

Attachment 13

(4 pages)

Summary of potential geotechnical issues, risks and consequences to development, and suggested risk treatment practices (1 page)

Terminology used in geotechnical risk assessment (1 page), and

Examples of good and poor hillside engineering practices (2 pages)

Table 13.1 Summary of geotechnical issues, risks and consequences to development, and suggested risk treatment practices

	Geotechnical issue	Likelihood of occurrence	Consequences to property	Level of risk to property	Risk treatment
1	Surface soil erosion	Possible	Minor	Moderate	Control stormwater and upslope runoff. Revegetate cleared areas but avoid planting trees which will grow large. Refer to the examples of good and poor engineering hillside practice in Attachment 14
2	Tunnel erosion	Unlikely	Minor	Low	As for issue 1
3	Soil creep	Unlikely	Minor	Very low	As for issue 1
4	Shallow-seated landslide (involving, for example, soil, boulder beds, talus, colluvium, etc)	Possible	Medium	Moderate	As for issue 1. Minimise cut and fill, but support all excavations more than about 0.8m high with engineered and drained retaining walls. Avoid loading slopes with fill. Investigate foundations for the proposed retaining walls on western/northern boundaries
5	Upslope deep-seated landslide (eg in boulder beds, talus, colluvium, bedrock etc)	Unlikely	Major	Moderate	Investigate steeper western slopes with diamond drilling. Refine slope stability analysis and risk. If necessary, recommend risk treatment.
6	Foundation movement due to reactive soils	Almost certain	Major	Very high	Conduct appropriate site investigations at each future house site. Classify all sites in accordance with AS2870. Investigate foundations for the proposed retaining walls on western/northern boundaries
7	Low strength materials (eg uncontrolled fill, soft soils)	Almost certain	Major	Very high	As for issue 6. Place future fill in a controlled manner, under engineering supervision.
8	Vegetation removal	Almost certain	Minor	High	As for issue 6. Also, revegetate cleared areas but avoid planting trees which will grow large.
9	Flooding or waterlogging	Possible	Minor	Moderate	As for issue 1. Act on recommendations of flood assessment (if any).
10	Riverbank collapse	Unlikely	Minor	Low	Act on recommendations of flood assessment (if any).
11	On-site wastewater disposal	Not applicable			Area is to be sewered.
12	Site contamination from previous activities	Unlikely	Minor	Low	Visual inspection during site development, and cover or clean up as required. Existing Type 3 fill is inert.
13	Earthquake risk	Almost certain (magnitude <5); Likely (magnitude >5)	Insignificant to Minor	Low to Moderate	Generally accept risk. A similar range of risks exists throughout Tasmania.
14	Sea level rise	Not applicable			
15	Storm surge	Not applicable			
16	Shoreline recession	Not applicable			

Notes

1. The assessments are unavoidably subjective to varying degrees.
2. See next page for an explanation of the terms used in this table.
3. Further reading: Australian Geomechanics Society Subcommittee (2007). Landslide Risk Management Aust. Geomechanics 42(1) March 2007, pp 1 – 219.

Terminology used in geotechnical risk assessment (1 page)

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007
 APPENDIX C: - QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY (CONTINUED)

QUALITATIVE RISK ANALYSIS MATRIX - LEVEL OF RISK TO PROPERTY

LIKELIHOOD	Indicative Value of Approximate Annual Probability	CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
		1: CATASTROPHIC 200%	2: MAJOR 60%	3: MEDIUM 20%	4: MINOR 5%	5: INSIGNIFICANT 0.5%
A - ALMOST CERTAIN	10 ⁻¹	VH	VH	VH	H	M or L (5)
B - LIKELY	10 ⁻²	VH	VH	H	M	L
C - POSSIBLE	10 ⁻³	VH	H	M	M	VL
D - UNLIKELY	10 ⁻⁴	H	M	L	L	VL
E - RARE	10 ⁻⁵	M	L	L	VL	VL
F - BARELY CREDIBLE	10 ⁻⁶	L	VL	VL	VL	VL

Notes: (5) For Cell A5, may be subdivided such that a consequence of less than 0.1% is Low Risk.
 (6) When considering a risk assessment it must be clearly stated whether it is for existing conditions or with risk control measures which may not be implemented at the current time.

RISK LEVEL IMPLICATIONS

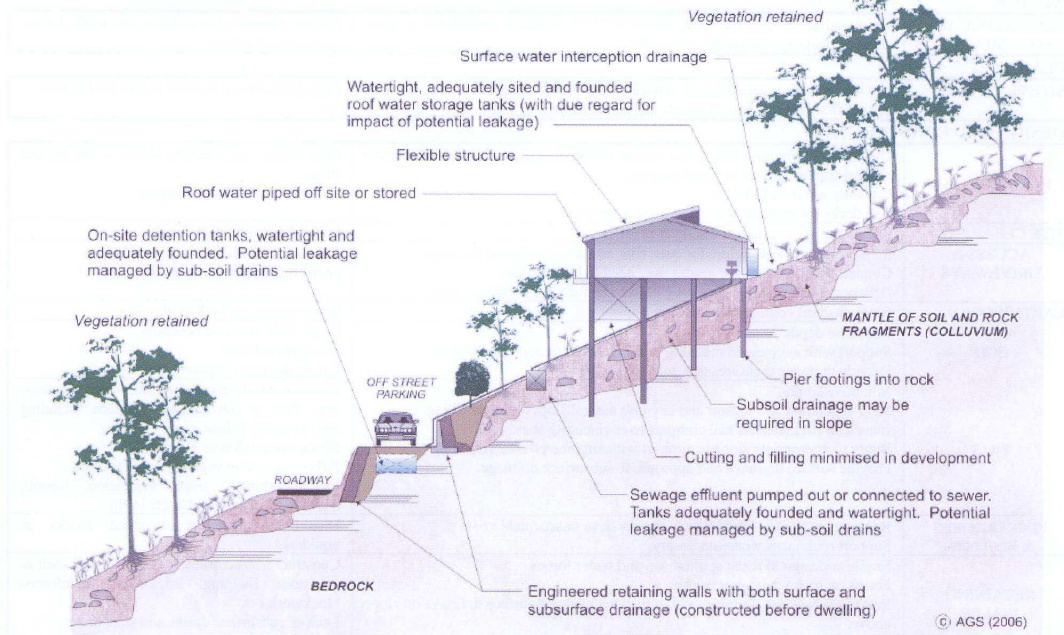
Risk Level	Example Implications (7)
VH VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
H HIGH RISK	Unacceptable without treatment. Detailed investigation, planning and implementation of treatment options required to reduce risk to Low. Work would cost a substantial sum in relation to the value of the property.
M MODERATE RISK	May be tolerated in certain circumstances (subject to regulator's approval) but requires investigation, planning and implementation of treatment options to reduce the risk to Low. Treatment options to reduce to Low risk should be implemented as soon as practicable.
L LOW RISK	Usually acceptable to regulators. Where treatment has been required to reduce the risk to this level, ongoing maintenance is required.
VL VERY LOW RISK	Acceptable. Manage by normal slope maintenance procedures.

Note: (7) The implications for a particular situation are to be determined by all parties to the risk assessment and may depend on the nature of the property at risk; these are only given as a general guide.

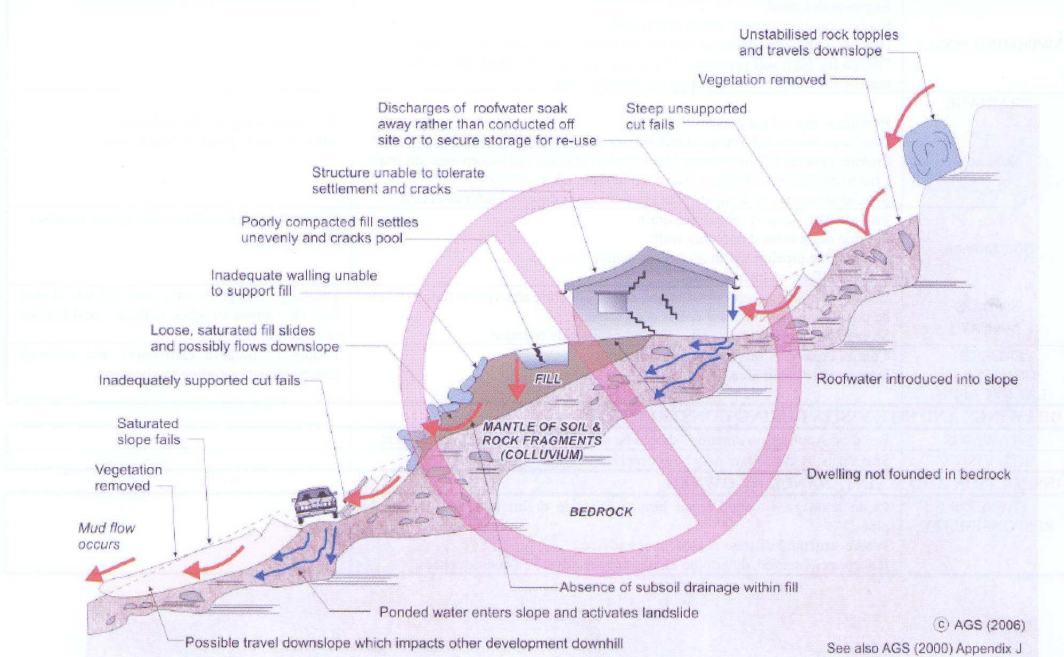
Examples of good and poor hillside engineering practices

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE



APPENDIX G - SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

ADVICE	GOOD ENGINEERING PRACTICE	POOR ENGINEERING PRACTICE
GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
PLANNING		
SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
DESIGN AND CONSTRUCTION		
HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.
DRAWINGS AND SITE VISITS DURING CONSTRUCTION		
DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	
INSPECTION AND MAINTENANCE BY OWNER		
OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	

Attachment 14
(13 pages including this page)
Three 4-page CSIRO pamphlets

CSIRO Information sheet BTF 18. *Foundation Maintenance and Footing Performance: A Homeowner's Guide* (replaces Information Sheet 10/91; dated 2003)

CSIRO Building Technology File No. 19. *A builder's guide to preventing damage to dwellings. Part 1 – Site investigation and preparation* (February 2003)

CSIRO Building Technology File No. 22. *A builder's guide to preventing damage to dwellings. Part 2 – Sound construction methods* (August 2003)