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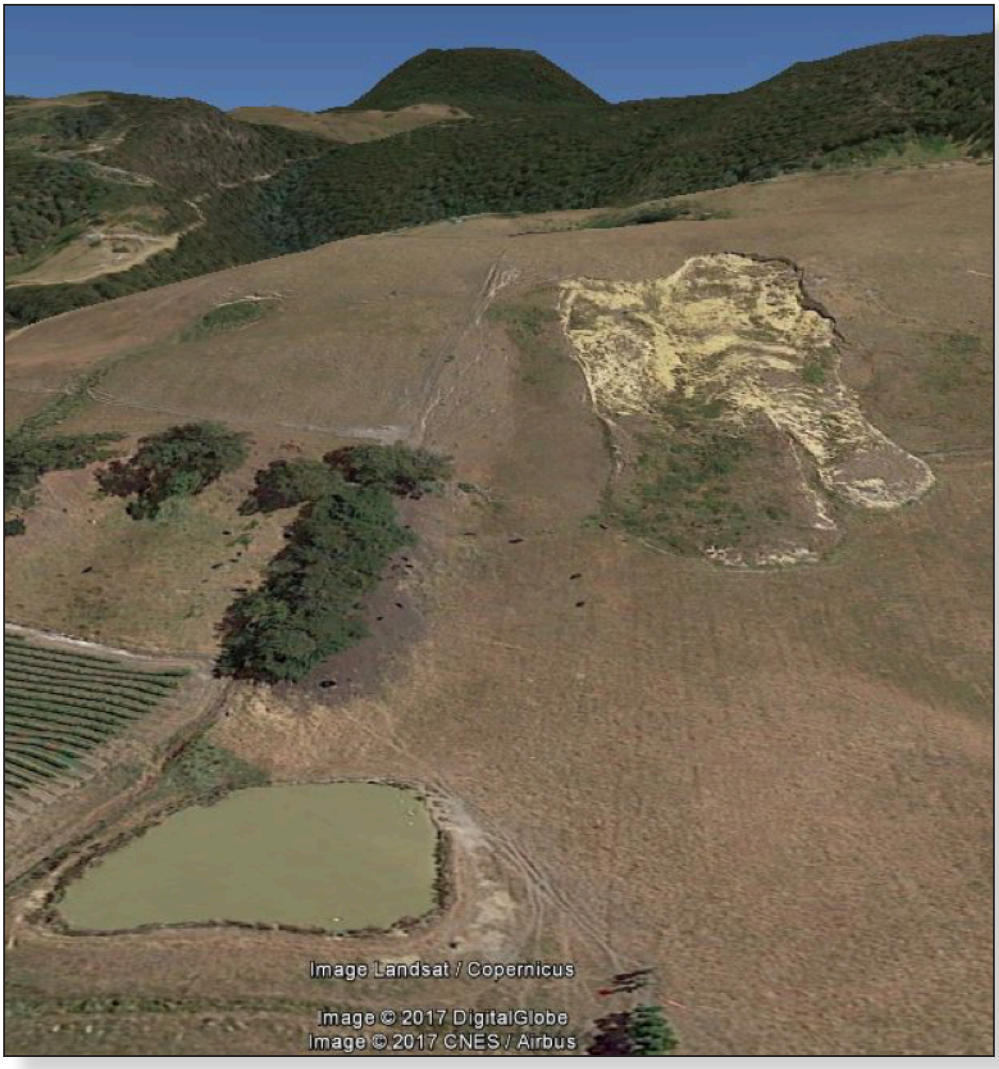
BUILDING ON TASMANIAN LANDSCAPES: Guidance for geotechnical reporting in Tasmania

by W. C. Cromer and C. Mazengarb



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Cover photo:
September 2016 satellite image of the Home Hill landslide near Ranelagh in southern Tasmania. View is oblique with 1.5 times vertical exaggeration. Source: Google Earth.

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Introduction

Current situation

Mineral Resources Tasmania's (MRT) mission is *to contribute to the economic development of Tasmania by providing the necessary information and services to foster responsible land management, and mineral resource and infrastructure development, for the benefit of the Tasmanian community.* MRT does not regulate geotechnical related developments but provides information for the public good to assist the identification and management of geohazards in the landscape. On occasion, MRT reviews geotechnical reports as a courtesy to other agencies and monitors some developments. The senior author of this document (a private geotechnical practitioner) also reviews geotechnical reports at the request of practitioners and regulators. From this combined experience we consider that there are significant issues with regards to the adequacy of many geotechnical investigations that need to be addressed.

"Geotechnical" relates to the interaction of geology and human activity. Geotechnical investigations explore the potential risks to development posed by soil, rock and water, and the resulting reports reports are tools which communicate the site conditions to people involved in development.

Geotechnical reports are typically required by regulators for planning and building purposes and may cover a range of issues, such as soil-tests for footing[1] design, landslide risk assessment, waste-water design and many others. If the requirement is not clearly defined in the planning scheme or building regulations, regulators may request unnecessary investigations. Conversely, while standards and best practice guidelines exist for various geotechnical activities, the quality of investigation and reporting can unfortunately fall short of these standards and guidelines.

The timing of geotechnical investigations and advice in the development process is also important and the geotechnical setting should ideally inform the planning and development process from the beginning. However, reality does not always conform to best-practice. For instance, some subdivisions are being designed by surveyors without geotechnical input, often to maximise the number of properties and expected financial return, with the result that there are unrealistic expectations and unforeseen costs and risks if the design is later found to be inappropriate for the constraints of the landscape.

Geotechnical practitioners require a broad range of skills and experience. The formal qualifications necessary for geotechnical practice are defined under existing legislation, but the required levels of competency as judged by industry guidelines and standards are not. This allows some professionals into the market who may not have an acceptable level of competency and who should ideally be closely supervised by more experienced practitioners. In addition, while there is an implicit and justifiable requirement for suitably qualified practitioners to undertake site investigations, this is not always the case.

The consequences of regulators granting approval for developments based on sub-standard investigations are potentially very serious, particularly where risks to life are possible. For those regulators receiving geotechnical reports, it is often difficult for non-technical staff to assess whether or not the report is comprehensive and reliable. Regulators may choose to seek external advice if expertise is not present within the organisation, and this is the recommended course of action. However, this approach is not always followed and some developments have been approved on the basis of sub-standard reports. The quality of any external advice sought (peer review) may also vary if the contract brief with the reviewer does not follow an adopted format and does not address the key questions.

Even where quality geotechnical advice is obtained early in the development process, there is a need to ensure that recommendations are actually incorporated into the final development design and ongoing site management processes. Aspects of particular importance include appropriate location of buildings and infrastructure, adherence to the recommended construction type, and drainage design. The risks may be unacceptable (with respect to the planning scheme) if the geotechnical advice is not followed; however, regulators can reduce risks by ensuring that checklists and declaration forms, included here and modified from the Australian Geomechanics Society 2007 guidelines (AGS 2007c), are completed for relevant aspects of the development.

MRT and other State agencies provide information to assist with geotechnical investigations. Regulators and geotechnical practitioners can choose to make geotechnical reports publicly available, as is the practice of the senior author of this document. However, most

[1]In this document, footing refers to the man-made support for a structure, and foundation refers to the natural surface and subsurface materials supporting the footing.

privately-commissioned geotechnical reports, including landslide reports and AS2870 site classifications, remain inaccessible or un-discoverable to interested parties. This situation is unsatisfactory, as the information could be used to improve and inform subsequent investigations and contribute to the improvement of MRT's publicly available maps and databases.

The shortcomings discussed above are not at all unique to Tasmania, and other jurisdictions face the same issues. As an example, Paul and Miner (2016) analysed the landslide risk assessment process in Victoria and outlined the difficulty of achieving an acceptable standard of reporting and regulation in this field.

Improving the standard of geotechnical reporting and regulation in Tasmania

A set of draft guidelines to address the issues described above have been developed here. These guidelines are supported by the Office of Security and Emergency Management (Department of Premier and Cabinet) and Consumer Building and Occupational Services (Department of Justice).

These guidelines serve to:

- Outline the current situation
- Outline the required and desired processes and provide clarity for all parties
- Describe the types of geotechnical reports required
- Outline requirements and expectations of geotechnical practitioners
- Outline aspects of geotechnical investigations
- Ensure that approvals for development follow sound principles
- Provide preliminary assessment tools for non-technical staff in Councils
- Provide an appropriate structure for technical reviews
- Outline existing data sources and a process for making geotechnical reports publicly available.

This is not a statutory document, but is intended to reflect current best practice consistent with publications of the Australian Geomechanics Society and relevant standards. The authors acknowledge and utilise previous advice from the Tasmanian Chapter of the Australian Geomechanics Society (Tasmanian Chapter, 1998) relating to geotechnical reporting for subdivisions and an unpublished draft practice document for AS2870 site classification (Tasmanian Chapter, 2006).

Declaration forms and checklists in this document are modifications of landslide management forms contained in *Practice Note Guidelines for Landslide Risk Management* (AGS, 2007c). These forms have been adapted to encompass the wider scope of geotechnical reporting and move beyond a focus solely on landslide risk management. However, there may be instances where practitioners prefer to use the original forms.

This document will be released to key stakeholders for consultation and feedback. Revisions will be undertaken in an agreed timeframe.

Definitions

Geotechnical issues and reports

Geotechnical issues (or hazards) are natural or man-made ground conditions with the potential to adversely affect land use and development. The issues in Tasmania can typically include landslides and reactive (expansive) soils (Figure 1). Geotechnical issues on specific sites are described and addressed through geotechnical reports. The scope and content of geotechnical investigations leading to geotechnical reports are set out in AS1726 (2017) *Geotechnical site investigations.*

Geotechnical reports are commonly requested by regulators when land use is to be changed or an area is proposed for subdivision, but they may be applied to any land development at any scale. It is increasingly common in Tasmania for one or more interested parties to require a geotechnical assessment as a condition of a land purchase.

Landslide issues and reports

Landslide issues are particularly important in certain Tasmanian settings and are a subset of geotechnical issues (Figure 1). Landslide issues are addressed by landslide reports. A landslide report, commonly called a Landslide Risk Assessment, or Landslide Risk Management (LRM), may be a stand-alone document, or it may be embodied in a more comprehensive geotechnical report. The accepted process for landslide site investigation, assessment and reporting in Australia is set out in the series of *Landslide Risk Management* documents issued by the Australian Geomechanics Society (AGS, 2007a-e).

Site classification reports

Site classification reports are geotechnical reports that describe and classify foundation conditions for residential buildings in Australia. Site classification reports are used to govern the design and placement of building footings and may influence the choice of construction materials. These reports are a means of

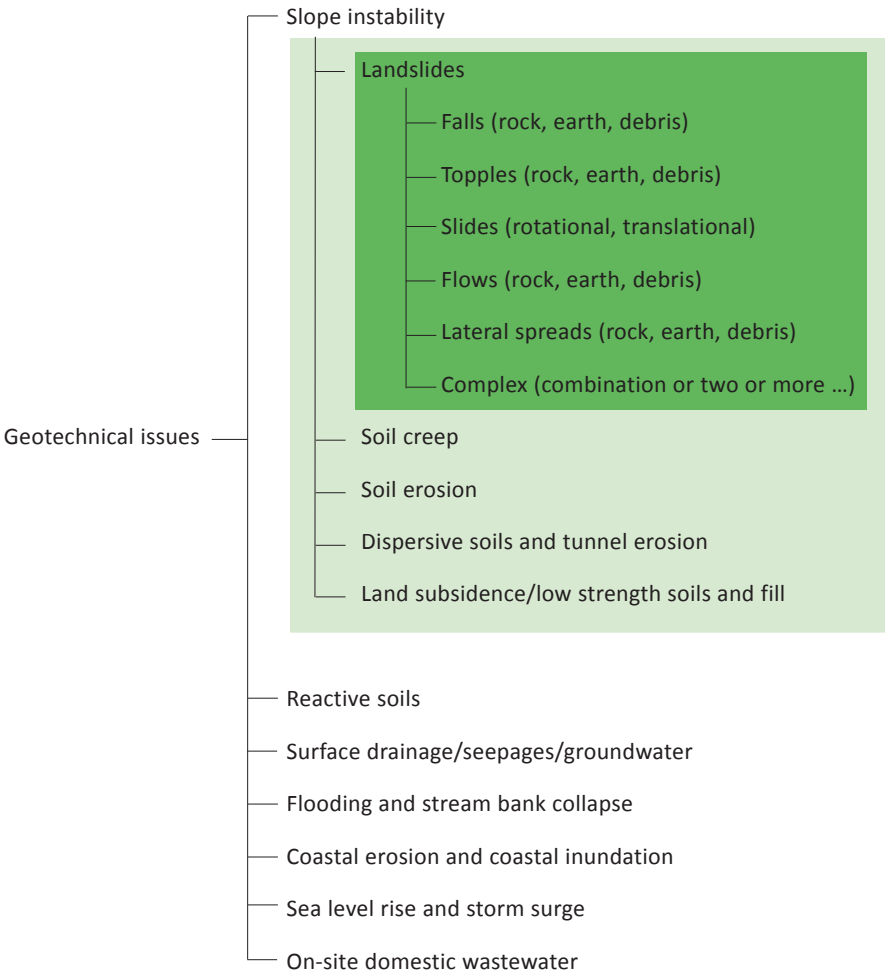

FIGURE 1. Geotechnical issues addressed in geotechnical reports in Tasmania. The list is not exhaustive. The light green area includes natural and man-made slope instability issues, and the dark green area within it includes those issues typically addressed in Landslide Risk Management. It is implicit in AS2870 (2011) that site classifications should also address most, if not all, geotechnical issues.

minimising the hazards of poor ground conditions to buildings, including the potentially damaging effects of reactive soils that are relatively common in Tasmania.

Foundation issues are a subset of geotechnical issues. The scope of investigations, and the classification of sites, are described in AS2870 (2011) *Residential slabs and footings*.

An AS2870 site classification may be a stand-alone document, or it may be embodied in a more comprehensive geotechnical report.

Wastewater reports

Wastewater reports are required for areas without a reticulated sewage system where some form of on-site treatment and disposal is planned. Geotechnical and other qualified practitioners provide an appropriate site and soil assessment, and land application area design in accordance with AS/NZS1547 (2012) *On-site domestic wastewater management*.

On-site waste water systems may fail if not designed correctly causing harm to the environment and posing a potential health hazard.

Combined reports

Regulators in Tasmania commonly request that geotechnical reports address most if not all of the range of issues listed in Figure 1, including landslide reporting and AS2870 classification. These reports can be combined into a single document provided it satisfies all the constituent requirements.

Availability of geotechnical reports and data

A register of geotechnical reports

Most privately-commissioned geotechnical reports, including landslide reports, AS2870 site classifications and waste water reports, remain inaccessible or unknown to other interested parties including MRT. Geotechnical reports required by regulators to accompany development applications are publicly-available documents and the quality of future investigations would benefit from having this information available. Accordingly, regulators ought not be reluctant to make the reports available to interested parties. Where possible or appropriate, the author of a geotechnical report, and the client, are encouraged to formally instruct a regulator that it is free to publicise the existence of the document, or the document itself.

The regulator in turn is encouraged to make the report available to interested parties, including in particular future practitioners doing AS2870 site classifications. It is suggested that reports, or references to their availability, be uploaded to regulators' websites or into a state register.

Geotechnical data sources

The Tasmanian Government has made major investments in spatial technology to provide better access to information for the community, business and public sectors. There is now a large and growing range of spatial information online and publicly available that is relevant to geotechnical investigations among other applications. Of particular note is the geological information accessible from the MRT website (www.mrt.tas.gov.au) that includes landslide maps and various databases. Geotechnical practitioners are encouraged to enhance the State's geotechnical database by making reports and data available to MRT. This practice will improve the accuracy of geological and landslide maps and various databases served to the public. At the time of writing MRT is preparing a set of geotechnical geoguides for specific geological units in the State. The first of these relates to the Launceston Group in the Tamar Valley area.

The Land Tasmania LIST website (www.thelist.tas.gov.au) is another important data repository containing a large collection of spatial layers, including cadastre, LiDAR data and historic aerial photographs. Historic aerial photographs are a key information source for site assessment and the collection, dating back to the 1940s, is currently being loaded onto the LIST website. This air photo facility enables geotechnical practitioners to preview and order images without needing to visit the air photo collection in person in Hobart.

Another source of potentially useful spatial information is the Geoscience Australia data portal (ww.ga.gov.au/data-pubs) that focuses on providing national datasets, including LiDAR data.

Geotechnical practitioners in Tasmania

Geotechnical reports must be compiled by suitably qualified people, here called 'practitioners'. In Tasmania, the qualifications required for practitioners' reports are specified in the Director of Building Control's *Certificates by Qualified Persons for an Assessable Item Determination* under the *Building Act 2016* (Table 1).

Geotechnical (including landslide risk assessment) reports and AS2870 classifications are required to be issued by geotechnical engineers or engineering geologists. Suitably certified soil scientists may also conduct AS2870 site classifications (with the proviso outlined in clause 2.3.2), but not geotechnical (including landslide) reports.

According to AGS 2007c (section 3.3.2), a practitioner undertaking landslide risk management should have this specialist subject as a core competency. In reality, landslide risk assessment requires a broad range of skills and experience and for challenging sites, a specialist practitioner and/or a small team may be required to perform the work at the required standard. From the regulator's perspective, measuring the competency of a practitioner(s) may be difficult and it is recommended that the practitioner(s) include a signed declaration to the effect attached to the geotechnical report. In addition the practitioner(s) should also supply a current resume (or a link to a current resume) outlining past experience and any specific training that has been undertaken.

Regulators should consider requiring practitioners to be a member of a relevant professional institute. While this is not a measure of qualification or competency, a condition of membership, especially if it offers professional accreditation, is an obligation to conduct oneself in an ethical and professional manner and to commit to ongoing professional development. Regulators should also ensure that practitioners submitting geotechnical reports have appropriate professional indemnity and public liability insurance.

Landslide Risk Management

The Landslide Risk Management (LRM) process

The flow chart in Figure 2 illustrates a conceptual role of practitioners and regulators in relation to planning and building controls, LRMs, geotechnical reports and AS2870 site classifications in Tasmania.

LRM reports

Where a landslide risk assessment is needed for a proposed land use or development, the LRM required by a regulator may be:

> "a stand-alone document which assesses only landslide risk in accordance with the AGS 2007 guidelines, or part of a broader investigation and geotechnical report which addresses not only landslide risk but all or some of the range of geotechnical issues listed in Figure 1 and in accordance with AS1726 (2017)."

Even though a proposed land use or development may be exempt from a relevant planning scheme landslide hazard code (i.e., a LRM is not requested by the regulator), a geotechnical investigation and report may still be required by one or more interested parties, including owners, occupiers, developers, purchasers, sellers, insurers, lenders and receivers.

The scope and content of such a report would be determined by the interested parties and the practitioner. The report may address one or more specific geotechnical issues, or a range of issues (Figure 1). The report must be done by a suitably qualified person and be in accordance with AS1726 (2017) and AGS (2007c,d).

Reports may be compiled by different practitioners

Where both are required, LRMs, and AS2870 site classifications (see below) may be conducted by different practitioners at different times. A record of those involved, their qualifications, competencies and contribution should be included in the LRM report.

AGS (2007) requirements for LRMs

Irrespective of whether the LRM is a stand-alone document, or incorporated in a broader geotechnical report, it shall be prepared in accordance with AGS (2007) *Landslide Risk Management*.

Section 10 ("Reporting Standards") of AGS (2007c) states:

> "The report on the risk assessment is to document the data gathered, the logic applied and conclusion reached in a defensible manner.
>
> The practitioner will gather relevant data, will assess the relevance of the data and will reach

TABLE 1. Extract from Schedule 1 [Certificates by Qualified Persons for an Assessable Item Determination 2016 issued by the Tasmanian Director of Building Control under the *Building Act* 2016. The schedule sets out required qualifications for practitioners issuing geotechnical (including landslide) reports and AS2870 site classifications, and AS/NZS1547 site and soil assessments for wastewater.

Column 1	Column 2	Column 3	Column 4
Certificate type	**Given by**	**Qualifications**	**Speciality area of expertise**
Foundation classification – AS2870 and Stability Report in accordance with Foundation and Footings Society (Tasmania) Code of Practice	Soil scientist	Certified Professional Soil Scientist (Stage 2 or Stage 3) accredited by the Australian Society of Soil Science Inc. and has PL insurance	Foundation classification in accordance with AS2870
	Engineering geologist	BSc major in geology and has PL insurance	
	Geotechnical engineer	Licenced as an Engineer - Civil	
Geological	Engineering geologist	BSc major in geology and has PL insurance	Engineering geology
Geotechnical including landslide risk assessment in accordance with "Practice Note Guidelines for Landslide Risk Management 2007" published by the Australian Geomechanics Society	Geotechnical engineer	Licenced as an Engineer - Civil	Geotechnical reports
	Engineering geologist	BSc major in geology with core competencies in landslide risk assessment and has PL insurance	
Structural	Structural engineer		Structural engineering

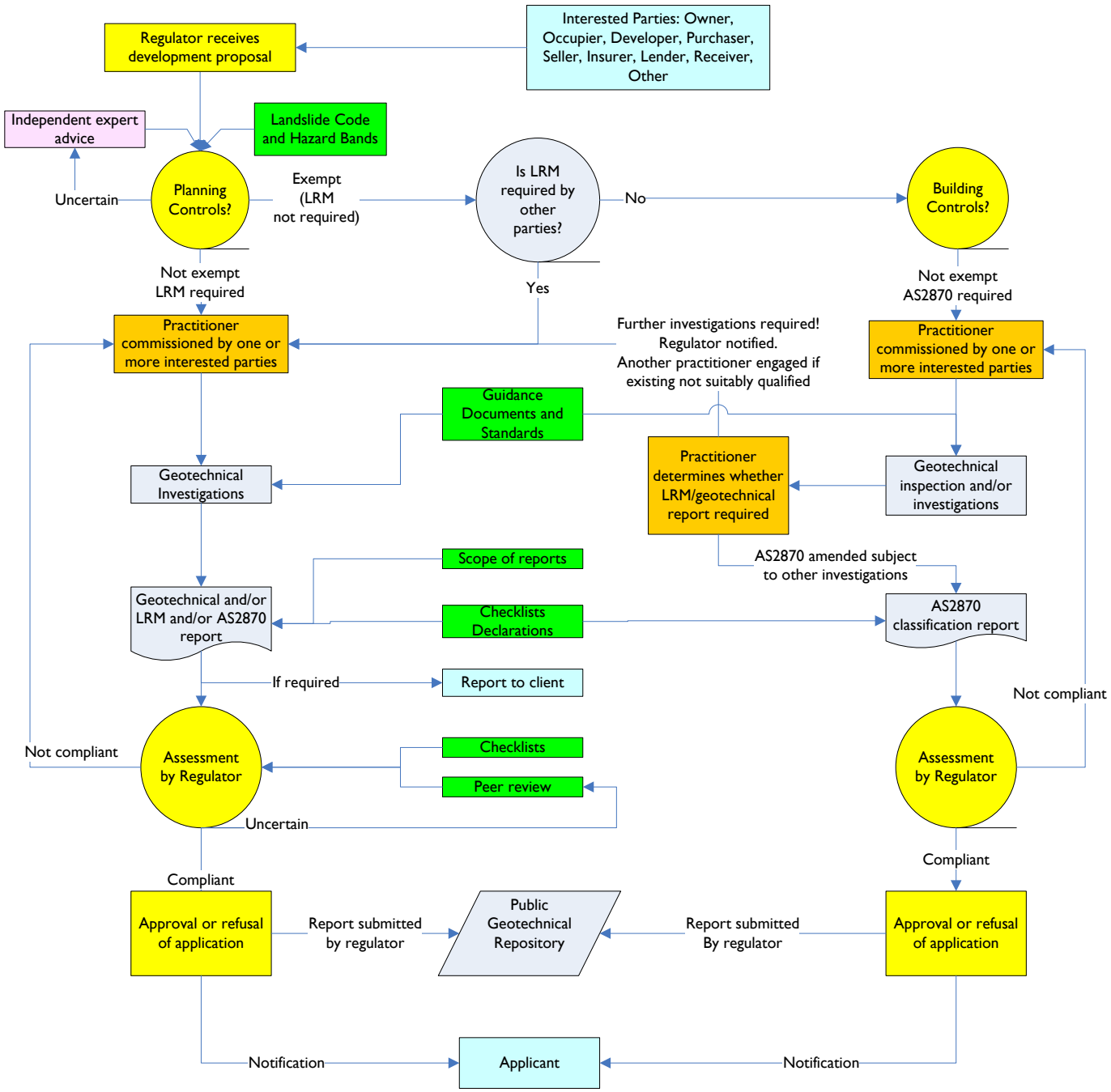

FIGURE 2. Example process flowchart for Landslide Risk Management, geotechnical reports and AS2870 site classifications in Tasmania.

conclusions as to the appropriate geotechnical model and basic assessment of the slope forming processes and rates. Full documentation of these results provides evidence of completion, provides transparency in the light of uncertainty, enables the assessment to be re-examined or extended at a later date and enables the assessment to be defended against critical review. The process often identifies uncertainties or limitations of the assessment which also need to be documented and understood."

Section 10.2 provides a list of data to be presented (reproduced here as Table 2), and states (in relation to the presented data):

"Where any of the above [list of data] is not or cannot be completed, the report should document the missing elements, including an explanation as to why [they are missing].

Section 10 concludes:

"The report needs to clearly state whether the risk assessment is based on existing conditions or with risk treatment measures implemented. In some cases, the assessment for both existing and after treatment should be documented to demonstrate the effect of risk control measures on reducing risk.

"A report which does not properly document the assessment is of limited value and would appear to have no reasonable basis."

Suggested scope for LRMs

Table 3 is a recommended scope for a LRM. The items listed in the scope should appear in the report or in a checklist (Attachment 1) relating to the report. Not all LRMs require the same amount of investigation and reporting, and practitioners may vary the detail to reflect this. If there is doubt as to an appropriate scope of works for a particular investigation and LRM report, practitioners should obtain advice from suitably experienced peers. In any case, all LRMs shall adequately address the recommendations of Section 10 of AGS (2007c) and shall include:

- A completed geotechnical declaration and checklist (Attachment 1), and
- A Certificate of Currency for Professional Indemnity Insurance.

As stated earlier, where an item is omitted from a LRM, the report itself, or the checklist relating to it, or both, must explain the omission.

It is suggested that for clarity, the text of the report may be brief, but supported where appropriate by attachments providing more detail.

Recommendations in the report should be in plain language, clearly set out, and in a form capable of being readily included in permit conditions by a regulator.

Declaration forms and checklists

We are reluctant to add to the ever-increasing list of paperwork that practitioners of all types must complete

TABLE 2. Data required in Landslide Risk Management reports*

a.	List of data sources.
b.	Discussion of investigation methods used, and any limitations thereof.
c.	Site plan (to scale) with geomorphic mapping results.
d.	All factual data from investigations, such as borehole and test pit logs, laboratory test results, groundwater level observations, photographs.
e.	Location of all subsurface investigations and/or outcrops/ cuttings.
f.	Location of cross section(s).
g.	Cross section(s) (to scale) with interpreted subsurface model showing investigation locations.
h.	Evidence of past slope instability performance.
i.	Local history of instability with assessed trigger events.
j.	Identification of landslides, on plan or section or both, and discussed in terms of the geomorphic model, relevant slope forming process and process rates. Landslides need to be considered above the site, below the site and adjacent to the site.
k.	Assessed likelihood of each landslide with basis thereof.
l.	Assessed consequence to property and life for each landslide with basis thereof.
m.	Resulting risk for each landslide.
n.	Risk assessment in relation to tolerable risk criteria (e.g. regulator's published criteria where appropriate).
o.	Risk mitigation measures and options, including reassessed risk once these measures are implemented."

* Slightly modified from AGS (2007a) Section 10.2.

Notes [not included in AGS (2007a) Section 10.2] to accompany Table 2.

1. It is desirable that all plans, maps, photographs, drill holes, test pits etc. should be located to 10m or better accuracy in Map Grid of Australia coordinates (GDA94 MGA Zone 55) .
2. Electronic copies of reports should preferably be in searchable PDF format.

TABLE 3. Recommended scope for Landslide Risk Management reports

Title pages, authorship, date of report, citation, disclaimers etc.
Authority for regulator to publicise report
SUMMARY
- Geotechnical summary
- AS2870 classification (where appropriate)

Completed geotechnical declaration and checklist
Certificate of Currency for Professional Indemnity Insurance
INTRODUCTION
Background
Standards and guidelines referred to
Scope of investigations
Methodology, dates and personnel
DESK TOP STUDY
Landslide hazard bands
MRT landslide hazard maps (Summary statements only. Refer to supporting Attachment)
Previous relevant investigations and reports
SITE DESCRIPTION
Location, size, access
Topography and relief
Climate
- Rainfall – monthly, annually
- High intensity rainfall frequency; IFD curve for site

Geomorphology
Surface drainage (Summary statements only. Refer to supporting Attachment)
Geology (Summary statements only. Refer to supporting Attachment)
- Published geology (include map(s))
- Site observations

Soils (Summary statements only. Refer to supporting Attachment)
- Soil distribution, textures, thickness

Groundwater (Summary statements only. Refer to supporting Attachment)
- Published known groundwater bores and water quality
- Groundwater conditions, occurrence and movement

Slope stability
- Published evidence of slope instability (MRT maps, reports)
- Site observations of slope instability
- Summary of slope forming processes

LANDSLIDE RISK MANAGEMENT
- Summary statements only. Refer to supporting attachment.

CONCLUSIONS
RECOMMENDATIONS
Recommendations to create awareness of interested parties
Geotechnical recommendation specific to the development about good and bad hillside construction practices
Recommendations to manage specific geotechnical issues (where appropriate)
Recommendations about unexpected subsurface conditions
Statement that the practitioner must inspect and certify engineering plans and site construction
REFERENCES
ATTACHMENTS (where appropriate)
Brief from regulator or client
Proposal plan, etc, land title documentation
Location maps (district scale aerials, orthophotos, satellite imagery)
Location maps (detail scale aerials, orthophotos, satellite imagery)
Topography maps (eg Lidar-generated hill shading and slope gradient maps)
Historic aerial photographs (orthophotos and individual images) and/or Google Earth satellite imagery
Tasmanian Landslide Hazard Maps (if available) in relation to the proposal
Geotechnical fact map with standard (AGS) symbols, and interpreted cross section (natural and other scales)
Site (and test pit) photographs
Test pit logs (on industry-standard log sheets) or summary table(s) of test pit logs
Drill hole logs (on industry-standard log sheets) with photographs of samples, core, etc
Investigation results

to satisfy regulators. However, we support AGS (2007) and the guidelines recommend the use of declaration forms and checklists for LRM practitioners to complete as a means of providing appropriate documentation for the control of submissions and the approval process. Accordingly, we have compiled the example declaration form (Form A) included here as Attachment 1 and others can be found in AGS 2007c (Appendices A-H) that relate to different types and stages of developments.

Peer reviews of LRMs

A regulator may request a peer review of an LRM if, as set out in Clause 3.4.1 of AGS 2007c, there are "specific concerns in relation to the adequacy of a submission, or the conclusions reached, or if required by a Hazard Zoning study." The review may also be a component of a regulator's or other party's audit process or part of mediation for an agreement.

A peer review of an LRM shall be conducted by an independent geotechnical practitioner who shall consider:

- The LRM report in terms of its adequacy of compliance with AGS(2007c), and
- The reasonableness of the assessment conclusions and risk control measures specified in it, and "the specific development proposals as defined by the design drawings."

It is recommended that peer review reports of LRMs incorporate Forms D or E (Attachment 3) or both.

AS2870 site classifications

Basis and scope of AS2870 site classifications

Site classification for a residential dwelling or extension in accordance with AS2870 (2011) *Residential slabs and footings* is based on the expected ground surface movement and the depth to which the movement extends, and is especially related to reactive clayey soils and "normal" moisture conditions (Clause 2.1.2 of the Standard).

However, a range of situations (some of which are listed in Clause 2.1.3 of the Standard) may produce "abnormal" conditions, so an AS2870 site classification should note if they are absent and comment in detail if they are present.

Accordingly, it is recommended that a robust classification should address the geotechnical issues in Figure 1. The importance of this is recognised by Clause 2.1.1 of the Standard which states "site classification may require consideration of factors beyond the boundaries of the subject site."

The process of conducting an AS2870 site classification is depicted on the right hand side of Figure 2.

Requirements for AS2870 site classifications

An AS2870 site classification is generally required for each new house or house extension, and related construction in Tasmania (*Building Act 2016)*.

In Tasmania, the Director of Building Control has determined that:

> "practitioners permitted to classify sites in accordance with AS2870 (2011) are restricted to engineering geologists, geotechnical engineers and suitably qualified soil scientists, and an AS2870 site classification includes a "Stability Report in accordance with Foundation and Footings Society (Tasmania) Code of Practice."

In the case of Class P sites, AS2870 (2011) Clause 2.1.3 provides for a classification report for the site, the inclusion of the basis for the classification, and recommendations for further investigations.

Investigation procedures and reporting

Tasmania's inherently variable site conditions increase the risk associated with relying on site information provided by those who are not suitably qualified practitioners, or who are not supervised in the field by qualified persons. It is acceptable to engage others to drill holes, dig test pits, sample soils or do related work, but the signatory to a site classification report must be suitably qualified, must be present on site to carry out the assessment or supervise operations. Regulators should ensure that a record of the personnel and their involvement is attached to the report.

An AS2870 site classification may be a stand-alone document, or it may be incorporated in a geotechnical (including landslide) report. It is recommended that all AS2870 site classifications, stand-alone or not, should routinely address the range of geotechnical issues potentially affecting land use and development, including landslide risk, listed in Figure 1.

Geotechnical investigations at subdivision scale, and site specific (building footprint related) investigations, are often undertaken at different stages of the development process and may be separated in time. Because subsurface conditions often change rapidly both laterally and vertically, it is unwise at subdivision scale to classify land in accordance with AS2870 unless the building site(s) or envelope(s) can be identified on the ground and the report specifically relates to them. Where this is not possible, general comments about subsurface conditions are appropriate, but no site specific classifications should be made.

As with all geotechnical investigations, there is a clear requirement for the practitioner to produce AS2870 reports at a standard consistent with AS1726. The report needs to document the data gathered, the logic applied and conclusions reached in a defensible manner. It is critical that reports describe and justify the method for determining the site classification and all associated empirical laboratory results (if any). Map-accurate plans with bar scale and north arrow should clearly and accurately show property boundaries, contours, the location of test holes, and all other relevant features.

Geotechnical considerations for wastewater disposal and design

Large areas of Tasmania do not have reticulated sewerage infrastructure and residential development in these areas will require some form of domestic wastewater management that satisfies regulatory requirements. Sewer-serviced land is a layer available on The LIST website (www.thelist.tas.gov.au) that can be used to identify such areas.

By far the most common form of domestic wastewater management is on-site treatment and disposal. Off-site disposal (short term storage and pumping or evacuation) is rare and typically discouraged by regulators.

AS/NZS1547 and Tasmanian guidelines for wastewater management

AS/NZS1547 (2012) On-site domestic wastewater management sets out the scope of site investigations, soil classification and design for on-site wastewater systems. (Designs not included in the Standard are acceptable in Tasmania subject to approval by regulators.)

Further guidance for system design in Tasmania is contained in the Director of Building Control's Director's Guidelines for *On-site Wastewater Management Systems* (issued under the Building Act 2016).

On-site wastewater investigations

Subsurface conditions are a dominant influence on the size, design and location of wastewater disposal systems. Investigations aim to categorise on-site soils as to their hydraulic ability to receive wastewater. Typically, the investigations involve test pitting, augering or drilling, soil descriptions, sampling and testing, and so are inherently geotechnical in nature and ought to be conducted to the standards set out in AS1726 as well as AS/NZS1547.

System sizing and location

The size of a wastewater disposal ("land application") area is determined by relating soil hydraulic capability to wastewater volume.

The location (and sometimes the detailed design) of a sized land application system is determined by applying vertical and horizontal setbacks between the disposal area and sensitive features like property boundaries, buildings, and surface water and groundwater.

AS/NZS1547 and AS2870 investigations can be combined

The site and soil evaluation for wastewater investigations is not to be confused with the site classification for AS2870. The purposes of the investigations are different, they are usually conducted at different locations on a site, and at different times by different practitioners. Nevertheless, there are common components and provided a practitioner is qualified in both disciplines (Table 1), it is efficient to conduct simultaneous investigations, using the same information sources, techniques and tools. Two separate reports are typically produced: an AS/NZS1547 wastewater site assessment and system design report, and an AS2870 site classification report.

Geotechnical constraints for on-site wastewater disposal

Wastewater disposal may contribute to slope instability

The placement of on-site wastewater systems on or near landslides or landslide-susceptible areas should be discouraged - something that is not explicitly mentioned

in AS/NZS1547. All parties should be made aware and consider the potential consequences of introducing fluids onto such sites. For clay-rich soils in particular, the introduction of wastewater may contribute to the reactivation of landslides as has happened in the Tamar Valley in recent times. In cases such as these, the location of the wastewater system should be moved to a more suitable position if possible, or alternative options (e.g. off-site disposal) considered.

We recommend that at the desktop stage of the investigation practitioners look for indications of unstable landforms such as on the MRT online landslide database, landslide maps, the Landslide Hazard Bands (particularly Medium to High bands), aerial and satellite imagery (see previous section on Geotechnical Data Sources) and during the subsequent site investigation. Practitioners without landslide expertise are strongly advised to seek specialist advice from persons with appropriate competency in such cases.

Dispersive soils

The presence or absence of dispersive soils at proposed on-site wastewater disposal areas should be established during site investigations, and managed if necessary.

Staged investigations and report currency

Geotechnical investigations may be staged. For example, a preliminary desktop study with little or no site investigation at the pre-approval stage of a residential subdivision or other development can inform the owner or developer of likely geotechnical risks to the proposal. This approach can be followed by more detailed geotechnical investigations before subdivision or other plans have been finalised to ensure that the design is appropriate to the constraints of the landscape. This will result in more realistic expectations to the developer and may minimise the costs of mitigating hazards.

Depending on the degree to which a geotechnical report is prepared, regulators may request further information, or require a peer review of the report, when the proposal is submitted for planning or building approval. An amended report, or supplementary geotechnical reports, may be required to address, for example, omissions in the original report, or other geotechnical issues such as potential or actual coastal erosion, coastal inundation, dispersive soils, acid sulphate soils, etc. The latter four issues, among others, are called up in overlays to the current interim planning schemes, and geotechnical practitioners may be qualified to address some or all of them. (Whether or not these issues affect a particular development proposal is indicated at an individual property level on the Tasmanian Governent website www.iplan.tas.gov.au, and usually on www.thelist.tas.gov.au).

During the construction phase of a development, the geotechnical practitioner may be required to undertake site inspections to ensure that the expected ground conditions are encountered and, if not, to advise on the unexpected conditions and the potential effects on development. There may also be a requirement for the practitioner to undertake a final inspection to ensure that the geotechnical aspects of the as-built design conforms to the recommendations of the geotechnical report. These activities can be recorded as signed declarations on provided forms along with any supplementary technical documentation.

Conditions on site can change with time, caused by a range of natural and man-made processes. Regulators should not accept geotechnical (including AS2870 and AS/NZS1547) reports if it is known that site conditions have or might have changed, or if investigations relating to the report were done more than 2 years prior to an application for a planning or building permit. If this is the case, the geotechnical practitioner must declare that findings, conclusions and recommendations in the report are still valid, or update the report if necessary.

Recommendations

The following recommendations are not necessarily government policy in relation to geotechnical investigations and reporting, but they arise naturally from a consideration of the investigation process, current standards and guidelines, the roles of regulators and practitioners, and the need to improve the public dissemination of geotechnical information.

Regulators to develop a standardised assessment process

Regulators are encouraged to develop a standardised approach for the assessment of geotechnical reports to satisfy legislative requirements. This document provides guidance on how this can be done.

Geotechnical practice

Geotechnical practitioners are encouraged to review and if appropriate modify their current practice against this guidance.

Enhancing public awareness of geotechnical reports

Where possible or appropriate, an author of a geotechnical report, and the client, are encouraged to formally instruct a regulator that it is free to publicise the existence of the document, or the document itself.

Geotechnical reports required by regulators to accompany development applications are publicly available documents. Regulators are therefore encouraged to make geotechnical (including landslide, AS/NZS1547 and AS2870) reports publicly and freely available.

The locations and full downloadable copies of reports should be made accessible either on a regulator's website or as a state facility on LISTmap (www.thelist.tas.gov.au).

References

AGS 2007a. Guideline for landslide susceptibility, hazard and risk zoning for land use planning. Australian Geomechanics Society, *Australian Geomechanics* **42**(1): 13-36 [available online: www.australiangeomechanics.org].

AGS 2007b. Commentary on guideline for landslide susceptibility, hazard and risk zoning for land use planning. Australian Geomechanics Society, *Australian Geomechanics* **42**(1): 37–58 [available online: www.australiangeomechanics.org].

AGS 2007c. Practice Note guidelines for landslide risk management. Australian Geomechanics Society, *Australian Geomechanics* **42**(1): 63–114 [available online: www.australiangeomechanics.org].

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AGS 2007e. Australian GeoGuides for slope management and maintenance. Australian Geomechanics Society, *Australian Geomechanics* **42**(1): 159–182 [available online: www.australiangeomechanics.org].

Paul, D.R.; Miner, A.S. 2016. Fifteen Years of Slope Stability and Risk Assessment for Local Government Planning In Victoria. A Discussion of Common Mistakes and Shortcomings. *Excavations and Slope Stability in Melbourne Geology: Experiences and Recent Developments*, Melbourne, Wednesday 16 Nov 2016. Australian Geomechanics Society Victoria Chapter.

Tasmanian Chapter, AGS 1998. Guidelines for geotechnical assessment of subdivisions. Australian Geomechanics Society. *Australian Geomechanics* **33**(3): 53–57.

Tasmanian Chapter, AGS 2006. Recommended practice for AS2870 site classification in Tasmania. Australian Geomechanics Society, Tasmanian Division: Hobart.

Attachment 1

Geotechnical declaration (Form A) and checklist (Form B)

These two forms are modified from form A of AGS (2007c) and practitioners may choose to use the original AGS forms if deemed more appropriate.

A complete declaration and checklist must accompany each LRM.

FORM A Geotechnical Declaration and Verification — Tasmania		Development Application
Office Use Only		Regulator (add in or change to appropriate name)

To be submitted with a development application. If this form is not submitted with the geotechnical report the report will be refused.
This form is essential to verify that the geotechnical report has been prepared in accordance with *Building for Landslide: Geotechnical guidance for regulators and practitioners using the Tasmanian Landslide Code* (June 2014) ("the guidelines") and that the author of the geotechnical report is a geotechnical engineer or engineerinfg geologist as defined in the Tasmanian Director of Building Control's *Certificates of Specialists or Other Persons*. Alternatively, where a geotechnical report has been prepared for subdivision or is greater than two years old or by a professional person not recognised by the Director of Building Control, then this form may be used as technical verification of the geotechnical report if it is signed by a geotechnical engineer or engineering geologist as defined by the Director of Building Control.

Section 1	**RELATED APPLICATION**	
DA Application Number		
DA Site Address		
DA Applicant		

Section 2	**GEOTECHNICAL REPORT**	
Details	Title	
	Author	Dated / /
	Author's company / Organisation's name	Report Reference No.

Section 3	**CHECKLIST**
	The attached checklist (FORM B) covers the recommended requirements to be addressed in a geotechnical report. The checklist is to accompany the report. Each item is to be cross-referenced to the section or page of the report which addresses that item. Missing items require an explanation by the practitioner.

Section 4	**DECLARATION**
YES ☐ ☐ ☐ NO ☐ ☐ ☐	**I am a geotechnical engineer or engineering geologist and I prepared or verified the geotechnical report as described above on behalf of the company or organisation below.** • To the best of my knowledge, I am satisfied that the subdivision works have been carried out in accordance with all th requirements and recommendations of the above geotechnical report and planning permit conditions relating to geotechnical issues. • To the best of my knowledge, I am satisfied that where any variations from the approved design documents have occurred during construction, those variations are consistent with all recommendations of the above geotechnical report and planning permit conditions relating to geotechnical issues. • I am aware that the Council requires this declaration prior to sealing of the Plan of Subdivision and will rely on it as verification that the works have been carried out in accordance with th recommendation by the geotechnical report and will ensure that geotechnical risks are no higher than "tolerable" as defined in Section 8.2 of the *Practice Note Guidelines for Landslide Risk Management 2007* (AGS, 2007c), assuming that future development of the site is also undertaken in accordance with the geotechnical report recommendations.

Section 5	**GEOTECHNICAL ENGINEER / ENGINEERING GEOLOGIST DETAILS**	
Company/ Organisation name		
Name (Company representative)	Surname	Ms / Mr / other
	Given names	
	Chartered Professional Status	Registration No.
Signature		Date / /

FORM B Checklist to accompany Form A Geotechnical Declaration and Verification — Tasmania			
Report section #	Report page #	Item	Comment or explanation of omission of an item
		Title, authorship, date of report, citation, disclaimers, etc.	
		Authority for regulator to publicise report	
		SUMMARY	
		Geotechnical summary	
		AS2870 classification (where appropriate)	
		Completed geotechnical declaration and checklist	
		Certificate of Currency for Professional Indemnity Insurance	
		INTRODUCTION	
		Background	
		Standards and guidelines referred to	
		Scope of investigations	
		Methodology, dates and personnel	
		DESK TOP STUDY	
		Landslide hazard bands	
		MRT landslide hazard maps (summary statements only. Refer to supporting	
		Previous relevant investigations and reports	
		SITE DESCRIPTION	
		Location, size, access	
		Topography and relief	
		Climate	
		Rainfall	
		High intense rainfall frequency. IFD curve for site	
		Geomorphology	
		Surface drainage (summary statements only. Refer to supporting attachment.)	
		Geology (summary statements only. Refer to supporting attachment.)	
		Published geology (include map(s))	
		Site observations	
		Slop stability	
		Published evidence of slope instability (MRT map(s))	
		Site observations of slope stability	
		Summary of slope forming processes	
		Hydrogeological model of site and environs	
		LANDSLIDE RISK MANAGEMENT	
		Summary statements only. Refer to supporting	
		CONCLUSIONS	
		RECOMMENDATIONS	
		Recommendations to create awareness of interested parties	
		Fundamental geotechnical recommendation about hillside construction practices	
		Recommendations to manage recognised landslide and other geotechnical risks	
		Recommendations about unexpected subsurface conditions	
		Statement that practitioner must inspect and certify engineering plans and site construction	
		REFERENCES	
		ATTACHMENTS (where appropriate)	

continued

FORM B continued

Report section #	Report page #	Item	Comment or explanation of omission of an item
		Brief from regulator	
		Proposal plan, etc., land title	
		Location maps (district scale aerials, orthophotos, satellite imagery)	
		Topography maps (Lidar-generagted hill shading and slope gradient maps)	
		Historic aerial photograph and/or Google Earth satellite imagery	
		Tasmanian Landslide Hazard Maps in relation to the proposal	
		Geotechnical fact map with standard symbols and interpreted cross section (natural scale)	
		Site (and test pit) photographs	
		Test pit logs (on industry-standard log sheets)	
		Drill hole logs (on industry standard log shets)with photographs of samnples, cores, etc.	
		Investigation results	
		Geology, soils, surface drainage, groundwater, etc.	
		Laboratory test results (e.g., dispersion, shrink-swell, Attebergs, shear box)	
		Justification for AS2870 site classification; footing notes for builders, etc.	
		Landslide Risk Management (before and after treatment)	
		Hazard Analysis	
		Landslide characterization (types, materials, status)	
		Frequency analysis of landslides	
		Consequence Analysis	
		Consequence scenarios and elements at risk	
		Temporal spatial probability for elements at risk	
		Consequences to property	
		Consequences to people	
		Risk estimation to property	
		Qualitative risk estimation	
		Qualitative and semi-qualitative risk estimation	
		Quantitative risk estimation	
		Quantitative risk estimation of loss of life	
		Qualitative risk estimation	
		Qualitative and semi-qualitative risk estimation	
		Tolerable risk criteria and risk evaluation	
		Tolerable risk criteria used in evaluation	
		Risk evaluation for each scenario	
		Risk mitigation	
		Need for risk mitigation	
		Design life of proposed development	
		Risk mitigation measures	
		Risk mitigation plan	
		Risk mitigation maintenance	
		Summary of geotechnical issues, risks and treatments (Attachment 3)	
		Terminolgy used in geotechnical risk assessment	
		Examples of good and bad hillside construction practices	
		References to AGS Geoguides	

Attachment 2

Risk assessment matrix (Form C) for geotechnical issues

Each item on the list of geotechnical issues in Figure 1 of this document can usefully be subjected to a risk to property assessment by allocating likelihood, consequence and risk level in accordance with the qualitative risk analysis matrix and terminology in Appendix C (page 92) of AGS (2007a).

An example is presented on the following page.

Practitioners may vary the number and order of geotechnical issues. Not all issues will be applicable at all sites.

In LRM and (where appropriate) AS2870 site classifications, Form C should be accompanied by the qualitative risk analysis matrix and terminology in Appendix C of AGS (2007a), and the examples of good and bad hillside construction practice on pages 174 and 175 of the Australian Geoguides for Slope Management and Maintenance [AGS (2007e)].

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FORM C Summary of geotechnical issues, risks and treatments for proposed development (Example only)

Site address:

						1	2	3		4	
				#	Issue	Likelihood of occurrence	Consequences to development	Level of risk before treatment	Recommended risk treatment(s)	Level of risk after treatment	Comments
Geotechnical issues	Slope instability	Landslides (includes regression and run-out scenarios)	Falls	1	Rockfall	Barely credible	Medium	Very low	None required	Very low	No upslope rock
				2	Earthfall	Barely credible	Medium	Very low	None required	Very low	No upslope earth exposures
				3	Debris fall	Barely credible	Medium	Very low	None required	Very low	No upslope earth exposures
			Topples	4	Rock topple	Barely credible	Medium	Very low	None required	Very low	No upslope earth exposures
				5	Earth topple	Barely credible	Medium	Very low	None required	Very low	No upslope earth exposures
				6	Debris topple	Barely credible	Medium	Very low	None required	Very low	No upslope earth exposures
			Slides	7	Deep-seated rotational	Barely credible	Major	Very low	None required	Very low	Shallow stable bedrock
				8	Deep-seated translational	Barely credible	Major	Very low	None required	Very low	Shallow stable bedrock
				9	Shallow rotational	Unlikely	Medium	Low	Control upslope surface runoff with table drains and culverts; control shallow subsurface seepages		
				10	Shallow translational	Possible	Major	Moderate	As for issue 9. Minimise cut and fill. Pier footings into (not onto) bedrock at 2.5 m in accordance with accompanying (or this) AS2870 classification report.		Development is within the moderate landslide hazard band
			Flows	11	Rock flow	Rare	Major	Very low	None required	Very low	
				12	Earth flow	Rare	Major	Very low	None required	Very low	
				13	Debris flow	Unlikely	Major	Moderate	None required	Moderate	
				14	Soil creep	Unlikely	Minor	Low	As for issue 9.	Low	
				15	Surface soil erosion	Possible	Minor	Moderate	As for issue 9.	Low	
				16	Tunnel erosion (dispersive soils)	Possible	Medium	Very high	As for issue 9.	Low	
				17	Low strength materials (eg uncontrolled fill, soft soils)	Almost certain	Major	Very high	Pier footings into (not onto) bedrock at 2.5 m	Low	Uncontrolled clay fill 2 m thich at development site
				18	Foundation movement due to reactive or	Almost certain	Major	Very high	Pier footings into (not onto) bedrock at 2.5 m	Low	Uncontrolled clay fill 2 m thich at development site is reactive
				19	Surface drainage	Almost certain	Medium	Very high	As for issue 9.	Moderate	Upslope off site runoff discharges onto site
				20	Flooding or water-logging	Waterlogging possible		Moderate	As for issue 9.	Low	
				21	Shallow groundwater seepages	Possible	Medium	Moderate	As for issue 9.	Low	
				22	Riverbank collapse	Not applicable					
				23	De- or re-vegetation	Possible	Medium	Moderate	Avoid or monimise the planting or removal of large trees near the house	Low	
				24	On-site domestic waste water disposal	Almost certain	Minor	High	Locate and size wastewater disposal system in accordance with accompanying AS/NZS 1547 wastewater report. Do not divert surface	Moderate	
				25	Site contamination from previous activities	Unlikely	Minor	Low	Visual inspection and clean-up if required during development	Low	No history of potentially contaminating activities
				26	Sea level rise	Not applicable					
				27	Storm surge	Not applicable					
				28	Shoreline recession	Not applicable					
				29	Earthquake risk	Almost certain (M <5); likely (M >5)	Insignificant to minor	Low to moderate	None required	Low to moderate	Generally accept risk. A similar range of risks exists throughout Tasmania
				30	Other						

Notes

1. The assessments are unavoidably subjective to varying.
2. See AGS (2007a) for an explanation of the terms used in Columns 1, 2, 3 and 4.
3. Further reading: AGS (2007a). Landslide risk management. *Australian Geomechanics* 42(1) March 2007. p. 1-219.

Attachment 3

Landslide Risk Management checklists (Forms D and E)

These checklists are for internal use by regulators or practitioners. It is not intended to necessarily be a part of landslide reports.

Form D is an extended version of Table 2.

Form E lists, in order, all items (with their clause numbers) in AGS (2007c) required to be addressed in landslide risk management, and the corresponding clause number for commentary from AGS (2007d).

Either or both checklists, in these or modified forms, can usefully be incorporated in peer reviews of landslide risk management reports.

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FORM D Data included in a reviewed LRM compared to that required by AGS (2007c).

	AGS (2007c) Section 10.2 states: "The data to be presented includes –	Review of LRM report		
		Data included in report?	Stated explanation for omission of data	Comment
a	List of data sources.			
b	Discussion of investigation methods used, and any limitations therof.			
c	Site plan (to scale) with geomorphic mapping results.			
d	All factual data from investigations, such as borehole and test pit logs, laboratory test results, groundwater level observations, record photographs.			
e	Location of all subsurface investigations and/or outcrops/cuttings.			
f	Location of cross section(s).			
g	Cross section(s) (to scale) with interpreted subsurface model showing investigation locations.			
h	Evidence of past performance.			
i	Local history of instability with assessed trigger events.			
j	Identification of landslides, on plan or section or both, and discussed in terms of the geomorphic model, relevant slope-forming process and process rate. Landslides need to be considered above the site, below the site and adjacent to the site.			
k	Assessed likelihood of each landslide with basis thereof.			
l	Assessed consequence to property and life for each landslide with basis thereof.			
m	Resulting risk for each landslide.			
n	Risk assessment in relation to tolerable risk criteria (e.g., regulator's published criteria where appropriate).			
o	Risk mitigation measures and options, including re-assessed risk once these measures are implemented."			

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FORM E Landslide risk management checklist.

				AGS (2007a) reference			
		Item		(2007c)	(2007d)	Addressed in landslide report?	Comments/reason for not addressing issue
		Desktop		5.1	C5.1		
		Site investi-gation	Inspection	5.2.2	Tables C1, C2		
			Mapping (geomorphic)	5.2.2	Tables C1, C2		
			Mapping (geology)	5.2.2	Tables C1, C2		
			Boreholes	5.2.3	Tables C1, C2		
			Test pits	5.2.3	Tables C1, C2		
			Groundwater levels etc.	5.2.4	Tables C1, C2		
			Cross sections	5.2.5	Tables C1, C2		
			Slope processes	5.2.6, 5.2.7	Tables C1, C2		
			Landslide location(s)	5.2.7	Tables C1, C2		
			Conceptual geotech model	5.2.7	Tables C1, C2		
		Site plans		5.1			
RISK MANAGEMENT	RISK ASSESSMENT	HAZARD ANALYSIS	Landslide character-isation	History of movement; current movement, velocity	5.3	Table C1(4)		
				Geotechnical characterisation	5.3, Tables B1, B2, Fig. B3	Table C1(5)		
				Landslide mechanisms, dimensions	5.3, Tables B1, B2, Fig. B3	Table C1(6)		
				Shear mechanisms, strength of rupture surface	5.3, Tables B1, B2, Fig. B3	Table C1(7)		
				Assessment of stability	5.3, Tables B1, B2, Fig. B3	Table C1(8)		
				Assessments of deformation, travel distance	5.3, Tables B1, B2, Fig. B3	Table C1(9)		
			Frequency analysis	Historical analysis	5.4.1b	5.4.1(ii)		
				Empirical ranking method	5.4.1c			
				Geology/geomorphology	5.4.1d			
				Rainfall/slope analysis	5.4.1e	5.4.1(iii)		
				Probabilistic analysis	5.4.1f			
				"Degree of belief"	5.4.1g	5.4.1(iv)		
				Exaplanation of applied logic to frequency of analysis				
				Use of event tree	5.4.1h, 5.4.1i	5.4.1(v)		
				Estimate of annual probability	5.4.2a, 5.4.2b, 5.4.2c	5.4.2a, 5.4.2b, 5.4.2c		
		CONSEQUENCE ANALYSIS	Con-sequence analysis	Elements at risk	6.1			
				Temporal spatial probability	6.2	C6.2		
				Consequence to property	6.3	C6.3		
				Consequence to people	6.4	C6.4		

continued

FORM E continued

	Risk estimation	Quantitative risk estimation to property	7.1	C7.		
		Quantitative risk estimation to life	7.1	C7.1		
		Semi-quantitative and qualitative risk estimation to property	7.2	C7.2		
		Risk matrix for property loss	7.3	C7.3		
	Risk assessment	Risk evaluation against tolerable criteria for property loss	8.1, 8.2	C8.1, C8.2		
		Risk evaluation against tolerable criteria for loss of life	8.1, 8.2	C8.1, C8.2		
	Risk mitigation	Accept the risk	9.1.1a	C9.1		
		Avoid the risk	9.1.1b	C9.1		
		Reduce the frequency	9.1.1c	C9.1		
		Reduce the consequences	9.1.1d	C9.1		
		Monitor the risk	9.1.1e	C9.1		
		Transfer the risk	9.1.1f	C9.1		
		Postpone the decision	9.1.1g	C9.1		
		Risk mitigation plan	9.1.3			