



14 July 2022

Jane Doogue
Nelson City Council
110 Trafalgar Street
Nelson 7010

Peer Review – Tahunanui Level B Liquefaction Assessment Report

5-G3431.53-001-LR-Rev0

Dear Jane,

1 Introduction

At the request of the Nelson City Council¹, WSP New Zealand Limited (WSP) has reviewed the Tahunanui Level B Liquefaction Assessment Report prepared by Beca Limited (Beca) dated 13 April 2022². Beca were commissioned by the Nelson City Council to complete a liquefaction vulnerability assessment of the Tahunanui area to a 'Level B – Calibrated Desktop Assessment' level of detail as per the joint MBIE guidance³ (MBIE 2017).

WSP's peer review is undertaken to:

- Ensure that the Level B assessment completed by Beca meets the requirements of a Level B assessments under the MBIE 2017 national guidance '*Planning and engineering guidance for potentially liquefaction-prone land*', and
- Confirm that the findings of the assessment with regard to liquefaction categories assigned within the study area.

Specifically, WSP have reviewed the following aspects of the Beca report:

- The geomorphic assessment used to identify local features for relevance to the liquefaction assessment.
- The extent and types of deep geotechnical investigation data used in the report.
- The depth of groundwater assumed in the report.
- The design earthquake scenarios used in the liquefaction assessment.
- The methodology used to complete the quantitative liquefaction assessment.
- The assigned liquefaction susceptibility of the Tahunanui area.

¹ Nelson City Council, 2022. Offer of Service – Peer Review of Nelson Liquefaction Assessment prepared by Beca, dated 2 May 2022.

² Beca Limited, 2021. Tahunanui Level B Liquefaction Assessment, prepared for Nelson City Council. Reference No. 3160254-306125624-30, revision A_DRAFT, dated 13 April 2022

³ MBIE, 2017. Planning and Engineering guidance for potentially liquefaction-prone land Resource Management Act and Building Act aspects. ISBN (online) 978-1-98-851770-4, Rev0.1, issued September 2017.

WSP have reviewed the technical aspect of the Beca report only. We have not reviewed the spelling, grammar or structure of the report. Nelson City Council has provided WSP with documentation to support the review^{2,4, 5,6}.

2 Geotechnical Review

The following sections of this letter address each bullet point that WSP were asked to address and the outcomes of the review.

2.1 Geomorphic Assessment used to Identify Local Features for Relevance to the Liquefaction Assessment

The ground model for the Tahunanui study area was developed from detailed geomorphic mapping completed by Johnson (1979)⁷, a Digital Elevation Model (DEM), and historic aerial imagery. The geomorphological map presented in Appendix A (Drawing No. GIS-3160254-02) of the Beca report sufficiently represents the geomorphology of the Tahunanui study area (as defined in Drawing No. GIS-3160254-02) based on the available data.

We note that the “Infilled Estuary” terrain near the airport is not all infilled and remains an estuary environment with tidal flows. This estuarine area also includes areas that are significantly lower than the surrounding area providing a free-face for lateral-spreading if liquefaction occurs. The potential for lateral spreading in this area is alluded to in the Beca report.

2.2 Deep Geotechnical Investigation Data

The MBIE 2017 (Table 3.3)³, requires a minimum of three investigations per geological sub-unit, and an investigation density of one investigation per two square kilometres. The Beca report presents sufficient data to meet the one investigation per two square kilometres requirement. In Beca section 2.4 they acknowledge that they have not met this requirement in the Muritai Gravel and Stoke Fan Gravel units (further described in Beca Section 3). There is also insufficient data in the “Infilled Estuary” terrain (Drawing No. GIS-3160254-02); however, there is likely to be high variability in the reclaimed portions of this area and it does not have a material impact on the assessed ‘high liquefaction vulnerability’ in that area.

The Cone Penetration Test (CPT) data presented by Beca are all from the New Zealand Geotechnical Database (NZGD). All the CPT data presented in Table 2-4² extend to 10 m below ground level (bgl) or deeper. Where CPTs penetrated to between 6 m and 10 m bgl

⁴ Beca, 2021. Nelson Regional Liquefaction Assessment, reference no. 3160254-306125624-19, dated 23 November 2021.

⁵ Johnson, 2017. An Assessment of areas of lower risk of potential settlement due to seismic-induced ground shaking, Tahunanui, Nelson City. Dated 4 September 2017.

⁶ Tonkin and Taylor, 2014. Tahunanui Liquefaction Assessment Stage 2 – Assessment of Eastern Margin. Reference No. 871023, dated September 2014.

⁷ Johnston, M.R, 1979. Geology of the Nelson urban area. New Zealand Geological Survey urban series map 1. New Zealand Department of Scientific and Industrial research, Wellington.

Beca have inferred a liquefaction vulnerability and presented this data in Drawing No. GIS-3160254-02 (Appendix A). All CPTs <6 m were deemed shallow refusal and no liquefaction vulnerability has been assigned.

2.3 Depth to Groundwater

MBIE 2017 (Table 3.2)³ identifies that a Level B liquefaction vulnerability assessment should include a small number of groundwater monitoring points to provide high-level understanding of variations in groundwater level over time. Beca has not discussed if groundwater monitoring points were available for this assessment. Identifying whether monitoring points were utilized in the groundwater model would help build on the development of the groundwater model.

Beca identified that a groundwater model is not currently available for the Tahunanui area, so used groundwater data from the NZGD to generate a basic model to show how the groundwater varies over the Tahunanui area. To determine the depth to groundwater for the liquefaction assessment, Beca used the reported groundwater for CPT investigations. If no groundwater measurement was completed, they assigned a representative groundwater value based on proximal values and ground surface elevations.

The approach to determine depth to groundwater is sufficient for the assessment.

Beca (section 2.2) noted that tidal variations are expected in this area. The tidal influence on groundwater level highlights the potential for global sea level rise to influence the liquefaction vulnerability of this area over time. This consideration is discussed in MBIE 2017 (Section 4.2.4). Depending on the time-period of interest to the Nelson City Council, the elevation of the groundwater level could be increased to account for approximate future sea level rise. That is, there is an element of time-dependence in the liquefaction vulnerability due to predicted future sea level rise. However, this is not expected to have a material impact on the current assessment of liquefaction vulnerability because it is assessed as high over the majority of the study area.

2.4 Design Earthquake Scenarios

MBIE 2017 (section 4.3)³ outlines seismic hazard considerations for liquefaction vulnerability assessment and recommends a 500-year return period earthquake ground motion for a Level B liquefaction vulnerability assessment.

Beca (section 2.3) have considered 500-year 100-year, and 25-year return period ground motions for their liquefaction vulnerability assessment of the Tahunanui area. The seismic hazard values adopted for each return period are consistent with updated MBIE Module 1 guidance⁸ which is suitable for this assessment.

It is noted that the national seismic hazard model is currently under revision by GNS Science and may provide revised seismic hazard estimates for the study area over the coming months.

⁸ MBIE 2021. Earthquake Geotechnical Engineering Practice in New Zealand – Module 1. Overview of the guidelines, rev1. ISBN (Online) 978-0-947497-51-4, Wellington, New Zealand.

2.5 Methodology Utilized to Complete the Quantitative Liquefaction Assessment

MBIE 2017⁹ does not require a specific method of quantitative assessment for liquefaction vulnerability. The quantitative liquefaction assessment utilized by Beca for the Tahunanui study area follows industry standards⁹.

2.6 Assigned Liquefaction Susceptibility of the Tahunanui Area

Our understanding of how Beca completed the liquefaction categorisation of the Tahunanui area is as follows:

- Complete quantitative liquefaction assessment for each CPT for the design earthquake scenarios.
- Compare the 500-year and 100-year liquefaction-induced ground damage with the performance criteria outlined in Table 2-3, Figure 2-3 and Figure 2-4² to determine the representative liquefaction vulnerability category.
- The liquefaction vulnerability category (high, medium, low) was assigned to each CPT that penetrated deeper than 10 m bgl. An inferred liquefaction vulnerability category was assigned to CPTs that penetrated to depths between 6 m and 10 m bgl.
- The liquefaction vulnerability category was overlain with geomorphic mapping to assign liquefaction vulnerability classification to geomorphological units using professional judgement.

In our opinion:

- Beca have drawn on available data in the study area.
- Analysed the data following the MBIE 2017 guidance.
- Produced a Level B liquefaction hazard assessment map (Drawing No. GIS-3160254-02) that is reasonable.

The Beca report could be further enhanced by:

- Collection and incorporation of additional geotechnical data to characterise the ground-conditions / liquefaction-vulnerability in the areas underlain by Muritai Gravel and Stoke Fan Gravel units.
- Taking into consideration a consistent groundwater profile (in elevation) across the study area and incorporating some measure of the potential effects of sea level rise on groundwater levels (and therefore liquefaction vulnerability) over the period of interest to Nelson City Council for planning purposes (e.g. possibly 50 or 100 years).

⁹ MBIE 2021. Earthquake Geotechnical Engineering Practice in New Zealand – Module 3. Identification, assessment, and mitigation of liquefaction hazard, rev1. ISBN (Online) 978-0-947524-48-7, Wellington, New Zealand.

3 Closure

Beca have completed a Level B assessment that meets the requirements of a Level B assessments under the MBIE 2017 national guidance '*Planning and engineering guidance for potentially liquefaction-prone land*', and they have provided reasonable liquefaction vulnerability categories based on the assessment completed.

Beca have clearly stated the assumptions and limitations associated with a Level B assessment for the Tahunanui study area. WSP agree with the Beca statement that the liquefaction vulnerability map is not considered a replacement for site-specific liquefaction assessments.

We trust that this letter report meets your requirements. If you have any questions, please do not hesitate to contact the undersigned.

Yours sincerely
WSP New Zealand Limited



Dr Latasha Templeton
Senior Engineering Geologist



Dr Jeff Fraser
Principal Engineering Geologist

Attachments: Attachment A - Limitations



Attachment A – Limitations

This report (**Report**) has been prepared by WSP New Zealand Limited exclusively for Nelson City Council (**Client**) in relation to the Tahunanui Level B Liquefaction Assessment Report prepared by Beca Limited (Beca) (**Purpose**) and in accordance with the Professional Services Brief dated 2 June 2022 (Infrastructure Professional Services Contract: MSA-4023). The findings in this Report are based on and are subject to the assumptions specified in the Report. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

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