

**BEFORE THE HEARING COMMISSIONERS
AT QUEENSTOWN**

IN THE MATTER of the Resource Management Act 1991
(RMA or the Act)

AND

IN THE MATTER of the proposed the Queenstown Lakes
District Plan pursuant to Part 1 of the First
Schedule to the Resource Management
Act 1991

ON BEHALF OF RCL Queenstown PTY Ltd

STATEMENT OF EVIDENCE OF GARY DENT

3 February 2017

INTRODUCTION

1. My name is Gary Dent. I have a Bachelor of Engineering (Civil) and a Diploma in Hydraulic Engineering and I am a member of the Institution of Professional Engineers of New Zealand. Currently I am a Director and Principal Water Resources Engineer for Fluent Infrastructure Solutions Limited in Dunedin.
2. My qualifications and professional associations are:
 - a. Qualifications
 - Bachelor of Engineering (Civil), New Zealand
 - Diploma in Hydraulic Engineering, Delft, The Netherlands
 - CPEng and IntPE (2013)
 - b. Professional Memberships
 - Member . Institution of Professional Engineers New Zealand
 - Member . New Zealand Hydrological Society
 - Member . Water New Zealand (NZ Water & Wastes Association Waiora Aotearoa).
3. I have practiced as a professional engineer since 1982 in the fields of irrigation engineering, flood hydrology, river engineering, urban stormwater and wastewater reticulation engineering, infrastructure asset management and environmental effects assessment.

BACKGROUND

4. I have been asked to comment on the flood hazard and the scope of flood mitigation options related to a preliminary proposal for the establishment of educational facilities including buildings and playing fields at Jacks Point. The yellow area identified for the location of buildings is indicated as the Built area in Figure 1 (attached). The area within the outer red boundary, outside the yellow shaded area is likely to contain playing fields as part of a greater Education Facility area location.
5. The Built area, and the land to a kilometre to the east of the built area in Figure 1 has been altered by construction activities in the recent past. A flood channel has been constructed on the southern boundary of the locality of the Education Facility area.
6. The locality of the Education Facility is affected by flood waters that arrive via Stream 1 and Stream 2 (see Figure 1). The upper catchments of Streams 1 and 2 are located high on the western face of the Remarkables Range. Flows from the upper catchments move down gradient to State Highway 6, cross SH6, and then flow down slope for over a kilometre to the Built area.

7. Flood hazards are critical for buildings but is less critical for playing fields that can, when appropriate, be used as flood detention areas for managing flood hazards. The flood mitigation options discussed in this evidence take the criticality of different land uses into consideration.
8. Reference has been made to the Otago Regional Council Hazard Register and the hazard classification for the Education Facility locality is attached as Figure 4. The Built site area falls partially within an area that is identified as an %Alluvial Fan (regional scale) Active, Floodwater Dominated . the balance of the site falls within an area that has a %liquefaction Risk . Possibly Moderate+classification. The topography of the Built area and the land immediately upstream is generally rolling or gentle and uniformly sloping to Maori Jack Road.
9. This preliminary assessment has identified that the proposed development area is affected by flooding and suggests two possible flood mitigation options that could be considered for the proposed type of development.

FLOOD HAZARD ASSESSMENT

10. LiDAR data from the Otago Regional Council, from a survey in 2016, for the catchment area affecting the built area and a 4 hour duration 100 year Average Return Period rainfall design hyetograph was used to provide an indication of flood extent and an estimate of peak flood flows for the various primary flow paths based on the current topography. Given the size and topography of the Stream 1 and Stream 2 catchments the 6 hour duration storm was considered to be the storm duration that would generate maximum flow. The flood extents and peak flows are illustrated in Figure 2 provides additional information on the nature of the floodwater dominated hazard identified in the ORC hazard register.

INDICATIVE FLOOD MITIGATION OPTIONS

11. Two possible flood mitigation options are illustrated in Figure 3.

MITIGATION OPTION 1

12. Option 1 would divert Stream 1 to the Stream 2 alignment so that the primary flood hazard is diverted from the built area. This option would also require the existing flood channel on the southern boundary of the Education facility area to be increased in size to accommodate the Stream 1 flow.
13. Diverting Stream 1 to Stream 2 and increasing the conveyance capacity of the existing floodway would increase the flow rate at Maori Point Road and therefore an additional culvert pipe would be required. Simply making the flood channel larger would also increase the combined Stream 1 and Stream 2 flow rate that would potentially have adverse effects on the watercourse downstream and therefore detention storage of some form is likely to be required.
14. To assist with detention storage the diversion from Stream 1 to Stream 2 would be a bank up to of the order of 2 metres high with a channel along the toe of the bank that would convey the annual flood. For larger flood events, a wide flood berm

adjoining the bank would absorb and convey the peak flows. The flood berm may also utilise some minor banks across the flood berm to help absorb peak flows.

15. The enlargement of the existing channel on the southern boundary could also utilise a flood berm or alternatively a detention pond in a playing field area may be a more practical solution.
16. A trapezoidal channel for conveyance of the annual flood flow for Stream 1 diversion would be of the order 5 metres wide and 0.75m deep . the flood berm could be of the order of 20 metres wide making a total constructed channel width of the order of 25m.
17. The enlargement for the existing channel would increase the top width of the existing flood channel from of the order of 10m to 20m with a flood berm or to 12m without a flood berm but would require a detention facility. For the slope and the flow of the order of 10m³/s care would be required to manage flow velocity to avoid erosion and sedimentation. This could be achieved with planting or drop structures.
18. A secondary internal stormwater management system would be required in the area between the Stream 1 diversion and the lower limits of the built area. The secondary flood flow would require a typical stormwater system but not the substantial floodway channel that would be required to convey floodwaters through the site for Option 2.

MITIGATION OPTION 2

19. For Option 2, Stream 1 would be confined to a channel that would convey the flood flow along the northern boundary of the education facility area to Maori Jack Road. The new channel would be formed to suit the layout of buildings and other facilities and would have a channel width of the order of 12m to 15m and would be of the order of 1.3m deep. As for the extended Stream 2 channel for Option 1 erosion and sedimentation would need to be part of the channel design.
20. Currently major flood flows down Stream 1 flows are dispersed across the area between Stream 1 channel and the existing Stream 2 channel. See Figure 2. The flow dispersion means that some flood detention capacity would likely be required. Open areas such as playing fields could serve as detention areas.
21. As for Option 1, an internal stormwater system would be required for the education facility area.

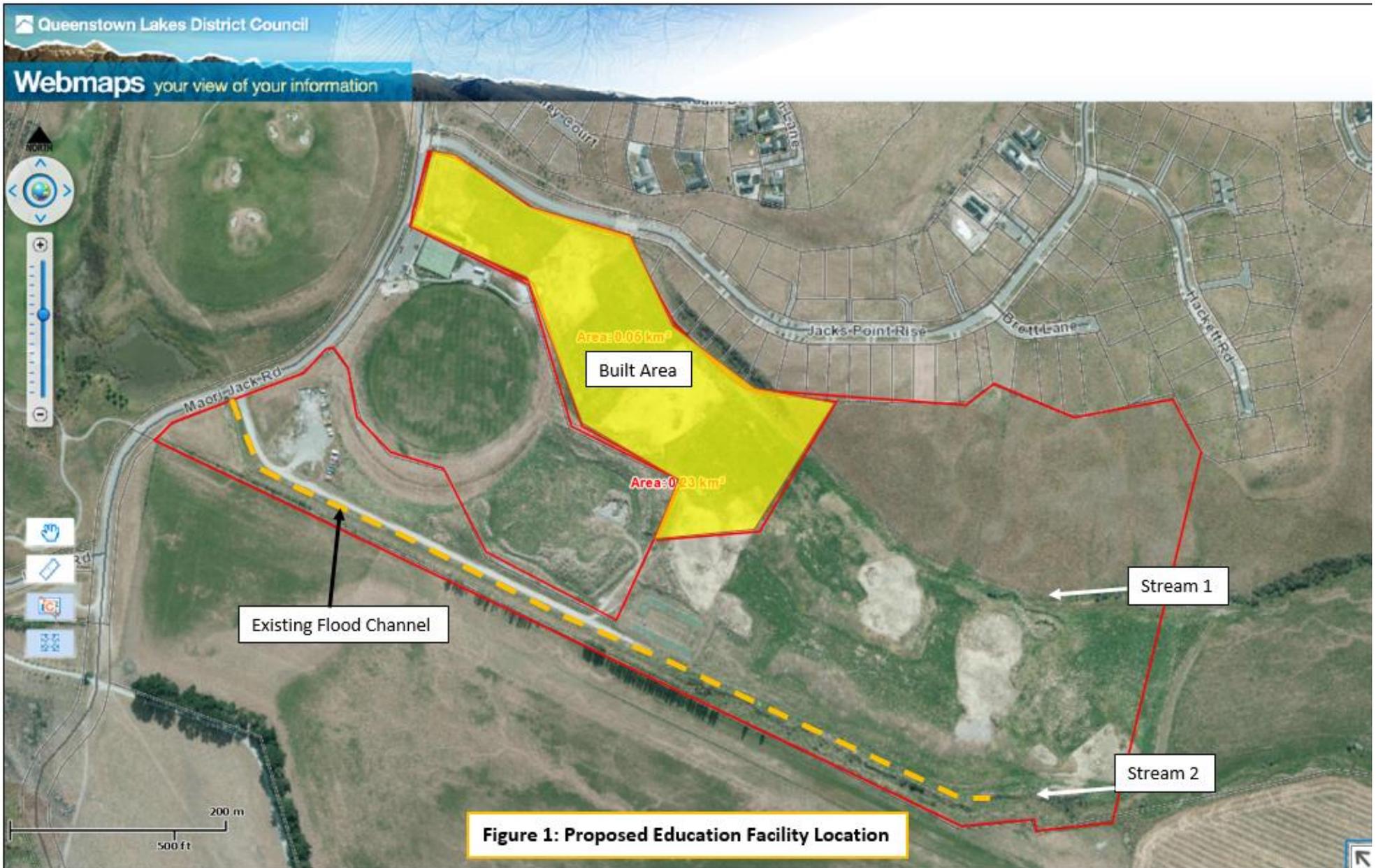
CONCLUSIONS

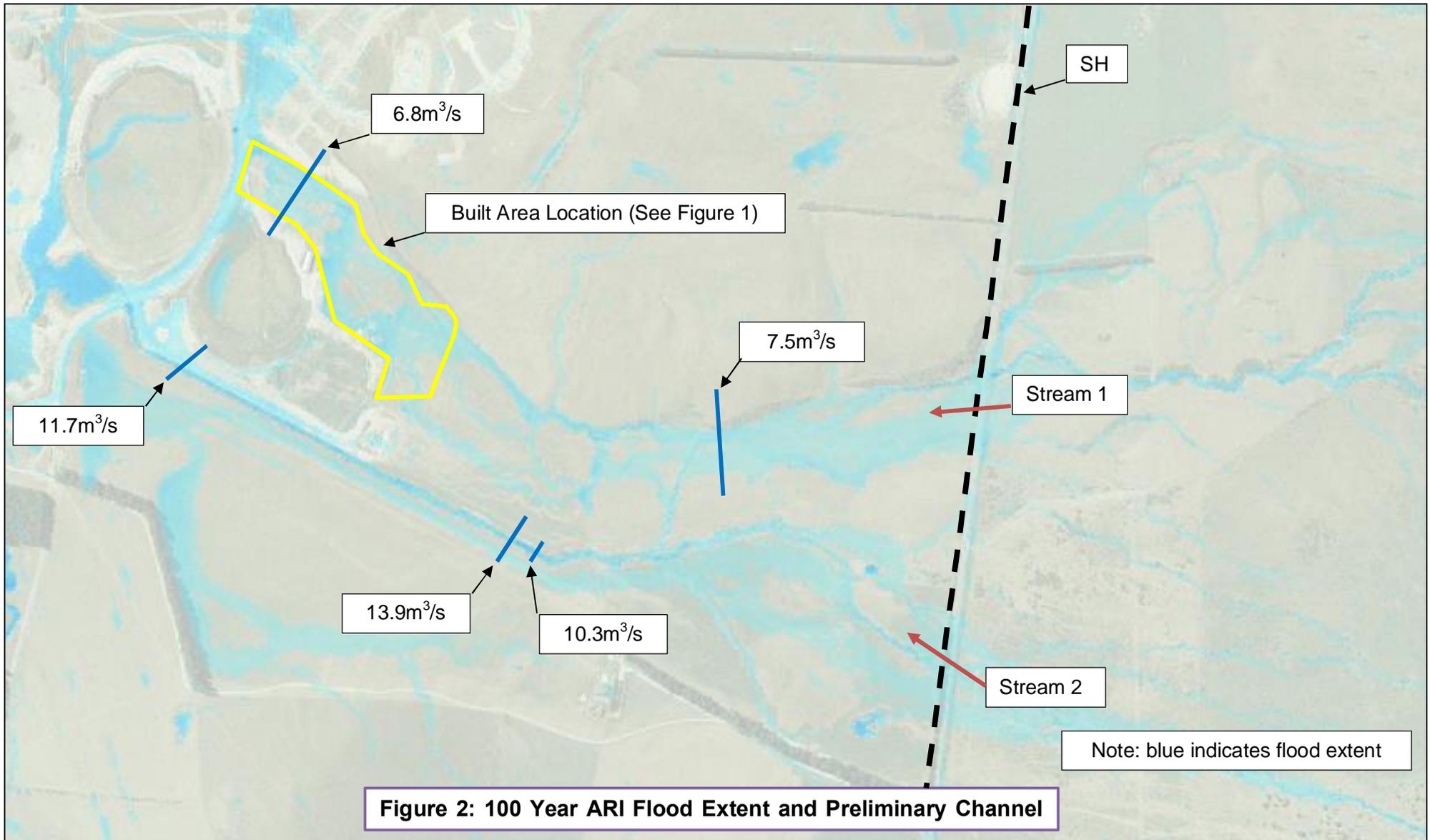
22. The flood flows from Streams 1 and 2 are able to be accommodated in flood channels and detention areas that could be accommodated in the area of proposed education facility land use.
23. Mitigation Option 1 would remove the flood hazard from the built area. Mitigation Option 2 would also be a feasible hazard mitigation solution.

Gary Dent
Principal Water Resources Engineer
Fluent Solutions
3 February 2017

ATTACHMENTS

- Figure 1 . Proposed Education Facility Location
- Figure 2 . 100 Year ARI Flood Extent and Primary Channel Flood Flows
- Figure 3 . Possible Flood Mitigation Options
- Figure 4 . Otago Regional Council Flood Hazard Register Map





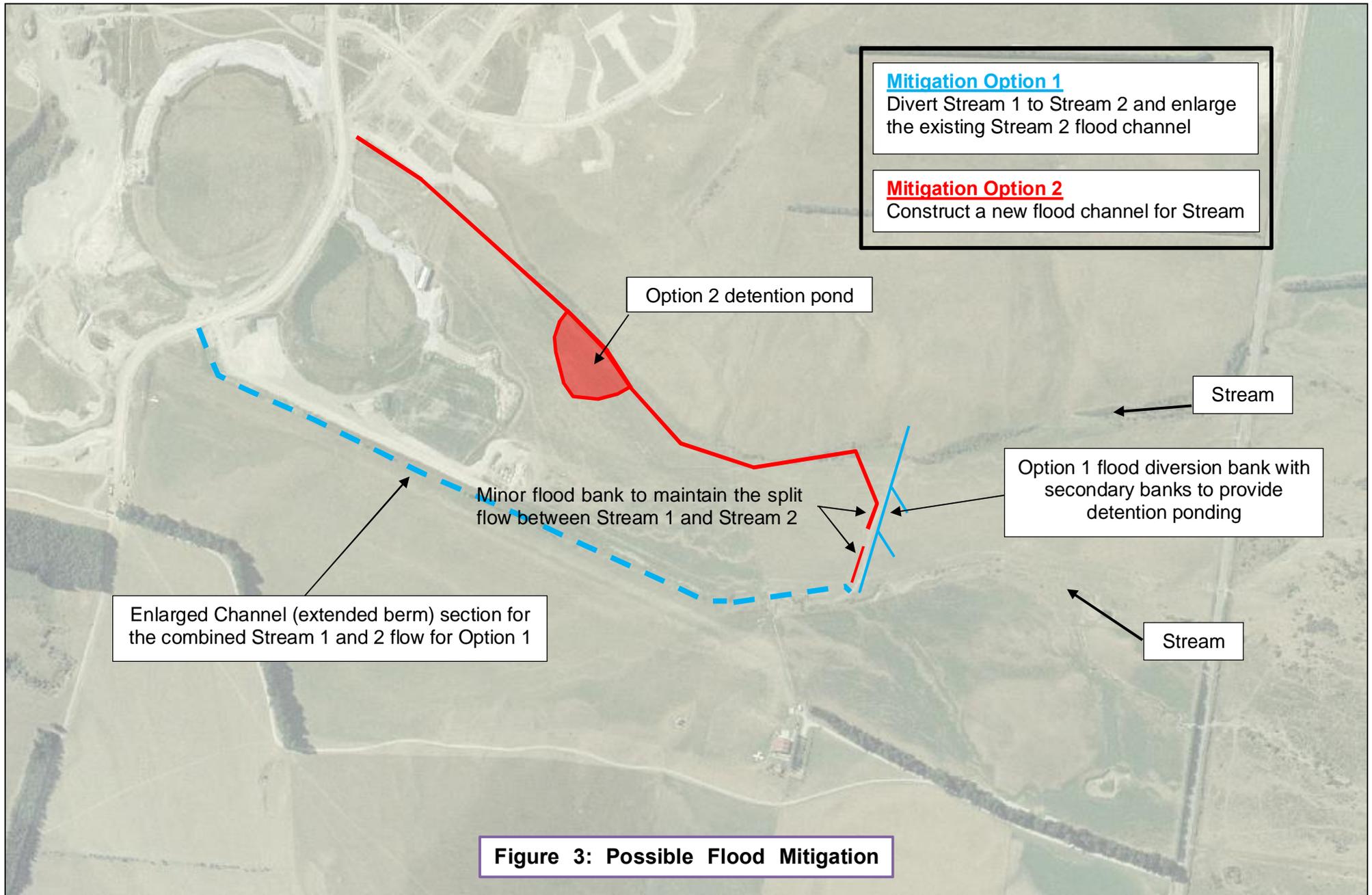


Figure 4: Otago Regional Council Flood Hazard Register Map – Regional Data

