



GEOTECHNICAL SLOPE STABILITY GUIDELINES

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1 INTRODUCTION

This guideline presents the geotechnical slope stability assessment requirements for development within the Lake Macquarie City Council (Council) Local Government Area (LGA). The guideline has been prepared following a three year geotechnical study completed in 2019.

Approximately 30 years prior to the current study, Council arranged for the preparation of geotechnical maps that identified the potential risk of landslides within parts of the LGA. The purpose of the latest study was to revise the maps to ensure they meet current 'best practice and Council statutory requirements', as well as to provide geotechnical mapping of the entire LGA which was previously lacking. The re-mapping of the LGA also captured landform changes, mainly due to development, since the original geotechnical mapping occurred.

This Guideline is compatible with the Australian Geomechanics Society Landslide Risk Management Guidelines (2007), particularly the "Practice Note Guidelines for Landslide Risk Management".

2 DO YOU NEED A GEOTECHNICAL REPORT WITH A SLOPE STABILITY ASSESSMENT?

The following development types do not require submission of a Slope Stability Assessment with a Development Application:

- Minor development such as Garages, Carports, Decks, Pergolas, Fiberglass Swimming Pools and Cut/Fill not exceeding 1m high/deep.
- Development in Geo_4, Geo_5 or Geo_6 zone that consist of less than 3 storeys and less than 1000 m² gross floor area. This is not applicable to developments of subdivision only or sensitive use facilities.
- Subdivision development only consisting of:
 - less than 5 lots; and
 - not including any new public road; and
 - within any of the following LEP planning zones: Rural and Transition zones, Residential Zones or Environment Protection zones; and
 - within a Geo_4, Geo_5 or Geo_6 zone.
- Subdivision development only consisting of:
 - 5 or more lots and/or includes new public road; and
 - within any of the following LEP planning zones: Rural and Transition zones, Residential Zones or Environment Protection zones; and
 - within a Geo_6 zone.

After lodgement of a Development Application, Council may still require the submission of Geotechnical Report for the abovementioned development types following a site inspection.

For any development within a Geo_6 zone not mentioned above, Council has the discretion to not require a Slope Stability Assessment if the site slopes are less than 5 degrees (approx. 9%). A Geotechnical report may still be required for other aspects of the site unrelated to slope stability e.g. site classification,

Note: sensitive use facilities include schools, child care, health care, aged care and emergency services.

3 GEOTECHNICAL SLOPE STABILITY ZONES

revised slope stability geotechnical zones have been derived based on a developed geological model along with ground slopes. The mapping output consists of 10m square pixels across the LGA, each with its own geotechnical zone classification (Geo Zones). The Geo Zones are categorised in Table 1.

Table 1 - Slope Stability Geo Zones

Slope	Newcastle Coal Measures		Narrabeen Group		Quaternary Sediments	
	With Coal or Tuff	Without Coal or Tuff	With Claystone-shale	Without Claystone-shale	Not indurated	Indurated
≥0° to <5°	Geo 5	Geo 6	Geo 6	Geo 6	Geo 6	Geo 6
≥5° to <15°	Geo 3	Geo 4	Geo 3A	Geo 6	Geo 3C	Geo 6
≥15°	Geo 1	Geo 2	Geo 1A	Geo 2A	Geo 1C	Geo 2C

Note: 5° is approximately equal to 9% and 15° is approximately equal to 27%

The severity of the Geo Zones takes the following order i.e. 1 being the most severe and 6 being the least severe:

1. Geo 1, Geo 1A, Geo 1C
2. Geo 2, Geo 2A, Geo 2C
3. Geo 3, Geo 3A, Geo 3C
4. Geo 4
5. Geo 5
6. Geo 6

4 APPLICATION OF GEOTECHNICAL ZONES

The Geo Zone map is comprised of 10m cells across the LGA. As these cells are smaller than most allotments, any given site may contain several different Geo Zones within its perimeter. This is because the 10m cells are sensitive to local slope changes such as minor cut and fill, fill batters and other anomalous areas of slope.

For any new development, the most severe zone within an area that consists of the development lot(s) plus a 20m buffer around it applies.

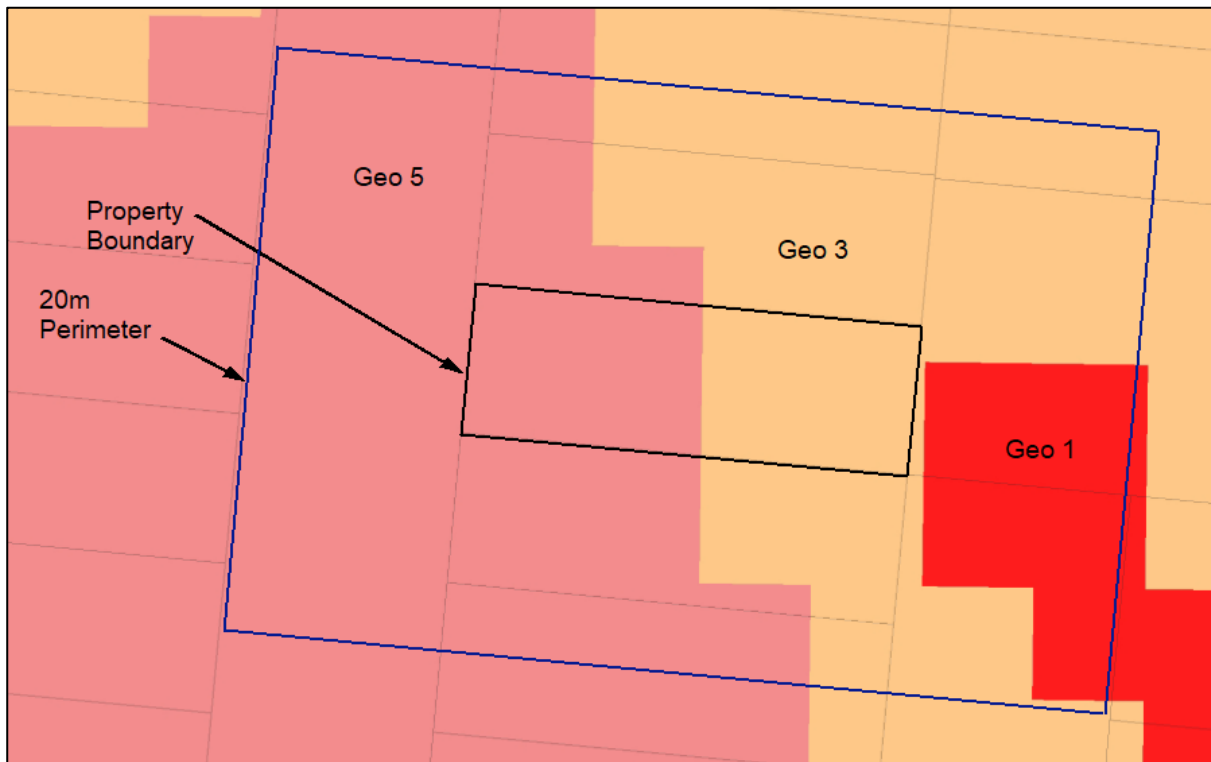


Figure 1 - Example – Geo Zones applicable to an allotment

In the example shown in Figure 1 a 20m perimeter has been drawn around the development lot and three Geo Zones exist within the area shown. The most severe zone is Geo 1, therefore this is the zone that applies to the lot.

For development that is any of the following, the Geo zone may be refined to be the most dominant zone within an area that consist of the footprint of the proposed development plus a 20m buffer around it:

- Minor developments,
- Subdivisions of less than 5 lots and does not include any new public road, and
- Other developments that are less than 3 storeys high and/or less than 1000m² Gross Floor Area.

Note: minor developments include garages, carports, decks, pergolas, fibreglass swimming pools, cut/fill not exceeding 1m high/deep.

In the following example, a development application for a single dwelling is proposed on an allotment as identified in Figure 2.

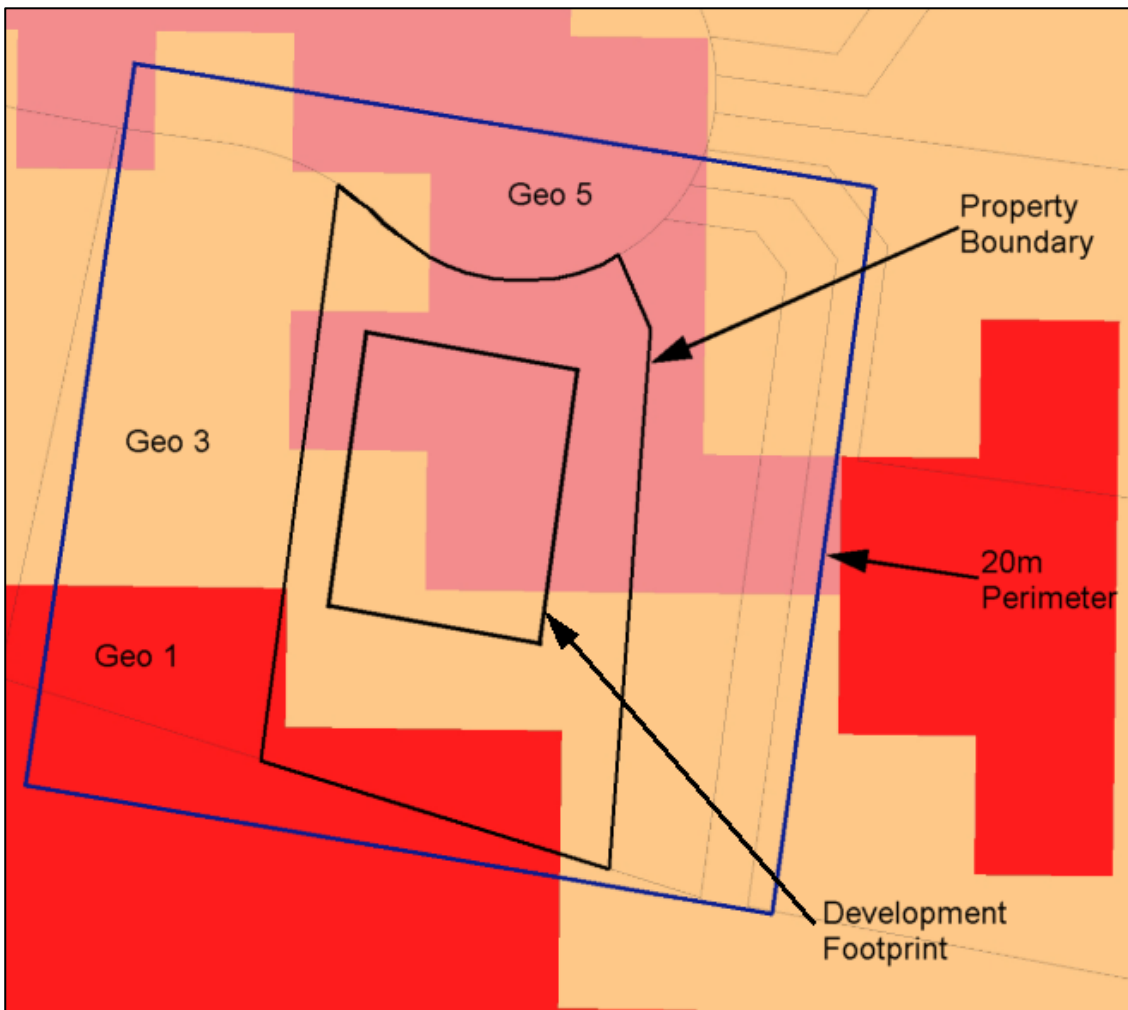


Figure 2 - Example – Refined Geo Zone applicable based on development footprint

In the example shown in Figure 2 a 20m perimeter has been drawn around the building footprint and three Geo Zones exist within the area shown. An analysis of the three zones shows that the most dominant zone is Geo 3 which is 1593m² in area, followed by Geo 5 with 984m², and finally Geo 1 with 488m². Therefore, the zone that applies to the development is Geo 3.

For the avoidance of doubt, the development footprint is to include the external perimeter of all proposed buildings and structures as defined in the Building Code of Australia i.e. inclusive of all building classes 1 to 10.

5 CONSULTANT QUALIFICATIONS AND EXPERIENCE

The minimum qualifications and experience required to undertake slope stability risk assessments is prescribed below. The consultant is required to be a Geotechnical Engineer or Engineering Geologist who is:

- University Qualified with a degree in Engineering or Geology; and
- Has achieved chartered status (CPEng or CPGeo or RP Geo) and has a minimum 5 years' experience advising on engineering and building works within the Sydney Basin overlying the Newcastle Coal Measures (NCM) and Narrabeen Group Strata (NGS); or
- Is a member or fellow of Engineers Australia or the Australian Institute of Geosciences, or who is eligible for membership of these, who has a minimum of 10 years' experience advising on engineering and building works within the Sydney Basin overlying the NCM and NGS;

If the Geotechnical Engineer or Engineering Geologist is employed by a company the signatory or internal reviewer of the report must have the above minimum qualifications.

6 REQUIREMENTS FOR INVESTIGATION AND GEOTECHNICAL REPORTS

6.1 REPORT CLASSIFICATIONS

Four separate report classifications exist in Lake Macquarie LGA (Class A, B, C and D). The minimum requirements of each report class is identified in Appendix B.

The class of geotechnical report required to support a development application is based on the type of development, the Geo Zone and the planning zone applicable to the site which is detailed in the following sections (also refer to Appendix A for tabulated format).

6.1.1 DEVELOPMENTS (EXCLUDING SUBDIVISION DEVELOPMENT AND SENSITIVE USE FACILITIES)

- Developments (excluding Subdivision Development and Sensitive Use Facilities) that is less than 3 storeys and/or less than 1000m² in Gross Floor Area, within:
 - all LMLEP Planning Zones, and
 - Geo_1, Geo_1A, Geo_1C, Geo_3, Geo_3A or Geo_3C

Report Class Required: **Class B**

- Developments (excluding Subdivision Development and Sensitive Use Facilities) that is less than 3 storeys and/or less than 1000m² in Gross Floor Area, within:
 - all LMLEP Planning Zones, and
 - Geo_2, Geo_2A, or Geo_2C

Report Class Required: **Class A**

- Developments (excluding Subdivision Development and Sensitive Use Facilities) that is less than 3 storeys and/or less than 1000m² in Gross Floor Area, within:
 - all LMLEP Planning Zones, and
 - Geo_4, Geo_5, or Geo_6

Report Class Required: Only if specified by LMCC after site inspection. (If required **Class A**)

- Developments (excluding Subdivision Development and Sensitive Use Facilities) that is 3 storeys or more and/or greater than or equal to 1000m² in Gross Floor Area, within:
 - all LMLEP Planning Zones, and
 - all Geo Zones

Report Class Required: **Class B**; or **Class C** if specified by Council after a site inspection

6.1.2 SUBDIVISION DEVELOPMENT ONLY

- Subdivision Development of any size within:
 - LMLEP Planning Zones: Rural and Transition Zones, Residential Zones, or Environment Protection Zones, and
 - Geo_1, Geo_1A, Geo_1C, Geo_2, Geo_2A, Geo_2C, Geo_3, Geo_3A or Geo_3C

Report Class Required: **Class C**

- Subdivision Development of less than 5 lots, and not including new public road, within:
 - LMLEP Planning Zones: Rural and Transition Zones, Residential Zones, or Environment Protection Zones, and
 - Geo_4, Geo_5 or Geo_6

Report Class Required: Only if specified by LMCC after a site inspection. (If required **Class B**)

- Subdivision Development of 5 or more lots, and/or that includes new public road, within:
 - LMLEP Planning Zones: Rural and Transition Zones, Residential Zones, or Environment Protection Zones, and

- Geo_4 or Geo_5

Report Class Required: **Class B**; or **Class C** if specified by Council after a site inspection

- Subdivision Development of 5 or more lots, and/or that includes new public road, within:
 - LMLEP Planning Zones: Rural and Transition Zones, Residential Zones, or Environment Protection Zones, and
 - Geo_6

Report Class Required: Only if specified by LMCC after a site inspection. (If required **Class B**)

- Subdivision Development of any size within:
 - LMLEP Planning Zones: Business Zones; Industrial and Business Park Zones; Infrastructure Zones; Recreation, or Tourist Special Activity Zones, and
 - Geo_1, Geo_1A, Geo_1C, Geo_2, Geo_2A, Geo_2C, Geo_3, Geo_3A, Geo_3C, or Geo_4

Report Class Required: **Class C**

- Subdivision Development of any size within:
 - LMLEP Planning Zones: Business Zones; Industrial and Business Park Zones; Infrastructure Zones; Recreation, or Tourist Special Activity Zones, and
 - Geo_5 or Geo_6

Report Class Required: **Class B**; or **Class C** if specified by Council after a site inspection

6.1.3 SENSITIVE USE FACILITIES

Sensitive use facilities include (but are not limited to) schools, child care, health care, aged care, and emergency services where any number of people can congregate within.

- Sensitive use facilities within:
 - all LMLEP Planning Zones, and
 - Geo_1, Geo_1A, Geo_1C, Geo_2, Geo_2A, Geo_2C, Geo_3, Geo_3A, Geo_3C or Geo_4

Report Class Required: **Class C**

- Sensitive use facilities within:
 - all LMLEP Planning Zones, and
 - Geo_5 or Geo_6

Report Class Required: **Class A**

- Sensitive use facilities within:
 - all LMLEP Planning Zones, and
 - Geo_5 or Geo_6

Report Class Required: **Class B**; or **Class C** if specified by Council after a site inspection

6.1.4 SITES WITH KNOWN LANDSLIDES OR UNACCEPTABLE RISK

Class D reports are for proposed developments with a known history of landslides including rockfall, (as a guide see Council's [web map showing historical landslides](#)) or a site for which the geotechnical report(s) submitted with a development application (Class A, B or C) indicates an unacceptable risk i.e. very high risk, high risk, moderate risk, unless satisfactorily managed by other controls. There are two types of Class D reports:

- A Class D-1 report is for the design of remedial works to reduce the risk to an acceptable level. In addition to the design, the report also documents the investigations and analysis undertaken, and what monitoring is required after construction to validate the installed remedial works. Council approval of the Class D-1 report is mandatory prior to the commencement of remediation;
- A Class D-2 report is the work-as-executed report and also presents the results of monitoring and inspections during construction that are required to verify that the works were installed as designed and are effective. The report would be required to be submitted prior to occupation of the development.

6.2 MINIMUM SCOPE OF INVESTIGATION AND REPORT CONTENT

When a geotechnical report is required by this guideline (refer to Appendix A) the minimum site investigation and report content is required to comply with the requirements identified in Appendix B.

To ensure that all items required for any given Report Class are included, the “Geotechnical Checklist and Declaration of Report” (refer Appendix C) is required to be submitted with the report. If the items required within Appendix B are omitted from the report, justification must be included in the report. Council may reject the report if the justification is either missing or deemed unacceptable.

The item numbers identified in Appendix B are not intended to define the internal structure of the report. The content listed in the Table is mandatory; however the internal structure of the report is at the discretion of the author.

The report should discuss the geological setting, including stratigraphy, based on published maps (including the NSW Seamless Geology), published data, and other relevant information which may be held by the Geotechnical Consultant.

In general the naming of the geological units should be based on the Unit Name as shown on the NSW Seamless Geology Map and database which can be downloaded from the NSW Planning & Environment – Resources & Environment website.

For areas within the Permian Coal Measures the Unit Name listed in the NSW Seamless Geology is the subgroup. Where it is known or can be inferred, the formation name should also be identified. The relevant names are shown in Appendix E.

The report should comment on tuffs, coal seams or claystone-shales which are within the subgroup or formations identified. For the Permian subcrop, the proximity (direction and distance) to any known coal seam subcrop near the site should be noted.

6.3 GEOTECHNICAL REPORTS OLDER THAN 5 YEARS

Geotechnical reports older than 5 years from the date shown on the report, and/or all reports submitted for a previous (unrelated) development application on the site, will only be accepted by Council if they have been reviewed by a qualified geotechnical consultant who must confirm that:

- The scope of the investigation undertaken for the previous report and the contents of the report are appropriate for the new development;
- If the report includes a site classification to AS2870:2011, confirmation that no cutting or filling has occurred since the site classification was made (refer AS2870:2011 Section 2.5).

6.4 GEOTECHNICAL INSPECTIONS DURING CONSTRUCTION

The report must provide clear recommendations stating whether:

- Further investigation or remedial works are required prior to the commencement of development.
- Minor remedial works required as part of the development.
- Geotechnical inspections are required during development.

6.5 GEOTECHNICAL REPORT SUMMARY TABLE

A Summary Table, as shown in Table 2 below, must be included as the final item in the main text of the report (for all report classes).

Table 2 - Summary Table

Assessed by:	Assessment Date:	
Lot No. and DP:		
House No:		
Street:		
Suburb:		
Site Data	Site Area 1*	Site Area 2*
Site Classification AS28970 (if required)		
Land Slope (degrees)		
Geological Unit and Lithology of underlying bedrock as per Table 2 of Council’s Geotechnical Slope Stability Guidelines		
Description of Surficial Soil		
Type of Slope Stability Hazards (e.g. landslide, rockfall, retaining wall failure). List all reasonably plausible hazards.		
Risk Assessment		
Are remedial works or control measures necessary to achieve an acceptable risk level?		
If remedial works or control measures are required can they be incorporated into the construction process?		
Is the design and installation of remedial works necessary to make the site suitable for development?		
Are geotechnical inspections required during construction?		
Are there risks from adjoining land?		
Does the site or its development present a risk for adjoining land?		

*Add additional columns as required

7 REFERENCES

Hawkins, G, "Report on Q2416 Geotechnical Mapping of the Lake Macquarie LGA Lake Macquarie", Douglas Partners, Report No. 91048.00.R.002.Rev0 dated 30 May 2019

8 APPENDICES

8.1 APPENDIX A – GEOTECHNICAL REPORT CLASS REQUIRED FOR DEVELOPMENT

Table 3 - Geotechnical Report Class Required to Support a Development Application

Proposed Development and/or Landslide Remediation Plan	Proposed Building (and/or)		LMLEP Planning Zones	LMCC Geo-Zones	Report Class Required
	Storeys	Gross Floor Area			
Minor Development such as Garages, Carports, Decks, Pergolas, Fiberglass Swimming Pools and Cut / Fill not exceeding 1 m high /deep.	N/A	N/A	All	All	Only if specified by LMCC after site inspection. (If required Class A)
Sensitive use facilities such as schools, child care, health care, aged care, emergency services; with the capacity of less than 50 people at any one time	N/A	N/A	All	Geo_5 and Geo_6*	Class A
Sensitive use facilities such as schools, child care, health care, aged care, emergency services; with the capacity of 50 people or more at any one time	N/A	N/A	All	Geo_5 and Geo_6*	Class B; or Class C if specified by Council after a site inspection
Sensitive use facilities such as schools, child care, health care, aged care, emergency services; where any number of people can congregate	N/A	N/A	All	Geo_1, Geo_1A, Geo_1C, Geo_2, Geo_2A, Geo_2C, Geo_3, Geo_3A, Geo_3C, Geo_4	Class C
<u>Development not Considered to be Subdivision Only or a Sensitive Use Facility</u>	< 3 storeys	< 1000 m ²	All	Geo_2, Geo_2A, Geo_2C,	Class A
<u>Development not Considered to be Subdivision Only or a Sensitive Use Facility</u>	< 3 storeys	< 1000 m ²	All	Geo_1, Geo_1A, Geo_1C, Geo_3, Geo_3A, Geo_3C	Class B
<u>Development not Considered to be Subdivision Only or a Sensitive Use Facility</u>	< 3 storeys	< 1000 m ²	All	Geo_4, Geo_5 and Geo_6	Only if specified by LMCC after site inspection. (If required Class A)
<u>Development not Considered to be Subdivision Only or a Sensitive Use Facility</u>	≥ 3 storeys	≥ 1000 m ²	All	All Geo Zones*	Class B; or Class C if specified by Council after a site inspection

Proposed Development and/or Landslide Remediation Plan	Proposed Building (and/or)		LMLEP Planning Zones	LMCC Geo-Zones	Report Class Required
	Storeys	Gross Floor Area			
Subdivision only of any size	N/A	N/A	Rural and Transition Zones; Residential Zones; Environment Protection Zones.	Geo_1, Geo_1A, Geo_1C, Geo_2, Geo_2A, Geo_2C, Geo_3, Geo_3A, Geo_3C	Class C
Subdivision only of less than 5 lots and does not include new public road	N/A	N/A	Rural and Transition Zones; Residential Zones; Environment Protection Zones.	Geo_4, Geo_5 and Geo_6	Only if specified by LMCC after a site inspection. (If required Class B)
Subdivision only of 5 or more lots and/or that includes new public road	N/A	N/A	Rural and Transition Zones; Residential Zones; Environment Protection Zones.	Geo_4 and Geo_5	Class B; or Class C if specified by Council after a site inspection
Subdivision only of 5 or more lots and/or that includes new public road	N/A	N/A	Rural and Transition Zones; Residential Zones; Environment Protection Zones.	Geo_6	Only if specified by LMCC after a site inspection. (If required Class B)
Subdivision only of any size	N/A	N/A	Business Zones; Industrial & Business Park; Infrastructure Zones; Recreation, Tourist Special Activities Zones.	Geo_1, Geo_1A, Geo_1C, Geo_2, Geo_2A, Geo_2C, Geo_3, Geo_3A, Geo_3C, Geo_4	Class C
Subdivision only of any size	N/A	N/A	Business Zones; Industrial & Business Park; Infrastructure Zones; Recreation, Tourist Special Activities Zones.	Geo_5 and Geo_6*	Class B; or Class C if specified by Council after a site inspection
Design of remedial works for landslides Only applies to sites where: Current or potential landsliding or rock falls have been identified on or affecting the site and if the resulting risk is unacceptable (Very High Risk, High Risk; Moderate	N/A	N/A	All	All Geo Zones	Class D-1

Proposed Development and/or Landslide Remediation Plan	Proposed Building (and/or)		LMLEP Planning Zones	LMCC Geo-Zones	Report Class Required
	Storeys	Gross Floor Area			
Risk unless satisfactorily managed by other controls)					
Validation of installed remedial works which comprise subsoil drainage by monitoring of in ground installation Where subsoil drainage is required to stabilise current or past instability, an in ground monitoring installation is required. As landsliding is dependent of rainfall the monitoring installation must be monitored for sufficient time to confirm that it is affective.	N/A	N/A	All	All Geo Zones	Class D-2

*Council has the discretion to not require a Geotechnical Slope Stability Report in a Geo_6 zone if site slopes are less than 5° (approx. 9%). A Geotechnical Report may still be required for other aspects of the development unrelated to slope stability.

8.2 APPENDIX B – MINIMUM REQUIREMENTS FOR GEOTECHNICAL INVESTIGATION AND REPORT CONTENT

Table 4 - Minimum Requirements for Geotechnical Investigation and Report Content

Scope	Item	Minimum Requirements for Geotechnical Investigation and Report Content	Report Class			
			Class A	Class B	Class C	Class D
Site Investigation	SI-1	<p>A site inspection (mandatory) including:</p> <ul style="list-style-type: none"> • Vegetation on site • Development on site and adjacent areas[#]. • Slope measurement by clinometer or from survey plan with 1 m or less contour interval if available. • Overland water flow path, if overland flow is present during the inspection. Otherwise inferred overland flow path from geomorphology if possible. • Groundwater seepage at time of inspection and / or evidence of possible intermittent seepage (e.g. staining, erosion, damp patches and vegetation changes) 	Y	Y	Y	Y
	SI-2	<p>Observed slope morphology including:</p> <ul style="list-style-type: none"> • Overall slope and maximum slope based on clinometer measurements or from survey plan with 1 m or less contour interval; • Delineation of site into areas of similar slope; • All slopes to be measured in degrees, they may be recorded in degrees and percentages; • Slope aspect (direction) in degrees with 3 significant figures (eg 037°) or points of compass (eg North West or NW) 	Y	Y	Y	Y
	SI-3	Cut or fill on site and/or adjacent areas	Y	Y	Y	Y
	SI-4	Evidence of soil creep and/or slope instability on site and adjacent areas.	Y	Y	Y	Y
	SI-5	Basic sub-surface investigation by hand auger, hand held dynamic penetrometer or push tube sampler including samples for lot classification to AS 2870:2011 (or latest amended version)	O	Y	O	O
	SI-6	<p>Sub-surface investigation by methods such as:</p> <ul style="list-style-type: none"> • Drill rig including augering, thin walled tube sampling, SPT testing; • Hydraulic push tube sampler; 		O	Y	Y

Scope	Item	Minimum Requirements for Geotechnical Investigation and Report Content	Report Class			
			Class A	Class B	Class C	Class D
		<ul style="list-style-type: none"> Excavation of test pits by hydraulic excavator or backhoe. 				
	SI-7	Sub-surface investigation of bedrock strata by non core and/or core drilling and/or test pits with a hydraulic excavator with single tine ripper and/or hydraulic rock breaker. (Note: Bedrock is considered to be below backhoe refusal.)		O	O	Y
	SI-8	Installation of slotted casing standpipes, piezometers and/or other in-ground monitoring.			O	Y
Report Content	1	Identification of Site by Street Number and Street Name and by Lot No and Deposited Plan. Description of the size and shape of the lot and locality.	Y	Y	Y	Y
	2	A description of work undertaken to provide the assessment	Y	Y	Y	Y
	3	<p>Geological setting, including stratigraphy, based on published maps and published data and other information which may be held by the geotechnical consultant.</p> <p>In general the naming of the geological units should be based on the Unit Name as shown on the NSW-Seamless Geology (NSW-SG) Map and Database, which can be downloaded from the NSW Planning & Environment-Resources & Environment Website.</p> <p>For areas within the Permian Coal Measures the Unit Name within the NSW-SG is the Sub-group. Where possible the Formation Name should also be identified.</p> <p>The report should comment on tuffs or coal seams or claystone-shales which are within the subgroup or formations identified. For the Permian subcrop, the proximity (direction and distance) to any nearby coal seam should be noted.</p>	Y	Y	Y	Y
	4	A site description including all items listed in SI-1	Y	Y	Y	Y
	5	Slope Geomorphology as per SI-2, cut and fill as per SI-3	Y	Y	Y	Y
	6	<p>Evidence of soil creep and/or slope instability on site and adjacent areas as per SI-4.</p> <p>If no evidence of soil slope instability was observed this should be stated in the report.</p>	Y	Y	Y	Y
	7	The results of sub-surface investigation as per SI-5 to SI-7 where these are undertaken	Y	Y	Y	Y

Scope	Item	Minimum Requirements for Geotechnical Investigation and Report Content	Report Class			
			Class A	Class B	Class C	Class D
	8	Logs of boreholes and test pits if undertaken	O	O	Y	Y
	9	Site plan showing: <ul style="list-style-type: none"> • Existing development on site and adjacent areas; • Proposed development footprint or recommended building pad if known; • Delineation of areas of consistent slope and position of breaks in slope, with Slope in degrees (or degrees and percentages), and slope aspect (direction); • Rock outcrop; • Cut and/or fill; • Retaining walls; • Location of bores, test pits and piezometers; • Surface water flow and groundwater seepage; • Areas of instability or soil creep. 	O	Y	Y	Y
	10	Geological Cross Section of site with scale of 1:200 or larger scale showing: <ul style="list-style-type: none"> • Inferred soil and rock profile; • Water table or standing water levels in piezometers. 		O	O	Y
	11	Risk Assessment as per AGS 2007 requirements (Ref 4 and 5 of main text) These should include: <ul style="list-style-type: none"> • Risk assessment of all reasonably plausible slope stability hazards with the potential to impact on the site and development on the site, including short term hazards during construction; • Hazards from the site affecting adjacent areas (e.g. unsupported cuttings or slumping of fill embankments); • Hazards originating on adjacent areas affecting the site. The risk assessment to property will normally be assessed using the qualitative assessment matrices of the AGS 2007 Guidelines (refer Appendix D). In some instances a semi quantitative risk assessment to property based on probability and value of the asset at risk may be appropriate. If the geotechnical consultant perceives a risk to life a semi quantitative assessment is required, as per AGS 2007 Guidelines ^{##} .	Y	Y	Y	Y

Scope	Item	Minimum Requirements for Geotechnical Investigation and Report Content	Report Class			
			Class A	Class B	Class C	Class D
		<p>If the risk rating exceeds the acceptable risk level, control measures must be identified to manage or treat the risk.</p> <p>The report should include a revised risk assessment of the risk level after adopting the control measures.</p>				
	12	<p>Advice from the geotechnical engineer in relation to appropriate development of the site including:</p> <ul style="list-style-type: none"> • Earthworks including maximum cut and fill without additional investigation; • Retaining walls; • Surface and sub-surface drainage; • Suitable footings and allowable bearing pressures; • Site maintenance from a geotechnical view point; • Details of any geotechnical inspection regime to provide adequate notification to the owner, builder, and certifier. 	Y	Y	Y	Y
	13	The report must state whether the site is suitable for development unconditionally or conditionally.	Y	Y	Y	Y
	14	The report must state whether or not additional investigation is required.	Y	Y	Y	Y
	15	If remediation or control measures are required the report must indicate if these can be incorporated into the construction phase, or whether they require specific design and installation prior to the site being acceptable for development.	Y	Y	Y	Y
	16	<p>Report on the Design of Remedial Measures such as large stabilisation berms or subsoil drainage systems and other stabilisation measures which must be installed to make the site suitable for development with an acceptable risk level.</p> <p>The report must specify any post construction monitoring of piezometers or other in ground monitoring devices required to verify that the remedial works are affective prior to the commencement of development on site.</p> <p>The report must identify the requirement for geotechnical inspections at various stages in the remediation works which are necessary to allow the geotechnical engineer to verify that the works have</p>				Y

Scope	Item	Minimum Requirements for Geotechnical Investigation and Report Content	Report Class			
			Class A	Class B	Class C	Class D
		<p>been undertaken in accordance with the remedial design.</p> <p>The report must specify any ongoing maintenance and inspection regimes which apply to the remedial measures.</p>				
	17	<p>Works as executed report for the installation of remedial measures designed as per Item 16. Note that approval by LMCC is required prior to the commencement of such works.</p> <p>The report must include:</p> <ul style="list-style-type: none"> • A plan and or sections showing the location and level of subsurface drainage relative to slide plane, water table and geology; • Location of flushing and inspection access ports to be shown on the plan and/or sections; • A record of geotechnical inspections during construction; • A declaration by the contractor that the remedial works have been undertaken in accordance with the design and have included any modifications directed by the geotechnical engineer during or after geotechnical inspections; • A statement by the Geotechnical consultant that, based on their observations during construction, they believe the works were undertaken in accordance with their design; • Details of the results of the post construction monitoring program to verify that the remedial measures are effective, if required by the design report. 				Y

Notes: # In this Table 'adjacent areas' means area upslope, downslope and to either side of the site;

Refer to "Commentary on Guideline for Landslide Susceptibility, Hazard and Risk Zoning for Land Use Planning" and "Practice Note Guidelines for Landslide Risk Management", Australian Geomechanics Vol 42 No 1 March 2007

Y – Required minimum. If any items labelled Y are omitted from an investigation or report the geotechnical consultant must justify the omission in the report.

O – May be required depending on site conditions and development type

8.3 APPENDIX C – GEOTECHNICAL CHECKLIST AND DECLARATION OF REPORT

Table 5 - Geotechnical Checklist and Declaration of Report

Section 1		Development Application and Site	
Site Address:			
Lot No. and DP			
Owner/Applicant			
Section 2		Geotechnical Report	
Geotechnical Consultant/Firm			
Author			
Internal Reviewer			
Title			
Report No			
Date			
Report Class (A, B, C, D1 or D2)			
Checklist		Items required for relevant class of report	
	Yes	No	In accordance with LMCC Geotechnical Slope Stability Guidelines
Item			Site Investigation
SI1 to SI-4			Has a site inspection been undertaken?
SI-5 to SI-6			Has subsurface investigation been undertaken?
SI-7			Has subsurface investigation of the bedrock been undertaken?
SI-8			Has subsurface monitoring been installed?
Item			Report Content
1			Identification of site by street name and number, lot number and deposited plan. Description of the size and shape of the lot.
2			Description of work undertaken to provide assessment.
3			Geological setting and stratigraphy, with names of Geological Units as per "Unit Name" in NSW-Seamless Geology. Formation Names for Newcastle Coal Measures strata where known.
			Comments on coal seams, tuffs, claystones or claystone-shale where appropriate.
4			Site descriptions including data from site investigation items SI-1 to SI-4.
5			Slope Geomorphology and cut or fill

6		Comment on evidence of slope instability or soil creep, or a statement that no evidence of slope instability was observed.
7		Results of subsurface investigation
8		Logs of boreholes and/or test pits
9		Site plan with details listed in Item 9 of Table 1 in Appendix B in LMCC Geotechnical Slope Stability Guidelines
10		Geological cross section
11		Slope Stability Assessment as per AGS 2007 and requirements of LMCC Geotechnical Slope Stability Guidelines
12		Advice on appropriate development for the site
13		Does the report state if the site is suitable for the proposed development either conditionally or unconditionally?
14		Does the report state whether additional investigation is required?
15		Does the report require geotechnical inspections during construction?
16		Does the report recommend specific remediation to be undertaken during construction?
17		Does the report recommend specific remedial measures which require specific design and implementation prior to the site being acceptable for development?
		Is this report a Class D-1 report for the design of remedial measures which must be implemented prior to the site being acceptable for development?
		Is this report a Class D-2 Works as Executed report with remedial measures required prior to the site being acceptable for development?
Declaration		<p>To be completed by author or internal reviewer of report</p> <p>I am a geotechnical engineer or engineering geologist as per the requirements of LMCC Geotechnical Slope Stability Guidelines, and on behalf of the consultant/firm, I:</p> <p>am aware that the geotechnical report I have either prepared or am technically verifying (referenced above) is to be submitted in support of a development application for the proposed development site (referenced above) and its findings will be relied upon by LMCC in determining the development application and any subsequent certificates that may be required by law, and</p> <p>the report was prepared in accordance with the AGS Guidelines (2007) as amended and LMCC's Geotechnical Slope Stability Guidelines.</p>

**Consultant/Firm
Representative**

Signature:

Name:

Date:

8.4 APPENDIX D – QUALITATIVE RISK MATRICES FROM AUSTRALIAN GEOMECHANICS SOCIETY (2007)

PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007
APPENDIX C: LANDSLIDE RISK ASSESSMENT
QUALITATIVE TERMINOLOGY FOR USE IN ASSESSING RISK TO PROPERTY

QUALITATIVE MEASURES OF LIKELIHOOD

Approximate Annual Probability		Implied Indicative Landslide Recurrence Interval		Description	Descriptor	Level
Indicative Value	Notional Boundary					
10 ⁻¹	5x10 ⁻²	10 years	20 years	The event is expected to occur over the design life.	ALMOST CERTAIN	A
10 ⁻²		100 years		The event will probably occur under adverse conditions over the design life.	LIKELY	B
10 ⁻³	5x10 ⁻³	1000 years	200 years	The event could occur under adverse conditions over the design life.	POSSIBLE	C
10 ⁻⁴	5x10 ⁻⁴	10,000 years	2000 years	The event might occur under very adverse circumstances over the design life.	UNLIKELY	D
10 ⁻⁵	5x10 ⁻⁵	100,000 years	20,000 years	The event is conceivable but only under exceptional circumstances over the design life.	RARE	E
10 ⁻⁶	5x10 ⁻⁶	1,000,000 years	200,000 years	The event is inconceivable or fanciful over the design life.	BARELY CREDIBLE	F

Note: (1) The table should be used from left to right; use Approximate Annual Probability or Description to assign Descriptor, not *vice versa*.

QUALITATIVE MEASURES OF CONSEQUENCES TO PROPERTY

Approximate Cost of Damage		Description	Descriptor	Level
Indicative Value	Notional Boundary			
200%	100%	Structure(s) completely destroyed and/or large scale damage requiring major engineering works for stabilisation. Could cause at least one adjacent property major consequence damage.	CATASTROPHIC	1
60%		Extensive damage to most of structure, and/or extending beyond site boundaries requiring significant stabilisation works. Could cause at least one adjacent property medium consequence damage.	MAJOR	2
20%	40%	Moderate damage to some of structure, and/or significant part of site requiring large stabilisation works. Could cause at least one adjacent property minor consequence damage.	MEDIUM	3
5%	10%	Limited damage to part of structure, and/or part of site requiring some reinstatement stabilisation works.	MINOR	4
0.5%	1%	Little damage. (Note for high probability event (Almost Certain), this category may be subdivided at a notional boundary of 0.1%. See Risk Matrix.)	INSIGNIFICANT	5

- Notes: (2) The Approximate Cost of Damage is expressed as a percentage of market value, being the cost of the improved value of the unaffected property which includes the land plus the unaffected structures.
(3) The Approximate Cost is to be an estimate of the direct cost of the damage, such as the cost of reinstatement of the damaged portion of the property (land plus structures), stabilisation works required to render the site to tolerable risk level for the landslide which has occurred and professional design fees, and consequential costs such as legal fees, temporary accommodation. It does not include additional stabilisation works to address other landslides which may affect the property.
(4) The table should be used from left to right; use Approximate Cost of Damage or Description to assign Descriptor, not *vice versa*

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		CONSEQUENCES TO PROPERTY (With Indicative Approximate Cost of Damage)				
	Indicative Value of Approximate Annual Probability	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

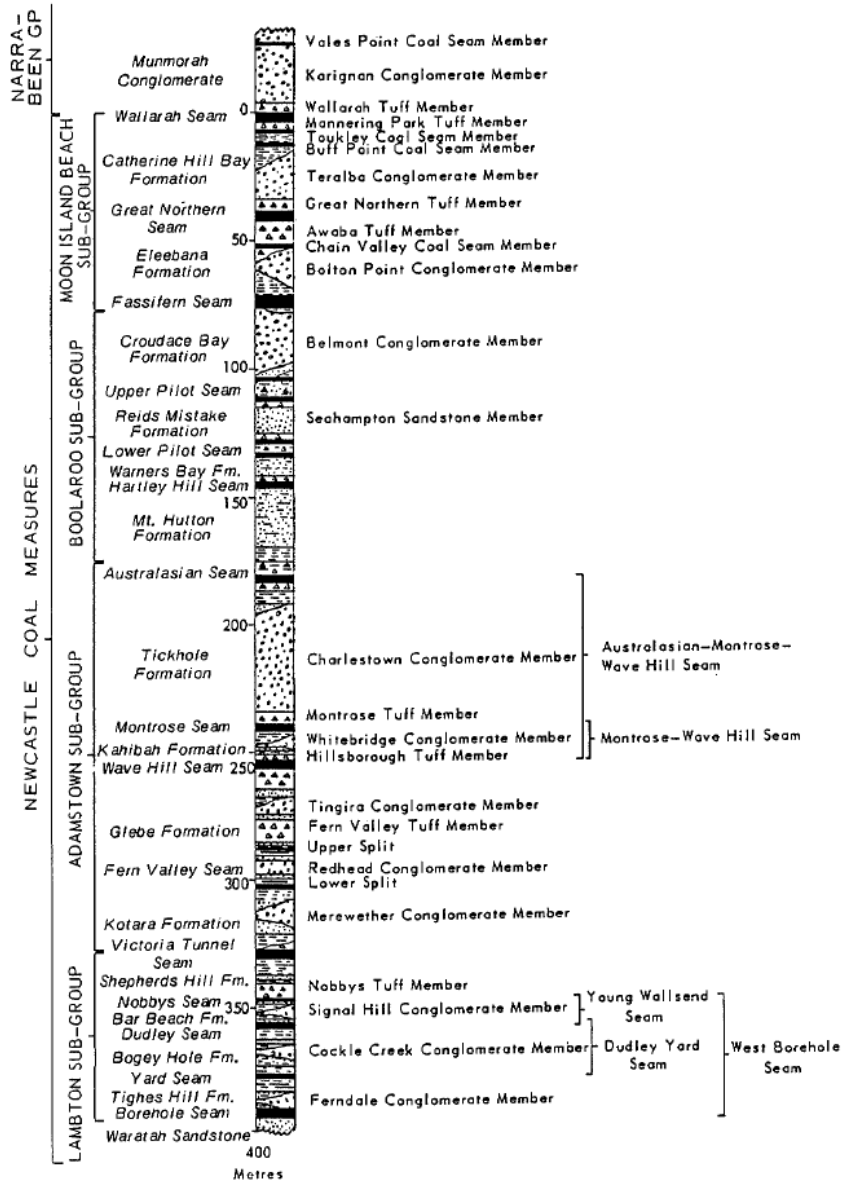
Risk Level		Example Implications (7)
VH	VERY HIGH RISK	Unacceptable without treatment. Extensive detailed investigation and research, planning and implementation of treatment options essential to reduce risk to Low; may be too expensive and not practical. Work likely to cost more than value of the property.
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.

8.5 APPENDIX E – STRATIGRAPHIC COLUMN OF THE NEWCASTLE COAL MEASURES

FELL: LANDSLIDING IN THE GOSFORD-LAKE MACQUARIE-NEWCASTLE AREA 269

Table 2. Stratigraphic column of the Newcastle Coal Measures (Herbert & Helby, 1980).



Reproduced from Fell R, "Landsliding in the Gosford-Lake Macquarie-Newcastle Area", February 1995, Australian Geomechanics Society.

8.6 APPENDIX F – GEOTECHNICAL GUIDELINES QUICK REFERENCE CHECKLIST

- Define the development footprint and add a 20m perimeter so the appropriate Geo Zone can be determined.
- Refer to Section 4 of the guideline for the methodology to be used to determine the applicable Geo Zone i.e. either the most dominant zone by area or the most severe zone, depending on the development type.
- Refer to Appendix A to determine the type of Geotechnical Report Class required for the development.
- Ensure the Geotechnical Consultant meets the qualification and experience requirements of Section 5.
- The Geotechnical Consultant to undertake site investigation and provide a report that complies with the requirements in Appendix B.
- The Geotechnical Consultant to complete the “Geotechnical Checklist and Declaration of Report” contained in Appendix C and submit with the report.
- The Geotechnical Consultant to provide clear recommendations regarding Geotechnical Inspections in accordance with Section 6.4
- The Geotechnical Consultant to provide a summary table in the report in accordance with Section 6.5.