AS2870-2011 and the Australian Geomechanics Society's Landslide Risk Management Guidelines

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1. ABSTRACT

Since its advent in 1986, AS2870 has always referred any landslip issues to the Australian Geomechanics Society's (AGS) guidelines, however many practitioners have little experience in Landslide Risk Management (LRM). This paper presents some guidelines for the AS2870 practitioners on when a LRM assessment is required, as well as presenting an alternative method to the current AGS guidelines to assess landslide susceptibility.

Keywords: Landslide, Risk, AGS, LRM, AS2870

2. INTRODUCTION

AS 2870, in its various forms from 1986 to 2011 has always required a site with a landslide risk potential to be classified as Class P, but has never provided any specific advice on recognizing this landslide risk potential, other than in its referenced document – the Australian Geomechanics Society's guidelines for Landslide Risk Management (LRM), initially known as AGS 1985, then AGS 2000, now AGS 2007.

Many AS 2870 site classifiers do not have either the knowledge or experience to carry out a Landslide Risk Assessment and in a significant number of cases, would not be able to visually identify a landslide risk indicator onsite. Some use a disclaimer similar to "This site classification report has not considered the landslip risk potential of this site". Unfortunately, stakeholders can misinterpret this being that the site has no landslip potential.

This paper is intended to give all AS2870 practitioners enough information to at least suspect when a site has a landslide potential that must be brought to the attention of all stakeholders so that a suitably experienced geotechnical engineer can be engaged to make a landslide risk assessment of the site.

The AGS 2007 LRM guideline is a broad-brush document, theoretically covering large infrastructures such as dams, railways and highways down to 400m^2 housing allotments. This paper provides an alternative, specific methodology for those classifying housing allotments.

Many local government agencies are not only aware of the landslide risk potential in their area; they have commissioned their own landslide hazard assessments. Most of the maps are in the public domain or are available upon request. The list below is of known local government areas with these maps (but is not exhaustive):

- Victoria - Yarra Ranges, Colac-Otways, Surf Coast, Mornington Peninsula
- Tasmania – Mineral Resources Tasmania (MRT) has a landslide map series at 1:25,000 covering the following areas – Hobart, Launceston, Ulverstone, Wynyard, Glenorchy, Devonport, Burnie.
- NSW – Wollongong City Council and nearby surrounds, Pittwater, Ryde, Baulkham Hills, Gosford, Lismore, Ballina, Shoalhaven.
- QLD – Beechmont, Brisbane, Canungra, Numinbah, Capalaba, Darra, Enoggera, Mapleton, Maleny, Mt Gravatt, Mt Mee, Petrie, Rosewood, Marburg, Sandgate, Springbrook, Tamborine Mountain, Toowoomba, Wynnum, Gatton, Lockyer Valley, Currumbin, Cairns, Redcliffe, Scenic Rim, Whitsundays, Townsville.

3. LANDSLIDES AND THEIR IDENTIFICATION

The USA Geological Survey Fact Sheet 2004-3072 (July 2004), also reproduced in AGS 2007, shows graphically the ten most common types of landslip events. The AS2870 practitioner does not need to fully understand the geotechnical mechanisms generating these different landslide events, but should be able to recognise them. Both the AS2870 practitioner and the geotechnical engineer must be aware that two or more landside events can have the potential to adversely affect the same site. e.g. an allotment affected by creep may also be down slope from a rock escarpment, where a rock fall may be a possibility.

Most Australians are aware of the 1997 Thredbo landslide, which was almost an instantaneous catastrophic event, but what is not widely recognised is the fact that the majority of landslide events are slow, and might only involve 10 mm of ground movement per rainfall event, with the events at 5 year or more intervals. 10 mm of ground movement over 5 years can cause unsightly and expensive damage, but 40 mm over 20 years could cause the need for demolition of a structure (with the design life of a structure in Australia being 50 years).

The simplistic definition of a landside is

"The down slope movement of soil and/or rock under the forces of gravity which may alter stability of an existing slope and/or cause damage (or the potential to cause damage) to structures and/or infrastructure within the zone of influence of the landslide event. A landslide event does not include fretting and erosion generated on a slope during rains, unless it causes or has the potential to cause damage or alter the stability of the slope as defined above."

4. IDENTIFYING THE POTENTIAL FOR LANDSLIDE

Table 1 is a "tick and flick" list that should be used on all building allotments, regardless of the slope (even flat sites can be included).

Table 1

	Question	Score rate	Score
1	Is the site within an area covered by a landslide map?	Yes = 5 No = 1 Don't Know = 10	
2	If in a known mapped area, what is the zone applicable to this site?	Very Low/Low = 1 Moderate = 5 High/Very High = 10	
3	Are any of the features shown on the USGS fact sheet of this paper within 200m of the proposed building footprint?	Yes = 5 No = 1 Don't Know = 10	
4	If features shown on the USGS fact sheet exist, would you describe the features' effect on the landscape as;	Minor = 5 Significant = 7 Major = 10	
		TOTAL	

It is the opinion of the authors that if the total score from Table 1 is 10 or more, then according to AS2870-2011 Section 1.3, this site must be classified as Class P (landslide risk) and if the AS2870 practitioner is not a suitably experienced geotechnical engineer, the recommendations of the site classification report should be similar to:

"This site may have the potential to be adversely impacted on by a landslide event at some time during its life expectancy, therefore a detailed slope stability investigation must be commissioned and carried out by a geotechnical engineer experienced in Landslide Risk Management."

This type of recommendation is also consistent with Clause 1.11.1 of AS2870-2011.

5. QUALIFICATIONS OF LANDSIDE RISK ASSESSORS

Through the various governmental agencies (local, state and federal) there is little consensus on this issue and the requirements can change across local, state and federal boundaries.

It is the authors' opinion that there should be some consistency and that only three broad categories of practitioners are suitable, with all of these having at least five years post-university experience and mentoring in the geotechnical field with specific experience in slope stability assessment and with a sound knowledge of domestic and low-rise construction.

Consultants who may have significant experience in landslides, but little or no domestic or low-rise construction experience, may be unsuitable when it comes to recommending economical modifications to the construction programme to negate or minimise the potential effects of a landslide event on a residential allotment.

Graduates in Geotechnical Engineering – The only undergraduate degree known in the discipline is offered at the University of Tasmania. RMIT used to offer Geological Engineering, but it is no longer offered. All the other courses specifically in Geotechnical Engineering in Australia are post-grad, therefore most geotechnical graduates are overseas trained and would need to be NPER-3 approved, as well as being mentored in slope stability for a minimum of five years and have knowledge of domestic construction.

Graduates in Civil/Structural Engineering – These would form the majority of practitioners, but to be considered suitable (besides being NPER-3 approved) would need to have been mentored in a geotechnical engineering practice specialising in slope stability assessment under supervision of a recognised practitioner for a minimum of five years and have a knowledge of domestic construction. They should have also completed at least one of the following short courses:

- A course similar to the UNSW's "Short Course in Landslip Risk Management"
- A "Geology for Engineers" course as periodically advertised in the AGS Journal
- RTA Slope Risk Assessment Course

Geology Graduates – They would need to be approved as RP Geo by the Australian Institutes of Geoscientists and would need to have been mentored for a minimum of five years in a geotechnical engineering practice specialising in slope stability assessment under supervision of a recognised practitioner and completed at least one of the above short courses.

There may be other suitably experienced practitioners, but their qualifications and experience would need to be considered on a case-by-case basis.

At the time of writing, it is generally accepted that Professional Indemnity Insurance cover of $2M is the minimum requirement for practitioners working on domestic landslide reports.

6. A LANDSLIDE HAZARD ASSESSMENT SYSTEM FOR DOMESTIC ALLOTMENTS

This method had its origins in the 1999 SMEC report to the Gold Coast City Council (Qld) entitled "Gold Coast City Council Slope Stability Study – Contract 7001991029." Sadegh-Vaziri and Taylor further refined the principles of this SMEC 1999 report in their 2002 paper entitled "Implementation of Landslide Risk Management on the City of the Gold Coast." Sadegh-Vaziri and Taylor's work was further updated by Patrick Kidd in his 2011 paper entitled "Updating the Landslide Hazard Assessment System within the City of the Gold Coast."

The Sadegh-Vaziri and Taylor and Kidd's papers produced what many peer professionals believe to be suitable methodology to investigate areas down to 25m^2, rather than the large scale areas of the AGS 2007 guidelines, and at the time of writing as resulted in thousands of allotments being assessed on the Gold Coast over the past ten years.

This paper is intended to extend the validity of this work Australia-wide and provide the following:

- Consistency between practitioners (as opposed to the subjective outcomes of the AGS 2007 methodology).
- Site-specific assessment for smaller allotments
- Consistent construction guidelines
- Final plain-language classification, which can be understood by all stakeholders.

7. ANALYSING THE LANDSLIDE RISK POTENTIAL OF A SMALL ALLOTMENT (<1 HECTARE)

All practitioners using this methodology must have a full understanding of the referenced papers by Sadegh-Vaziri and Taylor (2001) and Kidd (2011).

One of the critical factors of adopting one method developed in a specific area to another area with respect to slope stability is rainfall. All practitioners should be aware of the rainfall history of the area in which they work. Records are free from the Bureau of Meteorology (BOM) webpage.

Providing that the rainfall records do not show periodic rainfall exceeding that of the Gold Coast, it is the authors' opinion that this method can be used with confidence anywhere.

The rainfall on which this methodology is based can be summarised as follows:

24-hour periods: 350 mm to 500 mm

72-hour periods: 650 mm to 1000 mm

Table 3 is a multi-purpose table, which can be used in the following way:

Case 1 For natural undeveloped sites, cells (1) to (7) are applicable

Case 2 Where there have been man-made alterations (cut and fill), but it is still undeveloped, cells (1) to (14) are applicable.

Case 3 Where there is an existing dwelling, all 22 cells can be used to determine susceptibility

Case 4 Where there is a proposed dwelling, by using all 22 cells, the anticipated susceptibility can be calculated.

In all four cases above, where susceptibility is considered too high (or unacceptable) then by recommending further works such as batter retention, improved site drainage etc, the susceptibility level can be lowered.

8. CONCLUSIONS

Table 3 gives the practitioner the "Landslide Susceptibility" of the site. The relationship between the output of Table 3 and the Landslide Susceptibility is as per Table 2

Table 2

Output	Susceptibility
<0.2	Very Low
0.2 - 0.6	Low
>0.6 – 2.0	Moderate
>2.0 – 6.0	High
>6.0	Very High

Referring back to AS2870, it is the authors opinion that the output of 0.6 or less does not require a P classification, unless of course factors other than Slope Stability outlined in section 1.3 of AS2870 have the potential to adversely affect the site.

When the output of the table exceeds 0.6, then by changing the earthworks and/or construction proposal in the cells 8 to 22, a different outcome may be achieved. The input for cells 1 – 7 are fixed for the specific site and cannot be varied once determined for a particular building envelope.

Table 3

A. Natural Site Conditions

(1) Natural Surface Slope

	Level	Factor
<5º	L	0.1
5º to 15º	M	0.5
15º to 30º	M	0.8
30º to 45º	H	0.8
>45º	M	0.8

(2) Slope Shape/Appearance

Crest or ridge	L	0.7
Planar/convex	M	0.9
Rough/irregular	H	1.2
Concave	H	1.5

(3) Site Geology

Problematical geological boundary	VH	1.5
Volcanic extrusive (basalts etc)	H	1.2
Volcanic intrusive (granites etc)	M	1.0
Sedimentary rocks	M	1.0
Low grade metamorphic rocks	M	1.0
High grade metamorphic rocks	L	0.9
Hill wash (recent colluvial)	VH	2.0

(4) Soil Profile

Bedrock at surface	VL	0.1
Residual Soil –bedrock <1m	L	0.5
Residual Soil - bedrock 1 to 3m	M	0.9
Residual Soil - bedrock >3m	H	1.5
Transported Soil - <1m deep	H	1.5
Transported Soil – 1 to 3m deep	VH	2.0
Transported Soil – 3 to 6m deep	VH	4.0
Transported Soil >6m deep	VH	2.0

(5) Regional Position on Hillside (refer AS4055-2066)

Ridgeline	L	0.7
Crest	M	0.8
Upper 1/3 of slope	M	0.9
Mid 1/3 of slope	H	1.2
Lower 1/3 of slope	H	1.5

(6) Evidence of Groundwater

No evidence	L	0.7
Minor moistness	M	0.9
Generally wet	H	1.5
Evidence of springs	VH	3.0
Do not know	VH	4

(7) Evidence of Slope Instability

No sign of instability	L	0.8
Indicators of soil creep	H	1.2
Minor irregularity	VH	2.0
Major irregularity	VH	5.0
Active instability	VH	10.0
Don't know	VH	15.0

B. Earthworks (proposed/existing)

(8) Cut Depth

	Level	Factor
No cut existing nor proposed	L	0.9
< 1m	M	1.1
1 to 3m	M	1.5
3 to 6m	H	1.7
>6m	VH	2.5

(9) Cut Batter Angle

<30º	L	0.5
30º to 45º	M	1.0
45º to 60º	H	1.5
>60º	VH	3.0

(10) Cut Batter Support

Engineered concrete/masonry wall	L	0.5
Engineered crib wall	M	0.9
Engineered gabion wall	M	1.0
Engineered dry rock stack wall	H	1.2
Engineered post and wale wall	H	1.5
Other (including non engineered)	VH	2.0

(11) Fill Depth

No fill – existing nor proposed	L	0.9
<1m	M	1.1
1 to 3m	M	1.5
3 to 6m	H	1.7
>6m	VH	2.5

(12) Fill Batter Angle

<30º	L	0.5
30º to 45º	H	1.2
45º to 60º	VH	2.0
>60º	VH	4.0

(13) Fill Batter Support

Engineered concrete/masonry wall	L	0.8
Engineered crib wall	M	1.0
Engineered gabion wall	H	1.2
Engineered dry rock stack wall	VH	1.5
Engineered post and wale wall	VH	1.8
Other (including non engineered)	VH	4.0

(14) Type of Fill

AS3798 (Level 1 certified)	L	0.7
Compacted but not certified	M	1.0
Track-rolled fill (clay)	H	1.2
Track-rolled fill (sand)	VH	1.5
Obvious compressible fill	VH	3.0

C. Construction (proposed/existing)

(15) Waste water, sewerage etc	Level	Factor
Fully sewered	M	0.8
Onsite surface disposal within 10m of structure	H	1.5
Onsite surface disposal >10m of structure	M	0.9
Onsite subsurface disposal within 10m of structure	VH	2.0
Onsite subsurface disposal >10m of structure	H	1.0
Not known	VH	4.0

(16) Stormwater Disposal

To the kerb or council system	M	0.7
Rainwater tank with engineer-approved overflow	M	0.7
Rainwater tank without engineer approved overflow	H	1.2
Dispersed >10m downslope (approved)	M	1.0
Directly onto ground	M	1.5
Onsite rubble pit	VH	3.0
Not known	VH	4.0

(17) Expandable/mechanical stormwater and drainage pipe connectors

Specifically engineer designed and inspected	L	0.8
As per AS2870-2011 for extremely reactive sites	M	1.0
Not used	VH	2.0
Not known	VH	4.0

(18) Footing System

Timber/flexible floor (suspended, able to be re-levelled)	L	0.7
Engineer designed suspended slab	M	1.0
As per AS2870-2011	H	1.2
Less than AS2870-2011 generally applies to old houses)	VH	2.0
Not known	VH	4.0

(19) The Foundation Strata

Bedrock	L	0.7
Residual soil	M	1.0
Transported soil	H	1.2
Fill	VH	3.0
Not known	VH	4.0

(20) In-ground Tanks (any type)

>10m from footing	L	0.5
6 to 10m from footing	M	0.7
3 to 6m from footing	H	1.5
<3m from footing	VH	2.5
Not known	VH	4.0

(21) Landscaping	Level	Factor
AS2870-2011 compliant (+upslope diversion bund/swale)	L	0.7
AS2870-2011 compliant	M	0.9
Non-AS2870-2011 compliant	H	1.5
Obvious evidence of water ponding/poor drainage	VH	2.5
Not known	VH	4.0

(b) For Upslope boulder/flow event only

Engineer designed catching net	L	0.7
Engineer designed upslope bund	M	0.9
Engineer designed upslope fence	M	1.0
Non engineer approved method	H	1.5
No action taken	VH	4.0

Summary	Factor
(1) Natural surface slope	
(2) Slope shape/appearance	
(3) Site geology	
(4) Soil profile	
(5) Regional position on hillside	
(6) Evidence of groundwater	
(7) Evidence of slope instability	
(8) Cut depth	
(9) Cut batter angle	
(10) Cut batter support	
(11) Fill depth	
(12) Fill batter angle	
(13) Fill batter support	
(14) Type of fill	
(15) Waster water system (sewerage etc)	
(16) Storm water disposal	
(17) Expandable/mechanical pipes	
(18) Footing system	
(19) The foundation strata	
(20) In-ground tanks	
(21) Landscaping	
(22) Upslope boulder/flow events	
OUTPUT = (1X2X3X4 ETC)	

References

Australian Geomechanics Society, sub-committee on Landslide Risk Management, “Landslide Risk Management Concepts and Guidelines” AGS Journal Vol. 35, No 1, March 2000

Kidd, Patrick. “Updating the Landslide Hazard Assessment System within the City of the Gold Coast”, AGS Journal Vol 42, No 2 June 2011

McGregor and Taylor. “A method of Slope Stability Zoning”, AGS Journal Vol 36, No 3, September 2001

Sadegh-Vaziri, Mehran and Taylor, Brett. “Implementation of Landslide Risk Management on the City of Gold Coast” [online]. Australian Geomechanics: Journal and News of the Australian Geomechanics Society, Vol. 37, No. 2, May 2002: 227-234.

SMEC Australia Pty. Ltd. “Landslip Study for the City of Gold Coast”, August, 1999

Standards Australia. “Residential Footings & Slabs”, AS2870-2011