HONG KONG RAINFALL AND LANDSLIDES IN 1998

GEO REPORT No. 105

T.W.K. Lam

GEOTECHNICAL ENGINEERING OFFICE

CIVIL ENGINEERING DEPARTMENT

THE GOVERNMENT OF THE HONG KONG SPECIAL ADMINISTRATIVE REGION

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PREFACE

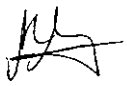
In keeping with our policy of releasing information which may be of general interest to the geotechnical profession and the public, we make available selected internal reports in a series of publications termed the GEO Report series. A charge is made to cover the cost of printing.

The Geotechnical Engineering Office also publishes guidance documents as GEO Publications. These publications and the GEO Reports may be obtained from the Government's Information Services Department. Information on how to purchase these documents is given on the last page of this report.

R.K.S. Chan
Head, Geotechnical Engineering Office
November 2000

FOREWORD

This Report presents a review of rainfall and landslides in Hong Kong throughout 1998. Geotechnical engineers of the District Divisions of the Geotechnical Engineering Office (GEO) provided details of most of the landslides. Supplementary landslide data were provided by the GEO's 1998 Landslide Investigation Consultants, the Agriculture and Fisheries Department, Architectural Services Department, Drainage Services Department, Fire Services Department, Highways Department, Housing Department and Water Supplies Department. The Hong Kong Observatory provided rainfall information. All contributions are gratefully acknowledged.



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ABSTRACT

This Report presents a review of rainfall and landslides in Hong Kong throughout 1998. Rainfall information has been obtained from the Geotechnical Engineering Office (GEO) automatic raingauge system and from the Hong Kong Observatory (HKO). Most of the landslide data have been taken from the records of incidents reported to the GEO in 1998. Supplementary data have been obtained from the GEO's 1998 Landslide Investigation Consultants and other Government Departments.

Rainfall at the HKO in 1998 amounted to 2565 millimetres, 16% above normal. The black rainstorm signal was issued once on 9 June when a daily rainfall of 411 millimetres was recorded.

One Landslip Warning was issued in 1998, during the rainstorm of 9 June. A total of 228 incidents was reported to the District Divisions of the GEO, 216 of which were classified as genuine landslides, and 24 of which were major (events with a volume of collapsed or distressed mass of 50 m^3 or more, or where a fatality has occurred). No fatalities or injuries were reported. The consequences resulting from the landslides included the temporary evacuation of 22 squatter huts, 6 houses and 10 flats, and the permanent evacuation of 11 squatter huts. Sixty-eight landslides resulted in the blockage of sections of road, pedestrian pavement or access.

CONTENTS

1. INTRODUCTION

This Report presents factual data on rainfall and landslide occurrence in 1998. Rainfall information has been obtained from the Geotechnical Engineering Office (GEO) and the Hong Kong Observatory (HKO). Most of the landslide data have been taken from the records of incidents reported to the District Divisions of the GEO. Supplementary data have been obtained from the GEO's 1998 Landslide Investigation Consultants and other Government Departments.

In this Report, a landslide is defined as the detachment or excessive lateral displacement of a soil or rock mass, and includes the failure of fill slopes, cut slopes, natural slopes, retaining walls and rock or boulder falls. A 'major' landslide is defined as a failure in which the estimated/recorded volume of the collapsed or distressed mass is 50 m^3 or more, or where a fatality has occurred. The arrangement of this Report is similar to previous annual rainfall and landslide reports (Chen, 1993; Chan, 1994 & 1995; Evans, 1992; Lam, 1999; Premchitt, 1991a-1991e; Siu, 1991; Tang, 1992; Wong, 1996 & 1997). This Report reviews rainfall and landslides throughout the year rather than emphasising any one specific rainstorm.

2. RAINFALL

2.1 The Raingauge System

In the rugged terrain of Hong Kong, the distribution and intensity of rainfall during a storm can vary dramatically with respect to both geography and time. To provide sufficient coverage for a meaningful analysis of rainfall distribution, the HKO has installed a network of raingauges which, in 1998, comprised 24 automatic and 51 manual raingauges at 68 locations. Three automatic raingauges have also been installed by the Drainage Services Department (DSD). The 'principal' raingauge is located at the HKO's headquarters in Tsim Sha Tsui, and a continuous rainfall record has been kept at this location since 1884.

Since 1978 the GEO, in cooperation with the HKO, has also established an automatic raingauge system (comprising 48 raingauges in 1998) which transmits real-time rainfall data via telephone lines to the GEO and the HKO at five-minute intervals. The locations of the GEO automatic raingauges were selected to supplement the network of other types of raingauges and to provide specific information in areas of particular geotechnical interest. The locations of all GEO, HKO and DSD raingauges are shown in Figure 1.

In this Report, the 'maximum 24-hour' rainfall refers to the maximum rolling 24-hour rainfall (calculated from rolling rainfall amounts using one clock-hour data) and the 'daily' rainfall refers to the 24-clock-hour rainfall (midnight to midnight). The 'daily' rainfall is based on an arbitrary fixed period and does not necessarily represent the maximum rainfall. When rainfall is quoted without reference to the location of measurement, it can be assumed to be from the HKO headquarters in Tsim Sha Tsui.

2.2 Hong Kong Observatory Records

The weather for 1998 was described in the Monthly Weather Summary for July 1998

(HKO, 1998a), August 1998 (HKO, 1998b) and December 1998 (HKO, 1999). The comments on rainfall are as follows:

> "The annual total rainfall recorded at the Observatory was 2564.6 millimetres, 16 per cent above normal. The Black Rainstorm Signal was issued once on 9 June when a record daily rainfall for June of 411.3 millimetres was received".
>
> "The rainfall recorded in May totalled 335.2 millimetres, six per cent above normal. However the accumulated rainfall since January amounted to 830.2 millimetres which was 35 per cent above the normal for this five-month period".
>
> "Over twice the average rainfall was recorded in June making it the fifth wettest June on record. 411.3 millimetres of rain fell on 9 June, the highest for any day in June (and necessitated the issuance of the Black rainstorm warning signal for the first time in the year). On that day, various rainstorm warnings were continuously in force for more than 18 hours. Over 400 millimetres of rainfall were recorded in most parts of Kowloon and over 500 millimetres in Sai Kung".
>
> "The total rainfall of 267.2 millimetres in July was 56.3 millimetres below the normal figure, but the cumulative rainfall since 1 January, 1911.9 millimetres, was still 45 per cent more than the normal for the same period".
>
> "The total rainfall of 245.4 millimetres in August was 146 millimetres below normal. However the cumulative rainfall since 1 January, 2157.3 millimetres, was still 26 per cent more than the normal for the same period".

Some rainfall maxima for the heaviest rainstorms in 1998 are shown in Table 1, together with some data on the resulting consequences, and these are compared with similar data for selected previous major rainstorms.

The cumulative rainfall for 1998 recorded at the HKO is shown in Figure 2. The daily rainfall at the HKO and the daily 24-hour maximum rainfall recorded at GEO raingauge stations in the whole of Hong Kong in 1998 are shown in Figures 3a and 3b, and the numbers of landslides reported to the GEO in Figure 3c. Figure 4 shows the monthly rainfall in 1998 in comparison with recorded maximum and mean monthly rainfalls.

Figure 5 shows the hourly rainfall intensities for the heaviest maximum 24-hour rainstorms recorded at the HKO in 1998. In 1998, the most intense maximum 24-hour rainfall over the whole of Hong Kong was recorded at raingauge station N15 at Sai Kung on 8 and 9 June (see Figure 5).

2.3 Geotechnical Engineering Office Records

The maximum 24-hour, maximum five-hour rainfalls (rolling rainfall amounts using one clock hour rainfall as the basic unit) and maximum one-hour rainfall (rolling rainfall amounts using five-minute rainfall as the basic unit) recorded by the GEO raingauges during the 12 heaviest rainstorms in 1998 are given in Table 1.

2.4 Rainfall Distribution

Rainfall distribution with time and location can be assessed by referring to the detailed GEO and HKO records. Figure 6 shows the total annual rainfall distribution. Isohyets of 24-hour rainfall for the heaviest rainfall recorded at the HKO are shown in Figure 7, with the 24-hour period determined with reference to rainfall records at the HKO (an approach consistent with previous reports). Figure 7 also shows the locations of landslide incidents.

2.5 Warnings Issued by the Hong Kong Observatory

Relevant warnings issued by the HKO and Landslip Warnings jointly issued by the GEO and the HKO in 1998 are summarised in Table 2. Only one Landslip Warning was issued in 1998.

2.6 Comparison with Past Rainstorms and Estimated Return Periods

The cumulative rainfall for 1998 is shown in Figure 2 in comparison with the wettest year (1997) and the driest year (1963) since records began in 1884, and the mean rainfall from 1961 to 1990. The 1998 total annual rainfall at the HKO was 2564.6 mm, which is 16 percent above normal. Figure 4 shows monthly rainfall in 1998 compared with the recorded maximum (since 1884) and mean (1961-1990) monthly rainfalls.

The return periods of the nine heaviest rainfall events recorded at the HKO in 1998 were estimated for rainfall durations of one hour to fifteen days (Table 3). The estimated return periods were assessed based on 100 years (1884-1939 and 1947-1990) of historical rainfall data at the HKO (Lam & Leung, 1994), and range from four to thirty one years. However, the most intense rainfall in 1998 was recorded at raingauge station N15 in Sai Kung, New Territories. Using available site specific rainfall data (1984 to 1997 inclusive) from raingauge station N15, Table 3 also shows the estimated return period for rainfall durations from one hour to fifteen days at this location range from about three to two hundred and eleven years based on Gumbel's method (Lam & Leung, 1994).

3. LANDSLIDES

3.1 Landslide Occurrence in 1998

The numbers of incidents reported to various Government departments in 1998 are summarized in Table 4.

A total of 228 incidents was reported to the District Divisions of the GEO, and details of these are summarized in Appendix A. In total, 216 incidents were classified as genuine landslides, 24 (11%) of which were major (summarized in Table A1). The remaining reported incidents were either not landslides or incidents that were of no geotechnical concern, such as fallen trees, and were therefore not considered in the statistical analysis described below. The locations of all the reported incidents are shown in Drawing No. GCSP 8/20, which is attached to this Report. Selected incidents are illustrated in Plates 1 to 10. Further details of these failures can be found in the incident files of the District Divisions of the GEO and in detailed landslide studies conducted by GEO's 1998 Landslide Investigation Consultants.

Wherever possible, the dates and times of the landslides were assessed by geotechnical engineers. Some incidents were not reported to the GEO until several days or weeks after they had occurred. For these, it was difficult to determine the exact time of occurrence. Out of the 216 reported landslide incidents, the time of occurrence was determined to within one day for 180. Of these 180 incidents, the time of occurrence was determined to within one hour for 59. The numbers of landslide incidents that occurred when the Landslip Warning was raised are shown in Table 5.

Based on GEO's landslide inspection reports, 26 landslides were considered by the inspecting geotechnical engineer to be associated with poor slope maintenance. This amounted to about 12% of all the reported genuine landslides.

It should be noted that there were almost certainly other landslides which were not reported to GEO, many of which will have occurred in remote areas with no immediate consequences.

3.2 Facilities Affected by Landslides

3.2.1 General

The numbers of landslides affecting various types of facility (building lot, road, etc.) in Hong Kong, Kowloon and the New Territories are shown in Table 6. The numbers of major failures affecting different types of facility are also given in Table 6. It should be noted that a failure may affect more than one type of facility. Landslide consequences, classified according to failure type, are shown in Table 7.

3.2.2 Squatter Areas

A total of 21 landslides affected squatter areas and two of these were major (Table 6). These landslides led to the permanent evacuation of 11 squatter huts and the temporary evacuation of 22 squatter huts (Table 7). One major landslide incident ME 98/6/36 is described in Section 4.

3.2.3 Building Lots

Twenty-five landslides affected building lots and private properties, and six of these

were major (Table 6). These landslides resulted in the partial or total temporary evacuation of 6 houses and 10 flats (Table 7). Landslide incidents ME 98/5/10, ME 98/6/22, ME 98/6/55 and MW 98/2/1 are described in Section 4.

3.2.4 Roads and Access

One hundred and twenty landslides affected sections of road, access, footpath and pedestrian pavement. Seventeen of these were major (Table 6). Sixty-eight landslides resulted in the blockage or closure of sections of road, pedestrian pavement and/or access (Table 7). Landslide incidents ME 98/6/10, MW 98/2/1, MW 98/6/9, MW 98/6/11 and MW 98/6/12 are described in Section 4.

3.2.5 Construction Sites

Three landslides affected construction sites. None of these were major (Table 6).

3.2.6 Carparks, Playgrounds, Gardens and Yards

Twelve landslides affected carparks, playgrounds, gardens and yards. One of these was major (Table 6).

3.2.7 Catchwaters and Reservoirs

Landslides affecting catchwaters and reservoirs were usually dealt with separately by the Water Supplies Department and were not reported to the GEO. A total of 27 incidents were reported to the WSD, of which 18 were landslides, 5 of which affected catchwaters. Three landslides in this category were reported to the GEO and landslide incident K 98/6/13 is described in Section 4.

3.2.8 Other Areas

Other areas affected by landslides include country and urban parks, open areas and hillsides. A total of three areas within the country and urban parks were reported to have been affected by landslides, one of which was major. Fifty-two reported landslides affected open areas and hillsides, and three of these were major.

3.3 Types of Failures

3.3.1 General

Landslides reported to the GEO have been classified into six types of failure, i.e. fill slopes, cut slopes, natural slopes, retaining walls, rock/boulder falls and others. The numbers of different types of landslide are shown in Table 8.

3.3.2 Fill Slopes

There were 11 fill slope failures, forming 5.1% of all landslides reported. Three of these failures were major. Landslide incidents ME 98/6/10 and MW 98/5/2 are described in Section 4.

3.3.3 Cut Slopes

There were 105 cut slope failures, forming 48.7% of all landslides reported. These were classified further according to types of material involved, i.e. soil, soil/rock and rock.

There were 85 reported incidents for soil cut slopes, eight of which were major. Landslide incidents K 98/6/13, ME 98/6/36, MW 98/2/1 and MW 98/6/11 are described in Section 4. There were 20 soil/rock cut slope failures, two of which were major. Landslide incident MW 98/6/9 is described in Section 4. No rock cut slope failures were reported.

3.3.4 Retaining Walls

There were 16 reported failures of retaining walls, forming 7.4% of all landslides reported. None of these incidents were major.

3.3.5 Natural Slopes

There were 26 natural slope failures reported, forming 12.0% of all landslides. Nine of these failures were major. Landslide incidents ME 98/5/10, ME 98/6/22 and ME 98/6/55 are described in Section 4.

3.3.6 Rock and Boulder Falls

Sixteen rock and boulder falls were reported, forming 7.4% of all landslides. None of these incidents were major.

3.4 Landslide Volume Distribution

Tables 9 and 10 show the distribution of landslide volume for all landslide incidents which were reported to the GEO. The approximate volume of failure was recorded for 214 out of 216 reported landslides. Of the landslides for which the volume was recorded, 103 landslides (about 47.7%) involved less than 5 m^3 of material. Twenty-four of the reported landslides (about 10.7 %) involved a failure volume of 50 m^3 or above. Of these 24 major failures, three were fill slopes, eight were soil cut slopes, two were soil/rock slopes, and nine were natural slopes. There were no rock slopes, retaining walls or rock/boulder falls in this group.

3.5 Rainfall-Landslide Relationships

The relationship between rainfall and landslides in 1998 is illustrated in plots of total annual rainfall distribution and landslides in Figure 6, while Figure 7 shows the maximum 24-hour rainfall isohyets and landslides known to have occurred during the rainstorm of 8/9 June.

4. NOTABLE LANDSLIDES

4.1 General

Out of the 216 landslides reported to the GEO in 1998, eleven are described in more detail here. These eleven have been selected mainly on the basis of their failure volume, consequence or technical interest.

4.2 Incident K 98/6/13: Fung Wong High Service Reservoir, West of Sha Tin Pass Road, near Tsz Wan Shan

(A major soil cut slope failure which resulted in the disruption of the reservoir operation, Plate 1)

On the morning of 9 June 1998, a major soil cut slope failure occurred at the southwestern corner of cut slope No. 11NE-A/C21, adjoining Fung Wong Service Reservoir, to the west of Sha Tin Pass Road. The landslide produced a wedge-shaped scar of about 19 m in length and 12 m in width, with a maximum depth of about 2.5 m. The estimated failure volume was about 120 m^3. The travel angle of the landslide debris, measured from the crown of the landslide to the fence at the toe was about 46º, however, this may not reflect the actual mobility of the debris because of the influence of the fence. Debris from the landslide blocked the 3 m-wide access track between the toe of the slope and the edge of the reservoir, and some debris spilled over into the uncovered reservoir.

The landslide seems to have been triggered by rainfall. Other factors were: (a) the presence of a flat area formed along the ridgeline above the landslide allowing possible ponding and run off onto the landslide site; (b) the presence of an unprotected area of natural terrain directly above the crown of the landslide which allowed ingress of water; (c) the presence of adverse, partly kaolin and manganese infilled, relict joints in the soil mass; (d) the build-up of transient water pressures in the soil mass, particularly along relict discontinuities; and (e) inadequate slope maintenance.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999a).

4.3 Incident ME 98/5/10: Luk Keng Wong Uk, New Territories

(A major natural slope failure which resulted in the deposition of debris between house Nos. 73 and 74, Plate 2)

On the morning of 24 May 1998, a major failure occurred on the natural hillside above village housing at Luk Keng Wong Uk in the northeast New Territories. Approximately 9 m^3 of debris was deposited around the village houses.

The form of the rupture surface was of an elongated spoon-shape approximately 30 m long, 10 m wide and a maximum of 1 m deep. The total volume of displaced material was about 150 m^3. Debris from the landslide was channelised along the stream course until it deposited on more gently inclined ground. The debris deposited around the village houses was either from the accumulated debris of the initial failure or from secondary outwash of debris deposited on the hillside.

The landslide was triggered by rainfall. The location of the landslide towards the top of the stream course suggested that the failure might be part of the geomorphologic development of the hillside.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999b).

4.4 Incident ME 98/6/10: Below Au Tau Village Road, Tseung Kwan O

(A major fill slope failure which resulted in the closure of Au Tau Village Road and the open space at the toe of the rock slope, Plate 3)

In the early afternoon of 9 June 1998, a landslide occurred on slope No. 11NE-D/F284 located below Au Tau Village Road, near Tsui Lam Estate at Tseung Kwan O. The landslide affected the full height of the fill slope. The landslide scar was about 8 m to 20 m in width and the volume of the landslide was about 170 m^3. The travel angle of the landslide debris was about 23º to 26º. Debris from the landslide debris deposited on the natural hillside below, and at one location extended almost to the crest of the rock slopes above Tsui Lam Estate, about 80 m to the east. Au Tau Village Road as well as the open space at the toe of the rock slopes were closed following the landslide.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999c).

The investigation concluded that the landslide primarily involved liquefaction of a loose fill slope. The probable contributory factors of the landslide include: (a) the uncontrolled dumping of fill between 1976 and 1991; (b) the loose nature of the fill which was susceptible to collapse and liquefaction upon water ingress; (c) overland flow from the road bend above the crest of the fill slope; and (d) discharge of water from an open-jointed PVC pipe.

4.5 Incident ME 98/6/22: No. 30 Pak Sha Wan Village, Sai Kung

(A natural slope failure which resulted in the temporary evacuation of one dwelling,

No. 30 Pak Sha Wan Village, Plate 4)

A major natural slope failure occurred during the evening of 9 June 1998 on the natural hillside above Pak Sha Wan Village, Sai Kung. The landslide occurred within a drainage line and formed a shallow channel of 7 m to 10 m width and approximately 90 m length in colluvial soils. The height of the back scarp was 2 m and the volume of the landslide was about 300 m^3. The travel angle, as measured to the toe of the main terminal deposit immediately below a retaining wall, was 25º. After detailed study, more than one phase of landsliding had been identified. The debris appears to have been relatively mobile, probably as a result of channelisation within the drainage line. The debris was deposited above and on the platforms formed for village houses. No fatalities or injuries were reported but the landslide resulted in the temporary evacuation of one dwelling.

The natural terrain landslide was triggered by very severe rainfall. The probable cause of the failure was the development of transient elevated water pressures in the surface colluvium. Both concentrated surface and subsurface water flows also contributed to the landslide.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999d).

4.6 Incident ME 98/6/36: Yue Sun Garden, Wo Mei, Hiram's Highway near Sai Kung

(Three soil cut slope failures which resulted in the permanent evacuation of one hut and the temporary evacuation of five huts within Yue Sun Garden, Plate 5)

On 9 June 1998, three major soil cut slope failures occurred within the L-shaped cut slope No. 11NE-B/C513 adjacent to Yue Sun Garden, Wo Mei, adjacent to Hiram's Highway near Sai Kung. The landslides comprised the failure of approximately 50 m of the slope and involved a total volume of about 1350 m^3 of decomposed tuff.

Landslide No. 1 occurred at about 9:00 a.m. and involved about 200 m^3 of material. The scar was about 15 m wide and 13 m long with a maximum depth of approximately 2 m. The landslide scar was generally "spoon-shaped". Landslide No. 2 occurred at 6:00 p.m. It appeared to have been essentially an extension of the first landslide southwards. This incident released about 1100 m^3 of material, with the resulting scar being approximately 35 m wide and 25 m long with a maximum depth of about 3 m. Landslide No. 3 occurred at about 7:00 p.m. and comprised a shallow surficial failure involving about 50 m^3 of material. The scar was about 10 m wide and 8 m long with a maximum depth of approximately 1 m. This landslide does not appear to have been directly connected to the first two incidents. The travel angles of the debris for the three landslides were about 34º, 30º and 50º respectively. Following the landslides, a structure damaged by the landslide debris was evacuated and subsequently dismantled. The remaining structures within Yue Sun Garden were temporarily evacuated.

The failures were probably caused by a combination of the build-up of transient elevated water pressures in the soil mass following severe rainfall, inadequate surface water

drainage provision, and the presence of erosion pipes which provided preferential flow paths for water ingress. The lack of slope maintenance may also have contributed. The site has a history of instability.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999e).

4.7 Incident ME 98/6/55: Above the Outward Bound School, Tai Mong Tsai, near Sai Kung

(A natural slope failure which resulted in the temporary evacuation of the "Captain's House", Plate 6)

At about 5:30 p.m. on 9 June 1998, a major natural slope failure occurred adjacent to the Outward Bound School, Tai Mong Tsai, near Sai Kung. The landslide involved the failure of the natural hillside close to the main ridgeline of a coastal peninsula. The failure volume was about 900 m^3 and debris from the main body of the landslide came within 20 m of a dwelling known as the "Captain's House" at the toe of the hillside.

Two main backscarps (termed "upper" and "lower") were identified, as were zones of depletion and accumulation. The upper backscarp, which corresponded to the main area of failure, was located immediately below the main ridge of the peninsula and was about 30 m in length and typically between 2 m and 3 m high. The lower backscarp was about 15 m wide and 6 m high with a slope angle and it typically between 35° and 50°. The travel angle of the landslide was approximately 27°, and it resulted in the temporary evacuation of the "Captain's House".

The landslide was triggered by very severe rainfall. The open-jointed nature of the volcaniclastic rock in the vicinity of the mainscarp probably resulted in an increased susceptibility to surface water infiltration. The presence of numerous near-surface erosion pipes would also have promoted concentrated subsurface water flow into this area of the hillside. The failure was probably caused by either the development of water pressures in open joints within the volcaniclastic rocks, or elevated water pressure in the soil mass, or a combination of both these factors.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999f).

4.8 Incident MW 98/2/1: Hang Lok Lane, Sha Tin

(A major cut slope failure which involved a section of Hang Lok Lane and resulted in the temporary evacuation of a total of 143 residents, Plate 7)

At about 8:50 a.m. on 8 February 1998, a major cut slope failure occurred at slope No. 7SW-D/C293 between Hang Lok Lane and To Fung Shan Road, Shatin. The landslide

involved an approximately 36 m long section of the slope together with a section of retaining wall and Hang Lok Lane above the slope. The failed slope was a shotcrete-covered cut slope, about 5.5 m in height and inclined at an angle of about 55° to the horizontal. The landslide resulted in a 9 m high and 36 m wide landslide surface and the failure volume was about 1100 m^3. The travel angle of the landslide was about 26° as measured from the crest to the distal end of the debris. The landslide debris comprised mainly soil, collapsed retaining wall segments, fragments of shotcrete cover, bricks and trees. The lower portion of the slope and the full width of To Fung Shan Road were buried by debris and 143 residents who lived in Nos. 5, 7 to 10 and 12 Hang Lok Lane were evacuated.

The landslide was probably caused by leakage from a 3 inch fresh water main which was located under Hang Lok Lane. Because of water ingress, the soil behind the retaining wall was wetted up and weakened. The prolonged seepage flow resulted in an increase in pore water pressure near the slope toe triggering the failure.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1998a).

4.9 Incident MW 98/5/2: Below Ramp G of the Ting Kau Bridge and Approach Viaduct, Ting Kau

(Three major fill slope failures affecting approximately 40% of the combined face area (3300 m^2 out of 7200 m^2) of two newly formed fill slopes, Plate 8)

Between 4 May 1998 and 9 June 1998, three major fill slope failures occurred successively during separate rainstorm events in two newly constructed fill slopes located below Ramp G of the Ting Kau Bridge and Approach Viaduct along Tuen Mun Road, Ting Kau. The landslides ultimately affected approximately 40% of the combined face area of the slopes (3300 m^2 out of 7200 m^2) and had an estimated total debris volume of 1300 m^3.

The north-eastern fill slope (slope A) was approximately 80 m long and 28 m high, comprising four batters separated by three 1.5 m wide berms. The south-western fill slope (slope B) was about 130 m long and 40 m high, and comprised seven batters. The two slopes were generally triangular in plan and incorporated a surface drainage system comprising open surface channels draining into stepped channels which ultimately discharge into the natural stream courses. The slopes supported a heavy cover of hydroseeded grass. The initial landslide occurred on 4 May 1998 mainly in slope B, with an estimated debris volume of about 500 m^3. The mode of failure involved principally a shallow planar slide of the near-surface material. The second landslide occurred on 24 May 1998 mainly in slope A, with an estimated debris volume of about 400 m^3. The mode of failure comprised shallow sliding along a surface of rupture of about 0.3 m to 0.4 m below and parallel to the slope face. The third incident occurred between 24 May and 9 June 1998 in Slope B, with an estimated volume of about 400 m^3. The failures were limited to slope B and affected previously intact areas of the slope. All three travel angles of the debris were about 33°. Cracking and separation had also been observed in the road pavement and soft verge behind the slope crest.

The landslides were probably triggered by rainfall. The failures were diagnosed as

being caused by the development of transient elevated water pressures above a planar interface in the near-surface fill following direct infiltration. The method of construction adopted is liable to have resulted in the near-surface fill being in a less well-compacted state, which could have contributed to the failure.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999g).

4.10 Incident MW 98/6/9: Sunny Villa, 218 Castle Peak Road, New Territories

(A soil/rock cut slope failure which resulted in the closure of the access road to Sunny Villa, Plate 9)

A major soil/rock cut slope failure occurred at about 5:50 p.m. on 9 June 1998. The landslide occurred in the upper part of the eastern portion of slope No. 6SE-D/C304 located above the access road to the Sunny Villa Apartment blocks at 218 Castle Peak Road, New Territories. The maximum height of the slope was about 45 m and 30 m at its western and eastern portion, respectively. The slope face was generally formed in three batters and each batter was separated by a 1.5 m wide berm. The soil portion of the cut slope was heavily vegetated while the rock portion was generally bare.

The main scarp of the landslide was about 28 m wide and 4.5 m high as measured at the middle section of the scarp. The surface of rupture was about 2 m deep and 15 m long, with the lower three-quarters covered by detached materials. The landslide released about 200 m^3 of debris that completely blocked the access road to Sunny Villa. As the landslide debris was constrained by the bank at the far side of the access road, the travel angle of the landslide debris could not be determined reliably.

The landslide was probably triggered by rainfall. The probable causes of the failure include wetting up of the near-surface material and development of transient elevated water pressures as a result of ingress of water during rainfall. Overtopping of surface water from the blocked crest channel immediately above the landslide site probably promoted water ingress into the soil mass. The presence of adversely oriented relict joints with kaolin infill within the completely decomposed volcanics gave rise to relatively low shear strength, and inadequate slope maintenance was probably a contributory factor.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999h).

4.11 Incident MW 98/6/11: Tai Po Road near Chak On Estate

(A major cut slope failure which resulted in the closure of Tai Po Road, Plate 10)

Some time before 16:50 on 9 June 1998, a major failure occurred within an active construction site at a newly-formed cut slope (No. 11NW-B/C60) above Tai Po Road, near

Chak On Estate. Tai Po Road, immediately adjacent to the construction works, was closed to traffic until the completion of temporary stabilization works.

The landslide area was trapezoidal in plan, about 17 m high and 37 m wide at its base, tapering to about 10 m wide at the crest and wedge-shaped in section, with an average depth of about 4 m. The total volume of the landslide debris was about 1400 m^3. No travel angle was determined since the landslide traveled only a fairly short distance (about 1 m) and the debris remained largely on the relatively shallow cut slope. The landslide mass remained relatively intact, apart from shear/tension cracks dividing it into separate blocks. However, extensive signs of distress, in the form of significant cracking and dislocation of berm slabs, were observed. The western margin of the landslide was delineated by a planar, persistent, subvertical discontinuity running the whole height of the landslide. The slip moved approximately 1 m before coming to rest whilst a large amount of material was eroded onto the slip road under construction.

The landslide was probably triggered by moderately heavy rainfall. Inadequate surface water drainage provision, together with poor maintenance and the existence of cracks in the damaged road pavement, could have played a role in causing surface erosion and probably increased infiltration. The presence of an adversely oriented persistent, thin sandy silty clay layer and persistent relict discontinuities were also contributory factors.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999i).

4.12 Incident MW 98/6/12: PFA Fill Slope at Siu Lang Shui, Tuen Mun

(Two major and one minor fill slope failures which resulted in the closure of one lane of road, Plate 11)

Two major and one minor failures occurred on 9 June 1998 within an unauthorized Pulverized Fuel Ash (PFA) fill slope (No. 5SE-D/F17), at Siu Lang Shui, Tuen Mun. The fill slope formed an "L"-shaped extension to a cut platform and was inclined at around 35°. The main landslide occurred within the main body of end-tipped PFA on the south-facing embankment, and was 60 m wide, 30 m long and 2 m deep with a volume of about 1000 m^3. Another major landslide occurred at the southwestern corner of the platform and the scar was 8 m wide, 10 m long and 4 m (maximum) deep, with a volume of approximately 80 m^3. The minor failure occurred at the northern end of the western section. The disturbed area measured about 7 m wide and 10 m long, involving a volume of around 20 m^3. The main consequence of the landslides was that PFA fill was washed out of the failed area, and debris was deposited as far as Lung Mun Road resulting in the closure of one lane.

These landslides were probably triggered by heavy rainfall. Direct infiltration and subsurface seepage from localised ponding on the platform caused the main failure. The second major failure was caused by concentrated surface water flows overtopping the crest of the PFA slope. The cause of the minor failure was considered to be the wetting up of loose PFA and building debris causing collapse settlement of the loose soil structure. The low density of the PFA fill was a contributory factor.

A comprehensive investigation into the landslide was carried out by the GEO's 1998 Landslide Investigation Consultants. Details of the investigation and its findings can be found in GEO (1999j).

5. CONCLUSIONS

Rainfall at the HKO amounted to 2565 millimetres in 1998, 16% above normal. One Landslip Warning was issued in 1998. A total of 228 incidents was reported to the District Divisions of the GEO, 216 of which were classified as genuine landslides, and 24 of which were major. No fatalities or injuries occurred. The consequences resulting from the landslides included the temporary evacuation of 22 squatter huts, 6 houses and 10 flats and the permanent evacuation of 11 squatter huts, while 68 landslides resulted in the blockage of sections of road, pedestrian pavement and/or access.

Based on GEO's landslide inspection reports, 26 of the landslides (about 12%) which occurred in 1998 were considered by the inspecting geotechnical engineers to be related to poor slope maintenance.

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Table 1 - Rainfall and Landslides in 1998, Compared with Selected Previous Major Rainstorms

Date[1] of Event	Maximum Rainfall (mm)[2]								Landslide Consequences			
	Hong Kong Observatory					GEO Raingauges[3]			Number of Reported Landslides[4]		Persons Killed (Injured)	Number of Huts Evacuated Permanently
	24-hr	5-hr	1-hr	Antecedent		24-hours	5-hours	1-hour	GEO[6]	FSD[6]		
				4 days	15 days							
8-9 June 98[5]	429	164	48	58	181	562 (N15)	223 (N15)	98 (N09)	96	-	-	9
26-27 Apr 98	143	94	72	37	88	160 (H03)	103 (N14)	85 (N14)	2	-	-	-
31 Aug-1 Sept 98	85	66	33	37	93	144 (H15)	97 (N08)	73 (N12)	1	-	-	-
17-18 Feb 98	84	52	22	12	25	135 (K06)	83 (K06)	55 (N09)	3	-	-	-
23-24 June 98	82	53	38	21	560	88 (H12)	57 (H12)	50 (H12)	1	-	-	-
12-13 July 98	81	53	20	57	167	209 (H17)	175 (N17)	62 (N17)	1	-	-	-
23-24 May 98	80	57	33	11	117	214 (N09)	156 (N07)	80 (H08)	13	-	-	-
3-4 July 98	76	41	33	52	219	112 (H01)	77 (H01)	74 (H01)	2	-	-	-
2-3 May 98	74	65	35	59	190	103 (N12)	92 (H01)	54 (H01)	3	-	-	-
10-11 June 98	66	51	29	460	626	108 (H18)	70 (H09)	45 (N09)	13	4	-	-
3-4 June 98	59	38	28	66	172	97 (N13)	74 (N16)	69 (N16)	0	-	-	
9-10 Oct 98	57	41	29	32	35	78 (H09)	53 (H09)	35 (H09)	1	-	-	-
Selected Previous Major Rainstorms (for comparison only)												
29 May 82	394	153	44*	1	11	430	237	111*	551	15	22(26)	1153
17 Jun 83	347	274	69*	2	77	460	303	101*	155	5	(2)	149
20-21 May 89[5]	388	149	37*	28	42	566	224	51	340	3	2(3)	199
8 May 92[5]	324	196	110*	65	71	385	244	110	350	9	3(5)	92
4-5 Nov 93[5]	107	31	9*	8	8	742	350	94	377	2	-	25
2-3 Jul 97[5]	110	49	18	183	380	799	296	125	118	6	1(9)	59

Notes:
(1) The events in 1998 are arranged in order of the intensity of 24-hour rainfall recorded at the Hong Kong Observatory, Tsim Sha Tsui.
(2) The maximum 24-hour rainfall, the maximum five-hour rainfall and the maximum 1-hour rainfall with an asterisk are the rolling rainfall amounts using one-clock hour rainfall as the basic unit. The maximum 1-hour rainfall values without an asterisk are the rolling rainfall amounts using 5-minute rainfall as the basic unit.
(3) The maxima are selected from the 48 GEO Raingauges for the rainstorms. The GEO Raingauge reference number is shown in brackets.
(4) Reported totals are for genuine reported landslides known to have occurred on specific dates.
(5) Landslip warnings were issued for these events.
(6) GEO = Geotechnical Engineering Office; FSD = Fire Services Department.

Table 2 - Warnings Issued by the Hong Kong Observatory in 1998[1]

Month	Monthly Total Rainfall (mm)	Dates on which Warnings were in Effect				
		Thunderstorm	Flood	Landslip[2]	Tropical Storm	Rainstorm
January	48.9	14, 15	-	-	-	-
February	153.7	14, 15-16, 17, 17-18, 18, 22-23	17	-	-	-
March	55.3	4, 9-10, 10	-	-	-	-
April	237.1	12, 14, 19, 24-25, 25, 26-27, 27, 28, 30	-	-	-	12, 26, 27 (Amber) 26 (Red)
May	335.2	2-3, 3, 4, 12, 15, 17, 19, 21, 24, 30	-	-	-	2, 15, 24 (Amber) 2, 24 (Red)
June	814.5	1, 2, 2-3, 3, 3-4, 4-5, 5-6, 8, 8-9, 9-10, 10-11, 11-12, 18, 19, 20, 22-24, 24, 26, 27	-	9 (4:52a.m.-10:30a.m.)	-	4, 9, 10, 11, 23 (Amber) 9 (Red) 9 (Black)
July	267.2	2, 3, 4, 4-5, 5, 6, 7, 10, 12, 13, 27	-	-	-	2, 3, 4, 13 (Amber)
August	245.4	2, 6, 7, 18, 22, 22-23, 23, 25, 26, 27, 28, 29, 30-31, 31	-	-	9 Aug - 10 Aug (Signal 1-3, Penny) 21 Aug - 22 Aug (Signal 1, Tropical Depression)	7, 8, 30-31 (Amber)
September	230.9	1, 2, 3, 5, 6, 7, 8, 9, 9-10, 11, 12, 12-13, 14	-	-	12 Sept - 13 Sept (Signal 1, Tropical Depression)	1, 6 (Amber)
October	133.9	10	-	-	15 Oct - 16 Oct (Signal 1, Zeb) 23 Oct - 26 Oct (Signal 1-3, Babs)	-
November	28.8	-	-	-	-	-
December	13.7	-	-	-	-	-
Total	2564.6	87 days	1 day	1 Warning	5 Warnings	5 days

Notes: (1) Information in this Table was based on HKO (1998).
(2) Landslip Warnings were issued after consultation between GEO and HKO.

Table 3 - Maximum Rainfall Recorded at the Hong Kong Observatory and in Sai Kung in 1998 and Estimated Return Periods

Raingauge R01 at the Hong Kong Observatory

Duration	Rainfall[1] (mm)	Ending Date/Time		Estimated Return Period (Years)[2]
		Date	Time	
1 hour	72	26/4/98	22:00	5
4 hours	152	9/6/98	9:00	4
8 hours	243	9/6/98	13:00	8
12 hours	361	9/6/98	17:00	31
24 hours	428	9/6/98	18:00	20
2 days	458	10/6/98	12:00	13
4 days	534	11/6/98	14:00	11
7 days	580	11/6/98	11:00	10
15 days	702	11/6/98	14:00	8

Notes: (1) Rainfall maxima as recorded at the Hong Kong Observatory, Tsim Sha Tsui.
(2) Return periods were assessed from Gumbel's method, based on 100 years (1884-1939 and 1947-1990) of rainfall data at the Hong Kong Observatory, after Lam & Leung (1994).

Raingauge N15 in Sai Kung

Duration	Rainfall[1] (mm)	Ending Time		Estimated Return Period (Years)[2]
		Date	Time	
1 hour	88	9/6/98	6:15	10
4 hours	219	9/6/98	7:00	48
8 hours	268	9/6/98	18:30	39
12 hours	359	9/6/98	17:25	148
24 hours	562	9/6/98	18:30	211
2 days	562	10/6/98	8:15	25
4 days	583	12/6/98	2:00	7
7 days	602	10/6/98	8:15	7
15 days	687	12/6/98	2:00	3

Notes: (1) Rainfall maxima as recorded at Raingauge Station N15 in Sai Kung.
(2) Return periods were assessed from the Gumbel's method (Lam & Leung, 1994), based on fourteen years (1984-1997) of rainfall data at raingauge N15 in Sai Kung.

Table 4 - Number of Incidents Reported to Various Departments in 1998

Department	Total Number	Type of Incident		
		Landslide	Flooding	Others[(1)]
Agriculture & Fisheries Department	35	35	0	0
Architectural Services Department	8	3	0	5
Drainage Services Department	258	0	258	0
Fire Services Department	27	8	17	2
Geotechnical Engineering Office, Civil Engineering Department	228	216	0	12
Highways Department	278	34	20	224
Housing Department	7	3	0	4
Water Supplies Department	27	18	0	9

Notes: (1) "Others" includes minor signs of distress and incidents of no geotechnical concern such as fallen trees.

Table 5 - Number of Landslides Occurring when the Landslip Warning was Raised in 1998

Landslip Warning Period	No. of Landslides with Dates of Occurrence Known	No. of Landslides with Time of Occurrence Known to within One Hour			
	Occurred on the Days of Warning	Occurred within 24 hours before Warning Issued	Occurred when Warning was in Force	Occurred within 24 hours after Warning Cancelled	Occurred in the Period from 24 Hours before Warning Issued to 24 Hours after Warning Cancelled
9/6(4:52) - 9/6(10:30)	33	1	16	0	17

Notes:
(1) Total number of landslides reported to the GEO in 1998 was 216.
(2) 180 landslides were recorded with known dates of occurrence.
(3) 59 landslides were recorded with the time of occurrence given to within one hour.
(4) The above was based on the time and date estimated by GEO's Inspection Officers, which might not be accurate.

Table 6 - Number of Landslides Reported to GEO Affecting Different Facilities[1]

Affected Facility[3]	Districts[4]				All[2]
	Hong Kong	Kowloon	New Territories		
			Mainland East	Mainland West	
Squatters	1(0)	0(0)	12(2)	8(0)	21(2)
Building Lots/Properties	2(0)	1(1)	15(3)	7(2)	25(6)
Roads	8(2)	6(2)	30(2)	17(3)	61(9)
Pedestrian Pavements	10(2)	5(1)	17(2)	8(0)	40(5)
Footpaths, Lanes, Private Access, Footbridges	5(1)	0(0)	10(1)	4(1)	19(3)
Construction Sites	2(0)	0(0)	0(0)	1(0)	3(0)
Country and Urban Parks	0(0)	2(1)	0(0)	1(0)	3(1)
Open Areas/Hillside	2(0)	0(0)	39(3)	11(0)	52(3)
Catchwaters/Conduits/Culverts	0(0)	0(0)	2(0)	1(0)	3(0)
Carparks, Playgrounds, Gardens, Yards	2(0)	2(1)	7(0)	1(0)	12(1)
Cemetery/Graves	0(0)	0(0)	0(0)	0(0)	0(0)
Unclassified	4(1)	1(1)	6(1)	3(2)	11(5)

Legend:

61(9) Sixty- one landslides of which nine were major.

Notes:
(1) Incidents which were not genuine landslides have been excluded.
(2) The numbers of landslides affecting different types of facility are based on Sections 11 and 12 of GEO's Incident Reports.
(3) One landslide may affect more than one type of facility.
(4) Based on GEO's district boundaries, which are shown in Drawing No. GCSP 8/20.

Table 7 - Consequence Related to Type of Failure[1]

Type of Failure[3]		No. of Squatter Huts Evacuated[2]		No. of Blocks, Houses or Flats Evacuated or Partially Closed[2]	No. of Landslides Involving Blockage or Closure[2]			Deaths[2] (Injuries)
		Permanent	Temporary		Roads	Pedestrian Pavements	Footpaths, Back Lanes, Private Access	
Fill Slope		2	-	-	5	1	-	-
Cut Slope	Soil	5	11	1 Block 2 flats	11	6	2	-
	Soil/ Rock	-	-	-	10	2	1	-
	Rock	-	-	-	-	-	-	-
Natural Slope		1	5	2 houses 5 flats	4	4	1	-
Retaining Wall		3	1	4 house 1 flat	-	3	-	-
Rock/Boulder Fall		-	5	-	3	2	1	-
Others (e.g. washout, subsidence)		-	-	2 flats	7	3	2	-

Notes:
(1) Incidents which were not genuine landslides have been excluded.
(2) Based on Sections 11 and 12 of GEO's Incident Reports.
(3) A failure may give rise to more than one type of consequence.

Table 8 - Number of Landslides Reported to GEO Classified by Type of Failure[1]

Type of Failure[2]		Number	Percentage (%)
Fill Slope		11(3)	5.1
Cut Slope	Soil	85(8)	39.4
	Soil/Rock	20(2)	9.3
	Rock	0(0)	0.0
Retaining Wall		16(0)	7.4
Natural Slope		26(9)	12.0
Rock/Boulder Fall		16(0)	7.4
Others (e.g. washout, subsidence)		42(2)	19.4
Total		216(24)	100.0

Legend:

85(8) Eighty-five landslides of which eight were major failures.

Notes:
(1) Incidents which were not genuine landslides have been excluded.
(2) Data shown in this table are based on Sections 5 and 6 of GEO's Incident Reports. Where a landslide involved more than one type of failure, the predominant type has been adopted.

Table 9 - Landslide Volume Distribution with Respect to District[1]

Volume of Failure (m^3)	Districts[2]				All
	Hong Kong	Kowloon	New Territories		
			Mainland East	Mainland West	
<5	19	2	64	18	103(47.7%)
≥5 to <10	1	2	19	9	31(14.3%)
≥10 to <20	3	4	12	16	35(16.2%)
≥20 to <50	3	3	11	4	21(9.7%)
≥50 to <200	3	4	5	0	12(5.6%)
≥200 to <500	0	0	2	1	3(1.4%)
≥500 to <1000	0	1	1	1	3(1.4%)
≥1000	0	1	2	3	6(2.8%)
Unknown	0	0	2	0	2(0.9%)
Non-genuine	[3]	[1]	[8]	[0]	[12]
Total	29(13.4%)	17(7.9%)	118(54.6%)	52(24.1%)	216(100%)

Legend:

103(47.7%) 103 landslides, which amount to 47.7% of the 216 landslides reported to GEO.

Notes: (1) Incidents which were not genuine landslides have been excluded.
(2) Based on GEO's district boundaries, which are shown in Drawing No. GCSP 8/20.

Table 10 - Landslide Volume Distribution with Respect to Type of Failure[1]

Volume of Failure (m^3)	Fill Slope	Cut Slope			Retaining Wall	Natural Slope	Rock/Boulder Fall	Others (e.g. washout, subsidence)	Total
		Soil	Soil/Rock	Rock					
<5	1	37	12	0	5	2	16	30	103(47.7%)
≥5 to <10	0	15	4	0	4	3	0	5	31(14.3%)
≥10 to <20	6	15	0	0	4	5	0	5	35(16.2%)
≥20 to <50	1	9	2	0	3	6	0	0	21(9.7%)
≥50 to <200	0	3	2	0	0	5	0	2	12(5.6%)
≥200 to <500	0	1	0	0	0	2	0	0	3(1.4%)
≥500 to <1000	2	0	0	0	0	1	0	0	3(1.4%)
≥1000	1	4	0	0	0	1	0	0	6(2.8%)
Unknown	0	1	0	0	0	1	0	0	2(0.9%)
Total	11(5.1%)	85(39.4%)	20(9.3%)	0(0%)	16(7.4%)	26(12.0%)	16(7.4%)	42(19.4%)	216(100%)

Note: (1) Incidents which were not genuine landslides have been excluded.

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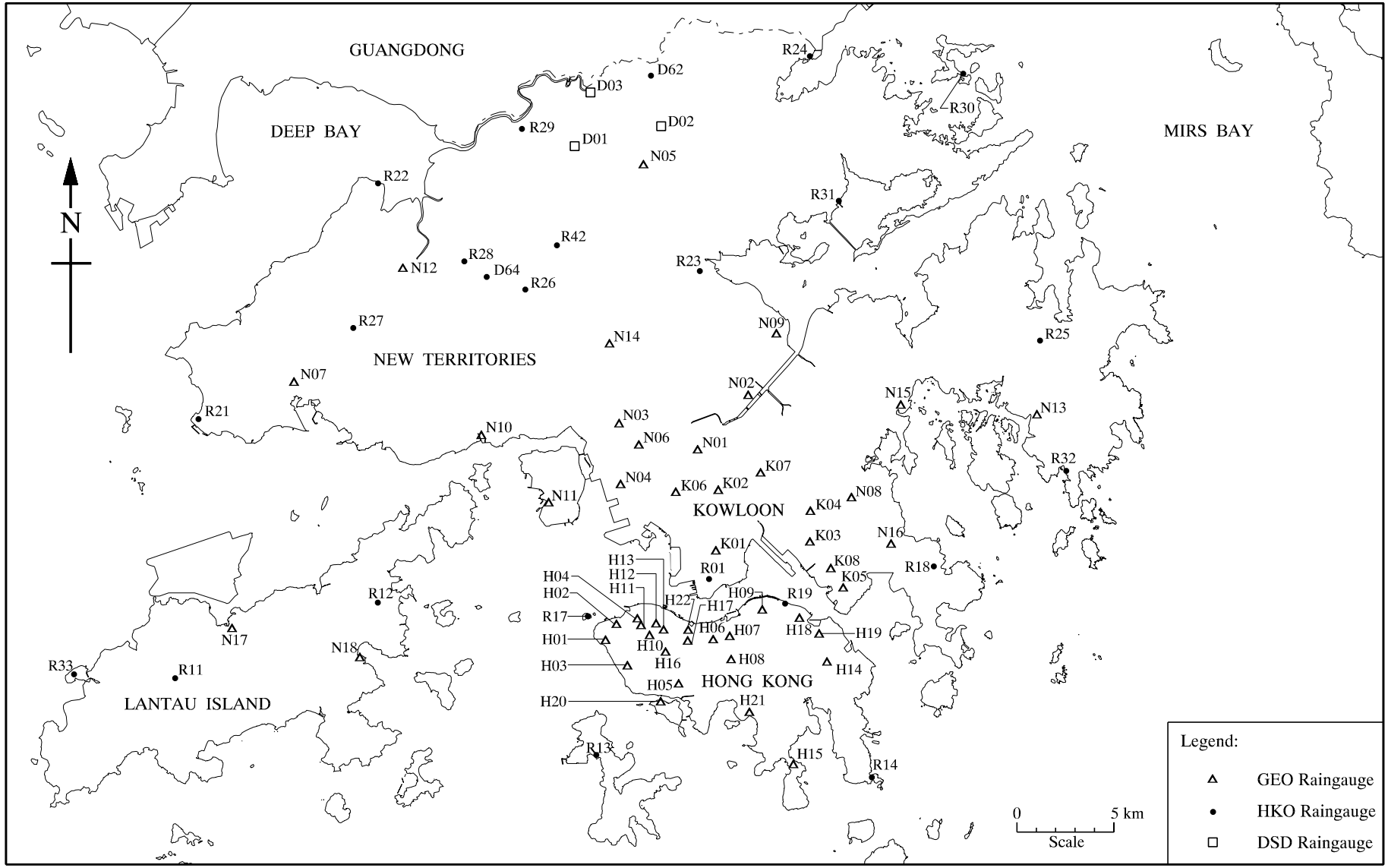
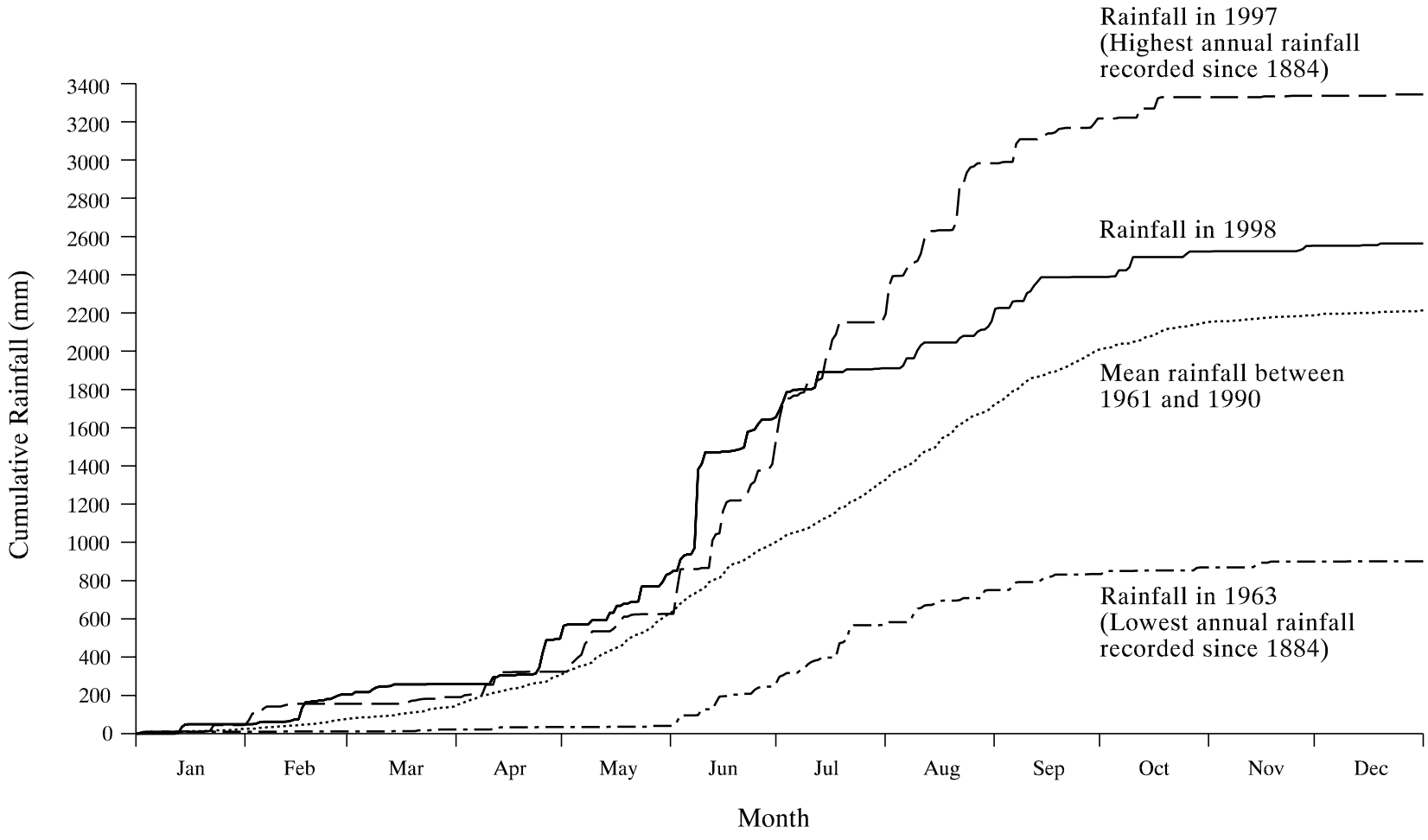
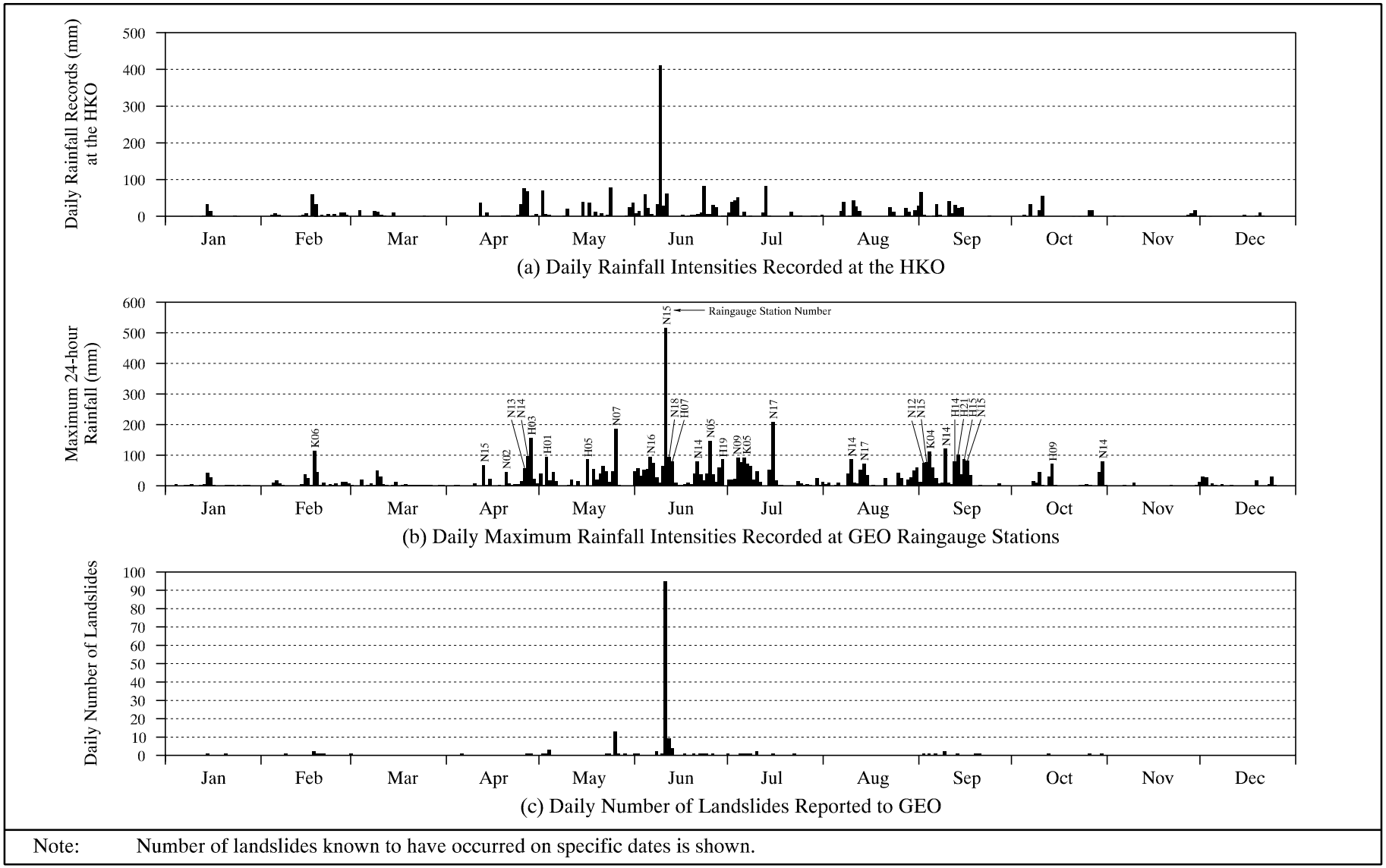


Figure 1 - Locations of GEO, HKO and DSD Automatic Raingauges



Note: Rainfalls recorded at the Hong Kong Observatory, Tsim Sha Tsui are shown.

Figure 2 - Cumulative Rainfall for 1998 and Recorded Highest, Mean and Lowest Cumulative Rainfalls



Note: Number of landslides known to have occurred on specific dates is shown.

Figure 3 - Daily Rainfall Recorded at the HKO, Daily Maximum Rainfall Recorded at GEO Raingauge Stations and Daily Landslides Reported to GEO in 1998

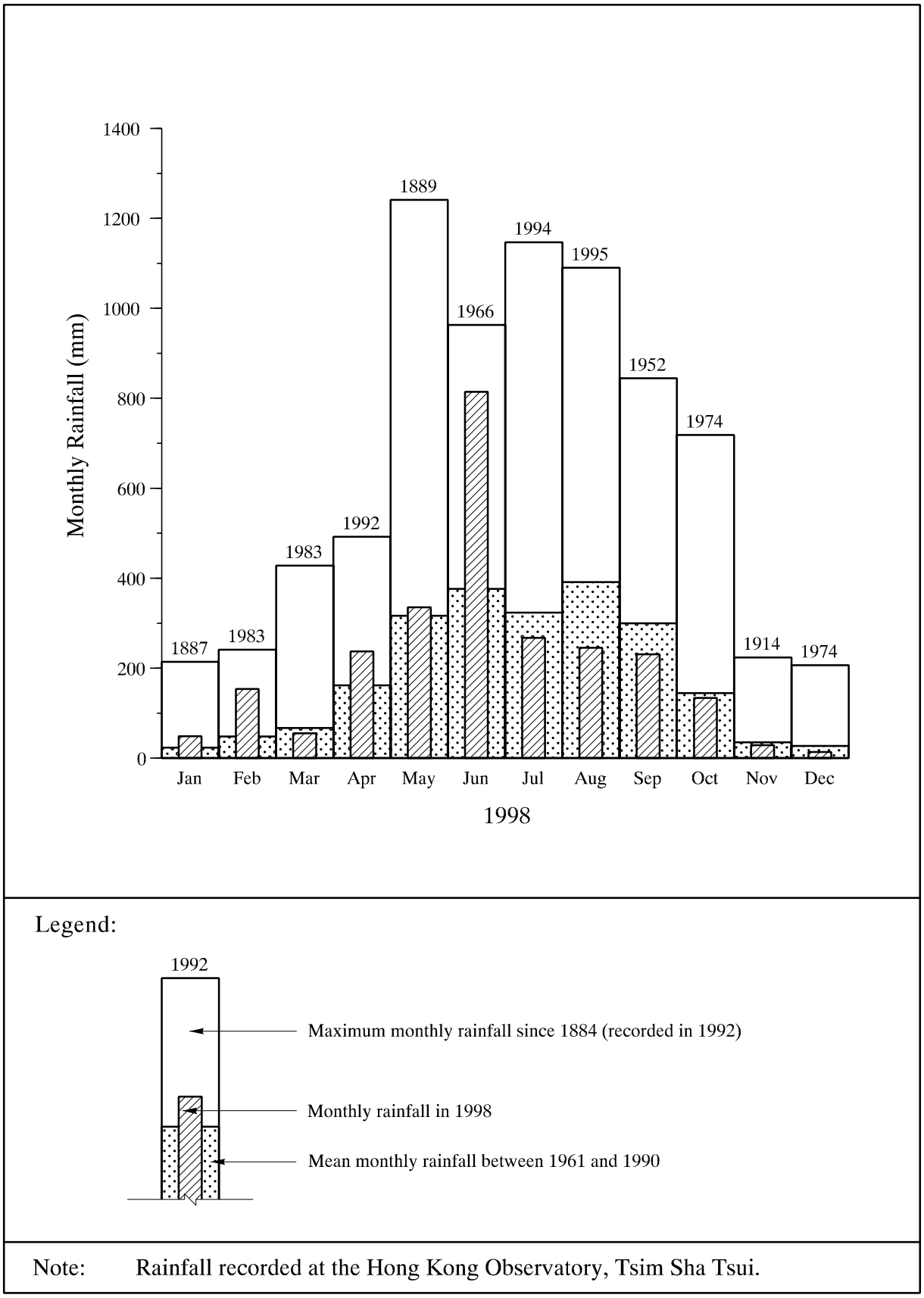
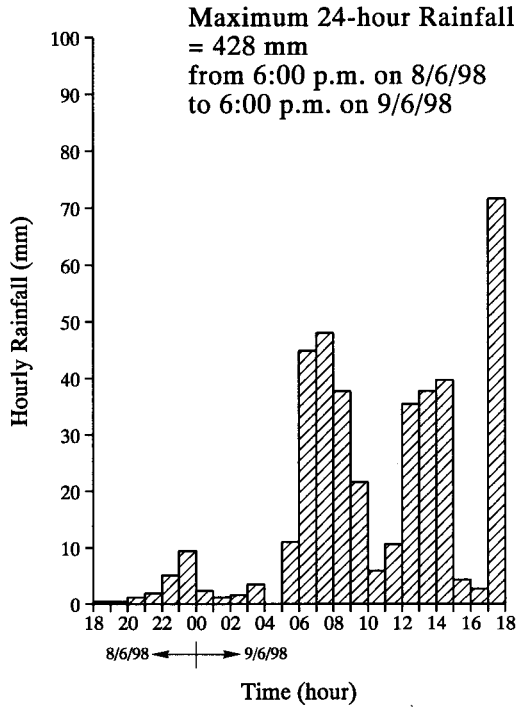
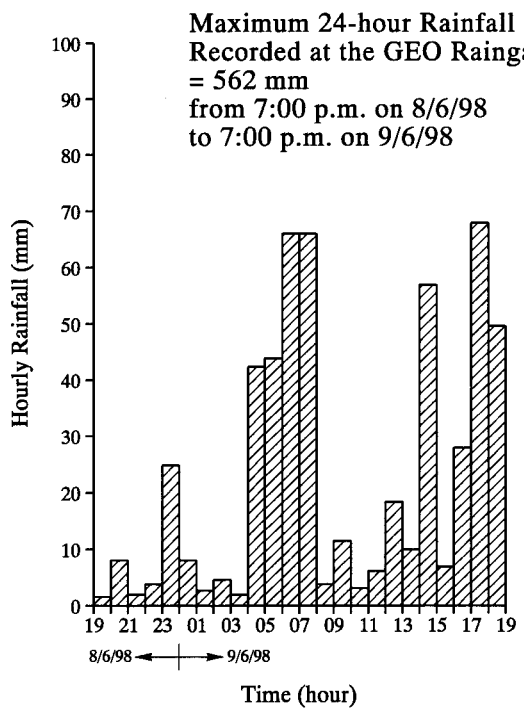


Figure 4 - Monthly Rainfall in 1998 in Comparison with Recorded Maximum and Mean Monthly Rainfall

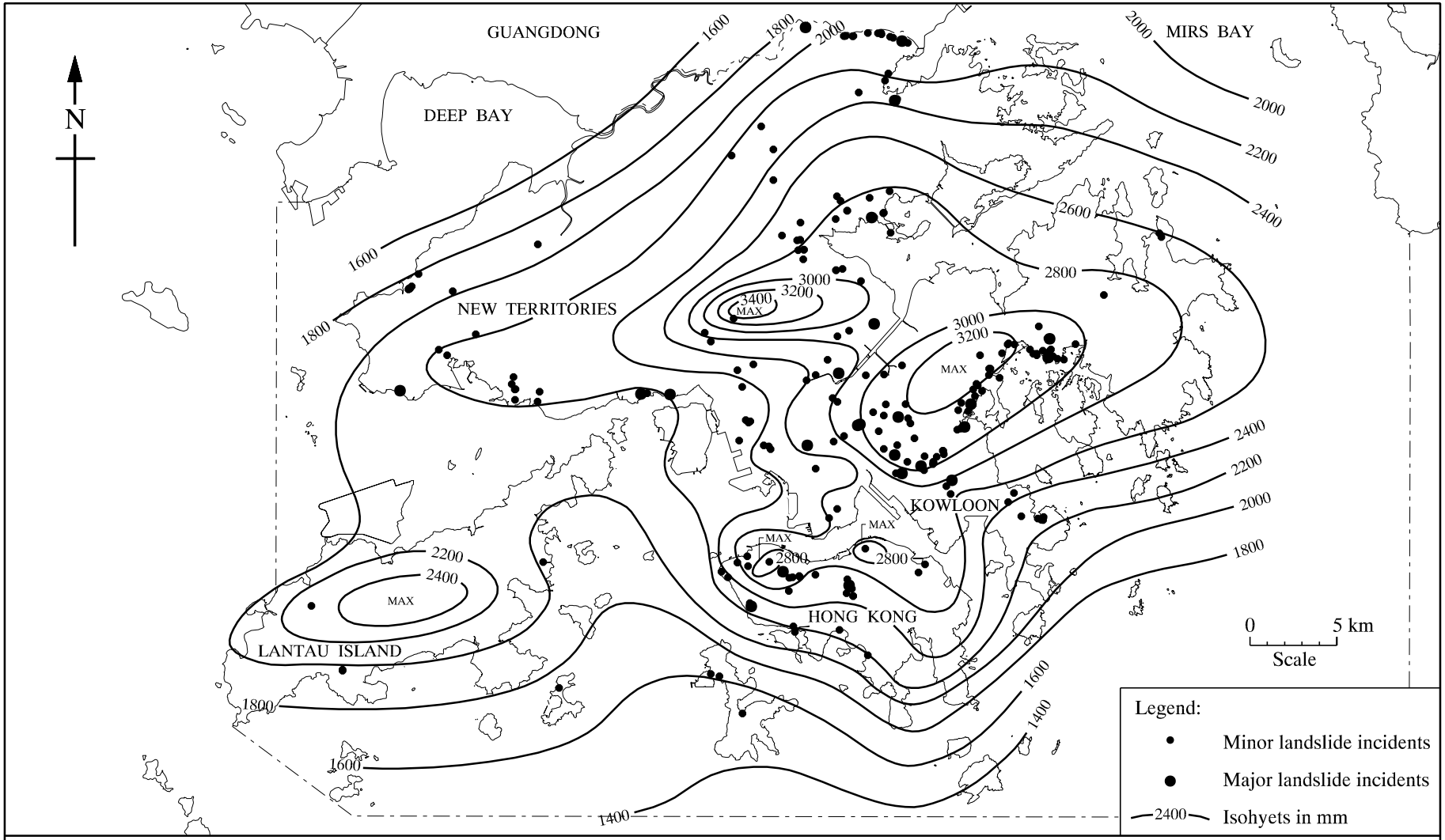


(a) Recorded at the HKO



(b) Recorded at the GEO Raingauge Station (N15) at the Sai Kung

Figure 5 - Hourly Rainfall Intensities for the Maximum 24-hour Rainfall Recorded at the HKO in Comparison with the Maximum 24-hour Rainfall Recorded at Raingauge Station N15 in 1998



Notes: (1) Isohyets are supplied by the Hong Kong Observatory.
(2) Genuine landslides reported to have occurred in 1998 (216 nos.) are shown.

Figure 6 - Total Annual Rainfall Distribution and Locations of Landslides in 1998

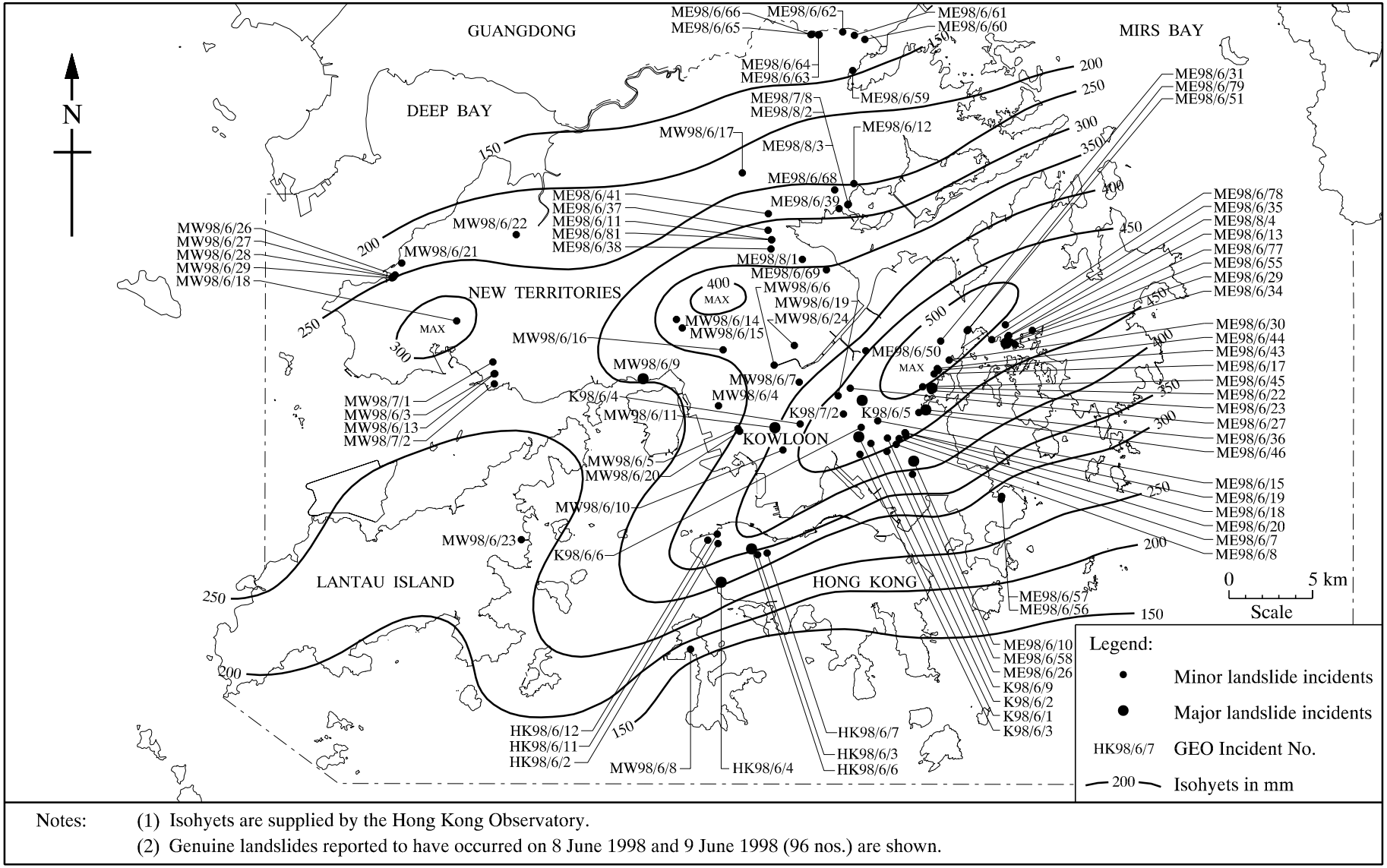


Figure 7 - 24-hour Rainfall Distribution from 6:00 p.m. on 8 June 1998 to 6:00 p.m. on 9 June 1998 and Locations of Landslides

LIST OF PLATES

Photo Ref. LSR 5/99 Taken on: 30-6-98

Description: A major soil cut slope failure which resulted in the disruption of the reservoir operation.

Plate 1 - Fung Wong Service Reservoir, Sha Tin Pass Road, near Tze Wan Shan (Incident K 98/6/13)

(a) Negative No. ME 98/066/12 Taken on: 25-5-98

Description: A major natural slope failure which resulted in the debris deposited between houses Nos. 73 and 74.

(b) Negative No. ME 98/066/13 Taken on: 25-5-98

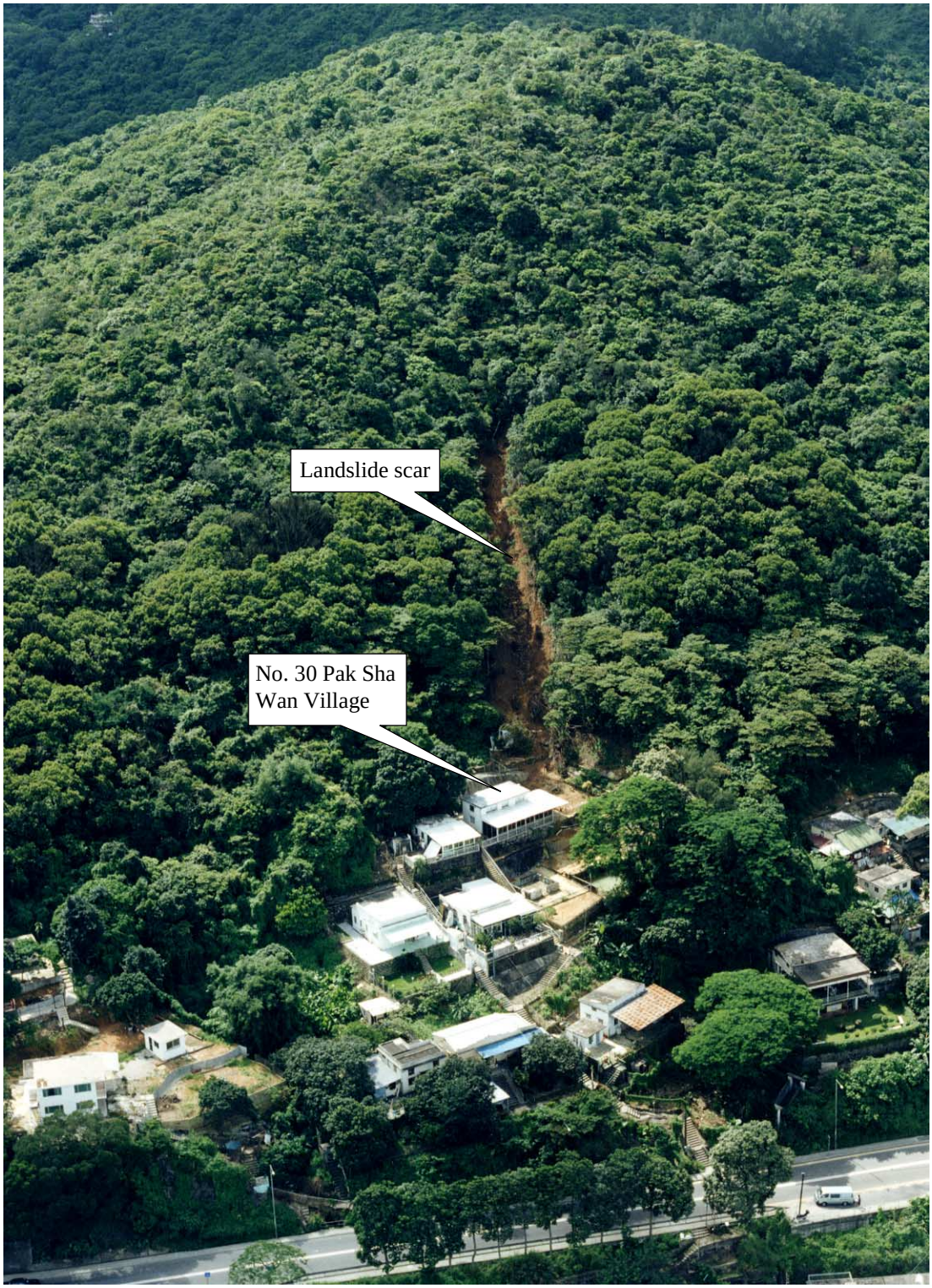
Description: Debris deposited between Village Houses Nos. 73 and 74.

Plate 2 - Luk Keng Wong Uk, New Territories (Incident ME 98/5/10)

Negative No. PS 954(17580) Taken on: 29-6-98

Description: A major fill slope failure which resulted in the closure of Au Tau Village Road and the open space at the toe of the rock slope.

Plate 3 - Below Au Tau Village Road, Tseung Kwan O (Incident ME 98/6/10)



Negative No. PS 951(17535) Taken on: 29-6-98

Description: A major natural slope failure which resulted in the temporary evacuation of one dwelling, No. 30 Pak Sha Wan Village.

Plate 4 - No. 30 Pak Sha Wan Village, Sai Kung (Incident ME 98/6/22)

Negative No. PS 952(17556) Taken on: 29-6-98

Description: Three major soil cut slope failures which resulted in the permanently evacuation of one hut and temporarily evacuation of five huts.

Plate 5 - Yue Sun Garden, Wo Mei, Hiram's Highway near Sai Kung (Incident ME 98/6/36)

Negative No. PS 951(17543) Taken on: 29-6-98

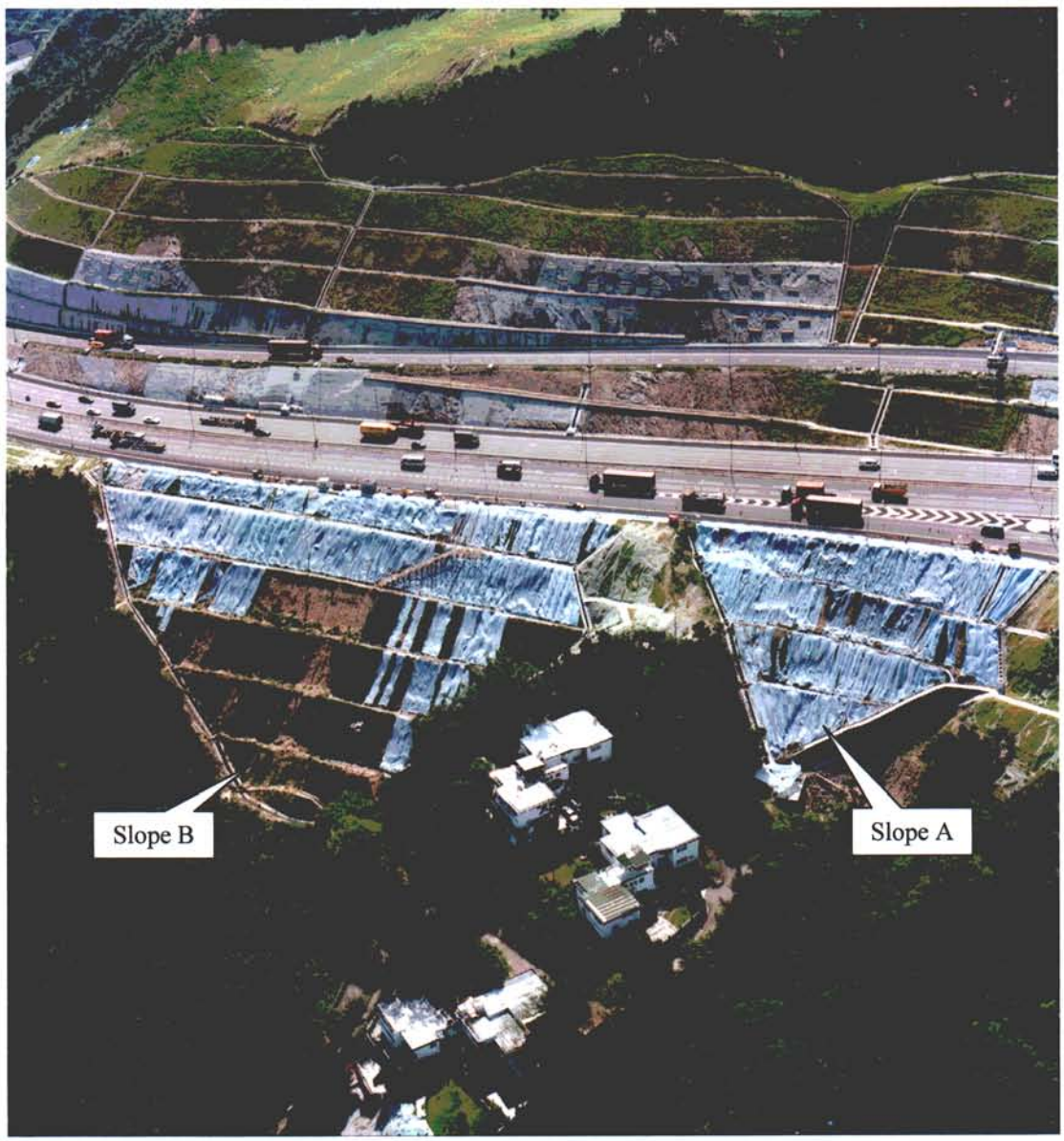
Description: A major natural slope failure which resulted in the temporarily evacuation of the Captain's house.

Plate 6 - Above the Outward Bound School, Tai Mong Tsai near Sai Kung (Incident ME 98/6/55)

Photo Ref. LSR 15/98 Taken on: 8-2-98

Description: A major soil cut slope failure which involved a section of Hang Lok Lane and resulted in the temporarily evacuation of a total of 143 residents.

Plate 7 - Hang Lok Lane, Sha Tin (Incident MW 98/2/1)



Negative No. PS 953(17565) Taken on: 29-6-98

Description: Three major fill slope failures affected approximately 40% of the combined slope surface (3300 m^2 out of 7200 m^2) of two newly-formed fill slopes.

Plate 8 - Below Ramp G of the Ting Kau Bridge and Approach Viaduct at Ting Kau (Incident MW 98/5/2)

Photo Ref. LSR 3/99 Taken on: 29-6-98

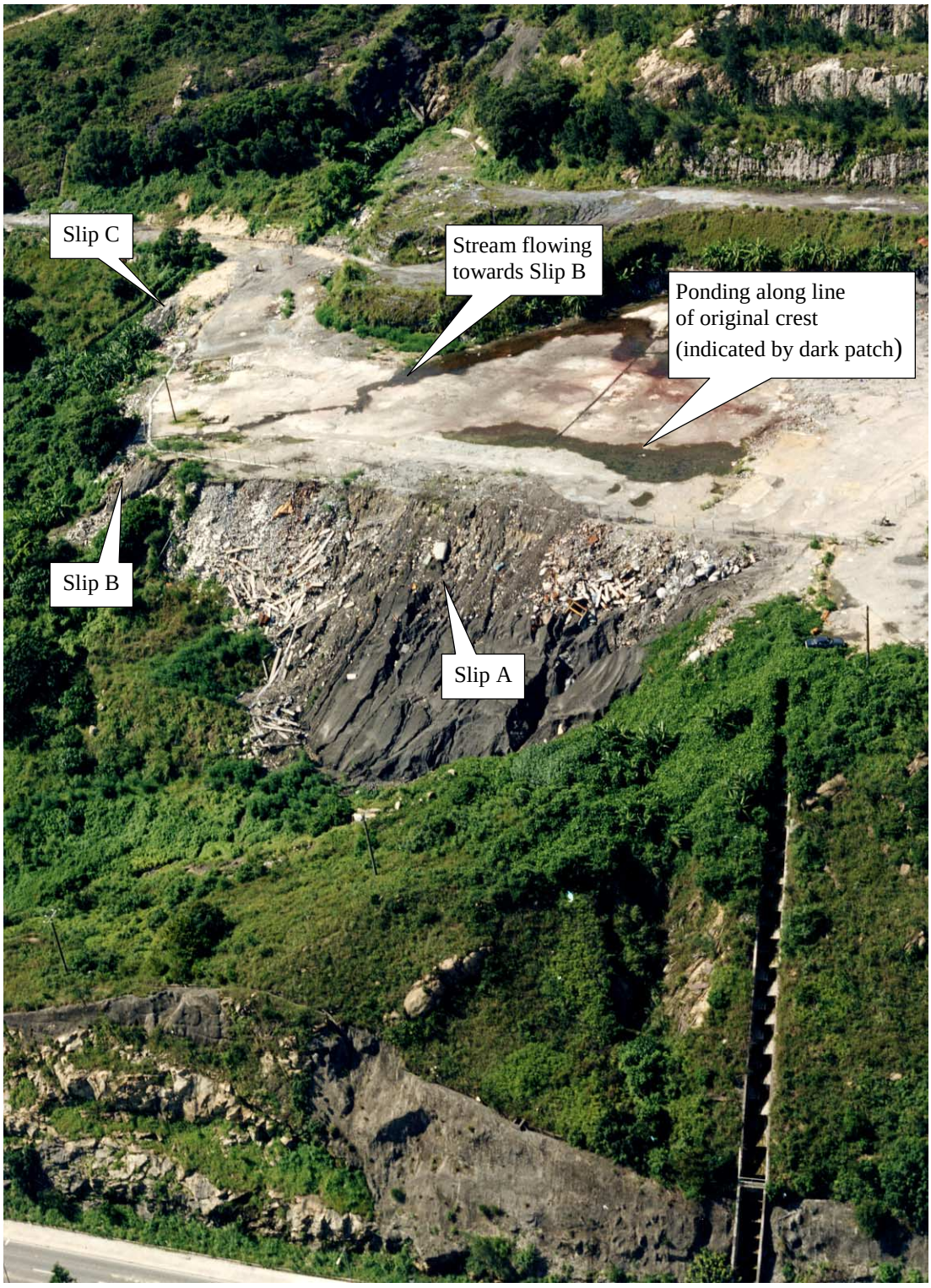
Description: A major soil cut slope failure which resulted in the closure of the access road to Sunny Villa.

Plate 9 - Sunny Villa, 218 Castle Peak Road, New Territories (Incident MW 98/6/9)

Photo Ref. LSR 18/99 Taken on: 10-6-98

Description: A major cut slope failure which resulted in the closure of Tai Po Road.

Plate 10 - Tai Po Road near Chak On Estate (Incident MW 98/6/11)



Negative No. PS 953(17560) Taken on: 29-6-98

Description: Three PFA fill slope failures which resulted in the closure of one lane of road.

Plate 11 - PFA Fill Slope at Siu Lang Shui, Tuen Mun (Incident MW 98/6/12)

APPENDIX A

LIST OF INCIDENTS REPORTED TO THE GEO

LIST OF TABLES

Table A1 - List of Major Landslides Reported to GEO in 1998 (Sheet 1 of 4)

Incident No.	Location (Slope No.)	Failure							Facility Affected	Consequence
		Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)		
HK98/2/1	Beside 38 Broadwood Road, Happy Valley.	18/2 (~22:00)	Washout	Major (~80)	11	9.5	40	4.2	Trail	Trail closed.
HK98/6/4	Between Catch Pit No. VT11 & VT12,Victoria Road, Pok Fu Lam. (11SW-C/C138)	~9/6 (17:00)	Soil/rock cut slope, natural slope	Major (60)		10			Pedestrian pavement, road	Pedestrian pavement closed, 2 lanes of road closed.
HK98/6/6	Behind Dynasty Court & Hillsboroagh Court, Hornsey Road, Mid-Levels.	9/6 (15:15)	Natural slope	Major (50-100)		10			Road, pedestrian pavement, major gullery	1 lane of road closed, pedestrian pavement closed, major gullery blocked.
K98/6/1	West Coast Public Car Park, Fung Shing Street, Ngau Chi Wan, Choi Hung. (11NE-A/F116)	9/6 (17:00)	Washout	Major (~120-200)	15			12-15	Road, carpark, pedestrian pavement	
K98/6/5	Below police post, Fei Ngo Shan Road, Tsz Wan Shan. (7SE-C/C42)	9/6 (12:30)*	Soil cut slope	Major (2500)*	170*	40*	30*		Road	1 lane of road closed.
K98/6/12	Ex-quarry site, north of Choi Sing House, Choi Ha Estate, Jordan Valley.	Unknown	Soil/rock cut slope	Major (~60)	50	12		10		
K98/6/13	Fung Wong High Level Service Reservoir, Shatin Pass Road, Tsz Wan Shan. (11NE-A/C21)	9/6 (05:00 to 09:00)	Soil cut slope	Major (120)*	29*	12*		13*	WSD reservoir	Access track blocked, disruption of the reservoir operation.

Table A1 - List of Major Landslides Reported to GEO in 1998 (Sheet 2 of 4)

Incident No.	Location (Slope No.)	Failure							Facility Affected	Consequence
		Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)		
K98/7/1	East uphill of Shun Chi Court, below Anderson Road, Sai Kung.	29/6	Natural slope	Major (~560)	25	15		25	Building lot	
K98/7/3	Fung Wong High Level Service Reservoir, Shatin Pass Road, Tsz Wan Shan. (11NE-A/C214)	4/7	Soil cut slope	Major (100-200)	7			7	Country Park	
ME98/5/10	Above House No. 74, Wong Uk, Luk Keng, Sha Tau Kok.	24/5 (08:00)*	Natural slope	Major (150)*		10	~24*	10	Open area/hillside, village houses	
ME98/5/15	Zone 266, Lin Ma Hang Road, Sha Tau Kok.	24/5	Natural slope	Major (225)		15		15	Open area/hillside	
ME98/6/3	Ma Nin Village, Kau To, Shatin.	97	Natural slope	Major (50)		10		10	Pedestrian pavement	Pedestrian pavement closed.
ME98/6/10	Near Cable Post No. P11/8 of Ma Yau Tong Line, access road to Au Tau Village, Tseung Kwan O. (11NE-D/F284)	9/6 (13:45)*	Fill Slope*	Major (170)*	30	8-20	23-26*	28	Open area/hillside, access road	Access road closed.
ME98/6/22	House No. 30, Pak Sha Wan Village, Sai Kung.	9/6 (p.m.)*	Natural slope	Major (300)*	42*	7-10*	25*	20*	Licenced house, hut for pigeons/bird	1 house temporarily evacuated, 1 hut for pigeons/bird was damaged.
ME98/6/36	Yue Sun Garden, Wo Mei, Sai Kung. (11NE-B/C513)	9/6 (1st a.m. 2nd 18:00 3rd unknown)	Soil cut slope	Major (200)* (1100)* (50)*	10* 16*	15* 35* 10*	34* 30* 50*	5* 16*	Squatter	1 hut permanently evacuated, 5 huts temporarily evacuated.

Table A1 - List of Major Landslides Reported to GEO in 1998 (Sheet 3 of 4)

Incident No.	Location (Slope No.)	Failure							Facility Affected	Consequence
		Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)		
ME98/6/55	Outward Boung School, Tai Mong Tsai, Sai Kung.	9/6 (05:30)*	Natural slope	Major (900*)	31*	15*	27*	10*	Building lot	1 house temporarily evacuated.
ME98/7/4	Tai Po Tsai Village, Yan Yee Road, Sai Kung.	Unknown	Natural slope	Major (~50-80)	15			15	Footpath	
ME98/9/3	Zone 197, Border Fence Road, Sha Tau Kok.	24/5	Natural slope	Major (60)	10	12		10	Border road, Shengzhen river	
ME98/12/1	Lamp Post No. N88769, Ting Kok Road, Tai Po. (7NE-A/C8)	20/7	Soil cut slope	Major (~80)	20			5	Pedestrian pavement	
MW98/2/1	In front of On Lok Villa, Hang Lok Lane, Tung Lo Wan, Shatin. (7-SW-D/C293)	8/2 (08:50)*	Soil cut slope, retaining wall	Major (1100)*	11*	36*	26*	6*	Road, building lot, building access	2 lanes of road closed, 143 residents evacuated.
MW98/5/2	Near Ting Kau Bridge/Tuen Mun High-Interchange.	1st :4/5 2nd :24/5 3rd :9/6	Fill slope	Major (1st :500 2nd :400 3rd :400)*			33* 33* 33*		Hard shoulder	Hard shoulder closed.
MW98/6/9	Access road to Sunny Villa, 218 Castle Peak Road. (6SE-D/C304)	9/6 (17:50)*	Cut slope	Major (200)*	27*	28*		14*	Road, access road, suspected car being buried.	2 lane of road closed.
MW98/6/11	Below WSD Service Reservoir, near Chak On Estate, Tai Po Road, Tai Wo Ping. (11NW-B/C69 & 11NW-B/C60)	9/6 (before 16:50)*	Soil cut slope*	Major (1400)*	22	10-37		15*	Road	4 lanes of road closed.

Table A1 - List of Major Landslides Reported to GEO in 1998 (Sheet 4 of 4)

Incident No.	Location (Slope No.)	Failure							Facility Affected	Consequence
		Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)		
MW98/6/12	Siu Lang Shui, Lung Mun Road, Tuen Mun. (5SE-D/F17)	9/6*	Fill slope	Major (1000, 80, 20)*	26	60* 8* 7*	35* 35* 35*		Vallery	1 lane of road closed.

Legend:

+	Information from GEO Detailed Investigation.
*	Information from GEO's 1998 Landslide Investigation Consultants.
(1)	Height of Landslide is the difference in elevation measured from the crest of failure to the distal end of the main body of the landslide debris.
(2)	Width of Landslide is the maximum width of landslide scar.
(3)	Travel angle of landslide is the angle between the crest of failure to the distal end of the main body of landslide debis and the horizontal. The angle reported is approximate and is based on information contained in the GEO Incident Reports, except where stated otherwise.
(4)	Scar Height is the maximum height of landslide scar.

Table A2 - List of Incidents in Hong Kong Island Reported to GEO in 1998 (Sheet 1 of 5)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[1] (m)	Width[2] (m)	Estimated Travel Angle[3] (degree)	Scar Height[4] (m)			
HK98/2/1	Beside 38 Broadwood Road, Happy Valley.	19/2	HyD/HK	18/2 (~22:00)	Washout	Major (~80)	11	9.5	40	4.2	Trail	Trail closed.	Washout
HK98/2/2	Tai Hang Road, Jardine's Lookout. (11SE-C/C54)	20/2	HyD/HK	20/2 (03:00)	Rock fall	Minor (2)				2	Road	1 lane of road closed.	
HK98/3/1	18 Gough Hill Road, Mid-Levels. (11SW-D/CR482)	2/3	Arch SD	1/3	Rock fall	Minor (0.08)					Open area behind a tennis court		
HK98/4/1	Opposite 62 Blue Pool Road, Happy Valley. (11SW-D/FR287)	12/4	BD	12/4 (08:00)		Minor (<2)	8				Road, pedestrian pavement	1 lane of road closed, pedestrian pavement closed.	No failure, only tree fallen.
HK98/4/2	17 Blue Pool Road, Happy Valley. (11SW-D/FR287)	27/4	HyD/HK	27/4 (~02:00)		Minor (<5)	8	2		2.2	Road, pedestrian pavement	Pedestrian pavement closed, 2 lanes of road blocked.	No failure, only tree fallen.
HK98/5/1	North-east below Ap Lei Chau Bridge, Ap Lei Chau.	15/5	HyD/HK	~3/5	Soil cut slope	Minor (2-3)	3.5			1.5	Construction site		
HK98/5/2	South-west of Hong Kong Stadium, access road to Chung Man Tsuen, So Kon Po. (11SW-D/CR227)	24/5	Police	24/5	Soil/rock cut slope, rock fall	Minor (5)*		6*			Lane of access road along side of Hong Kong Stadium	Private access closed, pedestrian pavement closed.	
HK98/5/3	Adjacent Lump Post No. 24388 & Catch Pit No. ST2, Stubbs Road, Happy Valley. (11SW-D/C566 & 11SW-D/N22)	24/5	HyD/HK	24/5	Soil/rock cut slope	Minor (1)					Road	1/2 lane of road closed.	

Table A2 - List of Incidents in Hong Kong Island Reported to GEO in 1998 (Sheet 2 of 5)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
HK98/5/4	Between Hong Kong Country Club & Deep Water Golf Club, Island Road, Deep Water Bay. (15NW-B/C117)	31/5	HyD/HK	31/5 (06:30)	Soil/rock cut slope	Minor (1-2)	6				Road, pedestrian pavement	1 lane of road blocked.	
HK98/6/1	North of 56-58 Mount Davis Road, Western District. (11SW-C/C202)	30/5	Police	30/5 (20:15)	Rock fall	Minor (2-3)	5				Carpark	1 car was damaged.	Wedge failure
HK98/6/2	Between 88 & 92 Pok Fu Lam Road. (11SW-A/C324)	9/6	BD	9/6 (08:00)	Soil cut slope	Minor (25)	7	7			Building access, watchman kiosk	1 watchman kiosk destroyed.	
HK98/6/3	Near May Road, Peak Tram (PTC) Station, The Peak. (11SW-D/CR1562)	9/6	Public	9/6 (12:45)	Soil cut slope	Minor (~0.5)	1.5	2		1.5	Peak tramway	Peak tramway temporarily suspended.	
HK98/6/4	Between Catch Pit No. VT11 & VT12,Victoria Road, Pok Fu Lam. (11SW-C/C138)	9/6	GEO	~9/6 (17:00)	Soil/rock cut slope, natural slope	Major (60)		10			Pedestrian pavement, road	Pedestrian pavement closed, 2 lanes of road closed.	
HK98/6/5	Near Lamp Post No. 39670, Victoria Road. (11SW-A/C293)	10/6	HyD/HK	10/6 (morning)	Soil/rock cut slope	Minor (~2)	5	2		2	Pedestrian pavement	Pedestrian pavement closed.	
HK98/6/6	Behind Dynasty Court & Hillsboroagh Court, Hornsey Road, Mid-Levels.	9/6	GEO	9/6 (15:15)	Natural slope	Major (50-100)		10			Road, pedestrian pavement, major gullery	1 lane of road closed, pedestrian pavement closed, major gullery blocked.	

Table A2 - List of Incidents in Hong Kong Island Reported to GEO in 1998 (Sheet 3 of 5)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
HK98/6/7	West wing of 7C Bowen Road, Mid-Levels. (11SW-B/CR183)	9/6	GEO	9/6 (before 17:10)	Rock fall	Minor (<0.1)	15				Rear yard of building		
HK98/6/8	Above 7C Bowen Road, Mid-Levels.	11/6	HyD/HK	11/6 (09:40)*	Natural slope*	Minor (10)*	59*	10-18*		40*	Building lot	5 flats evacuated, 3 car parks evacuated.	Washout
HK98/6/9	House No. 27 & 28, Dai Hau Wan Upper Village, Pok Fu Lam.	10/6	Police	10/6 (21:15)	Retaining wall	Minor (~34)	6.5	9		2.5	Village hut, public footpath	2 village houses temporarily evacuated, pedestrian pavement closed.	
HK98/6/10	Behind 48-50 Aberdeen Main Road, Aberdeen. (11SW-D/C1436)	11/6	BD	11/6 (14:00)	Rock fall	Minor (~0.03)	15				Rear lane		
HK98/6/11	North-west of Ricci Hall, 93 Pok Fu Lam Road, Mid-Levels. (11SW-A/F40)	9/6	Police	9/6 (06:00-08:00)	Fill slope	Minor (15)					Road, wall/building foundation	2 lanes of road closed.	
HK98/6/12	Behind basketball court, Forbes Street, Kennedy Town.	9/6	GEO	9/6	Washout	Minor (~1)	2.5				Open area, pedestrian pavement		Minor washout
HK98/6/13	6 Hau Fung Lane, Wan Chai. (11SW-B/C254)	11/6	Public	10/6	Soil cut slope	Minor (<1)					Construction site		
HK98/6/14	Near driving centre, Hawthorn Road, Happy Valley.	12/6	HyD/HK	11/6	Natural slope	Minor (~20)	8	4		8	Pedestrian pavement	Pedestrian pavement closed.	

Table A2 - List of Incidents in Hong Kong Island Reported to GEO in 1998 (Sheet 4 of 5)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[1] (m)	Width[2] (m)	Estimated Travel Angle[3] (degree)	Scar Height[4] (m)			
HK98/6/15	Staircase to Cheung Fai Temple, Ngoi Man Street, Shau Kei Wan. (11SE-B/CR307)	15/6	Police	15/6 (18:00)	Soil cut slope	Minor (10)	4	5		4	Staircase	Footpath closed.	
HK98/6/16	Telegraph Bay Village, Pok Fu Lam.	12/6	DO/S	10/6	Washout	Minor (~3)	2		32	2	Pedestrian pavement		Washout
HK98/7/1	Near Catch Pit No. VT14 about 150m south of petrol station, Baguio Villa, Victoria Road. (11SW-C/C139)	3/7	Police	3/7 (18:30)	Rock fall	Minor (2)					Road	1 lane of road closed.	
HK98/7/2	Below 1 Chatham Path, Mid-Levels. (11SE-D/C837)	3/7	Public	Unknown	Soil cut slope	Minor (3)	2	5		2	Pedestrian pavement		
HK98/7/3	North of Sky Scraper, 132-142 Tin Hau Temple Road, North Point. (11SE-A/CR43)	6/7	HyD/HK	5/7 (11:45)	Rock fall	Minor (1)	5				Pedestrian pavement	Pedestrian pavement closed.	
HK98/7/4	Boundary of 27-31 South Bay Road & 110 Repulse Bay Road. (15NE-A/CR376)	6/7	Public	6/7 (10:00)	Retaining wall	Minor (6)	2.5			2.5	Nursey platform		Masonry wall
HK98/7/5	Adjacent 41 Conduit Road, opposite Lamp Post No. 39946, Mid-Levels. (11SW-A/C404)	16/7	Public	May, 1998	Washout	Minor (3.5)	2.5	4		2.5			Washout

Table A2 - List of Incidents in Hong Kong Island Reported to GEO in 1998 (Sheet 5 of 5)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
HK98/9/1	13 A Kung Ngam Road, Shau Kei Wan. (11SE-B/C87)	17/9	Police	17/9 (02:20)	Rock fall	Minor (~1)*	3-5*	2.5*		2.5	Road, pedestrian pavement	1 lane of road closed, pedestrian pavement closed.	
HK98/11/1	South of Tanner Court, 60 Tanner Road, North Point. (11SE-A/C94)	30/11	Public	28/11 (06:00)		Minor (~0.1)				4	Building lot	1 flat evacuated.	Fallen of broken chunam.

Legend:

+	Information from GEO Detailed Investigation.
*	Information from GEO's 1998 Landslide Investigation Consultants.
(1)	Height of Landslide is the difference in elevation measured from the crest of failure to the distal end of the main body of the landslide debris.
(2)	Width of Landslide is the maximum width of landslide scar.
(3)	Travel angle of landslide is the angle between the crest of failure to the distal end of the main body of landslide debis and the horizontal. The angle reported is approximate and is based on information contained in the GEO Incident Reports, except where stated otherwise.
(4)	Scar Height is the maximum height of landslide scar.

Table A3 - List of Incidents in Kowloon Reported to GEO in 1998 (Sheet 1 of 3)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
K98/4/1	Po Lam Road platform contract slope adjacent Sau Mau Ping Road.	27/4	Police	27/4 (12:54)		N.A.	12	12		6	Road	1 lane of road closed.	Dislodgement of stone pitching which covered a reinforced fill slope.
K98/6/1	West Coast Public Car Park, Fung Shing Street, Ngau Chi Wan, Choi Hung. (11NE-A/F116)	9/6	HyD/K	9/6 (17:00)	Washout	Major (~120-200)	15			12-15	Road, carpark, pedestrian pavement		Washout
K98/6/2	Under flyover which is near Shun Lee Estate Fire Station, New Clear Water Bay Road. (11NE-A/C455)	9/6	HyD/K	9/6 (13:45)	Soil cut slope	Minor (~10)	6.5	3	41	4	Pedestrian pavement, road	1 lane of road closed.	
K98/6/3	Choi Ha Road behind Tak Po Garden, Kowloon Bay. (11NE-C/C191)	9/6	GEO	9/6 (p.m.)	Soil cut slope	Minor (~15)	8	4.5	27	4	Road, pedestrian pavement	1 lane of road closed.	Washout
K98/6/4	Behind Waterloo Road Caltex petrol station, Lung Cheung Road Park, Kolwoon Tong. (11NW-B/C639)	10/6	HyD/K	9/6	Washout	Minor (~2)				1.5	Platform below the slope facing the petrol station		Washout
K98/6/5	Below police post, Fei Ngo Shan Road, Tsz Wan Shan. (7SE-C/C42)	10/6	FSD	9/6 (12:30)*	Soil cut slope	Major (2500)*	170*	40*	30*		Road	1 lane of road closed.	
K98/6/6	Jat's Incline.	9/6	Police	9/6 (21:40)	Soil cut slope	Minor (~40-50)	7				Country Park, Road		

Table A3 - List of Incidents in Kowloon Reported to GEO in 1998 (Sheet 2 of 3)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
K98/6/7	Opposite East Kowloon Clinic, Ping Ting Road, Ngau Chi Wan. (11NE-A/C68)	10/6	HyD/K	9/6 or 10/6	Soil cut slope	Minor (~8)	6	8		6			
K98/6/8	Near Tate's Pass, Fei Ngo Shan Road. (7SE-C/C594)	10/6	HyD/K	9/6 or 10/6	Soil/rock cut slope	Minor (~40)	7	12		7	Road		
K98/6/9	Near Tsiu Lan Shue, Anderson Road Quarry, Sai Kung. (11NE-B/FR94)	13/7	Public	9/6	Washout	Minor (15-20)	8			4			Washout
K98/6/10	Gun Club Hill Barracks, Chatham Road South, Tsim Sha Tsui. (11NW-D/FR313)	21/6	HyD/K	21/6	Soil cut slope	Minor (3)	8	3		1	Pedestrian pavement		Washout
K98/6/11	Under Chatham Road North, near exit of tunnel, Winslow Street, Hung Hom.	23/6	HyD/K	20/6	Natural slope	Minor (~22)		8		8	Pedestrian pavement		
K98/6/12	Ex-quarry site, north of Choi Sing House, Choi Ha Estate, Jordan Valley.	16/6	HD	Unknown	Soil/rock cut slope	Major (~60)	50	12		10			
K98/6/13	Fung Wong High Level Service Reservoir, Shatin Pass Road, Tsz Wan Shan. (11NE-A/C21)	30/7	WSD	9/6 (05:00 to 09:00)	Soil cut slope	Major (120)*	29*	12*		13*	WSD reservoir	Access track blocked, disruption of the reservoir operation.	
K98/7/1	East uphill of Shun Chi Court, below Anderson Road, Sai Kung.	3/7	GEO	29/6	Natural slope	Major (~560)	25	15		25	Building lot		Washout

Table A3 - List of Incidents in Kowloon Reported to GEO in 1998 (Sheet 3 of 3)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height(1) (m)	Width(2) (m)	Estimated Travel Angle(3) (degree)	Scar Height(4) (m)			
K98/7/2	10 m from end of Lok Wah Street, Tsz Wan Shan. (11NE-A/C13)	15/7	HyD/K	9/6	Soil cut slope	Minor (~8)		4		4	Carpark		Washout
K98/7/3	Fung Wong High Level Service Reservoir, Shatin Pass Road, Tsz Wan Shan. (11NE-A/C214)	30/7	WSD	4/7	Soil cut slope	Major (100-200)	7			7	Country Park		
K98/11/1	Access road to Ma Chai Hang Fresh Water Service Reservoir behind Block 7-9, Tsui Chuk Garden, Wong Tai Sin.	9/9	DLO/KE	Unknown	Soil cut slope	Minor (~10)	4						

Legend:

+ Information from GEO Detailed Investigation.

* Information from GEO's 1998 Landslide Investigation Consultants.

(1) Height of Landslide is the difference in elevation measured from the crest of failure to the distal end of the main body of the landslide debris.

(2) Width of Landslide is the maximum width of landslide scar.

(3) Travel angle of landslide is the angle between the crest of failure to the distal end of the main body of landslide debis and the horizontal. The angle reported is approximate and is based on information contained in the GEO Incident Reports, except where stated otherwise.

(4) Scar Height is the maximum height of landslide scar.

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 1 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/1/1	No. G2, Marina Cove, Hiram's Highway, Sai Kung. (7SE-D/C51)	5/1	Public	Unknown	Washout	Minor (5-10)	3			3	Open area/hillside		Washout
ME98/2/1	South-west of Shung Him Tong, Fanling.	17/2	Police	17/2	Soil cut slope	Minor (<1)	2.2	2			Squatter	1 hut temporarily evacuated.	
ME98/2/2	House No. 152, Tai Hang Hau Village, Clear Water Bay, Sai Kung.	23/2	Public	Early Feburary, 1998	Washout	Minor (1)	1.5			1.5	Backyard, washroom		Washout
ME98/2/3	East of House No.152, Tai Hang Hau Village, Clear Water Bay, Sai Kung.	23/2	Public	95?	Natural slope	Minor (10)	9				Area without access to public		
ME98/3/1	Behind House No. 33, Pak Tau Ha Tsuen, Nam Chung, Luk Keng, Sha Tau Kok.	26/2	Public	19/2	Soil/rock cut slope	Minor (3)	8			1.5	Squatter		Washout
ME98/3/2	House No. 32, Tan Ka Wan, Sai Kung.	20/2	DO/TP	Janaury, 1998	Soil cut slope	Minor (<5)	6			5	Building lot		
ME98/3/3	House No. 41 A & B, Tseng Lan Shue, Clearwater Bay Road, Sai Kung. (11NE-B/C709)	28/2	Public	Unknown		N.A.	3	8					Sign of distress with no failure mass, overhang of soil mass at upper part of slope.
ME98/4/1	Adjacent House No. 45A, Shatin Wai.	28/4	HyD/NT	26/4 (night)	Washout	Minor (6)	3			3	Pedestrian pavement		Washout

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 2 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/4/2	Behind Lot 1623, DD 243, Mang Kung Uk, Sai Kung. (12NW-C/R174)	29/4	BD	27/4	Retaining wall	Minor (~15)	3			3	Building access, pedestrian pavement		
ME98/5/1	Junction of Hang Hau Wing Lung Road and Clear Water Bay, Sai Kung.	1/5	Public	Unknown	Washout	Minor (1-2)	3.2			1.5	Pedestrian pavement		Washout
ME98/5/2	Behind House No. 142, Kam Shan Village, Tai Po.	15/4	Public	Unknown		N.A.	3			3	Open area/hillside, pedestrian pavement, squatter	Pedestrian pavement closed.	Significant sign of distress with no failre mass.
ME98/5/3	Below House No. 34, Kam Shan Road, Tai Po.	5/5	HyD/NT	1/5 (10:00)	Soil cut slope	Minor (~1)	3			2	Pedestrian pavement		
ME98/5/4	Hut No. 59, (RTP/MSH/456, X/MSH/200, 201&2) Mui Shue Hang Villgae, Tai Po.	3/5	Police	3/5 (09:59)	Natural slope, soil cut slope	Minor (~8)	1.8			1.8	Squatter	4 huts temporarily evacuated.	Closure order recommended.
ME98/5/5	Access road to Outward Bound School, Sai Kung.	4/5	DO/SK	Unknown	Soil cut slope	Minor (~3)	2				Pedestrian pavement		
ME98/5/6	Near Pik Fa Lam, Fei Ngo Shan Road, Sai Kung. (11NE-A/C515)	25/5	Police	25/5 (a.m.)	Soil/rock cut slope	Minor (6)	5			5	Road	Road blocked.	Washout
ME98/5/7	Zone 245, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C57)	25/5	HyD/NT	24/5 (midnight)	Soil cut slope	Minor (~2)	3.5				Open area/hillside		

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 3 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/5/8	Zone 253, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C120)	25/5	Police	24/5 (midnight)	Soil cut slope	Minor (20)	8	6		8	Open area/hillside		
ME98/5/9	Near west side of House No. 32, Luk Keng Tsuen, Sha Tau Kok. (3NE-C/C166)	25/5	Public	24/5	Soil cut slope	Minor (~4.5)	3	3		3	Open area/hillside		
ME98/5/10	Above House No. 74, Wong Uk, Luk Keng, Sha Tau Kok.	25/5	Public	24/5 (08:00)*	Natural slope	Major (150)*		10	~24*	10	Open area/hillside, village houses		
ME98/5/11	Adjoining the access leading to Sheung Wo Hang, Sha Tau Kok Road, Sha Tau Kok.	24/5	FSD	24/5 (10:20)	Natural slope, Soil cut slope	Minor (~20)	5			5	Access road	Access road blocked.	
ME98/5/12	Near Ha Yeung Clearwater Bay Road (Kowloon Bound), Sai Kung. (12NW-C/C13)	22/5	HyD/NT	22/5	Washout	Minor (~2)	3				Road	Lane of road blocked.	Washout
ME98/5/13	Zone 254, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C127)	25/5	HyD/NT	24/5 (midnight)	Soil cut slope	Minor (~2)	2.5	2.5			Open area/hillside		
ME98/5/14	Zone 261, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C143)	25/5	HyD/NT	24/5 (midnight)	Soil cut slope, rock fall	Minor (6)	4	2		4	Open area/hillside		
ME98/5/15	Zone 266, Lin Ma Hang Road, Sha Tau Kok.	25/5	HyD/NT	24/5	Natural slope	Major (225)		15		15	Open area/hillside		
ME98/5/16	Near Lump Post No. N9010, Wo Mei, Sai Kung. (11NE-B/C542)	21/5	DO/SK	21/5 (a.m.)	Washout	Minor (2-3)	4	1.2		4	Road	1/10 lane of road blocked.	Washout

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 4 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/1	Tso Wo Hang, Tai Mong Tsai Road, Sai Kung. (8SW-A/C11)	21/5	HyD/NT	Unknown	Soil cut slope	Minor (~3)	1.4	1.5		1.4	Pedestrian pavement	Pedestrian pavement closed.	
ME98/6/2													Same as Incident No. ME98/6/4
ME98/6/3	Ma Nin Village, Kau To, Shatin.	2/6	Public	97	Natural slope	Major (50)		10		10	Pedestrian pavement	Pedestrian pavement closed.	
ME98/6/4	Adjacent House No.4, Ma Yau Tong, Tseung Twan O.	3/6	Public	27/5	Soil cut slope, retaining wall	Minor (3)	5.5			4.5	Carpark		
ME98/6/5	House No. 42, Ha Hang Village, Tai Po. (3SW-D/C177)	29/5	DO/TP	24/5	Soil cut slope, natural slope	Minor (4.5)	5.5	2		5.5	Pedestrian pavement, open area		
ME98/6/6	South of Yucca Villa, Kau To Village, Shatin.	9/6	FSD	9/6 (early morning)		N.A.					Building lot		No failure, fence wall collapse.
ME98/6/7	Behind House No. 40A, Tseung Lan Shue, Sai Kung. (11NE-B/C709)	9/6	GEO	9/6	Washout	Minor (~2)				2	Backyard		Washout & flooding
ME98/6/8	Hut No. XTS.A.43, Tan Shan, Sai Kung.	9/6	HyD/NT	9/6	Soil cut slope	Minor (~30)	7		54.24	7	Squatter, access road	1 hut permanently evacuated.	
ME98/6/9	Adjacent carpark near House No. 9, Tan Shan, Sai Kung.	9/6	HyD/NT	Unknown	Soil cut slope	Minor (<5)	2.5			2.5	Building access		

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 5 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/10	Near Cable Post No. P11/8 of Ma Yau Tong Line, access road to Au Tau Village, Tseung Kwan O. (11NE-D/F284)	9/6	HyD/NT	9/6 (13:45)*	Fill slope*	Major (170)*	30	8-20*	23-26*	28	Open area/hillside, access road	Access road closed.	
ME98/6/11	Hut No. 6, Ma Wo Tsuen, Tai Po.	9/6	DO/TP	9/6 (06:30)	Soil cut slope, fill slope	Minor (25)		5		3.5	Road, squatter	Road closed.	
ME98/6/12	Adjacent footpath in Po Sam Pai, Tai Po.	9/6	Police	9/6	Natural slope	Minor (3)	5	2		5	Footpath	Footpath closed.	
ME98/6/13	House No. 44, Tai Mong Tsai Tsuen, Sai Kung.	9/6	FSD	9/6 (06:50)	Retaining wall	Minor (~30)	3	10		3	Village house	3-storey village house temporarily evacuated.	
ME98/6/14	House No. 12A, Shek Wu San Tsuen, Sheung Shui. (3SW-A/C68)	5/6	DO/TP	3/5	Soil cut slope, soil/rock cut slope	Minor (20)		10		1.5	Squatter, building lot	1 hut temporarily evacuated.	
ME98/6/15	Near Pak Fa Lam, Fei Ngo Shan Road, Sai Kung. (11NE-B/C590)	9/6	HyD/NT	9/6 (p.m.)	Soil/rock cut slope	Minor (30-40)	7	5		7	Road	Road closed.	
ME98/6/16	Carpark in front of 49 Luk Mei Tsuen, Luk Cheng Road, Sai Kung. (7SE-D/C33)	10/6	Police	10/6 (a.m.)	Washout	Minor (3-5)	5	6	40	3	Parking space	Parking space closed.	Washout
ME98/6/17	House No. 8B, Fung On Village, Sai Kung.	10/6	Public	9/6 (a.m.)	Washout	Minor (14-20)	7	7		7	Open area/hillside		Washout

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 6 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/18	Licence House No. S12035, Pak Shek Wo Sun Tsuen, Sai Kung. (11NE-B/C372)	10/6	DO/SK	9/6 (a.m.)	Washout	Minor (2)	4	1.5		4	Open area/hillside		Washout
ME98/6/19	In front of W.C. in Pak Shen Wo Sun Tsuen, Sai Kung.	10/6	DO/SK	9/6 (a.m.)	Washout	Minor (3-5)		4			Public toilet		Washout
ME98/6/20	Opposite Lamp Post No. V07146, Pak Shek Wo Sun Tsuen, Sai Kung. (11NE-B/C404)	10/6	Public	9/6 (a.m.)	Washout	Minor (3-4)	5	2			Village road		Washout
ME98/6/21													Same as Incident No. ME98/6/36
ME98/6/22	House No. 30, Pak Sha Wan Village, Sai Kung.	9/6	Public	9/6 (p.m.)*	Natural slope	Major (300)*	42*	7-10*	25*	20*	Licenced house, hut for pigeons/bird	1 house temporarily evacuated, 1 hut for pigeons/bird was damaged.	
ME98/6/23	Adjacent W.C. in Fishman New Village, Pak Sha Wan, Sai Kung.	10/6	Public	9/6 (a.m.)	Washout	Minor (1)					Open area/hillside		Washout
ME98/6/24	South of House No. 6, Tan Shan Tsuen, Sai Kung. (11NE-B/CR99)	10/6	Public	10/6 (a.m.)	Washout	Minor (0.2-0.5)		2			Open area/hillside		Washout
ME98/6/25													Same as Incident No. ME98/6/9

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 7 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/26	No. 4A, Block A, Flamingo Gardens, Fei Wan Road, Sai Kung. (11NE-B/C431)	10/6	DO/SK	9/6 (a.m.)	Washout	Minor (2-3)	15	4			Landscape at the crest of slope		Washout
ME98/6/27	Kwun Ping Road, Shatin.	9/6	GEO	9/6	Natural slope	Minor (3)		3		2	Road		
ME98/6/28													Same as Incident No. ME98/6/13
ME98/6/29	Opposite Outward Bound Camp, Tai Mong Tsai Road. (8SW-B/C74)	9/6	Police	9/6 (11:00)	Soil cut slope	Minor (~10-20)	10				Road	2 lanes of road closed.	
ME98/6/30	House No. 89, Sun On Tsuen, Po Lo Che, Sai Kung. (8SW-C/C130)	9/6	Police	9/6 (a.m.)	Soil cut slope	Minor (3-5)	7				Open area/hillside		Washout
ME98/6/31	House No. 108, Nam Shan Tsuen, Sai Kung.	9/6	HyD/NT	~9/6 (06:00)	Retaining wall	Minor (~5)	1.5				Road		
ME98/6/33	DD257, Lot 410-412, Tsam Chuk Wan, Sai Kung. (8SW-B/R2)	9/6	Public	9/6 (15:50)	Retaining wall	N.A.				0.8	Carpark	1 parking area temporarily evacuated.	
ME98/6/34	Opposite monumant, Tai Mong Tsai Road, Sai Kung. (8SW-B/C100)	9/6	HyD/NT	9/6	Soil cut slope	Minor (1-2)	2			2	Side walk		Washout
ME98/6/35	Near Fung San Road, Tai Mong Tsai Road, Sai Kung. (8SW-A/C57)	9/6	HyD/NT	9/6 (a.m.)	Soil/rock cut slope	Minor (2-3)	20				Road	1/4 lane of road blocked.	

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 8 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/36	Yue Sun Garden, Wo Mei, Sai Kung. (11NE-B/C513)	9/6	GEO	9/6 (1st a.m. 2nd 18:00 3rd un-known)	Soil cut slope	Major (200)* (1100)* (50)*	10* 16*	15* 35* 10*	34* 30* 50*	5* 16*	Squatter	1 hut permanently evacuated, 5 huts temporarily evacuated.	
ME98/6/37	Near House No. 54, Kam Shan Garden, Kam Shan Road, Shatin.	9/6	DO/TP	9/6	Soil cut slope	Minor (4)	1.2			1.2	Pedestrian pavement		Washout
ME98/6/38	Lot 1091, DD22, Block 17, Wun Yin Ha Tsuen, Tai Po. (7NW-B/C242)	9/6	DO/TP	9/6 (a.m.)	Soil cut slope	Minor (2)	2				Open area/hillside		
ME98/6/39	J/0 Ting Kok Road & Sam Mun Tsai Road, Tai Po. (7NE-A/C8, 7NE-A/C110 & 7NE-A/C112)	9/6	HyD/NT	9/6	Natural slope, soil cut slope	Minor (20)	25			5	Road, pedestrian pavement	Pedestrian pavement closed, 1 lane of road blocked.	Washout
ME98/6/40	House No. 97, Sheung Wo Che Village, Shatin. (7SE-A/C389)	9/6	Police	9/6		Minor (<0.5)	2.5			0.5	Building lot	1 flat evacuated.	No failure, chunam spall.
ME98/6/41	Near Hut No. RTP/CH/80, Chuk Hang, Tai Po. (7NW-B/C149)	9/6	DO/TP	9/6	Soil cut slope	Minor (<1)	1	1		1	Squatter	1 hut permanently evacuated.	
ME98/6/42	175m north-west from junction of Shatin Pass Road and Kwun Ping Road, Shatin.	10/6	FSD	Unknown	Soil cut slope	Minor (~10)	4				Road	1 lane of road blocked.	

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 9 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/43	House No. 49, Tai Ho Tun, Sai Kung.	10/6	DO/SK	9/6 (p.m.)	Soil cut slope	Minor (3-5)	1.8	3		1.8	Pig farm, licence house	1 house permanently evacuated, 3 houses temporarily evacuated.	Washout
ME98/6/44	River bank at Tai Chung Hau, Sai Kung.	10/6	DO/SK	9/6 (a.m.)		Minor (10-20)	3	12			Open area/hillside		Erosion by river flow.
ME98/6/45	House No.11 Bernand Gardens, Hing Keng Shek, Sai Kung.	11/6	DO/SK	9/6 (a.m.)	Washout	Minor (5-10)	20			20	Access road		Washout and erosion by concentrated surface runoff due to broken surface channel.
ME98/6/46	Opposite House No. 35, Mok Tse Che New Village, Sai Kung.	11/6	DO/SK	9/6 (a.m.)	Washout	Minor (3-5)	1.8	5		1.8	Road		Washout
ME98/6/47	Mang Hung Wu Road, Sai Kung.	11/6	DO/SK	9/6 (a.m.)	Washout	Minor (5-7)		4			Footpath, access road	1/2 lane of road/footpath closed.	Washout
ME98/6/48	House No. 22A, Ta Ho Tun Ha Wai, Sai Kung.	10/6		Unknown	Fill slope	Minor (~10-20)	4		34	4	Open Area, private gardens		
ME98/6/49	Man Sau San Chuen, Po Lo Che, Sai Kung. (8SW-C/CR199)	11/6	GEO	Unknown	Masonry wall	N.A.	4				Footpaths, lanes, private access		Significant sign of distress with no failure mass.

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 10 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/50	House No. 17, Shek Kwu Lung Tsuen, Shatin.	11/6	DO/ST	9/6	Fill slope, natural slope	Minor (30)	10	10	34	10	Open area/hillside, surface drainage channel	Surface drainage channel broken.	
ME98/6/51	Tai Mong Tsai Road, Tai Wan, Sai Kung.	10/6	HyD/NT	9/6	Retaining	Minor (~20)					Road, pedestrian pavement	1 lane of road closed.	No-fine concrete wall failure.
ME98/6/52	Near Pak Tam Au, Pak Tam Road, Sai Kung. (8NW-D/C45)	9/6	Police	Unknown	Soil cut slope	Minor (~20)	5		49		Pedestrian pavement	Pedestrian pavement closed.	
ME98/6/53	Hong Kong Sea Cadet Corps, Tang Shiu Kin Nautical Centre, Tsam Chuk Wan, Sai Kung. (8SW-B/C204)	10/6	GEO	Unknown	Soil/rock cut slope	Minor (5-10)	7		49	3	Building access		
ME98/6/54	Near Fung Sau Road, Tai Mong Tsai Road, Sai Kung. (8SW-A/C92)	9/6	HyD/NT	Unknown	Soil cut slope	Minor (~10)	4-5				Pedestrian pavement	Pedestrian pavement closed.	
ME98/6/55	Outward Boung School, Tai Mong Tsai, Sai Kung.	10/6	GEO	9/6 (05:30)*	Natural slope	Major (900)*	31*	15*	27*	10*	Building lot	1 house temporarily evacuated.	
ME98/6/56	Near Tai Hang Hau Road, Lung Ha Wan Road, Sai Kung. (12NW-C/C348)	11/6	DO/SK	9/6	Soil/rock cut slope	Minor (3)	7			3	Road		Washout
ME98/6/57	Near Pak Lee Garden, Lung Ha Wan Road, Sai Kung. (12NW-C/C349)	11/6	DO/SK	9/6	Soil cut slope	Minor (5)	5				Road	1 lane of road blocked.	

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 11 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/58	Below access road to Ma Yau Tong Village, Sai Kung.	12/6	DO/SK	9/6	Washout	Minor (9)	3	8		3	Village access, channel at slope toe		Washout
ME98/6/59	Access road to Wu Shek Kok, Sha Tau Kok.	11/6	DO/N	9/6	Natural slope	Minor (36)	9	8	39	9	Pedestrian pavement		
ME98/6/60	Pole No. 20, Zone 265, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C146)	10/6	HyD	9/6 (09:30)	Soil cut slope	Minor (2)	5				Open area/hillside		
ME98/6/61	Pole No. 46, Zone 259, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C140)	10/6	HyD/NT	9/6 (09:30)	Soil cut slope	Minor (2)	6				Open area/hillside		
ME98/6/62	Pole No. 82, Zone 251, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C125)	10/6	HyD/NT	9/6 (09:30)	Soil cut slope	Minor (2)	2			2	Open area/hillside		
ME98/6/63	Pole No. 140, Zone 235, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C92)	10/6	HyD/NT	9/6 (09:30)	Soil cut slope	Minor (8)	4				Open area/hillside		
ME98/6/64	Pole No. 141, Zone 235, Lin Ma Hang Road, Sha Tau Kok. (3NE-A/C92)	10/6	HyD/NT	9/6 (09:30)	Soil cut slope	Minor (30)	7				Open area/hillside		

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 12 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/65	Pole No. 156, Zone 231, Lin Ma Hang Road, Sha Tau Kok. (3NW-B/F1)	10/6	HyD/NT	9/6 (09:30)	Soil/rock cut slope	Minor (3)	4			4	Open area/hillside		
ME98/6/66	Pole No. 158, Zone 230, Lin Ma Hang Road, Sha Tau Kok. (3NW-B/C20)	10/6	HyD/NT	9/6 (09:30)	Rock fall	Minor (1)	5			5	Open area/hillside		
ME98/6/67	End of Ma Ying Road, Wong Mo Ying, Sai Kung.	11/6	WSD	Unknown	Natural slope, fill slope	Minor (~10-30)	5~6		23		Watermain and ruin		
ME98/6/68	300m north-west from Wai Ha, Tung Tsz Shan Road, Tai Po.	15/6	DO/TP	9/6	Soil cut slope	Minor (~7)	4			4	Country road		
ME98/6/69	San San Yuen House No. 444A, Cheung Shue Tau, Tai Po. (7NE-C/R45)	9/6	HD	9/6 (05:00)	Retaining wall	Minor (~15)					Footpath		Washout
ME98/6/70													The Incident No. was not used.
ME98/6/71	Near House No. 33, Kwai Tei New Village, Shatin.	16/6	DO/ST	Unknown	Natural slope	Minor (~5)	23				Open area/hillside		
ME98/6/72	Wong Chuk Yeung Tsuen Path, Shatin. (7SW-B/C150)	19/6	DO/ST	18/6	Soil/rock cut slope	Minor (~2)	4			4	Open area/hillside		Washout

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 13 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/6/73	House No. 21A, Sun King Terrace, Sai Kung. (8SW-C/CR145)	20/6	DO/SK	Unknown	Washout	Minor (~1)					Backyard		Washout
ME98/6/74	House No. 20, Sun King Terrace, Sai Kung. (8SW-C/C149)	20/6	DO/SK	Unknown	Washout	Minor (2-5)	2-4			2-4	Backyard		Washout
ME98/6/75	House No. 1A, Mak Bin Tsuen, Tai Mong Tsai Road, Sai Kung.	20/6	DO/SK	Unknown	Soil cut slope	Minor (~5-15)	4	15		4	Building access		
ME98/6/76	Hut No. 15, X/LCH/30, Lai Chi Hang Village, Tai Po Kau.	24/6	Police	24/6 (p.m.)	Soil cut slope	Minor (<1)	1.6				Squatter		
ME98/6/77	East of House No. 14C, Wong Keng Tei, Sai Kung. (8SW-B/C152)	20/6	DO/SK	9/6	Soil cut slope	Minor (~1-2)	1			1	Carpark		
ME98/6/78	Tsz Tang of Tai Po Tsai Village, Yan Yee Road, Sai Kung.	20/6	DO/SK	9/6	Soil cut slope	Minor (~3-5)	5.5			1.5	Building lot		
ME98/6/79	South of House No. 12B, Tai Wan Village, Sai Kung.	20/6	DO/SK	9/6	Washout	Minor (~2)					Stream course		Washout
ME98/6/80	Near South Cannel, Tan Ka Wan, Sai Kung.	20/6	Public	Unknown	Washout	Minor (~1-5)					Building access		Washout
ME98/6/81	No. 6, Ma Wo Tsuen, Tai Po.	9/6	DO/TP	9/6 (06:30)	Washout	Minor (1)	1			1	Road	1 lane of road blocked.	Washout

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 14 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/7/1	Tsung Tsai Yuen, Tai Po Road, Tai Po Kau.	30/6	HyD/NT	22/6	Retaining wall	Minor (10)					Open area/hillside, pedestrian pavement	Pedestrian pavement closed.	
ME98/7/2	DD27, House No. 189, Sam Mun Tsai Village, Tai Po. (7NE-A/C130)	30/6	DO/TP	10/6	Soil cut slope	Minor (~1)					Squatter		
ME98/7/3	House No. 41, Ha Hang Village, Tai Po. (3SW-D/C177)	8/7	HyD/NT	10/6	Soil cut slope	Minor (~4.5)					Open areas near village house		
ME98/7/4	Tai Po Tsai Village, Yan Yee Road, Sai Kung.	17/7	DO/SK	Unknown	Natural slope	Major (~50-80)	15			15	Footpath		
ME98/7/5	400m north-east from Fung Yuen Lo Tsuen, access road to Sha Lo Tung. (3SW-D/C171)	15/7	DO/TP	~8/7	Soil/rock cut slope	Minor (3)	5	8		5	Road	1/2 lane of road blocked.	
ME98/7/6	650m north from Fung Yuen Lo Tsuen, access road to Sha Lo Tung. (3SW-D/C152)	15/7	DO/TP	~8/7	Soil cut slope	Minor (0.6)	2			2	Access road.		
ME98/7/7	65 Ting Kok Road, Tai Po. (7NW-B/C165)	23/6	Public	97	Soil cut slope	Minor (~2.5)	3				Open area/hillside		
ME98/7/8	Behind House No. 94 & 95, Shuen Wan Chan Uk, Tai Po. (7NE-A/C106)	26/6	DO/TP	~9/6	Soil cut slope	Minor (6)	4	4		4	Building lot		
ME98/8/1	House No. 15, Lai Chi Hang Tsuen, Tai Po Kau, Tai Po.	6/8	DO/TP	6/8 (09:30)	Washout	Minor (1-2)	2	1		0.5	Open area/hillside		Washout

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 15 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/8/2	House No. 89, Shuen Wan Chan Uk, Tai Po. (7NE-A/C106)	12/8	Public	~9/6	Soil cut slope	Minor (2)	4			4	Open area behind village house		
ME98/8/3	House No. 91, Shuen Wan Chan Uk, Tai Po. (7NE-A/C106)	12/8	Public	~9/6	Soil cut slope	Minor (~6)	7			7	Open area behind village house		
ME98/8/4	Next to House No. 40F, Chi Fai Path, Sai Kung.	10/8	DO/SK	9/6	Retaining wall	Minor (7)					Open area/hillside, building lot		
ME98/8/5	Lamp Post No. V81414, Mau Tso Ngam, Shatin.	21/8	DO/ST	June, 1998	Washout	Minor (2-3)	3	2.5		3	Village road		Washout
ME98/9/1	House No. 18, Ngau Pei Sha New Village, Shatin. (7SE-C/C324)	1/9	DO/ST	30/8 (night)	Rock fall, boulder fall	Minor (0.002)	5				Open area/hillside		
ME98/9/2	Behind House No. 719G, Tan Cheung Ha Tseung, Sai Kung. (8SW-C/C144 & 8SW-C/C2)	1/9	Public	1/9 (a.m.)	Soil cut slope	Minor (1)	4.5	3			Building lot		Washout
ME98/9/3	Zone 197, Border Fence Road, Sha Tau Kok.	1/9	HyD/NT	24/5	Natural slope	Major (60)	10	12		10	Border road, Shengzhen river		
ME98/9/4	Zone 197, Border Fence Road, Sha Tau Kok.	1/9	HyD/NT	24/5	Natural slope	Minor (24)	8	10		8	Border road		

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 16 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
ME98/10/1	Near Hut No. X/KS/293, Kam Shan Village, Tai Po. (7NW/CR39)	5/10	HyD/NT	Unknown	Retaining wall	N.A.					Squatter	1 hut permanently evacuated.	Significant sign of distress, no failure mass, wall bulging & stone rubbles dislocating.
ME98/10/2	DD52, Lot 259, Fung Sau Road, Sai Kung. (8SW-A/C56)	26/10	Police	Unknown	Washout	Minor (2)	5				Building lot, open area/hillside		Washout
ME98/10/3	DD252, Lot 259, Fung Sau Road, Sai Kung. (8SW-A/C64)	26/10	Police	Unknown	Washout	Minor (1)	3				Building lot, open area/hillside		Washout
ME98/10/4	Zone 269, Border Fence Road, Sha Tau Kok. (3NE-A/C110)	20/10	HyD/NT	9/10	Soil cut slope	Minor (5)	5				Border road		
ME98/10/5	Zone 230, Lin Ma Hang Road, Sha Tau Kok. (3NW-B/C6)	20/10	HyD/NT	9/10	Soil/rock cut slope	Minor (~10)	4				Border road		
ME98/10/6	West of House No. 11, Tui Min Hoi, Fishermen New Village, Sai Kung. (8SW-C/CR225)	23/10	DO/SK	Unknown	Washout	Minor (~2)	4				Building lot		Washout

Table A4 - List of Incidents in Eastern New Territories Reported to GEO in 1998 (Sheet 17 of 17)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height(1) (m)	Width(2) (m)	Estimated Travel Angle(3) (degree)	Scar Height(4) (m)			
ME98/11/1	House No. 56–56A, Kam Shan Village, Kam Shan Road, Tai Po.	23/10	DO/TP	6/8		N.A.					Pedestrian pavement		Significant sign of distresss, slightly bulging damaged balustrade and crack on pointing.
ME98/11/2													The Incident No. was not used.
ME98/11/3	Access road to Ma Wo Village, Tai Po.	31/10	DO/TP	16/9	Soil cut slope	Minor (3)					Pedestrian pavement		
ME98/12/1	Lamp Post No. N88769, Ting Kok Road, Tai Po. (7NE-A/C8)	4/12	Public	20/7	Soil cut slope	Major (~80)	20			5	Pedestrian pavement		

Legend:

\+ Information from GEO Detailed Investigation.
* Information from GEO's 1998 Landslide Investigation Consultants.
(1) Height of Landslide is the difference in elevation measured from the crest of failure to the distal end of the main body of the landslide debris.
(2) Width of Landslide is the maximum width of landslide scar.
(3) Travel angle of landslide is the angle between the crest of failure to the distal end of the main body of landslide debis and the horizontal. The angle reported is approximate and is based on information contained in the GEO Incident Reports, except where stated otherwise.
(4) Scar Height is the maximum height of landslide scar.

Table A5 - List of Incidents in Western New Territories Reported to GEO in 1998 (Sheet 1 of 7)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
MW98/1/1	Behind Lo Wai Public School, Tsuen Wan. (7SW-C/C300)	31/12	DO/TW	Unknown	Natural slope	Minor (13)		6		4	Building lot		
MW98/1/2	Hut No. RK/19D/50, Kau Wah Keng Upper Village, Kwai Chung.	15/1	Public	14/1 (12:00)	Fill slope	Minor (~2)	2.5			2.5	Squatter	1 hut permanently evacuated.	
MW98/1/3	Footpath in Kwai Chung Au, 6.5 Miles Village, Kwai Chung.	21/1	HD	20/1	Soil cut slope	Minor (~15)		10		5	Pedestrian pavement	Pedestrian pavement closed.	
MW98/2/1	In front of On Lok Villa, Hang Lok Lane, Tung Lo Wan, Shatin. (7-SW-D/C293)	8/2	FSD	8/2 (08:50)*	Soil cut slope, retaining wall	Major (1100)*	11*	36*	26*	6*	Road, building lot, building access	2 lanes of road closed, 143 residents evacuated.*	
MW98/2/2	House No. 13C, Cheung Ming Yuen, So Kwun Wat, Tuen Mun.	18/2	Police	17/2 (18:00)	Retaining wall	Minor (~3)	3				Squatter		
MW98/4/1	Chainage 7.9 km, Kwai Chung Road, Kwai Chung. (11NW-A/C80)	2/4	HyD/NT	End of March, 1998	Rock fall, rock cut slope	Minor (3)		3			Hard shoulder of road		
MW98/5/1	Below Lot No. 415 above Castle Peak Road, Ting Kau, Tsuen Wan. (6SE-C/FR147)	25/5	HyD/NT	Unknown	Fill slope	Minor (10)		3		8	Culvert at toe		
MW98/5/2	Near Ting Kau Bridge/Tuen Mun High-Interchange.	29/5	HyD/NT	1st :4/5 2nd :24/5 3rd :9/6	Fill slope	Major (1st :500 2nd :400 3rd :400)*			33* 33* 33*		Hard shoulder	Hard shoulder closed.	

Table A5 - List of Incidents in Western New Territories Reported to GEO in 1998 (Sheet 2 of 7)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
MW98/6/1	Opposite Lamp Post No. U7901, Mile Stone 8.5, South Lantau Road, Lantau Island. (13NE-A/C132)	8/6	HyD/NT	6/6 (a.m.)	Soil cut slope	Minor (5)	4	3.5		4	Pedestrian pavement	Pedestrian pavement closed.	
MW98/6/2	Opposite Lamp Post No. U7905, Mile Stone 8.5, South Lantau Road, Lantau Island. (13NE-A/C132)	8/6	HyD/NT	6/6 (a.m.)	Soil cut slope	Minor (5)		3		3	Pedestrian pavement	Pedestrian pavement closed.	
MW98/6/3	House No. 43, Siu Sau Village, Tuen Mun. (6SW-C/CR798)	9/6	GEO	9/6 (03:00)	Retaining wall	Minor (~20)					Squatter, pedestrian pavement	1 hut temporarily evacuated, pedestrian pavement closed.	Washout
MW98/6/4	Above Lai Yiu Estate, Bus Terminus, Kwai Chung. (11NW-A/F16)	9/6	GEO	9/6 (a.m.)	Fill slope	Minor (15)		6			Pedestrian pavement and flower bed	1 bus lane at bus terminus closed, pedestrian pavement closed.	Washout
MW98/6/5	Adjacent Ching Cheung Road, Kwai Chung. (11NW-A/C56)	9/6	HyD/NT	9/6 (~09:00)	Soil/rock cut slope	Minor (<1)	4	2.5			Verge road	Road closed.	
MW98/6/6	Hut Nos. RPAK/C/149 & 150, Area 5, Pak Tin Tsuen, Shek Kip Mei.	9/6	GEO	9/6 (04:00)	Soil cut slope	Minor (5)	3	2		2	Squatter	1 hut permanently evacuated, 1 hut evacuated temporarily.	Washout
MW98/6/7	South Corner of Man Sam House, King Tin Court, Shatin. (7SW-D/C235)	9/6	GEO	9/6 (11:00)	Washout	Minor (2)					Building lot		Washout

Table A5 - List of Incidents in Western New Territories Reported to GEO in 1998 (Sheet 3 of 7)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
MW98/6/8	House No. 13, Tai Wan To Village, Yung Shue Wan, Lamma Island.	9/6	Police	9/6 (08:30)	Retaining wall	Minor (2.5)	2				Building lot	1 flat evacuated.	
MW98/6/9	Access road to Sunny Villa, 218 Castle Peak Road. (6SE-D/C304)	9/6	Police	9/6 (17:50)*	Cut slope	Major (200)*	27*	28*		14*	Road, access road, suspected car being buried.	2 lane of road closed.	
MW98/6/10	Behind United Christian College, Tong Yam Street, Tai Hang Tung. (11NW-B/C37)	10/6	Public	9/6	Soil cut slope	Minor (10)	20	5		3	Building lot	2 floors of the school block evacuated.	
MW98/6/11	Below WSD Service Reservoir, near Chak On Estate, Tai Po Road, Tai Wo Ping. (11NW-B/C69 & 11NW-B/C60)	9/6	HyD/NT	9/6 (before 16:50)*	Soil cut slope*	Major (1400)*	22	10-37*		15*	Road	4 lanes of road closed.	
MW98/6/12	Siu Lang Shui, Lung Mun Road, Tuen Mun. (5SE-D/F17)	10/6	HyD/NT	9/6*	Fill slope	Major (1000, 80, 20)*	26	60* 8* 7*	35* 35* 35*		Vallery	1 lane of road closed.	
MW98/6/13	House No. 34, Siu Sau Village, Tuen Mun. (6SW-C/C679)	9/6	GEO	9/6	Washout	Minor (~15)	10	1.5		10	Squatter		Washout
MW98/6/14	Lamp Post No. FA5605, Route Twisk, Chuen Lung, Tsuen Wan. (6SE-B/C58)	9/6	Police	9/6 (17:00)	Soil/rock cut slope	Minor (3)	7			7	Road	1 lane of road closed.	

Table A5 - List of Incidents in Western New Territories Reported to GEO in 1998 (Sheet 4 of 7)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
MW98/6/15	DD435, LOT 11, Chuen Lung Village, Wang Lung Chuen, Tsuen Wan.	9/6	Police	9/6	Natural slope	Minor (~15)	4.5			4.5	Open area/hillside	1 pigsty temporarily evacuated.	
MW98/6/16	Hut No. RTW/4AE/322, Wo Yi Hop Squatter Area, Tuen Wan.	9/6	FSD	9/6	Retaining wall	Minor (~5)	2.5				Squatter, pedestrian pavement	2 huts permanently evacuated.	
MW98/6/17	South of crematorium, Wo Hop Shek Cemetery, Kiu Tau Road, Fanling.	11/6	Arch SD	9/6 (night)	Natural slope	Minor (~20)		10		2.5	Road	1/2 lane of road.	
MW98/6/18	House No. 147, Tseng Tau Chung Tsuen, Tuen Mun.	10/6	Public	9/6 (16:00)	Soil/rock cut slope	Minor (8)	7.5	2.5		3	Open area at backyard		
MW98/6/19	Below access road to Mau Tat, Lion Rock Country Park.	12/6	DO/ST	9/6	Fill slope	Minor (15)	9	6		7	Squatter, local access road	1 hut permanently evacuated.	
MW98/6/20	Above Hut No. 98, Lai Chi Kok Cottage Area.	11/6	HD	9/6 (15:25)	Boulder fall	Minor (1.5)					Cottage	5 huts temporarily evacuated.	
MW98/6/21	Near Firing Range Boundary Marker No. 22, Ha Pak Nai, Nim Wan Road, Yuen Long. (5NE-D/C12)	15/6	DO/YL	9/6	Soil cut slope	Minor (~5)	3	2		3	Rural road		
MW98/6/22	Hut No. YY/X/803, Pak Fa Tsuen, Ping Shan, Yuen Long.	16/6	HD	9/6	Retaining wall	Minor (5)	2	4		2	Backyard		
MW98/6/23	Country trail to Miu Wo at Trappist Haven Monastery, Lantau Ialand. (10SW-B/CR298)	9/6	GEO	9/6 (a.m.)	Soil cut slope	Minor (10)	4.5	2		4.5	Open area/hillside, Country Park		

Table A5 - List of Incidents in Western New Territories Reported to GEO in 1998 (Sheet 5 of 7)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
MW98/6/24	Below access road to Yau Oi Tsuen, To Fung Shan, Shatin.	15/6	Public	9/6	Fill slope	Minor (15)				6	Local access road		
MW98/6/25	Footpath to burial ground at Kuk Lin, Shatin.	15/6	DO/ST	Unknown	Natural slope, soil cut slope	Minor (5)	3.5	3	30	2.5	Local footpath		
MW98/6/26	Ha Pak Nai, Nim Wan Road, Yeun Long.	15/6	DO/YL	9/6	Soil cut slope	Minor (20)	2.5	12		2.5	Rural road		
MW98/6/27	Ha Pak Nai, Nim Wan Road, Yuen Long. (5NE-D/C33)	15/6	DO/YL	9/6	Soil cut slope, natural slope	Minor (30)	8	10		8	Rural road		
MW98/6/28	Ha Pin Nai, Nim Wan Road, Yuen Long. (5NE-D/C33)	15/6	DO/YL	9/6	Soil cut slope	Minor (10)	4	8		4	Rural road		
MW98/6/29	Ha Pin Nai, Nim Wan Road, Yuen Long. (5NE-D/C33)	15/6	DO/YL	9/6	Soil cut slope, natural slope	Minor (10)	5	5			Rural road		
MW98/6/30	Slip road to Hung Mui Kuk Road at Lion Rock Tunnel Road.	22/6	HyD/NT	Before 19/6	Soil cut slope	Minor (5)	3		48	2	Open area/hillside		
MW98/7/1	So Kwun Wat Road, Tuen Mun.	8/7	DO/TM	9/6	Retaining wall	Minor (~10)	2			2	Rural road		
MW98/7/2	Tsing Tai Road, Tuen Mun. (6SW-C/C739)	9/7	Public	9/6	Soil cut slope	Minor (3)	2.2			2.2	Pedestrian pavement		

Table A5 - List of Incidents in Western New Territories Reported to GEO in 1998 (Sheet 6 of 7)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
MW98/7/3	Chainage 19+00, Sham Wat Road, Lantau North Country Park, Lantau Island. (9SW-D/C139)	14/7	HyD/NT	13/7	Soil cut slope	Minor (10)	6	4		3	Road	1/2 lane of road blocked.	
MW98/7/4	House No. 20, Tai Kwai Wan San Tsuen, Cheung Chau.	7/7	DO/TS	10/6	Retaining wall	Minor (1)	2.5				Open areas/hillside		
MW98/7/5	House No. 33, Chung Mei Tsuen, So Kwu Wan, Lamma Island.	17/7	Public	Unknown	Washout	Minor (1)	2.8	3			Building lot		Washout
MW98/9/1	Siu Lam Interchange, Castle Peak Road, Tuen Mun.	3/9	HyD/NT	3/9	Rock fall	Minor (0.15)					Pedestrian pavement		
MW98/9/2	Backyard of Houses No. 30, 32 & 34, Ham Tin Tsuen, Tsuen Wan. (7SW-C/C263)	2/9	DO/TW	Late Feburary	Rock fall	Minor (~0.5)	2				Open areas/hillside	Backyard of House No. 30 to 35 closed.	
MW98/9/3	Ping Kong, Sheung Shui. (3SW-A/C124)	15/9	DLO/N	Unknown	Soil/rock cut slope	Minor (3)	4				Access road	Access road blocked.	
MW98/9/4	Tsing Shan Monastery, Tuen Mun. (5SE-B/CR92)	25/9	DO/TM	March, 1998	Soil cut slope	Minor (2)	5	3		5	Open area at toe, footpath at crest		
MW98/10/1	DD131, Tsing Shan Tsuen, Tuen Mun.	5/10	Public	June, 1998	Retaining wall	Minor (3)		3			Construction site at toe, open area at crest		
MW98/10/2	Platform of Ha Kwai Chung Tsuen Resite Village. (11NW-A/C52)	22/10	DO/KT	22/10 (13:30)	Rock fall	Minor (0.5)	6				Open area/hillside		

Table A5 - List of Incidents in Western New Territories Reported to GEO in 1998 (Sheet 7 of 7)

Incident No.	Location (Slope No.)	Call		Failure							Facility Affected	Consequence	Remarks
		Date	From	Date (Time)	Type	Scale (m^3)	Height[(1)] (m)	Width[(2)] (m)	Estimated Travel Angle[(3)] (degree)	Scar Height[(4)] (m)			
MW98/10/3	Access road to Tai Mo Shan Weather Radar Station, Tsuen Wan.	19/10	DLO/TW	Unknown	Soil cut slope	Minor (~10)	7				Open space adjacent to access road		
MW98/10/4	Behind House No. 13, Tai Shan East Village, Yung Shue Wan, Lamma Island. (14NE-B/CR114)	26/10	Police	26/10 (03:00)	Rock fall	Minor (0.5)	2.5	1		0.8	Building access		
MW98/10/5	Sim Lam Village, Siu Lam, Tuen Mun. (6SW-D/C696)	29/10	DO/TM	Unknown	Soil cut slope	Minor (~15)	6	4	50	6	Open area/hillside		

Legend:

\+ Information from GEO Detailed Investigation.

* Information from GEO's 1998 Landslide Investigation Consultants.

(1) Height of Landslide is the difference in elevation measured from the crest of failure to the distal end of the main body of the landslide debris.

(2) Width of Landslide is the maximum width of landslide scar.

(3) Travel angle of landslide is the angle between the crest of failure to the distal end of the main body of landslide debis and the horizontal. The angle reported is approximate and is based on information contained in the GEO Incident Reports, except where stated otherwise.

(4) Scar Height is the maximum height of landslide scar.

APPENDIX B

DAILY RAINFALL AT THE HONG KONG OBSERVATORY IN 1998

LIST OF TABLES

Table B1 - Summary of Daily Rainfall at the Hong Kong Observatory in 1998

Date	January	February	March	April	May	June	July	August	September	October	November	December
1	0.0	Trace	Trace	0.0	Trace	6.5	9.5	0.0	65.7	0.0	Trace	0.5
2	0.0	Trace	0.0	0.0	69.2	14.0	38.7	Trace	3.5	0.0	0.6	Trace
3	0.0	Trace	0.0	0.0	4.5	0.2	42.5	Trace	0.1	Trace	0.0	0.3
4	0.0	2.7	14.6	Trace	2.8	58.8	51.3	0.0	0.0	2.4	0.0	0.0
5	0.0	6.5	0.0	Trace	0.0	22.0	0.7	0.0	0.5	0.2	0.3	0.0
6	0.0	3.5	0.0	0.0	0.0	4.8	11.4	12.4	32.8	32.0	Trace	Trace
7	Trace	0.2	Trace	0.0	0.0	1.0	Trace	38.8	3.2	Trace	0.0	Trace
8	Trace	0.0	Trace	0.0	Trace	32.6	1.8	0.0	Trace	0.0	0.0	0.0
9	0.1	0.0	13.8	0.0	0.9	411.3	Trace	0.7	Trace	15.4	0.0	0.0
10	Trace	0.0	10.6	0.0	20.5	28.6	0.0	41.9	41.1	54.4	0.0	0.0
11	0.0	Trace	4.0	Trace	Trace	60.7	0.0	25.4	7.9	Trace	0.0	0.0
12	0.2	Trace	2.1	36.7	0.0	Trace	9.0	13.6	29.8	0.0	0.0	0.0
13	1.7	0.6	0.0	0.1	0.0	0.0	80.8	0.0	21.2	0.0	0.0	Trace
14	31.8	4.3	0.3	9.9	0.0	Trace	2.0	0.0	24.7	0.0	Trace	2.4
15	13.2	6.8	9.4	0.0	37.6	Trace	Trace	0.0	0.0	0.0	0.0	Trace
16	1.2	0.2	0.0	0.0	0.0	3.9	Trace	0.0	0.0	0.0	0.0	Trace
17	0.0	58.4	Trace	0.0	37.3	0.2	Trace	0.0	Trace	0.0	Trace	0.0
18	0.0	33.0	Trace	0.0	0.3	0.7	Trace	Trace	Trace	0.0	0.0	1.5
19	Trace	Trace	Trace	2.0	10.8	4.3	0.0	0.0	0.0	0.0	Trace	8.4
20	Trace	3.8	Trace	1.0	1.2	4.1	Trace	Trace	0.0	0.1	Trace	0.6
21	Trace	0.3	Trace	1.6	7.9	5.1	12.1	0.0	0.0	Trace	Trace	0.0
22	Trace	4.4	Trace	Trace	Trace	8.5	0.6	23.4	0.0	0.3	0.0	0.0
23	0.6	Trace	0.0	Trace	2.7	81.4	0.5	12.1	0.4	0.0	0.0	0.0
24	0.1	6.1	Trace	3.8	78.1	4.8	0.4	0.0	Trace	0.0	0.0	0.0
25	Trace	0.0	0.4	32.6	Trace	5.4	Trace	Trace	0.0	14.4	Trace	Trace
26	0.0	8.7	0.1	76.4	0.0	29.8	Trace	0.2	0.0	14.9	3.8	0.0
27	Trace	9.9	Trace	66.9	Trace	23.0	Trace	21.1	0.0	Trace	8.1	0.0
28	Trace	4.3	Trace	0.3	0.0	Trace	0.4	10.5	0.0	0.0	14.7	0.0
29	0.0		Trace	0.4	1.6	1.5	1.6	1.8	0.0	0.0	Trace	0.0
30	0.0		0.0	5.4	23.0	1.3	Trace	15.9	0.0	0.0	1.3	0.0
31	0.0		Trace		36.8		3.9	27.6		0.0		0.0
Total	48.9	153.7	55.3	237.1	335.2	814.5	267.2	245.4	230.9	133.9	28.8	13.7

Note: Annual Total of 1998 is 2,564.6 mm.

LIST OF DRAWINGS

Drawing No.	
GCSP 8/20	Location Map of Reported Incidents in 1998