AECOM

Hong Kong Housing Authority

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Consultancy for Environmental Design Studies for Public Housing Development at Yip Wong Road, Tuen Mun

Air Ventilation Assessment – Initial Study (AVA-IS)

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1 INTRODUCTION

Background

1.1 AECOM Asia Co. Ltd. has been commissioned by the Hong Kong Housing Authority (HKHA) to undertake an Air Ventilation Assessment (AVA) Study – Initial Study (IS) using Computational Fluid Dynamics (CFD) for the potential Public Housing Development located at Yip Wong Road, Tuen Mun to examine the air ventilation impact of the proposed building design qualitatively and formulate effective and practicable measures enhancing the air ventilation as part of the continuous design improvement process.

Objectives

1.2 The AVA Study for the proposed Public Housing Development at Yip Wong Road (i.e. the Project Area) has been conducted in accordance with the methodology outlined in the Technical Guide for AVA for Developments in Hong Kong (the Technical Guide) annexed in HPLB and ETWB TC No. 1/06. The main purposes of this AVA Study, echoing the Technical Guide, are:

- To assess the characteristics of the wind availability (V_∞) of the Site;
- To give a general pattern and a rough quantitative estimate of wind performance at the pedestrian level reported using Wind Velocity Ratio (VR);
- To quantitatively assess the air ventilation performance in the neighbourhood of the Project Area; and
- To compare two design scenarios in terms of air ventilation performance aspect.

Content of This Report

1.3 Section 1 is the introduction section. The remainder of the report is organized as follows:

- Section 2 on site characteristics;
- Section 3 on assessment methodology;
- Section 4 on assessment criteria;
- Section 5 on key findings of AVA study;
- Section 6 on directional analysis; and
- Section 7 with a summary and conclusion.

2 SITE CHARACTERISTICS

Project Area and Its Surrounding Area

2.1 The Project Area is currently an open ground, bounded by Tuen Mun River Promenade to the East, Tin Hau Road at the north and Wong Chu Road at the south. Yip Wong Road splits the Project Area into two portions while the elevated section south bound allows connectivity of Project Area underneath.

2.2 According to the “Approved Tuen Mun Outline Zoning Plan No. S/TM/35”, the Project Area is zoned as “Residential (Group A)” (“R(A)”). There exist middle-rise industrial buildings belong to the Nan Fung Industrial City to the north, while the high-rise residential cluster including Lung Yat Estate and Lung Mun Oasis is located to the southwest of the Project Area. To the east are Tuen Mun River and high-rise residential buildings belong to Yau Oi Estate.

2.3 To the immediate the north of the Project Area is an open lot carpark namely Bao Tao Carpark and Tin Hau Road West Carpark. There exists a small knoll of around 40mPD in height in Area 33 “Green Belt” (“GB”).

Figure 2.1 Overview of the Project Area and its Surroundings (Source: GeoInfo Map)

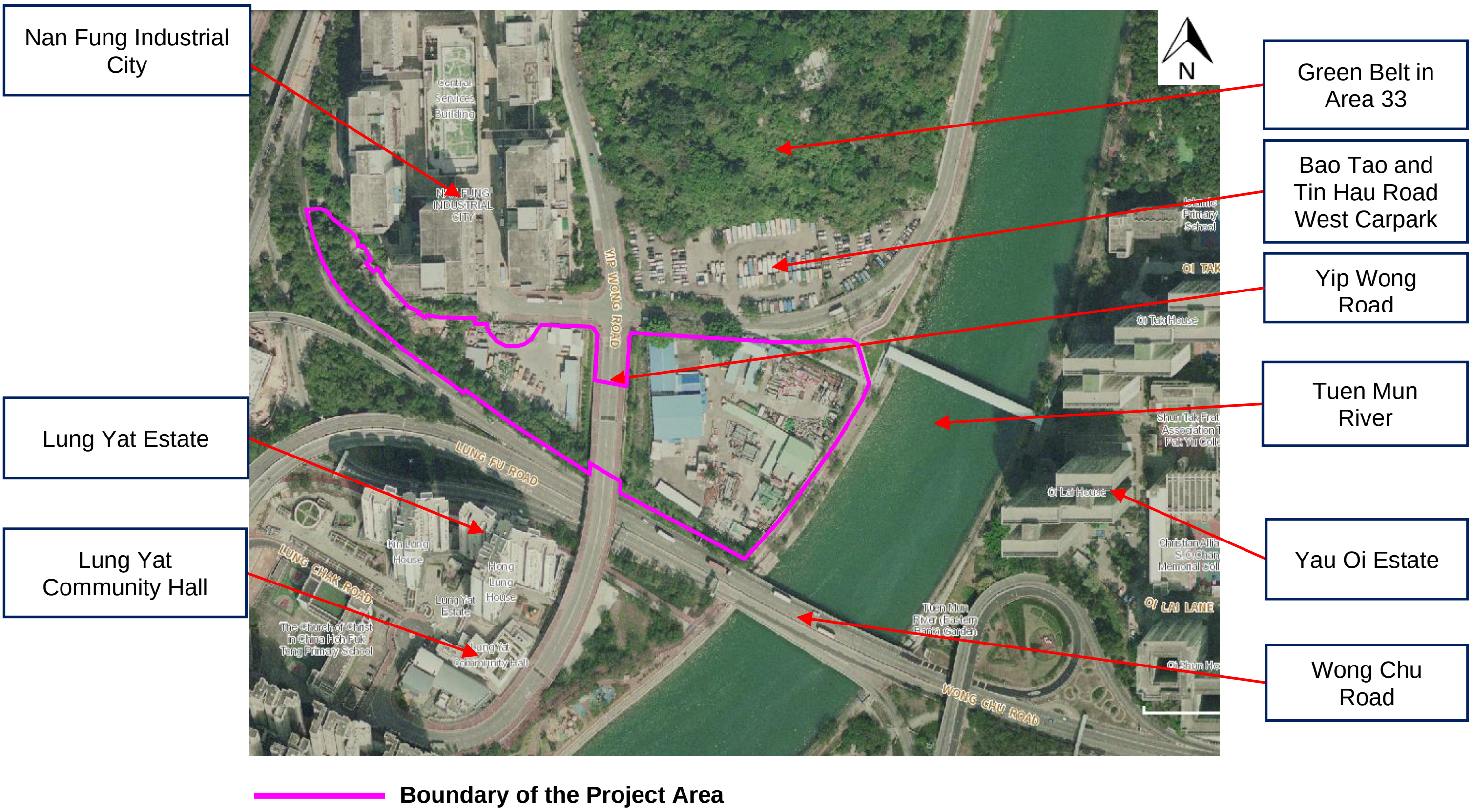
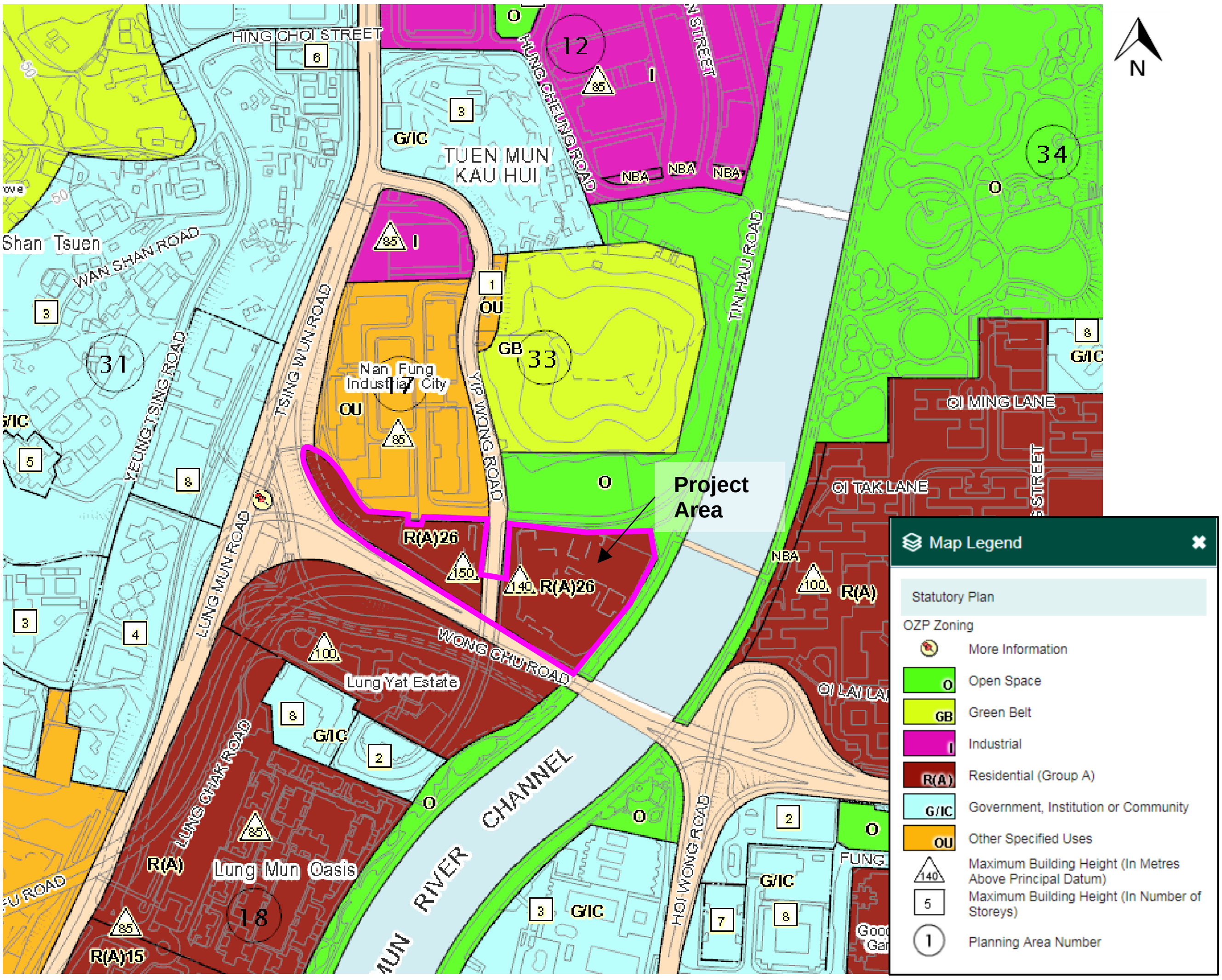


Figure 2.2 Close-up view of the Project Area and its Surroundings as shown on the OZP (Source: Town Planning Board)



Project Area

Wind Environment

2.4 The site wind availability of the Project Area was simulated under at least 8 probable prevailing wind directions (which would represent occurrence of more than 75% of time) under both annual and summer condition to illustrate the change in local wind condition due to the Project Area. These prevailing wind directions were determined based on the wind availability simulation result of Regional Atmospheric Modelling System (RAMS) model published by Planning Department (PlanD from hereafter). **Figure 2.3** shows the location of relevant wind data extraction while the wind roses representing annual and summer winds at the Project Area of this study were presented in **Figure 2.4** below. Furthermore, the summarized chosen prevailing wind directions and their related occurrence probability were listed in **Table 2.1**. Details of the wind probability table was presented in **Appendix A**.

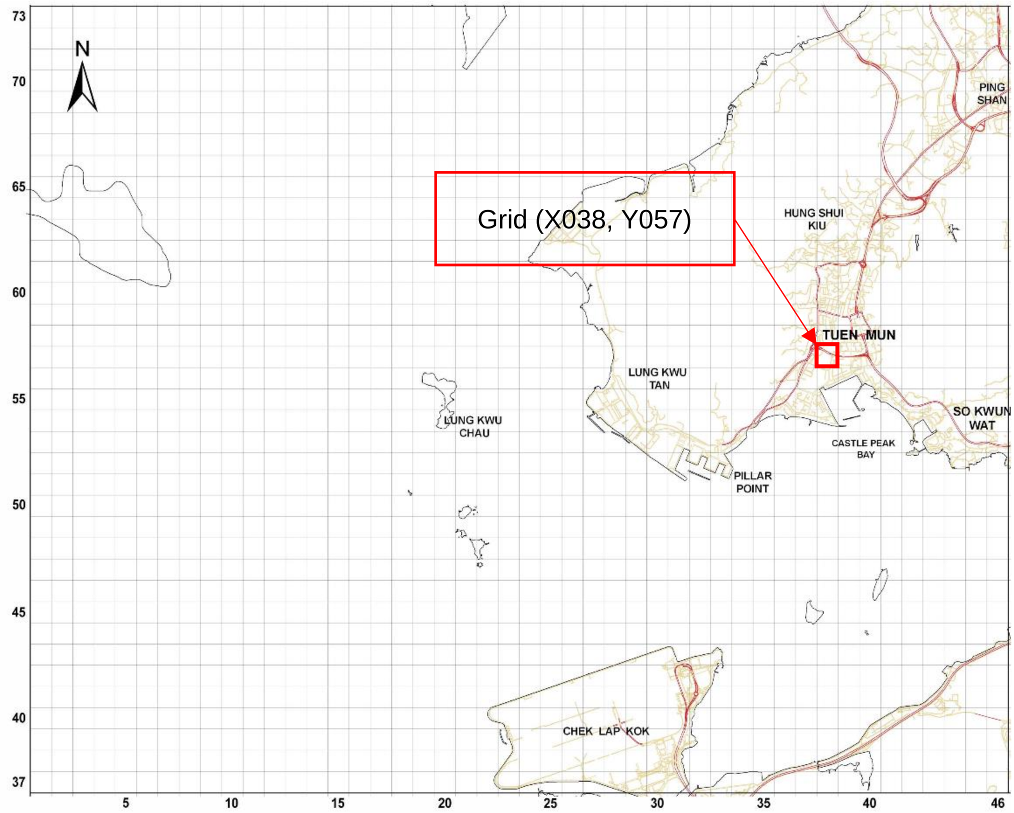
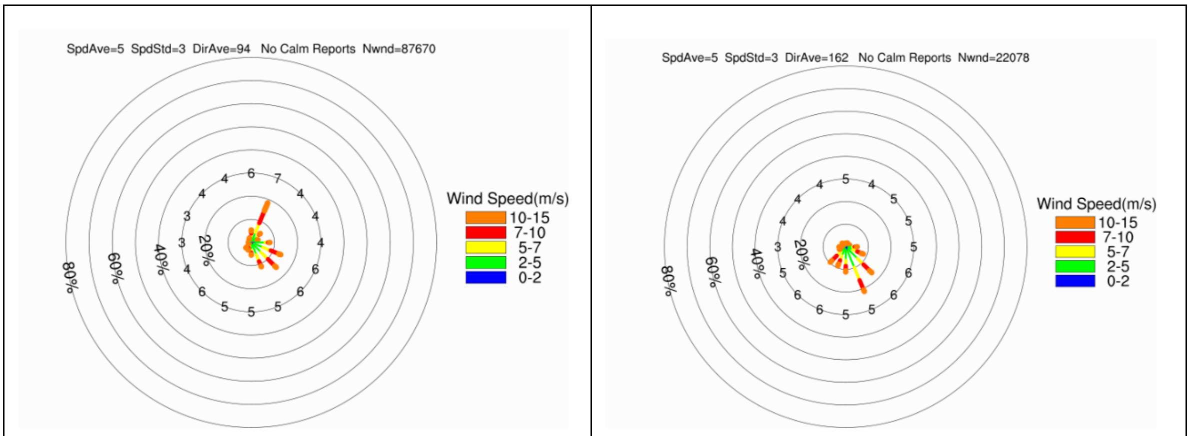


Figure 2.3 **Location of Data Extraction in RAMS Model**



(a) Annual Wind Rose (b) Summer Wind Rose

Figure 2.4 **Wind Rose at Grid (X038, Y057)**

Table 2.1 Simulated Wind Directions and their Corresponding Percentage Occurrence

Annual Wind Direction	% of Annual Occurrence	Summer Wind Direction	% of Summer Occurrence
NNE	18.60%	E	5.2%
NE	5.50%	ESE	8.5%
E	8.10%	SE	16.4%
ESE	13.80%	SSE	21.5%
SE	15.20%	S	11.2%
SSE	11.40%	SSW	9.2%
S	5.50%	SW	9.7%
SSW	3.5%	/	/
Total occurrence	81.6%	**Total occurrence**	81.7%

Vertical Wind Profiles

2.5 Wind environment under different wind directions was defined in the CFD environment. According to the Technical Guide (HPLB and ETWB, 2006) Para 20, wind profile for the Project Area could be appropriated from the $V\infty$ data developed from RAMS and with reference to the Power Law or Log Law using coefficients appropriate to the site conditions. In this assessment, vertical wind profile condition below 20mPD was determined using the Log Law while the wind speed above 20mPD was adopted from the RAMS wind and wind profile in PlanD's website.

2.6 Vertical wind profile and roughness lengths were determined accordingly as follow:

$$\text{Log Law} \quad U_z = \frac{u^*}{\sigma} \ln\left(\frac{Z}{Z_0}\right)$$

Where
U_Z : wind speed at height z from ground
u^* : friction velocity
σ : von Karman constant = 0.4 for fully rough surface
Z : height z from ground
Z_0 : roughness length.

2.7 The roughness length for determining vertical wind profiles under different wind direction was tabulated in **Table 2.2**. In this study, the land further away from the surrounding area were urban areas with mid to high-rise developments, as a result, a roughness length with Z_0=3 was adopted for the inflow wind profiles.

Table 2.2 Roughness Length for Determining Vertical Wind Profiles under Different Wind Directions

Land Type of Upwind Area(1)	Roughness Length(2), Z_O
Urban area with mid and high-rise developments	3
Sea or open space	0.1

Notes:
(1) The land type refers to the area upwind of the model domain further away from the Surrounding Area
(2) With reference to Feasibility Study for Establishment of Air Ventilation Assessment System (CUHK, 2005)

3 ASSESSMENT METHODOLOGY

3.1 This AVA study was carried out in accordance with the guidelines stipulated in the Technical Guide for AVA for Developments in Hong Kong with regard to Computational Fluid Dynamics (CFD) modelling. Reference was also made to the “Recommendations on the use of CFD in Predicting Pedestrian Wind Environment” issued by a working group of the COST action C14 “Impact of Wind and Storms on City Life and Built Environment” (COST stands for the European Cooperation in the field of Scientific and Technical Research). COST action C14 is developed by European Laboratories/Institutes dealing with wind and/or structural engineering, whose cumulative skills, expertise and facilities had an internationally leading position. Thus, it was considered that the COST action C14 was a valid and good reference for CFD modelling in AVA study.

Modelling Tool and Model Setup

3.2 Assessment was conducted by means of 3-dimensional CFD model. The well-recognised commercial CFD package FLUENT was used in this exercise. FLUENT model has been widely applied for various AVA research and studies worldwide. The accuracy level of the FLUENT model was very much accepted by the industry for AVA application.

Computational Domain

3.3 A 3D CFD model including major topographical features and building morphology which would likely affect the wind flow was constructed. The methodology described in the Technical Guide was adopted for this assessment. According to the Technical Guide, the Assessment Area should include the project’s surrounding up to a perpendicular distance of 1H while the Surrounding Area (marked in blue) should at least include the project’s surrounding up to a perpendicular distance of 2H calculating from the project boundary, H being the height of the tallest building within Surrounding Area. In this study, the value of H about 130 meters with the computational domain size of around 2000m x 2000m x 1000m. In addition, grid expansion ratio and the blockage ratio should not excess 1.3 and 3% respectively. The ground of the computational domain should include topography.

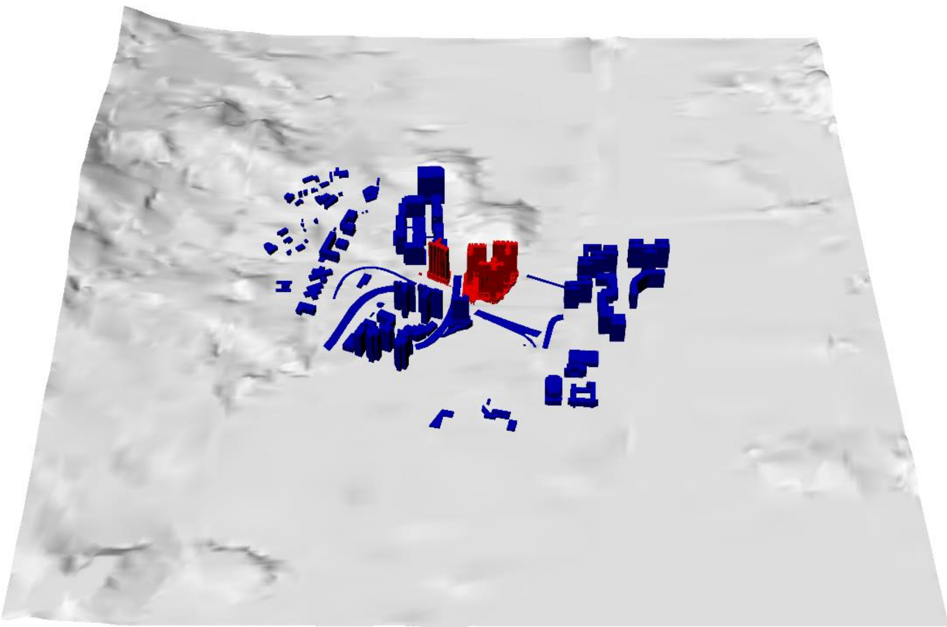
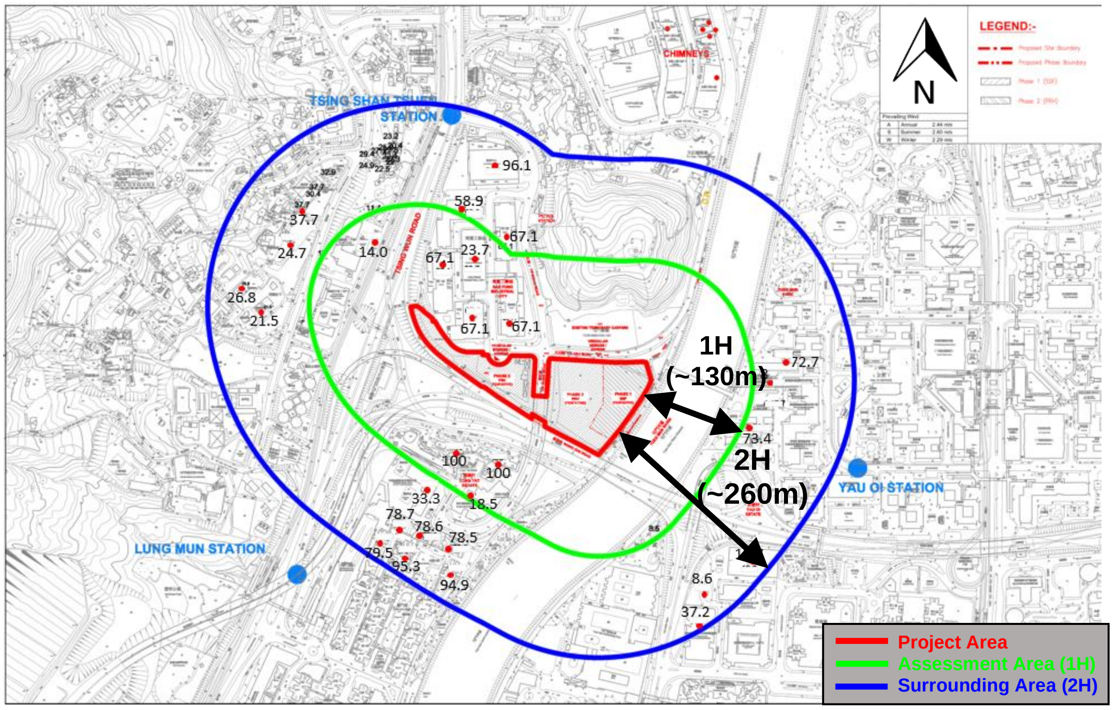


Figure 3.1 Geometry of Computational Model

Assessment and Surrounding Areas

3.4 Both the Baseline Scheme and Proposed Scheme were assessed under annual and summer wind conditions. A 3D model was built according to the GIS information obtained from Lands Department to include all existing, planned and committed development, if any, within the Surrounding Area. All other major elevated structures including the elevated road of Wong Chu Road, Yip Wong Road, existing high-rise residential buildings and natural slopes within the Surrounding Area were also included in the model. The Assessment Area (marked in Green) and Surrounding Area (marked in Blue) have also been incorporated in the simulation model for Air Ventilation Assessment as shown in **Figure 3.2**.



H being the height of the tallest building on site

Figure 3.2 Boundaries of the Project Area, Assessment Area and Surrounding Area

Studied Schemes

3.5 The site contains 2 sub-sites, i.e. the eastern portion (Phase2) and western portion (Phase1). The illustrative scheme of the site contains 4 high-rise blocks, namely Block1 to Block 4 being sandwiched by Wong Chu Road to the south and Tin Hau Road to the North. These 4 blocks are located on podiums with 1 to 2-storeys in height. A site constrains of 23m from the southern site boundary (existing Drainage Reserve) is limited and open area at the western portion of the site is allowed for air ventilation and pedestrian comfort.

3.6 The site is zoned “R(A)26” for high-density residential developments according to the approved OZP No. S/TM/35. The site has an overall PR of 6.5 of which the domestic PR should not exceed 6.0, and a building height restriction of +150mPD and +140mPD for Phase 1 and Phase 2 respectively.

3.7 **Figure 3.3** and **Figure 3.4** demonstrated model geometry of the Baseline Scheme and the Proposed Scheme in the simulation. Both schemes have considered the above constraints and development parameters.

Baseline Scheme

3.8 The Baseline Scheme consists of domestic blocks ranging from 39 to 41 domestic storeys for Site B and 39 storeys for Site C at a maximum building height of 138mPD on three relatively small and 2- to 3-storey non-domestic podium. Building Gap between each building blocks was provided for wind to penetrate. But distance of building gap between Block 2 and 3 is less than 15m for ventilation. Northern portion of the site is EVA and pedestrian entrance. Southern and Western portion of the site is open area and drainage reserve.

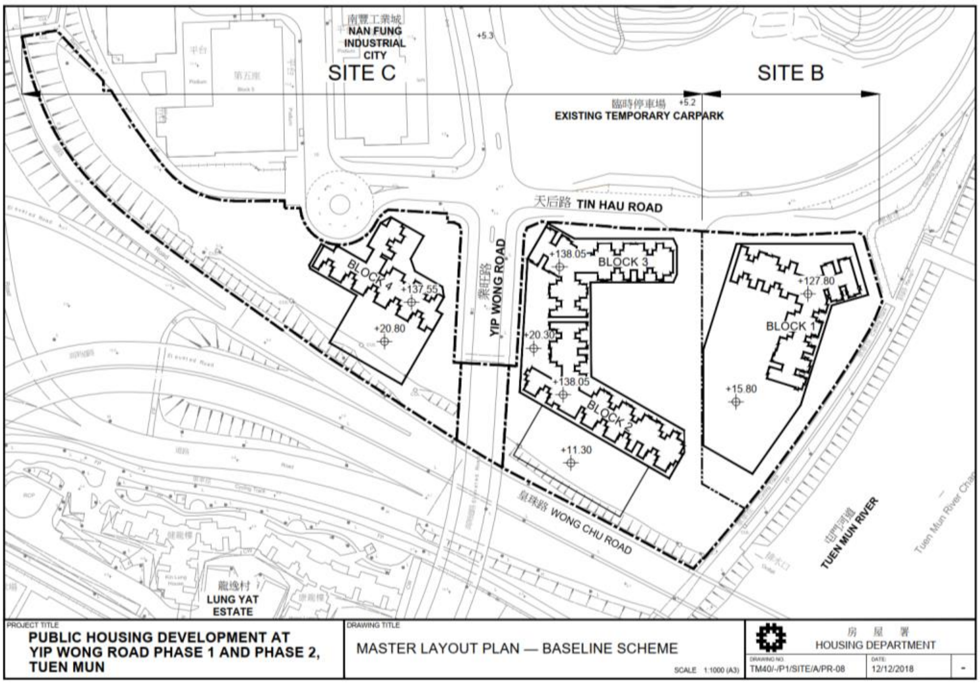


Figure 3.3 Baseline Scheme – Master Layout Plan

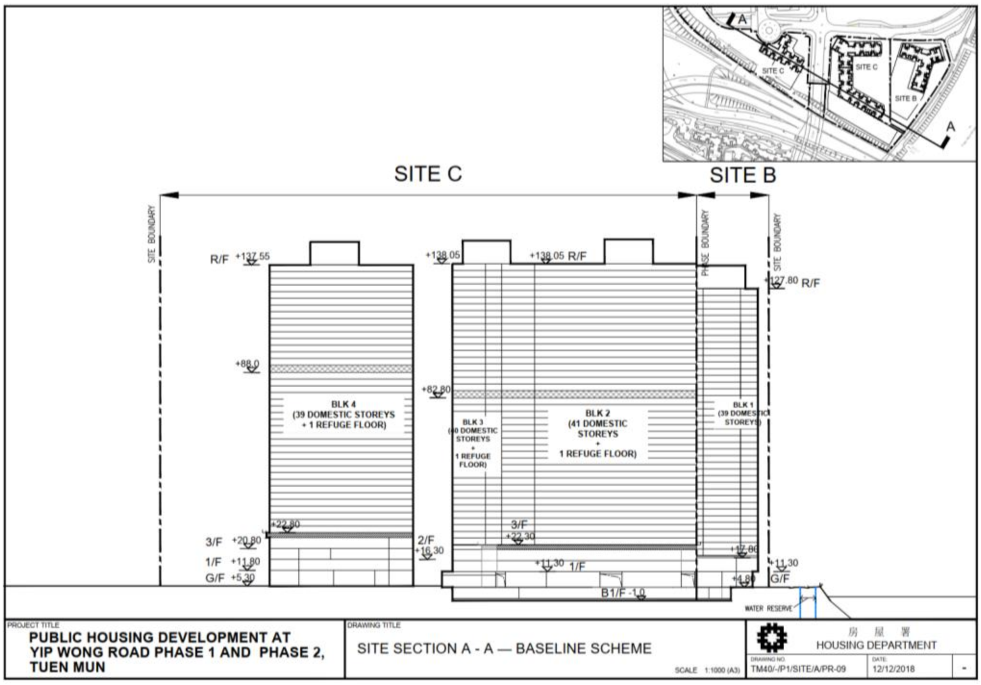


Figure 3.4 Indicative Plan of Baseline Scheme – Section A-A

Proposed Scheme

3.9 The Proposed Scheme consists of domestic blocks ranging from 34 to 37 domestic storeys for Phase 2 and 38 domestic storeys for Phase 1 on 4-storeys and 3-storeys non-domestic podium respectively. Which the building height is from 121mPD to 129mPD with a domestic PR of 6.0.

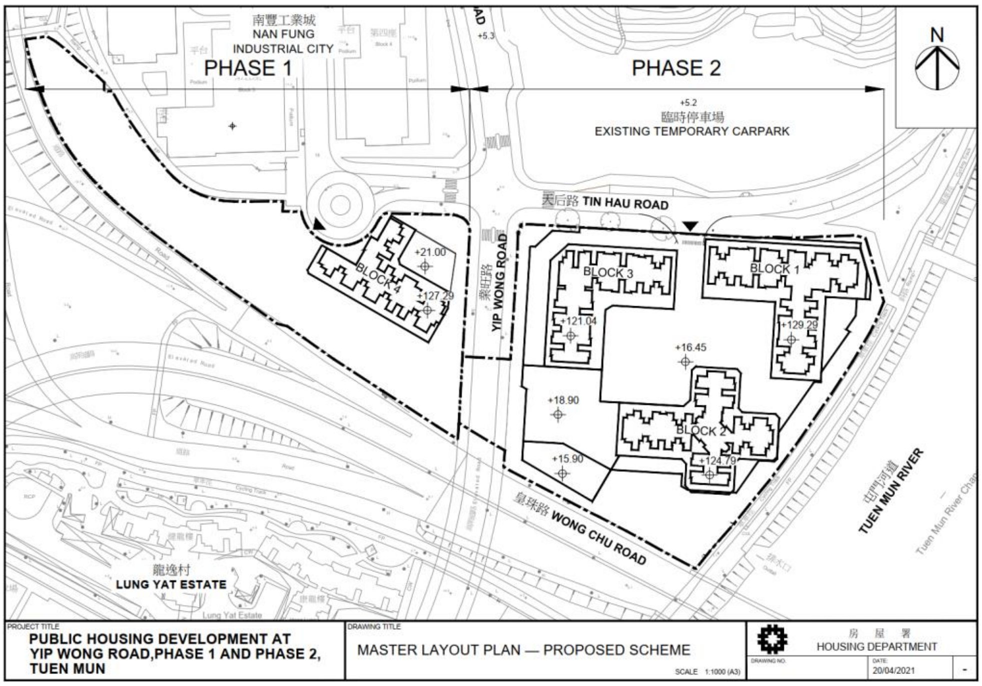


Figure 3.5 Proposed Scheme – Master Layout Plan

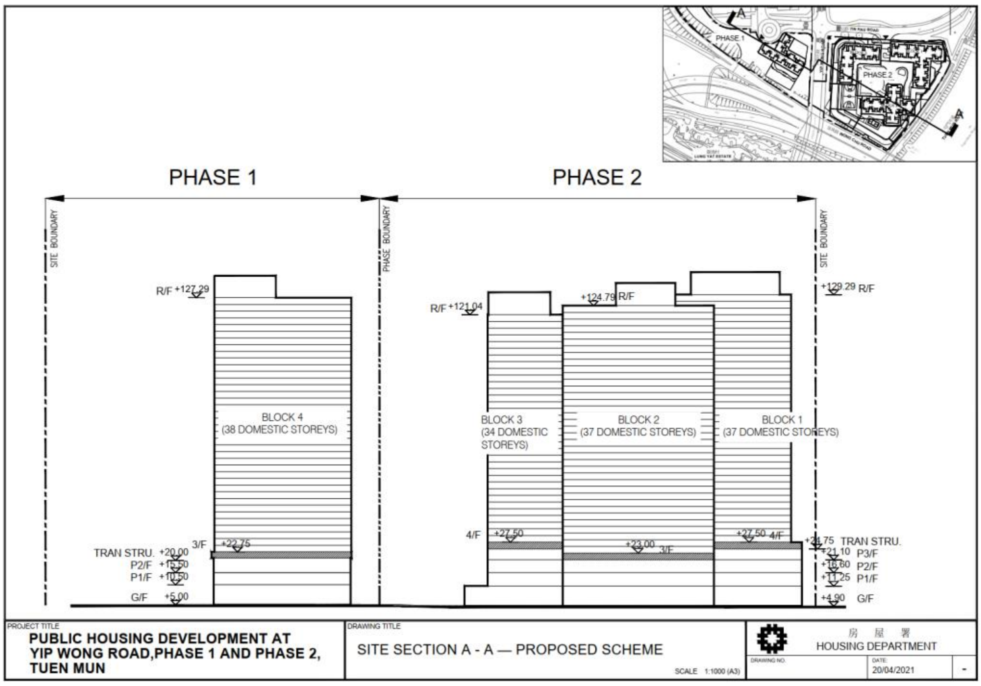


Figure 3.6 Indicative Plan of Proposed Scheme – Section A-A

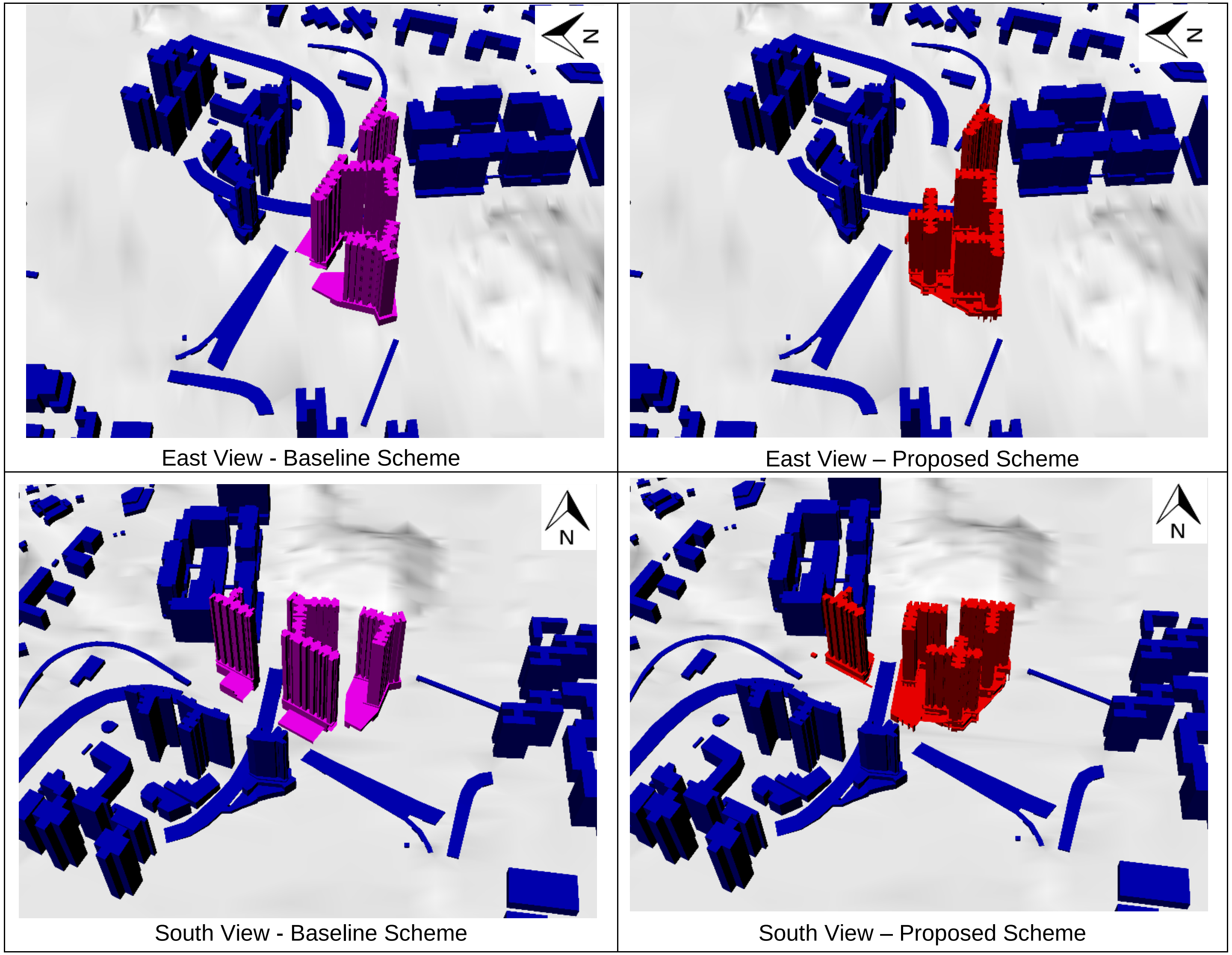
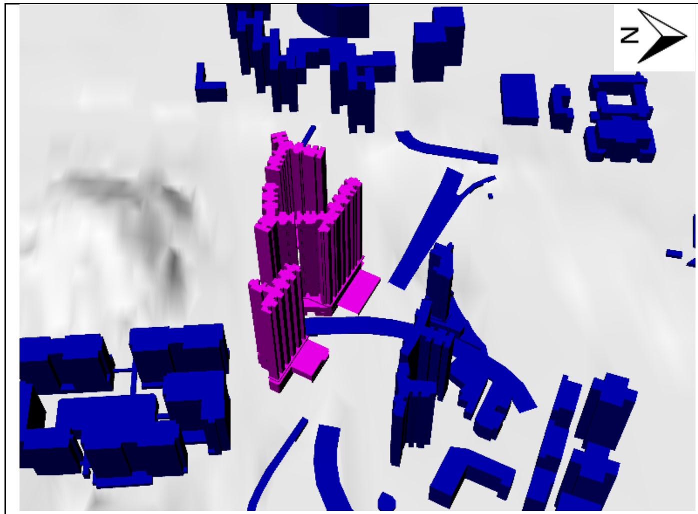
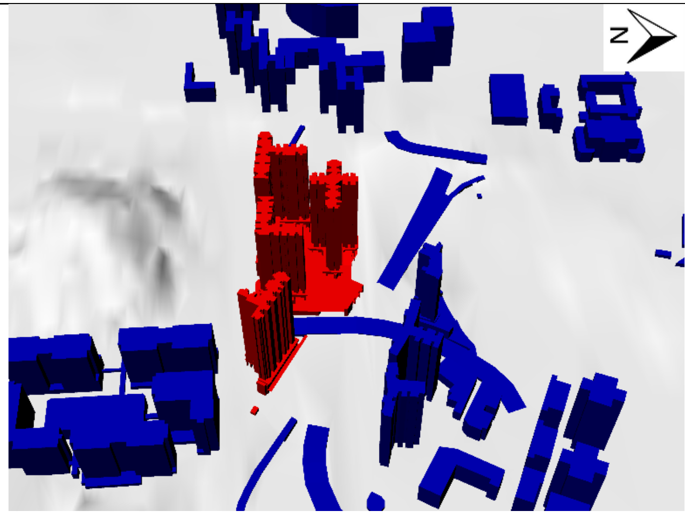


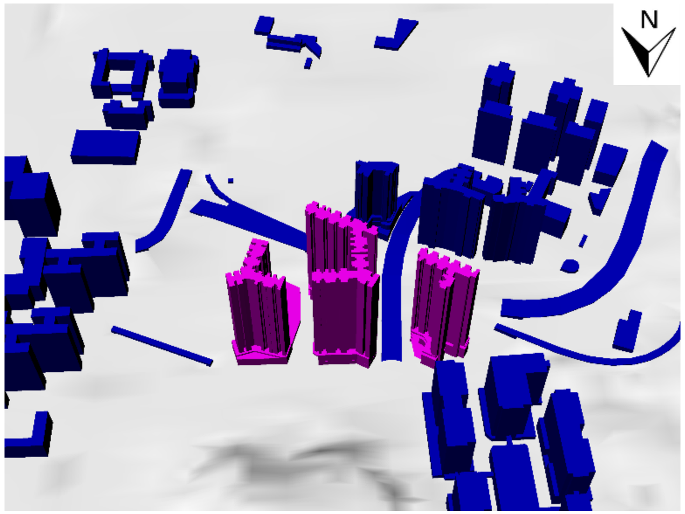
Figure 3.7 Model Geometry under East and South views



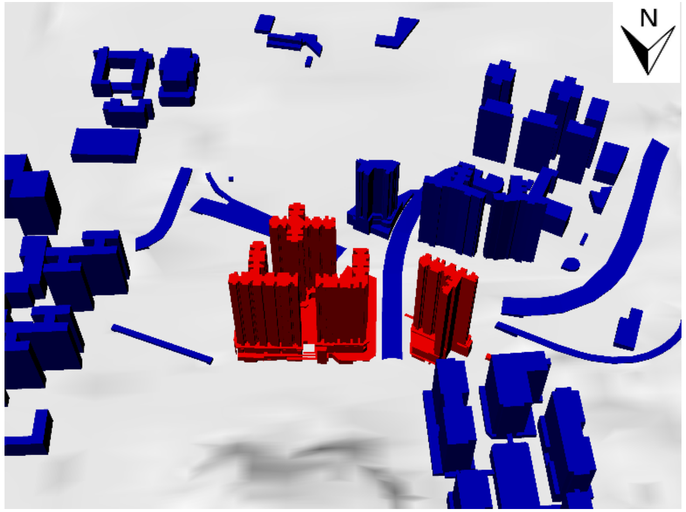
West View - Baseline Scheme



West View – Proposed Scheme



North View – Baseline Scheme



North View – Proposed Scheme

Figure 3.8 Model Geometry under West and North views

Mesh Setup

3.10 The total number of cells for this study was about 7,000,000 cells in tetrahedral mesh. Polyhedral mesh cells counted could often be much smaller than comparable tetrahedral meshes with equivalent accuracy as well as improve mesh quality and manner of convergence (Franklyn, 2006). Grids might be converted to polyhedral mesh, if necessary. The horizontal grid size employed in the CFD model in the vicinity of the Project Area was taken as a global minimum size of about 2m (smaller grid size was also employed for specific fine details) and increased for the grid cells further away from the Project Area. The maximum mesh size within the whole computational domain was about 60m. Besides, six layers of prism cells (each layer of 0.5m thick) were employed above the terrain. The blockage ratio and grid expansion ratio of this computational model was 1.2 and 3% respectively.

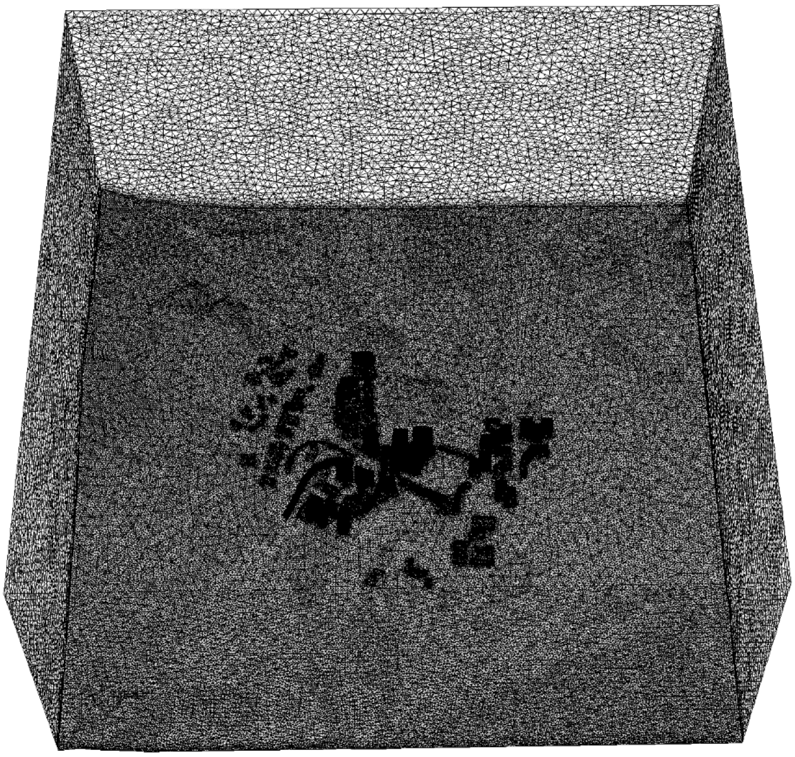


Figure 3.9 Mesh of the Simulation Domain

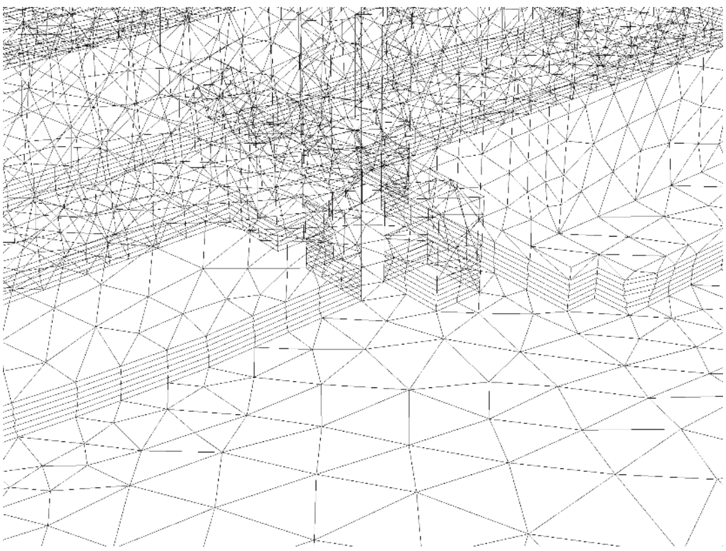


Figure 3.10 Prism Layers Near Ground

Turbulence Model

3.11 As recommended in COST action C14, realizable K-epsilon turbulence model was adopted in the CFD model to simulate the real life problem. Common computational fluid dynamics equations were adopted in the analysis.

3.12 Variables including fluid velocities and fluid static pressure were calculated throughout the domain. The CFD code captures, simulates and determines the air flow inside the domain under study based on viscous fluid turbulence model. Solutions were obtained by iterations.

Calculation Method and Boundary Condition

3.13 The advection terms of the momentum and viscous terms are resolved with the second order numerical schemes. The scaled residuals were converged to an order of magnitude of at least 1×10^{-4} as recommended in COST action C14.

3.14 The inflow face of the computational domain was set as the velocity inlet condition and the outflow face was set as the zero gradient condition. For the two lateral and top faces, symmetric boundary condition was used. Lastly for the ground and building walls, no slip condition was employed.

4 ASSESSMENT CRITERIA AND TEST POINTS LOCATION

Wind Velocity Ratio (VR)

4.1 Wind velocity ratio (VR) indicates how much of the wind availability is experienced by pedestrians on the ground which is a relatively simple indicator to reflect the wind environment of the study site. VR is defined as VR = Vp /V_{INF} where V_{INF} is the wind velocity at the top of the wind boundary layer (greater than 500m in height) would not be affected by the ground roughness and local site features and Vp is the wind velocity at the 2m pedestrian level.

4.2 VRw is the frequency weighted wind velocity ratio calculated based on the frequency of occurrence of 8 selected wind directions or over 75% of occurrence for annual and summer respectively for the purpose of comparison.

4.3 For Site Air Ventilation Assessment, the Site Spatial Average Wind Velocity Ratio (SVRw) and individual VR_W of all perimeter test points were reported. SVRw was the average of VRw of all perimeter test points.

4.4 For Local Air Ventilation Assessment, the Local Spatial Average Wind Velocity Ratio (LVRw) of all overall test points and perimeter test points, and individual VRw of the overall test points were reported. LVRw was the average of all overall test points and perimeter test points.

4.5 The SVRw and LVRw were worked out so as to understand the overall impact of air ventilation on the immediate and further surroundings of the Project Area.

Test Points

4.6 Both perimeter test points and overall test points were selected within the Assessment Area in order to assess the impact on the immediate surroundings and local areas respectively. Overall test points were evenly distributed over surrounding open spaces, streets and other parts of the Assessment Area where pedestrian could or would mostly access. There were 31 Perimeter Test Points and 103 Overall Test Points. Preliminary locations of perimeter and overall test points were illustrated in **Figure 4.1**.

4.7 The Test Points were further divided into 10 groups in order to analyse the respective localized wind environment performances. The coverage of the Test Points Groups were shown in **Figure 4.1** while the description of major covering regions of each group were summarized in **Table 4.1.**

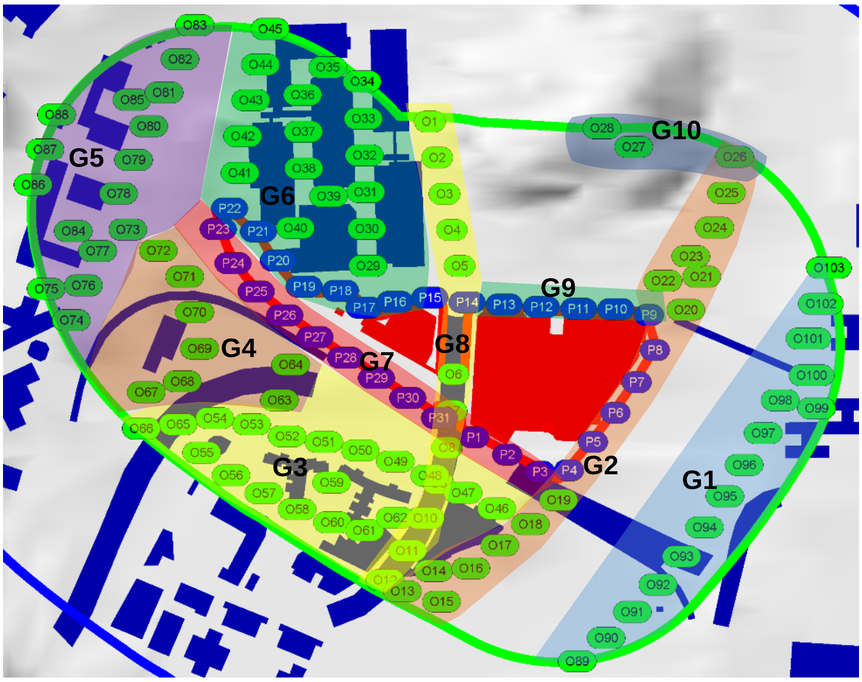


Figure 4.1 Distribution of Test Points

Table 4.1 Test Point Groups and Respective Represented Locations

Test Point Groups	Test Point Numbers	Major Location Covered
G1*	O89-O103	Tuen Mun River (Eastern Bank)
G2*	O13-O26, P4-P9	Tuen Mun River (Western Bank)
G3*	O46-O66	Lung Yat Estate
G4	O63-O72	Pumping Station & Bike Trail
G5	O73-O88	G/IC Cluster
G6	P15-P22, O1-O5, O29-O45	Nan Fung Industrial City
G7	P1-P3, P23-P31	Wong Chu Road
G8	O1-O12	Yip Wong Road
G9	P10-P18	Tin Hau Road
G10	O26-O28	Tin Hau Temple Plaza

* Perimeter test points were selected within interval similar to overall test points

5 KEY FINDINGS OF AVA STUDY

5.1 A big design features different between Proposed Scheme and Baseline Scheme were observed. Four building blocks was sitting on three 2-to 3- storeys podiums and an empty bay between two Phases was provided in Baseline Scheme as a breezeway for cross-ventilation. In addition, the building setback of domestic block maintained the effectiveness of Wong Chu Road and Yip Wong Road as the major air path for prevailing wind.

5.2 For the Proposed Scheme, four orientated building blocks on top of two 3- to 4-storeys podium to house the supporting facilities. Air permeable space in the carpark and under the domestic tower allowed prevailing wind to penetrate through such that significant impact on the overall pedestrian wind environment would not be anticipated. The existing drainage reverses and >15m building gaps were reserved as buffer zone and air path for prevailing wind.

5.3 The open space and drainage reverse at the western and the south of the site minimized the coverage of podium that allowed easterly wind skimmed over or flew though the site. Also, empty bays at driveway allowed prevailing wind to enter the carpark. To mitigate the air ventilation impact, air permeable space of the Project Area in the car park could promote air movement at pedestrian level.

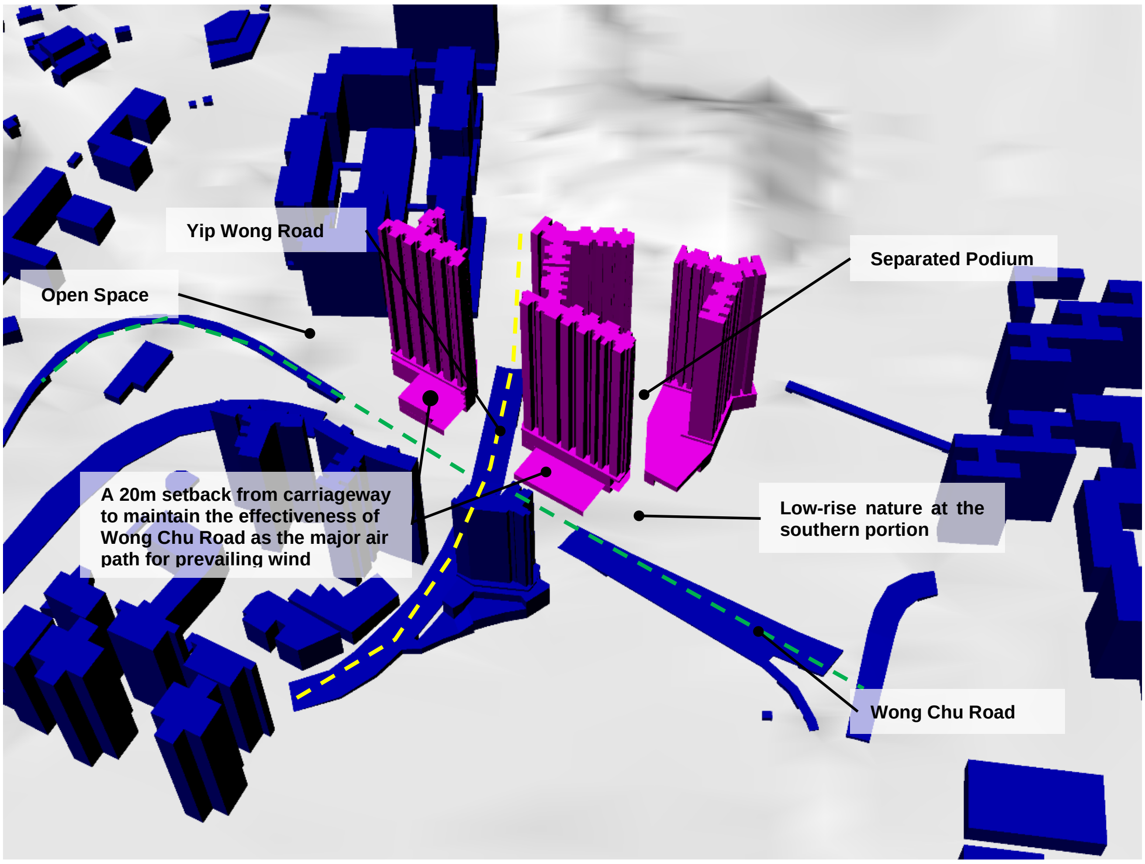


Figure 5.1 Good Design Features in Baseline Scheme

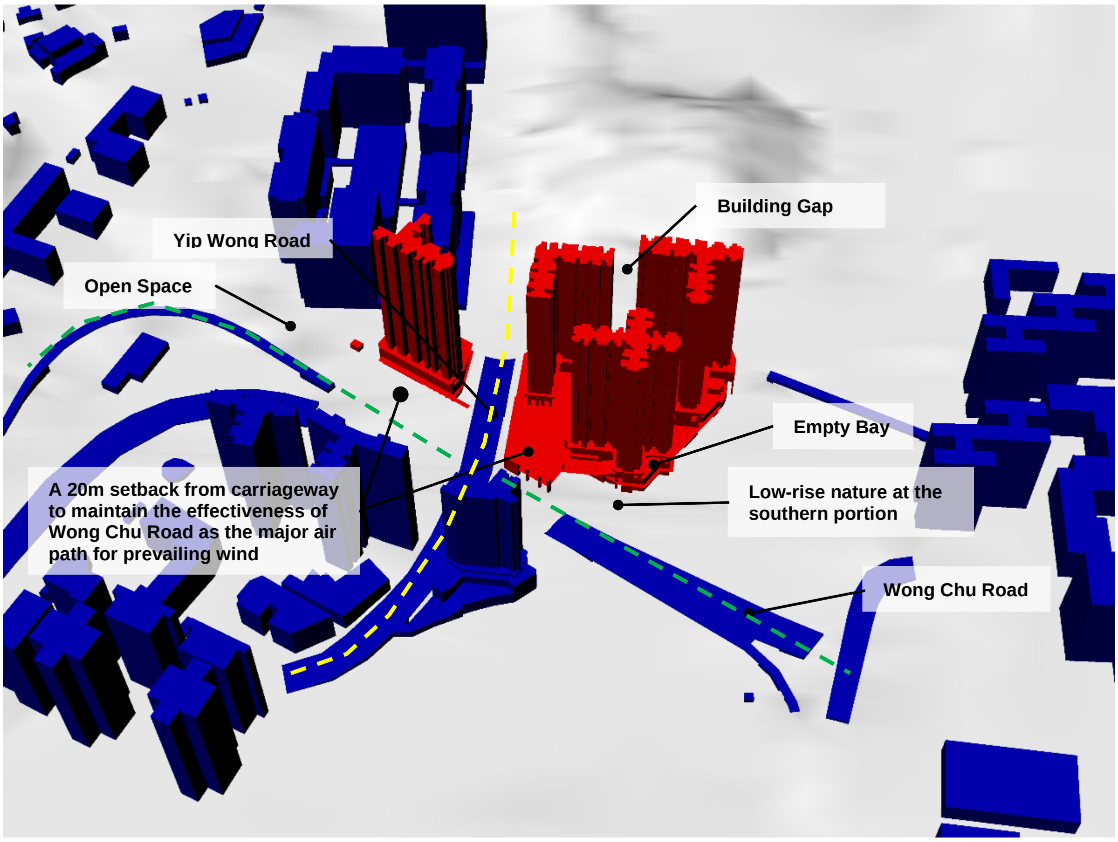


Figure 5.2 Good Design Features in Proposed Scheme

Wind Velocity Ratio Results

5.4 A summary of the predicted wind velocity ratios for the Perimeter Test Points and the Overall Test Points i.e. SVR_W and LVR_W under both annual and summer prevailing winds were presented in **Table 5.1** below. Details of the predicted wind velocity ratios were presented in **Appendix B**.

Table 5.1 Summary of Wind Velocity Ratio

	Annual Winds		Summer Winds	
	Baseline Scheme	Proposed Scheme	Baseline Scheme	Proposed Scheme
SVR_W	0.247	0.256	0.271	0.289
LVR_W	0.228	0.233	0.246	0.261

5.5 The results of VRw for different groups of test points were summarized in **Table 5.2** below.

Table 5.2 Summary of Wind Velocity Ratio for Different Test Point Groups

Group	Description	Test Points	Average VR_w (Annual Winds)		Average VR_w (Summer Winds)	
			Baseline Scheme	Proposed Scheme	Baseline Scheme	Proposed Scheme
G1*	Tuen Mun River (Eastern Bank)	O89-O103	0.238	0.232	0.256	0.248
G2*	Tuen Mun River (Western Bank)	O13-O26, P4-P9	0.265	0.287	0.290	0.341
G3*	Lung Yat Estate and Bike Trail	O46-O66	0.208	0.206	0.252	0.261
G4	Pumping Station & Bike Trail	O63-O72	0.205	0.197	0.245	0.255
G5	G/IC Cluster	O73-O88	0.216	0.210	0.215	0.205
G6	Nan Fung Industrial City	P15-P22, O1-O5, O29-O45	0.157	0.171	0.155	0.192
G7	Wong Chu Road	P1-P3, P23-P31	0.307	0.325	0.372	0.384
G8	Yip Wong Road	O1-O12	0.302	0.315	0.289	0.319
G9	Tin Hau Road	P10-P18	0.207	0.176	0.181	0.177
G10	Tin Hau Temple Plaza	O26-O28	0.334	0.337	0.384	0.347

* Perimeter test points were selected within interval similar to overall test points

5.6 Contour plots of wind velocity ratio at 2m above the pedestrian level of assessment area under prevailing wind directions were shown in directional analysis in Section 6.

Site Air Ventilation Assessment

5.7 The SVRw indicated how the lower portion of the buildings within the Project Area affecting the wind environment of its immediate vicinity. Under annual winds, the average of predicted SVRw over these prevailing winds for the Baseline Scheme and Proposed Scheme were increase from 0.247 to 0.256, indicated a slightly better wind environment around the development site boundary. In summer, the SVRw were also increase from 0.271 to 0.289 which indicated a better wind environment during summer conditions.

5.8 Test points O1 to O12 were located along the portion of Yip Wong Road at the middle of the Project Area. This focus area aligned with Yip Wong Road as major wind corridor under annual and summer conditions. The VRw was increased from 0.302 to 0.315 for the Baseline and Proposed Scheme under annual condition, while they were 0.289 and 0.319 in summer condition due to the coverage of podium in Proposed Scheme diverting more southerly wind into Yip Wong Road freely, while the building gap and separated podium between Block 1 and 3 to allow wind penetration to Tin Hau Road.

5.9 It was expected that the Proposed Scheme would have slightly better air ventilation performance at the south perimeter of the Site under summer condition when compared to Baseline Scheme due to continuous podium alignment. The air ventilation performance monitored by test points P1 to P3 and P23 to P31 increased from 0.307 to 0.325 for the Baseline and Proposed Scheme under annual conditions, while in summer conditions, VR increased from 0.372 to 0.384 as more wind was diverted to this area.

Local Air Ventilation Assessment

5.10 The LVRw indicated the overall wind environment within the Assessment Area of the Baseline Scheme and Proposed Scheme under the annual and summer winds. The LVRw increased from 0.228 to 0.233 under the annual prevailing winds. During the summer seasons, the LVRw increased from 0.246 to 0.261. The results indicated that the Proposed Scheme would have slightly improvement on the pedestrian wind environment compared to the Baseline Scheme at the Project Area boundary and throughout the Assessment Area.

5.11 The average wind velocity ratio of Group 1 test points reflected the wind environment along the Tuen Mun River (Eastern Bank) to the east of the Project Area. The Proposed Scheme maintained a similar wind environment within the Group 1 area that the average VRw in Group 1 test points were slightly reduced from 0.238 to 0.232 for the Baseline Scheme and Proposed Scheme. While in summer season, the average VRw for the Baseline Scheme and the Proposed Scheme were also reduced from 0.256 to 0.248, indicating a slightly worse wind environment.

5.12 The VRw values of Group 2 Test Points indicated the air ventilation performance of the Tuen Mun River (Western Bank) near by the Project Area and The Esplanade. The results indicated that the VRw values increased from 0.265 to 0.287 for the Baseline Scheme and the Proposed Scheme respectively for annual winds. As for summer, a slightly better wind environment was observed between the Baseline Scheme and the Proposed Scheme with increased in VRw from 0.290 to 0.341.

5.13 The ventilation performance of the Lung Yat Estate and bike trail was assessed by Group 3 test points. The VRw of both schemes were 0.208 and 0.206 respectively, indicating a similar ventilation performance in this area under annual conditions. For the summer winds, VRw increased from 0.252 to 0.261. There was slight ventilation enhancement for this monitoring region for the Proposed Scheme.

5.14 Group 4 test points located at the south-west to the Project Area, covering Pumping Station and Bike Trail. It was observed that the Proposed Scheme would have slightly enhancement of air ventilation compared to Baseline Scheme with VRw were increased from 0.245 to 0.255 during summer season and reduced from 0.205 to 0.197 in annually which was represented the proposed development would have slightly negative impact for Group 4.

5.15 Group 5 test points located at G/IC cluster to the west of the Project Area, and the VRw indicated a similar wind environment at this area. It was observed that the average velocity ratio was reduced from 0.216 to 0.210 for Baseline Scheme and the Proposed Scheme under annual conditions. For the summer VRw also reduced from 0.215 to 0.205 for Baseline Scheme and Proposed Scheme.

5.16 Group 6 test points located at Nan Fung Industrial City to the north of the Project Area, and the VRw indicated a slightly better pedestrian wind environment. It was noticed that the average velocity ratio was increased from 0.157 to 0.171 for the Baseline Scheme and the Proposed Scheme under annual conditions. While summer VRw were 0.155 and 0.192 respectively for the Baseline Scheme and the Proposed Scheme.

5.17 The average wind velocity ratio of Group 7 test points reflected the wind environment along with the Wong Chu Road to the south of Project Area. It was observed that the Proposed Scheme would have obvious enhancement of air movement compared to Baseline Scheme with VRw were increase from 0.307 to 0.325 under annual conditions. While summer VRw were also increased from 0.372 to 0.384 for Baseline Scheme and Proposed Scheme.

5.18 Group 8 test points were equally spaced at Yip Wong Road at the middle of the Project Area. Under annual condition, the VRw could be maintained at 0.302 and 0.315 for the Baseline Scheme and the Proposed Scheme which implied slight improvement on air ventilation performance within this region. As for summer winds, there was better ventilation performance between the Baseline Scheme and the Proposed Scheme with the overall VRw of 0.289 increased to 0.319.

5.19 The Group 9 test points on Tin Hau Road was evenly placed and the VRw indicated an impact in this area under annual and summer wind conditions. As for annual winds, where VRw was reduced from 0.207 to 0.176, also reduced from 0.181 to 0.177 for summer winds.

5.20 Group 10 test points were located at Tin Hau Temple Plaza to the north of Project Area and the leeward side of Tsing Shan Keuk Look-out. Under annual condition, the VRw could be maintained a similar result at 0.334 and 0.337 for the Baseline Scheme and Proposed Scheme. However, the VRw under summer wind was reduced from 0.384 to 0.347, which indicated less wind was diverted to this area in summer conditions.

6 DIRECTIONAL ANALYSIS

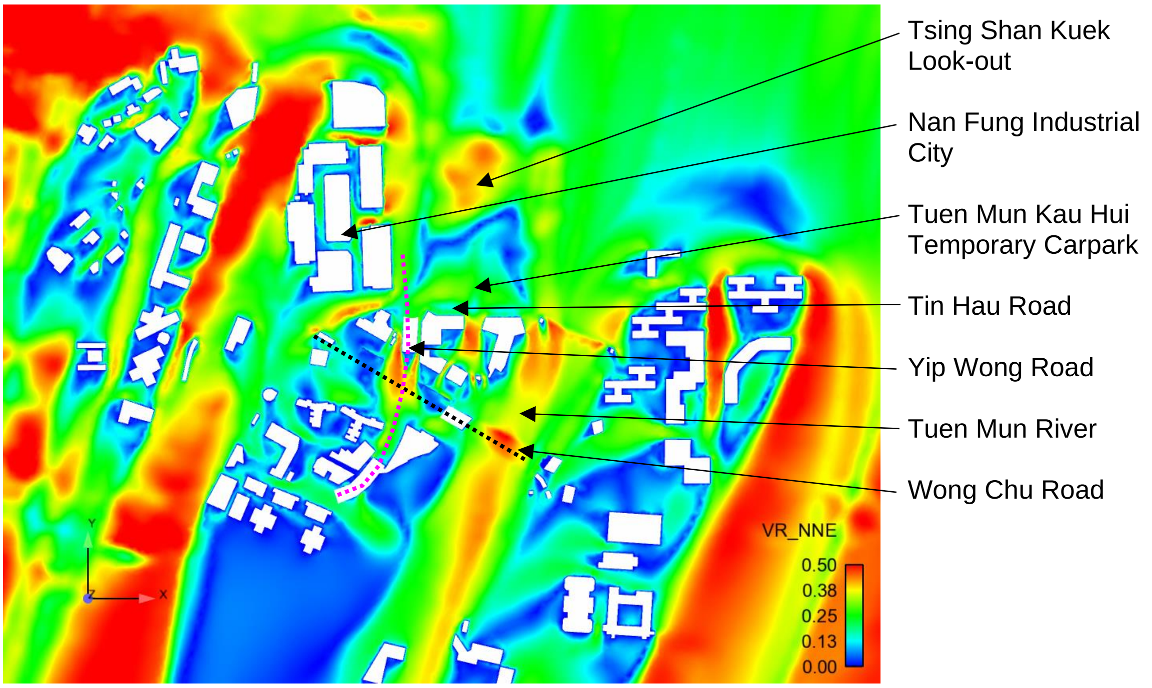
NNE: (Annual: 18.6%)

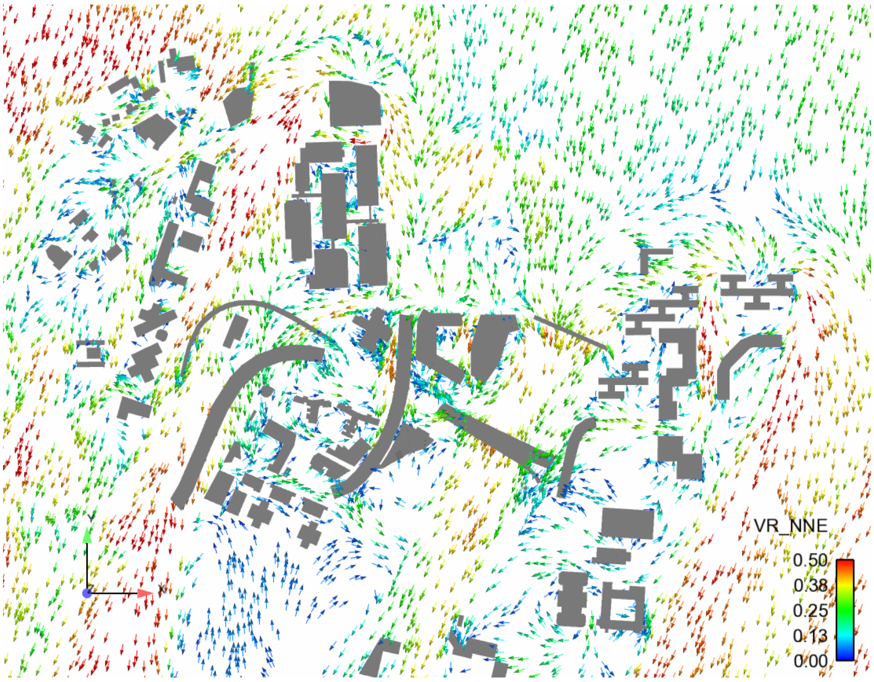
6.1 Under NNE wind, site wind availability of the Project Area mainly relied on coming from Tuen Mun River wind and part of katabatic wind from natural slopes of Tsing Shan Keuk Look-out to the north. The incoming wind was unobstructed and then pass through the Tuen Mun Kau Hui temporary carpark located to the immediate north of the Project Area.

6.2 In the Baseline Scheme, incoming wind could pass through freely by the building gap and separated podium between Block 1 and 3 and skim over the elevated Yip Wong Road at middle of Project Area to ventilate Wong Chu Road and the downstream reaching Lung Yat Estate and The Esplanade. A portion of incoming wind would be diverted to move along Tin Hau Road, reaching Nan Fung Industrial City.

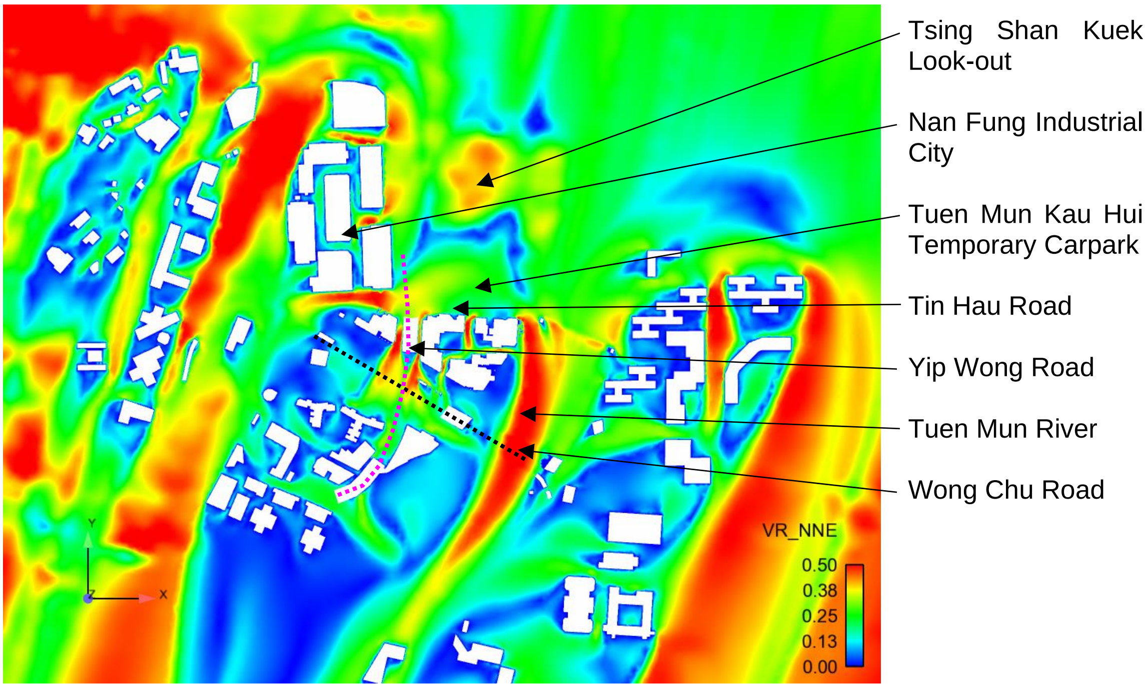
6.3 Similar wind effect was observed in the Proposed Scheme. A drawback was observed at south portion of Project Area as the Phase 2 podium and the disposition of Block 2 would weaken the incoming wind.

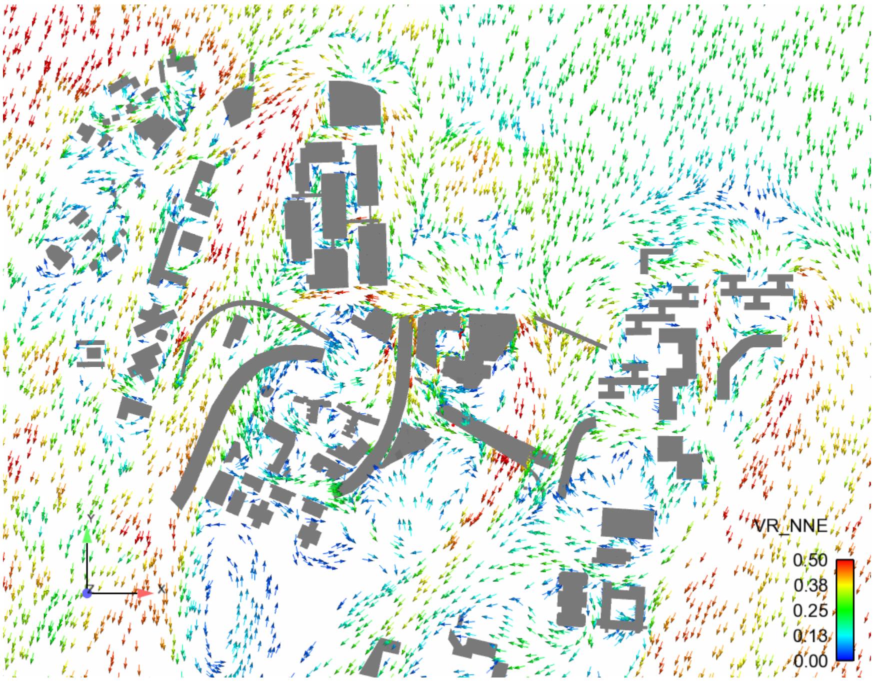
Baseline Scheme





Proposed Scheme





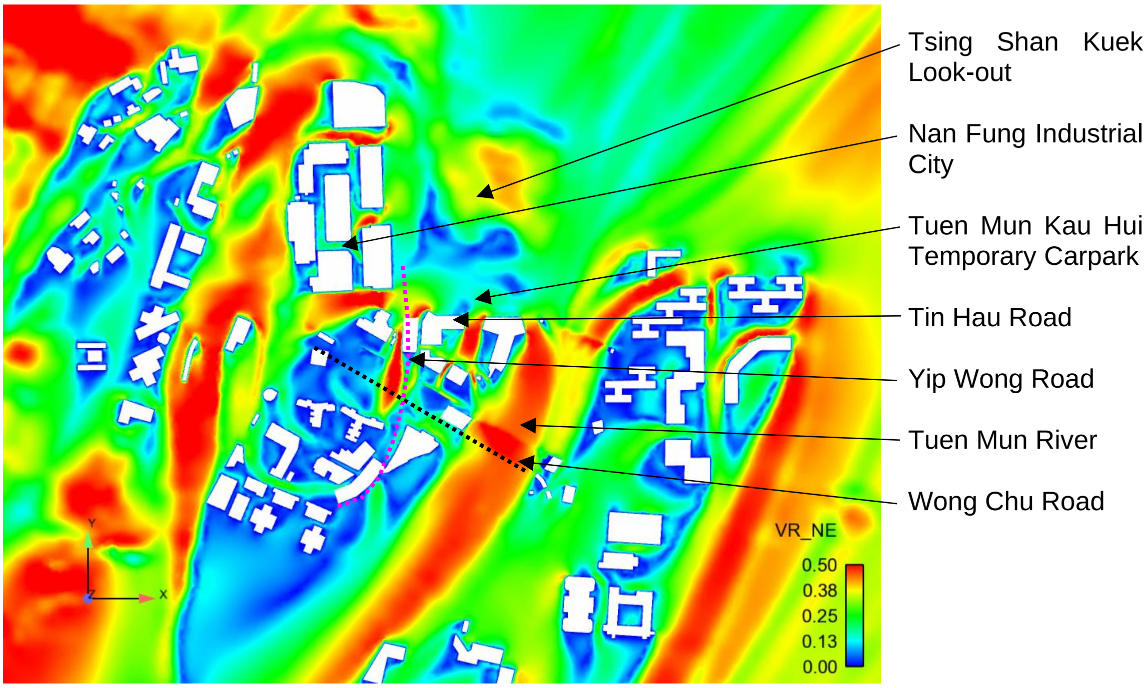
NE: (Annual:5.5%)

6.4 Similar to NNE wind, site wind availability of the Project Area mainly relied on coming from Tuen Mun River wind and part of katabatic wind from natural slopes of Tsing Shan Keuk Look-out to the north. The incoming wind was unobstructed and then pass through the Tuen Mun Kau Hui temporary carpark located to the immediate north of the Project Area.

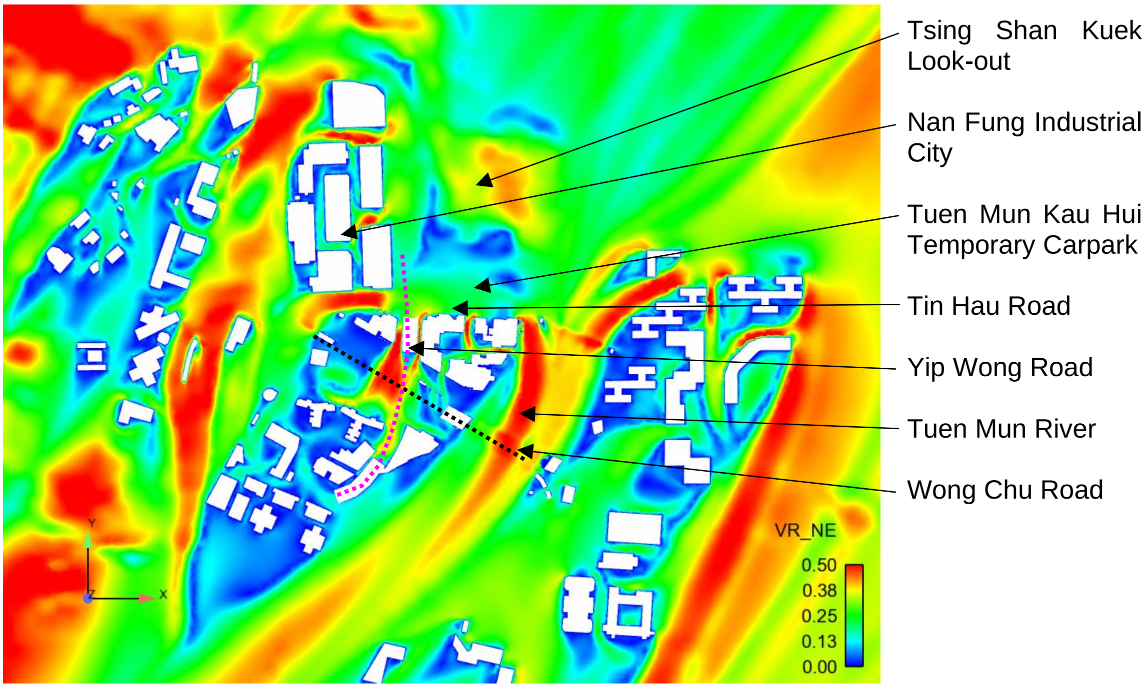
6.5 In the Baseline Scheme, incoming wind could pass through the building gap and separated podium between Block 1 and 3 and skim over the elevated Yip Wong Road at middle of Project Area to ventilate Wong Chu Road and the downstream reaching Lung Yat Estate and The Esplanade. A portion of incoming wind would be diverted to move along Tin Hau Road, reaching Nan Fung Industrial City.

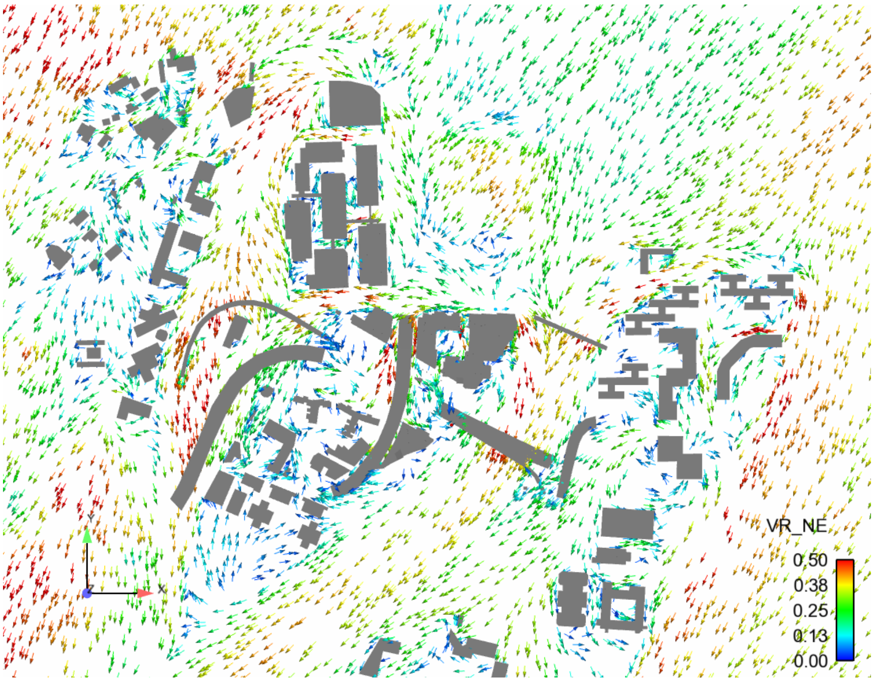
6.6 Similar wind effect was observed in the Proposed Scheme. There is a advantage observed at Tin Hau Road to the west of Block 4 due to the podium design, which would divert a portion of wind into Yip Wong Road resulting in weaker flow into Tin Hau Road but a slightly better wind environment in the region of Lun Yat Estate and Bike Trail.

Baseline Scheme



Proposed Scheme





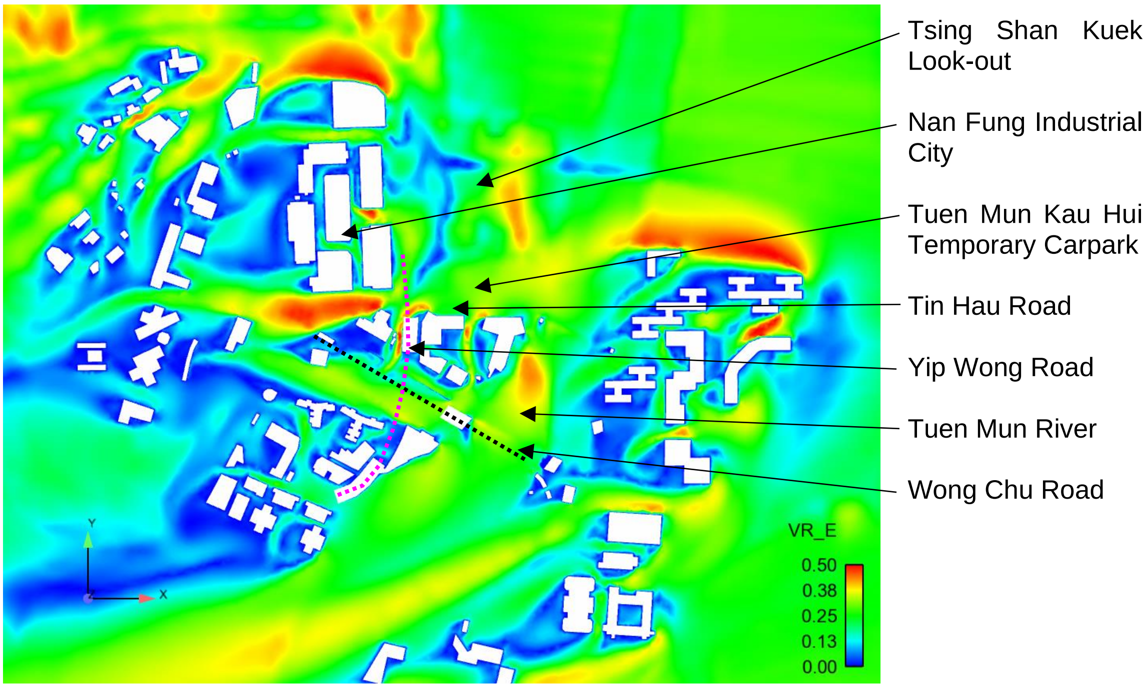
E: (Annual: 8.1% Summer: 5.2%)

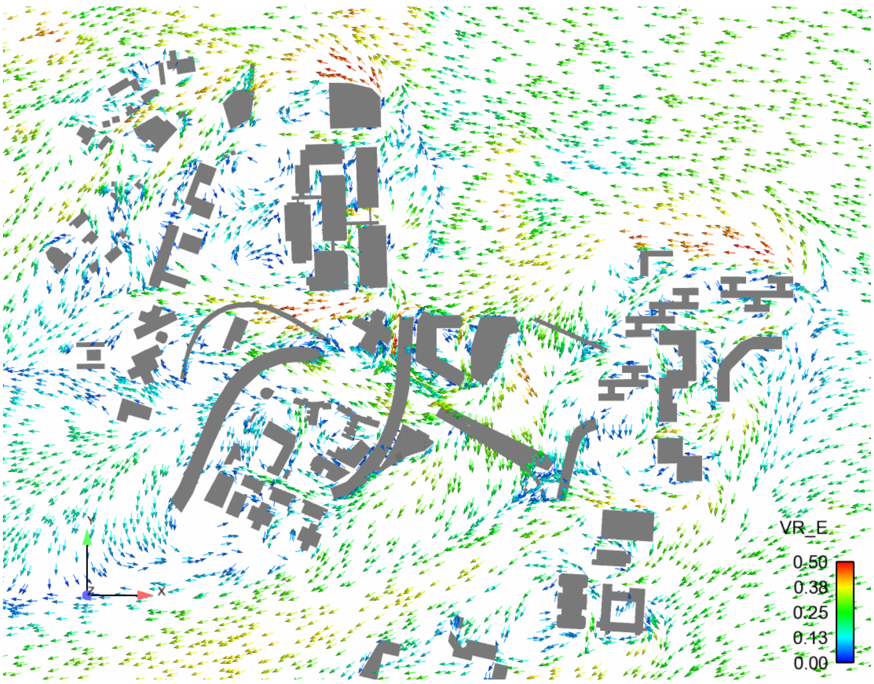
6.7 E incoming wind was weakened by Yau Oi Estate, creating a turbulent zone at leeward side of Yau Oi Estate. Site wind availability was mainly from the reattached air flow from building gaps and open spaces.

6.8 In the Baseline Scheme, the air flow reaching the Tuen Mun River and Tuen Mun Kau Hui, would adopt Tin Hau Road and Wong Chu Road at northern and southern of the Site to reach the G/IC cluster and Lung Yat Estate. A portion of wind would enter the air permeable space between Block 1 and 3 and Yip Wong Road to ventilate the downstream.

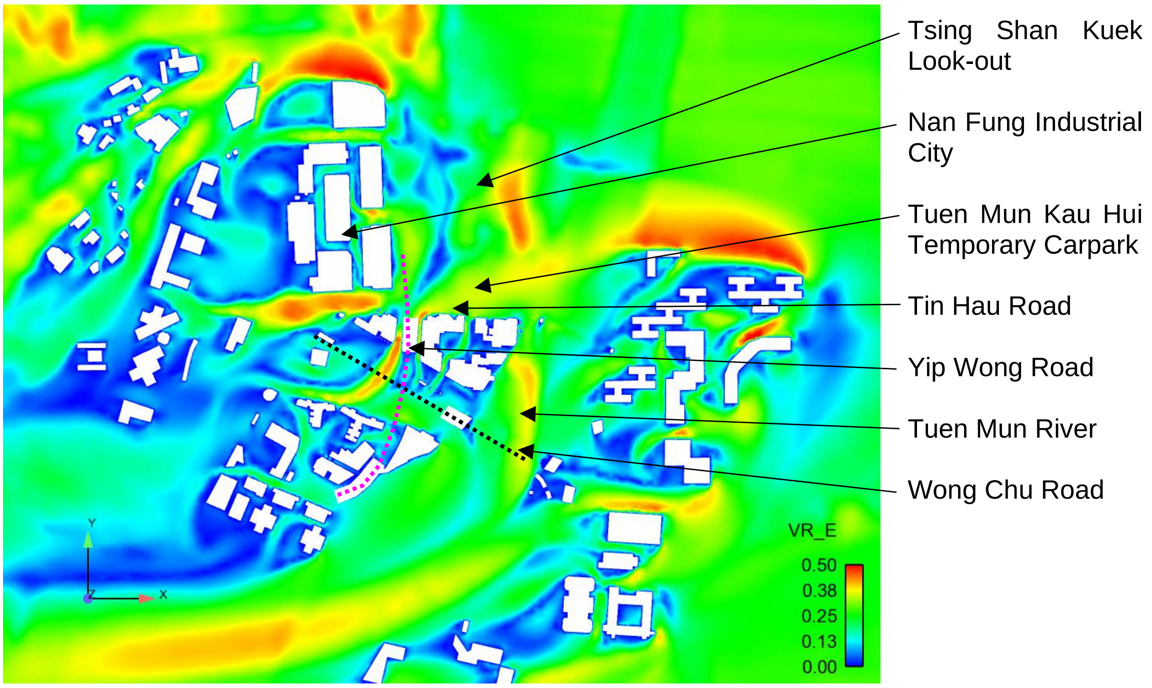
6.9 Similar in the Proposed Scheme, however, wind flow along Wong Chu Road would be weakened due the disposition of Block 2, reducing the air ventilation performance in the downwind area.

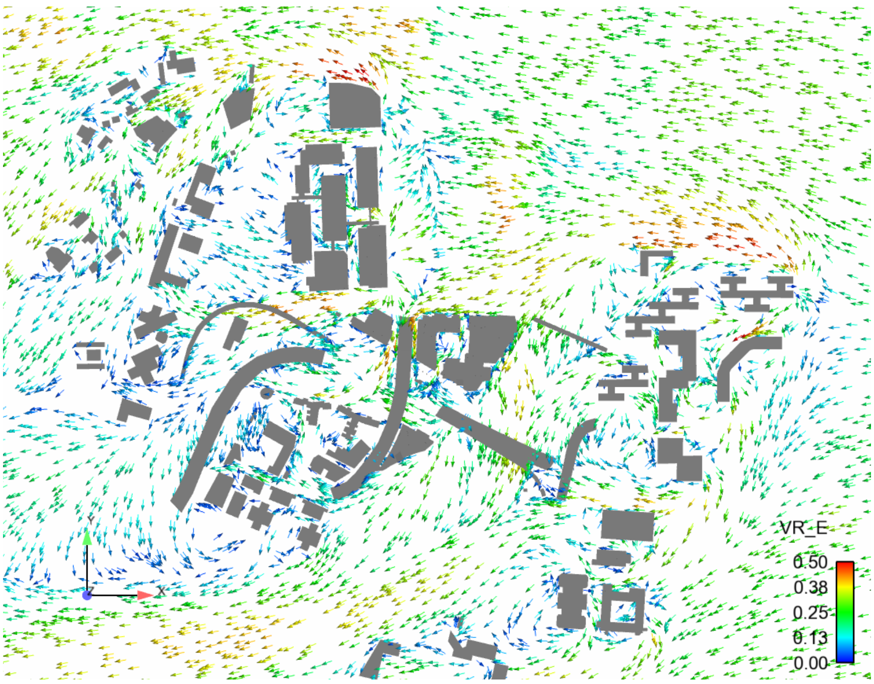
Baseline Scheme





Proposed Scheme





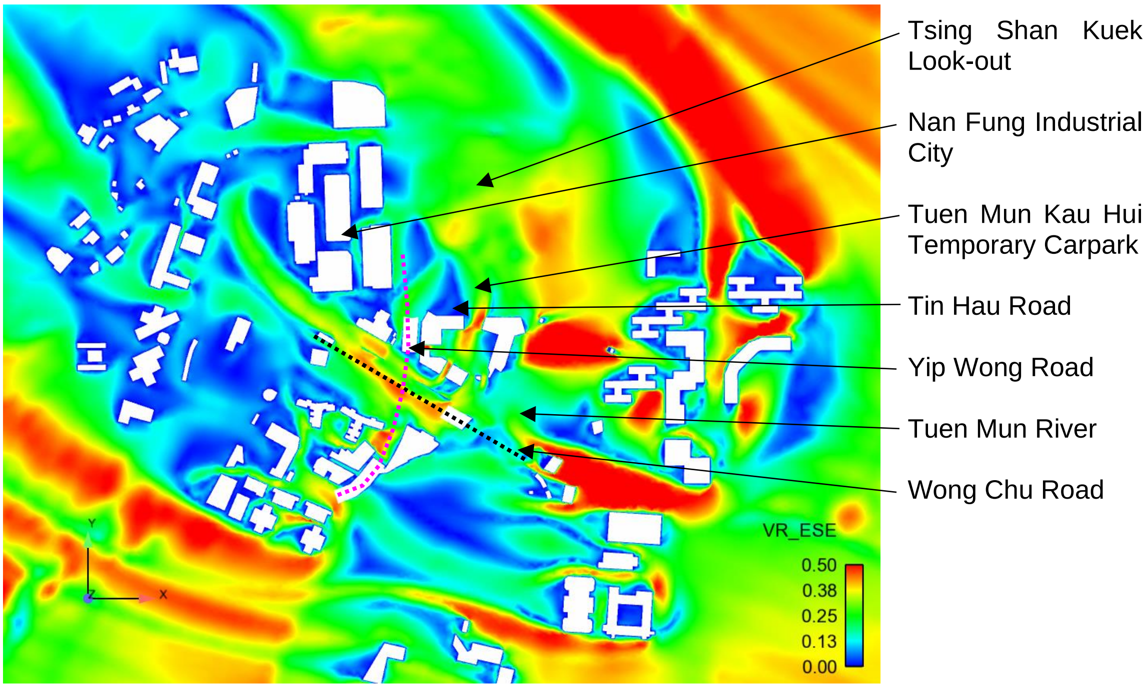
ESE: (Annual: 13.8% Summer: 8.5%)

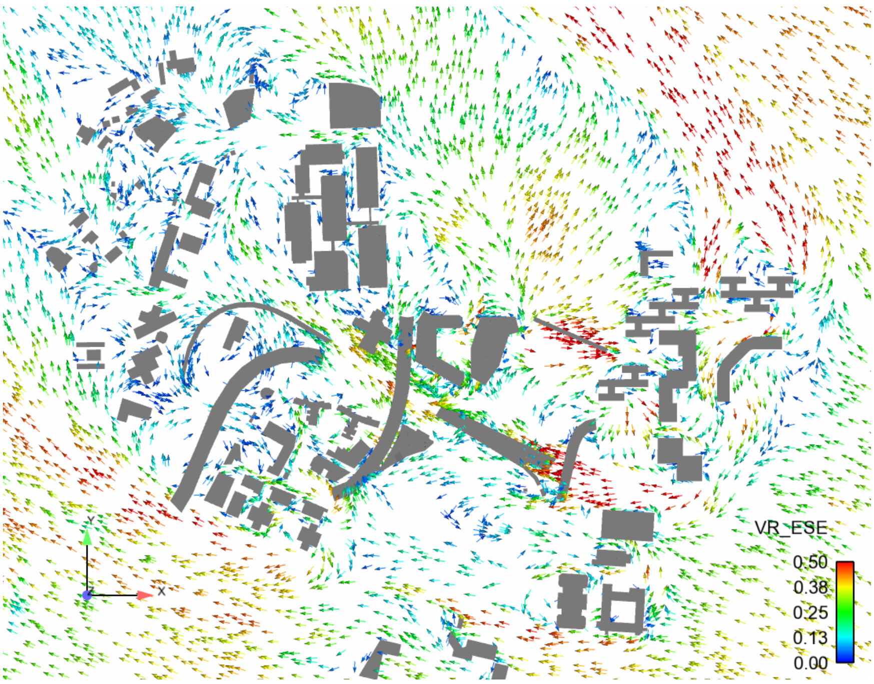
6.10 ESE incoming wind was channelized by Wong Chu Road towards south, and then disperse by Tuen Mun River to the south of the Project Area.

6.11 In Baseline Scheme, the incoming wind was channelized by the high-rise residential developments located aside Wong Chu Road, ventilating the G/IC cluster in the downstream. A portion of winds would pass through the building gap and separated podium between Block 1 and 3 to reach Tin Hau Road.

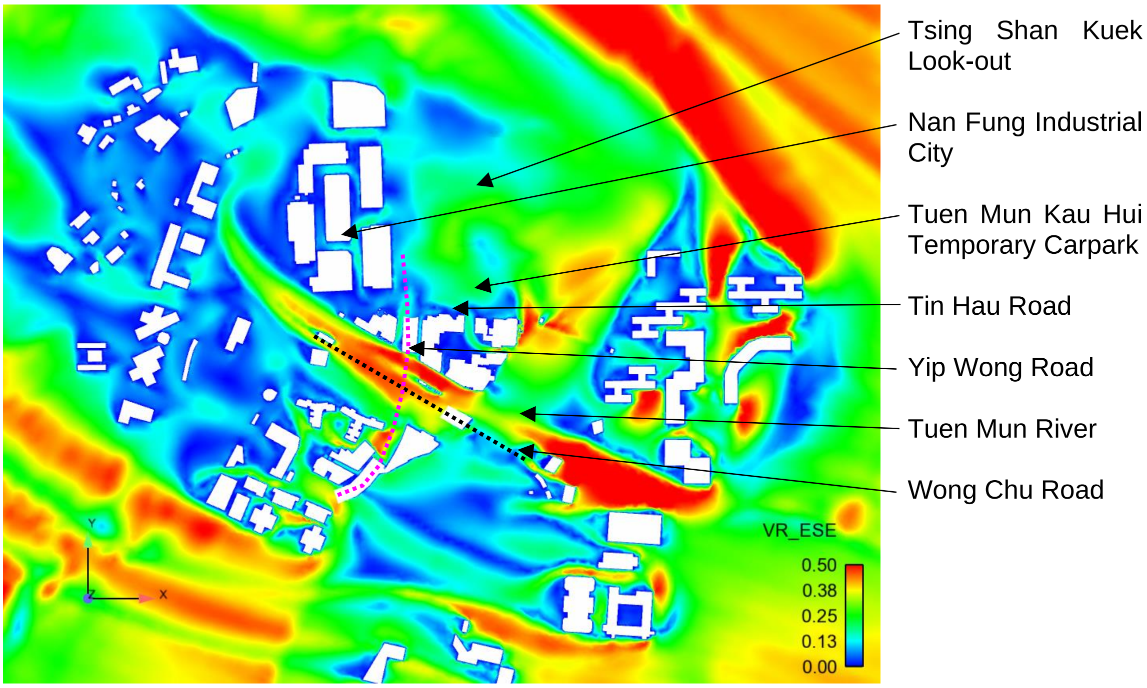
6.12 When compared to Proposed Scheme, due to the podium coverage, the channel effect on Wong Chu Road was more significant. A weaker wind environment was observed at Tin Hau Road.

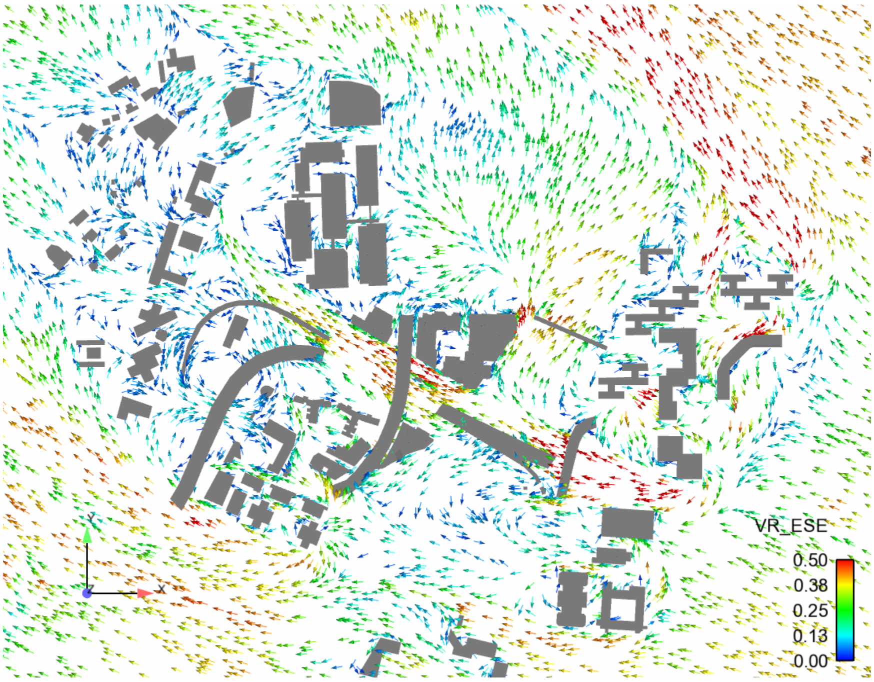
Baseline Scheme





Proposed Scheme





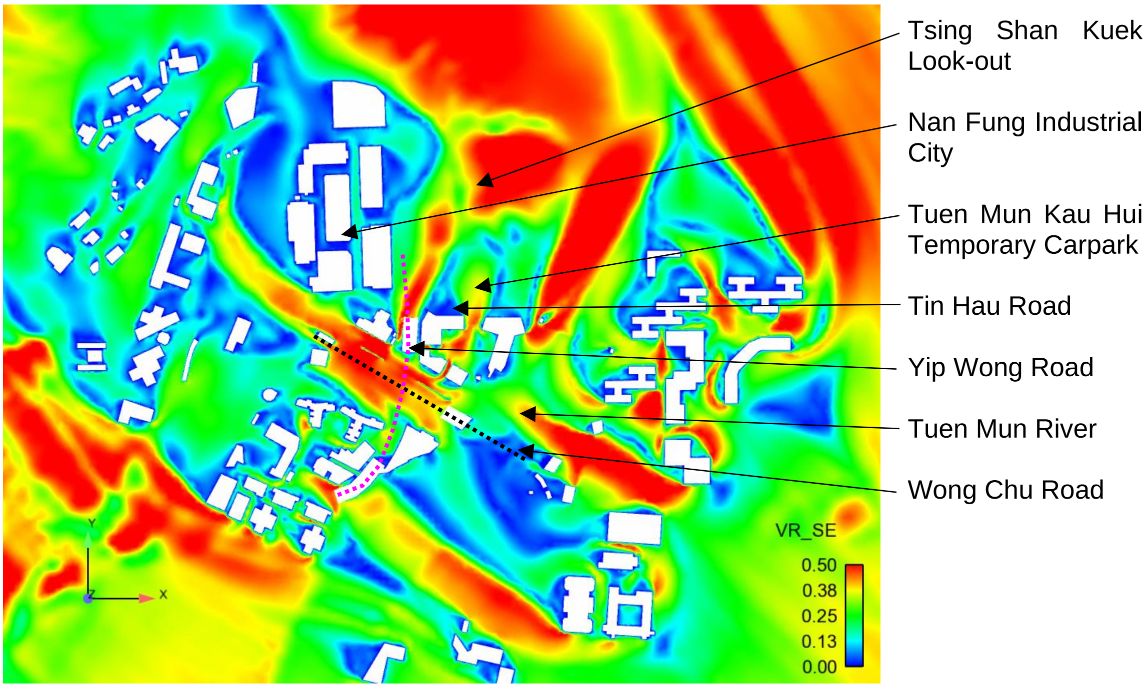
SE (Annual: 15.2% Summer: 16.4%)

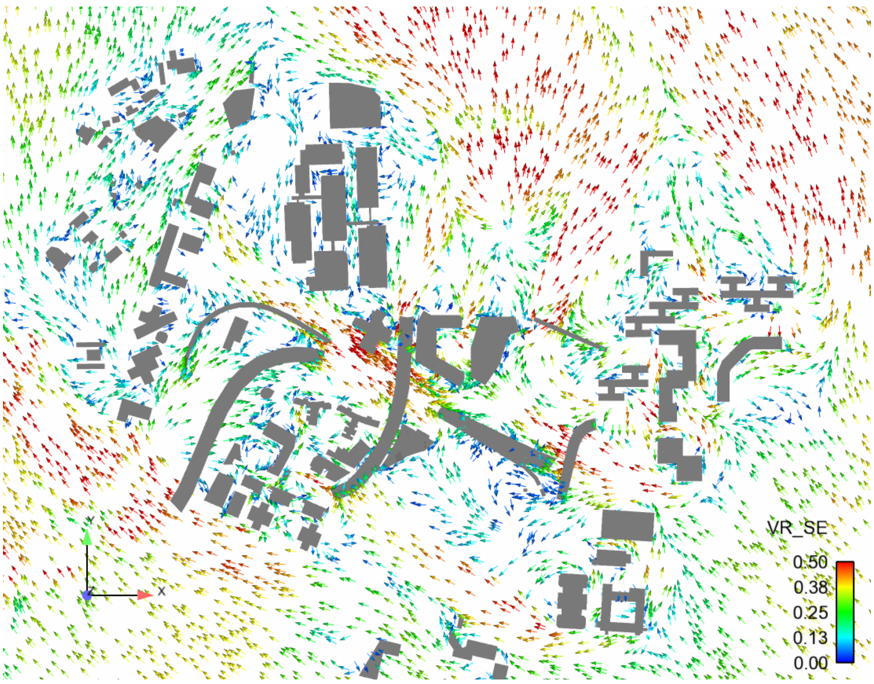
6.13 SE incoming wind was channelized by Wong Chu Road towards south, and then disperse by Tuen Mun River to the east and south of the Project Area.

6.14 In Baseline Scheme, the incoming wind was channelized by the high-rise residential developments located aside Wong Chu Road, ventilating the G/IC cluster in the downstream. A portion of winds would pass through the building gap and separated podium between Block 1 and 3 to reach Tin Hau Road, while another portion would enter Yip Wong Road to ventilate the downstream.

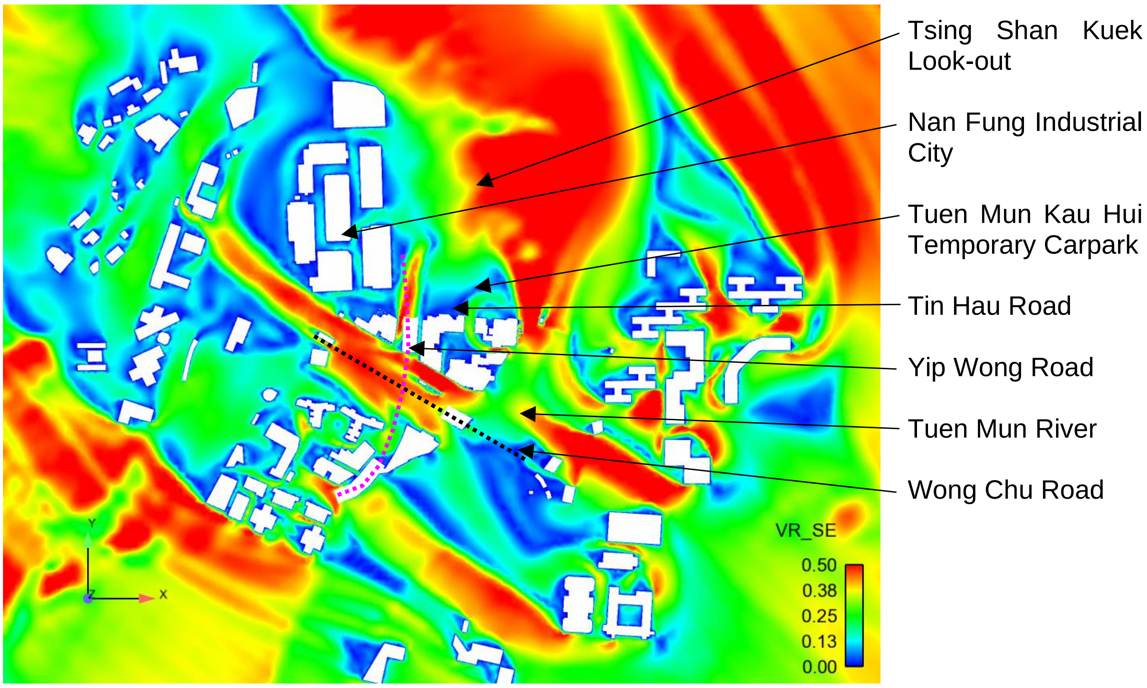
6.15 Similar wind effect was observed in both Baseline Scheme and Proposed Scheme, while the podium coverage of the Proposed Scheme would accelerate the wind flow along Wong Chu Road and divert more wind at eastern perimeter to Tsing Shan Kuen Look-out, resulting a slightly higher VR in these areas.

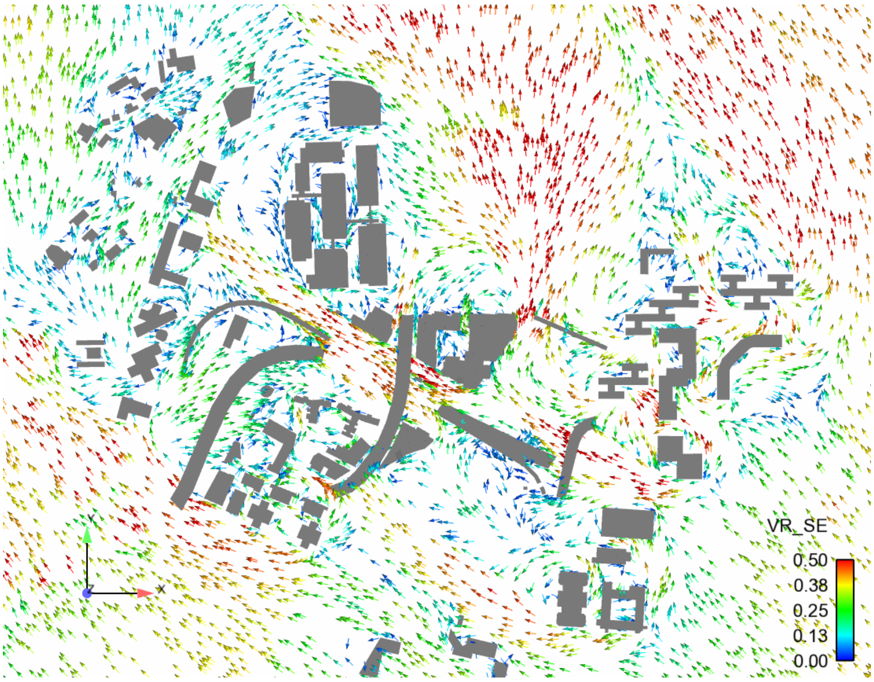
Baseline Scheme





Proposed Scheme





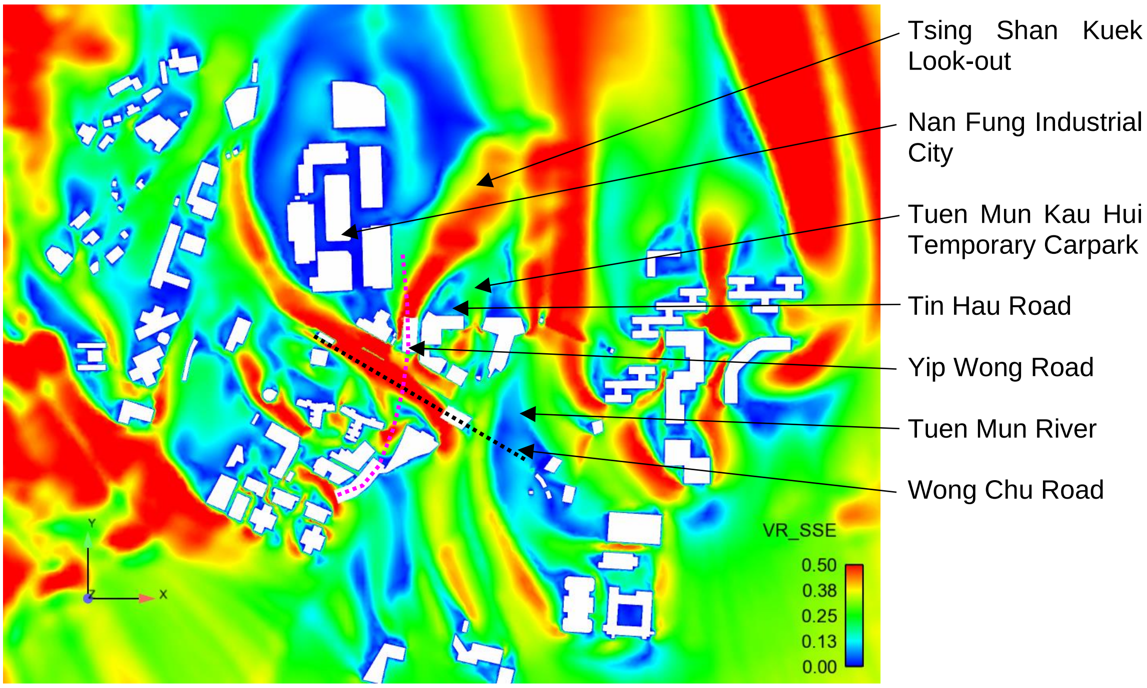
SSE (Annual: 11.4% Summer: 21.5%)

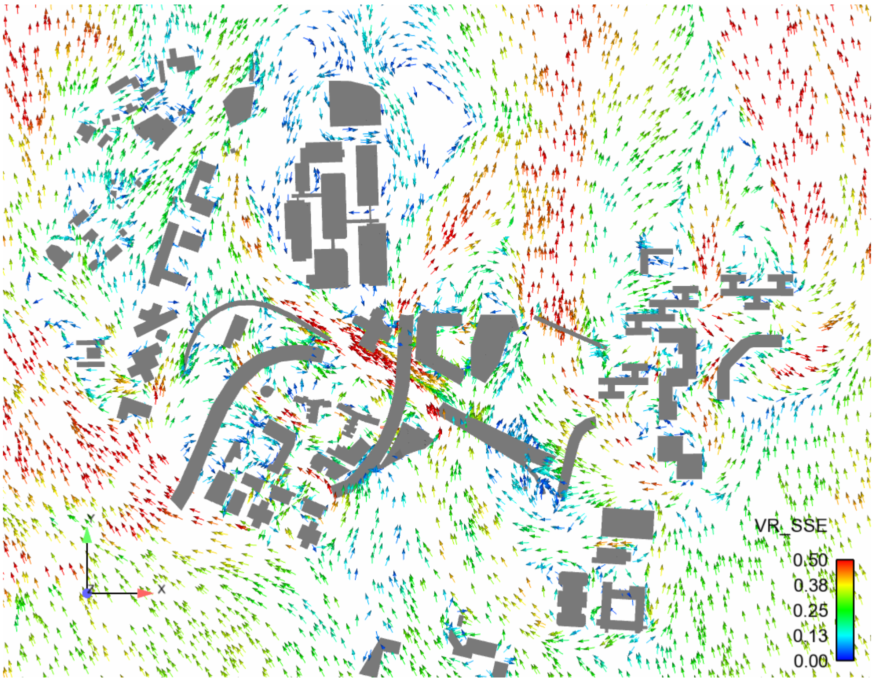
6.16 SSE incoming wind flew into Tuen Mun River freely to the south of Project Area without obstruction. A portion of wind adopted Wong Chu Road as the major air path and reached the south perimeter of the Project Area.

6.17 In the Baseline Scheme, the incoming wind was split into Wong Chu Road and Tuen Mun River (Western Bank). A portion of winds would pass through the building gap and separated podium between Block 1 and 3 to reach Tin Hau Road. Incoming wind would be modulated by Block 2 aligning Wong Chu Road and flow into Yip Wong Road to ventilate the Tuen Mun Kau Hui Temporary Carpark and Tsing Shan Keuk Look-out.

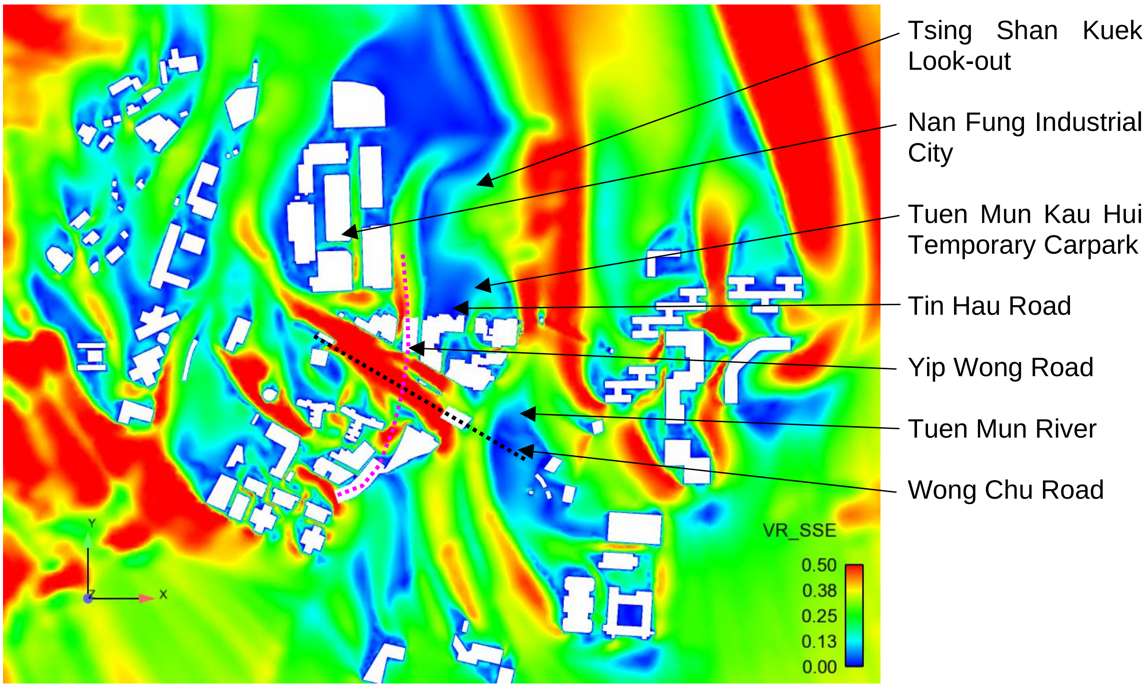
6.18 Similar VR was observed in the Proposed Scheme while there was sightly weaker flow into Yip Wong Road and Tin Hau Road due to the podium coverage, resulting a slightly worse wind environment at Tuen Mun Kau Hui Temporary Carpark and Tsing Shan Keuk Look-out. However, more wind would be diverted into Tin Hau Road near Block 4 to ventilate the Nan Fung Industrial City.

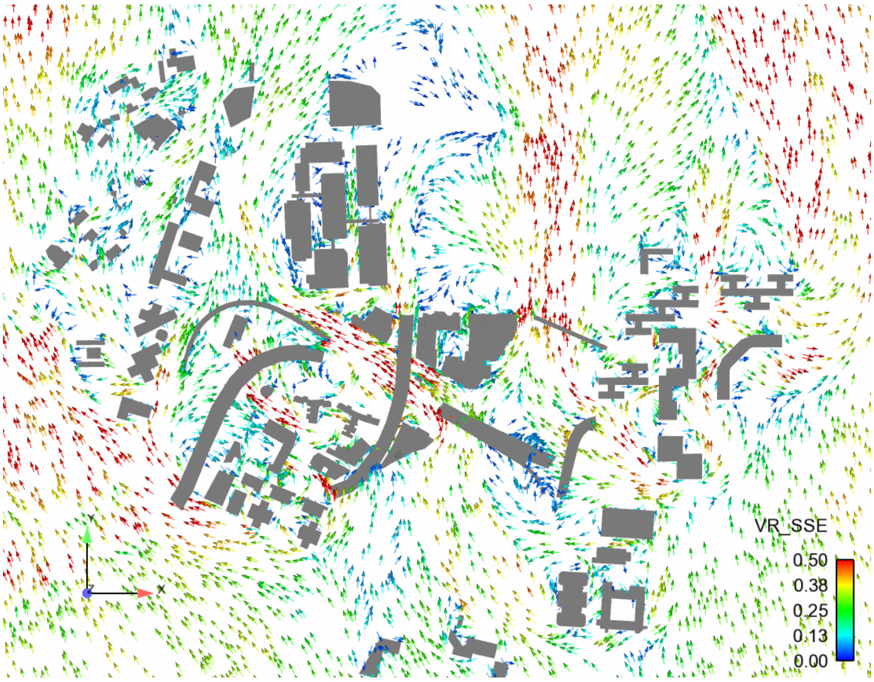
Baseline Scheme





Proposed Scheme





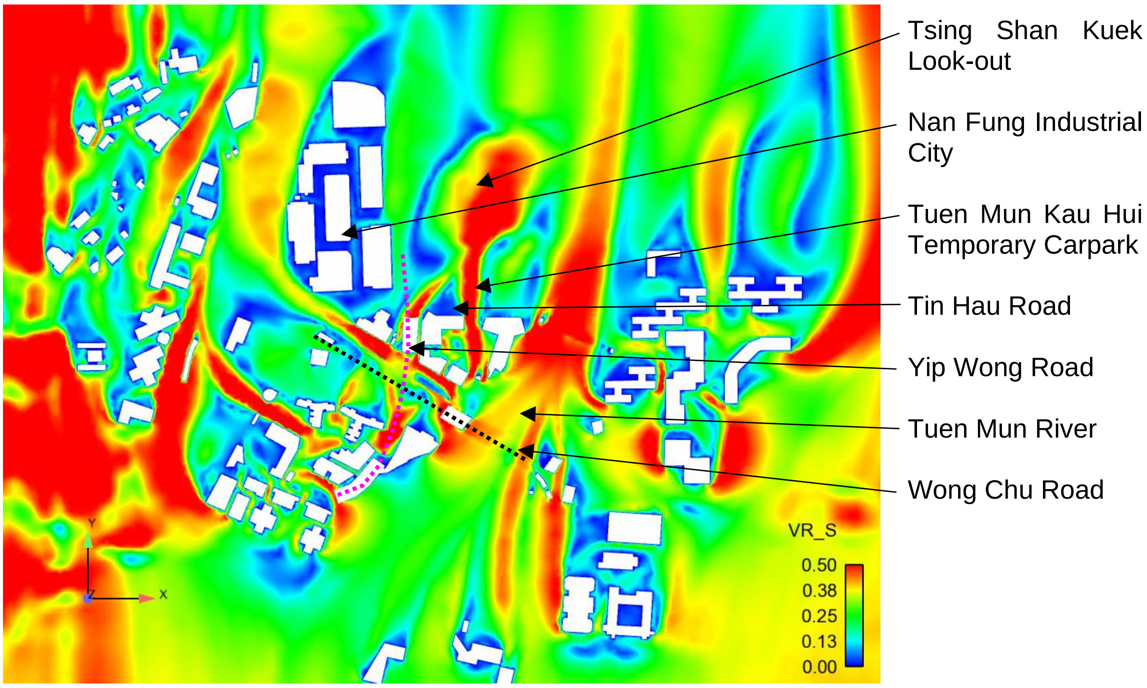
S (Annual: 5.5% Summer: 11.2%)

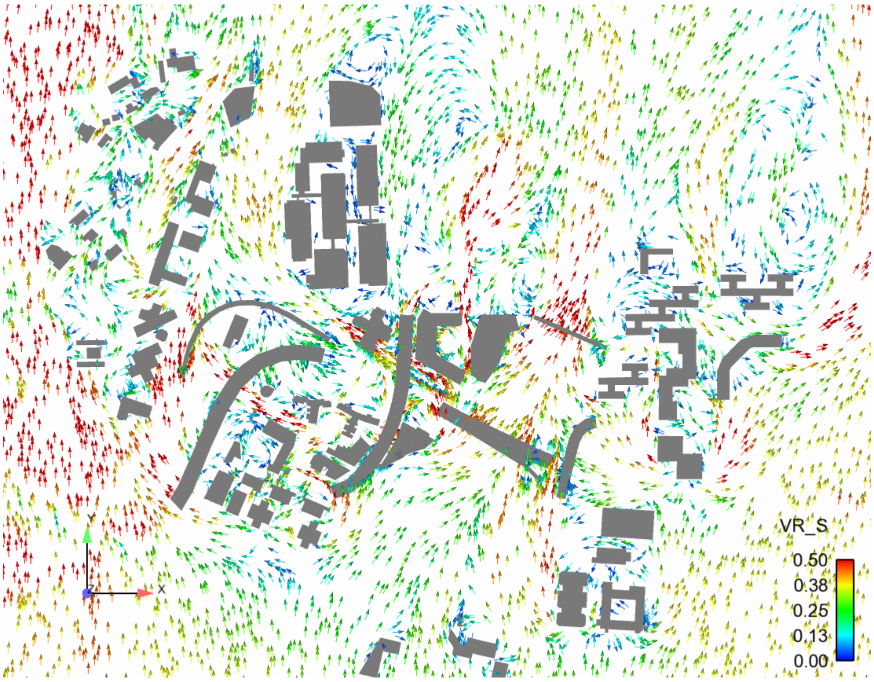
6.19 S incoming wind was channelized along to Tuen Mun River freely to the south of the Project Area without obstruction. A portion of wind adopted Wong Chu Road as the major air path and reached the south perimeter of the Project Area.

6.20 In the Baseline Scheme, the incoming wind was split into Wong Chu Road and Tuen Mun River (Western Bank). A portion of winds would pass through the building gap and separated podium between Block 1 and 3 to reach Tin Hau Road. Incoming wind would be modulated by Block 2 aligning Wong Chu Road and flow into Yip Wong Road to ventilate the Tuen Mun Kau Hui Temporary Carpark and Tsing Shan Keuk Look-out.

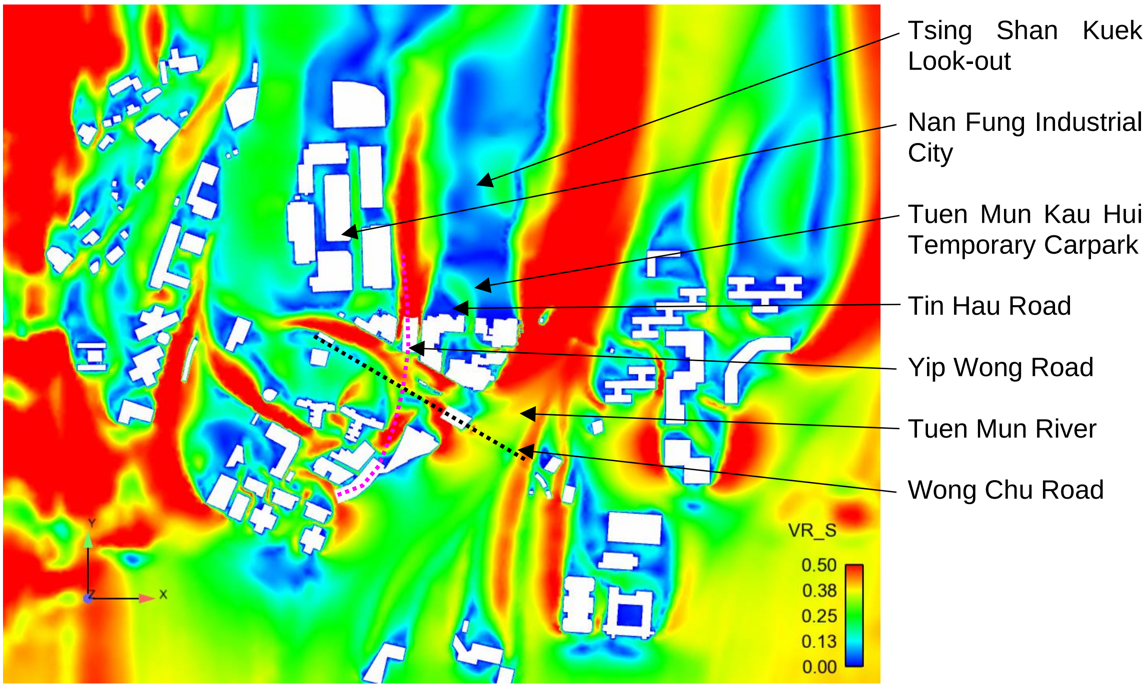
6.21 Similar VR was observed in the Proposed Scheme while there was weaker flow into Tin Hau Road due to the podium coverage, resulting a large wake region at Tuen Mun Kau Hui Temporary Carpark and Tsing Shan Keuk Look-out. However, more wind would be diverted into Yip Wong Road and Tin Hau Road near Block 4 to ventilate the downstream.

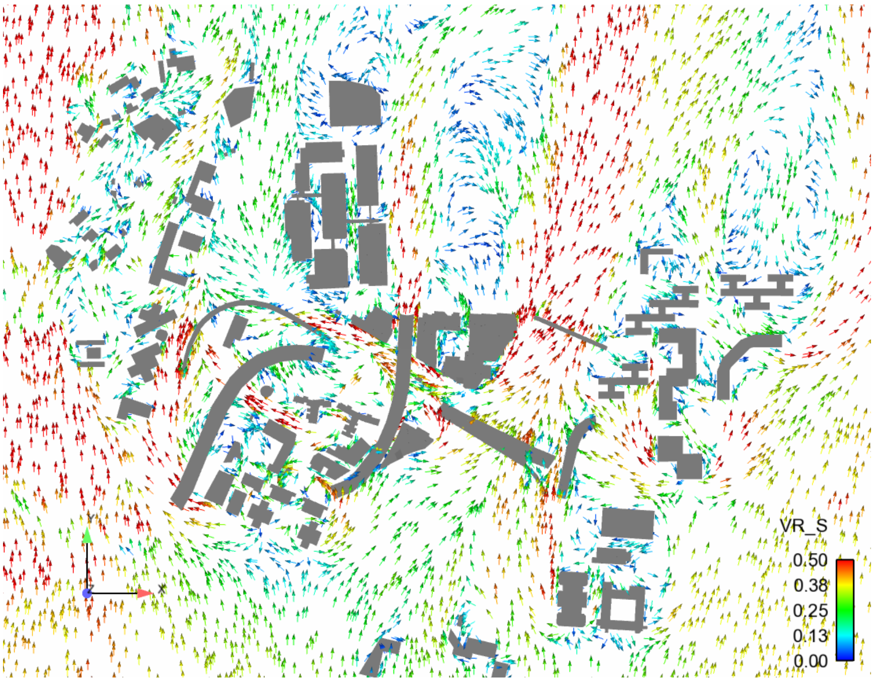
Baseline Scheme





Proposed Scheme





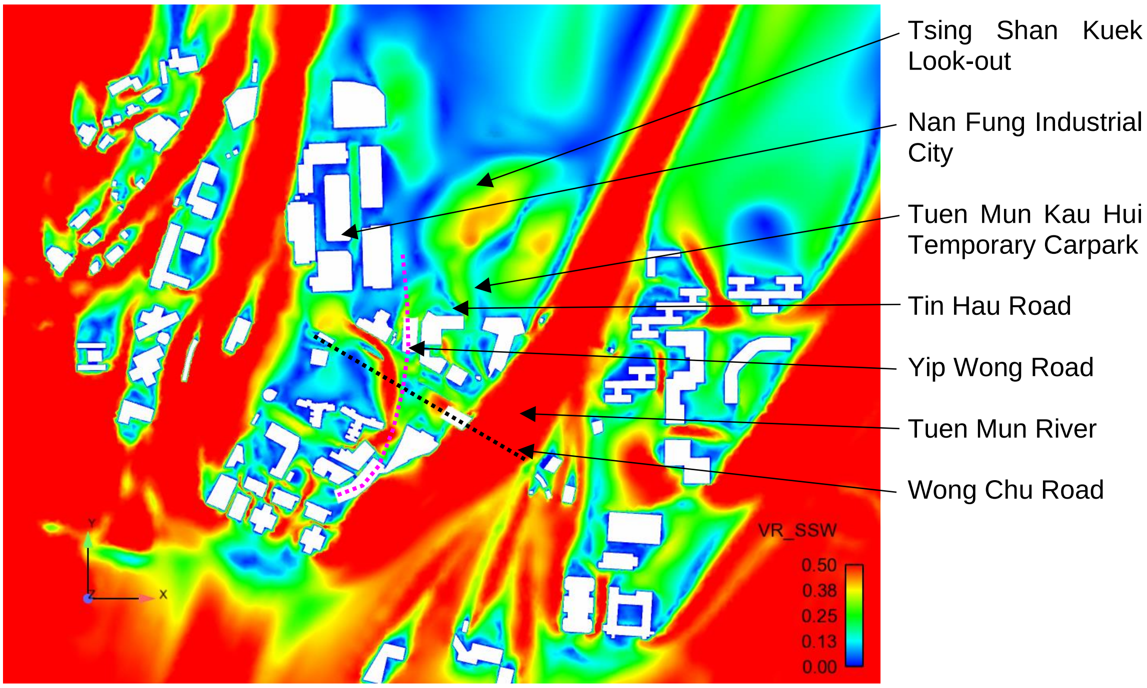
SSW: (Annual: 3.5% Summer: 9.2%)

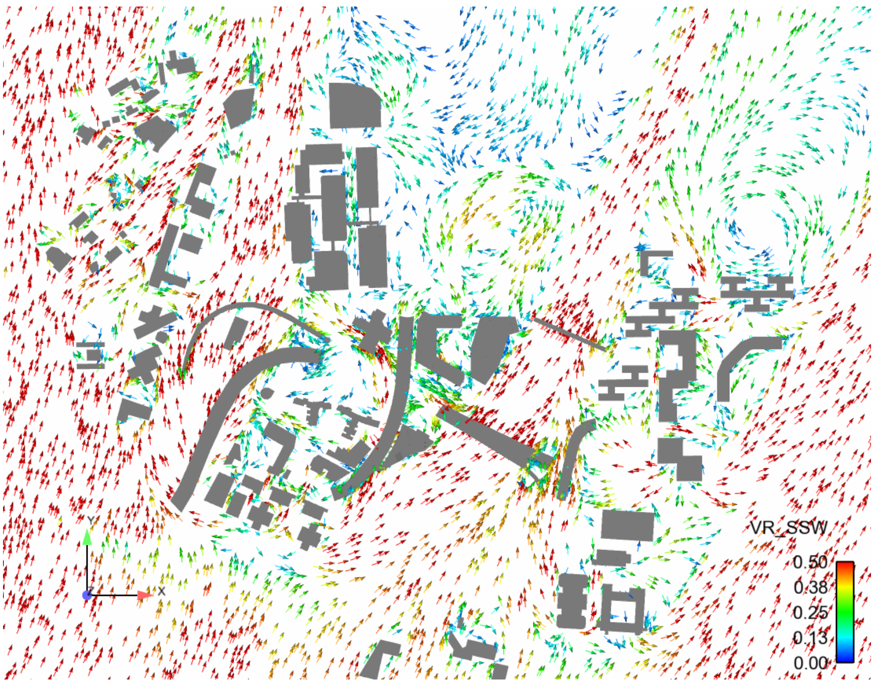
6.22 SSW incoming wind would be weakened by high-rise residential clusters in the windward side. Wind was channelized into Yip Wong Road and Tuen Mun River to the south of the Project Area.

6.23 In the Baseline Scheme, the incoming wind would be diverted into Wong Chu Road, ventilating Lung Yat Estate and Bike Trail. A portion of winds would pass through the building gap and separated podium between Block 1 and 3 to reach Tin Hau Road. Incoming wind would be modulated by Block 2 aligning Wong Chu Road and flow into Yip Wong Road to ventilate the Tuen Mun Kau Hui Temporary Carpark and Tsing Shan Keuk Look-out.

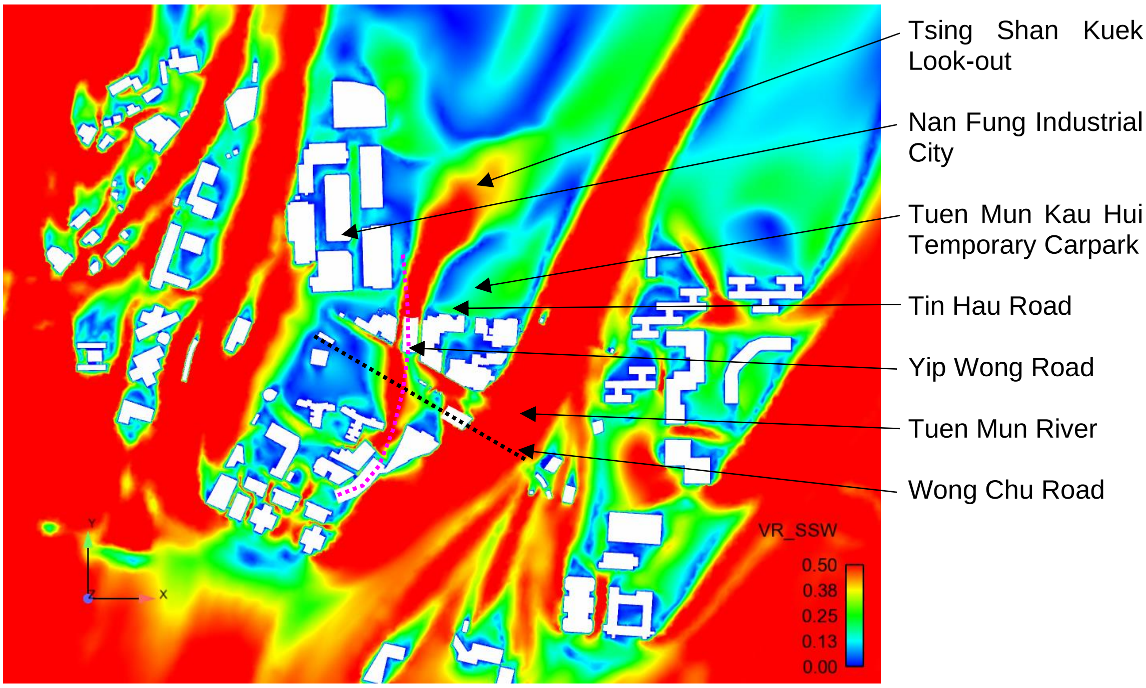
6.24 In the Proposed Scheme, due to the podium coverage, the incoming wind could not pass through the Project Area effectively, resulting a worse air ventilation performance in focus area along Tin Hau Road and Tuen Mun Kau Hui Temporary Carpark. Alternatively, more wind would enter Yip Wong Road to ventilate the downstream.

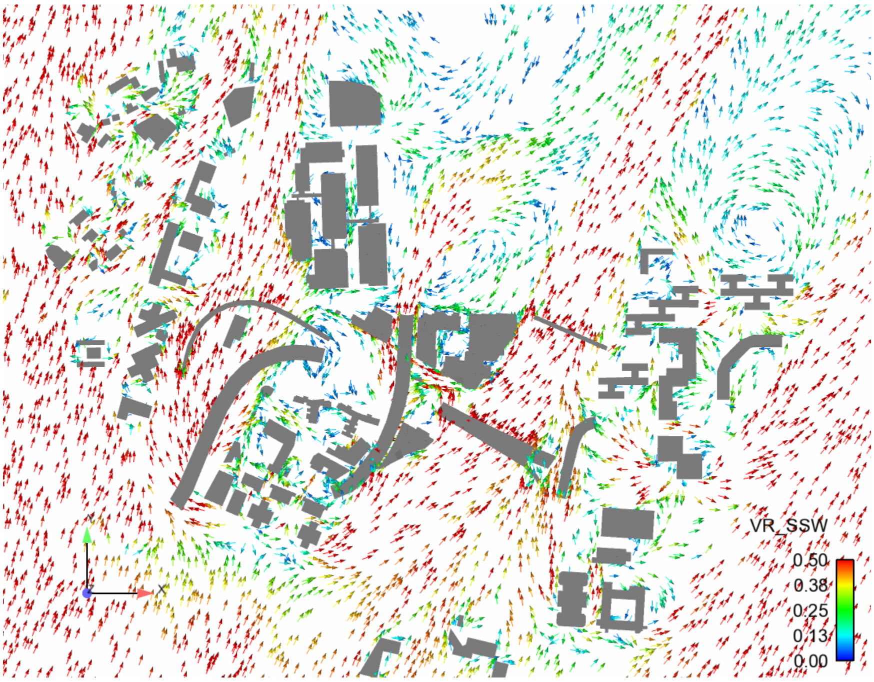
Baseline Scheme





Proposed Scheme





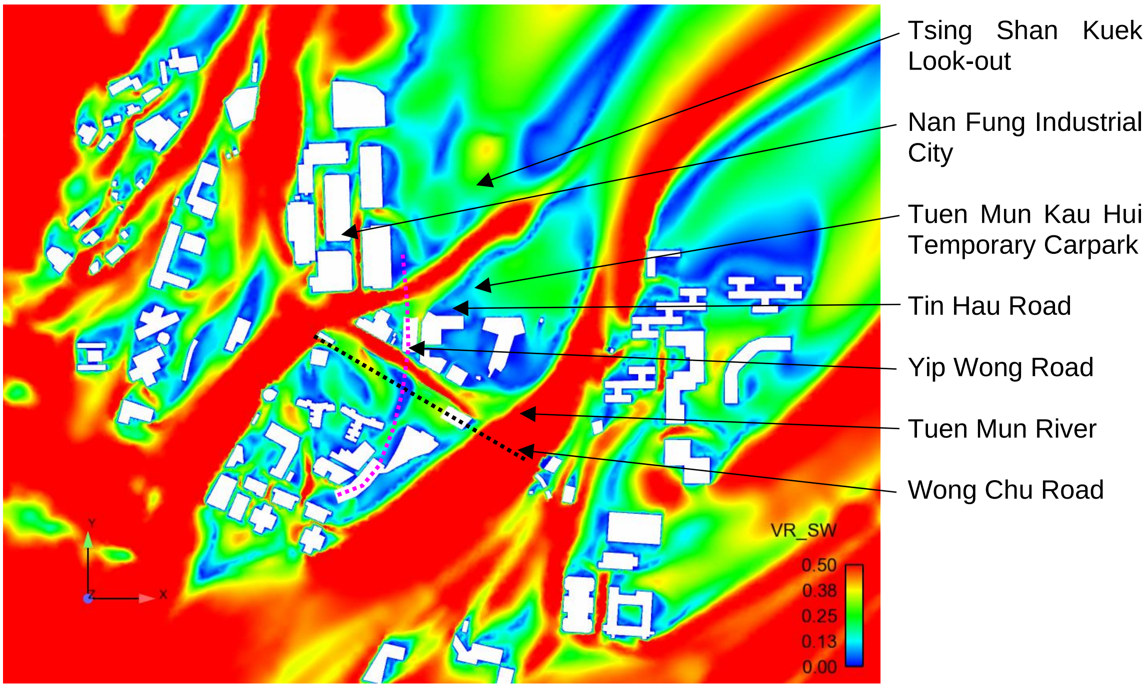
SW: (Summer: 9.7%)

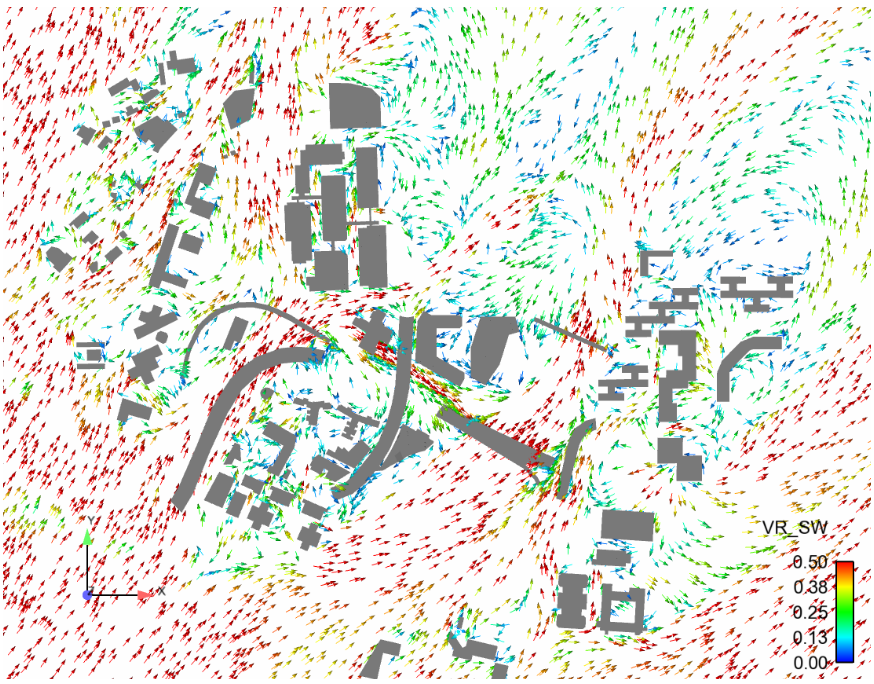
6.25 SW incoming wind would be weakened by high-rise residential clusters in the windward side. Incoming wind would adopt Lung Fu Road as major air path and reach the Project Area at the west.

6.26 In the Baseline Scheme, the incoming wind would be split by Block 4 flowing into Tin Hau Road and Wong Chu Road.

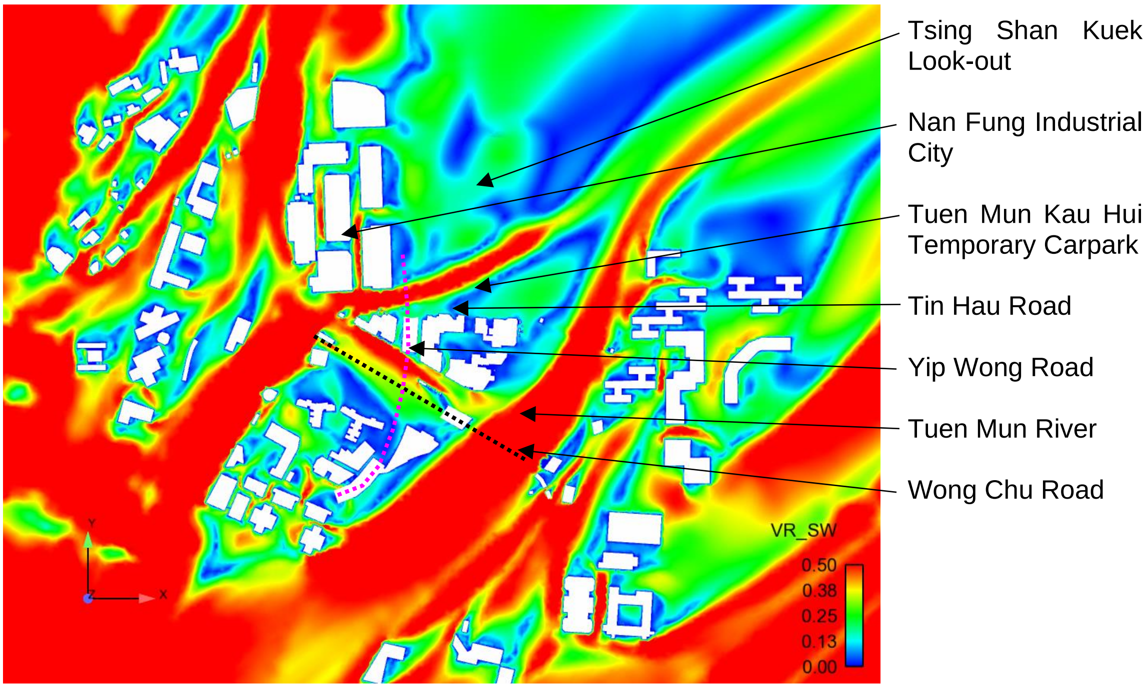
6.27 Similar VR was observed in the Proposed Scheme while there was slightly different air flow pattern at Wong Chu Road due to the morphology.

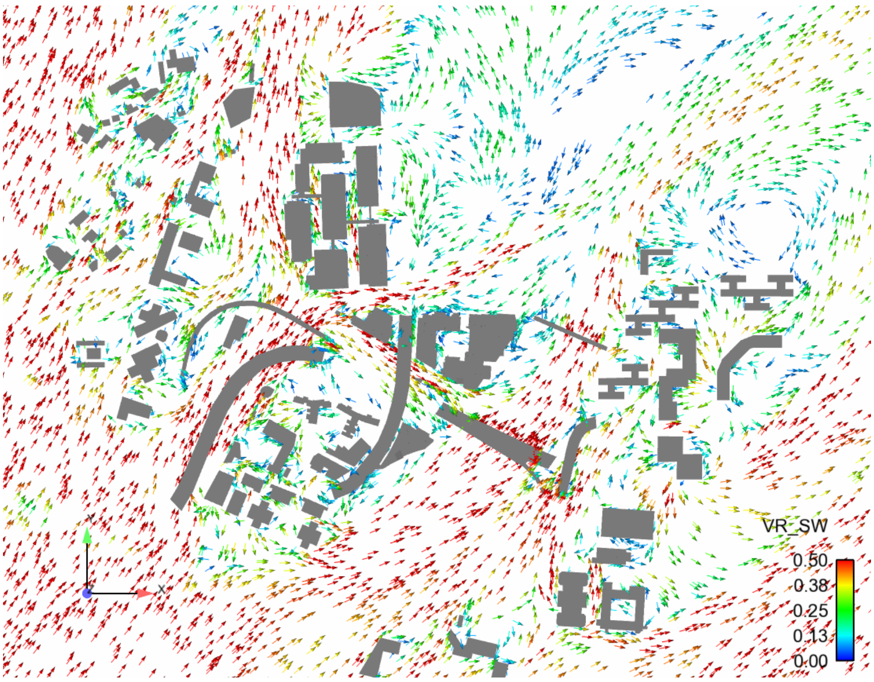
Baseline Scheme





Proposed Scheme



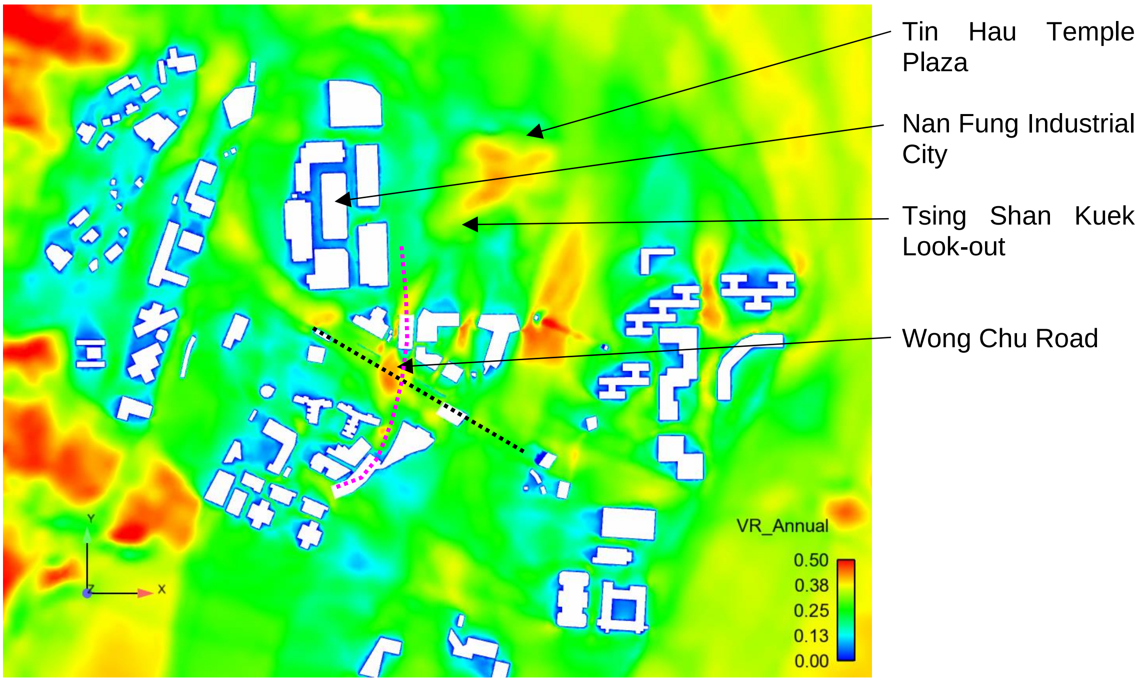


Overall Annual Frequency Weighted VR: (81.6%)

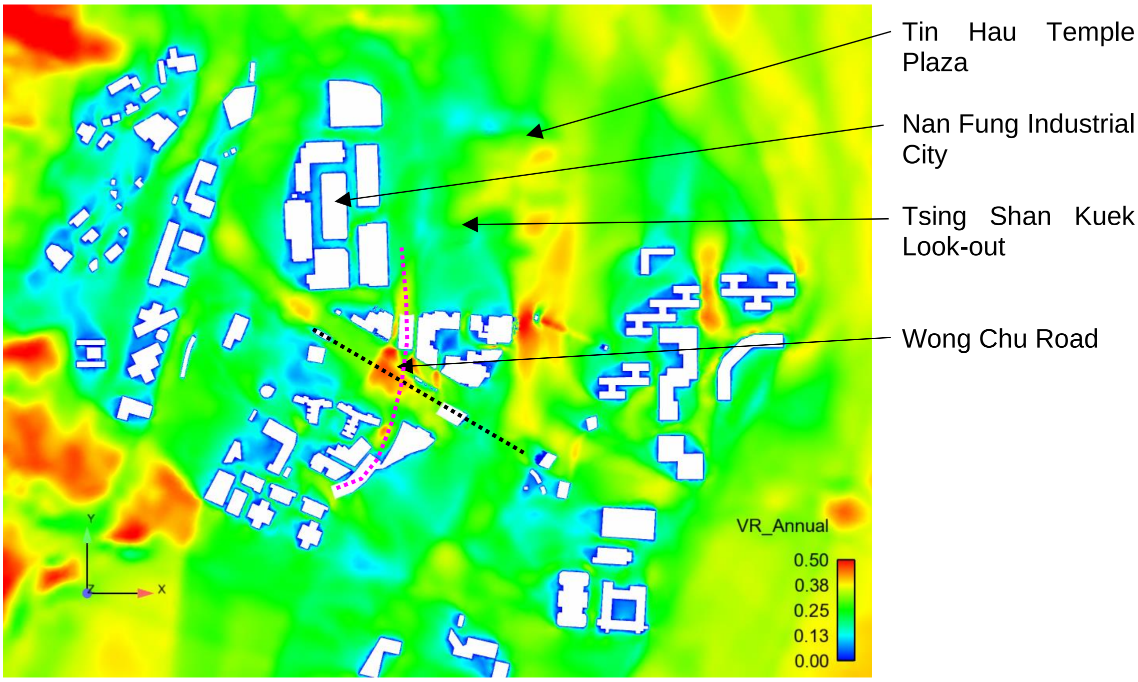
6.28 According to the overall annual frequency weighted VR plot, observable air ventilation enhancements and drawbacks were summarized as follow:

- The separated podium and domestic blocks disposition of the Baseline Scheme would allow more southern winds penetration to natural slopes of Tsing Shan Kuek Look-out and pedestrian level of Tin Hau Temple Plaza to the northeast and downstream, while the Proposed Scheme would divert more wind to Wong Chu Road at pedestrian level
- Domestic blocks of the Baseline Scheme aligned with Wong Chu Road would allow smooth easterly wind flow along Wong Chu Road, while the Proposed Scheme would allow more southeast penetration to Nan Fung Industrial City

Baseline Scheme



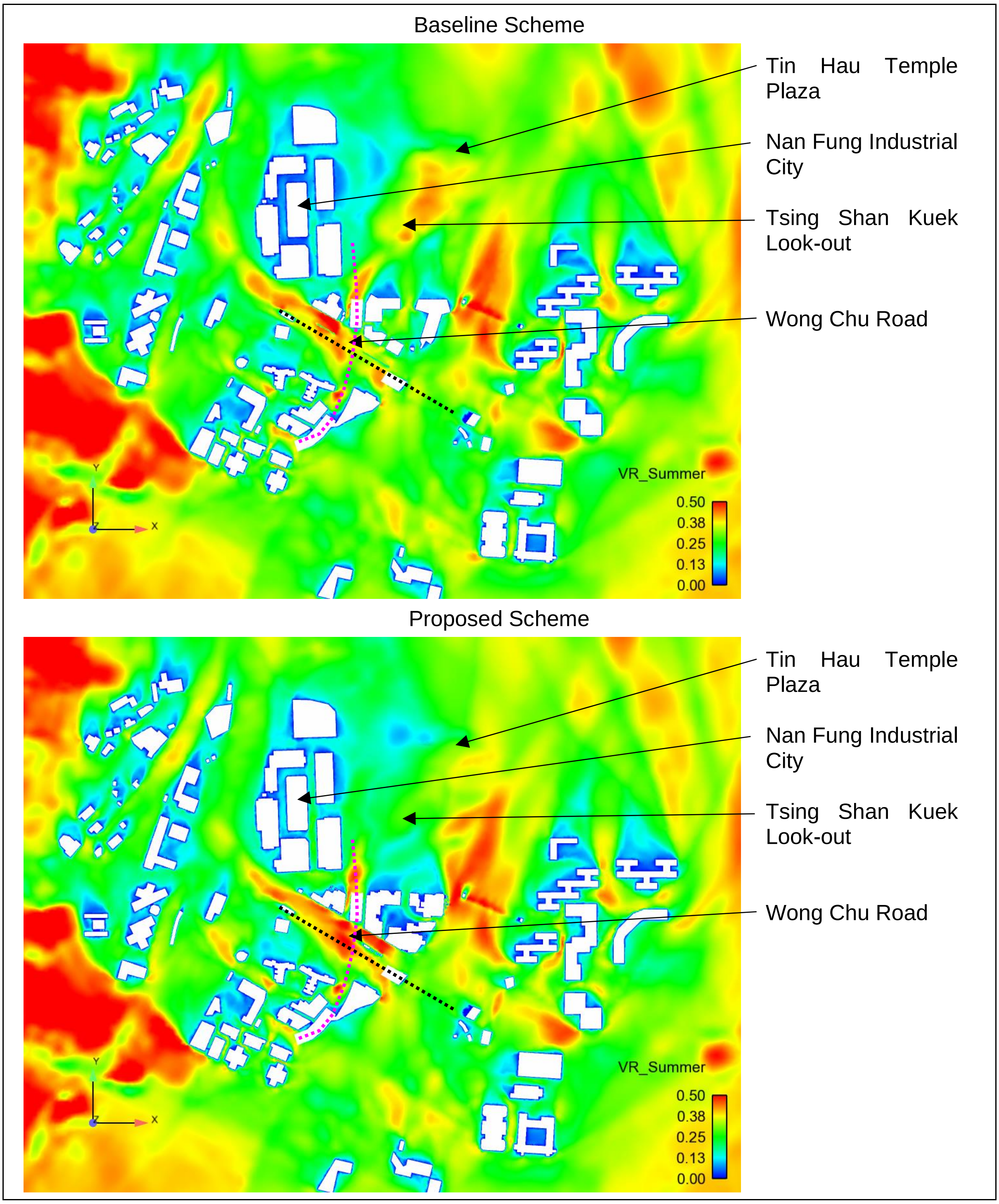
Proposed Scheme



Overall Summer Frequency Weighted VR: (81.7%)

6.29 According to the overall summer frequency weighted VR plot, observable air ventilation enhancements and drawbacks were summarized as follow:

- The separated podium and domestic blocks disposition of the Baseline Scheme would allow more southern winds penetration to natural slopes of Tsing Shan Kuek Look-out and pedestrian level of Tin Hau Temple Plaza to the northeast and downstream, while the Proposed Scheme would divert more wind to Wong Chu Road at pedestrian level
- Domestic blocks of the Baseline Scheme aligned with Wong Chu Road would allow smooth easterly wind flow along Wong Chu Road, while the Proposed Scheme would allow more southeast penetration to Nan Fung Industrial City



7 SUMMARY AND CONCLUSIONS

7.1 This AVA Study Report aimed at assessing the characteristics of the wind availability of the site, providing a general pattern and a quantitative estimate of wind performance at the pedestrian level under the annual and summer wind directions with the highest occurrence and investigating the effectiveness of ventilation for the scheme designs for the Proposed Public Housing Development at Yip Wong Road, namely the Baseline Scheme and the Proposed Scheme.

7.2 To mitigate the potential air ventilation impact on site perimeter of the Project Area, several good design features were considered in the Proposed Scheme, such as building setback, empty bays at grade and podium level, building gap and open space reserved, noise mitigation measures other than noise barrier as far as practicable to enhance wind environment in the immediate vicinity.

7.3 It was found that the separated podium and domestic blocks disposition of the Baseline Scheme would allow more southern winds penetration to natural slopes of Tsing Shan Kuek Look-out and pedestrian level of Tin Hau Temple Plaza to the northeast and downstream, while the Proposed Scheme would divert more wind to Wong Chu Road at pedestrian level. Domestic blocks of the Baseline Scheme aligned with Wong Chu Road would allow smooth easterly wind flow along Wong Chu Road, while the Proposed Scheme would allow more southeast penetration to Nan Fung Industrial City.

7.4 From the finding of this AVA Initial Study, the SVRw for both the Baseline Scheme and the Proposed Scheme increased from 0.247 to 0.256 under the annual prevailing wind from NNE, NE, E, ESE, SE, SSE, S and SSW directions accounted for about 81.6% of the whole year time, which indicated a slightly better air ventilation performance in the vicinity of the Proposed Scheme under annual prevailing winds. This was due to the fact that air permeability of podium such as semi-enclosed carpark and empty bays in the Proposed Scheme would allow prevailing wind to penetrate through the Project Area to ventilate the pedestrian level around podium.

7.5 The LVRw for the Baseline Scheme and the Proposed Scheme increased from 0.228 to 0.233 under the annual wind directions stated above as the disposition of domestic blocks in the Proposed Scheme would allow various wind directions penetration. It could be concluded that the Proposed Scheme would not impact the air ventilation performance compared to Baseline Scheme under the major annual winds.

7.6 From the finding of this AVA Initial Study, the SVRw for the Baseline Scheme and the Proposed Scheme also increase from 0.271 to 0.289 under the summer prevailing wind from E, ESE, SE, SSE, S, SSW and SW directions accounted for about 81.7% of the whole year time, which indicated a better wind environment during summer conditions.

7.7 The LVRw for the Baseline Scheme and the Proposed Scheme increased from 0.246 to 0.261 under summer wind conditions. It could be concluded that the Proposed Scheme would have a slightly better air ventilation performance compared to the Baseline Scheme.

7.8 In addition to the good design features identified, the followings are some general recommendations that would be adopted as far as practical in the detailed design stage of the Proposed Development to facilitate wind penetration:

- Building Permeability (refer to P in the PNAP APP-152 Sustainable Building Design Guideline);
- Building setback;
- Greenery of 30% of the gross site area with at least half of it at grade or at podium garden;
- Avoidance of long continuous facades;
- Reference could also be made to recommendations of design measures in the Hong Kong Planning Standards and Guidelines;
- Alternative approach (such as acoustic window and/ or acoustic balcony) in resolving noise exceedance to avoid use of any noise barriers for more effective air paths; and
- Terraced podium design to further mitigate the ventilation impact at site perimeter.

APPENDIX A

Wind Probability Table

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Tabulated Results – Percentage Occurrence of Directional Winds – Annual

d_00774	Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
V infinity (m/s)	Sum	0.054	0.186	0.055	0.031	0.081	0.138	0.152	0.114	0.054	0.035	0.033	0.012	0.013	0.007	0.013	0.021
00_to_01	0.045	0.002	0.003	0.003	0.003	0.008	0.003	0.003	0.003	0.002	0.002	0.001	0.001	0.004	0.002	0.002	0.002
01_to_02	0.094	0.005	0.008	0.007	0.007	0.014	0.009	0.008	0.009	0.007	0.004	0.002	0.002	0.003	0.002	0.002	0.003
02_to_03	0.111	0.005	0.009	0.009	0.006	0.015	0.012	0.013	0.015	0.009	0.005	0.003	0.002	0.002	0.001	0.002	0.003
03_to_04	0.112	0.006	0.012	0.009	0.004	0.013	0.014	0.016	0.015	0.008	0.004	0.003	0.002	0.002	0.001	0.002	0.003
04_to_05	0.115	0.007	0.016	0.009	0.003	0.010	0.017	0.019	0.014	0.007	0.004	0.003	0.001	0.001	0.001	0.002	0.002
05_to_06	0.119	0.007	0.021	0.007	0.002	0.007	0.018	0.022	0.017	0.005	0.004	0.004	0.001	0.000	0.000	0.001	0.002
06_to_07	0.111	0.006	0.023	0.005	0.002	0.005	0.019	0.021	0.014	0.005	0.003	0.004	0.001	0.000	0.000	0.001	0.002
07_to_08	0.096	0.004	0.022	0.003	0.001	0.003	0.016	0.020	0.012	0.004	0.003	0.004	0.001	0.000	0.000	0.001	0.001
08_to_09	0.071	0.004	0.021	0.001	0.001	0.002	0.012	0.014	0.007	0.003	0.002	0.003	0.000	0.000	0.000	0.000	0.000
09_to_10	0.047	0.003	0.015	0.001	0.000	0.002	0.008	0.008	0.003	0.001	0.001	0.002	0.000	0.000	0.000	0.000	0.001
10_to_11	0.032	0.002	0.014	0.001	0.000	0.001	0.005	0.005	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
11_to_12	0.019	0.001	0.010	0.000	0.000	0.001	0.003	0.002	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
12_to_13	0.012	0.001	0.006	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
13_to_14	0.007	0.000	0.004	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14_to_15	0.004	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15_to_16	0.002	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16_to_17	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17_to_18	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18_to_19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19_to_20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20_to_21	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21_to_22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22_to_23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23_to_24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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<u>Tabulated Results – Percentage Occurrence of Directional Winds – Summer</u>

d_00774	Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
V infinity (m/s)	Sum	0.017	0.019	0.016	0.019	0.052	0.085	0.164	0.215	0.112	0.092	0.097	0.030	0.030	0.014	0.022	0.015
00_to_01	0.044	0.002	0.002	0.002	0.002	0.007	0.003	0.003	0.004	0.003	0.003	0.002	0.001	0.005	0.002	0.002	0.002
01_to_02	0.094	0.003	0.003	0.002	0.002	0.006	0.007	0.011	0.015	0.012	0.008	0.006	0.004	0.006	0.004	0.003	0.002
02_to_03	0.118	0.002	0.003	0.002	0.002	0.006	0.009	0.019	0.026	0.014	0.010	0.007	0.005	0.005	0.002	0.004	0.003
03_to_04	0.117	0.002	0.003	0.002	0.002	0.006	0.008	0.019	0.026	0.016	0.010	0.008	0.005	0.004	0.001	0.003	0.003
04_to_05	0.120	0.002	0.002	0.002	0.002	0.005	0.008	0.021	0.027	0.016	0.012	0.009	0.004	0.004	0.001	0.003	0.002
05_to_06	0.119	0.001	0.002	0.001	0.002	0.004	0.009	0.021	0.033	0.013	0.012	0.012	0.003	0.002	0.001	0.002	0.001
06_to_07	0.109	0.001	0.001	0.001	0.002	0.003	0.011	0.016	0.029	0.012	0.010	0.014	0.002	0.001	0.001	0.002	0.001
07_to_08	0.096	0.001	0.001	0.001	0.001	0.003	0.009	0.016	0.026	0.011	0.008	0.013	0.002	0.001	0.001	0.001	0.000
08_to_09	0.068	0.001	0.000	0.001	0.001	0.003	0.007	0.012	0.015	0.007	0.005	0.011	0.001	0.001	0.001	0.001	0.000
09_to_10	0.043	0.000	0.001	0.001	0.000	0.002	0.005	0.009	0.006	0.004	0.004	0.007	0.001	0.000	0.000	0.001	0.000
10_to_11	0.028	0.000	0.000	0.000	0.001	0.002	0.003	0.007	0.004	0.002	0.004	0.003	0.001	0.000	0.000	0.000	0.000
11_to_12	0.017	0.000	0.000	0.000	0.000	0.001	0.002	0.003	0.002	0.001	0.003	0.002	0.001	0.000	0.000	0.000	0.000
12_to_13	0.010	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.001	0.002	0.000	0.000	0.000	0.000	0.000
13_to_14	0.007	0.000	0.000	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000
14_to_15	0.003	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15_to_16	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16_to_17	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17_to_18	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18_to_19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19_to_20	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20_to_21	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21_to_22	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22_to_23	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23_to_24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

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APPENDIX B

Velocity Ratio

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Wind Velocity Ratio – Baseline Scheme

	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	Annual	Summer
Annual	18.6%	5.5%	8.1%	13.8%	15.2%	11.4%	5.5%	3.5%		81.6%	
Summer			5.2%	8.5%	16.4%	21.5%	11.2%	9.2%	9.7%		81.7%
O1	0.41	0.33	0.19	0.14	0.06	0.08	0.29	0.08	0.08	0.21	0.12
O2	0.31	0.22	0.31	0.21	0.15	0.09	0.24	0.08	0.28	0.21	0.17
O3	0.28	0.16	0.30	0.14	0.19	0.17	0.17	0.10	0.07	0.20	0.16
O4	0.27	0.11	0.28	0.12	0.25	0.24	0.13	0.09	0.02	0.21	0.18
O5	0.16	0.29	0.17	0.22	0.46	0.52	0.11	0.19	0.62	0.29	0.37
O6	0.42	0.57	0.07	0.15	0.44	0.65	0.71	0.25	0.15	0.40	0.42
O7	0.46	0.57	0.03	0.41	0.53	0.61	0.50	0.47	0.14	0.45	0.45
O8	0.47	0.56	0.27	0.42	0.44	0.24	0.58	0.60	0.25	0.42	0.39
O9	0.40	0.48	0.32	0.17	0.31	0.54	0.66	0.80	0.18	0.40	0.44
O10	0.44	0.42	0.05	0.39	0.48	0.44	0.44	0.72	0.23	0.41	0.42
O11	0.44	0.34	0.09	0.25	0.15	0.11	0.13	0.09	0.19	0.23	0.14
O12	0.43	0.10	0.03	0.02	0.17	0.18	0.23	0.40	0.23	0.20	0.19
O13	0.03	0.15	0.21	0.12	0.23	0.11	0.18	0.55	0.08	0.15	0.19
O14	0.04	0.05	0.23	0.18	0.19	0.14	0.08	0.31	0.12	0.14	0.17
O15	0.09	0.10	0.30	0.09	0.04	0.09	0.16	0.53	0.23	0.13	0.17
O16	0.08	0.11	0.32	0.19	0.14	0.24	0.19	0.45	0.11	0.18	0.22
O17	0.07	0.07	0.31	0.13	0.11	0.36	0.44	0.69	0.11	0.21	0.30
O18	0.17	0.12	0.24	0.11	0.19	0.43	0.47	0.69	0.12	0.24	0.33
O19	0.26	0.41	0.17	0.15	0.17	0.18	0.46	0.78	0.19	0.25	0.28
O20	0.35	0.29	0.26	0.34	0.20	0.39	0.25	0.22	0.18	0.30	0.28
O21	0.31	0.21	0.34	0.40	0.56	0.52	0.49	0.50	0.25	0.42	0.47
O22	0.26	0.17	0.33	0.34	0.11	0.52	0.09	0.20	0.23	0.27	0.28
O23	0.30	0.18	0.37	0.40	0.50	0.47	0.35	0.05	0.23	0.37	0.37
O24	0.25	0.22	0.36	0.40	0.56	0.51	0.45	0.24	0.19	0.39	0.42
O25	0.26	0.23	0.33	0.39	0.55	0.51	0.42	0.15	0.13	0.38	0.40
O26	0.25	0.22	0.27	0.38	0.53	0.50	0.38	0.06	0.12	0.36	0.37
O27	0.05	0.37	0.43	0.36	0.28	0.28	0.47	0.22	0.64	0.27	0.36
O28	0.23	0.36	0.35	0.33	0.45	0.44	0.59	0.40	0.30	0.37	0.42
O29	0.11	0.25	0.20	0.06	0.11	0.01	0.02	0.12	0.54	0.10	0.12
O30	0.16	0.04	0.16	0.13	0.15	0.00	0.07	0.02	0.55	0.11	0.13
O31	0.23	0.23	0.23	0.15	0.15	0.01	0.06	0.16	0.63	0.16	0.17
O32	0.30	0.29	0.19	0.08	0.17	0.03	0.08	0.20	0.52	0.17	0.16
O33	0.06	0.08	0.05	0.07	0.18	0.02	0.02	0.22	0.32	0.08	0.12
O34	0.07	0.13	0.02	0.10	0.16	0.02	0.05	0.21	0.09	0.09	0.09
O35	0.14	0.08	0.04	0.03	0.04	0.02	0.03	0.04	0.16	0.06	0.05
O36	0.20	0.08	0.14	0.01	0.05	0.05	0.02	0.02	0.38	0.08	0.08
O37	0.23	0.12	0.10	0.06	0.06	0.01	0.02	0.04	0.45	0.09	0.09
O38	0.15	0.18	0.12	0.03	0.07	0.03	0.02	0.05	0.47	0.08	0.10
O39	0.17	0.21	0.26	0.06	0.01	0.01	0.03	0.05	0.08	0.10	0.05
O40	0.09	0.09	0.07	0.01	0.03	0.01	0.03	0.23	0.29	0.06	0.08
O41	0.34	0.38	0.06	0.06	0.10	0.04	0.25	0.45	0.44	0.18	0.18
O42	0.40	0.35	0.05	0.10	0.11	0.05	0.30	0.49	0.43	0.21	0.20
O43	0.41	0.33	0.04	0.08	0.11	0.06	0.30	0.46	0.38	0.20	0.19
O44	0.48	0.04	0.07	0.03	0.08	0.06	0.31	0.49	0.55	0.19	0.20
O45	0.51	0.34	0.04	0.05	0.11	0.09	0.26	0.33	0.40	0.22	0.17
O46	0.25	0.31	0.16	0.33	0.35	0.20	0.16	0.17	0.17	0.26	0.23
O47	0.10	0.21	0.32	0.18	0.26	0.16	0.07	0.20	0.11	0.18	0.18
O48	0.30	0.11	0.35	0.21	0.21	0.21	0.50	0.36	0.01	0.26	0.25
O49	0.11	0.20	0.29	0.27	0.42	0.16	0.12	0.13	0.18	0.23	0.22

O50	0.27	0.11	0.29	0.13	0.21	0.29	0.35	0.08	0.16	0.23	0.23
O51	0.26	0.09	0.27	0.06	0.14	0.08	0.15	0.11	0.22	0.15	0.13
O52	0.05	0.06	0.21	0.10	0.25	0.08	0.19	0.11	0.06	0.13	0.14
O53	0.15	0.13	0.17	0.09	0.19	0.14	0.20	0.05	0.19	0.15	0.15
O54	0.20	0.28	0.08	0.05	0.18	0.18	0.18	0.28	0.74	0.16	0.24
O55	0.23	0.30	0.07	0.05	0.16	0.53	0.57	0.27	0.54	0.24	0.35
O56	0.14	0.12	0.08	0.05	0.08	0.51	0.63	0.31	0.23	0.20	0.31
O57	0.18	0.12	0.13	0.17	0.22	0.56	0.60	0.37	0.39	0.27	0.39
O58	0.07	0.04	0.13	0.19	0.21	0.25	0.32	0.25	0.09	0.17	0.22
O59	0.08	0.06	0.09	0.25	0.26	0.45	0.45	0.17	0.22	0.22	0.31
O60	0.15	0.06	0.09	0.37	0.33	0.33	0.42	0.27	0.09	0.26	0.30
O61	0.09	0.05	0.13	0.37	0.36	0.33	0.33	0.54	0.08	0.26	0.32
O62	0.13	0.05	0.11	0.39	0.25	0.32	0.36	0.51	0.12	0.25	0.30
O63	0.15	0.04	0.30	0.11	0.17	0.34	0.22	0.07	0.13	0.18	0.21
O64	0.15	0.06	0.12	0.02	0.10	0.19	0.25	0.15	0.42	0.12	0.18
O65	0.21	0.34	0.02	0.03	0.16	0.40	0.34	0.53	0.62	0.21	0.32
O66	0.36	0.28	0.07	0.05	0.21	0.09	0.55	0.71	0.64	0.24	0.31
O67	0.19	0.21	0.10	0.04	0.19	0.10	0.34	0.59	0.33	0.17	0.23
O68	0.17	0.28	0.23	0.03	0.13	0.43	0.13	0.66	0.61	0.21	0.32
O69	0.25	0.37	0.23	0.08	0.09	0.11	0.18	0.65	0.51	0.19	0.23
O70	0.28	0.46	0.36	0.20	0.11	0.22	0.05	0.47	0.06	0.24	0.19
O71	0.27	0.48	0.30	0.15	0.23	0.24	0.11	0.35	0.02	0.25	0.20
O72	0.31	0.40	0.16	0.09	0.25	0.23	0.16	0.62	0.36	0.24	0.26
O73	0.46	0.33	0.10	0.10	0.13	0.21	0.17	0.38	0.22	0.23	0.19
O74	0.36	0.29	0.09	0.08	0.07	0.19	0.44	0.40	0.16	0.21	0.20
O75	0.04	0.05	0.28	0.20	0.04	0.02	0.41	0.35	0.19	0.13	0.17
O76	0.48	0.37	0.29	0.15	0.15	0.09	0.39	0.27	0.38	0.27	0.22
O77	0.45	0.32	0.21	0.11	0.10	0.13	0.42	0.07	0.11	0.23	0.16
O78	0.41	0.23	0.15	0.15	0.19	0.21	0.38	0.19	0.27	0.25	0.22
O79	0.51	0.37	0.15	0.14	0.31	0.23	0.27	0.28	0.28	0.30	0.25
O80	0.50	0.36	0.06	0.19	0.29	0.36	0.31	0.31	0.38	0.32	0.30
O81	0.49	0.42	0.10	0.12	0.08	0.42	0.37	0.39	0.41	0.28	0.29
O82	0.51	0.49	0.03	0.09	0.02	0.25	0.40	0.51	0.53	0.25	0.26
O83	0.50	0.52	0.15	0.14	0.03	0.08	0.37	0.53	0.55	0.25	0.23
O84	0.16	0.07	0.20	0.17	0.07	0.08	0.11	0.05	0.05	0.12	0.09
O85	0.29	0.35	0.04	0.04	0.14	0.17	0.09	0.07	0.27	0.16	0.13
O86	0.20	0.05	0.04	0.05	0.22	0.20	0.29	0.53	0.47	0.17	0.26
O87	0.15	0.08	0.05	0.06	0.17	0.22	0.35	0.52	0.46	0.16	0.26
O88	0.06	0.04	0.03	0.04	0.14	0.17	0.29	0.34	0.36	0.11	0.20
O89	0.43	0.45	0.18	0.07	0.17	0.32	0.19	0.42	0.51	0.27	0.27
O90	0.38	0.44	0.18	0.14	0.03	0.25	0.36	0.40	0.53	0.24	0.25
O91	0.31	0.41	0.20	0.17	0.03	0.11	0.46	0.37	0.56	0.22	0.24
O92	0.26	0.33	0.16	0.13	0.06	0.11	0.26	0.37	0.54	0.18	0.21
O93	0.30	0.36	0.15	0.28	0.47	0.26	0.37	0.27	0.51	0.32	0.34
O94	0.30	0.36	0.14	0.05	0.32	0.34	0.27	0.45	0.50	0.26	0.31
O95	0.28	0.33	0.10	0.08	0.34	0.42	0.30	0.48	0.39	0.27	0.33
O96	0.27	0.25	0.14	0.26	0.08	0.26	0.22	0.37	0.36	0.22	0.23
O97	0.23	0.17	0.24	0.39	0.26	0.12	0.14	0.40	0.55	0.25	0.27
O98	0.08	0.04	0.05	0.07	0.07	0.07	0.03	0.02	0.10	0.06	0.06
O99	0.33	0.04	0.21	0.32	0.34	0.28	0.29	0.35	0.52	0.29	0.33
O100	0.37	0.14	0.04	0.35	0.30	0.23	0.14	0.34	0.21	0.27	0.24
O101	0.37	0.48	0.24	0.36	0.07	0.17	0.08	0.45	0.56	0.26	0.24
O102	0.27	0.40	0.08	0.32	0.12	0.22	0.10	0.43	0.60	0.23	0.25
P1	0.09	0.09	0.16	0.26	0.44	0.53	0.12	0.17	0.24	0.26	0.33

P2	0.12	0.03	0.24	0.26	0.41	0.30	0.46	0.49	0.28	0.27	0.35
P3	0.15	0.07	0.32	0.30	0.28	0.20	0.35	0.34	0.34	0.24	0.29
P4	0.24	0.29	0.26	0.25	0.23	0.29	0.18	0.45	0.35	0.26	0.28
P5	0.22	0.26	0.22	0.13	0.26	0.25	0.26	0.50	0.23	0.23	0.27
P6	0.06	0.26	0.17	0.17	0.09	0.26	0.39	0.46	0.06	0.18	0.23
P7	0.27	0.34	0.25	0.14	0.17	0.20	0.44	0.47	0.02	0.24	0.23
P8	0.36	0.44	0.23	0.41	0.44	0.36	0.56	0.35	0.12	0.39	0.37
P9	0.30	0.35	0.14	0.15	0.13	0.28	0.13	0.16	0.13	0.21	0.18
P10	0.18	0.18	0.25	0.21	0.07	0.04	0.08	0.10	0.15	0.14	0.10
P11	0.29	0.36	0.40	0.46	0.33	0.21	0.11	0.07	0.12	0.31	0.23
P12	0.22	0.10	0.20	0.01	0.10	0.07	0.12	0.15	0.08	0.12	0.10
P13	0.22	0.21	0.25	0.04	0.02	0.08	0.04	0.07	0.05	0.12	0.06
P14	0.25	0.45	0.40	0.16	0.39	0.50	0.57	0.23	0.31	0.34	0.39
P15	0.15	0.30	0.22	0.17	0.25	0.25	0.13	0.06	0.18	0.20	0.19
P16	0.35	0.22	0.47	0.03	0.10	0.04	0.17	0.07	0.53	0.18	0.16
P17	0.40	0.36	0.44	0.08	0.10	0.08	0.13	0.07	0.60	0.21	0.17
P18	0.29	0.49	0.46	0.11	0.21	0.10	0.04	0.28	0.59	0.23	0.22
P19	0.15	0.42	0.41	0.09	0.23	0.30	0.25	0.27	0.38	0.23	0.27
P20	0.03	0.05	0.03	0.08	0.06	0.04	0.06	0.12	0.45	0.05	0.11
P21	0.11	0.17	0.07	0.08	0.14	0.05	0.06	0.36	0.36	0.11	0.15
P22	0.31	0.43	0.04	0.05	0.05	0.18	0.39	0.46	0.42	0.19	0.22
P23	0.24	0.40	0.03	0.24	0.25	0.40	0.34	0.45	0.23	0.27	0.31
P24	0.21	0.35	0.20	0.31	0.41	0.42	0.30	0.61	0.32	0.32	0.39
P25	0.12	0.24	0.44	0.34	0.44	0.47	0.27	0.39	0.56	0.33	0.42
P26	0.23	0.39	0.47	0.34	0.44	0.54	0.14	0.23	0.64	0.36	0.41
P27	0.29	0.22	0.17	0.34	0.46	0.59	0.08	0.37	0.39	0.34	0.39
P28	0.12	0.06	0.03	0.35	0.47	0.60	0.09	0.21	0.27	0.28	0.36
P29	0.03	0.04	0.13	0.41	0.55	0.67	0.18	0.17	0.44	0.31	0.43
P30	0.13	0.11	0.18	0.31	0.44	0.59	0.31	0.47	0.21	0.31	0.41
P31	0.43	0.45	0.15	0.28	0.48	0.61	0.31	0.23	0.02	0.40	0.37

Wind Velocity Ratio – Proposed Scheme

	NNE	NE	E	ESE	SE	SSE	S	SSW	SW	Annual	Summer
Annual	18.6%	5.5%	8.1%	13.8%	15.2%	11.4%	5.5%	3.5%		81.6%	
Summer			5.2%	8.5%	16.4%	21.5%	11.2%	9.2%	9.7%		81.7%
O1	0.40	0.34	0.17	0.08	0.10	0.16	0.44	0.03	0.04	0.22	0.15
O2	0.29	0.23	0.31	0.10	0.18	0.31	0.49	0.05	0.10	0.24	0.23
O3	0.25	0.19	0.31	0.11	0.06	0.30	0.54	0.07	0.04	0.21	0.21
O4	0.11	0.14	0.31	0.13	0.32	0.31	0.59	0.34	0.11	0.24	0.31
O5	0.36	0.24	0.21	0.09	0.46	0.32	0.61	0.68	0.57	0.33	0.43
O6	0.52	0.55	0.36	0.28	0.43	0.49	0.50	0.71	0.54	0.45	0.48
O7	0.46	0.51	0.27	0.31	0.31	0.54	0.54	0.60	0.35	0.41	0.44
O8	0.47	0.40	0.20	0.43	0.44	0.26	0.57	0.66	0.18	0.41	0.39
O9	0.38	0.34	0.23	0.16	0.32	0.54	0.67	0.80	0.10	0.37	0.43
O10	0.44	0.42	0.19	0.36	0.48	0.49	0.46	0.72	0.08	0.43	0.43
O11	0.46	0.25	0.11	0.23	0.17	0.11	0.15	0.10	0.08	0.23	0.13
O12	0.41	0.19	0.10	0.13	0.19	0.16	0.22	0.41	0.19	0.23	0.20
O13	0.03	0.11	0.15	0.18	0.23	0.13	0.19	0.52	0.14	0.15	0.21
O14	0.04	0.08	0.15	0.19	0.18	0.15	0.09	0.23	0.10	0.13	0.15
O15	0.11	0.06	0.23	0.15	0.05	0.07	0.17	0.54	0.23	0.13	0.17
O16	0.10	0.05	0.23	0.19	0.15	0.22	0.20	0.43	0.17	0.17	0.22
O17	0.12	0.02	0.25	0.18	0.10	0.37	0.46	0.75	0.19	0.22	0.32
O18	0.24	0.12	0.22	0.17	0.21	0.41	0.45	0.73	0.29	0.27	0.36
O19	0.07	0.23	0.14	0.23	0.21	0.26	0.33	0.70	0.29	0.21	0.30
O20	0.33	0.31	0.26	0.17	0.25	0.44	0.20	0.28	0.10	0.29	0.27
O21	0.25	0.25	0.32	0.37	0.42	0.49	0.61	0.62	0.20	0.38	0.45
O22	0.21	0.20	0.33	0.31	0.59	0.52	0.67	0.09	0.23	0.38	0.44
O23	0.23	0.21	0.36	0.33	0.49	0.46	0.69	0.58	0.22	0.39	0.46
O24	0.25	0.25	0.37	0.38	0.44	0.51	0.68	0.66	0.16	0.40	0.47
O25	0.26	0.26	0.33	0.34	0.46	0.53	0.68	0.62	0.04	0.40	0.46
O26	0.26	0.25	0.28	0.28	0.50	0.51	0.66	0.44	0.23	0.38	0.45
O27	0.11	0.40	0.45	0.27	0.47	0.36	0.08	0.21	0.09	0.29	0.29
O28	0.30	0.38	0.36	0.28	0.50	0.31	0.16	0.37	0.02	0.34	0.30
O29	0.22	0.24	0.23	0.06	0.07	0.25	0.18	0.09	0.46	0.16	0.19
O30	0.09	0.10	0.12	0.15	0.15	0.39	0.21	0.10	0.55	0.17	0.26
O31	0.23	0.17	0.19	0.13	0.08	0.31	0.24	0.12	0.60	0.18	0.24
O32	0.30	0.29	0.15	0.11	0.11	0.32	0.27	0.19	0.51	0.21	0.25
O33	0.08	0.09	0.05	0.03	0.07	0.27	0.27	0.22	0.29	0.11	0.19
O34	0.10	0.13	0.05	0.09	0.13	0.23	0.26	0.22	0.05	0.13	0.16
O35	0.18	0.03	0.18	0.14	0.10	0.10	0.03	0.07	0.18	0.12	0.11
O36	0.19	0.12	0.10	0.03	0.04	0.04	0.14	0.02	0.42	0.09	0.10
O37	0.20	0.14	0.17	0.04	0.11	0.05	0.11	0.02	0.47	0.11	0.12
O38	0.14	0.17	0.16	0.07	0.13	0.08	0.03	0.05	0.49	0.11	0.13
O39	0.18	0.21	0.13	0.12	0.10	0.10	0.02	0.06	0.11	0.13	0.09
O40	0.20	0.18	0.07	0.05	0.03	0.08	0.12	0.31	0.39	0.11	0.13
O41	0.32	0.34	0.06	0.04	0.08	0.03	0.21	0.43	0.49	0.16	0.17
O42	0.34	0.34	0.07	0.04	0.10	0.03	0.25	0.49	0.44	0.18	0.18
O43	0.28	0.18	0.09	0.02	0.11	0.07	0.20	0.46	0.39	0.15	0.17
O44	0.35	0.08	0.03	0.03	0.10	0.08	0.21	0.50	0.54	0.16	0.20
O45	0.50	0.31	0.04	0.06	0.12	0.16	0.13	0.34	0.40	0.22	0.18
O46	0.28	0.21	0.11	0.32	0.38	0.37	0.24	0.07	0.08	0.28	0.26
O47	0.16	0.24	0.27	0.22	0.29	0.23	0.08	0.07	0.13	0.21	0.19
O48	0.21	0.35	0.28	0.22	0.21	0.19	0.38	0.59	0.16	0.25	0.27
O49	0.22	0.24	0.19	0.25	0.40	0.33	0.20	0.12	0.03	0.27	0.25

O50	0.14	0.27	0.36	0.17	0.18	0.29	0.37	0.12	0.05	0.22	0.22
O51	0.10	0.22	0.26	0.06	0.15	0.17	0.16	0.07	0.18	0.14	0.15
O52	0.02	0.04	0.24	0.07	0.24	0.09	0.16	0.06	0.08	0.11	0.13
O53	0.04	0.18	0.11	0.10	0.18	0.16	0.22	0.03	0.24	0.12	0.16
O54	0.12	0.22	0.13	0.05	0.18	0.33	0.06	0.32	0.76	0.16	0.27
O55	0.23	0.15	0.03	0.05	0.16	0.60	0.59	0.27	0.61	0.24	0.38
O56	0.07	0.18	0.06	0.08	0.11	0.55	0.61	0.26	0.19	0.20	0.31
O57	0.19	0.03	0.09	0.22	0.26	0.59	0.60	0.37	0.34	0.28	0.40
O58	0.07	0.10	0.13	0.21	0.21	0.30	0.34	0.24	0.19	0.18	0.25
O59	0.14	0.05	0.07	0.24	0.25	0.43	0.46	0.17	0.19	0.23	0.30
O60	0.04	0.07	0.07	0.38	0.29	0.33	0.40	0.25	0.08	0.22	0.28
O61	0.06	0.09	0.12	0.37	0.34	0.32	0.31	0.51	0.07	0.24	0.31
O62	0.11	0.07	0.18	0.40	0.24	0.35	0.33	0.51	0.04	0.25	0.30
O63	0.03	0.06	0.21	0.12	0.11	0.27	0.15	0.09	0.35	0.12	0.19
O64	0.08	0.07	0.19	0.06	0.10	0.08	0.18	0.06	0.53	0.10	0.16
O65	0.24	0.32	0.12	0.04	0.16	0.55	0.56	0.56	0.63	0.26	0.40
O66	0.37	0.29	0.11	0.02	0.21	0.12	0.48	0.70	0.66	0.24	0.31
O67	0.18	0.23	0.16	0.05	0.18	0.43	0.46	0.57	0.45	0.23	0.35
O68	0.19	0.29	0.13	0.05	0.14	0.46	0.12	0.67	0.59	0.21	0.32
O69	0.24	0.35	0.19	0.09	0.06	0.25	0.08	0.66	0.54	0.19	0.25
O70	0.28	0.39	0.35	0.11	0.07	0.23	0.27	0.47	0.15	0.23	0.22
O71	0.28	0.43	0.04	0.09	0.13	0.14	0.18	0.34	0.04	0.18	0.14
O72	0.32	0.40	0.12	0.03	0.17	0.12	0.17	0.62	0.41	0.20	0.22
O73	0.46	0.33	0.11	0.09	0.12	0.20	0.11	0.32	0.21	0.23	0.17
O74	0.37	0.32	0.10	0.05	0.09	0.23	0.42	0.41	0.11	0.22	0.21
O75	0.04	0.07	0.12	0.15	0.09	0.04	0.38	0.42	0.19	0.12	0.17
O76	0.48	0.39	0.21	0.06	0.14	0.15	0.34	0.33	0.35	0.25	0.21
O77	0.45	0.33	0.10	0.14	0.09	0.07	0.40	0.07	0.10	0.21	0.13
O78	0.33	0.23	0.06	0.07	0.27	0.13	0.32	0.12	0.28	0.20	0.19
O79	0.43	0.33	0.13	0.15	0.31	0.18	0.16	0.23	0.29	0.26	0.22
O80	0.49	0.35	0.12	0.18	0.24	0.24	0.19	0.17	0.39	0.28	0.23
O81	0.49	0.41	0.08	0.17	0.14	0.25	0.22	0.22	0.41	0.26	0.22
O82	0.51	0.48	0.05	0.18	0.11	0.28	0.24	0.40	0.52	0.27	0.25
O83	0.50	0.51	0.20	0.15	0.12	0.29	0.22	0.44	0.55	0.29	0.28
O84	0.18	0.06	0.11	0.08	0.12	0.08	0.10	0.05	0.04	0.11	0.08
O85	0.29	0.32	0.08	0.08	0.09	0.12	0.08	0.05	0.28	0.15	0.11
O86	0.22	0.05	0.09	0.06	0.21	0.19	0.24	0.54	0.48	0.18	0.25
O87	0.17	0.08	0.05	0.05	0.17	0.26	0.30	0.53	0.49	0.17	0.27
O88	0.12	0.06	0.01	0.02	0.18	0.28	0.31	0.44	0.54	0.15	0.27
O89	0.48	0.36	0.23	0.09	0.19	0.34	0.23	0.51	0.51	0.29	0.30
O90	0.46	0.35	0.25	0.09	0.05	0.22	0.38	0.49	0.48	0.25	0.26
O91	0.41	0.33	0.30	0.10	0.08	0.09	0.45	0.44	0.47	0.24	0.24
O92	0.30	0.29	0.27	0.11	0.04	0.09	0.28	0.31	0.40	0.18	0.18
O93	0.30	0.36	0.20	0.51	0.47	0.27	0.32	0.23	0.46	0.35	0.35
O94	0.30	0.34	0.21	0.02	0.32	0.33	0.34	0.43	0.50	0.26	0.32
O95	0.28	0.29	0.17	0.10	0.37	0.42	0.32	0.50	0.45	0.29	0.36
O96	0.28	0.22	0.22	0.12	0.08	0.21	0.33	0.38	0.37	0.20	0.23
O97	0.20	0.16	0.28	0.07	0.27	0.13	0.09	0.43	0.48	0.19	0.23
O98	0.14	0.03	0.07	0.04	0.09	0.07	0.12	0.05	0.09	0.08	0.08
O99	0.33	0.06	0.22	0.15	0.36	0.28	0.14	0.34	0.34	0.26	0.27
O100	0.38	0.13	0.05	0.03	0.31	0.24	0.19	0.34	0.08	0.22	0.20
O101	0.36	0.48	0.19	0.08	0.02	0.19	0.08	0.44	0.52	0.20	0.20
O102	0.26	0.39	0.07	0.11	0.19	0.24	0.20	0.43	0.45	0.21	0.25
P1	0.23	0.06	0.08	0.43	0.44	0.53	0.29	0.16	0.39	0.32	0.38

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P2	0.12	0.09	0.15	0.43	0.43	0.34	0.36	0.18	0.05	0.28	0.31
P3	0.07	0.01	0.14	0.36	0.33	0.32	0.09	0.56	0.35	0.23	0.31
P4	0.13	0.16	0.09	0.35	0.28	0.27	0.08	0.42	0.35	0.22	0.27
P5	0.03	0.15	0.16	0.11	0.17	0.23	0.39	0.59	0.24	0.17	0.27
P6	0.04	0.12	0.23	0.22	0.22	0.33	0.58	0.76	0.03	0.24	0.34
P7	0.25	0.27	0.36	0.32	0.27	0.33	0.52	0.73	0.06	0.33	0.36
P8	0.51	0.53	0.29	0.41	0.45	0.43	0.63	0.76	0.11	0.47	0.45
P9	0.41	0.40	0.22	0.42	0.51	0.49	0.58	0.14	0.16	0.42	0.40
P10	0.10	0.09	0.25	0.10	0.06	0.11	0.01	0.11	0.17	0.10	0.10
P11	0.22	0.24	0.32	0.06	0.12	0.09	0.01	0.21	0.15	0.15	0.12
P12	0.17	0.16	0.31	0.05	0.04	0.05	0.03	0.24	0.14	0.11	0.09
P13	0.31	0.31	0.36	0.08	0.02	0.04	0.03	0.15	0.17	0.16	0.09
P14	0.36	0.32	0.29	0.07	0.25	0.27	0.60	0.67	0.15	0.30	0.32
P15	0.37	0.26	0.15	0.05	0.10	0.32	0.19	0.14	0.40	0.21	0.21
P16	0.23	0.28	0.29	0.07	0.06	0.26	0.20	0.09	0.57	0.18	0.21
P17	0.06	0.11	0.33	0.05	0.08	0.25	0.20	0.08	0.64	0.13	0.22
P18	0.39	0.49	0.43	0.06	0.10	0.37	0.06	0.08	0.55	0.25	0.23
P19	0.43	0.42	0.41	0.12	0.23	0.28	0.09	0.19	0.33	0.28	0.23
P20	0.07	0.08	0.04	0.01	0.05	0.04	0.09	0.29	0.43	0.06	0.12
P21	0.12	0.10	0.04	0.03	0.08	0.09	0.15	0.35	0.37	0.10	0.15
P22	0.32	0.38	0.07	0.02	0.03	0.16	0.21	0.43	0.42	0.17	0.18
P23	0.26	0.36	0.09	0.13	0.30	0.36	0.17	0.43	0.22	0.25	0.27
P24	0.21	0.30	0.04	0.31	0.47	0.37	0.14	0.62	0.38	0.30	0.36
P25	0.33	0.27	0.43	0.40	0.48	0.46	0.05	0.47	0.55	0.38	0.41
P26	0.30	0.42	0.40	0.41	0.45	0.54	0.38	0.27	0.61	0.40	0.45
P27	0.04	0.11	0.13	0.41	0.44	0.49	0.51	0.10	0.34	0.29	0.39
P28	0.11	0.05	0.05	0.43	0.46	0.59	0.36	0.05	0.34	0.30	0.39
P29	0.04	0.05	0.12	0.45	0.48	0.62	0.17	0.07	0.37	0.29	0.39
P30	0.40	0.45	0.36	0.44	0.44	0.60	0.28	0.33	0.38	0.43	0.44
P31	0.34	0.46	0.10	0.46	0.46	0.62	0.45	0.71	0.39	0.43	0.50
S1	0.13	0.03	0.09	0.41	0.42	0.28	0.21	0.31	0.30	0.25	0.31
S2	0.12	0.11	0.07	0.48	0.53	0.47	0.47	0.61	0.39	0.35	0.46
S3	0.07	0.10	0.05	0.50	0.54	0.56	0.39	0.39	0.48	0.33	0.46
S4	0.10	0.12	0.11	0.46	0.46	0.48	0.36	0.25	0.62	0.31	0.43
S5	0.46	0.53	0.43	0.50	0.48	0.50	0.42	0.68	0.59	0.48	0.51
S6	0.02	0.03	0.06	0.45	0.42	0.49	0.50	0.19	0.60	0.28	0.42
S7	0.02	0.03	0.03	0.36	0.49	0.56	0.56	0.12	0.52	0.28	0.44
S8	0.06	0.10	0.17	0.32	0.51	0.49	0.43	0.16	0.44	0.29	0.41
S9	0.28	0.42	0.40	0.31	0.46	0.41	0.12	0.13	0.42	0.34	0.34
S10	0.31	0.26	0.34	0.28	0.46	0.33	0.08	0.34	0.34	0.32	0.32
S11	0.19	0.28	0.03	0.11	0.26	0.10	0.18	0.51	0.36	0.18	0.22
S12	0.30	0.36	0.07	0.02	0.10	0.23	0.20	0.46	0.37	0.19	0.21
S13	0.41	0.45	0.35	0.12	0.14	0.15	0.19	0.34	0.21	0.25	0.19
S14	0.42	0.44	0.39	0.11	0.13	0.20	0.52	0.40	0.13	0.29	0.25
S15	0.54	0.57	0.45	0.09	0.16	0.14	0.20	0.49	0.13	0.31	0.20
S16	0.28	0.28	0.19	0.18	0.53	0.54	0.61	0.56	0.14	0.37	0.44
S17	0.09	0.03	0.04	0.46	0.56	0.56	0.65	0.21	0.29	0.34	0.46
S18	0.29	0.06	0.20	0.12	0.17	0.11	0.47	0.27	0.44	0.20	0.24
S19	0.59	0.55	0.07	0.21	0.21	0.38	0.39	0.13	0.38	0.34	0.28
S20	0.08	0.16	0.04	0.04	0.08	0.05	0.34	0.18	0.24	0.09	0.13
S21	0.20	0.12	0.29	0.30	0.19	0.21	0.06	0.20	0.07	0.21	0.18
S22	0.46	0.54	0.33	0.05	0.32	0.04	0.19	0.15	0.43	0.26	0.19
S23	0.60	0.61	0.32	0.06	0.07	0.32	0.12	0.12	0.11	0.29	0.17
S24	0.08	0.07	0.31	0.22	0.34	0.35	0.40	0.41	0.06	0.25	0.31

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S25	0.18	0.04	0.30	0.32	0.20	0.39	0.35	0.16	0.39	0.25	0.31
S26	0.56	0.59	0.05	0.26	0.33	0.32	0.23	0.06	0.19	0.34	0.24