

**SECTION 3 :
DETAILED STUDY OF THE
FLOODING INCIDENT
AT MEI CHUNG COURT,
SHATIN ON 2 JULY 1997**

Halcrow Asia Partnership Ltd

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FOREWORD

This report presents the findings of a detailed study of a flooding incident (GEO incident No. MW97/7/7) which occurred on 2 July 1997 at Mei Chung Court, Shatin. During the rainstorm of 2 July 1997, blockage of a natural stream course at a footbridge caused stream flow to over-spill onto a nearby footpath and into the Mei Chung Court housing estate. This resulted in severe erosion of the slopes on the boundary of the estate and within a play area, and the inundation of the lower level of a multi-storey car park with floodwater and debris. No fatalities or injuries were reported.

The key objectives of the detailed study were to document the facts about the incident, present relevant background information and establish the probable causes of the incident. The scope of the study was generally limited to site reconnaissance, desk study and analysis. Recommendations for follow-up actions are reported separately.

The report was prepared as part of the 1997 Landslip Investigation Consultancy (LIC), for the Geotechnical Engineering Office (GEO), Civil Engineering Department (CED), under Agreement No. CE 68/96. This is one of a series of reports produced during the consultancy by Halcrow Asia Partnership Ltd (HAP). The report was written by Dr P Jennings and reviewed by Dr R Moore and Mr H Siddle. The assistance of the GEO in the preparation of the report is gratefully acknowledged.



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1. INTRODUCTION

This report presents the findings of a detailed study of a flooding incident (GEO incident No. MW97/7/7) which occurred on 2 July 1997 at Mei Chung Court, Shatin (Figure 1). During the rainstorm of 2 July 1997, blockage of a natural stream course at a footbridge caused stream flow to over-spill onto a nearby footpath and into Mei Chung Court housing estate. This resulted in erosion of the slopes on the boundary of the estate and within a play area, and the inundation of the lower level of a multi-storey car park with floodwater and debris (Plate 1). No fatalities or injuries were reported.

Following the flooding incident, Halcrow Asia Partnership Ltd (the 1997 Landslip Investigation Consultants) carried out a detailed study of the incident for the Geotechnical Engineering Office (GEO), Civil Engineering Department (CED), under Agreement No. CE 68/96. This is one of a series of reports produced during the consultancy by Halcrow Asia Partnership Ltd (HAP).

The key objectives of the study were to document the facts about the incident, present relevant background information and establish the probable causes of the incident. The incident was treated as a special case detailed study, as it primarily involved flooding which resulted in severe erosion of formed slopes. The scope of the study was restricted to the geotechnical aspects of the incident. Recommendations for follow-up actions are reported separately.

This report presents the findings of the detailed study which comprised the following key tasks:

- (a) a review of relevant documents relating to the history of the site,
- (b) analysis of rainfall records,
- (c) interviews with witnesses to the flooding,
- (d) detailed observations and measurements at Mei Chung Court, the surrounding area and the natural stream course,
- (e) theoretical analysis of water flow in the natural stream course,
- (f) review of the role and performance of the formed slopes and associated drainage system at Mei Chung Court during the flooding incident, and
- (g) diagnosis of the causes of the flooding incident.

2. THE SITE

2.1 Site Description

The location of Mei Chung Court housing estate and surrounding area affected by the flooding on 2 July 1997 is shown in Figure 2. The flooding affected a paved footpath, providing access from Mei Tin Road to Fuk Lok Tsuen, and the northern part of the estate which comprised formed slopes, a play area, the lower level of a multi-storey car park and a residential block.

The affected slopes were situated on the estate boundary (Figure 2). Slope No. 7SW-D/C790 was around 10 m high at a gradient of about 35°, and covered in vegetation with a drainage network of surface channels. On the northern perimeter of the housing estate, two cut slopes (Nos. 7SW-D/C791 and 7SW-D/CR801) were affected by the floodwater (Figure 2), and these slopes were around 5 m high at a gradient of about 20°, with a vegetation cover and a drainage network of surface channels.

Floodwater was diverted from a natural stream, about 80 m north of the estate, where a branch of the Fuk Lok Tsuen footpath crosses the stream via a footbridge (Figure 2). The footpath and the deck of the footbridge are constructed in concrete, about 2.5 m wide, and are used for pedestrian and vehicular access.

The natural stream, the source of the floodwater, passes to the north and east of the estate before entering the Shing Mun River (Figure 2). The stream is located within a valley area of some 97 ha, of generally naturally vegetated steep upper hillside, lower gentler slopes and valley floor containing minor buildings and plantations (Figure 1).

The extent of the drainage catchment feeding water into the stream at the footbridge is shown in Figure 1. This comprises the lower portion of the valley only, with an area of some 25 ha. A Water Supplies Department (WSD) weir situated across the stream intercepts water draining from the upper valley. The weir is located some 500 m upstream from the estate and the associated intake shaft abstracts stream water, via a water tunnel, to Lower Shing Mun Reservoir for storage or to Shatin Treatment Works for treatment.

2.2 Site History

A review of the site history was undertaken using aerial photographic interpretation (API) and documentary records. Summary results of the API are presented in Table 1.

The earliest available aerial photographs, from 1949, show the estate site as cultivated land with several scattered small buildings. The area immediately north of the estate site contains several buildings, which are the seminary buildings present today (Figure 2). In 1949, a footbridge was sited across the stream at the location of the present footbridge. It is not known when the footbridge was constructed prior to 1949. A trackway leading south from the footbridge follows a similar route as the current Fuk Lok Tsuen footpath.

In 1949, the course of the natural stream involved in the recent flooding appears to follow much the same alignment as the present stream course. A minor tributary of the stream was present between the seminary buildings and the area to the east of the trackway. This tributary is present today as a dry gully feature, although it is no longer joined to the valley stream (Figure 2).

From 1949 to the commencement of the construction of the estate platform in the late 1980's, the aerial photographs show a history of reducing cultivation at the estate site with a corresponding increase in the development of small buildings.

The valley upstream of the estate shows relatively little change from the 1949 aerial photographs to the present day. The more notable changes include the construction of the WSD weir and associated shaft in the upper valley by 1975, and the Shing Mun Tunnel Road viaduct across the lower valley by 1992 (Figure 1).

A review of documentary records, summarised in Appendix A, shows that the estate site was part of planning area '4D' which was zoned for residential development, as shown on the Shatin outline development plan issued in 1979 by the New Territories Development Department (NTDD, renamed Territory Development Department in 1986). A proposed layout for the area was subsequently issued in 1980 by NTDD.

In 1981, NTDD passed the proposed layout of area 4D to the Geotechnical Control Office (GCO) amongst others for comment. In response, the GCO stated that "No objection is raised against the proposed use of the above planning area". The GCO also included comments on the geology and engineering of the site, and stated that "both main southward draining tributaries of the Shing Mun River (which cross area 4D) have reasonably large catchment areas and adequate drainage measures should be required as the first stage of development. The photographs, particularly those of the 1960's, show severe sheet erosion of the granite especially on the ridge crests and considerable siltation of drainage may therefore be anticipated".

In 1983, a geotechnical study of area 4D by consultants Maunsell Consultants Asia (MCA) was prepared for NTDD based on the 1980 proposed layout. The study recommended an alternative layout, which subsequently formed the basis for the revised layout issued by NTDD in 1984. In their comments on the MCA study report, the GCO stated that they had "no adverse comments on the stability analysis, and the site formation layout is therefore feasible provided the groundwater assumptions can be substantiated by MCA".

Further geotechnical reports for area 4D were produced by MCA, namely, a site formation report in 1986, a drainage design report for the proposed slope drainage system in 1987, and supplementary geotechnical assessment reports in 1992 and 1993 that substantiated the groundwater assumptions adopted in the 1983 report. The design of the slope drainage system included consideration of surface run-off from the slope and adjacent related slopes, but it did not include flow from the stream involved in the flooding incident. With respect to the geotechnical design of the slopes and associated drainage, the GCO stated that they had "no adverse comment in general on the proposed drainage system".

In 1989, in response to NTDD's proposal to use area 4D as a supplementary housing site, the GCO stated that "there are no objections in principle to the use of the five areas (including area 4D) as supplementary housing sites provided that the geotechnical limitations affecting these sites are considered and dealt with in an appropriate manner during site formation". The GCO's response also stated that "the site is located on terrain identified in the Geotechnical Area Studies Programme (GCO, 1987) as colluvium and drainage plain", and that "attention to both subsurface and surface drainage is needed to reduce the possibility of slope instability and flooding".

The formation of the estate site based on MCA's design was completed by 1990. The formed site included four cut platforms and the slopes on the estate boundary, including Slope Nos. 7SW-D/C790, 7SW-D/C791 and 7SW-D/CR801. In 1991, the Housing Department submitted a geotechnical report to the GCO which modified the site layout in order to maximise the development potential. The report included the design for enlargement of platforms and inclusion of a retaining wall. The report was checked by the GCO who stated that they had "no adverse comments on the proposed site formation works to enlarge the existing platforms".

Mei Chung Court platform remained vacant until the commencement of building construction in 1995 which was substantially completed in early 1996.

In May 1997, Slope No. 7SW-D/C790 was inspected and registered in the New Catalogue of Slopes as part of the GEO's project entitled 'Systematic Identification and Registration of Slopes in the Territory' (SIRST) to systematically update the 1977/78 Catalogue of Slopes.

2.3 Land Status

The land status within the area of the flooding, as established by the District Lands Office, is presented in Figure 2. Several private lots are present to the north of the estate, associated with a seminary. However, the footpath and footbridge are located on Government land.

3. THE INCIDENT

3.1 Description of the Incident

The description of the incident is based on accounts from eye-witnesses at the estate, from site observations by HAP and, in particular, an incident report by the Housing Department (1997). A plan showing the details of the flooding incident is presented in Figure 3.

During the rainstorm on 2 July 1997, stormwater flow within the natural stream course over-spilled the stream banks at the location of a blockage at a footbridge (Figure 3). Stormwater flooded onto a nearby footpath and, in part, was diverted downhill towards Mei Chung Court, sited on a cut platform below the level of the footpath.

At about 05:25 hours whilst on patrol, the estate management superintendent observed heavy rainwater run-off (floodwater) from the Fuk Lok Tsuen footpath spilling onto the slopes behind Lok Chung House of Mei Chung Court (Figure 3). The floodwater entered the estate at several locations causing severe erosion of the formed slopes.

Floodwater flowed through the estate causing erosion and undermining of paved areas, notably within a play area to the east of Lok Chung House. The floodwater entered the lower level of the multi-storey car park where it was impounded (Figure 3). Shortly after 05:25 hours floodwater had already entered the car park and was up to 0.6 m deep. The lower level of the car park was reported by management staff to be inundated to a depth of 2.6 m by 05:48 hours. At 06:15 hours floodwater started to overflow from the car park and into the lower floor of Fu Chung House. At 07:00 hours floodwater started to enter the meter room of Lok Chung House.

At 05:48 hours the estate management staff reported the incident to the Police. The Police and Fire Services Department (FSD) arrived on site at 05:55 hours. Divers from the FSD commenced a search of the submerged lower level of the car park at about 09:00 hours. No persons were found. At 10:40 hours the Police contacted the GEO for geotechnical advice on the affected slopes. The GEO inspected the site at 11:45 hours (GEO Incident Report No. MW97/7/7).

The flow of floodwater into the estate is reported to have continued for most of the morning, with a notable reduction in flow after about 11:00 hours, which corresponds with an amelioration in rainfall (see Section 4). Due to the potential for further heavy rain, at 17:00 hours Police evacuated the occupants of the seminary buildings located to the north of the estate (Figure 3). Following an increase in rainfall between about 19:00 hours and 19:30 hours, flooding of the lower level of the car park was again reported.

Rain continued until about 04:00 hours on 3 July 1997 before diminishing, with no further reports of serious flooding at the estate.

Two separate flood warnings were issued during the time of the incident, from 05:00 hours to 11:55 hours on 2 July 1997 and from 15:15 hours on the 2 July 1997 to 09:30 hours on 3 July 1997. A landslide warning was also in effect, from 06:25 hours on 2 July 1997 to 8:40 hours on 5 July 1997.

3.2 Consequential Damage

Flood damage within the estate included severe erosion of slopes concentrated at six locations (Figure 3), undermining and erosion of paved areas mainly concentrated in the play area to the east of Lok Chung House, damage to fixtures in Lok Chung and Fu Chung House and damage to around seventy vehicles within the car park. The Fuk Luk Tsuen footpath above the estate suffered gully erosion and undermining.

A photograph taken on 3 July 1997 is shown in Plate 1. This shows the accumulated sediment in the lower level of the multi-storey car park after floodwater had subsided.

3.3 Immediate Follow-up Action

Following the incident, to prevent recurrence of flooding, the existing footbridge was demolished, obstructions within the natural stream course removed, and a new bridge constructed. The eroded section of Fuk Lok Tsuen footpath was also repaired.

The Drainage Services Department (DSD) is examining the long-term drainage improvement to the area.

4. RAINFALL

Analysis of rainfall data recorded at the time of the flooding has been carried out to determine the characteristics and estimated return period of the rainfall event. The rainfall data from several GEO automatic raingauges (Nos. N01, N02, N06 and N14) in the vicinity of the site were reviewed. The raingauges record and transmit rainfall data to the GEO and the Hong Kong Observatory (HKO) at 5-minute intervals. The rainfall data from individual raingauges showed similar characteristics, and therefore the nearest raingauge to Mei Chung Court, raingauge No. N02, was selected as representative of rainfall at the site.

The daily and hourly rainfall recorded during June and July 1997 are shown in Figure 4. The daily rainfall during the 31-day period preceding the flooding incident was generally below 20 mm, and only exceeded 100 mm on 4 June and 16 June 1997. The hourly rainfall record during the days preceding the incident showed generally no rainfall, except for a rainstorm event from 04:00 hours to 12:00 hours on 1 July 1997, with a maximum rolling hourly intensity of 27 mm/hr. The 24-hour rainfall total prior to the incident was about 120 mm.

The incident occurred during the early stages of a rainstorm event that commenced at about 04:00 hours on 2 July 1997. By the time of the onset of flooding, at 05:25 hours, the site had received between 40 mm and 60 mm of rainfall as shown in Figure 5.

The rolling 60-minute rainfall immediately preceding the incident was 43 mm/hr. An analysis of the return period for this rainfall event using the historical rainfall records at the HKO (Lam & Leung, 1994) indicates that the estimated return period is 1 year. The rainfall during the preceding 31-day period indicates that this 60-minute rolling rainfall total was previously exceeded during the rainstorm of 4 June 1997, with 63 mm/hr.

Rainfall intensity increased after the onset of flooding (Figure 6) and greatly escalated the scale of the incident. The maximum 60-minute rolling rainfall intensity for the rainstorm was 124 mm/hr, which occurred between 05:25 hours and 06:25 hours on 2 July 1997, with an estimated return period of about 32 years.

5. SOURCES OF FLOODWATER

From field observations, the major source of floodwater was found to be stream flow diverted from the natural stream course at the footbridge. Stormwater would have originated as run-off from the catchment shown in Figure 1.

The possibility of an increased flow in the natural stream due to overflow of the WSD weir located at the upstream end of the catchment was investigated. The WSD commented that "the intake was designed to abstract stream water from upstream. It is provided with a spillway for overflow of stream water in the case that the level of the stream rises to the spillway level. It should be noted that the quantity of water overflow would always be the natural yield deducted by the water abstracted by the intake (shaft) and be less than the natural flow. Therefore there was no increased flow in the natural stream due to overflow of the WSD weir. It can be viewed that the natural storm is attenuated by the water abstraction under such circumstances."

The likely stormwater flow at the footbridge and response time to rainfall was determined from a synthesised hydrograph for the catchment area, assuming no over-spill of the WSD weir (Water Authority, 1968). The results, which are considered indicative, are shown with the 5-minute rainfall record in Figure 6. The response time between rainfall and peak stormwater flow is estimated at 14 minutes, with an estimated peak stormwater flow of $1.7 \text{ m}^3/\text{sec}$.

The discharge capacity of the stream channel beneath the footbridge was compared with the indicative stormwater flow at 05:25 hours (Figure 6). A scoping calculation indicates that about an 80% reduction in channel cross-section was necessary to prevent stormwater flow from passing beneath the footbridge. If the channel was unobstructed, there was sufficient capacity beneath the bridge to accommodate the theoretical peak flow of $1.7 \text{ m}^3/\text{sec}$.

Other sources of floodwater, such as run-off from the cut slope (No. 7SW-D/C787) to the west of the footpath (Figure 2), are considered minor in comparison with the amount of stormwater from the stream.

6. CONDITIONS AND DAMAGE AT THE ESTATE AND SURROUNDING AREA

6.1 General

A walkover inspection was undertaken to establish conditions within the natural stream course, the surrounding area and the estate following the flooding. These are detailed below and presented in Figure 3.

6.2 Natural Stream Course

On the upstream side of the footbridge an accumulation of debris (comprising silty sandy gravel with many sub-rounded cobbles and some sub-rounded boulders) was found to

have completely blocked the upstream side of the bridge. This can be seen in a photograph taken during the morning of 3 July 1997 (Plate 3).

Clearance of debris from the channel upstream of the bridge by the DSD revealed up to about 0.8 m depth of generally loose debris underlain by more bouldery debris (Plate 4). The space beneath the bridge, on the unblocked downstream side, was about 1.7 m wide by 1 m high (Plate 5). The width of the stream course either side of the bridge varied, but typically ranged from 3 m to 4 m.

The deck of the footbridge was constructed in concrete (Plate 5), the appearance of which suggested the possibility of a later date of construction than 1949 (the earliest available aerial photographs, see Section 2.2). The construction of the deck may coincide with the resurfacing of the footpath, as identified in the 1992 aerial photographs (Table 1).

Based on site observations, the debris removed from the stream course appeared to be consistent with transported stream deposits. It was not possible to determine the length of time the debris had been deposited at this location.

An inspection of the natural stream course further upstream of the footbridge did not reveal any significant evidence of a concentrated source of debris that may have entered the stream and contributed to the blockage at the footbridge. Only a minor, possibly recent landslide of about 20 m³ in volume was identified on the stream bank, some 350 m upstream of the footbridge (Plate 6). It is not considered likely that this landslide contributed significantly to the debris at the footbridge.

The most likely source of debris contributing to the blockage was the stream bed deposits. The deposits comprised transported detrital material, grading from silty sandy rounded gravel to rounded to sub-rounded cobbles and boulders.

6.3 Area between the Estate and Footbridge

Uphill of the estate, erosion gullies formed parallel to the footpath from the footbridge to the estate, exploiting the existing surface drainage channel and an abandoned stream course (Figure 3). A photograph taken on 3 July 1997 shows the extent of the erosion (Plate 7). Where floodwater entered the estate, flood debris accumulated against the estate boundary fence (Plate 8).

6.4 The Estate

The floodwaters which reached the estate caused serious erosion to two cut slopes (Nos. 7SW-D/C791 and 7SW-D/CR801), to the north of the multi-storey car park and Slope No. 7SW-D/C790 to the north of Lok Chung House (Figures 2 and 3).

Erosion scars were observed on the cut slope (No. 7SW-D/C791) at four locations beneath the section where floodwater entered the estate or over-topped the slope drainage (Plate 9). The scars were generally less than 1 m deep but locally up to 2 m deep. Exposures

in the erosion scars showed localised fill up to 1 m deep overlying completely decomposed granite. It is estimated that a total volume of about 45 m³ of soil was washed from the slope.

Erosion scars were concentrated at two locations on Slope No. 7SW-D/C790. The scars to the northwest of Lok Chung House were shallow, typically 0.5 m deep within completely decomposed granite. To the northeast of Lok Chung House a further scar, over 2 m deep exposed alluvial deposits (of dense sandy gravel with many sub-rounded cobbles and occasional sub-rounded boulders) overlying completely decomposed granite (Plate 10). The estimated volume of the soil removed from the slope was 55 m³.

Paved areas beneath the slopes, including the play area, were undermined as floodwater followed the general fall towards the multi-storey car park. The ground floor of Lok Chung and Fu Chung House were also affected by floodwater causing damage to fixtures and lifts.

Staining on the walls and columns inside the basement level of the car park indicated a floodwater level of about 1.7 m (Plate 2), though some eye-witnesses stated that the flooding was up to 2.5 m deep. The floodwater deposited soft sandy silt debris in the basement, with an estimated volume of about 100 m³.

7. PROBABLE CAUSES OF THE FLOODING INCIDENT

The serious erosion of the slopes and flood damage at Mei Chung Court on 2 July 1997 were the result of diverted stormwater flow from a natural stream course which had become blocked with debris. The following factors probably contributed to the incident:

- (a) the presence of a natural stream course with the potential for increased mobilisation of stream deposits during storm flow conditions,
- (b) the presence of a local constriction in the natural stream course at a footbridge resulting in accumulation of stream deposits and consequent blockage of the stream, and
- (c) the presence of a preferential surface drainage path, namely the footpath and a minor abandoned tributary stream course (Figure 3), which allowed water to flow towards the estate and over-spill the crest of the slopes on the northern boundary of the estate.

8. CONCLUSIONS

The flooding was initiated during the early morning (at about 05:25 hours) on 2 July 1997 when the preceding 60-minute rolling rainfall was 43 mm/hr with an estimated return period of only about one year. Therefore, it is concluded that the channel was probably significantly obstructed prior to the onset of the flooding.

The scale of the flooding greatly escalated as the rainfall intensity increased to a peak intensity of 124 mm/hr between 05:25 hours and 06:25 hours.

The affected slopes, designed to current geotechnical standards, did not have any overall slope instability problems despite being inundated by floodwater and debris during the incident. However, the surface water drainage and slope protection measures were not designed to take account of the possibility of over-spill from the natural stream course, and consequently severe surface erosion of material from the slopes occurred during the flooding incident.

9. REFERENCES

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Table 1 - Summary of Site Development from API

Year	Photographic Reference No.	Attitude (feet)	Observation
1949	Y02112, Y02113	5800 ft	Seminary buildings (now the Asian Christian Conference Centre) are present north of Mei Chung Court (MCC) site, including trackway and footbridge at the location of the 1997 flooding incident. The majority of the MCC site is cultivated land, irrigated fields fed by a minor tributary stream are present in the northeast. The tributary stream runs from the main valley stream to the west of the seminary buildings. The seminary is situated on high ground between the tributary and main valley streams. Boulders visible in main stream at location of footbridge.
1963	5349, 5350	-	Field network increased and more buildings present within valley to north of MCC site. Footbridge is still present. The trackway leading to the footbridge has increased in width. Irrigated fields are still present in northeast of MCC site. Another footbridge is constructed south of seminary.
1975	11553, 11554	3000 ft	Large scale development of small buildings on fields in south of MCC site. Irrigated fields are still being worked in northeast of MCC site. Another footbridge built downstream to east of the school. Weir structure and overflow vertical shaft constructed in the mid-upper section of the valley.
1977	20078, 20079	4000 ft	Small building development continuing on MCC site. Cultivation of fields on MCC site in decline. Tree growth obscures the view of the footbridge.
1984	56850, 56851	4000 ft	Mei Shing Court is under construction. The valley stream is culverted south of MCC site. No significant new developments upstream. Change of cultivation type in fields in northeast of MCC site, appear not to be irrigated.
1986	A04906, A04907	4000 ft	Construction of Mei Shing Court is completed. Footbridge is not clearly shown. Cultivation of fields in northeast of MCC site in decline.
1992	A31920, A31921	4000 ft	Platform area and slopes at the MCC site are completed. Footpath connecting to the footbridge has a high reflectance suggesting it was recently re-surfaced. Slopes along the west of the trackway formed and stream trained at the location of viaduct. Boulders within the stream bed are clearly visible in vicinity of footbridge. Shing Mun Tunnel Road is completed.
1995	CN10822, CN10823	2500 ft	MCC is under construction. Boulders present at the upstream edge of footbridge.
1996	CN14957, CN14953	4000 ft	Construction of Mei Chung Court is substantially completed.

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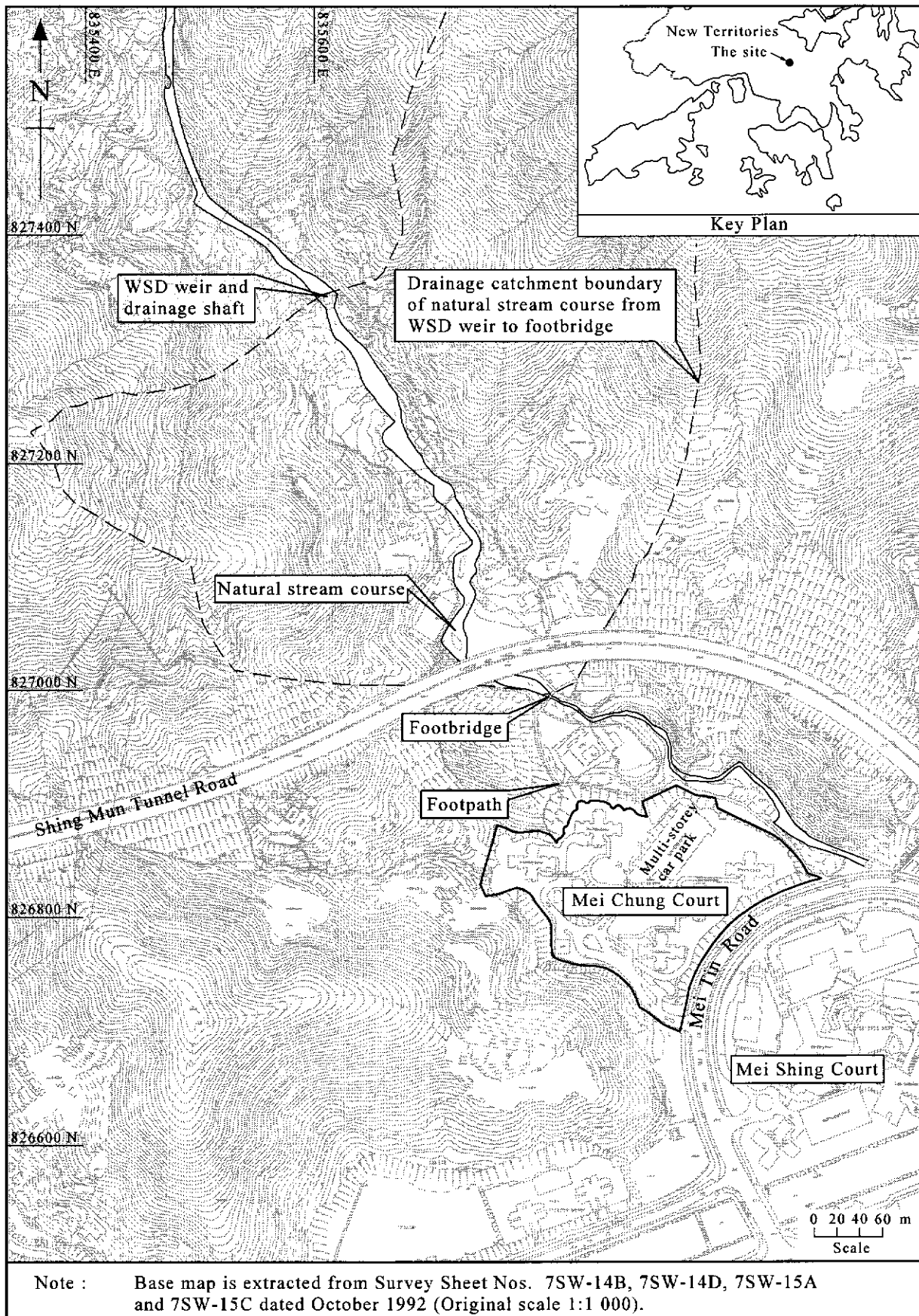


Figure 1 - Site Location Plan

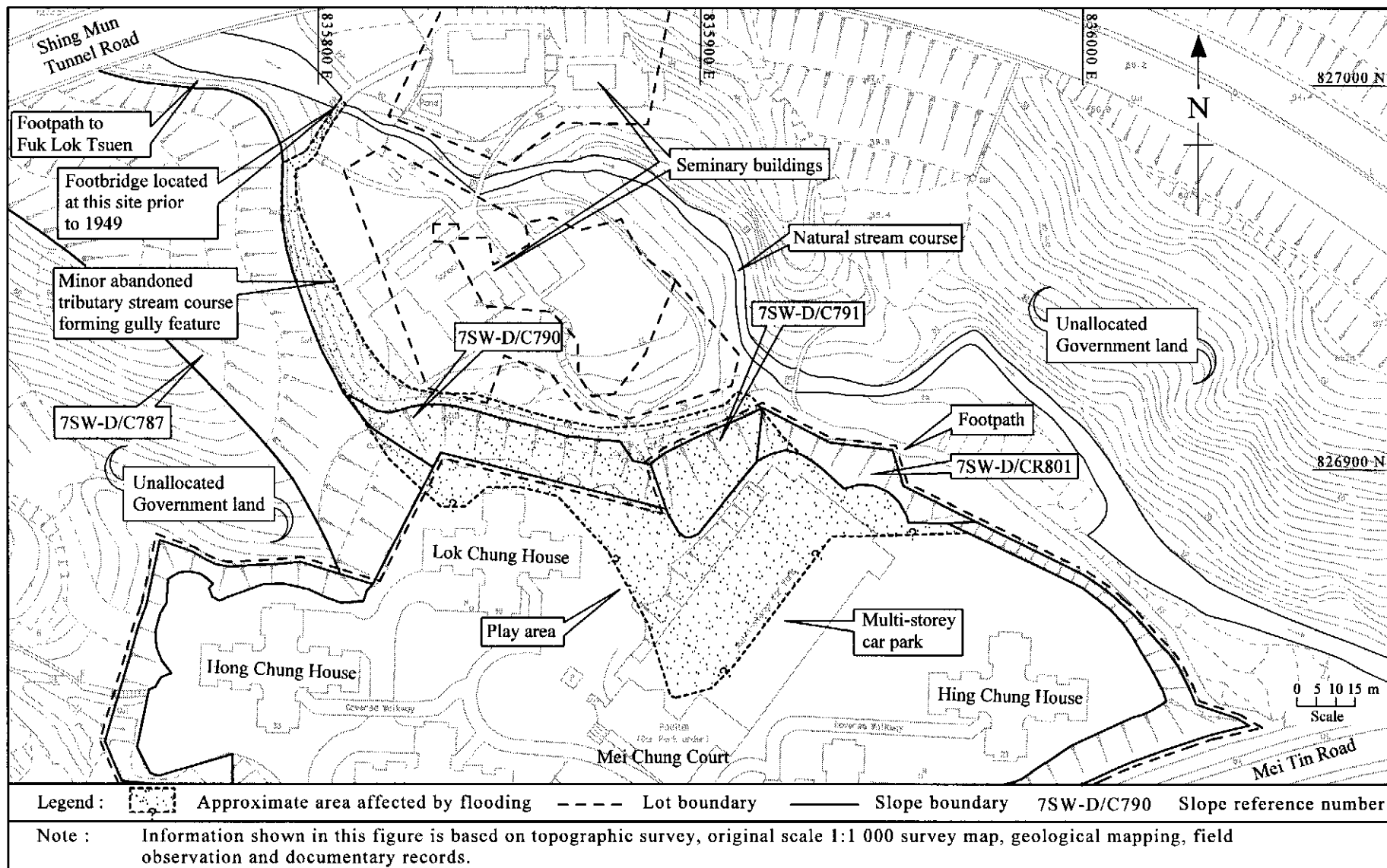


Figure 2 - Plan of the Flood Affected Areas

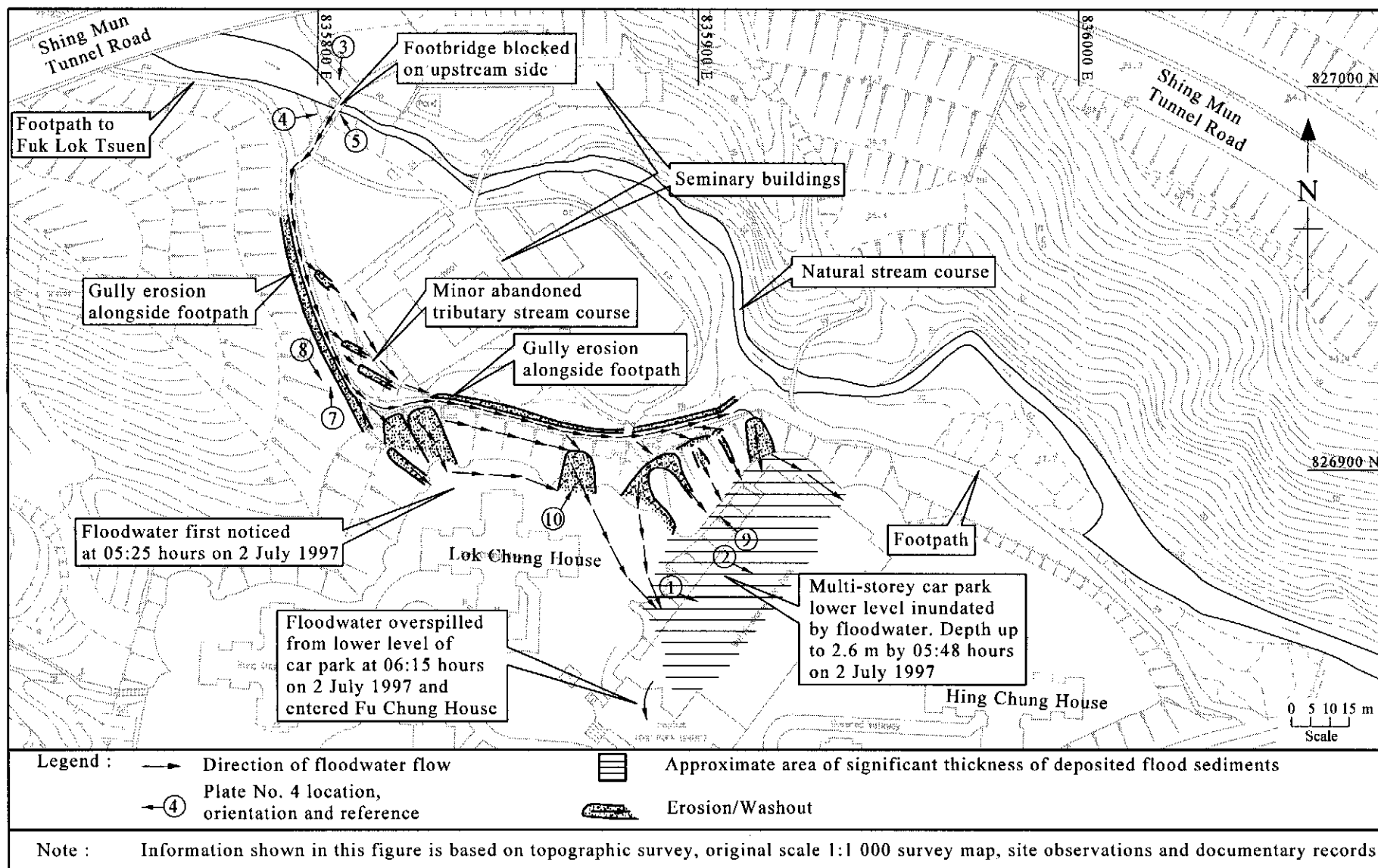
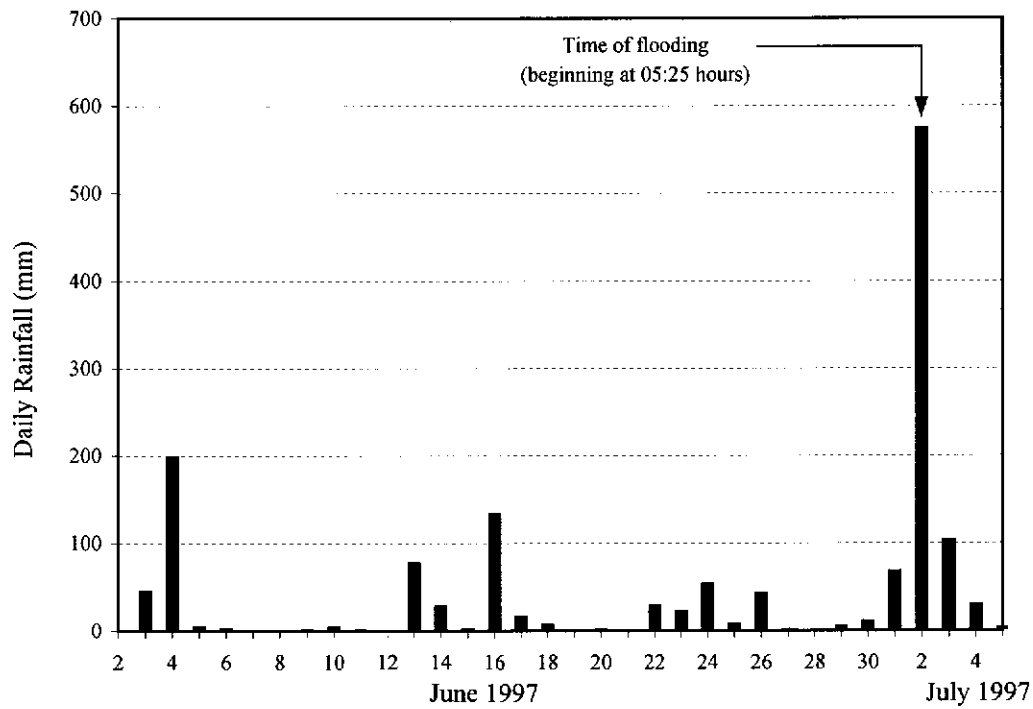
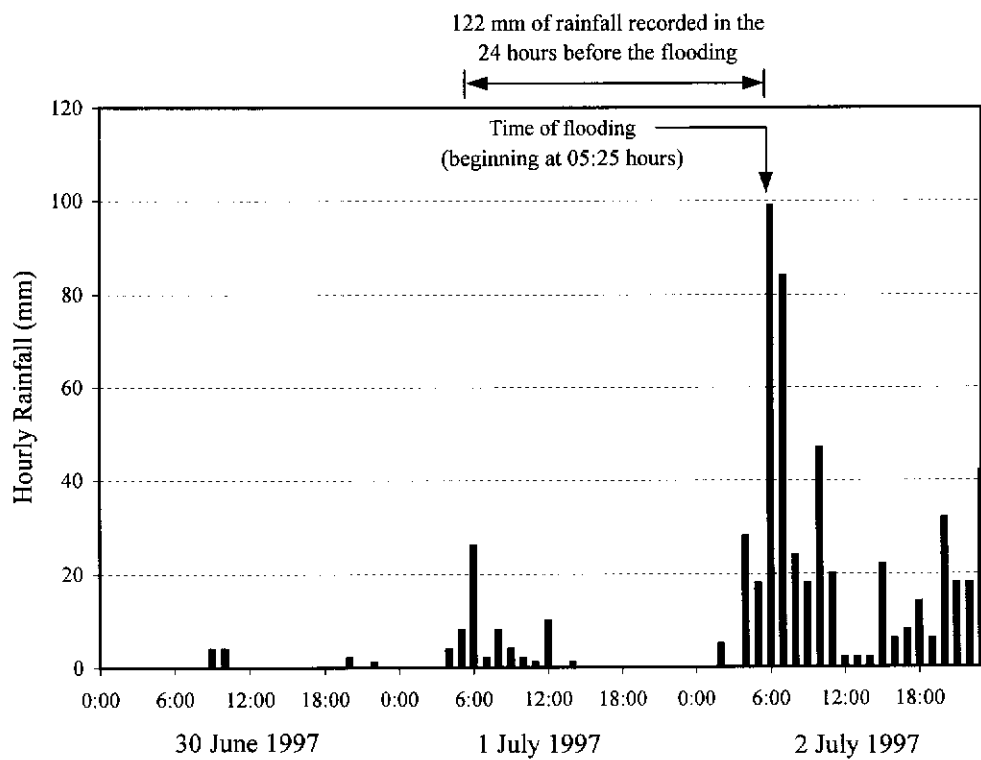


Figure 3 - Plan of Area Showing Details of Flooding Incident



(a) Daily Rainfall Recorded between 2 June and 5 July 1997



(b) Hourly Rainfall Recorded between 30 June and 2 July 1997

Figure 4 - Rainfall Records at GEO Raingauge No. N02

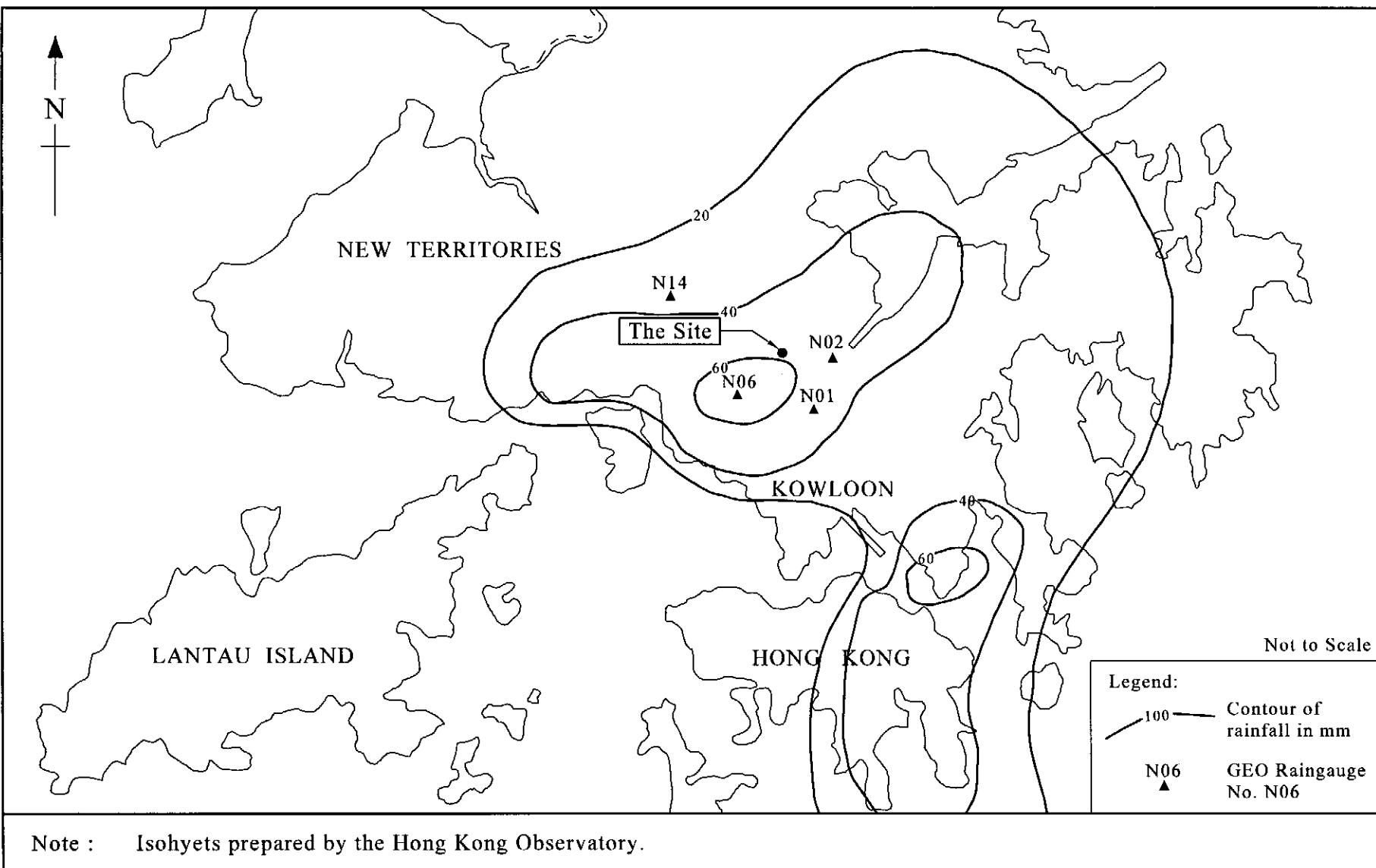


Figure 5 - Isohyets of Rainfall between 03:50 Hours and 05:25 Hours on 2 July 1997

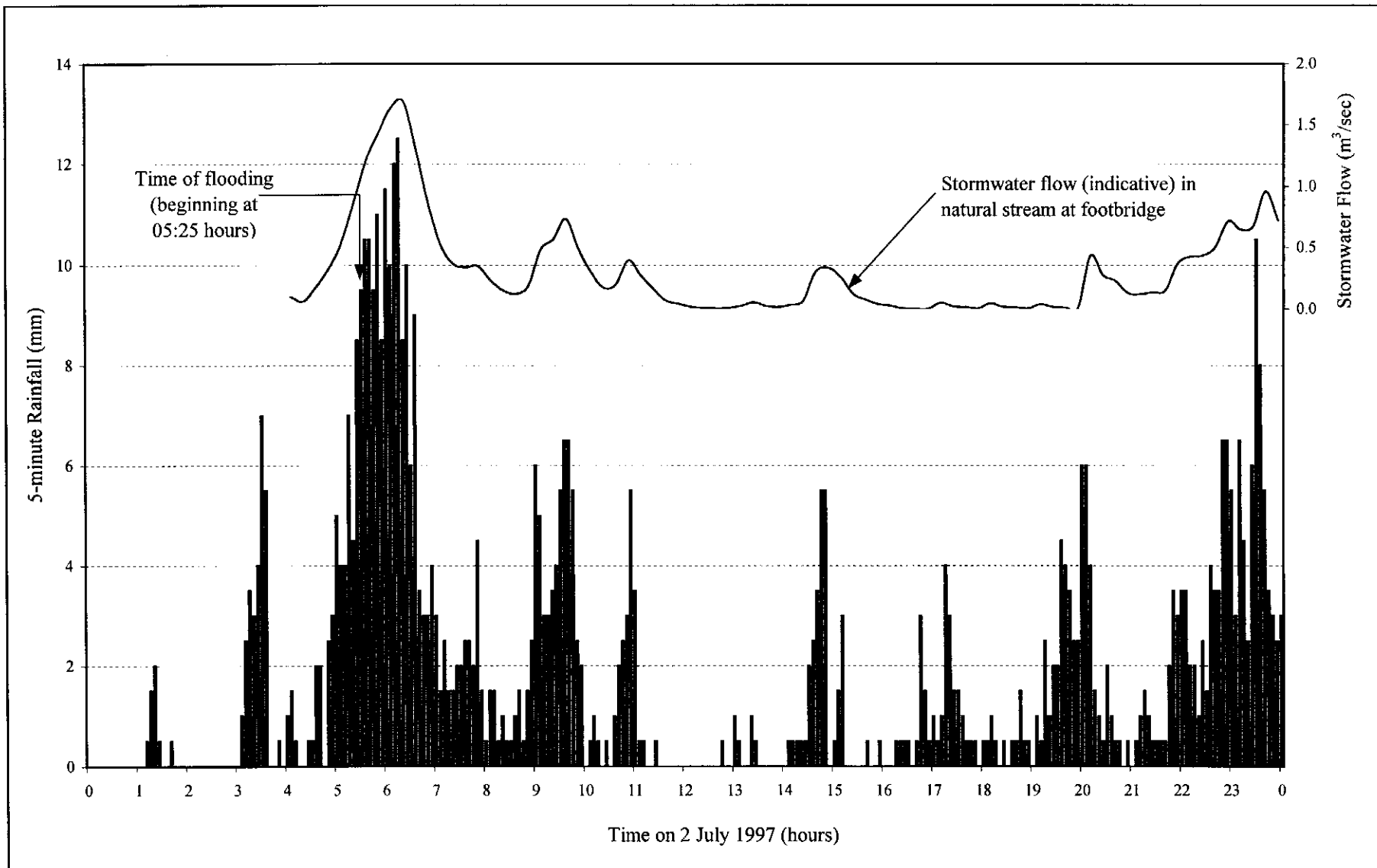


Figure 6 - Rainfall Recorded at GEO Raingauge No. N02 at 5-minute Intervals and Stormwater Flow in Natural Stream at Footbridge

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Plate 1 - View of Basement Level (L1) of Multi-storey Car Park
(Photograph Taken on 3 July 1997)



Plate 2 - View of Floodwater
Staining, up to 1.7 m,
in Car Park
(Photograph Taken in
August 1997)



Plate 3 - View of Footbridge where Stream Over-spilled its Channel
(Photograph Taken on 3 July 1997)

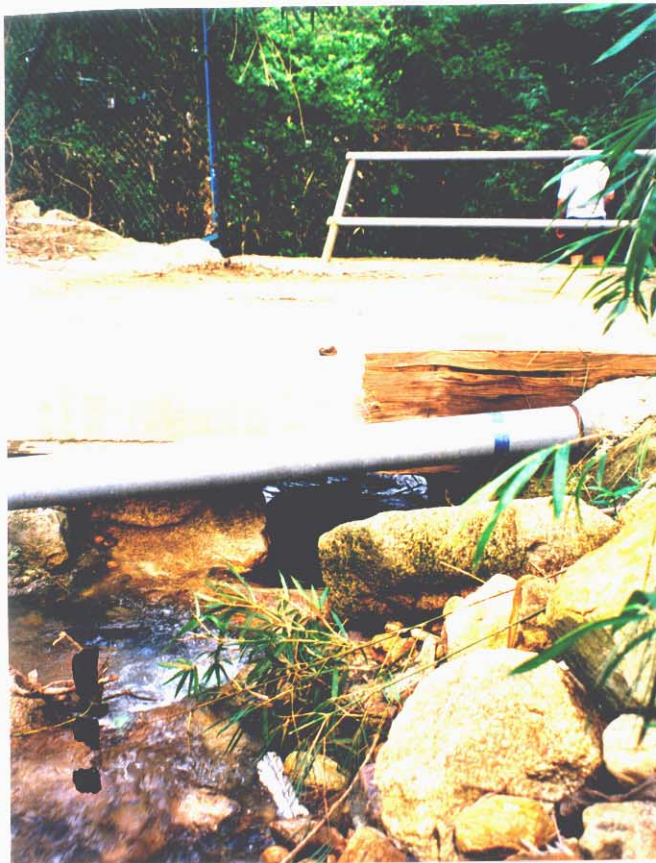


Plate 4 - General View of
Upstream Edge of
Footbridge Following
Clearance Works
(Photograph Taken in
August 1997)



Plate 5 - General View of Unblocked Downstream Edge of Footbridge
(Photograph in August 1997)



Plate 6 - View of Possible
Recent Landslide on
Stream Bank
(Photograph in August
1997)



Plate 7 - Gully Erosion alongside Fuk Lok Tsuen Footpath
(Photograph Taken on 3 July 1997)



Plate 8 - Accumulation of Flood Debris against Estate Boundary Fence
(Photograph Taken on 3 July 1997)



Plate 9 - Photograph Showing Flood Damage to Cut Slope No. 7SW-D/C791 at Mei Chung Court
(Photograph Taken on 3 July 1997)



Plate 10 - View of Erosion Scar and Undermined U-Channel on Slope
No. 7SW-D/C790 (Photograph Taken on 3 July 1997)

APPENDIX A
SUMMARY OF DOCUMENTS REVIEWED

Table A1 - Summary of Documents Reviewed (Sheet 1 of 6)

Year	Document Title	By Whom	To Whom	Remarks
1980	(Draft) Shatin outline Development Plan No. 77/202BD	NTDD	Various	Mei Chung Estate site located within planning area 4D. Zoned for private residential development.
1980	Layout Plan STP 80/008 for Area 4D	NTDD	Various	Sketch plan of proposed layout of planning area 4D.
1981	Shatin New Town Development Sketch Plan No. STP80/008 Planning Area 4D Shatin	GCO	NTDD	Geotechnical comments on sketch plan No. STP80/008. In their comments, the GCO stated "No objection is raised against the proposed use of the above planning area". Comments on the geological and engineering aspects of area 4D were also included. With particular reference to drainage, the GCO commented that, "Both main southward drainage tributaries of the Shing Mun River have reasonably large catchment areas and adequate drainage measures should be required as the first stage of development. The photographs, particularly those of the 1960's, show severe sheet erosion of the granite especially on the ridge crests and considerable siltation of drainage may therefore be anticipated."

Table A1 - Summary of Documents Reviewed (Sheet 2 of 6)

Year	Document Title	By Whom	To Whom	Remarks
1981	Geotechnical Checking of New Works Shatin New Town Development – Planning Area 4D	Binnie and Partners (Hong Kong)	GCO	In response to a request by the GCO, Binnie and Partners (B&P) visited and undertook an API of area 4D to assess the stability of slopes. B&P commented that, “detailed investigation is required to establish the existing stability and hence the extent of development acceptable. An assessment of groundwater levels, based on piezometer readings will be of particular importance.”
1983	Shatin New Town Area 4D Site Formation Proposals Stability Analysis of Slopes	Maunsell Consultants Asia (MCA)	NTDD & GCO	Study report examined stability analysis of existing slopes. Alternative layout recommended.
1984	Shatin New Town Formation, Roads & Drains in Area 4D Geotechnical Study – Proposed Platform Layout	GCO	NTDD	Review of MCA (1983) study report. GCO comments that, “The study report delineates a revised site formation layout that satisfies the safety factor requirements, and the design of the slopes is backed up by slope stability analysis”. The GCO concluded that they “have no adverse comments on the stability analysis, and the site formation layout is therefore feasible provided the ground water assumptions can be substantiated by MCA”.

Table A1 - Summary of Documents Reviewed (Sheet 3 of 6)

Year	Document Title	By Whom	To Whom	Remarks
1984	Shatin New Town Development Planning Area 4D, Layout Plan No. STP/L4D/5 Explanatory Notes	NTDD	Various	Revised site layout plan based on MCA (1983) and accompanying explanatory notes.
1986	Shatin New Town Route 5 – Shatin Connection Phase 1 Area 4D Site Formation Geotechnical Submission	MCA	TDD * & GCO	Report examined and analysed the stability of slopes adjacent to, and between platforms for the proposed development. Also included an assessment of ground water levels at critical sections.
1986 (June and Oct)	Shatin New Town Formation, Roads & Drains in Area 4D Geotechnical Submission	GCO	TDD	Checking of MCA (1983) report found acceptable however comments that final assessment on groundwater monitoring is outstanding.
1987	Shatin New Town, Stage II Contract No. ST24/85 Route 5 – Sha Tin Connection Phase 1 Drainage Design	MCA	GCO	Proposed slope drainage system design submission included design calculations and drainage layout plans. Plans show drainage design allows for surface run-off from cut slopes from nearby related slopes.
1987	Shatin New Town, Stage II Contract No. ST24/85 Route 5 – Shatin Connection Phase 1 Drainage Design	GCO	TDD	In response to the slope drainage design submitted by MCA (1987), the GCO stated that they had “no adverse comment in general on the proposed drainage system”.

* NTDD renamed Territory Development Department in 1986

Table A1 - Summary of Documents Reviewed (Sheet 4 of 6)

Year	Document Title	By Whom	To Whom	Remarks
1989	Supplementary Housing Sites in Shatin	GCO	TDD	GCO provided geotechnical comment on proposed housing sites in the Shatin area, including planning area 4D. The GCO stated that, "There are no objections in principle to the use of the five areas [including area 4D] as supplementary housing sites provided that geotechnical limitations affecting these sites are considered and dealt with in an appropriate manner during site formation." The GCO went on to state that, "This site [area 4D] is located on terrain identified in the Geotechnical Area Studies Programme as colluvium and drainage plain. It lies across two natural drainage lines with a steep and extensive catchment area", and that, "Attention to both subsurface and surface drainage is needed to reduce the possibility of slope instability and flooding."
1991	Shatin Area 4D Supplementary Site Formation Geotechnical Report	Civil Engineering Section Construction Branch, HD	GCO	Stability analysis of slopes and retaining walls modified from the original site layout (MCA, 1983) to optimise development potential. Modification included enlargement of platforms creating a fill slope and retaining wall within the site and increase (of 1 m) in cut slopes in northwest of site.

Table A1 - Summary of Documents Reviewed (Sheet 5 of 6)

Year	Document Title	By Whom	To Whom	Remarks
1991	Shatin Area 4D Supplementary Site Formation Geotechnical Report	GCO	HD	In response to the HD (1991) geotechnical report the GCO stated they had "no adverse geotechnical comments on the proposed site formation works to enlarge the existing platforms."
1992 (Oct)	Shatin New Town Stage II Contract No. ST24/8S Route 5 – Shatin Connection, Phase 1 Area 4D Supplementary Geotechnical Assessment	MCA	HD and GEO	Review of additional geotechnical information for the site, included piezometer records, triaxial test results and borehole logs.
1992 (Nov) and 1993 (Mar)	Shatin New Town Stage II Contract No. ST24/8S Route 5 – Shatin Connection, Phase 1 Area 4D Supplementary Information	MCA	HD and GEO	Groundwater assessment of site slopes. MCA found "that the groundwater table is not critical and will not affect the site".
1993	Home Ownership Scheme STTL396, Shatin Area 4D	GEO	HD, DLO and NENT	In response to MCA (1993), GEO had "no further comment" with regard to groundwater table at the site.
1996 (Sept)	Phase 2 Systematic Inspection of Features in the Territory (SIFT 2 Version 4.4)	Consultants to GEO	GEO	Identification of slope (7SW-D/C790) from API.

Table A1 - Summary of Documents Reviewed (Sheet 6 of 6)

Year	Document Title	By Whom	To Whom	Remarks
1997 (May)	SIRST – Field Sheet and Previous History / Documentation – Background Information	Consultants to GEO	GEO	Provided details of slope No. 7SW-D/C790, including field observations and background information.