CONSULTANCY STUDY FOR AIR VENTILATION ASSESSMENT SERVICES

Cat. A1– Term Consultancy for Expert Evaluation on Air Ventilation Assessment (PLN AVA 2015)

Final Report

For an Instructed Project for Tai Po

June 2017

INSTITUTE OF Future Cities

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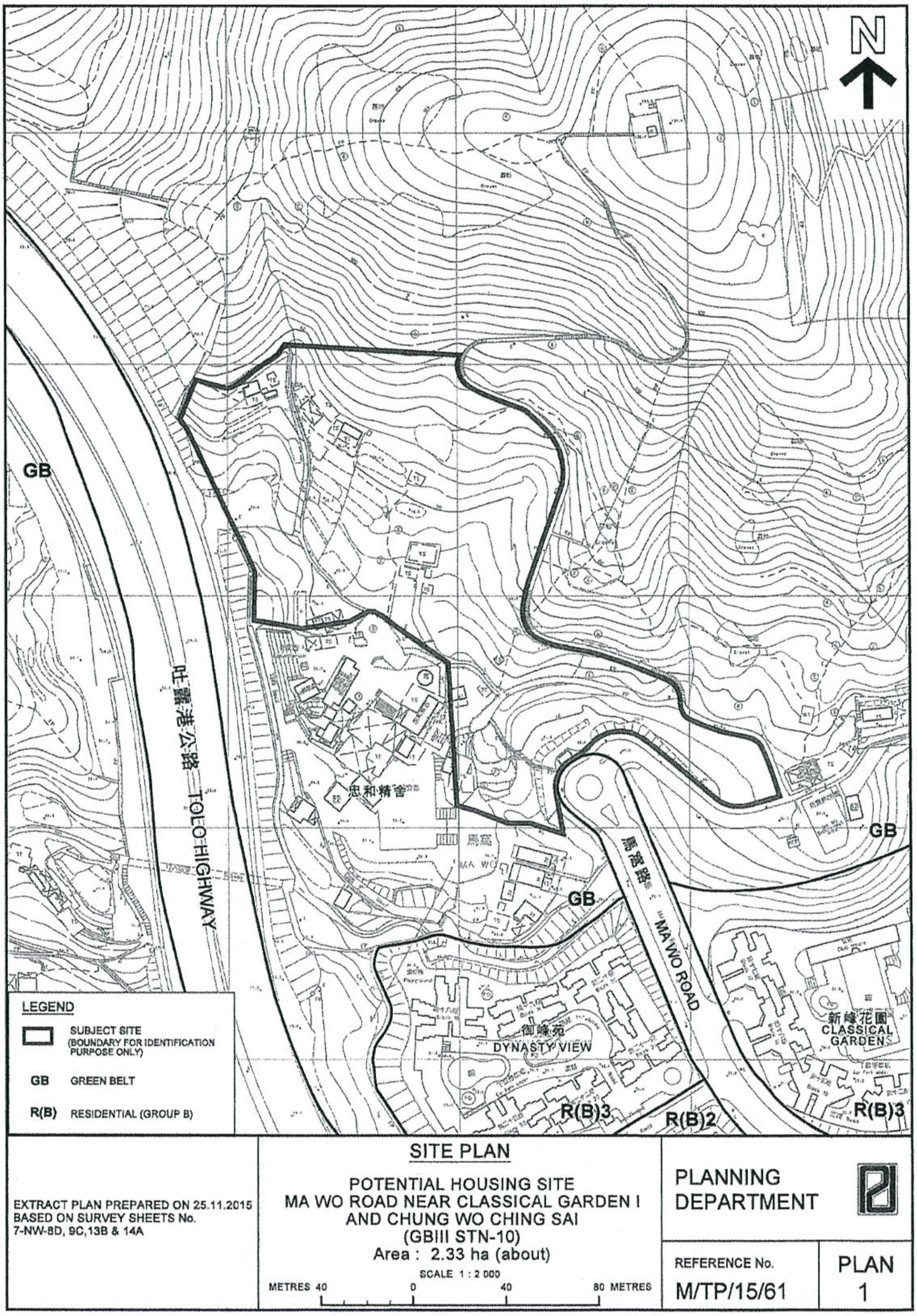
The Study Area



Expert Evaluation Report
for an Instructed Project for Tai Po

Executive summary

0.1 Wind Availability

(a) The annual wind of the Project Area mainly comes from the east (E) and southeast (SE). The summer wind of this area mainly comes from the east (E) southeast (SE), south (S) and southwest (SW).

0.2 Existing Conditions

(a) The Project Area has a relatively open exposure to the wind from the east as there are no immediate developments east of this project area. There are some developments including Dynasty View, Grand Dynasty View and Classical Gardens up to 65 mPD south of the Project Area. However, due to the higher ground level of the Project Area (above 60mPD), the wind from southerly quarters can flow into the Project Area over the surrounding developments.

0.3 Expert Evaluation of Project Areas

(a) In general, air ventilation can achieve better performance if measures, such as breezeways, air paths, open spaces, gaps between buildings and building permeability are applied. Especially reducing site coverage of the podia to allow more open space at grade is recommended.

(b) When prevailing wind comes from the east, southeast, south and southwest, the developments in the Project Area are likely to create some wake areas on the leeward side. However, there are no sensitive receivers in the surrounding areas, which are mostly "Green Belt". On the whole, proposed development in the Project Area will have no significant air ventilation impacts on the surrounding areas.

0.4 Further Work

(a) The Project area would have no major air ventilation issues. However, all future developments in the Project Area should consider the following design principles at the detailed design stage as the prevailing effort for improvement in urban climate.

- Minimization of podium bulk with ground coverage of no more than 65%;
- Building setback with reference to PNAP APP-152;

- Greenery (preferably tree planting) of no less than 30% for sites larger than 1 ha, and 20% for sites below 1 ha at lower levels, preferably at grade; and

- Avoid long and continuous façades.

大埔委託項目空氣流通專家評估報告

行政摘要

0.1 風環境資料

(a) 項目範圍的全年盛行風為東風和東南風。夏季的盛行風則以東風、東南風、南風和西南風為主。

0.2 目前的情況

(a) 項目範圍對於東風相對開敞迎風，因為項目範圍的東面並無近期發展。項目範圍的南面有一些發展區包括御峰苑、御峰豪園和新峰花園，達主水平基準上65米。然而，由於項目範圍有較高的地面上平(主水平基準上60米)，偏南風可穿透周圍發展而流通至項目範圍。

0.3 專家評估和建議

(a) 一般來說，如果採取措施例如通風廊、風道、休憩用地、樓宇間距和建築通透度，空氣流通表現更佳。特別建議減少平台的上蓋面積，在地面提供更多休憩用地。

(b) 當盛行風來自東、東南、南和西南方，項目範圍的發展有可能造成背風面的一些弱風區。然而，在周邊地區沒有易受空氣污染影響力的受體，主要為「綠化地帶」。整體而言，項目範圍的擬建發展對周圍地區對空氣流通影響不大。

0.4 進一步工作

(a) 項目範圍並無太大的空氣流通問題。然而，項目範圍內的所有未來發展應在詳細設計階段考慮以下的設計原則，以盡力改善城市氣候。

- 平台面積縮減至不超過地面覆蓋範圍的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》的樓宇向後退入；
- 於低層甚或地面進行綠化 (植樹更佳)，佔地超過1公頃的地盤的不少於30%，佔地少於1公頃的地盤的不少於20%；以及
- 避免連續/過長的外牆。

Expert Evaluation Report
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1.0 The Assignment

1.1 To increase land supply to meet the housing needs of Hong Kong, the Government has continued reviewing various land uses and rezoning sites as appropriate and, where the original intended use is no longer required, converting the land for housing development. A potential housing site in Tai Po Area was identified. It is considered necessary to conduct an Expert Evaluation to assess the preliminary air ventilation impacts of the proposed housing developments on the surrounding areas.

1.2 This expert evaluation report is based on the materials given by Planning Department (PlanD) to the Consultant including:

Site Plan of Project Area
Height of the existing buildings of surrounding areas
Wind information from Hong Kong Observatory and PlanD

1.3 The consultant has studied the foregoing materials. During the preparation of the report, the consultant has visited the site and conducted working sessions with PlanD.

2.0 Background

2.1 PlanD's study: "Feasibility Study for Establishment of Air Ventilation Assessment System" (Feasibility Study) has recommended that it is important to allow adequate air ventilation through the built environment for pedestrian comfort.

2.2 Given Hong Kong's high density urban development, the Feasibility Study opines that: "more air ventilation, the better" is the useful design guideline.

2.3 The Feasibility Study summarizes 10 qualitative guidelines for planners and designers. For the OZP level of consideration, breezeways/air paths, street grids and orientations, open spaces, non-building areas, waterfront sites, scales of podium, building heights, building dispositions, and greeneries are all important strategic considerations.

2.4 The Feasibility Study also suggests that Air Ventilation Assessment (AVA) be conducted in three stages: Expert Evaluation, Initial Studies, and Detailed Studies. The suggestion has been adopted and incorporated into Housing Planning and Lands Bureau (HPLB) and Environment, Transport and Works Bureau (ETWB) Technical Circular no. 1/06. The key purposes of Expert Evaluation are to the following:

(a) Identify good design features.

(b) Identify obvious problem areas and propose some mitigation measures.
(c) Define "focuses" and methodologies of the Initial and/or Detailed studies.
(d) Determine if further study should be staged into Initial Study and Detailed Study, or Detailed Study alone.

2.5 To conduct the Expert Evaluation systematically and methodologically, it is necessary to undertake the following information analyses:
(a) Analyse relevant wind data as the input conditions to understand the wind environment of the Area.
(b) Analyse the topographical features of the study area, as well as the surrounding areas.
(c) Analyse the greenery/landscape characteristics of the study area, as well as the surrounding areas.
(d) Analyse the land use and built form of the study area, as well as the surrounding areas.

Based on the analyses of site context and topography:
(e) Estimate the characteristics of the input wind conditions of the study area.
(f) Identify the wind paths and wind flow characteristics of the study area through slopes, open spaces, streets, gaps and non-building areas between buildings, and low rise buildings; also identify stagnant/problem areas, if any.
(g) Estimate the need of wind for pedestrian comfort.

Based on the analyses of the EXISTING urban conditions:
(h) Evaluate the strategic role of the study area in air ventilation term.
(i) Identify problematic areas which warrant attention.
(j) Identify existing "good features" that needs to be kept or strengthened.

Based on an understanding of the EXISTING urban conditions:
(k) Compare the prima facie impact, merits or demerits of the different development restrictions as proposed by PlanD on air ventilation.
(l) Highlight problem areas, if any. Recommend improvements and mitigation measures if possible.
(m) Identify focus areas or issues that may need further studies. Recommend appropriate technical methodologies for the study if needed.

3.0 The Wind Environment

3.1 Hong Kong Observatory (HKO) stations provide useful and reliable data on the wind environment in Hong Kong (Figure 3.1). There are some 46 stations operated by HKO in Hong Kong. Together, these stations allow for a good general understanding of the wind environment especially near ground level.

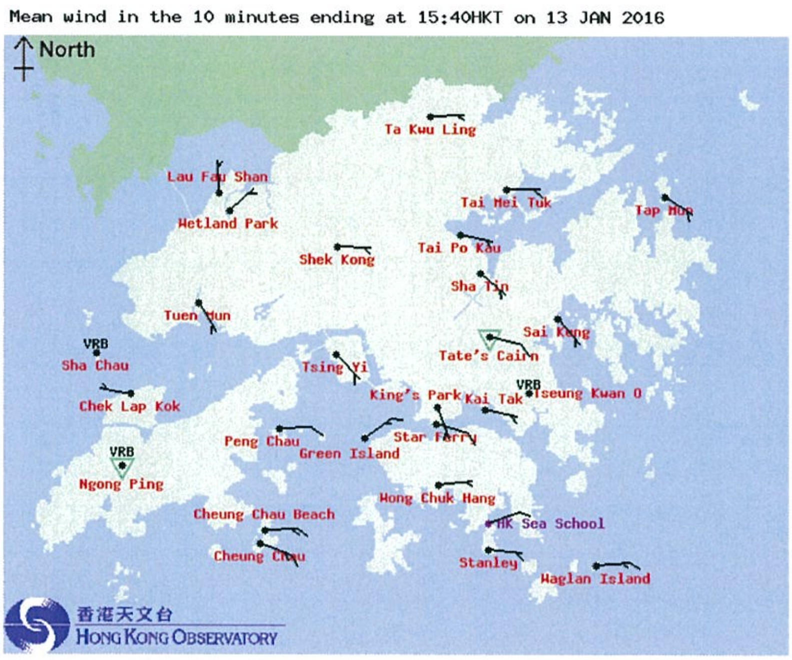

Figure 3.1 Some of the HKO stations in Hong Kong. This is a screen capture at 15:40 on 13 Jan 2016 from the HKO website. The arrows show the wind directions and speeds at the given time.

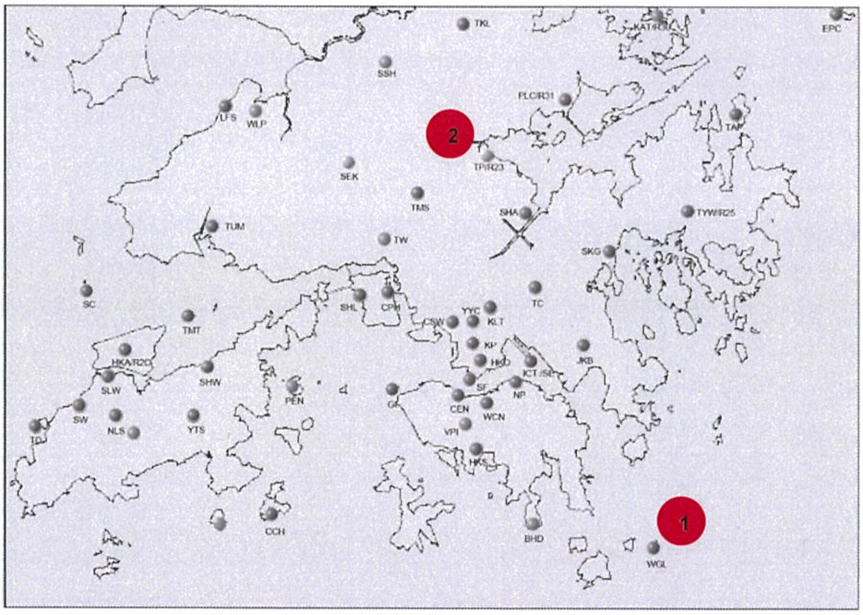

Figure 3.2 The HKO stations at 1: Waglan Island (WGL), 2: Tai Po.

3.2 The HKO station at Waglan Island (WGL) is normally regarded by wind engineers as the reference station for wind related studies (Location 1 in Figure 3.2). The station has a very long measurement record, and is unaffected by Hong Kong's complex topography. However it is known not to be able to capture the thermally induced local wind circulation like sea breezes very well. Based on WGL wind data, AVA studies are typically employed to estimate the site wind availability taking into account the topographical features around the site.

3.3 Based on the annual wind rose of WGL (Figure 3.3), it is apparent that the annual prevailing wind in Hong Kong is from the east. A major component of wind also comes from the northeast; and there is a minor, but nonetheless observable component from the southwest. WGL has weak to moderate wind (0.1m/s to 8.2 m/s) approximately 70% of the time.

3.4 For the AVA study, seasonally or monthly wind environment should be understood (Figures 3.4 and 3.5). During winter, the prevailing wind comes from the northeast, whereas during summer, it comes from the southwest. As far as AVA is concerned, in Hong Kong, the summer wind is very important and beneficial for thermal comfort. Hence, based on WGL data, it is very important to plan our city, on the one hand, to capture the annual wind characteristics, and on the other hand, to maximize the penetration of the summer winds (mainly from the South-West) into the urban fabric.

3.5 Apart from WGL, the wind data of Tai Po (Figure 3.6) have also been extracted from HKO for reference[1] (Figure 3.7 to Figure 3.9) as the nearest station measuring wind environment for the Project Area. It can be observed that the annual prevailing winds are mainly from the northeast and east. The summer prevailing winds are mainly from the northeast, east, southeast, southwest and west.

3.6 Noting the limitation of the data of Waglan Island mentioned in para. 3.2, wind characteristic from the web-based database system provided by PlanD has also been referred[2]. Data from the Project Area (x:078; y:069) were simulated at 200m, 300m and 500m above the ground (Figures 3.10). This location, according to the application of Regional Atmospheric Modeling System (RAMS), was selected to reflect the general wind patterns of the Project Area induced by topography. Prevailing wind directions are summarised in Table 1. As the HKO station at Tai Po is relatively far away from the Project Area and the surroundings of Tai Po are different from those of Project Area (Figure 3.6), the web-based wind data provided by PlanD is likely to be more representative to reflect the wind availability of the Project Area. Based on the wind data from the PlanD, it can be observed that the annual prevailing wind of the Project Area is mainly from east and southeast. The summer wind of Project Area mainly comes from the east, southeast, south and southwest. In general, the wind data from PlanD's website is consistent with that of Tai Po and Waglan Island.

[1] http://www.hko.gov.hk/cis/region_climat/TP/TP_windrose_year_e.htm
[2] http://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/index.html

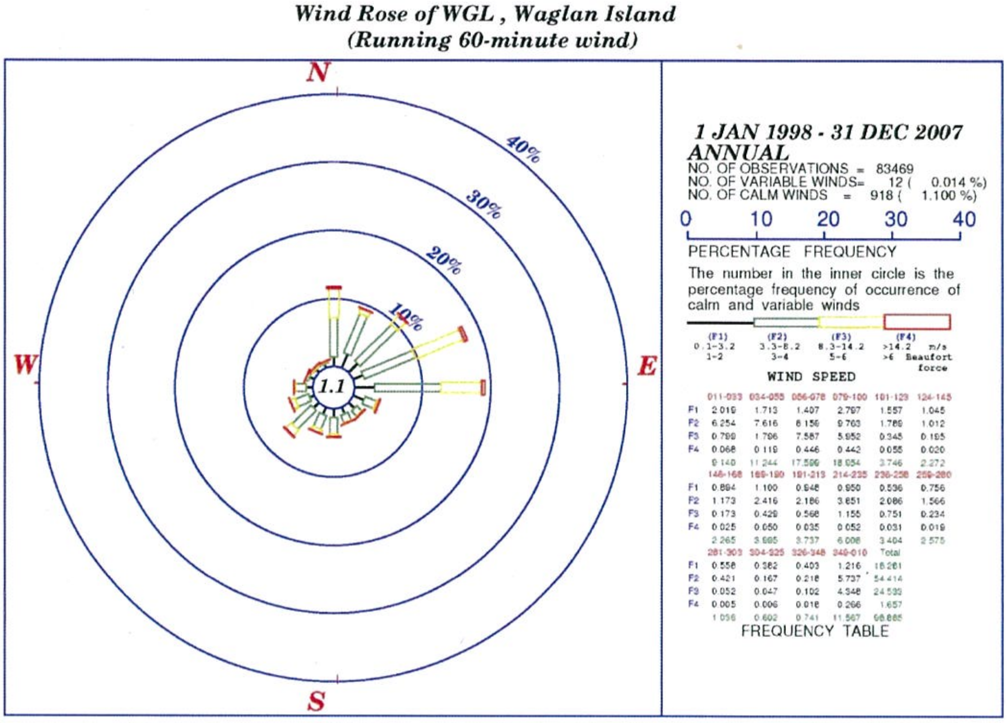

Figure 3.3 Wind rose of WGL from 1998 to 2007[1] (annual).

[1] Wind data from 1998 to 2007 are the latest available 10-year data from HKO to the consultant.

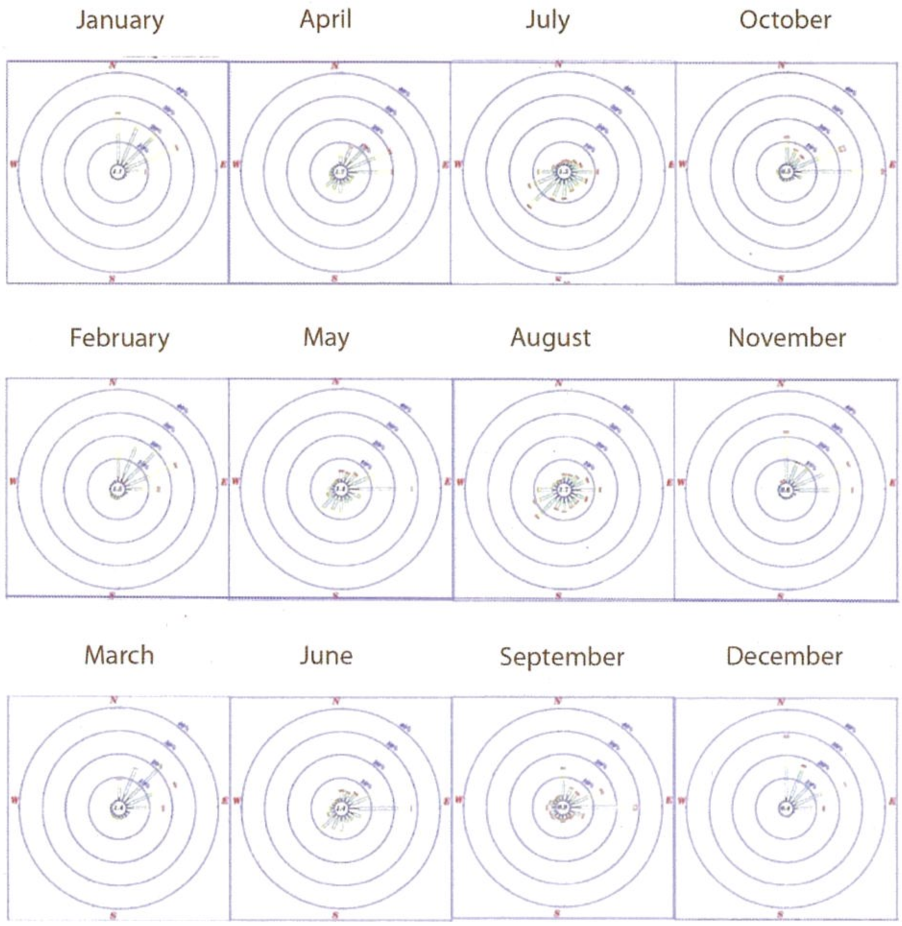

Figure 3.4 Monthly wind roses of WGL from 1998 to 2007.

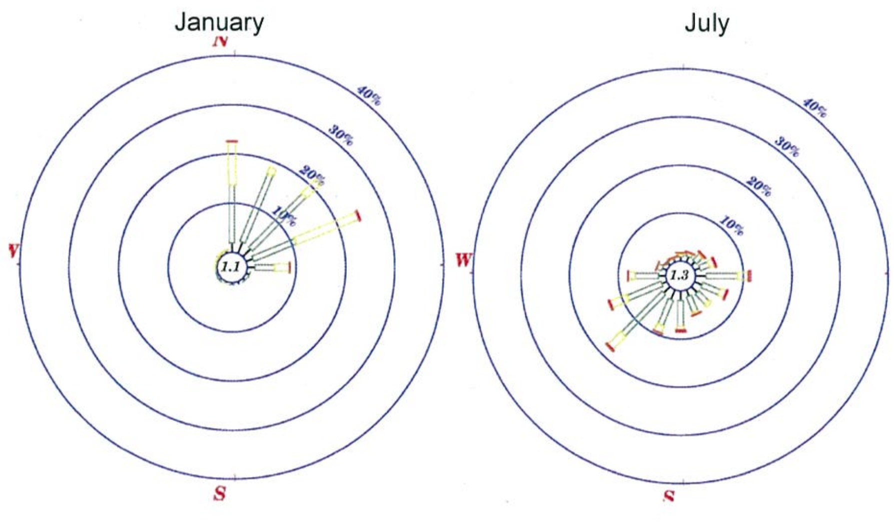

Figure 3.5 Wind roses of WGL from 1998 to 2007 (Jan and July).

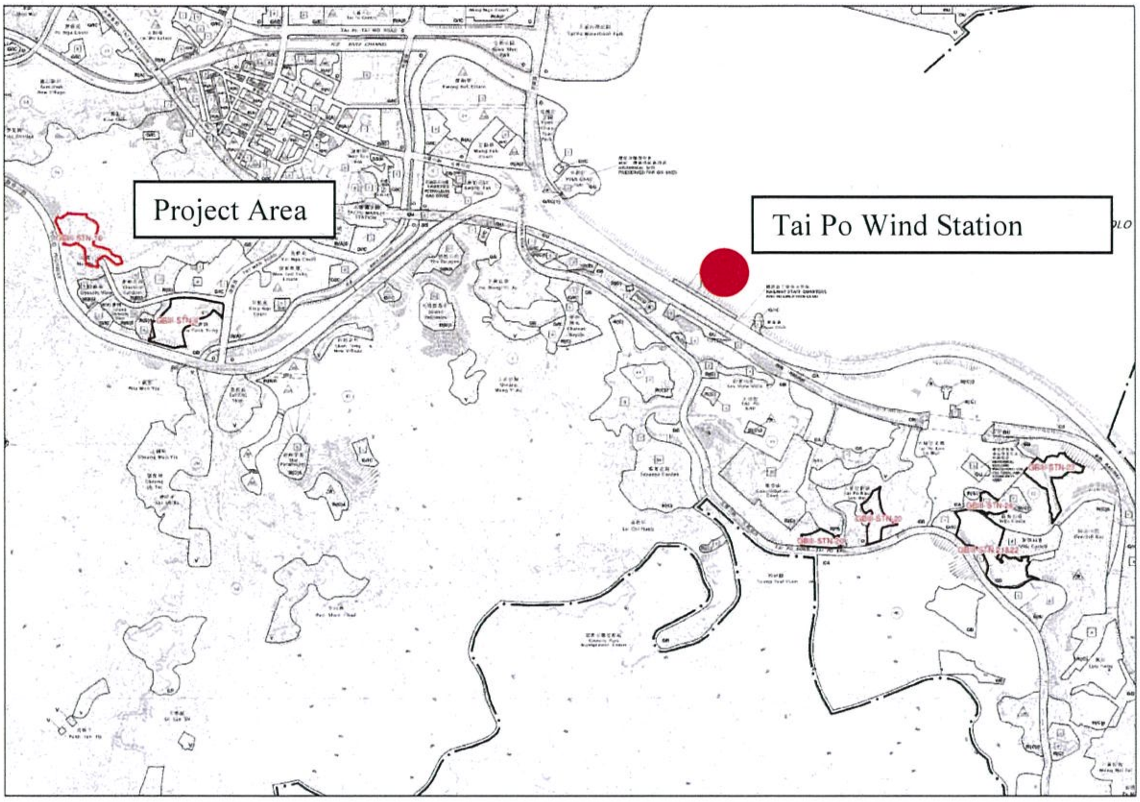

Figure 3.6 The location of Tai Po Wind Station and the Project Area.

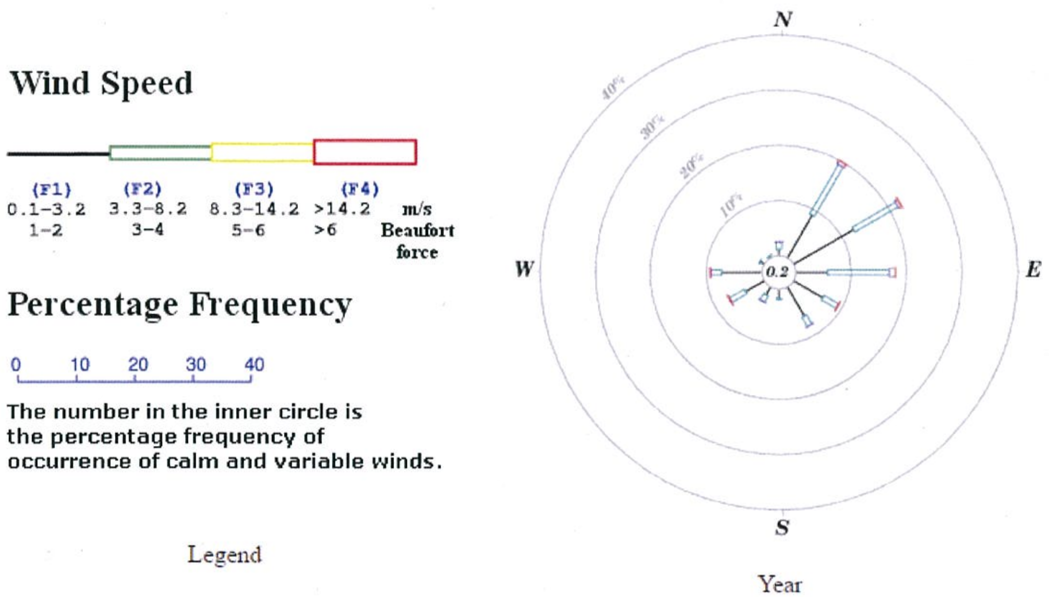

Figure 3.7 Wind rose of Tai Po from 2000 to 2015 (annual)

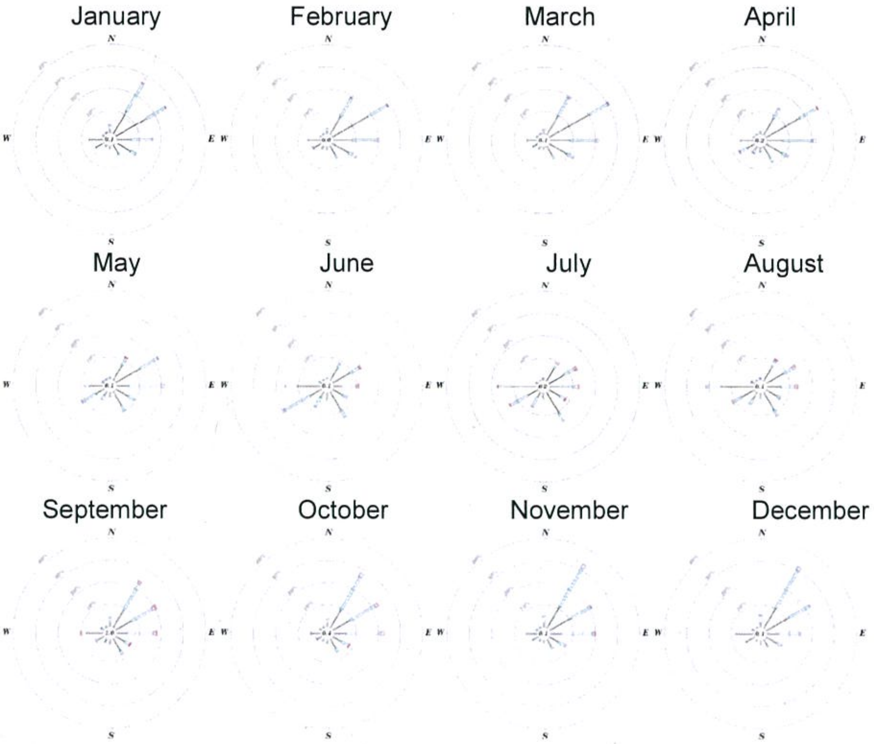

Figure 3.8 (as an example) monthly wind roses of Tai Po from 2000 to 2015

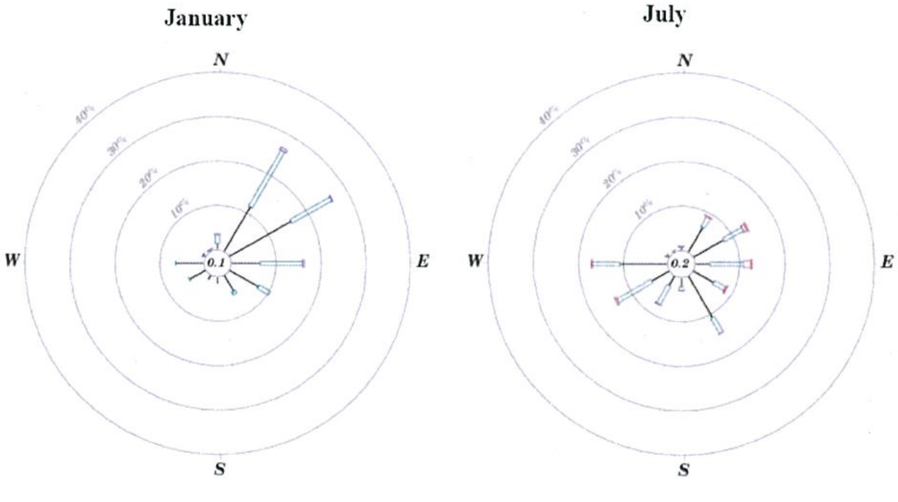

Figure 3.9 (as an example) Wind roses of Tai Po from 2000 to 2015 (Jan and July)

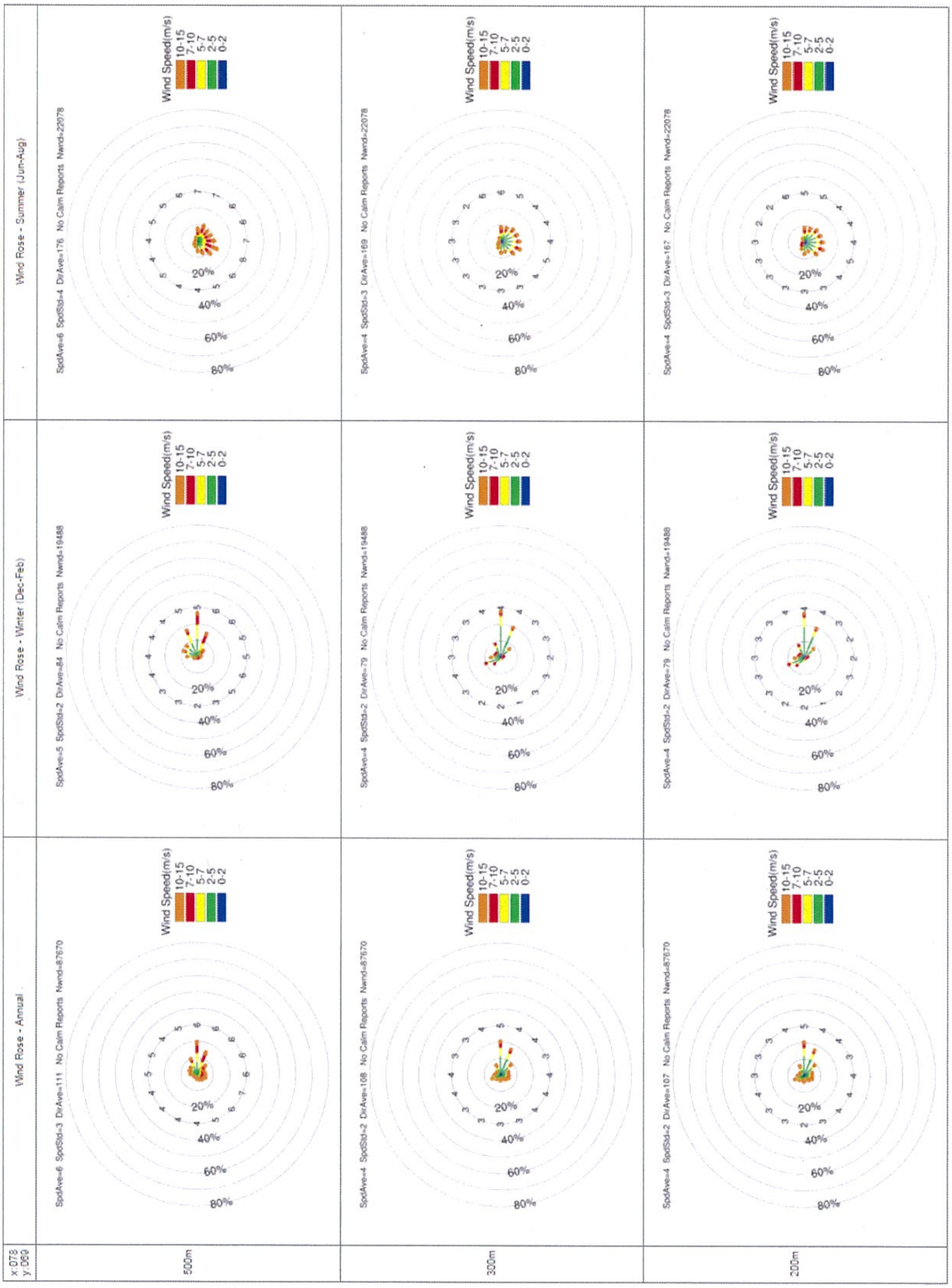

Figure 3.10 The wind data provided by PlanD for the Project Area (x:078; y:069).

3.7 In summary, based on the available wind data (Table 1) by considering that wind data provided by Planning Department is likely to be more representative to reflect the wind availability of the Project Area elaborated in Para. 3.6, it can be concluded that the annual wind of the Project Area mainly comes from the east (E) and southeast (SE). The summer wind of the area mainly comes from the east (E) southeast (SE), south (S) and southwest (SW) (Figure 3.11).

Table 1 Summary of Prevailing Wind Directions

			Period	
			Annual	Summer
HKO station	Tai Po		NE, E	NE, E, SE, SW, W
Wind data provided by Planning Department	Project Area (x:078; y:069)	200m	E, SE	E, SE, S, SW
		300m	E, SE	E, SE, S, SW
		500m	E, SE	E, SE, S, SW

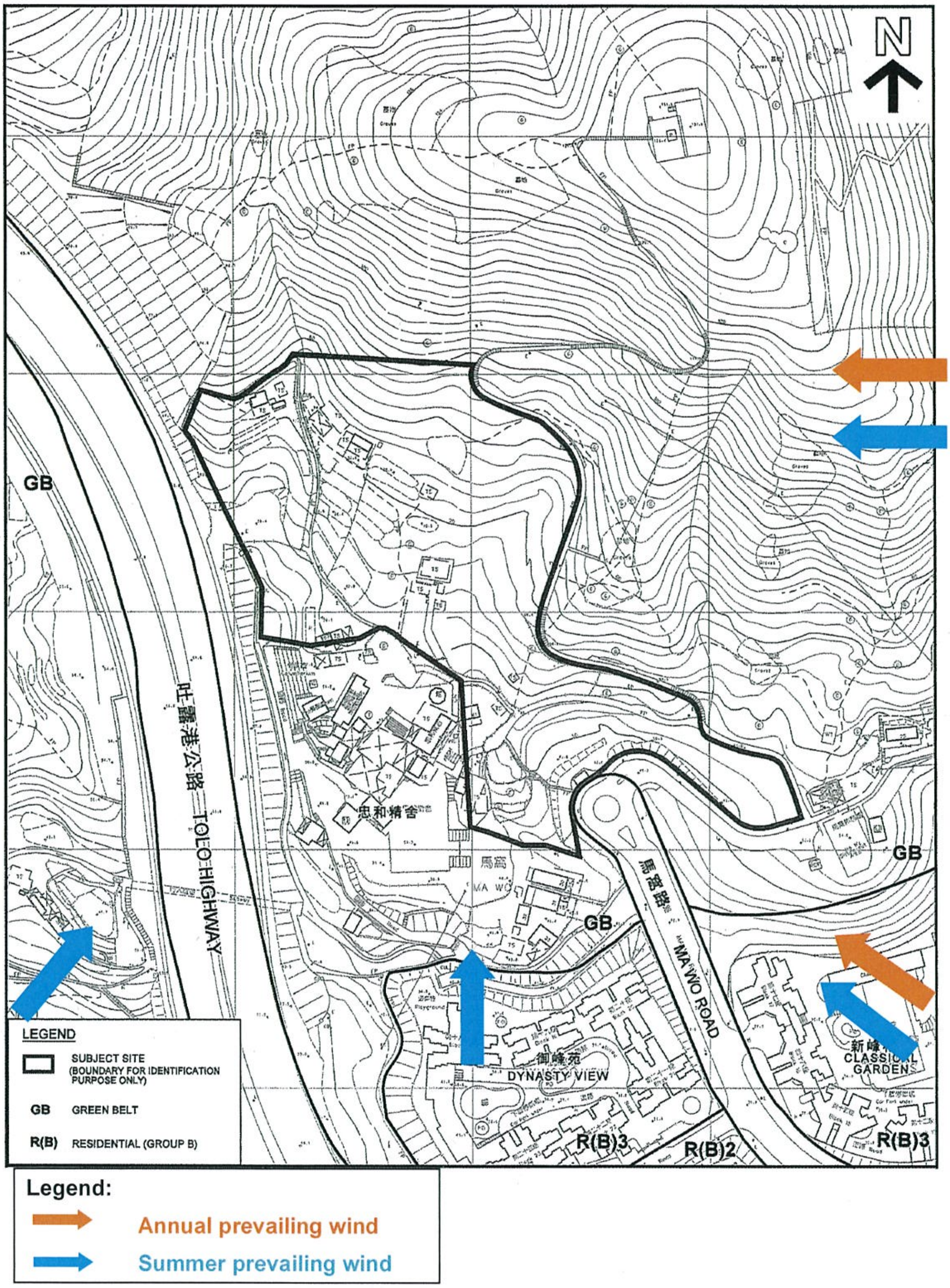

Figure 3.11 A summary of the prevailing winds of the Project Area.

4.0 Topography and the Wind Environment

4.1 Referring to Tai Po AVA Expert Evaluation report in 2010[1], some major breezeways through Tai Po central area such as Lam Tsuen River can be identified and some katabatic (downhill) air movement can be expected from the vegetated hill slopes in Tai Po area (Figures 4.1 and 4.2). The Project Area is not on the major breezeways identified previously.

4.2 The natural topography of Tai Po area descends from the high level at north-east (about 400 mPD) and south (about 335 mPD) towards Tolo Harbour (Figure 4.1). The Project Area is located on the hill slope in the southwestern fringe of Tai Po area with ground level at around 50mPD to 100mPD. With relatively high ground level of the Project Area, the wind from the east will be unobstructed by the topography flowing to the Project Area. However, wind from the southerly quarters will be slowed and weakened by the shielding effects of the hills southeast, south and southwest of the Project Area.

4.3 As previous AVA report mentioned[1], katabatic (downhill) air movements can be expected from the vegetated hill slopes surrounding Tai Po area (Figure 4.1). The Project Area is unlikely to block the major katabatic air movements in Tai Po area.

[1] http://www.pland.gov.hk/pland_en/info_serv/ava_register/ProjInfo/AVRG51_AVA_FinalReport.pdf

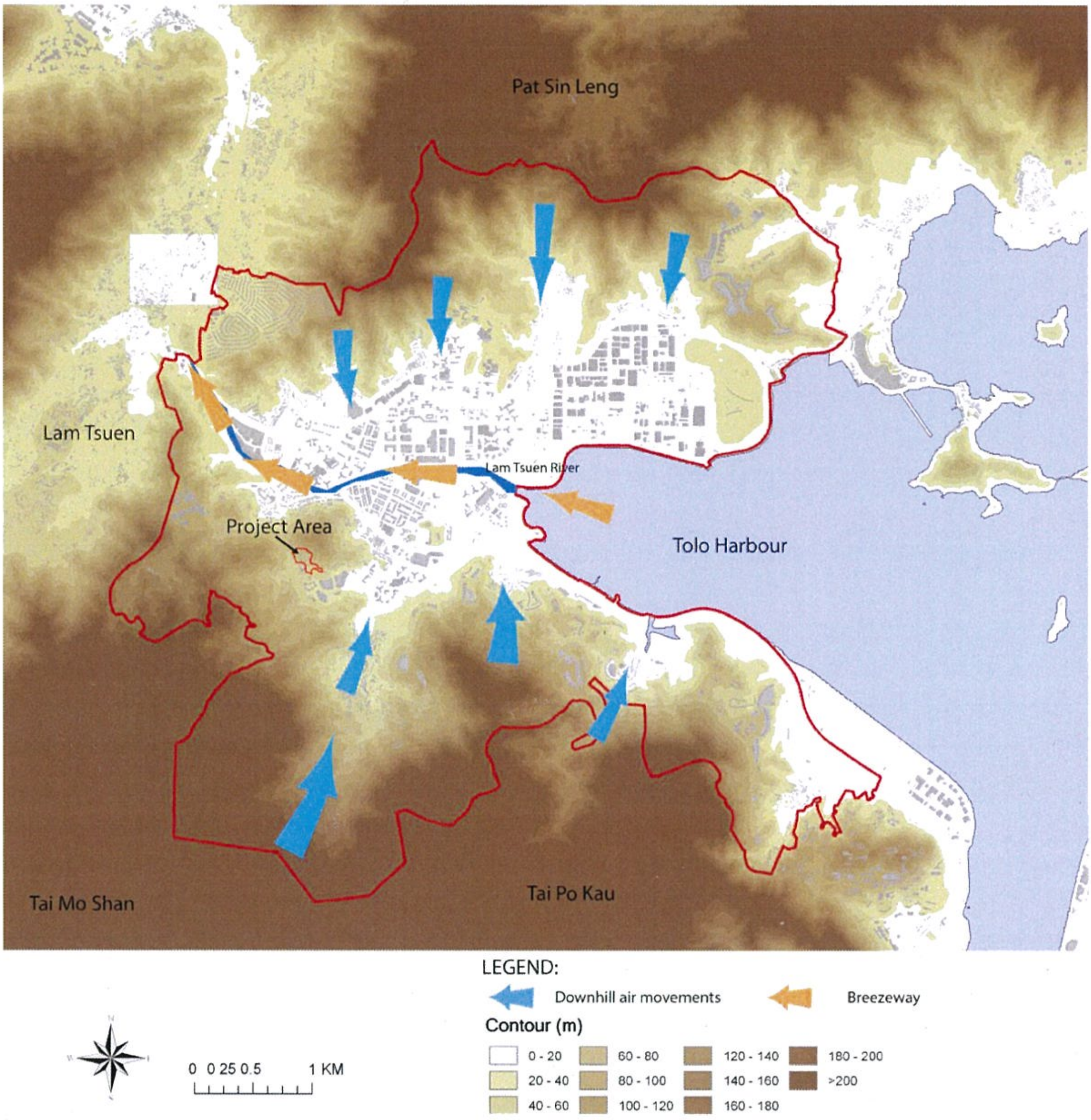

Figure 4.1 Topography and wind environment surrounding the Project Area.

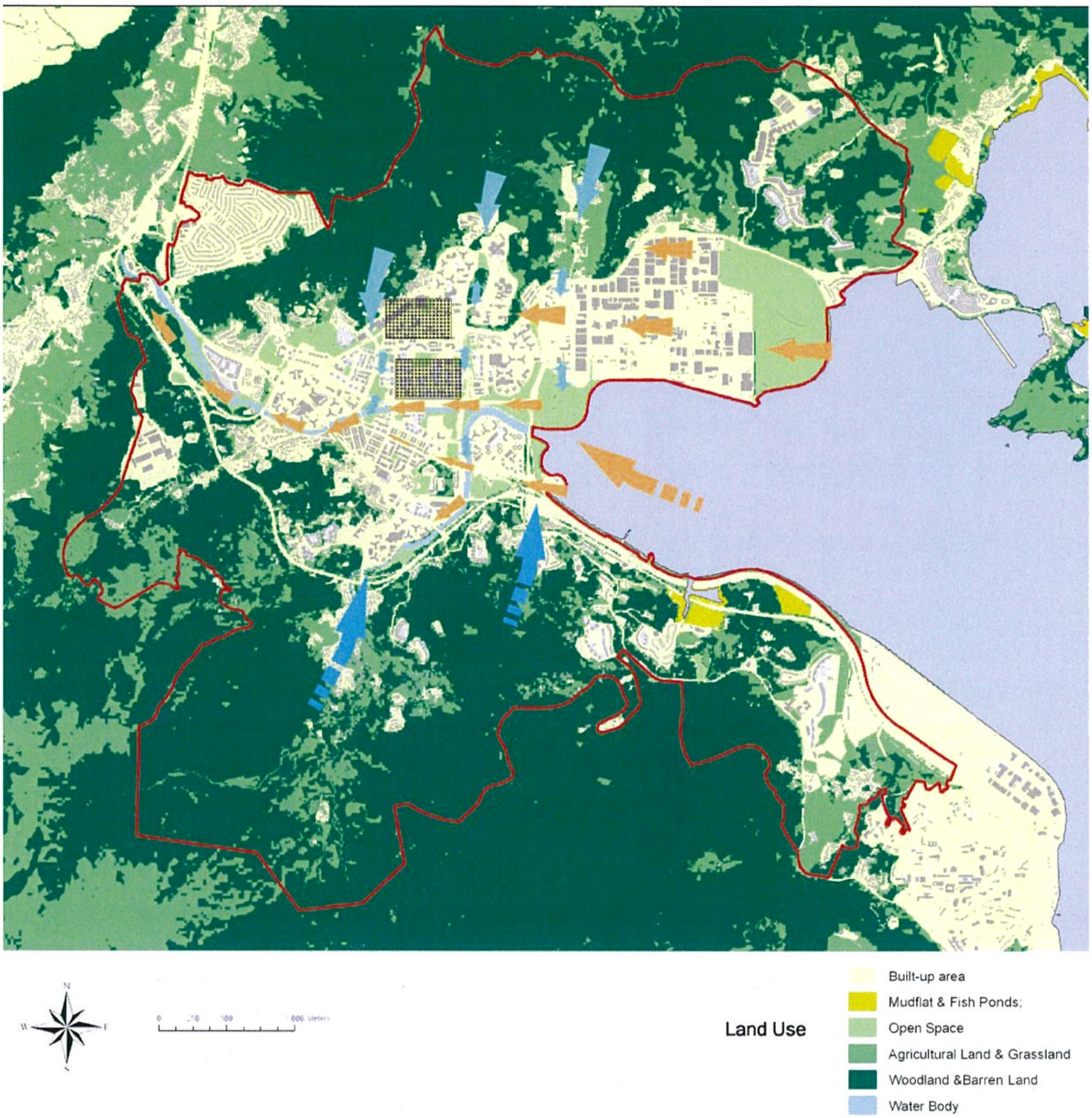

Figure 4.2 Air paths of the Tai Po area[1]

[1] http://www.pland.gov.hk/pland_en/info_serv/ava_register/ProjInfo/AVRG51_AVA_FinalReport.pdf

5.0 Existing Conditions

5.1 The existing building heights surrounding the Project Area are shown in Figure 5.1. The Project Area has a relatively open exposure to the wind from the east as there are no immediate developments east of this project area. There are some developments including Dynasty View, Grand Dynasty View and Classical Gardens up to 65 mPD south of the Project Area. However, due to the higher ground level of the Project Area (above 60mPD), the wind from southerly quarters can flow into the Project Area over the surrounding developments.

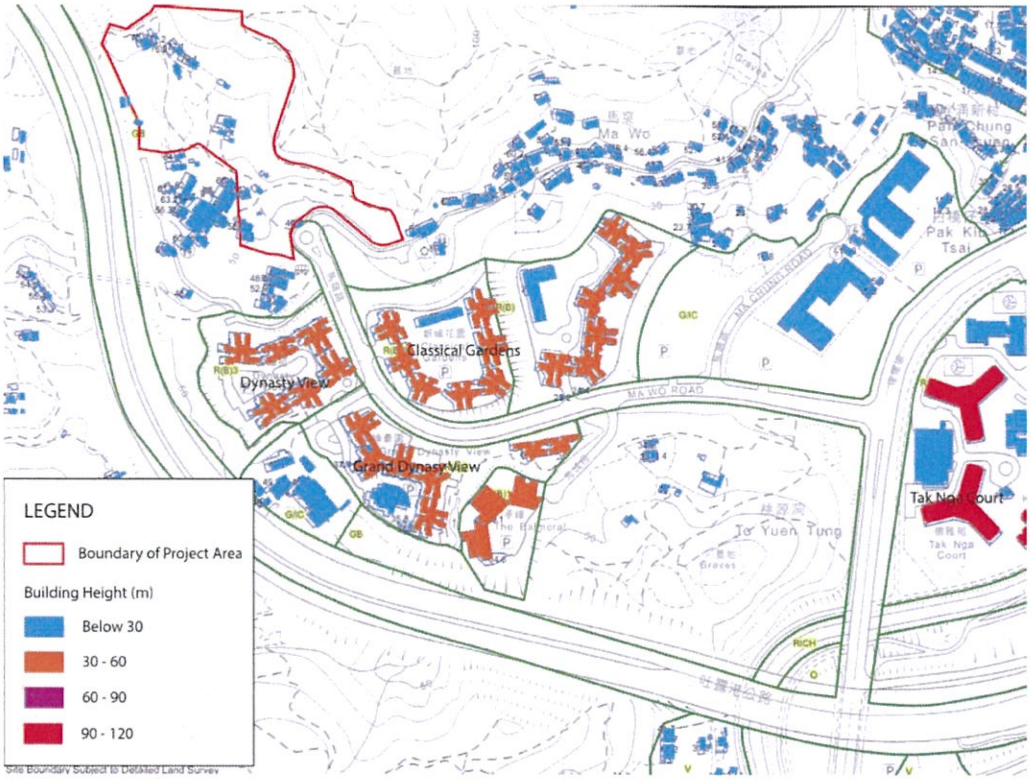

Figure 5.1 Absolute height of the existing buildings surrounding the Project Areas.

6.0 Air Paths

6.1 Major roads/streets in parallel with or less than 30 degrees to the prevailing wind directions together with open spaces and low-rise buildings can form air paths. For the Project Area, there are some mid-rise to high-rise developments in the surrounding. The roads between the developments such as Ma Wo Road, Tolo Highway, Ma Shing Path, Ma Chung Road, Tat Wan Road and Tai Po River can function as air paths for the surrounding areas (Figures 6.1 and 6.2).

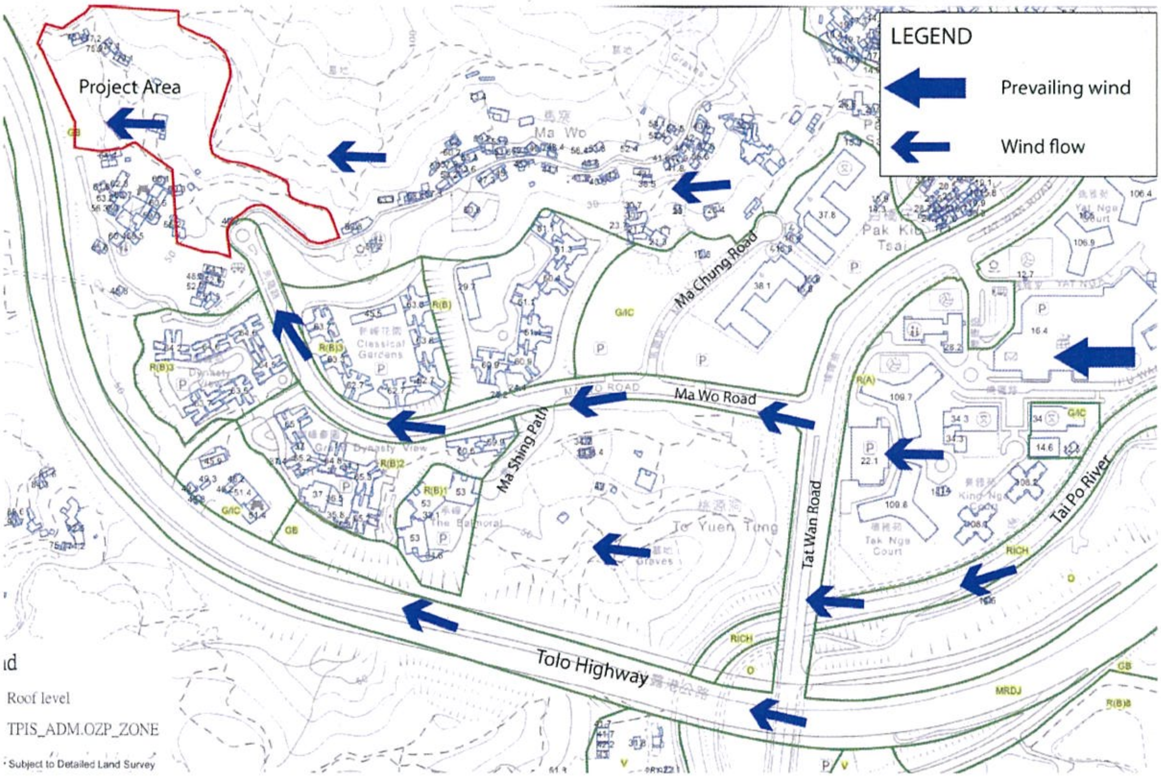

Figure 6.1 Wind flow in the Project Area and surrounding areas under easterly prevailing winds.

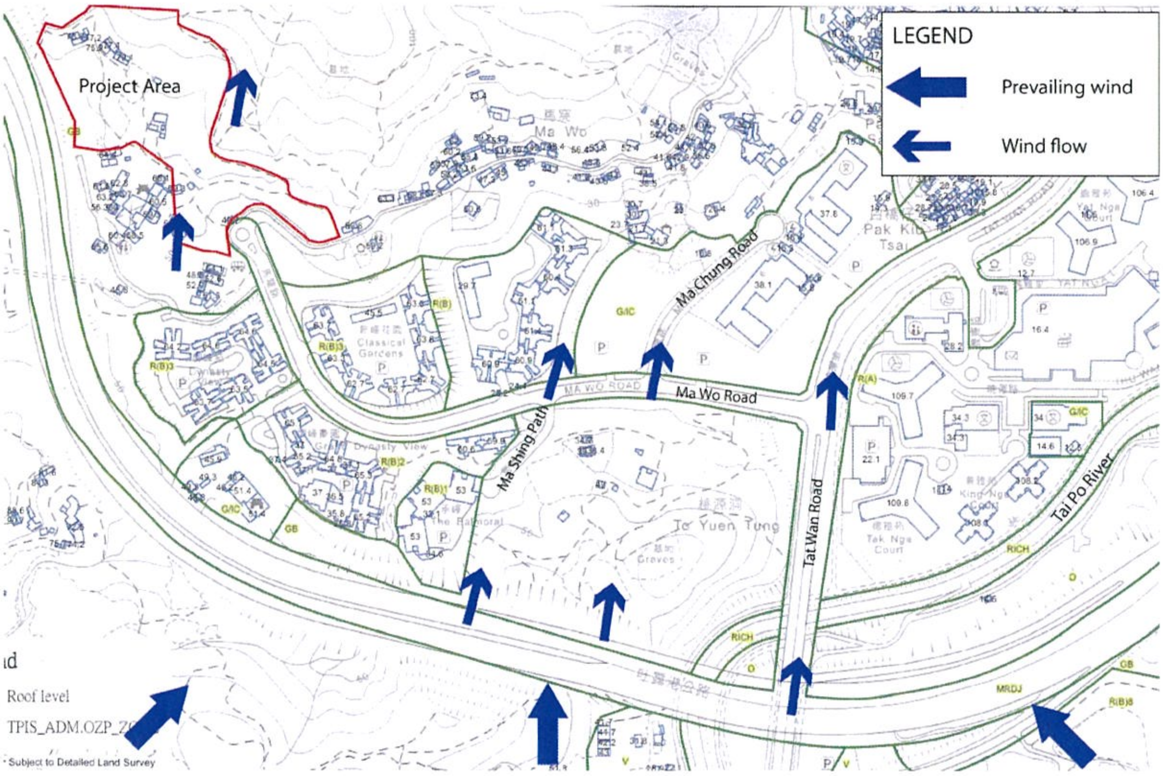

Figure 6.2 Wind flow in the Project Area and surrounding areas under southerly prevailing winds.

7.0 Expert Evaluation of Project Areas

7.1 The AVA Study has assessed the wind performance of the potential housing site in Ma Wo. In general, air ventilation can achieve better performance if measures, such as breezeways, air paths, open spaces, gaps between buildings and building permeability are applied. Especially reducing site coverage of the podia to allow more open space at grade is recommended (See Figure A-1 in Appendix).

7.2 The Project Area of about 23,300m^2 is located to the southwest of the urban core at Ma Wo Road off Tat Wan Road (Figure 7.1). It is currently zoned "Green Belt" under the approved Tai Po OZP No. S/TP/26. These is a small knoll at about 63mPD to the east. This project area is proposed to be rezoned to residential developments with Building Height of 13 storeys[1] and Plot Ratio of 4.

7.3 When prevailing wind comes from the east, southeast, south and southwest, the developments in the Project Area are likely to create some wake areas on the leeward side. However, there are no sensitive receivers in the surrounding areas, which mostly are "Green Belt". On the whole, proposed development in the Project Area will have no significant air ventilation impacts on the surrounding areas.

[1] Overall building height of about 110mPD

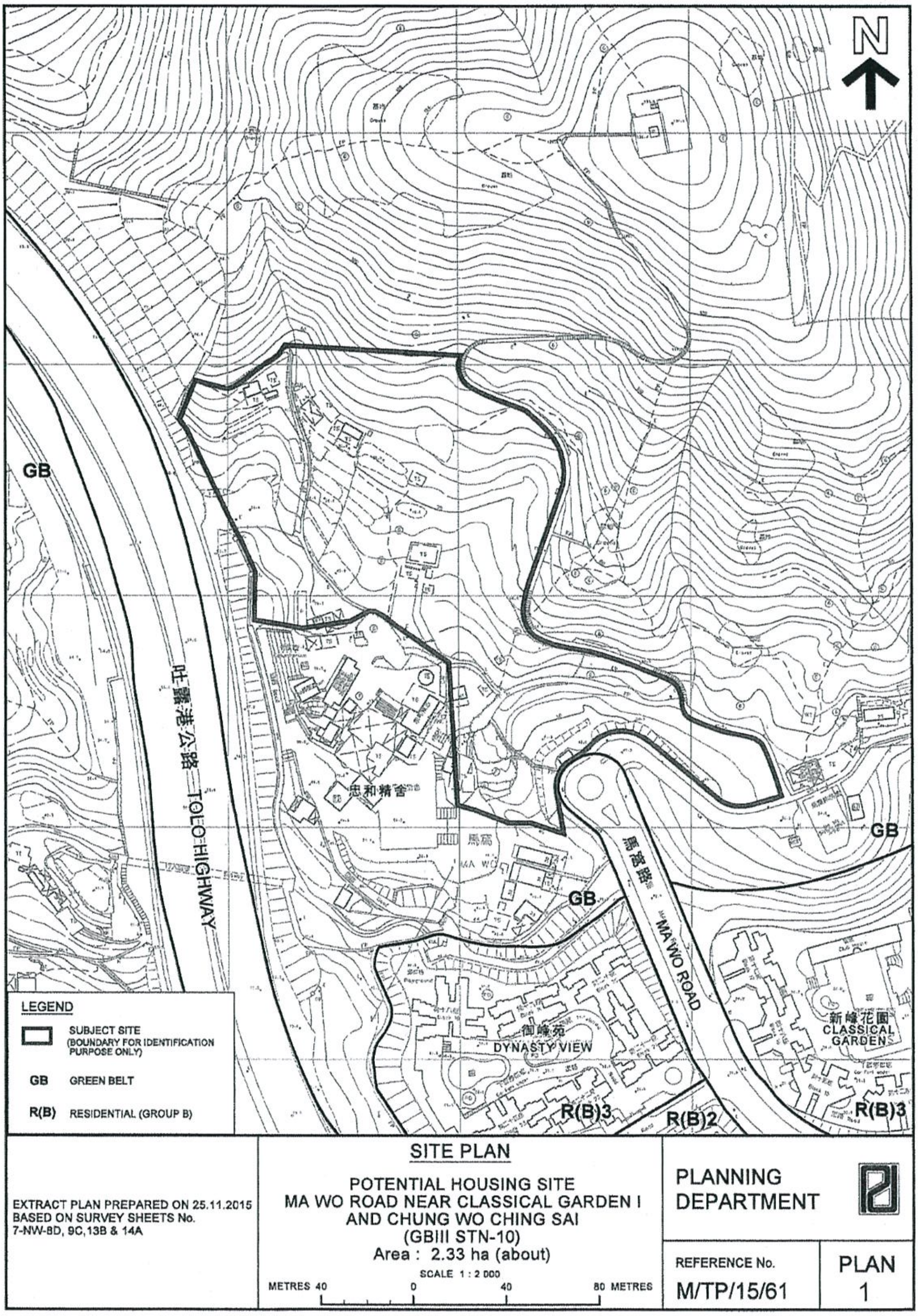

Figure 7.1 Site plan of the Project Area.

8.0 Further Work

8.1 The Project area would have no major air ventilation issues. However, all future developments in the Project Area should consider the following design principles at the detailed design stage as the prevailing effort for improvement in urban climate.

- Minimization of podium bulk with ground coverage of no more than 65%;
- Building setback with reference to PNAP APP-152;
- Greenery (preferably tree planting) of no less than 30% for sites larger than 1 ha, and 20% for sites below 1 ha at lower levels, preferably at grade; and
- Avoid long and continuous façades.

Appendix

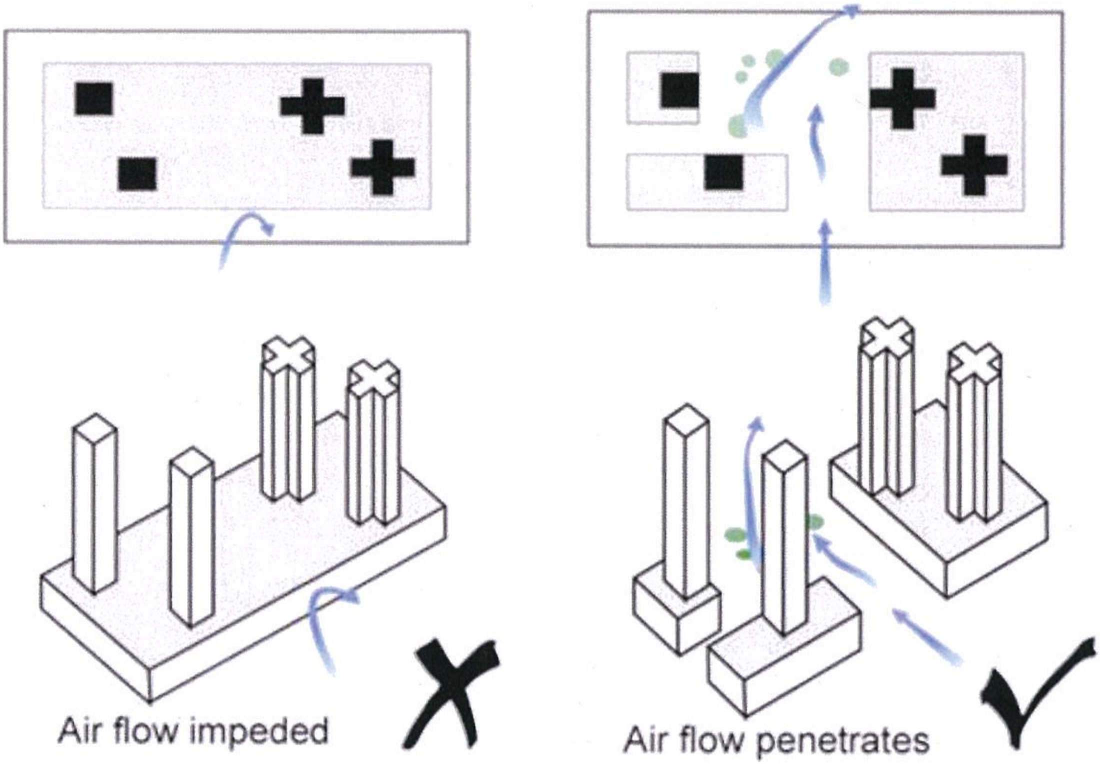

Figure A-1 Reducing Site Coverage of the Podia to Allow More Open Space at Grade

[Reference: Hong Kong Planning Standard and Guidelines]

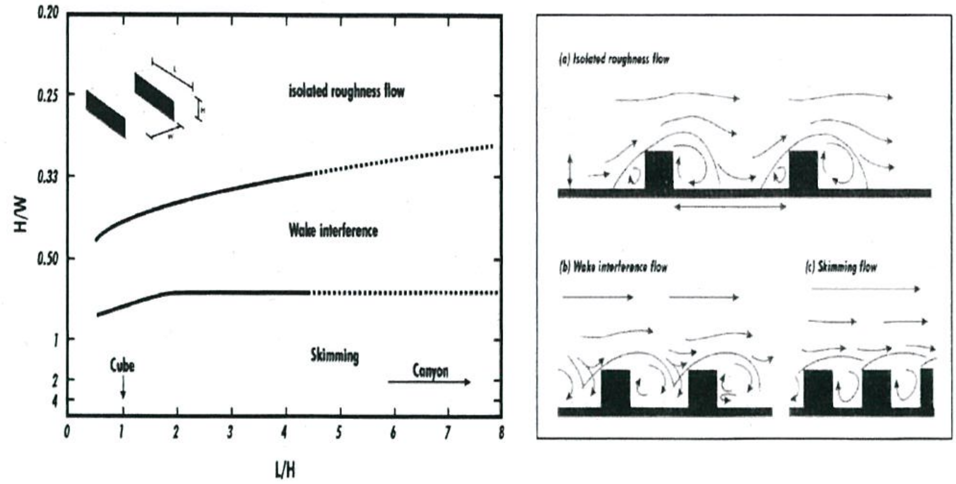

Figure A-2 The relationship between building height and street width ratio and the possible flow regimes.

[Reference: Oke, T. R. (1987). *Boundary layer climates*. Routledge.]

With wind from directions perpendicular to the canyons, downwashes due to the differentials in building heights is occasionally likely when building heights are very different. Otherwise, with smaller building height differences, this is unlikely. It is known that for long and deep canyons with an H/W ratio of 2 and above, a double vortex phenomenon will be observed (see Figure A-2). However, beyond a H/W ratio of 2:1, the ground level of canyons, even with the so call downwash effects, will have very weak eddies and air ventilation.

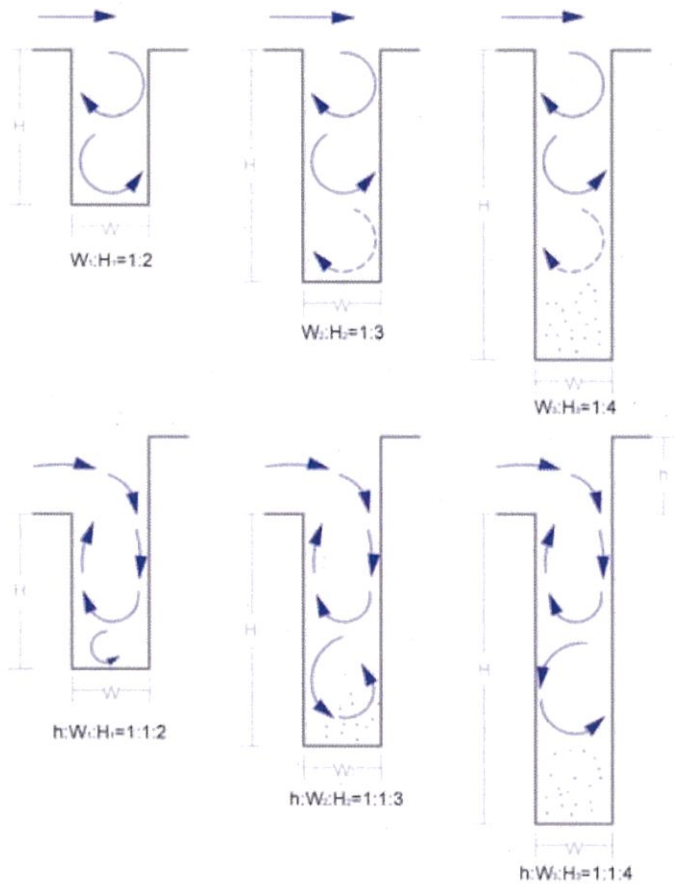

Figure A-3 The figure shows a generic understanding of the wind regimes in canyons, and canyons with downwashes.

[Reference: A. KOVAR-PANSKUS, P. LOUKA, J.-F. SINI, E. SAVORY, M. CZECH, A. ABDELQARI, P. G. MESTAYER and N. TOY, INFLUENCE OF GEOMETRY ON THE MEAN FLOWWITHIN URBAN STREET CANYONS – A COMPARISON OF WIND TUNNEL EXPERIMENTS AND NUMERICAL SIMULATIONS, Water, Air, and Soil Pollution: Focus 2: 365–380, 2002, Kluwer Academic Publishers.]

Prepared by

Date: 22 June 2017

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