2 November 2021

Mr Jarrod Thompson
Stride Investment Management Limited
Level 12, 34 Shortland Street
Auckland 1010

Dear Jarrod

RE: Geotechnical Assessment - Johnsonville Town Centre Redevelopment, Johnsonville, Wellington

(Our Reference: P2021.005.630_06)

1 Introduction

ENGEO Ltd was requested by Barker & Associates (B&A), on behalf of Stride Investment Management Limited (Stride), to undertake a geotechnical assessment of the property at Johnsonville Town Centre Redevelopment, Johnsonville, Wellington. We understand that Stride wish to consider a Fast-Track Resource Consent Application under the COVID-19 Recovery (Fast-track Consenting) Act 2020 (The Act). B&A have asked for specific commentary regarding the following sections of the Act:

- Section 19(d)(ix)

strengthening environmental, economic, and social resilience, in terms of managing the risks from natural hazards and the effects of climate change:

- Section 20(3)(o)

a description of whether and how the project would be affected by climate change and natural hazards.

We have provided commentary on the relative level of risk and resilience that may be expected at Johnsonville compared to the Wellington Central City and the 'Regionally Significant Centre' of Kilbirnie as defined in the Greater Wellington Regional Policy Statement (RPS) and Wellington City District Plan.

1.1 Risk and Resilience

In our assessment, we have considered risks from natural hazards broadly in accordance with Section 106 of the Resource Management Act (RMA) which considers 'significant risk'. As outlined in S106(1A), the assessment of the risk from natural hazards requires a combined assessment of hazard likelihood and the material damage to land or structures that would result given the hazard occurs.

As a general term, 'Resilience' can be considered as the ability to recover from an adverse event (see for example Mason et al, 2018) – more resilient assets recover quicker than those that have low resilience. From a geotechnical perspective, geotechnically resilient sites essentially can be considered to be less effected under earthquake or large storm events compared to less resilience sites where more widespread effects would be expected to occur, which would take longer to recover from.

2 Site Description and Geology

The Johnsonville Town Centre is located between Johnsonville Road, Moorefield Road and Broderick Road in Johnsonville. As described in Tonkin & Taylor (2007), the ground surface within the proposed site slopes gently (less than 5°) from the northern-western side at an elevation of approximately 146 masl[1] towards the south-eastern corner which is at an elevation of around 137 masl.

Begg & Mazengarb (1996) indicate the Bedrock geology to be tectonically deformed Sandstone and Siltstone of the Torlesse Supergroup (commonly termed 'Greywacke'). In the area of the site, the Torlesse Greywacke is overlain by a relatively thick sequence of sedimentary soils (typically colluvium, alluvium and swamp deposits).

As indicated on the New Zealand Active Faults Database (AFD), the closest active faults to the Johnsonville Town Centre are:

- The Wellington Fault, located approximately 2.5 km southeast of the site. The Wellington Fault is indicated to have a recurrence interval of less than 2000 years, with an estimated single event lateral displacement of between 1 to 5 m.
- The Ohariu Fault, located approximately 3.3 km northwest of the site. This fault is indicated to have a recurrence interval between 2000 and 3500 years, with an estimated single event lateral displacement also between 1 and 5 m.

3 Previous Reporting

The subsurface conditions in the area of the proposed Johnsonville Town Centre Redevelopment have been previously documented by Tonkin & Taylor (2007) and their updated report completed in 2019. In summary:

- The 2007 report interpreted the subsurface conditions at the site based on seven geotechnical boreholes, supplemented by four additional boreholes that had been drilled for environmental sampling.
- An additional four boreholes were drilled for the 2019 updated report, supplemented by three Cone Penetration Tests (CPT).

The inferred subsurface conditions from these investigations are summarised in Section 3.1 below.

3.1 Interpreted Subsurface Conditions

In Tonkin & Taylor (2019) the subsurface conditions at the Johnsonville Town Centre are summarised as follows.

[1] metres above sea level

- A layer of fill material extends generally across the site up to a thickness of 4 metres in places, however around 2 metres thickness is typically encountered.
- Below the fill material, natural alluvial deposits were encountered with softer materials including some organic swamp deposits, above dense to very dense Alluvium at depth.
- The upper, 'softer' materials were typically described as Soft to Stiff Clayey Silt / Silty Clay with layers of medium dense Gravelly Sand.
- The lower alluvial material was noted by Tonkin & Taylor as generally comprising dense to very dense sandy Gravel, deposited on top of the undulating bedrock surface.
- The depth to rock was interpreted to vary between typically 4 m and 12 m across the site, however, was inferred to be deepest near the western to south-western property boundary, due to the presence of a buried alluvial channel. In this location, rock was inferred to be approximately 20 m below ground surface, although it is possibly deeper, as the borehole in this area did not encounter rock.
- Groundwater levels were noted as typically 1 to 2 metres below the ground surface across the site.

4 Natural Hazards

We have considered the effect of the following natural hazards:

- Earthquake induced liquefaction.
- Earthquake induced fault rupture.
- Landsliding (slope instability), either induced by a large regional earthquake, or as a result of a large rainstorm event.
- Tsunami and Seiche[2]. While detailed assessment of these hazards is not our area of expertise, we have offered some high-level comments of the relative threat at Johnsonville in relation to the Wellington City and Kilbirnie areas.

We have not provided commentary on volcanic eruption hazard (Ash fall) as we expect this threat to be: (a) less likely compared to hazards identified above and (b) have a widespread impact, such that there is no real material difference between different regions in the Wellington area.

4.1 Liquefaction

As outlined in Section 3.1, the interpreted subsurface profile includes an upper layer of soft alluvial deposits. At the northern end of the Johnsonville Town Centre Redevelopment, this material was sampled in the 2007 investigations and described as Silt with slight plasticity, with SPT-N blow counts between 0 and 4. In the 2019 investigations, soft material (SPT-N < 9) was also encountered at the southern end of the site, however was described as Clayey Silt, with High Plasticity.

[2] The term 'Seiche' describes the disturbance or oscillation in the water level of a lake or partially enclosed body of water (in this case, Wellington Harbour)

It is unclear from the material descriptions and recorded strengths that these 'soft' materials are prone to liquefaction as there appears to be significant variability in their composition and the unit is interpreted to have a variable thickness. We note that the wider Johnsonville area is not shown to have a liquefaction potential on the GWRC combined Earthquake Hazard Map, however we recommend that this hazard is considered further as part of any future detailed design phase.

4.1.1 Historical Records

The Wellington area experienced severe ground shaking as a result of the magnitude 8.2 1855 Wairarapa Earthquake. Felt intensities during the Wairarapa Earthquake were likely to have been MMI[3] 9-10 in the wider Johnsonville area (Dowrick, 2005), well above the level at which liquefaction effects would be expected to be initiated.

Hancox (2005) indicates that "*In the Wellington urban area there were several reports of extrusions of grey mud from fissures up to c. 25 m long in the Thorndon, Government House, Willis, and Manners Street areas adjacent to Lambton Harbour and the former Te Aro swamp*" however, there is no mention of liquefaction effects in the Johnsonville area even though there would presumably have been European occupation in the area at this time.

4.2 Fault Rupture

The wider Johnsonville area is not located on or in very close to known active faults. It is therefore not expected to be subject to significant ground deformation as a result of earthquake induced fault rupture on either the Wellington or Ohariu Faults. Some sympathetic rupture on splays from the Wellington Fault is possible but would be expected to result in only small deformation in the Johnsonville area.

4.3 Landsliding

The Johnsonville Town Centre is located on gentle topography and is surrounded by low height, rolling terrain with only minor cut and fill slopes. The site is in an area noted to have Low and Very Low earthquake induced slope instability (Figure 6 of Hancox, 2005).

4.4 Tsunami and Seiche

As noted in Section 2, the Johnsonville Town Centre at an elevation of approximately 140 m and therefore we would expect that the site is not subject to any significant threat from Tsunami or Seiche induced inundation.

Hancox (2005) notes that during the 1855 Wairarapa Earthquake, Lambton Quay was inundated by a Tsunami of approximately 2 to 2.5 m high, while the Rongotai Isthmus (where Kilbirnie is now situated) was inundated by water to approximately 1 m in depth.

5 Assessed Natural Hazard Risk and Resilience

Based on our assessment of the natural hazards outlined in Section 4, we consider that the area of the Johnsonville Town Centre has a relatively low level of risk from the identified natural hazards, and therefore can be considered to have a significant level of Resilience (as per the definition provided in Section 1.1). While there is a *possibility* that the site may be affected by liquefaction due to a large regional earthquake, given the historical precedence, we expect that the affected area and degree of settlement would likely to be relatively small. It is expected that any liquefaction effects can be readily

[3] Modified Mercalli Index

mitigated during the design process (founding the proposed buildings on rock or removing susceptible materials, for example).

In contrast, the Central City and Kilbirnie Areas are considered to be at higher risk from natural hazards and have significantly lower resilience, as follows:

Wellington Central City – This area is near to the Wellington Fault such that it may be partly affected during rupture. The Central City area is close to sea level and has precedence for Tsunami inundation and is also partly built on reclaimed land, such that it is also likely to be subject to liquefaction effects.

Kilbirnie – The Kilbirnie area is in close proximity to the active Evans Bay Fault, but it is unclear what the slip rate and recurrence interval on this fault is as it is buried. However, the Kilbirnie area is close to sea level and has historical precedence for Tsunami inundation following the 1855 Wairarapa Earthquake. In addition, this area is likely to be located on a significant thickness of low-density soils that may be susceptible to liquefaction.

In summary, the Johnsonville Town Centre area is considered to be relatively less susceptible, and is expected to be able to recover faster from future adverse events compared to the Central City and Kilbirnie areas identified in the the Greater Wellington Regional Policy Statement (RPS) and Wellington City District Plan.

5.1 Effect of Climate Change

The hazards considered as potentially affecting the proposed development in the area of the Johnsonville Town Centre are largely earthquake / seismic related, and therefore not related to climate change phenomena. Landsliding can be commonly initiated by large rainstorm events which are expected to become more frequent as a result of climate change (larger storms expected more often), however, the wider Johnsonville area is located in an area of low risk, such that the likelihood of landsliding, however initiated, is expected to be low.

6 Summary

Based on our assessment of the historical records and subsurface geology at the proposed Johnsonville Town Centre Redevelopment, from a geotechnical perspective we consider that risks posed by the identified geohazards are not likely to be significant compared to other areas of Wellington and will be able to be appropriately managed subject to on-going design development.

7 Limitations

i. We have prepared this report in accordance with the brief as provided. This report has been prepared for the use of our client, Stride Property Ltd, their professional advisers and the relevant Territorial Authorities in relation to the specified project brief described in this report. No liability is accepted for the use of any part of the report for any other purpose or by any other person or entity.

ii. The recommendations in this report are based on the ground conditions indicated from published sources, site assessments and subsurface investigations described in this report based on accepted normal methods of site investigations. Only a limited amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it should be appreciated that actual conditions could vary from the assumed model.

iii. Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

iv. This Limitation should be read in conjunction with the Engineering NZ / ACENZ Standard Terms of Engagement.

v. This report is not to be reproduced either wholly or in part without our prior written permission.

We trust that this information meets your current requirements. Please do not hesitate to contact the undersigned on (04) 472 0820 if you require any further information.

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8 References

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