

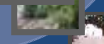
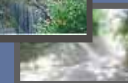
# New Priority Ranking Systems (NPRS) for Selection of Man-made Slopes

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Geotechnical Engineering Office,  
Civil Engineering and Development Department



# Content

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- Introduction
- Landslip Prevention and Mitigation Program (LPMitP)
- New Priority Ranking Systems (NPRS)
- Slope Selection
- NPRS for Soil Cut Slopes
- NPRS for Rock Cut Slopes
- NPRS for Fill Slopes
- NPRS for Retaining Walls
- Combined Ranking
- Calibration Exercises
- Examples

## Slope Safety Achievements by 2010

- all the high-risk old substandard man-made slopes affecting buildings and busy roads would have been dealt with
- overall landslide risk of old man-made slopes would have been reduced to below 25 % of the risk that existed in 1977



# Old Substandard Slopes with Moderate Risk (affecting roads and open space)



# Old Technology Slopes



**1999 Shek Kip Mei landslide –  
emergency evacuation of 700+ people**

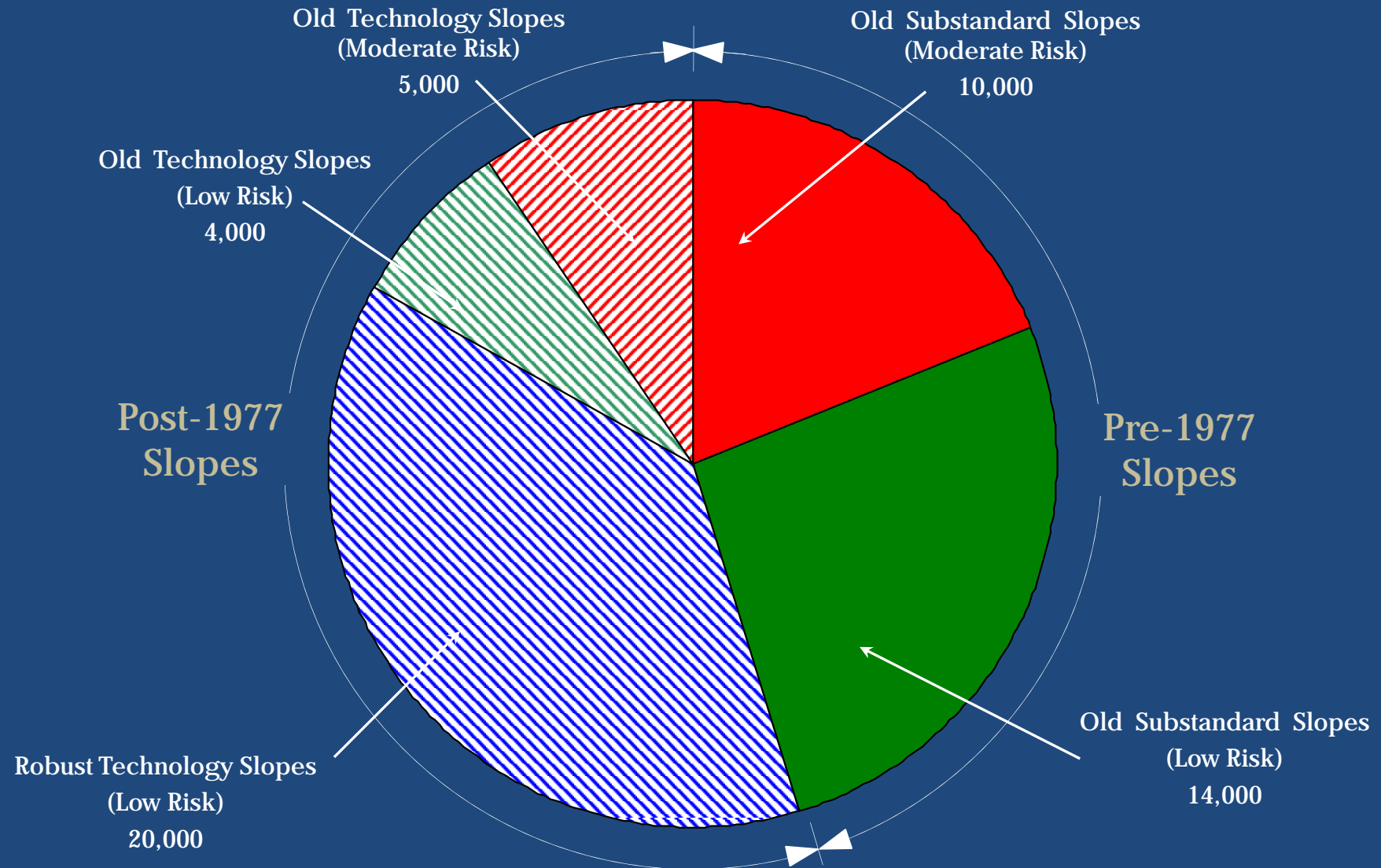


- slope formed /treated based on knowledge and technology from 1977 to late 1980s
- slope trimmed to less steep gradient without reinforcement or structural support
- prone to deterioration based on performance history

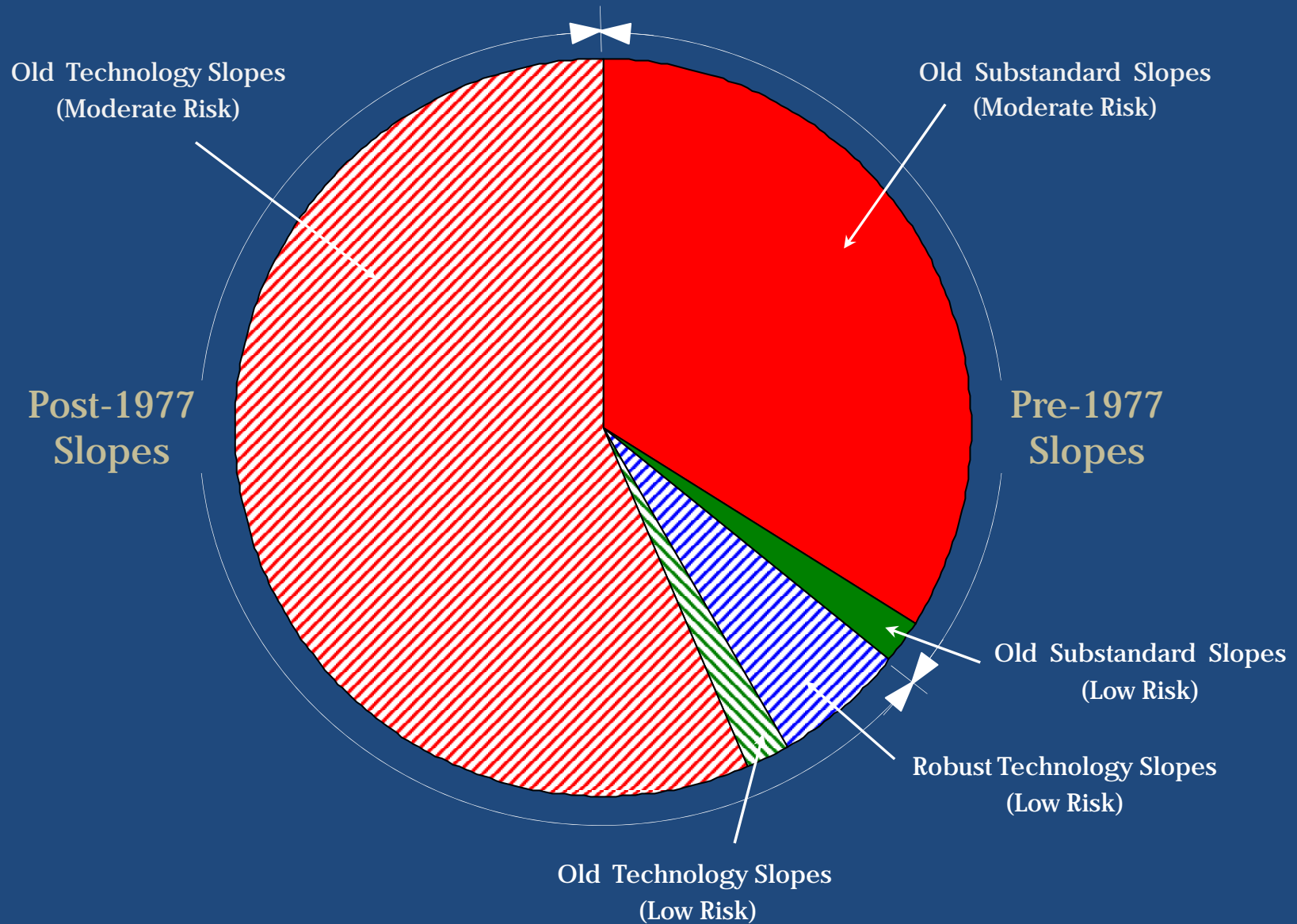
# Risk Classification of Man-made Slopes

Risk Classification		Consequence-to-life Category		
		1	2	3
Pre-1977 Slopes	Old Substandard Slopes	High (Minimal)	Moderate (10,000)	Low (14,000)
Post-1977 Slopes	Old Technology Slopes	Moderate ← (5,000) →	Moderate	Low (4,000)
	Robust Technology Slopes	Low ←	Low (20,000)	Low →

# Slopes in Different Groups



# Risk Profile by 2010





## Post-2010 Landslip Prevention and Mitigation Programme (LPMitP)

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To dovetail with the Landslip Preventive Measures (LPM) Programme, the Government has launched the LPMitP on a rolling basis, in order to contain the landslide risks associated with the remaining man-made slopes and vulnerable natural hillside catchments

## Annual Output of LPMitP

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Implemented on a rolling basis, LPMitP's annual output is to:

- upgrade 150 government man-made slopes
- conduct safety-screening studies for 100 private man-made slopes
- implement risk mitigation works for 30 natural hillside catchments



# Action on Man-made Slopes Under LPMitP

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## LPMitP targets:

- old substandard slopes and old technology slopes with moderate risk (i.e. both pre- and post-1977)
- slopes at a more advanced state of degradation with signs of distress or past instabilities



# New Priority Ranking Systems (NPRS)

## New Priority Ranking Systems (NPRS)

- comprise individual NPRS for different slope features (i.e. soil cut slopes, rock cut slopes, fill slopes and retaining walls)
- encompass both pre-1977 and post-1977 slope features (i.e. cater for slopes with different level of geotechnical engineering)
- improve resolution on ranking of moderate risk slopes
- apply to both government and private slopes
- development of the NPRS was reviewed by the Slope Safety Technical Review Board (SSTRB)

# Slopes excluded from ranking

Soil Cut Slopes	Rock Cut Slopes, Fill Slopes and Retaining Walls
Treated with robust technology (e.g. soil nails), and processed and accepted by GEO	Processed and accepted by GEO
Formed/treated in or after year 2000, and processed and accepted by GEO	

## NPRS - Risk Based Systems

Total Score (TS) =

*reflects likely risk  
of landslide*

Instability Score (IS)  
Consequence Score (CS)

*reflects likelihood of  
failure*

*reflects likely consequence  
of failure*

# Instability Score (Soil Cut Slopes)

$$\begin{aligned} \text{IS} &= \text{Instability Potential (IP)} && \text{Actual Performance (AP)} \\ &= \text{A1} \quad \text{A2} \quad \text{A3} \quad \text{A4} \quad \text{A5} && \text{B1} \quad \text{B2} \end{aligned}$$

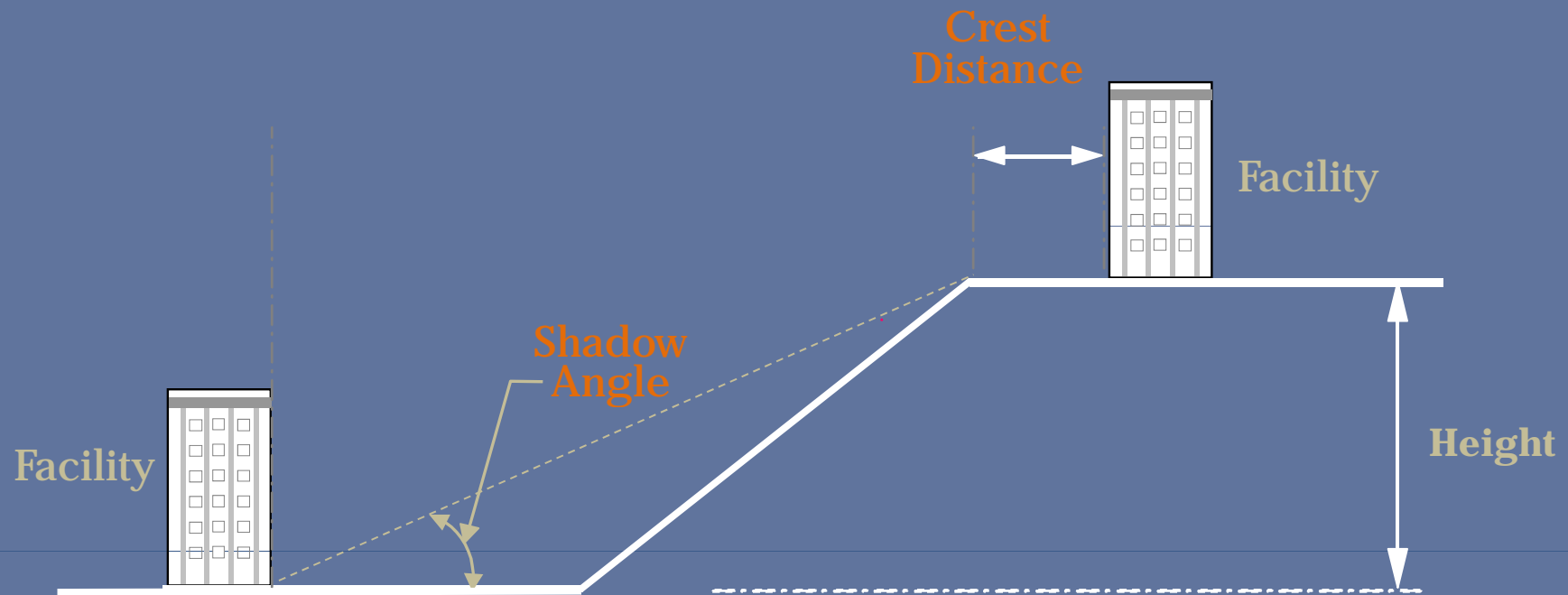
- Age of slope (A1)
- Level of Geotechnical Engineering Input (A2)
- Slope Geometry (A3)
- Surface Cover/Drainage (A4)
- Site Characteristics (A5)

- Signs of Distress (B1)
- Instability after Formation/Treatment (B2)

# Consequence Score (CS)

CS accounts for:

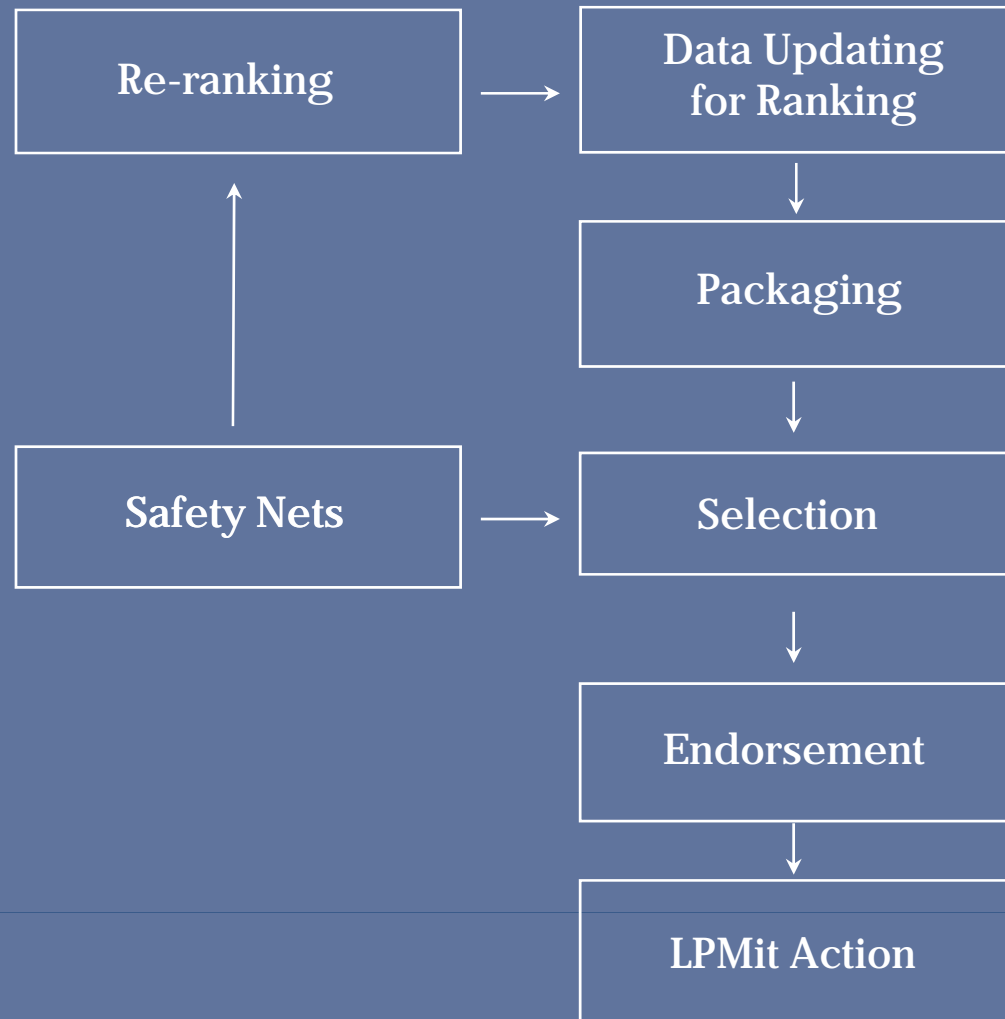
- type and proximity of facilities affected
- scale of failure
- topography adjacent to slope



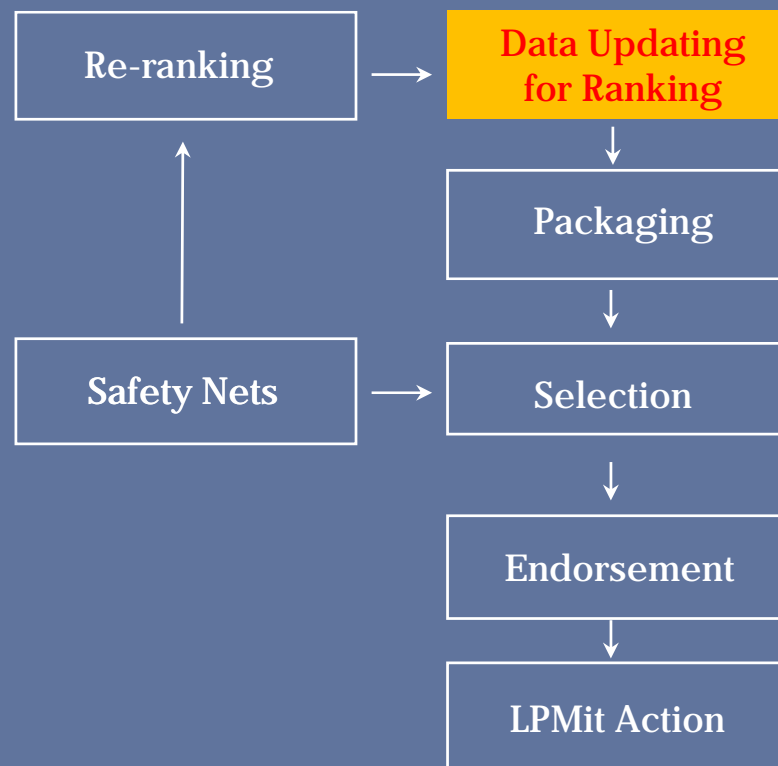


# Slope Selection

# Slope Selection



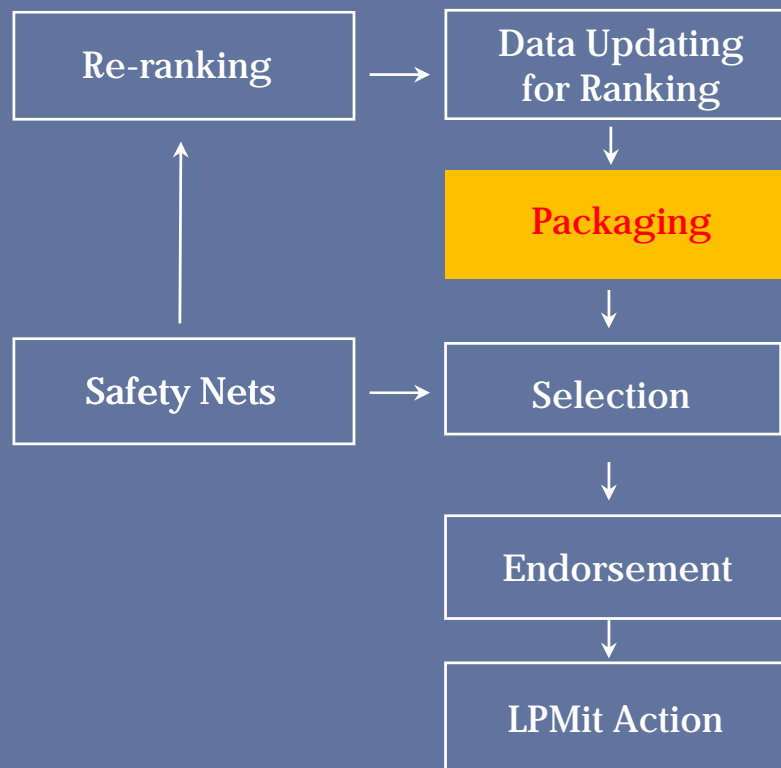
# Data Updating and Ranking



To ensure that deserving candidate slopes will be accorded appropriate priority and selected, data will be collected/updated for ranking through:

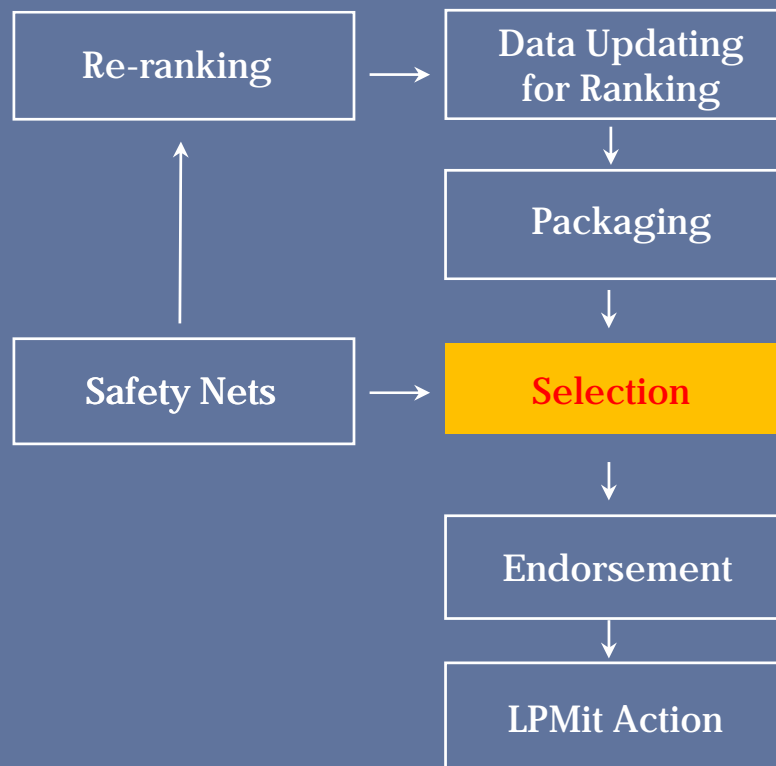
- LPMitP
- Routine engineering inspection of slopes

# Packaging



Packaging slopes into area-based batches for selection

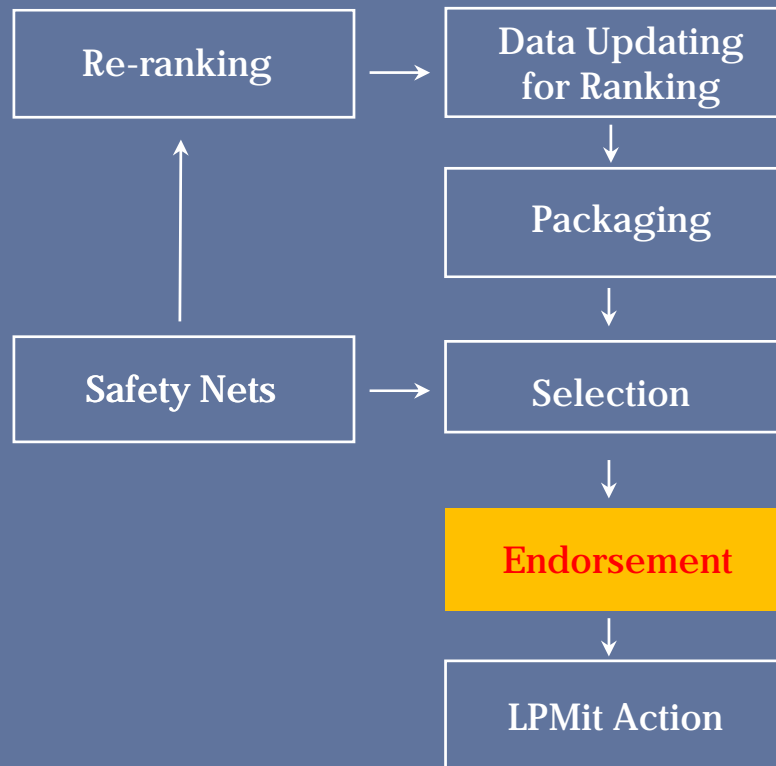
# Selection for LPMitP Action



Selection of slopes for action requires the following:

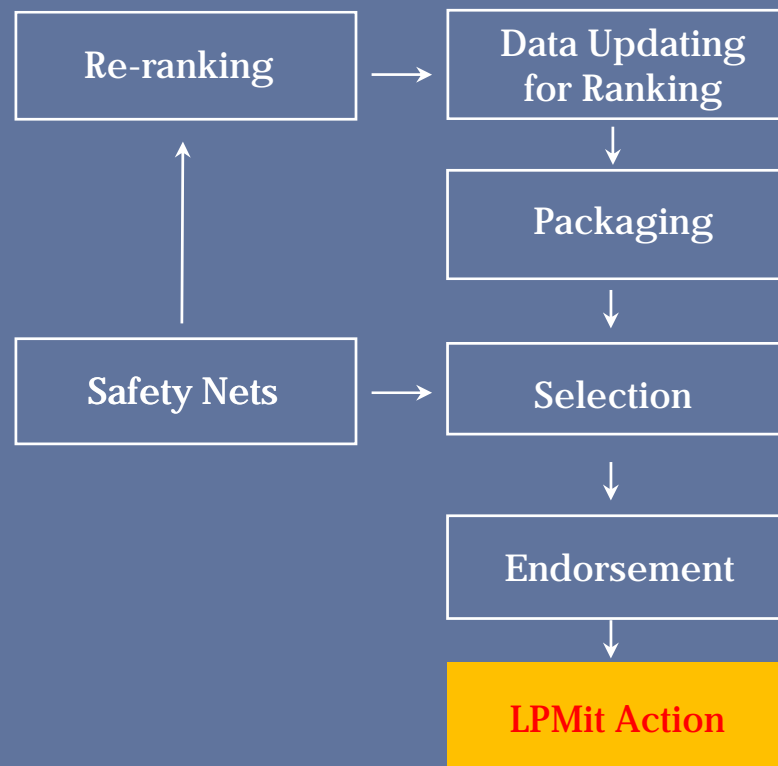
- checking association with future development projects
- integrated approach to cover deserving slopes in the vicinity
- data validation

# Endorsement



Endorsement by the LPM Committee

# LPMitP Action



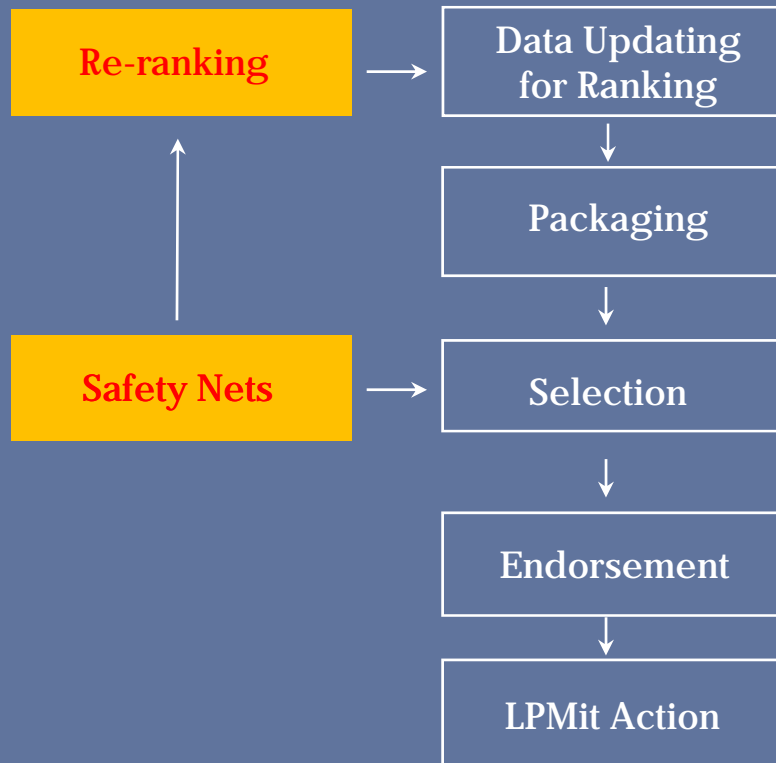
## Investigation and design by:

- LPMitP Consultancies
- GEO's in-house team

## Upgrading works by:

- LPMitP Consultancies
- GEO's in-house contracts

# Safety Nets



Safety nets include the following:

- slopes with signs of distress or instability based on Engineer Inspection (EI) or Landslide Investigation (LI) will be considered for urgent action or re-ranking.
- a keep-in-view system for slopes deferred from LPMitP action due to development projects and other circumstances



# NPRS for Soil Cut Slopes

# NPRS for Soil Cut Slopes

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$$\text{Total Score (TS)} = \text{Instability Score (IS)} + \text{Consequence Score (CS)}$$

# NPRS for Soil Cut Slope - IS

$$\begin{aligned} \text{IS} &= \text{Instability Potential (IP)} && \text{Actual Performance (AP)} \\ &= \text{A1 A2 A3 A4 A5} && \text{B1 B2} \end{aligned}$$

- Age of slope (A1)
- Level of Geotechnical Engineering Input (A2)
- Slope Geometry (A3)
- Surface Cover/Drainage (A4)
- Site Characteristics (A5)

- Signs of Distress (B1)
- Instability after Formation/Treatment (B2)

# Age of Slope (A1)

$$IS = A1 \times A2 \times A3 \times A4 \times A5 \times B1 \times B2$$

Year of Formation / Treatment (Y)	A1
$Y \leq 1980$	8
$1980 < Y \leq 1990$	6
$1990 < Y \leq 1995$	2
$Y > 1995$	1

- "Y" represents the year formation or treatment works completed on the subject slope



# Level of Geotechnical Engineering Input (A2)

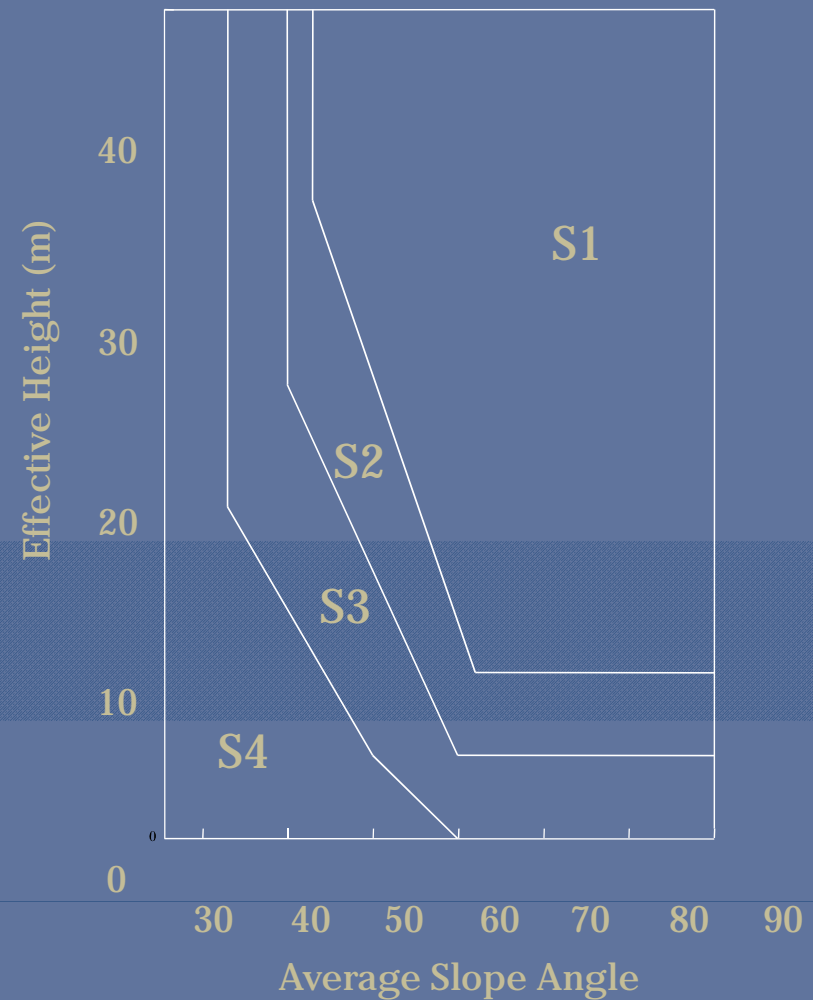
$$IS = A1 \times A2 \times A3 \times A4 \times A5 \times B1 \times B2$$

	<u>A2</u>
<b>None or little</b> e.g. pre-1977 slopes and post-1977 slopes falling outside any engineering project boundary	8
<b>Some</b> e.g. post-1977 slopes without GEO checking records but falling within the boundary of engineering projects	6
<b>Substantial</b> e.g. slopes checked by GEO but with outstanding comments	2
<b>Checked and accepted by GEO</b>	1

# Slope Geometry (A3)

$$IS = A1 \times A2 \times A3 \times A4 \times A5 \times B1 \times B2$$

Slope Geometry	A3
S1	8
S2	4
S3	2
S4	1



# Slope Protection and Surface Drainage (A4)



$$IS = A1 \times A2 \times A3 \times A4 \times A5 \times B1 \times B2$$

Slope Protection Surface Drainage	Soil slope or crest area substantially unprotected	Soil slope or crest area partially protected	Soil slope or crest area substantially protected
Few or no channels + potential for convergent flow of surface water above crest or located on a drainage line or depression	8	4	2
Few or no channels	4	2	1.5
Adequate channels	2	1.5	1

# Slope Protection

Level of Protection	Area coverage
Substantially protected	> 75 %
Partially protected	25 % to 75 %
Substantially unprotected	< 25 %

- slope protection includes both hard cover and vegetation

# Surface Drainage

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Factors to be considered in assessing adequacy of surface drainage provisions:

- site topography
- catchment size
- environmental factors

# Site Characteristics (A5)

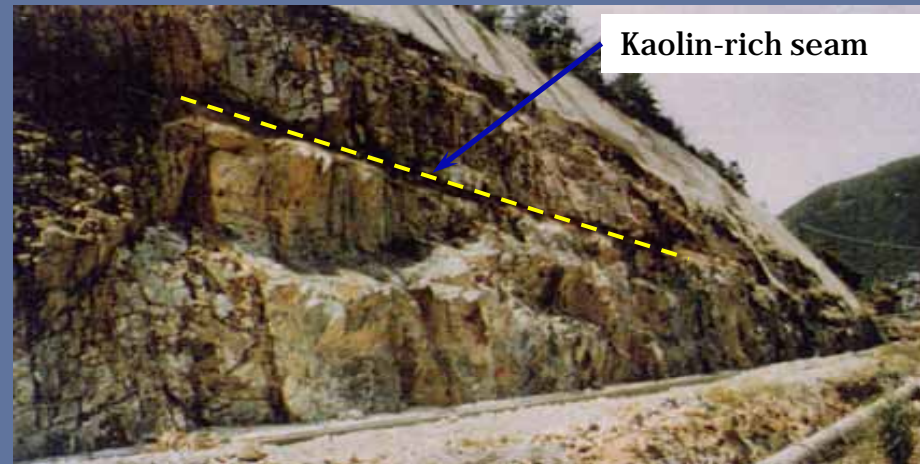
$$IS = A1 \times A2 \times A3 \times A4 \times A5 \times B1 \times B2$$

Adverse Geological Settings \ Adverse Hydrogeological Settings	Significant	Moderate	Minor/None
Significant	10	8	5
Moderate	8	3	2
Minor/None	5	2	1

# Adverse Geological Settings

## Significant

sites with relict massive failure, observable or recorded adverse discontinuities (e.g. adversely oriented, persistent, pre-existing shear surfaces or zones)



## Moderate

observable or recorded adverse geological materials (e.g. weathered dykes)



## Minor/None

none of the above

Fei Tsui Road Landslide in 1995

# Adverse Hydrogeological Settings

## Significant

observable or recorded adverse groundwater conditions (e.g. high groundwater over most area of the slope or complex groundwater conditions with significant storm response)

## Moderate

seepage below mid-height of slope

## Minor/None

no signs of seepage



Ching Cheung Road Landslide in 1997

# Signs of Distress (B1)

$$IS = A1 \times A2 \times A3 \times A4 \times A5 \times \mathbf{B1} \times B2$$

## Severe

signs of slope movement (e.g. tension cracks behind slope crest, severe cracking and bulging or documented evidence of continuing movement)

## Moderate

signs of extensive minor defects (e.g. cracking of slope cover and damaged channels)

**Minor/None** none or few isolated minor defects

# Examples of Severe Signs of Distress Slope Movement



Collapse of  
side wall of  
surface  
channel



Subsidence  
of slope  
cover



Tension  
crack at  
crest



Cracking of  
catchpit



# Examples of Severe Signs of Distress

## Severe Cracking of Surface Cover



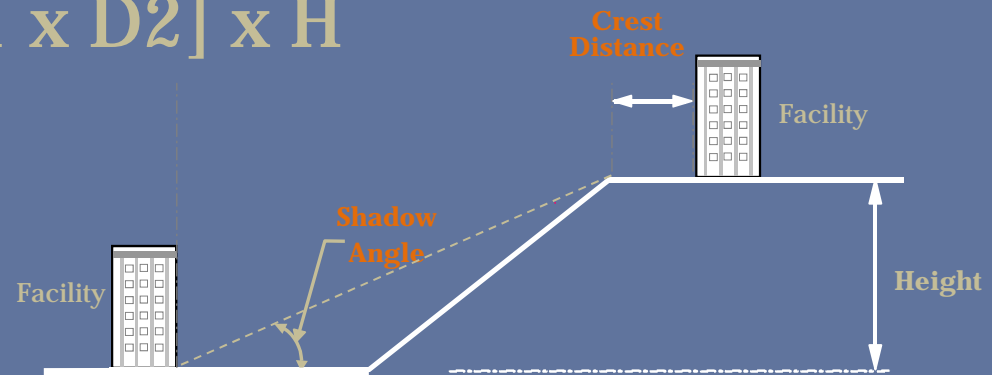
# Instability after Treatment/Formation (B2)

$$IS = A1 \times A2 \times A3 \times A4 \times A5 \times B1 \times B2$$

<u>Instability after Treatment/Formation</u>	<u>B2</u>
Massive failures (>500 m <sup>3</sup> )	10
Major/repeated minor failures	5
Minor failures	2
No failure	1






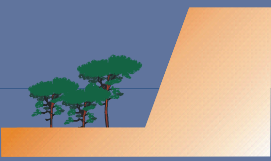
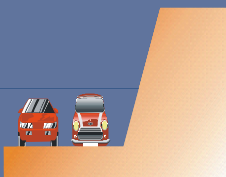
# NPRS for Soil Cut Slopes - CS

$$CS = [C1 \times C2 + D1 \times D2] \times H$$



- Type of Crest Facility (C1)
- Vulnerability of Crest Facility (C2)
- Type of Toe Facility (D1)
- Vulnerability of Toe Facility (D2)
- Slope Height (H)

# Facility Groups

<u>Facility Group No</u>	<u>Facilities</u>	<u>FG</u>	<u>Facility Group No</u>	<u>Facilities</u>	<u>FG</u>
Group 1 : ( a )	Building of high density of occupation 	9	Group 3 :	Road with moderate traffic density, densely - used open space, etc 	0.25
( b )	Road with very heavy traffic density, bus shelter, etc 	3	Group 4 :	Road with low traffic density, lightly - used open space, etc 	0.002
Group 2 : ( a )	Building of moderate density of occupation 	2	Group 5 :	Remote area, Road with very low traffic density, etc 	0.0002
( b )	Road with heavy traffic density, major infrastructures, etc 	1			

# Facility Groups

$$CS = [C1 \times C2 + D1 \times D2] \times H$$

Facility Groups		C1 / D1
1 (a)	Building of high density of occupation	9
1 (b)	Road with very heavy traffic density, bus shelter, etc	3
2 (a)	Building of moderate density of occupation	2
2 (b)	Road with heavy traffic density, major infrastructures, etc	1
3	Road with moderate traffic density, densely - used open space, etc	0.25
4	Road with low traffic density, lightly - used open space, etc	0.002
5	Remote area, Road with very low traffic density, etc	0.0002

# Vulnerability Factors - Crest

$$CS = [C1 \times C2 + D1 \times D2] \times H$$

(b) Others

Feature Height, H (m)	Distance from Crest, D (m)		
	$10 > D \geq 6$	$6 > D \geq 3$	$D < 3$
$H < 5$	0	0.00025	0.0075
$5 \leq H < 10$	0	0.00125	0.0375
$10 \leq H < 15$	0	0.005	0.15
$15 \leq H < 20$	0.002	0.04	0.4
$20 \leq H$	0.002	0.074	0.54

# Vulnerability Factors - Toe

$$CS = [C1 \times C2 + D1 \times D2] \times H$$

(a) Buildings									
Feature Height, H (m)	Shadow Angle, $\omega$ (degrees)								
	> 50	45 - 50	40 - 45	35 - 40	30 - 35	25 - 30	20 - 25	15 - 20	10 - 15
H < 5	0.0225	0.0225	0.0155	0.005	0.001	0.0001	0	0	0
5 ≤ H < 10	0.1125	0.1125	0.0775	0.025	0.005	0.0005	0	0	0
10 ≤ H < 15	0.45	0.45	0.31	0.10	0.02	0.002	0	0	0
15 ≤ H < 20	0.95	0.92	0.70	0.35	0.11	0.02	0	0	0
20 ≤ H	0.95	0.95	0.86	0.59	0.26	0.075	0.013	0	0

# NPRS for Soil Cut Slopes - TS

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Total Score

$$TS = IS \times CS$$



# NPRS for Rock Cut Slopes

# NPRS for Rock Cut Slope - IS

$$\begin{aligned} \text{IS} &= \text{Instability Potential (IP)} && \text{Actual Performance (AP)} \\ &= \text{A1 A2 A3 A4} && \text{B1 B2} \end{aligned}$$

- Level of Geotechnical Engineering Input (A1)
- Slope Geometry (A2)
- Mode and Scale of Instability (A3)
- Seepage and Drainage Conditions (A4)

- Signs of Distress (B1)
- Instability after Formation/Treatment (B2)

# Mode and Scale of Instability (A3)

$$IS = A1 \times A2 \times A3 \times A4 \times B1 \times B2$$

## A3a – Mode and scale of failure

Mode of failure Scale of failure (volume)	Ravelling	Toppling	Wedge	Planar
Large (> 50 m <sup>3</sup> )	6	10	10	10
Medium (5 – 50 m <sup>3</sup> )	3	6	6	6
Small (< 5 m <sup>3</sup> )	2	3	3	3
None	1	1	1	1

## A3b – Potential for failure to occur

Low potential for failure	0.5
High potential for failure	1.0

$$A3 = A3a \times A3b$$

# Data Collection for Factor A3

Feature No. "Worked Example 2"	SITE OBSERVATIONS/FINDINGS			
	RAVELLING	TOPPLING	WEDGE	PLANAR
Rock Lithology and Nature of Discontinuity (See Remark A)	Volcanic Rock with Joints	—	Volcanic Rock with Joints	—
Dips of discontinuities/line of intersection of discontinuities (°)	Multiple sets of sub-vertical joints	—	45° / 350°, 50° / 340° 90° / 220°, 80° / 287°	—
Persistence of Discontinuity (m) (i.e. max. dim. of trace length exposed)	0.1 – 0.4 m	—	1 – 7 m	—
Discontinuity Spacing (m)	0.1 – 0.4 m	—	1 – 5 m	—
Discontinuity Roughness and Infilling (See Remarks B and C)	Rough and staining	—	Rough and staining	—
Width of discontinuity aperture (See Remark D)	0 – 20 mm	—	Narrow to tight	—
Probable Scale of Failure Volume (m <sup>3</sup> )	6 × 4 × 0.4 = 9.6 m <sup>3</sup> (H) (W) (D)	—	7 × 4 × 1 = 28 m <sup>3</sup> (H)(W)(D)	—

# Mode and Scale of Failure



Ravelling Failure – Kennedy Road



Wedge Failure – Pokfulam Road



Planar Failure – Tai Tam Road



Toppling Failure – Mt Butler

# Documentary Records

Seam with Loose Sand-sized Material and Lenses of Kaolinitic Clay



Plate 3 - General View of Planar, Obliquely Outward-dipping PW0/30 and PW90/100 Rock Mass Weathering Zone Interface (84356 81362), Associated with Kaolinitic Clay Development, in Slope 11SE-D/C188, West of Siu Sai Wan Estate (Taken 17/7/96)



Plate 6 - Unregistered Slope 15NW-3B/S10 (834250E 811530N), in Lei Tung Estate Showing a Relatively Planar Weathered Seam (Largely Covered by Chunnam) of Kaolinitic Clay, c.150 mm Thick, Dipping c.30-35° out of the Slope at about Mid-height within Grade II Tuff. Extensive Groundwater Seepage was Noted from the Seam during Site Inspection. (Taken 12/11/96)

ASSESSMENT OF  
GEOLOGICAL FEATURES  
RELATED TO RECENT  
LANDSLIDES IN VOLCANIC  
ROCKS OF HONG KONG  
PHASE 2A -  
CHAI WAN STUDY AREA

GEO REPORT No. 60  
S.D.G. Campbell & N.P. Kaur

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

ASSESSMENT OF  
GEOLOGICAL FEATURES  
RELATED TO RECENT  
LANDSLIDES IN VOLCANIC  
ROCKS OF HONG KONG  
PHASE 2B -  
ABERDEEN STUDY AREA

GEO REPORT No. 67  
C.A.M. Frank, S.D.G. Campbell & W.W.L. Sham

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SPECIAL ADMINISTRATIVE REGION



# NPRS for **Fill** Slopes

# NPRS for Fill Slope - IS

IS =      **Instability Potential (IP)**                      **Actual Performance (AP)**

Sliding                       $IS_1 = A1 \times A2 \times B1 \times B2$

Liquefaction               $IS_2 = A1 \times A3 \times B1 \times B2$

Washout                     $IS_3 = A1 \times A4 \times B1 \times B2$

- Level of Geotechnical Engineering Input (A1)
- Factors affecting sliding and minor washout failure (A2)
- Factors affecting liquefaction failure (A3)
- Factors affecting major washout failure (A4)

- Signs of Distress (B1)
- Instability after Formation/Treatment (B2)

# Fill Slope Failures

## Liquefaction



**Kennedy Road (1992)**

## Major Washout



**Tseung Kwan O Chinese  
Permanent Cememntray (2004)**

# Factors for difference modes of failure

Sliding  $IS_1 = A1 \times A2 \times B1 \times B2$

Liquefaction  $IS_2 = A1 \times A3 \times B1 \times B2$

Washout  $IS_3 = A1 \times A4 \times B1 \times B2$

Where

$$A2 = A2_a \times A2_b \times A2_c \times A2_d \times A2_e$$

$$A3 = \frac{1}{4} \times A2 \times A3_a \times A3_b$$

$$A4 = (A2)^{1/3} \times A4_a \times A4_b \times A4_c \times A4_d \times A4_e \times A4_f \times A4_g \times A4_h$$



Au Tau Village Road Failure in 1998

Factors	Range
(A2) Sliding	
(A2a) Geometry	1 to 32
(A2b) Type of surface Cover	1 to 4
(A2c) Surface Drainage Provision	1 or 2
(A2d) Signs of Seepage	1 or 2
(A2e) Potential Leaking Services	1 to 2
(A3) Liquefaction	
(A3a) Slope Height	0.5 to 4
(A3b) Type of Surface Cover	0.25 to 1.1
(A4) Major Washout	
(A4a) Catchment Characteristics	0.5 to 8
(A4b) Type of Crest Facility	0.05 to 1
(A4c) Volume of Fill Body	0.1 to 2
(A4d) Channelisation of Debris	0.5 or 2
(A4e) Erosion & Entrainment along Debris Trail	1 or 2
(A4f) Spread of Debris	0.5 or 1
(A4g) Unstable Terrain	1 or 2
(A4h) Masonry Wall at Crest	1 to 3

# Catchment Characteristics and Site Setting for Factor A4

Based on Site observations, Survey maps, Aerial photos and SIFT reports



Aerial Photographs

SIFT Data (from SIFT Report)	
6.1 Part of Large Fill Body <b>C1</b>	6.1 Volume of Fill Body (cu m) <b>C1</b>
<input type="radio"/> Yes <input checked="" type="radio"/> No <input type="radio"/> Unknown	<input type="radio"/> <=100 <input type="radio"/> 100-500 <input type="radio"/> 500-1000 <input checked="" type="radio"/> 1000-10000 <input type="radio"/> >10000
6.2 Critical Section Profile Type <b>C1</b>	<input type="radio"/> A <input type="radio"/> C <input type="radio"/> E <input type="radio"/> F <input checked="" type="radio"/> G <input type="radio"/> H <input type="radio"/> I <input type="radio"/> J <input type="radio"/> Others : D
<b>6.3 Topographic Situation</b>	
Catchment Size (sq m) <b>C1</b>	<input type="radio"/> <=100 <input type="radio"/> 100-500 <input type="radio"/> 500-1000 <input type="radio"/> 1000-10000 <input checked="" type="radio"/> >10000
Topographic Setting <b>C1</b>	<input type="radio"/> Adjacent Drainage Line <input type="radio"/> Traverse Drainage Line <input type="radio"/> Adjacent Topographic Depression <input type="radio"/> Traverse Topographic Depression <input type="radio"/> Spurline <input checked="" type="radio"/> Planar Slope
Debris Trail <b>C2</b>	<input type="radio"/> Channelisation <input checked="" type="radio"/> Spread <input type="radio"/> Erosion & Entrainment along Debris Trail
Unstable Terrain ( from GASP Report ) <b>C1</b>	<input checked="" type="radio"/> Yes <input type="radio"/> No Between fill feature & toe facilities, any of the following: - Zones of general instability ..... colluvial or in-situ Instability on disturbed terrain
Type of Crest Facility <b>C1</b>	<input type="radio"/> Road <input type="radio"/> Minor Development <input checked="" type="radio"/> Platform & Urban Development <input type="radio"/> Catchwater <input type="radio"/> Natural e.g. Rural foot path

SIFT Reports



# NPRS for Retaining Walls

# NPRS for Retaining Walls - IS

IS = Instability Potential (IP)      Actual Performance (AP)

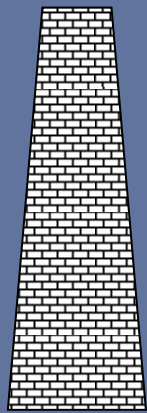
= A1 A2 A3 A4 A5      B1 B2

- Level of Geotechnical Engineering Input (A1)
- Wall Slenderness (A2)
- Wall Type (A3)
- Slope Protection/Drainage (A4)
- Seepage Conditions (A5)

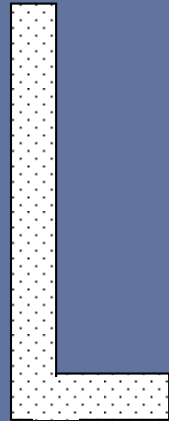
- Signs of Distress (B1)
- Instability after Formation/Treatment (B2)

# Slenderness Ratio ( $H_e/B_w$ )

$$IS = A1 \times A2 \times A3 \times A4 \times B1 \times B2$$



$B_w$



$B_w$

- Documentary Records
- Weephole Probing
- If unable to determine, accord  $H_e/B_w > 5$



Kwun Lung Lau Failure in 1994

# Wall Type (A3)

$$IS = A1 \times A2 \times A3 \times A4 \times B1 \times B2$$

Type of Wall	A3
Random rubble masonry wall	8
Dry packed dressed block/squared rubble wall without ties, or Masonry wall with horizontal beams made of lime-stabilised soil or brick	5
Dressed block/squared rubble wall with ties, or Masonry wall with concrete horizontal beams	3
Concrete wall	1



# Combined Methodology Ranking Score

A simple method to rank all types of features in terms of the relative risk of each feature

Ranking Score (RS) is determined by assigning a proportion of the total risk of a particular type according to the ratio of TS to  $\Sigma TS$ , i.e.

$$RS = \frac{TS}{\Sigma TS} \times \text{Proportion of Total Risk for a Particular Feature Type}$$

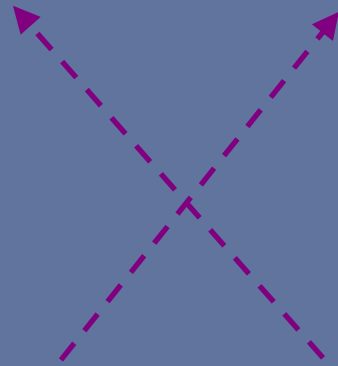
# Calibration Exercises

- to improve consistency of data-collection
- participated by two LPMitP Consultants

## No.1

CE20/2008  
Selected 4 features  
(one of each type)

CE21/2008  
Selected 4 features  
(one of each type)



## No.2

CE20/2008

CE21/2008

### Each Consultant

- 4 teams carried out data collection and calculated the scores **independently**
- Project Manager examined the data & scores, identified differences and suggested improvement

### Each Consultant

- Repeat for features of the other Consultant
- Project Manager examined the data & scores, discussed any differences between the **teams and another Consultant** and suggested improvement

# Examples of Ranked Slope

# Example of Slopes Ranked High

## Soil Cut Slope



Height of the slope = 40 m,  $\theta = 50^\circ$

Formed pre-1977 and modified in association with the road widening works before 1990's

Road with heavy traffic at toe

Previous inspection records indicated an inferred failure scar at southern end

# Example of Slopes Ranked High

## Rock Cut Slope



Height of the slope = 45 m,  $\theta = 70^\circ$

Formed pre-1977

Road with heavy traffic at slope toe

Previous inspection records indicated signs of distress

# Example of Slopes Ranked High

## Fill Slope



Height of the slope = 16 m,  
 $\theta = 35^\circ$

No record of formation

Road with heavy traffic at toe

# Example of Slopes Ranked High

## Retaining Wall



Dressed block masonry wall  
without ties

Height of the wall = 8 m

Formed pre-1977

Road with heavy traffic at crest

# Merits of NPRS

## Merits of the new systems:

- simple parameters (some have already been collected)
- a unified system for post-1977 and pre-1977 slopes
- computation of Consequence Score closely resembles QRA of man-made slopes which better reflect the severity of the failure consequence

Thank You