ANSYS R19.1 VR 0.8 0.6 0.4 0.2 0.0 ANSYS R19.1 VR 0.8 0.6 0.4 0.2 0.0

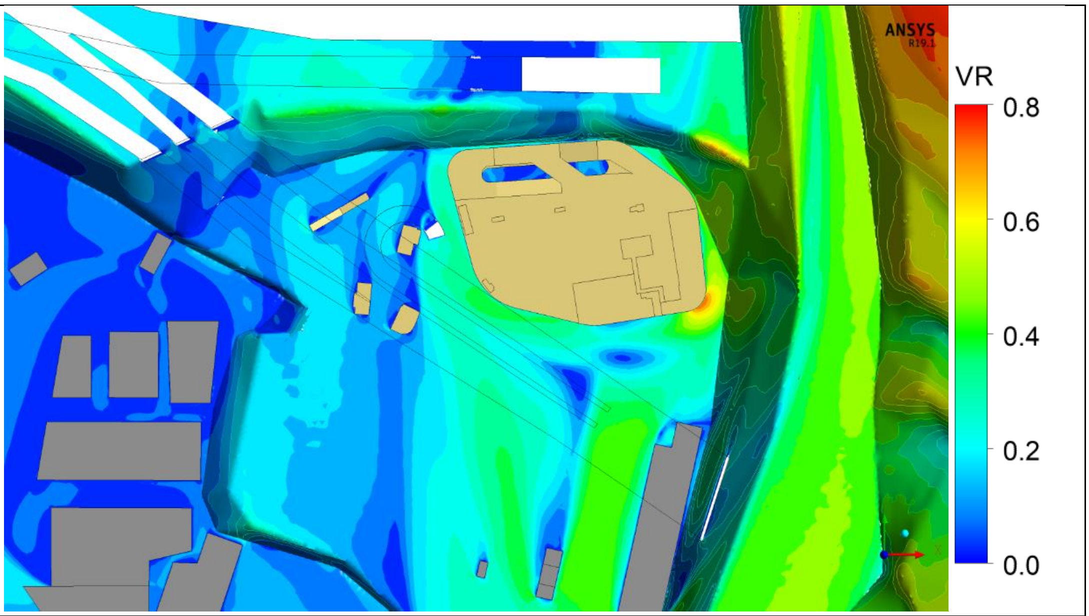
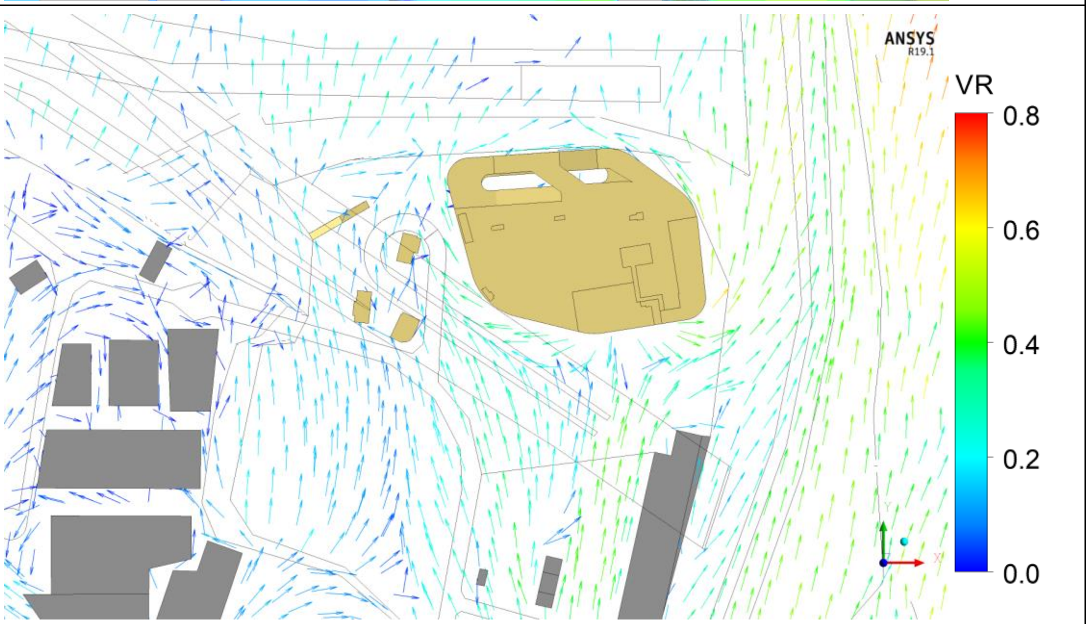
E	 

ESE	ANSYS R19.1 VR 0.8 0.6 0.4 0.2 0.0
	ANSYS R19.1 VR 0.8 0.6 0.4 0.2 0.0

SE	
	

SSE	ANSYS R19.1 VR 0.8 0.6 0.4 0.2 0.0 ANSYS R19.1 VR 0.8 0.6 0.4 0.2 0.0

S	 ANSYS R19.1 VR 0.8 0.6 0.4 0.2 0.0  ANSYS R19.1 VR 0.8 0.6 0.4 0.2 0.0

SSW	
	

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Appendix C – Baseline Scheme Velocity Ratios

Baseline Scheme Wind Velocity Ratio									
Test Points	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**Weighted**
P1	0.12	0.10	0.02	0.03	0.10	0.11	0.05	0.30	0.070
P2	0.07	0.10	0.02	0.01	0.05	0.11	0.06	0.20	0.053
P3	0.08	0.08	0.05	0.03	0.03	0.02	0.01	0.08	0.040
P4	0.05	0.06	0.04	0.02	0.11	0.03	0.02	0.18	0.044
P5	0.03	0.09	0.03	0.01	0.11	0.02	0.01	0.09	0.037
P6	0.13	0.03	0.03	0.05	0.02	0.06	0.07	0.13	0.046
P7	0.04	0.03	0.01	0.07	0.02	0.06	0.02	0.13	0.030
P8	0.17	0.22	0.12	0.10	0.22	0.03	0.03	0.17	0.108
P9	0.22	0.05	0.19	0.10	0.05	0.02	0.02	0.14	0.090
P10	0.16	0.35	0.20	0.07	0.11	0.04	0.03	0.09	0.124
P11	0.63	0.44	0.61	0.08	0.31	0.05	0.05	0.10	0.277
P12	0.69	0.46	0.69	0.09	0.30	0.04	0.05	0.06	0.299
P13	0.65	0.47	0.68	0.06	0.30	0.03	0.06	0.06	0.291
P14	0.55	0.37	0.60	0.02	0.28	0.02	0.06	0.04	0.246
P15	0.60	0.36	0.67	0.02	0.33	0.02	0.07	0.06	0.267
P16	0.54	0.30	0.64	0.03	0.33	0.02	0.08	0.10	0.253
P17	0.47	0.26	0.59	0.03	0.32	0.02	0.08	0.04	0.225
P18	0.45	0.27	0.56	0.04	0.32	0.03	0.08	0.12	0.226
P19	0.45	0.29	0.52	0.06	0.32	0.05	0.09	0.17	0.229
P20	0.48	0.31	0.51	0.07	0.32	0.08	0.09	0.23	0.239
P21	0.30	0.24	0.21	0.07	0.25	0.09	0.10	0.25	0.155
P22	0.21	0.22	0.01	0.08	0.25	0.10	0.10	0.23	0.104
P23	0.01	0.17	0.09	0.11	0.26	0.10	0.10	0.19	0.095
P24	0.07	0.01	0.15	0.12	0.25	0.09	0.09	0.14	0.086
P25	0.07	0.16	0.03	0.15	0.18	0.11	0.09	0.18	0.086
P26	0.04	0.13	0.11	0.16	0.14	0.09	0.08	0.19	0.091
P27	0.13	0.04	0.03	0.01	0.06	0.00	0.02	0.07	0.035
P28	0.09	0.06	0.10	0.02	0.10	0.02	0.03	0.37	0.073
P29	0.05	0.20	0.05	0.15	0.17	0.09	0.08	0.33	0.101
P30	0.08	0.22	0.07	0.15	0.20	0.08	0.06	0.28	0.107
P31	0.07	0.26	0.11	0.13	0.18	0.07	0.05	0.28	0.113
P32	0.06	0.30	0.13	0.13	0.15	0.06	0.05	0.28	0.119
P33	0.06	0.28	0.12	0.15	0.16	0.11	0.04	0.32	0.123
P34	0.06	0.19	0.11	0.19	0.18	0.12	0.04	0.26	0.110
P35	0.06	0.24	0.10	0.18	0.18	0.12	0.05	0.03	0.098
P36	0.07	0.23	0.10	0.13	0.19	0.12	0.05	0.20	0.104
P37	0.09	0.20	0.09	0.06	0.20	0.10	0.05	0.18	0.093
P38	0.12	0.10	0.06	0.04	0.19	0.08	0.06	0.21	0.076
P39	0.14	0.03	0.04	0.04	0.17	0.06	0.05	0.24	0.064
P40	0.14	0.08	0.03	0.03	0.15	0.07	0.05	0.27	0.068
O41	0.11	0.07	0.13	0.05	0.17	0.09	0.04	0.24	0.087
O42	0.12	0.09	0.11	0.06	0.17	0.09	0.05	0.21	0.085
O43	0.10	0.08	0.09	0.06	0.16	0.08	0.06	0.18	0.076
O44	0.10	0.08	0.08	0.06	0.13	0.07	0.06	0.16	0.069
O45	0.11	0.06	0.06	0.07	0.10	0.06	0.06	0.15	0.061
O46	0.12	0.04	0.04	0.07	0.02	0.05	0.06	0.12	0.048
O47	0.10	0.01	0.03	0.08	0.02	0.04	0.05	0.09	0.038

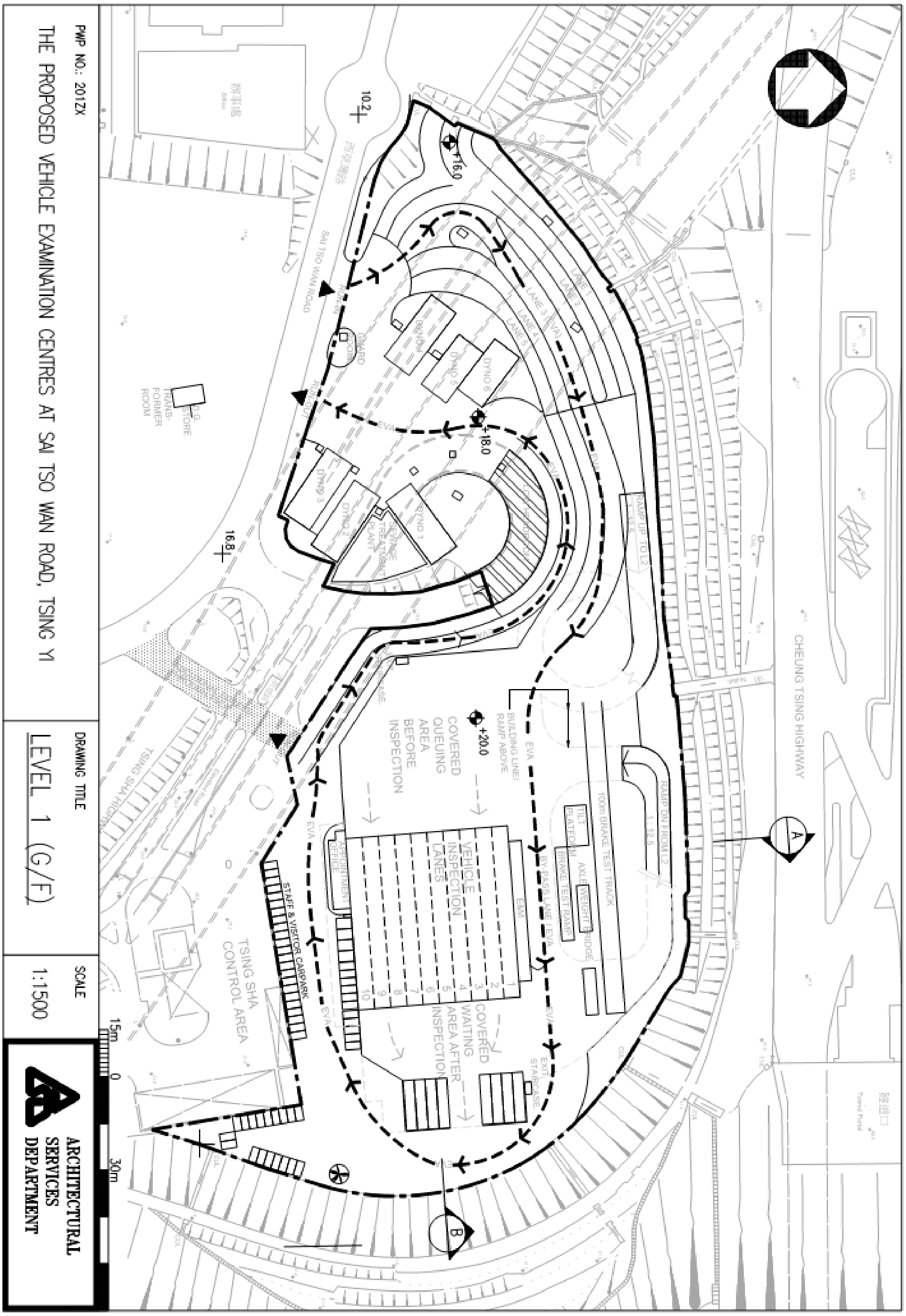
Baseline Scheme Wind Velocity Ratio									
Test Points	NE	ENE	E	ESE	SE	SSE	S	SSW	Weighted
O48	0.07	0.02	0.02	0.09	0.04	0.04	0.04	0.11	0.040
O49	0.08	0.08	0.04	0.11	0.10	0.04	0.04	0.14	0.058
O50	0.10	0.10	0.06	0.12	0.14	0.03	0.04	0.16	0.071
O51	0.17	0.16	0.08	0.13	0.19	0.03	0.03	0.16	0.093
O52	0.20	0.16	0.09	0.15	0.21	0.04	0.02	0.15	0.101
O53	0.14	0.09	0.06	0.05	0.03	0.05	0.04	0.01	0.051
O54	0.12	0.10	0.05	0.03	0.09	0.04	0.04	0.05	0.052
O55	0.11	0.14	0.04	0.12	0.08	0.05	0.05	0.06	0.064
O56	0.14	0.16	0.05	0.18	0.06	0.05	0.06	0.10	0.080
O57	0.17	0.17	0.07	0.22	0.06	0.05	0.06	0.08	0.092
O58	0.20	0.18	0.09	0.24	0.07	0.05	0.06	0.04	0.098
O59	0.23	0.18	0.14	0.13	0.09	0.04	0.06	0.02	0.099
O60	0.26	0.19	0.18	0.04	0.10	0.03	0.05	0.02	0.101
O61	0.28	0.20	0.22	0.03	0.11	0.03	0.05	0.02	0.113
O62	0.30	0.21	0.25	0.07	0.11	0.03	0.05	0.05	0.128
O63	0.34	0.23	0.30	0.13	0.11	0.04	0.05	0.05	0.150
O64	0.36	0.23	0.32	0.04	0.10	0.05	0.05	0.05	0.148
O65	0.35	0.22	0.31	0.05	0.08	0.04	0.05	0.05	0.141
O66	0.12	0.24	0.14	0.12	0.09	0.04	0.30	0.41	0.138
O67	0.10	0.25	0.13	0.15	0.13	0.07	0.30	0.40	0.143
O68	0.07	0.26	0.12	0.17	0.19	0.05	0.30	0.40	0.145
O69	0.05	0.27	0.11	0.19	0.23	0.02	0.30	0.40	0.145
O70	0.04	0.29	0.11	0.21	0.26	0.04	0.30	0.40	0.149
O71	0.06	0.31	0.10	0.22	0.29	0.05	0.30	0.39	0.155
O72	0.09	0.32	0.10	0.23	0.30	0.07	0.30	0.39	0.162
O73	0.13	0.34	0.10	0.24	0.32	0.08	0.30	0.39	0.171
O74	0.18	0.36	0.09	0.24	0.34	0.09	0.31	0.37	0.179
O75	0.22	0.37	0.08	0.24	0.34	0.12	0.31	0.38	0.185
O76	0.24	0.37	0.07	0.24	0.34	0.14	0.31	0.37	0.187
O77	0.26	0.39	0.06	0.23	0.34	0.14	0.31	0.33	0.184
O78	0.27	0.39	0.02	0.23	0.35	0.15	0.32	0.34	0.180
O79	0.29	0.39	0.03	0.21	0.34	0.16	0.31	0.36	0.183
O80	0.32	0.36	0.09	0.17	0.34	0.17	0.30	0.36	0.188
O81	0.35	0.33	0.12	0.13	0.34	0.18	0.29	0.36	0.187
O82	0.38	0.32	0.15	0.10	0.33	0.19	0.27	0.35	0.191
O83	0.41	0.36	0.17	0.07	0.32	0.21	0.26	0.36	0.203
O84	0.44	0.44	0.20	0.03	0.32	0.23	0.24	0.35	0.215
O85	0.47	0.51	0.25	0.04	0.31	0.24	0.22	0.33	0.235
O86	0.50	0.55	0.30	0.00	0.30	0.25	0.22	0.35	0.252
O87	0.11	0.10	0.14	0.05	0.16	0.10	0.04	0.26	0.094
O88	0.33	0.20	0.29	0.06	0.04	0.04	0.04	0.05	0.131
O89	0.30	0.18	0.26	0.06	0.09	0.04	0.04	0.05	0.124
O90	0.27	0.16	0.23	0.06	0.14	0.03	0.03	0.06	0.114
SVR	0.127								
LVR	0.128								

Appendix D – Proposed Scheme Velocity Ratios

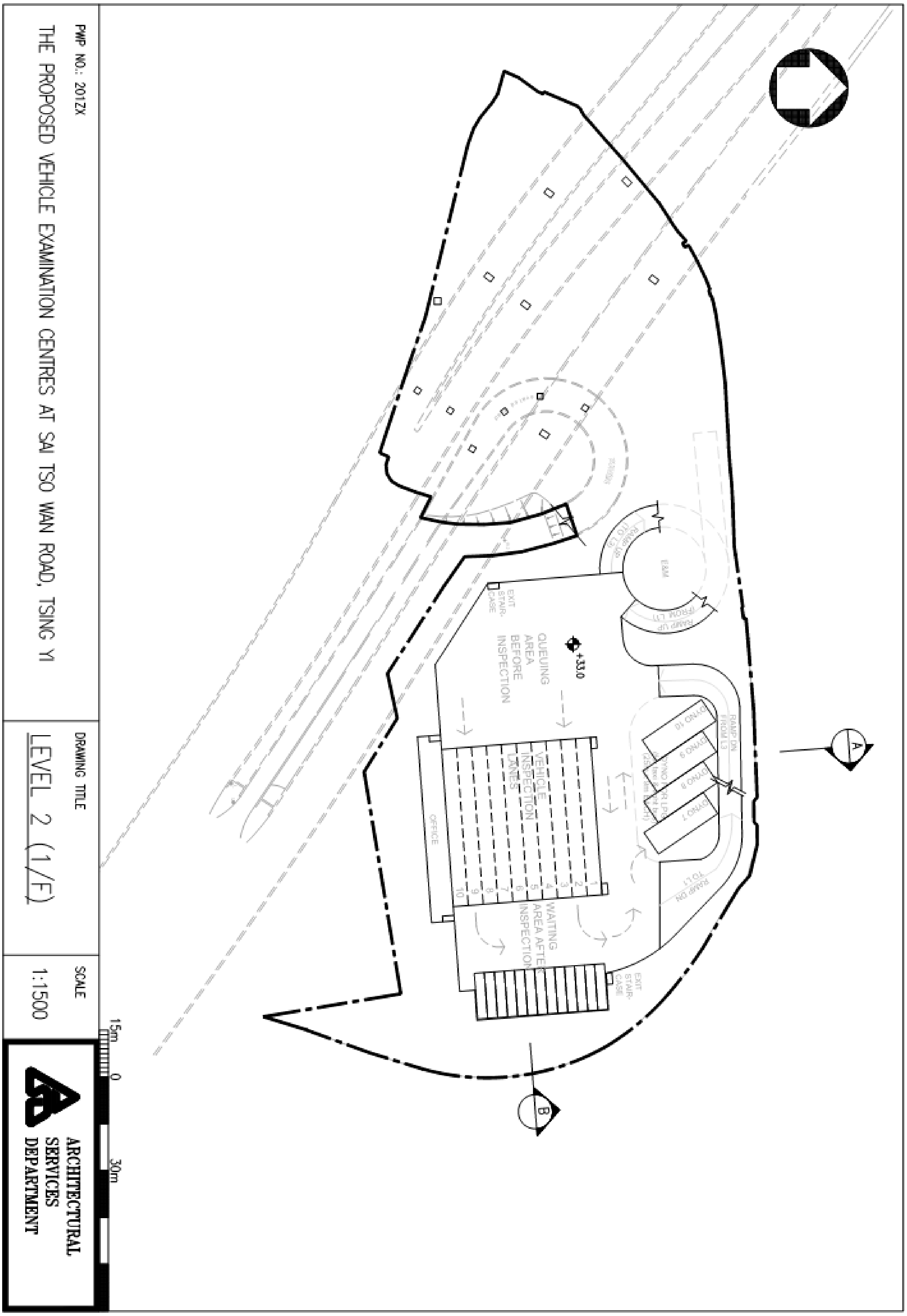
Proposed Scheme Wind Velocity Ratio									
Test Points	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**Weighted**
P1	0.04	0.10	0.04	0.06	0.07	0.06	0.06	0.33	0.066
P2	0.03	0.07	0.03	0.05	0.06	0.06	0.05	0.30	0.055
P3	0.05	0.02	0.02	0.02	0.02	0.03	0.04	0.22	0.036
P4	0.03	0.10	0.02	0.05	0.08	0.04	0.07	0.17	0.048
P5	0.01	0.10	0.03	0.01	0.08	0.02	0.02	0.18	0.041
P6	0.05	0.14	0.09	0.03	0.11	0.03	0.08	0.07	0.062
P7	0.02	0.11	0.06	0.04	0.09	0.02	0.05	0.10	0.049
P8	0.05	0.05	0.05	0.07	0.03	0.03	0.03	0.18	0.046
P9	0.09	0.43	0.03	0.06	0.03	0.05	0.02	0.16	0.093
P10	0.45	0.35	0.41	0.05	0.14	0.06	0.04	0.08	0.193
P11	0.56	0.42	0.53	0.07	0.22	0.05	0.05	0.10	0.245
P12	0.58	0.48	0.62	0.11	0.24	0.05	0.06	0.06	0.277
P13	0.55	0.47	0.61	0.11	0.25	0.03	0.06	0.08	0.271
P14	0.49	0.41	0.56	0.08	0.26	0.05	0.07	0.05	0.245
P15	0.51	0.39	0.61	0.03	0.29	0.05	0.08	0.10	0.255
P16	0.47	0.31	0.57	0.03	0.29	0.04	0.08	0.14	0.236
P17	0.45	0.24	0.53	0.07	0.28	0.03	0.08	0.17	0.222
P18	0.45	0.24	0.52	0.11	0.28	0.03	0.08	0.12	0.219
P19	0.45	0.27	0.52	0.14	0.28	0.04	0.07	0.06	0.223
P20	0.49	0.31	0.57	0.14	0.33	0.06	0.08	0.19	0.255
P21	0.44	0.24	0.48	0.16	0.29	0.07	0.08	0.27	0.229
P22	0.35	0.16	0.35	0.19	0.24	0.08	0.07	0.24	0.185
P23	0.29	0.13	0.30	0.22	0.23	0.10	0.09	0.21	0.166
P24	0.25	0.12	0.24	0.18	0.24	0.08	0.08	0.16	0.141
P25	0.11	0.12	0.08	0.17	0.21	0.05	0.01	0.30	0.100
P26	0.16	0.21	0.07	0.03	0.04	0.02	0.09	0.36	0.095
P27	0.21	0.33	0.06	0.07	0.02	0.06	0.07	0.44	0.123
P28	0.10	0.25	0.08	0.10	0.05	0.05	0.10	0.46	0.114
P29	0.07	0.25	0.08	0.17	0.08	0.07	0.14	0.53	0.128
P30	0.07	0.22	0.09	0.21	0.14	0.10	0.15	0.43	0.129
P31	0.04	0.18	0.04	0.20	0.15	0.10	0.11	0.30	0.099
P32	0.04	0.04	0.02	0.13	0.14	0.09	0.05	0.28	0.063
P33	0.05	0.03	0.07	0.19	0.16	0.12	0.09	0.25	0.082
P34	0.04	0.03	0.07	0.18	0.16	0.13	0.13	0.19	0.079
P35	0.02	0.16	0.08	0.16	0.17	0.13	0.10	0.15	0.091
P36	0.02	0.06	0.08	0.17	0.18	0.11	0.06	0.23	0.081
P37	0.03	0.07	0.08	0.13	0.16	0.09	0.02	0.25	0.074
P38	0.03	0.03	0.06	0.08	0.13	0.08	0.04	0.28	0.064
P39	0.03	0.07	0.06	0.05	0.10	0.06	0.05	0.29	0.063
P40	0.04	0.11	0.05	0.04	0.08	0.06	0.05	0.29	0.066
O41	0.03	0.17	0.11	0.02	0.09	0.08	0.03	0.26	0.078
O42	0.03	0.15	0.10	0.03	0.08	0.07	0.04	0.23	0.073
O43	0.03	0.13	0.10	0.04	0.07	0.06	0.05	0.19	0.066
O44	0.03	0.11	0.09	0.04	0.06	0.05	0.06	0.16	0.060
O45	0.03	0.11	0.08	0.05	0.05	0.03	0.06	0.13	0.057
O46	0.02	0.11	0.08	0.05	0.06	0.02	0.06	0.10	0.052
O47	0.01	0.12	0.07	0.06	0.05	0.02	0.06	0.10	0.051

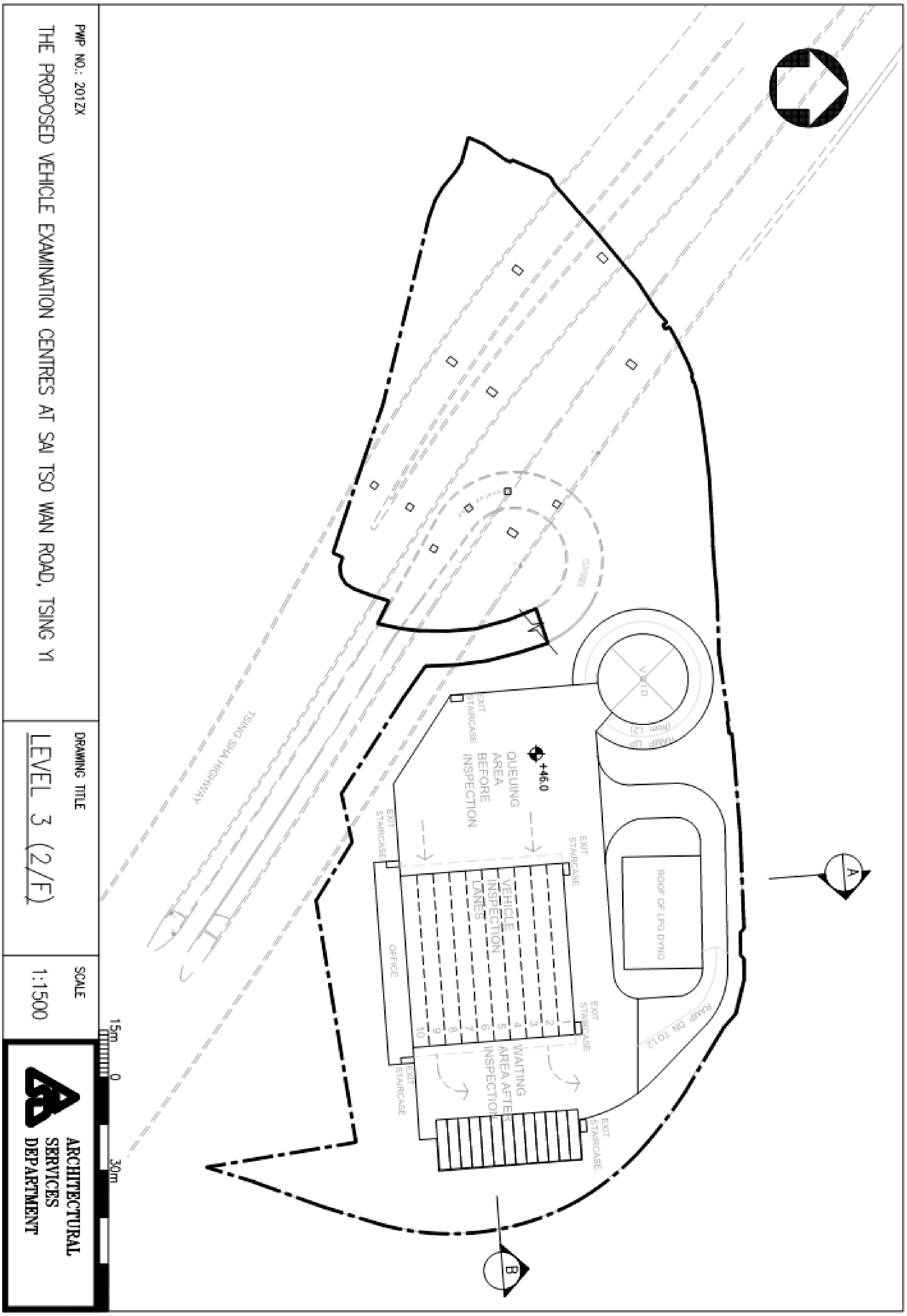
Proposed Scheme Wind Velocity Ratio									
Test Points	**NE**	**ENE**	**E**	**ESE**	**SE**	**SSE**	**S**	**SSW**	**Weighted**
O48	0.01	0.15	0.07	0.06	0.07	0.03	0.05	0.12	0.058
O49	0.01	0.16	0.07	0.06	0.03	0.04	0.05	0.14	0.059
O50	0.03	0.11	0.07	0.06	0.05	0.06	0.04	0.16	0.055
O51	0.04	0.03	0.06	0.06	0.05	0.06	0.03	0.17	0.047
O52	0.06	0.14	0.06	0.06	0.04	0.05	0.02	0.16	0.060
O53	0.05	0.24	0.06	0.01	0.05	0.05	0.04	0.02	0.059
O54	0.04	0.19	0.07	0.04	0.05	0.04	0.04	0.05	0.057
O55	0.06	0.23	0.09	0.09	0.08	0.05	0.05	0.06	0.079
O56	0.09	0.23	0.12	0.13	0.09	0.05	0.06	0.10	0.096
O57	0.12	0.24	0.14	0.17	0.11	0.06	0.06	0.07	0.105
O58	0.13	0.24	0.14	0.19	0.11	0.05	0.06	0.04	0.107
O59	0.14	0.25	0.15	0.12	0.10	0.05	0.06	0.02	0.100
O60	0.16	0.26	0.16	0.04	0.08	0.05	0.06	0.01	0.096
O61	0.18	0.26	0.18	0.03	0.06	0.05	0.05	0.01	0.101
O62	0.21	0.28	0.21	0.06	0.04	0.05	0.05	0.03	0.114
O63	0.26	0.30	0.24	0.10	0.04	0.06	0.05	0.06	0.135
O64	0.28	0.32	0.25	0.03	0.06	0.06	0.05	0.05	0.134
O65	0.27	0.31	0.23	0.04	0.14	0.05	0.05	0.05	0.135
O66	0.04	0.20	0.07	0.15	0.13	0.04	0.30	0.40	0.118
O67	0.01	0.21	0.07	0.15	0.18	0.06	0.29	0.40	0.120
O68	0.07	0.25	0.08	0.17	0.23	0.07	0.30	0.40	0.138
O69	0.22	0.29	0.08	0.19	0.25	0.03	0.30	0.40	0.159
O70	0.29	0.33	0.08	0.21	0.28	0.02	0.30	0.40	0.174
O71	0.31	0.37	0.07	0.23	0.29	0.04	0.30	0.39	0.183
O72	0.33	0.41	0.05	0.24	0.30	0.06	0.30	0.39	0.189
O73	0.34	0.44	0.04	0.25	0.31	0.08	0.31	0.39	0.195
O74	0.35	0.48	0.03	0.25	0.32	0.09	0.31	0.37	0.198
O75	0.37	0.51	0.05	0.25	0.32	0.12	0.31	0.38	0.211
O76	0.38	0.52	0.07	0.25	0.33	0.13	0.31	0.38	0.220
O77	0.39	0.51	0.09	0.25	0.33	0.13	0.31	0.34	0.220
O78	0.41	0.44	0.10	0.24	0.33	0.14	0.32	0.35	0.215
O79	0.43	0.27	0.11	0.21	0.33	0.15	0.31	0.36	0.195
O80	0.45	0.06	0.11	0.17	0.33	0.16	0.30	0.35	0.165
O81	0.46	0.11	0.12	0.13	0.33	0.17	0.28	0.35	0.168
O82	0.48	0.27	0.12	0.09	0.33	0.18	0.26	0.35	0.187
O83	0.49	0.40	0.13	0.06	0.32	0.20	0.24	0.34	0.204
O84	0.51	0.49	0.15	0.05	0.32	0.21	0.22	0.33	0.219
O85	0.52	0.55	0.19	0.03	0.32	0.23	0.19	0.33	0.232
O86	0.54	0.58	0.25	0.01	0.32	0.24	0.19	0.34	0.247
O87	0.02	0.18	0.12	0.01	0.09	0.09	0.03	0.28	0.081
O88	0.27	0.29	0.21	0.06	0.15	0.04	0.04	0.05	0.128
O89	0.26	0.27	0.18	0.07	0.15	0.04	0.03	0.05	0.121
O90	0.26	0.25	0.14	0.07	0.15	0.03	0.03	0.06	0.109
SVR	**0.133**								
LVR	**0.130**								

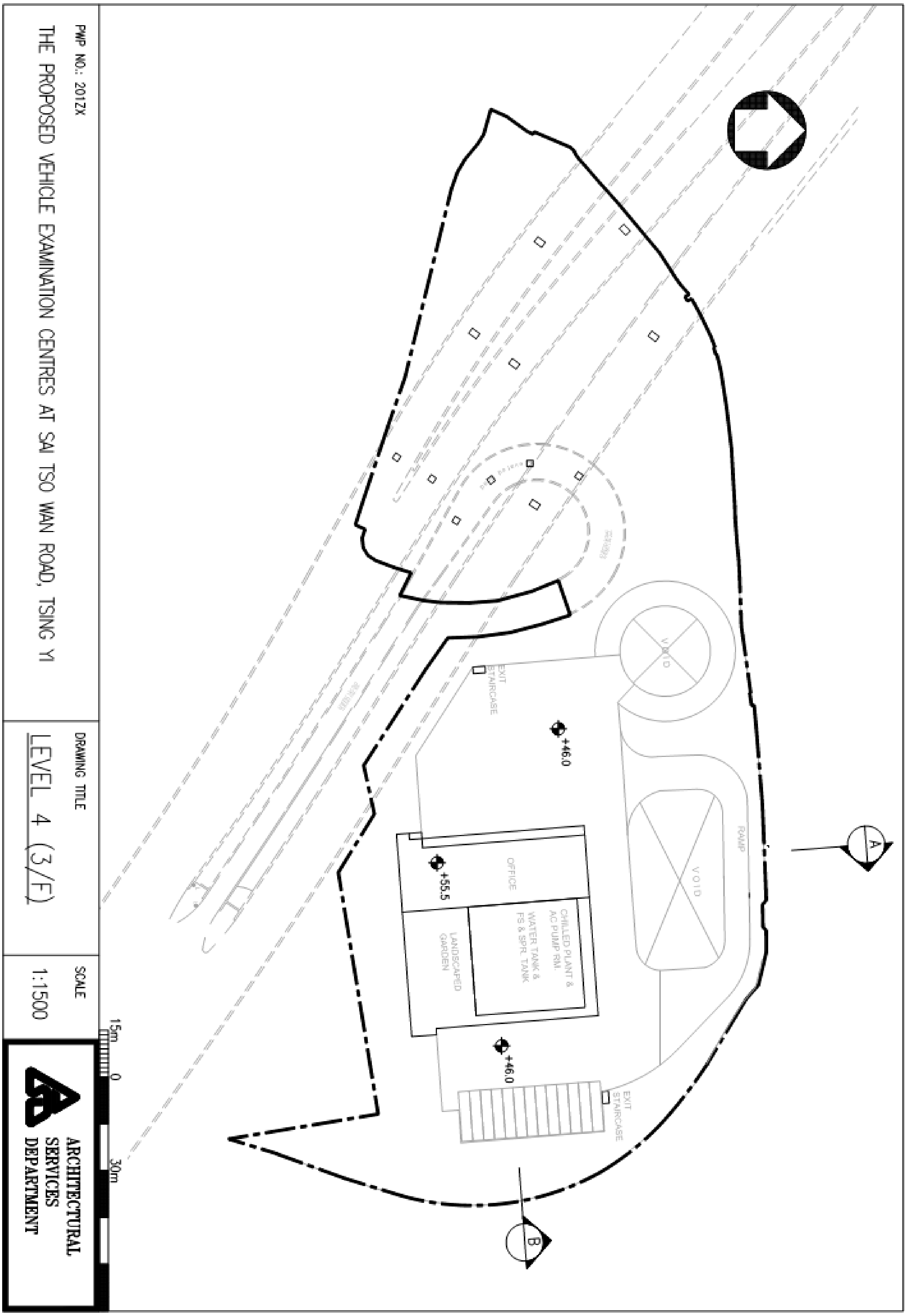
Appendix E – Baseline Scheme Architectural Layouts



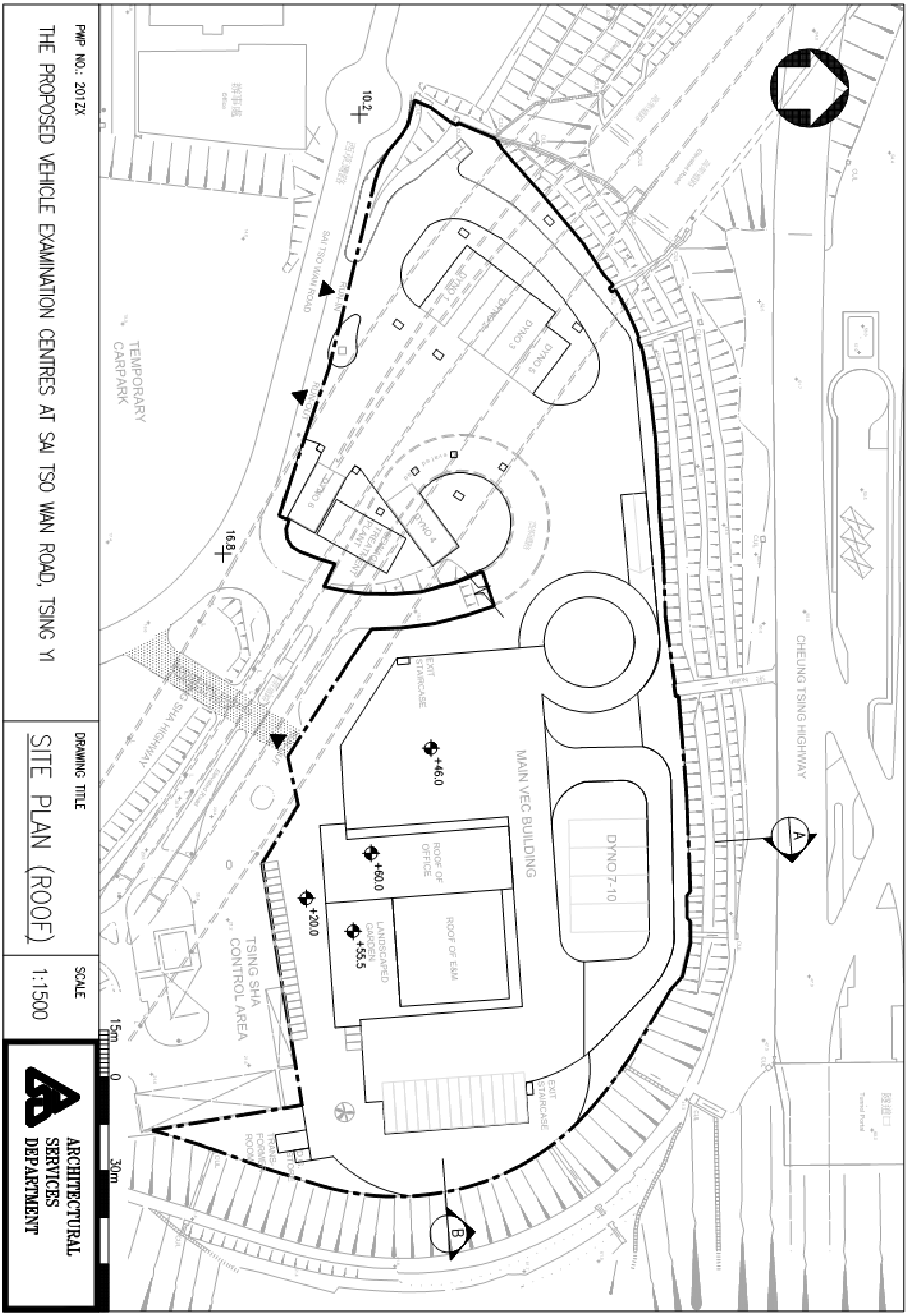
CUNDALL


PWP NO.: 201ZX
THE PROPOSED VEHICLE EXAMINATION CENTRES AT SAI TSO WAN ROAD, TSING YI
DRAWING TITLE
LEVEL 2 (1/F)
SCALE
1:1500
ARCHITECTURAL SERVICES DEPARTMENT
15m 0 30m
QUEUING AREA BEFORE INSPECTION
VEHICLE INSPECTION LANES
WAITING AREA AFTER INSPECTION
OFFICE
EXIT STAIRCASE
E&M
+33.0
A
B

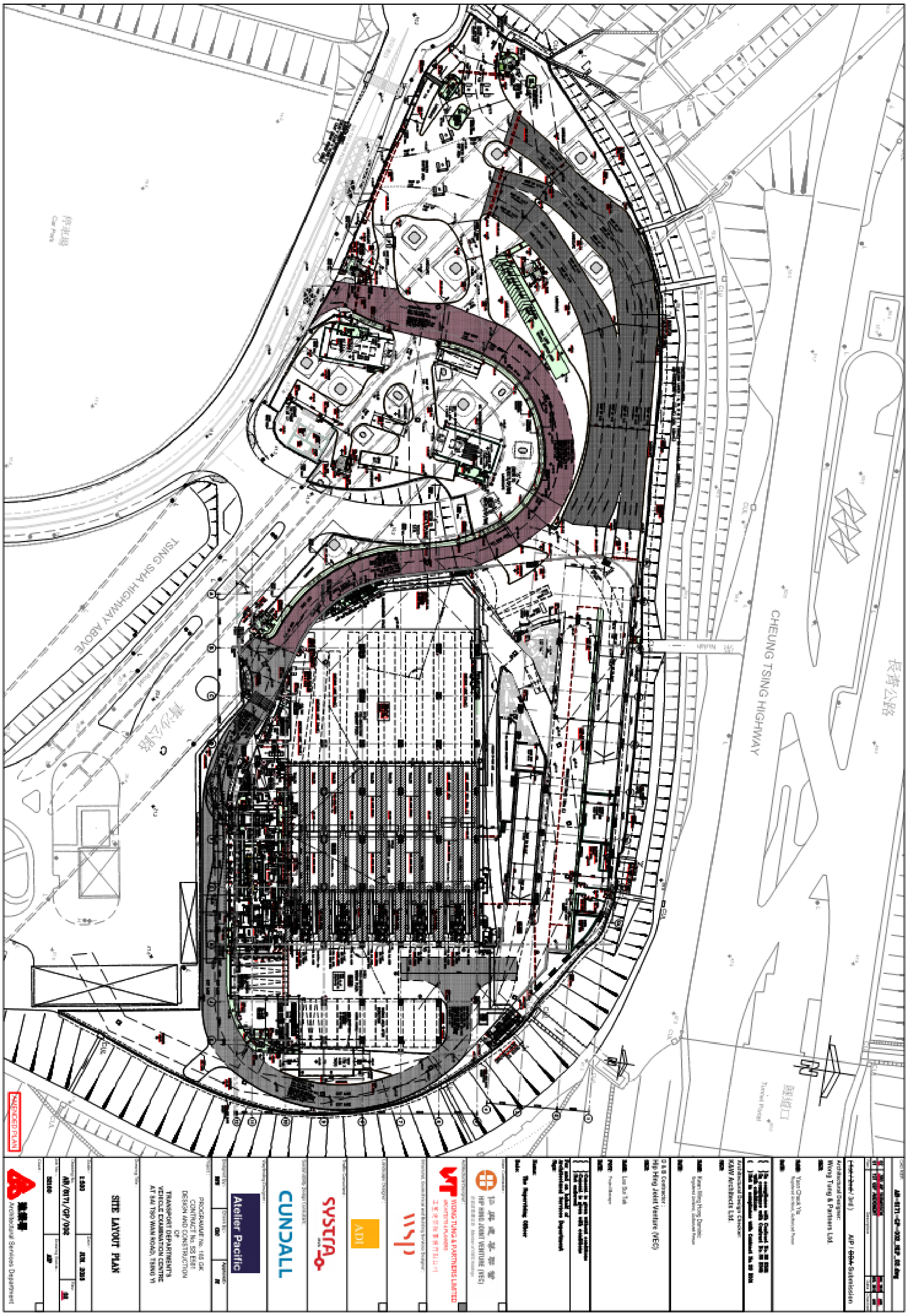

PWP NO.: 201ZX
THE PROPOSED VEHICLE EXAMINATION CENTRES AT SAI TSO WAN ROAD, TSING YI
DRAWING TITLE
LEVEL 3 (2/F)
SCALE
1:1500
ARCHITECTURAL SERVICES DEPARTMENT
15m
0
30m
TSING SHA HIGHWAY
+46.0
QUEUING AREA BEFORE INSPECTION
VEHICLE INSPECTION LANES
EXIT STAIRCASE
OFFICE
ROOF OF LPG DYNO
RAMP DN TO L2
VOID
A
B


PWP NO.: 201ZX
THE PROPOSED VEHICLE EXAMINATION CENTRES AT SAI TSO WAN ROAD, TSING YI
DRAWING TITLE
LEVEL 4 (3/F)
SCALE
1:1500
ARCHITECTURAL SERVICES DEPARTMENT
15m
0
30m
VOID
RAMP
VOID
EXIT STAIRCASE
+46.0
OFFICE
+55.5
CHILLED PLANT & AC PUMP RM
WATER TANK & FS & SPR. TANK
LANDSCAPED GARDEN
+46.0
EXIT STAIRCASE
A
B

CUNDALL


PWP NO.: 201ZX
THE PROPOSED VEHICLE EXAMINATION CENTRES AT SAI TSO WAN ROAD, TSING YI
DRAWING TITLE
SITE PLAN (ROOF)
SCALE
1:1500
ARCHITECTURAL
SERVICES
DEPARTMENT
15m
0
30m
10.2
16.8
TEMPORARY
CARPARK
SAI TSO WAN ROAD
DYNO 3
DYNO 5
DYNO 4
EXIT
STAIRCASE
MAIN VEC BUILDING
DYNO 7-10
+46.0
ROOF OF
OFFICE
+60.0
ROOF OF E&M
+20.0
LANDSCAPED
GARDEN
+55.5
TSING SHA
CONTROL AREA
CHEUNG TSING HIGHWAY
A
B

Appendix F – Proposed Architectural Drawings



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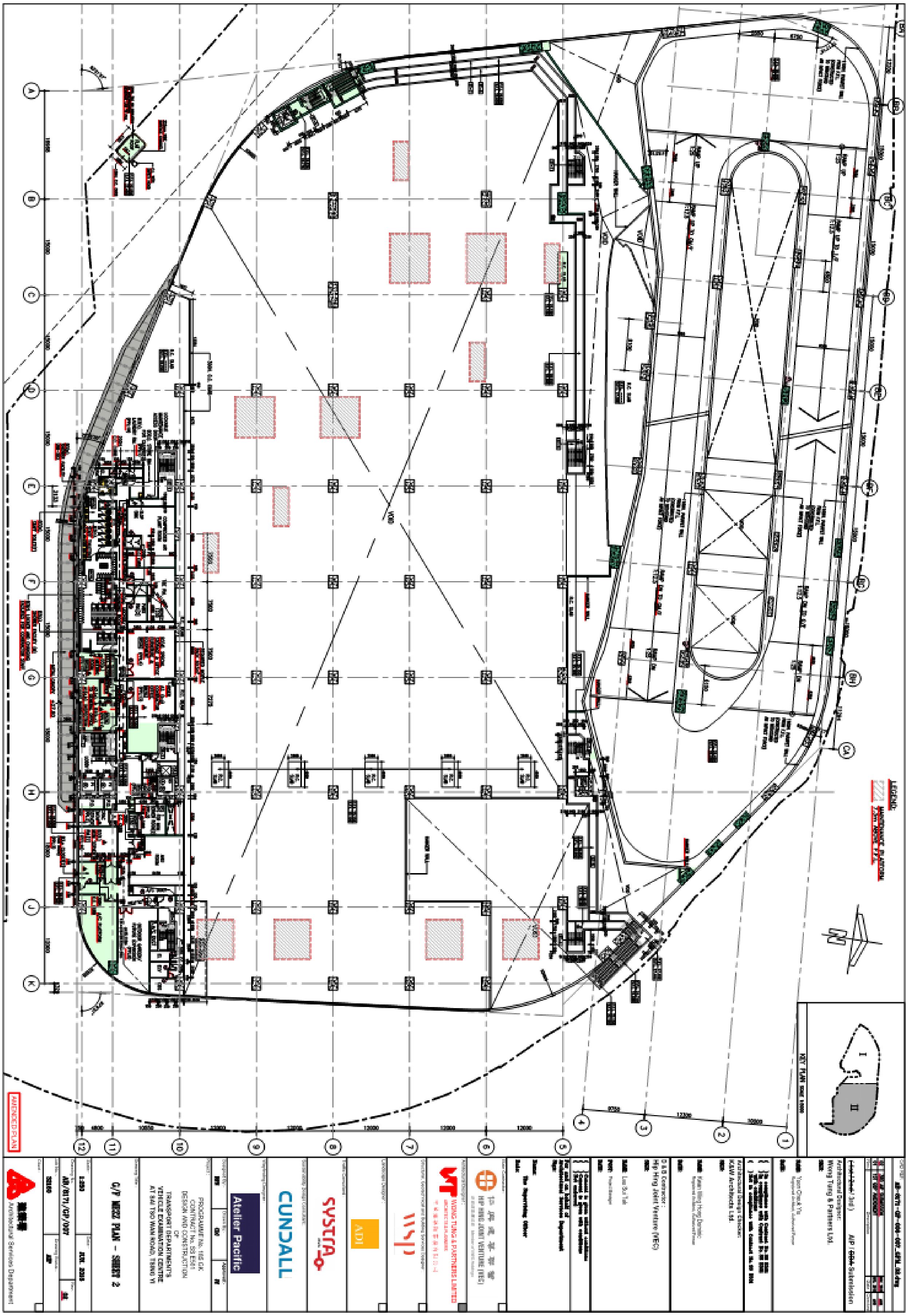
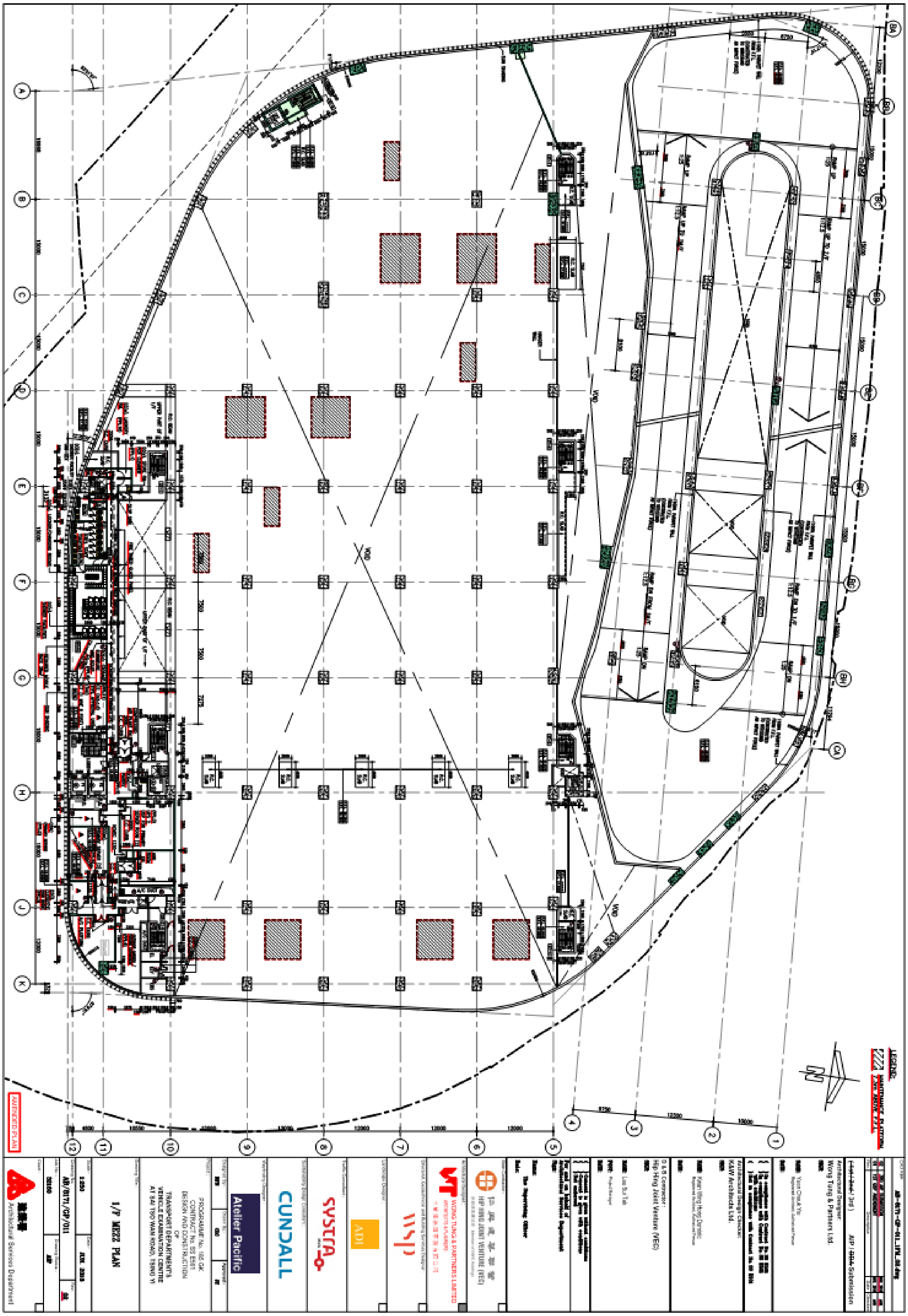
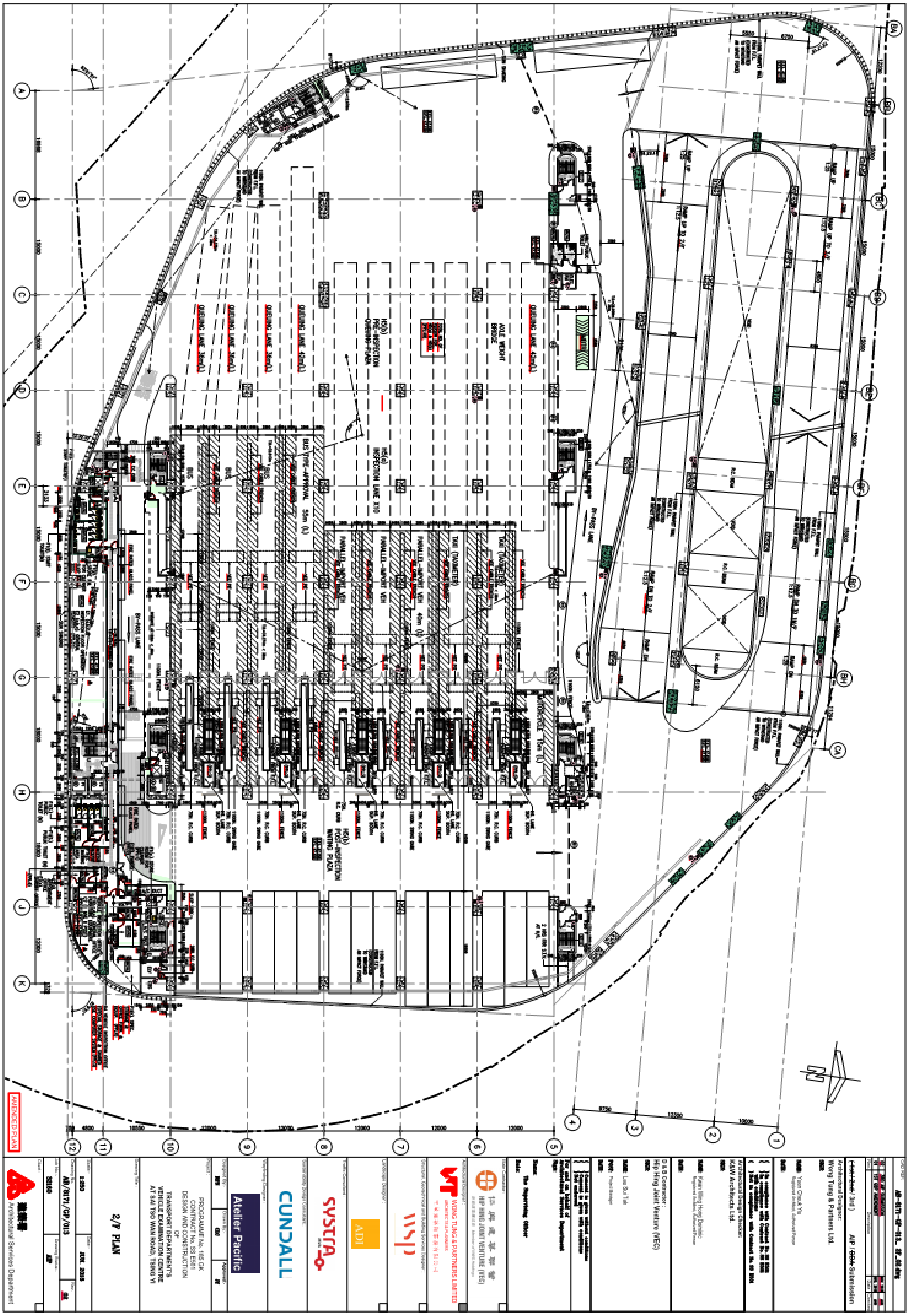
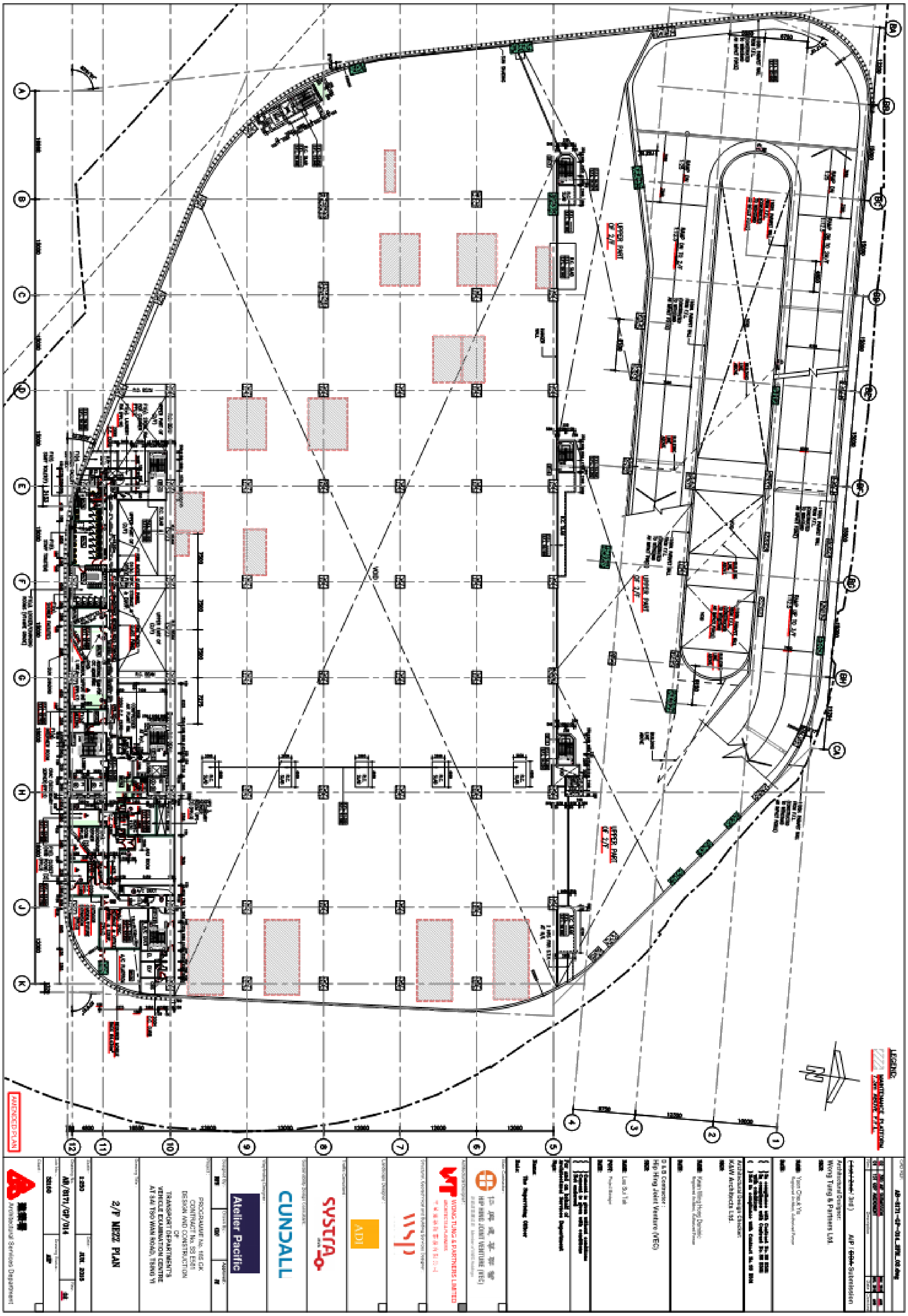


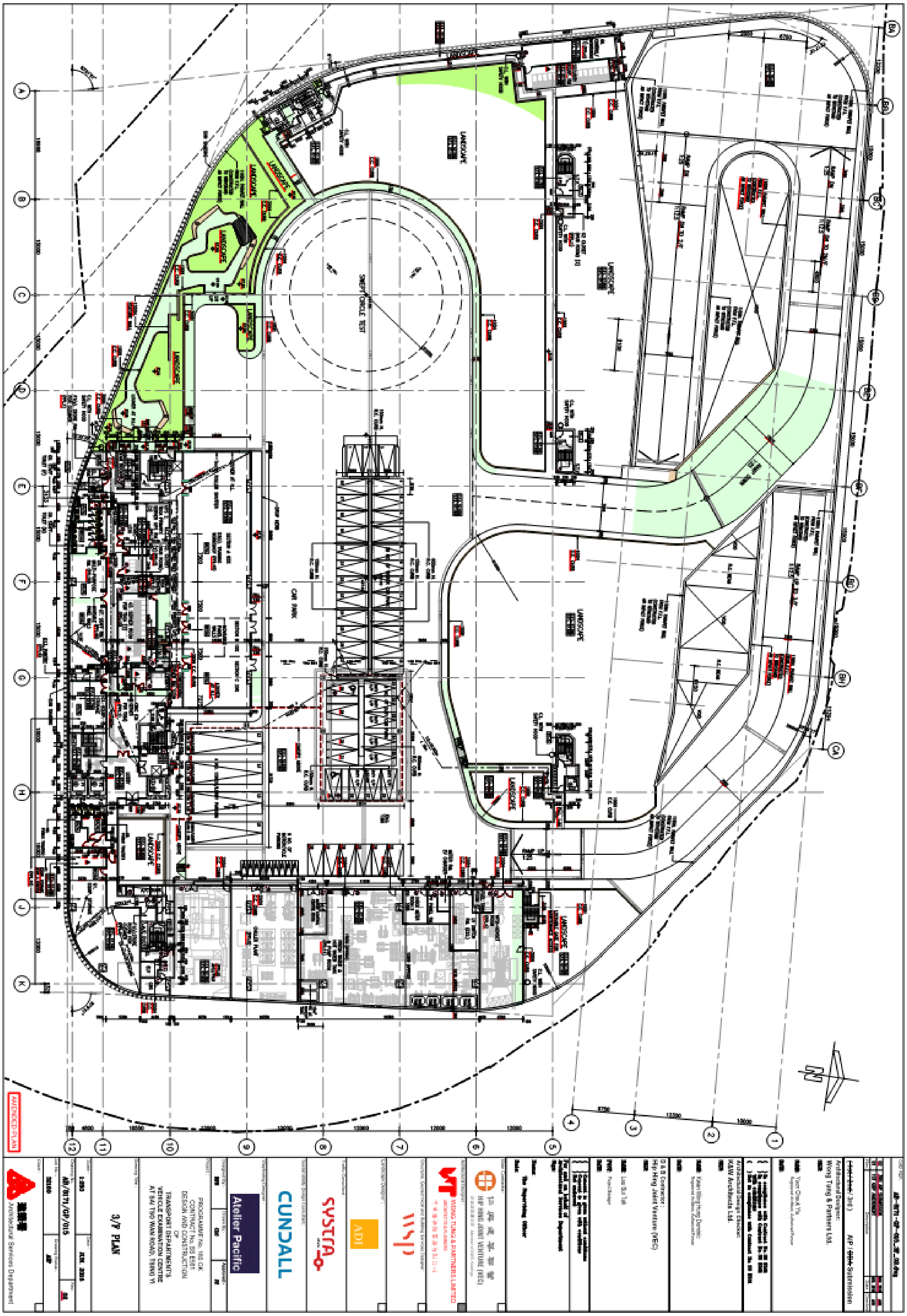

1/F PLAN
AMENDED PLAN
CUNDALL
Atelier Pacific



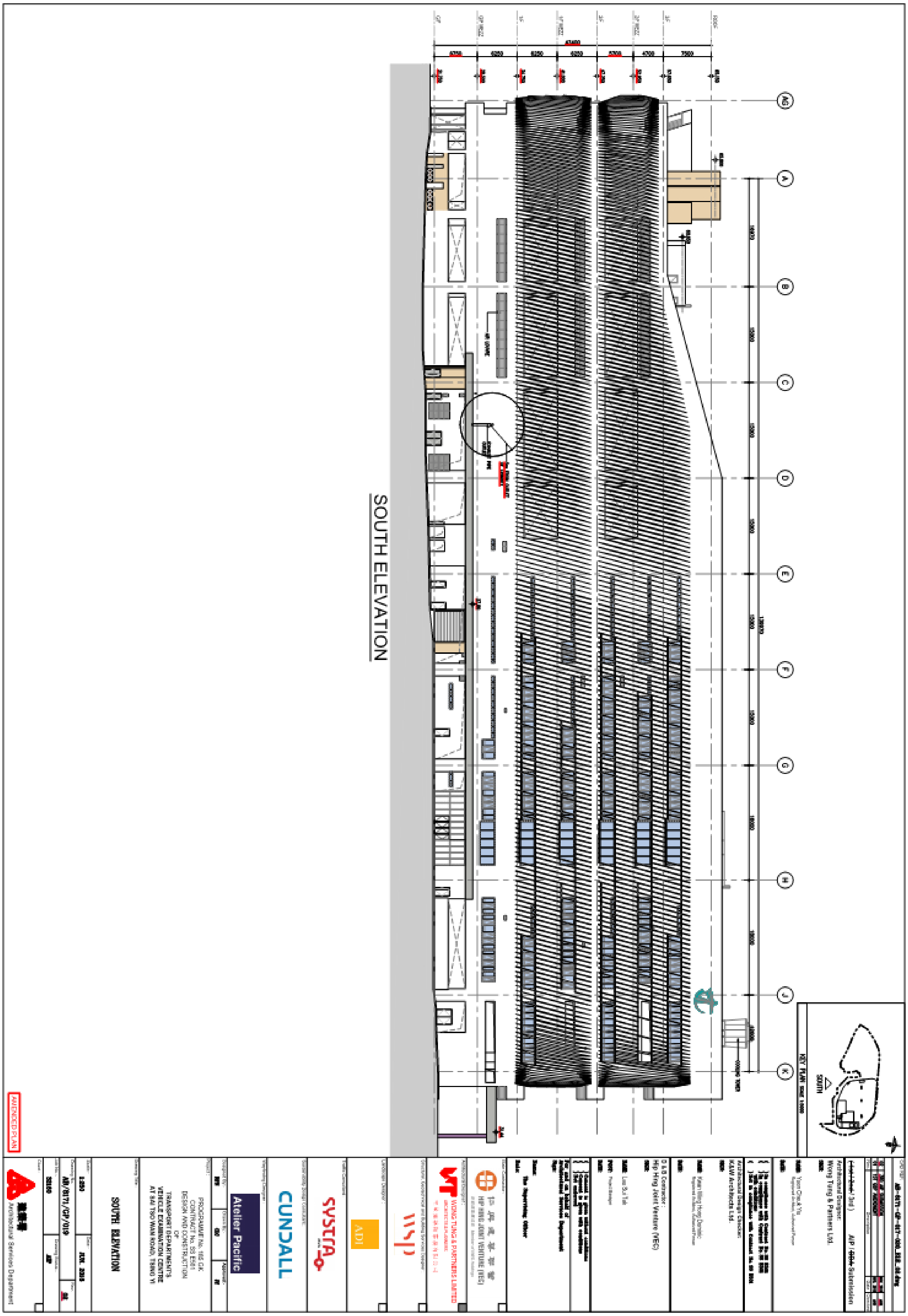


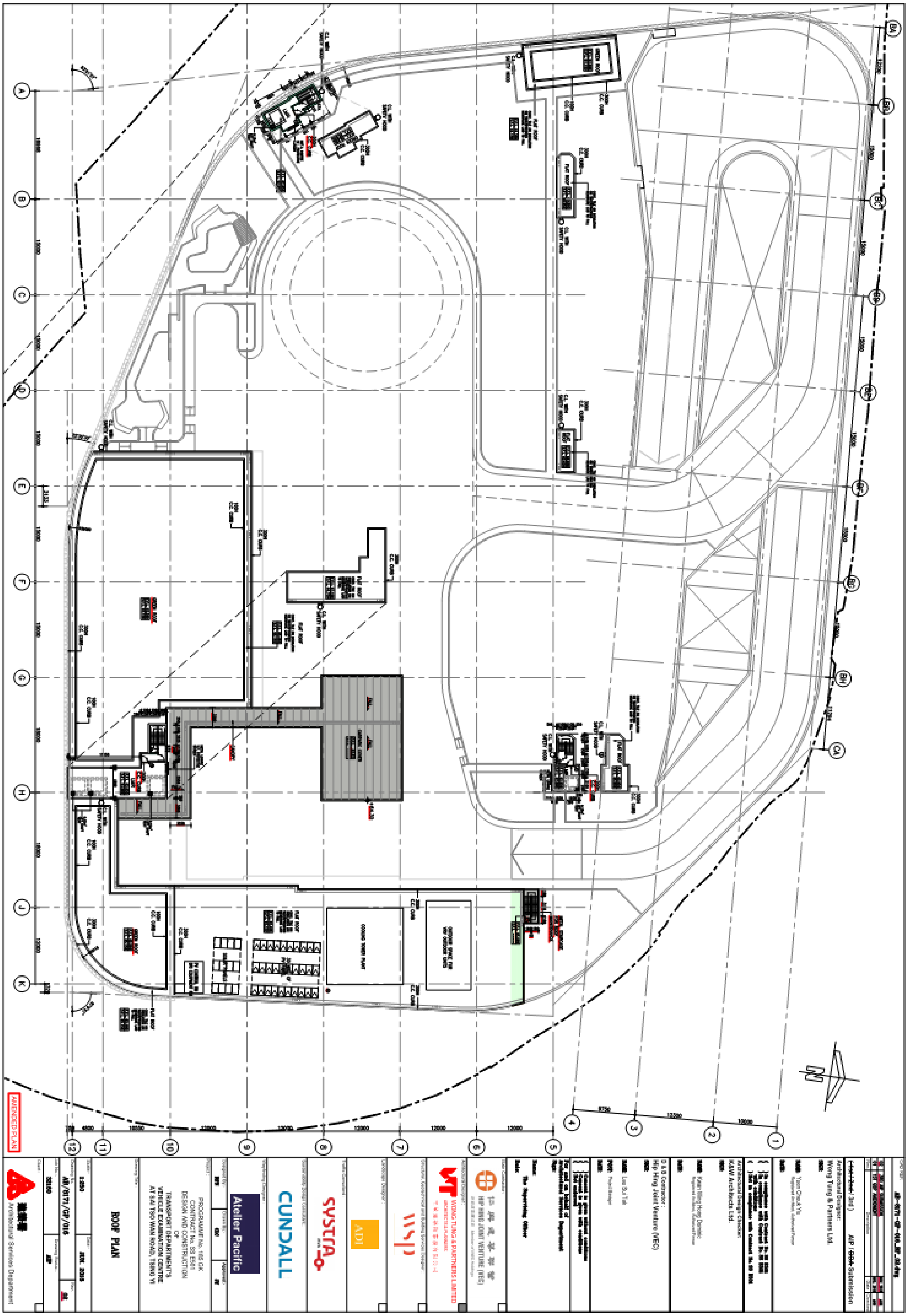
CUNDALL





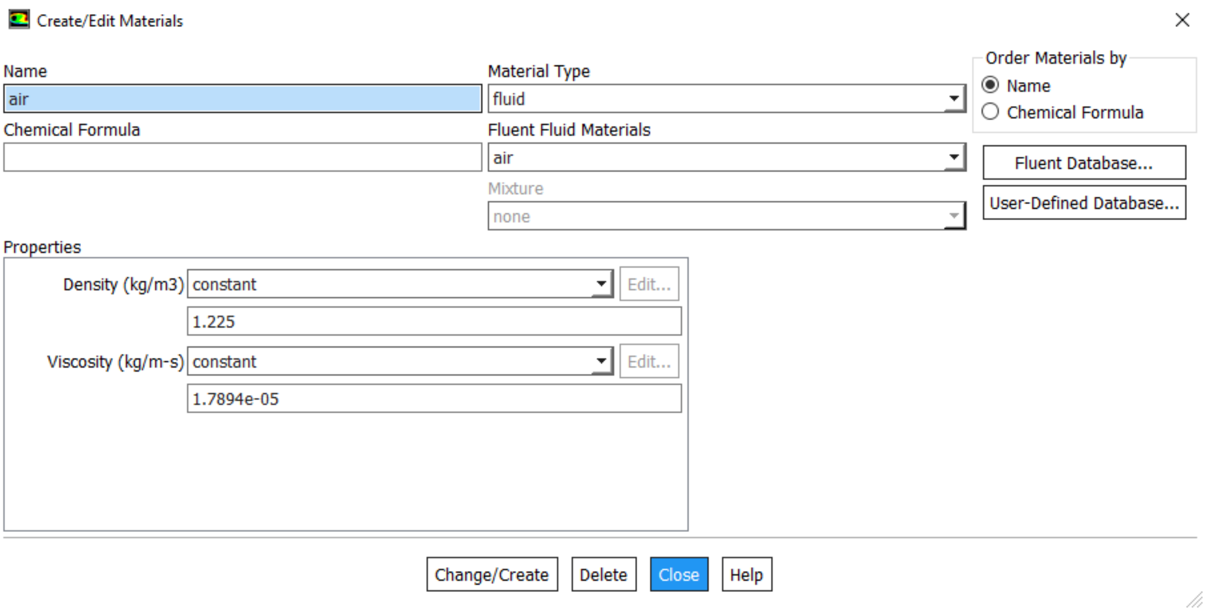
AMENDED PLAN
3/F PLAN
Atelier Pacific
CUNDALL


SOUTH ELEVATION

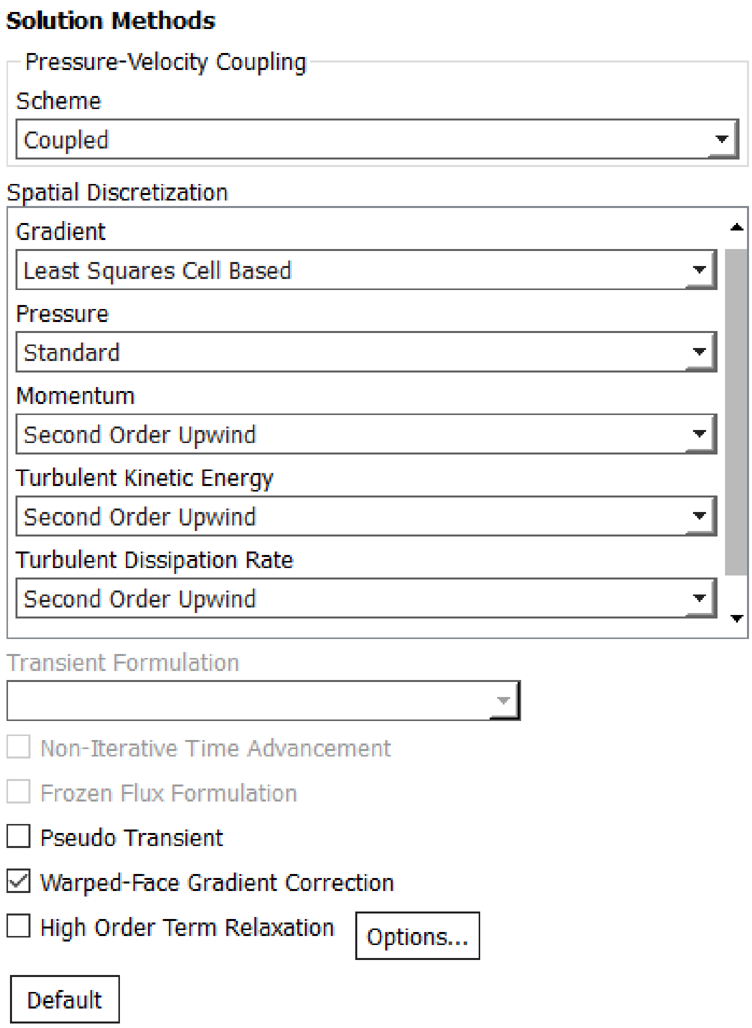

ROOF PLAN
AMENDED PLAN
Atelier Pacific
CUNDALL
SYSTRA
Architectural Services Department

Appendix G – Input Parameters

Air Properties



Solution Methods


Solution Methods
Pressure-Velocity Coupling
Scheme
Coupled
Spatial Discretization
Gradient
Least Squares Cell Based
Pressure
Standard
Momentum
Second Order Upwind
Turbulent Kinetic Energy
Second Order Upwind
Turbulent Dissipation Rate
Second Order Upwind
Transient Formulation
Non-Iterative Time Advancement
Frozen Flux Formulation
Pseudo Transient
Warped-Face Gradient Correction
High Order Term Relaxation
Options...
Default

Viscous Model