GEOTECHNICAL ASSESSMENT REPORT TEMPLATE

- For use by Chartered Professional Engineer or Professional Engineering Geologist
- Replace this page with Engineer's cover page(s)

CONTENTS

1 INTRODUCTION AND SCOPE

INTRODUCTION

In late January and early February, ex-tropical cyclones Hale and Gabrielle caused two significant rainfall events that affected several communities in Auckland. Cyclone Gabrielle resulted in widespread catastrophic flooding and slope instability in various regions of Auckland. Numerous landslides, rockfalls, and debris avalanches occurred, damaging residential property and infrastructure.

The government decided to categorise properties in the affected areas into categories mentioned on this link (https://www.beehive.govt.nz/release/update-assessment-affected-properties-post-cyclone-and-flooding) with the intent to manage future severe weather event risk.

PURPOSE

The purpose of this report is to undertake a landslide risk assessment using AGS 2007 as per the guidelines provided by Auckland Council (https://www.aucklandcouncil.govt.nz/recovery-extreme-weather-disasters/property-categorisation-resolution/Pages/get-own-geotechnical-report.aspx) and propose potential mitigation options available to mitigate any intolerable risk, to assist Auckland Council and Government in categorising the property.

SCOPE

This report has been prepared in accordance with the scope attached as APPENDIX A: Scope, which was based on Auckland Council document reference AKLCGEO-1790012875-3847.

[Notes for authors guidance are presented in italics bounded by square brackets – these should be deleted or replaced before the report is completed]

		Notes
Street address		
Council Property ID		
Property owner name		
Client organisation		
Client contact name		
EQC/Insurer Claim Number		

Consultant	**Company**		
	Author		
	Reviewer		
	Approver		
Document date issued			
Document version		[start at 1, increase by 1 for each new draft or final issue]	
Document status		Draft / Final	

2 SUMMARY OF INSPECTIONS UNDERTAKEN

Site inspections were undertaken on the following dates:

Date / time	Inspector(s) names	Areas assessed	Inspection intent	Inspection limitations

The following safety hazards were identified on site:

Hazard	Potential mitigation for future site work

3 SUMMARY OF DOCMENTATION REVIEWED

The following documents were reviewed:

Document Date	Title	Author(s) / Organisation	Source of document	Notes

4 SITE DESCRIPTION

The key features of the site are:

	Site Description
Topography	
Geology	
Surface indications of instability [1]	
Cut / fill areas	
Water, springs and overland flow paths	
Site use history	
Vegetation	
Buildings	
Other structures including retaining walls	
Other relevant features	

[1] Note that land damage / landsliding is described in the following section, and is not duplicated here

5 DAMAGE SUMMARY

5.1 HOMEOWNER COMMENTS

The homeowner provided the following commentary:

- *[enter "none" if not provided]*

5.2 BUILDING / STRUCTURE DAMAGE FROM THE EVENT

The following damage was caused to the buildings/structures:

- *[enter "none" if no structural damage has occurred]*

5.3 LAND DAMAGE FROM THE EVENT

The landslide has been described in the NZ Landslides database, and site photographs attached to that report. The URL for the landslide(s) in the database are:

- *[Insert URL here]*

Reports summarising the data and photographs entered have been downloaded from the NZ Landslides Database and are appended to this report in APPENDIX B: NZ Landslides Database Report(s.

5.4 PRE-EXISTING CONDITION OF THE LAND

The following damage existed on site before the event:

- *[None identified, or describe briefly and indicate date and severity if possible]*

The following evidence of instability existed on site before the event:

- *[None identified, or describe briefly and indicate date and severity if possible]*

The following evidence of instability in the surrounding area existed before the event:

- *[None identified, or describe briefly and indicate date and severity if possible]*

5.5 REPAIRS UNDERTAKEN

The following emergency / temporary works have been undertaken:

Date(s)	**Work undertaken** (describe nature of work undertaken, and intent)	**Undertaken by** (name/org)	**Efficacy of work** (describe limitations)

The following permanent repairs have been undertaken:

Date(s)	**Work undertaken** (describe nature of work undertaken, and intent)	**Undertaken by** (name/org)	**Efficacy of work** (describe limitations)

6 LAND STABILITY ASSESSMENT

6.1 ENGINEERING GEOLOGICAL MODEL

The engineering geological model is presented in APPENDIX C: Engineering Geological Model. This is presented as:

- A plan [amend this list as appropriate]
- A cross section through the most critical slope
- Other

Key risks identified relating to the accuracy of the engineering geological model are:

Risk No	Summary of risk / uncertainty	Implications on findings
R1		
R2		
…etc		

6.2 GEOTECHNICAL PARAMETERS USED

[If geotechnical parameters have been derived and used, present them in the table format below, or delete the table and enter "Not applicable"]

Parameter	Best estimate Value	Plausible range	Justification for selected values

6.3 QUALITATIVE STABILITY ANALYSIS

6.3.1 Methodology

[Describe methodology, e.g. mapping of landslides, identification of potential triggers]

6.3.2 Results / findings

[Describe in qualitative terms the relative stability of different parts of the site, and the implications for each residential property on the site or on adjacent sites]

6.3.2.1 Summary of slope stability hazards

Slope stability hazards (including existing landslides and potentially unstable slopes) identified are:

Hazard No	**Brief description of slope stability hazard** (inc. type, location, scale, potential failure mechanism)	**Likely instability triggers for this hazard**
H1		
H2		
…etc		

6.3.2.2 Details of slope stability hazards

Each landslide risk summarised above is detailed in the tables below, along with a comment about the assumptions and uncertainties. For further details on the landslide form see the output from the NZ Landslides Database in Appendix B:

Hazard H1	**Description of landslide**	**Comment on uncertainty and assumptions**
Landslide type (Hungr et al 2014)		
Predominant materials		
Inferred depth of failure and failure mechanism		
Inferred trigger mechanisms relating to 2023 failures		
Other potential trigger mechanisms		

Hazard H1	Description of landslide	Comment on uncertainty and assumptions
Position of ground loss / gain relative to site and building		
Summary of land / assets above landslide		
Summary of land / assets below landslide		
Impact of water, springs and overland flow paths on landslide (inc stormwater / wastewater disposal)		
Other relevant features		

Hazard H2	Description of landslide	Comment on uncertainty and assumptions
Landslide type (Hungr et al 2014)		
Predominant materials		
Inferred depth of failure and failure mechanism		
Inferred trigger mechanisms relating to 2023 failures		

Hazard H2	Description of landslide	Comment on uncertainty and assumptions
Other potential trigger mechanisms		
Position of ground loss / gain relative to site and building		
Summary of land / assets above landslide		
Summary of land / assets below landslide		
Impact of water, springs and overland flow paths on landslide (inc stormwater / wastewater disposal)		
Other relevant features		

6.3.2.3 Summary of features at risk from slope stability hazards

Potentially vulnerable features (e.g. people, structures, assets) are:

Feature No	Feature type	Hazard No (to which the feature may be vulnerable)	Description of how the feature may be vulnerable to the hazard (inc. distance from the hazard, potential consequences)
F1			
F2			
…etc			

6.4 QUANTITIVE STABILITY ANALYSIS

6.4.1 Methodology

[If a quantitative analysis has not been undertaken as part of this study, enter "Not undertaken" here with justification given (for example, not required for this level of study, or insufficient data to undertake reliable modelling)]

6.4.2 Calculations

Calculations are presented in full in APPENDIX D: Calculations.

6.4.3 Results / findings

[Describe the results]

7 UNMITIGATED RISK ASSESSMENT

7.1 RISK OF LOSS OF LIFE

The following scenario(s) have been assessed using the AGS2007c methodology:

Scenario Title	*[Provide the classification of the landslide in accordance with Hungr (2014)]*		
Scenario description	*[Describe scenario 1]*		
	Best estimate Value	**Plausible range[2]**	**Justification for selected values**
$P_{(H)}$			
$P_{(S:H)}$			
$P_{(T:S)}$			
$V_{(D:T)}$			
$R_{(LoL)}$			

Scenario Title	*[Provide the classification of the landslide in accordance with Hungr (2014)]*		
Scenario description	*[Describe scenario 2, delete if not undertaken, duplicate if more scenarios needed]*		
	Best estimate Value	**Plausible range**	**Justification for selected values**
$P_{(H)}$			
$P_{(S:H)}$			
$P_{(T:S)}$			
$V_{(D:T)}$			
$R_{(LoL)}$			

The critical risk to loss of life is:

-

Based on the guidance in the AGS2007 guidelines, this risk is:

[2] Nominally 95th percentile range. It is not anticipated that there will be sufficient data to make a statistical analysis, so this range will be based on expert judgement.

- Acceptable / Tolerable / Intolerable [delete as appropriate]

7.2 RISK OF LOSS OF PROPERTY

The following scenario(s) have been assessed using the AGS2007c methodology:

Scenario Title	*[Provide the classification of the landslide in accordance with Hungr (2014)]*		
Scenario description	*[Describe scenario 1]*		
	Best estimate Value	**Plausible range**	**Justification for selected values**
Likelihood (Indicative Value of Approximate Annual Probability)			
Likelihood [3] (Category)			
Consequences to property			
Risk level			

Scenario Title	*[Provide the classification of the landslide in accordance with Hungr (2014)]*		
Scenario description	*[Describe scenario 2, delete if not undertaken, duplicate if more scenarios needed]*		
	Best estimate Value	**Plausible range**	**Justification for selected values**
Likelihood (Indicative Value of Approximate Annual Probability)			
Likelihood [4] (Category)			

[3] See AGS2007c Appendix C

[4] See AGS2007c Appendix C

Scenario Title	*[Provide the classification of the landslide in accordance with Hungr (2014)]*		
Scenario description	*[Describe scenario 2, delete if not undertaken, duplicate if more scenarios needed]*		
	Best estimate Value	**Plausible range**	**Justification for selected values**
Consequences to property			
Risk level			

The critical risk to property is:

- Very high / High / Moderate / Low / Very Low [delete as appropriate]

Based on the guidance in the AGS2007 guidelines, this risk is:

- Acceptable / Usually acceptable / May be tolerated / Unacceptable without treatment [delete as appropriate]

8 MITIGATION METHODOLOGY

8.1 LONG-TERM MITIGATION OPTIONS CONSIDERED

The following options have been considered to provide long-term mitigation of the identified risks:

Option No	Description of option	Likely cost[5]	Residual long-term risk once implemented	
			to life	to property
L1				
L2				
…etc				

8.2 SHORT-TERM MITIGATION OPTIONS CONSIDERED

Option No	Description of option	Likely cost[6]	Residual short-term risk once implemented	
			to life	to property
S1				
S2				
…etc				

8.3 RECOMMENDED LONG-TERM MITIGATION OPTION DETAILS

The following option is considered to be the most cost-effective practical option which will reduce the risk to at least a tolerable level:

- Option L1 / L2 / S2 *[select one or replace as appropriate]*

[5] Full cost including design, consenting and construction. Costs to P50 (see Note 7 for explanation), may be given as a range where uncertainty is higher.

[6] Full cost including design, consenting and construction. Costs to P50 (see Note 7 for explanation), may be given as a range where uncertainty is higher.

A sketch of this option is presented in Appendix G.

It is considered feasible to design and construct this option in the following timeframe:

- Less than a year / Less than two years / Two to three years / More than three years *[select one or replace as appropriate, note that remedial option that take more than two years might not meet the requirements of Category 2 work]*

[Provide a list of items with likely costs for the preferred option. Give enough detail to allow checking by a quantity surveyor – for construction this is expected to go to the detail of likely wall dimensions (e.g. wall length, post lengths/diameters/materials). Add a new line to the table for each described item if required.]

Stage	Item(s)	Likely cost (P50) [7]	Estimated cost range	
			Minimum (P10)	Maximum (P90)
Investigation				
Design				
Consenting				
Construction	*[e.g Timber pole retaining wall, 15m long, 300SED timber poles at 0.9m centres, each 5m long]*			
Construction	*[e.g. Site clearance]*			
Construction supervision				
Operational (annualised)				
Maintenance (annualised)				
End-of-life				

[7] Cost confidence presented as the probability that the cost will not exceed the likely cost given. Cost estimates can be reported at 'P10', 'P50' and 'P90' levels. P90 represents the estimate of costs such that there is a 90 per cent probability of the project being delivered within that cost estimate. P50 represents the estimate of costs such that there is a 50 per cent probability of the project being delivered within that cost estimate.

Stage	Item(s)	Likely cost (P50) [7]	Estimated cost range	
			Minimum (P10)	Maximum (P90)
	TOTALS			

This pricing has taken into account the following construction considerations:

Construction considerations	Description (incl impact on solution)	Difficulty level			
		Easy	Moderate	Hard	N/A
Consenting					
Construction access					
Earthworks					
Constructability					
Maintenance					
…etc					

The following risks and assumptions should be considered when using the above estimates:

Risk / Assumption name	Description (incl impact on solution)	Likelihood of impact occuring	Cost implications if impact occurs
Risk 1			
…etc			

9 RBA PLACARD

9.1 SUMMARY OF CURRENT SITUATION

	Current situation
RBA placard applied	
Mitigation undertaken since RBA placard applied	
Changes in hazard or risk since RBA placard applied	

9.2 RECOMMENDED MITIGATION ACTIONS

[Describe which of the short-term mitigation options presented in Section 8.2 should be implemented before a downgrade to the RBA placard is considered]

10 ADDITIONAL INFORMATION REQUIRED

10.1 UNCERTAINTY

[Describe the level of uncertainty in your findings]

10.2 ADDITIONAL INFORMATION REQUIRED

[Describe additional information required to reduce the uncertainty]

[If geotechnical investigations are required to reduce the uncertainty, provide a scope of works in APPENDIX F: Draft scope for further investigation. This shall be in the format of the New Zealand Ground Investigation Specification Volume 2.]

Summary of information required	Summary of scope to acquire this information (reference appendix where appropriate)	Likely cost[8]	Benefits

11 LIMITATIONS

[Describe any limitations in the report or assessment]

[8] Full cost including supervision, consenting and reporting. Costs to ±50%, may be given as a range where uncertainty is higher.

APPENDIX A: SCOPE

FORMAT

The report is presented using the template provided by the Auckland Council (https://www.aucklandcouncil.govt.nz/recovery-extreme-weather-disasters/property-categorisation-resolution/Pages/get-own-geotechnical-report.aspx)

PRELIMINARY ASSESSMENT

Preliminary Geotechnical & Damage Assessment (Factual)

Review the background information about the property that is attached provided by Auckland Council or easily publicly available, carry out an appropriate desktop and onsite visual inspection to assess any land damage and develop an Engineering Geological Model. The assessment must include a review of the property file should be reviewed prior to attending site.

Damage to be reported

Identify and explain the following (with supporting evidence):

- land damage that has been caused by the event
- work that has been carried out to repair the land damage and any aspect of that work considered inadequate
- pre-existing conditions or damage to the land that have been exacerbated by the event
- conditions or damage to the land you consider to be pre-existing and not exacerbated by the event
- Sources of off-site risk

  Where the property is damaged by, or at risk from, land instability, the full extent of the unstable land shall be assessed. A complete engineering geological model of the full feature (not limited to the subject site) shall be generated. Where such an investigation is not able to be achieved (for example, through an inability to obtain rights to access the land) these limitations shall be clearly explained in the report and conservative assumptions made about the scale of the land instability.

- Landslide data and map

  Where a landslide has occurred, it shall be mapped into the NZ Landslides Database. If the landslide has already been created in the NZ Landslides Database, the record shall be updated to reflect the findings of the site assessment (a duplication of entries shall be avoided).
  Data entered into the NZ Landslides Database does not need to be re-entered into the report, except as an attachment directly exported from the NZ Landslides Database. The report shall present the unique ID of the landslide from the NZ Landslides Database as a URL to allow the Territorial Authority to easily review the data.

Supporting information

- The report shall contain appropriate photographs, test results, and diagrams to illustrate the points being made.
- Include a scaled site plan so that a reader can understand the property layout and land damage locations.
- These photographs, test results, diagrams and plans do not need to be duplicated if they are also presented in the output from the NZ Landslides Database and appended to the report.

- Identify any house or outbuilding damage that is relevant to the land damage, including evidence of structural damage, foundation dishevelment and settlement or movement and cosmetic damage to cladding and linings. Your report should also discuss how the levels and variances relate to the land damage.
- Identify where this report agrees or disagrees with any other engineering report/s on the property and provide reasons as to why it agrees or disagree.

Land Stability Assessment (Interpretative)

Undertake a qualitative assessment of the stability of land which may affect the safe use of the property.
In the report, present the following (with supporting evidence appended):

- An Engineering Geological Model including a cross-section or cross sections (to scale, and showing the structures and property boundaries) through:
  - The centreline of any landslides.
  - The most critical section for slope stability hazard relative to the property.

Unmitigated Risk Assessment

Risk of loss of life

Undertake a quantitative assessment of the Annual Individual Fatality Risk for users of the property in accordance with AGS (2007c) Practice Note Guidelines for Landslide Risk Management 2007 section 7.
In your report, present the following (with supporting evidence and calculations appended):

- A best estimate of Annual Individual Fatality Risk for each residential building potentially exposed to a landslide.
- An evaluation of the sensitivity arising from uncertainty.
- All parameters used in the assessment.

If an individual vulnerability, $V_{(D:T)}$, of less than 0.8 is selected, convincing evidence shall be presented to justify why the building is unlikely to collapse or to be inundated with debris.

At least one such assessment shall be a scenario based on the event. Where different reasonable combinations of different input values may result in higher $R_{(LoL)}$ – for example, a more frequent event with only slightly lower consequences – these other combinations shall also be assessed and presented in the same table format.

Risk of loss of property

Undertake a qualitative risk assessment for the risk to property in accordance with AGS (2007c) Practice Note Guidelines for Landslide Risk Management 2007 Appendix C.
In your report, present the following (with supporting evidence):

- A best estimate of qualitative level of risk to property.
- An evaluation of the sensitivity arising from uncertainty.

Reinstatement / Risk Mitigation methodology

If an intolerable risk to life or property caused by geotechnical conditions is identified, provide opinion on whether the long-term risk can be reduced to a tolerable or acceptable level**.**
As part of providing opinion:

- if the land damage cannot be remedied or fully remedied, explain why;
- if there are any conditions, damage, alterations or renovations that predate the event and/or prevent reinstatement of the land to the required standard, please explain why.

If the risk can be reduced to a tolerable or acceptable level, describe the methodology needed to achieve this, and outline the expected scope of works to be completed as part of the construction programme. If there is more than one appropriate and feasible methodology for reinstatement to the required standard,

please describe the functional advantages and disadvantages of each possible methodology and state the residual risk to life and property once the mitigation measures are in place.
Your recommended remediation methodology should present a cost estimate for each option as P10, P50 and P90 estimates (cost estimate accuracy ±50%) and be sufficiently detailed to allow an estimator to prepare a costed scope of works based on your report.
Reinstatement or risk reduction methodologies should be divided into short-term (to enable use of the property for a period of a year) and long-term (to enable ongoing use of the property).

Placard Review

Where the property has been assigned a placard as part of a Rapid Building Assessment process, provide a information to enable the Territorial Authority to undertake an appropriately informed review of the placard. In the report:

- State the current placard type
- Describe any mitigation that has occurred since the placard was placed
- Describe any other change that may alter the risk that has occurred since the placard was placed
- Describe the present risk to life (not long-term risk or risk to property)
- If the present risk to life is intolerable, describe which of the mitigation actions need to be completed so that the present risk is tolerable or acceptable.

Mitigated Risk Assessment

Undertake a risk assessment in accordance with AGS2007c. In the report present:

- The unmitigated risk
- The mitigated risk (for each of the risk reduction methodologies presented in the previous section)

Additional information required

Where there is uncertainty in the Engineering Geological Model, or where the risk is marginal and needs further information to refine and confirm a more accurate risk assessment, provide:

- A commentary on the uncertainty.
- A description of any additional investigations or assessments needed to complete your assessment of the reinstatement recommendations.
- Where intrusive geotechnical investigations are required, present:
  - A draft scope in the format of the New Zealand Ground Investigation Specification Volume 2
  - A cost estimate for the investigation, including reporting and subsequent secondary assessment as described in the following section (cost estimate accuracy ±30%)

APPENDIX B: NZ LANDSLIDES DATABASE REPORT(S)

APPENDIX C: ENGINEERING GEOLOGICAL MODEL

APPENDIX D: CALCULATIONS

APPENDIX E: OTHER SUPPORTING INFORMATION

APPENDIX F: DRAFT SCOPE FOR FURTHER INVESTIGATION

APPENDIX G: CONCEPTUAL REMEDIAL WORKS

APPENDIX H: COSTING DETAILS FOR CONCEPTUAL REMEDIAL WORKS (WHERE REQUIRED)