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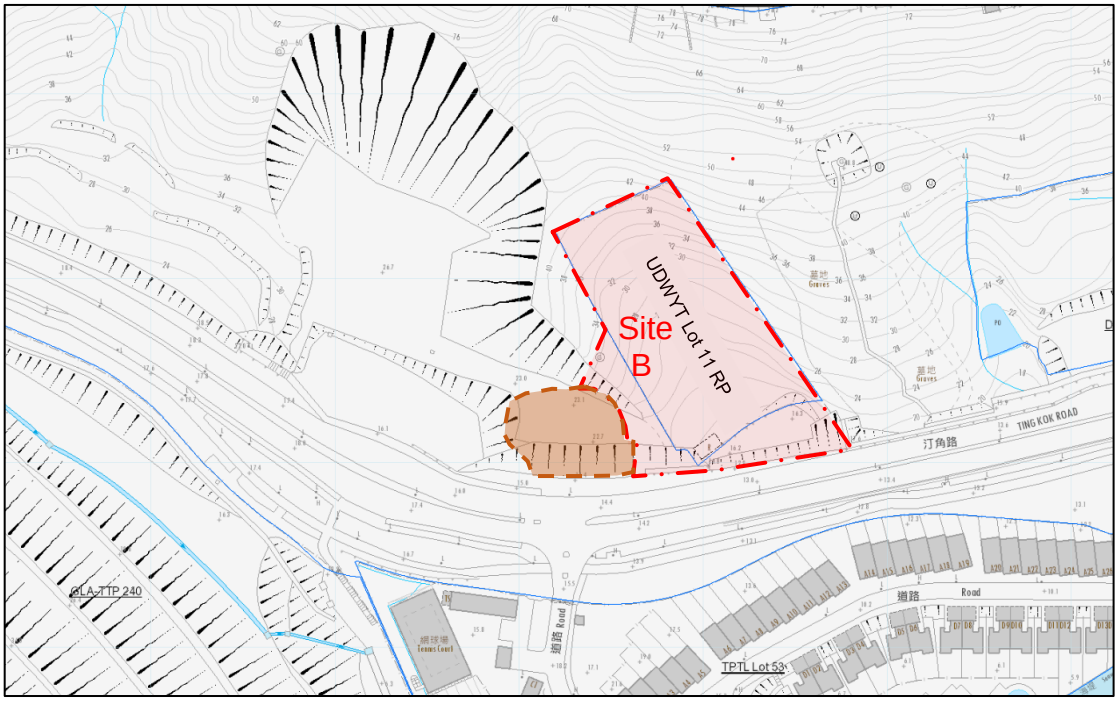
1) PROJECT BACKGROUND

This Geotechnical Assessment Report is prepared for Kam Luk Investment Company Limited ("The Applicant") in support of the development proposal prepared for the Land Sharing Pilot Scheme (“LSPS”) for proposed public residential housing / starter homes (“SH”) development at Lot 14 RP in Unsurveyed District at Wong Yue Tan (“UDWYT Lot 14 RP”) and adjoining Government Land (“Site A”), and proposed private residential development at Lot 11 RP in Unsurveyed District at Wong Yue Tan (“UDWYT Lot 11 RP”) and adjoining Government Land (“Site B”) in Wong Yue Tan, Tai Po. This report presents a geotechnical assessment to evaluate the geotechnical feasibility of the proposed development at Site B.

The proposed development at Site B comprises a double Y-shaped residential building with the associated building platform, carpark and access road. The proposed run-in/out is located at the south linking to Ting Kok Road.

2) DESCRIPTION OF SITE



Site B is located to the north of Ting Kok Road, partly within UD Wong Yue Tan Lot 11RP. The site is accessible from Ting Kok Road to the south of the area.

A general view of Site B from Ting Kok Road. There are some existing cut slope and retaining wall adjacent to Ting Kok Road.

The site is bounded on the north and east sides by natural hillside. The south side is Ting Kok Road. The west side has some existing platform and cut slopes.

The proposed development is consisted of double Y-shaped residential building with associated building platform, carpark and access road.

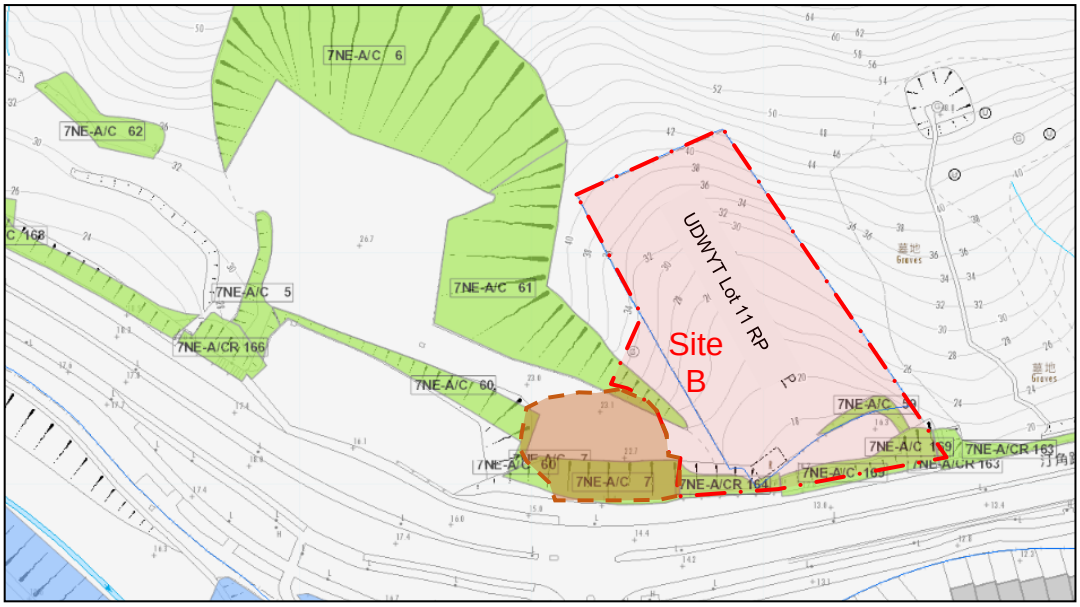
2.1 Site Topography

The site is bounded by natural hillside along the north and east sides, which levels near the site boundary vary between +13mPD and +44mPD. There are two existing platform at the southern of the site at +16mPD and +18mPD.

6 registered features are situated in the vicinity of the site and they will be discussed in the following section 2.2.

2.2 Existing Registered Slope Features

There are 7 registered features in the vicinity of the proposed development. The locations of these features are shown in the follow figure.



Current Maintenance responsibility of features in the vicinity of the proposed development:

Feature No.	Sub-division No.	Maintenance Responsibility
7NE-A/C7	-	HyD
7NE-A/C59	1	UDWYT Lot 11 RP
	2	HyD
7NE-A/C60	-	LandsD
7NE-A/C61	-	LandsD
7NE-A/CR163	-	HyD
7NE-A/CR164	1	UDWYT Lot 11 RP
	2	HyD
7NE-A/C169	-	HyD

Feature No. 7NE-A/C7 (partly within site)

This feature comprised a soil cut slope adjacent to Ting Kok road, located southwest of the Site. This slope feature is generally 7.2 high and 50m long with an average gradient of 33°.

Feature No. 7NE-A/C59 (within site)

This feature comprised a soil cut slope near the southern boundary of the Site. This slope feature is generally 4m high and 30m long with an average gradient of 50°.

Feature No. 7NE-A/C60 (partly within site)

This feature comprised a soil cut slope to the west of the Site. This slope feature is generally 4m high and 88m long with an average gradient of 40°.

Feature No. 7NE-A/C61 (partly within site)

This feature comprised a soil cut slope to the west of the Site. This slope feature is generally 15m high and 126m long with an average gradient of 40°.

Feature No. 7NE-A/CR163 (partly within site)

This feature comprised a soil cut slope and a retaining wall near the south-eastern corner of the site. This slope portion is generally 2m high and 16m long with an average gradient of 26°. And the retaining wall portion is a concrete retaining wall with height about 5.5m

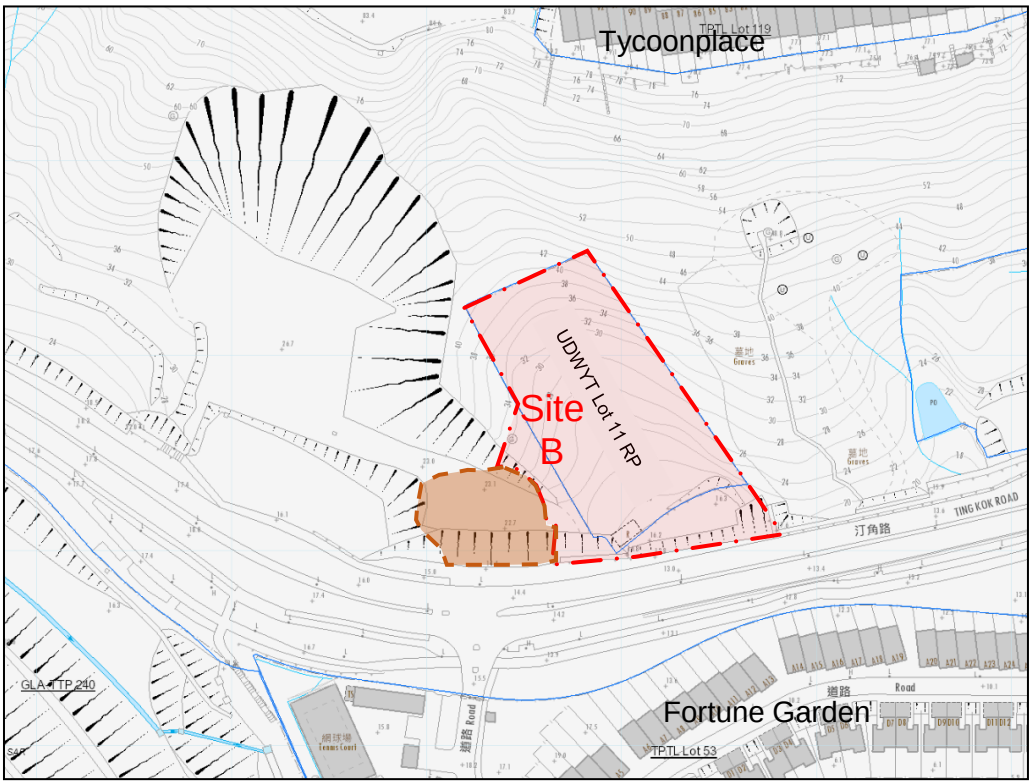
Feature No. 7NE-A/CR164 (within site)

This feature comprised a soil cut slope and a retaining wall near the south-western corner of the Site. This slope portion is generally 6-8.5m high and 30m long with an average gradient of 33°. And the retaining wall portion is a concrete retaining wall with height about 2.5m

Feature No. 7NE-A/C169 (within site)

This feature comprised a soil cut slope to the south of the Site. This slope feature is generally 7.5m high and 45m long with an average gradient of 33°.

2.3 Surrounding Buildings/structures

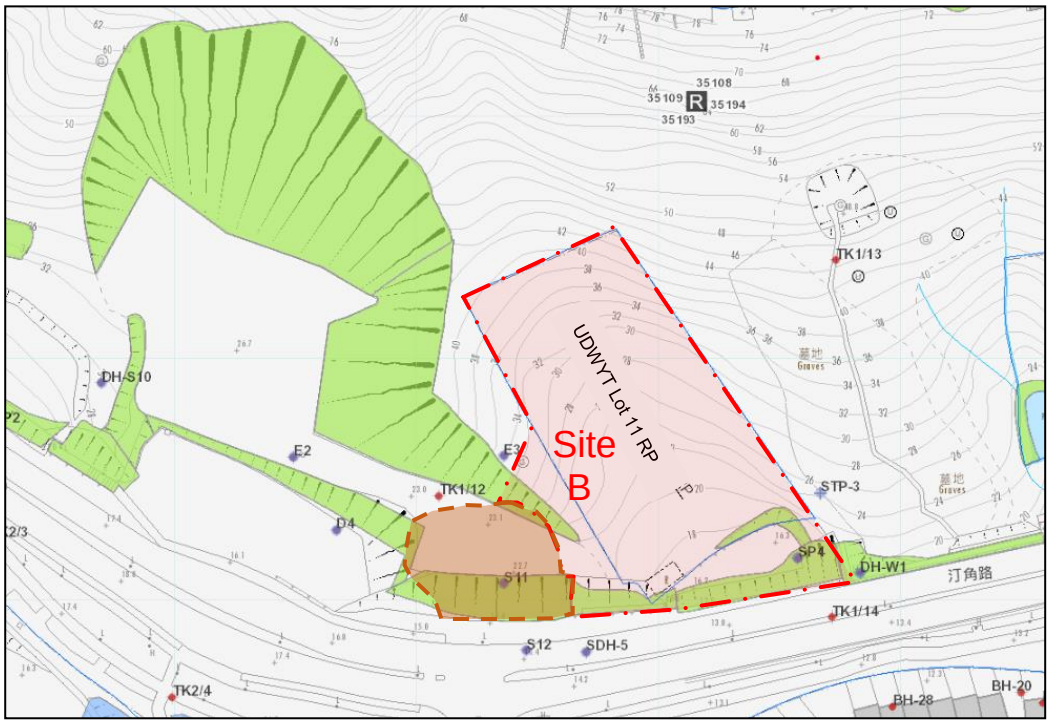


As shown in figure above, to the south of Site B is Ting Kok Road and then Fortune Garden is on the opposite side of Ting Kok Road, which is about 40m from the southern boundary of Site B. To the north of the Site is a natural hillside, another residential development, namely Tycoonplace is located about 50m from the northern boundary of Site B.

3) SITE GEOLOGY

With reference to the 1:20,000 geological map published by the Geotechnical Control Office, Hong Kong Geological Survey Sheet 7, the solid geology for the area comprises colluvium and Porphyritic medium- and fine-grained granodiorite under Shing Mun formation belonging to Tsuen Wan Volcanic group in middle Jurassic age. This would be confirmed by findings of existing and proposed ground investigation results.

3.1 Existing Site Investigation



Ground investigation records for the existing ground investigation record near the site are obtained from GIU of GEO.

The borehole E3 (GIU ref: 30746) located near the middle of the proposed development. The log indicated 4m colluvium and then underlying by 9m completely decomposed granodiorite (CDGd) and highly decomposed granodiorite (HDGd) down to the end of borehole at 17.1m depth. 7-days Groundwater monitoring for piezometer at borehole E3 indicated the highest ground water table at 15.92m depth (+18.04mPD).

The borehole TK1/13 (GIU ref:05911) located about 50m to the east of the lot boundary. The borehole log indicated 7.5m colluvium and then underlying by 25.48m CDGd to HDGd. The bedrock of SDGd was encountered at 32.98m depth (+10.85mPD). 7-days Groundwater monitoring for piezometer at borehole TK1/13 indicated the highest ground water table at 30.89m depth (+12.94mPD).

The borehole SDH-5 (GIU ref:35108) located at Ting Kok Road about 10m to the south of lot boundary. The borehole log indicated 0.5m fill underlying by 13.04m CDGd to HDGd. The bedrock of M/SDGd was encountered at 13.54m depth (+3.52mPD).

3.2 Proposed Site Investigation

Site-specific site investigation works would be proposed to obtain information for the future design analyses.

The proposed works include:

- vertical boreholes (with piezometers/standpipes)
- slope stripping
- trial pits
- coreholes

The proposed ground investigation works may be further reviewed.

3.3 Soil and Rock

According to the existing ground investigation records from GIU, generally, the geology within the site is colluvium overlying completely decomposed granodiorite (CDGd) and then highly decomposed granodiorite (HDGd) to bedrock of moderately/slightly decomposed granodiorite (M/SDGd).

Based on the currently available information, general description of each stratum is outlined as below:

- Colluvium –composed of yellowish red to yellowish brown, clayey sandy SILT with occasional angular to sub-angular, fine to coarse gravel sized quartz and moderately weak to moderately strong granodiorite fragments..

- Completely Decomposed Granodiorite– composed of extremely weak to weak, yellowish red to yellowish brown, mottled white, grey and prink, completely decomposed, medium grained GRANODIORITE. (Clayey sandy SILT with occasional fine gravel sized quartz fragments).

- Bedrock of Moderately to Slightly Decomposed Granodiorite (M/SDGd) – composed of moderately strong to strong, pinkish grey dappled red to light pinkish grey with dark green speckles, fine to medium grained GRANODIORITE. The bedrock profile in the development area is generally dipping downwards from northwest to southeast, about +22mPD to +4mPD.

The site geology shall be reviewed upon the completion of ground investigation works in the future.

3.4 Geotechnical Parameters

Without the laboratory test results from the detailed ground investigation, the recommended soil parameters for preliminary design and analysis are summarised below: -

	Recommended Soil Parameters for Design Purposes		
Soil Type	Bulk Density	Effective cohesion c'	Effective friction ϕ'
Coll	19	2	35
CDGd	19	5	35
HDGd	19	7	38

The recommended soil strength parameters for Colluvium and CDV are within the typical range of the geotechnical parameters as suggested in Table 8 of the GEOGUIDE I [GEO, 2020]. And the parameters for HDV are assumed based on our previous job experience.

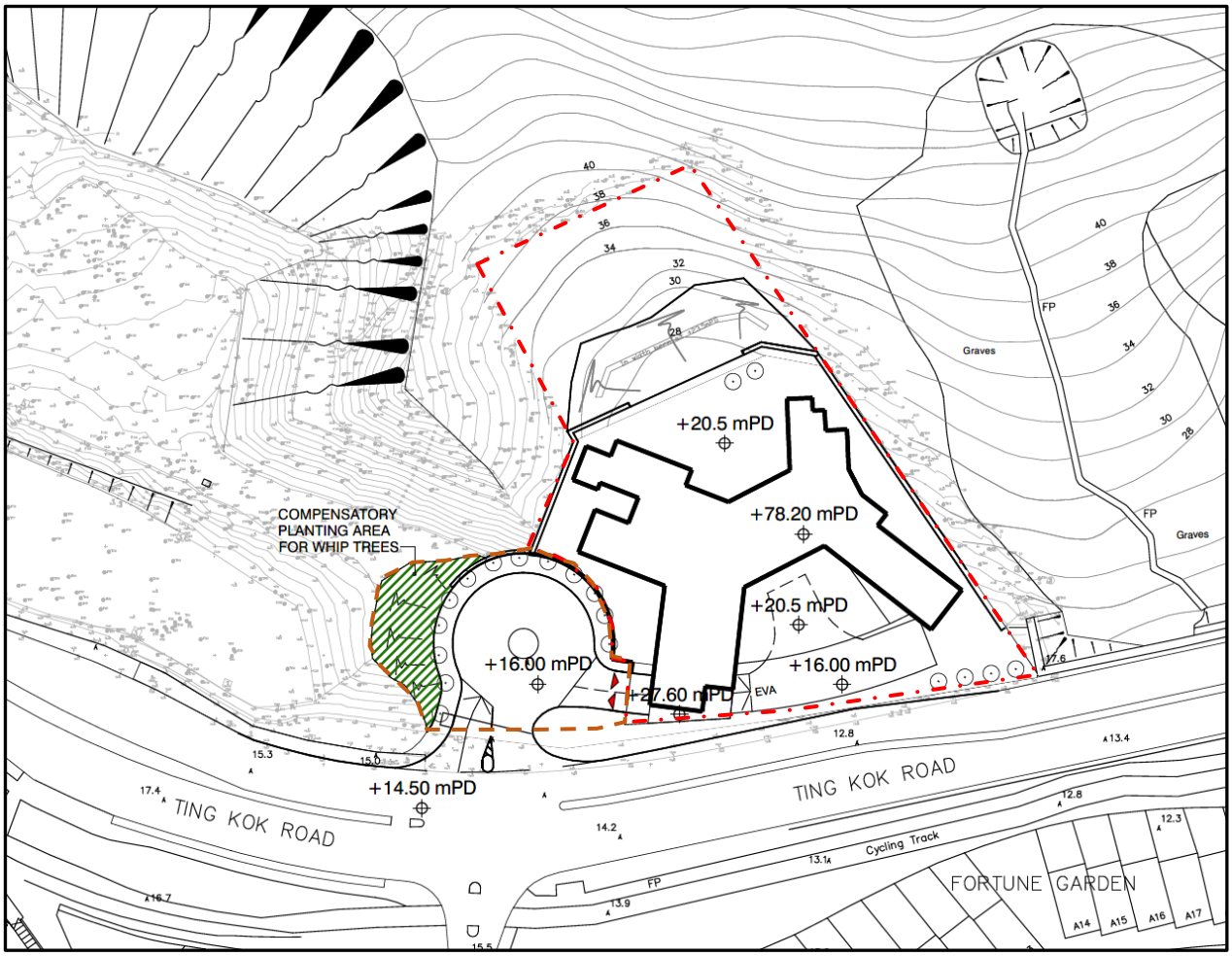
The geotechnical parameters will be reviewed upon the completion of future ground investigation and laboratory tests.

3.5 Groundwater

7-days Groundwater monitoring for piezometer at borehole E3 indicated the highest ground water table at 15.92m depth (+18.04mPD) and 7-days Groundwater monitoring for piezometer at borehole TK1/13 indicated the highest ground water table at 30.89m depth (+12.94mPD). Therefore, the groundwater level could be expected to locate quite low.

Piezometers and/or standpipes may be installed as part of the future ground investigation works so as to measure and confirm the groundwater table regularly in the vicinity of the site. The design ground water table shall be 1m above the highest observed ground water table or one-third of the retained height / slope height, whichever is higher.

4) PROPOSED DEVELOPMENT

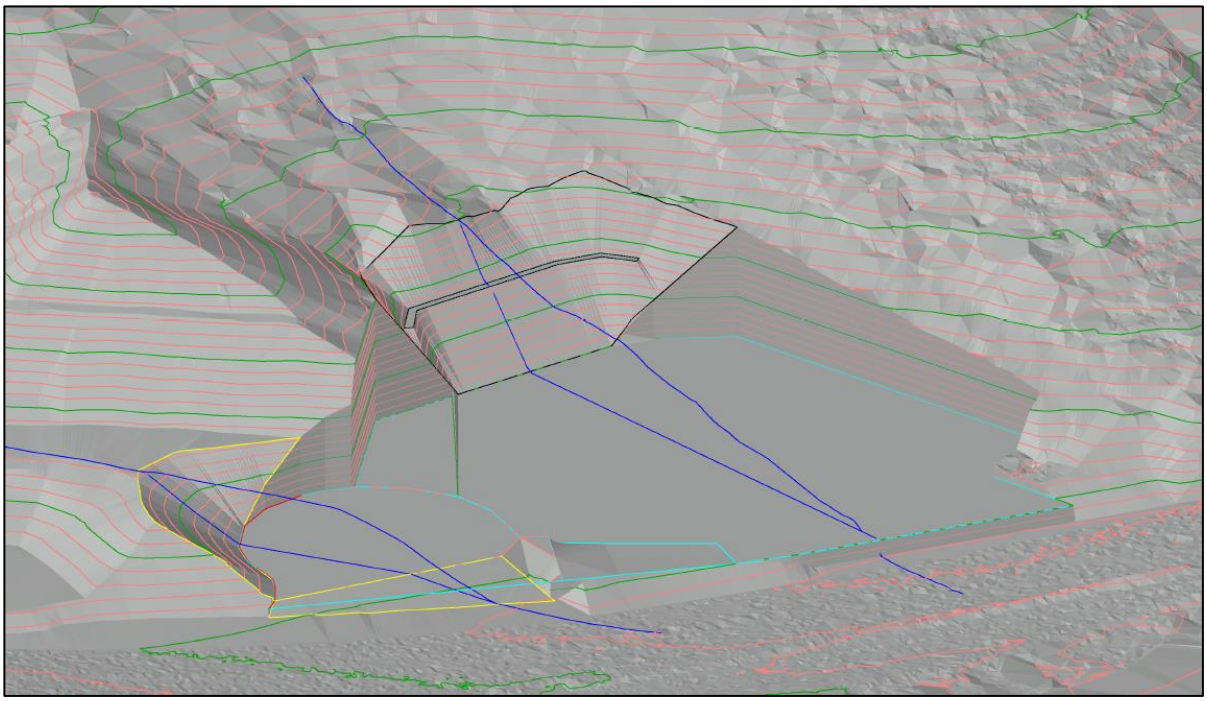


The proposed development comprises a double Y-shaped multi-storey residential building. The level of the proposed building platform is 20.5mPD. The proposed run-in/out and EVA is located at the south of the site and will be linked to Ting Kok Road.

5) GEOTECHNICAL CONSIDERATIONS

The following section gives an assessment on the geotechnical aspects of the proposed development:-

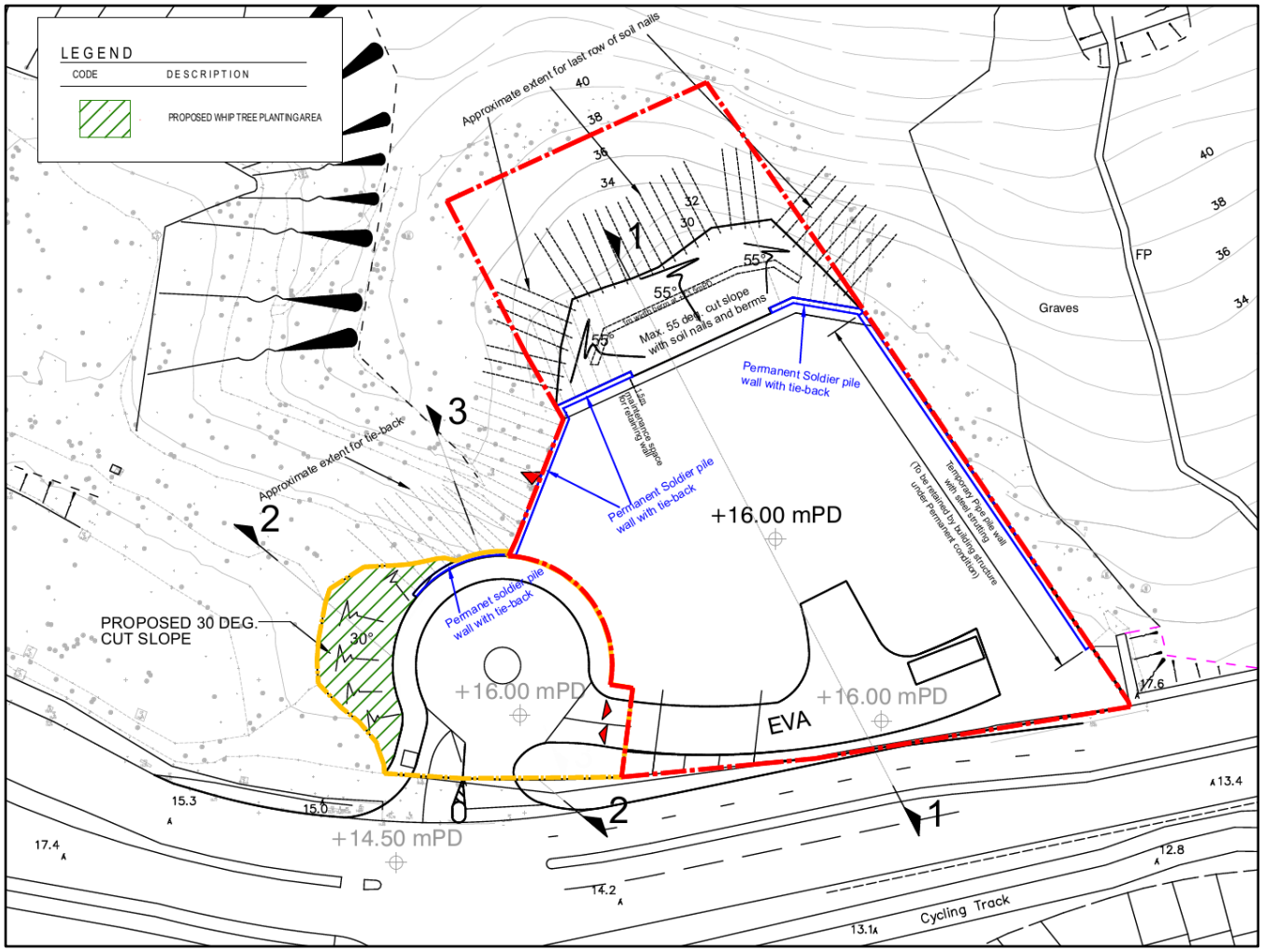
5.1 Site formation and Excavation and Lateral support works

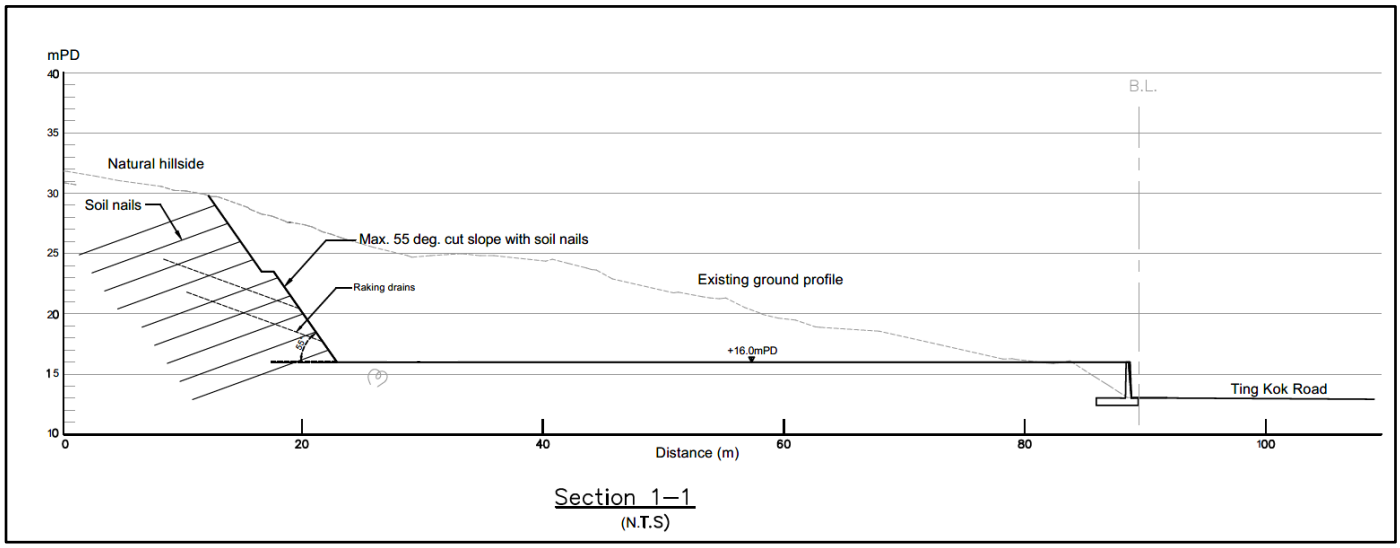


In view of the level difference between the existing ground levels of about +30mPD near the northern part of the site and +16mPD for the building platform of proposed building (i.e. a maximum of approximately 16m depth including pile cap), bored pile wall, sheet pile wall, pipe pile wall or solider pile wall with tie-back/struts or other retaining structures would be adopted to retain the level difference. Where underground obstruction is encountered, preboring technique will be undertaken if necessary. A 30 degree open cut slope is proposed for the formation of the roundabout to the west of the site.

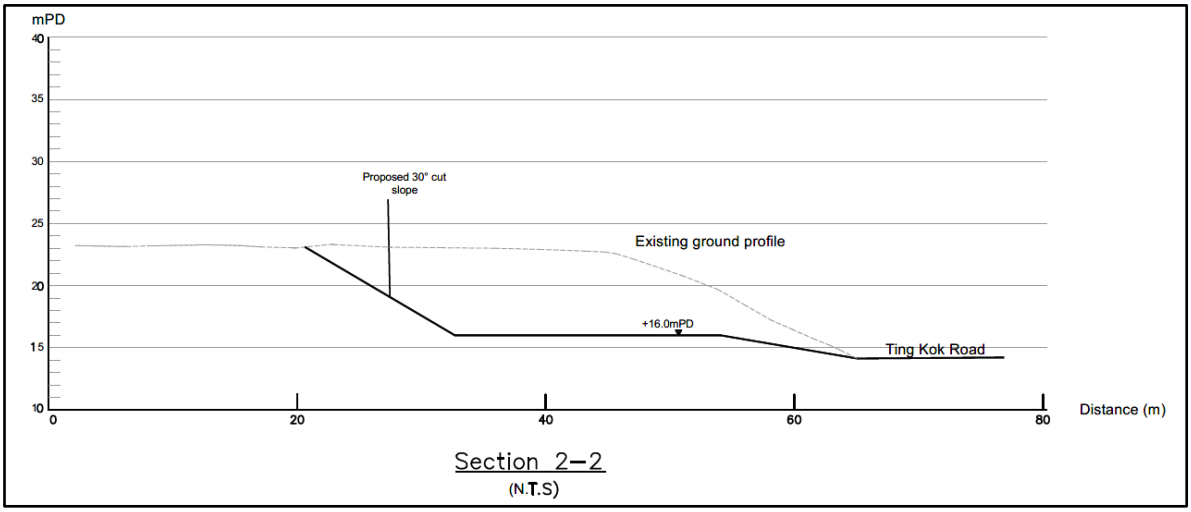
The effect of the proposed ELS works to the surrounding buildings, roads and utilities will be further assessed in detailed design. The ELS works should be designed in a manner that the effect of the proposed works should be minimal.

Preliminary site formation plan and section are as follows:

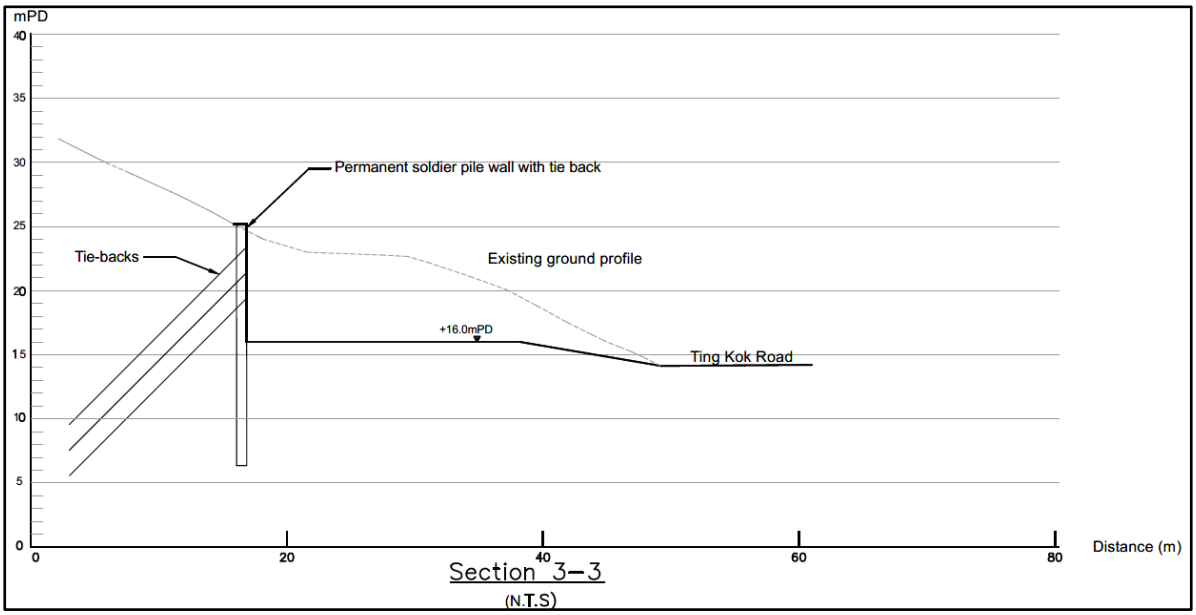




Section 1–1
(N.T.S)



Section 2–2
(N.T.S)



Section 3–3
(N.T.S)

5.2 Impact on Existing Slope Features

Feature No. 7NE-A/C7

Eastern portion of the feature would be removed during the site formation works. The western end of the feature may be remained.

Feature No. 7NE-A/C59

The whole feature would be removed during the site formation works.

Feature No. 7NE-A/C60

A small slope near eastern end of feature may be modified during the site formation works. The middle and western portion of this feature would be remained.

Feature No. 7NE-A/C61

The eastern end portion of feature may be removed during the site formation works. The middle and western portion of this feature would be remained.

Feature No. 7NE-A/CR163

The small portion at western end of the feature may be modified during the site formation works. The middle and eastern portion of this feature would be remained.

Feature No. 7NE-A/CR164

This feature would be removed during the site formation works.

Feature No. 7NE-A/C169

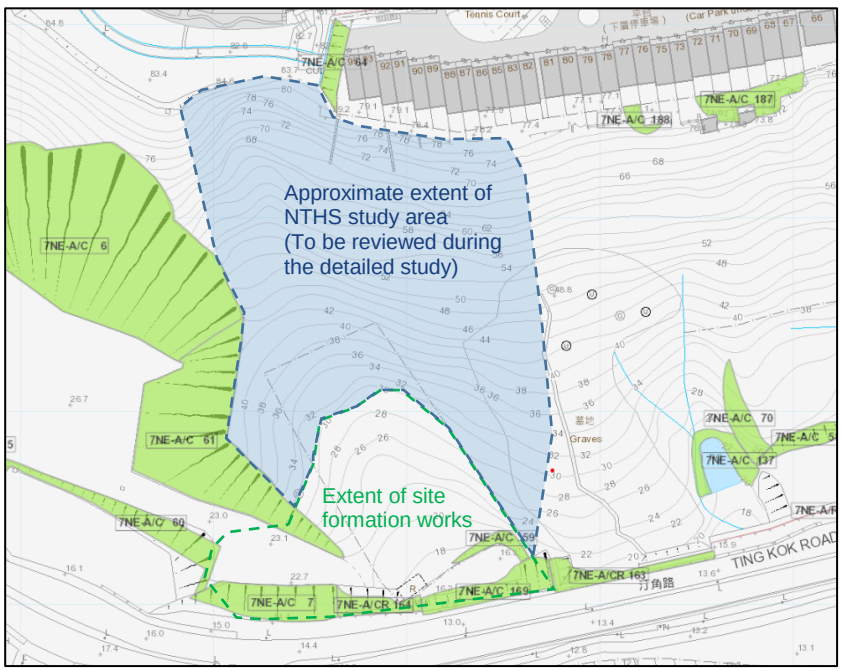
This feature would be removed during the site formation works.

The effect of the proposed works on these features will be further assessed during detailed design stage. All newly formed slopes and retaining walls (if any) will be registered in accordance with GEO Circular No. 15. The slope registration of all affected existing slopes and retaining walls will be updated. Maintenance manuals for all new or affected slopes and walls will be prepared or reviewed at completion of the slope works in accordance with Geoguide 5 (GEO, 2003). In general, the maintenance responsibility of slopes/retaining walls is determined based on the ownership of land, which is conferred by a lease document issued by the Lands Department, such as a government lease or conditions of grant, conditions of sale, and conditions of exchange. Owners may also be liable under specific lease conditions for the maintenance of slopes/retaining wall adjoining their lot.

5.3 Stability of Natural Terrain

Site B is located on a southerly facing slope. The proposed development may be affected by natural terrain hazards from the ground above site to the north and north-east.

Based on the preliminary assessment, the site satisfied the “Alert Criteria” according to GEO report no. 138 and detail natural terrain hazard studies are required. Detailed site reconnaissance of the surrounding terrain should be undertaken to identify any possible natural terrain hazards to the site such as areas of steep colluvial deposits or unstable boulders etc. Proposed mitigation will be dependant on the nature and scale of any identified risk which shall be determined at the detailed design stage. The approximate extent of the NTHS study area is shown on the figure below.



5.4 Proposed Foundation

The choice of foundation types will depend on the geological conditions encountered, loading requirements, the construction methodology and sequence and effect of proposed works to the nearby structures. The foundation scheme to be adopted shall be determined in term of cost and efficiency of the foundation construction.

In view of the large loading of the multi-storey residential building, it is proposed to transfer the loading to the deeper soil/rock strata using pile foundation.

The foundation system for the above structure will be designed to resist the following loads:

- Dead and live vertical loads from the superstructure
- Lateral wind load
- Soil and water loads from basement structure

Based on the height and configuration of the proposed building and the available information on the geology of the site, the following foundation types are considered feasible for the buildings.

Large Diameter Bored Pile

Bored piles are considered to be feasible for supporting high-rise buildings. All pile would be founded on Grade III or better rockhead with total core recovery > 85%. According to table 2 of the “Code of Practice for Foundations “, these pile may have a bearing capacity of 5000kPa. Bases on the currently available ground investigate records, the rockhead level is located varies from +4mPD to +22mPD.

Since the construction bored pile involves the use of temporary steel casing installed down to hard soil stratum /bedrock, its effect on adjacent building and structure shall be insignificant.

Mini-pile/Socketed H-pile foundation

Mini-piles or Socket H-pile socket into socked into bedrock are considered to be feasible for supporting building platform. All socketed piles would be embedded into the Grade III or better rock with total core recovery > 85%. Based on the currently available ground investigation records, the rockhead level is located varies from +4mPD to +22mPD.

The proposed mini-piles or Socket H-pile foundation should be designed in a way that the effect of the adjacent buildings and structure is significant. The effect of the proposed mini-pile/ socketed H-pile foundation on adjacent buildings, structure, slopes and retaining wall shall be assessed.

Footings

The utilization of footings to support some portions of the development may be feasible. In accordance with the Code of Practice for Foundations [BD, 2017], the allowable bearing pressure of the footing shall be as follows:

Description of rock or soil	Allowable bearing pressure (without wind)	
	Dry	Submerged
Slightly to moderately decomposed moderately strong granite or volcanic rock of material weathering grade III or better, and with not less than 85% TCR of the designated grade, which has a minimum UCS of rock material not less than 25 MPa (or an equivalent point load index strength PLI50 not less than 1 MPa)	5000kPa	
Moderately decomposed, moderately strong to moderately weak rock of material weathering grade better than IV, with a total core recovery of more than 50% of the grade	3000kPa	
Highly to completely decomposed, moderately weak to weak rock of material weathering grade V or better, with SPT N-value ≥ 200	1000kPa	
Non-cohesive soil: Very dense – SPT N-value > 50	500kPa	250kPa
Non-cohesive soil: Dense – SPT N-value 30-50; requires pick for excavation; 50mm peg hard to drive	300kPa	150kPa

The effect of the proposed bored pile/mini-pile / socketted H-pile / footing foundation on adjacent buildings, structures and slopes shall be insignificant and will be further assessed during detailed design stage.

6) MONITORING SCHEME

A comprehensive monitoring programme, which comprises the followings, shall be implemented on site in order to monitor the effect of the proposed works on the surrounding ground, and safeguard the adjacent utilities and structures:

1. Settlement check points around the site;

2. Settlement check points on surrounding utilities;

3. Tilting checkpoints on nearby buildings;

4. Vibration checkpoints around the site; and

5. Piezometers/standpipes at locations around the site.

The initial readings of all the above monitoring points and piezometers/standpipes shall be taken prior to the commencement of construction works on site and these devices shall be monitored regularly throughout the construction works.

7) CONCLUSION

This report has discussed all the relevant issues regarding the geotechnical assessment of the proposed development at Site B.

Detailed site reconnaissance of the surrounding terrain should be undertaken to identify any possible natural terrain hazards to the site such as areas of steep colluvial deposits or unstable boulders etc. Proposed mitigation will be dependant on the nature and scale of any identified risk which shall be determined at the detailed design stage.

Pile foundation is recommended for the proposed multi-storey building. The utilization of mini-pile/socket H-pile/footings to support some portions of the development may be feasible.

All existing structures, slopes and retaining walls affecting or being affected by the proposed development will be assessed. If necessary, precautionary or upgrading works will be carried out in detailed design to ensure that the surrounding structures, slopes and retaining walls will not be adversely affected.

With reference to the preceding discussions, it is considered that the proposed development is **geotechnically feasible**.