IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of a submission in respect of the **PROPOSED WAIKATO DISTRICT PLAN** by **AMBURY PROPERTIES LIMITED** pursuant to Clause 6 of Schedule 1 of the Act seeking the rezoning of land at Ohinewai

SUMMARY STATEMENT OF NICHOLAS IAN SPEIGHT

1. My name is Nicholas Ian Speight. I am a Senior Geotechnical Engineer and Director of Initia Ltd, a specialist geotechnical consultancy company. I prepared a statement of evidence dated 9 July 2020, and a statement of rebuttal evidence dated 24 August 2020. The purpose of this document is to summarise those statements.

2. I outlined my qualifications, experience and commitment to comply with the Environment Court Expert Witness code of Conduct in my evidence in chief ("EIC").

3. A series of historical and recent geotechnical investigations undertaken at the site confirm that the land is generally underlain by between 3 and 10 m of recent alluvial soils – predominantly sands and very soft to firm clays/silts and peat. Older alluvial soils comprising interbedded sands, silts, clays and peat are present beneath the recent deposits. Rock is anticipated at depths of 100 m or more below ground level.

4. The geology and specific ground conditions at the site present several geotechnical challenges for development. Sand layers below groundwater level are assessed as susceptible to liquefaction during seismic events. Soft soils – predominantly peat and soft clays - are highly compressible when surcharged, e.g. from new fill placed to lift the site levels and building loads. These geotechnical risks will need to be appropriately mitigated for future development on the land.

5. Preliminary geotechnical analyses and assessments have been undertaken to assess the relative soil compressibility due to surcharging and susceptibility to liquefaction under an ultimate limit state seismic event. With regard to soil compressibility, Figure 529-004 in **Attachment A** of my EIC illustrates the estimated ground surface settlements that could occur due to surcharging of the site with an overall pressure of approximately 45 kPa. This is equivalent to approximately 2.5 m of new fill or 1 m of new fill plus loading from a typical light industrial warehouse slab. Predicted settlements range between 55 mm to greater than 2,000 mm under a 45 kPa applied pressure.

6. Figure 529-003 in **Attachment A** of my EIC illustrates the calculated Liquefaction Severity Number (LSN) across the site for an Ultimate Limit State earthquake. The LSN is an index which was developed following the

Canterbury Sequence of earthquakes and is used for categorising the effects of liquefaction for differing ground conditions and variability in soils. LSN values at the site range between 0 (no expression of liquefaction) to > 50 (severe damage).

7. The Sleepyhead Estate Masterplan was prepared with consideration to the key geotechnical risks at the site, particularly 'settlement' of soft soils. As can be seen from the Masterplan, proposed development has been avoided/limited in areas of the site underlain by highly compressible soil; parks and wetland reserves are proposed over the eastern and central areas of the site.

8. Ground improvements will be required to prepare most of the land for future development. Several different options have been considered including deep pile foundations for all buildings, stone columns or rammed aggregate piers, excavation and re-compaction/replacement, dynamic compaction and preloading. A summary of ground improvement options which could be considered at the site are presented on the table attached in **Attachment B** of my EIC**.**

9. The preferred ground improvement options have been identified as dynamic compaction, excavation and re-compaction/replacement and preloading. Dynamic compaction or excavation and re-compaction/replacement are proposed to mitigate liquefaction severity. Preloading is recommended to mitigate post-construction settlements. In some areas of the site, ground improvements will be required to address both liquefaction and settlement risks, i.e. two types of ground improvement may be necessary.

10. A dynamic compaction field trial was undertaken in Allotment 405 (the north western block of land) in September 2019. Testing was undertaken prior to and following dynamic compaction to evaluate the efficacy of this method. The results demonstrated that dynamic compaction is an effective method for mitigating liquefaction susceptibility in soils extending up to 5 m below ground level. It is the preferred method for ground improvement at Ohinewai for liquefaction risk mitigation, compared with excavation and re-compaction/replacement, as it is significantly faster, less expensive and more effective; densifying soils to a depth of 5 m, compared with just 3 m for the excavation and re-compaction/replacement option. It also mitigates the risks associated with excavating below groundwater level.

11. Preloading will be required in most areas of the site where there is a net increase in ground surface stress due to the proposed development. Preloading involves the temporary placement of fill above final design ground level to initiate settlement in the subsurface soils to depths of up to 30 m below ground level. The preload is usually held in place until settlements are approximately 90% of the estimated long-term total or until estimated residual settlements are considered tolerable to the proposed future development. Timeframes for preloading are expected to range between 6 and 12 months depending on ground conditions, preload heights and the development type.

12. The geotechnical effects of the proposed development (earthworks, construction of civil infrastructure such as roads/buried services etc, and new buildings) are expected to be limited to settlement from either surcharging of ground levels – such as placement of new fill or building construction – or from lowering of the groundwater level. During construction, there may also be vibration and noise effects from Dynamic Compaction.

13. The offsite settlement effects of surcharging the ground from placement of new fill and/or building loads are expected to be low to negligible at distances of 10 to 20 m from the works area. Therefore, this effect can be relatively

easily mitigated and controlled by avoiding or minimising surcharge close to the property boundaries where existing buildings or infrastructure are located

14. The effects of groundwater drawdown due to excavations below groundwater level can be controlled if necessary, by installation of 'grout curtains', sheetpile walls, 'slurry' walls or other impermeable materials/structures for cutting off groundwater flows.

15. Where large areas of the site are 'sealed' with impermeable surfaces such as pavements and roofs, this can have a 'rainfall shadowing' effect. A reduction in groundwater level can potentially induce consolidation of compressible soil layers such as the Rotokawau Formation peat. Where necessary, this can be mitigated by the installation of stormwater soakage devices to recharge groundwater levels. However, I note that the proposed ground improvements at the site (i.e. preloading) will effectively mitigate the effects of a reduction in groundwater level. The effects of 'rainfall shadowing' outside the site boundaries are expected to be negligible.

16. Dynamic Compaction field trials completed at Ohinewai have demonstrated that vibration magnitudes are expected to be less than the typically permissible magnitude of 2 mm/s Peak Particle Velocity at distances of 50 m or more from the Dynamic Compaction works. If ground improvement for liquefaction mitigation is required at distances closer than 50 m from existing dwellings, it may be necessary to employ alternative ground improvement methods such as excavation and replacement/re-compaction.

17. I have read Mr Dean Fergusson's statement of evidence for the Ralph Estates. In my Statement of Rebuttal Evidence I have concluded that whilst an open cast coal mine may be technically feasible at Ohinewai, such works would result in significant groundwater dewatering to depths of 80 m or more below ground level with associated widespread ground surface settlements. For a 19MT open cast pit in the location indicated in Mr Fergusson's evidence, settlements of up to 3,800 mm (3.8 m) could occur directly adjacent to the pit perimeter with up to 1.4 m of settlement at State Highway 1 and the North Island Main Trunk Line. This settlement would increase flood risk vulnerability within 2km of the pit and possible long-term inundation (ponding) in already low-lying land. Significant damage to buried infrastructure and housing/buildings within the Ohinewai Township and adjoining areas could also be expected.

18. Before future development of the site proceeds, it will be essential that a comprehensive scope of geotechnical investigation and laboratory testing is undertaken to determine specific ground improvement requirements for earthworks, civil infrastructure and buildings. This would ideally be completed in stages as the development progresses. In terms of groundwater considerations and the potential need for stormwater soakage, further groundwater monitoring and assessment will be required during Resource Consent/subdivision consent stage.

Nicholas Ian Speight
9 September 2020