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By Email: lauren.christie@winton.nz
Bridesdale Farm Developments Limited

Attention: Lauren Christie
Winton – General Manager – Queenstown

Dear Lauren

Bridesdale Farm – Proposed District Plan Zone Change
Flood Assessment – 50655 – Bridesdale – T14 – Dent G – Evidence

1.0 Introduction

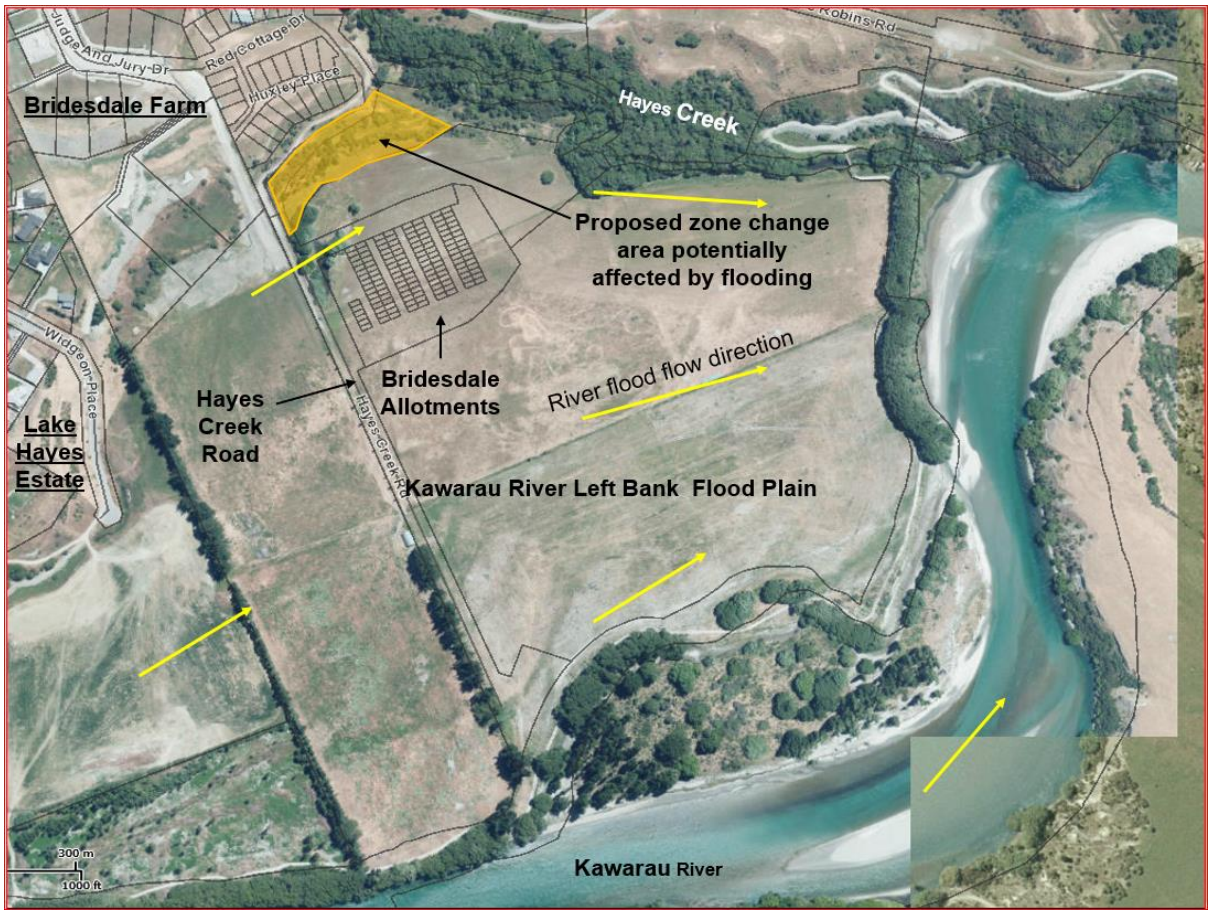
As requested we have completed a flood risk assessment for additional medium density residential zoning in support of an application for a zone change to the Queenstown Lakes District Council (QLDC) District Plan. The application relates to an area of land in the Bridesdale Farm subdivision between Lake Hayes and the Kawarau River.

We have completed a summary assessment of the potential effects of floods in the Kawarau River on the zone change application area and recommend minimum levels for building platform levels and underside of slab and floor joist levels complying with the QLDC Land Development and Subdivision Code of Practice.

2.0 Zone Change Application Location

The location of the proposed zone change application area and the proximity of the flood hazard resulting from the Kawarau River left bank flood plain is illustrated in Figure 2.1. The location of the proposed additional medium density residential zone below Hayes Creek Road that is potentially affected by flooding is highlighted in Figure 2.1.

Figure 2.1: Proposed Bridesdale Zone Change Location



3.0 Flood Assessment

3.1 Flood History

The left bank flood plain of the Kawarau River is flooded from time to time. Given the land development potential in the locality and wider flood effects due to flooding in the Kawarau River, flood level data has been recorded for some significant events since the November 1999 flood. During the November 1999 flood the left bank flood plain was inundated to a level of 311.35m.

Flood water levels in the Kawarau River, and therefore estimated flood flows, are measured at the Chard Road water level recorder 5.5 kilometres downstream of the Bridesdale Farm residential area. The water level recorder station is at the western end of Chard Road and has recorded river water levels from 1963 to 2017. The water level recorder station is operated by Contact Energy. Derived flow data was procured for the site from National Institute of Water and Atmospheric Research (NIWA). The water level and derived flow data has been subjected to General Extreme Value analysis to derive Average Recurrence Interval data in order to understand the likely frequency of flooding across the left bank flood plain below the land within the proposed zone change.

3.2 Assessment Methodology

From the Chard Farm flood flow record and recorded peak flood levels at Bridesdale Farm for significant floods since, and including the November 1999 event, the flood level versus flood flow relationship has been used to predict the peak flood water for the 100-year Average Recurrence Interval (ARI) flow including allowance for climate change.

3.2.1 Climate Change

The Chard Farm water level recorder data does not include provision for climate change. Due to a 2°C increase in average temperature from 1990 to 2090 rainfall event depth is projected to increase by 15%. Flow rates for relatively small rural catchments typically increase by of the order of 25% to 30% due to the projected increase in rainfall depth due to climate change.

The Kawarau River catchment includes Lake Wakatipu and the Shotover River, and at the peak flow in the Kawarau River at Chard Farm, the flow contribution from the respective sub-catchments is similar. The Lake is likely to deliver a muted response to the Kawarau River while the Shotover River is likely to respond more intensely to the increase in rainfall depth. To provide an allowance for climate change in the projected flood depths we have assumed that the increase in flow from Lake Wakatipu would be of the order of the rainfall increase (15%) and the increase from the Shotover River would be 25%. Therefore, given the similar contributions to peak flow from each sub-catchment, the projected historical ARI flow estimates have been increased by 20% for the purposes of estimating ARI flood water levels at zone change site.

3.2.2 Average Recurrence Interval Flow Estimates

The results of the General Extreme Value (GEV) analysis of the estimated maximum annual flows based on measured maximum flood water levels from NIWA is summarised in Table 3.1.

Table 3.1: GEV Analysis Results and Climate Change Adjustment

ARI (yr)	Estimated GEV Analysis Peak Flood Flow (m^3/s)	
	Recorded Data without Allowance for Climate Change	Adjusted Flow with Climate Change (20%)
5	680	820
10	780	935
20	880	1055
50	1020	1270
100	1130	1355
1000	1550	1860

3.2.3 Flood Level Projection

The flood level projection for 5-year to 100-year Average Recurrence Interval flood events including allowance for climate change is presented in Figure 3.2. For the 100-year ARI flood event (including allowance for climate change), the predicted flood level is 312.1m.

4.0 Regulatory Requirements

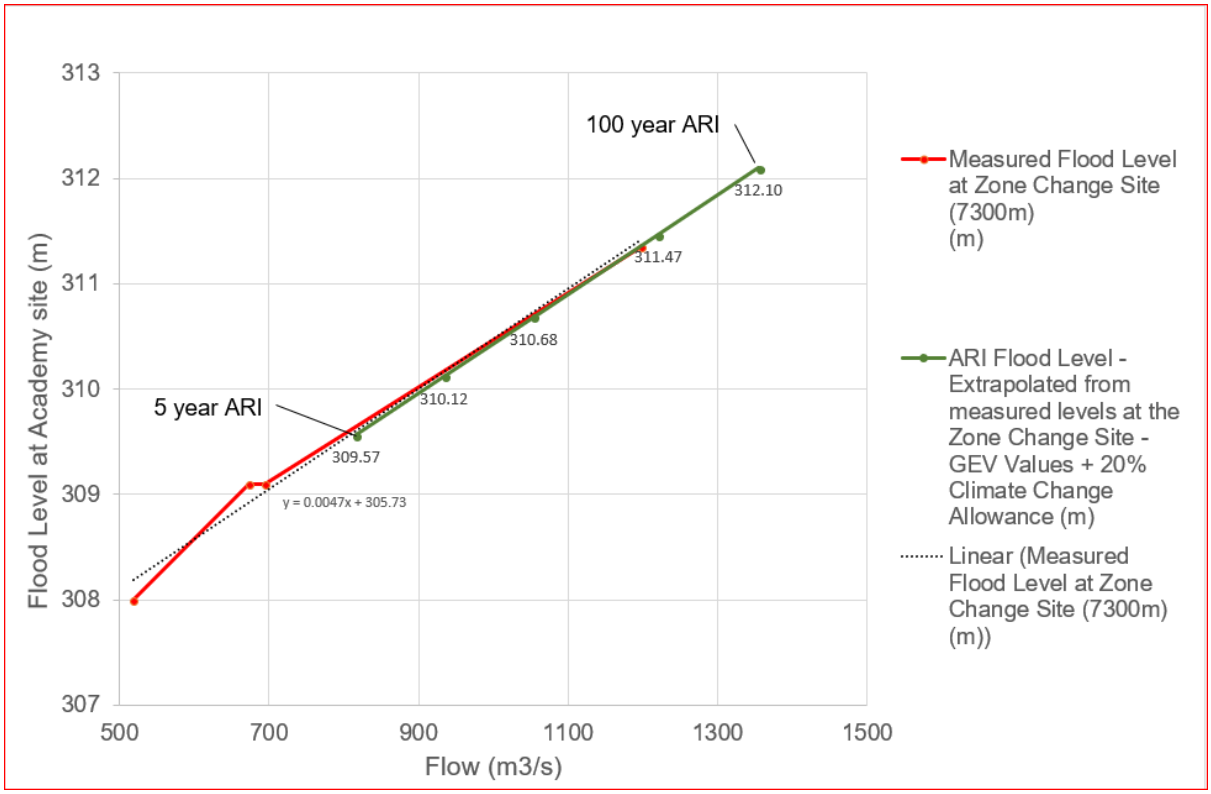
4.1 NZ Building Code

The New Zealand Building Code provisions relating to Surface Water are as follows:

"E1.3.2 Surface water, resulting from an event having a 2% probability of occurring annually, shall not enter buildings."

Clause E1.3.2 applies only to Housing, Communal Residential and Communal Non-residential buildings. The proposed Bridesdale Farm zone change is for residential development and therefore compliance for residential buildings is required.

Figure 3.2: Measured and Estimated flood Levels at Bridesdale Farm – Zone Change Area



4.2 Land Development Code of Practice

QLDC Land Development and Subdivision Code of Practice (COP) prescribes design freeboard requirements for buildings that determine the minimum habitable floor levels that are higher than required under the NZ Building Code.

The QLDC COP requirements for determining the minimum freeboard height additional to the computed top water flood level of the 1% AEP (100-year ARI storm) design storm flood level should be:

"Freeboard	***Minimum height***
Habitable dwellings (including attached garages)	*0.5 m*
Commercial and industrial buildings	*0.3 m*
Non-habitable residential buildings and detached garages	*0.2 m*

The minimum freeboard shall be measured from the top water level to the building platform level or the underside of the floor joists or underside of the floor slab, whichever is applicable."

The freeboard requirement is a minimum. In this case the precision of flood level estimation for the 100-year ARI event is subject to the hydrological condition of the catchment, climate change risk and the river channel condition and therefore for residential buildings we recommend a greater freeboard. That is, a freeboard to the building platform level, or the underside of the floor joists, or underside of the floor slab, whichever is applicable, of 1m is proposed.

Based on the estimated flood level of 312.1m plus the recommended 1mfreeboard, a minimum level for platform levels for habitable buildings of 313.1m is required. The freeboard for non-habitable building platform levels similarly greater than required by the COP as recommended below.

5.0 Recommendation

Based on the assessment methodology and the QLDC COP guidance the recommended minimum freeboard to the design building platform level, or the underside of the floor joists, or underside of the floor slab requirements for buildings on the lots in the proposed zone change area are as follows:

1. Freeboard of 1.0m for habitable buildings – minimum design level 313.1m.
2. Freeboard of 0.7m for non-habitable buildings – minimum design level 312.8m.

For further clarification please contact Gary Dent.

Yours faithfully
FLUENT INFRASTRUCTURE SOLUTIONS LTD
Per:

Gary Dent
Senior Environmental Engineer | Director