Hong Kong Housing Authority

Proposed Public Rental Housing and Home Ownership Scheme Developments at Sites 3 & 5 of Lin Cheung Road Site

Air Ventilation Assessment - Initial Study

213232-07

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Ove Arup & Partners Hong Kong Ltd
Level 5 Festival Walk
80 Tat Chee Avenue
Kowloon Tong
Kowloon
Hong Kong
www.arup.com

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Contents

Appendices

1 Introduction

1.1 Background of Study

Ove Arup & Partners Hong Kong Ltd. (Arup) was commissioned by the Hong Kong Housing Authority (HKHA) to carry out an Air Ventilation Assessment (AVA) for the Proposed Public Rental Housing (PRH) and Home Ownership Scheme (HOS) Developments at Sites 3 & 5 of Lin Cheung Road Site.

The current application site is zoned “Residential (Group A) 12” on the Approvaed South West Kowloon Outline Zoning Plan No. S/K20/30, with maximum building height of 120mPD. Planning permission from Town Planning Board (TPB) for minor relaxation of building height restriction from 120mPD to 125mPD for the domestic blocks under Section 16 (S16) of the Town Planning Ordinance is required. The AVA – Initial Study is conducted to assess the air ventilation impact of the proposed developments in the area.

1.2 Objective of the Study

The objective of the study is to investigate the air ventilation performance of the proposed developments using the methodology the AVA as stipulated in the “Technical Circular No. 1/06 – Air Ventilation Assessments” (Technical Circular) and Annex A to the Technical Circular “Technical Guide for Air Ventilation Assessment for Developments in Hong Kong” (Technical Guide) jointly issued by Housing, Planning and Lands Bureau and Environmental, Transport and Works Bureau on 19th July 2006.

1.3 Scope of Study- Initial Study

The main scope of the study is to carry out an AVA Initial Study to assess the ventilation performance of the proposed developments and surrounding environment. The deliverables of this study can be summarised as follows:

- Evaluation of the wind performance to gather the typical wind characteristics
- Identification of the general ventilation performance over the assessment area
- Assessment of air ventilation performance at focus areas

2 Background Information

2.1 Site and Surrounding Area Characteristics

The proposed developments at Sites 3 & 5 of Lin Cheung Road Site are located on a relatively low elevation facing the waterfront. The Developments are also bounded by the West Kowloon Highway to the north-east, Hing Wah Street West to the west and the existing Cheung Sha Wan Wholesale Food market (CSWWFM) to the south-east.

There are some high-rise residential clusters located at the surroundings, such as Hoi Lai Estate, Fu Cheong Estate, Wing Cheong Estate, and etc. A committed development, namely Nam Cheong Station Development which is located on the eastern side of these sites, has been taken into account in the assessment model. Future residential developments, namely Northwest Kowloon Reclamation Area (NWKR) Site 6, Sites 1, 2 and 4A of Lin Cheung Road Site and Fat Tseung Street West (FTSW) are also included in the model. Planned Sites 1, 2 and 4A of Lin Cheung Road Site consist of buildings for social welfare facilities and residential / hotel developments, while the indicative layout is referred to the CSWWWM Phase 2 and FTSW AVA Report submitted and approved by PlanD dated Nov 2013.

Figure 1 Aerial Photo of the Proposed Development and Surrounding Areas

2.2 Study Scenarios

Two schemes are compared in this AVA study, namely the Baseline Scheme and Proposed Scheme.

2.2.1 Baseline Scheme

The Baseline Scheme is formulated based on the approved AVA report submitted in December 2013 at the rezoning stage. The development includes 2 residential blocks (Block 1 and Block 2) at Site 3 and 5 residential blocks (Block 3 – Block 7) at Site 5 with maximum building height of 120mPD. The development also consist of a podium under Block 1 and 2, RCP structures at east and west portion. These building structures have a building level of 10mPD. There are retail facilities at ground floor of the residential block in Site 3.

Table 1 Maximum building height of each residential block under the Baseline Scheme

Block No.	Maximum Building Height
1	≈ 100 mPD
2	≈ 120 mPD
3	≈ 120 mPD
4	≈ 115 mPD
5	≈ 115 mPD
6	≈ 110 mPD
7	≈ 120 mPD

Two non-building areas are incorporated in the Baseline Scheme to facilitate the ventilation penetration. Five G/F empty bays are also incorporated into the scheme to enhance the ventilation with the site. A large building separation is also provided for the development with a width of ~53m between Blocks 2 and 3 and ~76m between Block 2 and 4, measured between the domestic blocks above the transfer plate level. This separation acts as a local air path for wind penetration to the downwind region. A proposed footbridge has been included to connect 8/F of Block 2 at Lin Cheung Road Site 3 and NWKR Site 6 to provide interconnection for the residents.

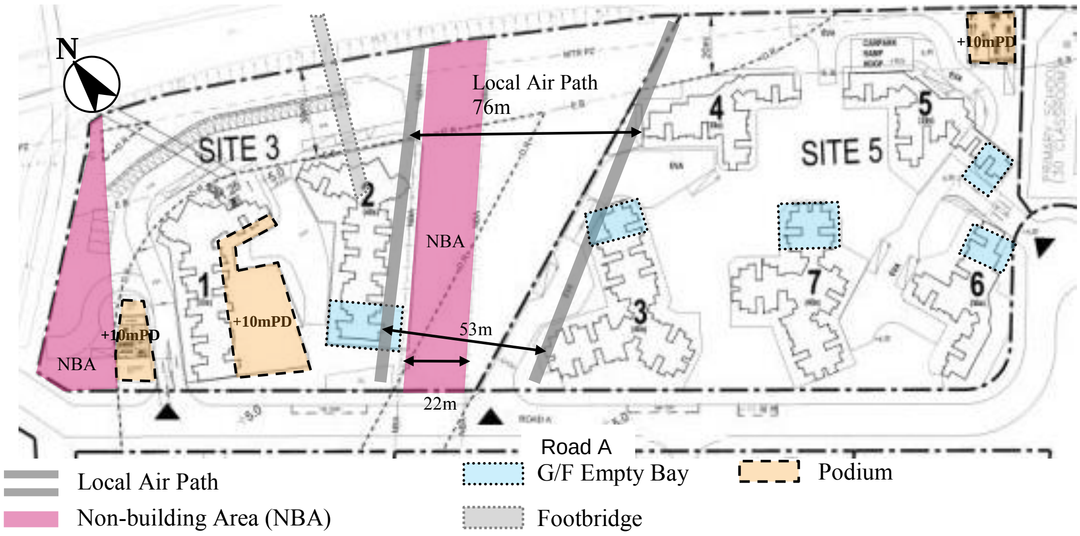


Figure 2 Master Layout Plan of Baseline Scheme for Sites 3 & 5

The three-dimensional model of the developments under the Baseline Scheme at Sites 3 & 5 conforming with the development restriction as stipulated on the OZP are shown at Figure 3 to Figure 6 from different view angles.

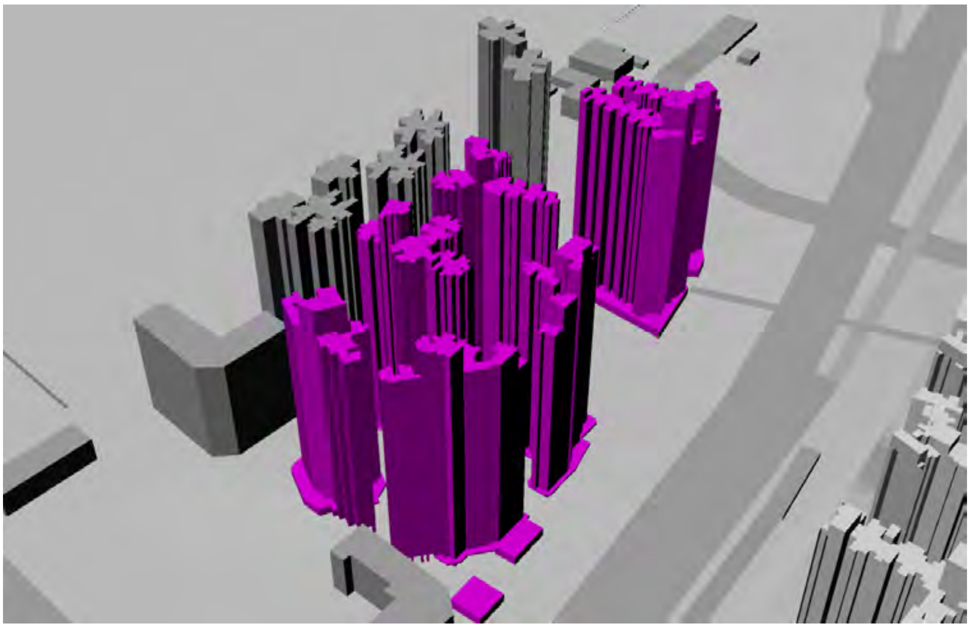


Figure 3 Easterly view of the Baseline Scheme for Sites 3 & 5

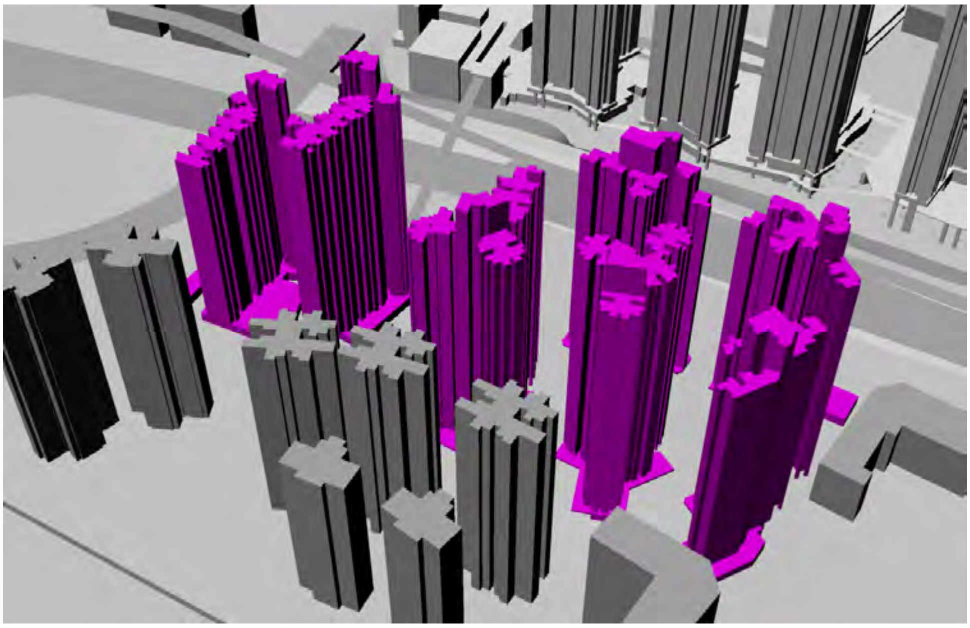


Figure 4 Southerly view of the Baseline Scheme for Sites 3 & 5

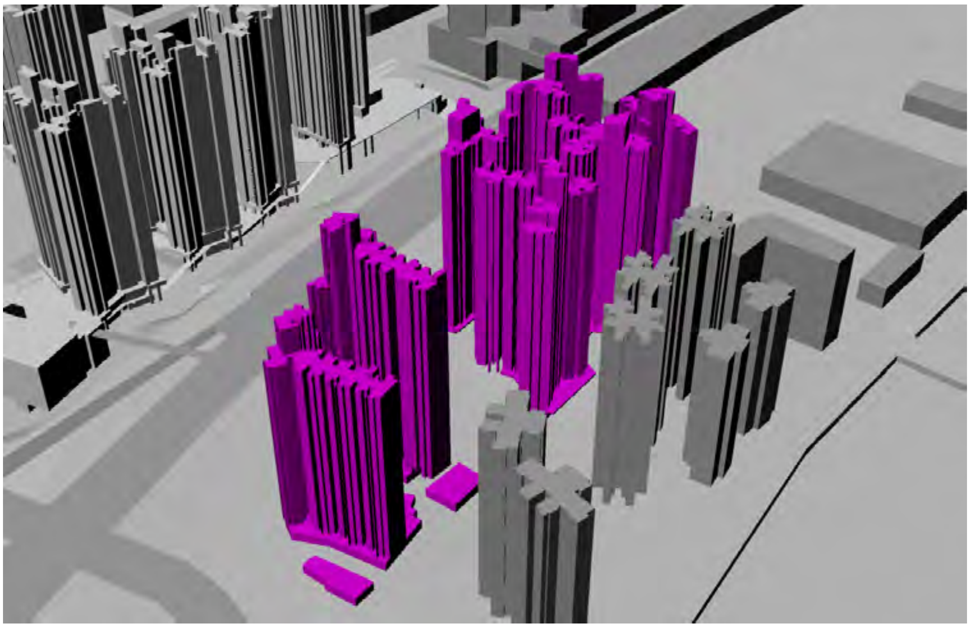


Figure 5 Westerly view of the Baseline Scheme for Sites 3 & 5

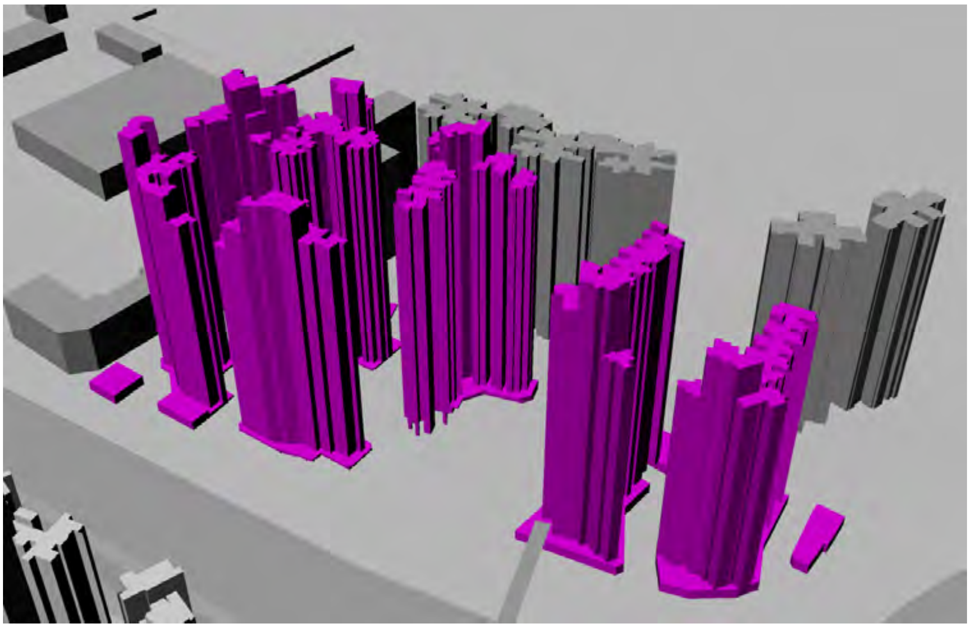


Figure 6 Northerly view of the Baseline Scheme for Sites 3 & 5

2.2.2 Proposed Scheme

The Proposed Scheme is further developed based on the previous approved scheme with additional office space at first floor of one domestic block that results in slight increase in building height and the need to raise the ground level of the site from 5.0mPD to 6.5mPD in average to cater for the flexibility to allow gravitational sewage discharge from the site, i.e., the maximum building height in some of the blocks are raised to above 120mPD with the maximum at 125mPD. The proposed development includes non-domestic premises, retails and a semi-basement carpark. The non-domestic premises and retails facilities are located at G/F and podium floor (~11mPD) of Site 3. A semi-basement carpark is located at Site 5 between Blocks 4 - 5 with height level of +9.2mPD. Landscape areas located between Blocks 1 - 2, open space between Blocks 2 - 3, Blocks 3 - 7 and Blocks 6 – 7 are all at grade with elevation of around +5.97mPD to +6.55mPD.

Table 2 Proposed Building Height of each residential block under the Proposed Scheme

Block No.	Proposed Building Height
1	≈ 103 mPD
2	≈ 125 mPD
3	≈ 123 mPD
4	≈ 120 mPD
5	≈ 117 mPD
6	≈ 120 mPD
7	≈ 123 mPD

The Proposed Scheme has incorporated similar design features committed in the Baseline Scheme, such as five G/F empty bays and two non-building areas of 45m and 22m. Similar to the Baseline Scheme, a local air path is provided for the development with the width of ~46m between Blocks 2 and 3 and ~81m between Blocks 2 and 4 for wind penetration to the downwind region. The width of the local air path is measured between the domestic blocks above the transfer plate level. An elevated walkway of +11.22mPD is connected to a staircase of +11.22mPD at the open space between Site 3 and Site 5 for pedestrian access. Figure 8 shows the detailed layout plan and elevation of the elevated walkway together with the staircase. A proposed footbridge is also included to connect 8/F at Block 2 of Site 3 and NWKR Site 6. Table 2 shows the latest building height of each residential block. Figure 11 shows the geometric details of the non-domestic facilities.

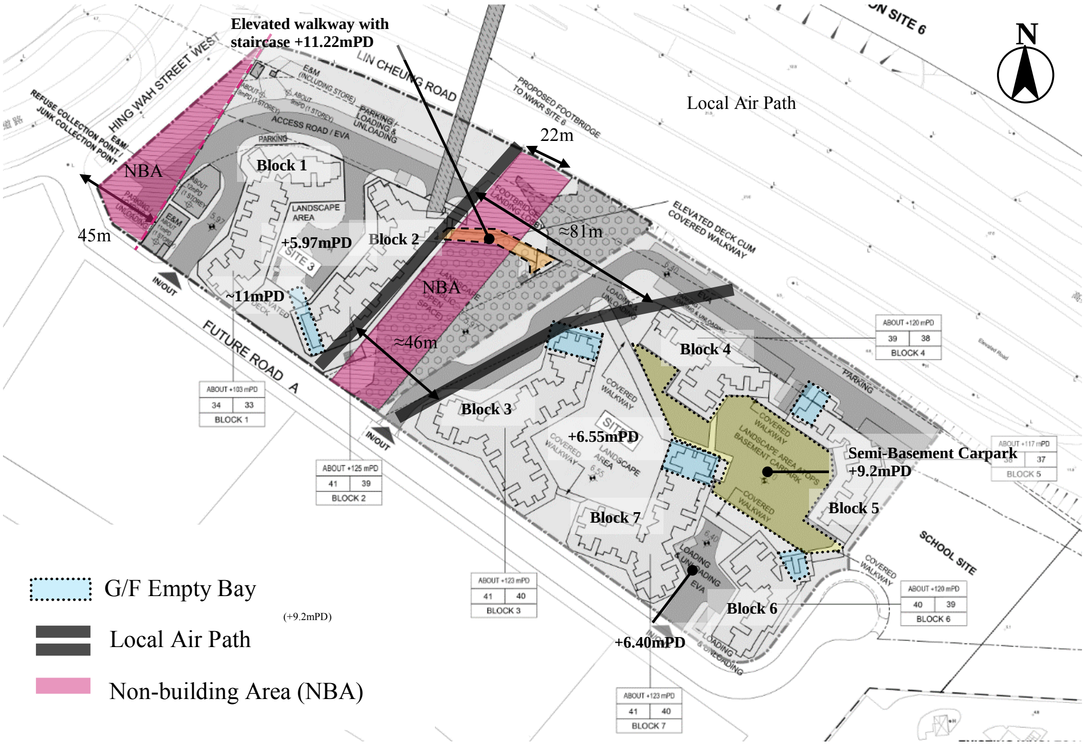


Figure 7 Master Layout Plan at G/F of Proposed Scheme for Lin Cheung Road Sites 3 & 5

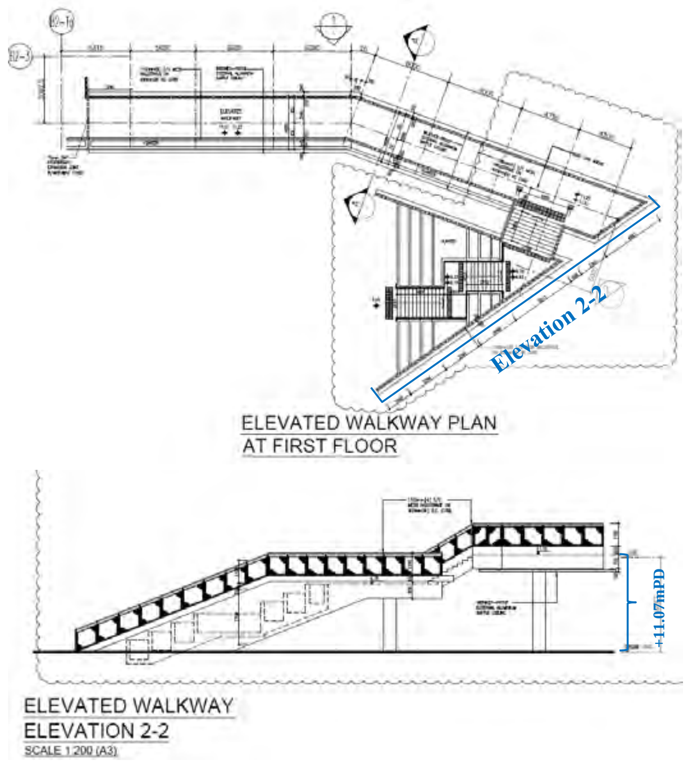


Figure 8 Layout Plan and Elevation of Elevated Walkway and Staircase within the Open Space for the Proposed Scheme

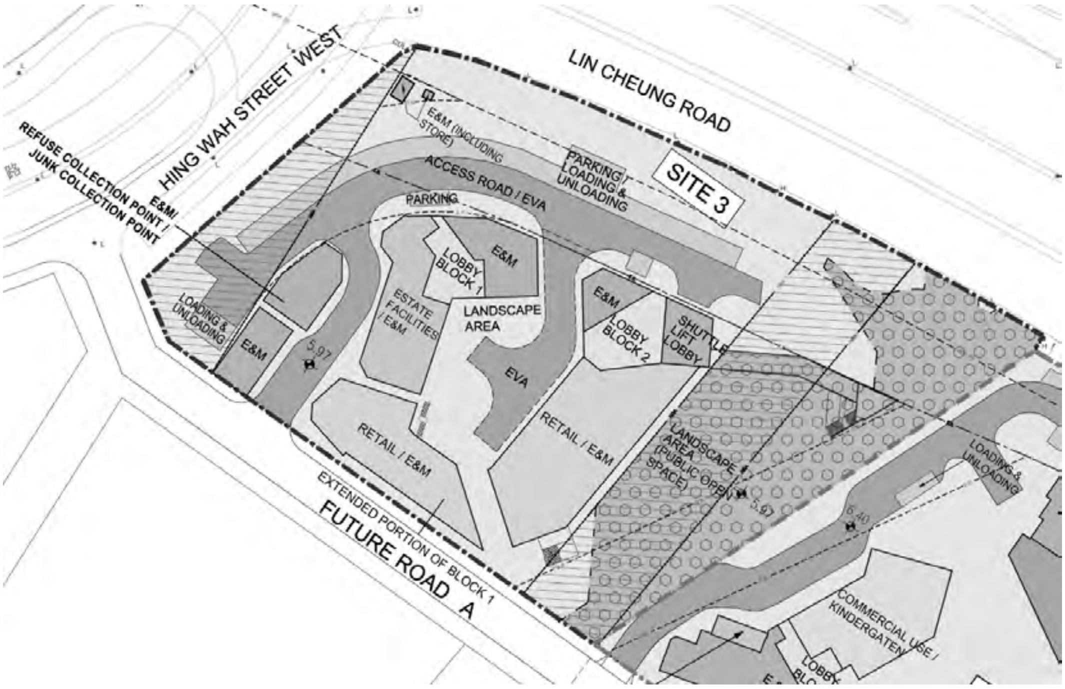


Figure 9 G/F Layout of the Proposed Scheme Site 3

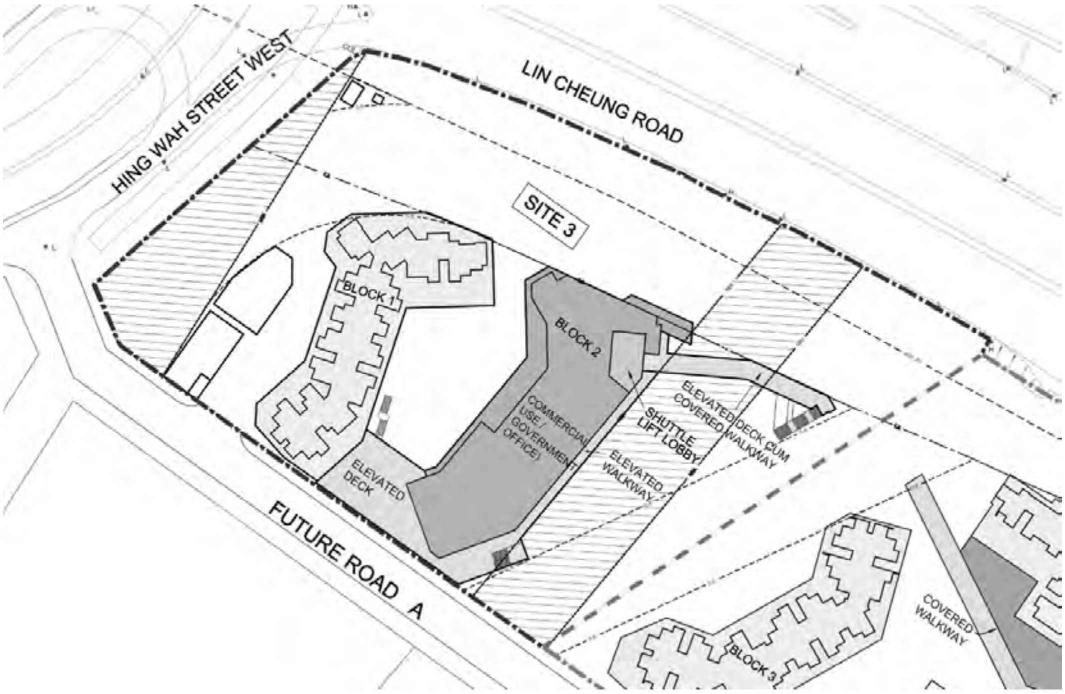


Figure 10 1/F Layout of the Proposed Scheme Site 3

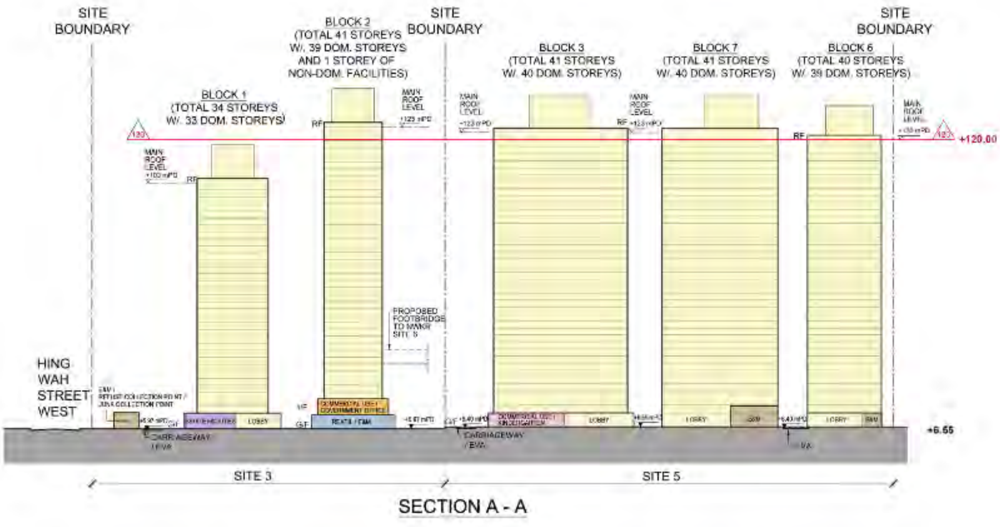


Figure 11 Section of the Proposed Scheme

The three-dimensional model of the proposed developments under the Proposed Scheme is shown at Figure 12 to Figure 15 at different angles of view.

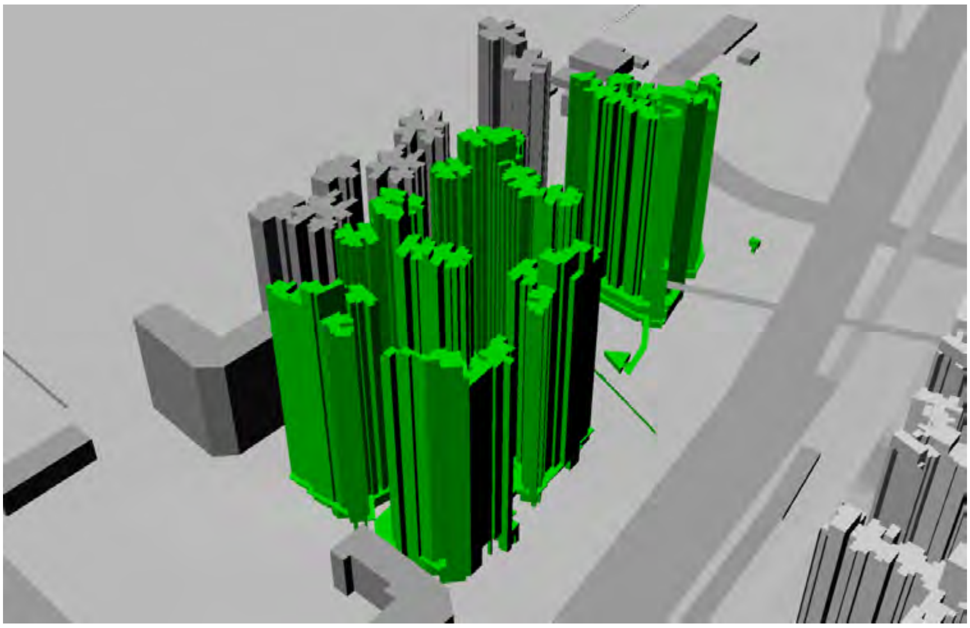


Figure 12 Easterly view of the Proposed Scheme for Sites 3 & 5

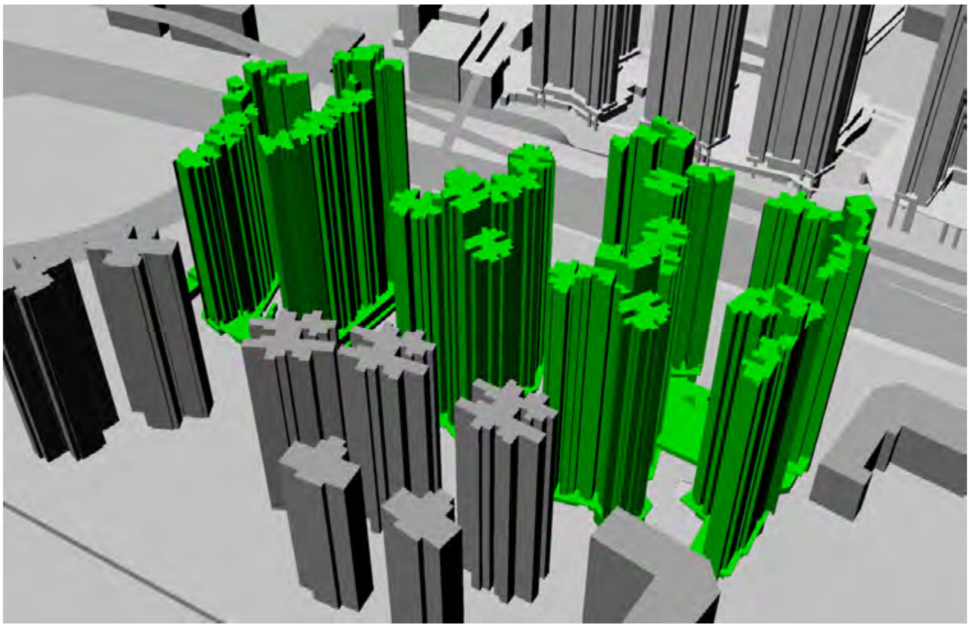


Figure 13 Southerly view of the Proposed Scheme for Sites 3 & 5

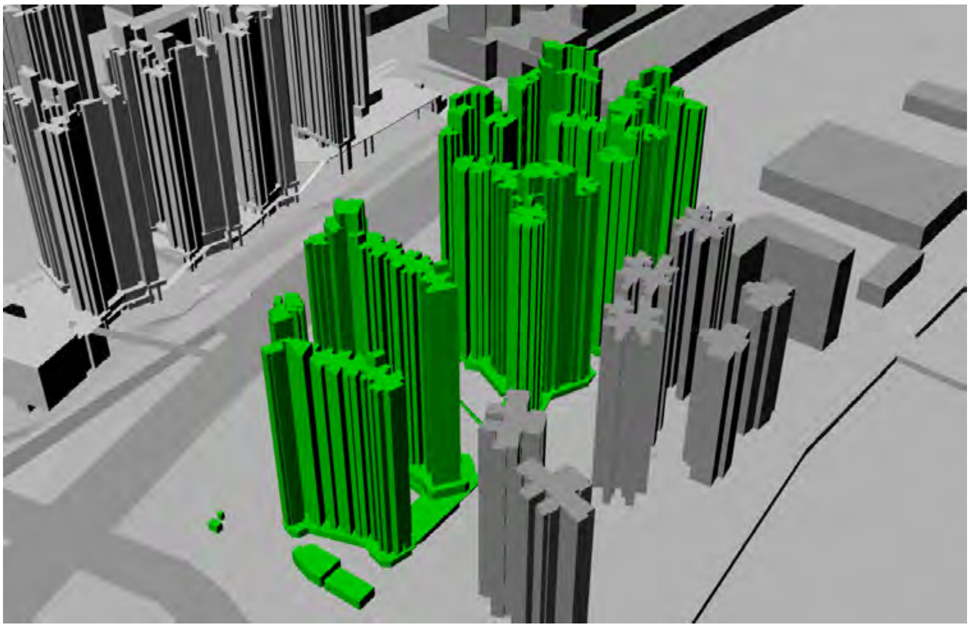


Figure 14 Westerly view of the Proposed Scheme for Sites 3 & 5

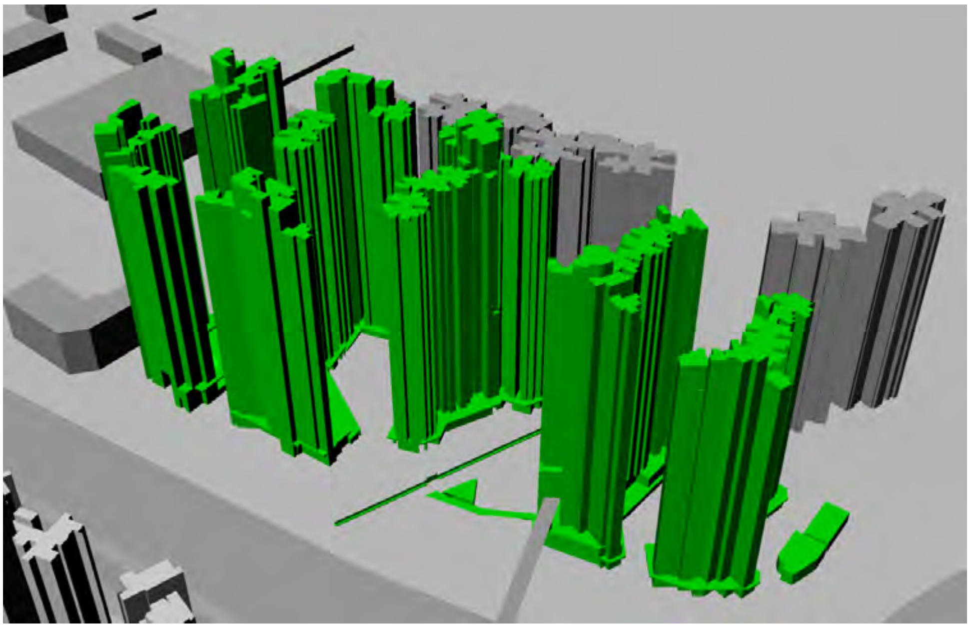


Figure 15 Northerly view of the Proposed Scheme for Sites 3 & 5

3 Methodology of AVA Study

This study adopted the AVA methodology for initial study as stipulated in Annex A of the Technical Circular on “Technical Guide for Air Ventilation Assessment for Developments in Hong Kong” (Technical Guide).

3.1 Wind Availability

Based on the methodology of AVA, the site wind availability data was obtained from the Urban Climatic Map (UCMap) Study for Cheung Sha Wan[1]. The annual wind rose demonstrating the frequency of occurrence of different wind directions are shown in Figure 16.

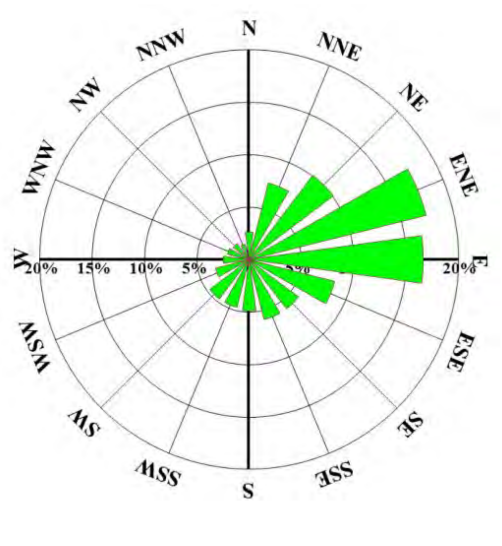
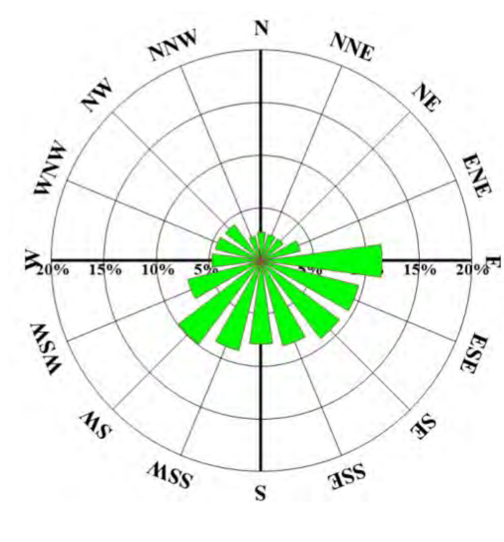
<table>
<tr><th>Annual (+450mPD)</th><th>Summer (+450mPD)</th></tr>
<tr><td>
</td><td>
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Figure 16 Wind rose for the Development under Annual and Summer Wind Condition

1 Urban Climatic Map and Standards for Wind Environment – Feasibility Study, Department of Architecture, CUHK, 1/22/2009

3.1.1 Annual Prevailing Wind

Eight prevailing wind directions (highlighted in red colour in Table 3) are considered in the AVA Initial Study which covers 76.6% of the total annual wind frequency. They are north-north-easterly (7.5%), north-easterly (10.1%), east-north-easterly (17.4%), easterly (16.6%), east-south-easterly (8.4%), south-easterly (5.9%), south-south-easterly (5.9%) and southerly (4.9%) winds.

Table 3 Annual wind frequency of the wind directions considered in this study

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	
Frequency	2.6%	7.5%	10.1%	17.4%	16.6%	8.4%	5.9%	5.9%	
Wind Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
Frequency	4.9%	4.7%	4.7%	3.3%	2.5%	2.1%	1.9%	1.5%	76.6%

** The wind frequency showing in red colour represents the selected winds for the CFD simulation.*

3.1.2 Summer Prevailing Wind

Nine prevailing wind directions (highlighted in red colour in Table 4) are considered in the AVA Initial Study which covers 77.1% of the total summer wind frequency (from 1 June to 30 August). They are easterly (11.5%), east-south-easterly (9.5%), south-easterly (9.3%), south-south-easterly (8.3%), southerly (7.9%), south-south-westerly (8.8%), south-westerly (9.9%), west-south-westerly (7.2%) and westerly (4.7%) winds.

Table 4 Summer wind frequency of the wind directions considered in this study

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	
Frequency	2.7%	2.6%	2.6%	3.8%	11.5%	9.5%	9.3%	8.3%	
Wind Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
Frequency	7.9%	8.8%	9.9%	7.2%	4.7%	4.5%	4.3%	2.4%	77.1%

** The wind frequency showing in red colour represents the selected winds for the CFD simulation.*

3.1.3 Wind Profile

The vertical discretization of the velocity profile is approximated by using an exponential law, which is a function of ground roughness and height:

$$U_Z = U_G \left(\frac{z}{z_G} \right)^n$$

where

U_G = reference velocity at height Z_G

Z_G = reference height

Z = height above ground

U_Z = velocity at height z

n = power law exponent

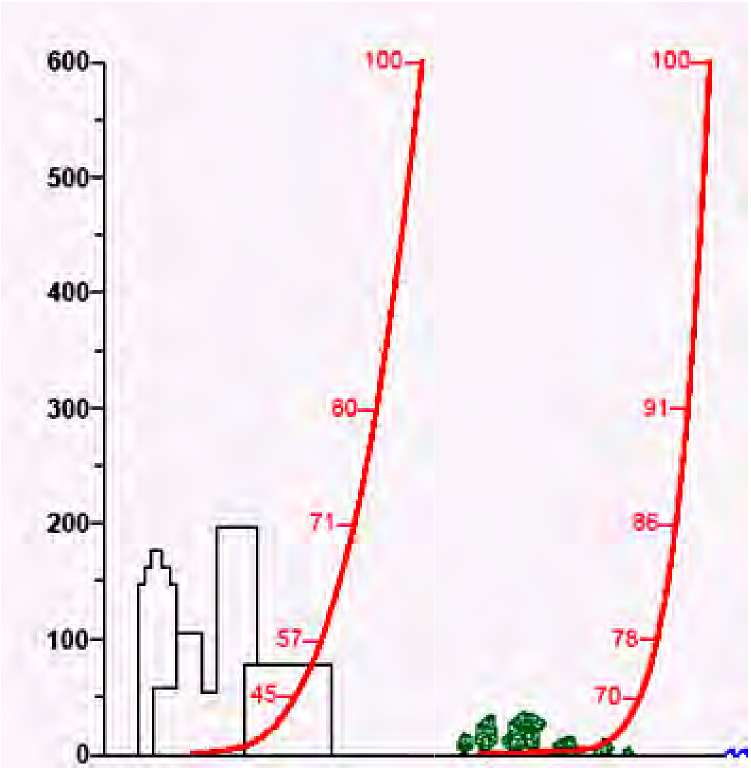


Figure 17 Wind Profile applied in the AVA Initial Study

The power *n* is related to the ground roughness. A larger value of the power *n* represents the higher roughness of the ground i.e. the dense city. Alternatively, smaller n represents the lower ground roughness i.e. the sea surface.

Terrain crossed by approaching wind	*n*-value
Sea and open space	~0.15
Suburban or mid-rise	~0.35
City centre or high-rise	~0.50

As the developments are located in the urban city and surrounded by medium rise building in NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW and W directions, the *n*-value was assumed to be 0.35 for wind from these directions. Furthermore, developments are facing the waterfront in S, SSW, SW and WSW directions, hence the n-value is assumed to be 0.15 for the wind from these directions.

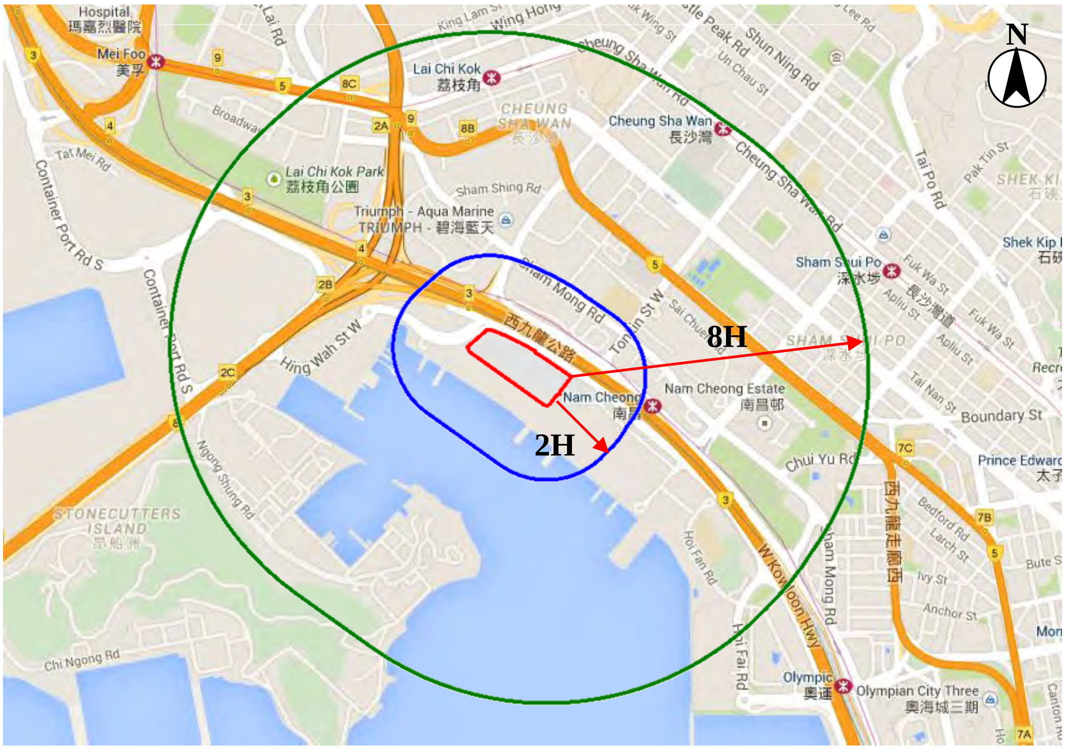
Table 5 n-value for the prevailing wind directions

Wind Direction	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W
n-value	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.15	0.15	0.15	0.15	0.35

3.2 Study Area

3.2.1 Project Assessment Area and Surrounding Areas

With reference to the Technical Guide, the areas of evaluation and assessment should include all areas measured from the site boundary as well as a belt up to 1H, where H is the height of the tallest building of the proposed development, around the site boundary. The tallest building of the Proposed Development has a physical building height of around 120m. While the Assessment Area is proposed to be 2H ≈ 240m in order to cover the most immediate surrounding area. Notwithstanding, in order to capture a more representative wind profile of the surrounding area of the Project Site, the Surrounding Area are proposed to be 8H, which extend far beyond 2H from the Project Site. The committed/planned development at the Nam Cheong Station Development, Sites 1, 2 & 4A of Lin Cheung Road Site, NWKR Site 6 and FTSW Site are thus included into the model. The neighbouring elevated structures, such as West Kowloon Highway and Tsing Sha Highway are also modelled in the study.



Site Boundary
Assessment Area

Figure 18 Site Boundary and Assessment Area for the study (Image Source: Google Earth)

3.2.2 Assessment Parameter

The Wind Velocity Ratio (VR) as proposed by the Technical Circular is employed to assess the ventilation performances of the proposed development and surrounding environment. Higher VR implies better ventilation. The calculation of VR is given by the following formula:

$$VR = \frac{V_p}{V_\infty} \tag{1}$$

where

V_∞ = the wind velocity at the top of the wind boundary layer (typically assumed to be around 596 m above the centre of the site of concern, or at a height where wind is unaffected by the urban roughness below).

V_P = the wind velocity at the pedestrian level (2 m above ground) after taking into account the effects of buildings.

The average VR is defined as the weighted average VR with respect to the percentage of occurrence of all considered wind directions. This gives a general idea of the ventilation performance at the considered location on an annual basis.

3.3 Test Point for Local and Site Ventilation Assessment

Monitoring test points are evenly placed along the site boundary and within the assessment area of the proposed development to determine the ventilation performance. There are three types of test points in the study:

3.3.1 Perimeter Test Points

35 perimeter test points are positioned at the site boundary of the proposed development. In accordance with the Technical Circular for AVA, perimeter points are positioned at interval of 10 – 15m alongside the site boundary.

3.3.2 Overall Test Points

95 overall test points are evenly positioned in the open space on the streets and places where pedestrian frequently access within the assessment area.

3.3.3 Special Test Points

20 special test points are evenly distributed and positioned at the local air path within the project site and the waterfront promenade to study the impact on ventilation performance due to the proposed development.

Figure 19 shows the location of all perimeter (orange spots), overall (green spots) and special test points (pink spots) within the assessment area.

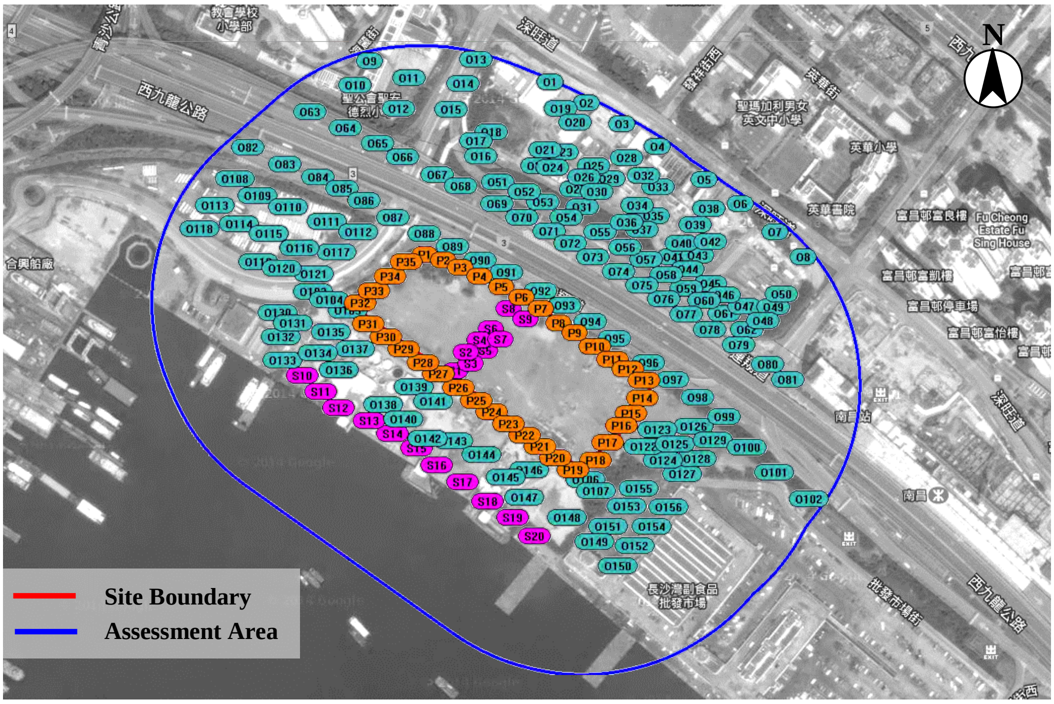


Figure 19 Location of perimeter, overall and special points – Overall Plan (Image Source: Google Map)

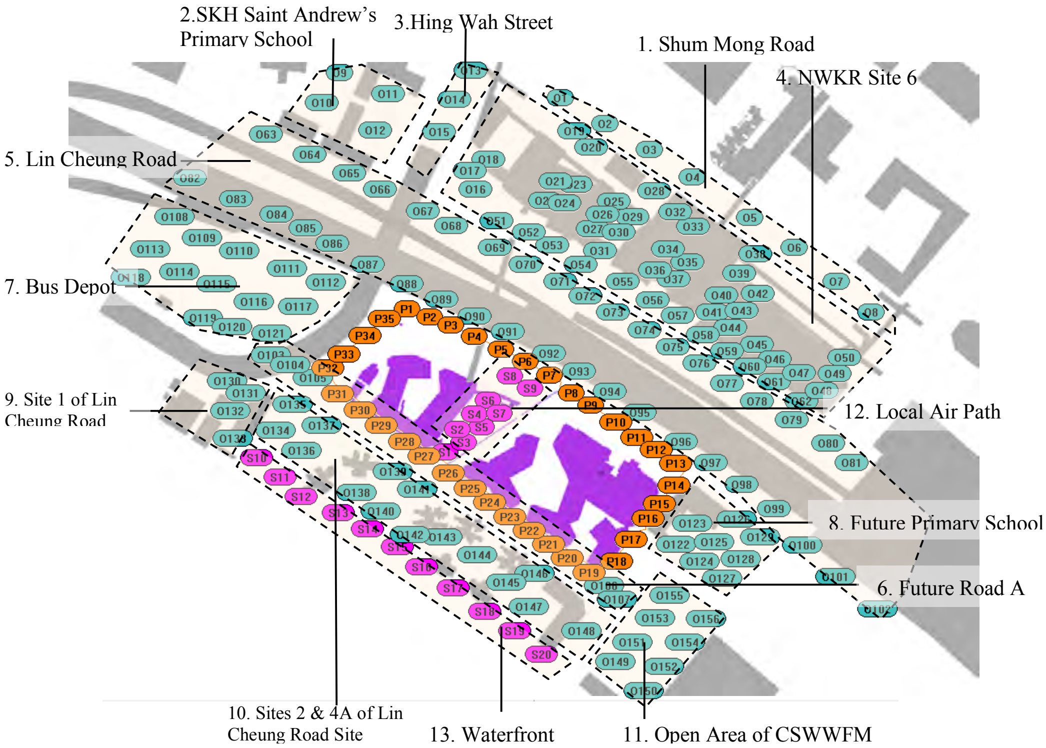


Figure 20 Location of perimeter, overall and special points – Overall Plan (Image Source: Simulation model)

3.4 Assessment Tools

Computational Fluid Dynamics (CFD) technique is utilized for this AVA initial study. The CFD software Star-CCM+ was used in this study. With the use of three-dimensional CFD method, the local airflow distribution can be visualised in detail. The air velocity distribution within the flow domain, being affected by the site-specific design and the surrounding buildings, has been simulated under the prevailing wind conditions round the year.

3.4.1 CFD Model

The size of the CFD model for this Study is approximately 5700m (L) x 5000m (W) x 1500m (H). The whole CFD domain covers the entire development and the surrounding buildings. The model also takes information of the surrounding buildings and site topography via Geographical Information System (GIS) platform. Body-fitted unstructured grid technique is used to fit the geometry to reflect the complexity of the development geometry. A prism layer of 3m above ground (totally 6 layers and each layer is 0.5m) is incorporated in the meshing so as to better capture the approaching wind. The expansion ratio is 1.5% while the maximum blockage ratio is 3.5%.

Finer grid system (with the smallest grid size of 0.5m) is applied to the most concerned area based on preliminary judgement, while coarse grid system (grid size of more than 20m at location far away from the site) is applied to the area of surrounding buildings for better computational performance while maintaining satisfactory result.

3.4.2 Turbulence Model

As highlighted in recent academic and industrial research literatures by CFD practitioners, the widely used standard k - ε turbulence model technique may not adequately model the effects of large scale turbulence around buildings and ignores the wind gusts leading to the relatively poor prediction in the recirculation regions around building. Therefore in this CFD simulation, realizable k – ε turbulence modelling method is applied. This technique provides more accurate representation of the levels of turbulence that can be expected in an urban environment.

3.4.3 Calculation Method

The Segregated Flow model solves the flow equations in a segregated manner. The linkage between the momentum and continuity equations adopted the predictor-corrector approach. A collocated variable arrangement and a Rhie-and-Chow-type pressure-velocity coupling combined with a SIMPLE-type algorithm. A higher order differencing scheme is applied to discretize the governing equations. The convergence criterion is set to 0.0005 on mass conservation. The calculation will repeat until the solution satisfies this convergence criterion.

The prevailing wind direction as mentioned in Section 3.1 is set to inlet boundary of the model with wind profile as detailed in Section 3.1.3. The downwind boundary is set to pressure with value of atmospheric pressure. The top and side boundaries are set to symmetry. In addition, to eliminate the boundary effects, the model domain is built beyond the Surrounding Area as required in the Technical Circular.

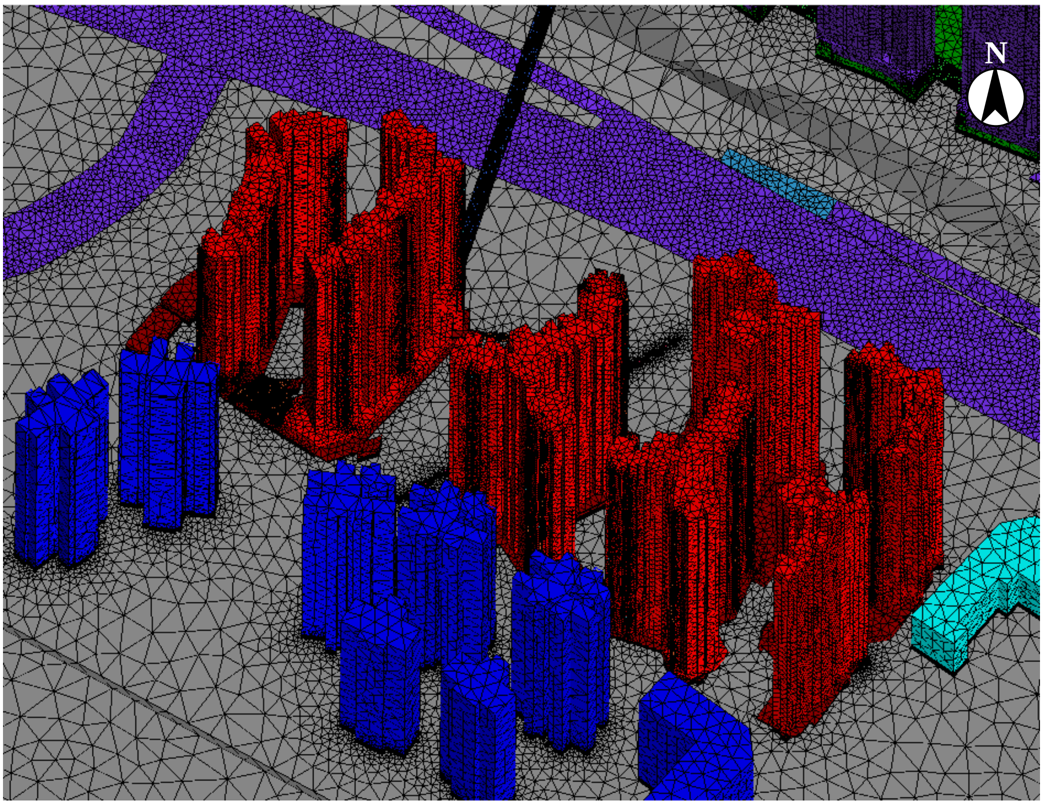


Figure 21 Mesh for CFD Analysis

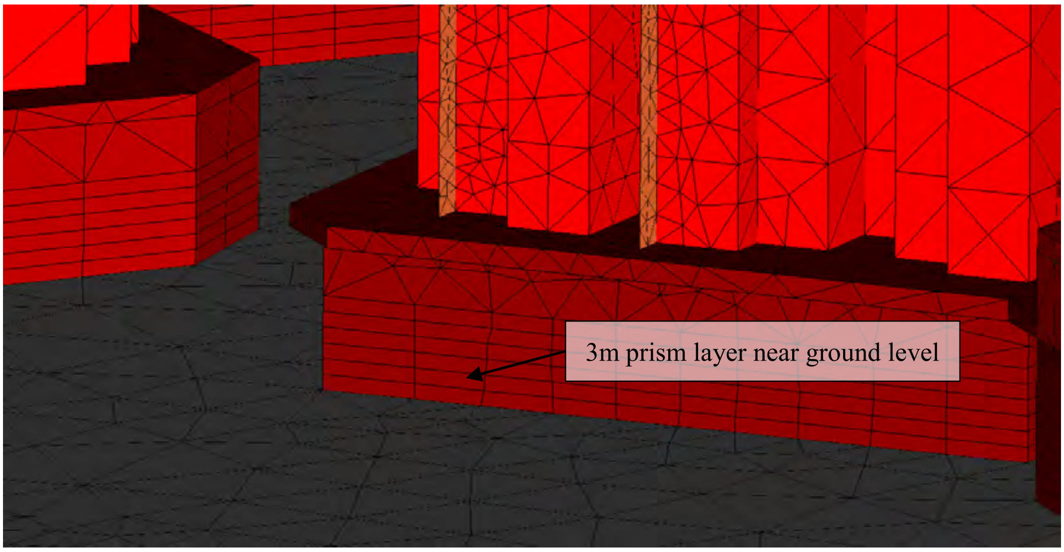


Figure 22 3m of prism layer

3.4.4 AVA Study Parameters

CFD simulations have been conducted to study the wind environment. As specified in the Technical Circular, indicator of ventilation performance should be the Wind Velocity Ratio (VR), defined as the ratio of the wind velocity at the pedestrian level (2m above ground) to the wind velocity at the top of the wind boundary layer. Site spatial average velocity ratio (SVR) and a Local spatial average velocity ratio (LVR) should be determined. The details of the assessment result for the scheme would be presented in the next section.

Table 6 Terminology of the AVA Initial Study

Terminology	**Description**
Velocity Ratio (VR)	The velocity ratio (VR) represents the ratio of the air velocity at the measurement position to the value at the reference points.
Site spatial average velocity ratio (SVR)	The SVR represent the average VR of all perimeter test points at the site boundary which identified in the report.
Local spatial average velocity ratio (LVR)	The LVR represent the average VR of all points, i.e. perimeter and overall test points at the site boundary which identified in the report.

4 Results and Discussion

4.1 Annual Overall Pattern of Ventilation Performance

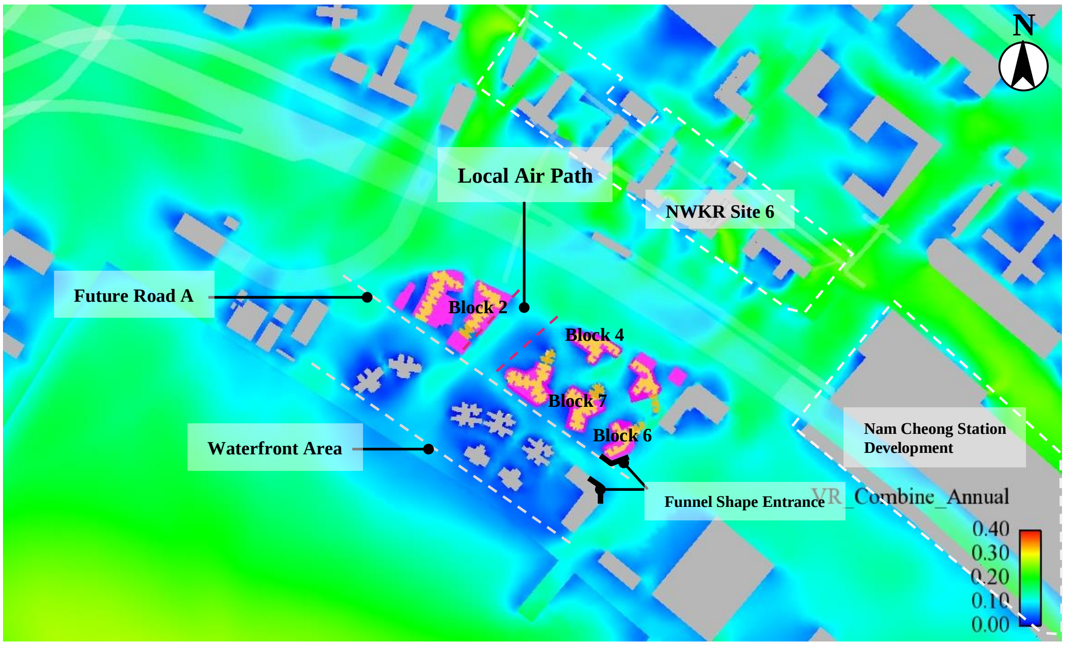


Figure 23 Contour Plot of Annual Average VR at 2m Pedestrian Level for Baseline Scheme

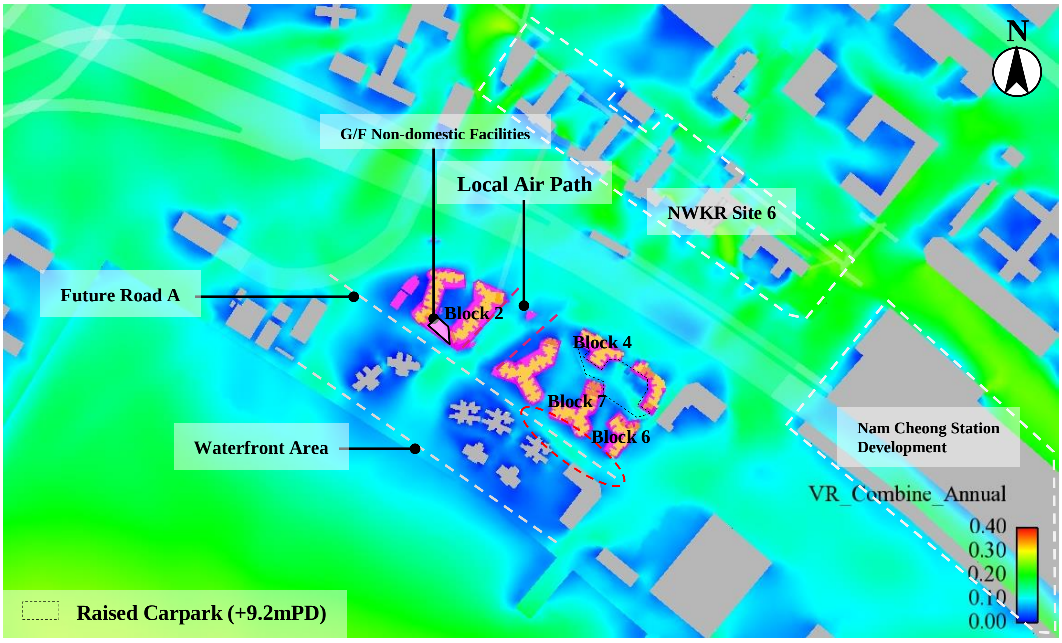


Figure 24 Contour Plot of Annual Average VR at 2m Pedestrian Level for Proposed Scheme

The integrated effect of these winds indicates the overall wind ventilation performance. Annual wind is dominated by E (16.6%) and ENE (17.4%) directions. The above contour plots show that:

- The overall ventilation performances of the Baseline Scheme and Proposed Scheme are quite similar;
- The major prevailing winds under annual wind condition mainly approaches from the ENE and E directions. The winds enter the project site through the future dense building developments at the upward direction, such as Nam Cheong Station Development and NWKR Site 6.
- A slightly enhanced ventilation performance is observed along the local air path under the Proposed Scheme due to the wider wind entrance between Blocks 2 and 4.
- Under the Proposed Scheme, the G/F non-domestic facilities at Site 3 induced a wind shadow to the leeward side, resulting in a slightly worse ventilation performance at the NW part of Future Road A. While the building separation between Block 1 and 2 allow the annual wind flow through and penetrate to the NW part of Future Road A and enhance the ventilation performance.
- The SE portion of Future Road A achieves a slightly higher ventilation performance under the Proposed Scheme due to downwash effect by Blocks 6 & 7 under SE and SSE wind condition. While for the Baseline Scheme, wind flows along the Future Road A and reaches the NW portion of the road. It is mainly due to the building setback of Block 6 which creates a "funnel shape" at the entrance of Future Road A, which facilitates the wind penetration through the road (red circle in Figure 24). For the detailed analysis, please refer to Section 4.4.6 & 4.4.7.
- The proposed footbridge and staircase within the local air path would create a wind shadow in the immediate leeward region. Yet, as the staircase is a low-rise structure (around 11mPD) and the footbridge have a relatively high permeability, which allow effective wind penetration. Considering under the overall annual prevailing wind, the overall VR results of leeward surrounding focus areas are similar in most of the cases. Thus, it is expected that the ventilation impact to its surroundings is minimal.

4.2 Summer Overall Pattern of Ventilation Performance

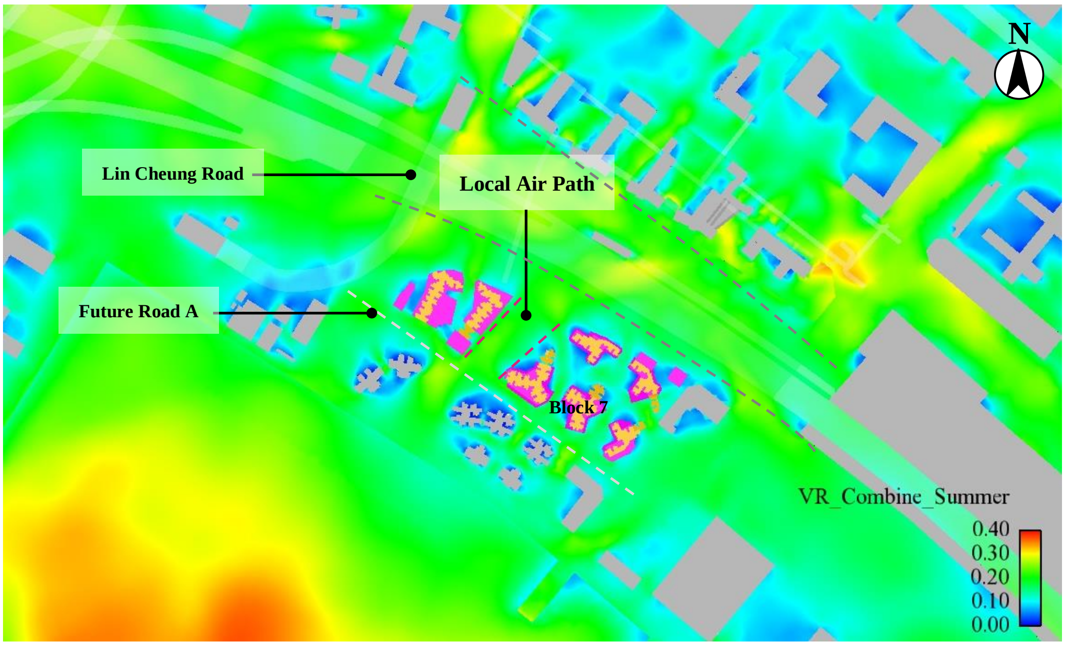


Figure 25 Contour Plot of Summer Average VR at 2m Pedestrian Level for Baseline Scheme

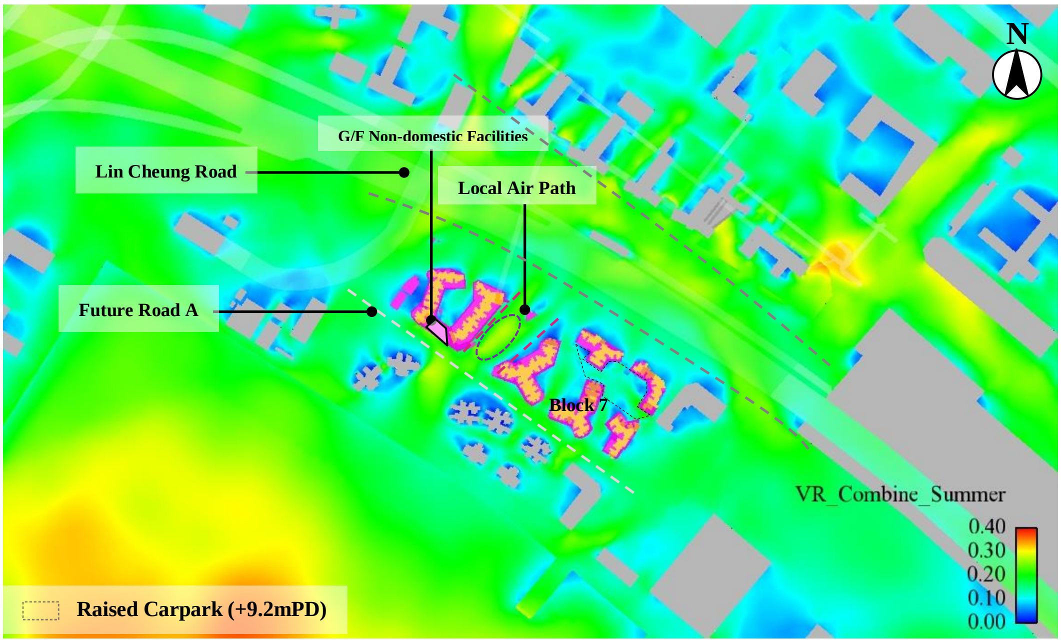


Figure 26 Contour Plot of Summer Average VR at 2m Pedestrian Level for Proposed Scheme

The integration of the effect of these winds indicates the overall wind ventilation performance. During the summer, including June to August, the summer prevailing wind is dominated by E (11.5%) and SW (9.9%) winds. The above contour plots show that:

- The overall ventilation performances of the Baseline Scheme and Proposed Scheme are quite similar;
- Under the Proposed Scheme some localized areas within the local air path have slightly higher VR (purple circle in Figure 26). It is mainly due to the G/F non-domestic facilities at Site 3 under the Proposed Scheme which diverts the summer prevailing wind to the local air path instead of flowing into internal courtyard in Site 3.
- The proposed footbridge and staircase within the local air path would create a wind shadow in the immediate leeward region. Yet, as the staircase is a low-rise structure (around 11mPD) and the footbridge have a relatively high permeability, which allow effective wind penetration. Considering under the overall summer prevailing wind, the overall VR results of leeward surrounding focus areas are similar in most of the cases. Thus, it is expected that the ventilation impact to its surroundings is minimal.

4.3 SVR and LVR

The average Velocity Ratios of all test points are determined and extracted. The results of all test points are presented in Appendix A. According to the Technical Circular, the Velocity Ratio at each test point is assessed and the SVR and the LVR under the prevailing winds are determined and reported to assess the impact of the proposed development schemes to the wind environment. The SVR and LVR value of the test points are summarized as follows:

Table 1 Annual SVR and LVR of the Assessment Area for the Development Schemes

Annual	Baseline Scheme	Proposed Scheme
SVR	0.11	0.11
LVR	0.12	0.12

Table 2 Summer SVR and LVR of the Assessment Area for the Development Schemes

Summer	Baseline Scheme	Proposed Scheme
SVR	0.17	0.17
LVR	0.18	0.18

4.3.1 Site Air Ventilation Assessment

The SVR of the annual and summer wind conditions are similar for both Baseline Scheme and Proposed Scheme. The SVR under annual and summer wind condition for both schemes are 0.11and 0.17 respectively. The results indicate the ventilation performance under both schemes are similar at the immediate surroundings of the developments under both conditions.

4.3.2 Local Air Ventilation Assessment

The LVR of the annual and summer wind conditions are similar for both Baseline Scheme and Proposed Scheme. The LVR under annual and summer wind condition for both schemes are 0.12 and 0.18 respectively. The results indicate that the surrounding areas have similar ventilation performance under both Baseline and Proposed Schemes.

4.4 Directional Analysis

4.4.1 NNE Wind Direction

The NNE wind contributes 7.5 % of the annual wind rose. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 27 and Figure 28 respectively. The overall ventilation performance under NNE wind can be summarized as below:

- The air paths at Hing Wah Street West, Tonkin Street West, and along the building gaps of NWKR Site 6 (black arrows in Figure 27 and Figure 28) are effective for wind penetration.
- A slightly higher VR is found at the local air path under the Proposed Scheme.
- A slightly higher VR is found at Future Road A under the Baseline Scheme.

A slightly higher VR is observed along the local air path under the Proposed Scheme. Under the Proposed Scheme, a larger portion of wind from Lin Cheung Road would enter the local air path due to podium chamfer design (red arrow in Figure 28).

The G/F non-domestic facilities block the wind penetration and create wind shadow at Future Road A under the Proposed Scheme (green circle in Figure 28), while the ground level separation between Blocks 1 and 2 allows wind penetration towards Future Road A under the Baseline Scheme (orange arrow in Figure 27). Thus, the VR at the localised area of Future Road A near Site 3 is slightly higher under the Baseline Scheme.

The building setback of Block 6 under the Baseline Scheme creates a "funnel shape" at the entrance of Future Road A and facilitates wind penetration along the road. On the other hand, the building frontage of Block 6 would diverts more wind flow towards open area of CSWWFM under the Proposed Scheme (blue arrow in Figure 28). In this connection, the ventilation performance at the SE part of Future Road A under the Baseline Scheme is slightly better than the Proposed Scheme, while the ventilation performance at open area of CSWWFM is slightly enhanced under the Proposed Scheme.

The presence of low-rise structure such as gas kiosk and plant nursery (red circle in Figure 28) at the NW part of the Proposed Scheme induced a small wind shadow and resulting a slightly lower VR at the leeward region, while wind flows towards the leeward region with no obstruction under the Baseline Scheme.

Under the Proposed Scheme, the stronger air stream at the local air path could further channel towards waterfront area. While under the Baseline Scheme, the weaker air stream tends to penetrate into Sites 2 & 4A. This results in a slightly higher VR within Sites 2 & 4A under the Baseline Scheme. Nevertheless, the VR of overall Sites 2 & 4A is both 0.04 under two schemes under NNE wind, indicating that their ventilation performance are comparable.

The staircase within the NBA of the Proposed Scheme induces a small wind shadow in the immediate leeward region of the Developmental Site. Yet, as the staircase is a low-rise structure (around 11mPD) and the footbridge have a relatively high permeability, which allow effective wind penetration. Thus, it is expected that the ventilation impact to its surroundings is minimal.

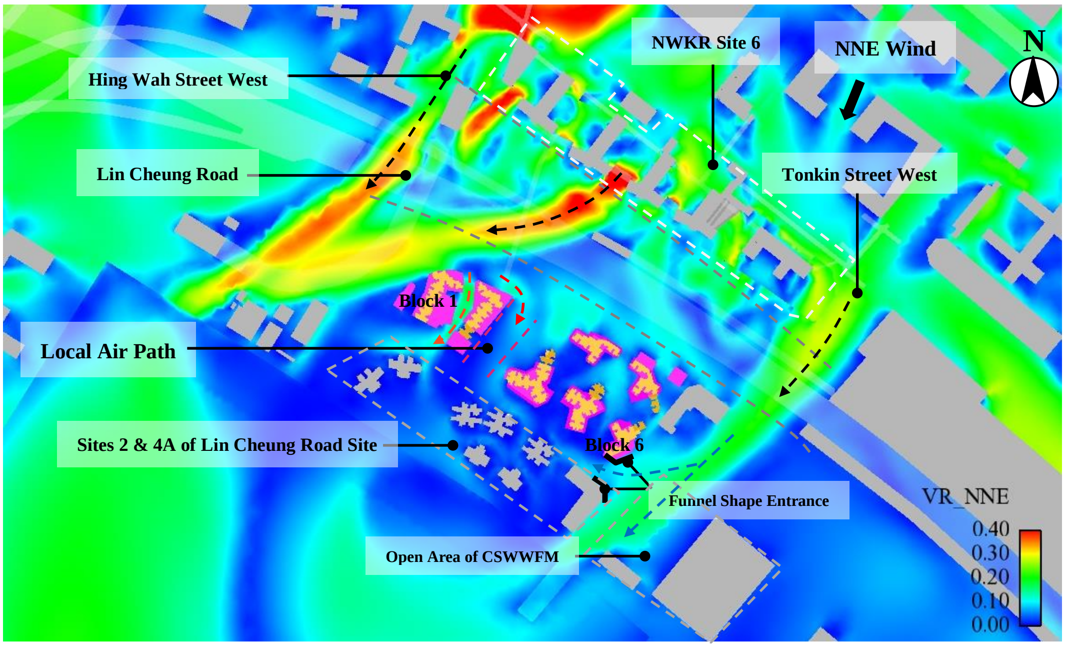


Figure 27 VR Contour Plot under NNE Wind of Baseline Scheme

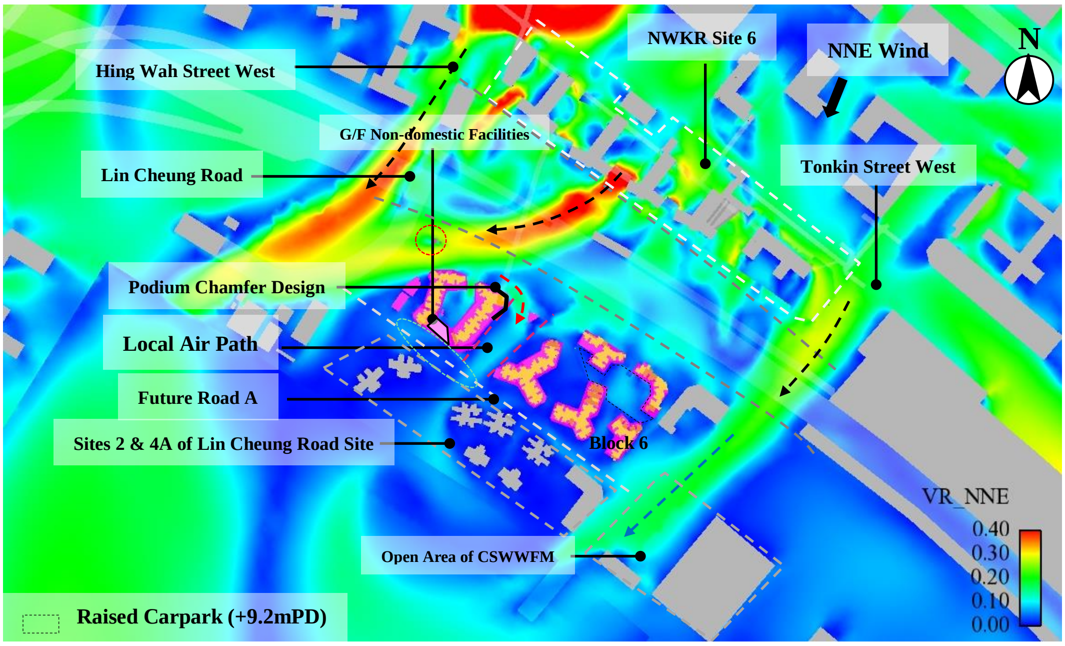


Figure 28 VR Contour Plot under NNE Wind of Proposed Scheme

4.4.2 NE Wind Direction

The NE wind contributes 10.1 % of the annual wind rose. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 29 and Figure 30 respectively. The overall ventilation performance under NE wind can be summarized as below:

- The air path along Tonkin Street West (black arrow in Figure 29) is effective for wind penetration.
- The project site is located at the wind shadow of NWKR Site 6, the wind availability of the Development is relatively calm.
- A slightly better VR is found at the local air path and Sites 2 & 4A of Lin Cheung Road Site under the Proposed Scheme.
- A slightly higher VR is found at part of bus depot area and Site 1 of Lin Cheung Road Site under the Baseline Scheme.

It is found that the VR value is higher along the local air path under the Proposed Scheme. It is mainly due the larger building separation between Blocks 2 and 4 of the Proposed Scheme allows more wind flow into the local air path. Furthermore, the slightly taller and longer building frontage of Block 4 in the Proposed Scheme is also more effective capturing the high level wind to the street level, and further diverts to local air path and Sites 2 & 4A of Lin Cheung Road Site. (red and orange arrows in Figure 28).

Furthermore, the building separation between Block 2 and Block 4 is about 76m under the Baseline and 81m under the Proposed Schemes, respectively. A larger building separation between Blocks 2 and 4 under the Proposed Scheme also facilitates more wind penetration through Sites 3 & 5 developments and slightly enhances the aforementioned areas.

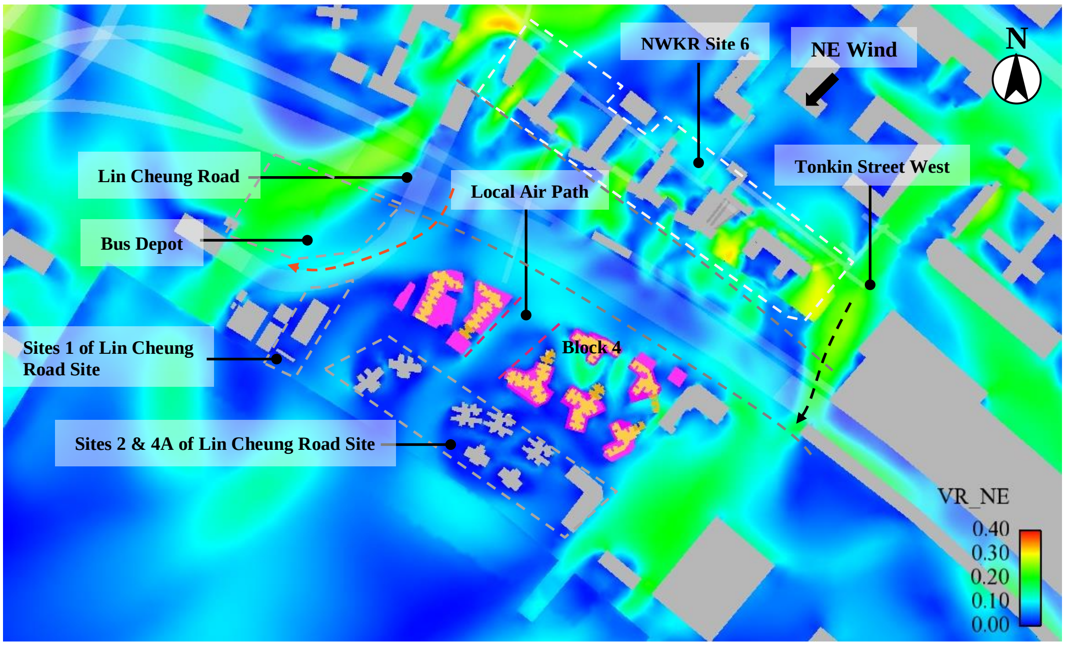


Figure 29 VR Contour Plot under NE Wind of Baseline Scheme

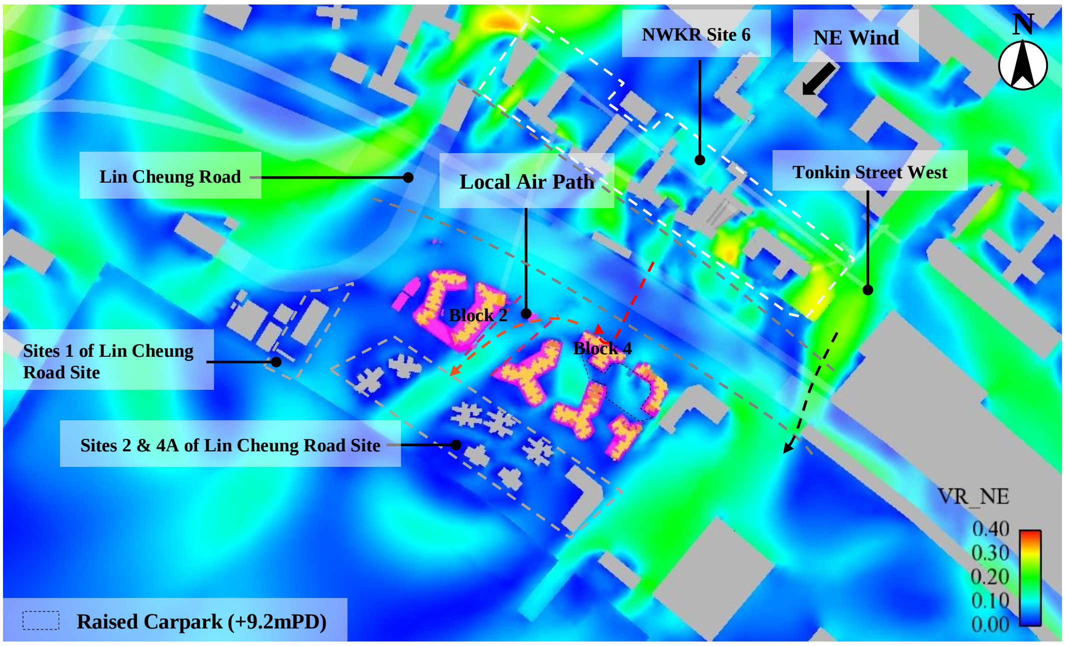


Figure 30 VR Contour Plot under NE Wind of Proposed Scheme

4.4.3 ENE Wind Direction

The ENE wind contributes 17.4 % of the annual wind rose. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 31 and Figure 32 respectively. The overall ventilation performance under ENE wind can be summarized as below:

- Wind mainly enters the project site from Tonkin Street West.
- The project site is located at the wind shadow of NWKR Site 6, the wind reaching the Development is relatively calm.
- The overall ventilation performance is similar for both schemes.

The prevailing wind mainly enters the project site from Tonkin Street West. For the Proposed Scheme, a portion of wind penetrates through the building gap between Block 5 and the future primary school, while the other portion diverts towards Lin Cheung Road (red arrow in Figure 32). On the other hand, the presence of a Refuse Collection Point (RCP) Block in the Baseline Scheme would diverts the majority of the incoming wind towards Lin Cheung Road (red arrow in Figure 31). Thus, slightly higher VR is obtained along the road under the Baseline Scheme.

The RCP under the Baseline Scheme would create a small wake area in the leeward region within the Development. Nevertheless, the RCP would not induces significant adverse impacts to the surroundings.

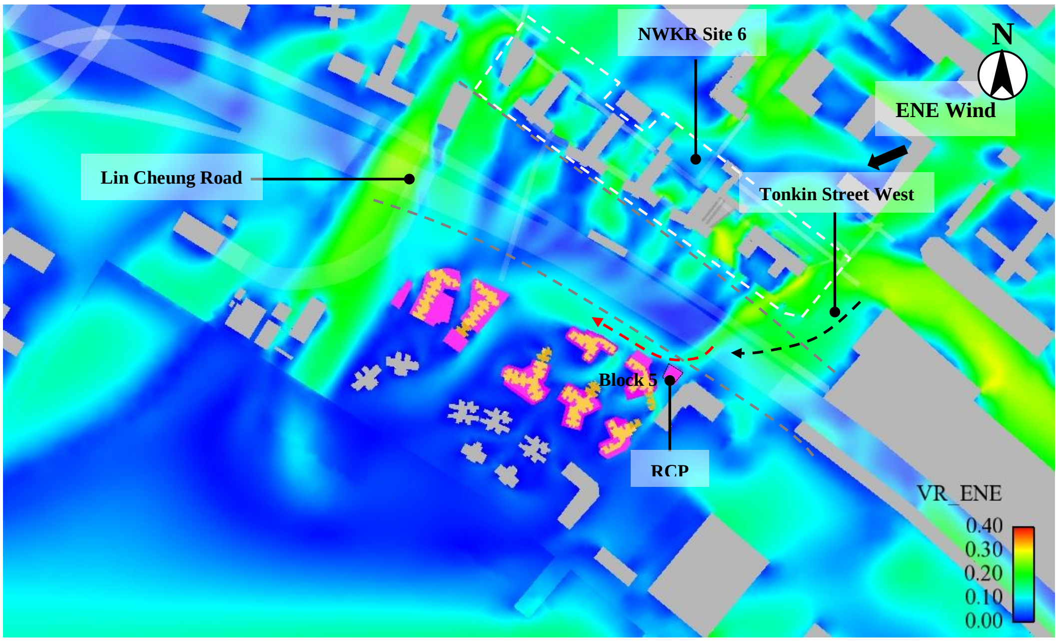


Figure 31 VR Contour Plot under ENE Wind of Baseline Scheme

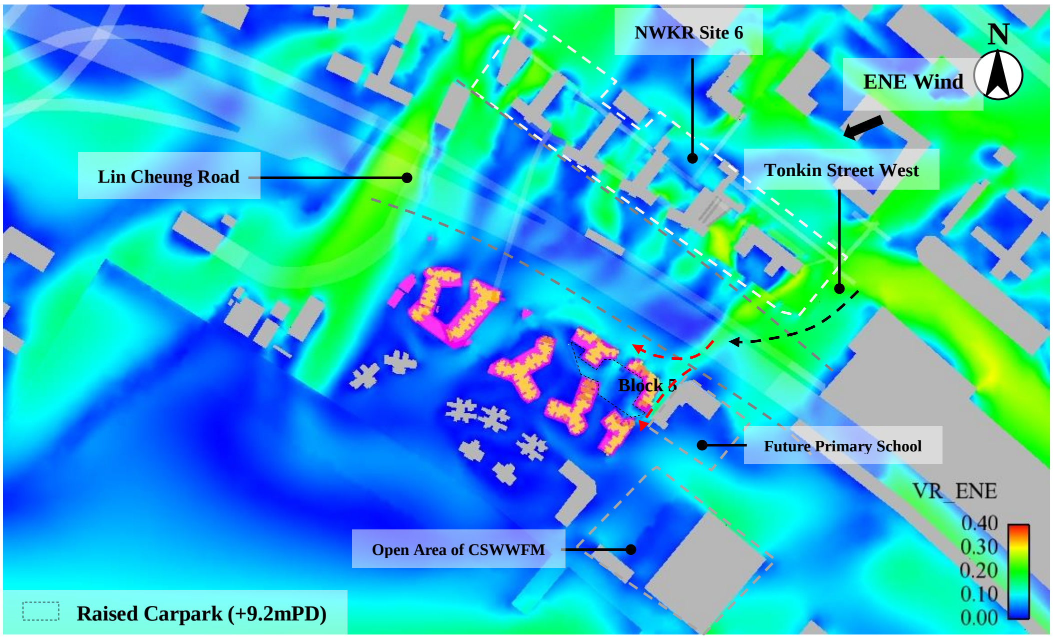


Figure 32 VR Contour Plot under ENE Wind of Proposed Scheme

4.4.4 E Wind Direction

The E wind contributes 16.6 % and 11.5 % of the annual and summer wind rose, respectively. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 33 and Figure 34 respectively. The overall ventilation performance under E wind can be summarized as below:

- The air paths along Tonkin Street West and Hing Wah Street West are effective for wind penetration.
- The overall ventilation performance is similar for both schemes.
- A slightly higher VR is observed along the local air path and Sites 2 & 4A of Lin Cheung Road Site under the Proposed Scheme.
- A slightly lower VR is observed at the SE part of Future Road A under the Proposed Scheme.

The prevailing wind mainly enters the project site from Lin Cheung Road. It is found that the Proposed Scheme has a smaller wake-zone along the local air path as compared with the Baseline Scheme. The slightly larger building separation between Blocks 2 and 4 under the Proposed Scheme enhances the wind permeability and allows larger air volume flow into the local air path and reaches Sites 2 & 4A of Lin Cheung Road Site (blue arrow in Figure 34). Thus, a slightly higher VR is observed at the aforementioned areas under the Proposed Scheme.

Similar to NNE wind, the "funnel shape" layout of the entrance at Future Road A under the Baseline Scheme enhances the wind penetration along the road (red arrow in Figure 33) and resulting a slightly better ventilation performance.

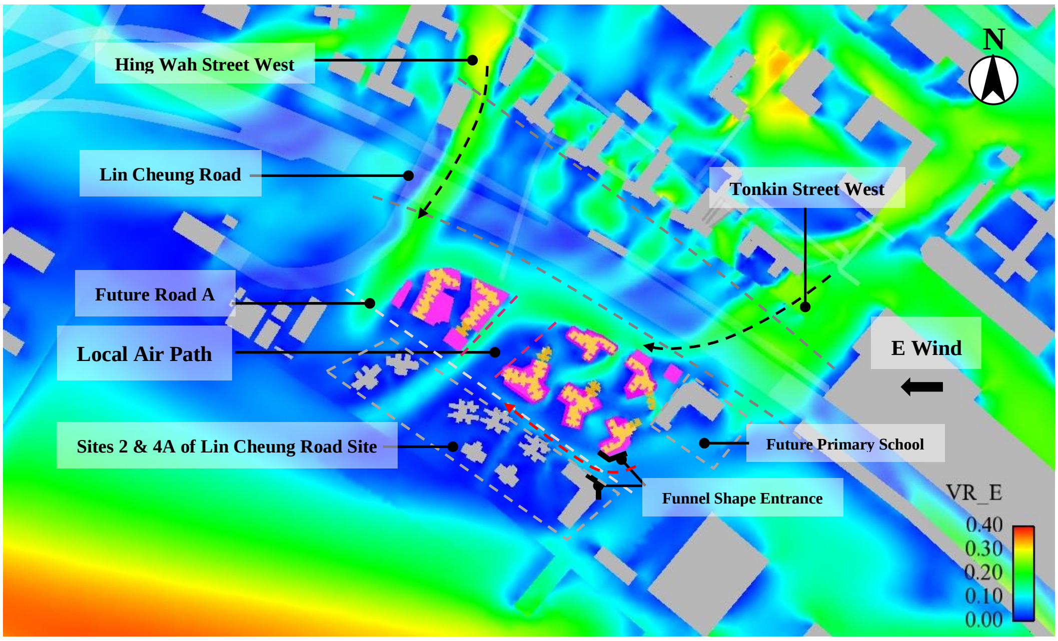


Figure 33 VR Contour Plot under E Wind of Baseline Scheme

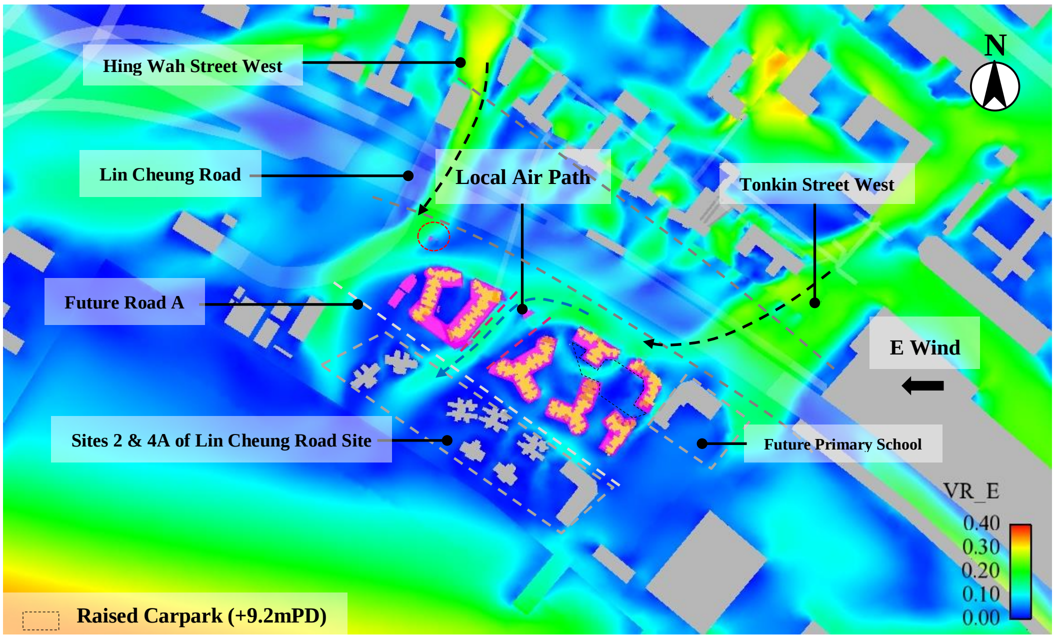


Figure 34 VR Contour Plot under E Wind of Proposed Scheme

4.4.5 ESE Wind Direction

The ESE wind contributes 8.4 % and 9.5 % of the annual and summer wind rose, respectively. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 35 and Figure 36 respectively. The overall ventilation performance under ESE wind can be summarized as below:

- The prevailing wind mainly enters the project site from CSWWFM.
- Lin Cheung Road is a major air path under ESE wind.
- A slightly better ventilation performance is observed at Site 4 of Lin Cheung Road Site and the centre of Future Road A under the Proposed Scheme.

Under the Proposed Scheme, Block 2 has a longer building façade and slightly taller building height as compared to the Baseline Scheme. The larger building frontage of Block 2 is desirable to capture the high level wind and downwash towards to Site 4 of Lin Cheung Road Site and centre of Future Road A (red arrow in Figure 40), and thus slightly enhances the ventilation performance of the areas. An additional streamline plot is provide at Figure 37 in the revised report to show the downwash effect by the building facade of Block 2 under ESE wind.

A larger wake zone is observed at the NE portion of the project site under the Proposed Scheme (orange region in Figure 36). As the building frontage of Block 5 are perpendicular to the prevailing wind direction, the incoming wind would diverts towards NE direction and create a wake zone at the leeward side. In contrast, the building frontage of Block 5 under the Baseline Scheme is more or less in alignment to the prevailing wind, and allows wind penetration towards the leeward region. Thus, the Baseline Scheme observed a slightly higher VR at aforementioned area. Nevertheless, the wake zone is mainly located within the project site, such that the impact to the surroundings is minimal.

A higher VR values is found in the open space between Block 3 and Block 7 under the Proposed Scheme. Compared with the Baseline Scheme, the Proposed Scheme of Block 7 has a longer building frontage with the alignment facing perpendicular to the incoming wind direction. Thus, the Proposed Scheme is more effective in terms of capture the high-level wind to open space between Block 3 and Block 7.

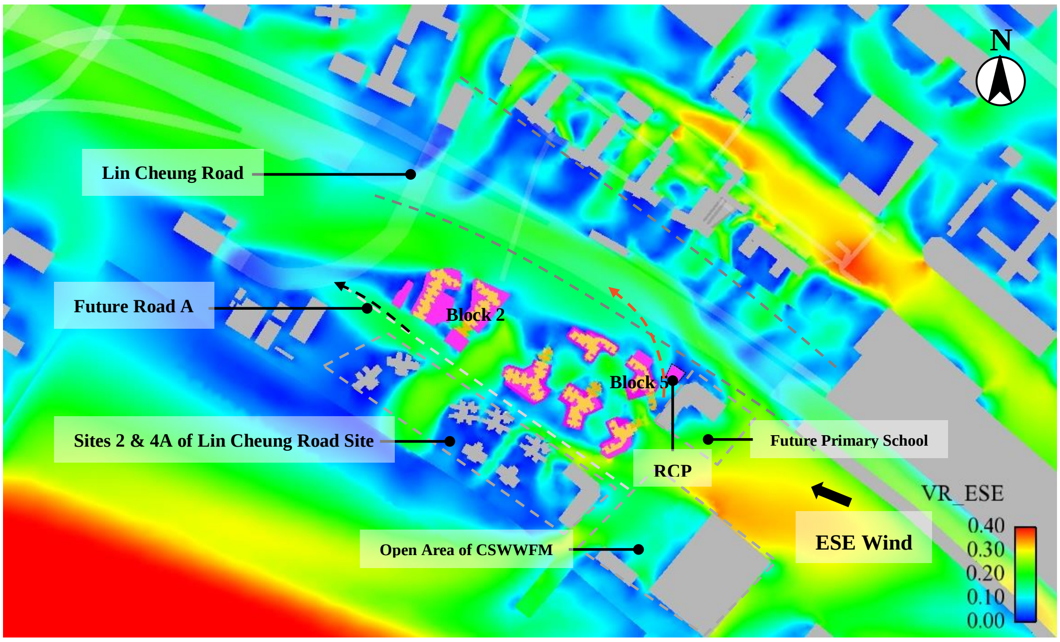


Figure 35 VR Contour Plot under ESE Wind of Baseline Scheme

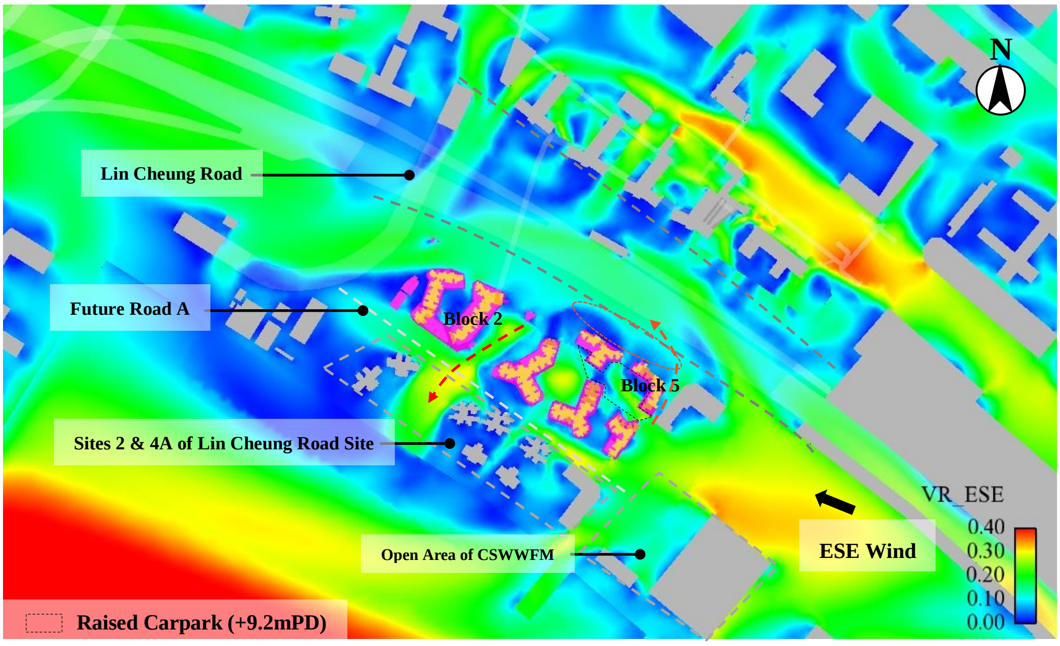


Figure 36 VR Contour Plot under ESE Wind of Proposed Scheme

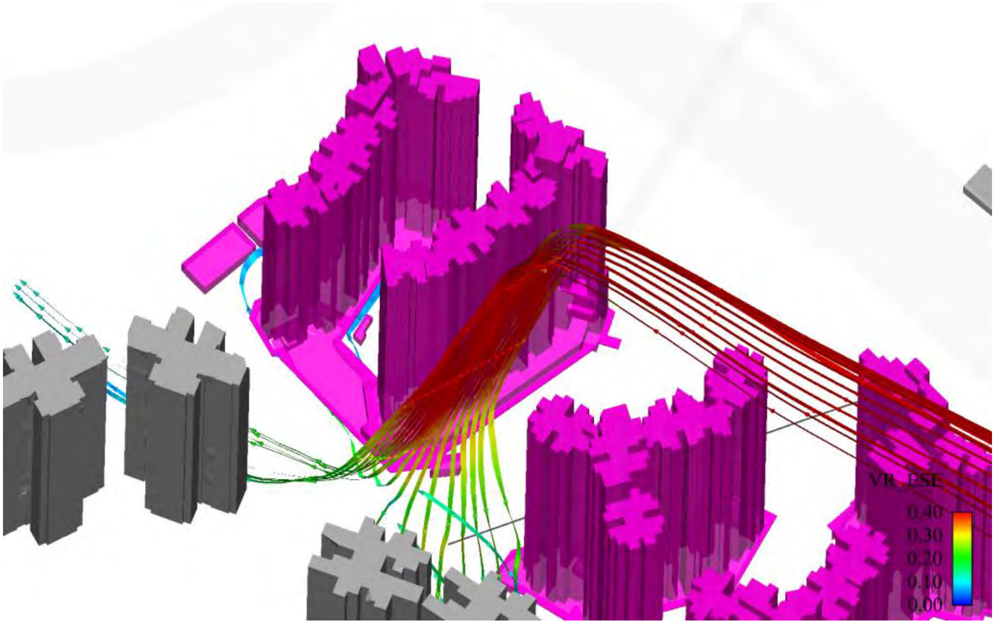


Figure 37 VR Streamline Plot under ESE Wind of Proposed Scheme at Local Air Path

4.4.6 SE Wind Direction

The SE wind contributes 5.9 % and 9.3 % of the annual and summer wind rose, respectively. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 38 and Figure 39 respectively. The overall ventilation performance under SE wind can be summarized as below:

- The prevailing wind enters the project site from CSWWFM.
- Lin Cheung Road is a major air path under SE wind.
- A relatively better VR is observed at Future Road A under the Baseline Scheme.

In both schemes, the building separation between Block 6 and Site 4A of Lin Cheung Road Site acts as a wind entrance for Future Road A. The setback of Block 6 under the Baseline Scheme creates a funnel shape at the wind entrance which facilitate the wind penetrate along Future Road A (blue arrow in Figure 37), while the building façade of Block 6 under the Proposed Scheme is perpendicular to the prevailing wind direction, and thus it is less favourable for wind penetration towards Future Road A (red arrow in Figure 38), resulting in worse ventilation performance at that area as compared to the Baseline Scheme.

The VR result around local air path is slightly higher under the Baseline Scheme. The building separation between Blocks 5 & 6 is slightly larger in the Baseline Scheme. Thus, more wind can penetrate through the building blocks into the local air path and leads to a slightly higher VR under the Baseline Scheme.

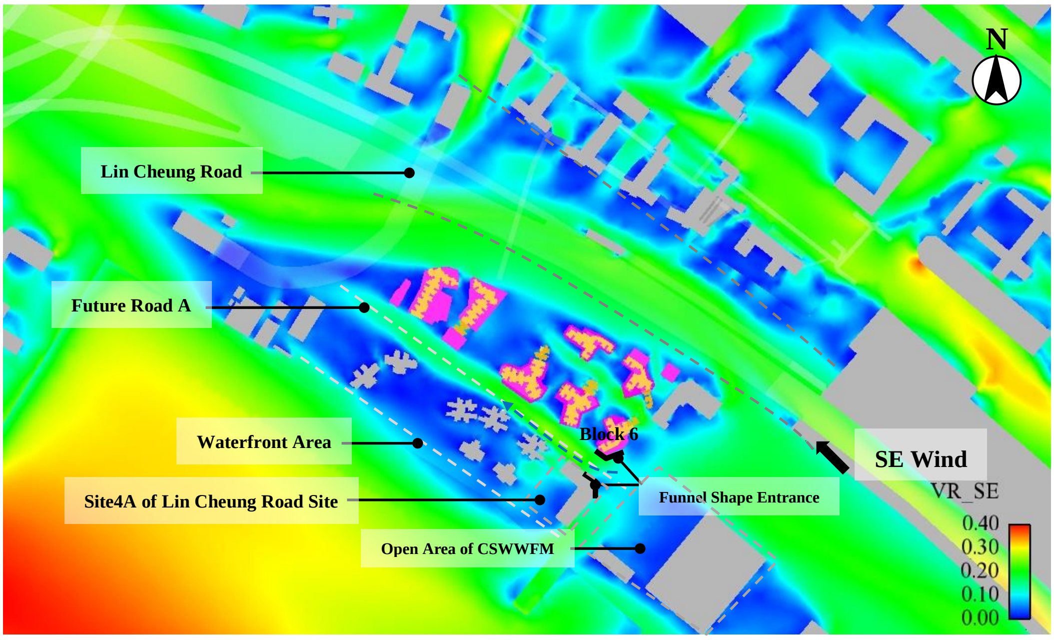


Figure 38 VR Contour Plot under SE Wind of Baseline Scheme

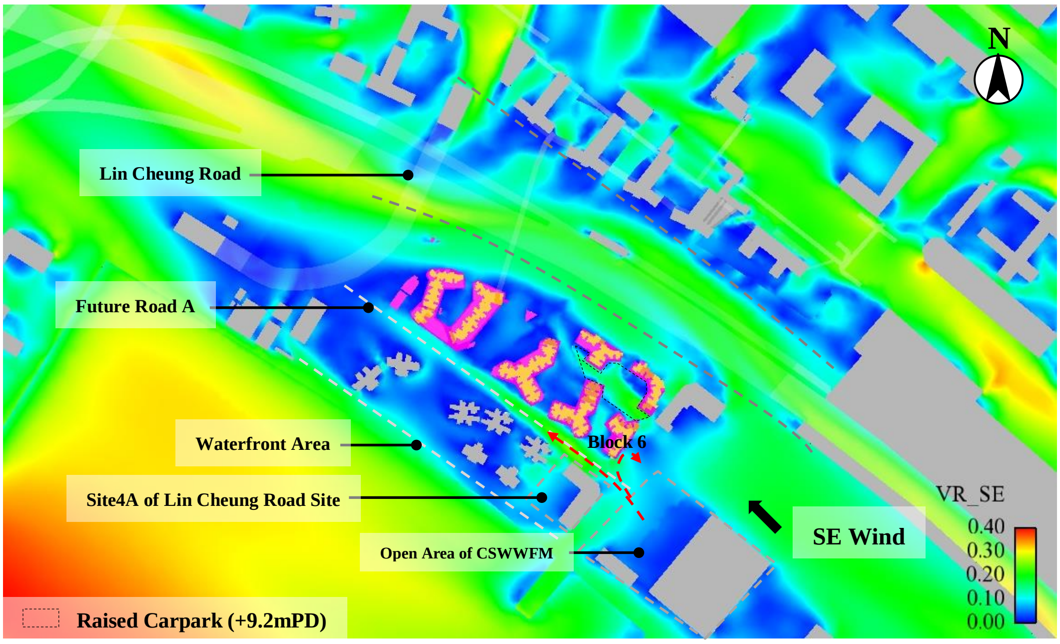


Figure 39 VR Contour Plot under SE Wind of Proposed Scheme

4.4.7 SSE Wind Direction

The SSE wind contributes 5.9 % and 8.3 % of the annual and summer wind rose, respectively. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 40 and Figure 41 respectively. The overall ventilation performance under SSE wind can be summarized as below:

- Lin Cheung Road is a major air path under SSE wind.
- The prevailing wind enters the project site from CSWWFM and the waterfront.
- A slightly higher VR is found at SE part of Sites 2 & 4A of Lin Cheung Road Site and Future Road A under the Proposed Scheme.

Similar to NNE wind, the "funnel shape" layout of the entrance at Future Road A under the Baseline Scheme enhances the wind penetrate further along the road (blue arrow in Figure 40) and resulting a slightly higher VR at the NW portion of Future Road A.

On the contrast, the building frontage of Block 6 under the Proposed Scheme is perpendicular to the prevailing wind direction. It is more effective on capturing the high level wind and downwash towards the street levels (red arrows in Figure 40). Thus, a slightly higher VR is observed at SE part of Future Road A and Sites 2 & 4A of Lin Cheung Road Site under the Proposed Scheme.

The VR is better under Baseline Scheme for the area between Block 3 and 7. Similar to the SE wind condition, more of the SSE wind penetrates through the larger building separation between Blocks 5 & 6 into the local air path and the open area between Blocks 3 & 7 under the Baseline Scheme, thus leading to a smaller VR in this area under the Proposed one.

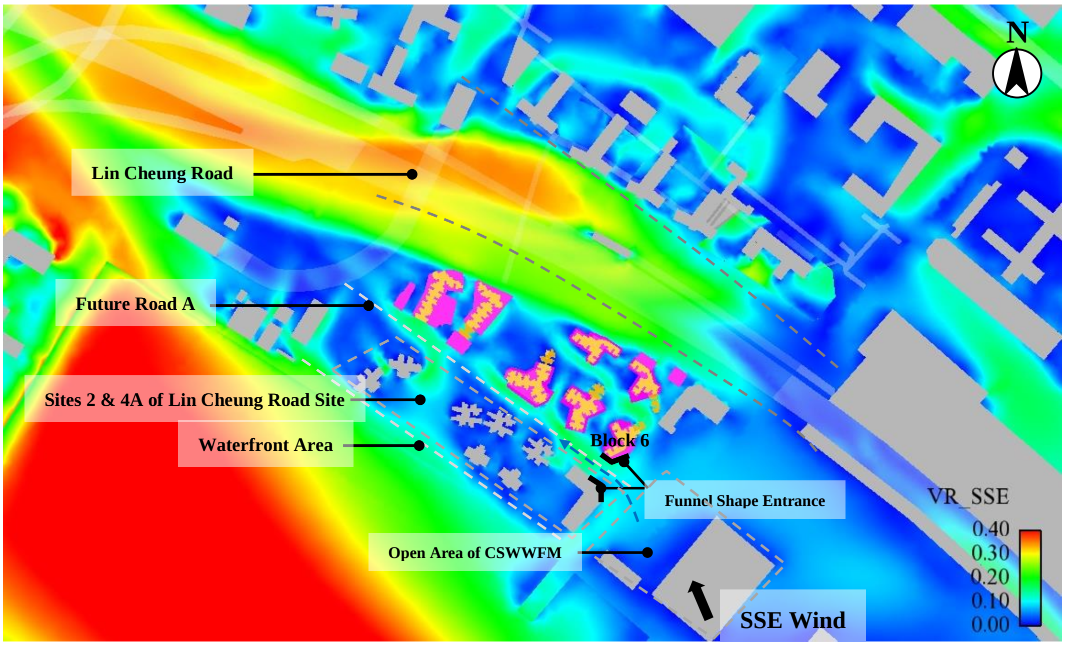


Figure 40 VR Contour Plot under SSE Wind of Baseline Scheme

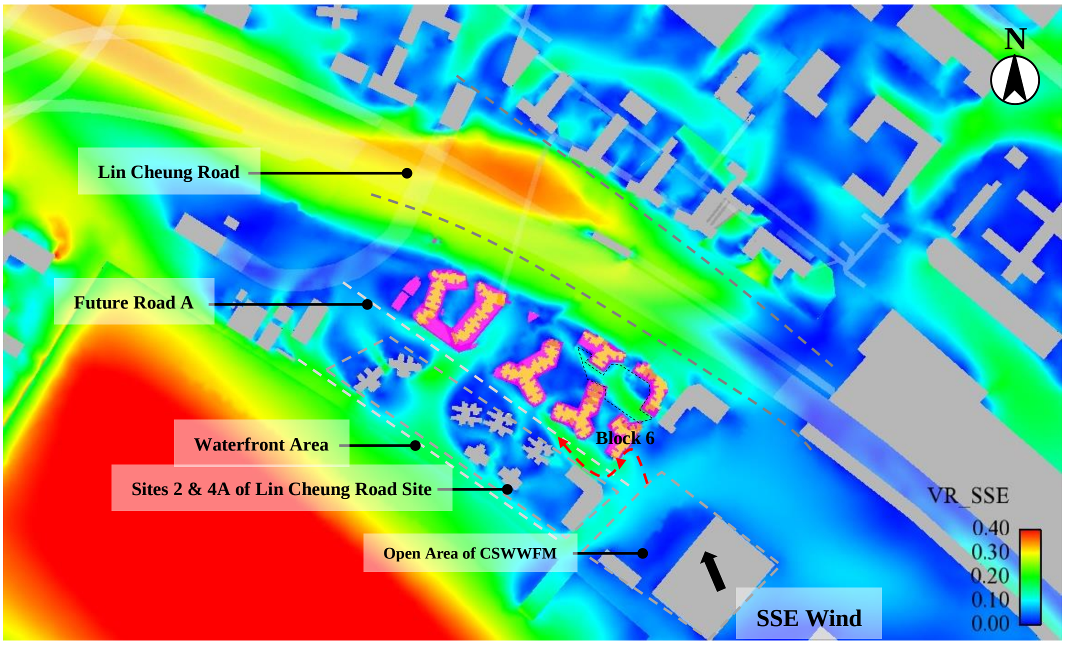


Figure 41 VR Contour Plot under SSE Wind of Proposed Scheme

4.4.8 S & SSW Wind Directions

The S wind contributes 4.9 % and 7.9 % of the annual and summer wind rose, and SSW wind contributes 4.7 % and 8.8 % of the annual and summer wind rose respectively. The contour plots of VR value for S & SSW are shown in Figure 42 through Figure 45. The overall ventilation performance under S & SSW winds can be summarized as below:

- The prevailing wind enters the project site from the waterfront.
- A higher VR is observed at Future Road A and local air path under the Proposed Scheme.
- A lower VR is observed at Lin Cheung Road under the Proposed Scheme.

Under the S winds, the VR of Future Road A is similar under the two schemes. However, it is found that the NW portion of Future Road A is slightly worse under the Proposed Scheme. The southern corner at G/F Block 2 in the Proposed Scheme has been chamfered that allow incoming wind to be diverted to both the local air path and Future Road A more evenly. On the contrast, the Baseline Scheme would diverts more wind towards NW portion of Future Road A but much less wind to the local air path. Thus, the VR at the NW part of Future Road A is less under Proposed Scheme as compared with the Baseline Scheme. The air path for both schemes is marked using blue arrows in Figure 43 and Figure 45.

Furthermore, it is also noted that the Baseline Scheme has a slightly larger building separation between Blocks 3 and 7, together with the provision of empty bay at Block 5 facilitate the incoming wind penetrate to Lin Cheung Road.

It is also noted that a slightly longer building frontage of Block 2 under the Proposed Scheme would capture more high level wind and downwash to the local air path. Thus, a relatively higher VR is observed.

NWKR Site 6 is located at the downwind region of the Development. The ventilation performance at NWKR Site 6 both schemes are comparable under S and SSW wind conditions.

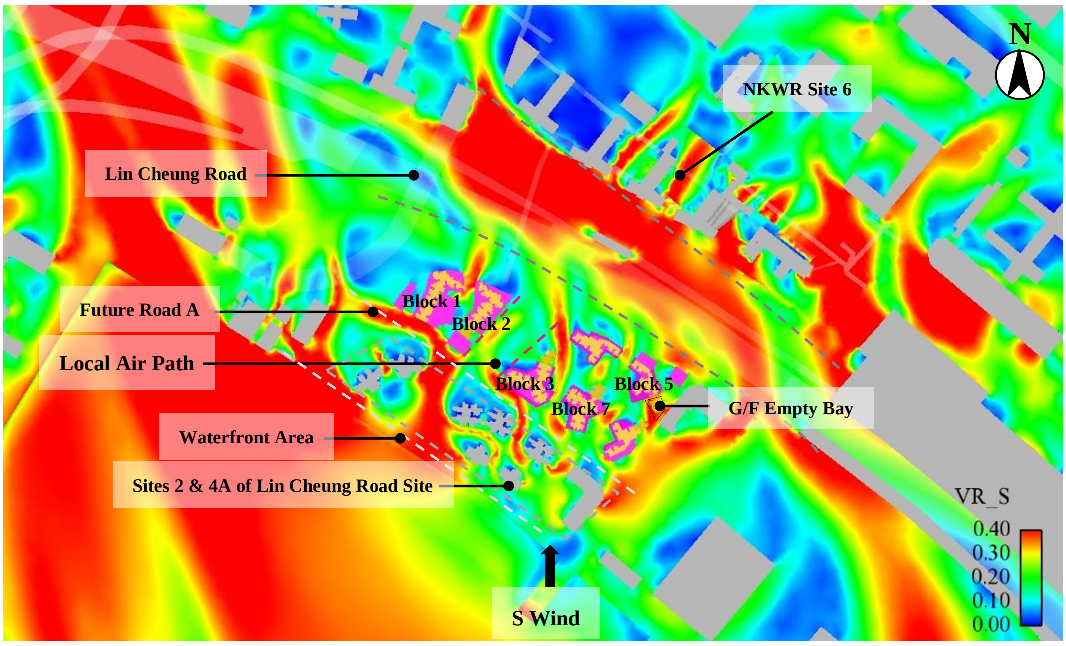


Figure 42 VR Contour Plot under S Wind of Baseline Scheme

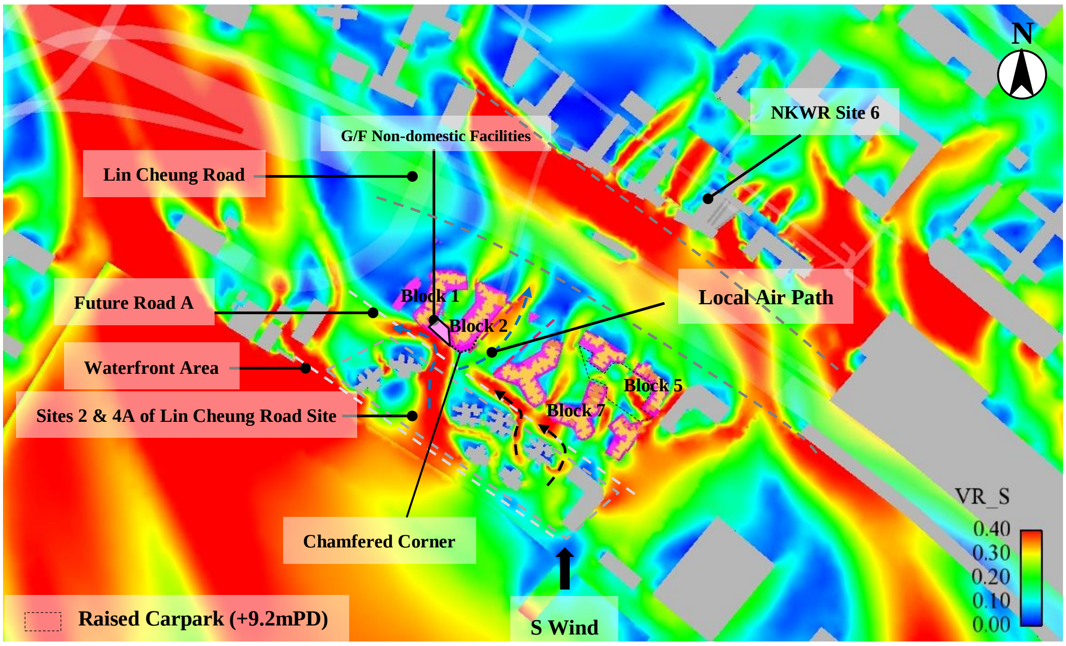


Figure 43 VR Contour Plot under S Wind of Proposed Scheme

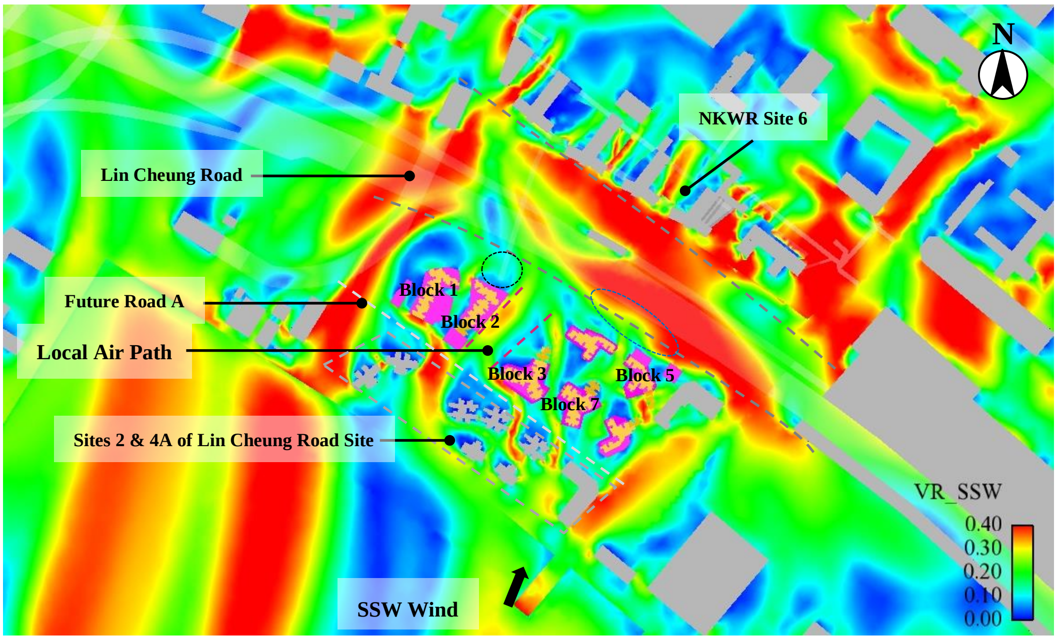


Figure 44 VR Contour Plot under SSW Wind of Baseline Scheme

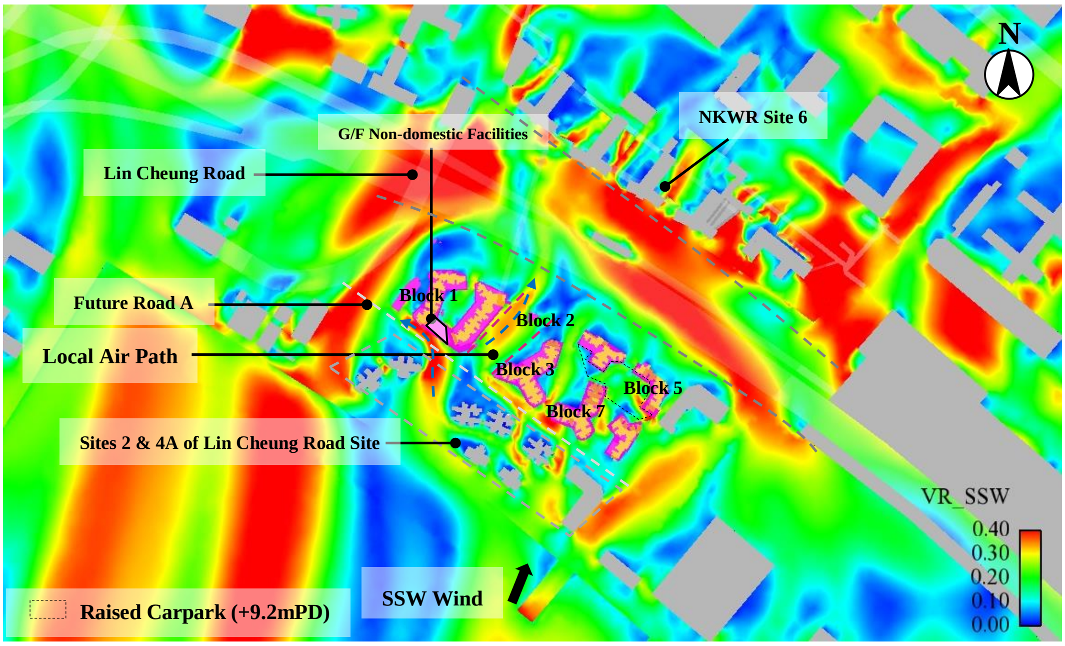


Figure 45 VR Contour Plot under SSW Wind of Proposed Scheme

4.4.9 SW Wind Direction

The SW wind contributes 4.7% and 9.9 % of the annual and summer wind rose respectively. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 46 and Figure 47 respectively. The overall ventilation performance under SW wind can be summarized as below:

- The prevailing wind enters the project site from the waterfront.
- A slightly higher VR is observed along Future Road A, open area of CSWWFM and future primary school area under the Proposed Scheme.
- A slightly higher VR is observed at some localized area of Lin Cheung Road under the Baseline Scheme.

Under both schemes, the prevailing SW wind from the waterfront area would penetrate into inner Cheung Sha Wan area through the local air path.

Compare with the Baseline Scheme, the building separation between Blocks 2 and 3 of the Proposed Scheme is slightly reduced. As the wind entrance is slightly reduced, the air volume along local air path is also reduced (blue arrow in Figure 47). Thus, a slightly lower VR is observed at some localized area of Lin Cheung Road under the Proposed Scheme.

The ventilation performance of the open area of CSWWFM and future primary school area is slightly better under the Proposed Scheme. The longer building frontage of Block 7 and the smaller building gap between Blocks 6 & 7 under the Proposed Scheme would diverts more portion of the wind to the southeast portion of Future Road A and further travel towards the environmental buffer, open area of CSWWFM and the future primary school area (purple arrows in Figure 47). On the other hand, the larger building separation under the Baseline Scheme allows the wind to penetrate into open space of the Development. While the Baseline Scheme has a larger separation between Blocks 6 and 7 which allows more wind penetration to the inner core of the Development.

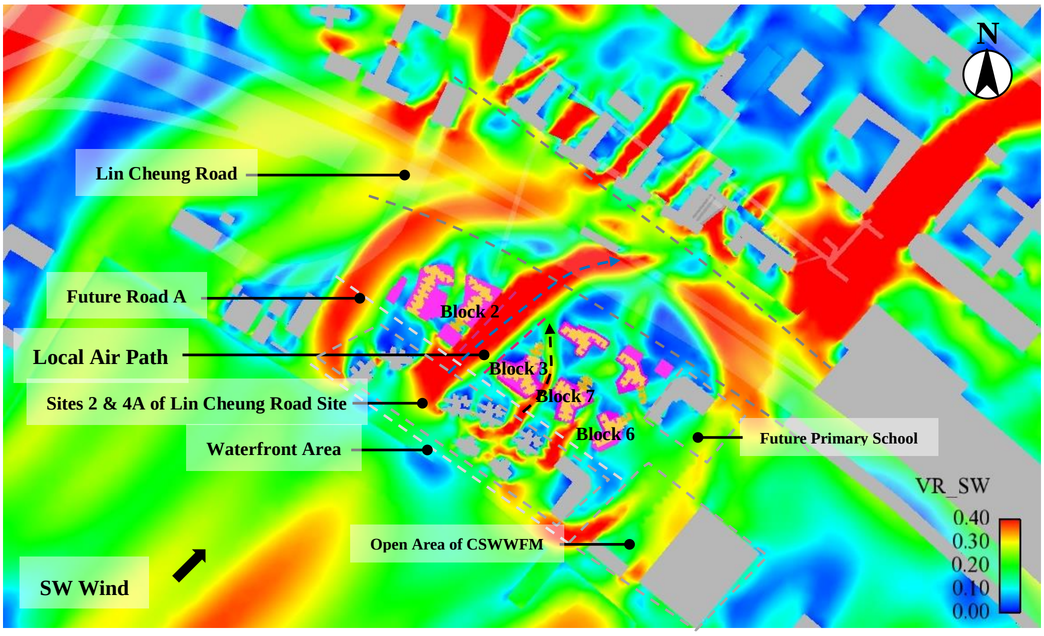


Figure 46 VR Contour Plot under SW Wind of Baseline Scheme

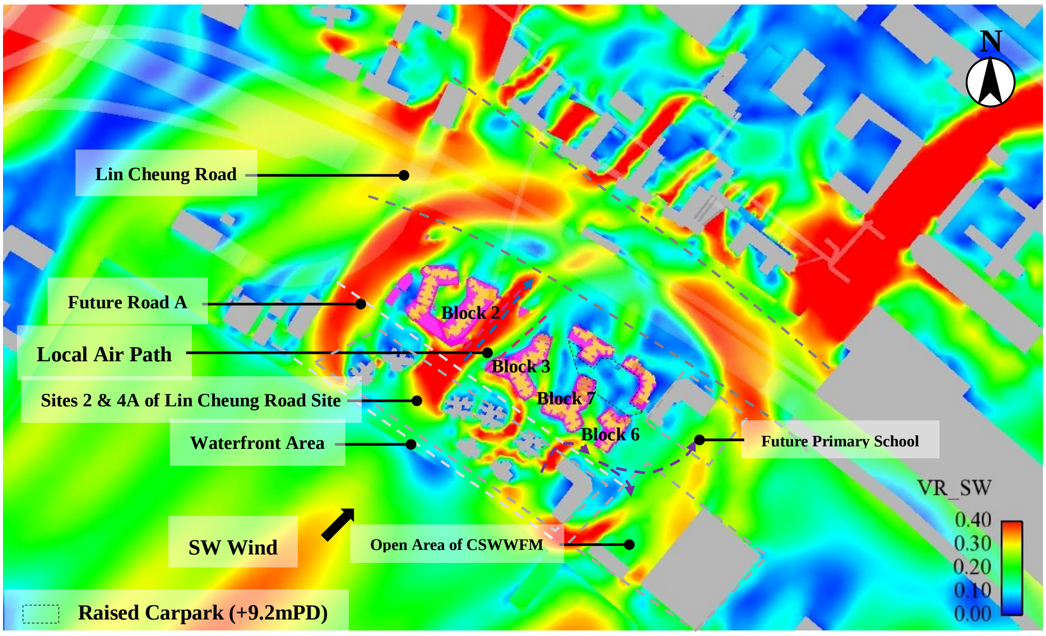


Figure 47 VR Contour Plot under SW Wind of Proposed Scheme

4.4.10 WSW Wind Direction

The WSW wind contributes 7.2 % of the summer wind rose. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 48 and Figure 49 respectively. The overall ventilation performance under WSW wind can be summarized as below:

- A slightly higher VR is observed at the open area of CSWWFM, future primary school area and a portion of Lin Cheung Road under the Proposed Scheme.

The G/F non-domestic facilities in Site 3 in the Proposed Scheme diverts the incoming wind to the local air path (blue arrows in Figure 49), while the wind would penetrate through Blocks 1 and 2 in the Baseline Scheme. Therefore, VR at the local air path is slightly enhanced under the Proposed Scheme.

Under the Proposed Scheme, the G/F non-domestic facilities on Site 3 diverts the incoming wind to the local air path and further to the eastern part of NWKR Site 6. On the other hand, the wind is divided into two air streams and penetrates through Blocks 1 and 2 and the local air path more evenly under the Baseline Scheme. A higher VR is observed there at the two places under the Proposed Scheme.

Similar to SW wind, Block 7 in the Proposed Scheme would diverts the wind from Future Road A to the environmental buffer, open area of CSWWFM and the future primary school area (purple arrows in Figure 49). Therefore, the VR is slightly better at the open area of CSWWFM and the future primary school area under the Proposed Scheme as compared with the Baseline Scheme. Furthermore, the open area near the school site has a slightly higher VR value under Baseline Scheme. The building disposition of Block 5 under the Baseline Scheme helps to diverts a portion of the prevailing wind to the open area (red arrows in Figure 48) and slightly enhance the ventilation performance at the open area.

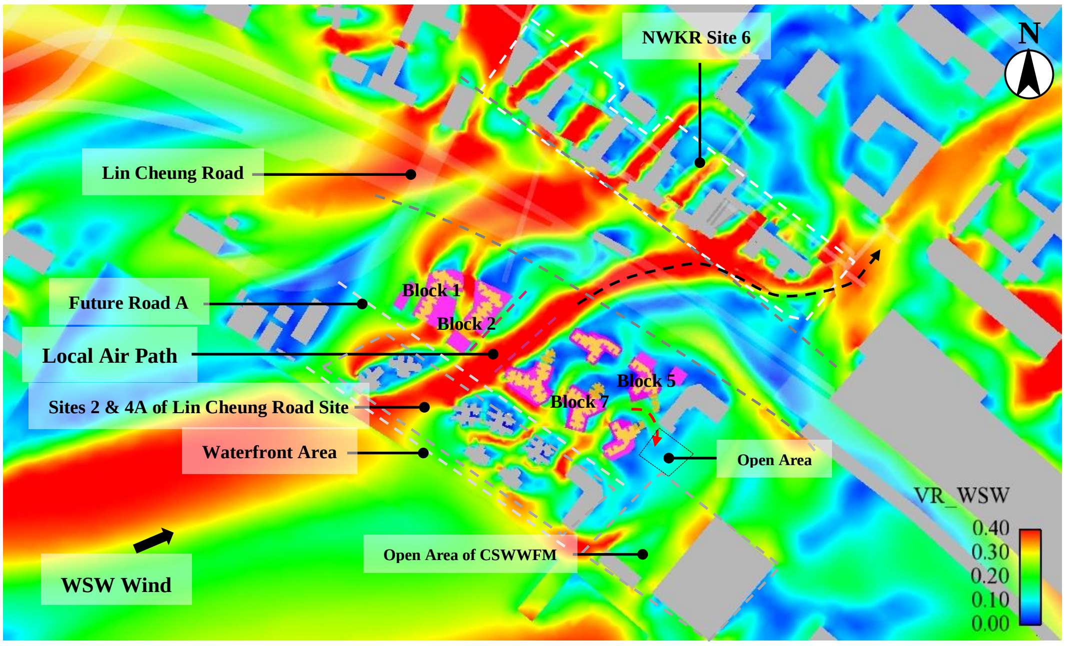


Figure 48 VR Contour Plot under WSW Wind of Baseline Scheme

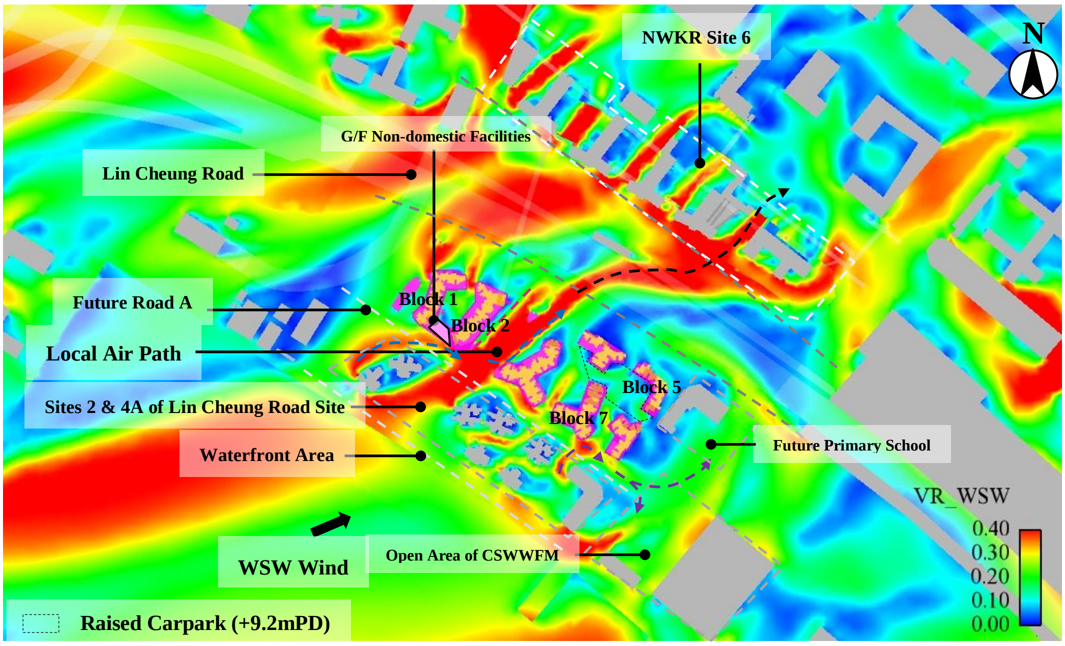


Figure 49 VR Contour Plot under WSW Wind of Proposed Scheme

4.4.11 W Wind Direction

The W wind contributes 4.7 % of the summer wind rose. The contour plots of VR value for Baseline Scheme and Proposed Scheme are shown in Figure 50 and Figure 51 respectively. The overall ventilation performance under W wind can be summarized as below:

- The prevailing wind mainly enters the project site from the waterfront.
- A slightly higher VR is observed at Lin Cheung Road under the Baseline Scheme.

Similar to SW wind, the slightly reduction of building separation between Blocks 2 and 3 under the Proposed Scheme would lead to less air volume of wind flow to Lin Cheung Road as compared to the Baseline Scheme (blue arrow in Figure 51). Furthermore, the presence of the staircase in the Proposed Scheme (red circle in Figure 51) would further reduce the wind penetration along the local air path. In this connection, a lower VR is observed along Lin Cheung Road under the Proposed Scheme.

Similar to SW wind, the Block 7 of the Proposed Scheme in favour to diverts the wind towards the open area of CSWWFM (purple arrows in Figure 51) and slightly enhance the ventilation performance of that area.

NWKR Site 6 is located at the leeward region of the Development, which has a similar ventilation performance under W wind.

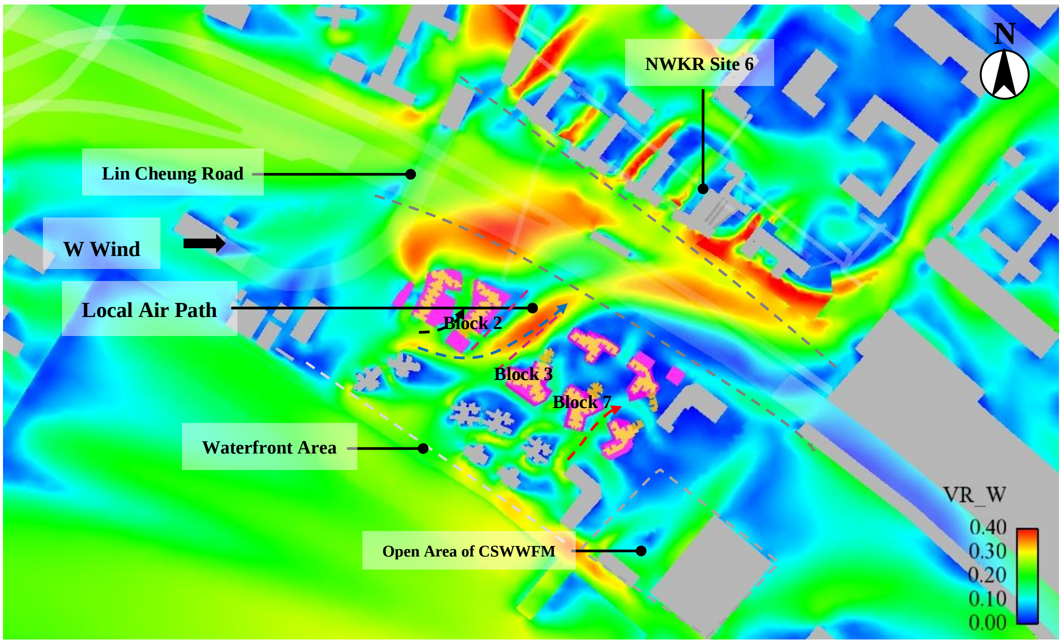


Figure 50 VR Contour Plot under W Wind of Baseline Scheme

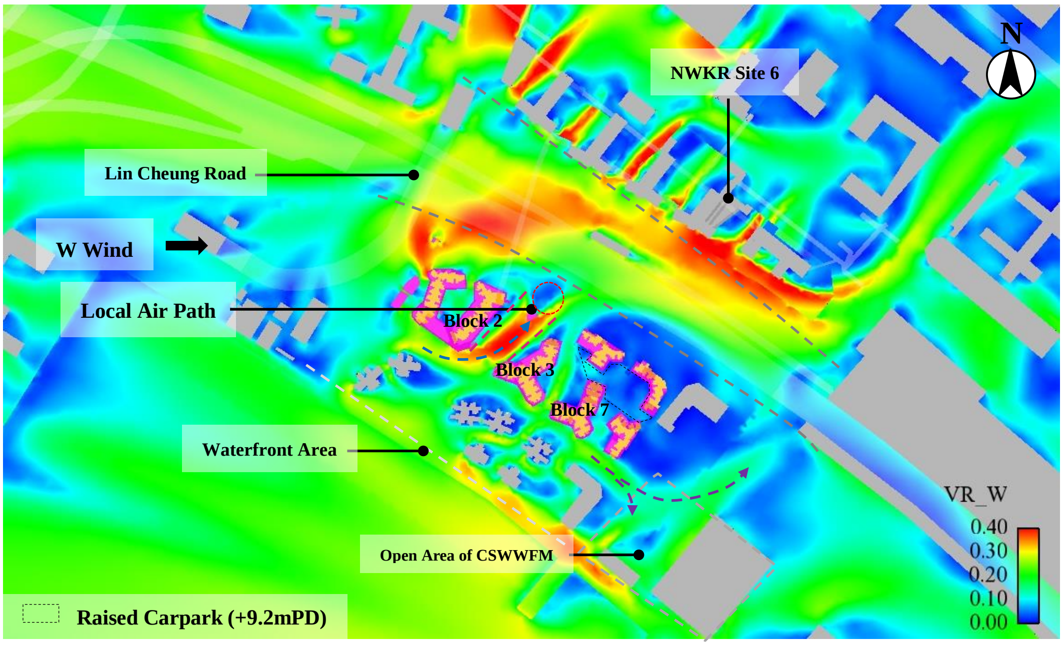


Figure 51 VR Contour Plot under W Wind of Proposed Scheme

4.5 Focus Area

As stipulated in Technical Circular, the wind performance of existing developments adjacent to the study area should be assessed. To identify the average velocity ratio in each development, test points located at the pedestrian level of determined zones should be grouped and averaged to reflect the local wind performance at that location. The Focus Areas for frequent pedestrian access and activity zones are defined for the detailed analysis as follows:

1. Shum Mong Road
2. SKH Saint Andrew's Primary School
3. Hing Wah Street Westx
4. NWKR Site 6
5. Lin Cheung Road
6. Future Road A
7. Bus Depot
8. Future Primary School
9. Site 1 of Lin Cheung Road Site (GIC Site)
10. Sites 2 & 4A of Lin Cheung Road Site
11. Open Area of CSWWFM
12. Local Air Path
13. Waterfront Area

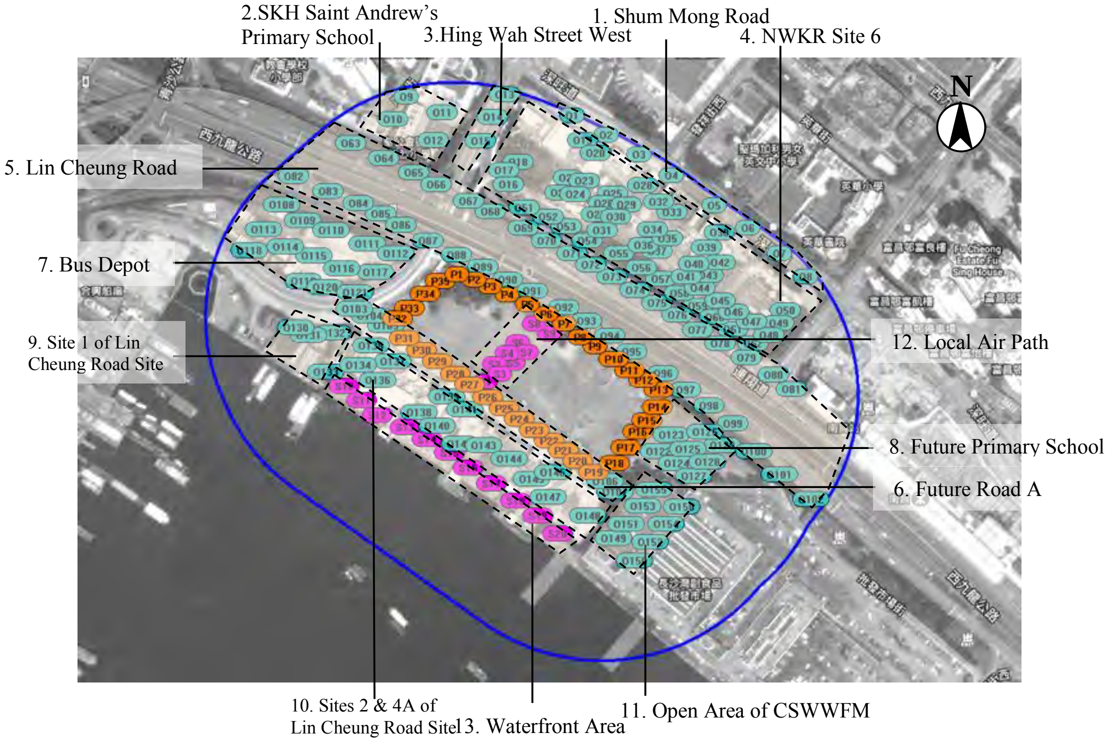


Figure 52 Focus Areas for the Study (Image Source: Google Earth)

4.5.1 Annual Wind Condition

Table 7 Average VR Results for Focus Areas of the Development Scheme under annual wind condition

Focus Areas		Test Points	Annual VR	
			Baseline Scheme	Proposed Scheme
1	Shum Mong Road	O1 – O8	0.13	0.14
2	SKH Saint Andrew's Primary School	O9 – O12	0.10	0.10
3	Hing Wah Street West	O13 – O15	0.22	0.22
4	NWKR Site 6	O16 – O62	0.14	0.14
5	Lin Cheung Road	O63 – O102	0.13	0.13
6	Future Road A	P19 – P31 O103 – O107	0.09	0.09
7	Bus Depot	O108 – O121	0.14	0.14
8	Future Primary School	O122 – O129	0.12	0.12
9	Site 1 of Lin Cheung Road Site (GIC Site)	O130 – O133	0.07	0.07
10	Sites 2 & 4A of Lin Cheung Road Site	O134 – O148	0.07	0.07
11	Open Area of CSWWFM	O149 – O156	0.10	0.10

The average VR at the focus areas under annual prevailing wind is shown in Table 7. The results show that most Focus Areas achieved similar VR under both schemes except Shum Mong Road achieve a slightly higher VR under the Proposed Scheme. The results indicate that the ventilation impact of both scheme is quite similar.

Under annual wind condition, the Proposed Development is generally located at the upwind side under Cheung Sha Wan Area at most of the prevailing wind directions, such as NNE, NE, ENE, E wind. The ventilation impact of the proposed development to the focus areas are minimal and thus most of the focus areas observed a similar VR under both schemes.

4.5.2 Summer Wind Condition

Table 8 Average VR Results for Focus Areas of the Development Scheme under summer wind condition

Focus Areas		Test Points	Summer VR	
			Baseline Scheme	Proposed Scheme
1	Shum Mong Road	O1 – O8	0.16	0.17
2	SKH Saint Andrew's Primary School	O9 – O12	0.15	0.15
3	Hing Wah Street West	O13 – O15	0.23	0.23
4	NWKR Site 6	O16 – O62	0.20	0.20
5	Lin Cheung Road	O63 – O102	0.21	0.20
6	Future Road A	P19 – P31 O103 – O107	0.17	0.18
7	Bus Depot	O108 – O121	0.19	0.18
8	Future Primary School	O122 – O129	0.17	0.17
9	Site 1 of Lin Cheung Road Site (GIC Site)	O130 – O133	0.08	0.08
10	Sites 2 & 4A of Lin Cheung Road Site	O134 – O148	0.17	0.17
11	Open Area of CSWWFM	O149 – O156	0.15	0.15

The average VR at the focus areas under summer prevailing wind is shown in Table 8. Most of the Focus Area show a similar average VR value except Shum Mong Road, Lin Cheung Road, Future Road A and Bus Depot. The Proposed Scheme achieved a slightly higher VR at Shum Mong Road and Future Road A, while the Baseline Scheme achieve a slightly higher VR at Bus Depot and Lin Cheung Road. Nevertheless, the VR values is quite similar (≈ 0.01 differences) and both schemes ventilation performance is comparable.

4.5.3 Special Test Points

Special test points are located on the local air path and the waterfront at pedestrian level within the Project Site under both schemes. The average VR of all special test points are determined and extracted. The results of all special test points are presented in the Appendix A.

Table 9 Average VR Results of special test points under annual wind condition

Focus Areas		Test Points	Annual VR	
			Baseline Scheme	**Proposed Scheme**
9	Local Air Path	S1 – S9	0.10	0.11
10	Waterfront Area	S10 – S20	0.07	0.07

Local air path has a slightly higher VR in the Proposed Scheme under annual prevailing wind condition due to the larger building separation between Blocks 2 and 4. For the waterfront area, both schemes achieve a similar VR value. It indicates the waterfront area has a similar ventilation performance under annual wind condition.

Table 10 Average VR Results of special test points under summer wind condition

Focus Areas		Test Points	Summer VR	
			Baseline Scheme	Proposed Scheme
9	Local Air Path	S1 – S9	0.21	0.23
10	Waterfront Area	S10 – S20	0.17	0.17

Local air path has a higher VR in the Proposed Scheme under summer prevailing wind condition due to the addition of G/F non-domestic facilities in Site 3 would diverts the summer prevailing W and WSW wind to the local air path instead of flowing into open space in Site 3.

For the waterfront area, both schemes achieve similar VR under both schemes. It indicates both areas have similar ventilation performance under summer wind condition.

4.6 Expert Review Analysis on Conforming Scheme

This section investigate the ventilation impact on a new scheme, i.e. the Conforming Scheme, which reduce the building height of the Proposed Scheme, so that all the buildings are within the permitted building height of +120mPD. The figure and table below shows the building heights in the conforming scheme.

Table 11 Proposed Building Height of each residential block under the Conforming Scheme

Block No.	Proposed Scheme Building Height	Conforming Scheme Building Height
1	≈ 103 mPD	≈ 103 mPD
2	≈ 125 mPD	≈ 119 mPD
3	≈ 123 mPD	≈ 120 mPD
4	≈ 120 mPD	≈ 120 mPD
5	≈ 117 mPD	≈ 117 mPD
6	≈ 120 mPD	≈ 120 mPD
7	≈ 123 mPD	≈ 120 mPD

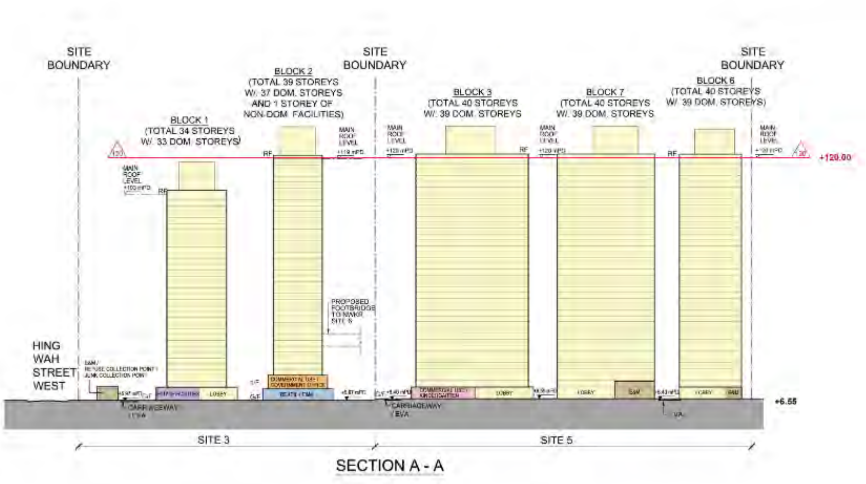


Figure 53 Elevation of conforming scheme

Comparing with the Proposed Scheme (~3m height reduction), the conforming scheme has a slightly lower building height at Block 2, 3 and 7. The lower building height would slightly enhance the building permeability and more favourable for wind penetration to the leeward regions. Nevertheless, the changes on the conforming scheme are relatively minor as compared with the whole development, it is expected that the overall ventilation performance would be similar between two schemes.

5 Conclusion

Ove Arup & Partners Hong Kong Ltd. (Arup) was commissioned by the Hong Kong Housing Authority (HKHA) to carry out an Air Ventilation Assessment (AVA) for the Proposed Public Rental Housing (PRH) and Home Ownership Scheme (HOS) Developments at Sites 3 & 5 of Lin Cheung Road Site.

The Proposed Developments at Sites 3 & 5 of Lin Cheung Road Site are located at Cheung Sha Wan area and bounded by the West Kowloon Highway to the north-east, Hing Wah Street West to the west and the existing CSWWFM to the south-east. There are some high-rise residential clusters located at the surroundings, such as Hoi Lai Estate, Fu Cheong Estate and Wing Cheong Estate, etc. The AVA – Initial Study is conducted to assess the air ventilation impact of the proposed developments minor relaxation of the building height restriction from 120mPD to 125mPD.

A series of CFD simulations using realizable k– ε turbulence model are performed based on the AVA methodology for the Initial Study as stipulated in the Technical Circular and Technical Guide. Twelve wind directions in total, which cover 76.6 % and 77.1 % of annual and summer wind conditions of the areas, have been considered. The ventilation performance for the Proposed Developments at the site boundary and within the assessment area was assessed.

According to the Technical Circular, the Velocity Ratio at each testing point are assessed in terms of SVR and LVR, respectively. A total of 35 perimeter test points and 156 overall test points are selected to assess the ventilation performance of the Proposed Developments.

The major findings of this study could be summarized as follows:

- Under annual wind condition, the SVR is 0.11 for both Baseline Scheme and Proposed Scheme, while the LVR is 0.12 for both schemes.
- Under summer wind condition, the SVR and the LVR are 0.17 and 0.18 for both schemes, respectively.
- In annual wind condition, all the focus areas show a similar average VR value.
- All of the focus areas achieve a similar ventilation performance under the annual condition. While Shum Mong Road and Future A achieve a slightly higher VR under Proposed Scheme. Also, Lin Cheung Road and Bus Depot has a slightly higher VR under Baseline Scheme
- For local air path, the Proposed Scheme has a slightly higher VR under annual and summer wind condition. For the waterfront area, both schemes achieve a similar VR value under both annual and summer wind conditions.

Summarising the ventilation performance among all the immediate surrounding areas between Baseline and Proposed Scheme, the ventilation impact to the surroundings between two schemes are comparable.

Appendix A

Velocity Ratio Table of the Test Points

A1 VR Tables for Baseline Scheme

A1.1 Annual Condition

Table 1 VR value for the Perimeter Points of Baseline Scheme under Annual Condition

	NNE	NE	ENE	E	ESE	SE	SSE	S	Overall
Frequency	**7.5%**	**10.1%**	**17.4%**	**16.6%**	**8.4%**	**5.9%**	**5.9%**	**4.9%**	**76.7%**
P1	0.27	0.07	0.11	0.09	0.19	0.20	0.28	0.22	**0.15**
P2	0.31	0.04	0.10	0.07	0.18	0.19	0.27	0.12	**0.14**
P3	0.17	0.08	0.05	0.10	0.18	0.18	0.26	0.35	**0.14**
P4	0.02	0.09	0.04	0.10	0.17	0.17	0.25	0.06	**0.10**
P5	0.02	0.10	0.08	0.10	0.15	0.16	0.25	0.16	**0.11**
P6	0.07	0.11	0.09	0.10	0.16	0.17	0.24	0.28	**0.13**
P7	0.10	0.09	0.12	0.12	0.16	0.16	0.25	0.26	**0.14**
P8	0.11	0.09	0.11	0.12	0.16	0.16	0.25	0.19	**0.14**
P9	0.08	0.07	0.11	0.15	0.15	0.15	0.25	0.14	**0.13**
P10	0.09	0.06	0.12	0.13	0.12	0.14	0.23	0.31	**0.13**
P11	0.08	0.08	0.13	0.14	0.10	0.11	0.17	0.19	**0.12**
P12	0.10	0.09	0.12	0.13	0.14	0.12	0.12	0.35	**0.13**
P13	0.03	0.03	0.06	0.03	0.02	0.07	0.11	0.33	**0.06**
P14	0.07	0.03	0.05	0.05	0.12	0.13	0.09	0.25	**0.08**
P15	0.04	0.10	0.08	0.08	0.05	0.10	0.07	0.34	**0.10**
P16	0.11	0.18	0.13	0.14	0.01	0.02	0.05	0.35	**0.12**
P17	0.10	0.12	0.07	0.05	0.15	0.09	0.08	0.30	**0.10**
P18	0.09	0.09	0.06	0.08	0.16	0.09	0.08	0.25	**0.10**
P19	0.08	0.05	0.03	0.08	0.26	0.18	0.13	0.22	**0.10**
P20	0.01	0.01	0.02	0.03	0.18	0.21	0.16	0.14	**0.07**
P21	0.01	0.04	0.02	0.03	0.10	0.23	0.18	0.22	**0.07**
P22	0.04	0.05	0.03	0.04	0.09	0.24	0.13	0.37	**0.09**
P23	0.02	0.02	0.03	0.05	0.08	0.23	0.08	0.06	**0.06**
P24	0.05	0.04	0.02	0.06	0.08	0.22	0.12	0.43	**0.09**
P25	0.07	0.04	0.02	0.05	0.11	0.20	0.12	0.35	**0.09**
P26	0.03	0.03	0.03	0.02	0.23	0.18	0.04	0.07	**0.06**
P27	0.01	0.09	0.07	0.14	0.19	0.16	0.05	0.36	**0.12**
P28	0.02	0.01	0.02	0.01	0.16	0.15	0.11	0.45	**0.08**
P29	0.09	0.02	0.03	0.04	0.17	0.15	0.15	0.28	**0.09**
P30	0.01	0.01	0.02	0.02	0.18	0.15	0.14	0.52	**0.08**
P31	0.03	0.04	0.10	0.12	0.16	0.13	0.10	0.39	**0.12**
P32	0.17	0.02	0.18	0.14	0.08	0.02	0.08	0.08	**0.11**
P33	0.24	0.06	0.11	0.19	0.08	0.03	0.06	0.10	**0.12**
P34	0.30	0.09	0.10	0.22	0.21	0.17	0.09	0.08	**0.16**
P35	0.29	0.08	0.10	0.18	0.21	0.19	0.27	0.21	**0.17**

Table 2 VR value for the Overall Points of Baseline Scheme under Annual Condition

	NNE	NE	ENE	E	ESE	SE	SSE	S	Overall
Frequency	7.5%	10.1%	17.4%	16.6%	8.4%	5.9%	5.9%	4.9%	76.7%
O1	0.24	0.13	0.17	0.09	0.07	0.07	0.07	0.06	**0.12**
O2	0.15	0.02	0.10	0.09	0.16	0.07	0.12	0.04	**0.10**
O3	0.17	0.04	0.09	0.09	0.23	0.16	0.14	0.10	**0.12**
O4	0.18	0.05	0.11	0.11	0.34	0.24	0.11	0.04	**0.14**
O5	0.02	0.06	0.10	0.12	0.34	0.25	0.09	0.13	**0.13**
O6	0.13	0.05	0.08	0.11	0.31	0.23	0.02	0.07	**0.12**
O7	0.10	0.12	0.14	0.05	0.31	0.24	0.04	0.35	**0.15**
O8	0.10	0.11	0.18	0.16	0.32	0.24	0.06	0.46	**0.19**
O9	0.03	0.10	0.14	0.19	0.15	0.19	0.08	0.11	**0.13**
O10	0.04	0.05	0.09	0.14	0.10	0.13	0.09	0.14	**0.10**
O11	0.03	0.08	0.09	0.11	0.07	0.11	0.07	0.03	**0.08**
O12	0.14	0.11	0.07	0.11	0.10	0.09	0.06	0.16	**0.10**
O13	0.52	0.32	0.18	0.27	0.23	0.27	0.14	0.10	**0.26**
O14	0.11	0.16	0.26	0.30	0.24	0.27	0.13	0.26	**0.23**
O15	0.07	0.06	0.19	0.23	0.21	0.21	0.07	0.18	**0.16**
O16	0.06	0.06	0.13	0.11	0.09	0.02	0.04	0.52	**0.11**
O17	0.38	0.28	0.15	0.15	0.20	0.09	0.07	0.45	**0.21**
O18	0.35	0.28	0.25	0.21	0.24	0.12	0.11	0.05	**0.22**
O19	0.09	0.04	0.12	0.08	0.15	0.09	0.11	0.05	**0.09**
O20	0.10	0.03	0.10	0.07	0.02	0.09	0.04	0.04	**0.07**
O21	0.24	0.09	0.12	0.15	0.06	0.09	0.08	0.01	**0.11**
O22	0.32	0.24	0.20	0.23	0.28	0.18	0.09	0.06	**0.21**
O23	0.08	0.07	0.12	0.17	0.11	0.04	0.06	0.01	**0.10**
O24	0.12	0.08	0.10	0.13	0.06	0.03	0.06	0.01	**0.09**
O25	0.07	0.07	0.05	0.08	0.11	0.09	0.08	0.10	**0.07**
O26	0.03	0.05	0.09	0.11	0.14	0.06	0.10	0.09	**0.08**
O27	0.14	0.09	0.11	0.19	0.12	0.06	0.01	0.03	**0.11**
O28	0.10	0.08	0.09	0.07	0.23	0.12	0.10	0.39	**0.12**
O29	0.09	0.13	0.13	0.14	0.24	0.13	0.11	0.25	**0.15**
O30	0.22	0.17	0.13	0.10	0.22	0.12	0.03	0.21	**0.14**
O31	0.42	0.22	0.15	0.13	0.18	0.11	0.04	0.38	**0.19**
O32	0.23	0.10	0.10	0.11	0.24	0.15	0.02	0.16	**0.13**
O33	0.25	0.10	0.07	0.06	0.22	0.14	0.05	0.39	**0.13**
O34	0.18	0.03	0.10	0.14	0.18	0.06	0.07	0.48	**0.13**
O35	0.23	0.09	0.05	0.15	0.14	0.06	0.10	0.26	**0.12**
O36	0.21	0.26	0.26	0.32	0.28	0.13	0.04	0.26	**0.24**

O37	0.31	0.19	0.16	0.19	0.08	0.01	0.03	0.33	**0.16**
O38	0.11	0.04	0.06	0.10	0.18	0.15	0.10	0.32	**0.11**
O39	0.23	0.21	0.17	0.15	0.29	0.18	0.01	0.58	**0.20**
O40	0.20	0.23	0.18	0.18	0.28	0.14	0.02	0.42	**0.20**
O41	0.15	0.17	0.13	0.13	0.20	0.09	0.04	0.32	**0.15**
O42	0.12	0.21	0.21	0.19	0.28	0.15	0.17	0.09	**0.19**
O43	0.25	0.24	0.21	0.18	0.03	0.02	0.12	0.12	**0.17**
O44	0.22	0.30	0.30	0.24	0.26	0.02	0.02	0.52	**0.24**
O45	0.09	0.05	0.06	0.01	0.03	0.03	0.23	0.38	**0.08**
O46	0.10	0.07	0.07	0.05	0.05	0.03	0.20	0.23	**0.08**
O47	0.10	0.18	0.27	0.25	0.23	0.08	0.09	0.10	**0.19**
O48	0.28	0.30	0.20	0.23	0.07	0.07	0.04	0.23	**0.19**
O49	0.27	0.30	0.19	0.22	0.04	0.05	0.14	0.40	**0.20**
O50	0.19	0.24	0.16	0.17	0.17	0.07	0.15	0.52	**0.19**
O51	0.14	0.11	0.05	0.05	0.04	0.11	0.30	0.55	**0.12**
O52	0.16	0.15	0.10	0.09	0.10	0.11	0.30	0.55	**0.15**
O53	0.08	0.03	0.04	0.07	0.03	0.04	0.29	0.51	**0.09**
O54	0.37	0.15	0.10	0.12	0.11	0.07	0.26	0.43	**0.17**
O55	0.17	0.03	0.05	0.06	0.02	0.03	0.19	0.42	**0.09**
O56	0.11	0.13	0.09	0.11	0.07	0.04	0.16	0.43	**0.12**
O57	0.02	0.08	0.07	0.09	0.02	0.03	0.10	0.35	**0.08**
O58	0.11	0.13	0.13	0.16	0.19	0.08	0.09	0.34	**0.15**
O59	0.16	0.12	0.08	0.08	0.09	0.05	0.13	0.36	**0.11**
O60	0.18	0.09	0.04	0.02	0.03	0.01	0.13	0.27	**0.07**
O61	0.11	0.08	0.23	0.20	0.13	0.08	0.08	0.17	**0.15**
O62	0.12	0.07	0.19	0.18	0.07	0.03	0.05	0.18	**0.13**
O63	0.06	0.05	0.04	0.08	0.11	0.12	0.19	0.14	**0.09**
O64	0.05	0.04	0.02	0.11	0.05	0.09	0.09	0.24	**0.07**
O65	0.05	0.02	0.07	0.05	0.05	0.10	0.27	0.30	**0.09**
O66	0.31	0.22	0.23	0.08	0.05	0.13	0.20	0.33	**0.18**
O67	0.21	0.03	0.18	0.22	0.14	0.14	0.34	0.42	**0.19**
O68	0.05	0.01	0.14	0.14	0.10	0.05	0.35	0.49	**0.14**
O69	0.08	0.15	0.07	0.05	0.06	0.11	0.35	0.51	**0.13**
O70	0.08	0.08	0.11	0.13	0.03	0.08	0.33	0.49	**0.14**
O71	0.47	0.11	0.04	0.10	0.07	0.07	0.30	0.45	**0.16**
O72	0.24	0.16	0.14	0.17	0.13	0.09	0.29	0.45	**0.18**
O73	0.08	0.06	0.10	0.07	0.03	0.14	0.25	0.43	**0.12**
O74	0.17	0.16	0.13	0.18	0.07	0.14	0.22	0.41	**0.17**
O75	0.10	0.08	0.10	0.11	0.11	0.18	0.22	0.38	**0.14**

O76	0.18	0.16	0.09	0.08	0.08	0.19	0.21	0.37	**0.14**
O77	0.20	0.13	0.11	0.07	0.08	0.17	0.18	0.38	**0.14**
O78	0.02	0.18	0.29	0.25	0.16	0.11	0.11	0.34	**0.20**
O79	0.17	0.04	0.19	0.20	0.12	0.08	0.05	0.23	**0.15**
O80	0.28	0.21	0.16	0.20	0.11	0.11	0.02	0.34	**0.18**
O81	0.12	0.21	0.12	0.12	0.06	0.12	0.03	0.45	**0.14**
O82	0.15	0.11	0.05	0.06	0.16	0.17	0.33	0.42	**0.14**
O83	0.13	0.04	0.08	0.03	0.13	0.15	0.34	0.16	**0.11**
O84	0.09	0.10	0.05	0.05	0.11	0.15	0.33	0.19	**0.11**
O85	0.04	0.24	0.03	0.09	0.10	0.16	0.33	0.14	**0.12**
O86	0.35	0.20	0.23	0.10	0.09	0.12	0.32	0.15	**0.19**
O87	0.06	0.03	0.22	0.03	0.13	0.14	0.30	0.16	**0.13**
O88	0.08	0.06	0.12	0.18	0.13	0.21	0.30	0.04	**0.14**
O89	0.27	0.06	0.09	0.04	0.17	0.21	0.30	0.23	**0.14**
O90	0.28	0.09	0.08	0.02	0.18	0.19	0.27	0.12	**0.12**
O91	0.10	0.09	0.04	0.04	0.18	0.18	0.26	0.25	**0.11**
O92	0.06	0.10	0.08	0.09	0.17	0.18	0.26	0.17	**0.12**
O93	0.07	0.07	0.08	0.10	0.16	0.19	0.25	0.27	**0.12**
O94	0.07	0.06	0.07	0.07	0.15	0.17	0.24	0.28	**0.11**
O95	0.10	0.05	0.05	0.06	0.13	0.17	0.22	0.28	**0.10**
O96	0.11	0.09	0.06	0.14	0.10	0.14	0.16	0.31	**0.12**
O97	0.07	0.11	0.06	0.08	0.17	0.15	0.13	0.23	**0.11**
O98	0.09	0.13	0.08	0.11	0.26	0.22	0.10	0.34	**0.14**
O99	0.22	0.10	0.10	0.14	0.23	0.15	0.06	0.38	**0.15**
O100	0.02	0.13	0.10	0.04	0.28	0.17	0.05	0.40	**0.12**
O101	0.03	0.02	0.06	0.06	0.27	0.16	0.04	0.40	**0.10**
O102	0.04	0.02	0.07	0.07	0.28	0.15	0.04	0.37	**0.11**
O103	0.29	0.10	0.20	0.02	0.08	0.04	0.03	0.05	**0.11**
O104	0.24	0.07	0.21	0.05	0.09	0.05	0.03	0.27	**0.13**
O105	0.10	0.02	0.20	0.10	0.14	0.11	0.03	0.26	**0.12**
O106	0.10	0.09	0.03	0.05	0.19	0.11	0.10	0.37	**0.10**
O107	0.12	0.12	0.04	0.05	0.18	0.10	0.10	0.37	**0.11**
O108	0.16	0.14	0.08	0.06	0.20	0.22	0.33	0.42	**0.16**
O109	0.16	0.16	0.10	0.07	0.19	0.19	0.31	0.43	**0.16**
O110	0.12	0.20	0.09	0.06	0.18	0.18	0.30	0.28	**0.15**
O111	0.30	0.18	0.06	0.08	0.13	0.20	0.30	0.16	**0.15**
O112	0.17	0.06	0.24	0.08	0.15	0.24	0.29	0.21	**0.17**
O113	0.16	0.14	0.05	0.08	0.18	0.23	0.21	0.26	**0.13**
O114	0.13	0.18	0.07	0.09	0.17	0.22	0.13	0.28	**0.13**

O115	0.04	0.21	0.09	0.09	0.18	0.23	0.15	0.33	**0.14**
O116	0.34	0.15	0.08	0.08	0.19	0.21	0.12	0.28	**0.15**
O117	0.24	0.08	0.21	0.05	0.20	0.20	0.18	0.11	**0.15**
O118	0.15	0.12	0.06	0.07	0.08	0.11	0.05	0.47	**0.11**
O119	0.23	0.16	0.13	0.07	0.18	0.13	0.02	0.15	**0.13**
O120	0.35	0.12	0.10	0.06	0.15	0.09	0.03	0.26	**0.13**
O121	0.29	0.10	0.16	0.02	0.18	0.12	0.04	0.25	**0.13**
O122	0.04	0.12	0.04	0.07	0.15	0.07	0.04	0.41	**0.10**
O123	0.05	0.10	0.03	0.02	0.14	0.06	0.05	0.12	**0.06**
O124	0.16	0.12	0.08	0.06	0.26	0.14	0.08	0.30	**0.13**
O125	0.14	0.08	0.04	0.07	0.20	0.11	0.08	0.39	**0.11**
O126	0.16	0.13	0.10	0.13	0.21	0.15	0.02	0.43	**0.15**
O127	0.14	0.16	0.07	0.08	0.29	0.17	0.08	0.18	**0.13**
O128	0.17	0.15	0.07	0.03	0.26	0.16	0.07	0.23	**0.12**
O129	0.18	0.14	0.10	0.07	0.26	0.17	0.06	0.20	**0.14**
O130	0.16	0.06	0.05	0.01	0.06	0.03	0.06	0.19	**0.06**
O131	0.16	0.06	0.08	0.01	0.06	0.04	0.08	0.11	**0.07**
O132	0.10	0.04	0.17	0.02	0.03	0.02	0.01	0.11	**0.07**
O133	0.03	0.02	0.01	0.02	0.06	0.09	0.15	0.43	**0.06**
O134	0.03	0.05	0.18	0.06	0.04	0.06	0.03	0.30	**0.09**
O135	0.03	0.04	0.20	0.08	0.10	0.04	0.01	0.13	**0.09**
O96	0.01	0.05	0.07	0.03	0.04	0.04	0.04	0.19	**0.05**
O97	0.06	0.03	0.08	0.09	0.14	0.05	0.06	0.10	**0.08**
O98	0.02	0.01	0.04	0.06	0.15	0.01	0.06	0.09	**0.05**
O99	0.03	0.06	0.05	0.10	0.21	0.04	0.15	0.57	**0.12**
O100	0.04	0.06	0.04	0.05	0.24	0.01	0.09	0.39	**0.09**
O101	0.01	0.05	0.04	0.03	0.22	0.01	0.07	0.08	**0.06**
O102	0.07	0.02	0.02	0.03	0.03	0.03	0.07	0.35	**0.05**
O103	0.03	0.05	0.03	0.03	0.02	0.05	0.04	0.33	**0.05**
O104	0.03	0.04	0.02	0.06	0.18	0.05	0.04	0.27	**0.07**
O105	0.03	0.04	0.01	0.01	0.03	0.14	0.05	0.20	**0.04**
O106	0.01	0.04	0.04	0.03	0.07	0.21	0.14	0.45	**0.09**
O107	0.01	0.04	0.02	0.04	0.13	0.08	0.06	0.27	**0.06**
O108	0.13	0.10	0.03	0.04	0.14	0.13	0.09	0.30	**0.09**
O109	0.12	0.15	0.06	0.08	0.14	0.08	0.06	0.25	**0.10**
O110	0.06	0.18	0.04	0.05	0.14	0.03	0.02	0.11	**0.07**
O111	0.14	0.19	0.04	0.07	0.16	0.07	0.07	0.24	**0.11**
O112	0.04	0.19	0.03	0.05	0.12	0.02	0.02	0.01	**0.06**
O113	0.18	0.18	0.03	0.06	0.15	0.05	0.08	0.26	**0.11**

O114	0.05	0.20	0.01	0.02	0.14	0.03	0.04	0.09	**0.07**
O115	0.17	0.16	0.06	0.06	0.28	0.13	0.08	0.26	**0.13**
O116	0.04	0.16	0.13	0.08	0.35	0.16	0.08	0.14	**0.14**
O117	0.24	0.13	0.17	0.09	0.07	0.07	0.07	0.06	**0.12**
O118	0.15	0.02	0.10	0.09	0.16	0.07	0.12	0.04	**0.10**
O119	0.17	0.04	0.09	0.09	0.23	0.16	0.14	0.10	**0.12**
O120	0.18	0.05	0.11	0.11	0.34	0.24	0.11	0.04	**0.14**
O121	0.02	0.06	0.10	0.12	0.34	0.25	0.09	0.13	**0.13**
O122	0.13	0.05	0.08	0.11	0.31	0.23	0.02	0.07	**0.12**
O123	0.10	0.12	0.14	0.05	0.31	0.24	0.04	0.35	**0.15**
O124	0.10	0.11	0.18	0.16	0.32	0.24	0.06	0.46	**0.19**
O125	0.03	0.10	0.14	0.19	0.15	0.19	0.08	0.11	**0.13**
O126	0.04	0.05	0.09	0.14	0.10	0.13	0.09	0.14	**0.10**
O127	0.03	0.08	0.09	0.11	0.07	0.11	0.07	0.03	**0.08**
O128	0.14	0.11	0.07	0.11	0.10	0.09	0.06	0.16	**0.10**
O129	0.52	0.32	0.18	0.27	0.23	0.27	0.14	0.10	**0.26**
O130	0.11	0.16	0.26	0.30	0.24	0.27	0.13	0.26	**0.23**
O131	0.07	0.06	0.19	0.23	0.21	0.21	0.07	0.18	**0.16**
O132	0.06	0.06	0.13	0.11	0.09	0.02	0.04	0.52	**0.11**
O133	0.38	0.28	0.15	0.15	0.20	0.09	0.07	0.45	**0.21**
O134	0.35	0.28	0.25	0.21	0.24	0.12	0.11	0.05	**0.22**
O135	0.09	0.04	0.12	0.08	0.15	0.09	0.11	0.05	**0.09**
O136	0.10	0.03	0.10	0.07	0.02	0.09	0.04	0.04	**0.07**
O137	0.24	0.09	0.12	0.15	0.06	0.09	0.08	0.01	**0.11**
O138	0.32	0.24	0.20	0.23	0.28	0.18	0.09	0.06	**0.21**
O139	0.08	0.07	0.12	0.17	0.11	0.04	0.06	0.01	**0.10**
O140	0.12	0.08	0.10	0.13	0.06	0.03	0.06	0.01	**0.09**
O141	0.07	0.07	0.05	0.08	0.11	0.09	0.08	0.10	**0.07**
O142	0.03	0.05	0.09	0.11	0.14	0.06	0.10	0.09	**0.08**
O143	0.14	0.09	0.11	0.19	0.12	0.06	0.01	0.03	**0.11**
O144	0.10	0.08	0.09	0.07	0.23	0.12	0.10	0.39	**0.12**
O145	0.09	0.13	0.13	0.14	0.24	0.13	0.11	0.25	**0.15**
O146	0.22	0.17	0.13	0.10	0.22	0.12	0.03	0.21	**0.14**
O147	0.42	0.22	0.15	0.13	0.18	0.11	0.04	0.38	**0.19**
O148	0.23	0.10	0.10	0.11	0.24	0.15	0.02	0.16	**0.13**
O149	0.25	0.10	0.07	0.06	0.22	0.14	0.05	0.39	**0.13**
O150	0.18	0.03	0.10	0.14	0.18	0.06	0.07	0.48	**0.13**
O151	0.23	0.09	0.05	0.15	0.14	0.06	0.10	0.26	**0.12**
O152	0.21	0.26	0.26	0.32	0.28	0.13	0.04	0.26	**0.24**

O153	0.31	0.19	0.16	0.19	0.08	0.01	0.03	0.33	**0.16**
O154	0.11	0.04	0.06	0.10	0.18	0.15	0.10	0.32	**0.11**
O155	0.23	0.21	0.17	0.15	0.29	0.18	0.01	0.58	**0.20**
O156	0.20	0.23	0.18	0.18	0.28	0.14	0.02	0.42	**0.20**

Table 3 VR value for the Special Test Points of Baseline Scheme under Annual Condition

	NNE	NE	ENE	E	ESE	SE	SSE	S	Overall
Frequency	7.5%	10.1%	17.4%	16.6%	8.4%	5.9%	5.9%	4.9%	76.7%
S1	0.01	0.07	0.08	0.10	0.25	0.07	0.10	0.17	**0.10**
S2	0.01	0.09	0.10	0.15	0.18	0.07	0.07	0.35	**0.12**
S3	0.05	0.05	0.04	0.02	0.25	0.05	0.10	0.19	**0.07**
S4	0.04	0.08	0.08	0.14	0.21	0.06	0.06	0.34	**0.12**
S5	0.06	0.03	0.02	0.02	0.26	0.04	0.01	0.07	**0.06**
S6	0.08	0.08	0.07	0.13	0.06	0.05	0.06	0.29	**0.10**
S7	0.09	0.04	0.05	0.06	0.05	0.06	0.05	0.11	**0.06**
S8	0.03	0.09	0.12	0.13	0.13	0.13	0.24	0.19	**0.13**
S9	0.11	0.10	0.13	0.15	0.14	0.12	0.23	0.29	**0.15**
S10	0.02	0.05	0.15	0.03	0.06	0.11	0.20	0.51	**0.11**
S11	0.02	0.08	0.13	0.04	0.04	0.10	0.19	0.56	**0.11**
S12	0.01	0.05	0.02	0.01	0.02	0.13	0.21	0.58	**0.08**
S13	0.03	0.02	0.03	0.10	0.12	0.07	0.10	0.24	**0.08**
S14	0.05	0.06	0.01	0.01	0.22	0.06	0.11	0.35	**0.08**
S15	0.07	0.06	0.03	0.03	0.10	0.05	0.11	0.40	**0.08**
S16	0.08	0.01	0.01	0.01	0.05	0.06	0.09	0.38	**0.06**
S17	0.02	0.02	0.04	0.03	0.13	0.05	0.04	0.14	**0.05**
S18	0.01	0.06	0.04	0.01	0.05	0.09	0.03	0.10	**0.04**
S19	0.03	0.06	0.03	0.01	0.02	0.07	0.05	0.18	**0.04**
S20	0.04	0.02	0.03	0.11	0.19	0.14	0.11	0.09	**0.08**

A1.2 Summer Condition

Table 4 VR value for the Perimeter Points of Baseline Scheme under Summer Condition

	E	ESE	SE	SSE	S	SSW	SW	WSW	W	Overall
Frequency	**11.5%**	**9.5%**	**9.3%**	**8.3%**	**7.9%**	**8.8%**	**9.9%**	**7.2%**	**4.7%**	**77.1%**
P1	0.09	0.19	0.20	0.28	0.22	0.10	0.36	0.36	0.34	**0.23**
P2	0.07	0.18	0.19	0.27	0.12	0.10	0.25	0.27	0.34	**0.19**
P3	0.10	0.18	0.18	0.26	0.35	0.13	0.14	0.35	0.34	**0.21**
P4	0.10	0.17	0.17	0.25	0.06	0.17	0.12	0.07	0.34	**0.15**
P5	0.10	0.15	0.16	0.25	0.16	0.18	0.20	0.13	0.25	**0.17**

P6	0.10	0.16	0.17	0.24	0.28	0.19	0.38	0.23	0.15	**0.21**
P7	0.12	0.16	0.16	0.25	0.26	0.08	0.44	0.33	0.29	**0.22**
P8	0.12	0.16	0.16	0.25	0.19	0.19	0.09	0.37	0.26	**0.19**
P9	0.15	0.15	0.15	0.25	0.14	0.17	0.04	0.06	0.01	**0.13**
P10	0.13	0.12	0.14	0.23	0.31	0.23	0.14	0.13	0.07	**0.17**
P11	0.14	0.10	0.11	0.17	0.19	0.26	0.17	0.16	0.01	**0.15**
P12	0.13	0.14	0.12	0.12	0.35	0.36	0.03	0.10	0.05	**0.16**
P13	0.03	0.02	0.07	0.11	0.33	0.32	0.04	0.05	0.11	**0.12**
P14	0.05	0.12	0.13	0.09	0.25	0.20	0.14	0.13	0.03	**0.13**
P15	0.08	0.05	0.10	0.07	0.34	0.26	0.12	0.09	0.03	**0.13**
P16	0.14	0.01	0.02	0.05	0.35	0.21	0.05	0.15	0.07	**0.12**
P17	0.05	0.15	0.09	0.08	0.30	0.16	0.13	0.05	0.02	**0.12**
P18	0.08	0.16	0.09	0.08	0.25	0.03	0.15	0.06	0.01	**0.11**
P19	0.08	0.26	0.18	0.13	0.22	0.16	0.09	0.24	0.18	**0.16**
P20	0.03	0.18	0.21	0.16	0.14	0.14	0.13	0.34	0.18	**0.16**
P21	0.03	0.10	0.23	0.18	0.22	0.10	0.43	0.17	0.19	**0.18**
P22	0.04	0.09	0.24	0.13	0.37	0.20	0.05	0.31	0.25	**0.17**
P23	0.05	0.08	0.23	0.08	0.06	0.10	0.46	0.23	0.10	**0.16**
P24	0.06	0.08	0.22	0.12	0.43	0.28	0.08	0.28	0.06	**0.18**
P25	0.05	0.11	0.20	0.12	0.35	0.19	0.09	0.23	0.09	**0.15**
P26	0.02	0.23	0.18	0.04	0.07	0.03	0.37	0.49	0.16	**0.17**
P27	0.14	0.19	0.16	0.05	0.36	0.26	0.43	0.30	0.27	**0.23**
P28	0.01	0.16	0.15	0.11	0.45	0.37	0.37	0.22	0.28	**0.23**
P29	0.04	0.17	0.15	0.15	0.28	0.08	0.08	0.39	0.25	**0.16**
P30	0.02	0.18	0.15	0.14	0.52	0.13	0.05	0.22	0.21	**0.16**
P31	0.12	0.16	0.13	0.10	0.39	0.18	0.27	0.21	0.11	**0.19**
P32	0.14	0.08	0.02	0.08	0.08	0.37	0.38	0.14	0.13	**0.16**
P33	0.19	0.08	0.03	0.06	0.10	0.25	0.36	0.20	0.17	**0.16**
P34	0.22	0.21	0.17	0.09	0.08	0.07	0.36	0.28	0.35	**0.20**
P35	0.18	0.21	0.19	0.27	0.21	0.06	0.37	0.33	0.35	**0.23**

Table 5 VR value for the Overall Points of Baseline Scheme under Summer Condition

	E	ESE	SE	SSE	S	SSW	SW	WSW	W	Overall
Frequency	11.5%	9.5%	9.3%	8.3%	7.9%	8.8%	9.9%	7.2%	4.7%	77.1%
O1	0.09	0.07	0.07	0.07	0.06	0.04	0.19	0.48	0.22	**0.13**
O2	0.09	0.16	0.07	0.12	0.04	0.12	0.05	0.11	0.15	**0.10**
O3	0.09	0.23	0.16	0.14	0.10	0.05	0.16	0.19	0.20	**0.14**
O4	0.11	0.34	0.24	0.11	0.04	0.18	0.09	0.17	0.26	**0.17**
O5	0.12	0.34	0.25	0.09	0.13	0.15	0.13	0.07	0.19	**0.17**

O6	0.11	0.31	0.23	0.02	0.07	0.09	0.07	0.03	0.17	**0.13**
O7	0.05	0.31	0.24	0.04	0.35	0.30	0.21	0.03	0.07	**0.18**
O8	0.16	0.32	0.24	0.06	0.46	0.39	0.44	0.31	0.12	**0.28**
O9	0.19	0.15	0.19	0.08	0.11	0.30	0.25	0.33	0.18	**0.20**
O10	0.14	0.10	0.13	0.09	0.14	0.31	0.21	0.19	0.20	**0.16**
O11	0.11	0.07	0.11	0.07	0.03	0.21	0.15	0.08	0.15	**0.11**
O12	0.11	0.10	0.09	0.06	0.16	0.15	0.16	0.14	0.16	**0.12**
O13	0.27	0.23	0.27	0.14	0.10	0.24	0.44	0.51	0.37	**0.28**
O14	0.30	0.24	0.27	0.13	0.26	0.17	0.33	0.40	0.31	**0.27**
O15	0.23	0.21	0.21	0.07	0.18	0.03	0.10	0.13	0.12	**0.15**
O16	0.11	0.09	0.02	0.04	0.52	0.31	0.06	0.10	0.08	**0.14**
O17	0.15	0.20	0.09	0.07	0.45	0.35	0.25	0.18	0.15	**0.21**
O18	0.21	0.24	0.12	0.11	0.05	0.44	0.44	0.52	0.29	**0.26**
O19	0.08	0.15	0.09	0.11	0.05	0.08	0.14	0.20	0.12	**0.11**
O20	0.07	0.02	0.09	0.04	0.04	0.11	0.25	0.23	0.11	**0.11**
O21	0.15	0.06	0.09	0.08	0.01	0.05	0.40	0.47	0.14	**0.16**
O22	0.23	0.28	0.18	0.09	0.06	0.32	0.53	0.58	0.41	**0.29**
O23	0.17	0.11	0.04	0.06	0.01	0.23	0.39	0.38	0.27	**0.18**
O24	0.13	0.06	0.03	0.06	0.01	0.30	0.44	0.43	0.30	**0.19**
O25	0.08	0.11	0.09	0.08	0.10	0.23	0.10	0.04	0.02	**0.10**
O26	0.11	0.14	0.06	0.10	0.09	0.38	0.05	0.06	0.04	**0.12**
O27	0.19	0.12	0.06	0.01	0.03	0.07	0.02	0.02	0.01	**0.07**
O28	0.07	0.23	0.12	0.10	0.39	0.15	0.40	0.26	0.17	**0.21**
O29	0.14	0.24	0.13	0.11	0.25	0.04	0.49	0.44	0.31	**0.23**
O30	0.10	0.22	0.12	0.03	0.21	0.01	0.53	0.49	0.36	**0.22**
O31	0.13	0.18	0.11	0.04	0.38	0.22	0.49	0.51	0.37	**0.26**
O32	0.11	0.24	0.15	0.02	0.16	0.11	0.10	0.07	0.03	**0.12**
O33	0.06	0.22	0.14	0.05	0.39	0.30	0.09	0.05	0.14	**0.16**
O34	0.14	0.18	0.06	0.07	0.48	0.38	0.23	0.08	0.19	**0.20**
O35	0.15	0.14	0.06	0.10	0.26	0.20	0.44	0.42	0.33	**0.22**
O36	0.32	0.28	0.13	0.04	0.26	0.18	0.12	0.09	0.07	**0.18**
O37	0.19	0.08	0.01	0.03	0.33	0.27	0.58	0.60	0.44	**0.26**
O38	0.10	0.18	0.15	0.10	0.32	0.09	0.23	0.14	0.03	**0.15**
O39	0.15	0.29	0.18	0.01	0.58	0.52	0.39	0.10	0.14	**0.27**
O40	0.18	0.28	0.14	0.02	0.42	0.39	0.32	0.03	0.03	**0.21**
O41	0.13	0.20	0.09	0.04	0.32	0.36	0.08	0.11	0.08	**0.16**
O42	0.19	0.28	0.15	0.17	0.09	0.31	0.05	0.58	0.33	**0.23**
O43	0.18	0.03	0.02	0.12	0.12	0.45	0.17	0.51	0.27	**0.20**
O44	0.24	0.26	0.02	0.02	0.52	0.37	0.42	0.47	0.38	**0.29**

O45	0.01	0.03	0.03	0.23	0.38	0.50	0.29	0.44	0.39	**0.23**
O46	0.05	0.05	0.03	0.20	0.23	0.15	0.19	0.38	0.39	**0.16**
O47	0.25	0.23	0.08	0.09	0.10	0.21	0.16	0.34	0.45	**0.20**
O48	0.23	0.07	0.07	0.04	0.23	0.39	0.41	0.18	0.38	**0.22**
O49	0.22	0.04	0.05	0.14	0.40	0.49	0.49	0.26	0.10	**0.25**
O50	0.17	0.17	0.07	0.15	0.52	0.60	0.56	0.40	0.03	**0.31**
O51	0.05	0.04	0.11	0.30	0.55	0.34	0.22	0.24	0.15	**0.21**
O52	0.09	0.10	0.11	0.30	0.55	0.37	0.26	0.31	0.17	**0.24**
O53	0.07	0.03	0.04	0.29	0.51	0.40	0.32	0.37	0.23	**0.24**
O54	0.12	0.11	0.07	0.26	0.43	0.40	0.33	0.39	0.27	**0.25**
O55	0.06	0.02	0.03	0.19	0.42	0.43	0.16	0.30	0.25	**0.19**
O56	0.11	0.07	0.04	0.16	0.43	0.45	0.29	0.31	0.28	**0.23**
O57	0.09	0.02	0.03	0.10	0.35	0.38	0.30	0.31	0.30	**0.20**
O58	0.16	0.19	0.08	0.09	0.34	0.36	0.17	0.41	0.34	**0.22**
O59	0.08	0.09	0.05	0.13	0.36	0.37	0.23	0.40	0.30	**0.21**
O60	0.02	0.03	0.01	0.13	0.27	0.26	0.27	0.35	0.30	**0.16**
O61	0.20	0.13	0.08	0.08	0.17	0.20	0.25	0.22	0.32	**0.18**
O62	0.18	0.07	0.03	0.05	0.18	0.20	0.20	0.13	0.33	**0.14**
O63	0.08	0.11	0.12	0.19	0.14	0.30	0.16	0.32	0.23	**0.17**
O64	0.11	0.05	0.09	0.09	0.24	0.04	0.27	0.20	0.25	**0.14**
O65	0.05	0.05	0.10	0.27	0.30	0.17	0.34	0.32	0.30	**0.20**
O66	0.08	0.05	0.13	0.20	0.33	0.36	0.41	0.37	0.29	**0.24**
O67	0.22	0.14	0.14	0.34	0.42	0.42	0.35	0.41	0.25	**0.29**
O68	0.14	0.10	0.05	0.35	0.49	0.32	0.34	0.39	0.26	**0.26**
O69	0.05	0.06	0.11	0.35	0.51	0.28	0.31	0.36	0.28	**0.24**
O70	0.13	0.03	0.08	0.33	0.49	0.25	0.35	0.44	0.31	**0.25**
O71	0.10	0.07	0.07	0.30	0.45	0.33	0.31	0.42	0.36	**0.25**
O72	0.17	0.13	0.09	0.29	0.45	0.37	0.26	0.31	0.36	**0.26**
O73	0.07	0.03	0.14	0.25	0.43	0.39	0.30	0.06	0.27	**0.21**
O74	0.18	0.07	0.14	0.22	0.41	0.40	0.27	0.29	0.27	**0.24**
O75	0.11	0.11	0.18	0.22	0.38	0.38	0.21	0.46	0.29	**0.25**
O76	0.08	0.08	0.19	0.21	0.37	0.34	0.17	0.24	0.32	**0.21**
O77	0.07	0.08	0.17	0.18	0.38	0.24	0.36	0.06	0.34	**0.20**
O78	0.25	0.16	0.11	0.11	0.34	0.12	0.36	0.08	0.33	**0.20**
O79	0.20	0.12	0.08	0.05	0.23	0.21	0.34	0.07	0.30	**0.17**
O80	0.20	0.11	0.11	0.02	0.34	0.25	0.32	0.18	0.20	**0.19**
O81	0.12	0.06	0.12	0.03	0.45	0.36	0.37	0.23	0.04	**0.20**
O82	0.06	0.16	0.17	0.33	0.42	0.06	0.27	0.15	0.24	**0.20**
O83	0.03	0.13	0.15	0.34	0.16	0.15	0.29	0.20	0.25	**0.18**

O84	0.05	0.11	0.15	0.33	0.19	0.16	0.27	0.27	0.24	**0.19**
O85	0.09	0.10	0.16	0.33	0.14	0.22	0.23	0.32	0.24	**0.19**
O86	0.10	0.09	0.12	0.32	0.15	0.32	0.29	0.39	0.20	**0.21**
O87	0.03	0.13	0.14	0.30	0.16	0.36	0.28	0.31	0.20	**0.20**
O88	0.18	0.13	0.21	0.30	0.04	0.38	0.33	0.25	0.27	**0.23**
O89	0.04	0.17	0.21	0.30	0.23	0.22	0.34	0.37	0.35	**0.23**
O90	0.02	0.18	0.19	0.27	0.12	0.08	0.14	0.36	0.37	**0.17**
O91	0.04	0.18	0.18	0.26	0.25	0.25	0.15	0.03	0.32	**0.17**
O92	0.09	0.17	0.18	0.26	0.17	0.29	0.40	0.17	0.12	**0.21**
O93	0.10	0.16	0.19	0.25	0.27	0.38	0.31	0.42	0.28	**0.25**
O94	0.07	0.15	0.17	0.24	0.28	0.34	0.02	0.03	0.13	**0.16**
O95	0.06	0.13	0.17	0.22	0.28	0.33	0.26	0.13	0.06	**0.19**
O96	0.14	0.10	0.14	0.16	0.31	0.43	0.03	0.16	0.02	**0.17**
O97	0.08	0.17	0.15	0.13	0.23	0.40	0.02	0.18	0.05	**0.16**
O98	0.11	0.26	0.22	0.10	0.34	0.44	0.35	0.29	0.12	**0.25**
O99	0.14	0.23	0.15	0.06	0.38	0.38	0.37	0.31	0.15	**0.24**
O100	0.04	0.28	0.17	0.05	0.40	0.35	0.29	0.34	0.07	**0.22**
O101	0.06	0.27	0.16	0.04	0.40	0.27	0.18	0.20	0.13	**0.19**
O102	0.07	0.28	0.15	0.04	0.37	0.20	0.18	0.04	0.14	**0.16**
O103	0.02	0.08	0.04	0.03	0.05	0.19	0.14	0.03	0.07	**0.07**
O104	0.05	0.09	0.05	0.03	0.27	0.09	0.07	0.02	0.12	**0.08**
O105	0.10	0.14	0.11	0.03	0.26	0.43	0.40	0.12	0.11	**0.19**
O106	0.05	0.19	0.11	0.10	0.37	0.28	0.08	0.15	0.14	**0.16**
O107	0.05	0.18	0.10	0.10	0.37	0.39	0.07	0.12	0.11	**0.16**
O108	0.06	0.20	0.22	0.33	0.42	0.15	0.29	0.22	0.25	**0.23**
O109	0.07	0.19	0.19	0.31	0.43	0.17	0.29	0.25	0.24	**0.23**
O110	0.06	0.18	0.18	0.30	0.28	0.18	0.23	0.31	0.21	**0.21**
O111	0.08	0.13	0.20	0.30	0.16	0.23	0.27	0.35	0.13	**0.20**
O112	0.08	0.15	0.24	0.29	0.21	0.40	0.29	0.30	0.13	**0.23**
O113	0.08	0.18	0.23	0.21	0.26	0.08	0.28	0.24	0.18	**0.19**
O114	0.09	0.17	0.22	0.13	0.28	0.10	0.21	0.30	0.11	**0.18**
O115	0.09	0.18	0.23	0.15	0.33	0.18	0.16	0.31	0.10	**0.19**
O116	0.08	0.19	0.21	0.12	0.28	0.16	0.26	0.28	0.16	**0.19**
O117	0.05	0.20	0.20	0.18	0.11	0.38	0.27	0.24	0.13	**0.20**
O118	0.07	0.08	0.11	0.05	0.47	0.01	0.20	0.21	0.10	**0.14**
O119	0.07	0.18	0.13	0.02	0.15	0.18	0.24	0.24	0.15	**0.15**
O120	0.06	0.15	0.09	0.03	0.26	0.15	0.25	0.20	0.12	**0.14**
O121	0.02	0.18	0.12	0.04	0.25	0.27	0.20	0.20	0.08	**0.15**
O122	0.07	0.15	0.07	0.04	0.41	0.35	0.07	0.08	0.02	**0.14**

O123	0.02	0.14	0.06	0.05	0.12	0.13	0.09	0.12	0.02	**0.08**
O124	0.06	0.26	0.14	0.08	0.30	0.30	0.23	0.16	0.07	**0.18**
O125	0.07	0.20	0.11	0.08	0.39	0.30	0.21	0.15	0.02	**0.17**
O126	0.13	0.21	0.15	0.02	0.43	0.37	0.31	0.20	0.02	**0.21**
O127	0.08	0.29	0.17	0.08	0.18	0.17	0.26	0.25	0.11	**0.18**
O128	0.03	0.26	0.16	0.07	0.23	0.23	0.20	0.23	0.10	**0.17**
O129	0.07	0.26	0.17	0.06	0.20	0.33	0.31	0.17	0.10	**0.19**
O130	0.01	0.06	0.03	0.06	0.19	0.16	0.05	0.05	0.03	**0.07**
O131	0.01	0.06	0.04	0.08	0.11	0.05	0.04	0.07	0.05	**0.05**
O132	0.02	0.03	0.02	0.01	0.11	0.12	0.04	0.04	0.07	**0.05**
O133	0.02	0.06	0.09	0.15	0.43	0.23	0.14	0.03	0.04	**0.13**
O134	0.06	0.04	0.06	0.03	0.30	0.41	0.38	0.16	0.11	**0.17**
O135	0.08	0.10	0.04	0.01	0.13	0.44	0.40	0.15	0.12	**0.17**
O96	0.03	0.04	0.04	0.04	0.19	0.31	0.30	0.37	0.14	**0.16**
O97	0.09	0.14	0.05	0.06	0.10	0.24	0.26	0.30	0.13	**0.15**
O98	0.06	0.15	0.01	0.06	0.09	0.10	0.14	0.37	0.17	**0.12**
O99	0.10	0.21	0.04	0.15	0.57	0.42	0.44	0.37	0.07	**0.26**
O100	0.05	0.24	0.01	0.09	0.39	0.31	0.30	0.33	0.24	**0.21**
O101	0.03	0.22	0.01	0.07	0.08	0.15	0.47	0.50	0.22	**0.19**
O102	0.03	0.03	0.03	0.07	0.35	0.21	0.17	0.18	0.16	**0.13**
O103	0.03	0.02	0.05	0.04	0.33	0.19	0.29	0.34	0.22	**0.15**
O104	0.06	0.18	0.05	0.04	0.27	0.25	0.30	0.25	0.20	**0.17**
O105	0.01	0.03	0.14	0.05	0.20	0.20	0.32	0.18	0.22	**0.14**
O106	0.03	0.07	0.21	0.14	0.45	0.39	0.52	0.41	0.29	**0.27**
O107	0.04	0.13	0.08	0.06	0.27	0.30	0.24	0.16	0.02	**0.15**
O108	0.04	0.14	0.13	0.09	0.30	0.38	0.09	0.13	0.08	**0.15**
O109	0.08	0.14	0.08	0.06	0.25	0.15	0.17	0.14	0.09	**0.13**
O110	0.05	0.14	0.03	0.02	0.11	0.22	0.26	0.18	0.17	**0.13**
O111	0.07	0.16	0.07	0.07	0.24	0.23	0.17	0.20	0.13	**0.15**
O112	0.05	0.12	0.02	0.02	0.01	0.02	0.30	0.28	0.21	**0.11**
O113	0.06	0.15	0.05	0.08	0.26	0.26	0.25	0.18	0.11	**0.15**
O114	0.02	0.14	0.03	0.04	0.09	0.11	0.31	0.29	0.15	**0.13**
O115	0.06	0.28	0.13	0.08	0.26	0.30	0.23	0.12	0.05	**0.17**
O116	0.08	0.35	0.16	0.08	0.14	0.15	0.30	0.31	0.18	**0.19**
O117	0.09	0.07	0.07	0.07	0.06	0.04	0.19	0.48	0.22	**0.13**
O118	0.09	0.16	0.07	0.12	0.04	0.12	0.05	0.11	0.15	**0.10**
O119	0.09	0.23	0.16	0.14	0.10	0.05	0.16	0.19	0.20	**0.14**
O120	0.11	0.34	0.24	0.11	0.04	0.18	0.09	0.17	0.26	**0.17**
O121	0.12	0.34	0.25	0.09	0.13	0.15	0.13	0.07	0.19	**0.17**

O122	0.11	0.31	0.23	0.02	0.07	0.09	0.07	0.03	0.17	**0.13**
O123	0.05	0.31	0.24	0.04	0.35	0.30	0.21	0.03	0.07	**0.18**
O124	0.16	0.32	0.24	0.06	0.46	0.39	0.44	0.31	0.12	**0.28**
O125	0.19	0.15	0.19	0.08	0.11	0.30	0.25	0.33	0.18	**0.20**
O126	0.14	0.10	0.13	0.09	0.14	0.31	0.21	0.19	0.20	**0.16**
O127	0.11	0.07	0.11	0.07	0.03	0.21	0.15	0.08	0.15	**0.11**
O128	0.11	0.10	0.09	0.06	0.16	0.15	0.16	0.14	0.16	**0.12**
O129	0.27	0.23	0.27	0.14	0.10	0.24	0.44	0.51	0.37	**0.28**
O130	0.30	0.24	0.27	0.13	0.26	0.17	0.33	0.40	0.31	**0.27**
O131	0.23	0.21	0.21	0.07	0.18	0.03	0.10	0.13	0.12	**0.15**
O132	0.11	0.09	0.02	0.04	0.52	0.31	0.06	0.10	0.08	**0.14**
O133	0.15	0.20	0.09	0.07	0.45	0.35	0.25	0.18	0.15	**0.21**
O134	0.21	0.24	0.12	0.11	0.05	0.44	0.44	0.52	0.29	**0.26**
O135	0.08	0.15	0.09	0.11	0.05	0.08	0.14	0.20	0.12	**0.11**
O136	0.07	0.02	0.09	0.04	0.04	0.11	0.25	0.23	0.11	**0.11**
O137	0.15	0.06	0.09	0.08	0.01	0.05	0.40	0.47	0.14	**0.16**
O138	0.23	0.28	0.18	0.09	0.06	0.32	0.53	0.58	0.41	**0.29**
O139	0.17	0.11	0.04	0.06	0.01	0.23	0.39	0.38	0.27	**0.18**
O140	0.13	0.06	0.03	0.06	0.01	0.30	0.44	0.43	0.30	**0.19**
O141	0.08	0.11	0.09	0.08	0.10	0.23	0.10	0.04	0.02	**0.10**
O142	0.11	0.14	0.06	0.10	0.09	0.38	0.05	0.06	0.04	**0.12**
O143	0.19	0.12	0.06	0.01	0.03	0.07	0.02	0.02	0.01	**0.07**
O144	0.07	0.23	0.12	0.10	0.39	0.15	0.40	0.26	0.17	**0.21**
O145	0.14	0.24	0.13	0.11	0.25	0.04	0.49	0.44	0.31	**0.23**
O146	0.10	0.22	0.12	0.03	0.21	0.01	0.53	0.49	0.36	**0.22**
O147	0.13	0.18	0.11	0.04	0.38	0.22	0.49	0.51	0.37	**0.26**
O148	0.11	0.24	0.15	0.02	0.16	0.11	0.10	0.07	0.03	**0.12**
O149	0.06	0.22	0.14	0.05	0.39	0.30	0.09	0.05	0.14	**0.16**
O150	0.14	0.18	0.06	0.07	0.48	0.38	0.23	0.08	0.19	**0.20**
O151	0.15	0.14	0.06	0.10	0.26	0.20	0.44	0.42	0.33	**0.22**
O152	0.32	0.28	0.13	0.04	0.26	0.18	0.12	0.09	0.07	**0.18**
O153	0.19	0.08	0.01	0.03	0.33	0.27	0.58	0.60	0.44	**0.26**
O154	0.10	0.18	0.15	0.10	0.32	0.09	0.23	0.14	0.03	**0.15**
O155	0.15	0.29	0.18	0.01	0.58	0.52	0.39	0.10	0.14	**0.27**
O156	0.18	0.28	0.14	0.02	0.42	0.39	0.32	0.03	0.03	**0.21**

Table 6 VR value for the Special Test Points of Baseline Scheme under Summer Condition

	E	ESE	SE	SSE	S	SSW	SW	WSW	W	Overall
Frequency	11.5%	9.5%	9.3%	8.3%	7.9%	8.8%	9.9%	7.2%	4.7%	77.1%
S1	0.10	0.25	0.07	0.10	0.17	0.14	0.50	0.40	0.29	**0.22**
S2	0.15	0.18	0.07	0.07	0.35	0.31	0.55	0.35	0.25	**0.25**
S3	0.02	0.25	0.05	0.10	0.19	0.26	0.48	0.46	0.33	**0.22**
S4	0.14	0.21	0.06	0.06	0.34	0.32	0.55	0.09	0.13	**0.22**
S5	0.02	0.26	0.04	0.01	0.07	0.14	0.47	0.48	0.36	**0.19**
S6	0.13	0.06	0.05	0.06	0.29	0.34	0.57	0.06	0.11	**0.19**
S7	0.06	0.05	0.06	0.05	0.11	0.12	0.46	0.45	0.38	**0.18**
S8	0.13	0.13	0.13	0.24	0.19	0.26	0.51	0.08	0.07	**0.20**
S9	0.15	0.14	0.12	0.23	0.29	0.16	0.48	0.33	0.31	**0.24**
S10	0.03	0.06	0.11	0.20	0.51	0.29	0.25	0.20	0.01	**0.18**
S11	0.04	0.04	0.10	0.19	0.56	0.38	0.34	0.18	0.11	**0.21**
S12	0.01	0.02	0.13	0.21	0.58	0.25	0.23	0.21	0.29	**0.20**
S13	0.10	0.12	0.07	0.10	0.24	0.03	0.11	0.39	0.28	**0.15**
S14	0.01	0.22	0.06	0.11	0.35	0.21	0.20	0.29	0.24	**0.18**
S15	0.03	0.10	0.05	0.11	0.40	0.30	0.16	0.20	0.18	**0.16**
S16	0.01	0.05	0.06	0.09	0.38	0.31	0.21	0.20	0.27	**0.16**
S17	0.03	0.13	0.05	0.04	0.14	0.22	0.17	0.28	0.25	**0.13**
S18	0.01	0.05	0.09	0.03	0.10	0.15	0.34	0.36	0.32	**0.15**
S19	0.01	0.02	0.07	0.05	0.18	0.25	0.27	0.29	0.29	**0.15**
S20	0.11	0.19	0.14	0.11	0.09	0.12	0.42	0.39	0.33	**0.20**

A2 VR Tables for Proposed Scheme

A2.1 Annual Condition

Table 7 VR value for the Perimeter Points of Proposed Scheme under Annual Condition

	NNE	NE	ENE	E	ESE	SE	SSE	S	Overall
Frequency	7.5%	10.1%	17.4%	16.6%	8.4%	5.9%	5.9%	4.9%	76.7%
P1	0.28	0.06	0.11	0.10	0.15	0.17	0.26	0.07	**0.14**
P2	0.31	0.06	0.09	0.03	0.15	0.16	0.27	0.10	**0.12**
P3	0.29	0.08	0.06	0.05	0.14	0.16	0.26	0.24	**0.13**
P4	0.21	0.09	0.05	0.07	0.14	0.15	0.25	0.34	**0.13**
P5	0.08	0.10	0.04	0.08	0.11	0.15	0.25	0.16	**0.10**
P6	0.07	0.10	0.08	0.11	0.12	0.15	0.24	0.11	**0.11**
P7	0.10	0.09	0.09	0.13	0.12	0.16	0.25	0.05	**0.12**
P8	0.14	0.09	0.10	0.16	0.10	0.15	0.24	0.22	**0.14**
P9	0.13	0.07	0.08	0.15	0.08	0.17	0.25	0.21	**0.13**
P10	0.11	0.03	0.08	0.12	0.11	0.17	0.23	0.15	**0.11**
P11	0.11	0.08	0.09	0.14	0.09	0.15	0.17	0.14	**0.11**
P12	0.10	0.07	0.07	0.12	0.09	0.13	0.14	0.25	**0.11**
P13	0.06	0.07	0.13	0.09	0.12	0.13	0.11	0.19	**0.11**
P14	0.04	0.06	0.10	0.06	0.16	0.19	0.15	0.36	**0.11**
P15	0.04	0.13	0.14	0.11	0.07	0.10	0.08	0.49	**0.13**
P16	0.06	0.13	0.12	0.10	0.14	0.12	0.09	0.47	**0.13**
P17	0.06	0.12	0.02	0.09	0.15	0.09	0.06	0.40	**0.10**
P18	0.07	0.05	0.05	0.04	0.14	0.10	0.11	0.26	**0.08**
P19	0.05	0.01	0.06	0.06	0.29	0.18	0.16	0.24	**0.11**
P20	0.03	0.04	0.03	0.08	0.26	0.22	0.18	0.19	**0.10**
P21	0.02	0.05	0.03	0.08	0.15	0.23	0.20	0.12	**0.09**
P22	0.03	0.04	0.04	0.04	0.06	0.22	0.18	0.42	**0.09**
P23	0.02	0.05	0.02	0.06	0.12	0.21	0.07	0.35	**0.08**
P24	0.04	0.01	0.01	0.04	0.06	0.21	0.11	0.45	**0.08**
P25	0.03	0.02	0.01	0.04	0.05	0.18	0.06	0.44	**0.07**
P26	0.06	0.07	0.02	0.02	0.03	0.16	0.01	0.39	**0.07**
P27	0.03	0.12	0.07	0.13	0.22	0.12	0.15	0.15	**0.12**
P28	0.03	0.02	0.02	0.03	0.18	0.12	0.11	0.47	**0.08**
P29	0.06	0.02	0.04	0.03	0.16	0.11	0.11	0.35	**0.08**
P30	0.06	0.04	0.04	0.03	0.14	0.11	0.11	0.34	**0.08**
P31	0.05	0.04	0.09	0.02	0.12	0.08	0.07	0.12	**0.07**
P32	0.11	0.03	0.14	0.08	0.04	0.02	0.03	0.06	**0.08**

P33	0.21	0.08	0.13	0.12	0.09	0.02	0.04	0.03	**0.10**
P34	0.30	0.08	0.09	0.11	0.19	0.12	0.02	0.06	**0.12**
P35	0.13	0.07	0.10	0.15	0.14	0.08	0.15	0.07	**0.11**

Table 8 VR value for the Overall Points of Proposed Scheme under Annual Condition

	NNE	NE	ENE	E	ESE	SE	SSE	S	Overall
Frequency	7.5%	10.1%	17.4%	16.6%	8.4%	5.9%	5.9%	4.9%	76.7%
O1	0.28	0.16	0.17	0.08	0.07	0.05	0.08	0.08	**0.13**
O2	0.14	0.02	0.11	0.06	0.17	0.11	0.11	0.04	**0.09**
O3	0.16	0.05	0.11	0.14	0.31	0.20	0.14	0.10	**0.14**
O4	0.17	0.04	0.11	0.12	0.34	0.23	0.13	0.09	**0.14**
O5	0.03	0.05	0.10	0.12	0.35	0.24	0.10	0.15	**0.13**
O6	0.14	0.07	0.13	0.11	0.32	0.22	0.02	0.22	**0.14**
O7	0.10	0.12	0.14	0.05	0.31	0.23	0.07	0.37	**0.15**
O8	0.08	0.10	0.18	0.19	0.32	0.23	0.06	0.46	**0.19**
O9	0.01	0.10	0.14	0.19	0.15	0.19	0.06	0.06	**0.13**
O10	0.05	0.05	0.10	0.14	0.11	0.12	0.06	0.08	**0.09**
O11	0.04	0.09	0.09	0.10	0.07	0.11	0.06	0.02	**0.08**
O12	0.14	0.15	0.06	0.11	0.12	0.08	0.05	0.17	**0.10**
O13	0.55	0.33	0.18	0.27	0.23	0.27	0.14	0.06	**0.26**
O14	0.11	0.14	0.25	0.30	0.25	0.28	0.11	0.04	**0.21**
O15	0.10	0.07	0.20	0.25	0.21	0.22	0.07	0.45	**0.19**
O16	0.12	0.07	0.07	0.03	0.02	0.01	0.06	0.54	**0.09**
O17	0.36	0.28	0.17	0.17	0.21	0.11	0.07	0.49	**0.21**
O18	0.38	0.28	0.25	0.21	0.23	0.14	0.11	0.03	**0.22**
O19	0.07	0.04	0.13	0.08	0.17	0.10	0.11	0.04	**0.10**
O20	0.11	0.03	0.11	0.07	0.01	0.09	0.03	0.02	**0.07**
O21	0.24	0.09	0.11	0.17	0.03	0.10	0.10	0.02	**0.12**
O22	0.30	0.22	0.20	0.23	0.29	0.18	0.12	0.06	**0.21**
O23	0.08	0.07	0.12	0.16	0.12	0.02	0.03	0.01	**0.10**
O24	0.13	0.08	0.11	0.15	0.04	0.05	0.08	0.02	**0.10**
O25	0.07	0.06	0.05	0.07	0.10	0.09	0.05	0.05	**0.07**
O26	0.02	0.07	0.08	0.12	0.13	0.07	0.07	0.05	**0.08**
O27	0.13	0.09	0.11	0.16	0.12	0.05	0.01	0.03	**0.10**
O28	0.11	0.07	0.08	0.07	0.19	0.10	0.03	0.33	**0.11**
O29	0.09	0.12	0.12	0.14	0.22	0.12	0.05	0.12	**0.13**
O30	0.21	0.17	0.13	0.11	0.22	0.12	0.02	0.09	**0.14**
O31	0.42	0.22	0.15	0.13	0.20	0.10	0.09	0.39	**0.19**
O32	0.22	0.11	0.09	0.09	0.24	0.14	0.02	0.13	**0.12**

O33	0.24	0.11	0.08	0.03	0.22	0.13	0.11	0.41	**0.13**
O34	0.15	0.04	0.10	0.14	0.18	0.02	0.08	0.45	**0.13**
O35	0.23	0.09	0.09	0.16	0.13	0.05	0.08	0.26	**0.13**
O36	0.22	0.27	0.27	0.32	0.26	0.10	0.06	0.24	**0.24**
O37	0.32	0.20	0.15	0.18	0.07	0.07	0.07	0.39	**0.18**
O38	0.12	0.04	0.06	0.11	0.20	0.14	0.12	0.32	**0.12**
O39	0.23	0.22	0.18	0.15	0.27	0.15	0.02	0.58	**0.21**
O40	0.17	0.21	0.18	0.16	0.28	0.11	0.03	0.42	**0.19**
O41	0.15	0.17	0.15	0.13	0.20	0.08	0.04	0.31	**0.15**
O42	0.12	0.20	0.20	0.19	0.27	0.14	0.17	0.05	**0.18**
O43	0.24	0.24	0.21	0.20	0.03	0.01	0.13	0.13	**0.17**
O44	0.21	0.30	0.30	0.23	0.26	0.04	0.02	0.53	**0.24**
O45	0.08	0.06	0.06	0.04	0.03	0.04	0.26	0.39	**0.09**
O46	0.10	0.07	0.07	0.04	0.04	0.03	0.21	0.29	**0.08**
O47	0.07	0.17	0.23	0.27	0.20	0.11	0.09	0.13	**0.19**
O48	0.27	0.30	0.20	0.23	0.12	0.08	0.04	0.24	**0.20**
O49	0.28	0.30	0.19	0.23	0.03	0.05	0.13	0.42	**0.20**
O50	0.19	0.23	0.22	0.20	0.21	0.14	0.15	0.56	**0.22**
O51	0.17	0.10	0.03	0.08	0.08	0.11	0.31	0.52	**0.13**
O52	0.14	0.13	0.10	0.11	0.12	0.12	0.31	0.51	**0.16**
O53	0.05	0.02	0.04	0.07	0.04	0.03	0.30	0.50	**0.09**
O54	0.35	0.17	0.11	0.11	0.15	0.08	0.26	0.44	**0.18**
O55	0.20	0.03	0.06	0.04	0.01	0.03	0.20	0.44	**0.09**
O56	0.12	0.14	0.10	0.12	0.06	0.04	0.16	0.44	**0.13**
O57	0.06	0.09	0.07	0.07	0.03	0.03	0.11	0.34	**0.08**
O58	0.12	0.11	0.15	0.17	0.19	0.08	0.11	0.34	**0.15**
O59	0.16	0.13	0.09	0.09	0.09	0.06	0.13	0.38	**0.12**
O60	0.19	0.12	0.14	0.02	0.03	0.03	0.14	0.33	**0.11**
O61	0.13	0.05	0.24	0.20	0.13	0.06	0.07	0.22	**0.15**
O62	0.13	0.07	0.18	0.18	0.03	0.03	0.05	0.19	**0.12**
O63	0.07	0.07	0.04	0.08	0.10	0.14	0.16	0.26	**0.09**
O64	0.06	0.04	0.05	0.10	0.05	0.09	0.06	0.15	**0.07**
O65	0.05	0.04	0.08	0.03	0.05	0.10	0.19	0.04	**0.07**
O66	0.30	0.22	0.24	0.07	0.05	0.13	0.16	0.06	**0.16**
O67	0.13	0.01	0.17	0.23	0.16	0.11	0.32	0.05	**0.16**
O68	0.09	0.02	0.14	0.10	0.09	0.03	0.35	0.30	**0.12**
O69	0.08	0.18	0.12	0.05	0.07	0.14	0.36	0.40	**0.14**
O70	0.08	0.09	0.10	0.13	0.02	0.09	0.35	0.35	**0.13**
O71	0.44	0.09	0.03	0.08	0.08	0.09	0.33	0.43	**0.15**

O72	0.28	0.22	0.15	0.19	0.11	0.17	0.31	0.44	**0.21**
O73	0.08	0.04	0.06	0.06	0.09	0.21	0.27	0.43	**0.11**
O74	0.18	0.15	0.12	0.17	0.12	0.22	0.24	0.39	**0.18**
O75	0.08	0.07	0.09	0.13	0.17	0.22	0.23	0.35	**0.14**
O76	0.12	0.16	0.09	0.09	0.18	0.21	0.24	0.35	**0.15**
O77	0.19	0.13	0.12	0.08	0.09	0.21	0.19	0.39	**0.14**
O78	0.04	0.18	0.29	0.27	0.11	0.18	0.11	0.37	**0.21**
O79	0.20	0.04	0.19	0.22	0.09	0.12	0.04	0.24	**0.15**
O80	0.28	0.21	0.16	0.21	0.07	0.10	0.02	0.33	**0.17**
O81	0.11	0.20	0.11	0.04	0.09	0.11	0.03	0.45	**0.12**
O82	0.15	0.04	0.07	0.02	0.15	0.30	0.32	0.38	**0.13**
O83	0.13	0.06	0.07	0.01	0.11	0.29	0.31	0.23	**0.11**
O84	0.10	0.16	0.05	0.05	0.08	0.26	0.30	0.03	**0.11**
O85	0.03	0.24	0.03	0.08	0.07	0.24	0.30	0.13	**0.12**
O86	0.35	0.18	0.22	0.10	0.08	0.24	0.30	0.17	**0.19**
O87	0.16	0.05	0.20	0.01	0.13	0.26	0.29	0.18	**0.14**
O88	0.12	0.08	0.12	0.20	0.12	0.26	0.29	0.12	**0.16**
O89	0.21	0.07	0.07	0.03	0.14	0.23	0.29	0.05	**0.11**
O90	0.36	0.09	0.08	0.05	0.14	0.16	0.28	0.26	**0.14**
O91	0.23	0.10	0.04	0.04	0.13	0.16	0.27	0.19	**0.11**
O92	0.09	0.09	0.07	0.09	0.14	0.17	0.28	0.17	**0.12**
O93	0.12	0.07	0.06	0.11	0.14	0.17	0.25	0.16	**0.12**
O94	0.12	0.04	0.08	0.06	0.15	0.17	0.24	0.29	**0.11**
O95	0.09	0.04	0.05	0.08	0.13	0.15	0.22	0.26	**0.10**
O96	0.12	0.06	0.06	0.14	0.11	0.08	0.18	0.16	**0.10**
O97	0.07	0.10	0.07	0.08	0.04	0.07	0.14	0.16	**0.08**
O98	0.12	0.14	0.09	0.12	0.25	0.20	0.12	0.29	**0.15**
O99	0.23	0.13	0.12	0.16	0.23	0.15	0.08	0.37	**0.17**
O100	0.01	0.13	0.06	0.08	0.27	0.18	0.06	0.39	**0.12**
O101	0.04	0.01	0.05	0.06	0.27	0.16	0.05	0.40	**0.10**
O102	0.04	0.02	0.06	0.06	0.28	0.15	0.04	0.37	**0.10**
O103	0.27	0.05	0.21	0.12	0.12	0.03	0.02	0.16	**0.13**
O104	0.23	0.02	0.20	0.17	0.03	0.04	0.06	0.25	**0.13**
O105	0.13	0.01	0.19	0.10	0.08	0.01	0.06	0.12	**0.10**
O106	0.09	0.07	0.03	0.03	0.22	0.14	0.13	0.35	**0.10**
O107	0.13	0.13	0.03	0.04	0.18	0.11	0.10	0.34	**0.10**
O108	0.16	0.18	0.08	0.09	0.20	0.25	0.27	0.47	**0.17**
O109	0.16	0.20	0.07	0.08	0.19	0.23	0.25	0.38	**0.16**
O110	0.12	0.22	0.06	0.04	0.18	0.24	0.26	0.27	**0.14**

O111	0.26	0.13	0.05	0.06	0.12	0.24	0.27	0.03	**0.12**
O112	0.32	0.04	0.24	0.06	0.12	0.21	0.26	0.12	**0.16**
O113	0.16	0.19	0.07	0.10	0.18	0.15	0.08	0.35	**0.14**
O114	0.11	0.20	0.09	0.10	0.16	0.12	0.03	0.36	**0.13**
O115	0.03	0.18	0.10	0.08	0.17	0.13	0.02	0.33	**0.12**
O116	0.37	0.10	0.08	0.06	0.15	0.10	0.02	0.25	**0.12**
O117	0.31	0.06	0.23	0.06	0.17	0.11	0.08	0.06	**0.14**
O118	0.15	0.17	0.08	0.12	0.10	0.06	0.05	0.39	**0.12**
O119	0.31	0.13	0.14	0.08	0.16	0.03	0.02	0.28	**0.14**
O120	0.35	0.10	0.13	0.07	0.17	0.04	0.05	0.22	**0.13**
O121	0.29	0.08	0.22	0.05	0.19	0.07	0.06	0.34	**0.15**
O122	0.05	0.11	0.07	0.05	0.20	0.08	0.05	0.39	**0.10**
O123	0.04	0.08	0.02	0.04	0.11	0.05	0.06	0.14	**0.06**
O124	0.16	0.11	0.08	0.04	0.24	0.12	0.09	0.33	**0.12**
O125	0.18	0.09	0.04	0.05	0.21	0.11	0.08	0.36	**0.11**
O126	0.19	0.16	0.05	0.11	0.21	0.14	0.03	0.40	**0.14**
O127	0.16	0.16	0.08	0.08	0.28	0.15	0.08	0.19	**0.13**
O128	0.19	0.16	0.03	0.12	0.25	0.16	0.07	0.23	**0.13**
O129	0.20	0.16	0.11	0.15	0.25	0.17	0.07	0.19	**0.16**
O130	0.17	0.05	0.09	0.02	0.07	0.03	0.06	0.15	**0.07**
O131	0.13	0.02	0.14	0.03	0.07	0.04	0.07	0.18	**0.08**
O132	0.03	0.01	0.18	0.08	0.02	0.04	0.02	0.01	**0.07**
O133	0.02	0.02	0.01	0.02	0.05	0.14	0.17	0.47	**0.07**
O134	0.06	0.07	0.18	0.15	0.04	0.01	0.03	0.22	**0.11**
O135	0.02	0.05	0.19	0.10	0.10	0.01	0.08	0.19	**0.10**
O96	0.03	0.03	0.10	0.08	0.04	0.03	0.04	0.17	**0.07**
O97	0.03	0.02	0.06	0.03	0.12	0.05	0.11	0.18	**0.06**
O98	0.02	0.11	0.04	0.10	0.10	0.05	0.06	0.09	**0.07**
O99	0.02	0.11	0.04	0.12	0.27	0.07	0.22	0.55	**0.14**
O100	0.04	0.12	0.04	0.06	0.23	0.04	0.13	0.37	**0.10**
O101	0.06	0.09	0.03	0.02	0.27	0.04	0.03	0.08	**0.07**
O102	0.03	0.05	0.01	0.02	0.03	0.05	0.08	0.32	**0.05**
O103	0.01	0.06	0.02	0.03	0.03	0.04	0.08	0.33	**0.05**
O104	0.03	0.04	0.01	0.05	0.17	0.04	0.05	0.27	**0.07**
O105	0.01	0.04	0.02	0.01	0.08	0.13	0.03	0.17	**0.05**
O106	0.02	0.05	0.02	0.04	0.04	0.14	0.08	0.40	**0.07**
O107	0.01	0.03	0.02	0.02	0.10	0.07	0.06	0.31	**0.06**
O108	0.13	0.11	0.04	0.06	0.16	0.14	0.12	0.28	**0.10**
O109	0.14	0.14	0.07	0.06	0.13	0.07	0.06	0.26	**0.10**

O110	0.08	0.17	0.05	0.05	0.14	0.03	0.02	0.21	**0.09**
O111	0.17	0.17	0.05	0.04	0.16	0.09	0.08	0.29	**0.11**
O112	0.07	0.19	0.04	0.05	0.12	0.02	0.02	0.02	**0.07**
O113	0.18	0.17	0.04	0.04	0.16	0.06	0.08	0.27	**0.10**
O114	0.09	0.19	0.05	0.03	0.13	0.03	0.01	0.13	**0.08**
O115	0.18	0.15	0.08	0.05	0.24	0.08	0.09	0.28	**0.12**
O116	0.06	0.16	0.15	0.04	0.35	0.12	0.07	0.15	**0.13**
O117	0.28	0.16	0.17	0.08	0.07	0.05	0.08	0.08	**0.13**
O118	0.14	0.02	0.11	0.06	0.17	0.11	0.11	0.04	**0.09**
O119	0.16	0.05	0.11	0.14	0.31	0.20	0.14	0.10	**0.14**
O120	0.17	0.04	0.11	0.12	0.34	0.23	0.13	0.09	**0.14**
O121	0.03	0.05	0.10	0.12	0.35	0.24	0.10	0.15	**0.13**
O122	0.14	0.07	0.13	0.11	0.32	0.22	0.02	0.22	**0.14**
O123	0.10	0.12	0.14	0.05	0.31	0.23	0.07	0.37	**0.15**
O124	0.08	0.10	0.18	0.19	0.32	0.23	0.06	0.46	**0.19**
O125	0.01	0.10	0.14	0.19	0.15	0.19	0.06	0.06	**0.13**
O126	0.05	0.05	0.10	0.14	0.11	0.12	0.06	0.08	**0.09**
O127	0.04	0.09	0.09	0.10	0.07	0.11	0.06	0.02	**0.08**
O128	0.14	0.15	0.06	0.11	0.12	0.08	0.05	0.17	**0.10**
O129	0.55	0.33	0.18	0.27	0.23	0.27	0.14	0.06	**0.26**
O130	0.11	0.14	0.25	0.30	0.25	0.28	0.11	0.04	**0.21**
O131	0.10	0.07	0.20	0.25	0.21	0.22	0.07	0.45	**0.19**
O132	0.12	0.07	0.07	0.03	0.02	0.01	0.06	0.54	**0.09**
O133	0.36	0.28	0.17	0.17	0.21	0.11	0.07	0.49	**0.21**
O134	0.38	0.28	0.25	0.21	0.23	0.14	0.11	0.03	**0.22**
O135	0.07	0.04	0.13	0.08	0.17	0.10	0.11	0.04	**0.10**
O136	0.11	0.03	0.11	0.07	0.01	0.09	0.03	0.02	**0.07**
O137	0.24	0.09	0.11	0.17	0.03	0.10	0.10	0.02	**0.12**
O138	0.30	0.22	0.20	0.23	0.29	0.18	0.12	0.06	**0.21**
O139	0.08	0.07	0.12	0.16	0.12	0.02	0.03	0.01	**0.10**
O140	0.13	0.08	0.11	0.15	0.04	0.05	0.08	0.02	**0.10**
O141	0.07	0.06	0.05	0.07	0.10	0.09	0.05	0.05	**0.07**
O142	0.02	0.07	0.08	0.12	0.13	0.07	0.07	0.05	**0.08**
O143	0.13	0.09	0.11	0.16	0.12	0.05	0.01	0.03	**0.10**
O144	0.11	0.07	0.08	0.07	0.19	0.10	0.03	0.33	**0.11**
O145	0.09	0.12	0.12	0.14	0.22	0.12	0.05	0.12	**0.13**
O146	0.21	0.17	0.13	0.11	0.22	0.12	0.02	0.09	**0.14**
O147	0.42	0.22	0.15	0.13	0.20	0.10	0.09	0.39	**0.19**
O148	0.22	0.11	0.09	0.09	0.24	0.14	0.02	0.13	**0.12**

O149	0.24	0.11	0.08	0.03	0.22	0.13	0.11	0.41	**0.13**
O150	0.15	0.04	0.10	0.14	0.18	0.02	0.08	0.45	**0.13**
O151	0.23	0.09	0.09	0.16	0.13	0.05	0.08	0.26	**0.13**
O152	0.22	0.27	0.27	0.32	0.26	0.10	0.06	0.24	**0.24**
O153	0.32	0.20	0.15	0.18	0.07	0.07	0.07	0.39	**0.18**
O154	0.12	0.04	0.06	0.11	0.20	0.14	0.12	0.32	**0.12**
O155	0.23	0.22	0.18	0.15	0.27	0.15	0.02	0.58	**0.21**
O156	0.17	0.21	0.18	0.16	0.28	0.11	0.03	0.42	**0.19**

Table 9 VR value for the Special Test Points of Proposed Scheme under Annual Condition

	NNE	NE	ENE	E	ESE	SE	SSE	S	Overall
Frequency	7.5%	10.1%	17.4%	16.6%	8.4%	5.9%	5.9%	4.9%	76.7%
S1	0.07	0.13	0.08	0.14	0.21	0.02	0.10	0.18	**0.12**
S2	0.06	0.10	0.08	0.15	0.14	0.03	0.12	0.33	**0.12**
S3	0.09	0.11	0.07	0.10	0.24	0.04	0.10	0.25	**0.11**
S4	0.05	0.07	0.07	0.13	0.23	0.05	0.10	0.35	**0.12**
S5	0.08	0.09	0.08	0.08	0.28	0.06	0.08	0.29	**0.12**
S6	0.11	0.05	0.05	0.10	0.09	0.07	0.07	0.34	**0.09**
S7	0.10	0.09	0.08	0.11	0.19	0.07	0.07	0.23	**0.11**
S8	0.04	0.09	0.08	0.13	0.10	0.07	0.20	0.28	**0.11**
S9	0.04	0.09	0.10	0.15	0.10	0.02	0.10	0.02	**0.09**
S10	0.03	0.07	0.13	0.05	0.04	0.18	0.20	0.52	**0.12**
S11	0.01	0.08	0.11	0.10	0.01	0.16	0.20	0.53	**0.12**
S12	0.01	0.06	0.02	0.01	0.01	0.17	0.20	0.56	**0.08**
S13	0.02	0.11	0.02	0.07	0.05	0.10	0.08	0.18	**0.07**
S14	0.05	0.08	0.02	0.03	0.19	0.11	0.14	0.32	**0.09**
S15	0.09	0.01	0.03	0.03	0.09	0.07	0.16	0.37	**0.08**
S16	0.05	0.01	0.04	0.01	0.06	0.06	0.15	0.35	**0.06**
S17	0.02	0.04	0.01	0.02	0.06	0.04	0.11	0.16	**0.04**
S18	0.02	0.01	0.01	0.02	0.02	0.08	0.07	0.09	**0.03**
S19	0.01	0.04	0.03	0.03	0.07	0.07	0.05	0.17	**0.05**
S20	0.05	0.03	0.05	0.08	0.20	0.16	0.14	0.10	**0.09**

A2.2 Summer Condition

Table 10 VR value for the Perimeter Points of Baseline Scheme under Summer Condition

	E	ESE	SE	SSE	S	SSW	SW	WSW	W	Overall
Frequency	11.5%	9.5%	9.3%	8.3%	7.9%	8.8%	9.9%	7.2%	4.7%	77.1%
P1	0.10	0.15	0.17	0.26	0.07	0.07	0.25	0.25	0.30	**0.17**

P2	0.03	0.15	0.16	0.27	0.10	0.04	0.29	0.33	0.34	**0.17**
P3	0.05	0.14	0.16	0.26	0.24	0.12	0.19	0.34	0.31	**0.19**
P4	0.07	0.14	0.15	0.25	0.34	0.22	0.04	0.10	0.32	**0.17**
P5	0.08	0.11	0.15	0.25	0.16	0.15	0.19	0.28	0.14	**0.16**
P6	0.11	0.12	0.15	0.24	0.11	0.20	0.35	0.28	0.07	**0.18**
P7	0.13	0.12	0.16	0.25	0.05	0.07	0.21	0.50	0.12	**0.17**
P8	0.16	0.10	0.15	0.24	0.22	0.17	0.11	0.20	0.16	**0.16**
P9	0.15	0.08	0.17	0.25	0.21	0.17	0.06	0.04	0.07	**0.13**
P10	0.12	0.11	0.17	0.23	0.15	0.14	0.18	0.10	0.04	**0.14**
P11	0.14	0.09	0.15	0.17	0.14	0.13	0.15	0.14	0.03	**0.13**
P12	0.12	0.09	0.13	0.14	0.25	0.18	0.03	0.12	0.04	**0.12**
P13	0.09	0.12	0.13	0.11	0.19	0.18	0.11	0.11	0.03	**0.12**
P14	0.06	0.16	0.19	0.15	0.36	0.16	0.04	0.05	0.03	**0.13**
P15	0.11	0.07	0.10	0.08	0.49	0.27	0.05	0.10	0.04	**0.14**
P16	0.10	0.14	0.12	0.09	0.47	0.28	0.10	0.03	0.03	**0.15**
P17	0.09	0.15	0.09	0.06	0.40	0.18	0.08	0.08	0.01	**0.13**
P18	0.04	0.14	0.10	0.11	0.26	0.14	0.11	0.04	0.02	**0.11**
P19	0.06	0.29	0.18	0.16	0.24	0.12	0.33	0.25	0.24	**0.20**
P20	0.08	0.26	0.22	0.18	0.19	0.15	0.35	0.38	0.25	**0.22**
P21	0.08	0.15	0.23	0.20	0.12	0.14	0.10	0.20	0.15	**0.15**
P22	0.04	0.06	0.22	0.18	0.42	0.42	0.17	0.28	0.20	**0.21**
P23	0.06	0.12	0.21	0.07	0.35	0.33	0.26	0.27	0.15	**0.20**
P24	0.04	0.06	0.21	0.11	0.45	0.35	0.21	0.35	0.20	**0.21**
P25	0.04	0.05	0.18	0.06	0.44	0.34	0.26	0.16	0.16	**0.18**
P26	0.02	0.03	0.16	0.01	0.39	0.25	0.10	0.46	0.20	**0.16**
P27	0.13	0.22	0.12	0.15	0.15	0.11	0.41	0.38	0.31	**0.21**
P28	0.03	0.18	0.12	0.11	0.47	0.33	0.39	0.34	0.26	**0.24**
P29	0.03	0.16	0.11	0.11	0.35	0.25	0.06	0.37	0.25	**0.17**
P30	0.03	0.14	0.11	0.11	0.34	0.33	0.15	0.19	0.19	**0.17**
P31	0.02	0.12	0.08	0.07	0.12	0.19	0.30	0.19	0.09	**0.13**
P32	0.08	0.04	0.02	0.03	0.06	0.35	0.38	0.15	0.16	**0.14**
P33	0.12	0.09	0.02	0.04	0.03	0.33	0.39	0.19	0.19	**0.16**
P34	0.11	0.19	0.12	0.02	0.06	0.25	0.40	0.28	0.27	**0.18**
P35	0.15	0.14	0.08	0.15	0.07	0.22	0.41	0.35	0.39	**0.21**

Table 11 VR value for the Overall Points of Baseline Scheme under Summer Condition

	E	ESE	SE	SSE	S	SSW	SW	WSW	W	Overall
Frequency	11.5%	9.5%	9.3%	8.3%	7.9%	8.8%	9.9%	7.2%	4.7%	77.1%
O1	0.08	0.07	0.05	0.08	0.08	0.06	0.23	0.45	0.25	**0.14**

O2	0.06	0.17	0.11	0.11	0.04	0.12	0.06	0.05	0.12	**0.09**
O3	0.14	0.31	0.20	0.14	0.10	0.05	0.12	0.15	0.15	**0.15**
O4	0.12	0.34	0.23	0.13	0.09	0.08	0.09	0.33	0.26	**0.18**
O5	0.12	0.35	0.24	0.10	0.15	0.11	0.13	0.11	0.11	**0.16**
O6	0.11	0.32	0.22	0.02	0.22	0.05	0.19	0.06	0.09	**0.15**
O7	0.05	0.31	0.23	0.07	0.37	0.30	0.23	0.13	0.06	**0.20**
O8	0.19	0.32	0.23	0.06	0.46	0.38	0.44	0.29	0.07	**0.28**
O9	0.19	0.15	0.19	0.06	0.06	0.28	0.25	0.33	0.18	**0.19**
O10	0.14	0.11	0.12	0.06	0.08	0.28	0.21	0.19	0.20	**0.15**
O11	0.10	0.07	0.11	0.06	0.02	0.20	0.15	0.12	0.18	**0.11**
O12	0.11	0.12	0.08	0.05	0.17	0.17	0.15	0.17	0.17	**0.13**
O13	0.27	0.23	0.27	0.14	0.06	0.24	0.41	0.49	0.37	**0.27**
O14	0.30	0.25	0.28	0.11	0.04	0.14	0.32	0.39	0.30	**0.24**
O15	0.25	0.21	0.22	0.07	0.45	0.05	0.14	0.18	0.13	**0.19**
O16	0.03	0.02	0.01	0.06	0.54	0.16	0.03	0.02	0.05	**0.10**
O17	0.17	0.21	0.11	0.07	0.49	0.26	0.19	0.19	0.13	**0.20**
O18	0.21	0.23	0.14	0.11	0.03	0.38	0.43	0.53	0.29	**0.26**
O19	0.08	0.17	0.10	0.11	0.04	0.06	0.16	0.07	0.11	**0.10**
O20	0.07	0.01	0.09	0.03	0.02	0.09	0.27	0.24	0.13	**0.10**
O21	0.17	0.03	0.10	0.10	0.02	0.09	0.48	0.56	0.23	**0.19**
O22	0.23	0.29	0.18	0.12	0.06	0.49	0.56	0.60	0.45	**0.32**
O23	0.16	0.12	0.02	0.03	0.01	0.30	0.38	0.34	0.24	**0.17**
O24	0.15	0.04	0.05	0.08	0.02	0.38	0.44	0.44	0.31	**0.20**
O25	0.07	0.10	0.09	0.05	0.05	0.35	0.06	0.04	0.02	**0.10**
O26	0.12	0.13	0.07	0.07	0.05	0.38	0.06	0.06	0.04	**0.12**
O27	0.16	0.12	0.05	0.01	0.03	0.03	0.02	0.02	0.03	**0.06**
O28	0.07	0.19	0.10	0.03	0.33	0.09	0.49	0.40	0.27	**0.21**
O29	0.14	0.22	0.12	0.05	0.12	0.06	0.54	0.54	0.39	**0.23**
O30	0.11	0.22	0.12	0.02	0.09	0.01	0.56	0.54	0.40	**0.22**
O31	0.13	0.20	0.10	0.09	0.39	0.37	0.47	0.52	0.38	**0.28**
O32	0.09	0.24	0.14	0.02	0.13	0.13	0.04	0.05	0.02	**0.10**
O33	0.03	0.22	0.13	0.11	0.41	0.30	0.08	0.03	0.14	**0.16**
O34	0.14	0.18	0.02	0.08	0.45	0.36	0.22	0.03	0.18	**0.18**
O35	0.16	0.13	0.05	0.08	0.26	0.20	0.40	0.44	0.31	**0.21**
O36	0.32	0.26	0.10	0.06	0.24	0.18	0.21	0.18	0.11	**0.20**
O37	0.18	0.07	0.07	0.07	0.39	0.32	0.57	0.63	0.45	**0.29**
O38	0.11	0.20	0.14	0.12	0.32	0.16	0.20	0.12	0.10	**0.17**
O39	0.15	0.27	0.15	0.02	0.58	0.52	0.40	0.12	0.09	**0.26**
O40	0.16	0.28	0.11	0.03	0.42	0.41	0.32	0.02	0.04	**0.21**

O41	0.13	0.20	0.08	0.04	0.31	0.37	0.07	0.04	0.04	**0.15**
O42	0.19	0.27	0.14	0.17	0.05	0.35	0.12	0.52	0.21	**0.22**
O43	0.20	0.03	0.01	0.13	0.13	0.46	0.20	0.46	0.18	**0.19**
O44	0.23	0.26	0.04	0.02	0.53	0.38	0.36	0.41	0.41	**0.28**
O45	0.04	0.03	0.04	0.26	0.39	0.47	0.32	0.39	0.41	**0.24**
O46	0.04	0.04	0.03	0.21	0.29	0.15	0.15	0.36	0.39	**0.16**
O47	0.27	0.20	0.11	0.09	0.13	0.23	0.10	0.42	0.43	**0.20**
O48	0.23	0.12	0.08	0.04	0.24	0.39	0.39	0.25	0.34	**0.22**
O49	0.23	0.03	0.05	0.13	0.42	0.50	0.47	0.37	0.09	**0.26**
O50	0.20	0.21	0.14	0.15	0.56	0.62	0.55	0.39	0.04	**0.33**
O51	0.08	0.08	0.11	0.31	0.52	0.24	0.21	0.22	0.19	**0.21**
O52	0.11	0.12	0.12	0.31	0.51	0.29	0.25	0.27	0.23	**0.23**
O53	0.07	0.04	0.03	0.30	0.50	0.37	0.32	0.37	0.26	**0.24**
O54	0.11	0.15	0.08	0.26	0.44	0.38	0.28	0.35	0.29	**0.25**
O55	0.04	0.01	0.03	0.20	0.44	0.41	0.17	0.32	0.27	**0.20**
O56	0.12	0.06	0.04	0.16	0.44	0.45	0.30	0.37	0.31	**0.23**
O57	0.07	0.03	0.03	0.11	0.34	0.38	0.27	0.42	0.36	**0.20**
O58	0.17	0.19	0.08	0.11	0.34	0.38	0.04	0.46	0.40	**0.22**
O59	0.09	0.09	0.06	0.13	0.38	0.40	0.27	0.40	0.38	**0.23**
O60	0.02	0.03	0.03	0.14	0.33	0.29	0.27	0.39	0.37	**0.18**
O61	0.20	0.13	0.06	0.07	0.22	0.17	0.23	0.33	0.36	**0.19**
O62	0.18	0.03	0.03	0.05	0.19	0.21	0.20	0.18	0.34	**0.15**
O63	0.08	0.10	0.14	0.16	0.26	0.33	0.17	0.31	0.23	**0.19**
O64	0.10	0.05	0.09	0.06	0.15	0.04	0.28	0.23	0.25	**0.13**
O65	0.03	0.05	0.10	0.19	0.04	0.16	0.34	0.32	0.28	**0.16**
O66	0.07	0.05	0.13	0.16	0.06	0.35	0.41	0.37	0.26	**0.20**
O67	0.23	0.16	0.11	0.32	0.05	0.46	0.36	0.43	0.26	**0.26**
O68	0.10	0.09	0.03	0.35	0.30	0.47	0.34	0.39	0.28	**0.25**
O69	0.05	0.07	0.14	0.36	0.40	0.05	0.30	0.39	0.31	**0.21**
O70	0.13	0.02	0.09	0.35	0.35	0.32	0.37	0.44	0.32	**0.25**
O71	0.08	0.08	0.09	0.33	0.43	0.33	0.32	0.40	0.35	**0.25**
O72	0.19	0.11	0.17	0.31	0.44	0.34	0.32	0.30	0.36	**0.27**
O73	0.06	0.09	0.21	0.27	0.43	0.36	0.17	0.22	0.30	**0.22**
O74	0.17	0.12	0.22	0.24	0.39	0.38	0.17	0.37	0.33	**0.25**
O75	0.13	0.17	0.22	0.23	0.35	0.37	0.17	0.37	0.32	**0.25**
O76	0.09	0.18	0.21	0.24	0.35	0.33	0.30	0.40	0.30	**0.26**
O77	0.08	0.09	0.21	0.19	0.39	0.22	0.35	0.17	0.30	**0.21**
O78	0.27	0.11	0.18	0.11	0.37	0.12	0.33	0.05	0.29	**0.20**
O79	0.22	0.09	0.12	0.04	0.24	0.18	0.30	0.05	0.27	**0.17**

O80	0.21	0.07	0.10	0.02	0.33	0.25	0.30	0.13	0.22	**0.18**
O81	0.04	0.09	0.11	0.03	0.45	0.36	0.35	0.24	0.06	**0.19**
O82	0.02	0.15	0.30	0.32	0.38	0.10	0.27	0.13	0.24	**0.20**
O83	0.01	0.11	0.29	0.31	0.23	0.18	0.29	0.21	0.25	**0.20**
O84	0.05	0.08	0.26	0.30	0.03	0.20	0.26	0.26	0.24	**0.18**
O85	0.08	0.07	0.24	0.30	0.13	0.24	0.23	0.33	0.23	**0.20**
O86	0.10	0.08	0.24	0.30	0.17	0.33	0.29	0.39	0.16	**0.23**
O87	0.01	0.13	0.26	0.29	0.18	0.40	0.27	0.26	0.20	**0.21**
O88	0.20	0.12	0.26	0.29	0.12	0.34	0.39	0.32	0.31	**0.26**
O89	0.03	0.14	0.23	0.29	0.05	0.19	0.33	0.39	0.40	**0.21**
O90	0.05	0.14	0.16	0.28	0.26	0.23	0.18	0.36	0.35	**0.20**
O91	0.04	0.13	0.16	0.27	0.19	0.09	0.07	0.11	0.29	**0.14**
O92	0.09	0.14	0.17	0.28	0.17	0.13	0.32	0.05	0.17	**0.17**
O93	0.11	0.14	0.17	0.25	0.16	0.18	0.16	0.34	0.21	**0.18**
O94	0.06	0.15	0.17	0.24	0.29	0.25	0.12	0.09	0.20	**0.17**
O95	0.08	0.13	0.15	0.22	0.26	0.17	0.19	0.14	0.02	**0.15**
O96	0.14	0.11	0.08	0.18	0.16	0.29	0.05	0.24	0.05	**0.14**
O97	0.08	0.04	0.07	0.14	0.16	0.31	0.04	0.19	0.09	**0.12**
O98	0.12	0.25	0.20	0.12	0.29	0.41	0.36	0.29	0.07	**0.24**
O99	0.16	0.23	0.15	0.08	0.37	0.37	0.39	0.31	0.13	**0.25**
O100	0.08	0.27	0.18	0.06	0.39	0.35	0.29	0.33	0.09	**0.23**
O101	0.06	0.27	0.16	0.05	0.40	0.27	0.17	0.19	0.11	**0.18**
O102	0.06	0.28	0.15	0.04	0.37	0.20	0.17	0.05	0.13	**0.16**
O103	0.12	0.12	0.03	0.02	0.16	0.22	0.15	0.01	0.10	**0.10**
O104	0.17	0.03	0.04	0.06	0.25	0.13	0.15	0.04	0.15	**0.11**
O105	0.10	0.08	0.01	0.06	0.12	0.41	0.40	0.11	0.16	**0.16**
O106	0.03	0.22	0.14	0.13	0.35	0.07	0.19	0.23	0.22	**0.16**
O107	0.04	0.18	0.11	0.10	0.34	0.37	0.06	0.12	0.16	**0.16**
O108	0.09	0.20	0.25	0.27	0.47	0.11	0.29	0.21	0.24	**0.23**
O109	0.08	0.19	0.23	0.25	0.38	0.15	0.28	0.24	0.23	**0.22**
O110	0.04	0.18	0.24	0.26	0.27	0.16	0.22	0.32	0.20	**0.20**
O111	0.06	0.12	0.24	0.27	0.03	0.23	0.28	0.35	0.11	**0.19**
O112	0.06	0.12	0.21	0.26	0.12	0.42	0.29	0.27	0.18	**0.21**
O113	0.10	0.18	0.15	0.08	0.35	0.06	0.28	0.23	0.17	**0.17**
O114	0.10	0.16	0.12	0.03	0.36	0.10	0.20	0.31	0.10	**0.16**
O115	0.08	0.17	0.13	0.02	0.33	0.18	0.16	0.30	0.10	**0.16**
O116	0.06	0.15	0.10	0.02	0.25	0.17	0.27	0.26	0.14	**0.15**
O117	0.06	0.17	0.11	0.08	0.06	0.38	0.26	0.20	0.15	**0.16**
O118	0.12	0.10	0.06	0.05	0.39	0.02	0.20	0.22	0.10	**0.14**

O119	0.08	0.16	0.03	0.02	0.28	0.18	0.24	0.21	0.11	**0.14**
O120	0.07	0.17	0.04	0.05	0.22	0.16	0.25	0.19	0.11	**0.14**
O121	0.05	0.19	0.07	0.06	0.34	0.26	0.19	0.17	0.10	**0.16**
O122	0.05	0.20	0.08	0.05	0.39	0.31	0.11	0.12	0.04	**0.15**
O123	0.04	0.11	0.05	0.06	0.14	0.11	0.14	0.13	0.02	**0.09**
O124	0.04	0.24	0.12	0.09	0.33	0.32	0.26	0.21	0.04	**0.18**
O125	0.05	0.21	0.11	0.08	0.36	0.26	0.28	0.20	0.02	**0.18**
O126	0.11	0.21	0.14	0.03	0.40	0.29	0.26	0.22	0.02	**0.19**
O127	0.08	0.28	0.15	0.08	0.19	0.15	0.25	0.27	0.12	**0.17**
O128	0.12	0.25	0.16	0.07	0.23	0.22	0.23	0.24	0.08	**0.18**
O129	0.15	0.25	0.17	0.07	0.19	0.32	0.34	0.17	0.02	**0.20**
O130	0.02	0.07	0.03	0.06	0.15	0.12	0.04	0.05	0.02	**0.06**
O131	0.03	0.07	0.04	0.07	0.18	0.04	0.03	0.07	0.06	**0.06**
O132	0.08	0.02	0.04	0.02	0.01	0.05	0.02	0.03	0.08	**0.04**
O133	0.02	0.05	0.14	0.17	0.47	0.24	0.14	0.03	0.03	**0.14**
O134	0.15	0.04	0.01	0.03	0.22	0.39	0.37	0.15	0.11	**0.17**
O135	0.10	0.10	0.01	0.08	0.19	0.42	0.40	0.14	0.13	**0.18**
O96	0.08	0.04	0.03	0.04	0.17	0.33	0.34	0.33	0.14	**0.16**
O97	0.03	0.12	0.05	0.11	0.18	0.21	0.24	0.31	0.11	**0.15**
O98	0.10	0.10	0.05	0.06	0.09	0.15	0.16	0.40	0.13	**0.13**
O99	0.12	0.27	0.07	0.22	0.55	0.42	0.46	0.33	0.01	**0.28**
O100	0.06	0.23	0.04	0.13	0.37	0.29	0.28	0.33	0.21	**0.21**
O101	0.02	0.27	0.04	0.03	0.08	0.02	0.44	0.50	0.21	**0.17**
O102	0.02	0.03	0.05	0.08	0.32	0.19	0.17	0.17	0.17	**0.12**
O103	0.03	0.03	0.04	0.08	0.33	0.23	0.28	0.31	0.22	**0.16**
O104	0.05	0.17	0.04	0.05	0.27	0.27	0.30	0.17	0.13	**0.16**
O105	0.01	0.08	0.13	0.03	0.17	0.19	0.27	0.21	0.23	**0.14**
O106	0.04	0.04	0.14	0.08	0.40	0.40	0.49	0.40	0.25	**0.24**
O107	0.02	0.10	0.07	0.06	0.31	0.35	0.17	0.16	0.03	**0.14**
O108	0.06	0.16	0.14	0.12	0.28	0.38	0.08	0.11	0.05	**0.15**
O109	0.06	0.13	0.07	0.06	0.26	0.18	0.17	0.17	0.09	**0.13**
O110	0.05	0.14	0.03	0.02	0.21	0.25	0.24	0.19	0.16	**0.14**
O111	0.04	0.16	0.09	0.08	0.29	0.26	0.30	0.27	0.17	**0.18**
O112	0.05	0.12	0.02	0.02	0.02	0.01	0.29	0.28	0.21	**0.11**
O113	0.04	0.16	0.06	0.08	0.27	0.28	0.25	0.19	0.14	**0.16**
O114	0.03	0.13	0.03	0.01	0.13	0.12	0.31	0.29	0.15	**0.13**
O115	0.05	0.24	0.08	0.09	0.28	0.31	0.26	0.18	0.11	**0.18**
O116	0.04	0.35	0.12	0.07	0.15	0.11	0.31	0.30	0.19	**0.18**
O117	0.08	0.07	0.05	0.08	0.08	0.06	0.23	0.45	0.25	**0.14**

O118	0.06	0.17	0.11	0.11	0.04	0.12	0.06	0.05	0.12	**0.09**
O119	0.14	0.31	0.20	0.14	0.10	0.05	0.12	0.15	0.15	**0.15**
O120	0.12	0.34	0.23	0.13	0.09	0.08	0.09	0.33	0.26	**0.18**
O121	0.12	0.35	0.24	0.10	0.15	0.11	0.13	0.11	0.11	**0.16**
O122	0.11	0.32	0.22	0.02	0.22	0.05	0.19	0.06	0.09	**0.15**
O123	0.05	0.31	0.23	0.07	0.37	0.30	0.23	0.13	0.06	**0.20**
O124	0.19	0.32	0.23	0.06	0.46	0.38	0.44	0.29	0.07	**0.28**
O125	0.19	0.15	0.19	0.06	0.06	0.28	0.25	0.33	0.18	**0.19**
O126	0.14	0.11	0.12	0.06	0.08	0.28	0.21	0.19	0.20	**0.15**
O127	0.10	0.07	0.11	0.06	0.02	0.20	0.15	0.12	0.18	**0.11**
O128	0.11	0.12	0.08	0.05	0.17	0.17	0.15	0.17	0.17	**0.13**
O129	0.27	0.23	0.27	0.14	0.06	0.24	0.41	0.49	0.37	**0.27**
O130	0.30	0.25	0.28	0.11	0.04	0.14	0.32	0.39	0.30	**0.24**
O131	0.25	0.21	0.22	0.07	0.45	0.05	0.14	0.18	0.13	**0.19**
O132	0.03	0.02	0.01	0.06	0.54	0.16	0.03	0.02	0.05	**0.10**
O133	0.17	0.21	0.11	0.07	0.49	0.26	0.19	0.19	0.13	**0.20**
O134	0.21	0.23	0.14	0.11	0.03	0.38	0.43	0.53	0.29	**0.26**
O135	0.08	0.17	0.10	0.11	0.04	0.06	0.16	0.07	0.11	**0.10**
O136	0.07	0.01	0.09	0.03	0.02	0.09	0.27	0.24	0.13	**0.10**
O137	0.17	0.03	0.10	0.10	0.02	0.09	0.48	0.56	0.23	**0.19**
O138	0.23	0.29	0.18	0.12	0.06	0.49	0.56	0.60	0.45	**0.32**
O139	0.16	0.12	0.02	0.03	0.01	0.30	0.38	0.34	0.24	**0.17**
O140	0.15	0.04	0.05	0.08	0.02	0.38	0.44	0.44	0.31	**0.20**
O141	0.07	0.10	0.09	0.05	0.05	0.35	0.06	0.04	0.02	**0.10**
O142	0.12	0.13	0.07	0.07	0.05	0.38	0.06	0.06	0.04	**0.12**
O143	0.16	0.12	0.05	0.01	0.03	0.03	0.02	0.02	0.03	**0.06**
O144	0.07	0.19	0.10	0.03	0.33	0.09	0.49	0.40	0.27	**0.21**
O145	0.14	0.22	0.12	0.05	0.12	0.06	0.54	0.54	0.39	**0.23**
O146	0.11	0.22	0.12	0.02	0.09	0.01	0.56	0.54	0.40	**0.22**
O147	0.13	0.20	0.10	0.09	0.39	0.37	0.47	0.52	0.38	**0.28**
O148	0.09	0.24	0.14	0.02	0.13	0.13	0.04	0.05	0.02	**0.10**
O149	0.03	0.22	0.13	0.11	0.41	0.30	0.08	0.03	0.14	**0.16**
O150	0.14	0.18	0.02	0.08	0.45	0.36	0.22	0.03	0.18	**0.18**
O151	0.16	0.13	0.05	0.08	0.26	0.20	0.40	0.44	0.31	**0.21**
O152	0.32	0.26	0.10	0.06	0.24	0.18	0.21	0.18	0.11	**0.20**
O153	0.18	0.07	0.07	0.07	0.39	0.32	0.57	0.63	0.45	**0.29**
O154	0.11	0.20	0.14	0.12	0.32	0.16	0.20	0.12	0.10	**0.17**
O155	0.15	0.27	0.15	0.02	0.58	0.52	0.40	0.12	0.09	**0.26**
O156	0.16	0.28	0.11	0.03	0.42	0.41	0.32	0.02	0.04	**0.21**

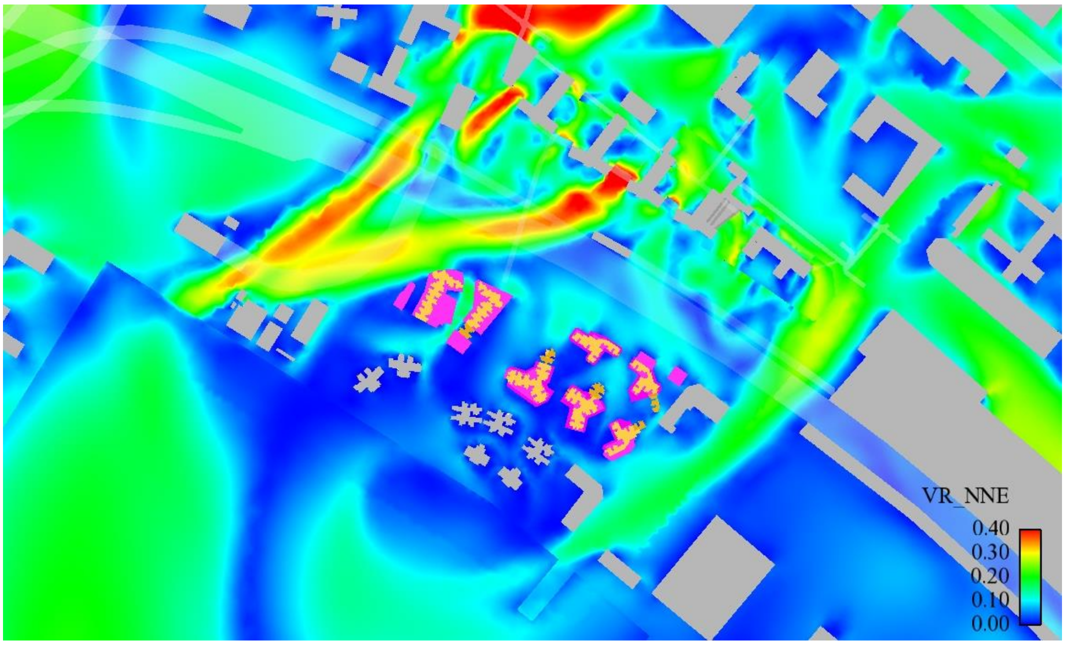
Table 12 VR value for the Special Test Points of Baseline Scheme under Summer Condition

	E	ESE	SE	SSE	S	SSW	SW	WSW	W	Overall
Frequency	11.5%	9.5%	9.3%	8.3%	7.9%	8.8%	9.9%	7.2%	4.7%	77.1%
S1	0.14	0.21	0.02	0.10	0.18	0.16	0.49	0.53	0.35	**0.23**
S2	0.15	0.14	0.03	0.12	0.33	0.30	0.49	0.32	0.23	**0.23**
S3	0.10	0.24	0.04	0.10	0.25	0.30	0.43	0.60	0.40	**0.26**
S4	0.13	0.23	0.05	0.10	0.35	0.34	0.52	0.40	0.24	**0.26**
S5	0.08	0.28	0.06	0.08	0.29	0.32	0.42	0.59	0.40	**0.26**
S6	0.10	0.09	0.07	0.07	0.34	0.34	0.51	0.38	0.24	**0.23**
S7	0.11	0.19	0.07	0.07	0.23	0.28	0.35	0.57	0.37	**0.23**
S8	0.13	0.10	0.07	0.20	0.28	0.31	0.46	0.38	0.08	**0.23**
S9	0.15	0.10	0.02	0.10	0.02	0.04	0.22	0.30	0.04	**0.11**
S10	0.05	0.04	0.18	0.20	0.52	0.26	0.22	0.18	0.01	**0.18**
S11	0.10	0.01	0.16	0.20	0.53	0.35	0.32	0.17	0.12	**0.21**
S12	0.01	0.01	0.17	0.20	0.56	0.31	0.24	0.20	0.27	**0.20**
S13	0.07	0.05	0.10	0.08	0.18	0.08	0.11	0.36	0.26	**0.13**
S14	0.03	0.19	0.11	0.14	0.32	0.19	0.16	0.27	0.26	**0.17**
S15	0.03	0.09	0.07	0.16	0.37	0.27	0.13	0.20	0.22	**0.16**
S16	0.01	0.06	0.06	0.15	0.35	0.29	0.14	0.20	0.26	**0.15**
S17	0.02	0.06	0.04	0.11	0.16	0.23	0.16	0.26	0.25	**0.13**
S18	0.02	0.02	0.08	0.07	0.09	0.13	0.33	0.34	0.30	**0.14**
S19	0.03	0.07	0.07	0.05	0.17	0.25	0.25	0.29	0.28	**0.15**
S20	0.08	0.20	0.16	0.14	0.10	0.06	0.38	0.38	0.34	**0.19**

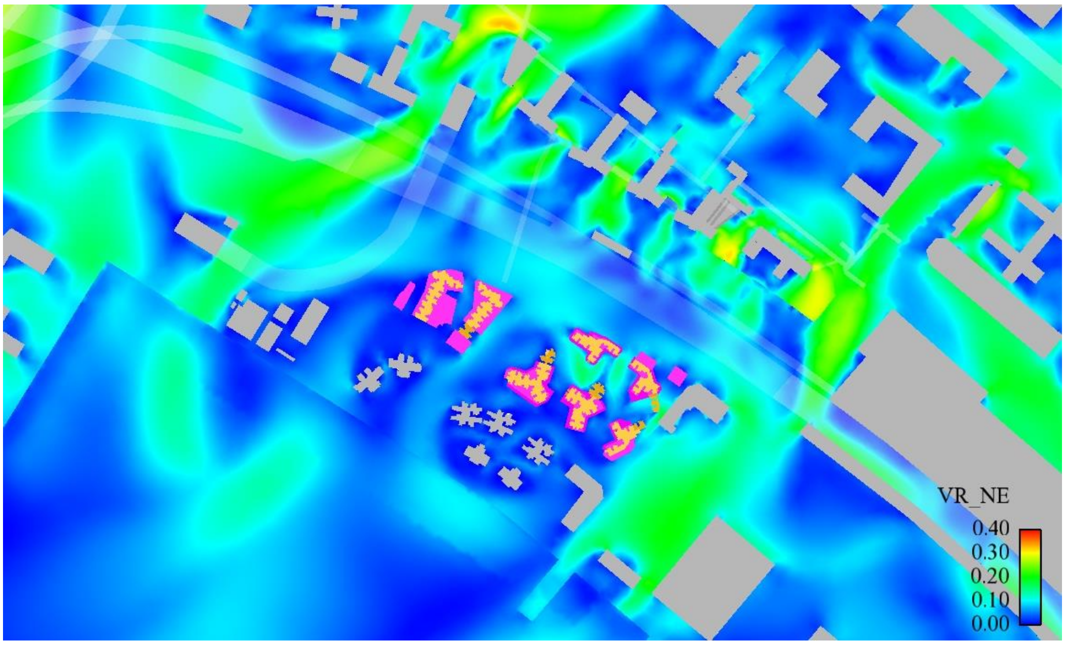
Appendix B

Directional VR Contour Plots

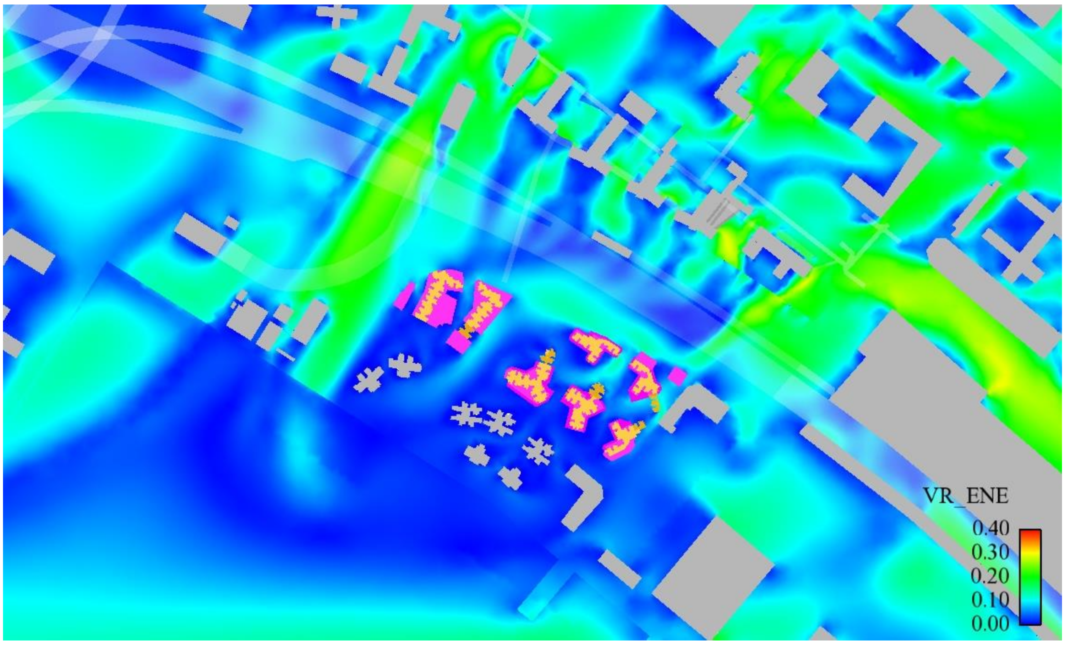
B1 Baseline Scheme Directional VR Contour Plots



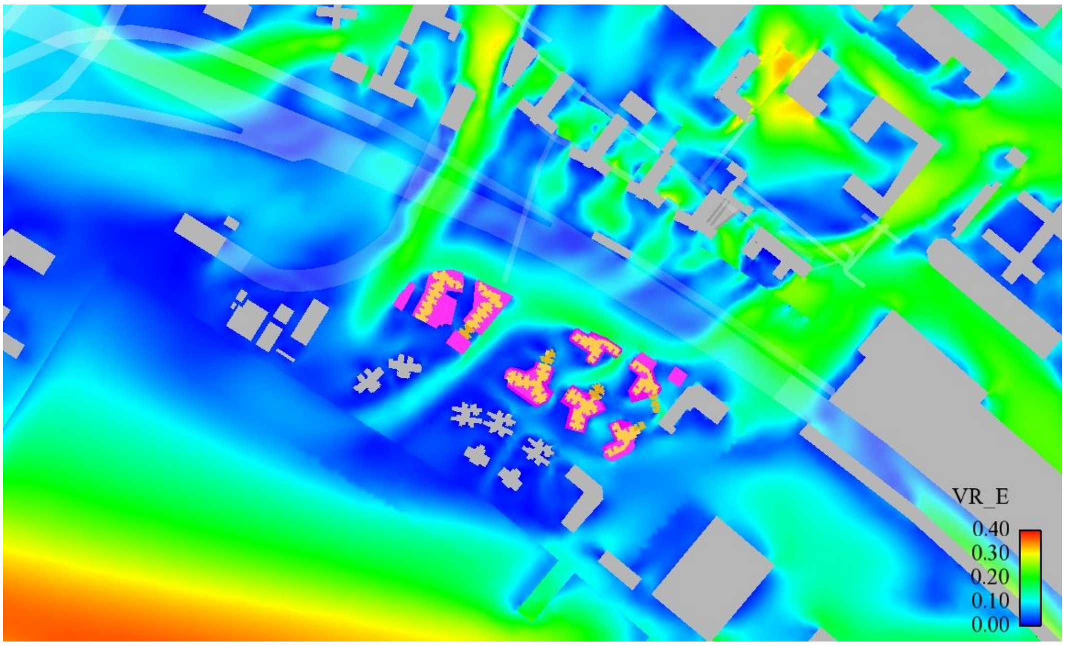
Contour Plot under NNE Wind (Baseline Scheme)



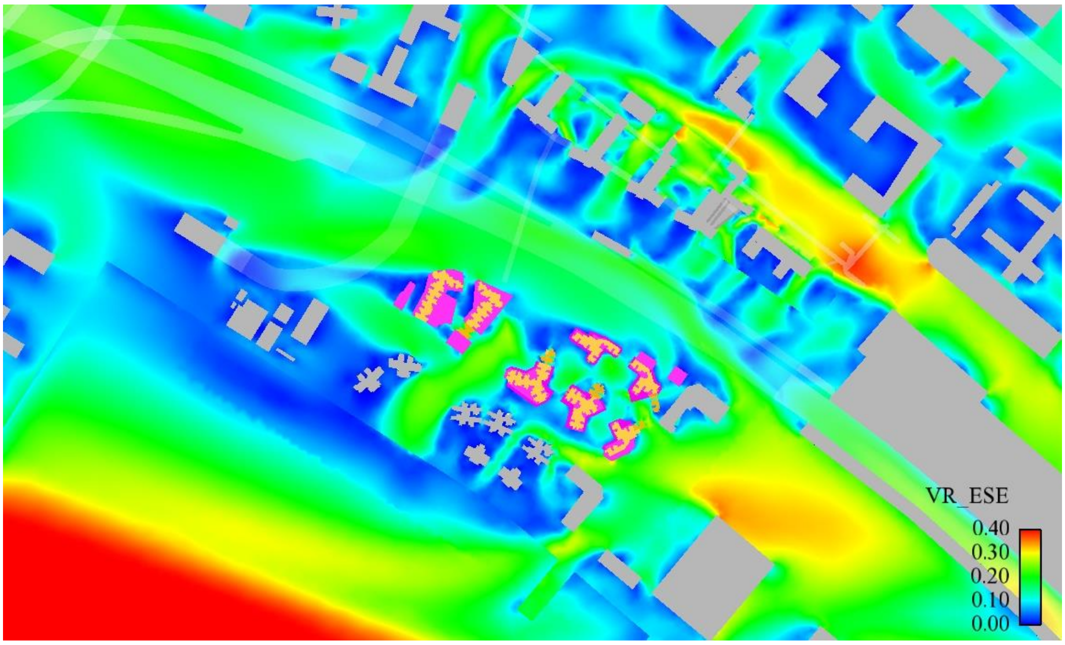
Contour Plot under NE Wind (Baseline Scheme)



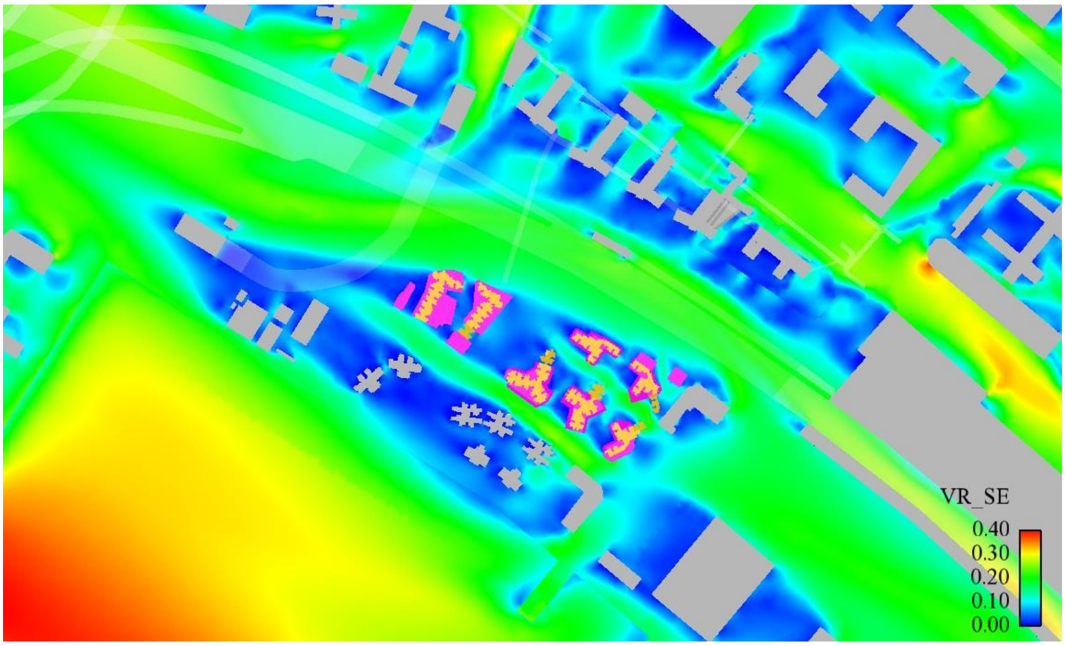
Contour Plot under ENE Wind (Baseline Scheme)



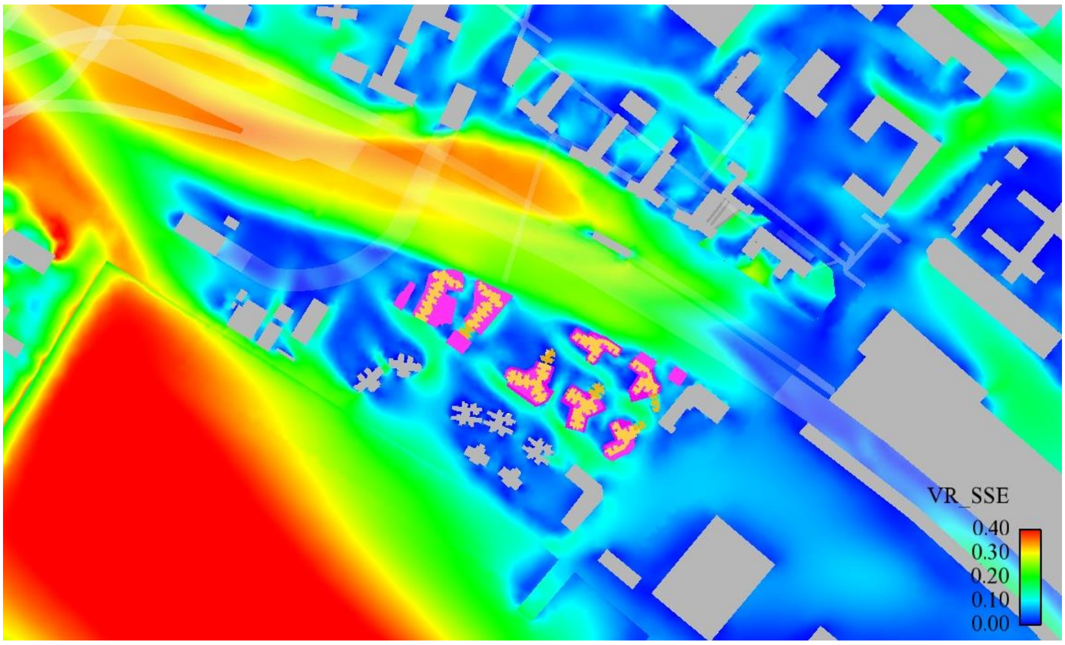
Contour Plot under E Wind (Baseline Scheme)



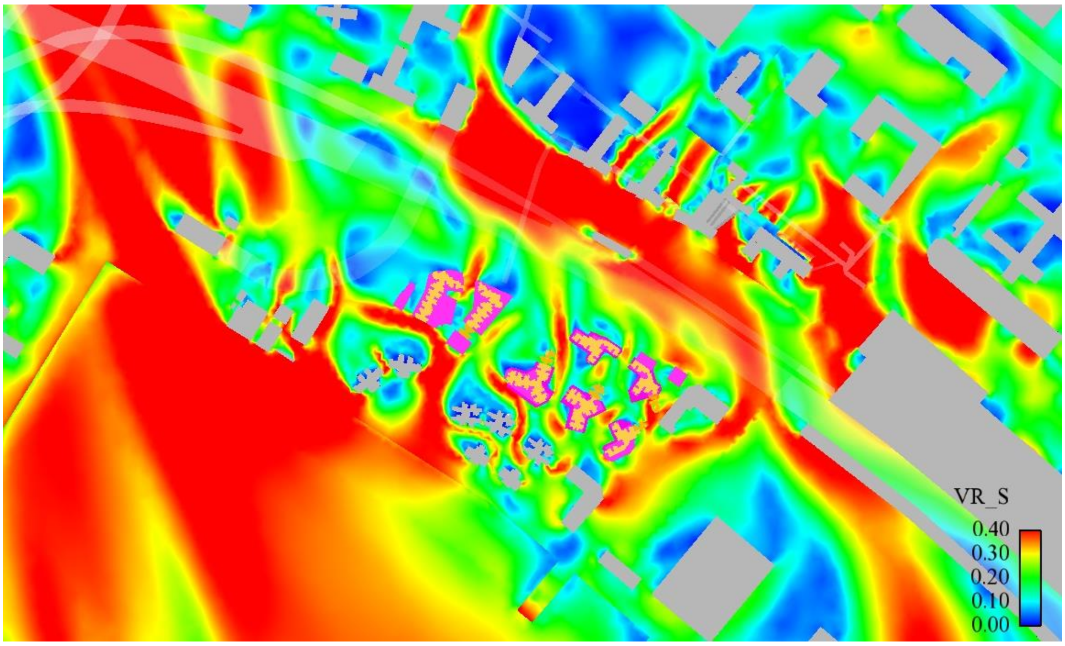
Contour Plot under ESE Wind (Baseline Scheme)



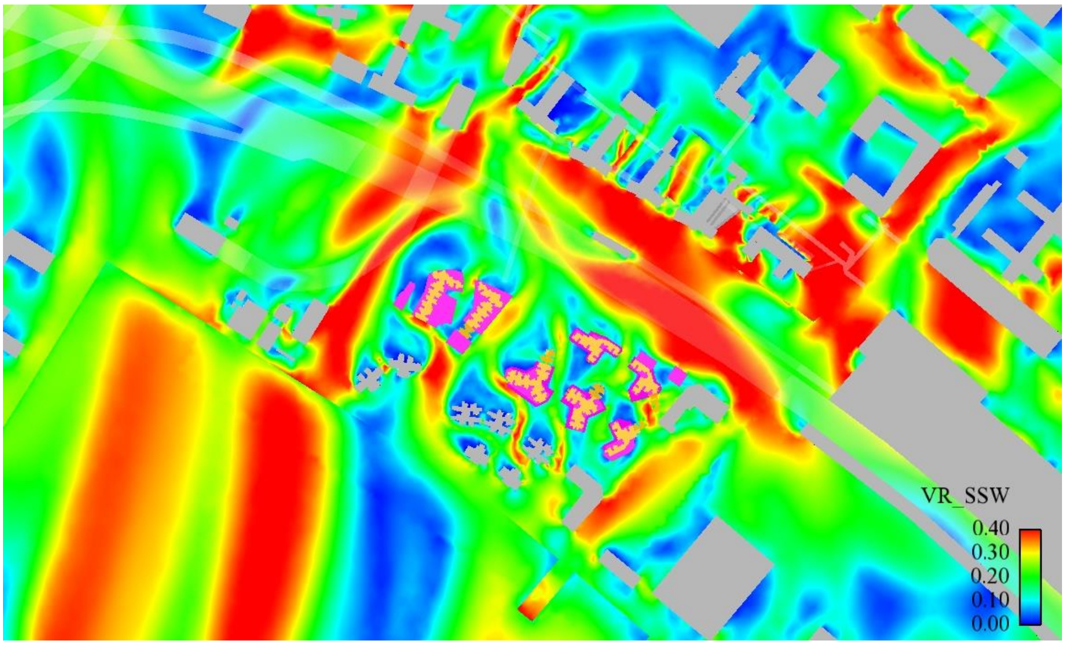
Contour Plot under SE Wind (Baseline Scheme)



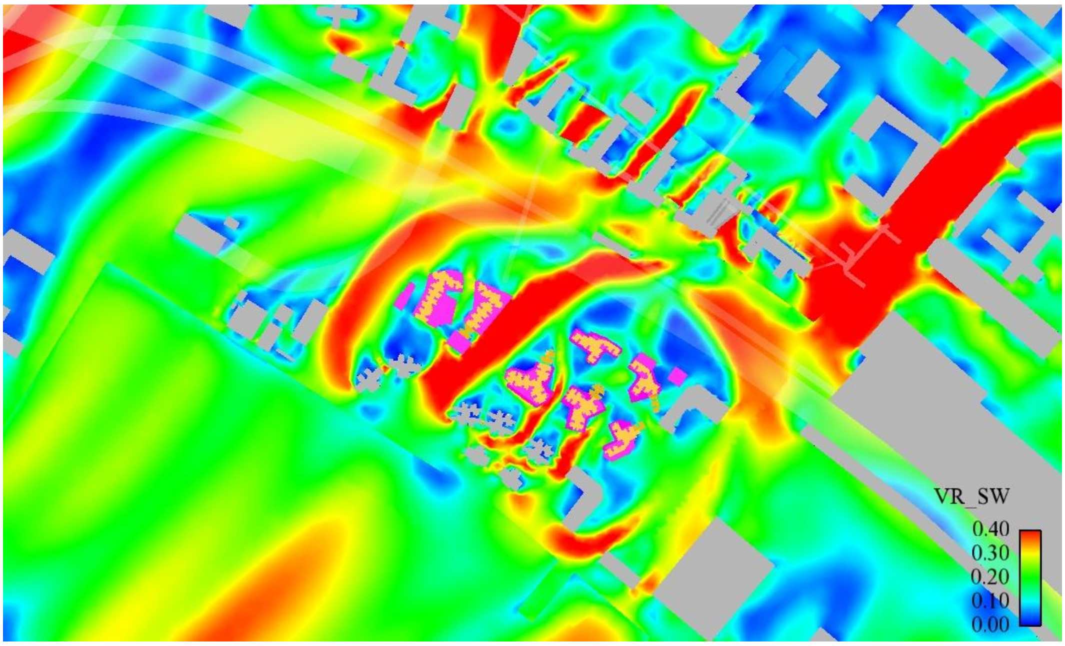
Contour Plot under SSE Wind (Baseline Scheme)



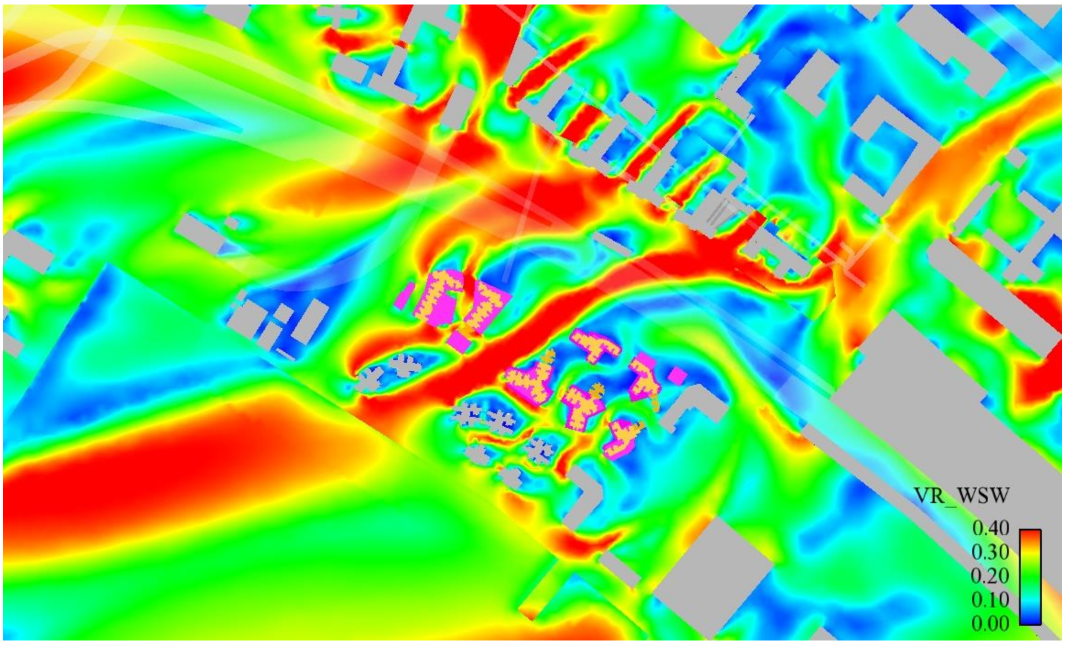
Contour Plot under S Wind (Baseline Scheme)



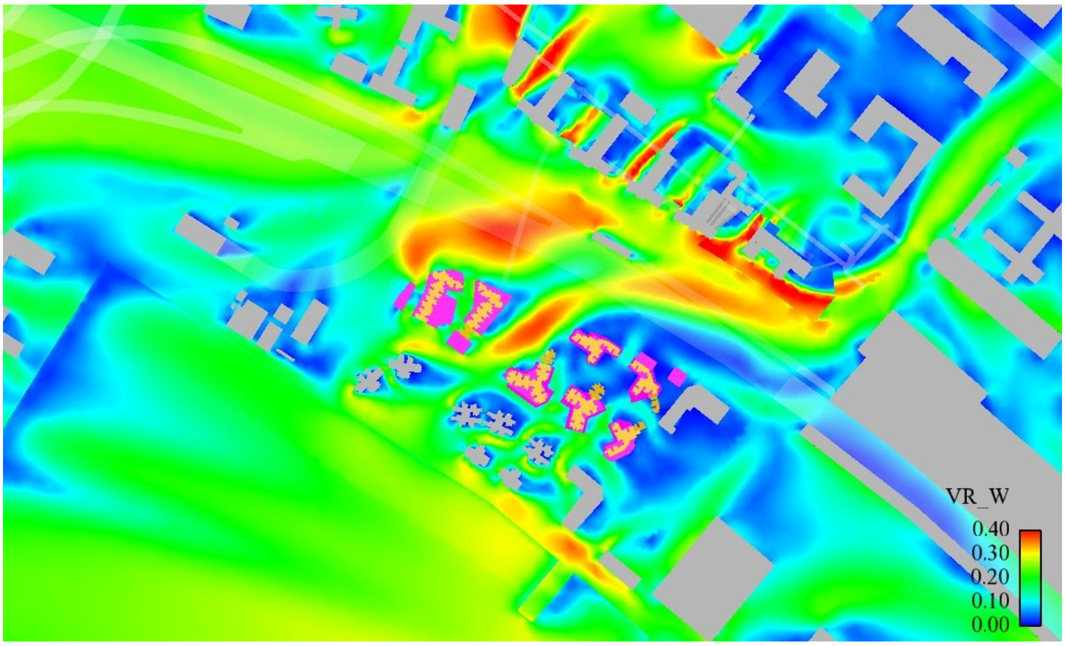
Contour Plot under SSW Wind (Baseline Scheme)



Contour Plot under SW Wind (Baseline Scheme)

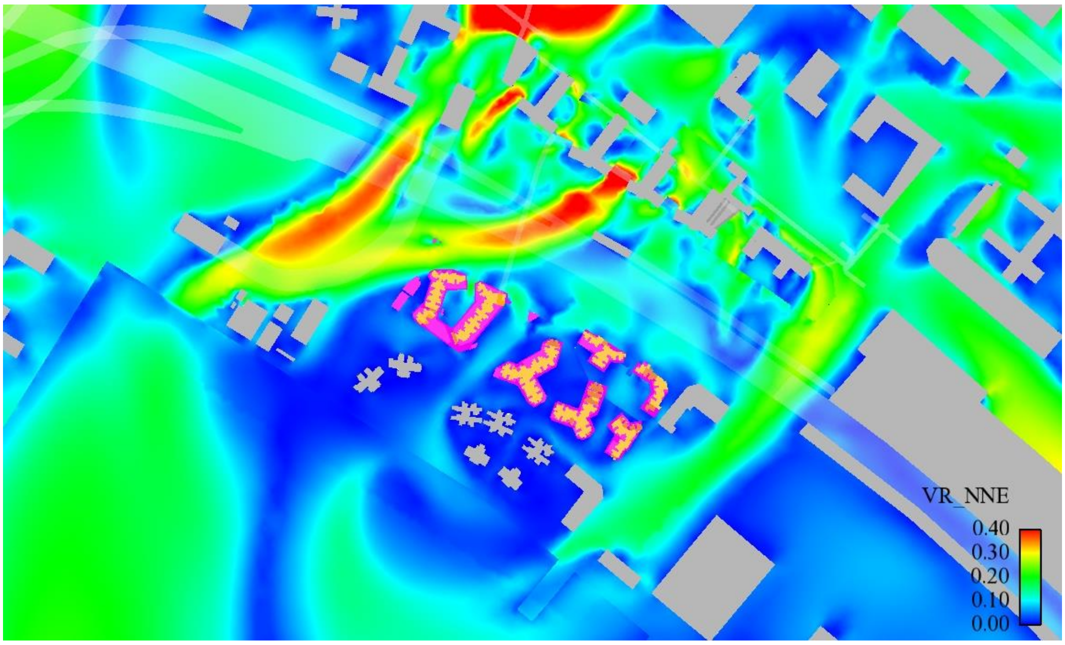


Contour Plot under WSW Wind (Baseline Scheme)

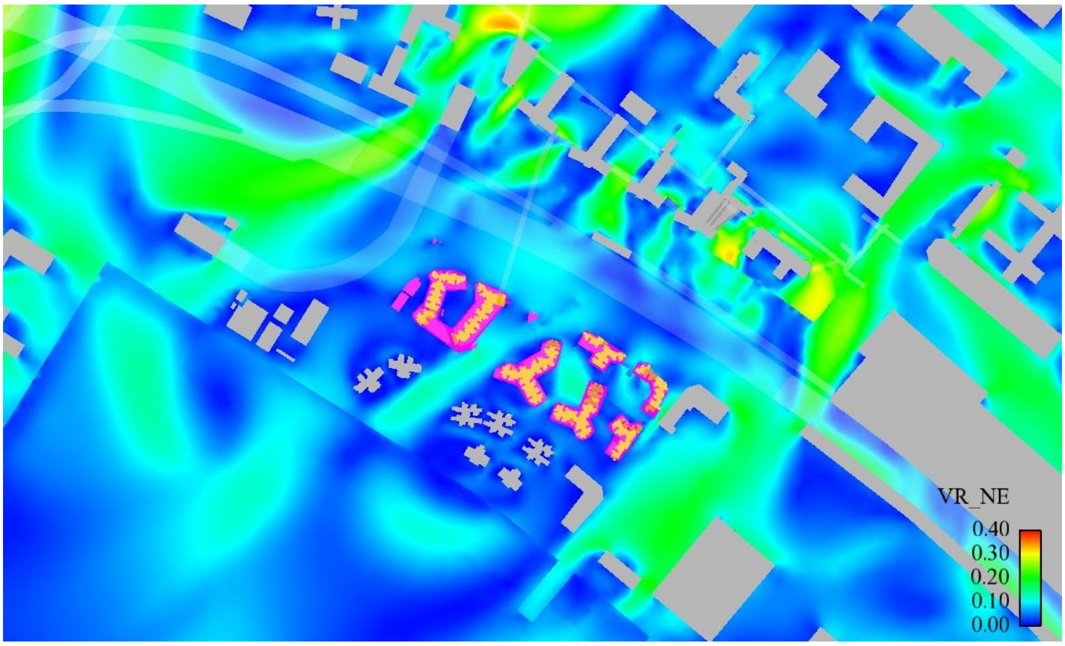


Contour Plot under W Wind (Baseline Scheme)

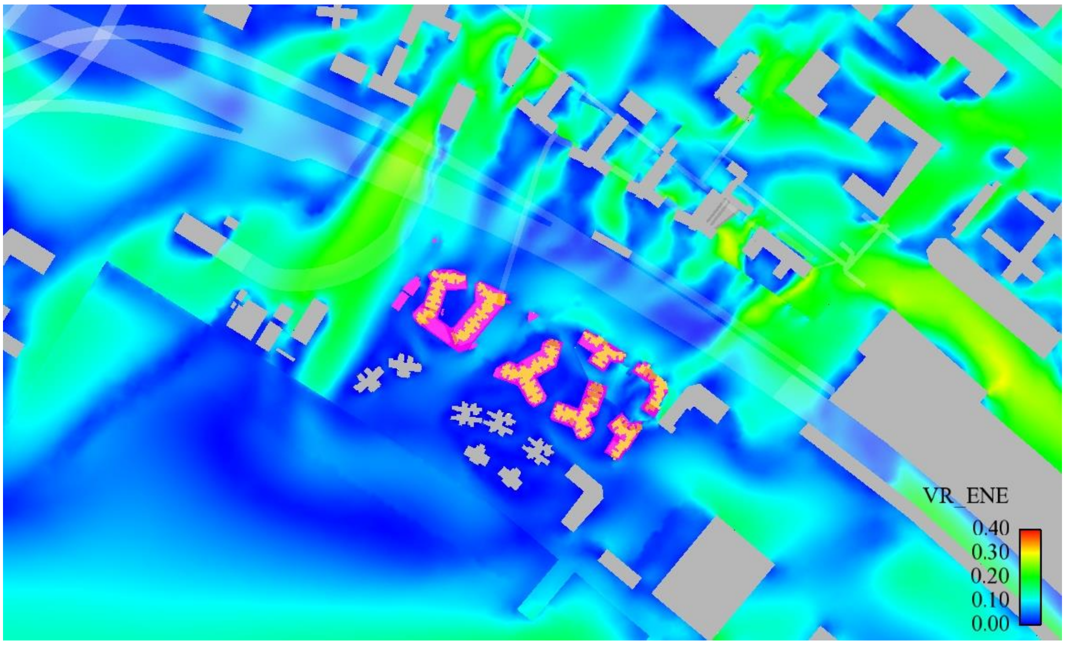
B2 Proposed Scheme Directional VR Contour Plots



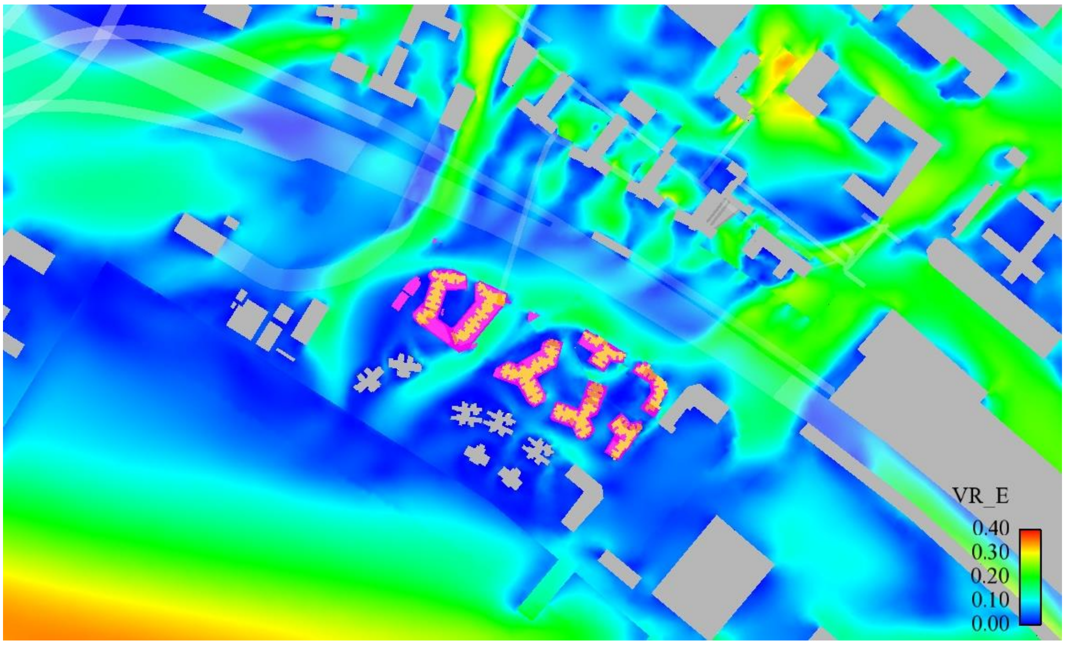
Contour Plot under NNE Wind (Proposed Scheme)



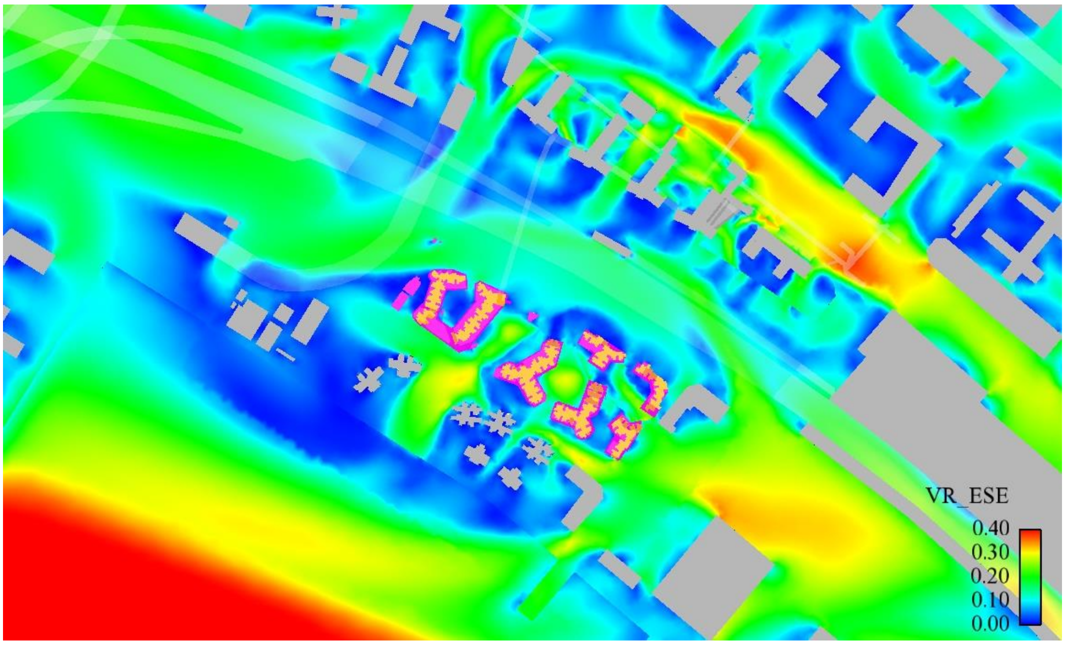
Contour Plot under NE Wind (Proposed Scheme)



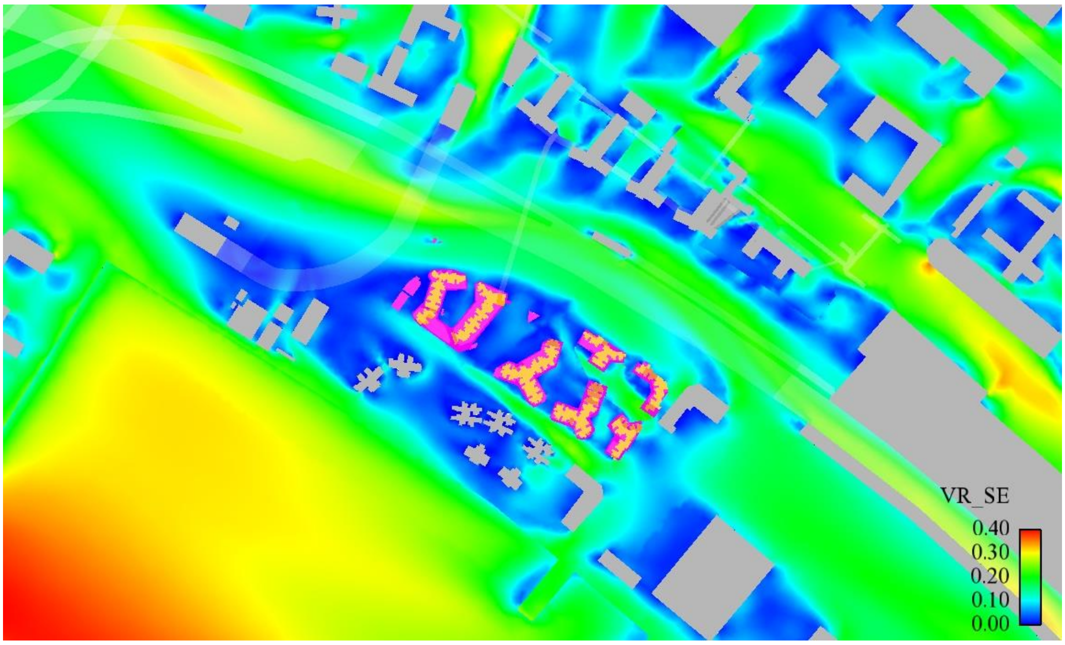
Contour Plot under ENE Wind (Proposed Scheme)



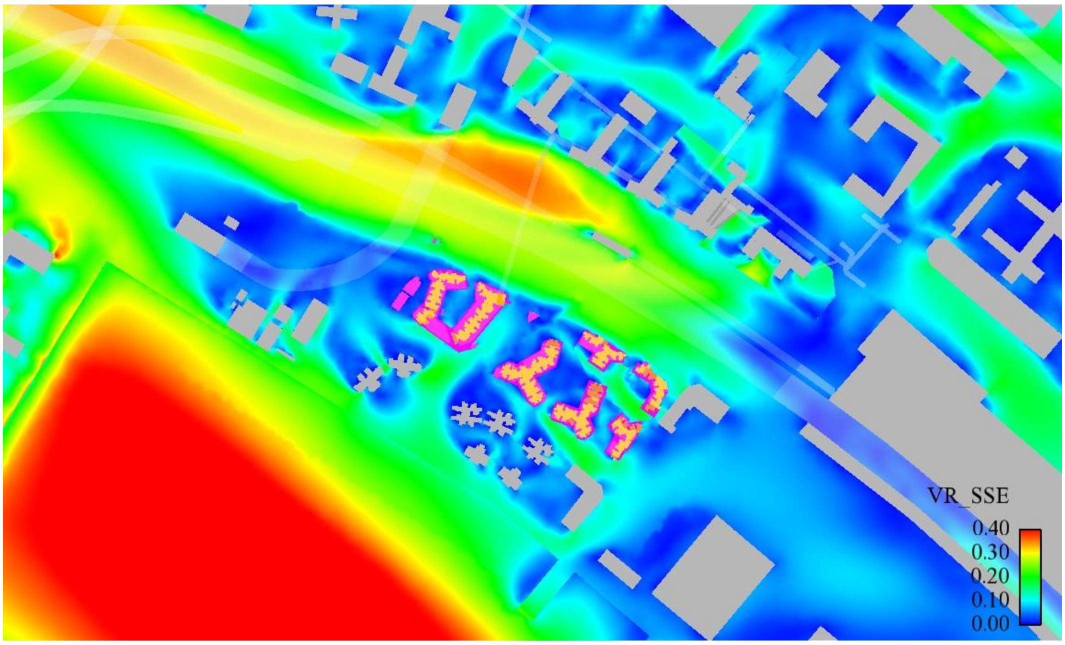
Contour Plot under E Wind (Proposed Scheme)



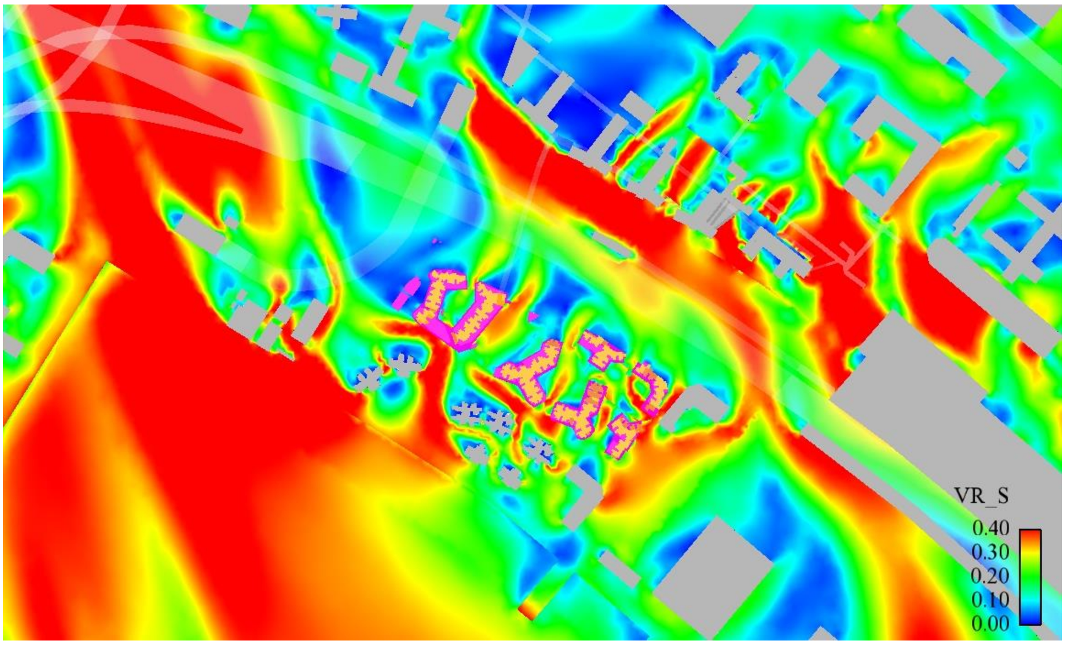
Contour Plot under ESE Wind (Proposed Scheme)



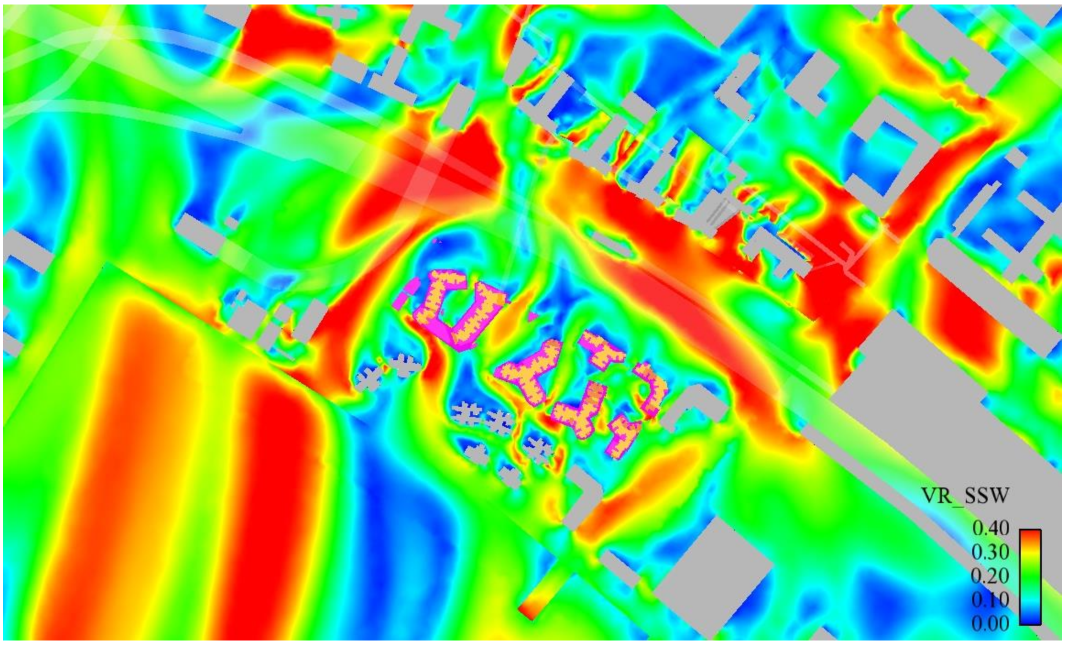
Contour Plot under SE Wind (Proposed Scheme)



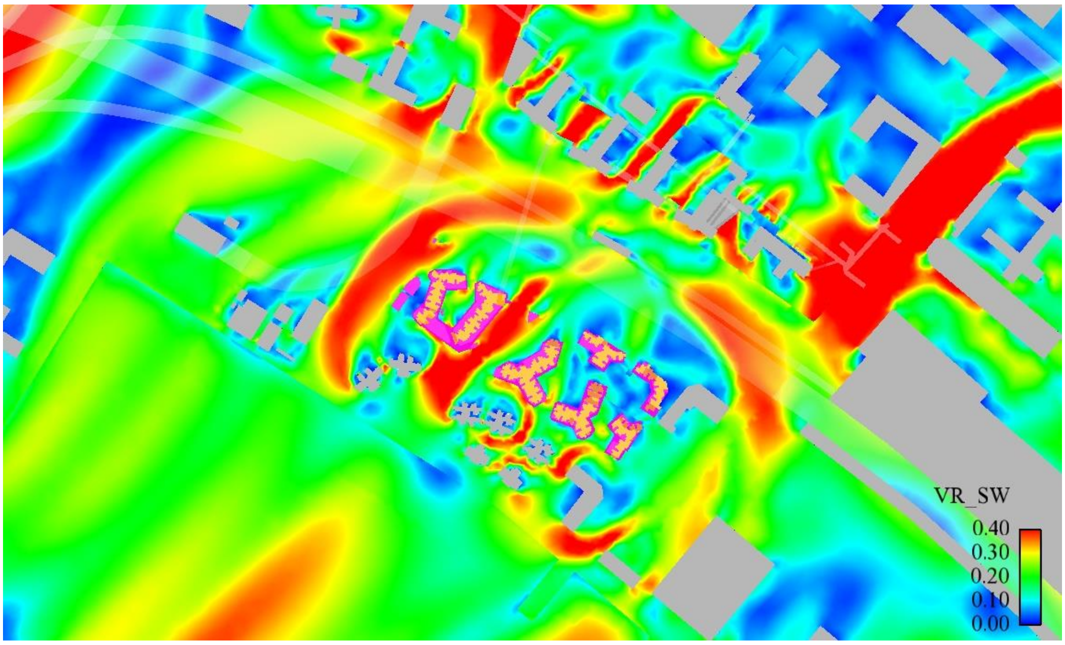
Contour Plot under SSE Wind (Proposed Scheme)



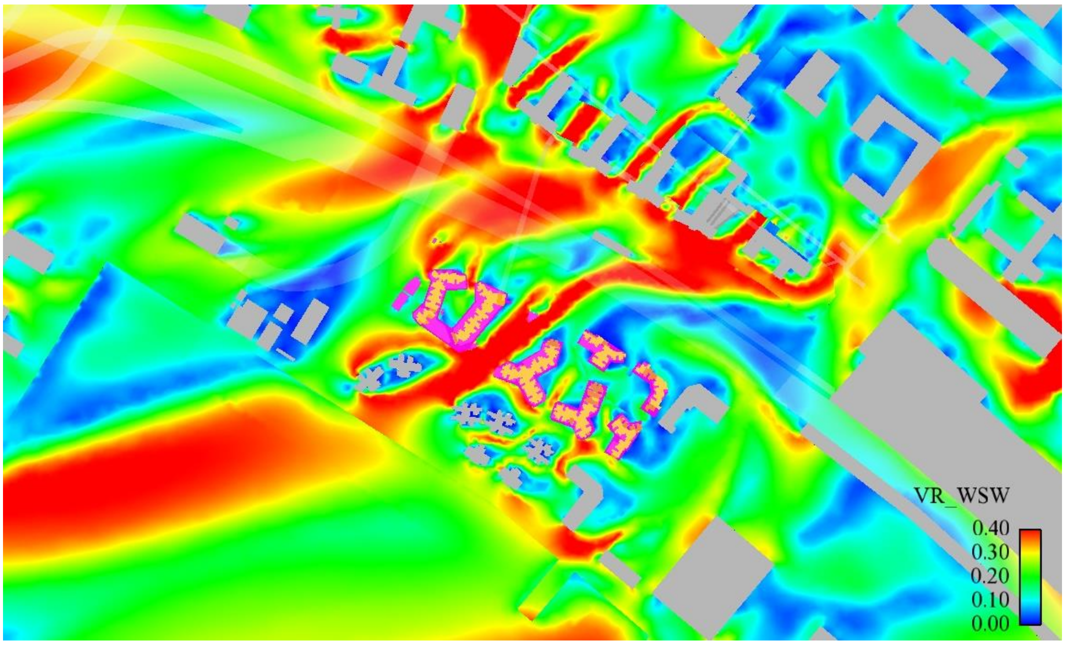
Contour Plot under S Wind (Proposed Scheme)



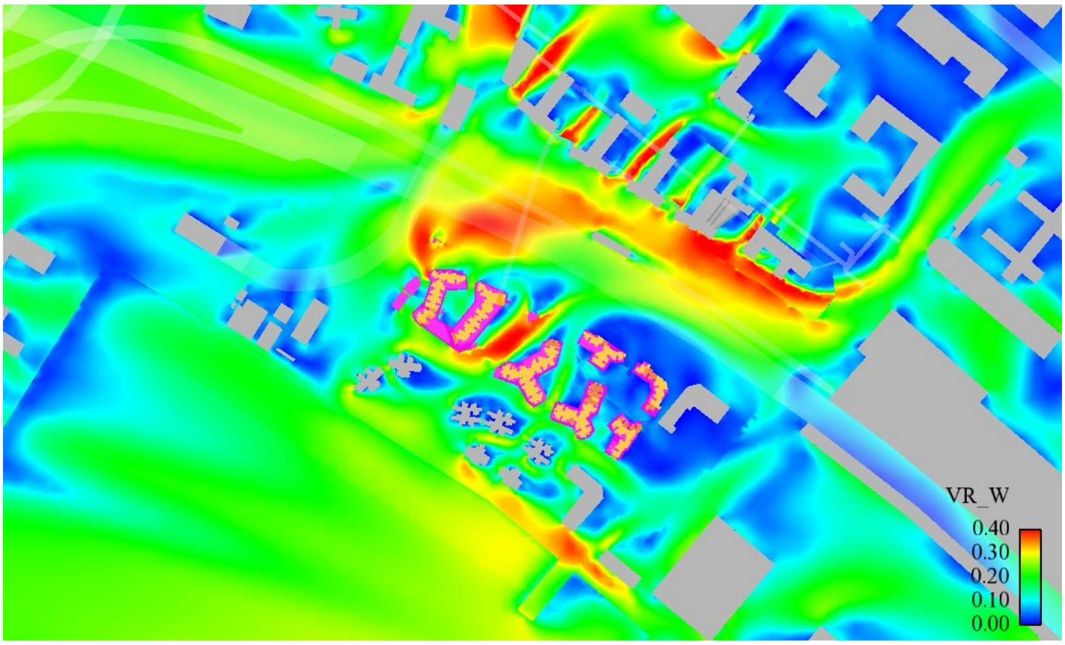
Contour Plot under SSW Wind (Proposed Scheme)



Contour Plot under SW Wind (Proposed Scheme)



Contour Plot under WSW Wind (Proposed Scheme)

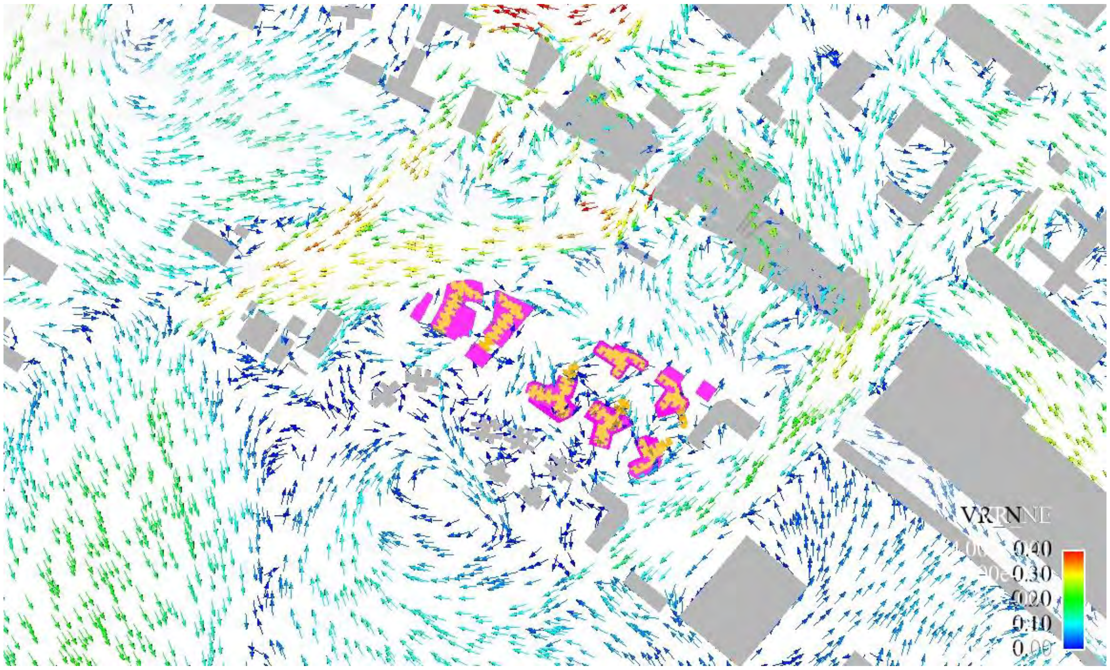


Contour Plot under W Wind (Proposed Scheme)

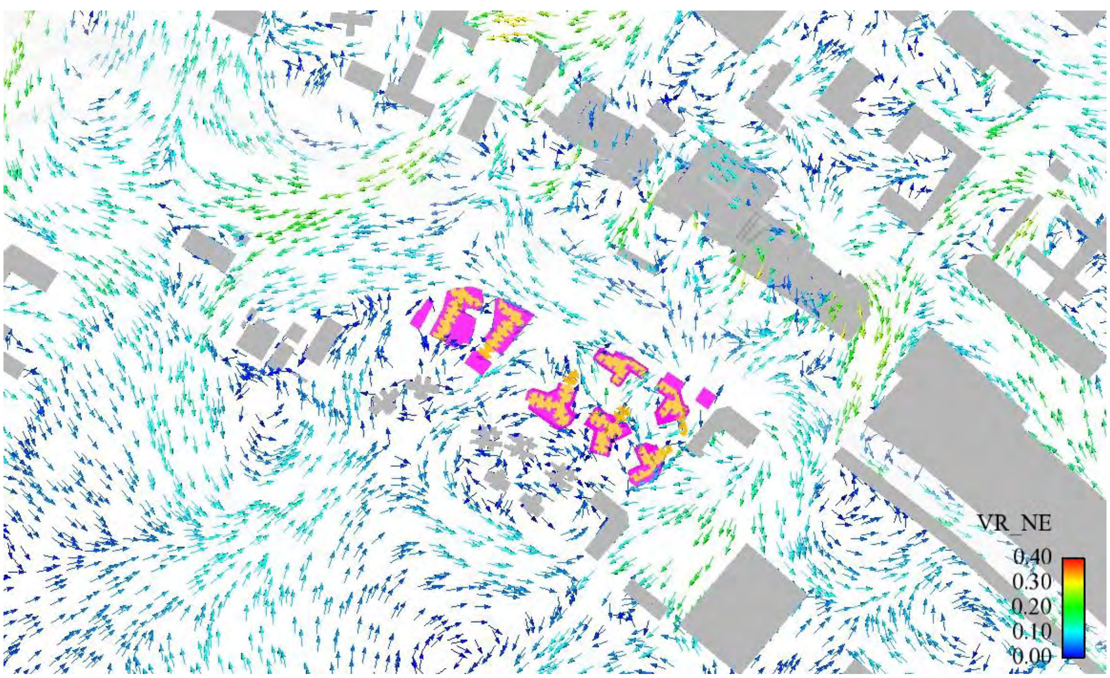
Appendix C

Directional VR Vector Plots

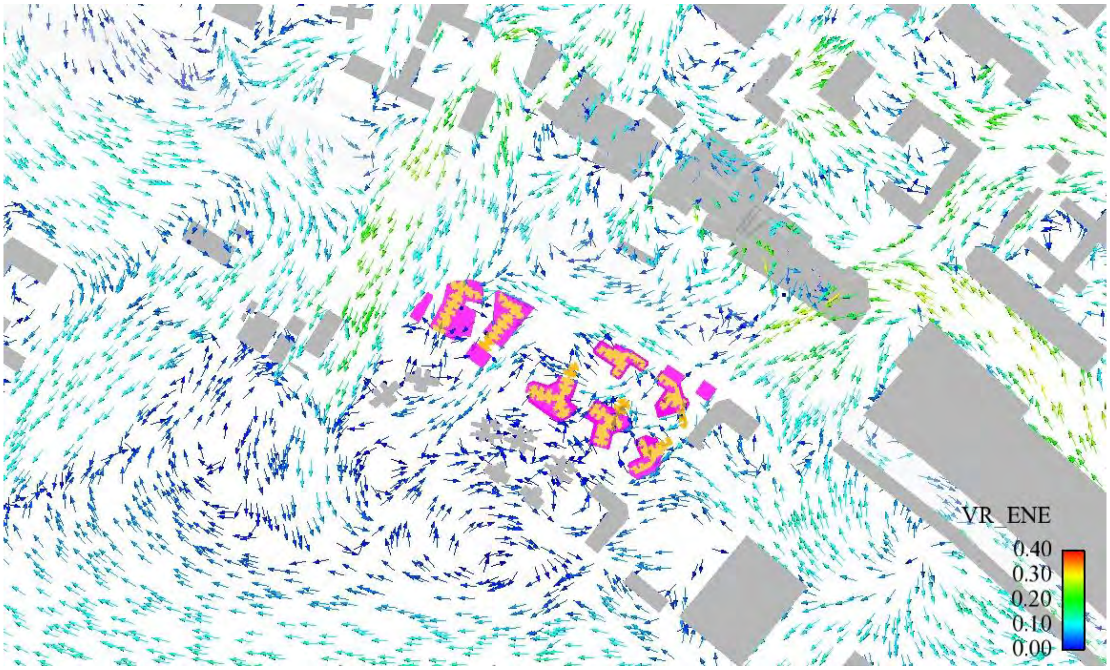
C1 Baseline Scheme Directional VR Vector Plots



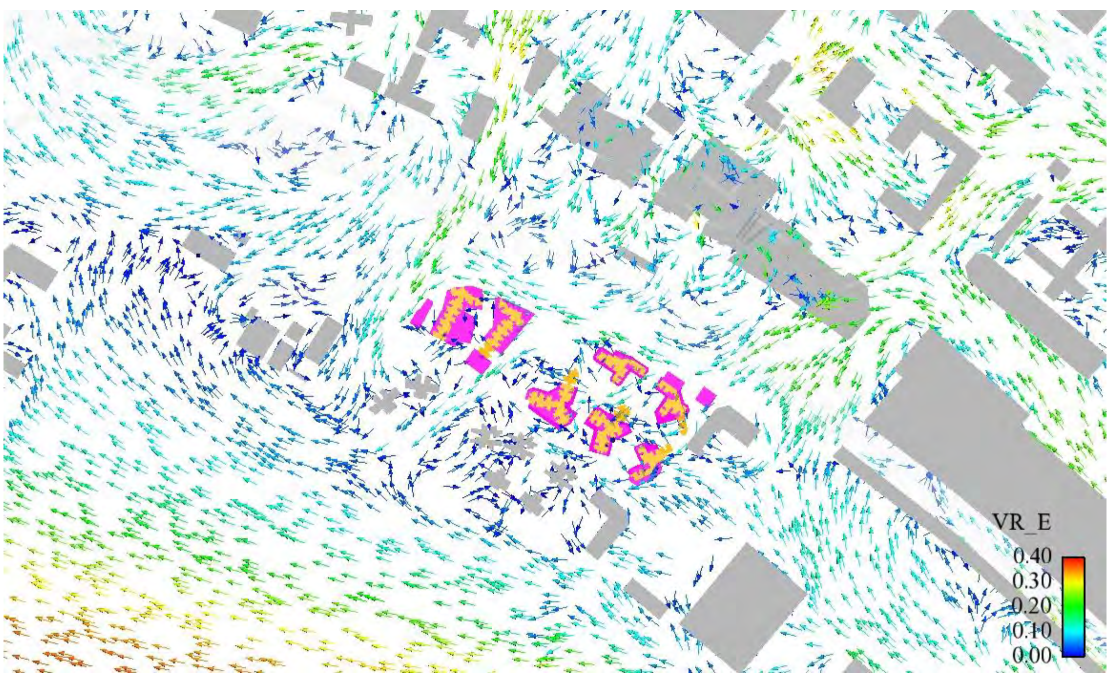
Vector Plot under NNE Wind (Baseline Scheme)



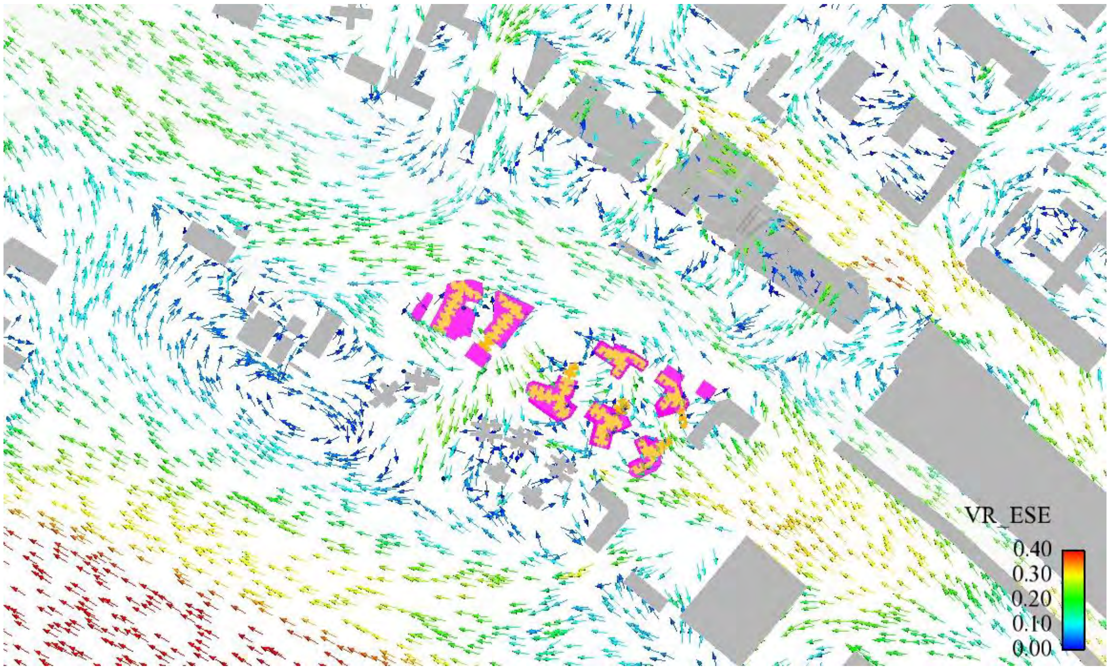
Vector Plot under NE Wind (Baseline Scheme)



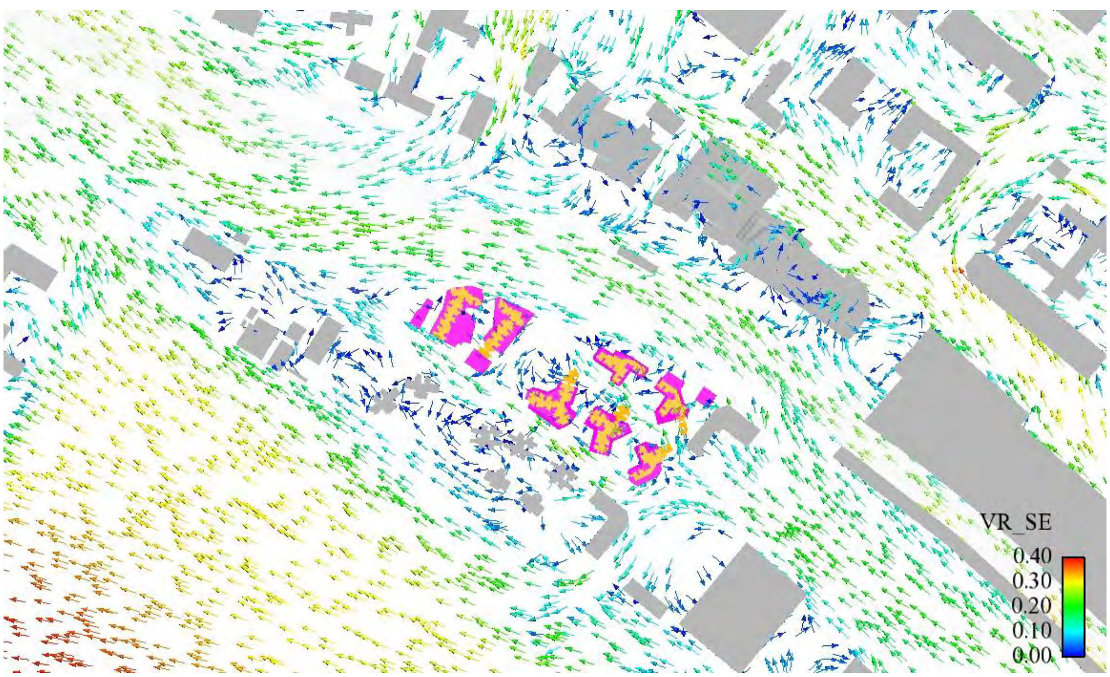
Vector Plot under ENE Wind (Baseline Scheme)



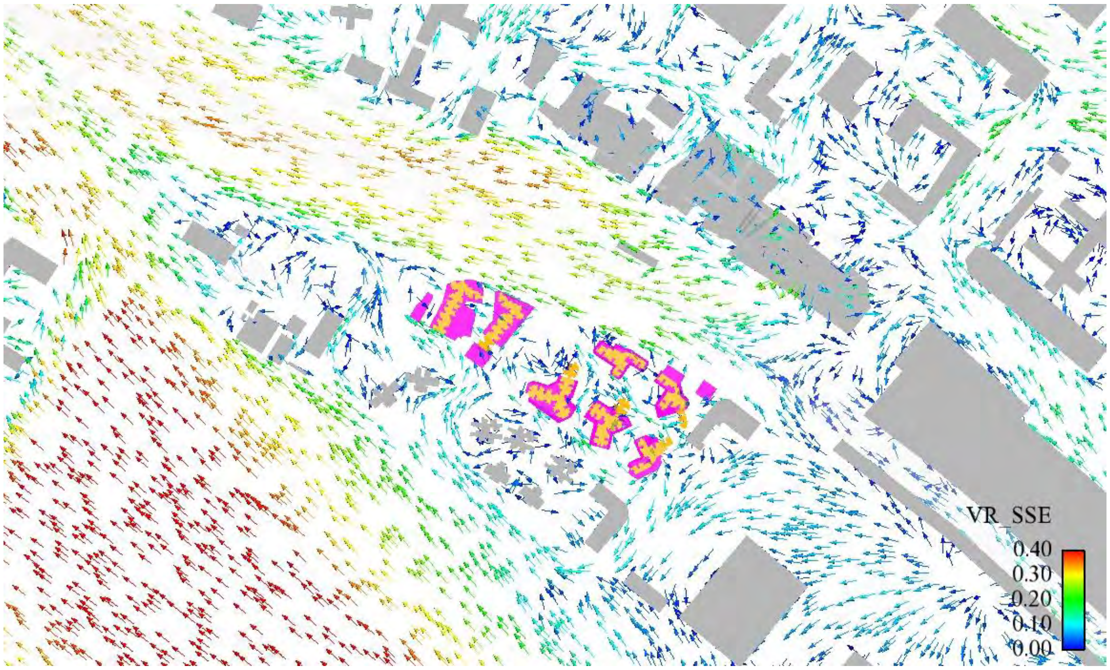
Vector Plot under E Wind (Baseline Scheme)



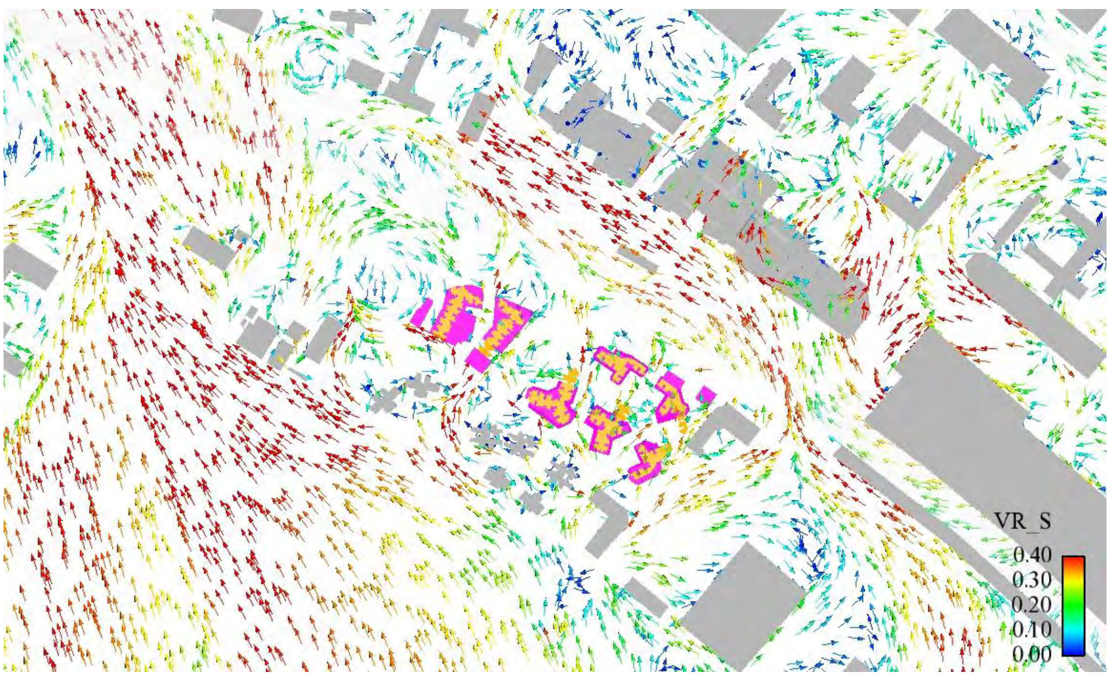
Vector Plot under ESE Wind (Baseline Scheme)



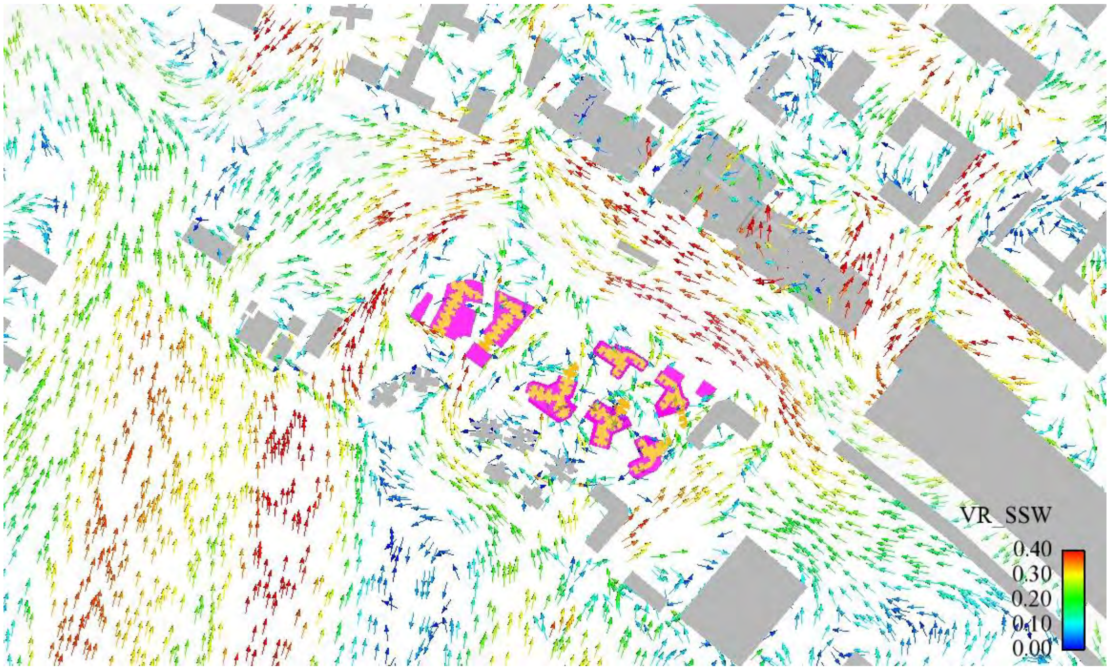
Vector Plot under SE Wind (Baseline Scheme)



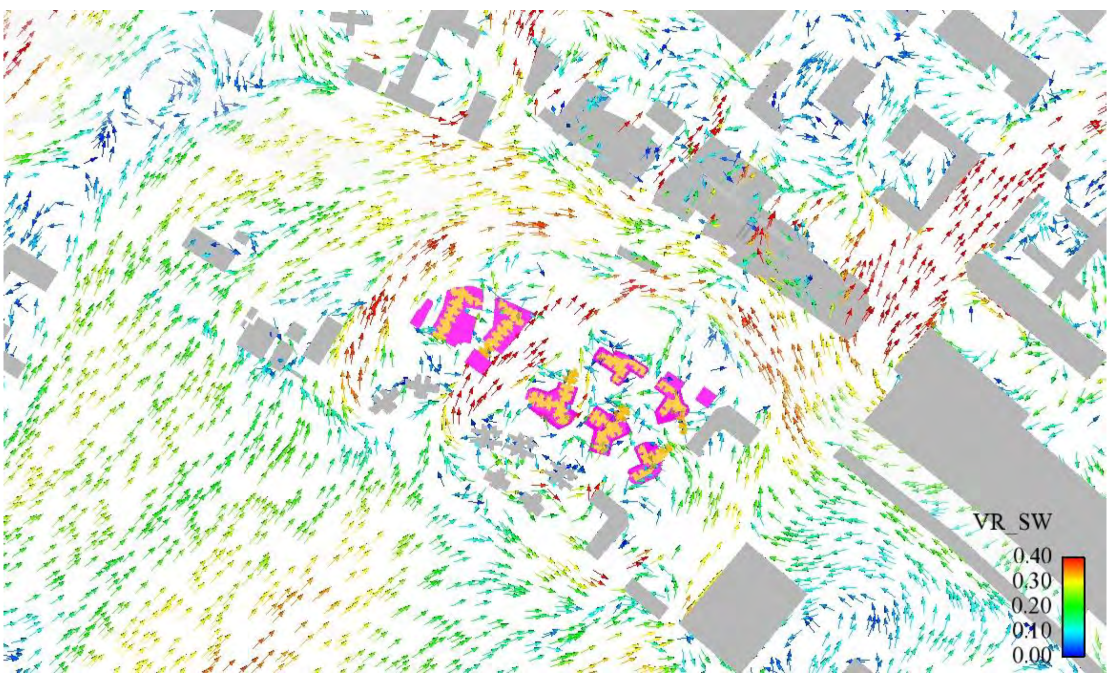
Vector Plot under SSE Wind (Baseline Scheme)



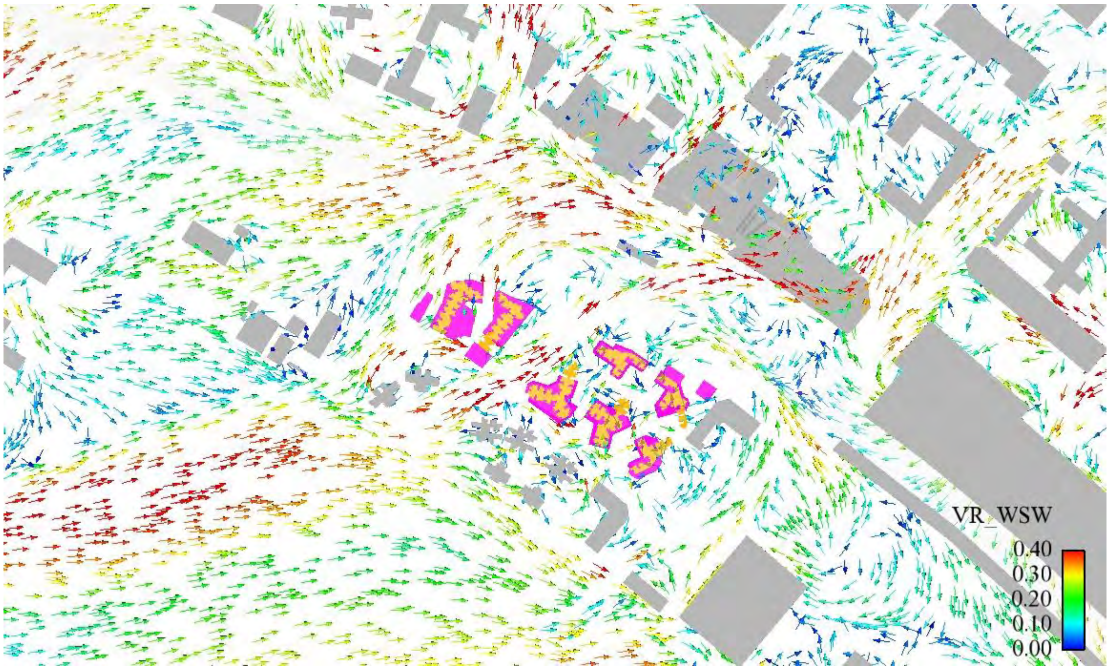
Vector Plot under S Wind (Baseline Scheme)



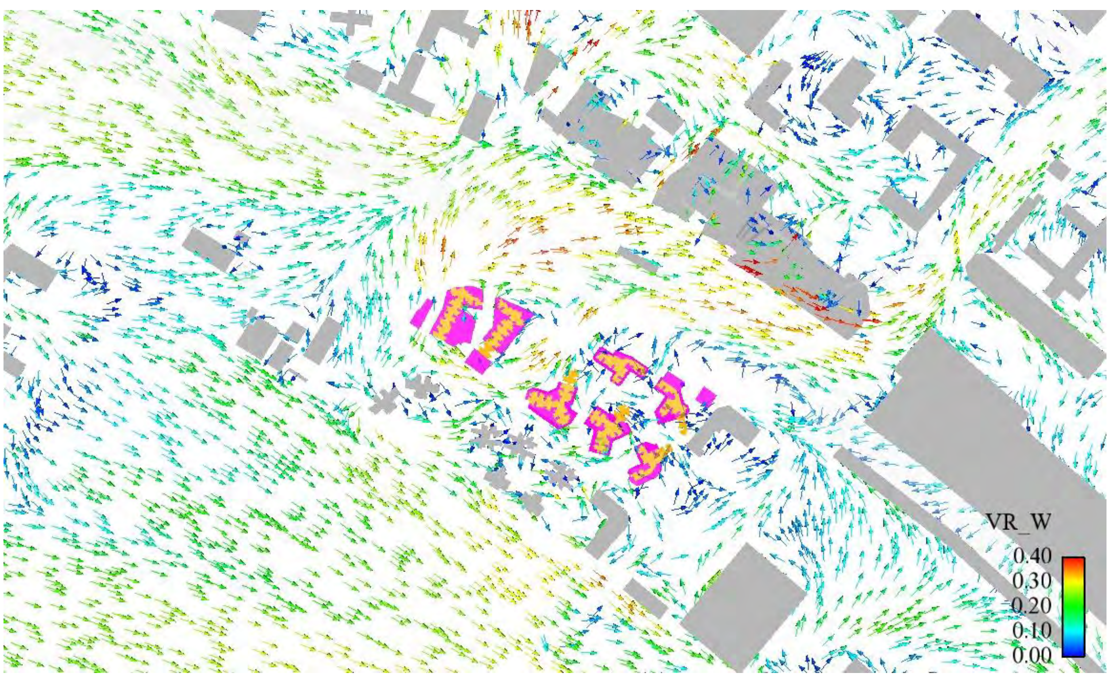
Vector Plot under SSW Wind (Baseline Scheme)



Vector Plot under SW Wind (Baseline Scheme)

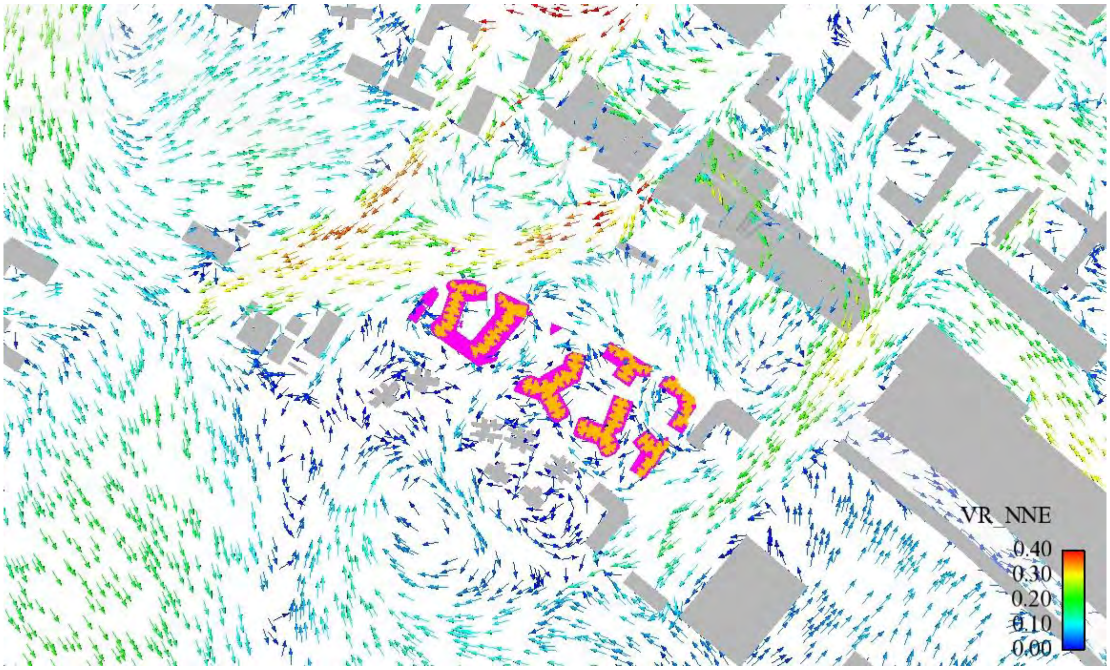


Vector Plot under WSW Wind (Baseline Scheme)

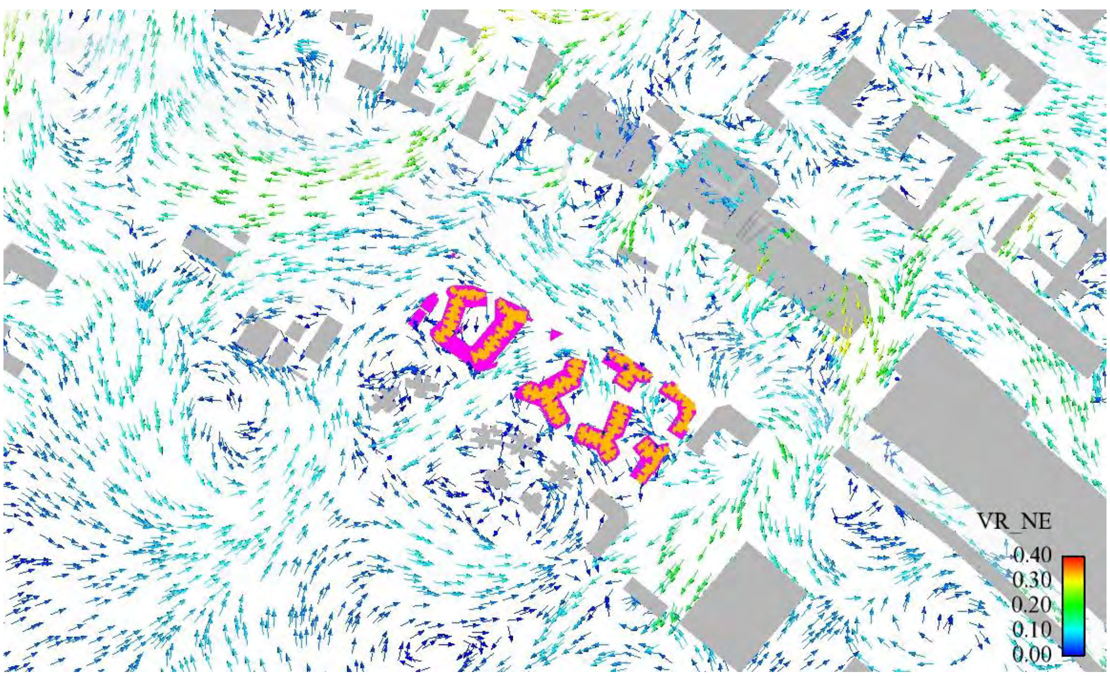


Vector Plot under W Wind (Baseline Scheme)

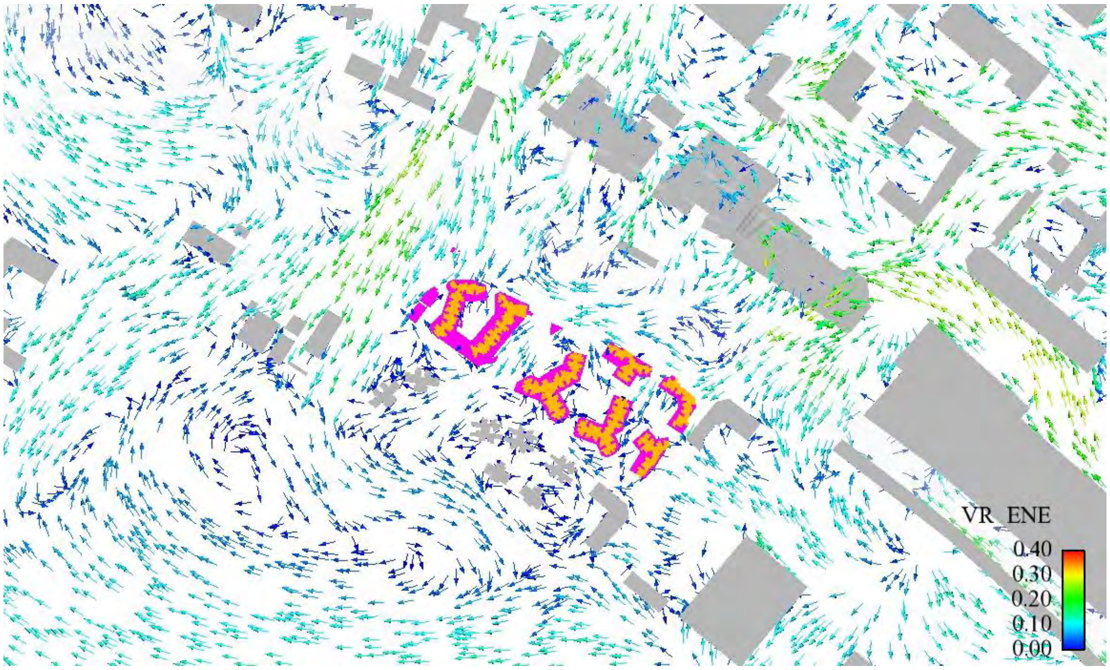
C2 Proposed Scheme Directional VR Vector Plots



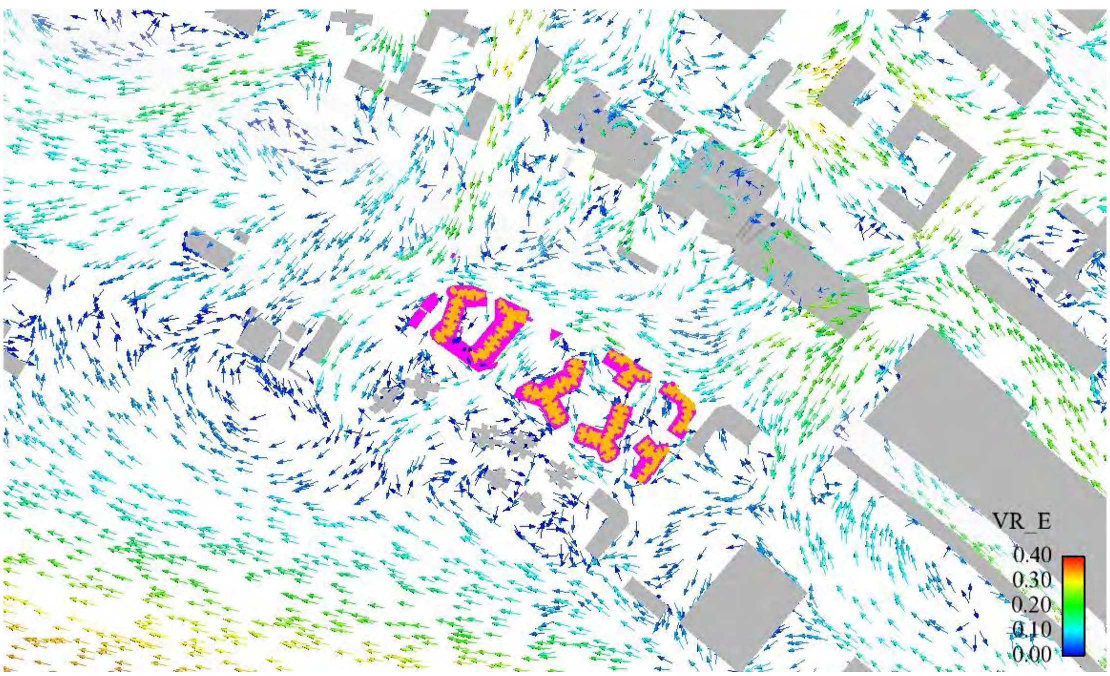
Vector Plot under NNE Wind (Proposed Scheme)



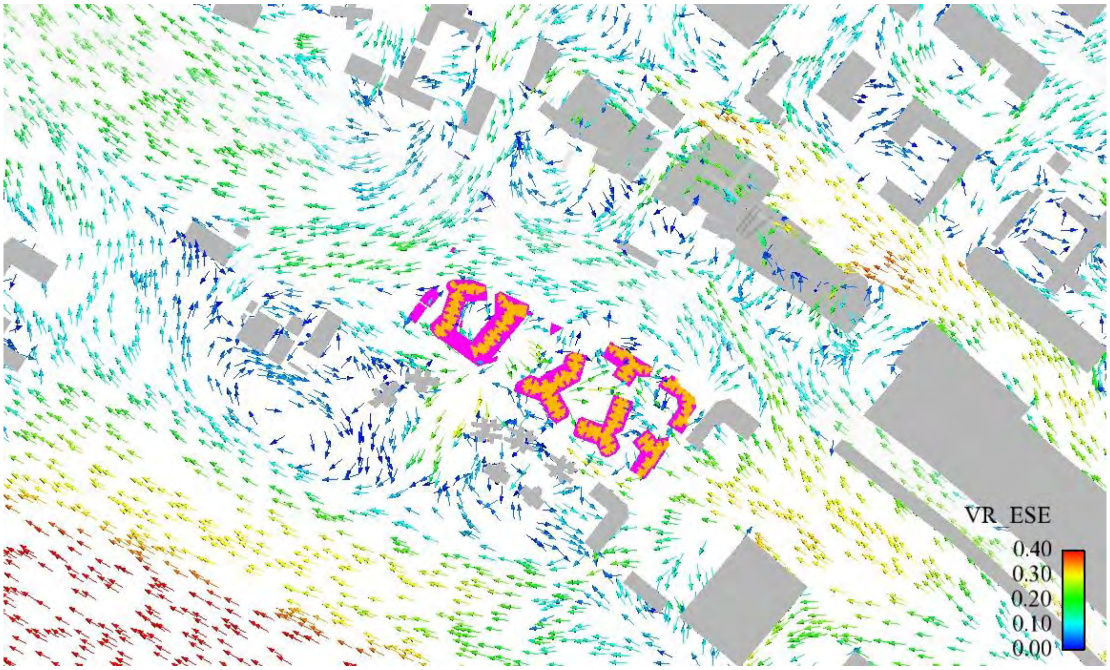
Vector Plot under NE Wind (Proposed Scheme)



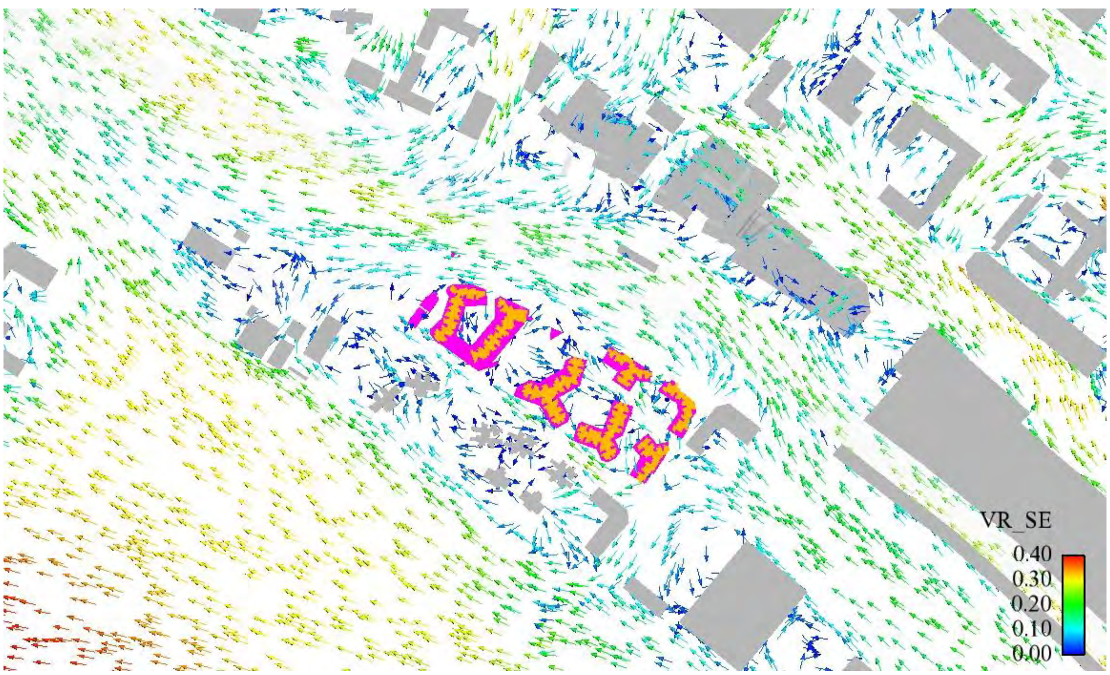
Vector Plot under ENE Wind (Proposed Scheme)



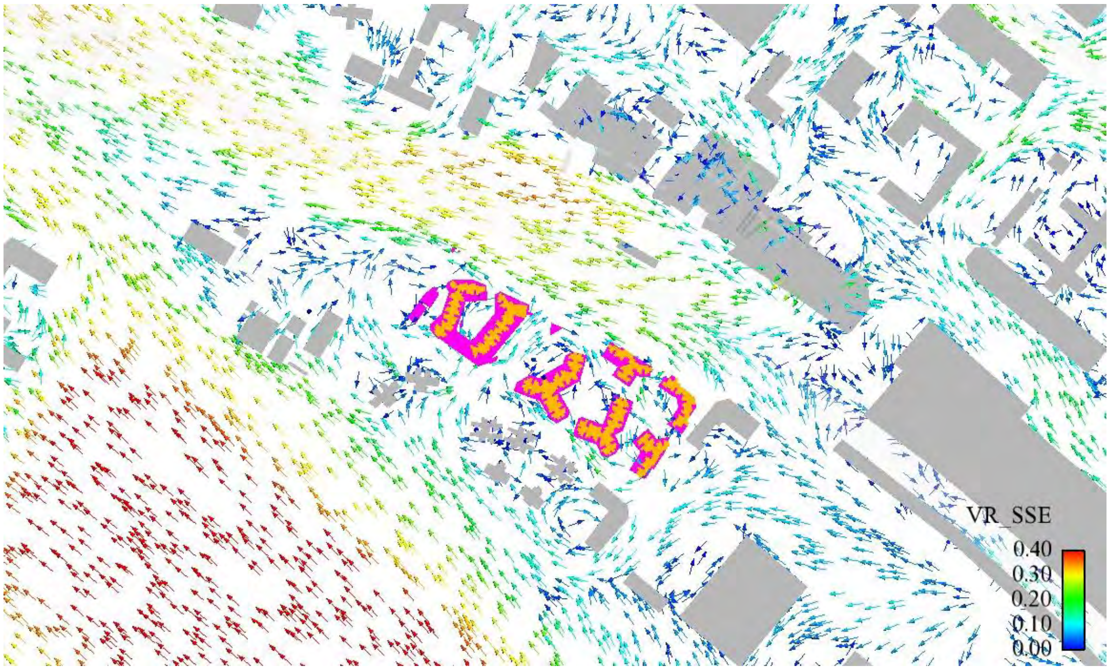
Vector Plot under E Wind (Proposed Scheme)



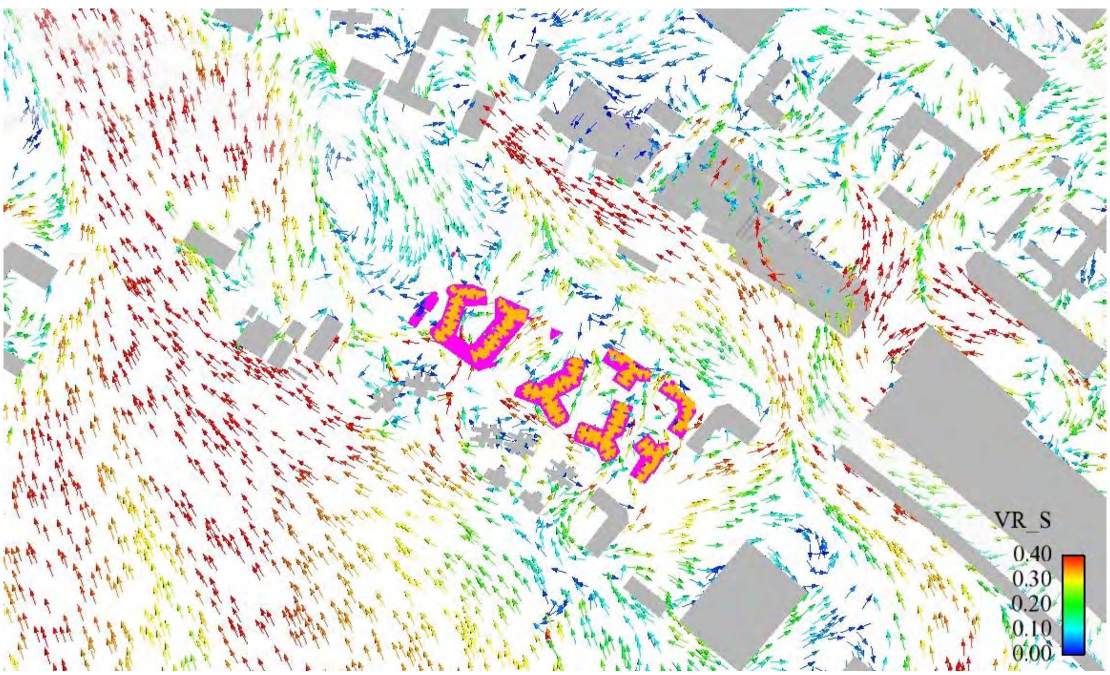
Vector Plot under ESE Wind (Proposed Scheme)



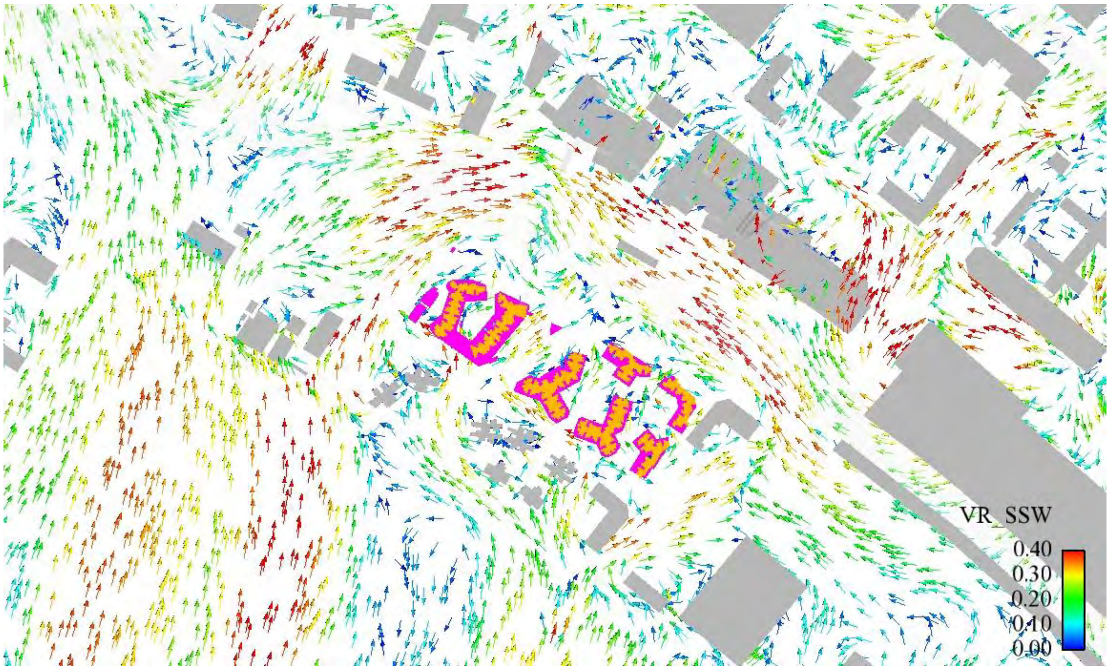
Vector Plot under SE Wind (Proposed Scheme)



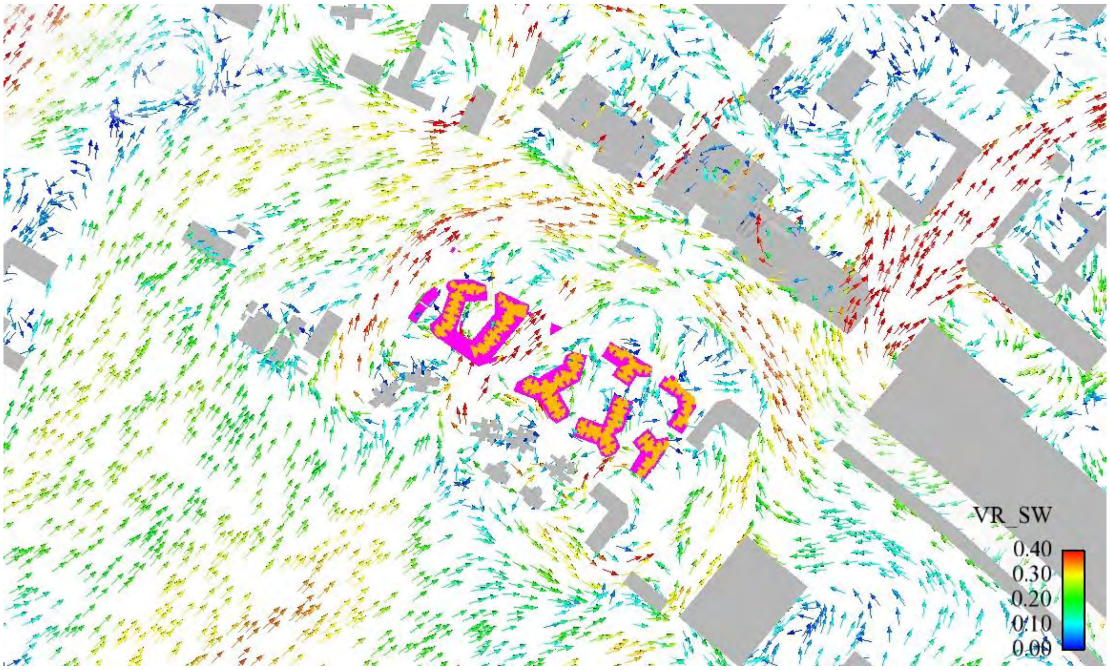
Vector Plot under SSE Wind (Proposed Scheme)



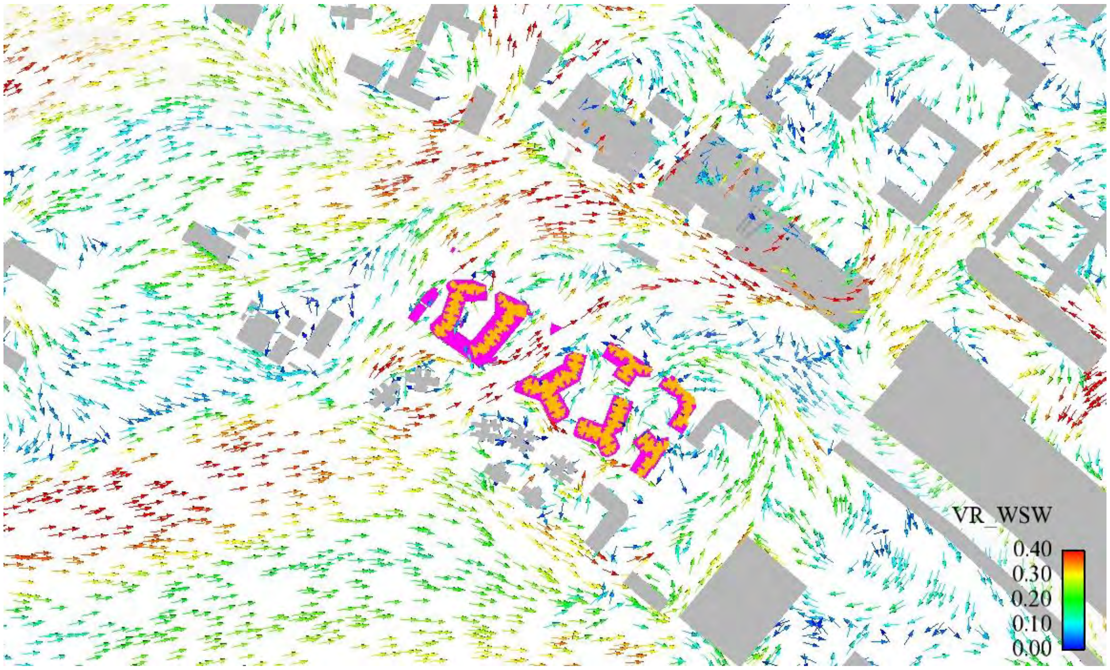
Vector Plot under S Wind (Proposed Scheme)



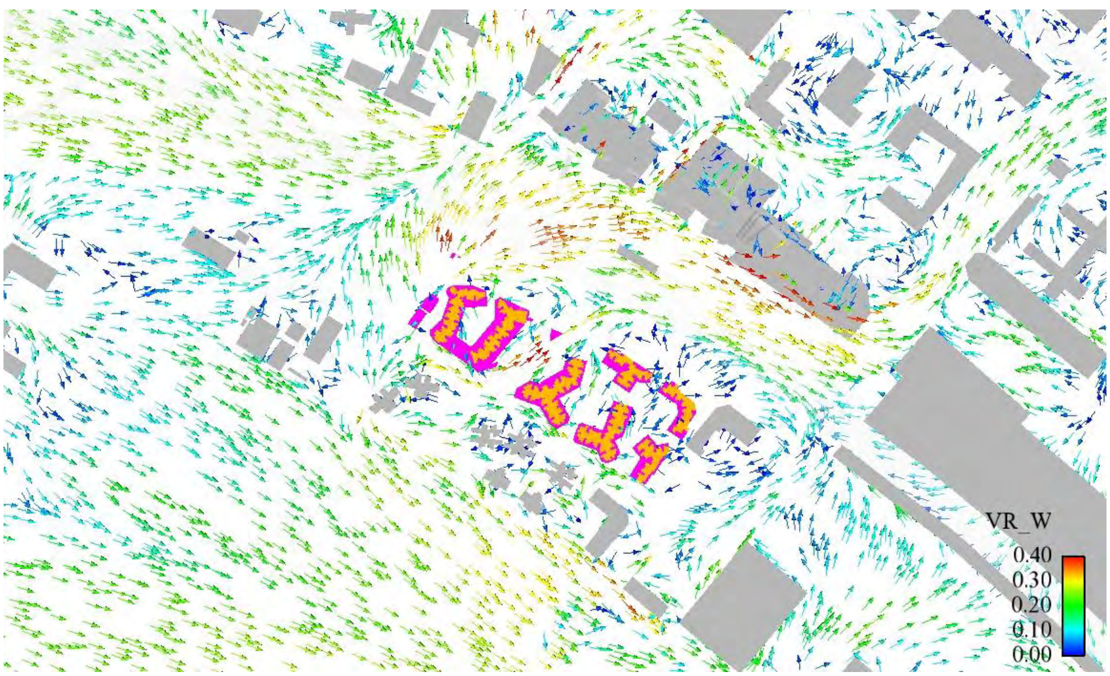
Vector Plot under SSW Wind (Proposed Scheme)



Vector Plot under SW Wind (Proposed Scheme)



Vector Plot under WSW Wind (Proposed Scheme)



Vector Plot under W Wind (Proposed Scheme)