REVIEW OF THE 16 JULY 2006 LANDSLIDE ON SLOPE NO. 14NE-B/CR180 NO. 49 PO WAH YUEN YUNG SHUE WAN LAMMA ISLAND

GEO REPORT No. 234

Fugro Scott Wilson Joint Venture

GEOTECHNICAL ENGINEERING OFFICE
CIVIL ENGINEERING AND DEVELOPMENT DEPARTMENT
THE GOVERNMENT OF THE HONG KONG
SPECIAL ADMINISTRATIVE REGION

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This report is largely based on GEO Landslide Study Report No. LSR 10/2007 produced in December 2007

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Prepared by:

Geotechnical Engineering Office,
Civil Engineering and Development Department,
Civil Engineering and Development Building,
101 Princess Margaret Road,
Homantin, Kowloon,
Hong Kong.

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PREFACE

In keeping with our policy of releasing information which may be of general interest to the geotechnical profession and the public, we make available selected internal reports in a series of publications termed the GEO Report series. The GEO Reports can be downloaded from the website of the Civil Engineering and Development Department (http://www.cedd.gov.hk) on the Internet. Printed copies are also available for some GEO Reports. For printed copies, a charge is made to cover the cost of printing.

The Geotechnical Engineering Office also produces documents specifically for publication. These include guidance documents and results of comprehensive reviews. These publications and the printed GEO Reports may be obtained from the Government's Information Services Department. Information on how to purchase these documents is given on the second last page of this report.

R.K.S. Chan
Head, Geotechnical Engineering Office
November 2008

FOREWORD

This report presents the findings of a review of a landslide (Incident No. 2006/07/0672) that occurred on 16 July 2006 on slope No. 14NE-B/CR180, above a village house at No. 49 Po Wah Yuen, Yung Shue Wan on Lamma Island. The failure involved a shallow landslide in the soil cut slope with an estimated debris volume of about 15 m^3, which was deposited on the level ground at the slope toe. Muddy water associated with the debris mound was reported to have entered the dwelling through the gap at the base of the rear door. No casualties were reported as a result of the incident.

The key objectives of the review were to document the facts about the incident, the site history and pertinent observations. The scope of the review does not include any ground investigation or detailed diagnosis of the causes of the incident. Recommendations for follow-up actions are reported separately.

The report was prepared as part of the 2006/2007 Landslide Investigation Consultancy (LIC) for Hong Kong Island and Outlying Islands, for the Geotechnical Engineering Office (GEO) of the Civil Engineering and Development Department (CEDD), under Agreement No. CE 49/2005 (GE). This is one of a series of reports produced during the consultancy by Fugro Scott Wilson Joint Venture (FSW).

Y C Koo
Project Director
Fugro Scott Wilson Joint Venture

Agreement No. CE 49/2005 (GE)
Study of Landslides Occurring in Hong Kong Island and Outlying Islands in 2006 and 2007

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1. INTRODUCTION

At around 2:00 a.m. on 16 July 2006, a landslide (Incident No. 2006/07/0672) occurred on slope No. 14NE-B/CR180 located above a village house at No. 49 Po Wah Yuen, Yung Shue Wan, Lamma Island (Figure 1 and Plate 1). An Amber Rainstorm Warning had just been issued at about the time of the failure and was subsequently escalated to Red Rainstorm Warning at 2:35 a.m. and to Black Rainstorm Warning at 2:50 a.m. on the same day. Debris from the landslide, with an estimated volume of about 15 m^3, was deposited on a level ground between the slope toe and the dwelling. Muddy water associated with the debris mound was reported to have entered the dwelling through the gap beneath the rear door. No casualties were reported as a result of the failure. The occupants of No. 49 Po Wah Yuen voluntarily evacuated from the dwelling until the completion of urgent repair works.

Following the incident, Fugro Scott Wilson Joint Venture (FSW), the 2006 and 2007 Landslide Investigation Consultants, carried out a review of the landslide incident for the Geotechnical Engineering Office (GEO) of the Civil Engineering and Development Department (CEDD), under Agreement No. CE 49/2005 (GE).

This review report documents the facts about the incident, the site history and pertinent observations made by FSW in respect of the subject area. The scope of the review does not include any ground investigation or detailed diagnosis of the causes of the incident. Recommendations for follow-up actions are reported separately.

2. THE SITE

2.1 Site Description

The general landform in the vicinity of the July 2006 landslide comprises a southwesterly-trending spur ridge extending above the coastline at the Yung Shue Wan ferry pier in the northwest of Lamma Island. The southeast-facing flank of the spur, which extends to the waterfront at Yung Shue Wan Main Street, has been extensively modified to form building platforms at various elevations for the mostly residential dwellings comprising Po Wah Yuen. This has resulted in the formation of numerous cut slopes, fill slopes and retaining walls. Access to the platforms is provided by a series of concrete stairways.

Slope No. 14NE-B/CR180 comprises a 25 m long, south-facing, combined cut slope and retaining wall feature located above the village houses at Nos. 49 and 50 Po Wah Yuen, and below Nos. 59 and 60 Po Wah Yuen to the north (see Figure 1). The slope is bisected by a concrete stairway that extends between Nos. 49 and 50 Po Wah Yuen, and provides access to No. 59 Po Wah Yuen.

The portion of slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen, in which the July 2006 landslide occurred, comprises a 6 m high soil cut inclined at between 50° and 80°, with a 0.4 m high planter wall at the slope toe. Prior to the July 2006 landslide, the slope had a chuman surface cover. A 200 mm wide drainage channel extends along the slope crest.

The four-storey village house occupying No. 49 Po Wah Yuen, which is at an elevation of about 27.5 mPD, is located at about 2.5 m to the south of the planter wall at the toe of slope No. 14NE-B/CR180. The eastern part of the crest area of this portion of the

slope is occupied by the stairway access to No. 59 Po Wah Yuen, which incorporates a concrete retaining structure and shotcreted slope face along the southern edge. The ground above the western portion of the crest area extends beneath a suspended concrete slab, which is supported on concrete columns that comprises a portion of the level yard area at No. 59 Po Wah Yuen at an elevation of about 35 mPD.

The portion of slope No. 14NE-B/CR180 above No. 50 Po Wah Yuen comprises a soil/rock cut with a masonry wall at the crest, and has an overall height of about 6 m. The maximum heights of the soil/rock cut and retaining wall are about 4 m and 2 m respectively. The soil/rock cut face is inclined at 80° to 85°. It has a surface cover of chunam and exposes a rock outcrop at the western end. The masonry wall face is sub-vertical. The three-storey village house occupying No. 50 Po Wah Yuen, which is at an elevation of about 26 mPD, is located at 0.6 m from the slope toe. A 2.8 m wide concrete footpath at No. 60 Po Wah Yuen extends along the crest of the masonry wall, and the three-storey village house occupying No. 60 Po Wah Yuen is located at 4.5 m from the slope crest.

2.2 Water-carrying Services

According to the Water Supplies Department (WSD), two 80 mm diameter freshwater mains are located in the vicinity of slope No. 14NE-B/CR180 (Figure 2). The first extends beneath the concrete footpath at the crest of the feature above No. 50 Po Wah Yuen and part way along the crest of the feature above No. 49 Po Wah Yuen. The second is exposed above ground surface and extends along the concrete stairway Nos. 49 and 50 Po Wah Yuen.

Records of the Drainage Services Department (DSD) indicate that there are no buried drainage works or foulwater sewers in the immediate vicinity of slope No. 14NE-B/CR180.

3. MAINTENANCE RESPONSIBILITY

According to the records obtained from the Slope Maintenance Responsibility Information System (SMRIS) of the Lands Department (Lands D), the maintenance responsibility of slope No. 14NE-B/CR180 previously rested with the tenants of Short Term Tenancy (STT) Nos. CX468 and CX985 (see Appendix A), which comprised the areas surrounding Nos. 49 and 50 Po Wah Yuen respectively (Figure 2), as of the date of the landslide, but has been reverted to Lands D since April 2007 (see Appendix B).

Notwithstanding the records in the SMRIS, a review of files held by the District Lands Office/Islands Division (DLO/Islands) of the Lands D indicates that the STT Nos. CX468 and CX985, which cover slope No. 14NE-B/CR180, were actually terminated on 31 January 2006 and 1 July 2005 respectively (see Section 5.3).

4. SITE DEVELOPMENT AND PREVIOUS INSTABILITIES

4.1 Site Development

The site development history has been established from a review of the available file records in the GEO, which include a LPM Stage 2 Study Report incorporating an aerial

photograph interpretation (API) for slope No. 14NE-B/CR180 prepared by the LPM consultants, C M Wong & Associated Ltd (CMWAL), in 2003. A review of aerial photographs has been carried out as part of the present study to verify the information from the previous API. Salient information relevant to the history of the site is presented in Figure 3, and the detailed observations made from the aerial photographs studied are summarised in Appendix C.

The 1945 aerial photographs show the general vicinity of the present-day location of slope No. 14NE-B/CR180 being undeveloped hillside extending below the spur ridge to the north. The hillside has a sparse cover of grass and shrubs. No obvious natural drainage lines are apparent. Agricultural terraces are present at the toe of the hillside at the present-day location of the northern extent of Yung Shue Wan.

The 1963 aerial photographs show the ground in the general vicinity of the present-day location of slope No. 14NE-B/CR180 to be disturbed, and two huts are present to the north and south respectively, as well as a low-rise structure further to the southeast. Building platforms were formed at Nos. 41 and 42 Po Wah Yuen to the west, and were occupied by low-rise structures. A number of squatter huts are present at Nos. 16 to 18 and Nos. 27 to 29 Po Wah Yuen. The agricultural terraces identified in the 1945 aerial photographs have been extended further to the north. A footpath is visible along the spur ridge to the north. The 1964 aerial photographs indicate further construction activity to the west of the present-day location of slope No. 14NE-B/CR180.

The hillside presently occupied by Po Wah Yuen was progressively developed to the present-day arrangement during the period covered by the 1973 to 1982 aerial photographs. The development at No. 49 Po Wah Yuen and the formation of the western portion of slope No. 14NE-B/CR180 are first visible in the 1976 aerial photographs and those at Nos. 50 and 59, as well as the eastern portion of slope No. 14NE-B/CR180 in the 1978 aerial photographs. The development at No. 60 Po Wah Yuen is first visible in the 1979 aerial photographs. The concrete staircase providing access to No. 59 Po Wah Yuen and extending along the common boundary between Nos. 49 and 50 Po Wah Yuen is first visible in the 1978 aerial photographs.

Following the time of formation, little change in slope No. 14NE-B/CR180 is evident in the aerial photograph records, which is hidden from view by the adjacent dwellings in the majority of cases up to the 1993 aerial photographs. The footpath above the slope crest was re-paved and realigned in the 1988 aerial photographs.

Vegetation comprising small trees is visible on the western portion of slope No. 14NE-B/CR180 in the 1993 aerial photographs, which becomes heavier with time. The 1997 aerial photographs show the vegetation to have been cleared and a hard surface cover of chunam/shotcrete to have been applied to the eastern portion of the feature above No. 49 Po Wah Yuen. A small tree is visible on the western portion of slope No. 14NE-B/CR180 in the 2000 aerial photographs, and the vegetation cover becomes heavier in the succeeding years to the present.

4.2 Previous Instabilities

According to the GEO's landslide database, 17 previous landslides have been identified within Po Wah Yuen, the closest to slope No. 14NE-B/CR180 being located about 35 m to the west of the July 2006 failure. These incidents typically involve minor failures associated with the cut and fill slopes separating the individual building platforms. Relevant details of these incidents are presented in Table 1 and the respective locations are shown in Figure 3. As shown in Table 1, infiltration has been reported as a possible cause of failure in the majority of cases. Other factors reported as possible causes of failure include "groundwater", "washout" and "erosion".

No previous landslides were identified in the vicinity of the July 2006 failure from the aerial photograph records or the documentary records; however, recently replaced hard surface cover at the eastern end of the portion of slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen is visible in the 1997 aerial photographs, which could possibly comprise the repair of a local instability at that time (Figure 3). No records relating to the replacement of the hard surface cover at this time could be located by FSW. Additionally, a small rockfall incident was reported to have occurred from this same portion of the slope in November 2003, which was reported to the GEO by the Islands District Council.

Two relict landslides are shown in the GEO's Enhanced Natural Terrain Landslide Inventory (ENTLI) situated at about 75 m to the west and about 35 m to the south of the July 2006 failure respectively (Figure 3). No relevant landslide data in the vicinity of the July 2006 failure are shown in the GEO's Natural Terrain Landslide Inventory (NTLI) and the Large Landslide Database.

5. PREVIOUS ASSESSMENTS

5.1 SIFT and SIRST Studies

In October 1996, slope No. 14NE-B/CR180 was first registered as slope No. 14NE-B/C180 under GEO's "Systematic Inspection of Features in the Territory" (SIFT) project, and categorised a Class 'C1' feature, i.e. slopes that "have been formed or substantially modified before 30.6.78 or to have been illegally formed after 30.6.78".

In October 1997, slope No. 14NE-B/C180 was inspected under the "Systematic Identification and Registration of Slopes in the Territory" (SIRST) project initiated by the GEO. The SIRST field sheet notes that the chunam surface was in a "fair" condition, and that no signs of seepage were observed. Potentially leaky services were present but no signs of leakage were observed. The slope was recorded as having no inferred past instability. The consequence-to-life category of the subject slope was rated as '1'.

5.2 LPM Stage 2 Study

Slope No. 14NE-B/C180 was included in the LPM Programme in 2002. A Stage 2 Study Report (ref. No. S2R 88/2003) was completed by CMWAL under Agreement No. CE 14/2002 (GE) in October 2003 (CMWAL, 2003). The registration details for the feature were changed to slope No. 14NE-B/CR180 in December 2003 following a request by

CMWAL to the GEO for revision to the feature type, as well as the feature boundary, based on desk study and site inspection.

The scope of the LPM Stage 2 Study included desk study, aerial photograph interpretation, site inspection and stability assessment. According to the Stage 2 Study report, the maintenance responsibility of slope No. 14NE-B/CR180 was, at that time, divided between the tenants of Short Term Tenancy (STT) Nos. CX468 and CX985, which comprised the ground surrounding No. 49 Po Wah Yuen and No. 50 Po Wah Yuen respectively, the extent of which is shown on Figure 2.

The desk study identified previous ground investigation data from two drillholes located about 30 m to the southeast of slope No. 14NE-B/CR180, which indicated that the local ground profile comprised an insitu weathering profile of granite, with completely decomposed material (i.e. Grade V) overlying slightly decomposed granitic bedrock.

Inspection of the feature by CMWAL in March 2003 for the LPM Stage 2 Study identified that the chunam surface cover over the western portion of slope No. 14NE-B/CR180 behind No. 49 Po Wah Yuen was cracked and damaged (Plate 2), and that "slight" vegetation was growing on the upper portion of the slope face. The majority of the randomly spaced, 40 mm diameter weepholes in the chunam surfacing were found to be partially blocked at the time of inspection, as was the 300 mm wide crest U-channel.

The chunam surface covering the eastern portion of slope No. 14NE-B/CR180 behind No. 50 Po Wah Yuen was also found to have cracked and a small area of chunam was found missing at the eastern end of the feature. Minor vegetation was present on the slope face, as well as a mature tree located at the eastern end. The five 40 mm diameter weepholes provided through the masonry wall portion of the feature indicated a wall thickness of about 700 mm. Minor cracking was observed at the eastern end of the wall. No evidence of seepage from weepholes was observed; however, a number of weepholes were found to be partially blocked. No signs of leakage from any of the "several" water pipes located at the slope crest were observed during the inspection.

The geological models for the two critical sections analysed (one within each maintenance sub-division) as part of the stability assessment (Figure 4) comprised completely decomposed granite (CDG).

The results of the stability analyses for both critical sections indicated that the requirements for the service of a Dangerous Hillside (DH) Order (GEO, 2006) were met for both sub-divisions. However, as each sub-division was within an STT area, a recommendation was made by the GEO to DLO/Islands on 31 December 2003 for the issue of 'Warning Letters' to the tenants of STT No. CX468 and No. CX985 respectively (see Appendix D).

5.3 Follow-up Actions by Lands Department

The 'Warning Letters' were issued by the DLO/Islands to the tenants of STT No. CX468 and STT No. CX985 on 26 January and 27 January 2005 respectively.

The tenants of STT No. CX985 subsequently wrote to DLO/Islands on 15 February 2005 requesting termination of the STT No. CX985, which incorporated the eastern portion of slope No. 14NE-B/CR180. The request was granted by the DLO/Islands on 12 May 2005, and the STT was terminated on 1 July 2005.

DLO/Islands issued a letter to the tenant of STT No. CX468 on 29 July 2005 reminding the requirement of submission of an investigation report for the western portion of slope No. 14NE-B/CR180 by 26 August 2005. The tenant of STT No. CX468 subsequently wrote to the DLO/Islands on 30 October 2005 requesting termination of the STT, which incorporated the western portion of slope No. 14NE-B/CR180. The request was accepted by the DLO/Islands on 12 December 2005, and the STT was terminated on 31 January 2006.

Subsequent to the acceptance of the application for the termination of STT No. CX468, DLO/Islands sent a memo dated 19 December 2005 to Chief Estate Surveyor/Estate Management (CES/EM) of the Lands D requesting for the updating of the maintenance responsibility of the western portion of slope No. 14NE-B/CR180 upon the termination of the STT on 31 January 2006. The memo was marked to be copied to Chief Geotechnical Engineer/Slope Safety (CGE/SS) of the GEO; however, no record of receipt of this memo could be found in the GEO. It is also noted that no similar memo for the eastern portion of the slope, in relation to STT No. CX985 could be located in DLO/Islands' office and the GEO, following the termination of the STT on 1 July 2005.

Upon receipt of the July 2006 landslide incident report, DLO/Islands further requested CES/EM on 18 July 2006 to update the maintenance responsibility of slope No. 14NE-B/CR180 with respect to the area of the previous STT No. CX468.

On 8 September 2006, CGE/SS wrote to CES/EM advising that "the stability of the above feature is still below the required safety standard and is liable to become dangerous based on our Stage 2 Study Report. As it is an ICC case with high CNPCS score of 10.73 for the above feature, grateful if you could accord top priority (as with DHO case) to review the MR of this feature and advise us as soon as possible for our follow up action, if necessary". According to CES/EM, the review of the maintenance responsibility of the slope was completed on 29 January 2007 after seeking geotechnical advice from the consultant to CGE/SS, viz. CMWAL, and the result of the review was despatched to CGE/SS on 22 February 2007.

6. THE 16 JULY 2006 INCIDENT AND POST-FAILURE OBSERVATIONS

6.1 Description of the 16 July 2006 Incident

The 16 July 2006 landslide (Incident No. 2006/07/0672) occurred in the western portion of slope No. 14NE-B/CR180 behind the four-storey village house at No. 49 Po Wah Yuen. Based on the account of the residents of No. 49 Po Wah Yuen and the information in the GEO incident report, the timing of the failure was around 2:00 a.m. on 16 July 2006. The GEO was subsequently notified of the incident by the Lands D on 18 July 2006. No casualties were reported as a result of the failure. According to the GEO incident report, the residents of No. 49 Po Wah Yuen voluntarily evacuated from the dwelling until emergency repair works were completed.

A plan view of the landslide is presented in Figure 2. Elevation and sectional views are presented in Figure 5.

The source area of the landslide (Plate 1) extended over the majority of the slope face above No. 49 Po Wah Yuen from the slope crest to the toe planter wall, with dimensions of about 5.5 m wide by 4 m long. The landslide scar was relatively shallow, having a maximum depth of about 0.3 m, and concave, with a steep scarp inclined at 70° or more. CDG was exposed in landslide scar. The slope profile prior to the failure was inferred to be inclined at around 60° to the horizontal.

Debris from the landslide, with an estimated volume of about 15 m^3 and comprising chunam surfacing, soil and a small amount of vegetation, was mostly deposited on the open space between the toe of slope No. 14NE-B/CR180 and the adjacent dwelling. A portion of the debris deposited against the rear wall of the village house and against the rear door (Plate 3), which allowed muddy water pass through the gap at the base of the door and enter the dwelling. The travel angle of the debris (Wong & Ho, 1996), as measured from the main scarp to the rear wall of the dwelling, was about 53°.

6.2 Post-failure Observations

The GEO inspected the landslide site on 20 July 2006, and reported that there was no field evidence of past instability at or adjoining the failure location, and that blocked/broken drains had been identified at the slope crest. The GEO also reported that a tree growing from the slope face had been blown about during the stormy weather conditions on 16 July 2006, leading to damage to the chunam surface cover, based on advice received from one of the residents of No. 49 Po Wah Yuen, and considered this to be a possible contributory cause of the failure. A photograph taken by the GEO on 20 July 2006 (Plate 4) shows the mature tree with chunam surrounding the root mass remaining within the landslide scar.

FSW inspected the landslide site on 15 November 2006, by which time urgent repair works (comprising the application of shotcrete to the landslide scar and surrounding slope face and reconstruction of the crest drainage channel) had been completed (Plate 5). Bulging and associated cracking were observed in the toe planter wall (Plate 6), which was assessed as pre-dating the July 2006 landslide based on the placement of ceramic tiles around the bulge on the adjacent open space at the slope toe.

Cracks up to 20 mm in width were identified in original sections of the crest drainage channel remaining in place on the western side of the reconstructed portion (Plates 7 and 8).

The retaining structure above the slope crest was observed to contain cracks (Plate 9) and gaps (Plate 10), suggesting the previous occurrence of movement. A 19 mm diameter galvanized iron pipe protruded from the mass concrete portion of the wall above the crest channel (Plate 11), the purpose and function of which were not clear; however, no signs of discharge from the pipe were observed.

Above the concrete stairway providing access to No. 59 Po Wah Yuen, the immediate catchment above slope No. 14NE-B/CR180 appeared to comprise the level building platform at No. 59 Po Wah Yuen (Plate 12). No obvious features that would promote the

concentration of surface runoff and no signs of seepage/leaking services were observed.

The portion of slope No. 14NE-B/CR180 located above No. 50 Po Wah Yuen was found to be in good condition, with a shotcrete surface cover recently applied to the slope portion of the feature (Plate 13).

7. METEOROLOGICAL RECORDS

7.1 Wind Records

Based on the Hong Kong Observatory (HKO) records, the Strong Monsoon signal was in force between 10:45 p.m. on 14 July 2006 and 9:15 a.m. on 17 July 2006, which anticipated wind speeds in excess of or expected to exceed 40 km/h near sea level anywhere in Hong Kong. Mean wind speeds during these two days, as measured at Waglan Island, were 50.5 km/h and 47.5 km/h respectively, compared to a mean wind speed of 22.7 km/h for the month of July 2006 and a normal wind speed of 20.0 km/h for the month of July.

The nearest HKO monitoring station to the landslide site, located at Wong Chuk Hang, about 6.8 km to the southeast of the failure, recorded mean wind speeds for 15 July and 16 July 2006 of 15 km/h and 11 km/h respectively (Figure 6), with peak wind gusts of 48 km/h and 65 km/h respectively.

7.2 Rainfall Records

Rainfall data were obtained from the GEO automatic raingauge No. N27, which is the nearest raingauge to the landslide site and located at the Sok Kwu Wan Police Post on Lamma Island, about 3.2 km to the southeast of the landslide (Figure 1). The raingauge records and transmits rainfall data at 5-minute intervals to the HKO and the GEO.

For the purpose of rainfall analysis, the time of the failure was assumed to be at 2:00 a.m. on 16 July 2006, based on the witness accounts and the GEO incident report.

The daily rainfall recorded by raingauge No. N27 over the month preceding the failure, together with the hourly rainfall readings for the period between 12:00 a.m. on 15 July 2006 and 11:00 p.m. on 16 July 2006, are presented in Figure 7. The maximum 24-hour and 12-hour rolling rainfall before the failure was 13.5 mm and 11.5 mm respectively.

Table 1 presents the estimated return periods for the maximum rolling rainfall for various durations recorded by raingauge No. N27 with reference to historical rainfall data at the HKO in Tsim Sha Tsui (Lam & Leung, 1994). The estimated return periods for all rainfall durations were less than 2 years.

The maximum rolling rainfall for the rainstorm on 16 July 2006 has been compared with the past major rainstorms between 2000 and 2005 recorded by raingauge No. N27, which came into operation in 1999 (Figure 8). The maximum rolling rainfall for the rainstorm on 16 July 2006 is less severe than the previous significant rainstorms.

The estimation of return periods by reference to the site-specific statistical parameters derived by Evans & Yu (2001) was not possible in this instance, as raingauge No. N27 was not included in that study.

8. DISCUSSION

The 16 July 2006 landslide occurred during fairly light rainfall on slope No. 14NE-B/CR180, situated above village houses at Nos. 49 and 50 Po Wah Yuen on ground previously included within two STT lease areas. The landslide event was minor with negligible consequence. The landslide comprised a typical rain-induced shallow failure of a substandard and poorly maintained slope and is of no surprise in technical terms.

The slope was established as being substandard by the LPM Stage 2 Study in 2003, following which 'Warning Letters' were issued by DLO/Islands to the respective tenants in early 2005. At the request of the tenants, the STT lease areas incorporating slope No. 14NE-B/CR180 were terminated, and the land status of part of slope No. 14NE-B/CR180 was reverted to Government land in July 2005 (the portion behind No. 50 Po Wah Yuen) and the remainder in January 2006 (the portion behind No. 49 Po Wah Yuen), i.e. 12 months and 6 months before the 2006 landslide respectively. The assessment of the maintenance responsibility of the slope was completed by Lands D in early 2007. It is not certain whether the fact that the slope of concern had outstanding 'Warning Letters' was taken into account by Lands D during the process in this instance. The GEO was not aware of the termination of the STT lease areas before the landslide incident.

Explanation for the timing of the failure during a rainfall event exceeded in severity by preceding rainfall events recorded by the closest raingauge remains circumspect in the absence of any observation of concentration of surface runoff above the landslide scar. Nevertheless, the topography and arrangement of development above the slope crest is complex and could give rise to locally more severe surface flow conditions not obvious during dry weather conditions. Additionally, the wind speed data recorded prior to the failure indicates that wind gusts of up to 60 km/h may have been experienced at the landslide site. These records, coupled with the observations made by the occupants of No. 49 Po Wah Yuen that the mature tree on the slope face having been blown around under the windy conditions, suggests that loosening of the ground around the tree root mass, together with possible progressive slope deterioration due to lack of maintenance, might have been contributory factors to the failure.

9. REFERENCES

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LIST OF TABLES

Table 1 - Summary of Previous GEO Landslide Incidents (Sheet 1 of 2)

Incident No.	Date of Failure	Approximate Location of Landslide Source Area	Approximate Debris Volume (m^3)	Debris Description	Possible Causes of Failure	Consequence
GC82/38	31 May 1982	Unregistered cut slope to the east of No. 43 Po Wah Yuen	unknown	unknown	unknown	Building lot affected
MW86/5/6	23 May 1986	Western portion of slope No. 14NE-B/R119 behind No. 54 Po Wah Yuen	2	Soil debris with broken chunam	Groundwater and erosion	Nil
MW87/6/3	Between 4 and 6 Jun 1987	Eastern portion of slope No. 14NE-B/C182 behind No. 45 Po Wah Yuen	2	Soil debris	Infiltration and erosion	Building lot affected
MW88/7/6	19 Jul 1988	Eastern portion of Slope No. 14NE-B/C6 behind No. 72 Po Wah Yuen,	1.5	Soil debris	Groundwater and infiltration	Building rear path partially affected
MW88/7/12	20 Jul 1988	Western portion of slope No. 14NE-B/C153 behind No. 9 Yung Shue Wan Main Street, Lamma Island	3	Soil debris	Groundwater and infiltration	Pedestrian pavement affected
HK89/5/5 A MW89/5/5 B	2 May 1989	Centre portion of slope No. 14NE-B/C6 behind No. 72 Po Wah Yuen	< 1	Soil debris & broken chunam	Groundwater and infiltration	Building rear path affected
MW91/6/10	20 Jun 1991	Upper portion of slope No. 14NE-B/C6 behind No. 72 Po Wah Yuen	3	Soil debris with broken chunam	Infiltration	Rear lane partially blocked
MW94/7/11	22 Jul 1994	Centre portion of slope No. 14NE-B/C7 behind No. 65 Po Wah Yuen	20	Soil debris	Infiltration	Building lot affected

Table 1 - Summary of Previous GEO Landslide Incidents (Sheet 2 of 2)

Incident No.	Date of Failure	Approximate Location of Landslide Source Area	Approximate Debris Volume (m^3)	Debris Description	Possible Causes of Failure	Consequence
MW94/8/38~A	Around 1992	Unregistered soil cut slope to the east of No. 42 Po Wah Yuen	5	Soil debris	Infiltration and washout	Building lot and access affected
MW94/8/38~B		1.8 m high brick wall to the east of No. 38 Po Wah Yuen,	NA (brick wall tilted)	NA	Not mention	NIL
MW94/8/38~C		1.7 m wall to the east of No. 34 Po Wah Yuen	NA (wall tilted)	NA	Not mention	NIL
MW99/8/20	24 Aug 1999	Western portion of slope No. 14NE-B/C7 behind No. 65 Po Wah Yuen,	15	Soil debris	Infiltration	Building lot affected
MW99/9/13	16 Sep 1999	Eastern portion of slope No. 14NE-B/R8 behind No. 53 Po Wah Yuen	NA	Tree	Tree fall	Building/Private access affected
MW2000/8/14	unknown	Eastern portion of slope No. 14NE-B/C6 behind No. 72 Po Wah Yuen	2	Soil debris	Infiltration and washout	Village house affected
2005/08/0276	9 Jul 2005	Eastern portion of slope No. 14NE-B/C223 behind No. 40B Po Wah Yuen	2	Soil debris	Infiltration	Open space affected
2005/09/0515	21 Aug 2005	Unregisterable soil cut slope behind No. 27 Po Wah Yuen	0.2	Soil debris	Washout	Building access affected

Table 2 - Maximum Rolling Rainfall at GEO Raingauge No. N27 for Selected Durations Preceding the 16 July 2006 Landslide and the Estimated Return Periods Based on Lam & Leung (1994)

Duration	Maximum Rolling Rainfall (mm)	End of Period	Estimated Return Period (Years)
5 Minutes	2.5	01:40 hours on 16 July 2006	< 2
15 Minutes	5	01:50 hours on 16 July 2006	< 2
1 Hour	10.5	02:00 hours on 16 July 2006	< 2
2 Hours	11	02:00 hours on 16 July 2006	< 2
4 Hours	11	02:00 hours on 16 July 2006	< 2
12 Hours	11.5	02:00 hours on 16 July 2006	< 2
24 Hours	13.5	02:00 hours on 16 July 2006	< 2
2 Days	14.5	02:00 hours on 16 July 2006	< 2
4 Days	14.5	02:00 hours on 16 July 2006	< 2
7 Days	43	02:00 hours on 16 July 2006	< 2
15 Days	84.5	02:00 hours on 16 July 2006	< 2
31 Days	115.5	02:00 hours on 16 July 2006	< 2

Notes:
(1) Return periods were derived from Table 3 of Lam & Leung (1994).
(2) Maximum rolling rainfall was calculated from 5-minute data.
(3) The use of 5-minute data for durations between 4 hours and 31 days results in better data resolution, but may slightly over-estimate the return periods using Lam & Leung (1994)'s data, which are based on hourly rainfall for these durations.
(4) The landslide is assumed to have occurred at 02:00 hours on 16 July 2006 for the purpose of rainfall analysis.
(5) The nearest GEO raingauge to the landslide site is raingauge No. N27, which is located about 3.2 km to the southeast of the 16 July 2006 landslide site and is operational since 1 October 1999.

LIST OF FIGURES

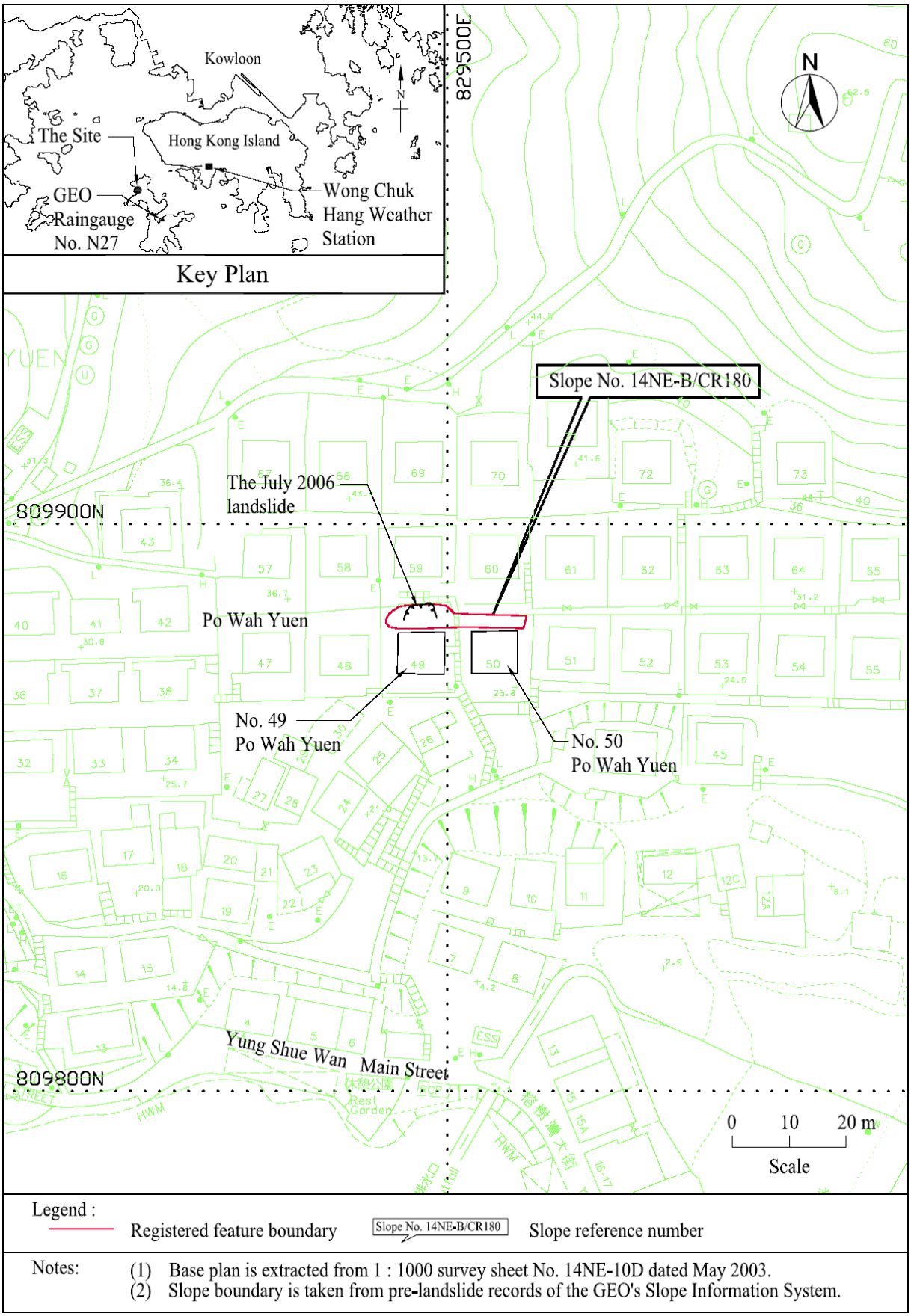

Figure 1 - Site Location Plan

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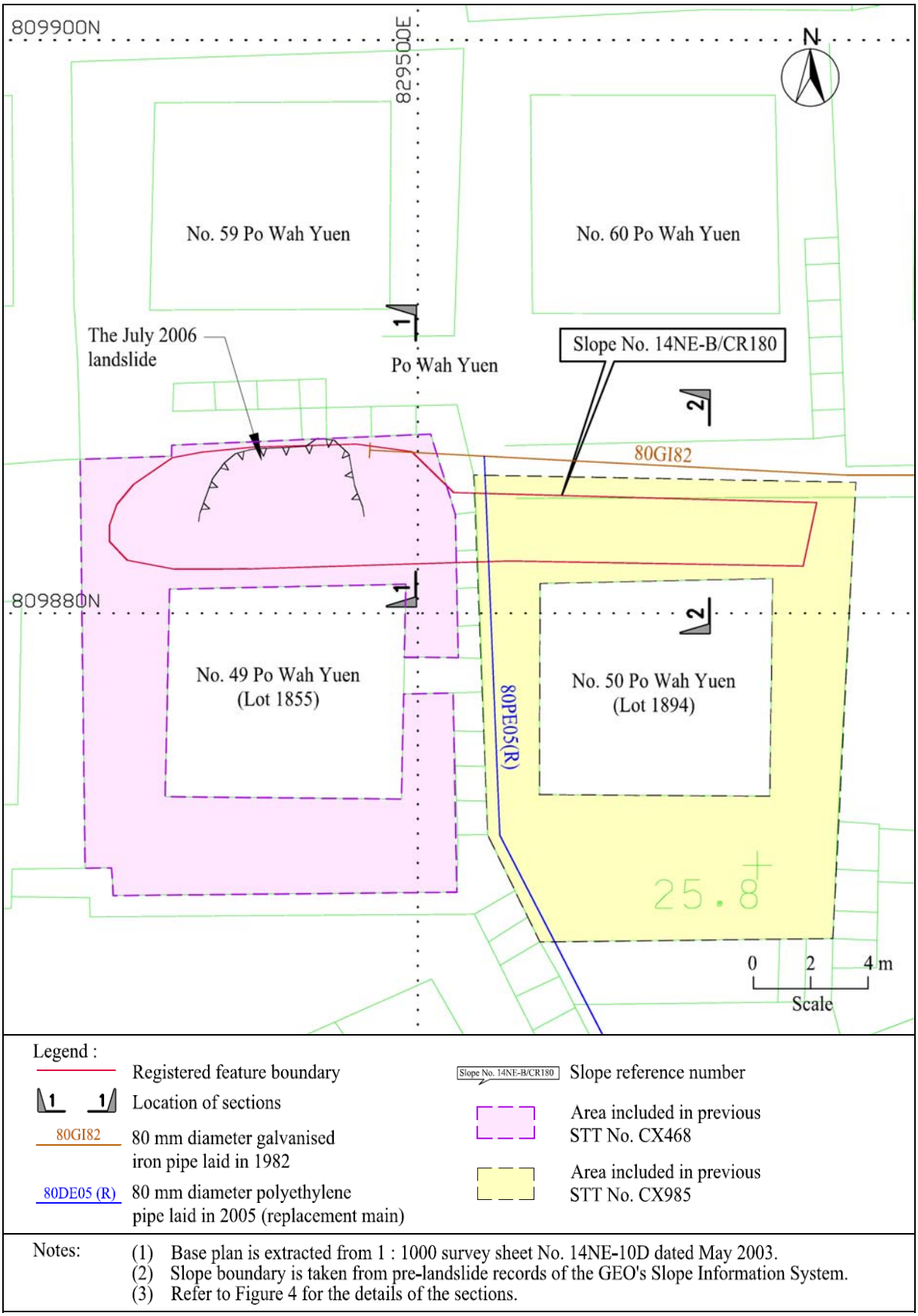

Figure 2 - Site Plan

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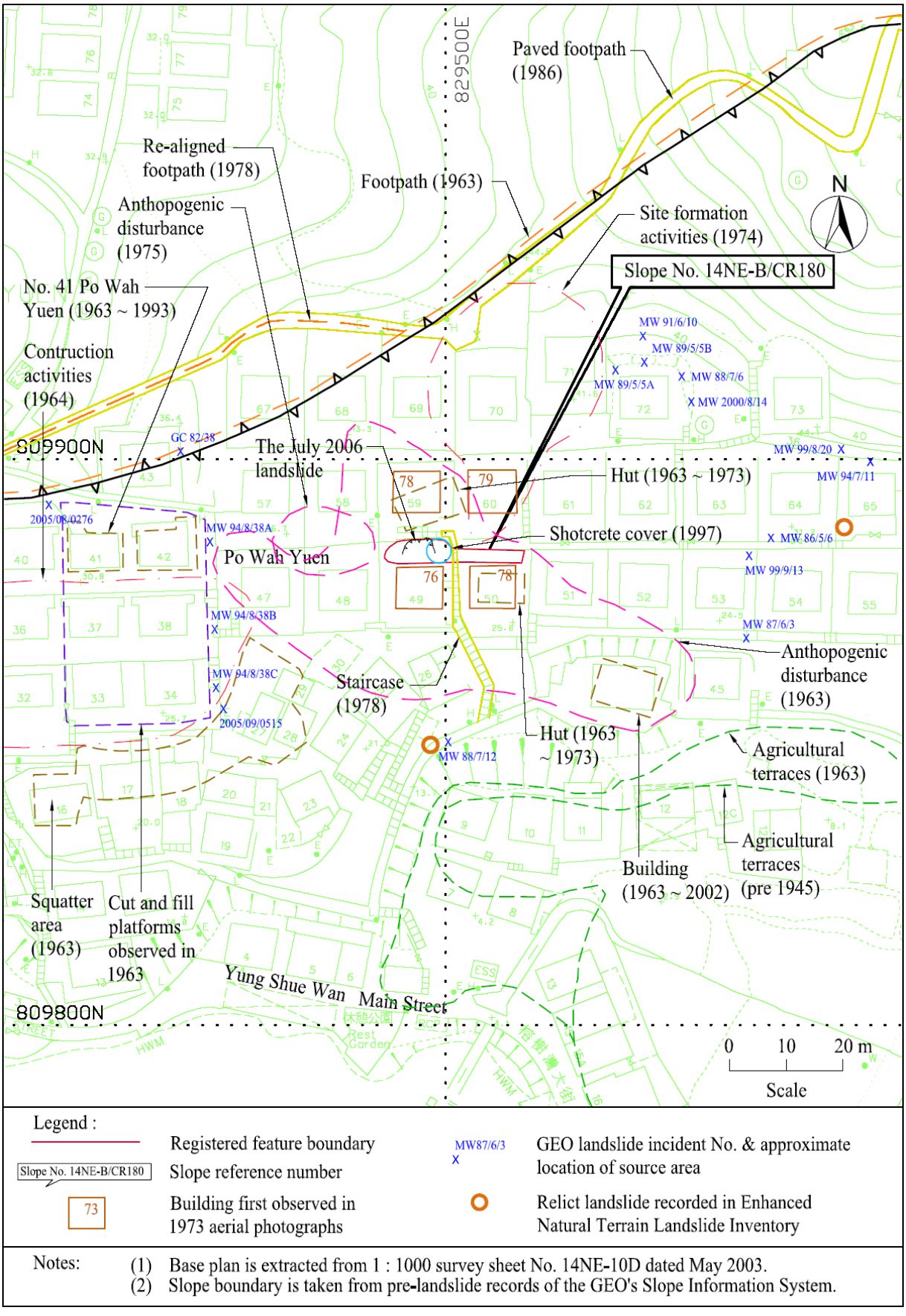
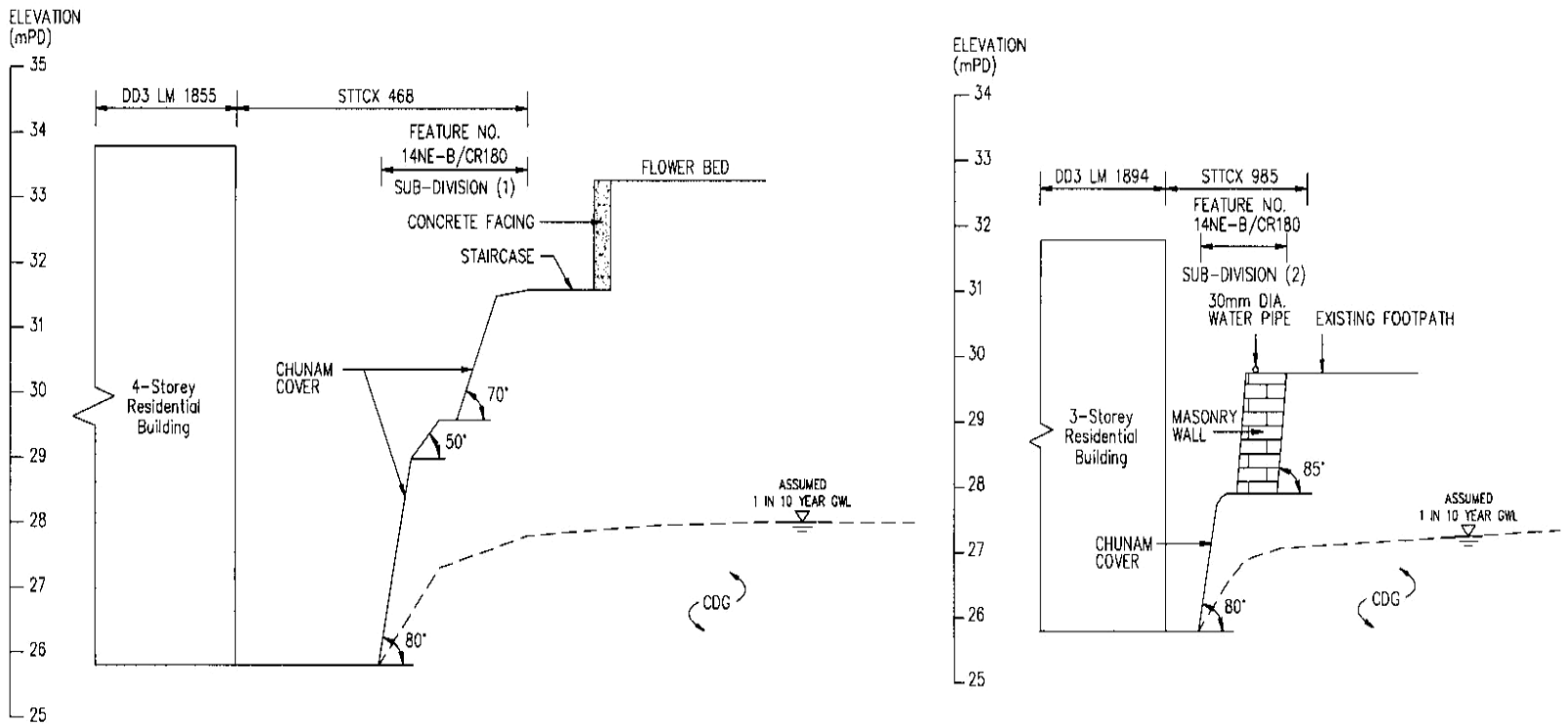


Figure 3 - Site Development Plan



Geological Section 1 - 1

Geological Section 2 - 2

Note: Refer to Figure 2 for section locations.

Figure 4 - Geological Sections 1-1 and 2-2 through Slope No. 14NE-B/CR180 (Extracted from Figures 4 and 6 of LPM Stage 2 Study Report No. S2R 88/2003 respectively (CMWAL, 2003))

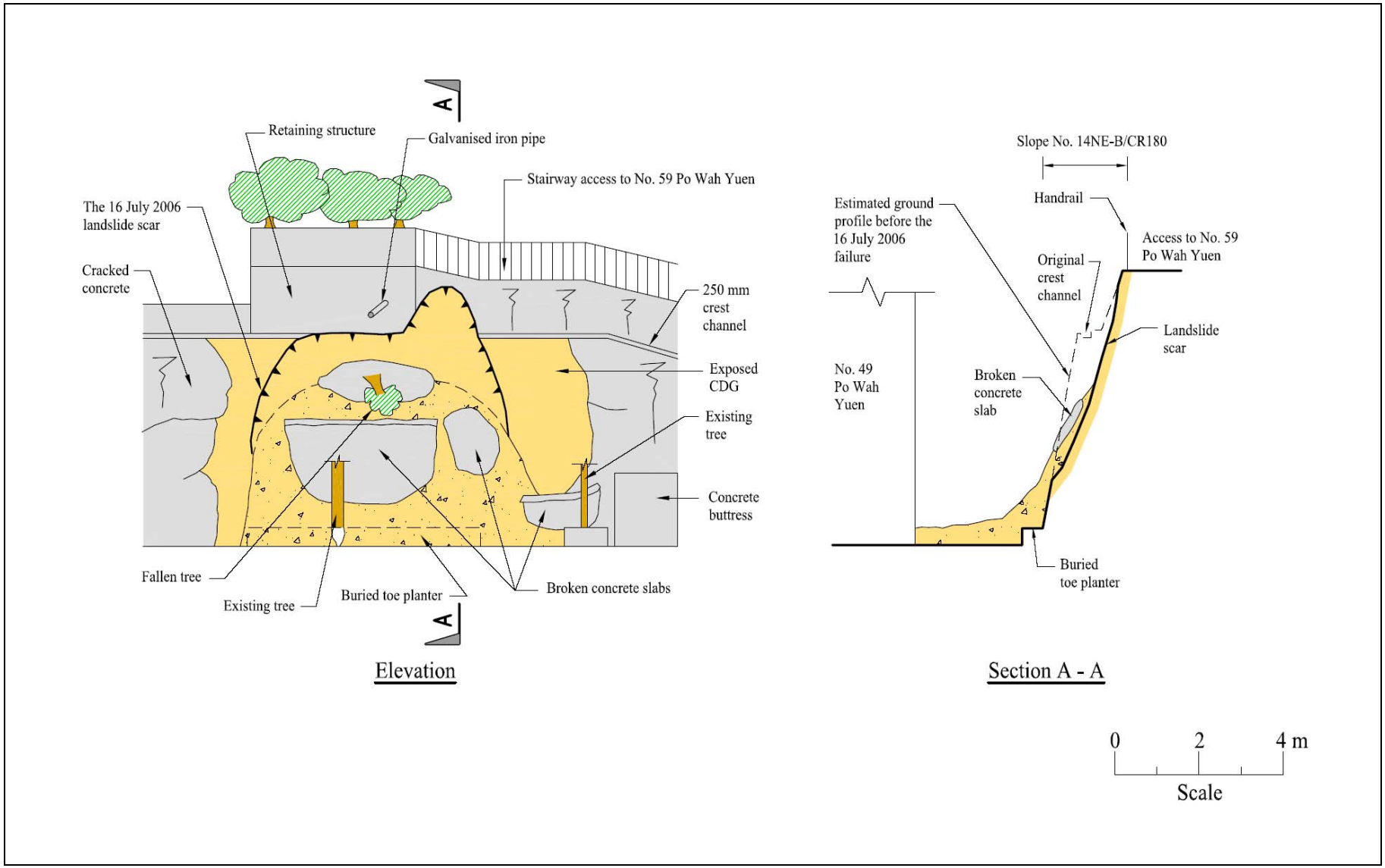
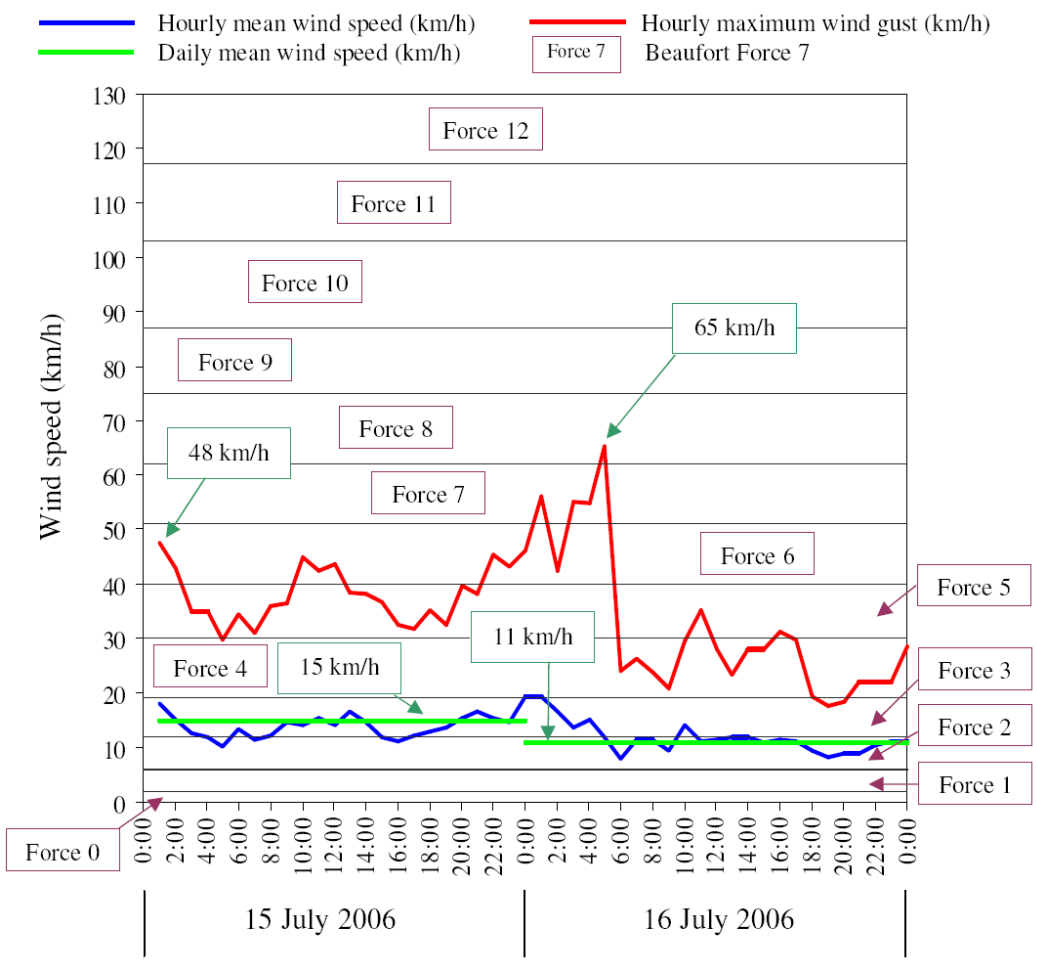


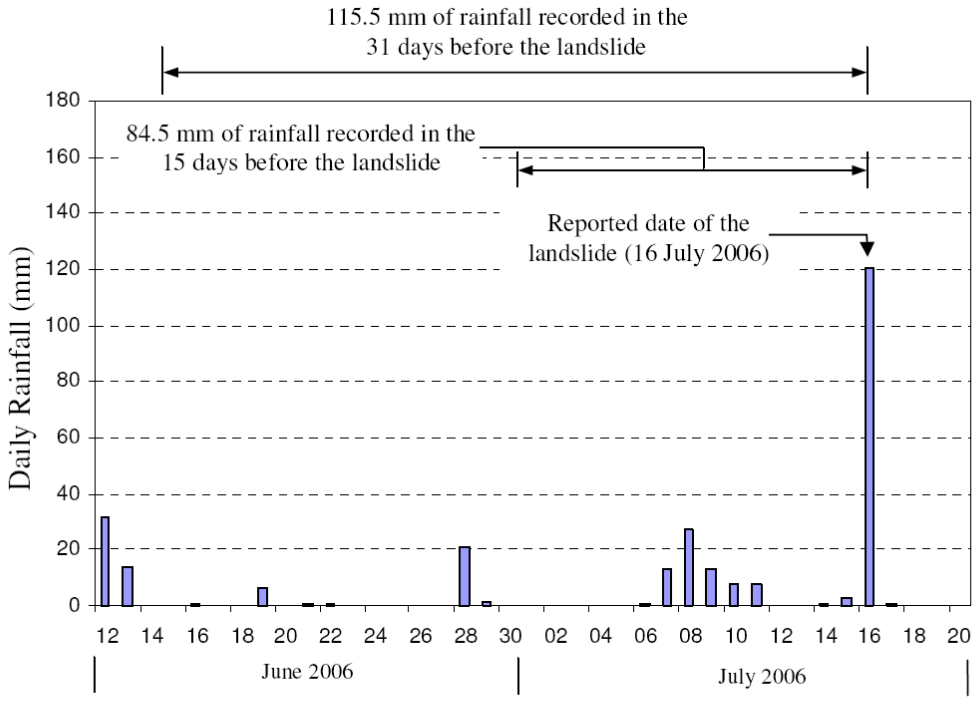
Figure 5 - Elevation View and Cross-section A-A through the 16 July 2006 Landslide Scar



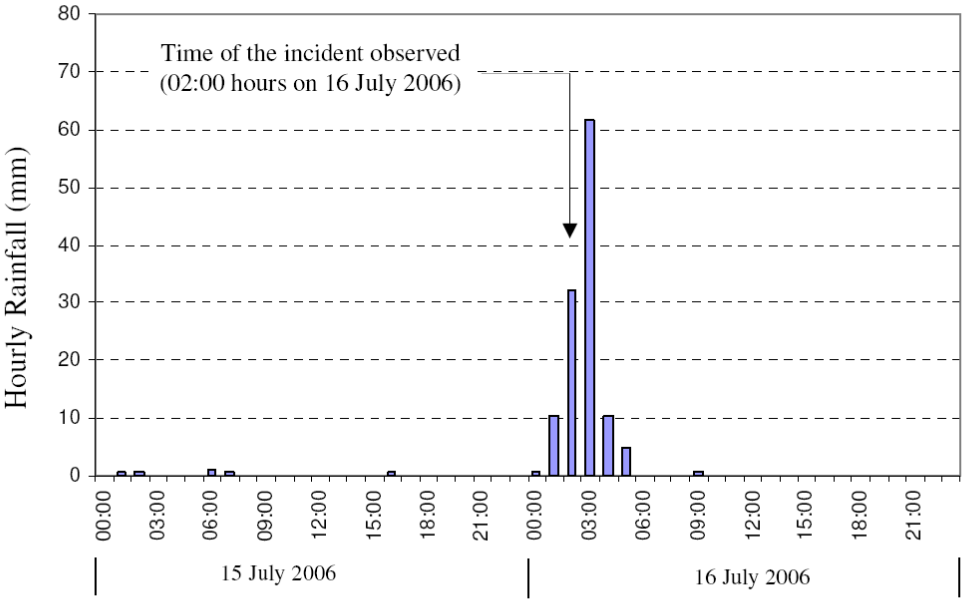
Beaufort Force	Description	Wind Speed (km/h)	Illustration
Force 0	Clam	< 2	
Force 1	Light	2 – 6	
Force 2		7 – 12	
Force 3	Moderate	13 – 19	
Force 4		20 – 30	
Force 5	Fresh	31 – 40	
Force 6	Strong	41 – 51	
Force 7		52 – 62	
Force 8	Gale	63 – 75	
Force 9		76 – 87	
Force 10	Storm	88 – 103	
Force 11		104 – 117	
Force 12	Hurricane	>= 118	

Note: Relationships between the Beaufort force, descriptive terms of wind speeds and wind speeds are extracted from Hong Kong Observatory publications.

Figure 6 - Wind Speed Data Recorded at HKO Wong Chuk Hang Weather Station

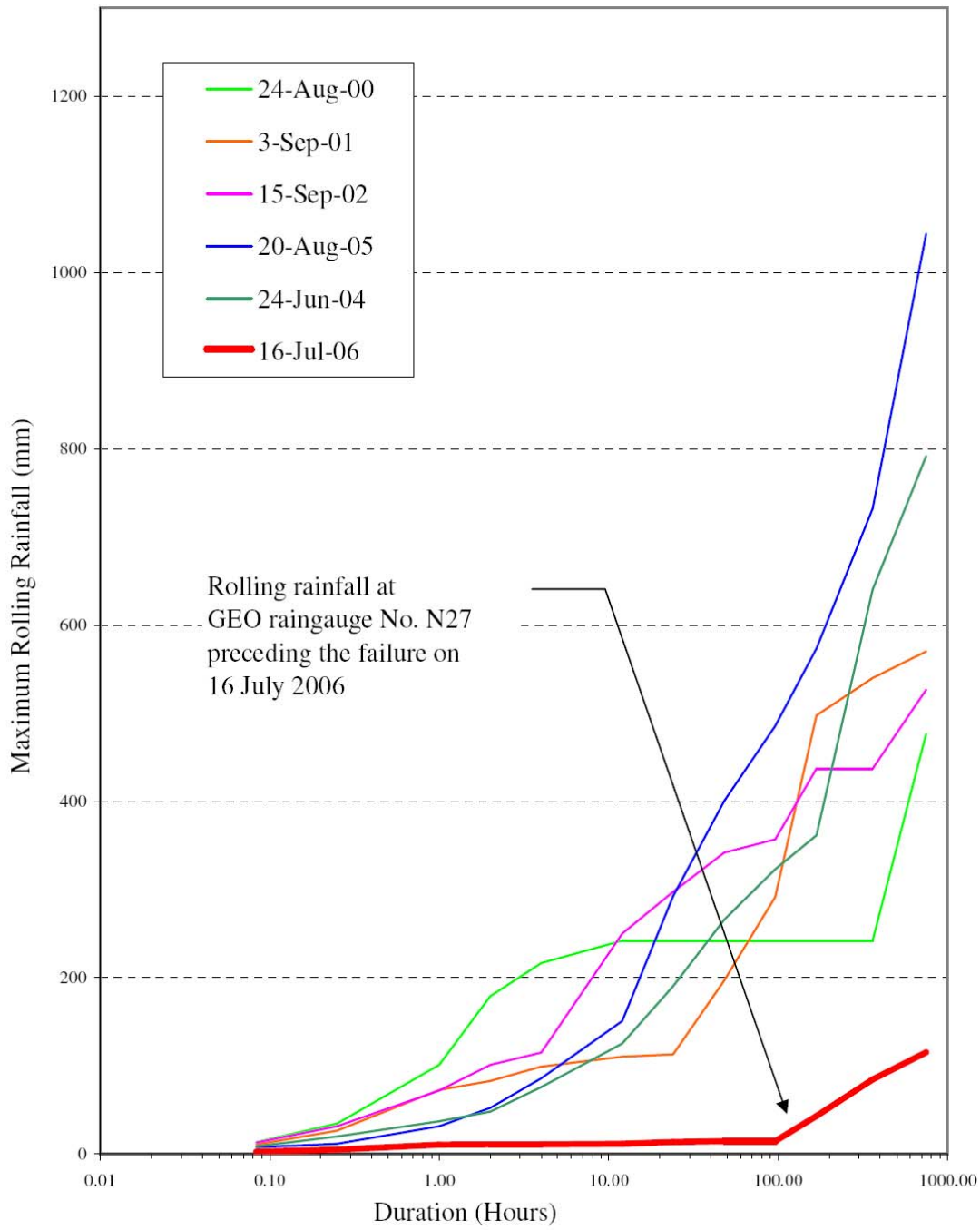


(a) Daily Rainfall Recorded between 12 June and 20 July 2006



(b) Hourly Rainfall Recorded between 00:00 hours on 15 July and 23:00 hours on 16 July 2006

Figure 7 - Rainfall Recorded at GEO Raingauge No. N27



Notes:
(1) Rainfall data are evaluated from 5-minute readings from GEO raingauge No. N27 (located about 3230 m to the southeast of the landslide site).
(2) Rolling rainfall of previous rainstorms calculated at GEO raingauge No. N27 since 01 Oct 1999 when the raingauge was installed.

Figure 8 - Maximum Rolling Rainfall Preceding the 16 July 2006 Landslide and Selected Previous Major Rainstorms Recorded at GEO Raingauge No. N27

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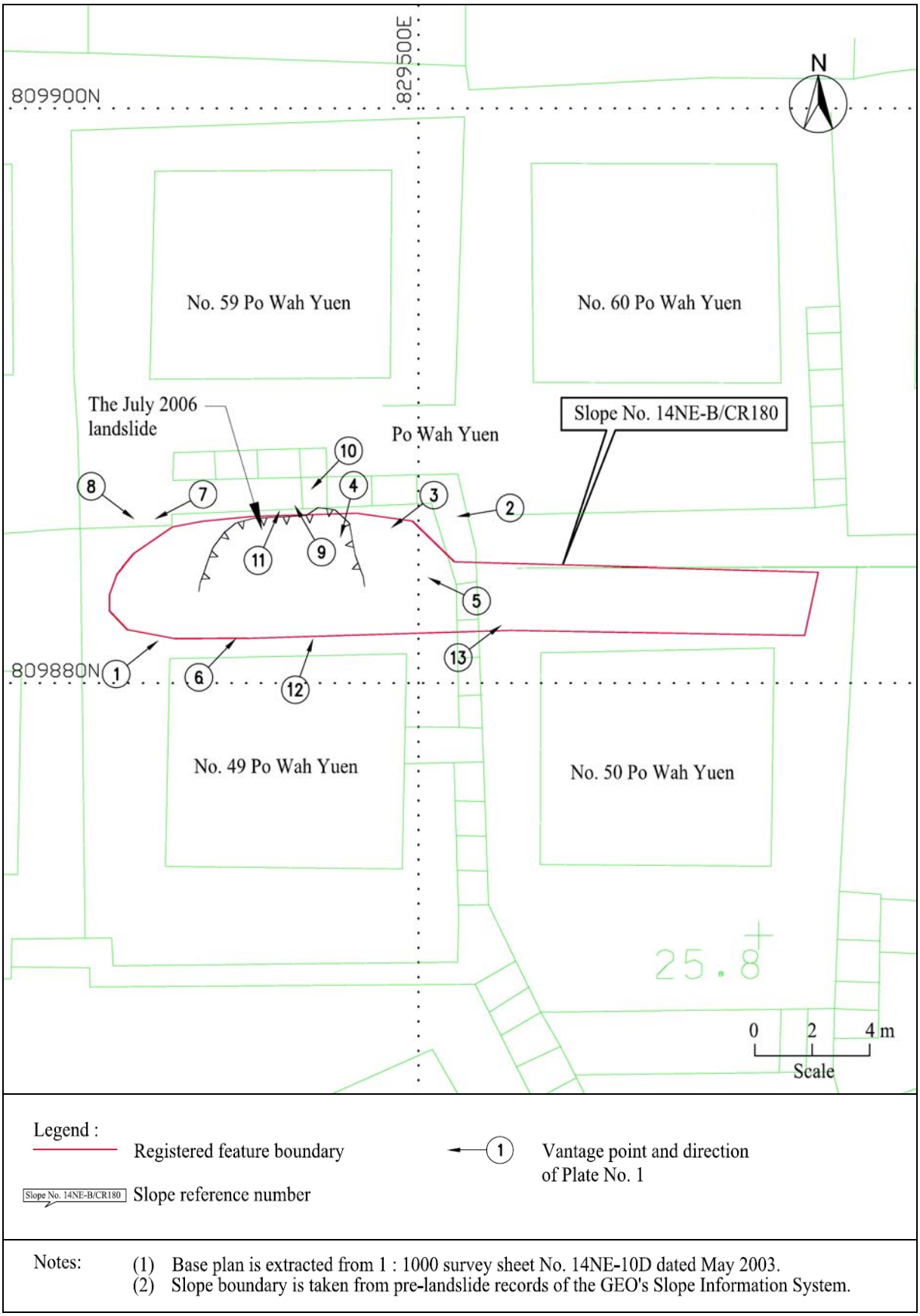

Figure 9 - Locations and Directions of Photographs

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LIST OF PLATES

Plate 1 - View Northeast across Slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen Showing Landslide Scar
(Photograph taken by GEO on 20 July 2006)

Note: See Figure 9 for the location and direction of photograph

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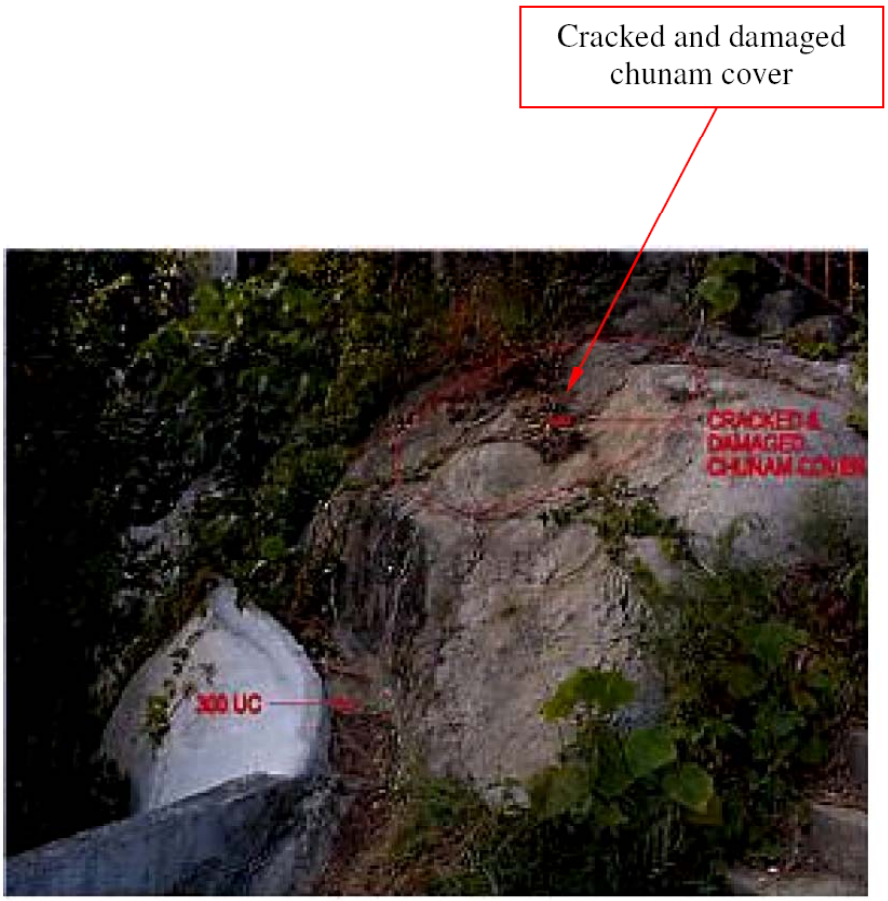

Plate 2 - View of Upper Portion of Slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen Showing Poor Condition of Chunam Surface Cover (Photograph taken by C M Wong & Associates in April 2003)

Note: See Figure 9 for the location and direction of photograph.

Plate 3 - View Showing Arrangement at Rear of No. 49 Po Wah Yuen
(Photograph taken on 15 November 2006)

Note: See Figure 9 for the location and direction of photograph.

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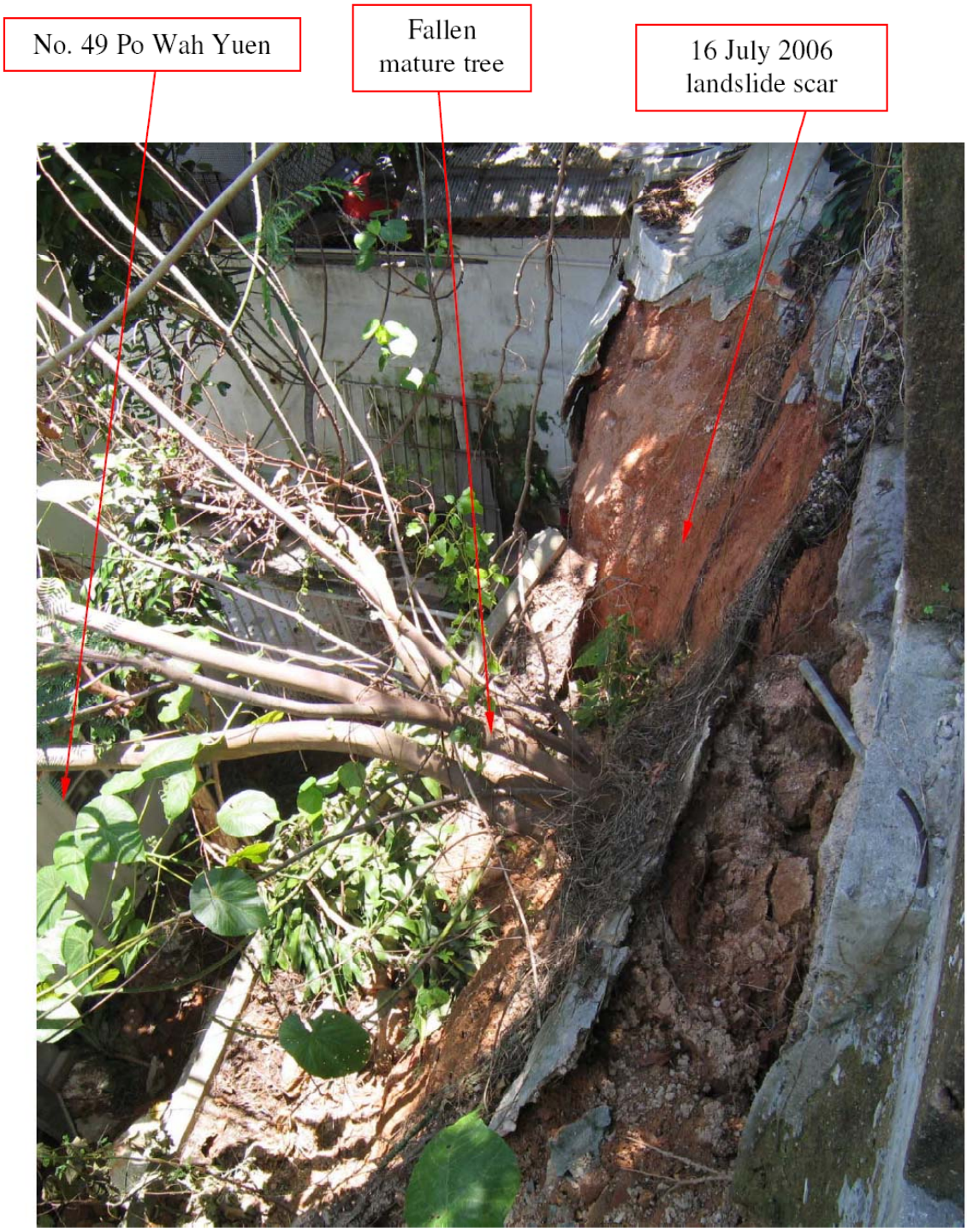

Plate 4 - View West across Slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen Showing 16 July 2006 Landslide Scar and Mature Tree with Chunam Surround to Root Mass Remaining within Scar (Photograph taken by GEO on 20 July 2006)

Note: See Figure 9 for the location and direction of photograph.

Plate 5 - View West across Slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen Following Urgent Repair Works (Photograph taken on 15 November 2006)

Note: See Figure 9 for the location and direction of photograph.

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Plate 6 - Close View of Toe Planter Wall Showing Bulging and Cracking (Photograph taken on 15 November 2006)

Note: See Figure 9 for the location and direction of photograph.

Plate 7 - Close View of Example of Cracking in Crest U-channel
(Photograph taken on 15 November 2006)

Note: See Figure 9 for the location and direction of photograph.

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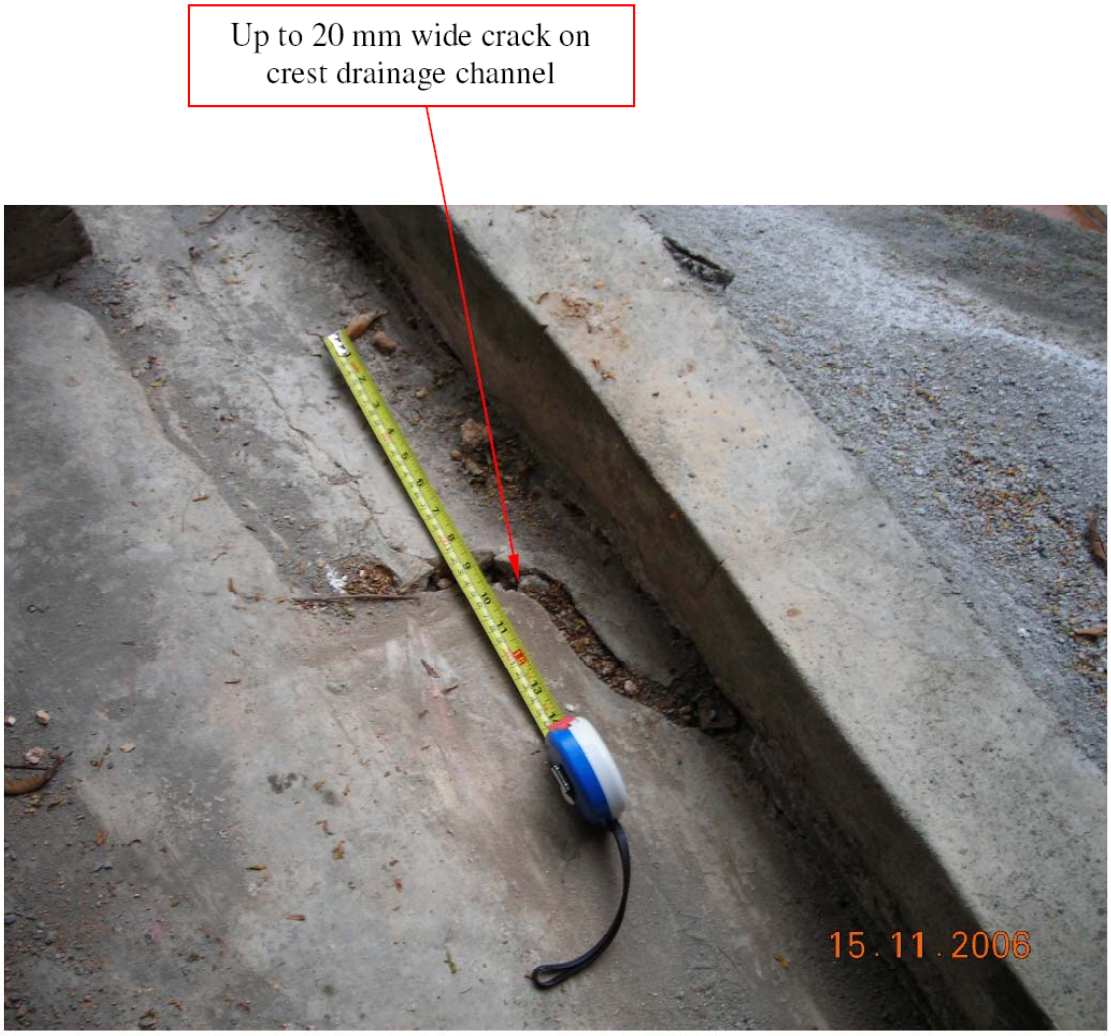

Plate 8 - Close View of Example of Cracking in Crest U-channel
(Photograph taken on 15 November 2006)

Note: See Figure 9 for the location and direction of photograph.

Plate 9 - Close View of Retaining Wall at Crest of Slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen Showing Existing Cracks (Photograph taken on 15 November 2006)

Note: See Figure 9 for the location and direction of photograph.

Plate 10 - Close View of Crest Area of the Retaining Wall at Crest of Slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen Showing Gaps between Concrete Elements (Photograph taken on 15 November 2006)

Note: See Figure 9 for the location and direction of photograph.

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Plate 11 - Close View of 19 mm Diameter Galvanised Iron Pipe Protruding from Retaining Wall at Crest of Slope No. 14NE-B/CR180 above No. 49 Po Wah Yuen (Photograph taken on 15 November 2006)

Note: See Figure 9 for the location and direction of photograph.

Plate 12 - View of Arrangement at Building Platform of No. 59 Po Wah Yuen (Photograph taken on 5 March 2007)

Note: See Figure 9 for the location and direction of photograph

Plate 13 - View across Eastern Portion of Slope No. 14NE-B/CR180 above No. 50 Po Wah Yuen (Photograph taken on 5 March 2007)

Note: See Figure 9 for the location and direction of photograph.

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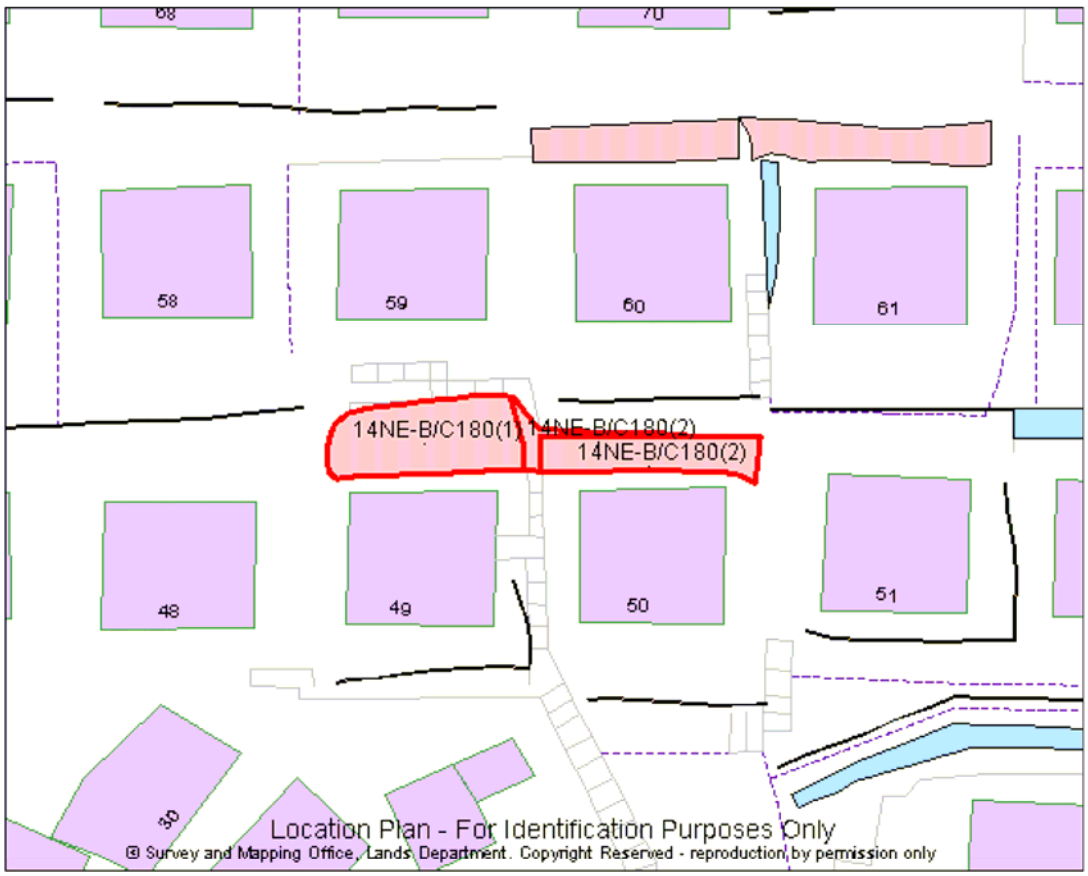
APPENDIX A

RECORDS OF SLOPE IN SMRIS (AS AT 28 MARCH 2007)

Slope Report

FOR IDENTIFICATION PURPOSES ONLY

Slope Location Plan



Legend

Responsible Slope / Part of Slope Boundary

Lot Boundary

Slope Maintenance Responsibility Category

Government

Private

Joint (Government and Private)

LANDS DEPARTMENT	Not To Scale
Office: SIMAR Unit, Estate Management Section	Date: 28/03/2007

Slope Number

14NE-B/C180

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IASMP01001

SIMAR REGISTER

28/03/2007 02:29 PM

Slope No.	Slope Sub-division No.	Location	Responsible Lot(s) / Party(s)	Maintenance Agent	Slope Plan*	Remarks
14NE-B/C180	1	WITHIIN STT CX468 & STT CX985 & ADJOINING GL	STTCX468	N/A	as per the attached	Slope information being reviewed.
14NE-B/C180	2	WITHIIN STT CX468 & STT CX985 & ADJOINING GL	STTCX985	N/A	as per the attached	Slope information being reviewed.
14NE-B/C180	2	WITHIIN STT CX468 & STT CX985 & ADJOINING GL	STTCX985	N/A	as per the attached	Slope information being reviewed.

- End of Report -

* Note: (i) The attached slope plan(s) are for the purpose of identification of the slope(s) only.
(ii) The slope(s) mentioned in the Register may not be shown in the attached slope plan(s).

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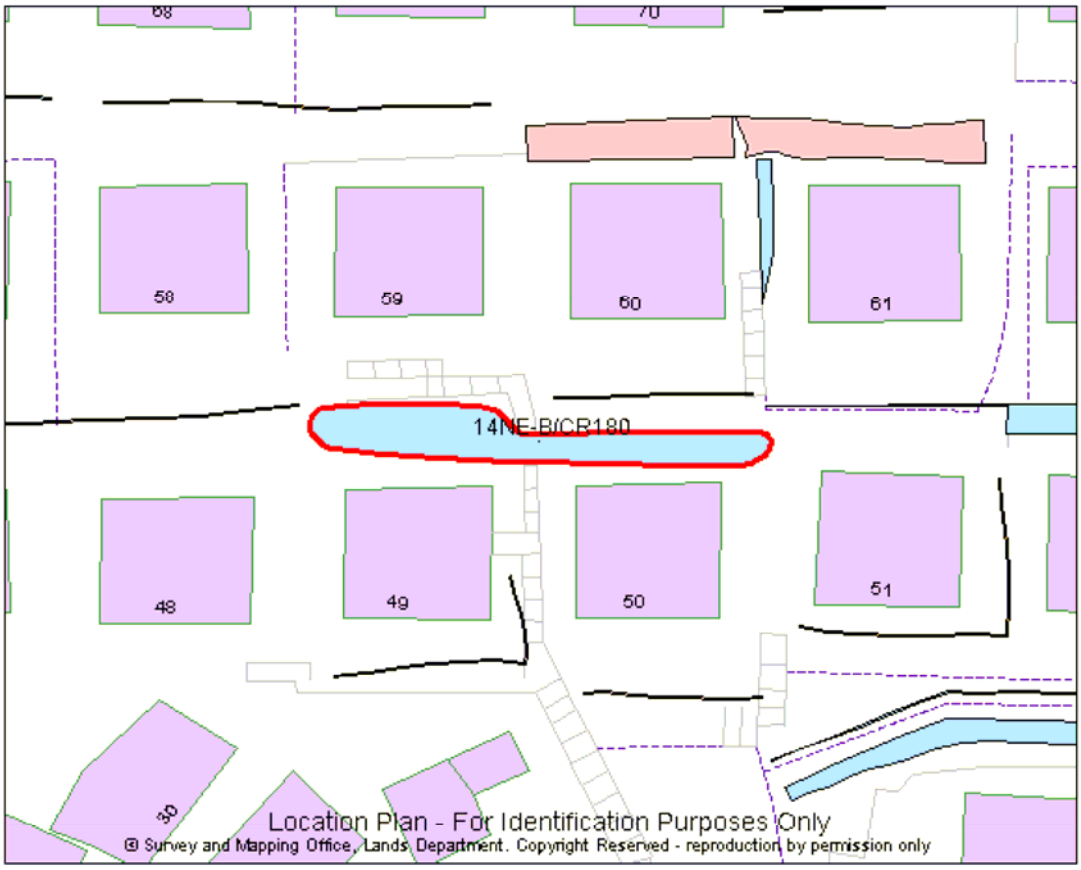
APPENDIX B

RECORDS OF SLOPE IN SMRIS (AS AT 18 APRIL 2007)

Slope Report

FOR IDENTIFICATION PURPOSES ONLY

Slope Location Plan



Legend

Responsible Slope / Part of Slope Boundary

Lot Boundary

Slope Maintenance Responsibility Category

Government

Private

Joint (Government and Private)

LANDS DEPARTMENT	Not To Scale
Office: SIMAR Unit, Estate Management Section	Date: 18/04/2007

Slope Number

14NE-B/CR180

IASMP01001 **SIMAR REGISTER** 18/04/2007 10:47 AM

Slope No.	Slope Sub-division No.	Location	Responsible Lot(s) / Party(s)	Maintenance Agent	Slope Plan*	Remarks
14NE-B/CR180		ON GOVERNMENT LAND NEAR DD3LM LOTS 1771, 1774, 1855 AND 1894	Lands D	Lands D	as per the attached	For enquiries about the maintenance of this slope / sub-division of the slope, please contact the Maintenance Agent direct.

- End of Report -

* Note: (i) The attached slope plan(s) are for the purpose of identification of the slope(s) only.
(ii) The slope(s) mentioned in the Register may not be shown in the attached slope plan(s).

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APPENDIX C

AERIAL PHOTOGRAPH INTERPRETATION

C.1 DETAILED OBSERVATIONS

The following comprise the detailed observations made from the aerial photographs studied (see Figure C1). A list of aerial photographs used in this study is given in Section C.2.

Year	Observations
1945	High altitude photographs of poor resolution. The present-day location of slope No. 14NE-B/CR180 is situated on undeveloped, south-southeasterly facing natural hillside. Agricultural terraces are visible at the toe of the hillside to the southeast. The hillside is bounded by a rounded west-southwest trending spur to the north and is generally covered with sparse vegetation including grasses and shrubs. No natural streamcourses are apparent in the local vicinity. The various development associated with Yung Shue Wan are not present.
1963	The local hillside in and around the present-day location of slope No. 14NE-B/CR180 appears to be disturbed, indicated by areas of high reflectivity, and two huts are apparent to the north and south. A footpath is visible along the spur to the north. Cut and fill platforms and two low-rise structures are evident on the hillside to the west. A low-rise building is evident to the southeast. A number of squatter huts are visible to the south of the platforms.
1964	Possible construction activities, indicated by areas of high reflectivity, appear to be in progress to the west of the present-day location of slope No. 14NE/B/CR180. No other major changes evident.
1973	The present-day residential buildings at Nos. 31 to 42 and 61 to 63 Po Wah Yuen have been constructed. Numerous building platforms involving cut and fill earthworks and the resultant formation of cut slopes and fill slopes have been formed as a result. The two huts visible to the north and south of the present-day location of slope No. 14NE-B/CR180 in the 1963 aerial photographs have been demolished. Yung Shue Wan Main Street has been constructed and generally conforms to the present-day alignment. A narrow path is visible to the north of Yung Shue Wan Main Street.
1974	The present-day residential building at No. 70 Po Wah Yuen is visible. The squatter area visible in the 1963 aerial photographs appears to be under re-development as Nos. 16 to 30 Po Wah Yuen.

Year	Observations
1974 cont'd	An area of high reflectivity, possibly site formation activities, is visible immediately to the north of the present-day location of slope No. 14NE-B/CR180.
1975	An area of high reflectivity, indicating disturbance, is evident immediately to the west of the present-day location of slope No. 14NE-B/CR180. The present-day residential building at No. 64 Po Wah Yuen is visible to the east of the present day slope No. 14NE-B/CR180. A footpath extending from the northern end of the access path to the residential building at No. 61 Po Wah Yuen towards the northeast is visible. Construction activities in and around the previous squatter area to the southwest of the present day slope No. 14NE-B/CR180 are in progress.
1976	The present-day residential buildings at Nos. 49, 52, 76 and 72 Po Wah Yuen are visible. The western portion of the slope No. 14NE-B/CR180 has been formed in association with the site formation works for No. 49 Po Wah Yuen. The slope surface appears to be covered with chunam. Construction activities in and around the previous squatter area to the southwest of the present-day location of slope No. 14NE-B/CR180 are in progress.
1978	The present-day residential buildings at Nos. 43, 47, 48, 50, 53, 59, 67, 69 and 73 Po Wah Yuen are visible. The eastern portion of the slope No. 14NE-B/CR180 has been formed in association with the site formation works for No. 50 Po Wah Yuen. The slope face appears to be covered with chunam. A stairway leading upslope to No. 59 Po Wah Yuen is visible between Nos. 49 and 50 Po Wah Yuen. The footpath along the ridgeline above slope No. 14NE-B/CR180 has been re-aligned. Construction activities in and around the previous squatter area to the southwest of the present-day location of slope No. 14NE-B/CR180 are in progress.
1979	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south.

Year	Observations
1979 cont'd	The present residential buildings at Nos. 51, 58 and 60, Po Wah Yuen have been constructed. Construction activities in and around the squatter area to the southwest of the present-day location of slope No. 14NE-B/CR180 have been completed. The residential buildings at Nos. 16 to 30 Po Wah Yuen have been constructed.
1980	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. The present-day residential buildings at Nos. 54, 55, 57, 68 and 71 Po Wah Yuen have been constructed. A small structure is visible on the platform to the south of the structure sited on No. 50 Po Wah Yuen.
1981	No stereopair. Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1982	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1984	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1985	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1986	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. The footpath above of the slope No. 14NE-B/CR180 has been re-paved and re-aligned to the current alignment.
1987	No stereopair. No major changes observed at slope No. 14NE-B/CR180 or the adjacent area.

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Year	Observations
1988	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1989	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1990	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1992	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1993	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. A number of small trees are visible growing on the western portion of slope No. 14NE-B/CR180. The building at No. 41 Po Wah Yuen has been demolished. The small structure observed in front of No.50 Po Wah Yuen in the 1980 aerial photographs has been removed.
1994	Slope No. 14NE-B/CR180 hidden by the shadow of Nos. 49 & 50 Po Wah Yuen to the south. No major changes observed in the general area.
1995	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. Vegetation growth on the western portion of slope No. 14NE-B/CR180 is heavier. The western portion of slope No. 14NE-B/CR180 has been partially masked by vegetation growing from the toe planter/slope face.
1996	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. Vegetation growth on the western portion of slope No. 14NE-B/CR180 is heavier. The western portion of slope No. 14NE-B/CR180 has been completely masked by vegetation growing from the toe planter/slope face.
1997	The vegetation on the western portion of slope No. 14NE-B/CR180 adjacent to the staircase has been cleared and the hard surface cover appears to have been replaced.

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Year	Observations
1998	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area.
1999	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area.
2000	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. A small tree is visible on the shotcreted western portion of slope No. 14NE-B/CR180.
2002	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. Vegetation on the western portion of slope No. 14NE-B/CR180 is heavier and completely masks the slope. The eastern portion of slope No. 14NE-B/CR180 is hidden by the shadow of No. 50 Po Wah Yuen.
2003	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. Vegetation on the western portion of slope No. 14NE-B/CR180 is heavier. The eastern portion of slope No. 14NE-B/CR180 is hidden by No. 50 Po Wah Yuen to the south.
2004	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. The western portion of slope No. 14NE-B/CR180 has been completely masked by vegetation growing from the toe planter/slope face.
2005	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. The western portion of slope No. 14NE-B/CR180 has been completely masked by vegetation growing from the toe planter/slope face. The eastern portion of slope No. 14NE-B/CR180 is hidden by the shadow of No. 50 Po Wah Yuen.
2006	No major changes observed at slope No. 14NE-B/CR180 or the adjacent area. The western portion of slope No. 14NE-B/CR180 has been completely masked by vegetation growing from the toe planter/slope face.

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C.2 LIST OF PHOTOGRAPHS

Date	Reference No.	Altitude
11/11/1945	Y290, Y291	20,000’
13/2/1963	Y6504, Y6505	3,900’
1964	Y12795, Y12796	12,500’
20/12/1973	8063, 8064	12,500’
21/11/1974	9658, 9659	12,500’
19/12/1975	11677, 11678	12,500’
4/11/1976	15867, 15868	12,500’
5/7/1978	22174, 22175	4,000’
25/1/1979	24630, 24631	12,500’
24/11/1980	33233, 33234	10,000’
26/10/1981	38942	10,000’
10/10/1982	44414, 44416	10,000’
22/11/1984	57318, 57319	5,000’
7/7/1985	A1656, A1657	10,000
20/9/1986	A6119, A6120	4,000’
5/1/1987	A8379	20,000’
16/1/1988	A12289, A12290	10,000’
20/11/1989	A19417, A19418	10,000’
4/12/1990	A24737, A24738	10,000’
11/11/1992	A33104, A33105	10,000’
2/11/1993	CN5167, CN5168	3,000’
24/10/1994	A39649, A39650	10,000’
19/7/1995	CN10086, CN10087	3,500’
23/10/1996	CN15444, CN15445	4,000’
23/6/1997	CN17540, CN17541	4,000’
23/10/1998	CN21014, CN21015	4,000’
8/2/1999	CN22749, CN22750	4,000’
9/8/2000	CN27604, CN27605	4,000’
25/10/2002	CW45696, CW45697	8,000’
27/11/2003	CW53862, CW53863	4,000’
2/12/2004	CW62457, CW62458	4,000’
15/12/2005	CW70098, CW70099	8,000’
10/2/2006	CW71439, CW71440	4,000’

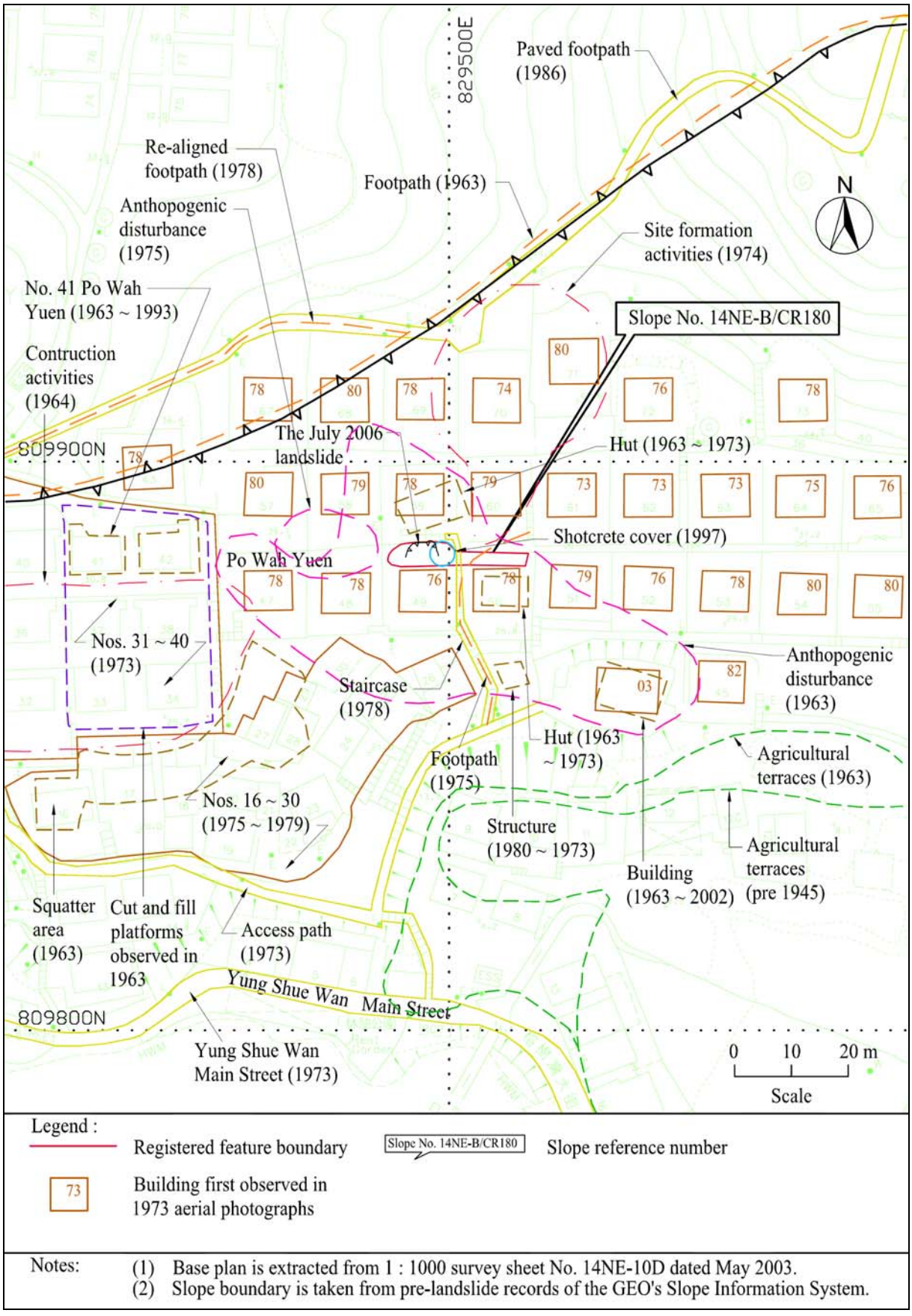

Figure C1 - Site Development History

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APPENDIX D

MEMO FROM GEO TO DLO/ISLANDS
DATED 31 DECEMBER 2003
(RECOMMENDATIONS FOR THE ISSUE OF WARNING LETTERS)

MEMO

From CGE/A To DLO/I thro' AD(G)/HKL

Ref. _____ in GCA 4/23/3-5 (Attn.: _____)

Tel no. 2762 5300 Your Ref. _____ in _____

Fax no. 2624 7589 dated _____ Fax No. _____

Date 31 DEC 2003 Total Pages _____

GEOTECHNICAL ENGINEERING OFFICE ADVISORY DIVISION
02 JAN 2004
DESPATCHED

Agreement No. CE 14/2002 (GE)
10-Year Extended LPM Project, Phase 3, Package H
Stability Studies of Private Slopes
Recommendation for a Warning Letter to the tenants of STTCX985
Feature No. 14NE-B/CR180 (Sub-division No. 2)
No. 50 Po Wah Yuen, Yung Shue Wan, Lamma Island

Our consultants for the above Agreement have carried out a Stage 2 Study on the above feature. The relevant SIMAR report indicates that the tenants of STTCX985 are responsible for the maintenance of Sub-division No. 2 of the feature.

2. The conclusion of the study is that the stability of Sub-division No. 2 of the feature is below the required safety standard and is liable to become dangerous. The Buildings Department has advised that they will not serve a DH Order to tenants of land under a Short Term Tenancy Agreement.

3. As Sub-division No. 2 of the feature has been identified as liable to become dangerous, I recommend that you instruct the tenants of STTCX985 to carry out the works listed in the enclosed warning letter in order to remove the potential danger to the occupants of the land under Short Term Tenancy and the general public at large. I understand that the BD may offer assistance to process the technical submissions from the tenants' consultants and exercise administrative control of the slope works under the Buildings Ordinance.

4. A copy of the Stage 2 Report No. S2R88/2003 for the feature is attached.

5. Please inform us if the Short Term Tenancy Agreement concerned is terminated by the tenants so that we can arrange the necessary follow-up action to deal with the sub-standard Sub-division No. 2 of the feature.

6. I will be writing to you on a quarterly basis in order to monitor the status of this case. I would be grateful if you would ensure that your staff keep this matter in view so that they can respond promptly to our enquiries.

(K C Lam)
Ag. Chief Geotechnical Engineer/Advisory
Geotechnical Engineering Office
Civil Engineering Department

c.c. CGE/MW – w/ draft warning letter and S2R88/2003
CGE/SS)
CGE/LI) w/draft warning letter only
CGE/SM, LandsD)
CBS/SS, BD)
TS/GEO – w/o
STO(G)/A2 – please sent S2R to GIU & slope file

Warning Letter

Feature No. 14NE-B/CR180 (Sub-division No. 2)
STTCX985, No. 50 Po Wah Yuen, Yung Shue Wan, Lamma Island

The Geotechnical Engineering Office of the Civil Engineering Department has recommended issue of the following warning letter to the party responsible for the maintenance of Feature No. 14NE-B/CR180 (Sub-division No. 2).

2. The concern is Feature No. 14NE-B/CR180 (Sub-division No. 2) within Short Term Tenancy Area STTCX985, which is liable to become so dangerous that it will collapse or be likely to collapse, either totally or partially, and thereby cause risk of injury to persons or damage to property. Sub-division No. 2 of the feature of concern is indicated (coloured pink) on the attached plan. Pursuant to Paragraph ..... of the Tenancy Agreement, you are responsible for the maintenance of Sub-division No. 2 of the feature.

3. To correct the dangerous situation, you are required to carry out the following works:

Stage 1

(i) Investigate, analyse, report on the above feature, and submit remedial/preventive works proposals for approval by the District Lands Office/Islands based on the findings of the investigation within 7 months of the date of this letter.

Stage 2

(ii) Upon the approval from the District Lands Office/Islands of any necessary design for remedial/preventive works, you are required to carry out such approved works, such that works are commenced within 2 months of the date of the approval and are completed within 6 months of the date of the approval.

4. You are required to appoint within 2 months of the date of this letter a suitably qualified geotechnical engineer (GE) (a suitable qualification being Registered Professional Engineer (Geotechnical)) with adequate experience in slope remedial/preventive works to provide a geotechnical consultancy service for the work required stated in Item 3(i) above. The appointment of the GE must include responsibility for monitoring stability until completion of the remedial/preventive works and for giving warning of impending danger. An Authorised Person (AP) should also be appointed as the coordinator of the work required by this letter if the GE is not an AP.

5. The recommended standard of good practice for maintenance of man-made slopes and retaining walls is given in the "Guide to Slope Maintenance" (Geoguide 5) published by the Geotechnical Engineering Office. If you have already been following the requirements of Geoguide 5 you may be in possession of certain geotechnical information that may be useful to demonstrate compliance with the requirements of this warning letter. If this is the case, you should inform this Office accordingly.

6. Relevant Preliminary (Stage 1) and Detailed (Stage 2) Study Reports on the subject feature are available for viewing and copying at the Civil Engineering Library located in basement LG1 of the Civil Engineering Building at No. 101 Princess Margaret Road, Kowloon, Hong Kong. These reports will provide further background on the safety concerns regarding the subject feature.

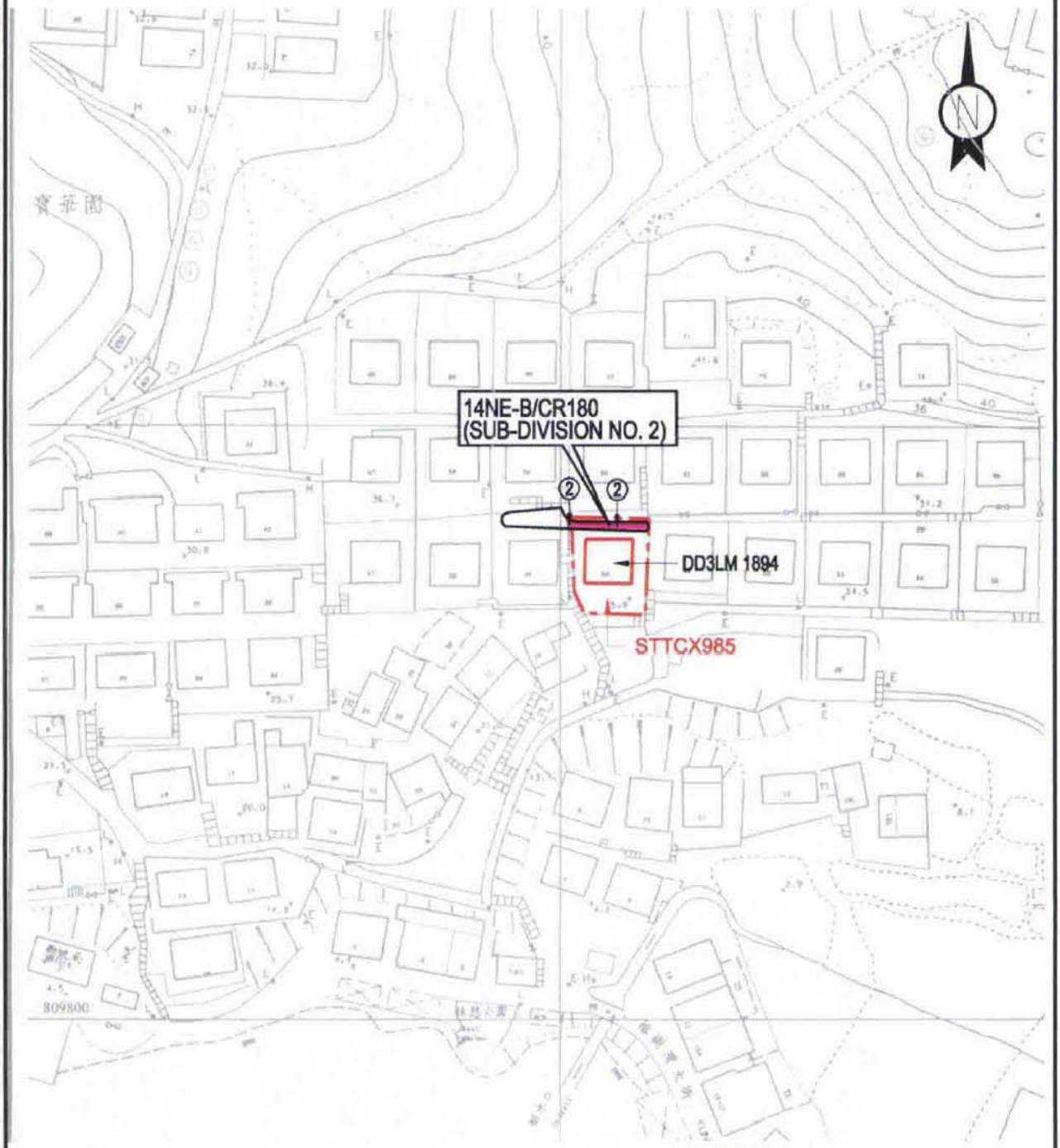
7. Should you have any queries or need further advice, please contact the undersigned by telephone or in writing. With regard to specific enquiries on geotechnical matters, please contact the Chief Geotechnical Engineer/Advisory at telephone No. 2762 5300. Your local District Officer may also provide advice or assistance.

( )
for District Lands Officer/Islands

c.c. CBS/SS, BD
CGE/A, GEO
CGE/MW, GEO
CGE/SM, LandsD

OCATION : No. 50 Po Wah Yuen, Yung Shue Wan, Lamma Island | STTCX 985

FEATURE NO. 14NE-B/CR180 (Sub-division No. 2)



LOCATION PLAN

Civil Engineering Department
Geotechnical Engineering Office

Survey sheet reference no. 14NE-10D

Agreement No. CE14/2002 (GE)
10-Year Extended LPM Project
Phase 3, Package H
Stability Studies of Private Slopes
in Hong Kong Island, Kowloon
and Outlying Islands - Investigation

Drawn	YYT	Checked	CYC
Scale	1:1000	Date	SEP 03
Drg. No.	-	Figure No.	-

C M WONG & ASSOCIATES LTD

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MEMO

From CGE/A To DLO/I thro' AD(G)/HKI

Ref. _____ in GCA 4/23/3-5 (Attn.)

Tel no. 2762 5300 Your Ref. _____ in _____

Fax no. 2624 7589 Dated _____ Fax No. _____

Date _____ Total Pages _____

GEOTECHNICAL ENGINEERING OFFICE
ADVISORY DIVISION
02 JAN 2004
DESPATCHED

Agreement No. CE 14/2002 (GE)
10-Year Extended LPM Project, Phase 3, Package H
Stability Studies of Private Slopes
Recommendation for a Warning Letter to the tenants of STTCX468
Featuer Nos. 14NE-B/R7 and 14NE-B/CR180 (Sub-division No. 1)
No. 49 Po Wah Yuen, Yung Shue Wan, Lamma Island

Our consultants for the above Agreement have carried out a Stage 2 Study on the above features. The relevant SIMAR reports indicate that the tenants of STTCX468 are responsible for the maintenance of these features.

2. The conclusion of the study is that the stability of these features is below the required safety standard and is liable to become dangerous. The Buildings Department has advised that they will not serve a DH Order to tenants of land under a Short Term Tenancy Agreement.

3. As these features have been identified as liable to become dangerous, I recommend that you instruct the tenants of STTCX468 to carry out the works listed in the enclosed warning letter in order to remove the potential danger to the occupants of the land under STT and the general public at large. I understand that the BD may offer assistance to process the technical submissions from the tenants' consultants and exercise administrative control of the slope works under the Buildings Ordinance.

4. A copy of the Stage 2 Report No. S2R88/2003 for these features is attached.

5. Please inform us if the STT concerned is terminated by the tenants so that we can arrange the necessary follow-up action to deal with the sub-standard features.

6. I will be writing to you on a quarterly basis in order to monitor the status of this case. I would be grateful if you would ensure that your staff keep this matter in view so that they can respond promptly to our enquiries.

(K C Lam)
Ag. Chief Geotechnical Engineer/Advisory
Geotechnical Engineering Office
Civil Engineering Department

c.c. CGE/MW – w/ draft warning letter and S2R88/2003
CGE/SS)
CGE/LI) w/draft warning letter only
CGE/SM, LandsD)
CBS/SS, BD)
TS/GEO – w/o
STO(G)/A2 – please sent S2R to GIU & slope file

Warning Letter

Feature Nos. 14NE-B/R7 and 14NE-B/CR180 (Sub-division No. 1)
STTCX 468, No. 49 Po Wah Yuen, Yung Shue Wan, Lamma Island

The Geotechnical Engineering Office of the Civil Engineering Department has recommended issue of the following warning letter to the party responsible for the maintenance of Feature Nos. 14NE-B/R7 and 14NE-B/CR180 (Sub-division No. 1).

2. The concern is Feature Nos. 14NE-B/R7 and 14NE-B/CR180 (Sub-division No. 1) within Short Term Tenancy Area STTCX468, which are liable to become so dangerous that they will collapse or be likely to collapse, either totally or partially, and thereby cause risk of injury to persons or damage to property. The features of concern are indicated (coloured pink) on the attached plan. Pursuant to Paragraph ..... of the Tenancy Agreement, you are responsible for the maintenance of these features.

3. To correct the dangerous situation, you are required to carry out the following works:

Stage 1

(i) Investigate, analyse, report on the above features, and submit remedial/preventive works proposals for approval by the District Lands Office/Islands based on the findings of the investigation within 7 months of the date of this letter.

Stage 2

(ii) Upon the approval from the District Lands Office/Islands of any necessary design for remedial/preventive works, you are required to carry out such approved works, such that works are commenced within 2 months of the date of the approval and are completed within 6 months of the date of the approval.

4. You are required to appoint within 2 months of the date of this letter a suitably qualified geotechnical engineer (GE) (a suitable qualification being Registered Professional Engineer (Geotechnical)) with adequate experience in slope remedial/preventive works to provide a geotechnical consultancy service for the work required stated in Item 3(i) above. The appointment of the GE must include responsibility for monitoring stability until completion of the remedial/preventive works and for giving warning of impending danger. An Authorised Person (AP) should also be appointed as the coordinator of the work required by this letter if the GE is not an AP.

5. The recommended standard of good practice for maintenance of man-made slopes and retaining walls is given in the "Guide to Slope Maintenance" (Geoguide 5) published by the Geotechnical Engineering Office. If you have already been following the requirements of Geoguide 5 you may be in possession of certain geotechnical information that may be useful to demonstrate compliance with the requirements of this warning letter. If this is the case, you should inform this Office accordingly.

6. Relevant Preliminary (Stage 1) and Detailed (Stage 2) Study Reports on the subject features are available for viewing and copying at the Civil Engineering Library located in basement LG1 of the Civil Engineering Building at No. 101 Princess Margaret Road, Kowloon, Hong Kong. These reports will provide further background on the safety concerns regarding the subject features.

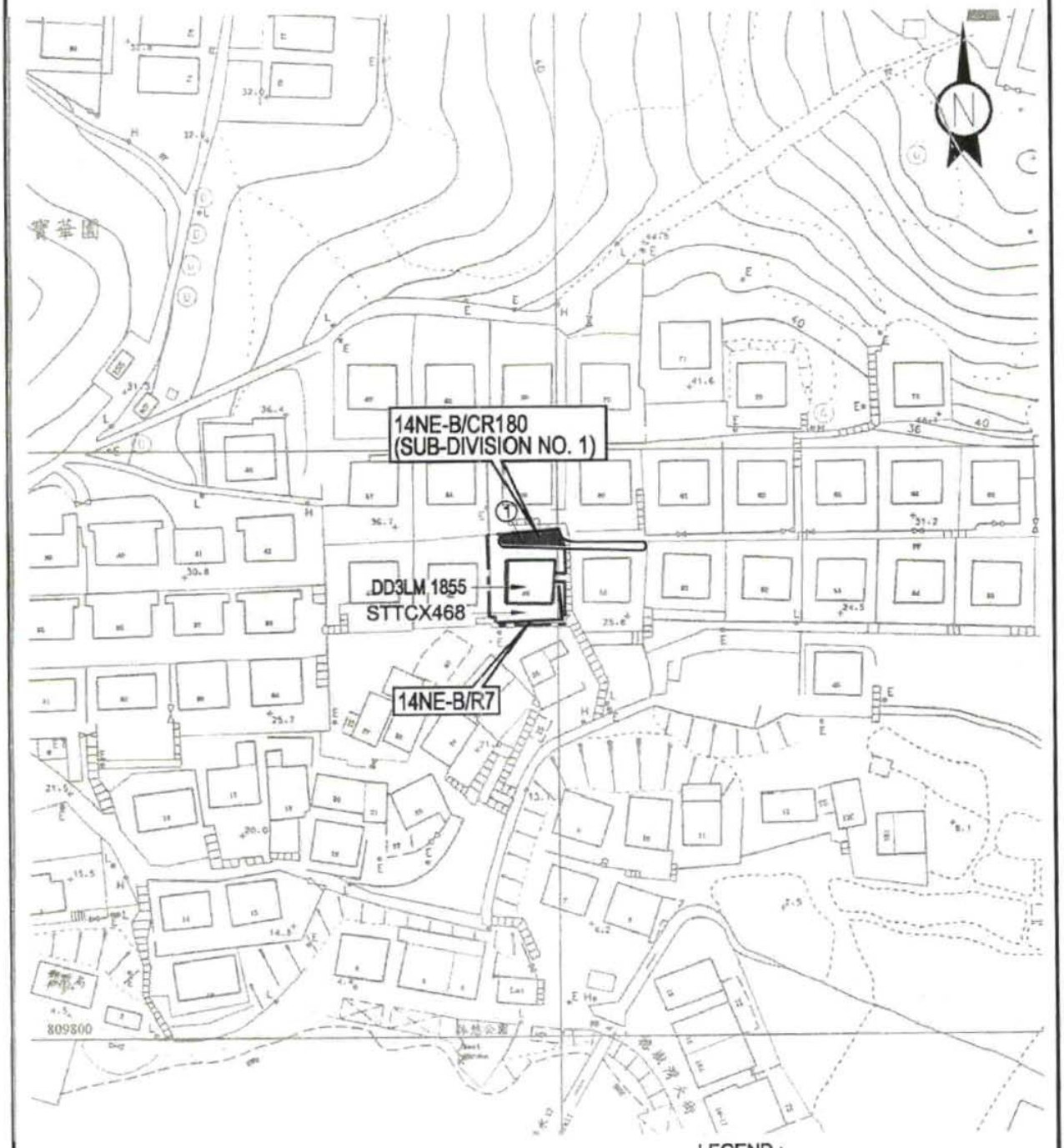
7. Should you have any queries or need further advice, please contact the undersigned by telephone or in writing. With regard to specific enquiries on geotechnical matters, please contact the Chief Geotechnical Engineer/Advisory at telephone No. 2762 5300. Your local District Officer may also provide advice or assistance.

( )
for District Lands Officer/Islands

c.c. CBS/SS, BD
CGE/A, GEO
CGE/MW, GEO
CGE/SM, LandsD

LOCATION : No. 49 Po Wah Yuen, Yung Shue Wan, Lamma Island | STTCX 468

FEATURE NOS. 14NE-B/R7 & 14NE-B/CR180 (Sub-division No. 1)



LOCATION PLAN

Civil Engineering Department Geotechnical Engineering Office	Agreement No. CE14/2002 (GE) 10-Year Extended LPM Project Phase 3, Package H Stability Studies of Private Slopes in Hong Kong Island, Kowloon and Outlying Islands - Investigation	Drawn YYT	Checked CYC
		Scale 1:1000	Date SEP 03
		Drg. No. -	Figure No. -
Survey sheet reference no. 14NE-10D		C M WONG & ASSOCIATES LTD	

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GEO PUBLICATIONS AND ORDERING INFORMATION
土力工程處刊物及訂購資料

A selected list of major GEO publications is given in the next page. An up-to-date full list of GEO publications can be found at the CEDD Website http://www.cedd.gov.hk on the Internet under "Publications". Abstracts for the documents can also be found at the same website. Technical Guidance Notes are published on the CEDD Website from time to time to provide updates to GEO publications prior to their next revision.

部份土力工程處的主要刊物目錄刊載於下頁。而詳盡及最新的土力工程處刊物目錄，則登載於土木工程拓展署的互聯網網頁 http://www.cedd.gov.hk 的"刊物"版面之內。刊物的摘要及更新刊物內容的工程技術指引，亦可在這個網址找到。

Copies of GEO publications (except maps and other publications which are free of charge) can be purchased either by:

writing to
Publications Sales Section,
Information Services Department,
Room 402, 4th Floor, Murray Building,
Garden Road, Central, Hong Kong.
Fax: (852) 2598 7482

or
- Calling the Publications Sales Section of Information Services Department (ISD) at (852) 2537 1910
- Visiting the online Government Bookstore at http:// www.bookstore.gov.hk
- Downloading the order form from the ISD website at http://www.isd.gov.hk and submit the order online or by fax to (852) 2523 7195
- Placing order with ISD by e-mail at puborder@isd.gov.hk

讀者可採用以下方法購買土力工程處刊物(地質圖及免費刊物除外):

書面訂購
香港中環花園道
美利大廈4樓402室
政府新聞處
刊物銷售組
傳真: (852) 2598 7482

或
- 致電政府新聞處刊物銷售小組訂購 (電話：(852) 2537 1910)
- 進入網上「政府書店」選購，網址爲 http://www.bookstore.gov.hk
- 透過政府新聞處的網站 (http://www.isd.gov.hk) 於網上遞交訂購表格，或將表格傳真至刊物銷售小組 (傳真：(852) 2523 7195)
- 以電郵方式訂購 (電郵地址：puborder@isd.gov.hk)

1:100 000, 1:20 000 and 1:5 000 maps can be purchased from:

Map Publications Centre/HK,
Survey & Mapping Office, Lands Department,
23th Floor, North Point Government Offices,
333 Java Road, North Point, Hong Kong.
Tel: 2231 3187
Fax: (852) 2116 0774

讀者可於下列地點購買1:100 000，1:20 000及1:5 000地質圖：

香港北角渣華道333號
北角政府合署23樓
地政總署測繪處
電話: 2231 3187
傳真: (852) 2116 0774

Requests for copies of Geological Survey Sheet Reports, publications and maps which are free of charge should be sent to:

For Geological Survey Sheet Reports and maps which are free of charge:
Chief Geotechnical Engineer/Planning,
(Attn: Hong Kong Geological Survey Section)
Geotechnical Engineering Office,
Civil Engineering and Development Department,
Civil Engineering and Development Building,
101 Princess Margaret Road,
Homantin, Kowloon, Hong Kong.
Tel: (852) 2762 5380
Fax: (852) 2714 0247
E-mail: jsewell@cedd.gov.hk

For other publications which are free of charge:
Chief Geotechnical Engineer/Standards and Testing,
Geotechnical Engineering Office,
Civil Engineering and Development Department,
Civil Engineering and Development Building,
101 Princess Margaret Road,
Homantin, Kowloon, Hong Kong.
Tel: (852) 2762 5346
Fax: (852) 2714 0275
E-mail: wmcheung@cedd.gov.hk

如欲索取地質調查報告、其他免費刊物及地質圖，請致函：

地質調查報告及地質圖:
香港九龍何文田公主道101號
土木工程拓展署大樓
土木工程拓展署
土力工程處
規劃部總土力工程師
(請交:香港地質調查組)
電話: (852) 2762 5380
傳真: (852) 2714 0247
電子郵件: jsewell@cedd.gov.hk

其他免費刊物:
香港九龍何文田公主道101號
土木工程拓展署大樓
土木工程拓展署
土力工程處
標準及測試部總土力工程師
電話: (852) 2762 5346
傳真: (852) 2714 0275
電子郵件: wmcheung@cedd.gov.hk

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MAJOR GEOTECHNICAL ENGINEERING OFFICE PUBLICATIONS
土力工程處之主要刊物

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GEOTECHNICAL MANUALS

Geotechnical Manual for Slopes, 2nd Edition (1984), 300 p. (English Version), (Reprinted, 2000).

斜坡岩土工程手冊(1998)，308頁(1984年英文版的中文譯本)。

Highway Slope Manual (2000), 114 p.

GEOGUIDES

Geoguide 1	Guide to Retaining Wall Design, 2nd Edition (1993), 258 p. (Reprinted, 2007).
Geoguide 2	Guide to Site Investigation (1987), 359 p. (Reprinted, 2000).
Geoguide 3	Guide to Rock and Soil Descriptions (1988), 186 p. (Reprinted, 2000).
Geoguide 4	Guide to Cavern Engineering (1992), 148 p. (Reprinted, 1998).
Geoguide 5	Guide to Slope Maintenance, 3rd Edition (2003), 132 p. (English Version).
岩土指南第五冊	斜坡維修指南，第三版(2003)，120頁(中文版)。
Geoguide 6	Guide to Reinforced Fill Structure and Slope Design (2002), 236 p.
Geoguide 7	Guide to Soil Nail Design and Construction (2008), 97 p.

GEOSPECS

Geospec 1	Model Specification for Prestressed Ground Anchors, 2nd Edition (1989), 164 p. (Reprinted, 1997).
Geospec 3	Model Specification for Soil Testing (2001), 340 p.

GEO PUBLICATIONS

GCO Publication No. 1/90	Review of Design Methods for Excavations (1990), 187 p. (Reprinted, 2002).
GEO Publication No. 1/93	Review of Granular and Geotextile Filters (1993), 141 p.
GEO Publication No. 1/2000	Technical Guidelines on Landscape Treatment and Bio-engineering for Man-made Slopes and Retaining Walls (2000), 146 p.
GEO Publication No. 1/2006	Foundation Design and Construction (2006), 376 p.
GEO Publication No. 1/2007	Engineering Geological Practice in Hong Kong (2007), 278 p.

GEOLOGICAL PUBLICATIONS

The Quaternary Geology of Hong Kong, by J.A. Fyfe, R. Shaw, S.D.G. Campbell, K.W. Lai & P.A. Kirk (2000), 210 p. plus 6 maps.

The Pre-Quaternary Geology of Hong Kong, by R.J. Sewell, S.D.G. Campbell, C.J.N. Fletcher, K.W. Lai & P.A. Kirk (2000), 181 p. plus 4 maps.

TECHNICAL GUIDANCE NOTES

TGN 1	Technical Guidance Documents