

**The 2007 International Forum on Landslide Disaster
Management Post-Forum Workshop
“Recent Development in Natural Terrain Landslide Risk
Management and Mitigation”**

**“Mitigation Works and
Instrumentation at Various
Natural Terrain Sites”**

Presented by Don Sum & Stuart Millis

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Presentation Outline

Part I : Landslide Hazard Mitigation Works – By Don Sum

1. Project Background
2. Natural Terrain Hazards Identified
3. General Layout of Natural Terrain Mitigation Works
4. Special Monitoring System
5. Public Relation

Part II : Field Instrumentation Works – By Stuart Millis

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1. Project Background

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Project Background

- **An existing development at On Yam, Shek Lei, Victoria Road and Luk Keng Wong Uk is affected by Natural Terrain Landslide Hazards**
- **Ove Arup & Partners Hong Kong Ltd (Arup) was commissioned to undertake detailed design of hazards mitigation works for these sites**

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Project Background

- **Proposed Natural Terrain Hazard Mitigation Works:**

- Tensioned Steel Mesh Fences at Victoria Road, Shek Lei and Luk Keng Wong Uk
- Rigid Barriers at Victoria Road, On Yam and Shek Lei
- Soil Nailing at Victoria Road, Shek Lei and Luk Keng Wong Uk
- Baffles at On Yam and Luk Keng Wong Uk
- Upgrading works including soil nailing with grillage / concrete slab, retaining wall structures at man-made slopes within Victoria Road site and Luk Keng site (Integrated approach)

- **Contract Period :** Total 24 months (from May 2007 to May 2009)

- **Total Contract :
Sum** HK\$ 138 millions (US\$ 17.7 millions)

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Victoria Road Site

Recent major landslides in 1966, 1994, 1999 and 2005



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Victoria Road Site -- 1966 Landslides



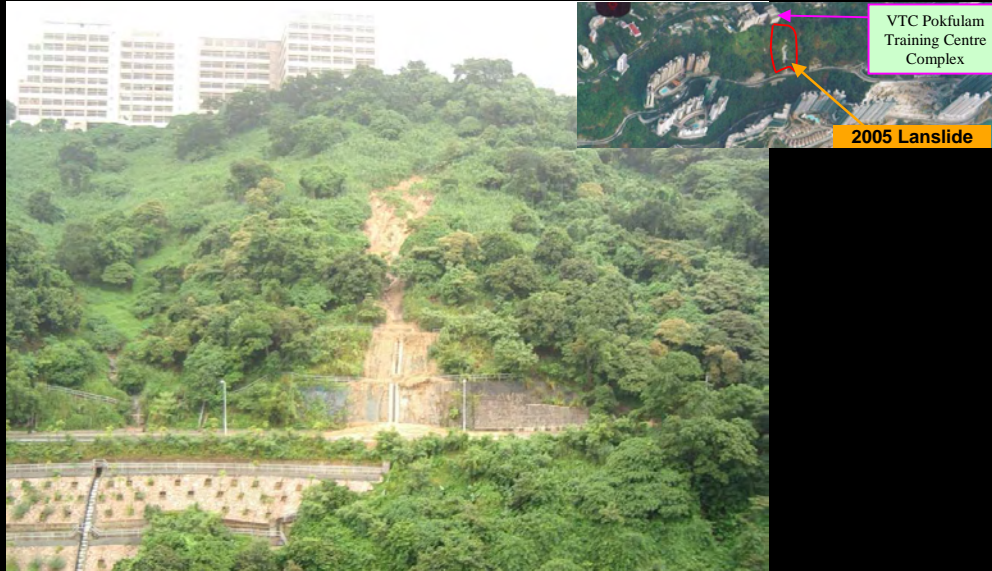
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Victoria Road Site – 1994 and 1999 Landslides



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Victoria Road Site -- 2005 Landslide

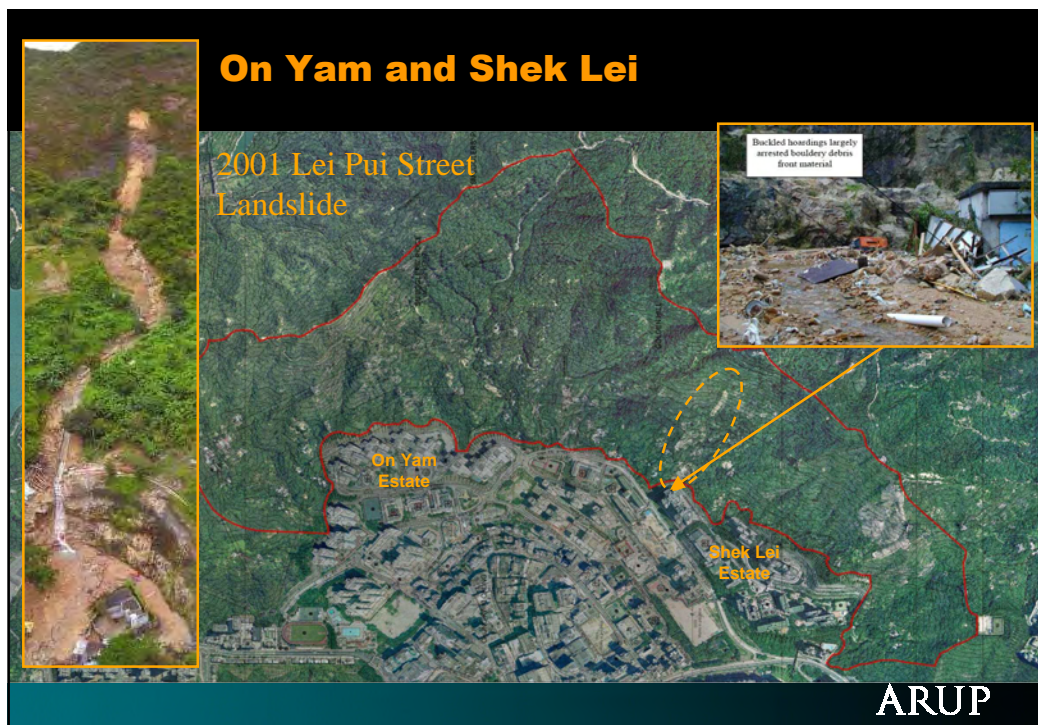


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Victoria Road Site

- **Major landslides** with volumes over 100m³ occurred in recent years
- The run-out from the failures **became channelised** in an ephemeral drainage line and reached Victoria Road, which was subsequently closed to traffic
- The hillside has a history of shallow open hillslope landslides, with over **30 natural terrain failures** identified by the API
- Other more sizeable events, such as the **Baguio Villa Landslide**, have occurred within the site, although these were triggered by failure of man-made features

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On Yam and Shek Lei – Lei Pui Street

- **800m³ Channelised Debris Flow** occurred on 1st September 2001.
- The run-out from the failure reached Lei Pui Street, some **350m from the landslide source**.
- Several squatter dwellings were completely destroyed by the failure.
- Over **50 other recent landslides** had been recorded within the study area.

Luk Keng Wong Uk Site



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Luk Keng Wong Uk Site



On 12 August 1997, a landslide occurred within the Study Area and some of the **channelized debris** was deposited at the rear of a village house



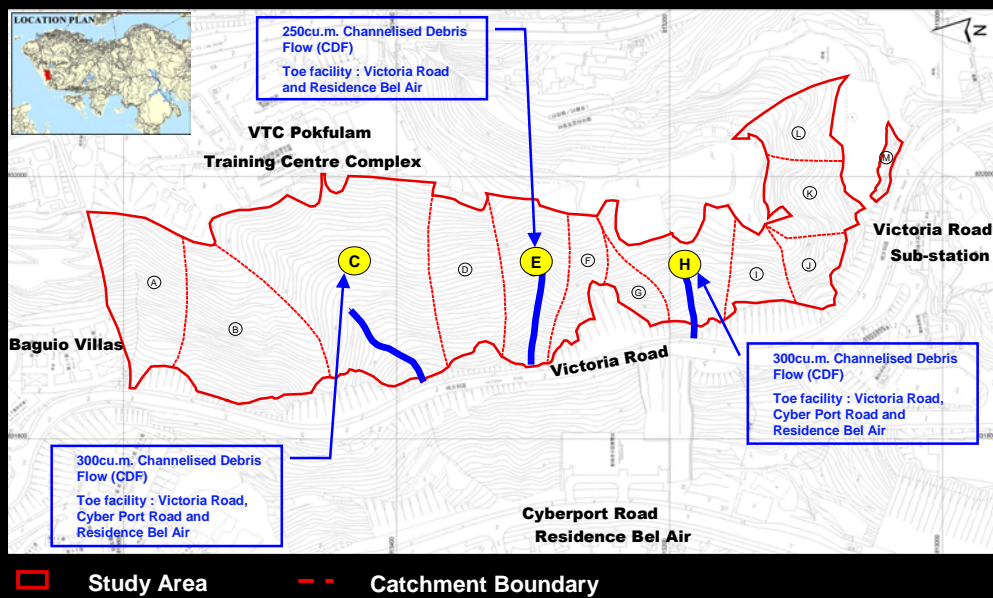
On 24 May 1998, another landslide, with a source volume of about 150 m³, occurred at about 20 m to the north of the 1997 landslide. Some of the **channelized debris deposited** in an alley between two village houses.

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2. Natural Terrain Hazards Identified

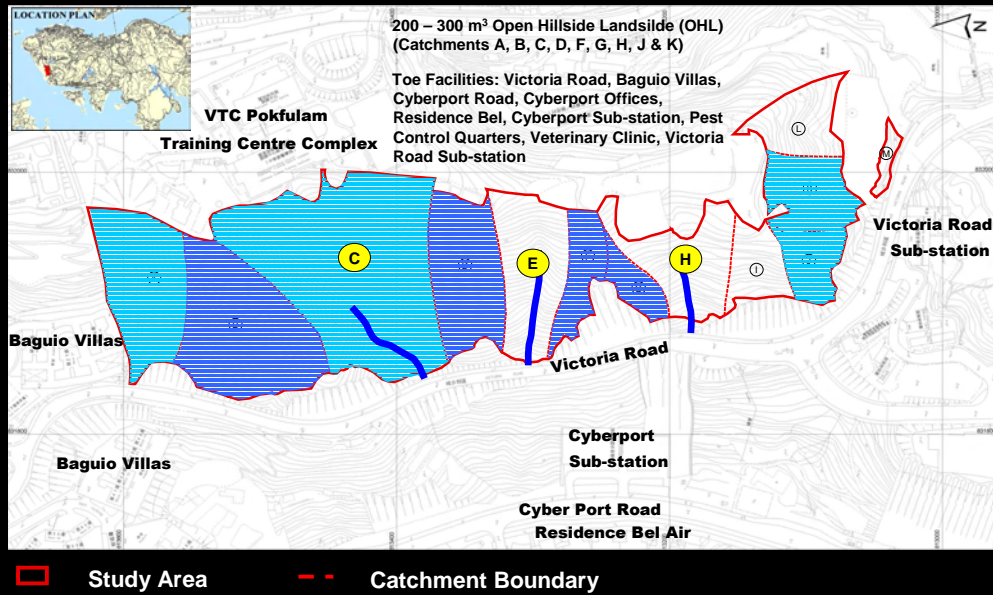
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Victoria Road site -- Hazards Identified



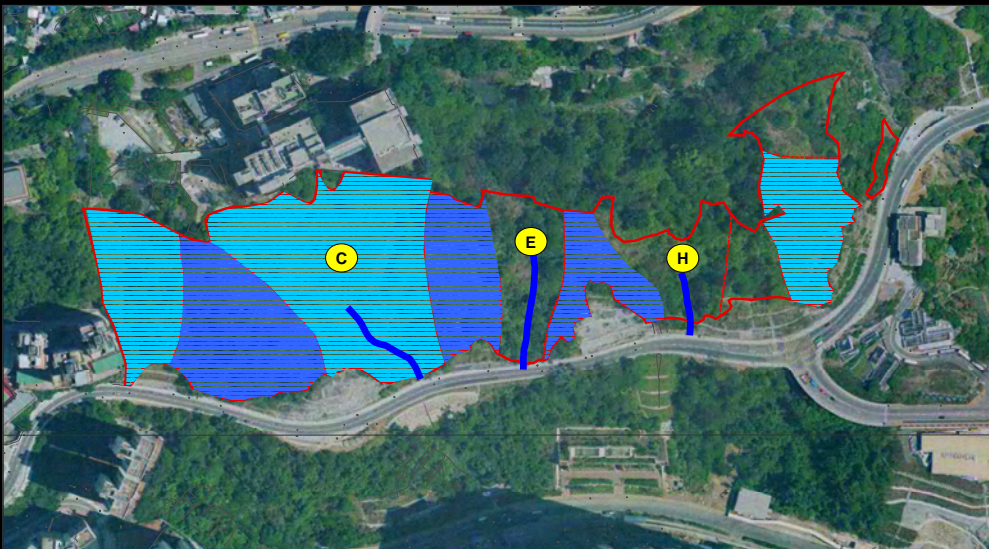
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Victoria Road site -- Hazards Identified



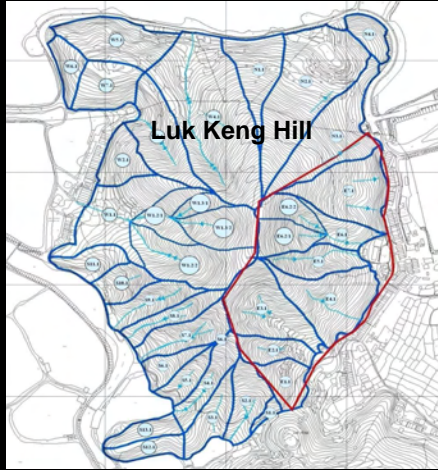
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AREAS AFFECTED BY HAZARDS - PHOTO



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Luk Keng Wong Uk site -- Hazards Identified



Location: Above Luk Keng Wong Uk, Luk Keng

No. of Drainage Catchments: 8

Minimum Elevation: +2mPD

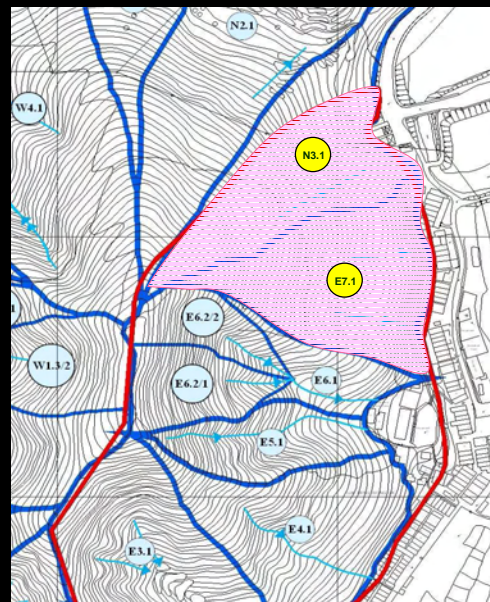
Maximum Elevation: +120mPD



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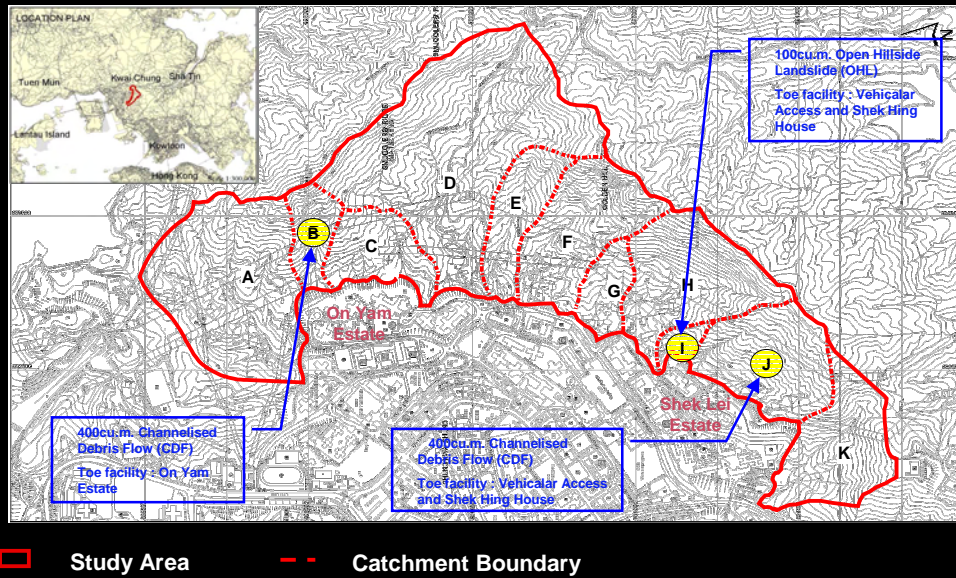
Luk Keng Wong Uk site -- Hazards Identified

- Catchments N3.1 and E7.1 have potential landslides that could cause significant risk and NTHMM for these catchments are required.
- Catchment N3.1 – 300cu.m Open Hillside Landslide (OHL)
- Catchment E7.1 – 530cu.m Channelized Debris Flow (CDF)



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On Yam and Shek Lei -- Hazards Identified

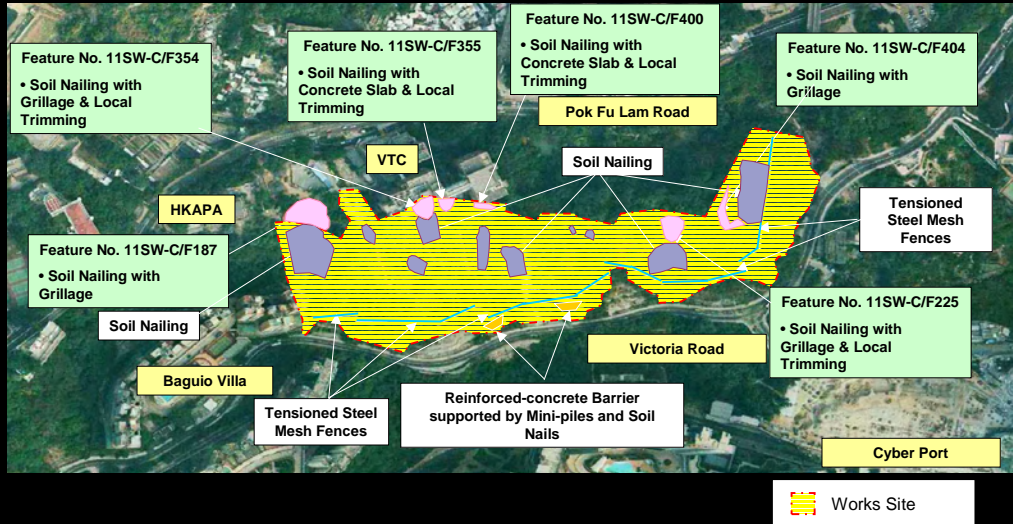


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3. General Layout of Natural Terrain Mitigation Works

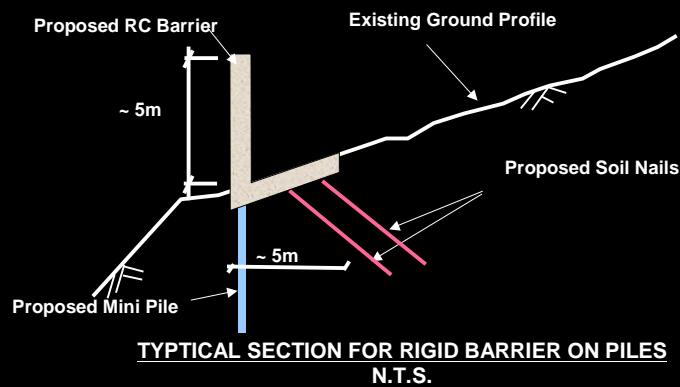
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Proposed Works at Victoria Road



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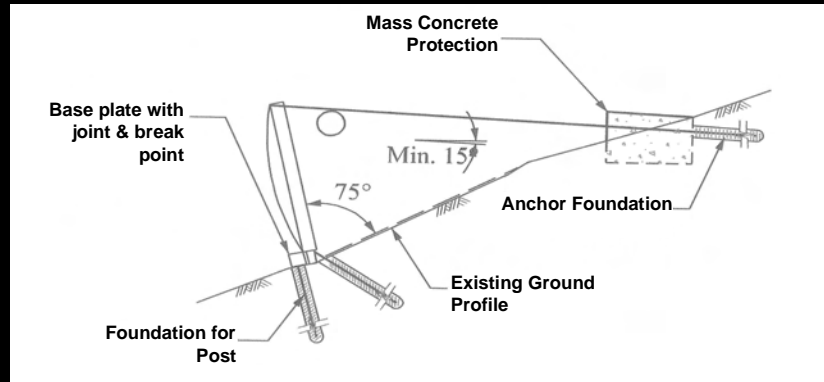
CDF in Catchments C and E



- To **RESIST** debris impact force
- Smaller on plan (~10m x 4.5m) due to the use of piles, but higher stem (~3m to 5m) to maintain containment volume
- Less excavation into hillside, estimated excavation volume
- No TTM required during construction (except mobilisation of plan / material)

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OHL in Catchments

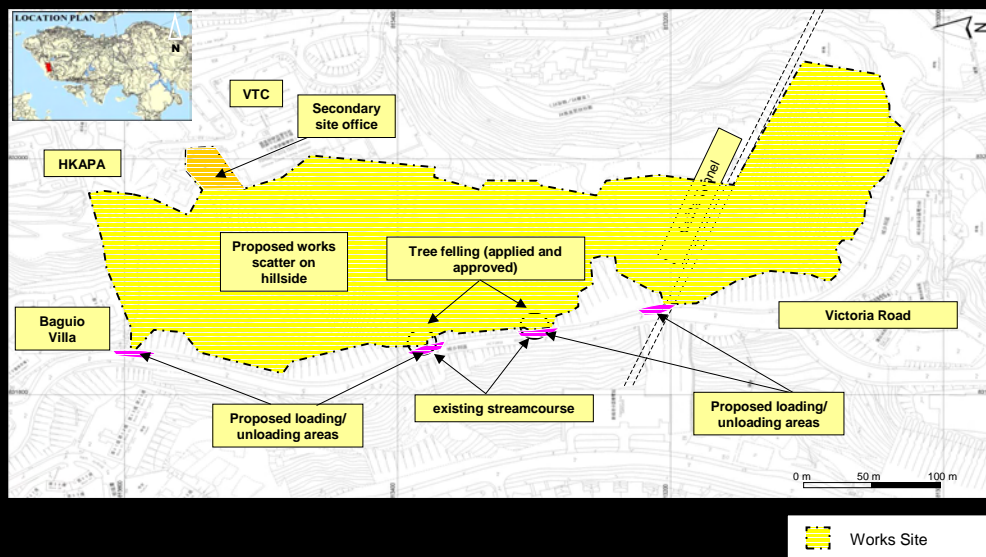


DETAIL FOR TENSIONED STEEL MESH FENCE (TSMF)
N.T.S.

- To **RESIST** debris impact force
- Deformation will be resulted (replacement cost), need to be set back from road
- Minimum excavation into hillside
- Less impact to Traffic

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Site Constraints at Victoria Road



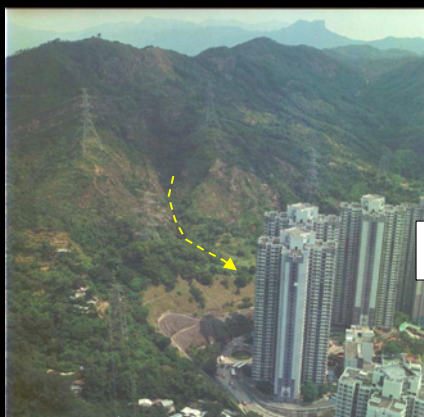
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Site Constraints at Victoria Road

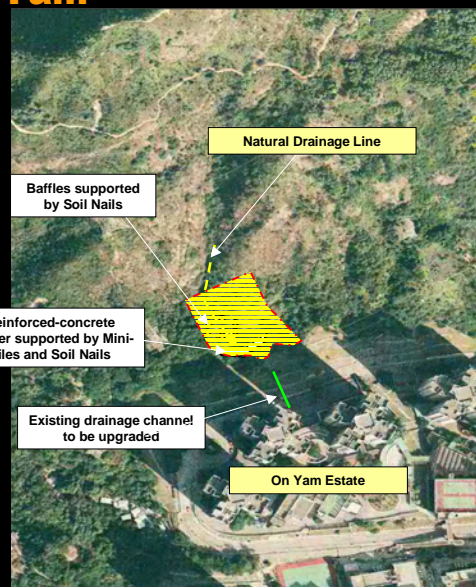
- **Works spread throughout the entire large steep hillside area**
 - A number of works areas/ interface between different works types
 - A large area and network of scaffolding
- **Vocational Training Council and HK Academy for Performing Arts** within close proximity the works site
- **Control Measures for noise / dust during construction**
- **Traffic arrangement**
 - Loading/unloading areas along Victoria Road
- **Hong Kong Electric Company Ltd. 4m diameter cable tunnel** across the works site
 - Advanced permission / notification required for construction
- **Construction works at existing streamcourse**
 - Precautionary measures to avoid blockage of existing drainage system

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Proposed Works at On Yam

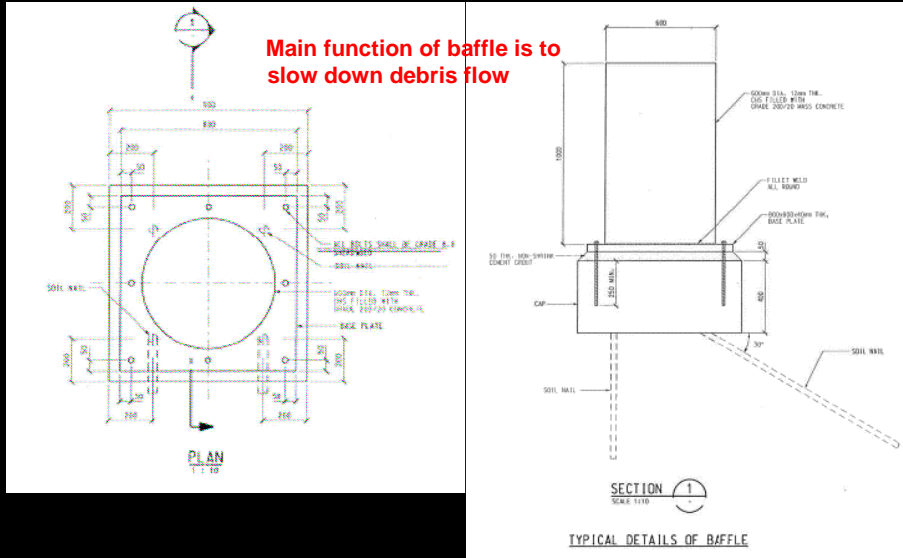


 Works Site



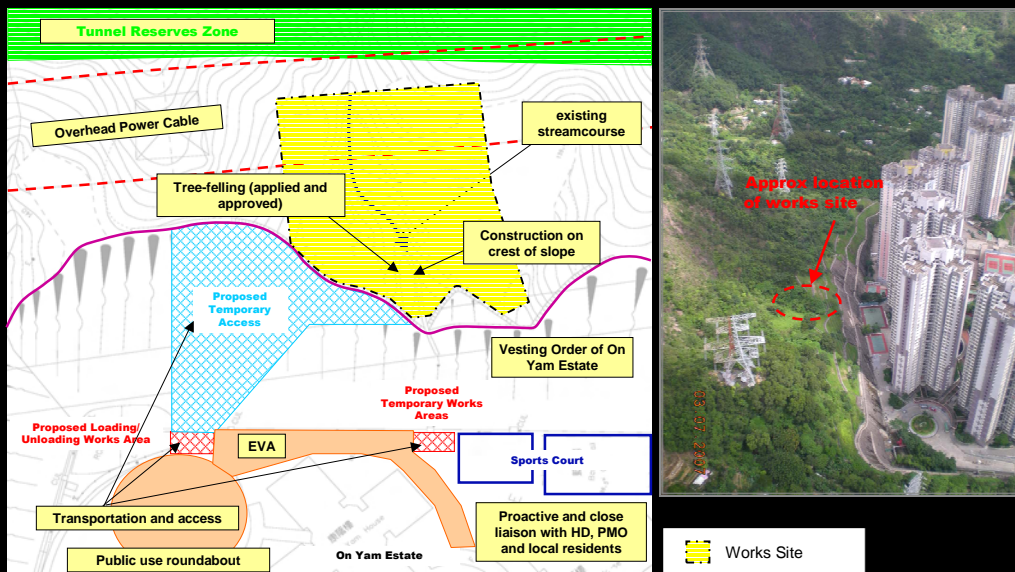
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Typical Details of Baffles



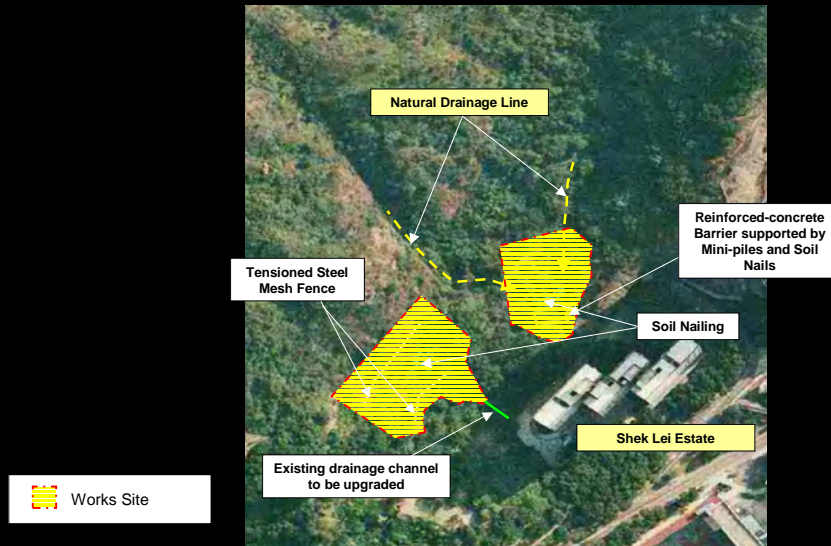
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Site Constraints at On Yam



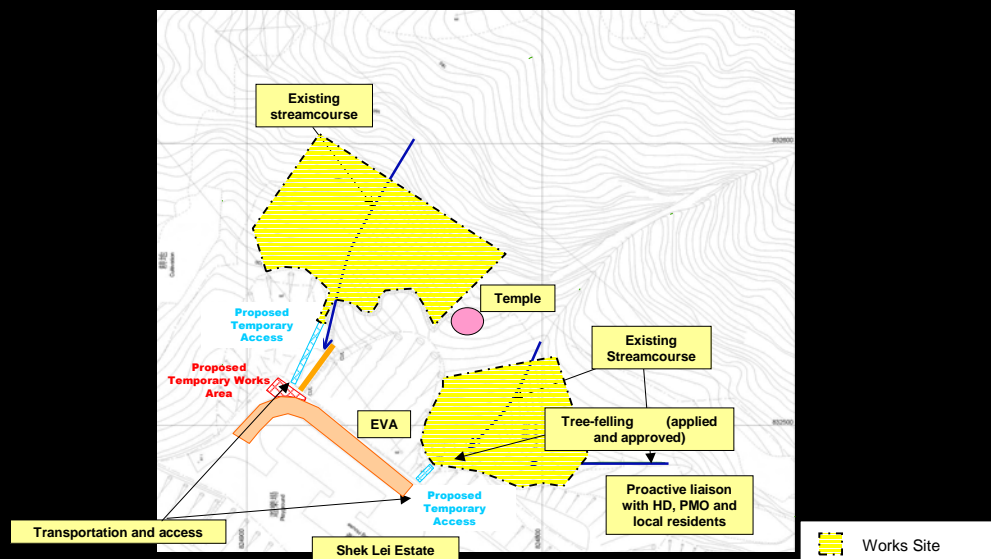
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Proposed Works at Shek Lei



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Site Constraints at Shek Lei



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Site Constraints at On Yam / Shek Lei

- In close proximity to densely populated residential areas and construction on the crest of slope
 - Stringent **air and noise control** and safety precautionary measures
 - **Difficult access**
- Transportation/access to the site
 - **Loading/unloading areas** and works areas agreed with HD in principle and follow-up liaison by contractor required
- No works allowed within **Vesting Order** of OY/SL Estate
- **Overhead cable and electric pylon** located within the site thus usage of helicopter is prohibited
- **Construction Works at existing streamcourse**
 - Precautionary measures to avoid block of existing drainage system
- **Tree-felling** is unavoidable for construction of rigid barrier

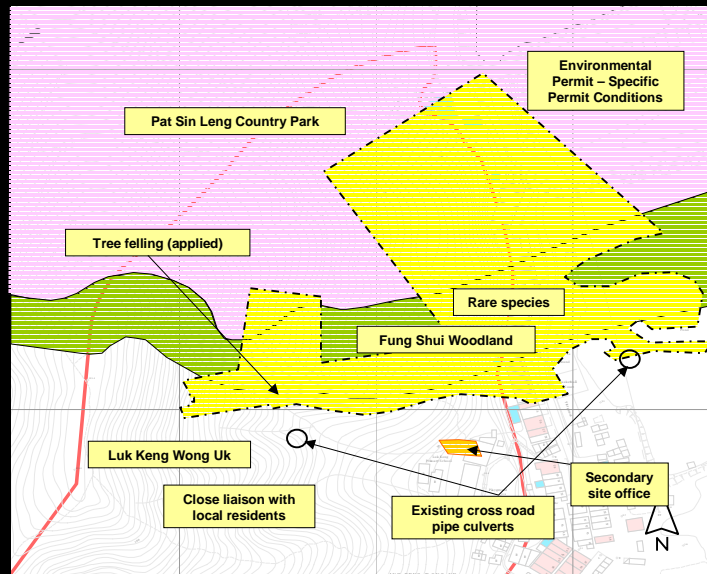
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Proposed Works at Luk Keng Wong Uk



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Site Constraints at Luk Keng Wong Uk



- Environmental sensitive area / Fung Shui Woodland / Pat Sin Leng Country Park located within the site
- Rare species to be protected
- Specific requirements from AFCD (e.g. deployment of tree expert)

Works Site

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Site Constraints at Luk Keng Wong Uk

- **Designated Area under EIAO -- Environmental Permit - specific permit conditions from EPD:**
 - To minimize the construction impact to the Pat Sin Leng Country Park and the conservation area within the project site boundary:
 - **Portable drilling tools** and small piling rig shall be used and no heavy construction equipment shall be employed;
 - Construction plant shall be **transported by labour** and no haul road shall be constructed;
 - Tree losses of common species arising from the Project shall be compensated and the loss to **compensation ratio** shall be at least **1:1.5**.
 - An **ecologist/ plant specialist** shall be employed to station on site during construction to supervise the selection of the locations of the works and the avoidance of disturbance to the trees and concerned plants there. The ecologist/ plant specialist shall also supervise and advise during replanting.

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4. Special Monitoring System

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Special Monitoring System

1. Mesh Fence Monitoring System

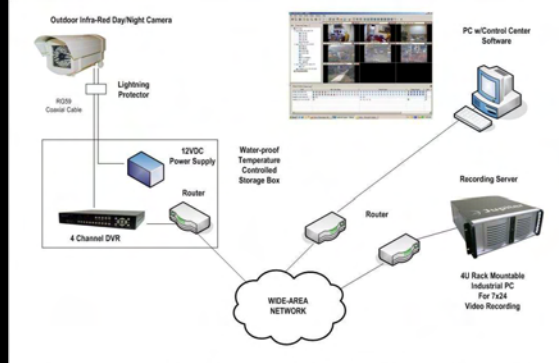
- Provide **continuous monitoring (24-hrs)** to the TSMF
- **Alarm message** transmit to designated receivers in the event of the mesh fence being hit by external object(s)
- Main Components of the system :
 - (i) 150 nos **radio based sensor** mounted on supporting ropes of TSMF
 - (ii) 5 nos. **base station** consisting of a receiver with ground plain antenna for up to 40 sensors with 300m radius distance

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Special Monitoring System

2. Landslide Video Capturing System

- Provide **continuous video capturing (24-hrs recording)** to the landslide resisting structures in the event of the structure being hit by landslide debris
- Clearly capture the **motion of landslide debris** and the **behaviour of the proposed structures**
- Cameras can be **remotely controlled** and monitored using the control center software through board brand network
- **Send email** to pre-defined email account, with thumbnail images of the captured pictures



Main Components of the system : Day/night Indoor/Outdoor Infra-red color Camera; Digital Video Recorder (DVR); Desktop computer; Control Center software; Routers etc.

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Public Relation / Press

- Address public concerns and to prevent possible complaints

Information Leaflet on Victoria Road Slope
Contract No. GE/2006/10

Contract Title: Landslide Hazard Mitigation Work Shek Lei, Victoria Road and Lok and Field Instrumentation Works Hillside

Government Department: Geotechnical Engineering Office Civil Engineering and Development

Consultants: Ove Arup & Partners Hong Kong Carrier Construction Limited

Duration: May 2007 to May 2009

合約編號 GE/2006/10
工程簡介 -
安穩鄰近橋樑及管線附近之天然山坡山泥傾瀉

合約名稱: 安穩、石籬、域多利道及鹿頸廣道的山坡泥傾瀉風險緩減工程及於另外四個山體的現場監測儀器安裝工程

政府部門: 土木工程拓展署 土力工程處

顧問公司: 奧雅納工程顧問

承建商: 奇興工程有限公司

工期: 2007年7月至2008年9月(約15個月)

合約編號 GE/2006/10
工程簡介 -
石籬鄰近橋樑附近之天然山坡山泥傾瀉風險緩減工程

合約名稱: 安穩、石籬、域多利道及鹿頸廣道的山坡泥傾瀉風險緩減工程及於另外四個山體的現場監測儀器安裝工程

政府部門: 土木工程拓展署 土力工程處

顧問公司: 奧雅納工程顧問

承建商: 奇興工程有限公司

工期: 2007年7月至2008年12月(約18個月)

(圖本: 2007年6月)

(圖本: 2007年6月)

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END

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