CONSULTANCY STUDY FOR AIR VENTILATION ASSESSMENT SERVICES

CAT. B – TERM CONSULTANCY FOR AIR VENTILATION ASSESSMENTS BY COMPUTATIONAL FLUID DYNAMICS (PLNQ B-1/AVA 2018)

# FINAL REPORT

# FOR

# PLNQ B-1/AVA 2018 FOR AN INSTRUCTED PROJECT AT YAU KOM TAU, TSUEN WAN

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***Submitted to:***

**Planning Department**

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| **Project:** | PLNQ B-1/AVA 2018 for an Instructed Project at Yau Kom Tau, Tsuen Wan<br>Final Report |
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Appendix A – Detailed Velocity Ratio of each Test Point

## EXECUTIVE SUMMARY

BeeXergy Consulting Limited (BXG) was commissioned by the Planning Department (PlanD) of the Hong Kong Special Administrative Region Government to undertake an Air Ventilation Assessment (AVA) – Initial Study (IS) using Computational Fluid Dynamics (CFD) for an Instructed Project at Yau Kom Tau, Tsuen Wan. The Project Area involves two sites at Yau Kom Tau, namely Sites 1 with 0.84 ha and 2 with 4.92 ha (the Sites), which are zoned "Green Belt" ("GB") on the approved Tsuen Wan Outline Zoning Plan No. S/TW/33.

The objectives of this Instructed Project is to assess the air ventilation impacts of the proposed medium-density residential developments with stipulated development parameters. It is also the purpose of this Project to recommend any design improvements and/or mitigation measures which may be adopted to minimize any adverse air ventilation impact.

A series of CFD simulations using realizable k- ε turbulence model were performed based on the AVA methodology for the IS as stipulated in the Technical Circular No. 1/06 on Air Ventilation Assessment (2006). Ten wind directions covering about 78.7% occurrence of annual wind and about 79.5% of summer wind were studied. The ventilation performance for the proposed development at the Project Area and all focus areas within the assessment area were assessed and summarized below:

- The annual weighted Site Spatial Average Velocity Ratio (SVR) for the Baseline Scheme and Proposed Scheme are 0.27 and 0.24 respectively. The summer weighted Site Spatial Average Velocity Ratio (SVR) for the Baseline Scheme and Proposed Scheme are 0.30 and 0.28 respectively.
- The annual weighted Local Spatial Average Velocity Ratio (LVR) for the Baseline Scheme and Proposed Scheme are 0.25 and 0.23 respectively. The summer weighted LVR for the Baseline Scheme and Proposed Scheme are 0.28 and 0.26 respectively.
- The Proposed Scheme is expected to have slightly adverse impact on the pedestrian wind environment when compared with the Baseline Scheme under both annual and summer wind conditions.

Nonetheless, the following good design features are incorporated in the Proposed Scheme to minimize adverse impact on the pedestrian wind environment:

- For Site 1, the building separation of approximately 15m along the NE-SW alignment is considered effective under NE, SSW, SW and WSW direction whilst the building separation of approximately 17m is considered effective under ENE, E, ESE, SE, SSE and S winds.
- For Site 2, the 60m-wide Drainage Tunnel Protection Zone is considered effective under

NE, ENE, E, SSE, S, SSW, SW and WSW direction, whilst the NW-SE aligned building separations are considered effective to increase the building permeability within the site.

Besides the aforementioned good design features in the Proposed Scheme, future developments should consider the following design principles at the detailed design stage:

- Provision of building separation(s) of at least 15m-wide along with the prevailing wind directions;
- Adopt building permeability equivalent to 20% to 33.3% with reference to PNAP APP-152;
- Minimize podium bulk with ground coverage of no more than 65% where feasible;
- Adopt building setback with reference to PNAP APP-152;
- Incorporate greening measures with a target of not less than 30% for sites larger than 1 ha, and not less than 20% for sites below 1 ha, preferably through tree planting at grade;
- Avoid long continuous façades; and
- Make reference to the recommendations of design measures in the Hong Kong Planning Standards and Guidelines.

## 行政摘要

香港特別行政區政府規劃署委託豐能顧問有限公司利用計算流體力學（CFD）為荃灣油柑頭一個指定項目進行空氣通風評估 (AVA) – 初步研究。此項目涉及兩個地盤，分別為佔地約 0.84 公頃的地盤 1 及約 4.92 公頃的地盤 2。根據荃灣分區計劃大綱核准圖(大綱圖）編號 S/TW/33，兩個地盤現時均被劃定為「綠化地帶」。

本項目的目標是評估擬議中密度住宅項目的規定開發規模對空氣通風的影響，本研究亦會建議一系列改善、設計及/或緩解措施，以改善項目區及其周邊地區的行人風環境，或盡量減少因重建而產生的不利通風影響。

根據技術通告第 1/06 號中規定對初步研究的空氣流通評估方法，本研究進行了一系列利用 realizable k-ε 湍流模型的 CFD 模擬。總共研究了十個風向包括全年盛行風 (發生率約 78.7%) 及夏季盛行風 (發生率約 79.5%)。在評估範圍內所有重點領域及擬議發展的通風表現進行的評估和總結如下：

- 基線方案及擬議方案全年地盤空間的平均風速比（SVR）分別為 0.27 及 0.24。而基線方案及擬議方案夏季地盤空間的平均風速比（LVR）分別為 0.30 及 0.28。
- 基線方案及擬議方案全年地域性空間的平均風速比（LVR）分別為 0.25 及 0.23。而基線方案及擬議方案的夏季地域性空間的平均風速比（LVR）分別為 0.28 及 0.26。
- 與基線方案相比，預料擬議方案將會對行人風環境帶來輕微的負面影響。

擬議方案具備以下良好的設計特徵以減低對行人風環境的負面影響：

- 地盤 1 內約 15 米闊東北至西南向的樓宇間距能促進東北、西南偏南、西南及西南偏西風向的空氣通風，而約 17 米闊的樓宇間距則有助促進東北偏東、東、東南偏東、東南、東南偏南及南風的通風。
- 地盤 2 內的 60 米闊雨水排水隧道保護區能促進東北、東北偏東、東、東南偏南、南、西南偏南、西南及西南偏西風向的通風，而多條西北至東南的樓宇間距亦有效地增強擬議方案的通透性。

除以上提及地盤 1 及 2 的良好的設計特徵外，未來的發展亦應在詳細設計階段考慮以下設計原則：

- 沿盛行風方向提供至少 15 米闊的樓宇間距；
- 參考《認可人士、註冊結構工程師及註冊岩土工程師作業備考》 APP-152，提供相當於 20% 至 33.3%建築物滲透率;
- 盡可能縮減平台體積，使地面覆蓋率不超過 65%;
- 參考《認可人士、註冊結構工程師及註冊岩土工程師作業備考》 APP-152 採用建築物後移;
- 大於 1 公頃的地盤需提供不低於 30%綠化覆蓋率，而 1 公頃以下的地盤則需提供不低

於 20%綠化覆蓋率，並於地面種植樹木為佳;

- 避免過長的建築物; 及
- 參考《香港規劃標準與準則》中有關的良好通風設計措施的建議。

# 1 INTRODUCTION

## 1.1 PROJECT BACKGROUND

BeeXergy Consulting Limited (BXG) was commissioned by the Planning Department (PlanD) of the Hong Kong Special Administrative Region Government to undertake an Air Ventilation Assessment (AVA) Initial Study using Computational Fluid Dynamics (CFD) for an instructed project at Yau Kom Tau, Tsuen Wan.

The Project Area involves two sites at Yau Kom Tau, namely Sites 1 and 2 (the Sites), which are zoned “Green Belt” (“GB”) on the approved Tsuen Wan Outline Zoning Plan No. S/TW/33 (the OZP) (Figure 2). The Sites have been identified as potential sites to be rezoned for residential developments.

According to the consultancy study on Air Ventilation Assessment by Expert Evaluation for the Tsuen Wan Area (2012) (the previous AVA EE), Tsuen Wan Bay Western Area and Yau Kom Tau are located on the foothill and its seafront, with ample green belt areas and open space along the sea front and natural vegetated lands in the hinterland. These areas enjoy abundant downhill wind and sea breeze throughout the year. The Sites lie on air paths allowing the prevailing wind to permeate throughout the region. In order to assess if any potential adverse air ventilation impacts might be induced on the surrounding pedestrian wind environment with the proposed rezoning of the Site for residential developments from “GB” to “Residential (Group B)” (“R(B)”) for both sites, a site-specific quantitative AVA has been conducted in supporting the rezoning proposal for the Town Planning Board (TPB) consideration.

## 1.2 STUDY OBJECTIVES

This Instructed Project (the Project) is to assess the potential air ventilation impacts of the proposed residential developments with the stipulated development parameters. It is also the purpose of this project to recommend design improvements and/or mitigation measures which may be adopted to minimise any adverse air ventilation impact.

The findings and recommendations of the Project will form an essential basis to substantiate the rezoning proposal from air ventilation perspective and to incorporate any design requirements for future development on the Project Area for consideration by the TPB.

## 1.3 PROJECT AREA AND ITS SURROUNDING AREA

The Project Area for this AVA Initial Study covers the two potential housing sites at Yau Kom Tau, which have site areas of about 0.84 ha for Site 1 and 4.92 ha for Site 2. At present, two Sites are natural vegetation slopes. Site 1 is located to the south of Tuen Mun Road with predominately high-rise residential developments located to its immediate east and south. Site 2 is located to the north of Tuen Mun Road with Yau Kom Tau Village and Ha Fa Shan lie to its immediate southwest and north respectively. Some temporary structures and ruins can be found in Site 2. The Project Area lie on air paths allowing northerly, north-easterly, southerly and south-westerly wind to reach the Tsuen Wan Western Area and Yau Kom Tau as identified in the previous AVA EE (2012).

According to the OZP, the Sites are currently zoned “GB” and surrounded by Yau Kom Tau Village zoned “Village Type Development” (“V”), several residential development zoned “R(A)”/”R(B)” and the Yau Kom Tau Water Treatment Works zoned “Government, Institution or Community”(“G/IC”). Yau Kom Tau Village has a building height up to approximately 82.2mPD whereas Yau Kom Tau Water Treatment Works has a building height up to approximately 86.4mPD.

To the east of Site 1 lies a cluster of residential developments interspersed with G/IC developments, areas zoned “Open Space” (“O”) and areas zoned “GB”. These residential developments include: Greenview Court, Bayview Garden, Belvedere Garden Phases 1, 2 & 3, Serenade Cove and The Panorama with a building height up to approximately 122.9mPD, 107.5mPD, 115.8mPD, 141.4mPD, 132.7mPD, 116.9mPD and 158.2mPD respectively. The aforementioned G/IC developments within this region include: Tsuen Wan Government Primary School, Hong Kong Baptist Convention Primary School, Tsuen Wan West Sports Centre and Wang Fat Ching She with a building height up to approximately 43.5mPD, 30.9mPD, 20.3mPD and 34.1mPD respectively.

To the immediate south and southwest of Site 1 lies the residential developments of One Kowloon Peak Phases 1 & 2 as well as Greenview Terrace with a building height up to approximately 110.8mPD, 68.6mPD and 86.5mPD respectively.

To the further west of Site 1 lies a cluster of residential developments interspersed with GB regions. These residential developments include: Long Beach Gardens, The Bay Bridge, The Westminster Terrace, Grandview Villa, Hanley Villa, Golden Villa and Sunny Villa with a building height up to approximately 65.7mPD, 59.0mPD, 182.0mPD, 66.1mPD, 150.8mPD, 135.5mPD and 96.4mPD respectively.

Figure 1 shows an overview of the Project Area and its surroundings. Figure 2 shows a view of the Project Area and its surroundings as shown on the OZP. The maximum building height for the existing developments in the vicinity of the Project Area are listed out in Table 1.

Table 1 Existing Developments around the Project Area

| Name of Existing Development | Maximum Building Height (mPD) |
|---|---|
| Yau Kom Tau Village | 82.2 |
| Yau Kom Tau Water Treatment Works | 86.4 |
| Greenview Court | 122.9 |
| Bayview Garden | 107.5 |
| Belvedere Garden | Phase 1: 115.8 |
| | Phase 2: 141.4 |
| | Phase 3: 132.7 |
| Serenade Cove | 116.9 |
| The Panorama | 158.2 |
| Tsuen Wan Government Primary School | 43.5 |
| Hong Kong Baptist Convention Primary School | 30.9 |
| Tsuen Wan West Sports Centre | 20.3 |
| Wang Fat Ching She | 34.1 |
| One Kowloon Peak | Phase 1: 110.8 |
| | Phase 2: 68.6 |
| Greenview Terrace | 86.5 |
| Long Beach Gardens | 65.7 |
| The Bay Bridge | 59.0 |
| The Westminster Terrace | 182.0 |
| Grandview Villa | 66.1 |
| Hanley Villa | 150.8 |
| Golden Villa | 135.5 |
| Sunny Villa | 96.4 |


Figure 1 Overview of the Project Area and its Surroundings


Figure 2 View of the Project Area and its Surroundings as shown on the OZP

## 2 EXISTING WIND ENVIRONMENT

As identified in the AVA EE, the Sites enjoy abundant northerly and north-easterly wind as well as downhill wind from Ha Fa Shan whereas south-westerly wind coming from Tuen Mun Road, Castle Peak Road – Ting Kau and sea breeze from Rambler Channel.

For Site 1, Tuen Mun Road acts as the main wind corridor to bring annual north-easterly wind to the site. A portion of annual wind also travels along another air path, namely Castle Peak Road – Tsuen Wan, to reach Site 1 and its downwind regions (i.e. One Kowloon Peak and Greenview Terrace). In contrast, summer south-westerly winds are mainly coming from the Rambler Channel. The high-rise building clusters (i.e. Greenview Terrace and One Kowloon Peak) along the waterfront may act as a wind barrier and block a portion of summer wind to Site 1. However, summer south-westerly wind are expected to reach Site 1 via two wide openings, namely the opening between The Westminster Terrace & Greenview Terrace as well as the opening between One Kowloon Peak and Bayview Garden. A portion of summer wind also reaches Site 1 and the downwind regions (i.e. Greenview Court and Bayview Garden) via two key air paths, namely Tuen Mun Road and Castle Peak Road – Ting Kau.

For Site 2, annual north-easterly winds and downhill winds from Ha Fa Shan are expected to reach Site 2 and its downwind regions (i.e. Yau Kom Tau Village). A portion of annual north-easterly winds are also expected to come from Tuen Mun Road (via Tsuen Wan Road), while summer south-westerly winds are mainly coming from Rambler Channel. However, the high-rise building clusters (i.e. Greenview Terrace and One Kowloon Peak) along the waterfront are anticipated to weaken the low level summer wind towards Site 2. Nonetheless, Site 2 is situated on significantly higher ground hence it is expected high-level summer wind could skim over the aforementioned high-rise buildings along the waterfront to reach Site 2.

A detailed qualitative analysis on the existing wind environment is presented in Section 5. Figure 3 shows the annual and summer air paths for the Sites as identified in and extracted from the Air Ventilation Assessment by Expert Evaluation for the Tsuen Wan OZP (2012).

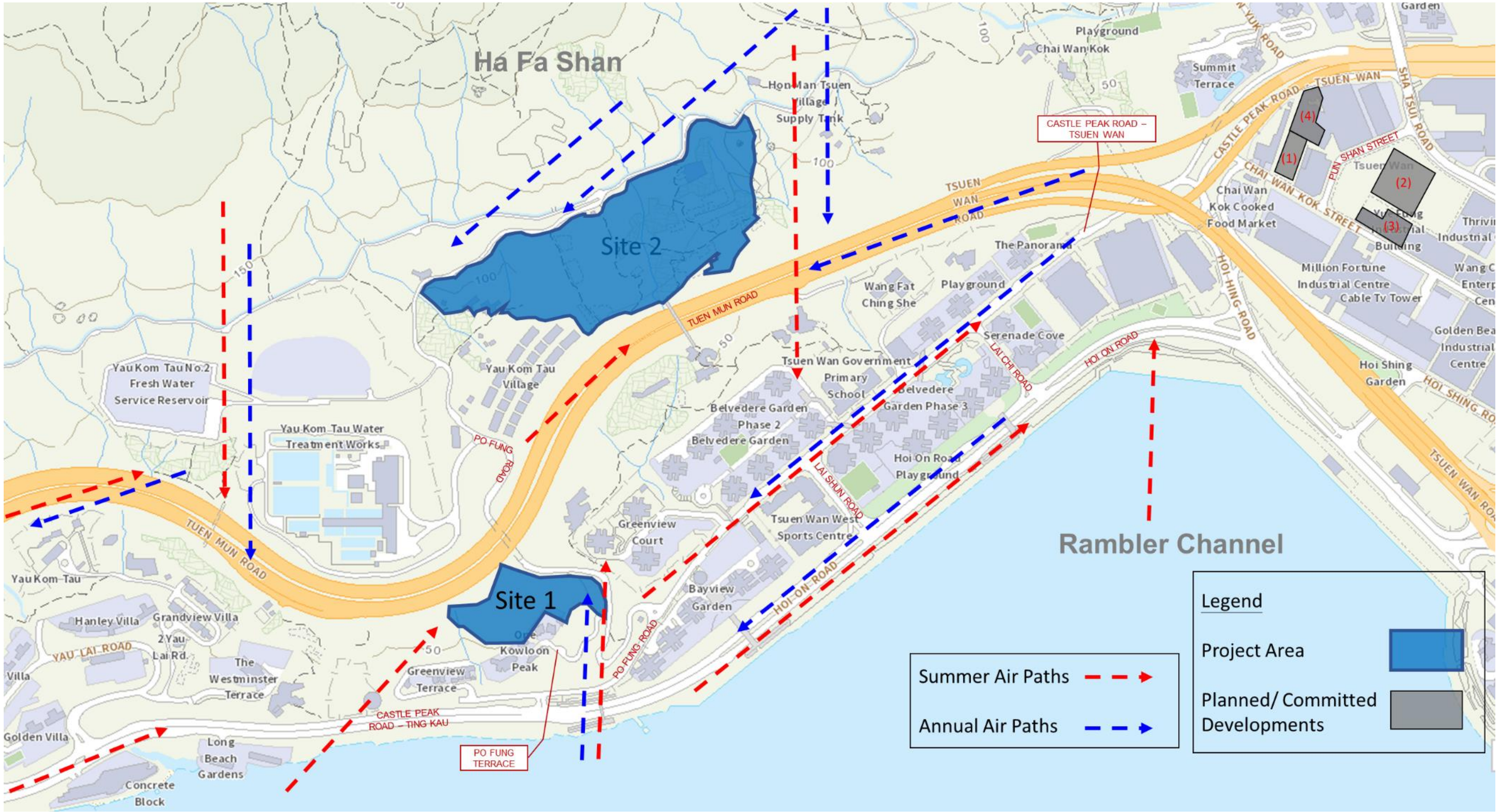


Figure 3 Existing Air Paths and Location of Committed Developments around the Project Area

## 2.1 STUDIED SCENARIOS

Both the Baseline Scheme and Proposed Scheme are assessed under annual and summer wind conditions. A 3D computational model has been built according to the GIS information provided by the PlanD. All major elevated structures and noise barriers will be incorporated in the simulation model. All known planned/committed developments within the surrounding area, including approved planning applications, rezoning proposals and approved building plans are reviewed, and where appropriate, are included in the model. Table 2 shows the location and information respectively of the approved planning applications, rezoning proposals and approved building plans within the Surrounding Area.

Table 2 Planned / Committed Developments within the Surrounding Area

| | **Location (No. as shown in Figure 3)** | **Building Height Restriction (BHR) on OZP (mPD)** | **Proposed BH – Main Roof (mPD)** | **No. of Storeys Above Ground** | **Source** |
|---|---|---|---|---|---|
| (1) | DD355 Lot 303s. A (11-15 Chai Wan Kok Street) | 100 | 99.3 | 19 | Based on the building plan approved on 29.10.2018 |
| (2) | TWIL 49 (8-14 Sha Tsui Road) | 100 | 99.9 | 19 | Based on planning application A/TW/509 approved on 13.12.2019 |
| (3) | DD355 Lot 309&310 (23-33 Chai Wan Kok Street) | 100 | 99.2 | 16 | Based on building plan approved on 27.03.2019 |
| (4) | DD355 Lot 338 s.A (18-20 Pun Shan Street) | 100 | 100 | 23 | Based on planning application A/TW/508 approved on 17.01.2020 |
| ***Remarks: Details of (4) are based on the information provided by Planning Department in May 2020. The CFD simulation was conducted based on the latest available information in Dec 2019. The approved changes to the building layout / height for this development will be qualitatively assessed in Section 8*** | | | | | |

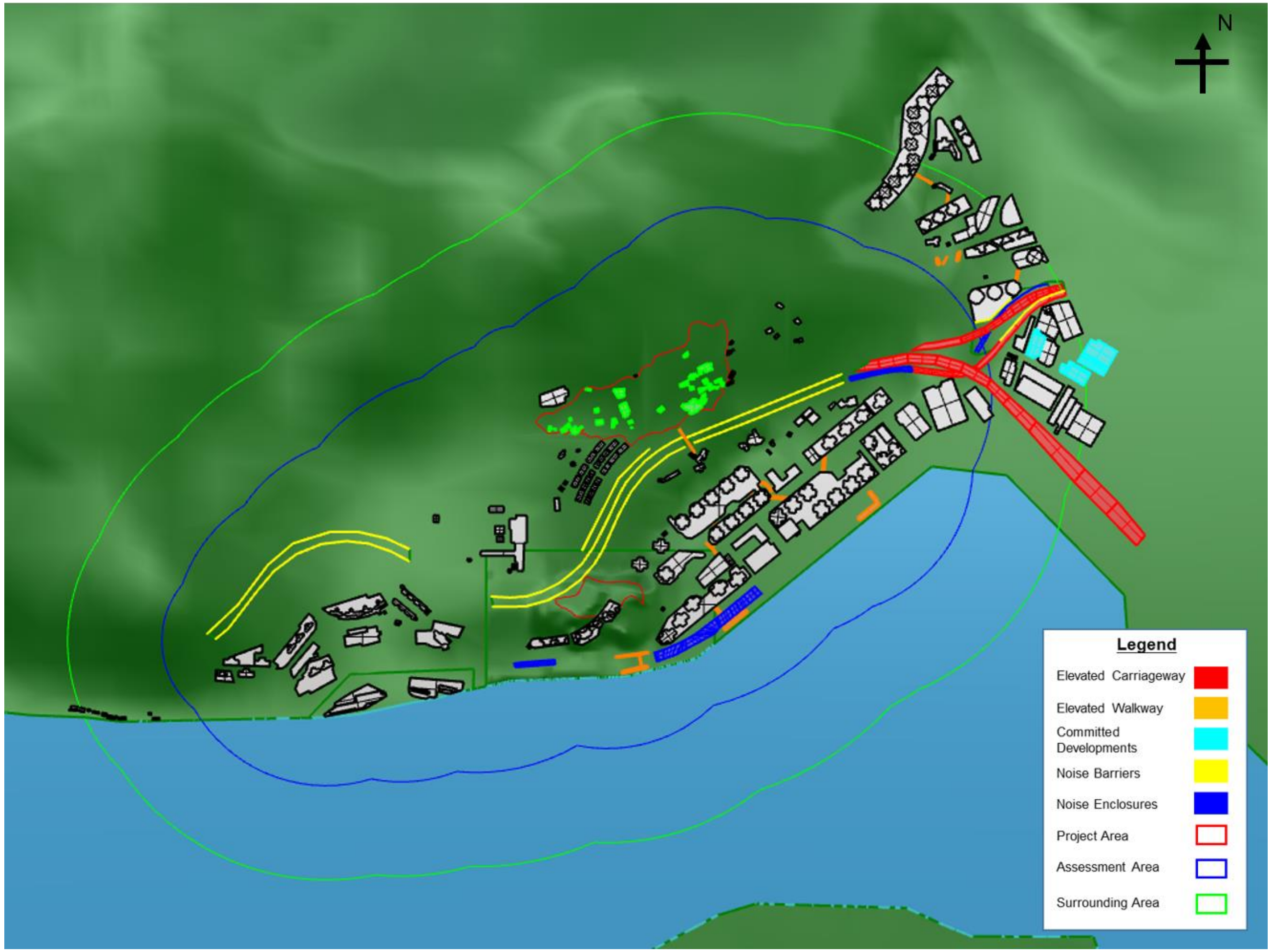


Figure 4 Overview of the 3D Computational Model


Figure 5 Isometric View of the 3D Computational Model from the North

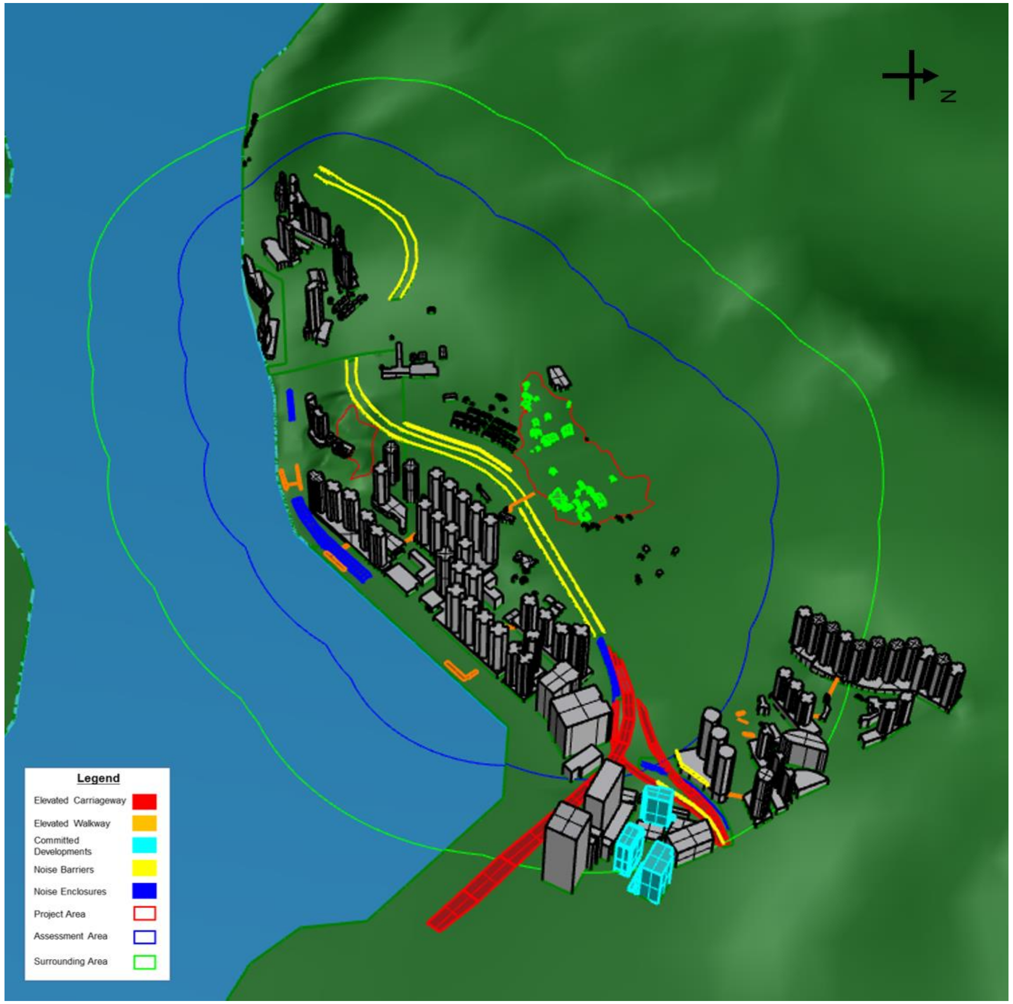


Figure 6 Isometric View of the 3D Computational Model from the East

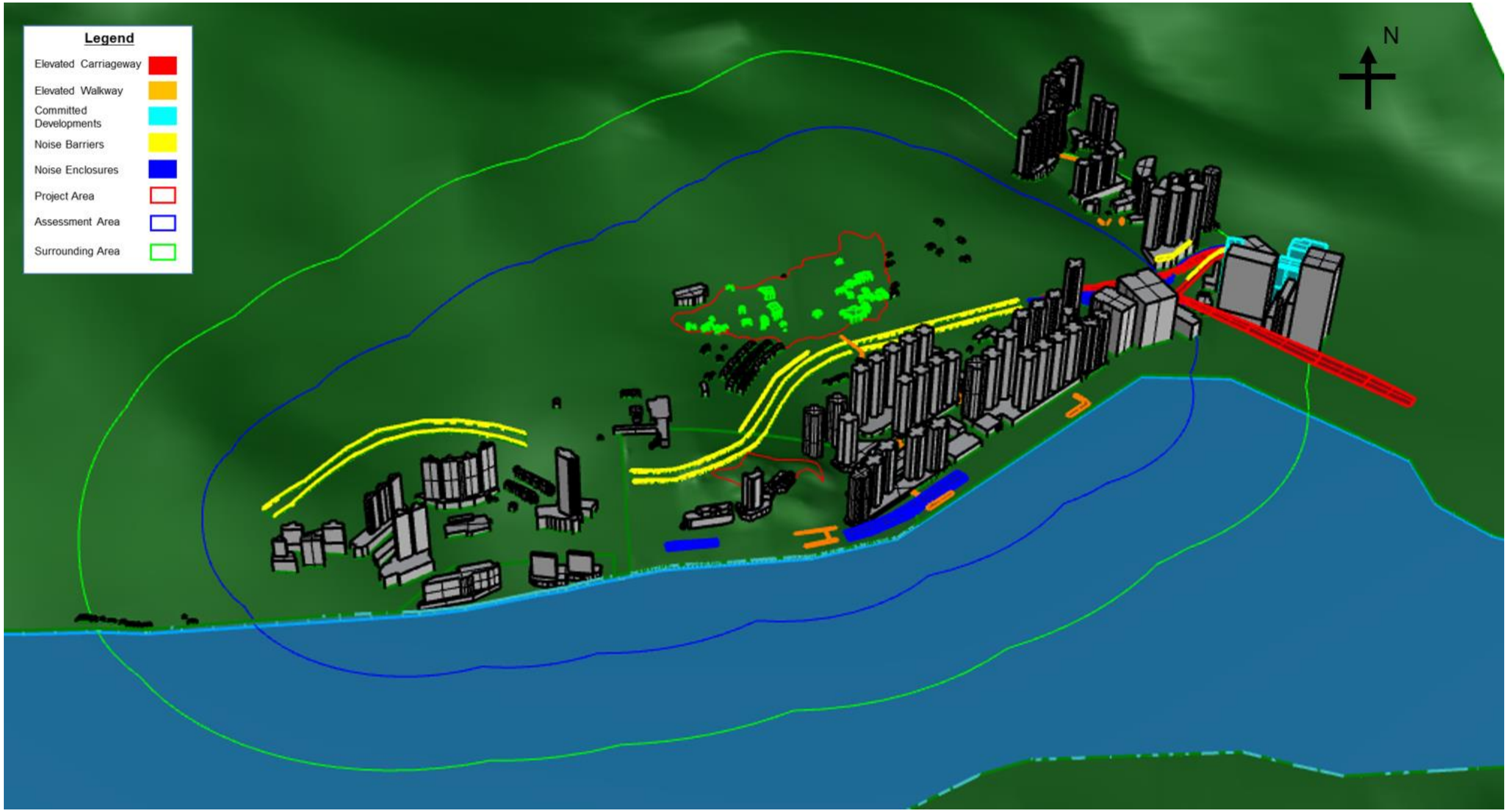


Figure 7 Isometric View of the 3D Computational Model from the South

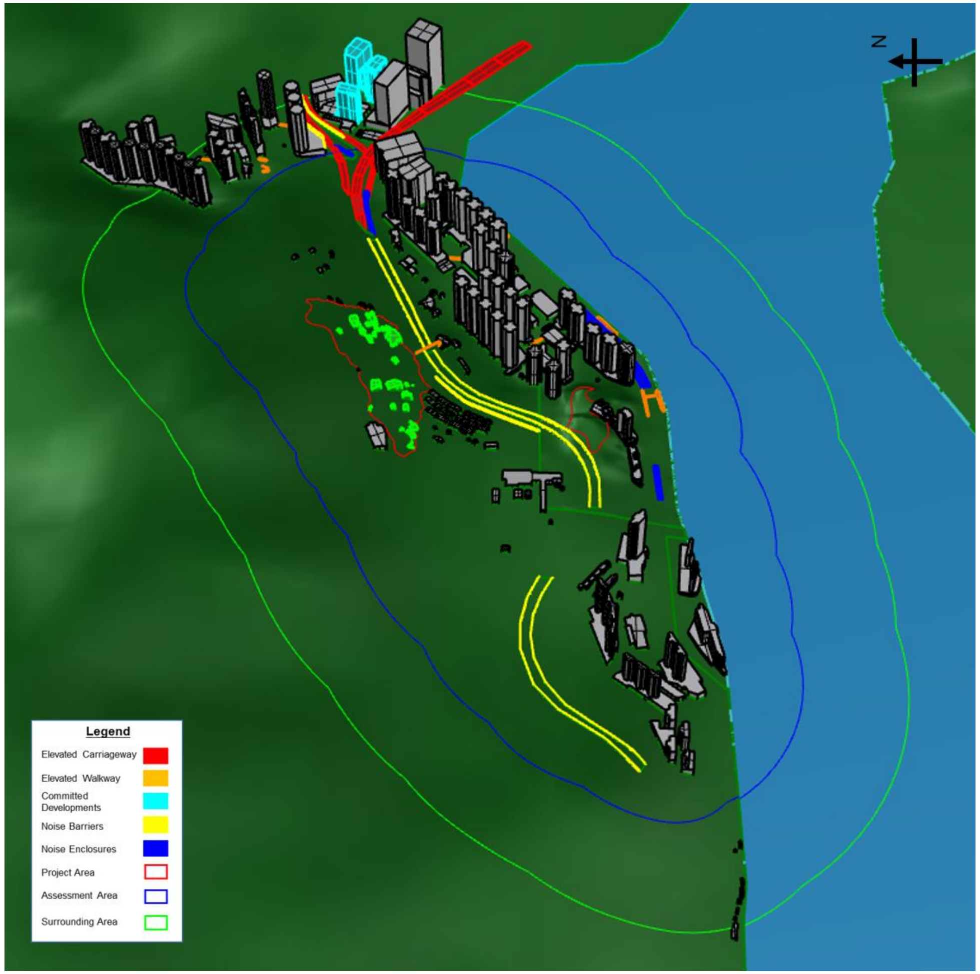


Figure 8 Isometric View of the 3D Computational Model from the West

### 2.1.1 Baseline Scheme

The Baseline Scheme represents the existing condition of the Project Area. As mentioned in Section 1.3, Site 1 is covered by natural vegetation without any building structure, while Site 2 is occupied by some temporary structures and ruins amid natural vegetation.

Figure 9 and Figure 10 shows the existing site plan of Site 1 and Site 2 respectively.

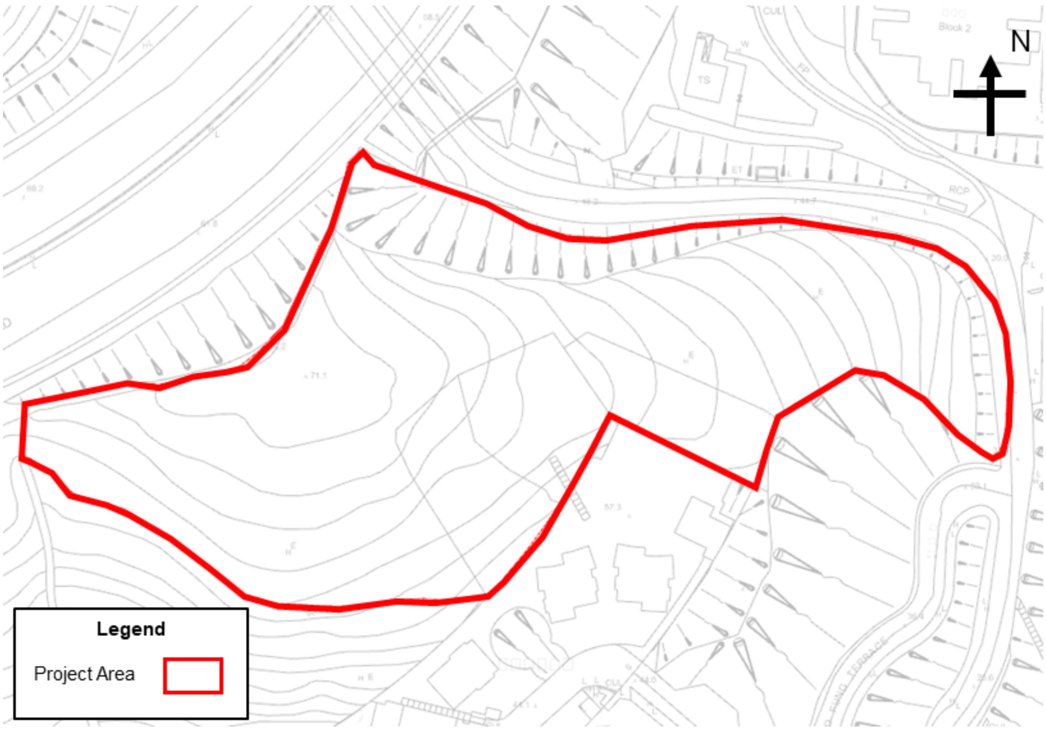


Figure 9 Site Plan showing Existing Features in Site 1

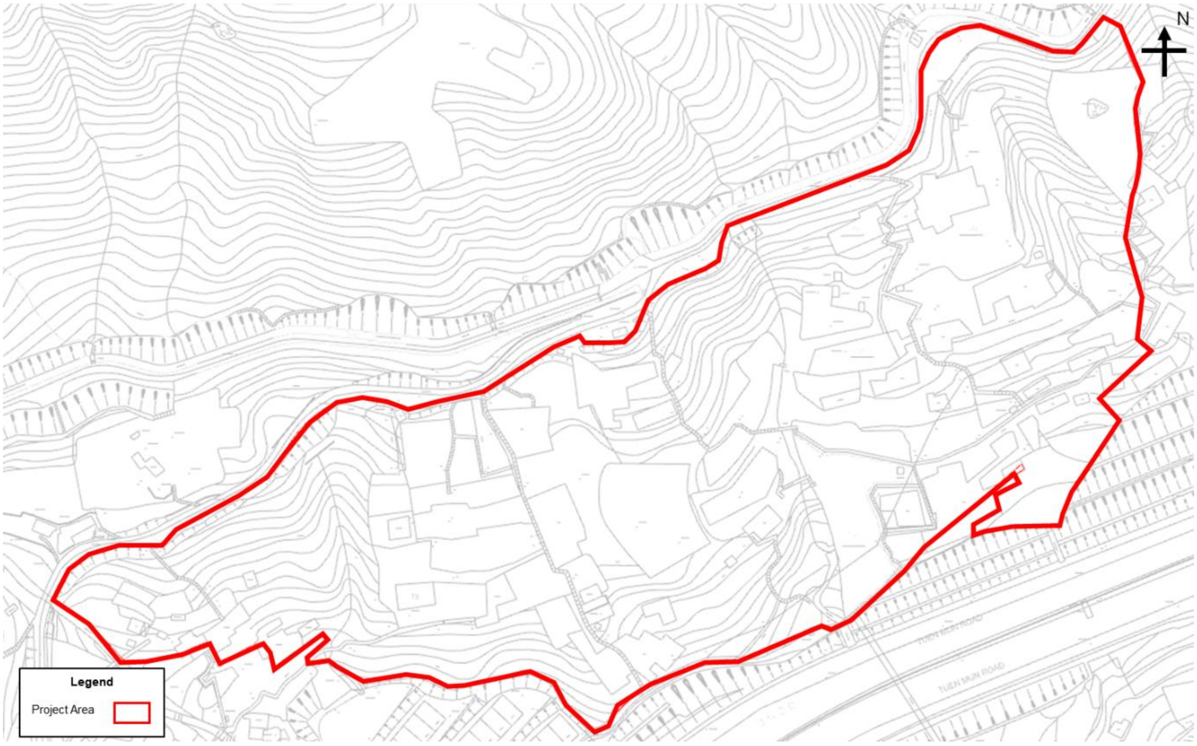


Figure 10 Site Plan showing Existing Features in Site 2

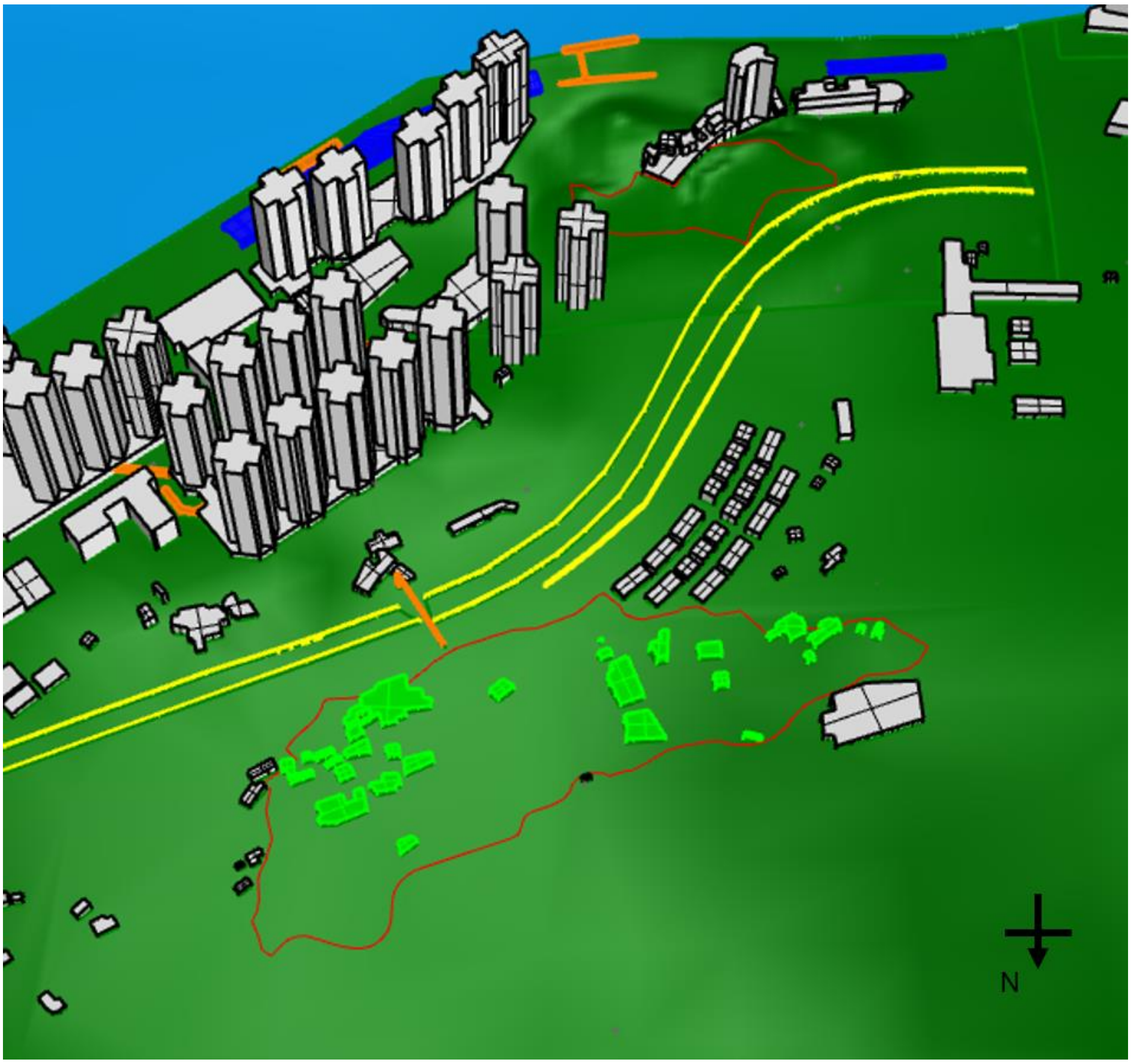


Figure 11 Zoomed-in view of the Baseline Scheme from the North

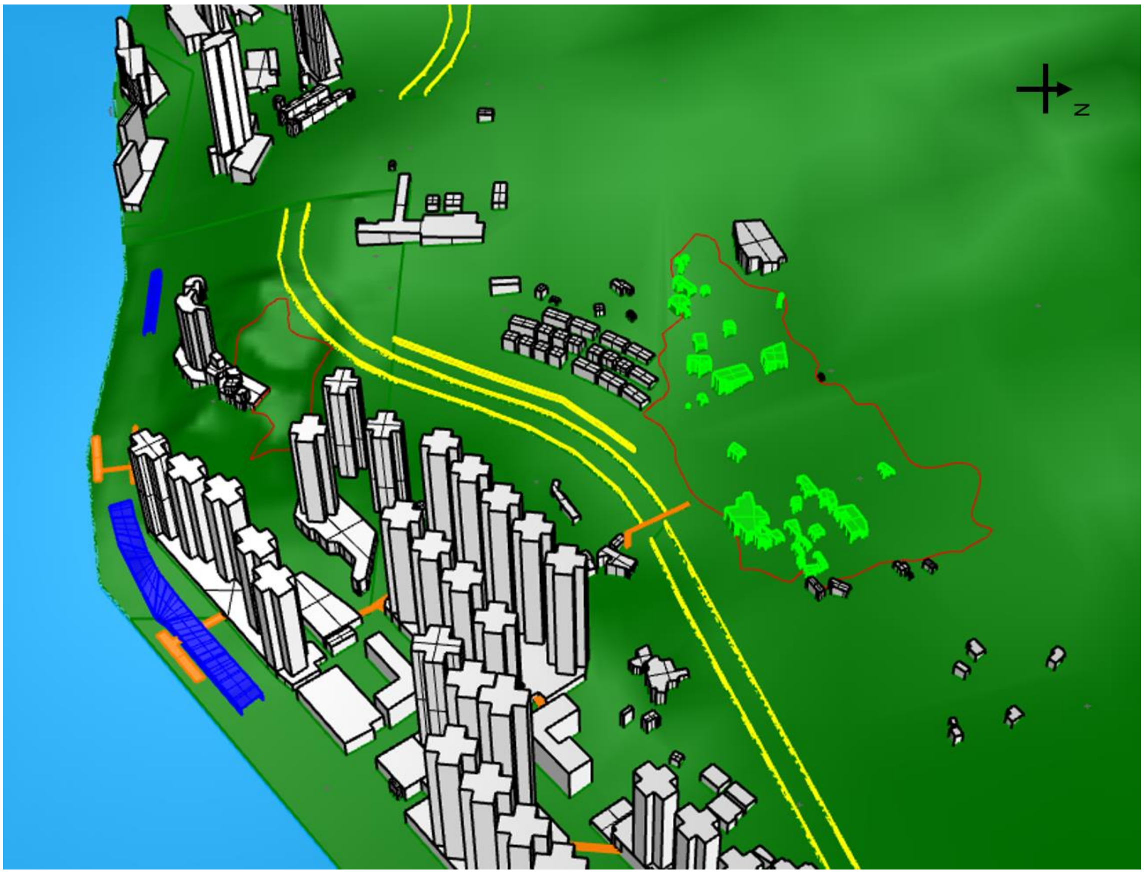


Figure 12 Zoomed-in view of the Baseline Scheme from the East

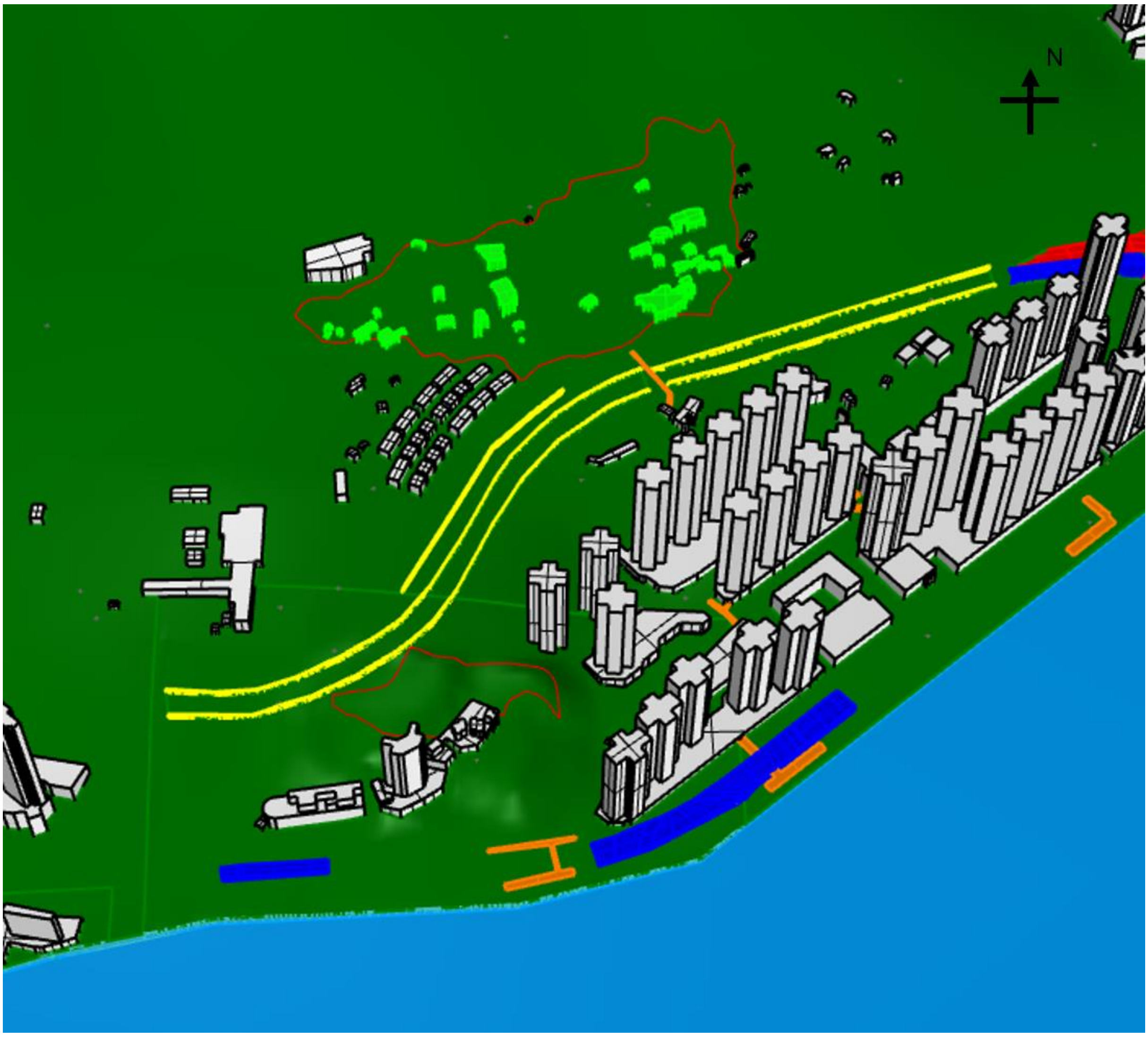


Figure 13 Zoomed-in view of the Baseline Scheme from the South

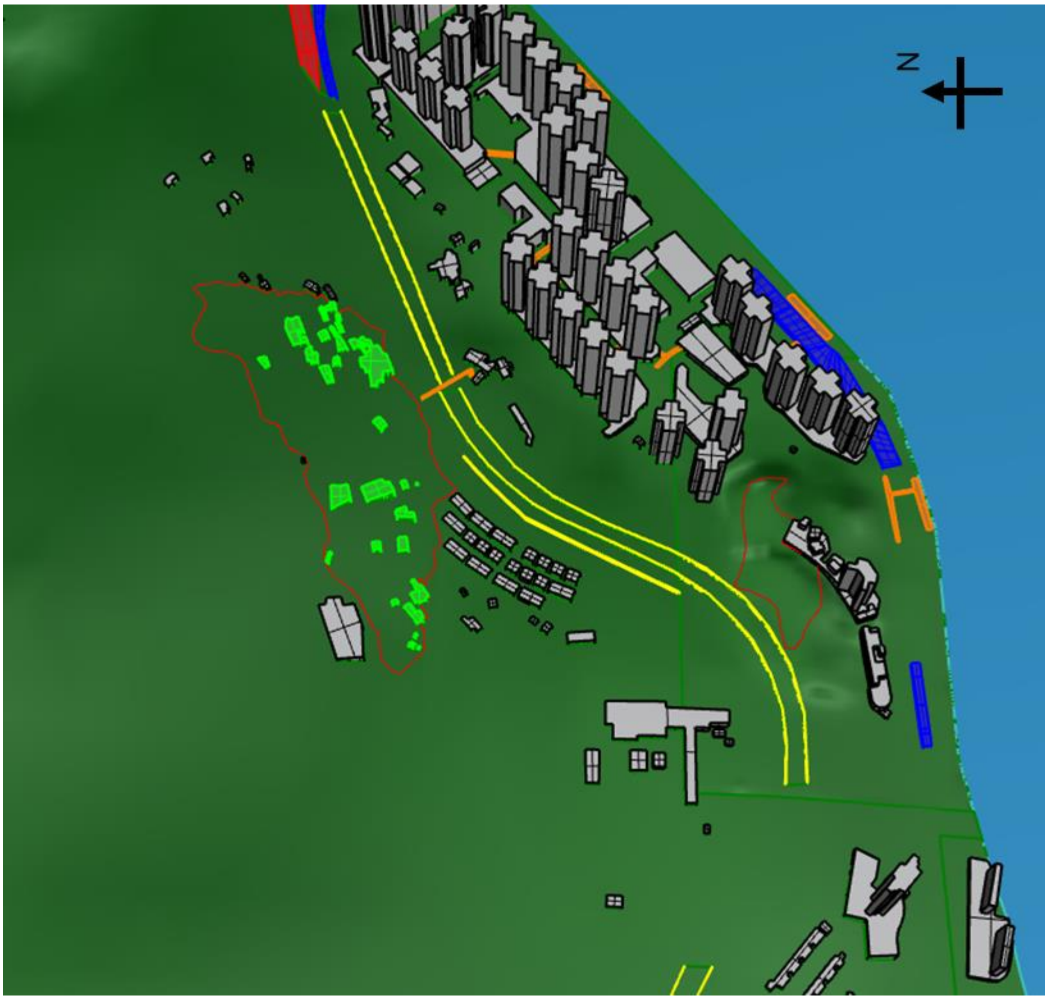


Figure 14 Zoomed-in view of the Baseline Scheme from the West

### 2.1.2 Proposed Scheme

The indicative Proposed Scheme for Site 1 comprises of four residential towers and a 3-storey recreation house cum social welfare facilities[1] of 75mPD. The eastern portion of Site 1 consists of two towers of 26-residential storey on lobby floor with a maximum building height of 136.9mPD. The western portion of Site 1 accommodates two towers of 23-residential storey on lobby floor with a building height of 137.45mPD.

The indicative Proposed Scheme for Site 2 comprises of nine residential towers and a 2-storey recreation house cum social welfare facilities[1] at 106mPD at the southeastern portion of Site 2. The eastern portion of Site 2 consists of three towers (i.e. a single 18-residential storey tower on lobby floor with a building height of 178.7mPD, a 19-residential storey tower on lobby floor with a building height of 177.85mPD and a 20-residential storey tower on lobby floor with a building height of 178mPD). The central portion of Site 2 consists of three 25-residential storey towers on lobby floor of 179.75mPD. The western portion of the Site 2 accommodates three towers (i.e. a 10-residential storey tower on lobby floor with a building height of 136.5mPD and two 23-residential storey towers on lobby floor with a building height of 177.45mPD). There are no proposed buildings/structures within a 60m-wide Drainage Tunnel Protection Zone running beneath Site 2 in NE-SW direction, which also favours wind penetration from the prevailing wind directions.

Figure 15 and Figure 16 shows the indicative layout of the Proposed Scheme for Site 1 and Site 2 respectively. The isometric views of Proposed Scheme model are shown in Figure 17 to Figure 20.

[1] *Remarks: social welfare facilities (SWFs) were not originally included in the indicative Proposed Schemes of the two sites of which the CFD simulation was conducted. Subsequently with the incorporation of the SWFs, which were assumed to be placed as one additional storey on the recreation houses at both sites, a qualitative analysis was conducted to assess the change. Please refer to Section 9.*


Figure 15 Master Layout Plan of the Proposed Scheme for Site 1

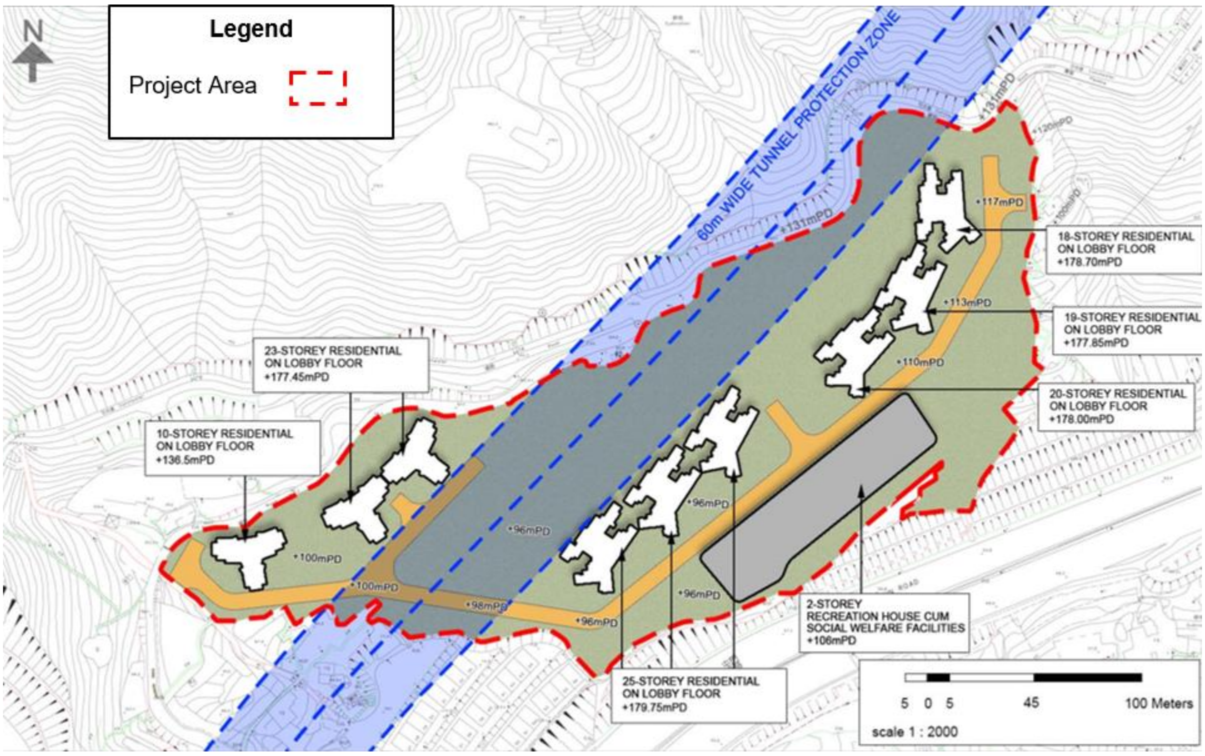


Figure 16 Master Layout Plan of the Proposed Scheme for Site 2


Figure 17 Zoomed-in view of the Proposed Scheme from the North


Figure 18 Zoomed-in view of the Proposed Scheme from the East


Figure 19 Zoomed-in view of the Proposed Scheme from the South


Figure 20 Zoomed-in view of the Baseline Scheme from the West

# 3 SITE WIND AVAILABILITY

The wind profile input for the CFD simulation requires wind data at different heights and at the wind boundary level. The characteristic of the site wind availability should be identified in order to investigate the wind performance of the Project Area. Site wind availability data could be used for assessing the wind characteristics in terms of the magnitude and frequency of approaching wind from each wind direction. In this study, the simulated Regional Atmospheric Modelling System (RAMS) wind data from PlanD has been used for the quantitative assessment.

## 3.1 RAMS WIND DATA

City University of Hong Kong (CityU) utilized the meso-scale numerical model Regional Atmospheric Modeling System (RAMS) to produce site wind availability data for Hong Kong and is available at Planning Department's database[2]. Based on the archived dataset, wind statistics and wind roses for each 0.5km×0.5km grid box at different height levels could be extracted. Simulated data at grid (X064, Y054) corresponds to the location of the Project Area and both annual and summer wind conditions at 500m above ground are referenced in this study. The location of grid (X064, Y054) is shown in Figure 21. The extracted wind roses shows that north easterly wind dominate under the annual wind condition while south westerly wind dominate under the summer wind condition. Figure 22 and Figure 23 shows the annual and summer wind roses at 500m above ground level for grid (X064, Y054) respectively.

[2] http://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/index.html

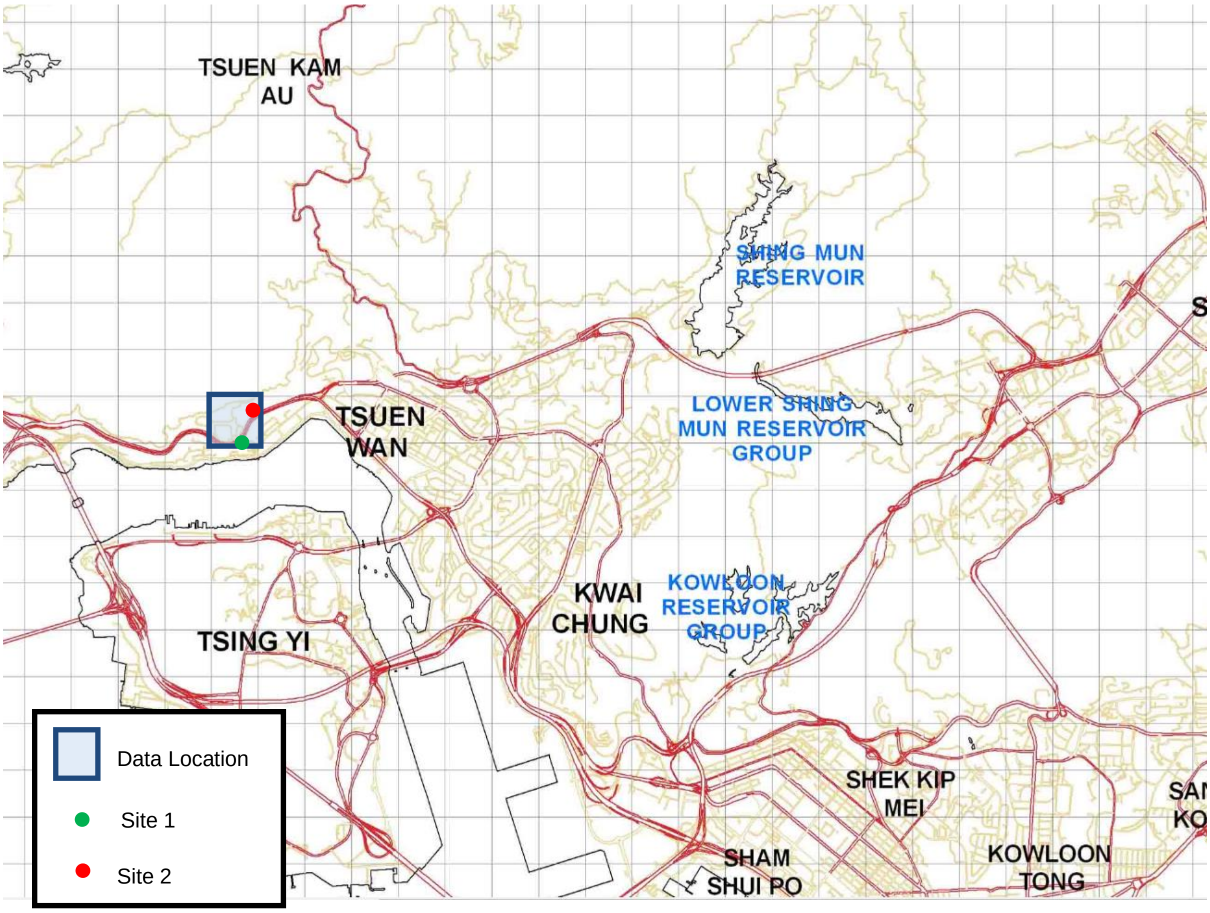


Figure 21 Location of the Selected RAMS Wind Data - Grid (X064, Y054)

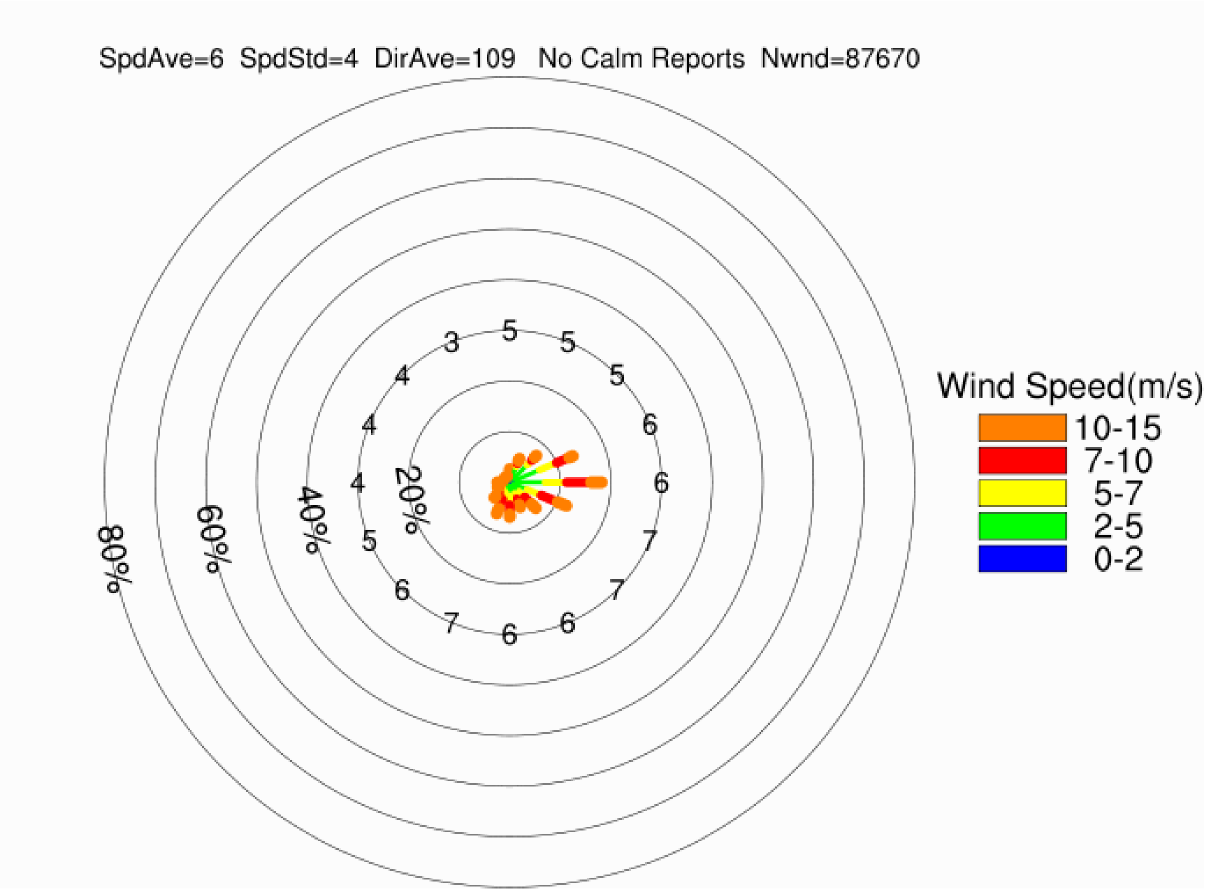


Figure 22 Annual Wind Rose at 500m - Grid (X064, Y054)

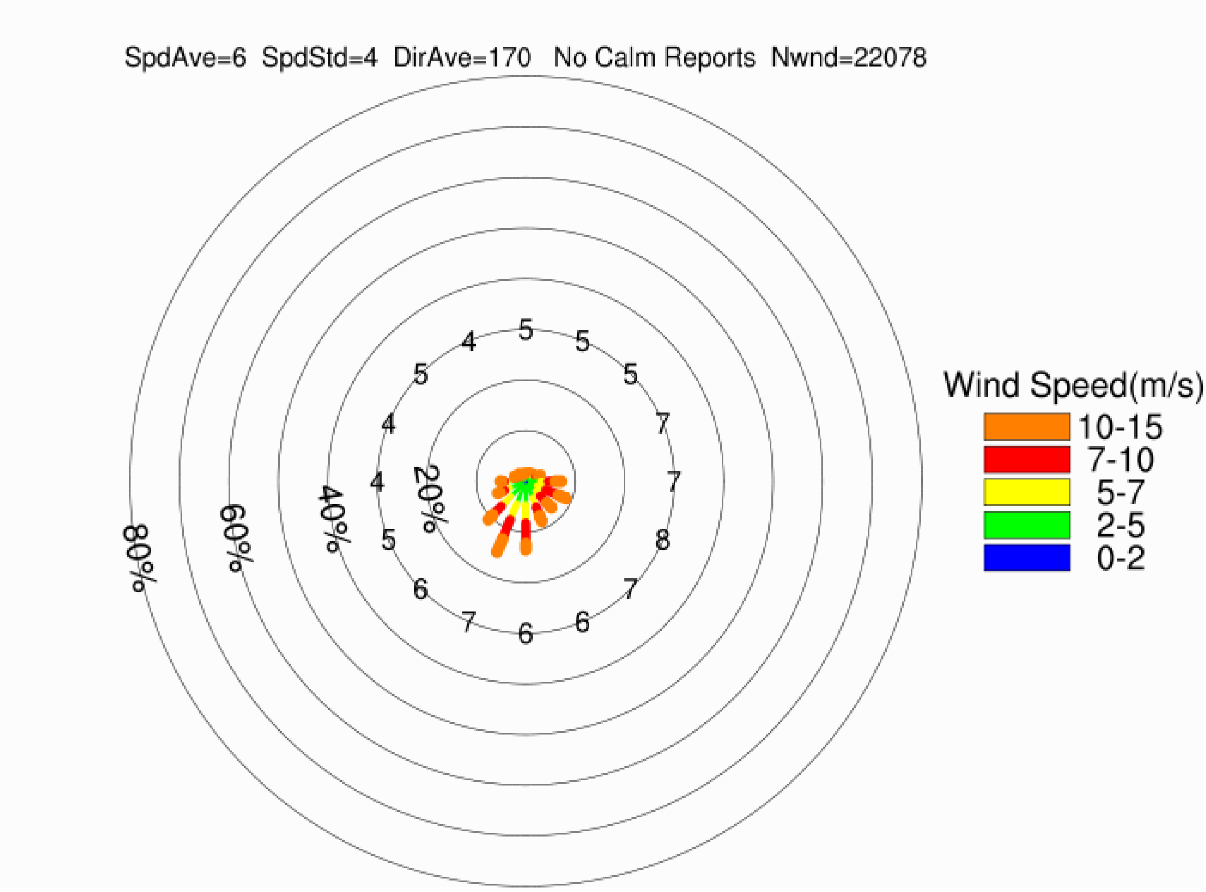


Figure 23 Summer Wind Rose at 500m - Grid (X064, Y054)

### 3.1.1 Annual Prevailing Wind

Eight prevailing wind directions (bolded in Table 3) are considered in this quantitative assessment which covers 78.7% of the total annual wind frequency. They are Northeast (7.5%), East-Northeast (13.7%), East (18.6%), East-Southeast (12.3%), Southeast (7.4%), South-Southeast (5.4%), South (7.0%) and South-Southwest (6.8%) winds.

Table 3 Annual Wind Frequency at 500m

| Direction | Frequency (%) |
|---|---|
| N | 2.7 |
| NNE | 5.2 |
| **NE** | **7.5** |
| **ENE** | **13.7** |
| **E** | **18.6** |
| **ESE** | **12.3** |
| **SE** | **7.4** |
| **SSE** | **5.4** |
| **S** | **7.0** |
| **SSW** | **6.8** |
| SW | 4.3 |
| WSW | 2.6 |
| W | 2.4 |
| WNW | 1.3 |
| NW | 1.3 |
| NNW | 1.3 |
| **Remarks: Bolded wind directions denotes wind directions selected for this study.** | |

### 3.1.2 Summer Prevailing Wind

Eight prevailing wind directions (bolded in Table 4) are considered in this quantitative assessment which covers 79.5% of the total summer wind frequency. They are East (7.8%), East-Southeast (9.2%), Southeast (7.7%), South-Southeast (8.6%), South (13.8%), South-Southwest (15.4%), Southwest (10.9%) and West-Southwest (6.1%) winds.

Table 4 Summer Wind Frequency at 500m

| Direction | **Frequency (%)** |
|---|---|
| N | 1.5 |
| NNE | 1.9 |
| NE | 2.1 |
| ENE | 3.4 |
| **E** | **7.8** |
| **ESE** | **9.2** |
| **SE** | **7.7** |
| **SSE** | **8.6** |
| **S** | **13.8** |
| **SSW** | **15.4** |
| **SW** | **10.9** |
| **WSW** | **6.1** |
| W | 5.2 |
| WNW | 2.5 |
| NW | 2.0 |
| NNW | 1.6 |
| **Remarks: Bolded wind directions denotes wind directions selected for this study.** | |

## 3.2 WIND PROFILE

As mentioned in Section 3.1, the RAMS wind data extracted from Planning Department's Website will be adopted in this AVA Initial Study. The wind profile data from 10 – 500m will be directly adopted as it reflects the exact wind data whereas the power law equation will be used to approximate near ground wind profile (i.e. 0 – 10m). For wind data above 500m, wind velocity shall be assumed as the wind velocity at 500m. Figure 24 to Figure 27 indicates the overall wind profile curve adopted for the CFD simulation.

The vertical discretization of 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*

*UG = reference velocity at height zG*

*UZ = velocity at height z*

*ZG = reference height*

*n = power law exponent*

*Z = height above ground*

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. Table 5 shows the *n* value adopted for CFD simulation.

Table 5 Value of *n* (Power Law Exponent) Adopted for CFD Simulation

| Direction | Value of n |
|---|---|
| **NE** | 0.15 |
| **ENE** | 0.15 |
| **E** | 0.35 |
| **ESE** | 0.35 |
| **SE** | 0.15 |
| **SSE** | 0.35 |
| **S** | 0.35 |
| **SSW** | 0.15 |
| **SW** | 0.15 |
| **WSW** | 0.15 |

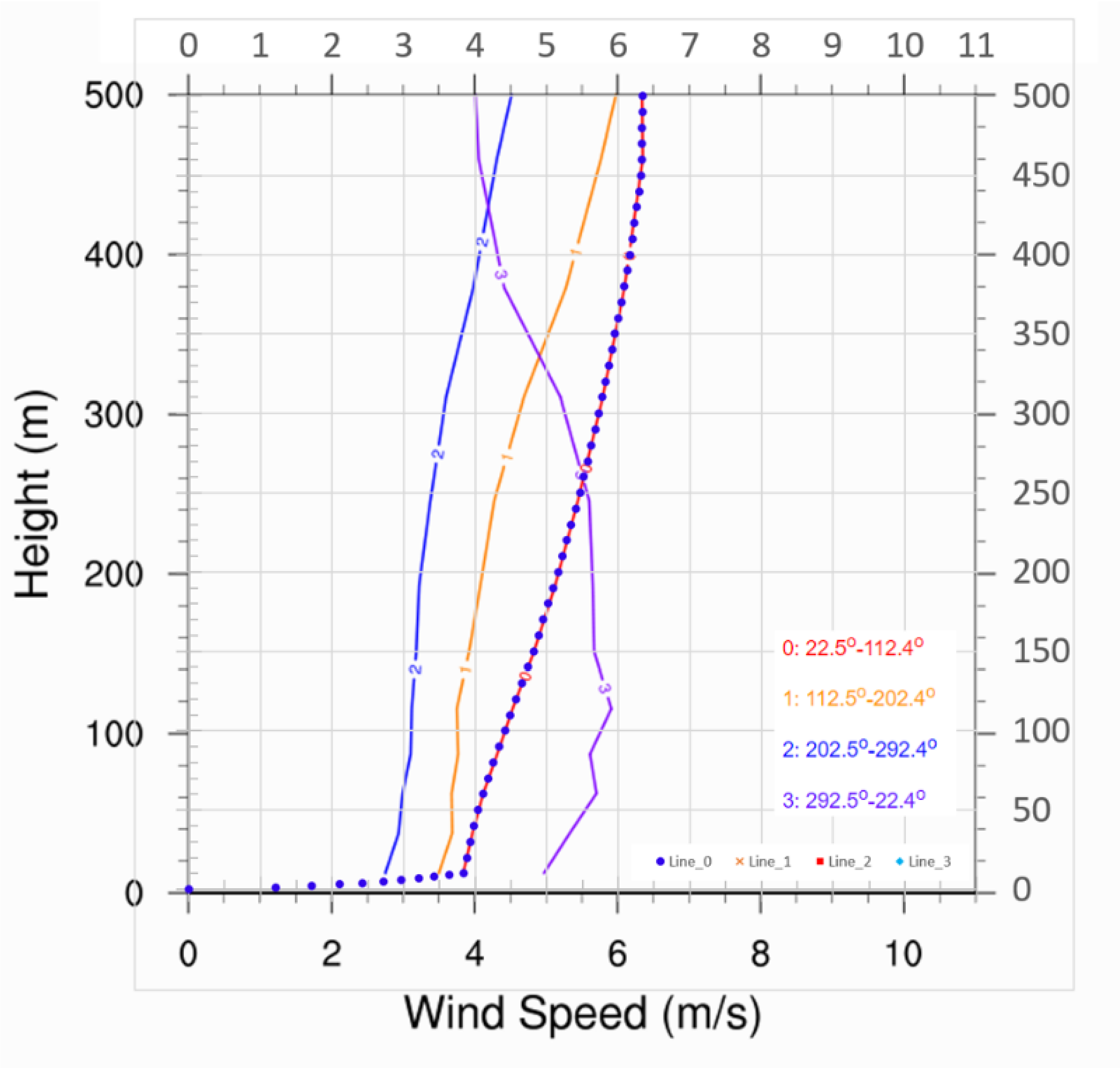


Figure 24 Wind Profile Curve for Wind Directions of 22.5º - 112.4º at Grid (X064, Y054)

*(line – original data from RAMS, dots – input data adopted for CFD simulation)*

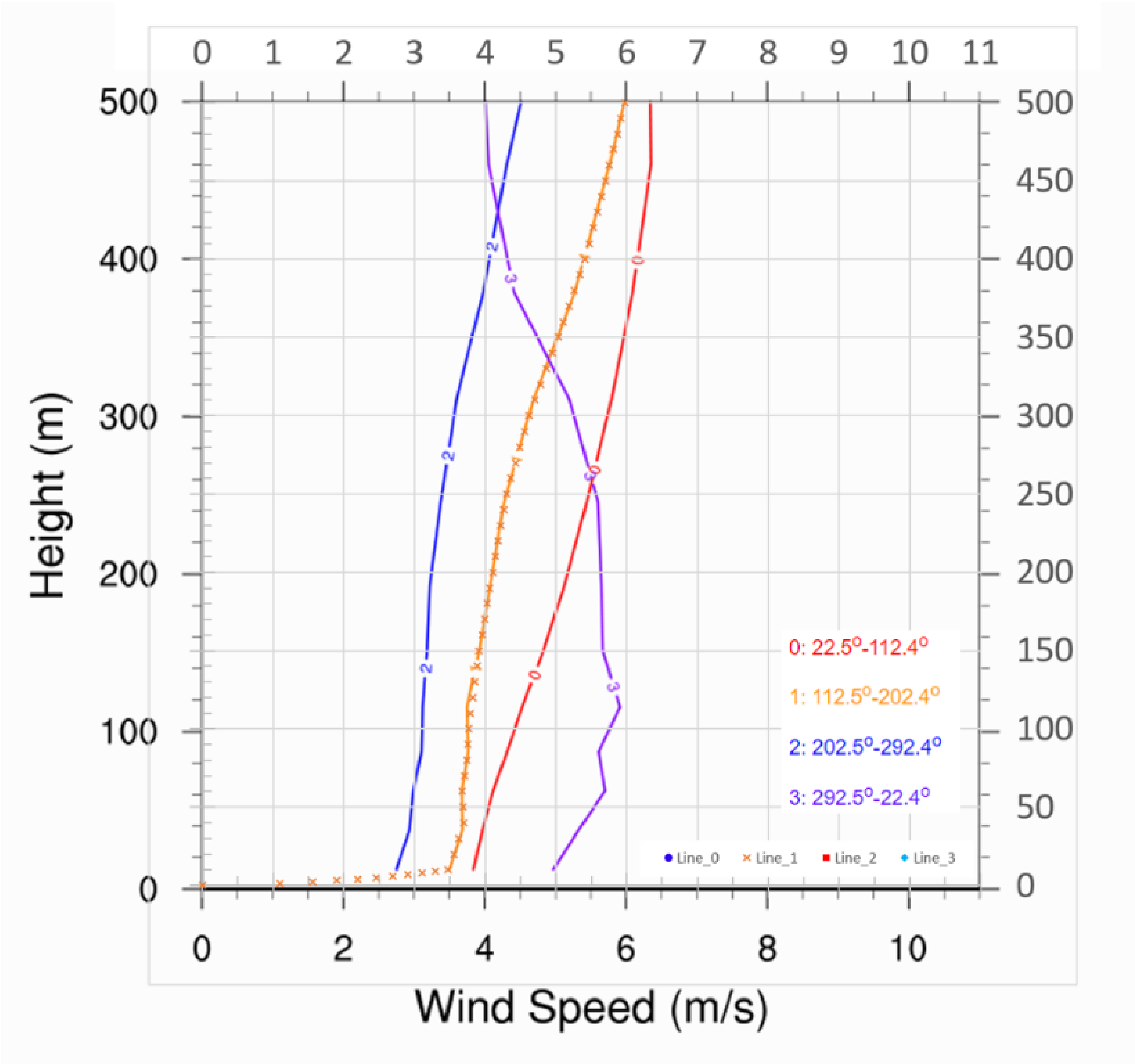


Figure 25 Wind Profile Curve for Wind Directions of 112.5º - 202.4º at Grid (X064, Y054)

*(line – original data from RAMS, dots – input data adopted for CFD simulation)*

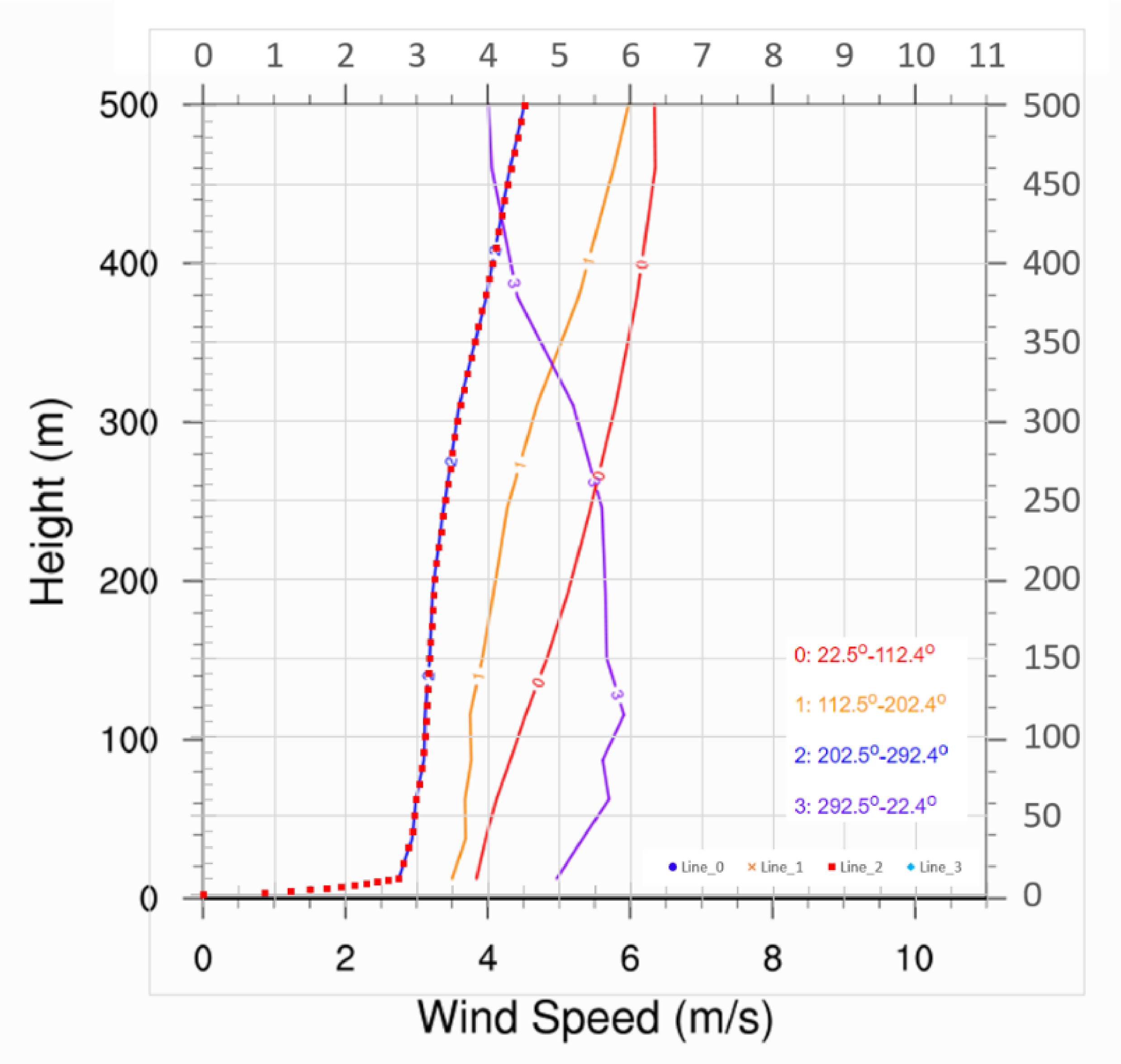


Figure 26 Wind Profile Curve for Wind Directions of 202.5º - 292.4º at Grid (X064, Y054)

*(line – original data from RAMS, dots – input data adopted for CFD simulation)*

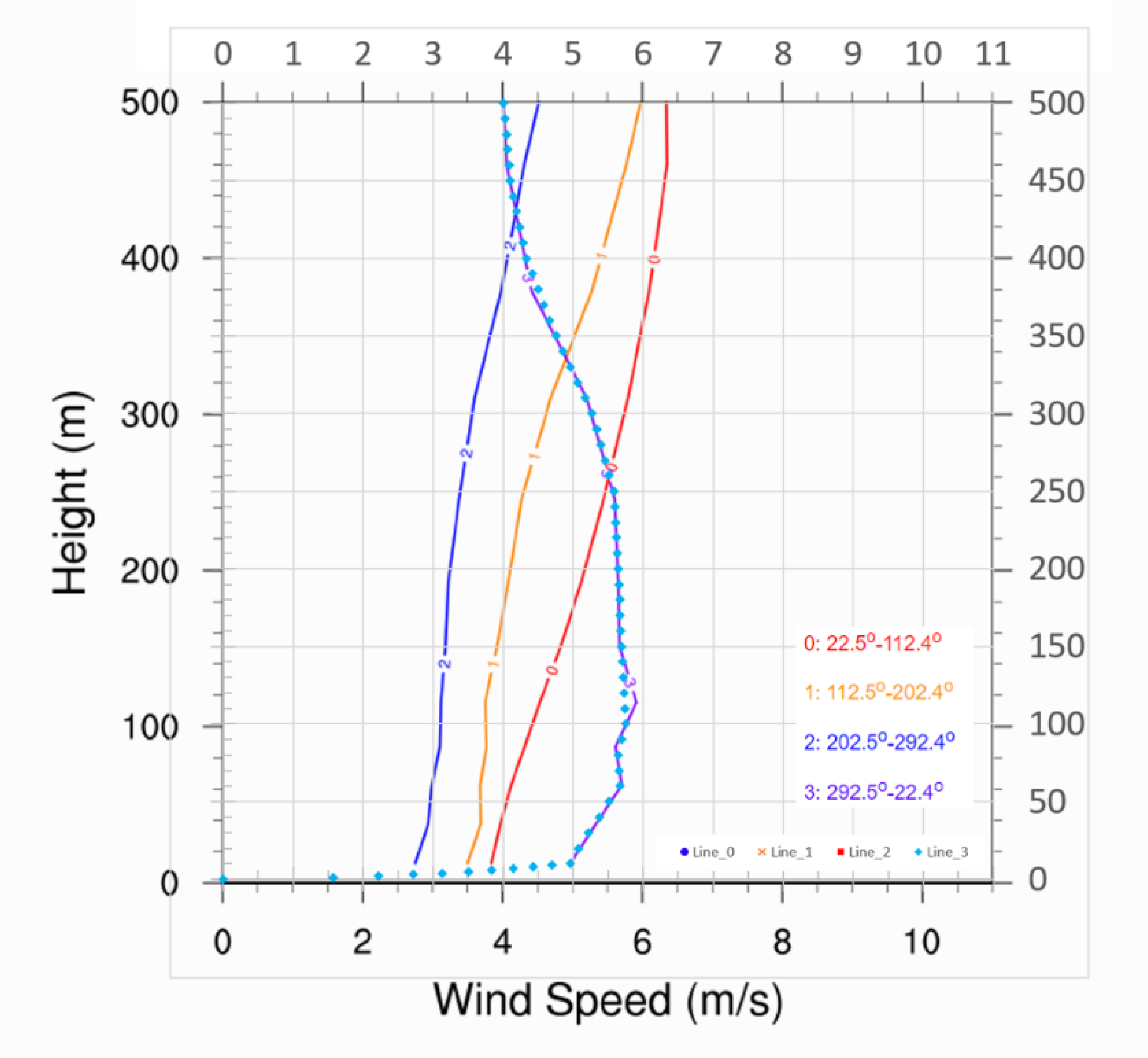


Figure 27 Wind Profile Curve for Wind Directions of 292.5º - 22.4º at Grid (X064, Y054)

*(line – original data from RAMS, dots – input data adopted for CFD simulation)*

Table 6 shows the data for each wind profile curve adopted in the current AVA Initial Study, which acts as the inlet boundary data in the CFD simulation.

Table 6 Wind Profile Data for All Wind Directions

| Height (m) | Wind Speed (m/s) | | | |
|---|---|---|---|---|
| | 22.5º – 112.4º | 112.5º – 202.4º | 202.5º – 292.4º | 292.5º – 22.4º |
| 0 | 0.00 | 0.00 | 0.00 | 0.00 |
| 10 | 3.83 | 3.47 | 2.74 | 4.95 |
| 20 | 3.88 | 3.55 | 2.81 | 5.08 |
| 40 | 3.98 | 3.69 | 2.94 | 5.37 |
| 60 | 4.11 | 3.68 | 2.99 | 5.67 |
| 80 | 4.26 | 3.75 | 3.07 | 5.65 |
| 100 | 4.41 | 3.76 | 3.11 | 5.75 |
| 150 | 4.81 | 3.91 | 3.18 | 5.69 |
| 200 | 5.16 | 4.10 | 3.25 | 5.65 |
| 250 | 5.46 | 4.30 | 3.40 | 5.58 |
| 300 | 5.73 | 4.62 | 3.56 | 5.27 |
| 350 | 5.96 | 5.02 | 3.81 | 4.75 |
| 400 | 6.17 | 5.41 | 4.07 | 4.33 |
| 450 | 6.32 | 5.70 | 4.27 | 4.10 |
| 500 | 6.34 | 5.97 | 4.51 | 4.01 |

# 4 METHODOLOGY FOR CFD SIMULATION

The AVA methodology for this study follows the guidelines set out in the Technical Guide in Annex A of the AVA Technical Circular No. 1/06 (2006) (the Technical Circular for AVA). The following section describes the study methodology in detail.

### 4.1.1 Assessment and Surrounding Areas

With reference to the Technical Guide, the Assessment Area of the Instructed Project should include the project's surrounding up to a perpendicular distance H from the site boundary of the Project Area, where H is the height of the tallest building on site. The Surrounding Area will be up to a perpendicular distance of 2H from the site boundary of the Project Area.

As set out in the Project Brief, the coverage of the Assessment and Surrounding Areas are 200m and 400m respectively measured from the site boundary of the Project Area. The model takes information on the surrounding buildings and site topography via the Geographical Information System (GIS) platform. The computational domain of the CFD model for this AVA Initial Study is approximately 3300m (L) x 3300m (W) x 2500m (H).

Figure 28 shows the size and location of the Project Area, Assessment Area, Surrounding Area and the computational domain.

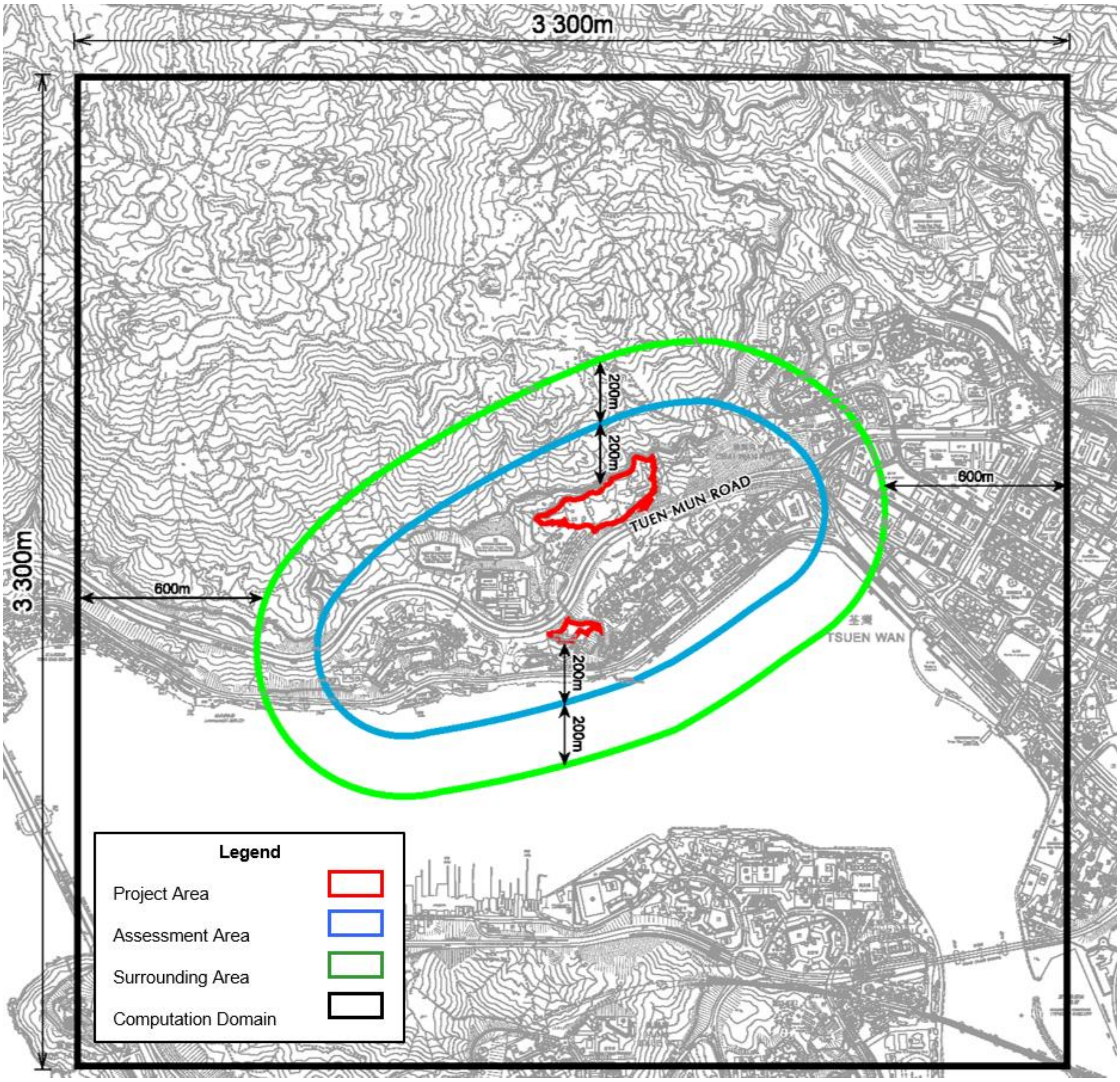


Figure 28 Project, Assessment and Surrounding Areas along with Computational Domain.

### 4.1.2 Modelling Tool

CFD technique was utilized for the AVA Initial Study. A commercial CFD package ANSYS ICEM CFD and STAR-CCM+ were used. Both software are widely adopted in the industry for AVA studies and other types of complex fluid flow related problems.

### 4.1.3 Mesh Setup

Body-fitted unstructured grid technique is used to fit the geometry to reflect the geometry details which is essential for proper modeling on turbulence flow. 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 near ground as shown in Figure 29. The expansion ratio is 1.3 while the maximum blockage ratio is 2%.

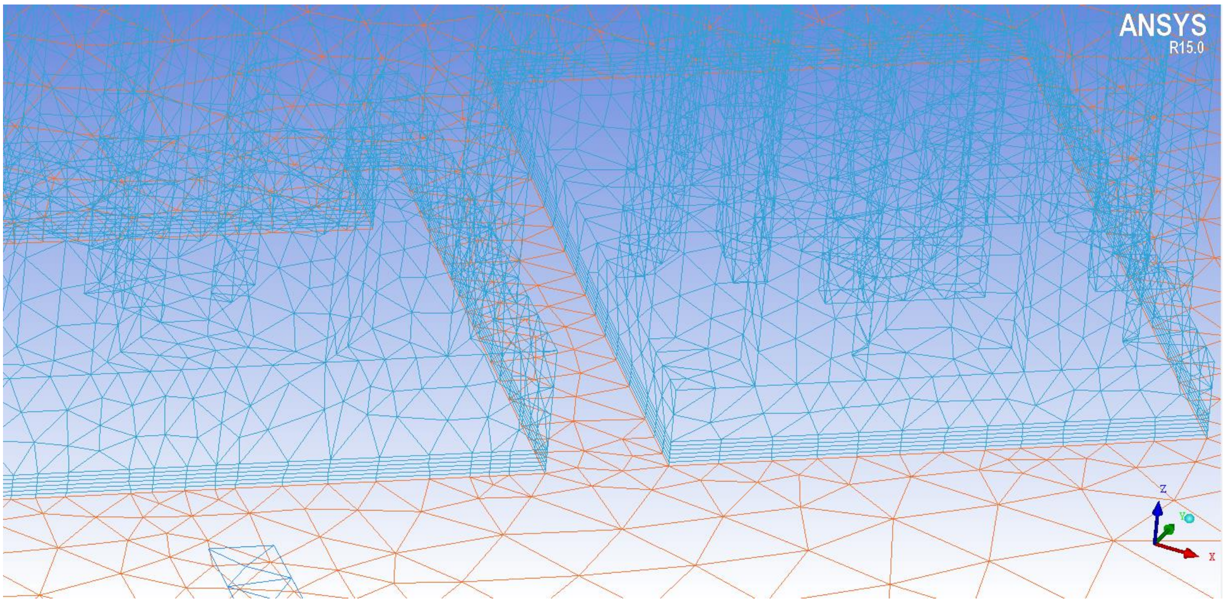


Figure 29 Prism Mesh Layers at Ground Level

### 4.1.4 Turbulence Model

Nowadays, various turbulence models are available in the market which most of them are mature for industrial use.

According to COST Action C14 (2004)[3], realizable k – ε turbulence model could attenuate the stagnation point anomaly without leading to worse results in the wake. It is recommended for modeling pedestrian wind environment, as this technique provides more accurate representation of the levels of turbulence that can be expected in an urban environment.

### 4.1.5 Calculation Method and boundary condition

Pressure-Based segregated algorithm will be adopted to solve the governing equations. The pressure and velocity coupling will be handled by SIMPLE algorithm or its variation. A collocated variable arrangement with Rhie-and-Chow-type approach is also adopted to prevent checker board problem. A higher order differencing scheme is applied to discretize all governing equations. The convergence criterion is set to 0.0001 on mass, momentum and turbulence equations. The calculation will repeat until the solution satisfies this convergence criterion. The prevailing wind direction is set to inlet boundary of the model with respective wind profile as detailed in Section 3.2. 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 more than 5H from the Surrounding Area as recommended in the Technical Circular.

### 4.1.6 Summary

Based on previous sections, the detail parameters of the model are summarized below.

| | **CFD Model** |
|---|---|
| **Computational Model Scale** | 1:1 scale to real environment |
| **Model details** | Topography, Buildings blocks, Streets/highways, all major elevated structures and noise barriers are included. No minor structures like signboard, street light, trees, shrubs, turfs, etc are included in the |

[3] J. Franke, C. Hirsch, A.G. Jensen, H.W. Krüs, M. Schatzmann, P.S. Westbury, S.D. Miles, J.A. Wisse and N.G. Wright, Recommendations on the use of CFD in Wind Engineering, In J.P.A.J. van Beek (Ed.), Proc. Int. Conf. on Urban Wind Engineering and Building Aerodynamics: COST C14 – Impact of Wind and Storm on City life and Built Environment, Rhode-Saint-Genèse, 2004.

| | |
|---|---|
| | simulation model. |
| **Domain** | 3300m(L) x 3300m(W) x 2500m(H) |
| **Assessment Area** | 200m from the Project Area |
| **Surrounding building Area** | 400m from the Project Area |
| **Turbulence Model** | Realizable k-ε model |
| **Grid Expansion Ratio** | maximum expansion ratio = 1.3 |
| **Prismatic layer** | 6 layer of prismatic layers and 0.5m each (i.e. total 3m above ground) |
| **Inflow boundary Condition** | Respective wind profile obtained from RAMS |
| **Outflow boundary** | Pressure boundary condition with pressure equal to zero |
| **Wall boundary condition** | Logarithmic law boundary |
| **Solving algorithms** | SIMPLE with Rhie and Chow approach + Higher order differencing scheme |
| **Blockage ratio** | < 2% |
| **Convergence criteria** | ≤ 1.0E-$^{4}$ |

## 4.2 AVA INDICATOR

### 4.2.1 Wind Velocity Ratio

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

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

$V_P$= the wind velocity at the pedestrian level (2m above ground).

$V_\infty$= the wind velocity at the top of the wind boundary layer (typically assumed to be around 500m above the center of the site of concern, or at a height where wind is unaffected by the urban roughness below).

The Average VR is defined as the frequency 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 at both annual and summer wind conditions.

### 4.2.2 Spatial Average Velocity Ratio

CFD simulations will be conducted to study the wind environment under annual and summer wind conditions. 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 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 SVR gives an idea of how the lower portion of the proposed development may affect the immediate surroundings. When problems are detected, it is likely that design changes may be needed for the lower portion of the development (e.g. the coverage of the podium).

The LVR gives an idea of how the upper portion of the proposed development may affect the local surroundings. When problems are detected, it is likely that design changes may be needed for the upper portion of the development (e.g. re-orientation of blocks and building height adjustment on the towers).

Table 7 Terminology of the AVA Initial Study

| *Terminology* | *Description* |
|---|---|
| *Site spatial average velocity ratio (SVR)* | The SVR represent the average VR of all perimeter test points along the site boundary as identified in the report. |
| *Local spatial average velocity ratio (LVR)* | The LVR represents the average VR of all points, i.e. perimeter and overall test points within the Assessment Area, as identified in the report. |

## 4.3 TEST POINTS FOR SVR AND LVR

Test points are evenly placed along the site boundary and open spaces, on the streets and places of the Project and Assessment Areas which are accessed frequently by pedestrians for determining the pedestrian ventilation performance. Test points have been placed at 2m above ground or podium level for determining the pedestrian ventilation performance. Three types of test points have been adopted in this study.

### 4.3.1 Perimeter Test Points

Perimeter test points are the test points positioned along the site boundary of the Project Area. In accordance with the Technical Circular for AVA, 60 perimeter test points (i.e. 30 perimeter test points for each site) are evenly positioned in areas that are accessible to pedestrians as shown in Figure 30 and Figure 31.

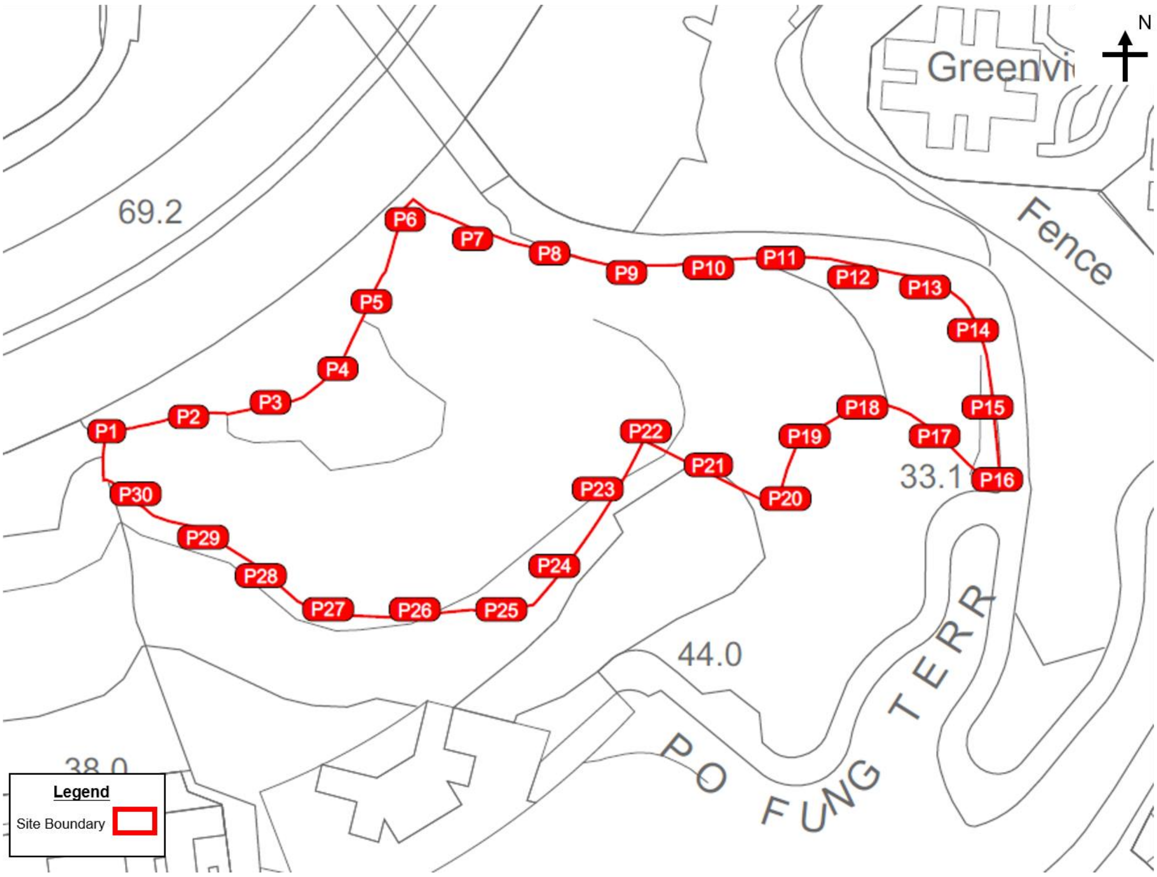


Figure 30 Location of the Perimeter Test Points for Site 1

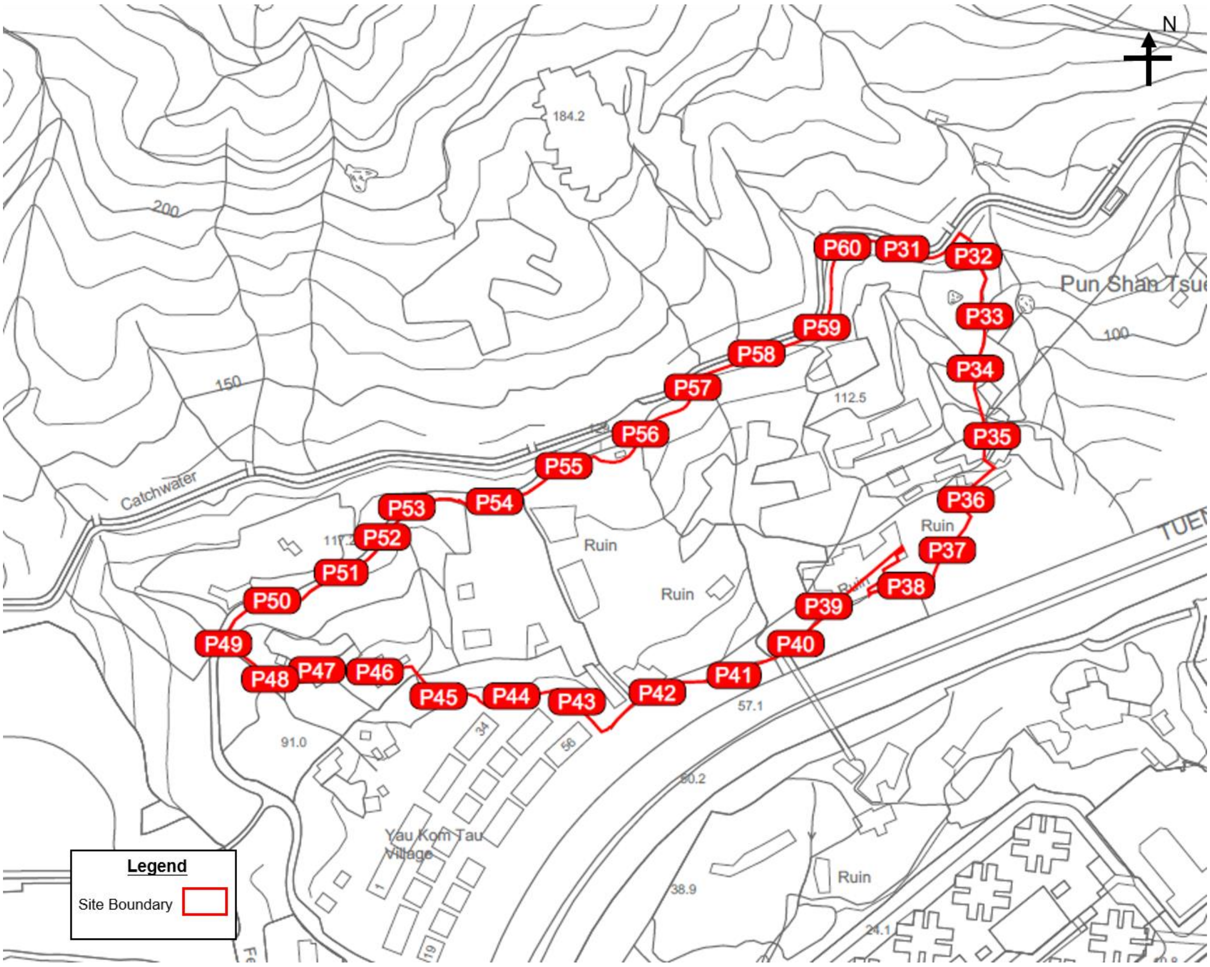


Figure 31 Location of the Perimeter Test Points for Site 2

### 4.3.2 Overall Test Points

Overall test points are those points evenly positioned in the open spaces, on the streets and places where pedestrian frequently access within the Assessment Area. 131 overall test points are placed and shown in Figure 32.

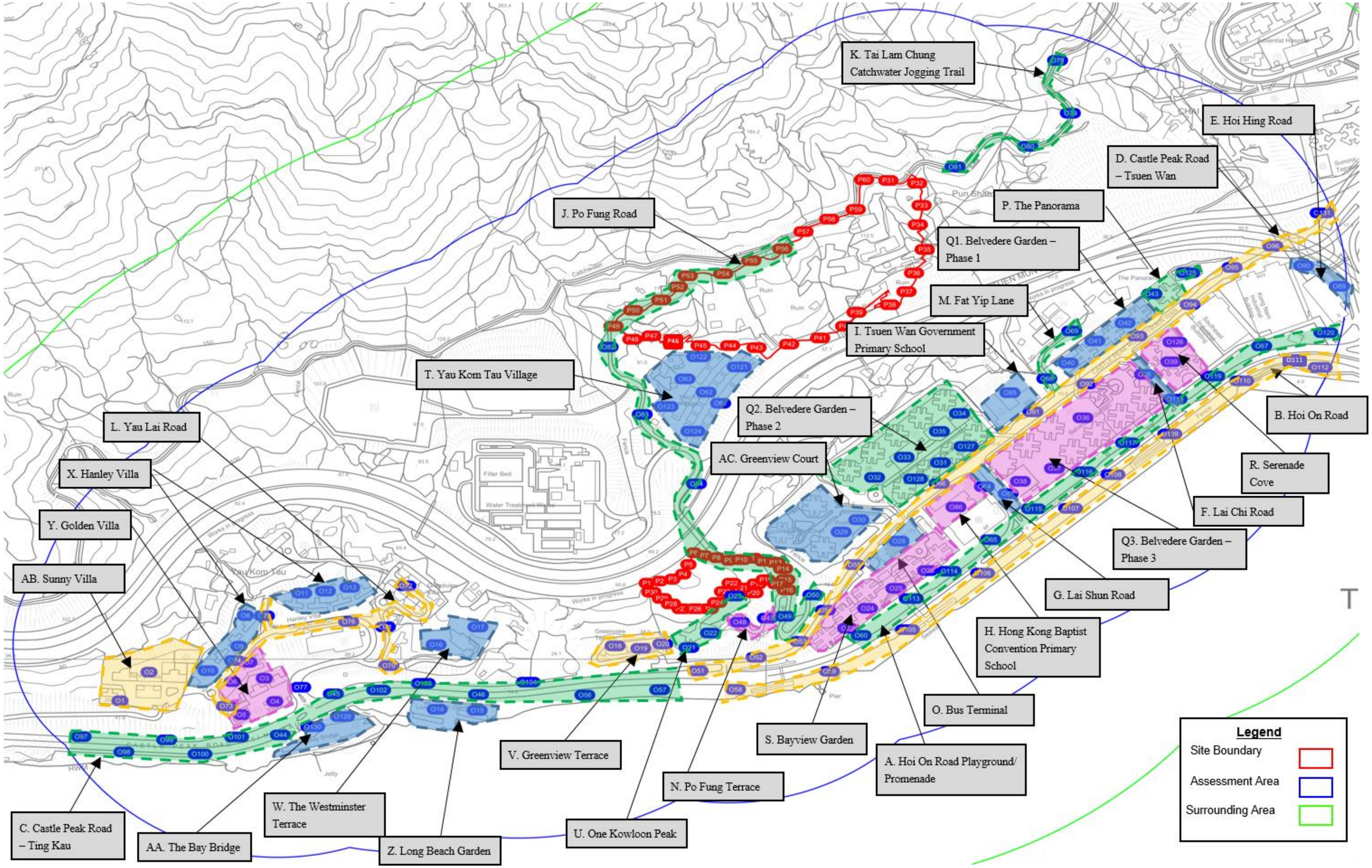


Figure 32 Location of the Overall Test Points

### 4.3.3 Special Test Points

Besides the overall test points, special test points are selected within the two Sites, including along the building separation in Site 1 and the 60m wide Drainage Tunnel Protection Zone in Site 2. 19 special test points (i.e. 7 and 12 special test points for Site 1 and Site 2 respectively) are selected as shown in Figure 33 and Figure 34.

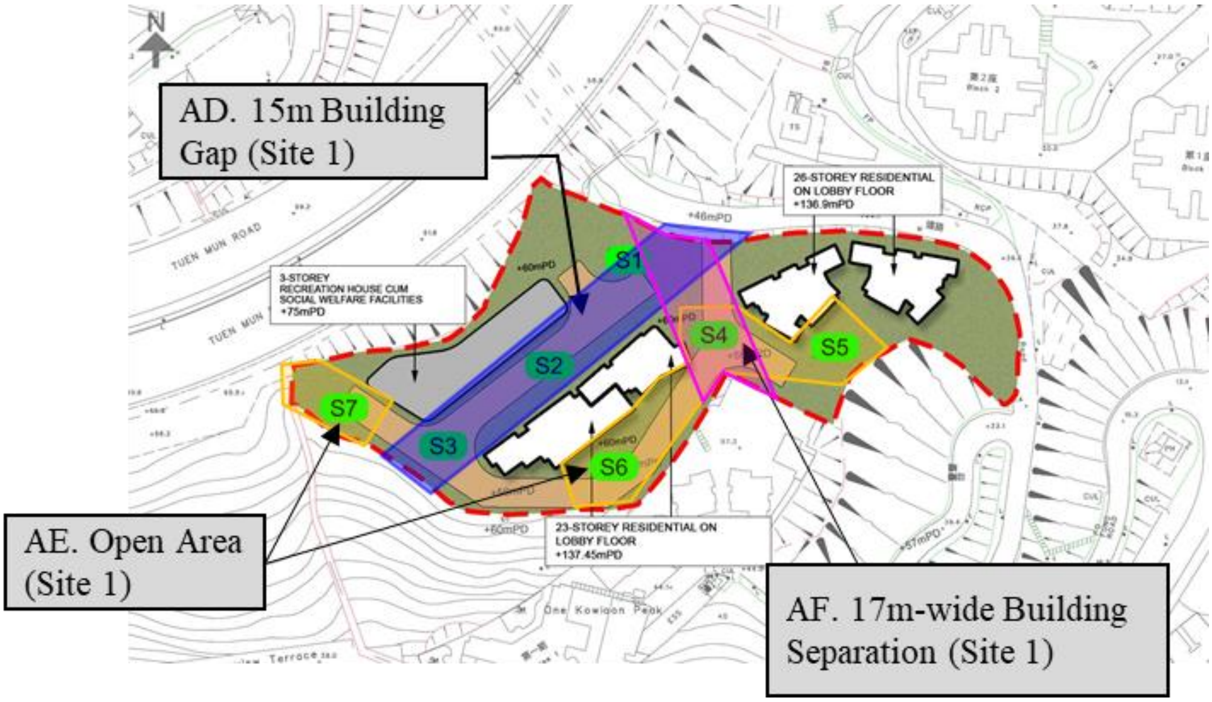


Figure 33 Location of the Special Test Points for Site 1

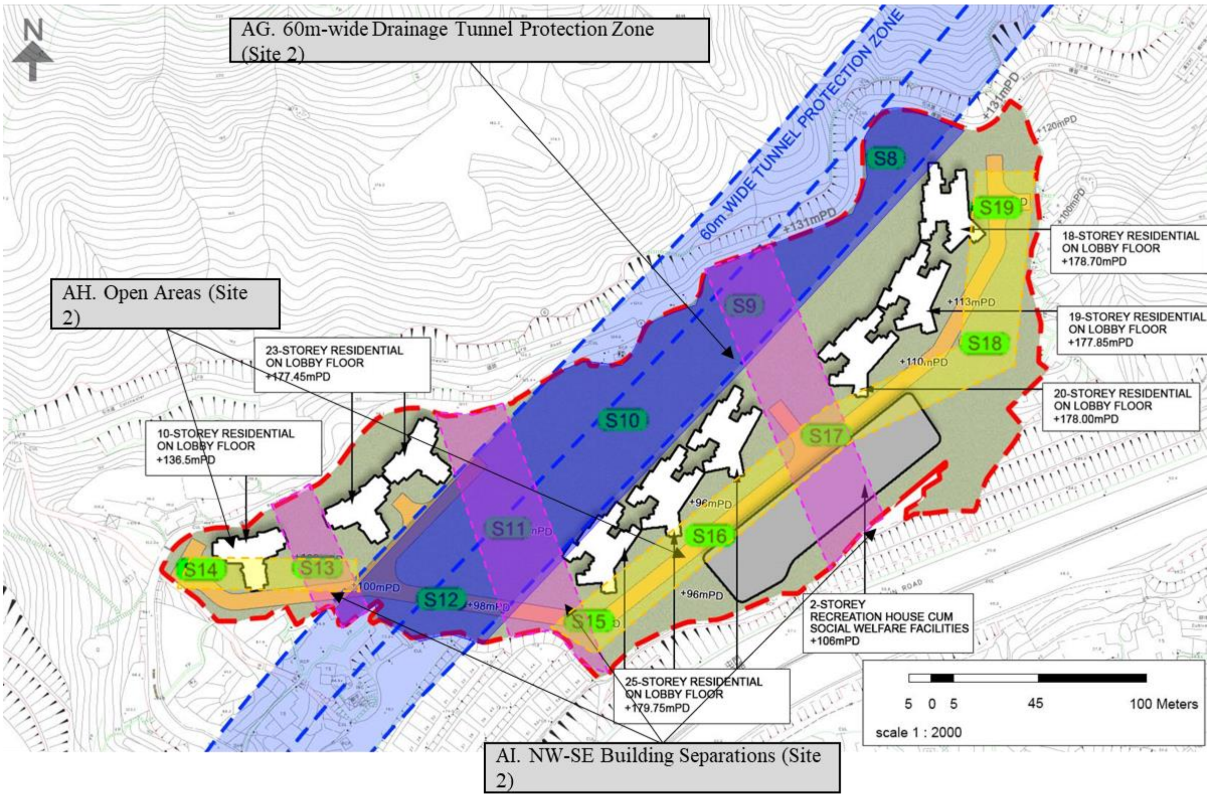


Figure 34 Location of the Special Test Points for Site 2

### 4.3.4 Focus Areas

In addition to the SVR for Site 1 (i.e. P01-P30), SVR for Site 2 (i.e. P31-P60) and LVR (i.e. P01-60 and O1-O131), the spatial average wind velocity ratio of various focus areas will be presented for in-depth quantitative analysis.

Table 8 shows the various focus areas and their representative test points. Figure 32 to Figure 34 shows the location of the focus areas within the Assessment Area.

Table 8 Focus Areas and their Representative Test Points

| | Focus Areas | Test Points |
|---|---|---|
| **A** | Hoi On Road Playground/Promenade | O60, O65, O67, O113 – O120 |
| **B** | Hoi On Road | O58, O59, O105 – O112 |
| **C** | Castle Peak Road – Ting Kau | O44 – O46, O56, O57, O97 – O104 |
| **D** | Castle Peak Road – Tsuen Wan | O51 – O55, O66, O91 – O96, O131 |
| **E** | Hoi Hing Road | O89, O90 |
| **F** | Lai Chi Road | O88, O118 |
| **G** | Lai Shun Road | O64, O87 |
| **H** | Hong Kong Baptist Convention Primary School | O86 |
| **I** | Tsuen Wan Government Primary School | O85 |
| **J** | Po Fung Road | P6 – P16, P49 – P56,O49 – O50, O82 – O84 |
| **K** | Tai Lam Chung Catchwater Jogging Trail | O78 – O81 |
| **L** | Yau Lai Road | O70 – O77 |
| **M** | Fat Yip Lane | O68, O69 |
| **N** | Po Fung Terrace | O47 – O48 |
| **O** | Bus Terminal | O28 |
| **P** | The Panorama | O43, O125 |
| **Q1** | Belvedere Garden – Phase 1 | O40 –O42 |
| **Q2** | Belvedere Garden – Phase 2 | O31 – O35, O127, O128 |
| **Q3** | Belvedere Garden – Phase 3 | O36 - O38 |
| **R** | Serenade Cove | O39, O126 |
| **S** | Bayview Garden | O24 – O27 |
| **T** | Yau Kom Tau Village | O61 – O63, O121 – O124 |
| **U** | One Kowloon Peak | O21 – O23 |
| **V** | Greenview Terrace | O18 – O20 |
| **W** | The Westminster Terrace | O16 – O17 |
| **X** | Hanley Villa | O8-O13 |
| **Y** | Golden Villa | O3 – O7 |
| **Z** | Long Beach Garden | O14, O15 |
| **AA** | The Bay Bridge | O129, O130 |
| **AB** | Sunny Villa | O1, O2 |
| **AC** | Greenview Court | O29, O30 |

| **Special Test Points** | | |
|---|---|---|
| **AD** | 15m-wide Building Separation (Site 1) | S1 – S3 |
| **AE** | Open Areas (Site 1) | S4 – S7 |
| **AF** | 17m-wide Building Separation (Site 1) | S1, S4 |
| **AG** | 60m-wide Drainage Tunnel Protection Zone (Site 2) | S8 – S12 |
| **AH** | Open Areas (Site 2) | S13 – S19 |
| **AI** | NW-SE Building Separations (Site 2) | S9, S11, S13, S15, S17 |

# 5 QUALITATIVE ANALYSIS OF THE EXISTING WIND ENVIRONMENT, BASELINE SCHEME AND PROPOSED SCHEME

The following section presents the qualitative analysis of the existing wind environment, Baseline Scheme and Proposed Scheme under annual and summer prevailing wind directions.

## 5.1 NE WIND

High-rise residential buildings including Greenview Court (around +122.9mPD) and Belvedere Garden Phase 2 (around +141.4mPD) are situated at the northeast of the Site 1. Under the Baseline Scheme, potential impact on air ventilation is anticipated within the Site 1 and immediate downstream regions due to blockage effect induced by these existing high residential buildings. However, mid-level NE wind from Ha Fa Shan is anticipated to travel along Tuen Mun Road and reach Site 1 via the open spaces south of the Tuen Mun Road and north of the Belvedere Garden Phase 2. Therefore, it is anticipated that the wind availability of Site 1 would not be adversely impacted by the aforementioned residential buildings (Red Arrow (1) in Figure 35).

It is observed that Site 2 is located at the foothill of Ha Fa Shan and there are no high-rise developments at the upwind regions of Site 2. Thus, a portion of incoming NE wind is anticipated to be obstructed and diverted by the hilly terrain of Ha Fa Shan. Nonetheless, a portion of NE wind may reach Site 2 as downhill wind from Ha Fa Shan. Considering Site 2 mainly comprises of low-rise temporary structures under the Baseline Scheme, NE wind is expected to penetrate through the Site 2 to reach its downstream area with minimal disturbance i.e. Yau Kom Tau Village (Red Arrow (2) in Figure 35).

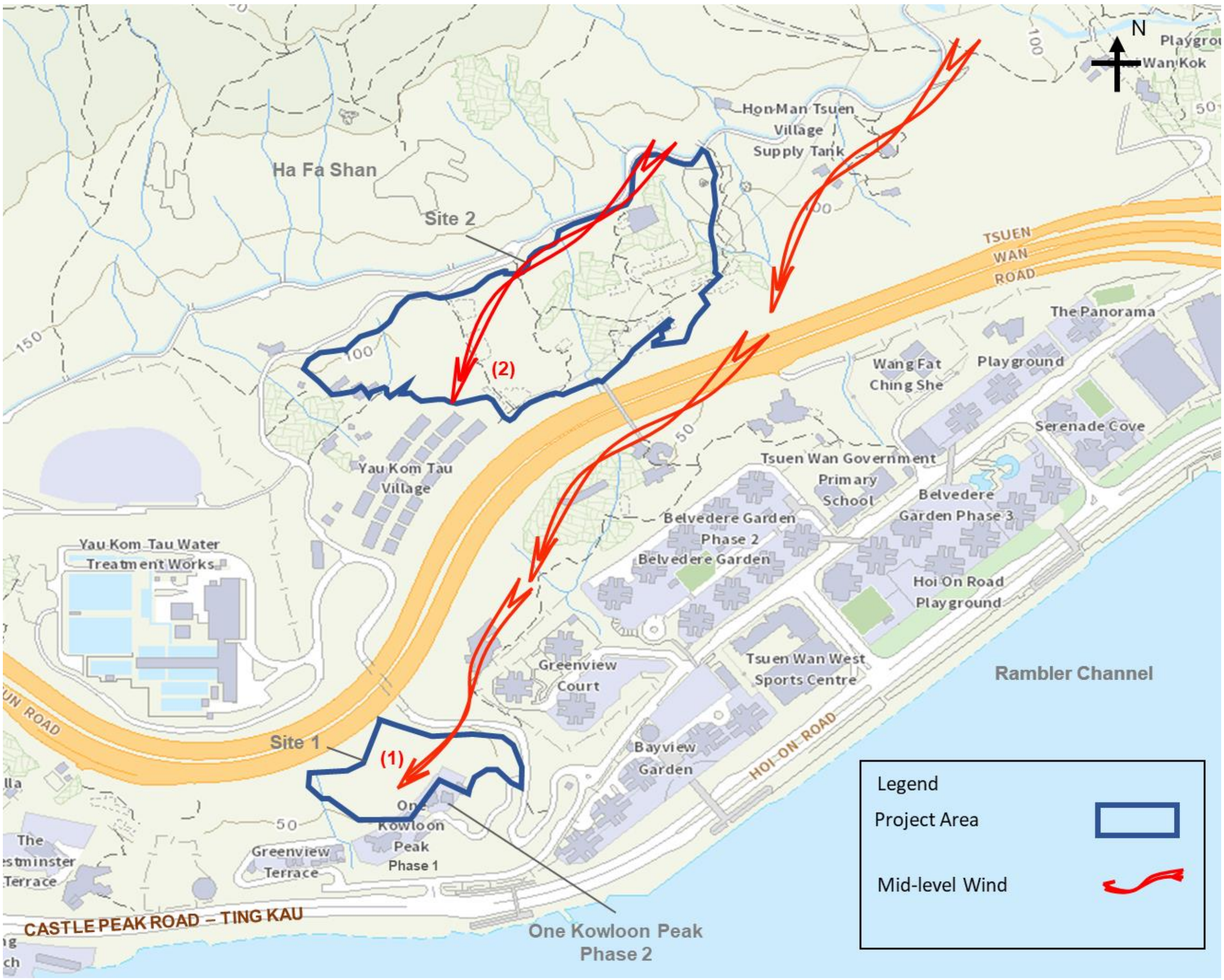


Figure 35 Major Air Paths under Baseline Scheme (NE Wind)

On the other hand, the high-rise developments in the Proposed Scheme are expected to obstruct a portion of the incoming NE wind towards the downwind regions. These regions will include Greenview Terrace and One Kowloon Peak for Site 1 as well as Yau Kom Tau Village for Site 2. However, specific good design measures (including building separations in Site 1 and 60m-wide Drainage Tunnel Protection Zone in Site 2) are implemented to mitigate adverse air ventilation impact to the aforementioned downwind regions.

For Site 1, the building separation between the recreation house and left-most residential tower is expected to facilitate NE wind to penetrate through Site 1 to reach the downwind regions as it is in alignment with the NE wind (Magenta Arrow (1) in Figure 36). For Site 2, the 60m-wide Drainage Tunnel Protection Zone is also expected to facilitate penetration of NE wind through the Site 2 to reach the downwind regions as it is also in alignment with the NE wind (Magenta Arrow (2) in Figure 36).

Further improvement and mitigation measures including increasing building permeability, reducing ground coverage of building structures through ventilation bay or permeable garden as well as adopting aerodynamically shaped building frontage, should be considered to further reduce adverse air ventilation impact to downwind regions.

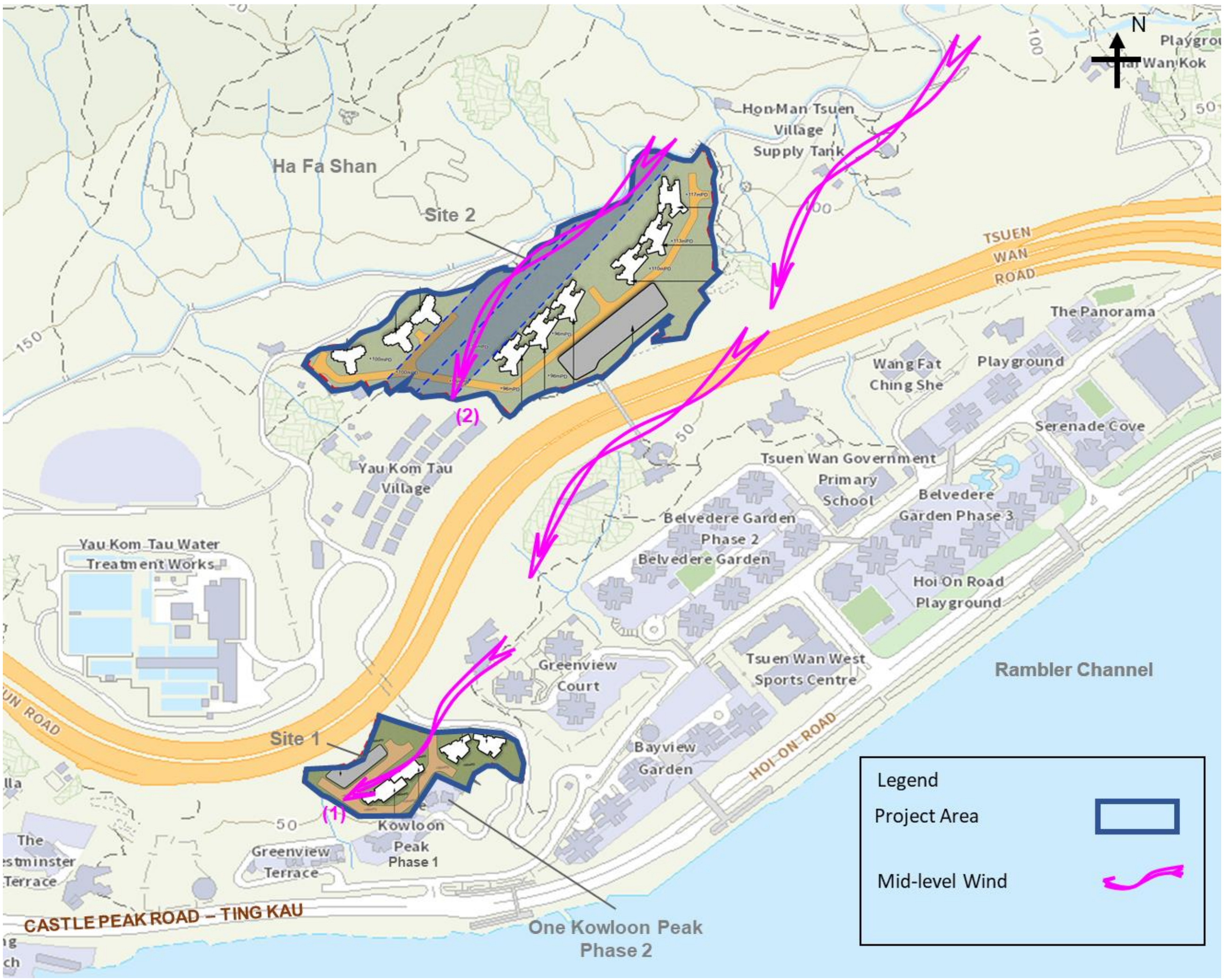


Figure 36 Major Air Paths under Proposed Scheme (NE Wind)

## 5.2 ENE, E AND ESE WINDS

ENE, E and ESE winds are major annual prevailing winds. The 30-meter wide Tuen Mun Road acts as the major wind corridor which brings annual ENE, E and ESE winds to ventilate Site 1 and 2. Thus, it is expected that both Site 1 and 2 would enjoy good air ventilation performance.

In the Baseline Scheme, the incoming ENE, E and ESE winds are expected to travel along Tuen Mun Road via Tsuen Wan Road to reach the area to the north of Site 1 (Blue Arrow (1) in Figure 37). In addition, the 10-meter wide Castle Peak Road – Tsuen Wan also acts as an essential air path for ENE, E and ESE winds from Tsuen Wan Town Centre to reach the eastern part of Site 1. The alignment of high-rise buildings on both sides of Castle Peak Road – Tsuen Wan is also expected to channelize ENE, E and ESE winds towards Site 1 to optimize its site wind availability (Blue Arrow (2) in Figure 37).

Under the Baseline Scheme, some low-rise temporary structures and Hon Man Tsuen Village Supply Tank are situated to the northeast of Site 2. However, it is anticipated that mid-level ENE, E and ESE winds would skim over the temporary structures and Hon Man Tsuen Village Supply Tank to penetrate through Site 2 and ventilate its downstream regions including Yau Kom Tau Village (Red Arrow in Figure 37) due to the low-rise nature of the temporary structures currently residing within Site 2.

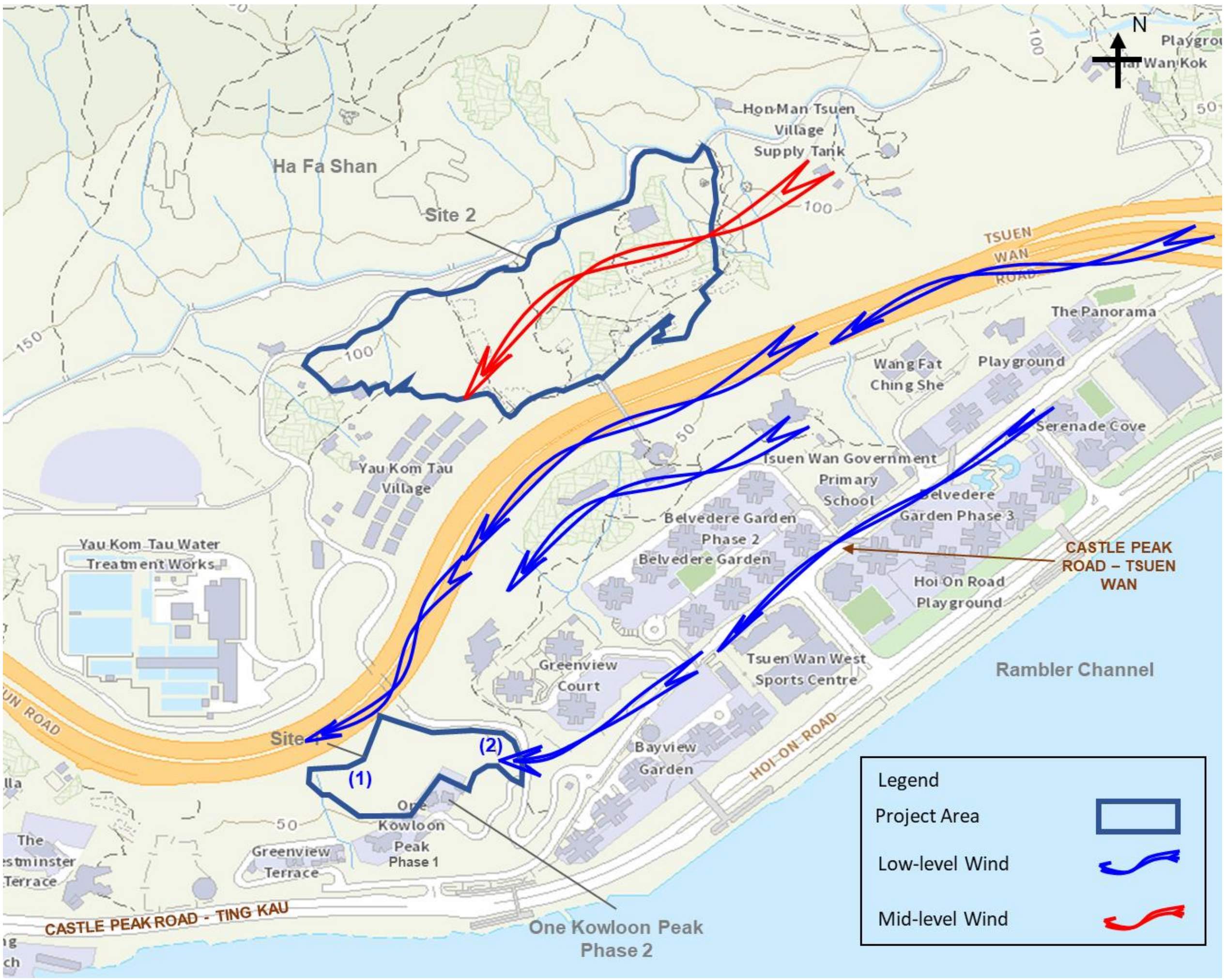

Figure 37 Major Air Paths under Baseline Scheme (ENE, E and ESE Winds)

On the other hand, the high-rise developments in the Proposed Scheme are expected to obstruct a portion of the incoming ENE, E and ESE winds toward the downwind regions. Although the good design measures (including building separations in Site 1 and 60m-wide Drainage Tunnel Protection Zone in Site 2) are not perfectly aligned with the ENE, E and ESE winds, these good design measures may still help to reduce adverse air ventilation impact to the downwind regions.

For Site 1, the low-level ENE, E and ESE winds mainly travel along Tuen Mun Road via Tsuen Wan Road.

Although the proposed developments in the Proposed Scheme are expected to weaken the ENE, E and ESE winds to Site 1 when compared with the Baseline Scheme, the 15m wide building separation between the 3-storey recreation house and 23-storey residential blocks allows the ENE, E and ESE winds to penetrate through Site 1 to ventilate the downwind regions including: One Kowloon Peak and Greenview Terrace (Black Arrow (1) in Figure 38). Another portion of low-level ENE, E and ESE winds would reach the eastern portion of Site 1 via Castle Peak Road – Tsuen Wan. A building setback of approximately 10m from the south site boundary of Site 1 is expected to help reduce adverse air ventilation impact to One Kowloon Peak (Black Arrow (2) in Figure 38). For Site 2, some low-rise temporary structures and Hon Man Tsuen Village Supply Tank are situated to the northeast of Site 2. However, it is anticipated that mid-level ENE, E and ESE winds would skim over the temporary structures and Hon Man Tsuen Village Supply Tank then penetrate through Site 2 through the 60m-wide Drainage Tunnel Protection Zone to reach Yau Kom Tau Village (Magenta Arrow in Figure 38).

Further improvement and mitigation measures including increasing building permeability, reducing ground coverage of building structures through ventilation bay or permeable garden as well as adopting aerodynamically shaped building frontage, should be considered to further reduce adverse air ventilation impact to downwind regions.

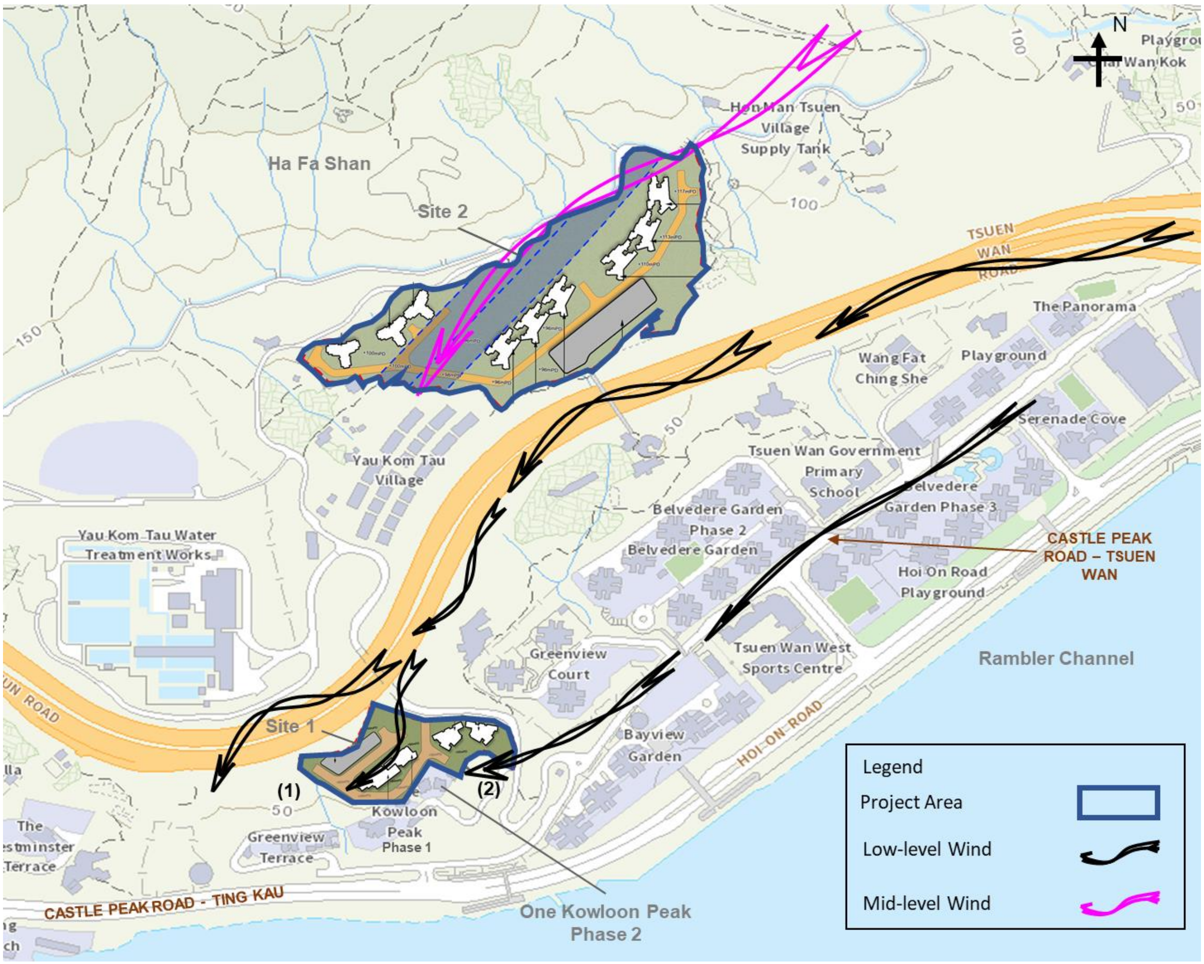


Figure 38 Major Air Paths under Proposed Scheme (ENE, E and ESE Winds)

## 5.3 SE AND SSE WINDS

The SE and SSE winds mainly come from Rambler Channel. In the Baseline Scheme, the high-rise residential developments of Bayview Garden to the southeast of Site 1 is expected to impede SE and SSE winds from reaching Site 1. Nonetheless, a portion of low-level SE and SSE winds from Rambler Channel is anticipated to reach the eastern part of Site 1 via the open area between One Kowloon Peak Phase 2 and Bayview Garden (Blue Arrow in Figure 39). Additionally, a portion of mid-level sea breeze is expected to skim over the low-rise Phase 2 of One Kowloon Peak (around +68.6mPD / 19-storeys) to ventilate Site 1 and its downstream regions (Red Arrow in Figure 39).

The high-rise buildings along the waterfront including, the Bayview Garden, the Greenview Court and the Belvedere Garden Phases 2 & 3, may form a wind barrier to impede SE and SSE winds. Nonetheless, high-level SE and SSE winds are expected to skim over the aforementioned buildings to reach the southern portion of Site 2 as Site two is located on significantly higher ground elevation compared with the buildings along the waterfront (Green Arrows in Figure 39).

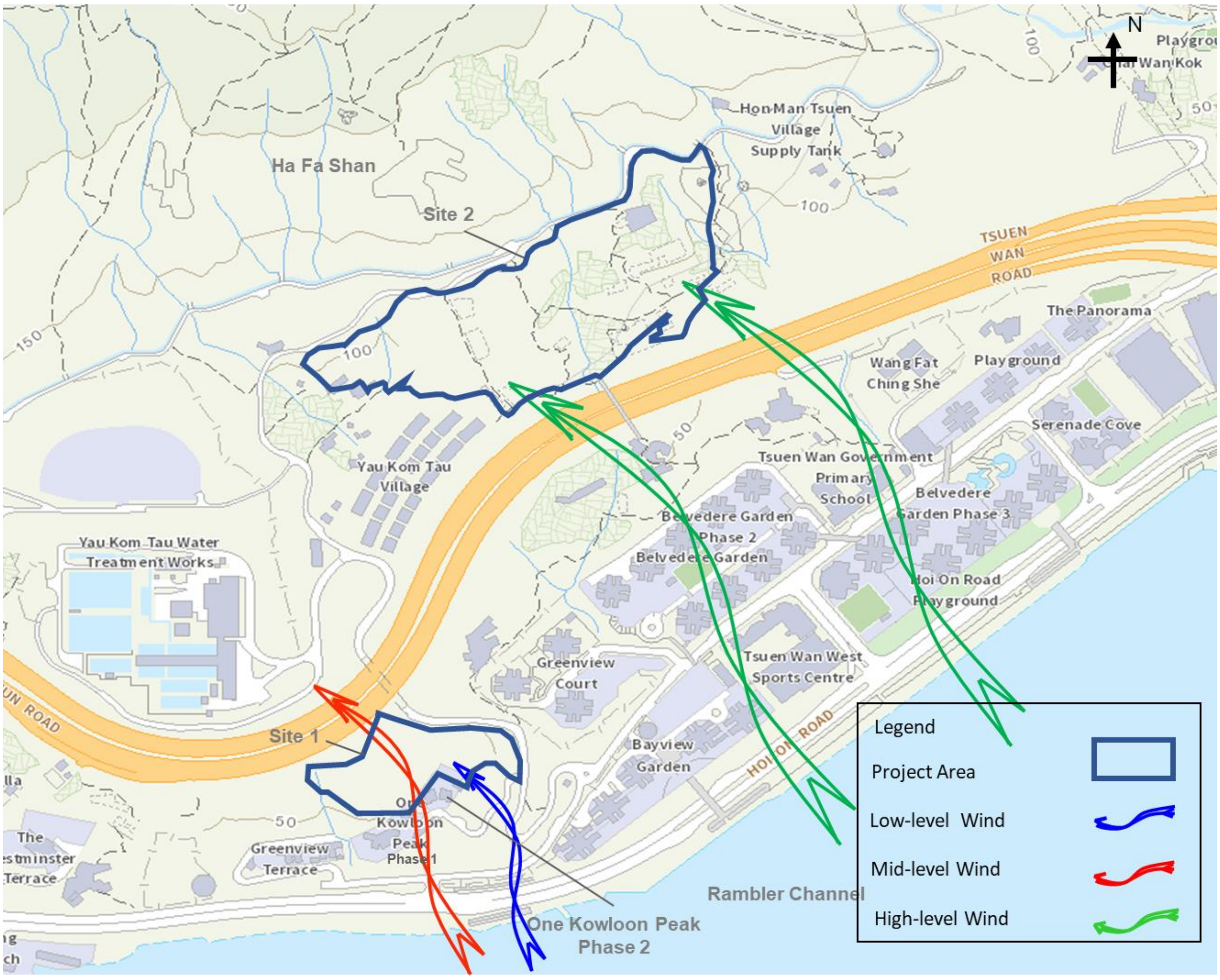


Figure 39 Major Air Paths under Baseline Scheme (SE and SSE Winds)

On the other hand, the high-rise developments in the Proposed Scheme is expected to obstruct a portion of the incoming low-level SE and SSE winds from Rambler Channel (Black Arrow in Figure 40). The high-rise residential towers in Site 1 would create a wake zone to the open area at the northern portion of Site 1 as well as its downstream region including Yau Kom Tau Water Treatment Works. However, the proposed high-rise towers are expected to capture a portion of mid and high level SE and SSE winds and direct it towards the open areas at the southern portion of Site 1 via downwash effect. Mid-level SE and SSE winds may also reach the downstream of the Site 1 via its lateral building separation (Magenta Arrow in Figure 40). Similarly, the high-rise residential towers in Site 2 would act as a barrier and reduce wind availability to the northern and western portion of Site 2 but will also create downwash effect to increase pedestrian wind availability at the south-eastern portion of Site 2 (Orange Arrows in Figure 40). The building separations at both sites and the 60m-wide Drainage Tunnel Protection Zone in Site 2 are not expected to facilitate SE and SSE wind penetration through the Project Area due to their alignments which are perpendicular to the directions of SE and SSE winds.

Further improvement and mitigation measures including increasing building permeability, reducing ground coverage of building structures through ventilation bay or permeable garden as well as adopting aerodynamically shaped building frontage, should be considered to further reduce adverse air ventilation impact to downwind regions.

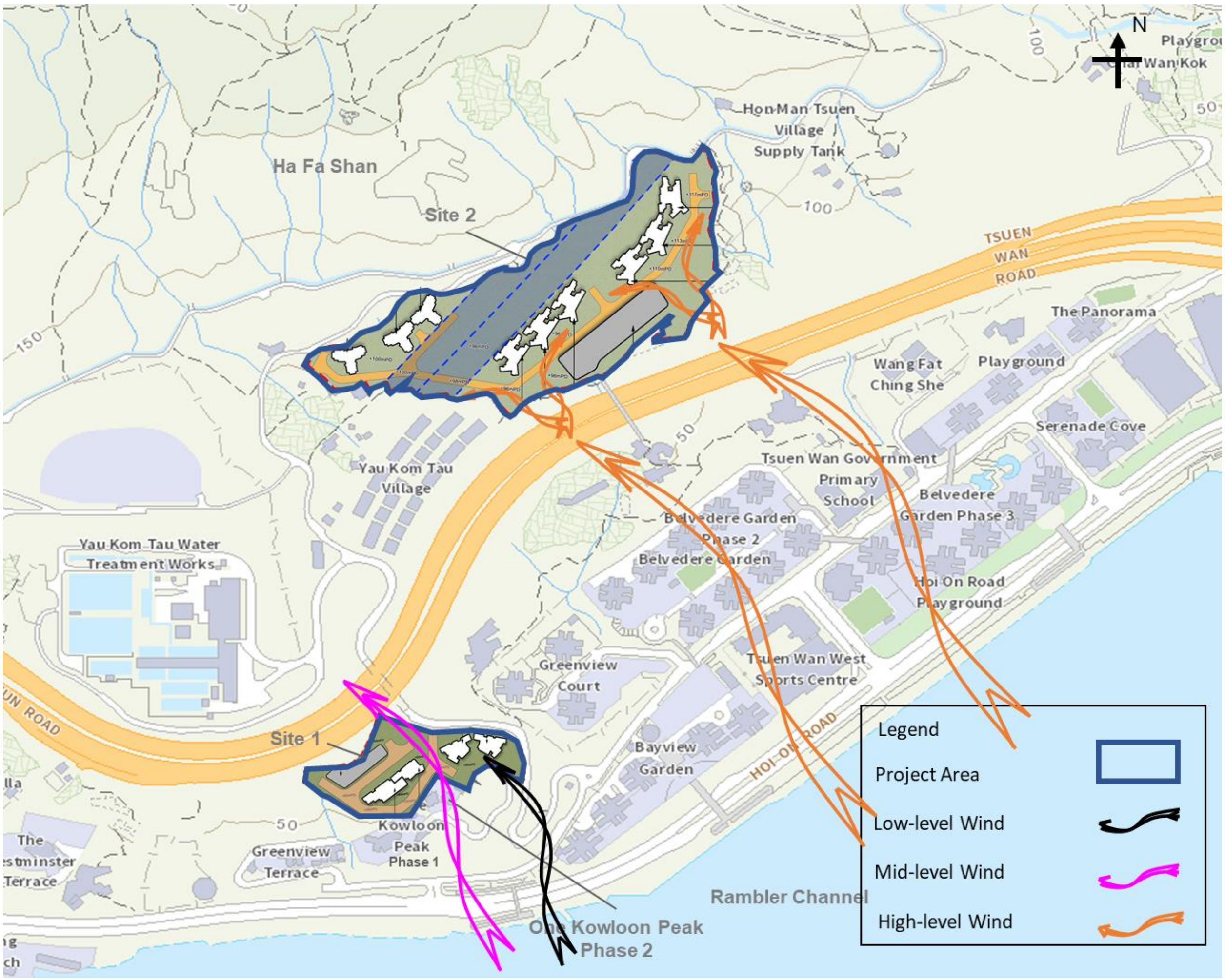


Figure 40 Major Air Paths under Proposed Scheme (SE and SSE Winds)

## 5.4 S WIND

S wind is also one of the major prevailing wind directions for summer scenario. The high-rise developments of One Kowloon Peak Phases 1 and 2, with a building height of 110.8mPD and 68.6mPD respectively, are located to the south and upwind region of Site 1, which may impede S wind from reaching Site 1. However, a portion of low-level S wind from Rambler Channel is anticipated to ventilate the eastern part of Site 1 through the open area between One Kowloon Peak Phase 2 and Bayview Garden (Blue Arrow in Figure 41). In addition, a portion of mid-level S wind is expected to skim over One Kowloon Peak Phase 2 to reach Site 1 and its downstream regions including Yau Kom Tau Village and the south western portion of Site 2 (Red Arrows in Figure 41).

Although the high-rise buildings along the waterfront including, the Bayview Garden, the Greenview Court and the Belvedere Garden, may form a wind barrier to impede S wind, high-level S wind is expected to skim over the aforementioned buildings to reach the southern portion of Site 2 as Site 2 is located on significantly higher ground elevation compared with the buildings along the waterfront (Green Arrows in Figure 41).

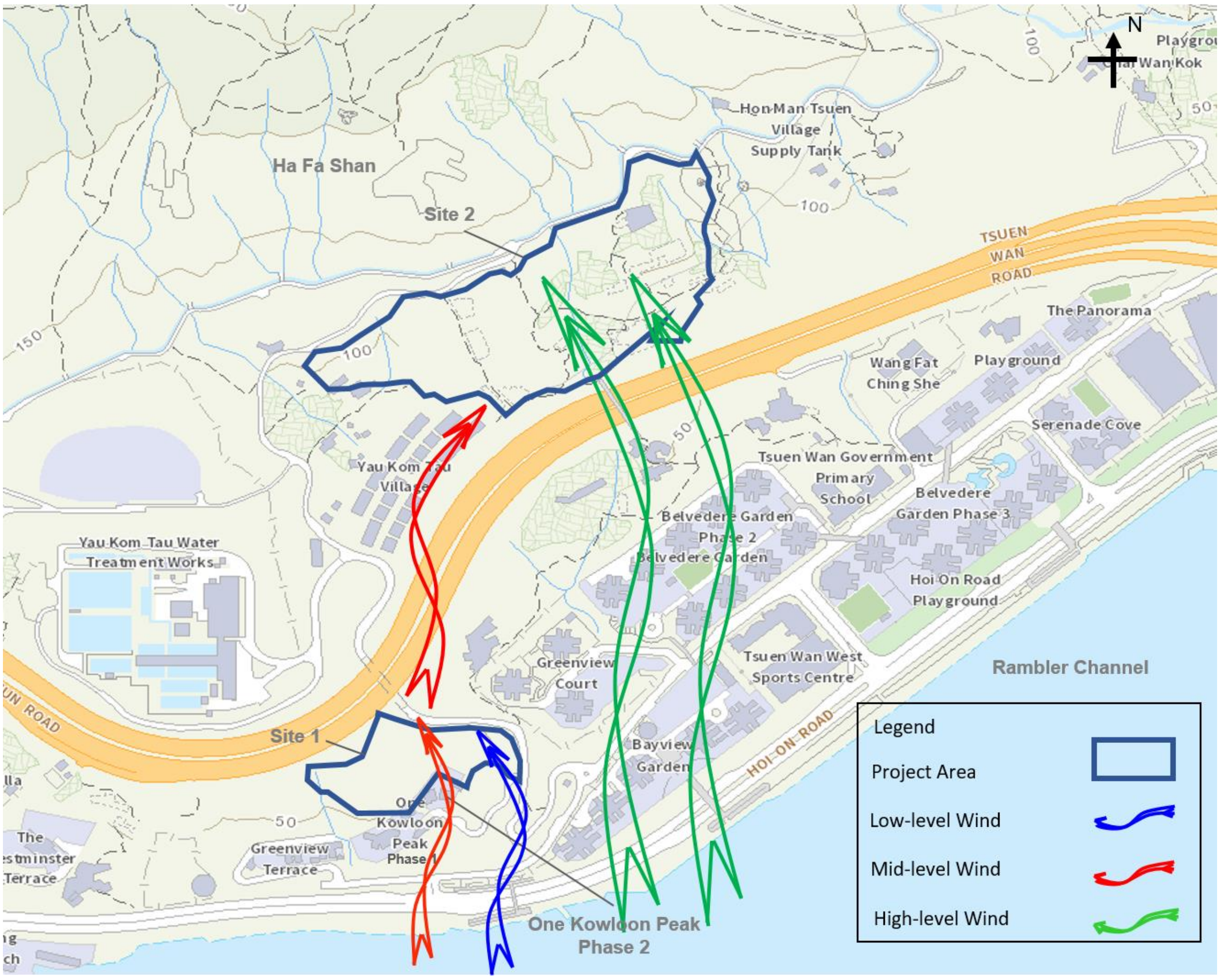


Figure 41 Major Air Paths under Baseline Scheme (S Wind)

On the other hand, the high-rise developments in the Proposed Scheme are expected to obstruct a portion of the incoming S wind. The high-rise residential towers in Site 1 may create a wake zone to the open area at the northern portion of Site 1. However, a portion of mid-level S wind is expected to pass through the building separation between the two clusters of residential towers within Site 1 to reach the downwind regions as it is in alignment with the S wind (Magenta Arrows in Figure 42). A portion of low-level S wind from Rambler Channel is anticipated to ventilate the eastern part of Site 1 through the open area between One Kowloon Peak Phase 2 and Bayview Garden (Black Arrows in Figure 42).

Similarly, the recreation house and high-rise residential towers in Site 2 is expect to act as a wind barrier and obstruct high-level S wind from ventilating the northern portion of Site 2. However, the building separations in Site 2 are expected to facilitate high-level S wind to penetrate through the Project Area but the 60m-wide Drainage Tunnel Protection Zone in Site 2 is not expected to facilitate S wind penetration as it is not in alignment with the S wind

(Orange Arrows in Figure 42). In addition, the high-rise residential towers would also allow high-level S wind to be diverted towards pedestrian level via downwash effect to increase wind flow at the southern portion of Site 2.

Therefore, the building separations at both sites are expected to facilitate S wind to penetrate through the Sites to reach the downwind regions. Further improvement and mitigation measures including increasing building permeability, reducing ground coverage of building structures through ventilation bay or permeable garden as well as adopting aerodynamically shaped building frontage, should be considered to further reduce adverse air ventilation impact to downwind regions.

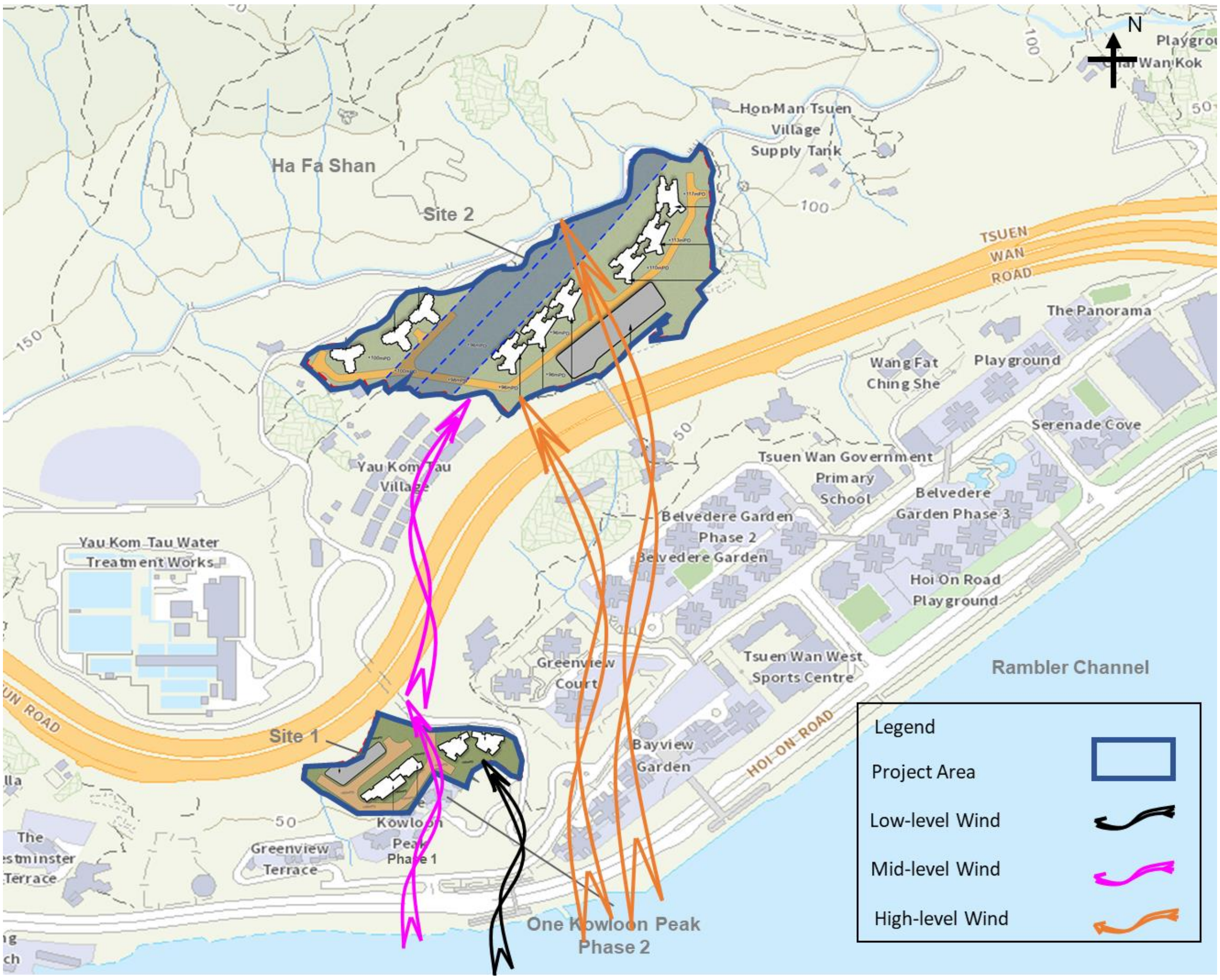


Figure 42 Major Air Paths under Proposed Scheme (S Wind)

## 5.5 SSW, SW AND WSW WINDS

The incoming summer prevailing SSW, SW and WSW winds mainly come from the Rambler Channel as sea breeze. The 30-meter wide Tuen Mun Road will act as the major wind corridor to allow the SSW, SW and WSW winds to reach the Project Area under summer condition.

In the Baseline Scheme, a portion of SSW, SW and WSW winds may be obstructed by the high-rise residential development of One Kowloon Peak Phase 1 but is expected to reach Site 1 via two open areas. The incoming wind is expected to reach the eastern part of the Site 1 via open area between One Kowloon Peak Phase 2 and Bayview Garden (Blue Arrow (1) in Figure 43). Since there are no building structures in Site 1, it is expected that the incoming winds would pass through Site 1 freely to ventilate the downwind regions including Greenview Court and Bayview Garden. Moreover, part of the SSW, SW and WSW winds would reach Tuen Mun Road via the open area to the west of Greenview Terrace. It is expected that the incoming wind would further travel along Tuen Mun Road to reach the northern portion of Site 2. Mid-level SW, SSW and WSW winds are expected to skim over the low-rise Yau Kom Tau Village to reach Site 2 (Red Arrow in Figure 43).

Although the high-rise buildings along the waterfront including the Bayview Garden, the Greenview Court, and the Belvedere Garden may form a wind barrier to impede SSW, SW and WSW winds. Nonetheless, the high-level SE and SSE winds are expected to skim over the building clusters along the waterfront including Bayview Garden and Belvedere Garden Phases 2 & 3 to reattach at Site 2 which is located on significantly higher ground elevation compared with the buildings along the waterfront (Green Arrow in Figure 43).

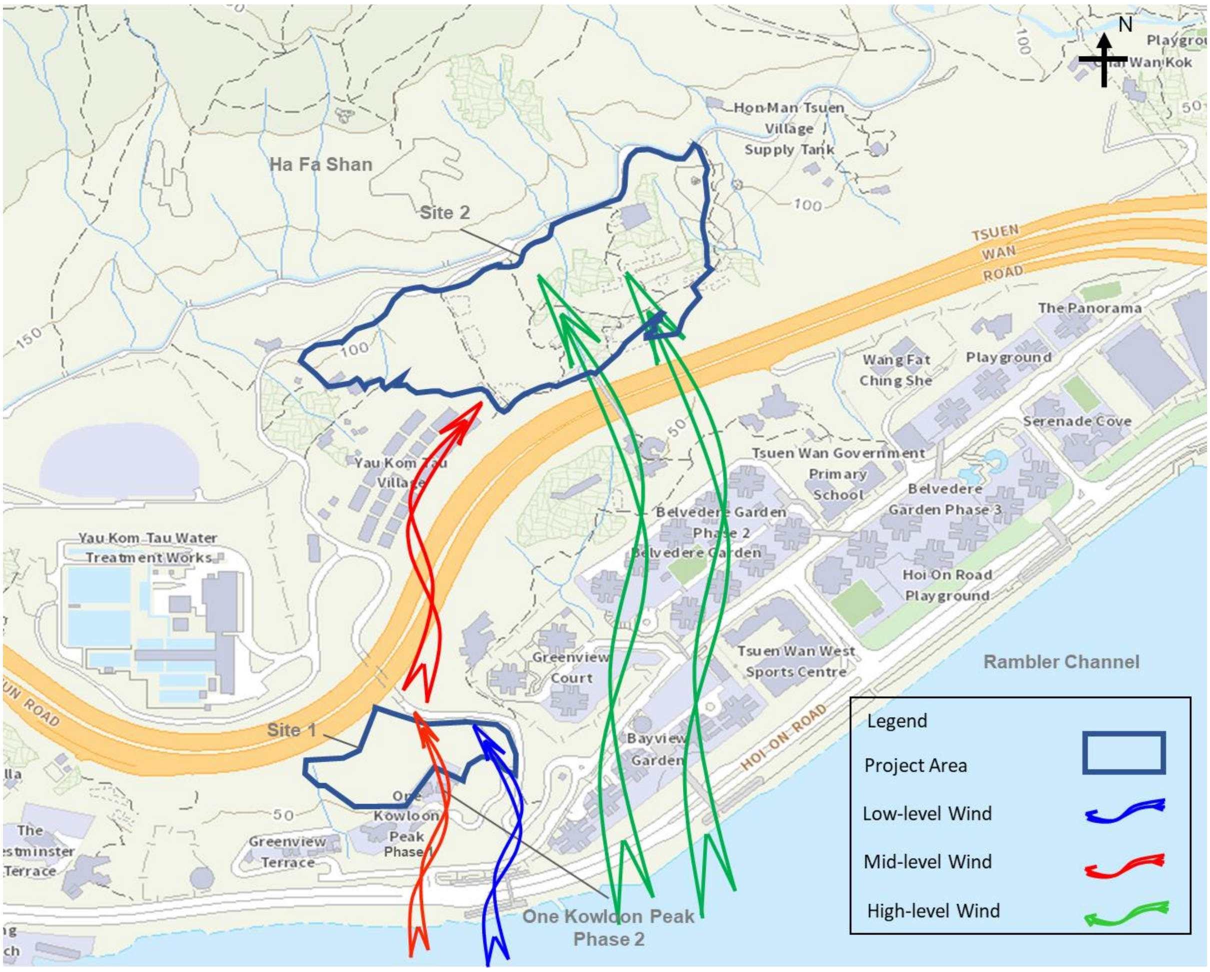


Figure 43 Major Air Paths under Baseline Scheme (SSW, SW and WSW Winds)

On the other hand, the high-rise developments in the Proposed Scheme are expected to obstruct a portion of the incoming SSW, SW and WSW winds. The high-rise residential towers in Site 1 may impede the wind availability within Site 1 but the building separation between the recreation house and middle residential tower cluster is expected to allow a portion of low-level SSW, SW and WSW winds to penetrate through Site 1 to reach the downwind regions including Greenview Court (Black Arrows (1) in Figure 44). Similarly, the high-rise residential towers in Site 2 would also act as a wind barrier and reduce wind availability of the north-eastern portion of Site 2. However, mid-level SW, SSW and WSW winds are expected to skim over the low-rise Yau Kom Tau Village to reach the 60m-wide Drainage Tunnel Protection Zone within Site 2 (Magenta Arrow in Figure 44). The 60m-wide Drainage Tunnel Protection Zone is expected to be effective in facilitating SSW, SW and WSW wind to penetrate through Site 2 as it is in alignment with these directions. Additionally, the building separations in Site 2 are expected to facilitate high-level S wind to penetrate through the Project Area (Orange Arrows in Figure 44).

Further improvement and mitigation measures including increasing building permeability, reducing ground coverage of building structures through ventilation bay or permeable garden as well as adopting aerodynamically shaped building frontage, should be considered to further reduce adverse air ventilation impact to downwind regions.

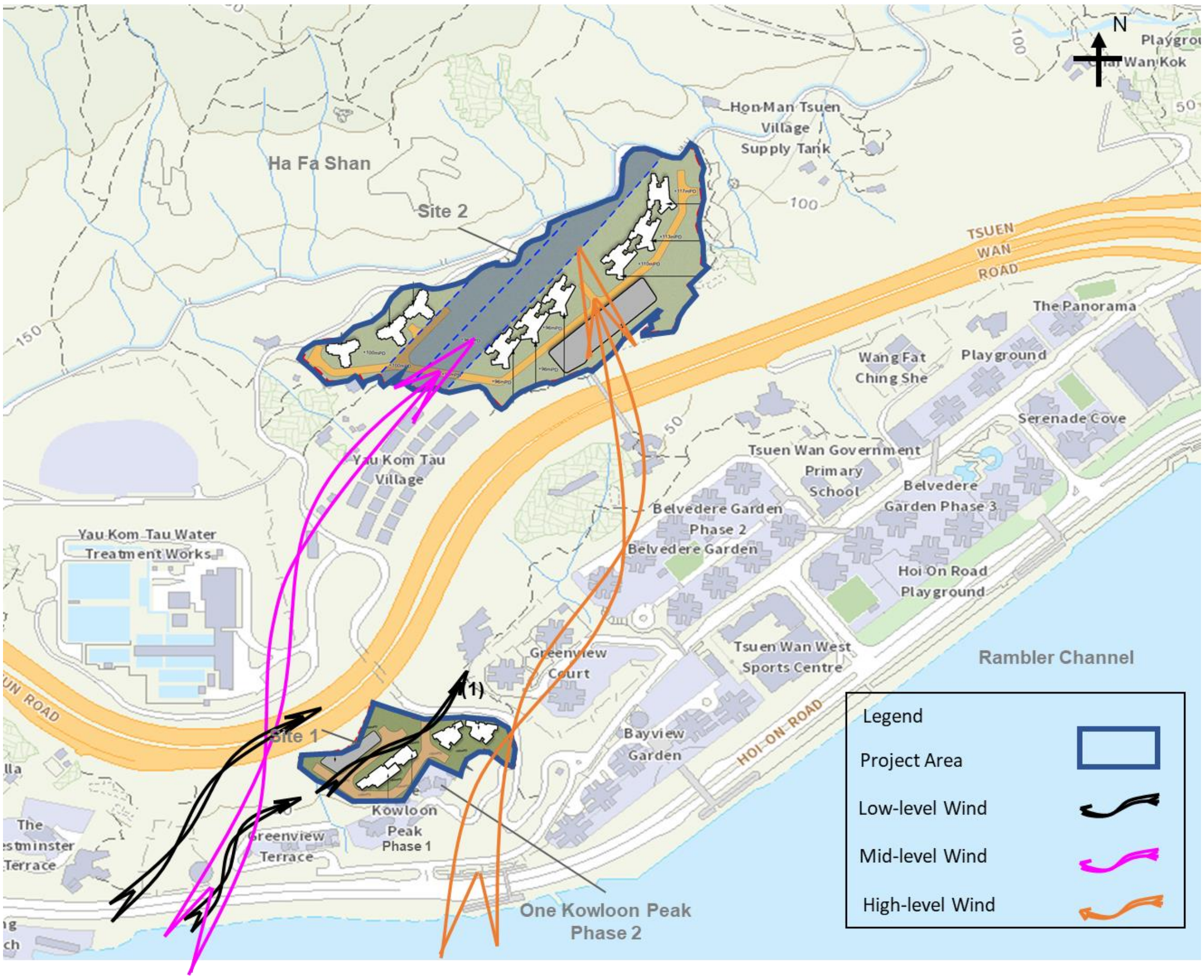


Figure 44 Major Air Paths under Proposed Scheme (SSW, SW and WSW Winds)

# 6 RESULTS AND DISCUSSION OF THE QUANTITATIVE ASSESSMENT

The following sections present the SVR, LVR and spatial average velocity ratio (SAVR) results of all focus areas for the Baseline Scheme and Proposed Scheme under annual and summer wind conditions.

## 6.1 SUMMARY OF VELOCITY RATIO (VR) RESULTS UNDER ANNUAL WIND CONDITION

According to the average Velocity Ratio (VR) simulation results under annual wind condition in Table 9, the SVR of the Baseline Scheme is higher (i.e. 0.27) than the Proposed Scheme (i.e. 0.24). The LVR of the Baseline Scheme is also higher (i.e. 0.25) than the Proposed Scheme (i.e. 0.23).

As mentioned in Section 2.1.1, the Baseline Scheme represents the existing condition of the Project Area. The Baseline Scheme for Site 1 is covered by natural vegetation without any building structures hence better ventilation performance is observed along the site boundary and at some downwind areas of Site 1 when compared with the Proposed Scheme, such as Po Fung Terrace (Baseline 0.33 vs Proposed 0.30) and open areas immediate west of Site 1 (Dark Green Circle in Figure 46). On the other hand, the Baseline Scheme for Site 2 is occupied by some low-rise temporary structures and ruins. Likewise, better ventilation performance is observed along the site boundary and at some downwind areas of Site 2 under the Baseline Scheme when compared with the Proposed Scheme such as open areas immediate west of Site 2 (Magenta Circle in Figure 46) and Yau Kom Tau Village (Baseline 0.16 vs Proposed 0.15). In addition, the high-rise nature of the Proposed Scheme reduced the ventilation performance at the open spaces along the northern boundary of Site 2 (Red Circle in Figure 46) as well as other focus areas within the Assessment Area including: Hoi On Road Playground/Promenade (Baseline 0.25 vs Proposed 0.24), Castle Peak Road – Ting Kau (Baseline 0.31 vs Proposed 0.29), Castle Peak Road – Tsuen Wan (Baseline 0.25 vs Proposed 0.24), Hoi Hing Road (Baseline 0.23 vs Proposed 0.21), Lai Chi Road (Baseline 0.28 vs Proposed 0.26), Lai Shun Road (Baseline 0.23 vs Proposed 0.19), Tsuen Wan Government Primary School (Baseline 0.05 vs Proposed 0.04), Po Fung Road (Baseline 0.30 vs Proposed 0.25), Tai Lam Chung Catchwater Jogging Trail (Baseline 0.50 vs Proposed 0.46), The Panorama (Baseline 0.12 vs Proposed 0.10), Belvedere Garden Phase 1 (Baseline 0.12 vs Proposed 0.11), Belvedere Garden Phase 3 (Baseline 0.23 vs Proposed 0.21), Serenade Cove (Baseline 0.13 vs Proposed 0.12), Bayview Garden (Baseline 0.22 vs Proposed 0.21), Golden Villa (Baseline 0.26 vs Proposed 0.24), The Bay Bridge (Baseline 0.11 vs Proposed 0.10) and Sunny Villa (Baseline 0.16 vs Proposed 0.15).

In contrast, the high-rise nature of the Proposed Scheme created downwash wind and the proposed building separations in Site 1 and Site 2 also causes annual wind to be diverted to specific regions. Thus, the following focus areas within the Assessment Area have higher VRs than the Baseline Scheme: Hong Kong Baptist Convention Primary School (Baseline 0.12 vs Proposed 0.15), Bus Terminal (Baseline 0.30 vs Proposed 0.31), One Kowloon Peak (Baseline 0.17 vs Proposed 0.18), Greenview Terrace (Baseline 0.07 vs Proposed 0.08) and Long Beach Garden (Baseline 0.21 vs Proposed 0.23). In Site 2, the high-rise residential towers in the Proposed Scheme would have a substantial impact on the annual prevailing wind thus affecting the wind availability of the downwind regions. Nonetheless, the 60m-wide Drainage Tunnel Protection Zone is incorporated to minimize the adverse ventilation impact caused by the Proposed Scheme.

For the remaining focus areas (i.e. Hoi On Road, Yau Lai Road, Fat Yip Lane, Belvedere Garden Phase 2, The Westminster Terrace, Hanley Villa and Greenview Court), the wind performance is comparable for both schemes.

The annual weighted average VR contour plot for the Baseline Scheme and Proposed Scheme is shown in Figure 45 and Figure 46 respectively.

Table 9 Summary of SVR, LVR and SAVR Results under Annual Wind Condition

| Focus Areas | | Test Points | Baseline Scheme | Proposed Scheme |
|---|---|---|---|---|
| SVR | | P1 – P60 | **0.27** | 0.24 |
| LVR | | P1 – P60, O1 – O131 | **0.25** | 0.23 |
| A | Hoi On Road Playground/Promenade | O60, O65, O67, O113 – O120 | **0.25** | 0.24 |
| B | Hoi On Road | O58, O59, O105 – O112 | 0.27 | 0.27 |
| C | Castle Peak Road – Ting Kau | O44 – O46, O56, O57, O97 – O104 | **0.31** | 0.29 |
| D | Castle Peak Road – Tsuen Wan | O51 – O55, O66, O91 – O96, O131 | **0.25** | 0.24 |
| E | Hoi Hing Road | O89, O90 | **0.23** | 0.21 |
| F | Lai Chi Road | O88, O118 | **0.28** | 0.26 |
| G | Lai Shun Road | O64, O87 | **0.23** | 0.19 |
| H | Hong Kong Baptist Convention Primary School | O86 | 0.12 | **0.15** |
| I | Tsuen Wan Government Primary School | O85 | **0.05** | 0.04 |
| J | Po Fung Road | P6 – P16, P49 – P56,O49 – O50, O82 – O84 | **0.30** | 0.25 |
| K | Tai Lam Chung Catchwater Jogging Trail | O78 – O81 | **0.50** | 0.46 |
| L | Yau Lai Road | O70 – O77 | 0.20 | 0.20 |
| M | Fat Yip Lane | O68, O69 | 0.10 | 0.10 |
| N | Po Fung Terrace | O47 – O48 | **0.33** | 0.30 |
| O | Bus Terminal | O28 | 0.30 | **0.31** |
| P | The Panorama | O43, O125 | **0.12** | 0.10 |
| Q1 | Belvedere Garden Phase 1 | O40 –O42 | **0.12** | 0.11 |

| | | | | |
|---|---|---|---|---|
| **Q2** | Belvedere Garden Phase 2 | O31 – O35, O127, O128 | 0.25 | 0.25 |
| **Q3** | Belvedere Garden Phase 3 | O36 - O38 | **0.23** | 0.21 |
| **R** | Serenade Cove | O39, O126 | **0.13** | 0.12 |
| **S** | Bayview Garden | O24 – O27 | **0.22** | 0.21 |
| **T** | Yau Kom Tau Village | O61 – O63, O121 – O124 | **0.16** | 0.15 |
| **U** | One Kowloon Peak | O21 – O23 | 0.17 | **0.18** |
| **V** | Greenview Terrace | O18 – O20 | 0.07 | **0.08** |
| **W** | The Westminster Terrace | O16 – O17 | 0.21 | 0.21 |
| **X** | Hanley Villa | O8 – O13 | 0.17 | 0.17 |
| **Y** | Golden Villa | O3 – O7 | **0.26** | 0.24 |
| **Z** | Long Beach Garden | O14, O15 | 0.21 | **0.23** |
| **AA** | The Bay Bridge | O129, O130 | **0.11** | 0.10 |
| **AB** | Sunny Villa | O1, O2 | **0.16** | 0.15 |
| **AC** | Greenview Court | O29, O30 | 0.22 | 0.22 |
| **Special Test Points** | | | | |
| **AD** | 15m-wide Building Separation (Site 1) | S1 – S3 | N/A | 0.17 |
| **AE** | Open Areas (Site 1) | S4 – S7 | N/A | 0.17 |
| **AF** | 17m-wide Building Separation (Site 1) | S1, S4 | N/A | 0.26 |
| **AG** | 60m-wide Drainage Tunnel Protection Zone (Site 2) | S8 – S12 | N/A | 0.24 |
| **AH** | Open Areas (Site 2) | S13 – S19 | N/A | 0.18 |
| **AI** | NW-SE Building Separations (Site 2) | S9, S11, S13, S15, S17 | N/A | 0.18 |

**Note:**
***Red*** **denotes VR is higher in the Proposed Scheme**
***Blue*** **denotes VR is higher in the Baseline Scheme**

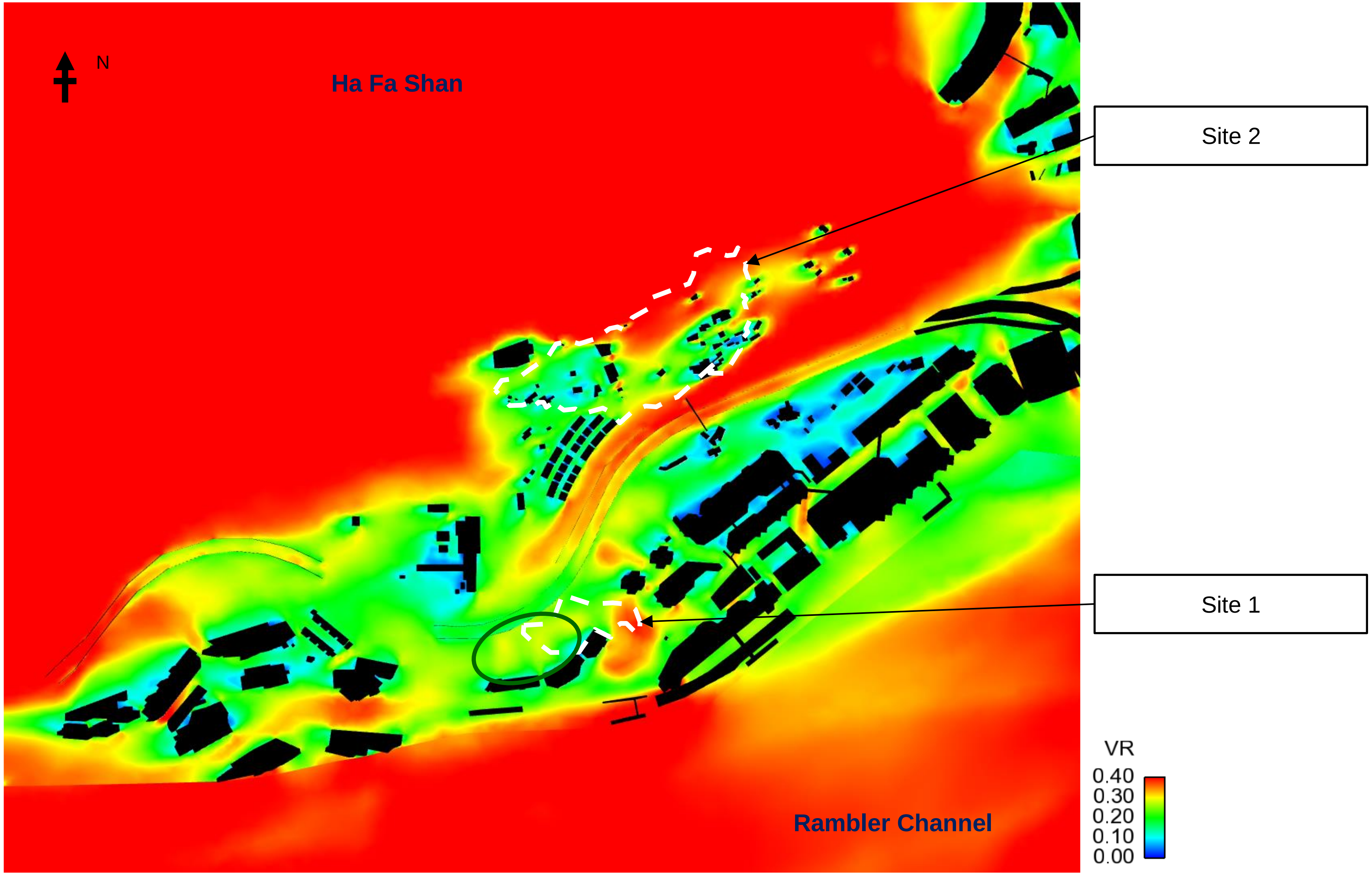


Figure 45 Annual Weighted Average VR Contour Plot at Pedestrian Level for Baseline Scheme

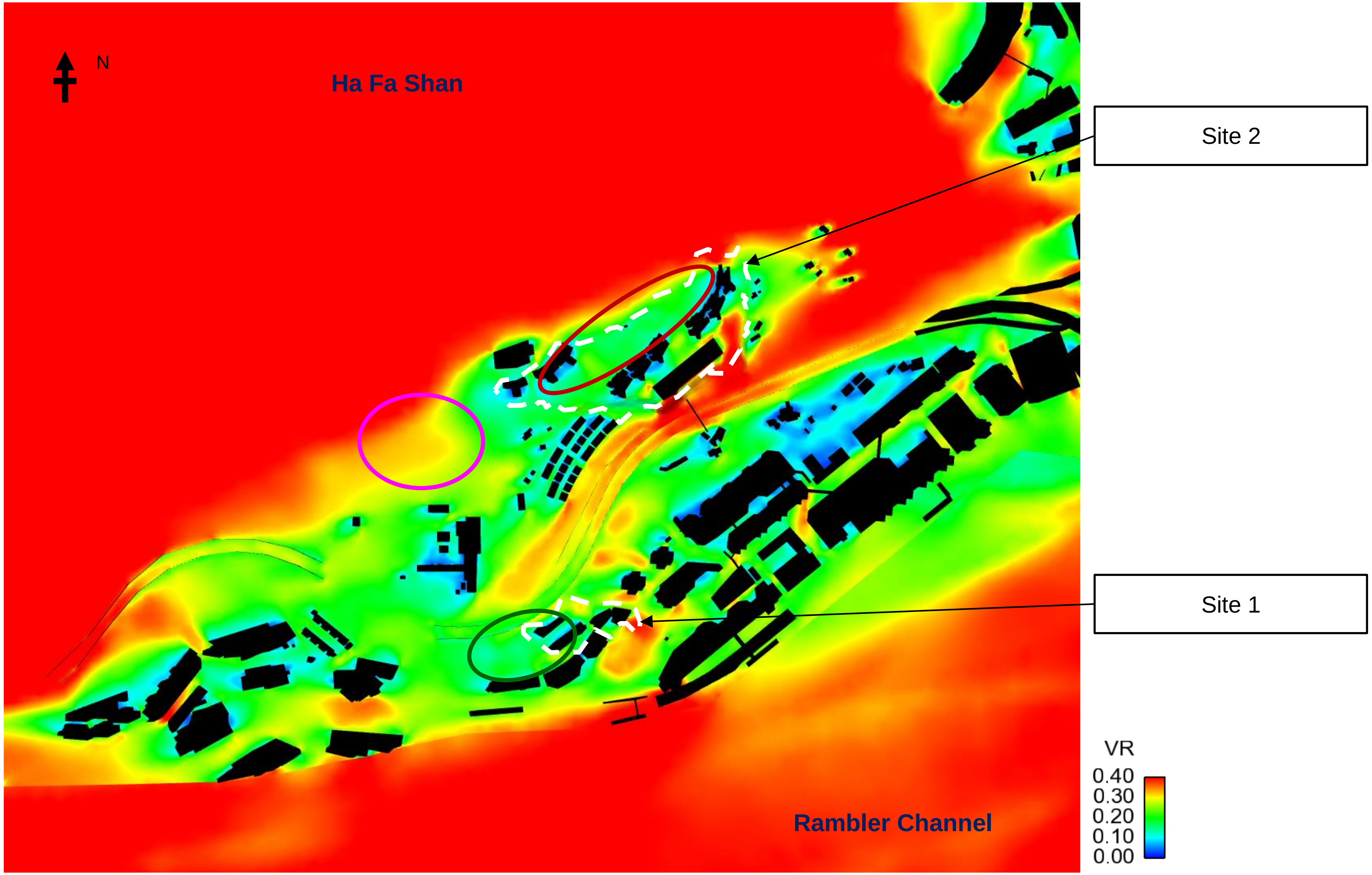


Figure 46 Annual Weighted Average VR Contour Plot at Pedestrian Level for Proposed Scheme

## 6.2 SUMMARY OF VELOCITY RATIO (VR) RESULTS UNDER SUMMER WIND CONDITION

According to the average VR results under summer wind condition in Table 2, both the SVR and LVR are higher in the Baseline Scheme when compared with the Proposed Scheme (SVR: Baseline 0.30 vs Proposed 0.28 and LVR: Baseline 0.28 vs Proposed 0.26).

The Baseline Scheme for Site 1 is covered by natural vegetation without any building structures hence better ventilation performance is observed along the site boundary and immediate downwind regions (Dark Green Circle in Figure 47). Besides, several focus areas have higher VR under the Baseline Scheme when compared with the Proposed Scheme including: Po Fung Road (i.e. Baseline 0.33 vs Proposed 0.27), Greenview Court (Baseline 0.22 vs Proposed 0.20), Belvedere Garden Phase 2 (Baseline 0.28 vs Proposed 0.26), Belvedere Garden Phase 3 (Baseline 0.24 vs Proposed 0.23) and Bayview Garden (Baseline 0.20 vs Proposed 0.19).

On the other hand, the Baseline Scheme for Site 2 is occupied by some low-rise temporary structures and ruins. Likewise, better ventilation performance is observed along the site boundary and at some downwind areas of Site 2 such as Tai Lam Chung Catchwater Jogging Trail (Baseline 0.47 vs Proposed 0.44). Nonetheless, the 60m-wide Drainage Tunnel Protection Zone is incorporated to minimize the adverse ventilation impact caused by the Proposed Scheme.

In addition, the high-rise nature of the Proposed Scheme is observed to impede summer winds thus affecting the wind performance of the open spaces within Site 2 (Magenta Circle in Figure 48) as well as the immediate downwind regions northeast of Site 2 (Blue Circle in Figure 48) and other focus areas within the Assessment Area including: Hoi On Road Playground/Promenade (i.e. Baseline 0.27 vs Proposed 0.26), Hoi On Road (Baseline 0.32 vs Proposed 0.31), Castle Peak Road – Ting Kau (Baseline 0.37 vs Proposed 0.36), Castle Peak Road – Tsuen Wan (Baseline 0.30 vs Proposed 0.29), Hoi Hing Road (Baseline 0.31 vs Proposed 0.27), Lai Shun Road (Baseline 0.26 vs Proposed 0.22), Tsuen Wan Government Primary School (Baseline 0.06 vs Proposed 0.05), Po Fung Terrace (Baseline 0.43 vs Proposed 0.37), The Panorama (Baseline 0.11 vs Proposed 0.09), One Kowloon Peak (Baseline 0.23 vs Proposed 0.22), Golden Villa (Baseline 0.31 vs Proposed 0.29), The Bay Bridge (Baseline 0.14 vs Proposed 0.12) and Sunny Villa (Baseline 0.26 vs Proposed 0.25).

In contrast, the high-rise nature of the Proposed Scheme and presence of building separation in Site 1 causes summer wind to be deflected thus several focus areas are observed to have higher VRs than the Baseline Scheme, namely Hong Kong Baptist Convention Primary School

(Baseline 0.20 vs Proposed 0.25), Bus Terminal (Baseline 0.31 vs Proposed 0.33), Greenview Terrace (Baseline 0.12 vs Proposed 0.14), The Westminster Terrace (Baseline 0.22 vs Proposed 0.25) and Long Beach Garden (Baseline 0.18 vs Proposed 0.21).

For the remaining focus areas (Lai Chi Road, Yau Lai Road, Fat Yip Lane, Belvedere Garden Phase 1, Serenade Cove, Yau Kom Tau Village and Hanley Villa), their wind performances are comparable for both schemes.

The summer weighted average VR contour plot for the Baseline Scheme and Proposed Scheme is shown in Figure 47 and Figure 48 respectively.

Table 10 Summary of SVR, LVR and SAVR Results under Summer Wind Condition

| Focus Areas | | Test Points | Baseline Scheme | Proposed Scheme |
|---|---|---|---|---|
| **SVR** | | P1 – P60 | **0.30** | 0.28 |
| **LVR** | | P1 – P60, O1 – O131 | **0.28** | 0.26 |
| **A** | Hoi On Road Playground/Promenade | O60, O65, O67, O113 – O120 | **0.27** | 0.26 |
| **B** | Hoi On Road | O58, O59, O105 – O112 | **0.32** | 0.31 |
| **C** | Castle Peak Road – Ting Kau | O44 – O46, O56, O57, O97 – O104 | **0.37** | 0.36 |
| **D** | Castle Peak Road – Tsuen Wan | O51 – O55, O66, O91 – O96, O131 | **0.30** | 0.29 |
| **E** | Hoi Hing Road | O89, O90 | **0.31** | 0.27 |
| **F** | Lai Chi Road | O88, O118 | 0.27 | 0.27 |
| **G** | Lai Shun Road | O64, O87 | **0.26** | 0.22 |
| **H** | Hong Kong Baptist Convention Primary School | O86 | 0.20 | **0.25** |
| **I** | Tsuen Wan Government Primary School | O85 | **0.06** | 0.05 |
| **J** | Po Fung Road | P6 – P16, P49 – P56,O49 – O50, O82 – O84 | **0.33** | 0.27 |
| **K** | Tai Lam Chung Catchwater Jogging Trail | O78 – O81 | **0.47** | 0.44 |
| **L** | Yau Lai Road | O70 – O77 | 0.26 | 0.26 |
| **M** | Fat Yip Lane | O68, O69 | 0.10 | 0.10 |
| **N** | Po Fung Terrace | O47 – O48 | **0.43** | 0.37 |
| **O** | Bus Terminal | O28 | 0.31 | **0.33** |
| **P** | The Panorama | O43, O125 | **0.11** | 0.09 |
| **Q1** | Belvedere Garden Phase 1 | O40 –O42 | 0.13 | 0.13 |
| **Q2** | Belvedere Garden Phase 2 | O31 – O35, O127, O128 | **0.28** | 0.26 |
| **Q3** | Belvedere Garden Phase 3 | O36 - 38 | **0.24** | 0.23 |

| | | | | |
|---|---|---|---|---|
| **R** | Serenade Cove | O39, O126 | 0.09 | 0.09 |
| **S** | Bayview Garden | O24 – O27 | **0.20** | 0.19 |
| **T** | Yau Kom Tau Village | O61 – O63, O121 – O124 | 0.15 | 0.15 |
| **U** | One Kowloon Peak | O21 – O23 | **0.23** | 0.22 |
| **V** | Greenview Terrace | O18 – O20 | 0.12 | **0.14** |
| **W** | The Westminster Terrace | O16 – O17 | 0.22 | **0.25** |
| **X** | Hanley Villa | O8 – O13 | 0.19 | 0.19 |
| **Y** | Golden Villa | O3 – O7 | **0.31** | 0.29 |
| **Z** | Long Beach Garden | O14, O15 | 0.18 | **0.21** |
| **AA** | The Bay Bridge | O129, O130 | **0.14** | 0.12 |
| **AB** | Sunny Villa | O1, O2 | **0.26** | 0.25 |
| **AC** | Greenview Court | O29, O30 | **0.22** | 0.20 |
| **Special Test Points** | | | | |
| **AD** | 15m-wide Building Separation (Site 1) | S1 – S3 | N/A | 0.26 |
| **AE** | Open Areas (Site 1) | S4 – S7 | N/A | 0.24 |
| **AF** | 17m-wide Building Separation (Site 1) | S1, S4 | N/A | 0.29 |
| **AG** | 60m-wide Drainage Tunnel Protection Zone (Site 2) | S8 – S12 | N/A | 0.34 |
| **AH** | Open Areas (Site 2) | S13 – S19 | N/A | 0.20 |
| **AI** | NW-SE Building Separations (Site 2) | S9, S11, S13, S15, S17 | N/A | 0.25 |
| **Note:** Highlighted in ***red*** where VR is higher in the Proposed Scheme. Highlighted in ***blue*** where VR is higher in the Baseline Scheme | | | | |

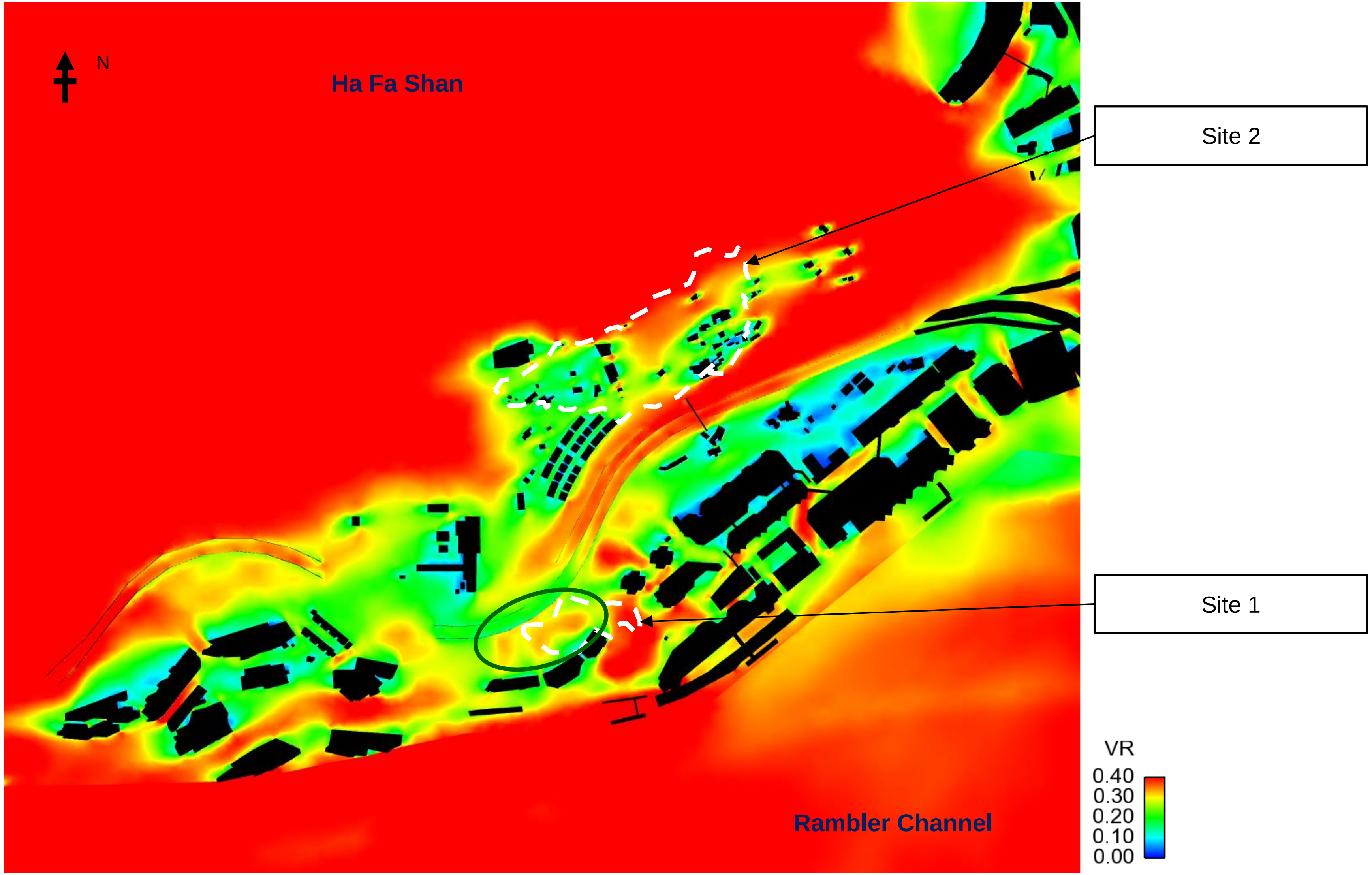


Figure 47 Summer Weighted Average VR Contour Plot at Pedestrian Level for Baseline Scheme

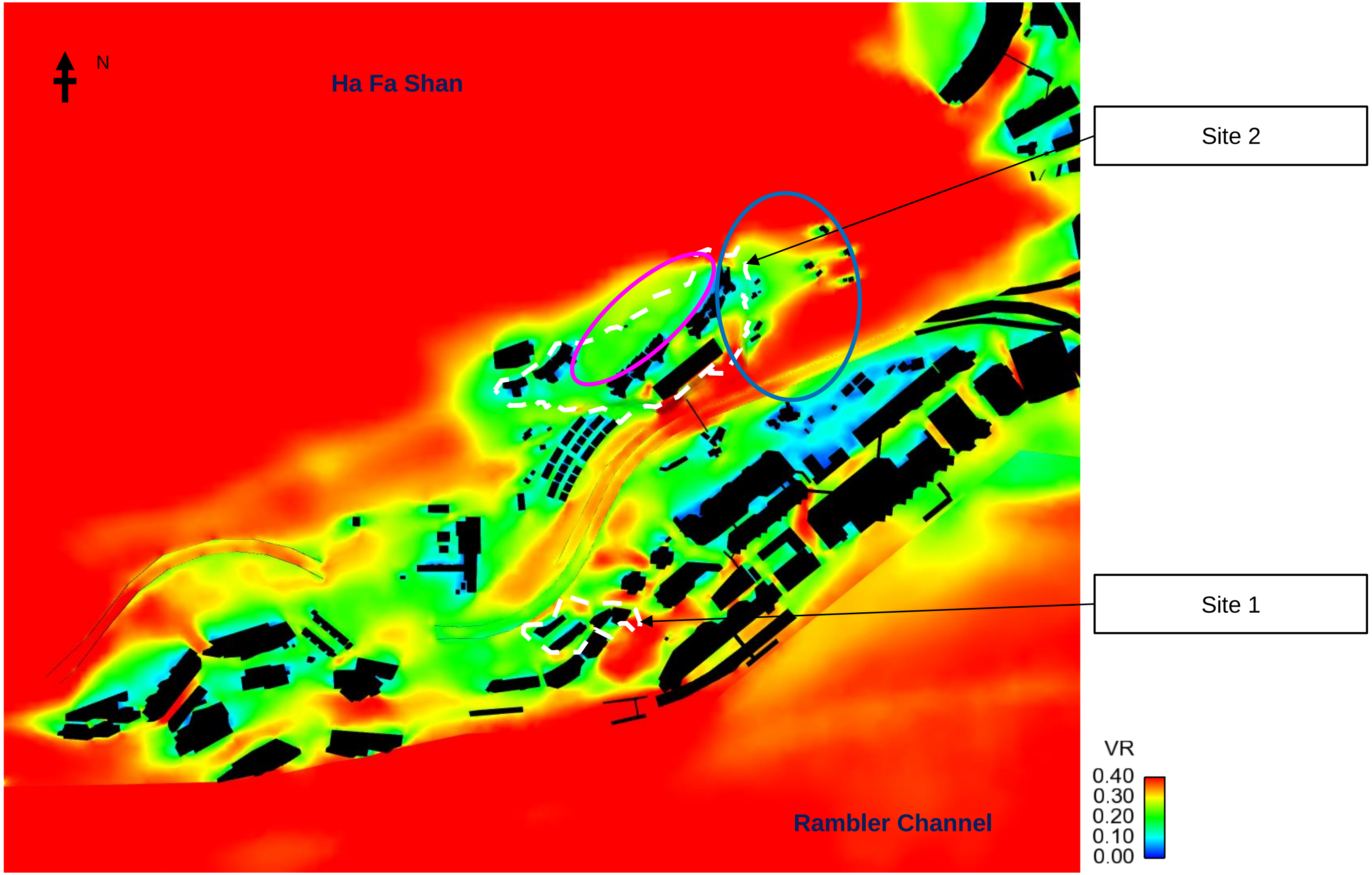


Figure 48 Summer Weighted Average VR Contour Plot at Pedestrian Level for Proposed Scheme

## 6.3 DIRECTIONAL ANALYSIS

### 6.3.1 NE Wind - Wind Frequency: 7.5% (Annual)

The incoming NE wind mainly comes from the foothill of Ha Fa Shan. For Site 1, the 30-meter-wide Tuen Mun Road acts as the main wind corridor to bring NE wind from Ha Fa Shan to Site 1. For Site 2, the strong downhill wind from Ha Fa Shan are able to freely reach Site 2 due to a lack of high-rise building structures at its upwind region.

*Site 1*

In the Baseline Scheme, high-rise residential buildings including Greenview Court (around 122.9mPD) and Belvedere Garden Phase 2 (around 141.4mPD), situated to the northeast of Site 1, are observed to create wind shadow to its immediate downwind regions and Site 1. However, a portion of NE wind travels along Tuen Mun Road to reach the north-western portion of Site 1. A portion of incoming NE wind could penetrate through Site 1 with minimal obstruction to ventilate the downwind regions such as Greenview Terrace and One Kowloon Peak.

In the Proposed Scheme, the proposed building structures in Site 2 diverted more NE wind towards Site 1 via Tuen Mun Road hence more wind could reach the northern portion of Site 1 when compared with the Baseline Scheme. However, the proposed high-rise building structures in Site 1 obstructed the NE wind and a wake zone is observed at the downwind regions such as Greenview Terrace and One Kowloon Peak. From the simulation results, the proposed 15m-wide building separation between the recreation house and the 23-storey residential towers at Site 1 facilitates effective penetration of NE wind through Site 1 to the further downwind regions (Blue Circle in Figure 51). However, the effectiveness is limited for the 17m-wide NNW-SSE aligned building separation between the 23-storey residential towers and the 26-storey residential towers at Site 1 as it is not aligned with the NE wind.

*Site 2*

In the Baseline Scheme, mid-level NE wind skims over the low-rise temporary structures and ruins and reattaches at pedestrian level to ventilate the downwind regions i.e. Yau Kom Tau Village.

In the Proposed Scheme, the presence of the high-rise residential towers and recreation house obstructs the NE wind from reaching the downwind regions hence lower VRs are observed at Yau Kom Tau Village and Po Fung Road when compared with the Baseline Scheme. In particular, a stagnant zone was created at the northern portion of Yau Kom Tau Village which significantly affect the pedestrian wind environment around this area and resulted in lower VR. Wake zones are also created in the further downwind regions, such as Hanley Villa, Yau Lai Road and The Westminster Terrace, as a result of the high-rise residential towers at Site. Nonetheless, the 60m-wide Drainage Tunnel Protection Zone is aligned with the NE wind thus could allow NE wind to penetrate through Site 2 and minimize the adverse air ventilation impact to the downwind regions.

According to the simulation results, the proposed three high-rise residential towers at the north-eastern portion of Site 2 creates downwash effect and diverted the NE wind southwards towards the open area of Site 2 and Tuen Mun Road (Dark Green Circle in Figure 51). Additionally, it is observed that the proposed 23-storey residential towers at the western portion of Site 2 induced downwash effect thus diverting high level NE wind towards the pedestrian level at the central portion of Site 2 (Magenta Circle in Figure 51).

Figure 49 and Figure 51 shows the VR contour plots of NE wind for the Baseline Scheme and Proposed Scheme respectively. Figure 50 and Figure 52 shows the VR vector plots of NE wind for the Baseline Scheme and Proposed Scheme respectively.

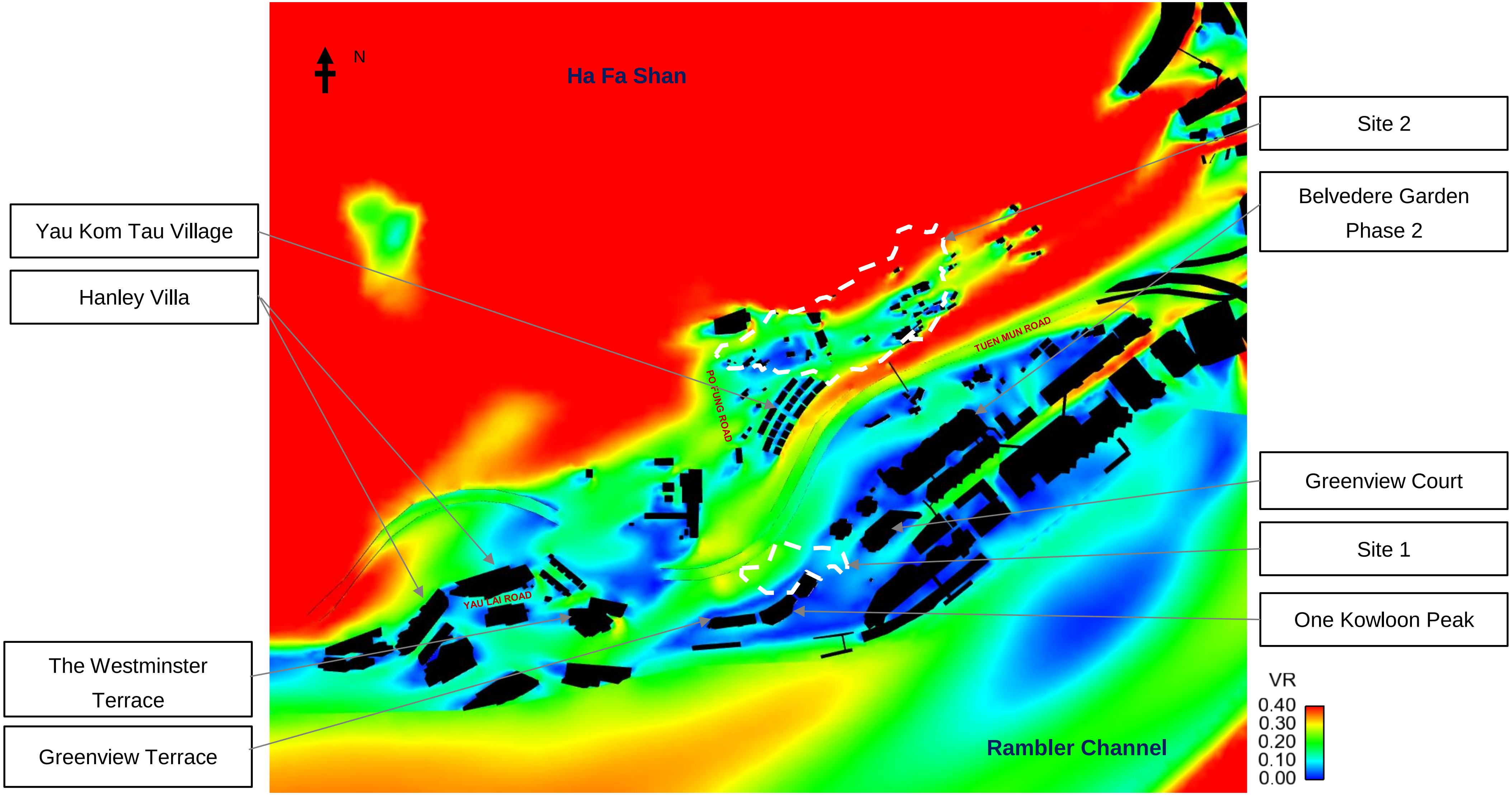


Figure 49 VR Contour Plot at Pedestrian Level under NE Wind for Baseline Scheme

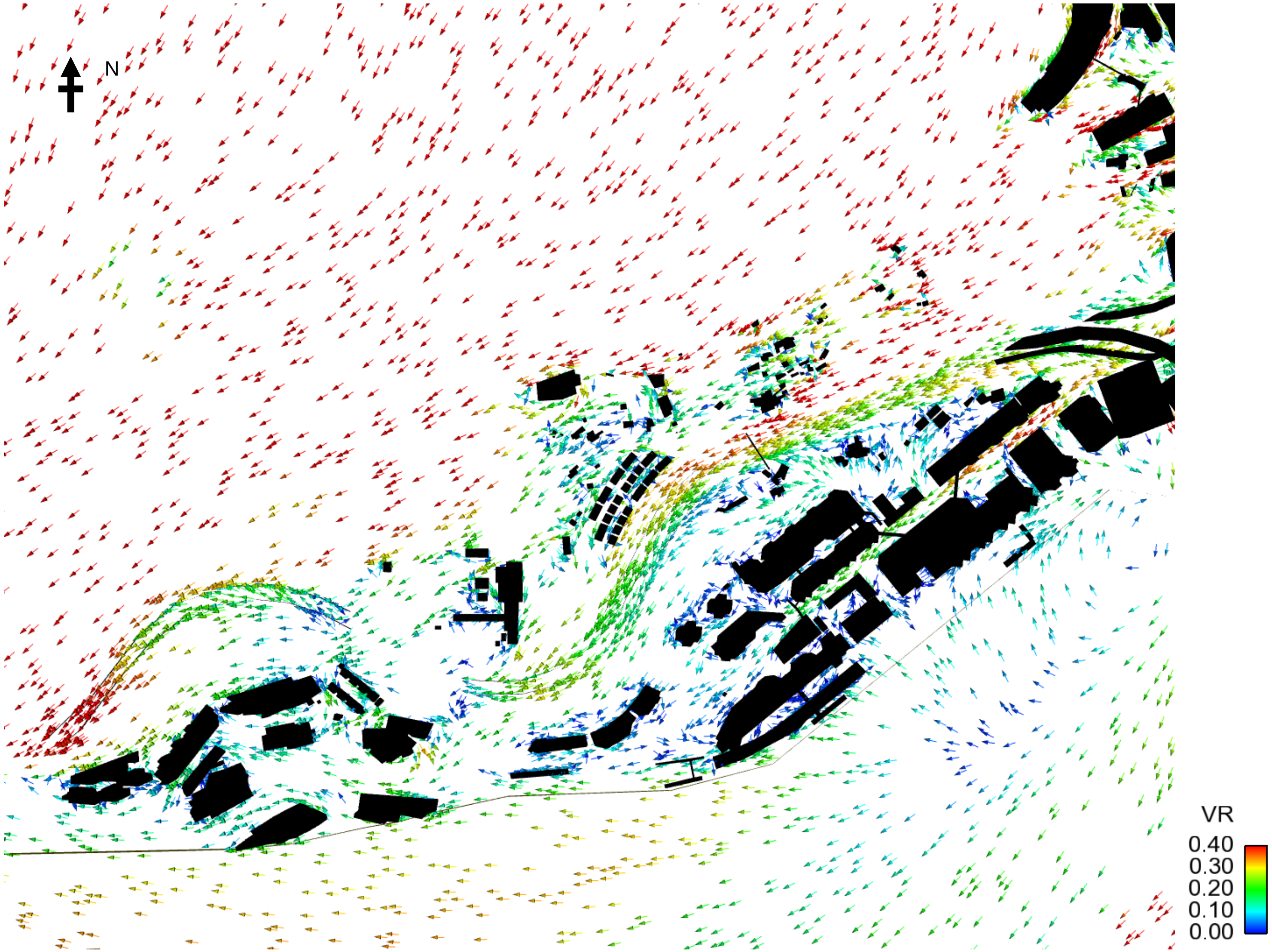


Figure 50 VR Vector Plot at Pedestrian Level under NE Wind for Baseline Scheme

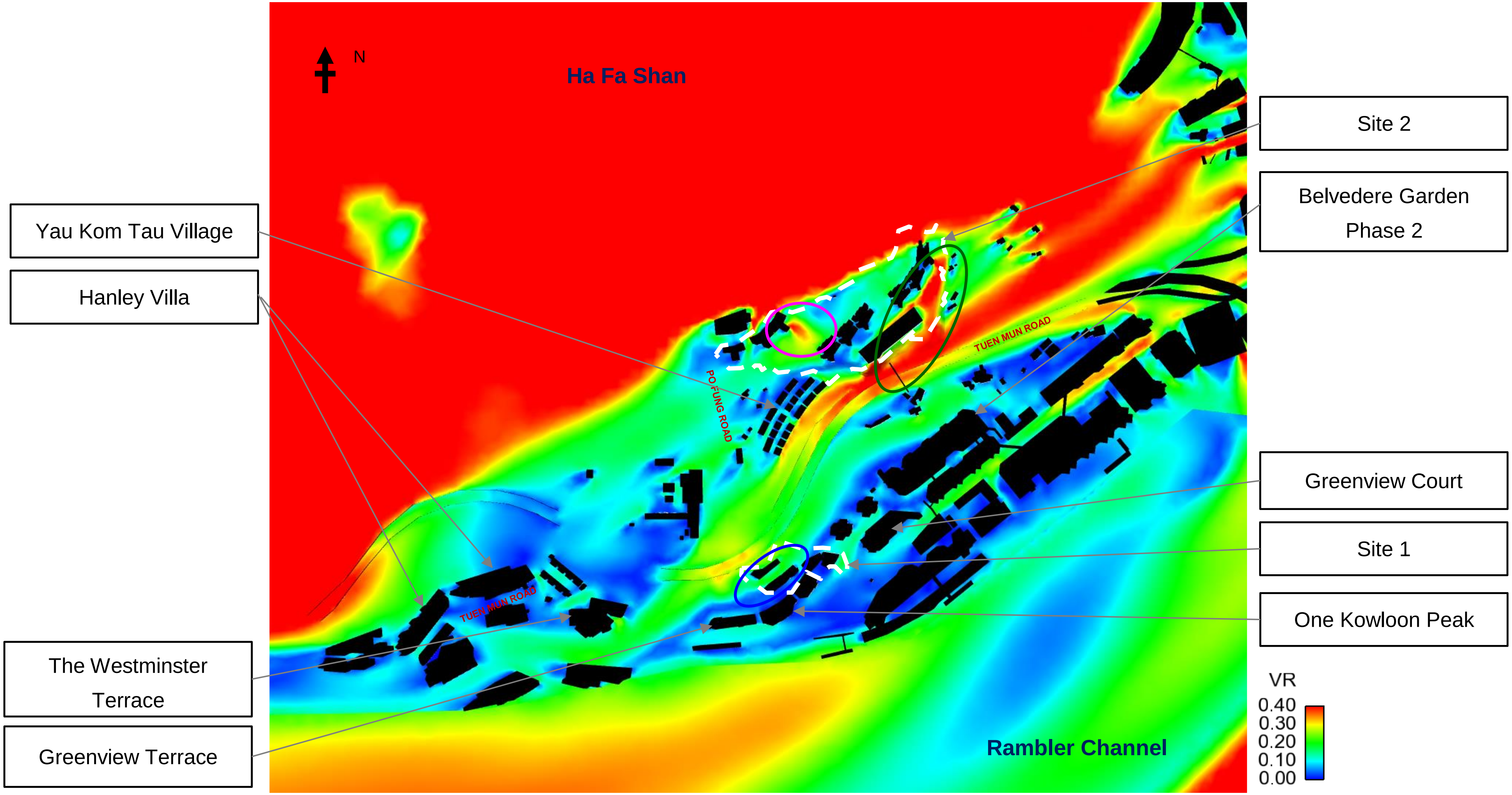


Figure 51 VR Contour Plot at Pedestrian Level under NE Wind for Proposed Scheme

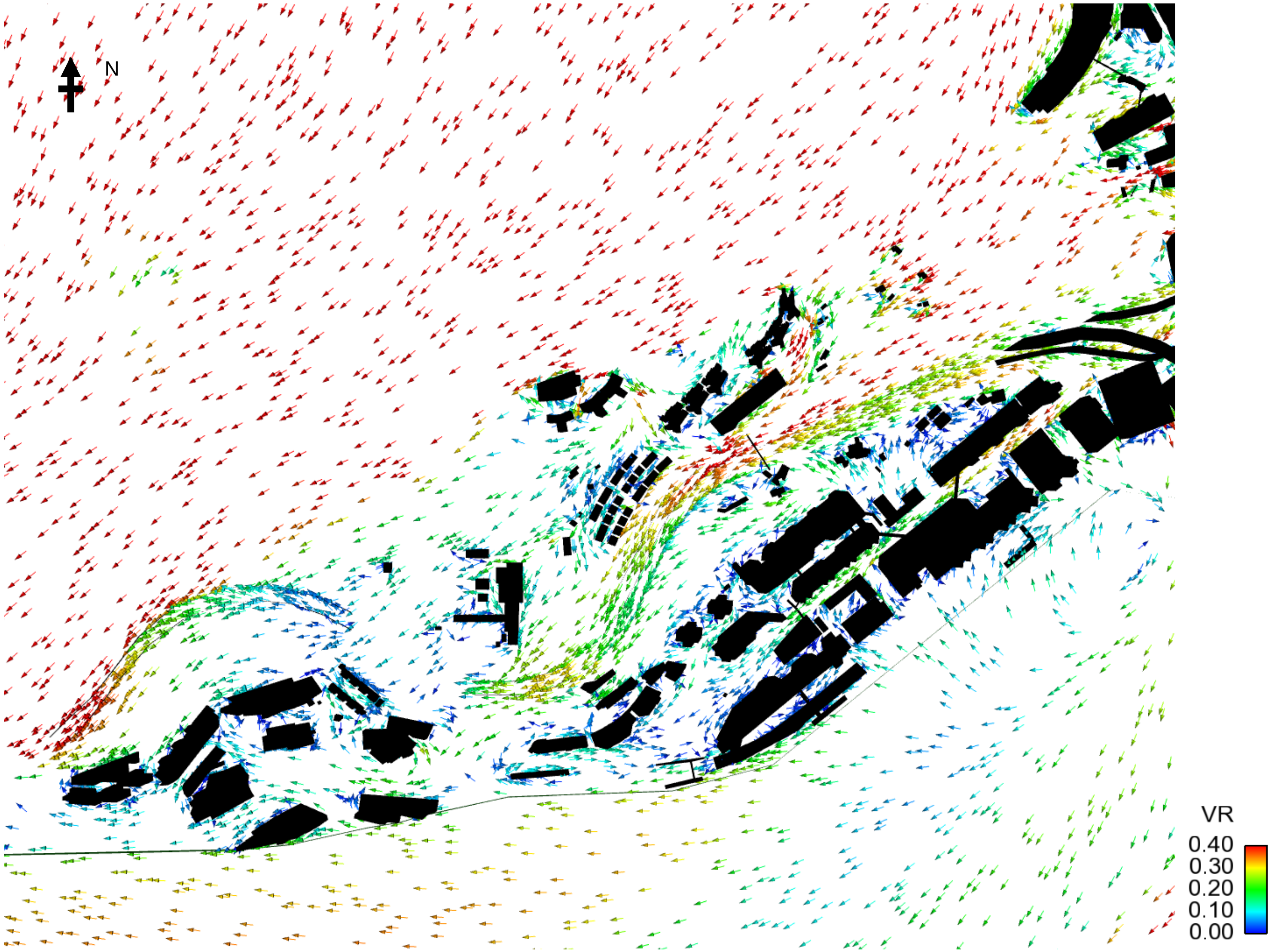


Figure 52 VR Vector Plot at Pedestrian Level under NE Wind for Proposed Scheme

### 6.3.2 ENE Wind - Wind Frequency: 13.7% (Annual)

The incoming ENE wind mainly comes from the foothill of Ha Fa Shan. For Site 1, ENE wind could reach Site 1 via Tuen Mun Road as well as open area to the east of the Site 1. For Site 2, the strong downhill wind from Ha Fa Shan could freely reach Site 2 due to a lack of high-rise building structures at its upwind region.

*Site 1*

In the Baseline Scheme, Tuen Mun Road acts as the major air path and ENE wind is observed to travel along Tuen Mun Road to reach the northern portion of Site 1 with minimal obstruction. A minor portion of mid-level ENE wind skims over the low-rise developments at the waterfront, namely Hong Kong Baptist Convention Primary School and Tsuen Wan West Sports Centre, to reach the eastern portion of Site 1. ENE wind could penetrate through Site 1 with minimal obstruction to ventilate the downwind regions such as Greenview Terrace as well as further downwind regions including The Westminster Terrace.

In the Proposed Scheme, the proposed building structures in Site 2 diverted more ENE wind towards Site 1 via Tuen Mun Road hence more wind could reach the northern portion of Site 1 when compared with the Baseline Scheme. However, the proposed high-rise building structures in Site 1 obstructed the ENE wind and created wake zone at the downwind region towards The Westminster Terrace. Additionally, slightly less wind flow could reach Greenview Terrace due to obstruction induced by the high-rise developments in Site 1. From the simulation results, the existing development of One Kowloon Peak would divert ENE wind to reach Site 1 and then travel along the proposed NNW-SSE aligned 17m-wide building separation between the 23-storey residential towers and the 26-storey residential towers at Site 1 (Blue Circle in Figure 55) whereas the proposed 15m building separation between the recreation house & the 23-storey residential towers at Site 1 would be less effective for penetration of ENE wind.

*Site 2*

In the Baseline Scheme, mid-level ENE wind skims over the low-rise temporary structures and ruins and reattaches at pedestrian level to ventilate the downwind regions i.e. Yau Kom Tau Village and open areas to the southwest of Site 2.

In the Proposed Scheme, the presence of the high-rise residential towers and recreation house obstructs the ENE wind from reaching the downwind regions hence lower VRs are observed at Yau Kom Tau Village and Po Fung Road when compared with the Baseline Scheme.

Additionally, the proposed 23-storey residential towers at the western portion of Site 2 creates downwash effect thus diverting high level ENE wind towards the pedestrian level at the central portion of Site 2 and Yau Kom Tau Village along the 32m-wide NW-SE aligned building separation (Magenta Circle in Figure 55). The 60m-wide Drainage Tunnel Protection Zone allows such downwash wind to the southern part of the Site 2 as well as the northern part of Yau Kom Tau Village. Additionally, it is observed from the simulation results that the proposed three high-rise residential towers at the north-eastern portion of Site 2 induced downwash effect and diverted the ENE wind southwards to travel along Tuen Mun Road (Dark Green Circle in Figure 55).

Figure 53 and Figure 55 shows the VR contour plots of ENE wind for the Baseline Scheme and Proposed Scheme respectively. Figure 54 and Figure 56 shows the VR vector plots of ENE wind for the Baseline Scheme and Proposed Scheme respectively.

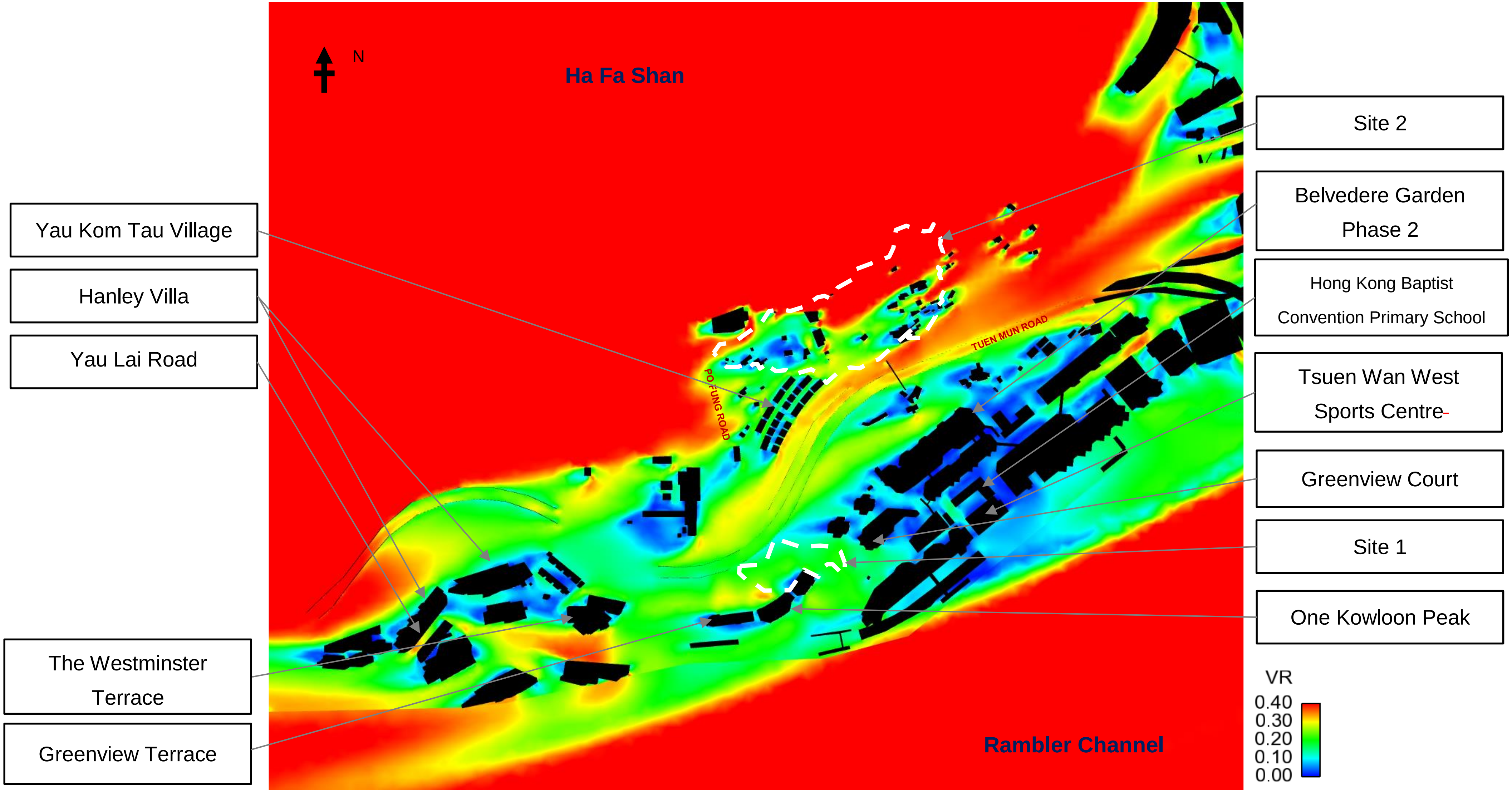


Figure 53 VR Contour Plot at Pedestrian Level under ENE Wind for Baseline Scheme

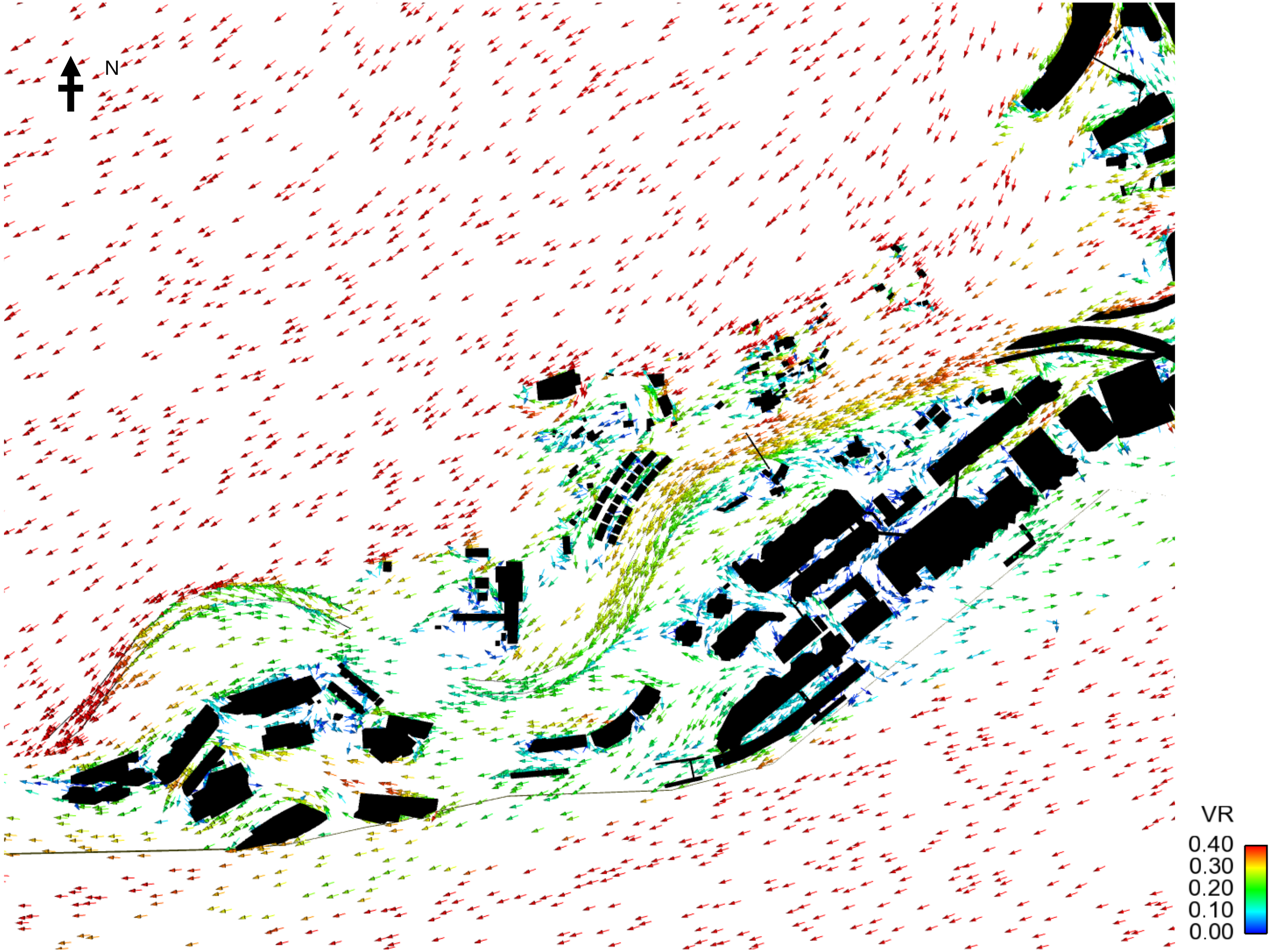


Figure 54 VR Vector Plot at Pedestrian Level under ENE Wind for Baseline Scheme

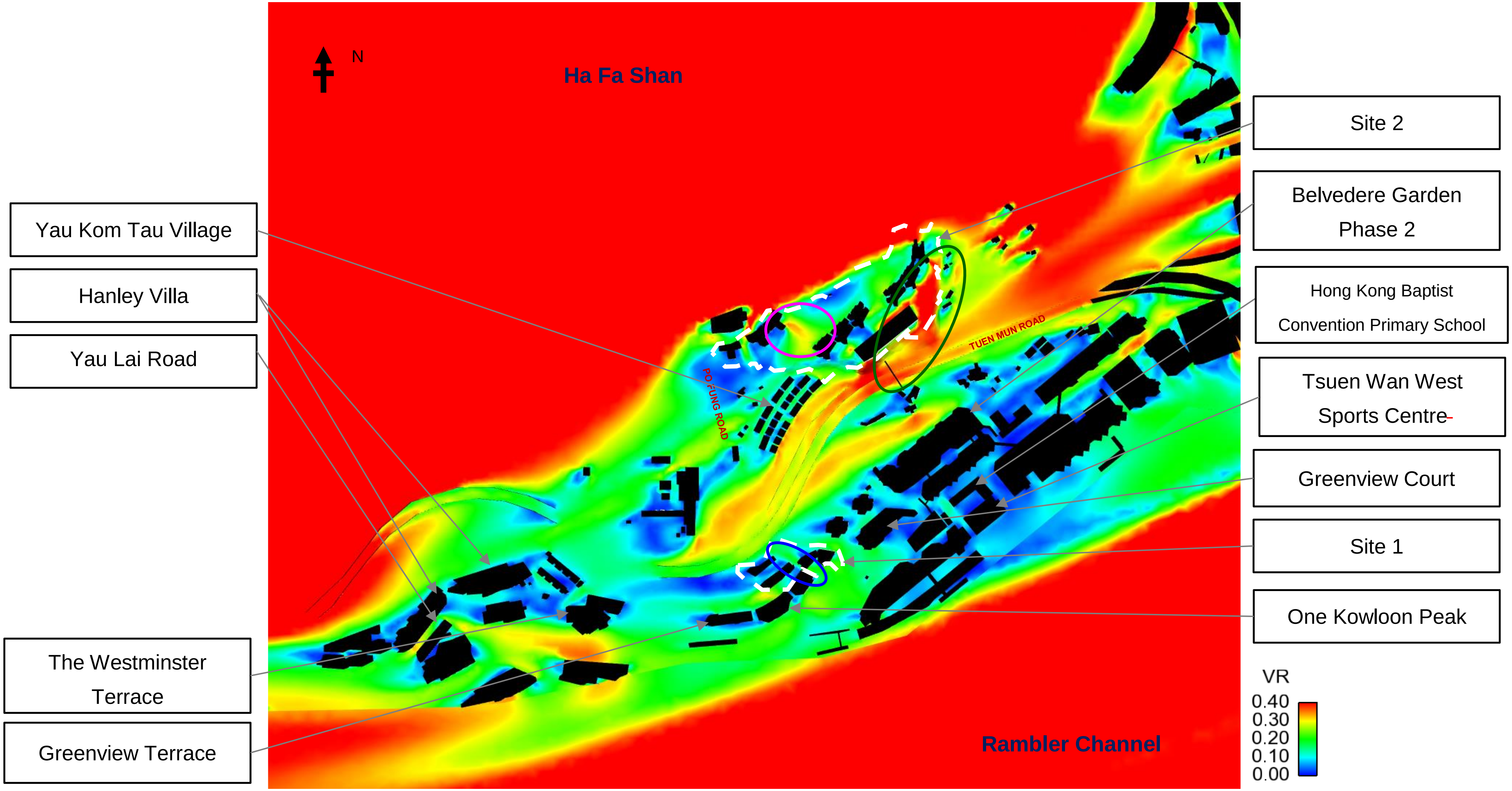


Figure 55 VR Contour Plot at Pedestrian Level under ENE Wind for Proposed Scheme

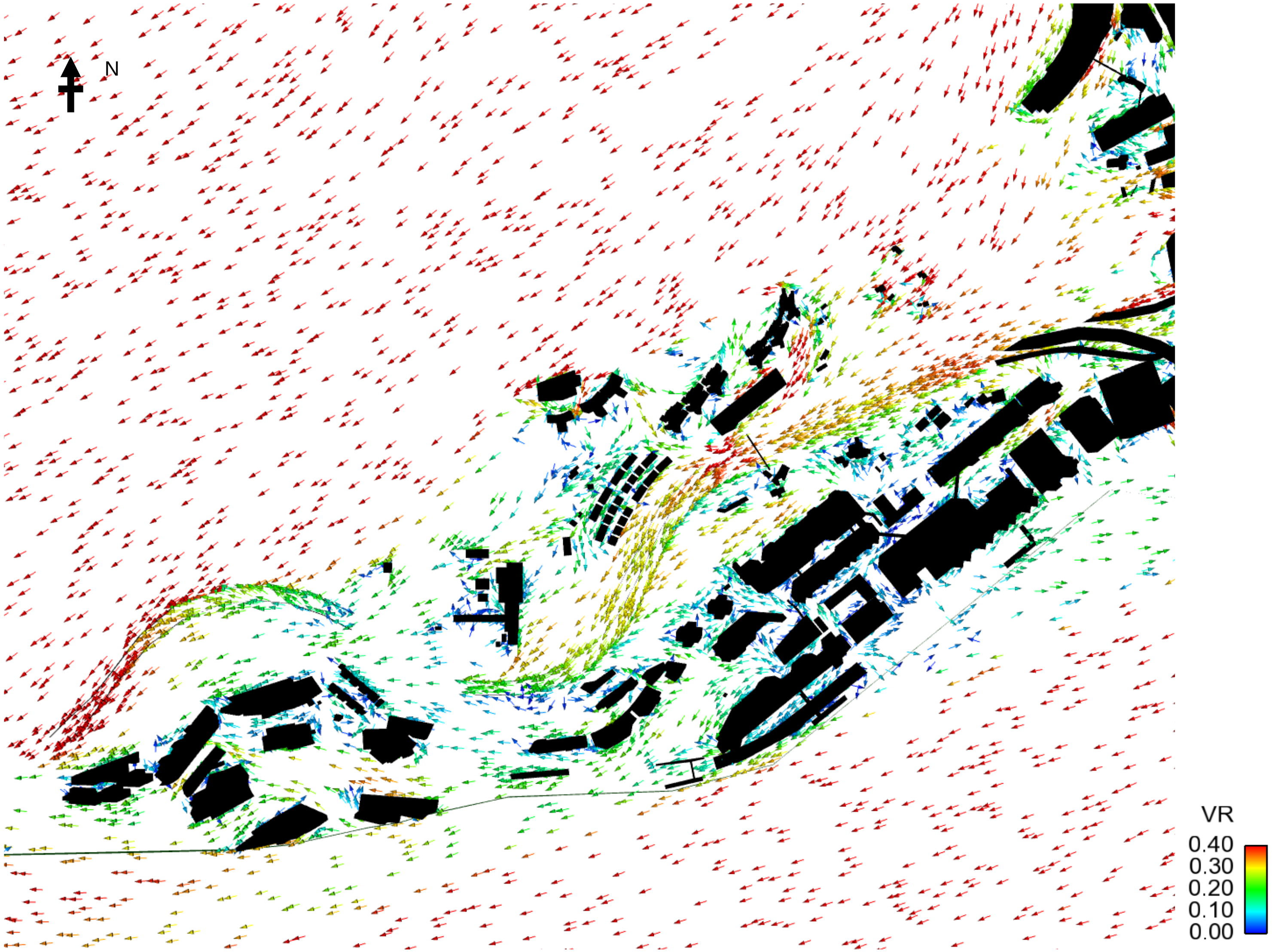


Figure 56 VR Vector Plot at Pedestrian Level under ENE Wind for Proposed Scheme

### 6.3.3 E Wind - Wind Frequency: 18.6% (Annual), 7.8% (Summer)

With an annual wind frequency of 18.6% and summer wind frequency of 7.8%, E wind is the prevailing wind direction under annual condition. The 30-meter-wide Tuen Mun Road will act as the main wind corridor to bring E wind to both Site 1 and Site 2.

*Site 1*

In the Baseline Scheme, E wind travels along Tuen Mun Road which acts as the major air path to reach the northern portion of Site 1. In addition, the mid-level E wind from Rambler Channel would be able to skim over the low-rise developments at the waterfront, namely Tsuen Wan West Sports Centre and the Bus Terminal, to reach the eastern portion of Site 1. Due to an absence of building structures in the Baseline Scheme, the incoming E wind penetrates through Site 1 freely and ventilates the downwind regions such as Greenview Terrace as well as further downwind regions including The Westminster Terrace. Thus, a higher VR is observed to the south-west of Site 1 when compared with the Proposed Scheme.

In the Proposed Scheme, the proposed high-rise building structures in Site 1 impede the E wind, and create a wake zone within Site 1 as well as the downwind regions including Greenview Terrace (Blue Circle in Figure 59). Additionally, less wind flow could reach the further downwind regions of The Westminster Terrace. The proposed easternmost tower at Site 1 could also divert incoming E wind towards the northern and southern portion of Site 1. From the simulation results, the NNW-SSE aligned proposed 17m-wide building separation between the 23-storey residential towers and the 26-storey residential towers at Site 1 allows wind penetration through Site 1 whereas relatively less wind could travel along the 15m building separation between the recreation house & the 23-storey residential towers at Site 1.

*Site 2*

In the Baseline Scheme, mid-level E wind skims over the low-rise temporary structures and ruins and re-attaches at pedestrian level to ventilate the downwind regions i.e. Yau Kom Tau Village. Relatively higher VR is observed within Site 2 compared to the Proposed Scheme.

In the Proposed Scheme, the presence of the high-rise residential towers and recreation house obstructs E wind from reaching the downwind regions hence lower VRs are observed at the undeveloped areas southwest of Site 2 as well as open areas within Site 2 when compared with the Baseline Scheme (Magenta Circle in Figure 59). According to the simulation results, the proposed three high-rise residential towers at the north-eastern portion of Site 2 induced downwash effect and diverted the E wind southwards towards Tuen Mun Road (Dark Green Circle in Figure 59). E wind could travel along Tuen Mun Road to ventilate Yau Kom Tau Village under both schemes. In addition, the proposed high-rise residential towers at the west portion of Site 2 would create downwash wind and then travel along the 20m-wide NW-SE aligned building separation. Meanwhile, these residential towers also create a large wake region in its downstream area.

Figure 57 and Figure 59 shows the VR contour plots of E wind for the Baseline Scheme and Proposed Scheme respectively. Figure 58 and Figure 60 shows the VR vector plots of E wind for the Baseline Scheme and Proposed Scheme respectively.

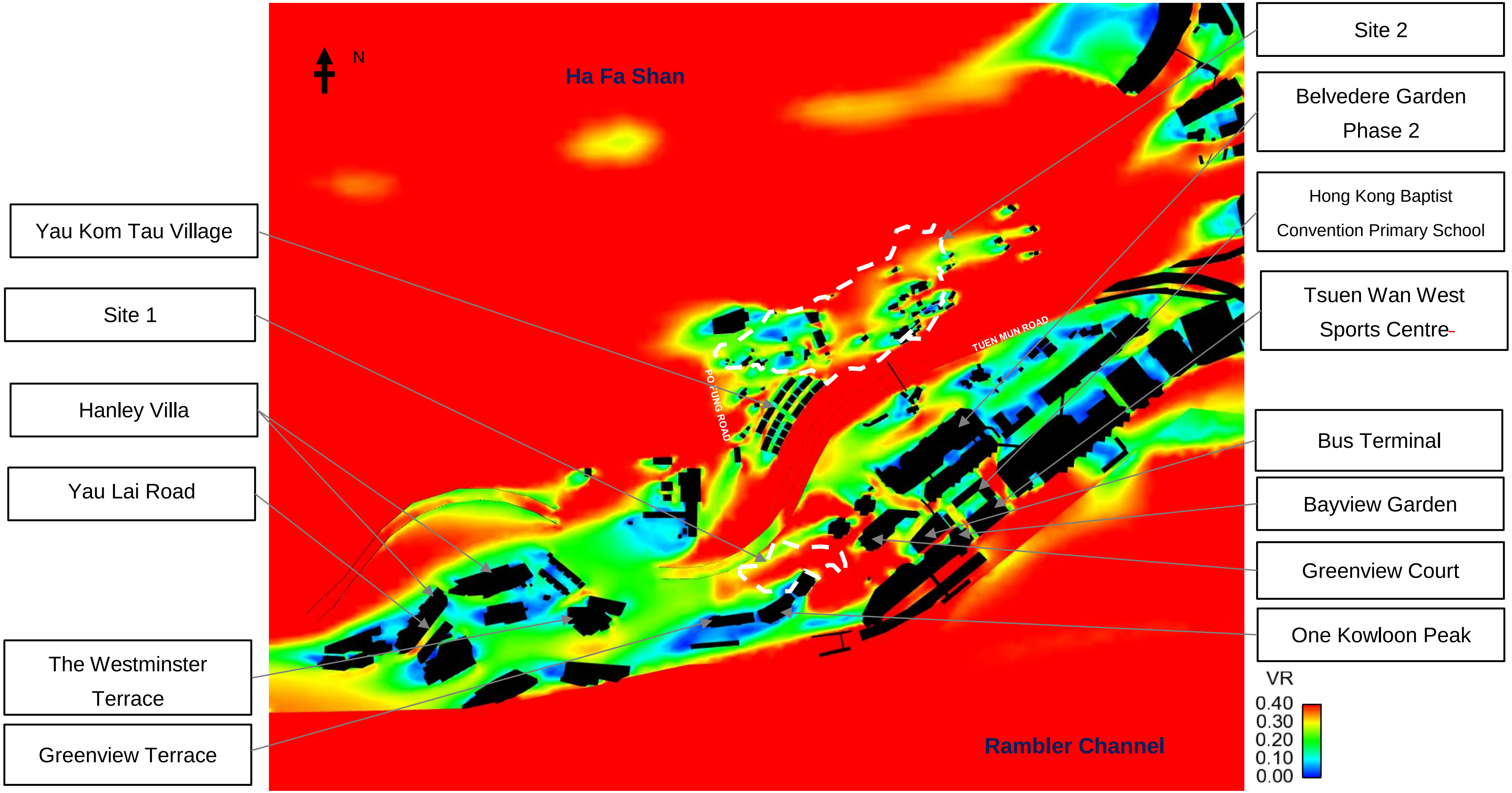


Figure 57 VR Contour Plot at Pedestrian Level under E Wind for Baseline Scheme

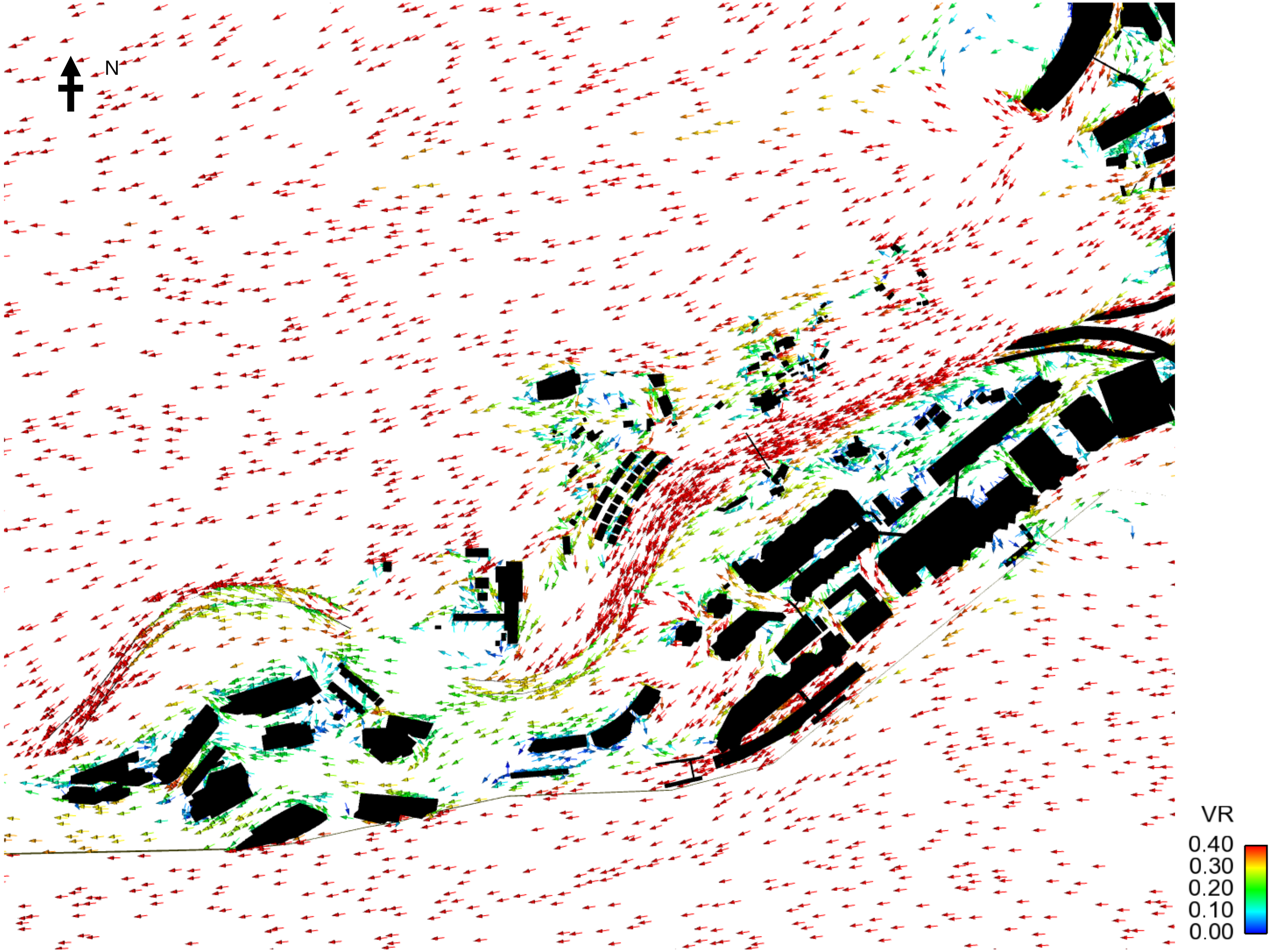


Figure 58 VR Vector Plot at Pedestrian Level under E Wind for Baseline Scheme

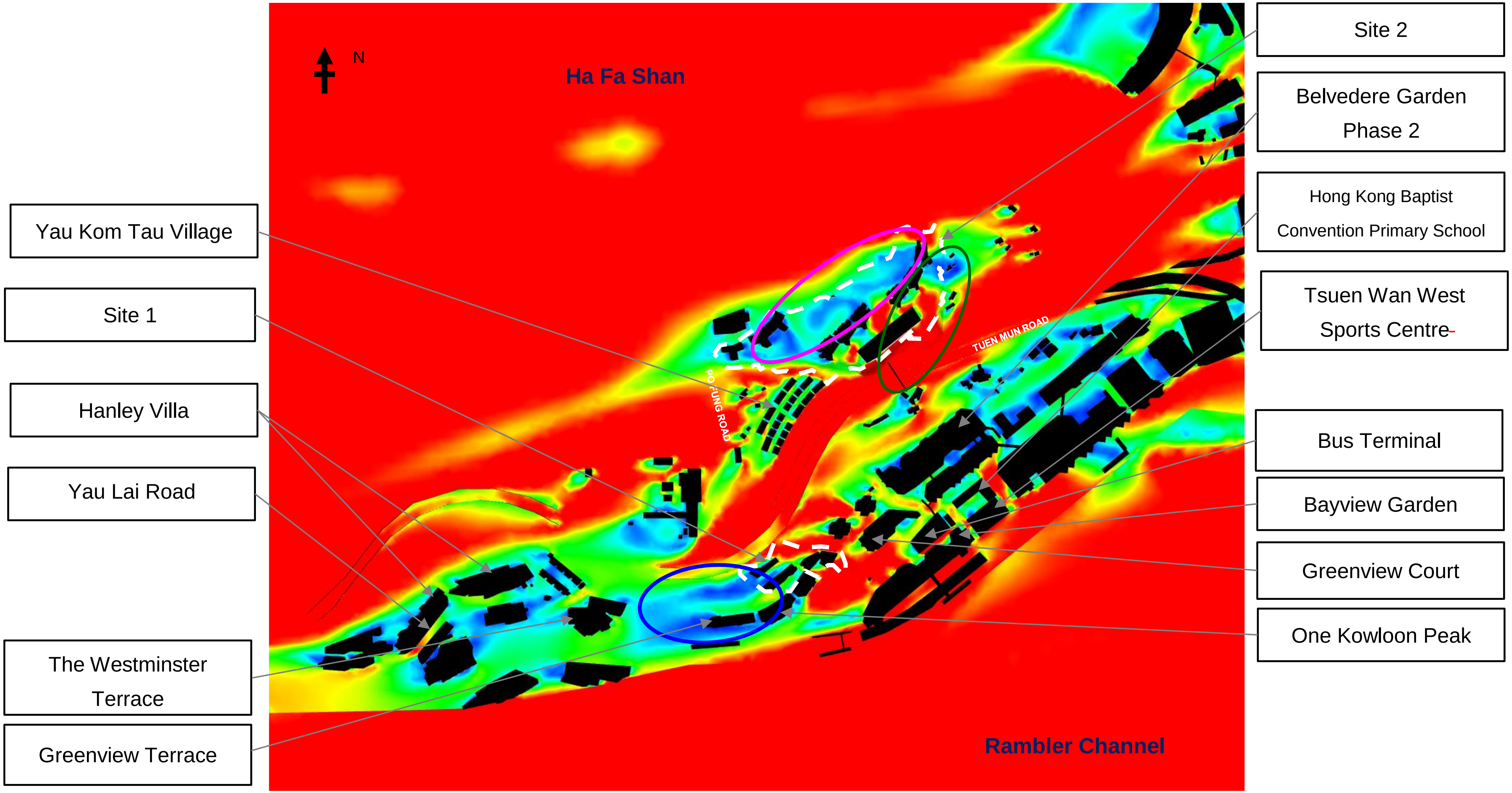


Figure 59 VR Contour Plot at Pedestrian Level under E Wind for Proposed Scheme

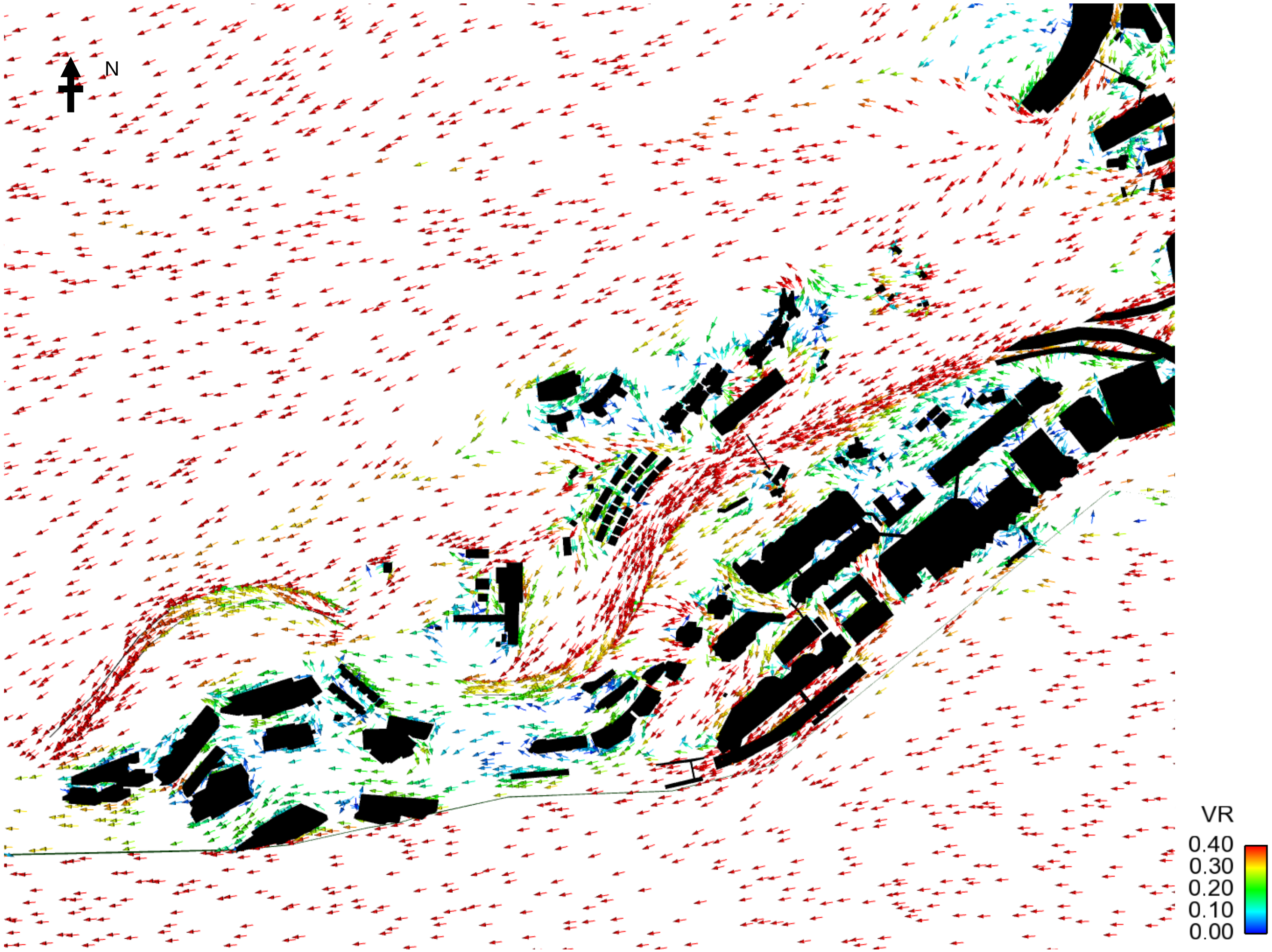


Figure 60 VR Vector Plot at Pedestrian Level under E Wind for Proposed Scheme

#### 6.3.4 ESE Wind - Wind Frequency: 12.3% (Annual), 9.2% (Summer)

*Site 1*

In the Baseline Scheme, the building clusters along the waterfront such as Belvedere Garden Phase 3, Bayview Garden etc. act as wind barrier which impede ESE wind coming from Rambler Channel. Nevertheless, a portion of mid-level ESE wind is still able to skim over the low-rise developments at the waterfront, namely Tsuen Wan West Sports Centre and the Bus Terminal, to reach the eastern portion of Site 1. Due to an absence of building structures in the Baseline Scheme, the incoming ESE wind freely penetrates through Site 1 and ventilates the downwind regions such as Greenview Terrace.

In the Proposed Scheme, the proposed easternmost tower at Site 1 could divert incoming ESE wind towards the northern and southern portion of Site 1. At the same time, these towers obstructs ESE wind and thus a lower VR is observed for the region under the Proposed Scheme due west of Site 1 when compared with the Baseline Scheme (Blue Circle in Figure 63). From the simulation results, the proposed NNW-SSE aligned 17m-wide building separation between the 23-storey residential towers and the 26-storey residential towers at Site 1 allows penetration of ESE wind though Site 1 whereas the proposed 15m building separation between the recreation house & the 23-storey residential towers at Site 1 is less effective for penetration of ESE wind through Site 1.

*Site 2*

In the Baseline Scheme, the wind availability of Site 2 is mainly from ESE wind travelling along the foothill of Ha Fa Shan and Tuen Mun Road. Mid-level ESE wind skims over the low-rise temporary structures and ruins and reattaches at pedestrian level to ventilate the downwind regions including Yau Kom Tau Village.

In the Proposed Scheme, the presence of the high-rise residential towers and recreation house impede the ESE wind to reach the downwind regions hence lower VRs are observed at the undeveloped areas southwest of Site 2 as well as the open areas within Site 2 when compared with the Baseline Scheme. According to the simulation results, the proposed three high-rise residential towers at the north-eastern portion of Site 2 induced downwash effect and diverted the ESE wind southwards towards Tuen Mun Road (Magenta Circle in Figure 63). As a result, higher VR is observed along Tuen Mun Road as well as the eastern portion of Yau Kom Tau Village. The proposed residential towers at the western portion of Site 2 would create downwash wind to the pedestrian level at the central portion of Site 2 along the 32m-wide and 20m-wide NW-SE aligned building separations (Dark Green Circles in Figure 63). However, it is observed that the downwash wind would be against the incoming ESE wind and resulted in relative lower VR along the 60m-wide Drainage Tunnel Protection Zone.

Figure 61 and Figure 19 shows the VR contour plots of ESE wind for the Baseline Scheme and Proposed Scheme respectively. Figure 62 and Figure 64 shows the VR vector plots of ESE wind for the Baseline Scheme and Proposed Scheme respectively.

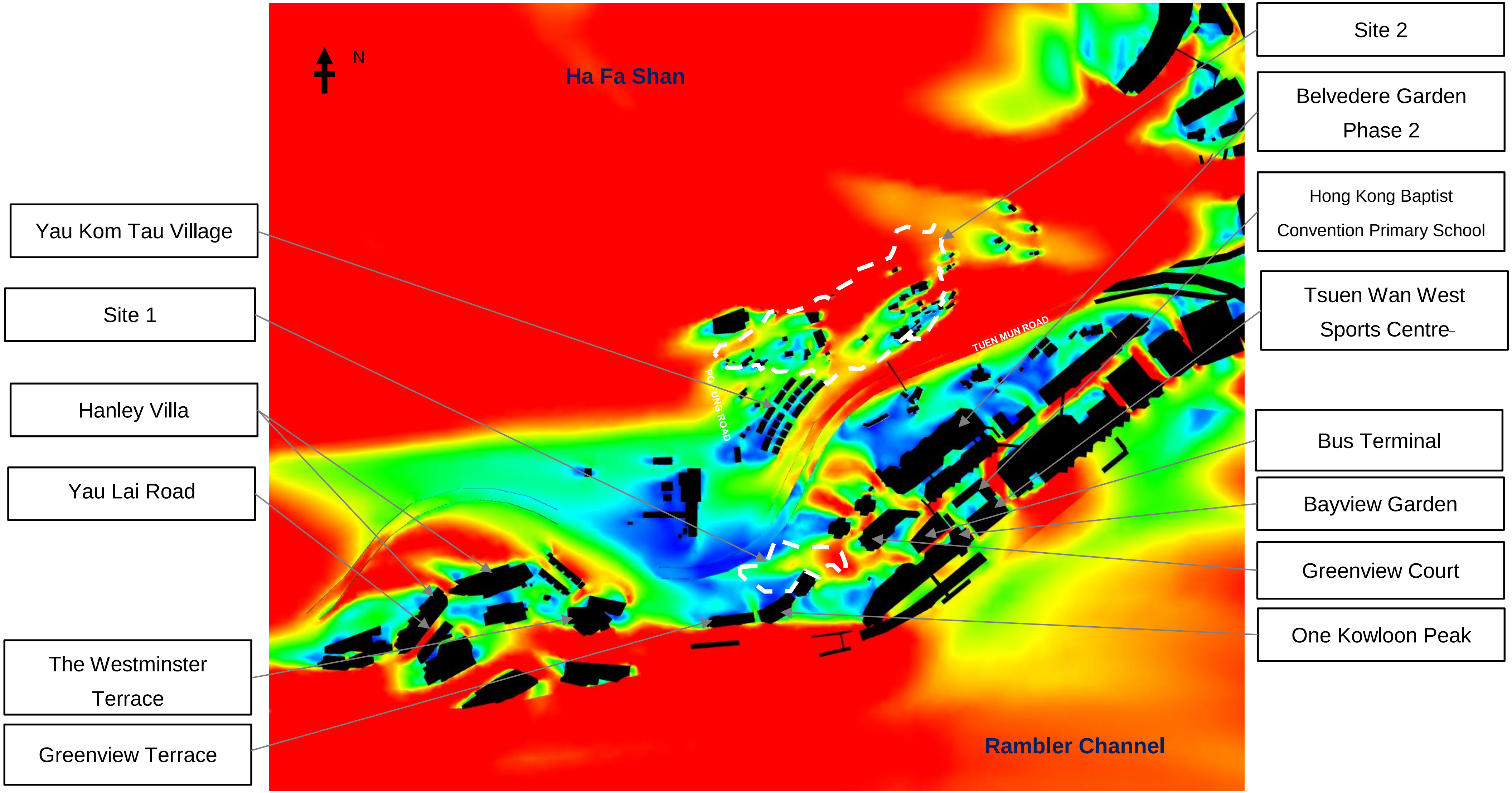


Figure 61 VR Contour Plot at Pedestrian Level under ESE Wind for Baseline Scheme

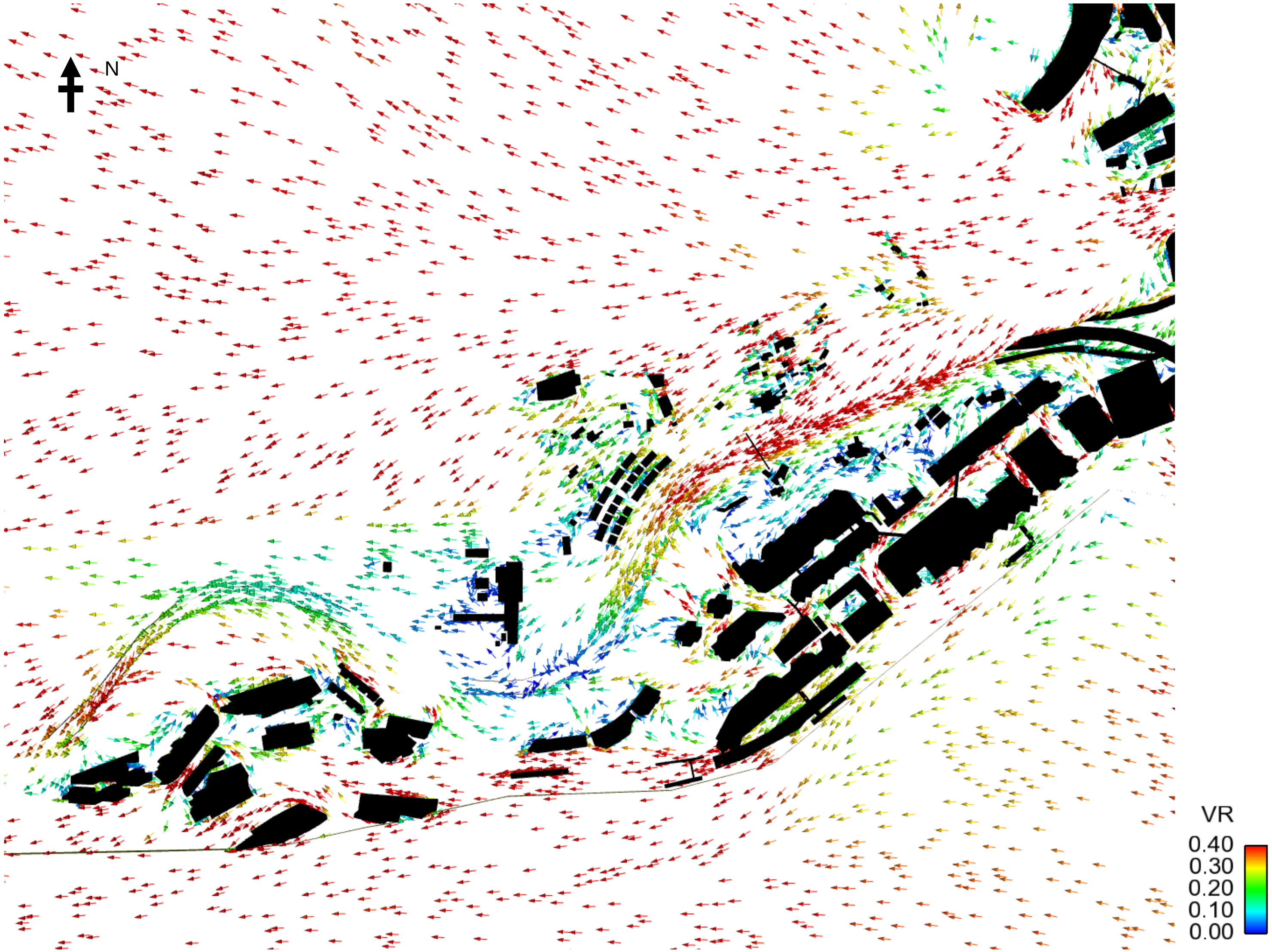


Figure 62 VR Vector Plot at Pedestrian Level under ESE Wind for Baseline Scheme

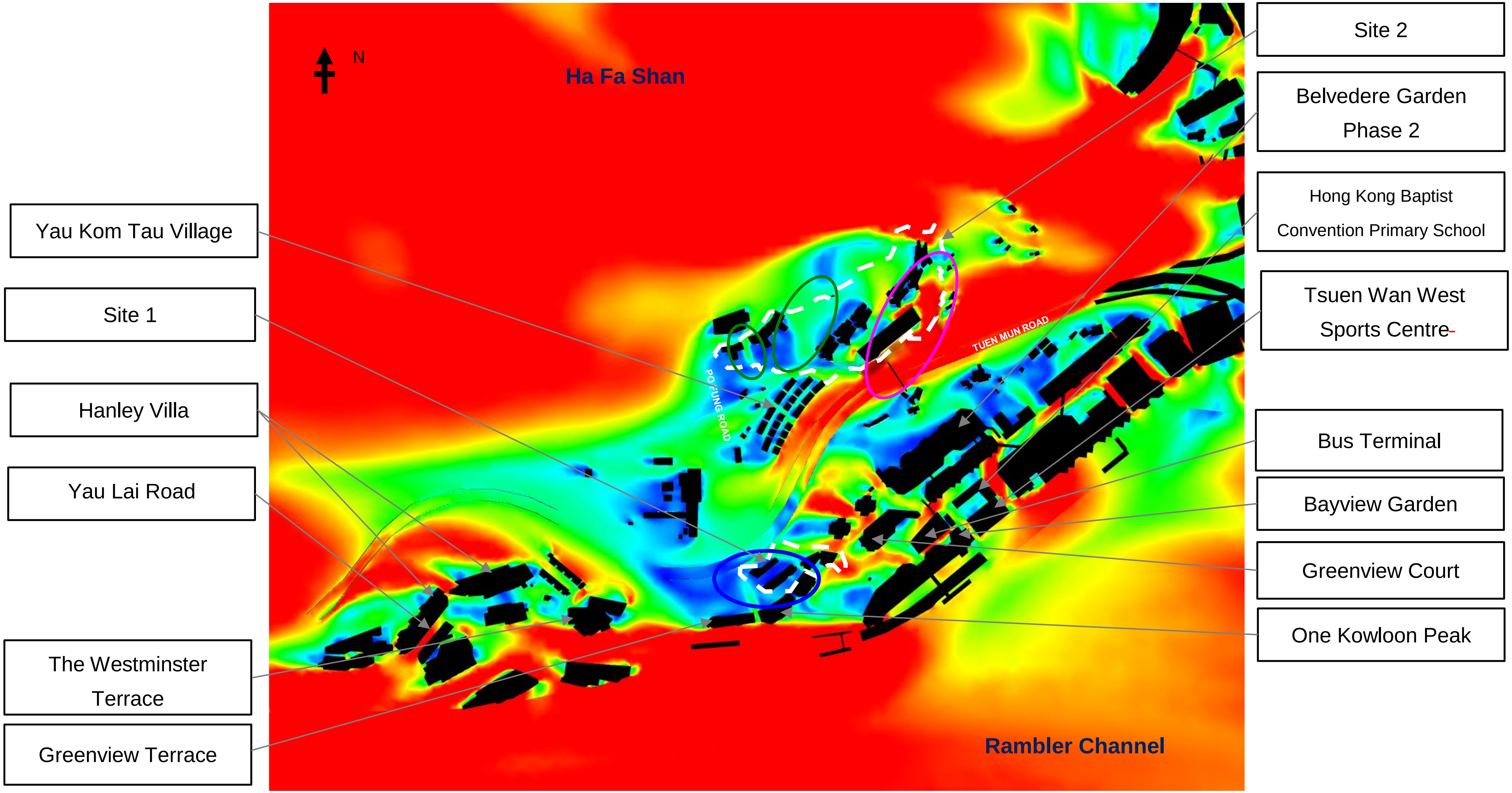


Figure 63 VR Contour Plot at Pedestrian Level under ESE Wind for Proposed Scheme

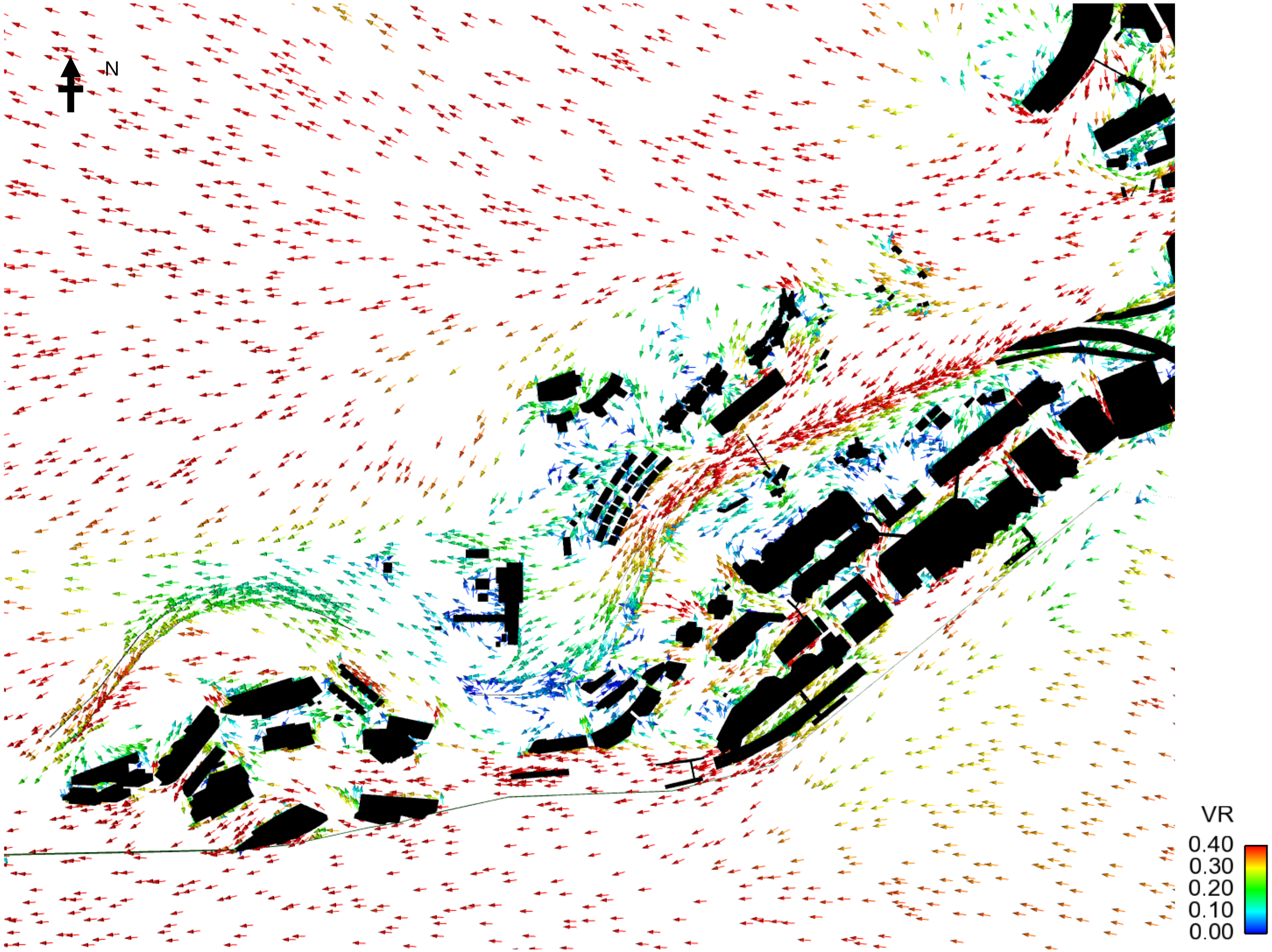


Figure 64 VR Vector Plot at Pedestrian Level under ESE Wind for Proposed Scheme

### 6.3.5 SE Wind - Wind Frequency: 7.4% (Annual), 7.7% (Summer)

*Site 1*

In the Baseline Scheme, the building clusters along the waterfront such as Bayview Garden act as wind barrier to impede the incoming SE wind from Rambler Channel. Nevertheless, a portion of mid-level SE wind would still be able to skim over the low-rise developments at the waterfront, namely Tsuen Wan West Sports Centre and the Bus Terminal, to reach the eastern portion of Site 1. A portion of mid-level SE wind was deflected southwards from Tuen Mun Road towards the northern portion of Site 1 as Tuen Mun Road is situated on higher terrain than Site 1.

In the Proposed Scheme, the high-rise nature of the 26-storey residential towers at the eastern portion of Site 1 diverts high-level SE wind towards the pedestrian level due to downwash effect. As a result, the Proposed Scheme has higher VR in the open areas at the southern portion of Site 1 when compared with the Baseline Scheme. However, the proposed high-rise residential towers in Site 1 also created a wake zone to the open area at the northern portion of Site 1 as well as its downwind regions under the Proposed Scheme (Blue Circle in Figure 67). From the simulation results, the proposed NNW-SSE aligned 17m-wide building separation between the 23-storey residential towers and the 26-storey residential towers at Site 1 could facilitate SE wind penetration through Site 1 (Red Circle in Figure 67) whereas the proposed 15m building separation between the recreation house & the 23-storey residential towers could not facilitate SE wind penetration through Site 1 due to its misalignment with the SE wind.

*Site 2*

In the Baseline Scheme, a portion of the SE wind from Rambler Channel is blocked by the high-rise residential buildings along the waterfront. However, Site 2 is situated on higher terrain with ground level at approximately +100mPD hence high level SE wind could skim over the cluster of high-rise residential buildings at the waterfront to reach the western portion of Site 2. Additionally, the wind availability of the eastern portion of Site 2 is mainly from the foothill of Ha Fa Shan as well as Tuen Mun Road. The downhill wind skims over the low-rise temporary structures and ruins within Site 2 to reach its downwind regions.

In the Proposed Scheme, the presence of the high-rise residential towers and recreation house create wake zones at the undeveloped areas northwest of Site 2 as well as open spaces within Site 2 when compared with the Baseline Scheme (Magenta Circles in Figure 67). From the simulation results, the 60m-wide Drainage Tunnel Protection Zone could not facilitate SE wind penetration through Site 2 as it is not aligned with the SE wind. The proposed three high-rise residential towers at the north-eastern portion of Site 2 created downwash effect and diverted the SE wind southwards towards Tuen Mun Road. As a result, higher VR is observed along Tuen Mun Road as well as the eastern portion of Yau Kom Tau Village when compared with the Baseline Scheme.

Figure 65 and Figure 67 shows the VR contour plots of SE wind for the Baseline Scheme and Proposed Scheme respectively. Figure 66 and Figure 68 shows the VR vector plots of SE wind for the Baseline Scheme and Proposed Scheme respectively.

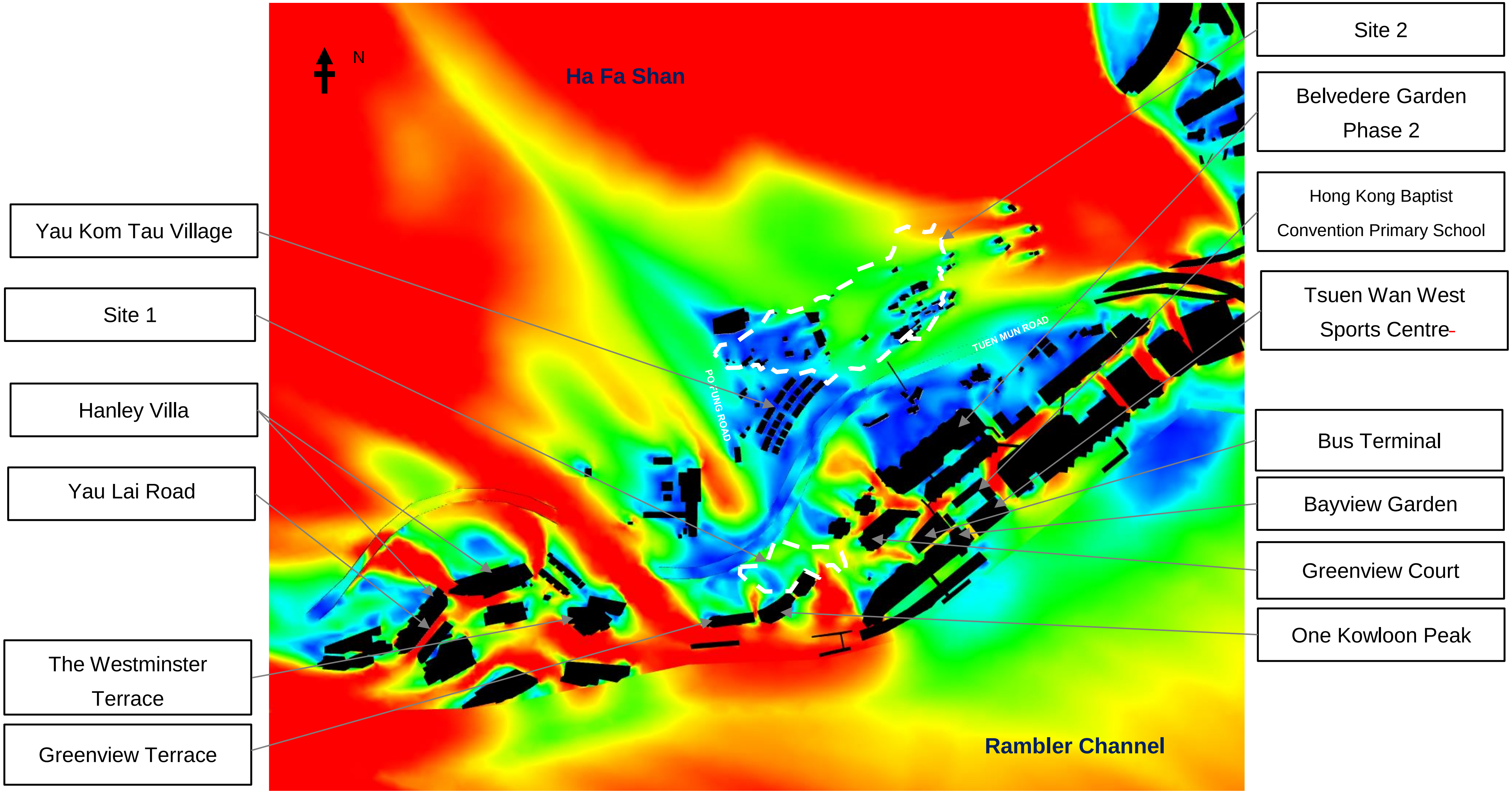


Figure 65 VR Contour Plot at Pedestrian Level under SE Wind for Baseline Scheme

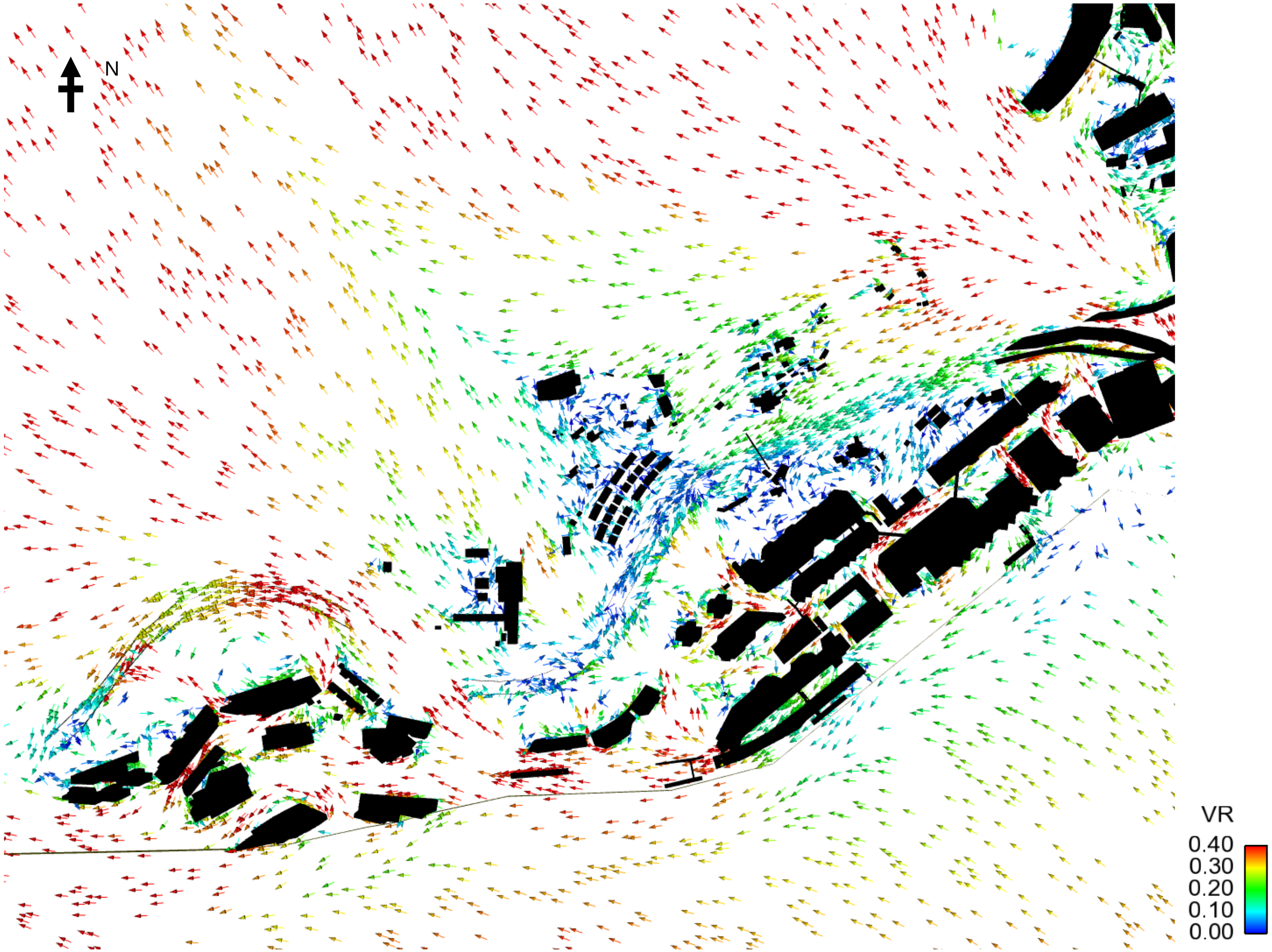


Figure 66 VR Vector Plot at Pedestrian Level under SE Wind for Baseline Scheme

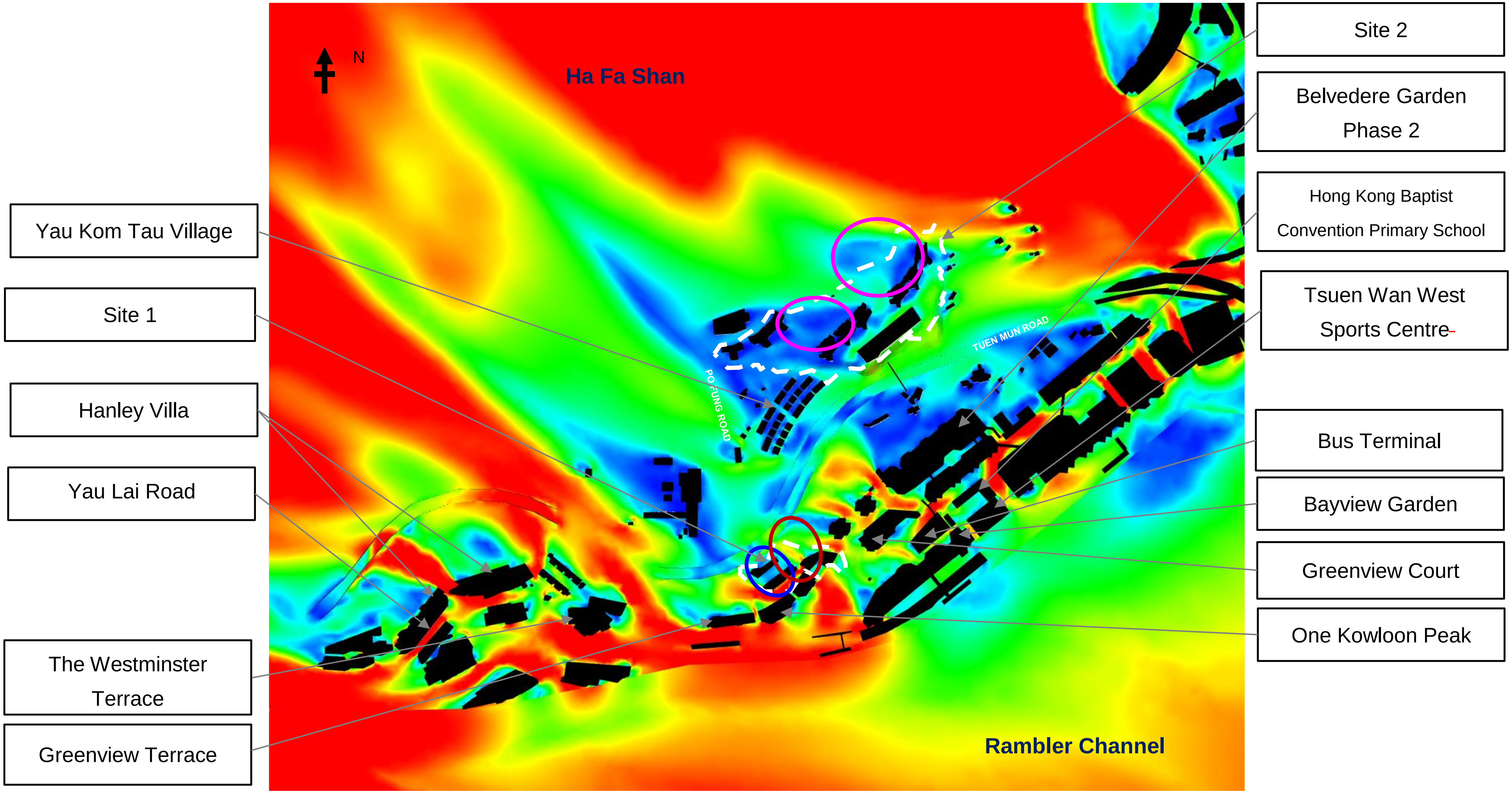


Figure 67 VR Contour Plot at Pedestrian Level under SE Wind for Proposed Scheme

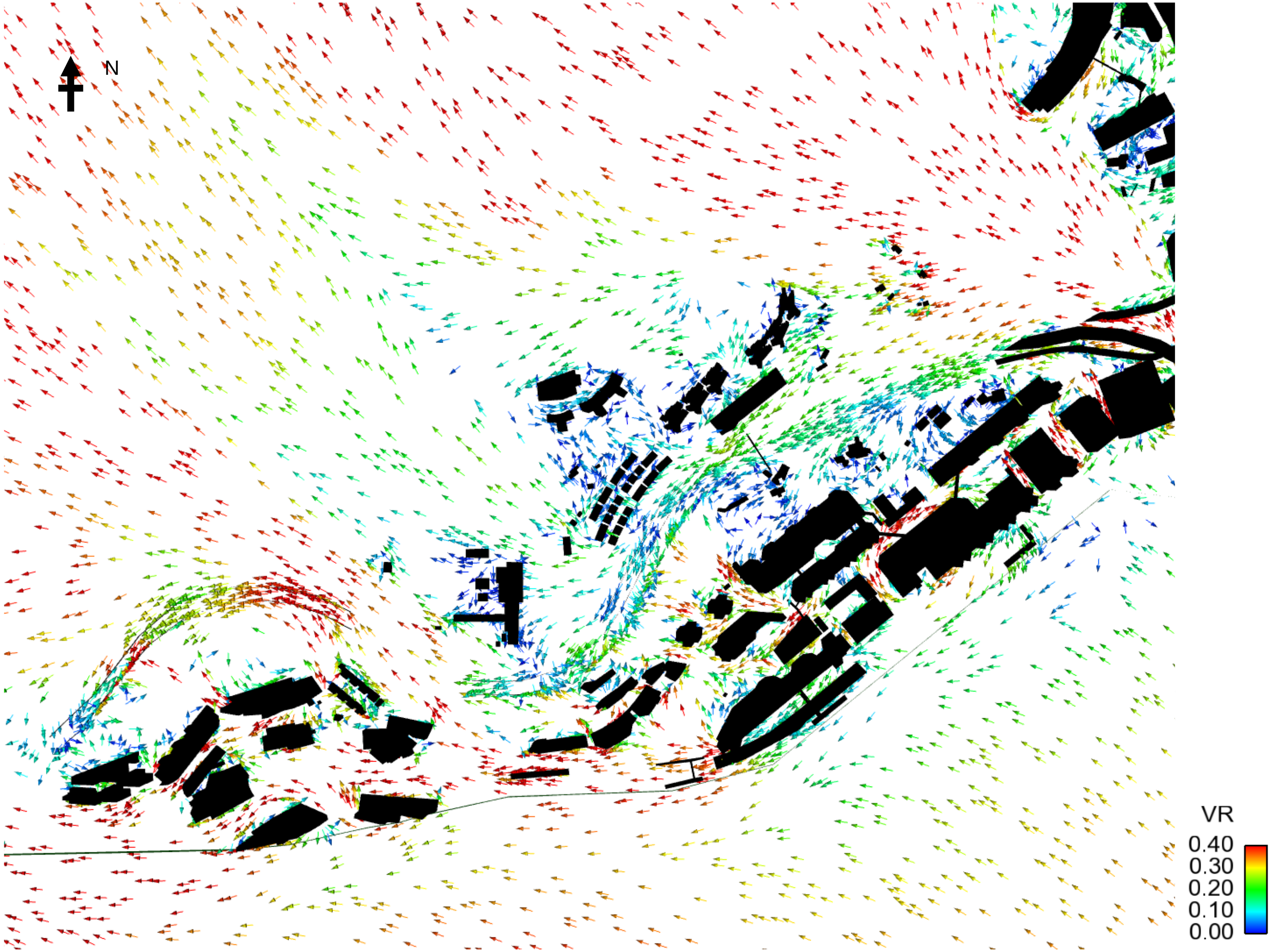


Figure 68 VR Vector Plot at Pedestrian Level under SE Wind for Proposed Scheme

### 6.3.6 SSE Wind - Wind Frequency: 5.4% (Annual), 8.6% (Summer)

The wind availability of both sites under SSE wind mainly comes from the Rambler Channel.

*Site 1*

In the Baseline Scheme, the high-rise residential developments of One Kowloon Peak, Bayview Garden and Greenview Terrace obstructs a portion of incoming SSE wind. However, a portion of incoming SSE wind is able to reach Site 1 through the building separations as well as open space between Greenview Terrace and One Kowloon Peak. Additionally, a portion of mid-level SSE wind would skim over the mid-rise developments at One Kowloon Peak Phase 2 (around 68.6mPD) and reach the southern portion of Site 1. Since there are no building structures within Site 1, the SSE wind would pass through Site 1 and reach its downwind regions to the northwest with minimal disturbance.

In the Proposed Scheme, the proposed high-rise residential towers in Site 1 created a wake zone to the open area at the central portion of Site 1 as well as its downwind regions including Yau Kom Tau Village (Magenta Circle in Figure 71). The 15m building separation between the recreation house & the 23-storey residential towers at Site 1 could not facilitate SSE wind penetration through Site 1 due to its misalignment with the SSE wind. However, the proposed 17m-wide building separation between the 23-storey residential towers & the 26-storey residential towers at Site 1 facilitates effective penetration of SSE wind through Site 1 (Red Circle in Figure 71).

*Site 2*

In the Baseline Scheme, a portion of the SSE wind from Rambler Channel is blocked by the high-rise residential buildings along the waterfront. However, Site 2 is situated on higher terrain with ground level at approximately +100mPD hence high level SSE wind could skim over the cluster of high-rise residential buildings at the waterfront to reach the western portion of Site 2. Additionally, a portion of mid-level SSE wind travels along Tuen Mun Road to reach the southern portion of Site 2. With an absence of high-rise building structures in the Baseline Scheme, the SSE wind could freely penetrate through Site 2. As a result, the Baseline Scheme has higher VRs are observed at the open spaces within Site 2 as well as immediate downwind regions to the northwest of Site 2 when compared with the Proposed Scheme.

In the Proposed Scheme, the presence of the high-rise residential towers and recreation house create downwash wind to counter act with the incoming SSE wind and resulted in a lower VR region to the east of Site 2 as well as the eastern portion of Site 2 when compared with the Baseline Scheme.

From the simulation results, the 23-storey residential towers at the western portion of Site 2 deflected the SSE wind towards the northeast (Dark Green Circle in Figure 71) and then travel along the proposed 60m-wide Drainage Tunnel Protection Zone.

Figure 69 and Figure 71 shows the VR contour plots of SSE wind for the Baseline Scheme and Proposed Scheme respectively. Figure 70 and Figure 72 shows the VR vector plots of SSE wind for the Baseline Scheme and Proposed Scheme respectively.

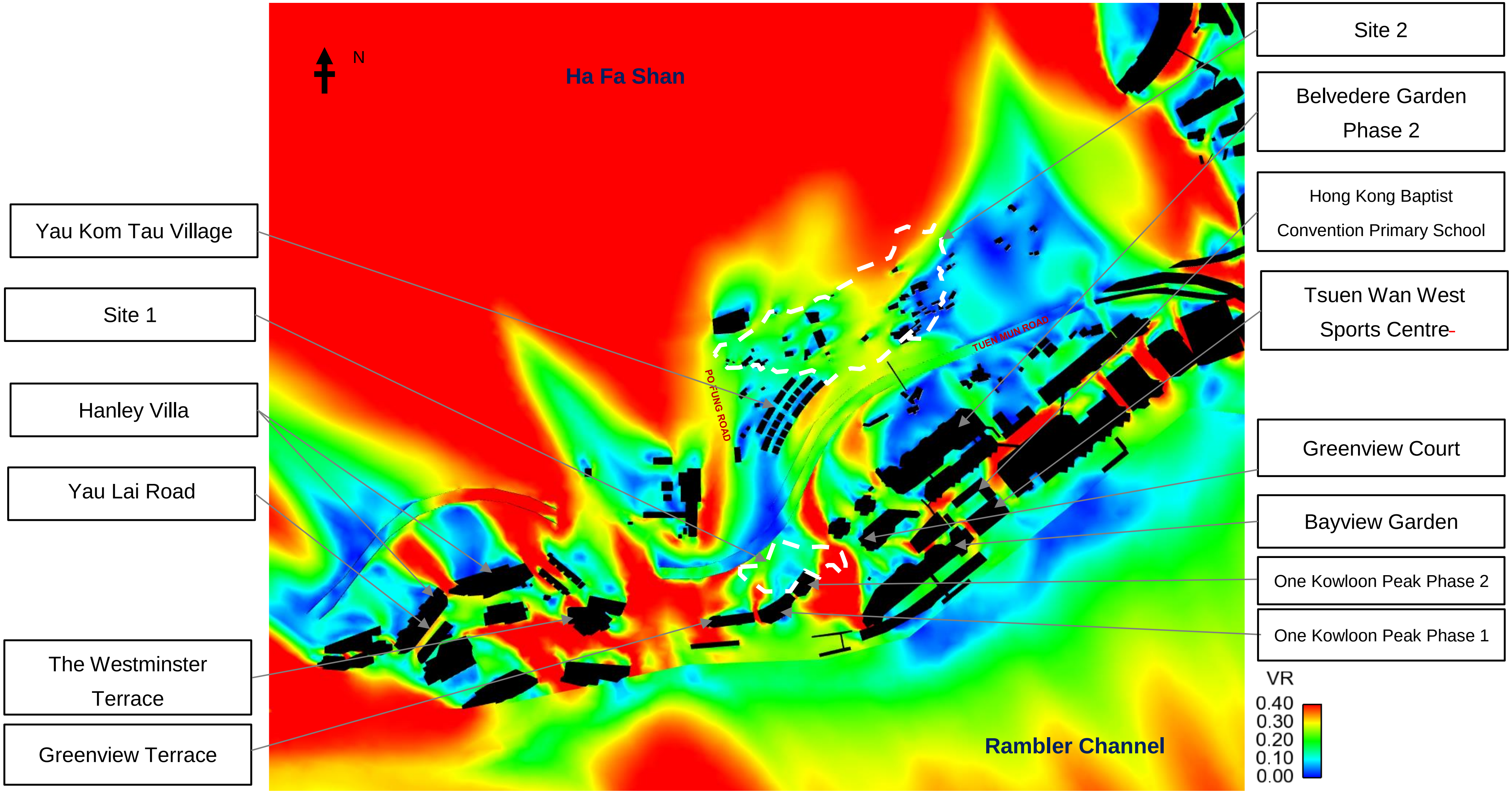


Figure 69 VR Contour Plot at Pedestrian Level under SSE Wind for Baseline Scheme

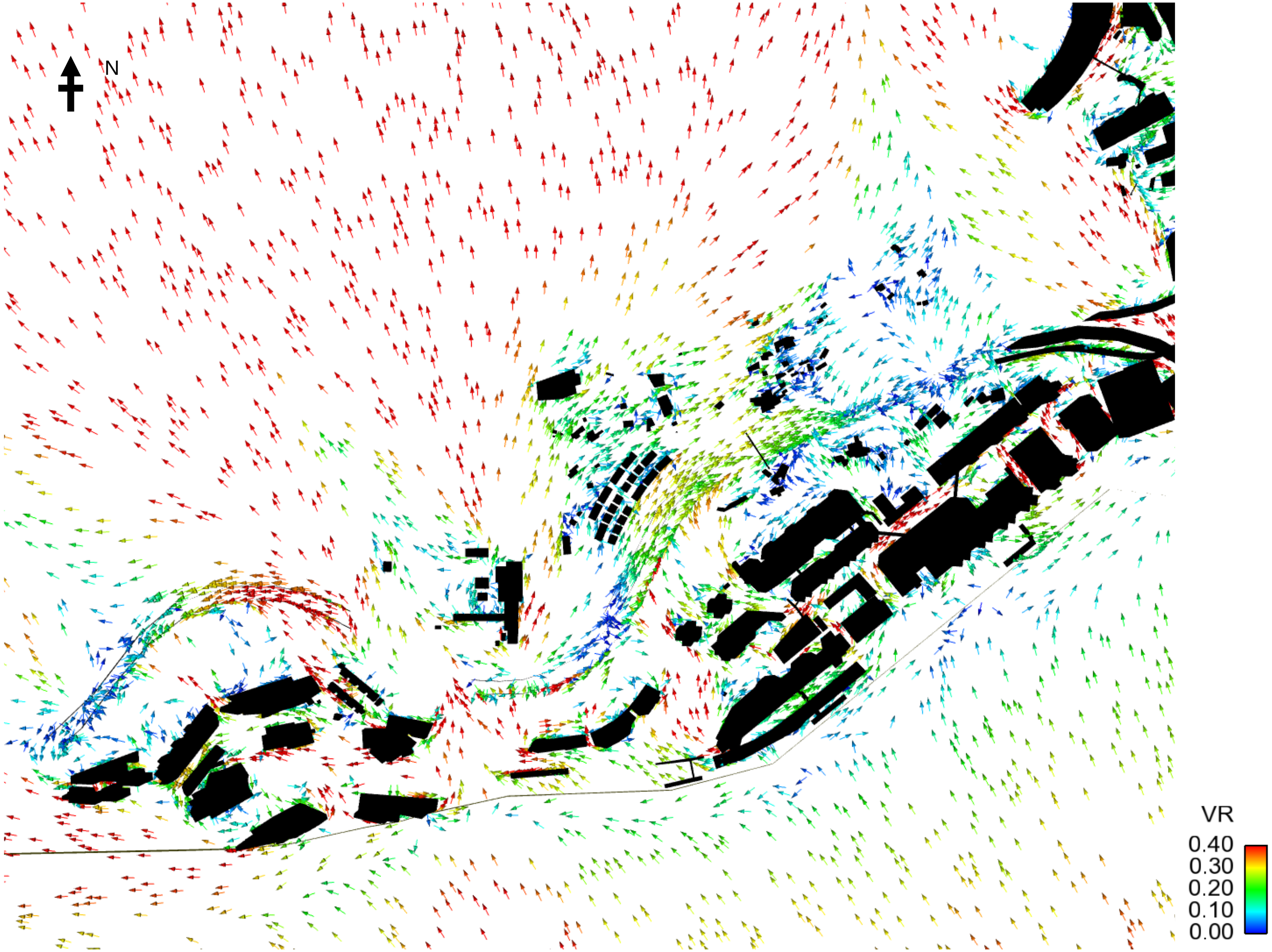


Figure 70 VR Vector Plot at Pedestrian Level under SSE Wind for Baseline Scheme

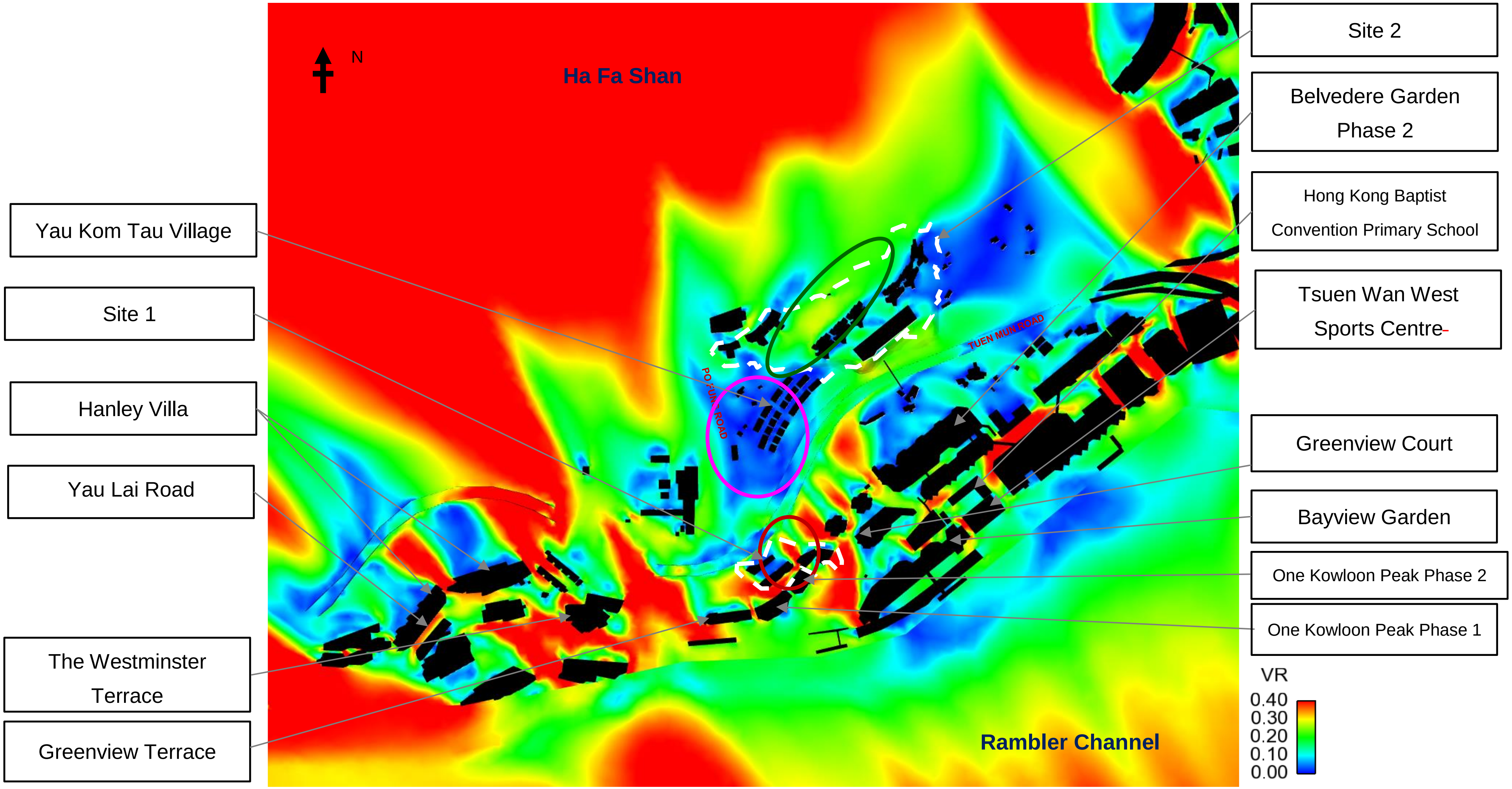


Figure 71 VR Contour Plot at Pedestrian Level under SSE Wind for Proposed Scheme

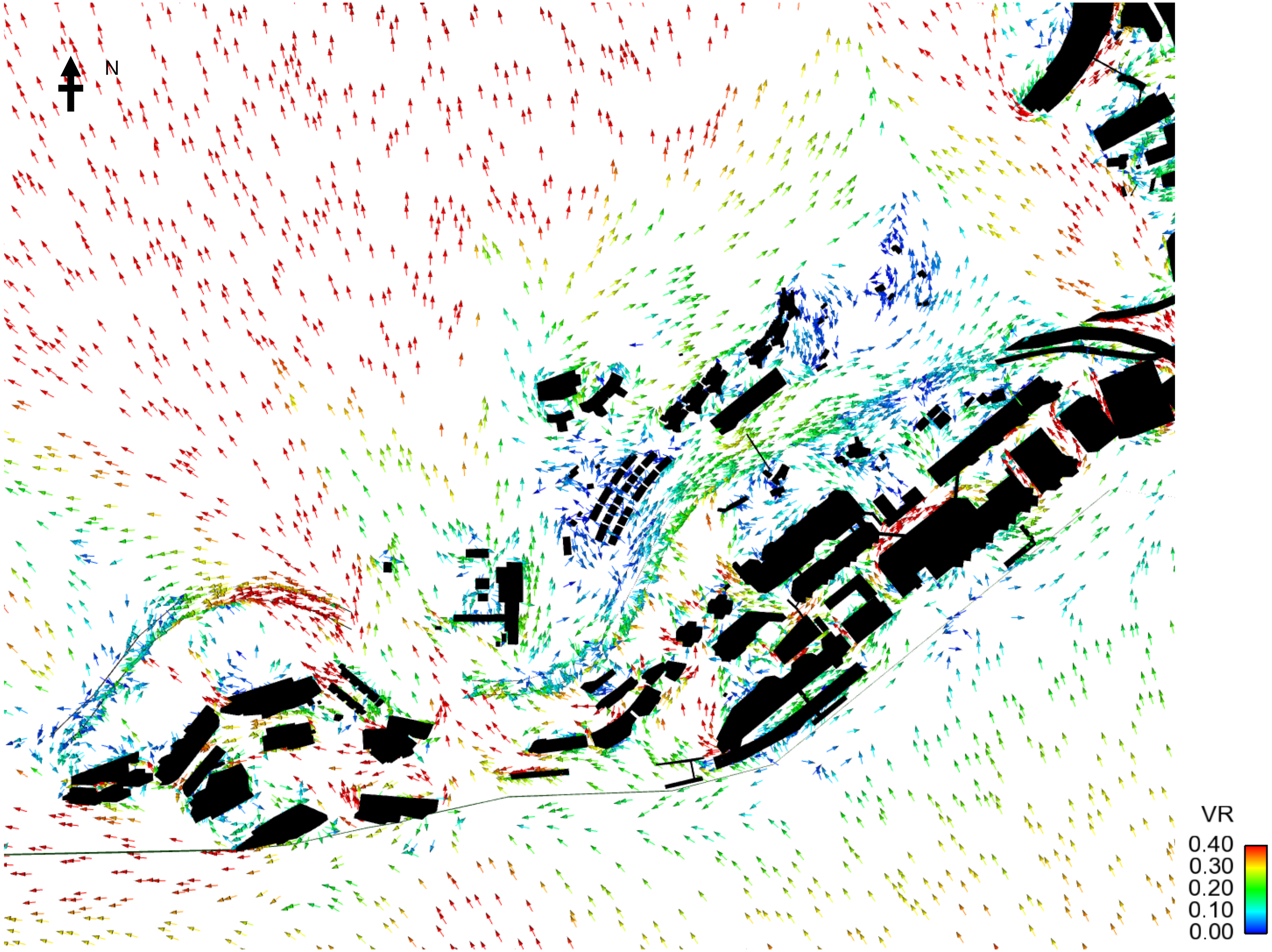


Figure 72 VR Vector Plot at Pedestrian Level under SSE Wind for Proposed Scheme

### 6.3.7 S Wind - Wind Frequency: 7.0% (Annual), 13.8% (Summer)

S wind is one of the major prevailing wind directions for summer scenario. The wind availability of both sites under S wind mainly comes from the Rambler Channel.

*Site 1*

In the Baseline Scheme, the high-rise residential developments of One Kowloon Peak and Greenview Terrace are located to the immediate south and upwind region of Site 1 under S wind. However, the blockage effect from these buildings does not have a significant impact on the wind availability of Site 1 as a significant portion of mid-level S wind would skim over the mid-rise developments at Greenview Terrace (around +86.5mPD) and penetrate through the building separation between these high-rise developments. Since there are no building structures within Site 1, the S wind could easily penetrate through Site 1 and ventilate its downwind regions such as Greenview Court.

In the Proposed Scheme, the proposed high-rise residential towers in Site 1 creates a wake zone to the downwind regions (i.e. the section of Tuen Mun Road immediate north of Site 1) hence lower VR is observed at this area when compared with the Baseline Scheme. The high-rise nature of the 23-storey residential towers at the central portion of Site 1 diverts high-level S wind towards the pedestrian level via downwash effect. As a result, slightly higher VR is observed in the open areas at the southern portion of Site 1 as well as the north of One Kowloon Peak Phase 1 and Phase 2 when compared with the Baseline Scheme (Magenta Circle in Figure 75).

Additionally, the proposed 17m-wide building separation between the 23-storey residential towers and the 26-storey residential towers at Site 1 facilitates penetration of S wind through Site 1 to minimize the adverse impact caused by the Proposed Scheme (Dark Green Circle in Figure 75). However, the proposed 15m-wide building separation between the recreation house & the 23-storey residential towers at Site 1 could not facilitate S wind penetration through Site 1 due to its misalignment with the S wind.

*Site 2*

In the Baseline Scheme, a portion of the S wind from Rambler Channel is blocked by the high-rise residential buildings along the waterfront including the Bayview Garden, the Greenview Court, and the Belvedere Garden. However, Site 2 is situated on higher terrain with ground level at approximately +100mPD hence higher level S wind could skim over the cluster of high-rise residential buildings at the waterfront and Yau Kom Tau Village to reach the south-western portion of Site 2. Additionally, a portion of mid-level S wind is observed to travel along Tuen

Mun Road to reach the southern portion of Site 2. With an absence of high-rise building structures in the Baseline Scheme, S wind could freely penetrate through Site 2.

In the Proposed Scheme, the presence of the high-rise residential towers in Site 1 impedes S wind travelling along Tuen Mun Road towards Site 2. As a result, lower VRs are observed at the southern portion of Site 2 when compared with the Baseline Scheme. The proposed high-rise residential towers in Site 2 also obstructed the S wind from reaching the downwind regions thus reduced wind availability is observed at the north-eastern portion of Site 2 when compared with the Baseline Scheme.

Nonetheless, the proposed 60m-wide Drainage Tunnel Protection Zone facilitates effective S wind penetration through Site 2 to reach the downwind regions as the 23-storey residential towers at the western portion of Site 2 deflected the S wind towards the northeast (Grey Circle in Figure 75).

Figure 73 and Figure 75 shows the VR contour plots of S wind for the Baseline Scheme and Proposed Scheme respectively. Figure 74 and Figure 76 shows the VR vector plots of S wind for the Baseline Scheme and Proposed Scheme respectively.

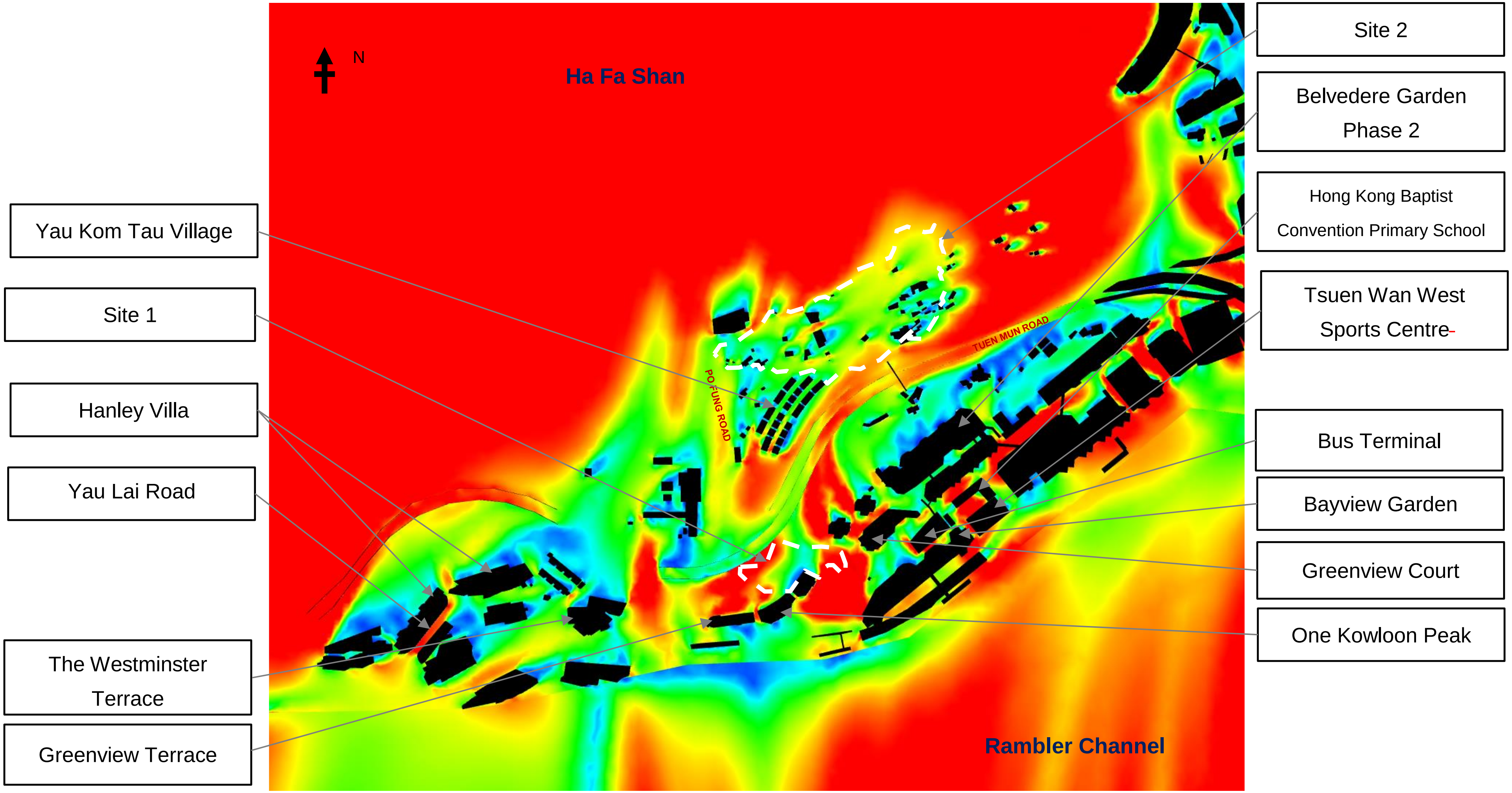


Figure 73 VR Contour Plot at Pedestrian Level under S Wind for Baseline Scheme

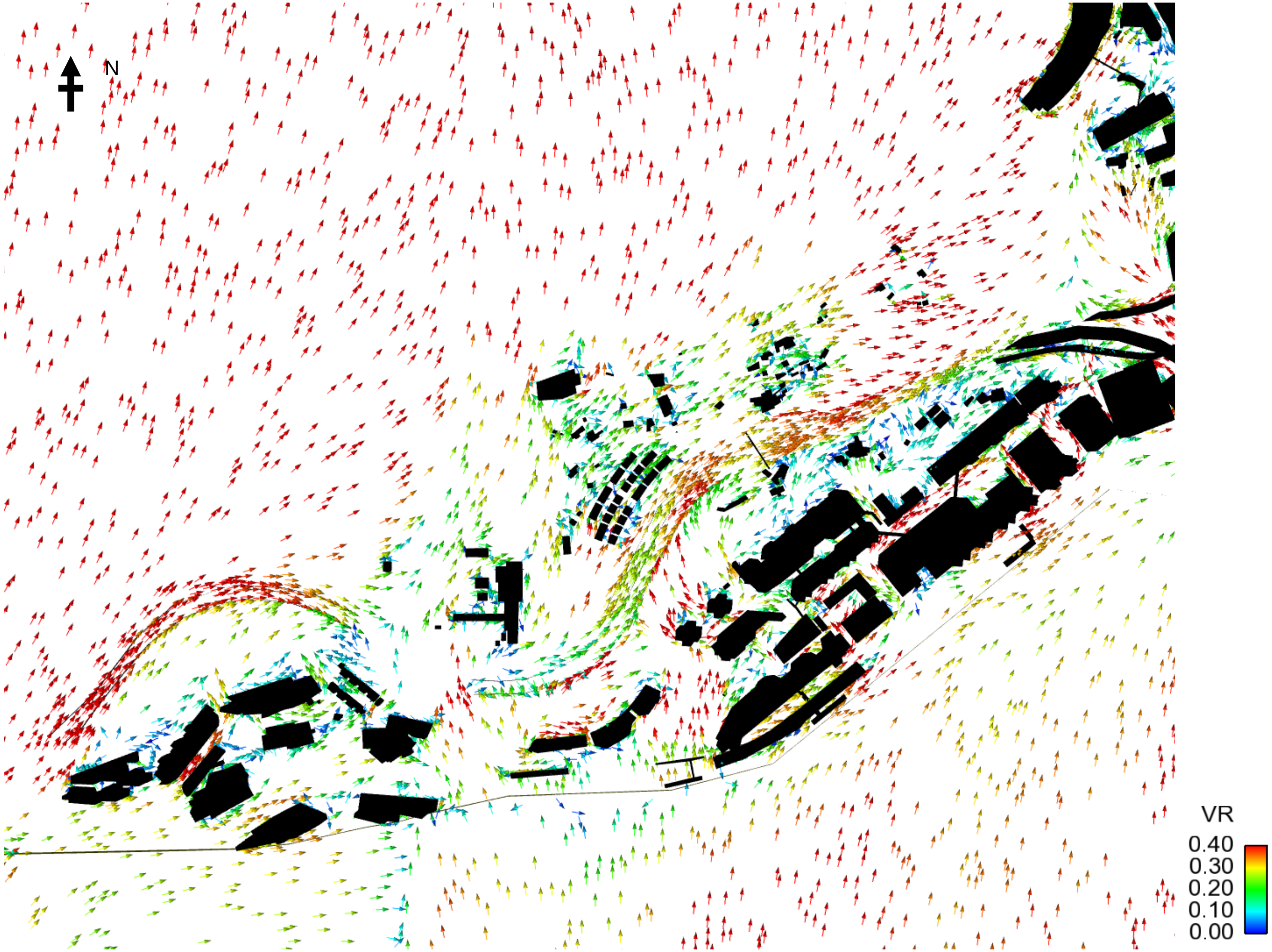


Figure 74 VR Vector Plot at Pedestrian Level under S Wind for Baseline Scheme

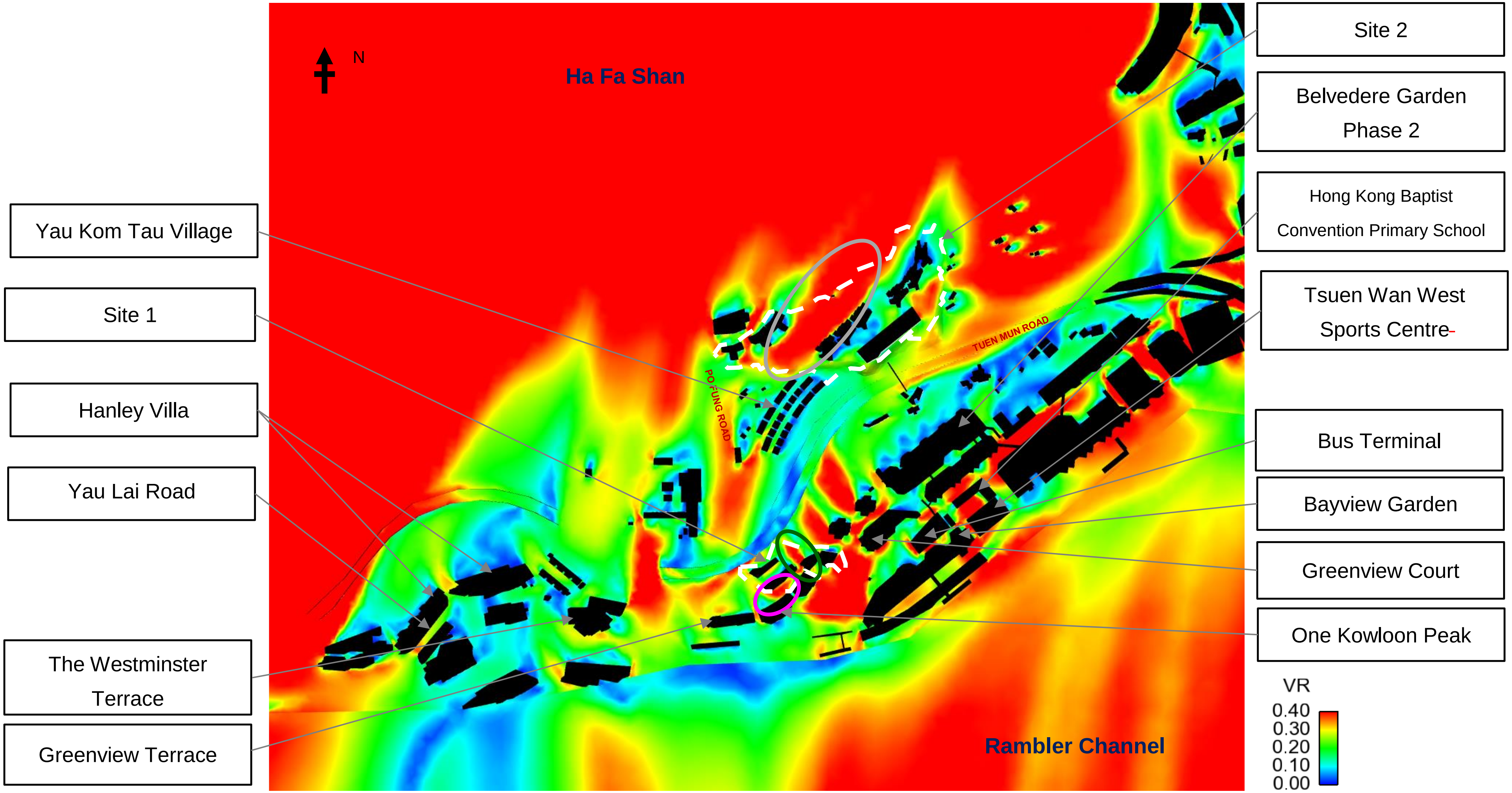


Figure 75 VR Contour Plot at Pedestrian Level under S Wind for Proposed Scheme

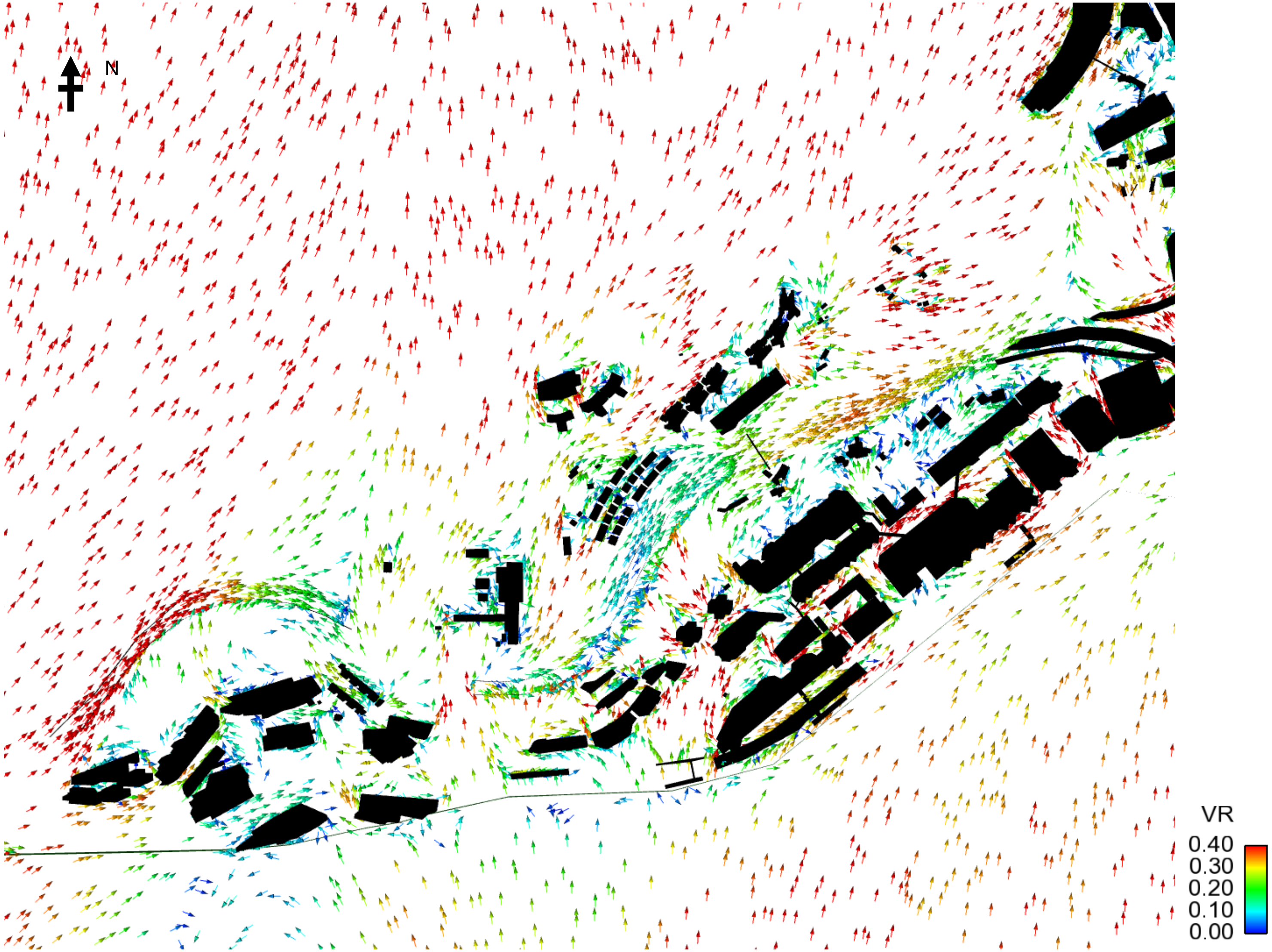


Figure 76 VR Vector Plot at Pedestrian Level under S Wind for Proposed Scheme

### 6.3.8 SSW Wind - Wind Frequency: 6.8% (Summer), 15.4% (Summer)

With a summer wind frequency of 15.4%, SSW wind is the prevailing wind for summer scenario. The wind availability of both sites under SSW wind mainly comes from the Rambler Channel.

*Site 1*

In the Baseline Scheme, SSW wind is obstructed by waterfront developments at the upwind regions including The Bay Bridge and Long Beach Garden. However, SSW wind is able to reach the south-western portion of Site 1 via the large open area between The Westminster Terrace and Greenview Terrace. Since there are no building structures within Site 1, the SSW wind could freely penetrate through Site 1 to ventilate the downwind regions including the open areas to the north-east of Site 1 and Greenview Court.

In the Proposed Scheme, the high-rise residential towers in Site 1 would impede SSW wind to the downwind regions (i.e. Greenview Court and Belvedere Garden) hence the extent of the wake zone is enlarged when compared with the Baseline Scheme (Red Circle in Figure 79). From the simulation results, the proposed 15m-wide building separation between the recreation house & the 23-storey residential towers at Site 1 facilitates penetration of SSW wind through Site 1 and minimize the adverse impact to the downwind regions (Magenta Circle in Figure 79). Additionally, the residential towers at the eastern portion of Site 1 would divert high-level SSW wind towards pedestrian level via downwash effect thus higher VR is observed at the south-eastern portion of Site 1 when compared with the Baseline Scheme.

*Site 2*

Since Site 2 is situated on higher terrain with ground level at approximately +100mPD, high level SSW wind could skim over the cluster of high-rise residential buildings at the waterfront and Yau Kom Tau Village to reach the south-western portion of Site 2. Additionally, a portion of mid-level SSW wind could also travel along Tuen Mun Road to reach the southern portion of Site 2. With an absence of high-rise building structures in the Baseline Scheme, SSW wind would freely penetrate through Site 2.

In the Proposed Scheme, the presence of the high-rise residential towers in Site 1 would reduce SSW wind travelling along Tuen Mun Road towards Site 2. As a result, lower VRs are observed at the southern portion of Site 2 in the Proposed Scheme when compared with the Baseline Scheme. The proposed high-rise residential towers in Site 2 also obstructed SSW wind from reaching the downwind regions thus a small wake zone is observed at the north-eastern portion of Site 2. Nonetheless, the proposed high-rise residential towers at the western portion would divert SSW wind to travel along the 60m-wide Drainage Tunnel Protection Zone and resulted in better penetration of SSW wind through Site 2 to reach the downwind regions effectively in the Proposed Scheme (Dark Green Circle in Figure 79).

Figure 77 and Figure 79 shows the VR contour plots of SSW wind for the Baseline Scheme and Proposed Scheme respectively. Figure 34 and Figure 80 shows the VR vector plots of SSW wind for the Baseline Scheme and Proposed Scheme respectively.

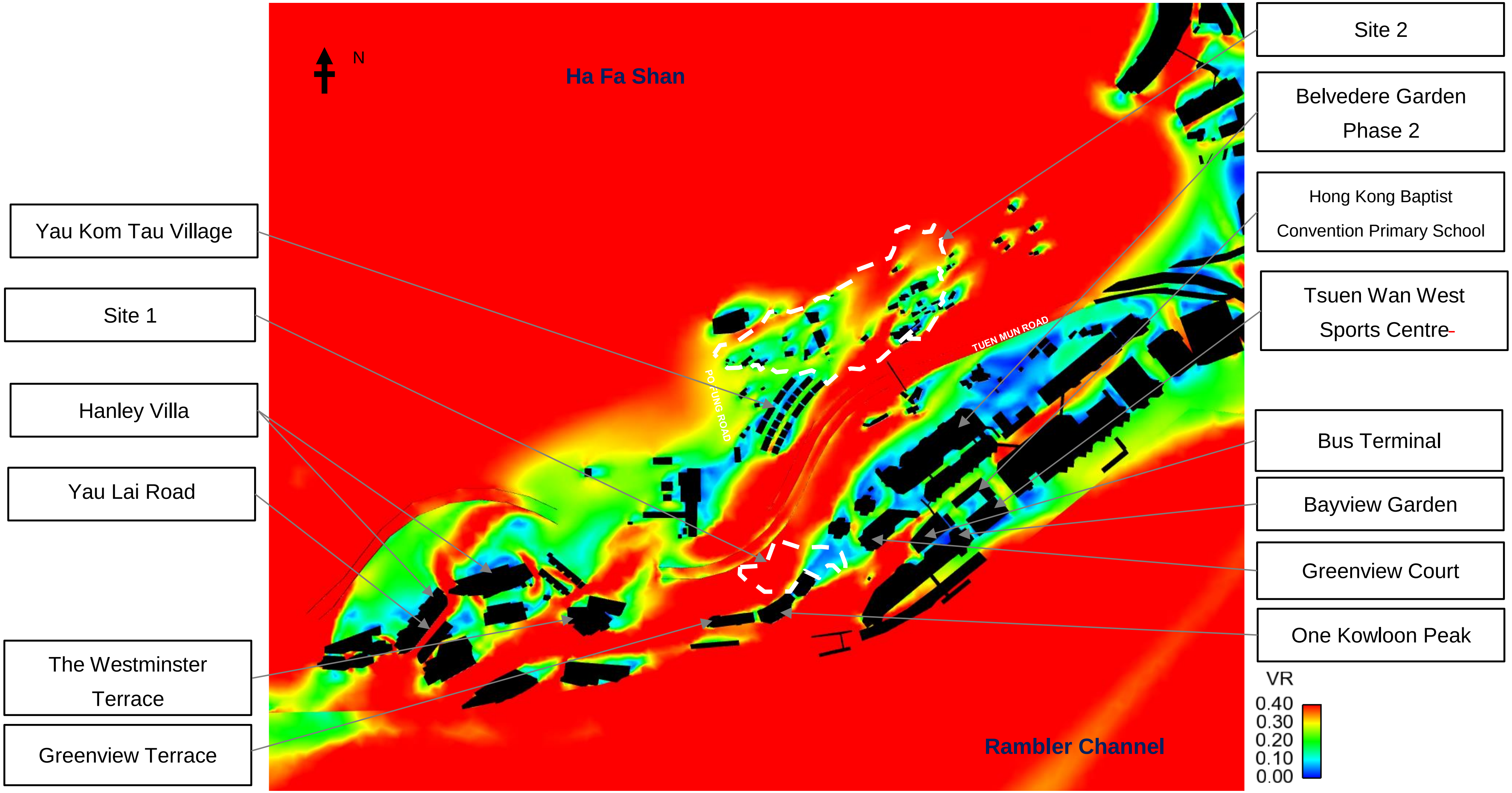


Figure 77 VR Contour Plot at Pedestrian Level under SSW Wind for Baseline Scheme

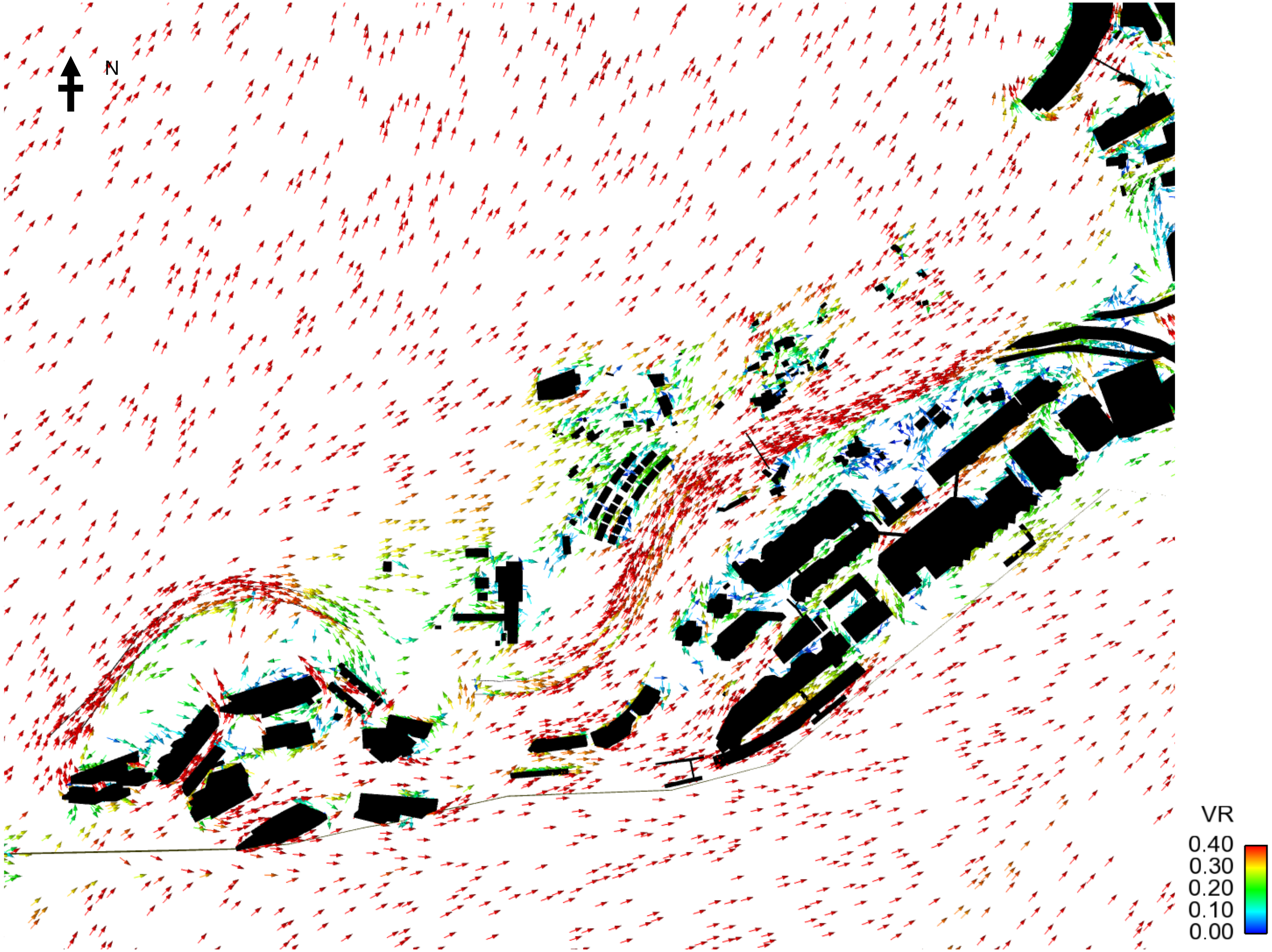


Figure 78 VR Vector Plot at Pedestrian Level under SSW Wind for Baseline Scheme

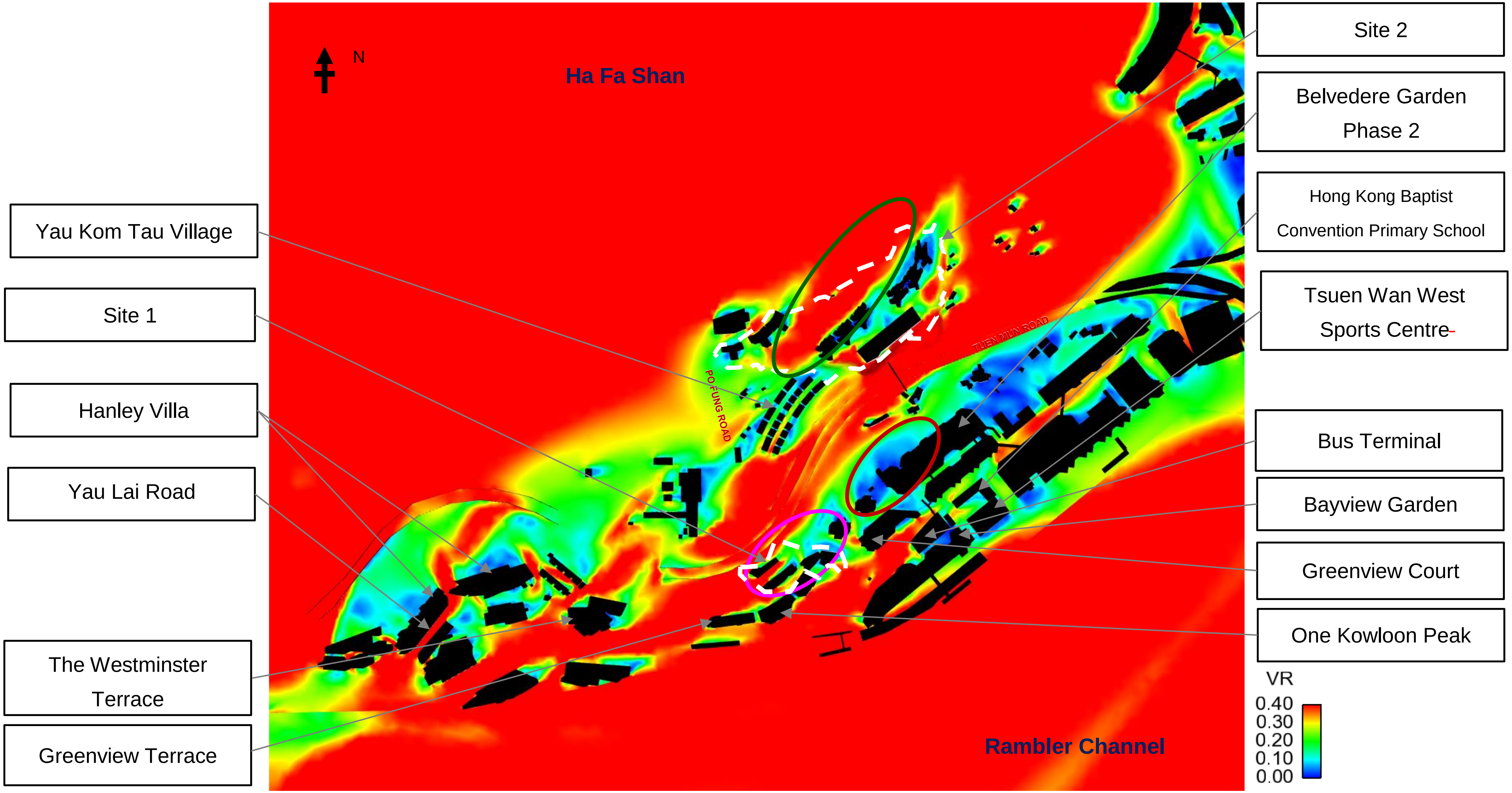


Figure 79 VR Contour Plot at Pedestrian Level under SSW Wind for Proposed Scheme

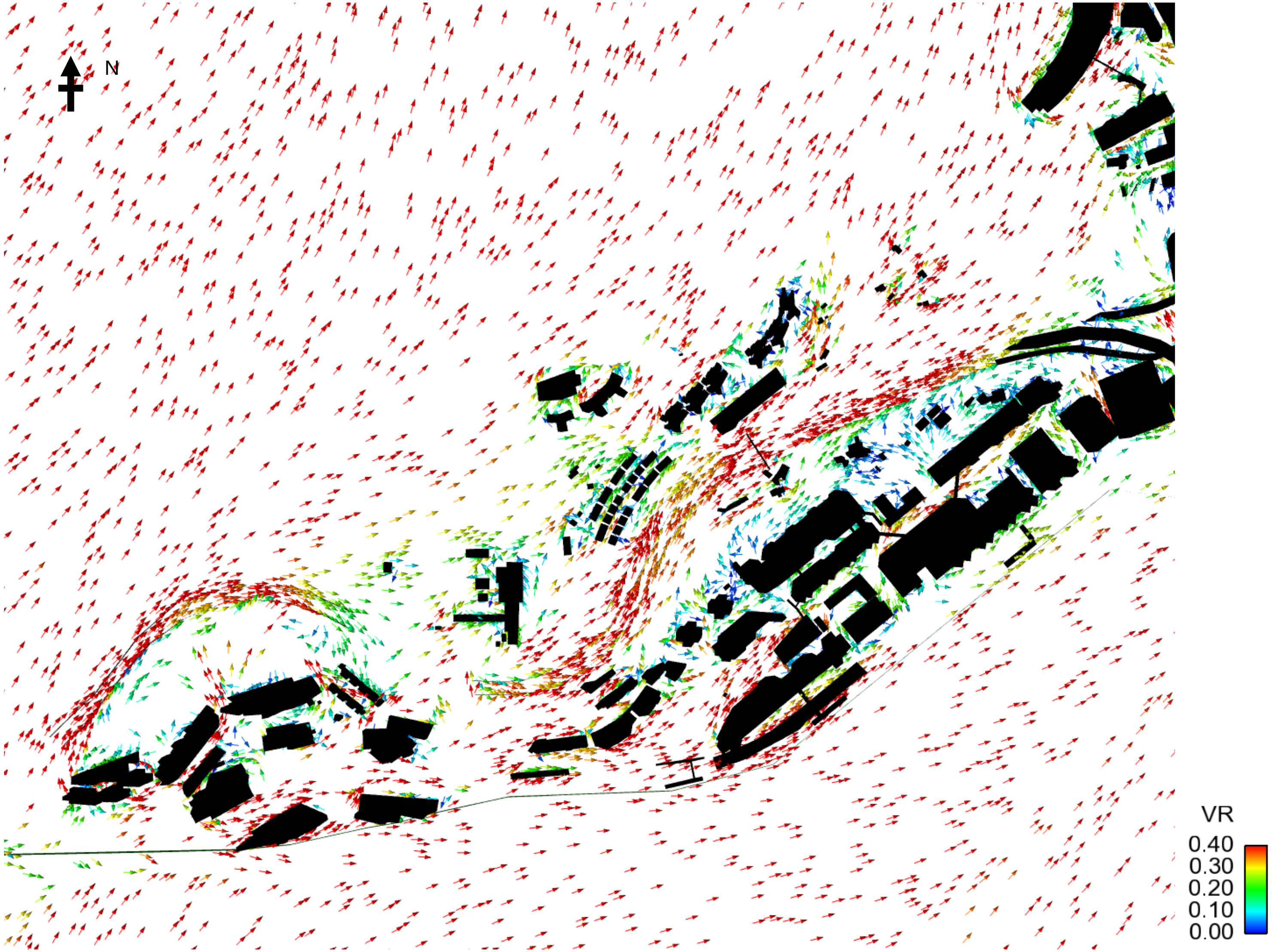


Figure 80 VR Vector Plot at Pedestrian Level under SSW Wind for Proposed Scheme

### 6.3.9 SW Wind - Wind Frequency: 10.9% (Summer)

SW wind is also one of the major prevailing wind directions for summer scenario. The wind availability of both sites under SW wind mainly comes from the Rambler Channel as well as Ha Fa Shan from the west.

*Site 1*

In the Baseline Scheme, SW wind is obstructed by waterfront developments at the upwind regions including The Bay Bridge and Long Beach Garden. Nevertheless, SW wind is still able to reach the western portion of Site 1 via the large open areas between The Westminster Terrace and Greenview Terrace. Additionally, a portion of SW wind could reach the western portion of Site 1 via Tuen Mun Road from the west. Since there are no building structures within Site 1, the SW wind could freely penetrate through Site 1 to ventilate the downwind regions including the open areas to the north-east of Site 1 and Greenview Court.

In the Proposed Scheme, the proposed high-rise residential towers in Site 1 would impede the SW wind to the downwind regions (i.e. Greenview Court and Belvedere Garden) hence lower VRs are observed for these regions when compared with the Baseline Scheme. Nevertheless, the proposed 15m-wide building separation between the recreation house & the 23-storey residential towers at Site 1 facilitates penetration of SW wind through Site 1 and minimize the adverse impact to the downwind regions (Magenta Circle in Figure 83).

*Site 2*

Since Site 2 is situated on higher terrain with ground level at approximately +100mPD, high level SW wind from Rambler Channel as well as mid-level SW wind from the western portion of Ha Fa Shan could skim over the cluster of high-rise residential buildings at the waterfront and Yau Kom Tau Village to reach the south-western portion of Site 2. Additionally, a portion of mid-level SW wind would travel along Tuen Mun Road to reach the southern portion of Site 2. With an absence of high-rise building structures in the Baseline Scheme, the SW wind would penetrate freely through Site 2.

In the Proposed Scheme, the presence of the high-rise residential towers in Site 1 would impede some SW wind travelling along Tuen Mun Road towards Site 2. However, the proposed high-rise residential towers at the west and central portion of Site 2 capture high-level SW wind and divert it towards the pedestrian level via downwash effect. As a result, the VR along the southern site boundary of Site 2 is higher when compared with the Baseline Scheme. The 60m-wide Drainage Tunnel Protection Zone also facilitates penetration of SW wind through Site 2 to reach the downwind regions effectively and to minimize the adverse impact caused by the high-rise buildings in the Proposed Scheme (Dark Green Circle in Figure

83).

Figure 81 and Figure 83 shows the VR contour plots of SW wind for the Baseline Scheme and Proposed Scheme respectively. Figure 82 and Figure 84 shows the VR vector plots of SW wind for the Baseline Scheme and Proposed Scheme respectively.

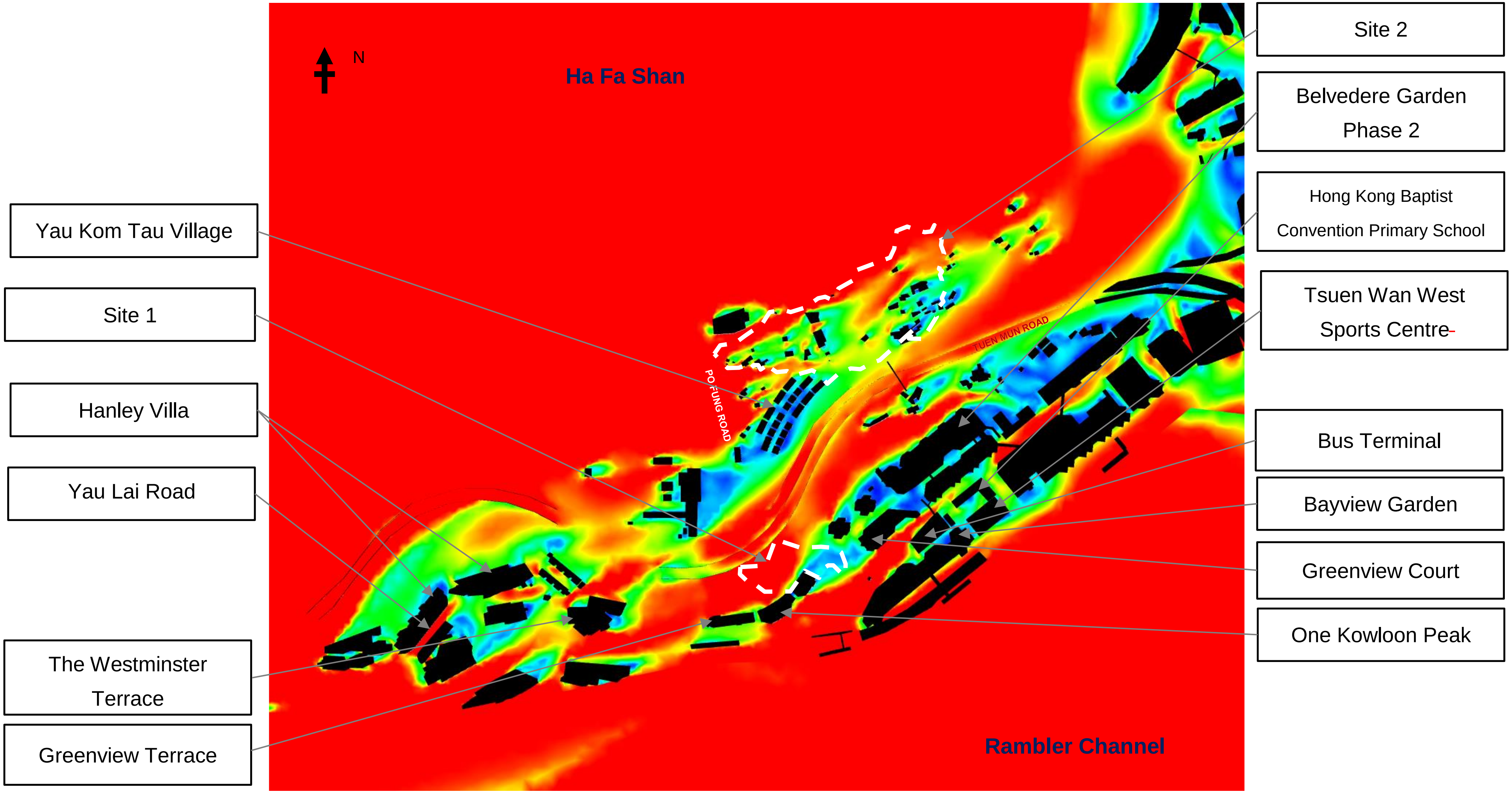


Figure 81 VR Contour Plot at Pedestrian Level under SW Wind for Baseline Scheme

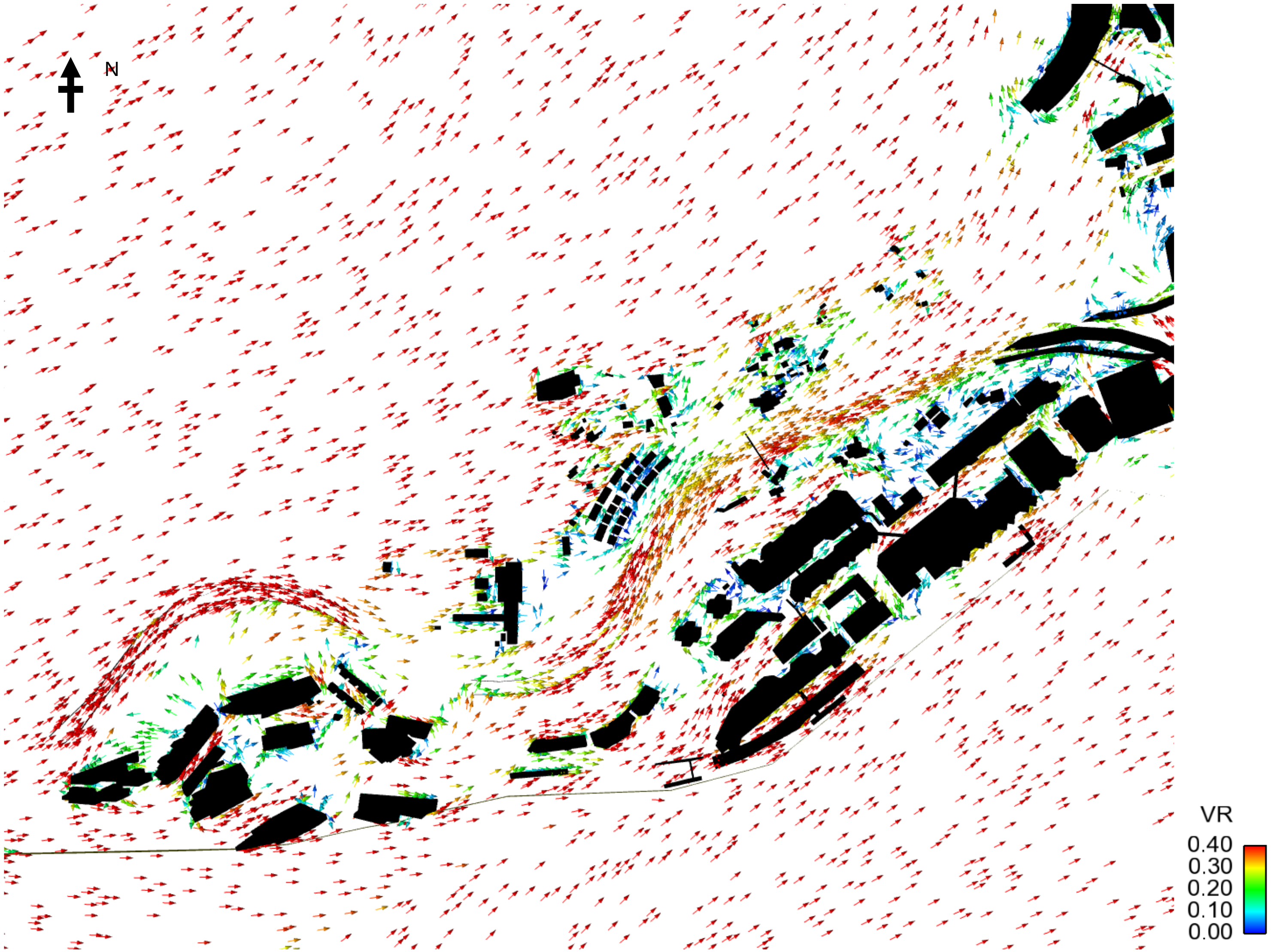


Figure 82 VR Vector Plot at Pedestrian Level under SW Wind for Baseline Scheme

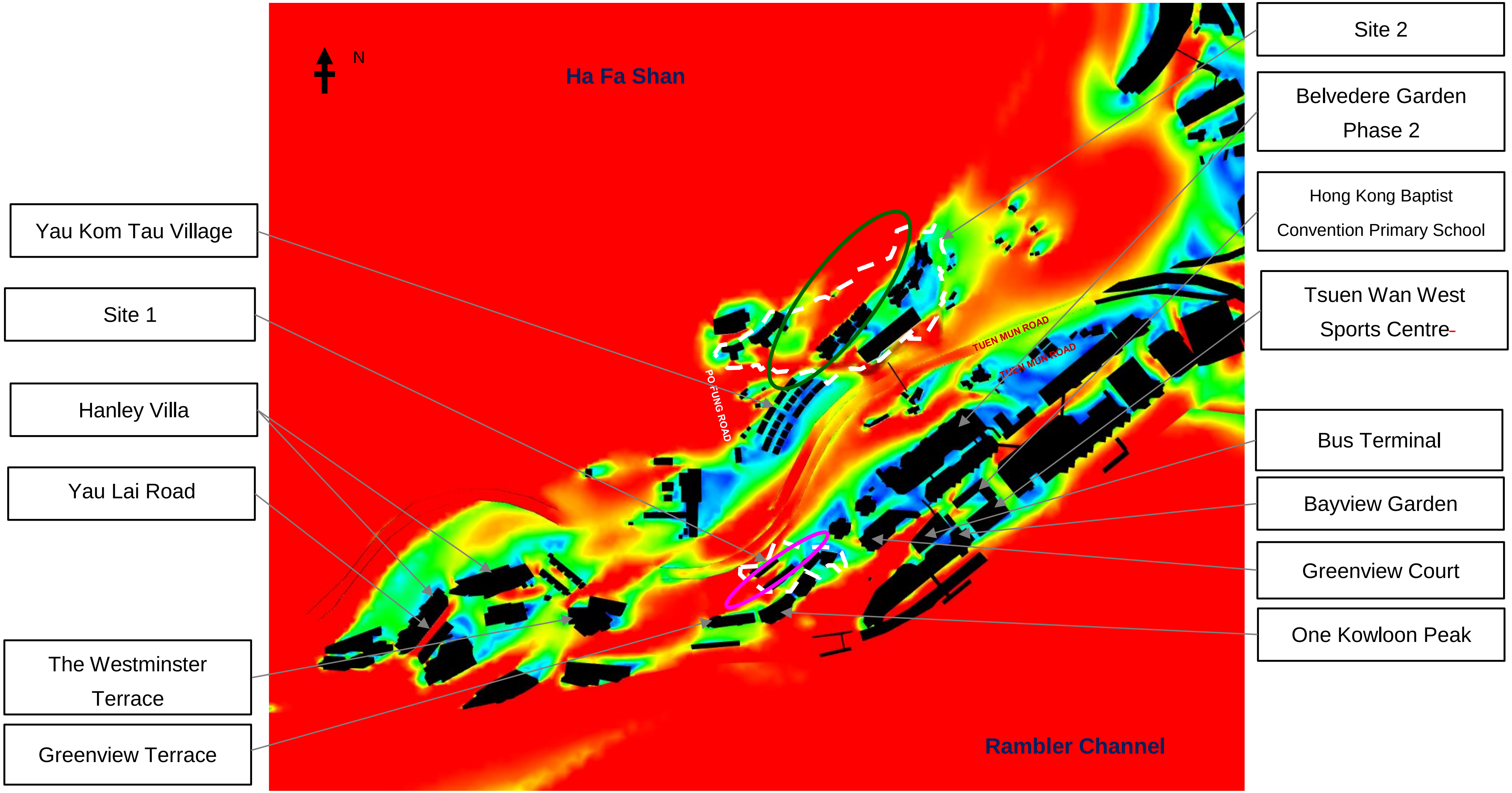


Figure 83 VR Contour Plot at Pedestrian Level under SW Wind for Proposed Scheme

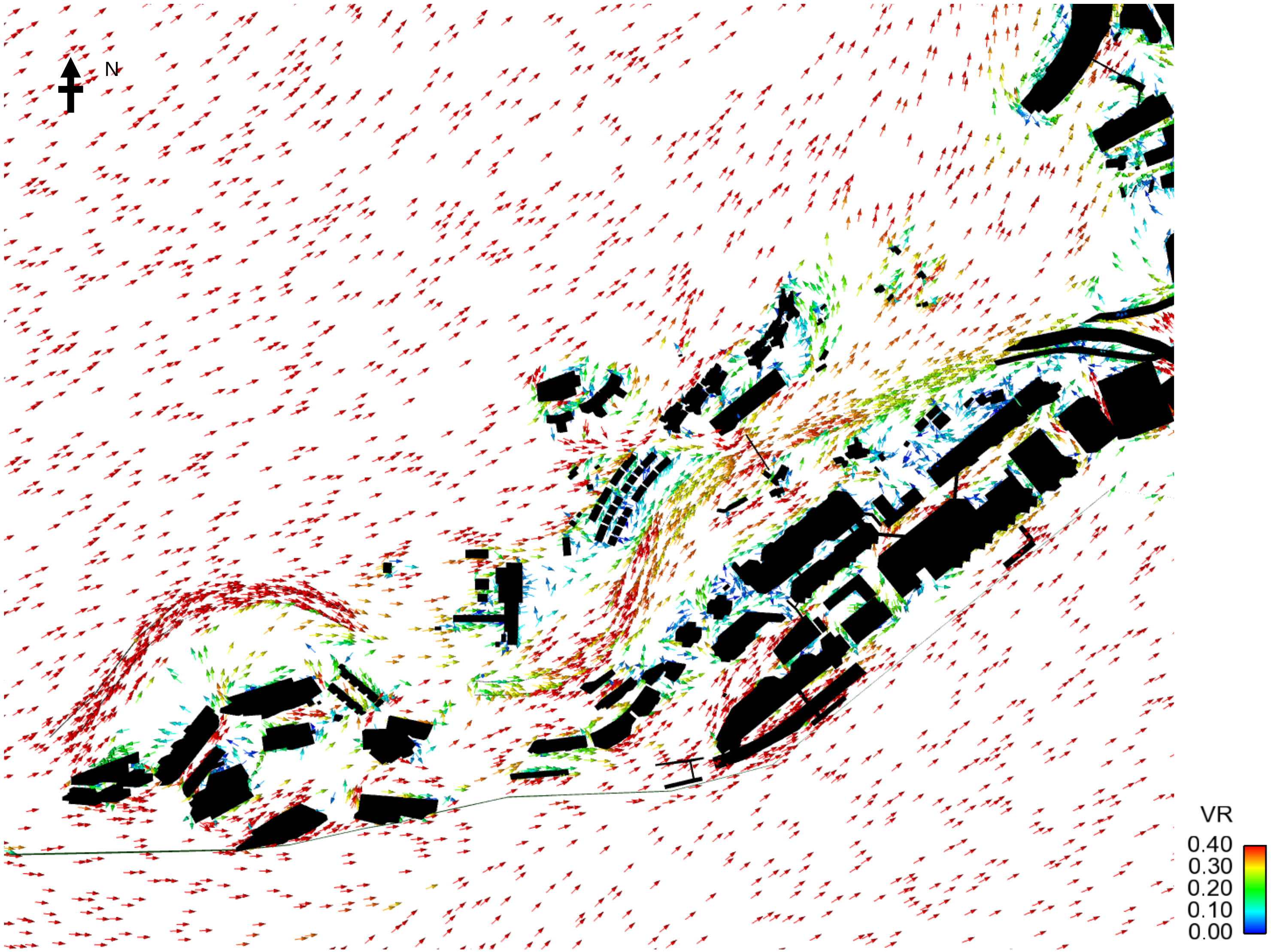


Figure 84 VR Vector Plot at Pedestrian Level under SW Wind for Proposed Scheme

### 6.3.10 WSW Wind - Wind Frequency: 6.1% (Summer)

WSW wind is also one of the major prevailing wind directions for summer scenario. The wind availability of both sites under WSW wind mainly comes from the Rambler Channel, Ha Fa Shan, Castle Peak Road – Ting Kau and Tuen Mun Road from the west.

*Site 1*

In the Baseline Scheme, a portion of WSW wind is obstructed by waterfront developments at the upwind regions including The Bay Bridge, Long Beach Garden, Golden Villa and The Westminister Terrace. Nevertheless, WSW wind from Tuen Mun Road and Castle Peak Road – Ting Kau could freely reach the western portion of Site 1. Since there are no building structures within Site 1, the WSW wind could freely penetrate through Site to ventilate the downwind regions including the open areas to the north-east of Site 1 and Greenview Court.

In the Proposed Scheme, the high-rise residential towers in Site 1 would slightly weaken WSW wind to the downwind regions (i.e. Greenview Court) when compared with the Baseline Scheme. Nevertheless, the proposed 15m building separation between the recreation house & the 23-storey residential towers at Site 1 facilitates penetration of WSW wind through Site 1 and minimize the adverse impact to the downwind regions (Magenta Circle in Figure 87). However, the proposed 17m-wide building separation between the 23-storey residential towers and the 26-storey residential towers at Site 1 does not facilitate penetration of WSW wind through Site 1 as it is not aligned with the WSW wind. Additionally, the residential towers at the eastern portion of Site 1 diverted the WSW wind towards the south thus higher VRs is observed at the open areas at the south-eastern portion of Site 1 and One Kowloon Peak when compared with the Baseline Scheme.

*Site 2*

In the Baseline Scheme, mid-level WSW wind from the western portion of Ha Fa Shan could reach the western portion of Site 2 with minimal obstruction. Another portion of mid-level WSW wind from Tuen Mun Road would skim over Yau Kom Tau Village to reach the south-western portion of Site 2. With an absence of high-rise building structures in the Baseline Scheme, the WSW wind would freely penetrate through Site 2.

In the Proposed Scheme, the proposed high-rise residential towers and recreation house at Site 1 would deflect wind towards the north hence more wind is observed to travel along Tuen Mun Road to reach the southern portion of Site 2 (Red Circle in Figure 87). The 60m-wide Drainage Tunnel Protection Zone facilitates effective penetration of WSW wind through Site 2 to reach the downwind regions, hence the adverse impact caused by the high-rise buildings in the Proposed Scheme could be minimized (Dark Green Circle in Figure 87).

Figure 85 and Figure 87 shows the VR contour plots of WSW wind for the Baseline Scheme and Proposed Scheme respectively. Figure 86 and Figure 88 shows the VR vector plots of WSW wind for the Baseline Scheme and Proposed Scheme respectively.

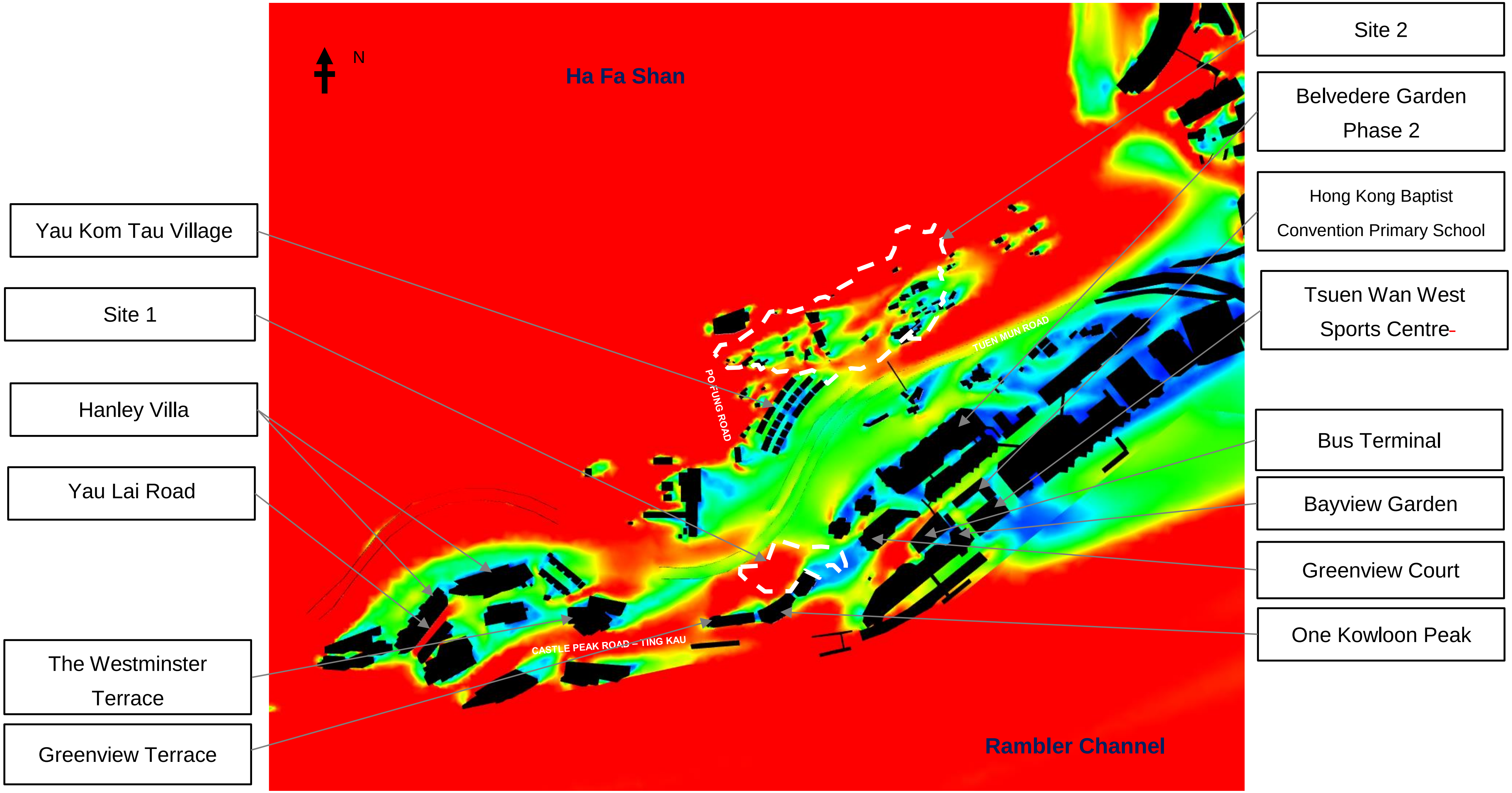


Figure 85 VR Contour Plot at Pedestrian Level under WSW Wind for Baseline Scheme

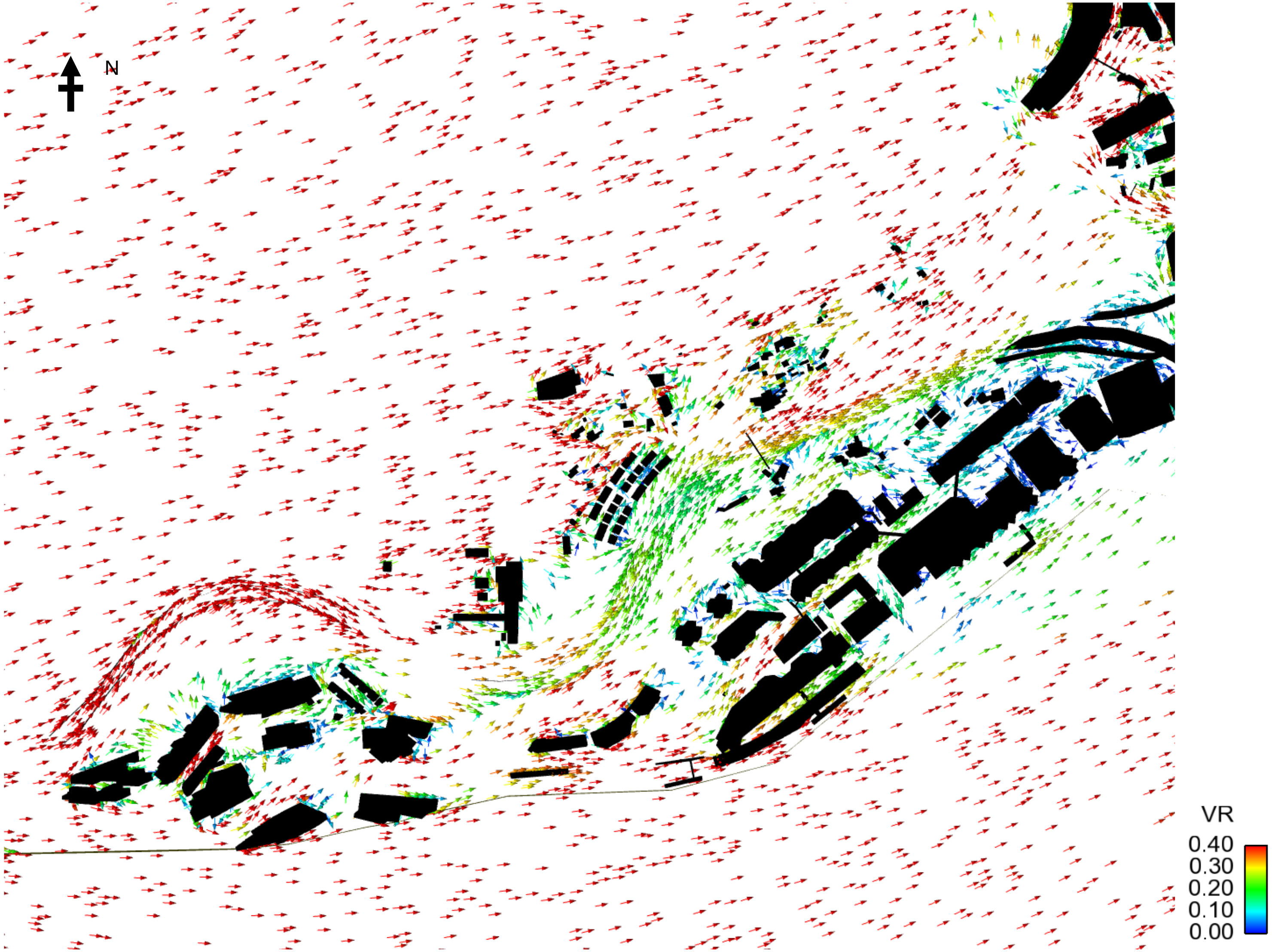


Figure 86 VR Vector Plot at Pedestrian Level under WSW Wind for Baseline Scheme

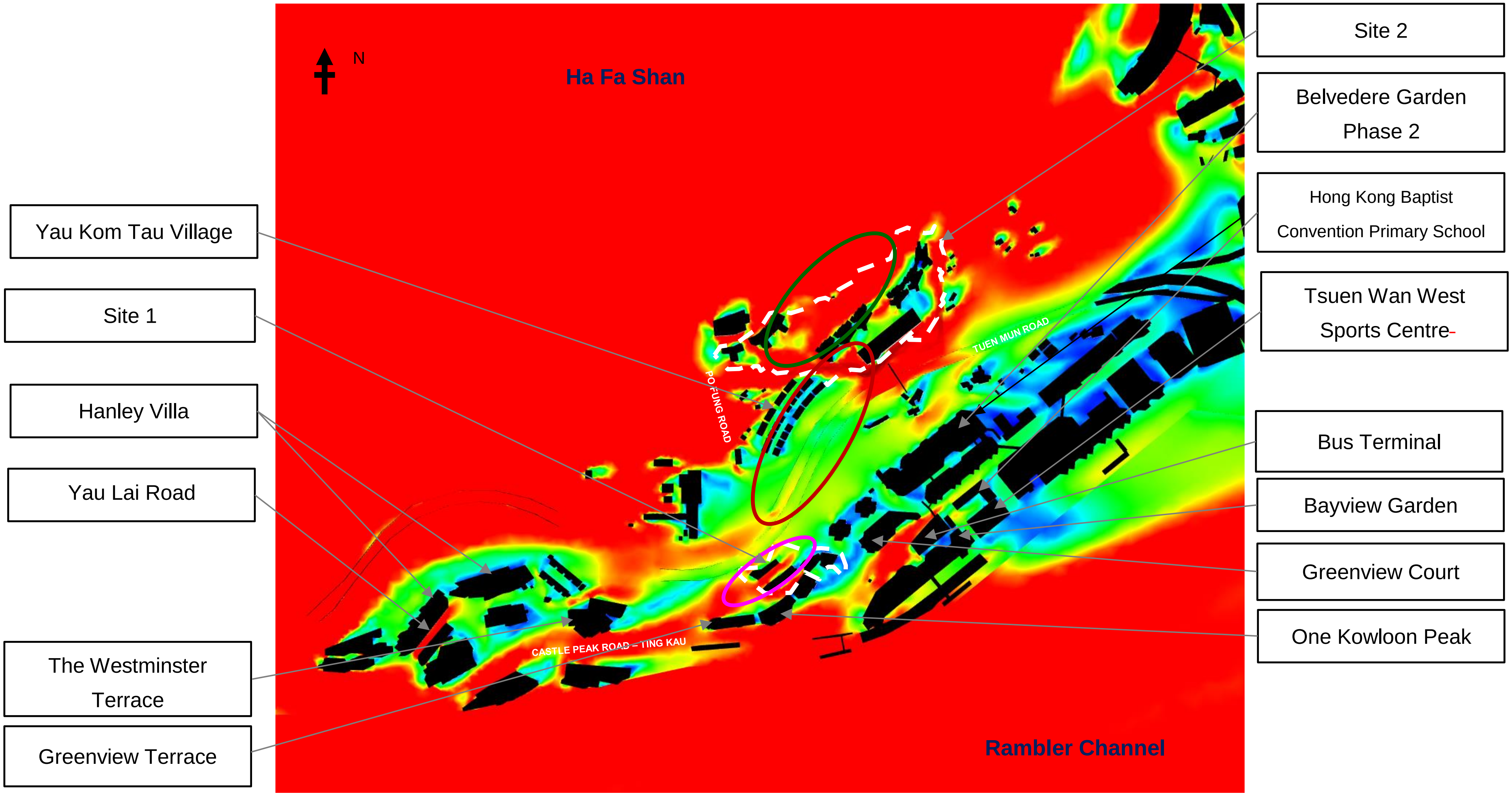


Figure 87 VR Contour Plot at Pedestrian Level under WSW Wind for Proposed Scheme

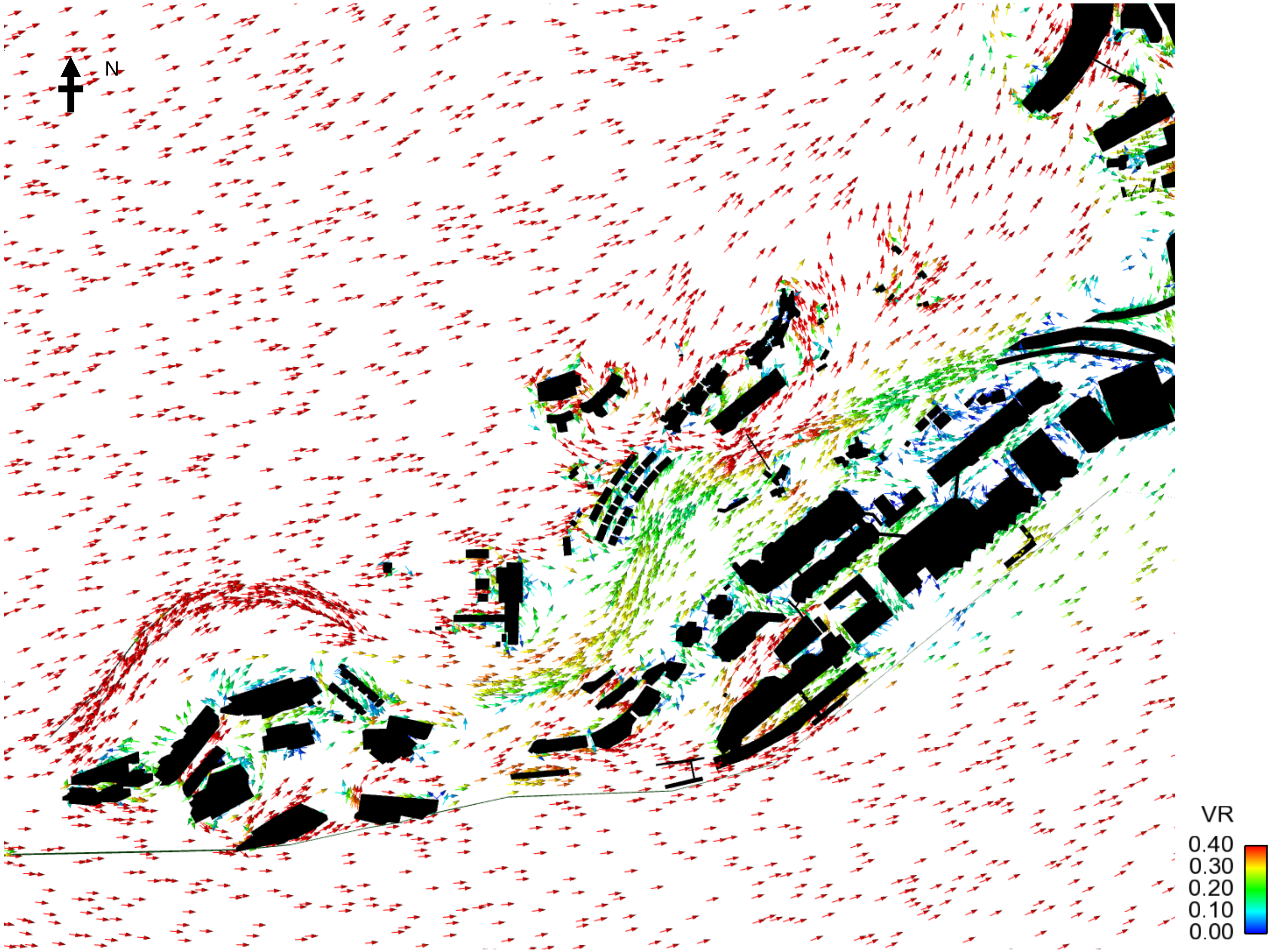


Figure 88 VR Vector Plot at Pedestrian Level under WSW Wind for Proposed Scheme

# 7 GOOD DESIGN FEATURES FOR WIND ENHANCEMENT

## 7.1 BUILDING SEPARATIONS AT SITE 1 AND 2

The quantitative analysis in the previous section show that the proposed building separations are in alignment with some of the prevailing wind directions which could minimize the potential adverse impact caused by the high-rise residential towers in the Proposed Scheme.

For Site 1, a building separation of approximately 15m is incorporated between the recreation house and the 23-storey residential towers oriented roughly along the NE-SW alignment. In addition, a building separation of approximately 17m (indicated in Figure 89) is incorporated between the 23-storey residential towers and 26-storey residential towers oriented roughly along the NNW-SSE alignment.

From the simulation results, the building separation of approximately 15m along the NE-SW alignment is considered effective under NE, SSW, SW and WSW direction whilst the building separation of approximately 17m is considered effective under ENE, E, ESE, SE, SSE and S winds.

For Site 2, the 60m-wide Drainage Tunnel Protection Zone (with its effect analogous to a building separation) is between the 23-storey residential towers and the 25-storey residential towers oriented roughly along the NE-SW alignment (indicated in Figure 90). In addition, the 60m-wide Drainage Tunnel Protection Zone is considered effective under NE, ENE, E, SSE, S, SSW, SW and WSW direction. In addition, one building separation of approximately 20m and two building separations of approximately 32m (both along the NW-SE alignment) are considered effective under NE, ENE, E and ESE directions to enhance the air ventilation performance.


Figure 89 Good Design Features of Site 1

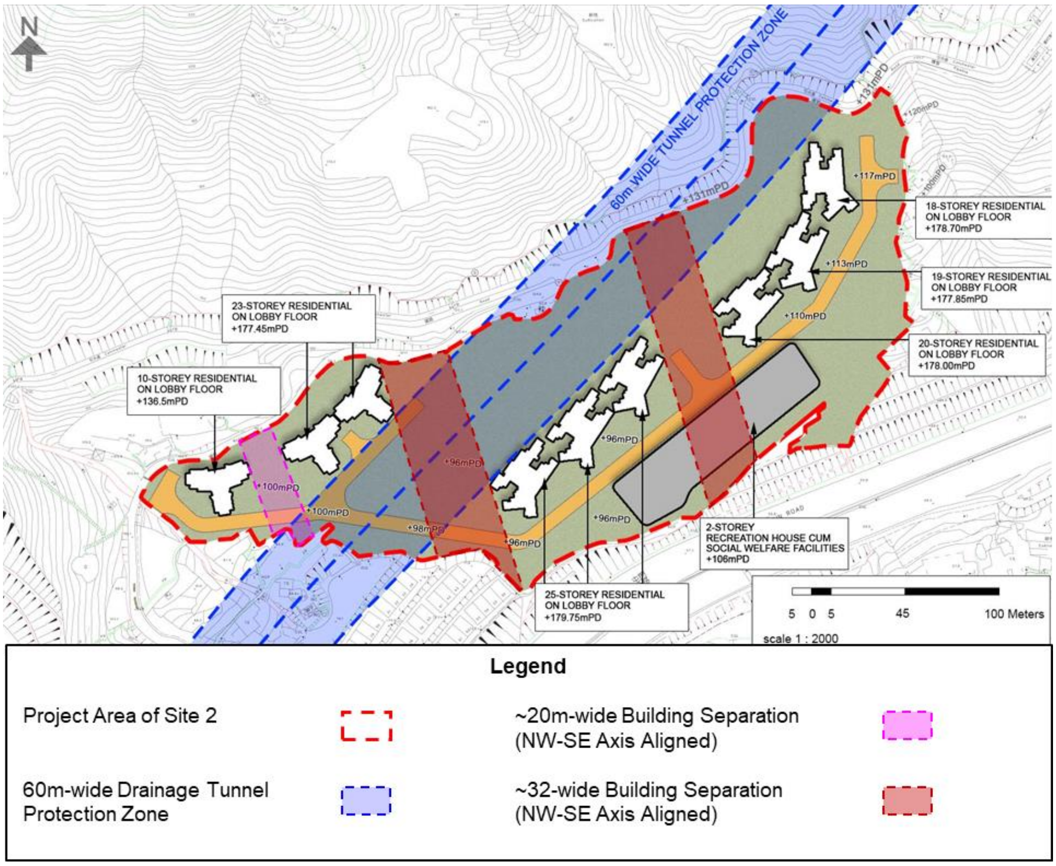


Figure 90 Good Design Features of Site 2

# 8 QUALITATIVE ANALYSIS FOR THE CHANGE IN BUILDING HEIGHT FOR COMMITTED DEVELOPMENT (4)

The Committed Development (4)[4] is located near the eastern boundary of the Surrounding Area with existing building height of 17.9mPD. It was approved with conditions on 17 Jan 2020 under planning application no. A/TW/508 on minor relaxation of plot ratio for permitted non-polluting industrial use. The proposed building height is 100mPD. Figure 91 shows the location of the planned / committed developments.

The Committed Development (4) is located over 1km to the north-east of Site 1 with high-rise developments such as Greenview Court, Belvedere Garden Phases 1 & 2 in between, hence it is expected that the wake region created by Committed Development (4) would not significantly affect the wind availability for Site 1.

Likewise, the Committed Development (4) is located over 500m from Site 2. Since Site 2 is situated on higher elevation (i.e. the ground level for the eastern portion of Site 2 is approximately 117mPD in comparison with the approved building height of Committed Development (4) of 100mPD) hence Committed Development (4) is not expected to create adverse air ventilation impact to Site 2 as high-level wind is able to reach Site 2 freely.

Considering that Committed Development (4) would impose minimal effect to existing annual air paths to the Sites as well as to Castle Peak Road – Tsuen Wan and Tuen Mun Road, it is anticipated that the cumulative impact created from the increase in building height of Committed Development (4) and the Sites would be negligible.

[4] Please refer to Table 2 for the details of Committed Development (4).


Figure 91 Location of the Planned/Committed Developments

# 9 QUALITATIVE ANALYSIS FOR THE CHANGE IN BUILDING HEIGHT FOR RECREATION HOUSE AT SITE 1 AND SITE 2

As mentioned in Section 2.1.2, CFD was conducted based on a scheme without social welfare facilities (SWFs). Followed by the inclusion of SWFs to the proposed scheme, an additional storey of 5m is proposed to be placed on the recreation houses at both sites. Due to the minor increase in building height (i.e. from 70mPD to 75mPD at Site 1 and from 101mPD to 106mPD at Site 2), a qualitative analysis is presented below to assess the potential air ventilation impact to the downwind regions.

<u>Site 1</u>

The recreation house is located at the western portion of Site 1. The 5m increase in building height of the recreation house is expected to create slightly larger wake zones to the immediate downwind regions, including the northern part of the Kowloon Peak Phase 1 and Greenview Terrace, due to increased blockage under the annual prevailing winds (i.e. NE, ENE, E and ESE) thus slightly lower VRs are expected at these downwind regions.

Likewise, the 5m increase in building height of the recreation house is expected to create slightly larger wake zones to the immediate downwind regions, including the open area located at the northern section of Site 1, due to increased blockage under the summer prevailing winds (i.e SSW, SW and WSW) thus slightly lower VR is expected at this downwind region.

<u>Site 2</u>

The recreation house is located at the southern part of Site 2. As Site 2 is situated on relatively higher altitude (i.e. ground elevation ranging from 96mPD to 117mPD), the proposed increase of 5m in building height of the recreation house is not expected to create any significant air ventilation impact to the immediate downwind region, namely Yau Kom Tau Village, under the annual prevailing winds (i.e. ENE, E and ESE) and summer prevailing winds (i.e. S, SSW and SW). This is due to Yau Kom Tau Village being situated on relatively lower altitude (i.e. ground elevation ranging from 70mPD to 80mPD) than Site 2 and no change to the effective width of its main air path, namely Tuen Mun Road.

However, the proposed 5m increase in the recreation house is expected to slightly reduce the wind availability to the immediate downwind region, namely the open area within Site 2 to the immediate north of the recreation house, under SE, SSE and S wind directions.

# 10 CONCLUSION

An Air Ventilation Assessment (AVA) Initial Study (IS) was conducted to assess the ventilation performance of the area within the Sites and the surrounding environment of Yau Kom Tau, Tsuen Wan.

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

AVA Study

A series of CFD simulations using realizable k- ε turbulence model were performed based on the AVA methodology for the IS as stipulated in the Technical Circular No. 1/06 on Air Ventilation Assessment (2006). Ten wind directions covering about 78.7% occurrence of annual wind and about 79.5% of summer wind were studied. The ventilation performance for the proposed development at the Project Area and all focus areas within the assessment area were assessed.

According to the Technical Circular No. 1/06 on Air Ventilation Assessment (2006), the Velocity Ratio of each test point was assessed in terms of SVR, LVR and SAVR of various focus areas within the Assessment Area. A total of 60 perimeter test points (i.e. 30 perimeter test points for Site 1 and 30 perimeter test points for Site 2), 131 overall test points and 19 special test points were selected to assess the ventilation performance.

- The annual weighted Site Spatial Average Velocity Ratio (SVR) for the Baseline Scheme and Proposed Scheme are 0.27 and 0.24 respectively. The summer weighted Site Spatial Average Velocity Ratio (SVR) for the Baseline Scheme and Proposed Scheme are 0.30 and 0.28 respectively.
- The annual weighted Local Spatial Average Velocity Ratio (LVR) for the Baseline Scheme and Proposed Scheme are 0.25 and 0.23 respectively. The summer weighted LVR for the Baseline Scheme and Proposed Scheme are 0.28 and 0.26 respectively.
- The Proposed Scheme is expected to have slightly adverse impact on the pedestrian wind environment when compared with the Baseline Scheme under both annual and summer wind conditions.
- For Site 1, the building separation of approximately 15m along the NE-SW alignment is considered effective under NE, SSW, SW and WSW direction whilst the building separation of approximately 17m is considered effective under ENE, E, ESE, SE, SSE and S winds.
- For Site 2, the 60m-wide Drainage Tunnel Protection Zone is considered effective under NE, ENE, E, SSE, S, SSW, SW and WSW direction, whilst the

NW-SE aligned building separations are considered effective to increase the building permeability within the site.

Besides the aforementioned good design features in the Proposed Scheme, future developments should consider the following design principles at the detailed design stage:

- Provision of building separation(s) of at least 15m-wide along with the prevailing wind directions;
- Adopt building permeability equivalent to 20% to 33.3% with reference to PNAP APP-152[5];
- Minimize podium bulk with ground coverage of no more than 65% where feasible;
- Adopt building setback with reference to PNAP APP-152;
- Incorporate greening measures with a target of not less than 30% for sites larger than 1 ha, and not less than 20% for sites below 1 ha, preferably through tree planting at grade;
- Avoid long continuous façades; and
- Make reference to the recommendations of design measures in the Hong Kong Planning Standards and Guidelines.

[5] https://www.bd.gov.hk/english/documents/pnap/APP/APP152.pdf

# APPENDIX A

# DETAILED VELOCITY RATIO OF EACH TEST POINT

| Baseline Scheme (VR) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | Annual | Summer |
| O1 | 0.08 | 0.05 | 0.05 | 0.34 | 0.36 | 0.40 | 0.29 | 0.51 | 0.59 | 0.62 | 0.21 | 0.40 |
| O2 | 0.19 | 0.12 | 0.04 | 0.01 | 0.28 | 0.05 | 0.21 | 0.11 | 0.16 | 0.11 | 0.11 | 0.13 |
| O3 | 0.08 | 0.08 | 0.07 | 0.17 | 0.28 | 0.29 | 0.09 | 0.27 | 0.06 | 0.31 | 0.14 | 0.18 |
| O4 | 0.10 | 0.21 | 0.19 | 0.25 | 0.26 | 0.39 | 0.26 | 0.49 | 0.37 | 0.55 | 0.25 | 0.35 |
| O5 | 0.14 | 0.37 | 0.30 | 0.47 | 0.53 | 0.30 | 0.14 | 0.49 | 0.02 | 0.47 | 0.35 | 0.33 |
| O6 | 0.13 | 0.15 | 0.26 | 0.43 | 0.23 | 0.10 | 0.20 | 0.59 | 0.33 | 0.31 | 0.26 | 0.33 |
| O7 | 0.13 | 0.19 | 0.24 | 0.42 | 0.29 | 0.19 | 0.28 | 0.63 | 0.41 | 0.42 | 0.29 | 0.38 |
| O8 | 0.19 | 0.18 | 0.08 | 0.10 | 0.13 | 0.13 | 0.13 | 0.08 | 0.11 | 0.30 | 0.12 | 0.12 |
| O9 | 0.09 | 0.11 | 0.22 | 0.34 | 0.38 | 0.29 | 0.30 | 0.51 | 0.22 | 0.12 | 0.26 | 0.32 |
| O10 | 0.06 | 0.10 | 0.15 | 0.32 | 0.32 | 0.40 | 0.14 | 0.21 | 0.05 | 0.15 | 0.20 | 0.21 |
| O11 | 0.12 | 0.14 | 0.18 | 0.05 | 0.16 | 0.06 | 0.18 | 0.38 | 0.18 | 0.16 | 0.15 | 0.19 |
| O12 | 0.13 | 0.13 | 0.21 | 0.14 | 0.28 | 0.16 | 0.02 | 0.07 | 0.16 | 0.17 | 0.15 | 0.13 |
| O13 | 0.11 | 0.17 | 0.17 | 0.14 | 0.27 | 0.10 | 0.05 | 0.19 | 0.07 | 0.20 | 0.15 | 0.14 |
| O14 | 0.18 | 0.20 | 0.24 | 0.27 | 0.45 | 0.41 | 0.02 | 0.04 | 0.28 | 0.33 | 0.23 | 0.22 |
| O15 | 0.10 | 0.28 | 0.17 | 0.38 | 0.13 | 0.25 | 0.05 | 0.12 | 0.06 | 0.02 | 0.20 | 0.14 |
| O16 | 0.32 | 0.14 | 0.18 | 0.11 | 0.17 | 0.72 | 0.15 | 0.30 | 0.34 | 0.11 | 0.22 | 0.26 |
| O17 | 0.18 | 0.11 | 0.16 | 0.48 | 0.29 | 0.16 | 0.12 | 0.09 | 0.10 | 0.05 | 0.21 | 0.17 |
| O18 | 0.04 | 0.04 | 0.01 | 0.08 | 0.08 | 0.12 | 0.20 | 0.14 | 0.10 | 0.23 | 0.07 | 0.12 |
| O19 | 0.03 | 0.09 | 0.03 | 0.06 | 0.03 | 0.15 | 0.27 | 0.25 | 0.21 | 0.07 | 0.10 | 0.16 |
| O20 | 0.02 | 0.03 | 0.01 | 0.11 | 0.18 | 0.03 | 0.04 | 0.07 | 0.06 | 0.08 | 0.05 | 0.07 |
| O21 | 0.08 | 0.33 | 0.17 | 0.31 | 0.53 | 0.36 | 0.22 | 0.57 | 0.50 | 0.52 | 0.30 | 0.40 |
| O22 | 0.02 | 0.21 | 0.20 | 0.06 | 0.07 | 0.15 | 0.22 | 0.29 | 0.37 | 0.13 | 0.16 | 0.20 |
| O23 | 0.05 | 0.03 | 0.08 | 0.05 | 0.10 | 0.05 | 0.06 | 0.14 | 0.06 | 0.25 | 0.07 | 0.09 |
| O24 | 0.06 | 0.07 | 0.26 | 0.18 | 0.14 | 0.18 | 0.34 | 0.22 | 0.19 | 0.29 | 0.18 | 0.23 |
| O25 | 0.04 | 0.07 | 0.47 | 0.40 | 0.33 | 0.28 | 0.30 | 0.10 | 0.09 | 0.04 | 0.28 | 0.24 |
| O26 | 0.04 | 0.08 | 0.45 | 0.29 | 0.17 | 0.07 | 0.24 | 0.12 | 0.01 | 0.10 | 0.22 | 0.18 |
| O27 | 0.05 | 0.12 | 0.34 | 0.30 | 0.20 | 0.08 | 0.14 | 0.04 | 0.15 | 0.06 | 0.19 | 0.15 |
| O28 | 0.05 | 0.06 | 0.64 | 0.43 | 0.29 | 0.12 | 0.08 | 0.29 | 0.41 | 0.37 | 0.30 | 0.31 |
| O29 | 0.05 | 0.12 | 0.35 | 0.22 | 0.19 | 0.16 | 0.20 | 0.20 | 0.15 | 0.21 | 0.21 | 0.21 |
| O30 | 0.02 | 0.07 | 0.40 | 0.39 | 0.05 | 0.30 | 0.16 | 0.22 | 0.15 | 0.26 | 0.23 | 0.23 |
| O31 | 0.07 | 0.02 | 0.30 | 0.53 | 0.53 | 0.58 | 0.65 | 0.24 | 0.26 | 0.13 | 0.33 | 0.41 |
| O32 | 0.16 | 0.07 | 0.30 | 0.27 | 0.31 | 0.09 | 0.26 | 0.12 | 0.05 | 0.10 | 0.21 | 0.18 |
| O33 | 0.18 | 0.13 | 0.22 | 0.10 | 0.09 | 0.03 | 0.36 | 0.24 | 0.12 | 0.14 | 0.17 | 0.18 |
| O34 | 0.12 | 0.18 | 0.28 | 0.13 | 0.12 | 0.02 | 0.40 | 0.27 | 0.18 | 0.15 | 0.20 | 0.21 |
| O35 | 0.16 | 0.16 | 0.26 | 0.01 | 0.32 | 0.31 | 0.35 | 0.22 | 0.14 | 0.15 | 0.21 | 0.22 |
| O36 | 0.07 | 0.19 | 0.08 | 0.16 | 0.35 | 0.42 | 0.51 | 0.26 | 0.26 | 0.04 | 0.21 | 0.28 |
| O37 | 0.07 | 0.12 | 0.24 | 0.47 | 0.36 | 0.24 | 0.07 | 0.17 | 0.08 | 0.06 | 0.23 | 0.20 |
| O38 | 0.10 | 0.07 | 0.41 | 0.36 | 0.27 | 0.18 | 0.10 | 0.28 | 0.26 | 0.12 | 0.25 | 0.25 |
| O39 | 0.16 | 0.21 | 0.06 | 0.05 | 0.03 | 0.02 | 0.06 | 0.08 | 0.07 | 0.03 | 0.09 | 0.06 |
| O40 | 0.03 | 0.04 | 0.06 | 0.04 | 0.15 | 0.19 | 0.02 | 0.10 | 0.16 | 0.02 | 0.07 | 0.09 |
| O41 | 0.04 | 0.12 | 0.10 | 0.27 | 0.13 | 0.13 | 0.18 | 0.07 | 0.03 | 0.02 | 0.13 | 0.12 |
| O42 | 0.03 | 0.10 | 0.08 | 0.24 | 0.24 | 0.26 | 0.20 | 0.14 | 0.14 | 0.06 | 0.15 | 0.17 |
| O43 | 0.04 | 0.12 | 0.10 | 0.05 | 0.12 | 0.04 | 0.12 | 0.18 | 0.16 | 0.14 | 0.10 | 0.12 |
| O44 | 0.11 | 0.23 | 0.25 | 0.50 | 0.37 | 0.14 | 0.30 | 0.55 | 0.44 | 0.32 | 0.31 | 0.38 |
| O45 | 0.13 | 0.27 | 0.24 | 0.41 | 0.46 | 0.17 | 0.31 | 0.59 | 0.45 | 0.50 | 0.31 | 0.40 |
| O46 | 0.14 | 0.28 | 0.19 | 0.44 | 0.38 | 0.19 | 0.09 | 0.18 | 0.26 | 0.28 | 0.25 | 0.23 |
| O47 | 0.03 | 0.22 | 0.50 | 0.17 | 0.50 | 0.50 | 0.56 | 0.56 | 0.54 | 0.36 | 0.37 | 0.48 |
| O48 | 0.02 | 0.26 | 0.41 | 0.09 | 0.26 | 0.32 | 0.43 | 0.59 | 0.50 | 0.27 | 0.29 | 0.39 |
| O49 | 0.05 | 0.21 | 0.53 | 0.12 | 0.44 | 0.57 | 0.57 | 0.47 | 0.47 | 0.26 | 0.36 | 0.44 |
| O50 | 0.07 | 0.17 | 0.51 | 0.19 | 0.17 | 0.18 | 0.42 | 0.40 | 0.56 | 0.31 | 0.29 | 0.36 |
| O51 | 0.05 | 0.22 | 0.24 | 0.50 | 0.34 | 0.20 | 0.17 | 0.46 | 0.46 | 0.46 | 0.28 | 0.35 |
| O52 | 0.01 | 0.09 | 0.15 | 0.41 | 0.39 | 0.28 | 0.26 | 0.43 | 0.54 | 0.43 | 0.23 | 0.37 |
| O53 | 0.04 | 0.14 | 0.11 | 0.13 | 0.35 | 0.46 | 0.41 | 0.38 | 0.53 | 0.19 | 0.21 | 0.34 |
| O54 | 0.02 | 0.14 | 0.26 | 0.05 | 0.13 | 0.16 | 0.22 | 0.51 | 0.48 | 0.30 | 0.18 | 0.29 |
| O55 | 0.11 | 0.12 | 0.35 | 0.27 | 0.33 | 0.14 | 0.10 | 0.47 | 0.55 | 0.47 | 0.25 | 0.33 |
| O56 | 0.17 | 0.22 | 0.23 | 0.48 | 0.42 | 0.25 | 0.25 | 0.52 | 0.44 | 0.29 | 0.31 | 0.37 |
| O57 | 0.19 | 0.22 | 0.38 | 0.50 | 0.44 | 0.29 | 0.15 | 0.54 | 0.48 | 0.44 | 0.35 | 0.40 |
| O58 | 0.25 | 0.17 | 0.61 | 0.55 | 0.41 | 0.25 | 0.29 | 0.57 | 0.63 | 0.58 | 0.42 | 0.48 |
| O59 | 0.19 | 0.25 | 0.61 | 0.49 | 0.37 | 0.24 | 0.05 | 0.49 | 0.46 | 0.53 | 0.38 | 0.39 |
| O60 | 0.03 | 0.10 | 0.40 | 0.27 | 0.15 | 0.13 | 0.34 | 0.44 | 0.55 | 0.38 | 0.25 | 0.35 |
| O61 | 0.10 | 0.10 | 0.13 | 0.15 | 0.08 | 0.07 | 0.07 | 0.06 | 0.03 | 0.05 | 0.10 | 0.08 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O62 | 0.07 | 0.07 | 0.13 | 0.12 | 0.01 | 0.07 | 0.09 | 0.10 | 0.06 | 0.06 | 0.09 | 0.08 |
| O63 | 0.18 | 0.25 | 0.35 | 0.24 | 0.01 | 0.08 | 0.05 | 0.06 | 0.12 | 0.16 | 0.20 | 0.12 |
| O64 | 0.14 | 0.05 | 0.44 | 0.49 | 0.41 | 0.33 | 0.27 | 0.22 | 0.22 | 0.10 | 0.31 | 0.30 |
| O65 | 0.05 | 0.07 | 0.38 | 0.27 | 0.14 | 0.14 | 0.26 | 0.15 | 0.30 | 0.06 | 0.21 | 0.22 |
| O66 | 0.20 | 0.04 | 0.11 | 0.18 | 0.15 | 0.20 | 0.41 | 0.25 | 0.26 | 0.25 | 0.17 | 0.24 |
| O67 | 0.14 | 0.13 | 0.44 | 0.29 | 0.23 | 0.14 | 0.18 | 0.11 | 0.14 | 0.02 | 0.24 | 0.19 |
| O68 | 0.05 | 0.03 | 0.03 | 0.03 | 0.06 | 0.11 | 0.05 | 0.10 | 0.06 | 0.10 | 0.05 | 0.07 |
| O69 | 0.03 | 0.15 | 0.22 | 0.13 | 0.03 | 0.18 | 0.18 | 0.14 | 0.09 | 0.15 | 0.14 | 0.14 |
| O70 | 0.14 | 0.30 | 0.23 | 0.43 | 0.37 | 0.42 | 0.30 | 0.49 | 0.36 | 0.41 | 0.32 | 0.38 |
| O71 | 0.09 | 0.07 | 0.07 | 0.09 | 0.20 | 0.21 | 0.11 | 0.05 | 0.16 | 0.20 | 0.10 | 0.13 |
| O72 | 0.18 | 0.09 | 0.07 | 0.28 | 0.30 | 0.49 | 0.16 | 0.40 | 0.39 | 0.21 | 0.20 | 0.30 |
| O73 | 0.04 | 0.07 | 0.07 | 0.18 | 0.27 | 0.12 | 0.21 | 0.33 | 0.23 | 0.21 | 0.14 | 0.21 |
| O74 | 0.14 | 0.27 | 0.28 | 0.42 | 0.49 | 0.33 | 0.38 | 0.68 | 0.44 | 0.40 | 0.35 | 0.45 |
| O75 | 0.03 | 0.11 | 0.19 | 0.33 | 0.36 | 0.36 | 0.30 | 0.56 | 0.14 | 0.12 | 0.25 | 0.32 |
| O76 | 0.11 | 0.05 | 0.07 | 0.11 | 0.26 | 0.11 | 0.19 | 0.08 | 0.30 | 0.08 | 0.11 | 0.15 |
| O77 | 0.08 | 0.11 | 0.13 | 0.12 | 0.20 | 0.15 | 0.09 | 0.25 | 0.07 | 0.15 | 0.14 | 0.15 |
| O78 | 0.56 | 0.66 | 0.65 | 0.40 | 0.49 | 0.24 | 0.60 | 0.61 | 0.56 | 0.77 | 0.55 | 0.54 |
| O79 | 0.53 | 0.58 | 0.62 | 0.60 | 0.43 | 0.22 | 0.55 | 0.61 | 0.43 | 0.87 | 0.55 | 0.53 |
| O80 | 0.52 | 0.61 | 0.55 | 0.45 | 0.44 | 0.08 | 0.31 | 0.60 | 0.44 | 0.37 | 0.48 | 0.42 |
| O81 | 0.43 | 0.50 | 0.48 | 0.34 | 0.37 | 0.05 | 0.39 | 0.45 | 0.43 | 0.80 | 0.40 | 0.40 |
| O82 | 0.22 | 0.28 | 0.40 | 0.36 | 0.15 | 0.29 | 0.23 | 0.32 | 0.54 | 0.59 | 0.30 | 0.35 |
| O83 | 0.26 | 0.34 | 0.49 | 0.20 | 0.08 | 0.26 | 0.23 | 0.30 | 0.43 | 0.55 | 0.30 | 0.31 |
| O84 | 0.24 | 0.29 | 0.56 | 0.25 | 0.04 | 0.06 | 0.34 | 0.46 | 0.36 | 0.21 | 0.32 | 0.31 |
| O85 | 0.10 | 0.05 | 0.01 | 0.07 | 0.04 | 0.04 | 0.09 | 0.05 | 0.06 | 0.06 | 0.05 | 0.06 |
| O86 | 0.03 | 0.05 | 0.08 | 0.05 | 0.16 | 0.17 | 0.59 | 0.07 | 0.13 | 0.21 | 0.12 | 0.20 |
| O87 | 0.02 | 0.01 | 0.17 | 0.20 | 0.17 | 0.13 | 0.23 | 0.27 | 0.28 | 0.14 | 0.14 | 0.21 |
| O88 | 0.04 | 0.05 | 0.22 | 0.57 | 0.49 | 0.45 | 0.38 | 0.07 | 0.02 | 0.03 | 0.27 | 0.27 |
| O89 | 0.22 | 0.34 | 0.23 | 0.21 | 0.29 | 0.50 | 0.49 | 0.34 | 0.72 | 0.09 | 0.30 | 0.39 |
| O90 | 0.17 | 0.08 | 0.10 | 0.07 | 0.27 | 0.28 | 0.41 | 0.16 | 0.42 | 0.03 | 0.16 | 0.24 |
| O91 | 0.24 | 0.05 | 0.20 | 0.17 | 0.45 | 0.51 | 0.61 | 0.42 | 0.43 | 0.18 | 0.27 | 0.40 |
| O92 | 0.19 | 0.14 | 0.13 | 0.27 | 0.19 | 0.29 | 0.40 | 0.34 | 0.37 | 0.13 | 0.22 | 0.29 |
| O93 | 0.35 | 0.27 | 0.12 | 0.45 | 0.33 | 0.24 | 0.33 | 0.36 | 0.34 | 0.10 | 0.29 | 0.30 |
| O94 | 0.39 | 0.37 | 0.31 | 0.04 | 0.26 | 0.33 | 0.32 | 0.21 | 0.20 | 0.07 | 0.27 | 0.22 |
| O95 | 0.30 | 0.24 | 0.25 | 0.14 | 0.24 | 0.29 | 0.41 | 0.24 | 0.27 | 0.05 | 0.25 | 0.25 |
| O96 | 0.28 | 0.23 | 0.33 | 0.19 | 0.29 | 0.19 | 0.15 | 0.06 | 0.08 | 0.09 | 0.23 | 0.16 |
| O97 | 0.13 | 0.27 | 0.31 | 0.53 | 0.42 | 0.44 | 0.27 | 0.23 | 0.49 | 0.60 | 0.33 | 0.38 |
| O98 | 0.19 | 0.32 | 0.33 | 0.44 | 0.44 | 0.41 | 0.27 | 0.33 | 0.48 | 0.47 | 0.34 | 0.38 |
| O99 | 0.15 | 0.28 | 0.27 | 0.40 | 0.30 | 0.38 | 0.29 | 0.44 | 0.49 | 0.54 | 0.31 | 0.39 |
| O100 | 0.15 | 0.29 | 0.29 | 0.49 | 0.37 | 0.41 | 0.29 | 0.48 | 0.55 | 0.53 | 0.34 | 0.43 |
| O101 | 0.15 | 0.29 | 0.28 | 0.45 | 0.36 | 0.24 | 0.30 | 0.34 | 0.47 | 0.48 | 0.31 | 0.36 |
| O102 | 0.15 | 0.30 | 0.25 | 0.34 | 0.35 | 0.53 | 0.30 | 0.48 | 0.26 | 0.32 | 0.32 | 0.36 |
| O103 | 0.21 | 0.37 | 0.32 | 0.45 | 0.44 | 0.44 | 0.20 | 0.53 | 0.43 | 0.45 | 0.36 | 0.40 |
| O104 | 0.07 | 0.24 | 0.10 | 0.38 | 0.40 | 0.33 | 0.27 | 0.44 | 0.36 | 0.37 | 0.25 | 0.34 |
| O105 | 0.11 | 0.08 | 0.40 | 0.28 | 0.13 | 0.13 | 0.26 | 0.52 | 0.59 | 0.39 | 0.25 | 0.35 |
| O106 | 0.09 | 0.07 | 0.36 | 0.26 | 0.14 | 0.24 | 0.48 | 0.48 | 0.56 | 0.21 | 0.26 | 0.37 |
| O107 | 0.08 | 0.13 | 0.48 | 0.42 | 0.25 | 0.09 | 0.31 | 0.25 | 0.41 | 0.09 | 0.29 | 0.29 |
| O108 | 0.05 | 0.13 | 0.29 | 0.35 | 0.22 | 0.06 | 0.30 | 0.29 | 0.44 | 0.25 | 0.23 | 0.29 |
| O109 | 0.10 | 0.17 | 0.18 | 0.22 | 0.07 | 0.21 | 0.37 | 0.28 | 0.44 | 0.21 | 0.19 | 0.27 |
| O110 | 0.11 | 0.21 | 0.36 | 0.23 | 0.10 | 0.23 | 0.30 | 0.22 | 0.35 | 0.15 | 0.24 | 0.25 |
| O111 | 0.05 | 0.16 | 0.39 | 0.25 | 0.16 | 0.10 | 0.26 | 0.22 | 0.24 | 0.16 | 0.23 | 0.23 |
| O112 | 0.25 | 0.16 | 0.34 | 0.46 | 0.08 | 0.15 | 0.23 | 0.24 | 0.20 | 0.16 | 0.26 | 0.24 |
| O113 | 0.02 | 0.09 | 0.46 | 0.30 | 0.23 | 0.20 | 0.26 | 0.30 | 0.44 | 0.23 | 0.26 | 0.30 |
| O114 | 0.04 | 0.06 | 0.53 | 0.30 | 0.17 | 0.23 | 0.44 | 0.22 | 0.39 | 0.20 | 0.28 | 0.32 |
| O115 | 0.03 | 0.05 | 0.48 | 0.40 | 0.29 | 0.18 | 0.04 | 0.05 | 0.06 | 0.05 | 0.24 | 0.17 |
| O116 | 0.05 | 0.10 | 0.41 | 0.45 | 0.33 | 0.18 | 0.28 | 0.28 | 0.29 | 0.18 | 0.28 | 0.30 |
| O117 | 0.08 | 0.15 | 0.04 | 0.28 | 0.20 | 0.19 | 0.37 | 0.25 | 0.37 | 0.16 | 0.17 | 0.25 |
| O118 | 0.15 | 0.21 | 0.41 | 0.34 | 0.23 | 0.25 | 0.40 | 0.20 | 0.30 | 0.02 | 0.29 | 0.28 |
| O119 | 0.04 | 0.11 | 0.43 | 0.21 | 0.27 | 0.38 | 0.47 | 0.22 | 0.37 | 0.02 | 0.27 | 0.31 |
| O120 | 0.41 | 0.29 | 0.39 | 0.30 | 0.29 | 0.22 | 0.32 | 0.21 | 0.23 | 0.12 | 0.32 | 0.26 |
| O121 | 0.11 | 0.16 | 0.26 | 0.15 | 0.05 | 0.09 | 0.20 | 0.20 | 0.09 | 0.15 | 0.17 | 0.15 |
| O122 | 0.16 | 0.23 | 0.32 | 0.21 | 0.05 | 0.13 | 0.20 | 0.22 | 0.32 | 0.42 | 0.21 | 0.23 |
| O123 | 0.12 | 0.18 | 0.25 | 0.10 | 0.04 | 0.04 | 0.14 | 0.16 | 0.41 | 0.53 | 0.15 | 0.20 |
| O124 | 0.09 | 0.09 | 0.19 | 0.12 | 0.06 | 0.06 | 0.37 | 0.37 | 0.12 | 0.17 | 0.16 | 0.21 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O125 | 0.22 | 0.14 | 0.13 | 0.16 | 0.15 | 0.09 | 0.11 | 0.10 | 0.05 | 0.05 | 0.14 | 0.10 |
| O126 | 0.17 | 0.17 | 0.07 | 0.52 | 0.14 | 0.12 | 0.02 | 0.03 | 0.11 | 0.06 | 0.17 | 0.12 |
| O127 | 0.12 | 0.12 | 0.15 | 0.44 | 0.51 | 0.54 | 0.51 | 0.36 | 0.35 | 0.08 | 0.30 | 0.39 |
| O128 | 0.06 | 0.05 | 0.53 | 0.58 | 0.56 | 0.52 | 0.19 | 0.18 | 0.14 | 0.14 | 0.35 | 0.33 |
| O129 | 0.03 | 0.05 | 0.11 | 0.15 | 0.13 | 0.17 | 0.03 | 0.17 | 0.06 | 0.09 | 0.10 | 0.11 |
| O130 | 0.08 | 0.11 | 0.13 | 0.15 | 0.08 | 0.07 | 0.06 | 0.29 | 0.23 | 0.34 | 0.12 | 0.17 |
| O131 | 0.27 | 0.16 | 0.40 | 0.23 | 0.48 | 0.52 | 0.49 | 0.40 | 0.40 | 0.17 | 0.34 | 0.40 |
| P1 | 0.25 | 0.19 | 0.28 | 0.14 | 0.06 | 0.35 | 0.49 | 0.58 | 0.53 | 0.35 | 0.27 | 0.38 |
| P2 | 0.25 | 0.19 | 0.28 | 0.15 | 0.01 | 0.20 | 0.51 | 0.59 | 0.53 | 0.37 | 0.26 | 0.37 |
| P3 | 0.24 | 0.20 | 0.31 | 0.20 | 0.06 | 0.20 | 0.46 | 0.57 | 0.53 | 0.43 | 0.27 | 0.38 |
| P4 | 0.22 | 0.20 | 0.31 | 0.18 | 0.19 | 0.23 | 0.41 | 0.55 | 0.52 | 0.43 | 0.27 | 0.38 |
| P5 | 0.24 | 0.16 | 0.24 | 0.05 | 0.24 | 0.22 | 0.42 | 0.56 | 0.54 | 0.39 | 0.24 | 0.36 |
| P6 | 0.23 | 0.13 | 0.34 | 0.04 | 0.16 | 0.17 | 0.41 | 0.55 | 0.52 | 0.33 | 0.24 | 0.35 |
| P7 | 0.21 | 0.14 | 0.24 | 0.01 | 0.21 | 0.13 | 0.35 | 0.51 | 0.49 | 0.32 | 0.21 | 0.31 |
| P8 | 0.18 | 0.15 | 0.25 | 0.10 | 0.23 | 0.12 | 0.25 | 0.46 | 0.45 | 0.31 | 0.21 | 0.29 |
| P9 | 0.15 | 0.15 | 0.36 | 0.22 | 0.20 | 0.17 | 0.11 | 0.38 | 0.34 | 0.34 | 0.23 | 0.26 |
| P10 | 0.09 | 0.15 | 0.45 | 0.27 | 0.23 | 0.10 | 0.12 | 0.31 | 0.31 | 0.35 | 0.25 | 0.26 |
| P11 | 0.07 | 0.17 | 0.55 | 0.35 | 0.23 | 0.10 | 0.16 | 0.06 | 0.15 | 0.28 | 0.27 | 0.21 |
| P12 | 0.11 | 0.19 | 0.63 | 0.40 | 0.26 | 0.58 | 0.50 | 0.03 | 0.04 | 0.22 | 0.37 | 0.31 |
| P13 | 0.11 | 0.20 | 0.58 | 0.40 | 0.29 | 0.57 | 0.43 | 0.05 | 0.06 | 0.20 | 0.35 | 0.30 |
| P14 | 0.12 | 0.21 | 0.51 | 0.42 | 0.31 | 0.60 | 0.56 | 0.06 | 0.05 | 0.13 | 0.36 | 0.32 |
| P15 | 0.06 | 0.22 | 0.60 | 0.45 | 0.23 | 0.70 | 0.74 | 0.21 | 0.09 | 0.05 | 0.41 | 0.39 |
| P16 | 0.07 | 0.21 | 0.61 | 0.42 | 0.22 | 0.57 | 0.61 | 0.38 | 0.23 | 0.05 | 0.40 | 0.41 |
| P17 | 0.05 | 0.22 | 0.55 | 0.39 | 0.17 | 0.67 | 0.68 | 0.28 | 0.15 | 0.04 | 0.38 | 0.38 |
| P18 | 0.09 | 0.20 | 0.48 | 0.37 | 0.22 | 0.71 | 0.69 | 0.08 | 0.11 | 0.04 | 0.35 | 0.34 |
| P19 | 0.08 | 0.19 | 0.40 | 0.31 | 0.46 | 0.61 | 0.63 | 0.10 | 0.13 | 0.06 | 0.33 | 0.34 |
| P20 | 0.05 | 0.14 | 0.38 | 0.27 | 0.52 | 0.56 | 0.59 | 0.09 | 0.08 | 0.08 | 0.31 | 0.32 |
| P21 | 0.04 | 0.22 | 0.30 | 0.18 | 0.18 | 0.12 | 0.04 | 0.08 | 0.10 | 0.15 | 0.18 | 0.13 |
| P22 | 0.03 | 0.19 | 0.45 | 0.19 | 0.15 | 0.09 | 0.05 | 0.26 | 0.13 | 0.26 | 0.22 | 0.19 |
| P23 | 0.05 | 0.07 | 0.17 | 0.06 | 0.22 | 0.06 | 0.05 | 0.30 | 0.20 | 0.31 | 0.12 | 0.17 |
| P24 | 0.06 | 0.02 | 0.05 | 0.08 | 0.23 | 0.07 | 0.05 | 0.26 | 0.20 | 0.31 | 0.09 | 0.15 |
| P25 | 0.06 | 0.09 | 0.03 | 0.06 | 0.12 | 0.14 | 0.11 | 0.34 | 0.29 | 0.36 | 0.10 | 0.19 |
| P26 | 0.01 | 0.19 | 0.14 | 0.03 | 0.03 | 0.08 | 0.30 | 0.49 | 0.46 | 0.47 | 0.15 | 0.28 |
| P27 | 0.13 | 0.28 | 0.31 | 0.03 | 0.14 | 0.30 | 0.35 | 0.59 | 0.55 | 0.54 | 0.25 | 0.37 |
| P28 | 0.20 | 0.25 | 0.40 | 0.04 | 0.20 | 0.43 | 0.32 | 0.60 | 0.55 | 0.52 | 0.29 | 0.40 |
| P29 | 0.24 | 0.22 | 0.37 | 0.07 | 0.26 | 0.18 | 0.43 | 0.57 | 0.53 | 0.47 | 0.29 | 0.38 |
| P30 | 0.26 | 0.20 | 0.29 | 0.16 | 0.04 | 0.15 | 0.47 | 0.57 | 0.53 | 0.39 | 0.26 | 0.36 |
| P31 | 0.48 | 0.52 | 0.53 | 0.36 | 0.33 | 0.36 | 0.31 | 0.38 | 0.50 | 0.75 | 0.43 | 0.42 |
| P32 | 0.41 | 0.46 | 0.41 | 0.32 | 0.35 | 0.21 | 0.33 | 0.39 | 0.39 | 0.72 | 0.38 | 0.38 |
| P33 | 0.30 | 0.45 | 0.23 | 0.29 | 0.23 | 0.08 | 0.32 | 0.38 | 0.38 | 0.57 | 0.29 | 0.31 |
| P34 | 0.07 | 0.11 | 0.11 | 0.14 | 0.07 | 0.04 | 0.20 | 0.16 | 0.22 | 0.21 | 0.11 | 0.15 |
| P35 | 0.07 | 0.08 | 0.13 | 0.12 | 0.06 | 0.06 | 0.17 | 0.17 | 0.11 | 0.16 | 0.11 | 0.13 |
| P36 | 0.09 | 0.05 | 0.16 | 0.10 | 0.04 | 0.01 | 0.12 | 0.18 | 0.11 | 0.16 | 0.10 | 0.12 |
| P37 | 0.41 | 0.35 | 0.50 | 0.45 | 0.24 | 0.04 | 0.21 | 0.46 | 0.29 | 0.38 | 0.37 | 0.32 |
| P38 | 0.38 | 0.35 | 0.46 | 0.45 | 0.23 | 0.21 | 0.27 | 0.51 | 0.32 | 0.41 | 0.38 | 0.36 |
| P39 | 0.08 | 0.07 | 0.16 | 0.10 | 0.07 | 0.17 | 0.24 | 0.23 | 0.15 | 0.21 | 0.13 | 0.17 |
| P40 | 0.38 | 0.34 | 0.45 | 0.30 | 0.18 | 0.28 | 0.33 | 0.46 | 0.28 | 0.34 | 0.35 | 0.34 |
| P41 | 0.38 | 0.34 | 0.52 | 0.35 | 0.17 | 0.29 | 0.35 | 0.47 | 0.28 | 0.34 | 0.38 | 0.36 |
| P42 | 0.29 | 0.27 | 0.43 | 0.30 | 0.13 | 0.28 | 0.31 | 0.43 | 0.21 | 0.28 | 0.32 | 0.31 |
| P43 | 0.23 | 0.29 | 0.39 | 0.29 | 0.09 | 0.16 | 0.16 | 0.17 | 0.15 | 0.19 | 0.26 | 0.19 |
| P44 | 0.22 | 0.31 | 0.40 | 0.29 | 0.07 | 0.18 | 0.21 | 0.17 | 0.25 | 0.33 | 0.27 | 0.23 |
| P45 | 0.06 | 0.12 | 0.11 | 0.22 | 0.07 | 0.15 | 0.23 | 0.24 | 0.35 | 0.30 | 0.14 | 0.22 |
| P46 | 0.03 | 0.13 | 0.07 | 0.13 | 0.10 | 0.13 | 0.10 | 0.25 | 0.41 | 0.43 | 0.11 | 0.20 |
| P47 | 0.11 | 0.09 | 0.10 | 0.17 | 0.10 | 0.22 | 0.24 | 0.24 | 0.35 | 0.34 | 0.14 | 0.23 |
| P48 | 0.03 | 0.05 | 0.14 | 0.03 | 0.13 | 0.22 | 0.25 | 0.25 | 0.43 | 0.46 | 0.12 | 0.24 |
| P49 | 0.24 | 0.34 | 0.29 | 0.34 | 0.17 | 0.28 | 0.24 | 0.31 | 0.46 | 0.51 | 0.29 | 0.32 |
| P50 | 0.25 | 0.33 | 0.23 | 0.23 | 0.05 | 0.18 | 0.17 | 0.31 | 0.35 | 0.37 | 0.23 | 0.24 |
| P51 | 0.31 | 0.40 | 0.26 | 0.31 | 0.04 | 0.25 | 0.31 | 0.39 | 0.60 | 0.76 | 0.29 | 0.36 |
| P52 | 0.13 | 0.18 | 0.16 | 0.14 | 0.08 | 0.28 | 0.38 | 0.32 | 0.37 | 0.67 | 0.19 | 0.30 |
| P53 | 0.18 | 0.30 | 0.12 | 0.28 | 0.12 | 0.27 | 0.36 | 0.25 | 0.20 | 0.69 | 0.23 | 0.28 |
| P54 | 0.38 | 0.45 | 0.38 | 0.48 | 0.23 | 0.28 | 0.35 | 0.35 | 0.41 | 0.47 | 0.38 | 0.37 |
| P55 | 0.45 | 0.52 | 0.43 | 0.50 | 0.23 | 0.25 | 0.28 | 0.35 | 0.53 | 0.78 | 0.41 | 0.40 |
| P56 | 0.53 | 0.60 | 0.42 | 0.51 | 0.21 | 0.27 | 0.27 | 0.28 | 0.49 | 0.79 | 0.42 | 0.38 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P57 | 0.54 | 0.60 | 0.40 | 0.50 | 0.20 | 0.34 | 0.30 | 0.36 | 0.53 | 0.80 | 0.43 | 0.41 |
| P58 | 0.54 | 0.59 | 0.44 | 0.48 | 0.23 | 0.37 | 0.30 | 0.39 | 0.57 | 0.81 | 0.44 | 0.43 |
| P59 | 0.49 | 0.53 | 0.38 | 0.44 | 0.25 | 0.37 | 0.29 | 0.40 | 0.45 | 0.79 | 0.41 | 0.40 |
| P60 | 0.50 | 0.56 | 0.57 | 0.38 | 0.30 | 0.39 | 0.31 | 0.41 | 0.57 | 0.69 | 0.46 | 0.43 |
| S1 | 0.20 | 0.20 | 0.38 | 0.23 | 0.24 | 0.11 | 0.25 | 0.52 | 0.50 | 0.43 | 0.28 | 0.34 |
| S2 | 0.19 | 0.21 | 0.40 | 0.26 | 0.16 | 0.12 | 0.28 | 0.53 | 0.50 | 0.47 | 0.28 | 0.35 |
| S3 | 0.21 | 0.24 | 0.42 | 0.07 | 0.11 | 0.40 | 0.30 | 0.60 | 0.56 | 0.53 | 0.29 | 0.39 |
| S4 | 0.08 | 0.20 | 0.44 | 0.28 | 0.15 | 0.14 | 0.11 | 0.34 | 0.29 | 0.33 | 0.25 | 0.26 |
| S5 | 0.08 | 0.19 | 0.47 | 0.31 | 0.40 | 0.23 | 0.20 | 0.04 | 0.05 | 0.10 | 0.28 | 0.20 |
| S6 | 0.04 | 0.05 | 0.08 | 0.05 | 0.12 | 0.14 | 0.15 | 0.36 | 0.32 | 0.37 | 0.10 | 0.21 |
| S7 | 0.25 | 0.21 | 0.31 | 0.15 | 0.08 | 0.11 | 0.48 | 0.57 | 0.52 | 0.42 | 0.26 | 0.36 |
| S8 | 0.48 | 0.52 | 0.48 | 0.39 | 0.29 | 0.37 | 0.29 | 0.39 | 0.50 | 0.75 | 0.42 | 0.41 |
| S9 | 0.49 | 0.54 | 0.35 | 0.45 | 0.19 | 0.33 | 0.27 | 0.36 | 0.40 | 0.70 | 0.39 | 0.37 |
| S10 | 0.35 | 0.44 | 0.37 | 0.46 | 0.23 | 0.11 | 0.17 | 0.19 | 0.09 | 0.13 | 0.33 | 0.21 |
| S11 | 0.11 | 0.22 | 0.35 | 0.18 | 0.02 | 0.19 | 0.27 | 0.26 | 0.30 | 0.39 | 0.22 | 0.25 |
| S12 | 0.02 | 0.07 | 0.04 | 0.11 | 0.03 | 0.14 | 0.22 | 0.23 | 0.30 | 0.31 | 0.09 | 0.18 |
| S13 | 0.15 | 0.16 | 0.36 | 0.19 | 0.04 | 0.11 | 0.12 | 0.18 | 0.35 | 0.54 | 0.19 | 0.22 |
| S14 | 0.24 | 0.34 | 0.31 | 0.34 | 0.09 | 0.24 | 0.26 | 0.31 | 0.43 | 0.50 | 0.28 | 0.31 |
| S15 | 0.21 | 0.29 | 0.35 | 0.31 | 0.12 | 0.20 | 0.22 | 0.21 | 0.23 | 0.29 | 0.26 | 0.24 |
| S16 | 0.10 | 0.17 | 0.15 | 0.10 | 0.06 | 0.24 | 0.24 | 0.28 | 0.26 | 0.27 | 0.16 | 0.21 |
| S17 | 0.09 | 0.11 | 0.16 | 0.08 | 0.08 | 0.24 | 0.23 | 0.38 | 0.24 | 0.29 | 0.16 | 0.23 |
| S18 | 0.28 | 0.40 | 0.36 | 0.48 | 0.25 | 0.06 | 0.21 | 0.29 | 0.13 | 0.17 | 0.33 | 0.25 |
| S19 | 0.31 | 0.46 | 0.27 | 0.34 | 0.22 | 0.20 | 0.30 | 0.36 | 0.36 | 0.59 | 0.32 | 0.32 |

| Proposed Scheme (VR) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NE | ENE | E | ESE | SE | SSE | S | SSW | SW | WSW | Annual | Summer |
| O1 | 0.07 | 0.05 | 0.06 | 0.34 | 0.41 | 0.39 | 0.37 | 0.50 | 0.57 | 0.65 | 0.22 | 0.41 |
| O2 | 0.16 | 0.08 | 0.04 | 0.02 | 0.23 | 0.05 | 0.09 | 0.09 | 0.10 | 0.11 | 0.08 | 0.09 |
| O3 | 0.02 | 0.07 | 0.16 | 0.09 | 0.23 | 0.31 | 0.18 | 0.20 | 0.02 | 0.33 | 0.14 | 0.18 |
| O4 | 0.08 | 0.24 | 0.21 | 0.24 | 0.27 | 0.39 | 0.09 | 0.47 | 0.38 | 0.59 | 0.24 | 0.32 |
| O5 | 0.09 | 0.34 | 0.29 | 0.48 | 0.54 | 0.28 | 0.04 | 0.51 | 0.06 | 0.34 | 0.33 | 0.31 |
| O6 | 0.09 | 0.15 | 0.29 | 0.41 | 0.20 | 0.07 | 0.19 | 0.52 | 0.20 | 0.28 | 0.25 | 0.29 |
| O7 | 0.08 | 0.17 | 0.24 | 0.41 | 0.28 | 0.14 | 0.19 | 0.60 | 0.39 | 0.41 | 0.26 | 0.35 |
| O8 | 0.15 | 0.08 | 0.02 | 0.15 | 0.16 | 0.14 | 0.05 | 0.07 | 0.07 | 0.26 | 0.09 | 0.10 |
| O9 | 0.06 | 0.10 | 0.22 | 0.33 | 0.35 | 0.32 | 0.24 | 0.57 | 0.21 | 0.12 | 0.25 | 0.32 |
| O10 | 0.02 | 0.08 | 0.16 | 0.32 | 0.34 | 0.39 | 0.26 | 0.11 | 0.05 | 0.16 | 0.19 | 0.21 |
| O11 | 0.08 | 0.15 | 0.17 | 0.06 | 0.15 | 0.07 | 0.18 | 0.36 | 0.21 | 0.15 | 0.15 | 0.19 |
| O12 | 0.10 | 0.13 | 0.19 | 0.12 | 0.26 | 0.13 | 0.01 | 0.04 | 0.14 | 0.15 | 0.13 | 0.11 |
| O13 | 0.04 | 0.17 | 0.16 | 0.16 | 0.29 | 0.25 | 0.12 | 0.24 | 0.07 | 0.18 | 0.17 | 0.18 |
| O14 | 0.18 | 0.17 | 0.23 | 0.28 | 0.42 | 0.42 | 0.27 | 0.08 | 0.30 | 0.32 | 0.25 | 0.27 |
| O15 | 0.09 | 0.28 | 0.20 | 0.44 | 0.15 | 0.25 | 0.13 | 0.10 | 0.03 | 0.03 | 0.22 | 0.16 |
| O16 | 0.29 | 0.10 | 0.16 | 0.09 | 0.14 | 0.74 | 0.33 | 0.40 | 0.42 | 0.15 | 0.22 | 0.32 |
| O17 | 0.15 | 0.06 | 0.12 | 0.48 | 0.43 | 0.14 | 0.13 | 0.10 | 0.08 | 0.01 | 0.20 | 0.18 |
| O18 | 0.03 | 0.04 | 0.03 | 0.08 | 0.11 | 0.10 | 0.22 | 0.17 | 0.14 | 0.21 | 0.08 | 0.14 |
| O19 | 0.05 | 0.03 | 0.03 | 0.05 | 0.09 | 0.36 | 0.29 | 0.21 | 0.19 | 0.09 | 0.10 | 0.18 |
| O20 | 0.02 | 0.03 | 0.02 | 0.10 | 0.14 | 0.17 | 0.10 | 0.06 | 0.05 | 0.07 | 0.07 | 0.09 |
| O21 | 0.07 | 0.31 | 0.23 | 0.26 | 0.51 | 0.29 | 0.17 | 0.55 | 0.47 | 0.48 | 0.29 | 0.37 |
| O22 | 0.03 | 0.21 | 0.20 | 0.03 | 0.05 | 0.13 | 0.18 | 0.30 | 0.34 | 0.11 | 0.15 | 0.19 |
| O23 | 0.01 | 0.08 | 0.16 | 0.11 | 0.15 | 0.02 | 0.05 | 0.16 | 0.13 | 0.09 | 0.10 | 0.11 |
| O24 | 0.06 | 0.05 | 0.30 | 0.17 | 0.20 | 0.17 | 0.32 | 0.19 | 0.22 | 0.27 | 0.19 | 0.23 |
| O25 | 0.03 | 0.06 | 0.47 | 0.40 | 0.30 | 0.24 | 0.27 | 0.11 | 0.12 | 0.05 | 0.27 | 0.24 |
| O26 | 0.04 | 0.05 | 0.41 | 0.26 | 0.12 | 0.04 | 0.21 | 0.15 | 0.06 | 0.08 | 0.20 | 0.17 |
| O27 | 0.04 | 0.11 | 0.33 | 0.30 | 0.19 | 0.08 | 0.09 | 0.04 | 0.15 | 0.05 | 0.18 | 0.14 |
| O28 | 0.06 | 0.08 | 0.65 | 0.42 | 0.26 | 0.06 | 0.04 | 0.40 | 0.51 | 0.46 | 0.31 | 0.33 |
| O29 | 0.08 | 0.11 | 0.29 | 0.26 | 0.22 | 0.08 | 0.34 | 0.12 | 0.07 | 0.09 | 0.20 | 0.19 |
| O30 | 0.02 | 0.12 | 0.38 | 0.43 | 0.05 | 0.34 | 0.11 | 0.16 | 0.12 | 0.09 | 0.23 | 0.20 |
| O31 | 0.09 | 0.05 | 0.31 | 0.56 | 0.55 | 0.59 | 0.66 | 0.28 | 0.27 | 0.12 | 0.35 | 0.43 |
| O32 | 0.22 | 0.16 | 0.32 | 0.27 | 0.31 | 0.05 | 0.12 | 0.04 | 0.01 | 0.12 | 0.21 | 0.14 |
| O33 | 0.24 | 0.21 | 0.25 | 0.02 | 0.07 | 0.06 | 0.32 | 0.18 | 0.08 | 0.14 | 0.18 | 0.15 |
| O34 | 0.17 | 0.25 | 0.28 | 0.14 | 0.11 | 0.04 | 0.40 | 0.23 | 0.16 | 0.14 | 0.22 | 0.21 |
| O35 | 0.21 | 0.23 | 0.28 | 0.09 | 0.30 | 0.26 | 0.30 | 0.18 | 0.13 | 0.14 | 0.23 | 0.21 |
| O36 | 0.05 | 0.18 | 0.07 | 0.27 | 0.37 | 0.35 | 0.47 | 0.26 | 0.24 | 0.08 | 0.22 | 0.28 |
| O37 | 0.03 | 0.13 | 0.12 | 0.49 | 0.38 | 0.15 | 0.06 | 0.12 | 0.08 | 0.05 | 0.19 | 0.17 |
| O38 | 0.08 | 0.06 | 0.37 | 0.31 | 0.31 | 0.13 | 0.10 | 0.25 | 0.26 | 0.12 | 0.22 | 0.23 |
| O39 | 0.16 | 0.17 | 0.04 | 0.13 | 0.03 | 0.06 | 0.11 | 0.05 | 0.07 | 0.05 | 0.10 | 0.07 |
| O40 | 0.06 | 0.03 | 0.05 | 0.03 | 0.13 | 0.21 | 0.09 | 0.15 | 0.14 | 0.09 | 0.08 | 0.11 |
| O41 | 0.08 | 0.10 | 0.11 | 0.24 | 0.07 | 0.03 | 0.18 | 0.08 | 0.06 | 0.07 | 0.12 | 0.11 |
| O42 | 0.05 | 0.10 | 0.09 | 0.26 | 0.08 | 0.28 | 0.17 | 0.15 | 0.15 | 0.02 | 0.14 | 0.16 |
| O43 | 0.10 | 0.06 | 0.05 | 0.06 | 0.03 | 0.05 | 0.08 | 0.17 | 0.14 | 0.04 | 0.07 | 0.09 |
| O44 | 0.08 | 0.18 | 0.21 | 0.48 | 0.25 | 0.16 | 0.11 | 0.57 | 0.43 | 0.40 | 0.26 | 0.34 |
| O45 | 0.13 | 0.25 | 0.17 | 0.40 | 0.47 | 0.15 | 0.14 | 0.58 | 0.44 | 0.49 | 0.28 | 0.36 |
| O46 | 0.12 | 0.27 | 0.21 | 0.40 | 0.41 | 0.15 | 0.08 | 0.20 | 0.27 | 0.27 | 0.25 | 0.24 |
| O47 | 0.03 | 0.22 | 0.50 | 0.04 | 0.43 | 0.34 | 0.43 | 0.55 | 0.47 | 0.25 | 0.31 | 0.40 |
| O48 | 0.08 | 0.24 | 0.42 | 0.13 | 0.22 | 0.20 | 0.33 | 0.53 | 0.49 | 0.25 | 0.28 | 0.35 |
| O49 | 0.03 | 0.21 | 0.55 | 0.12 | 0.44 | 0.47 | 0.50 | 0.48 | 0.45 | 0.28 | 0.35 | 0.43 |
| O50 | 0.04 | 0.16 | 0.52 | 0.21 | 0.19 | 0.24 | 0.50 | 0.36 | 0.48 | 0.35 | 0.30 | 0.37 |
| O51 | 0.05 | 0.23 | 0.25 | 0.51 | 0.36 | 0.19 | 0.14 | 0.46 | 0.42 | 0.48 | 0.28 | 0.35 |
| O52 | 0.01 | 0.11 | 0.20 | 0.44 | 0.37 | 0.23 | 0.24 | 0.43 | 0.53 | 0.46 | 0.24 | 0.36 |
| O53 | 0.02 | 0.16 | 0.05 | 0.10 | 0.32 | 0.42 | 0.44 | 0.36 | 0.54 | 0.21 | 0.19 | 0.33 |
| O54 | 0.03 | 0.14 | 0.28 | 0.14 | 0.15 | 0.10 | 0.23 | 0.48 | 0.50 | 0.34 | 0.20 | 0.30 |
| O55 | 0.09 | 0.12 | 0.37 | 0.28 | 0.33 | 0.16 | 0.17 | 0.46 | 0.57 | 0.49 | 0.26 | 0.35 |
| O56 | 0.13 | 0.23 | 0.26 | 0.48 | 0.42 | 0.28 | 0.21 | 0.50 | 0.42 | 0.29 | 0.31 | 0.36 |
| O57 | 0.16 | 0.20 | 0.44 | 0.50 | 0.42 | 0.25 | 0.14 | 0.53 | 0.45 | 0.47 | 0.35 | 0.39 |
| O58 | 0.21 | 0.17 | 0.58 | 0.55 | 0.40 | 0.22 | 0.24 | 0.57 | 0.62 | 0.54 | 0.40 | 0.46 |
| O59 | 0.21 | 0.24 | 0.63 | 0.51 | 0.37 | 0.21 | 0.12 | 0.52 | 0.49 | 0.55 | 0.40 | 0.41 |
| O60 | 0.02 | 0.09 | 0.40 | 0.26 | 0.11 | 0.11 | 0.34 | 0.39 | 0.49 | 0.37 | 0.23 | 0.32 |
| O61 | 0.13 | 0.12 | 0.20 | 0.26 | 0.17 | 0.04 | 0.03 | 0.07 | 0.03 | 0.03 | 0.15 | 0.10 |

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

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O125 | 0.22 | 0.13 | 0.13 | 0.09 | 0.18 | 0.09 | 0.11 | 0.12 | 0.04 | 0.01 | 0.13 | 0.10 |
| O126 | 0.09 | 0.15 | 0.08 | 0.40 | 0.14 | 0.10 | 0.05 | 0.04 | 0.13 | 0.03 | 0.14 | 0.11 |
| O127 | 0.12 | 0.10 | 0.14 | 0.37 | 0.46 | 0.52 | 0.44 | 0.38 | 0.33 | 0.06 | 0.27 | 0.36 |
| O128 | 0.07 | 0.05 | 0.47 | 0.53 | 0.55 | 0.47 | 0.20 | 0.19 | 0.13 | 0.13 | 0.33 | 0.31 |
| O129 | 0.04 | 0.02 | 0.08 | 0.12 | 0.15 | 0.16 | 0.01 | 0.16 | 0.12 | 0.12 | 0.09 | 0.11 |
| O130 | 0.07 | 0.11 | 0.12 | 0.16 | 0.08 | 0.04 | 0.11 | 0.25 | 0.07 | 0.16 | 0.12 | 0.13 |
| O131 | 0.27 | 0.14 | 0.37 | 0.21 | 0.37 | 0.39 | 0.33 | 0.30 | 0.32 | 0.17 | 0.29 | 0.31 |
| P1 | 0.28 | 0.14 | 0.33 | 0.03 | 0.18 | 0.20 | 0.34 | 0.55 | 0.49 | 0.26 | 0.24 | 0.33 |
| P2 | 0.30 | 0.11 | 0.26 | 0.03 | 0.13 | 0.05 | 0.14 | 0.62 | 0.54 | 0.39 | 0.19 | 0.29 |
| P3 | 0.20 | 0.04 | 0.13 | 0.04 | 0.03 | 0.04 | 0.18 | 0.16 | 0.15 | 0.15 | 0.10 | 0.12 |
| P4 | 0.20 | 0.04 | 0.04 | 0.02 | 0.09 | 0.05 | 0.17 | 0.21 | 0.21 | 0.19 | 0.08 | 0.13 |
| P5 | 0.27 | 0.20 | 0.47 | 0.21 | 0.06 | 0.06 | 0.25 | 0.48 | 0.43 | 0.33 | 0.28 | 0.30 |
| P6 | 0.26 | 0.17 | 0.38 | 0.18 | 0.28 | 0.15 | 0.15 | 0.53 | 0.48 | 0.34 | 0.27 | 0.32 |
| P7 | 0.22 | 0.16 | 0.39 | 0.19 | 0.29 | 0.28 | 0.34 | 0.30 | 0.27 | 0.30 | 0.27 | 0.30 |
| P8 | 0.20 | 0.16 | 0.47 | 0.25 | 0.28 | 0.44 | 0.42 | 0.16 | 0.18 | 0.23 | 0.30 | 0.30 |
| P9 | 0.14 | 0.13 | 0.43 | 0.24 | 0.12 | 0.13 | 0.15 | 0.17 | 0.15 | 0.23 | 0.22 | 0.19 |
| P10 | 0.06 | 0.13 | 0.48 | 0.28 | 0.21 | 0.15 | 0.23 | 0.11 | 0.10 | 0.05 | 0.24 | 0.19 |
| P11 | 0.04 | 0.17 | 0.56 | 0.34 | 0.29 | 0.18 | 0.29 | 0.06 | 0.03 | 0.02 | 0.29 | 0.21 |
| P12 | 0.12 | 0.14 | 0.43 | 0.33 | 0.17 | 0.04 | 0.00 | 0.06 | 0.07 | 0.03 | 0.21 | 0.12 |
| P13 | 0.09 | 0.25 | 0.40 | 0.37 | 0.41 | 0.08 | 0.08 | 0.07 | 0.06 | 0.15 | 0.26 | 0.18 |
| P14 | 0.18 | 0.18 | 0.41 | 0.31 | 0.15 | 0.64 | 0.65 | 0.08 | 0.06 | 0.04 | 0.32 | 0.30 |
| P15 | 0.16 | 0.21 | 0.59 | 0.42 | 0.17 | 0.62 | 0.70 | 0.36 | 0.26 | 0.04 | 0.41 | 0.42 |
| P16 | 0.06 | 0.21 | 0.59 | 0.42 | 0.18 | 0.54 | 0.60 | 0.49 | 0.40 | 0.10 | 0.40 | 0.45 |
| P17 | 0.13 | 0.23 | 0.59 | 0.41 | 0.10 | 0.53 | 0.60 | 0.38 | 0.29 | 0.07 | 0.39 | 0.39 |
| P18 | 0.02 | 0.23 | 0.43 | 0.26 | 0.25 | 0.28 | 0.21 | 0.25 | 0.19 | 0.12 | 0.27 | 0.25 |
| P19 | 0.00 | 0.22 | 0.42 | 0.24 | 0.28 | 0.19 | 0.06 | 0.20 | 0.13 | 0.11 | 0.24 | 0.19 |
| P20 | 0.03 | 0.16 | 0.39 | 0.25 | 0.34 | 0.31 | 0.37 | 0.18 | 0.16 | 0.17 | 0.27 | 0.27 |
| P21 | 0.04 | 0.22 | 0.43 | 0.23 | 0.06 | 0.23 | 0.29 | 0.15 | 0.12 | 0.15 | 0.24 | 0.20 |
| P22 | 0.01 | 0.14 | 0.36 | 0.16 | 0.52 | 0.39 | 0.34 | 0.32 | 0.27 | 0.41 | 0.27 | 0.34 |
| P23 | 0.05 | 0.06 | 0.15 | 0.04 | 0.30 | 0.28 | 0.22 | 0.33 | 0.28 | 0.42 | 0.15 | 0.25 |
| P24 | 0.05 | 0.09 | 0.12 | 0.04 | 0.27 | 0.29 | 0.24 | 0.28 | 0.27 | 0.41 | 0.15 | 0.24 |
| P25 | 0.02 | 0.18 | 0.18 | 0.07 | 0.45 | 0.49 | 0.40 | 0.28 | 0.28 | 0.43 | 0.22 | 0.32 |
| P26 | 0.02 | 0.23 | 0.27 | 0.08 | 0.38 | 0.45 | 0.41 | 0.43 | 0.31 | 0.46 | 0.26 | 0.35 |
| P27 | 0.04 | 0.23 | 0.20 | 0.09 | 0.54 | 0.53 | 0.40 | 0.42 | 0.40 | 0.38 | 0.27 | 0.37 |
| P28 | 0.16 | 0.07 | 0.04 | 0.05 | 0.27 | 0.38 | 0.33 | 0.51 | 0.46 | 0.39 | 0.17 | 0.33 |
| P29 | 0.17 | 0.08 | 0.05 | 0.07 | 0.23 | 0.33 | 0.29 | 0.46 | 0.41 | 0.35 | 0.16 | 0.29 |
| P30 | 0.13 | 0.03 | 0.02 | 0.09 | 0.31 | 0.34 | 0.24 | 0.50 | 0.46 | 0.33 | 0.16 | 0.31 |
| P31 | 0.35 | 0.36 | 0.56 | 0.54 | 0.33 | 0.19 | 0.11 | 0.27 | 0.38 | 0.50 | 0.39 | 0.33 |
| P32 | 0.33 | 0.28 | 0.23 | 0.32 | 0.31 | 0.05 | 0.21 | 0.25 | 0.20 | 0.45 | 0.26 | 0.24 |
| P33 | 0.26 | 0.23 | 0.13 | 0.02 | 0.02 | 0.04 | 0.24 | 0.37 | 0.11 | 0.39 | 0.16 | 0.18 |
| P34 | 0.33 | 0.32 | 0.05 | 0.20 | 0.05 | 0.03 | 0.21 | 0.35 | 0.23 | 0.49 | 0.19 | 0.21 |
| P35 | 0.19 | 0.26 | 0.10 | 0.26 | 0.02 | 0.02 | 0.14 | 0.40 | 0.21 | 0.15 | 0.18 | 0.19 |
| P36 | 0.17 | 0.27 | 0.23 | 0.30 | 0.10 | 0.02 | 0.20 | 0.23 | 0.20 | 0.32 | 0.21 | 0.20 |
| P37 | 0.44 | 0.40 | 0.62 | 0.50 | 0.29 | 0.26 | 0.34 | 0.71 | 0.47 | 0.62 | 0.47 | 0.48 |
| P38 | 0.39 | 0.35 | 0.53 | 0.45 | 0.25 | 0.24 | 0.28 | 0.60 | 0.41 | 0.57 | 0.41 | 0.42 |
| P39 | 0.24 | 0.29 | 0.39 | 0.32 | 0.22 | 0.22 | 0.21 | 0.48 | 0.34 | 0.51 | 0.31 | 0.34 |
| P40 | 0.25 | 0.23 | 0.33 | 0.29 | 0.19 | 0.21 | 0.20 | 0.38 | 0.28 | 0.39 | 0.27 | 0.29 |
| P41 | 0.42 | 0.45 | 0.67 | 0.49 | 0.26 | 0.28 | 0.25 | 0.56 | 0.42 | 0.58 | 0.47 | 0.43 |
| P42 | 0.11 | 0.19 | 0.18 | 0.17 | 0.09 | 0.14 | 0.18 | 0.23 | 0.35 | 0.61 | 0.17 | 0.23 |
| P43 | 0.14 | 0.23 | 0.30 | 0.20 | 0.12 | 0.01 | 0.13 | 0.11 | 0.21 | 0.36 | 0.19 | 0.17 |
| P44 | 0.06 | 0.19 | 0.39 | 0.21 | 0.10 | 0.03 | 0.25 | 0.16 | 0.24 | 0.63 | 0.21 | 0.23 |
| P45 | 0.12 | 0.07 | 0.34 | 0.12 | 0.05 | 0.10 | 0.28 | 0.21 | 0.47 | 0.68 | 0.18 | 0.27 |
| P46 | 0.15 | 0.11 | 0.34 | 0.05 | 0.04 | 0.02 | 0.27 | 0.26 | 0.49 | 0.70 | 0.17 | 0.26 |
| P47 | 0.13 | 0.06 | 0.23 | 0.05 | 0.05 | 0.11 | 0.31 | 0.28 | 0.45 | 0.64 | 0.15 | 0.26 |
| P48 | 0.07 | 0.06 | 0.26 | 0.05 | 0.01 | 0.18 | 0.18 | 0.13 | 0.33 | 0.43 | 0.13 | 0.19 |
| P49 | 0.06 | 0.06 | 0.06 | 0.15 | 0.04 | 0.16 | 0.25 | 0.23 | 0.26 | 0.08 | 0.11 | 0.17 |
| P50 | 0.10 | 0.21 | 0.14 | 0.17 | 0.08 | 0.05 | 0.15 | 0.21 | 0.46 | 0.72 | 0.15 | 0.23 |
| P51 | 0.20 | 0.29 | 0.10 | 0.20 | 0.08 | 0.17 | 0.31 | 0.25 | 0.29 | 0.15 | 0.19 | 0.21 |
| P52 | 0.30 | 0.33 | 0.12 | 0.19 | 0.06 | 0.23 | 0.40 | 0.41 | 0.15 | 0.46 | 0.24 | 0.27 |
| P53 | 0.46 | 0.50 | 0.17 | 0.20 | 0.02 | 0.20 | 0.36 | 0.32 | 0.19 | 0.56 | 0.28 | 0.26 |
| P54 | 0.13 | 0.13 | 0.18 | 0.17 | 0.09 | 0.13 | 0.29 | 0.29 | 0.22 | 0.35 | 0.17 | 0.22 |
| P55 | 0.15 | 0.10 | 0.17 | 0.16 | 0.15 | 0.20 | 0.39 | 0.42 | 0.32 | 0.42 | 0.20 | 0.30 |
| P56 | 0.06 | 0.06 | 0.15 | 0.12 | 0.17 | 0.25 | 0.40 | 0.36 | 0.30 | 0.39 | 0.17 | 0.28 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P57 | 0.21 | 0.06 | 0.18 | 0.17 | 0.08 | 0.23 | 0.43 | 0.50 | 0.50 | 0.63 | 0.20 | 0.36 |
| P58 | 0.40 | 0.26 | 0.10 | 0.22 | 0.08 | 0.22 | 0.42 | 0.51 | 0.49 | 0.59 | 0.25 | 0.35 |
| P59 | 0.09 | 0.09 | 0.06 | 0.18 | 0.09 | 0.20 | 0.37 | 0.43 | 0.46 | 0.57 | 0.16 | 0.31 |
| P60 | 0.52 | 0.55 | 0.53 | 0.49 | 0.31 | 0.22 | 0.41 | 0.50 | 0.49 | 0.60 | 0.47 | 0.44 |
| S1 | 0.20 | 0.19 | 0.45 | 0.19 | 0.30 | 0.27 | 0.29 | 0.27 | 0.25 | 0.31 | 0.28 | 0.29 |
| S2 | 0.20 | 0.02 | 0.05 | 0.01 | 0.09 | 0.04 | 0.16 | 0.42 | 0.41 | 0.38 | 0.10 | 0.21 |
| S3 | 0.21 | 0.09 | 0.02 | 0.01 | 0.09 | 0.14 | 0.25 | 0.54 | 0.51 | 0.42 | 0.13 | 0.28 |
| S4 | 0.06 | 0.19 | 0.22 | 0.15 | 0.41 | 0.47 | 0.42 | 0.26 | 0.17 | 0.18 | 0.24 | 0.29 |
| S5 | 0.01 | 0.17 | 0.10 | 0.02 | 0.05 | 0.04 | 0.18 | 0.09 | 0.06 | 0.05 | 0.09 | 0.08 |
| S6 | 0.03 | 0.13 | 0.18 | 0.04 | 0.45 | 0.45 | 0.40 | 0.34 | 0.27 | 0.44 | 0.21 | 0.32 |
| S7 | 0.14 | 0.04 | 0.05 | 0.09 | 0.21 | 0.33 | 0.29 | 0.43 | 0.38 | 0.31 | 0.15 | 0.28 |
| S8 | 0.54 | 0.56 | 0.43 | 0.39 | 0.22 | 0.21 | 0.39 | 0.48 | 0.49 | 0.63 | 0.42 | 0.41 |
| S9 | 0.14 | 0.15 | 0.10 | 0.23 | 0.12 | 0.22 | 0.41 | 0.49 | 0.53 | 0.63 | 0.20 | 0.36 |
| S10 | 0.10 | 0.12 | 0.11 | 0.10 | 0.02 | 0.28 | 0.48 | 0.52 | 0.46 | 0.49 | 0.18 | 0.34 |
| S11 | 0.32 | 0.31 | 0.13 | 0.16 | 0.06 | 0.24 | 0.44 | 0.43 | 0.26 | 0.29 | 0.24 | 0.28 |
| S12 | 0.22 | 0.15 | 0.15 | 0.03 | 0.06 | 0.15 | 0.42 | 0.43 | 0.44 | 0.68 | 0.18 | 0.31 |
| S13 | 0.06 | 0.19 | 0.02 | 0.10 | 0.05 | 0.09 | 0.33 | 0.24 | 0.31 | 0.26 | 0.12 | 0.19 |
| S14 | 0.04 | 0.09 | 0.12 | 0.02 | 0.06 | 0.18 | 0.36 | 0.18 | 0.12 | 0.07 | 0.11 | 0.16 |
| S15 | 0.06 | 0.16 | 0.24 | 0.07 | 0.06 | 0.08 | 0.23 | 0.20 | 0.44 | 0.76 | 0.15 | 0.24 |
| S16 | 0.08 | 0.17 | 0.27 | 0.22 | 0.13 | 0.07 | 0.11 | 0.39 | 0.37 | 0.06 | 0.20 | 0.22 |
| S17 | 0.04 | 0.17 | 0.47 | 0.12 | 0.09 | 0.13 | 0.23 | 0.03 | 0.18 | 0.29 | 0.20 | 0.17 |
| S18 | 0.46 | 0.50 | 0.37 | 0.45 | 0.24 | 0.04 | 0.40 | 0.46 | 0.07 | 0.28 | 0.39 | 0.31 |
| S19 | 0.24 | 0.17 | 0.14 | 0.07 | 0.05 | 0.03 | 0.09 | 0.06 | 0.21 | 0.67 | 0.12 | 0.14 |