ISSUE 209-4

AIR VENTILATION ASSESSMENT EXPERT REPORT (FINAL)

Agreement No. CE 8/2015 (WS)

First Stage of Desalination Plant at Tseung Kwan O – Investigation, Design and Construction

B&V PROJECT NO. 190495/29.2090

Report Authorized For Issue By:	For and on Behalf of Black & Veatch Hong Kong Limited

PREPARED FOR

Water Supplies Department

21 DECEMBER 2016

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All	Dec 2016	3	Final report for retention	SHY
All	Dec 2016	4	Final report for retention	SHY

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	Name	Signature	Date
Prepared	SH Yan		
Checked	Lorinda Lee		
Reviewed	Christina Ko		

1 Introduction

1.1 Background

1.1.1 Water Supplies Department appointed Black & Veatch Hong Kong Limited (B&V) to undertake the consultancy "Agreement No. CE 8/2015 (WS) First Stage of Desalination Plant at Tseung Kwan O – Investigation, Design, and Construction" on 16 November 2015.

1.1.2 The purpose of the project is to construct a sea water reverse osmosis (SWRO) desalination plant at Tseung Kwan O (TKO) Area 137, together with all ancillary facilities and the slope mitigation works in the adjoining Clear Water Bay Country Park.

1.1.3 The first stage of the proposed SWRO desalination plant will have a water production capacity of 135,000 cubic meters (m^3) per day with provision for future expansion to the ultimate capacity up to 270,000 m^3 per day when necessary.

1.1.4 The proposed desalination plant is a key supply management initiative under the Total Water Management (TWM) strategy promulgated in 2008. As one of the key supply management initiatives, the desalination plant will help diversify the water supply resources and serve as a new water source to better prepare Hong Kong for uncertainties such as acute climate change and low rainfall. Under the TWM strategy, Hong Kong should broaden its strategic investment in advanced water treatment for desalination of seawater.

1.1.5 B&V has commissioned BeeXergy Consulting Limited (BXG) to undertake the Air Ventilation Assessment (AVA) – Expert Evaluation (EE) for the proposed desalination plant at Tseung Kwan O (the Development) in order to fulfil the requirement under "Housing Planning and Lands Bureau – Technical Circular No. 1/06, Environment, Transport and Works Bureau – Technical Circular No. 1/06" issued on 19th July 2006.

1.2 Objective of Air Ventilation Assessment

1.2.1 The objective of this report is to:

(a) Evaluate the wind performance of the Development using the methodology of Air Ventilation Assessment, based on the Technical Circular and "Technical Guide for Air Ventilation Assessment for Development in Hong Kong – Annex A." as appended in Appendix A.

(b) Present the findings for the study of Stage 1 – Expert Evaluation as appended in Appendix A.

2 Conclusion

2.1.1 The Development consists of multiple buildings and erected water processing structure over a large area. According to the analysis, the annual prevailing wind comes from NE, ENE and E directions and the summer prevailing wind is from SW, SSW and E direction. Wind is expected to skim over the development or pass through the air path under NE quarter wind. Also, wind from SW quarter would not bring significant impact to the vicinity developed area as it is located beneath of Tin Ha Au. In general, negative ventilation impact induced by the site is considered insignificant. Details could refer to Section 6 of Appendix A. Also, several good design features are identified, which include:

- Low-rise design with maximum building height of 20m above ground level;
- Provision of open area in southern corner of the development;
- Provision of a 15m-wide wind path at 5m above ground; and
- Provision of a 15m-wide central wind path.

APPENDIX A

AIR VENTILATION ASSESSMENT EXPERT EVALUATION REPORT

PRESENTED BY BEEXERGY

AIR VENTILATION ASSESSMENT EXPERT EVALUATION REPORT

FOR

TSEUNG KWAN O DESALINATION PLANT

10 November 2016

Ref. No.: RT16106-CFD-01C

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Project:	Air Ventilation Assessment of desalination plant at Tseung Kwan O
Report No.:	RT16106-CFD-01C

Revision	Issue Date	Description	Author	Checker	Approver
Issue A	30/09/16	Issued report	Various	YS	HM
Issue B	01/11/16	Revised report	Various	YS	HM
Issue C	10/11/16	Revision for comments	Various	YS	HM

Checked by:

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Approved by:

Henry Mak
Director, BXG

Disclaimer:

- This report is prepared and submitted by Beexergy Consulting Limited with all reasonable skill to the best of our knowledge, incorporating our Terms and Conditions and taking account of the resources devoted to it by agreement with the client.
- We disclaim any responsibility to the client and others in respect of any matters outside the project scope.
- This report is confidential to the client and we accept no responsibility of whatsoever nature to third parties to whom this report, or any part thereof, is made known. Any such party relies upon the report at their own risk.

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1. INTRODUCTION

1.1. PROJECT BACKGROUND

BeeXergy Consulting Limited (BXG) was commissioned by the Black & Veatch (BV) to undertake an Air Ventilation Assessment (AVA) – Expert Evaluation (EE) for the proposed desalination plant at Tseung Kwan O (the Development) in order to fulfil the requirement under "Housing Planning and Lands Bureau – Technical Circular No. 1/06, Environment, Transport and Works Bureau – Technical Circular No. 1/06" issued on 19th July 2006 (the Technical Circular)

1.2. OBJECTIVE

According to the Technical Circular - clause 7(i), A development on waterfront site with lot frontage exceeding 100 meters in length shall be required to undertake to AVA. The objective of this study is to evaluate the wind performance of the Development using the methodology of Air Ventilation Assessment, based on the Technical Circular and "Technical Guide for Air Ventilation Assessment for Development in Hong Kong – Annex A" (the Technical Guide). This report presents the findings for the study of Stage 1 – Expert Evaluation.

1.3. STUDY TASKS

The major task of this study is to carry out an Expert Evaluation on the characteristics of the site wind availability data of the development area and assessment of the wind performance under existing development situation and the proposed building design option in a qualitative way. The expert evaluation will cover the following tasks:

- Identify the wind condition
- Identify problem areas (if any)
- Identify good design features

2. SITE CHARACTERISTICS

The Development consists of multiple administrative and process blocks with a maximum building height of 27mPD[1]. It is situated at the southeast of Fat Tong O next to Kwun Tsai and Tit Cham Chau. The Fat Tong O area is currently undeveloped. The closest building clusters are the Green Valley Landfill and Television Broadcasts Limited TVB City, which are located ~650m and ~1000m away from the development respectively. Considering the development is low-rise in nature (max height 20m above ground). Wind impact to these developed clusters is considered insignificant. Tin Ha Au is situated to the northeast of the site with a gentle slope up to 100m. Joss House Bay is located to the east while Junk Bay located to the west of the development that is open water surfaces. The topography of Fat Tong O area is shown in Figure 1.

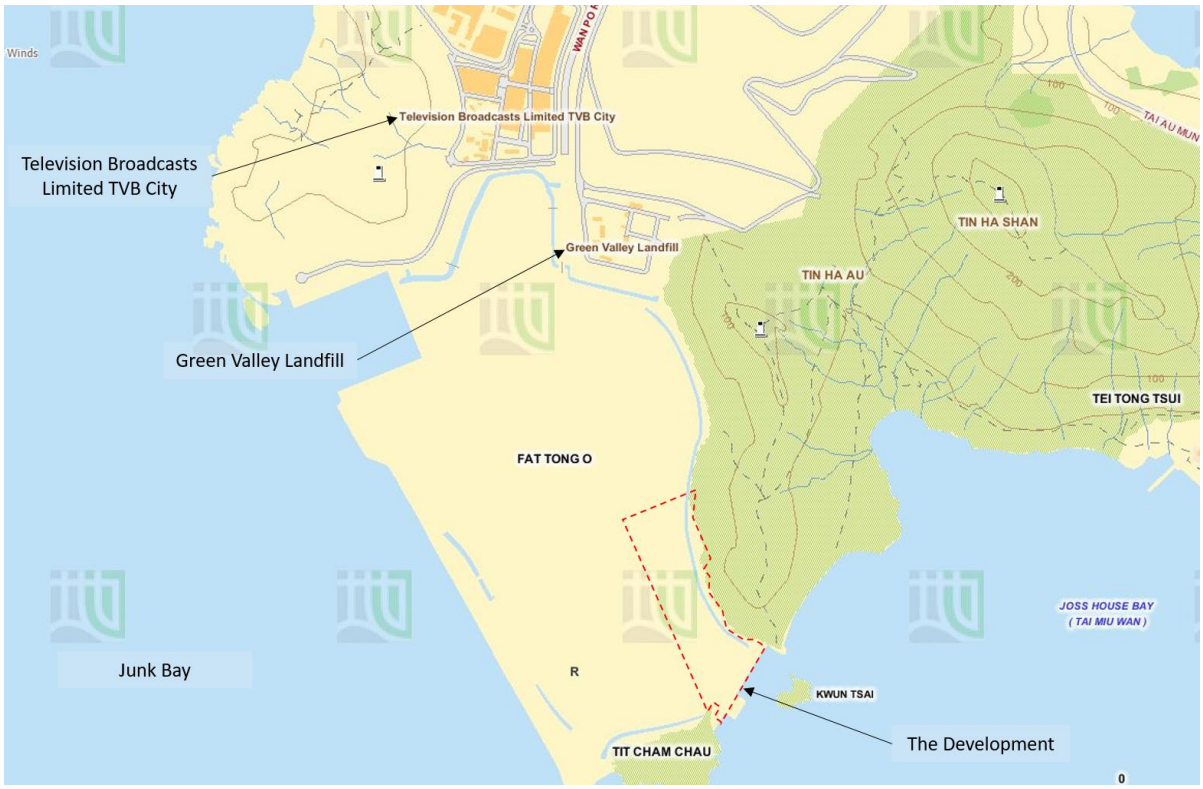

Figure 1 Topography of Fat Tong O Area

[1] The site formation level of development is not confirmed at the time of assessment. Based on the ground level of nearby areas such as TKO Industrial Estate and LOHAS Park, a ground level of 7mPD is assumed at the Development. The maximum building height of 27mPD is based on the assumed ground level and the maximum building height above ground as mentioned in the approved Environmental Assessment Report (AEIAR-192/2015)

3. SITE WIND AVAILABILITY

The characteristic of the natural wind availability of the site should be identified in order to investigate the wind performance of the Development site. Site wind availability data could be used to assess the wind characteristics in terms of the magnitude and frequency of approaching wind from different wind directions. There are three sources of site wind data for this Development, including the nearby Hong Kong Observatory (HKO) Station – Tsueng Kwan O Weather Station (Station Code:JKB), wind tunnel test and simulated RAMS

3.1. HONG KONG OBSERVATORY

The prevailing wind direction measured at the closest weather station – Tsueng Kwan O Weather Station from the Hong Kong Observatory[2] is tabulated in Table 1 for each month. The HKO measurement station is located around 6km from the development. The ENE wind is the annual prevailing wind direction while the S wind is the summer prevailing wind directions, which can be found in Table 1.

Table 1 Monthly Wind Direction Recorded at Tsueng Kwan O Weather Station 2015 (Source: Hong Kong Observatory)

Month		Prevailing Wind Direction (°)
January		10
February		10
March		10
April		180
May		180
June	**(Summer)**	180
July		190
August		180
September		10
October		60
November		60
December		60
Annual		60

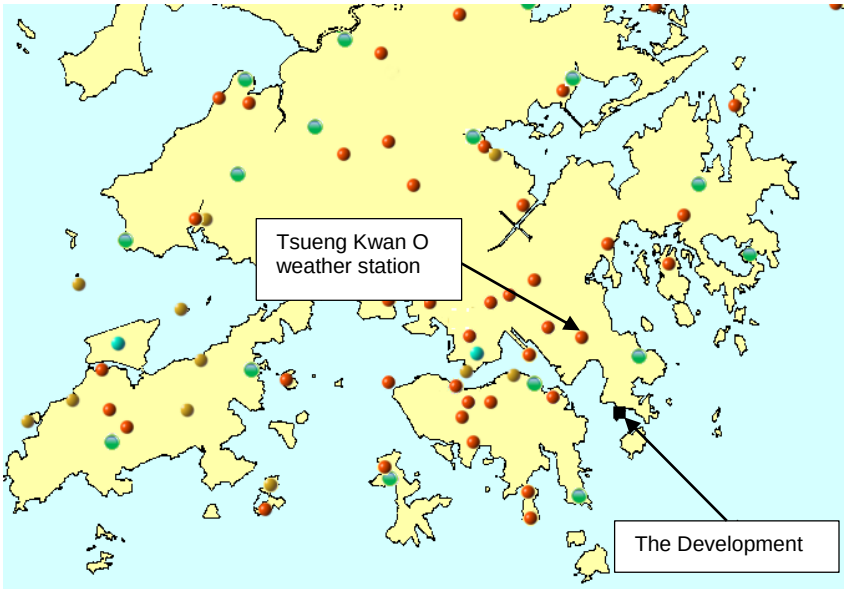

Figure 2 Topography of Fat Tong O Area

[2] Summary of Meteorological and Tidal Observations in Hong Kong 2015 (http://www.hko.gov.hk/publica/smo/smo2015.pdf)

3.2. WIND TUNNEL TEST

"Experimental Site Wind Availability Study for Tseung Kwan O, Hong Kong" conducted by the CLP Power Wind/Wave Tunnel Facility (WWTF) at The Hong Kong University of Science and Technology provides wind availability data for TKO area from wind tunnel experiment. The measurement location approximately locates at S.T.F.A. Leung Kit Wah Primary School which is around 6km away from the development. The wind roses under annual and summer conditions are shown in Figure 3 and Figure 4 respectively.

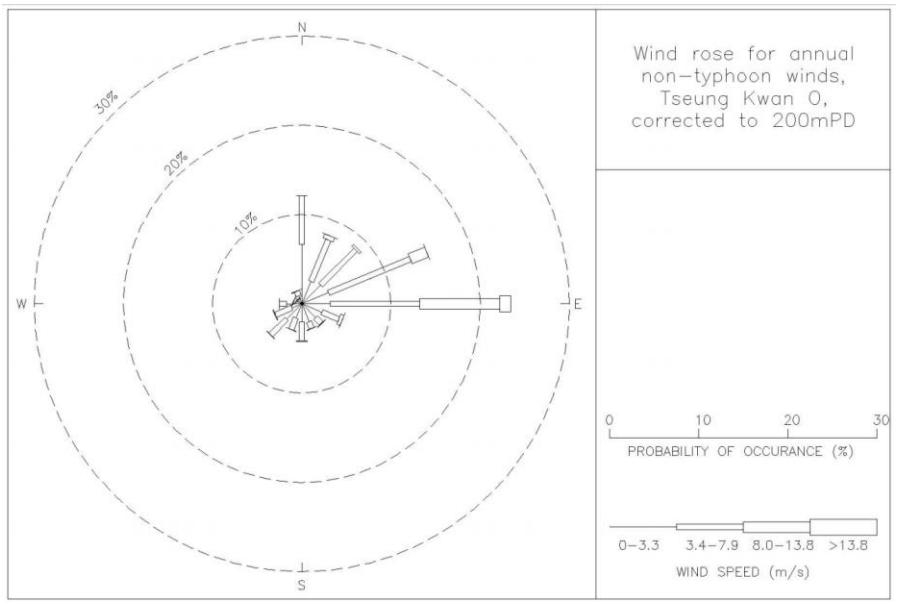

Figure 3 Wind Rose for TKO area under Annual Wind Condition at 200m

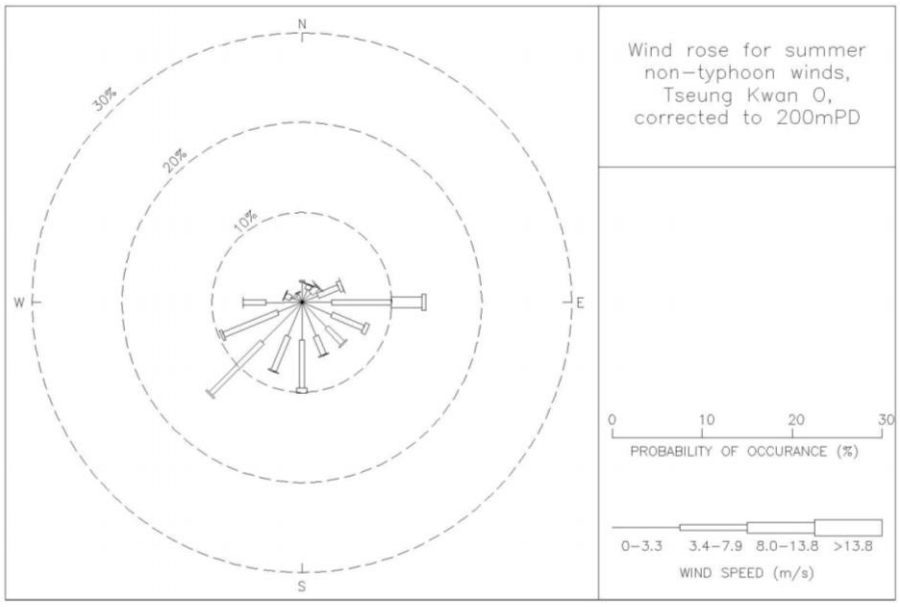

Figure 4 Wind Rose for the TKO area under Summer Wind Condition at 200m

According to the wind data from the wind tunnel test, E, ENE and N winds are identified as the annual prevailing wind direction while WSW, SW, E and S winds are identified as the summer prevailing wind direction.

Table 2 Prevailing Wind Frequency by Wind Tunnel Test

Prevailing Wind	Annual	Summer
Wind Direction	E, ENE, N	WSW, SW, E, S

3.3. RAMS WIND DATA

Planning Department (PlanD) has set up a set of wind availability data of the Territory for AVA study, which could be downloaded at Planning Department Website[3]. As stipulated in the Technical Guide, the site wind availability would be presented by using appropriate mathematical models (e.g. RAMS simulation).

The wind availability data at 200mPD obtained from the grid of (X101, Y031) for the RAMS simulation which is obtain right above the development area, as shown in Figure 5.

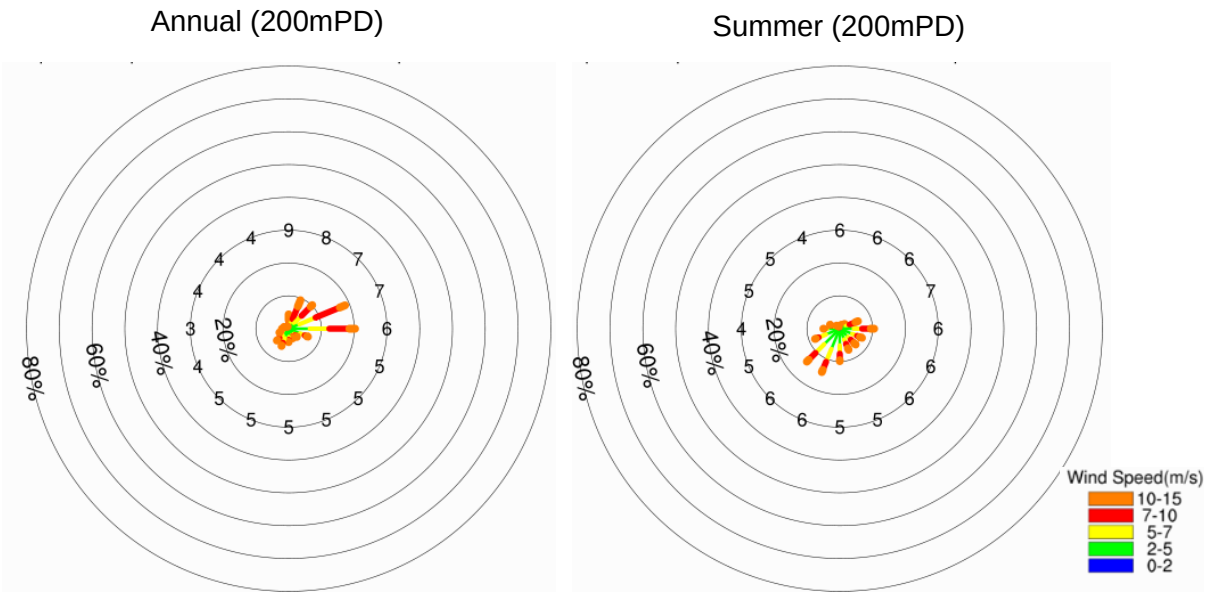

Figure 5 Wind Rose of Fat Tong O Area by RAMS Wind Data

Table 3 Prevailing Wind Frequency by RAMS Wind Data

Prevailing Wind	Annual			Summer		
Wind Direction	**NE**	**ENE**	**E**	**SW**	**SSW**	**E**
Wind Frequency	10.3%	18.7%	20.4%	14.3 %	14.4%	10.6%

According to the RAMS wind data, NE, ENE and E winds contribute to 10.3%, 18.7% and 20.4% of the annual wind frequency respectively while the SW, SSW and E winds contribute to 14.3%, 14.4% and 10.6% of the summer wind frequency respectively. Hence, NE, ENE and E winds are identified as the annual prevailing wind direction while SW, SSW and E winds are identified as the summer prevailing wind direction.

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

3.4. SITE WIND AVAILABILITY FOR CURRENT STUDY

These three sets of wind data have been studied. The wind data from closest Weather Station, wind tunnel and RAMS indicated prevailing winds directions are tabulated in Table 4.

The tabulated data reflects similar annual prevailing wind directions pattern under both annual and summer condition. Since HKO weather station and the wind tunnel measurement location is far from the site and RAMS Wind Data is obtained right above the development, Expert Evaluation of site wind performance would adopt RAMS Wind Data as the basis of study which are NNE, E, ESE for Annual and SW, SSW and E for Summer.

Table 4 Prevailing wind directions for the Study Area

Prevailing Wind Direction	HKO	Wind Tunnel Test	RAMS
Annual	ENE	E, ENE, N	NE, ENE, E
Summer	S	WSW, SW, E, S	SW, SSW, E

4. QUALITATIVE ASSESSMENT OF EXISTING CONDITION OF THE PROJECT SITE

The Development is located on undeveloped area which has no major building in the vicinity. Fat Tong O area is surrounded by water surface at both southern and western side with a hilly terrain to the east. With the consideration of the existing topographical condition, the wind environments under both annual and summer conditions are qualitatively assessed below based on the wind data presented in Section 3. Under annual wind condition, the prevailing winds are mainly from northeast quarter. The Tin Ha Shan and Tin Ha Au of approximately 250mPD and 100mPD in height situated at upstream of the wind entrance area. The topography would slightly divert the incoming wind. During the summer condition, wind from southwest quarter is more frequent. Since the Fat Tong O area is undeveloped and remain open, wind could reach the site directly.

4.1. NE PREVAILING WIND

NE wind is one of the annual prevailing winds. Figure 6 shows the incoming wind from NE direction is slightly regulated by the Tin Ha Shan and Tin Ha Au. One of major airstream bypasses the Tin Ha Shan to the north of the studied site and reaches Fat Tong O area (dark blue arrow). Another major airstream (light blue arrow) is passing through Tin Ha Shan and skimming over Tin Ha Au then reaches the development at the NE direction (Figure 6). Since the Tin Ha Au is 100mPD in height with gentle slope, wind is expected to reach the site at mid to low level.

Figure 6 NE prevailing wind

4.2. ENE PREVAILING WIND

ENE wind is one of the annual prevailing winds. Similar to NE wind, the ENE wind would be slightly diverted by the hilly topography including Tin Ha Shan and Tin Ha Au (Figure 7). The diverted wind again reaches the northern Fat Tong O area by passing through Tin Ha Shan (dark blue arrow) to the north of the development. Another portion of wind would flow over the open water of Joss House bay and skim over the Tin Ha Au and reach the site (light blue arrow). The strait between Tin Ha Au and Kwun Tsai Island allows the wind from Joss House Bay to reach the southern part of the development directly (green arrow).

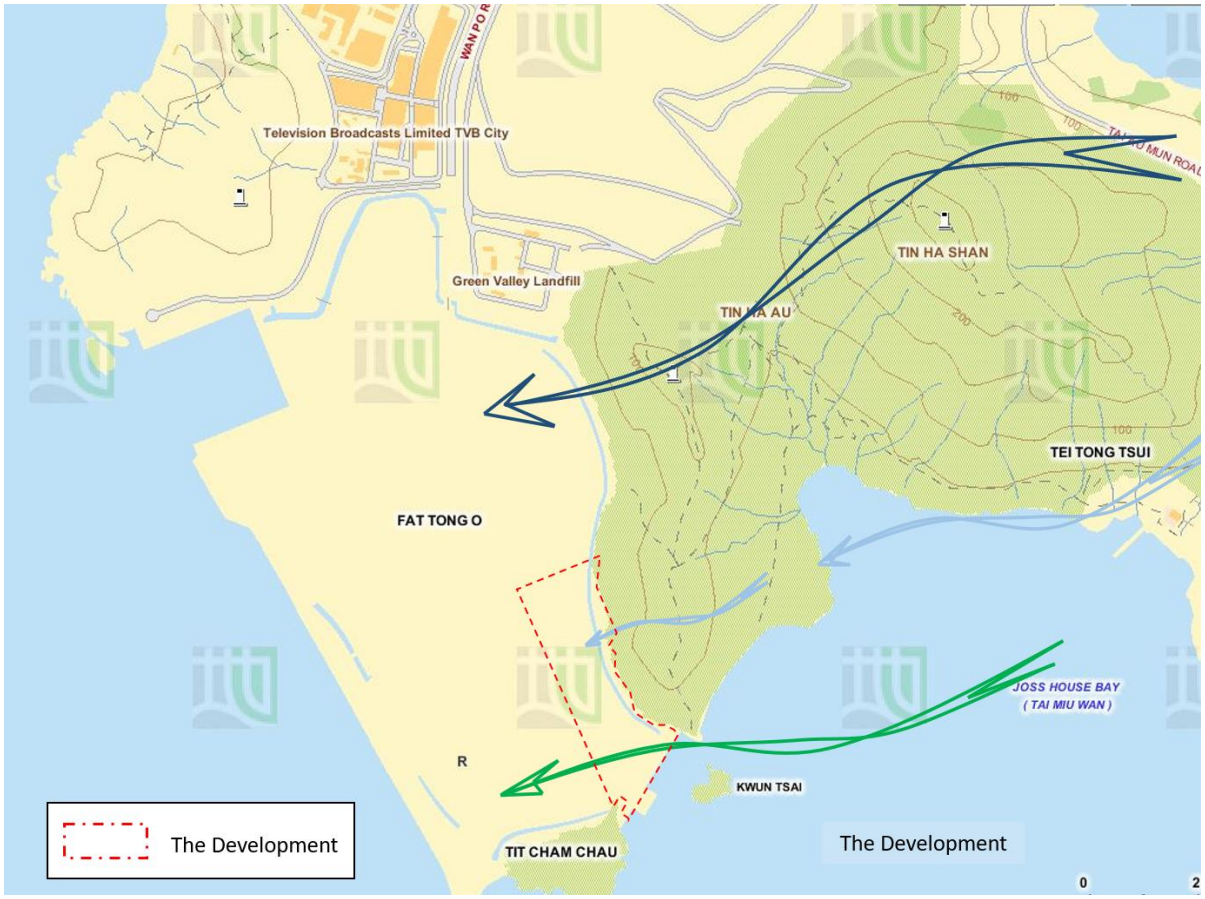

Figure 7 ENE prevailing winds

4.3. E PREVAILING WIND

E wind is the prevailing wind for both annual and summer (Figure 8). Easterly wind flows through southern part of Tin Ha Shan and passes through the valley between Tin Ha Shan and Tin Ha Au and continuously goes through the northern part of Fat Tong O until reaching west coast of Fat Tong O area (dark blue arrow). Wind from Joss House Bay reaches the southern Tin Ha Au and skims over the gentle slope and reaches the development (light blue arrow), while part of wind from Joss House Bay passes through the strait between Kwun Tsai Island and Tin Ha Au, then reaches the studied site directly (green arrow)

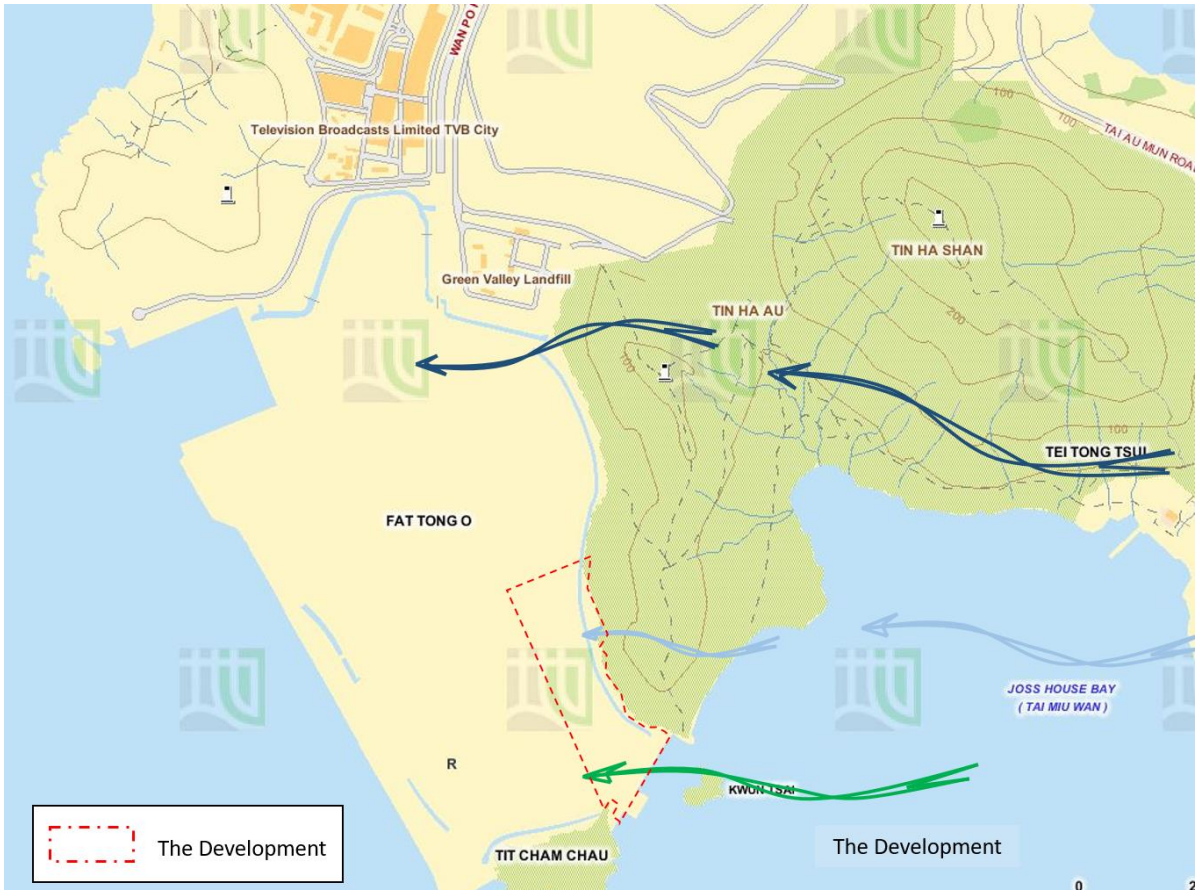

Figure 8 E prevailing winds

4.4. SW AND SSW PREVAILING WIND

SW and SSW is the major prevailing wind under summer condition (Figure 9). Since Fat Tong O is undeveloped flat land, wind from Junk Bay could freely reach the whole Fat Tong O area. Due to small level different between Tit Cham Chau and Fat Tong O, wind could also reach the development freely. As the development locates at the southeast corner of Fat Tong O area, wind from southwest quarter would not likely be affected and could reach Green Valley Landfill freely.

Figure 9 SW and SSW prevailing winds

5. DEVELOPMENT LAYOUT

The development site consists of 24 building blocks and treatment facilities ranging 2 – 20m above ground level. An open area locates at the southern part of development site. Most of the massive buildings are situated at the southern part of the site. The erected structures disturbed in scatter at northern portion of the site are relatively small in footprint. The building blocks and treatment facilities are regularly aligned with a 15m wind path located at the middle of the site. Additionally, the development is remained low-rise for better ventilation (Figure 10).

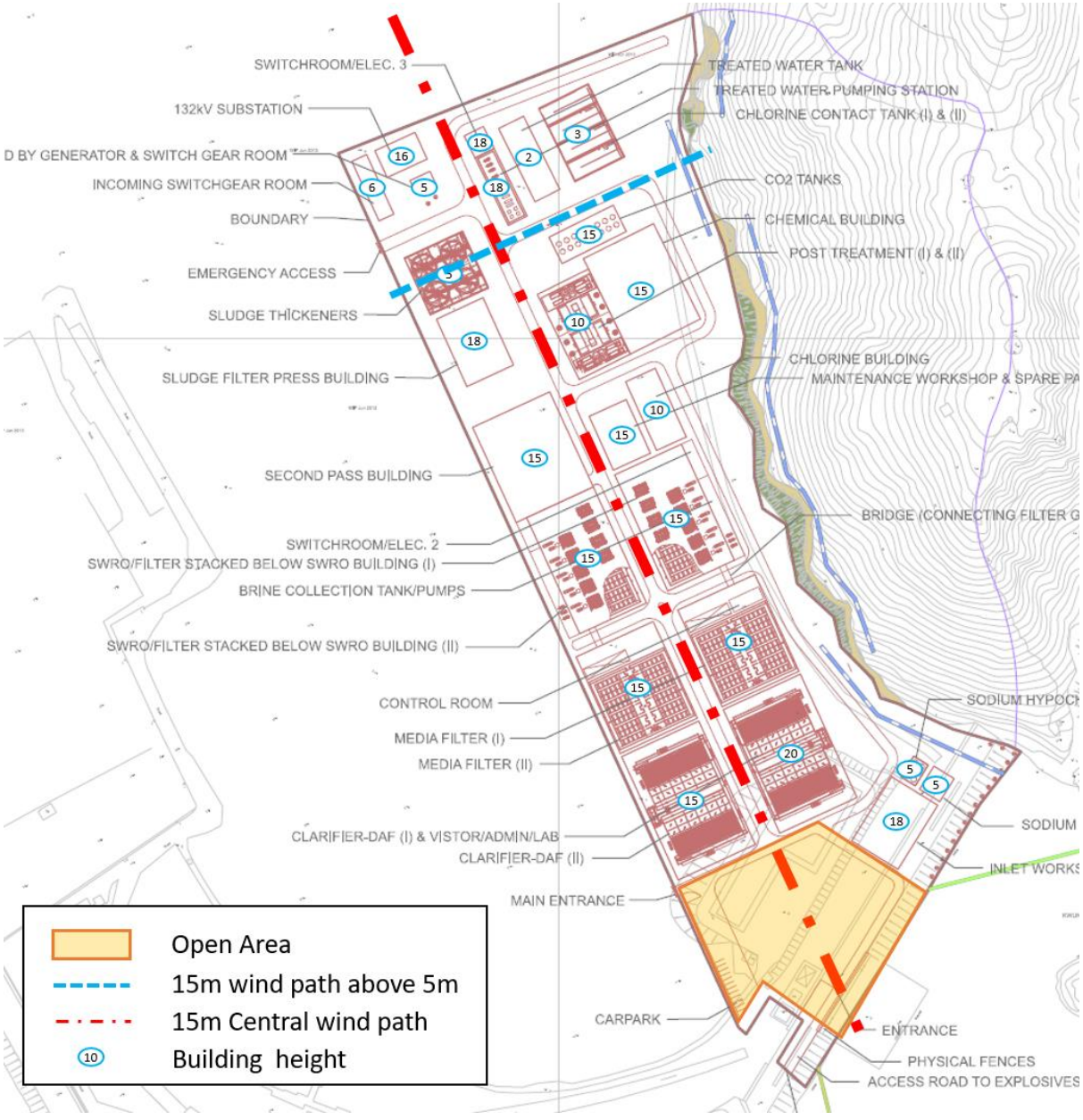

Figure 10 Site Layout and building height

6. VENTILATION PERFORMANCE OF THE PROPOSED DEVELOPMENT

6.1. NE AND ENE PREVAILING WIND

As mentioned in Section 4, wind reaching the development site under NE and ENE wind would be very similar. Most of the NE and ENE prevailing wind would skim over Tin Ha Au and reach the site (Figure 11). Wind from Tin Ha Au is expected to flow over the development at level of 15m above ground for northern part of development and reach Fat Tong O area, since the process buildings in this area are kept in low-rise (green dash arrow). Similarly, the low rise nature of the proposed development would allow wind from slope of Tin Ha Au to reattach at pedestrian level then flush to southern Fat Tong O area (red dash arrow). The open area at the southern tip allows wind from Joss House Bay to reach Fat Tong O area freely (blue arrow).

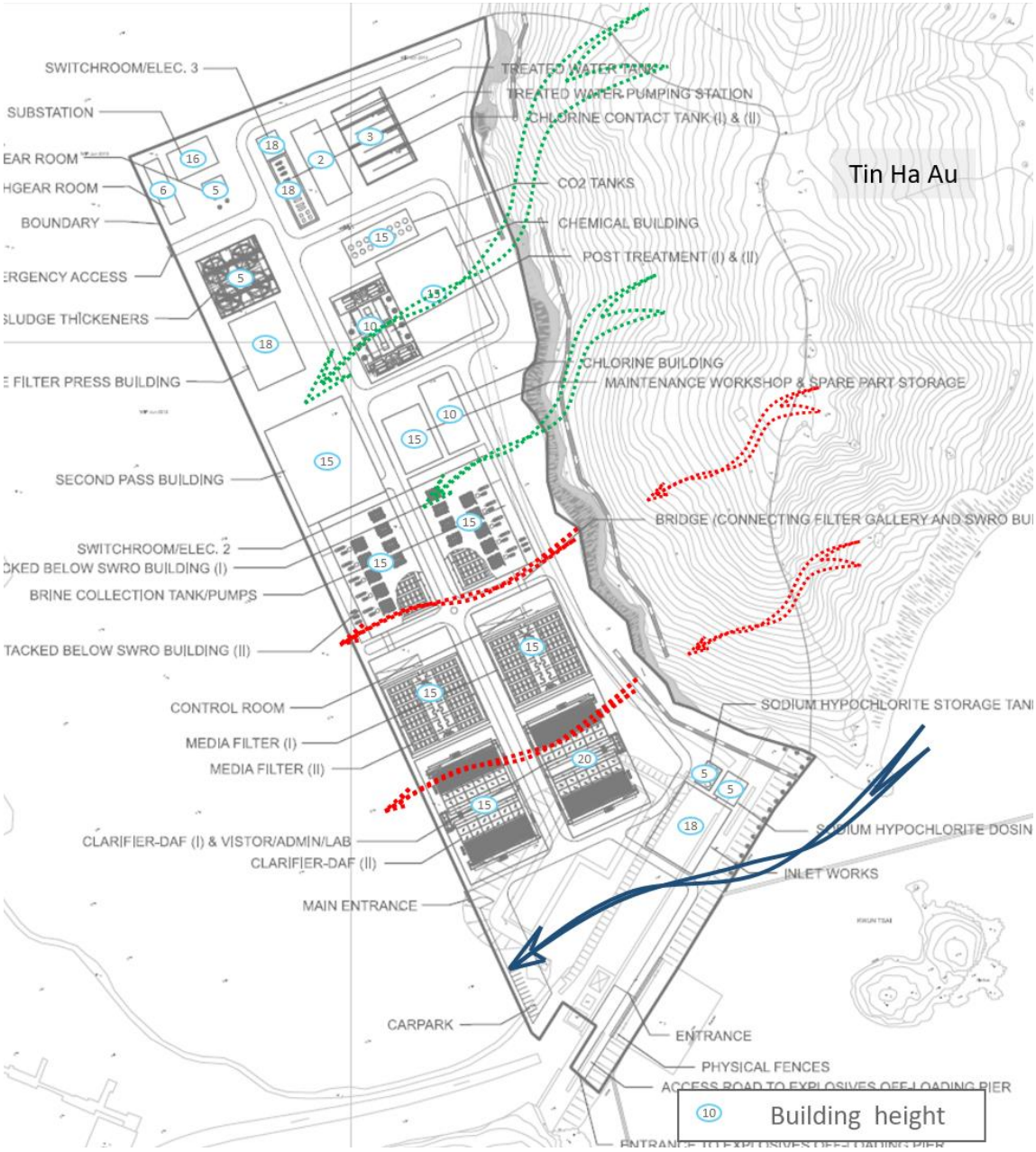

Figure 11 NE prevailing wind for development

6.2. E PREVAILING WIND

Under E wind condition, incoming wind would be diverted by the peak of Tin Ha Au and reach the northern part of the development. The eastern wind would then skim over the building cluster at a level of 15m above ground then reattach at pedestrian level of Fat Tong O area (green dash arrow). Another air stream from Joss House Bay would pass through the southern slope of Tin Ha Au. The low-rise nature of the proposed development would allow the modulated wind to skim over the development site and reattach to pedestrian level (red dash arrow). Meanwhile, the open area at the southern tip of development provides a free open space for easterly wind to reach Fat Tong O area without major blockage (blue arrow) (Figure 12).

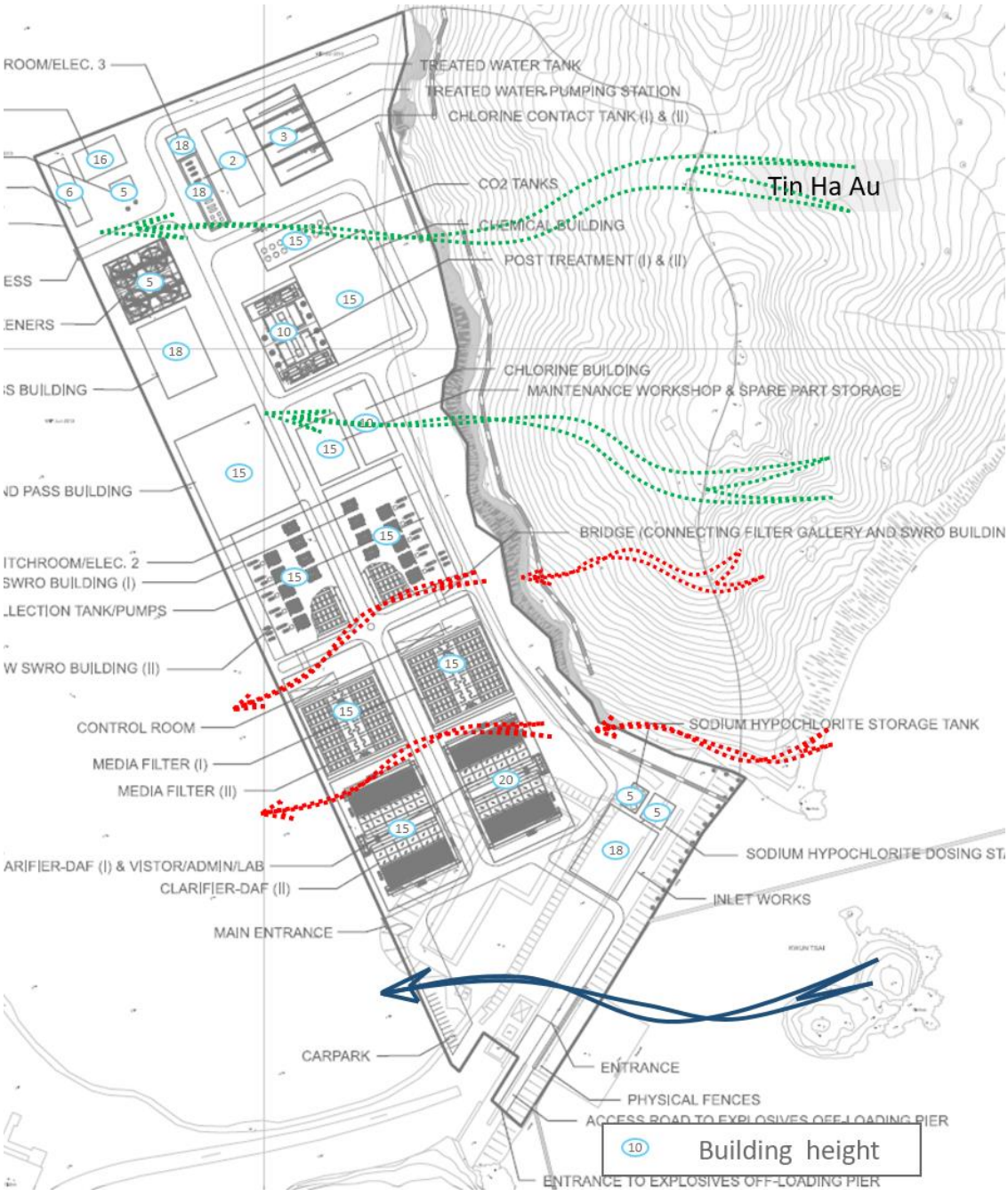

Figure 12 E prevailing wind for development

6.3. SW AND SSW PREVAILING WIND

As discussed in Section 4, wind from Junk Bay (SW and SSW wind) could reach the development freely without obstruction as the Fat Tong O area is undeveloped and open (Figure 13). The open area at southern tip allows direct wind penetration to Joss House Bay (blue arrow). The low-rise nature of proposed development allows wind flow to the greenery space of Tin Ha Au at pedestrian level (red arrow). Meanwhile, the low-rise nature of the development allows mid-level wind flow from Fat Tong O area to Tin Ha Au (green arrow). The low-rise erected structures with small footprints located at the northern site allow diffusion of wind flow. It could minimize the negative impact to the close proximity (orange arrow). Since Tin Ha Au is considered as a non-frequent access area, ventilation impact from the development is minimal.

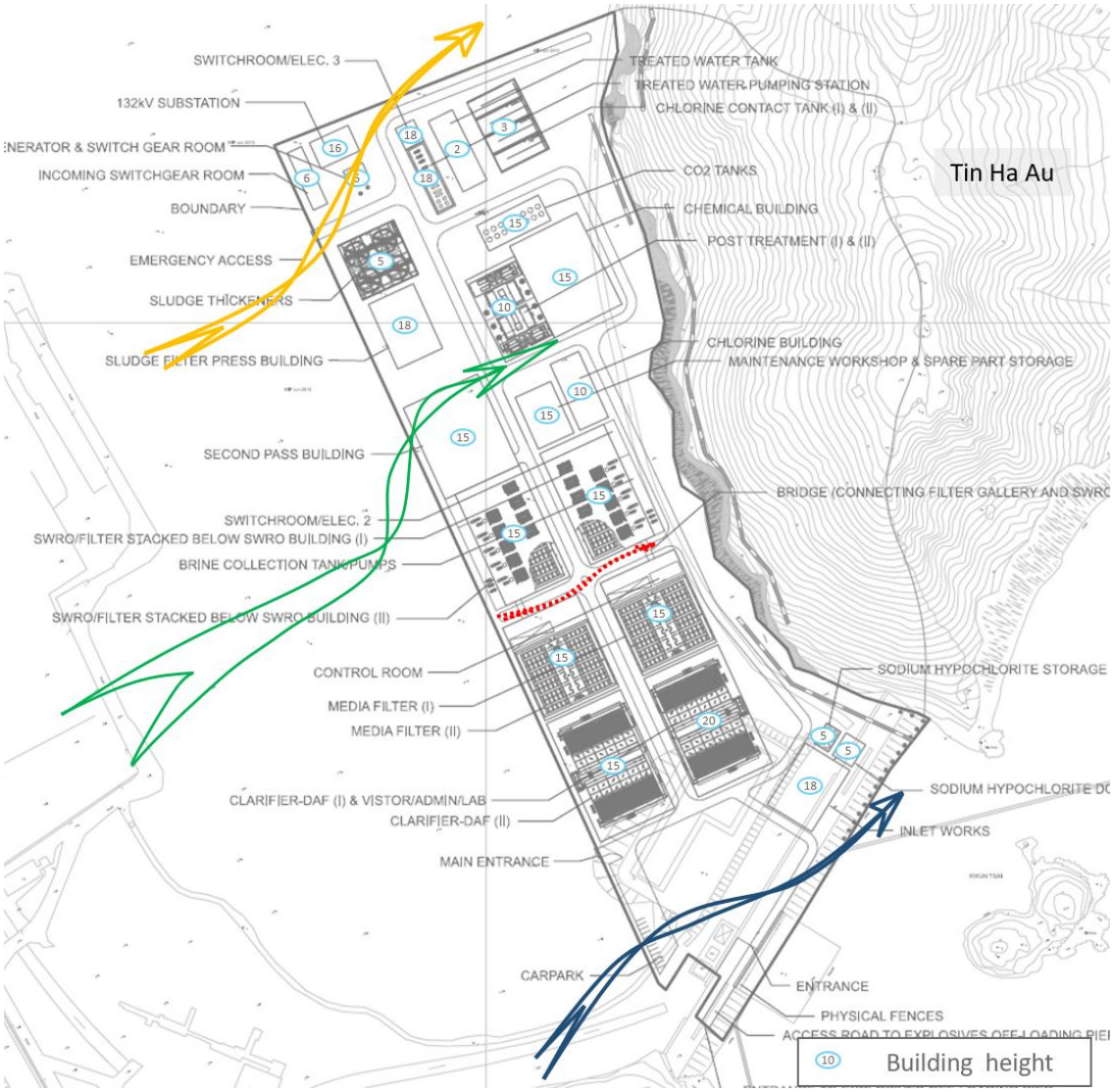

Figure 13 SW and SSW prevailing wind for development

7. GOOD DESIGN FEATURES

Building structures could bring influence to the wind flow. A wind responsive design could help to minimize the ventilation impact to the environment. The following good design features are identified that could help to accommodate the negative ventilation impact to the surrounding.

7.1. LOW-RISE DESIGN

The buildings and erected structures of the Development are low-rise (maximum building height is 20m above ground level). Such design allows incoming wind to skim over the development and reattach at pedestrian level in a short distance, and hence, minimize the ventilation impact from the development to the surrounding area.

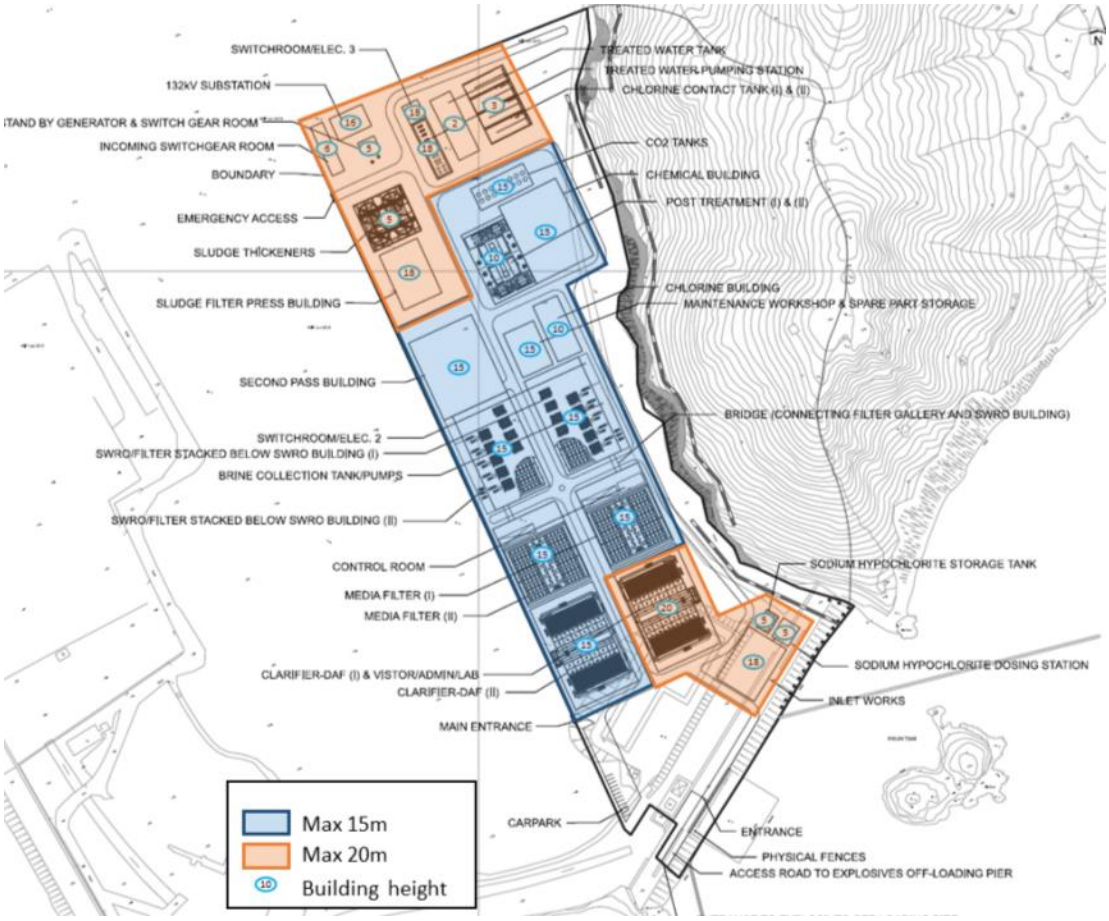

Figure 14 Low-rise design

7.2. OPEN AREA DESIGN

The open area in southern corner of the development allows direct wind penetration to Fat Tong O area under eastern hemisphere wind. The building structure is setback from the southern boundary which enhances the overall permeability of the site. It also opens up the major wind entrance for southern Fat Tong O area.

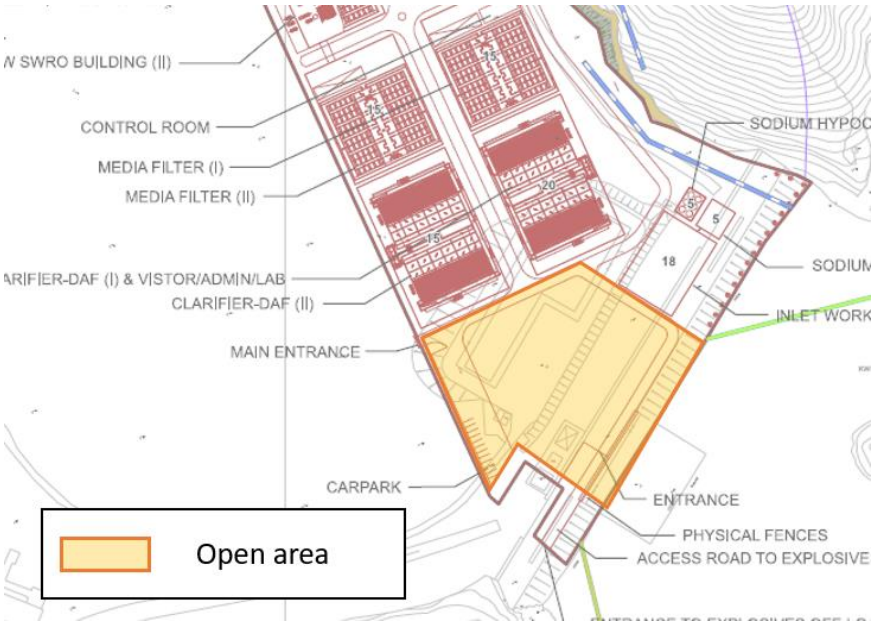

Figure 15 Open area design

7.3. MID-LEVEL WIND PATH

A 15m-width wind path located 5m above ground could help to ventilate the Fat Tong O area under ENE wind condition. Since this wind corridor is closed to the pedestrian level. It is expected the wind passing through this wind path would reattached to ground level in short distance.

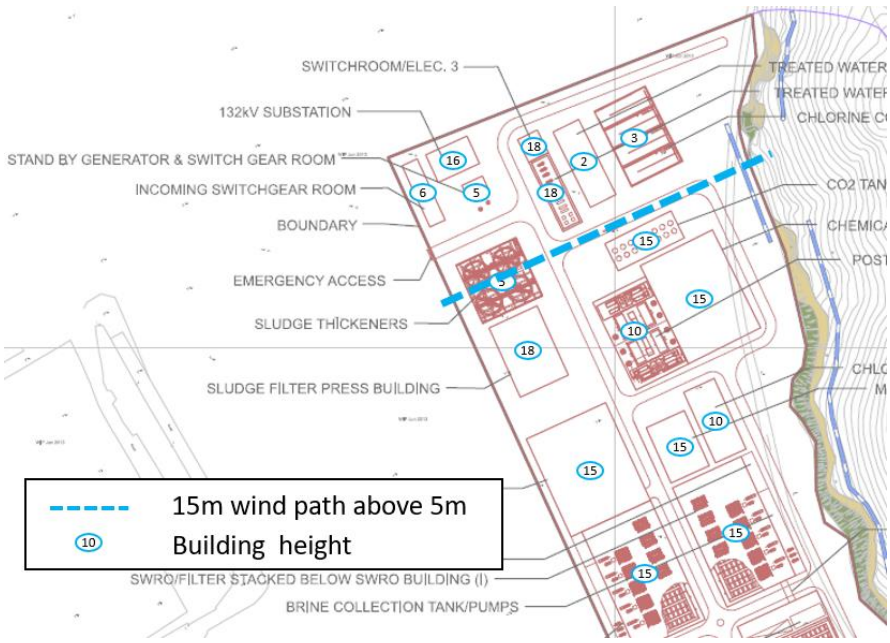

Figure 16 Mid-level wind path

7.4. CENTRAL WIND PATH

Although SE/NW is not one of the major prevailing wind, the central wind path makes the building aligns well which could provide a good connectivity to minor wind paths. And hence enhances the site overall permeability.

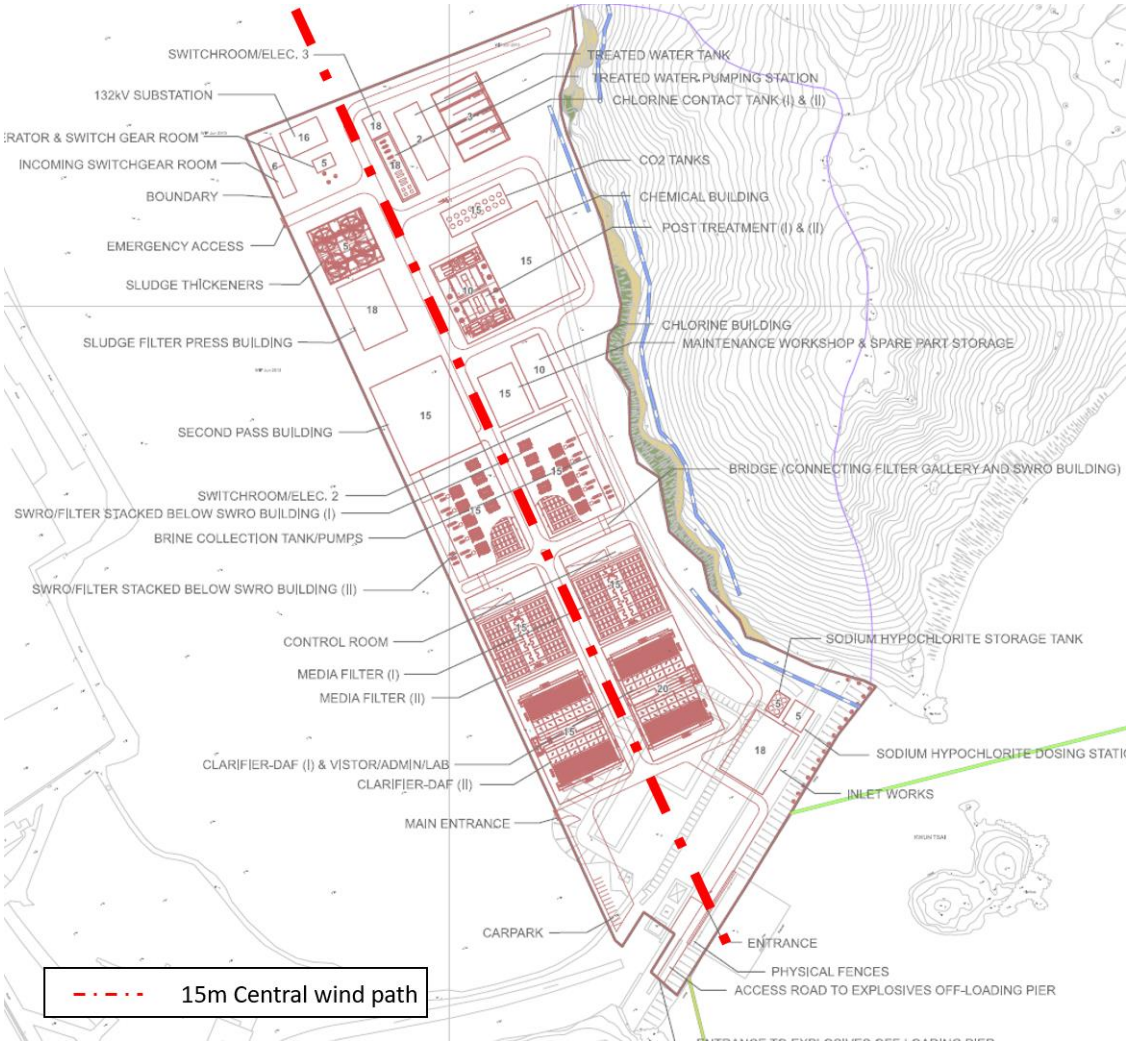

Figure 17 Central wind path

8. CONCLUSION

Qualitative assessment of the wind environment of the Development for the Tseung Kwan O Desalination Plant was conducted. The Development consists of multiple buildings and erected water processing structure over a large area. According to the analysis, the annual prevailing wind comes from NE, ENE and E directions and the summer prevailing wind is from SW, SSW and E direction. Wind is expected to skim over the development or pass through mid-level air path under NE quarter wind. Also, wind from SW quarter would not bring significant impact to the vicinity developed area as it is located beneath of Tin Ha Au. In general, negative ventilation impact induced by the site is considered insignificant. Details could refer to Section 6. Also, several good design features are identified, which include:

- Low rise design
- Open area design
- Mid-level wind path
- Central wind path

APPENDIX B

RESPONSES TO COMMENTS

Response to Comments

1. Comments on issue 3 from PlanD/UD&L received on 21 December 2016 via Email

No.	Comments	Response
1.	Conclusion (section 2) – The consultant should list out all the good design features in this conclusion section including (i) low-rise design with maximum building height of 20m above ground level; (ii) provision of open area in southern corner of the development; (iii) provision of a 15m-wide wind path at 5m above ground; and (iv) provision of a 15m-wide central wind path, in accordance with Appendix A.	Noted. Section 2 was amended accordingly.