Hong Kong Housing Authority

CB20170587

Consultancy for Environmental Design Studies for Public Housing Development at Chiu Shun Road, Tseung Kwan O

Air Ventilation Assessment – Initial Study (AVA-IS)

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	Name	Signature
Prepared:	Tsang Hon Wai	
Checked:	Elaine Ma	
Reviewed & Approved:	YT Tang	

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AECOM Asia Co. Ltd.
13/F, Grand Central Plaza, Tower 2, 138 Shatin Rural Committee Road, Shatin, NT, Hong Kong
Tel: (852) 3922 9000 Fax: (852) 3922 9797 www.aecom.com

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EXECUTIVE SUMMARY

In pursuit of the policy of "Enhancement of the Development Intensity of Public Housing Site" to allow the increase of domestic plot ratio for public housing sites by up to 30% where their technical feasibility permits, Air Ventilation Assessment (AVA) Study – Initial Study (IS) has been undertaken in support of this Section 16 planning application to examine the air ventilation impact of the proposed building design quantitatively for the proposed Public Housing Development located at Chiu Shun Road, Tseung Kwan O.

The assessment was conducted by using Computational Fluid Dynamics (CFD). A 3-dimensional CFD model was constructed to include major topographical features and building morphology according to GIS information obtained from Lands Department. A series of CFD simulations using realizable k- ε turbulence model were performed based on the Air Ventilation Assessment (AVA) methodology for the Initial Study as stipulated in Technical Circular No. 1/06 and recommendation suggested in COST action C14, the simulation models for Baseline and Proposed Scheme were prepared.

The annual and summer prevailing winds were studied. According to the RAMS wind data, NNE, NE, ENE, E, ESE, SE, SSW and SW winds were identified as the annual prevailing wind directions while E, ESE, SE, SSE, S, SSW, SW, WSW winds are identified as the summer prevailing wind directions, contributing up to 78.1% and 80.7% of total occurrence respectively. The ventilation performance for the Proposed Development at the Project Area and all focus areas within the assessment area were assessed and summarized below:

- The annual weighted Site Spatial Average Velocity Ratio (SVRw) for the Baseline Scheme and the Proposed Scheme is reduced from 0.36 to 0.34 Thus, a slight impact on air ventilation performance is observed in the vicinity of the Proposed Scheme under annual prevailing winds. This shows the additional podium floor in Proposed Scheme has slightly impacted the ventilation performance of the site boundary. Good design features mentioned in Section 6 have slightly improved the ventilation performance of the site boundary in the Proposed and Optional Schemes when compared with the Baseline Scheme. The summer weighted Site Spatial Average Velocity Ratio (SVRw) for both the Baseline Scheme and Proposed Scheme are 0.33 and 0.32 respectively, which implies a slight impact on the wind environment of the Proposed Scheme when compared to the original Baseline Scheme considered by Town Planning Board.

- The annual weighted Local Spatial Average Velocity Ratio (LVRw) for the Baseline Scheme and Proposed Scheme are reduced from 0.33 to 0.32. This shows a slight air ventilation impact of the local area. As for summer LVRw maintained at 0.30 and 0.29 respectively, the Proposed Scheme would be slightly worse than the Baseline Scheme from an air ventilation perspective under summer condition.

- Comparing the Baseline and Proposed Schemes, the ventilation performance is slightly impacted due to the additional podium floor for annual wind condition. However, there is no adverse impact on the ventilation performance is observed under summer wind condition.

All improvements and mitigation measures should consider the following design principles at the detailed design stage:

- Building permeability equivalent to 20% to 33.3% with reference to PNAP APP-152;
- Building setback with reference to PNAP APP-152;
- Greenery (preferably tree planting) of no less than 20% for sites below 1 ha, preferably at grade;
- 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 issue to eliminate the use of noise barriers for more effective air paths; and
- Terraced podium design to further mitigate the ventilation impact at site perimeter.

行政摘要

為推行“提升公營房屋用地的發展密度”的政策，在技術可行的情況下，政府可提升公營房屋用地的住宅地積比率至增加最多 30%，當局已進行空氣流通評估（AVA）定量研究 – 初步研究（IS）為將軍澳昭信路擬建的公屋發展評估空氣通風的影響，並以第 16 條提出規劃許可申請以得到城市規劃委員會的批准。

評估使用計算流體力學（CFD）進行。根據地政總署取得的地理資料，建造了一個三維 CFD 模型包括主要的地形特徵和建築形態。根據第 1/06 號技術通告規定的空氣流通評估初步研究的方法和 COST Action C14 中的建議，對基準方案和擬議方案進行了一系列的 CFD 電腦模擬。

根據 RAMS 風向資料，全年盛行風包括東北偏北、東北、東北偏東、東、東南偏東、東南、西南偏南和西南風，而夏季盛行風包括東、東南偏東、東南、東南偏南、西南偏南、西南、西南偏西風，分別占總發生率的 78.1%和 80.7%。對地盤擬議發展和評估區內重點區域的通風表現評估概述如下：

- 基準方案和擬議方案的全年地盤平均速度比率（SVRw）由 0.36 減至 0.34。由此可見，在全年盛行風向下，擬議方案中的兩層高平台對地盤邊界的通風表現有輕微影響。第 6 節提及的良好設計功能，較基線計畫略微改善建議及可選方案內地盤邊界的通風性能。基準方案和擬議方案的夏季地盤平均速度比率分別為 0.33 及 0.32。因此，與城市規劃委員會考慮的原基準方案比較，擬議方案對周邊的風環境有輕微的影響。

- 基準方案和擬議方案的全年地區平均速度比率（LVRw）從 0.34 降至 0.33。這表明局部地區對通風表現有輕微的影響。至於夏季的 LVRw，兩個方案分別維持在 0.30 及 0.29，從夏季通風表現的角度來看，擬議方案有輕微的影響。

- 比較基準方案和擬議方案，由於額外的平台層，擬議方案的全年及夏季通風表現將會受到輕微影響。

所有改進和緩解措施在詳細設計階段都應考慮以下設計原則：

- 參考 PNAP APP-152，提供建築物滲透率相當於 20%至 33.3%；
- 參照 PNAP APP-152，提供建築物的後移地帶；
- 1 公頃以下的地盤則需提供不低於 20%綠化覆蓋率，並於地面種植樹木為佳；
- 避免過長的建築物；
- 參考“香港規劃標準與準則”中有關的良好通風設計措施的建議；
- 以隔音窗和/或隔音陽臺解決噪音問題，排除使用隔音屏障，以更有效地利用通風廊；和
- 梯田式平台設計，進一步減輕地盤周邊的通風影響。

1 INTRODUCTION

Background

1.1 The policy of "Enhancement of the Development Intensity of Public Housing Site" has been approved by the Executive Council on 11 December 2018 (ExCo paper no. :DEVB(PL-CR) 13/2006 HDCR2-5/PLAN2/1-55/1-23) that the domestic plot ratio for these public housing sites should be allowed to increase by up to 30% where their technical feasibility permits. The relevant bureaux/departments shall undertake technical studies for individual sites to ascertain the feasibility and impacts of applying the higher plot ratio, and to seek approval of the Town Planning Board as appropriate according to the established procedure.

1.2 In pursuit of this policy, the Hong Kong Housing Authority (HKHA) proposes to increase the flat production of the proposed Public Housing Development located at Chiu Shun Road, Tseung Kwan O through minor relaxation of the total permissible maximum plot ratio from 6.5 to 6.65 under Section 16 of the Town Planning Ordinance. AECOM Asia Co. Ltd. has been commissioned by the HKHA to undertake an Air Ventilation Assessment (AVA) Study – Initial Study (IS) using Computational Fluid Dynamics (CFD) in support of this Section 16 planning application to examine the air ventilation impact of the proposed building design quantitatively and formulate effective and practicable measures enhancing the air ventilation as part of the continuous design improvement process.

Objectives

1.3 The AVA Study for the proposed public housing development at Chiu Shun 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 Proposed Development; and
- To compare two design scenarios in terms of air ventilation performance aspect.

Content of This Report

1.4 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 unoccupied site with an area of approximately 0.42 ha. It is located at the road junction of Chiu Shun Road and Ngan O Road, Tseung Kwan O, bounded by existing man made slopes to the east and southeast, Fat Tau Chau Village, Tin Ha Wan Village and Tin Hau Temple (Hang Hau) in the northeast and a low-rise Pak Shing Kok Ventilation Building in southwest.

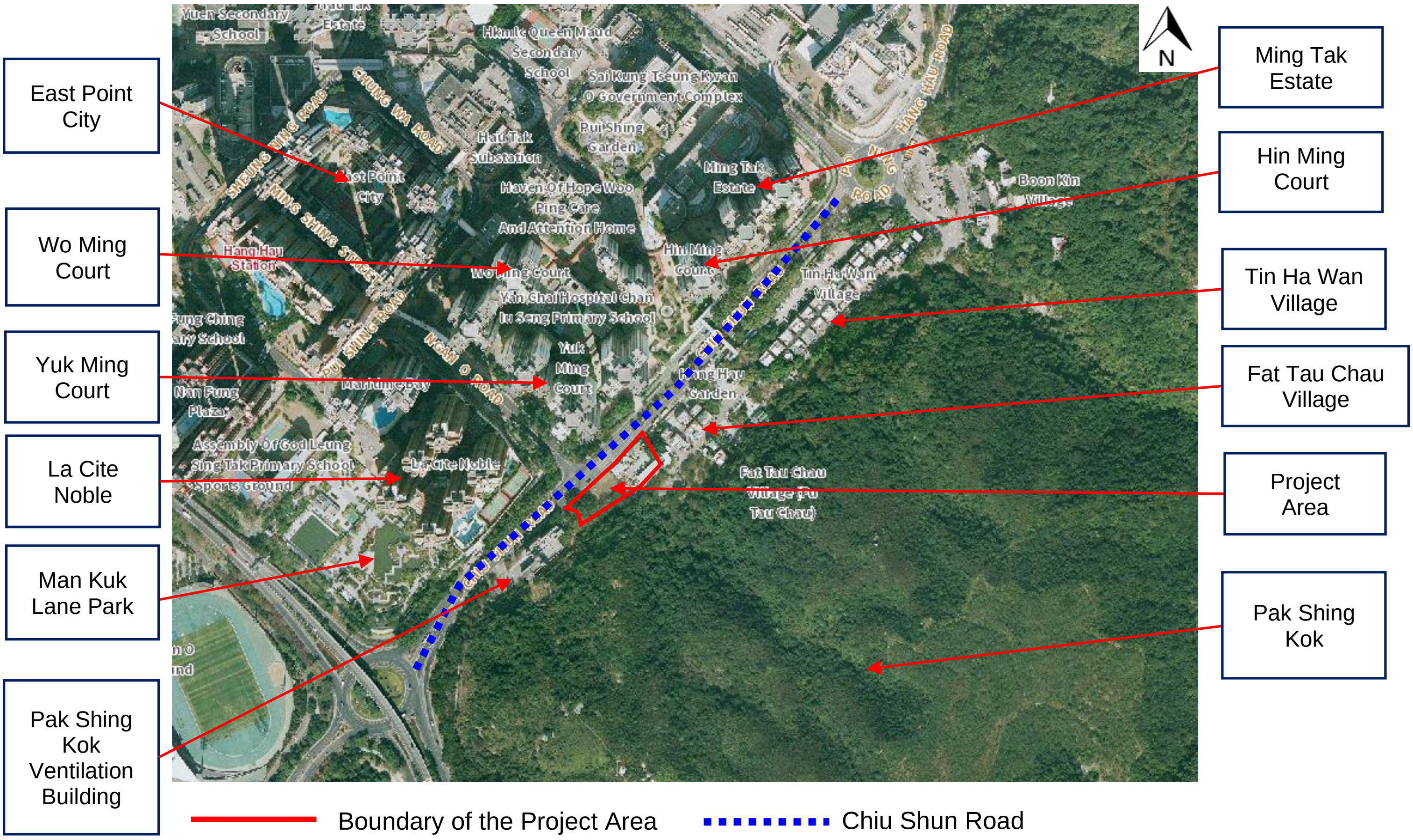
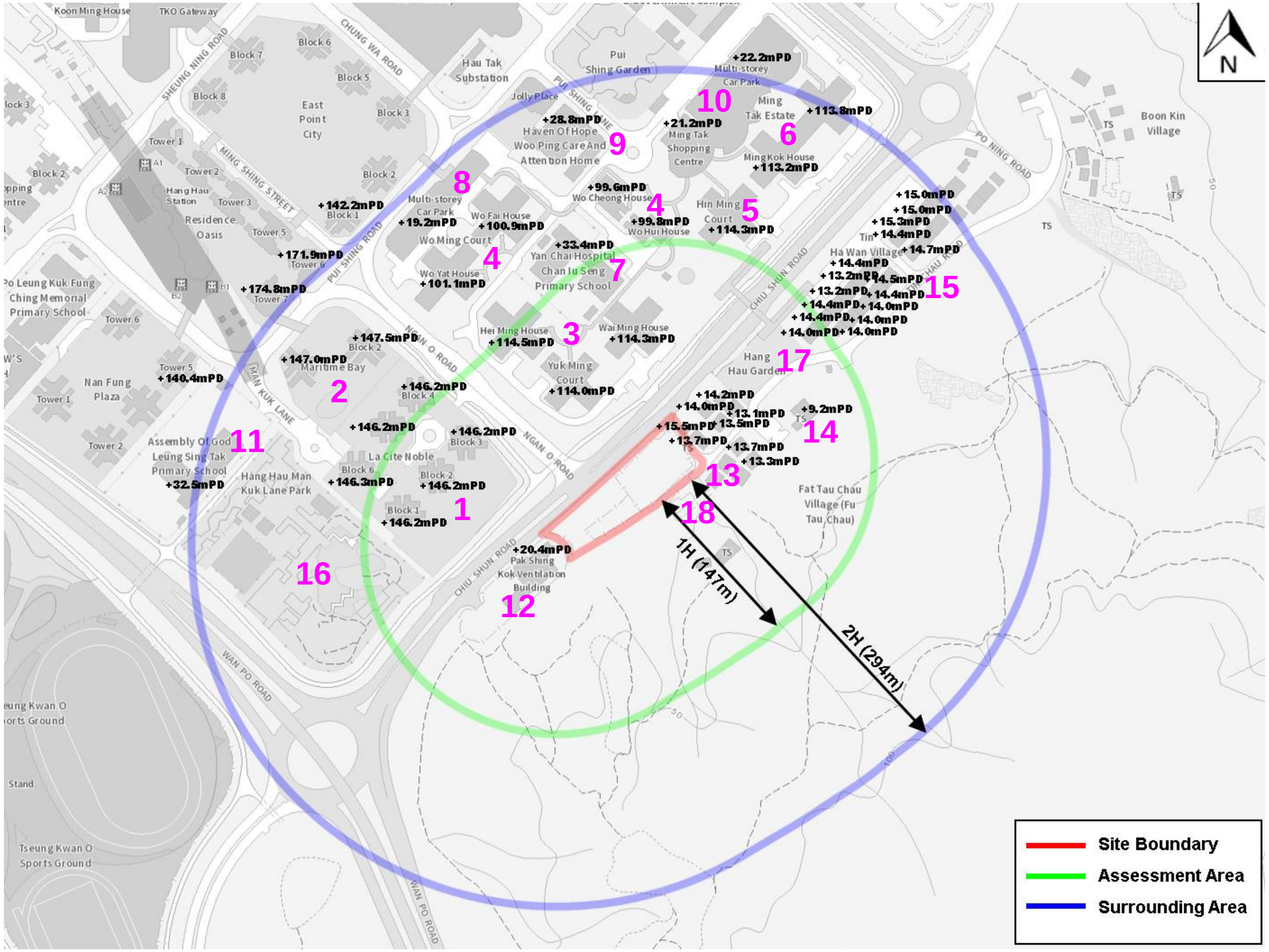


Figure 2.1 Overview of the Project Area and its Surroundings (Source: GeoInfo Map)

2.2 According to the “Approved Tseung Kwan O Outline Zoning Plan No. S/TKO/26”, the Project Area is zoned as “Residential (Group A) 7” (“R(A)7”), with a maximum plot ratio of 6.5 and 130mPD building height restriction. To the west of Chiu Shun Road are “R(A)” clusters.

2.3 To the southeast of the Project Area on the uphill topography of Pak Shing Kok including the DSD Water Tank, existing vegetated and man made slopes. To the southwest is Pak Shing Kok Ventilation Building (20.4mPD). To the west of the Project Area across Chiu Shun Road are Man Kuk Lane Park and high-rise residential sites including La Cite Noble (146.2mPD – 146.3mPD) and Maritime Bay (147.0mPD – 147.5mPD). To the north of Project Area across Chiu Shun Road is Ming Tak Estate development which consists of Ming Tak Estate (113.2mPD – 113.8mPD), Hin Ming Court (114.3mPD), Yuk Ming Court (114.0mPD – 114.5mPD), and Wo Ming Court (99.6mPD – 101.1mPD). To the northeast are Fat Tau Chau Village (Fu Tau Chau) and Tin Ha Wan Village.

2.4 Details of building heights of the existing developments within the Surrounding Area are shown in **Figure 2.2**.



1. La Cite Noble (146.2mPD – 146.3mPD)	2. Maritime Bay (147.0mPD – 147.5mPD)	3. Yuk Ming Court (114.0mPD – 114.5mPD)	4. Wo Ming Court (99.6mPD – 101.1mPD)
5. Hin Ming Court (114.3mPD)	6. Ming Tak Estate (113.2mPD – 113.8mPD)	7. Yan Chai Hospital Chan Iu Seng Primary School (33.4mPD)	8. Wo Ming Court Multi-storey Car Park (19.2mPD)
9. Haven of Hope Woo Ping Care and Attention Home (28.8mPD)	10. Ming Tak Shopping Centre (21.2mPD) and Multi-storey Car Park (22.2mPD)	11. Assembly of God Leung Sing Tak Primary School (32.5mPD)	12. Pak Shing Kok Air Ventilation Building (20.4mPD)
13. Fat Tau Chau Village (13.3mPD – 15.5mPD)	14. Tin Hau Temple (Hang Hau) (9.2mPD)	15. Tin Ha Wan Village (13.2mPD – 15.3mPD)	16. Man Kuk Lane Park (Open Ground)
17. Hang Hau Garden (Open Ground)	18. Water Tank (DSD)		

Figure 2.2 Close-up view of the Project Area and its Surroundings (Source: GeoInfo Map)

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 have an internationally leading position. Thus, it is considered that the COST action C14 is 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 had 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 being 147 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.

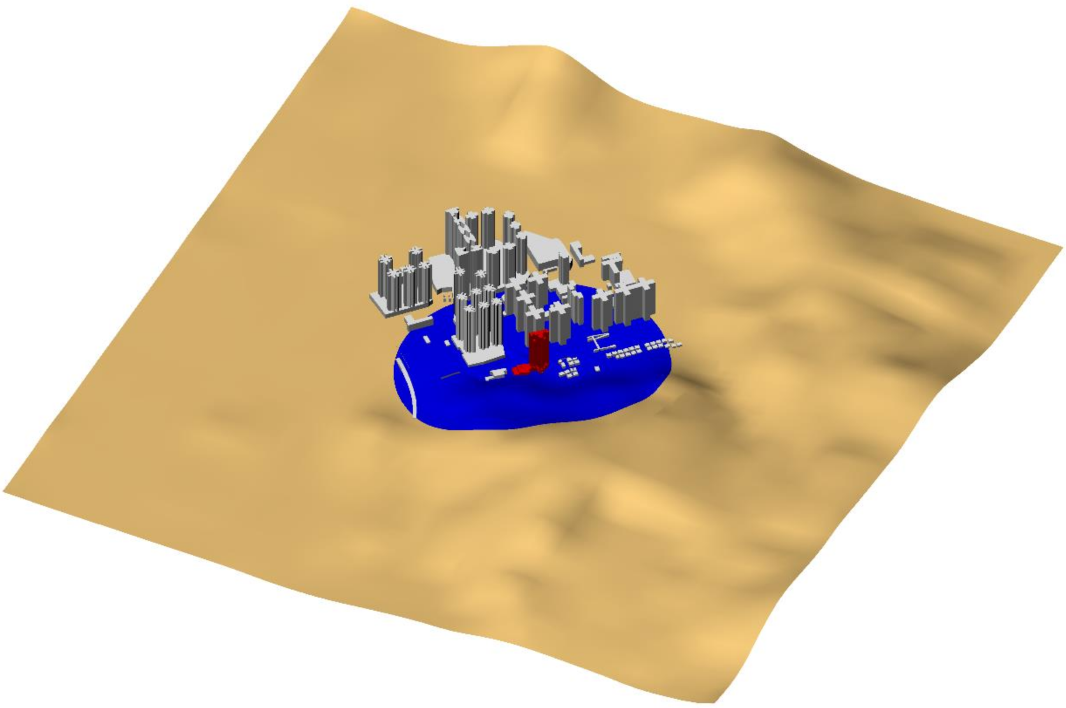
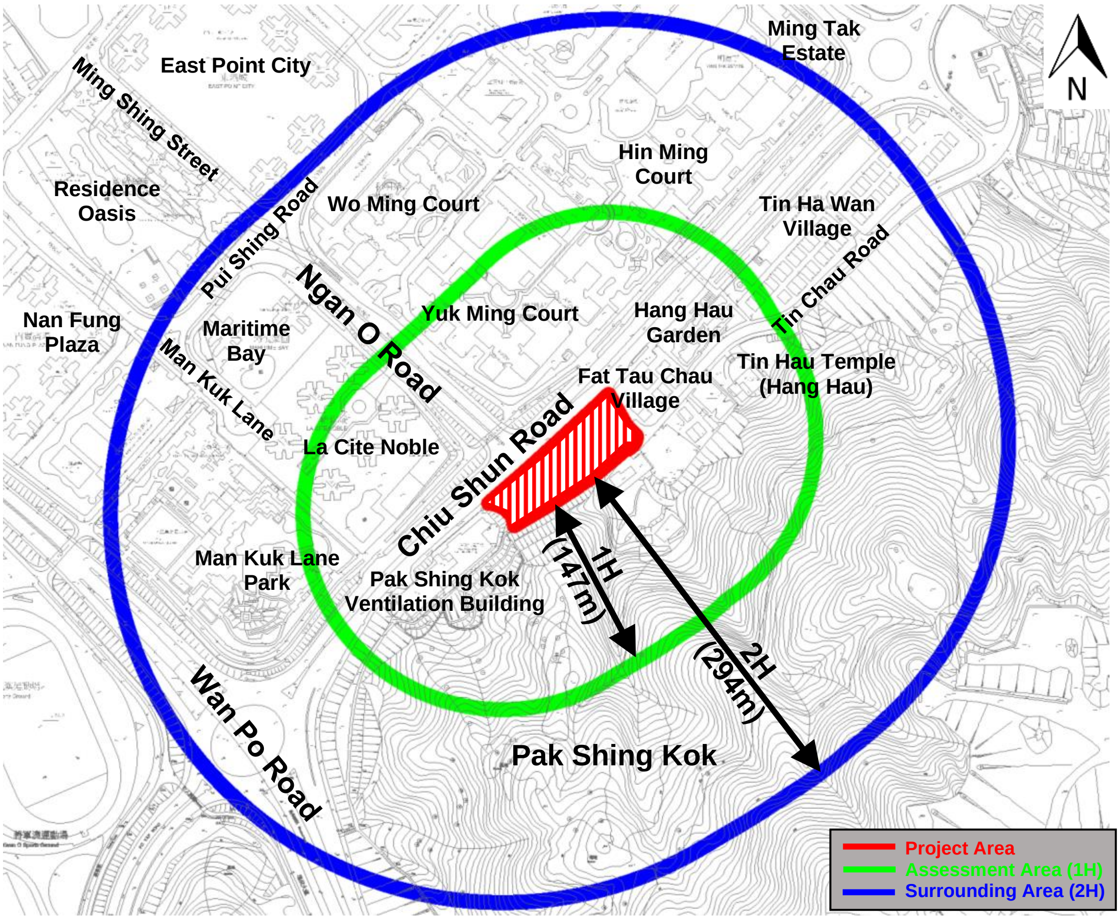


Figure 3.1 Geometry of Computational Model

Assessment and Surrounding Areas

3.4 Both the Baseline Scheme and Proposed Scheme are assessed under annual and summer wind conditions. A 3D model will be 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 Wan Po Road, footbridge across Chiu Shun Road at Hin Ming Court, noise barriers including Wan Po Road and Chiu Shun Road adjacent to Man Kuk Lane Park, within the Surrounding Area are 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 **Figure 3.10** and **Figure 3.11** demonstrated model geometry of the Baseline Scheme and the Proposed Scheme in the simulation.

Baseline Scheme

3.6 The Baseline Scheme adopt the conceptual layout plan for the proposed public housing development at the same Project Area as prepared in the Engineering Feasibility Study (EFS), which the proposed rezoning of the subject site to "R(A)7" was considered by the Town Planning Board on 11 August 2017, as the Baseline Scheme for comparison with the Proposed Scheme. The maximum permitted overall Plot Ratio of the Project Area is 6.5 (as land designated “R(A)7”).

3.7 The Baseline Scheme is a single domestic tower at a maximum building height of 130mPD on a relatively small and 1-storey non-domestic podium at around 13.1mPD in height to serve as the landscaped roof. Northeast portion of the site is open space of the existing tree, EVA and open carpark. Southeast portion of the site is unexcavated land. The 4-metre-high elevated podium garden design is adopted at 13.1mPD under the domestic tower to allow prevailing wind to skim over and penetrate through such that significant impact on the overall pedestrian wind environment would not be anticipated.

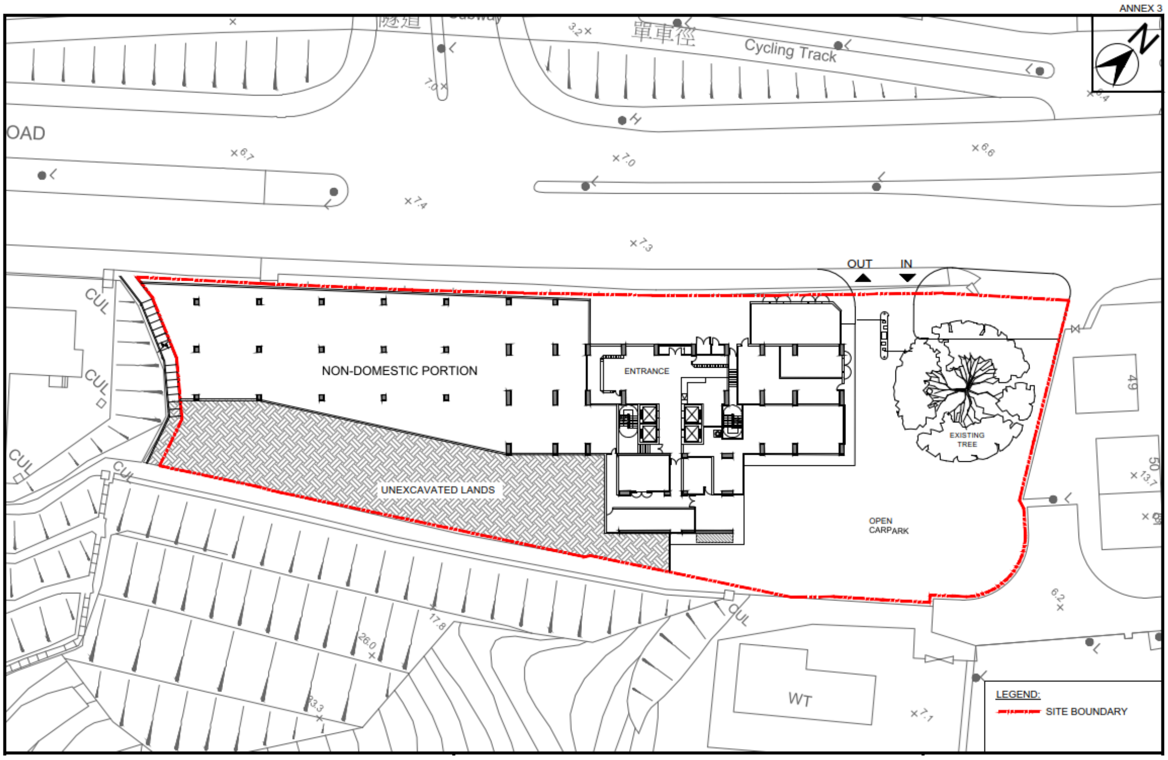


Figure 3.3 Indicative Plan of Baseline Scheme (Ground Floor)

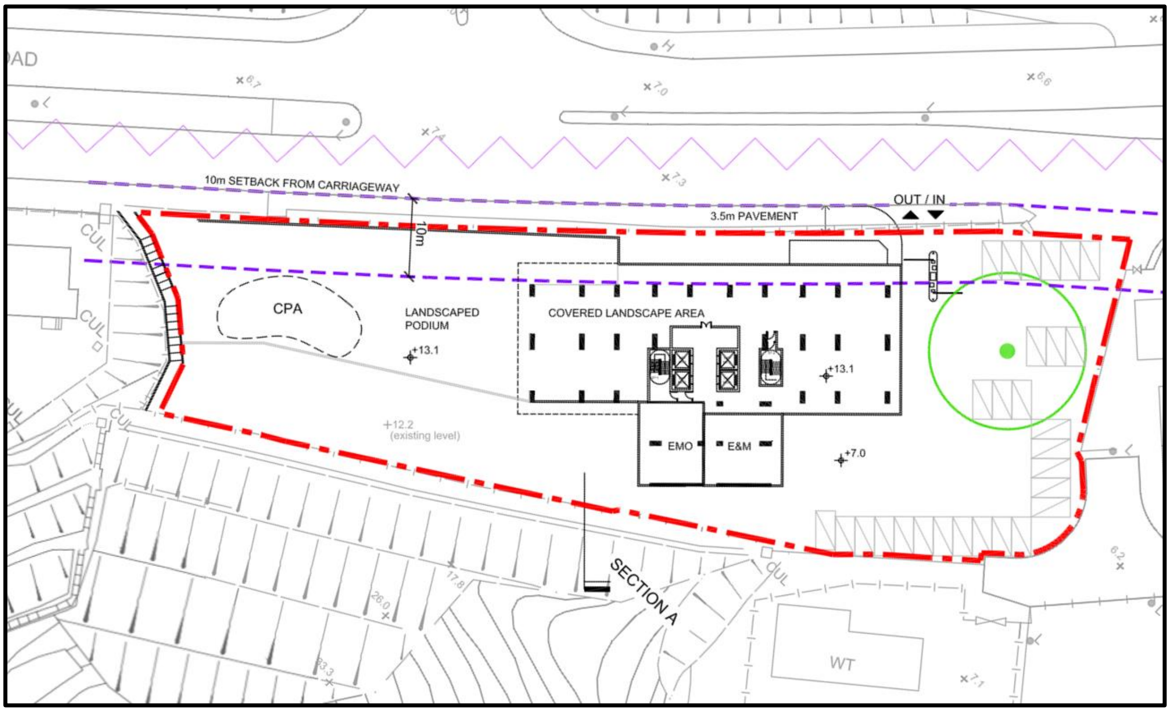


Figure 3.4 Indicative Plan of Baseline Scheme (Podium Floor)

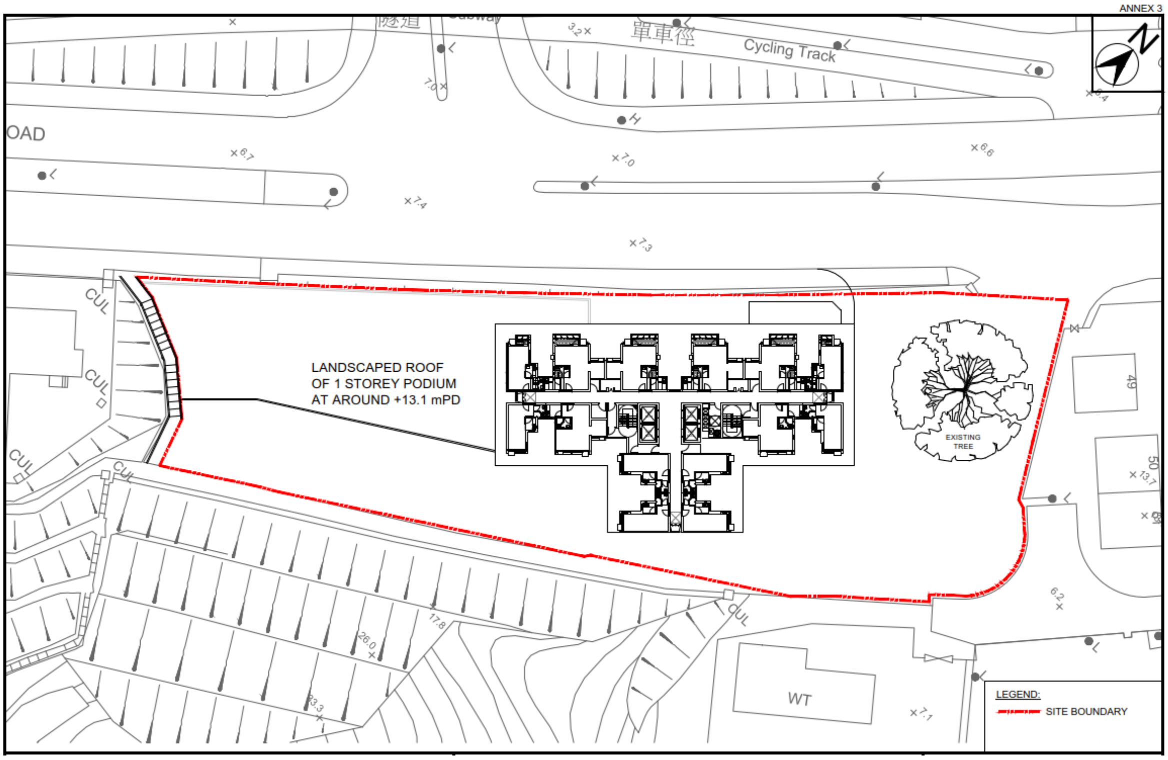


Figure 3.5 Indicative Plan of Baseline Scheme

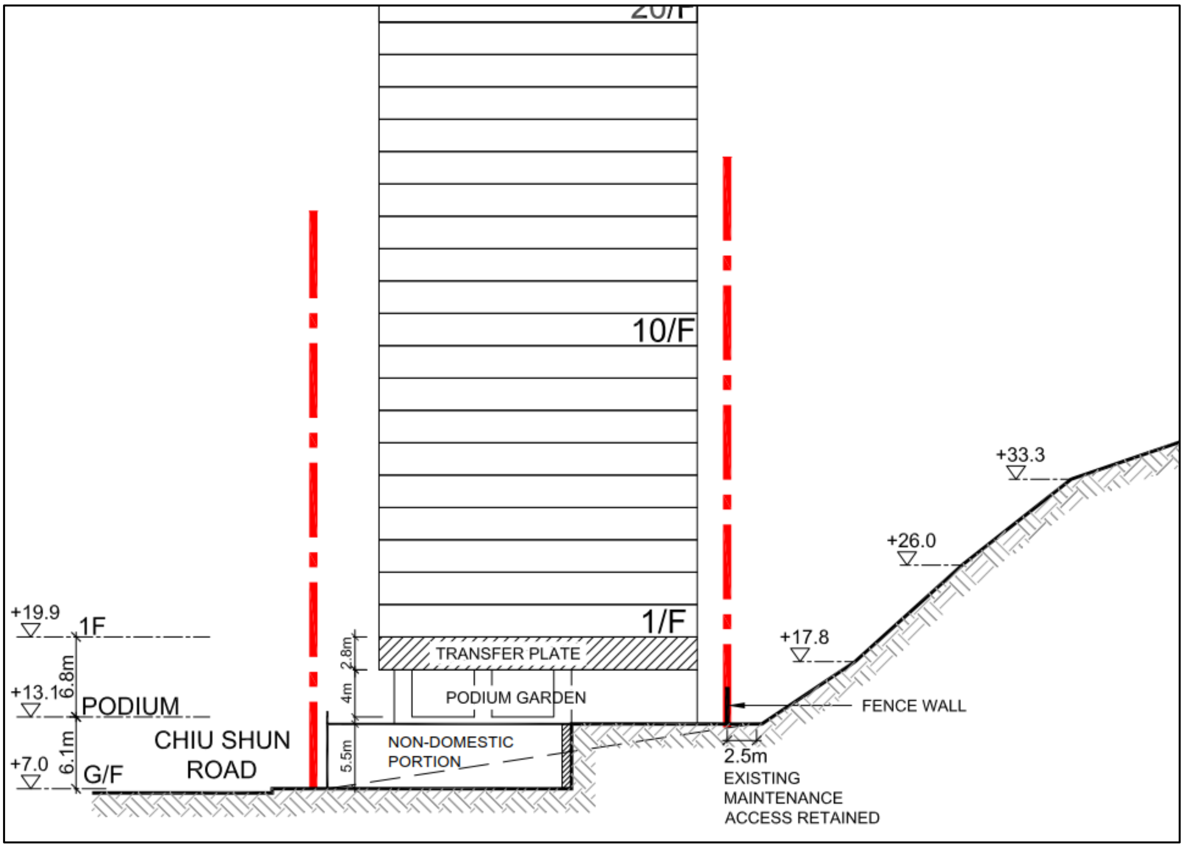


Figure 3.6 Indicative Plan of Baseline Scheme (Section A)

Proposed Scheme

3.8 The Proposed Scheme comprises of a 38-storey residential block on with around 4.8m high elevated podium garden at 18.1mPD. Terraced podium design is adopted for the 2-storey non-domestic podium at 18.8mPD for podium roof garden and 12.55mPD for open carpark. Supporting facilities includes carpark, building services and welfare facility, and estate management office. The Proposed Development has a building height of 130mPD at a maximum plot ratio of 6.65.

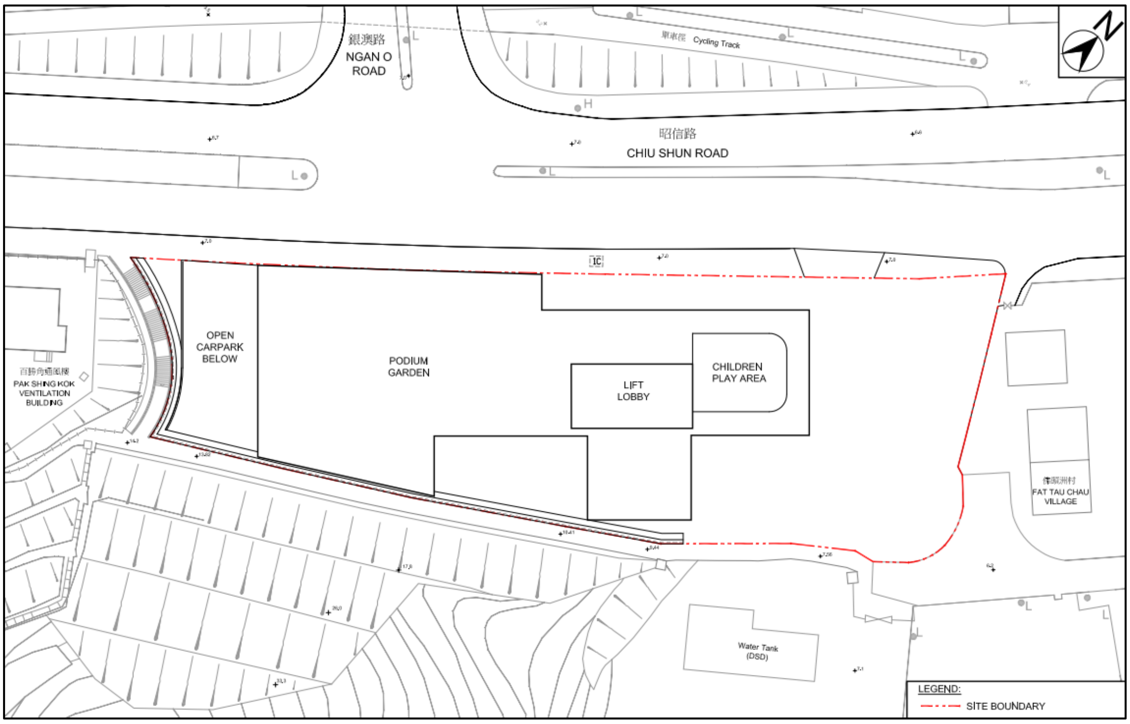


Figure 3.7 Indicative Plan of Proposed Scheme (Podium Floor)

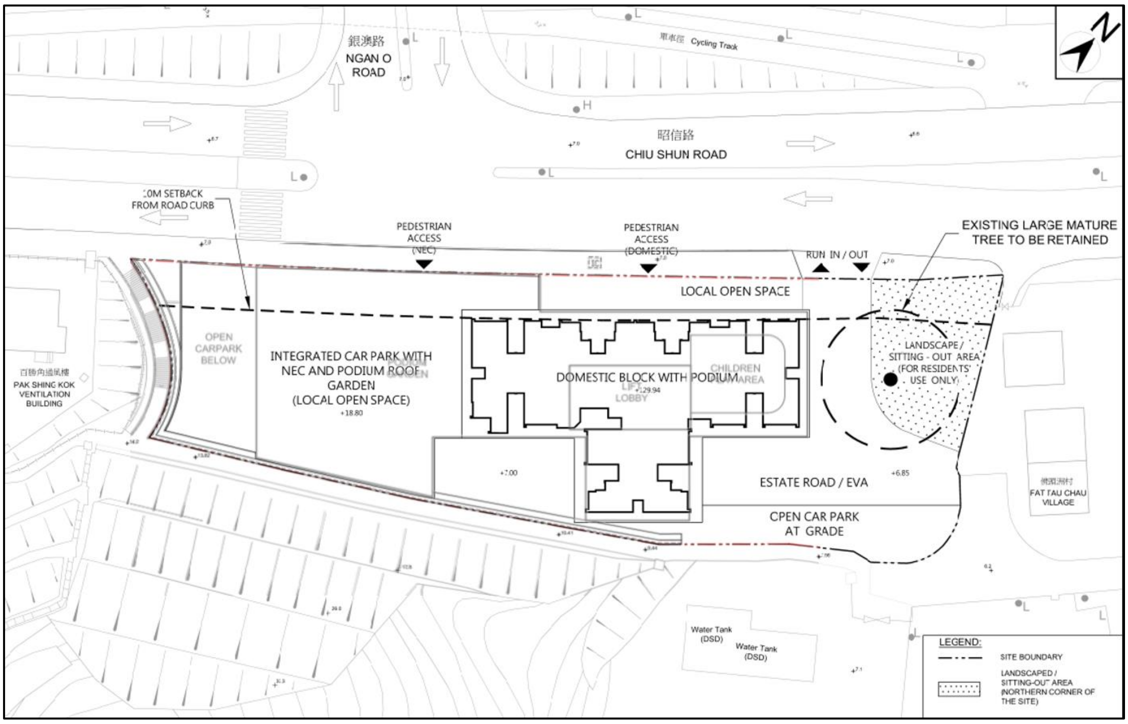


Figure 3.8 Indicative Plan of Proposed Scheme

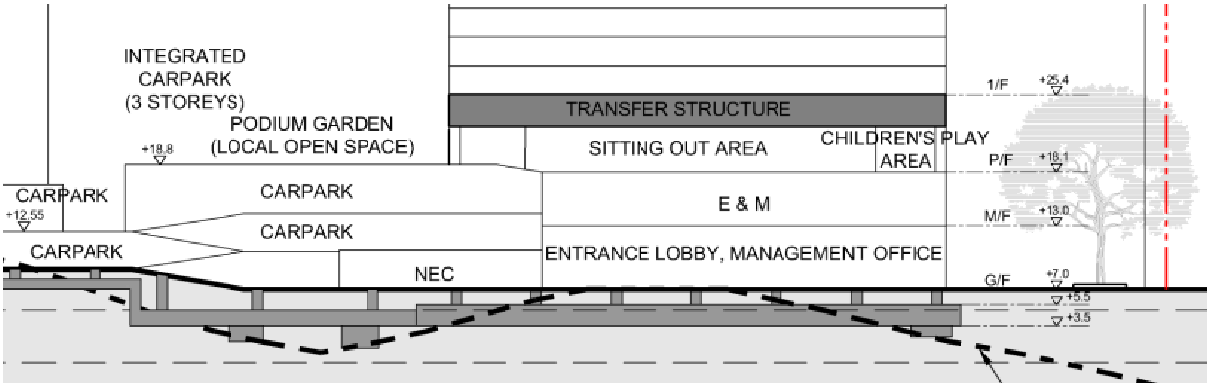
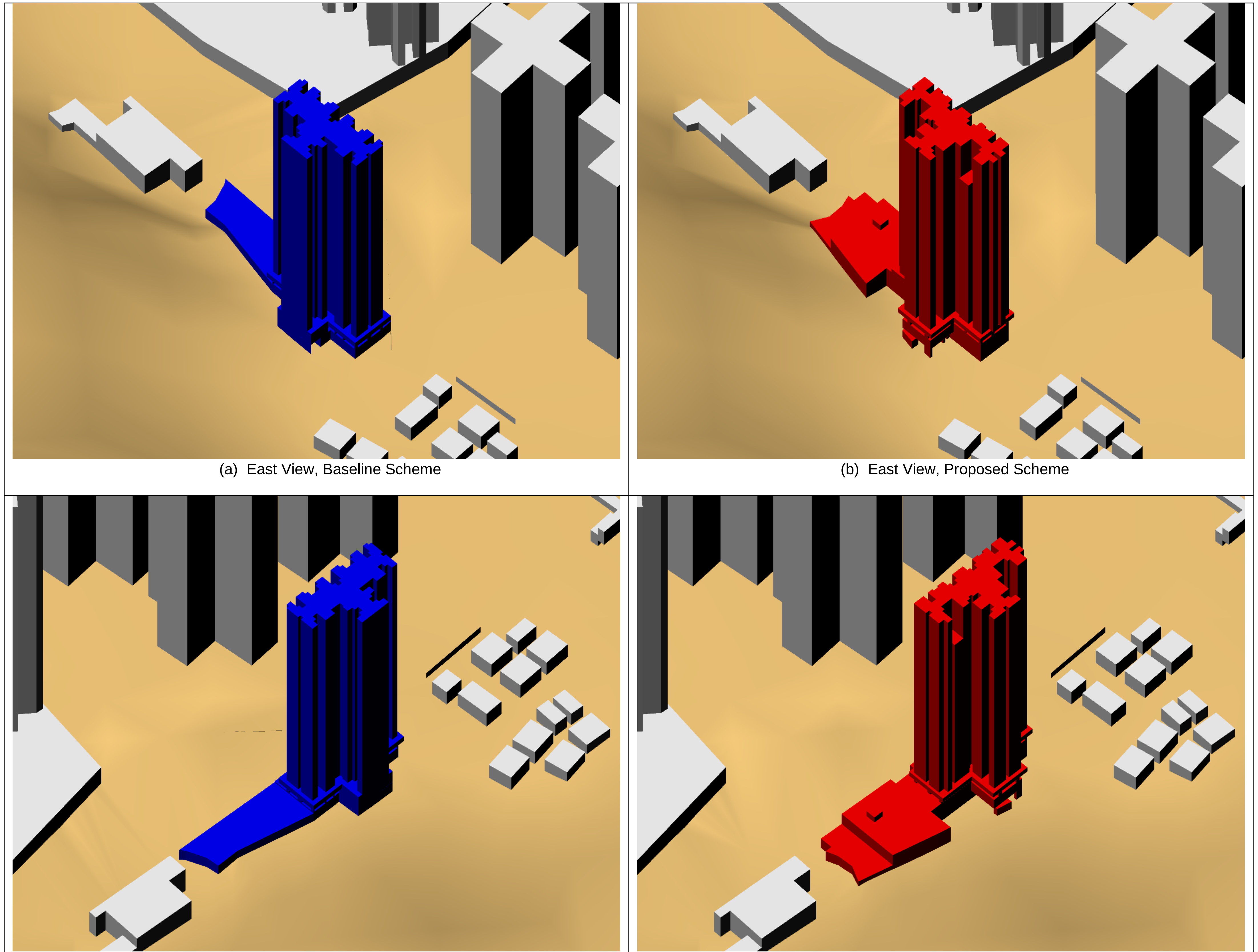


Figure 3.9 Indicative Plan of Proposed Scheme (Section)



(a) East View, Baseline Scheme

(b) East View, Proposed Scheme

(c) South View, Baseline Scheme

(d) South View, Proposed Scheme

Figure 3.10 Model Geometry under East and South view

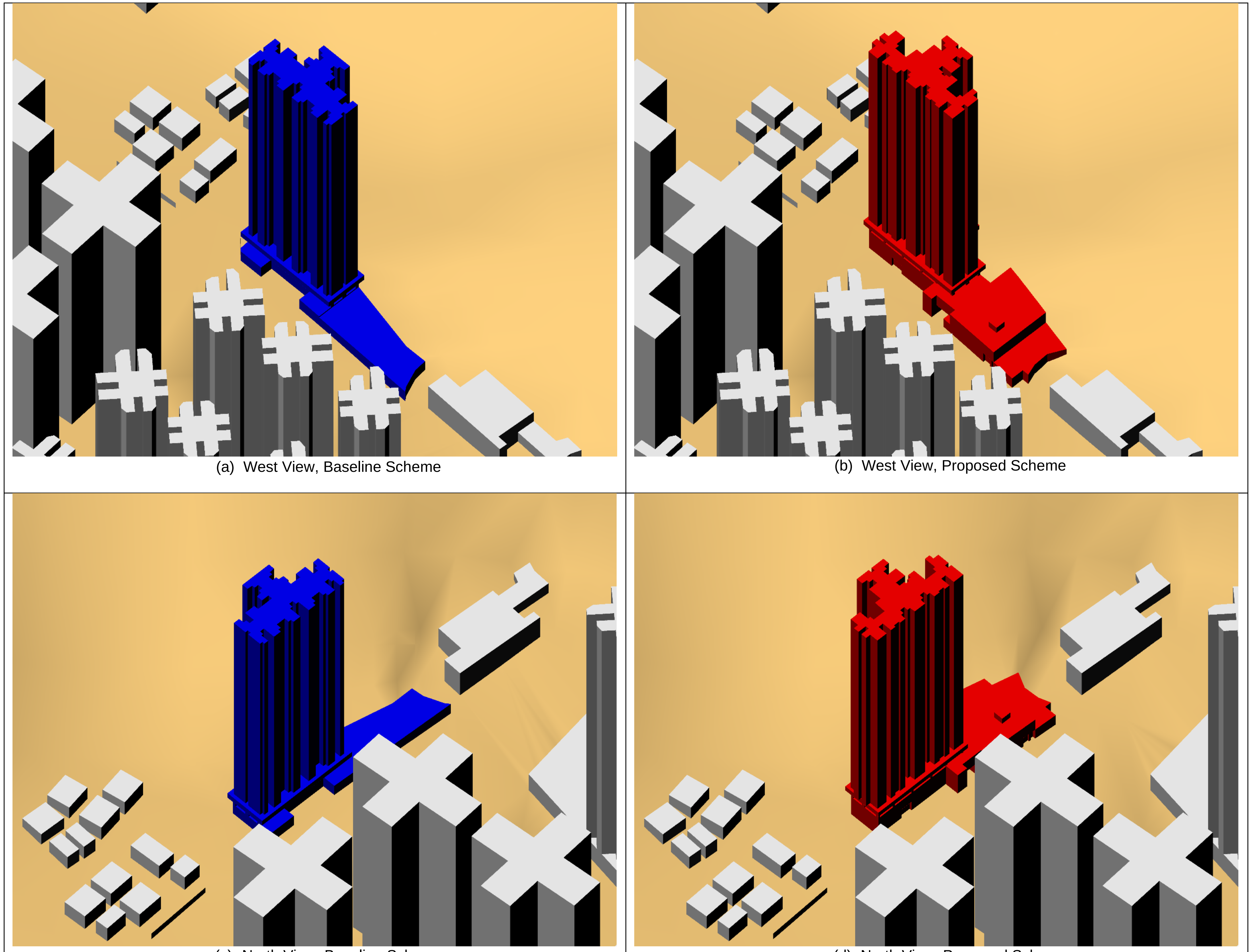

(a) West View, Baseline Scheme
(b) West View, Proposed Scheme
(c) North View, Baseline Scheme
(d) North View, Proposed Scheme

Figure 3.11 Model Geometry under West and North views

Wind Environment

3.9 The site wind availability of the Project Area will be 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 Proposed Development. These prevailing wind directions are determined based on the wind availability simulation result of Regional Atmospheric Modelling System (RAMS) model published by Planning Department (PlanD from hereafter). **Figure 3.12** shows the location of relevant wind data extraction while the wind roses representing annual and summer winds at the Project Area of this study are presented in **Figure 3.13** below. Furthermore, the summarized chosen prevailing wind directions and their related occurrence probability are listed in **Table 3.1**. Details of the wind probability table is presented in Appendix A.

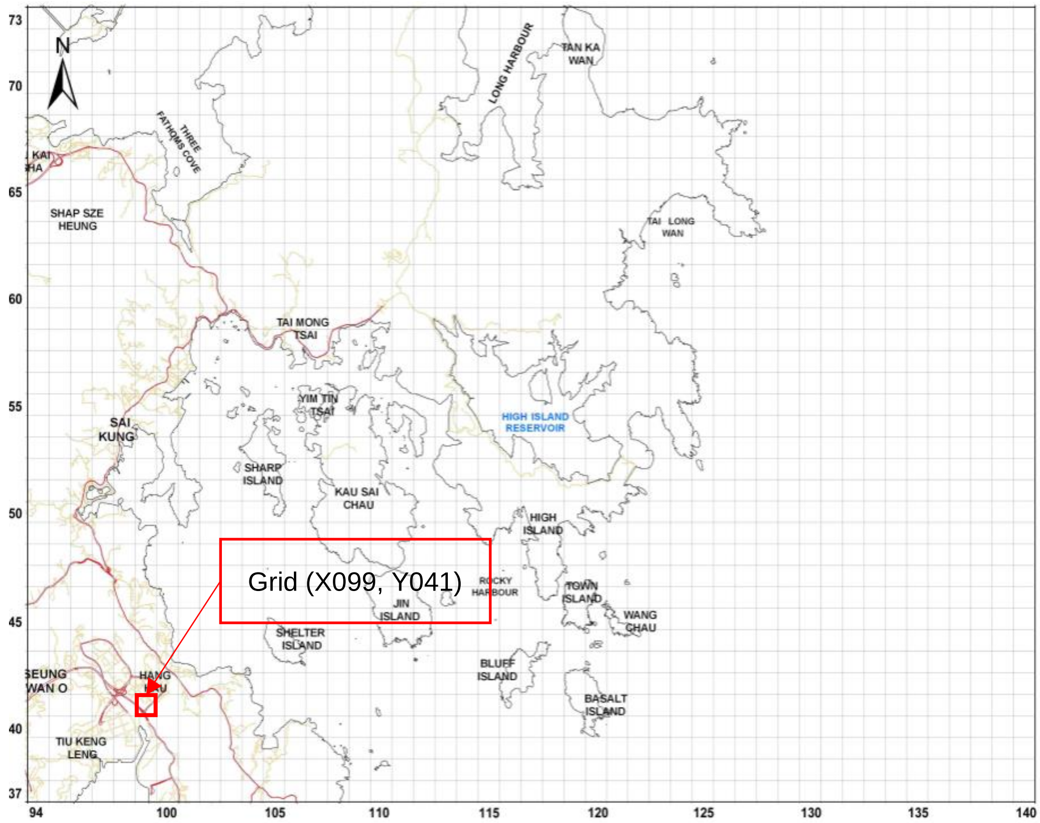
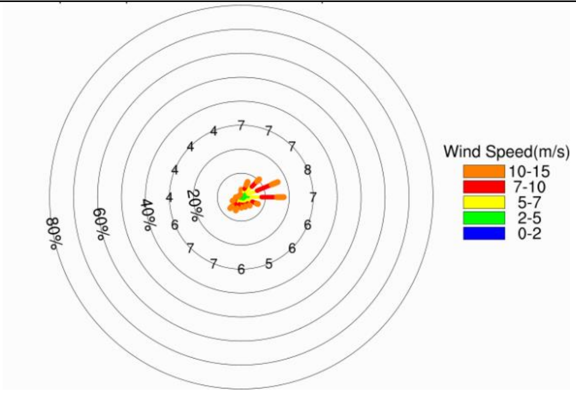
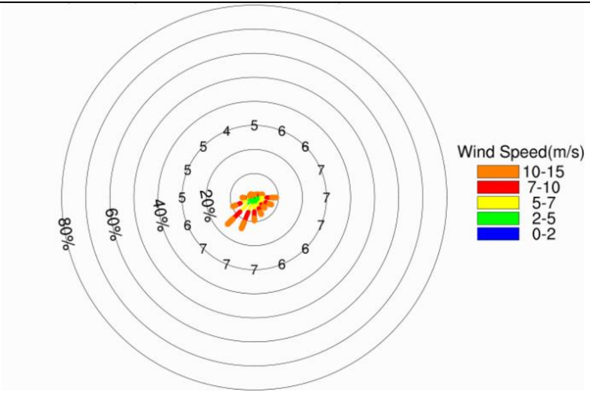


Figure 3.12 Location of data extraction in RAMS model



(a) Annual Wind Rose



(b) Summer Wind Rose

Figure 3.13 Wind Rose at Grid (X099, Y041) (500m height)

Table 3.1 Simulated Wind Directions and their corresponding percentage occurrence, at 500m height

Annual Wind Direction	% of Annual Occurrence	Summer Wind Direction	% of Summer Occurrence
E	18.0%	SW	16.0%
ENE	16.7%	SSW	14.2%
NE	10.7%	S	9.9%
ESE	7.6%	WSW	9.7%
NNE	7.2%	E	9.3%
SW	6.7%	ESE	7.8%
SSW	6.1%	SSE	7.6%
SE	5.1%	SE	6.2%
Total occurrence	78.1%	**Total occurrence**	80.7%

Vertical Wind Profiles

3.10 Wind environment under different wind directions will be defined in the CFD environment. According to the Technical Guide (HPLB and ETWB, 2006) per Para 20, wind profile for the Project Area could be appropriated from the V_∞ 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 is determined using the Log Law while the wind speed above 20mPD is adopted from the RAMS wind and wind profile in PlanD's website.

3.11 Vertical wind profile and roughness lengths are determined accordingly as follows:

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

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.

3.12 The roughness length for determining vertical wind profiles under different wind direction is tabulated in **Table 3.2**. In this study, the land further away from the surrounding area are urban areas with mid to high-rise developments, as a result, a roughness length with Z_0=3 is adopted for the inflow wind profiles.

Table 3.2 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)

Mesh Setup

3.13 The total number of cells for this study is about 6,000,000 cells in polyhedral mesh. Tetrahedral mesh cells counts can often be much smaller than comparable tetrahedral meshes with equivalent accuracy as well as improve mesh quality and manner of convergence (Franklyn, 2006). Grids may be converted to polyhedral mesh, if necessary. The horizontal grid size employed in the CFD model in the vicinity of the Project Area will be 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 will be 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 is 1.2 and 3% respectively.

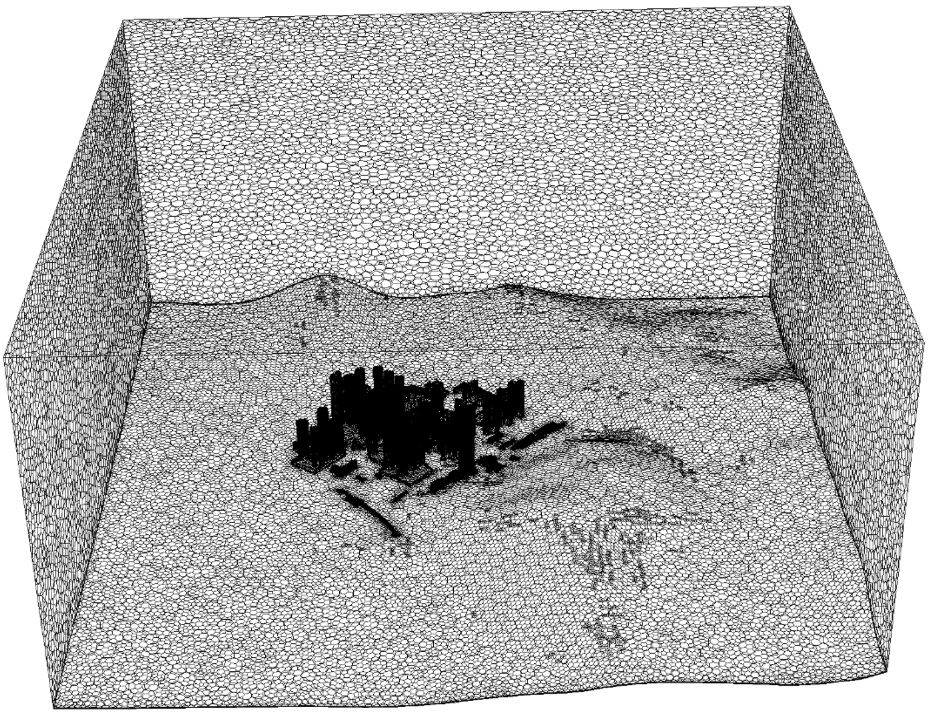


Figure 3.14 Mesh of the simulation domain

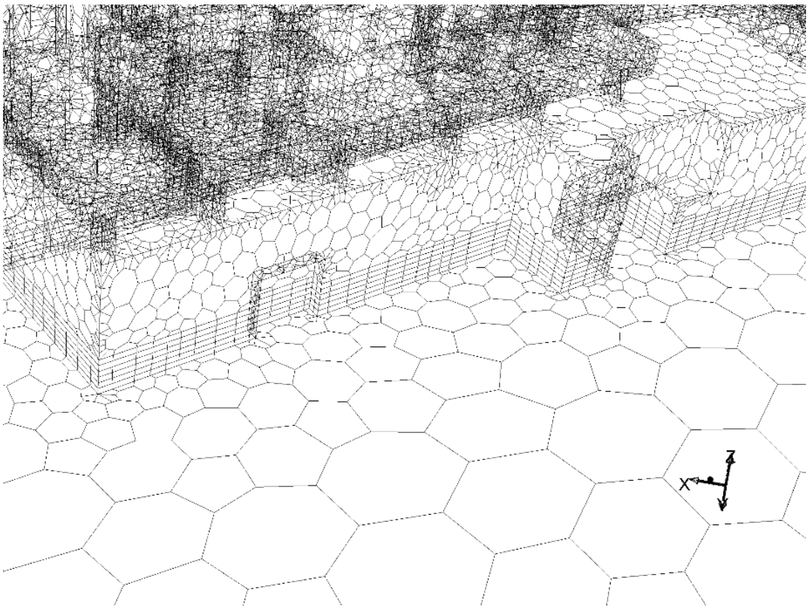


Figure 3.15 Prism layers near ground

Turbulence Model

3.14 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.

3.15 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

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

3.17 The inflow face of the computational domain is set as the velocity inlet condition and the outflow face is set as the zero gradient condition. For the two lateral and top faces, symmetric boundary condition is used. Lastly for the ground and building walls, no slip condition is 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 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 are reported. SVRw is 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 are reported. LVRw is the average of all overall test points and perimeter test points.

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

Test Points

4.6 Both perimeter test points and overall test points will be selected within the Assessment Area in order to assess the impact on the immediate surroundings and local areas respectively. Overall test points will be evenly distributed over surrounding open spaces, streets and other parts of the Assessment Area where pedestrian can or will mostly access. There will be 30 Perimeter Test Points, 102 Overall Test Points and 16 Special Test Points. Preliminary locations of perimeter, overall and special test points are illustrated in **Figure 4.1**.

4.7 The Test Points are further divided into 8 groups in order to analysis the respective localized wind environment performances. The coverage of the Test Points Groups are shown in **Figure 4.1** while the description of major covering regions of each group are summarized in **Table 4.1.**

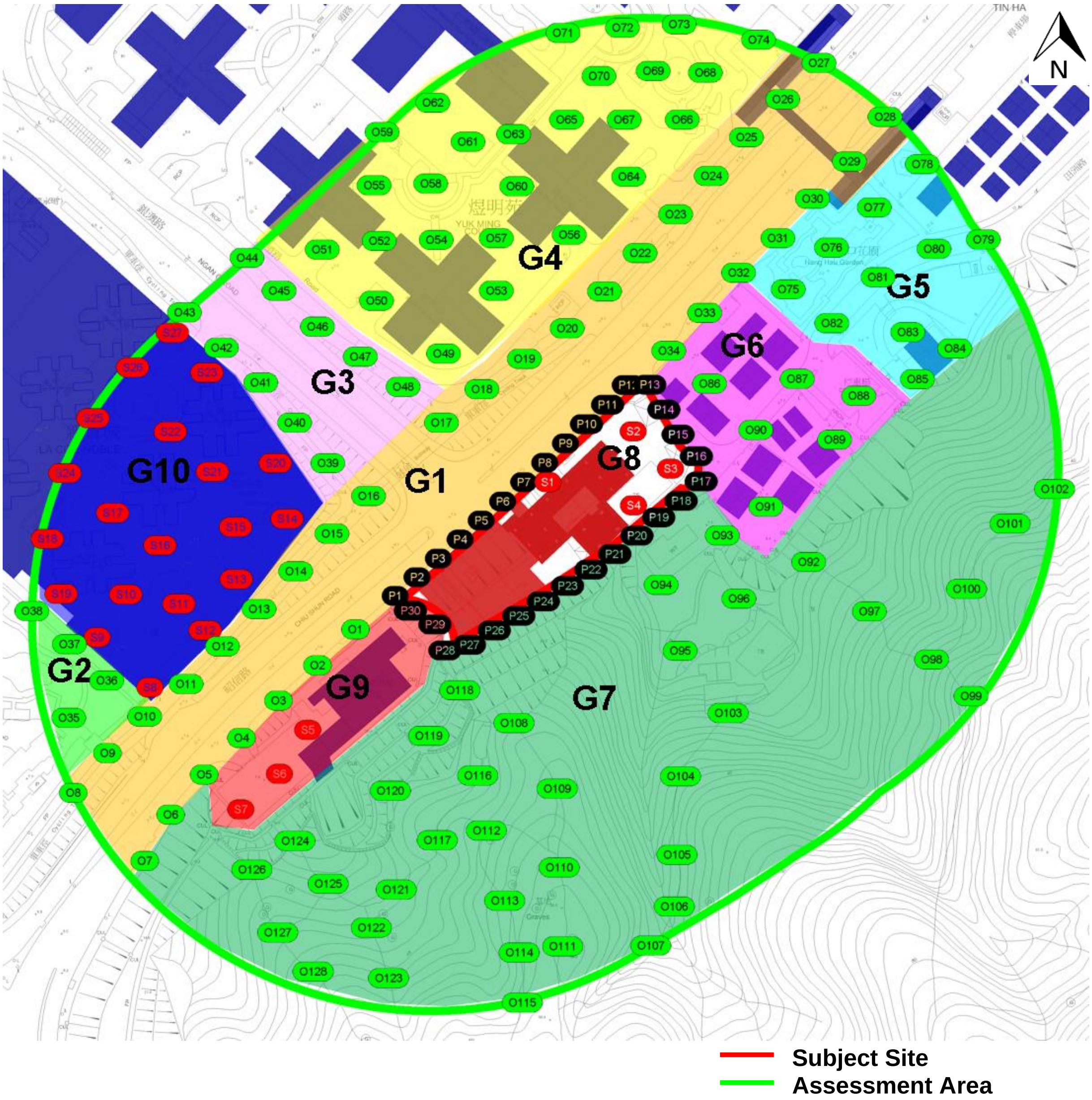


Figure 4.1 Distribution of Test Points

Table 4.1 Test Point Groups and respective represented locations

Test Point Groups	Test Point Numbers	Major location covered
G1*	P1, P3, P5, P7, P9, P11, O1 – O34	Chiu Shun Road
G2	O35 – O38	Hang Hau Man Kuk Lane Park
G3	O39 – O48	Ngan O Road
G4	O49 – O74	Yuk Ming Court
G5	O75 – O85	Hang Hau Garden and Tin Hau Temple
G6*	P13, P15, P17, O86 – O91	Fat Tau Chau Village
G7*	P19, P21, P23, P25, P27, P29, O92 – O128	Footpath of Pak Shing Kok
G8	S1 – S4	Chiu Shun Road Site
G9	S5 – S7	Pak Shing Kok Ventilation Building
G10	S8 – S27	Podium level of La Cite Noble

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

5 KEY FINDINGS OF AVA STUDY

Local Situation

5.1 The Proposed Development is a single block development having a continuous projected façade length (Lp) of less than 60m abut Chiu Shun Road that would minimize wall effect across prevailing wind direction as far as possible.

5.2 Buffer between the Proposed Development and adjacent developments is maximized as far as possible. Adjoining street canyons, the Lp along a street should not exceed 5 times the mean width of street canyon (U) as far as possible.

5.3 Both the Baseline and Proposed Schemes maintain the effectiveness of Chiu Shun Road as the major air path for prevailing wind by the building setback of the domestic block along the prevailing wind.

5.4 The Baseline Scheme has 1-storey simple podium form and a 4-metre-high elevated podium which could facilitate incoming wind to skim over the low-rise structure and penetrate though the permeable space. However, 2-storey podium in the Proposed Scheme is proposed to house the extra car parking and supporting facilities. To mitigate the air ventilation impact and to increase the air permeable space of the Proposed Scheme, empty bay of driveway at grade, stepped podium and a 4.8-metre-high elevated podium design of the Proposed Scheme could promote air movement at pedestrian level. Considering noise barriers may affect permeability of air flow at street level, the Proposed Scheme will avoid using noise barrier as noise mitigation measures.

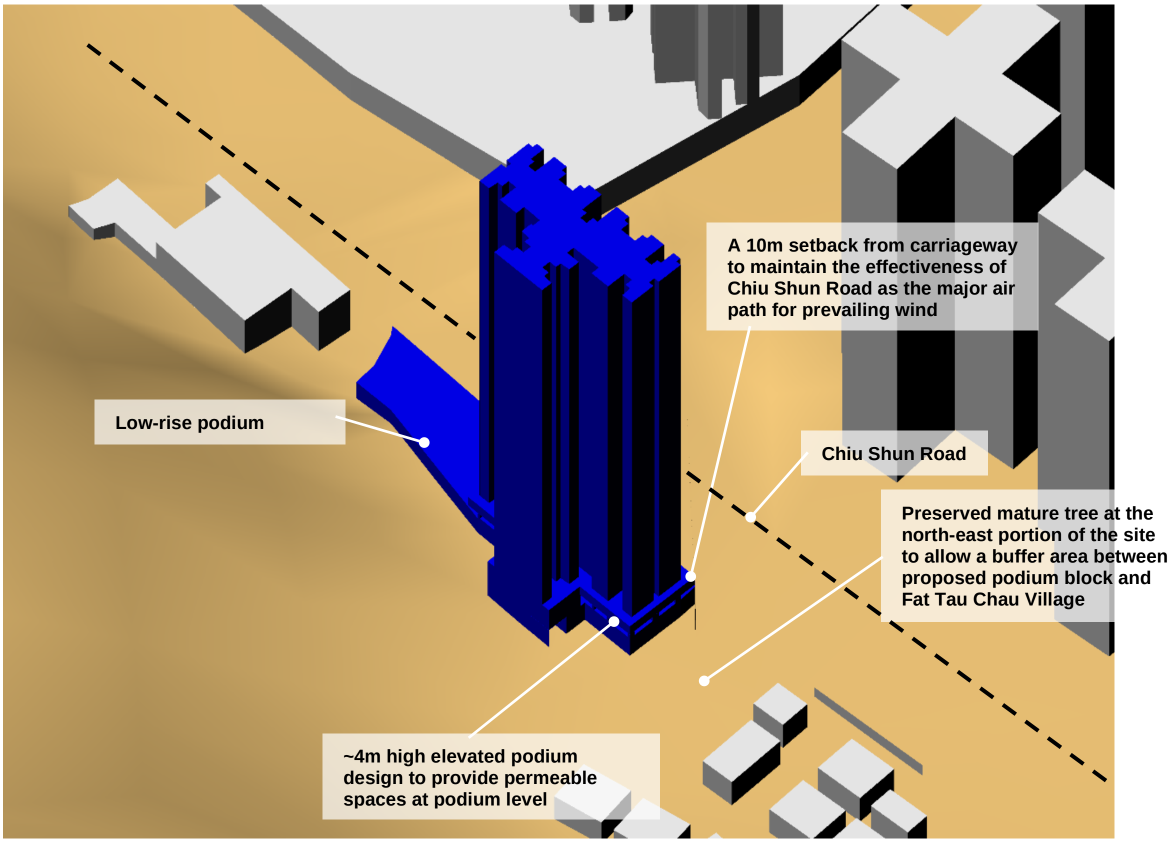


Figure 5.1 Good Design Features in Baseline Scheme

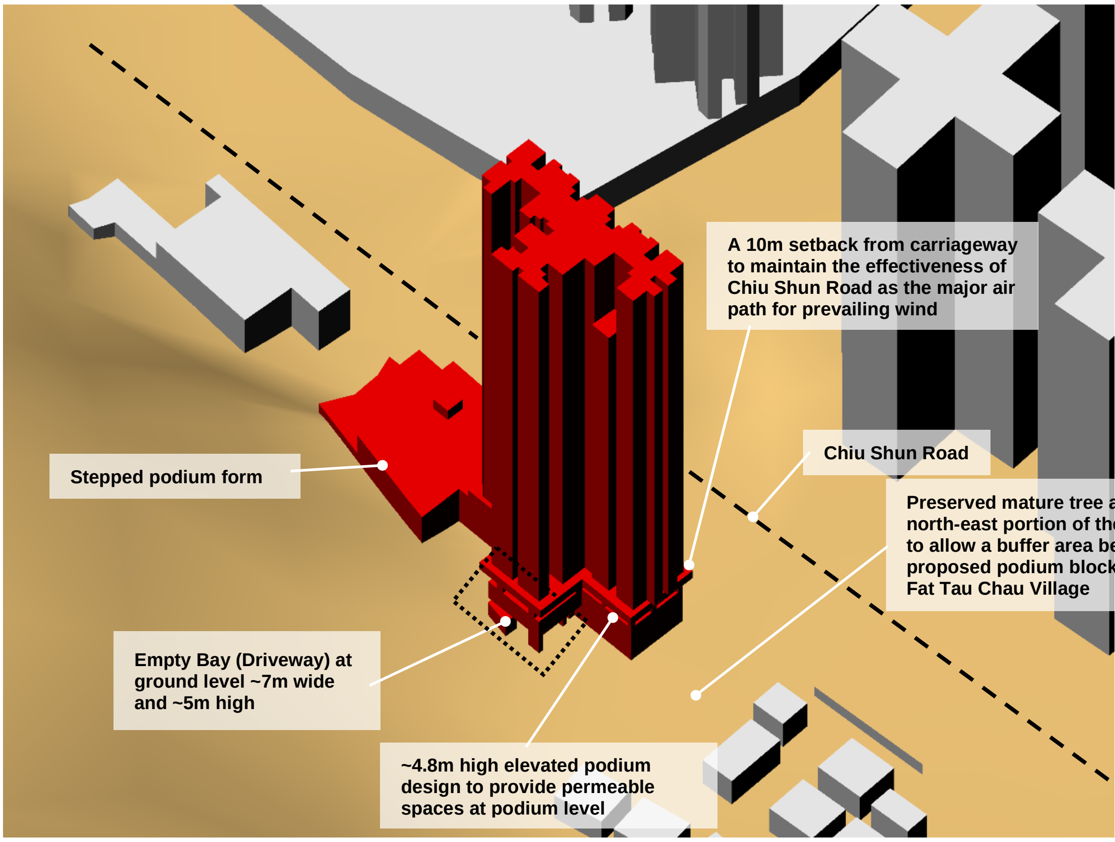


Figure 5.2 Good Design Features in Proposed Scheme

Wind Velocity Ratio Results

5.5 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 are presented in **Table 5.1** below. Details of the predicted wind velocity ratios are 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	0.36	0.34	0.33	0.32
LVR_W	0.35	0.34	0.30	0.29

5.6 The results of VRw for different groups of test points are 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*	Test points located west to the Project Area, covering Chiu Shun Road	P1, P3, P5, P7, P9, P11, O1 – O34	0.35	0.36	0.33	0.32
G2	Test points located west to the Project Area, covering Man Kuk Lane Park	O35 – O38	0.14	0.15	0.22	0.22
G3	Test points located west to the Project Area, covering Ngan O Road	O39 – O48	0.26	0.26	0.26	0.25
G4	Test points located northwest to the Project Area, covering Yuk Ming Court	O49 – O74	0.24	0.24	0.19	0.18
G5	Test points located northeast to the Project Area, covering Hang Hau Garden and Tin Hau Temple (Hang Hau)	O75 – O85	0.23	0.24	0.20	0.23
G6*	Test points located northeast to the Project Area, covering Fat Tau Chau Village	P13, P15, P17, O86 – O91	0.19	0.18	0.22	0.23
G7*	Test points located southeast to the Project Area, covering Footpath of Pak Shing Kok	P19, P21, P23, P25, P27, P29, O92 – O128	0.50	0.48	0.38	0.37
G8	Test points located within Project Area at main entrance and the open space at northern portion	S1 – S4	0.25	0.27	0.24	0.25
G9	Test points located southwest to the Project Area, covering Pak Shing Kok Ventilation Building	S5 – S7	0.18	0.22	0.24	0.24
G10	Test points located southwest to the Project Area, covering Podium level of La Cite Noble	S8 – S27	0.18	0.17	0.27	0.27

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

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

Site Air Ventilation Assessment

5.8 The layouts of the Proposed Scheme consist of a single tower and a 2-storey podium for carpark, welfare and auxiliary facilities, while Baseline Scheme is a single tower on a 1-storey podium. Both schemes have incorporated the elevated podium design with permeable spaces at podium level. With the minor relaxation proposal on additional plot ratio, the air ventilation impact at its site perimeter by the Proposed Scheme could be minimized when comparing to the Baseline Scheme.

5.9 The SVRw indicates 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 are both 0.36 and 0.34 respectively, indicating the Proposed Scheme has a slight air ventilation impact to site perimeter due to the 2-storey podium. While in summer, the SVRw are maintained at 0.33 and 0.32 by Baseline Scheme and Proposed Scheme respectively. The result indicates that there would be slightly adverse impact between the Proposed Scheme and the Baseline Scheme in terms of air ventilation performance in its immediate vicinity due to the fact that the Proposed Development aligns with Chiu Shun Road and would not affect the width of Chiu Shun Road and the ventilation performance of Chiu Shun Road as a wind corridor under northeast quadrant and southwest quadrant winds. While the low-rise podium, stepped podium and elevated podium design, and empty bays of the Proposed Scheme would allow prevailing wind to skim over and penetrate thought the Project Area to ventilate the pedestrian level around podium.

5.10 Test points P1 to P13 located along the portion of Chiu Shun Road at the northwest perimeter of the Project Area. This focus area aligns with Chiu Shun Road as major wind corridor under annual and summer conditions. The VRw is maintained at 0.38 and 0.39 for the Baseline and Proposed Scheme respectively for annual condition, while they are 0.39 and 0.37 in summer condition due to the continuous alignment of podium in Baseline Scheme to allow southwesterly winds flowing though smoothly.

5.11 There is ventilation performance impact in the footpath sandwiched by the Fat Tau Chau Village and the Project Area due to bulkiness of podium. The annual and summer VRw of Test Points P13 – P17 at this area is reduced from 0.22 to 0.20 and 0.29 to 0.28 respectively for the Baseline and Proposed Scheme.

5.12 It is expected that the Proposed Scheme would impact the south and east perimeter of the site under summer condition when compared to Baseline Scheme. The ventilation performance is monitored by Test Points P17 – P30, of which VR of annual conditions are reduced from 0.39 to 0.33 for the Baseline and Proposed Scheme due to the 2-storey podium obstructing easterly winds while VR is maintained at 0.30 and 0.28 respectively in summer conditions for the Baseline and Proposed Scheme.

Local Air Ventilation Assessment

5.13 The LVRw indicates the overall wind environment within the Assessment Area of the two schemes under the annual and summer winds. The LVRw for the Baseline Scheme and Proposed Scheme are reduced from 0.35 to 0.34 under the annual prevailing winds. While during the summer seasons, the LVRw are reduced from 0.30 to 0.29. The results indicate that the Proposed Scheme would have slightly adverse impact on the pedestrian wind environment compared to the Baseline Scheme at the Project Area boundary and throughout the Assessment Area.

5.14 The averaged wind velocity ratio of Group 1 test points reflects the wind environment along the Chiu Shun Road to the west of the Project Area. The Proposed Scheme maintained a slightly better wind environment within the Group 1 area compared to that of the Baseline Scheme under annual winds, since averaged VRw in Group 1 Test Points maintains at 0.35 and 0.36 for the Baseline Scheme and the Proposed Scheme respectively. While in summer seasons, the averaged VRw for Baseline Scheme and Proposed Scheme are maintained at 0.33 and 0.32 respectively, indicating a little impact on the wind environment.

5.15 Group 2 Test Points located west to the Project Area, covering a portion of Man Kuk Lane Park within the Assessment Area. It is observed that the Proposed Scheme would have a slightly better air ventilation than the Baseline with VRw increase from 0.14 to 0.15. While summer VRw are both maintained at 0.22 for Baseline and Proposed Scheme.

5.16 Group 3 Test Points located at Ngan O Road to the west of the Project Area, and the VRw obtained indicated the pedestrian wind environment there. It is noticed that the averaged velocity ratio obtained by the Proposed Scheme is similar to the Baseline Scheme at this area. The annual VRw are both maintained at 0.26 for Baseline and Proposed Scheme. While summer VRw are 0.26 and 0.25 respectively for Baseline and Proposed Scheme.

5.17 The VRw values of Group 4 Test Points indicate the air ventilation performance of the high-rise residential area of Yuk Ming Court to the northwest of the Project Area. The results indicate that similar wind environment is observed between the Baseline and the Proposed Scheme under the annual wind for both VRw are both maintained at 0.24. As for summer, the VRw values are reduced from 0.19 to 0.18 for the Baseline and the Proposed Scheme.

5.18 Group 5 Test Points are equally spaced at pedestrian walkway covering Hang Hau Garden and Tin Hau Temple (Hang Hau) to the northeast of Project Area. Under annual condition, the VRw could be maintained at 0.23 and 0.24 for Baseline and Proposed Scheme which implies a slight improvement on air ventilation performance within this region. As for summer winds, there is a better ventilation performance between Baseline and Proposed Scheme with the overall VRw of 0.20 increased to 0.23.

5.19 The ventilation performance of the adjacent Fat Tau Chau Village is assessed by Group 6 Test Points. The VRw decreased from 0.19 to 0.18 under annual conditions. There is slight ventilation enhancement on this monitoring region for the Proposed Scheme as the VRw increases from 0.22 to 0.23 for the summer seasons. The Proposed Scheme would allow a portion of south-westerly wind flow through the driveway empty bay at grade, improving the overall air ventilation performance at this area.

5.20 Group 7 Test Points are equally spaced at footpath of Pak Shing Kok to the southeast of Project Area. Under annual condition, the VRw could be maintained at 0.50 and 0.48 for Proposed and Baseline Scheme which implies that there is a slight impact in air ventilation. While in summer winds, there is a little drawback in Proposed Scheme with the overall VRw of 0.37 compared to that of 0.38 for the Baseline Scheme. Relatively high VRw under annual condition indicates the potential wind gust and pedestrian safety concerns. For wind amplification, the average hourly mean wind speed at this focus area would not exceed the possible dangerous level of 3.7 to 4.8m/s with Weibull distribution = 2 (Frank H. Durgin, 1997).

5.21 Special Test Points in Group 8 are located within site at main entrance (S1) and open space of the preserved tree (S2 – S4). The results of annual VRw are 0.25 and 0.27 respectively, while summer VRw are 0.24 and 0.25 respective for Baseline and Proposed Scheme which indicates an improvement of air ventilation in this monitoring region for the Proposed Scheme.

5.22 Pak Shing Kok Ventilation Building is monitored by Special Test Points in Group 9 as this region is a restricted area. The results of annual VRw are 0.18 and 0.22, while summer VRw are maintained at 0.24 for Baseline and Proposed Scheme which indicates similar to a better air ventilation in this monitoring region for the Proposed Scheme.

5.23 Some of the Special Test Points are distributed on the podium of a nearby residential development, La Cite Noble, within the assessment boundary in Group 10. The averaged VRw values obtained from these test points for Baseline Scheme and Proposed Scheme are maintained at 0.18 and 0.17 respectively under the annual winds, while are maintained at 0.27 under summer winds respectively. It suggests that the Proposed Scheme would not impact the air ventilation performance at this focus area significantly.

Pedestrian level wind criteria using the equivalent average - Frank H. Durgin 1997

6 DIRECTIONAL ANALYSIS

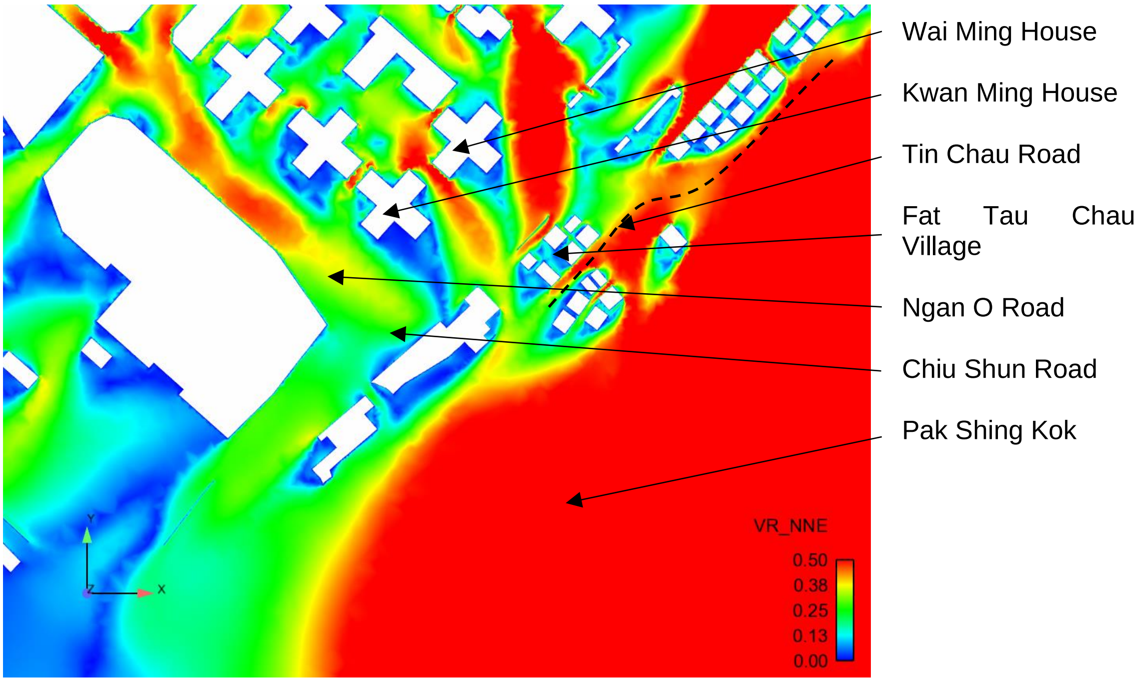
NNE: (Annual: 7.1%)

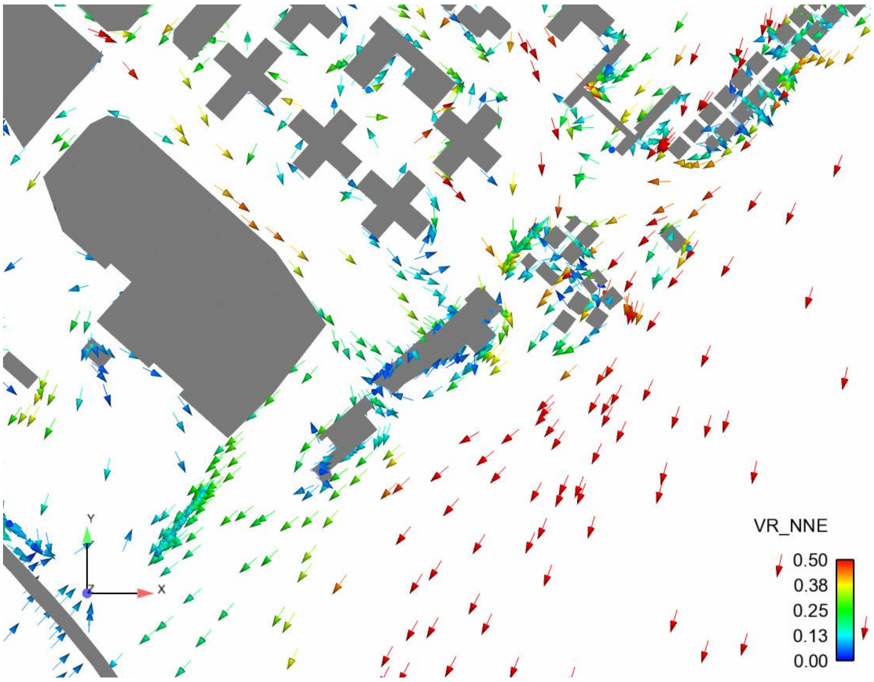
6.1 Under NNE wind, site wind availability of the Project Area mainly relies on redirected wind from Ngan O Road, building gap at Yuk Ming Court, incoming wind along Tin Chau Road and Green Belt ("GB") of Pak Shing Kok.

6.2 In the Baseline Scheme, a portion of wind from Ngan O Road is diverted towards Chiu Shun Road and Pak Shing Kok Ventilation Building that creates a wake at south perimeter of the Project Area. Incoming wind from building gap at Yuk Ming Court between Kwan Ming House and Wai Ming House flows through the Project Area via the low-rise nature at the northeast portion. Wind from Tin Chau Road and Green Belt of Pak Shing Kok is partially obstructed by the low-rise houses of Fat Tau Chau Village and then reaches the south perimeter of the Project Area.

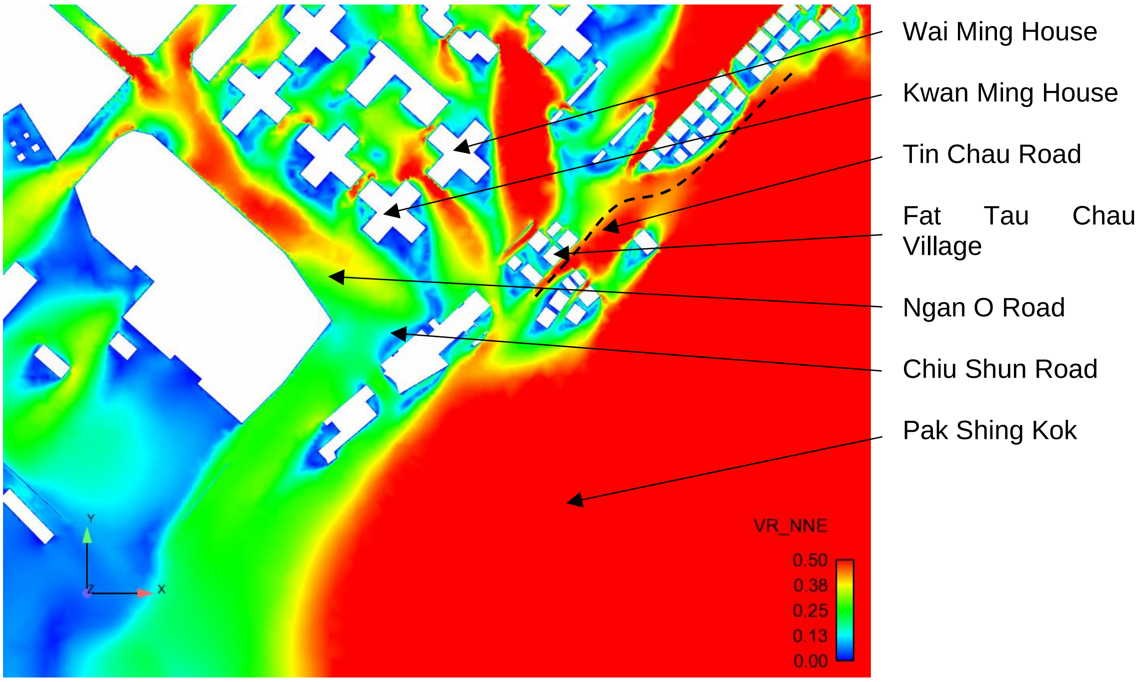
6.3 In the Proposed Scheme, a slight enhancement of winds is observed at south perimeter of the Project Area as the driveway empty bay at grade of the Proposed Scheme allows a portion of incoming wind from Tin Chau Road to flow around the site perimeter. A smaller wind stagnant area is observed at leeside of the podium.

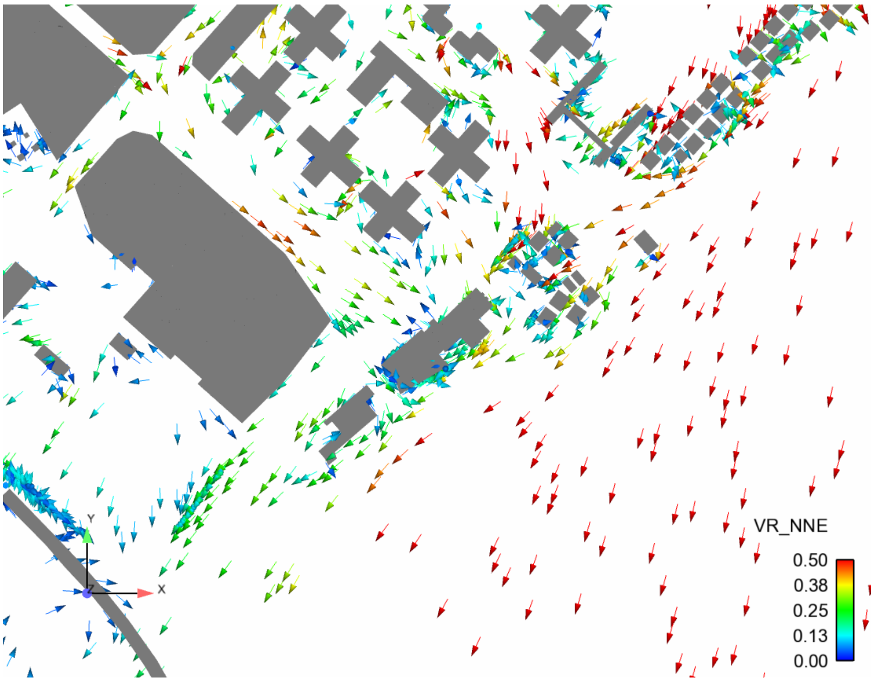
Baseline Scheme





Proposed Scheme





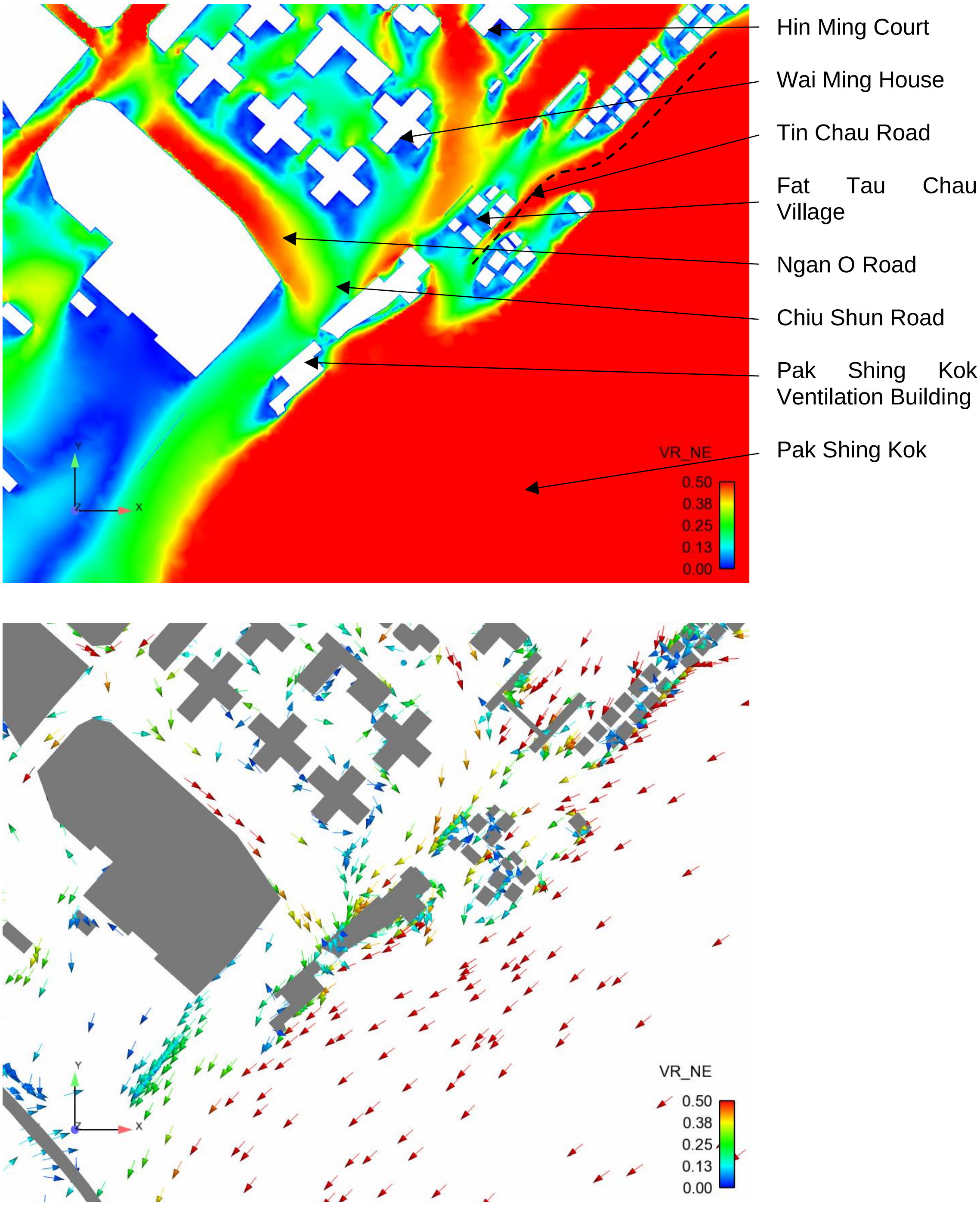
NE: (Annual: 10.7%)

6.4 Under NE wind, site wind availability of the Project Area mainly relies on redirected wind from Ngan O Road, building gap between Wai Ming House and Hin Ming Court, incoming wind along Chiu Shun Road, Tin Chau Road and Green Belt of Pak Shing Kok.

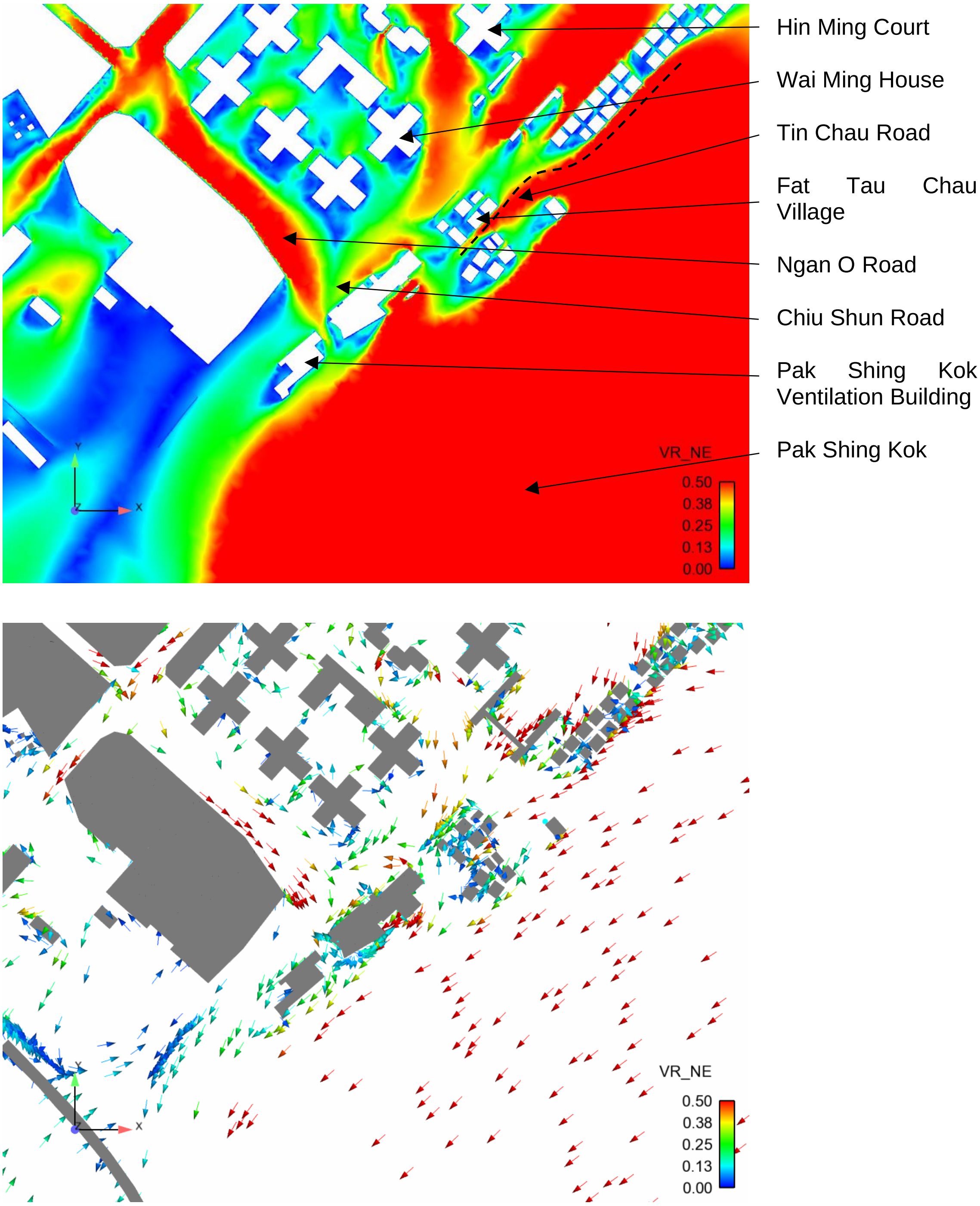
6.5 In the Baseline Scheme, a portion of wind from Ngan O Road is diverted towards Chiu Shun Road and Pak Shing Kok Ventilation Building that creates a wake at south perimeter of the Project Area. Incoming wind from building gap between Wai Ming House and Hing Ming Court merging with the incoming wind from Chiu Shun Road flows along the north perimeter of the Project Area. Wind from Tin Chau Road and Green Belt of Pak Shing Kok is partially obstructed by the low-rise houses of Fat Tau Chau Village and then reaches the south perimeter of the Project Area.

6.6 In the Proposed Scheme, a slight drawback of winds is observed at south perimeter of the Project Area as the air driveway empty bay at grade of the Proposed Scheme does not provide a continuous façade for incoming wind from Tin Chau Road to flow around the site perimeter, however, the morphology of the podium diverted this incoming wind towards the Green Belt of Pak Shing Kok. A slightly larger wind stagnant area is observed at leeside of the podium and extended to Pak Shing Kok Ventilation Building.

Baseline Scheme



Proposed Scheme



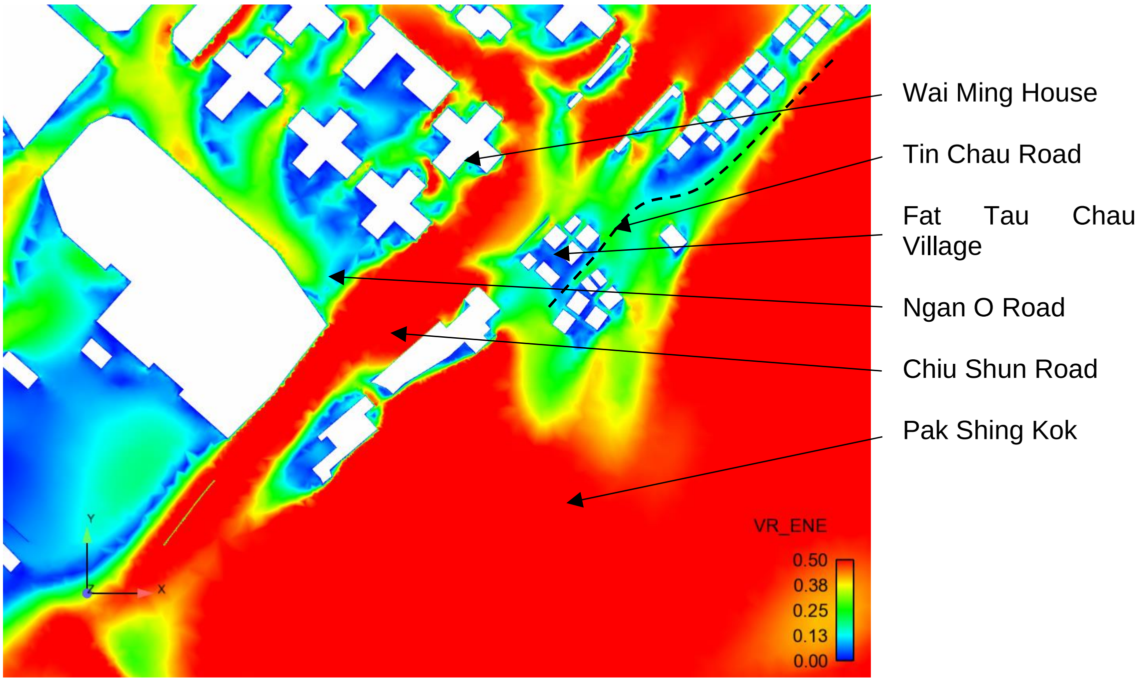
ENE: (Annual: 16.7%)

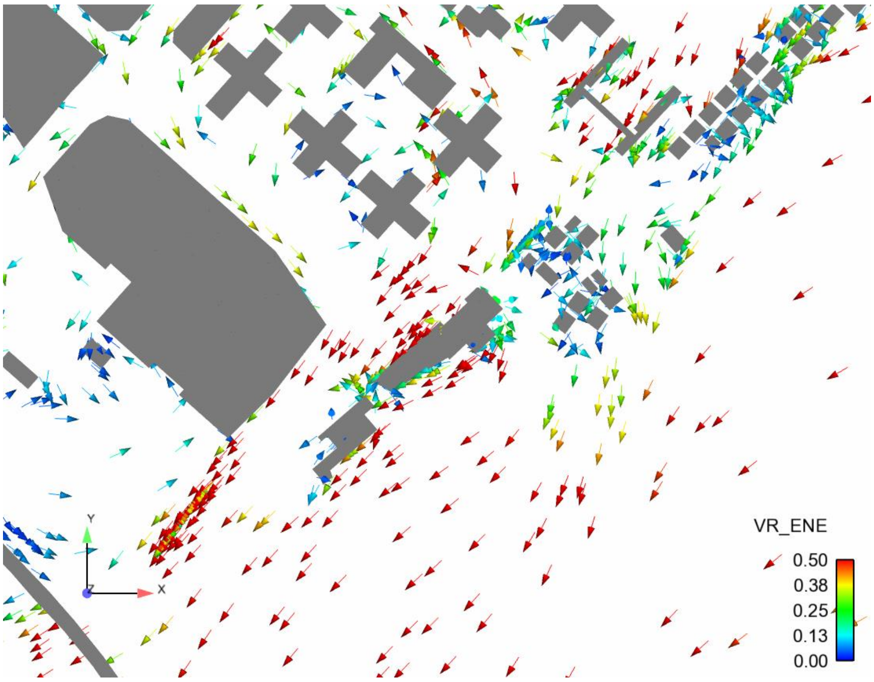
6.7 The incoming ENE wind mainly adopts Chiu Shun Road as major air path, combining with redirected wind from Ngan O Road at the north perimeter of the Project Area. Wind from Tin Chau Road is partially obstructed by the low-rise houses of Fat Tau Chau Village. Incoming wind from Green Belt of Pak Shing Kok is modulated by the topography towards north and reaches the south perimeter of the Project Area.

6.8 In the Baseline Scheme, incoming wind flows through Chiu Shun Road freely along the north perimeter of the Project Area, while incoming wind from Tin Chau Road and Pak Shing Kok is weakened by the downwash wind from Wai Ming House and the Baseline Scheme, creating a wind influencing zone at Fat Tau Chau Village.

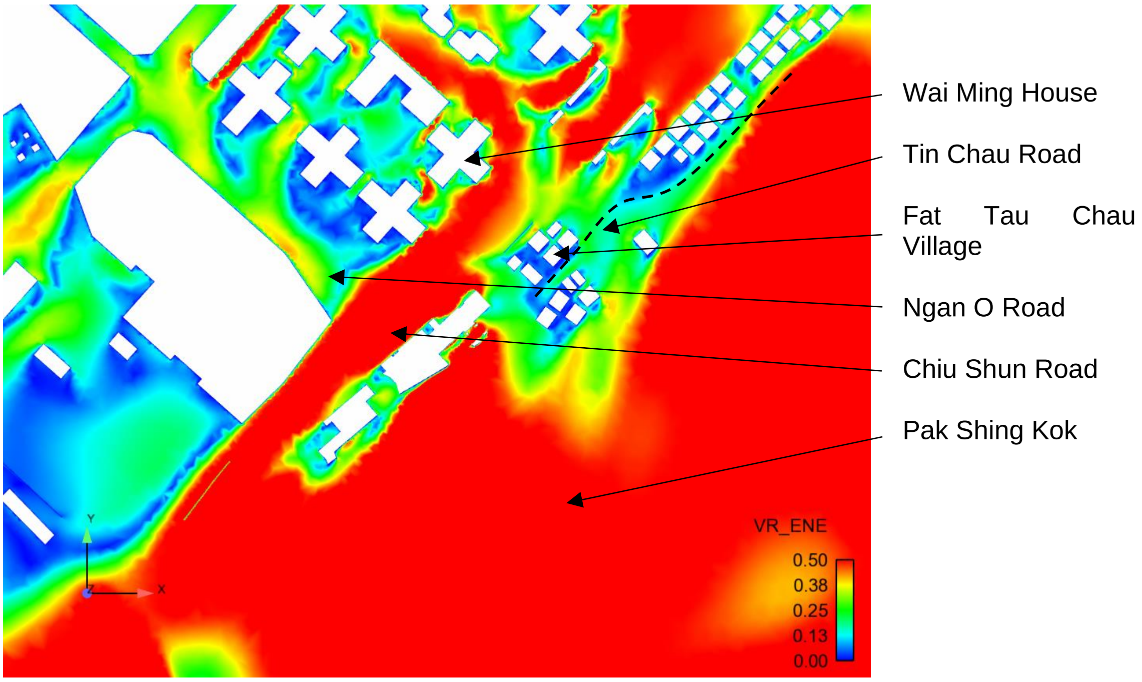
6.9 In the Proposed Scheme, similar phenomenon is observed resulting in lower VR at Fat Tau Chau Village. A slightly larger wind influencing zone is created by the morphology of the podium of the Proposed Scheme.

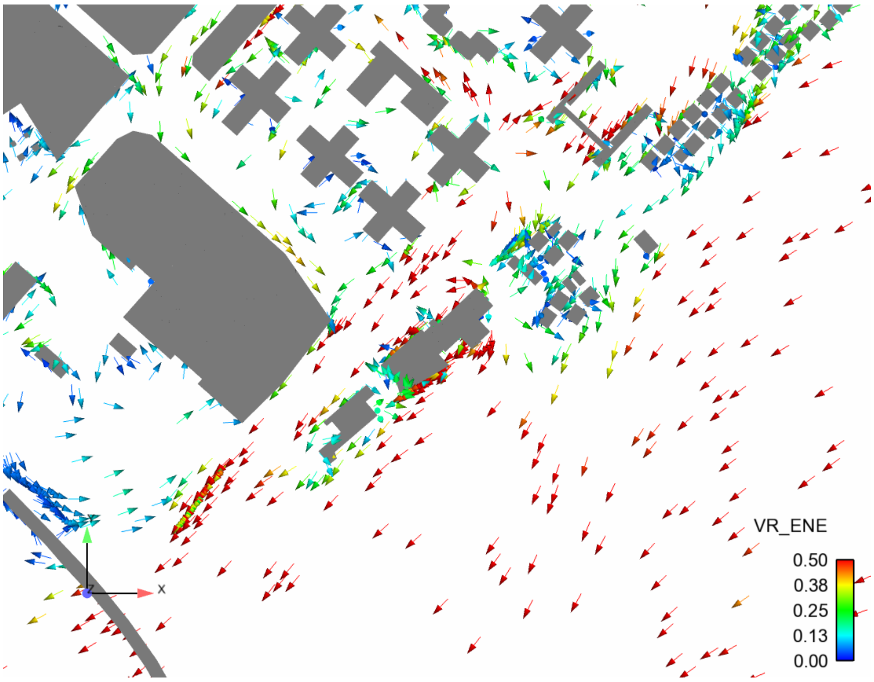
Baseline Scheme





Proposed Scheme





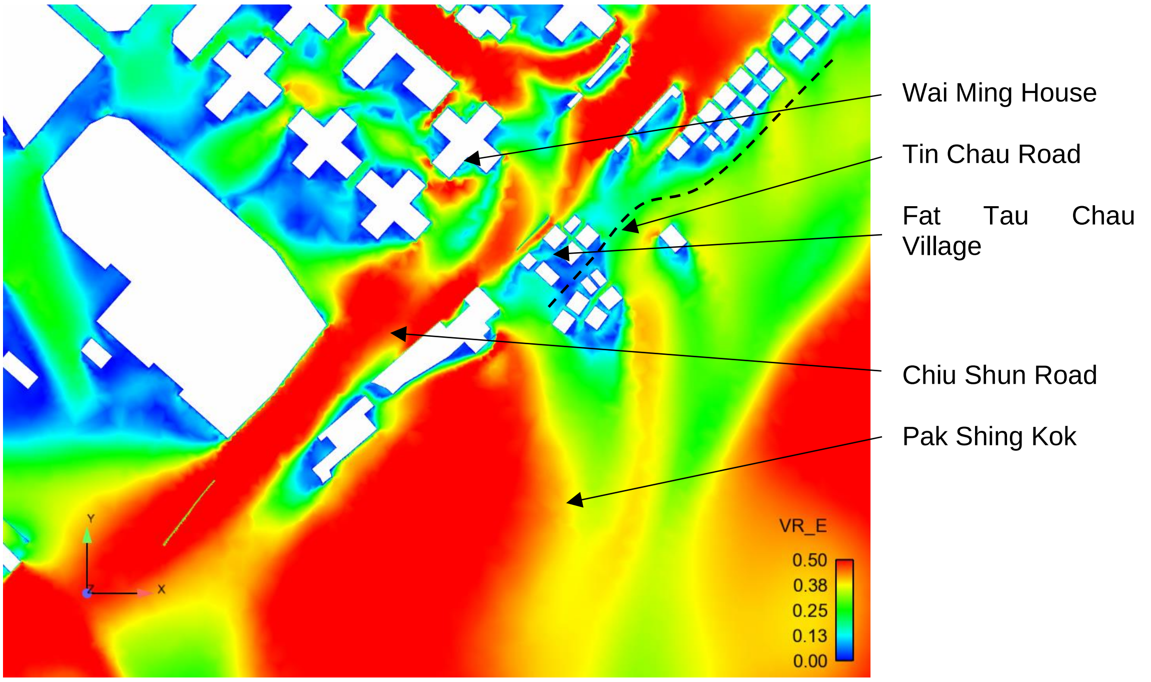
E: (Annual: 18.0%; Summer: 9.3%)

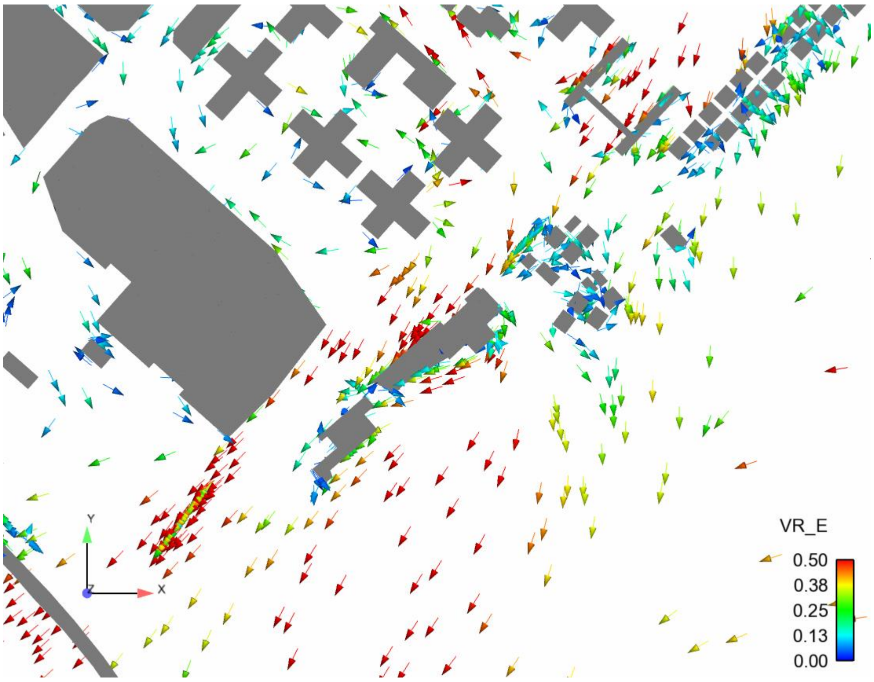
6.10 E incoming wind is weakened by Pak Shing Kok topography and reaches the south perimeter of the Project Area. A portion of incoming wind adopts Chiu Shun Road as major air path, reaching the north perimeter of the Project Area. Wind from Tin Chau Road is partially obstructed by the low-rise houses of Fat Tau Chau Village.

6.11 In the Baseline Scheme, incoming wind flows through Chiu Shun Road freely along the north perimeter of the Project Area, while incoming wind from Tin Chau Road and Pak Shing Kok is weakened by the downwash wind at Wai Ming House and the Baseline Scheme, creating a wind influencing zone at Fat Tau Chau Village.

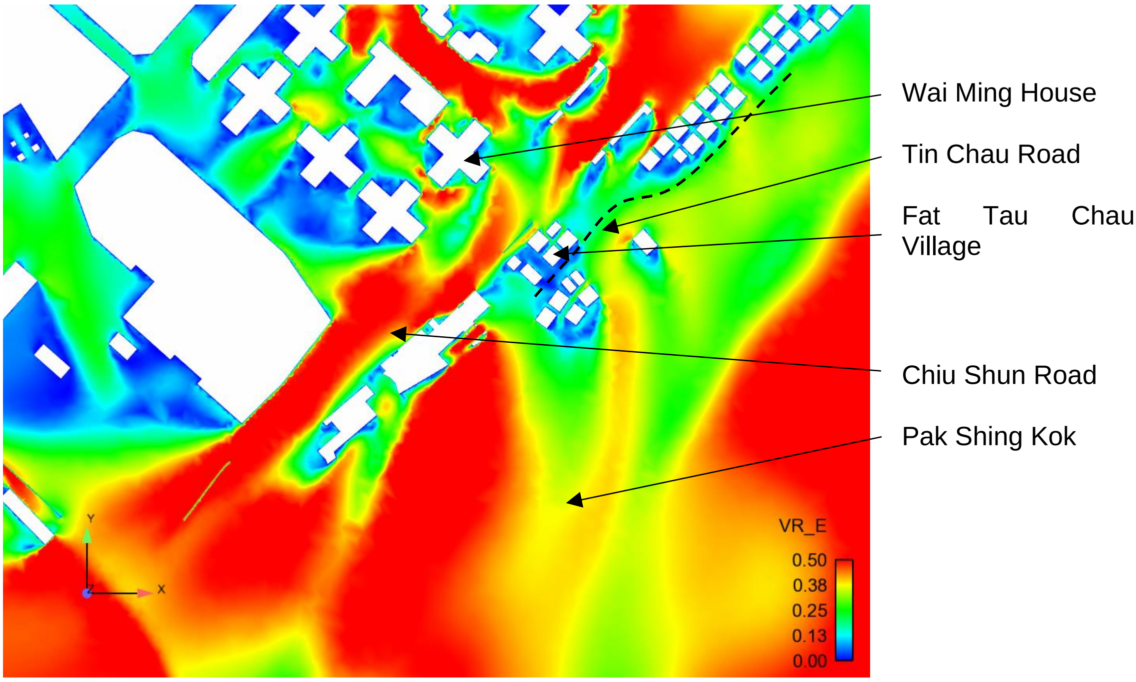
6.12 In the Proposed Scheme, similar phenomenon is observed resulting in lower VR at Fat Tau Chau Village. A slightly larger wind influencing zone is created by the morphology of the podium of the Proposed Scheme.

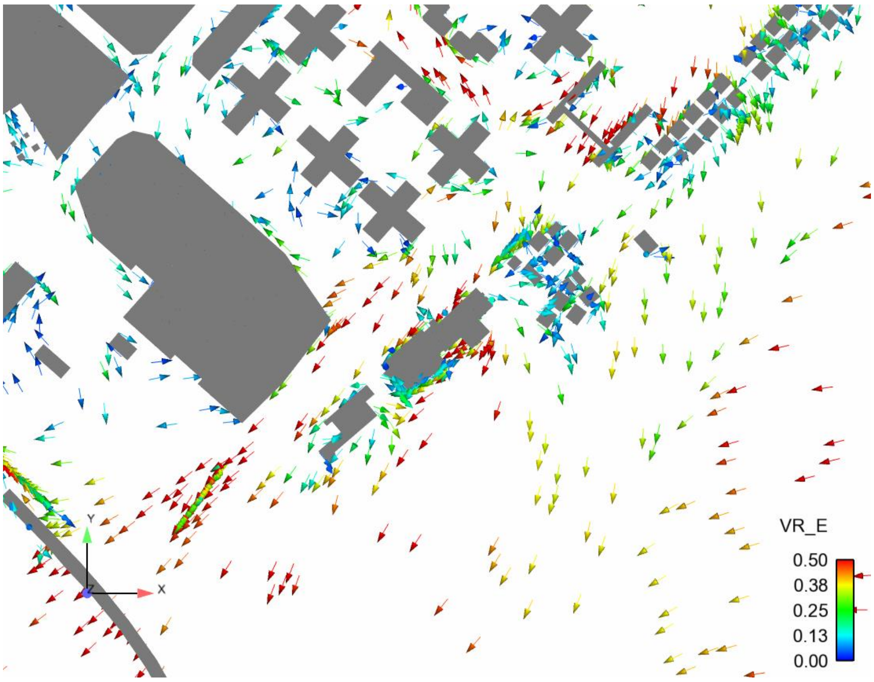
Baseline Scheme





Proposed Scheme





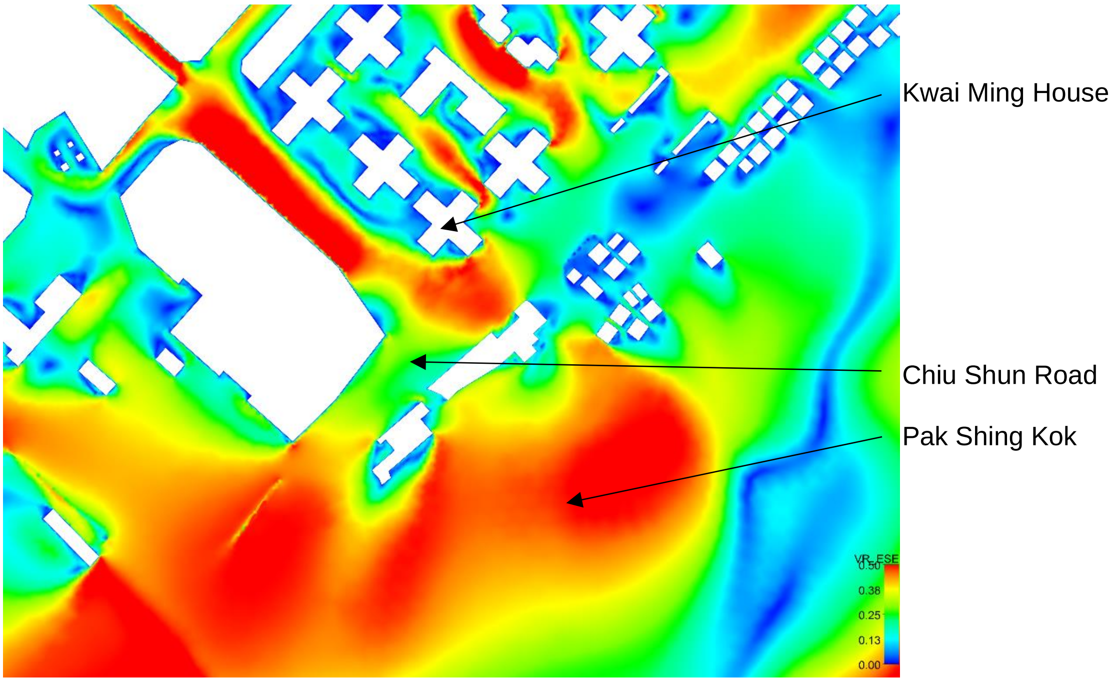
ESE: (Annual: 7.6%; Summer: 7.8%)

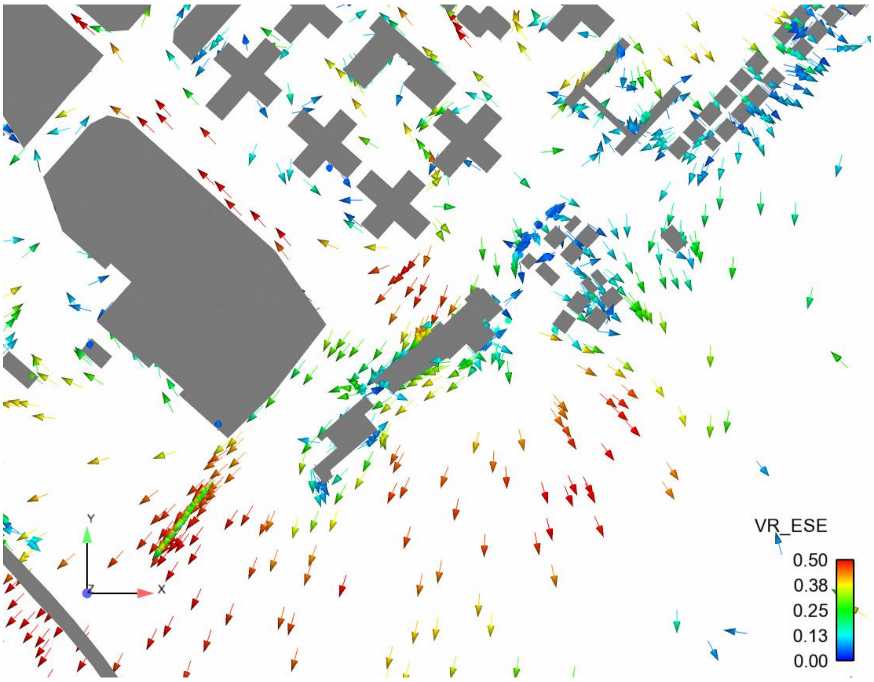
6.13 ESE incoming wind is weakened by Pak Shing Kok topography, creating a relative low VR region to the east and northeast of the Project Area. A portion of wind is diverted by Kwai Ming House and enters Chiu Shun Road, reaching the north perimeter of the Project Area.

6.14 The Baseline Scheme captured a portion of wind to reach the pedestrian level and then ventilate the south perimeter of the Project Area.

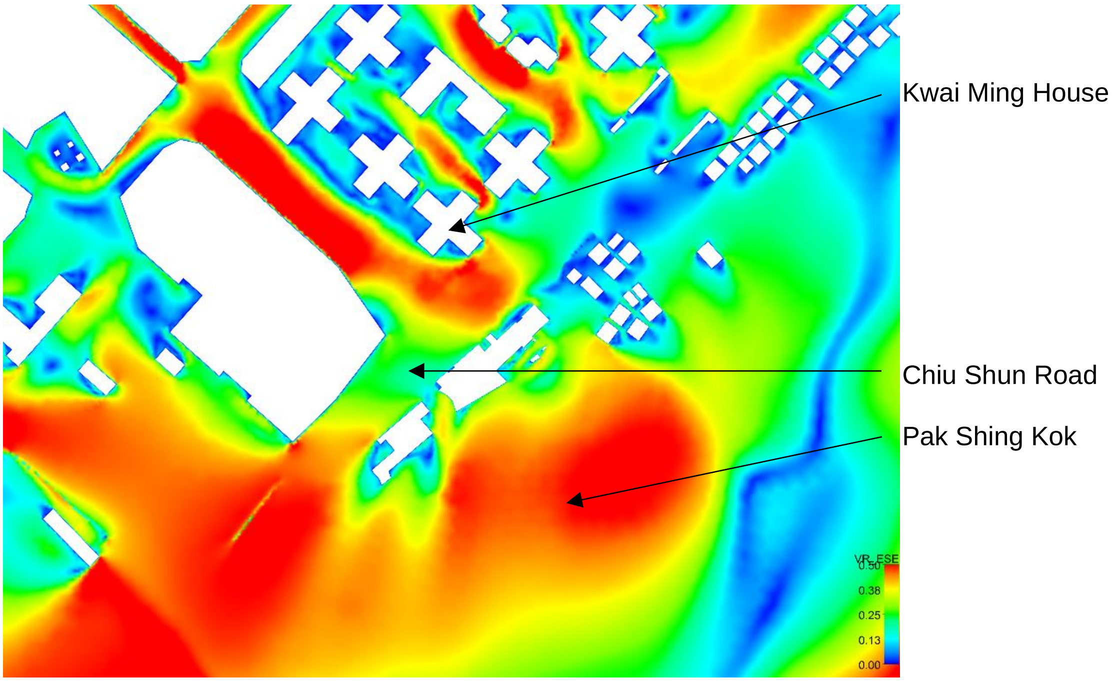
6.15 In the Proposed Scheme, similar phenomenon is observed that wind could reach the pedestrian level at south perimeter of the Project Area. A slightly larger wind influencing zone is created by the morphology of the Proposed Scheme.

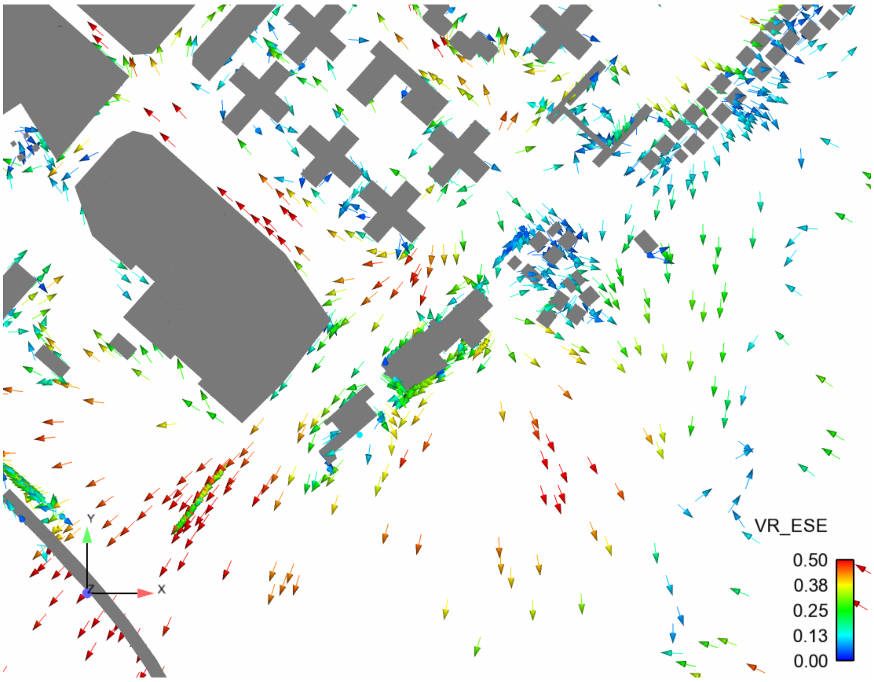
Baseline Scheme





Proposed Scheme





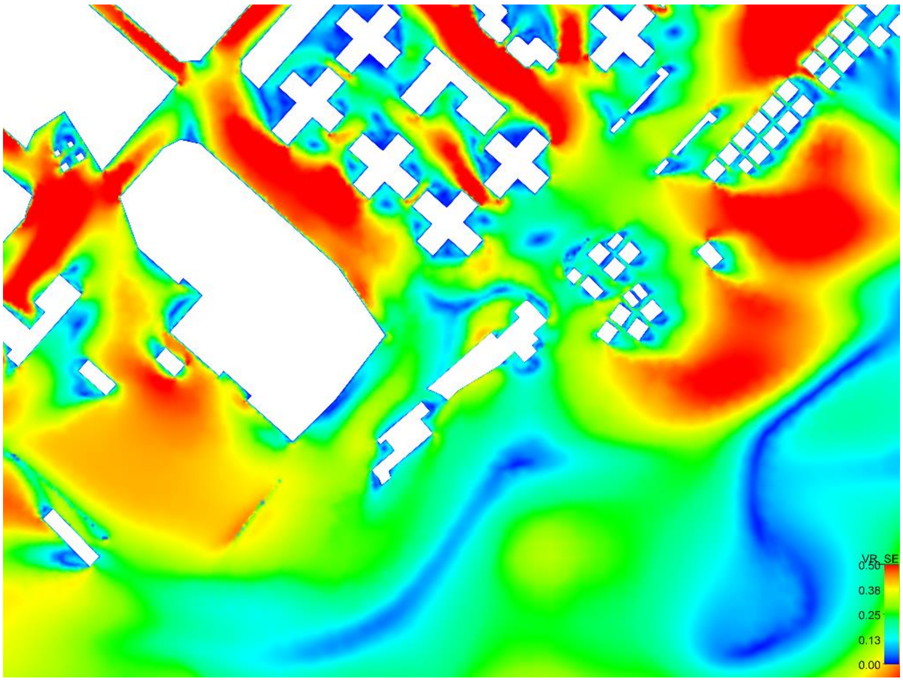
SE: (Annual: 5.1%; Summer: 6.2%)

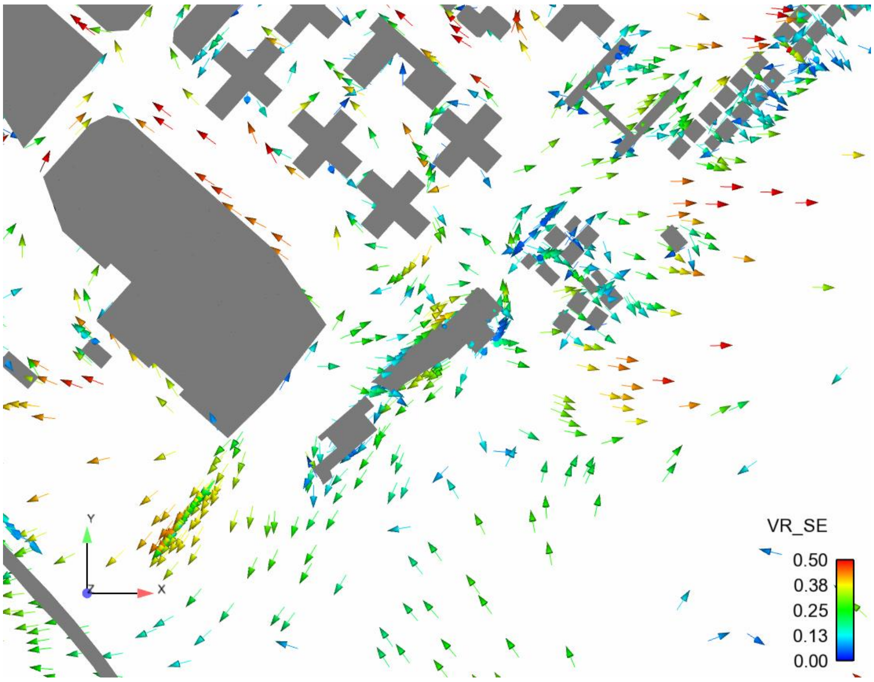
6.16 SE incoming wind is weakened by Pak Shing Kok topography, creating a relative low VR region to the east and southeast of the Project Area. A portion of wind is diverted by La Cite Noble to the podium level, however, could not ventilate Chiu Shun Road effectively at the north perimeter of the Project Area.

6.17 The Baseline Scheme captured a portion of wind to reach the pedestrian level and then ventilate the south perimeter of the Project Area and the south of Fat Tau Chau Village. Katabatic wind from Pak Shing Kok skims over the low-rise podium and reach Ngan O Road at downwind.

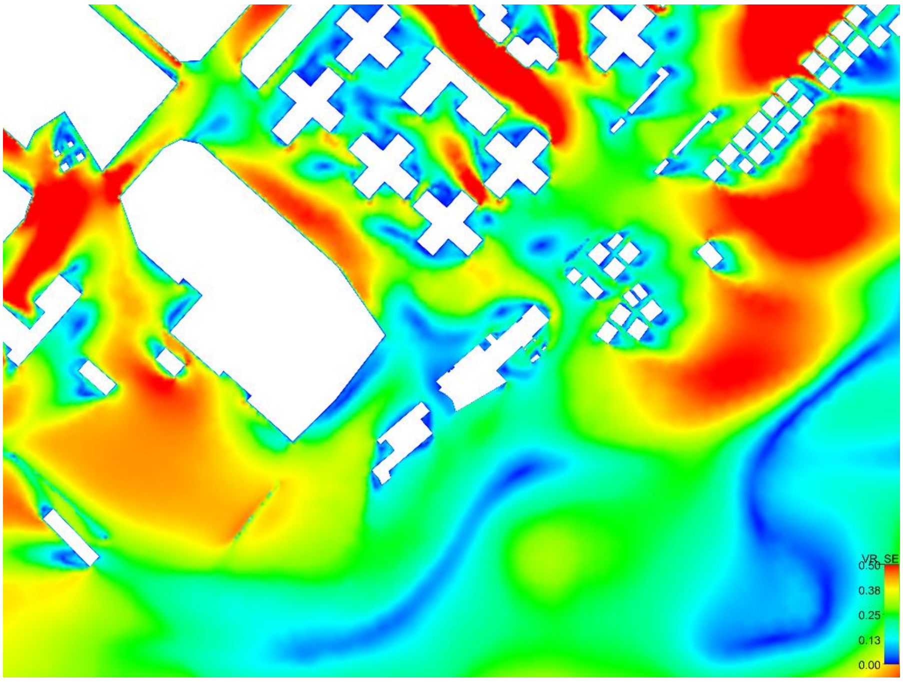
6.18 Similarly, in the Proposed Scheme, downwash wind of the Proposed Scheme could reach the pedestrian level at south perimeter. It is observed that the empty bay at grade facilitates diverted flow into the open space of the preserved tree within Project Area. However, a wind stagnant at Chiu Shun Road is observed from southwest portion of the podium as incoming wind is deflected from entering Ngan O Road, resulting a slightly lower VR in this region.

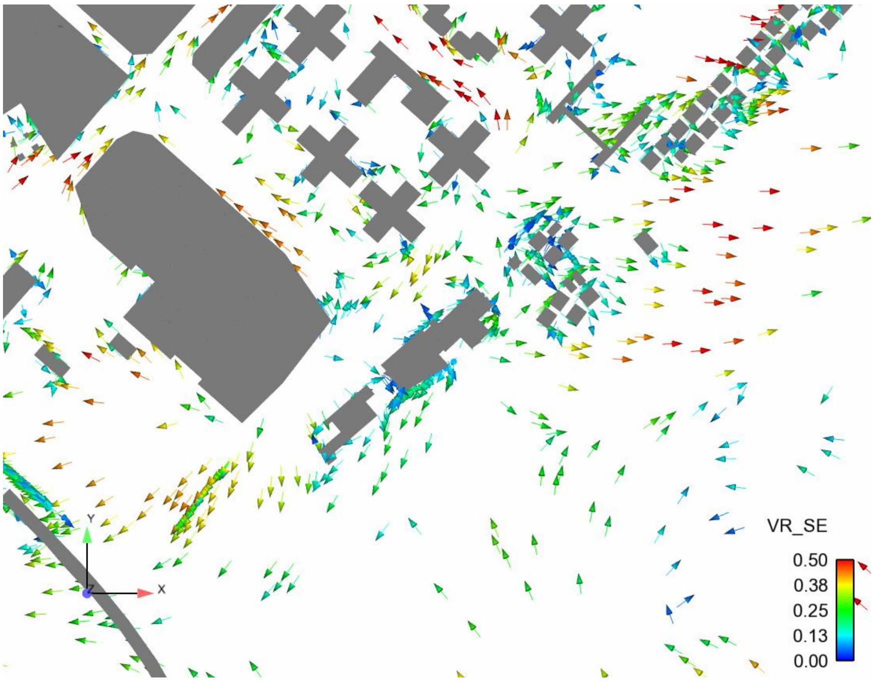
Baseline Scheme





Proposed Scheme





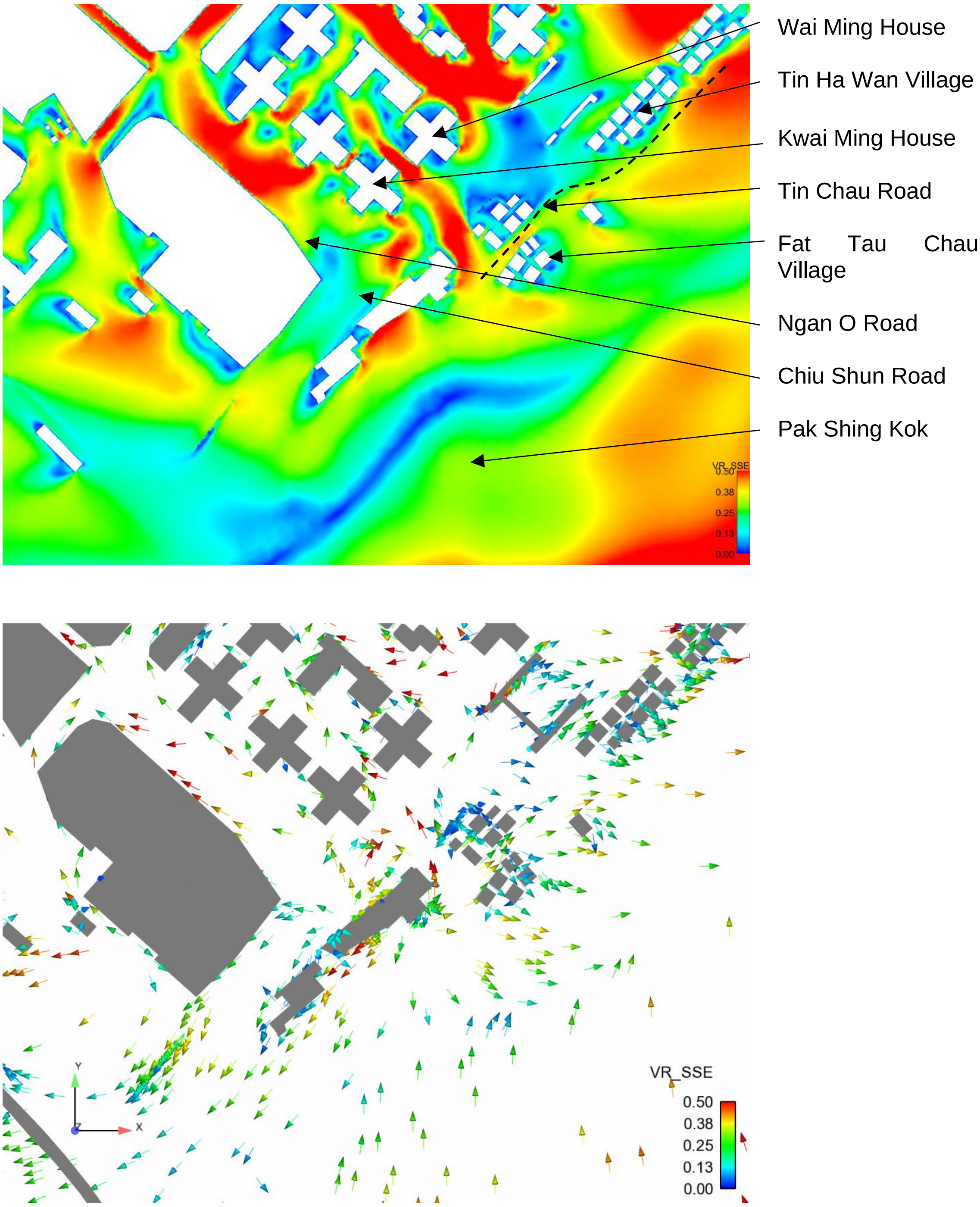
SSE: (Summer: 7.6%)

6.19 SSE incoming wind is weakened by Pak Shing Kok topography, creating a relative low VR region to the south and southeast of the Project Area. Air recirculation at the upwind of Project Area is observed due to downwash wind and the elevation difference from Pak Shing Kok down to the site perimeter. A portion of wind is diverted by Kwai Ming House to ventilate Chiu Shun Road and Ngan O Road to the northwest of the Project Area.

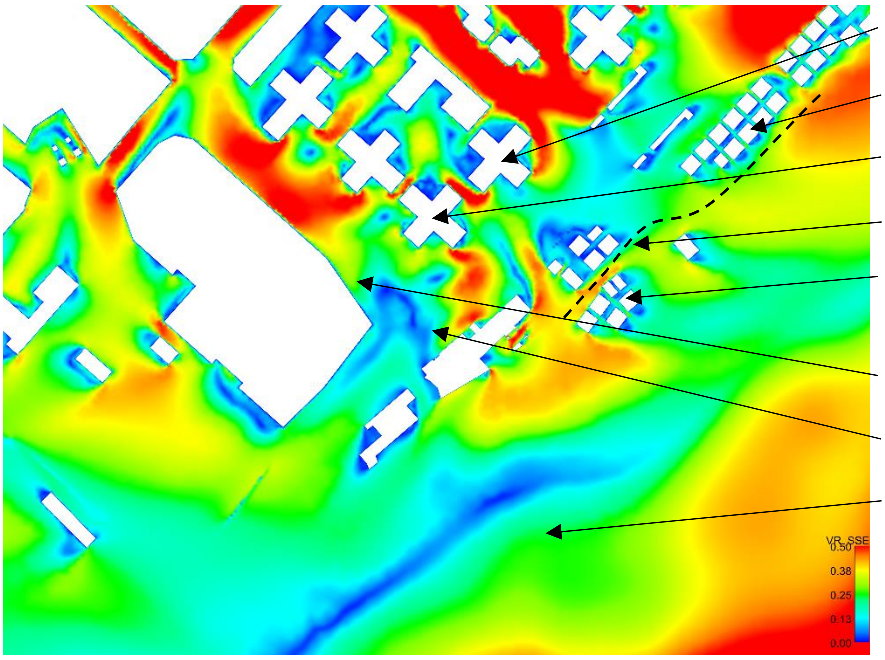
6.20 The Baseline Scheme captured a portion of wind to reach the pedestrian level and then ventilate the south perimeter of the Project Area. Katabatic wind from Pak Shing Kok skims over the low-rise podium (13.1mPD) while a portion of wind penetrate through the elevated podium at 13.1mPD and reach Ngan O Road at downwind. A portion of wind is diverted into the building gap of Kwai Ming House and Wai Ming House which ventilates the downstream.

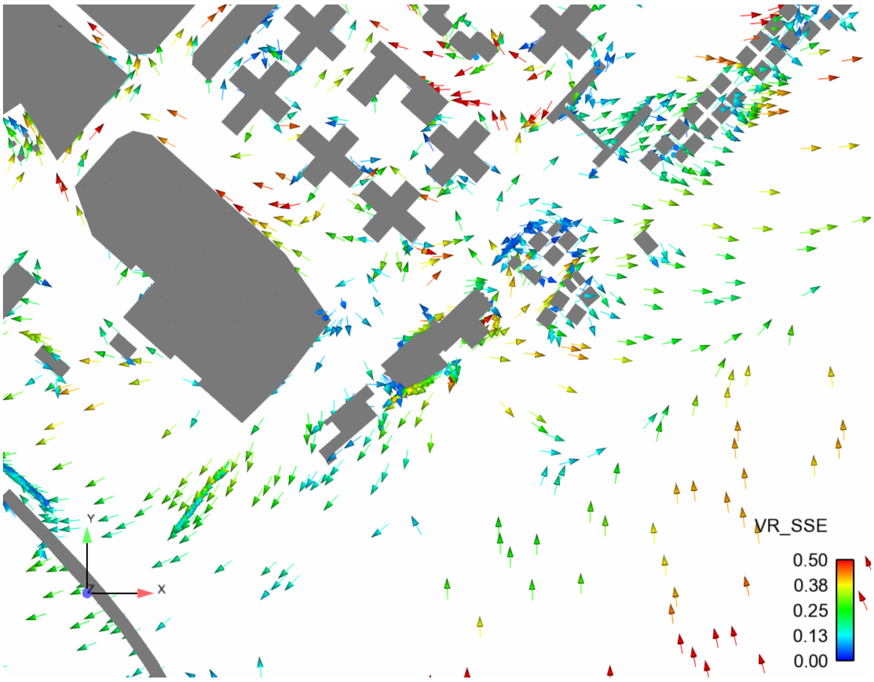
6.21 Similarly, in the Proposed Scheme, downwash wind of the Proposed Scheme could reach the pedestrian level at south perimeter and the landscape podium at 18.1mPD. Katabatic wind from Pak Shing Kok skims over the low-rise podium (18.1mPD) while a portion of wind penetrate through the elevated podium at 18.8mPD. The height of the podium (18.1mPD) and the bulkiness of podium at the southern portion diverts more downwash wind from the domestic tower back to Pak Shing Kok uphill encountering the katabatic wind from Pak Shing Kok, while it is diverted at the pedestrian level to the immediate south of the podium in the Baseline Scheme. As a result, the wind front at the south shifts towards Pak Shing Kok, showing in a different flow pattern and wind stagnant zone. Another wind stagnant is observed from southwest portion of the podium as incoming wind is partially obstructed to Chiu Shun Road at downstream, resulting a slightly lower VR at junction of Chiu Shun Road and Ngan O Road. The flow around the northeast edge of the podium and residential block further deflected onto Wai Ming House, which is then diverted to the north of Fat Tau Chau Village at pedestrian level while weakened to the south of Tin Ha Wan Village.

Baseline Scheme



Proposed Scheme





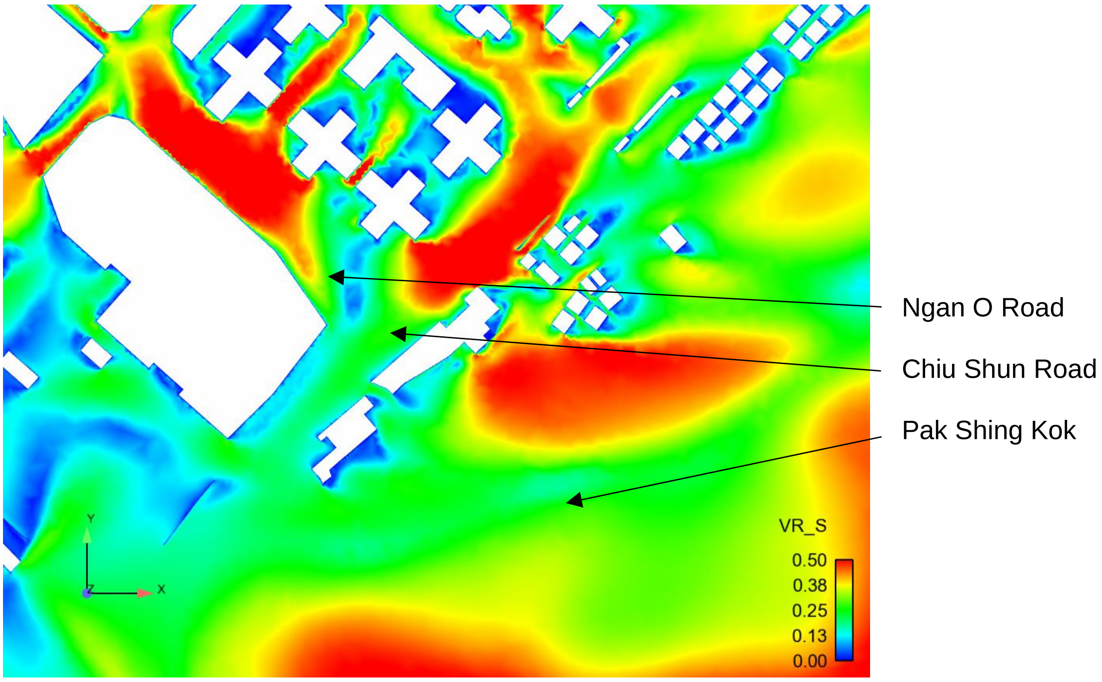
S: (Summer: 9.9%)

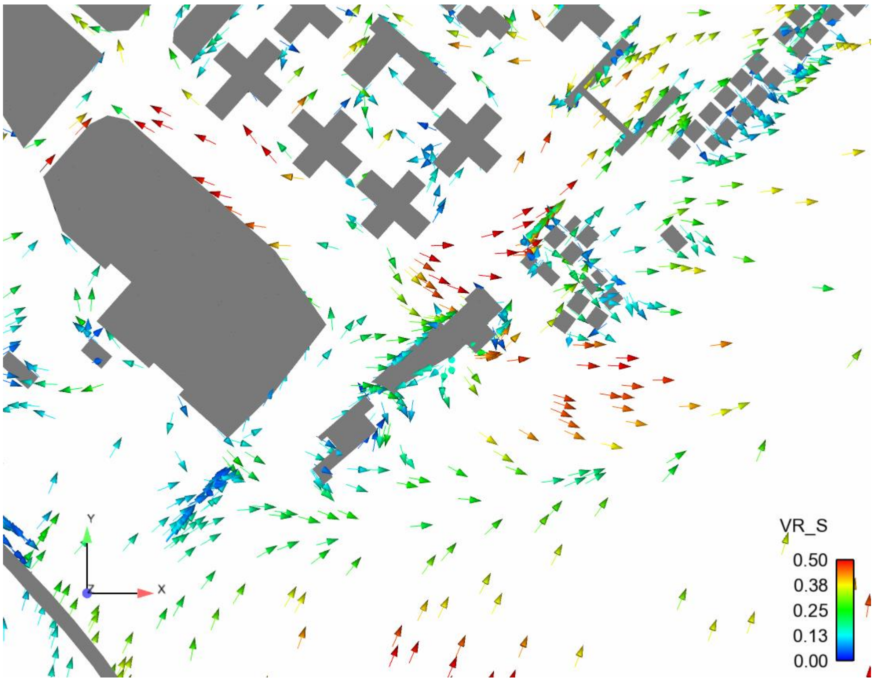
6.22 S incoming wind is weakened by Pak Shing Kok topography, creating a relative low VR region to the south of the Project Area. A portion of wind adopts Chiu Shun Road as air path and reaches the north perimeter of the Project Area.

6.23 The Baseline Scheme captured a portion of wind to reach the pedestrian level and then ventilate the south perimeter of the Project Area. Katabatic wind from Pak Shing Kok skims over the low-rise podium and reach Ngan O Road at downwind.

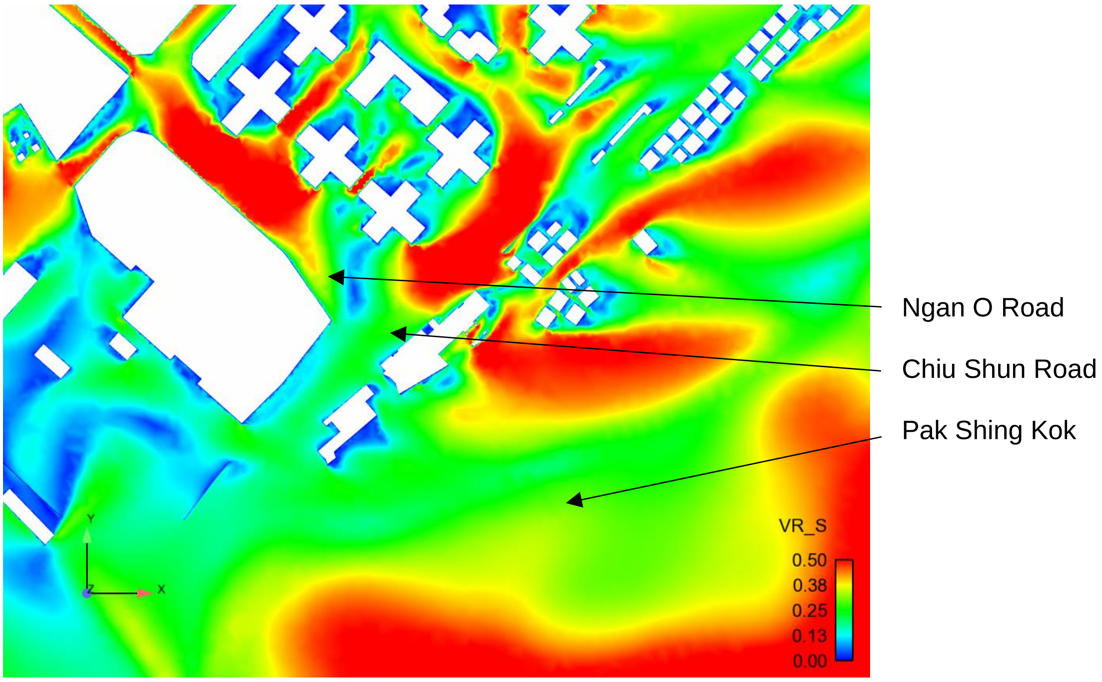
6.24 In the Proposed Scheme, due to the morphology of the podium, more downwash wind could reach the pedestrian level at south perimeter when compared to the Baseline Scheme, resulting a slightly larger VR zone at Green Belt of Pak Shing Kok. The morphology of the Proposed Scheme diverted more wind into Tin Chau Road to ventilate this area. Air stagnant is observed at the re-entrant space of at the north of podium due to its opening direction.

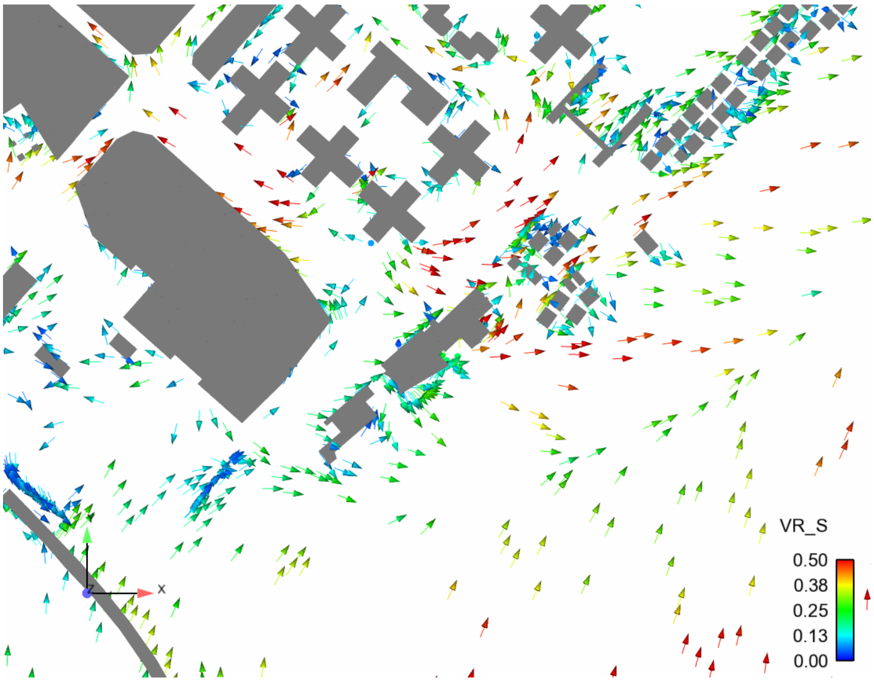
Baseline Scheme





Proposed Scheme





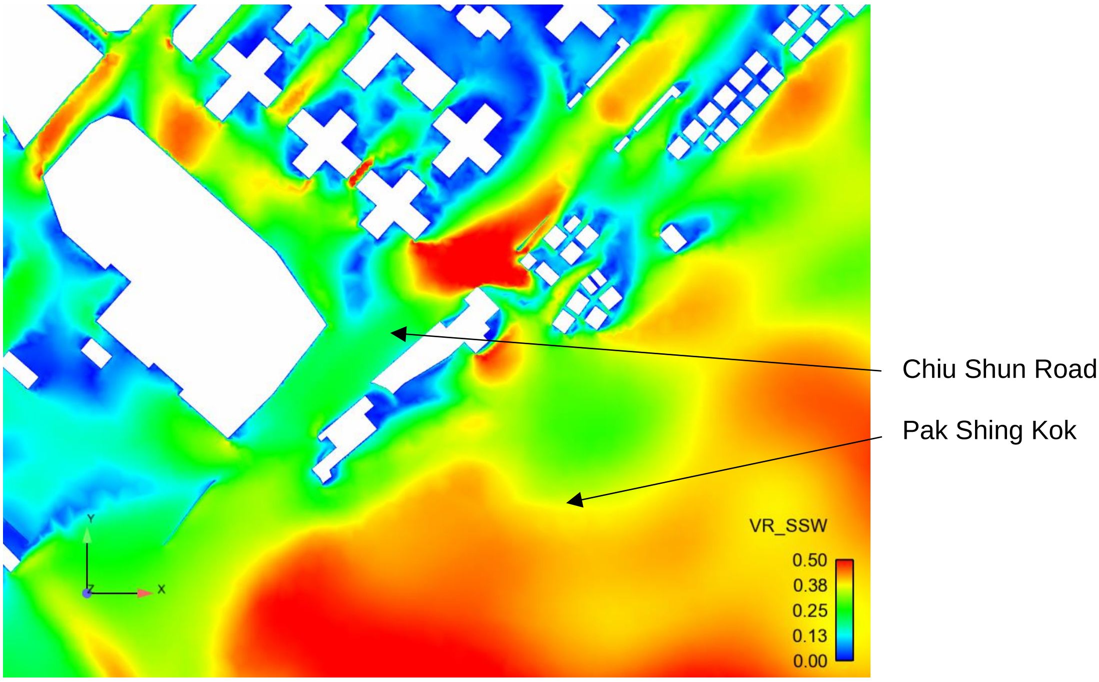
SSW: (Annual: 6.1%; Summer: 14.2%))

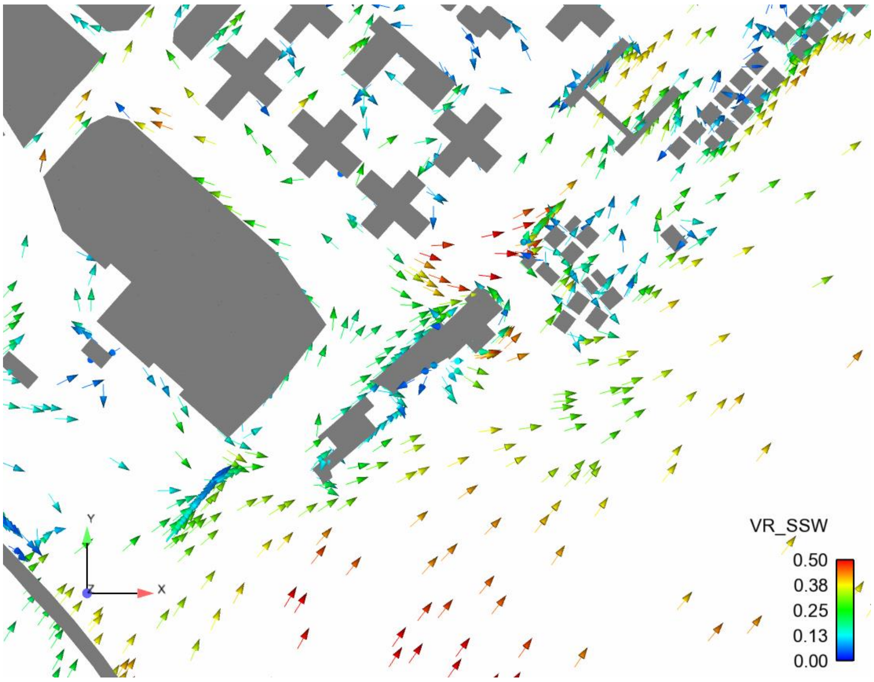
6.25 SSW incoming wind mainly adopts Chiu Shun Road as major air path and reaches the north perimeter of the Project Area. Wind from Pak Shing Kok is weakened by the topography, creating a relative low VR region to the southeast of the Project Area.

6.26 In the Baseline Scheme, the incoming from Chiu Shun Road flow through the north perimeter of the Project Area freely without adverse impact. The Baseline Scheme captured a portion of wind to reach the pedestrian level and then ventilate the south perimeter of the Project Area.

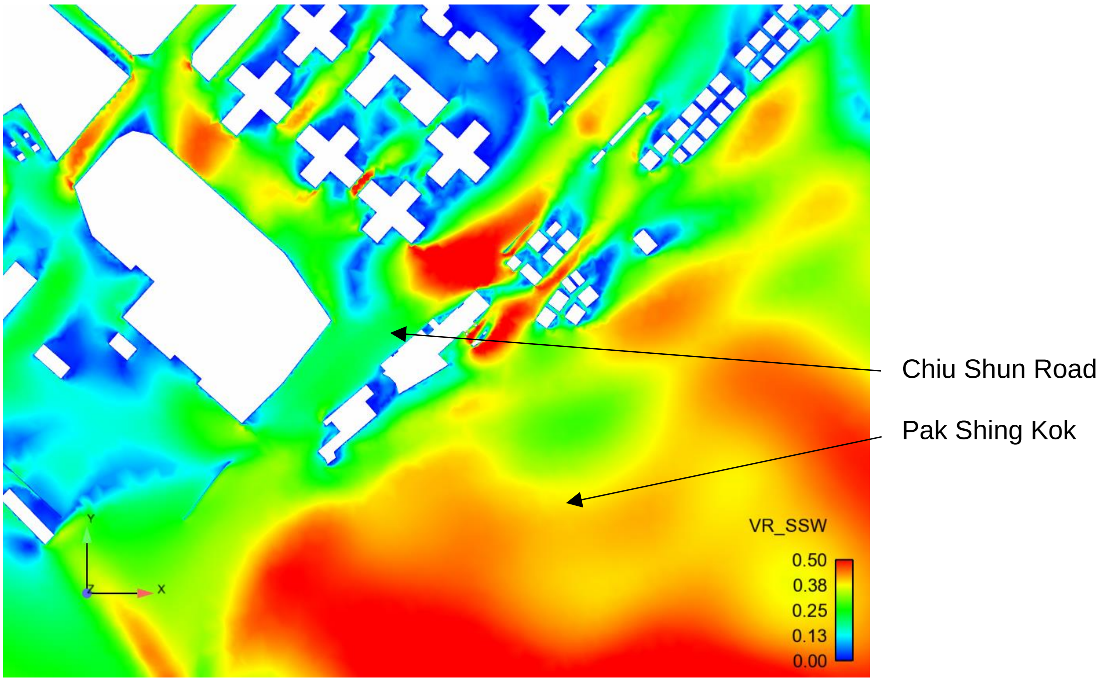
6.27 Similar observation could be found in the Proposed Scheme. Due to the different morphology of podium and residential block, a slightly different flow pattern and VR distribution is observed at downwind region. No adverse impact is observed.

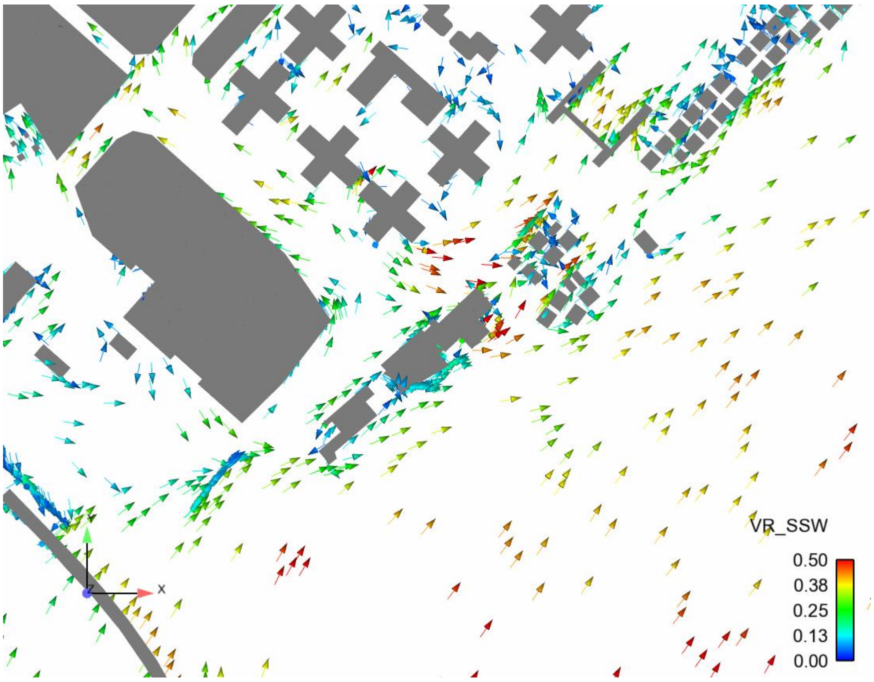
Baseline Scheme





Proposed Scheme





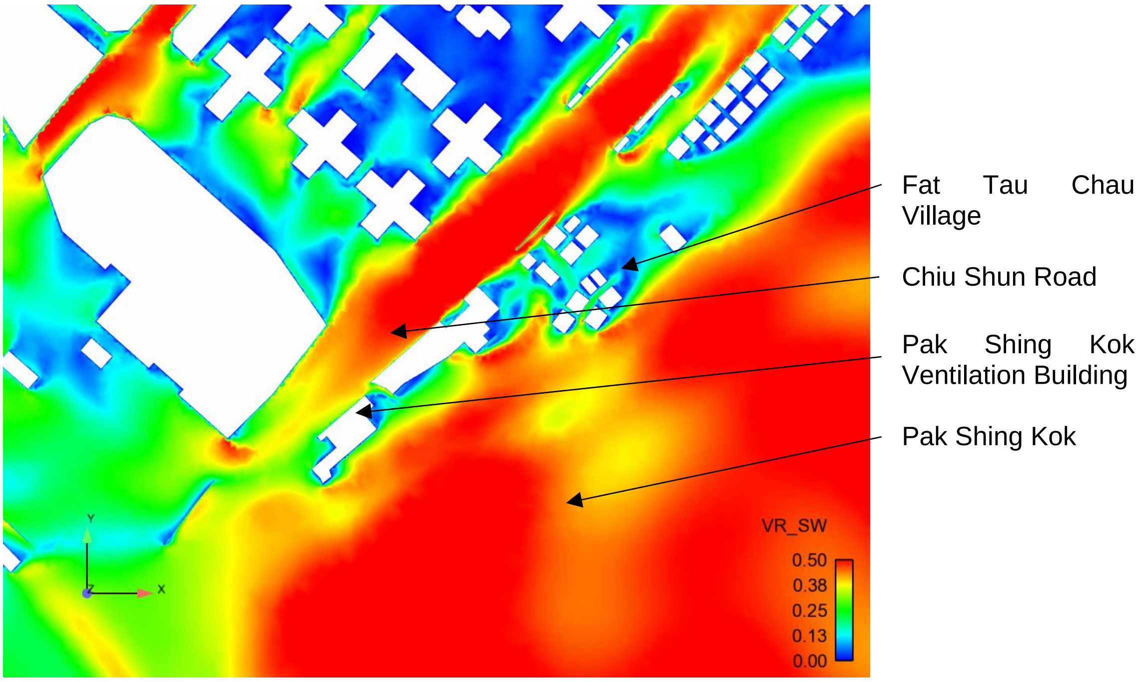
SW: (Annual: 6.7%; Summer: 16.0%)

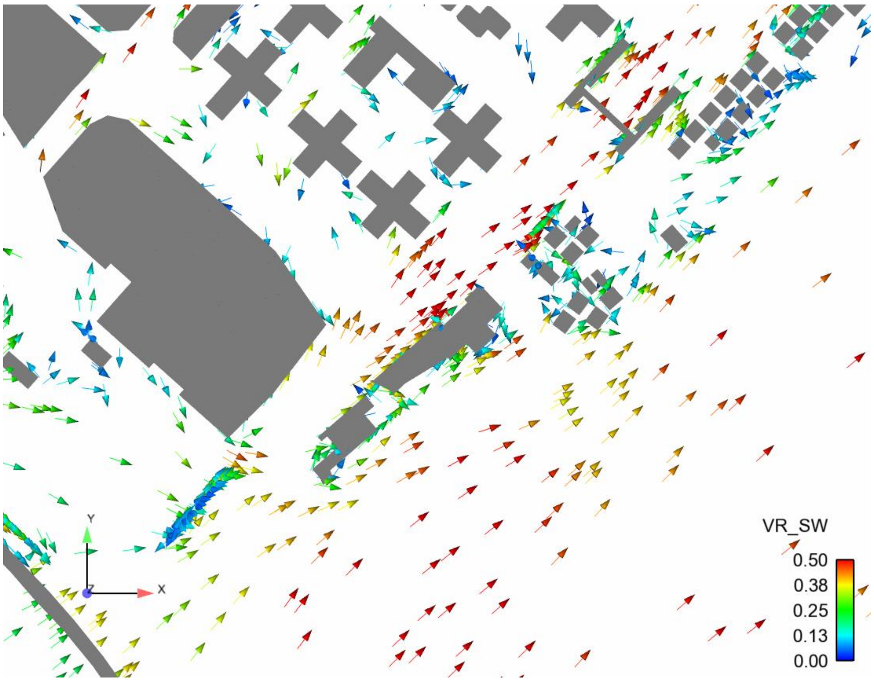
6.28 SW incoming wind is diverted by the Pak Shing Kok Ventilation Building. A portion of wind adopts Chiu Shun Road as major air path and reaches the north perimeter of the Project Area, while another portion flows over the Pak Shing Kok topography near the south perimeter of the Project Area.

6.29 In the Baseline Scheme, the incoming from Chiu Shun Road flow through the north perimeter of the Project Area freely without adverse impact. The Baseline Scheme captured a portion of wind to reach the pedestrian level and then ventilate the south perimeter of the Project Area.

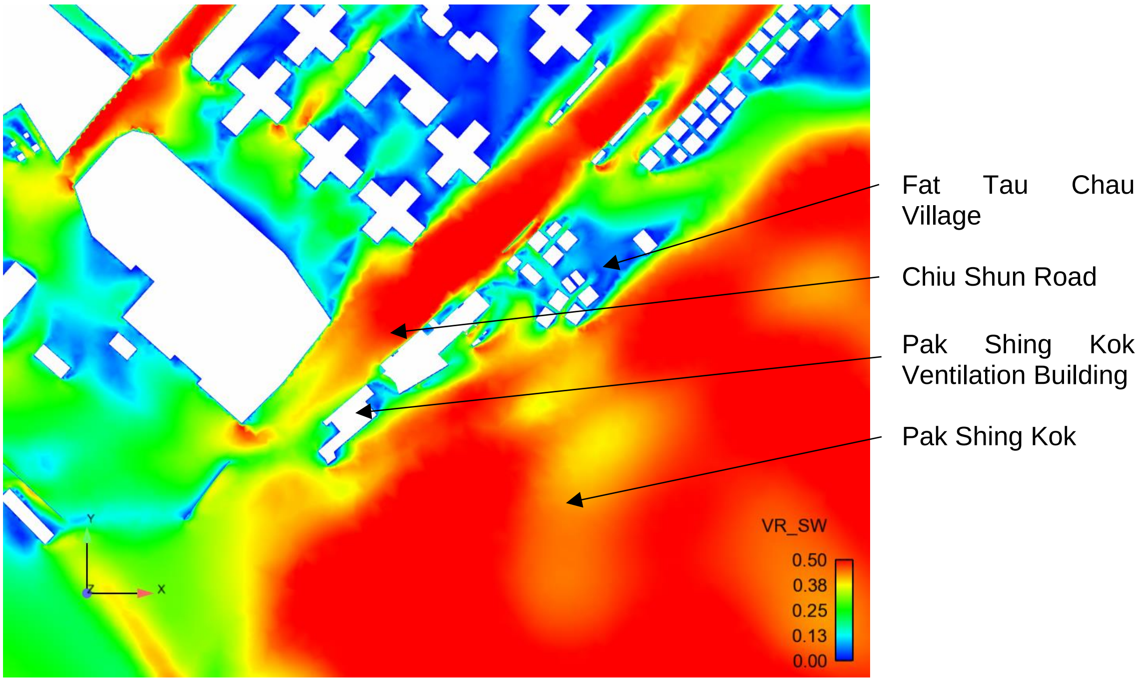
6.30 Similar observation could be found in the Proposed Scheme. Due to the different morphology of podium and residential block, a slightly different flow pattern and VR distribution is observed at Fat Tau Chau Village. No adverse impact is observed at downwind region. Moreover, the empty bay at grade allows flow around the northeast open space within site while wind acceleration is observed in the Baseline Scheme at the southeast perimeter. It is observed that the Proposed Scheme would have a higher VR in the area to the southeast of the subject site due to the larger podium coverage in the alignment with Pak Shing Kok Ventilation Building upwind. The incoming wind could flow freely over the slopes in this area while downwash wind could reach pedestrian level in the Baseline Scheme that could disturb the incoming wind, resulting in a lower VR.

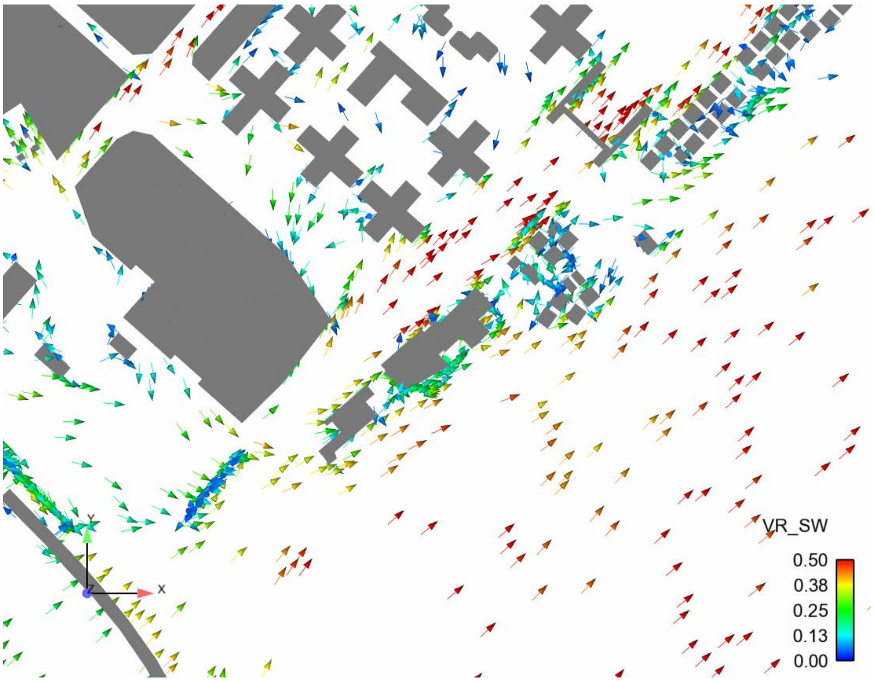
Baseline Scheme





Proposed Scheme





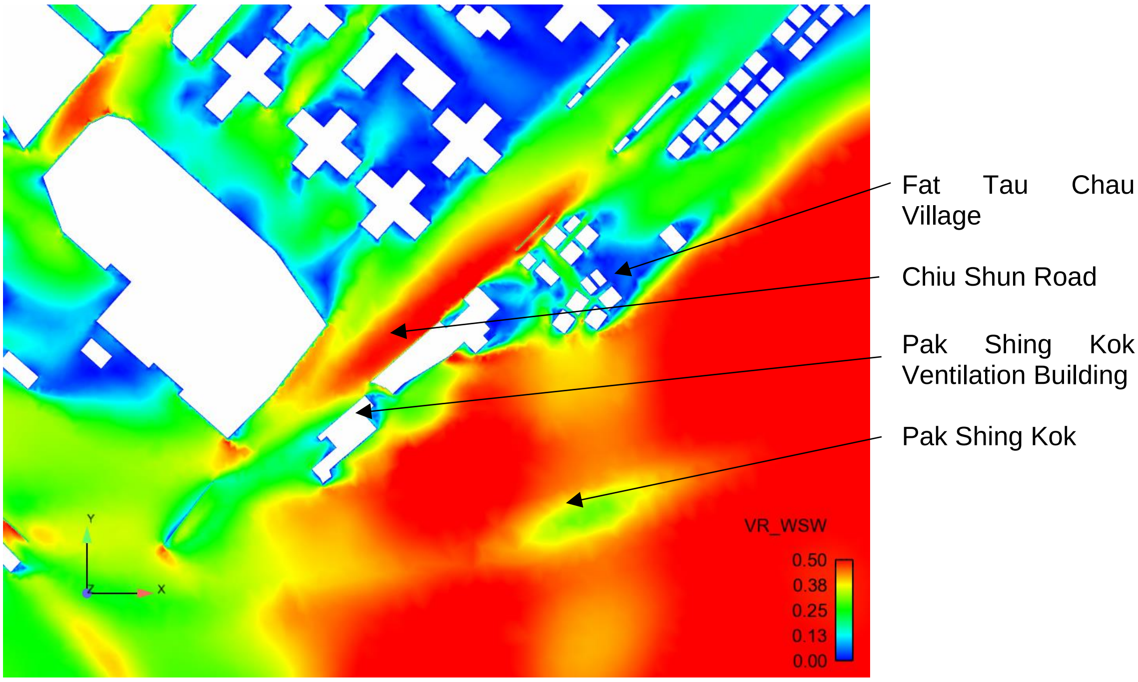
WSW: (Summer: 9.7%)

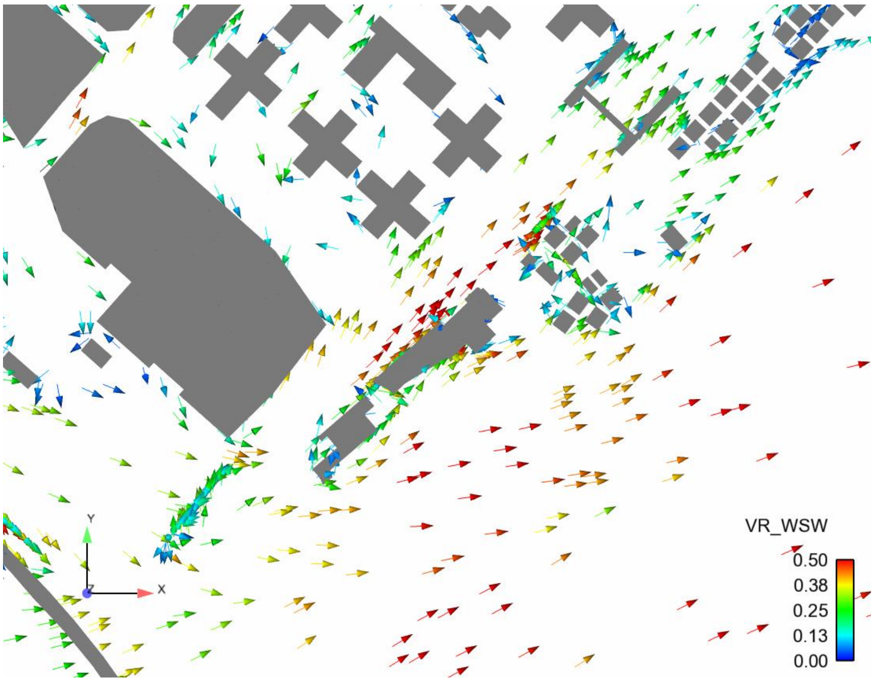
6.31 WSW incoming wind is diverted by the Pak Shing Kok Ventilation Building. A portion of wind adopts Chiu Shun Road as major air path and reaches the north perimeter of the Project Area, while another portion flows over the Pak Shing Kok topography near the south perimeter of the Project Area.

6.32 In the Baseline Scheme, the incoming from Chiu Shun Road flow through the north perimeter of the Project Area freely without adverse impact. The Baseline Scheme captured a portion of wind to reach the pedestrian level and then ventilate the south perimeter of the Project Area.

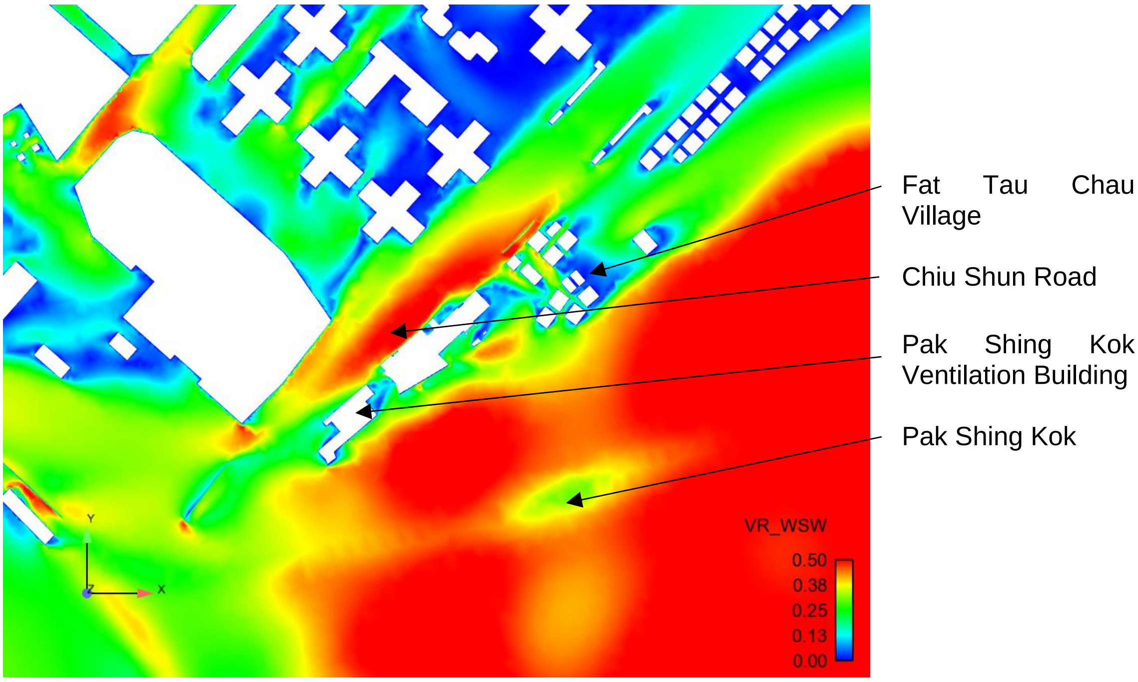
6.33 Similar observation could be found in the Proposed Scheme. Due to the different morphology of podium and residential block, a slightly different flow pattern and VR distribution is observed at Fat Tau Chau Village. No adverse impact is observed at downwind region. Moreover, the empty bay at grade allows flow around the northeast open space within site while wind acceleration is observed in the Baseline Scheme at the southeast perimeter. It is observed that the Proposed Scheme would have a lower VR in the area to the east of the subject site due to the fact that one additional podium floor in the Proposed Scheme could shelter WSW wind partially from reaching this area at pedestrian level.

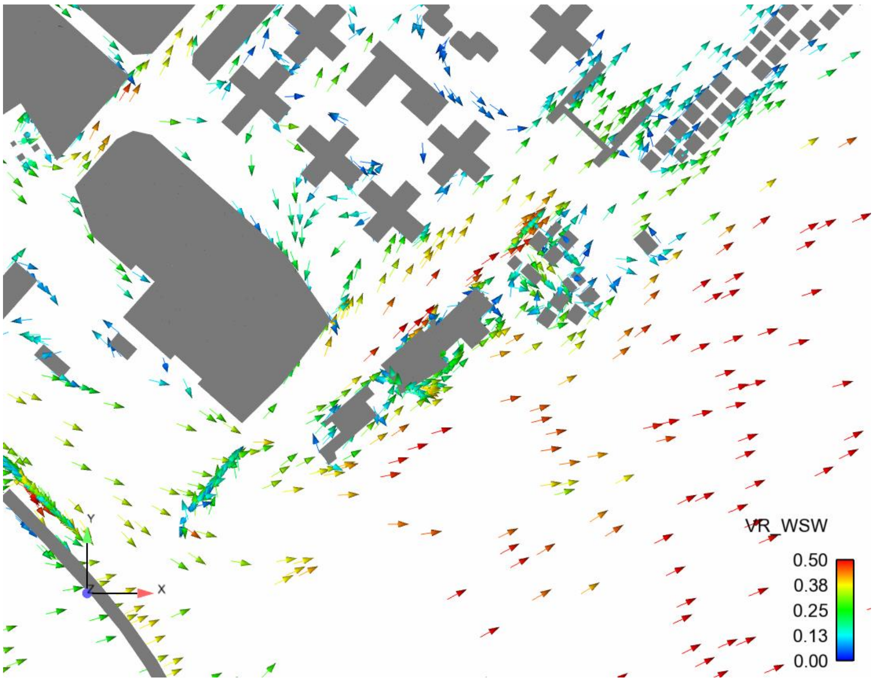
Baseline Scheme





Proposed Scheme



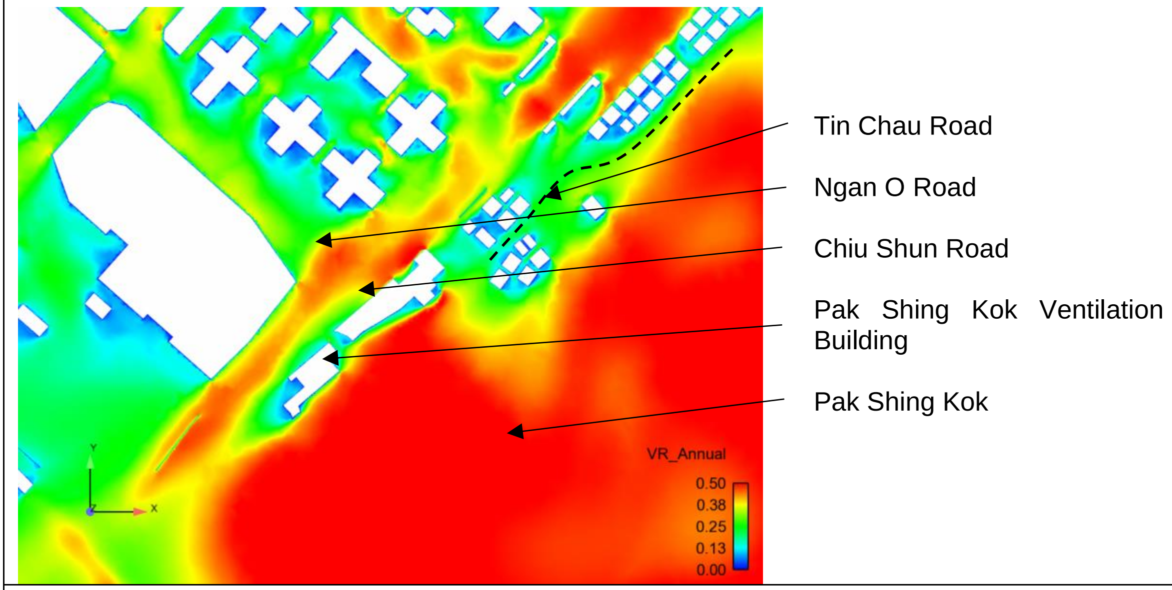


Overall Annual Frequency Weighted VR (78.1%)

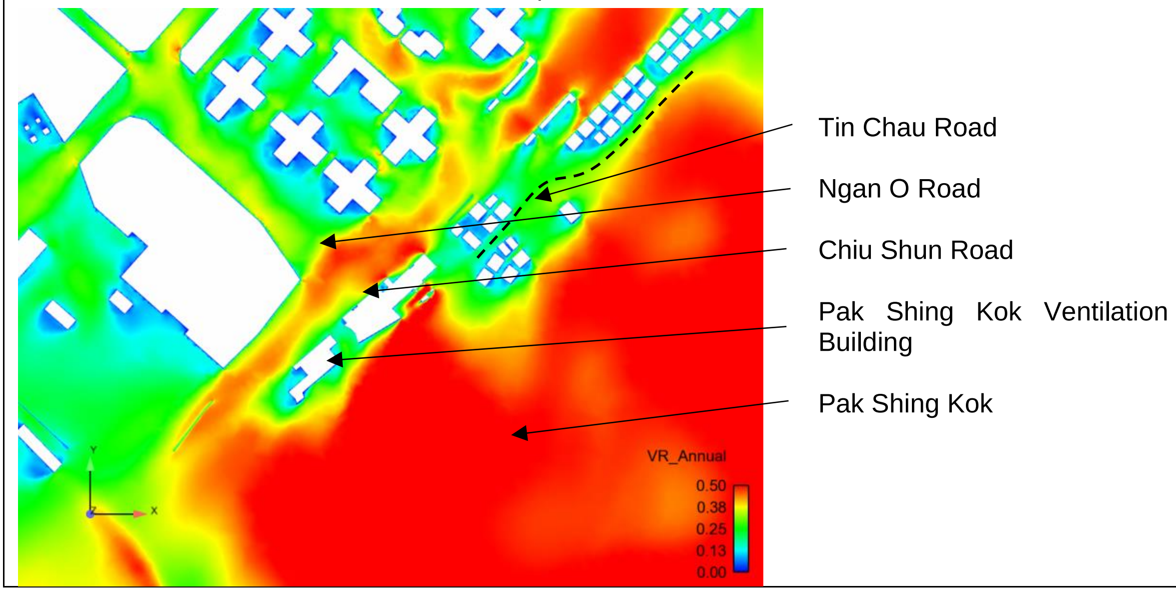
6.34 According to the overall annual frequency weighted VR plot, observable air ventilation enhancements and drawbacks are summarized as follow:

- Driveway empty bay at grade of the Proposed Scheme allows a portion of incoming wind from Tin Chau Road to flow around the site perimeter, however, the morphology of the podium diverted this incoming wind towards the Green Belt of Pak Shing Kok. A slightly larger wind stagnant area is observed at leeside of the podium and extended to Pak Shing Kok Ventilation Building
- The podium of the Proposed Scheme is not a continuous plane that would partially obstruct the incoming winds along Chiu Shun Road
- The podium of the Proposed Scheme partially obstructs south-easterly wind to enter Ngan O Road to ventilate the downwind area

Baseline Scheme



Proposed Scheme

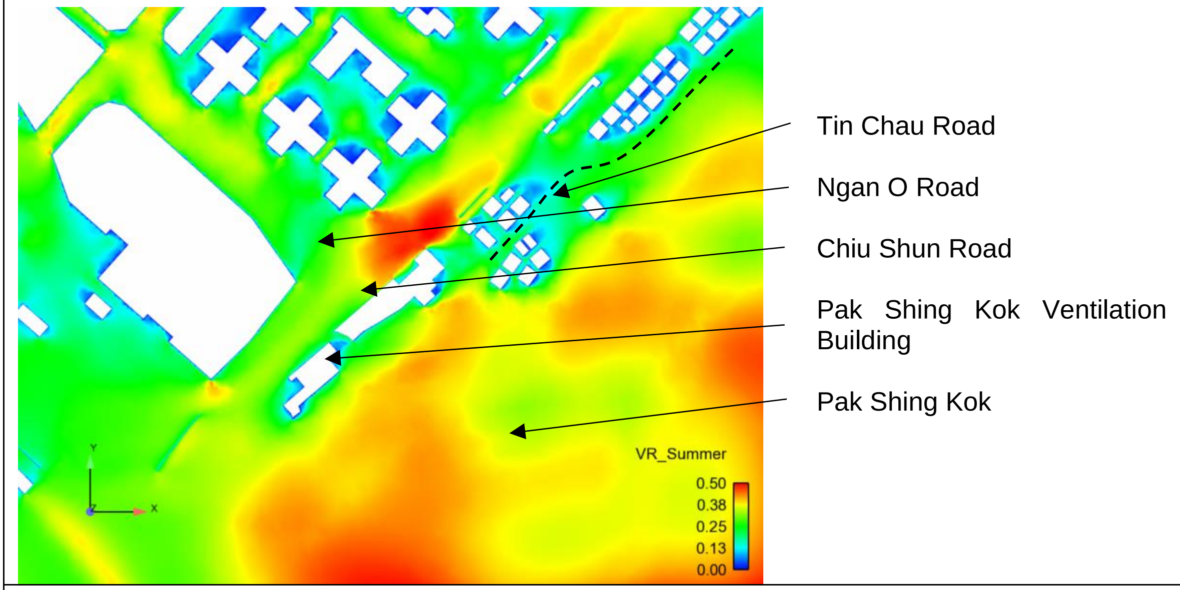


Overall Summer Frequency Weighted VR (80.7%)

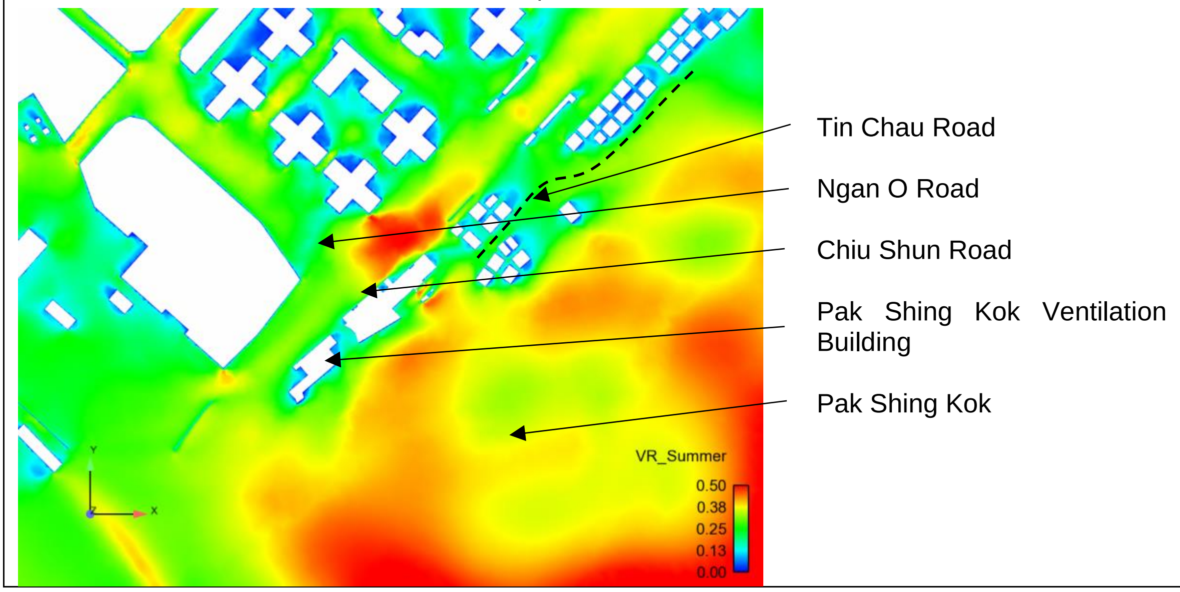
6.35 According to the overall summer frequency weighted VR plot, observable air ventilation enhancements and drawbacks are summarized as follow:

- Driveway empty bay at grade of the Proposed Scheme allows a portion of incoming wind from Tin Chau Road to flow around the site perimeter, however, the morphology of the podium diverted this incoming wind towards the Green Belt of Pak Shing Kok. A slightly larger wind stagnant area is observed at leeside of the podium and extended to Pak Shing Kok Ventilation Building
- The podium of the Proposed Scheme is not a continuous plane that would partially obstruct the incoming winds along Chiu Shun Road
- The podium of the Proposed Scheme partially obstructs south-easterly wind to enter Ngan O Road to ventilate the downwind area

Baseline Scheme



Proposed Scheme



7 SUMMARY AND CONCLUSIONS

7.1 This AVA Study Report aims 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 conceptual layout considered by the Town Planning Board on 11 August 2017 for rezoning, and the Proposed Development with minor relaxation for increasing the overall plot ratio from 6.5 to 6.65, namely the Baseline Scheme and the Proposed Scheme for the potential Chiu Shun Road Public Housing Development.

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

7.3 From the finding of this AVA Initial Study, the SVRw for both the Baseline Scheme and the Proposed Scheme is reduced from 0.36 to 0.34 under the annual prevailing wind from NNE, NE, ENE, E, ESE, SE, SSW and SW directions which amount to about 78.1% of the whole time in a year. Thus, a slight impact on air ventilation performance is observed in the vicinity of the Proposed Scheme under annual prevailing winds. This is due to the fact that the Proposed Development aligns with Chiu Shun Road and would not affect the width of Chiu Shun Road and the ventilation performance of Chiu Shun Road as a wind corridor under northeast quadrant and southwest quadrant winds. While the additional podium floor in Proposed Scheme could impact the air ventilation at site perimeter. Mitigation measures include stepped podium and elevated podium design, and empty bays of the Proposed Scheme would allow prevailing wind to skim over and penetrate thought the Project Area to ventilate the pedestrian level around podium.

7.4 The LVRw for the Baseline Scheme and the Proposed Scheme are reduced from 0.35 to 0.34 under the annual wind directions stated above. It can be concluded that the Proposed Scheme would have a slightly worse air ventilation performance compared to Baseline Scheme under the major annual winds.

7.5 From the finding of this AVA Initial Study, the SVRw for the Baseline Scheme and the Proposed Scheme are increased from 0.33 to 0.32 under the summer prevailing wind from E, ESE, SE, SSE, S, SSW, SW and WSW directions which amount to about 80.7% of the whole time in a year, which implies no significant impact on the wind environment of the Proposed Scheme when compared to the original Baseline Scheme considered by Town Planning Board.

7.6 The LVRw for the Baseline Scheme and the Proposed Scheme are decreased from 0.30 to 0.29 under summer wind conditions. It can be concluded that the Proposed Scheme would have a slight impact on air ventilation performance compared to Baseline Scheme.

7.7 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 (preferably tree planting) of no less than 20% for sites below 1 ha, preferably at grade;
- 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 issue to eliminate the use of noise barriers for more effective air paths; and
- Terraced podium design to further mitigate the ventilation impact at site perimeter.

7.8 To conclude, according to the simulation results in **Table 5.1**, similar LVR and SVR are achieved by the Proposed Scheme when compared with the Baseline Scheme under annual and summer wind conditions. No significant impact is anticipated to the surrounding pedestrian wind environment due to the Proposed Development with the minor relaxation for increasing the overall plot ratio from 6.5 to 6.65.

Appendix A

Wind Probability Table

Tabulated Results - Percentage Occurrence of Directional Winds
Annual - at 500m

f_01510	Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
V infinity (m/s)	Sum	0.033	0.072	0.107	0.167	0.180	0.076	0.051	0.044	0.045	0.061	0.067	0.041	0.023	0.010	0.010	0.011
00_to_01	0.019	0.001	0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.001
01_to_02	0.044	0.002	0.003	0.003	0.003	0.006	0.003	0.003	0.003	0.002	0.002	0.002	0.002	0.003	0.001	0.002	0.002
02_to_03	0.065	0.003	0.004	0.005	0.005	0.007	0.006	0.006	0.005	0.004	0.004	0.004	0.004	0.003	0.002	0.002	0.002
03_to_04	0.087	0.003	0.007	0.009	0.008	0.010	0.007	0.006	0.007	0.005	0.004	0.007	0.005	0.003	0.001	0.001	0.002
04_to_05	0.108	0.003	0.009	0.013	0.012	0.015	0.010	0.008	0.007	0.007	0.006	0.007	0.005	0.003	0.001	0.001	0.001
05_to_06	0.120	0.004	0.007	0.016	0.017	0.020	0.011	0.007	0.006	0.007	0.007	0.007	0.005	0.003	0.001	0.001	0.001
06_to_07	0.124	0.003	0.007	0.016	0.024	0.024	0.011	0.006	0.005	0.005	0.007	0.008	0.005	0.002	0.001	0.001	0.000
07_to_08	0.115	0.002	0.007	0.014	0.025	0.024	0.008	0.004	0.004	0.005	0.007	0.008	0.004	0.001	0.001	0.001	0.000
08_to_09	0.093	0.002	0.006	0.010	0.021	0.022	0.006	0.003	0.002	0.004	0.007	0.005	0.003	0.001	0.000	0.000	0.000
09_to_10	0.075	0.002	0.005	0.007	0.019	0.019	0.004	0.002	0.001	0.002	0.005	0.004	0.002	0.001	0.000	0.000	0.000
10_to_11	0.052	0.002	0.004	0.005	0.012	0.013	0.002	0.001	0.001	0.001	0.004	0.003	0.001	0.000	0.000	0.000	0.000
11_to_12	0.034	0.001	0.004	0.003	0.007	0.007	0.002	0.001	0.001	0.001	0.003	0.003	0.001	0.000	0.000	0.000	0.000
12_to_13	0.022	0.001	0.003	0.002	0.004	0.004	0.001	0.001	0.000	0.000	0.002	0.002	0.001	0.000	0.000	0.000	0.000
13_to_14	0.015	0.001	0.002	0.001	0.002	0.003	0.001	0.000	0.000	0.000	0.001	0.002	0.001	0.000	0.000	0.000	0.000
14_to_15	0.009	0.001	0.002	0.001	0.002	0.002	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.000	0.000	0.000	0.000
15_to_16	0.006	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000
16_to_17	0.004	0.001	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
17_to_18	0.003	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	0.002	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
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	0.000	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

Tabulated Results - Percentage Occurrence of Directional Winds
Summer - at 500m

f_01510	Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
V infinity (m/s)	Sum	0.011	0.015	0.021	0.039	0.093	0.078	0.062	0.076	0.099	0.142	0.160	0.097	0.050	0.021	0.021	0.013
00_to_01	0.026	0.001	0.001	0.001	0.001	0.003	0.002	0.002	0.001	0.001	0.002	0.002	0.001	0.003	0.001	0.001	0.001
01_to_02	0.054	0.002	0.002	0.002	0.003	0.004	0.004	0.004	0.004	0.004	0.005	0.004	0.004	0.005	0.002	0.002	0.002
02_to_03	0.077	0.002	0.002	0.002	0.003	0.005	0.006	0.007	0.006	0.007	0.008	0.009	0.008	0.005	0.003	0.003	0.002
03_to_04	0.103	0.001	0.002	0.003	0.004	0.006	0.007	0.009	0.011	0.009	0.009	0.016	0.012	0.007	0.002	0.003	0.002
04_to_05	0.109	0.001	0.001	0.002	0.004	0.009	0.010	0.007	0.010	0.012	0.011	0.015	0.012	0.007	0.002	0.003	0.002
05_to_06	0.115	0.001	0.001	0.003	0.004	0.011	0.011	0.006	0.008	0.014	0.014	0.018	0.013	0.007	0.003	0.002	0.001
06_to_07	0.112	0.000	0.001	0.001	0.002	0.012	0.011	0.006	0.008	0.012	0.016	0.020	0.012	0.005	0.002	0.002	0.001
07_to_08	0.099	0.000	0.001	0.001	0.003	0.009	0.006	0.005	0.009	0.013	0.016	0.020	0.010	0.003	0.001	0.002	0.001
08_to_09	0.078	0.000	0.000	0.001	0.003	0.007	0.005	0.004	0.005	0.010	0.018	0.013	0.007	0.002	0.001	0.001	0.001
09_to_10	0.060	0.001	0.000	0.000	0.004	0.007	0.004	0.004	0.003	0.005	0.013	0.010	0.005	0.001	0.001	0.001	0.000
10_to_11	0.048	0.000	0.001	0.000	0.001	0.006	0.002	0.002	0.004	0.005	0.011	0.008	0.004	0.002	0.001	0.001	0.000
11_to_12	0.036	0.000	0.000	0.000	0.001	0.004	0.003	0.002	0.003	0.003	0.006	0.009	0.003	0.001	0.000	0.000	0.000
12_to_13	0.025	0.000	0.000	0.001	0.001	0.002	0.002	0.002	0.001	0.001	0.004	0.006	0.002	0.001	0.000	0.000	0.000
13_to_14	0.019	0.000	0.000	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.004	0.004	0.002	0.000	0.000	0.000	0.000
14_to_15	0.012	0.000	0.000	0.000	0.001	0.003	0.001	0.000	0.001	0.000	0.002	0.002	0.001	0.000	0.000	0.000	0.000
15_to_16	0.008	0.000	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.001	0.001	0.002	0.001	0.000	0.000	0.000	0.000
16_to_17	0.006	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
17_to_18	0.004	0.000	0.000	0.000	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
18_to_19	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
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	0.000	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	0.001	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	0.000	0.000	0.000
23_to_24	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

Appendix B

Wind Velocity Ratios

VRs of Baseline Scheme

	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	Annual	Summer
Annual	**7.2%**	**10.7%**	**16.7%**	**18.0%**	**7.6%**	**5.1%**			**6.1%**	**6.7%**		**78.1%**	
Summer				**9.3%**	**7.8%**	**6.2%**	**7.6%**	**9.9%**	**14.2%**	**16.0%**	**9.7%**		**80.7%**
O1	0.19	0.19	0.08	0.28	0.25	0.23	0.15	0.19	0.22	0.39	0.38	0.22	0.28
O2	0.30	0.20	0.06	0.39	0.29	0.24	0.22	0.17	0.27	0.36	0.28	0.25	0.29
O3	0.34	0.26	0.25	0.49	0.40	0.34	0.33	0.18	0.22	0.34	0.19	0.34	0.30
O4	0.29	0.25	0.35	0.47	0.40	0.31	0.34	0.20	0.27	0.33	0.22	0.35	0.31
O5	0.29	0.26	0.44	0.49	0.44	0.33	0.36	0.19	0.31	0.32	0.25	0.39	0.33
O6	0.28	0.29	0.52	0.49	0.49	0.34	0.35	0.18	0.32	0.35	0.25	0.41	0.34
O7	0.23	0.30	0.50	0.46	0.50	0.34	0.29	0.18	0.32	0.37	0.26	0.40	0.34
O8	0.17	0.12	0.38	0.56	0.47	0.39	0.33	0.10	0.14	0.28	0.29	0.35	0.30
O9	0.19	0.12	0.38	0.51	0.44	0.36	0.32	0.16	0.23	0.33	0.35	0.35	0.33
O10	0.23	0.13	0.43	0.51	0.46	0.34	0.29	0.26	0.35	0.46	0.43	0.38	0.39
O11	0.28	0.15	0.55	0.51	0.39	0.20	0.29	0.11	0.12	0.21	0.22	0.36	0.24
O12	0.28	0.13	0.58	0.50	0.32	0.06	0.26	0.12	0.19	0.32	0.36	0.36	0.27
O13	0.26	0.10	0.61	0.50	0.27	0.08	0.22	0.12	0.22	0.38	0.42	0.36	0.29
O14	0.22	0.07	0.63	0.50	0.26	0.13	0.18	0.13	0.22	0.41	0.43	0.37	0.30
O15	0.16	0.21	0.69	0.52	0.30	0.22	0.14	0.16	0.22	0.43	0.40	0.41	0.31
O16	0.25	0.40	0.69	0.50	0.31	0.25	0.15	0.10	0.14	0.45	0.36	0.44	0.29
O17	0.25	0.12	0.70	0.47	0.46	0.21	0.25	0.34	0.30	0.47	0.32	0.42	0.37
O18	0.06	0.11	0.69	0.41	0.48	0.35	0.36	0.50	0.45	0.49	0.32	0.41	0.43
O19	0.20	0.17	0.57	0.25	0.41	0.38	0.27	0.47	0.43	0.52	0.35	0.36	0.40
O20	0.44	0.20	0.51	0.21	0.24	0.20	0.43	0.43	0.36	0.53	0.37	0.33	0.37
O21	0.22	0.17	0.56	0.16	0.19	0.18	0.32	0.42	0.29	0.51	0.36	0.30	0.33
O22	0.25	0.37	0.55	0.40	0.18	0.23	0.21	0.43	0.24	0.49	0.34	0.38	0.34
O23	0.56	0.45	0.44	0.27	0.25	0.31	0.32	0.46	0.23	0.47	0.31	0.37	0.34
O24	0.63	0.40	0.25	0.11	0.27	0.31	0.18	0.44	0.26	0.44	0.27	0.30	0.30
O25	0.09	0.04	0.38	0.38	0.22	0.23	0.04	0.29	0.24	0.39	0.23	0.27	0.27
O26	0.44	0.19	0.18	0.22	0.10	0.19	0.17	0.34	0.31	0.39	0.20	0.24	0.26
O27	0.04	0.20	0.03	0.07	0.03	0.06	0.10	0.25	0.32	0.39	0.20	0.12	0.21
O28	0.39	0.52	0.52	0.53	0.19	0.31	0.13	0.32	0.34	0.53	0.29	0.45	0.35
O29	0.24	0.46	0.49	0.53	0.13	0.35	0.16	0.34	0.30	0.52	0.28	0.41	0.35
O30	0.07	0.41	0.39	0.46	0.12	0.24	0.05	0.24	0.22	0.40	0.32	0.33	0.27
O31	0.13	0.32	0.38	0.43	0.06	0.30	0.07	0.33	0.25	0.46	0.38	0.32	0.31
O32	0.42	0.35	0.34	0.44	0.12	0.28	0.10	0.45	0.38	0.50	0.44	0.36	0.37
O33	0.40	0.37	0.26	0.26	0.12	0.21	0.06	0.52	0.46	0.51	0.49	0.31	0.37
O34	0.40	0.41	0.34	0.37	0.13	0.04	0.11	0.47	0.43	0.51	0.49	0.34	0.36
O35	0.07	0.04	0.14	0.20	0.33	0.34	0.31	0.14	0.26	0.32	0.32	0.19	0.27
O36	0.07	0.02	0.08	0.10	0.24	0.24	0.08	0.17	0.27	0.31	0.29	0.14	0.23
O37	0.09	0.01	0.06	0.10	0.28	0.38	0.17	0.10	0.21	0.25	0.24	0.14	0.21
O38	0.04	0.02	0.08	0.08	0.20	0.38	0.14	0.12	0.14	0.17	0.12	0.11	0.16
O39	0.28	0.44	0.27	0.33	0.18	0.23	0.11	0.28	0.26	0.08	0.07	0.28	0.19
O40	0.30	0.47	0.29	0.29	0.28	0.43	0.29	0.39	0.26	0.10	0.08	0.31	0.24
O41	0.36	0.50	0.36	0.26	0.49	0.46	0.36	0.38	0.20	0.13	0.16	0.34	0.27
O42	0.42	0.52	0.38	0.26	0.54	0.44	0.39	0.38	0.21	0.07	0.14	0.36	0.27
O43	0.46	0.54	0.36	0.22	0.52	0.45	0.49	0.51	0.33	0.03	0.05	0.35	0.29
O44	0.16	0.21	0.11	0.08	0.22	0.55	0.50	0.54	0.34	0.26	0.21	0.19	0.32
O45	0.18	0.25	0.05	0.06	0.16	0.46	0.46	0.42	0.34	0.16	0.15	0.16	0.26
O46	0.25	0.27	0.07	0.05	0.31	0.42	0.27	0.23	0.29	0.23	0.25	0.19	0.25
O47	0.30	0.25	0.11	0.07	0.37	0.34	0.33	0.15	0.19	0.12	0.09	0.19	0.19
O48	0.25	0.19	0.11	0.36	0.44	0.26	0.36	0.19	0.16	0.36	0.29	0.26	0.30
O49	0.03	0.05	0.08	0.10	0.14	0.10	0.25	0.21	0.18	0.24	0.15	0.10	0.18
O50	0.12	0.06	0.05	0.06	0.08	0.13	0.26	0.21	0.23	0.20	0.19	0.10	0.18
O51	0.03	0.02	0.04	0.04	0.15	0.11	0.33	0.22	0.14	0.19	0.14	0.07	0.16
O52	0.43	0.27	0.33	0.21	0.07	0.34	0.45	0.57	0.49	0.15	0.14	0.27	0.30
O53	0.11	0.05	0.25	0.27	0.19	0.07	0.29	0.09	0.05	0.02	0.02	0.16	0.11
O54	0.25	0.16	0.11	0.02	0.07	0.03	0.09	0.04	0.07	0.02	0.01	0.09	0.04
O55	0.26	0.18	0.05	0.06	0.14	0.06	0.07	0.13	0.05	0.01	0.02	0.10	0.06
O56	0.08	0.03	0.12	0.15	0.14	0.12	0.07	0.10	0.03	0.13	0.07	0.11	0.10
O57	0.43	0.21	0.28	0.30	0.45	0.61	0.70	0.08	0.17	0.11	0.01	0.30	0.25
O58	0.26	0.17	0.13	0.33	0.44	0.40	0.40	0.38	0.28	0.14	0.11	0.26	0.29
O59	0.28	0.16	0.16	0.16	0.38	0.34	0.33	0.21	0.13	0.03	0.06	0.19	0.18
O60	0.32	0.16	0.07	0.09	0.05	0.08	0.03	0.08	0.09	0.04	0.02	0.11	0.06
O61	0.35	0.15	0.07	0.10	0.17	0.31	0.11	0.26	0.16	0.12	0.07	0.15	0.15

O62	0.31	0.14	0.06	0.14	0.11	0.32	0.24	0.24	0.13	0.04	0.08	0.14	0.14
O63	0.55	0.11	0.54	0.54	0.33	0.22	0.36	0.13	0.23	0.12	0.04	0.38	0.23
O64	0.17	0.12	0.31	0.13	0.23	0.28	0.27	0.10	0.02	0.04	0.03	0.17	0.11
O65	0.13	0.18	0.29	0.25	0.16	0.07	0.08	0.02	0.01	0.02	0.01	0.18	0.07
O66	0.62	0.46	0.50	0.32	0.41	0.42	0.33	0.40	0.05	0.07	0.05	0.38	0.22
O67	0.29	0.23	0.48	0.45	0.24	0.39	0.51	0.18	0.04	0.01	0.04	0.32	0.19
O68	0.66	0.50	0.40	0.44	0.25	0.27	0.57	0.32	0.14	0.04	0.03	0.37	0.22
O69	0.51	0.46	0.54	0.46	0.48	0.48	0.58	0.43	0.04	0.04	0.06	0.42	0.27
O70	0.26	0.18	0.57	0.58	0.38	0.52	0.63	0.30	0.10	0.04	0.06	0.39	0.27
O71	0.41	0.20	0.51	0.61	0.52	0.63	0.72	0.42	0.07	0.05	0.08	0.42	0.32
O72	0.21	0.26	0.43	0.48	0.38	0.41	0.56	0.33	0.06	0.02	0.03	0.33	0.23
O73	0.67	0.55	0.32	0.39	0.35	0.38	0.54	0.41	0.10	0.07	0.01	0.37	0.24
O74	0.37	0.25	0.52	0.54	0.37	0.23	0.38	0.36	0.11	0.15	0.02	0.38	0.25
O75	0.21	0.17	0.24	0.21	0.06	0.28	0.10	0.15	0.14	0.16	0.24	0.19	0.17
O76	0.31	0.23	0.30	0.14	0.04	0.35	0.12	0.22	0.23	0.26	0.29	0.22	0.21
O77	0.14	0.30	0.40	0.26	0.04	0.32	0.19	0.30	0.31	0.40	0.31	0.28	0.29
O78	0.55	0.37	0.17	0.24	0.11	0.23	0.27	0.30	0.20	0.34	0.27	0.27	0.25
O79	0.44	0.57	0.14	0.22	0.15	0.46	0.28	0.26	0.28	0.22	0.27	0.28	0.26
O80	0.46	0.38	0.05	0.20	0.14	0.47	0.24	0.20	0.16	0.21	0.26	0.23	0.22
O81	0.42	0.39	0.12	0.20	0.10	0.39	0.17	0.18	0.17	0.18	0.25	0.23	0.20
O82	0.40	0.48	0.22	0.17	0.12	0.25	0.18	0.13	0.13	0.04	0.12	0.23	0.13
O83	0.48	0.13	0.26	0.36	0.18	0.32	0.38	0.28	0.19	0.06	0.20	0.26	0.22
O84	0.31	0.33	0.16	0.31	0.22	0.19	0.17	0.18	0.06	0.04	0.04	0.22	0.13
O85	0.17	0.12	0.21	0.12	0.12	0.38	0.32	0.23	0.16	0.14	0.07	0.17	0.18
O86	0.13	0.08	0.05	0.14	0.03	0.20	0.12	0.17	0.10	0.16	0.20	0.10	0.14
O87	0.46	0.48	0.13	0.05	0.09	0.14	0.30	0.20	0.14	0.15	0.05	0.19	0.14
O88	0.54	0.18	0.19	0.35	0.23	0.25	0.27	0.20	0.11	0.07	0.05	0.25	0.17
O89	0.25	0.12	0.15	0.20	0.23	0.18	0.21	0.17	0.05	0.05	0.04	0.16	0.12
O90	0.21	0.14	0.19	0.04	0.12	0.26	0.41	0.38	0.31	0.16	0.24	0.15	0.24
O91	0.19	0.09	0.04	0.16	0.17	0.20	0.19	0.22	0.16	0.34	0.35	0.15	0.23
O92	0.45	0.61	0.35	0.14	0.36	0.45	0.41	0.51	0.33	0.39	0.40	0.36	0.37
O93	0.17	0.06	0.28	0.29	0.44	0.35	0.34	0.40	0.25	0.31	0.32	0.26	0.33
O94	0.35	0.33	0.39	0.46	0.35	0.28	0.36	0.50	0.37	0.44	0.44	0.39	0.41
O95	0.54	0.63	0.36	0.44	0.42	0.27	0.33	0.48	0.30	0.39	0.43	0.43	0.39
O96	0.47	0.54	0.24	0.31	0.45	0.37	0.38	0.48	0.29	0.39	0.38	0.36	0.38
O97	0.65	0.63	0.36	0.39	0.41	0.47	0.31	0.48	0.31	0.43	0.44	0.45	0.40
O98	0.79	0.71	0.48	0.33	0.37	0.40	0.20	0.41	0.34	0.43	0.51	0.47	0.38
O99	0.82	0.74	0.49	0.26	0.31	0.22	0.26	0.31	0.38	0.44	0.51	0.45	0.35
O100	0.81	0.75	0.53	0.28	0.34	0.52	0.30	0.47	0.37	0.49	0.54	0.49	0.42
O101	0.80	0.77	0.56	0.31	0.31	0.49	0.25	0.40	0.39	0.53	0.56	0.51	0.42
O102	0.77	0.76	0.56	0.29	0.28	0.47	0.24	0.30	0.38	0.51	0.56	0.49	0.39
O103	0.60	0.65	0.47	0.40	0.50	0.21	0.15	0.41	0.27	0.39	0.42	0.45	0.35
O104	0.74	0.77	0.62	0.47	0.51	0.19	0.09	0.19	0.34	0.49	0.48	0.55	0.36
O105	0.82	0.82	0.66	0.46	0.49	0.27	0.25	0.28	0.40	0.49	0.39	0.57	0.39
O106	0.83	0.83	0.66	0.44	0.45	0.29	0.29	0.34	0.43	0.49	0.42	0.57	0.41
O107	0.81	0.83	0.67	0.44	0.42	0.30	0.30	0.35	0.44	0.50	0.49	0.57	0.42
O108	0.50	0.71	0.78	0.61	0.44	0.15	0.29	0.26	0.35	0.47	0.54	0.57	0.40
O109	0.65	0.85	0.81	0.61	0.47	0.12	0.05	0.24	0.42	0.57	0.57	0.63	0.42
O110	0.72	0.86	0.79	0.56	0.46	0.25	0.18	0.25	0.43	0.58	0.50	0.63	0.43
O111	0.75	0.86	0.75	0.52	0.42	0.27	0.26	0.33	0.45	0.54	0.50	0.61	0.43
O112	0.58	0.81	0.77	0.61	0.46	0.09	0.13	0.24	0.42	0.55	0.52	0.60	0.41
O113	0.65	0.84	0.77	0.57	0.45	0.18	0.10	0.26	0.43	0.57	0.47	0.61	0.41
O114	0.70	0.85	0.76	0.54	0.42	0.23	0.22	0.33	0.45	0.55	0.48	0.61	0.43
O115	0.73	0.86	0.75	0.52	0.40	0.23	0.25	0.37	0.46	0.54	0.53	0.60	0.44
O116	0.50	0.76	0.76	0.62	0.46	0.15	0.23	0.25	0.38	0.48	0.55	0.58	0.41
O117	0.50	0.77	0.71	0.59	0.48	0.16	0.19	0.23	0.41	0.50	0.48	0.57	0.40
O118	0.25	0.51	0.80	0.46	0.42	0.21	0.37	0.22	0.27	0.41	0.38	0.48	0.35
O119	0.32	0.51	0.71	0.49	0.48	0.22	0.32	0.10	0.29	0.42	0.43	0.48	0.35
O120	0.35	0.60	0.68	0.52	0.47	0.23	0.30	0.22	0.31	0.42	0.47	0.50	0.37
O121	0.47	0.77	0.67	0.58	0.49	0.19	0.19	0.19	0.42	0.50	0.43	0.56	0.39
O122	0.46	0.79	0.70	0.58	0.50	0.18	0.19	0.24	0.44	0.52	0.40	0.57	0.41
O123	0.51	0.83	0.75	0.58	0.47	0.09	0.08	0.36	0.47	0.55	0.45	0.59	0.42
O124	0.28	0.58	0.77	0.44	0.34	0.23	0.31	0.24	0.34	0.40	0.42	0.48	0.35
O125	0.35	0.71	0.68	0.55	0.46	0.25	0.30	0.20	0.43	0.44	0.40	0.54	0.39
O126	0.26	0.52	0.76	0.40	0.42	0.27	0.30	0.21	0.36	0.41	0.39	0.47	0.35
O127	0.31	0.73	0.74	0.54	0.44	0.26	0.28	0.26	0.47	0.47	0.38	0.55	0.40
O128	0.39	0.81	0.72	0.59	0.48	0.20	0.18	0.33	0.49	0.53	0.41	0.58	0.43

P1	0.13	0.25	0.18	0.26	0.15	0.17	0.11	0.16	0.20	0.40	0.45	0.22	0.26
P2	0.06	0.17	0.38	0.28	0.19	0.13	0.10	0.15	0.19	0.42	0.46	0.25	0.26
P3	0.06	0.13	0.47	0.34	0.18	0.14	0.14	0.16	0.17	0.42	0.47	0.28	0.27
P4	0.11	0.20	0.52	0.46	0.19	0.22	0.25	0.19	0.16	0.43	0.48	0.34	0.31
P5	0.15	0.36	0.53	0.57	0.30	0.33	0.32	0.21	0.21	0.46	0.50	0.41	0.36
P6	0.16	0.44	0.50	0.63	0.38	0.41	0.28	0.24	0.27	0.51	0.55	0.46	0.41
P7	0.07	0.44	0.49	0.62	0.43	0.36	0.16	0.36	0.31	0.53	0.54	0.45	0.42
P8	0.23	0.48	0.62	0.64	0.46	0.31	0.17	0.39	0.34	0.51	0.51	0.50	0.43
P9	0.26	0.45	0.67	0.62	0.40	0.25	0.18	0.37	0.41	0.59	0.55	0.51	0.45
P10	0.29	0.35	0.56	0.47	0.28	0.11	0.29	0.56	0.59	0.58	0.54	0.43	0.47
P11	0.38	0.35	0.33	0.45	0.23	0.28	0.54	0.57	0.60	0.56	0.51	0.39	0.49
P12	0.33	0.40	0.26	0.47	0.23	0.24	0.51	0.54	0.55	0.56	0.50	0.38	0.48
P13	0.37	0.28	0.10	0.40	0.21	0.31	0.43	0.45	0.45	0.45	0.44	0.30	0.41
P14	0.07	0.09	0.16	0.11	0.06	0.16	0.32	0.42	0.49	0.26	0.32	0.15	0.29
P15	0.11	0.14	0.17	0.16	0.12	0.20	0.33	0.16	0.37	0.13	0.17	0.17	0.21
P16	0.27	0.10	0.22	0.17	0.17	0.29	0.33	0.17	0.14	0.33	0.17	0.20	0.22
S1	0.26	0.22	0.27	0.20	0.23	0.32	0.36	0.32	0.32	0.40	0.28	0.26	0.31
S2	0.30	0.19	0.32	0.30	0.36	0.31	0.37	0.34	0.33	0.41	0.21	0.31	0.33
S3	0.32	0.28	0.35	0.36	0.38	0.29	0.39	0.38	0.39	0.36	0.18	0.34	0.35
S4	0.37	0.43	0.56	0.48	0.23	0.26	0.37	0.41	0.44	0.34	0.20	0.43	0.35
S5	0.39	0.56	0.74	0.54	0.23	0.12	0.26	0.40	0.48	0.48	0.45	0.50	0.40
S6	0.31	0.61	0.87	0.50	0.16	0.06	0.21	0.43	0.45	0.45	0.46	0.51	0.37
S7	0.21	0.66	0.96	0.54	0.29	0.17	0.24	0.34	0.32	0.37	0.40	0.53	0.34
S8	0.14	0.60	0.96	0.54	0.35	0.24	0.35	0.24	0.22	0.32	0.37	0.52	0.32
S9	0.11	0.53	0.95	0.52	0.36	0.26	0.42	0.18	0.14	0.30	0.34	0.50	0.30
S10	0.11	0.51	0.92	0.48	0.38	0.26	0.45	0.14	0.05	0.30	0.31	0.47	0.28
S11	0.08	0.53	0.90	0.44	0.39	0.25	0.45	0.10	0.08	0.28	0.29	0.46	0.27
S12	0.03	0.46	0.74	0.38	0.34	0.28	0.48	0.16	0.06	0.22	0.31	0.39	0.25
S13	0.07	0.10	0.05	0.06	0.06	0.06	0.10	0.17	0.15	0.35	0.36	0.10	0.19
S14	0.07	0.14	0.14	0.06	0.17	0.14	0.06	0.19	0.15	0.32	0.33	0.13	0.19
S15	0.11	0.35	0.42	0.38	0.33	0.31	0.26	0.22	0.23	0.19	0.17	0.32	0.25
S16	0.35	0.05	0.23	0.17	0.14	0.26	0.54	0.35	0.52	0.07	0.09	0.20	0.26
S17	0.15	0.16	0.22	0.21	0.19	0.27	0.41	0.30	0.11	0.17	0.08	0.19	0.20
S18	0.31	0.40	0.36	0.34	0.22	0.19	0.48	0.36	0.24	0.07	0.05	0.30	0.23
S19	0.09	0.08	0.09	0.07	0.11	0.21	0.04	0.11	0.14	0.21	0.21	0.11	0.14
S20	0.06	0.07	0.04	0.09	0.30	0.29	0.17	0.19	0.24	0.31	0.28	0.14	0.24
S21	0.21	0.22	0.28	0.26	0.41	0.28	0.32	0.21	0.32	0.40	0.38	0.29	0.33
S22	0.14	0.13	0.07	0.57	0.46	0.31	0.41	0.24	0.31	0.47	0.48	0.31	0.41
S23	0.08	0.05	0.04	0.24	0.49	0.47	0.43	0.20	0.29	0.39	0.42	0.21	0.36
S24	0.02	0.03	0.02	0.18	0.39	0.24	0.21	0.31	0.36	0.34	0.09	0.16	0.28
S25	0.24	0.12	0.07	0.13	0.30	0.13	0.20	0.29	0.39	0.49	0.31	0.19	0.31
S26	0.26	0.13	0.10	0.51	0.32	0.11	0.29	0.28	0.37	0.50	0.51	0.29	0.39
S27	0.28	0.10	0.08	0.27	0.23	0.08	0.24	0.31	0.40	0.52	0.28	0.22	0.33

VRs of Proposed Scheme

	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	Annual	Summer
Annual	**7.2%**	**10.7%**	**16.7%**	**18.0%**	**7.6%**	**5.1%**			**6.1%**	**6.7%**		**78.1%**	
Summer				**9.3%**	**7.8%**	**6.2%**	**7.6%**	**9.9%**	**14.2%**	**16.0%**	**9.7%**		**80.7%**
O1	0.19	0.16	0.37	0.33	0.28	0.17	0.13	0.20	0.21	0.39	0.39	0.28	0.28
O2	0.28	0.17	0.45	0.40	0.34	0.20	0.16	0.18	0.26	0.36	0.29	0.33	0.28
O3	0.32	0.20	0.56	0.47	0.43	0.33	0.26	0.20	0.20	0.34	0.21	0.39	0.30
O4	0.28	0.19	0.50	0.45	0.42	0.34	0.27	0.21	0.26	0.33	0.22	0.37	0.31
O5	0.28	0.20	0.51	0.47	0.45	0.35	0.28	0.22	0.31	0.30	0.25	0.39	0.32
O6	0.28	0.23	0.54	0.45	0.50	0.36	0.29	0.19	0.32	0.35	0.27	0.41	0.34
O7	0.28	0.23	0.60	0.48	0.51	0.36	0.26	0.18	0.32	0.37	0.27	0.42	0.34
O8	0.12	0.03	0.39	0.60	0.48	0.40	0.32	0.11	0.13	0.28	0.29	0.34	0.30
O9	0.16	0.04	0.36	0.55	0.46	0.36	0.29	0.17	0.25	0.34	0.37	0.34	0.34
O10	0.22	0.05	0.38	0.51	0.48	0.30	0.23	0.26	0.33	0.46	0.44	0.36	0.38
O11	0.27	0.08	0.51	0.53	0.40	0.19	0.21	0.11	0.12	0.21	0.23	0.35	0.24
O12	0.26	0.07	0.52	0.52	0.32	0.07	0.16	0.13	0.19	0.32	0.36	0.34	0.27
O13	0.25	0.05	0.54	0.51	0.26	0.04	0.13	0.12	0.21	0.37	0.42	0.34	0.28
O14	0.22	0.05	0.57	0.51	0.23	0.07	0.10	0.13	0.21	0.40	0.42	0.34	0.28
O15	0.14	0.20	0.65	0.53	0.27	0.12	0.10	0.17	0.22	0.43	0.40	0.39	0.30
O16	0.23	0.50	0.69	0.53	0.31	0.11	0.10	0.11	0.13	0.45	0.37	0.44	0.28
O17	0.32	0.04	0.70	0.49	0.46	0.33	0.09	0.36	0.31	0.48	0.37	0.43	0.37
O18	0.09	0.15	0.68	0.44	0.49	0.38	0.34	0.50	0.43	0.50	0.38	0.43	0.44
O19	0.23	0.19	0.58	0.27	0.42	0.35	0.36	0.52	0.45	0.52	0.37	0.38	0.42
O20	0.43	0.21	0.51	0.18	0.27	0.19	0.20	0.44	0.35	0.53	0.37	0.33	0.34
O21	0.22	0.24	0.54	0.19	0.20	0.21	0.25	0.44	0.30	0.51	0.35	0.31	0.33
O22	0.28	0.41	0.53	0.40	0.18	0.24	0.20	0.48	0.24	0.48	0.34	0.38	0.34
O23	0.57	0.46	0.47	0.28	0.25	0.29	0.34	0.53	0.23	0.45	0.31	0.38	0.34
O24	0.65	0.40	0.31	0.14	0.27	0.29	0.24	0.51	0.25	0.43	0.28	0.32	0.31
O25	0.15	0.03	0.38	0.34	0.21	0.20	0.10	0.34	0.22	0.38	0.23	0.26	0.27
O26	0.42	0.18	0.15	0.16	0.11	0.16	0.12	0.24	0.30	0.35	0.21	0.21	0.23
O27	0.04	0.25	0.05	0.04	0.03	0.09	0.10	0.17	0.31	0.36	0.21	0.12	0.19
O28	0.39	0.54	0.51	0.53	0.20	0.28	0.17	0.17	0.34	0.52	0.26	0.45	0.33
O29	0.24	0.48	0.47	0.52	0.17	0.31	0.19	0.13	0.32	0.50	0.25	0.41	0.32
O30	0.07	0.46	0.44	0.51	0.11	0.23	0.08	0.15	0.20	0.40	0.29	0.36	0.26
O31	0.17	0.32	0.36	0.41	0.05	0.28	0.12	0.19	0.24	0.44	0.35	0.31	0.28
O32	0.50	0.35	0.33	0.38	0.07	0.27	0.13	0.33	0.38	0.49	0.40	0.35	0.34
O33	0.41	0.38	0.26	0.24	0.10	0.21	0.09	0.50	0.45	0.50	0.45	0.30	0.36
O34	0.41	0.38	0.34	0.36	0.14	0.07	0.10	0.47	0.42	0.49	0.46	0.34	0.35
O35	0.08	0.04	0.15	0.15	0.37	0.34	0.28	0.15	0.26	0.32	0.34	0.19	0.27
O36	0.06	0.03	0.08	0.11	0.28	0.22	0.06	0.17	0.26	0.31	0.29	0.14	0.23
O37	0.05	0.03	0.06	0.11	0.32	0.35	0.11	0.10	0.20	0.25	0.25	0.14	0.21
O38	0.03	0.03	0.08	0.09	0.27	0.36	0.08	0.11	0.13	0.17	0.13	0.12	0.16
O39	0.24	0.55	0.14	0.35	0.20	0.18	0.11	0.27	0.25	0.10	0.08	0.27	0.19
O40	0.28	0.57	0.34	0.31	0.31	0.38	0.25	0.35	0.26	0.13	0.13	0.33	0.25
O41	0.36	0.59	0.37	0.27	0.51	0.43	0.32	0.33	0.21	0.12	0.20	0.36	0.27
O42	0.44	0.61	0.39	0.24	0.56	0.43	0.36	0.36	0.23	0.07	0.22	0.37	0.27
O43	0.47	0.63	0.37	0.13	0.53	0.45	0.47	0.50	0.33	0.04	0.07	0.35	0.28
O44	0.20	0.17	0.09	0.07	0.25	0.35	0.47	0.53	0.34	0.25	0.21	0.17	0.30
O45	0.27	0.19	0.05	0.06	0.40	0.27	0.44	0.41	0.33	0.19	0.15	0.18	0.27
O46	0.28	0.23	0.04	0.07	0.40	0.23	0.23	0.24	0.28	0.25	0.21	0.18	0.24
O47	0.36	0.24	0.11	0.10	0.42	0.24	0.27	0.14	0.17	0.06	0.19	0.19	0.18
O48	0.32	0.14	0.06	0.34	0.46	0.28	0.34	0.18	0.15	0.38	0.27	0.25	0.30
O49	0.03	0.07	0.04	0.09	0.18	0.10	0.25	0.23	0.19	0.27	0.19	0.10	0.20
O50	0.14	0.04	0.04	0.06	0.06	0.27	0.23	0.20	0.23	0.19	0.19	0.10	0.18
O51	0.02	0.03	0.02	0.04	0.06	0.28	0.34	0.22	0.15	0.20	0.14	0.07	0.17
O52	0.43	0.26	0.27	0.20	0.12	0.26	0.44	0.58	0.50	0.19	0.15	0.26	0.31
O53	0.10	0.03	0.25	0.27	0.22	0.14	0.22	0.13	0.04	0.02	0.03	0.16	0.11
O54	0.22	0.15	0.12	0.04	0.11	0.03	0.06	0.06	0.05	0.03	0.02	0.10	0.05
O55	0.26	0.15	0.09	0.06	0.06	0.05	0.04	0.13	0.05	0.02	0.02	0.09	0.05
O56	0.08	0.02	0.12	0.16	0.14	0.13	0.15	0.15	0.04	0.14	0.08	0.11	0.12
O57	0.40	0.20	0.25	0.30	0.47	0.58	0.51	0.08	0.13	0.08	0.01	0.29	0.22
O58	0.25	0.15	0.11	0.33	0.46	0.32	0.29	0.44	0.32	0.18	0.11	0.25	0.29
O59	0.27	0.12	0.13	0.17	0.41	0.21	0.21	0.23	0.12	0.03	0.06	0.18	0.16
O60	0.30	0.15	0.09	0.08	0.04	0.07	0.02	0.13	0.11	0.05	0.01	0.11	0.07
O61	0.36	0.16	0.12	0.12	0.10	0.34	0.10	0.28	0.18	0.15	0.06	0.17	0.16

O62	0.31	0.08	0.20	0.08	0.10	0.30	0.24	0.22	0.13	0.05	0.07	0.15	0.14
O63	0.50	0.11	0.50	0.49	0.29	0.18	0.27	0.29	0.26	0.14	0.04	0.35	0.24
O64	0.16	0.13	0.33	0.14	0.23	0.25	0.29	0.09	0.02	0.02	0.04	0.18	0.11
O65	0.14	0.21	0.32	0.27	0.15	0.08	0.09	0.03	0.03	0.02	0.01	0.20	0.08
O66	0.64	0.47	0.47	0.22	0.42	0.38	0.28	0.44	0.04	0.06	0.06	0.35	0.20
O67	0.28	0.25	0.45	0.44	0.22	0.40	0.51	0.08	0.06	0.01	0.05	0.31	0.18
O68	0.68	0.51	0.49	0.54	0.21	0.24	0.57	0.27	0.11	0.03	0.03	0.41	0.22
O69	0.51	0.48	0.49	0.48	0.47	0.47	0.56	0.42	0.04	0.05	0.03	0.41	0.26
O70	0.27	0.19	0.55	0.54	0.38	0.56	0.63	0.17	0.10	0.04	0.06	0.38	0.25
O71	0.42	0.21	0.50	0.57	0.52	0.66	0.69	0.40	0.08	0.04	0.06	0.41	0.31
O72	0.18	0.25	0.48	0.46	0.40	0.41	0.57	0.27	0.07	0.02	0.00	0.33	0.23
O73	0.67	0.55	0.18	0.27	0.37	0.40	0.53	0.33	0.07	0.07	0.00	0.31	0.21
O74	0.32	0.23	0.53	0.56	0.37	0.25	0.37	0.44	0.06	0.08	0.04	0.37	0.24
O75	0.19	0.17	0.24	0.19	0.04	0.26	0.14	0.09	0.12	0.19	0.22	0.18	0.15
O76	0.34	0.25	0.32	0.16	0.06	0.34	0.19	0.18	0.24	0.27	0.25	0.24	0.21
O77	0.18	0.32	0.39	0.28	0.05	0.26	0.19	0.25	0.32	0.37	0.26	0.29	0.27
O78	0.54	0.39	0.16	0.24	0.09	0.21	0.25	0.27	0.22	0.36	0.21	0.26	0.24
O79	0.44	0.58	0.13	0.22	0.15	0.46	0.27	0.39	0.23	0.34	0.29	0.29	0.29
O80	0.46	0.38	0.06	0.22	0.15	0.46	0.29	0.33	0.28	0.32	0.23	0.25	0.28
O81	0.43	0.40	0.13	0.22	0.11	0.38	0.24	0.33	0.35	0.29	0.21	0.26	0.27
O82	0.41	0.48	0.20	0.19	0.12	0.22	0.16	0.33	0.35	0.09	0.14	0.25	0.20
O83	0.43	0.12	0.27	0.36	0.18	0.32	0.33	0.48	0.17	0.10	0.31	0.26	0.26
O84	0.34	0.36	0.18	0.31	0.24	0.15	0.13	0.14	0.06	0.02	0.07	0.23	0.12
O85	0.10	0.12	0.17	0.12	0.12	0.35	0.32	0.31	0.14	0.07	0.19	0.14	0.18
O86	0.16	0.08	0.03	0.05	0.07	0.22	0.08	0.21	0.06	0.14	0.30	0.08	0.14
O87	0.48	0.49	0.15	0.07	0.09	0.12	0.30	0.45	0.39	0.09	0.08	0.21	0.21
O88	0.42	0.20	0.19	0.36	0.23	0.23	0.28	0.30	0.07	0.07	0.11	0.24	0.18
O89	0.22	0.15	0.15	0.21	0.24	0.17	0.20	0.20	0.05	0.04	0.03	0.16	0.12
O90	0.27	0.12	0.21	0.06	0.12	0.25	0.44	0.45	0.45	0.14	0.31	0.18	0.28
O91	0.14	0.09	0.07	0.16	0.16	0.18	0.21	0.20	0.17	0.31	0.25	0.14	0.21
O92	0.42	0.61	0.36	0.16	0.35	0.43	0.43	0.53	0.34	0.40	0.38	0.36	0.38
O93	0.17	0.04	0.22	0.26	0.40	0.31	0.39	0.39	0.26	0.29	0.26	0.23	0.31
O94	0.35	0.36	0.39	0.43	0.31	0.26	0.40	0.51	0.36	0.42	0.36	0.38	0.39
O95	0.52	0.64	0.40	0.41	0.43	0.27	0.39	0.44	0.34	0.40	0.43	0.44	0.39
O96	0.44	0.53	0.26	0.27	0.42	0.34	0.41	0.49	0.31	0.40	0.36	0.36	0.38
O97	0.66	0.63	0.38	0.38	0.41	0.45	0.29	0.48	0.34	0.44	0.45	0.45	0.41
O98	0.78	0.71	0.48	0.33	0.37	0.41	0.20	0.40	0.35	0.43	0.51	0.48	0.38
O99	0.82	0.74	0.49	0.26	0.32	0.23	0.24	0.28	0.38	0.44	0.51	0.46	0.35
O100	0.81	0.76	0.53	0.29	0.34	0.50	0.27	0.48	0.38	0.50	0.55	0.49	0.42
O101	0.80	0.77	0.56	0.32	0.31	0.49	0.21	0.43	0.41	0.54	0.56	0.51	0.42
O102	0.77	0.76	0.56	0.30	0.28	0.48	0.20	0.33	0.40	0.52	0.56	0.50	0.40
O103	0.63	0.66	0.50	0.36	0.50	0.23	0.21	0.35	0.28	0.40	0.43	0.46	0.35
O104	0.75	0.78	0.64	0.44	0.51	0.17	0.09	0.24	0.34	0.49	0.48	0.54	0.36
O105	0.84	0.83	0.68	0.43	0.49	0.26	0.17	0.27	0.40	0.49	0.40	0.57	0.38
O106	0.86	0.83	0.67	0.41	0.45	0.29	0.24	0.33	0.42	0.49	0.42	0.57	0.40
O107	0.84	0.84	0.68	0.42	0.42	0.30	0.26	0.35	0.44	0.50	0.49	0.57	0.41
O108	0.50	0.72	0.78	0.60	0.46	0.18	0.29	0.28	0.35	0.47	0.55	0.57	0.41
O109	0.64	0.86	0.82	0.59	0.47	0.08	0.12	0.24	0.41	0.57	0.57	0.62	0.41
O110	0.71	0.88	0.82	0.55	0.46	0.24	0.09	0.24	0.43	0.58	0.50	0.63	0.41
O111	0.75	0.87	0.77	0.49	0.42	0.26	0.23	0.33	0.44	0.54	0.49	0.61	0.42
O112	0.57	0.83	0.78	0.60	0.48	0.09	0.10	0.24	0.41	0.55	0.52	0.60	0.40
O113	0.64	0.86	0.80	0.56	0.45	0.17	0.09	0.25	0.42	0.56	0.46	0.61	0.40
O114	0.70	0.87	0.78	0.52	0.43	0.20	0.19	0.32	0.44	0.54	0.48	0.60	0.42
O115	0.73	0.87	0.76	0.50	0.40	0.20	0.23	0.37	0.46	0.54	0.53	0.60	0.43
O116	0.50	0.76	0.76	0.61	0.49	0.17	0.14	0.25	0.37	0.47	0.55	0.58	0.40
O117	0.51	0.78	0.71	0.54	0.45	0.19	0.12	0.24	0.40	0.50	0.48	0.56	0.39
O118	0.22	0.25	0.78	0.31	0.34	0.22	0.27	0.24	0.28	0.41	0.37	0.40	0.31
O119	0.32	0.35	0.64	0.25	0.29	0.23	0.23	0.09	0.29	0.42	0.43	0.37	0.29
O120	0.36	0.45	0.63	0.26	0.24	0.23	0.21	0.22	0.30	0.41	0.46	0.39	0.31
O121	0.49	0.77	0.68	0.43	0.38	0.22	0.15	0.20	0.41	0.50	0.42	0.52	0.36
O122	0.49	0.80	0.72	0.44	0.40	0.21	0.15	0.23	0.43	0.52	0.40	0.54	0.38
O123	0.53	0.86	0.78	0.53	0.42	0.09	0.08	0.35	0.46	0.55	0.45	0.58	0.40
O124	0.28	0.44	0.54	0.52	0.38	0.21	0.20	0.23	0.35	0.40	0.41	0.43	0.35
O125	0.37	0.60	0.67	0.44	0.42	0.24	0.21	0.20	0.43	0.44	0.40	0.49	0.37
O126	0.28	0.38	0.58	0.50	0.39	0.30	0.22	0.21	0.36	0.40	0.38	0.44	0.36
O127	0.34	0.63	0.71	0.50	0.44	0.24	0.22	0.25	0.47	0.46	0.38	0.52	0.39
O128	0.43	0.80	0.75	0.44	0.43	0.21	0.16	0.32	0.48	0.53	0.41	0.55	0.40

P1	0.21	0.41	0.51	0.26	0.17	0.11	0.16	0.22	0.19	0.40	0.42	0.32	0.26
P2	0.09	0.29	0.56	0.25	0.19	0.05	0.06	0.14	0.18	0.42	0.45	0.30	0.24
P3	0.09	0.29	0.58	0.28	0.21	0.06	0.13	0.16	0.18	0.43	0.49	0.31	0.26
P4	0.10	0.33	0.62	0.38	0.23	0.09	0.29	0.20	0.20	0.47	0.52	0.36	0.32
P5	0.09	0.35	0.64	0.46	0.26	0.13	0.36	0.25	0.24	0.50	0.51	0.39	0.35
P6	0.12	0.45	0.75	0.60	0.35	0.16	0.45	0.29	0.29	0.54	0.51	0.49	0.41
P7	0.06	0.42	0.71	0.50	0.39	0.16	0.48	0.41	0.35	0.53	0.43	0.45	0.42
P8	0.18	0.43	0.73	0.56	0.35	0.07	0.37	0.44	0.39	0.44	0.37	0.47	0.39
P9	0.26	0.43	0.71	0.59	0.35	0.12	0.29	0.50	0.47	0.49	0.46	0.49	0.43
P10	0.32	0.44	0.63	0.53	0.27	0.34	0.23	0.56	0.54	0.50	0.50	0.48	0.46
P11	0.38	0.29	0.36	0.47	0.23	0.28	0.14	0.59	0.56	0.54	0.51	0.39	0.45
P12	0.33	0.25	0.25	0.47	0.23	0.20	0.43	0.56	0.53	0.54	0.48	0.35	0.46
P13	0.40	0.06	0.11	0.34	0.11	0.25	0.37	0.46	0.44	0.43	0.46	0.25	0.38
P14	0.07	0.18	0.20	0.10	0.08	0.15	0.30	0.44	0.43	0.30	0.36	0.18	0.29
P15	0.10	0.17	0.21	0.18	0.12	0.14	0.32	0.17	0.15	0.12	0.24	0.16	0.17
P16	0.25	0.21	0.10	0.17	0.18	0.21	0.35	0.30	0.36	0.21	0.12	0.19	0.24
S1	0.29	0.20	0.15	0.19	0.25	0.27	0.39	0.40	0.47	0.33	0.27	0.24	0.33
S2	0.30	0.21	0.26	0.26	0.30	0.25	0.39	0.41	0.48	0.35	0.31	0.28	0.36
S3	0.35	0.27	0.32	0.32	0.30	0.22	0.38	0.50	0.56	0.39	0.30	0.33	0.39
S4	0.40	0.45	0.55	0.49	0.32	0.22	0.35	0.55	0.57	0.40	0.34	0.45	0.42
S5	0.44	0.68	0.80	0.56	0.39	0.15	0.32	0.59	0.56	0.46	0.39	0.56	0.45
S6	0.37	0.65	0.80	0.55	0.33	0.10	0.23	0.38	0.39	0.33	0.37	0.52	0.35
S7	0.36	0.55	0.80	0.51	0.28	0.12	0.29	0.23	0.22	0.19	0.19	0.47	0.25
S8	0.22	0.31	0.97	0.41	0.34	0.10	0.10	0.18	0.17	0.19	0.24	0.44	0.22
S9	0.15	0.15	0.72	0.08	0.31	0.16	0.30	0.14	0.14	0.13	0.20	0.27	0.17
S10	0.16	0.15	0.55	0.19	0.27	0.20	0.36	0.29	0.16	0.29	0.39	0.27	0.27
S11	0.14	0.10	0.35	0.17	0.08	0.19	0.36	0.15	0.13	0.24	0.17	0.19	0.19
S12	0.20	0.09	0.27	0.30	0.33	0.10	0.14	0.15	0.08	0.16	0.26	0.22	0.18
S13	0.14	0.14	0.18	0.21	0.36	0.07	0.08	0.12	0.07	0.22	0.11	0.18	0.16
S14	0.25	0.30	0.09	0.12	0.15	0.08	0.14	0.20	0.09	0.25	0.25	0.16	0.17
S15	0.19	0.32	0.66	0.51	0.12	0.16	0.36	0.29	0.24	0.05	0.05	0.37	0.21
S16	0.34	0.31	0.31	0.11	0.13	0.30	0.36	0.46	0.46	0.07	0.12	0.24	0.25
S17	0.16	0.06	0.18	0.18	0.18	0.20	0.40	0.38	0.42	0.24	0.13	0.19	0.27
S18	0.28	0.33	0.30	0.29	0.24	0.27	0.39	0.24	0.34	0.18	0.11	0.28	0.25
S19	0.08	0.06	0.15	0.13	0.12	0.13	0.03	0.13	0.14	0.21	0.20	0.13	0.15
S20	0.03	0.05	0.17	0.14	0.20	0.30	0.16	0.19	0.24	0.30	0.28	0.16	0.23
S21	0.18	0.18	0.58	0.39	0.41	0.33	0.26	0.20	0.31	0.40	0.37	0.37	0.34
S22	0.16	0.06	0.02	0.56	0.52	0.33	0.38	0.23	0.30	0.46	0.49	0.29	0.41
S23	0.07	0.01	0.05	0.22	0.49	0.46	0.38	0.19	0.29	0.39	0.44	0.20	0.35
S24	0.07	0.03	0.03	0.17	0.39	0.24	0.21	0.32	0.35	0.40	0.10	0.17	0.29
S25	0.23	0.02	0.04	0.07	0.28	0.15	0.20	0.29	0.39	0.50	0.34	0.16	0.31
S26	0.26	0.09	0.07	0.49	0.35	0.15	0.26	0.29	0.36	0.49	0.51	0.28	0.38
S27	0.27	0.09	0.09	0.22	0.22	0.11	0.22	0.31	0.39	0.54	0.25	0.21	0.32