

**BEFORE THE HEARINGS PANEL
FOR THE PROPOSED QUEENSTOWN LAKES DISTRICT PLAN**

IN THE MATTER of the Resource
Management Act 1991

AND

IN THE MATTER of Stage 3 of the
Proposed District Plan

**FIRST STATEMENT OF EVIDENCE OF ROBERT BOND
ON BEHALF OF QUEENSTOWN LAKES DISTRICT COUNCIL**

**GEOTECHNICAL ENGINEERING – SETTLEMENT ZONE AND LOWER DENSITY
SUBURBAN RESIDENTIAL ZONE – REZONINGS**

18 March 2020

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1. INTRODUCTION

- 1.1 My full name is Robert Bond. I hold the qualification of Bachelor of Engineering in Industrial Geology. I am a registered and Chartered Engineer with Engineering New Zealand (formerly IPENZ) with specialist areas in geotechnical engineering and management and I have been employed as a Principal Engineer and Work Group Manager at WSP New Zealand (formerly Opus Consultants) since 1998.
- 1.2 I have worked in New Zealand for over 10 years, my recent experience in terms of natural hazard risk assessment and rockfall management includes providing site response to rockfall events and completing rockfall assessments on behalf of Christchurch City Council following the Christchurch Earthquake and providing, and leading, the Geotechnical response to NZ Transport Agency (**NZTA**) following the Kaikōura earthquake prior to the establishment of the North Canterbury Transport and Infrastructure Recovery (**NCTIR**).
- 1.3 I currently manage the Geotechnical team responsible for the data collection and management of natural hazard risks in Central Otago for the NZTA State Highway network and Queenstown Lakes District Council (**QLDC** or **Council**) local roading network and have advised other councils and regulatory authorities on natural hazard risk. I was the lead designer for the development of the Diana Falls rockfall mitigation scheme which led to the development of the current MBIE, NZTA and the NZ Geotechnical Society design guide (NZGS) on passive rockfall protection systems and have acted as geotechnical expert on rockfall assessments for residential, commercial and infrastructure schemes.
- 1.4 Although this is a Council hearing, I confirm that I have read the Code of Conduct for Expert Witnesses contained in the Environment Court Practice Note 2014 and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions that I express, and that this evidence is within my area of expertise, except where I state that I am relying on the evidence of another person.

2. SCOPE

2.1 I have been asked to provide evidence in relation to five submissions seeking site specific re-zonings to the Settlement Zone (**SETZ**) and Lower Density Suburban Residential Zone (**LDSRZ**). My evidence focuses on geotechnical and natural hazard issues and addresses the following submissions:

- (a) Lake McKay Partnership Limited (**3196**);
- (b) Southern Ventures Property Limited (**3190**);
- (c) Cardrona Village Limited (**31019**);
- (d) Mark Butson (**31036**); and
- (e) Judith & Russell Brown (**31046**).

2.2 I have provided my view on each of the submission requests as to whether I oppose the relief sought, or whether I do not oppose the relief sought in terms of geotechnical / natural hazard effects.

2.3 Due to the time available to prepare this evidence I have not undertaken site visits. In terms of flooding, I have not completed any detailed analysis of flood risks affecting the sites, or carried out any independent model assessments.

2.4 In assessing the geotechnical / natural hazard risks raised by the site specific submissions, I have considered the relevant technical information provided with the submissions (as detailed in the response to each submission), a review of QLDC and Otago Regional Council available data relating to natural hazards, as well as WSP's (formerly Opus) available data.

2.5 I have also considered the Natural Hazards chapter of the Queenstown Lakes Proposed District Plan (**PDP**).

3. EXECUTIVE SUMMARY

3.1 Either no, or insufficient, technical assessment of geotechnical matters has been provided, and/or I assess that there is a perceived hazard for the following submissions¹ and based on the information I oppose the rezonings sought:

- (a) Lake McKay Partnership (3196);
- (b) Cardrona Village Limited (31019)
- (c) Mark Butson (31036)
- (d) J & R Brown (31046).

3.2 I do not oppose the following rezoning submission:

- (a) Southern Ventures Property Limited (3190).

4. LAKE MCKAY PARTNERSHIP LIMITED (3196)

4.1 The submitter has sought a rezoning at 24 Atkins Road, Luggate² from part Rural Residential Zone (**RRZ**) and Rural Zone to SETZ, including the removal of a Building Restriction Area (**BRA**) from the plan maps.

4.2 I have been advised by Ms Bowbyes that the current zones, whereby the RRZ applies to 12.3ha of land, and the balance is zoned Rural (landscape category RCL) can yield approximately 24 lots, and the SETZ would yield approximately 122 lots. This would result in an increase of approximately 97 lots. The RRZ provides for 4,000m² sites, whereas the Settlement Zone provides for 800m².

4.3 Based on the currently available information relating to both Liquefaction risk and Flood risk at the site it is my opinion that the area of the site currently outside of the area designated BRA is unlikely to be affected by the identified hazards to a significant degree.

1 As set out in the relevant section of this evidence.

2 Lot 1, DP 534249, held within Certificate of Title 880021.

- 4.4** As such it is my opinion that the Natural Hazard risks posed to the area outside of the BRA are low and are not a limiting factor when considering the suitability of up-zoning from RRZ/Rural to SETZ.
- 4.5** The identified hazards are however considered likely to pose a risk to the BRA area.
- 4.6** The Liquefaction potential of the BRA area is most likely controlled by a high groundwater table and the potential presence of soft/fine grained soils associated with the alluvial channels.
- 4.7** Detailed ground investigations would be required to assess the liquefaction potential fully on this area of the site however it is considered likely that site specific foundation solutions can be determined that would protect the development from the effects of liquefaction should it occur.
- 4.8** The risks posed by flooding to the BRA have been investigated by the submitter's consultant in terms of the 1:100 year event and have demonstrated the risk posed to the site to be generally low risk. However, no consideration of climate change (for example a 1:200 year event) or more significant events such as a 1:500 year event has been presented for review (acknowledging that the Natural Hazards chapters asks for "no less than a 100 year period").
- 4.9** It is considered likely that increased precipitation, more frequent storm events and combined flooding events (gully flow and Luggate Creek flooding) are possible. Additional modelling and provision of site specific mitigation measure proposals would need to be reviewed in order to fully assess the risks to future development and combined effects of both flooding of the Luggate Creek and the Gully as well as considering climate change.
- 4.10** Whilst I am of the opinion that mitigation of flood risks can be achieved through the use of earthworks, platform raising, specific foundation design and management of flood waters both on and off site, it is considered likely that effects on adjoining property upstream and

downstream of the site are likely as a result. The extent of this impact and or mitigation proposals is uncertain at this stage.

- 4.11** The potential effects of both a 1:200yr and 1:500yr event (which would then account for climate change and increased likelihoods of larger events) would also need to be considered on the surrounding area in order to fully assess the significance of the risk posed to or by the proposed rezoning to the SETZ density.
- 4.12** It is also noted in the submission that any future development is likely to discharge surface water and waste water to onsite disposal systems. The suitability of such systems (a matter I understand is covered in infrastructure evidence for the Council) and impact on flood risk or liquefaction risk would need to be carefully assessed in terms of future development within the BRA.
- 4.13** Based on my assessment of the information provided by the submission, together with my own independent assessment of natural hazard risks posed to the site, I would generally agree with the submitter that the area of the site outside the BRA is unlikely to be affected by either flooding or liquefaction to the point where the likely development is considered to be at a significant risk.
- 4.14** The level of risk posed to the area outside of the BRA is therefore unlikely to have any affect should a change in zoning occur.
- 4.15** It is my opinion that the risks posed to the BRA area are considered to be much higher and do not appear to have been assessed in sufficient detail by the submitter for me to not oppose a change in zoning.
- 4.16** As such whilst I generally agree with the submitter's consultant's findings of the likely hazards presented to the BRA area, I am of the opinion that the risk is sufficiently high, particularly with respect to flooding, to warrant further investigation and assessment prior to the removal of the BRA and a change in zoning for this area.
- 4.17** The potential impacts of site based disposal systems for both stormwater and waste water must also be carefully considered the BRA

area. There is insufficient detail provided to make any judgement on the suitability of such systems on this areas of the site at present or the potential effects on liquefaction or flooding.

- 4.18** It is my opinion that there is insufficient information pertinent to the BRA to support a change in zoning. At this stage and based on the information I have reviewed I oppose up-zoning of that part of the site located within the BRA to SETZ.

5. SOUTHERN VENTURES PROPERTY LIMITED (3190)

- 5.1** The submitter has sought a rezoning at a proposed development site in Albert Town from Rural and Rural Lifestyle Zone (**RLZ**) to Lower Density Suburban Residential Zone (**LDSR**).
- 5.2** I have been advised by Ms Bowbyes that the current RLZ can yield approximately 4 lots and the LDSR would yield approximately 65 lots. This would result in an increase of approximately 61 lots.
- 5.3** An assessment from Geosolve accompanied the submission, and concluded that the proposed rezoning is highly unlikely to be affected by either liquefaction or flooding (either from a dam burst or flooding of the Clutha or Cardrona Rivers). I generally agree with Geosolve's conclusions, assuming that the proposed mitigation measures suggested in the submission are adopted, namely lifting of the development platform and adopting a set back from the river for the proposed land filling area.
- 5.4** Liquefaction effects on the site are likely to be associated with a high groundwater table and soft/loose fine sediments associated with the Cardrona River and Clutha River channels. By adopting an earthwork solution lifting the development platforms combined with site specific foundation solutions the potential effects of liquefaction can in my opinion be successfully mitigated.
- 5.5** Detailed ground investigations would however be required in order to assess the liquefaction potential fully on this area of the site and to

assess settlement profiles of the subsoils however it is considered likely that site specific foundation solutions can be determined that would protect the development from the effects of liquefaction should it occur.

- 5.6** I agree that the effects of liquefaction are most likely to be mitigated through earthworks and in creating a development platform some 1.5-2.5m above existing ground level.
- 5.7** The design and development of the building platform will need to consider the subsidence and settlement effects of some areas of the existing floodplain areas, particularly the former landfill area and areas of soft or loose sediments. However, this design is in my opinion feasible.
- 5.8** I do not consider liquefaction to pose a significant risk to the proposed development and the mitigation measures proposed are considered to be reasonable.
- 5.9** The risks posed by flooding to the site have been investigated and assessed by Geosolve in terms of the 1:100 and 1:500 year event (in order to allow for climate change). The results indicate that the development area is likely to be affected by flooding and as such requires mitigation to reduce the effects accordingly.
- 5.10** The adoption of Geosolve's recommended set back combined with offsetting of flood volumes through localised excavation is considered a reasonable approach and considers the impact of the 1:100 and 1:200 year event as well as a potential dam burst scenario.
- 5.11** I would therefore agree with Geosolve in their adopted methodology and intended approach to adopting a minimum setback for construction and the adoption of flood volume off setting (excavation of borrow pits).
- 5.12** Whilst mitigation of flood risks can be achieved through the use of earthworks, platform raising, specific foundation design and management of flood waters through offsetting, it is however considered likely that the flood effects on adjoining properties upstream

and downstream will be increased by the proposed mitigation works. The effects on the downstream reaches are typically governed by the Clutha River and as such the downstream impacts are in my opinion likely to be insignificant. The effects upstream of the site are uncertain and are difficult to assess.

- 5.13** It is my opinion based on provided information and my own limited assessment of flood risk that the upstream effects would more likely than not be relatively minor.
- 5.14** The level of risk posed by liquefaction does require further detailed investigation and design to ensure ground settlements and liquefaction effects can be assessed and successfully mitigated.
- 5.15** In addition, the extent and form of the landfill fill materials will need to be fully assessed and possibly removed in order to reduce the potential for significant differential settlements or ground subsidence to occur.
- 5.16** These hazards are therefore unlikely to have any significant effect should the site be rezoned from RLZ to LDSR.
- 5.17** The risks posed to the more intensive zone from flooding however are more significant. Geosolve consider the impacts of flooding and propose mitigation in the form of offsetting and lifting of development platforms combined with an agreed set back of 250-300m. I agree with this assessment and consider it a reasonable level of mitigation.
- 5.18** On this basis I concur with Geosolve in that the risks posed by natural hazards (namely flooding) can be managed (by some site specific rules) and the impacts on the floodplain can be minimised and potentially partially offset.
- 5.19** On this basis I do not oppose the requested rezoning from Rural and RLZ to LDSR for this site.

6. CARDRONA VILLAGE LIMITED (31019)

- 6.1** This submission relates to a requested rezoning of the site at Cardrona.
- 6.2** It is my understanding that Cardrona Village Limited have submitted engineering details in support of a zone change to SETZ for a section of land located in the Cardrona Valley river floodplain.
- 6.3** Based on the information supplied with the submission it is my understanding that the submitter intends to undertake a comprehensive development of the land located on the western side of the Cardrona River for visitor accommodation and residential activities.
- 6.4** It is also understood that the submitter has, in principal an agreed land swap with Crown properties in order to exchange land on the eastern margin of the Cardrona River with land on the western side of the river.
- 6.5** The subject site I have reviewed is identified as the land on the western side of the Cardrona River that is being passed to the submitter.
- 6.6** As part of the WSP review of the available information I have completed an independent assessment of natural hazard risk posed to the subject site and can confirm that the site is subject to two main natural hazards as well as one further perceived natural hazard.
- 6.7** The key natural hazards affecting this site are considered to be 1) Liquefaction and 2) Flood Risk with minor hazards identified as 3) Unstable ground - Mining or Mine Wastes (tailings or subsidence).
- 6.8** On the basis of my assessment, the liquefaction effects on the site are likely to be associated with a high groundwater table and soft/loose fine sediments associated with the Cardrona River and associated connecting channels.
- 6.9** My assessment of qualitative risk posed to the intended development associated with this identified hazard is considered to be LOW – MEDIUM.

- 6.10** The submitted information reviewed includes references made to a geotechnical report compiled by KGA. The report has not been viewed as part of my assessment, however, comments presented in the Land and Survey summary report indicate that KGA consider the site to be suitable for development, but that site specific geotechnical investigations are required for building consent. As noted in the Land & Survey report, KGA consider the ground conditions in the area to typically comprise non engineered fills (mine tailings), soft and loose silts and dense conglomerates. Groundwater was proven at depths of between 2-3.5m depth.
- 6.11** Cardrona is a known to be affected by former mining operations and the site may be affected by such activities.
- 6.12** It is my opinion that a detailed site inspection and additional research is required in order to ascertain the presence of such workings or assess the extent of deposition of tailings on the site. At this stage I would consider the perceived risks posed to development on this site from this particular hazard as being LOW.
- 6.13** The general conclusion from KGA is that a liquefaction risk exists however the risk posed to future developments is considered to be LOW. Site specific investigations would be required to confirm foundation solutions and appropriate mitigation however, the risk is likely to be manageable. I generally agree with this assessment that the risk is likely to be LOW but that further investigations are required.
- 6.14** Overall, I do not consider the potential risks associated with liquefaction or mine wastes to be sufficient to reject the proposed zone change.
- 6.15** The submitted information includes extracts from a flood risk assessment prepared by Airey Consultants. The inspected detail indicates that the Cardrona River would flood the subject site.
- 6.16** As part of my assessment of the site natural hazards I have viewed the available data presented on the QLDC GIS and Otago Regional Council Natural Hazards database. I have also considered the

topography of the Cardrona river and valley including the flood plain and information pertaining to the channel forms and erosion as well as rainfall data provided by NIWA.

- 6.17** On the basis of my assessment it is evident that the subject site is potentially at MEDIUM – HIGH risk from flooding. Published flood zone maps indicate the site is at risk from a 1:100yr (channel contained), 1:200yr and 1:500yr flood event.
- 6.18** It is therefore my opinion that in order to facilitate future development substantial flood mitigation works would be required. In addition, the construction of mitigation measures (such as bunding, channelling or filling of land areas) would most likely impact on the existing river floodplain and river channel by necessarily narrowing and channelizing the river, possibly causing adverse effects on adjoining properties.
- 6.19** I am of the opinion that there is insufficient information provided with the submission to enable an adequate assessment of the risks posed to be made in relation to natural hazard risks for the site. On this basis, I oppose the rezoning request from a geotechnical/flood risk perspective.

7. MARK BUTSON (31036)

- 7.1** This submission relates to a requested rezoning of the site at Cardrona.
- 7.2** The submitter has requested that the part of the site that was zoned ODP Cardrona Rural Visitor Zone (**RVZ**), which has been zoned Rural in Stage 3, be rezoned to SETZ with a VASZ.
- 7.3** The submitter has not supplied any supporting technical assessment of the site pertaining to natural hazard assessments.
- 7.4** As part of my review I have completed an independent assessment of natural hazard risk and have concluded that the site is likely to be subject to two main natural hazards as well as two further perceived natural hazards.

- 7.5** On the basis of my limited assessment, the key natural hazards affecting this site are considered to be 1) Liquefaction and 2) Alluvial Fan (active). The two minor hazards that could be perceived at the site are 3) Unstable Mine wastes (tailings or subsidence) and 4) Slope stability (limited sections of the site area).
- 7.6** On the basis of my assessment, the liquefaction effects on the site are likely to be associated with a high groundwater table and soft/loose fine sediments associated with the Cardrona River and associated connecting channels. This risk, in my opinion, is likely to be relatively minor or low. However, the site would require specific investigation and assessment in order to determine the level of mitigation required for future development or to confirm or otherwise the existence of the hazard.
- 7.7** It is my opinion that whilst a liquefaction hazard may exist it is unlikely to present a high enough risk to preclude future development on this site.
- 7.8** The site has been assessed as being located within part of an alluvial fan and the fan is considered in part to be active (in terms of depositional processes). This can present several risks to the subject site from flooding, debris flows and aggradation of materials, for example.
- 7.9** The flood risk posed to the property associated with the alluvial fan and stream channel is uncertain. Additional information and site assessment is required in order to determine the extent of flood risk and likely impact on the site or future development. On the basis there is insufficient information provided with the submission, I am unable to adequately assess the flood risk to the site.
- 7.10** Additionally, Cardrona is a known area to be affected by former mining operations and the stability of the site may be affected by such activities. The submission does not provide any information in relation to this. A detailed site inspection and additional research is required in order to ascertain the presence of such workings or assess the

deposition of tailings on the site. An investigation of historic activities would then enable an assessment of the stability of the site and a determination made as to the suitability for future development on the site.

7.11 Slope stability is considered to be a potential hazard at this site but will most likely be limited to selective areas of the site. The site requires a detailed site inspection in order to fully determine the level of risk posed by this hazard.

7.12 My initial assessment of the site and the likelihood for these hazards to be present suggest that risks to future development are possible. The risks are however likely to be relatively low given the location of the site and based on my existing knowledge of the site. However, without further site inspections or investigations, it is my opinion that parts of the site may potentially be determined as being unsuitable for future development or possibly be limited to development with controls.

7.13 As outlined above, it is my opinion that there is insufficient information provided with the submission to enable an adequate assessment to be made in relation to natural hazards risks for the site. I oppose the rezoning request from a geotechnical perspective.

8. J & R BROWN (31046)

8.1 This submission relates to a requested rezoning of the site at 2374 Cardrona Valley Road.

8.2 The submission requests a zone change from Rural Residential to SETZ with a VASZ and removal of the ONL.

8.3 The submission is not supported by any technical evidence or information pertaining to natural hazard.

8.4 As part of my review I have completed an independent assessment of natural hazard risk and have concluded that the site is likely to be

subject to two main natural hazards as well as one further perceived natural hazard.

- 8.5** The key natural hazards affecting this site are considered to be 1) Liquefaction and 2) Flood Risk. The minor hazards identified that could be perceived at the site are also considered to be 3) Unstable ground - Mining or Mine Wastes (tailings or subsidence).
- 8.6** On the basis of my limited assessment the Liquefaction effects on the site are likely to be associated with a high groundwater table and soft/loose fine sediments associated with the Cardrona River and associated connecting channels. Based on my experience of the area and other similar developments and within the Cardrona valley this risk is likely to be relatively minor (low risk). However, the site would require specific investigation and assessment in order to determine the actual level of risk posed and the subsequent level of mitigation required for future development.
- 8.7** The risks posed to the site from Liquefaction are therefore, in my opinion, unlikely to preclude a change in zoning as they can be readily mitigated.
- 8.8** The flood risk posed to the property associated with the Cardrona River has not been assessed as part of the submission and I have not completed any detailed flood risk analysis of the site. I have however used published flood data and reviewed currently available flood reports and published maps that indicate current flood prone areas and indicate indicative flood levels.
- 8.9** As part of my review I inspected information pertaining to Flood risk in this area of Cardrona collated and presented by both QLDC and Otago Regional Council respectively. Rainfall data for the region was taken from information gathered by NIWA and reports prepared by various other consultants (such as GHD) reporting on flood studies for the Cardrona valley were sourced and inspected.
- 8.10** As part of my assessment of the site I have also considered the topography of the Cardrona river and valley including the flood plain

extents and viewed aerial imagery assessing the Cardrona River valley scour profile and bank erosion.

- 8.11** Viewed information indicates that the site is potentially at risk from the 1:100yr, 1:200yr and 1:500yr flood event and that extreme flood events may impact over 2/3 of the site area.
- 8.12** I am therefore of the opinion that, on the basis of the inspected data, the site is at risk from flooding. I consider the risks posed by flooding to the site to be significant, warranting additional investigation and assessment.
- 8.13** Additionally, Cardrona is an area known to be affected by former mining operations and the site may be affected by such activities. No information is provided with the submission in relation to this. A detailed site inspection and additional researches are required in order to ascertain the presence of such workings or assess the extent of deposition of tailings on the site. The assessment of such activities would then enable an assessment of the sites stability and suitability for future development to be made. I am therefore of the opinion that there is insufficient information currently available to conclude that the site is stable or suitable for future development.
- 8.14** For the reasons outlined above, I oppose the requested rezoning from a geotechnical and flood risk perspective.



Robert Bond
18 March 2020