**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 at Lung Cheung Road, Kowloon Tong

December 2016

INSTITUTE OF Future Cities

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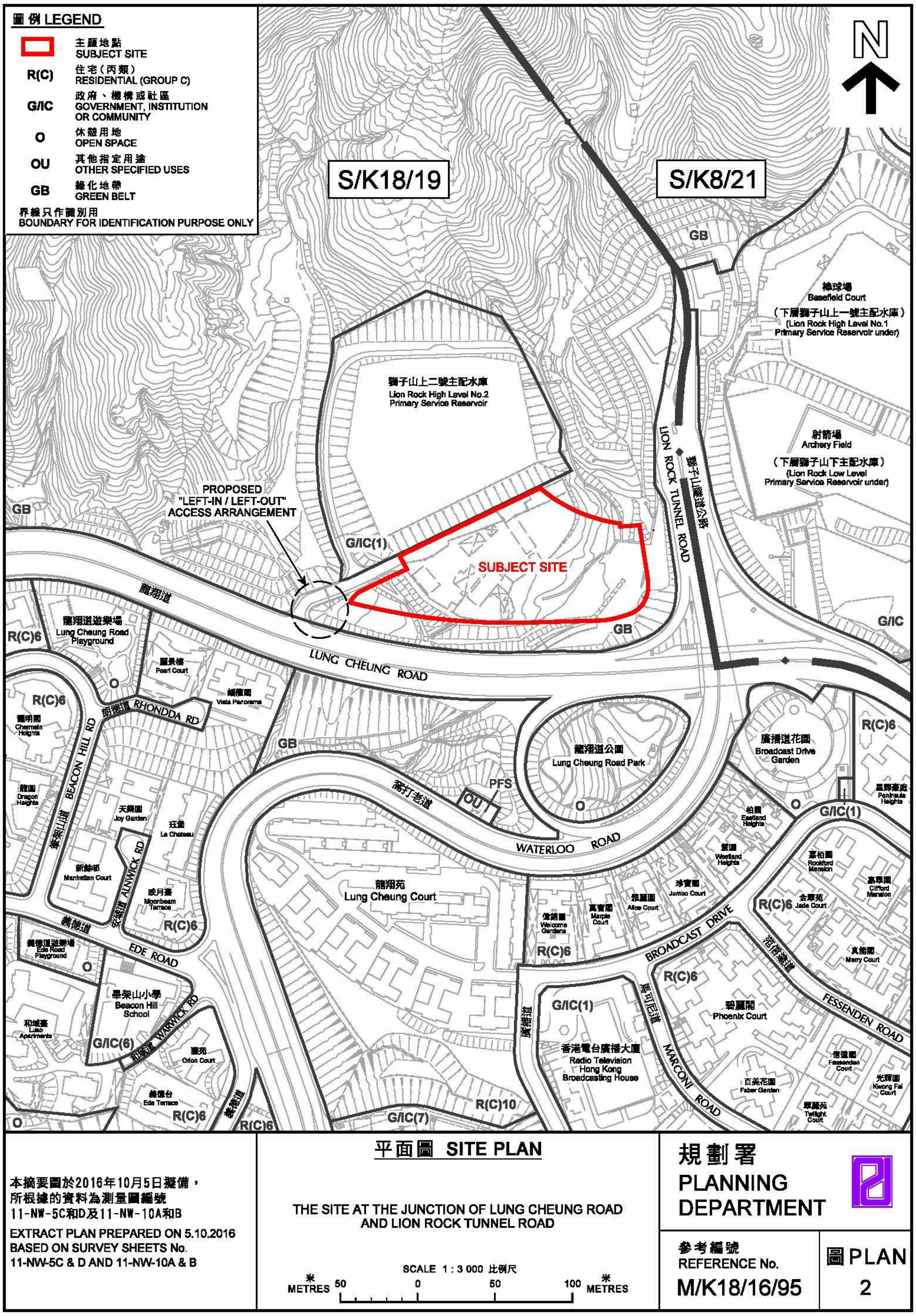
The Study Area (Subject Site)



Expert Evaluation Report

for an Instructed Project at Lung Cheung Road, Kowloon Tong

Executive Summary

0.1 Wind Availability

(a) The annual wind of the study area mainly comes from the ENE, E and ESE. The summer wind mainly comes from the E, ESE, S, SSW and SW.

0.2 Existing Conditions

(a) There are no developments northeast and east of the subject site. The north-easterly and easterly winds can flow to the subject site without obstruction.

(b) There are some developments with building heights lower than 110mPD south of the subject site including Lung Cheung Court, Welcome Gardens, Marple Court, Alice Court, Jumbo Court, Westland Heights, Eastland Heights and Peninsula Heights, etc. Due to the relatively higher ground elevation of the subject site around 100mPD, the ESE and S prevailing winds can flow to the subject site with little obstruction.

(c) Some developments with building heights around 130mPD located to the southwest of the subject site include Pearl Court and Vista Panorama. There are some gaps between these developments and a lot of open spaces nearby. The prevailing wind from the SW can flow to the subject site through the building gaps and open spaces southwest of the subject site.

0.3 Expert Evaluation of the Development Scheme

(a) Under the Air Ventilation Assessment (AVA) Study, the worst case scenario has been assumed. In general, air ventilation can achieve better performance if measures, such as breezeways, air paths, open spaces, gaps between buildings and building permeability especially near ground level, are applied.

(b) When prevailing wind comes from the E, the developments in the subject site are likely to create some wake areas on the leeward side. However, there are no sensitive receivers west of the subject site, which are open areas zoned “Green Belt” and a service reservoir.

(c) When prevailing wind comes from the ESE, S, SSW and SW, the developments in the subject site are likely to create some wake areas on the leeward side. Similarly, there are no sensitive receivers north of the subject site, which are open areas zoned “Green Belt” and a service reservoir.

(d) When prevailing wind comes from the ENE, the developments in the subject site are likely to create some wake areas on the leeward side, which will extend to Lung Cheung Road and the open areas zoned “Green Belt” south of the subject site. To avoid wall-like developments to block the penetration of ENE wind through the future development to reach the areas south of the subject site, it is recommended, at detailed design stage, that the project proponents should make reference to the design guidelines of Building Disposition and Building Permeability in "Hong Kong Planning Standard and Guidelines” (HKPSG) and follow the building separation requirement (20% - 33.3%) in the “Sustainable Building Design Guidelines” to provide some gaps in facilitating penetration of ENE wind through the future development to reach the areas south of the subject site.

(e) A footbridge (3m in width and 5.1m clearance) across Lung Cheung Road is proposed under the current development scheme. The frontal width of the lift tower and staircase of the footbridge is relatively small (less than 10m). The clearance under the deck of the footbridge is more than 5.1m and the major structure of the footbridge is quite isolated. Thus, it is anticipated that the footbridge would not have any significant air ventilation impact on the surroundings under all prevailing wind directions.

0.4 Further Work

(a) Given the building separation requirements under the Sustainable Building Design Guidelines as set out in Section 7 would be fulfilled as recommended in the building design of future development, the proposal at the subject site would have no major air ventilation issues. If the requirements of building separations cannot be met, further quantitative assessments should be conducted to demonstrate that the performance of any future development would be no worse off than the scenario with these measures.

Expert Evaluation Report

for an Instructed Project at Lung Cheung Road, Kowloon Tong

1.0 The Assignment

1.1 A site at Lung Cheung Road, Kowloon Tong has been identified for development. It is considered necessary to conduct an expert evaluation to assess the preliminary air ventilation impacts of the development proposals and development parameters including the imposition of appropriate development restrictions to guide future development.

1.2 This expert evaluation report is based on the materials including:

Site plan of the subject site
Height of the existing buildings of surrounding areas
Kowloon Planning Area No. 18 – Kowloon Tong – Outline Zoning Plan
Wind information from Hong Kong Observatory and Planning Department (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) weather 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.

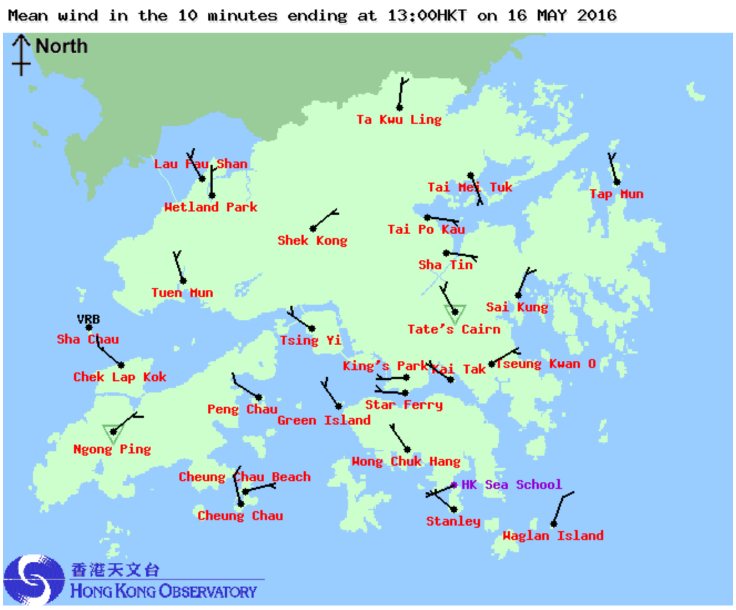


Figure 3.1 Some of the HKO weather stations in Hong Kong. This is a screen capture at 13:00 on 16 May 2016 from the HKO website. The arrows show the wind directions and speeds at the given time.

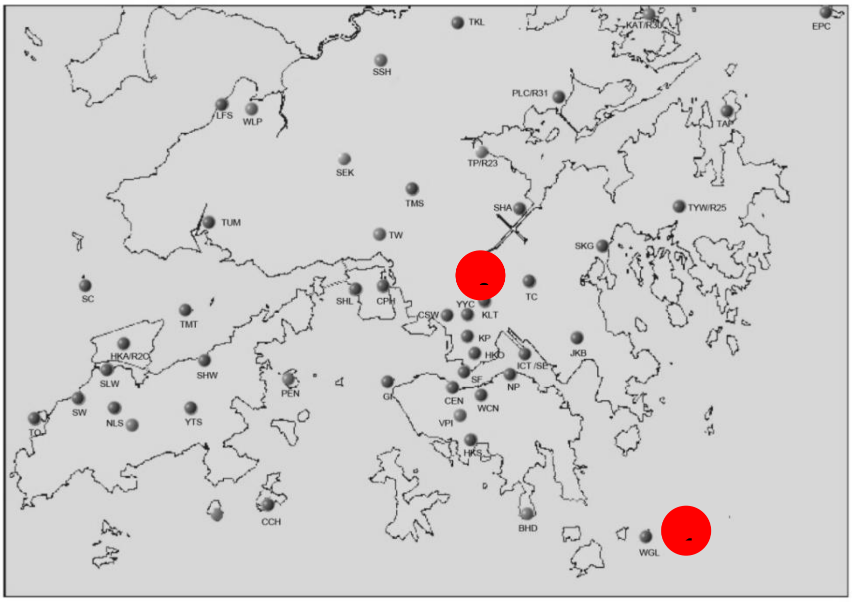


Figure 3.2 The HKO stations at 1: Waglan Island (WGL), 2: Kowloon Tsai (KLT)[1].

3.2 The HKO weather 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

[1] Kowloon Tsai ceased wind measurement and started temperature measurement from 1 Jan 2008 (http://www.weather.gov.hk/cis/annex/hkwxstn_e.htm)

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 Kowloon Tsai (KLT) have also been extracted from HKO (Figures 3.6 to 3.8) as the nearest weather station measuring wind environment for the subject site. It can be observed that the annual prevailing winds are mainly from the E and SE. The summer prevailing winds are mainly from the E, SE and SW.

3.6 Noting the limitation of the data of WGL mentioned in Para. 3.2, wind characteristic from the web-based database system provided by PlanD has also been referred[1]. Wind data around the subject site (x:081; y:048) were simulated at 200m, 300m and 500m above the ground (Figure 3.9). This location, according to the theories of Regional Atmospheric Modeling System (RAMS), was selected to reflect the general wind patterns of the subject site induced by topography. Prevailing wind directions are summarised in Table 1. Although the HKO weather station at KLT is the nearest to the Project Area, it is still relatively far away from the subject site and the surroundings of KLT are different from the subject site. The web-based wind data provided by PlanD is likely to be more representative to reflect the wind availability of the subject site. Based on the wind data from the PlanD, it can be observed that the annual prevailing wind of the subject site is mainly from ENE, E and ESE. The summer wind of the subject site mainly comes from the E, ESE, S, SSW and SW. In general, the wind data from PlanD's website is consistent with that of KLT and WGL.

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

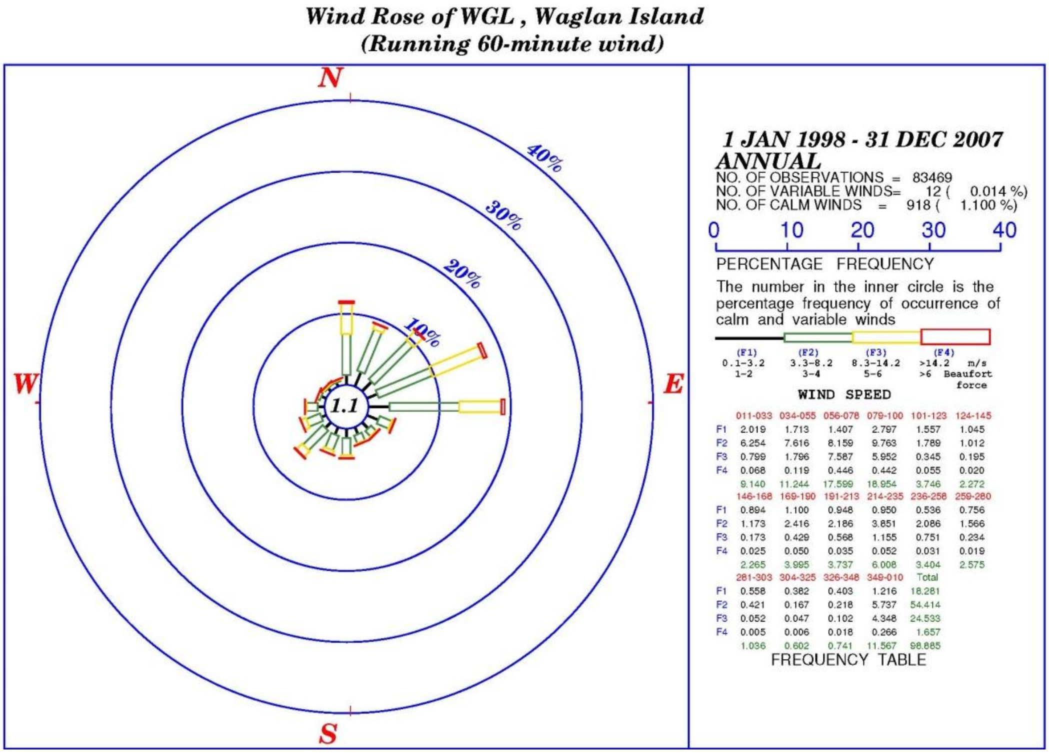


Figure 3.3 Wind rose of WGL from 1998 to 2007[1] (annual).

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

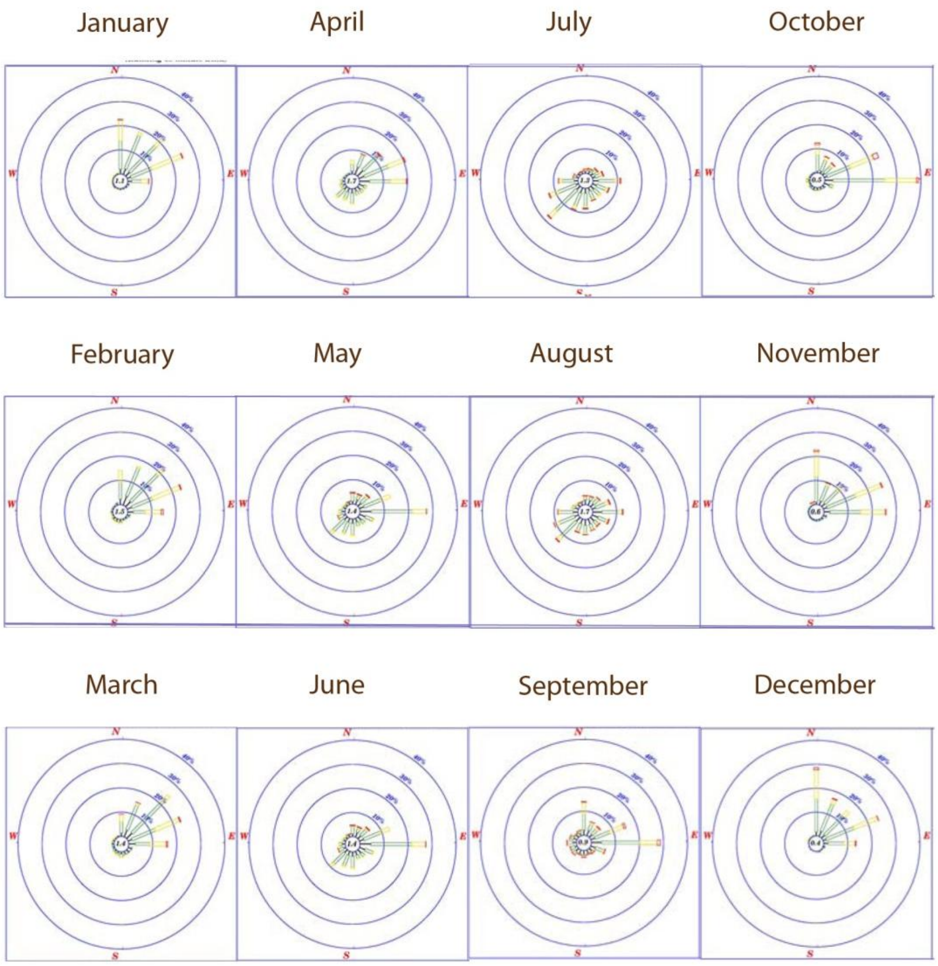


Figure 3.4 Monthly wind roses of WGL from 1998 to 2007.

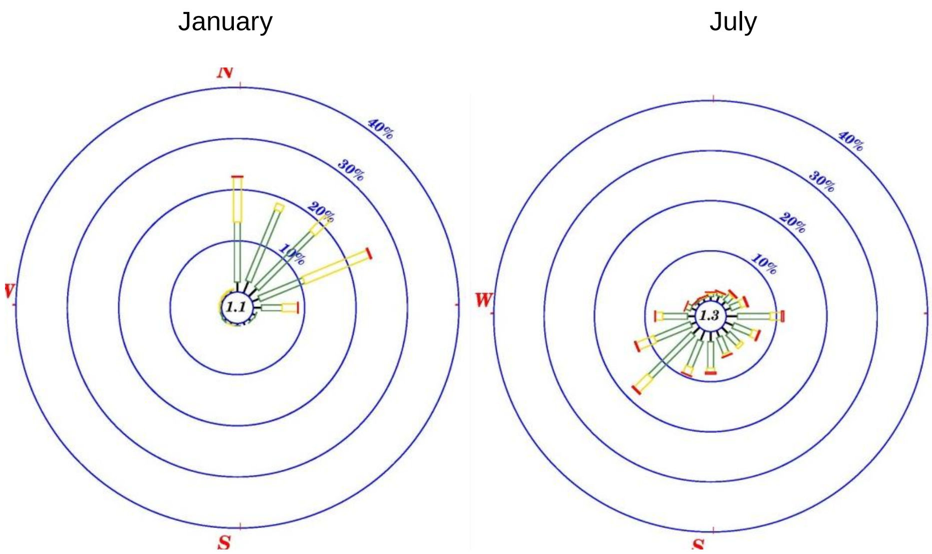


Figure 3.5 Wind roses of WGL from 1998 to 2007 (Jan and July).

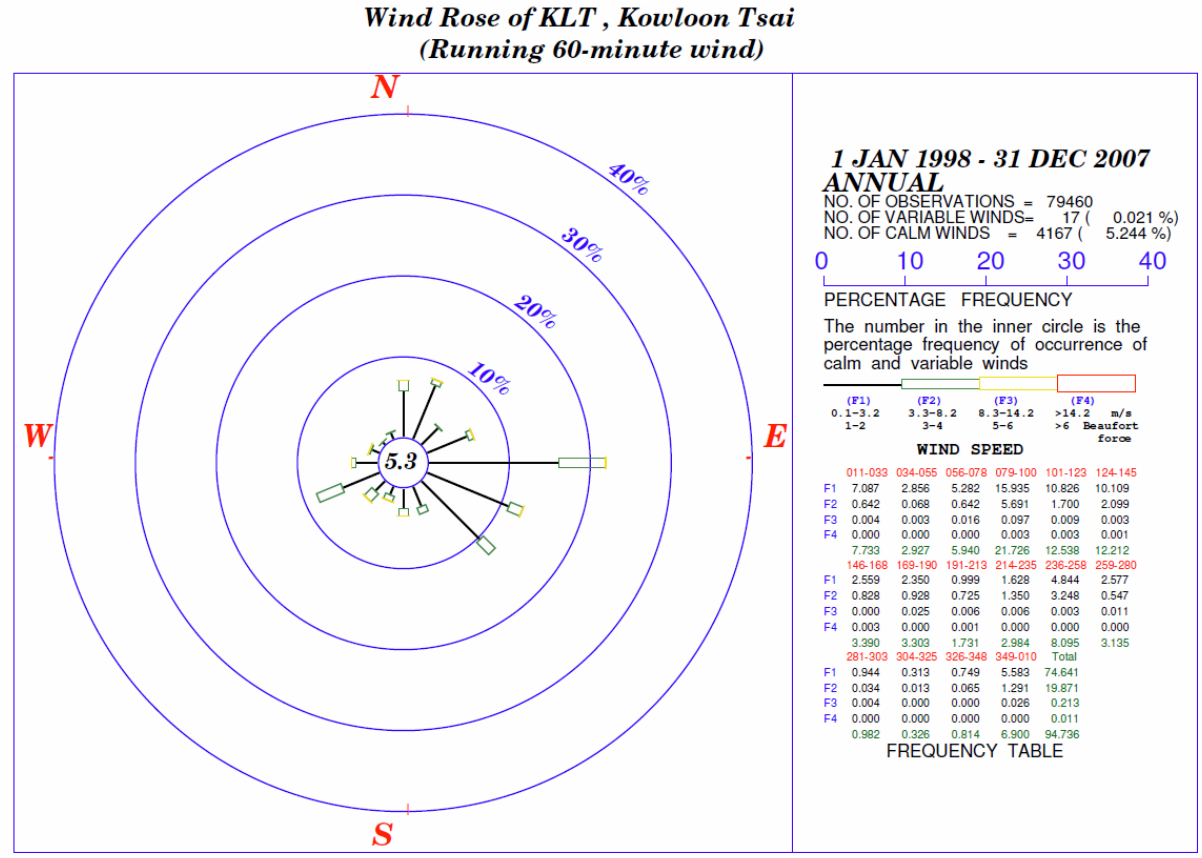


Figure 3.6 Wind rose of KLT from 1998 to 2007 (annual)

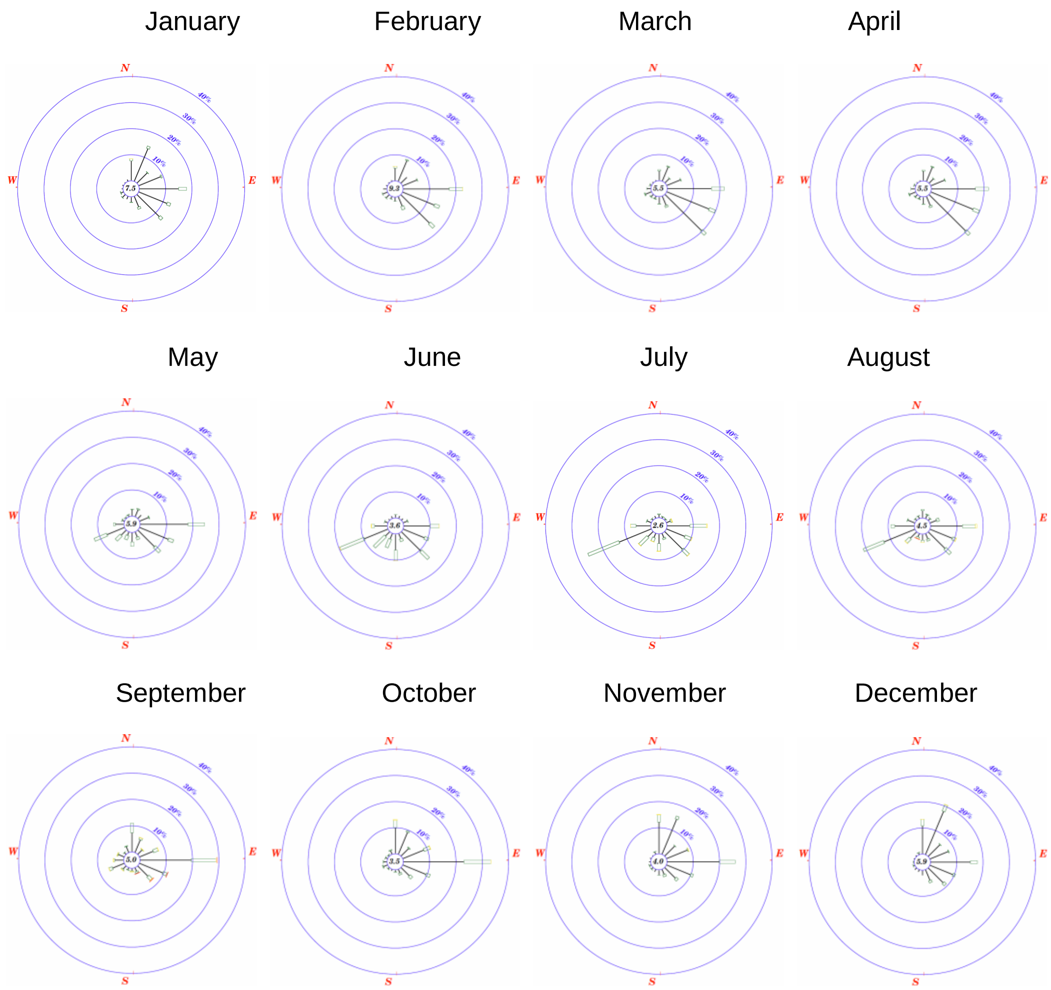


Figure 3.7 (as an example) monthly wind roses of KLT from 1998 to 2007.

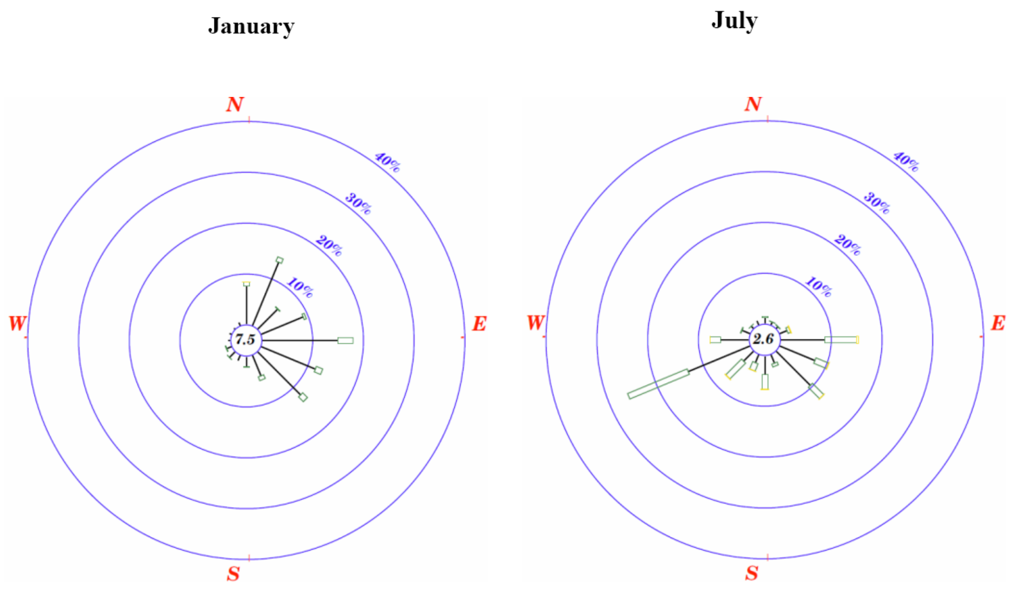


Figure 3.8 (as an example) Wind roses of KLT from 1998 to 2007 (Jan and July).

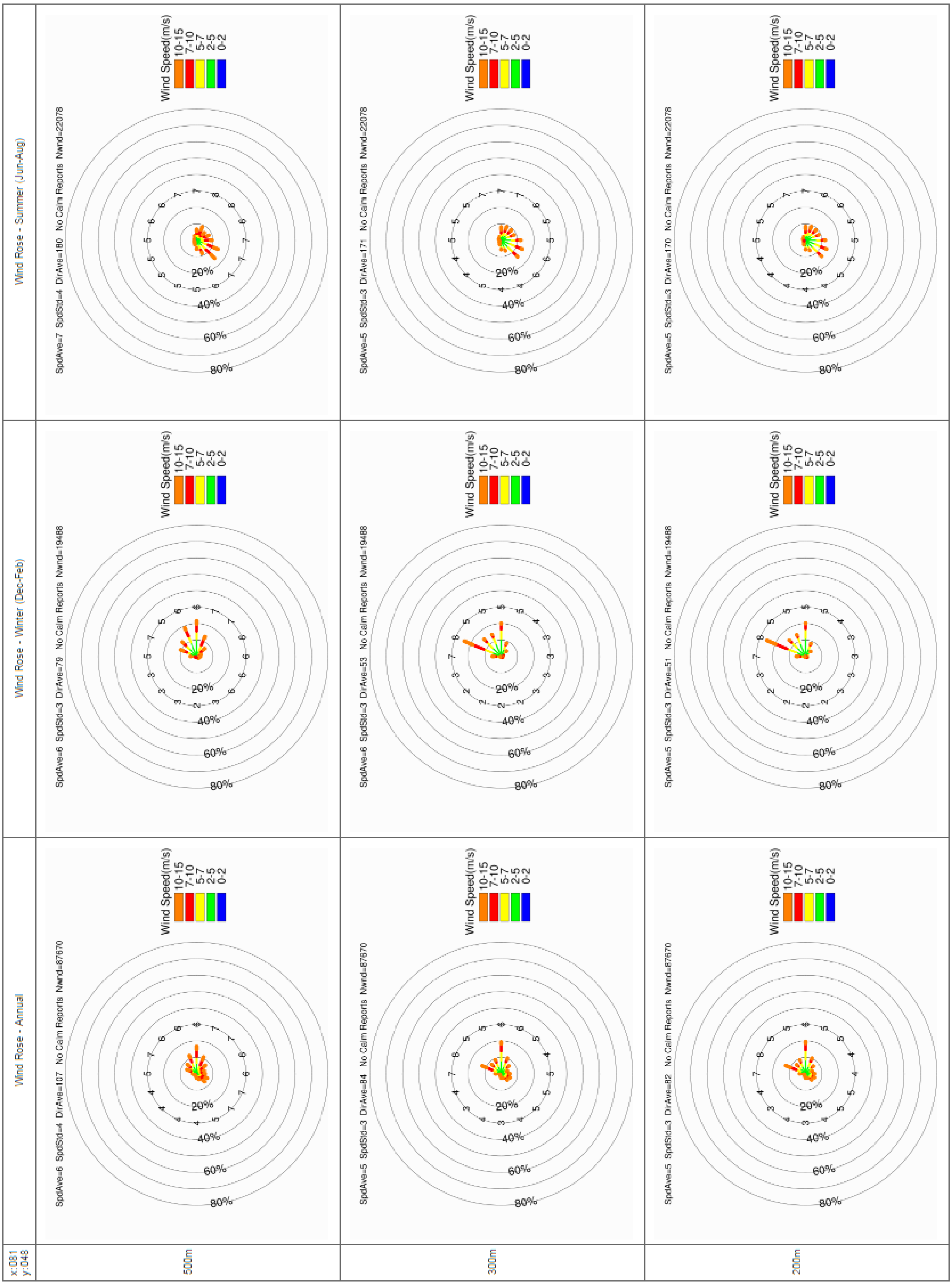


Figure 3.9 The wind data provided by PlanD for the subject site (x:081; y:048).

3.7 In summary, based on the available wind data (Table 1) by considering that wind data provided by PlanD is likely to be more representative to reflect the wind availability of the subject site elaborated in Para. 3.6, it can be concluded the annual wind of the subject site mainly comes from the ENE, E and ESE. The summer wind mainly comes from the E, ESE, S, SSW and SW (Figure 3.10).

Table 1 Summary of Prevailing Wind Directions

			Period	
			Annual	Summer
HKO weather station	Kowloon Tsai		E, SE	E, SE, SW
Wind data provided by Planning Department	Proposed Site (x:081; y:048)	200m	ENE, E, ESE	ESE, S, SSW, SW
		300m	ENE, E, ESE	ESE, S, SSW, SW
		500m	ENE, E, ESE	ESE, S, SSW, SW

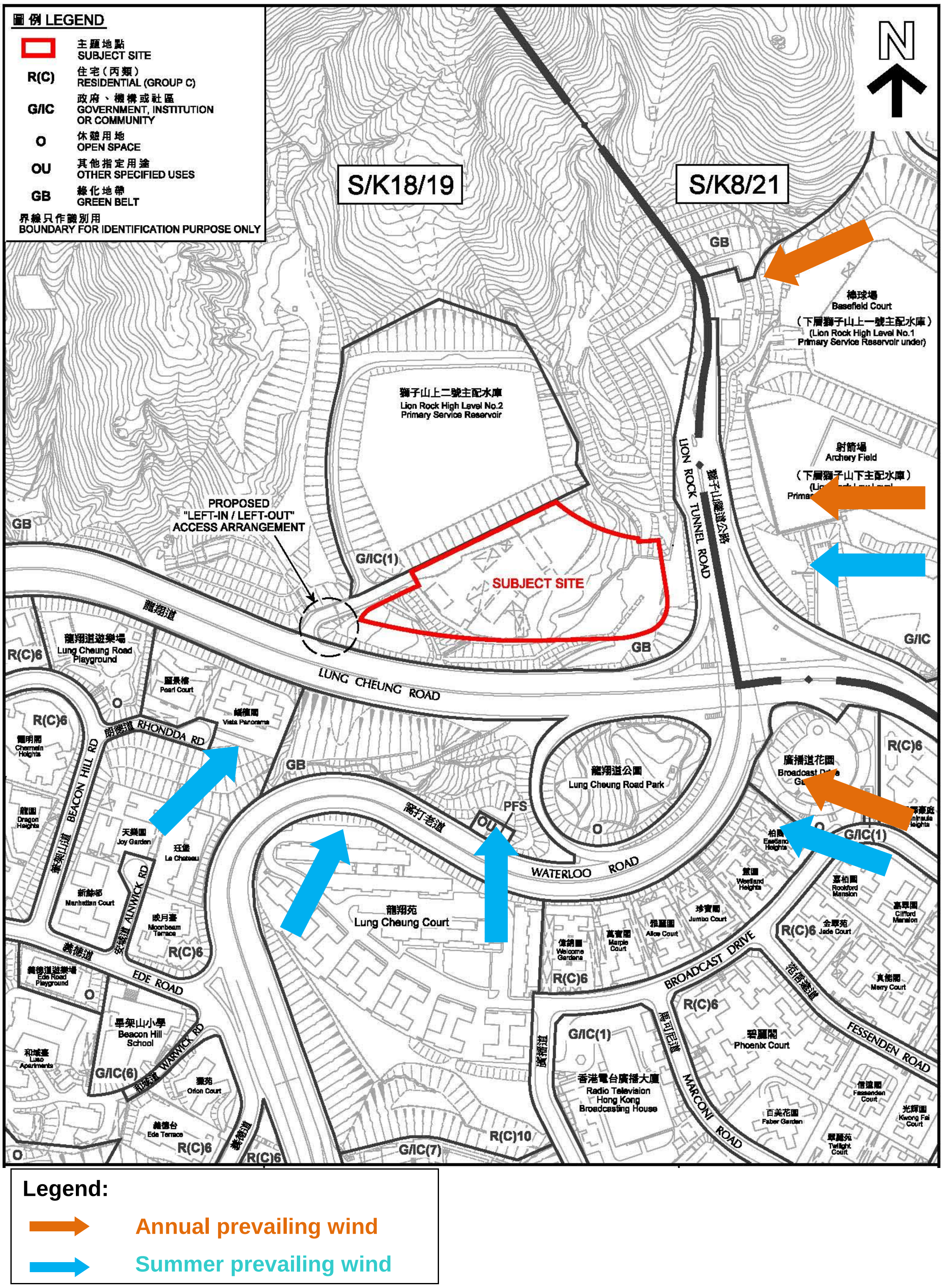


Figure 3.10 A summary of the prevailing winds of the subject site.

4.0 Topography and the Wind Environment

4.1 The subject site is located at the slope of hills by Lung Cheung Road. The ground elevation at around 100mPD is higher than the surroundings except for the northern slopes, which extends to Lion Rock with ground elevation up to 500mPD (Figure 4.1).

4.2 The prevailing wind from the northeast can flow to the subject site down the slope of hills. Due to the relative higher elevation of the subject site, the prevailing winds from the E, SSE, S and SW will be unobstructed by the topography flowing to the site.

4.3 Katabatic (downhill) air movements can be expected from the vegetated hill slopes north of the subject site (Figure 4.1).

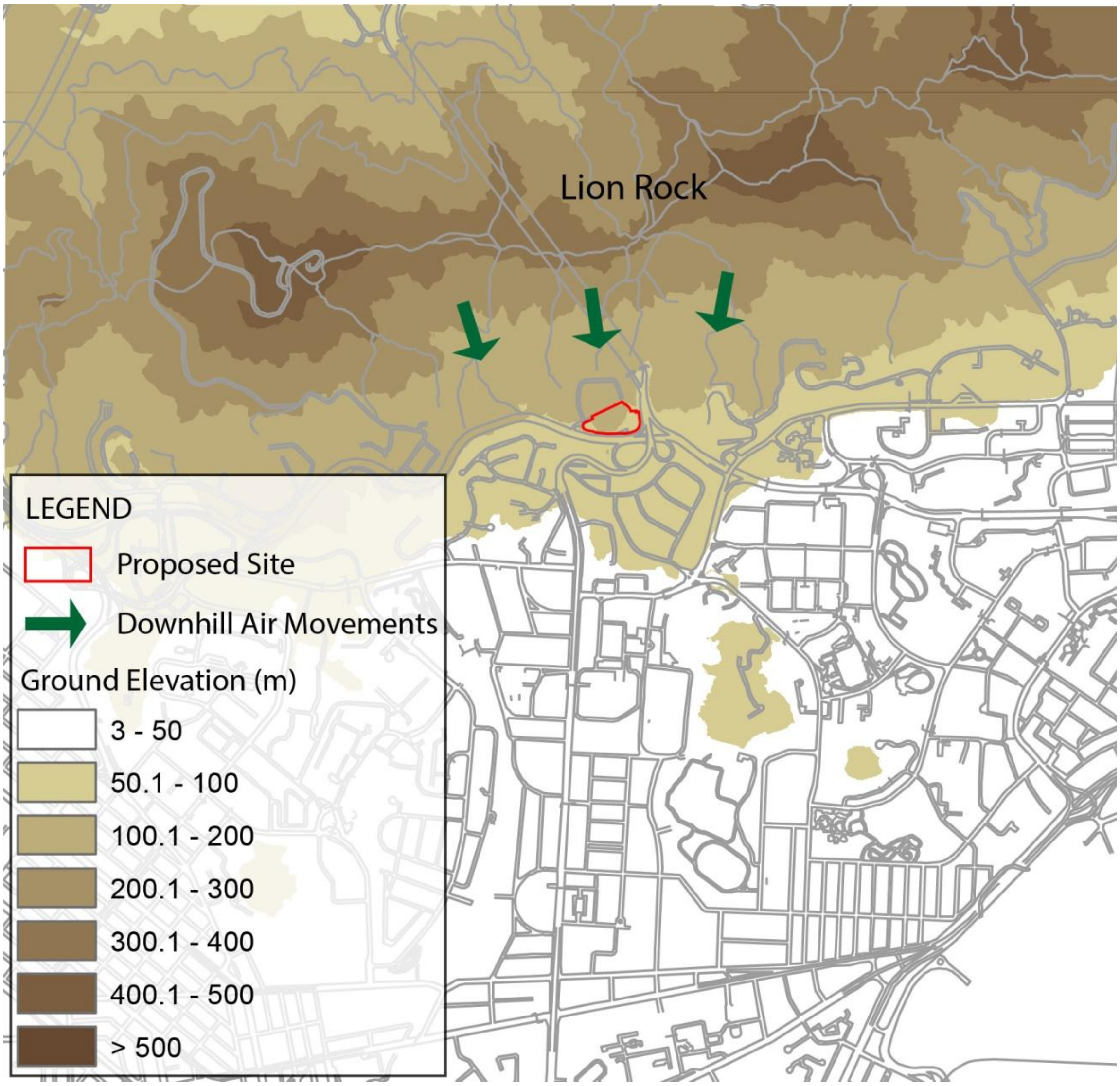


Figure 4.1 Topography and wind environment surrounding the subject site.

5.0 Existing Conditions

5.1 The existing building heights surrounding the subject site are shown in Figure 5.1. There are no developments northeast and east of the subject site. The NE and E winds can flow to the subject site without obstruction.

5.2 There are some developments with building heights lower than 120mPD south of the subject site and they include Lung Cheung Court, Welcome Gardens, Marple Court, Alice Court, Jumbo Court, Westland Heights, Eastland Heights and Peninsula Heights, etc. Due to the relatively high ground elevation of the subject site at around 100mPD, the ESE and S prevailing winds can flow to the subject site with little obstruction.

5.3 Some developments with building heights around 130mPD located to the southwest of the subject site include Pearl Court and Vista Panorama. Such existing developments would slightly block the SW wind. However, there are some gaps between these developments and a lot of open spaces and open areas nearby (such as Lung Cheung Road Playground, slopes south of Rhondda Road and "Green Belt" next to Vista Panorama). The SW prevailing wind can flow to the subject site through the building gaps, open spaces and open areas to reach the subject site.

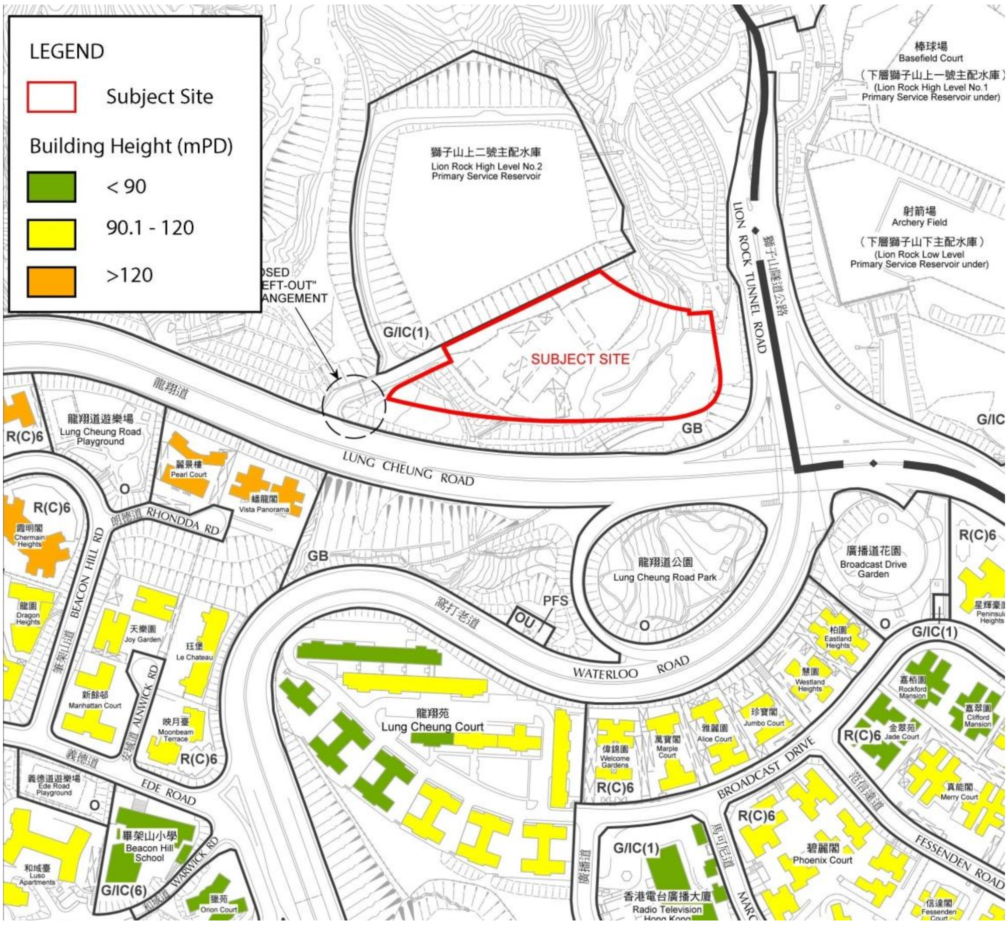


Figure 5.1 Building height (mPD) of the existing buildings surrounding the subject site.

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.

Currently the subject site is almost vacant without any developments. North and West of the subject site are also almost vacant without any developments. Prevailing winds from the E and ESE can flow freely through the subject site and Lung Cheung Road to the surrounding areas (Figure 6.1). The subject site is located at higher level, so that ESE and S winds are still able to skim over the existing developments located to the south of the subject site and flow through Lung Cheung Road, Lung Cheung Road Park, Broadcast Drive and Broadcast Drive Garden to reach the subject site and its further downstream areas (Figure 6.2). The SSW and SW winds can also travel through Beacon Hill Road, Warwick Road, Waterloo Road, the building separations and open spaces (as discussed in para. 5.3) and reach the subject site and its further downstream (Figure 6.2).

6.2 There are some developments south of the vacant subject site. Currently, prevailing wind from the ENE can flow to south of the subject site without obstruction. Wind then flows along Waterloo Road serving areas further south (Figure 6.3).

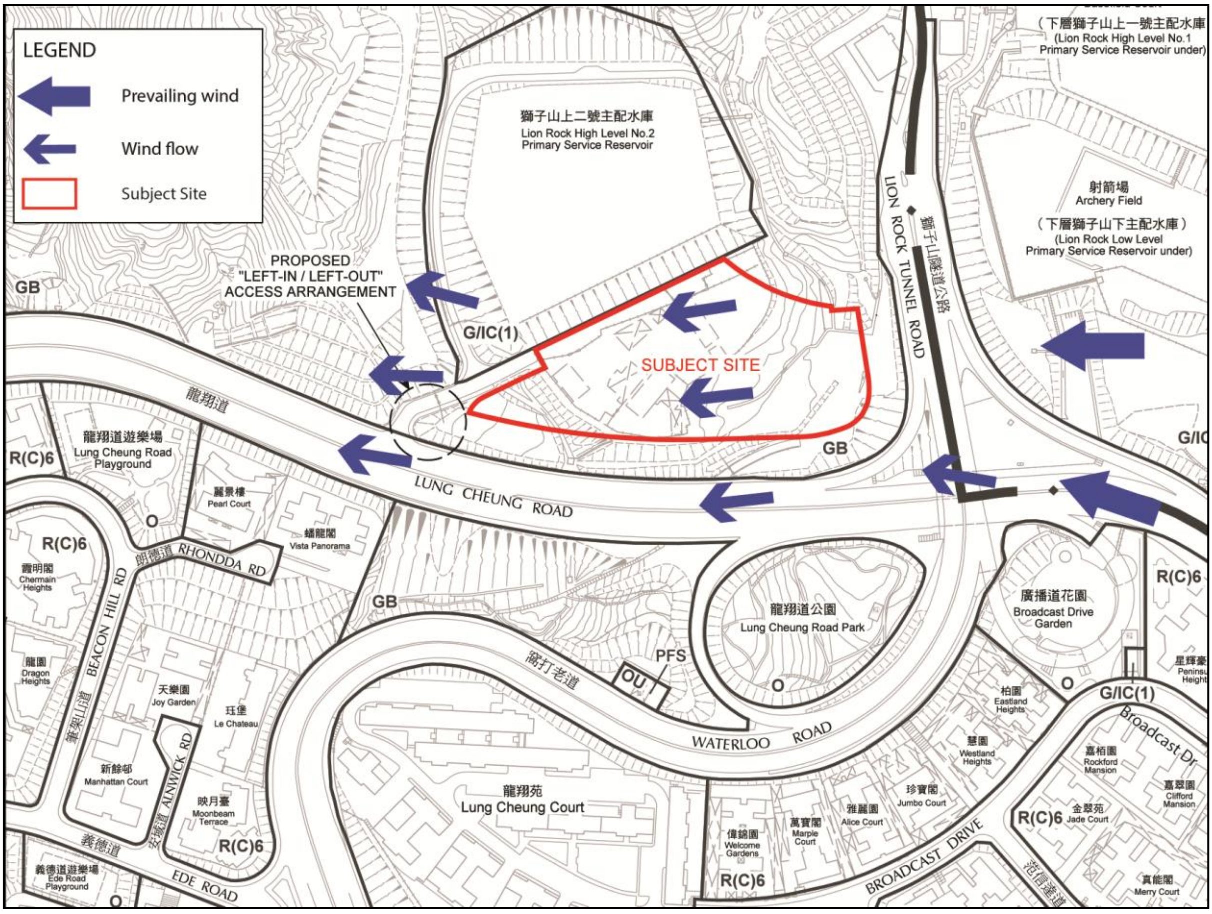


Figure 6.1 Wind flow in the subject site and surrounding areas under prevailing winds from the E.

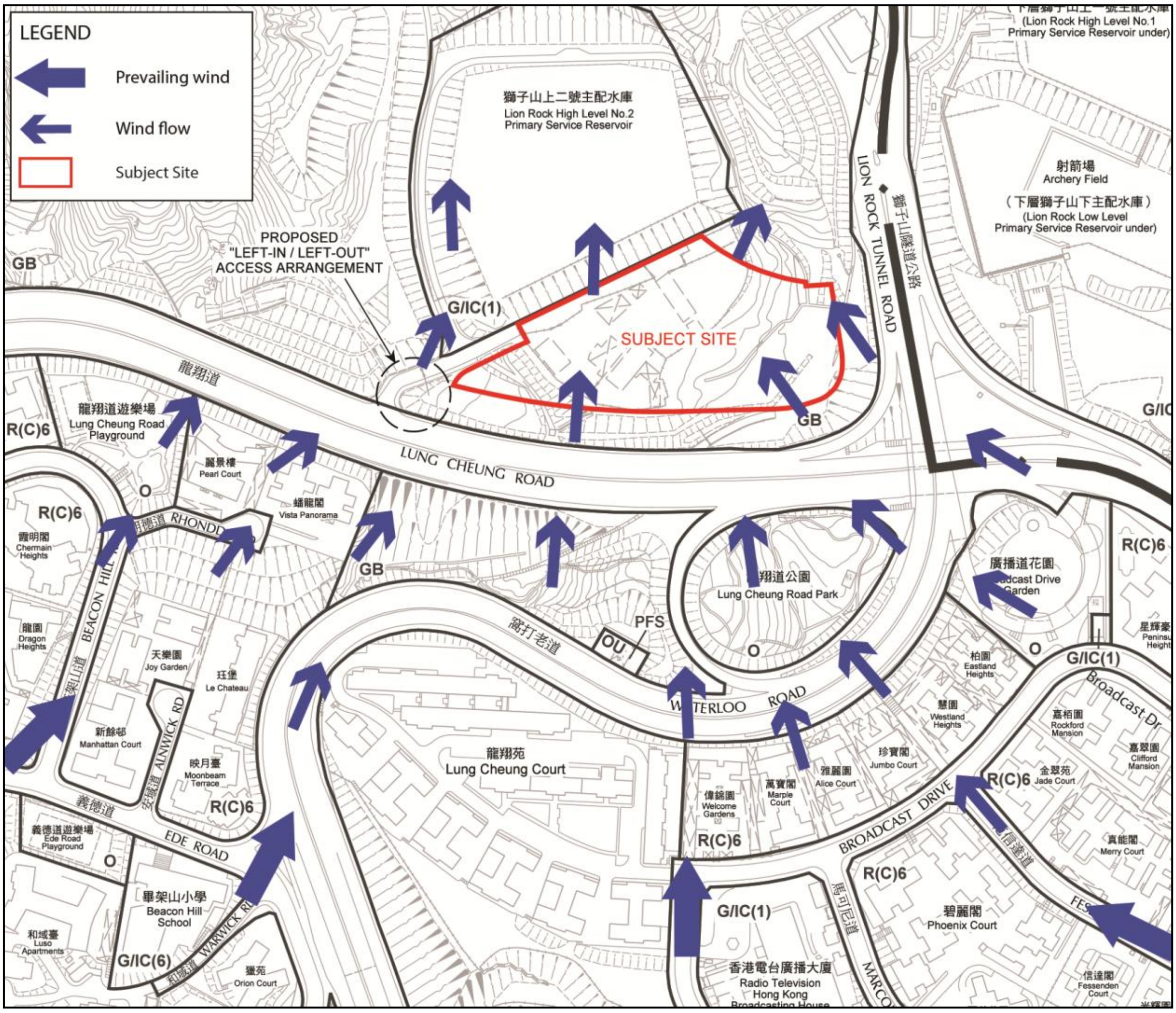


Figure 6.2 Wind flow in the subject site and surrounding areas under prevailing winds from the ESE, S, SSW and SW.

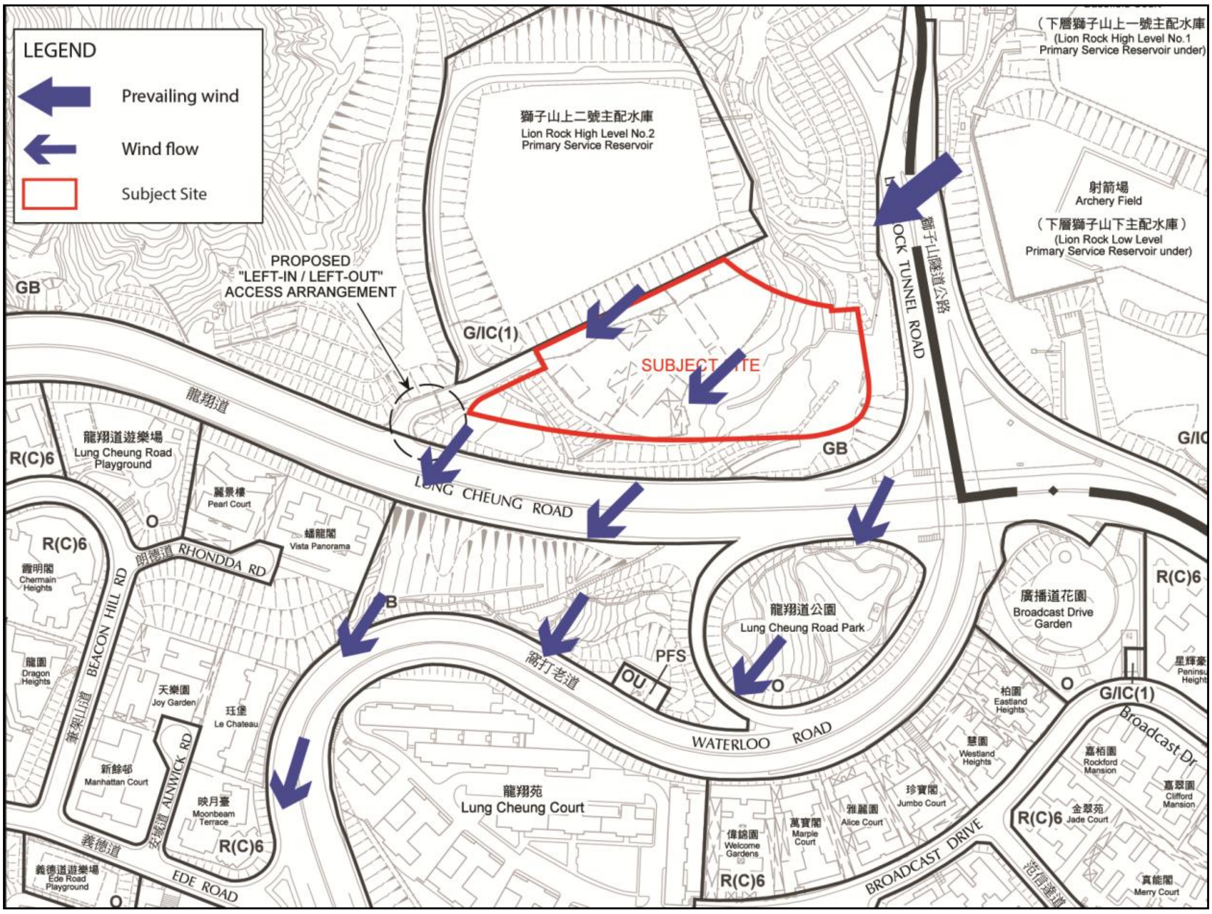


Figure 6.3 Wind flow in the subject site and surrounding areas under prevailing winds from the ENE.

7.0 Expert Evaluation of the Development Scheme

7.1 The AVA Study has assessed the wind performance of the subject site at Lung Cheung Road, Kowloon Tong (Figure 7.1). The site is 1.13ha and it is proposed for development with a plot ratio of 3.6 at maximum building height of 160mPD. Under the AVA Study, the worst case scenario has been assumed that there would be wake area on the leeward side of the building upon encountering the impermeable building. The depth of the possible wake area could be at least the height or the width of the frontal area of the building (see Figure A-1 and Figure A-2 in the Appendix). In general, air ventilation can achieve better performance if measures, such as Non-Building Area (NBA), building separations, setbacks, , open spaces and building permeability especially near ground level, are applied.

7.2 When prevailing wind comes from the E, the developments in the subject site are likely to create some wake areas on the leeward side (Figure 7.2). However, there are no sensitive receivers west of the subject site, which are open areas zoned “Green Belt” and a service reservoir.

7.3 When prevailing wind comes from the ESE, S, SSW and SW, the developments in the subject site are likely to create some wake areas on the leeward side (Figure 7.3). Similarly, there are no sensitive receivers north of the subject site, which are open areas zoned “Green Belt” and a service reservoir.

7.4 When prevailing wind comes from the ENE, the developments in the subject site are likely to create some wake areas on the leeward side (Figure 7.4), which will extend to Lung Cheung Road and the open areas zoned “Green Belt” south of the subject site. To avoid wall-like developments to block the penetration of ENE wind through the future development to reach the areas south of the subject site, it is recommended, at detailed design stage, that the project proponents should make reference to the design guidelines of Building Disposition and Building Permeability in "Hong Kong Planning Standard and Guidelines” (HKPSG) and follow the building separation requirement (20% - 33.3%) in the “Sustainable Building Design Guidelines”[1] to provide some gaps in facilitating penetration of ENE wind through the proposed development to reach the areas south of the proposed site.

[1] Hong Kong Buildings Department. Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers: Sustainable Building Design Guidelines (APP-152). 2016.

7.5 A footbridge (3m in width and 5.1m clearance) across Lung Cheung Road is proposed under the current development scheme (Figure 7.5). The frontal width of the lift tower and staircase of the footbridge is relatively small (less than 10m). The clearance under the deck of the footbridge is at least 5.1m and the major structure of the footbridge is quite isolated from the pedestrian level. Thus, it is anticipated that the footbridge would not have any significant air ventilation impact on the surroundings under all prevailing wind directions.

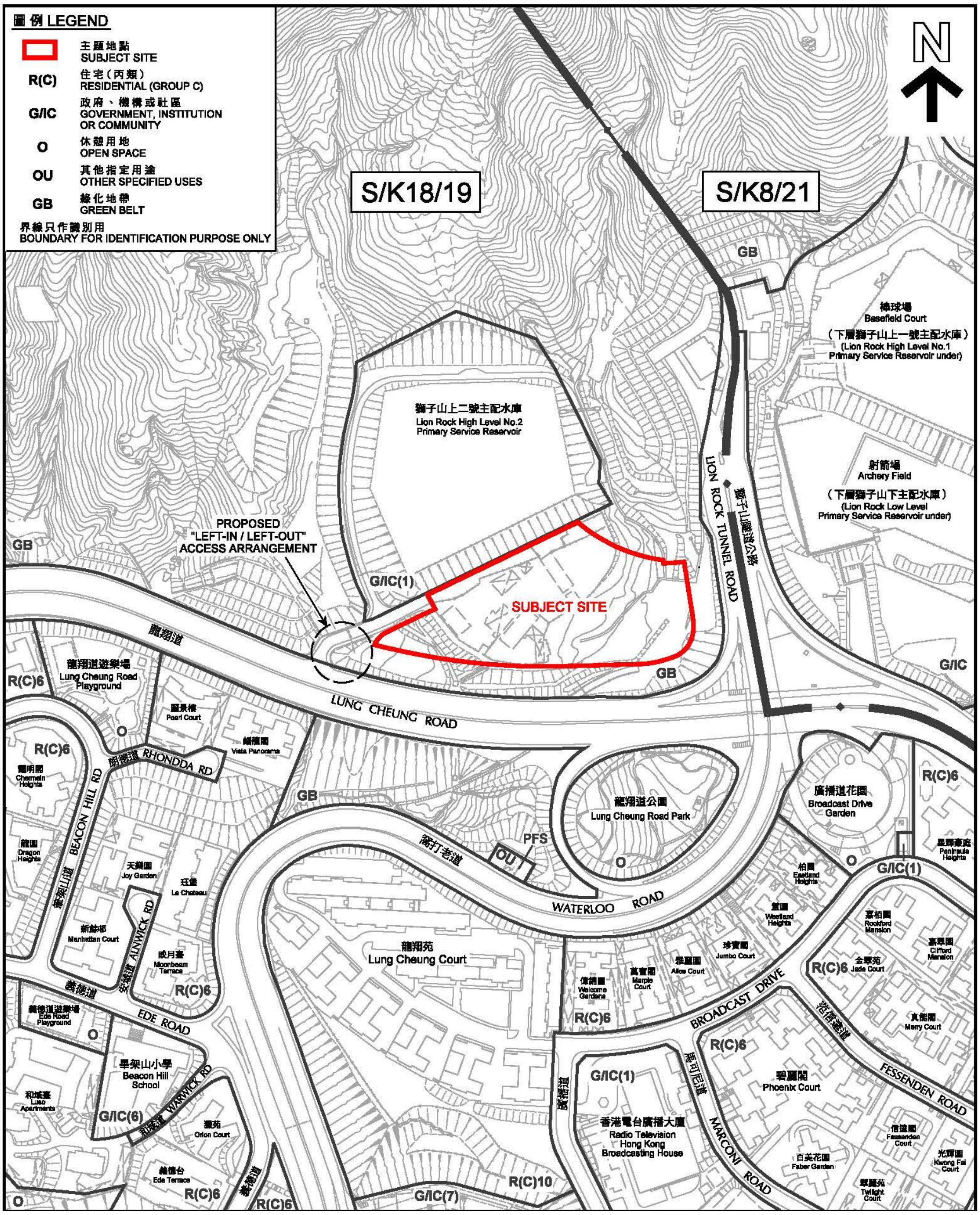


Figure 7.1 Site plan of the subject site.

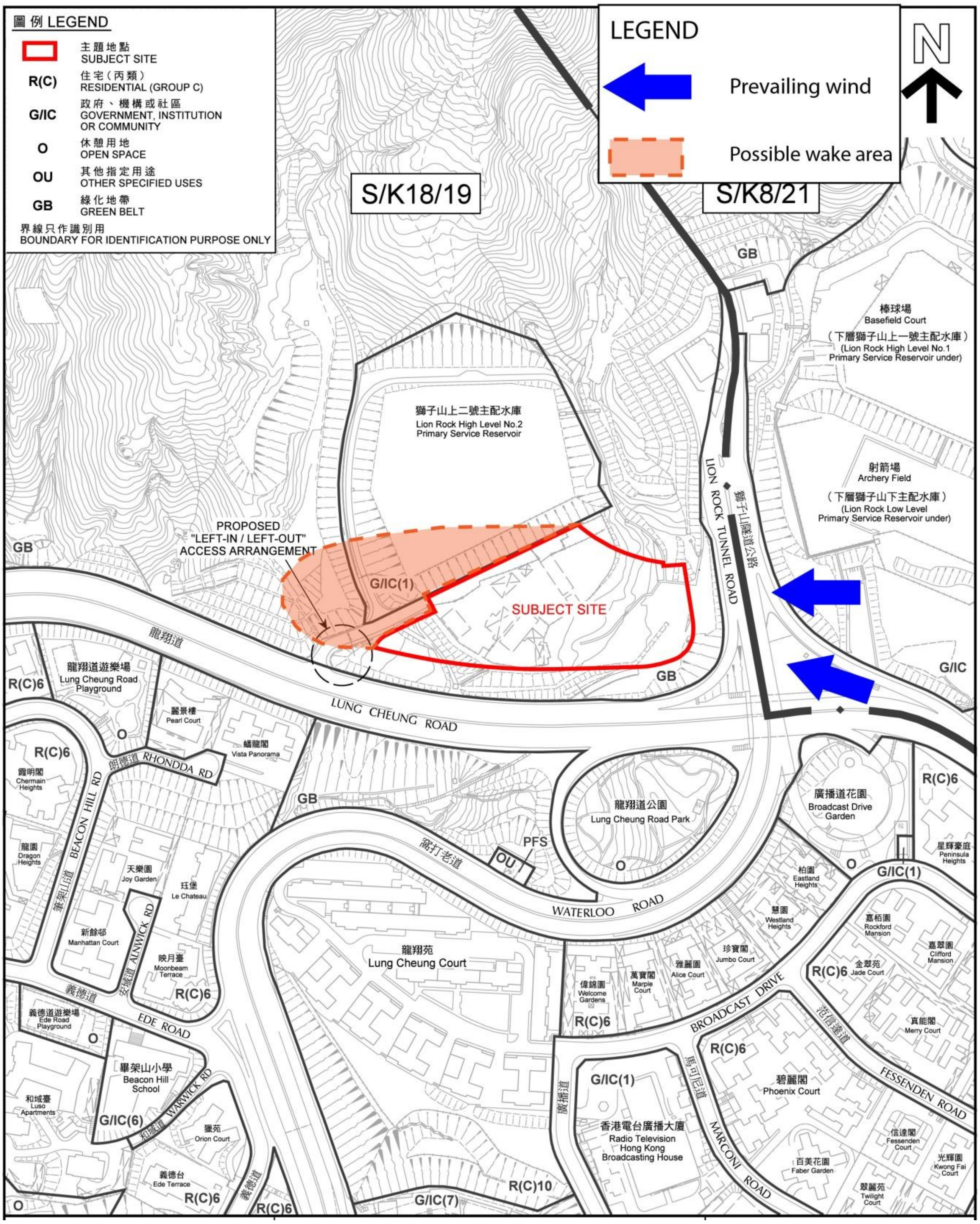


Figure 7.2 Possible wake areas caused by the developments in the subject site under prevailing wind from the E.

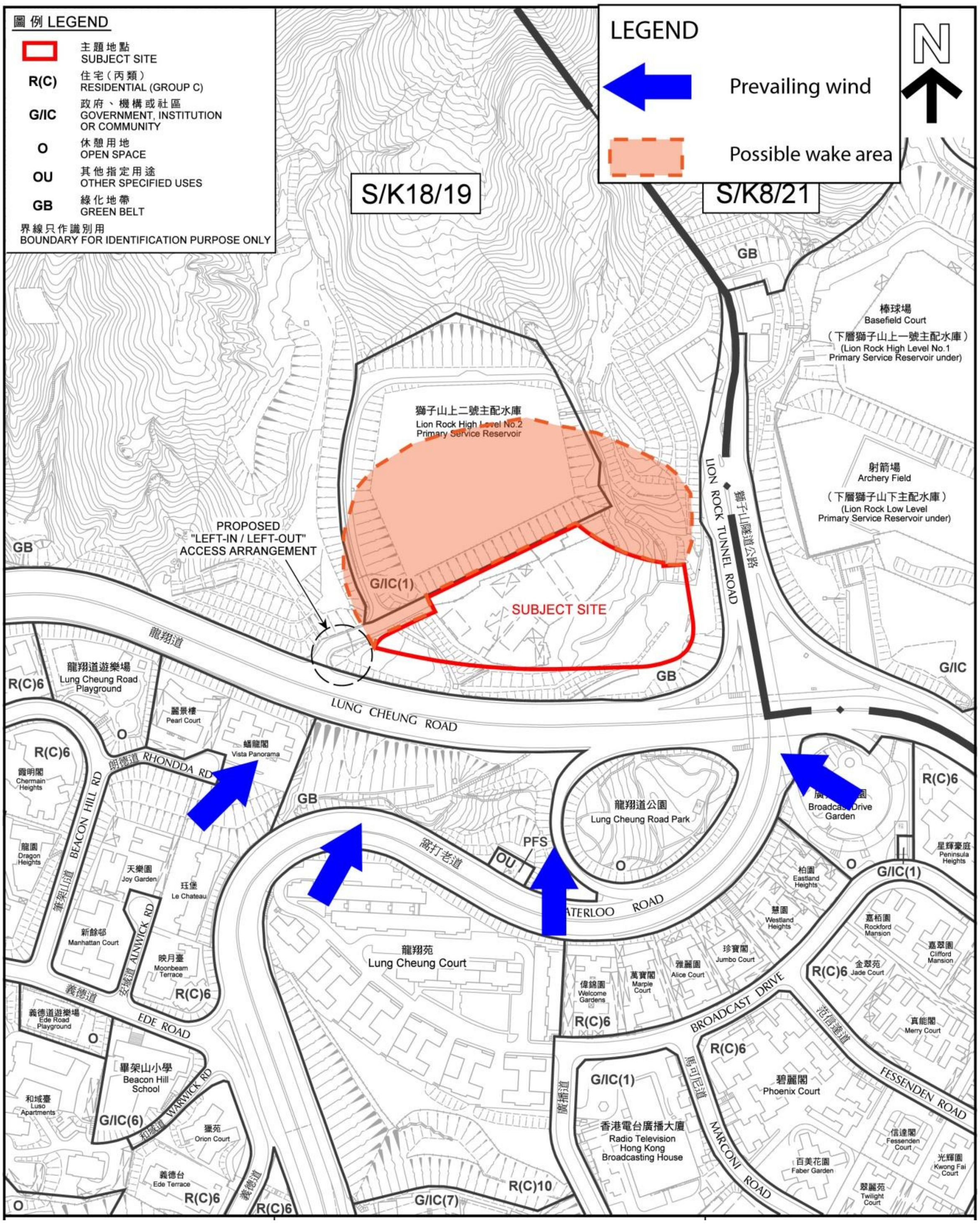


Figure 7.3 Possible wake areas caused by the developments in the subject site under prevailing winds from the ESE, S, SSW and SW.

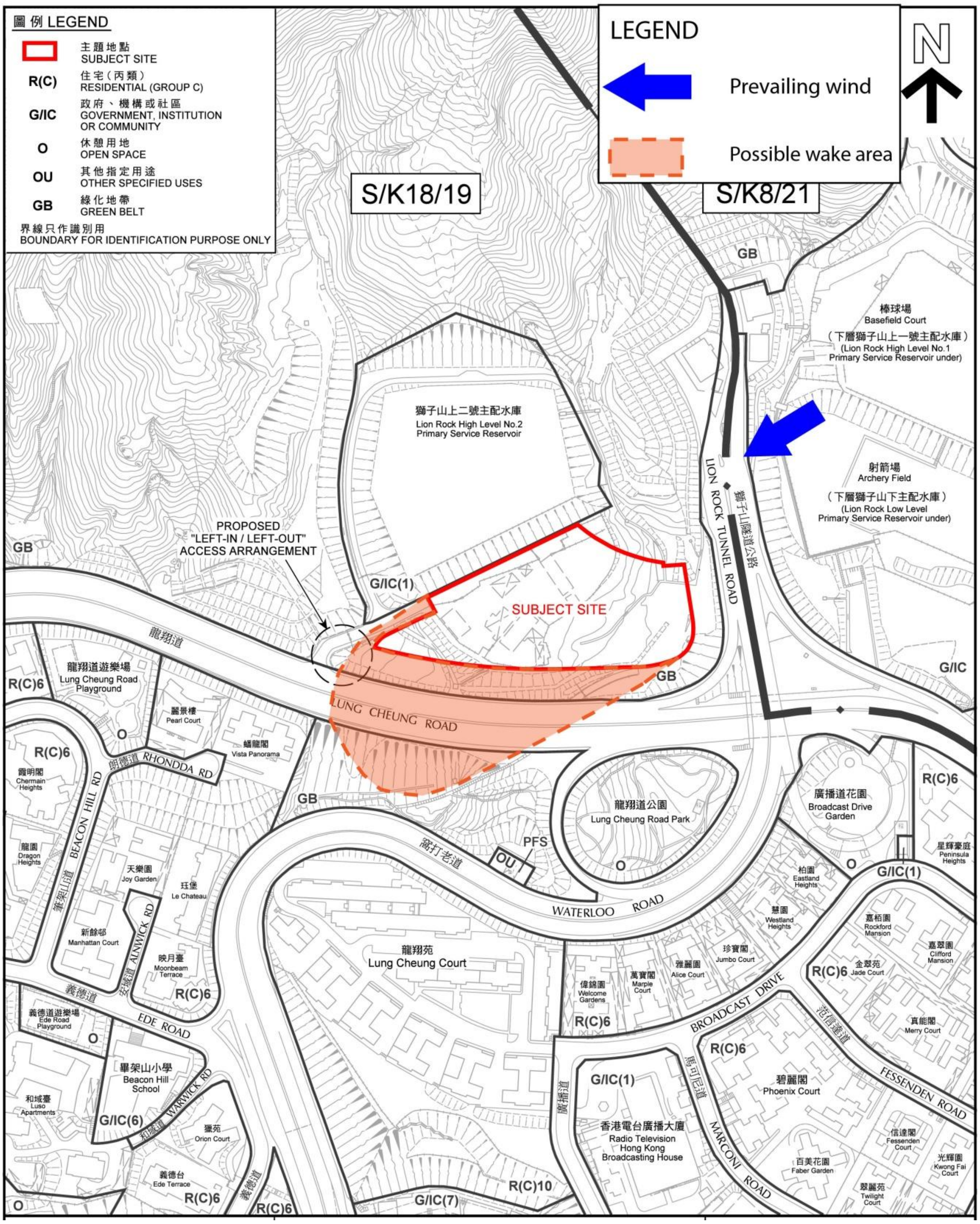


Figure 7.4 Possible wake areas caused by the developments in the subject site under prevailing winds from the ENE.

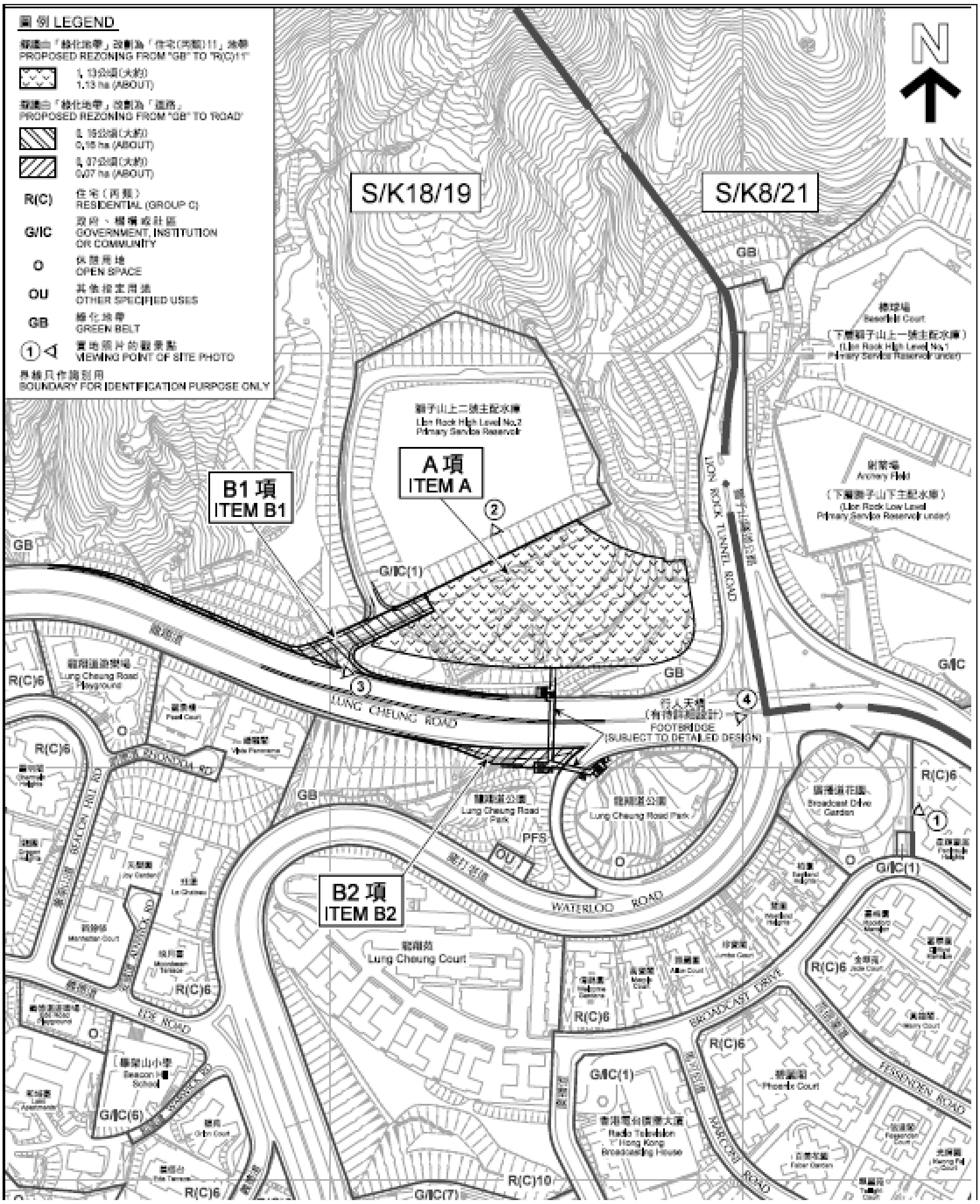


Figure 7.5 A proposed footbridge across Lung Cheung Road.

8.0 Further Work

8.1 Given the building separation requirements under the Sustainable Building Design Guidelines as set out in Section 7 would be fulfilled as recommended in the building design of future development, the proposal at the subject site would have no major air ventilation issues. If the requirements of building separations cannot be met, further quantitative assessments should be conducted to demonstrate that the performance of any future development would be no worse off than the scenario with these measures.

Appendix

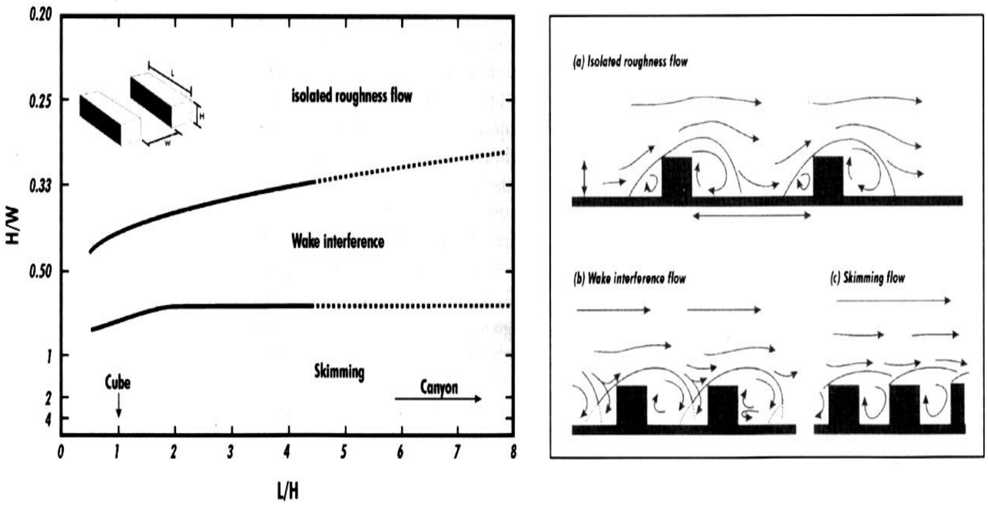
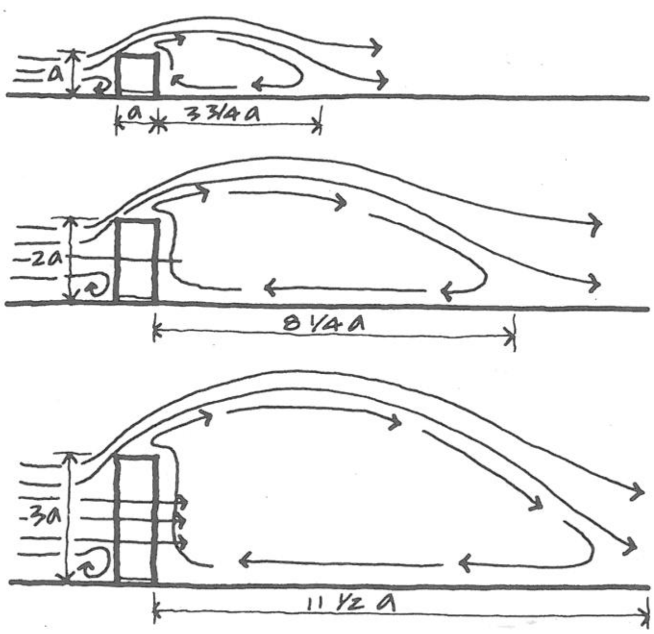
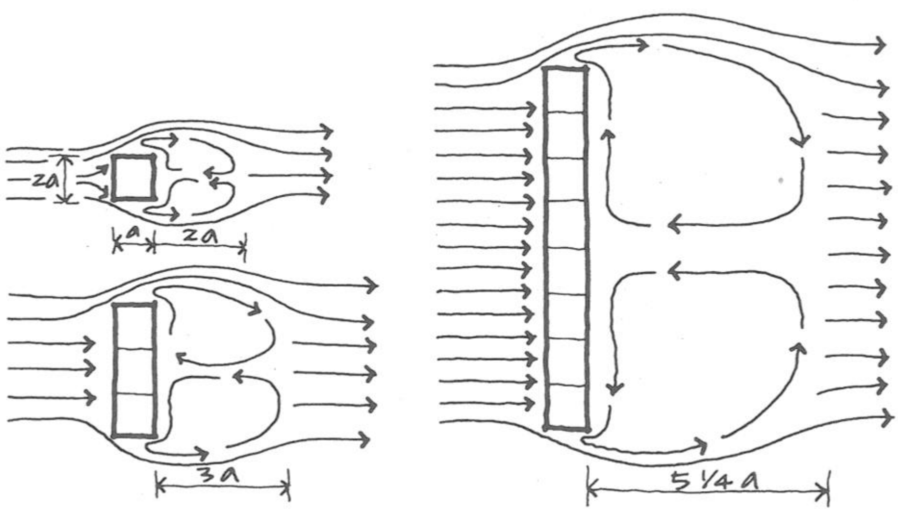


Figure A-1 The relationship between building height and street width ratio and the possible flow regimes.

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



(a) Impact of building height



(b) Impact of building width

Figure A-2 Wind flows around buildings.

Note: Arrows represent wind flow patterns, with closer lines indicating increased wind speed. Circular arrows indicate eddies. The low-pressure eddy zones will have markedly decrease wind speeds and are sometimes termed areas of "wind shadow" (wind wake).

[Reference: Brown, G. Z., & Sun, D. M. (2001). Wind, and Light: Architectural Design Strategies. *US: Wiley*.]

Prepared by

Date: 15 December 2016

Dr. Justin Ho

Endorsed by

Date: 15 December 2016

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On behalf of technical experts in the term consultant term

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