

Before Independent Commissioners

In Taupō

Under the Resource Management Act 1991 (the Act)

In the matter of Plan Change 37 – Nukuhau

**Statement of evidence of Geoffrey Burnett Farquhar for the Taupō
District Council (Geotechnical)**

Dated 6 October 2021

1 Summary of evidence

- 1.1 In the Geotechnical Report accompanying the Plan Change request, WSP carried out further work to address my comments on their pre-application version of the Geotechnical Report.
- 1.2 The landform currently consists of gently rolling farm paddocks and lifestyle blocks, with some residential dwellings and implement sheds. The land is crossed with gullies, some deeply incised (up to 5m) with steep sides. Two dominant gullies extend northwards from the Brentwood Gully across the 3 parcels of land in that area. Some gullies have had fill put in them. Some small tomos are evident across the land.
- 1.3 I consider that the Geotechnical Report adequately characterises the geology, geomorphology, ground conditions and groundwater conditions. Sufficient investigations have been undertaken to characterise the geomorphology and geotechnical characteristics of the land.
- 1.4 Sufficient work has been undertaken to identify and assess geotechnical constraints and the range of natural hazards that may affect the land and constrain residential development. The principal constraints are:
- a Building setback from the crest of gully slopes (which are not modified by earthworks).
 - b Areas of non-engineered filled ground.
 - c Existence of tomos and need to manage stormwater.
 - d The fault identified in the north-western corner of the land and associated fault avoidance zone.
 - e Perched groundwater levels.
 - f Possible liquefaction potential.
 - g Earthworks.
- 1.5 I consider that those constraints can be addressed through further geotechnical investigation and assessment, and engineering controls and land engineering works at subdivision stage, as per industry practice and as set out in the Outline Development Plan submitted with the Plan Change.
- 1.6 Overall I consider the geotechnical information provided to support the Private Plan Change satisfactorily demonstrates that the land is suitable for residential / urban development.

2 Introduction

- 2.1 My name is Geoffrey Burnett Farquhar. I hold the role of Technical Director – Dams and Geotechnical at GHD Limited. I am a Chartered Professional Engineer with 42 years' experience. Details of my qualifications and experience are given in Annexure 1 (refer to section 10).
- 2.2 My role in relation to Private Plan Change 37 (PPC37) to rezone approximately 78 hectares of land and enable creation of 780 new residential lots and a neighbourhood centre is as part of the s42A Reporting Team. I have been requested to consider the Plan Change Request and associated submissions on geotechnical matters.

3 Code of conduct

- 3.1 While this is not a hearing before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2014 and that I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

4 Scope of evidence

- 4.1 I have prepared evidence in relationship to my review of the Geotechnical Report submitted as part of the Plan Change request (Nukuhau Structure Plan - Geotechnical Report, WSP, 27 October 2020, Revision 5).
- 4.2 I have not undertaken a site visit at the time of preparing this evidence but am broadly familiar with the northern portion of the land from my review of the geotechnical aspects of the Notice for Requirement application for the West Kinloch Arterial route in 2007. I will undertake a site visit prior to the Hearing, and will accordingly inform the Panel of any amendments to this evidence where necessary. I have familiarised myself with the site through online aerial and street view imagery, and in particular site photographs in the following assessments accompanying the Plan Change request :
- a Nukuhau Structure Plan – Geotechnical Report (dated 27 October 2020)
 - b Nukuhau Taupō Plan Change – Detailed Site Investigation (dated September 2019)
 - c Nukuhau Private Plan Change – Landscape and Visual Assessment (dated 20 October 2020)

5 The Proposal

- 5.1 The Plan Change request seeks to change the zoning of 77.78 hectares of Rural Environment zoned land to a mix of General Residential and Medium Density Residential, with a Neighbourhood Shopping Centre and areas of stormwater and recreation reserves. The Plan Change will enable the future development of approximately 780 dwellings. The land is in six parcels.

6 The land and geology

- 6.1 The landform currently consists of gently rolling farm paddocks and lifestyle blocks, with some residential dwellings and implement sheds. The land is crossed with gullies, some deeply incised (up to 5m) with steep sides. Two dominant gullies extend northwards from the Brentwood Gully across the 3 parcels of land in that area. Some gullies have had fill put in them. Some small tomos are evident across the land.
- 6.2 The geology comprises mainly pumice sands of the Taupō Pumice Formation, while some areas may comprise pumice sands of the Oruanui Formation. Likely surficial soil types are pumice sands and ashy silts with the possibility of zones of silt and clay in some areas.
- 6.3 GNS Science identify four active faults with several splays within a 5 km radius of the land. Taupō District Council's online fault line mapping shows a recently identified fault and associated fault avoidance zone (either side of this identified fault) crossing the northwest corner of the land.

7 Review of Geotechnical Report

- 7.1 I reviewed Revision 4 of the Geotechnical Report (9 December 2019) prior to the Pan Change request and provided comments and questions for WSP to address. My review letter is presented in Annexure 2 (refer to section 11). The areas for WSP to address are summarised as follows:
- a Constraints and risks presented by gullies and tomos
 - b Liquefaction potential and mitigation strategies
 - c Earthworks constraints
 - d Hazard due to stormwater disposal
 - e Other geotechnical hazards
- 7.2 WSP carried out further work to address my comments and the results of that work are presented in the Geotechnical Report accompanying the Plan Change request (i.e. Revision 5 of WSP's report dated 27 October 2020). My evidence focuses solely on Revision 5 of WSP's report.

- 7.3 To make a recommendation on suitability of the land for future residential development, and comment on the efficiency and effectiveness of such development (in geotechnical terms), I would expect the accompanying Geotechnical Report to include:
- a Geology
 - b Geotechnical investigations
 - c Interpretation of ground and groundwater conditions
 - d Identification, risk assessment and mitigation measures for geo-hazards that have the potential land and buildings (e.g. stability, liquefaction, lateral spreading, fault rupture, earthquake shaking, fault rupture, tomos, geothermal settlement, stormwater disposal)
 - e Identification and assessment of geotechnical constraints on residential development including earthworks, settlement, stability, building foundation types, expansive soils)
- 7.4 I would expect the Report to use or reference the following standards and guidelines:
- a NZS 3604:2011 Timber-framed buildings
 - b NZS 1170.5:2004 Structural design actions
 - c NZS 4404:2010 Land development and subdivision infrastructure
 - d EQC, MBIE & MfE - Planning and engineering guidance for potentially liquefaction-prone land (2017)
 - e MfE & GNS - Planning for development of land on or close to active faults (2003)
 - f New Zealand Geotechnical Society – Field description of soil and rock (2005); Guideline for hand held shear vane test (2001)
 - g Ministry of Business, Innovation and Employment Earthquake Geotechnical Engineering Practice Modules
 - h Waka Kotahi New Zealand Transport Agency Bridge Manual 2018
 - i GNS active faults database
 - j Taupō District Council active fault maps
 - k Taupō District Council Code of Practice for the Development of Land (2009)

- 7.5 I consider that the report adequately characterises the geology, geomorphology, ground conditions and groundwater conditions.
- 7.6 Sufficient investigations have been undertaken to characterise the geomorphology and geotechnical characteristics of the land. I consider this to be the case based on industry practice for this geology.
- 7.7 Sufficient work has been undertaken to identify and assess geotechnical constraints and the range of natural hazards that may affect the land and constrain residential development. The principal constraints are:
- a Building setback from the crest of gully slopes (which are not modified by earthworks). Sufficient stability analyses have been performed to assess that a setback will be required. While a setback constrains the location of buildings adjacent to gullies it does not preclude overall residential development of the land.
 - b Areas of non-engineered filled ground. In this geology such areas would be expected in gullies. Non-engineered fill can be compressible and unsuitable to support buildings. Several areas of filled ground have been identified that will require further assessment as to their suitability for building on or incorporating into earthworks. That would typically be done at subdivision consent stage. Present indications are that the filled ground does not constrain or preclude overall residential development of the land.
 - c Existence of tomos and need to manage stormwater. Present indications are that tomos are not pervasive to the extent that they would constrain or preclude overall residential development of the land. However, they will need further assessment at subdivision consent stage to determine what measures should be undertaken with stormwater to avoid creation of tomos and what measures should be taken with building and land development to mitigate their effects. The need to manage stormwater infiltration with respect to the risk of tomos is also identified in Section 8.3 of the Stormwater Report (Nukuhau Plan Change – Stormwater Management, WSP, 23 October 2020).
 - d Fault. The fault identified in the north-western corner of the land and associated fault avoidance zone are sufficiently defined so that development can be precluded in that area of land.
 - e Perched groundwater levels. These need further assessment at subdivision consent stage to determine what measures should be undertaken with mitigate their effects in terms of slope stability, stormwater disposal and planned earthworks.
 - f Possible liquefaction potential. A Level C (detailed area-wide assessment) in terms of 'Planning and engineering guidance for potentially liquefaction-prone land (2017)' has been

undertaken and the density of deep ground investigations meets the guidance for a Level C assessment.

- g Earthworks. Earthworks anticipated with development of the land are not anticipated to be inappropriate in terms of typical urbanisation of greenfield areas.

7.8 I consider that those constraints can be addressed through further geotechnical investigation and assessment, and engineering controls and land engineering works at subdivision stage, as per industry practice and as set out in the Outline Development Plan submitted with the Plan Change.

8 Submissions

8.1 I have reviewed a summary of submissions and identified four submissions with comments related to geotechnical aspects. I comment on each of the submissions as follows.

8.2 Submission 18, Point 8.4 (Thomas Hendricks). Building set back from gully slopes. Mr Hendricks supports the recommended 10m building setback from the crest of gully slopes (as mentioned on page 27 of Appendix I - Geotechnical Report), due to “the cliff edges and anticipated potential for slips within 6m of cliff edges”. I support the recommendation for a building set back for stability reasons but note that the actual set back distance should be determined for each gully slope at the time of subdivision consent. This is normally done during engineering design when the final landform is proposed and following specific geotechnical investigations and assessment of stability. Existing statutory procedures for engineering approvals at subdivision consent should ensure the set back determination is assessed at that time.

8.3 Submission 18, Point 8.10 (Thomas Hendricks). Fault avoidance zone. Mr Hendricks seeks amendment to keep the fault avoidance zone identified in the Geotechnical Report free from residences and to offset this with extra floor for buildings in medium density. I support the comment about the fault avoidance zone and note that the fault avoidance zone is defined in geotechnical hazard assessment to prevent building in the area adjacent to the identified fault trace. This allows for the uncertainties in locating fault traces and defining where fault rupture effects might occur on the ground surface. The associated comment about allowing an offset of extra floors on buildings is outside my area of expertise.

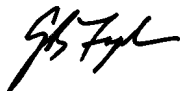
8.4 Submission 18, Point 8.16 (Thomas Hendricks). Geotechnical Report. Mr Hendricks supports the Appendix I Geotechnical Report. I have no comment on Mr Hendrick’s support of the report.

8.5 Submission 34 (Tukairangi Trust - Peter Marshall). Gullies. The trust seeks amendment so that large planted soil conservation areas should be set aside using existing gullies and overland water flow patterns to cope with increased run off from hard surfaces and stormwater. I support the trust’s use of gullies for stormwater management with engineering measures to prevent erosion.

- 8.6 Submission 43 (Waikato Regional Council). Provision 1. Proposed gully realignment. Council seeks amendments to the proposal to avoid effects to the existing gully system, including the requirement for a Gully Management Plan. Council's reasons are that to recreate the same hydraulic conditions and mitigate all effects is difficult to achieve as the pumice soils in the Taupō area are highly erosive and the realigned gullies will be difficult to maintain on a permanent basis. I support this reasoning based on the results of WSP's Geotechnical Report and my experience of the difficulty of controlling erosion in pumice soils.
- 8.7 Submission 53 (Lakes & Waterways Action Group Trust - Jane Penton). Proposed gully realignment. The trust recommends that the gullies not be modified as pumice soils are prone to erosion and are valuable stormwater management assets in their natural form. I support this reasoning based on the results of WSP's Geotechnical Report and my experience of the difficulty of controlling erosion in pumice soils.

9 Conclusions

- 9.1 I consider the geotechnical information provided to support the Private Plan Change satisfactorily demonstrates that the land is suitable for residential / urban development.
- 9.2 I consider that sufficient investigations and assessment have been performed to adequately identify the geotechnical hazards and constraints in developing the land.
- 9.3 I consider that those constraints can be addressed through further geotechnical investigation and assessment, and engineering controls and land engineering works at subdivision stage, as per industry practice and as set out in the Outline Development Plan submitted with the Plan Change.
- 9.4 Earthworks anticipated with development are not anticipated to be inappropriate in terms of typical urbanisation of greenfield areas.



Geoffrey Burnett Farquhar

6 October 2021

10 Annexure 1 – Qualifications and experience

- 10.1 I hold the role of Technical Director – Dams and Geotechnical at GHD Limited, a role I have held since 2015. I am a Geotechnical and Dams Engineer with 42 years' experience. I hold a Bachelor of Engineering (Civil) from the University of Auckland, a Bachelor of Divinity from the University of Otago, a Master of Science and Diploma of Imperial College from the University of London. I am a Chartered Professional Engineer and an International Professional Engineer (NZ). I am a Chartered Engineer in the United Kingdom. I am a Fellow of Engineering New Zealand and a Fellow of the Institution of Civil Engineers (London). I am a member of the following technical societies: New Zealand Geotechnical Society, New Zealand National Society for Earthquake Engineering, New Zealand Tunnelling Society, New Zealand Society on Large Dams and the New Zealand Hydropower Group.
- 10.2 I have recent and relevant experience as a geotechnical engineering specialist. Recent and current projects include the Public Private Partnership SH1 motorway extension from Puhoi to Warkworth (procurement of PPP and technical advisory services for Waka Kotahi New Zealand Transport Agency during design and construction); Waimea Community Dam (Nelson); Rotokauri private plan change (Hamilton); school buildings for the Ministry of Education (throughout NZ); Resource Consent reviews for land subdivision (Thames- Coromandel District Council); member of expert engineering panel for Greater Christchurch Claims Resolution Service (earthquake damage insurance claims for residential buildings).



9 April 2020

Hilary Samuel
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Our ref: 12528638

Your ref:

Dear Hilary

Nukuhau Private Plan Change Geotechnical Peer Review

1 Scope of review

This letter provides an initial review of the geotechnical report that will be submitted in support of the plan change. The purpose of this initial review is to identify information gaps or significant issues. The report reviewed is:

- Nukuhau Structure Plan Geotechnical Report, WSP (there are three document dates and two revision/issue numbers in the report, i.e. Issue 1, 16 October 2019; Revision 4, 9 December 2019; footer date 7 August 2019)

2 Summary

The report relies on opinion as to the suitability of the land for residential development. While the opinion may be correct, there is insufficient data to substantiate the opinion. Further work is required to provide data and further assessment is required to confirm the viability of the land for residential development.

3 Specific comments

3.1 Scope of assessment

The report states in the introduction (Section 1) that 'WSP undertook a preliminary general ground investigation' and'a high-level investigation to gauge sufficient and easily identifiable geotechnical constraints to the proposed change of use and subsequent development' rather than 'a detailed investigation'. This objective should be reconsidered in light of our review comments in this letter.

3.2 Geomorphology

The following questions need to be addressed. What constraints do the identified major gullies (Section 3.4) present to land development? Do other gullies on the land present any constraints? Why is it recommended that dwellings should be offset from steep sided gullies (Section 10)? Can the risks be mitigated during subdivision development? If so, how could they typically be mitigated? How pervasive

are the tomos and what risks/constraints do they provide to subdivision development? What strategies will mitigate the tomo risks in stormwater flow paths and gullies (Section 10)?

3.3 Investigations

Subsurface investigations (Section 4) comprised four shallow hand augerholes. Deep investigations were not undertaken. The basis for assessing ground conditions in that manner needs to be provided. Other data/evidence, e.g. deep ground information from adjacent subdivisions, might be relevant. Deeper investigations should be considered together with the location of the groundwater table to confirm the viability of the land for residential development.

3.4 Liquefaction

Liquefaction potential (section 6) needs to be assessed for plan change not during individual site investigations. Sufficient assessment needs to be undertaken to demonstrate that liquefaction does not present risks to residential land development. Feasible mitigation strategies should be identified if there are risks.

3.5 Bulk earthworks

The likely extent of bulk earthworks (cut and fill depths) should be considered so that their feasibility can be confirmed. Do earthworks provide any constraints to residential land development?

3.6 Stormwater disposal

The report states in the introduction (Section 1) that 'This report details the findings with special emphasis on 'Development constraints potential stormwater disposal methodologies anticipated level of additional geotechnical investigation, modelling and reporting to accompany subdivision consents'.

Section 9.2 touches on disposal methodologies. However, it appears that the topic is dealt with in a separate Stormwater Strategy Report. Section 10 states that the Stormwater Report will supersede the requirements of the geotechnical report. However, stormwater disposal needs to be fully assessed in the geotechnical report as it can cause a geotechnical hazard.

3.7 Other geohazards

Other geotechnical hazards (e.g. slope stability, expansive soils, geothermal induced settlement, lateral spreading/ground deformation during an earthquake) should be assessed in the report so that it is clear whether they are relevant and whether there is a potential for them to constrain residential development of the land.

Sincerely
GHD Limited



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11 Annexure 2 – Geotechnical Peer Review (GHD letter dated 9 April 2020)