Hong Kong Housing Authority

CB20210520

Proposed Public Housing Developments at Kam Sheung Road Site 1 (Phases 1 & 2), Yuen Long

Air Ventilation Assessment – Initial Study (AVA-IS)

October 2024

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1 INTRODUCTION

Background

1.1 AECOM Asia Co. Ltd. has been commissioned by the Hong Kong Housing Authority (HKHA) to undertake an Air Ventilation Assessment (AVA) Study – Initial Study (IS) for the Public Housing Developments located at Kam Sheung Road Site 1 (Phases 1 & 2), Yuen Long 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

1.2 The purpose of this study is to fulfil the requirement in the planning brief that a quantitative Air Ventilation Assessment (AVA) - Initial Study to be conducted at the detailed design stage. The AVA Study for the proposed public housing developments at 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 Project Area;
- 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 studied schemes in terms of air ventilation performance aspect.

Content of This Report

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

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

2 SITE CHARACTERISTICS

Site and Its Surrounding Area

2.1 The site, with a gross site area of about 5.8 hectares (ha), is located in Kam Tin South, Yuen Long district near Kam Sheung Road MTR Station. It is bounded by Tung Wui Road to its north, Ho Pui Stream to its east and a new road to be constructed by the Civil Engineering and Development Department (CEDD) to its west and is accessible via Tung Wui Road through the new road. Two other proposed public housing developments at Site 4a and Site 6 are located at its north-east and west respectively.

2.2 According to the approved Kam Tin South Outline Zoning Plan (OZP) No. S/YL-KTS/15, the site is zoned "Residential (Group A)" with an overall maximum permissible plot ratio (PR) of 3.0 and a maximum building height of +69mPD. Besides, the site is also subject to the Shek Kong Airfield Height Restriction (SKAHR) of +69mPD. The Planning Brief was endorsed by the New Territories District Planning Conference (NT DipCon) by circulation on 6 October 2022.

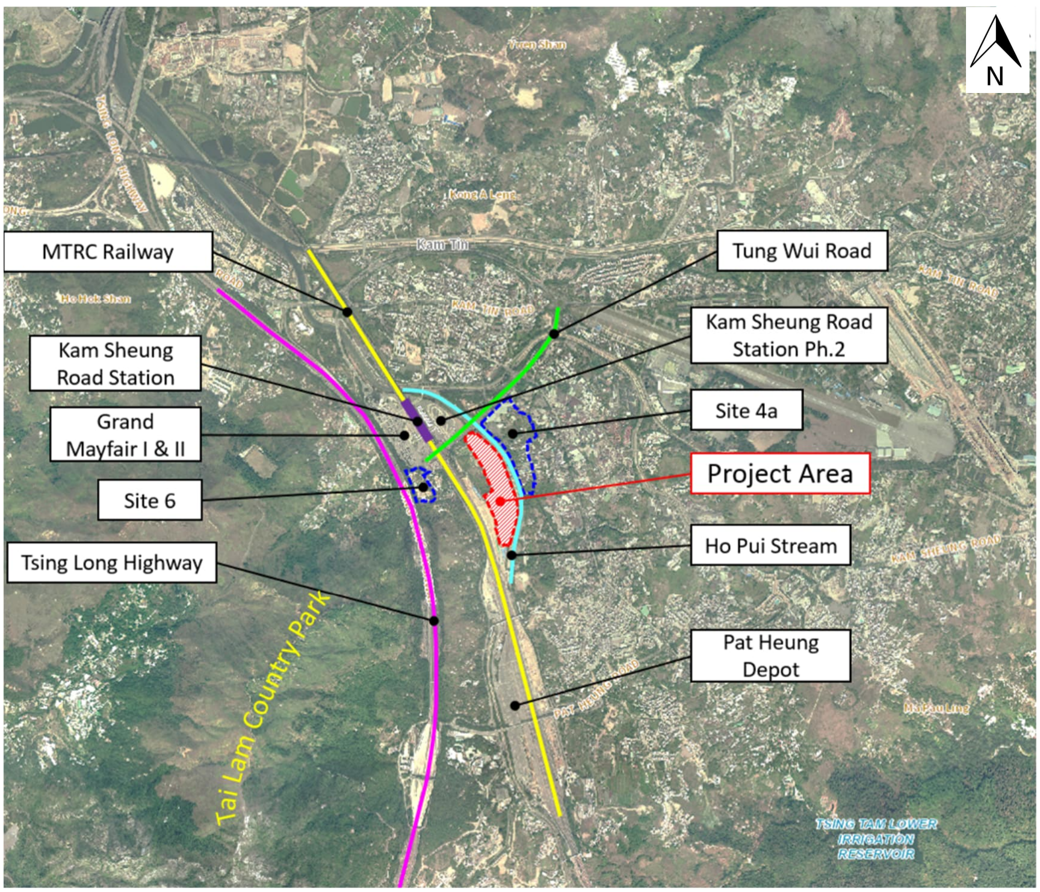


Figure 2.1 Overview of the Project Area and its Surroundings (Source: GeoInfo Map)

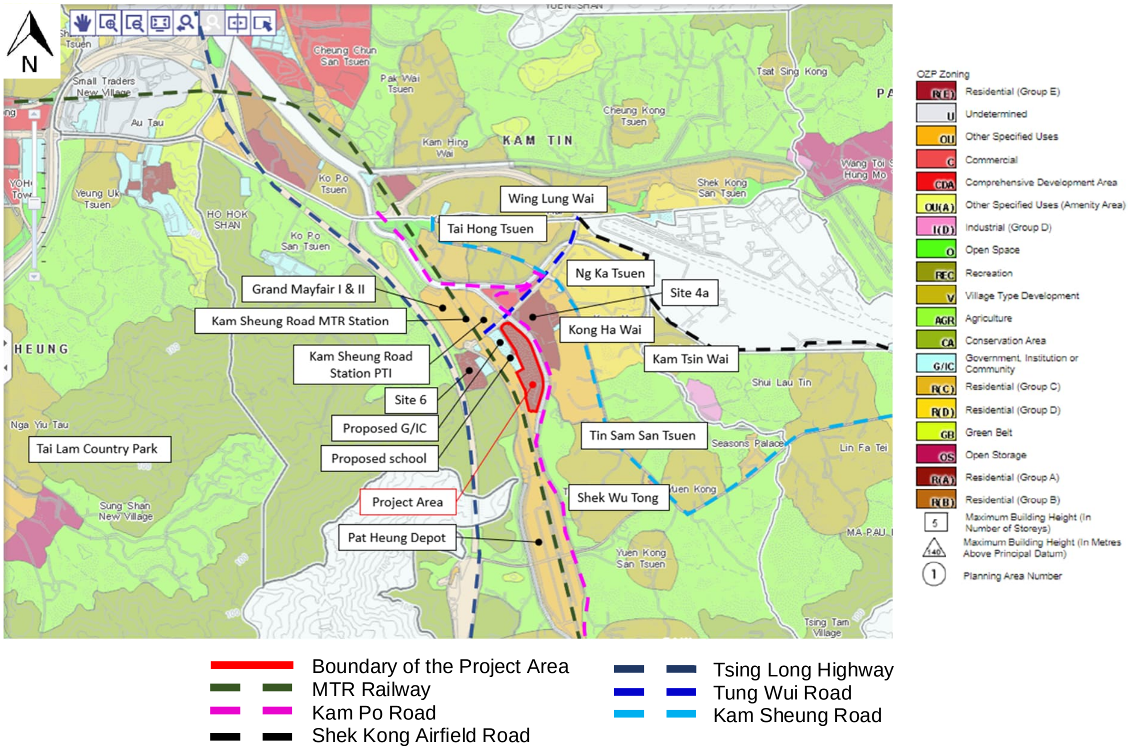


Figure 2.2 Land Use of the Project Area and its Surroundings in Draft OZP (Source: Statutory Planning Portal 2)

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 the AVA study.

Modelling Tool and Model Setup

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

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 surroundings up to a perpendicular distance of 1H while the Surrounding Area (marked in blue) should at least include the project’s surroundings up to a perpendicular distance of 2H calculated from the project boundary, H being the height of the tallest building within Surrounding Area or 100m away from the project site, whichever is larger. In this study, the tallest building within the Surrounding Area is 71.2m, such that 100 meters is adopted for 1H. The computational domain size of around 2500m x 2500m x 1000m. In addition, the grid expansion ratio and the blockage ratio should not exceed 1.3 and 3% respectively. The ground of the computational domain should include topography.

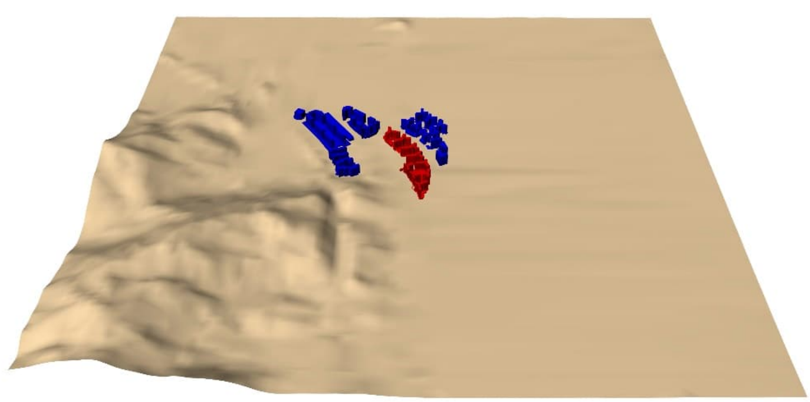


Figure 3.1 Geometry of Computational Model

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 the Lands Department to include all existing, planned and committed development, if any, within the Surrounding Area. All other major elevated structures including the elevated railway tracks, and noise barriers, if any, 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 into the simulation model for Air Ventilation Assessment as shown in **Figure 3.2**.

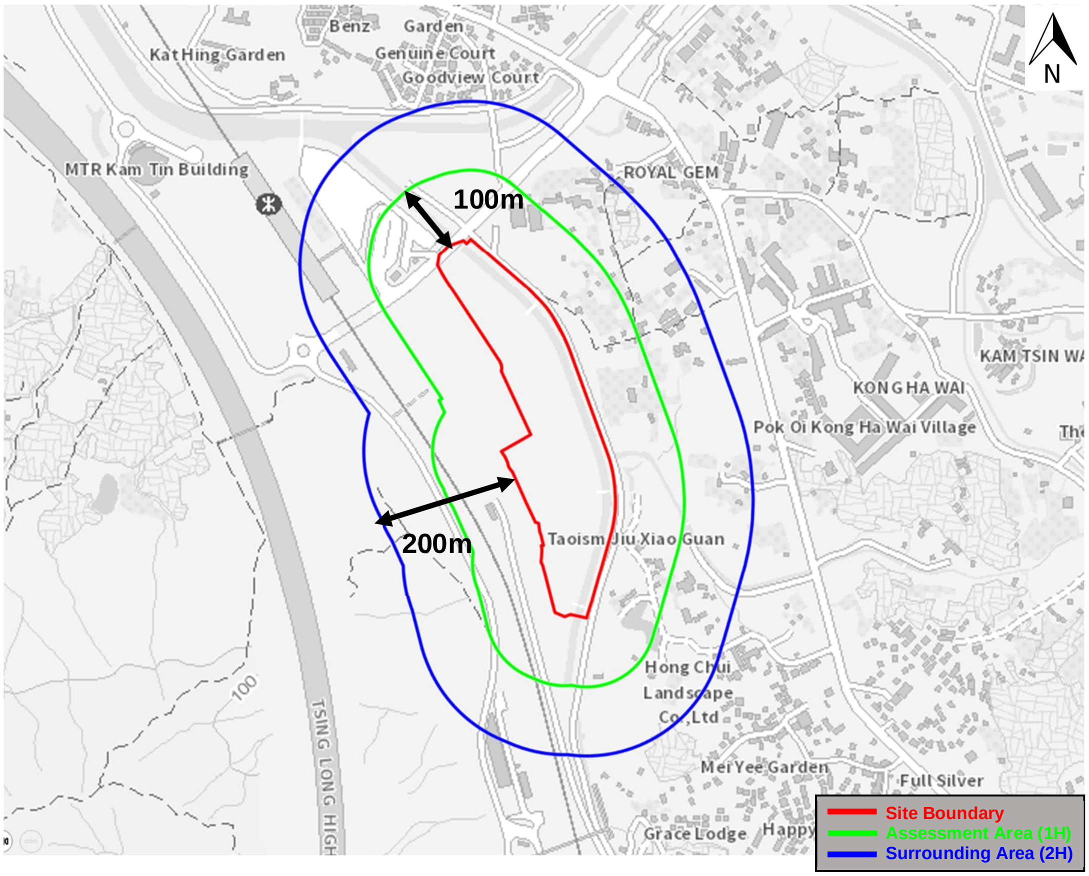


Figure 3.2 Boundaries of the Project Area, Assessment Area and Surrounding Area

Studied Schemes

3.5 **Figure 3.3** and **Figure 3.4** demonstrated model geometry of the Baseline Scheme and the Proposed Scheme in the simulation.

Baseline Scheme

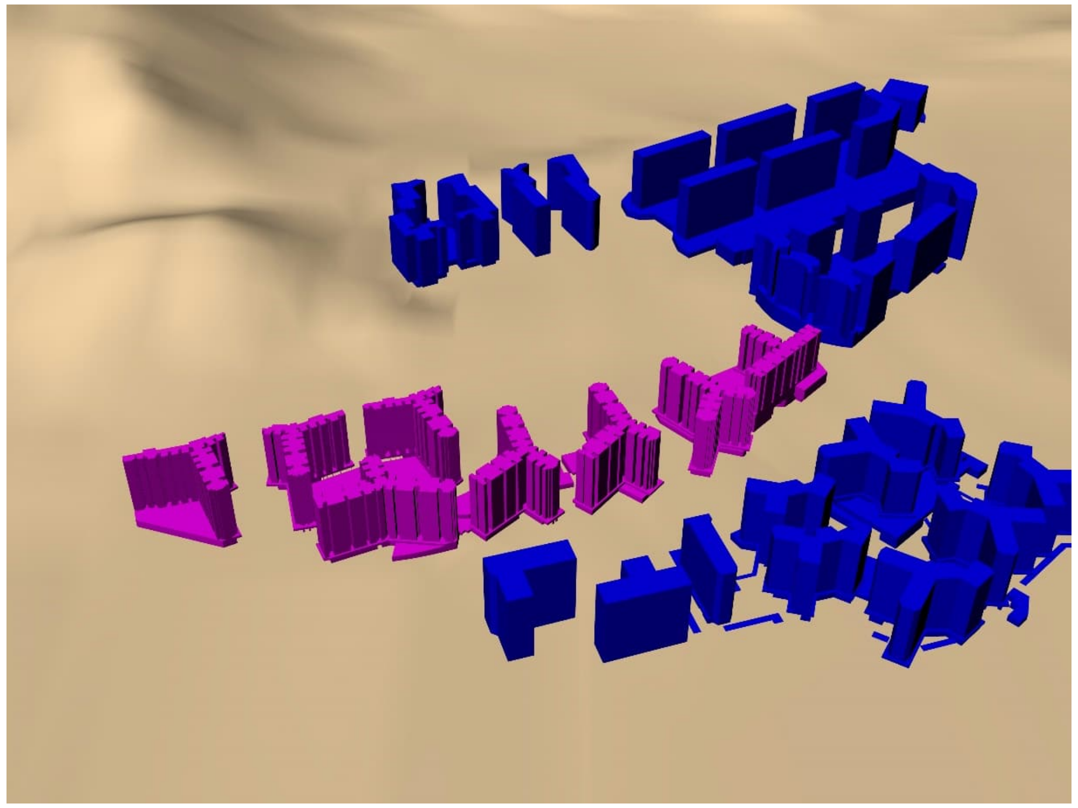
3.6 The Baseline Scheme comprises 8 blocks of 14 to 17 domestic storeys, with a 3-storeys podium of welfare facilities and ancillary facilities under Block 1 and a podium-free design under Block 2 to Block 8. Main domestic lift lobbies are located on the ground floor as shown in **Appendix C**.

3.7 The good design features of the Baseline Scheme are the podium-free design except Block 1 to reduce bulkiness, the 30m and 25m width wind corridors maintained between residential Block 2 and Block 3 as well as Block 7 and Block 8 which aligns in the ENE-WSW direction, empty bays under residential blocks, semi-basement carpark in-between Block 4 to Block 7 to minimize podium height, and building setback from the site boundary and nearby major roads is considered to reduce wind impact.

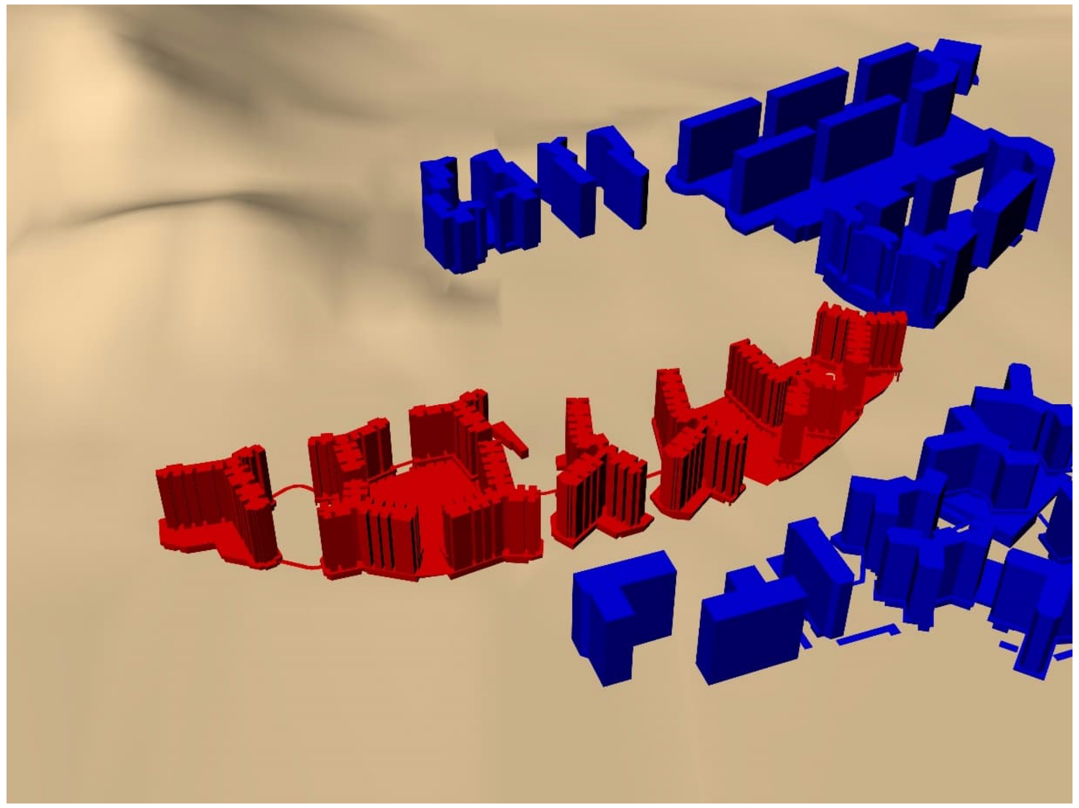
Proposed Scheme

3.8 The Proposed Scheme comprises 9 blocks of 15 to 17 domestic storeys, sitting on 2-storey podiums on the ground floor with welfare facilities under Block A and Block B. A podium-free design is adopted from Block 1 to Block 7. Landscape, open space, main domestic lift lobbies, and other ancillary facilities are located on the G/F and 1/F as shown in **Appendix D**.

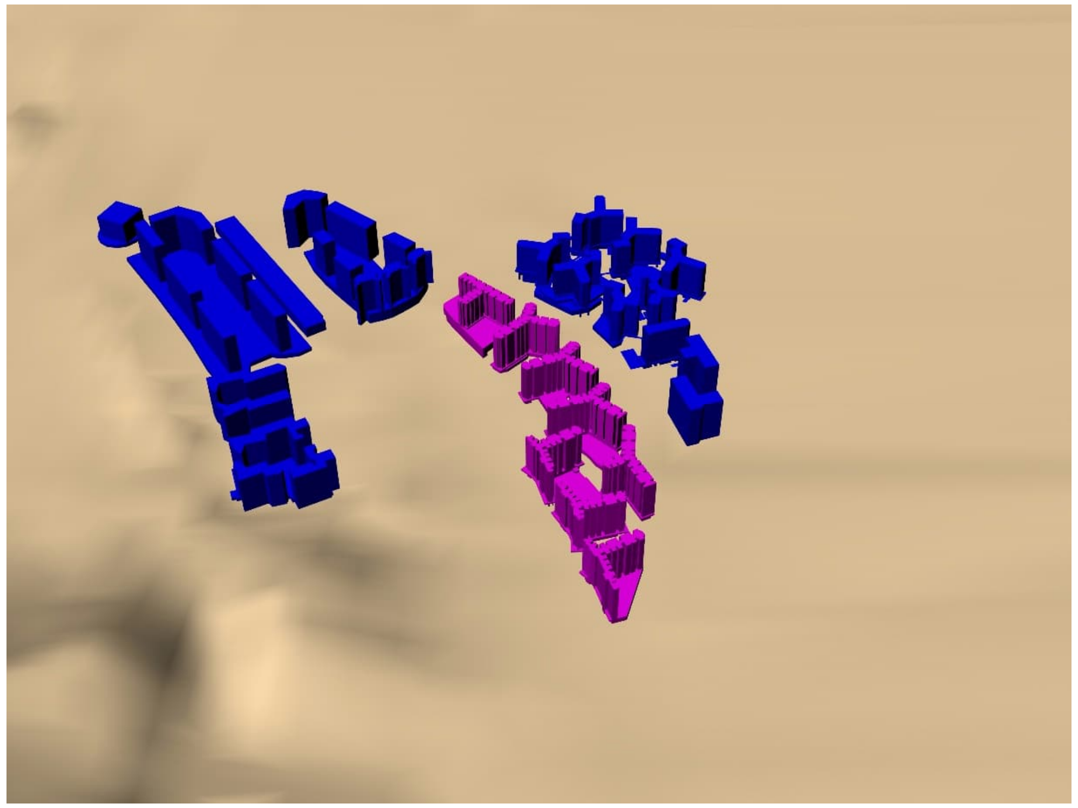
3.9 The proposed good design features include the podium-free design under Block 1 to Block 7, podium garden at Block A, as well as the truncated design under Block 1 to Block 6 to increase the air permeable spaces under the residential blocks. The 30m and 25m width wind corridors maintained between residential Block B and Block 1 as well as Block 5 (or Block 6) and Block 7 which aligns in the ENE-WSW direction, 15m width building gap between each building block, including the building gap between Block 3 and 4 as well as Block 5 and 6, building setback from the site boundary and nearby major roads are also considered to reduce wind impact.



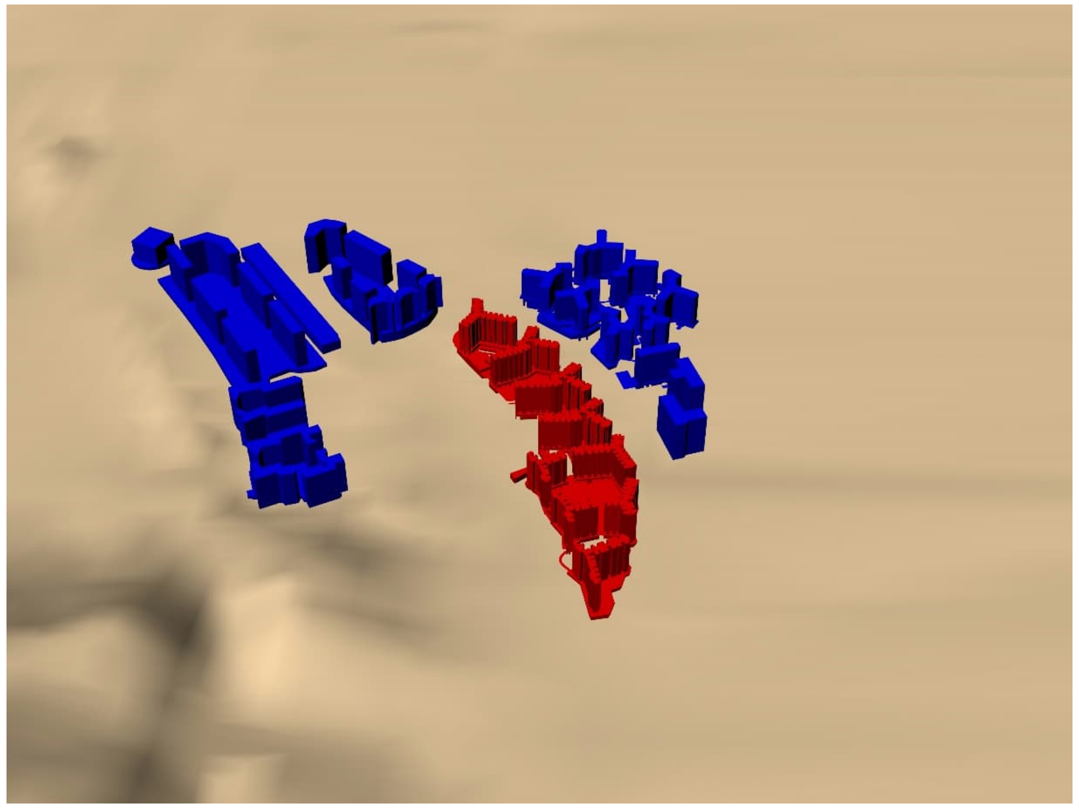
(a) East View, Baseline Scheme



(b) East View, Proposed Scheme

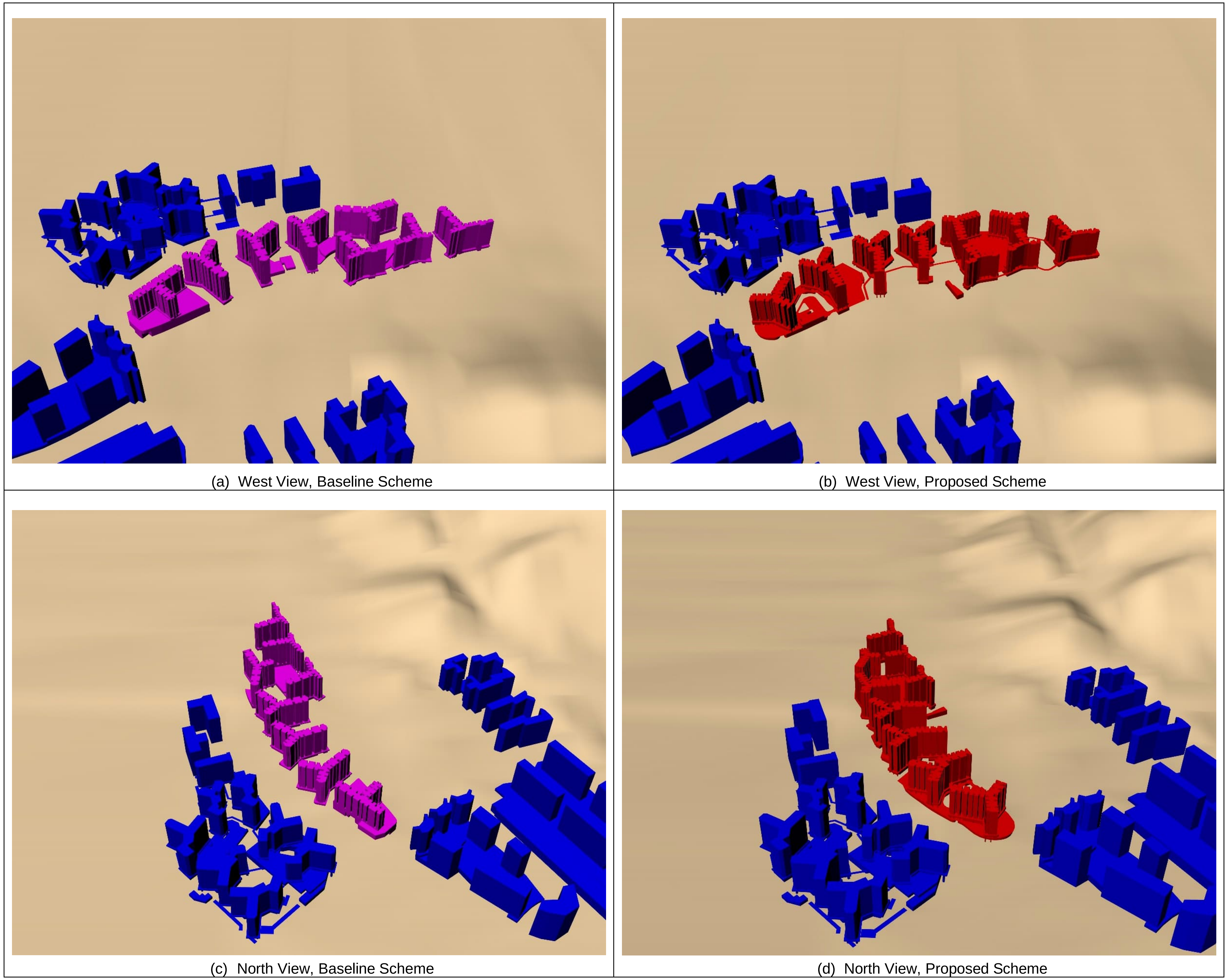


(c) South View, Baseline Scheme



(d) South View, Proposed Scheme

Figure 3.3 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 3.4 Model Geometry under West and North views

Wind Environment

3.10 The site wind availability of the Project Area will be simulated under at least 8 probable prevailing wind directions (which would represent the occurrence of more than 75% of the time) under both annual and summer conditions to illustrate the change in local wind conditions due to the Proposed Development. These prevailing wind directions are determined based on the wind availability simulation result of the Regional Atmospheric Modelling System (RAMS) model published by the Planning Department (PlanD from hereafter).

3.11 **Figure 3.5** 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 3.6** 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 are presented in **Appendix A**.

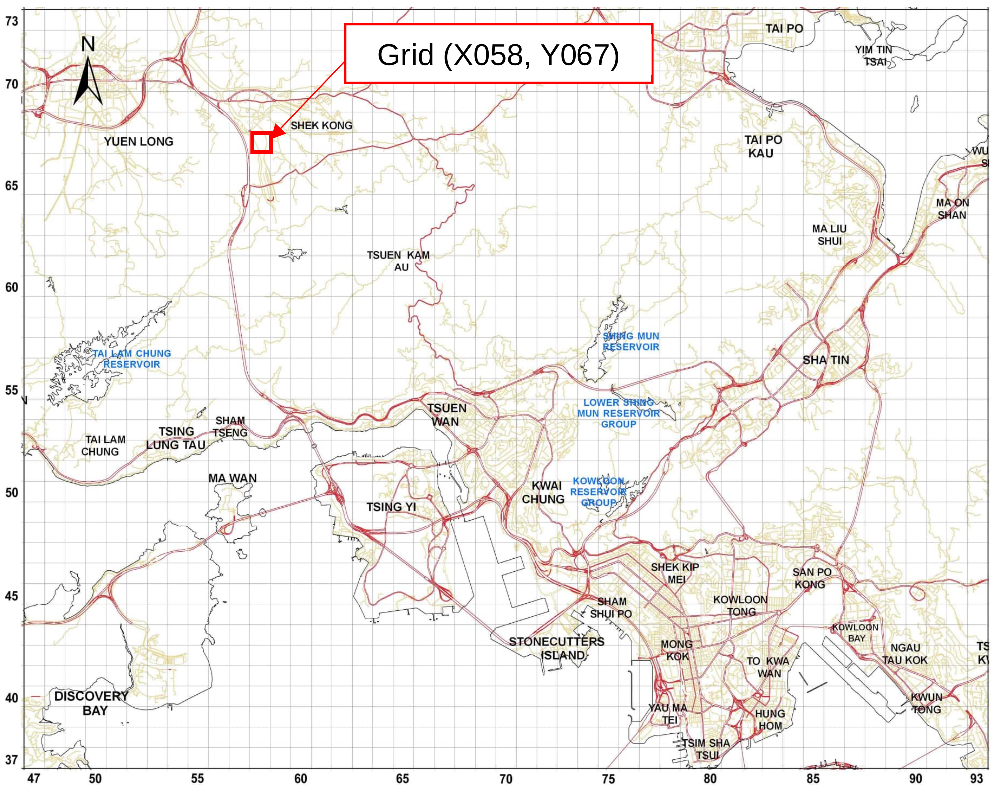
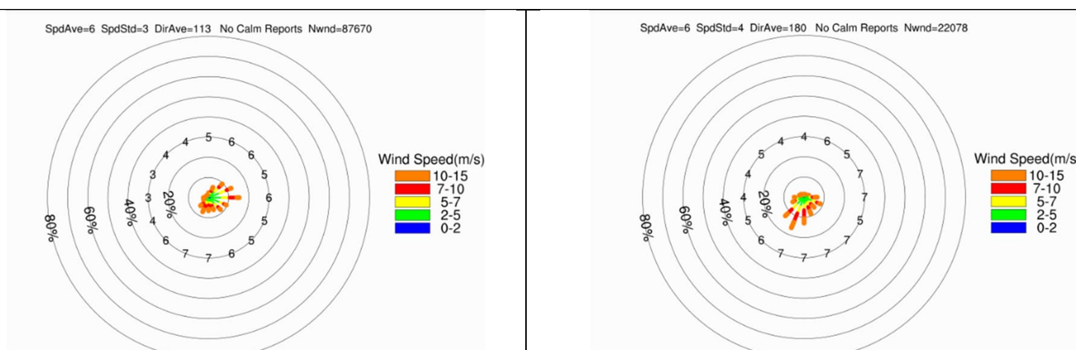


Figure 3.5 Location of data extraction in RAMS model



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

Figure 3.6 Wind Rose at Grid (X058, Y067) (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	15.4%	SSW	16.7%
ENE	12.2%	S	13.3%
NE	9.6%	SW	13.3%
ESE	9.6%	SSE	9.2%
SE	8.6%	ESE	8.8%
SSW	7.7%	SE	7.5%
S	6.7%	E	6.7%
SSE	6.6%	WSW	6.2%
Total occurrence	**76.4%**	**Total occurrence**	**81.7%**

Vertical Wind Profiles

3.12 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, the 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 on PlanD's website.

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

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

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

3.14 The roughness length for determining vertical wind profiles under different wind directions is tabulated in **Table 3.2**. In this study, the land further away from the surrounding area is 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

3.15 The total number of cells for this study is about 12,000,000 cells in tetrahedral mesh. Polyhedral mesh cell 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 (a 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 200m. 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 are 1.2 and 3% respectively.

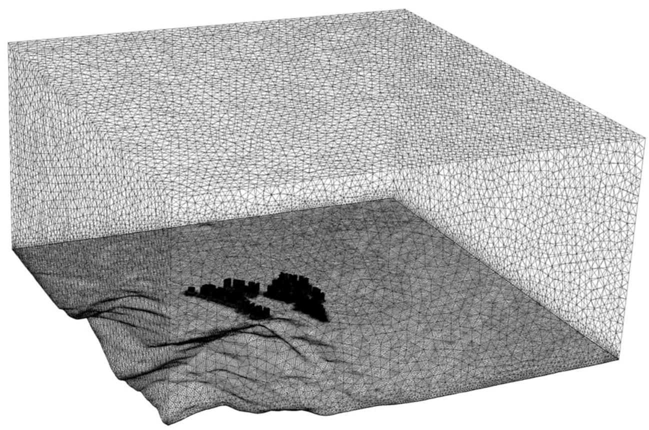


Figure 3.7 Mesh of the simulation domain

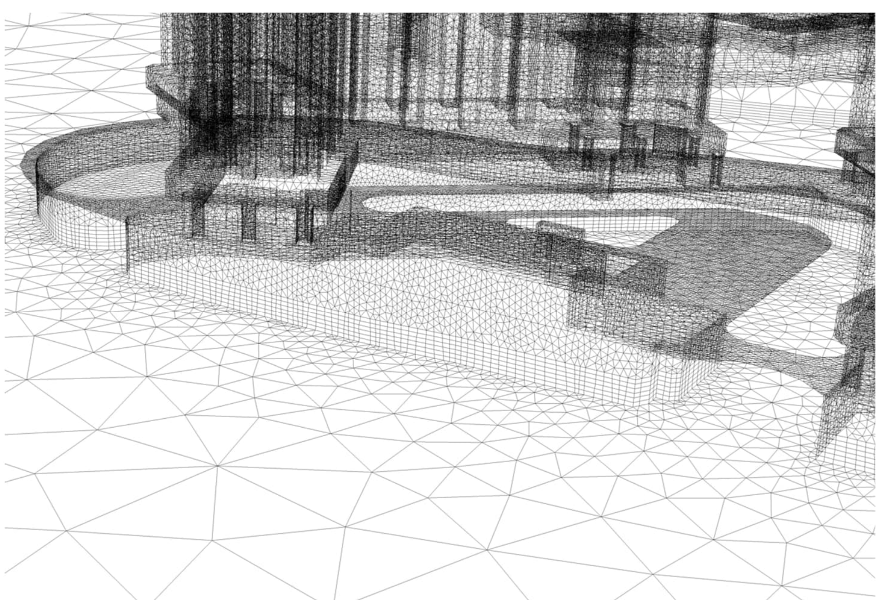


Figure 3.8 Prism layers near ground

Turbulence Model

3.16 As recommended in COST action C14, a 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.

3.17 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 the viscous fluid turbulence model. Solutions were obtained by iterations.

Calculation Method and Boundary Condition

3.18 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 1×10^{-4} as recommended in COST action C14.

3.19 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, a 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) that 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 the 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 the 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 which pedestrians can or will mostly access. There will be 45 Perimeter Test Points, 79 Overall Test Points, and 12 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 7 groups in order to analyse the respective localized wind environment performances. The coverage of the Test Points Groups is shown in **Figure 4.1** while the description of the major covering regions of each group is summarized in **Table 4.1.**

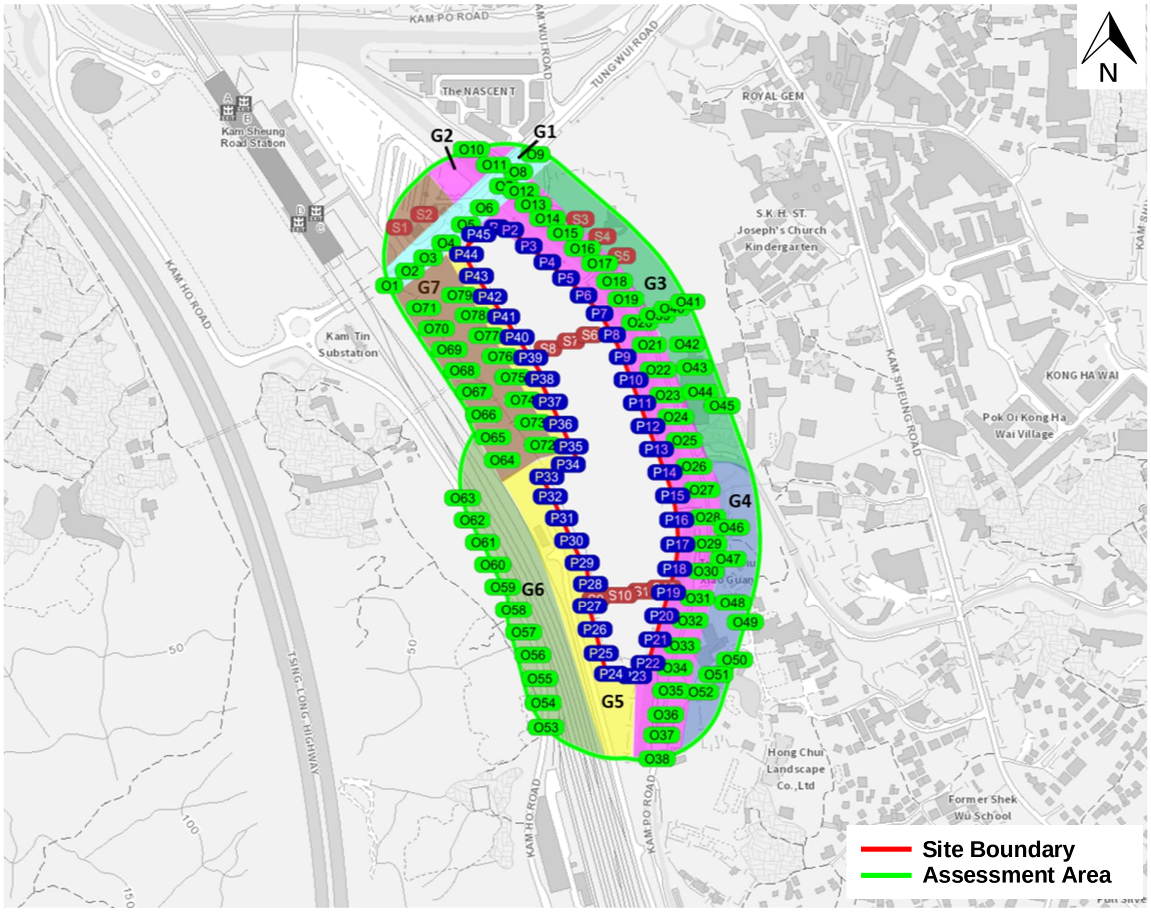


Figure 4.1 Distribution of Test Points

Table 4.1 Test Point Groups and respective represented locations

Test Point Groups	Test Point Numbers	Major location covered
G1	O1-O9	Tung Wui Road
G2	P1-P23, O10-O38	Kam Po Road / Ho Pui Stream
G3	O39-O45	Proposed public housing development Site 4a
G4	O46-O52	Shek Wu Tong
G5	P24-P45	Site Perimeter (western)
G6	O53-O63	Kam Ho Road
G7	O64-O79	Proposed primary school site and G/IC site

5 KEY FINDINGS OF AVA STUDY

Good design features

5.1 Good design features in the **Proposed Scheme** inherited from the **Baseline Scheme** include:

- Empty bays under residential blocks favour wind penetration at the pedestrian level.
- The 30m and 25m width wind corridors between residential Block B & Block 1 and Block 5/6 & Block 7 create the ENE-WSW wind corridors for the wind to penetrate through the Project Area and facilitate the wind availability downstream.
- Semi-basement carpark to minimize podium height.
- Podium-free design except Proposed Scheme's Block A and Block B to minimize the building bulk.
- The building setback from the site boundary and nearby major roads is considered, which would reduce the extent of wind influence regions to the vicinity areas and along the main corridors.

5.2 Additional good design features for improving the air ventilation performance of the **Proposed Scheme** include:

- Modified building morphology in Block A to minimize wind obstruction.
- Reduced number of storey of podium at Block A and inclusion of podium garden at 1/F of Block A and Block B.
- Reduced building frontage and maintained at least 15m building gaps between Block 4 and Block 5
- The truncated design under Block 1 to Block 6 to increase the air permeable spaces under the residential blocks
- More permeable design at podium level

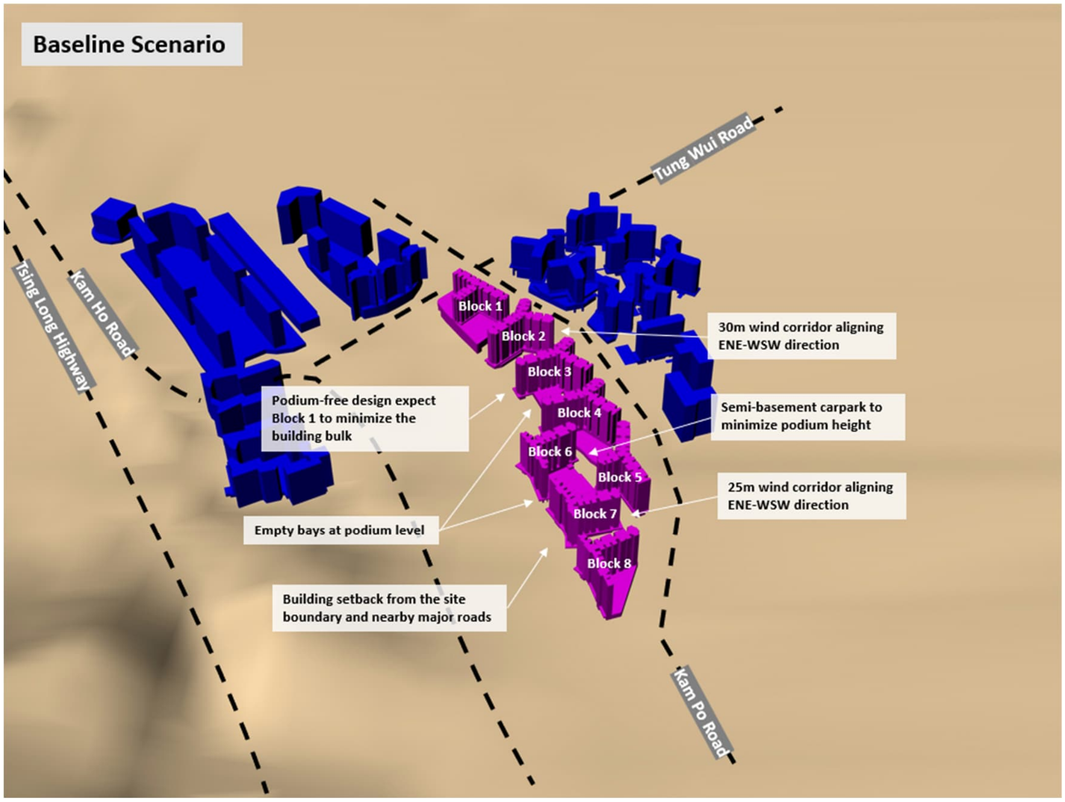


Figure 5.1 Good Design Features in Baseline Scheme

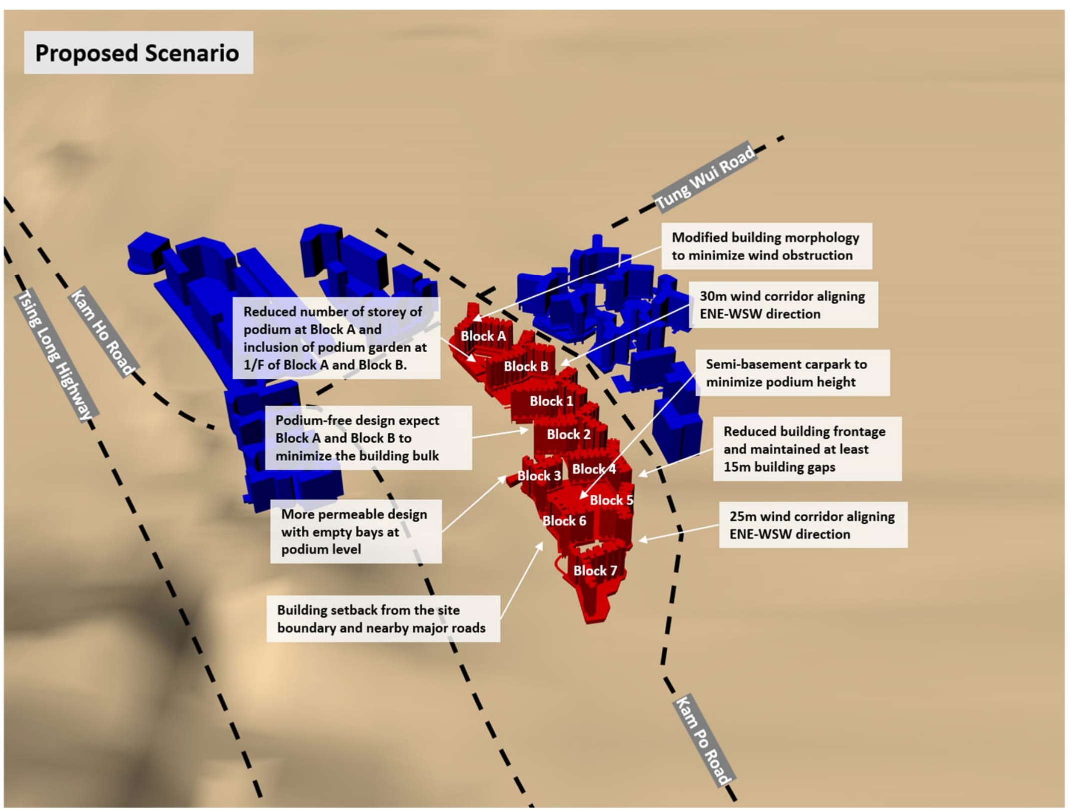


Figure 5.2 Good Design Features in Proposed Scheme

Wind Velocity Ratio Results

5.3 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	0.16	0.17	0.20	0.20
LVR_W	0.17	0.18	0.22	0.22

5.4 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	O1-O9	Tung Wui Road	0.15	0.17	0.20	0.22
G2	P1-P23, O10-O38	Kam Po Road / Ho Pui Stream	0.20	0.21	0.22	0.21
G3	O39-O45	Proposed public housing development Site 4a	0.18	0.18	0.16	0.16
G4	O46-O52	Shek Wu Tong	0.19	0.20	0.25	0.27
G5	P24-P45	Site Perimeter (western)	0.13	0.13	0.21	0.20
G6	O53-O63	Kam Ho Road	0.21	0.21	0.28	0.29
G7	O64-O79	Proposed primary school site and G/IC site	0.12	0.13	0.21	0.21

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

Site Air Ventilation Assessment

5.6 The layouts of the Proposed Scheme and the Baseline Scheme consist of 9 and 8 residential blocks respectively. However, the Proposed Scheme stands out by incorporating more empty bays at the podium level and therefore the podium is more permeable for wind penetration. Furthermore, the widened building gaps between Block 4 and Block 5 in the Proposed Scheme effectively reduce building frontage and hence alleviate the impact on air ventilation at the site perimeter when compared to the Baseline Scheme.

5.7 The SVRw indicates how the lower portion of the buildings within the Project Area affects the wind environment of its immediate vicinity. Under annual winds, the average predicted SVRw for the Proposed Scheme increases from 0.16 to 0.17 compared to the Baseline Scheme. This indicates that the Proposed Scheme demonstrates superior air ventilation performance due to its wider building gaps and the incorporation of empty spaces at the podium level within the Project Area, which promote wind penetration. While during summer, the SVRw maintains 0.20 for both the Proposed Scheme and the Baseline Scheme. This suggests that both schemes would experience similar air ventilation performance within the Project Area under summer winds.

Local Air Ventilation Assessment

5.8 The LVRw evaluates the overall wind environment within the Assessment Area for both schemes under annual and summer winds. The LVRw for the Proposed Scheme shows a slight increase from 0.17 to 0.18 compared to the Baseline Scheme under annual prevailing winds. While during the summer seasons, the LVRw remains constant at 0.22 for both the Baseline Scheme and the Proposed Scheme. These results suggest that the Proposed Scheme exhibits a slight improvement in the pedestrian wind environment compared to the Baseline Scheme at the site boundary and throughout the Assessment Area.

5.9 The averaged wind velocity ratio of Group 1 test points provides an assessment of the wind environment along Tung Wui Road. The Proposed Scheme exhibit an improved air ventilation performance under both annual and summer winds compared to the Baseline Scheme. This is evident from the averaged VRw in Group 1 Test Points, which increased from 0.15 to 0.17 and from 0.20 to 0.22 respectively annually and during summer. It should be noted that the building morphology of Block A in the Proposed Scheme is modified, resulting in a larger buffer area between the Project Area and the immediate surrounding developments. Along with the podium garden at 1/F of Block A and Block B, more wind could enter Tung Wui Road and enhance the ventilation performance along Tung Wui Road during annual and summer wind directions.

5.10 Group 2 Test Points are situated along Kam Po Road / Ho Pui Stream, and the VRw measurements obtained serve as indicators of the pedestrian wind environment in that specific area. The results illustrate a comparable air ventilation performance under the Proposed Scheme and the Baseline Scheme. The VRw slightly increases from 0.20 in the Baseline Scheme to 0.21 in the Proposed Scheme under annual wind directions, while the VRw slightly decreases from 0.22 in the Baseline Scheme to 0.21 in the Proposed Scheme under summer wind directions. The incoming wind is expected to flow between the Project Area and the proposed Site 4a, as both schemes incorporated the 30m and 25m width wind corridors, the incoming wind could flow along the wind corridors, leading to a similar ventilation performance.

5.11 Group 3 Test Points cover a portion of the Proposed public housing development Site 4a. It is noticed that the Proposed Scheme would have a comparable air ventilation performance for both schemes with the VRw maintained as 0.18 and 0.16 during annual and summer conditions respectively for the Proposed Scheme compared to the Baseline Scheme. The VRw is higher during annual conditions because Site 4a is in the upwind of the Project Area during summer. It also indicates that the permeable design in both schemes would favour the wind environment in Site 4a under both annual and summer conditions.

5.12 Group 4 Test Points cover a portion of Shek Wu Tong. It is observed that the Proposed Scheme would have an improvement in air ventilation when compared to the Baseline Scheme with the VRw increased from 0.19 to 0.20 and from 0.25 to 0.27 during annual and summer conditions respectively for the Proposed Scheme compared to the Baseline Scheme. It indicates that the widened building gaps between Block 4 and Block 5 in the Proposed Scheme would benefit the wind environment in Shek Wu Tong under both annual and summer conditions.

5.13 The VRw values of Group 5 Test Points indicate the air ventilation performance of the western site perimeter of the Project Area. The results reveal a similar wind environment under annual conditions, while a marginally deteriorated wind environment is observed during summer. This disparity can be attributed to fewer empty bays in the Baseline Scheme, which typically induce a relatively stronger downwash effect towards the western site perimeter of the Project Area that contributes to a slightly increased velocity ratio under summer wind directions. Meanwhile, the presence of the 30m and 25m wind corridors in both schemes benefits air permeability, resulting in a similar air ventilation performance. Specifically, the VRw values are 0.13 annually for both schemes, and slightly decreases from 0.21 to 0.20 during summer for the Proposed Scheme compared to the Baseline Scheme.

5.14 Group 6 Test Points are evenly spaced along a section of Kam Ho Road, covering the northwest quadrant of the Project Area. The results demonstrate a slight enhancement in the wind environment under summer scenarios. Under annual conditions, the VRw remains the same as 0.21 for both schemes. For summer conditions, the VRw value slightly rises from 0.28 in the Baseline Scheme to 0.29 in the Proposed Scheme. This implies a similar air ventilation performance within this region. It should be noted that a section of Kam Ho Road is situated upstream of the Project Area under summer wind directions, and the wind influence induced by the proposed development is not significant.

5.15 Group 7 Test Points cover the Proposed primary school site and G/IC site. It is noticed that the Proposed Scheme would have a slightly better air ventilation performance for the Proposed Scheme than the Baseline Scheme with the VRw slightly increased from 0.12 to 0.13 during annual conditions. The VRw maintained the same as 0.21 for both schemes under summer conditions. As the Proposed primary school site and G/IC site are located in the upwind of the Project Area in summer, the incoming wind would not be obstructed, such that the VRw is significantly higher than in the annual conditions.

6 DIRECTIONAL ANALYSIS

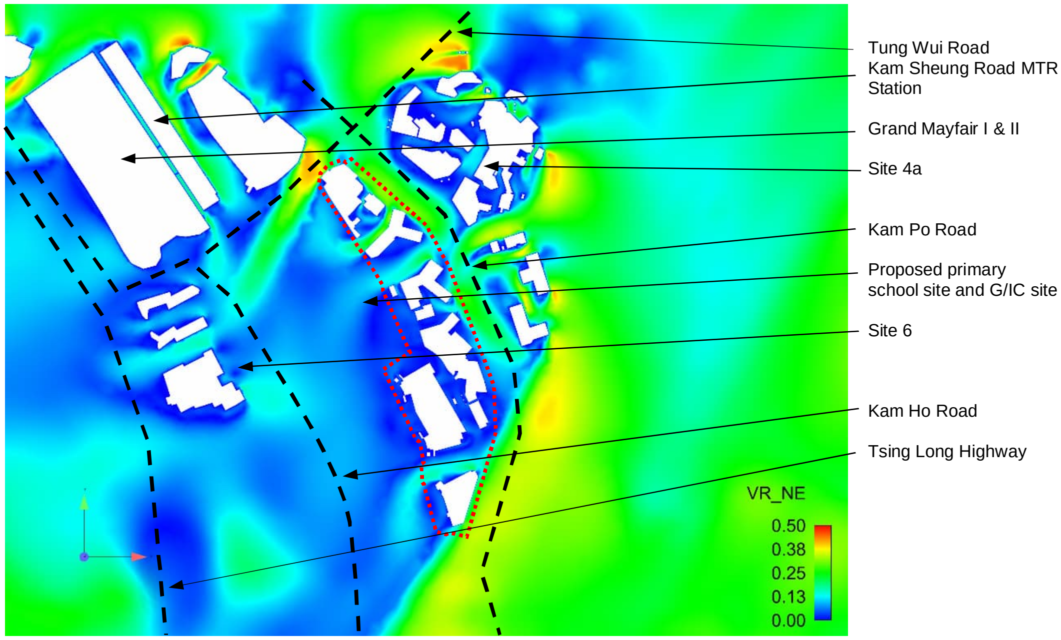
NE: (Annual: 9.6%)

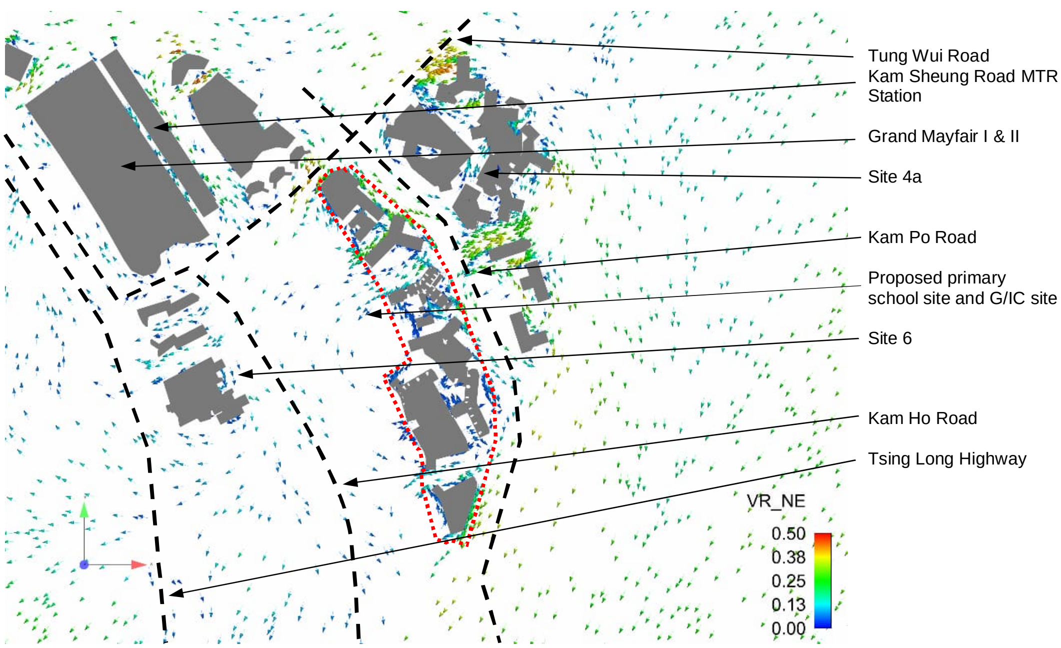
6.1 It has been observed that in NE wind conditions, the incoming wind travels through the low-rise villages of Ng Ka Tsuen (appro. 17mPD) and Kong Ha Wai (appro. 16mPD). These low-rise developments are located upwind, but their presence has no discernible effect on the wind environment of the Project Area as the incoming wind can pass over them unhindered. Yet, a small portion of the incoming wind may encounter slight obstruction due to the proposed public housing development at Site 4a in the upwind. Nonetheless, the incoming wind can gradually flow through the building gaps and reserved air permeability spaces between the residential towers at Site 4a, facilitating its access to the Project Area. Furthermore, another portion of the incoming wind utilizes Tung Wui Road as a primary wind corridor, as it aligns in the NE-SW direction, facilitating the incoming flow of NE wind towards the Project Area. Therefore, the site's wind availability is determined to be satisfactory.

6.2 Under the Baseline Scenario, it is observed that the incoming wind is hindered by the proposed mid-rise residential development (62.24mPD) and impacts the wind environment at the proposed primary school site and G/IC site and the proposed development Site 6. At lower levels, the relatively long frontage of the podium structure under Block 3, 4 and 5 is found to obstruct a portion of the incoming wind, resulting in a limited wind penetration through the central portion of the Project Area. Consequently, a localized stagnant zone characterized by low wind flow can be identified in the downwind of Block 3, 4 and 5. However, despite not aligning perfectly with the NE wind direction, it is also observed that the incoming wind at pedestrian level could pass through the building gap between Block 1 and Block 2, as well as the 30m and 25m width wind corridors that align in the ENE-WSW to alleviate the wind influence. Meanwhile, the incoming wind flowing along Tung Wui Road is unobstructed, and the velocity ratio of this wind corridor is satisfactory.

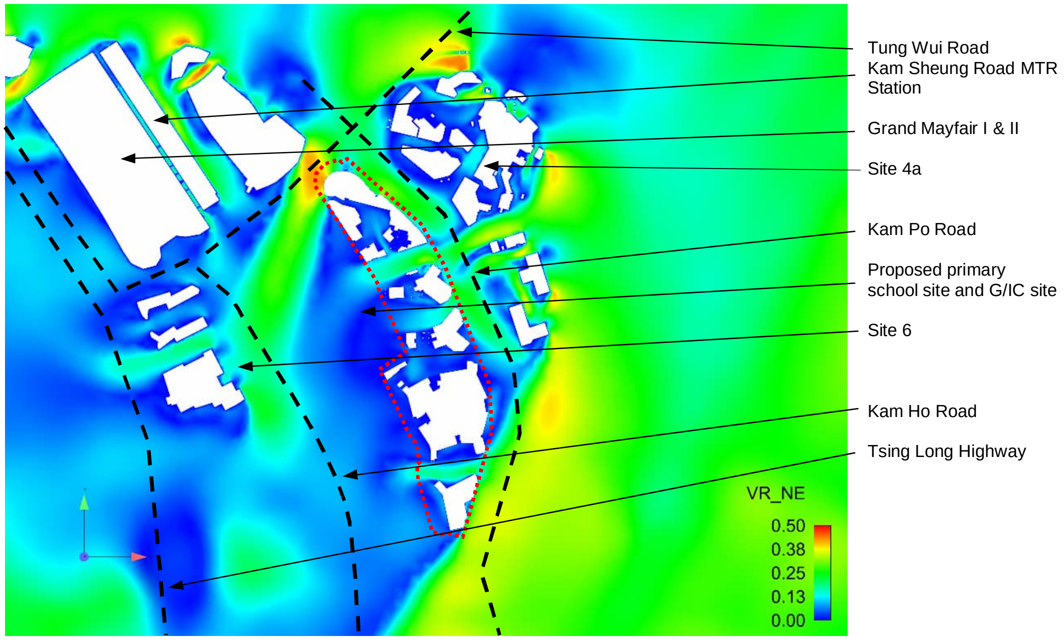
6.3 In the Proposed Scenario, it is observed that the proposed mid-rise residential developments (62.24mPD) have a reduced air ventilation impact on the immediate downstream area including the proposed primary school site and G/IC site and the proposed development Site 6 compared to the Baseline Scenario. This is due to the modified building morphology of Block A which has widened the entry of incoming wind from Tung Wui Road, along with the podium garden at 1/F of Block A and Block B, allowing a larger portion of the incoming wind to flow along Tung Wui Road and ventilate the downstream. It is noticeable that the Velocity Ratio (VR) of Site 6 is increased thanks to this good design feature. On the other hand, despite the longer building frontage under Block A and Block B, the reduced building frontage between Block 4 and Block 5 allows the incoming wind to penetrate the central portion of the Project Area via the 15m building gap, resulting in a similar VR in western site perimeter and Kam Ho Road. Additionally, the truncated design under Block 1 to Block 6 increases the air permeable spaces at the pedestrian level compared to the Baseline Scenario, such that the incoming wind could enter the Project Area freely and flow through each empty bay. Therefore, the VR in the downstream is observed to be satisfactory.

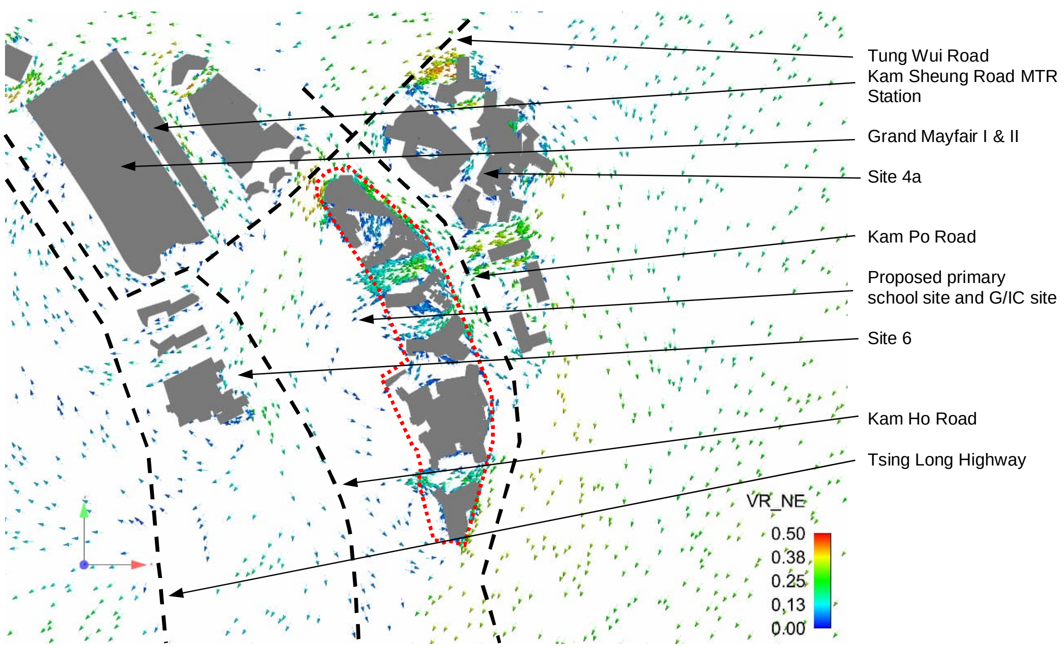
Baseline Scheme





Proposed Scheme





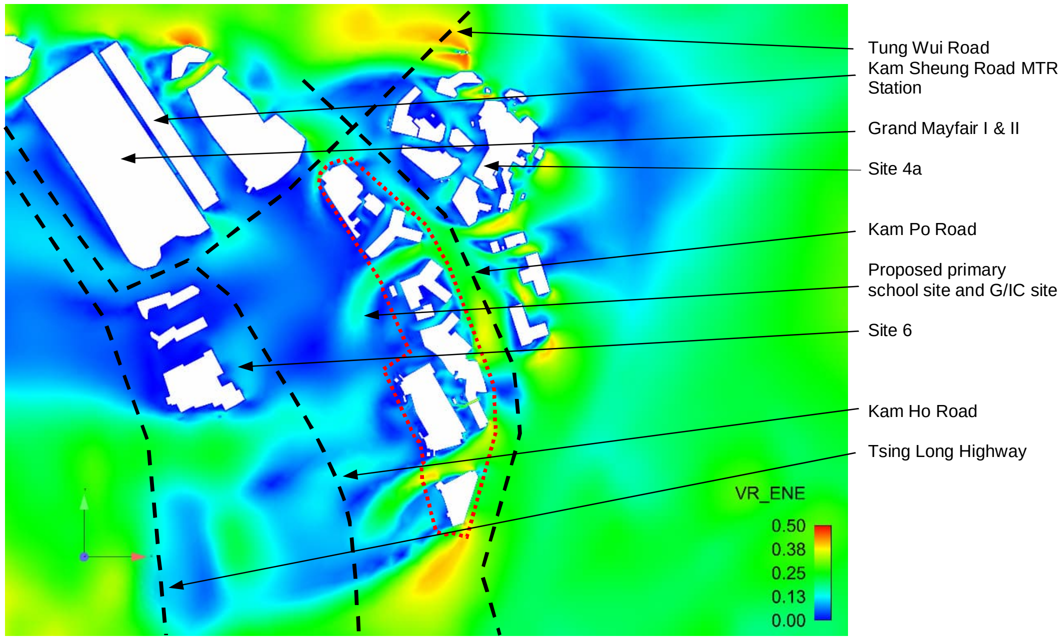
ENE: (Annual: 12.2%)

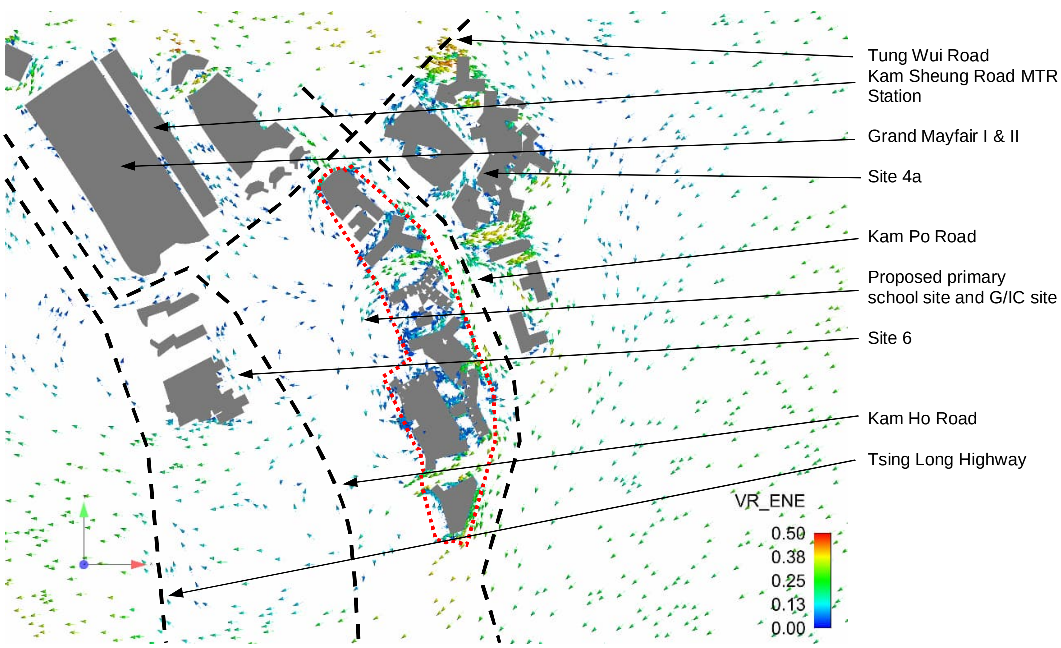
6.4 Similar to NE wind, it is observed that the incoming ENE wind would pass through the low-rise villages including Ng Ka Tsuen (17mPD appx.) and Kong Ha Wai (16mPD appx.). The low-rise villages would not induce wind influences against the Project Area as the ENE winds could skim over the low-rise developments. Then, the proposed public housing development Site 4a in the immediate east to the northeast would slightly weaken the wind environment, which the Project Area lies in the wind influencing zone of Site 4a. Notwithstanding, the reserved air permeable spaces within Site 4a could facilitate satisfactory wind penetration towards to Project Area. On the other hand, Tung Wui Road aligns in the NE-SW direction, which is less effective under ENE wind. Thus, the ENE wind is observed to only travel a section of Tung Wui Road and gradually flow towards Kam Sheung Road MTR Station (30mPD appx.).

6.5 In the Baseline Scenario, it is observed that the incoming wind flowing from Site 4a is slightly diminished by the proposed developments in the Project Area (62.24mPD). The frontage of the podium structure acts as a barrier, impeding a portion of the incoming wind at the pedestrian level, and resulting in the creation of a localized wind influencing zone in the immediate downstream area. However, the 30m and 25m width wind corridors that align in the ENE-WSW alleviate the wind influence, enhance wind penetration and decrease the wind stagnant area. Therefore, a portion of the incoming wind could flow towards the western site perimeter and a section of Kam Ho Road, providing a satisfactory VR to these areas.

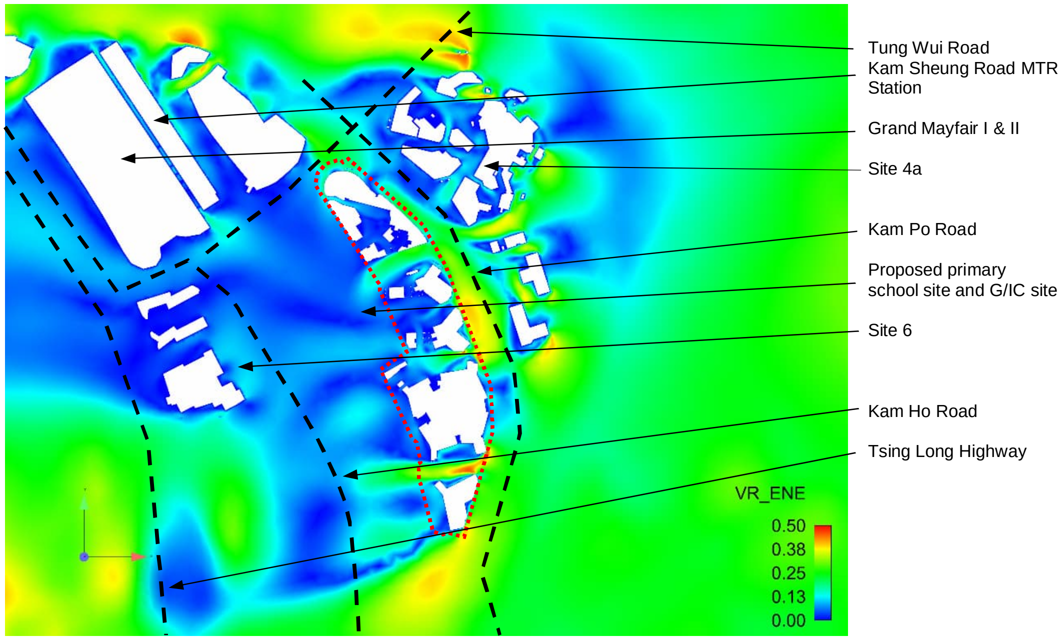
6.6 In the Proposed Scenario, it is observed that the proposed mid-rise residential developments (62.24mPD) have a less significant air ventilation impact on the immediate downstream area compared to the Baseline Scenario. The incoming wind is able to penetrate the central portion of the Project Area more effectively with fewer obstructions from the proposed developments at the pedestrian level, thanks to the reserved empty bays beneath the residential blocks, the 30m and 25m width wind corridors, as well as the truncated design under Block 1 to Block 6 could enhance the air permeability of the Project Area at pedestrian level, effectively reducing the wind stagnant area in the immediate downstream. Moreover, at a higher level, the 15m building gap between Block 4 and Block 5 allows the incoming wind to penetrate the central portion of the Project Area freely. Consequently, it is observed that the incoming wind could evenly distribute towards the downstream area including the proposed primary school site and G/IC site, Kam Ho Road, and the proposed development Site 6 via the reserved air permeable spaces, the velocity ratio of these areas is satisfactory.

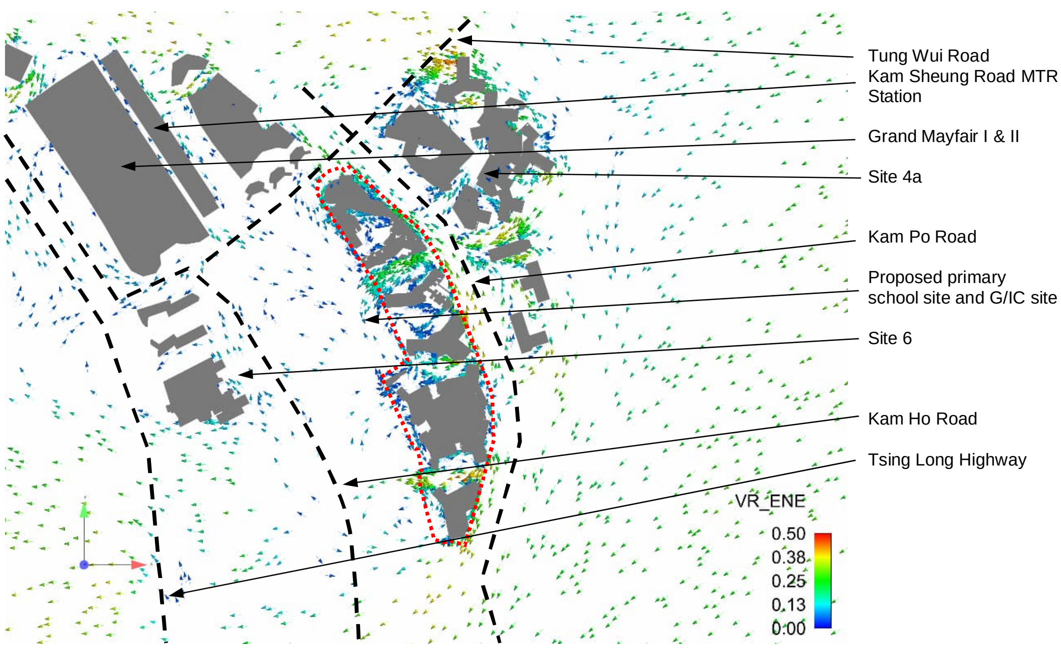
Baseline Scheme





Proposed Scheme





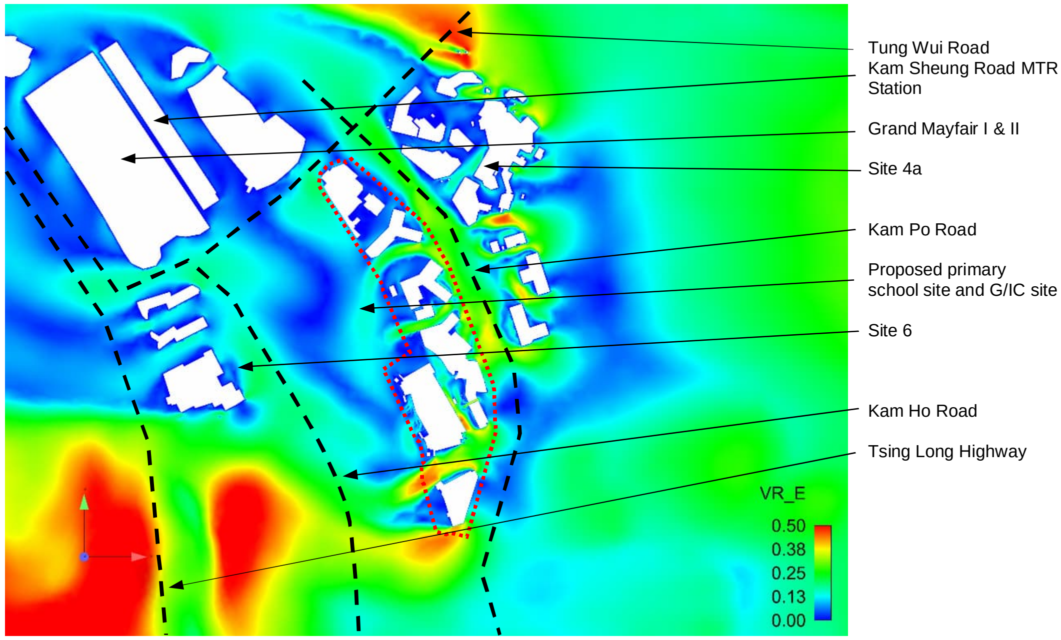
E: (Annual: 15.4%, Summer: 6.7%)

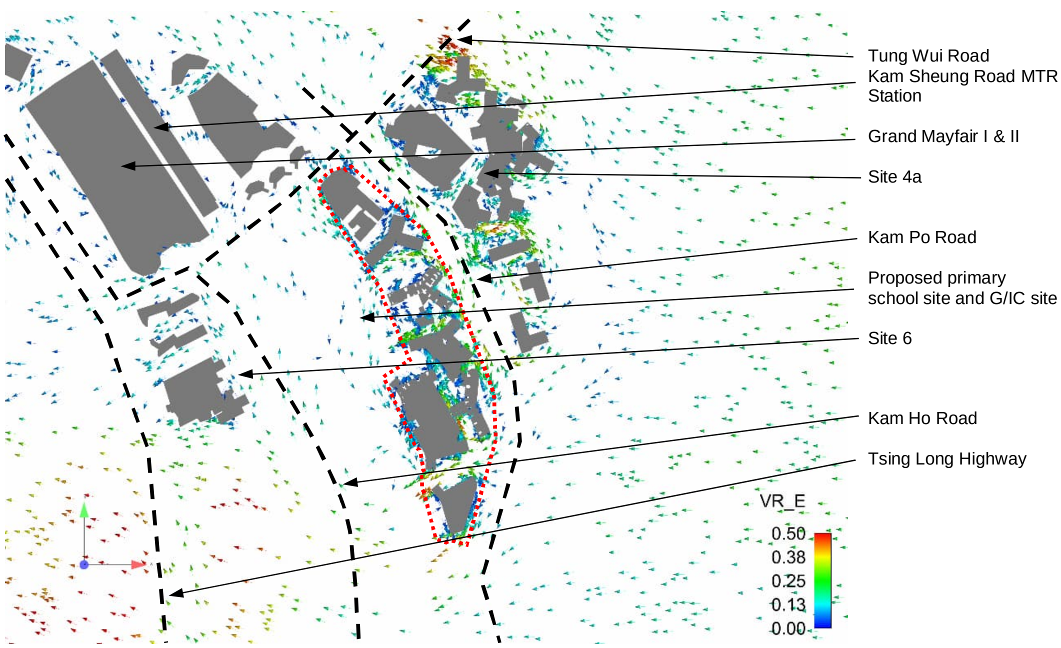
6.8 The easterly (E) wind is observed to flow over the low-rise villages, including Kong Ha Wai (16mPD) and Kam Tsin Wai (20mPD), before reaching the Project Area. The incoming easterly wind can flow along a section of Shek Kong Airfield Road and Kam Sheung Road as wind corridors and skim over the low-rise developments, then gradually reach the Project Area through the building gaps and empty bays of the proposed public housing development at Site 4a. In addition, Site 4a would not induce wind impact towards the central to the southern portion of the Project Area under the E direction. Therefore, the wind availability of the Project Area is expected to be satisfactory.

6.9 Under the Baseline Scenario, the incoming easterly wind flowing from the low-rise developments is found to be shielded by the proposed mid-rise developments (62.24mPD), creating a localized wind shadow in the downstream of the Project Area due to the long frontage of the podium. It leads to a slightly declined air ventilation performance in the western site perimeter and the Proposed primary school site and G/IC site. However, the empty bays at the podium and the building gaps including the 30m and 25m width wind corridors between Block 2 and Block 3, and Block 7 and Block 8 respectively, as well as the building gap between Block 3 and Block 4 are observed to facilitate the wind penetration, ensuring a satisfactory VR to the immediate downstream.

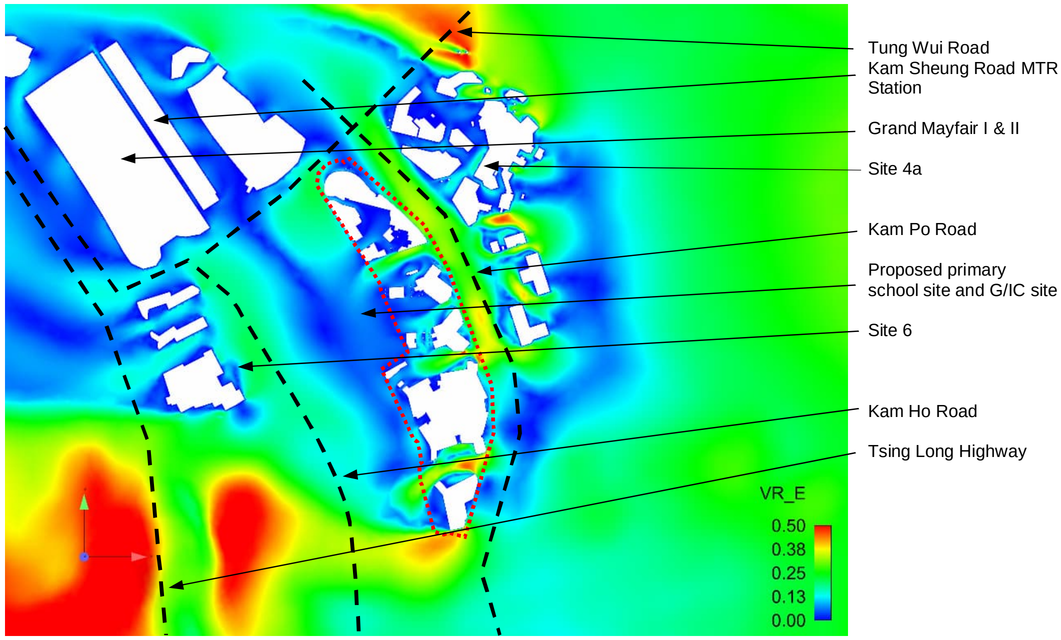
6.10 Under the Proposed Scenario, the proposed mid-rise residential developments (62.24mPD) are observed to alleviate the air ventilation impact on the immediate downstream compared to the Baseline Scenario. It is found that the wind flow pattern of the Proposed Scenario is similar to the Baseline Scenario, where a localized wind shadow is also observed in the immediate downstream, covering the western site perimeter and the Proposed primary school site and G/IC site. Yet, the increased VR is seen along Kam Ho Road and further downstream, covering the proposed development Site 6. It is because the more permeable design and widened building gaps as stated in the Proposed Scheme favour the wind penetration, that the incoming wind could reattach effectively and ventilate the downstream area. On the other hand, the proposed development in the Project Area could induce downwashed wind to Kam Po Road, such that the VR in Kam Po Road is satisfactory. Moreover, it is noticed that the VR along a section of Tung Wui Road is increased compared to the Baseline Scenario due to the modified building morphology of Block A. To summarize, it can be concluded that the Proposed Scenario, brings a better air ventilation performance to the surroundings than the Baseline Scenario.

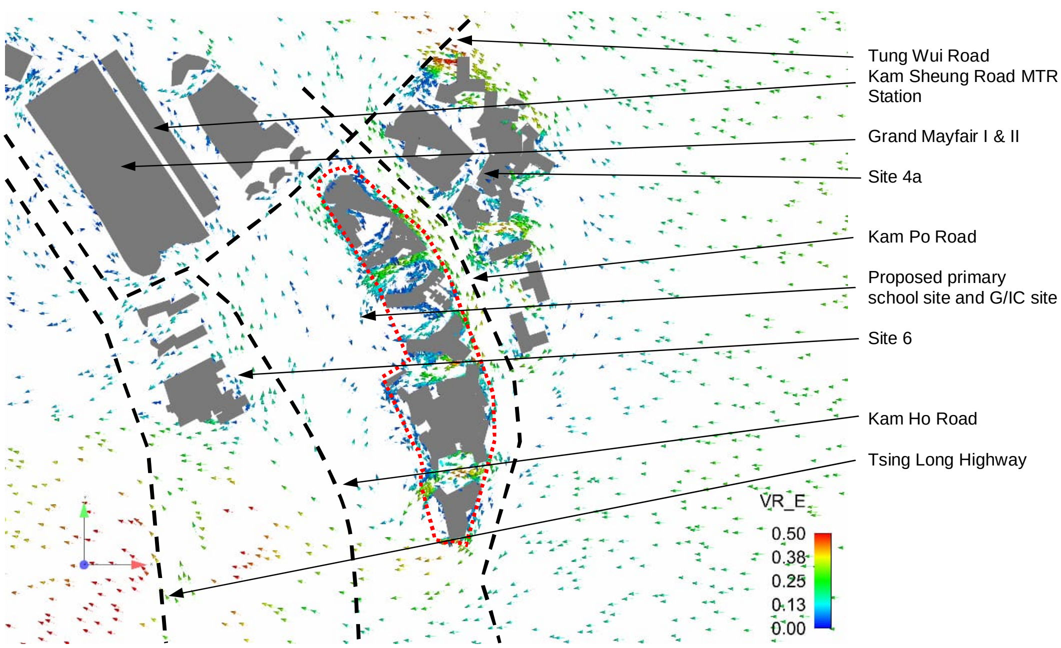
Baseline Scheme





Proposed Scheme





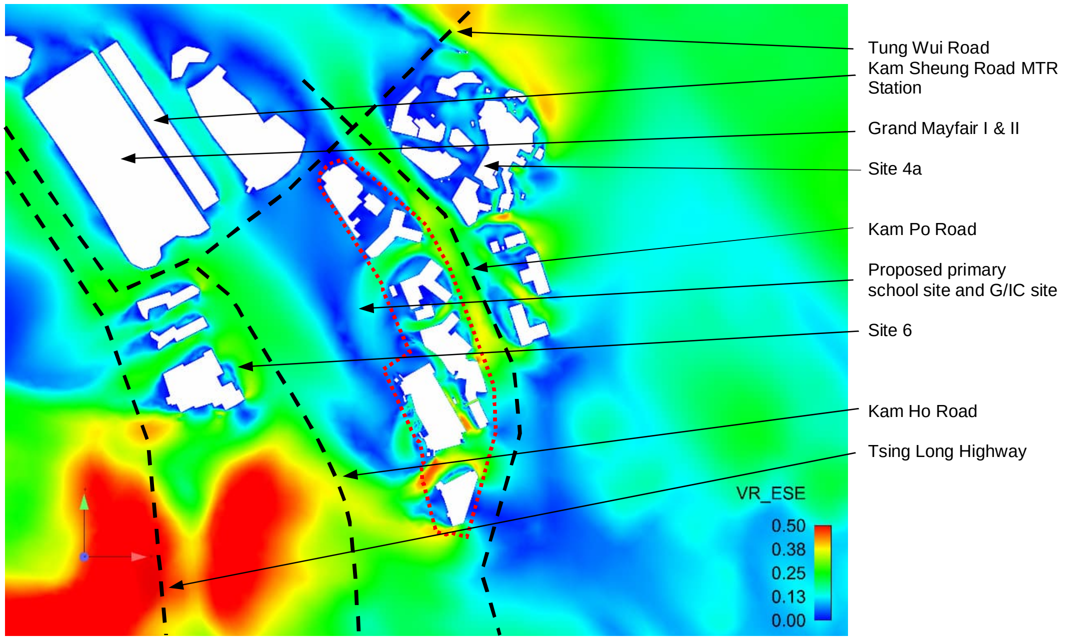
ESE: (Annual: 9.6%, Summer: 8.8%)

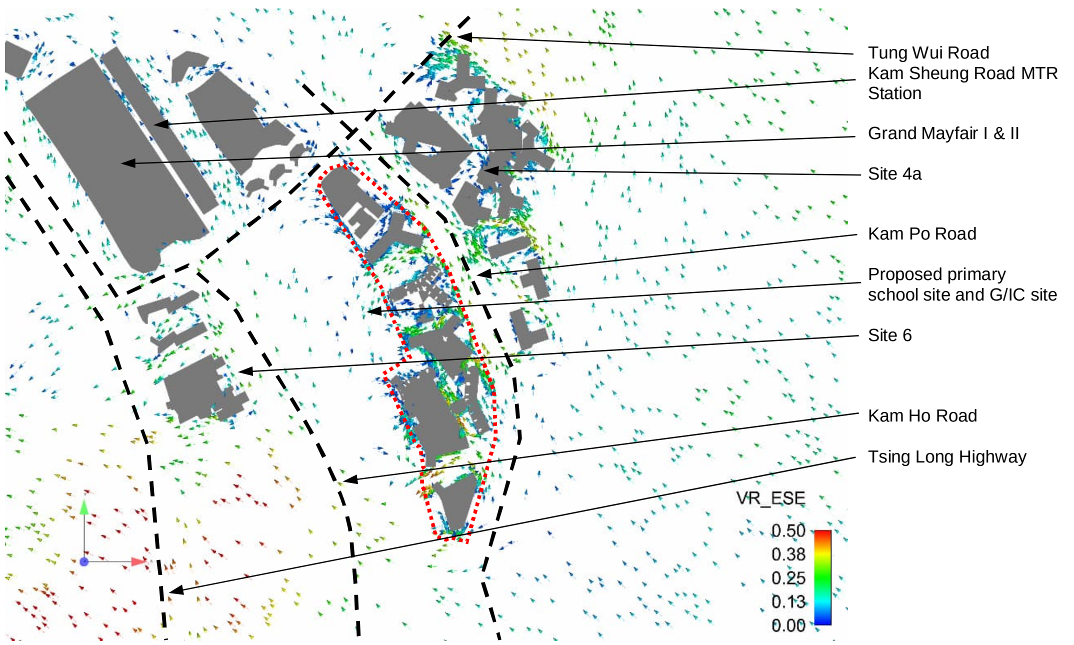
6.11 The incoming ESE wind under annual and summer conditions would flow along the extensive Agriculture ("AGR") area and low-rise villages including Kam Tsin Wai (20mPD) and Tin Sam San Tsuen (22mPD) before reaching the Project Area. The wind availability would then be slightly reduced by the proposed public housing development Site 4a to enter the Project Area. Nevertheless, the air permeable space in Site 4a is aligned in the ESE direction and able to facilitate wind penetration towards the Project Area. Thus, a satisfactory site wind availability in the Project Area is estimated.

6.12 In the Baseline Scenario, the incoming ESE wind is observed to be faintly captured by the proposed mid-rise developments (62.24mPD) and created a localized wind shadow to the immediate downstream, reducing the VR of the western site perimeter and the Proposed primary school site and G/IC site. A portion of the incoming wind is noticed to be diverted and flow along Kam Po Road, favouring the VR in Kam Po Road. Another portion of the incoming wind is found to penetrate the Project Area via the reserved 30m and 25m width wind corridors. The wind flow is observed to reattach effectively with the wind flowing along Kam Ho Road. A relatively high VR can be seen around the proposed development Site 6.

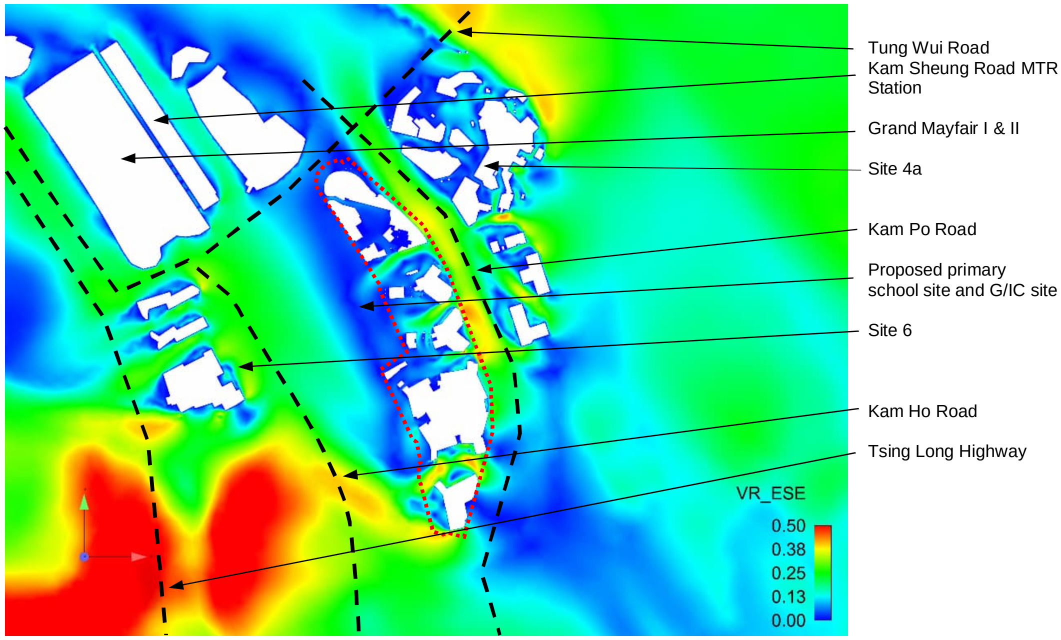
6.13 In the Proposed Scenario, the proposed mid-rise residential developments (62.24mPD) are observed to have a comparable air ventilation performance in the immediate downstream compared to the Baseline Scenario. It is also noticed that the incoming wind is diverted and travels through Kam Po Road. At lower elevations, it is observed that the incoming wind can pass through the air-permeable spaces in the podium, especially flow along the large air-permeable space between Block 6 and Block 7. This air path benefits the VR along Kam Po Road and hence also favours the site wind availability of the proposed development Site 6. At higher elevations, the building gap between Block 4 and Block 5 could allow the incoming wind to penetrate the central portion of the Project Area more effectively than the Baseline Scenario. To summarize, although a wind stagnant zone can still be identified in the Proposed Scenario, the VR in the immediate sensitive receivers is found to be relatively high. Therefore, the wind impact induce by the proposed development is found to be insignificant.

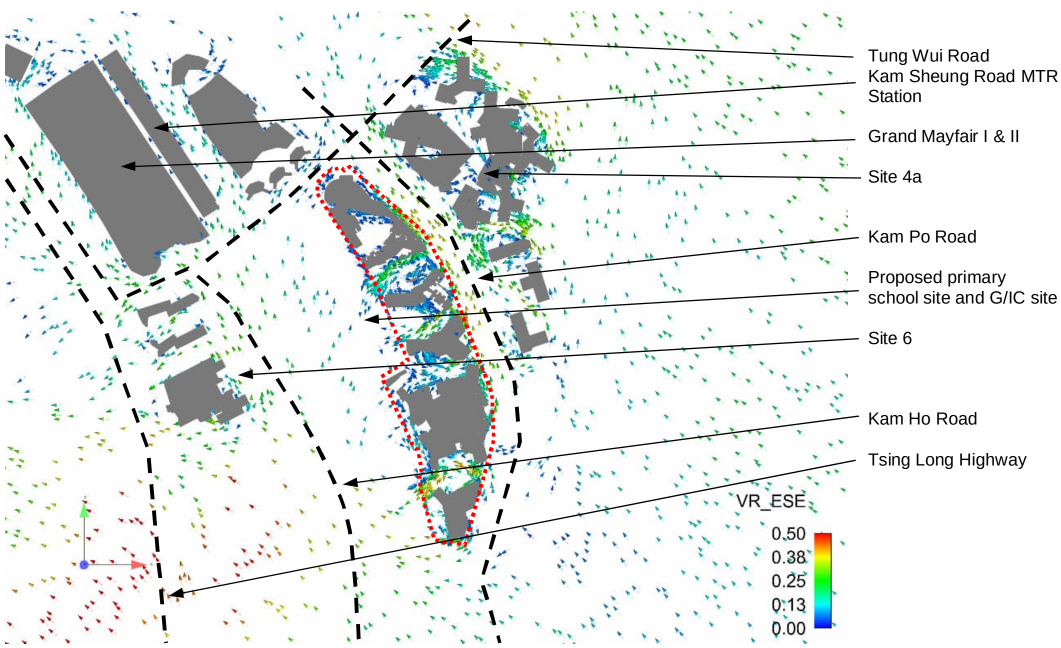
Baseline Scheme





Proposed Scheme





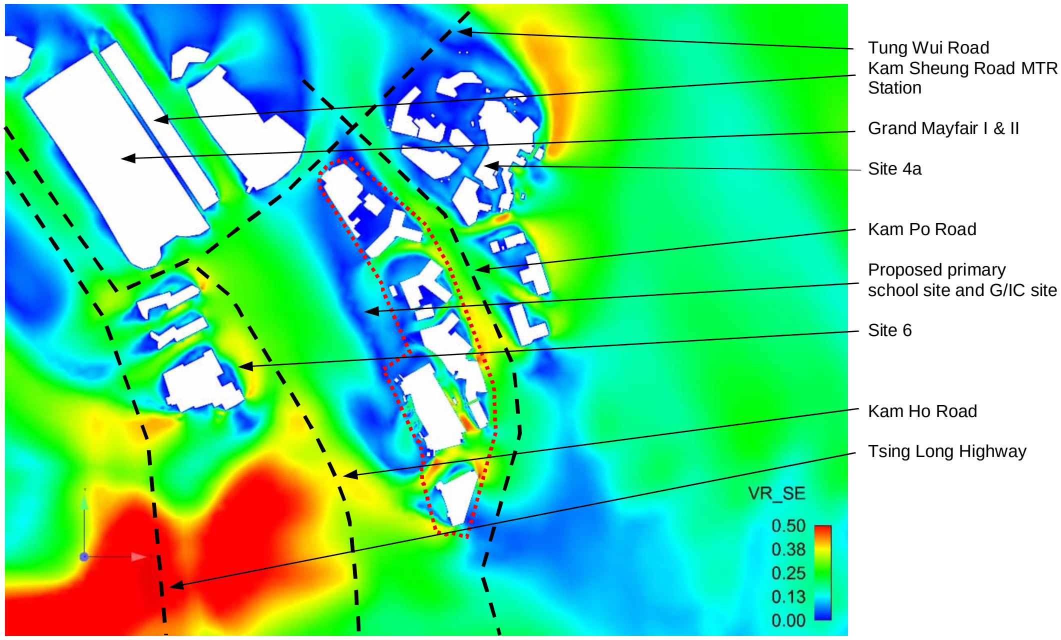
SE: (Annual: 8.6%, Summer: 7.5%)

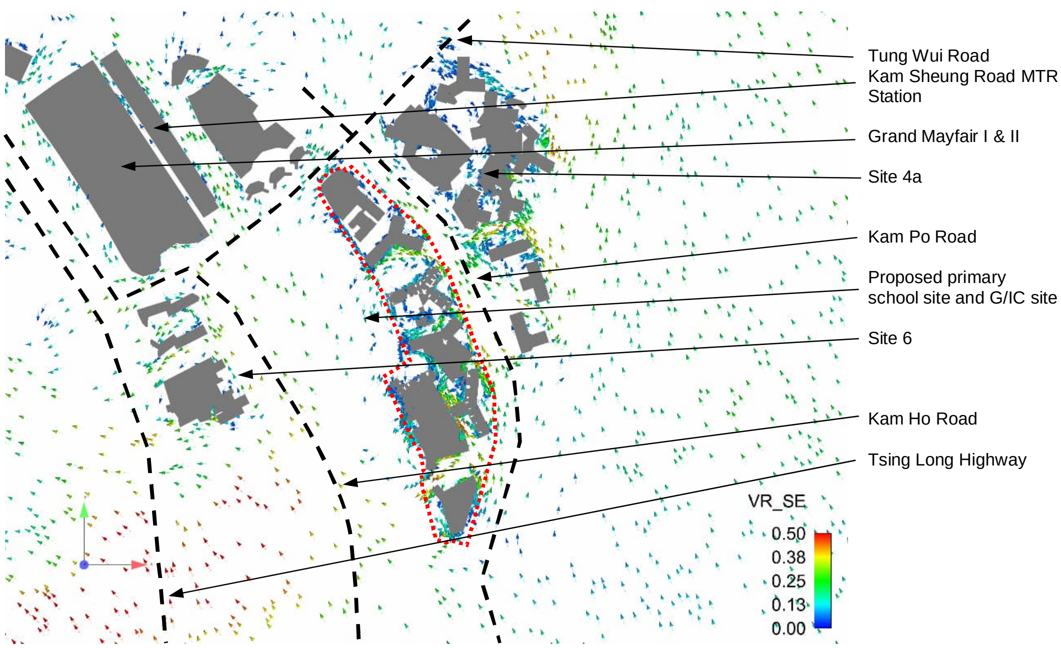
6.14 SE wind would pass through the Agriculture ("AGR"), Other Specified Uses ("OU"), and Village Type Development ("V") area including Tin Sam San Tsuen (22mPD) and Shek Wu Tong (22mPD) before ventilating the Project Area. A section of Kam Sheung Road serves as a wind corridor to introduce the incoming wind flowing from the agriculture area to the Project Area. Despite the proposed public housing development Site 4a would slightly weaken the wind availability of the Project Area, similar to ESE wind, the air permeable space in Site 4a could facilitate wind penetration towards the Project Area. As a result, the wind availability at the Project Area is satisfactory since Site 4a would not induce substantial wind influences against the Project Area.

6.15 In the Baseline Scenario, the proposed mid-rise residential developments (62.24mPD) would slightly obstruct the incoming wind, creating a localized wind stagnant area in the immediate downstream covering the western site perimeter and the Proposed primary school site and G/IC site. It is observable that a portion of the incoming wind encounters the relatively long frontage in the pedestrian level of Block 3, 4, and 5, which generates downwashed effect, and a higher VR is found along Kam Po Road. Similar to ESE wind, the incoming wind could flush into the building gaps and empty bays to reduce the wind stagnant area, which the incoming wind could penetrate the Project Area most effectively along the 25m-wide wind corridor between Block 7 and Block 8. As a result, the VR along Kam Ho Road is adequate.

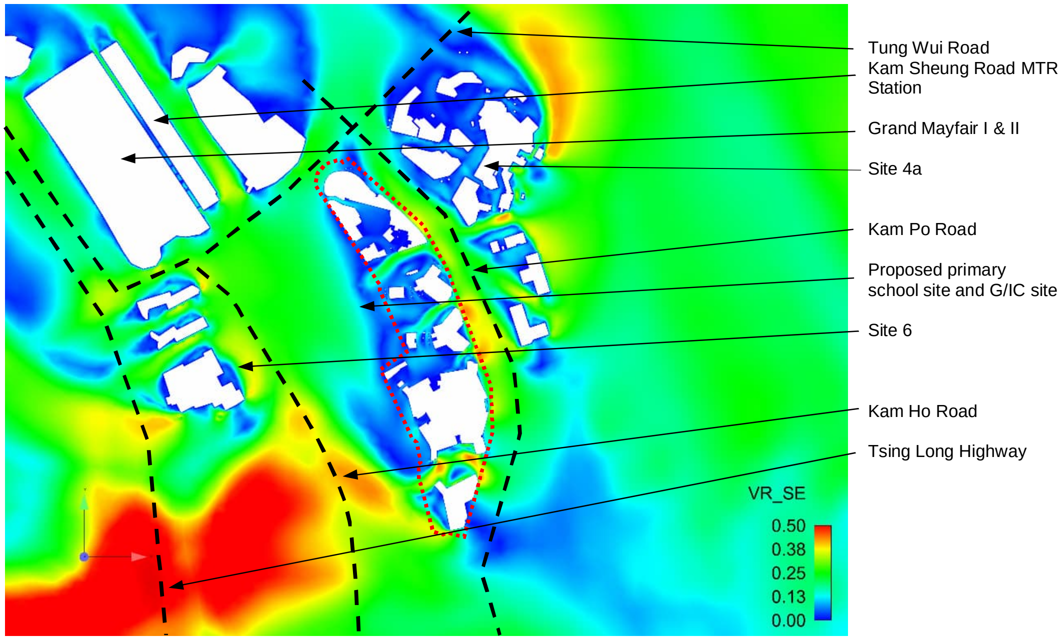
6.16 In the Proposed Scenario, the proposed mid-rise residential developments (62.24mPD) are anticipated to have a similar wind flow pattern as the Baseline Scenario, a relatively strong downwashed wind is noticed in the upwind of Block 2 and Block 4. Plus, a localized area with lower VR can also be observed in downstream of the Project Area. However, a smaller wind stagnant area can be observed compared to the Baseline Scenario, owing to the enhanced air permeability. Additionally, it is observed that the wind flowing along Kam Ho Road would redirect towards Tung Wui Road, which greatly improve the VR in the Proposed primary school site and G/IC site. The modified building morphology of Block A has widened the entry of Tung Wui Road, together with the podium garden at 1/F of Block A and Block B, facilitated a stronger wind flow and reduced the localized area with lower VR. A relatively higher VR can be seen along Tung Wui Road. In general, the air ventilation performance in the surrounding developments such as Site 6 and Grand Mayfair I & II (69mPD) is satisfactory.

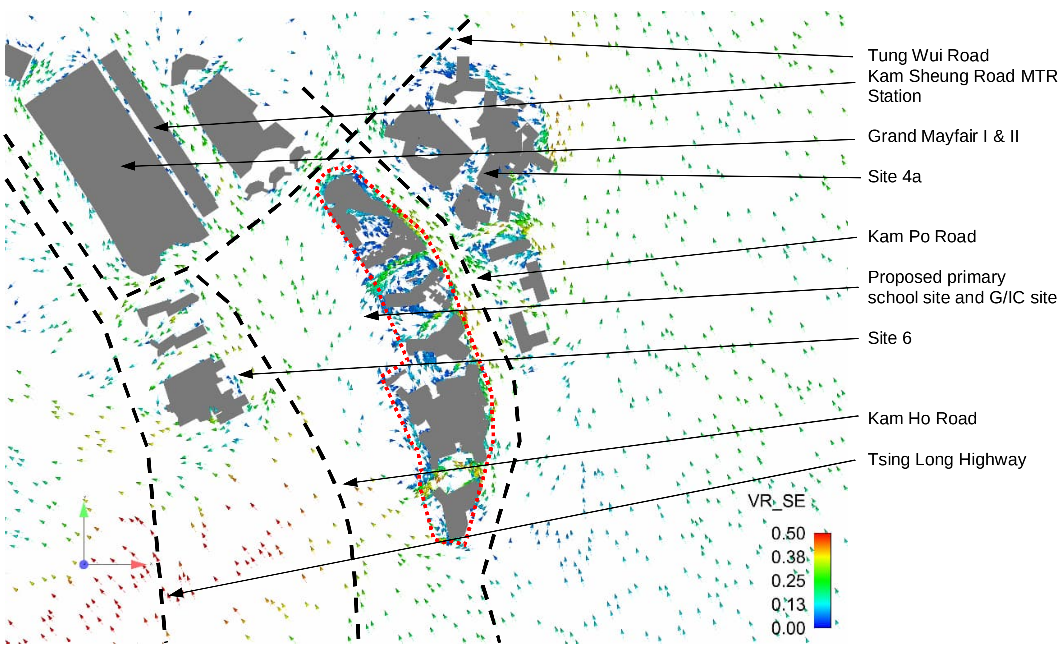
Baseline Scheme





Proposed Scheme





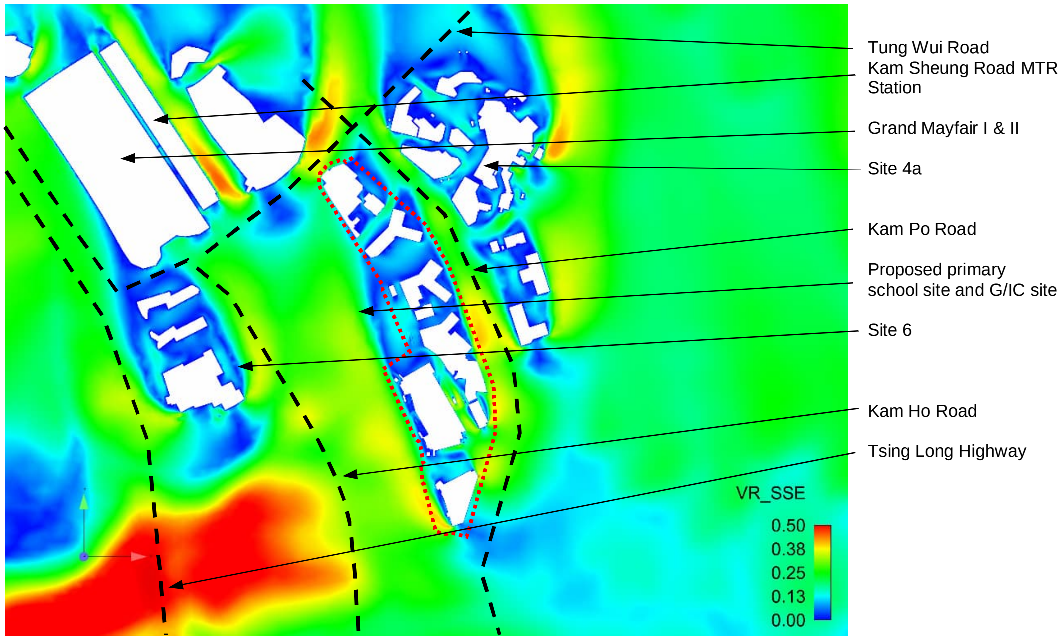
SSE: (Annual: 6.6%, Summer: 9.2%)

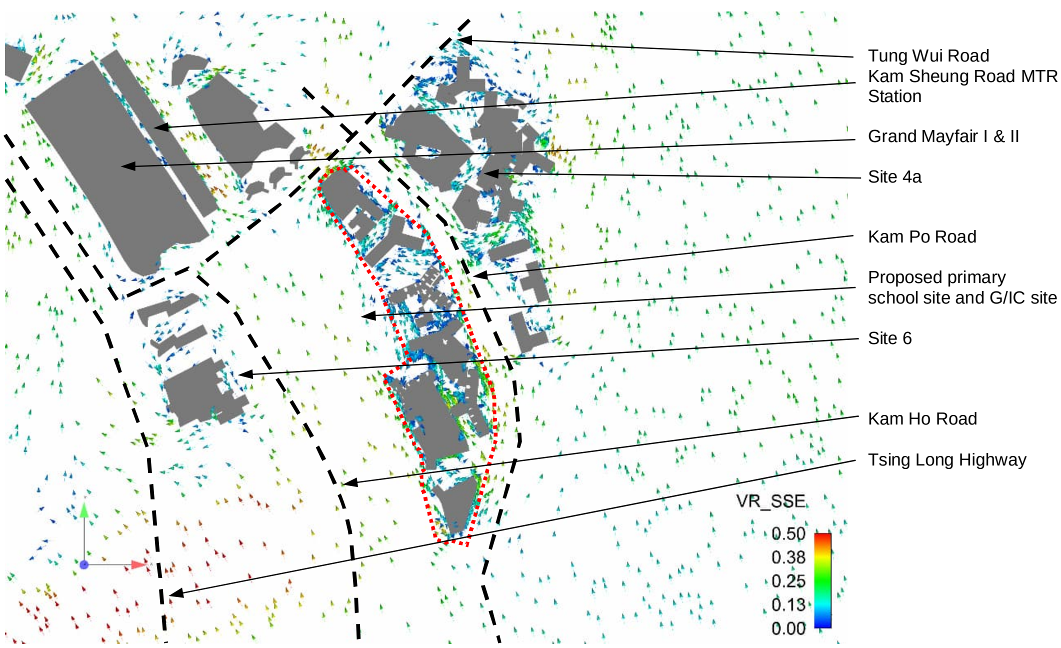
6.17 The incoming wind from SSE under annual and summer conditions is expected to pass through Shek Wu Tong (22mPD) and Pat Heung Depot before reaching the Project Area. The low-rise development would not induce wind impact on the Project Area. The site wind availability mainly relies on the MTR Railway, Kam Po Road, and Kam Ho Road, aligning in NNW-SSE direction, which perfectly serve as effective wind corridors for the incoming wind to penetrate the Project Area. The wind environment is observed to be excellent under the SSE direction.

6.18 In the Baseline Scenario, the short frontage by Block 5 and Block 8 of the proposed mid-rise residential developments (62.24mPD) in the Project Area would create a localized wind influencing zone, leading to a reduction in air ventilation performance within the Project Area. It is observed that the wind-influencing zone would not extend to the surrounding developments including Kam Sheung Road MTR Station (30.2mPD) and Grand Mayfair I & II (69mPD) due to the satisfactory VR along Tung Wui Road. It is also found that the podium-free design (expect Block 1) could minimize the building bulk and allow the incoming wind to flow freely between the building separation of Block 4, 5 and Block 6, 7, and 8 at the pedestrian level. Moreover, the air-permeable space between Block 1 and Block 2 also facilitates wind penetration at the pedestrian level.

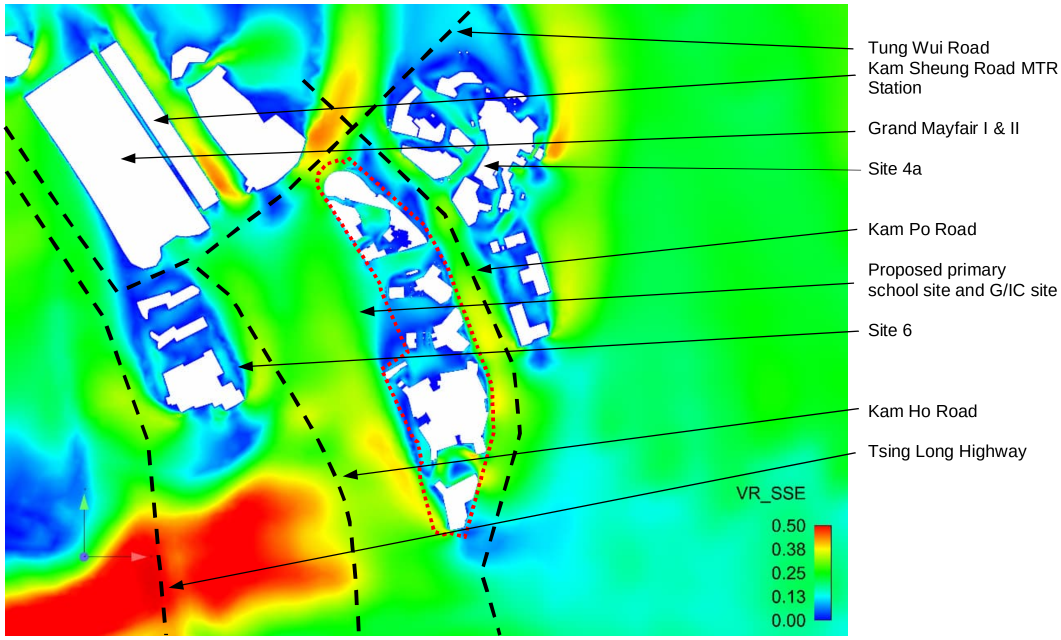
6.19 In the Proposed Scenario, the wind flow pattern is noticed to be similar as the Baseline Scenario. However, with a more permeable design, the air ventilation performance is slightly improved than the Baseline Scenario. Comparably, a localized wind influencing zone is created by the short frontage of Block 5 and Block 7, while the incoming wind flowing from Kam Po Road and the western site perimeter could reattach effectively, ventilating the Proposed primary school site and G/IC site and then flow along a section of Tung Wui Road. In addition to more empty bays, the truncated design under Block 1 to Block 6 could promote wind penetration within the Project Area. Moreover, the incoming wind adopts the 30m-wide building gap between Block B and Block 1 to penetrate the Project Area. As a result, the incoming wind is found to pass through the central courtyard of the Project Area more freely, leading to a slightly reduced wind-influencing zone, and a higher VR is noticed. At higher level, the building gap between Block 3 and 4 as well as Block 5 and 6 could facilitate wind penetrations. No significant wind influence is induced to the surrounding developments under SSE direction.

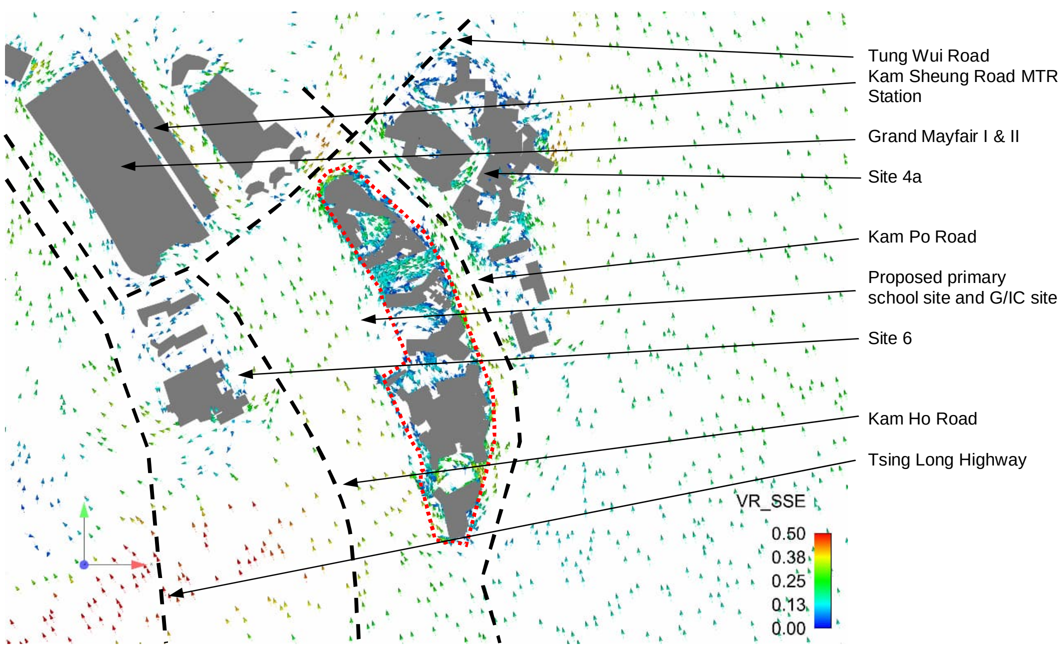
Baseline Scheme





Proposed Scheme





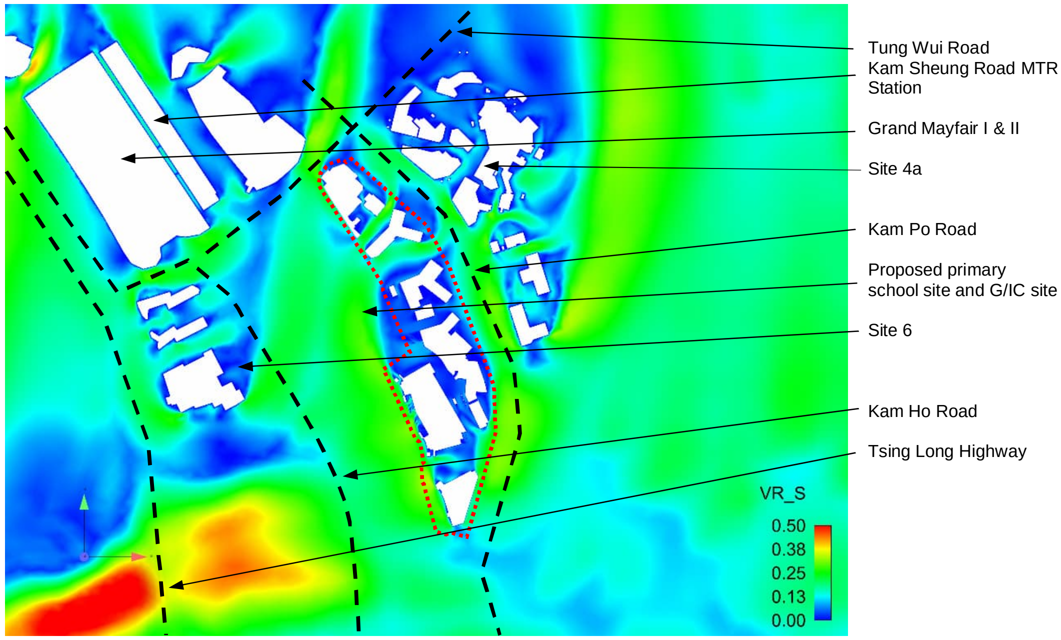
S: (Annual: 6.7%, Summer: 13.3%)

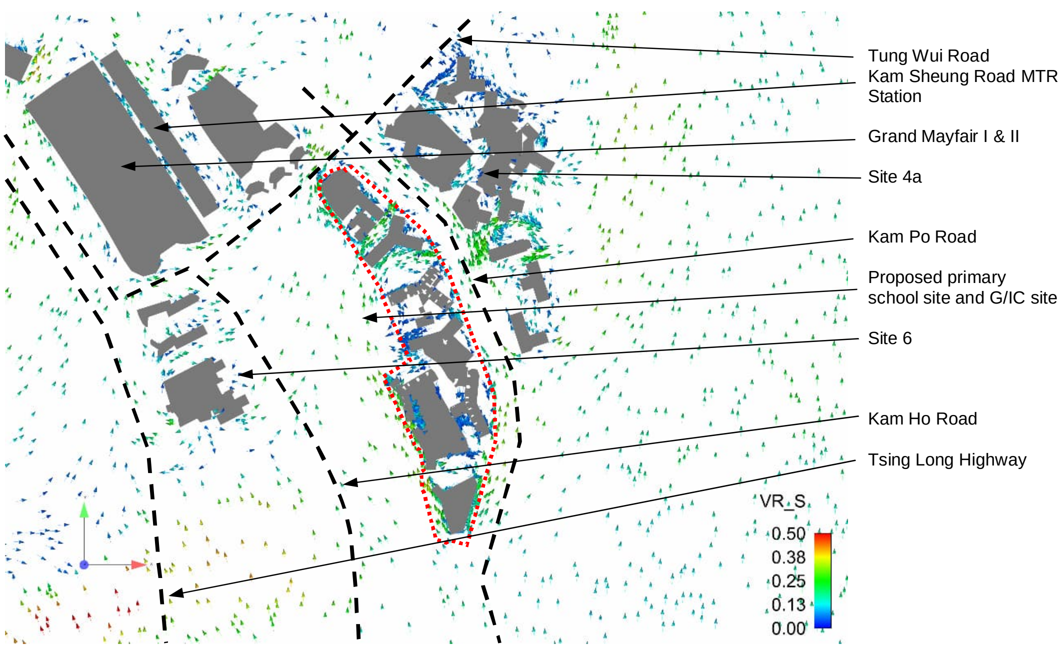
6.20 Similar to the SSE wind flow pattern, S wind under annual and summer conditions is expected to pass through Pat Heung Depot before reaching the Project Area. The low-rise development would not induce wind impact on the Project Area. MTR Railway, Kam Po Road, and Kam Ho Road, align in the NNW-SSE direction which serves as wind corridors facilitating the S winds to penetrate the Project Area. A portion of the incoming wind would pass through the Proposed primary school site and G/IC site in the immediate upwind and then enter the Project Area. The wind availability is expected to be satisfactory.

6.21 Under the Baseline Scenario, the proposed mid-rise residential developments (62.24mPD) in the Project Area would obstruct the incoming wind and create a localized wind stagnant area within the Project Area. The incoming wind would encounter Block 8 and split along the eastern site boundary / Kam Po Road and the western site boundary respectively. The air-permeable spaces between Block 1 to Block 3 are observed to effectively facilitate the wind penetration within the Project Area. As a result, the incoming wind would reattach quickly and not create wind impacts on the downstream area.

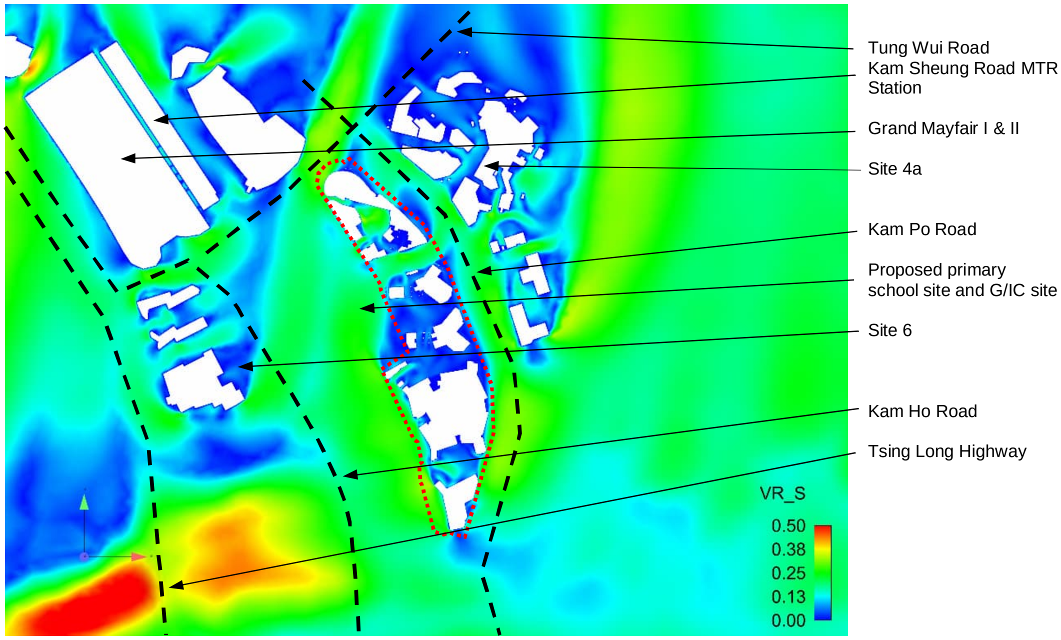
6.22 Under the Proposed Scenario, it is observed that the wind stagnant area created by the proposed mid-rise residential developments (62.24mPD) is reduced compared to the Baseline Scenario. Same as the Baseline Scenario, the incoming wind would split along the eastern site boundary / Kam Po Road and the western site boundary after interacting with Block 7, such that the VR along these areas is satisfactory under S wind. Noted that a light breeze of wind movement is found around the empty bays in the truncated floors, which could slightly enhance the air permeability. On the other hand, although the 30m-wide building separation between Block B and Block 1 does not align with the S wind direction, the incoming wind is found to flush into this air-permeable space and improve the air permeability of the Project Area. At higher level, the building gap between Block 3 and 4 as well as Block 5 and 6 could facilitate wind penetrations. Consequently, a slightly reduced wind stagnant and a slightly higher average wind velocity is found compared to the Baseline Scheme.

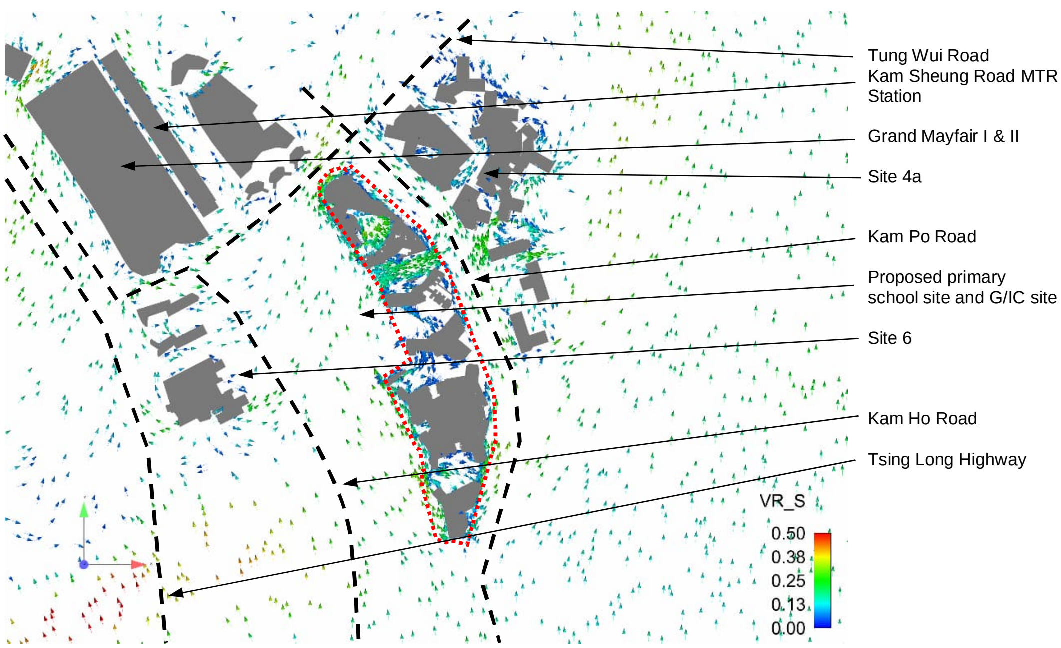
Baseline Scheme





Proposed Scheme





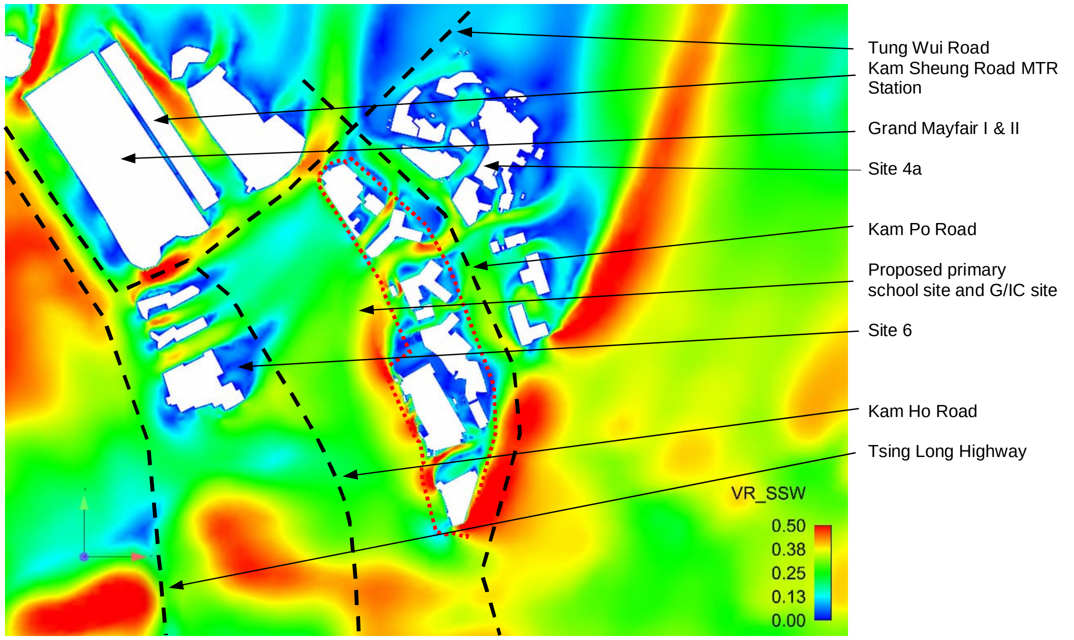
SSW: (Annual: 7.7%, Summer: 16.7%)

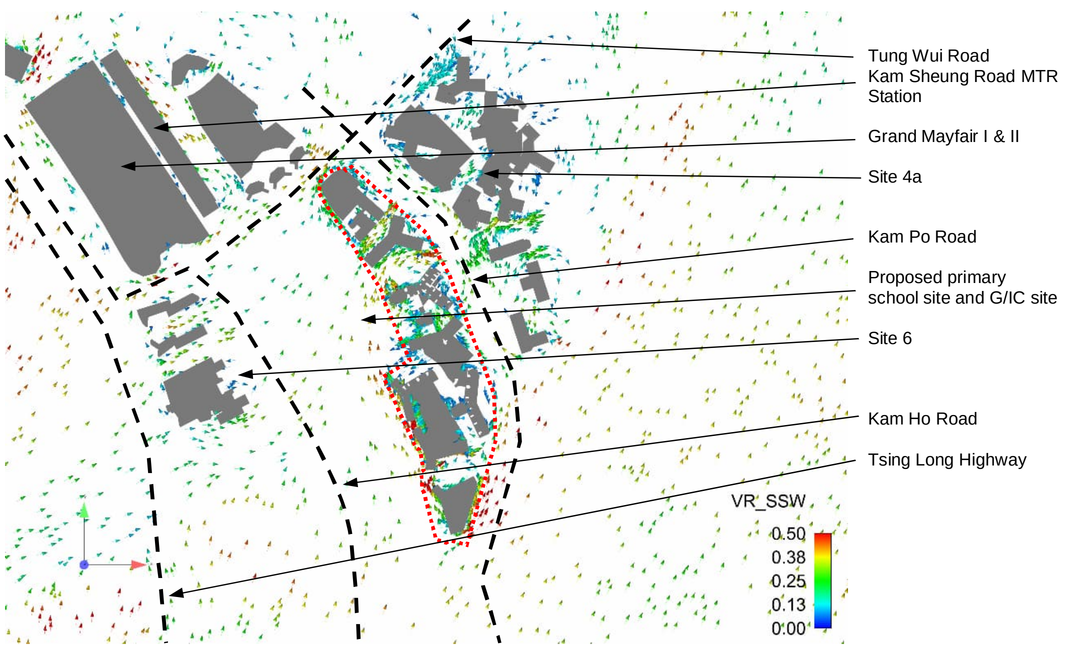
6.23 The incoming wind from SSW under annual and summer conditions is expected to pass through Tai Lam Country Park (200mPD) before reaching the Project Area. As the Tai Lam Country Park is located in the southwest of the Project Area, the hilly terrain will weaken the incoming SSW prevailing winds. High-level winds are expected to mostly flow over the hilly terrain. While the katabatic winds may flow towards the Proposed primary school site and G/IC site and reach the Project Area, maintaining a satisfactory wind environment.

6.24 In the Baseline Scenario, the incoming wind would be split by the proposed development Block 8, a limited area with a lower ventilation rate is observed in the immediate downstream of the Project Area. The proposed mid-rise residential developments (62.24mPD) in the Project Area would bring a minor wind hindrance to the proposed public housing development Site 4a, slightly lowering its wind availability. Yet, due to the air-permeable spaces reserved in the Project, the incoming wind could circulate via these spaces and alleviate the wind impact. Hence, the VR along Kam Po Road is found to be satisfactory. Additionally, the building morphology of Block 8 would escalate the VR in the downstream area. Therefore, a portion of Shek Wu Tong in the SW of the Project Area would receive a relatively high ventilation rate.

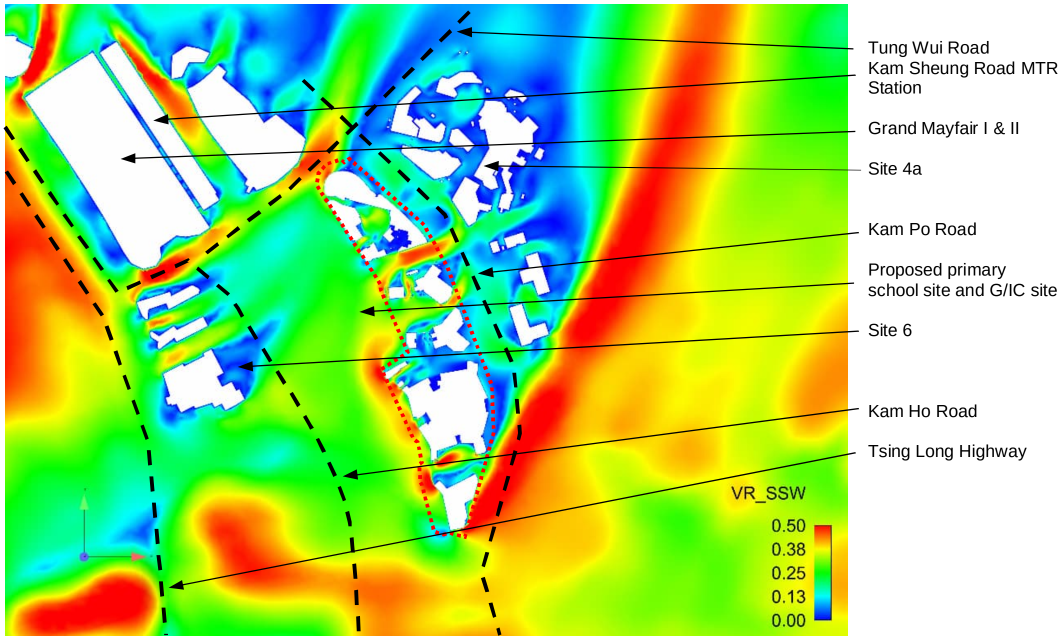
6.25 In the Proposed Scenario, the incoming wind would also be slightly hindered by the proposed mid-rise residential developments (62.24mPD) in the Project Area. Yet, incorporated with empty bays and building gaps as stated, the incoming wind could penetrate the Project Area effectively, which brings satisfactory VR to the immediate downstream, including Kam Po Road, low-rise villages in Shek Wu Tong, and the proposed development Site 4a. It is also apparent that the building morphology of Block 7 would similarly cause wind amplification to the downstream, including Shek Wu Tong. Plus, given that Tung Wui Road aligns in the NE-SW direction, the incoming wind could travel this wind corridor freely without obstruction from the Project Area. The larger wind entrance due to the modified building morphology of Block A leads to a higher VR along Tung Wui Road. A similar ventilation performance in the downstream area compared to the Baseline Scenario can be concluded.

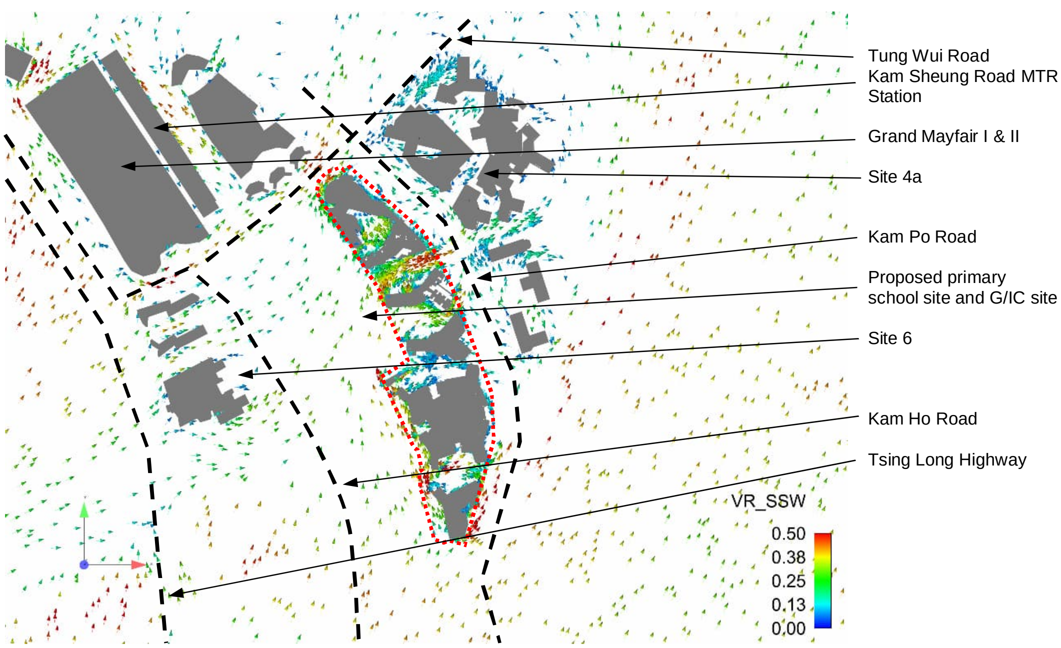
Baseline Scheme





Proposed Scheme





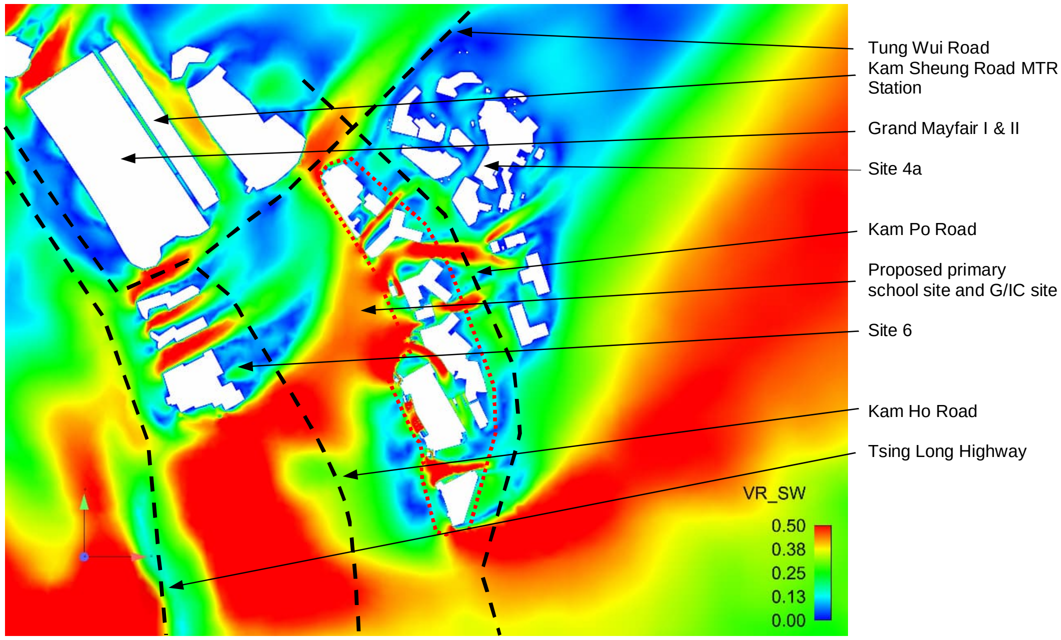
SW: (Summer: 13.3%)

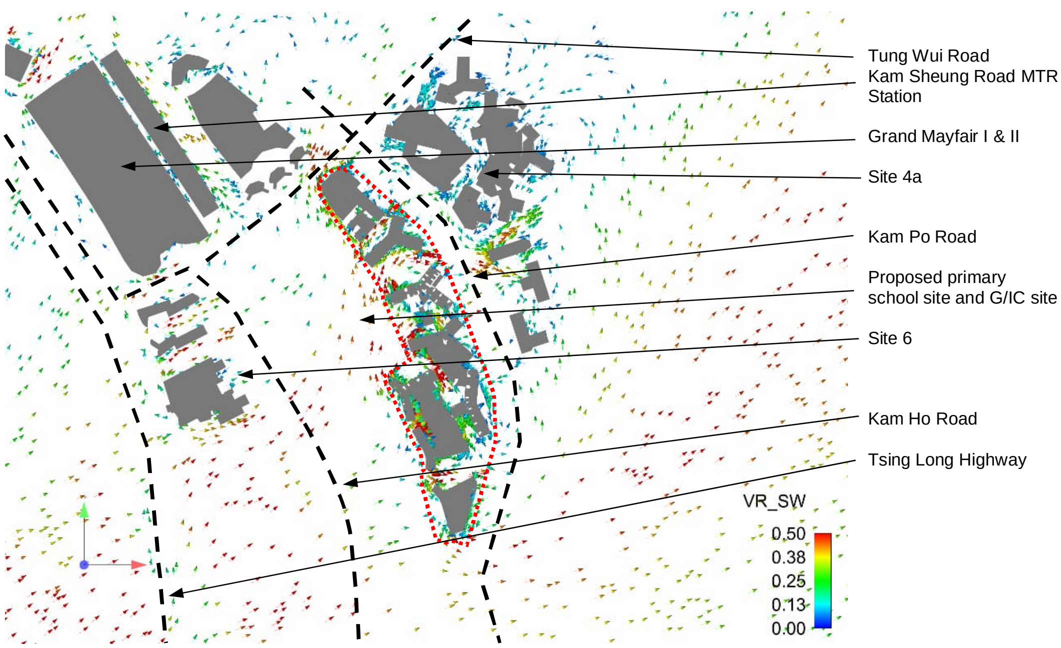
6.26 Similar to the SSW wind, the incoming SW wind is found to pass through Tai Lam Country Park (200mPD) and flow along the valley before reaching the Project Area with satisfactory site wind availability. Moreover, despite a portion of the incoming SW wind would encounter wind in the proposed public housing development Site 6 in the upwind, the building gaps reserved are found to promote an effective wind penetration. As a result, the incoming wind could flow towards the Proposed primary school site and G/IC site and the Project Area freely, the site wind availability is generally high.

6.27 In the Baseline Scenario, the incoming wind would be barely shielded by proposed mid-rise residential developments (62.24mPD) in the Project Area, and the wind availability to the immediate downstream is lowered. While with a relatively high wind availability, the SW wind would flush into each building gap and air-permeable space effectively. A satisfactory VR is ensured in the downstream area including Kam Po Road, low-rise villages in Shek Wu Tong, and the proposed public housing development Site 4a. Also, Tung Wui Road aligns perfectly in the SW direction, such that the unobstructed wind could flow along this wind corridor freely.

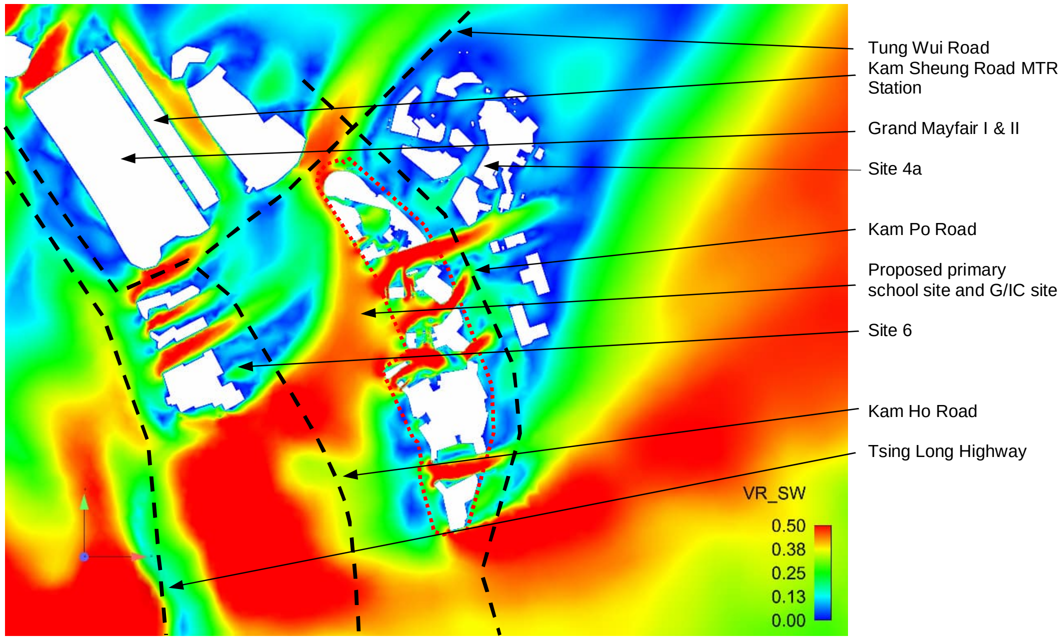
6.28 In the Proposed Scenario, with the inclusion of more air-permeable space and widened building gaps, the incoming wind could penetrate proposed mid-rise residential developments (62.24mPD) in the Project Area more effectively and evenly, especially in the central portion of the Project Area. The overall air ventilation performance within the Project Area and in the surrounding is close to the Baseline Scenario, where no significant wind stagnant could be found under SW wind direction.

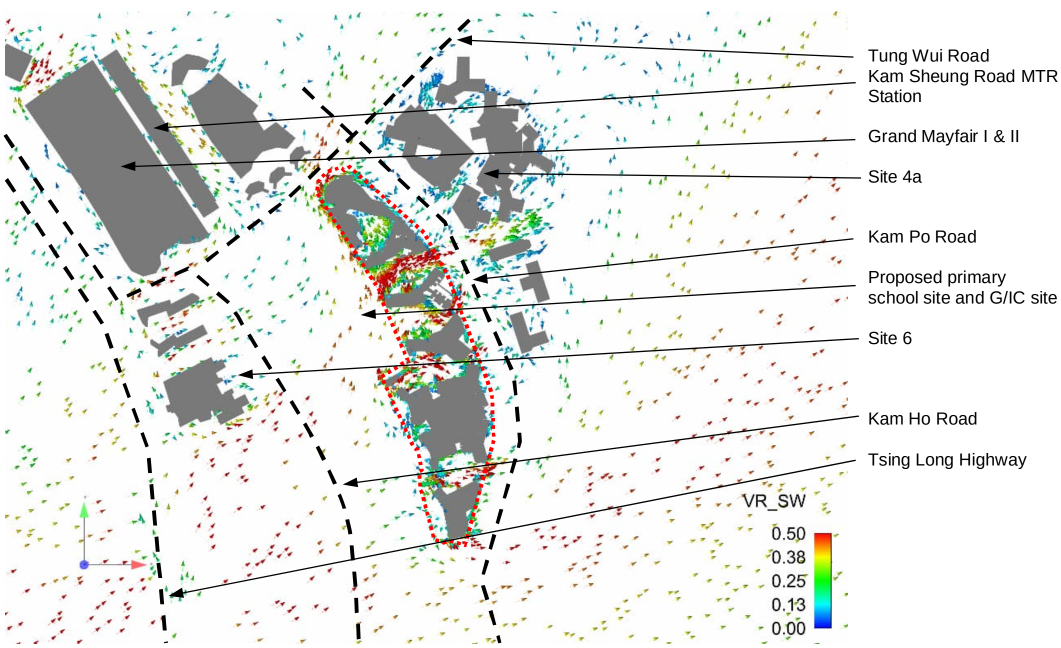
Baseline Scheme





Proposed Scheme





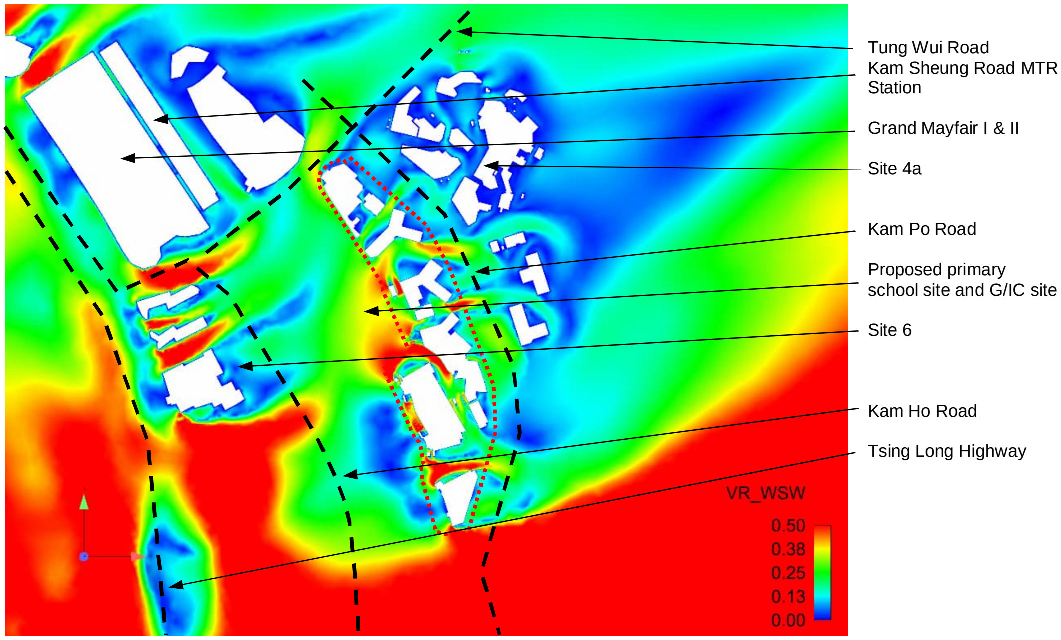
WSW: (Summer: 6.2%)

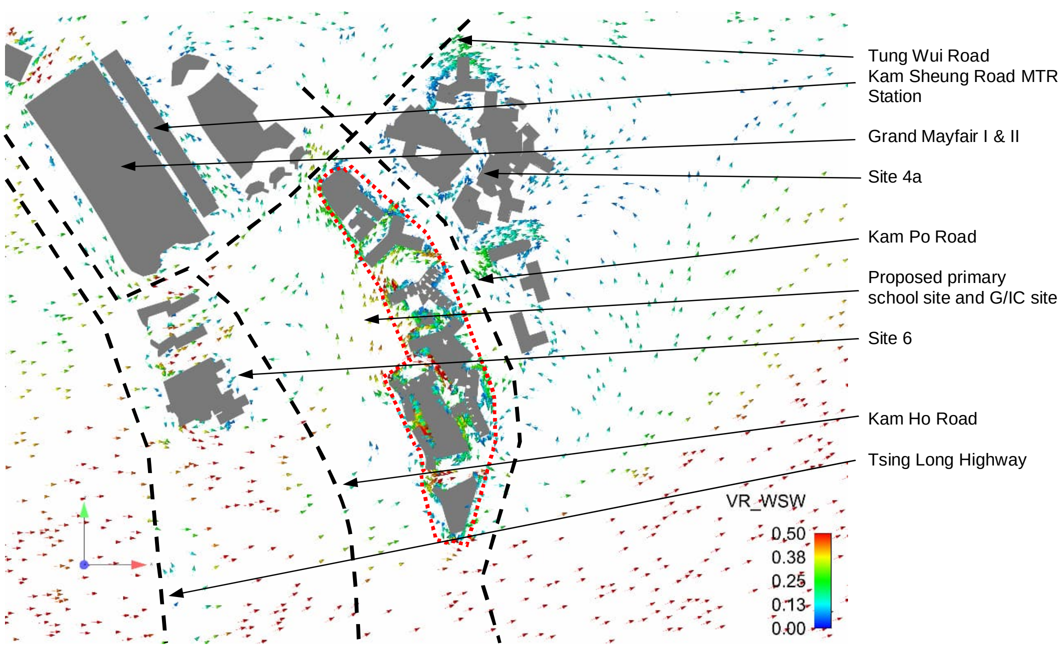
6.30 A comparable wind flow pattern can be noticed in the WSW wind when compared to the SSW wind, the incoming WSW wind is found to pass through Tai Lam Country Park (200mPD) and flow along the valley before reaching the Project Area with a satisfactory site wind availability. Although a portion of the incoming wind would pass through the proposed public housing development Site 6 in the upwind, as mentioned in the SW wind analysis, the proposed Site 6 development would hardly impact the wind availability of the Project Area thanks to effective wind corridors and large buffer zone between two sites. The incoming wind could enter the Proposed primary school site and G/IC site and the Project Area freely.

6.31 In the Baseline Scenario, the velocity ratio of the Project Area and the immediate surroundings are generally high as the major wind corridors including the reserved 30m and 25m width wind corridors are entirely aligned in the WSW direction, along with Tung Wui Road and the air permeable spaces, could facilitate wind penetration.

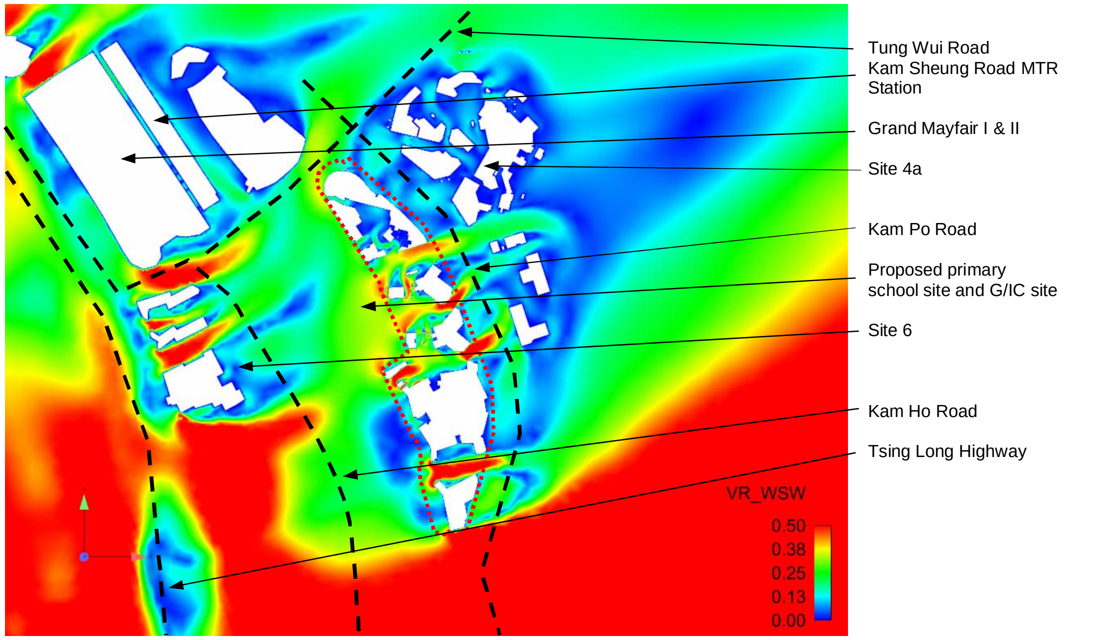
6.32 In the Proposed Scenario, it is observed that the incoming wind diffuses into each air-permeable space, not only penetrating through the building separations but observable air movement is also found around the empty bays under Block 1 and Block 2. Moreover, a slightly higher Velocity Ratio (VR) is observed at the 30m width wind corridors, such that a slightly stronger wind could reach the central portion of the proposed public housing development Site 4a, while the overall ventilation performance within the Project Area and the immediate surrounding such as Kam Po Road and low-rise villages in Shek Wu Tong, are similar to the Baseline Scenario.

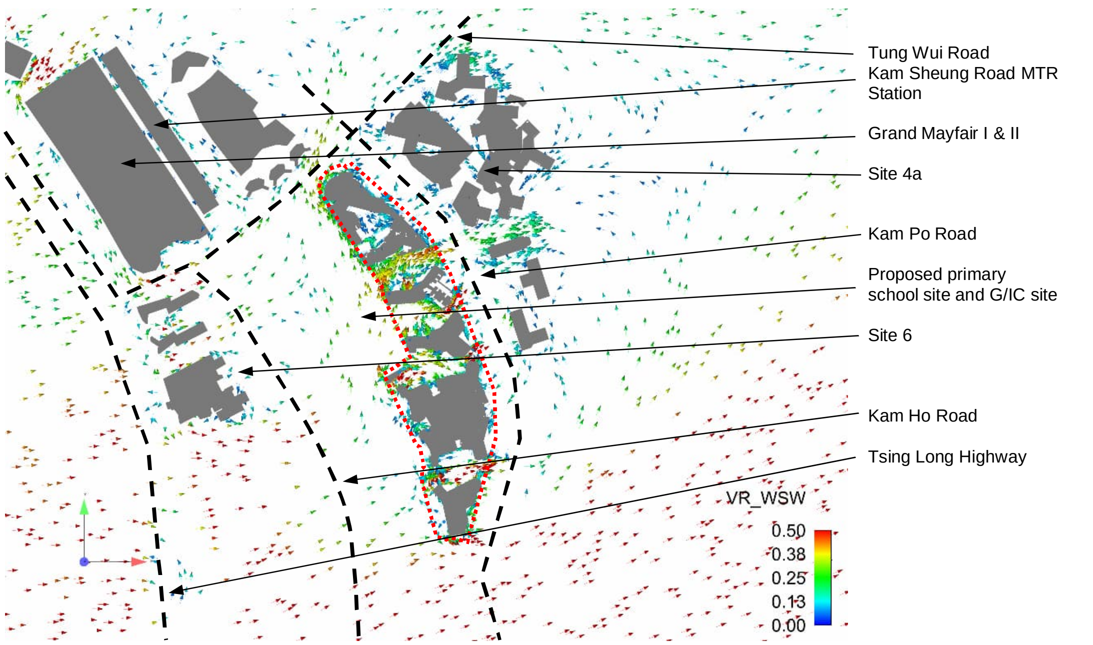
Baseline Scheme





Proposed Scheme

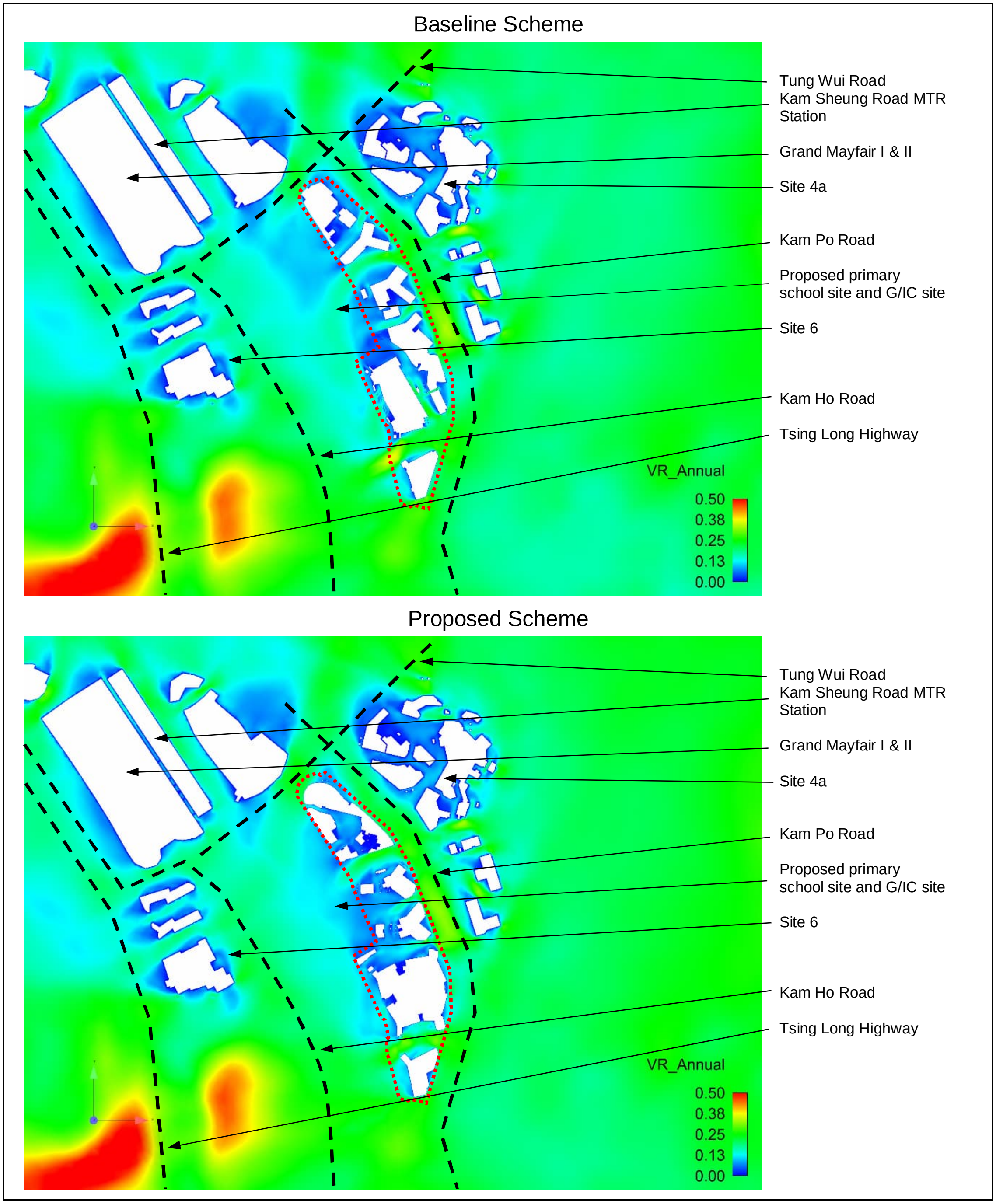




Overall Annual Frequency Weighted VR (76.4%)

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

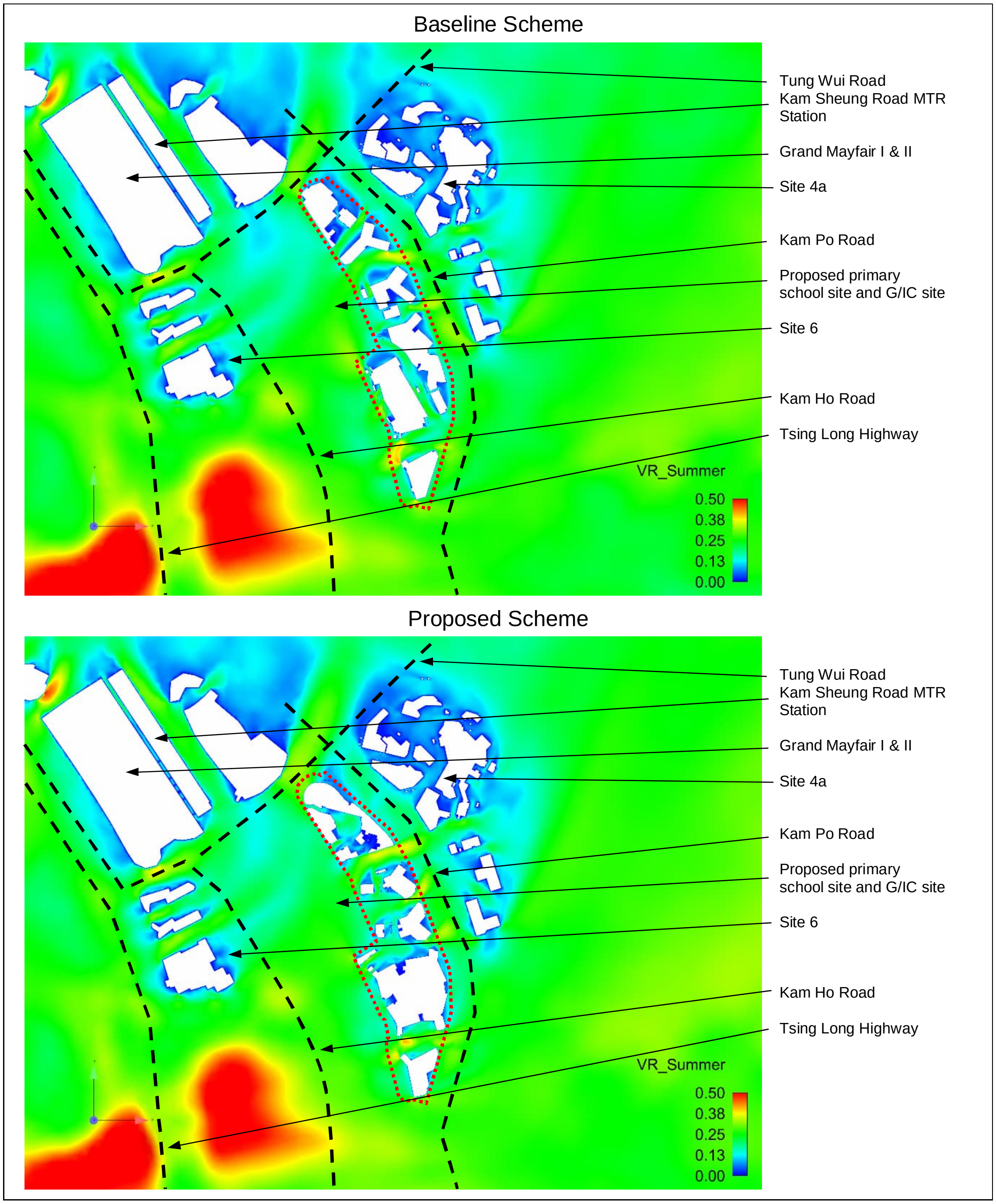
- Observable improvement of air ventilation performance within the Project Area
- A slightly smaller wind stagnant zone in the southwest of the Project Area



Overall Summer Frequency Weighted VR (81.7%)

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

- Observable improvement of air ventilation performance within the Project Area
- Similar wind environment at the northeast of the Project Area



7 SUMMARY AND CONCLUSIONS

7.1 The Kam Sheung Road Site 1 of this study is situated at Kam Tin South Area, Yuen Long in the New Territories. It is noticed that the Project Area is generally flat except for natural slopes from mild gradient to hilly towards Tseng Hang Shan (237mPD) in the Tai Lam Country Park to the southwest of the Project Area.

7.2 The existing developments in the vicinity of the Project Area are residential, village and open storage buildings varying in building height and density, which will cause observable impact upon the wind environment under different prevailing winds.

7.3 There are abundant low-rise buildings that allow prevailing winds to skim over in the vicinity of the Project Area. These air paths contribute to maintaining the air ventilation performance within the Project Area and their surrounding areas.

7.4 Kam Sheung Road Site 1 is located at the southeast portion of Kam Sheung Road MTR Station, near a large cluster of low-rise villages. The indicative layout of Kam Sheung Road Site 1 incorporated more than 15m-wide building gaps and air permeable spaces at the podium levels which would alleviate the possible wind influence by enhancing the wind permeability of the Project Area.

7.5 This AVA Study Report aims to assess the characteristics of the wind availability of the Project Area, providing a general pattern and a quantitative estimate of wind performance at the pedestrian level under the annual and summer wind directions with the highest occurrence and investigating the effectiveness of ventilation for the scheme designs for the Proposed Public Housing Development at Kam Sheung Road Site 1, namely the Baseline Scheme and the Proposed Scheme.

7.6 To mitigate the potential air ventilation impact on the site perimeter by the Proposed Development, several good design features were considered in the Proposed Scheme, such as the podium-free design to reduce the bulkiness of the proposed development, providing wide building gaps and empty bays to allow the penetration of prevailing wind, reserving building setback from the site boundary and nearby major roads to enhance air ventilation performance of the Project Area, modifying the building morphology of Block A, reduced number of storey of podium at Block A, inclusion of the podium garden at 1/F of Block A and Block B, as well as having a truncated design under Block 1 to Block 6 to improve air permeability, such that the wind environment in the immediate vicinity could be enhanced.

7.7 From the finding of this AVA Initial Study, the SVRw for the Proposed Scheme is increased from 0.16 to 0.17 compared to the Baseline Scheme under the annual prevailing wind from NE, ENE, E, ESE, SE, SSE, SE, and SSW directions which amount to about 76.4% of the whole time in a year. Thus, an improvement in air ventilation performance is observed in the vicinity of the Proposed Scheme under annual prevailing winds. This is due to the fact that the more permeable design in the Proposed Scheme helps mitigate the air ventilation impact of the compact residential blocks to allow wind penetration to reach the pedestrian level around the site perimeter.

7.8 The LVRw for the Proposed Scheme is increased from 0.17 to 0.18 compared to the Baseline Scheme under the annual wind directions stated above. It can be concluded that the Proposed Scheme would have a better overall air ventilation performance compared to the Baseline Scheme under the major annual winds.

7.9 Under the summer prevailing wind from E, ESE, SE, SSE, S, SSW, SW and WSW directions which amount to about 81.7% of the whole time in a year, the SVRw for the Proposed Scheme is maintained as 0.20 as the Baseline Scheme, which implies a similar performance on the wind environment for both schemes.

7.10 The LVRw for the Proposed Scheme maintains 0.22 compared to the Baseline Scheme under summer wind conditions. It can be concluded that the Proposed Scheme would have a similar wind environment in the Proposed Scheme when compared to the Baseline Scheme.

7.11 In addition to the good design features identified, the following 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:

- Adopt building permeability equivalent to 20% to 33.3% whenever possible with reference to PNAP APP-152.
- Avoid long continuous façades and face shorter frontages to the prevailing wind directions; and
- Reference to the recommendations of design measures in the Sustainable Building Design Guideline (SBDG) and Hong Kong Planning Standards and Guidelines (HKPSG).

7.12 To conclude, according to the simulation results in **Table 5.1**, improved SVR and LVR are achieved by the Proposed Scheme when compared with the Baseline Scheme under annual and summer wind conditions. No significant impact is anticipated on the surrounding pedestrian wind environment due to the Proposed Scheme.

Appendix A

Wind Probability Table

Tabulated Results – Percentage Occurrence of Directional Winds Annual – 500m

e_00294	Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
V infinity (m/s)	Sum	0.024	0.056	0.096	0.122	0.154	0.096	0.086	0.066	0.067	0.077	0.057	0.027	0.026	0.016	0.014	0.014
00_to_01	0.029	0.001	0.001	0.002	0.002	0.004	0.003	0.002	0.002	0.002	0.001	0.001	0.001	0.003	0.001	0.001	0.001
01_to_02	0.081	0.003	0.004	0.005	0.007	0.010	0.011	0.008	0.005	0.004	0.004	0.004	0.003	0.005	0.003	0.002	0.002
02_to_03	0.120	0.003	0.006	0.010	0.013	0.015	0.016	0.011	0.007	0.007	0.006	0.006	0.005	0.006	0.004	0.003	0.003
03_to_04	0.135	0.004	0.007	0.013	0.018	0.018	0.017	0.012	0.007	0.006	0.007	0.006	0.005	0.005	0.004	0.003	0.003
04_to_05	0.134	0.003	0.007	0.016	0.021	0.020	0.015	0.012	0.007	0.006	0.008	0.007	0.003	0.003	0.002	0.002	0.002
05_to_06	0.124	0.003	0.005	0.015	0.020	0.020	0.012	0.011	0.008	0.006	0.009	0.008	0.003	0.002	0.001	0.001	0.001
06_to_07	0.104	0.002	0.005	0.012	0.016	0.018	0.008	0.009	0.007	0.007	0.008	0.007	0.002	0.001	0.001	0.001	0.001
07_to_08	0.082	0.002	0.005	0.008	0.010	0.015	0.005	0.006	0.006	0.007	0.009	0.005	0.002	0.000	0.000	0.000	0.000
08_to_09	0.062	0.001	0.004	0.006	0.006	0.012	0.003	0.004	0.005	0.007	0.007	0.005	0.001	0.000	0.000	0.000	0.000
09_to_10	0.044	0.001	0.003	0.004	0.004	0.008	0.002	0.003	0.004	0.006	0.006	0.004	0.001	0.000	0.000	0.000	0.000
10_to_11	0.029	0.000	0.003	0.002	0.002	0.004	0.001	0.001	0.002	0.004	0.005	0.002	0.001	0.000	0.000	0.000	0.000
11_to_12	0.019	0.000	0.002	0.001	0.001	0.003	0.001	0.001	0.001	0.002	0.004	0.001	0.000	0.000	0.000	0.000	0.000
12_to_13	0.013	0.000	0.002	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000
13_to_14	0.008	0.000	0.001	0.001	0.000	0.001	0.000	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
14_to_15	0.005	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000
15_to_16	0.003	0.000	0.000	0.000	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16_to_17	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17_to_18	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18_to_19	0.001	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
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	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21_to_22	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22_to_23	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23_to_24	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Tabulated Results – Percentage Occurrence of Directional Winds Summer – 500m

e_00294	Wind direction	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
V infinity (m/s)	Sum	0.014	0.016	0.015	0.027	0.067	0.088	0.075	0.092	0.133	0.167	0.133	0.062	0.050	0.025	0.021	0.015
00_to_01	0.027	0.001	0.001	0.001	0.002	0.003	0.001	0.002	0.002	0.002	0.002	0.002	0.001	0.003	0.001	0.001	0.001
01_to_02	0.073	0.002	0.002	0.002	0.004	0.005	0.007	0.006	0.006	0.005	0.006	0.007	0.007	0.009	0.003	0.002	0.002
02_to_03	0.108	0.002	0.003	0.003	0.003	0.006	0.011	0.007	0.009	0.012	0.011	0.012	0.011	0.009	0.004	0.003	0.003
03_to_04	0.117	0.002	0.002	0.002	0.002	0.007	0.013	0.007	0.008	0.011	0.015	0.016	0.010	0.010	0.006	0.004	0.003
04_to_05	0.115	0.001	0.002	0.001	0.002	0.008	0.015	0.010	0.008	0.011	0.018	0.016	0.008	0.006	0.004	0.003	0.002
05_to_06	0.107	0.001	0.001	0.001	0.002	0.006	0.012	0.009	0.010	0.011	0.017	0.017	0.007	0.004	0.003	0.003	0.002
06_to_07	0.095	0.001	0.000	0.001	0.002	0.005	0.009	0.006	0.010	0.014	0.018	0.016	0.005	0.002	0.002	0.002	0.001
07_to_08	0.078	0.001	0.001	0.001	0.001	0.004	0.006	0.005	0.009	0.013	0.018	0.011	0.004	0.001	0.001	0.001	0.001
08_to_09	0.068	0.001	0.001	0.001	0.001	0.004	0.004	0.003	0.007	0.014	0.016	0.010	0.002	0.001	0.001	0.001	0.000
09_to_10	0.061	0.000	0.001	0.000	0.001	0.003	0.004	0.004	0.007	0.014	0.013	0.009	0.002	0.001	0.001	0.000	0.000
10_to_11	0.045	0.000	0.001	0.000	0.001	0.003	0.002	0.003	0.005	0.010	0.012	0.006	0.002	0.001	0.000	0.000	0.000
11_to_12	0.034	0.000	0.000	0.000	0.001	0.003	0.001	0.003	0.003	0.006	0.009	0.004	0.002	0.001	0.000	0.000	0.000
12_to_13	0.022	0.000	0.000	0.000	0.001	0.002	0.001	0.002	0.003	0.003	0.005	0.003	0.001	0.000	0.000	0.000	0.000
13_to_14	0.016	0.000	0.000	0.000	0.001	0.002	0.001	0.001	0.003	0.002	0.003	0.002	0.000	0.000	0.000	0.000	0.000
14_to_15	0.011	0.000	0.000	0.000	0.001	0.002	0.000	0.002	0.002	0.001	0.002	0.001	0.000	0.000	0.000	0.000	0.000
15_to_16	0.006	0.000	0.000	0.000	0.001	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000
16_to_17	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.000	0.001	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	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18_to_19	0.003	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19_to_20	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
20_to_21	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21_to_22	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22_to_23	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23_to_24	0.001	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

Velocity Ratio

Wind Velocity Ratio – Baseline Scheme

	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	Overall Annual	Overall Summer
Annual	**9.6%**	**12.2%**	**15.4%**	**9.6%**	**8.6%**	**6.6%**	**6.7%**	**7.7%**			**76.4%**	
Summer			**6.7%**	**8.8%**	**7.5%**	**9.2%**	**13.3%**	**16.7%**	**13.3%**	**6.2%**		**81.7%**
O1	0.06	0.07	0.03	0.08	0.18	0.16	0.07	0.28	0.08	0.20	0.10	0.14
O2	0.05	0.03	0.07	0.07	0.11	0.03	0.05	0.32	0.07	0.15	0.08	0.12
O3	0.22	0.01	0.07	0.08	0.13	0.14	0.10	0.35	0.17	0.15	0.13	0.17
O4	0.39	0.05	0.15	0.07	0.15	0.28	0.21	0.39	0.32	0.25	0.20	0.25
O5	0.37	0.20	0.14	0.03	0.15	0.37	0.29	0.43	0.48	0.34	0.23	0.31
O6	0.20	0.19	0.07	0.03	0.10	0.33	0.17	0.32	0.43	0.24	0.16	0.24
O7	0.20	0.14	0.19	0.22	0.12	0.24	0.13	0.18	0.39	0.18	0.18	0.21
O8	0.23	0.08	0.21	0.24	0.19	0.24	0.12	0.04	0.32	0.13	0.17	0.18
O9	0.22	0.05	0.13	0.11	0.15	0.25	0.04	0.07	0.26	0.12	0.12	0.14
O10	0.10	0.08	0.16	0.15	0.14	0.34	0.24	0.26	0.20	0.24	0.17	0.22
O11	0.18	0.09	0.19	0.21	0.14	0.36	0.27	0.31	0.42	0.27	0.20	0.29
O12	0.20	0.09	0.23	0.25	0.19	0.18	0.16	0.08	0.23	0.06	0.18	0.17
O13	0.19	0.10	0.25	0.26	0.20	0.21	0.20	0.18	0.10	0.15	0.20	0.19
O14	0.13	0.10	0.26	0.26	0.18	0.25	0.21	0.25	0.17	0.14	0.20	0.22
O15	0.07	0.04	0.26	0.24	0.12	0.27	0.20	0.25	0.11	0.04	0.18	0.20
O16	0.10	0.02	0.22	0.21	0.07	0.23	0.16	0.24	0.22	0.16	0.15	0.20
O17	0.15	0.07	0.17	0.19	0.08	0.23	0.14	0.23	0.22	0.14	0.15	0.18
O18	0.18	0.09	0.19	0.24	0.18	0.28	0.21	0.16	0.28	0.15	0.19	0.21
O19	0.15	0.04	0.27	0.28	0.26	0.27	0.22	0.32	0.19	0.11	0.22	0.25
O20	0.22	0.16	0.22	0.21	0.17	0.19	0.18	0.19	0.33	0.25	0.20	0.22
O21	0.09	0.18	0.18	0.18	0.22	0.21	0.22	0.25	0.43	0.23	0.19	0.25
O22	0.17	0.25	0.20	0.18	0.21	0.29	0.25	0.30	0.13	0.13	0.23	0.22
O23	0.16	0.32	0.29	0.17	0.27	0.34	0.29	0.32	0.14	0.28	0.27	0.26
O24	0.19	0.32	0.28	0.16	0.32	0.35	0.28	0.33	0.29	0.27	0.28	0.29
O25	0.20	0.28	0.29	0.31	0.37	0.36	0.28	0.36	0.29	0.32	0.30	0.32
O26	0.13	0.21	0.23	0.22	0.23	0.25	0.20	0.23	0.19	0.26	0.21	0.22
O27	0.09	0.10	0.08	0.15	0.18	0.27	0.25	0.34	0.14	0.15	0.16	0.21
O28	0.22	0.13	0.03	0.12	0.20	0.30	0.30	0.50	0.19	0.10	0.19	0.26
O29	0.32	0.20	0.08	0.09	0.19	0.28	0.30	0.51	0.19	0.05	0.22	0.25
O30	0.33	0.23	0.08	0.10	0.18	0.26	0.29	0.47	0.15	0.12	0.22	0.24
O31	0.34	0.24	0.06	0.13	0.21	0.27	0.28	0.50	0.14	0.29	0.23	0.26
O32	0.34	0.24	0.05	0.10	0.19	0.24	0.24	0.52	0.17	0.18	0.22	0.24
O33	0.36	0.26	0.12	0.04	0.12	0.17	0.18	0.51	0.18	0.20	0.21	0.22
O34	0.36	0.30	0.19	0.09	0.10	0.13	0.17	0.48	0.58	0.55	0.23	0.31
O35	0.33	0.30	0.19	0.10	0.07	0.08	0.12	0.37	0.55	0.61	0.20	0.27
O36	0.33	0.30	0.18	0.09	0.11	0.13	0.12	0.35	0.44	0.61	0.21	0.26
O37	0.33	0.29	0.16	0.12	0.16	0.17	0.16	0.38	0.41	0.62	0.22	0.28
O38	0.31	0.27	0.14	0.14	0.17	0.19	0.17	0.37	0.39	0.63	0.21	0.28
O39	0.31	0.25	0.16	0.15	0.12	0.14	0.23	0.18	0.18	0.14	0.19	0.17
O40	0.33	0.36	0.11	0.12	0.18	0.17	0.21	0.19	0.27	0.13	0.21	0.19
O41	0.32	0.38	0.35	0.05	0.24	0.23	0.06	0.17	0.41	0.15	0.25	0.20
O42	0.24	0.15	0.08	0.08	0.06	0.12	0.12	0.17	0.38	0.07	0.13	0.16
O43	0.18	0.23	0.27	0.29	0.22	0.10	0.07	0.10	0.13	0.05	0.20	0.14
O44	0.07	0.04	0.05	0.09	0.16	0.04	0.10	0.28	0.04	0.14	0.10	0.12
O45	0.29	0.19	0.18	0.19	0.18	0.11	0.13	0.28	0.16	0.04	0.19	0.17
O46	0.38	0.23	0.07	0.08	0.17	0.25	0.27	0.49	0.24	0.10	0.22	0.25
O47	0.37	0.22	0.08	0.08	0.16	0.23	0.26	0.45	0.24	0.03	0.21	0.23
O48	0.35	0.21	0.15	0.07	0.14	0.17	0.19	0.40	0.31	0.19	0.20	0.23
O49	0.33	0.20	0.17	0.06	0.10	0.13	0.16	0.40	0.48	0.22	0.19	0.25
O50	0.31	0.20	0.15	0.05	0.07	0.10	0.13	0.39	0.57	0.54	0.18	0.27
O51	0.32	0.22	0.13	0.04	0.06	0.09	0.13	0.40	0.58	0.61	0.17	0.27
O52	0.32	0.24	0.14	0.04	0.06	0.09	0.11	0.39	0.55	0.63	0.18	0.27
O53	0.07	0.24	0.27	0.23	0.24	0.27	0.20	0.43	0.42	0.48	0.24	0.33
O54	0.07	0.04	0.33	0.25	0.26	0.27	0.18	0.36	0.35	0.37	0.22	0.30
O55	0.07	0.12	0.34	0.31	0.29	0.29	0.18	0.31	0.29	0.29	0.24	0.28

O56	0.06	0.19	0.18	0.36	0.34	0.31	0.20	0.29	0.27	0.27	0.23	0.28
O57	0.07	0.07	0.23	0.35	0.38	0.32	0.21	0.28	0.29	0.22	0.23	0.28
O58	0.08	0.09	0.16	0.30	0.38	0.29	0.19	0.23	0.28	0.15	0.20	0.25
O59	0.09	0.13	0.14	0.21	0.34	0.29	0.20	0.22	0.32	0.16	0.19	0.24
O60	0.09	0.11	0.14	0.14	0.29	0.29	0.19	0.24	0.41	0.20	0.17	0.25
O61	0.09	0.13	0.15	0.12	0.26	0.30	0.19	0.27	0.46	0.26	0.18	0.26
O62	0.10	0.11	0.16	0.13	0.27	0.34	0.20	0.29	0.48	0.37	0.19	0.29
O63	0.10	0.08	0.12	0.15	0.24	0.31	0.17	0.29	0.48	0.30	0.17	0.27
O64	0.07	0.07	0.11	0.06	0.19	0.33	0.25	0.31	0.44	0.31	0.15	0.27
O65	0.08	0.08	0.10	0.03	0.19	0.33	0.25	0.30	0.45	0.31	0.15	0.26
O66	0.08	0.06	0.05	0.04	0.19	0.31	0.22	0.29	0.41	0.28	0.13	0.24
O67	0.06	0.05	0.01	0.04	0.17	0.28	0.19	0.27	0.29	0.21	0.11	0.20
O68	0.04	0.06	0.04	0.06	0.18	0.26	0.20	0.23	0.15	0.13	0.11	0.17
O69	0.05	0.06	0.05	0.07	0.18	0.22	0.20	0.20	0.19	0.18	0.11	0.17
O70	0.06	0.06	0.04	0.08	0.18	0.17	0.18	0.15	0.15	0.19	0.10	0.15
O71	0.25	0.06	0.07	0.08	0.16	0.09	0.15	0.13	0.11	0.14	0.12	0.12
O72	0.03	0.05	0.12	0.10	0.07	0.06	0.14	0.42	0.56	0.44	0.12	0.27
O73	0.01	0.06	0.13	0.12	0.08	0.11	0.20	0.43	0.45	0.38	0.13	0.26
O74	0.06	0.13	0.14	0.13	0.10	0.16	0.24	0.36	0.42	0.37	0.15	0.26
O75	0.10	0.14	0.11	0.12	0.10	0.20	0.24	0.28	0.43	0.34	0.15	0.25
O76	0.07	0.03	0.08	0.06	0.03	0.23	0.19	0.23	0.41	0.27	0.10	0.21
O77	0.11	0.04	0.10	0.06	0.04	0.23	0.14	0.21	0.31	0.20	0.10	0.17
O78	0.12	0.04	0.13	0.06	0.06	0.20	0.14	0.17	0.20	0.19	0.11	0.15
O79	0.10	0.05	0.15	0.06	0.07	0.16	0.16	0.15	0.19	0.21	0.11	0.15
P1	0.07	0.13	0.04	0.01	0.04	0.10	0.02	0.09	0.06	0.08	0.06	0.06
P2	0.22	0.04	0.09	0.07	0.02	0.03	0.03	0.13	0.09	0.06	0.08	0.07
P3	0.30	0.09	0.04	0.04	0.02	0.04	0.06	0.13	0.10	0.09	0.09	0.07
P4	0.32	0.11	0.04	0.04	0.06	0.06	0.12	0.06	0.09	0.06	0.10	0.07
P5	0.30	0.15	0.05	0.05	0.13	0.03	0.04	0.12	0.10	0.09	0.11	0.08
P6	0.22	0.15	0.14	0.19	0.24	0.04	0.06	0.08	0.13	0.09	0.15	0.11
P7	0.16	0.16	0.23	0.26	0.24	0.16	0.05	0.09	0.13	0.07	0.18	0.14
P8	0.09	0.26	0.33	0.33	0.35	0.17	0.07	0.31	0.69	0.41	0.25	0.33
P9	0.11	0.21	0.29	0.25	0.30	0.18	0.10	0.07	0.07	0.10	0.20	0.15
P10	0.24	0.21	0.31	0.24	0.31	0.22	0.12	0.05	0.13	0.11	0.22	0.16
P11	0.20	0.20	0.31	0.28	0.37	0.29	0.12	0.11	0.44	0.27	0.24	0.26
P12	0.11	0.18	0.27	0.24	0.32	0.33	0.10	0.22	0.19	0.23	0.22	0.22
P13	0.11	0.30	0.28	0.33	0.38	0.37	0.06	0.16	0.10	0.20	0.26	0.21
P14	0.07	0.25	0.28	0.32	0.36	0.31	0.01	0.05	0.15	0.25	0.22	0.18
P15	0.05	0.06	0.16	0.20	0.27	0.34	0.12	0.02	0.18	0.21	0.14	0.16
P16	0.04	0.18	0.06	0.13	0.25	0.38	0.22	0.18	0.13	0.14	0.16	0.19
P17	0.02	0.32	0.21	0.10	0.20	0.31	0.28	0.30	0.05	0.11	0.21	0.20
P18	0.16	0.32	0.23	0.20	0.27	0.32	0.30	0.33	0.13	0.25	0.26	0.26
P19	0.21	0.22	0.18	0.29	0.37	0.36	0.28	0.40	0.36	0.40	0.27	0.34
P20	0.27	0.24	0.03	0.13	0.23	0.24	0.23	0.44	0.23	0.12	0.21	0.24
P21	0.30	0.25	0.12	0.01	0.09	0.15	0.19	0.60	0.22	0.23	0.20	0.24
P22	0.33	0.37	0.28	0.15	0.07	0.08	0.15	0.55	0.32	0.23	0.26	0.26
P23	0.28	0.37	0.39	0.27	0.20	0.15	0.12	0.35	0.57	0.61	0.29	0.33
P24	0.06	0.22	0.42	0.39	0.33	0.28	0.17	0.11	0.32	0.33	0.26	0.27
P25	0.04	0.12	0.06	0.15	0.26	0.38	0.25	0.22	0.13	0.10	0.16	0.20
P26	0.03	0.08	0.07	0.10	0.13	0.36	0.29	0.35	0.13	0.14	0.15	0.22
P27	0.16	0.38	0.44	0.44	0.37	0.30	0.32	0.45	0.19	0.23	0.36	0.34
P28	0.02	0.02	0.07	0.09	0.06	0.19	0.26	0.35	0.32	0.31	0.11	0.23
P29	0.02	0.04	0.08	0.06	0.08	0.20	0.27	0.38	0.10	0.09	0.12	0.19
P30	0.04	0.06	0.12	0.20	0.16	0.24	0.30	0.44	0.29	0.22	0.17	0.28
P31	0.02	0.03	0.06	0.04	0.05	0.24	0.28	0.39	0.09	0.10	0.11	0.19
P32	0.02	0.06	0.08	0.04	0.07	0.25	0.28	0.42	0.36	0.28	0.13	0.26
P33	0.05	0.07	0.09	0.07	0.03	0.21	0.27	0.50	0.64	0.50	0.14	0.33
P34	0.04	0.05	0.05	0.06	0.07	0.08	0.07	0.07	0.13	0.35	0.06	0.10
P35	0.02	0.04	0.03	0.07	0.07	0.10	0.08	0.02	0.51	0.41	0.05	0.16
P36	0.03	0.08	0.16	0.09	0.04	0.13	0.05	0.16	0.50	0.42	0.10	0.20
P37	0.03	0.04	0.07	0.06	0.09	0.12	0.03	0.35	0.33	0.35	0.09	0.19

P38	0.08	0.04	0.03	0.14	0.12	0.06	0.03	0.39	0.51	0.45	0.10	0.24
P39	0.08	0.17	0.17	0.18	0.17	0.06	0.18	0.31	0.45	0.38	0.16	0.25
P40	0.09	0.03	0.07	0.05	0.06	0.11	0.16	0.20	0.43	0.30	0.09	0.19
P41	0.02	0.02	0.12	0.08	0.07	0.11	0.11	0.12	0.35	0.22	0.08	0.16
P42	0.06	0.01	0.13	0.07	0.07	0.14	0.17	0.20	0.36	0.24	0.10	0.19
P43	0.08	0.02	0.16	0.05	0.05	0.19	0.21	0.25	0.35	0.30	0.12	0.21
P44	0.06	0.11	0.19	0.02	0.05	0.20	0.25	0.30	0.46	0.36	0.14	0.25
P45	0.20	0.06	0.05	0.01	0.04	0.15	0.05	0.07	0.08	0.05	0.07	0.06
S1	0.06	0.08	0.03	0.02	0.04	0.13	0.08	0.13	0.12	0.03	0.06	0.08
S2	0.16	0.15	0.08	0.01	0.05	0.16	0.12	0.08	0.15	0.07	0.10	0.10
S3	0.05	0.04	0.10	0.08	0.05	0.16	0.09	0.05	0.12	0.04	0.07	0.09
S4	0.02	0.01	0.02	0.02	0.07	0.01	0.04	0.08	0.05	0.05	0.03	0.05
S5	0.02	0.16	0.15	0.04	0.06	0.09	0.11	0.12	0.13	0.11	0.10	0.11
S6	0.17	0.24	0.21	0.19	0.20	0.09	0.20	0.40	0.59	0.32	0.21	0.30
S7	0.10	0.26	0.08	0.17	0.05	0.10	0.14	0.28	0.39	0.13	0.15	0.19
S8	0.06	0.22	0.15	0.24	0.11	0.10	0.15	0.38	0.50	0.39	0.18	0.27
S9	0.15	0.37	0.42	0.44	0.38	0.17	0.32	0.49	0.36	0.28	0.35	0.37
S10	0.13	0.32	0.37	0.29	0.21	0.11	0.02	0.13	0.75	0.63	0.23	0.29
S11	0.18	0.37	0.37	0.11	0.11	0.11	0.08	0.19	0.50	0.49	0.22	0.23
S12	0.16	0.23	0.21	0.31	0.38	0.35	0.24	0.29	0.43	0.42	0.26	0.32

Wind Velocity Ratio – Proposed Scheme

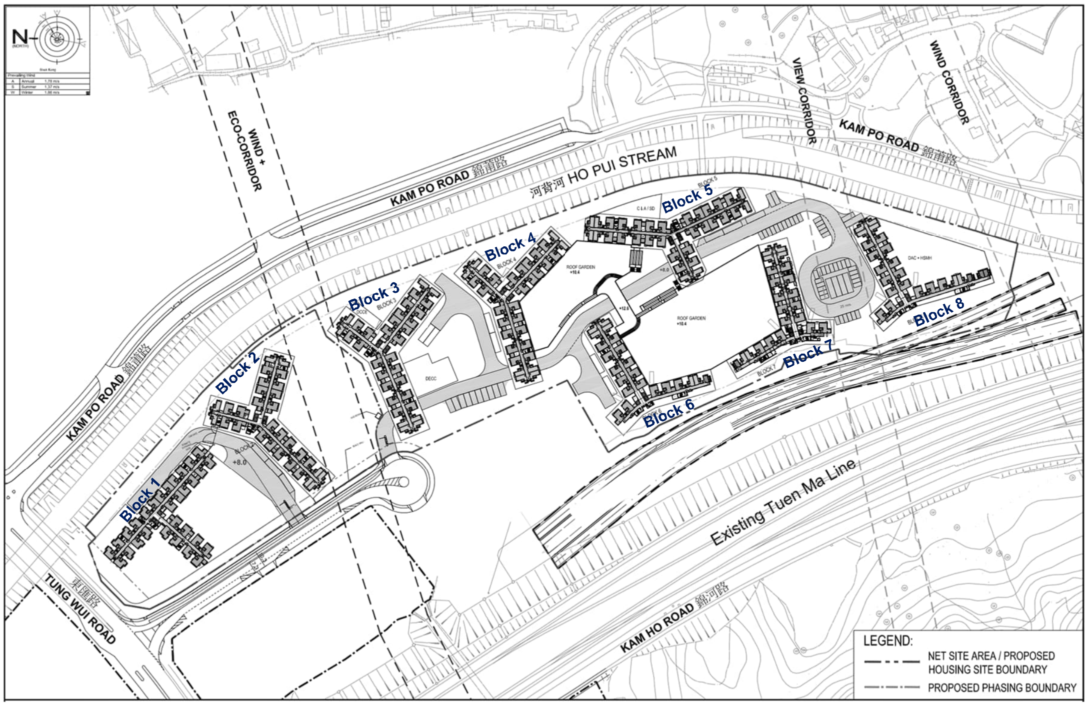
	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	Overall Annual	Overall Summer
Annual	**9.6%**	**12.2%**	**15.4%**	**9.6%**	**8.6%**	**6.6%**	**6.7%**	**7.7%**			**76.4%**	
Summer			**6.7%**	**8.8%**	**7.5%**	**9.2%**	**13.3%**	**16.7%**	**13.3%**	**6.2%**		**81.7%**
O1	0.07	0.04	0.06	0.13	0.20	0.16	0.06	0.30	0.06	0.19	0.12	0.15
O2	0.06	0.02	0.12	0.09	0.15	0.03	0.04	0.34	0.08	0.17	0.10	0.14
O3	0.16	0.02	0.09	0.09	0.20	0.16	0.12	0.38	0.20	0.17	0.14	0.20
O4	0.38	0.08	0.18	0.08	0.23	0.30	0.24	0.43	0.33	0.27	0.22	0.28
O5	0.39	0.21	0.16	0.06	0.23	0.38	0.30	0.46	0.46	0.34	0.25	0.33
O6	0.25	0.24	0.04	0.03	0.18	0.37	0.30	0.42	0.45	0.27	0.20	0.29
O7	0.20	0.15	0.17	0.19	0.16	0.32	0.21	0.22	0.36	0.19	0.20	0.24
O8	0.22	0.12	0.23	0.25	0.21	0.28	0.16	0.08	0.29	0.12	0.19	0.19
O9	0.19	0.09	0.15	0.12	0.18	0.25	0.07	0.03	0.21	0.08	0.13	0.13
O10	0.12	0.09	0.13	0.11	0.19	0.35	0.24	0.24	0.31	0.26	0.17	0.24
O11	0.19	0.11	0.16	0.17	0.19	0.40	0.31	0.35	0.42	0.27	0.21	0.31
O12	0.20	0.12	0.24	0.26	0.20	0.18	0.13	0.04	0.18	0.06	0.18	0.15
O13	0.18	0.09	0.27	0.27	0.20	0.14	0.17	0.09	0.11	0.14	0.19	0.16
O14	0.10	0.09	0.29	0.28	0.17	0.22	0.20	0.17	0.14	0.15	0.19	0.19
O15	0.02	0.05	0.27	0.25	0.11	0.26	0.21	0.19	0.05	0.04	0.17	0.17
O16	0.06	0.04	0.25	0.23	0.06	0.20	0.17	0.15	0.08	0.06	0.15	0.15
O17	0.13	0.05	0.20	0.21	0.09	0.23	0.17	0.19	0.15	0.13	0.15	0.17
O18	0.17	0.09	0.23	0.28	0.20	0.31	0.22	0.11	0.15	0.09	0.20	0.19
O19	0.14	0.10	0.28	0.30	0.28	0.30	0.22	0.15	0.10	0.04	0.22	0.20
O20	0.26	0.15	0.23	0.23	0.18	0.21	0.18	0.21	0.47	0.30	0.21	0.26
O21	0.07	0.20	0.23	0.23	0.25	0.22	0.20	0.14	0.15	0.06	0.19	0.18
O22	0.16	0.27	0.27	0.23	0.21	0.29	0.23	0.17	0.19	0.19	0.23	0.22
O23	0.14	0.32	0.30	0.21	0.25	0.32	0.27	0.17	0.22	0.14	0.25	0.23
O24	0.18	0.32	0.21	0.18	0.31	0.33	0.27	0.16	0.19	0.17	0.24	0.22
O25	0.18	0.29	0.26	0.30	0.36	0.35	0.27	0.19	0.10	0.27	0.27	0.25
O26	0.12	0.20	0.23	0.23	0.24	0.27	0.22	0.18	0.18	0.18	0.21	0.21
O27	0.07	0.15	0.10	0.20	0.24	0.29	0.26	0.14	0.16	0.19	0.17	0.20
O28	0.22	0.16	0.07	0.17	0.25	0.31	0.31	0.36	0.11	0.13	0.21	0.23
O29	0.30	0.16	0.02	0.11	0.21	0.29	0.31	0.50	0.14	0.09	0.21	0.25
O30	0.32	0.21	0.07	0.07	0.18	0.27	0.29	0.52	0.24	0.13	0.22	0.26
O31	0.34	0.25	0.11	0.09	0.19	0.27	0.29	0.52	0.12	0.07	0.24	0.25
O32	0.35	0.26	0.09	0.09	0.19	0.25	0.25	0.52	0.17	0.27	0.23	0.26
O33	0.36	0.28	0.12	0.02	0.11	0.17	0.19	0.48	0.35	0.07	0.21	0.23
O34	0.36	0.30	0.18	0.06	0.04	0.11	0.15	0.44	0.60	0.66	0.21	0.30
O35	0.34	0.30	0.20	0.11	0.04	0.08	0.10	0.38	0.52	0.65	0.20	0.27
O36	0.34	0.30	0.20	0.10	0.11	0.14	0.12	0.37	0.45	0.64	0.22	0.27
O37	0.34	0.30	0.18	0.12	0.17	0.19	0.17	0.40	0.42	0.64	0.23	0.29
O38	0.33	0.27	0.16	0.16	0.19	0.20	0.17	0.38	0.40	0.63	0.23	0.29
O39	0.31	0.29	0.22	0.19	0.10	0.10	0.23	0.15	0.43	0.24	0.21	0.21
O40	0.32	0.37	0.07	0.13	0.11	0.09	0.19	0.20	0.38	0.23	0.19	0.19
O41	0.31	0.37	0.32	0.09	0.26	0.21	0.06	0.20	0.32	0.20	0.25	0.20
O42	0.25	0.14	0.08	0.08	0.08	0.12	0.12	0.08	0.14	0.17	0.12	0.11
O43	0.16	0.21	0.29	0.30	0.26	0.11	0.06	0.11	0.09	0.07	0.20	0.14
O44	0.08	0.04	0.08	0.09	0.16	0.05	0.11	0.13	0.12	0.05	0.09	0.10
O45	0.27	0.20	0.17	0.19	0.21	0.10	0.13	0.23	0.10	0.07	0.19	0.15
O46	0.38	0.23	0.03	0.11	0.20	0.26	0.28	0.55	0.23	0.08	0.23	0.26
O47	0.36	0.21	0.03	0.10	0.18	0.24	0.27	0.51	0.30	0.07	0.21	0.26
O48	0.35	0.22	0.14	0.07	0.15	0.18	0.22	0.43	0.35	0.13	0.21	0.24
O49	0.34	0.21	0.17	0.04	0.10	0.14	0.17	0.42	0.48	0.35	0.19	0.26
O50	0.33	0.22	0.17	0.03	0.07	0.12	0.13	0.41	0.54	0.62	0.19	0.28
O51	0.34	0.23	0.16	0.03	0.07	0.11	0.13	0.41	0.55	0.66	0.19	0.28
O52	0.33	0.25	0.16	0.04	0.06	0.10	0.11	0.40	0.52	0.68	0.19	0.27
O53	0.06	0.24	0.29	0.25	0.26	0.29	0.21	0.43	0.42	0.50	0.25	0.34
O54	0.07	0.09	0.34	0.26	0.28	0.29	0.20	0.37	0.36	0.41	0.24	0.31
O55	0.08	0.18	0.33	0.32	0.31	0.30	0.19	0.33	0.28	0.31	0.26	0.29

O56	0.07	0.13	0.17	0.38	0.36	0.32	0.21	0.31	0.29	0.28	0.23	0.29
O57	0.07	0.11	0.15	0.40	0.42	0.33	0.21	0.29	0.32	0.22	0.23	0.29
O58	0.08	0.14	0.14	0.37	0.43	0.32	0.19	0.25	0.32	0.21	0.22	0.28
O59	0.08	0.10	0.14	0.28	0.40	0.31	0.20	0.24	0.36	0.24	0.20	0.27
O60	0.08	0.08	0.15	0.20	0.33	0.31	0.20	0.26	0.44	0.26	0.19	0.27
O61	0.08	0.10	0.16	0.16	0.28	0.31	0.20	0.29	0.47	0.30	0.18	0.28
O62	0.09	0.06	0.16	0.16	0.27	0.34	0.20	0.30	0.51	0.35	0.18	0.30
O63	0.09	0.05	0.14	0.17	0.23	0.31	0.17	0.30	0.49	0.26	0.17	0.27
O64	0.02	0.10	0.05	0.12	0.18	0.31	0.25	0.30	0.45	0.30	0.14	0.27
O65	0.04	0.08	0.04	0.11	0.20	0.30	0.24	0.29	0.45	0.29	0.14	0.26
O66	0.07	0.01	0.03	0.11	0.21	0.30	0.21	0.29	0.40	0.26	0.13	0.24
O67	0.06	0.04	0.04	0.10	0.21	0.28	0.17	0.26	0.29	0.19	0.13	0.21
O68	0.06	0.05	0.06	0.10	0.22	0.27	0.19	0.22	0.14	0.12	0.13	0.18
O69	0.19	0.06	0.10	0.12	0.22	0.25	0.20	0.21	0.19	0.19	0.15	0.19
O70	0.28	0.05	0.13	0.12	0.23	0.22	0.18	0.17	0.16	0.20	0.16	0.18
O71	0.26	0.04	0.15	0.12	0.21	0.16	0.15	0.15	0.12	0.16	0.15	0.15
O72	0.02	0.10	0.06	0.06	0.02	0.06	0.11	0.40	0.41	0.35	0.09	0.21
O73	0.02	0.05	0.06	0.04	0.08	0.15	0.21	0.35	0.38	0.34	0.10	0.23
O74	0.03	0.07	0.07	0.05	0.09	0.18	0.22	0.31	0.41	0.34	0.11	0.23
O75	0.09	0.09	0.10	0.06	0.05	0.20	0.20	0.26	0.44	0.32	0.12	0.22
O76	0.08	0.04	0.08	0.02	0.12	0.22	0.16	0.23	0.42	0.25	0.10	0.20
O77	0.04	0.05	0.13	0.03	0.14	0.24	0.14	0.22	0.36	0.21	0.11	0.20
O78	0.05	0.05	0.16	0.04	0.15	0.23	0.14	0.20	0.23	0.20	0.12	0.17
O79	0.24	0.05	0.18	0.04	0.16	0.23	0.19	0.19	0.22	0.24	0.15	0.18
P1	0.11	0.18	0.01	0.02	0.07	0.21	0.09	0.15	0.24	0.14	0.10	0.13
P2	0.18	0.19	0.06	0.02	0.03	0.12	0.06	0.08	0.19	0.07	0.09	0.09
P3	0.25	0.03	0.10	0.09	0.13	0.05	0.12	0.04	0.12	0.11	0.10	0.09
P4	0.31	0.17	0.18	0.19	0.22	0.05	0.16	0.14	0.04	0.08	0.18	0.13
P5	0.24	0.23	0.26	0.29	0.31	0.06	0.06	0.13	0.12	0.08	0.22	0.15
P6	0.18	0.21	0.33	0.36	0.37	0.05	0.06	0.11	0.07	0.07	0.23	0.15
P7	0.12	0.17	0.29	0.32	0.32	0.15	0.05	0.12	0.09	0.08	0.21	0.16
P8	0.20	0.28	0.31	0.31	0.33	0.06	0.16	0.39	0.51	0.35	0.27	0.31
P9	0.16	0.26	0.18	0.22	0.24	0.14	0.03	0.09	0.07	0.06	0.18	0.12
P10	0.27	0.31	0.20	0.27	0.27	0.27	0.09	0.36	0.62	0.36	0.26	0.32
P11	0.21	0.39	0.26	0.42	0.43	0.31	0.10	0.09	0.10	0.09	0.29	0.20
P12	0.14	0.36	0.23	0.34	0.35	0.31	0.07	0.11	0.17	0.14	0.25	0.19
P13	0.06	0.35	0.33	0.36	0.40	0.32	0.04	0.14	0.58	0.60	0.26	0.31
P14	0.06	0.26	0.28	0.28	0.30	0.21	0.03	0.09	0.10	0.09	0.20	0.15
P15	0.02	0.05	0.14	0.21	0.30	0.32	0.14	0.06	0.08	0.10	0.15	0.15
P16	0.09	0.11	0.17	0.28	0.35	0.38	0.24	0.07	0.10	0.10	0.20	0.19
P17	0.03	0.12	0.10	0.16	0.23	0.30	0.27	0.05	0.10	0.12	0.14	0.16
P18	0.14	0.30	0.22	0.05	0.15	0.31	0.29	0.22	0.05	0.05	0.20	0.17
P19	0.21	0.30	0.24	0.23	0.30	0.33	0.28	0.27	0.47	0.45	0.27	0.32
P20	0.28	0.29	0.05	0.17	0.29	0.32	0.24	0.40	0.19	0.16	0.23	0.25
P21	0.31	0.28	0.11	0.03	0.08	0.15	0.11	0.51	0.27	0.28	0.19	0.22
P22	0.32	0.36	0.27	0.14	0.04	0.09	0.16	0.57	0.40	0.36	0.25	0.29
P23	0.15	0.35	0.38	0.29	0.20	0.12	0.04	0.32	0.52	0.61	0.26	0.30
P24	0.06	0.14	0.40	0.40	0.35	0.29	0.18	0.08	0.31	0.32	0.25	0.26
P25	0.05	0.11	0.09	0.14	0.28	0.37	0.26	0.22	0.15	0.08	0.17	0.21
P26	0.02	0.07	0.13	0.13	0.11	0.31	0.30	0.37	0.17	0.17	0.16	0.23
P27	0.11	0.25	0.30	0.28	0.26	0.24	0.32	0.45	0.16	0.22	0.27	0.29
P28	0.04	0.07	0.07	0.05	0.06	0.12	0.21	0.35	0.23	0.24	0.11	0.19
P29	0.03	0.07	0.13	0.12	0.10	0.07	0.24	0.38	0.07	0.02	0.13	0.17
P30	0.01	0.06	0.08	0.08	0.09	0.03	0.26	0.42	0.08	0.09	0.11	0.17
P31	0.02	0.06	0.07	0.05	0.05	0.07	0.24	0.39	0.09	0.08	0.10	0.16
P32	0.02	0.02	0.08	0.04	0.05	0.14	0.25	0.44	0.42	0.33	0.11	0.25
P33	0.02	0.03	0.01	0.03	0.05	0.08	0.07	0.14	0.22	0.16	0.05	0.11
P34	0.03	0.02	0.01	0.04	0.02	0.06	0.06	0.19	0.45	0.27	0.05	0.16
P35	0.03	0.09	0.04	0.02	0.03	0.04	0.01	0.15	0.12	0.08	0.05	0.07
P36	0.07	0.02	0.05	0.08	0.03	0.05	0.03	0.37	0.46	0.39	0.08	0.21
P37	0.04	0.06	0.03	0.03	0.10	0.08	0.10	0.26	0.28	0.30	0.08	0.16

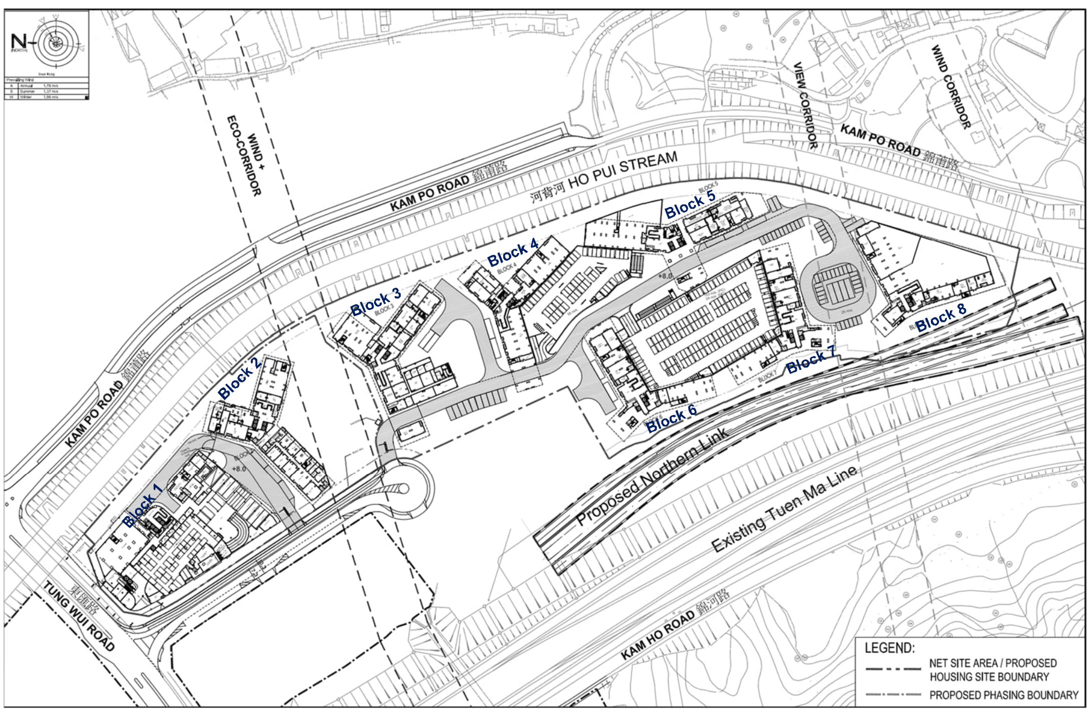
P38	0.06	0.07	0.02	0.03	0.06	0.14	0.18	0.43	0.60	0.46	0.10	0.28
P39	0.14	0.17	0.18	0.13	0.12	0.12	0.14	0.22	0.36	0.28	0.16	0.20
P40	0.02	0.02	0.02	0.04	0.01	0.13	0.19	0.19	0.36	0.23	0.06	0.16
P41	0.04	0.05	0.11	0.05	0.03	0.12	0.15	0.13	0.35	0.24	0.08	0.16
P42	0.05	0.08	0.13	0.04	0.02	0.13	0.15	0.23	0.39	0.27	0.10	0.19
P43	0.12	0.10	0.15	0.01	0.07	0.19	0.18	0.25	0.36	0.28	0.13	0.20
P44	0.42	0.11	0.19	0.04	0.16	0.29	0.29	0.35	0.47	0.36	0.22	0.29
P45	0.32	0.16	0.10	0.04	0.16	0.35	0.29	0.44	0.43	0.23	0.21	0.29
S1	0.07	0.09	0.04	0.02	0.05	0.12	0.08	0.11	0.13	0.05	0.07	0.08
S2	0.31	0.16	0.05	0.01	0.04	0.12	0.12	0.08	0.14	0.07	0.11	0.09
S3	0.07	0.10	0.10	0.09	0.06	0.28	0.15	0.07	0.05	0.07	0.11	0.11
S4	0.02	0.01	0.05	0.03	0.10	0.11	0.07	0.05	0.10	0.04	0.05	0.07
S5	0.03	0.16	0.14	0.06	0.06	0.16	0.09	0.12	0.19	0.08	0.11	0.12
S6	0.23	0.22	0.19	0.09	0.11	0.16	0.23	0.47	0.65	0.40	0.21	0.32
S7	0.19	0.22	0.21	0.11	0.13	0.19	0.26	0.46	0.66	0.38	0.22	0.34
S8	0.15	0.21	0.24	0.23	0.24	0.15	0.19	0.31	0.46	0.32	0.22	0.28
S9	0.18	0.34	0.31	0.27	0.22	0.05	0.26	0.48	0.32	0.20	0.27	0.29
S10	0.15	0.36	0.34	0.33	0.32	0.18	0.19	0.24	0.73	0.66	0.28	0.36
S11	0.17	0.42	0.45	0.29	0.18	0.07	0.08	0.11	0.55	0.55	0.26	0.26
S12	0.18	0.37	0.31	0.25	0.30	0.29	0.25	0.13	0.52	0.54	0.27	0.31

Appendix C

Baseline Scheme Layout Plan



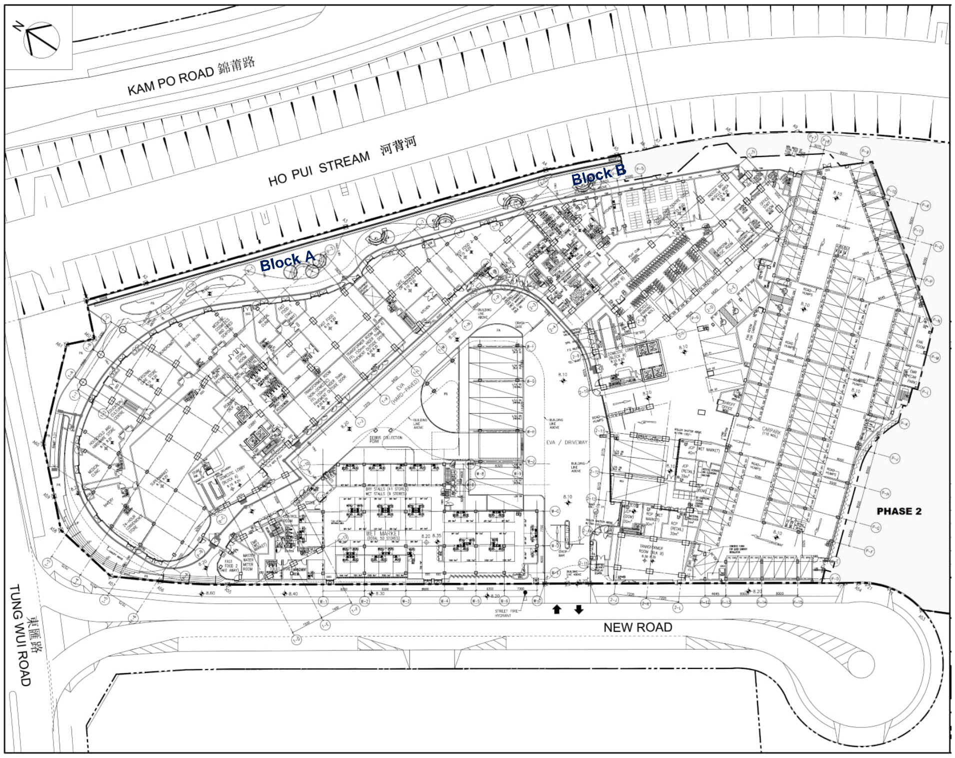
Baseline Scheme – Master Layout Plan



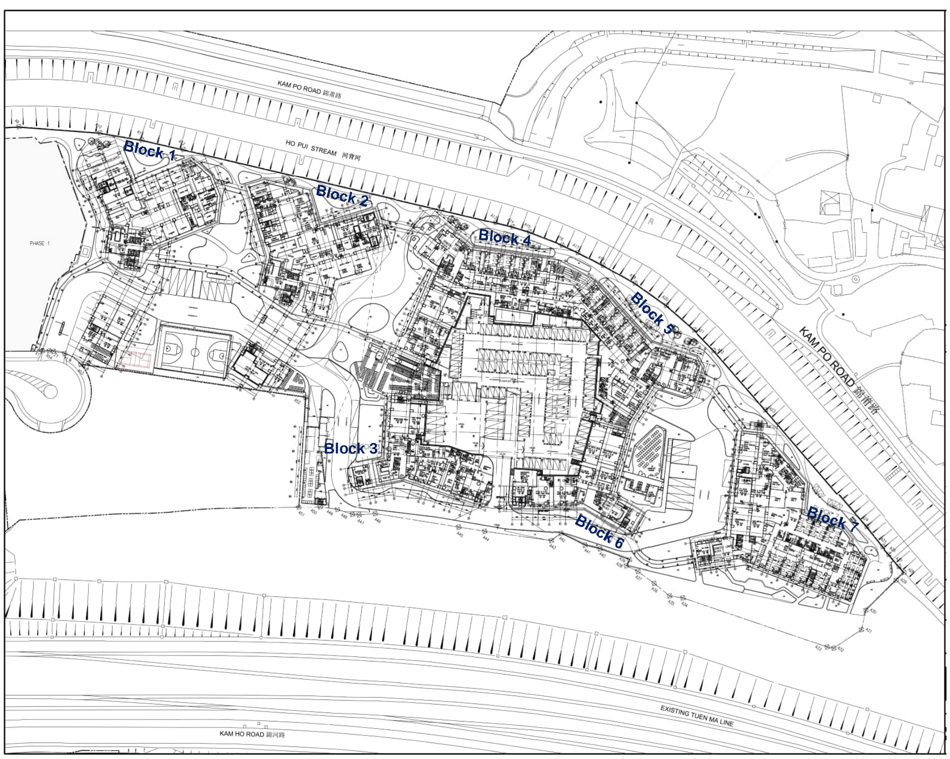
Baseline Scheme – G/F Layout Plan

Appendix D

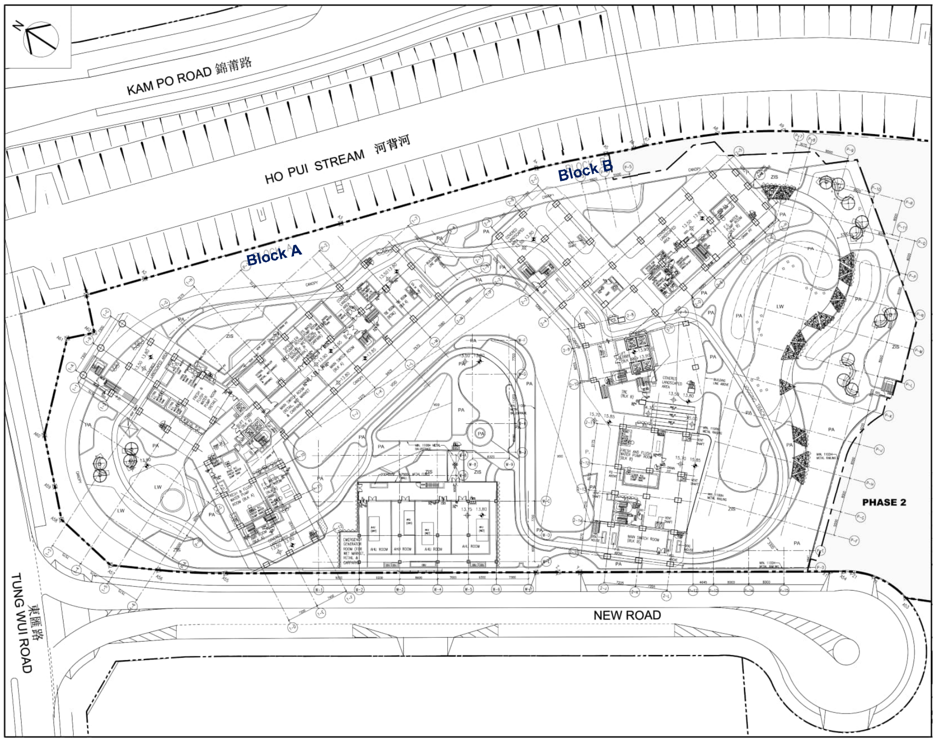
Proposed Scheme Layout Plan



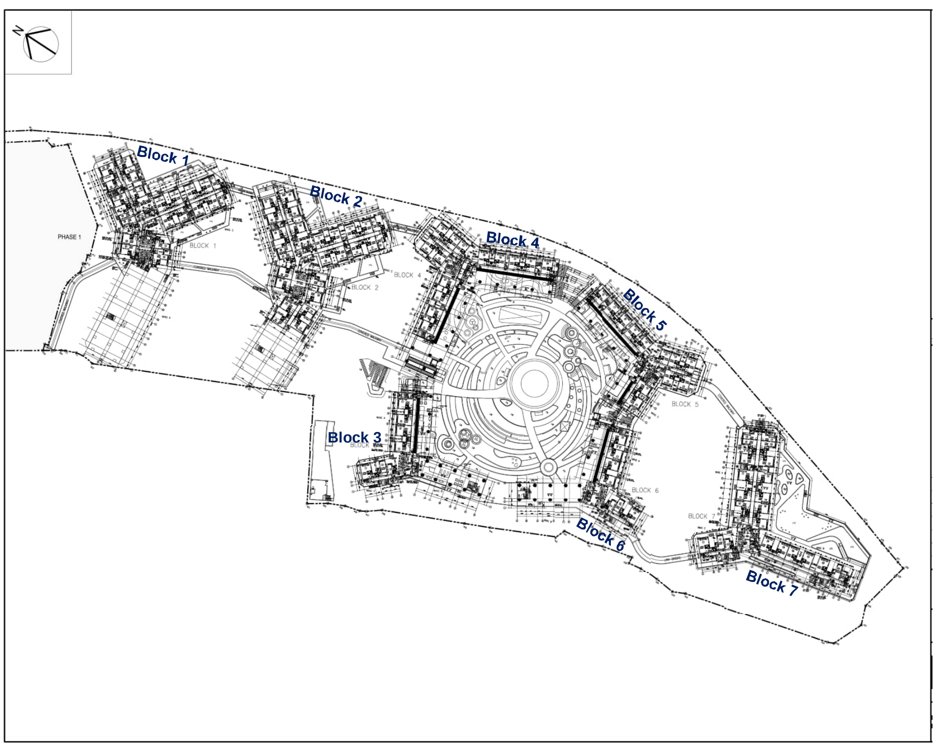
Proposed Scheme – G/F Layout Plan (Phase 1)



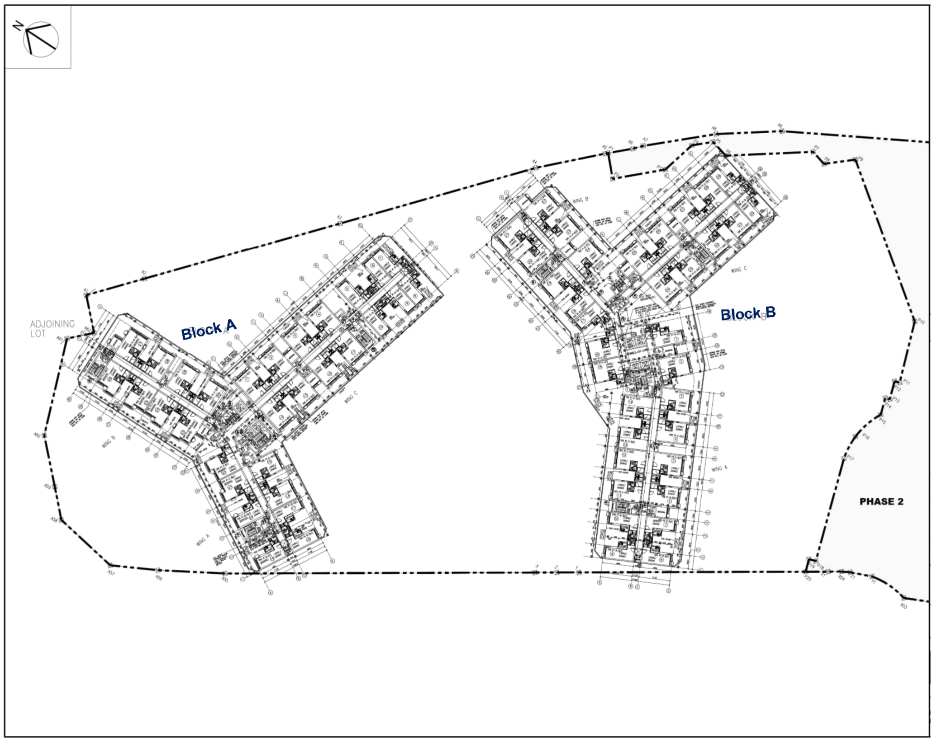
Proposed Scheme – G/F Layout Plan (Phase 2)



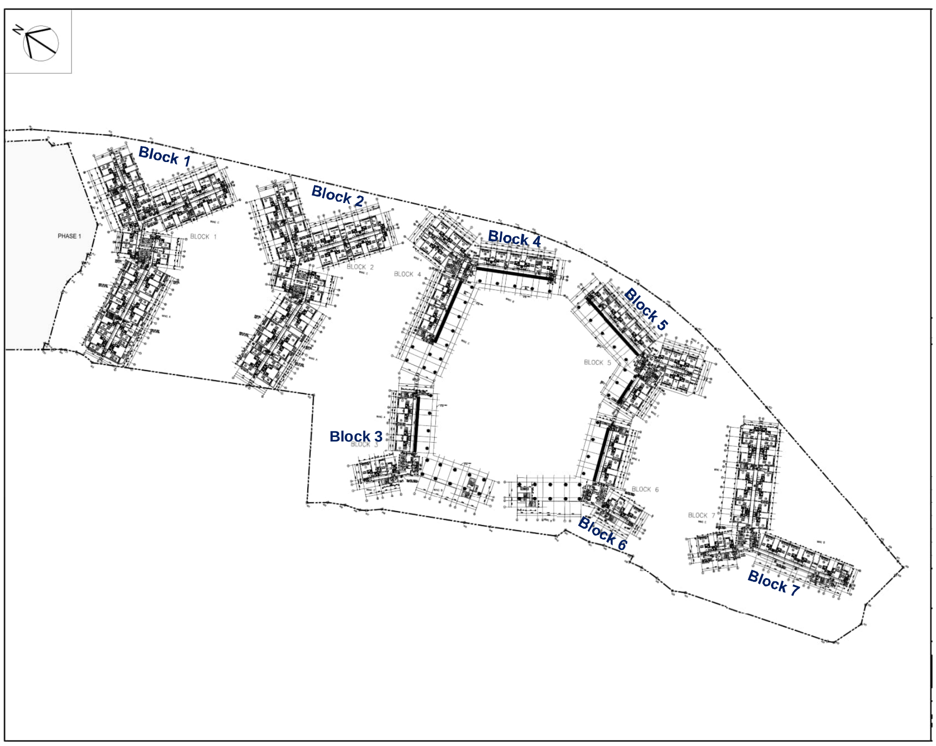
Proposed Scheme – 1/F Layout Plan (Phase 1)



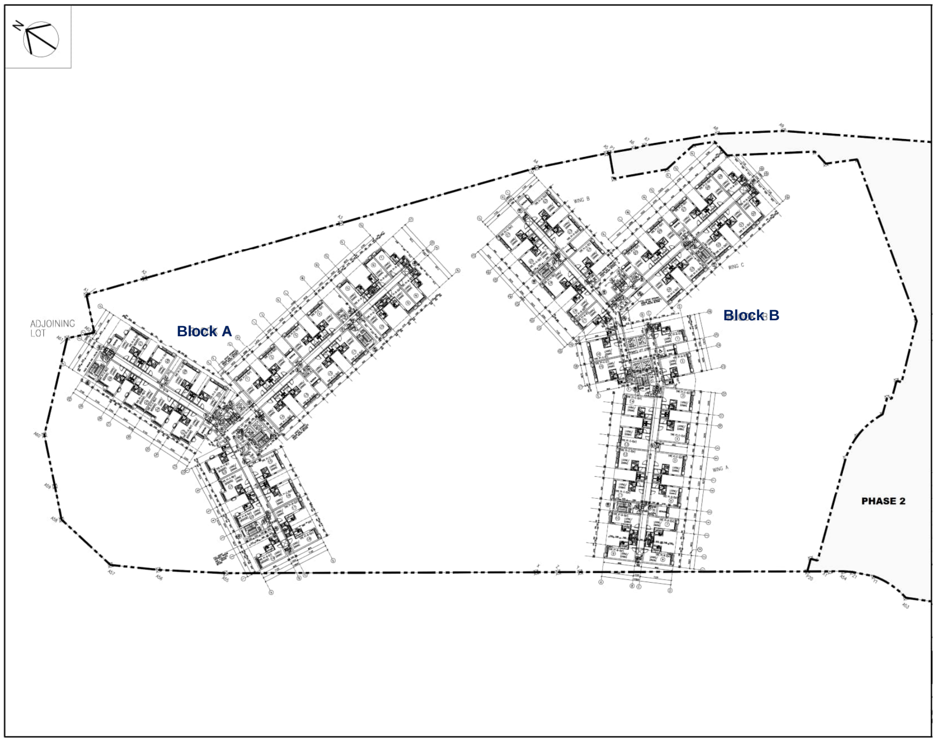
Proposed Scheme – 1/F Layout Plan (Phase 2)



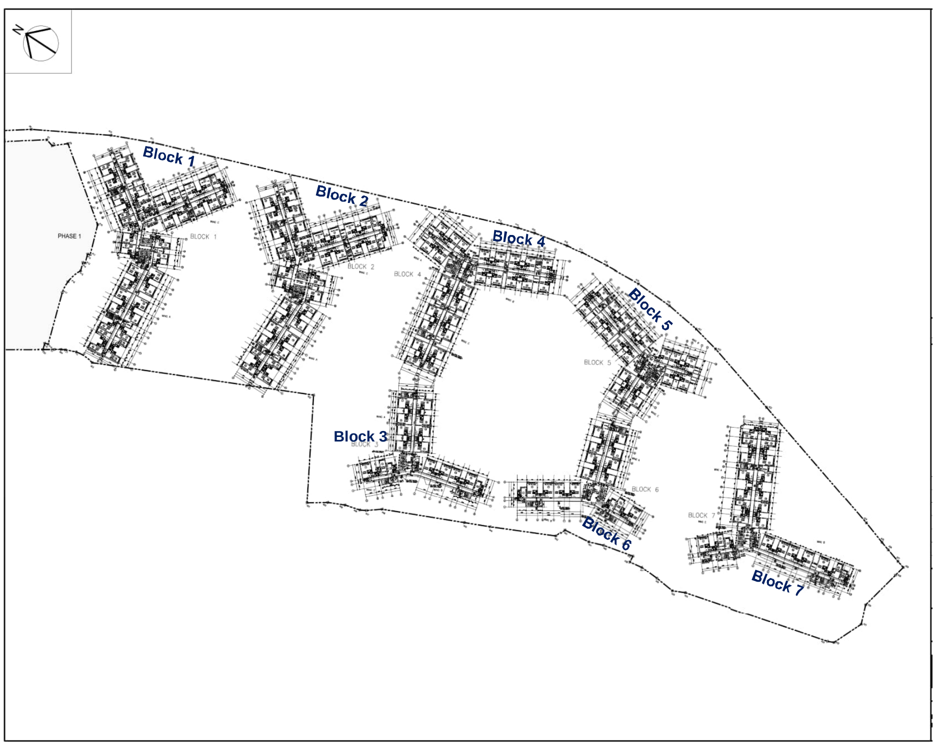
Proposed Scheme – 2/F Layout Plan (Phase 1)



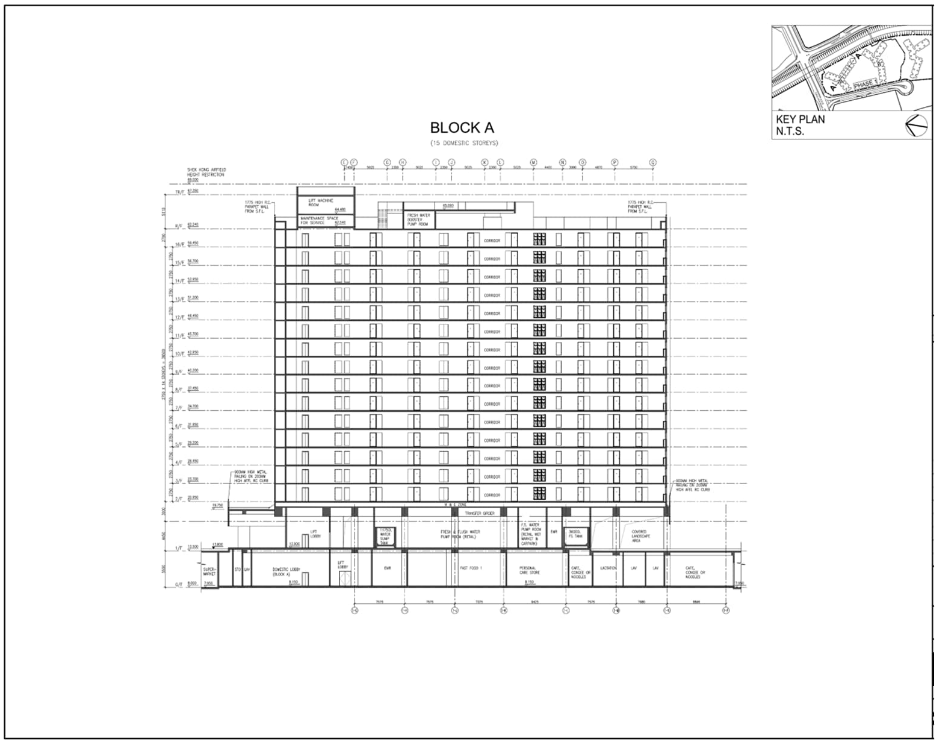
Proposed Scheme – 2/F Layout Plan (Phase 2)



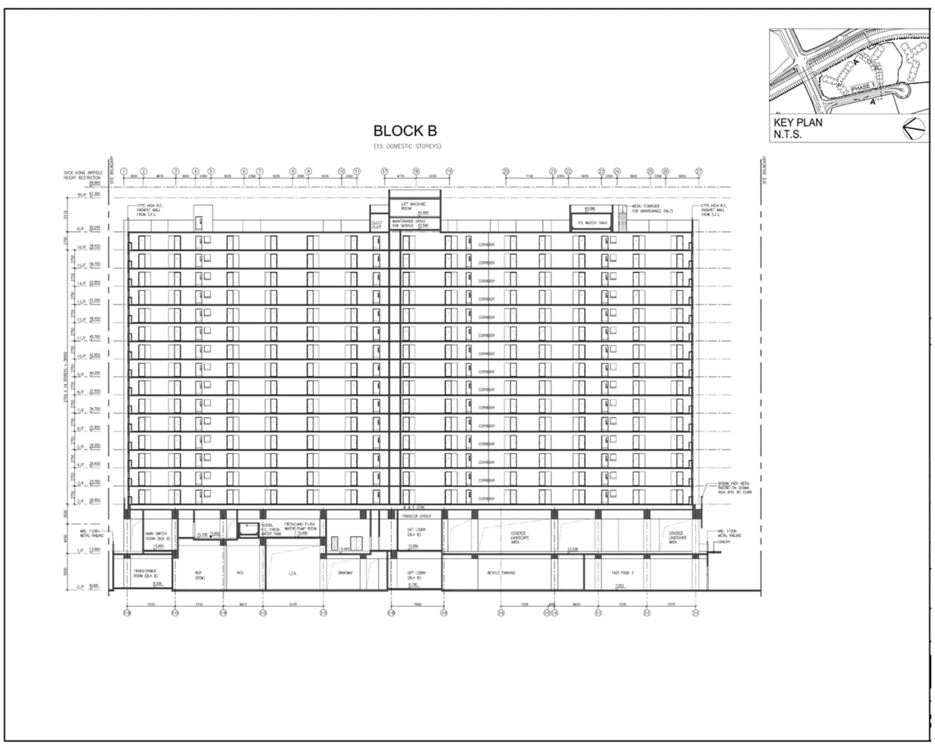
Proposed Scheme – Typical Floor Layout Plan (Phase 1)



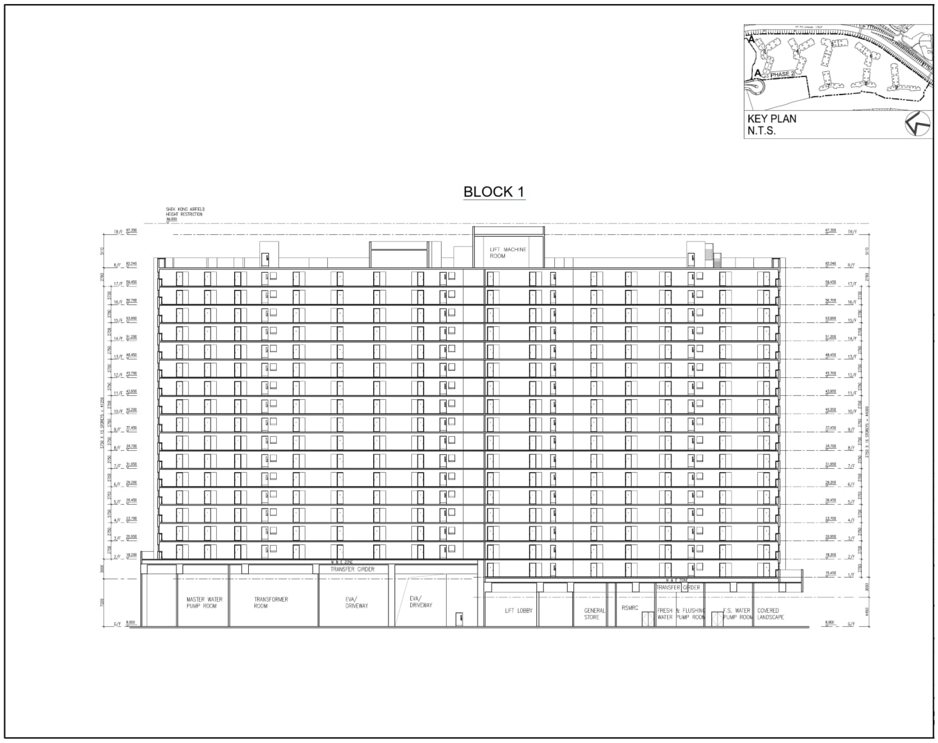
Proposed Scheme – Typical Floor Layout Plan (Phase 2)



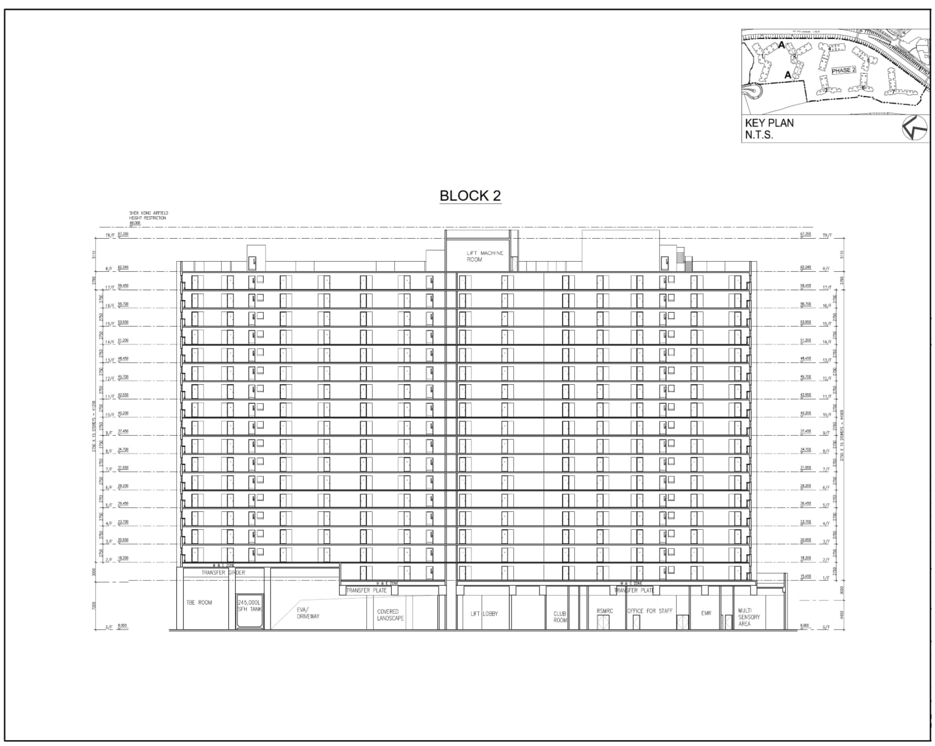
Proposed Scheme – Section A-A (Block A, Phase 1)



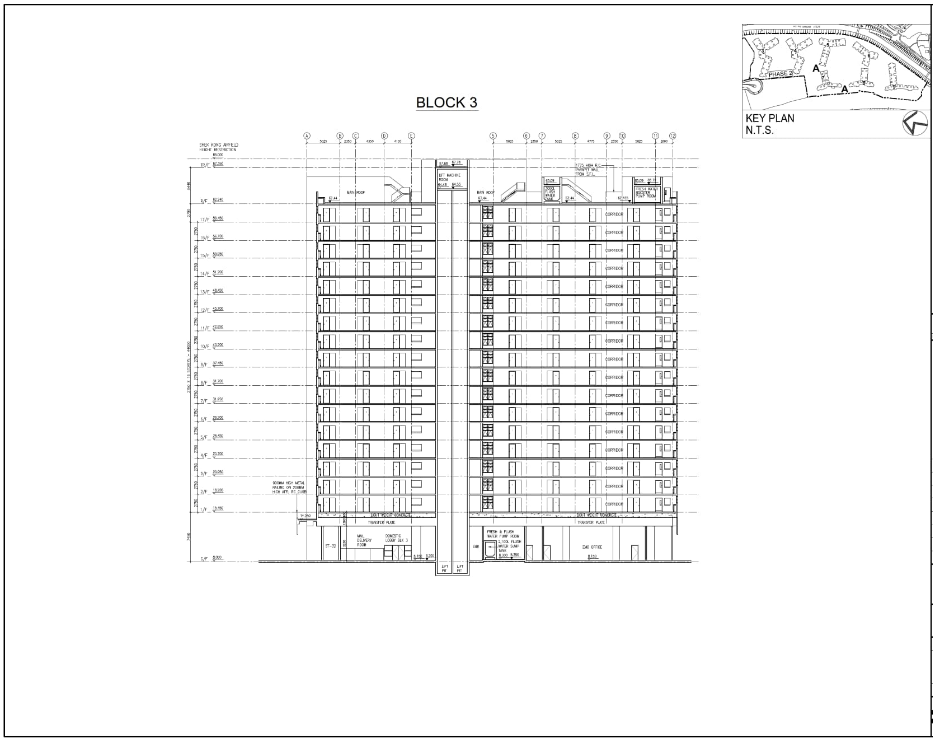
Proposed Scheme – Section A-A (Block B, Phase 1)



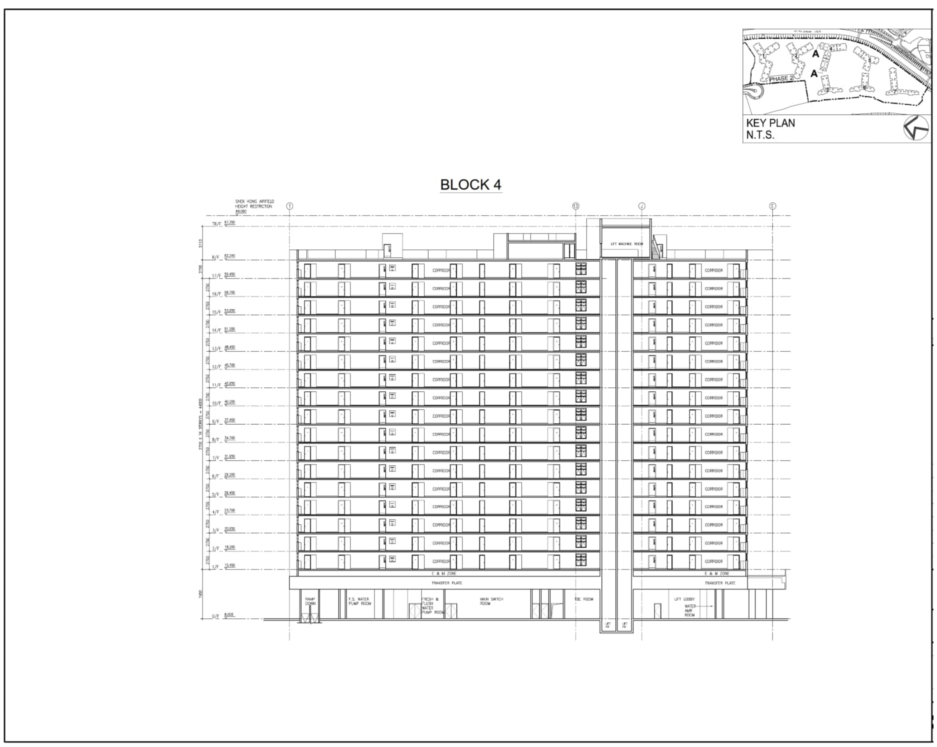
Proposed Scheme – Section A-A (Block 1, Phase 2)



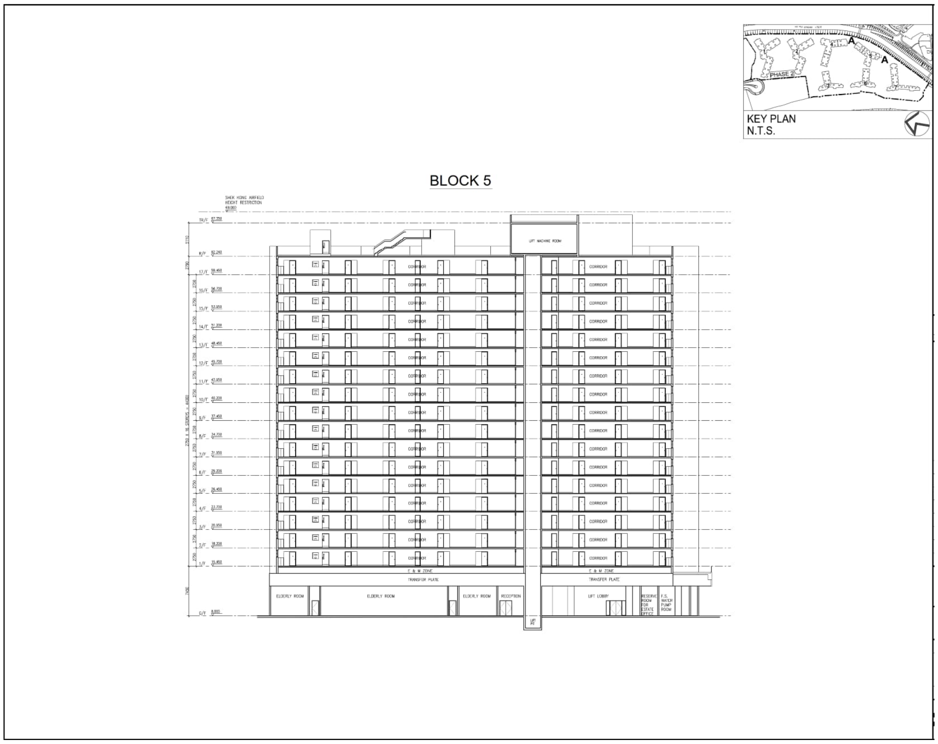
Proposed Scheme – Section A-A (Block 2, Phase 2)



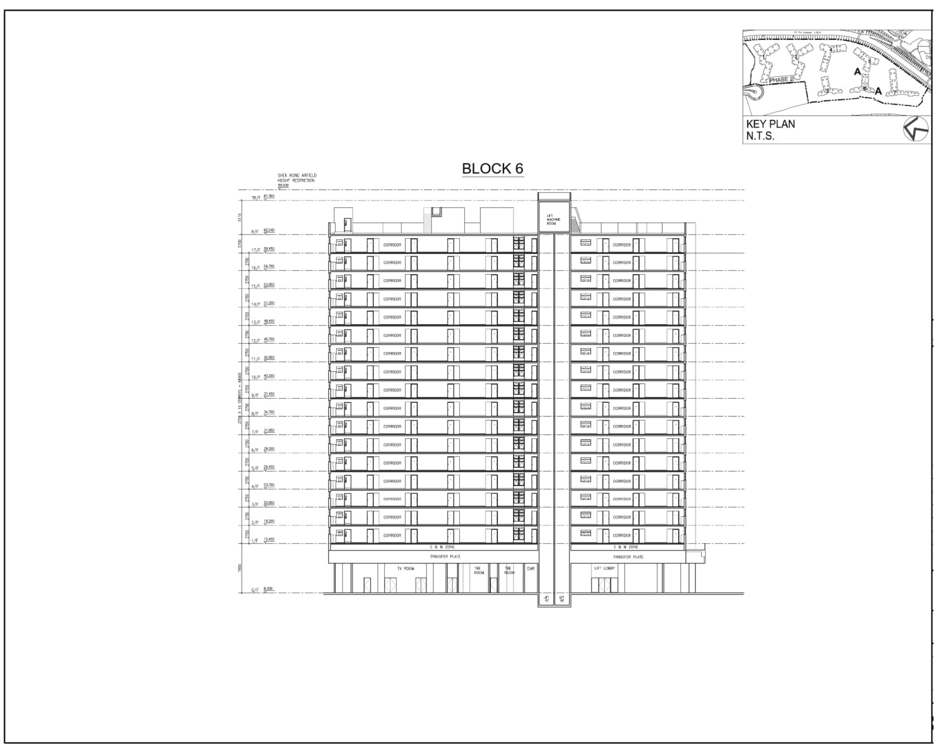
Proposed Scheme – Section A-A (Block 3, Phase 2)



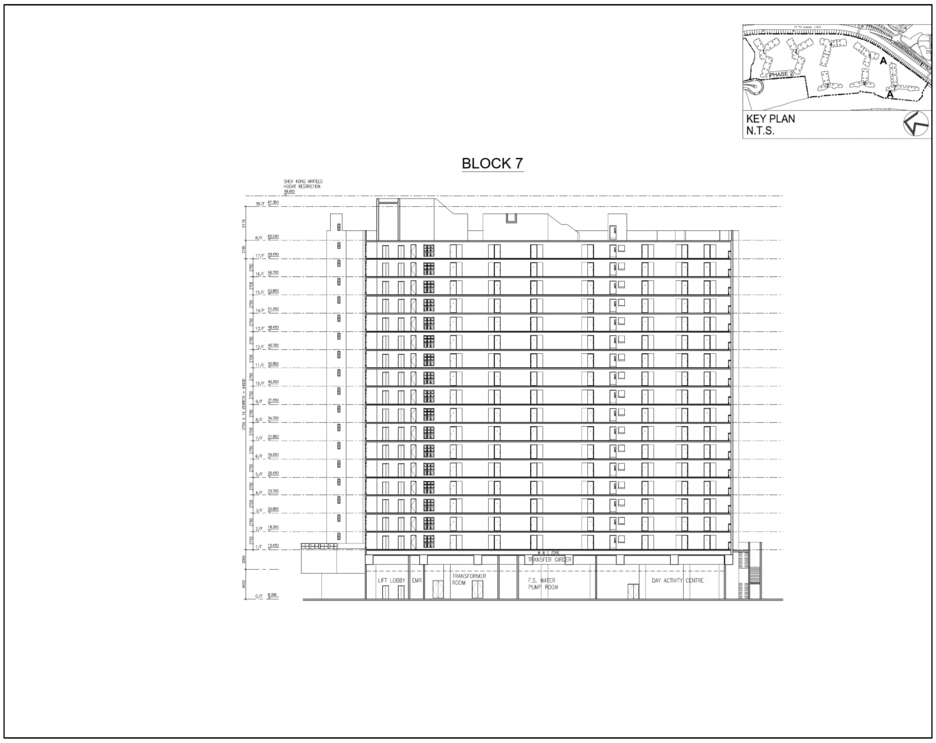
Proposed Scheme – Section A-A (Block 4, Phase 2)



Proposed Scheme – Section A-A (Block 5, Phase 2)



Proposed Scheme – Section A-A (Block 6, Phase 2)



Proposed Scheme – Section A-A (Block 7, Phase 2)