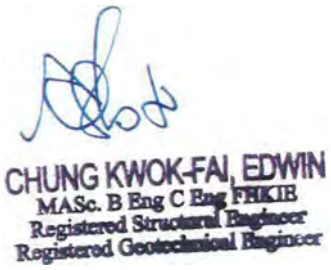
Natural Terrain Hazard Study

(Application number A/SK-CWBS/17)

Natural Terrain Hazard Study
for Proposed Filling of Land and
Excavation of Land for Permitted 2-Storey on Farm
Domestic Structure at Lot No. 30 (Part)
in D.D. 233, East of Clear Water Bay Road,
Sai Kung,
New Territories



Contents

APPENDICE

1 INTRODUCTION

A 2-storey domestic structure is proposed to be constructed within Lot No. 30 (Part) in D.D. 233, east of Clear Water Bay Road in Sai Kung (847695E 817907N). A natural terrain hazard study was carried out in 2014 with respect to the natural hillside located to the southwest of the proposed development site (The Site). This report documented the findings of the natural terrain hazards aroused from the natural hillside and the necessary mitigation measures to be carried out.

2 SITE DESCRIPTION

2.1 Site Location

The Natural Terrain Hazard Study (NTHS) Area is defined as a triangular shape hillside catchment demarcated from a northeast facing gentle open hillslope above the crest of the man-made Feature (12SW-A/CR166) located at about 23 m from the proposed development site. The location of The Site is shown in Plate 1 and Figure 1. The proposed domestic structure (refer as 'the site' in this report) is going to construct on the existing terraced farmland below Clear Water Bay Road, Sai Kung. There is no registered slope or retaining wall present within the proposed development site.

The NTHS Area comprises predominantly a gentle open hillslope covered with dense vegetation and has a small plan area of approximately 466 m^2 (Plate 2).

3 DESK STUDY

3.1 Topography

The general topography of the Study Area is based on the latest digital 1:1000 scale topographical map. The maximum altitude of the Study Area is about +131 mPD and its toe is at about +104 mPD. The elevation different between the toe and the crest of the Study Area is about 27 m. A slope angle map has been generated for the Study Area based on the 1:1000 topographic map with the aid of the software ArcGIS (Figure 2). As shown on the slope angle map, majority of the hillslopes within the Study Area is relatively gentle, with slope angle generally less than 30°.

3.2 Geological Maps

The geology of the Study Area is shown on the Hong Kong Geological Survey (HKGS) Map Sheet 12 (Clear Water Bay), 1:20,000-scale HGM20 series. The local geology of the Study Area is presented in Figure 3 and described below.

3.2.1 Solid Geology

The 1:20,000 scale geological map sheet 12 (HKGS, 1989) indicated that the Study Area is likely to be underlain by undivided, mainly trachydacite and rhyolite lava of Clear Water Bay Formation (JCB).

3.2.2 Superficial Geology

No superficial deposit has been marked within the Study Area indicating the possible thickness of superficial materials could be less than 2 m.

3.2.3 Structural Geology

No fault or photolineament has been recorded within the Study Area. A NW-SE trending inferred fault is indicated 40 m to the northeast of the Study Area.

3.3 GASP Report

The Geotechnical Area Studies Programme (GASP) comprised a systematic geotechnical information and assessment for land management and development planning of the Territory of Hong Kong. The findings were based on terrain classification techniques using aerial photographs, examination of geotechnical data collected from existing Site investigation records and available literature and field reconnaissance. The study was based on the bedrock geology given on the 1:50,000 scale geological map produced by Allen & Stephens (1971) 'Report on the Geological Survey of Hong Kong', which has subsequently been superseded. The following are extracts from the relevant GASP report (GASP Report VII, Clear Water Bay, 1988):

a) Physical Constraints Map – This map has indicated zones of insitu terrain which are generally steeper than 30° at the Study Area.

b) Engineering Geology Map – This map indicates that the Study Area is underlain by mainly banded acid lavas and some welded tuff.

c) Geotechnical Land Use Map – This map indicates that the Study Area is designated as Class III, which has high geotechnical limitations and is low suitability for development.

3.4 Enhanced Natural Terrain Landslide Inventory

In 1995, the GEO compiled the Natural Terrain Landslide Inventory (NTLI) from an interpretation of high-altitude (8,000ft and above) aerial photographs dated from 1945 to 1994 (King, 1999). In 2007, the GEO produced an Enhanced Natural Terrain Landslide Inventory (ENTLI) using low-altitude (8,000ft and below) aerial photographs to update the NTLI.

In accordance with **GEO Report No. 138** (GEO, 2003), landslides are classed as either "Relict" or "Recent", depending on their appearance in aerial photographs. "Relict" landslides are defined as those where the main scarp is well-defined but vegetation has re-established on the scar on the earliest set of available aerial photographs. "Recent" landslides are defined as having occurred within the timespan of the aerial photograph coverage. These are typically identified as having a light tone on the aerial photographs and are bare of vegetation.

The ENTLI has recorded no relict or recent natural terrain landslides within the Study Area. Three relict open hillside landslides were recorded at about 150 m to the northwest of the Study Area. Details of these ENTLIs are summarised in Table 3.1 and their approximate locations are shown in Figure 4.

Table 3.1 Summary of Natural Terrain Landslide Events Recorded in ENTLI

ENTLI No.	Recent / Relict	ENTLI Relict Landslide Class[1]	Year of Photo	Landslide Type[2]	Measured Width (m)	Source Length (m)	Head Elevation (mPD)	Tail Elevation (mPD)
12SWA0213E	Relict	C1	1963	R	8.5	13.5	163	156
12SWA0214E	Relict	C1	1963	R	11.0	12.0	140	132
12SWA0215E	Relict	C1	1963	R	14.0	11.0	183	176

Notes: (1) Relict landslide classification based on ENTLI record.
(2) R = relict

3.5 Historical Landslide Catchment (HLC) Inventory

Historical Landslide Catchments (HLCs) have been defined by GEO based on the results of the ENTLI. There is no HLC within the Study Area.

3.6 Large Landslide Study

The Large Landslide database was prepared by Scott Wilson (1999) for the GEO. Interpretation of landslide details with Map Sheet Ref No. 10-SW-C was conducted using the low altitude (3,900 ft.) 1963 aerial photographs to identify features thought to be landslides with source area greater than 20 m wide.

The database has no record of large landslides within or close to the Study Area.

3.7 Reported Landslide Incidents

The GEO landslide incidents database has no record of reported landslide incident within the Study Area.

3.8 Boulder Field Inventory

The Boulder Field Inventory is a boulder study of the whole territory of Hong Kong including a series of study reports and 1:20,000 maps. The study was based on the use of the 1963 low altitude aerial photographs.

Four main attributes (Percentage Area Covered, Boulder Type, Boulder Size and Boulder Shape) and additional attributes are defined for the boulder study. Multiple Attribute Mapping was adopted to define areas of land having a relatively uniform pattern of boulder deposits and the results were mapped on 1:20,000 topographic maps of Hong Kong.

The Boulder Field Inventory was compiled by MGSL. The inventory contains referenced polygons encompassing individual boulder fields. The Study Area lies within Polygon No. 611 (Figure 5) which indicates no boulder has been observed on the ground surface.

3.9 Previous Ground Investigation

There is no previous ground investigation work has been carried out within the Study Area. The nearest trial pit and borehole were located at the crest of the man-made Feature No. 12NW-C/C106 and about 45 m and 100 m to the northwest of the Study Area respectively (Figure 6). Both GI stations indicated about 2.0 m thick colluvium overlying the completely to highly decomposed volcanic rock. The colluvium typically comprises firm, yellowish brown, slightly sandy silty Clay with some gravel and cobbles.

3.10 Existing Facilities

The existing facility immediately below the Study Area is the Clear Water Bay Road and footpath which has an approximately width of 12.5 m (Plate 3).

3.11 Registered Man-made Slopes

A registered man-made Feature No. 12SW-A/CR166 is located immediately below the Study Area (Figure 7) on the upslope side of Clear Water Bay Road. According to the SIS record, the feature is a cut slope with maximum height and length of the feature is about 8.5 m and 70 m respectively. The average angle of the feature is only about 40°. There are retaining walls at the feature crest and toe along the northern portion of the feature. Detailed information of the feature extracted from SIS is presented in Appendix B.

4 AERIAL PHOTOGRAPH INTERPRETATION

4.1 General

In order to study the landslide history, geomorphology and engineering geology of the Study Area and its adjacent area, an aerial photograph interpretation (API) has been carried out using a total of 73 relevant aerial photographs taken between 1964 and 2013. Details of site development and geomorphology obtained from API are presented in the below sections and further information is provided in Appendix A.

4.2 Development History

Majority of the Study Area has been vegetated with grass and small trees since the first day of photography in 1964. Clear Water Bay Road and cut slope Feature 12SW-A/CR166 have already been constructed immediately below the Study Area in 1964. Before 1964, a footpath has already been

constructed traversing the middle of the Study Area and connect a grave structure to Clear Water Bay Road. Later in 1986, a couple of square structures, possibly urn structures were constructed immediately to the southeast of the grave.

The hillslope between Clear Water Bay Road and the site appeared to be remnant agricultural terraces and have been covered by dense vegetation since 1964. As revealed from the aerial photograph, active agricultural activities on the area below the Site have been observed before 1983 where village house development was observed after 2005.

4.3 Landslides

4.3.1 Natural Terrain Landslide History

The landslide history for the Study Area was obtained from a series of aerial photographs between 1964 and 2013.

Landslides have been classified as "relict" and "recent", in accordance with **GEO Report No. 138**. "Relict" landslides are defined as the landslides first observed on the earliest set of available aerial photographs where vegetation has re-established and the scarp is not well defined due to degradation. While "recent" landslides are defined as the landslides first observed on the earliest set of aerial photographs where vegetation has not re-established.

Based on the findings from API, no relict or recent landslide features could be within and in vicinity of the Study Area.

4.4 Geomorphological Conditions

The geomorphological map of the study area was developed based on API and cross-checked with field mapping. Details of the geomorphological features, including the morphology based on the system of Savigear (1965) and the regolith types based on the regolith guideline (**TGN 22**) are presented in Figure 8 and described below:

4.4.1 Morphology

Morphologically, the Study Area is located within a generally planar east facing open hillslope and is bounded by an east trending spurline at its south. Slope gradients within the Study Area are generally ranging approximately between 20 and 45 degrees. The upper part of the Study Area appears to be slightly steeper and less hummocky, whilst the lower part of the Study Area appears to have a relatively rougher surface and slightly gentler slope.

A minor concave change-in-slope is discerned at about +120 mPD, which approximately defined the boundary between the smoother upper slope and the more hummock lower slope. The lower hummocky surface may suggest thinker accumulation of colluvial deposits than the upper slope.

5.2.2 Regolith Mapping and Boulders

Figure 8 illustrates the mapped regolith types within the Study Area which generally include open hillslope colluvium deposit over the entire Study Area.

Majority of the hillslope within the Study Area was covered by open hillslope colluvium which generally consisted of firm, reddish brown dappled grey, slightly sandy, slightly clayey SILT with some subangular fine to coarse gravel and occasional cobbles (Plate 4).

No prominent boulder greater than 300mm diameters was observed within the Study Area.

The general slope gradient of the natural terrain within the mid-level and lower portions of the Study Area is about 25° (Plate 5 and 6). While the upper portion of the Study Area is inclined at about 30° (Plate 7).

5.2.3 Rock Exposures

No rock outcrop had been observed within the Study Area.

5.2.4 Natural Terrain Landslides

Neither relict nor recent landslide scar has been identified within the Study Area.

5.2.5 Drainage Line Characteristics

Neither perennial nor ephemeral drainage line has been identified within the Study Area.

5.2.6 Erosion and sign of distress

No active sign of erosion or distress have been identified within or in the vicinity of the Study Area.

5.2.7 Water Seepage

No water seepage was identified within the Study Area.

5.2.8 Soil Pipes

No obvious soil pipe was identified within the Study Area during the field mapping.

5.2.9 Vegetation

The Study Area is well vegetated with grasses, shrubs and trees over the majority of its extent.

5.2.10 Anthropogenic Features

Major anthropogenic features within and in the vicinity of the Study Area include the paved footpath, urns and graves (Plate 8 and 9). The locations of these features are marked in Figure 8.

6 ENGINEERING GEOLOGICAL/GEOMORPHOLOGICAL MODEL

6.1 General

Geomorphological and engineering geological models were formulated for the Study Area based on information obtained from the desk study, API, field mapping and current GIs. An Engineering Geological Model and Geomorphological model of the Study Area were developed and presented below:

6.2 Solid Geology

The solid geology within the Study Area was underlain by underlain by undivided, mainly trachydacite and rhyolite lava of Clear Water Bay Formation (JCB).

6.3 Superficial Geology

Superficial deposit within the Study Area is mainly colluvium which is expected to be transported from the upper terrain above the Study Area. The colluvium typically comprises firm, reddish brown, slightly sandy and slightly clayey SILT with some subangular gravel and cobbles and occasional cobbles of rock fragments.

6.4 Structural Geology

No fault or rock outcrop identified within the Study Area.

6.5 Geomorphological Model

6.5.1 General

To appreciate the geomorphological process within the Study Area, it is better to look at a wider picture within the Study Region. Terrain Units within the Study Region are divided into four main units developed based on the simplified land surface model (Dalrymple, et al., 1968). The key terrain units identified in vicinity of the Study Area include the Upper Slope Terrain, Upper Mid-Slope Terrain, Lower Mid-Slope Terrain and Foot Slope Terrain as described below and presented in Figure 9.

6.5.2 Upper Slope Terrain Unit

The Upper Slope Terrain comprises the gentle slopes along the West trending ridge located to the south of the Study Area. The slope gradient is generally less than 20 degrees. The Upper Slope Terrain appears to be the oldest terrain unit in the study region. The terrain comprises mainly saprolitic

soil. The predominant geomorphic processes are likely to be pedogenic process, eluviation and soil creeping. This terrain appears currently stable and mature with no evidence of recent or relict slope instabilities identified form the API. No Upper Slope Terrain Unit is identified within the Study Area.

6.5.3 Upper Mid-slope Terrain Unit

The Upper Mid-Slope Terrain Unit is locally demarcated by the convex change of slope immediately below the Upper Slope Terrain Unit at the downslope side of the ridgeline. The upper Mid-Slope Terrain largely covers the steeper hillside 150m to the northwest above the Study Area (above +146mPD) and generally has a slope gradient over 45°. Mass wasting process (landslide) may occur on this terrain unit where the hillside is influenced by the subsurface water action. The Upper Mid-Slope Terrain Unit was not identified within the Study Area.

6.5.4 Lower Mid-slope Terrain Unit

The Lower Mid-Slope Terrain is located immediately below the Upper Slope Terrain, generally below the convex break-in-slope well above the Study Area. The Lower Mid-Slope Terrain appears to be gentler in slope and therefore believed to have less active transportation process and have thicker accumulation of colluvium due to its gentler slope angle. Due to the generally gentle slope angle of the terrain unit and the lack of preferential water passage within the Study Area, the mass wasting process is considered to be relatively inactive.

6.5.5 Foot Slope Terrain Unit

The Foot Slope Terrain is located immediately below the Middle Slope Terrain at about +94 mPD. This terrain unit is considered to be predominantly depositional terrain underlain by relatively thick colluvium deposits over the saprolitic soil. The colluvium deposits within the terrain unit are expected to have varies composition and may represent different horizon of colluvium deposition of different age. Due to its generally gentle slope angle (5° to 10°) and the lack of mass wasting progress, this terrain is considered to have low susceptibility to landslides.

6.5.6 Disturbed Terrain Unit

Disturbed terrain represents the hillslopes had been utilized for agricultural terraces before 1985 and is evidenced on the Lower Mid-Slope Terrain below Clear Water Bay Road. Minor slope cuttings and rework of hillslope colluvium to form the terraces can be found within this terrain. Given the overall slope gradient within this terrain below the Study Area is less than 25° and the lack of evidences of landslide events associated with the terraces, the terrain is considered to be low susceptible to landslide.

4.4.2 Regolith

As the entire the Study Area is within the Lower Mid-Slope terrain, the underlying regolith within the Study Area is predominantly colluvium. Thicker accumulation of colluvium is believed to be present at the lower portion of the Study Area where relatively hummock surface and gentler slope angle are evidenced, whilst thinner colluvium is believed to be underlying the upper slope area. Thin veneer of the upper layer of colluvium could have been reworked in association with the footpath construction in the early dates.

4.4.3 Rock Outcrops

No prominent rock outcrop was identified within or in the vicinity of the Study Area from the aerial photographs.

4.4.4 Drainage Lines

No prominent drainage line was identified within the Study Area.

4.4.5 Erosion and sign of distress

No signs of erosion or other signs of distress were identified from the API within the Study Area.

4.5 Anthropogenic Features

As mentioned in above section 4.2, a footpath has already been constructed across the Study Area before 1964. Minor slope cutting (<0.5 m) and filling (<0.5 m) are expected associated with the formation of footpath.

Below Clear Water Bay, the hillslope above the Site are evidenced to be remnant agricultural terraces with very degraded terraces observed in 1964 aerial photographs. Further below the Site, agricultural activities are evidenced before 1985.

5 FIELDWORK

5.1 General

Fieldwork included detailed geological and geomorphological mapping, which was cross checked with the API and existing geological data.

5.2 Field Mapping

5.2.1 General

In general, the findings from field mapping were consistent with aerial photography interpretations.

7 HAZARD ASSESSMENT

7.1 General

Design Event Approach is adopted to assess the natural hazard based on the five generic hazard models defined in **GEO Report No. 138** (GEO, 2002) and TGN36 as follows: open hillslope landslide, channelized debris flow/debris flow, deep-seated landslide, rockfall / slide and boulder fall.

Based on the findings from detailed desk study and Field work as well as the geological and geomorphological model established in section 6, hazard assessment with respect to the five generic hazard models are discussed below.

7.2 Hazard Identification

7.2.1 Open Hillslope Landslide

No evidences of previous landslides are observed within the Study Area. Landslides happened only on the relatively steeper Upper Mid-Slope Terrain well above the Study Area on different terrain unit (Upper Mid-Slope Terrain) where different geomorphology is interpreted to be occurring.

Majority of the Study Area is regarded as the Lower Mid-Slope terrains with slope gradients generally 20°- 45° and is relatively stable. Also there is no significant water concentrate towards the Study Area and catchment area connected to the Study Area is relatively small. Mass wasting process across the general Study Area is observed to be inactive, with no signs of erosions or past instability. The geomorphological study of the area also revealed a generally an inactive transportation environment with inactive mass wasting process. Therefore, open hillslope landslide is not envisaged within the Study Area.

7.2.2 Channelised Debris Flow/Debris Flow

As there is no perennial or ephemeral natural drainage line within the Study Area, therefore it is considered that CDF/DF is a not viable hazard model within the Study Area.

7.2.3 Deep-seated Landslide

There is no clear evidence from field mapping and historical record showing that deep-seated landslide could have occurred. Therefore, deep-seated landslide is considered not a viable hazard.

7.2.4 Rock Fall

No rock outcrop was identified within the Study Area therefore rockfall is not considered a natural terrain hazard for this Study Area.

7.2.5 Boulder Fall

No prominent boulders greater than 300mm diameter was identified within the Study Area therefore boulder fall is not considered a natural terrain hazard for this Study Area.

7.3 Landslide Susceptibility

The landslide susceptibility class of the Study Area is derived according to the guidelines described in **GEO Report no. 138** (GEO, 2003) and detailed in Table 7.1.

Table 7.1 Summary of Hazard Types and Susceptibility classes

Hillside Catchment	Hazard Type	Terrain Unit	Susceptibility Class	Description of Hazard and Reason for the Susceptibility Class
Study Area	OHL	Lower Mid-Slope Terrain	D	No evident of recent or relict landslide has been identified within the Terrain Unit or similar unit in vicinity of the Study Area. Considering no significant water concentration is connected to the Study Area and the water divide on the upslope of the Study Area is likely to disperse surface runoff onto the adjacent valley catchments rather than onto the Study Area. No either perennial or ephemeral drainage line present within the Study Area and the overall slope gradient is less than 30°. The overall NTHS area is relatively small. Little geomorphological and other evidence of potential problems in the catchments and similar terrain in its vicinity. The Lower Mid-Slope Terrain within Study Area is therefore considered to have low susceptibility to open hillslope failure with a notional annual probability of occurrence less than 1/1000.

7.4 Consequence Assessment

The assessment of the consequence of landslide hazards has been undertaken in accordance with **GEO Report 138** (GEO, 2003) based on a combination of factors including terrain characteristics, hazard susceptibility and facility at risk.

Proximity of the Natural Terrain to the proposed domestic farm structure is shown in Figure 10 and detail of the consequence class of the facility at risk is presented in Table 7.2 below.

Table 7.2 Summary of the Consequence Class

Hillside Catchment	Consequence				
	Critical Facility at Risk	Facility Group	Angular Elevation	Proximity	Class
Study Area	Proposed Farm Domestic Structure	1	24	Far	III

7.5 Design Event Requirement

Based on the Consequence and Susceptibility Classes detailed in the previous Sections, the Design Event Requirements for each Hazard Zone have been derived in accordance with **GEO Report No. 138** (GEO, 2003) and these are summarised in Table 7.3.

Table 7.3 Design event Requirement for each Hazard Zone

Hillside Catchment	Hazard	Consequence Class	Susceptibility Class	Design Event Requirement
Current Study Area	OHL	III	D	Further study is not required

Based on the assessment of the design event requirements of the terrain units within the Study Area, further Study is considered not required.

8 HAZARD MITIGATION STRATEGY

8.1 Requirement of Mitigation Action

Following the review of the landslide hazards on the Study Area, there is only low degree of landslide hazard at the Study Area. Therefore, no mitigation action will be required for the natural terrain.

9 CONCLUSIONS

A natural terrain hazard assessment was carried out based on guidelines given in GEO Report 138 and the latest TGN 36, by reviewing the topography, geomorphology and landslide history of the Study Area. Results of the assessment showed that no natural terrain hazard was identified and landslide susceptibility within the Study Area is considered to be low. Following the result from the assessment, no mitigation works for the potential natural terrain hazard is considered necessary for the proposed development.

10 REFERENCES

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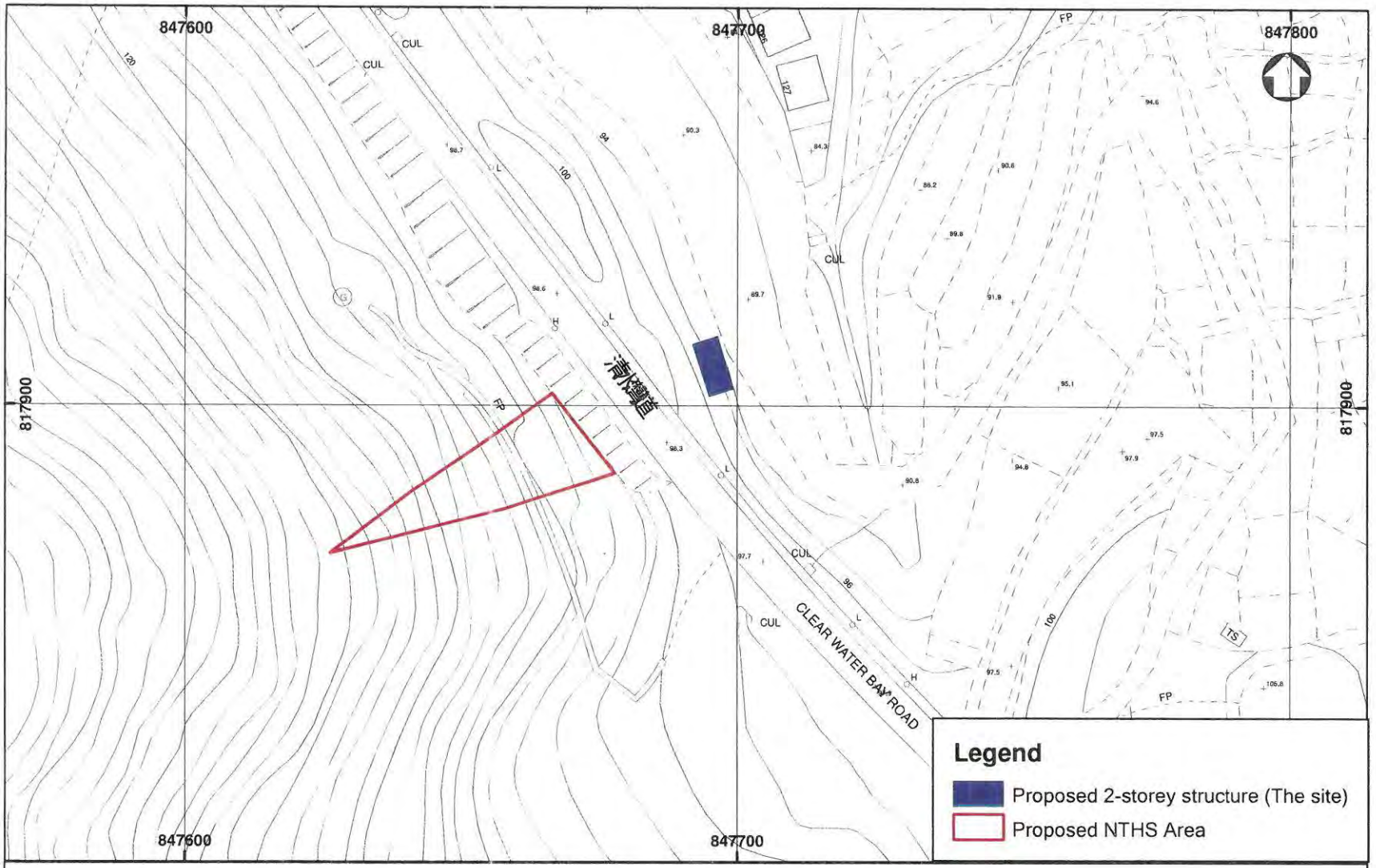
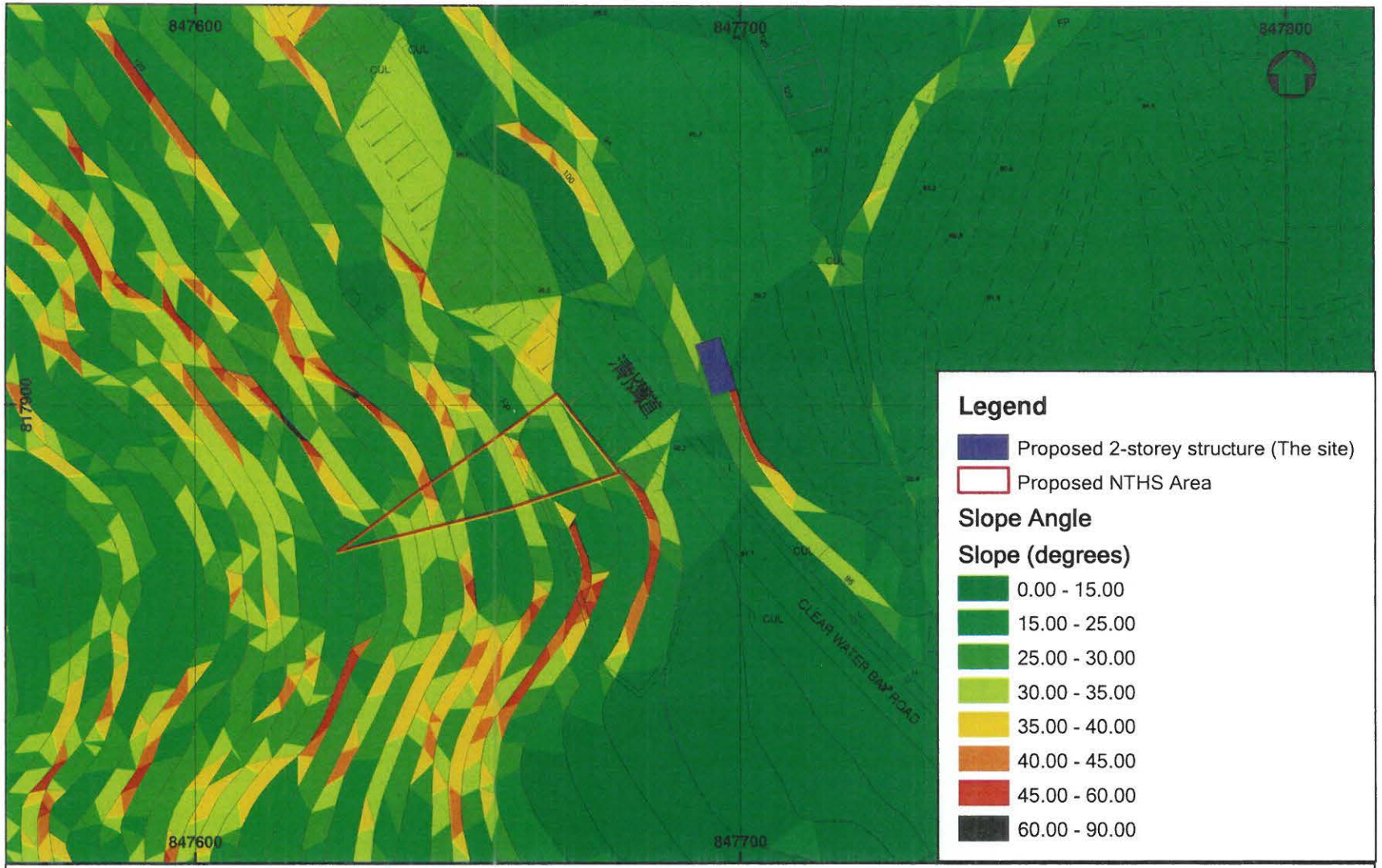
LIST OF FIGURES



PROJECT:	**Proposed Filling of Land and Excavation of Land for Permitted 2-Storey On Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories**		
TITLE:	**Location Plan of the Proposed 2-Storey Domestic Structure**	**SCALE:** 1 : 1000	**FIGURE NO :** FIGURE 1



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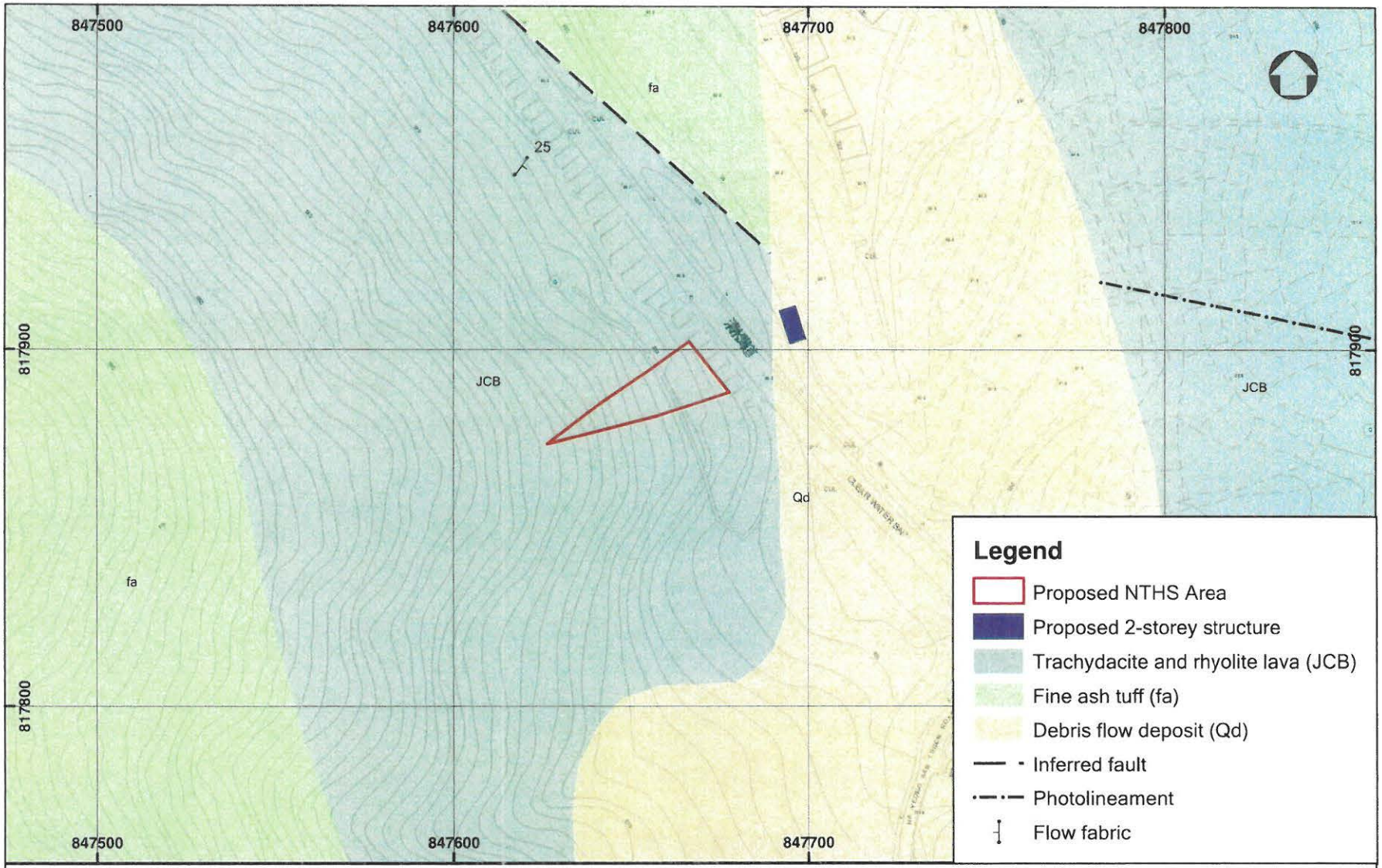

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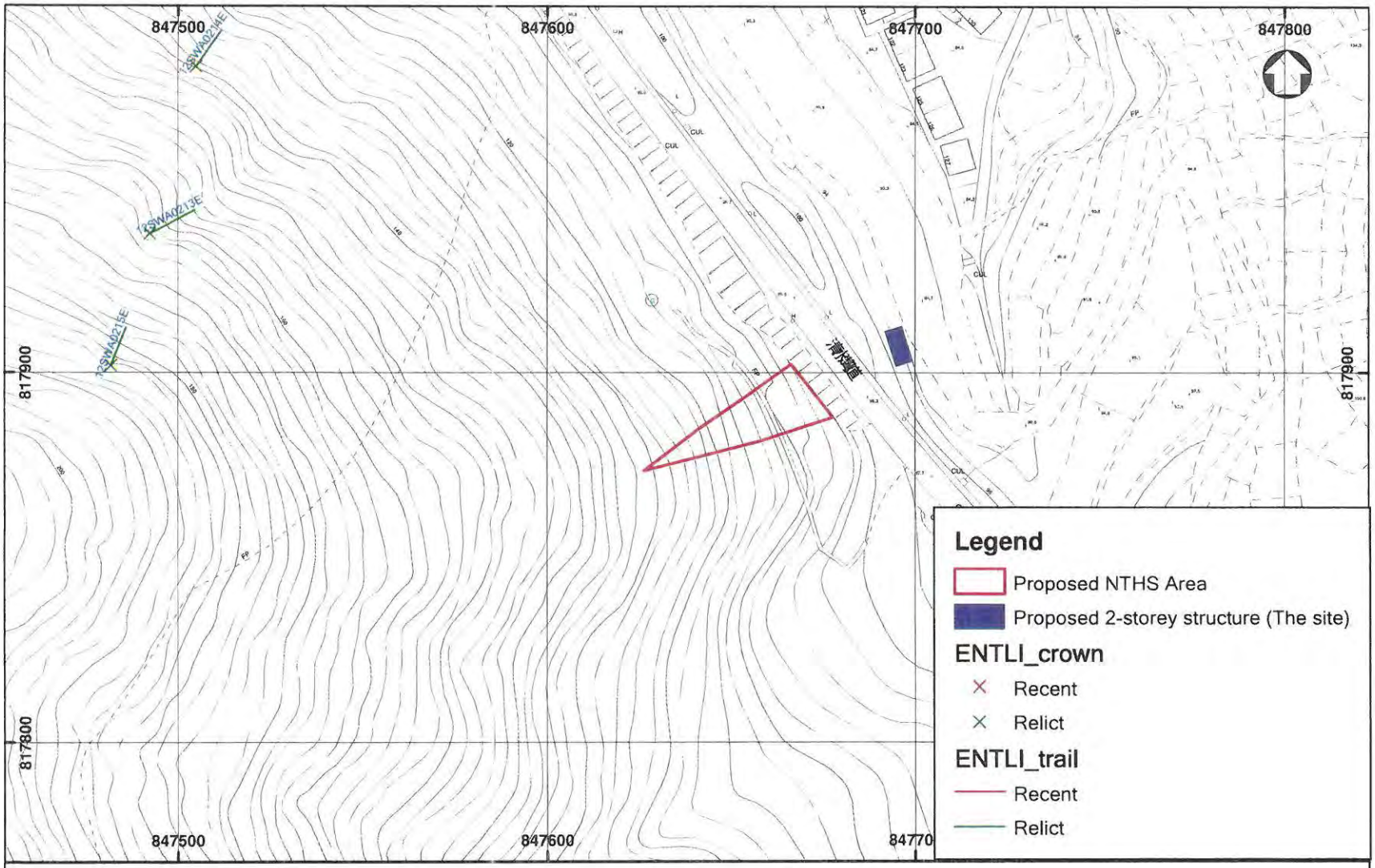
TITLE:	**Geological Map (1:20,000)**	**SCALE:** 1 : 1500	**FIGURE NO :** FIGURE 3



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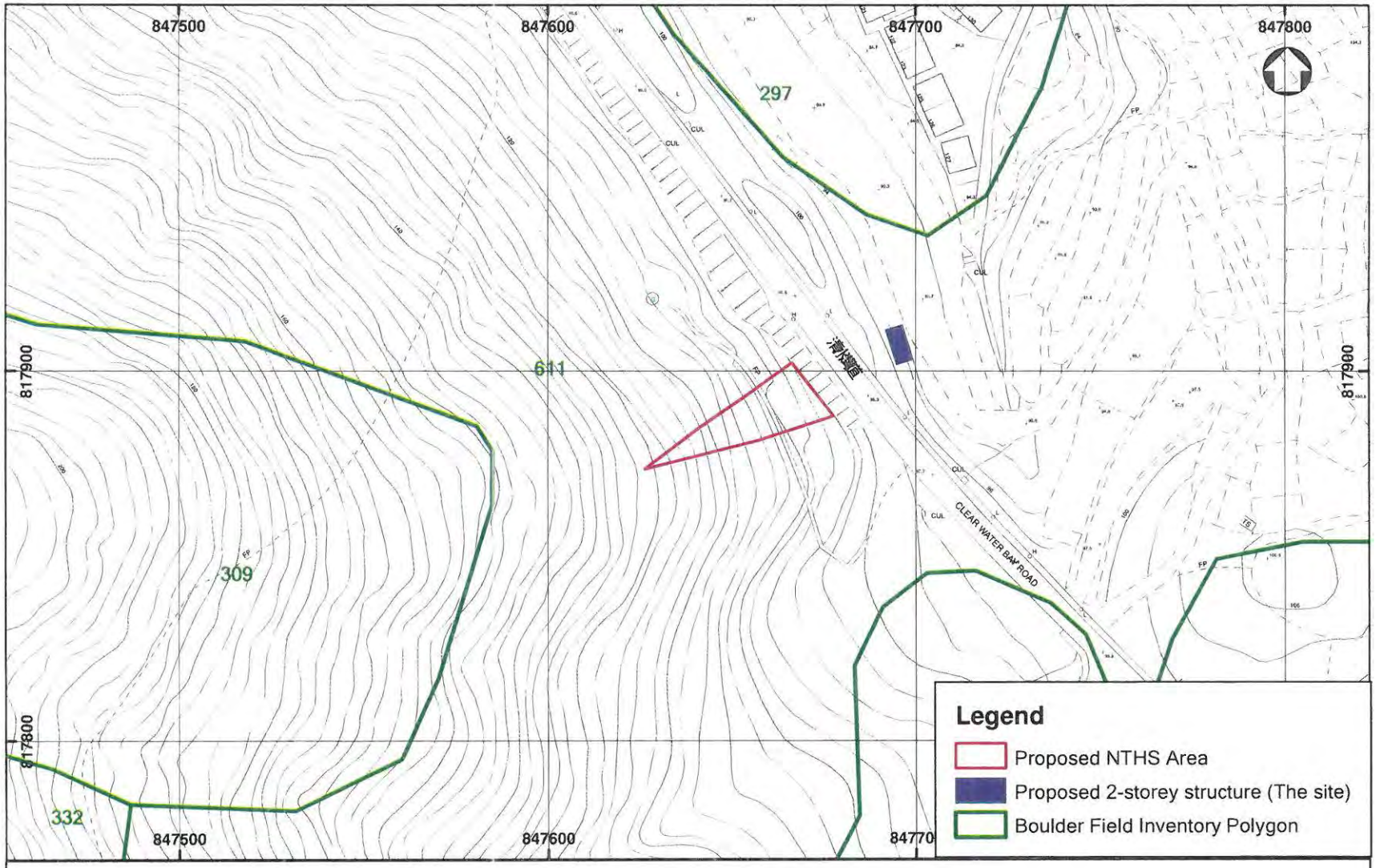
TITLE: Recorded Past Instabilities	**SCALE:** 1 : 1500	**FIGURE NO :** FIGURE 4



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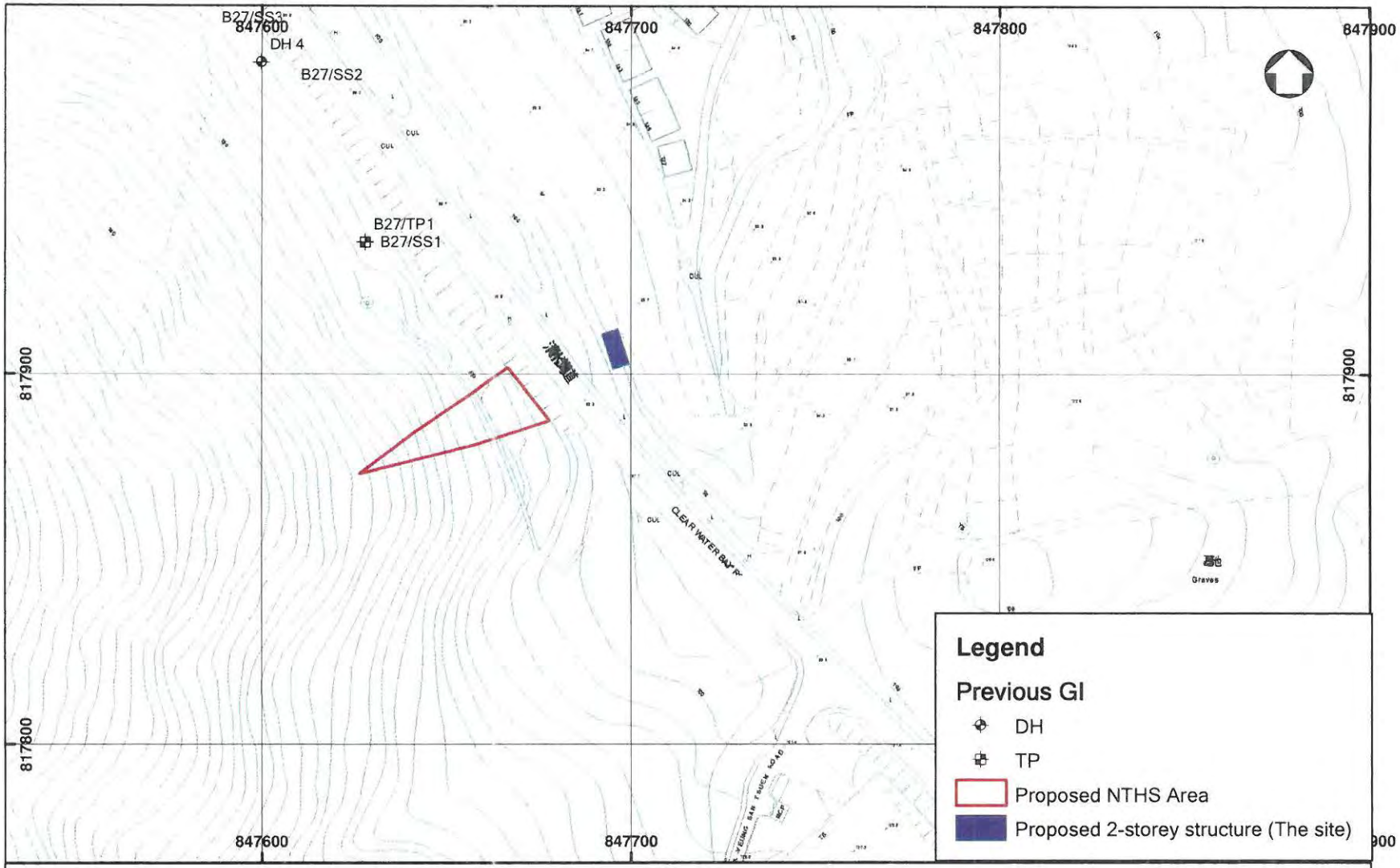
TITLE:	**Boulder Field Inventory**	**SCALE:** 1 : 1500	**FIGURE NO :** FIGURE 5



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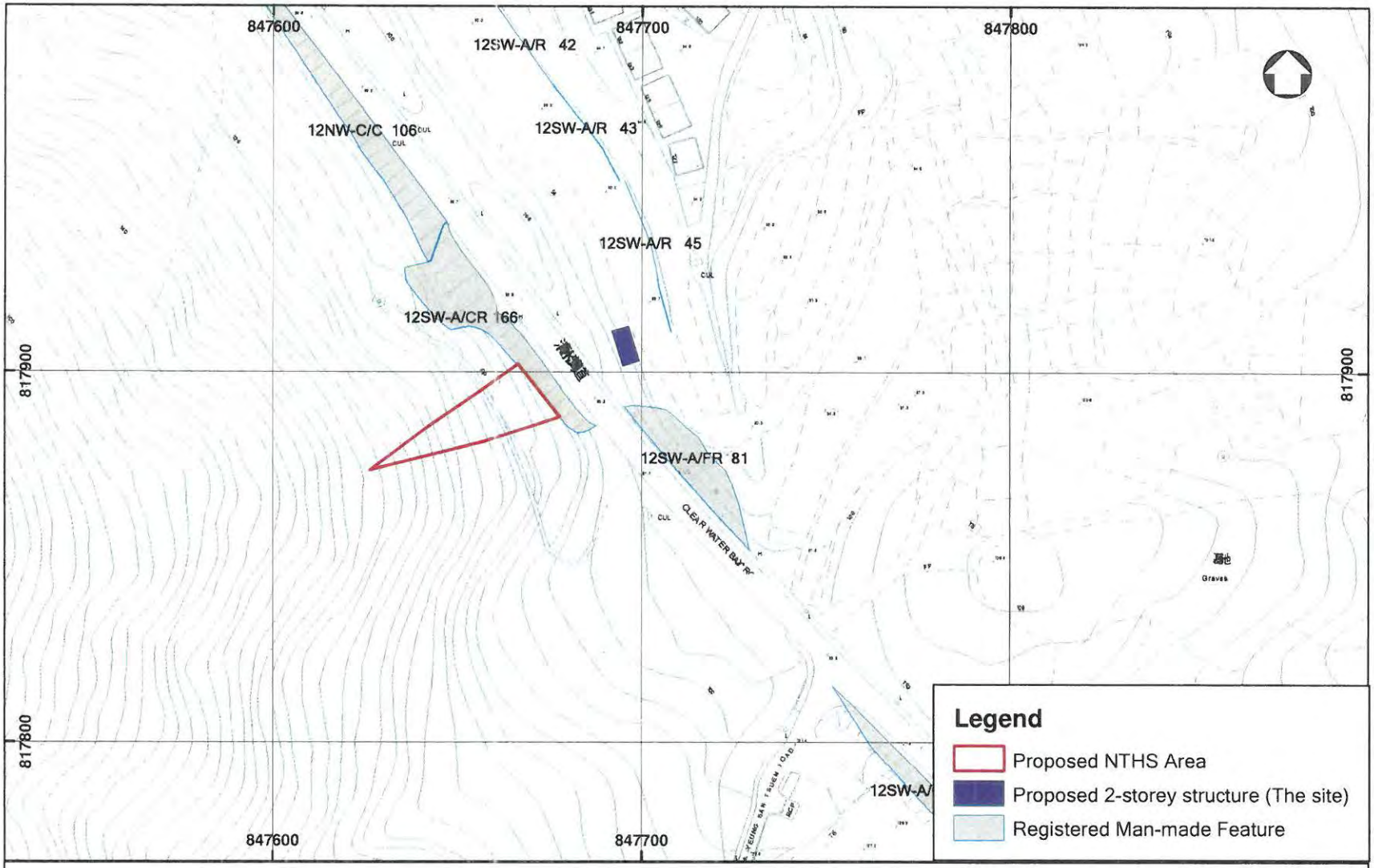
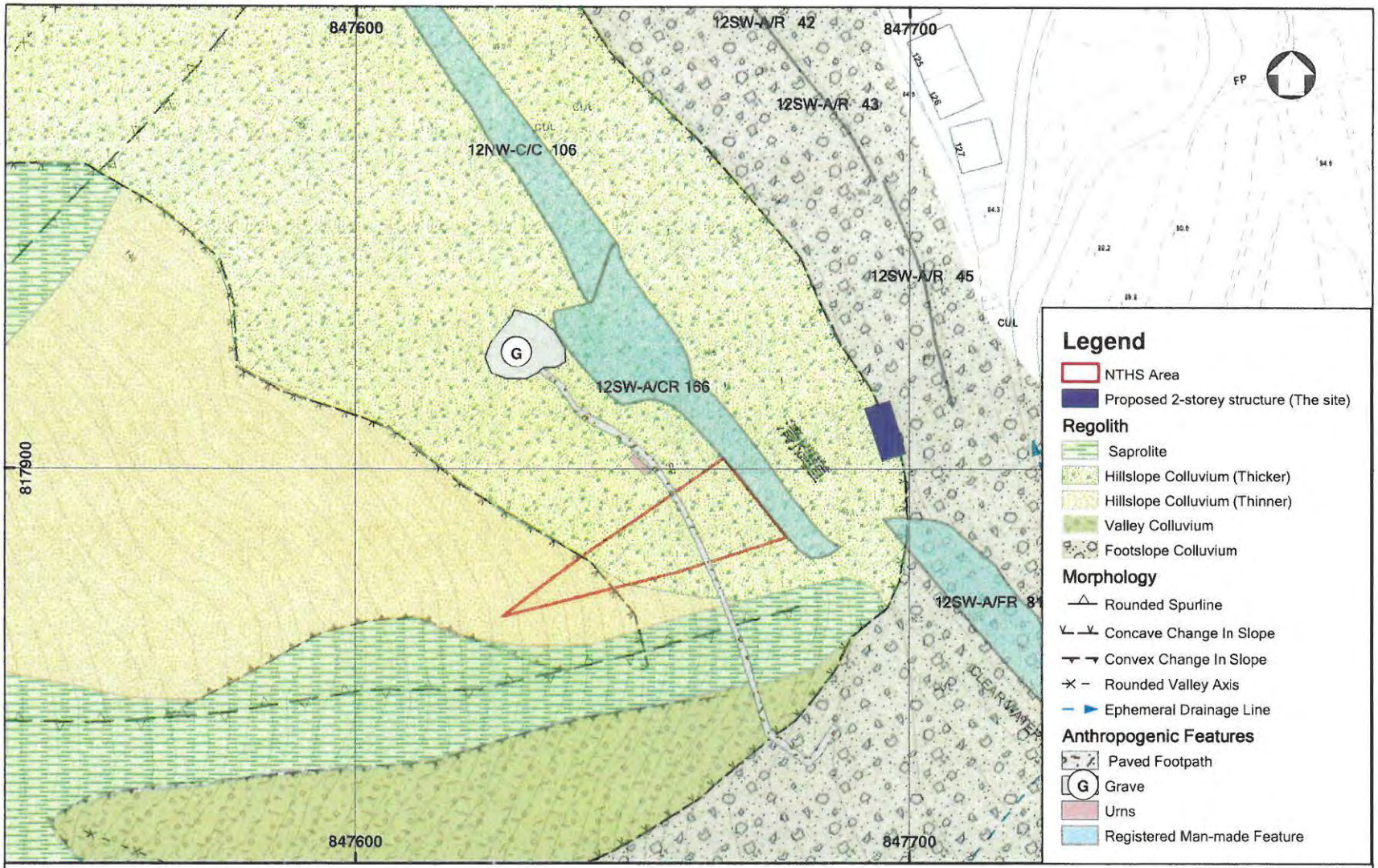
TITLE:	**Previous Ground Investigation**	**SCALE:** 1 : 1500	**FIGURE NO :** FIGURE 6

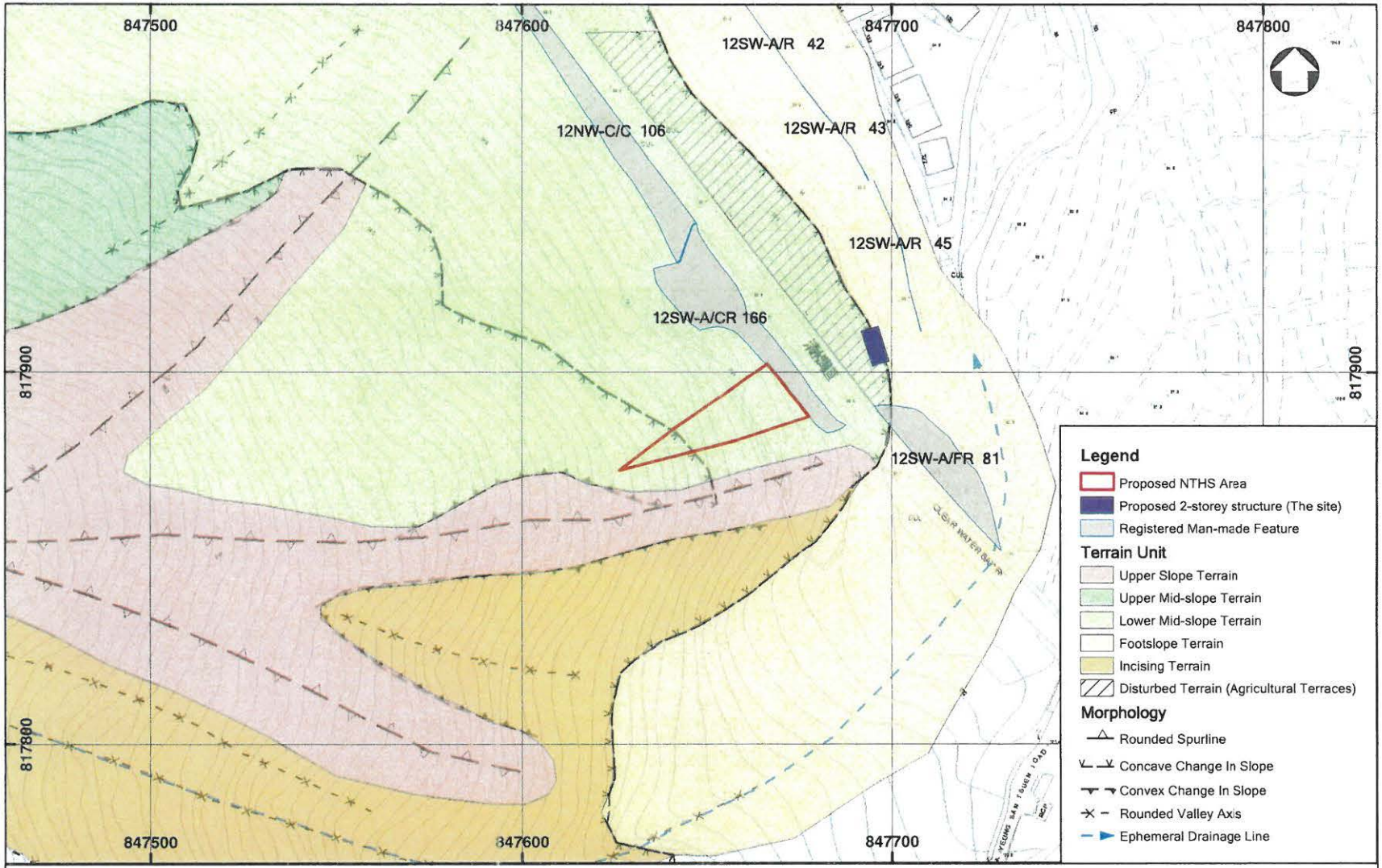


PROJECT:	**Proposed Filling of Land and Excavation of Land for Permitted 2-Storey On Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories**		
TITLE:	**Registered Man-made Features**	**SCALE:** 1 : 1500	**FIGURE NO :** FIGURE 7



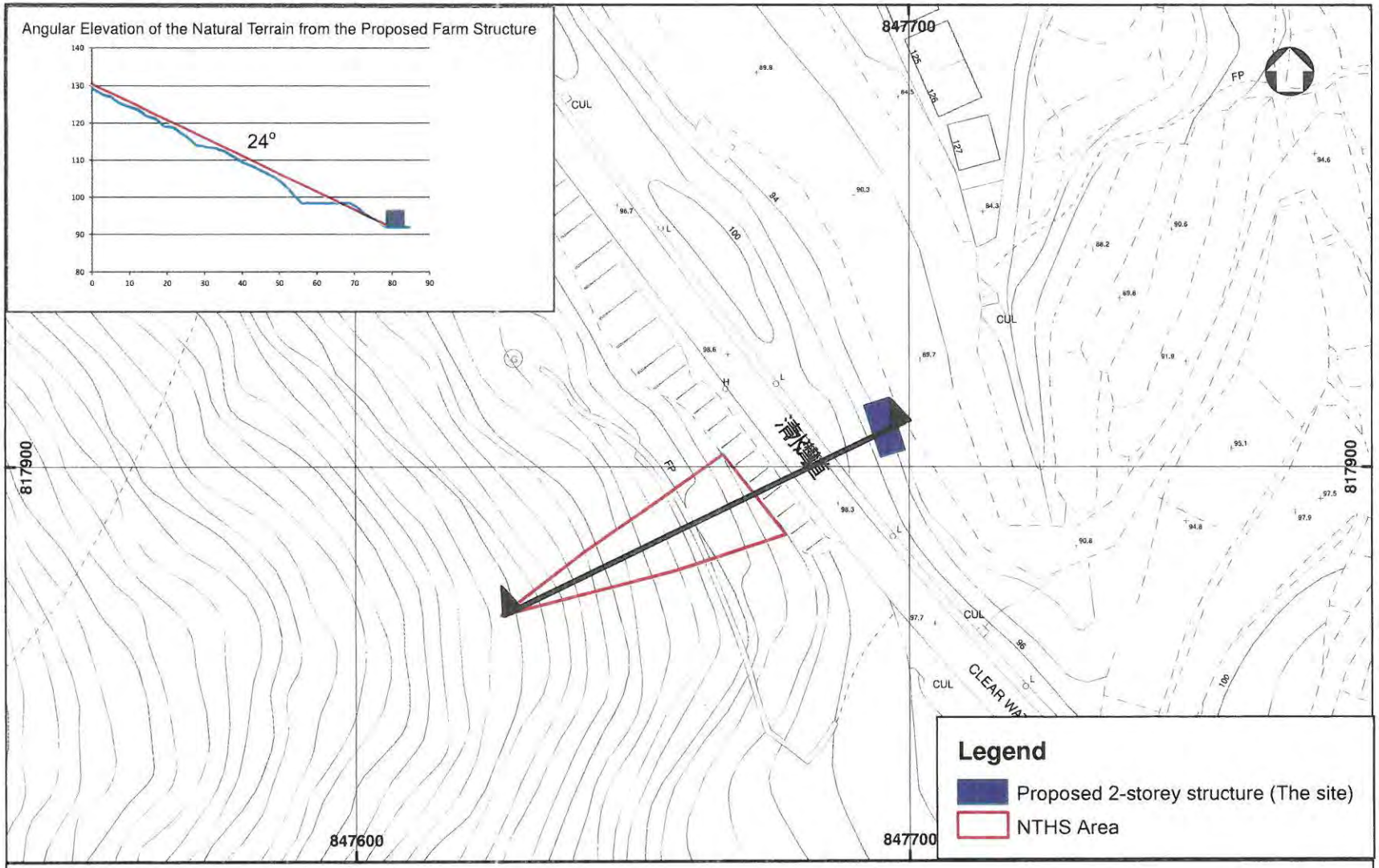
PROJECT: **Proposed Filling of Land and Excavation of Land for Permitted 2-Storey On Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories**

TITLE: Geomorphological Map	**SCALE:** 1 : 1000	**FIGURE NO :** FIGURE 8



PROJECT: **Proposed Filling of Land and Excavation of Land for Permitted 2-Storey On Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories**

TITLE: Terrain Unit Map	**SCALE:** 1 : 1500	**FIGURE NO :** FIGURE 9



PROJECT: **Proposed Filling of Land and Excavation of Land for Permitted 2-Storey On Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories**

TITLE: **Proximity of Proposed Farm Structure below the Study Area**

SCALE: **1 : 1000**

FIGURE NO : **FIGURE 10**

LIST OF PLATES

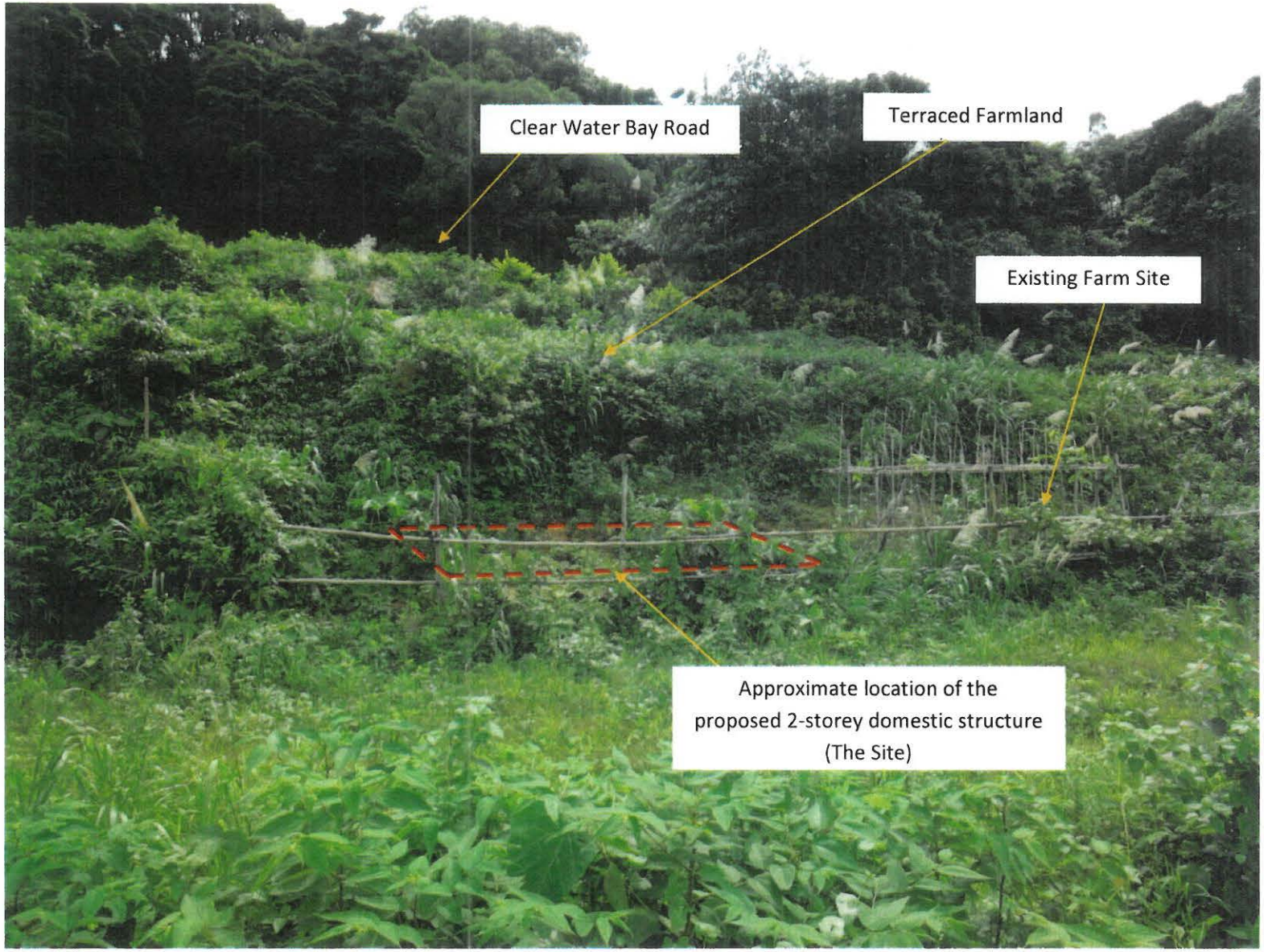


Plate 1 General view of the location of the proposed domestic structure (The Site)

Plate 2 General view of the location of the NTHS area

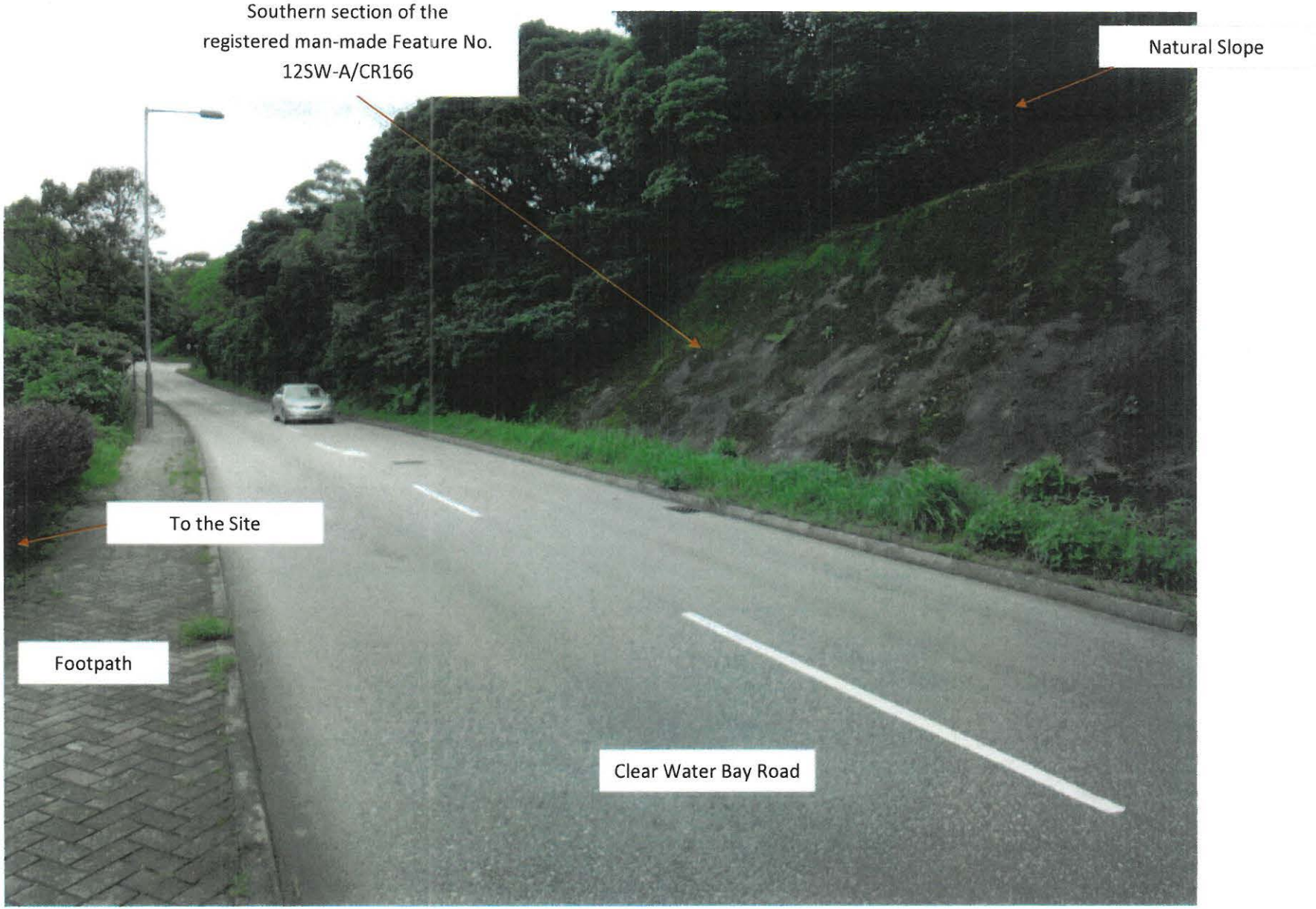


Plate 3 General view of the facilities below the Study Area

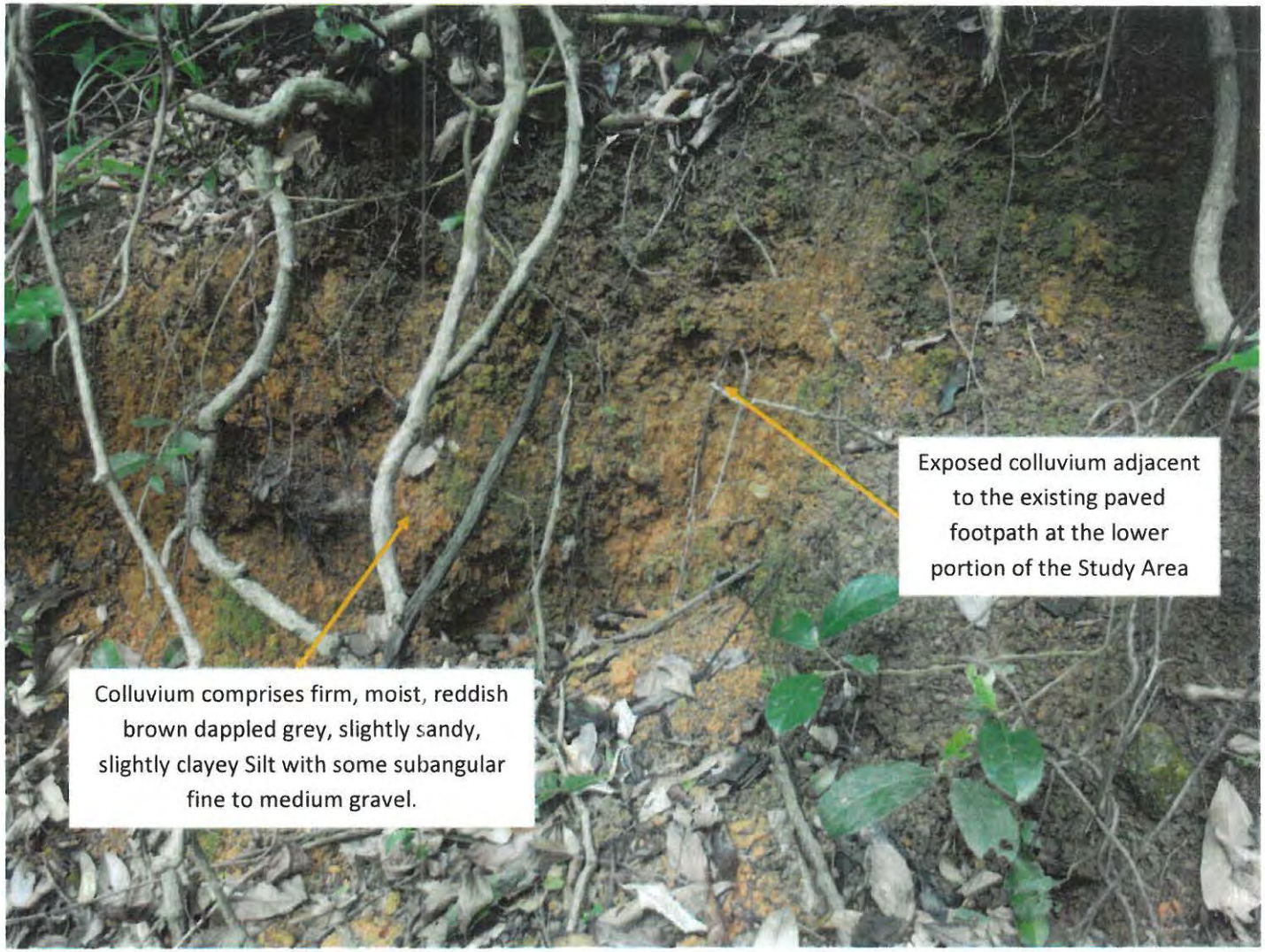


Plate 4 Exposed open hillslope colluvium

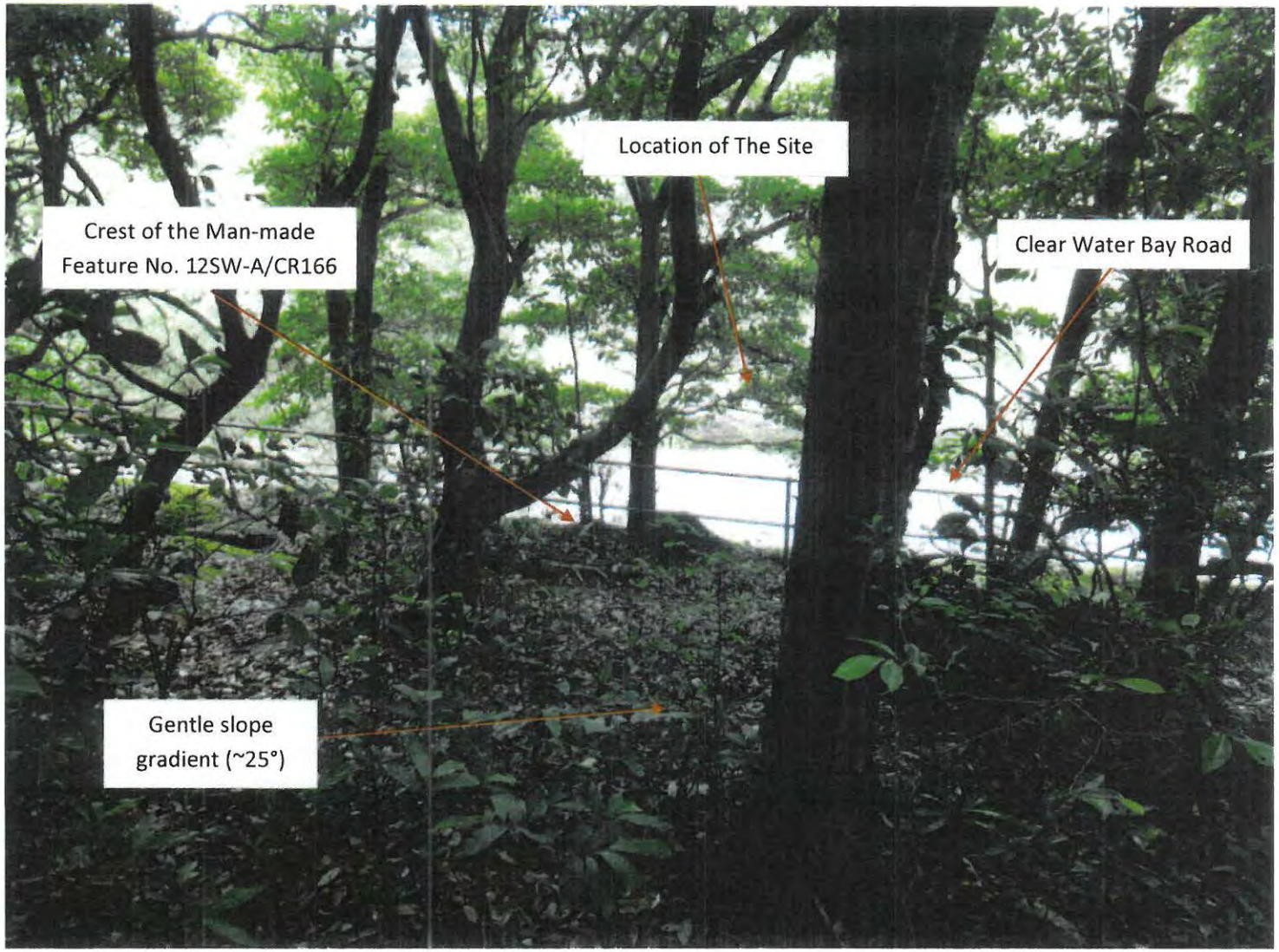


Plate 5 General view of the gentle slope at the lower portion of the Study Area below the existing paved footpath

Plate 6 General view of the natural slope at the mid-level of the NTHS area

Plate 7 General view of the natural slope at the upper portion of the NTHS area

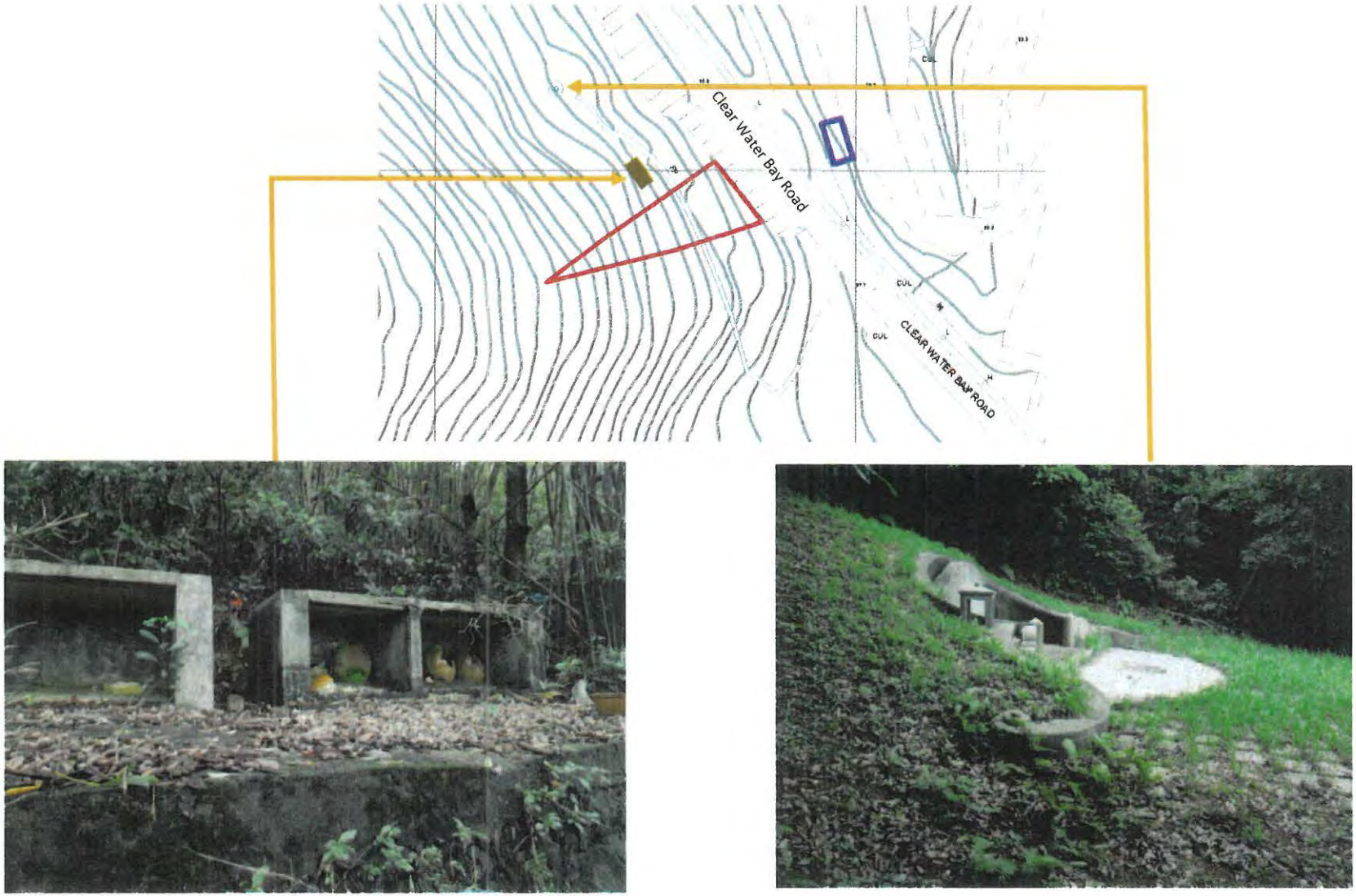


Plate 8 General view of the urns and grave to the northwest of the NTHS area

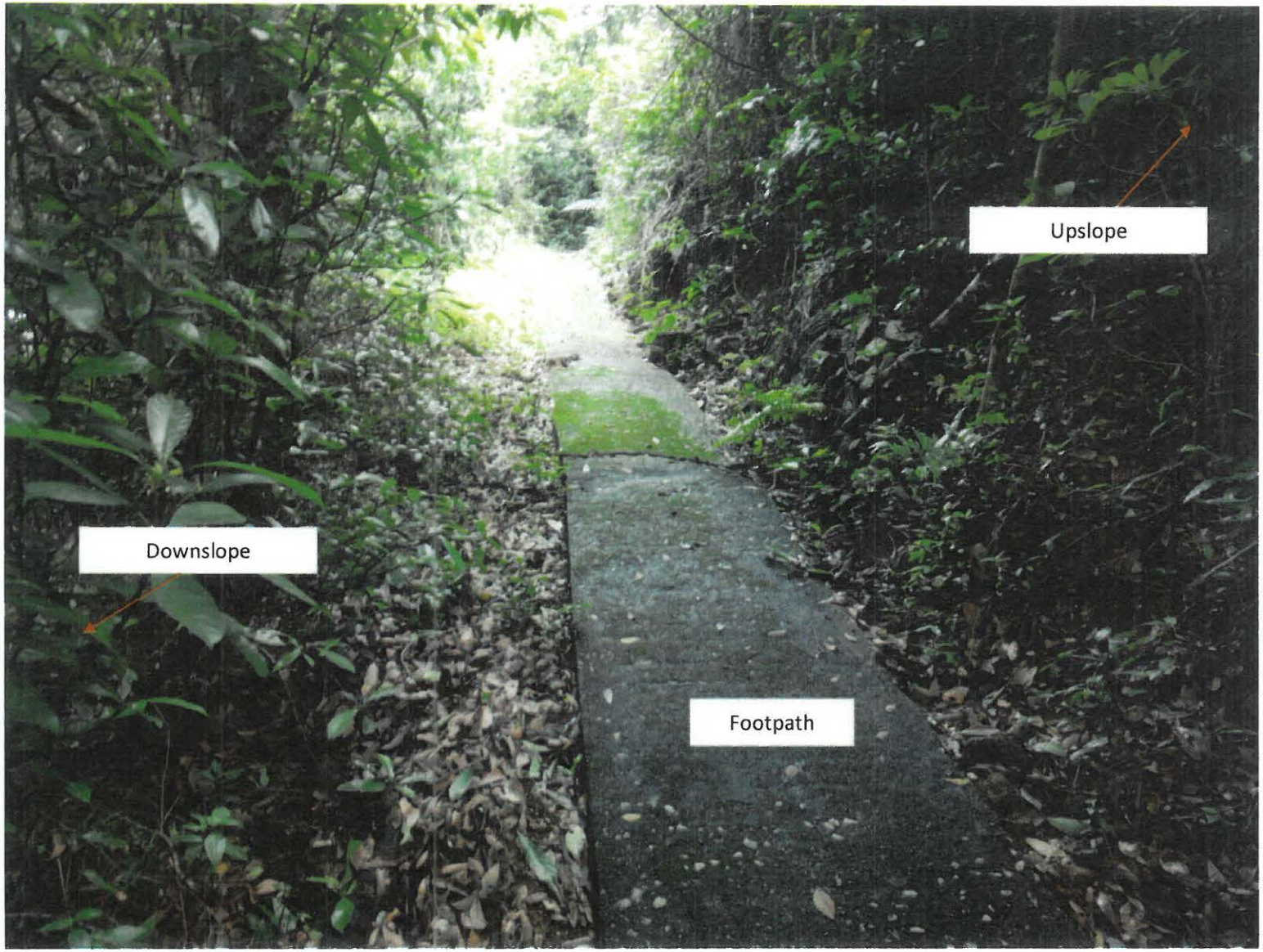


Plate 9 General view of the paved footpath within the lower portion of the Study Area

Appendix A

Aerial Photograph Interpretation

A.1 DETAILED OBSERVATIONS

The following report comprises the detailed observations made from the examination of aerial photographs taken between 1964 and 2013. A list of aerial photographs examined in this study is presented in Table A1. The interpretations on geomorphology and man-made features are shown in Figure A1 to A6.

YEAR	OBSERVATIONS
1964 13 Dec 1964 Figure A1	High altitude and high-resolution stereo pair. Geomorphology Geomorphological, the Study Area is a located on the Mid-Slope of an east facing gentle open hillslope bounded by an east trending spurline at the south. Slope gradients within the Study Area are generally ranging approximately between 20 and 45 degrees. The upper part of the Study Area appears to be slightly steeper, less hummocky and may suggest less deposition has been occurred. The lower part of the Study Area is has a relatively rougher surface and may have higher accumulation of colluvial deposits. Hillslope within the Study Area is generally planar. No distinctive drainage lines could be observed within the Study Area. There is no evidence of past or present instabilities within or in vicinity of the Study Area and the presence of drainage dividend above the Study Area has limited the amount of surface runoff onto the Study Area. Development Majority of the Study Area is vegetated with grass and small trees. Clear Water Bay Road has already been constructed immediately below the Study Area. A cut slope (12SW-A/CR166) has already been formed for the creation of Clear Water Bay Road. A footpath has already been constructed traversing the middle of the Study Area, which connect a grave structure to Clear Water Bay Road. Two linear features likely to be retaining wall structures could be discerned on cut slope 12SW-A/CR166 below the grave. The site where the small farmhouse structure is proposed, is located on an agricultural terraces located below Clear Water Bay Road. The vegetated slope between the site and Clear water Bay Road appears to have linear features parallel to the contour and could be evidenced of remnant agricultural terraces.
1973 (20 Dec 1973)	High altitude and fair resolution stereo pair. The entire Study Area is coved by dense grass, shrubs and small trees. No significant change to the Study Area except an increase in vegetation density.
1974 (10 Aug 1974) Figure A2	Low altitude and high resolution stereo pair. No significant change to the Study Area. The portion of Slope Feature (12SW-A/CR166) immediately below the Study Area appears to have a

YEAR	OBSERVATIONS
	highly reflective surface and may suggest slope works have been carried out on the portion of the slope. On the proposed farmhouse site, the agricultural activities appears to be still active.
1978 (10 Jan 1978)	High altitude and fair resolution stereo pair. The Study Area was overgrown with denser vegetation. No sign of distress or erosion can be observed within or in the vicinity of the Study Area.
1979 (28 Nov 1979)	High altitude and fair resolution single photograph. No apparent change observed on the Study Area. Very dense vegetation canopy occupied entire Study Area.
1980 (16 Apr 1980)	High altitude and fair resolution single photograph. No apparent change could be observed on the Study Area.
1981 (11 Feb 1981)	High altitude and fair resolution stereo pair. No significant change to the Study Area.
1983 (30 Nov 1981)	High altitude and fair resolution stereo pair. No significant change to the Study Area. Vegetation appears to start growing on the agricultural terraces at the proposed farmhouse site which may suggests the agricultural activities has been ceased.
1984 (20 Oct 1984)	High altitude and fair resolution stereo pair. No apparent change observed on the Study Area.
1985 (7 Jul 1985) Figure A3	High altitude and fair resolution stereo pair. Highly reflective surface could be observed on Feature 12SW-A/CR166 immediately below the Study Area on the similar area observed in 1974 photographs and may suggest slope work have been carried out on the slope portion again. No significant change could be observed across the Study Area.
1986 (22 Sep 1986)	Low altitude and high resolution stereo pair. No apparent change could be observed on the Study Area apart from a couple of square structures have been constructed immediately to the southeast of the grave. Bare soil surface could be observed on the highly reflective area on Feature 12SW-A/CR166 below the Study Area discerned in 1985 photographs.
1987	Low altitude and high resolution monograph.

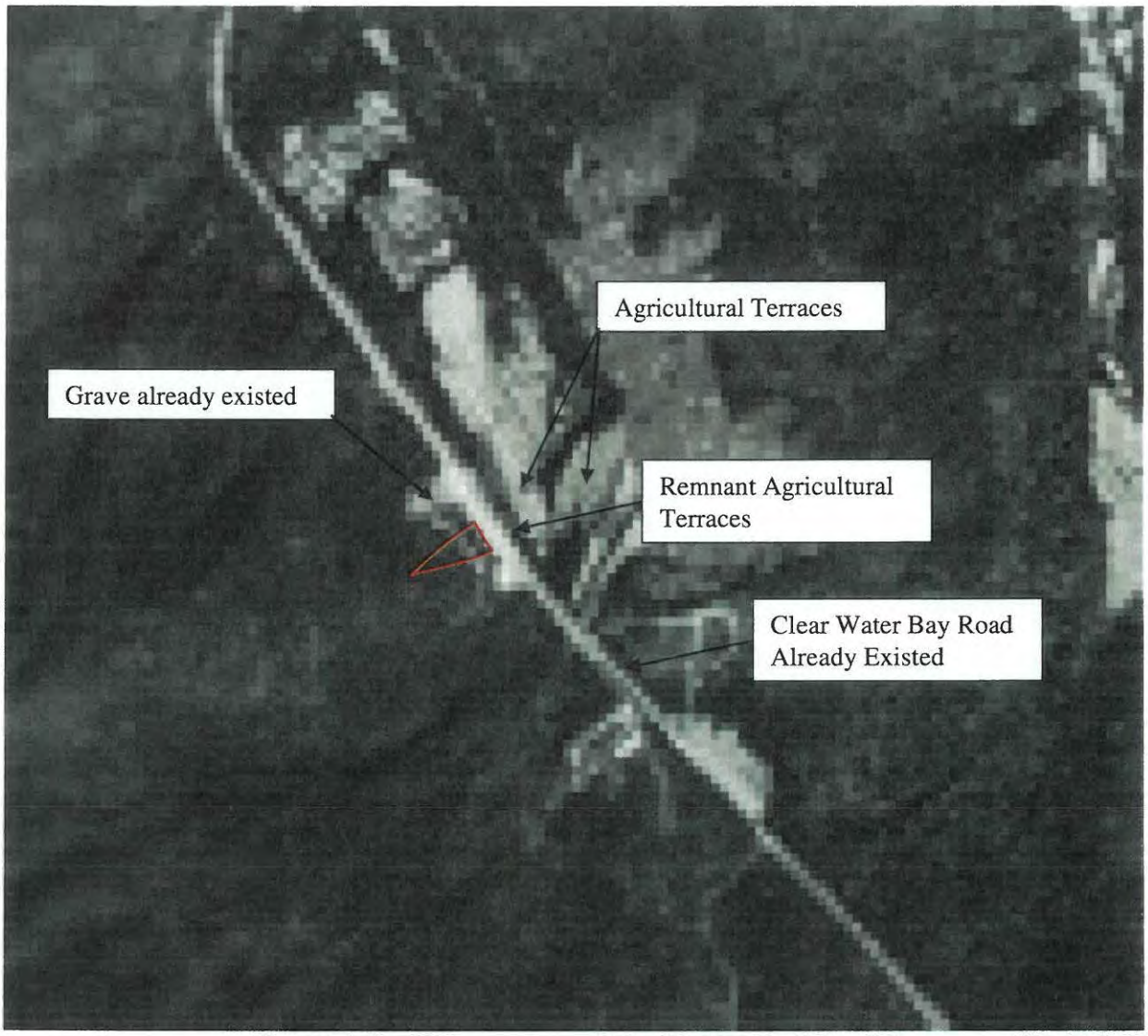
YEAR	OBSERVATIONS
(10 Dec 1987)	No significant changes could be observed on the Study Area. The bare slope surface on Feature 12SW-A/CR166 is observed to have vegetation growth.
1988 (25 Oct 1988)	Low altitude and high resolution stereo pair. No apparent change observed on the Study Area apart from a general increase in vegetation density.
1989 (28 Mar 1989)	Low altitude and high resolution monograph only. No significant change could be observed across the Study Area.
1990 (13 Nov 1990)	High altitude and high resolution stereo pair. No Significant changes were observed on the Study Area.
1991 (2 Oct 1991)	Low altitude and high resolution stereo pair. No apparent change observed on the Study Area.
1992 (16 Apr 1992)	Low altitude and high resolution stereo pair, Study Area partially covered by cloud. No apparent change observed on the Study Area.
1993 (2 Nov 1993)	Low altitude and high resolution mono photo. No apparent change observed on the Study Area.
1994 (20 Oct 1994)	Low altitude and high resolution stereo pair. No apparent change observed on the Study Area.
1995 (18 Jul 1995)	Low altitude and high resolution stereo pair color photos. No apparent change observed on the Study Area.
1996 (18 Nov 1996)	Low altitude and high resolution stereo pair color photos. No apparent change observed on the Study Area.
1997 (26 May 1997)	Low altitude and high resolution stereo pair color photos. No apparent change observed on the Study Area.
1998 (10 Nov 1998)	Fair resolution covered by smog. No Significant changes were observed on the Study Area.
1999	High altitude and high resolution stereo pair.

YEAR	OBSERVATIONS
(9 Dec 1999)	No Significant changes were observed on the Study Area.
2000 (16 Feb 2000)	High altitude and high resolution stereo pair. No Significant changes were observed on the Study Area.
2001 (20 Nov 2001)	High altitude and high resolution stereo pair. No Significant changes were observed on the Study Area.
2002 (15 Aug 2002)	High altitude and high resolution stereo pair. No Significant changes were observed on the Study Area.
2003 (31 May 2003)	Low altitude and fair resolution stereo pair. No Significant changes were observed on the Study Area.
2004 (4 Mar 2004)	Low altitude and high resolution stereo pair. No Significant changes were observed on the Study Area.
2005 (31 Oct 2005) Figure A4	Low altitude and high resolution stereo pair. No significant change is evidenced on the Study Area. Two building platforms have been created below the proposed farmhouse site. Retaining walls have been constructed at the lower side of the platforms.
2006 (9 Nov 2006) Figure A5	High altitude and high resolution stereo pair. No significant change is observed on the Study Area. A serious of village houses have been constructed on the building platform observed to in 2005 photography.
2007 (12 Jul 2007)	Low altitude and high resolution stereo pair. No significant change could be observed on the Study Area.
2008 (25 Nov 2008)	Low altitude and high resolution stereo pair. No significant change could be observed on the Study Area.
2010 (3 Nov 2010)	Low altitude and high resolution stereo pair. No significant change could be observed on the Study Area.
2011 (4 Aug 2011) Figure A6	Low altitude and high resolution stereo pair. No significant change could be observed on the Study Area. Vegetation

YEAR	OBSERVATIONS
	clearance could be observed on the remnant agricultural terraces located between the Site and Clear Water Bay Road. It is not certain whether the clearance is related to agricultural activities.
2012 (27 Mar 2012)	Low altitude and high resolution stereo pair. No significant change could be observed on the Study Area.
2013 (5 Jan 2013)	High altitude and high resolution stereo pair. No significant change is observed on the Study Area.

Table A1 - List of Photographs

Date of Photos Taken	Aerial Photo Reference No.	Flight Altitude (Feet)
13 Dec 1964	2536-7	12,500
20 Dec 1973	8005-6	12,500
10 Aug 1974	9305-6	4,000
10 Jan 1978	20762-3	12,500
28 Nov 1979	28028	10,000
16 Apr 1980	29704	4,000
11 Feb 1981	36731-2	25,000
30 Nov 1983	51385-6	10,000
20 Oct 1984	56488-9	11,000
7 Jul 1985	A01723-4	10,000
22 Sep 1986	A06397-8	4,000
10 Dec 1987	A11047	4,000
25 Oct 1988	A14828-9	4,000
28 Mar 1989	A16772	4,000
3 Dec 1990	A24427-8	10,000
2 Oct 1991	A27706-7	4,000
16 Apr 1992	A30333-4	4,000
2 Nov 1993	CN5162	3,000
20 Oct 1994	A39143-4	4,000
18 Jul 1995	CN10008-9	3,500
18 Nov 1996	CN15664-5	5,000
26 May 1997	CN17193-4	4,000
10 Nov 1998	CN21996-7	8,000
9 Dec 1999	CN25734-5	8,000
16 Feb 2000	CN25913-4	20,000
20 Nov 2001	CW35898-9	8,000
15 Aug 2002	CW42479-80	4,000
31 May 2003	CW47884-5	4,000
4 Mar 2004	CW55993-4	4,000
31 Oct 2005	CW67595-6	4,000
9 Nov 2006	CW75092-3	8,000
12 Jul 2007	C76826-7	3,000
25 Nov 2008	CS20092-3	6,000
3 Nov 2010	CS30124-5	6,000
4 Aug 2011	CW89667-9	3,000
27 Mar 2012	CW94958-60	2,000
5 Jan 2013	CW9978-9	8,000



Photograph No.: 2536 **Date of Photograph: 13 Dec 1964** **Altitude: 12,500'**

Legend:

Approximate Boundary of the Study Area

Project

Natural Terrain Hazard Study for Proposed Permitted 2-Storey on Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories

FIGURE A1

Location

Clear Water Bay Road, Sai Kung

Scale NTS

Date 1 Aug 2014

Photograph No.: 9305 **Date of Photograph: 10 Aug 1974** **Altitude: 4,000'**

Legend:

Approximate Boundary of the Study Area

Project

Natural Terrain Hazard Study for Proposed Permitted 2-Storey on Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories

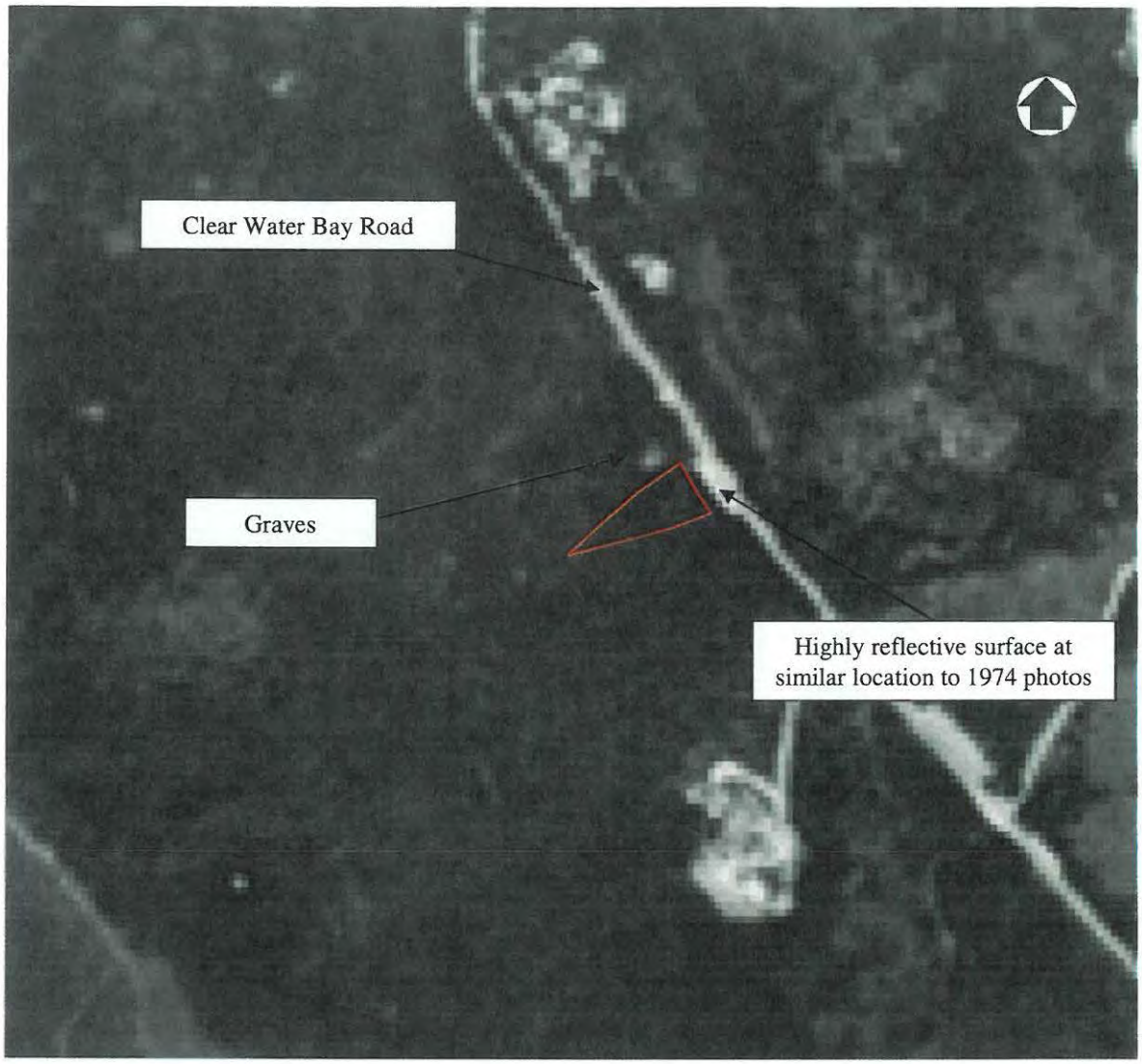
FIGURE A2

Location

Clear Water Bay Road, Sai Kung

Scale NTS

Date 1 Aug 2014



Photograph No.: A01724 **Date of Photograph: 7 July 1985** **Altitude: 10,000'**

Legend:

Approximate Boundary of the Study Area

Project: Natural Terrain Hazard Study for Proposed Permitted 2-Storey on Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories	FIGURE A3
	Location: Clear Water Bay Road, Sai Kung
	Scale: NTS / Date: 1 Aug 2014

Photograph No.: CW67595 **Date of Photograph: 31 Oct 2005** **Altitude: 4,000'**

Legend:

Approximate boundary of the Study Area

Project

Natural Terrain Hazard Study for Proposed Permitted 2-Storey on Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories

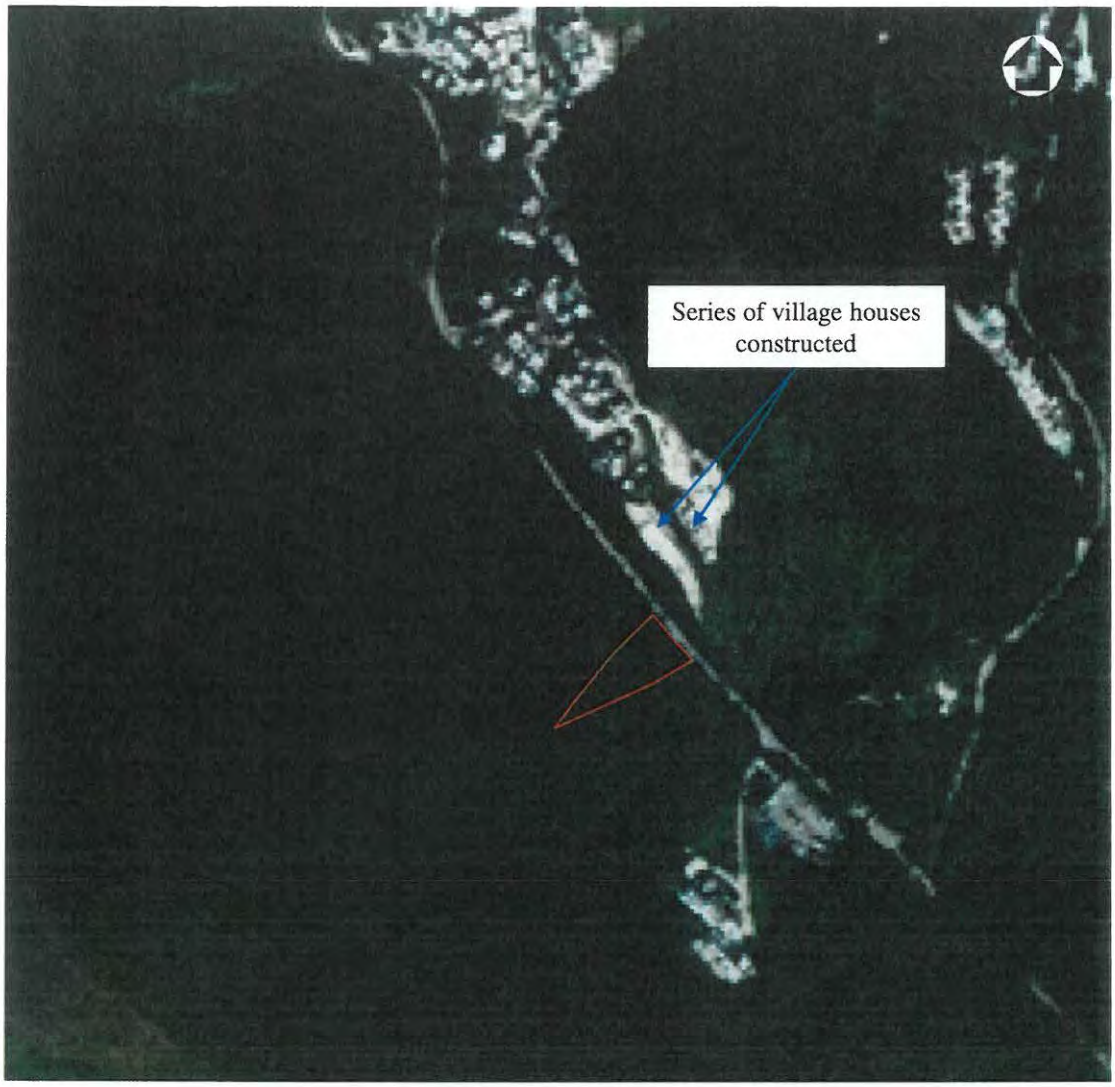
FIGURE A4

Location

Clear Water Bay Road, Sai Kung

Scale NTS

Date 1 Aug 2014



Photograph No.: CW75092 **Date of Photograph: 9 Nov 2006** **Altitude: 8,000'**

Legend:

Approximate boundary of the Study Area

Project

Natural Terrain Hazard Study for Proposed Permitted 2-Storey on Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories

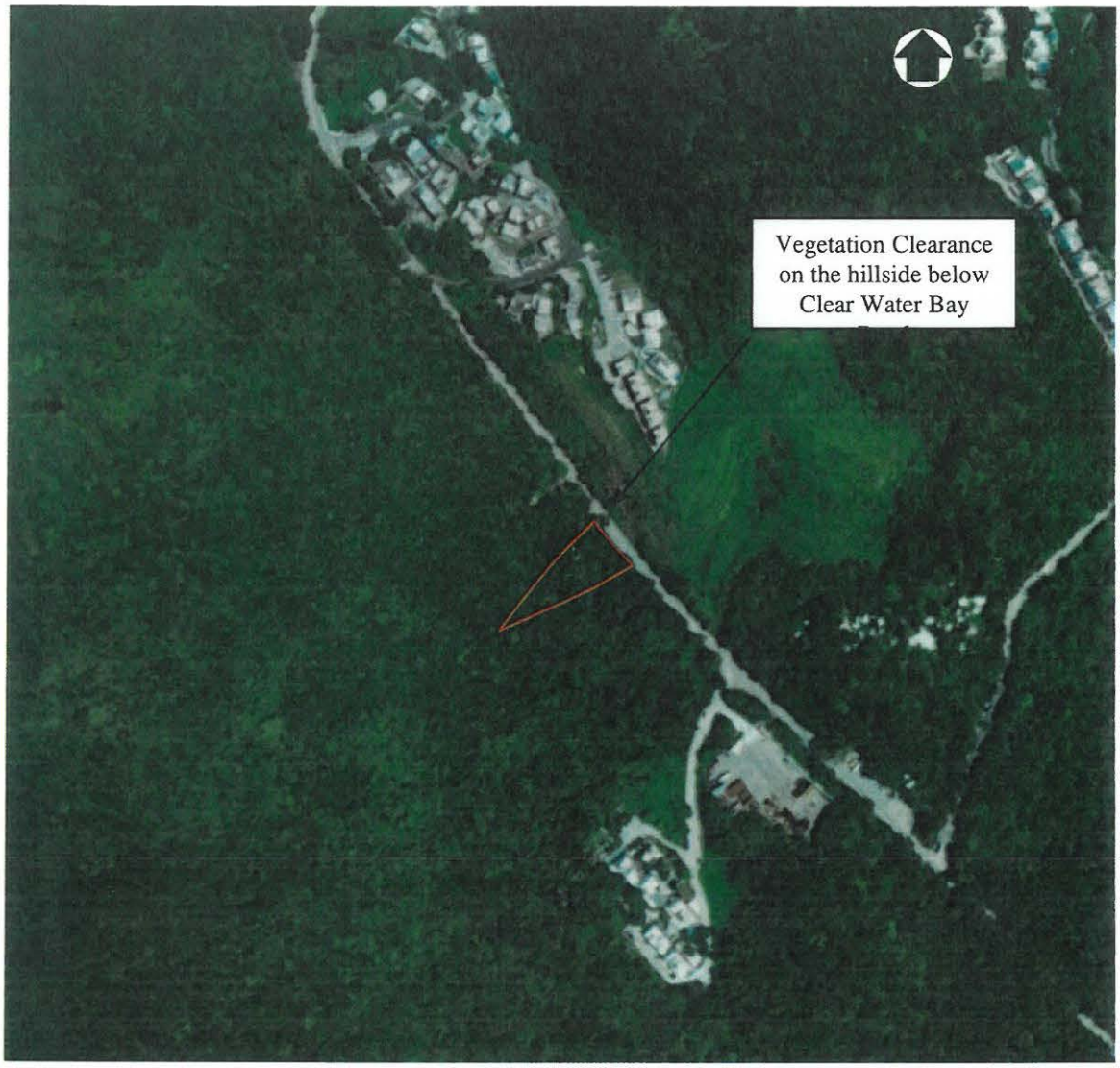
FIGURE A5

Location

Clear Water Bay Road, Sai Kung

Scale NTS

Date 1 Aug 2014



Photograph No.: CW89667 **Date of Photograph: 4 Aug 2011** **Altitude: 4,000'**

Legend:

Approximate boundary of the Study Area

Project: Natural Terrain Hazard Study for Proposed Permitted 2-Storey on Farm Domestic Structure at Lot No. 30 (Part) in D.D. 233, East of Clear Water Bay Road, Sai Kung, New Territories	FIGURE A6
	Location: Clear Water Bay Road, Sai Kung
	Scale: NTS / Date: 16 May 2014

Appendix B

SIS Record

BASIC INFORMATION

Location:	CLEAR WATER BAY ROAD, TKO
SIFT Ref.:	12SW- 2B/S 1
First Registration Date:	25-Feb-1998
Ranking Score (NPRS):	1 (Notional)
Sift Class:	C1
Data Source:	EI(HyD)
Approximate Coordinates:	Easting: 847661 Northing: 817913

CONSEQUENCE-TO-LIFE CATEGORY

Facility at Crest:	Undeveloped green belt
Distance of Facility from Crest (m):	0
Facility at Toe:	Road/footpath with moderate traffic density
Distance of Facility from Toe (m):	0
Consequence-to-life Category:	2
Remarks:	N/A

SLOPE PART

(1) Max. Height (m): 5.40 Length (m): 70 Average Angle (deg): 40
(2) Max. Height (m): 8.50 Length (m): 70 Average Angle (deg): 40

WALL PART

(1) Max. Height (m): 3.20 Length (m): 23 Face Angle (deg): 80

MAINTENANCE RESPONSIBILITY

(1) Sub Div.: 0 Government Feature Party: HyD Agent: HyD Land Cat.: 5b(iii) Reason Code: 56 MR Endorsement Date: 15-Feb-2002

DETAILS OF SLOPE / RETAINING WALL

Date of Inspection: 23-Dec-2013
Data Source: EI(HyD)
Slope Part Drainage: (1) Position: Toe Size(mm): 225
(2) Position: Toe Size(mm): 225
(3) Position: Crest Size(mm): 375
Wall Part Drainage: (1) Position: Crest Size(mm): 100
(2) Position: Crest Size(mm): 225

SLOPE PART

Slope Part (1)
Surface Protection (%): Bare: 0 Vegetated: 0 Chunam: 0 Shotcrete: 100 Other Cover: 0
Material Description: Material type: Soil Geology: N/A
Berm: No. of Berms: N/A Min. Berm Width (m): N/A
Weepholes: Size (mm): 65 Spacing (m): 1.20
Slope Part (2)
Surface Protection (%): Bare: 0 Vegetated: 0 Chunam: 0 Shotcrete: 100 Other Cover: 0
Material Description: Material type: Soil Geology: N/A
Berm: No. of Berms: N/A Min. Berm Width (m): N/A
Weepholes: Size (mm): 65 Spacing (m): 1.20

WALL PART

Wall Part (1)
Type of Wall: Wall Material: Others Wall Location: N/A
Berm: No. of Berms: N/A Min. Berm Width (m): N/A
Weepholes: Size (mm): 65 Spacing (m): 2.20

SERVICES

N/A

CHECKING STATUS INFORMATION

N/A

BACKGROUND INFORMATION

GIU Cell Ref.:	12SW2B2
Map Sheet Reference (1:1000):	12SW- 2B
Aerial Photos:	Photo Number (Year) Y08392 (1963) Y08393 (1963)
Nearest Raingauge Station (Station Number):	Inlet Pumping Station, Sewage Treatment Works, Shek Kok Road (N30)
Data Collected On:	23-Dec-2013
Date of Construction, Subsequent Modification and Demolition:	Modification: Constructed Before: 1963 After: N/A
Related Reports/Files or Documents:	N/A
Remarks:	N/A
Follow Up Actions:	N/A

DH-Order (To Be Confirmed with Buildings Department): None

Advisory Letter (To Be Confirmed with Buildings Department): None

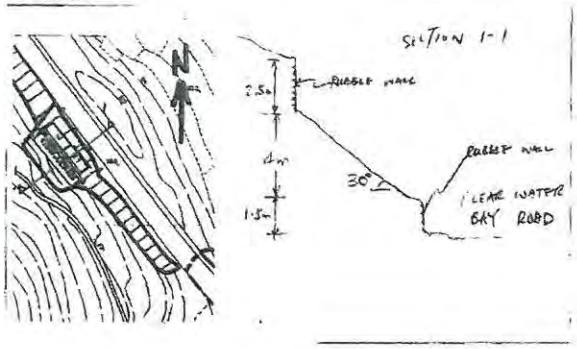
LPMIS: None

ENHANCED MAINTENANCE INFORMATION

N/A

STAGE 1 STUDY REPORT

Inspected On: 15-Sep-1997
Weather: Mainly Fine
District: ME



Section No: 1-1
Height(m): H1: 8 H2: 2
Type of Toe Facility: Road/footpath with moderate traffic density

Distance from Toe(m): 0
Type of Crest Facility: Undeveloped green belt

Distance from Crest(m): 0
Consequence Category: 2
Engineering Judgement: P

Section No: 2-2
Type of Toe Facility: N/A

Distance from Toe(m): 0
Type of Crest Facility: N/A

Distance from Crest(m): 0
Consequence Category: 2
Engineering Judgement: P

Sign of Seepage:	Slope: Signs of seepage Wall: Signs of seepage
Criterion A satisfied:	N
Sign of Distress:	Slope: None Wall: None
Criterion D satisfied:	N
Non-routine maintenance required:	N
Note:	N/A
Masonry wall/Masonry facing:	Y
Note:	Square rubbles toe wall and crest wall
Consequence category (for critical section):	2
Observations:	N/A
Emergency Action Required:	N
Action By:	N/A

ACTION TO INITIATE PREVENTIVE WORKS

Criterion A/Criterion D:	N/A
Action By:	N/A
Further Study:	Y
Action By:	Private and Government

OTHER EXTERNAL ACTION

Check / repair Services:	N
Action By:	N/A
Non-routine Maintenance:	N
Action By:	N/A

PHOTO

Feature No. 12SW-A/CR 166