GEOGUIDE 5

GUIDE TO SLOPE MAINTENANCE

GEOTECHNICAL ENGINEERING OFFICE
Civil Engineering Department
The Government of the Hong Kong
Special Administrative Region

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FOREWORD

This Geoguide presents a recommended standard of good practice for the maintenance of man-made slopes and retaining walls, disturbed terrain features and natural terrain hazard mitigation measures. It is aimed primarily at the engineering profession, but it will be of use to other parties concerned with slopes and retaining walls maintenance.

The standards for the maintenance of slopes in Hong Kong was first given in the second edition of the Geotechnical Manual for Slopes published in 1984. They were later updated and expanded to produce the first edition of this Geoguide in 1995.

Since the promulgation of this Geoguide, slope maintenance has been implemented in a more systematic manner for man-made slopes and retaining walls. The experience gained has enabled us to conduct a review on the requirements and standards for slope maintenance and led us to this revision. This edition allows slope owners to accord maintenance efforts to slopes and retaining walls with respect to their consequences. It also addresses other issues that have come up lately, including maintenance requirements for disturbed terrain features and measures implemented for the mitigation of natural terrain hazard. Opportunity is also taken to make other minor corrections and enhancements.

The preparation of this revision is under the overall direction of a Working Group. The membership of the Working Group, given on the next page, includes representatives from various government departments with slope maintenance responsibility and the Hong Kong Institution of Engineers. Wide consultation among professional bodies, property management companies, property development firms, consulting engineers, contractors, academics and government departments was made. Many individuals and organisations made very useful comments, which have been adopted to produce this final version. Their contributions are gratefully acknowledged.

As with other Geoguides, this document gives guidance on good engineering practices, and its recommendations are not intended to be mandatory. Practitioners are encouraged to provide comments to the Geotechnical Engineering Office at any time on the contents of this Geoguide, so that improvements can be made to future editions.

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1. INTRODUCTION

1.1 PURPOSE AND SCOPE OF THIS GEOGUIDE

Regular maintenance is essential for all man-made slopes and retaining walls, disturbed terrain features and natural terrain hazard mitigation measures to avoid deterioration or to upkeep their functions.

The purpose of this Geoguide is to recommend a standard of good practice for the maintenance of man-made slopes and retaining walls, disturbed terrain features and hazard mitigation measures provided to natural terrain (e.g. boulder fences and check dams). The document is aimed at professional geotechnical engineers, although it will also be useful to the general public, many of whom carry responsibility for slope maintenance as owners of property. The general public may refer to an abridged version of the Geoguide: Layman's Guide to Slope Maintenance (GEO, 2003a), produced by the Geotechnical Engineering Office, for simplified guidance on matters related to slope maintenance.

This Geoguide deals basically with the maintenance inspections and maintenance works necessary to keep in good condition well-designed and properly constructed slopes and retaining walls and man-made mitigation measures provided to natural terrain. The maintenance inspections and works recommended herein can also reduce the probability of instability of slopes and retaining walls and disturbed terrain features which are not up to the current geotechnical standards for design and construction.

Maintenance inspections are sub-divided into four categories:

(a) Routine Maintenance Inspections, which can be carried out by any responsible person with no professional geotechnical knowledge,

(b) Engineer Inspections for Maintenance, which should be carried out by a professionally-qualified geotechnical engineer,

(c) Regular Checks of Buried Water-carrying Services, which should be carried out by a specialist leakage detection contractor, and

(d) Regular Monitoring of Special Measures, which should be carried out by a firm with special expertise in the particular type of monitoring service required. Such monitoring is only necessary where the long term stability of the slope or retaining wall relies on specific measures which are liable to become less effective with the passage of time.

Chapter 2 describes the recommended approach to maintenance management and provides guidance on the necessary action to be taken for slopes and retaining walls, disturbed terrain features and natural terrain hazard mitigation measures. In addition, the importance

of a Maintenance Manual and maintenance records is highlighted.

Chapter 3 provides guidance on the scope of maintenance requirements for man-made slopes and retaining walls, including the purpose and scope of Routine Maintenance Inspections and Engineer Inspections for Maintenance. It describes the requirements for the frequency and personnel for these inspections. In addition, the need to undertake Regular Checks of Buried Water-carrying Services is presented. It also outlines the need for, and the types of, Regular Monitoring of Special Measures.

Chapter 4 describes technical aspects of maintenance inspections pertinent to the well keeping of man-made slopes and retaining walls, and Chapter 5 prescribes the use of preventive maintenance works to improve man-made slopes and retaining walls.

Chapter 6 gives guidelines on the maintenance of disturbed terrain features.

Chapter 7 provides guidance on the maintenance of hazard mitigation measures that are provided to natural terrain. The mitigation measures include stabilisation measures to prevent failure and defence measures to protect developments from landslide debris originating from natural terrain.

It is important to remember that maintenance inspections and works as specified in this Geoguide will only serve to maintain the existing level of stability (i.e. existing margin of safety against failure), or to bring about marginal improvement. That is to say, slope maintenance alone may not be adequate in ensuring that a slope or retaining wall meets the geotechnical standards as stipulated in the Geotechnical Manual for Slopes (GCO, 1984). To determine whether the slope or retaining wall meets the required standard, the owner or the party required to maintain the land may have to arrange for a Stability Assessment to be carried out by a professionally-qualified geotechnical engineer. Upgrading works will be required in case the slope or retaining wall does not satisfy the current safety standards.

1.2 MAINTENANCE RESPONSIBILITY

In Hong Kong, the responsibility for maintenance of land, including slopes and retaining walls, rests with the owner, as defined in the Building Management Ordinance (Chapter 344, Laws of Hong Kong), or the party assigned such a responsibility. Ownership is conferred by a lease document issued by the Lands Department, such as a government lease or conditions of grant, conditions of sale, and conditions of exchange. The public can have access to these lease documents and records of owners at the Land Registry.

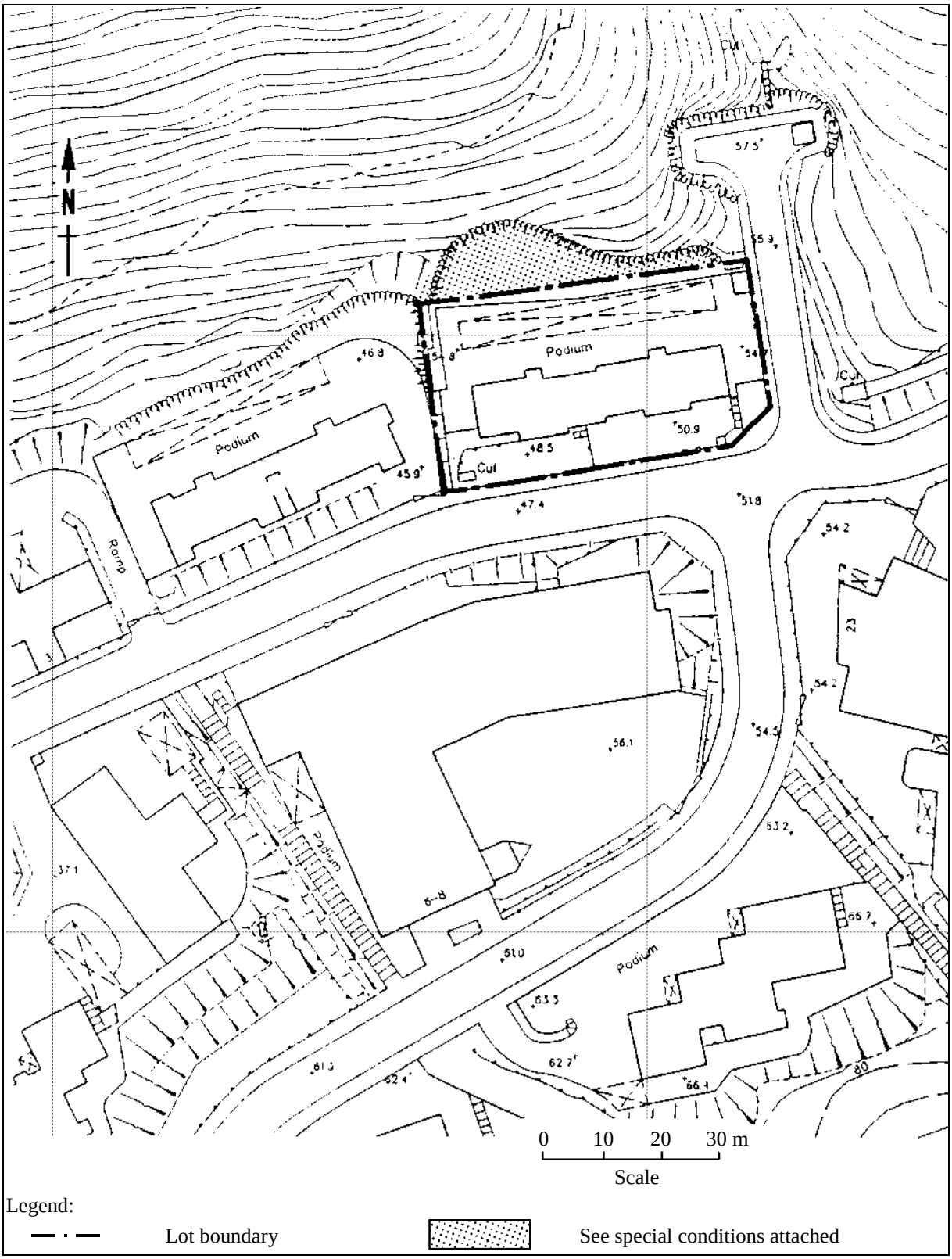
Occasionally, the lease document issued by the Lands Department may include a clause relating to maintenance responsibility for an area outside the lot boundary, as shown on a site plan attached to the lease document (Figure 1.1). Owners may also be liable for maintenance of land adjoining their lot, without such responsibility being stated in the lease document, when they have given themselves responsibility by their actions. For example, they may have cut into adjoining land, an action which could render them responsible for the slope maintenance under common law.

Private owners, including owners of individual flats in a multi-storey building, have

opportunities to examine the lease documents on purchase. They should carefully examine the lease documents to ascertain the extent of the land they are required to maintain. Where appropriate, professional advice may need to be sought from lawyers or estate surveyors on the interpretation of the lease documents in respect of maintenance responsibilities.

The Geotechnical Engineering Office maintains a Catalogue of Slopes that registers sizeable man-made slopes and retaining walls within the Hong Kong Special Administrative Region. Up-to-date information on these registered slopes and retaining walls is contained in the Slope Information System which can be accessed from the "Hong Kong Slope Safety" web site (http://hkss.ced.gov.hk). The Catalogue of Slopes also contains information on disturbed terrain features and natural terrain hazard mitigation measures.

The Lands Department maintains a Slope Maintenance Responsibility Information System (SMRIS) to provide a quick and convenient preliminary reference for the public to identify the owner or party who is responsible for the maintenance of particular registered slopes and retaining walls in the Catalogue of Slopes. The public can access the SMRIS from the Internet web site (http://www.slope.landsd.gov.hk/smris/).



Note: Special conditions of the lease documents require the slopes and retaining walls to be maintained by the lot owner.

Figure 1.1 Typical Site Plan Attached to Lease Documents Issued by the Lands Department

2. MAINTENANCE MANAGEMENT

2.1 MAINTENANCE MANAGEMENT ACTIONS

A slope or retaining wall that is not properly maintained will deteriorate and may become so unstable that it may collapse and cause injury to persons or damage to property. If this happens, great expense may be incurred in the remedial works. Retaining walls, except masonry walls, demand less maintenance on the wall structure but routine maintenance of the drainage provision to the wall is essential. Examples of well-maintained and poorly maintained slopes and retaining walls are shown in Plates 2.1 to 2.4. Similarly, maintenance of natural terrain hazard mitigation measures is necessary to ensure their continued functioning.

Owners or parties required to maintain land should undertake regular maintenance inspections and works. They can do this themselves or through an agent. For slopes and retaining walls maintained by a single owner, arranging maintenance action is fairly straightforward. For owners of individual flats in a multi-storey building, it is necessary in practice for an Owners' Corporation to discharge the maintenance responsibility on behalf of the individual owners, usually through a property management company. The Building Management Ordinance requires the Owners' Corporation to maintain the common parts of a building, which include slopes and retaining walls, in a state of good repair. The Deed of Mutual Covenant, which is registered in the Land Registry, defines the rights, interests and obligations of owners among themselves. In this document, the obligations of the owners, property managers and other parties, as appropriate, towards maintenance of slopes or retaining walls should be defined.

For government slopes, individual departments set up their own systems as appropriate to manage their maintenance actions.

If a slope or retaining wall has not been properly maintained before, the owner or party required to maintain land should take the following actions:

(a) Start Routine Maintenance Inspections and then carry out the maintenance works needed.

(b) Commission the first Engineer Inspection for Maintenance (Section 3.2) as soon as possible, particularly for slopes and retaining walls with no Maintenance Manual.

Thereafter, maintenance inspections and necessary maintenance works should be carried out regularly and as recommended in the Maintenance Manual.

The Government has set up a scheme that provides loans to individual owners of private buildings for reinstating or improving the safety of their slopes. The scheme is administered by the Buildings Department. Individual owners may apply for loans whether to carry out such works voluntarily, or in compliance with statutory orders, including slope repairs, regular slope maintenance works and removal of unauthorised building works. Further information about the loan scheme can be obtained from the Buildings Department.

(a) Vegetated Surface

(b) Shotcreted Surface

(c) Chunam Surface

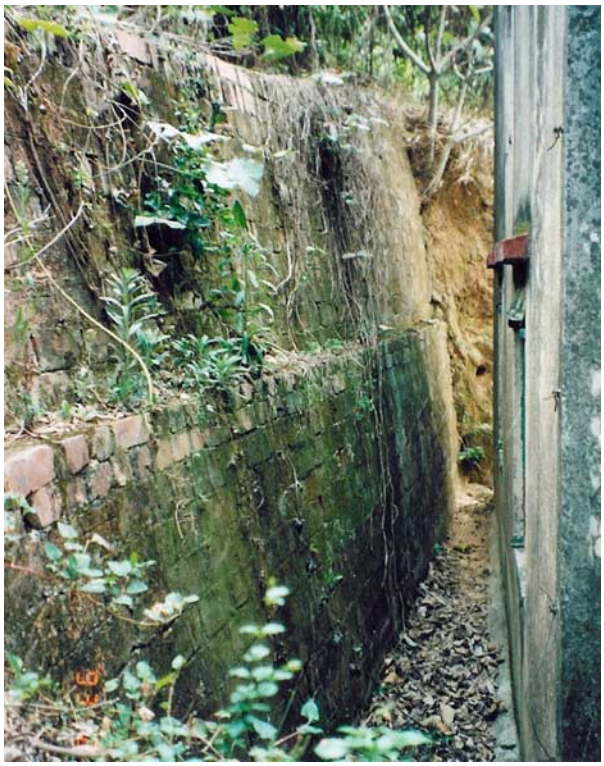
(d) Stone-pitched Surface

Plate 2.1 Well-maintained Slope Surface Cover

(a) Vegetated Surface

(b) Shotcreted Surface

(c) Chunam Surface



(d) Masonry Facing

Plate 2.2 Poorly-maintained Slope Surface Cover

(a) Exposed Down Pipe on Retaining Wall

(b) U-channel along Toe of Slope

(c) U-channel and Catchpit

(d) Stepped Channel

Plate 2.3 Well-maintained Surface Drainage Measures

(a) U-channel along Crest of Slope

(b) U-channel along Berm of Slope

(c) Catchpit at Toe of Slope

(d) Catchpit at Crest of Slope

Plate 2.4 Poorly-maintained Surface Drainage Measures

2.2 MAINTENANCE MANUALS

In order to assist the owners or parties required to maintain land to appreciate the maintenance requirements, the engineer who designs a slope or retaining wall or natural terrain hazard mitigation measure should prepare a Maintenance Manual as part of his design services.

A Maintenance Manual constitutes a key part of maintenance management. For existing slopes, retaining walls or disturbed terrain features for which a Maintenance Manual is not available, the engineer commissioned for Engineer Inspection for Maintenance or responsible for any upgrading works should prepare this document. Where a Maintenance Manual is available, it needs to be updated by the engineer, where necessary, in each Engineer Inspection for Maintenance.

A Maintenance Manual for man-made slopes and retaining walls should include the following information:

(a) a plan of the site showing the slopes and retaining walls to be maintained (Figure 2.1),

(b) record sheets containing general information on the slopes and retaining walls,

(c) as-built plans and typical cross-sections of all slopes and retaining walls, including details of surface cover, surface drainage, subsurface drainage, access points and stabilisation measures such as soil nails,

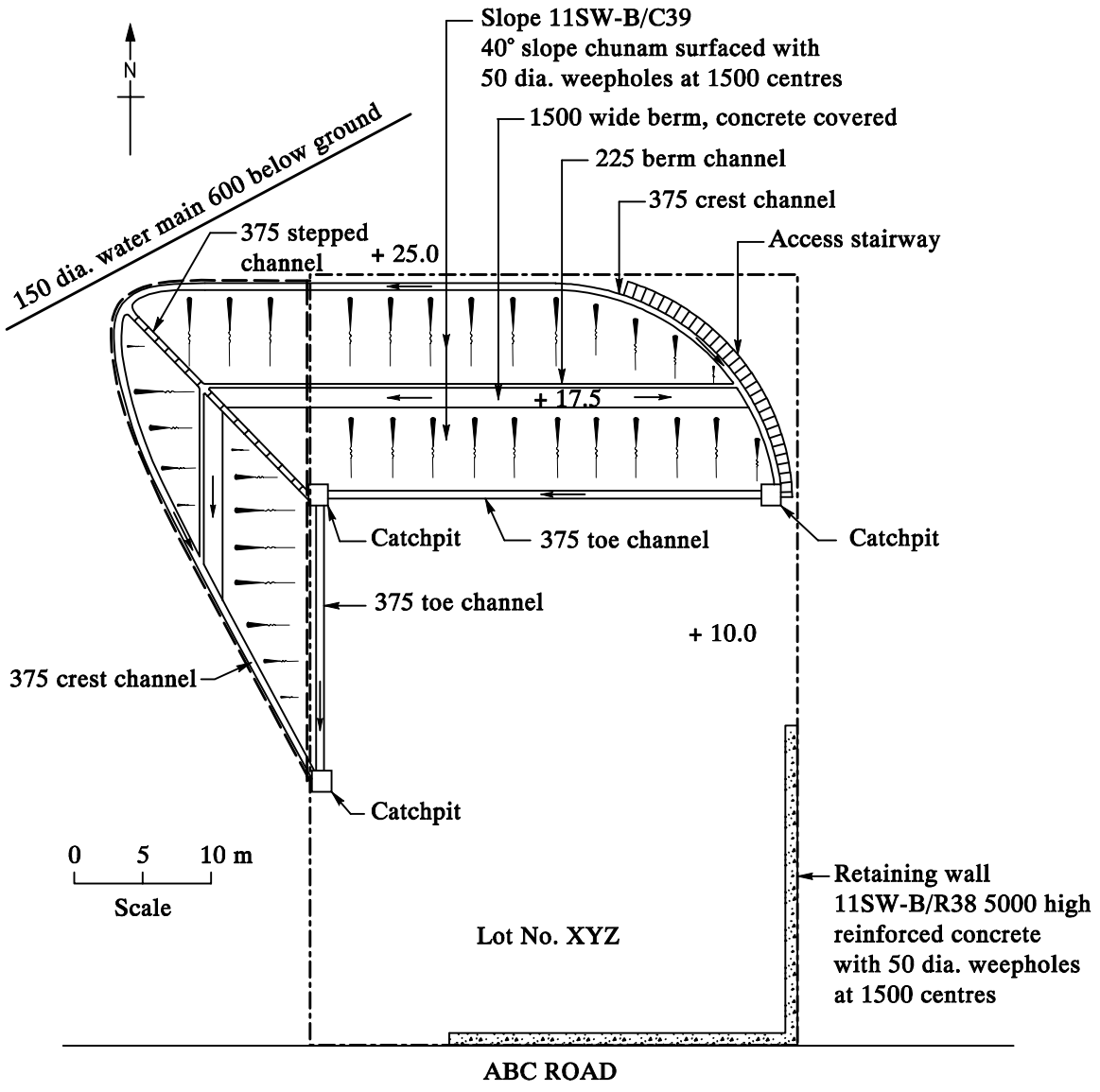
(d) layout plans of water-carrying services on or adjacent to the slopes or retaining walls, and proper documentation of any special features (e.g. ducting system) related to the services,

(e) as-built record photographs of the slopes and retaining walls,

(f) a list of man-made items requiring routine maintenance,

(g) recommendations on the frequency of Routine Maintenance Inspections, Engineer Inspections for Maintenance, and Regular Checks of Buried Water-carrying Services (including ducting systems) on or adjacent to the slopes and retaining walls, as appropriate,

(h) maintenance requirements for protection of reinforcement components in a reinforced fill slope or reinforced fill structure, if applicable,



Address: Lot No. XYZ, ABC Road

Reference Nos. of Slope/Retaining Wall to be maintained:

Slope No(s) : 11SW-B/C39
Retaining Wall No(s) : 11SW-B/R38

Legend:

Property boundary

Slopes formed outside of property to be maintained

Notes: (1) All dimensions are in millimetres.
(2) All levels are in metres above Principal Datum.

Figure 2.1 Typical Plan of Slopes/Retaining Walls to Be Maintained

(i) maintenance requirements for landscape items on the slopes and retaining walls and the rationale for their selections,

(j) outline of the basis of design and/or findings of Stability Assessments, including the consequence-to-life category of each slope and retaining wall,

(k) a monitoring schedule detailing requirements for Regular Monitoring of Special Measures where the long-term monitoring of specific measures included in the slope or retaining wall is a design requirement (e.g. ground anchors and designed raking drains are required by the Geotechnical Engineering Office to have long-term monitoring), and

(l) a list of other available documentary information pertaining to the slopes and retaining walls, e.g. geotechnical report.

An indicative format for the Maintenance Manual for man-made slopes and retaining walls is given in Appendix A. The format is also applicable for preparing Maintenance Manual for disturbed terrain features. Key aspects of the Maintenance Manual for natural terrain hazard mitigation measures are given in Chapter 7.

In order to assist the Routine Maintenance Inspection personnel, the Maintenance Manual should also include some guidelines on when an immediate Engineer Inspection for Maintenance should be arranged, e.g. where signs of leakage or suspected leakage, or ground subsidence are observed.

Construction drawings and details of design are seldom held by private owners. For slopes and retaining walls which have been processed by the statutory checking system of the Building Authority, the engineer undertaking the Engineer Inspection for Maintenance may approach the Buildings Department for such information. For slopes and retaining walls which were constructed by the Government after the establishment of the Geotechnical Control Office (now called the Geotechnical Engineering Office) in 1977, information on the slope or retaining wall design is usually available in the relevant government project departments.

Since 1978, the Geotechnical Engineering Office has been undertaking a long-term Landslip Preventive Measures Programme to upgrade substandard slopes and retaining walls. Reports on Stability Assessment and design of landslip preventive measures carried out under this programme are available for reference in the Civil Engineering Library of the Civil Engineering Department.

Engineers should always review previous Stability Assessments or designs of upgrading works to ensure that the factual information given therein is not out of date and the findings are still relevant, prior to incorporation into the Maintenance Manual. Superseded records or drawings that could provide useful information for understanding the history of the slopes and retaining walls should be appended in the Maintenance Manual.

2.3 CO-ORDINATED APPROACH TO SLOPE MAINTENANCE

Sometimes maintenance actions such as Routine Maintenance Inspections, Engineer Inspections for Maintenance, Regular Monitoring of Special Measures and Regular Checks of Buried Water-carrying Services are carried out by different maintenance parties at different times. In such circumstances, the person or party responsible for overseeing slope maintenance, such as the property management agent (in the case of private slopes) or the project engineer (in the case of government slopes) should arrange a review of all records of maintenance inspections and works. The purpose of this integrated review is to examine all relevant records together to provide insightful information for making a decision on whether additional maintenance works or other actions are required to be carried out.

2.4 MAINTENANCE RECORDS

Maintenance Manuals, and all records of maintenance inspections and maintenance works should be kept by the owner, the party required to maintain the land or the appointed agent. In practice, it is advisable to keep duplicate copies of all records and to store them in separate locations. Comprehensive and accurate record keeping is important for good maintenance management. In addition, where the owner or the party required to maintain the land is responsible for the maintenance of a large number of slopes and retaining walls, considerations should be given to keeping the Maintenance Manuals and maintenance records in electronic format for effective record management.

3. MAINTENANCE REQUIREMENTS FOR MAN-MADE SLOPES AND RETAINING WALLS

3.1 ROUTINE MAINTENANCE

3.1.1 Purpose and Scope of Routine Maintenance Inspections

Typical man-made items on slopes and retaining walls that require maintenance are illustrated in Figure 3.1. As a minimum, it is recommended that Routine Maintenance Inspections are carried out to ascertain the need for maintenance of man-made items, including:

(a) clearance of accumulated debris from drainage channels and slope surface,

(b) repair of cracked or damaged drainage channels or pavement,

(c) repair or replacement of cracked or damaged slope surface cover,

(d) unblocking of weepholes and outlet drainpipes,

(e) removal of any vegetation that has caused severe cracking of slope surface cover and drainage channels,

(f) re-grassing of bare soil slope surface areas,

(g) repair of missing or deteriorated pointing in masonry walls,

(h) removal of loose rock debris and undesirable vegetation from rock slopes or around boulders,

(i) repair of leaky exposed water-carrying services,

(j) repair or replacement of rusted steel slope furniture, and

(k) maintenance of landscape items on the slope.

In addition, a Regular Check of Buried Water-carrying Services on or adjacent to soil slopes or retaining walls should be undertaken (Section 3.3).

Where leakage is suspected from buried water-carrying services such as water pipes, water supply mains, sewers, stormwater drains or their ducting systems, prompt arrangement should be made for the investigation and repair of the services. Examples of suspected leakage are a significant increase in moisture on the surface or an increase in seepage from weepholes in slopes or retaining walls or from joints between masonry blocks.

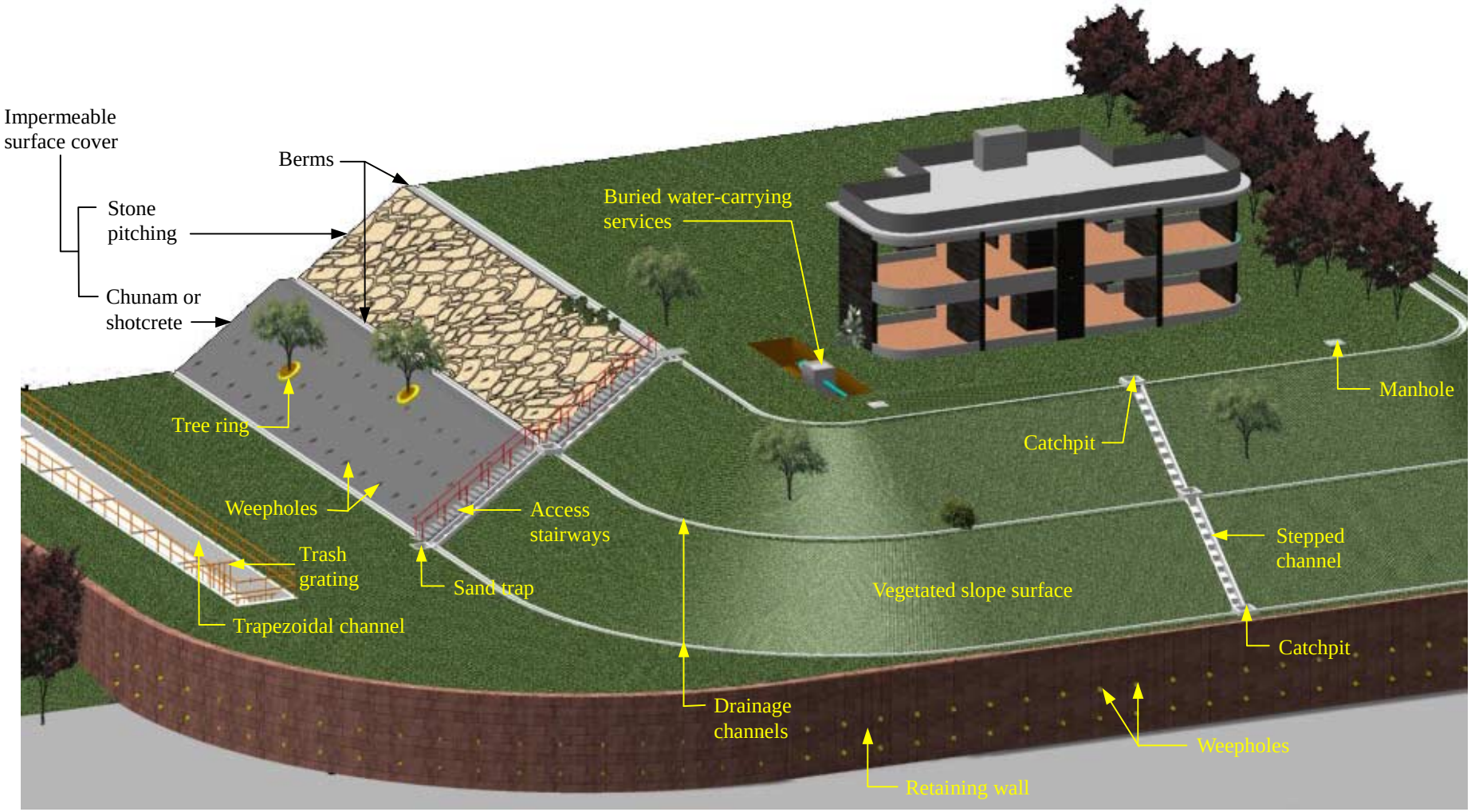


Figure 3.1 Typical Man-made Items on Slopes and Retaining Walls that Require Maintenance

Abnormal features on slopes or retaining walls should also be noted and an immediate Engineer Inspection for Maintenance should be arranged if necessary (Section 3.1.5).

Where repeated maintenance works are required for a particular aspect of a slope or retaining wall, such as repair of cracked drainage channels or surface cover, clearance of severely silted-up drainage channels, or reinstatement of areas of serious erosion, the problems should be investigated.

3.1.2 Frequency and Timing of Routine Maintenance Inspections

In general, Routine Maintenance Inspections should be carried out in accordance with Table 3.1.

Table 3.1 Recommended Frequency of Routine Maintenance Inspections

Consequence-to-life Category of Slopes and Retaining Walls (Works Bureau, 1999)	Frequency
Category 1 and 2	Once every year
Category 3	Once every two years

Designers or engineers undertaking Engineer Inspections for Maintenance may specify more frequent Routine Maintenance Inspections than those given in Table 3.1 if considered appropriate (e.g. where a high indirect consequence is anticipated in the event of failure of the slope or retaining wall). Conversely, less frequent maintenance inspections may be adopted for a slope or retaining wall taking into account its size, the stabilisation measures adopted, and the cost-benefit of the maintenance inspections. For example, less frequent Routine Maintenance Inspections may be adopted for small slopes and retaining walls with height not exceeding 3 m.

If Routine Maintenance Inspections are carried out not more than once a year, they should preferably be carried out between October and February, and any required maintenance works should be completed prior to the onset of the wet season in April.

In addition, it is good practice to inspect the drainage channels and clear any blockage after a heavy rainstorm.

3.1.3 Personnel for Routine Maintenance Inspections

Since the primary purpose of Routine Maintenance Inspections is to establish the need for basic maintenance of man-made items, such inspections do not demand professional geotechnical knowledge and can be carried out by any responsible person, including property management staff or maintenance staff.

Depending on the availability of manpower, owners or parties required to maintain land may decide to employ technically-qualified staff for the inspections. For example, government departments generally deploy staff at the rank of Assistant Clerk of Works,

Technical Officer or Works Supervisor to undertake Routine Maintenance Inspections.

3.1.4 Routine Maintenance Works

As a result of Routine Maintenance Inspections, typical routine maintenance works that may be needed are given in Table 3.2.

Most of the routine maintenance works can be carried out by general building or civil engineering maintenance contractors. The Government holds a list of Registered Contractors who have indicated their willingness in carrying out slope maintenance works. This list is available for public reference at the Buildings Department and District Offices.

For minor surface erosion on slopes of consequence-to-life Category 3, little or no works are needed if the erosion has been assessed by a professionally-qualified geotechnical engineer as not requiring treatment, taking due account of factors including cost-effectiveness of the repair works, direct and indirect consequence of failure, visual impact of the eroded surface, and whether the erosion is a precursor to a large failure or further deterioration of the eroded surface would be detrimental to the stability of the slope.

Soft landscape treatment of slopes and retaining walls, in form of vegetation, is normally designed to be ecologically sustainable and self-supporting once fully established. Routine maintenance should be carried out to prevent the vegetation from adversely affecting the functions of drainage channels and slope access. This includes clearing of litter and local trimming of overgrown vegetation near drainage channels or slope access. For specific maintenance works related to planted and natural vegetation including existing trees, such as pest and disease control, and tree surgery works, advice from horticulturists or specialist contractors should be sought where necessary. Guidance on the maintenance requirements for landscape items and bioengineering works is given in GEO Publication No. 1/2000: “Technical Guidelines on Landscape Treatment and Bio-engineering for Man-made Slopes and Retaining Walls” (GEO, 2000a). An abridged version of this document (GEO, 2002a) has also been prepared for the general public.

3.1.5 Need for Immediate Engineer Inspections for Maintenance

During Routine Maintenance Inspections, particular note should be taken of anything considered to be unusual or abnormal, such as signs of leakage, widening of cracks, settling ground, bulging or distortion of masonry walls, or settlement of the crest platforms. Some examples of such defects can be seen in Plate 3.1. These defects or observations have to be reported promptly to the owner or the party required to maintain the land, who should then appoint a professionally-qualified geotechnical engineer without delay to undertake an immediate Engineer Inspection for Maintenance, and to recommend any necessary actions.

Where a change in the land use in the vicinity of a slope or retaining wall is noted in a Routine Maintenance Inspection, the inspection personnel should report it to the owner or the party required to maintain the land. The responsible party should then review whether this would result in any change in the consequence-to-life category of the slope or retaining wall and the required frequency of maintenance inspections. Advice should be sought from a professionally-qualified geotechnical engineer when needed.

Table 3.2 Typical Routine Maintenance Works for Slopes and Retaining Walls

Man-made Item	Typical Maintenance Works Required	Guidance
Surface Drainage Channels, Catchpits and Sand Traps	(a) Clear debris, undesirable vegetation and other obstructions. (b) Repair minor cracks with cement mortar or flexible sealing compound. (c) Rebuild severely cracked channels. (d) Replace missing or deteriorated joint fillers and sealant.	(a) Works may be required outside site boundaries to prevent debris from blocking the drainage system. (b) Where large tree roots have damaged drainage channels, appropriate portions of the roots should be removed, taking care not to jeopardise the stability of the tree. Alternatively, the channels may be realigned.
Weepholes and Drainage Pipes	(a) Clear obstructions (e.g. weeds and debris) in weepholes and pipe ends. (b) Probe with rods for deeper obstructions.	(a) Pipes are prone to being blocked. Where pipes have been used on slopes and are leaky or severely blocked, they should be replaced with drainage channels where possible.
Impermeable Surface Cover (e.g. chunam and shotcrete)	(a) Remove undesirable vegetation growth. (b) Repair cracks or spalling. (c) Regrade and repair eroded areas. (d) Replace surface cover that has separated from underlying soil. (e) Replace missing or deteriorated joint fillers and sealant. (f) Remove dead, decaying or unstable trees.	(a) Cracked impermeable surface cover should be repaired by cutting a chase along the line of the crack, which is to be filled with a similar slope cover material or a flexible sealant. (b) Where large tree roots have damaged the surface cover, the cover should be replaced and tree rings should be provided. (c) Specialist advice may be sought in treating trees. Tree felling application should be obtained from relevant authority where necessary.
Vegetated Surface Cover	(a) Regrade eroded areas with compacted soil followed by re-planting. (b) Replant vegetation in areas where the vegetated surfacing has died. (c) Trim vegetation if overgrown. (d) Remove dead, decaying or unstable trees.	(a) Where erosion is shallow and does not affect the performance of existing surface drainage channels, the eroded area may be regraded by trimming, without backfilling. (b) Surface erosion may indicate an inadequate drainage system. Possible sources of concentrated flow should be identified and rectified. (c) Specialist advice may be sought on types of cover or species in areas where there is insufficient sunlight to support vegetation growth.
Rock Slopes and Boulders	(a) Repair cracked or spalled concrete surface and support. (b) Remove loose rock debris. (c) Remove undesirable vegetation.	(a) Trees giving rise to prising action in rock joints should be removed. The entire stump of the tree should be removed and the roots sterilised.
Facing	(a) Re-point deteriorated mortar joints on masonry face. (b) Repair cracked or spalled concrete surface and replace missing or deteriorated joint fillers and sealant.	(a) Continual distress (e.g. widening cracks) of a wall should be reported to the owner or the party required to maintain the land.

Note: Safe and efficient access is important for maintenance works.

(a) Tension Crack on Slope

(b) Crack in Retaining Wall

(c) Cracked Chunam Surface

(d) Cracked Surfacing and Wall

Plate 3.1 Abnormal Features

3.1.6 Records of Routine Maintenance

Indicative record sheets for Routine Maintenance Inspections and works are shown in Appendix B. The record sheets should be completed in two stages, namely, on completion of a Routine Maintenance Inspection and on completion of maintenance works.

3.2 ENGINEER INSPECTIONS FOR MAINTENANCE

3.2.1 Scope of the Inspections

An Engineer Inspection for Maintenance is not intended to determine whether or not a slope or retaining wall meets the geotechnical standards specified in the Geotechnical Manual for Slopes (GCO, 1984).

The purposes of an Engineer Inspection for Maintenance are:

(a) to determine if Stability Assessment have previously been carried out and if so, to review previous Stability Assessment reports to check whether the engineering approach used, the assumptions and the conclusions made in these reports are reasonable in light of current practice and safety standards,

(b) to identify all visible changes and signs of distress, including landslides that have taken place at or in the vicinity of the slope or retaining wall, in particular changes since the previous Stability Assessment if this has been carried out, and any discrepancies between records and site conditions, which could have implications for stability of the slope or retaining wall, and to judge whether these might be significant,

(c) to re-assess the consequence-to-life category of the slope or retaining wall,

(d) to check that Routine Maintenance Inspections have been carried out and documented satisfactorily,

(e) to assess the adequacy of routine maintenance works and supplement the list of man-made items requiring routine maintenance, as necessary,

(f) to re-assess the required frequency of Routine Maintenance Inspections, Engineer Inspections for Maintenance and Regular Checks of Buried Water-carrying Services,

(g) to look for and consider the implications of problems that are not explicitly included in the list of man-made items requiring routine maintenance, and bring to the attention of

the owner or party required to maintain the land any immediate and obvious danger noted and, if necessary, recommend emergency measures (e.g. repair works or detailed investigations),

(h) to identify the presence of exposed and buried water-carrying services on or in the vicinity of the slope or retaining wall (including relevant areas outside the lot boundary), check for signs of leakage of the services and recommend immediate detailed leakage checks, regular checks, repair or re-routing of the services, as necessary,

(i) to check that the Regular Checks of Buried Water-carrying Services and/or Regular Monitoring of Special Measures (if required) have been carried out and documented satisfactorily,

(j) to advise whether a Stability Assessment of the slope or retaining wall is necessary,

(k) to recommend the necessary preventive maintenance works (Chapter 5), and

(l) to prepare or update the Maintenance Manual to include all relevant information extracted from the previous Stability Assessment, and the desk study and site inspection(s) from this Engineer Inspection for Maintenance.

A model brief for an Engineer Inspection for Maintenance is given in Appendix C. This is to facilitate private owners in procuring such a service.

For government slopes, some additional tasks in relation to the management of the slope inventory held by the respective maintenance departments should be carried out in Engineer Inspections for Maintenance. The detailed scope of such tasks is given in Appendix D.

3.2.2 Frequency of the Inspections

The frequency of Engineer Inspections for Maintenance should normally be recommended by the designer in the Maintenance Manual, or as considered appropriate by the engineer commissioned to carry out the inspection. An Engineer Inspection for Maintenance may also be requested by those who carry out the Routine Maintenance Inspection. In general, the frequency of maintenance inspections should be once every five years for slopes and retaining walls in consequence-to-life Categories 1 and 2 and once every ten years for those in Category 3 (Table 3.3).

Table 3.3 Recommended Frequency of Engineer Inspections for Maintenance

Consequence-to-life Category of Slopes and Retaining Walls (Works Bureau, 1999)	Frequency
Category 1 and 2	Once every five years
Category 3	Once every ten years

More frequent Engineer Inspections for Maintenance than those given in Table 3.3 should be recommended if considered appropriate (e.g. where a high indirect consequence is anticipated in the event of failure of the slope or retaining wall). On the other hand, less frequent inspections may be adopted for the slope or retaining wall taking into account its size, the stabilisation measures adopted, and the cost-benefit of the maintenance inspections. For slopes or retaining walls stabilised with robust measures such as soil nail support, and where a post-construction performance review has confirmed the satisfactory performance of the works, the frequency of Engineer Inspections for Maintenance may be curtailed.

3.2.3 Personnel for the Inspections

An Engineer Inspection for Maintenance should be carried out by a professionally-qualified geotechnical engineer in Hong Kong. A suitable qualification is Registered Professional Engineer (Geotechnical), information on which can be obtained from the Engineers Registration Board.

Where considered necessary, the inspecting engineer should advise the owner or party required to maintain the land to consult a professionally-qualified structural engineer, e.g. a Registered Professional Engineer (Structural), for any suspected structural problems identified during the inspection.

3.2.4 Recommendations of the Inspections

The engineer undertaking the Engineer Inspection for Maintenance should recommend preventive maintenance works (see Section 5) or other maintenance actions, such as Regular Checks of Buried Water-carrying Services or Regular Monitoring of Special Measures, where considered necessary.

If an immediate and obvious danger is noted, the engineer should inform promptly in writing, together with a recommended course of action to the owner or party required to maintain the land. At the same time, a copy of this notification should be sent to the Geotechnical Engineering Office for government slopes and retaining walls, and to the Buildings Department for private slopes and retaining walls. The recommended course of action, such as evacuation or repair works, will depend on specific circumstances. If the danger can be reduced or eliminated by simple emergency repair works, these should be implemented without delay. In more complex situations, it is necessary to initiate a detailed investigation to establish the cause of the problem and to facilitate the design of upgrading works. The owner or party required to maintain the land should commission such an investigation without delay. In addition, interim precautionary measures (e.g. sealing off the dangerous areas) should be considered.

A Stability Assessment may be recommended if there is doubt on whether the slope or retaining wall is adequately safe, or if significant modifications have occurred to the slope or retaining wall or to the adjacent area, or if there is reason to believe that significant deterioration of the slope or retaining wall has occurred since the last Stability Assessment or slope upgrading works were undertaken. The urgency, likely outcome and cost-effectiveness of conducting the assessment should be considered in making such a recommendation.

A Stability Assessment should include an investigation of the slope or retaining wall with consideration of geology, hydrogeological conditions and mechanical properties of the ground materials. Some important aspects of a Stability Assessment are discussed by Ho et al (2002). Information from existing records (e.g. slope monitoring records, previous instability reports) on the slope or retaining wall and the adjacent area should also be reviewed. A model brief for a Stability Assessment of a slope or retaining wall is given in Appendix E.

It is sometimes more cost-effective to carry out preventive maintenance works or upgrading works using prescriptive measures to a slope or retaining wall than to undertaking a Stability Assessment involving ground investigation field works. Where it can be foreseen that upgrading works will be required anyway upon completion of a Stability Assessment, such an assessment need not be recommended. For instance, a slope with a history of failure does not require a Stability Assessment to prove that it does not meet current safety standards. In such cases, the owners or parties required to maintain land should be recommended to carry out preventive maintenance works or upgrading works for these slopes and retaining walls.

3.2.5 Records of the Inspections

Indicative record sheets for Engineer Inspections for Maintenance are given in Appendix F.

3.3 REGULAR CHECKS OF BURIED WATER-CARRYING SERVICES

3.3.1 General

Leakage from buried water-carrying services, e.g. water supply mains and stormwater drains, may not produce visible signs on the surface of a soil or retaining wall and yet may adversely affect its stability. Therefore, owners or parties responsible for maintaining water-carrying services that may affect slopes and retaining walls should arrange for Regular Checks of Buried Water-carrying Services, regardless of whether signs of suspected leakage have been observed. If a ducting system has been provided to the services, regular checks of the ducting system should also be carried out to detect any water flow in and leakage from it.

Occasionally, water-carrying services owned or maintained by other parties may traverse a private lot. The owner of the private lot should grant access to the services' owners to carry out Regular Checks of the Water-carrying Services. Such requirements are sometimes stipulated explicitly in the lease or grant document, such as areas designated as drainage reserves in the lease.

3.3.2 Frequency for Regular Checks of Water-Carrying Services

For those buried water-carrying services belonging to the slope owner or the party required to maintain the land, the Maintenance Manual should specify the frequency of the regular checks. Otherwise, the engineer appointed for the Engineer Inspection for Maintenance should recommend the frequency of the regular checks.

The frequency and extent of the examination of the services should take account of the nature of the material and construction of the pipes (e.g. rigid or flexible system), performance history in respect of leakage, the possible presence of loose fill, and likely effect on the stability of the slope or retaining wall should leakage occur. Reference should also be made to "Code of Practice on Inspection & Maintenance of Water Carrying Services Affecting Slopes" (Works Branch, 1996).

3.3.3 Methods for Checking Buried Water-Carrying Services

Checking of buried drains, sewers, water pipes, water mains and ducting systems should be carried out by specialist leakage detection contractors. Guidance on methods for checking buried water-carrying services is given in "Code of Practice on Inspection & Maintenance of Water Carrying Services Affecting Slopes" (Works Branch, 1996).

3.3.4 Repairs of Services

Any buried water-carrying services that are found to be damaged or leaky should be repaired without delay. Care should be taken to ensure that any repair works do not impair the hydraulic performance of the pipes.

3.3.5 Records of the Checks

Forms and records for Regular Checks of Buried Water-carrying Services should be designed by the engineer who recommends the regular checks, or by the specialist leakage detection contractor who conducts the regular checks.

3.4 ACCESS AND SAFETY PRECAUTIONS

Many slopes and retaining walls are high and steep, and care has to be taken for personal safety when inspections are carried out. Dense vegetation may pose difficulties in access.

Safe access is essential for maintenance inspections. Guidance on the provision and arrangement of access for slope maintenance that is safe for maintenance personnel, visually pleasing and where necessary, secure against trespassers, is given in GEO Report No. 136 entitled "Guidelines on Safe Access for Slope Maintenance" (Lam et al, 2003). Some examples of typical access arrangements for the inspection and maintenance of slopes and retaining walls are given in Plate 3.2.

For the personal safety of the inspecting personnel, it is prudent for the maintenance inspections to be carried out by at least two persons.

3.5 REGULAR MONITORING OF SPECIAL MEASURES

3.5.1 Need for the Monitoring

Regular Monitoring of Special Measures is only necessary in fairly rare circumstances, where the design relies on support or drainage measures that are critical for the continued stability of the slope or retaining wall and will become less effective with the passage of time. For example, the Geotechnical Engineering Office requires prestressed ground anchors and designed raking drains to be regularly monitored.

Requirements for Regular Monitoring of Special Measures are normally established by the designer. The design engineer should discuss with the client on the use of special measures and the associated obligations. The engineer should ensure that the owner or party required to maintain the land is aware of the obligations. The engineer should prepare a Monitoring Schedule, for inclusion in the Maintenance Manual (Section 2.2), to provide details including the recommended frequency of monitoring, guidance on qualifications and experience of monitoring personnel, protection of monitoring instruments, and 'alert levels' for monitoring results and the contingency actions if these levels are exceeded.

If there are special measures but there is no such Monitoring Schedule in the Maintenance Manual, then the owner or party required to maintain the land should commission the engineer undertaking the Engineer Inspection for Maintenance to prepare one.

Some guidance on the monitoring requirements for permanent prestressed ground anchors is given in Geospec 1: Model Specification for Prestressed Ground Anchors (GCO, 1989). Such monitoring work needs to be carried out by specialist firms. Guidance on the monitoring requirement for raking drains is given in Works Branch Technical Circular No. 10/91 (Works Branch, 1991) and Practice Notes for Authorized Persons and Registered Structural Engineers No. 137 (BOO, 1990).

The monitoring should be conducted at the recommended frequency, or more frequently as required. Where the results of monitoring exceed the 'alert levels' given in the Monitoring Schedule, the owner or the party required to maintain the land should promptly appoint a professionally-qualified geotechnical engineer to implement the stipulated contingency actions and to determine whether upgrading works are required. Such events should also be brought to the attention of engineers undertaking subsequent Engineer Inspections for Maintenance.

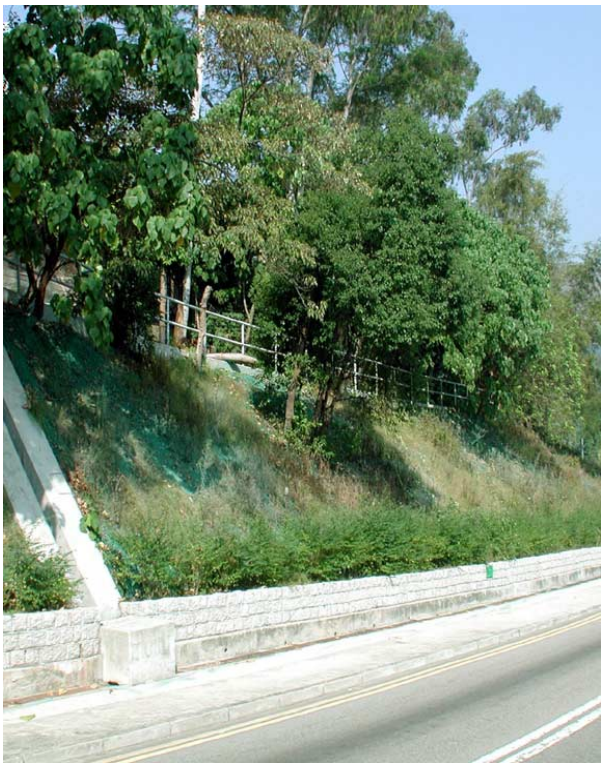
3.5.2 Types of Monitoring

Regular Monitoring of Special Measures will generally be necessary for:

(a) permanent prestressed ground anchors,

(a) Concealed Access to Stairway

(b) Ladders with Safety Loops



(c) Fencing Recessed into the Vegetated Land

(d) Combined Stepped Channel and Stairway

Plate 3.2 Examples of Access for Slope Inspection and Maintenance

(b) purposely designed raking drains which are not used in a prescriptive manner, and

(c) performance monitoring of other special measures which has been specified by the Building Authority or by the Geotechnical Engineering Office.

Raking drains installed as a prescriptive measure are not considered as “Special Measures”. Regular monitoring is not mandatory. However, regular inspections and routine maintenance of all raking drains should be carried out to ensure their continued performance.

3.5.3 Records of the Monitoring

The forms and records for Regular Monitoring of Special Measures should be designed by the designer or the specialist firm that conducts the inspection.

4. TECHNICAL ASPECTS OF MAINTENANCE FOR MAN-MADE SLOPES AND RETAINING WALLS

4.1 GENERAL

Most landslides in Hong Kong are shallow and small-scale failures caused by surface infiltration or erosion during heavy rainfall. Such landslides are often related to deficient or poorly-maintained slope surface covers and drainage provisions. Therefore, visual inspections and subsequent maintenance recommendations should be directed principally towards measures that minimise the infiltration of surface water and scouring by surface water flow. The provision of effective surface protective cover and adequate drainage, along with proper maintenance, is essential for the continued stability of man-made slopes and retaining walls.

Slopes undergoing progressive movement are liable to deteriorate and deform without full detachment during severe rainstorms, but could suddenly fail in a subsequent less severe rainstorm. Prolonged movement of a slope is reflected by open tension cracks infilled with foreign material, displacement of infilled discontinuities, etc. Care is needed to look for signs of distress and slope deformation during the Engineer Inspection for Maintenance by detailed examination of the slope and the nearby areas, including any steep natural hillside beyond the crest of the cut slope. Where situation warrants, the surface cover should be removed locally to check for any signs of distress.

During an Engineer Inspection for Maintenance, apart from signs of distress, particular note should also be taken of changes that can affect stability, with due regard to the assumptions made in the design of the slope or retaining wall. Examples of adverse changes are additional surcharge imposed by new developments, diversion of a watercourse towards the slope or retaining wall, or an increase in height or gradient of the slope or retaining wall.

Prior to undertaking a site inspection, the engineer should search and review all documentary information pertaining to the slope or retaining wall, together with that of the nearby areas which may provide clues on possible problems at the slope or retaining wall under consideration. The extent of the study of existing information depends on specific circumstances, such as the availability of a Maintenance Manual, previous design and construction records, and the likely consequences should the slope or retaining wall collapse. Useful information on the past performance of the slope or retaining wall may also be obtained through talking to the maintenance personnel and the owner or party required to maintain the land. For documentary information provided by the owner or party required to maintain the land, the engineer should verify with the appropriate authorities or persons that the information is correct and up-to-date.

The information reviewed by the geotechnical engineer should be fully documented and listed in the Engineer Inspection for Maintenance Report so that the work will not be duplicated unnecessarily during each Engineer Inspection for Maintenance, and effort should be focused on the new information that has become available since the last inspection. This also facilitates independent audit of the reports (see Section 4.16).

4.2 SURFACE PROTECTIVE COVER ON SOIL SLOPES

Many slopes are protected by impermeable surface covers that could be rigid or flexible. Rigid surface covers, such as chunam, shotcrete and stone-pitched facing, are susceptible to cracking. Bitumastic covers, though more flexible, may also crack. Details of cracking should be included in the inspection records, and recommendations for the necessary repair works should be made. Inspections should also be made for displaced, cracked or weathered stones on stone-pitched facings.

Rigid surface covers on soil slopes should be checked to see if they are in contact with the soil underneath. This can be done by tapping the cover gently with a light hammer. While doing so, care should be taken to avoid damaging the cover. A dull thud rather than a ringing sound may indicate that the cover has lost contact with the underlying soil, usually as a result of ground subsidence or erosion. The affected surface cover should be replaced, and the causes should be investigated. When the impermeable surface cover is removed for maintenance works, opportunity should be taken to inspect and check whether there are any hidden tension cracks or signs of movement in the slope beneath the protective surface.

The durability and effectiveness of the various forms of surface cover depend on the thickness of the cover as well as the type of material and quality of workmanship during construction. In particular, chunam covers can easily deteriorate and generally have a limited lifetime. It is advisable that such surface covers are replaced around every ten years.

Properly designed and suitably spaced movement joints should be provided for rigid surface covers. Where a rigid surface cover has been repaired locally, it is useful to check that no shrinkage cracks develop between the original surface and the new surface.

An impermeable surface cover surrounding or adjacent to trees should be examined for signs of distress caused by possible jacking action of tree roots. General and indiscriminate removal of vegetation and tree roots is not appropriate. The provision of tree rings should be considered. In severe cases, the trees may need to be felled. Consideration may also be given to replacing the tree species with one that does not have an extensive and strong root system. If the vegetation obstructs the flow of water from weepholes, it should be suitably trimmed to ensure proper functioning of the weepholes. Where necessary, specialist advice should be sought on the appropriate treatment for trees.

In inspecting vegetated slopes, details of any erosion scars should be noted, and recommendations should be made for repair works. An erosion control mat helps reduce the likelihood of surface erosion on a vegetated slope surface. Where an erosion control mat has been used, the anchorage system should be checked to ensure that it is sufficiently robust and secured to support the weight of the mat, the soil contained inside the mat and the subsequent vegetation growth. A wire mesh is sometimes used to secure the erosion control mat on a slope surface. Any rusted or damaged wire mesh should be repaired or replaced. The maintenance of proprietary surface protection products should follow any specific requirements in the manufacturers' specifications.

Surface erosion may indicate inadequacy of the drainage system or blockage of surface channels, culverts or catchpits. Possible sources of concentrated flow should be identified and any deficiency in the drainage system should be rectified to prevent recurrence of the

erosion (see also Section 4.3).

Erosion is particularly critical for reinforced fill slopes. The minimum soil cover specified for geosynthetic reinforcing elements should be maintained, and measures incorporated for the protection of the reinforcing elements and connections should be checked to ensure that their effectiveness is not reduced by post-construction activities in the vicinity of the slope, e.g. laying of utility services.

4.3 SURFACE DRAINAGE

The surface channels at the crest or on the berms of soil slopes or at the tops of retaining walls should be checked for the presence of gaps in the ground alongside the channels, because such gaps permit surface water to infiltrate into the ground.

The potential for water ponding near the crest of a slope or retaining wall should be assessed, and if necessary, improvement works should be recommended.

It may be necessary to inspect the area beyond the boundary of a slope or retaining wall. For example, where there are culverts or natural drainage lines that may affect the slope or retaining wall, these should be inspected for signs of cracking, blockage or insufficient capacity.

Environmental factors, including topographic features and human activities such as stockpiling and littering, may promote convergent surface water flow towards the slope or retaining wall, leading to washout failures or landslides if the surface water can find a path seeping into the ground. Such factors usually arise from the environment outside the confines of the site and should be carefully considered, and where necessary, works to prevent or protect against the action of such running surface water should be recommended. It is important that all conceivable water flow pathways that might affect a slope or retaining wall are considered.

Repeated erosion of the slope or the ground downslope may also reflect problems with the surface drainage system such as inadequately-sized channels and poor layout. Drains with sharp bends or convergence of several channels to a single catchpit often cause spillage of surface run-off. Preventive maintenance works should be carried out to increase the drainage capacity by enlarging the size of channels, modifying the alignment of sharp bends, constructing buffer walls, etc., where necessary. For a large catchment area, the layout of the drainage channels should be suitably planned so that the catchment area is partitioned into smaller sections and surface run-off is evenly diverted to several safe discharge points. This helps avoid the need for constructing overly large and deep drainage channels.

It is easier to identify drainage problems by inspections during rainstorms. Inspection personnel should arrange for such inspections if the adequacy of the drainage system is in doubt. They should also remind the owner or the party required to maintain land to record substantial surface water flow outside the drainage system, e.g. by taking photographs or videos.

4.4 GROUNDWATER SEEPAGE

Seepage traces on and adjacent to slopes or retaining walls should be recorded in photographs or hand-sketched drawings. Flow from seepage sources, weepholes, cut off drains, joints between masonry blocks, horizontal drains, etc. should be recorded and examined for signs of migration of solid material to check whether internal erosion of the ground is taking place. Account should be taken of those seepage traces that indicate the highest seepage level.

Where there are signs of abnormal seepage from, or moisture on, the surface of a soil slope or masonry wall, or signs that the seepage has increased substantially and suddenly, the causes should be investigated.

Arrangements should be made for clearing weepholes where blockages are suspected.

Where there are traces of seepage from a slope or retaining wall in an area where weepholes, raking drains or proprietary drainage mats have not been provided, the source of seepage should be determined and consideration should be given to recommending adequate drainage to be installed.

4.5 ROCK SLOPES

Many failures in rock slopes involve minor rockfalls. Rock slopes should be examined for the presence of loose blocks, and these should be removed or stabilised if found.

Small rock blocks are common at locations with weaker, more weathered or closely spaced joints. Rock mass with such local features is especially vulnerable to deterioration and, if exposed on a rock face, is likely to be a recurring source of rock blocks.

Where adversely orientated rock blocks are at risk of being dislodged by tree roots, consideration should be given to removing the rock blocks or the trees. Not all unplanned (e.g. natural) vegetation is detrimental to rock slope stability and factors such as the type of vegetation, and condition and orientation of rock joints need to be considered in deciding the removal of the vegetation. Indiscriminate removal of all unplanned vegetation should be avoided.

Observation should be made for the presence of open joints, and these might require local surfacing to prevent the ingress of surface water.

Where the risk of minor rockfall is high, measures such as installation of rock mesh netting and provision of a rock trap ditch or buffer zone (where space permits) could be more effective in mitigating the hazards. In particular, the provision of rock mesh netting is strongly recommended for protection against minor rockfall for unprotected steep rock faces of consequence-to-life Category 1 slopes, unless the rock mass is massive and very tightly and favourable jointed such that there is no credible minor rockfall potential.

Guidance on these measures for improving the stability and preventing the deterioration of rock slopes is given in Technical Guidance Note No. 13 (GEO, 2003b).

The condition of existing stabilisation measures should be assessed. Anchorage points for rock mesh netting should be examined to ensure that they remain intact and are firmly fixed to the rock slope rather than loosened rock blocks. Severely corroded anchorage points should be replaced. Engineers undertaking Engineer Inspections for Maintenance should also note the presence of any dislodged blocks or trapped loose rock fragments behind the mesh. Damaged mesh should be replaced.

For rock bolts protected with a concrete cover, the cover should be examined for signs of cracking and any defects so found should be repaired. Extensive cracking may indicate that significant movement has taken place in the rock mass and its causes should be investigated. Where monitoring of rock bolts is considered necessary, the monitoring requirements, including frequency of monitoring, testing procedure and the required lock-up torque, should be specified in the Maintenance Manual.

Detailed examination of rock slopes is sometimes difficult due to lack of proper access. In the case of a steep and high rock slope where an immediate access is not available for inspection, an assessment should be made by observing the condition of the rock slope from a vantage point, possibly with a pair of binoculars. This should be followed by detailed inspection using access, if considered necessary, e.g. by means of scaffolding and an elevated platform. Where a rock face is covered with vegetation to the extent that a proper inspection of the rock face cannot be made, judgement should be exercised in assessing how much vegetation clearance or thinning is needed.

Scaling of loose blocks should be carried out with care so as not to adversely affecting the stability of the remainder of the rock face. Removal of a tree should be complete with the removal of the stump and sterilising of the roots to prevent it from re-establishing. Appropriate means of effective tree removal should be sought from specialists. Where sealing of an open joint is needed, the works should be detailed to avoid blockage of drainage path that may lead to a build-up of cleft water pressure in the joint.

It is advisable to carry out a follow-up inspection of a rock slope after the completion of scaling and sealing works to review the adequacy of the works and to ensure that no other loose blocks are exposed following scaling and that the sealing of open joints has been done properly. The same applies to removal of trees or other vegetation.

Location of works on slopes are commonly recorded on plans. For steep slopes and where the works are local, marking on plans is not effective. For rock slopes, works recommendations are better marked on front elevation sketches or photographs.

4.6 TREES

Trees provide significant benefits in enhancing the quality of the environment and are often used in the soft landscape treatment of slopes and retaining walls. Unhealthy trees may fall down and result in casualties and loss in property. The health of a tree is affected by many factors such as change in soil conditions or damage to the root system by construction works. During inspection, signs which are indicative of poor health of a tree, such as discoloration of foliage, presence of dead branches and cavities on tree trunks, should be noted. Serious leaning of isolated trees suggests potential instability of the trees. Under

such circumstances, considerations should be given to seeking specialist advice from horticulturists on assessing the general health and necessary treatment of trees.

It is useful if photographic records of trees are taken during inspection so that comparison can be made to determine the condition of trees in future.

4.7 BOULDERS

Checks should be made for the location and extent of erosion around isolated boulders or outcrops of rock, the existence of basal and back-release joints, and the presence of water or evidence of past water flow. Due regard should be given to the presence of unstable upslope boulders which could impact on the boulder under consideration, particularly for those that are already overhanging or resting on other boulders where the contact is open or soil-filled or dipping out of the slope. Unstable upslope boulders outside the maintenance boundary of the slope or retaining wall should be reported to the Geotechnical Engineering Office if they are on government land, and to the Buildings Department otherwise.

Recommendations for works should be made where appropriate. The range of various stabilisation measures, including removal, in-situ stabilisation and wire mesh netting is described by Au & Chan (1991).

4.8 RETAINING WALLS

Inspections should be made for missing or deteriorated joint fillers and sealant and for minor cracking or spalling of concrete surfaces, and for deteriorated mortar joints or missing pointing on masonry walls and these should be repaired. If severe corrosion of the reinforcement or sulphate attack on concrete is suspected, advice from a professionally-qualified structural engineer should be sought.

Outlets of drainpipes provided to drainage layers behind retaining walls should be probed for blockage and cleared if necessary.

During inspections of retaining walls, signs of distress, such as settlement and tension cracks in the ground in close proximity to the retaining wall, severe cracking, deformation, tilting and bulging of the retaining wall, and dislocation of masonry blocks, should be noted, and recommendation should be made for further investigation.

More guidance on the maintenance requirements of retaining wall is given in Geoguide 1: Guide to Retaining Wall Design (GEO, 1993).

For reinforced fill structures, the gaps between the facing panels should be free from any undesirable vegetation growth. The measures incorporated for the protection of the reinforcing elements and connections should be checked to ensure that their effectiveness is not reduced by post-construction activities in the vicinity of the structure, e.g. laying of utility services. Further advice regarding maintenance of reinforced fill structures is given in Geoguide 6: Guide to Reinforced Fill Structure and Slope Design (GEO, 2002b).

4.9 WATER-CARRYING SERVICES

4.9.1 General

Leakage from water-carrying services, including water pipes, stormwater drains, foul sewers, catchwater channels and water tunnels, may adversely affect the stability of soil slopes, retaining walls, and rock slopes with unfavourable joint conditions. Ducting systems housing water-carrying services, as well as conduits such as telephone ducts, electric cable ducts or disused pipes, can transmit an appreciable amount of water. Water retaining structures, such as swimming pools and service reservoirs, may also leak. Their potential effects on the stability of the slope or retaining wall should likewise be considered.

The first step in the assessment of potential effects of water leakage on the stability of a slope or retaining wall is to identify the presence of buried water-carrying services in its vicinity. If this information is not already in the Maintenance Manual, the inspecting engineer should enquire owners of utility services. The inspecting engineer should also look for unauthorised buried services and other discrepancies from the record plans.

Guidance on the identification of water-carrying services is given in “Code of Practice on Inspection & Maintenance of Water Carrying Services Affecting Slopes” (Works Branch, 1996).

All services in the vicinity of the slope or retaining wall, together with manholes to which such services connect, should be examined for signs of leakage. In judging what the vicinity of a slope or retaining wall is, the inspecting engineer should note that leakage from services may travel long distances via subsurface seepage paths through permeable materials or preferential flow channels, particularly in loose fill and colluvial deposits.

4.9.2 Actions on Buried Water-Carrying Services

Whether leaky or not, consideration should be given to the possibility of diverting existing services away from a slope or retaining wall. Opportunities to divert existing services may arise when existing slopes within or adjacent to a lot are being upgraded or when existing services are being re-laid or repaired. The diversion can also be carried out as preventive maintenance works. In case diversion cannot be carried out, alternative measures, such as ducting the existing buried services or raising them above ground should be considered. However, diversion or ducting of existing services may be very costly and may even be impracticable due to site constraints. The inspecting engineer should establish that diversion or ducting is feasible before making such a recommendation.

If diversion and ducting of the services is not feasible, the inspecting engineer should give recommendations for regular checks of the services to verify their condition, together with the required frequency and extent of the checks.

Sometimes, buried water-carrying services owned by other private parties are found within or in the vicinity of the maintenance boundary of the slopes and retaining walls. Where no signs of leakage are observed on the slopes or retaining walls, but leakage from such services is likely to affect the stability of the slopes or retaining walls, the inspecting

engineer should draw the attention of the relevant services' owners to the need to carry out regular inspections and maintenance of their buried water-carrying services by distributing the government information leaflets on maintenance of buried water-carrying services affecting slopes.

The Government carries out regular inspections and repairs to its water-carrying services. If there are discrepancies between the layout of the services and the corresponding available utility plan, the inspecting engineer should inform the relevant government department.

4.9.3 Urgent Actions on Buried Water-Carrying Services with Signs of Leakage

Where leakage is suspected from buried water-carrying services for which the owner or the party required to maintain the land is also responsible, the inspecting engineer should recommend an immediate detailed leakage check of the services by a specialist leakage detection contractor.

Where leakage is suspected from buried water-carrying services on land that is outside the jurisdiction of the owner or the party required to maintain the slope or retaining wall, whose stability could be undermined by the leakage the inspecting engineer should identify the source of leakage where possible and advise the services' owners to investigate and repair the leak or damage without delay. The inspecting engineer should also recommend to the slope owner other landslide risk mitigation measures if considered necessary.

If the suspected leakage is from services owned by private parties, the case should also be referred to Buildings Department or Lands Department.

4.10 SLOPE FURNITURE

Furniture made of steel, such as boundary fences, handrails in staircases and signage posts, is susceptible to corrosion. If severely corroded, whole or part of these elements may fall off the slope or retaining wall. A thorough inspection is essential and any dust, earth and scale should be scraped away in order that the extent of the corrosion can be examined and the appropriate repair works determined. Attention should be paid to hinges and bolts, which are particularly susceptible to wear. All rust should be removed prior to application of suitable surface protection. If a new surface protection is applied, consideration should be given to using a colour scheme most sympathetic to the surroundings and whether the repair works should be applied to part or whole of the furniture so as to minimise the visual impact. In case of severe corrosion, consideration should be given to replacing the furniture. The footings and supports to the furniture items should be examined for signs of cracking and instability.

4.11 CLASSIFICATION OF OVERALL STATE OF SLOPE MAINTENANCE

The engineer undertaking an Engineer Inspection for Maintenance should assess the condition of individual man-made items, as listed in Table 4.1, which could affect the

performance of the slope or retaining wall. The principal factor to consider is the continuing function of the individual man-made items. Based on whether "Major" or "Minor" defects are observed, the overall state of slope maintenance is assessed in accordance with the criteria given in Table 4.2. The assessment of the overall state of slope maintenance provides a rational basis for the engineer to review the adequacy of maintenance and to take necessary actions as appropriate.

Regardless of the assessed overall state of slope maintenance for a slope or retaining wall, maintenance works should be carried out in accordance with the recommendations arising from Routine Maintenance Inspections and Engineer Inspections for Maintenance. This is to prevent the slope or retaining wall from deteriorating to such an extent that its stability would be adversely affected. Priority should be given to maintenance works for slopes and retaining walls whose overall state of slope maintenance is assessed as Class 2.

Table 4.1 Classification of Defects on Individual Man-made Items

	Man-made Item	Defects Affecting the Function of Particular Man-made Items	
		Minor	Major
1	Surface protection (e.g. vegetation or rigid cover)	The maintenance condition of the item would still allow it to continue to serve its intended function satisfactorily.	The maintenance condition of the item has severely hampered its adequate functioning.
2	Surface drainage system (including surface channels, catchpits and sand traps)		
3	Subsurface drainage system (including weepholes and subsurface drains)		
4	Water-carrying services		
5	Special measures (such as designed raking drains or prestressed ground anchors)		

Note: Assessment of defects is normally by visual inspection, such as checking for signs of unusual surface seepage, blockage of outlet drains and signs of surface erosion. The inspecting engineer should also use other measures to determine the defects, such as probing or dye colour test, as necessary.

Table 4.2 Classification System for Overall State of Maintenance of Slopes and Retaining Walls

Overall State of Slope Maintenance	Criteria
Class 1	None or only minor defects are identified. The overall state of maintenance of the slope or retaining wall is considered to be satisfactory in general.
Class 2	Major defects affecting the function of one or more man-made items are identified. There is a need for significant improvement in the maintenance actions implemented for the slope or retaining wall.

4.12 RE-ASSESSMENT OF CONSEQUENCE-TO-LIFE CATEGORY

When re-assessing the consequence-to-life category of a slope or retaining wall, the engineer should take into consideration such factors as possible failure mechanisms, site

conditions, the scale of failure, proximity of buildings and facilities to the slope or retaining wall, the likely density of occupation and frequency of usage of the affected buildings and facilities in the event of failure, the likely travel distance of landslide debris, the resistance of buildings and facilities to debris impact, and vulnerabilities of occupants and users. Guidance on the assessment of the consequence-to-life category of a slope or retaining wall is given in Works Bureau Technical Circular No. 13/99 (Works Bureau, 1999) and Technical Guidance Note No. 15 (GEO, 2003c) promulgated by the Geotechnical Engineering Office.

4.13 CHECKING CERTIFICATES FOR SLOPES AND RETAINING WALLS

Checking certificates are issued by the Geotechnical Engineering Office of the Civil Engineering Department for government slopes and retaining walls where its designs or stability assessments have been checked and found to be satisfactory. Details are given in Works Bureau Technical Circular No. 16/2001 (Works Bureau, 2001).

If the engineer undertaking the Engineer Inspection for Maintenance considers that the engineering approach, the assumptions and the conclusions made in previous Stability Assessment reports of a slope or retaining wall are reasonable in light of current practice and safety standards and that no further investigation and upgrading works are recommended, the maintenance department should submit the relevant documents to the Geotechnical Engineering Office for obtaining a checking certificate.

4.14 UNAUTHORISED CULTIVATION

Infiltration through unauthorised cultivation areas on or above a slope or retaining wall is detrimental to the stability of the slope or retaining wall, e.g. the Shek Kip Mei landslide incident in 1999 (GEO, 2000b). In addition, unauthorised cultivation may change the landform and affect the effective drainage of surface water during rainstorms. The engineer undertaking the Engineer Inspection for Maintenance should identify and assess the possible effect of any such unauthorised cultivation areas. Where unauthorised cultivation areas are found, the relevant government authorities (e.g. the Lands Department or the Buildings Department) should be notified for follow-up actions.

4.15 PRIORITISING MAINTENANCE ACTIONS

Where an Engineer Inspection for Maintenance or otherwise identifies that a slope or retaining wall is in need of preventive maintenance works or upgrading works, these should be arranged and carried out at the earliest possible opportunity. If a maintenance party has a large number of slopes and retaining walls that require action, the slopes and retaining walls could be prioritised for action, according to the consequence of failures and the condition of the slopes and retaining walls. For those slopes and retaining walls where preventive maintenance works or upgrading works are awaiting action, appropriate precautionary measures (e.g. inspection of the slopes and retaining walls at regular intervals) should be carried out to ensure that the condition of the slopes and retaining walls do not deteriorate to a state that warrants more urgent action. Advice on prioritisation and precautionary measures should be sought from a professionally-qualified geotechnical engineer where needed.

4.16 INDEPENDENT AUDIT OF ENGINEER INSPECTION FOR MAINTENANCE REPORTS

It is good practice to carry out an independent audit of the Engineer Inspection for Maintenance Reports, particularly for an assignment that covers the inspection of a large number of slopes and retaining walls. Generally, about 0.5 to 1% of the inspection reports are taken at random for quality assessment by an independent professionally-qualified geotechnical engineer. Where possible, the independent audit should be carried out in phases such that the early phases of audit would help benchmark the standard of the inspections. Working to the required standard at the start is much more effective than having to take corrective actions at a late stage. The auditing arrangement should be made known to the engineer undertaking the Engineer Inspection for Maintenance prior to implementation or be included in the scope of services of the Engineer Inspection for Maintenance where considered appropriate.

5. PREVENTIVE MAINTENANCE WORKS

5.1 GUIDELINES ON PREVENTIVE MAINTENANCE WORKS

The slope surface protective covers and drainage provisions at many old slopes in Hong Kong may not be adequate. Where existing provisions are deficient (see Chapter 4 for examples), Routine Maintenance Works which entail only upkeep of the existing surface protective cover and drainage in a sound condition is not sufficient to prevent ongoing deterioration of the slope. In such cases, recommendations on the necessary preventive maintenance works, which are works of preventive nature to reduce the rate of deterioration of slopes, should be made by the engineer undertaking the Engineer Inspection for Maintenance.

Where preventive maintenance works are planned, consideration should be given to including provision of nominal support and regrading where appropriate. In certain cases, this may suffice to meet the required geotechnical standards as stipulated in the Geotechnical Manual for Slopes (GCO, 1984). Such measures, without the need for detailed ground investigations and design analyses, are 'prescriptive measures' as denoted in the second edition of Geoguide 1: Guide to Retaining Wall Design (GEO, 1993). These can be readily incorporated in conventional slope maintenance works and can be carried out by Registered Specialist Contractors (Site Formation Works).

Recommended standards of good practice for the application of prescriptive measures to improvement works on cut slopes and retaining walls are given in GEO Report No. 56 (Wong et al, 1999), Technical Guidance Note No. 13 (GEO, 2003b) and Technical Guidance Note No. 17 (GEO, 2004).

Typical preventive maintenance works for soil cut and rock cut slopes are illustrated in Figure 5.1 and Figure 5.2 respectively.

It is preferable that the engineer designing and recommending the preventive maintenance works be assigned the task to review the completed works.

Buildings Ordinance (Chapter 123, Section 2) defines the types of works that are subject to control under the Ordinance. The necessary statutory approval should be obtained before execution of the works.

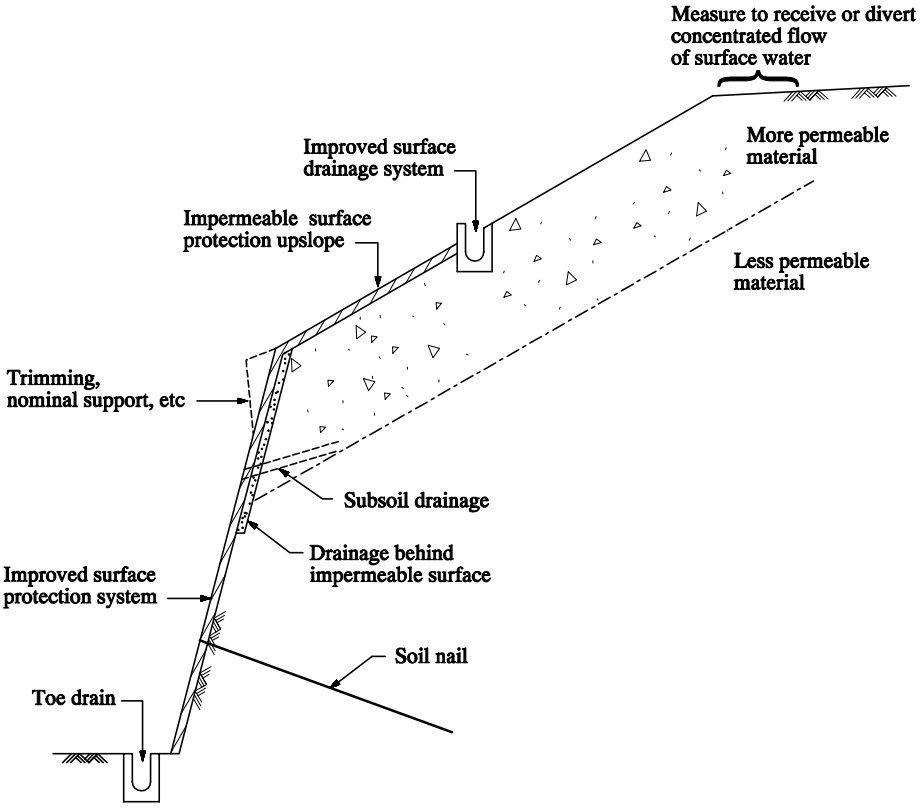


Figure 5.1 Typical Preventive Maintenance Works for Soil Slopes

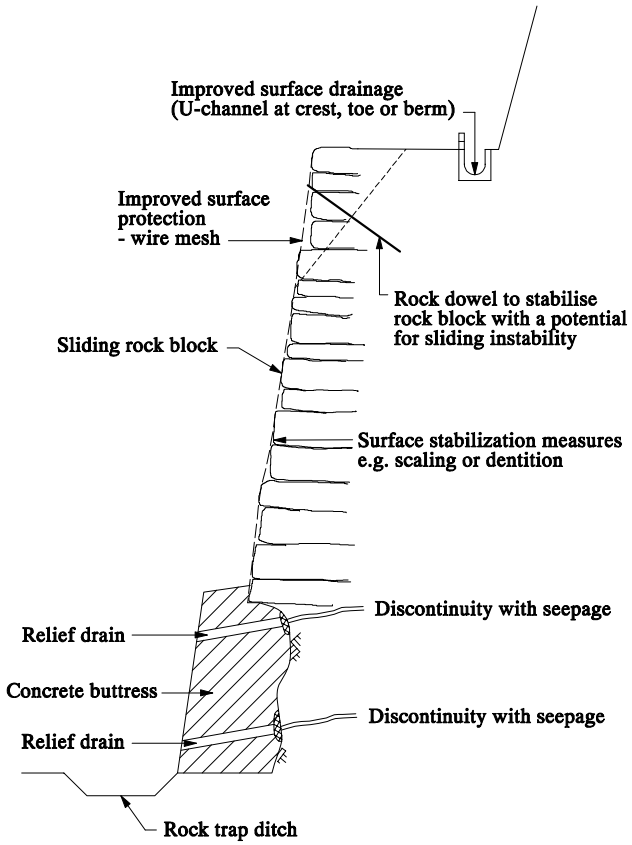


Figure 5.2 Typical Preventive Maintenance Works for Rock Slopes

6. MAINTENANCE REQUIREMENTS FOR DISTURBED TERRAIN FEATURES

6.1 GENERAL

Disturbed terrain features are tracts of hillside modified by human activities or landslides to the extent that its stability behaviour would be different from the original ground. There are two main types. More common are sizeable areas terraced by low slopes and retaining walls. The majority of them are results of agricultural activities. Other examples are cemeteries, sites of squatter activities and abandoned mines. The other type is repaired landslide scars.

6.2 PURPOSE AND SCOPE OF MAINTENANCE INSPECTIONS

Disturbed terrain features may contain man-made items such as surface channels and surface protection measures. Routine Maintenance Inspections and Engineer Inspections for Maintenance should be carried out to ensure adequate functioning of the man-made items. The recommendations given in Chapter 3 for man-made slopes and retaining walls in respect of scope and timing of maintenance inspections, personnel requirements, maintenance manuals and records of inspections are also applicable to the maintenance of disturbed terrain features.

6.3 FREQUENCY OF MAINTENANCE INSPECTIONS

In general, the recommended frequency of maintenance inspections for disturbed terrain features is given in Table 6.1.

Table 6.1 Recommended Frequency of Maintenance Inspections

Consequence-to-life Category of Disturbed Terrain Features (Works Bureau, 1999)	Frequency of Routine Maintenance Inspections	Frequency of Engineer Inspections for Maintenance
Category 1 and 2	Once every year	Once every five years
Category 3	Once every two years	Once every ten years
Category 3 located in a remote area(1)	React to known hazard(2)	React to known hazard(2)

Notes: (1) A disturbed terrain feature is in a remote area if it is surrounded by natural terrain such that a failure would bring no significant direct or indirect consequences (e.g. abandoned agricultural terraces in the countryside).

(2) Examples of known hazard are observed signs of distress and failures.

The designer or the engineer undertaking the Engineer Inspection for Maintenance may specify more frequent maintenance inspections than those given in Table 6.1 if considered appropriate (e.g. where a high indirect consequence is anticipated in the event of failure of the feature). Conversely, less frequent Routine Maintenance Inspections may be adopted, taking into account the consequence of failure and whether man-made items are present.

Notwithstanding the above, where it is confirmed in an Engineer Inspection for Maintenance that a disturbed terrain feature does not contain any man-made items, it is not necessary to carry out Routine Maintenance Inspections for it, irrespective of its consequence-to-life category. However, Engineer Inspections for Maintenance should still be carried out.

A Category 3 disturbed terrain feature in a remote area is one that is surrounded by natural terrain such that a failure would bring no significant direct or indirect consequences, e.g. abandoned agricultural terraces in the countryside. Routine Maintenance Inspections and Engineer Inspections for Maintenance are generally not necessary for it. An example of significant indirect consequence is if debris from the disturbed terrain feature could travel to affect a catchwater or cul-de-sac.

6.4 MAINTENANCE WORKS

Maintenance works needed for disturbed terrain features with man-made items are similar to those for man-made slopes and retaining walls, as described in Chapter 3. They generally include clearance and minor repairs to man-made items, such as drainage channels, rubble walls and the surface covers of small cut and fill slopes, to ensure their continued functioning.

Assessment of the need for maintenance works for disturbed terrain features should take into account the consequence of failures and the cost-benefit of the maintenance works. In general, Routine Maintenance Works should be carried out to maintain the man-made items found on disturbed terrain features.

Preventive maintenance works should be carried out for disturbed terrain features of consequence-to-life Categories 1 and 2 as needed. For those features of consequence-to-life Category 3, preventive maintenance works are generally not worth carrying out. Table 6.2 summarises the requirements for undertaking the maintenance works.

Table 6.2 Requirements for Undertaking Maintenance Works

Consequence-to-life Category of Disturbed Terrain Features (Works Bureau, 1999)	Routine Maintenance Works	Preventive Maintenance Works
Category 1 and 2	As recommended in Routine Maintenance Inspections and Engineer Inspections for Maintenance	As recommended in Routine Maintenance Inspections and Engineer Inspections for Maintenance
Category 3	As recommended in Routine Maintenance Inspections and Engineer Inspections for Maintenance	React to known hazard(2)
Category 3 located in a remote area (1)	React to known hazard(2)	React to known hazard(2)

Notes: (1) A disturbed terrain feature is in a remote area if it is surrounded by natural terrain such that a failure would bring no significant direct or indirect consequences (e.g. abandoned agricultural terraces in the countryside).

(2) Examples of known hazard are observed signs of distress and failures.

Where conditions warrant, studies of appropriate nature, with a view to undertaking any necessary stabilisation works, or defence and mitigation measures should be carried out taking into consideration the consequence, usage and site conditions of the disturbed terrain features. For example, for disturbed terrain features belonging to consequence-to-life Category 1, studies should be carried out if there are squatters on them or if the overall ground gradient is greater than 30°.

7. MAINTENANCE REQUIREMENTS FOR NATURAL TERRAIN HAZARD MITIGATION MEASURES

7.1 GENERAL

Natural terrain hazard mitigation measures can be broadly classified into two categories:

(a) Stabilisation Measures constructed on natural hillsides to prevent failure, e.g. boulder buttresses, soil nails, raking drains and retaining walls.

(b) Defence Measures to contain landslide debris or boulder fall from the hillside above, e.g. check-dams, earth bunds and boulder fences.

Natural hillsides do not require maintenance, and hazard mitigation measures do not normally result in substantial modification to the geometry and condition of the natural hillsides. The purpose of maintenance for hazard mitigation measures is confined to ensuring their physical integrity and satisfactory performance. The owner or the party required to maintain the mitigation measures is not required to maintain the natural hillsides or review the adequacy of the measures provided.

If a hillside is substantially modified by the stabilisation (e.g. major regrading) or Defence Measures, then it should be regarded as a man-made slope or retaining wall and should be maintained in accordance with the guidelines given in Chapter 3 for man-made slopes and retaining walls.

7.2 MAINTENANCE MANUAL FOR NATURAL TERRAIN HAZARD MITIGATION MEASURES

A Maintenance Manual should be prepared to assist the owner or the party required to maintain the mitigation measures to appreciate the maintenance requirements. The Maintenance Manual should include key aspects of the mitigation measures such as:

(a) a plan of the site showing the location of the natural terrain hazard mitigation measures,

(b) record sheets containing basic information on the natural terrain hazard mitigation measures,

(c) a list of maintenance actions,

(d) recommendations for the frequency of Routine Maintenance Inspections, and for requesting Engineer Inspections for Maintenance when anomalies are observed during Routine Maintenance Inspections,

(e) as-built plans and typical cross-sections of the natural terrain hazard mitigation measures,

(f) the purpose of the hazard mitigation measures and the developments or facilities to be protected, and

(g) as-built record photographs of the natural terrain hazard mitigation measures.

An indicative format for Maintenance Manual for natural terrain hazard mitigation measures is given in Appendix G.

7.3 ROUTINE MAINTENANCE INSPECTIONS FOR MITIGATION MEASURES

Routine Maintenance Inspections should be carried out to identify any maintenance works required to ensure the integrity and physical condition of the hazard mitigation measures and continued satisfactory performance of the measures. The general principles given for the maintenance of man-made slopes and retaining walls in Chapter 3, and the recommended good practice given in respect of the maintenance management, personnel requirements, attention to safe access and precautions, are applicable to the maintenance of natural terrain hazard mitigation measures. When it is decided to provide a permanent access to the hazard mitigation measure, it is necessary to consider the environmental impact and avoid a visually intrusive access as far as possible. The guidelines and examples given in GEO Report No. 136 (Lam et al, 2003) on safe access for slope maintenance are also relevant.

Routine Maintenance Inspections should cover the measures, the area containing the measures and the adjoining ground. In general, the inspection should assess the need for carrying out maintenance works of man-made items such as:

(a) clearing debris from drainage channels, catch trenches and pits, containment basins and straining structures,

(b) repairing or replacing damaged sections,

(c) unblocking weepholes and drainage outlet,

(d) removing any vegetation that has caused severe cracking of channels or hard surfaces,

(e) repairing or reinstating the ground adjoining the measures if affected by severe erosion, and

(f) other routine maintenance works to upkeep the integrity and function of the measures.

7.4 FREQUENCY OF ROUTINE MAINTENANCE INSPECTIONS

Routine Maintenance Inspections should be carried out at least once every year. If the inspection is to be carried out annually, it should preferably be completed well before the onset of the wet season. This will allow sufficient time for carrying out the necessary routine maintenance works. In addition, it is good practice to inspect Defence Measures and clear any significant volume of debris accumulated after a heavy rainstorm.

The designer or a professionally-qualified geotechnical engineer may specify less frequent Routine Maintenance Inspections taking into the consideration the consequence of failure in the natural terrain, e.g. where facilities on the land protected by the mitigation measures have been cleared or changed.

7.5 ENGINEER INSPECTIONS FOR MAINTENANCE OF MITIGATION MEASURES

The maintenance works required for Stabilisation Measures and Defence Measures are relatively simple, and do not normally require input from a professionally-qualified geotechnical engineer. Engineer Inspections for Maintenance are not required unless specified otherwise by the designer or in special provisions, e.g. delineation of "Green-hatched-black" area in the lease document. In cases where unusual conditions or problems are observed, e.g. a check dam filled up with a large amount of landslide debris or significant movement observed at boulders supported by buttresses, the owner or the party required to maintain the mitigation measures should seek advice from a professionally-qualified geotechnical engineer.

7.6 OTHER MEASURES

In some circumstances, dealing with natural terrain landslide hazards involves use of other measures such as:

(a) provision of a buffer zone (e.g. an open space) between the hillside and developments or facilities, and

(b) incorporation of debris basins, sand traps, etc. as part of the drainage facilities.

Unless specified otherwise by the designer, there are no maintenance requirements for such measures from the geotechnical point of view, apart from regular clearance of debris.

Re-vegetation may be carried out in a prescriptive manner to repair hillsides that are affected by landslides, hill fires, etc. The vegetation species to be adopted in such circumstances should be maintenance free. If special bio-engineering measures are adopted for the mitigation of natural terrain hazards, the designer should specify maintenance requirements.

8. SOURCES OF INFORMATION

8.1 INFORMATION PROVIDERS

Useful information relating to the maintenance of slopes and retaining walls can be obtained from a number of organisations.

The Geotechnical Engineering Office of the Civil Engineering Department operates a Slope Maintenance Hotline (Tel.: 2885 5888). The hotline provides advice to the general public on matters relating to maintenance of slopes and retaining walls, and suggests appropriate sources for more specific information. The public can also access the hotline through the Citizen's Easy Link (Tel.: 1823). The Geotechnical Engineering Office manages a Slope Information System that contains up-to-date information on registered man-made slopes and retaining walls, disturbed terrain features and landslide hazard mitigation measures within the Hong Kong Special Administrative Region. The Slope Information System can be accessed from the "Hong Kong Slope Safety" web site (http://hkss.ced.gov.hk).

The Geotechnical Information Unit forms part of the Civil Engineering Library, which is operated by the Geotechnical Engineering Office of the Civil Engineering Department. The Geotechnical Information Unit contains records of previous ground investigations and landslides, and reports on Stability Assessments and upgrading works carried out by the Geotechnical Engineering Office under its Landslip Preventive Measures Programme. In addition, other records of existing slopes and retaining walls are made available upon request.

Engineer Inspection for Maintenance Reports and Maintenance Manuals for government man-made slopes and retaining walls are held by various departments responsible for their maintenance.

The Engineers Registration Board at the Hong Kong Institution of Engineers holds a list of Registered Professional Engineers (Geotechnical).

The Buildings Department and District Offices keep a list of Registered Contractors who have indicated their willingness to carry out maintenance works for slopes and retaining walls.

The Home Affairs Department manages the Building Management Resource Centres to assist building owners, residents, owners' corporations, mutual aid committees and management bodies in improving the standards of management, safety and maintenance of their buildings.

The Hong Kong Association of Property Management Companies Limited may be consulted for general information about property management. The Association keeps a list of property management companies in Hong Kong.

The Lands Department is responsible for land administration. Information about land records, land boundaries, lease conditions and slope maintenance responsibility can be sought from the Lands Department. Large-scale plans and topographic maps can also be purchased from the Lands Department. The Slope Maintenance Responsibility Information System (SMRIS) contains information on the maintenance responsibility for registered man-made

slopes and retaining walls and can be accessed from the Lands Department's web site (http://www.slope.landsd.gov.hk/smris/).

Records of property owners, lease documents and Deeds of Mutual Covenant are kept at the Land Registry, where the public can make a search of these records.

The Water Supplies Department provides information on the location of water supply mains upon request.

The Drainage Services Department maintains as-built records of public stormwater drains and foul sewers, whereas the Buildings Department holds similar records for private lots.

Information on gas, electricity, telephone and similar services, including both the locations and details of existing facilities and the provision of future services, are available from the corporations supplying the services.

Further information regarding the services provided by the relevant government departments and their contact details can be found at the web site of the Government of the Hong Kong Special Administrative Region (http://www.info.gov.hk).

The Jockey Club Research and Information Centre for Landslip Prevention and Land Development, which is a non-profit making organisation, has developed geographic information systems that allow online Internet search or request of ground investigation and underground utilities records. Some of the services offered by the Centre are available to the public subject to payment of fees. Access to the information system can be found at the web site of the Centre (http://www.jcric.hku.hk).

8.2 DOCUMENTS

An abridged version of this Geoguide: Layman's Guide to Slope Maintenance (GEO, 2003a), has been produced by the Geotechnical Engineering Office of the Civil Engineering Department giving simplified guidance on matters related to slope maintenance for the general public. In addition, a "Layman's Guide on Landscape Treatment of Slopes and Retaining Walls" (GEO, 2002a) has also been prepared to provide guidelines to owners and encourage them to adopt landscape treatment to slopes and retaining walls when planning for the maintenance and upgrading works. Copies of the two layman's guides are available free of charge at District Offices and can be downloaded from the "Hong Kong Slope Safety" web site (http://hkss.ced.gov.hk).

The Government of the Hong Kong Special Administrative Region has prepared a code of practice entitled "Code of Practice on Inspection & Maintenance of Water Carrying Services Affecting Slopes" (Works Branch, 1996), which can be downloaded from the "Hong Kong Slope Safety" web site.

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APPENDIX A

INDICATIVE FORMAT FOR MAINTENANCE MANUAL FOR MAN-MADE SLOPES AND RETAINING WALLS

<table>
<tr><td colspan="8">MAINTENANCE MANUAL (SHEET 1 OF 8)
PART I - BASIC SLOPE/RETAINING WALL INFORMATION</td></tr>
<tr><td colspan="8">SLOPE/RETAINING WALL REFERENCE NO. (1)</td></tr>
<tr><td colspan="8">Location of Slope/Retaining Wall (address)</td></tr>
<tr><td colspan="2" rowspan="2">Map Co-ordinates
(1980 DATUM)</td><td colspan="2">Easting</td><td colspan="2" rowspan="2">Toe Elevation (mPD)</td><td colspan="2" rowspan="2"></td></tr>
<tr><td colspan="2">Northing</td></tr>
<tr><td colspan="4">Maximum Height of Slope/Retaining wall (m)</td><td colspan="4"></td></tr>
<tr><td colspan="4">Overall Slope Angle of Slope/Retaining wall (°)</td><td colspan="4"></td></tr>
<tr><td colspan="8">TECHNICAL INFORMATION (continue on separate sheets if necessary)</td></tr>
<tr><td colspan="4">Slope Portion</td><td colspan="4">Retaining Wall Portion</td></tr>
<tr><td colspan="2">Material Description</td><td colspan="2"></td><td colspan="2">Type of Wall</td><td colspan="2"></td></tr>
<tr><td colspan="2">Slope Surface Cover</td><td colspan="2"></td><td colspan="2">Location of Wall</td><td colspan="2"></td></tr>
<tr><td colspan="2">Max. Height (m)</td><td colspan="2"></td><td colspan="2">Max. Height (m)</td><td colspan="2"></td></tr>
<tr><td colspan="2">Length (m)</td><td colspan="2"></td><td colspan="2">Length (m)</td><td colspan="2"></td></tr>
<tr><td colspan="2">Average Slope Angle (°)</td><td colspan="2"></td><td colspan="2">Face Angle (°)</td><td colspan="2"></td></tr>
<tr><td colspan="2" rowspan="2">Berm</td><td>No.</td><td>Min. Width (m)</td><td colspan="2" rowspan="2">Berm</td><td>No.</td><td>Min. Width (m)</td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
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<tr><td colspan="2">Weepholes</td><td></td><td></td><td colspan="2">Weepholes</td><td></td><td></td></tr>
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<tr><td>On berm</td><td></td><td rowspan="2">At toe</td><td rowspan="2"></td></tr>
<tr><td>At toe</td><td></td></tr>
<tr><td>On slope</td><td></td></tr>
<tr><td colspan="2">Down Pipes</td><td></td><td colspan="2">Down Pipes</td><td></td></tr>
<tr><td colspan="2">Structural Measures (e.g. soil nail, anchor)</td><td></td><td></td><td colspan="2">Structural Measures (e.g. soil nail, anchor)</td><td></td><td></td></tr>
<tr><td colspan="8">TYPE AND SIZE OF SERVICES (see drawing)</td></tr>
<tr><td colspan="8">On slope: _____
_____
At crest: _____
_____</td></tr>
<tr><td colspan="8">Note: (1) Upon request, the Geotechnical Engineering Office can provide a slope or retaining wall reference number if applicable.</td></tr>
</table>

MAINTENANCE MANUAL **(SHEET 2 OF 8)**

PART I - BASIC SLOPE/RETAINING WALL INFORMATION

SLOPE/RETAINING WALL REFERENCE NO.

INFORMATION ON CONSEQUENCE-TO-LIFE CATEGORY

What facilities will be affected if this slope or retaining wall collapses (e.g. school, market, playground, highway and country park)?

At Crest: (a) Type(s) of facility _____

(b) Distance _____

At Toe: (a) Type(s) of facility _____

(b) Distance _____

Consequence-to-life category of the slope or retaining wall: _____

STUDY / UPGRADING / IMPROVEMENTS WORKS

(types of upgrading or improvement works, date of construction, outline of basis of most up-to-date design or findings of stability assessment, date of checking certificate issued by GEO [1])

Note: (1) For government slopes only.

MAINTENANCE MANUAL **(SHEET 3 OF 8)**

PART II - MAINTENANCE SCHEDULE OF SLOPE/RETAINING WALL

SLOPE/RETAINING WALL REFERENCE NO.

LIST OF ITEMS REQUIRING ROUTINE MAINTENANCE

(including requirements on man-made items, landscape items, etc)

MONITORING SCHEDULE FOR REGULAR MONITORING OF SPECIAL MEASURES

Type and Spacing of Special Measures: Anchors/Raking Drains (see drawing for details)

Details of Monitoring: (e.g. frequency of monitoring, types of tests and acceptance criteria)

MAINTENANCE MANUAL **(SHEET 4 OF 8)**

PART II - MAINTENANCE SCHEDULE OF SLOPE/RETAINING WALL

SLOPE/RETAINING WALL REFERENCE NO.

FREQUENCY OF MAINTENANCE INSPECTIONS

(a) Frequency of Routine Maintenance Inspection: _____

(b) Frequency of Engineer Inspection for Maintenance: _____

(c) Frequency of Regular Check of Water-Carrying Services (including buried services, ducting systems): _____

Guidelines on when professional advice or an immediate Engineer Inspection for Maintenance is required:

(e.g. landslide, signs of distress, new or significant increase of seepage, or change of facility in the vicinity of slope or retaining wall.) _____

_____

_____

_____

_____

OTHER INFORMATION

Relevant records: (e.g. ground investigation report, geotechnical report, landslide incident report and landscape design report.) _____

_____

_____

_____

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_____

_____

_____

_____

_____

INFORMATION PROVIDER

Prepared by: _____ Firm: _____

Signature: _____ Date: _____

MAINTENANCE MANUAL **(SHEET 5 OF 8)**

PART III - DRAWINGS AND PHOTOGRAPHIC RECORDS

SLOPE/RETAINING WALL REFERENCE NO.

LOCATION PLAN AND SITE PLAN (with scale)

MAINTENANCE MANUAL **(SHEET 6 OF 8)**

PART III - DRAWINGS AND PHOTOGRAPHIC RECORDS

SLOPE/RETAINING WALL REFERENCE NO.

PLAN/SECTIONS OF SLOPE/RETAINING WALL TO BE MAINTAINED
(Plan and sections based on as-built conditions. Include date of the plan, details of surface cover, surface drainage, subsurface drainage, access points, and stabilisation measures)

Note: All dimensions are in millimetres and all levels are in metres above Principal Datum.

MAINTENANCE MANUAL **(SHEET 7 OF 8)**

PART III - DRAWINGS AND PHOTOGRAPHIC RECORDS

SLOPE/RETAINING WALL REFERENCE NO.

LAYOUT PLAN OF WATER-CARRYING SERVICES ON OR ADJACENT TO SLOPE/RETAINING WALL (with date)

Note: All dimensions are in millimetres and all levels are in metres above Principal Datum.

MAINTENANCE MANUAL **(SHEET 8 OF 8)**

PART III - DRAWINGS AND PHOTOGRAPHIC RECORDS

SLOPE/RETAINING WALL REFERENCE NO.

RECORD PHOTOGRAPHS (with observations and date; and with the vantage points indicated on the plans)

Note: Add additional record sheets for photographs as necessary.

APPENDIX B

INDICATIVE RECORD SHEETS FOR ROUTINE MAINTENANCE INSPECTIONS AND WORKS

RECORD OF ROUTINE MAINTENANCE INSPECTION				**(SHEET 1 OF 4)**
SLOPE/RETAINING WALL REFERENCE NO.[(1)]				
Location of Slope/Retaining Wall (address)				
Date of Inspection:				
Date of Last Engineer Inspection for Maintenance:				
Due Date of Next Engineer Inspection for Maintenance:				
Weather Condition at Time of Inspection:				
Maintenance Action Item	Location Reference	Action Required		Works Completion Date
		No	Yes	
Clear drainage channels of accumulated debris				
Repair cracked/damaged drainage channels or pavements along crest and toe of slope or retaining wall				
Repair or replace cracked or damaged impermeable slope surface cover				
Remove surface debris and vegetation that has caused severe cracking of slope surface cover and drainage channels				
Remove loose rock debris and undesirable vegetation from rock slopes or boulders				
Re-vegetate bare soil slope surface				
Repair pointings in masonry walls				
Unblock weepholes and outlet drainpipes				
Repair leaky exposed water-carrying services				
Repair or replace rusted slope furniture (e.g. steel gates, boundary fences and stairs)				
Remove debris from defence measures				
Others (specify works and give details)				
Recommended Date for Completion of Above Works:				

Note: (1) Upon request, the Geotechnical Engineering Office can provide a slope or retaining wall reference number if applicable.

RECORD OF ROUTINE MAINTENANCE INSPECTION	**(SHEET 2 OF 4)**
SLOPE/RETAINING WALL REFERENCE NO.	

SITE PLAN (Reference numbers should be assigned to locations of man-made items for which maintenance works are required. The corresponding reference numbers should be quoted in the photographic records.)

Note: Add additional record sheets for site plan as necessary.

RECORD OF ROUTINE MAINTENANCE INSPECTION	**(SHEET 3 OF 4)**
SLOPE/RETAINING WALL REFERENCE NO.	
Immediate Engineer Inspection for Maintenance needed(1)?	(Yes/No)
Immediate arrangement for investigation and repair of buried water-carrying services needed?	(Yes/No)

OTHER OBSERVATIONS (continue on separate sheets if necessary)
(e.g. condition of trees for which specialist advice is needed) _____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Inspected by: _____ (Name of person undertaking inspection)

of _____ (Organisation)

Signature: _____ Date: _____

Due date of next inspection: _____

Received by: _____ (Name of owner or his authorised representative)

of _____ (Organisation)

Signature: _____ Date: _____

Note: (1) Defects or anomalies, such as signs of leakage, widening of cracks, settling ground, bulging or distortion of a masonry wall or settlement of the crest platform, should be reported to the owner or party responsible for the maintenance of the land.

RECORD OF ROUTINE MAINTENANCE INSPECTION	**(SHEET 4 OF 4)**
SLOPE/RETAINING WALL REFERENCE NO.	
RECORD PHOTOGRAPHS (with descriptions, date, and reference numbers as given on the site plan)	

Notes:
(1) Add additional record sheets for photographs as necessary.
(2) Record photographs should show in detail areas where maintenance works are required, signs of distress observed (e.g. tension cracks, bulging of wall), and be annotated with descriptions.

RECORD OF ROUTINE MAINTENANCE WORKS **(SHEET 1 OF 1)**

SLOPE/RETAINING WALL REFERENCE NO.

Maintenance works arranged by: _____ (Name)

of _____ (Organisation)

Signature: _____ Date: _____

Maintenance works carried out by: _____ (Name)

of _____ (Organisation)

Signature: _____ Date: _____

Maintenance works carried out on: _____

RECORD PHOTOGRAPHS (with descriptions, date, and reference numbers as given on the site plan)

Notes:
(1) Add additional record sheets for photographs as necessary.
(2) For removal of loose rocks from rock face or clearing debris from defence measures, e.g. check dam, the estimated volume of debris removed should be recorded.
(3) Record photographs should show in detail areas where maintenance works have been carried out and be annotated with descriptions.
(4) Record photographs before and after the execution of maintenance works should be taken from the same vantage points.

APPENDIX C

MODEL BRIEF FOR ENGINEER
INSPECTIONS FOR MAINTENANCE FOR PRIVATE SLOPES

MODEL BRIEF FOR ENGINEER INSPECTIONS FOR MAINTENANCE

1. Objective of the Assignment

The objective of this Assignment is to carry out an Engineer Inspection for Maintenance, including the preparation of an Engineer Inspection Report and the preparation/updating* of a Maintenance Manual, and, if required, the design, management and supervision of works, for slope/retaining wall* number _____, the location and extent of which are shown on the attached plan.

2. Description of the Assignment

The Assignment shall consist of the following items of work:

(a) to assess the state of maintenance and condition of the slope/retaining wall*,

(b) to establish if Stability Assessments of the slope/retaining wall* have previously been carried out and, if so, to carry out a review of these previous Stability Assessments,

(c) to determine whether a Stability Assessment and/or preventive maintenance or urgent repair works or access provision are necessary,

(d) to recommend, arrange, supervise and certify the satisfactory completion of any necessary works*, and

(e) to prepare/update* the maintenance documentation and recommend improvement for the maintenance process.

The review of previous Stability Assessments required in (b) above is not intended to certify or endorse any part or the whole of the previous Stability Assessments. It only aims to identify whether the previous Stability Assessments contains any obvious deficiencies in engineering approach or assumptions in the light of current local geotechnical engineering practice and safety standards, any monitoring records indicating deficiency in the design assumptions, and to judge whether the stability of the slope/retaining wall would be affected by any visible changes in conditions identified during the site inspection.

3. Deliverables

The Engineer shall submit _____ copies of the Engineer Inspection Report covering the tasks listed in Section 4 below and enclosing the Records of Engineer Inspection for Maintenance /and _____ copies of the Maintenance Manual to the Employer.

4. Services to be Provided by the Engineer

This Assignment shall be carried out by a professionally-qualified geotechnical engineer in Hong Kong. A suitable qualification is Registered Professional Engineer (Geotechnical). As the inspecting engineer, the geotechnical engineer shall prepare and sign the Records of Engineer Inspection for Maintenance. The geotechnical engineer shall also prepare and sign the Engineer Inspection Report.

Part 1 - Information Collection

(a) Starting from the sample checklist in Appendix H of Geoguide 5, prepare a checklist for the agreement of the Employer indicating the types of documents to be collected under this Assignment.

(b) Collect available documentary information pertaining to the slope/retaining wall* and the nearby areas which could have implications on its stability.

Part 2 - Site Inspection

(a) Carry out an inspection of the slope/retaining wall* and the nearby areas and prepare Records of Engineer Inspection for Maintenance according to the Indicative Record Sheets given in Appendix F of Geoguide 5. In particular,

(i) evaluate the adequacy of access to the slope/retaining wall for maintenance inspections taking into account the requirements of safety regulations and provide recommendations in accordance with Part 4(b) below,

(ii) identify visually any discrepancies between the records of previous engineer inspections for maintenance, maintenance manuals, the works as constructed, actual site conditions and the plans in the Stability Assessment Reports, design reports, drawings or as-built records,

(iii) identify all visible changes including landslides, unauthorised constructions, formation of unauthorised cultivation areas, appearance of tension cracks, or other signs of distress, that have taken place at or in the vicinity of the slope/retaining wall*, in particular any changes since the last Stability Assessment and Engineer Inspection, which could have implications on its stability, and to judge whether these might be significant,

(iv) identify the presence of buried and exposed water-carrying services (including any ducting systems housing the services) and unauthorised services, on or in the vicinity of the slope/retaining wall* (including relevant areas outside the lot boundary), both visually and with reference to the record plans for the services,

(v) check for signs of leakage of any exposed and buried water-carrying services (including any ducting systems housing the services) and identify the source of any leaky water-carrying services where possible and provide

recommendations in accordance with Part 4(c) below, and

(vi) look for and consider the implications of problems that are not explicitly included in the list of maintenance for man-made items, and bring to the attention of the Employer any immediate and obvious danger noted and provide recommendations in accordance with Part 4(d) below.

Part 3 - Assessment

Based on the tasks of Parts 1 and 2 above, carry out the following tasks:

(a) Evaluate the relevance and completeness of all information collected with reference to the checklist agreed by the Employer (see Part 1(a)). Determine whether Stability Assessments covering parts or the entirety of the slope/retaining wall* have previously been carried out. If so, review the previous Stability Assessment reports to check whether the engineering approach used, the assumptions and the conclusions made in these reports are reasonable in the light of current practice and safety standards.

(b) Re-assess the consequence-to-life category of the slope/retaining wall*, as set out in the standards and guidance documents promulgated by the Geotechnical Engineering Office.

(c) Check that Routine Maintenance Inspections and the recommendations for routine maintenance works have been carried out and documented satisfactorily.

(d) Check that Regular Checks of Buried Water-carrying Services (including any ducting systems housing the services) and/or Regular Monitoring of Special Measures (if required) and the recommendations arising from the checks have been carried out and documented satisfactorily.

(e) Assess the adequacy of routine maintenance works and supplement the list of basic maintenance works items, as necessary.

(f) Re-assess the required frequency of Routine Maintenance Inspections, Engineer Inspections for Maintenance, and Regular Checks of Buried Water-carrying Services (including any ducting systems housing the services).

Part 4 - Recommendations

(a) Recommend any necessary preventive maintenance works.

(b) Based on the task of Part 2(a)(i), recommend any necessary access to be provided for maintenance inspections and works.

(c) Based on the task of Part 2(a)(v), recommend any necessary immediate detailed leakage check, regular checks, repair and re-routing of the services. Where leaky water-carrying services are found, advise the services' owners and appropriate authorities for actions. Update the Maintenance Manual to include a provision to

initiate an out-of-turn Engineer Inspection for Maintenance whenever anomalies due to leaky services are observed.

(d) Based on the work of Part 2(a)(iii) & (vi), recommend any necessary emergency measures (e.g. cordoning off works), urgent repair or investigations.

(e) Advise whether a Stability Assessment of the slope/retaining wall* is needed taking into consideration the results of the tasks in Parts 2 and 3 and the results of the previous Stability Assessment(s), if any.

Part 5 - Reporting

(a) Prepare an Engineer Inspection Report covering the above tasks and enclosing the Records of Engineer Inspection for Maintenance for submission to the Employer.

(b) Explain the findings and recommendations of the Engineer Inspection to the Employer, in particular whether Stability Assessment or works are required to be carried out, with justifications and cost estimates including any site supervision costs, and answering any queries.

Part 6 - Preparation/Updating* of the Maintenance Manual

(a) Prepare/update* the Maintenance Manual to include all relevant information extracted from the previous Stability Assessment(s), and the desk study, records and details of any previous landslides and subsequent repair works, and site inspection(s) under this Assignment, with traceability to all source documents used.

(b) Prepare/update* the Maintenance Manual to include a statement of landscape design highlighting the rationale for the choice of the landscape items for the slope/retaining wall.

Part 7 - Design, Management and Supervision of Works (Optional Items)

(a) Prepare specifications and plans for the necessary routine and preventive maintenance works, urgent repair, and access provision based on the tasks of Part 4(a), (b) & (d) above.

(b) Recommend the requirements of a construction design review for the works in Part 7(a) above.

(c) Obtain or arrange to obtain all statutory approvals (e.g. from Building Authority) and agreements from any parties, as appropriate, required for the execution of the necessary maintenance works.

(d) Seek approval/agreement from the relevant authorities (e.g. Transport Department, Police, and District Lands Offices) and any affected parties (e.g. utility companies), if necessary, for the execution of the items of works on the slopes/retaining walls.

(e) Prepare the works contract, invite tenders, and provide recommendations for the Employer to appoint the most suitable Contractor to undertake the works.

(f) Undertake supervision of the items of works and all contract administration. Check whether the works have been carried out in accordance with the works contract requirements and if so certify payment for works that are satisfactorily completed.

(g) Carry out any necessary construction design reviews and liaise with the Contractor and the Employer as necessary.

(h) Prepare and certify the as-built construction records, including any design reviews carried out, and update the Maintenance Manual to document the works done, based on site inspections and the as-built records of the works. Submit relevant documents to statutory authorities certifying the completion of works.

5. Programme of Implementation

The due date for the commencement of the Assignment shall be _____.

The due date(s) for the completion of Parts 1 to 6 of Section 4 of the Assignment, including the submission of Record of Engineer Inspection for Maintenance and any relevant documents and reports, shall be _____.

6. Standards and Specifications

The Engineer shall adopt such technical and design standards and specifications as are applicable to and in current use by the Government of the Hong Kong Special Administrative Region or, if non-existent, international Codes of Practice and Specifications. Reference can be made to Technical Guidance Note (TGN) No. 1 which contains a list of guidance documents being used by the Geotechnical Engineering Office as the de facto geotechnical standards. The TGN can be found at the Civil Engineering Department web site at http://www.ced.gov.hk.

7. Information Provided by the Employer

All available information held by the Employer and relevant to the Assignment will be provided to the Engineer.

Notes: (1) * Deleted if not applicable.

(2) The agreement should be priced on the basis of all the tasks included in Parts 1 to 6 of Section 4 only. The fee for the tasks in Part 7 of Section 4, if found necessary, should be negotiated separately.

(3) The programme for the tasks in Part 7 of Section 4 should be agreed after completion of the tasks in Parts 1 to 6 of Section 4.

APPENDIX D

SCOPE OF SERVICES FOR ENGINEER INSPECTIONS FOR MAINTENANCE FOR GOVERNMENT SLOPES

1. General

Government maintenance departments generally have to maintain a large number of slopes, which spread all over the Hong Kong Special Administrative Region. The following section outlines the scope of works to be carried out in the Engineer Inspections for Maintenance and other provisions for procuring additional information for the effective management of their slope maintenance programme.

2. Services to be Provided by the Engineer undertaking Engineer Inspections for Maintenance for Government Slopes

Part 1 - Information Collection

(a) Starting from the sample checklist in Appendix H of Geoguide 5, prepare a checklist for the agreement of the Employer indicating the types of documents to be collected under this Assignment.

(b) Collect available documentary information pertaining to the slopes and retaining walls listed in _____ and the nearby areas that could have implications on their stability.

Part 2 - Site Inspection

(a) Carry out an inspection of the slopes and retaining walls and the nearby areas, and prepare Records of Engineer Inspections for Maintenance based on the Indicative Record Sheets given in Appendix F of Geoguide 5. In particular,

(i) evaluate the adequacy of access to the slopes and retaining walls for maintenance inspections taking into account the requirements of safety regulations and provide recommendations in accordance with Part 4(b) below,

(ii) identify visually any discrepancies between the records of previous Engineer Inspections for Maintenance, maintenance manuals, the as-constructed works, actual site conditions and the plans in the Stability Assessment Reports, design reports, drawings or as-built records, if any,

(iii) identify all visible changes including landslides, unauthorised constructions, formation of unauthorised cultivation areas, appearance of tension cracks, or other signs of distress, that have taken place at or in the vicinity of a slope or retaining wall, in particular any changes since the last Stability Assessment and Engineer Inspection, which could have implications on its stability, and to judge whether these might be significant,

(iv) identify the presence of buried and exposed water-carrying services, (including any ducting systems housing the services) and unauthorised services, on or in the vicinity of the slopes and retaining walls (including

relevant areas outside the lot boundary), both visually and with reference to the record plans for the services,

(v) check for signs of leakage of any exposed and buried water-carrying services (including any ducting systems housing the services) and identify the source of any leaky water-carrying services where possible and provide recommendations in accordance with Part 4(c) below, and

(vi) look for and consider the implications of problems that are not explicitly included in the list of maintenance for man-made items, and bring to the attention of the Employer any immediate and obvious danger noted and provide recommendations in accordance with Part 4(d) below.

(b) Where directed by the Employer, make arrangements for gaining access to any part of a slope or retaining wall and the nearby areas to be inspected including liaison with all relevant parties and authorities, the application of any necessary permits, general vegetation clearance for access and the provision of the necessary equipment and consumable for inspecting the slope safely.

(c) Collect or update relevant data used to determine the priority ranking of follow-up actions for slopes and retaining walls, including Stability Assessments, preventive maintenance works or upgrading works.

(d) Collect data for registration in accordance with WBTC No. 9/2000 or any more recent guidance documents promulgated by the Environment, Transport and Works Bureau for any unregistered slopes or retaining walls found within the project/allocation boundary, and for which the Employer has the obligation to maintain. In the event of an unregistered slope or retaining wall locating in the vicinity of the project/allocation boundary or the venue of inspection and whose maintenance responsibility is not clear, collect the basic information of the unregistered slope or retaining wall including its location, the height and gradient of the slope or retaining wall and record photographs.

Part 3 - Assessment

Based on the tasks of Parts 1 and 2 above, carry out the following tasks for each slope or retaining wall:

(a) Evaluate the relevance and completeness of all information collected with reference to the checklist agreed by the Employer (see Part 1(a)). Determine whether Stability Assessments covering parts or the entirety of the slope or retaining wall have previously been carried out. If so, review the previous Stability Assessment reports to check whether the engineering approach used, the assumptions and the conclusions made in these reports are reasonable in the light of current practice and safety standards.

(b) Re-assess the consequence-to-life category of the slope or retaining wall, as set out in the standards and guidance documents promulgated by the Geotechnical Engineering Office.

(c) Check that Routine Maintenance Inspections and the recommendations for routine maintenance works have been carried out and documented satisfactorily.

(d) Check that Regular Checks of Buried Water-carrying Services (including any ducting systems housing the services) and/or Regular Monitoring of Special Measures (if required) and the recommendations arising from the checks have been carried out and documented satisfactorily.

(e) Assess the adequacy of routine maintenance works and supplement the list of basic maintenance works items, as necessary.

(f) Re-assess the required frequency of Routine Maintenance Inspections, Engineer Inspections for Maintenance, and Regular Checks of Buried Water-carrying Services (including any ducting systems housing the services).

(g) Provide to the Slope Safety Division of Geotechnical Engineering Office through the Employer any updated details including any changes in the slope or retaining wall boundary and data in accordance with WBTC No. 9/2000 on Registration and Updating of the Catalogue of Slopes or more recent guidance documents promulgated by the Environment, Transport and Works Bureau.

Part 4 - Recommendations

(a) Recommend any necessary preventive maintenance works.

(b) Based on the task of Part 2(a)(i), recommend any necessary access to be provided for maintenance inspections and works.

(c) Based on the task of Part 2(a)(v), recommend any necessary immediate detailed leakage check, regular checks, repair and re-routing of the services. Where leaky water-carrying services are found, advise the services' owner and appropriate authorities for actions. Update the Maintenance Manual to include a provision to initiate an out-of-turn Engineer Inspection for Maintenance whenever anomalies due to leaky services are observed.

(d) Based on the work of Part 2(a)(iii)&(vi), recommend any necessary emergency measures (e.g. cordoning off works), urgent repair or investigations.

(e) Advise whether a Stability Assessment of a slope or retaining wall is needed taking into consideration the results of the tasks in Parts 2 and 3 and the results of the previous Stability Assessments, if any.

(f) If a Stability Assessment of a slope or retaining wall is considered necessary in Part 4(e), advise the Employer whether the slope or retaining wall can be upgraded by means of prescriptive measures or whether alternative mitigation measures can be used to reduce the potential consequence of failure, instead of carrying out a Stability Assessment.

(g) Based on the data collected in Part 2(c), advise the Employer a ranking list for

carrying out Stability Assessment, preventive maintenance works or upgrading works for the slopes and retaining walls, based on a suitable prioritising scheme approved by the Employer (e.g. the New Priority Classification System or other system proposed in consultation with the Geotechnical Engineering Office). Submit the key data collected in Part 2(c) to the Geotechnical Engineering Office. The ranking list should take into account the consequence-to-life category of the slopes and retaining walls and any possible action under the Landslip Preventive Measures Programme and/or other developments to be taken in consultation with the Geotechnical Engineering Office.

(h) Based on data collected in Part 2(d) above, register any unregistered slopes or retaining walls identified within the project/allocation boundary, which the Employer is responsible for their maintenance, in accordance with the guidance and standards promulgated by the Geotechnical Engineering Office. In case the unregistered slope or retaining wall lies in the vicinity of the project/allocation boundary or the venue of inspection or where its maintenance responsibility is not certain, provide the basic information to facilitate the registration by Geotechnical Engineering Office.

Part 5 - Reporting

(a) Prepare an Engineer Inspection Report covering the above tasks and enclosing the Records of Engineer Inspection for Maintenance for submission to the Employer.

(b) Explain the findings and recommendations of the Engineer Inspection to the Employer, in particular whether Stability Assessment or works are required to be carried out, with justifications and cost estimates including any site supervision costs, and answer any queries.

(c) Prepare the records of Engineer Inspection for Maintenance and Maintenance Manual in electronic format conforming to the database specification promulgated by the Geotechnical Engineering Office.

Part 6 - Preparation or Updating of Maintenance Manuals

(a) Prepare or update the Maintenance Manual for each slope or retaining wall to include all relevant information extracted from the previous Stability Assessments, and the desk study, records and details of any previous landslides and subsequent repair works, and action status and priority of the slope or retaining wall in the Landslip Preventive Measures Programme and site inspection(s) under this Assignment, with traceability to all source of documents used.

(b) Prepare or update the Maintenance Manual for each slope or retaining wall to include a statement of landscape design highlighting the rationale for the choice of the landscape items to the slope or retaining wall.

Part 7 - Design of Works (Optional Items)

(a) Compile a list of slopes/retaining walls* together with the necessary routine and

preventive maintenance works, urgent repair and access provision based on all the tasks of Parts 4(a), (b) and (d) above. The list should also include the specified items of prescriptive measures, wherever applicable and practicable, for the slopes/retaining walls*. Where directed by the Employer, prepare specifications and plans for the items of works on the slopes/retaining walls* selected from the list by the Employer to a standard that can be used directly in the Employer's works contract.

(b) When directed by the Employer, prepare specifications and plans for upgrading works using prescriptive measures where appropriate to a standard that can be used directly in the Employer's works contract. Make submissions to the Geotechnical Engineering Office for checking in accordance with WBTC No. 11/2000.

(c) Recommend the requirements of construction design review for the works in Part 7(a) and 7(b) above.

Part 8 - Independent Auditing of Reports of Engineer Inspections for Maintenance (Optional Item)

(a) When directed by the Employer, provide assistance to the professional geotechnical engineer appointed by the Employer to carry out an independent auditing of the Engineer Inspection Reports submitted under this agreement.

(b) When directed by the Employer, carry out independent auditing of Engineer Inspection Reports submitted under separate consultancy against the corresponding Brief.

Part 9 - Obtaining Checking Certificates for Stability Assessment of Slopes and Retaining walls (Optional Item)

(a) When directed by the Employer, submit previous Stability Assessment reports of a slope or retaining wall to the Geotechnical Engineering Office to apply for a Checking Certificate for the slope or retaining wall in accordance with WBTC No. 16/2001 and respond to any queries that may arise.

APPENDIX E

MODEL BRIEF FOR STABILITY ASSESSMENTS FOR PRIVATE SLOPES OR RETAINING WALLS

MODEL BRIEF FOR STABILITY ASSESSMENTS

1. Objectives of the Assignment

The objectives of the Assignment are:

(a) to determine whether the geotechnical standard of the slope/retaining wall* meets the requirements stipulated in the Geotechnical Manual for Slope (1984) or current standards promulgated by the Geotechnical Engineering Office of the Civil Engineering Department and

(b) to recommend /and arrange, supervise and certify satisfactory completion of* any necessary ground investigation and upgrading works.

2. Deliverables

The Engineer shall submit _____ copies of the Stability Assessment Report and _____ copies of the Maintenance Manual to the Employer.

3. Services to be Provided by the Engineer

This Assignment shall be carried out by a professionally-qualified geotechnical engineer in Hong Kong. A suitable qualification is Registered Professional Engineer (Geotechnical). The Engineer shall carry out the following tasks for slope/retaining wall* number _____, the location and extent of which are shown in the attached plan.

Part 1 - Basic Items

(a) Review the Engineer Inspection for Maintenance reports pertaining to the slope/retaining wall* and the nearby areas which could have implications on its stability.

(b) Where considered necessary, recommend, arrange and supervise ground investigation, monitoring and identification of buried services that could affect the stability of the slope/retaining wall*.

(c) Assess the geotechnical standard of the slope/retaining wall* with respect to the requirements stipulated in the Geotechnical Manual for Slopes (1984) or current standards promulgated by the Geotechnical Engineering Office.

(d) Provide recommendations on any necessary upgrading works.

(e) Prepare/update* the Maintenance Manual.

Part 2 - Design, Management and Supervision of Works (Optional Items)

(a) Prepare specifications and plans for the necessary upgrading works based on the tasks of Part 1 above.

(b) Recommend the requirements of a construction design review for the works in Part 2(a) above.

(c) Obtain or arrange to obtain all statutory approval (e.g. from Building Authority) and agreement from any parties, as appropriate, required for the execution of the necessary upgrading works.

(d) Seek approval or agreement from the relevant authorities (e.g. Transport Department, Police, and District Lands Offices) and any affected parties (e.g. utility companies), if necessary, for the execution of the items of works on the slope/retaining wall*.

(e) Prepare the works contract, invite tenders, and make recommendations for the Employer to appoint the most suitable Contractor to undertake the works.

(f) Undertake supervision of the items of works and all contract administration. Check whether the works have been carried out in accordance with the works contract requirements and if so certify payment for the works that are satisfactorily completed.

(g) Carry out any necessary construction design reviews and liaise with the Contractor and the Employer as necessary.

(h) Prepare and certify the as-built construction records, including any design reviews carried out, and update the Maintenance Manual to document the works done, based on a site inspection and the as-built records of the works. Submit relevant documents to statutory authorities certifying the completion of works.

4. Programme of Implementation

The due date for the commencement of the Assignment shall be _____.

The due date(s) for the completion of Part 1 of the Assignment, including the submission of Stability Assessment Report and any relevant documents and reports, shall be _____, working to a programme agreed with the Employer within _____ weeks of the commencement of the Assignment.

5. Standards and Specifications

The Engineer shall adopt such technical and design standards and specifications as are applicable to and in current use by the Government of the Hong Kong Special Administrative Region or, if non-existent, international Codes of Practice and Specifications. Reference can be

made to Technical Guidance Note (TGN) No. 1 which contains a list of guidance documents being used by the Geotechnical Engineering Office as the de facto geotechnical standards. The TGN can be found at the Civil Engineering Department web site at http://www.ced.gov.hk.

6. Information Provided by the Employer

All available information held by the Employer and relevant to the Assignment will be provided to the Engineer.

Notes: (1) * denotes item to be deleted if not applicable.

(2) The agreement should be priced on the basis of all the tasks included in Part 1 of Section 3 only. The fee for the tasks in Part 2 of Section 3, if found necessary, should be negotiated separately.

(3) The programme for the tasks in Part 2 of Section 3 should be agreed after completion of the tasks in Part 1.

APPENDIX F

INDICATIVE RECORD SHEETS FOR ENGINEER INSPECTIONS FOR MAINTENANCE

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 1 OF 10)

SLOPE/RETAINING WALL REFERENCE NO.(1)

Location of Slope/Retaining Wall (address)

Date of Inspection:

Date of Last Engineer Inspection:

Due Date of Next Engineer Inspection:

Weather Condition at Time of Inspection:

REVIEW OF ROUTINE MAINTENANCE

- Have routine maintenance works been satisfactory carried out? (give details if answer is "Partially") Yes/Partially/No

  ---

- Are the maintenance record sheets used adequate? Yes/No
- Have adequate maintenance records been kept? Yes/No
- Is there adequate access to the slope or retaining wall for Maintenance Inspections? Yes/No
- Has the full extent of the slope or retaining wall to be inspected and maintained been established (i.e. check against lease document issued by the Lands Department?) Yes/No

OTHER OBSERVATIONS

(e.g. recent works adjacent to the slope or retaining wall, estimated quantities of loose rock or debris removed from rock slope or defence measures)

Note: (1) Upon request, the Geotechnical Engineering Office can provide a slope or retaining wall reference number if applicable.

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 2 OF 10)		
SLOPE/RETAINING WALL REFERENCE NO.		
CONDITION OF SOIL SLOPE		
Items to be checked	Condition	Works Needed
Impermeable surface cover (Yes/No)	Good/Fair/Poor	
Weepholes (Yes/No)	Clear/Partly blocked/Blocked	
Vegetated surface (Yes/No)	Good/Fair/Poor	
Drainage channels (Yes/No)	Clear/Partly blocked/Blocked	
	No/Moderate/Severe Cracking	
Catchpits and sand traps (Yes/No)	Clear/Partly blocked/Blocked	
	No/Moderate/Severe Cracking	
Associated culverts & natural drainage lines (Yes/No)	Clear/Partly blocked/Blocked	
Stabilisation Measures (Yes/No)	Good/Fair/Poor	
Others (Specify)		
Questions to be asked	Remarks	Works Needed
Any recent slope failure? (Yes/No)	Record any of these anomalies since the last inspection and note any recurrence of the same problem. If yes to any of these questions, give details of the observations and implications of the problems (continue on separate sheets if necessary).	
Any recent erosion? (Yes/No)		
Any recent movement? (Yes/No)		
Any tension cracks at the crest? (Yes/No)		
Any recent seepage? (Yes/No)		
Any other signs of distress (please specify)? (Yes/No)		
COMMENTS (continue on separate sheets if needed)		

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 3 OF 10)		
SLOPE/RETAINING WALL REFERENCE NO.		
CONDITION OF RETAINING WALL		
Items to be checked	Condition	Works Needed
Weepholes (Yes/No)	Clear/Partly blocked/Blocked	
Mortar joints/pointing (Yes/No)	Good/Fair/Poor	
Drainage channels (Yes/No)	Clear/Partly blocked/Blocked	
	No/Moderate/Severe Cracking	
Outlets of drainpipes (Yes/No)	Clear/Partly blocked/Blocked	
Concrete facing (Yes/No)	Good/Fair/Poor	
Others (Specify)		
Questions to be asked	Remarks	Works Needed
Any recent wall settlement? (Yes/No)	Record any of these anomalies since the last inspection and note any recurrence of the same problem. If yes to any of these questions, give details of the observations and implications of the problems (continue on separate sheets if necessary).	
Any recent wall cracking? (Yes/No)		
Any recent wall tilting? (Yes/No)		
Any recent wall bulging? (Yes/No)		
Any recent seepage? (Yes/No)		
Any other signs of distress (please specify)? (Yes/No)		
COMMENTS (continue on separate sheets if needed)		

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 4 OF 10)		
SLOPE/RETAINING WALL REFERENCE NO.		
CONDITION OF ROCK SLOPE		
Items to be checked	Condition	Works Needed
Impermeable surface cover (Yes/No)	Good/Fair/Poor	
Weepholes (Yes/No)	Clear/Partly blocked/Blocked	
Vegetated surface (Yes/No)	Good/Fair/Poor	
Drainage channels (Yes/No)	Clear/Partly blocked/Blocked	
	No/Moderate/Severe Cracking	
Catchpits and sand traps (Yes/No)	Clear/Partly blocked/Blocked	
	No/Moderate/Severe Cracking	
Associated culverts & natural drainage lines (Yes/No)	Clear/Partly blocked/Blocked	
Stabilisation measures & protection (please specify) (Yes/No)	Good/Fair/Poor	
Others (Specify)		
Questions to be asked	Remarks	Works Needed
Any recent rockfall? (Yes/No)	Record any of these anomalies since the last inspection and note any recurrence of the same problem. If yes to any of these questions, give details of the observations and implications of the problems (continue on separate sheets if necessary).	
Any loose blocks on slope? (Yes/No)		
Any loose wedges on slope? (Yes/No)		
Any badly fractured zone? (Yes/No)		
Any open joints at the crest? (Yes/No)		
Any recent seepage? (Yes/No)		
Any other signs of instability (please specify)? (Yes/No)		
COMMENTS (continue on separate sheets if needed)		

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 5 OF 10)

SLOPE/RETAINING WALL REFERENCE NO.

BURIED WATER-CARRYING SERVICES (including ducting systems and conduits)

- Will services adversely affect the slope or retaining wall in event of leakage? (Yes/No)
- Has there been any change to services since last Engineer Inspection for Maintenance? (Yes/No)
- Are there signs of water leakage from services? (Yes/No)
- Do any services need immediate leakage testing? (Yes/No)
- Is re-routing of services necessary and practicable? (Yes/No)
- Do any services require regular checks? (If yes, recommend frequency) (Yes/No)

If yes in any of the above items, give details of observations and/or recommendations:

(continue on separate sheets if needed) _____

Others

_____

GENERAL COMMENTS

- Has Stability Assessment/upgrading works* been carried out? (Yes/No)
- Has the stability of the slope/retaining wall* previously been assessed to be adequate? (Yes/No)
- Are the engineering approach used, the assumptions and conclusions made in the previous Stability Assessment reports reasonable in light of the current practice and safety standards? (If no, give details) (Yes/No)
- Is there any change that has taken place, which could have reduced the stability of the slope/retaining wall since the last Stability Assessment/upgrading works*? (If yes, give details of observations?) (Yes/No)
- Has the consequence-to-life category of the slope/retaining wall changed? (If yes, from _____ to _____ and update slope record for facilities type affected) (Yes/No)
- Is the frequency of Routine Maintenance Inspections satisfactory? (If no, recommend new frequency) (Yes/No)
- Is the frequency of Engineer Inspection for Maintenance satisfactory? (If no, recommend new frequency) (Yes/No)
- Has Regular Check of Buried Water-carrying Services been carried out? (Yes/No)
- Has Regular Monitoring of Special Measures (if required) been satisfactorily carried out? (Yes/No)
- Have recommendations from past Engineer Inspections been carried out? (Yes/No)
- Are surface drains adequate in size and proper in layout? (If no, consider recommending Preventive Maintenance Works) (Yes/No)

Others

_____

* delete where appropriate.

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 6 OF 10)

SLOPE/RETAINING WALL REFERENCE NO.

RECOMMENDATIONS ON ROUTINE MAINTENANCE WORKS
(show location and nature of proposed works on a plan)

RECOMMENDATIONS ON PREVENTIVE MAINTENANCE WORKS
(show location and nature of proposed works on a plan)

OVERALL STATE OF SLOPE MAINTENANCE : Class 1 / Class 2 * ___

(Refer to Tables 4.1 & 4.2 of Geoguide 5: if a slope or retaining wall has major defects affecting the function of one or more of the following items, its overall state of slope maintenance is Class 2)

- Any major defects in surface protection? (Yes/No)
- Any major defects in surface drainage system? (Yes/No)
- Any major defects in subsurface drainage system? (Yes/No)
- Any major leakage of water-carrying services? (Yes/No)
- Any major defects in special measures? (Yes/No)

Others

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* delete where appropriate.

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 7 OF 10)

SLOPE/RETAINING WALL REFERENCE NO.

OTHER RECOMMENDATIONS

(e.g. where there is concern on the health of the trees and presence of decaying or dying trees, advice from specialist such as horticulturist may be recommended.)

Frequency of Inspections (update Maintenance Manual if necessary)

- Frequency of Routine Maintenance Inspections:
- Frequency of Engineer Inspections for Maintenance:
- Frequency of Regular Checks of Buried Water-Carrying Services:

Name of Inspecting Engineer: _____ (Name of person undertaking inspection)

of _____ (Organisation)

Qualification of Inspecting Engineer: (e.g. Registered Professional Engineer (Geotechnical))

Signature: _____ Date: _____

Received by: _____ (Name of owner or his authorised representative)

of _____ (Organisation)

Signature: _____ Date: _____

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 8 OF 10)

SLOPE/RETAINING WALL REFERENCE NO.

RECORDS OF INFORMATION SEARCH
(A list of the documents identified and reviewed, with comments on the contents, date, and places each is obtained. Some relevant sources of information are given in Appendix H of Geoguide 5 and Chapter 8.)

Note: (1) Add additional record sheets as necessary.

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 9 OF 10)

SLOPE/RETAINING WALL REFERENCE NO.

SITE PLAN (Reference numbers should be assigned to locations of man-made items for which maintenance works are required. The corresponding reference numbers should be quoted in the photographic records.)

Note: (1) Add additional record sheets as necessary.

RECORD OF ENGINEER INSPECTION FOR MAINTENANCE (SHEET 10 OF 10)

SLOPE/RETAINING WALL REFERENCE NO.

PHOTOGRAPHIC RECORDS **(**with descriptions, date and reference numbers as given on the site plan)

Notes: (1) Add additional record sheets as necessary.
(2) Record photographs should be taken from the same vantage points as the last inspection.

APPENDIX G

INDICATIVE FORMAT FOR MAINTENANCE MANUAL FOR NATURAL TERRAIN HAZARD MITIGATION MEASURES

MAINTENANCE MANUAL FOR NATURAL TERRAIN HAZARD MITIGATION MEASURES **(SHEET 1 OF 4)**

MITIGATION MEASURES REFERENCE NO.[1]

Location of Mitigation Measures

Map Co-ordinates (1980 DATUM)				Date of Construction
Easting		Northing		

Purpose of the Mitigation Measures (e.g. hazards being mitigated against, hazard locations and design volumes, and facilities to be protected) _____

TECHNICAL INFORMATION (continue on separate sheets if necessary)

Stabilisation Measures[2]

☐ Boulder Buttresses: Total No. of Buttresses: _____

☐ Soil Nails: Total No. of Soil Nails Installed: _____

Maximum Length of Soil Nails (m): _____

☐ Raking Drains: Total No. of Raking Drains: _____

Maximum Length of Raking Drains (m): _____

Others: _____

Defence Measures[2]

Types of Measures: Check Dam / Earth Bund / Boulder Fence / Others

Typical Dimensions: (e.g. length, maximum height) _____

Others: _____

MAINTENANCE REQUIREMENTS

Frequency of Routine Maintenance Inspections: _____

Man-made Items for Maintenance: _____

Guidelines on seeking geotechnical engineer's advice: _____

_____

INFORMATION PROVIDER

Records prepared by: _____ Firm: _____

Signature: _____ Date: _____

Notes:
(1) Upon request, the Geotechnical Engineering Office can provide a reference number if applicable.
(2) Use a separate Sheet 1 for each type of defence measure. Different types of stabilisation measures (e.g. buttresses and soil nails) in the same location can be considered as a group for record purpose.

MAINTENANCE MANUAL FOR NATURAL TERRAIN HAZARD MITIGATION MEASURES	**(SHEET 2 OF 4)**
MITIGATION MEASURES REFERENCE NO.	
LOCATION PLAN AND SITE PLAN (with scale and indication on access)	

MAINTENANCE MANUAL FOR NATURAL TERRAIN HAZARD MITIGATION MEASURES	**(SHEET 3 OF 4)**
MITIGATION MEASURES REFERENCE NO.	
PLAN/SECTIONS OF THE MITIGATION MEASURES TO BE MAINTAINED	
Note: All dimensions are in millimetres and all levels are in metres above Principal Datum.	

MAINTENANCE MANUAL FOR NATURAL TERRAIN HAZARD MITIGATION MEASURES	**(SHEET 4 OF 4)**
MITIGATION MEASURES REFERENCE NO.	
RECORD PHOTOGRAPHS (with descriptions and date; and with the vantage points indicated on the plans)	
Note: Add additional record sheets for photographs as necessary.	

APPENDIX H

SAMPLE CHECK LIST FOR INFORMATION SEARCH WHEN CONDUCTING ENGINEER INSPECTIONS FOR MAINTENANCE

SAMPLE CHECKLIST FOR INFORMATION SEARCH

General

- Relevant information held by the Employer and the maintenance personnel

Technical Background

- Geotechnical Engineering Office of Civil Engineering Department
  - Slope Information System (e.g. slope records, landslide incidents)
  - Landslip Preventive Measures Information System
  - Reports of detailed study of slopes/retaining walls (e.g. Stage 1, 2 & 3 study)
  - Landslide incident reports
  - Public project files
  - Slope files

Relevant Checking Files

- Buildings Department
  - Private development files
  - Dangerous Hillside Order files

Area and Site-specific Studies

- Geotechnical Engineering Office of Civil Engineering Department
  - Phase IIC and IID Landslide Study Reports
  - North Point Study Reports
  - Internal reports relevant to the slopes/retaining walls (e.g. landslide study reports and the Mid-levels Study Report.)

Buried and Exposed Services

- Water Supplies Department
- Drainage Services Department
- Highways Department
- Housing Department (services within public estates)
- Architectural Services Department (services in the vicinity of government buildings)
- Buildings Department (services within private developments)
- Relevant utility and transport corporations

GLOSSARY OF TERMS

GLOSSARY OF TERMS

Catalogue of Slopes. The Catalogue of Slopes contains information on all sizeable man-made slopes and retaining walls in Hong Kong. The Catalogue is maintained by the Geotechnical Engineering Office.

Consequence-to-life Category. A system that is used by the Geotechnical Engineering Office to classify a slope or retaining wall into one of several categories according to the severity of consequence in terms of loss of life should the slope or retaining wall fail.

Disturbed Terrain Feature. Disturbed terrain features contain repairs to landslide scars or comprise a series of composite cut and fill slopes where the ground surface has been disturbed, the natural slope gradient is greater than 15° and although the individual slopes do not meet the height criteria for registration, the total height does meet the criteria for registration in the Catalogue of Slopes. They generally cover situations where extensive modifications have been made to the ground surface, such as repairs to landslide scars, cemeteries, cleared squatter land and agricultural terraces (existing or now abandoned).

Engineer Inspection for Maintenance. Maintenance inspection by a professionally-qualified geotechnical engineer to assess the state of maintenance and condition of a slope or retaining wall and to ascertain the need for detailed investigation, Stability Assessment and improvement works.

Improvement Works. A collective term to mean preventive maintenance works and upgrading works.

Maintenance Manual. A document containing details of maintenance requirements of a slope or retaining wall.

Maintenance Works. Works carried out to maintain slopes or retaining walls in good condition, and to avoid deterioration.

Monitoring Schedule. A document providing detailed requirements of Regular Monitoring of Special Measures, including frequency of monitoring, requirement of personnel, ‘alert levels’ for monitoring results, contingency plans, etc.

Prescriptive Measures. Pre-determined, experience-based and suitably conservative modules of works prescribed to a slope or retaining wall to improve its stability or reduce the risk of failure, without detailed ground investigation and design analysis. These generally involve conventional and conservative details in design, and attention to specifications and control of materials, workmanship, protection and maintenance procedures.

Preventive Maintenance Works. Works of preventive nature to reduce the rate of deterioration of a slope or retaining wall, comprising the provision of simple, standardised and suitably conservative modules of works.

Regular Monitoring of Special Measures. Monitoring of special measures (e.g. prestressed ground anchors, designed raking drains) which are critical to the continued stability of the slope or retaining wall.

Routine Maintenance Inspection. Maintenance inspection of slopes or retaining walls that is carried out by any responsible person, including property management staff or maintenance staff, to establish the need of basic maintenance works for man-made items.

Routine Maintenance Works. Basic maintenance works, such as clearance of accumulated debris from drainage channels, repair of cracked slope surface cover, etc, carried out routinely to slopes and retaining walls.

Stability Assessment. An investigation or a study that is carried out for the purpose of assessing the stability of a slope or retaining wall to determine whether it meets the current geotechnical standard.

Upgrading Works. Works carried out to upgrade sub-standard slopes or retaining walls to the requirements stipulated in the Geotechnical Manual for Slopes (GCO, 1984) or current geotechnical standards promulgated by the Geotechnical Engineering Office of the Civil Engineering Department.