

銅鑼灣



Causeway Bay

Annex D

Air Ventilation Assessment



Patchway Holdings (HK) Limited

**Proposed Commercial
Development at Caroline Hill
Road, Hong Kong**

**Air Ventilation Assessment – Initial
Study**

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Issue 1 | January 2024

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number

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1 Introduction

1.1 Background

Ove Arup & Partners Hong Kong limited (Arup) was instructed to conduct an Air Ventilation Assessment (AVA) – Initial Study for the Proposed Commercial Development at Caroline Hill Road, Hong Kong (the Application Site).

The Development site is currently zoned as “Commercial (2)” (“C(2)”) on the Approved Wong Nai Chung Outline Zoning Plan (OZP) No. S/H7/21. This document is to support the Section 16 application.

The *Technical Guide for Air Ventilation Assessment for the Developments in Hong Kong (Annex A of Technical Circular No.1/06 for Air Ventilation Assessments)*^[1] (termed as *AVA Technical Circular hereafter*) dated 19 July 2006 lay down the foundation of this method statement.

1.2 AVA Initial Study

Among all available wind data, an Initial Study will be conducted by using Computational Fluid Dynamics (CFD) techniques. It aims to achieve the following tasks:

- Initially assesses the characteristics of the wind availability of the site;
- Gives a general pattern and a rough quantitative estimate of the wind performance at the pedestrian level using Velocity VR;
- Identify the air paths within the site ascertain their effectiveness; and
- Identify good design features and problem areas if any and recommend mitigation measures.

2 Location and Site Characteristics

The Application Site is located at the junction of Leighton Road and Caroline Hill Road, to the northwest of the open space of South China Athletic Association.

The Study Site is generally surrounded by densely built-up area in Causeway Bay area to its northeast and northwest, with mostly high-rise buildings up to +209.7mPD with some mid-rise buildings with around +40-50mPD; a hilly range with residential towers, such as Leighton Hill with +170.7mPD, Beverly Hill with +188.3mPD, to its west and southwest; buildings from South China Athletic Association (+90.7mPD) to its immediate southeast, open space provided by several recreational spaces such as South China Athletic Association, Disciplined Services Sports and Recreational Club, So Kon Po Recreation Ground, and Indian Recreation Club, as well as a hill to further southeast. The locations of major building blocks are indicated in Figure 1, with the detailed surrounding building context shown in Figure 1.

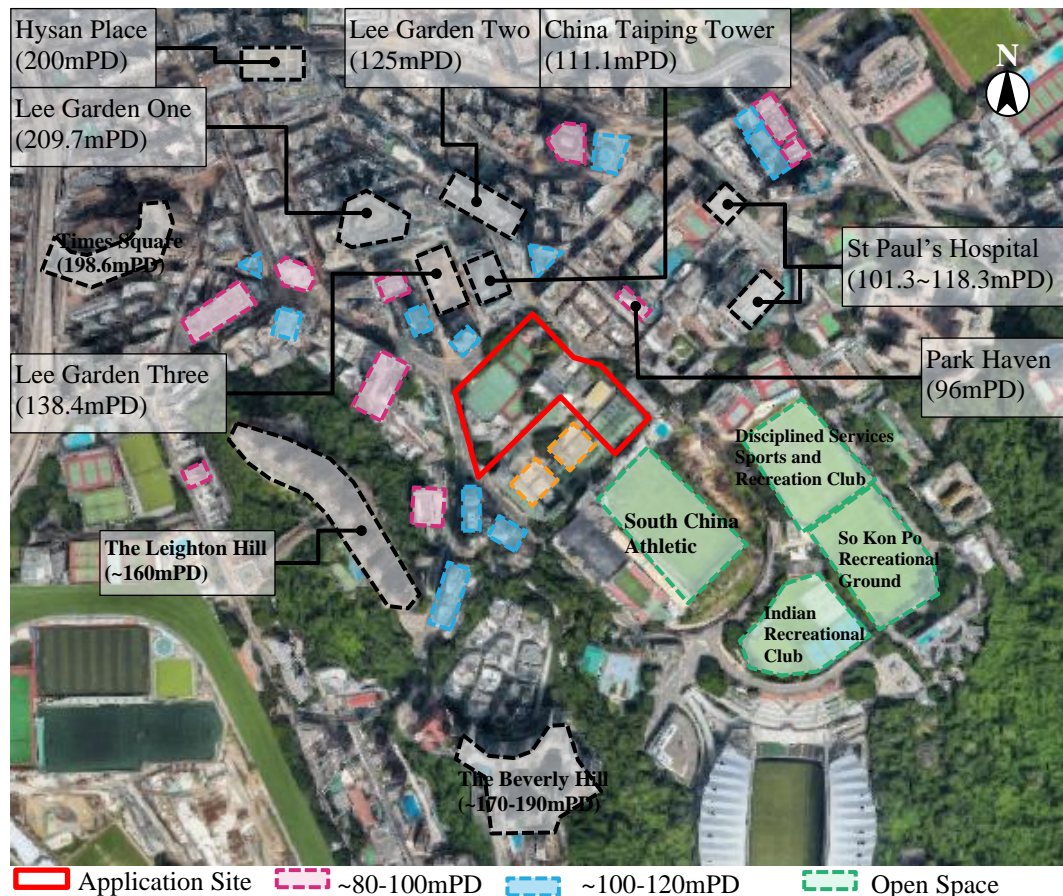


Figure 1 Site Location and Existing Surrounding Developments

2.1 Future Development

According to the GIS data and GeoInfo Map¹, there are several work-in-progress (WIP) sites and planned development within the Surrounding Area, which will also be considered in this AVA – Initial Study. The locations of these sites are shown in Figure 2. The building blocks of each site are shown in Appendix B.

Planned Development

The planned development is assumed based on the latest public information available:

- #1: 281 Gloucester Road Site - Planning Application A/H6/89
- #2: 17A and 17B Ventris Road Site – As there is no layout shown on the latest approved Planning Application A/H7/165. The building layout is assumed with Planning Application No. M/H9/11/9.
- #3: District Court at Caroline Hill Road – PWSC(2022-23)3
- #4: Planned Development on Construction of Dry Weather Flow Interceptor at Hung Hom and Causeway Bay, in Planning Application No. A/H8/437
- #5: Planned Development on 8 Leighton Road in Planning Application No. A/H7/183.

WIP Sites

The WIP sites is assumed based on the latest public information available:

- #6: 472 Hennessey Road; #7: 15 Matheson Street

The building massing is assumed according to information from Building Department (BD) with full site coverage up the 24 storeys for #5² and latest information of 27 storeys for #6³.

- #8: 22-24 Leighton Road; #9: 42-44 Yiu Wa Street

As there is no publicly available information for these sites, the building massing are assumed to be full site coverage up to the maximum allowable height from Approved Causeway Bay Outline Zoning Plan (OZP) No. S/H5/17, the Approved Wong Nai Chung Outline Zoning Plan (OZP) No. S/H5/21, the Approved Wan Chai Outline Zoning Plan (OZP) No. S/H5/28, Building (Planning) Regulation.

¹ <http://www2.map.gov.hk/gih3/view/index.jsp>

² <https://m.mingpao.com/fin/dailyp2.php?node=1620759618714&issue=20210512>

³ <https://www.landvision.com.hk/causeway-bay/11-15-matheson-street/b-5608/>

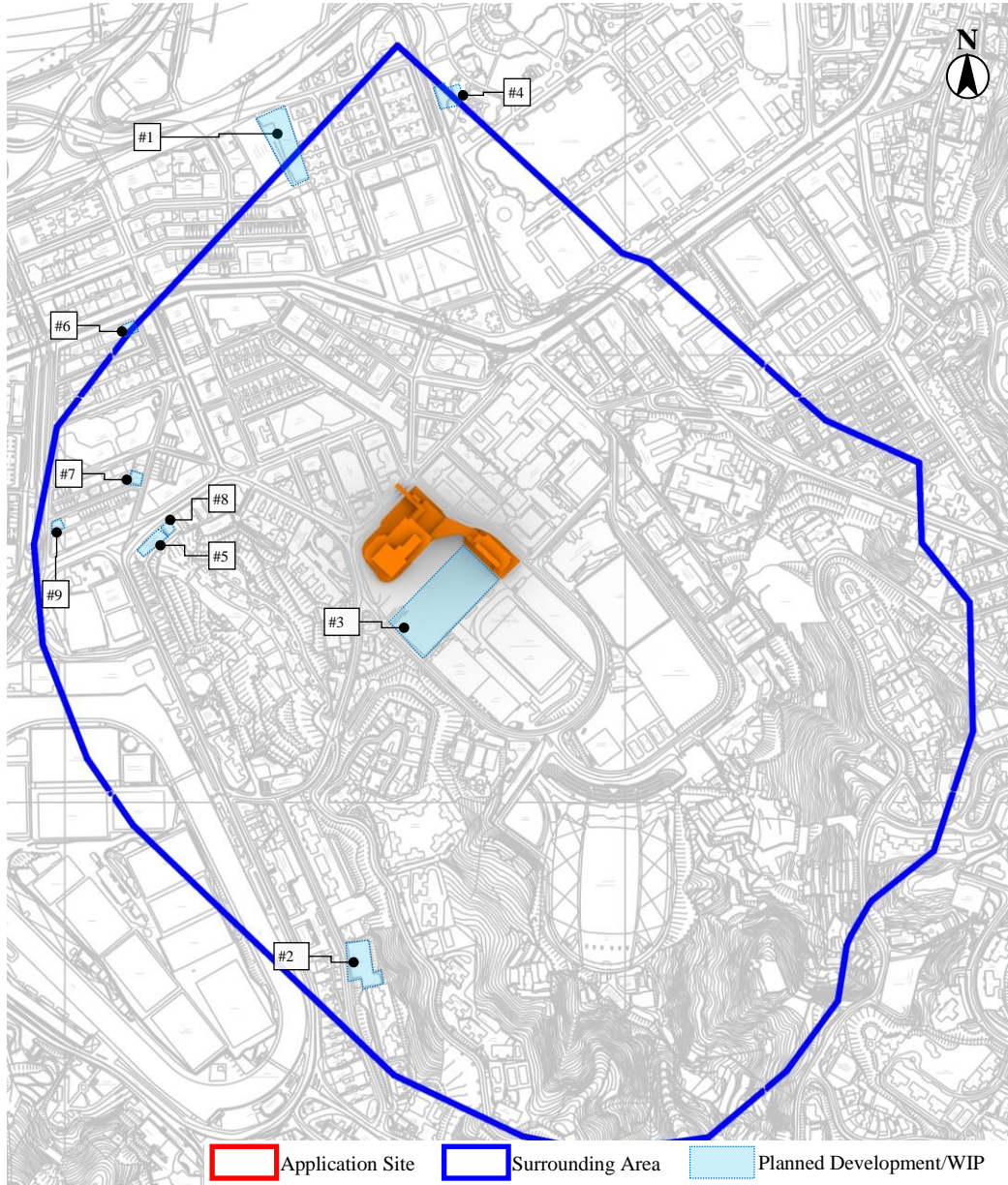


Figure 2 Location of the Planned/WIP Site around the Study Site

3 Proposed Methodology for Initial Study

3.1 Wind Data

As per the *AVA Technical Circular*^[1], at least 75% of the time in a typical reference year (frequency of occurrence) would be studied under both annual and summer wind condition in the Initial Study when using a Computational Fluid Dynamics (CFD) modelling technique. Since the CFD approach is adopted for the present project's AVA, this criterion together with the following selected wind data are to be applied as the methodology.

The site wind availability of the Study Site and its surrounding is an essential parameter for AVA. As stipulated in the *AVA Technical Circular*^[1] the site wind availability would be presented by using appropriate mathematical models. Planning Department (PlanD) has set up a set of simulated meso-scale data of Regional Atmospheric Modelling System (RAMS) of the territory for AVA study, which could be downloaded at Planning Department Website^[2]. Simulated meso-scale data of Regional Atmospheric Modelling System (RAMS) from PlanD will therefore be adopted in this AVA Study. The location of the Development falls within the location grid (x: 083, y:033) in the RAMS database as indicated in Figure 3.

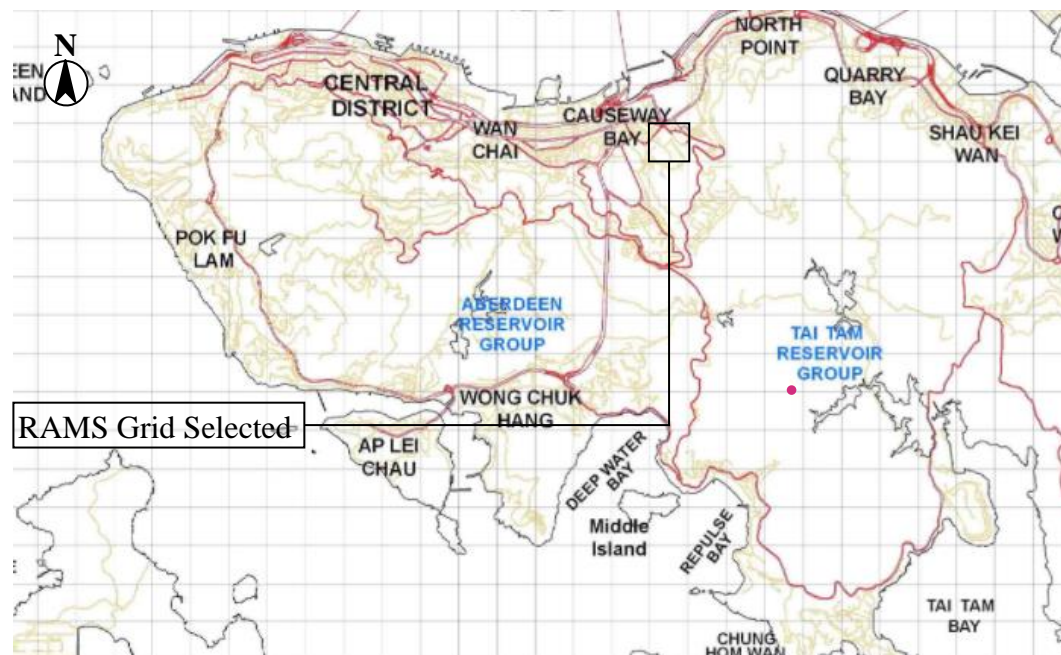


Figure 3 RAMS Grid and the Development Location

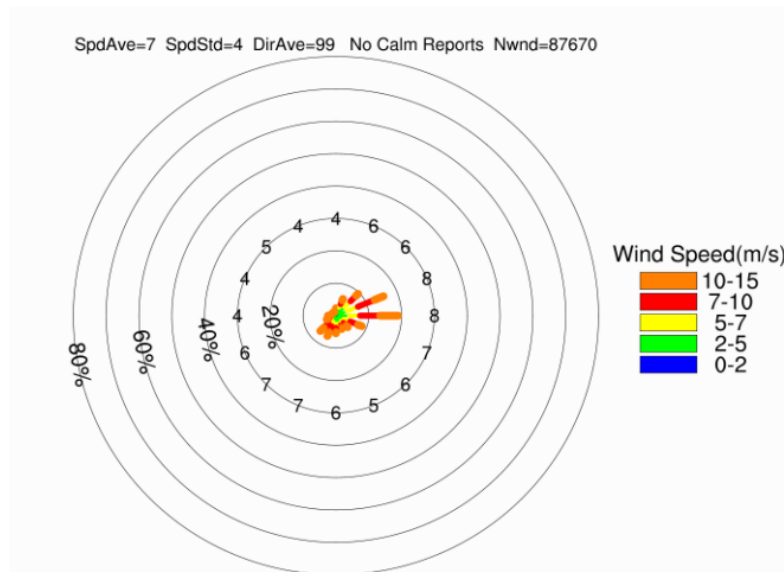


Figure 4 RAMS annual wind rose at 500mPD

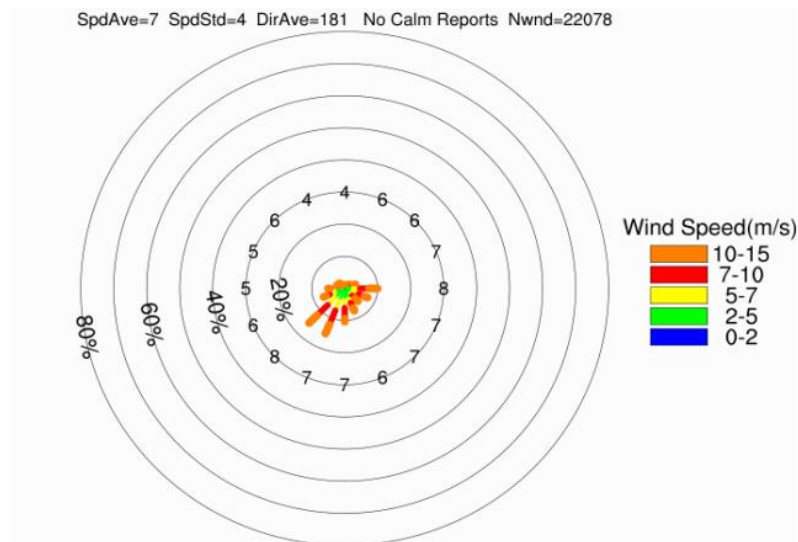


Figure 5 RAMS summer wind rose at 500mPD

3.1.1 Wind Directions

As mentioned in Section 3.1, the RAMS wind data of location grid (x:083, y:033) is adopted for the site wind availability in this study.

3.1.1.1 Annual Prevailing Wind

Eight prevailing wind directions (highlighted in red colour in Table 1) are considered in this AVA Study which covers 78.5% of the total annual wind frequency. They are north-north-easterly (5.6%), north-easterly (9.6%), east-north-easterly (16.0%), easterly (19.3%), east-south-easterly (8.6%), south (5.6%), south-south-westerly (6.9%) and south-westerly (6.9%) winds.

Table 1 Annual Wind Frequency

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	
Frequency	2.3%	5.6%	9.6%	16.0%	19.3%	8.6%	5.1%	4.5%	
Wind Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
Frequency	5.6%	6.9%	6.9%	3.1%	2.4%	1.3%	1.3%	1.3%	78.5%

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

3.1.1.2 Summer Prevailing Wind

Eight prevailing wind directions (highlighted in red colour in Table 2) are considered in this AVA Study which covers 80.6% of the total summer wind frequency. They are easterly (10.4%), east-south-easterly (7.6%), south-easterly (5.9%), south-south-easterly (7.6%), southerly (10.7%), south-south-westerly (15.6%), south-westerly (15.8%) and west-south-westerly (7.0%) winds.

Table 2 Summer Wind Frequency

Wind Direction	N	NNE	NE	ENE	E	ESE	SE	SSE	
Frequency	1.0%	1.2%	1.9%	3.8%	10.4%	7.6%	5.9%	7.6%	
Wind Direction	S	SSW	SW	WSW	W	WNW	NW	NNW	Sum
Frequency	10.7%	15.6%	15.8%	7.0%	5.1%	2.6%	2.3%	1.3%	80.6%

* The wind frequency showing in red colour represents the recommended wind direction for the CFD simulation.

3.1.2 Wind Profiles

The profiles of wind speed from the PlanD RAMS database (x:083, y:033) are shown in below.

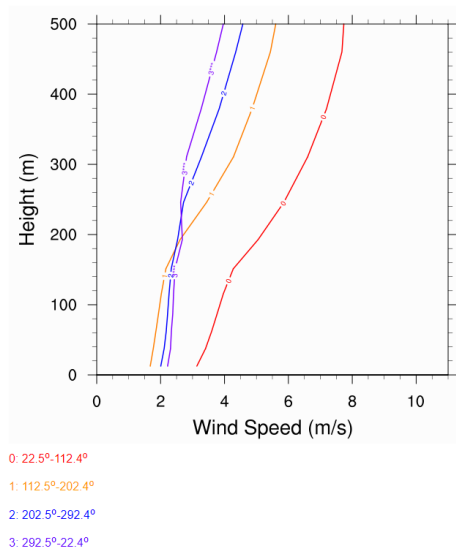


Figure 6 Normalised mean wind speed profile measured in 16 directions

The RAMS wind data is to be adopted in the AVA Initial study. It is recommended to extract the RAMS wind profile data directly as it can reflect the exact wind data. For wind data above 500m height, the velocity is assumed the same as the data at 500m. These wind data will be the input parameters in the CFD simulation.

3.2 Assessment and Surrounding Areas

With reference to the AVA Technical Circular [1] and the previous AVA Study from PLNQ B-1/AVA 2015[3], the Assessment Area and the Surrounding Area is extended beyond 1H and 2H from the site boundary with min. 200m and 400m respectively, as shown in Figure 7.

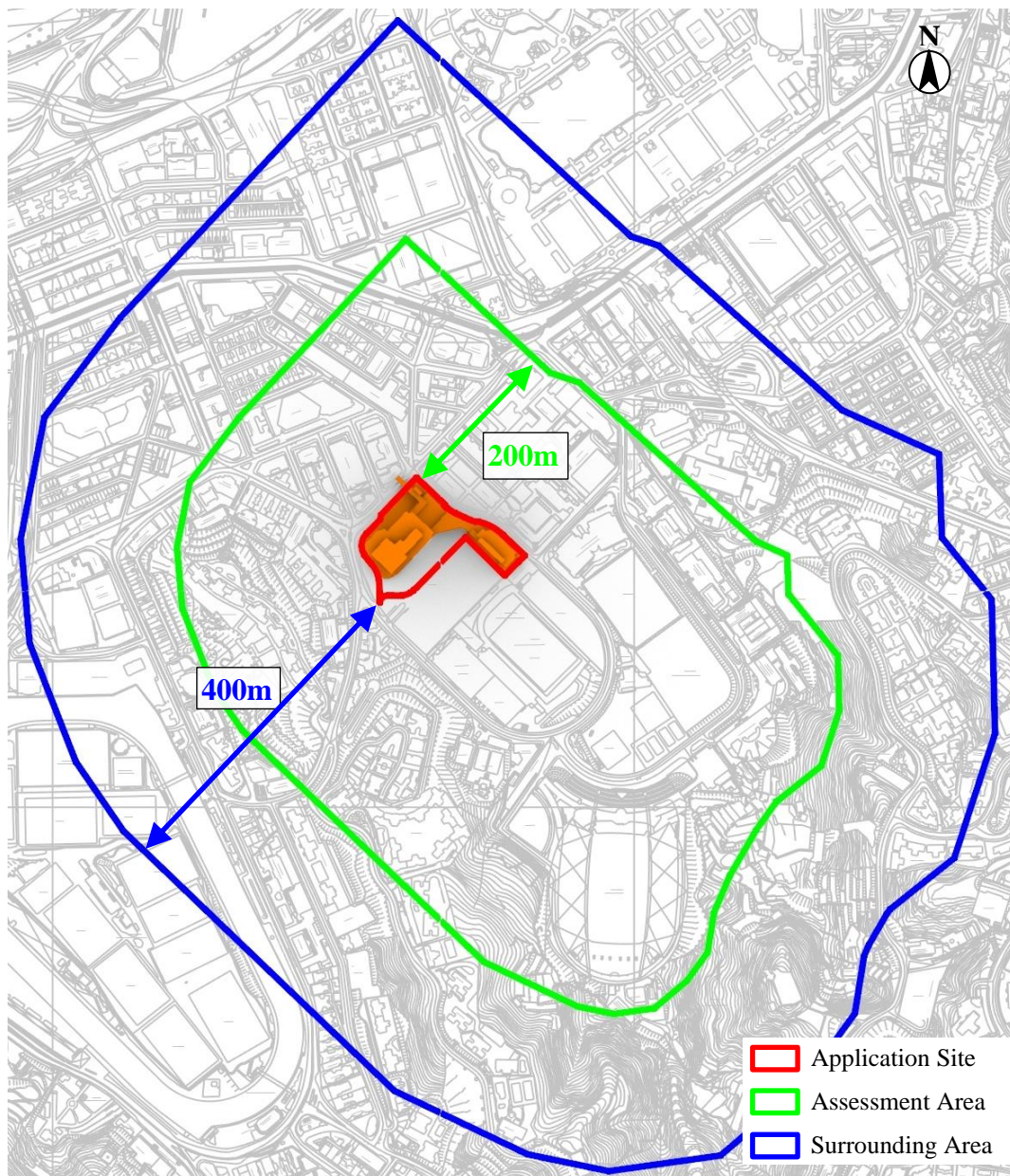


Figure 7 Application Site (red), Assessment Area (green) and Surrounding Area (blue)

Since there is no internationally recognized guideline or standard on using CFD for outdoor urban scale studies, reference was made to other CFD guidelines on different wind flow aspects to suggest a study approach for current study. The detail parameters are summarized in Table 3. The computational domain will be about 4600m (L) x 4300m (W) x 2100m (H), as shown in Figure 8. The surrounding model is shown in Figure 9 to Figure 12.

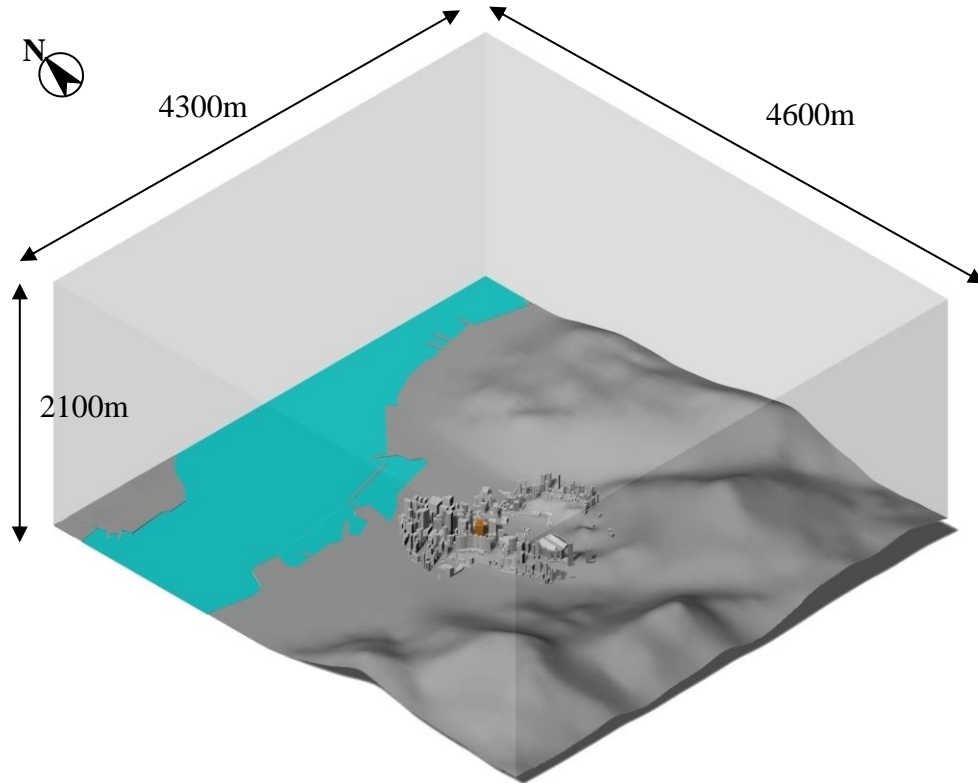


Figure 8 3D View of the Domain

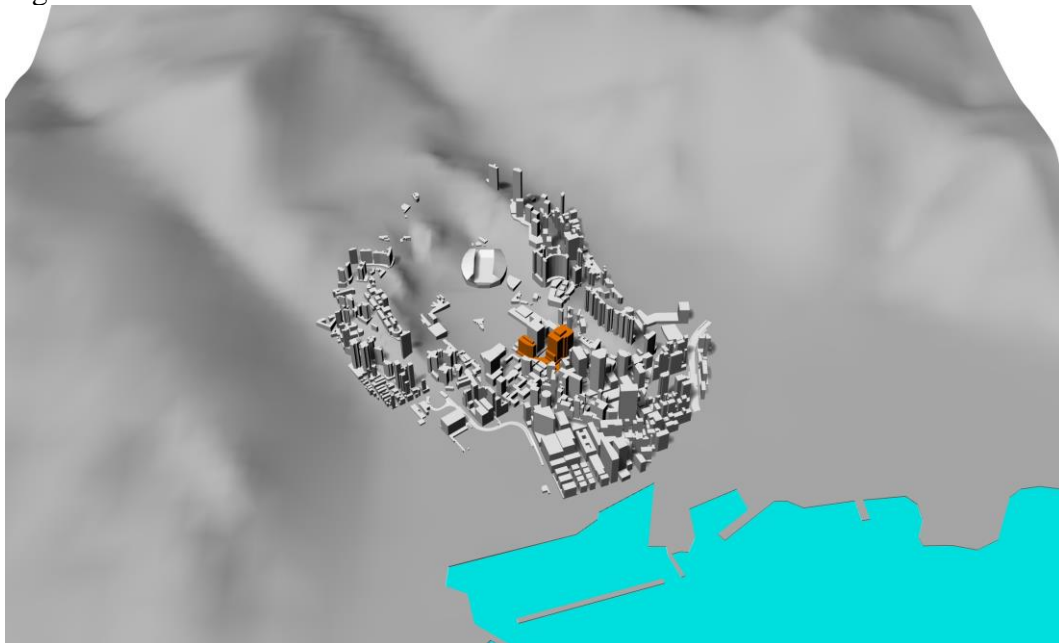


Figure 9 Northerly view of Surrounding Buildings

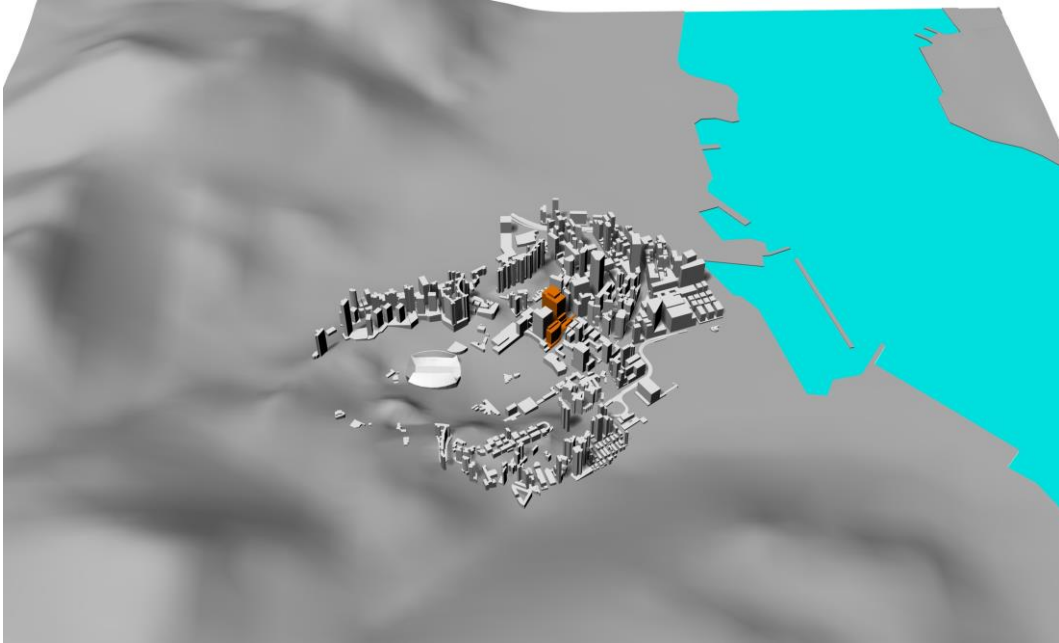


Figure 10 Easterly view of Surrounding Buildings

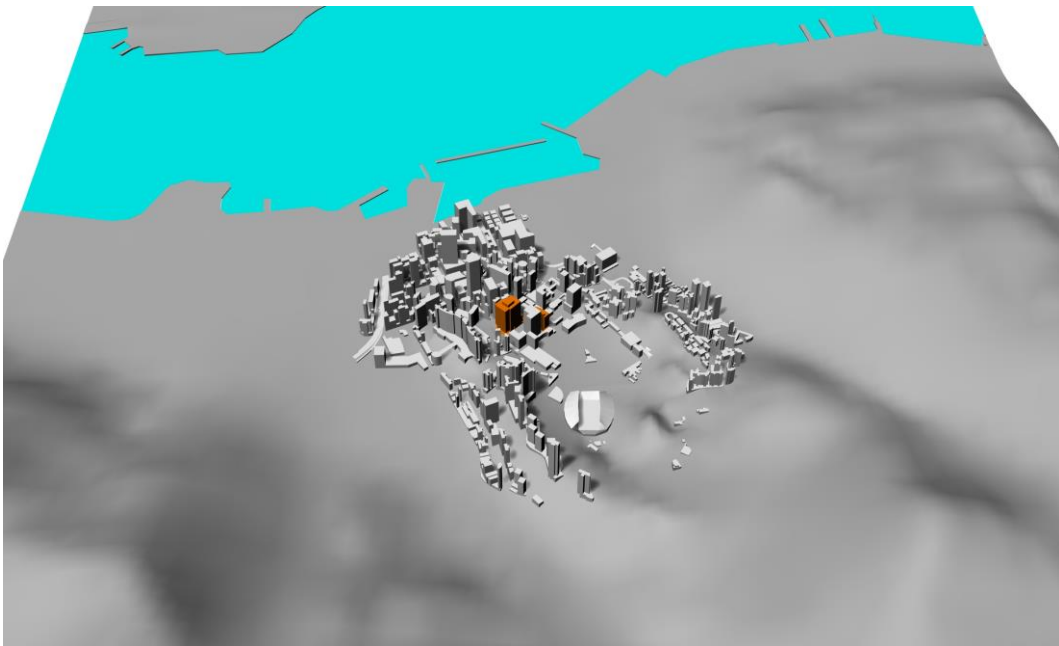


Figure 11 Southerly view of Surrounding Buildings

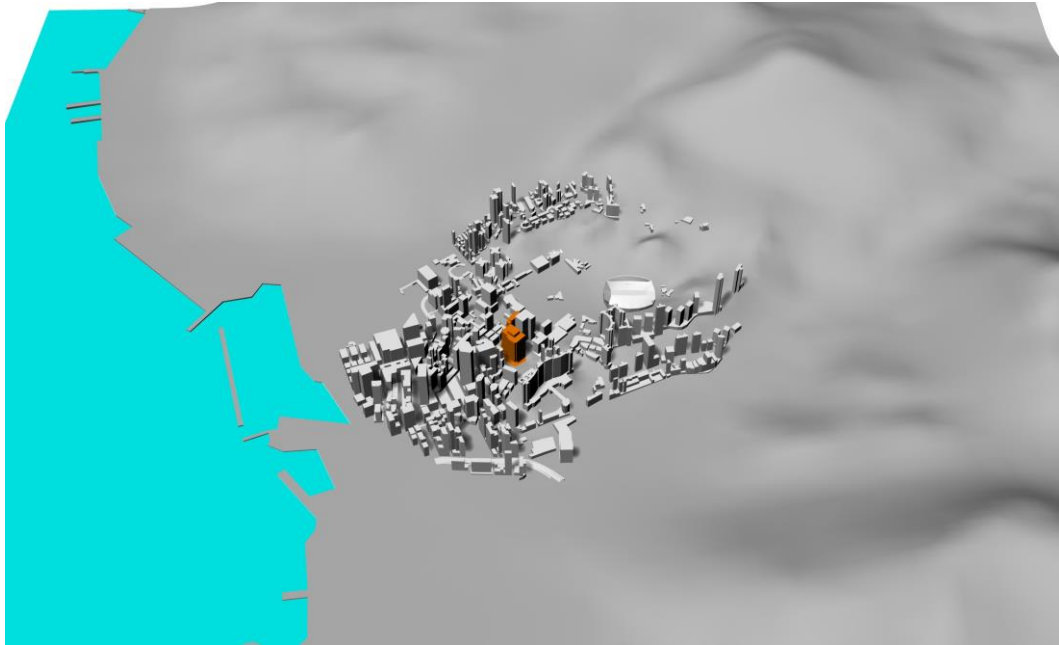


Figure 12 Westerly view of Surrounding Buildings

3.3 Technical Details for CFD simulation

3.3.1 Assessment Tool

Computational Fluid Dynamics (CFD) technique is adopted for the AVA Initial Study. A well-recognised commercial CFD package ANSYS ICEM-CFD and Ansys Fluent is used. Both software are widely used in the industry for AVA studies. With the use of three-dimensional CFD method, the local airflow distribution can be visualised in detail. The air velocity distribution within the flow domain, being affected by the site-specific design and the surrounding buildings, is simulated under the prevailing wind conditions in a year.

3.3.2 Mesh Setup

Body-fitted unstructured grid technique is used to fit the geometry to reflect the complexity of the development geometry. A prism layer of 3m above ground (totally 6 layers and each layer is 0.5m) is incorporated in the meshing to better capture the approaching wind as shown in Figure 13. The expansion ratio is 1.3 while the maximum blockage ratio is 3%.

Finer grid system is applied to the most concerned area based on preliminary judgement, while coarse grid system is applied to the area of surrounding buildings for better computational performance while maintaining satisfactory result. The mesh for the computational model is shown in Figure 14.

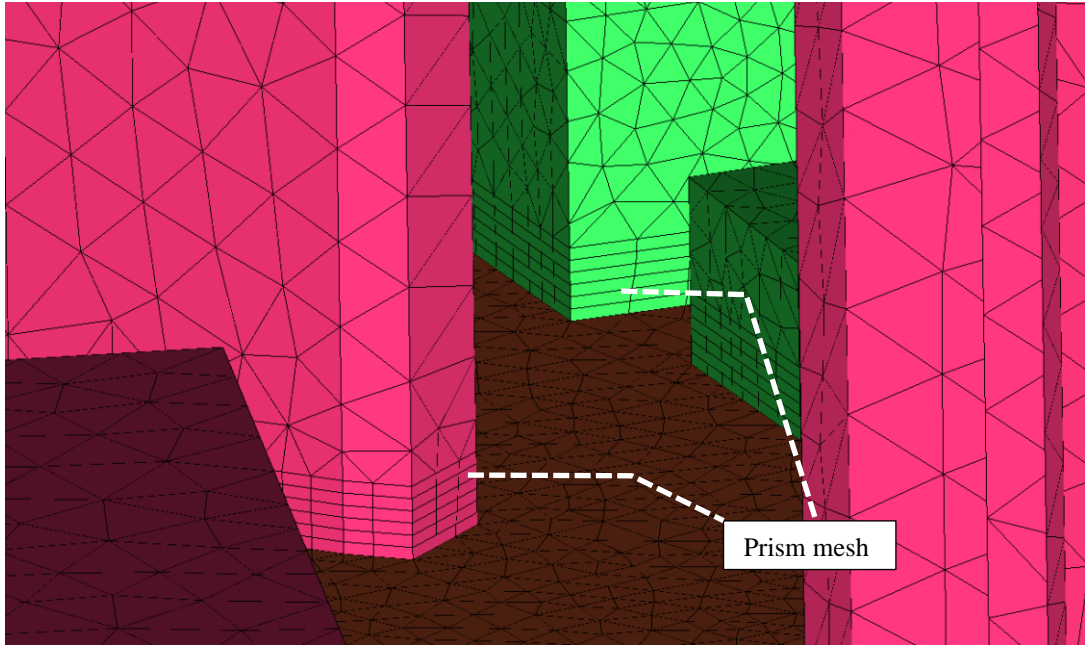


Figure 13 Prism mesh near the pedestrian level

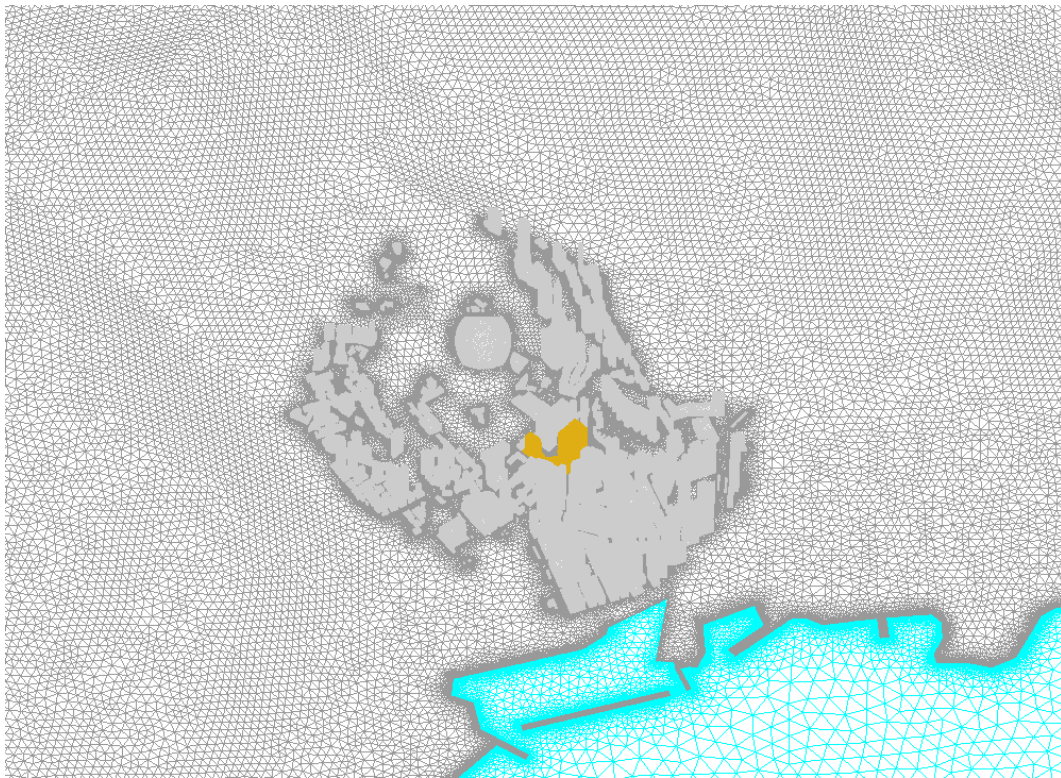


Figure 14 Mesh of the computational model

3.3.3 Turbulence Model

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

3.3.4 Calculation Method

The Segregated Flow model solves the flow equations in a segregated manner. The linkage between the momentum and continuity equations is based on the predictor-corrector approach. A collocated variable arrangement and a Rhie-and-Chow-type pressure-velocity coupling combined with a SIMPLE-type algorithm is adopted. A higher order differencing scheme is applied to discretize the governing equations. The convergence criterion is set to 0.0001 on mass conservation. The calculation repeat until the solution satisfies this convergence criterion.

The prevailing wind directions are set to inlet boundary of the model with wind profile as detailed in Section 3.1.2. 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 computational domain is built beyond the Surrounding Area as required in the Technical Circular.

3.3.5 Summary

Since there is no internationally recognized guideline or standard on using CFD for outdoor urban scale studies, reference was made to other CFD guidelines on different wind flow aspects to suggest a study approach for current study. The detail parameters are summarized in Table 3.

Table 3 Detail parameters to be adopted in the CFD

	CFD Model
Model Scale	Real Scale model
Model details	Only include Topography, Buildings blocks, Streets/Highways, no landscape is included
Domain	4600m(L) x 4300m(W) x 2100m(H)
Assessment Area	$\geq 1H$ area
Surrounding building Area	$\geq 2H$ area
Grid Expansion Ratio	The grid should satisfy the grid resolution requirement with 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	Incoming wind profile as measured from RAMS
Outflow boundary	Pressure boundary condition with dynamic pressure equal to zero

Wall boundary condition	Logarithmic law boundary
Turbulence Model	Realisable k-ε turbulence model
Solving algorithms	Rhie and Chow SIMPLE for momentum equation Hybrid model for all other equations
Blockage ratio	< 3%
Convergence criteria	Below 1.0E ⁻⁴

3.4 Data Presentation

The wind speed information at pedestrian level (2m above ground) will be acquired to determine the Wind Velocity Ratio (*VR*) as stipulated in the *AVA Technical Circular*^[1] and as defined as follows:

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

where V_p is the wind speed at the pedestrian height (2m above ground) and V_∞ is the wind velocity at the top of the boundary layer (defined as the height where wind is unaffected by urban roughness and determined by the topographical studies). Measurement will be taken in the following areas within the “Assessment Area”:

- Along the Development boundary (defined as “Perimeter” test-points), such that the Site-Spatial Average Velocity Ratio (*SVR*) can be determined (as per the *AVA Technical Circular*^[1]); and
- Throughout the Assessment Area other than the perimeter test-points (defined as “Overall” Test-points), such that the Local Spatial Average Velocity Ratio (*LVR*) can be determined by taking an average of all overall and perimeter test-points (as per the *AVA Technical Circular*^[1]).

3.5 Locations of Test Points

As per the technical circular, three types of test point – perimeter test point and overall test point will be adopted to assess the wind performance. The allocation of these test points will be distributed evenly as stated in the *AVA Technical Circular*^[1].

3.5.1 Perimeter Test Points

A total number of 42 perimeter test points (**Brown spots**), namely P points, are positioned at intervals of around 15m along the project site boundary in accordance with the *AVA Technical Circular*^[1]. The locations of perimeter test points are shown in Figure 15 below.

3.5.2 Overall Test Points

A total number of 198 overall test points (**Blue spots**), namely O points, are evenly distributed in open areas within the assessment area, such as the streets and places where pedestrian frequently access, and their locations are shown in Figure 16.

3.5.3 Special Test Points

A total number of 28 special test points, namely S points (**Purple spots**), evenly distributed in open areas within the Study Site. Their locations are shown in Figure 17 to Figure 18.

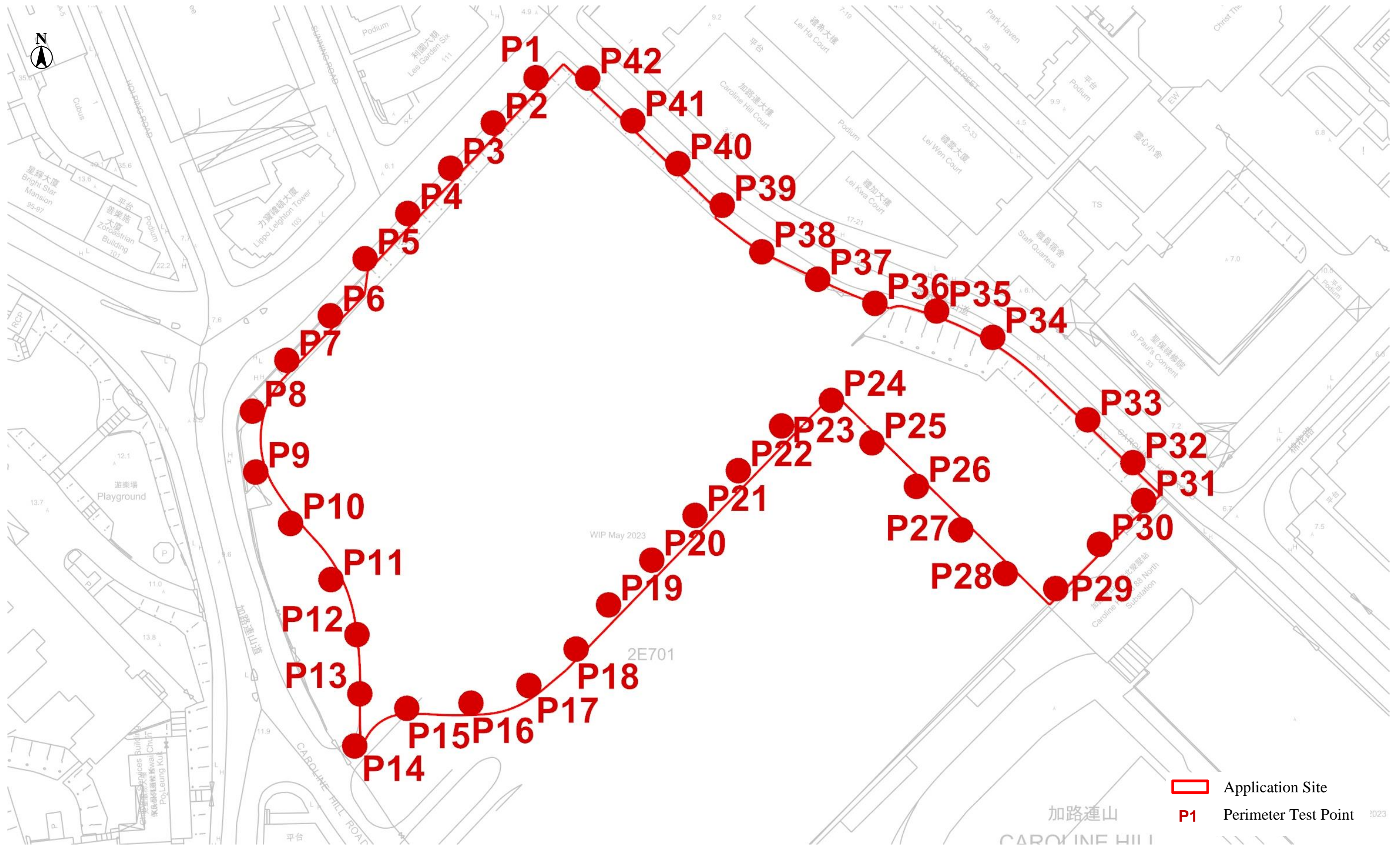


Figure 15 Location of Perimeter Test Points

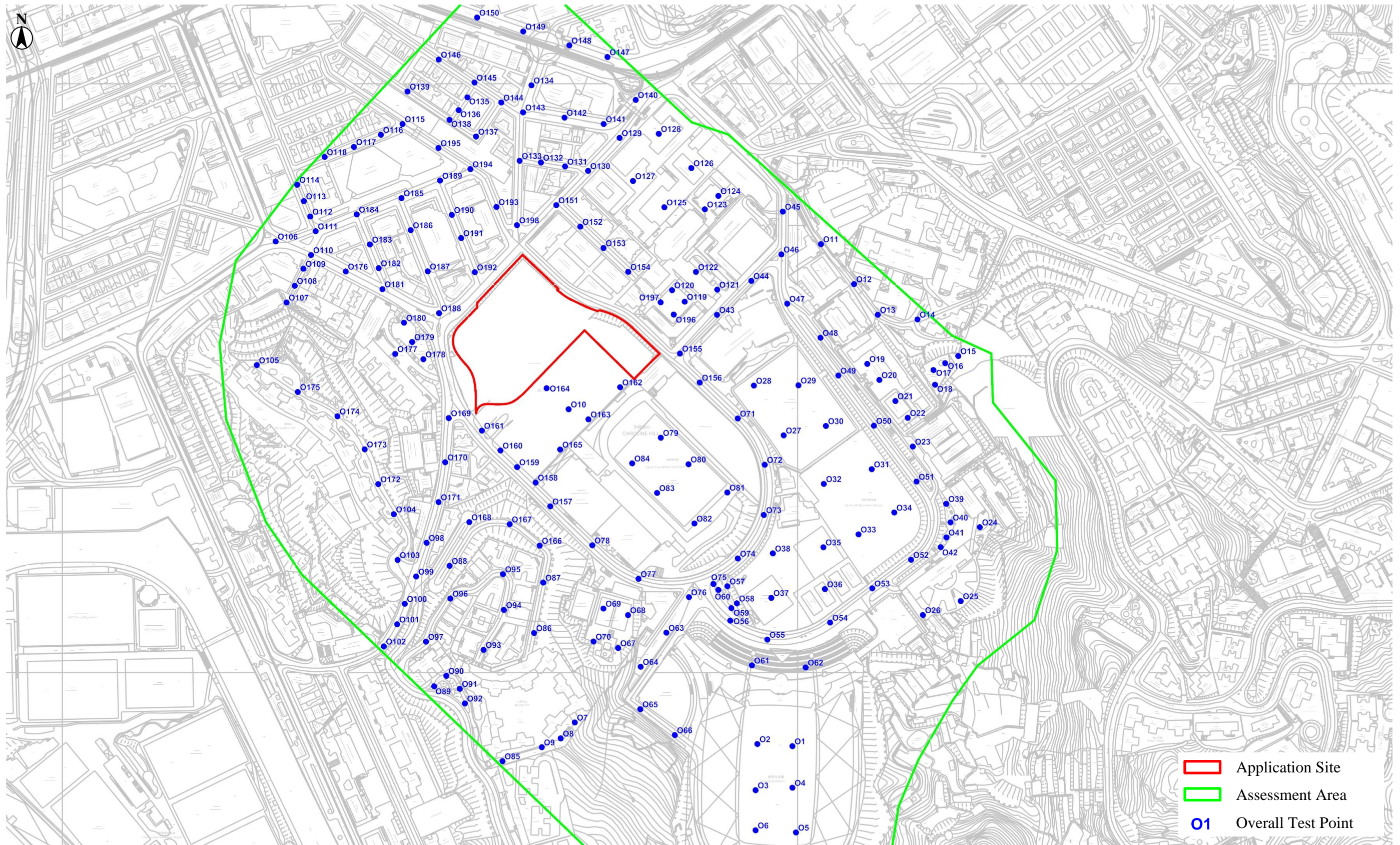


Figure 16 Location of Overall Test Points

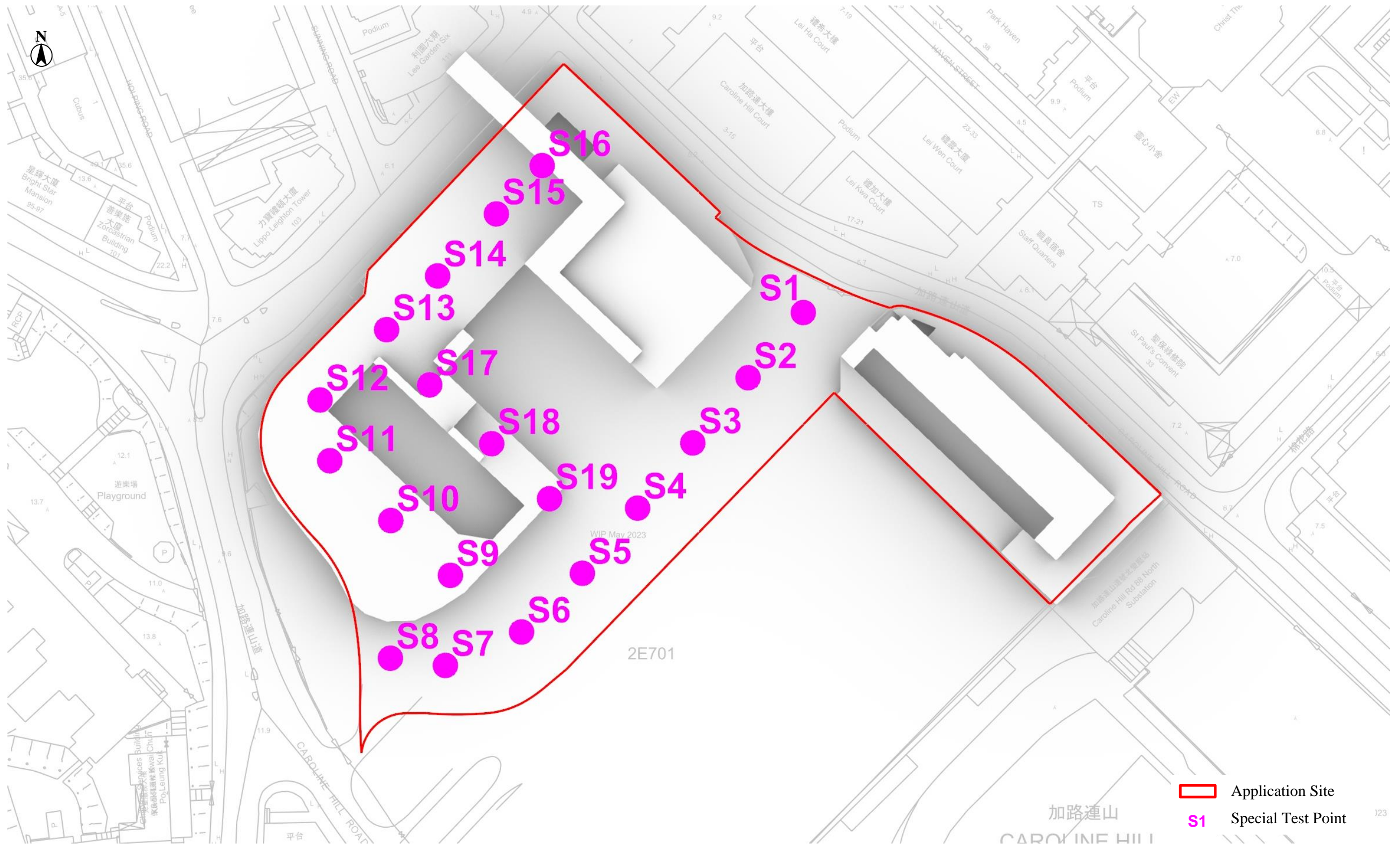


Figure 17 Location of Special Test Points on Street Level and G/F

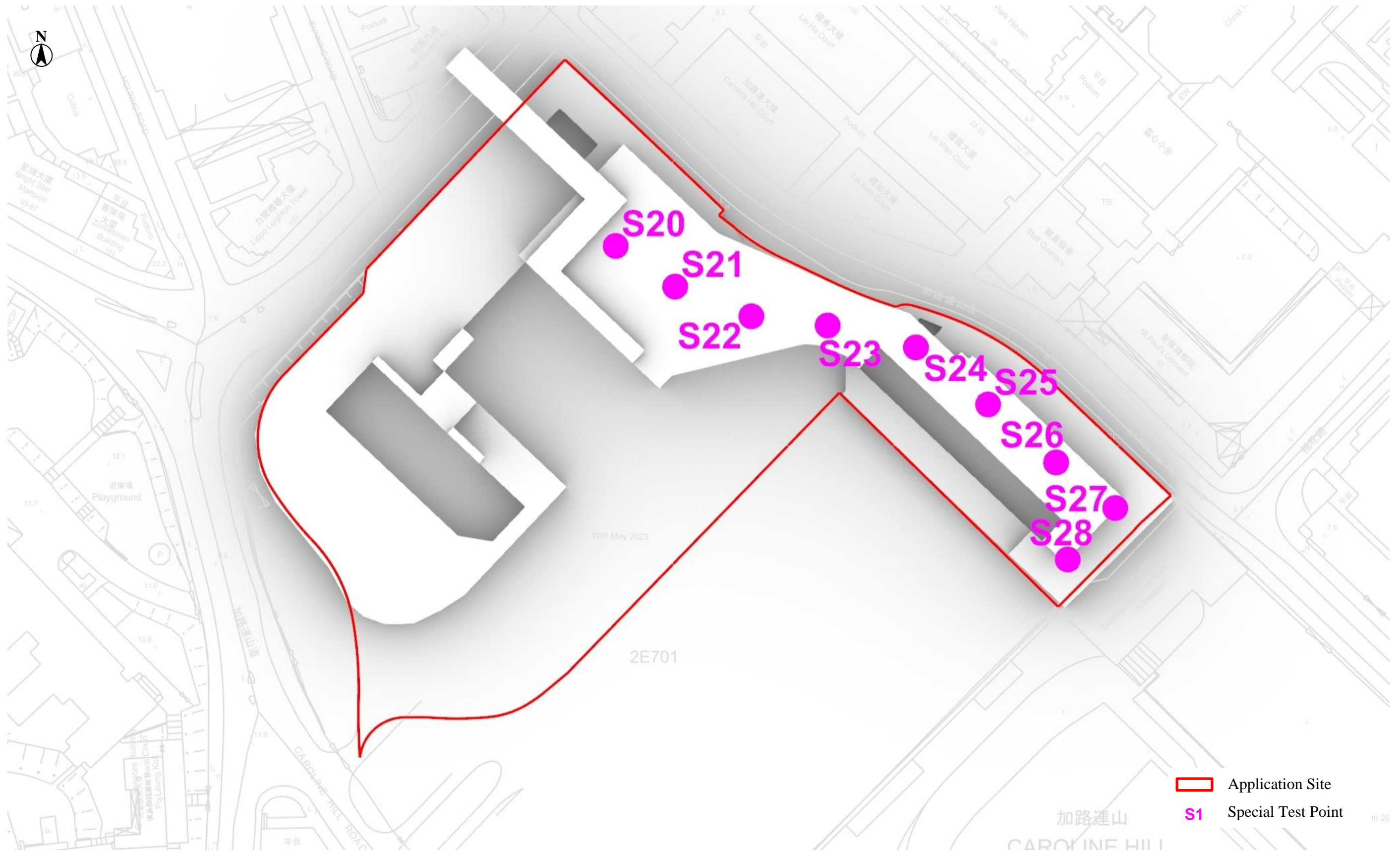


Figure 18 Location of Special Test Points on Podium Level

3.6 Focus Areas

Within the Proposed Assessment Area given in Figure 19, Figure 20 and Figure 21 a total of 51 focus areas are proposed. The associated test points for focus areas are tabulated in Table 4.

Table 4 Focus Areas and Corresponding Test Points

	Focus Area	Test Points
1	Yee Wo Street	O147-O150
2	Fung Un Street	O135, O136, O138, O145
3	Jardine's Bazaar	O143-O146
4	Jardine's Crescent	O137-O139, O144
5	Yun Ping Road	O115, O193-O195
6	Lan Fong Road	O115-O118
7	Lee Garden Road	O111-O114
8	Hysan Avenue	O106, O184, O185, O189, O194
9	Sun Wui Road	O181-O184
10	Hoi Ping Road	O185-O188
11	Leighton Lane	O107-O110
12	Sunning Road	O189-O192
13	Playground of Po Leung Kuk	O177-O180
14	Leighton Hill Road	O103-O105, O172-O175
15	Link Road	O98, O99, O169-O171
16	Elevated Road to Beverly Hill	O86-O88, O166-O168
17	Happy View Terrace	O93-O97
18	Broadwood Road	O99-O102
19	Rest Garden on Broadwood Road	O89-O92
20	Road south of Beverly Hill	O7-O9, O85
21	Confucius Hall Secondary School	O67-O70
22	Stadium Path	O63-O66, O76
23	Hong Kong Stadium	O1-O6, O61, O62
24	Eastern Hospital Road Sitting-out Area 1	O57-O60
25	Easter Hospital Road	O45-O56
26	Tung Wah Eastern Hospital	O24-O26
27	Indian Recreation Club	O35-O38
28	Caroline Hill Road	P32-P42, O71-O78, O155-O161
29	Eastern Hospital Road Sitting-out Area 2	O39-O42
30	South China Stadium	O79-O84
31	So Kon Po Recreation Ground	O31-O34
32	Proposed District Court	O10, O158-O165
33	Sir Ellis Kadoorie (S) Primary School	O19-O22
34	Disciplined Services Sports and Recreational Club	O27-O30
35	Ka Ning Path Rest Garden	O15-O18
36	Cotton Path Road	O43, O44, O46, O155
37	St. Paul's Convent	O119, O120, O196, O197
38	Ka Ning Road	O11-O14
39	Haven Street	O151-O154
40	St. Paul's Hospital	O121-O124

41	St. Paul's Convent School	O125-O128
42	Leighton Road	P1-P8, O106, O110, O129, O130, O151, O176, O188
43	Keswick Street	O130-O133
44	Pennington Street	O133, O134, O143, O198
45	Irvine Street	O140-O143
46	Internal Street of T1 on G/F	S13, S17-S19
47	Elevated Design of T1 on G/F	S9-S11
48	Access Road within Application Site	S1-S8
49	Open Space of T1&2 on G/F	S9-S19
50	Open Space of T2 on Podium Level	S20-S23
51	Elevated Design of T3 on Podium Level	S24-S28



Figure 19 Location of Focus Area

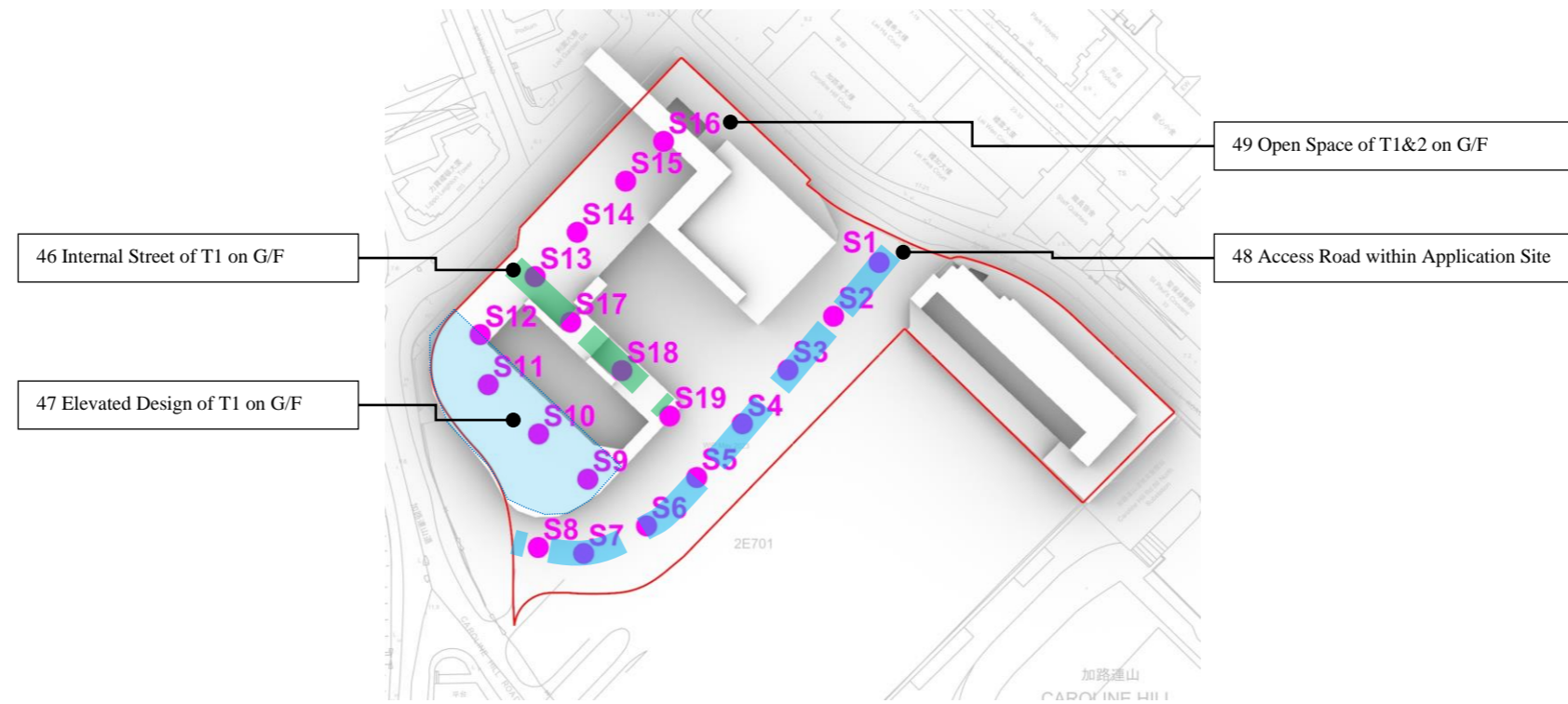


Figure 20 Location of Focus Area within Application Site - G/F

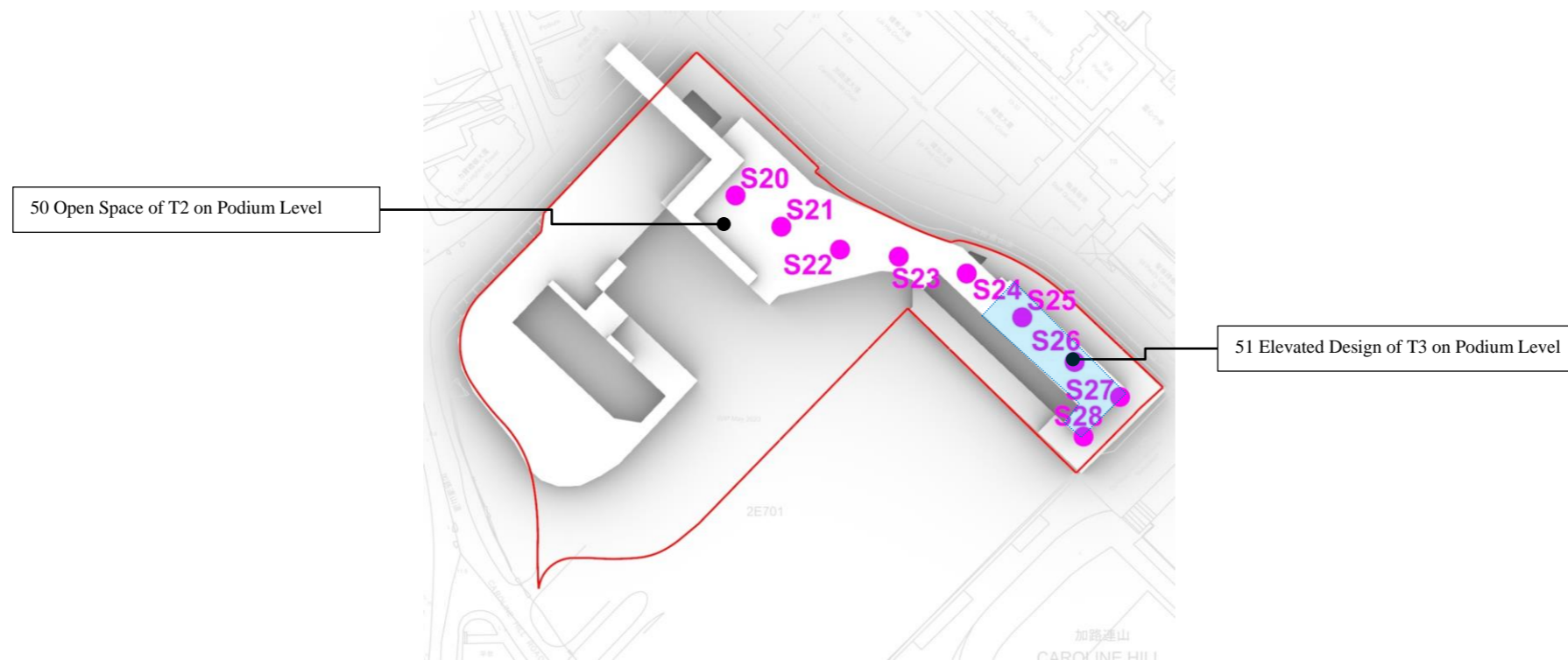


Figure 21 Location of Focus Area within Application Site - Podium Level

4 Design Schemes for Initial Study

Two schemes will be analysed and compared in this AVA Initial Study, namely the Baseline Scheme and the Proposed Scheme.

4.1 Baseline Scheme

Proposed Scheme is the previously approved scheme under Planning Application No. A/H7/181. The development parameters are summarized in Table 5 below. The layout plan of Baseline Scheme is shown in Figure 22 and Figure 23, with details in Appendix A. Major wind enhancement features are list below. The 3D model was constructed as shown in Figure 24 to Figure 27.

- #1: T1 – 15m setback is provided from the building edge for elevated design on G/F. The elevated design consists of 15m (W) x 8.5m (H).
- #2: T2 – Proposed building setback of min. 23m from north-eastern boundary above 2/F.
- #3: T3 – Elevated design on 2/F apart from the core area. The effective width of the elevated design is approximately 18m wide measured from north-eastern site boundary. The elevated design consists of approximately 18m (W) x 10m (H).
- #4: T1 – Building setback of approximate 5m on average from the south-western boundary.
- #5: T2 – Building setback of 4m at grade from north-eastern boundary.
- #6: T3 – Building setback of 7.5m above 2F from the south-western boundary abutting the district court site.

Table 5 Development Parameters of Baseline Scheme

Development Parameter	Baseline Scheme
Building Block(s)	2
Main Roof Height (mPD)	+135mPD for T1&2 +90mPD for T3

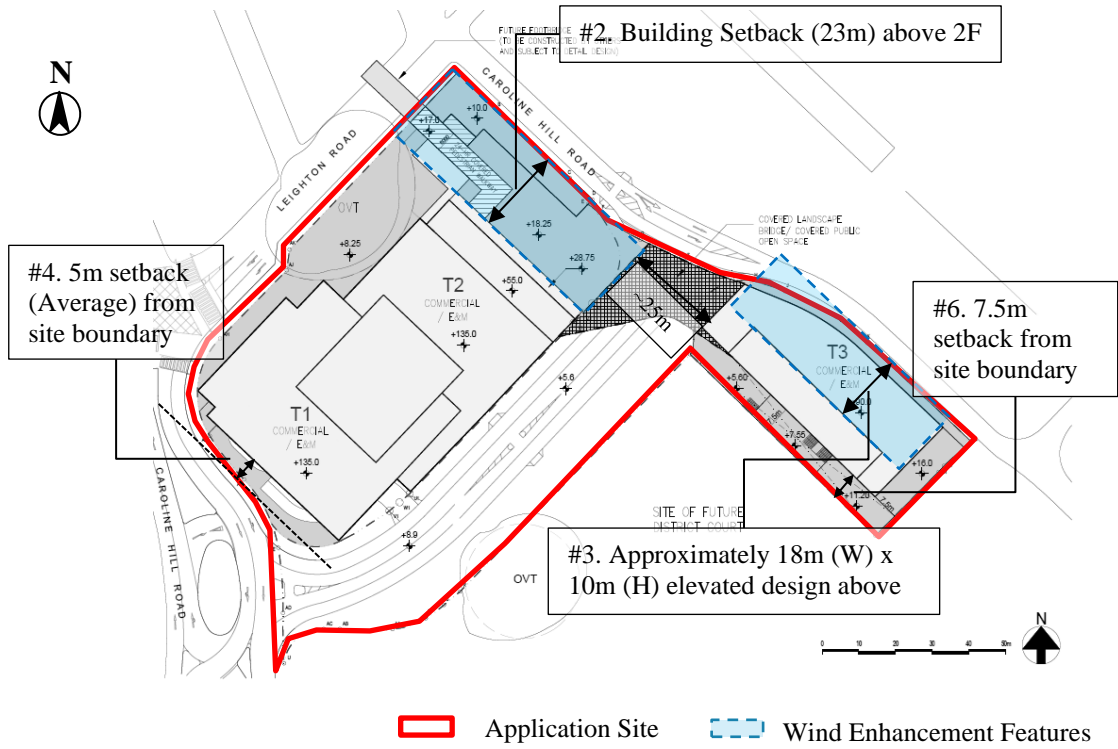


Figure 22 Baseline Scheme – Master Layout Plan

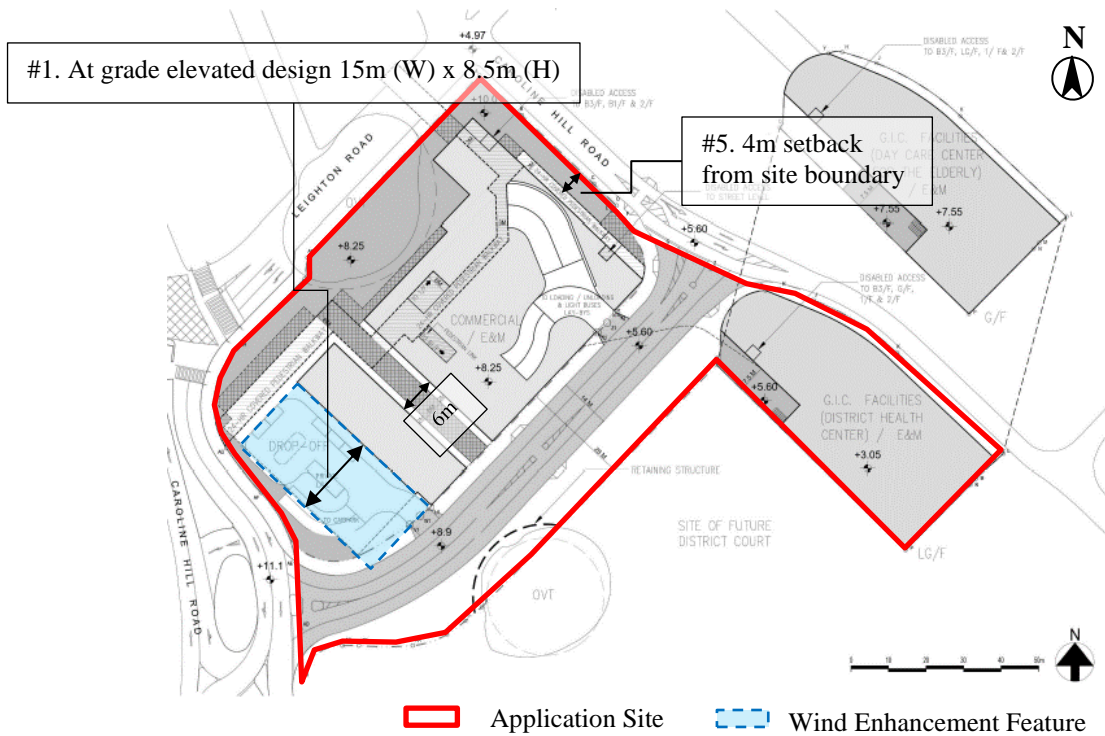


Figure 23 Baseline Scheme – GF Layout Plan



Figure 24 Northerly view of Baseline Scheme



Figure 25 Easterly view of Baseline Scheme

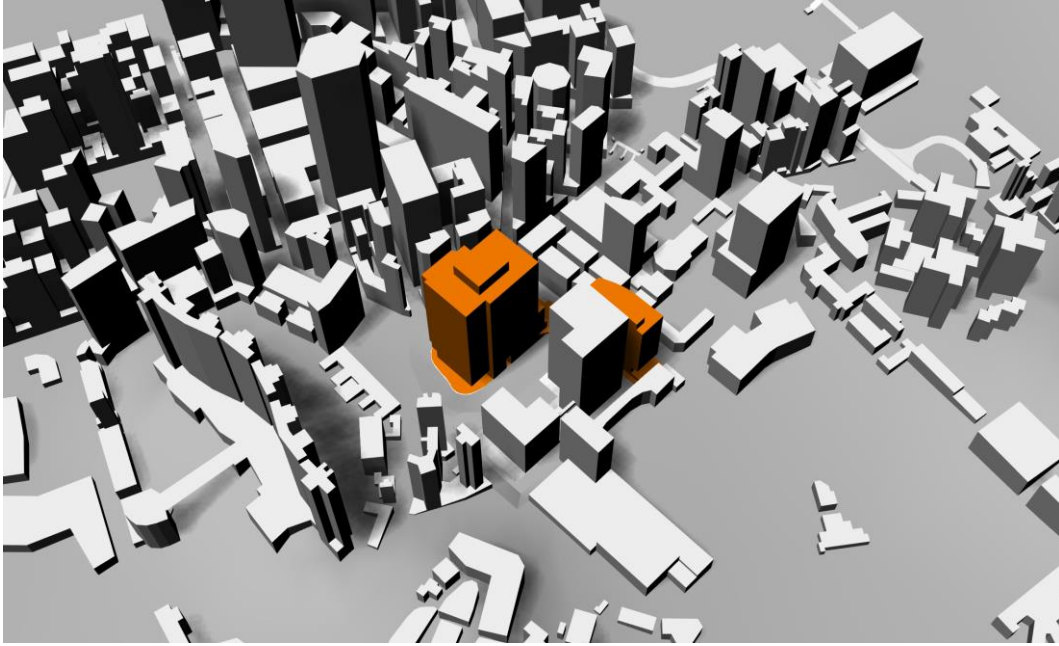


Figure 26 Southerly view of Baseline Scheme



Figure 27 Westerly view of Baseline Scheme

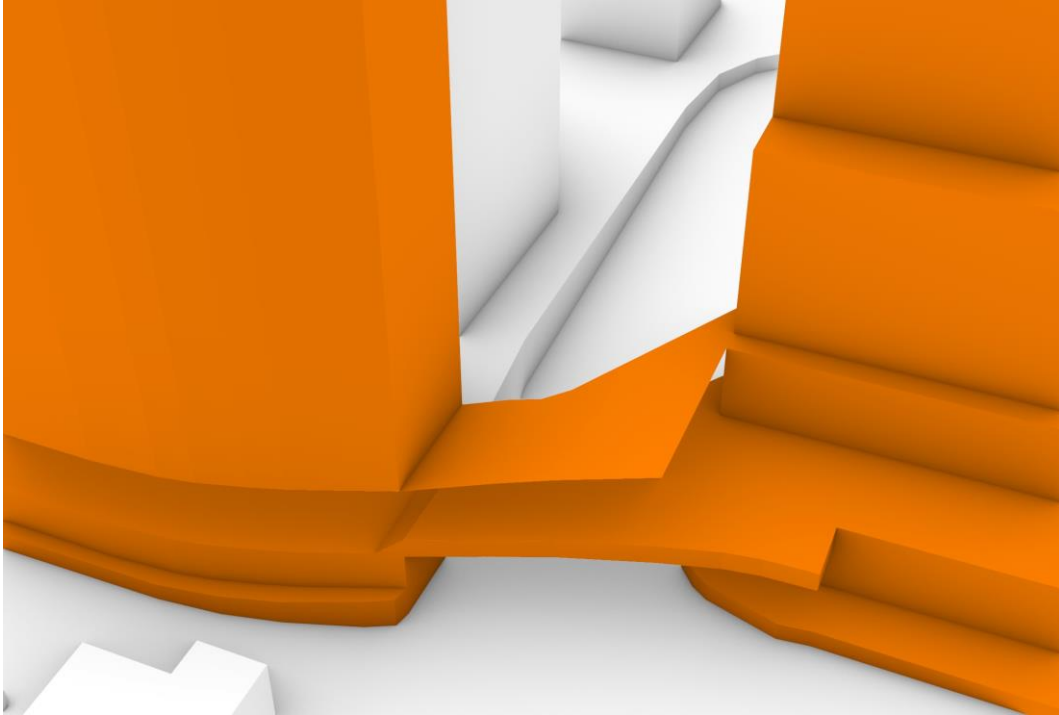


Figure 28 T2-T3 Footbridge of Baseline Scheme

4.2 Proposed Scheme

Proposed Scheme is the intended development scheme, with the same functional use as the Baseline Scheme. Amendments have been made to the building massing and T2-T3 footbridge.

The tower footprint of T2 is shifted from the north-eastern site boundary, the podium platform of T3 adjacent to south-western site boundary are lowered to connect to the street level and the footbridge between T2 and T3 are now enclosed. The development parameters are summarized in Table 6 below. The layout plan of Proposed Scheme is shown in Figure 29 and Figure 30, with details in Appendix A. Major wind enhancement features are list below. The 3D model was constructed as shown in Figure 31 and Figure 34.

- #1: T1 – 15m setback is provided from the building edge for elevated design on G/F. The elevated design consists of 15m (W) x 8.5m (H).
- #2: T2 – Building setback of min. 36m from north-eastern site boundary above 2/F.
- #3: T3 – Elevated design on 2/F apart from the core area. The effective width of the elevated design is approximately 18m wide on average measured from north-eastern site boundary. The elevated design consists of approximately 18m (W) x 10m (H)
- #4: T1 – Building setback of approximate 5m on average from the south-western boundary.
- #5: T2 – Building setback of 4m at grade from north-eastern boundary.
- #6: T3 – Building setback of 7.5m above 2F from the south-western boundary abutting the district court site.
- #7: T1 – Min. 6m Internal Street of T1 on G/F

Table 6 Development Parameters of Proposed Scheme

Development Parameter	Proposed Scheme
Building Block(s)	2
Maximum Building Height (mPD)	+135mPD for T1/T2 +90mPD for T3

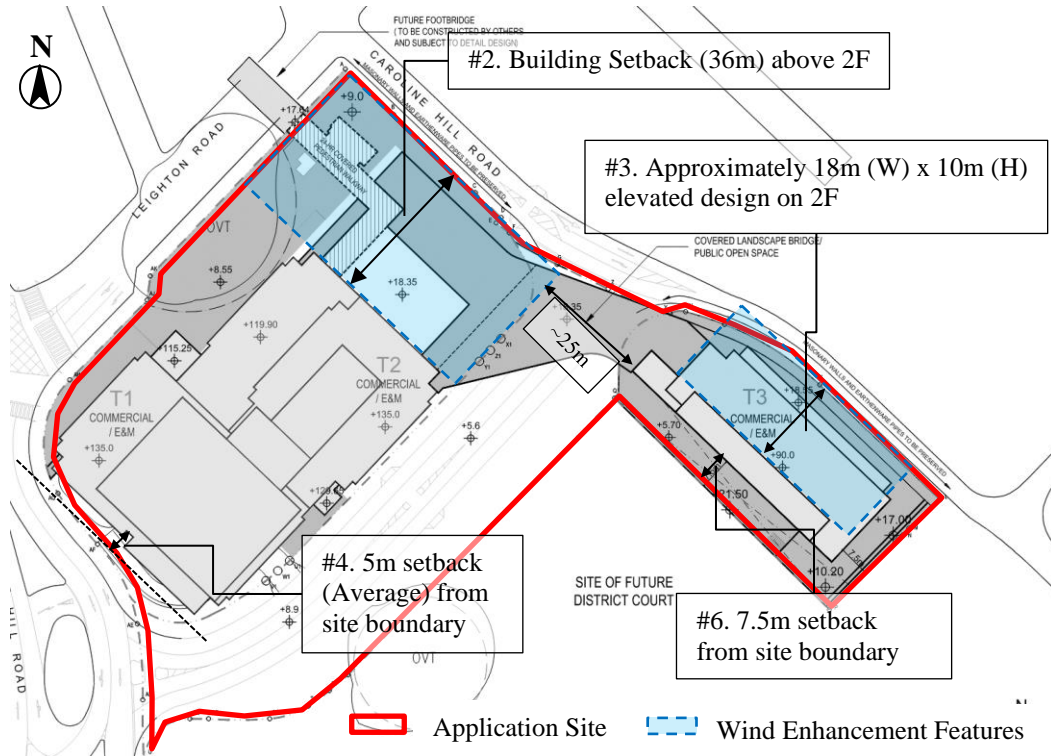


Figure 29 Proposed Scheme – Master Layout Plan

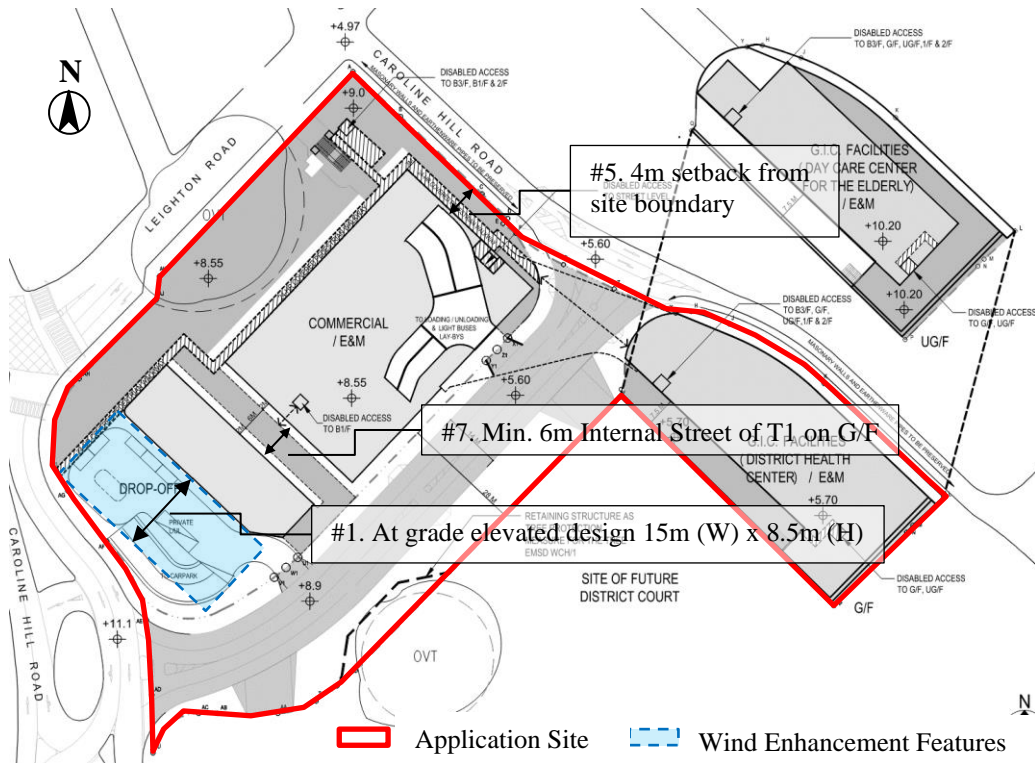


Figure 30 Proposed Scheme – GF Layout Plan



Figure 31 Northerly view of Proposed Scheme

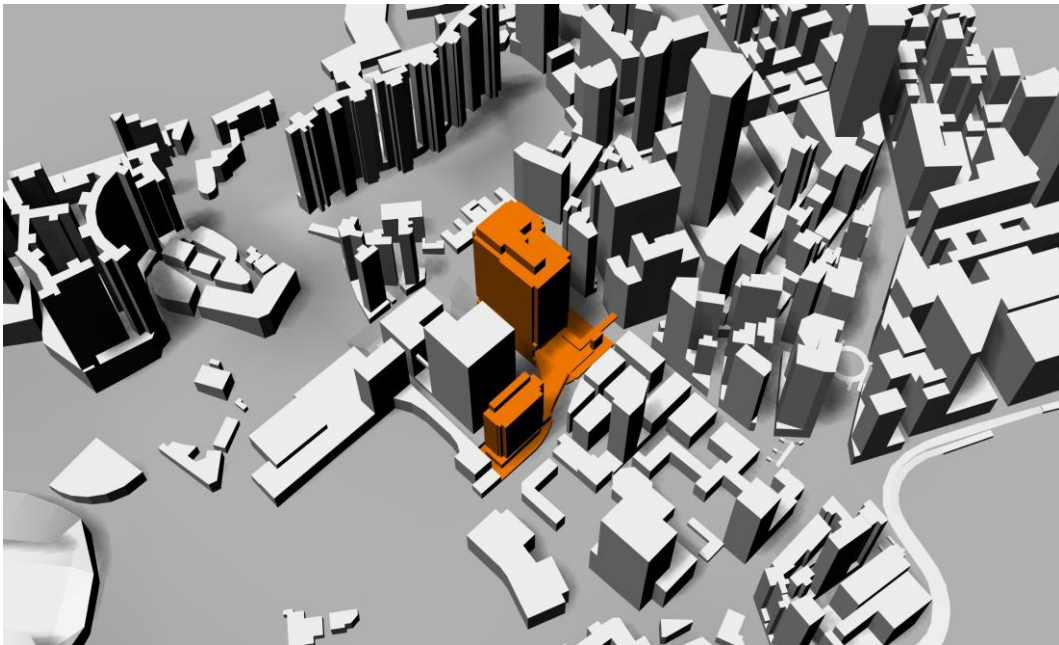


Figure 32 Easterly view of Proposed Scheme

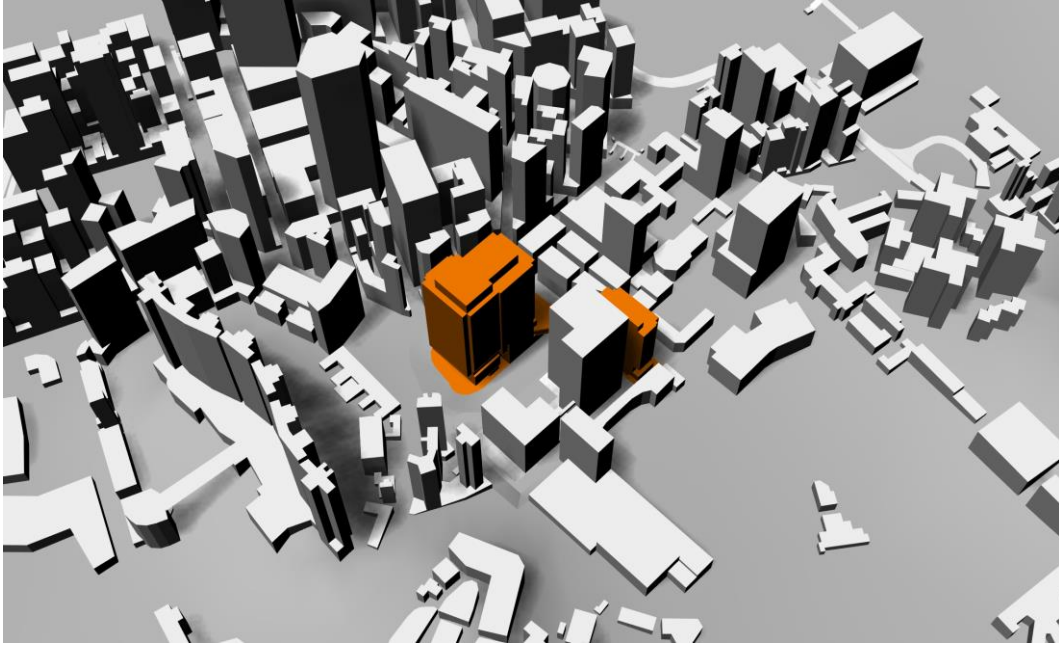


Figure 33 Southerly view of Proposed Scheme



Figure 34 Westerly view of Proposed Scheme

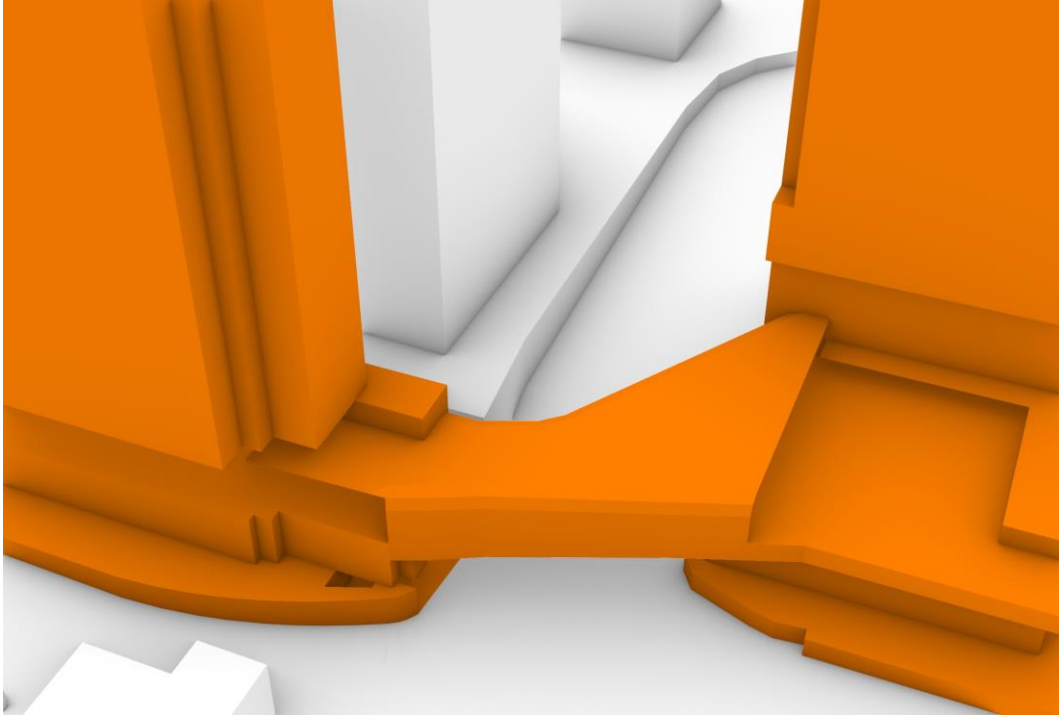


Figure 35 T2-T3 Footbridge of Proposed Scheme

5 Results and Discussion

The detailed contour and vector plots for each wind directions are shown in Appendix C and Appendix D.

5.1 Overall Pattern of Ventilation Performance under Annual Wind Condition

The overall wind performance of Baseline and Proposed Schemes under annual wind condition is presented in Figure 36 and Figure 37 respectively. Under annual wind conditions, prevailing winds are mostly from E quadrant, the Application Site is located at the leeward side of mid to high-rise developments and open space provided by recreational area with hilly terrain of Grandview Mansion to the further side. T1 and T2 are partially shielded by Proposed District Court. Surrounding wind environment is dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Incoming winds would be diverted to reach the Application Site from Caroline Hill Road, Leighton Road and Cotton Path. Some high-level incoming winds would skim over the mid-rise developments and open space to reach the Application Site from prevailing wind direction. The incoming wind directions are illustrated by **Black** arrows in Figure 36 and Figure 37 respectively.

Under both Schemes, downwash effect would be observed on T2, T3 and Proposed District Court. Under Baseline Scheme, larger frontal area of T3 would induce more prominent downwash effect. Downwash wind would ventilate the T3 podium and further travel to Caroline Hill Road, where slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 36.

Under Baseline Scheme, the larger façade of T2 would also divert some incoming wind towards Access Road within Application Site. While under Proposed Scheme, the enclosed T2-T3 footbridge would also divert some incoming wind towards Access Road within Application Site. Different in ventilation pattern would be observed illustrated by **Red** arrow in Figure 36 and Figure 37 respectively.

Under Proposed Scheme, the enclosed T2-T3 footbridge under Proposed Scheme would shield the T2 podium, where slightly lower VR would be observed, illustrated by **Red** circle in Figure 37.

The larger T3 building setback from north-eastern site boundary enhanced wind permeability, more incoming wind from Caroline Hill Road would continue to travel along, where slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 37.

In addition, larger building setback of T2 under Proposed Scheme allows incoming wind to skim over the T2 podium to ventilate Leighton Road and Playground of Po Leung Kuk on the leeward side, where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 37.

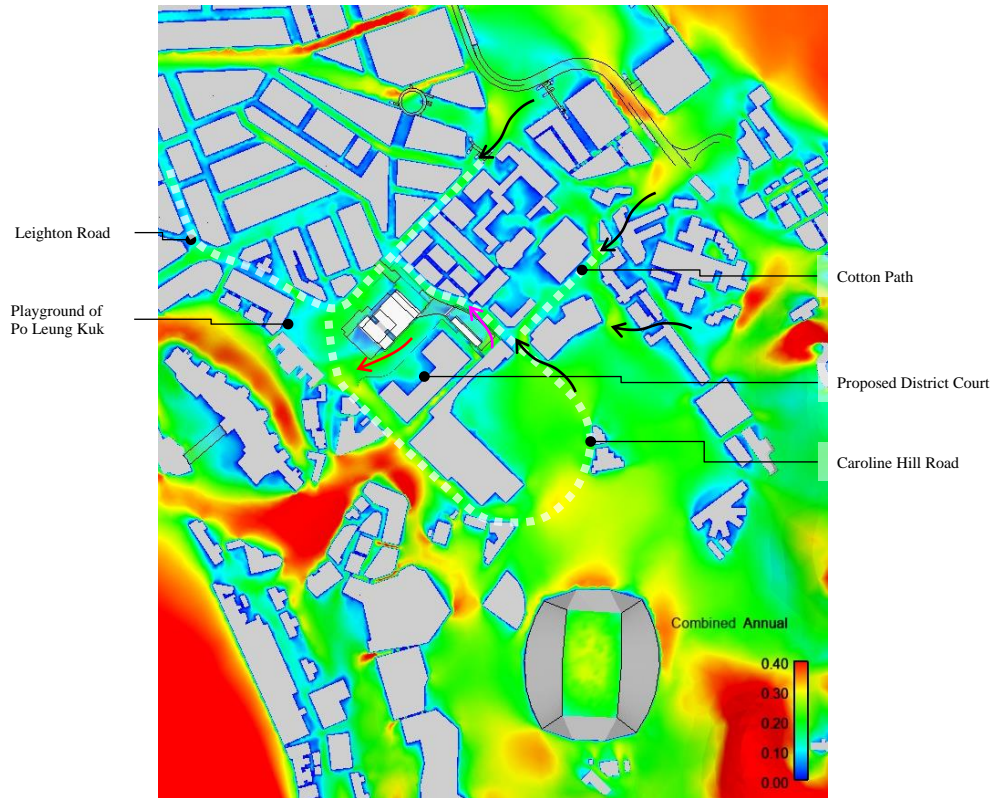


Figure 36 Contour plot of annual weighted VR under Baseline Scheme

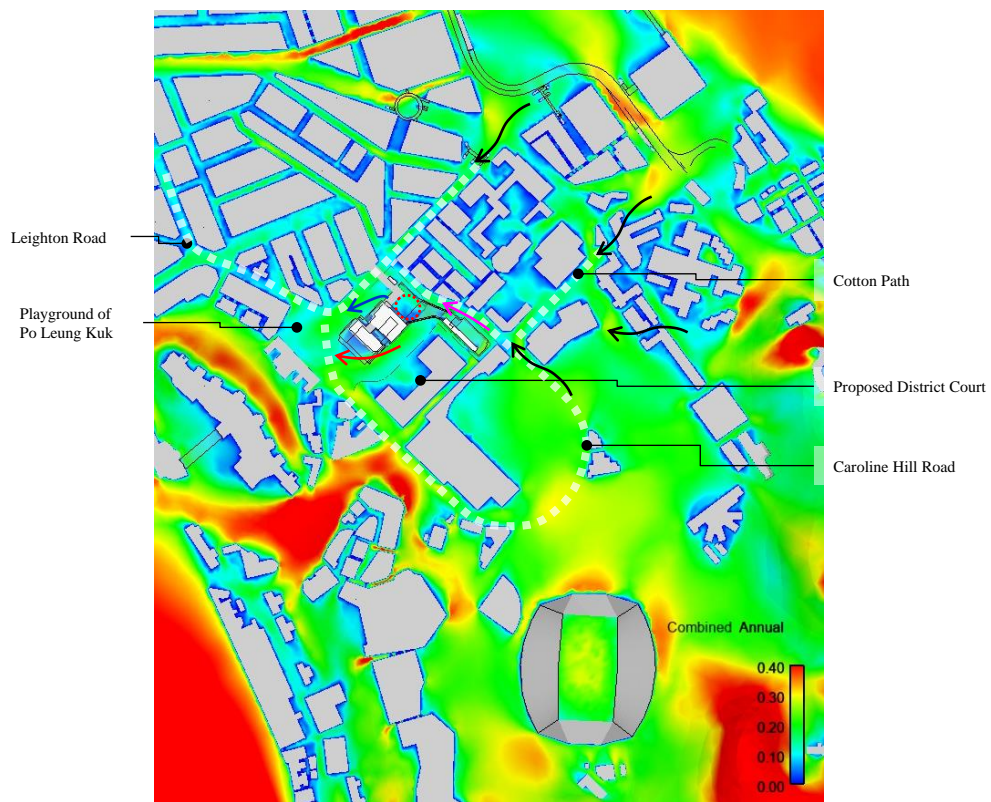


Figure 37 Contour plot of annual weighted VR under Proposed Scheme

5.2 Overall Pattern of Ventilation Performance under Summer Wind Condition

The overall wind performance of Baseline and Proposed Schemes under summer wind condition is presented in Figure 38 and Figure 39 respectively.

Under summer condition, the prevailing winds are mostly from SW quadrant. The Application Site is located at the leeward side of density built mid to high-rise developments and hilly terrain of Beverly Hill. T1 and T2 are shielded by The Leighton Hill, while T3 is shielded by Proposed District Court. Surrounding wind environment is relatively calm and dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to the upwind developments and hilly terrain, incoming winds would be diverted to reach the Application Site from Leighton Road, Sunning Road, Yun Ping Road and Caroline Hill Road. The incoming wind directions are illustrated by **Black** arrows in Figure 38 and Figure 39 respectively.

Under both Schemes, downwash effect would be observed on Proposed District Court.

Under Baseline Scheme, mid-level incoming wind from Yun Ping Road and Pennington Street would flow through T2-T3 footbridge and ventilate the Access Road within Application Site, where slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 38.

Under Proposed Scheme, due to the larger building setback of T3 from north-eastern site boundary and larger T3 core, incoming wind from Caroline Hill Road would enter and be channelled to ventilate the T3 podium, where slightly higher VR would be observed, illustrate by **Black** circle in Figure 39.

Under Proposed Scheme, the enclosed T2-T3 footbridge would divert some incoming wind to street level, together with the larger building setback of T3 from north-eastern site boundary, where slightly higher VR on part of the Access Road within Application Site and Caroline Hill Road would be observed, illustrate by **White** arrows in Figure 39.

Under Proposed Scheme, due to the less prominent wind traveling from the north-west along Caroline Hill Road, the incoming wind from the opposite direction would be less limited to travel along the same road, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 39.

Under both Scheme, incoming wind from Yun Ping Road and Pennington Street would travel along north-western site boundary. Under Baseline Scheme, the incoming wind would continue to travel to ventilate the Elevated Design of T1 on G/F. While under Proposed Scheme, the incoming wind would be diverted toward Caroline Hill Road. Where different in ventilation pattern would be observed, illustrated by **Red** arrow in Figure 38 and Figure 39 respectively.

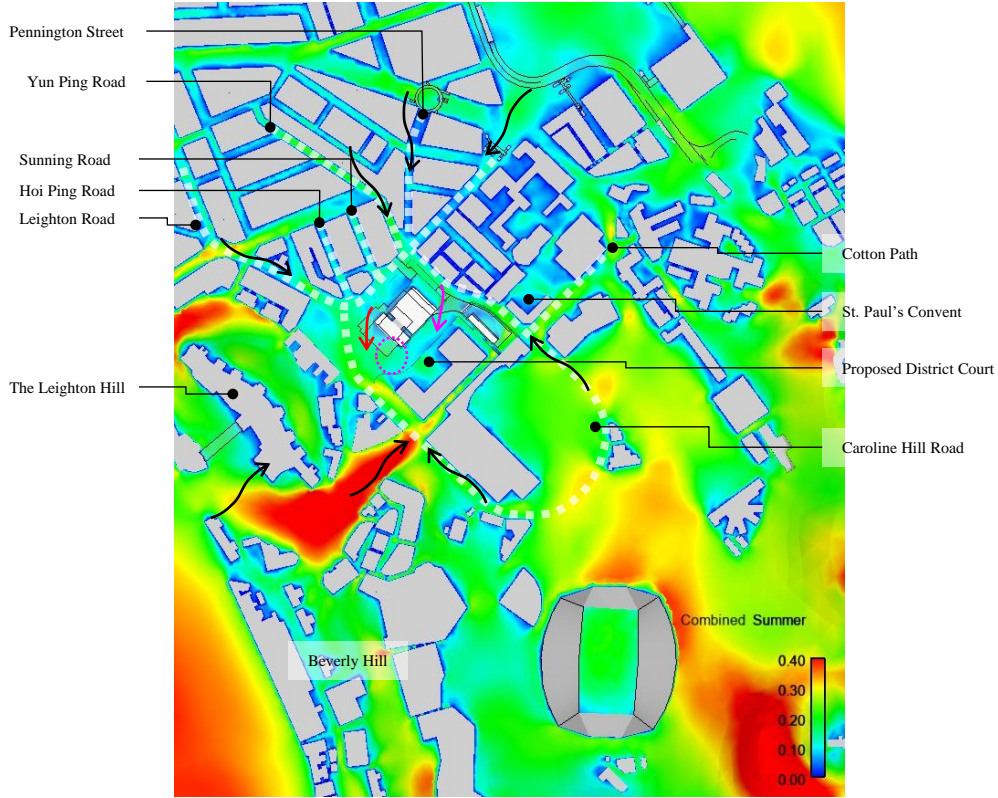


Figure 38 Contour plot of summer weighted VR under Baseline Scheme

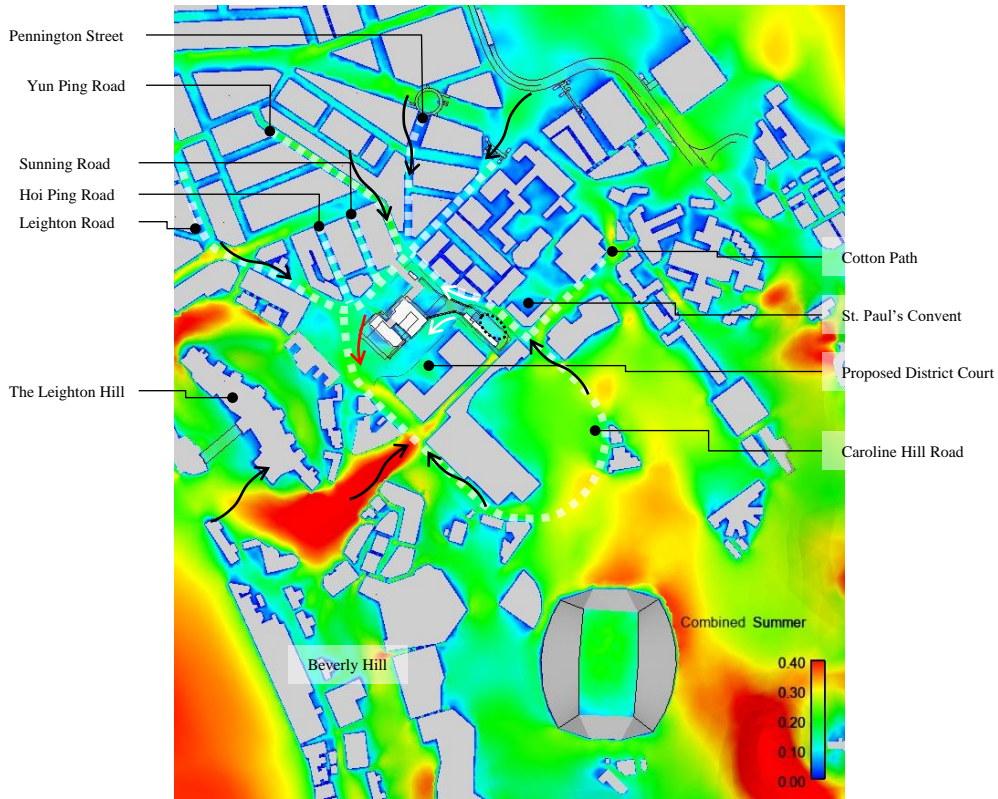


Figure 39 Contour plot of summer weighted VR under Proposed Scheme

5.3 Directional Analysis

5.3.1 NNE Wind

The overall wind performance of Baseline and Proposed Schemes under NNE wind is presented in Figure 40 and Figure 41, respectively.

The Application Site is located at the leeward side of densely built high-rise developments. Surrounding wind environment is relatively calm and dominated by upwind developments, except for some localized difference around the Application Site.

Due to the surrounding buildings, incoming wind would be diverted to reach the Application from Sun Wui Road, Hoi Ping Road, Sunning Road, Yun Ping Road, and Leighton Road. Some high-level wind would skim over the mid-rise buildings to reach the Application Site from north-east. The incoming wind directions are illustrated by **Black** arrows in Figure 40 and Figure 41, respectively.

Under both Scheme, stepping building height of T3 (lower) and Proposed District Court (taller) allows induced downwash effect on both buildings. Under Baseline Scheme, due larger frontal area of T3 more downwashed wind be induced to ventilate the Proposed District Court podium, where slightly higher VR would be observed, illustrated by **White** circle in Figure 40.

Under Baseline Scheme, mid-level incoming wind from Leighton Road would pass through the T2-T3 footbridge to ventilate the Access Road within Application Site, where slightly higher VR would be observed, illustrated by **Purple** circle in Figure 40.

Under Proposed Scheme, less podium setback of T1 from north-western site boundary divert the incoming wind from Leighton Road towards Playground of Po Leung Kuk, while shielded the Elevated Design of T1 on G/F, where slightly higher VR on Playground of Po Leung Kuk and slightly lower VR on Elevated Design of T1 on G/F would be observed, illustrated by **Red** arrow in Figure 41.

Due to less prominent wind from Leighton Road traveling towards The Leighton Hill, downwash effect from The Leighton Hill would be more prominent, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 41.

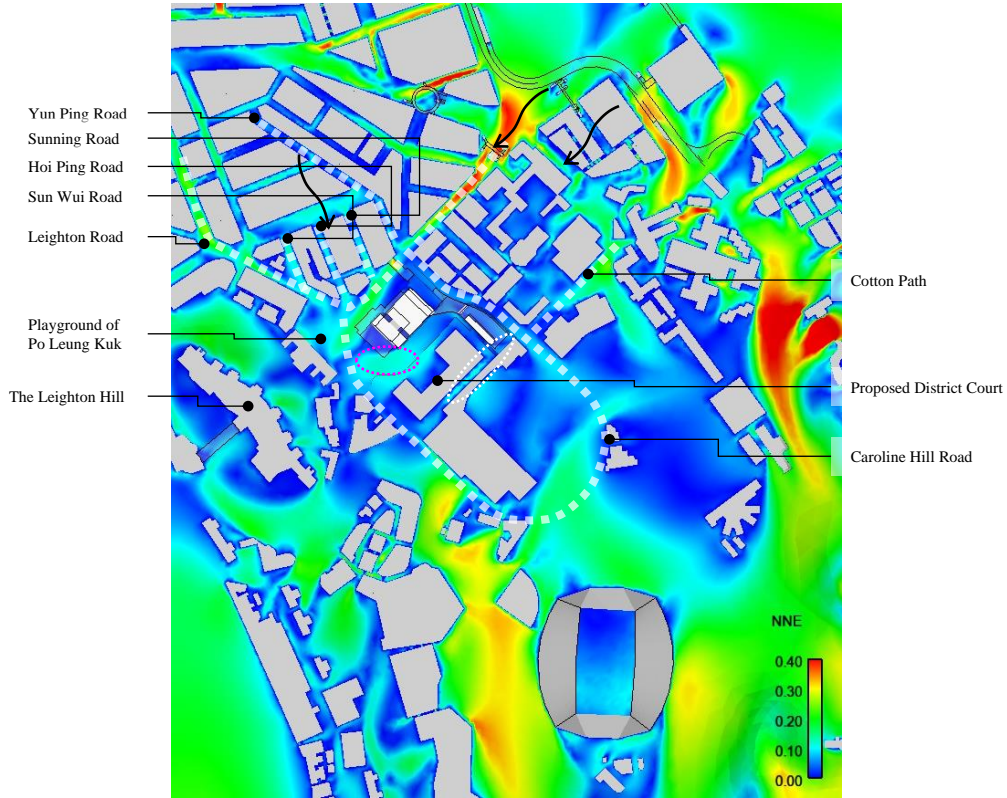


Figure 40 Contour plot of VR of Baseline Scheme under NNE wind

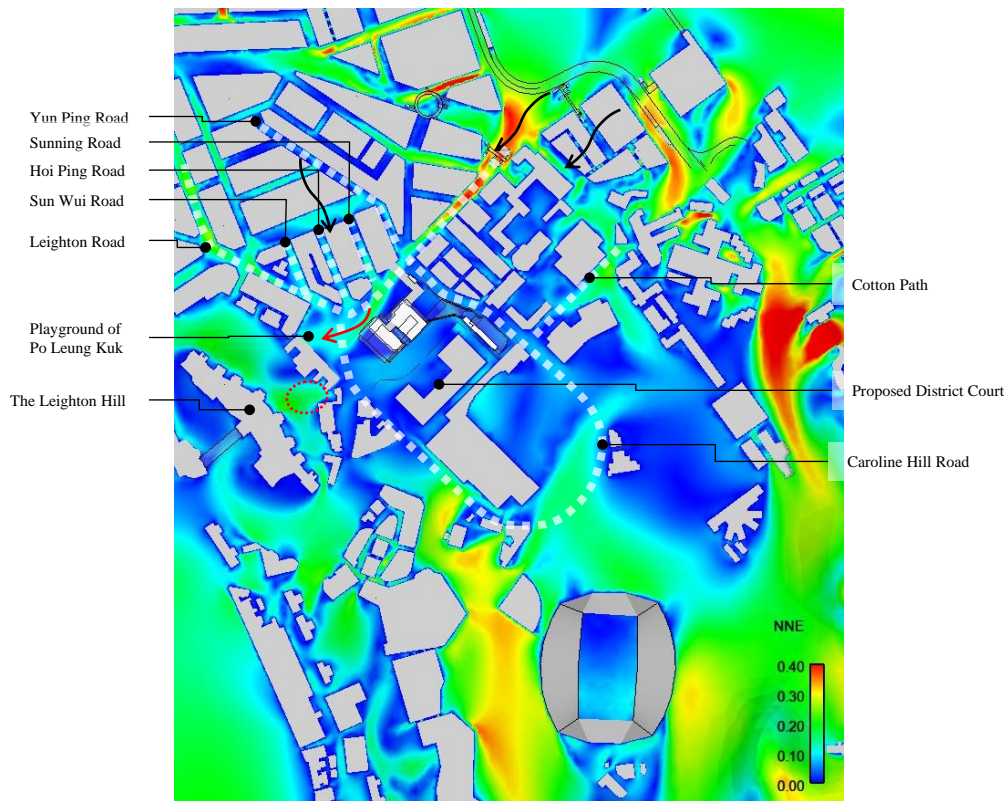


Figure 41 Contour plot of VR of Proposed Scheme under NNE wind

5.3.2 NE Wind

The overall wind performance of Baseline and Proposed Schemes under NE wind is presented in Figure 42 and Figure 43 respectively.

The Application Site is located at the leeward side of densely built high-rise developments. Surrounding wind environment is dominated by upwind developments, except for some localized difference around the Application Site.

Due to the surrounding buildings, incoming wind would be diverted to reach the Application from Leighton Road. Some high-level wind would skim over the mid-rise building to reach the Application Site from prevailing wind direction. The incoming wind direction is illustrated by **Black** arrows in Figure 42 and Figure 43 respectively.

Under both Schemes, downwash effect would be observed on T2, T3 and Proposed District Court.

Under Baseline Scheme, due to the larger setback of T1 podium from north-western boundary, incoming wind would continue to travel along north-western site boundary and Leighton Road to ventilate the leeward side, where slightly higher VR Playground of Po Leung Kuk would be observed, illustrated by **Black** circles in Figure 42. While, under Proposed Scheme, the incoming wind would be diverted away from the north-western site boundary to travel along Leighton Road and enter Sun Wui Road and Hoi Ping Road, where slightly higher VR would be observed, illustrated by **Black** circle in Figure 43.

In addition, under Proposed Scheme, the enclosed T2-T3 footbridge would divert some incoming wind to street level, together with the larger T3 building setback from north-eastern site boundary, slightly higher VR on Caroline Hill Road would be observed, illustrated by **White** arrow in Figure 43.

However, the footbridge would also shield some incoming wind from reaching the T2 podium, where slightly lower VR would be observed, illustrated by **White** circle in Figure 43.

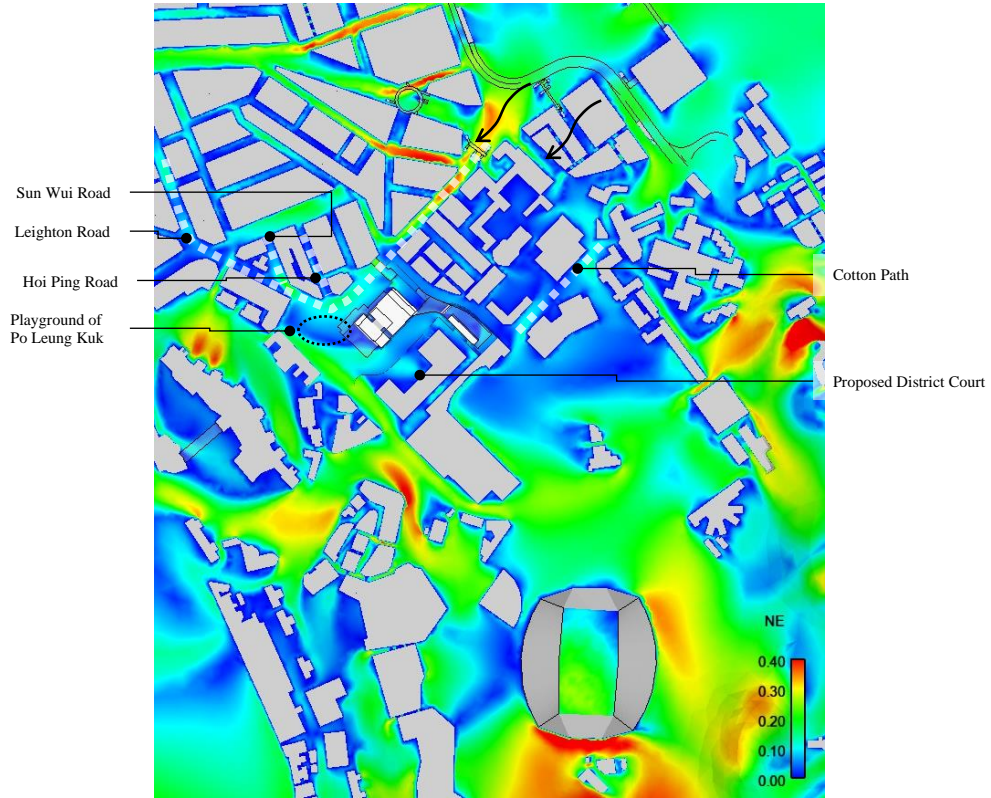


Figure 42 Contour plot of VR of Baseline Scheme under NE wind

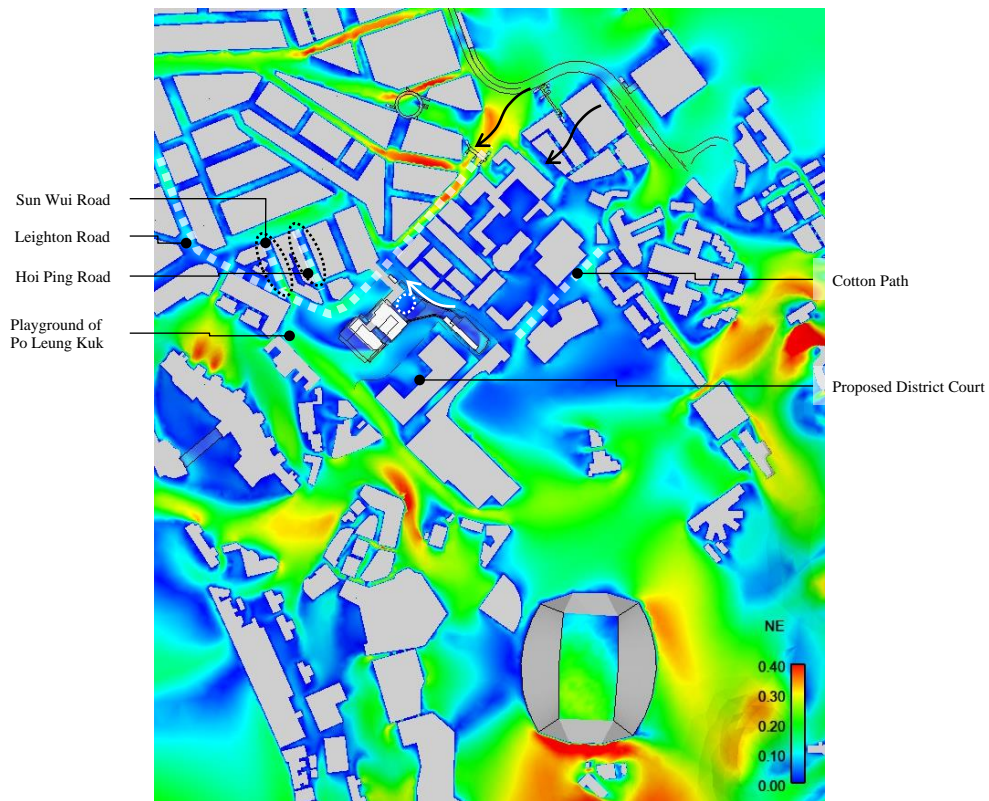


Figure 43 Contour plot of VR of Proposed Scheme under NE wind

5.3.3 ENE Wind

The overall wind performance of Baseline and Proposed Schemes under ENE wind is presented in Figure 44 and Figure 45 respectively.

The Application Site is located at the leeward side of densely built mid to high-rise developments. Surrounding wind environment is dominated by upwind developments, except for some localized difference around the Application Site.

Due to the surrounding buildings, incoming wind would be diverted to reach the Application from Leighton Road and Cotton Path. Some high-level wind would skim over the mid-rise building to reach the Application Site from north-east. The incoming wind directions are illustrated by **Black** arrows in Figure 44 and Figure 45 respectively.

Under both Schemes, downwash effect would be observed on T2, T3 and Proposed District Court. Under Baseline Scheme, due to larger frontal area of T3 more downwashed wind would be induced to ventilate Proposed District Court, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 44. Under Proposed Scheme, larger T3 core and higher T3 podium would divert downwashed wind from Proposed District Court to ventilate the area under enclosed T2-T3 footbridge, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 45.

Under Baseline Scheme, due to larger south-eastern façade of T2, the downwash effect from T2 would be more prominent. The downwashed wind that reach the T2 podium would further travel to the street level to ventilate Caroline Hill Road, Leighton Road and other streets towards the leeward side. Slightly higher VR would be observed, illustrated by **Blue** arrows in Figure 44.

Under Proposed Scheme, the larger building setback of T2 on podium level allows incoming wind to skim over and ventilate the north-western site boundary, where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 45.

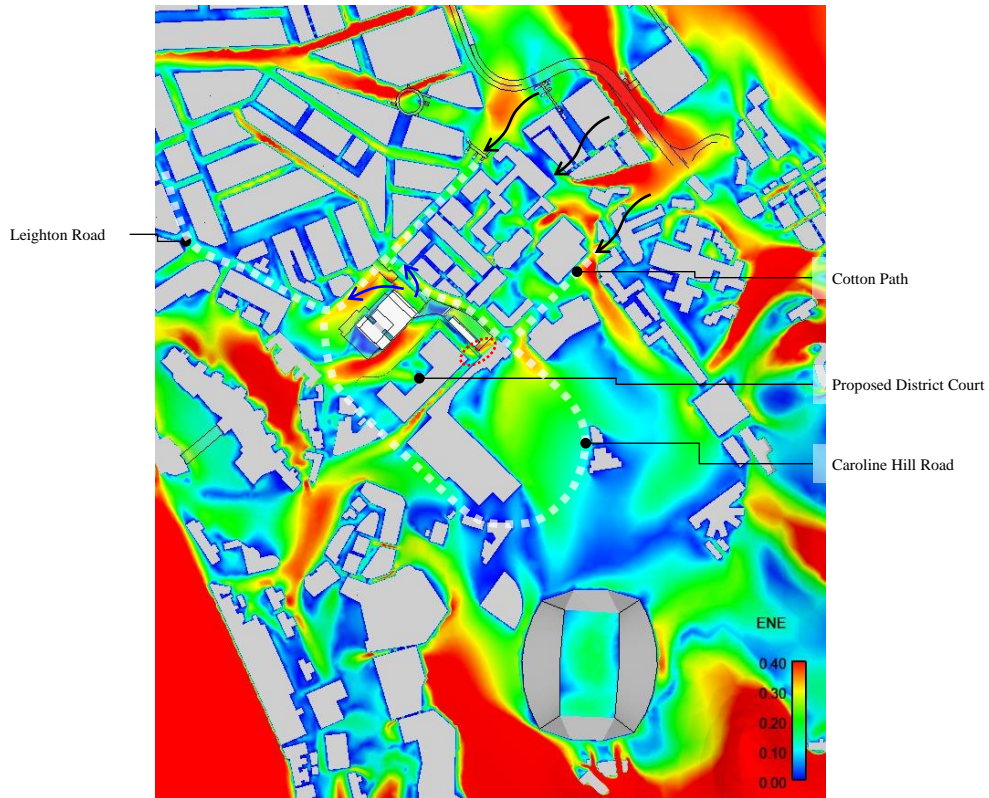


Figure 44 Contour plot of VR of Baseline Scheme under ENE wind

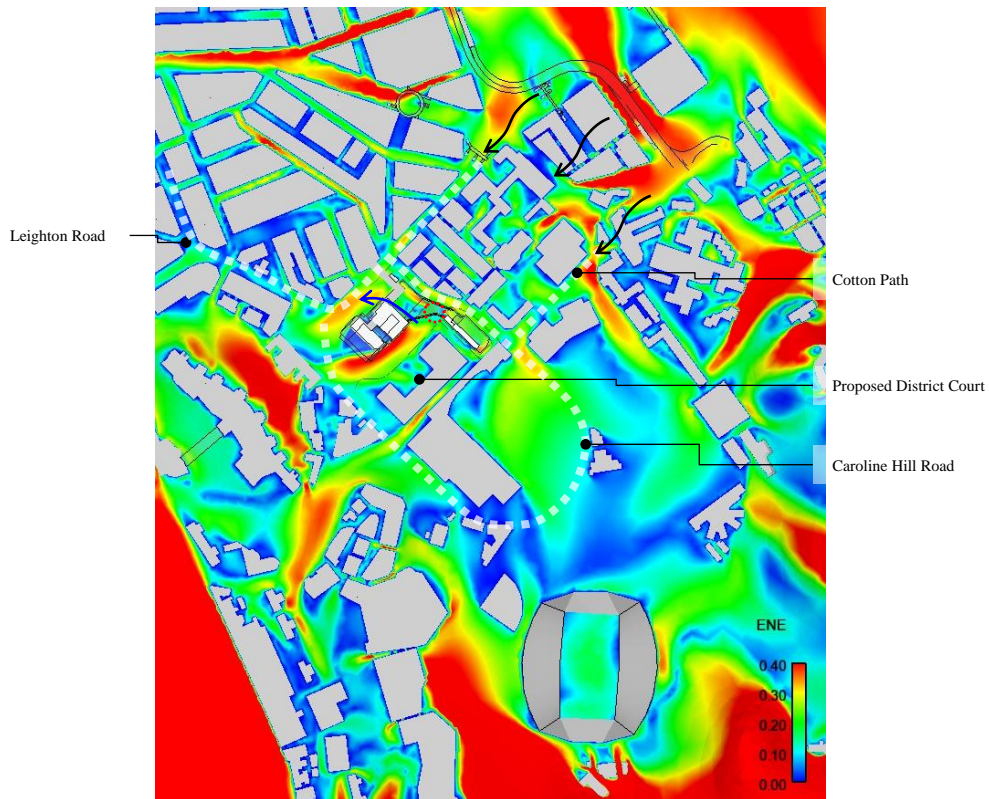


Figure 45 Contour plot of VR of Proposed Scheme under ENE wind

5.3.4 E Wind

The overall wind performance of Baseline and Proposed Schemes under E wind is presented in Figure 46 and Figure 47 respectively.

The Application Site is located at the leeward side of mid to high-rise development with hilly terrain of Grandview Mansion on further side. Surrounding wind environment is dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to surrounding buildings and hilly terrain, incoming wind would be diverted to reach the Application from Caroline Hill Road and Cotton Path. Some high-level wind would skim over the mid-rise building to reach the Application Site from the north-east direction. The incoming wind directions are illustrated by **Black** arrows Figure 46 and Figure 47 respectively.

Under both Schemes, downwash effect would be observed on T2, T3 and Proposed District Court. Under Baseline Scheme, due to the larger frontal area of T3, more downwashed wind from T3 would ventilate the T3 podium and Caroline Hill Road., slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 46.

Under Proposed Scheme, the setback of T2 enhanced the wind permeability, incoming wind would skim over the T2 podium to ventilate the north-western site boundary and Leighton Road, where slightly higher VR would be observed, illustrated by **Black** circles in Figure 47.

Under Proposed Scheme, the enclosed T2-T3 footbridge would divert some incoming wind towards street level, together with the larger building setback of T3 from north-eastern site boundary, slightly higher VR on Caroline Hill Road would be observed, illustrated by **Red** arrows in Figure 47.

However, the footbridge would also shield incoming wind from reaching the T2 Podium, where slightly lower VR would be observed, illustrated by **Red** circle in Figure 47.

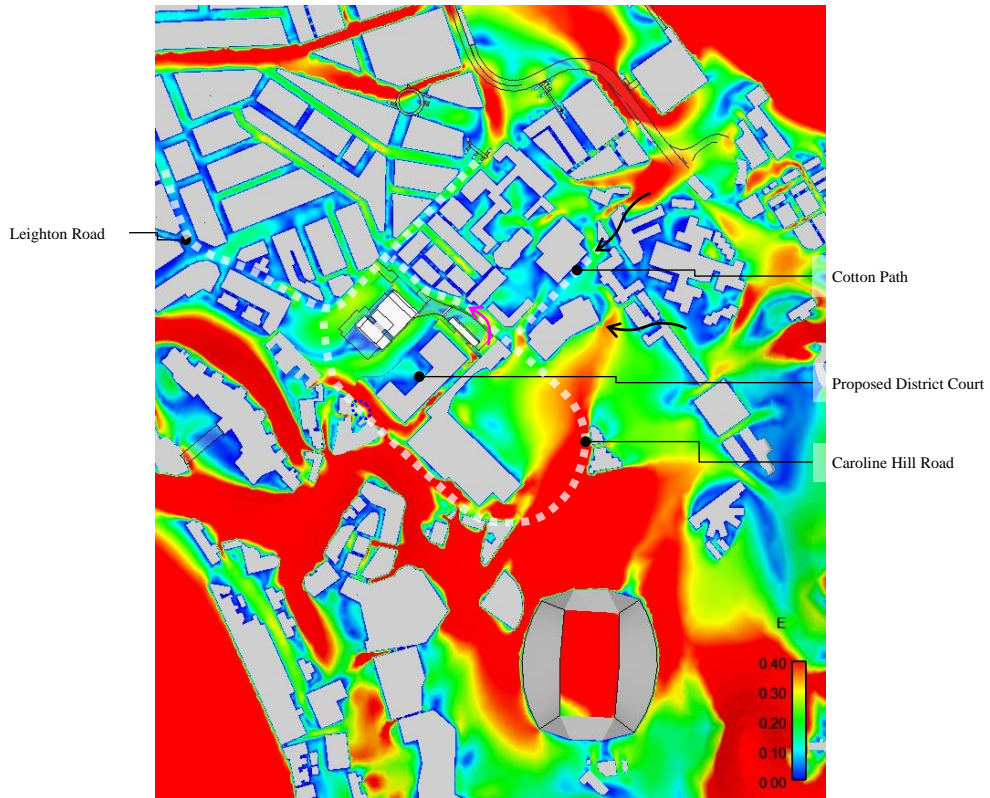


Figure 46 Contour plot of VR of Baseline Scheme under E wind

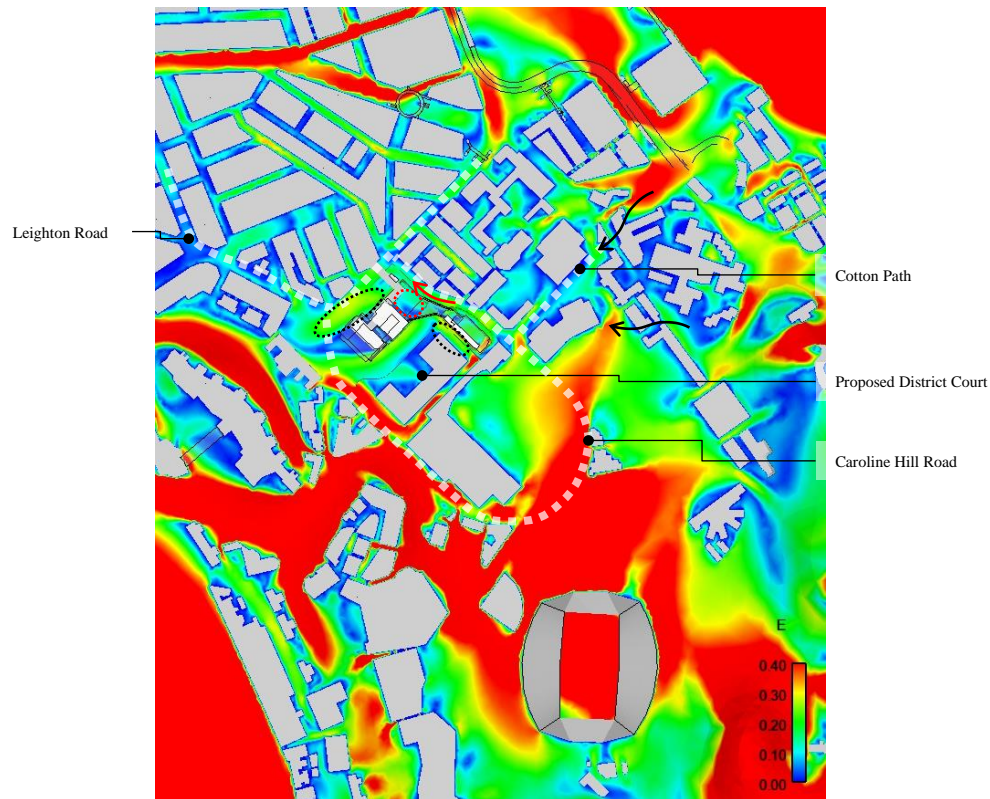


Figure 47 Contour plot of VR of Proposed Scheme under E wind

5.3.5 ESE Wind

The overall wind performance of Baseline and Proposed Schemes under ESE wind is presented in Figure 48 and Figure 49 respectively.

The Application Site is located at the leeward side of mid-rise building and open space provided by recreational area with hilly terrain of Grandview Mansion on further side, Also T1&T2 are partially shield by Proposed District Court. Surrounding wind environment is dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to the surrounding building and hilly terrain, incoming wind would be diverted to reach the Application from Caroline Hill Road. Some high-level wind would skim over the mid-rise building to reach the Application Site from prevailing wind direction. The incoming wind directions are illustrated by **Black** arrows Figure 48 and Figure 49 respectively.

Under both Schemes, downwash effect would be observed on T1, T2, T3 and Proposed District Court. Under Baseline Scheme, due to larger frontal area of T3 more downwashed wind would be induced to ventilate the T3 podium, where slightly higher VR would be observed, illustrated by **Blue** circle in Figure 48.

Also, the larger frontal area of T2 and T3 would induce more prominent downwash effect to ventilate the Access Riad within Application Site and Caroline hill road, where slightly higher VR would be observed, illustrated by **Blue** arrows in Figure 48.

Under Proposed Scheme, the Internal Street of T1 on G/F would divert incoming wind to further ventilate the Hoi Ping Road, where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 49.

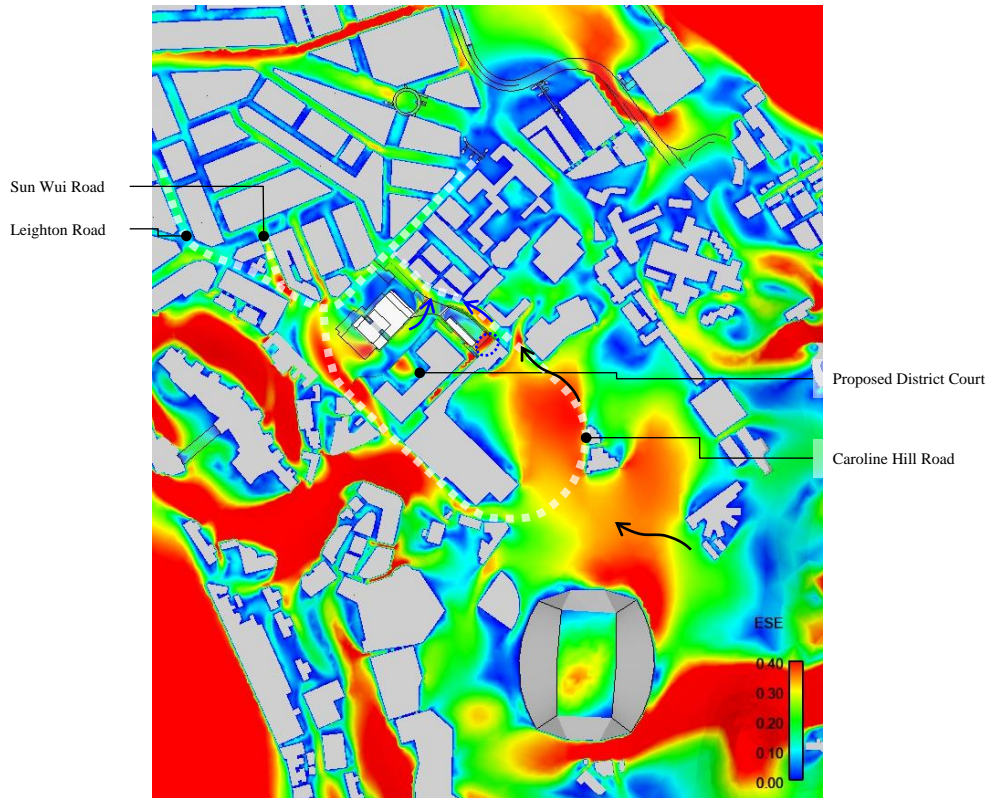


Figure 48 Contour plot of VR of Baseline Scheme under ESE wind

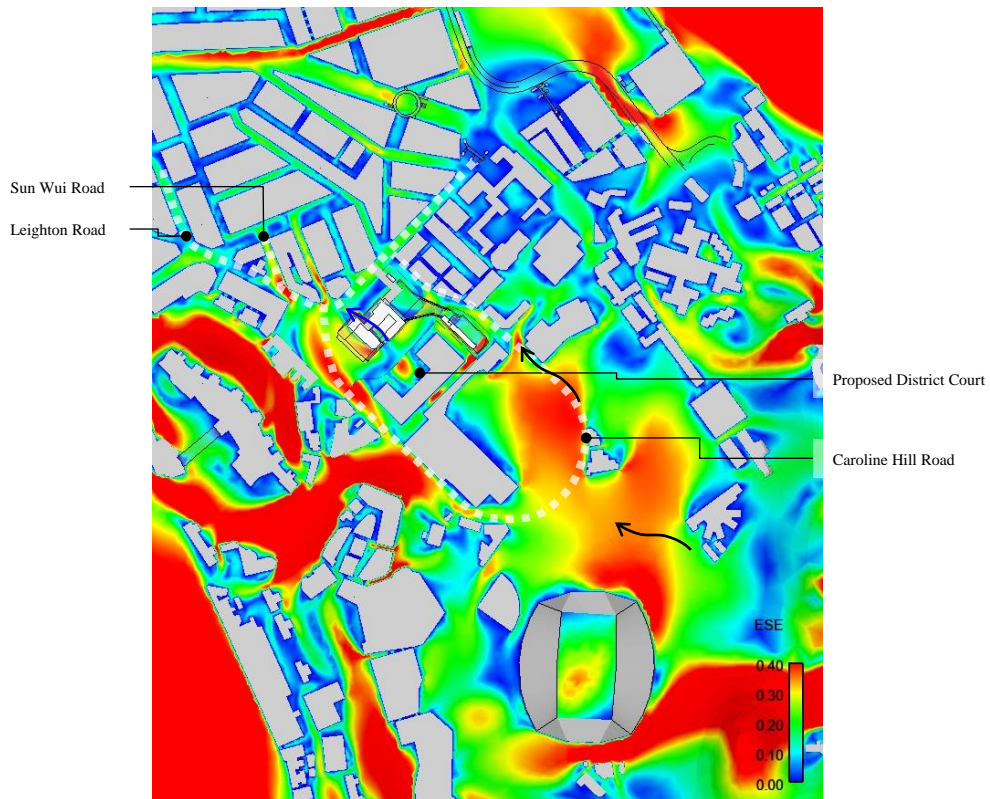


Figure 49 Contour plot of VR of Proposed Scheme under ESE wind

5.3.6 SE Wind

The overall wind performance of Baseline and Proposed Schemes under SE wind is presented in Figure 50 and Figure 51 respectively.

The Application Site is located at the leeward side of South China Stadium and open space provided by recreational area with hilly terrain on further side. Also, T1&T2 are shielded by Proposed District Court. Surrounding wind environment is dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to the hilly terrain and surrounding buildings, incoming wind would be diverted to reach the Application from Caroline Hill Road. Some high-level wind would reach the T3 from prevailing wind direction with relatively low obstruction. The incoming wind direction is illustrated by **Black** arrows Figure 50 and Figure 51 respectively.

Under both Schemes, downwash effect would be observed on T3 and Proposed District Court. Under Baseline Scheme, due to the larger frontal area of T3 more downwashed wind would be induced to ventilate the T3 podium and to further ventilate the streets at the leeward side such as St. Paul's Convent. Slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 50.

Under Proposed Scheme, the enclosed T2-T3 footbridge would divert the incoming wind to the street level, together with the larger building setback of T3 from north-eastern site boundary, slightly higher VR on Access Road within Application Site would be observed, illustrated by **White** arrow in Figure 51.

However, the footbridge would also shield the T2 podium, where slightly lower VR would be observed, illustrated by **White** circle in Figure 51.

Under Proposed Scheme, the larger building setback of T2 allows incoming wind to skim over the T2 podium and ventilate Leighton Road and Sunning Road, where slightly higher VR can be observed, illustrated by **Red** arrow in Figure 51.

Due to the smaller frontal area of T3 under Proposed Scheme, more mid and high level winds would be diverted towards Lok Sing Centre at the far leeward side, and induce more prominent downwash effect to ventilate the Gloucester Road and Yee Wo Street, where slightly higher VR would be observed, illustrated by **Blue** circles in Figure 51.

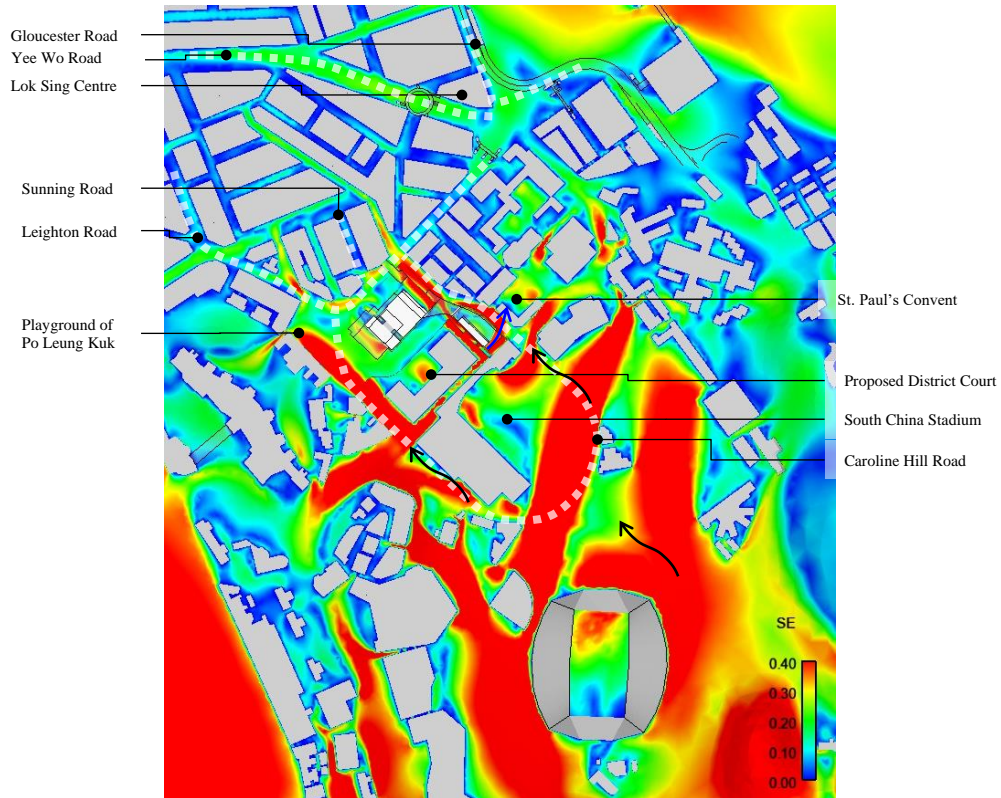


Figure 50 Contour plot of VR of Baseline Scheme under SE wind

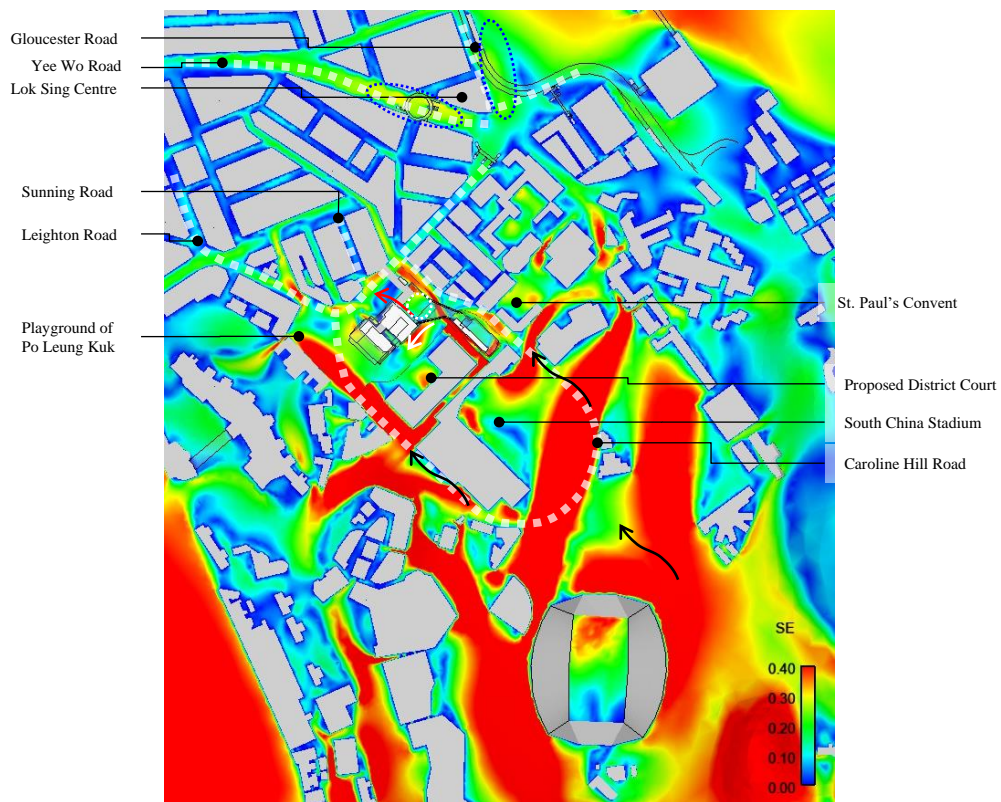


Figure 51 Contour plot of VR of Proposed Scheme under SE wind

5.3.7 SSE Wind

The overall wind performance of Baseline and Proposed Schemes under SSE wind is presented in Figure 52 and Figure 53 respectively.

The Application Site is located at the leeward side of Hong Kong Stadium and hilly terrain on further side. Also, T1&T2 are shielded and T3 are partially shielded by Proposed District Court respectively. Surrounding wind environment is dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to the hilly terrain, incoming wind would reach the Application from Caroline Hill Road. Some high-level wind would skim over the Hong Kong Stadium and open space to reach the T3 from prevailing wind direction. The incoming wind directions are illustrated by **Black** arrows in Figure 52 and Figure 53 respectively.

Under both Schemes, downwash effect would be observed on T3 and Proposed District Court. Under Baseline Scheme, due larger frontal area of T3 more downwashed wind would be induced to ventilate the T3 podium, where slightly higher VR would be observed, illustrated by **Black** circle in Figure 52.

Also, under Baseline Scheme, the larger façade of T2 would divert some high-level towards Access Road within Application Site and Elevated Design of T1 on G/F, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 52.

Under Proposed Scheme, the larger building setback of T2 allows incoming wind to skim over the T2 podium and ventilate the Leighton Road and Yun Ping Road, where slightly higher VR can be observed, illustrated by **Red** arrow in Figure 53.

In addition, the enclosed T2-T3 footbridge would divert the incoming wind to the street level, together with the larger building setback of T3 from north-eastern site boundary, slightly higher VR on Access Road within Application Site and Caroline Hill Road would be observed, illustrated by **White** arrow in Figure 53.

However, the footbridge would also shield the podium of T2 where slightly lower VR would be observed, illustrated by **White** circle in Figure 53.

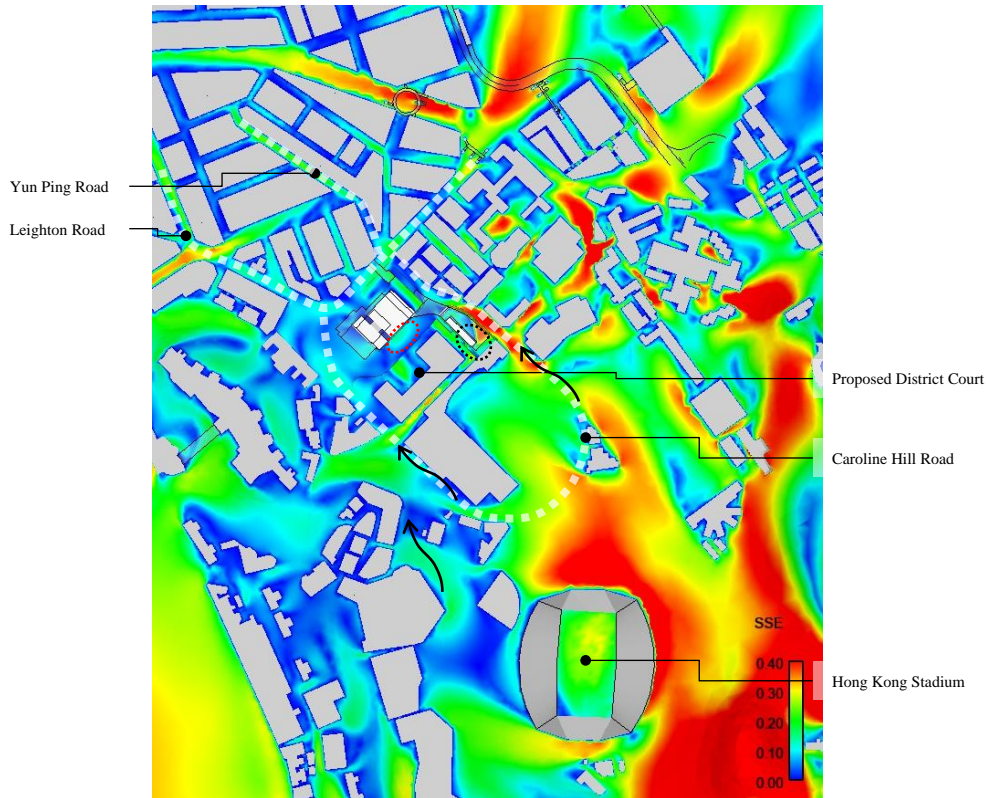


Figure 52 Contour plot of VR of Baseline Scheme under SSE wind

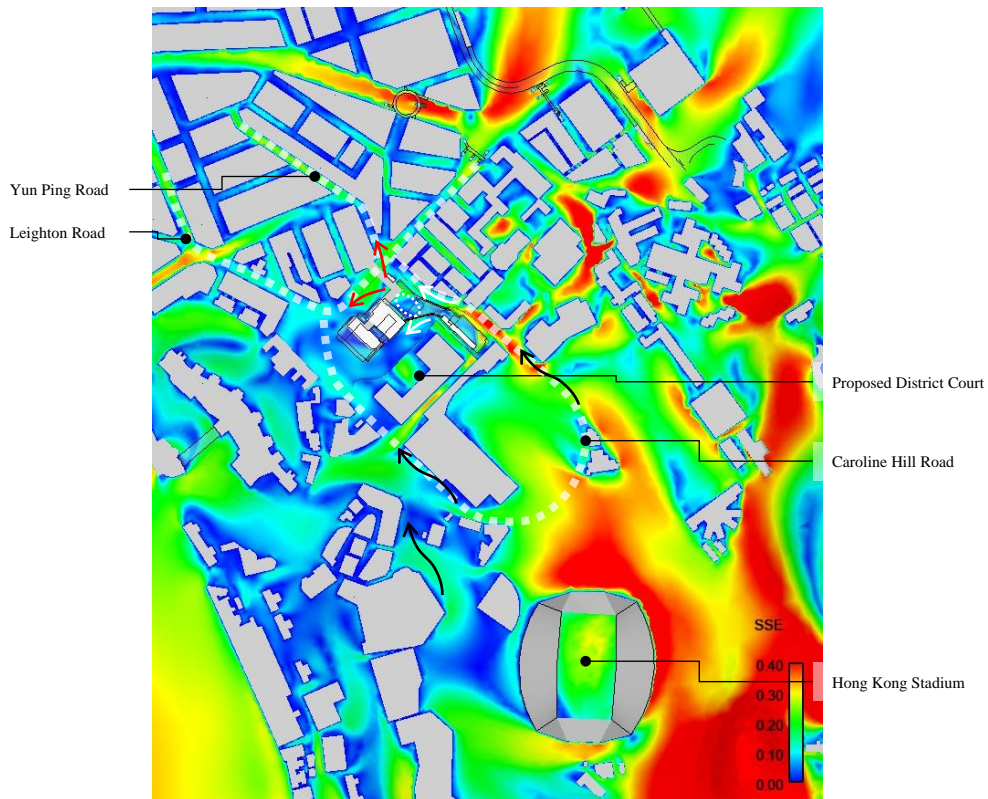


Figure 53 Contour plot of VR of Proposed Scheme under SSE wind

5.3.8 S Wind

The overall wind performance of Baseline and Proposed Schemes under S wind is presented in Figure 54 and Figure 55 respectively.

The Application Site is located at the leeward side Beverly Hill. Also, T1, T2 and T3 are partially shielded by Proposed District Court. Surrounding wind environment is relatively calm and dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to the upwind developments and hilly terrain, incoming wind would be diverted to reach the Application from Caroline Hill Road, Leighton Road and Yun Ping Road. Some high-level wind would flow around Beverly Hill to reach the T3 from prevailing wind direction. The incoming wind directions are illustrated by **Black** arrows Figure 54 and Figure 55 respectively.

Under both Schemes, downwash effect would be observed on T1 and Proposed District Court.

Under both Schemes, incoming wind from northern Caroline Hill Road would recirculate toward the Access Road within Application Site to recover the wind shadow. Under Baseline Scheme, the incoming wind would enter the Access Road within Application Site. While under Proposed Scheme, the enclosed T2-T3 footbridge and larger building setback of T3 from north-eastern site boundary would divert the incoming wind to travel along Caroline Hill Road, where different in ventilation pattern would be observed, illustrated by **Red** arrow in Figure 54 and Figure 55 respectively.

Under Proposed Scheme, due to smaller podium setback of T1 from north-western boundary, incoming wind from Leighton Road would be diverted towards Hoi Ping Road, where slightly higher VR would be observed, illustrated by **White** arrow in Figure 55.

However, it would shield the Caroline Hill Road on the leeward side, where slightly higher VR would be observed, illustrated by **Red** circle in Figure 55.

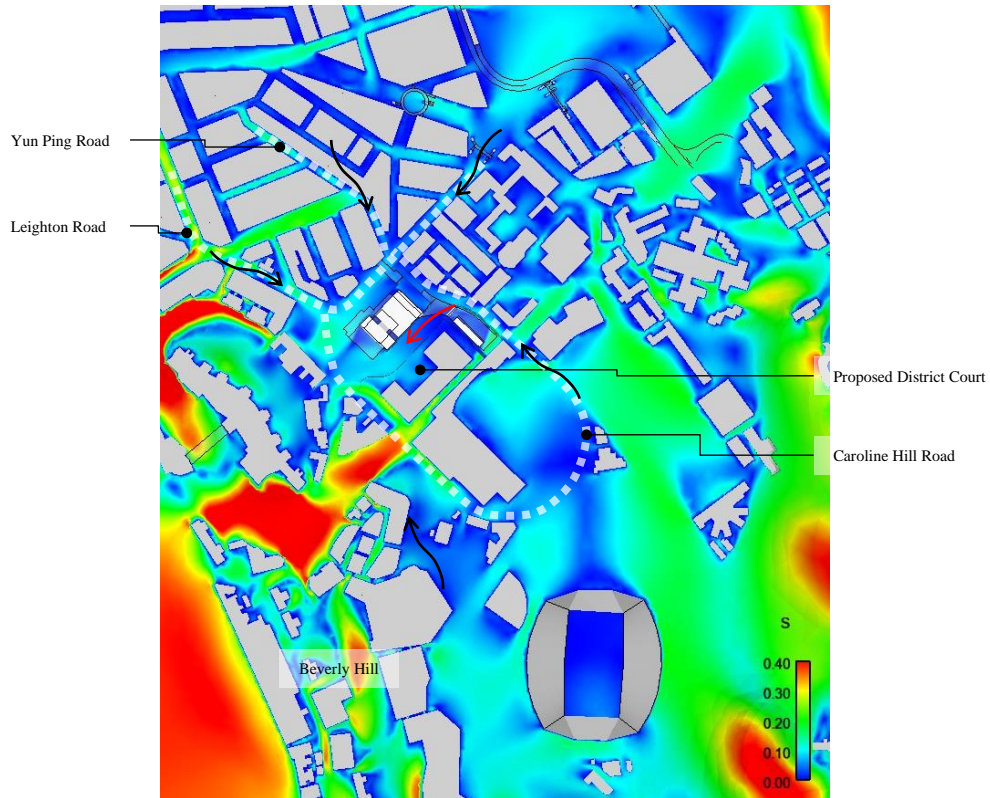


Figure 54 Contour plot of VR of Baseline Scheme under S wind

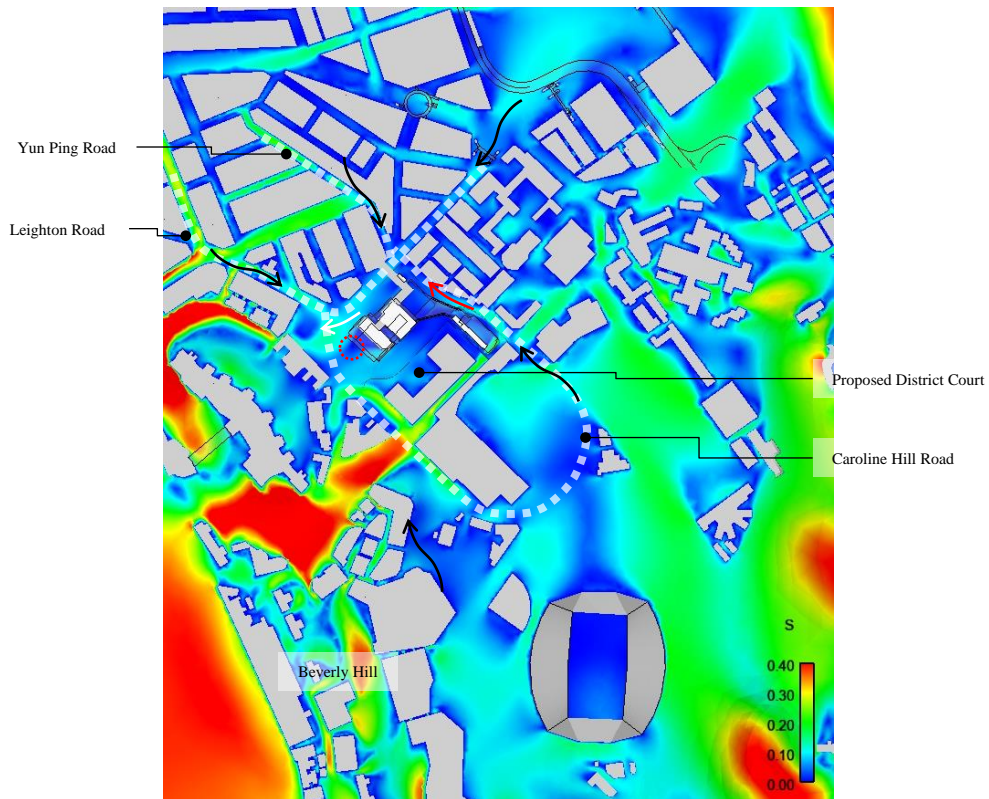


Figure 55 Contour plot of VR of Proposed Scheme under S wind

5.3.9 SSW Wind

The overall wind performance of Baseline and Proposed Schemes under SSW wind is presented in Figure 56 and Figure 57 respectively.

The Application Site is located at the leeward side Beverly Hill. Also, T1, T2 and T3 are partially shielded by Proposed District Court. Surrounding wind environment is relatively calm and dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to the upwind developments and hilly terrain, incoming wind would be diverted to reach the Application from Caroline Hill Road, Leighton Road and Yun Ping Road. Some high-level wind would reach the T3 from prevailing wind direction. The incoming wind directions are illustrated by **Black** arrows Figure 56 and Figure 57 respectively.

Under both Schemes, downwash effect would be observed on T1 and Proposed District Court. Under Baseline Scheme, due to the smaller T3 core, incoming wind from Caroline Hill Road would pass through the T3 podium to ventilate the Proposed District Court podium, where slightly higher VR would be observed, illustrated by **Black** circle in Figure 56.

Under Baseline Scheme, permeable T2-T3 footbridge allows incoming wind to pass through and ventilate the leeward side where slightly higher VR on Caroline Hill Road would be observed, illustrated by **Red** arrow in Figure 56.

Under Proposed Scheme, larger building setback of T3 from north-eastern site boundary and larger T3 core channel more incoming wind from Caroline Hill Road into enclosed T2-T3 footbridge to ventilate T2 podium, where slightly lower VR would be observed, illustrated by **Red** arrow in Figure 57.

In addition, Internal Street of T1 on G/F and protruded T2 podium would divert incoming wind to flow from Access Road within Application Site to north-western site boundary, where slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 57.

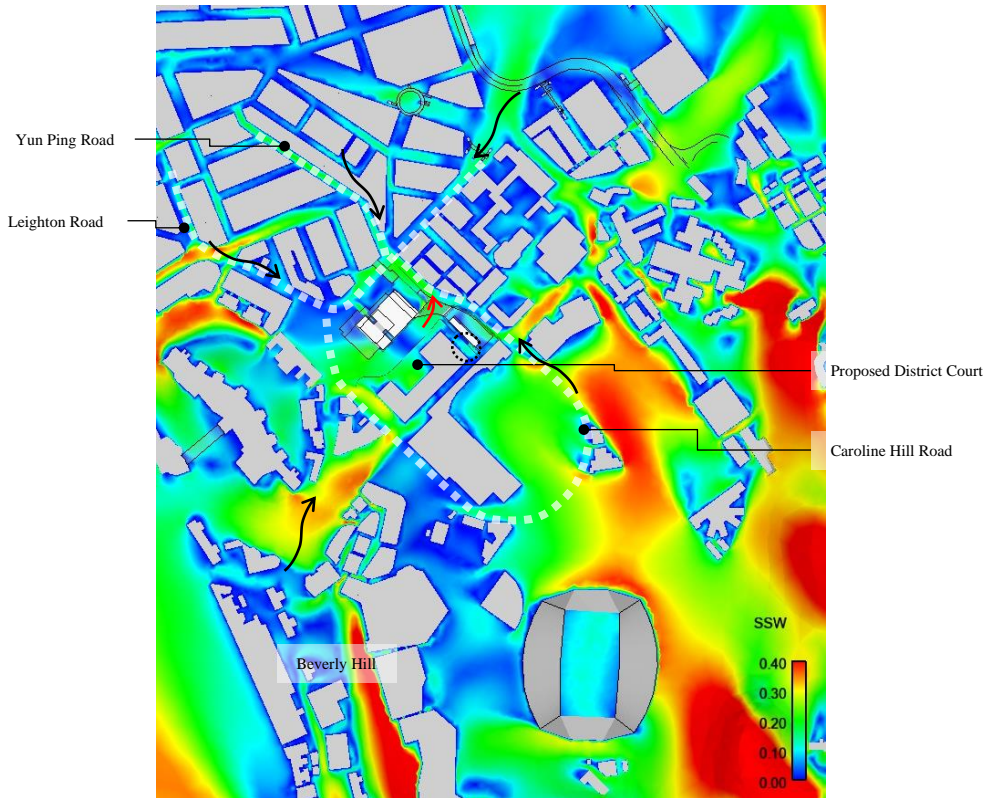


Figure 56 Contour plot of VR of Baseline Scheme under SSW wind

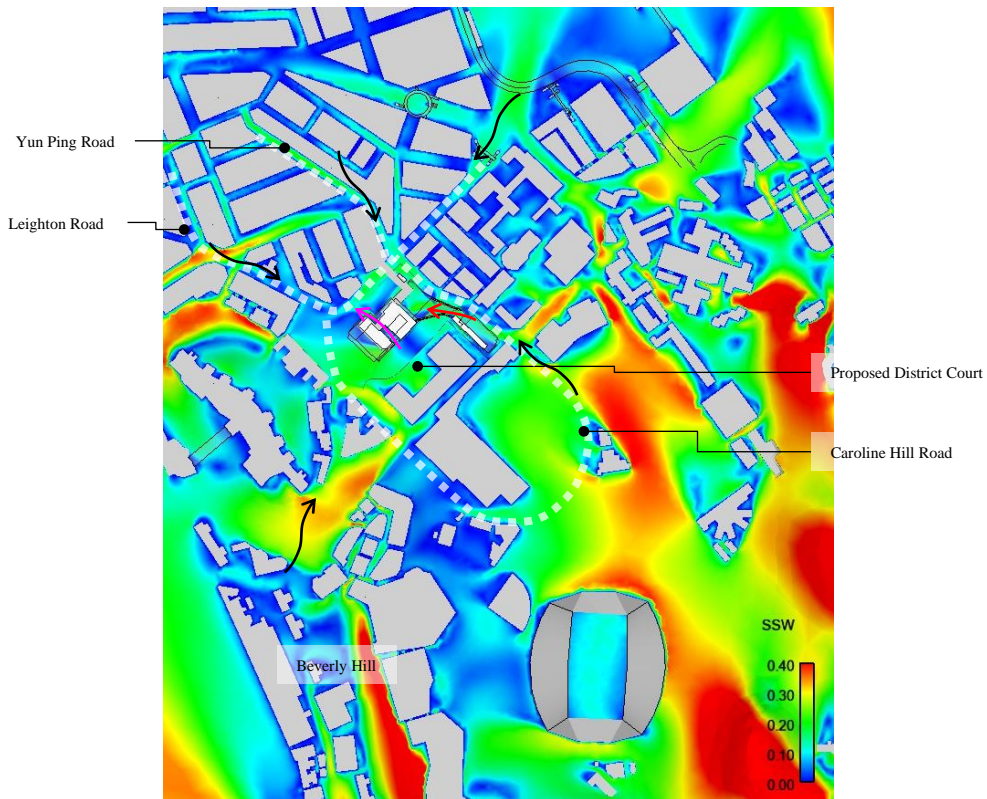


Figure 57 Contour plot of VR of Proposed Scheme under SSW wind

5.3.10 SW Wind

The overall wind performance of Baseline and Proposed Schemes under SW wind is presented in Figure 58 and Figure 59 respectively.

The Application Site is located at the leeward side of density built mid to high-rise developments at higher elevation. T1 and T2 are shielded by The Leighton Hill, while T3 is shielded by Proposed District Court. Surrounding wind environment is dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to the upwind developments and hilly terrain, incoming wind would be diverted to reach the application site from Leighton Road, Hoi Ping Road, Sunning Road, Yun Ping Road and Caroline Hill Road. Some high-level wind would skim over the mid-rise buildings to reach the T1 from prevailing wind direction. The incoming wind directions are illustrated by **Black** arrows in Figure 58 and Figure 59 respectively.

Under both Schemes, downwash effect would be observed on Proposed District Court. Under Baseline Scheme, due to the smaller T3 core the downwashed wind from Proposed District Cour would travel towards T3 podium, where slightly higher VR would be observed, illustrated by **Black** circle in Figure 58.

However, the air stream would continue to travel towards St. Paul's Convent and limit the incoming wind from Cotton Path, where slightly lower VR would be observed, illustrated by **Red** circle in Figure 58.

On other hand, under Proposed Scheme, due to less prominent air stream traveling from Proposed District Court to T3 podium, together with larger building setback of T3 from north-eastern site boundary, more incoming wind from Caroline Hill Road would reach the T3 podium, where slightly lower VR would be observed, illustrated by **Purple** circle in Figure 59.

Under Baseline Scheme, mid-level incoming wind from Yun Ping Road and Pennington Street would flow through the T2-T3 footbridge and ventilate the Access Road within Application Site, where slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 58.

Under both Scheme, incoming wind from Yun Ping Road and Pennington Street would travel along north-western site boundary. Under Baseline Scheme, due to larger setback of T1 podium from north-western site boundary, the incoming wind would continue to travel to ventilate the Elevated Design of T1 on G/F. While under Proposed Scheme, Internal Street of T1 on G/F and protruded T1 podium would divert incoming wind towards Access Road within Application Site. Where different in ventilation pattern would be observed, illustrated by **Red** arrow in Figure 58 and Figure 59 respectively.

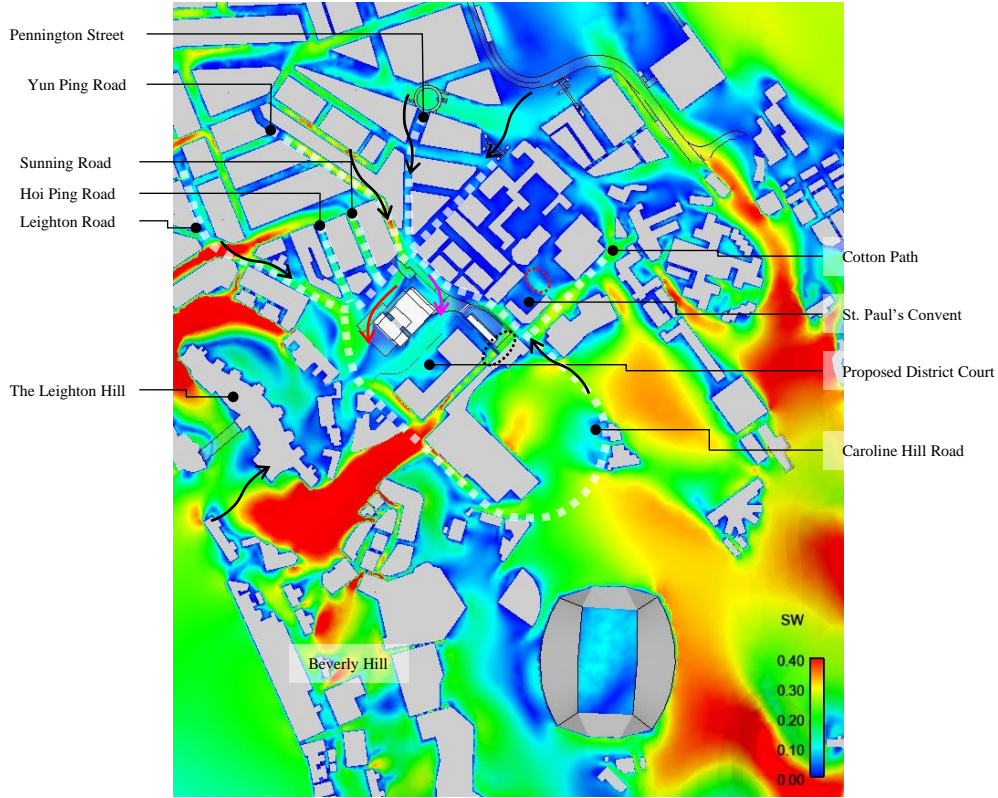


Figure 58 Contour plot of VR of Baseline Scheme under SW wind

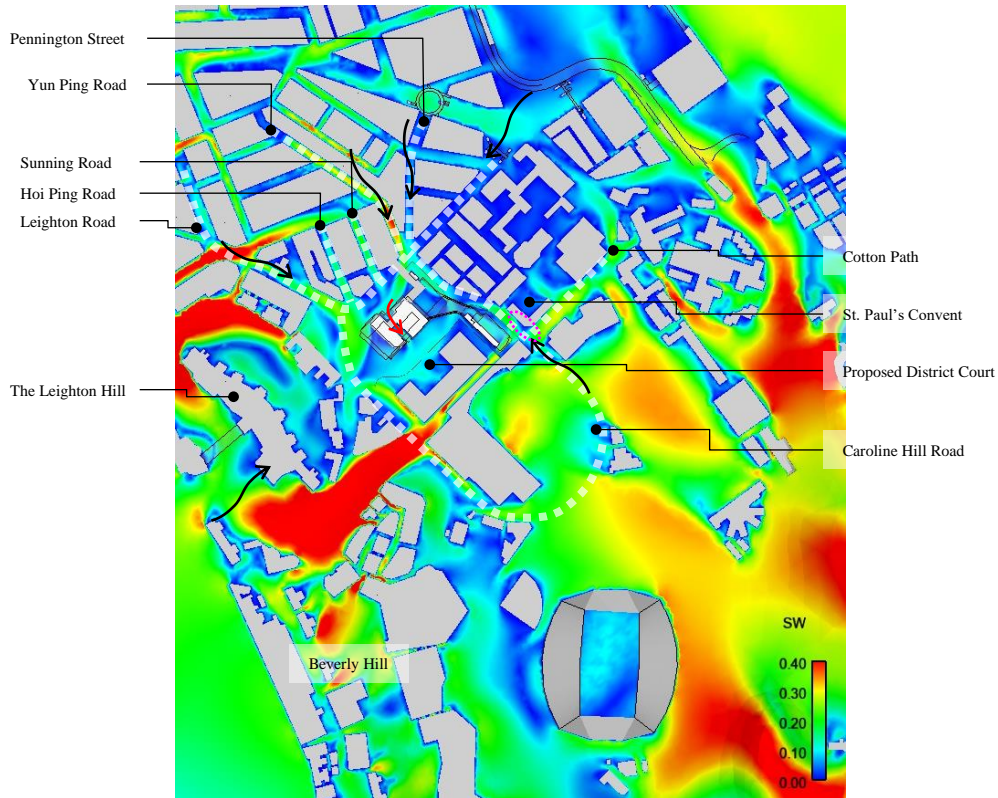


Figure 59 Contour plot of VR of Proposed Scheme under SW wind

5.3.11 WSW Wind

The overall wind performance of Baseline and Proposed Schemes under WSW wind is presented in Figure 60 and Figure 61 respectively.

The Application Site is located at the leeward side of density built mid to high-rise developments at higher elevation. T1 and T2 are shielded by The Leighton Hill, while T3 is shielded by Proposed District Court. Surrounding wind environment is dominated by upwind developments and hilly terrain, except for some localized difference around the Application Site.

Due to the upwind developments and hilly terrain, incoming wind would be diverted to reach the application site from Leighton Road, Hoi Ping Road, Sunning Road, Yun Ping Road, Pennington Street and Caroline Hill Road. The incoming wind directions are illustrated by **Black** arrows in Figure 60 and Figure 61 respectively.

Under Baseline Scheme, the incoming wind traveling along the building separation between Proposed District Court and South China Stadium would continue to ventilate the T3 podium due smaller T3 core, where slightly higher VR would be observed, illustrated by **Black** circle in Figure 60.

Under Baseline Scheme, mid-level incoming wind from Yun Ping Road and Pennington Street would flow through the T2-T3 footbridge and ventilate the Access Road within Application Site, where slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 60.

Under Proposed Scheme, the incoming wind from Yun Ping Road and Pennington Street would be channelled by the enclosed T2-T3 footbridge to ventilate the podium of T3 where slightly higher VR would be observed, illustrated by **Purple** arrow in Figure 61.

Under Proposed Scheme, due to the wider separation of Internal Street of T1 on G/F, more incoming wind from Leighton Road, Hoi Ping Road and Sunning Road would enter to ventilate the Access Road within the Application Site, where slightly higher VR would be observed, illustrated by **Red** arrow in Figure 61.

Under Proposed Scheme, less setback of T1 podium from north-western site boundary, the incoming wind from Hoi Ping Road would be limited towards the Elevated Design of T1 on G/F and Caroline Hill Road, where slightly lower VR would be observed, illustrated by **Black** circle in Figure 61.

However, more wind would be diverted towards the Caroline Hill Road where slightly higher VR would be observed, illustrated by **Blue** arrow in Figure 61.

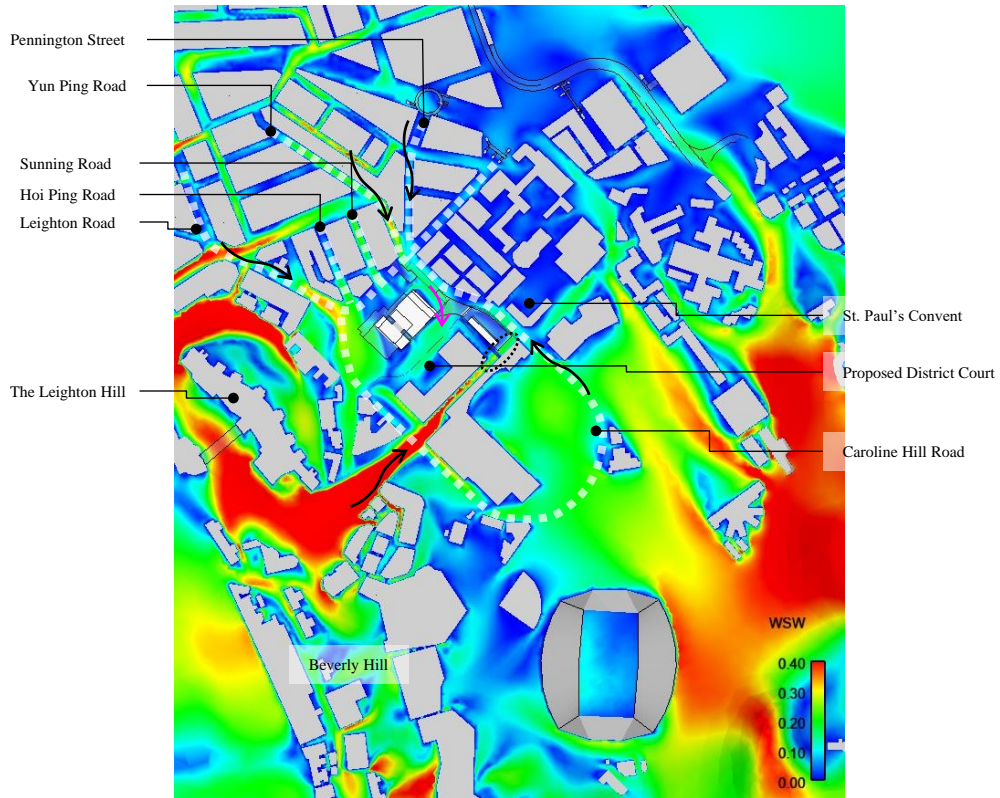


Figure 60 Contour plot of VR of Baseline Scheme under WSW wind

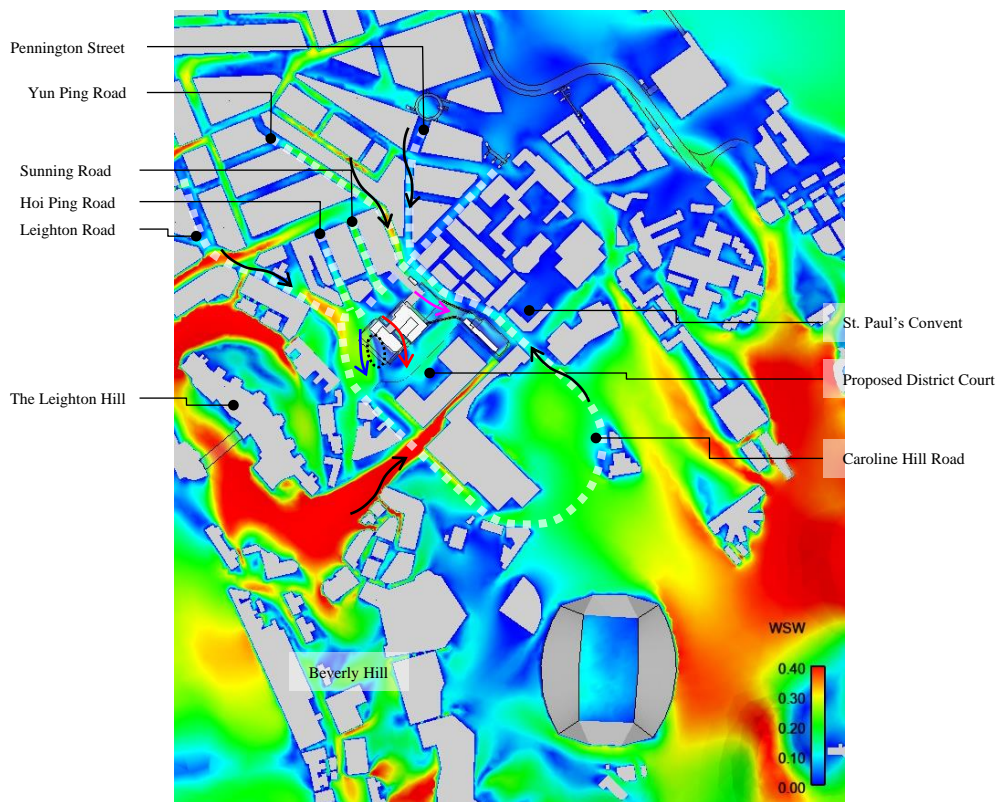


Figure 61 Contour plot of VR of Proposed Scheme under WSW wind

5.3.12 SVR and LVR

The average Velocity Ratios of all test points are determined and extracted. The results of all test points are presented in Appendix E. According to the *AVA Technical Circular*, the Velocity Ratio (VR) at each test point is assessed and the SVR and the LVR under the annual and summer conditions are determined and reported to assess the impact of Proposed Scheme to the wind environment, comparing Baseline Scheme. The SVR and LVR value of the test points are summarized as follows:

Table 7 Annual SVR and LVR for Baseline and Proposed Schemes

	Baseline Scheme	Proposed Scheme
SVR	0.16	0.15
LVR	0.19	0.19

Table 8 Summer SVR and LVR for Baseline and Proposed Schemes

	Baseline Scheme	Proposed Scheme
SVR	0.14	0.14
LVR	0.18	0.18

The result indicates that, due to the densely built-up area and hilly terrain in surrounding areas, both Scheme would achieve similar ventilation performance along the Application Site boundary and in the Surrounding Area, under annual and summer conditions.

5.4 Focus Areas

Within the Assessment Area and Application Site given in Figure 19 to Figure 21 respectively, a total of 51 focus areas are proposed. The associated test points and averaged VR for focus areas are tabulated in Table 9.

Table 9 Focus Areas and Corresponding Test Points

	Focus Area	Annual Condition		Summer Condition	
		Baseline	Proposed	Baseline	Proposed
1	Yee Wo Street	0.23	0.23	0.18	0.18
2	Fung Un Street	0.11	0.11	0.10	0.10
3	Jardine's Bazaar	0.21	0.21	0.13	0.13
4	Jardine's Crescent	0.12	0.12	0.14	0.14
5	Yun Ping Road	0.19	0.19	0.20	0.20
6	Lan Fong Road	0.17	0.17	0.13	0.13
7	Lee Garden Road	0.10	0.10	0.14	0.14
8	Hysan Avenue	0.15	0.15	0.20	0.20
9	Sun Wui Road	0.13	0.13	0.17	0.17
10	Hoi Ping Road	0.13	0.14	0.14	0.14
11	Leighton Lane	0.18	0.18	0.21	0.21
12	Sunning Road	0.12	0.13	0.12	0.13
13	Playground of Po Leung Kuk	0.13	0.13	0.12	0.12
14	Leighton Hill Road	0.30	0.30	0.22	0.22

15	Link Road	0.27	0.27	0.27	0.27
16	Elevated Road to Beverly Hill	0.35	0.35	0.30	0.30
17	Happy View Terrace	0.20	0.20	0.21	0.21
18	Broadwood Road	0.42	0.42	0.39	0.39
19	Rest Garden on Broadwood Road	0.11	0.11	0.17	0.17
20	Road south of Beverly Hill	0.30	0.30	0.29	0.29
21	Confucius Hall Secondary School	0.26	0.26	0.15	0.15
22	Stadium Path	0.21	0.21	0.17	0.17
23	Hong Kong Stadium	0.28	0.28	0.23	0.23
24	Eastern Hospital Road Sitting-out Area 1	0.28	0.28	0.28	0.28
25	Easter Hospital Road	0.21	0.21	0.26	0.26
26	Tung Wah Eastern Hospital	0.11	0.11	0.14	0.14
27	Indian Recreation Club	0.27	0.27	0.30	0.30
28	Caroline Hill Road	0.20	0.19	0.20	0.19
29	Eastern Hospital Road Sitting-out Area 2	0.13	0.13	0.18	0.18
30	South China Stadium	0.18	0.18	0.20	0.20
31	So Kon Po Recreation Ground	0.22	0.22	0.27	0.27
32	Proposed District Court	0.21	0.21	0.23	0.23
33	Sir Ellis Kadoorie (S) Primary School	0.12	0.12	0.15	0.15
34	Disciplined Services Sports and Recreational Club	0.19	0.19	0.26	0.26
35	Ka Ning Path Rest Garden	0.22	0.22	0.18	0.18
36	Cotton Path Road	0.16	0.16	0.21	0.21
37	St. Paul's Convent	0.09	0.08	0.09	0.09
38	Ka Ning Road	0.12	0.12	0.17	0.17
39	Haven Street	0.12	0.12	0.08	0.08
40	St. Paul's Hospital	0.13	0.13	0.09	0.09
41	St. Paul's Convent School	0.08	0.08	0.07	0.07
42	Leighton Road	0.16	0.16	0.13	0.14
43	Keswick Street	0.13	0.13	0.09	0.09
44	Pennington Street	0.13	0.13	0.09	0.09
45	Irvine Street	0.17	0.17	0.10	0.10
46	Internal Street of T1 on G/F	0.14	0.12	0.13	0.12
47	Elevated Design of T1 on G/F	0.09	0.12	0.13	0.11
48	Access Road within Application Site	0.15	0.14	0.12	0.12
49	Open Space of T1&2 on G/F	0.19	0.19	0.20	0.20
50	Open Space of T2 on Podium Level	0.15	0.15	0.17	0.17
51	Elevated Design of T3 on Podium Level	0.15	0.15	0.19	0.19

Annual Condition

Under annual condition, the prevailing wind are mostly from E quadrant.

Under Baseline Scheme, due to the larger frontal area of T2 and T3, more prominent downwash effect would be induced to ventilate the podium and street level such as ***Caroline Hill Road, St. Paul's Convent, Access Road within Application Site and Internal Road of T1 on G/F.***

While under Proposed Scheme, the enclosed T2-T3 footbridge would also divert some incoming wind to ventilate the street level such as ***Elevated Design of T1 on G/F.***

Under Proposed Scheme, the larger building setback of T2 allows more incoming wind to skim over the T2 podium, and ventilate the leeward side including ***Hoi Ping Road and Sunning Road.***

Summer Condition

Under summer condition, the prevailing winds are mostly from SW quadrant.

Under Proposed Scheme, the larger building setback of T2 enhanced the wind permeability, more incoming wind would pass through and further skim over T2 podium and ventilate the leeward side such as ***Sunning Road and Leighton Road.***

Under Baseline Scheme, incoming wind from Yun Ping Road and Pennington Street would flow along the north-eastern site boundary to ventilate the leeward side including ***Caroline Hill Road, Internal Road of T1 on G/F and Elevated Design of T1 on G/F***

6 Conclusion

An Air Ventilation Assessment (AVA) – Initial Study was conducted to assess the ventilation performance of Baseline Scheme and Proposed Scheme in accordance to *the AVA Technical Circular*.

Two schemes were assessed using Computational Fluid Dynamics (CFD) techniques. A series CFD simulation using Realizable k- ϵ turbulence model were performed under annual and summer wind conditions with reference to *the AVA Technical Circular*. For annual wind condition, NNE, NE, ENE, E, ESE, S, SSW and SW were selected which gives total wind frequency of 78.5% over a year while E, ESE, SE, SSE, S, SSW, SW and WSW were selected for summer condition, which gives total wind frequency of 80.6%.

The Velocity Ratio (VR) as proposed by *the AVA Technical Circular* was employed to assess the ventilation performance under different schemes and its impact to the surroundings.

With reference to *the AVA Technical Circular*, 42 perimeter test points and 198 overall test points and 28 special test points were allocated to assess the ventilation performance in the Application Site and Assessment Area.

The simulation results show the Proposed Scheme would achieve similar ventilation performance as Baseline along the Application Site boundary and in the Surrounding Area under both annual and summer conditions. Also, the surrounding wind environment are dominated by densely built-up area of Causeway Bay and hilly terrain at the southern side.

Major wind enhancement features are maintained with similar performance as Baseline Scheme including:

- #1. T1 – 15m (W) x 8.5m (H) elevated design of T1 on G/F, and
- #3. T3 – Approximately 18m (W) x 10m (H) on average elevated design of T3 on podium level, and
- #4: T1 – Building setback of approximate 5m on average from the south-western boundary, and
- #5: T2 – Building setback of 4m at grade from north-eastern boundary, and
- #6: T3 – Building setback of 7.5m above 2F from the south-western boundary abutting the district court site.
- #7: T1 – Min. 6m internal street of T1 on G/F.

Although the enclosed T2-T3 footbridge reduced the permeability across the Application Site, following major wind enhancement feature improved wind permeability across T2 podium to mitigate the ventilation impact:

- #2. 36m building setback from north-eastern site boundary above 2/F

7 Reference

- [1] Annex A of Technical Circular No. 1/06 issued by the Housing, Planning and Lands Bureau pertaining specifically to Air Ventilation Assessments, 19th July, 2006

(https://www.devb.gov.hk/filemanager/en/content_679/hplb-etwb-tc-01-06.pdf)

- [2] Planning Department RAMS Data
(http://www.pland.gov.hk/pland_en/info_serv/site_wind/site_wind/)

- [3] AVA Report for PLNQ B-1/AVA 2015
(https://www.pland.gov.hk/pland_en/info_serv/ava_register/ProjInfo/AVR_G142_AVA_FinalReport.pdf)

Appendix A

Layout Plans of Baseline, Proposed Schemes

A1 Layout Plan of Baseline Scheme

LEGEND

	APPLICATION SITE
	PINK HATCHED BLUE NO STRUCTURE ERECTED ABOVE OR WITHIN 4M BELOW GROUND LEVEL
	PUBLIC OPEN SPACE
	PUBLIC OPEN SPACE (COVERED)
	COMMERCIAL/E&M
	G.I.C. FACILITIES
	G.I.C. FACILITIES (PERFORMING ARTS & CULTURAL FACILITIES)
	FUTURE FOOTBRIDGE
	LIGHT BUSES LAYBYS
	CARPARK (PVP)
	CARPARK (PRIVATE)
	CARPARK (G.I.C. FACILITIES)
	ACCESS ROAD
	LOADING/UNLOADING
	UNEXCAVATED
	24-HR COVERED PEDESTRIAN WALKWAY
	PEDESTRIAN LINK



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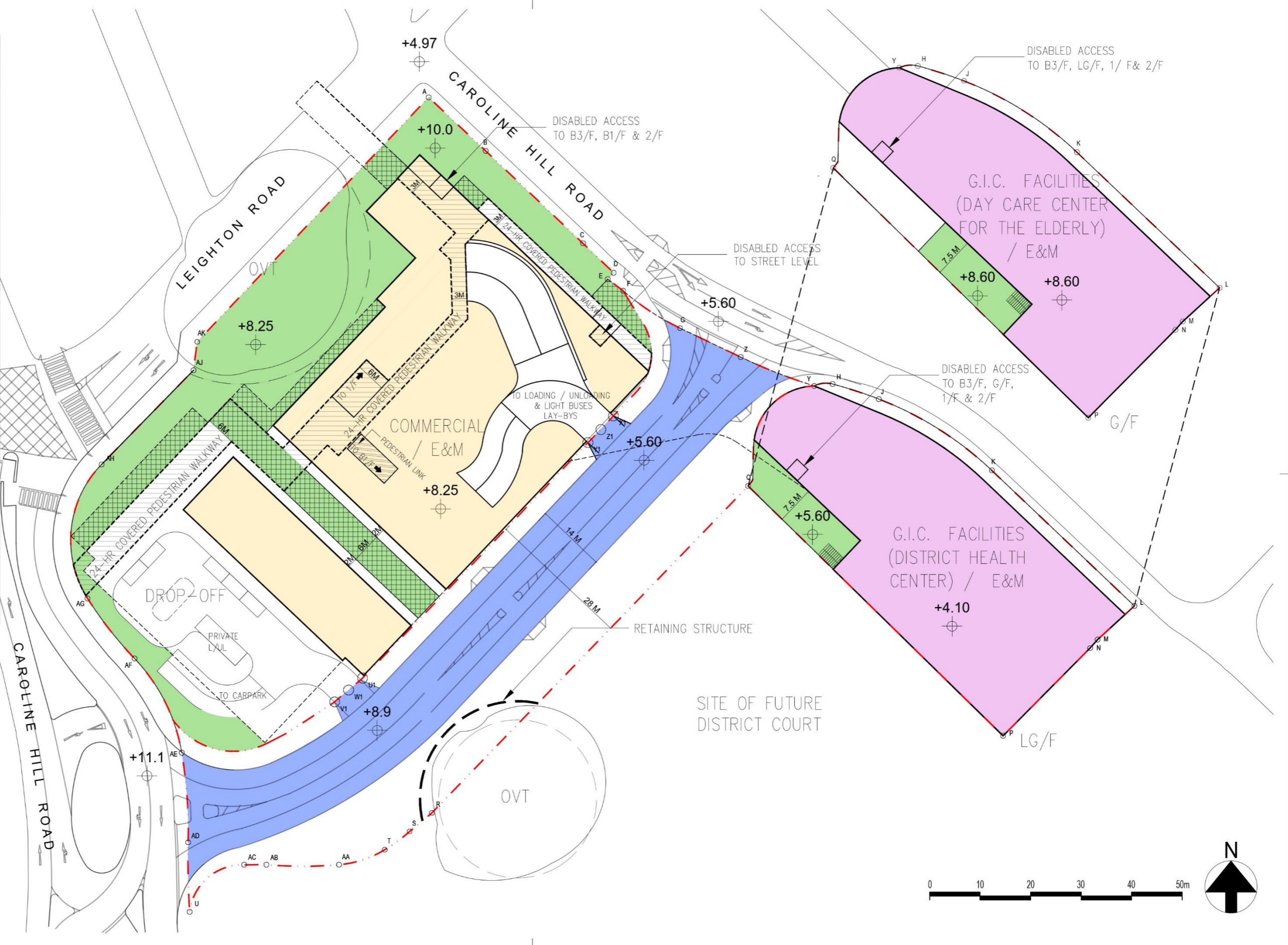
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Drawing Title	LAYOUT PLAN (ALL LEVELS)
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	MAR 2022
Drawing No.	MLP-001

Drawing Purpose

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- PUBLIC OPEN SPACE
(COVERED)
- COMMERCIAL/E&M
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- G.I.C. FACILITIES
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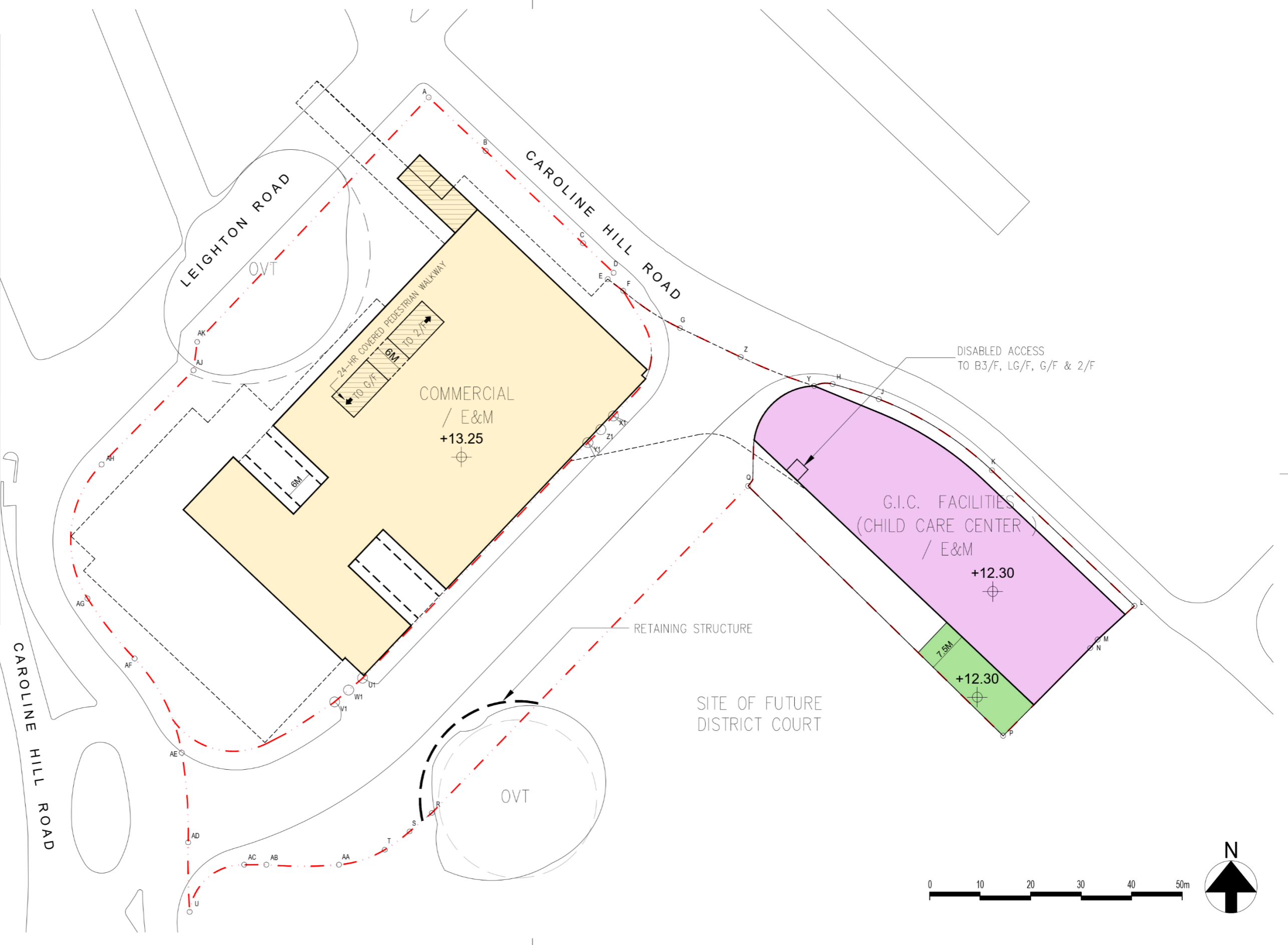
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Project No. 21105HK
Scale 1:750 (A3) Issue Date MAR 2022
Drawing No. MLP-006

Drawing Purpose

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- PUBLIC OPEN SPACE
(COVERED)
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- ACCESS ROAD
- LOADING/UNLOADING
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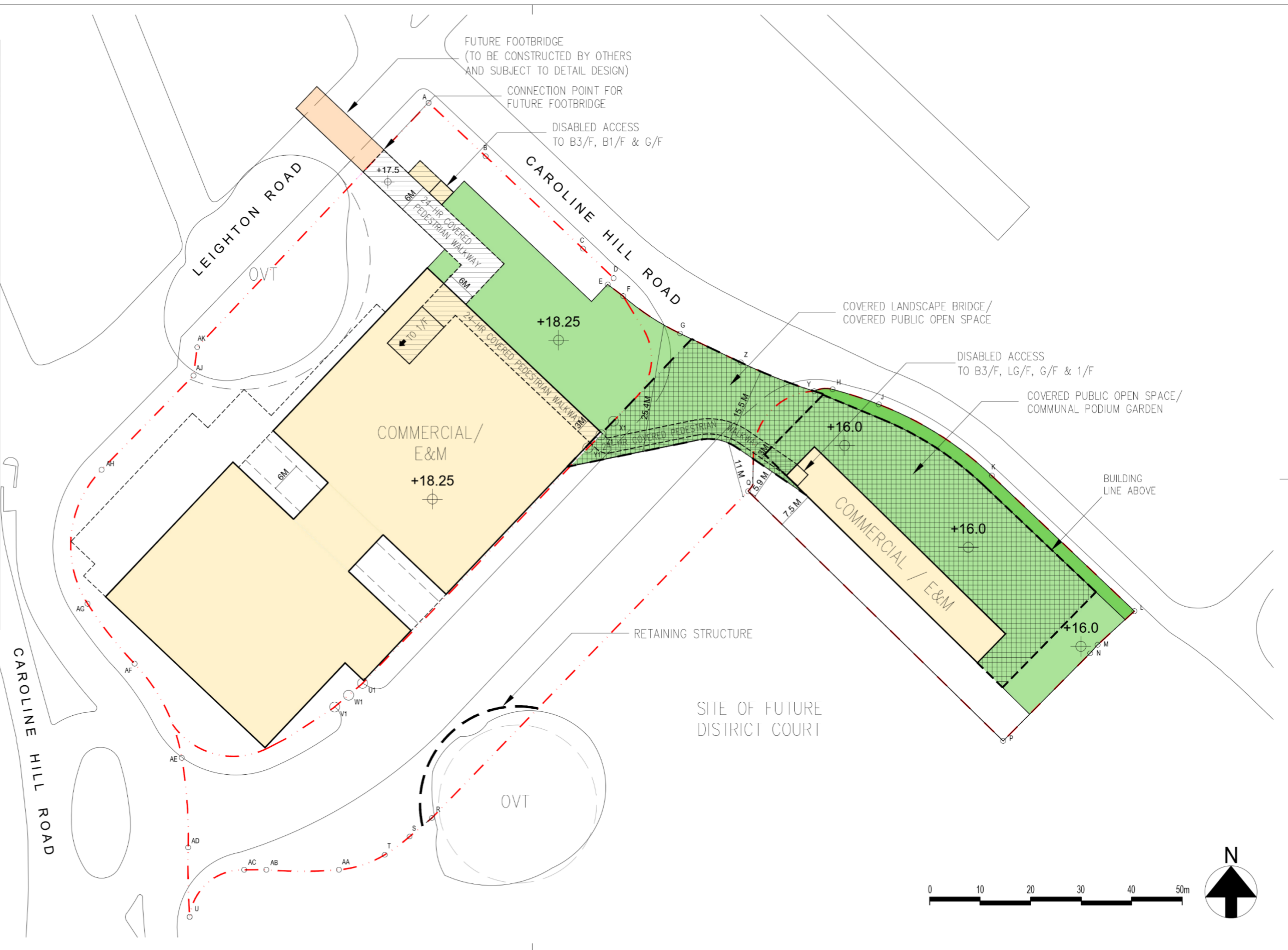
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Drawing Title	FIRST FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	MAR 2022
Drawing No.	MLP-007

Drawing Purpose

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	PUBLIC OPEN SPACE (COVERED)
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	G.I.C. FACILITIES (PERFORMING ARTS & CULTURAL FACILITIES)
	FUTURE FOOTBRIDGE
	LIGHT BUSES LAYBYS
	CARPARK (PVP)
	CARPARK (PRIVATE)
	CARPARK (G.I.C. FACILITIES)
	ACCESS ROAD
	LOADING/UNLOADING
	UNEXCAVATED
	24-HR COVERED PEDESTRIAN WALKWAY
	PEDESTRIAN LINK



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
















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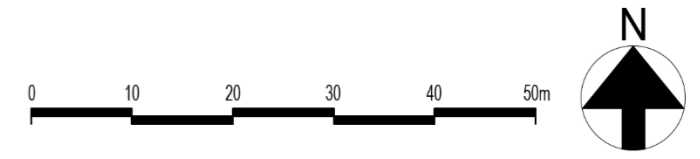
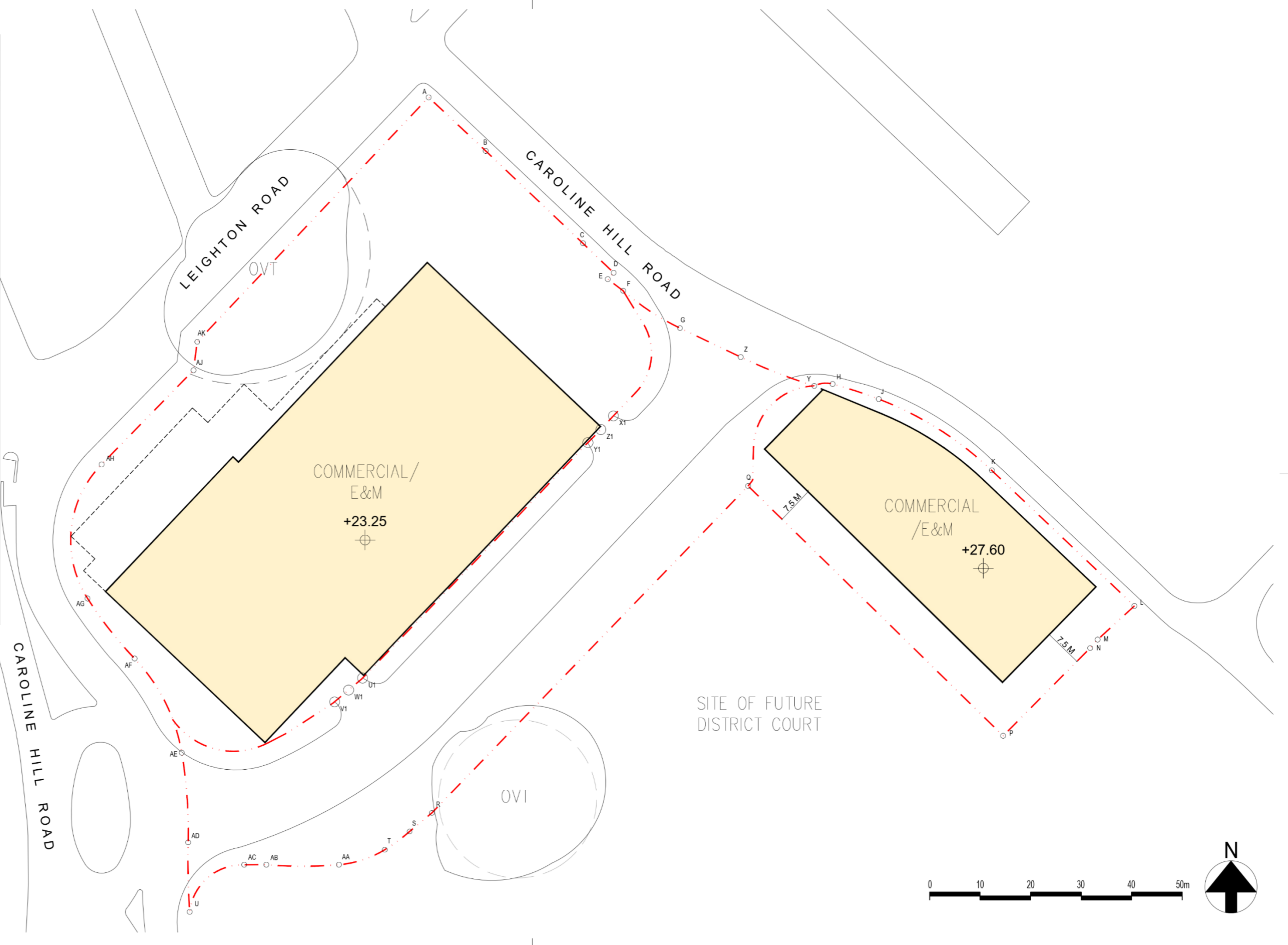
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Scale	1:750 (A3)
Issue Date	MAR 2022
Drawing No.	MLP-008

Drawing Purpose

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WITHIN 4M BELOW GROUND LEVEL
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-  PUBLIC OPEN SPACE
(COVERED)
-  COMMERCIAL/E&M
-  G.I.C. FACILITIES
-  G.I.C. FACILITIES
(PERFORMING ARTS &
CULTURAL FACILITIES)
-  FUTURE FOOTBRIDGE
-  LIGHT BUSES LAYBYS
-  CARPARK (PVP)
-  CARPARK (PRIVATE)
-  CARPARK
(G.I.C. FACILITIES)
-  ACCESS ROAD
-  LOADING/UNLOADING
-  UNEXCAVATED
-  24-HR COVERED
PEDESTRIAN WALKWAY
-  PEDESTRIAN LINK



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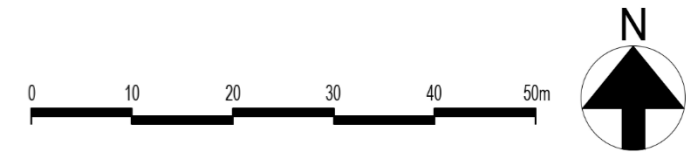
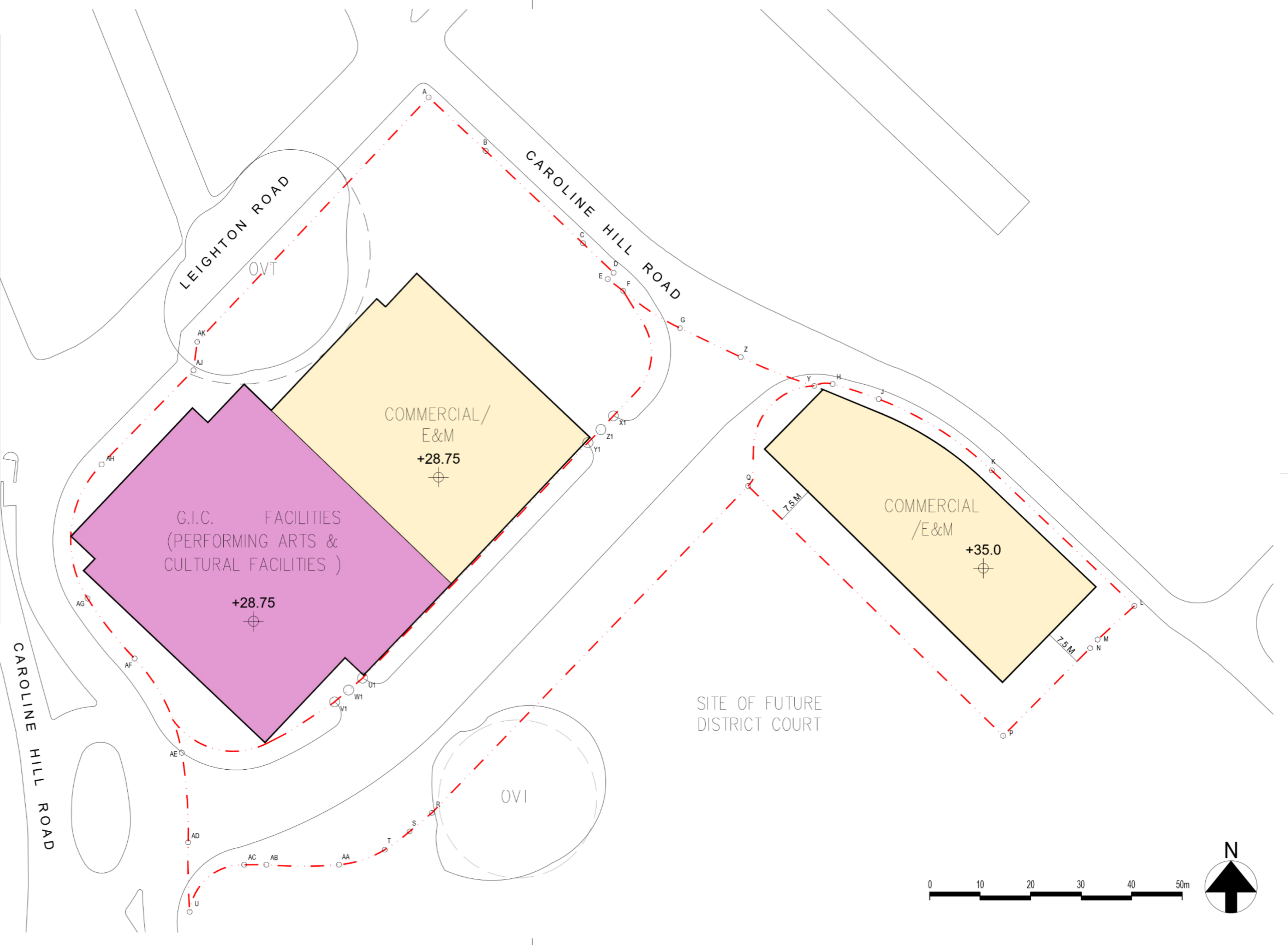
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Issue Date	MAR 2022
Drawing No.	MLP-009

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	PUBLIC OPEN SPACE (COVERED)
	COMMERCIAL/E&M
	G.I.C. FACILITIES
	G.I.C. FACILITIES (PERFORMING ARTS & CULTURAL FACILITIES)
	FUTURE FOOTBRIDGE
	LIGHT BUSES LAYBYS
	CARPARK (PVP)
	CARPARK (PRIVATE)
	CARPARK (G.I.C. FACILITIES)
	ACCESS ROAD
	LOADING/UNLOADING
	UNEXCAVATED
	24-HR COVERED PEDESTRIAN WALKWAY
	PEDESTRIAN LINK



Rev.	Description	Drawn	Checked	Approved	Date
1	11st SUBMISSION				13-2022

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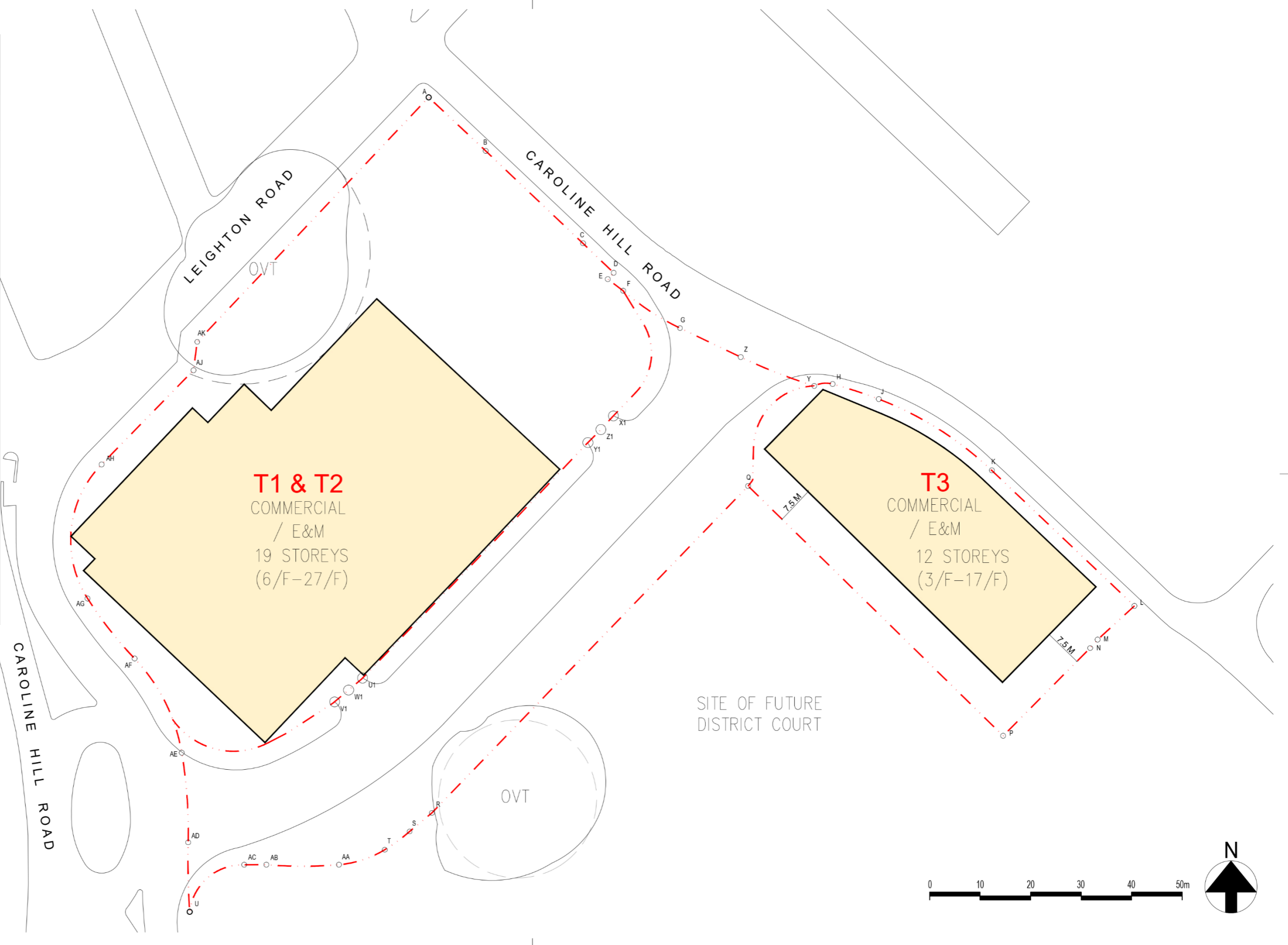
Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	FIFTH FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	MAR 2022
Drawing No.	MLP-010

Drawing Purpose

LEGEND

	APPLICATION SITE
	PINK HATCHED BLUE NO STRUCTURE ERECTED ABOVE OR WITHIN 4M BELOW GROUND LEVEL
	PUBLIC OPEN SPACE
	PUBLIC OPEN SPACE (COVERED)
	COMMERCIAL/E&M
	G.I.C. FACILITIES
	G.I.C. FACILITIES (PERFORMING ARTS & CULTURAL FACILITIES)
	FUTURE FOOTBRIDGE
	LIGHT BUSES LAYBYS
	CARPARK (PVP)
	CARPARK (PRIVATE)
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	ACCESS ROAD
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	UNEXCAVATED
	24-HR COVERED PEDESTRIAN WALKWAY
	PEDESTRIAN LINK



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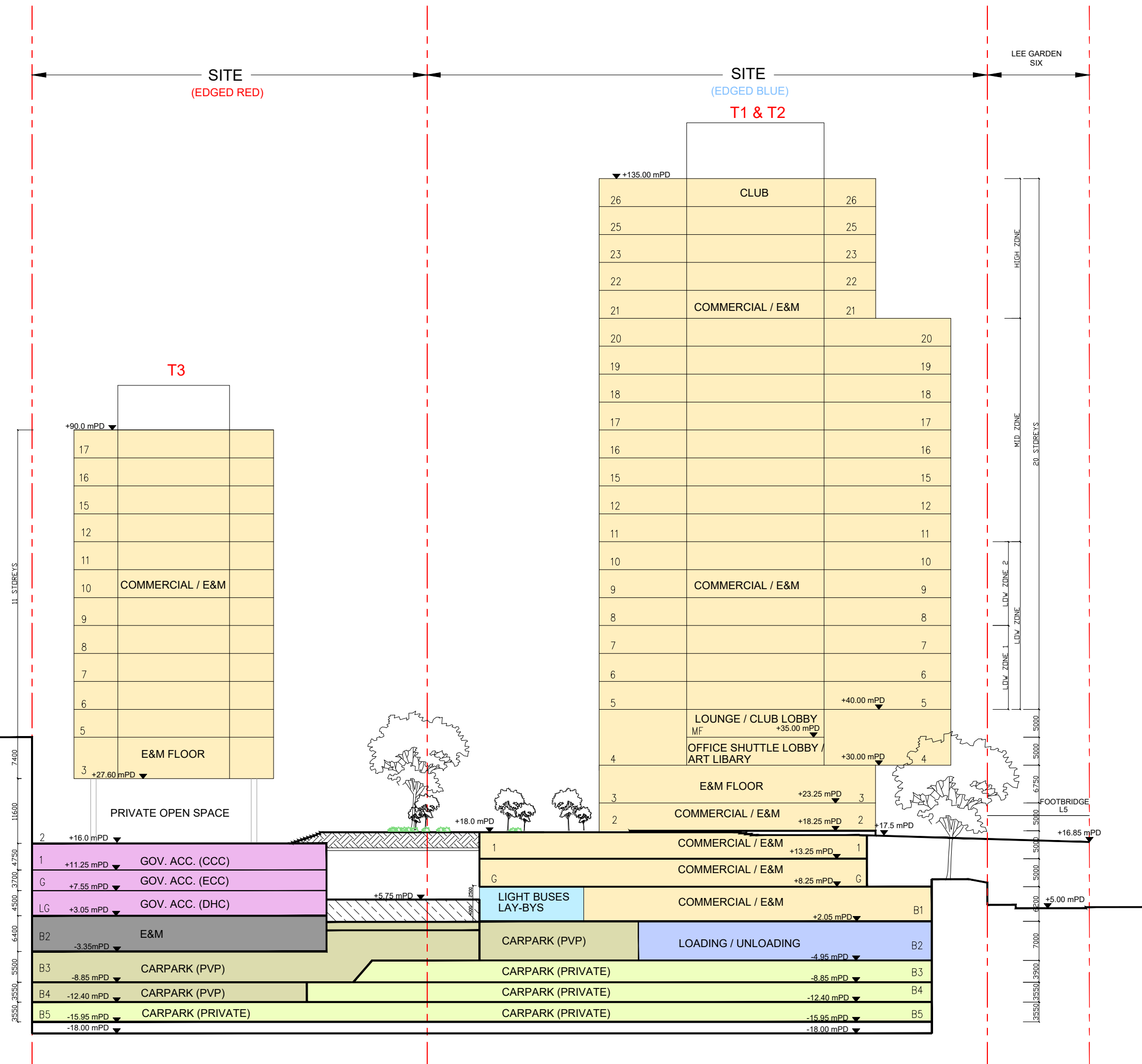
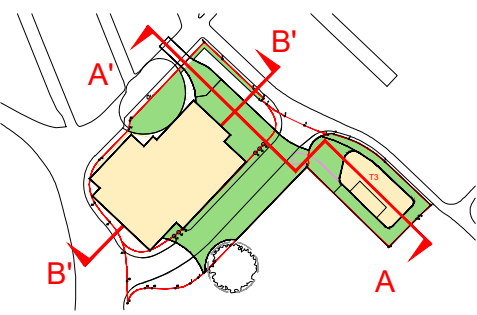
B.D. Ref.	
F.S.D. Ref.	
D.L.O. Ref.	
Drawn	Date 3-2022
Checked	Date 3-2022
Approved	Date 3-2022
Ord File No.	

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Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	TYPICAL FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	MAR 2022
Drawing No.	MLP-011

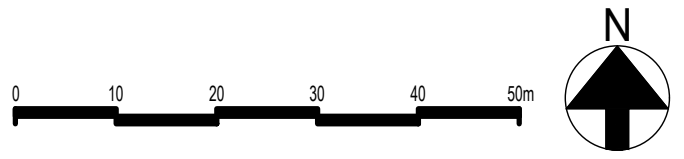
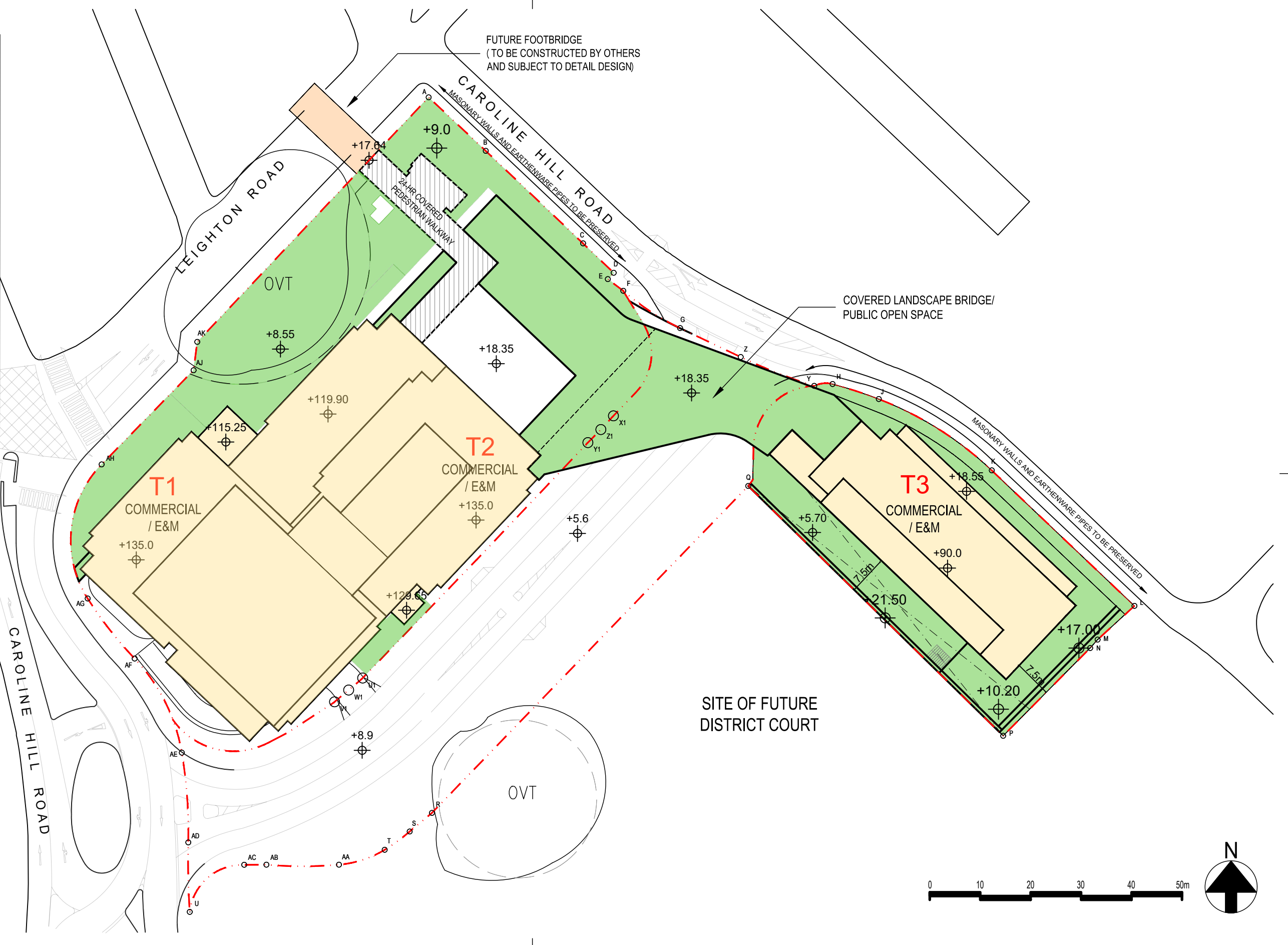
Drawing Purpose



A2 Layout Plan of Proposed Scheme

LEGEND

	APPLICATION SITE
	PINK HATCHED BLUE NO STRUCTURE ERECTED ABOVE OR WITHIN 4M BELOW GROUND LEVEL
	PUBLIC OPEN SPACE
	COMMERCIAL/E&M
	G.I.C. FACILITIES
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	ACCESS ROAD
	LOADING & UNLOADING CARPARK (PVP)
	UNEXCAVATED
	24-HR PEDESTRIAN WALKWAY
	PEDESTRIAN LINK
	E&M
	COMMUNAL PODIUM GARDEN



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Cad File No.	



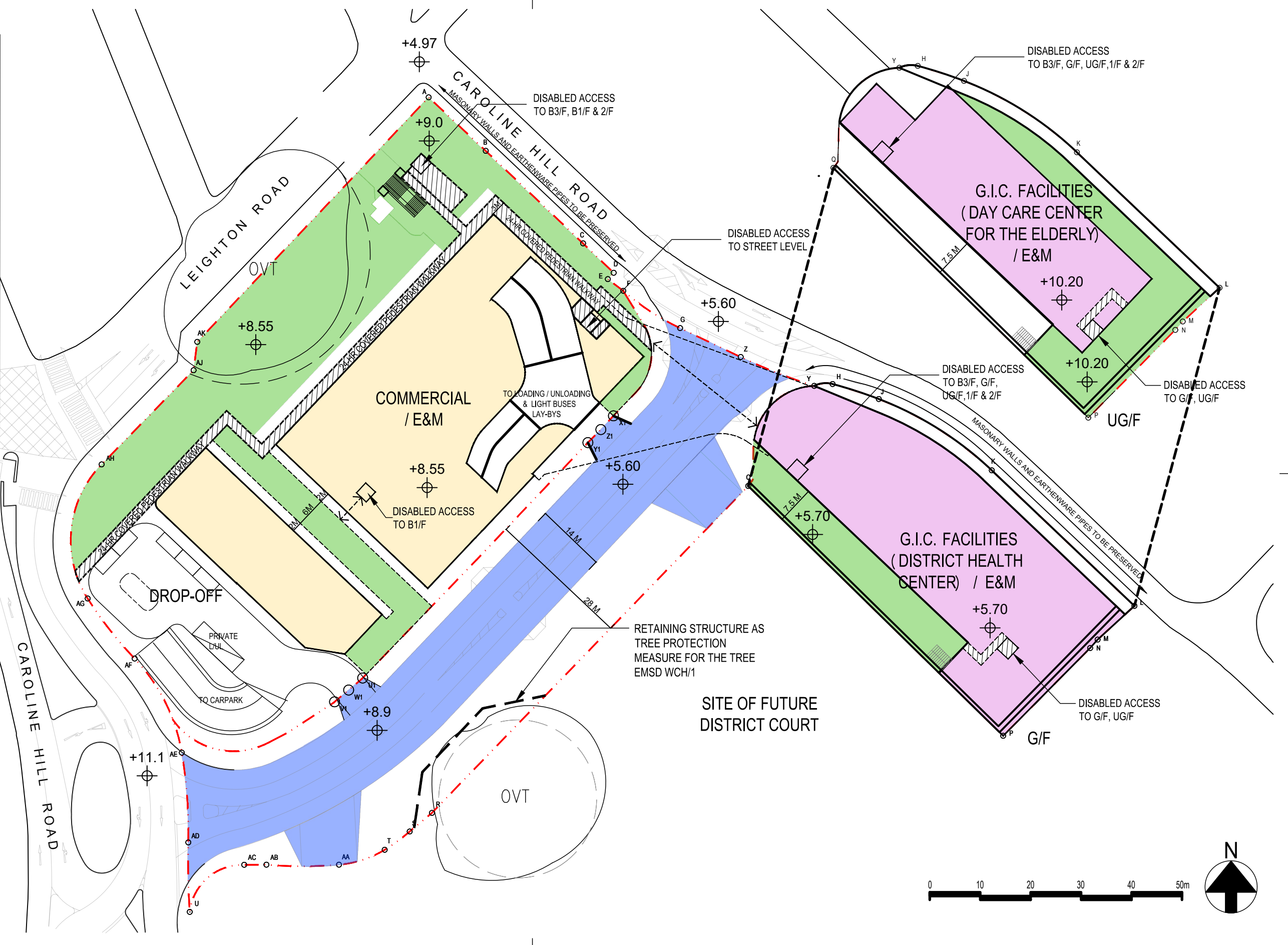
Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	LAYOUT PLAN (ALL LEVELS)
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	Jan 2024
Drawing No.	MLP-001

Drawing Purpose

LEGEND

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	PUBLIC OPEN SPACE
	COMMERCIAL/E&M
	G.I.C. FACILITIES
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	CARPARK (PVP)
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	ACCESS ROAD
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	UNEXCAVATED
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	E&M
	COMMUNAL PODIUM GARDEN



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Cad File No.	



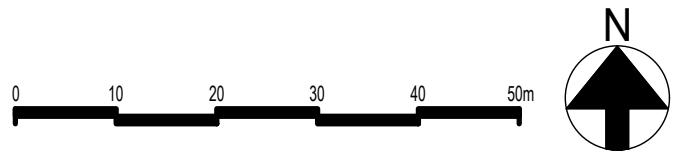
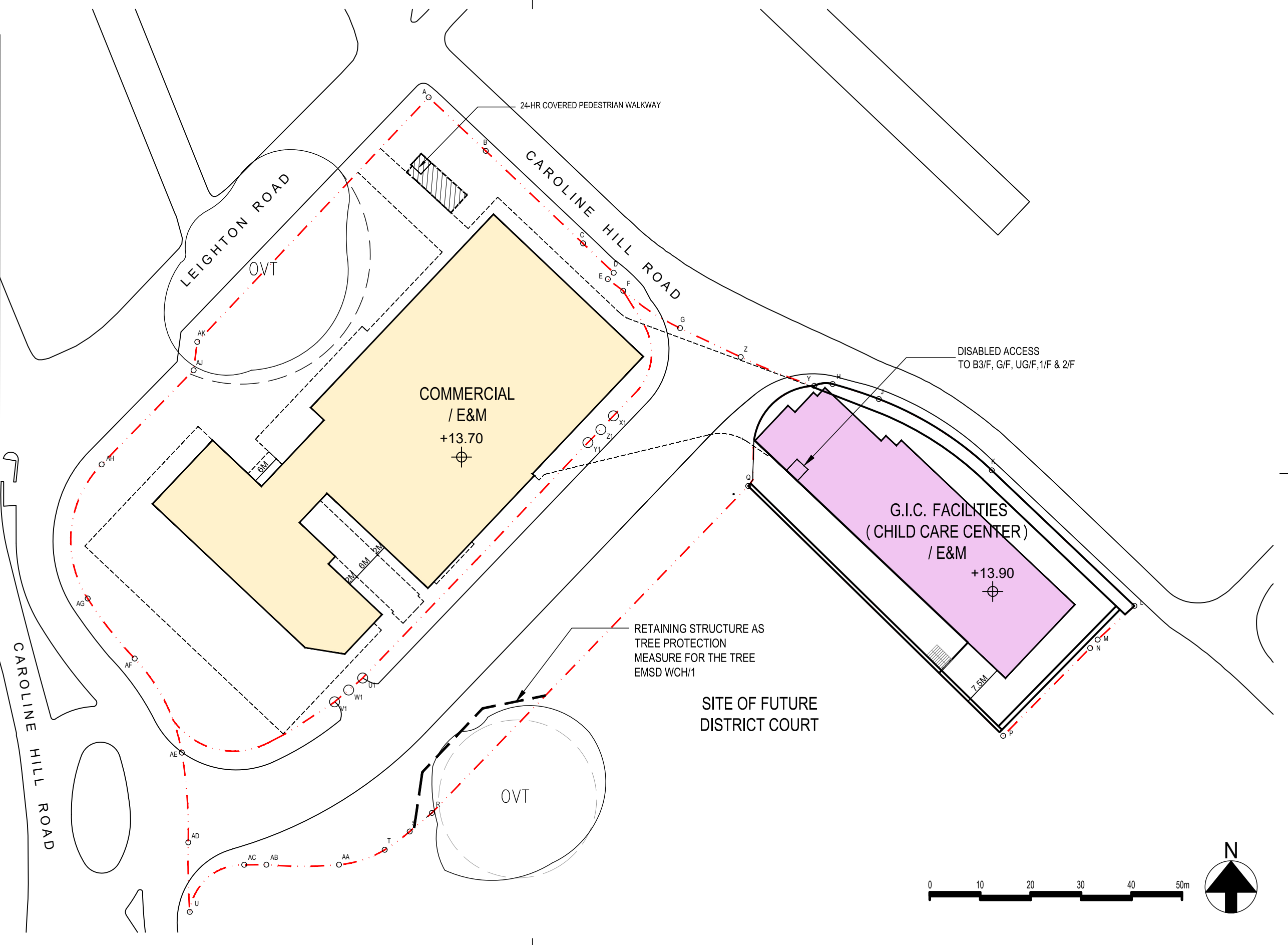
Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	GROUND FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	Jan 2024
Drawing No.	MLP-006

Drawing Purpose

LEGEND

	APPLICATION SITE
	PINK HATCHED BLUE NO STRUCTURE ERECTED ABOVE OR WITHIN 4M BELOW GROUND LEVEL
	PUBLIC OPEN SPACE
	COMMERCIAL/E&M
	G.I.C. FACILITIES
	G.I.C. FACILITIES (PERFORMING ARTS & CULTURAL FACILITIES)
	FUTURE FOOTBRIDGE
	LIGHT BUSES LAYBYS
	CARPARK (PVP)
	CARPARK (PRIVATE)
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	ACCESS ROAD
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	UNEXCAVATED
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	PEDESTRIAN LINK
	E&M



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Approved	Date 1-2024
Cad File No.	



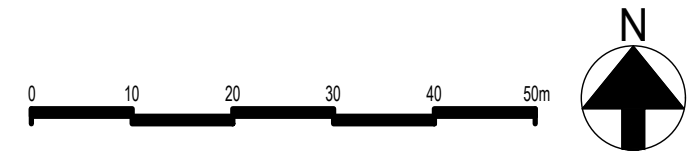
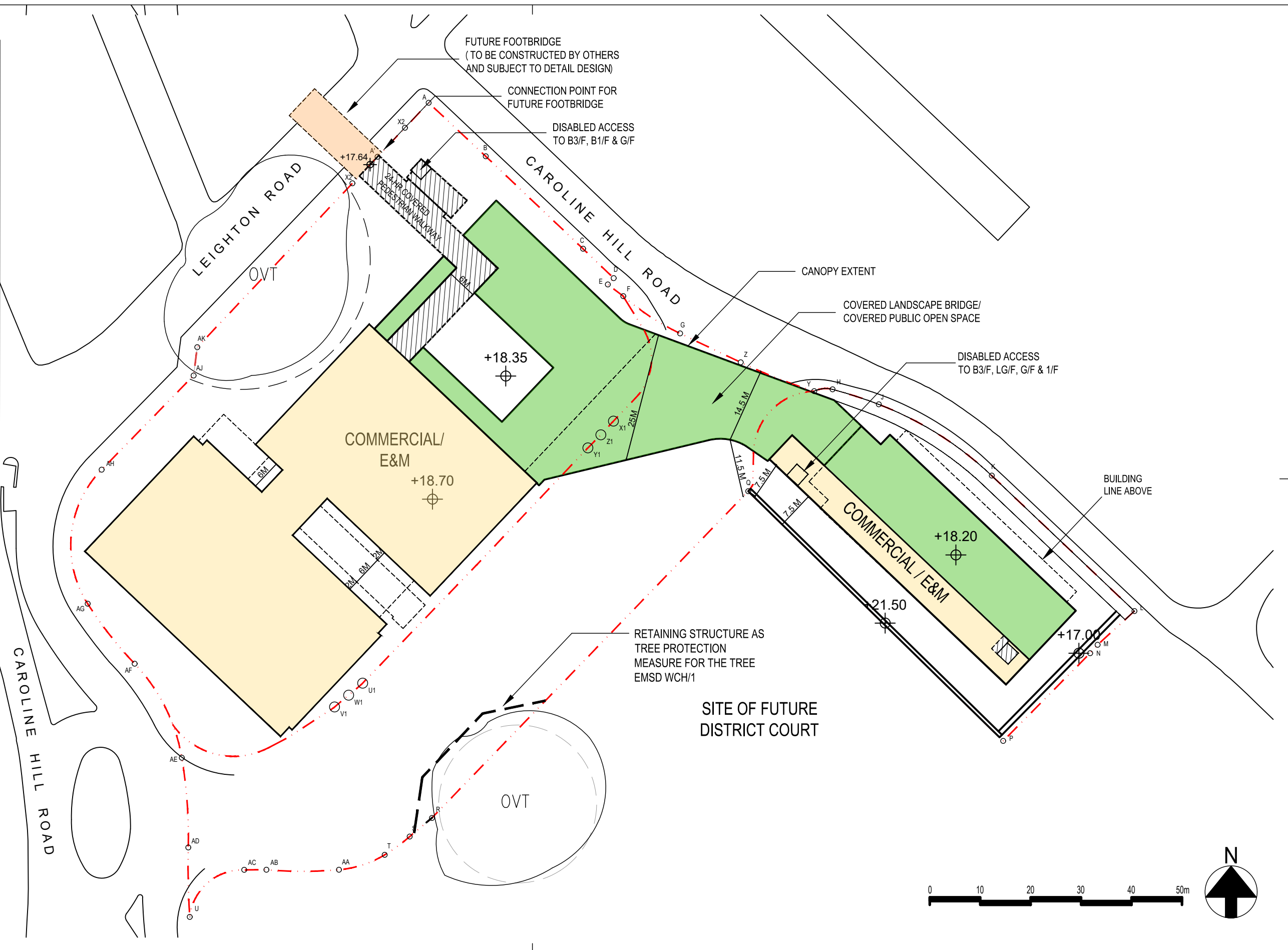
Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	FIRST FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	Jan 2024
Drawing No.	MLP-007

Drawing Purpose

LEGEND

	APPLICATION SITE
	PINK HATCHED BLUE NO STRUCTURE ERECTED ABOVE OR WITHIN 4M BELOW GROUND LEVEL
	PUBLIC OPEN SPACE
	COMMERCIAL/E&M
	G.I.C. FACILITIES
	G.I.C. FACILITIES (PERFORMING ARTS & CULTURAL FACILITIES)
	FUTURE FOOTBRIDGE
	LIGHT BUSES LAYBYS
	CARPARK (PVP)
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	ACCESS ROAD
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	UNEXCAVATED
	24-HR PEDESTRIAN WALKWAY
	PEDESTRIAN LINK
	E&M



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Cad File No.	



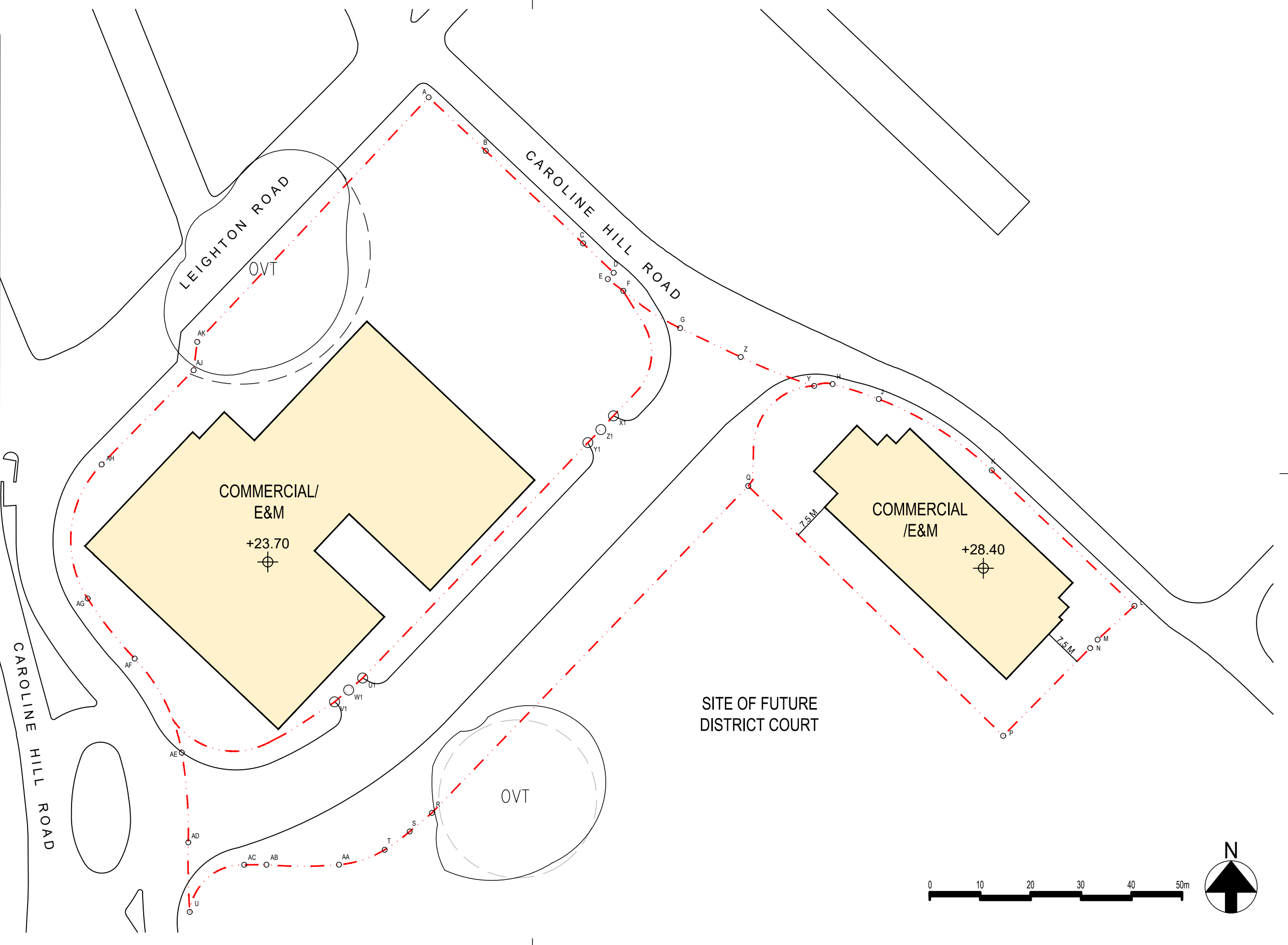
Project Title
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Drawing Title	SECOND FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	Jan 2024
Drawing No.	MLP-008

Drawing Purpose

LEGEND

	APPLICATION SITE
	PINK HATCHED BLUE NO STRUCTURE ERECTED ABOVE OR WITHIN 4M BELOW GROUND LEVEL
	PUBLIC OPEN SPACE
	COMMERCIAL/E&M
	G.I.C. FACILITIES
	G.I.C. FACILITIES (PERFORMING ARTS & CULTURAL FACILITIES)
	FUTURE FOOTBRIDGE
	LIGHT BUSES LAYBYS
	CARPARK (PVP)
	CARPARK (PRIVATE)
	CARPARK (G.I.C. FACILITIES)
	ACCESS ROAD
	LOADING & UNLOADING CARPARK (PVP)
	UNEXCAVATED
	24-HR PEDESTRIAN WALKWAY
	PEDESTRIAN LINK
	E&M



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Approved	Date 1-2024
Cad File No.	



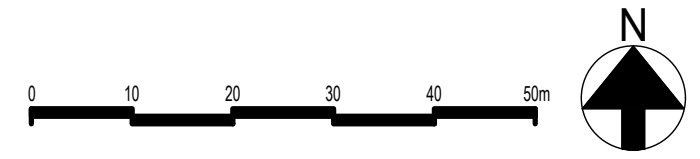
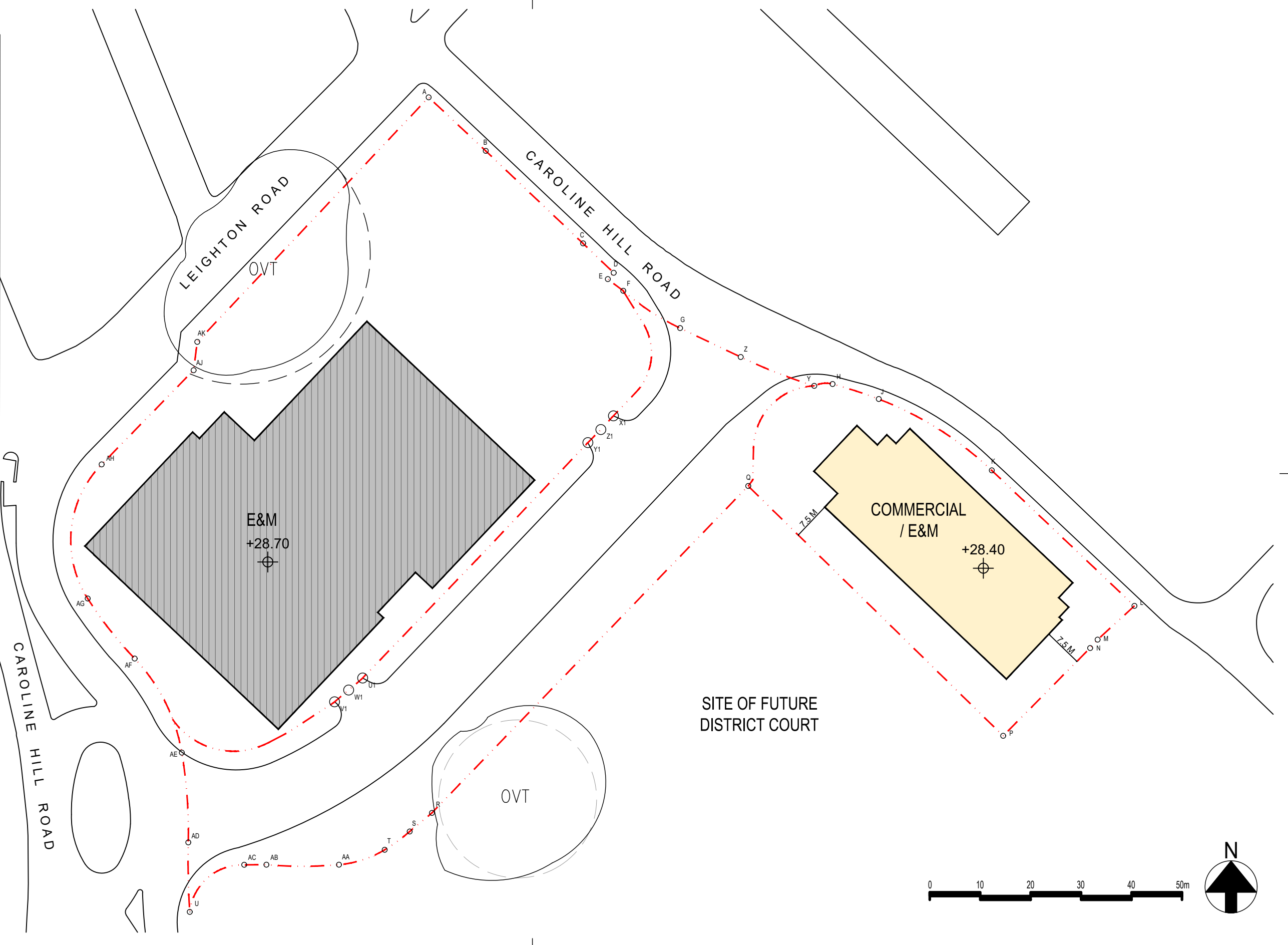
Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	THIRD FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	Jan 2024
Drawing No.	MLP-009

Drawing Purpose

LEGEND

	APPLICATION SITE
	PINK HATCHED BLUE NO STRUCTURE ERECTED ABOVE OR WITHIN 4M BELOW GROUND LEVEL
	PUBLIC OPEN SPACE
	COMMERCIAL/E&M
	G.I.C. FACILITIES
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	FUTURE FOOTBRIDGE
	LIGHT BUSES LAYBYS
	CARPARK (PVP)
	CARPARK (PRIVATE)
	CARPARK (G.I.C. FACILITIES)
	ACCESS ROAD
	LOADING & UNLOADING CARPARK (PVP)
	UNEXCAVATED
	24-HR PEDESTRIAN WALKWAY
	PEDESTRIAN LINK
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Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

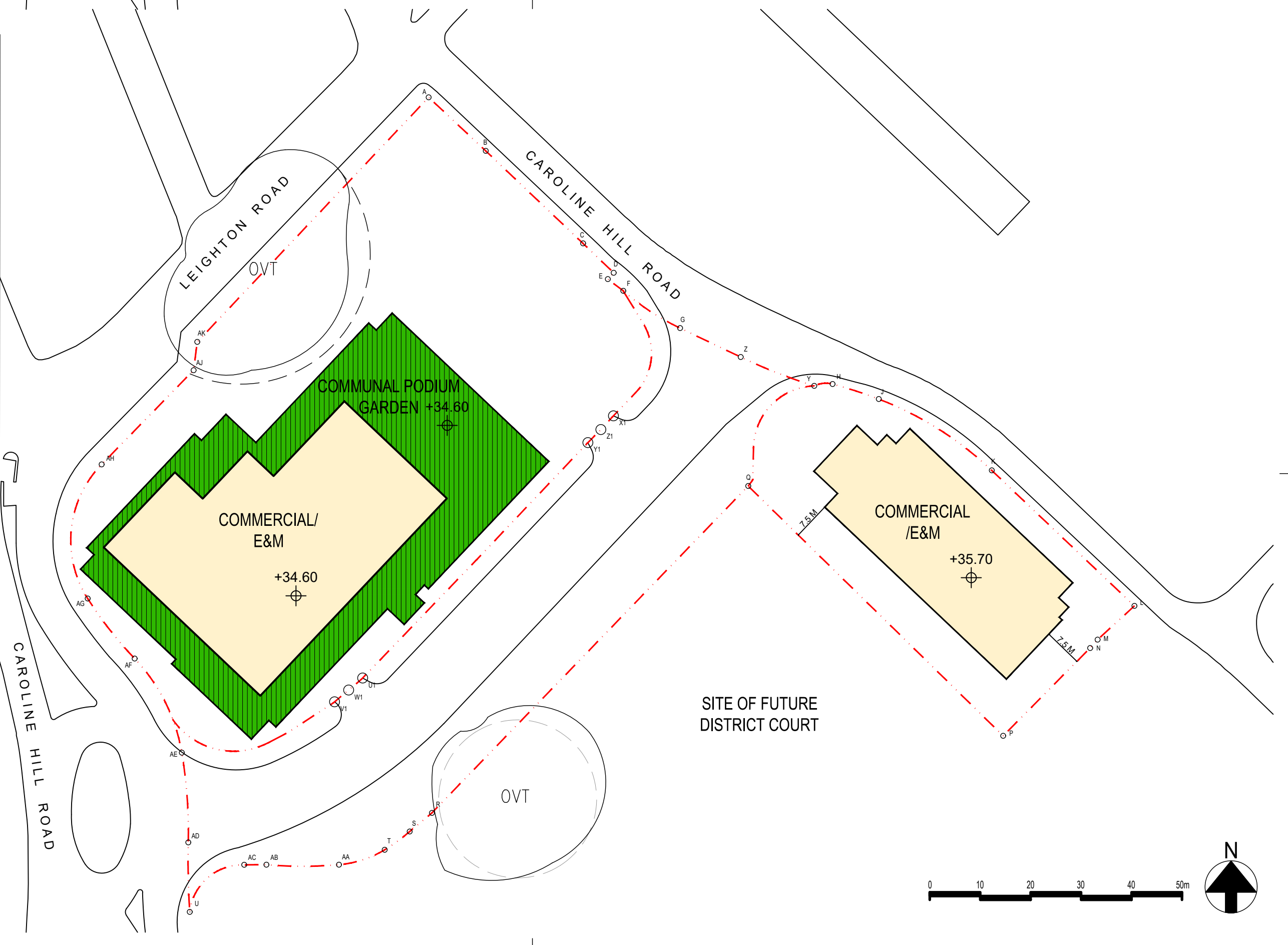
Drawing Title
FORTH FLOOR PLAN

Project No. 21105HK
Scale 1:750 (A3) Issue Date Jan 2024
Drawing No. MLP-009.1

Drawing Purpose

LEGEND

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	PUBLIC OPEN SPACE
	COMMERCIAL/E&M
	G.I.C. FACILITIES
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	CARPARK (PRIVATE)
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	PEDESTRIAN LINK
	E&M
	COMMUNAL PODIUM GARDEN



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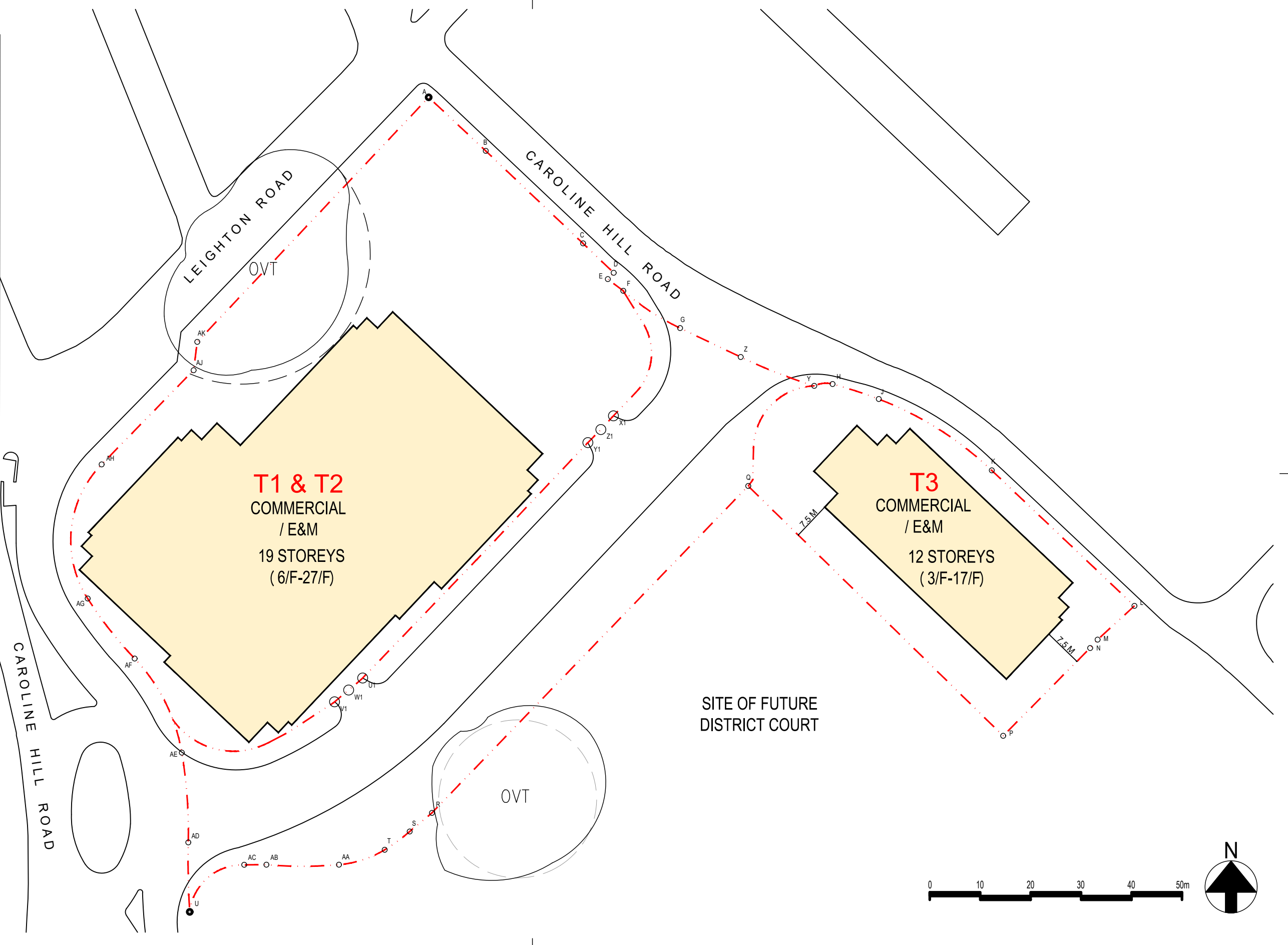
Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	FIFTH FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	Jan 2024
Drawing No.	MLP-010

Drawing Purpose

LEGEND

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	E&M



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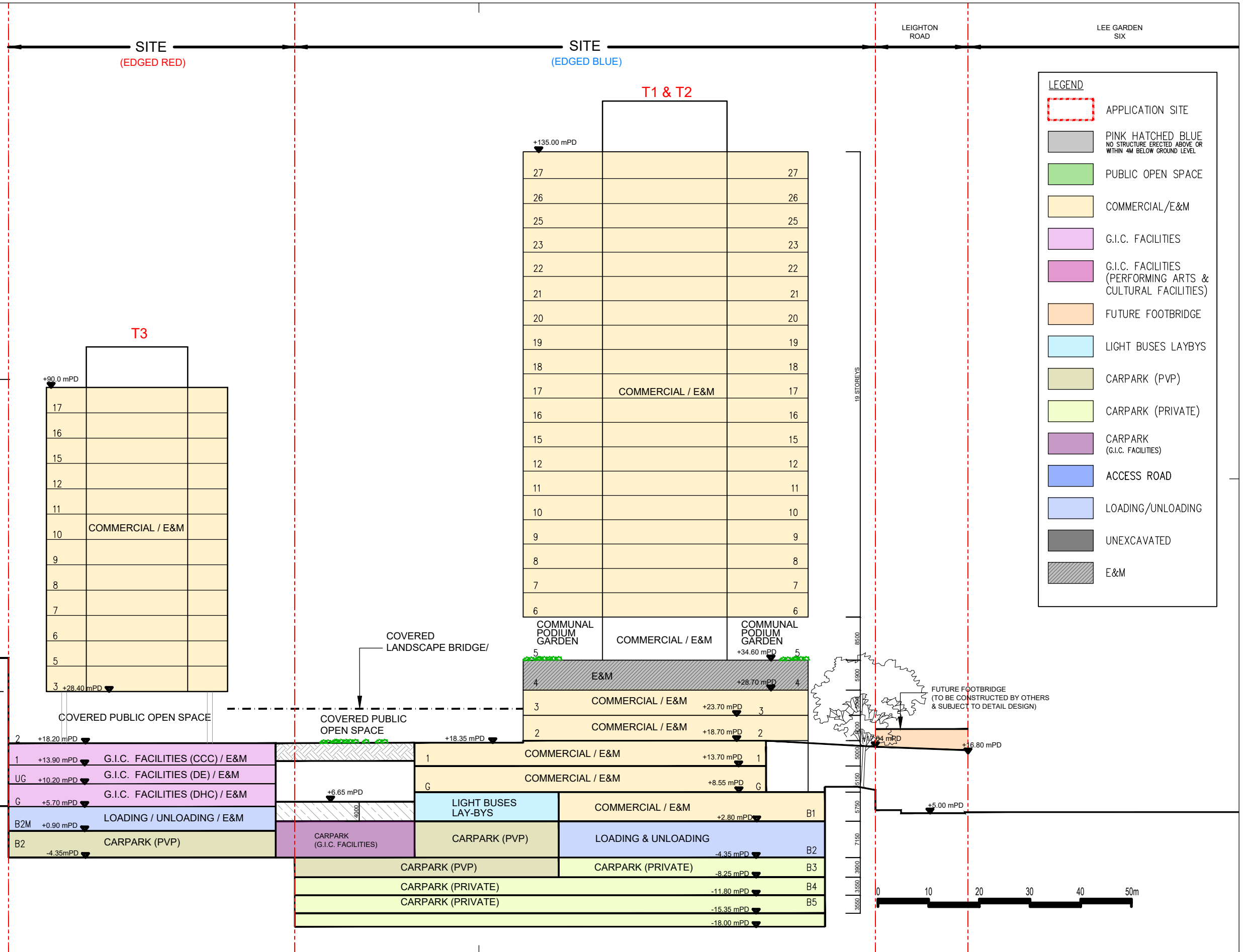
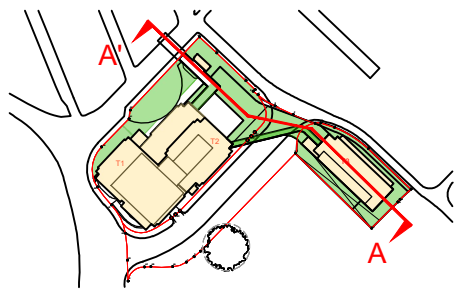
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Approved	Date 1-2024
Cad File No.	



Project Title
PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	TYPICAL FLOOR PLAN
Project No.	21105HK
Scale	1:750 (A3)
Issue Date	Jan 2024
Drawing No.	MLP-011

Drawing Purpose



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Approved	Date 1-2024
Cad File No.	



Project Title
 PROPOSED COMMERCIAL DEVELOPMENT ON IL NO.8945 AT CAROLINE HILL ROAD, CAUSEWAY BAY, HONG KONG

Drawing Title	Project No.	Scale	Issue Date
SECTION AA'	21105HK	1:750 (A3)	Jan 2024
Drawing No.	MLP-012		

Drawing Purpose

Appendix B

Layout Plan of Planned
Development within
Surrounding Area

B1 Layout Plan of Planned Development within Surrounding

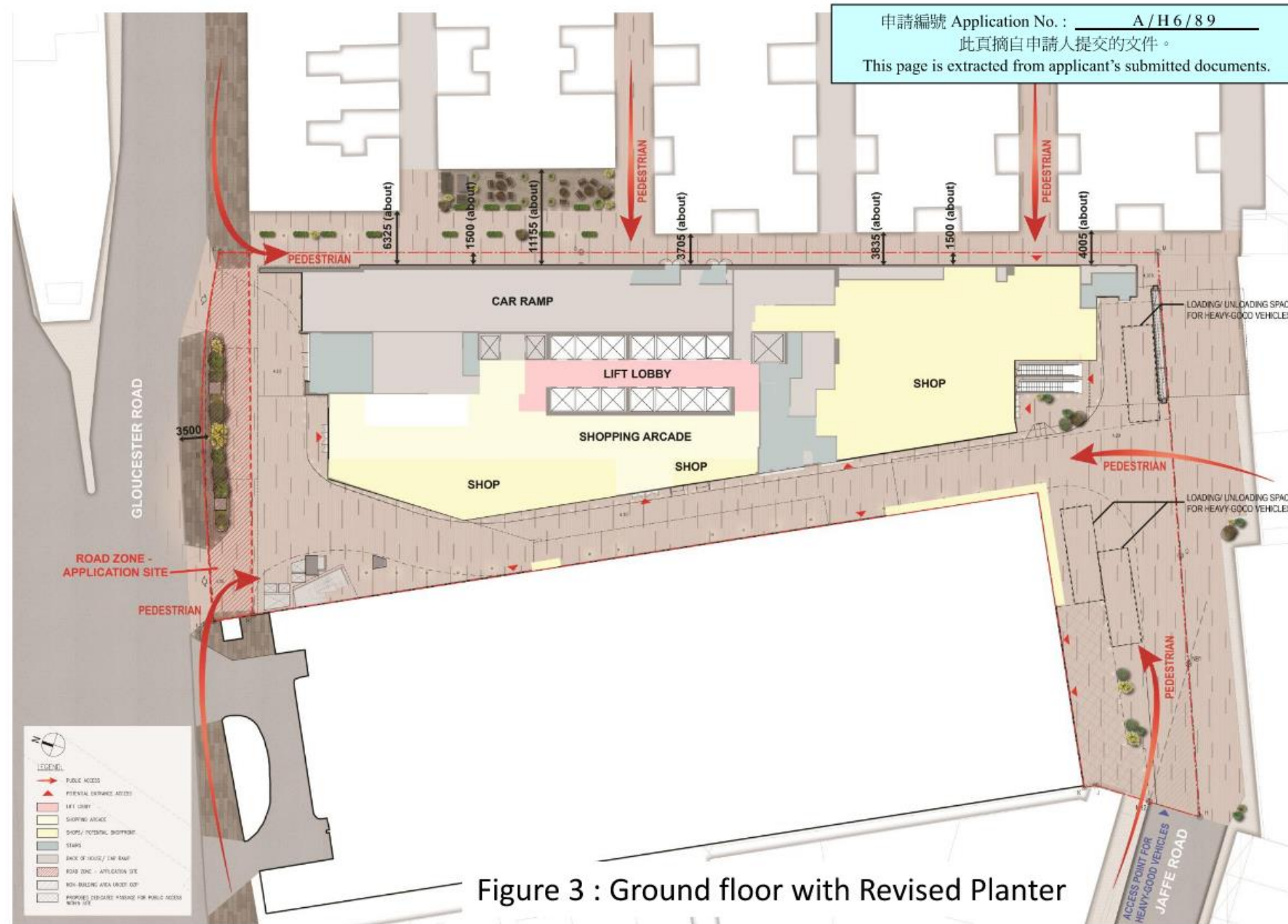
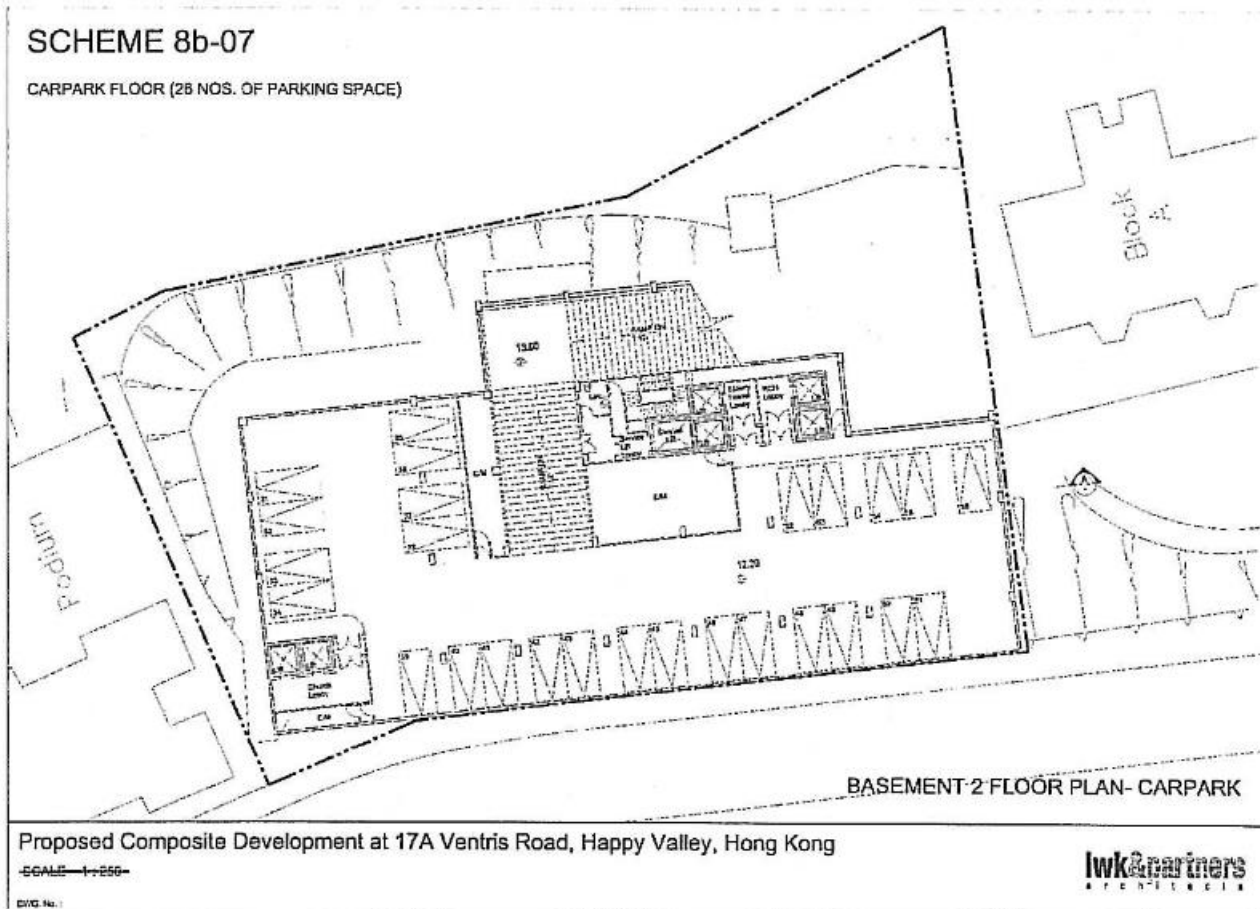
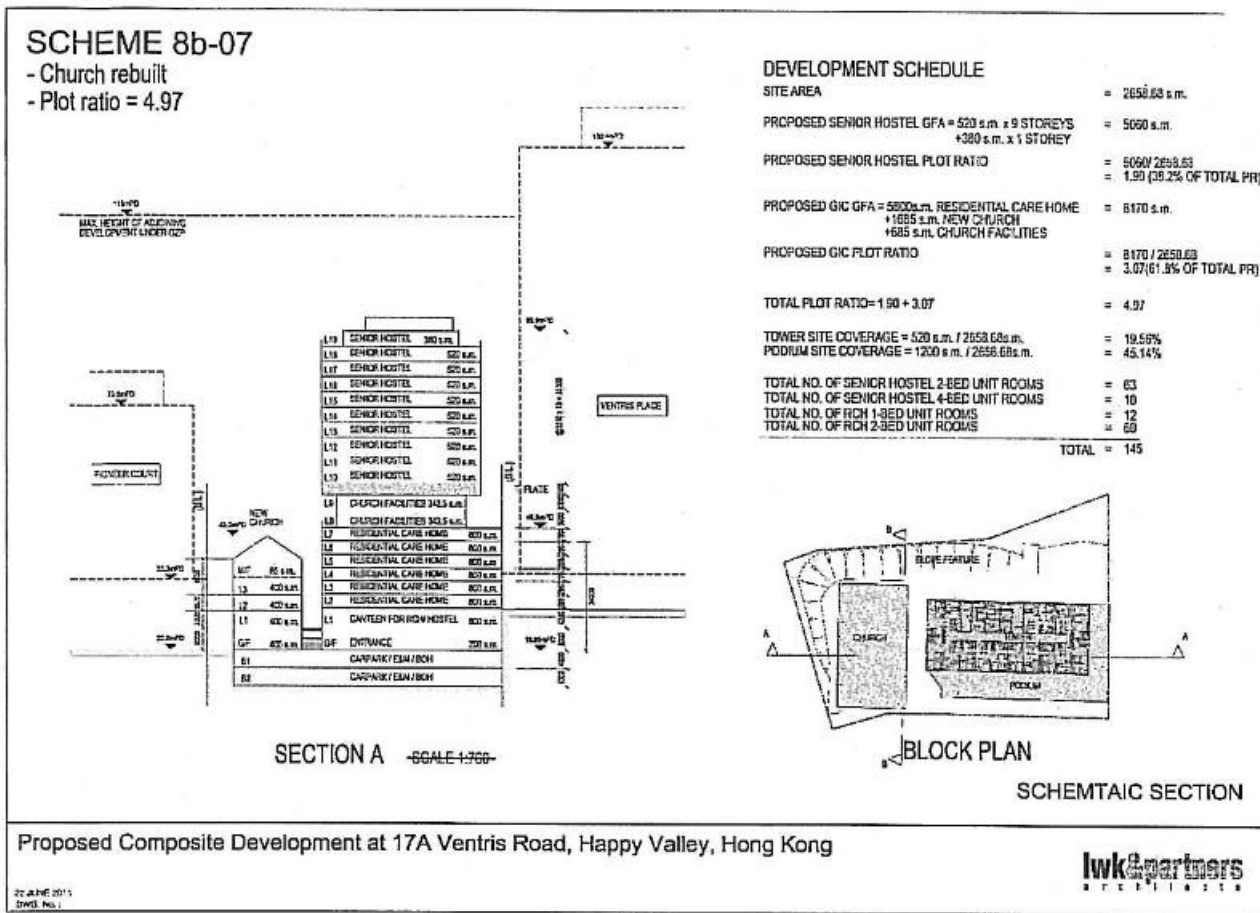


Figure B 1 #1 281 Gloucester Road Site



資料來源：由擬議人提供
SOURCE : SUBMITTED BY THE PROPONENT

參考編號 REFERENCE No. M/H7/11/9	繪圖 DRAWING 1
------------------------------------	--------------------

Figure B 2 #2 17A and 17B Ventris Road Site -1



資料來源：由擬議人提供
SOURCE : SUBMITTED BY THE PROPONENT

參考編號 REFERENCE No. M/H7/11/9	繪圖 DRAWING 9
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Figure B 3 #2 17A and 17B Ventris Road Site - 2

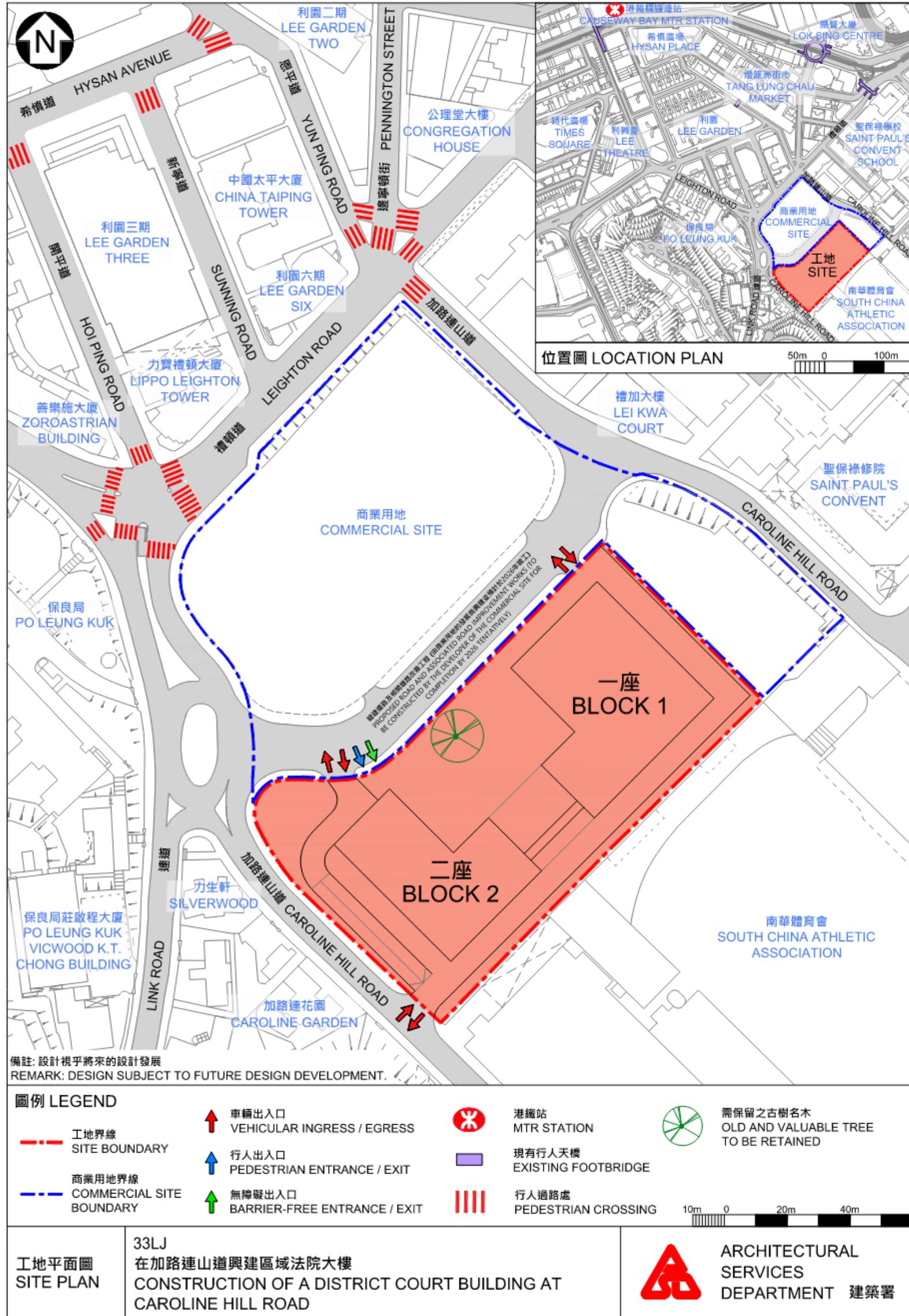


Figure B 4 #3 District Court at Caroline Hill Road – Layout

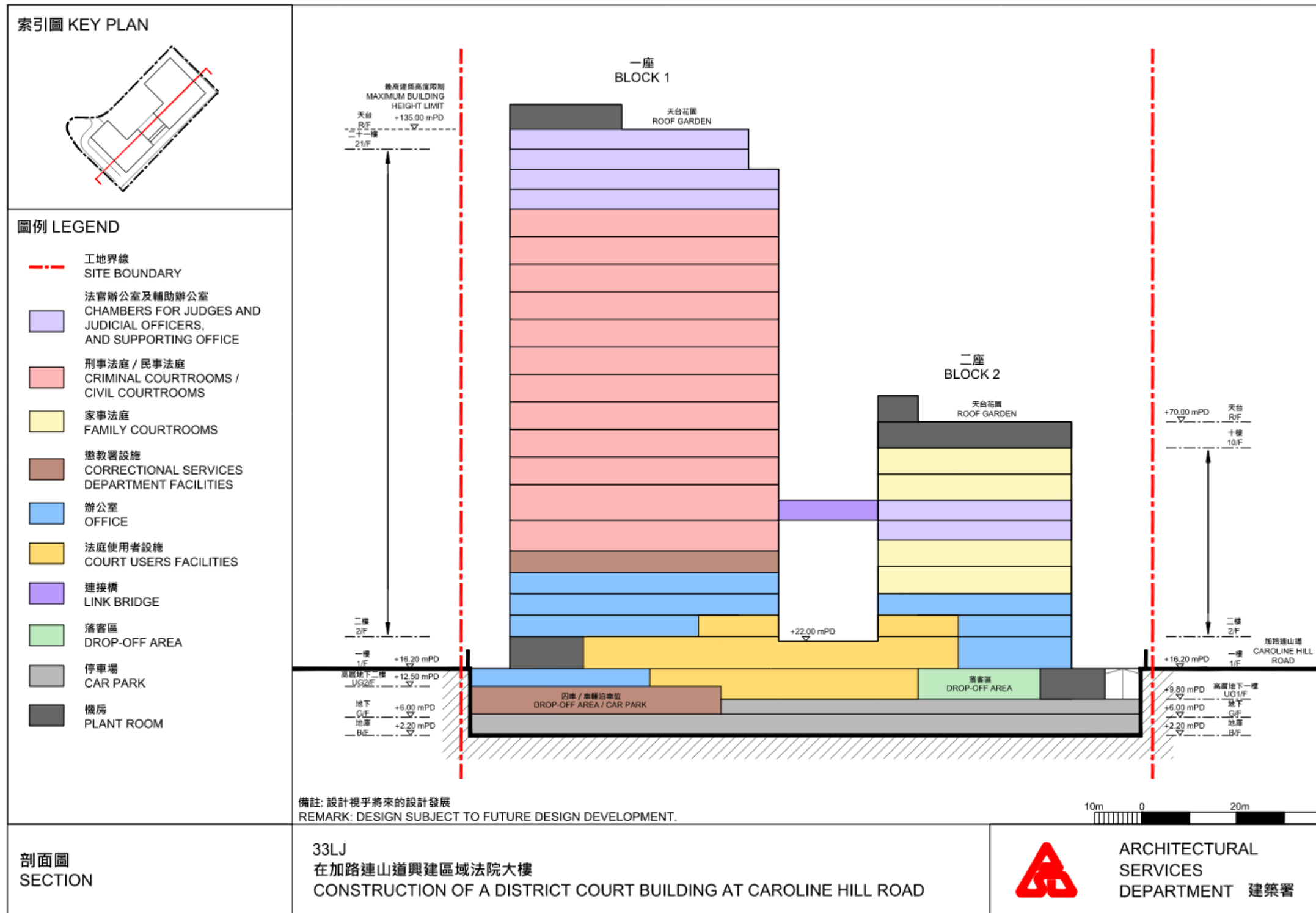
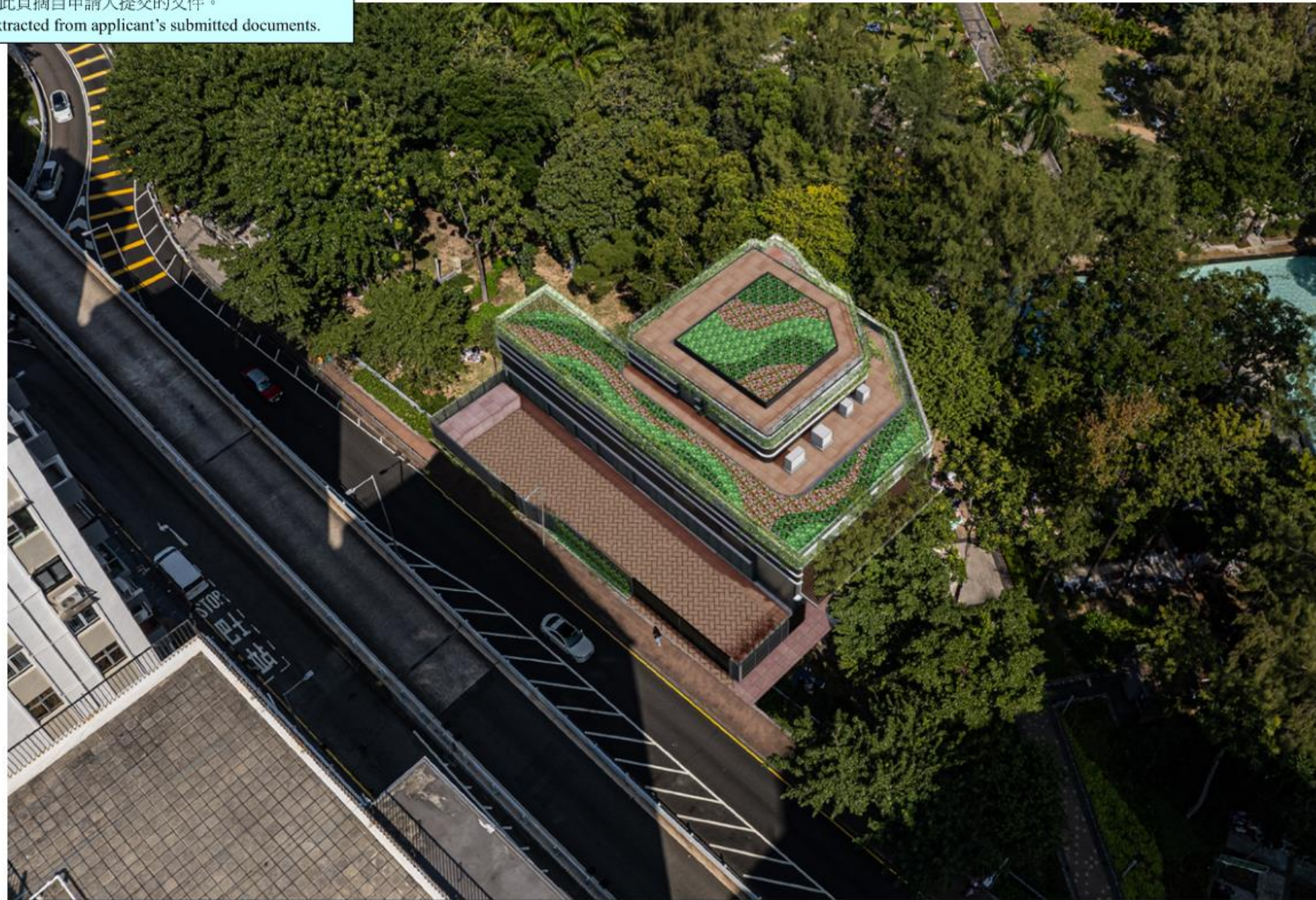


Figure B 5 #3 District Court at Caroline Hill Road - Section

申請編號 Application No. : A / H 8 / 4 3 7
 此頁摘自申請人提交的文件。
 This page is extracted from applicant's submitted documents.



 香港特別行政區政府渠務署 THE GOVERNMENT OF THE HONG KONG SPECIAL ADMINISTRATIVE REGION DRAINAGE SERVICES DEPARTMENT	 BINNIES HONG KONG LIMITED 賓尼斯工程顧問有限公司	Project Title: AGREEMENT NO. CE 79/2019 (DS) - CONSTRUCTION OF DRY WEATHER FLOW INTERCEPTOR AT HUNG HOM AND CAUSEWAY BAY - INVESTIGATION, DESIGN AND CONSTRUCTION	Drawing Title: PHOTOMONTAGE	Drawing no. FIGURE 11		
				Prepared W.B	Checked SW	Scale NTS

Figure B 6 #4 Planned Development on Construction of Dry Weather Flow Interceptor at Hung Hom and Causeway Bay

Appendix C

Contour Plots of Velocity Ratio (VR)

C1 Baseline Scheme

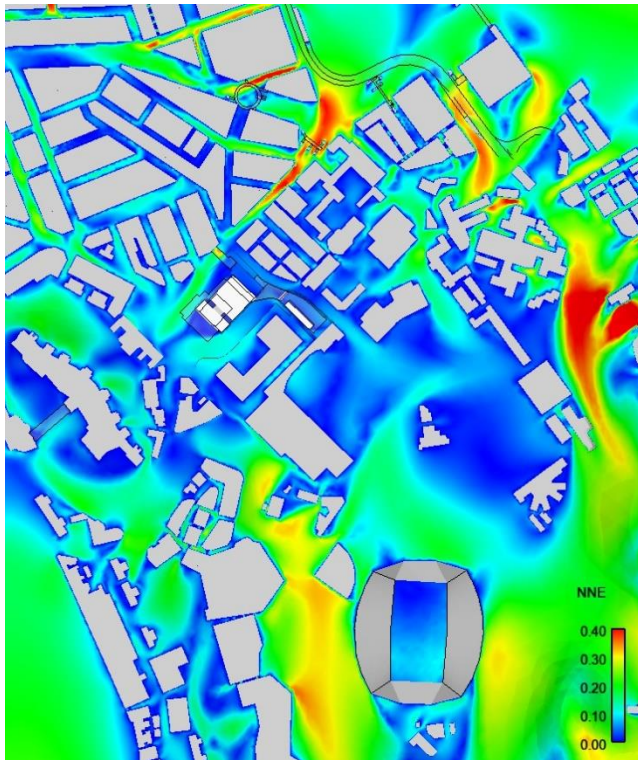


Figure C 1 Contour Plot of VR under NNE Wind

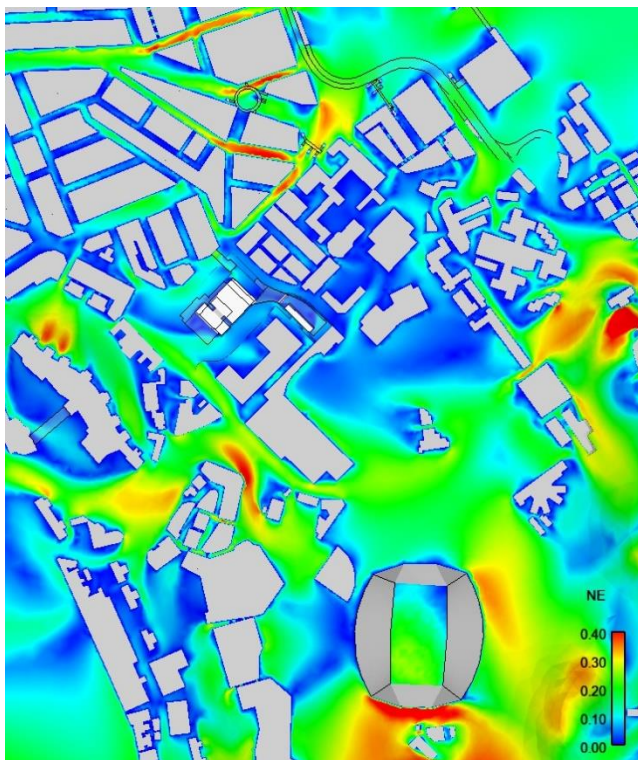


Figure C 2 Contour Plot of VR under NE Wind

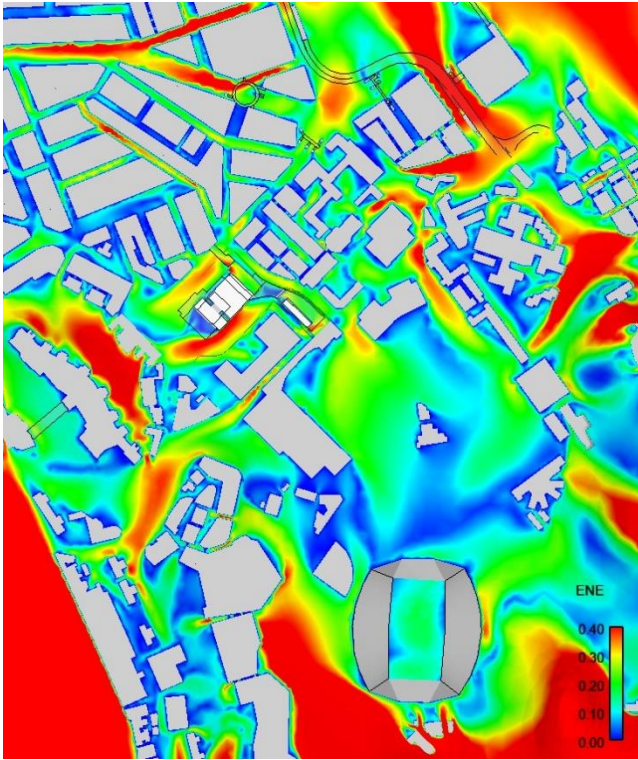


Figure C 3 Contour Plot of VR under ENE Wind

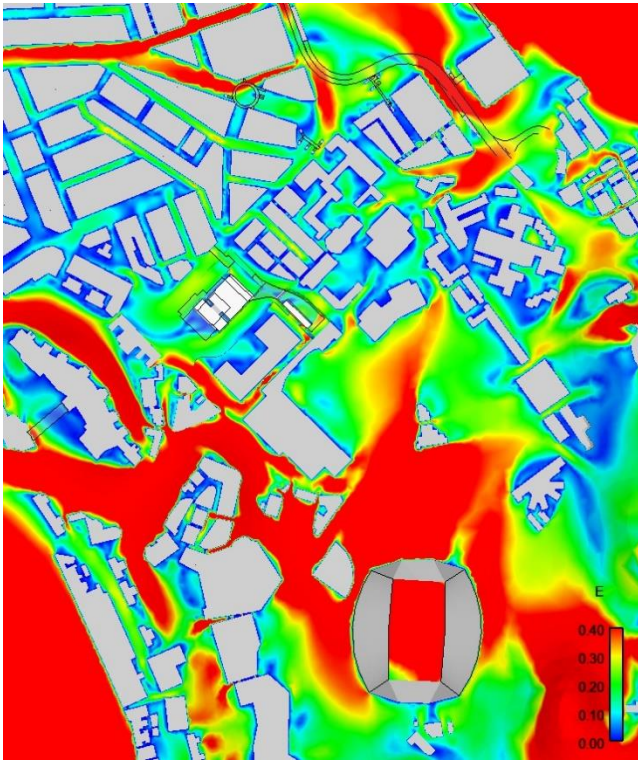


Figure C 4 Contour Plot of VR under E Wind

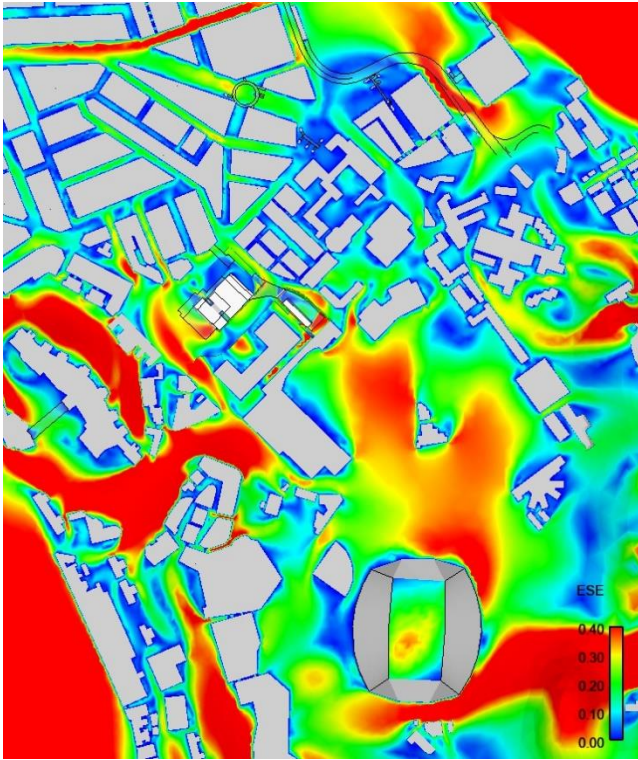


Figure C 5 Contour Plot of VR under ESE Wind

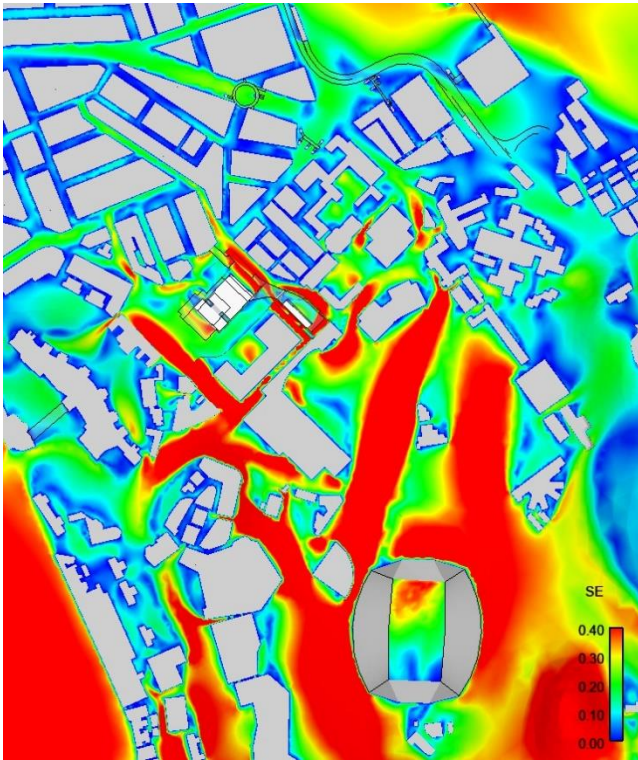


Figure C 6 Contour Plot of VR under SE Wind

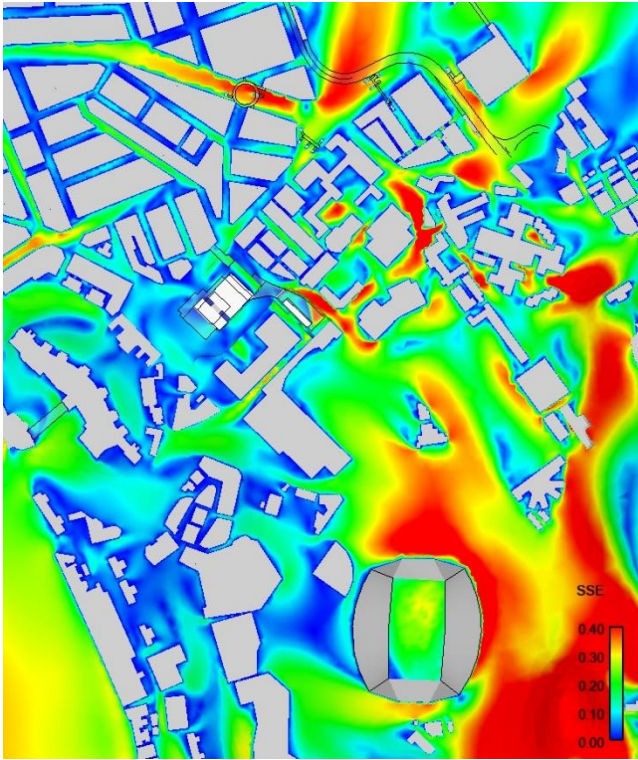


Figure C 7 Contour Plot of VR under SSE Wind

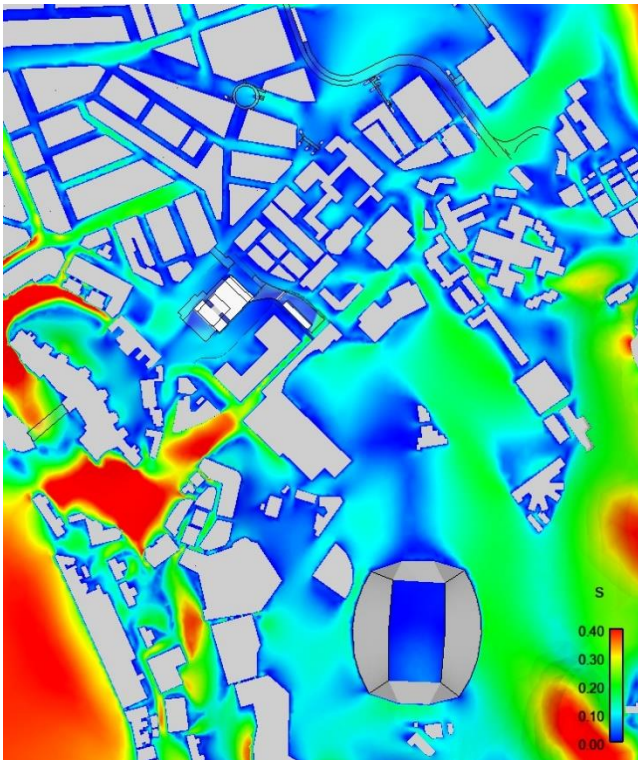


Figure C 8 Contour Plot of VR under S Wind

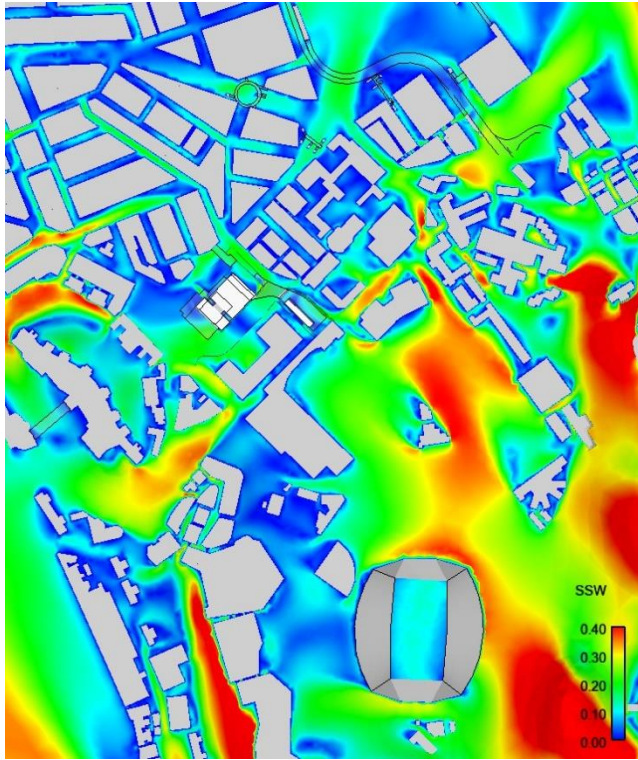


Figure C 9 Contour Plot of VR under SSW Wind

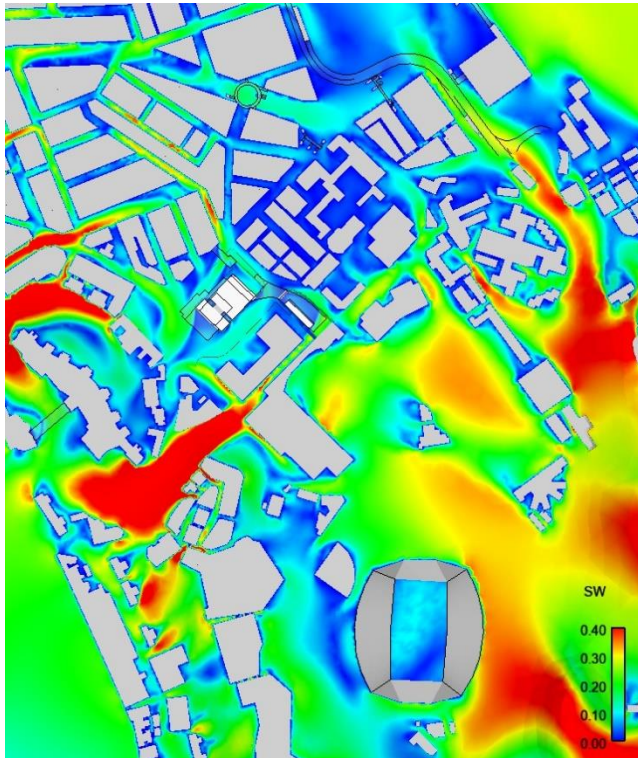


Figure C 10 Contour Plot of VR under SW Wind

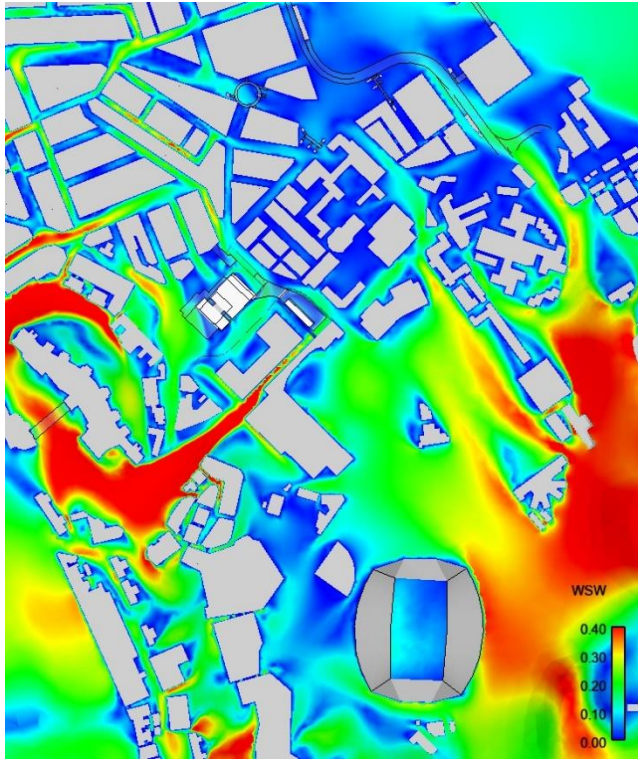


Figure C 11 Contour Plot of VR under WSW Wind

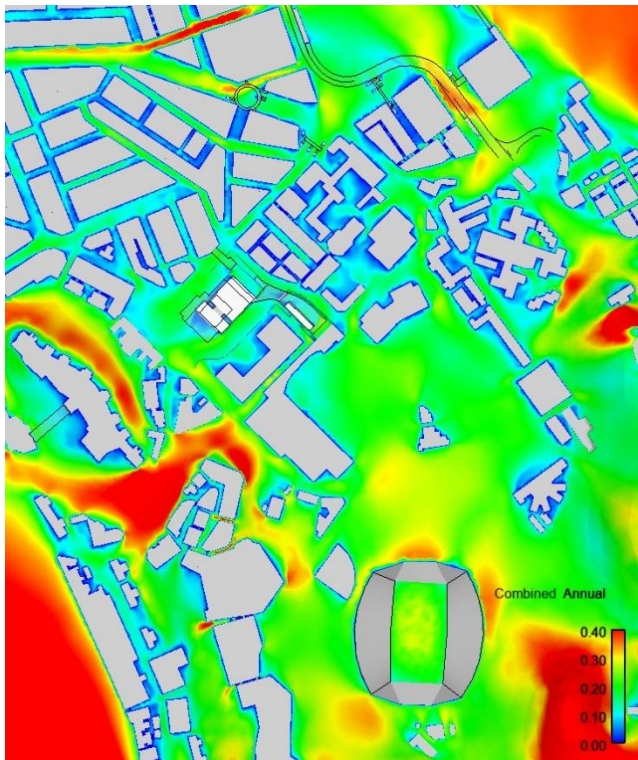


Figure C 12 Annual Weighted Average Contour Plot of VR

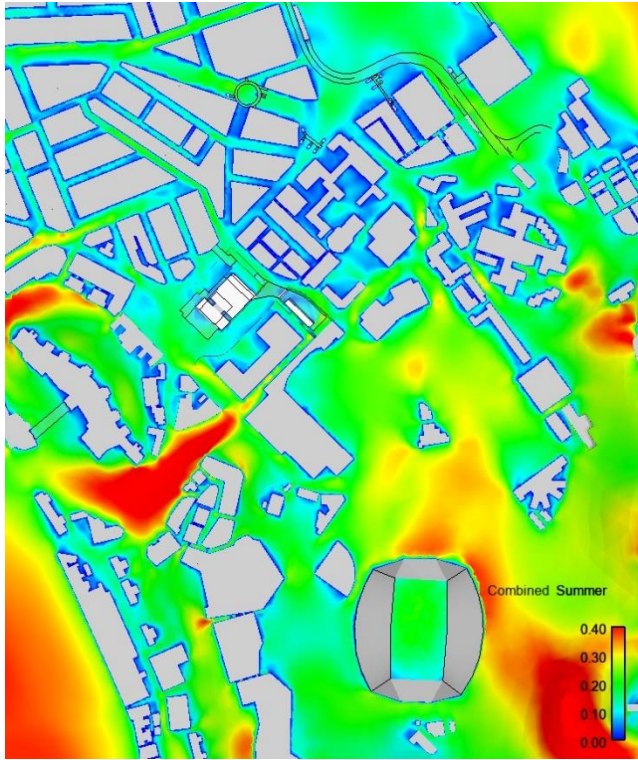


Figure C 13 Summer Weighted Average Contour Plot of VR

C2 Baseline Scheme (Computational Domain)

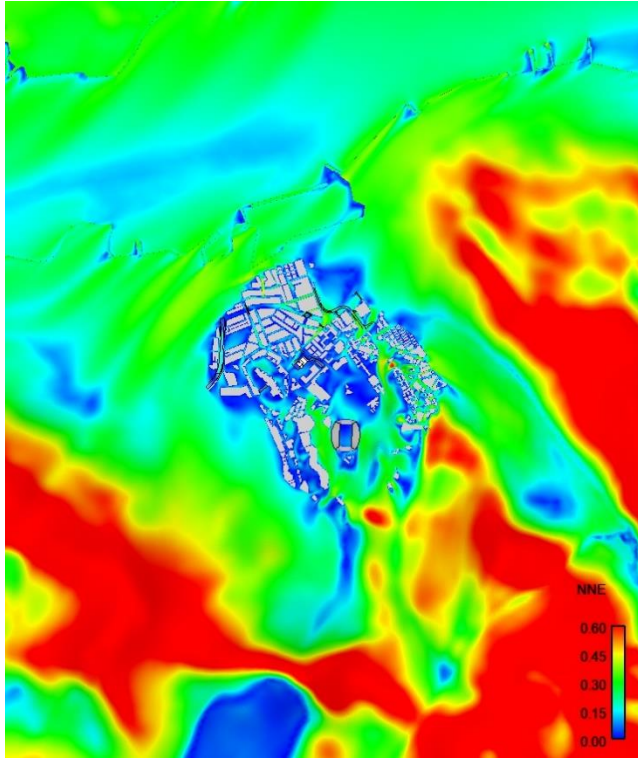


Figure C 14 Contour Plot of VR under NNE Wind

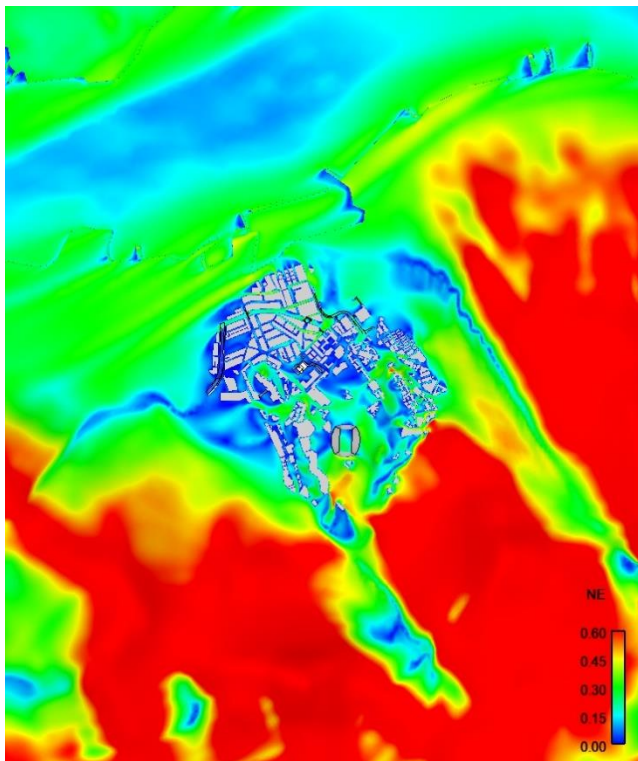


Figure C 15 Contour Plot of VR under NE Wind

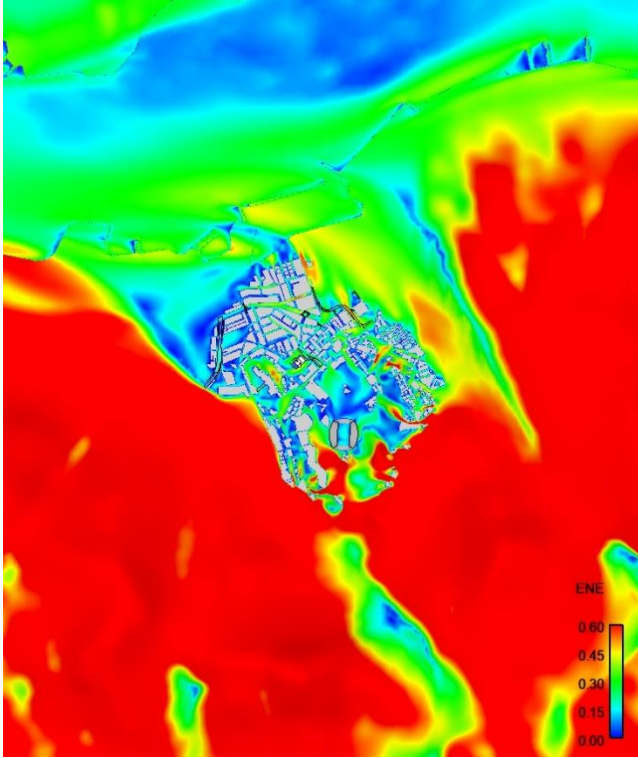


Figure C 16 Contour Plot of VR under ENE Wind

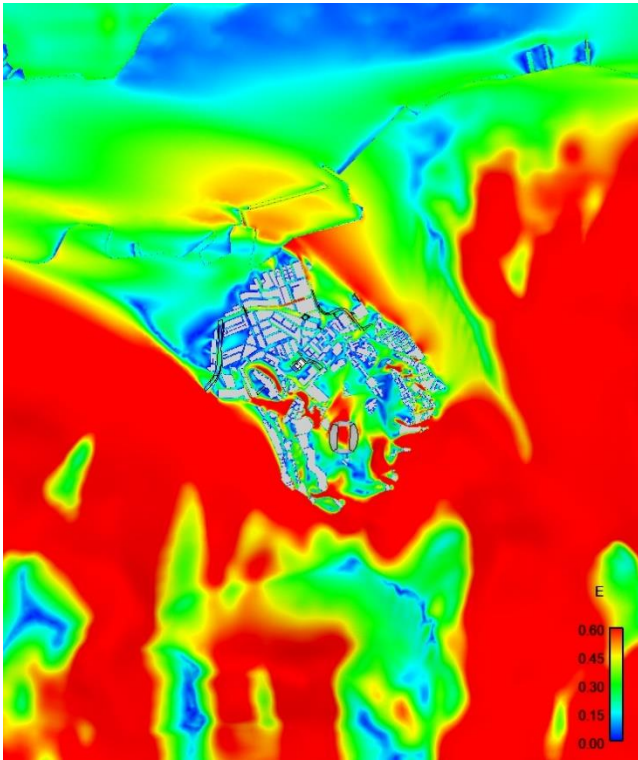


Figure C 17 Contour Plot of VR under E Wind

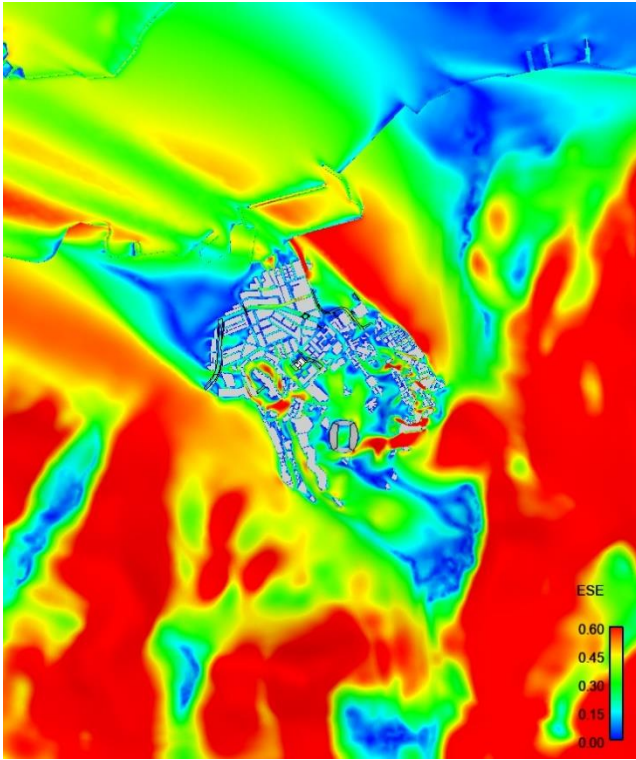


Figure C 18 Contour Plot of VR under ESE Wind

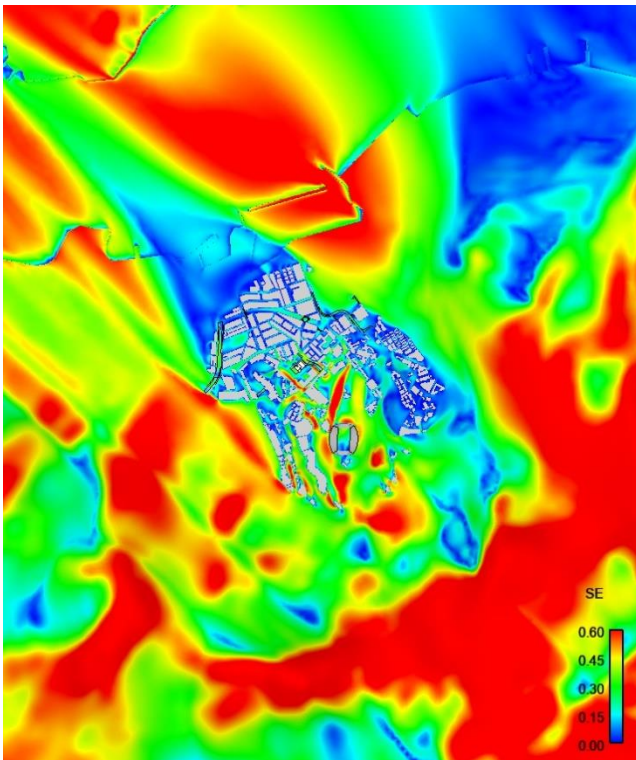


Figure C 19 Contour Plot of VR under SE Wind

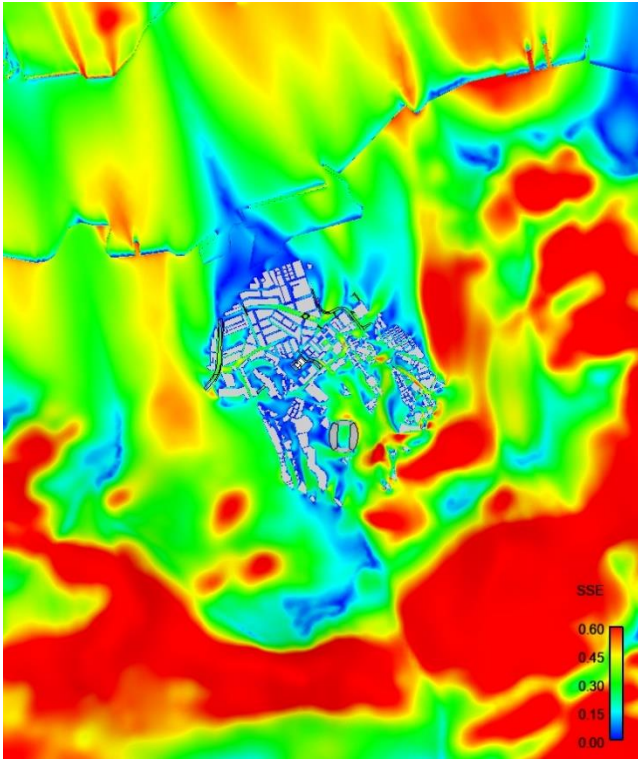


Figure C 20 Contour Plot of VR under SSE Wind

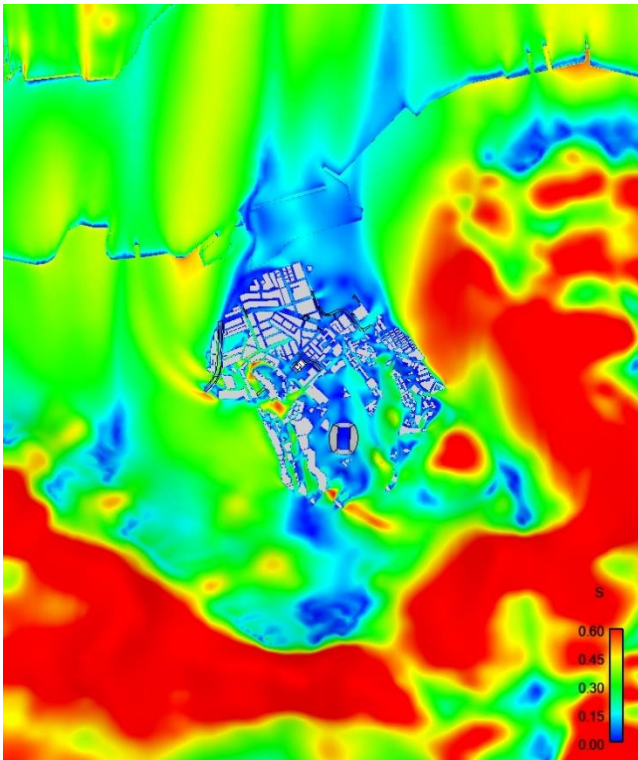


Figure C 21 Contour Plot of VR under S Wind

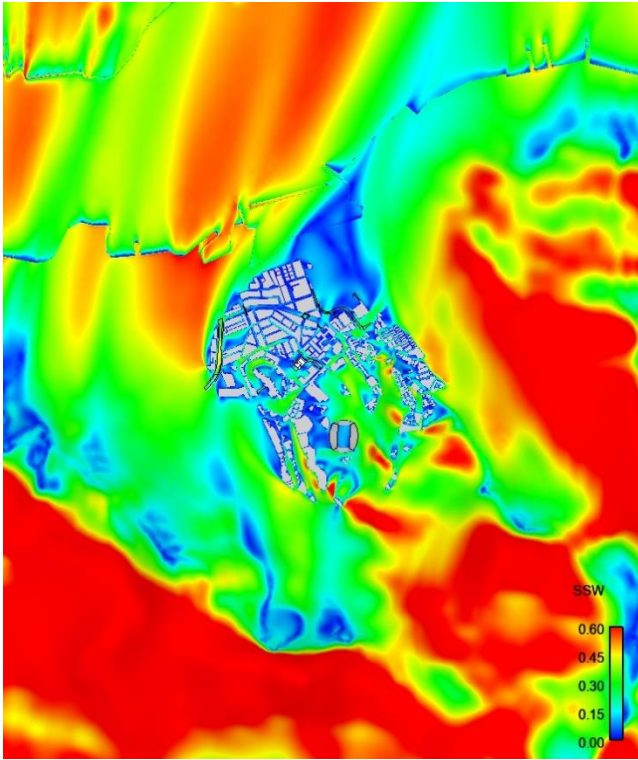


Figure C 22 Contour Plot of VR under SSW Wind

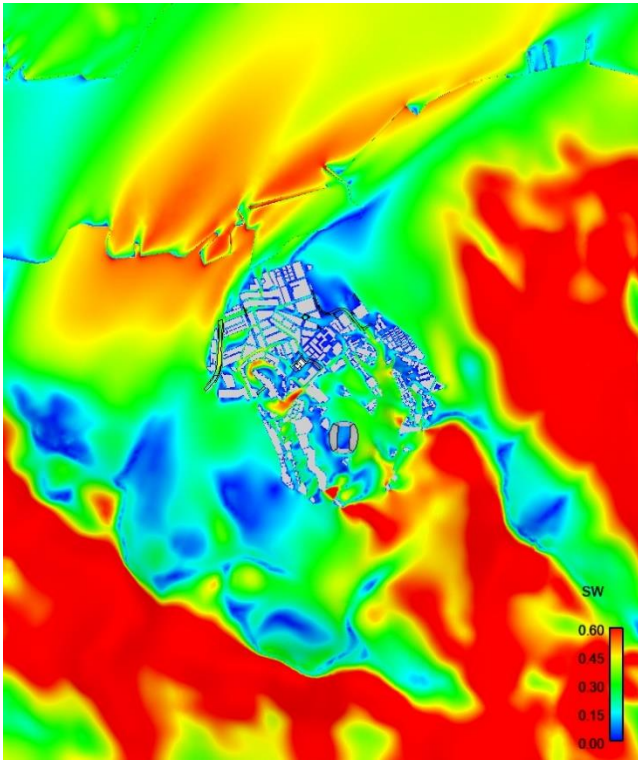


Figure C 23 Contour Plot of VR under SW Wind

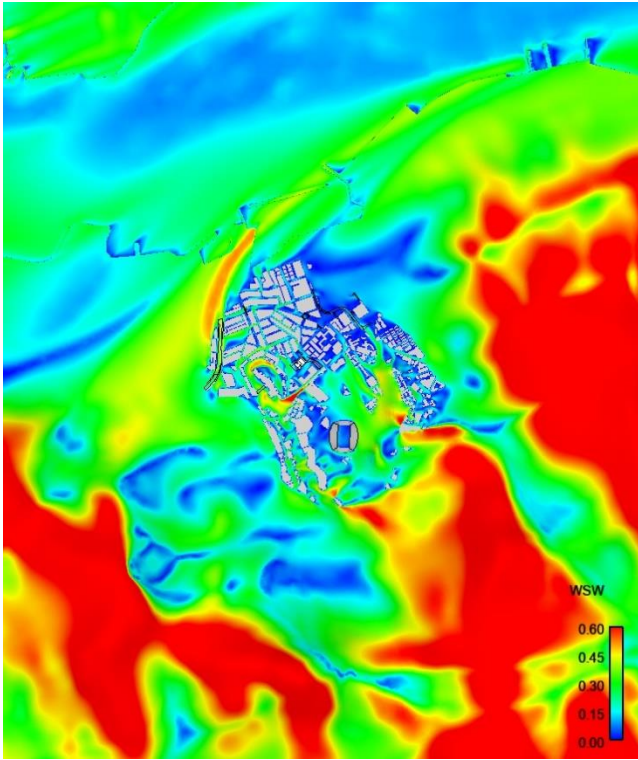


Figure C 24 Contour Plot of VR under WSW Wind

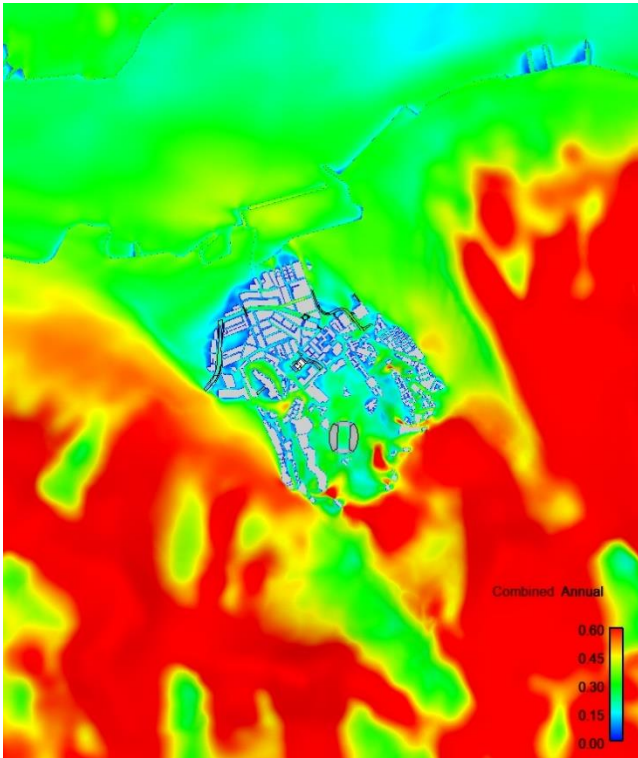


Figure C 25 Annual Weighted Average Contour Plot of VR

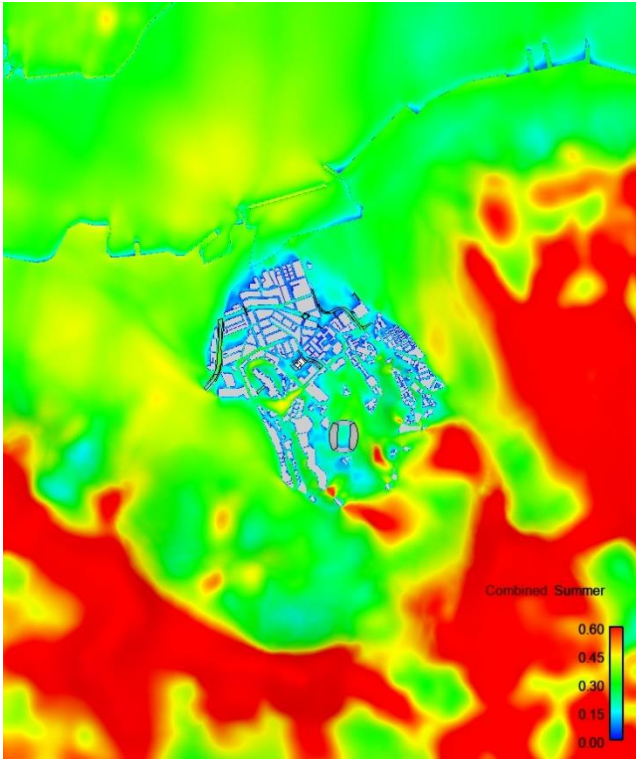


Figure C 26 Summer Weighted Average Contour Plot of VR

C3 Proposed Scheme

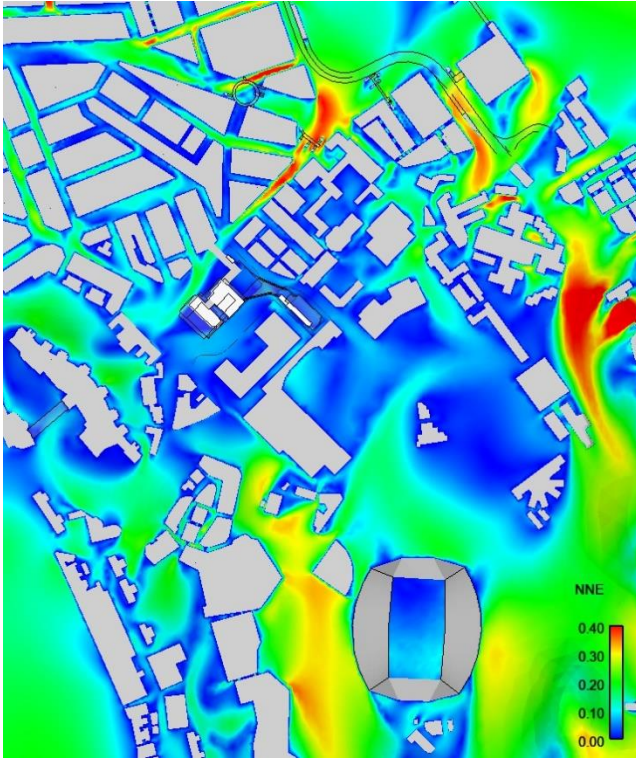


Figure C 27 Contour Plot of VR under NNE Wind

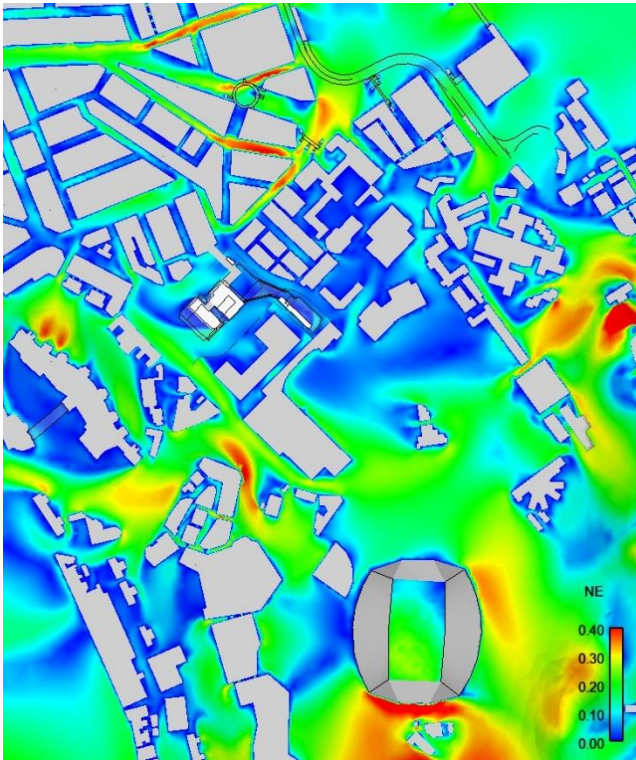


Figure C 28 Contour Plot of VR under NE Wind

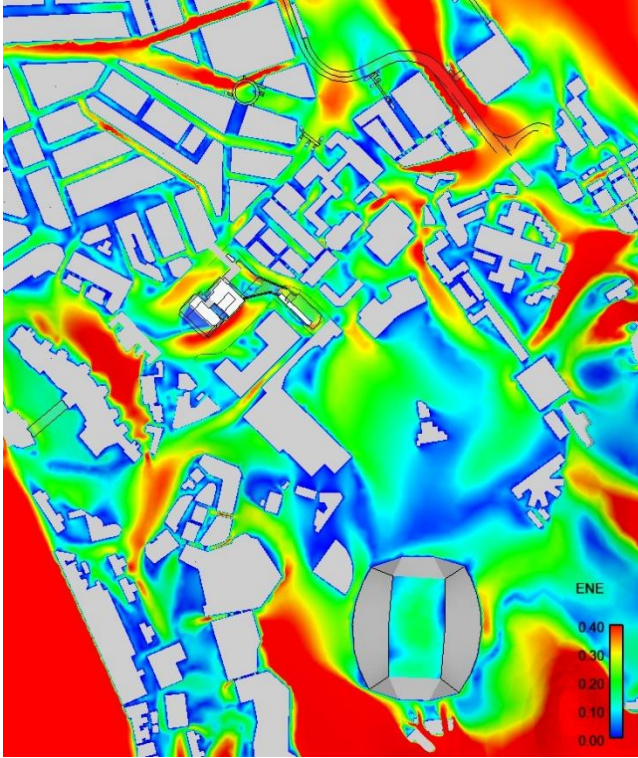


Figure C 29 Contour Plot of VR under ENE Wind

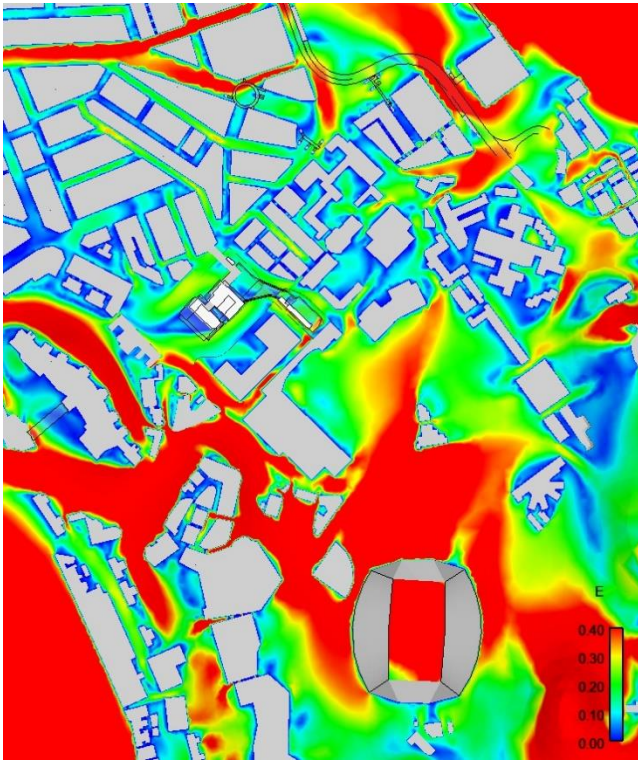


Figure C 30 Contour Plot of VR under E Wind

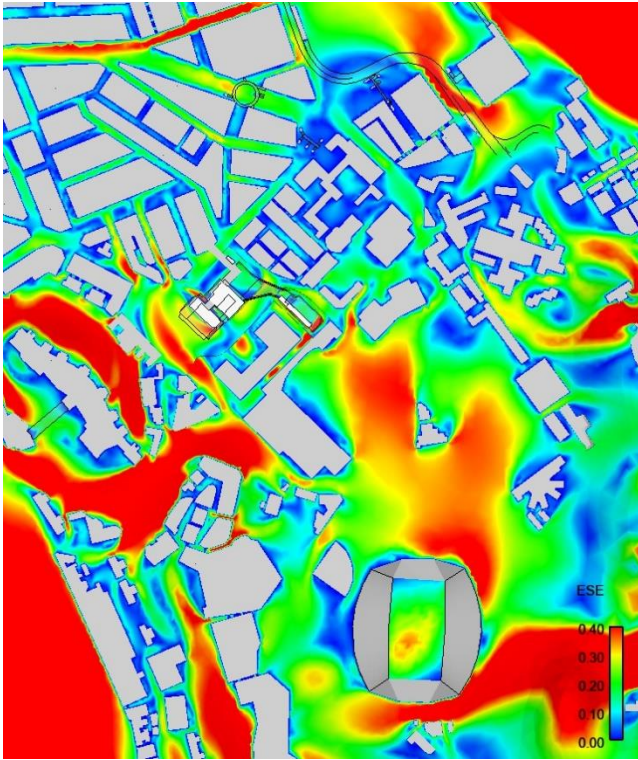


Figure C 31 Contour Plot of VR under ESE Wind

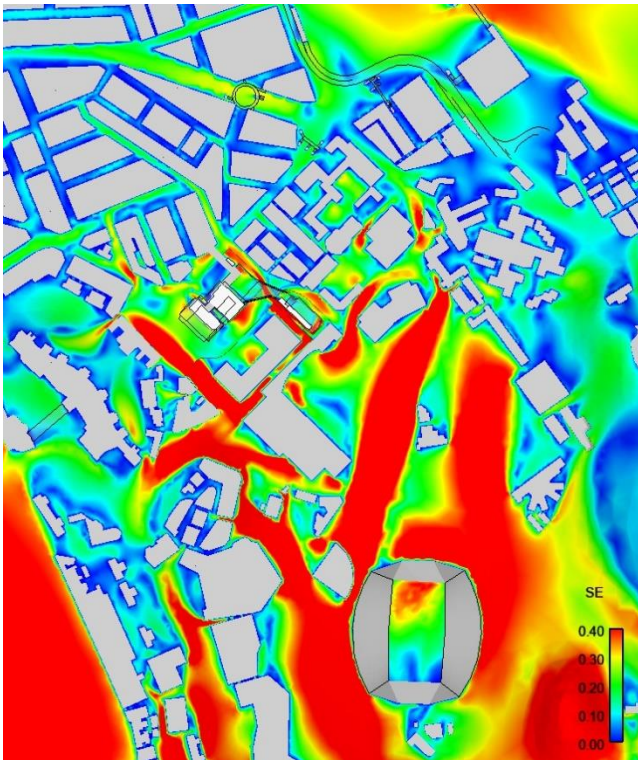


Figure C 32 Contour Plot of VR under SE Wind

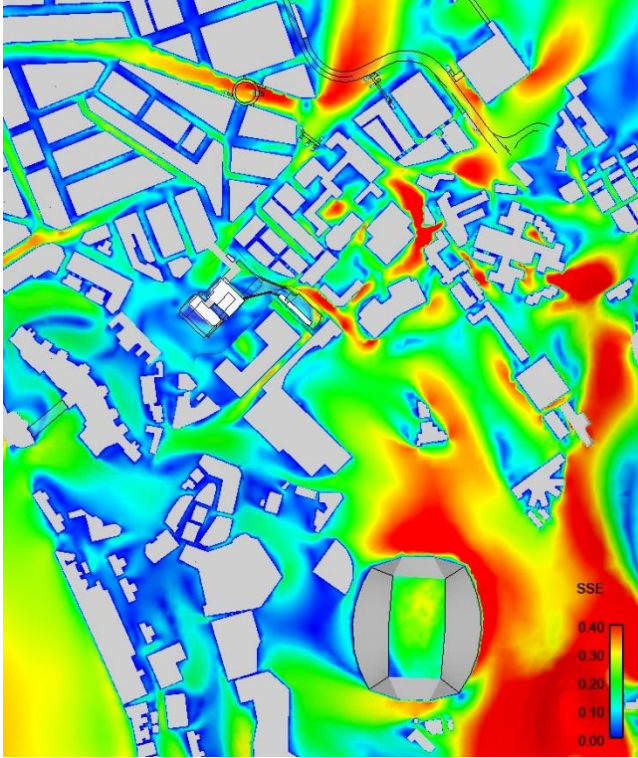


Figure C 33 Contour Plot of VR under SSE Wind

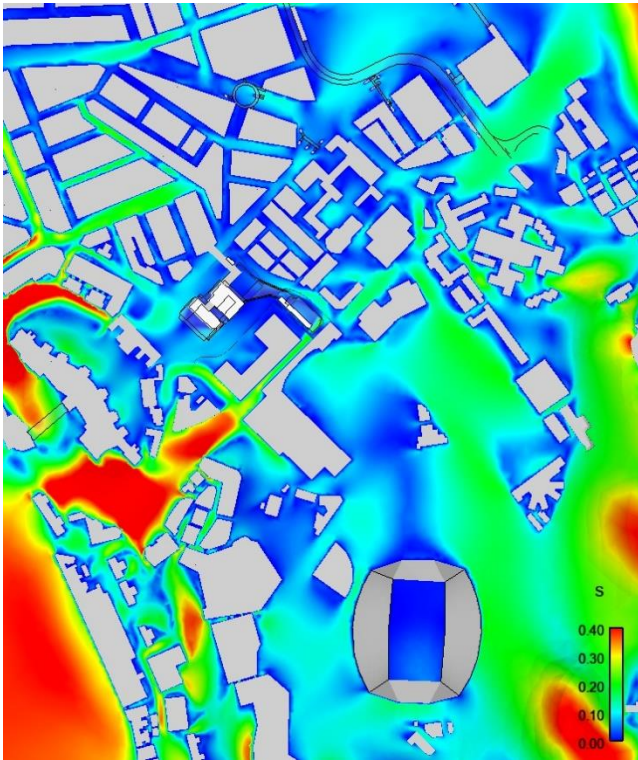


Figure C 34 Contour Plot of VR under S Wind

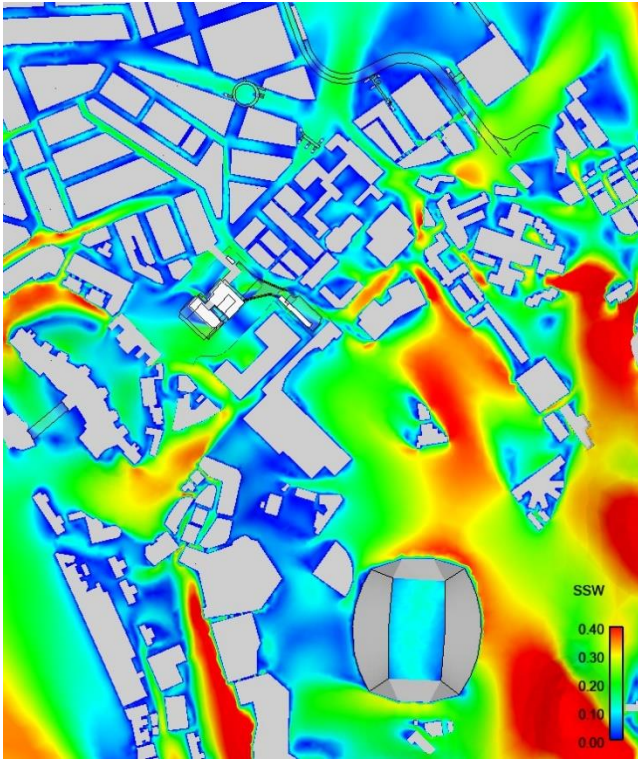


Figure C 35 Contour Plot of VR under SSW Wind

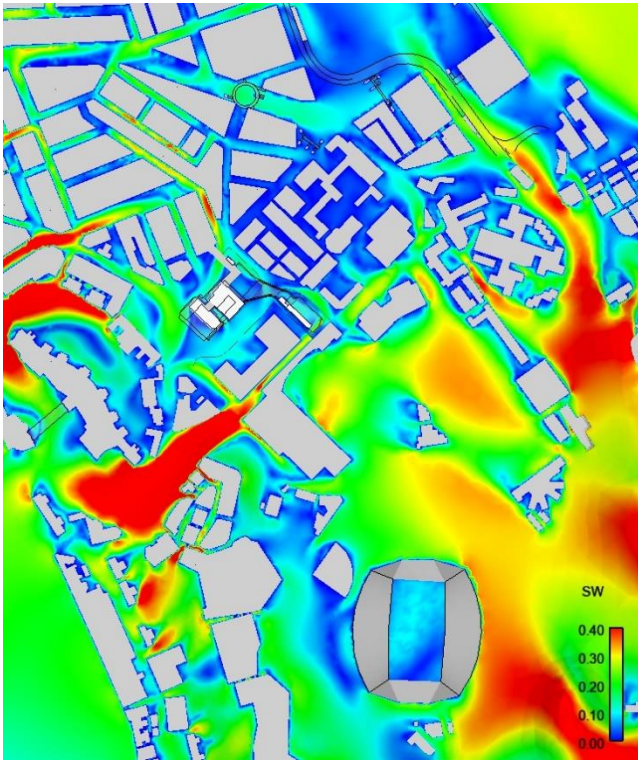


Figure C 36 Contour Plot of VR under SW Wind

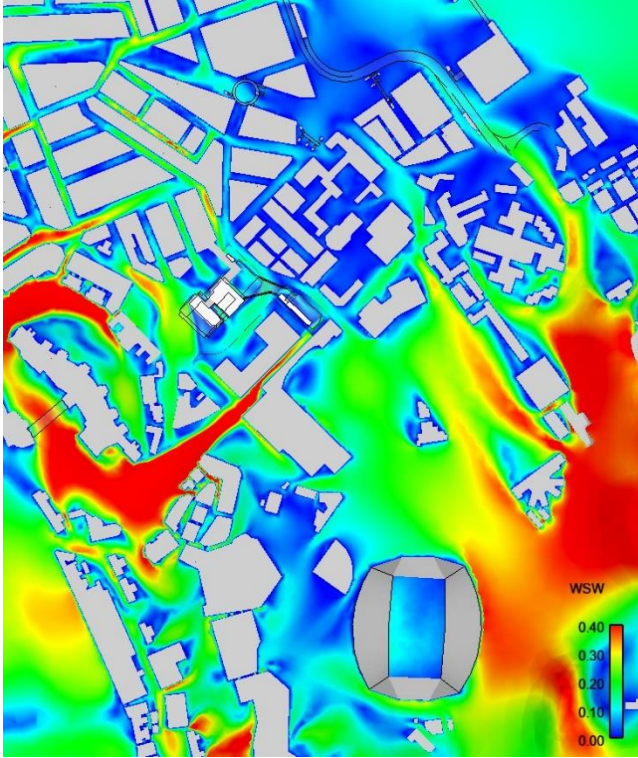


Figure C 37 Contour Plot of VR under WSW Wind

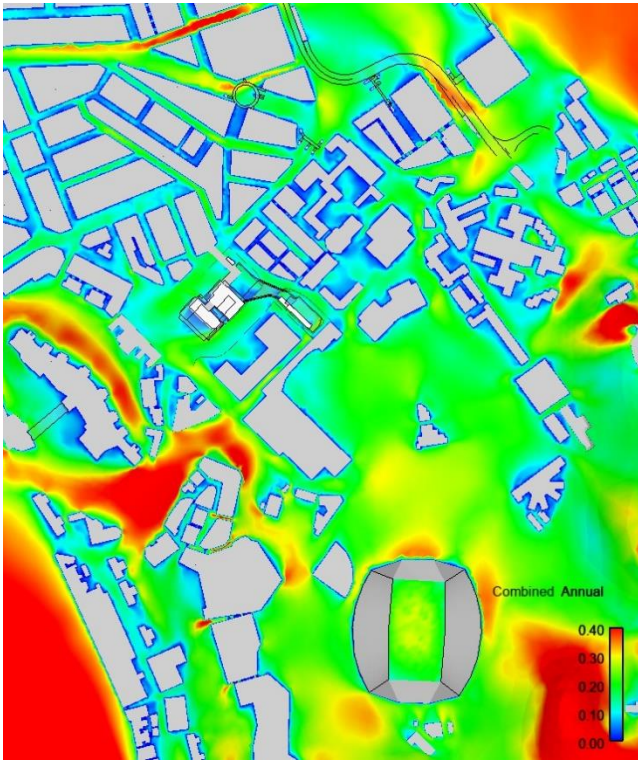


Figure C 38 Annual Weighted Average Contour Plot of VR

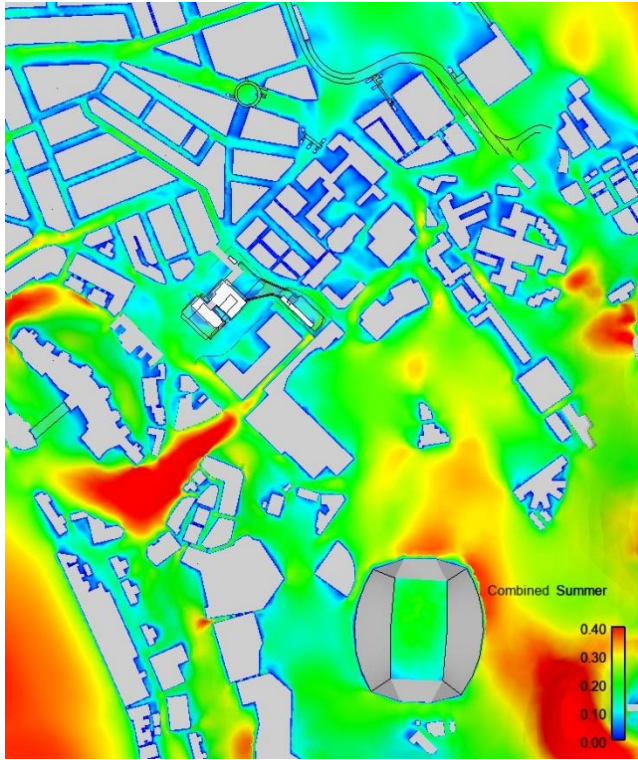


Figure C 39 Summer Weighted Average Contour Plot of VR

C4 Proposed Scheme (Computational Domain)

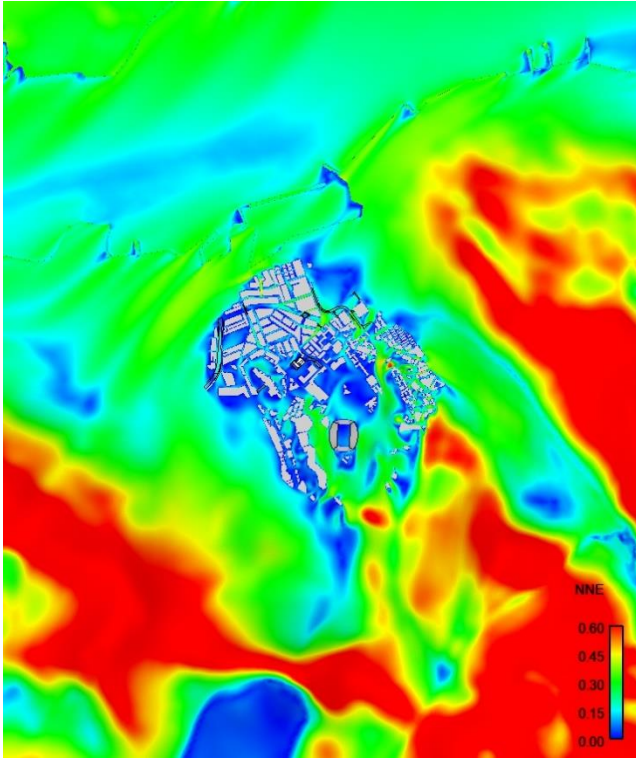


Figure C 40 Contour Plot of VR under NNE Wind

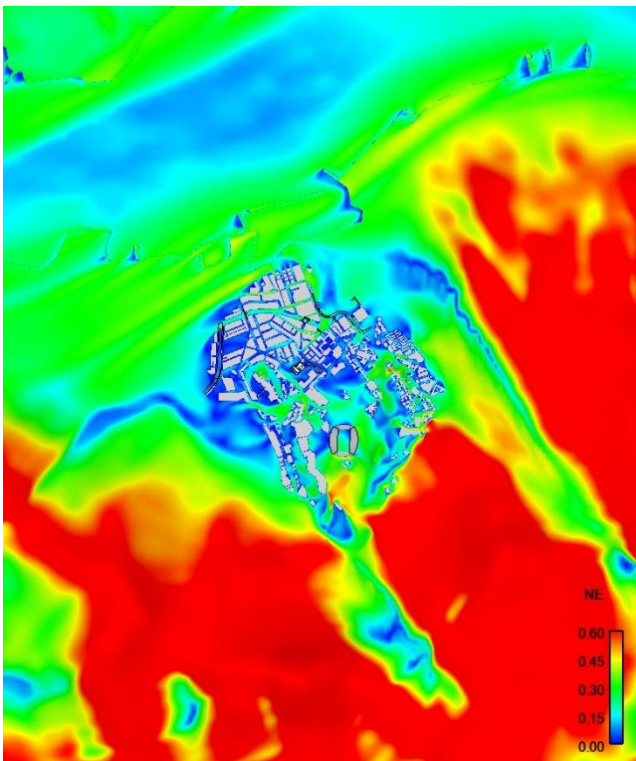


Figure C 41 Contour Plot of VR under NE Wind

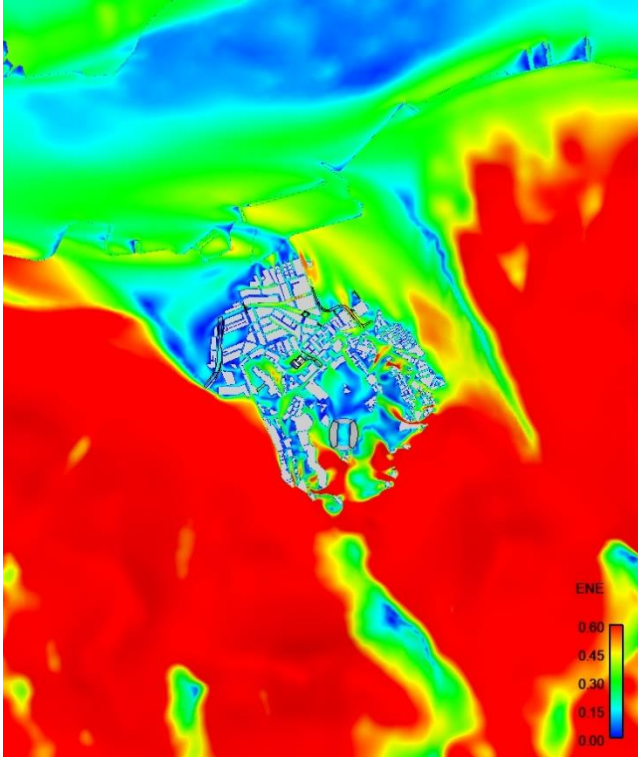


Figure C 42 Contour Plot of VR under ENE Wind

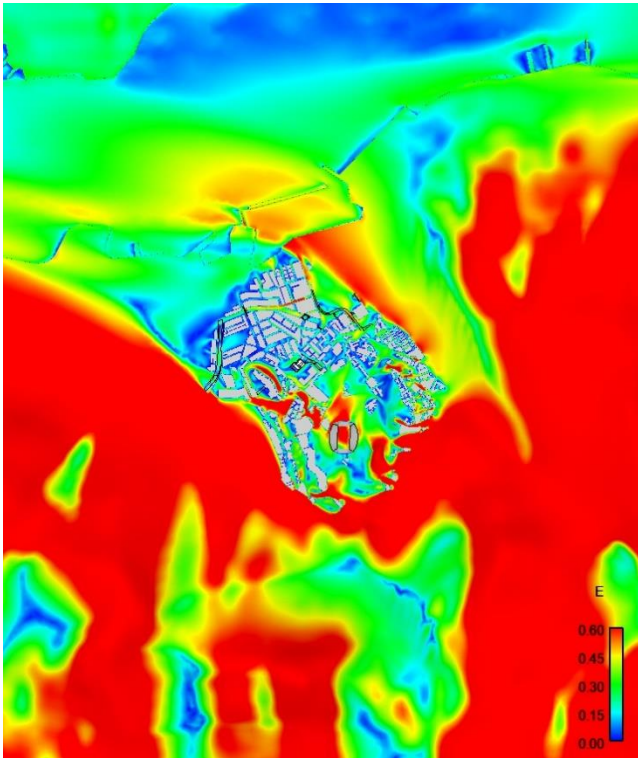


Figure C 43 Contour Plot of VR under E Wind

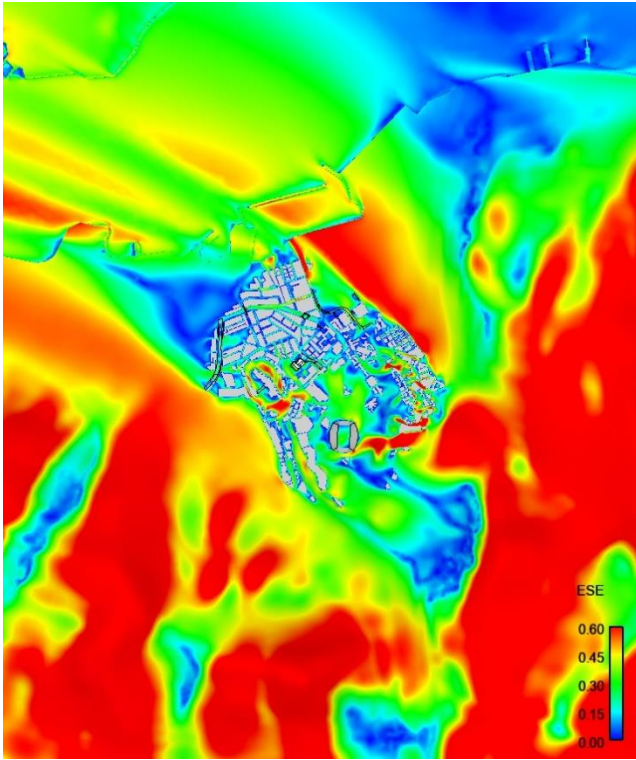


Figure C 44 Contour Plot of VR under ESE Wind

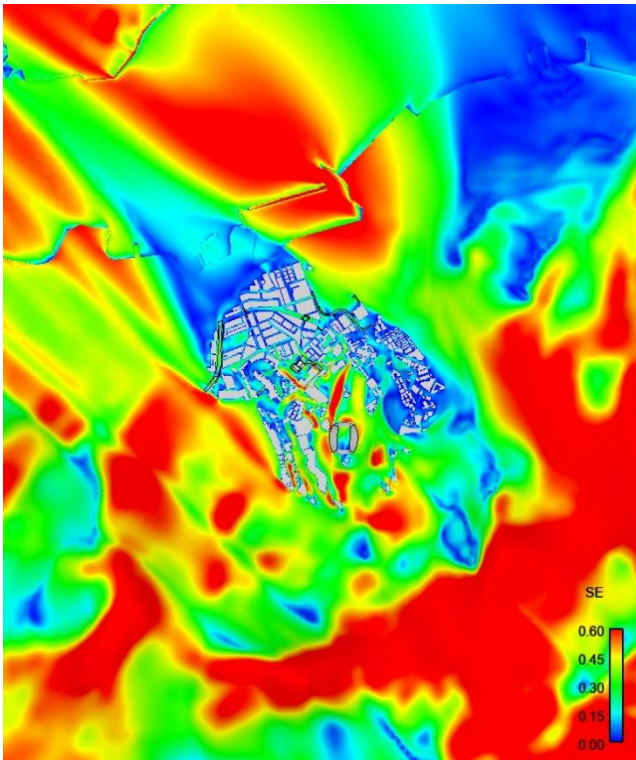


Figure C 45 Contour Plot of VR under SE Wind

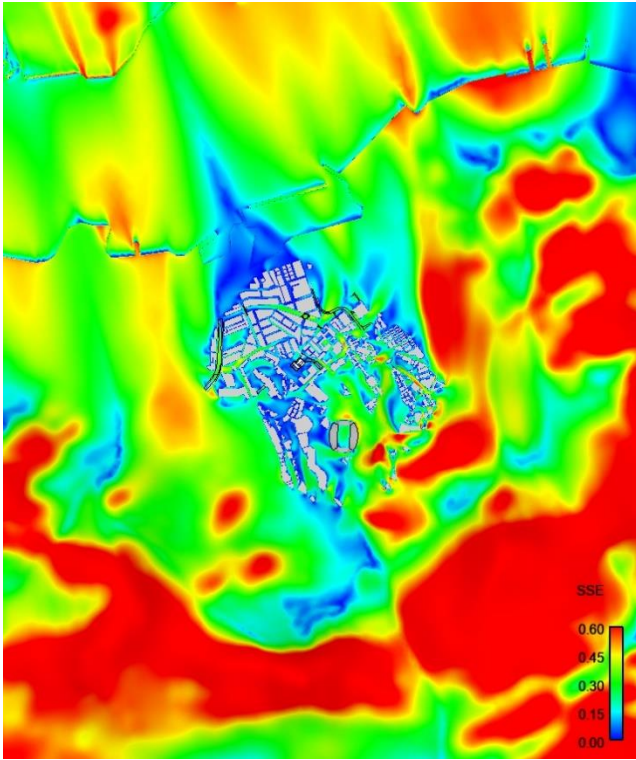


Figure C 46 Contour Plot of VR under SSE Wind

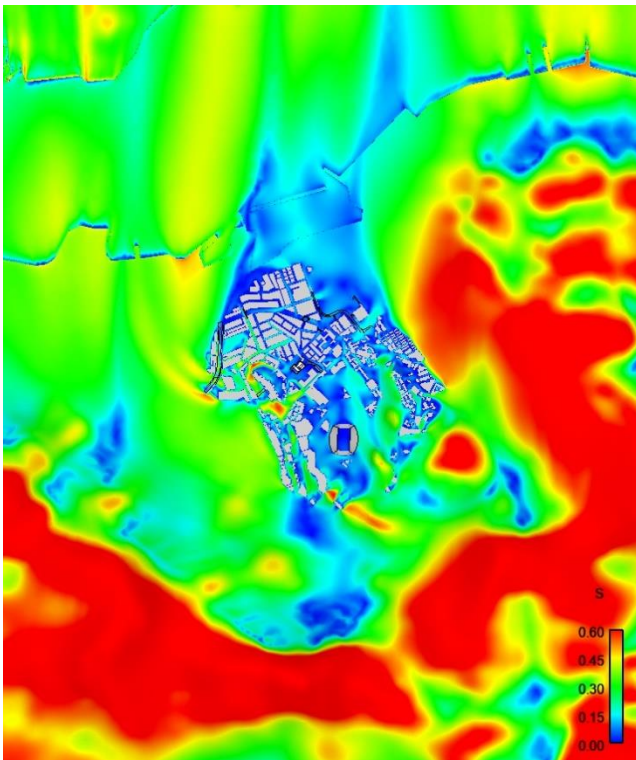


Figure C 47 Contour Plot of VR under S Wind

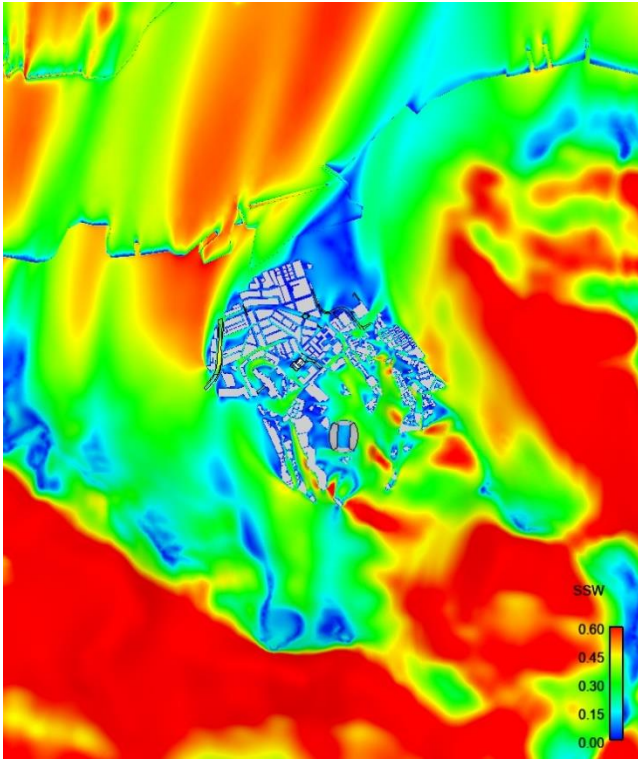


Figure C 48 Contour Plot of VR under SSW Wind

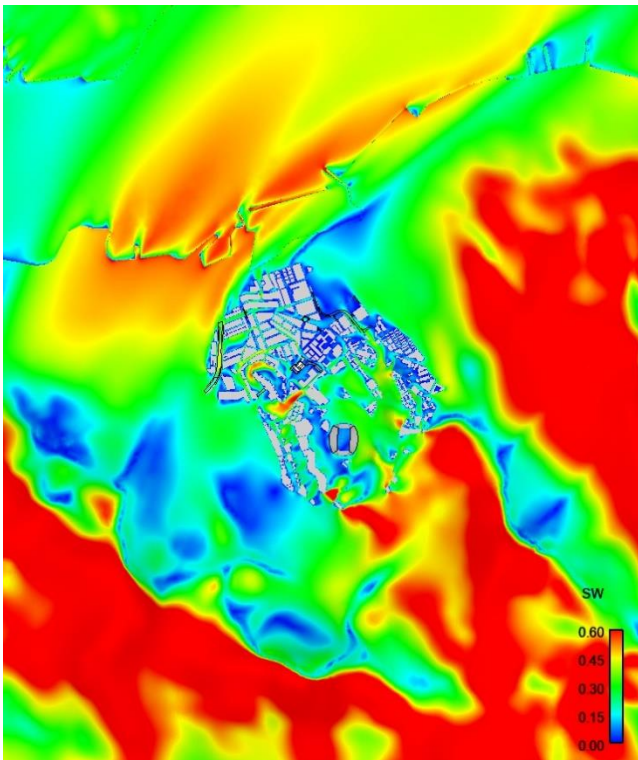


Figure C 49 Contour Plot of VR under SW Wind

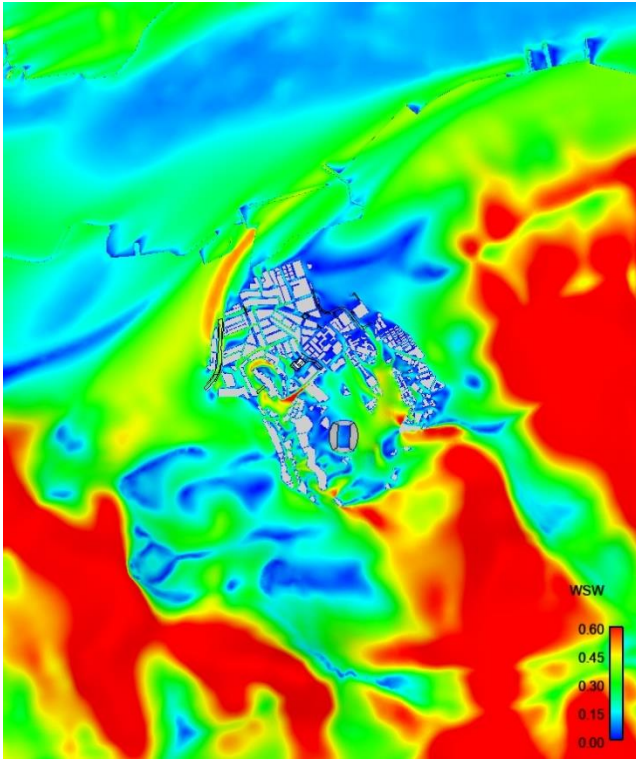


Figure C 50 Contour Plot of VR under WSW Wind

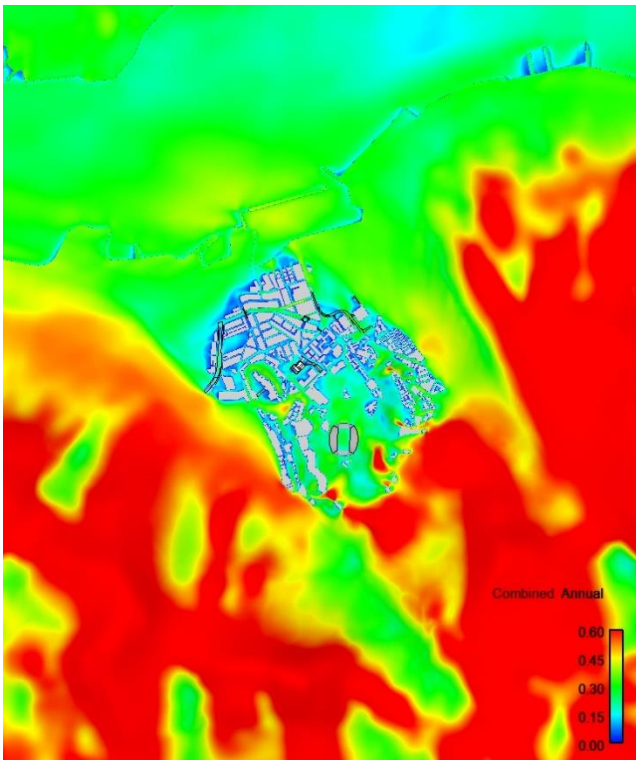


Figure C 51 Annual Weighted Average Contour Plot of VR

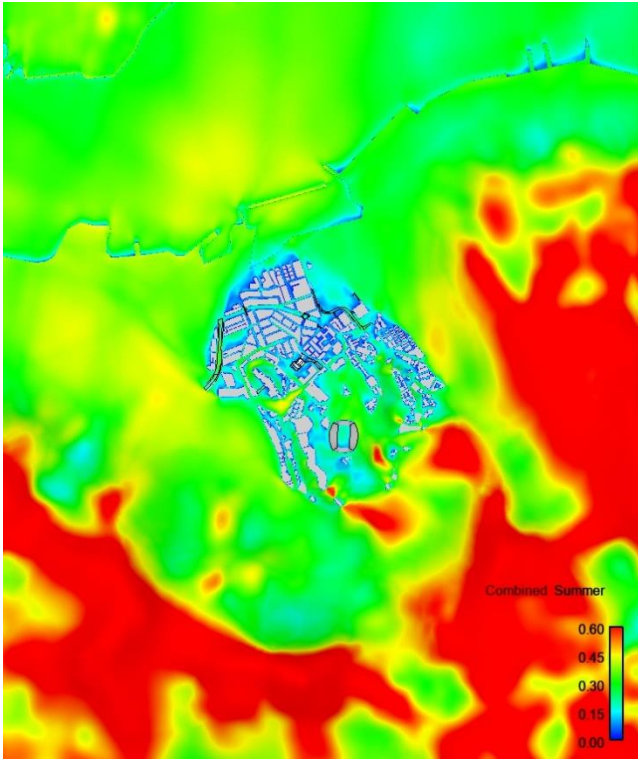


Figure C 52 Summer Weighted Average Contour Plot of VR

Appendix D

Vector Plots of Velocity Ratio (VR)

D1 Baseline Scheme

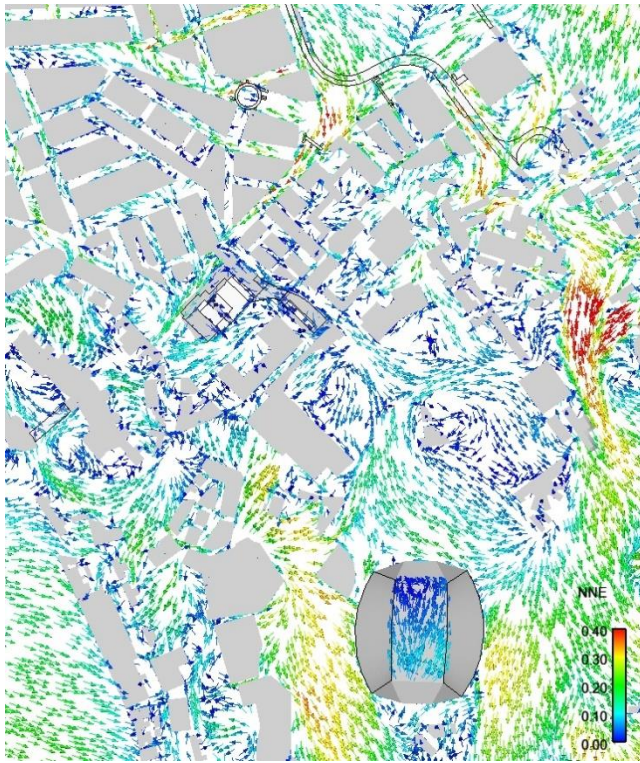


Figure D 1 Vector Plot of VR under NNE Wind

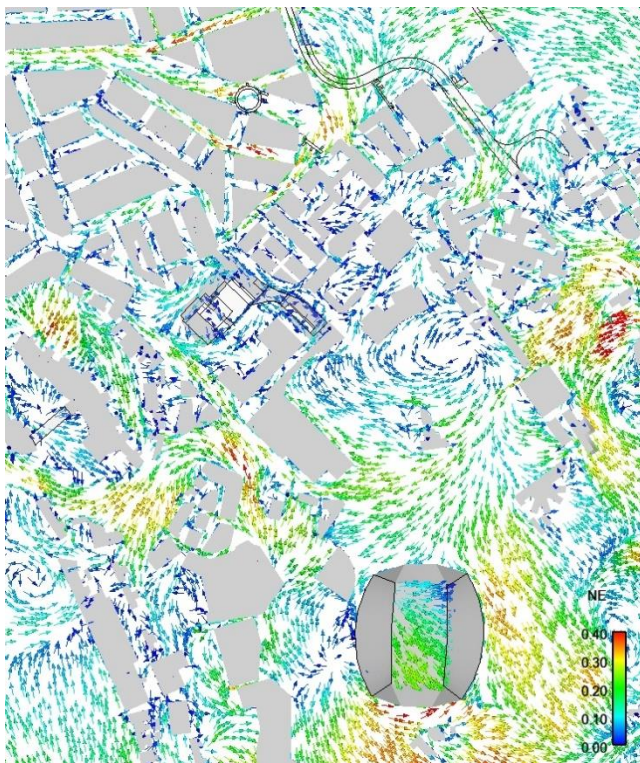


Figure D 2 Vector Plot of VR under NE Wind

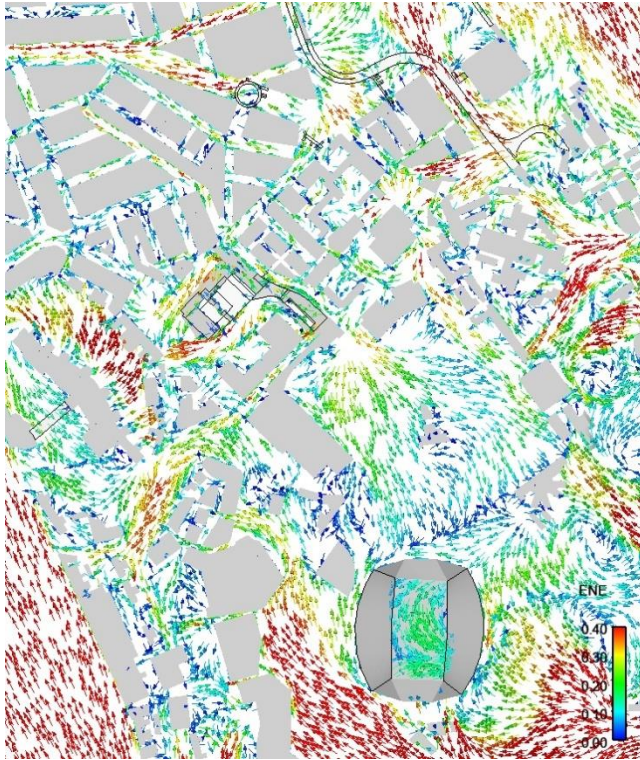


Figure D 3 Vector Plot of VR under ENE Wind

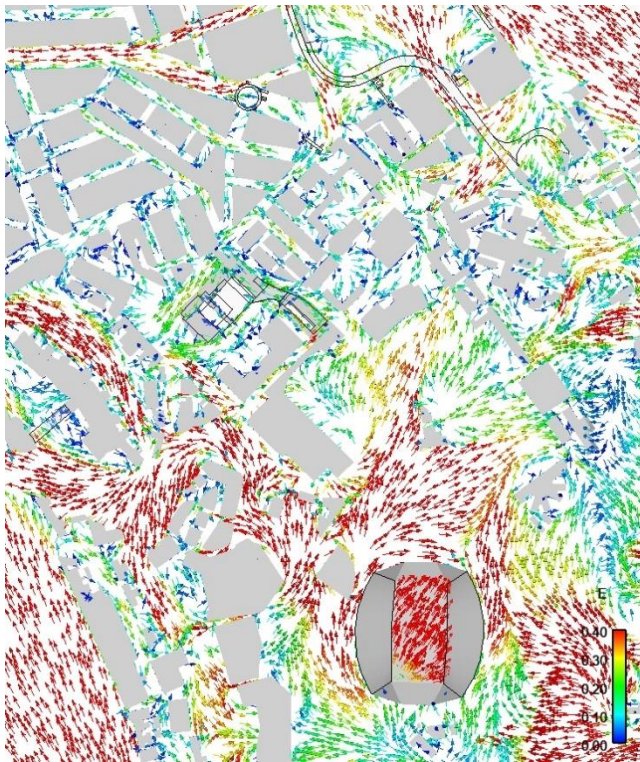


Figure D 4 Vector Plot of VR under E Wind

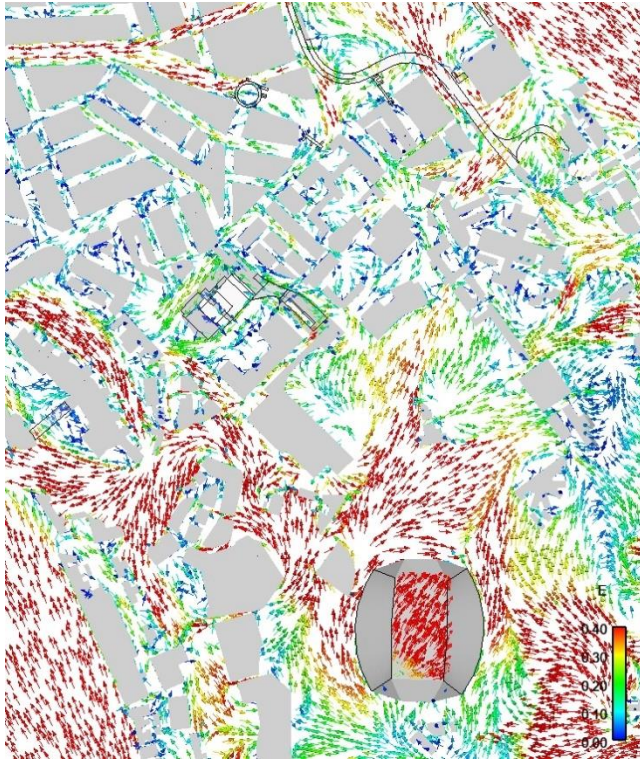


Figure D 5 Vector Plot of VR under ESE Wind

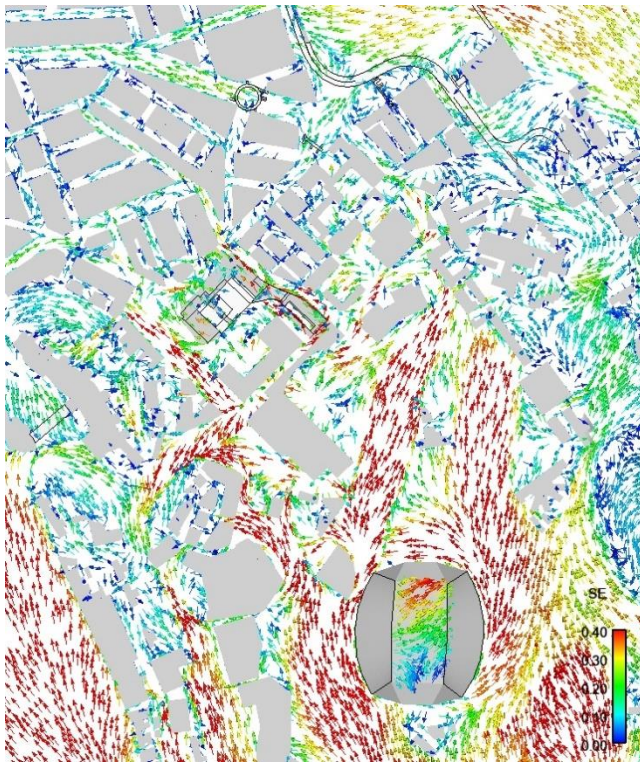


Figure D 6 Vector Plot of VR under SE Wind

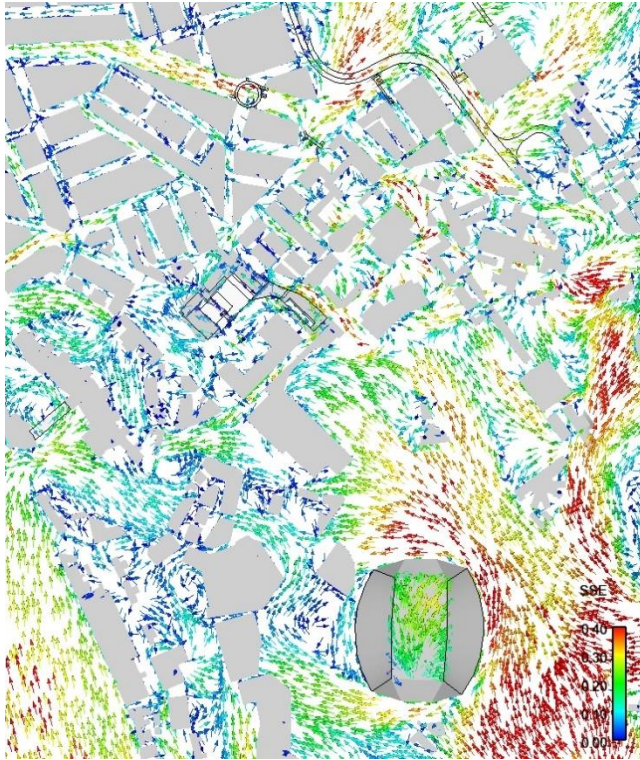


Figure D 7 Vector Plot of VR under SSE Wind



Figure D 8 Vector Plot of VR under S Wind



Figure D 9 Vector Plot of VR under SSW Wind

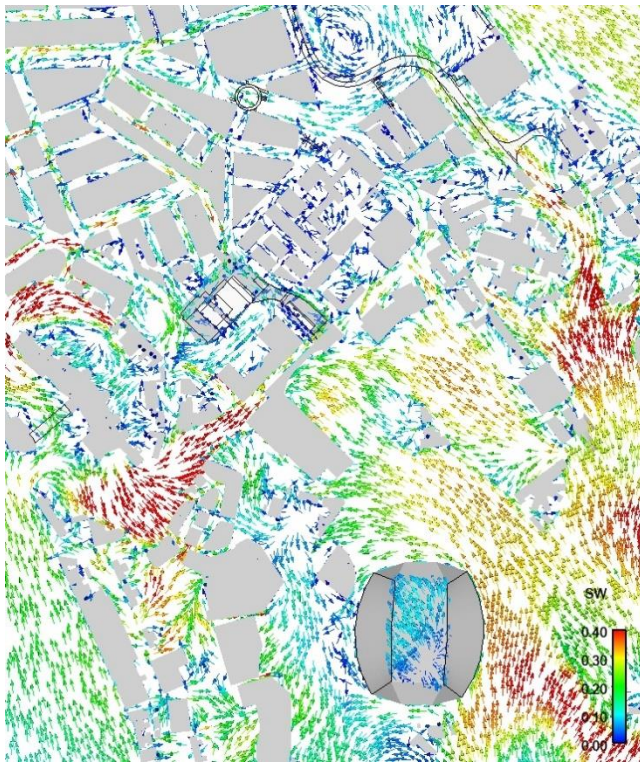


Figure D 10 Vector Plot of VR under SW Wind

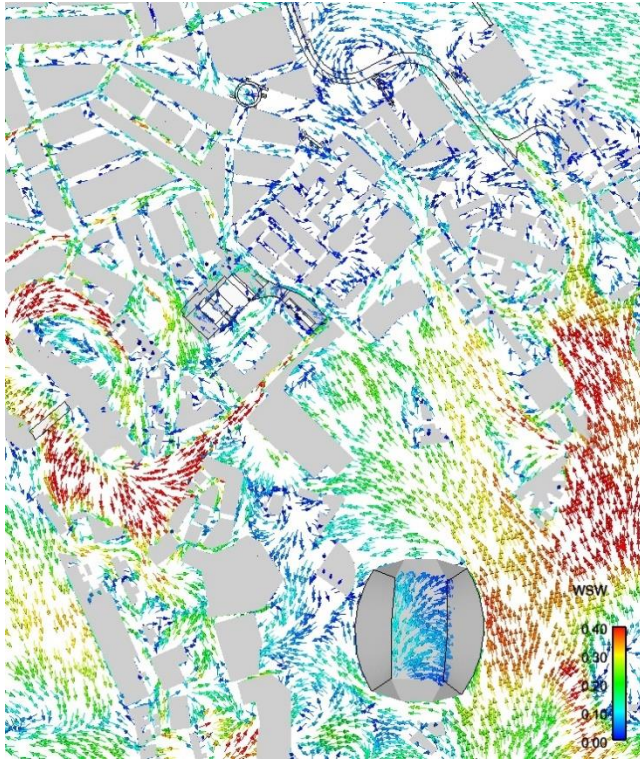


Figure D 11 Vector Plot of VR under WSW Wind

D2 Proposed Scheme



Figure D 12 Vector Plot of VR under NNE Wind

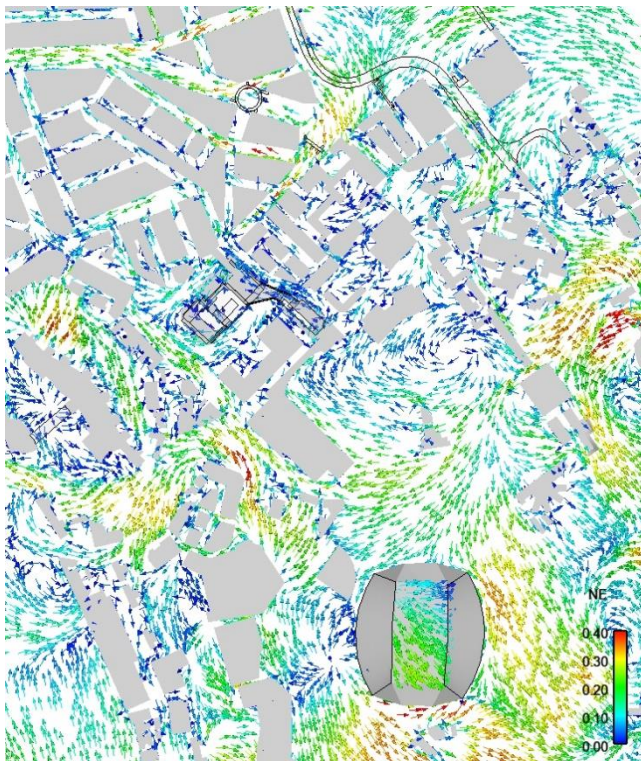


Figure D 13 Vector Plot of VR under NE Wind

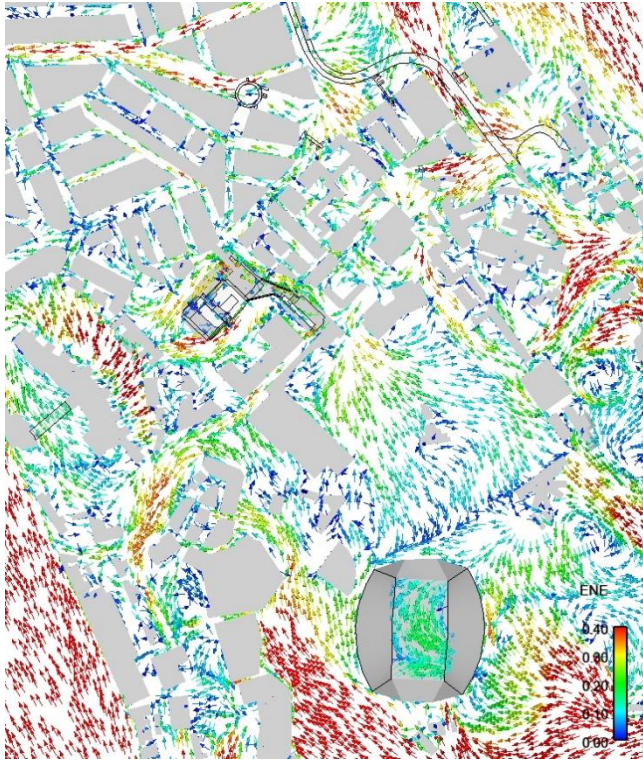


Figure D 14 Vector Plot of VR under ENE Wind

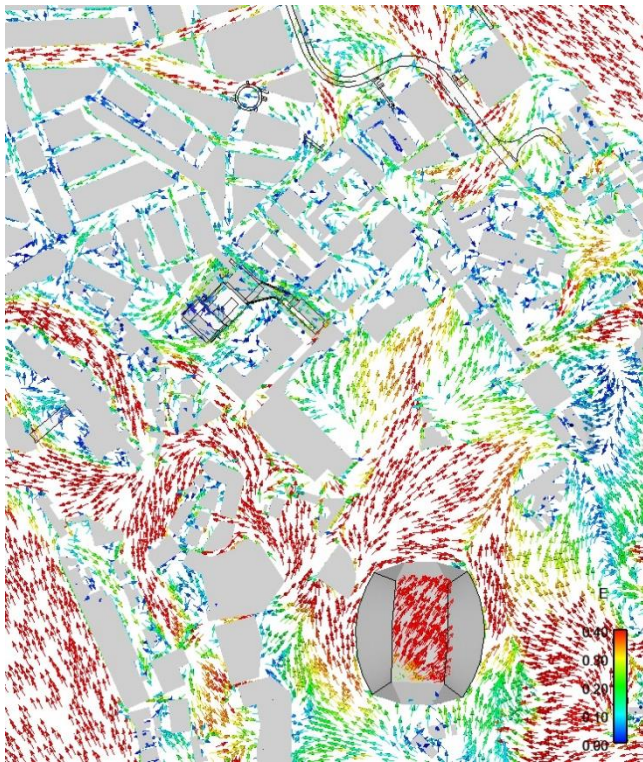


Figure D 15 Vector Plot of VR under E Wind

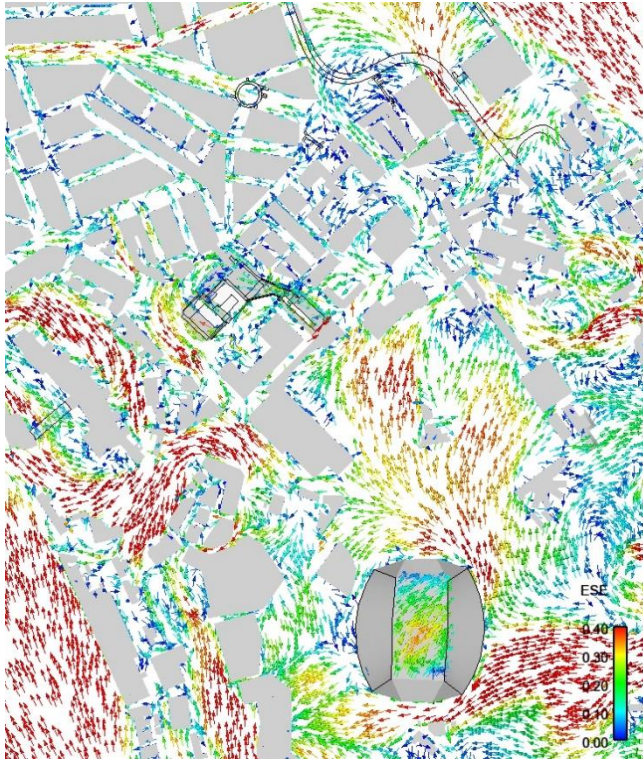


Figure D 16 Vector Plot of VR under ESE Wind

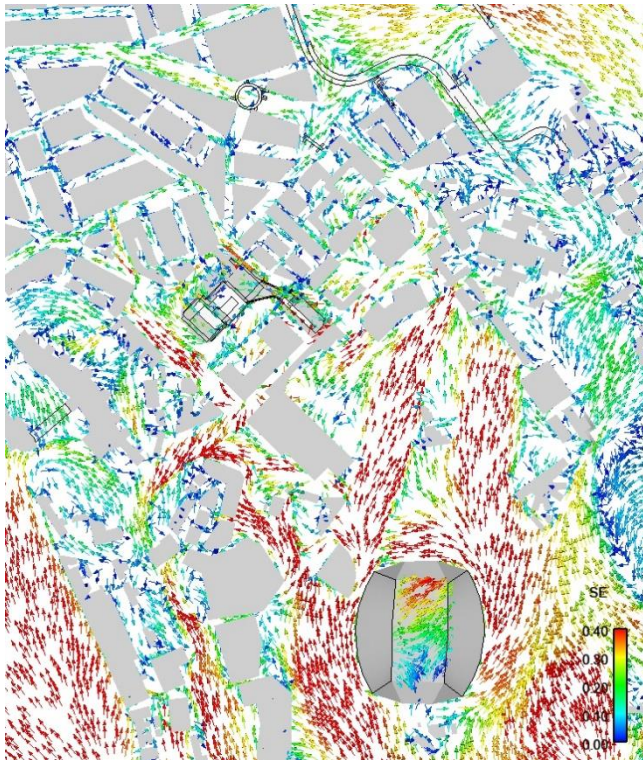


Figure D 17 Vector Plot of VR under SE Wind

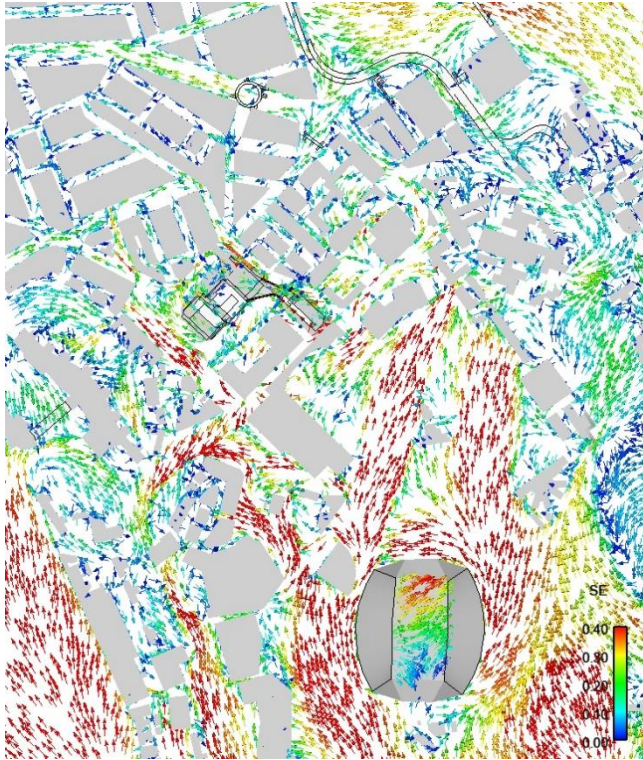


Figure D 18 Vector Plot of VR under SSE Wind

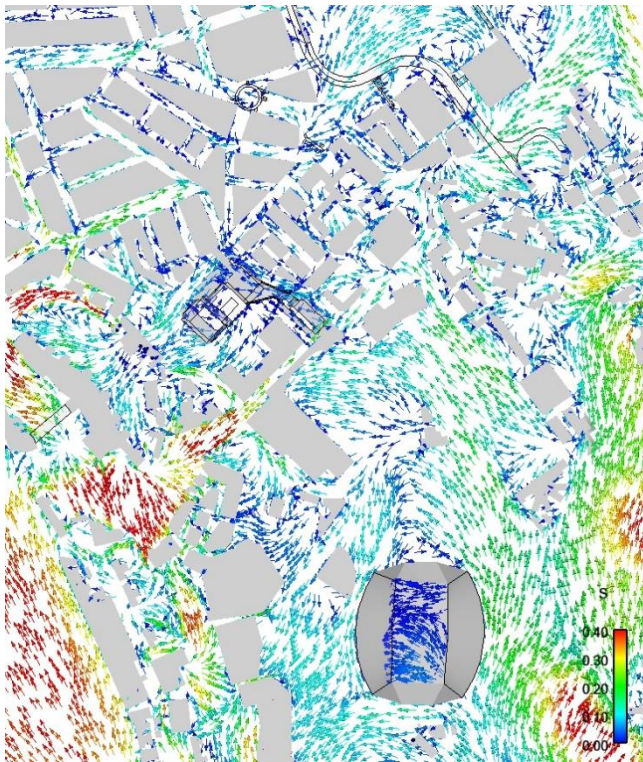


Figure D 19 Vector Plot of VR under S Wind



Figure D 20 Vector Plot of VR under SSW Wind

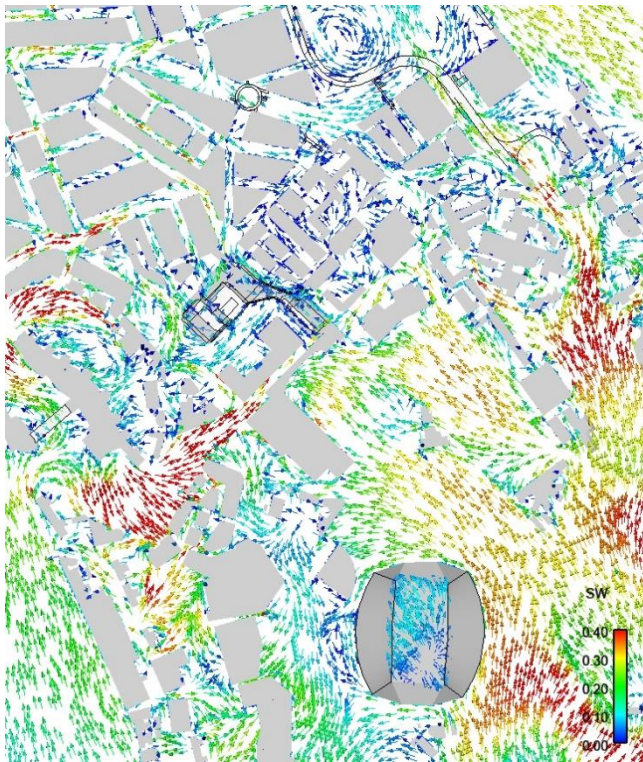


Figure D 21 Vector Plot of VR under SW Wind

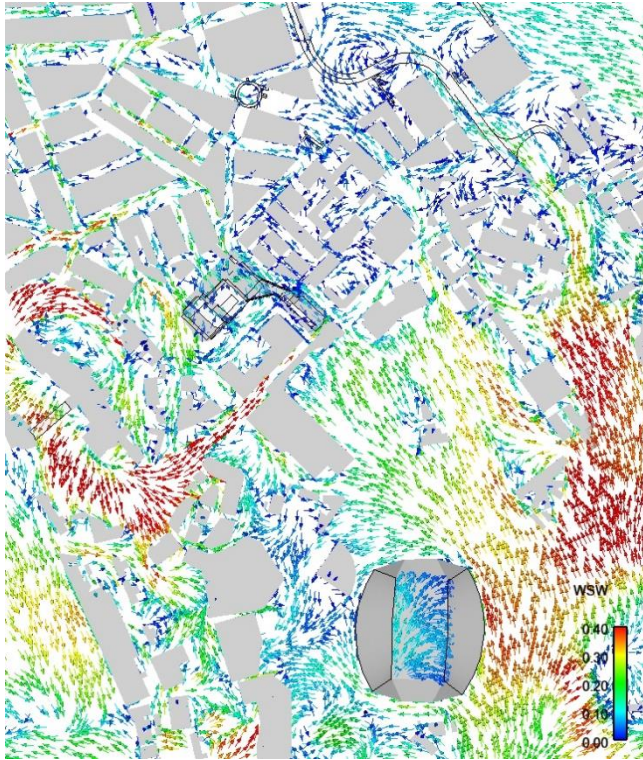


Figure D 22 Vector Plot of VR under WSW Wind

Appendix E

Velocity Ratio (VR) at Test Points

E1 Baseline Scheme

Table E1 Velocity Ratio of Perimeter Test Points

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
P1	0.04	0.06	0.23	0.13	0.16	0.23	0.16	0.07	0.14	0.15	0.14
P2	0.10	0.11	0.32	0.23	0.09	0.09	0.16	0.09	0.08	0.12	0.02
P3	0.12	0.10	0.34	0.22	0.10	0.10	0.16	0.08	0.10	0.05	0.06
P4	0.15	0.10	0.35	0.24	0.09	0.08	0.11	0.08	0.11	0.06	0.14
P5	0.19	0.12	0.34	0.27	0.13	0.22	0.06	0.09	0.09	0.04	0.04
P6	0.18	0.12	0.32	0.27	0.16	0.08	0.10	0.09	0.04	0.03	0.06
P7	0.17	0.10	0.30	0.25	0.14	0.20	0.06	0.10	0.04	0.10	0.10
P8	0.16	0.08	0.27	0.23	0.26	0.18	0.05	0.11	0.06	0.17	0.22
P9	0.13	0.06	0.23	0.20	0.29	0.22	0.06	0.11	0.06	0.19	0.23
P10	0.07	0.03	0.21	0.07	0.30	0.21	0.07	0.07	0.12	0.18	0.22
P11	0.07	0.11	0.16	0.14	0.31	0.21	0.08	0.08	0.18	0.04	0.20
P12	0.12	0.11	0.40	0.23	0.25	0.20	0.09	0.09	0.20	0.07	0.17
P13	0.11	0.10	0.35	0.17	0.18	0.19	0.06	0.09	0.20	0.10	0.14
P14	0.08	0.20	0.18	0.30	0.38	0.45	0.09	0.11	0.16	0.16	0.06
P15	0.12	0.07	0.31	0.13	0.10	0.14	0.04	0.09	0.18	0.11	0.08
P16	0.10	0.06	0.25	0.11	0.07	0.13	0.05	0.08	0.16	0.10	0.07
P17	0.10	0.07	0.26	0.10	0.06	0.13	0.05	0.09	0.16	0.12	0.10
P18	0.10	0.06	0.26	0.09	0.06	0.08	0.07	0.08	0.14	0.12	0.13
P19	0.09	0.05	0.27	0.08	0.07	0.07	0.03	0.07	0.10	0.12	0.14
P20	0.08	0.04	0.28	0.07	0.08	0.08	0.02	0.05	0.03	0.13	0.14
P21	0.06	0.05	0.27	0.09	0.09	0.08	0.03	0.04	0.05	0.13	0.15
P22	0.04	0.06	0.25	0.08	0.08	0.10	0.03	0.02	0.10	0.11	0.14
P23	0.02	0.06	0.24	0.06	0.06	0.10	0.03	0.01	0.14	0.07	0.11
P24	0.06	0.09	0.21	0.26	0.23	0.52	0.20	0.01	0.13	0.04	0.09
P25	0.05	0.07	0.17	0.24	0.26	0.53	0.22	0.01	0.04	0.03	0.08
P26	0.04	0.06	0.15	0.24	0.23	0.52	0.20	0.02	0.07	0.05	0.06
P27	0.05	0.05	0.17	0.26	0.23	0.52	0.17	0.03	0.11	0.06	0.05
P28	0.07	0.08	0.31	0.34	0.35	0.57	0.22	0.06	0.11	0.08	0.06
P29	0.06	0.08	0.22	0.30	0.37	0.49	0.20	0.16	0.08	0.27	0.23
P30	0.06	0.06	0.24	0.26	0.37	0.40	0.14	0.15	0.05	0.25	0.22
P31	0.07	0.07	0.27	0.28	0.40	0.44	0.20	0.13	0.12	0.20	0.18
P32	0.07	0.02	0.20	0.19	0.24	0.34	0.30	0.12	0.23	0.19	0.14
P33	0.05	0.03	0.23	0.27	0.28	0.42	0.36	0.13	0.19	0.19	0.16
P34	0.03	0.05	0.23	0.19	0.30	0.45	0.36	0.09	0.03	0.14	0.12
P35	0.03	0.06	0.27	0.18	0.30	0.46	0.25	0.08	0.03	0.10	0.09
P36	0.04	0.05	0.16	0.18	0.12	0.26	0.13	0.06	0.13	0.03	0.05
P37	0.05	0.06	0.18	0.20	0.23	0.25	0.10	0.07	0.14	0.05	0.05
P38	0.06	0.05	0.19	0.18	0.33	0.47	0.10	0.05	0.21	0.11	0.12
P39	0.06	0.06	0.24	0.18	0.19	0.41	0.02	0.05	0.18	0.11	0.12
P40	0.06	0.06	0.23	0.16	0.22	0.40	0.03	0.04	0.18	0.12	0.12
P41	0.05	0.06	0.21	0.13	0.24	0.40	0.04	0.02	0.19	0.12	0.12
P42	0.04	0.06	0.16	0.13	0.24	0.40	0.05	0.03	0.20	0.12	0.11

Table E2 Velocity Ratio of Overall Test Points

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O1	0.04	0.13	0.18	0.77	0.25	0.33	0.33	0.01	0.13	0.09	0.05
O2	0.03	0.19	0.15	0.80	0.22	0.39	0.27	0.01	0.12	0.09	0.10
O3	0.08	0.27	0.13	0.67	0.35	0.20	0.24	0.02	0.12	0.10	0.11
O4	0.08	0.22	0.19	0.72	0.31	0.21	0.27	0.03	0.11	0.06	0.08
O5	0.11	0.26	0.16	0.57	0.10	0.07	0.19	0.05	0.08	0.05	0.05
O6	0.09	0.28	0.18	0.38	0.28	0.12	0.15	0.04	0.11	0.06	0.09
O7	0.05	0.11	0.20	0.05	0.25	0.22	0.02	0.23	0.11	0.05	0.10
O8	0.17	0.15	0.18	0.34	0.37	0.45	0.06	0.11	0.33	0.22	0.24
O9	0.05	0.29	0.29	0.87	0.51	0.64	0.07	0.36	0.40	0.39	0.38
O10	0.07	0.11	0.09	0.31	0.38	0.49	0.15	0.13	0.08	0.22	0.07
O11	0.05	0.03	0.11	0.13	0.02	0.08	0.18	0.13	0.13	0.06	0.04
O12	0.05	0.13	0.10	0.07	0.24	0.15	0.35	0.19	0.31	0.37	0.20
O13	0.03	0.10	0.10	0.15	0.29	0.29	0.29	0.14	0.22	0.35	0.18
O14	0.05	0.10	0.07	0.04	0.24	0.11	0.13	0.05	0.11	0.07	0.09
O15	0.06	0.31	0.47	0.28	0.16	0.08	0.26	0.05	0.06	0.26	0.29
O16	0.03	0.30	0.24	0.24	0.28	0.08	0.22	0.05	0.10	0.28	0.27
O17	0.03	0.27	0.13	0.23	0.30	0.12	0.18	0.06	0.14	0.27	0.17
O18	0.04	0.28	0.33	0.26	0.26	0.10	0.18	0.08	0.15	0.24	0.07
O19	0.03	0.03	0.06	0.13	0.09	0.18	0.15	0.07	0.17	0.11	0.13
O20	0.04	0.10	0.11	0.14	0.13	0.25	0.24	0.10	0.24	0.15	0.14
O21	0.04	0.10	0.17	0.12	0.13	0.29	0.22	0.09	0.22	0.14	0.08
O22	0.05	0.12	0.21	0.16	0.15	0.35	0.12	0.06	0.12	0.09	0.05
O23	0.05	0.08	0.28	0.19	0.16	0.23	0.36	0.17	0.33	0.22	0.13
O24	0.06	0.20	0.07	0.20	0.18	0.07	0.14	0.03	0.07	0.23	0.33
O25	0.02	0.03	0.04	0.06	0.04	0.05	0.14	0.03	0.05	0.17	0.23
O26	0.06	0.12	0.06	0.23	0.19	0.25	0.14	0.09	0.14	0.18	0.22
O27	0.10	0.09	0.15	0.25	0.20	0.39	0.32	0.14	0.37	0.31	0.23
O28	0.05	0.06	0.13	0.31	0.31	0.41	0.16	0.09	0.25	0.21	0.15
O29	0.02	0.03	0.07	0.31	0.09	0.45	0.16	0.15	0.33	0.31	0.24
O30	0.08	0.08	0.08	0.21	0.21	0.26	0.22	0.16	0.35	0.34	0.26
O31	0.03	0.18	0.11	0.25	0.33	0.43	0.17	0.15	0.28	0.34	0.29
O32	0.01	0.21	0.10	0.23	0.15	0.24	0.34	0.16	0.39	0.29	0.29
O33	0.01	0.14	0.14	0.41	0.36	0.45	0.32	0.18	0.36	0.21	0.31
O34	0.03	0.13	0.16	0.32	0.33	0.39	0.11	0.10	0.16	0.28	0.19
O35	0.03	0.21	0.07	0.48	0.34	0.35	0.32	0.14	0.35	0.30	0.24
O36	0.08	0.18	0.08	0.49	0.34	0.35	0.34	0.13	0.33	0.32	0.26
O37	0.14	0.19	0.08	0.58	0.32	0.20	0.35	0.06	0.27	0.28	0.23
O38	0.09	0.24	0.10	0.55	0.33	0.18	0.34	0.04	0.29	0.30	0.22
O39	0.06	0.16	0.11	0.21	0.13	0.15	0.29	0.09	0.19	0.21	0.32
O40	0.06	0.19	0.07	0.23	0.11	0.13	0.24	0.06	0.12	0.27	0.37
O41	0.04	0.19	0.05	0.14	0.10	0.13	0.20	0.09	0.18	0.25	0.26
O42	0.02	0.16	0.05	0.04	0.07	0.14	0.14	0.11	0.19	0.27	0.21
O43	0.09	0.07	0.07	0.05	0.12	0.38	0.32	0.16	0.34	0.28	0.16
O44	0.12	0.05	0.18	0.10	0.16	0.22	0.30	0.11	0.27	0.20	0.18
O45	0.16	0.10	0.34	0.18	0.22	0.45	0.55	0.18	0.38	0.23	0.20
O46	0.22	0.13	0.41	0.17	0.16	0.31	0.42	0.13	0.26	0.19	0.15
O47	0.15	0.08	0.32	0.08	0.06	0.15	0.16	0.18	0.38	0.33	0.16
O48	0.12	0.06	0.33	0.26	0.09	0.35	0.28	0.13	0.34	0.22	0.29

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O49	0.10	0.03	0.27	0.22	0.04	0.26	0.10	0.19	0.35	0.31	0.31
O50	0.07	0.08	0.13	0.12	0.24	0.41	0.24	0.19	0.34	0.31	0.34
O51	0.05	0.18	0.20	0.21	0.25	0.19	0.27	0.14	0.24	0.29	0.37
O52	0.01	0.11	0.07	0.21	0.19	0.16	0.09	0.06	0.09	0.17	0.11
O53	0.04	0.20	0.07	0.36	0.34	0.44	0.31	0.18	0.32	0.33	0.32
O54	0.12	0.19	0.05	0.42	0.37	0.38	0.35	0.13	0.32	0.31	0.28
O55	0.16	0.16	0.05	0.67	0.32	0.40	0.42	0.04	0.27	0.25	0.18
O56	0.13	0.17	0.11	0.53	0.26	0.49	0.31	0.10	0.20	0.23	0.16
O57	0.14	0.22	0.16	0.58	0.28	0.63	0.28	0.09	0.21	0.24	0.19
O58	0.15	0.19	0.13	0.56	0.28	0.45	0.31	0.09	0.21	0.25	0.18
O59	0.14	0.19	0.13	0.55	0.26	0.51	0.31	0.10	0.20	0.24	0.17
O60	0.14	0.22	0.13	0.58	0.27	0.69	0.28	0.10	0.19	0.23	0.17
O61	0.12	0.14	0.06	0.86	0.21	0.43	0.40	0.03	0.32	0.23	0.14
O62	0.19	0.09	0.13	0.67	0.39	0.58	0.46	0.03	0.37	0.26	0.17
O63	0.15	0.09	0.04	0.48	0.27	0.35	0.12	0.09	0.12	0.18	0.11
O64	0.25	0.22	0.01	0.57	0.27	0.36	0.06	0.10	0.04	0.09	0.07
O65	0.31	0.07	0.16	0.44	0.04	0.29	0.02	0.03	0.10	0.03	0.01
O66	0.29	0.04	0.15	0.36	0.03	0.28	0.04	0.03	0.09	0.05	0.03
O67	0.29	0.25	0.10	0.71	0.11	0.24	0.12	0.05	0.03	0.07	0.04
O68	0.26	0.18	0.07	0.61	0.10	0.16	0.03	0.03	0.02	0.02	0.02
O69	0.06	0.24	0.13	0.64	0.05	0.29	0.05	0.04	0.03	0.05	0.02
O70	0.32	0.27	0.25	0.66	0.19	0.57	0.13	0.05	0.03	0.09	0.07
O71	0.08	0.05	0.23	0.33	0.37	0.45	0.22	0.10	0.24	0.25	0.19
O72	0.10	0.09	0.15	0.42	0.39	0.68	0.11	0.02	0.10	0.08	0.13
O73	0.08	0.07	0.12	0.52	0.37	0.54	0.11	0.01	0.10	0.08	0.11
O74	0.15	0.25	0.15	0.60	0.31	0.66	0.29	0.07	0.23	0.26	0.20
O75	0.14	0.23	0.12	0.59	0.27	0.70	0.27	0.09	0.19	0.23	0.17
O76	0.18	0.17	0.06	0.51	0.20	0.54	0.21	0.09	0.15	0.18	0.13
O77	0.06	0.25	0.02	0.34	0.26	0.28	0.19	0.09	0.16	0.24	0.19
O78	0.19	0.23	0.14	0.51	0.25	0.49	0.05	0.16	0.02	0.25	0.24
O79	0.01	0.05	0.26	0.18	0.24	0.24	0.15	0.11	0.20	0.28	0.16
O80	0.06	0.07	0.24	0.24	0.33	0.13	0.21	0.09	0.23	0.27	0.21
O81	0.10	0.09	0.17	0.32	0.36	0.64	0.23	0.03	0.24	0.14	0.20
O82	0.05	0.20	0.21	0.24	0.32	0.24	0.26	0.04	0.22	0.16	0.14
O83	0.02	0.18	0.21	0.16	0.09	0.18	0.20	0.05	0.19	0.32	0.19
O84	0.04	0.12	0.17	0.15	0.08	0.16	0.14	0.06	0.14	0.19	0.10
O85	0.04	0.23	0.33	0.64	0.32	0.60	0.08	0.13	0.21	0.37	0.28
O86	0.18	0.17	0.23	0.50	0.32	0.41	0.11	0.06	0.05	0.09	0.16
O87	0.24	0.34	0.05	0.78	0.22	0.39	0.04	0.02	0.05	0.20	0.11
O88	0.06	0.26	0.32	0.78	0.50	0.11	0.06	0.31	0.32	0.53	0.53
O89	0.14	0.10	0.09	0.06	0.10	0.22	0.04	0.08	0.19	0.26	0.25
O90	0.15	0.07	0.14	0.06	0.23	0.29	0.06	0.23	0.22	0.44	0.28
O91	0.04	0.02	0.06	0.08	0.09	0.06	0.06	0.09	0.29	0.18	0.09
O92	0.08	0.03	0.04	0.07	0.07	0.05	0.04	0.11	0.26	0.23	0.17
O93	0.15	0.14	0.11	0.24	0.11	0.04	0.01	0.16	0.14	0.32	0.09
O94	0.08	0.10	0.05	0.17	0.05	0.07	0.04	0.18	0.12	0.25	0.26
O95	0.11	0.10	0.09	0.05	0.08	0.07	0.03	0.20	0.23	0.35	0.46
O96	0.12	0.20	0.18	0.45	0.39	0.13	0.08	0.21	0.22	0.36	0.30
O97	0.13	0.14	0.21	0.48	0.34	0.12	0.05	0.18	0.17	0.26	0.24

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O98	0.05	0.19	0.30	0.50	0.40	0.47	0.15	0.25	0.28	0.48	0.38
O99	0.12	0.29	0.36	0.74	0.60	0.36	0.11	0.42	0.33	0.54	0.45
O100	0.15	0.31	0.32	0.71	0.59	0.27	0.12	0.51	0.30	0.51	0.43
O101	0.18	0.28	0.31	0.60	0.54	0.27	0.10	0.47	0.28	0.43	0.41
O102	0.21	0.27	0.32	0.54	0.52	0.17	0.08	0.29	0.07	0.26	0.24
O103	0.13	0.28	0.25	0.64	0.61	0.22	0.09	0.45	0.35	0.56	0.52
O104	0.09	0.11	0.33	0.35	0.27	0.25	0.08	0.04	0.11	0.06	0.18
O105	0.16	0.29	0.32	0.32	0.31	0.06	0.06	0.10	0.07	0.05	0.05
O106	0.16	0.05	0.17	0.05	0.20	0.19	0.28	0.20	0.31	0.45	0.37
O107	0.07	0.21	0.23	0.07	0.15	0.07	0.09	0.29	0.29	0.39	0.35
O108	0.12	0.19	0.28	0.08	0.10	0.07	0.14	0.29	0.25	0.35	0.32
O109	0.15	0.14	0.21	0.10	0.14	0.03	0.12	0.30	0.28	0.31	0.34
O110	0.15	0.11	0.13	0.10	0.12	0.07	0.08	0.19	0.18	0.22	0.23
O111	0.13	0.09	0.05	0.15	0.07	0.21	0.30	0.20	0.31	0.35	0.34
O112	0.10	0.07	0.06	0.06	0.17	0.13	0.06	0.03	0.08	0.11	0.12
O113	0.06	0.04	0.09	0.06	0.07	0.03	0.02	0.02	0.12	0.18	0.19
O114	0.09	0.05	0.12	0.07	0.08	0.03	0.04	0.04	0.16	0.23	0.24
O115	0.07	0.09	0.34	0.23	0.20	0.21	0.23	0.08	0.20	0.29	0.23
O116	0.11	0.05	0.20	0.13	0.17	0.09	0.06	0.13	0.04	0.08	0.06
O117	0.13	0.07	0.29	0.19	0.20	0.12	0.10	0.14	0.05	0.07	0.04
O118	0.11	0.09	0.28	0.18	0.19	0.09	0.07	0.13	0.06	0.04	0.03
O119	0.06	0.03	0.09	0.10	0.16	0.32	0.14	0.03	0.04	0.04	0.04
O120	0.02	0.04	0.12	0.11	0.19	0.28	0.19	0.09	0.13	0.03	0.04
O121	0.03	0.04	0.25	0.13	0.19	0.18	0.19	0.11	0.18	0.11	0.04
O122	0.07	0.05	0.20	0.10	0.15	0.19	0.11	0.04	0.10	0.04	0.02
O123	0.07	0.03	0.22	0.17	0.03	0.08	0.14	0.03	0.06	0.02	0.04
O124	0.12	0.06	0.30	0.25	0.07	0.06	0.10	0.01	0.07	0.05	0.06
O125	0.05	0.03	0.15	0.14	0.08	0.22	0.38	0.11	0.08	0.03	0.04
O126	0.05	0.03	0.13	0.11	0.10	0.23	0.08	0.04	0.03	0.03	0.02
O127	0.06	0.04	0.15	0.08	0.07	0.06	0.04	0.06	0.03	0.01	0.01
O128	0.09	0.07	0.11	0.07	0.05	0.12	0.12	0.04	0.05	0.03	0.07
O129	0.31	0.25	0.20	0.19	0.08	0.17	0.29	0.11	0.14	0.05	0.07
O130	0.38	0.36	0.15	0.15	0.14	0.06	0.06	0.08	0.09	0.02	0.07
O131	0.05	0.07	0.09	0.14	0.09	0.08	0.01	0.05	0.06	0.03	0.03
O132	0.06	0.08	0.19	0.21	0.19	0.17	0.09	0.06	0.10	0.03	0.04
O133	0.03	0.09	0.17	0.21	0.19	0.16	0.11	0.05	0.10	0.07	0.09
O134	0.01	0.06	0.03	0.11	0.10	0.05	0.05	0.01	0.04	0.05	0.02
O135	0.01	0.03	0.05	0.06	0.05	0.02	0.03	0.02	0.01	0.07	0.04
O136	0.02	0.10	0.11	0.14	0.13	0.06	0.09	0.03	0.01	0.11	0.11
O137	0.01	0.03	0.04	0.06	0.03	0.03	0.04	0.02	0.07	0.17	0.19
O138	0.02	0.06	0.08	0.10	0.10	0.04	0.06	0.03	0.13	0.38	0.39
O139	0.02	0.03	0.02	0.07	0.06	0.02	0.05	0.04	0.03	0.28	0.27
O140	0.33	0.30	0.26	0.10	0.04	0.16	0.27	0.06	0.13	0.06	0.07
O141	0.08	0.26	0.12	0.14	0.10	0.05	0.12	0.05	0.04	0.09	0.09
O142	0.22	0.39	0.23	0.20	0.21	0.05	0.12	0.09	0.12	0.08	0.06
O143	0.21	0.35	0.23	0.22	0.22	0.07	0.04	0.08	0.10	0.10	0.11
O144	0.19	0.35	0.31	0.32	0.32	0.15	0.20	0.09	0.15	0.17	0.20
O145	0.13	0.26	0.22	0.23	0.23	0.09	0.11	0.02	0.12	0.12	0.07
O146	0.05	0.24	0.20	0.21	0.22	0.03	0.05	0.02	0.06	0.18	0.04

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O147	0.16	0.08	0.25	0.21	0.16	0.18	0.36	0.10	0.10	0.12	0.02
O148	0.07	0.17	0.18	0.11	0.21	0.21	0.44	0.11	0.12	0.12	0.05
O149	0.25	0.33	0.49	0.52	0.31	0.24	0.38	0.07	0.16	0.14	0.10
O150	0.11	0.19	0.38	0.41	0.25	0.23	0.34	0.04	0.09	0.13	0.12
O151	0.20	0.21	0.07	0.17	0.19	0.10	0.08	0.05	0.07	0.02	0.04
O152	0.05	0.05	0.10	0.25	0.10	0.05	0.18	0.03	0.10	0.03	0.01
O153	0.04	0.06	0.19	0.28	0.12	0.04	0.22	0.06	0.05	0.01	0.03
O154	0.07	0.06	0.18	0.15	0.05	0.06	0.09	0.03	0.05	0.01	0.03
O155	0.08	0.04	0.18	0.24	0.14	0.12	0.35	0.12	0.19	0.17	0.07
O156	0.09	0.06	0.33	0.20	0.26	0.37	0.35	0.09	0.26	0.18	0.20
O157	0.10	0.27	0.17	0.40	0.37	0.13	0.11	0.19	0.07	0.27	0.21
O158	0.06	0.11	0.26	0.30	0.10	0.56	0.18	0.27	0.07	0.39	0.51
O159	0.03	0.25	0.09	0.42	0.29	0.55	0.02	0.05	0.19	0.07	0.03
O160	0.03	0.23	0.09	0.44	0.33	0.57	0.04	0.05	0.22	0.08	0.03
O161	0.07	0.24	0.09	0.46	0.40	0.62	0.11	0.06	0.25	0.15	0.05
O162	0.09	0.09	0.14	0.36	0.41	0.59	0.23	0.19	0.04	0.28	0.29
O163	0.10	0.11	0.31	0.28	0.38	0.35	0.29	0.19	0.06	0.25	0.37
O164	0.08	0.10	0.12	0.13	0.33	0.32	0.11	0.05	0.17	0.06	0.04
O165	0.05	0.06	0.33	0.38	0.19	0.45	0.28	0.24	0.11	0.34	0.41
O166	0.15	0.39	0.19	0.99	0.51	0.42	0.13	0.09	0.07	0.18	0.14
O167	0.10	0.30	0.21	0.75	0.49	0.42	0.21	0.13	0.05	0.20	0.07
O168	0.06	0.20	0.24	0.44	0.47	0.54	0.20	0.39	0.32	0.57	0.50
O169	0.07	0.10	0.17	0.23	0.16	0.22	0.11	0.15	0.25	0.16	0.19
O170	0.03	0.04	0.13	0.11	0.06	0.08	0.04	0.06	0.09	0.09	0.19
O171	0.03	0.17	0.07	0.61	0.36	0.10	0.13	0.23	0.17	0.14	0.21
O172	0.09	0.21	0.26	0.59	0.42	0.26	0.13	0.11	0.17	0.07	0.24
O173	0.12	0.17	0.46	0.56	0.42	0.16	0.14	0.08	0.14	0.10	0.21
O174	0.06	0.10	0.46	0.53	0.41	0.10	0.07	0.14	0.09	0.12	0.11
O175	0.12	0.24	0.16	0.36	0.31	0.21	0.15	0.23	0.20	0.14	0.12
O176	0.10	0.03	0.12	0.04	0.09	0.17	0.13	0.07	0.07	0.14	0.13
O177	0.10	0.17	0.11	0.09	0.07	0.42	0.08	0.05	0.09	0.16	0.20
O178	0.11	0.08	0.15	0.16	0.35	0.39	0.08	0.13	0.08	0.06	0.13
O179	0.09	0.05	0.21	0.17	0.24	0.22	0.06	0.06	0.06	0.07	0.11
O180	0.04	0.06	0.14	0.14	0.18	0.14	0.10	0.05	0.04	0.08	0.11
O181	0.10	0.12	0.06	0.20	0.36	0.25	0.13	0.12	0.09	0.18	0.27
O182	0.10	0.12	0.12	0.06	0.33	0.28	0.11	0.11	0.08	0.08	0.13
O183	0.13	0.07	0.04	0.04	0.29	0.27	0.13	0.15	0.07	0.04	0.06
O184	0.04	0.11	0.08	0.13	0.25	0.26	0.18	0.20	0.26	0.31	0.29
O185	0.10	0.15	0.04	0.10	0.20	0.08	0.09	0.21	0.20	0.21	0.18
O186	0.09	0.04	0.04	0.10	0.26	0.14	0.10	0.07	0.04	0.11	0.07
O187	0.07	0.09	0.14	0.16	0.35	0.17	0.10	0.05	0.07	0.15	0.15
O188	0.11	0.13	0.14	0.11	0.29	0.31	0.12	0.06	0.05	0.16	0.21
O189	0.11	0.12	0.12	0.15	0.07	0.06	0.08	0.18	0.04	0.10	0.13
O190	0.05	0.06	0.15	0.19	0.09	0.08	0.12	0.05	0.10	0.22	0.22
O191	0.11	0.08	0.07	0.14	0.08	0.04	0.14	0.06	0.10	0.18	0.19
O192	0.11	0.10	0.17	0.12	0.21	0.25	0.08	0.03	0.14	0.13	0.17
O193	0.06	0.22	0.23	0.21	0.18	0.33	0.04	0.07	0.14	0.37	0.32
O194	0.06	0.08	0.26	0.22	0.16	0.19	0.14	0.09	0.11	0.24	0.19
O195	0.04	0.04	0.30	0.19	0.15	0.15	0.19	0.11	0.17	0.31	0.22

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O196	0.06	0.02	0.12	0.04	0.12	0.17	0.09	0.03	0.05	0.03	0.03
O197	0.05	0.04	0.14	0.15	0.18	0.16	0.19	0.08	0.05	0.04	0.03
O198	0.05	0.15	0.15	0.14	0.09	0.07	0.12	0.01	0.04	0.09	0.10

Table E3 Velocity Ratio of Special Test Points

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
S1	0.04	0.03	0.06	0.10	0.22	0.40	0.06	0.03	0.17	0.08	0.10
S2	0.05	0.06	0.13	0.17	0.19	0.11	0.05	0.02	0.17	0.11	0.16
S3	0.06	0.07	0.31	0.19	0.22	0.13	0.09	0.03	0.11	0.12	0.16
S4	0.08	0.06	0.34	0.16	0.19	0.15	0.09	0.05	0.02	0.11	0.13
S5	0.10	0.07	0.33	0.14	0.06	0.17	0.06	0.07	0.08	0.12	0.13
S6	0.11	0.09	0.32	0.16	0.11	0.18	0.03	0.09	0.16	0.12	0.11
S7	0.11	0.09	0.33	0.17	0.08	0.18	0.06	0.09	0.18	0.11	0.04
S8	0.12	0.10	0.39	0.20	0.20	0.18	0.08	0.09	0.20	0.08	0.17
S9	0.04	0.11	0.04	0.12	0.38	0.30	0.10	0.09	0.20	0.07	0.03
S10	0.01	0.03	0.01	0.05	0.32	0.33	0.08	0.05	0.13	0.04	0.10
S11	0.03	0.02	0.11	0.05	0.24	0.32	0.05	0.04	0.04	0.16	0.18
S12	0.12	0.08	0.28	0.22	0.14	0.23	0.07	0.10	0.03	0.13	0.10
S13	0.09	0.08	0.26	0.22	0.27	0.30	0.05	0.07	0.21	0.12	0.02
S14	0.04	0.09	0.26	0.23	0.04	0.16	0.08	0.05	0.05	0.12	0.07
S15	0.01	0.08	0.26	0.20	0.04	0.11	0.05	0.04	0.02	0.09	0.04
S16	0.01	0.04	0.11	0.12	0.04	0.11	0.02	0.02	0.05	0.04	0.02
S17	0.01	0.09	0.13	0.10	0.32	0.31	0.01	0.03	0.22	0.05	0.07
S18	0.01	0.12	0.20	0.15	0.33	0.31	0.01	0.03	0.23	0.12	0.17
S19	0.01	0.05	0.13	0.08	0.16	0.17	0.02	0.03	0.09	0.11	0.15
S20	0.04	0.09	0.30	0.20	0.07	0.31	0.11	0.03	0.11	0.06	0.13
S21	0.03	0.04	0.22	0.18	0.05	0.33	0.12	0.04	0.09	0.10	0.12
S22	0.04	0.02	0.24	0.19	0.28	0.46	0.19	0.06	0.26	0.09	0.13
S23	0.07	0.06	0.28	0.24	0.32	0.56	0.19	0.07	0.15	0.03	0.11
S24	0.04	0.05	0.28	0.15	0.04	0.10	0.12	0.03	0.10	0.05	0.04
S25	0.04	0.03	0.22	0.15	0.11	0.20	0.08	0.04	0.08	0.06	0.05
S26	0.05	0.01	0.18	0.19	0.16	0.18	0.06	0.03	0.11	0.04	0.04
S27	0.05	0.07	0.31	0.30	0.41	0.44	0.23	0.15	0.09	0.23	0.16
S28	0.06	0.06	0.34	0.25	0.35	0.43	0.14	0.15	0.06	0.22	0.20

E2 Proposed Scheme

Table E4 Velocity Ratio of Perimeter Test Points

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
P1	0.04	0.05	0.21	0.11	0.14	0.21	0.20	0.06	0.12	0.10	0.13
P2	0.09	0.08	0.28	0.20	0.21	0.10	0.22	0.08	0.13	0.19	0.07
P3	0.12	0.08	0.25	0.18	0.19	0.15	0.21	0.07	0.13	0.05	0.04
P4	0.16	0.10	0.29	0.22	0.17	0.16	0.19	0.08	0.14	0.08	0.16
P5	0.19	0.12	0.33	0.27	0.14	0.19	0.16	0.08	0.13	0.03	0.05
P6	0.16	0.11	0.32	0.26	0.33	0.20	0.07	0.09	0.16	0.04	0.10
P7	0.12	0.10	0.32	0.25	0.20	0.28	0.08	0.09	0.04	0.09	0.16
P8	0.12	0.05	0.29	0.21	0.28	0.28	0.03	0.10	0.06	0.19	0.22
P9	0.10	0.04	0.25	0.02	0.28	0.26	0.05	0.09	0.08	0.21	0.25
P10	0.01	0.02	0.05	0.07	0.27	0.24	0.07	0.01	0.15	0.17	0.26
P11	0.04	0.12	0.26	0.15	0.27	0.21	0.08	0.06	0.19	0.05	0.24
P12	0.08	0.11	0.39	0.22	0.23	0.19	0.08	0.08	0.19	0.07	0.17
P13	0.08	0.10	0.30	0.16	0.19	0.21	0.07	0.08	0.19	0.08	0.17
P14	0.05	0.20	0.14	0.32	0.35	0.46	0.08	0.10	0.17	0.12	0.08
P15	0.08	0.07	0.27	0.12	0.11	0.15	0.06	0.08	0.17	0.10	0.04
P16	0.07	0.05	0.23	0.10	0.06	0.11	0.06	0.07	0.16	0.10	0.08
P17	0.06	0.06	0.23	0.11	0.10	0.17	0.06	0.08	0.16	0.10	0.09
P18	0.06	0.06	0.22	0.11	0.10	0.19	0.03	0.07	0.14	0.11	0.11
P19	0.06	0.06	0.24	0.08	0.10	0.18	0.02	0.06	0.10	0.11	0.12
P20	0.05	0.04	0.27	0.08	0.11	0.22	0.03	0.04	0.03	0.12	0.12
P21	0.04	0.05	0.28	0.08	0.11	0.21	0.06	0.02	0.05	0.11	0.13
P22	0.01	0.06	0.26	0.08	0.08	0.10	0.04	0.01	0.10	0.10	0.12
P23	0.01	0.07	0.24	0.07	0.06	0.07	0.07	0.01	0.12	0.09	0.10
P24	0.10	0.09	0.21	0.26	0.21	0.56	0.19	0.01	0.13	0.03	0.02
P25	0.08	0.07	0.16	0.22	0.25	0.52	0.18	0.01	0.08	0.04	0.03
P26	0.06	0.05	0.11	0.21	0.23	0.53	0.19	0.02	0.10	0.04	0.05
P27	0.07	0.03	0.15	0.26	0.23	0.53	0.16	0.02	0.07	0.05	0.04
P28	0.07	0.08	0.22	0.31	0.34	0.49	0.19	0.08	0.08	0.07	0.08
P29	0.05	0.08	0.22	0.27	0.34	0.46	0.20	0.13	0.07	0.22	0.16
P30	0.05	0.07	0.26	0.27	0.35	0.37	0.16	0.15	0.04	0.22	0.16
P31	0.05	0.07	0.25	0.26	0.30	0.21	0.16	0.12	0.10	0.18	0.11
P32	0.06	0.03	0.19	0.12	0.17	0.24	0.23	0.12	0.22	0.17	0.12
P33	0.05	0.04	0.22	0.26	0.25	0.32	0.30	0.12	0.19	0.18	0.13
P34	0.03	0.05	0.24	0.19	0.24	0.32	0.32	0.11	0.06	0.14	0.09
P35	0.04	0.07	0.29	0.20	0.23	0.30	0.21	0.11	0.03	0.13	0.05
P36	0.04	0.06	0.20	0.19	0.15	0.13	0.17	0.08	0.14	0.08	0.02
P37	0.04	0.06	0.19	0.19	0.25	0.13	0.11	0.07	0.14	0.05	0.09
P38	0.07	0.05	0.23	0.17	0.18	0.48	0.12	0.05	0.07	0.11	0.12
P39	0.07	0.07	0.25	0.18	0.05	0.41	0.14	0.05	0.05	0.13	0.12
P40	0.06	0.06	0.23	0.16	0.09	0.35	0.12	0.04	0.12	0.13	0.13
P41	0.05	0.06	0.18	0.14	0.10	0.35	0.09	0.02	0.15	0.13	0.11
P42	0.04	0.05	0.12	0.15	0.09	0.35	0.02	0.04	0.17	0.12	0.10

Table E5 Velocity Ratio of Overall Test Points

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O1	0.04	0.14	0.17	0.76	0.25	0.33	0.33	0.01	0.13	0.09	0.06
O2	0.02	0.19	0.15	0.80	0.22	0.39	0.27	0.01	0.11	0.09	0.10
O3	0.07	0.27	0.14	0.67	0.35	0.20	0.24	0.02	0.12	0.10	0.11
O4	0.08	0.22	0.19	0.72	0.32	0.21	0.27	0.03	0.11	0.06	0.09
O5	0.11	0.26	0.16	0.57	0.10	0.07	0.19	0.05	0.08	0.05	0.05
O6	0.09	0.28	0.17	0.39	0.28	0.12	0.15	0.04	0.11	0.05	0.09
O7	0.05	0.10	0.20	0.05	0.25	0.22	0.02	0.23	0.11	0.05	0.10
O8	0.17	0.14	0.18	0.34	0.37	0.45	0.05	0.11	0.33	0.22	0.25
O9	0.06	0.29	0.29	0.87	0.51	0.64	0.07	0.36	0.40	0.39	0.38
O10	0.06	0.12	0.10	0.33	0.40	0.48	0.15	0.12	0.07	0.22	0.06
O11	0.05	0.03	0.11	0.13	0.02	0.09	0.18	0.14	0.13	0.06	0.05
O12	0.04	0.13	0.10	0.07	0.23	0.15	0.35	0.19	0.31	0.37	0.18
O13	0.03	0.09	0.09	0.16	0.29	0.29	0.29	0.14	0.22	0.35	0.17
O14	0.05	0.10	0.07	0.03	0.24	0.11	0.13	0.05	0.11	0.07	0.09
O15	0.06	0.31	0.47	0.28	0.14	0.07	0.26	0.06	0.07	0.26	0.29
O16	0.02	0.30	0.24	0.24	0.27	0.08	0.22	0.05	0.10	0.28	0.27
O17	0.03	0.27	0.13	0.23	0.30	0.11	0.18	0.06	0.14	0.27	0.18
O18	0.03	0.28	0.33	0.26	0.27	0.10	0.18	0.08	0.15	0.24	0.08
O19	0.02	0.03	0.06	0.12	0.09	0.18	0.15	0.06	0.17	0.11	0.13
O20	0.04	0.10	0.11	0.13	0.13	0.25	0.24	0.10	0.25	0.15	0.14
O21	0.05	0.10	0.17	0.12	0.13	0.29	0.22	0.09	0.22	0.14	0.08
O22	0.05	0.12	0.20	0.15	0.15	0.35	0.12	0.06	0.12	0.09	0.05
O23	0.06	0.08	0.27	0.19	0.16	0.22	0.36	0.17	0.33	0.22	0.13
O24	0.06	0.20	0.07	0.23	0.18	0.07	0.14	0.03	0.07	0.23	0.33
O25	0.02	0.03	0.04	0.05	0.04	0.05	0.14	0.03	0.05	0.17	0.23
O26	0.06	0.12	0.06	0.23	0.19	0.25	0.14	0.09	0.14	0.18	0.22
O27	0.10	0.10	0.14	0.26	0.20	0.39	0.32	0.14	0.38	0.31	0.23
O28	0.03	0.06	0.13	0.32	0.31	0.42	0.16	0.10	0.25	0.21	0.15
O29	0.02	0.03	0.07	0.32	0.09	0.43	0.16	0.15	0.33	0.31	0.24
O30	0.07	0.08	0.08	0.21	0.21	0.26	0.22	0.16	0.35	0.34	0.27
O31	0.03	0.18	0.11	0.26	0.33	0.43	0.17	0.15	0.28	0.34	0.29
O32	0.02	0.21	0.10	0.23	0.15	0.25	0.34	0.16	0.40	0.29	0.29
O33	0.01	0.13	0.13	0.42	0.36	0.45	0.32	0.18	0.36	0.21	0.31
O34	0.03	0.13	0.16	0.32	0.33	0.39	0.11	0.10	0.16	0.28	0.20
O35	0.03	0.21	0.07	0.48	0.34	0.36	0.32	0.14	0.35	0.30	0.25
O36	0.08	0.18	0.08	0.48	0.34	0.35	0.34	0.13	0.33	0.32	0.27
O37	0.14	0.19	0.07	0.57	0.32	0.20	0.35	0.06	0.27	0.29	0.23
O38	0.09	0.24	0.09	0.54	0.33	0.18	0.34	0.05	0.29	0.30	0.22
O39	0.06	0.16	0.11	0.19	0.13	0.15	0.29	0.09	0.19	0.21	0.32
O40	0.06	0.18	0.06	0.26	0.11	0.13	0.24	0.06	0.12	0.27	0.37
O41	0.04	0.18	0.05	0.19	0.09	0.13	0.20	0.08	0.18	0.25	0.26
O42	0.02	0.16	0.04	0.08	0.06	0.13	0.14	0.11	0.19	0.27	0.22
O43	0.09	0.07	0.07	0.06	0.12	0.41	0.27	0.16	0.35	0.28	0.15
O44	0.12	0.05	0.18	0.09	0.16	0.27	0.31	0.11	0.27	0.20	0.17
O45	0.16	0.10	0.34	0.19	0.22	0.45	0.55	0.17	0.38	0.23	0.19
O46	0.21	0.13	0.41	0.17	0.17	0.31	0.42	0.13	0.26	0.19	0.15
O47	0.14	0.08	0.32	0.09	0.06	0.16	0.16	0.18	0.39	0.32	0.15
O48	0.11	0.05	0.32	0.26	0.09	0.33	0.28	0.13	0.34	0.22	0.29

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O49	0.09	0.03	0.26	0.22	0.04	0.26	0.10	0.19	0.35	0.31	0.31
O50	0.06	0.08	0.12	0.12	0.24	0.41	0.24	0.19	0.34	0.31	0.34
O51	0.05	0.17	0.20	0.22	0.25	0.19	0.27	0.13	0.25	0.29	0.37
O52	0.01	0.11	0.07	0.24	0.19	0.16	0.09	0.06	0.09	0.17	0.11
O53	0.04	0.20	0.07	0.36	0.34	0.44	0.31	0.18	0.32	0.33	0.32
O54	0.12	0.19	0.06	0.42	0.37	0.38	0.35	0.13	0.32	0.31	0.28
O55	0.16	0.16	0.04	0.67	0.32	0.40	0.42	0.04	0.27	0.25	0.18
O56	0.13	0.16	0.10	0.52	0.26	0.49	0.31	0.10	0.20	0.23	0.16
O57	0.14	0.22	0.15	0.58	0.29	0.64	0.28	0.09	0.21	0.25	0.19
O58	0.14	0.19	0.12	0.55	0.28	0.45	0.31	0.09	0.22	0.25	0.19
O59	0.14	0.18	0.12	0.54	0.27	0.51	0.31	0.09	0.21	0.24	0.17
O60	0.14	0.21	0.12	0.57	0.27	0.69	0.28	0.10	0.19	0.24	0.18
O61	0.12	0.14	0.07	0.86	0.22	0.43	0.40	0.03	0.32	0.23	0.14
O62	0.19	0.09	0.14	0.67	0.39	0.58	0.46	0.04	0.37	0.26	0.18
O63	0.15	0.08	0.03	0.48	0.27	0.35	0.12	0.09	0.12	0.18	0.11
O64	0.26	0.23	0.01	0.57	0.28	0.36	0.06	0.10	0.04	0.09	0.07
O65	0.31	0.07	0.15	0.44	0.04	0.29	0.02	0.03	0.10	0.02	0.01
O66	0.29	0.04	0.15	0.36	0.03	0.28	0.04	0.03	0.09	0.05	0.03
O67	0.29	0.25	0.10	0.71	0.12	0.24	0.12	0.06	0.03	0.07	0.04
O68	0.26	0.19	0.07	0.61	0.10	0.16	0.03	0.04	0.02	0.02	0.02
O69	0.06	0.24	0.13	0.64	0.05	0.29	0.05	0.04	0.03	0.05	0.02
O70	0.32	0.27	0.26	0.66	0.20	0.57	0.13	0.04	0.03	0.09	0.07
O71	0.07	0.05	0.23	0.34	0.37	0.46	0.23	0.10	0.24	0.25	0.19
O72	0.10	0.09	0.15	0.41	0.39	0.69	0.11	0.02	0.10	0.08	0.13
O73	0.08	0.07	0.11	0.51	0.37	0.53	0.11	0.01	0.10	0.08	0.11
O74	0.15	0.25	0.14	0.59	0.31	0.67	0.29	0.06	0.23	0.26	0.20
O75	0.14	0.22	0.10	0.58	0.27	0.70	0.27	0.09	0.19	0.23	0.18
O76	0.17	0.16	0.06	0.51	0.21	0.54	0.21	0.10	0.15	0.18	0.13
O77	0.07	0.25	0.02	0.33	0.26	0.28	0.19	0.09	0.16	0.23	0.19
O78	0.18	0.23	0.14	0.51	0.25	0.49	0.05	0.16	0.02	0.24	0.24
O79	0.02	0.04	0.25	0.18	0.24	0.24	0.16	0.11	0.20	0.28	0.17
O80	0.06	0.07	0.24	0.25	0.33	0.14	0.21	0.10	0.23	0.27	0.22
O81	0.11	0.09	0.17	0.32	0.36	0.64	0.23	0.04	0.24	0.14	0.21
O82	0.04	0.20	0.20	0.24	0.32	0.23	0.26	0.05	0.22	0.16	0.14
O83	0.04	0.18	0.20	0.15	0.09	0.18	0.20	0.05	0.19	0.32	0.20
O84	0.07	0.12	0.16	0.15	0.08	0.16	0.14	0.06	0.14	0.20	0.11
O85	0.04	0.23	0.33	0.64	0.32	0.60	0.08	0.13	0.21	0.37	0.28
O86	0.18	0.17	0.22	0.50	0.32	0.41	0.11	0.06	0.05	0.09	0.16
O87	0.24	0.34	0.07	0.78	0.22	0.39	0.05	0.02	0.05	0.20	0.11
O88	0.09	0.26	0.32	0.78	0.50	0.08	0.06	0.32	0.32	0.54	0.53
O89	0.14	0.10	0.08	0.06	0.10	0.22	0.04	0.08	0.19	0.26	0.25
O90	0.15	0.07	0.14	0.06	0.23	0.29	0.06	0.24	0.22	0.44	0.28
O91	0.04	0.03	0.06	0.07	0.09	0.06	0.06	0.10	0.29	0.18	0.09
O92	0.08	0.03	0.04	0.07	0.07	0.05	0.04	0.11	0.26	0.23	0.17
O93	0.16	0.14	0.09	0.25	0.11	0.04	0.01	0.15	0.14	0.32	0.09
O94	0.09	0.10	0.05	0.17	0.05	0.08	0.04	0.18	0.12	0.25	0.26
O95	0.11	0.10	0.09	0.05	0.08	0.07	0.03	0.20	0.23	0.35	0.46
O96	0.11	0.19	0.18	0.45	0.39	0.13	0.07	0.21	0.22	0.36	0.30
O97	0.14	0.14	0.21	0.48	0.34	0.13	0.05	0.18	0.17	0.26	0.24

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O98	0.09	0.18	0.28	0.51	0.41	0.46	0.14	0.27	0.28	0.48	0.39
O99	0.14	0.29	0.35	0.75	0.61	0.35	0.11	0.44	0.33	0.54	0.46
O100	0.15	0.31	0.31	0.71	0.59	0.26	0.12	0.52	0.30	0.51	0.43
O101	0.17	0.28	0.29	0.60	0.54	0.26	0.10	0.48	0.28	0.43	0.41
O102	0.21	0.27	0.26	0.54	0.53	0.15	0.08	0.29	0.07	0.26	0.25
O103	0.12	0.28	0.24	0.64	0.61	0.22	0.09	0.46	0.35	0.56	0.52
O104	0.10	0.11	0.33	0.35	0.26	0.25	0.07	0.03	0.11	0.06	0.17
O105	0.16	0.28	0.25	0.30	0.32	0.06	0.06	0.08	0.06	0.05	0.05
O106	0.17	0.05	0.15	0.03	0.20	0.19	0.28	0.19	0.31	0.46	0.37
O107	0.08	0.21	0.24	0.08	0.15	0.08	0.09	0.27	0.28	0.39	0.35
O108	0.13	0.15	0.28	0.08	0.10	0.07	0.14	0.29	0.25	0.35	0.32
O109	0.16	0.12	0.22	0.09	0.13	0.06	0.14	0.30	0.28	0.31	0.34
O110	0.16	0.11	0.18	0.11	0.10	0.12	0.07	0.19	0.18	0.22	0.23
O111	0.13	0.08	0.06	0.15	0.07	0.22	0.30	0.20	0.31	0.35	0.34
O112	0.10	0.09	0.06	0.05	0.17	0.12	0.04	0.04	0.08	0.11	0.12
O113	0.06	0.04	0.10	0.07	0.08	0.02	0.03	0.05	0.12	0.18	0.19
O114	0.08	0.05	0.13	0.08	0.08	0.03	0.05	0.06	0.16	0.23	0.24
O115	0.07	0.10	0.32	0.23	0.17	0.18	0.26	0.16	0.21	0.29	0.23
O116	0.12	0.05	0.21	0.14	0.16	0.07	0.06	0.17	0.04	0.08	0.06
O117	0.13	0.07	0.30	0.20	0.19	0.10	0.10	0.18	0.05	0.08	0.04
O118	0.12	0.10	0.26	0.19	0.18	0.06	0.07	0.17	0.06	0.04	0.03
O119	0.05	0.03	0.09	0.08	0.14	0.29	0.13	0.03	0.04	0.04	0.03
O120	0.02	0.05	0.12	0.11	0.17	0.27	0.17	0.09	0.13	0.04	0.03
O121	0.03	0.05	0.26	0.11	0.18	0.17	0.18	0.11	0.19	0.11	0.04
O122	0.07	0.05	0.19	0.11	0.15	0.19	0.12	0.04	0.11	0.04	0.02
O123	0.07	0.04	0.22	0.17	0.03	0.07	0.13	0.03	0.07	0.03	0.04
O124	0.12	0.07	0.30	0.25	0.06	0.06	0.09	0.01	0.07	0.04	0.06
O125	0.05	0.03	0.15	0.14	0.07	0.26	0.37	0.11	0.09	0.03	0.04
O126	0.05	0.03	0.12	0.11	0.10	0.24	0.09	0.05	0.04	0.03	0.02
O127	0.06	0.04	0.15	0.08	0.06	0.10	0.08	0.05	0.02	0.01	0.02
O128	0.09	0.07	0.11	0.07	0.04	0.12	0.12	0.04	0.05	0.02	0.07
O129	0.31	0.25	0.21	0.19	0.09	0.19	0.28	0.11	0.15	0.05	0.07
O130	0.38	0.36	0.15	0.15	0.14	0.06	0.07	0.07	0.09	0.02	0.07
O131	0.05	0.08	0.11	0.14	0.11	0.08	0.08	0.05	0.05	0.03	0.03
O132	0.06	0.09	0.19	0.21	0.20	0.14	0.13	0.05	0.08	0.02	0.04
O133	0.02	0.09	0.17	0.20	0.20	0.14	0.14	0.05	0.12	0.07	0.09
O134	0.01	0.06	0.03	0.11	0.09	0.05	0.04	0.01	0.05	0.05	0.02
O135	0.01	0.03	0.04	0.06	0.05	0.05	0.02	0.03	0.01	0.07	0.04
O136	0.01	0.10	0.11	0.14	0.13	0.09	0.09	0.03	0.01	0.11	0.11
O137	0.01	0.03	0.04	0.06	0.03	0.04	0.04	0.02	0.07	0.17	0.19
O138	0.02	0.06	0.08	0.11	0.10	0.06	0.06	0.01	0.12	0.38	0.38
O139	0.02	0.03	0.03	0.07	0.06	0.04	0.05	0.01	0.02	0.28	0.28
O140	0.33	0.30	0.27	0.10	0.04	0.17	0.27	0.06	0.13	0.05	0.07
O141	0.08	0.26	0.12	0.14	0.11	0.07	0.11	0.05	0.02	0.09	0.09
O142	0.22	0.39	0.23	0.20	0.21	0.07	0.10	0.09	0.09	0.08	0.06
O143	0.21	0.35	0.24	0.22	0.22	0.04	0.04	0.08	0.08	0.10	0.11
O144	0.19	0.35	0.31	0.32	0.32	0.14	0.19	0.09	0.14	0.17	0.20
O145	0.13	0.26	0.22	0.23	0.23	0.03	0.10	0.02	0.12	0.12	0.07
O146	0.05	0.24	0.20	0.21	0.22	0.04	0.04	0.03	0.08	0.18	0.04

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O147	0.16	0.08	0.25	0.21	0.17	0.26	0.36	0.10	0.12	0.12	0.02
O148	0.07	0.17	0.18	0.11	0.22	0.29	0.43	0.11	0.13	0.12	0.05
O149	0.24	0.33	0.49	0.52	0.31	0.29	0.38	0.07	0.14	0.14	0.10
O150	0.11	0.19	0.38	0.41	0.26	0.27	0.33	0.03	0.12	0.13	0.12
O151	0.20	0.21	0.07	0.17	0.19	0.15	0.07	0.03	0.06	0.02	0.05
O152	0.05	0.05	0.12	0.25	0.07	0.11	0.20	0.04	0.07	0.02	0.02
O153	0.03	0.06	0.20	0.27	0.11	0.04	0.23	0.06	0.04	0.01	0.04
O154	0.07	0.06	0.18	0.14	0.05	0.04	0.10	0.03	0.03	0.01	0.04
O155	0.07	0.05	0.19	0.26	0.21	0.26	0.36	0.11	0.20	0.17	0.07
O156	0.08	0.06	0.32	0.21	0.26	0.36	0.31	0.08	0.24	0.15	0.17
O157	0.08	0.27	0.17	0.41	0.37	0.14	0.10	0.19	0.07	0.27	0.21
O158	0.06	0.11	0.25	0.27	0.12	0.51	0.22	0.27	0.07	0.40	0.53
O159	0.02	0.25	0.08	0.42	0.30	0.55	0.02	0.06	0.19	0.06	0.04
O160	0.01	0.23	0.09	0.45	0.32	0.59	0.05	0.06	0.23	0.06	0.03
O161	0.03	0.23	0.13	0.46	0.38	0.62	0.11	0.10	0.24	0.13	0.05
O162	0.08	0.09	0.09	0.38	0.43	0.61	0.25	0.20	0.08	0.29	0.30
O163	0.07	0.12	0.28	0.23	0.38	0.35	0.29	0.19	0.07	0.27	0.38
O164	0.02	0.09	0.11	0.10	0.32	0.27	0.21	0.03	0.16	0.05	0.06
O165	0.05	0.06	0.35	0.40	0.20	0.49	0.31	0.25	0.11	0.34	0.44
O166	0.13	0.38	0.19	0.97	0.52	0.44	0.13	0.09	0.07	0.17	0.14
O167	0.09	0.29	0.21	0.70	0.50	0.42	0.20	0.13	0.05	0.20	0.08
O168	0.08	0.18	0.24	0.43	0.48	0.53	0.20	0.40	0.32	0.57	0.51
O169	0.05	0.09	0.07	0.22	0.18	0.23	0.11	0.16	0.25	0.15	0.18
O170	0.03	0.04	0.13	0.11	0.07	0.08	0.04	0.07	0.08	0.10	0.18
O171	0.03	0.17	0.11	0.61	0.36	0.10	0.13	0.24	0.16	0.04	0.19
O172	0.08	0.21	0.26	0.59	0.41	0.27	0.13	0.13	0.17	0.08	0.22
O173	0.13	0.18	0.44	0.64	0.42	0.17	0.14	0.08	0.13	0.09	0.21
O174	0.11	0.08	0.43	0.55	0.40	0.08	0.08	0.14	0.09	0.17	0.11
O175	0.12	0.21	0.12	0.36	0.33	0.14	0.16	0.19	0.20	0.15	0.11
O176	0.11	0.04	0.11	0.07	0.07	0.23	0.14	0.09	0.09	0.15	0.11
O177	0.11	0.17	0.12	0.08	0.08	0.42	0.08	0.10	0.12	0.17	0.20
O178	0.10	0.14	0.16	0.08	0.34	0.38	0.05	0.12	0.11	0.07	0.10
O179	0.11	0.06	0.22	0.17	0.26	0.20	0.06	0.07	0.08	0.07	0.12
O180	0.04	0.03	0.17	0.13	0.16	0.12	0.11	0.05	0.07	0.08	0.11
O181	0.10	0.10	0.09	0.11	0.36	0.31	0.13	0.13	0.08	0.18	0.27
O182	0.10	0.14	0.13	0.12	0.34	0.30	0.12	0.10	0.09	0.08	0.14
O183	0.13	0.09	0.07	0.03	0.31	0.30	0.14	0.13	0.08	0.04	0.05
O184	0.03	0.11	0.05	0.14	0.26	0.27	0.18	0.21	0.26	0.31	0.30
O185	0.10	0.15	0.08	0.10	0.23	0.08	0.07	0.21	0.20	0.22	0.17
O186	0.09	0.07	0.06	0.13	0.28	0.15	0.07	0.04	0.05	0.11	0.07
O187	0.08	0.15	0.15	0.17	0.38	0.22	0.11	0.07	0.08	0.16	0.15
O188	0.10	0.12	0.16	0.14	0.25	0.28	0.12	0.06	0.07	0.18	0.23
O189	0.12	0.15	0.14	0.17	0.08	0.09	0.08	0.19	0.03	0.10	0.13
O190	0.04	0.05	0.19	0.19	0.11	0.09	0.12	0.05	0.10	0.22	0.21
O191	0.11	0.07	0.16	0.15	0.11	0.06	0.14	0.06	0.09	0.18	0.19
O192	0.13	0.09	0.18	0.15	0.18	0.25	0.08	0.03	0.12	0.14	0.18
O193	0.06	0.22	0.23	0.21	0.16	0.26	0.03	0.06	0.13	0.37	0.33
O194	0.07	0.08	0.28	0.22	0.16	0.19	0.16	0.11	0.12	0.24	0.20
O195	0.04	0.03	0.29	0.18	0.10	0.10	0.22	0.16	0.18	0.31	0.22

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
O196	0.05	0.02	0.13	0.04	0.08	0.15	0.08	0.03	0.05	0.04	0.03
O197	0.04	0.04	0.15	0.13	0.16	0.20	0.16	0.08	0.05	0.03	0.03
O198	0.05	0.14	0.12	0.14	0.05	0.05	0.12	0.01	0.11	0.09	0.10

Table E6 Velocity Ratio of Special Test Points

Points	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW
S1	0.07	0.02	0.14	0.08	0.22	0.33	0.07	0.03	0.16	0.09	0.12
S2	0.04	0.06	0.18	0.16	0.19	0.22	0.11	0.02	0.15	0.08	0.14
S3	0.04	0.08	0.32	0.19	0.24	0.32	0.09	0.02	0.10	0.09	0.14
S4	0.05	0.07	0.32	0.18	0.20	0.33	0.07	0.04	0.02	0.10	0.12
S5	0.06	0.07	0.28	0.15	0.08	0.18	0.03	0.06	0.08	0.10	0.12
S6	0.07	0.08	0.26	0.14	0.06	0.09	0.05	0.08	0.15	0.11	0.10
S7	0.08	0.09	0.29	0.15	0.07	0.13	0.07	0.08	0.18	0.10	0.08
S8	0.08	0.10	0.33	0.17	0.17	0.15	0.08	0.08	0.19	0.08	0.05
S9	0.07	0.13	0.41	0.25	0.34	0.21	0.09	0.09	0.21	0.09	0.03
S10	0.01	0.02	0.04	0.02	0.33	0.22	0.05	0.01	0.12	0.03	0.05
S11	0.01	0.02	0.03	0.02	0.29	0.27	0.02	0.01	0.03	0.05	0.19
S12	0.10	0.03	0.24	0.06	0.11	0.18	0.07	0.07	0.03	0.12	0.13
S13	0.06	0.05	0.21	0.18	0.28	0.16	0.05	0.06	0.14	0.11	0.11
S14	0.02	0.09	0.28	0.23	0.04	0.07	0.17	0.05	0.05	0.12	0.09
S15	0.01	0.08	0.31	0.18	0.01	0.04	0.15	0.04	0.06	0.16	0.02
S16	0.01	0.04	0.13	0.10	0.04	0.03	0.02	0.01	0.04	0.03	0.13
S17	0.04	0.08	0.04	0.08	0.38	0.30	0.10	0.02	0.21	0.14	0.16
S18	0.05	0.04	0.05	0.08	0.21	0.18	0.05	0.01	0.12	0.13	0.16
S19	0.03	0.07	0.19	0.14	0.08	0.17	0.02	0.05	0.07	0.09	0.13
S20	0.04	0.05	0.16	0.11	0.14	0.23	0.13	0.02	0.13	0.05	0.05
S21	0.03	0.01	0.10	0.11	0.15	0.14	0.07	0.03	0.21	0.05	0.10
S22	0.02	0.02	0.05	0.10	0.10	0.14	0.07	0.03	0.07	0.05	0.05
S23	0.04	0.03	0.20	0.18	0.17	0.21	0.09	0.05	0.15	0.06	0.07
S24	0.04	0.04	0.27	0.10	0.13	0.13	0.09	0.03	0.15	0.09	0.09
S25	0.03	0.02	0.22	0.17	0.15	0.14	0.07	0.04	0.13	0.11	0.07
S26	0.04	0.02	0.19	0.16	0.13	0.11	0.07	0.04	0.12	0.09	0.07
S27	0.04	0.07	0.29	0.33	0.43	0.37	0.25	0.17	0.10	0.26	0.16
S28	0.07	0.08	0.31	0.32	0.41	0.43	0.19	0.18	0.04	0.27	0.22