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Copies to:	A Dawe, GM Policy and Science, ORC F Matthews, Manager Policy and Planning, ORC
From:	J-L Payan, Manager Natural Hazards, ORC
Date:	15 June 2023
Subject:	Gordon Road Spillway – Natural hazard's Response to Key Issues

1. This memorandum sets out a response from the ORC's Natural Hazards team to some of the issues raised in the submissions in respect of the Gordon Road Spillway Consultation. The detail in respect of these issues is largely derived from the affidavits in support of the application to undertake this consultation.

2. The sections in this memorandum follow the issues identified in the section 42A report. The memorandum covers the Reliability of data used to model flooding hazard and the Appropriate activity status for natural hazards sensitive activities in the Gordon Road Floodway as identified in the 42A report. In my assessment, I have considered the information provided in the submissions.

Reliability of data used to model flooding hazard

3. Appendix 2 presents a selection of photographs taken by ORC staff during the July 2017 flood event and showing different locations within the mapped Gordon Road Floodway area. The photographs are observations confirming the extent and severity of flooding in the various parts of the floodway.

4. The photographs were not taken at the peak of the flood and do not represent the maximum extent of flooding. They have been taken after the spillway had operated. The flood water in the photographs is from a combination of sources: overtopping from the Gordon Road spillway located on the true-right bank downstream of the Gordon Road Bridge, from overland flows (North and East), overtopping of the drainage network and internal rainfall accumulation[1].

5. The July 2017 flood event, although large, is not representative of the full range of flood events that can occur in this area (larger events could reasonably be expected such as in April 2006, Figure 1).

[1] As described in Affidavit of Dr Jean-Luc Payan for the Appellant in support of an application under section 293.

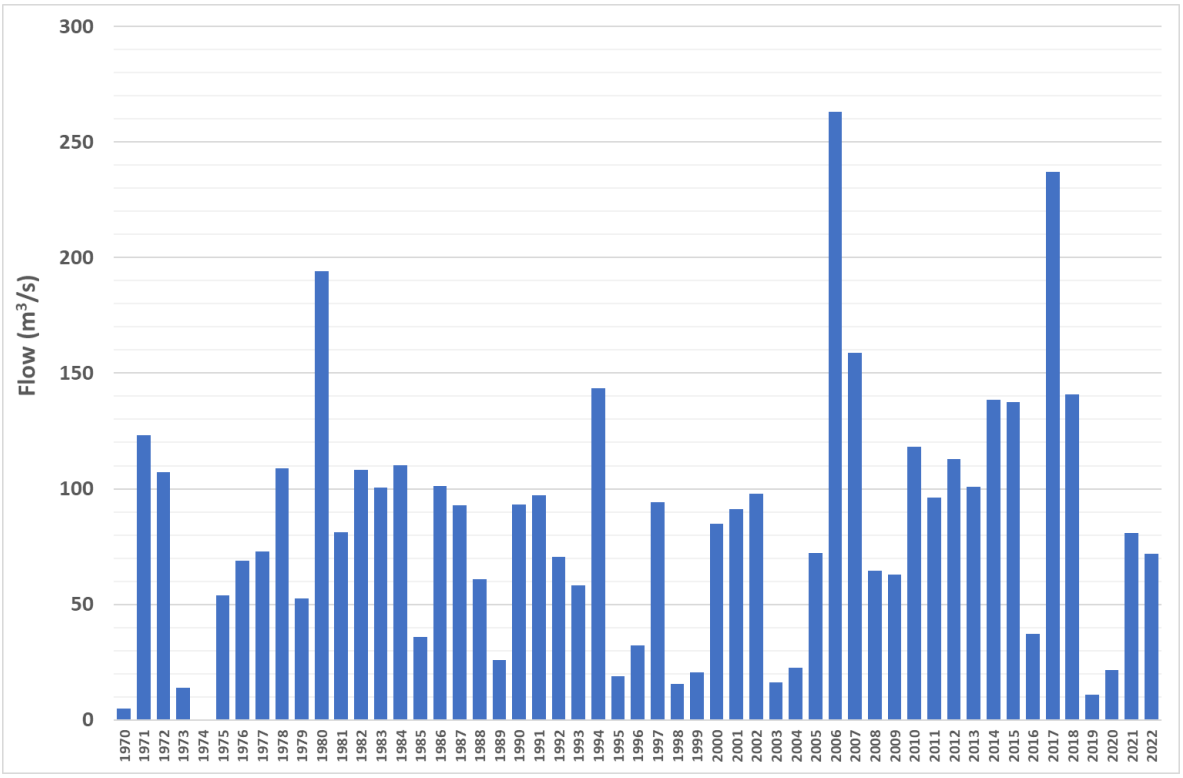


Figure 1. Annual highest flows in the Silver Stream in the vicinity of the Gordon Road spillway since recording started in January 1970. From 1970 to 1974 and from 1987 to 2012 the recorder was located downstream the Gordon Road spillway. From 1975 to 1987 and from 2012 until today the recorder is located upstream of the Gordon Road spillway. No data is available for 1974. The 2006 peak was estimated due to the location of the recorder downstream of the Gordon Road spillway.

6. As mentioned in my affidavit the modelling report was peer reviewed by Tonkin and Taylor (T+T). The peer reviewer concluded that the model is an appropriate tool for modelling the flood hazard in the Gordon Road floodway.

7. The model was calibrated using data (debris mark survey) surveyed by ORC after the July 2017 flood event and visually checked by ORC using photos and videos collected during the July 2017 event. T+T confirmed that "the modelling approach and parameters selected in the development of the model, are soundly based and reflect conventional professional practice.

8. Further, simulation results compared to available monitoring data for the 2006, 2010 and 2017 flood events provided validation of the model as a tool to investigate the flooding processes and present-day flood hazards in the North Taieri/Gordon Road Floodway area".

9. Some submissions appear to show a potential misalignment between the residents' experience of flooding in the Gordon Road Floodway and the modelled hazard categories i.e. dwellings located mainly within flood hazard category H1, with residents experiencing significant flooding[2] into the dwelling. It is important to note that flood hazard categories are mapped based on the modelled flood depth and velocity. Depth of water in the H1 category can be up to 300mm. The modelling does not take into account the design (such as floor level)

[2] Jill and Brian Bennett - 155 Dukes Road South

of existing dwellings. Therefore, the resident's experience of the flooding events affecting a dwelling does not represent an inaccuracy in the flood model.

10. When considering land flooding (as opposed to flooding of dwellings), the modelling results (flood extent and characteristics) are consistent with the residents' experience of flooding in the Gordon Road Floodway.

11. Appendix 2 provides an example illustrating the consistency of the residents' experience of flooding with the modelling results. I consider the July 2017 event to be a representative event for the floodway and was used to illustrate the consistency of the residents' experience of flooding with the modelling results. However, in their submissions, the residents have not always specified the date of the flood events associated with their observations and the comparison with the modelled July 2017 flood event can only be indicative.

Appropriate activity status for natural hazards sensitive activities in the Gordon Road Floodway

12. The original Gordon Road Floodway mapping was undertaken in 2015[3] and was based on observations made after flood events, in particular the April 2006 flood event, site visits, discussions with local residents and using detailed topographical information derived from LiDAR data.

13. I have re-assessed flood hazard risk associated with the Gordon Road Floodway taking into account the flood modelling undertaken by Bloxam Burnett & Olliver[4] and peer reviewed by Tonkin and Taylor Ltd[5] and information from the submissions made during the consultation period.

14. In order to identify areas within the Gordon Road Floodway based on their relative level of flood hazard risk, the following factors were considered:
    a. Flood hazard characteristics[6]: i.e. likelihood, depth of inundation, velocity of water, and the speed of the flooding happening
    b. Ability to safely access or exit a property (for occupiers and Emergency Management Services)
    c. Safe floodway functioning: i.e. the ability of the spilled water to flow safely from the spillway to the Cutoff bank area and then to the East Taieri Upper Pond (Figure 2)
    d. Ability to reliably predict the timing of reaching the threshold of spillway operation and duration and peak overflow
    e. The rapid transition from no overland flow to extensive and fast overland flow
    f. The redirection and blockage of overland flow due to surface obstructions associated with residential land use (outbuildings, fences, hedgerows etc.)

[3] Refer to "Flood hazard on the Taieri Plain - Review of Dunedin City District Plan: Natural hazards", ORC, August 2015
[4] As described in Affidavit of Dr Bikesh Shrestha for the Appellant in support of an application under section 293
[5] As described in Affidavit of Tom Bassett for the Appellant in support of an application under section 293
[6] As described in Affidavit of Dr Jean-Luc Payan for the Appellant in support of an application under section 293

g. The flashy[7] nature of the Silver Stream catchment.

15. I have also considered the guidance on risk included within Chapter 11 of Dunedin City Second Generation District Plan (2GP). Section 11.1.2 provides guidance on quantifying the potential risk associated with an application. It states that:

> *Site specific investigation will identify local variation in the risk level specified in this Plan. Risk can also be reduced through mitigation measures including site design and layout, material used, and the design of buildings and structures. This means that while in a certain area there is a potential for a high risk (for example on a site in a Hazard 1 Overlay Zone), this risk can sometimes be reduced to a low risk, under the right circumstances. The resource consent process is used to determine the actual risk of a particular proposal at a specific location, and whether it can meet the policy test of being 'no more than low'. This assessment will also include the potential off-site risks (e.g. diversion of floodwater creating or exacerbating risk). It will also consider the residual risk in the event any proposed mitigation measures should fail.*

Table 11.1.2A Risk in section 11 of the 2GP shown below sets out how the combination of likelihood and consequence is combined to produce a risk assessment of low, moderate, or high.

Table 11.1.2A Risk Guidance

Likelihood	Minor consequences	Moderate consequences	Major consequences
Very likely (less than 1:50 (1 in 50 year event) or annual exceedance probability (AEP) 2% or more)	Low to Moderate risk	Moderate to High risk	High risk
Moderately likely[1] (1:50 - 1:200 or AEP range 0.5% to 2%)	Low risk	Moderate risk	High risk
Unlikely (1:200 - 1:500 or AEP range 0.2% to 0.5%)	Low risk	Low risk	Moderate risk
Very unlikely (1:500 to 1:2500 or AEP range 0.04% to 0.2%)	Very low risk	Low risk	Moderate risk
Extremely unlikely (more than 1: 2500 or AEP 0.04% or less)	Very low risk	Very low risk	Low risk

[1] Where likelihood is unknown or poorly established, use 'moderately likely'.

Minor consequence is defined as:

> For the purposes of the natural hazards provisions, minor consequences as a result of a natural hazard event include:
>
> - limited property damage that may be repairable without access to insurance, such as cracks in walls or wet foundations
> - minor, non-life threatening injuries
> - localised (rather than district-wide) economic impact; and
> - restricted site access to a site for no more than 2 days due to flood waters, but where safe access is still possible on foot.

Moderate consequence is defined as:

> For the purposes of the natural hazards provisions, moderate consequences means having at least 2 of the following outcomes as a result of a natural hazard event:

[7] As described in Affidavit of Dr Jean-Luc Payan for the Appellant in support of an application under section 293

- serious structural damage to property which is costly, but still repairable, where access to insurance is almost always necessary to fix damage
- a potential for significant injury
- physical isolation on-site for more than 2 days at a time
- potential for economic impact that may be felt at a district-wide scale; and
- some reliance on civil defence.

Major consequence is defined as;

For the purposes of the natural hazards provisions, major consequence means having at least 2 of the following outcomes as a result of a natural hazard event:

- significant property or asset damage or loss, including structural damage that is extensive and so severe that it may lead to a property being abandoned or an asset requiring complete replacement
- a likely potential for long term displacement, deaths or serious injuries
- potential for significant effects to be felt over a wider area, including public health issues
- potential for economic impact to be felt at a regional scale; and
- significant civil defence assistance being required, including temporary shelter or evacuation.

16. Using the guidance and definitions from Section 11 of the 2GP, the updated flood modelling, the factors mentioned above and information from submissions, I have identified areas of the Gordon Road Spillway that I consider to be 'higher risk' and areas that are 'lower risk' (Figure 2).

17. The identified higher risk areas correspond to the areas where:
    - the flood hazard characteristics are such that they are a potential threat to life (flood hazard category H3 or higher),
    - the ability to safely access the property is compromised or restricted (flood hazard category H2 or higher)
    - buildings are vulnerable to structural damage (flood hazard category H5)
    - properties are likely to rely on civil defence assistance (for example for evacuation in a relatively short timeframe[8]).

18. The higher risk areas also include areas where the flood hazard characteristics may not be a threat to life but where the areas are within the flowpath of the spilled water and likely to affect the safe functioning of the spillway.

19. Using the guidance and definitions from Section 11 of the 2GP, I consider that the consequences listed above correspond to the "moderate" and "major" consequences categories.

[8] As described in Affidavit of Matthew Stuart Alley for Appellant in support of an application under section 293

20. Depending on the severity of the event[9], the likelihood associated with the higher risk areas ranges from "very likely" to "moderately likely" based on table 11.1.2A in Section 11 of the 2GP.

    Combining the consequence rating and likelihood rating based on table 11.1.2A (see table below), the risk corresponding to the higher risk areas of the Gordon Road Floodway is determined as "moderate risk" to "high risk" depending on the scale of the flood event and on the volume of water spilled into the floodway. At the mapped full extent of the Gordon Road Floodway, most of the higher risk areas within the Gordon Road Floodway are determined as "high risk" based on table 11.1.2A.

Table 11.1.2A Risk Guidance

Likelihood	Minor consequences	Moderate consequences	Major consequences
Very likely (less than 1:50 (1 in 50 year event) or annual exceedance probability (AEP) 2% or more)	Low to Moderate risk	Moderate to High risk	High risk
Moderately likely[1] (1:50 - 1:200 or AEP range 0.5% to 2%)	Low risk	Moderate risk	High risk
Unlikely (1:200 - 1:500 or AEP range 0.2% to 0.5%)	Low risk	Low risk	Moderate risk
Very unlikely (1:500 to 1:2500 or AEP range 0.04% to 0.2%)	Very low risk	Low risk	Moderate risk
Extremely unlikely (more than 1: 2500 or AEP 0.04% or less)	Very low risk	Very low risk	Low risk

[1] Where likelihood is unknown or poorly established, use 'moderately likely'.

21. The identified lower risk areas (Figure 2) are located at the margin of the Gordon Road Floodway and where the flood hazard characteristics associated with spilled water are less likely to be a threat to life (flood hazard category H2 or less). Access to the areas (through Dukes Road South) is less likely to become unsafe[10].

22. **It is important to note that the lower risk areas are part of the Gordon Road Floodway and have a degree of flood hazard (refer to Appendix 2 for illustration); the lower risk areas are not necessarily areas where flood hazard risk is low, they are areas where the risk is lower than other areas in the Gordon Road floodway**.

[9] The spillway operation starts when the flows in the Silver Stream at Gordon Road exceed approximately 120-130m^3/s with the spillway fully operating when flows exceed 150-170m^3/s as described in affidavit of Dr Jean-Luc Payan. The thresholds of the spillway operation correspond to flows having more than a 2% Annual Exceedance Probability (AEP). The mapped full extent of the higher risk areas within the Gordon Road Floodway corresponds to an event having a 1% AEP.

[10] Refer to submissions: Richard-and-Jennifer-Quelch, John-and-Ronda-McLaren, Jason-and-Lisa-Breen, Jill-and-Brian-Bennett

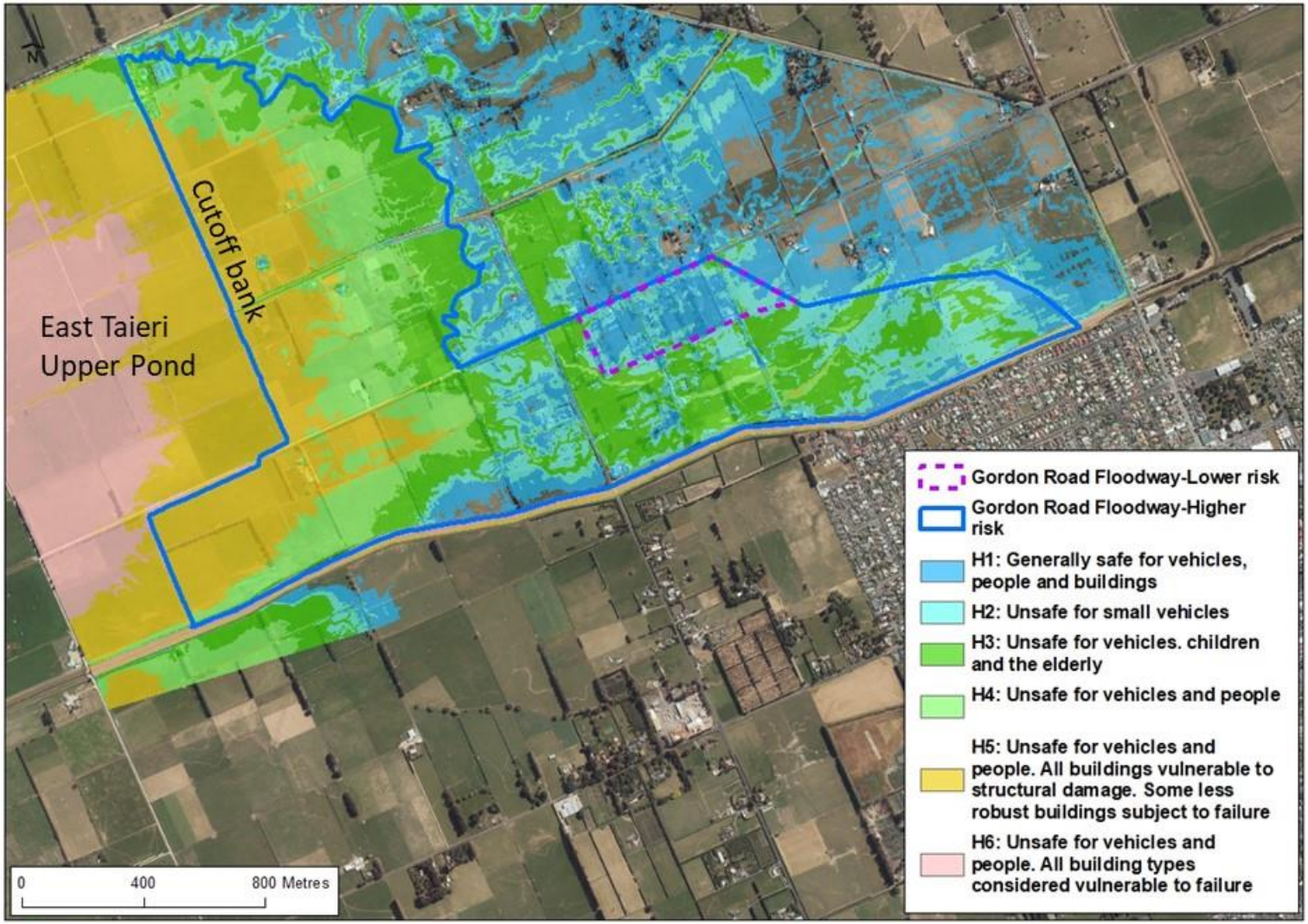
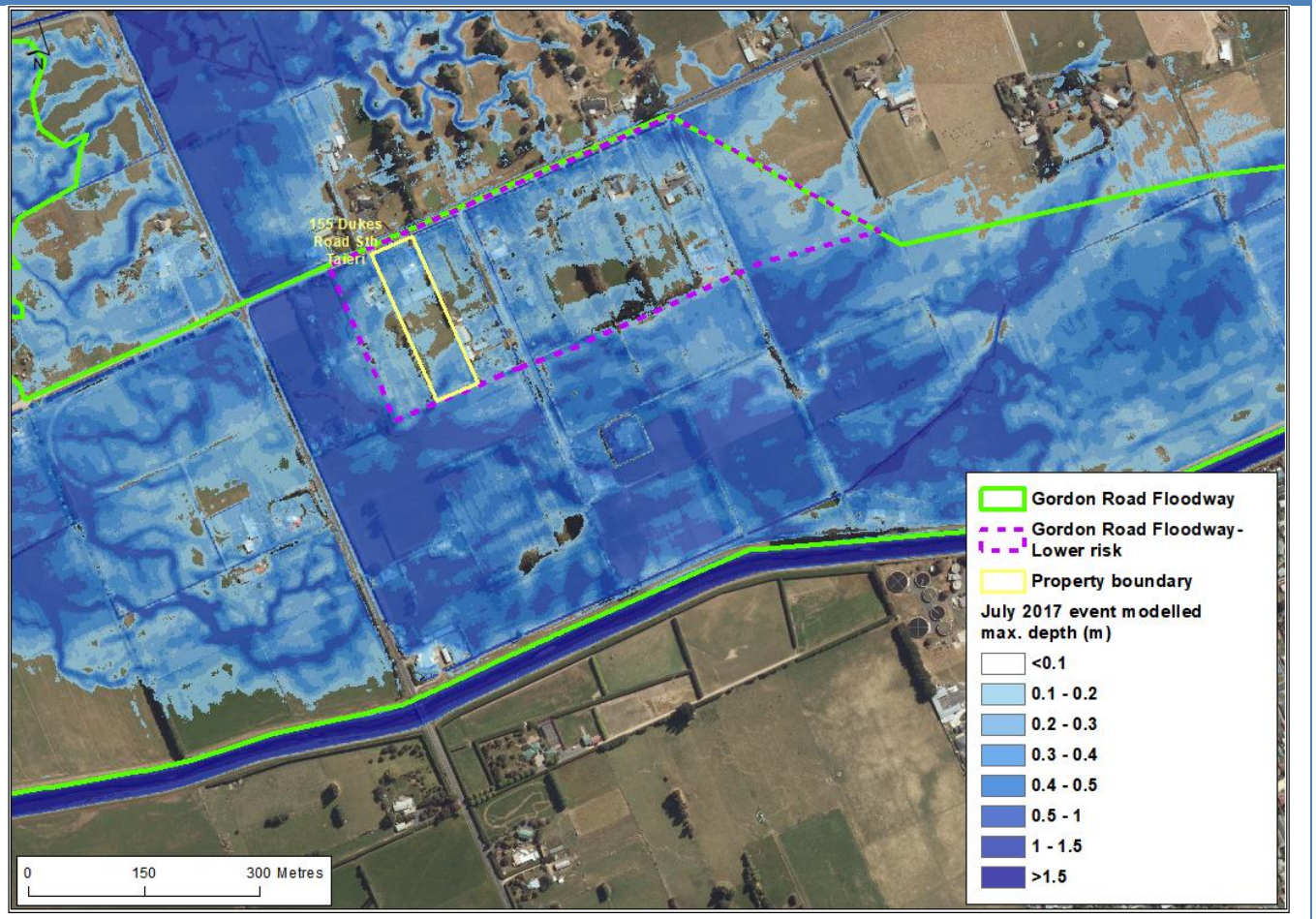
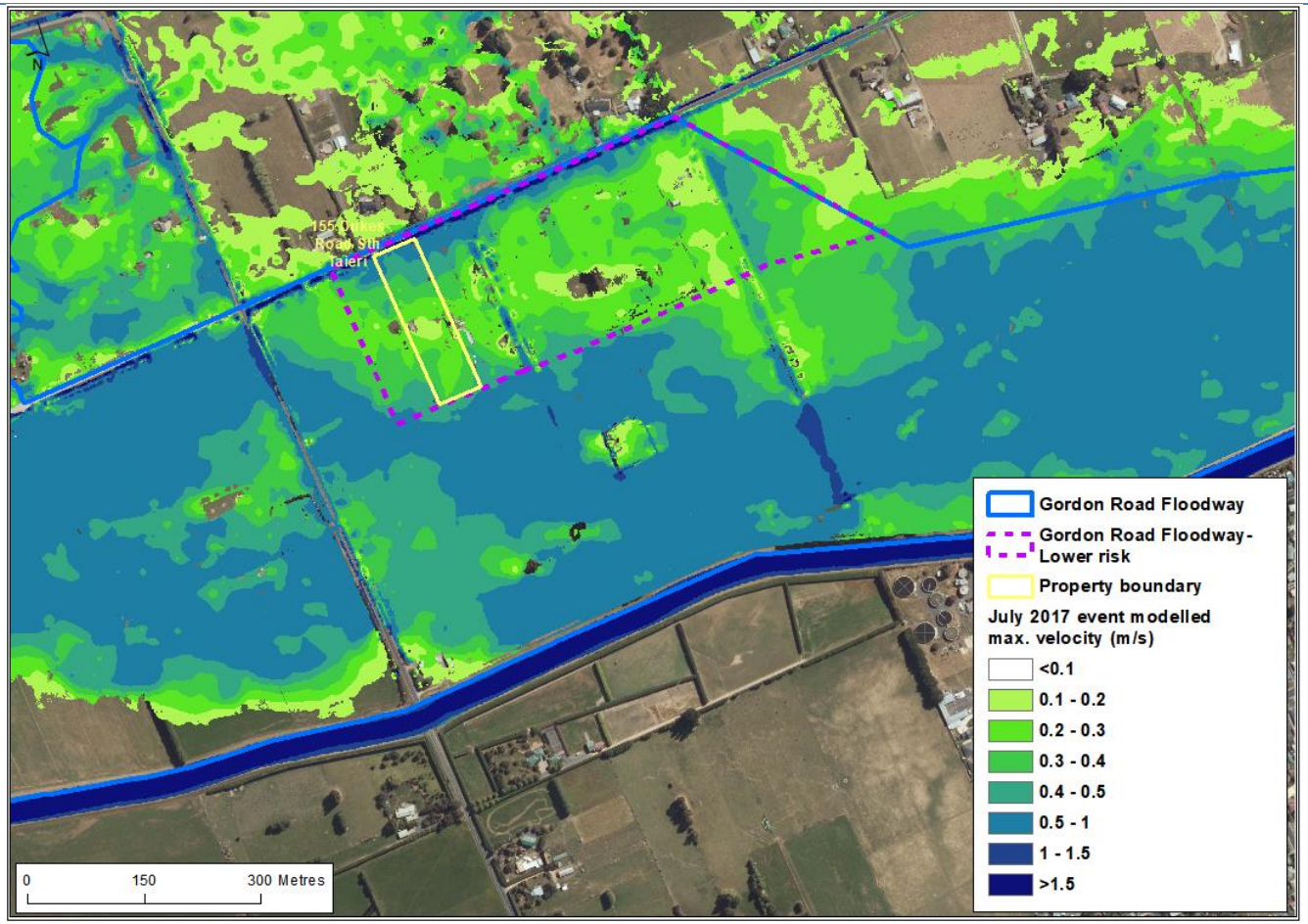


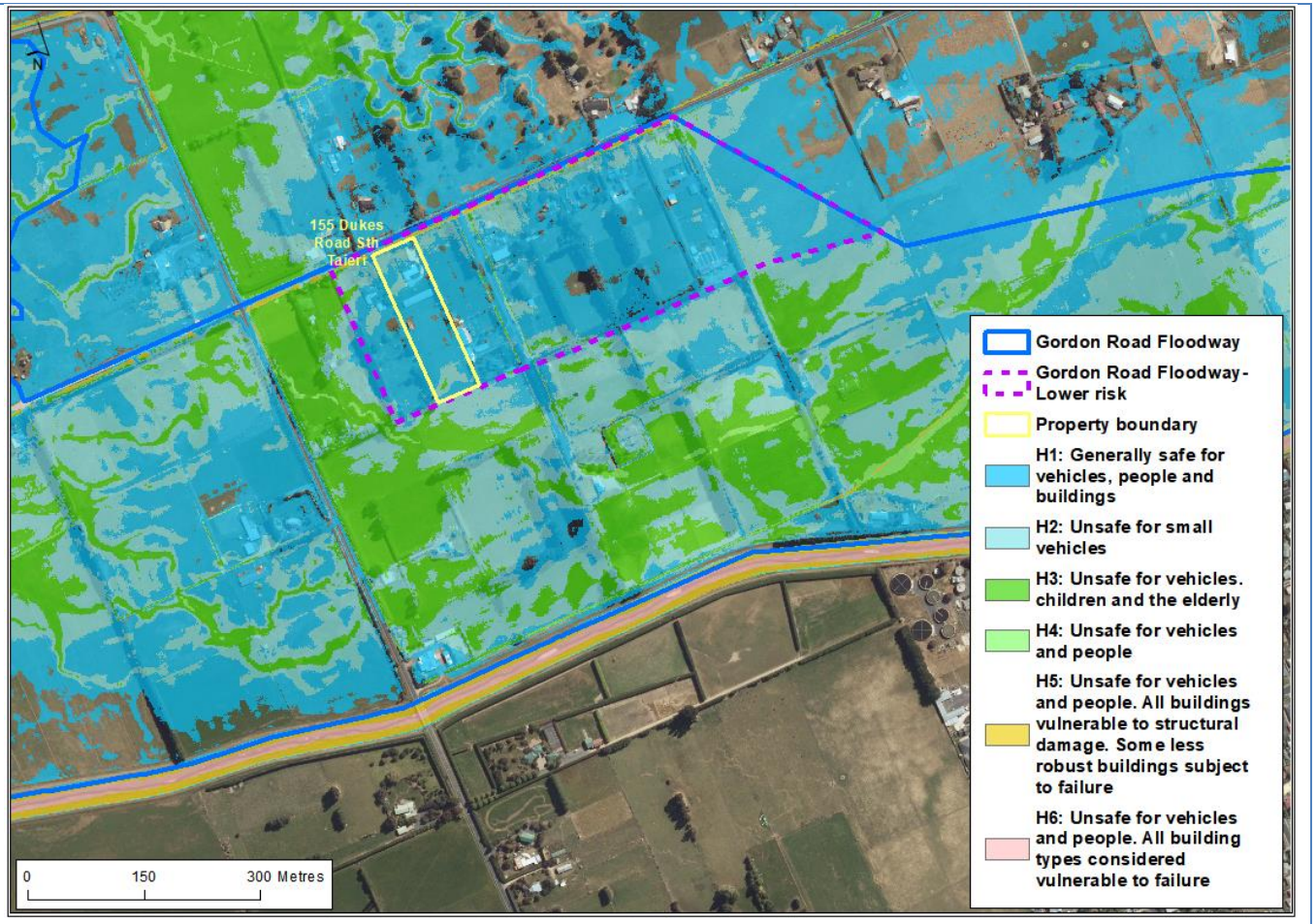
Figure 2. Areas of higher risk (blue line) and lower risk (purple dashed line) for people and properties within the mapped Gordon Road Floodway. The hazard category map (background map) corresponds to the 1% Annual Exceedance Probability (AEP) event model results

Appendix 1: Examples illustrating the consistency of the residents' experience of flooding with the modelling results

Property/Submitters	Flood observations/information from submissions	July 2017 flood event modelled flood hazard characteristics (max. depth, max. velocity, hazard categories)
155 Dukes Road South/Jill and Brian Bennett	• Experienced three significant floods in 2006, 2017, and 2018. • In all the flood events that have happened since 2006 not once the submitters have felt their lives were at risk and they have been able to leave the property if that is what has been required • Only the back of the property and the front where the house has been built on a concrete slab are at risk of flood water • The waters are not swift but do flow continuously thru the property • All properties have areas that don't flood and people are able to walk thru flood water in gumboots without getting wet feet in most areas [estimated to be 0.3-0.4m]	 July 2017 flood event modelled maximum depth – Maximum depth is in general less than 0.2m for most of 155 Dukes Road South with a maximum depth in the range of 0.3-0.4m at the front and back of the property



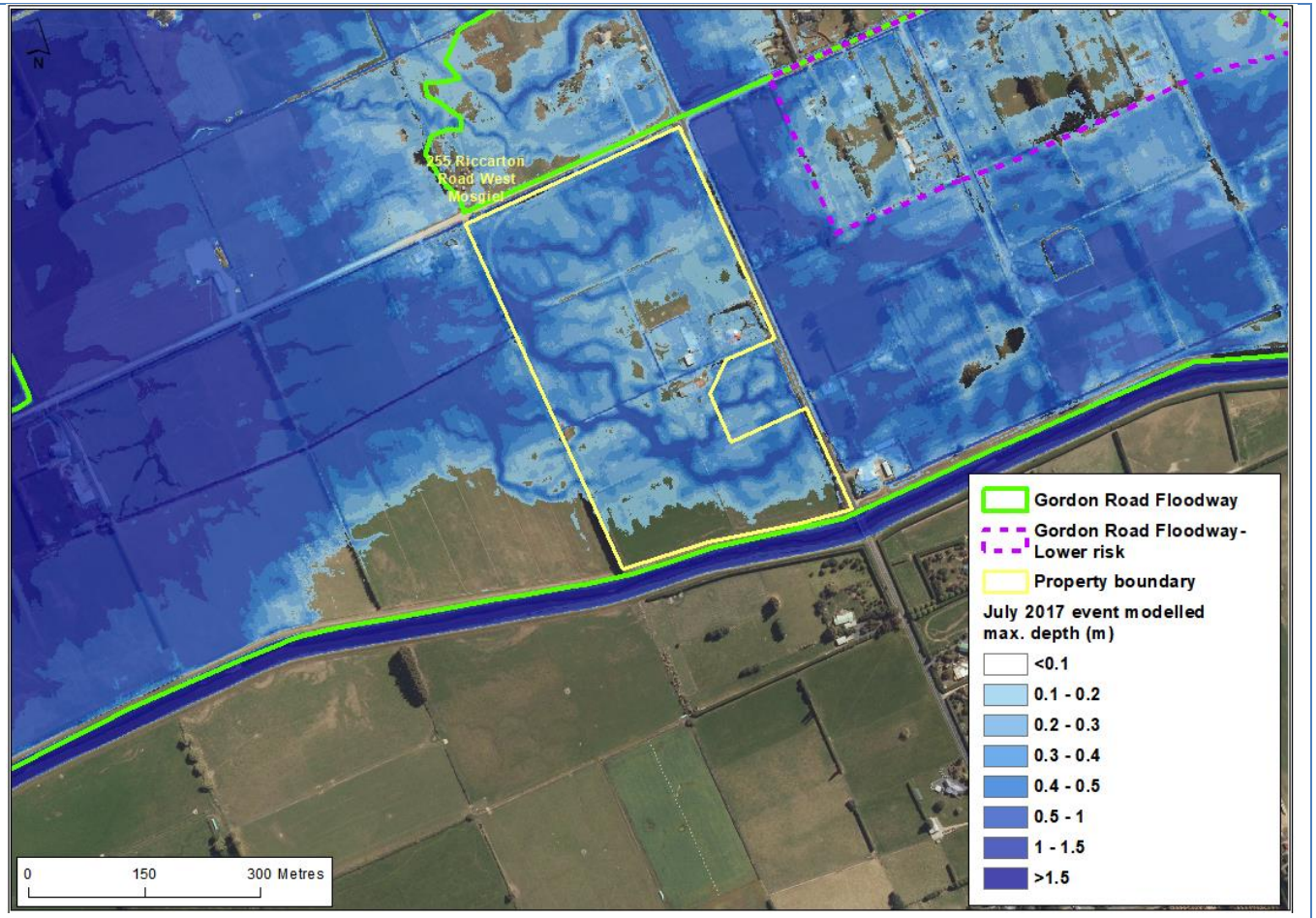
July 2017 flood event modelled maximum velocity - Maximum velocity is in general less than 0.5m/s for most of 155 Dukes Road South



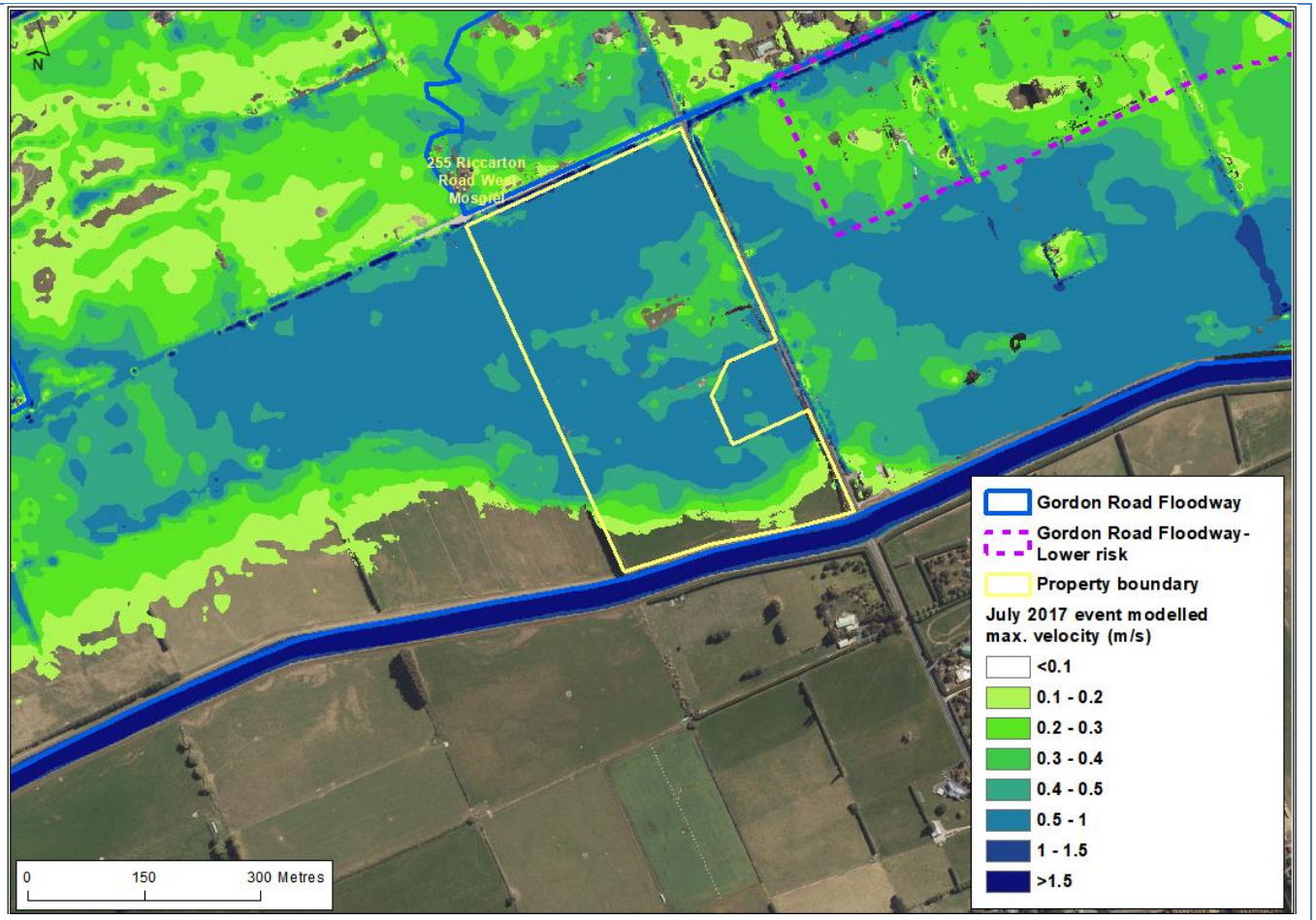
July 2017 flood event flood hazard categories – Most of 155 Dukes Road South is categorised in H1 with the back and front of the property categorised in H2

255 Riccarton Road West/Belinda and Ferg Horne

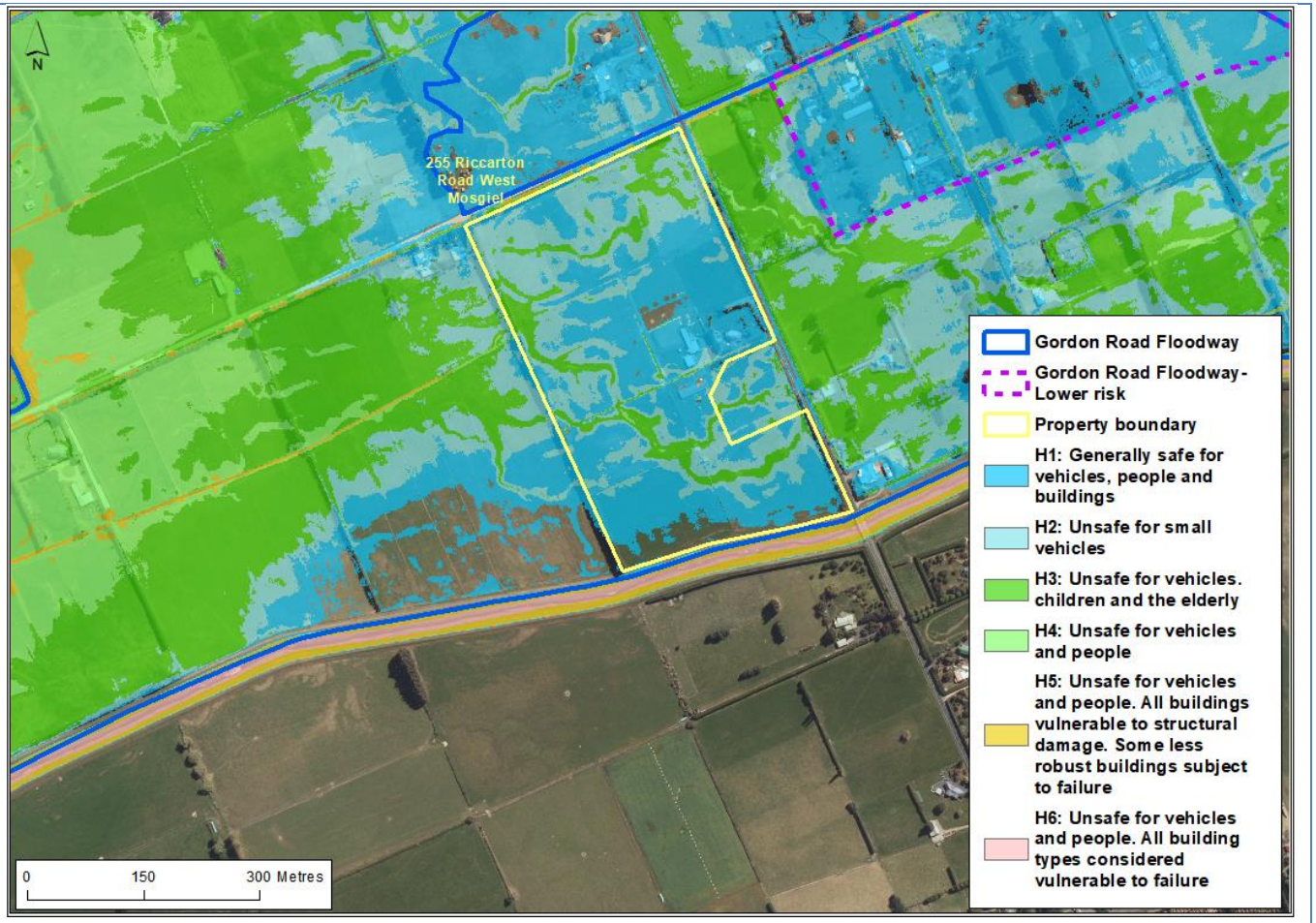
- The house never had water in it
- The water was only about a foot [approx. 0.3m] deep and was gone from the whole land area in a few hours
- Some sheds about a foot of water
- Shearing shed not flooded



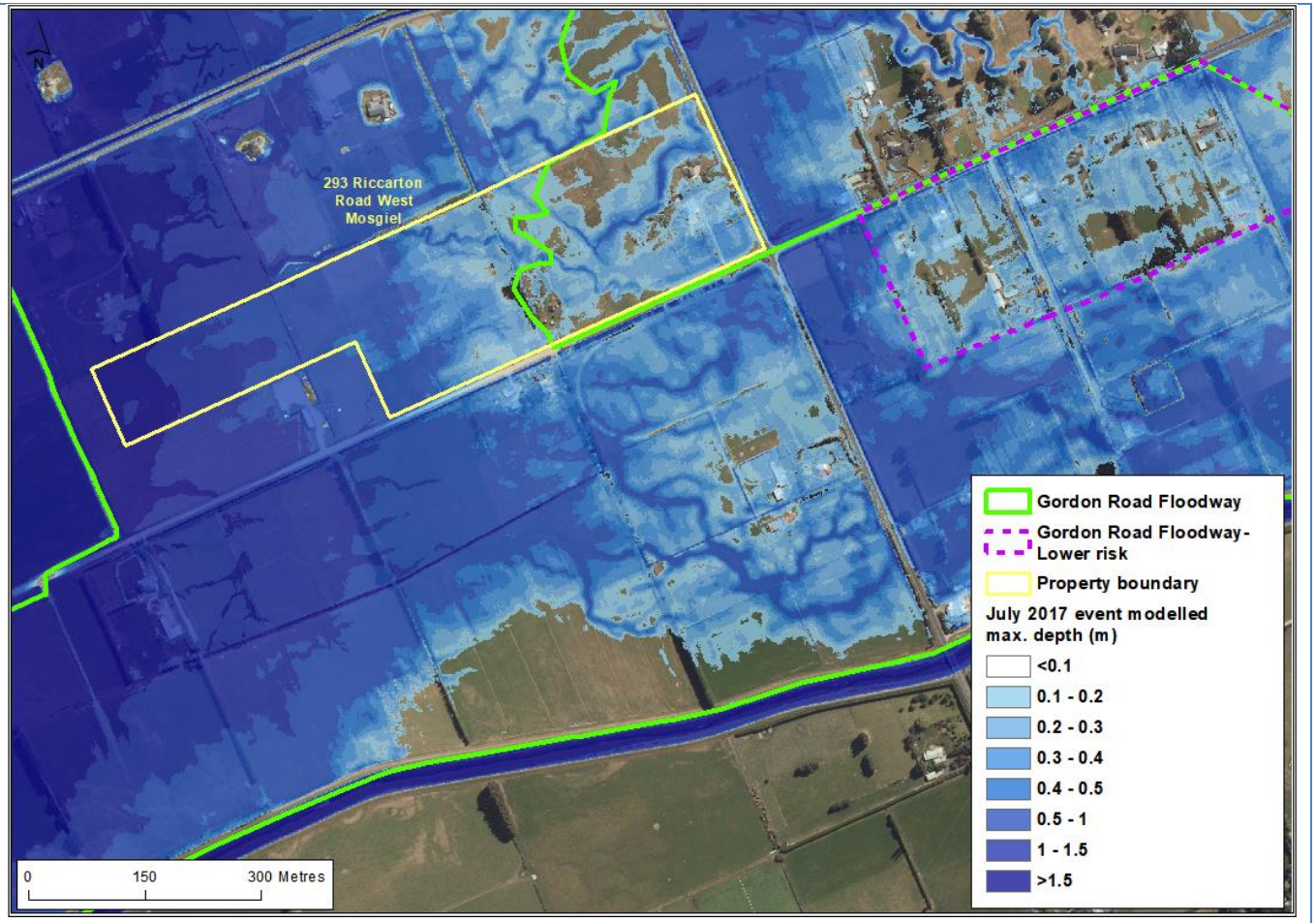
July 2017 flood event modelled maximum depth – Maximum depth is in general less than 0.3m (a foot) for most of 255 Riccarton Road West with a maximum depth in the range of 0.6-0.7m localised in the swales crossing the property East to West

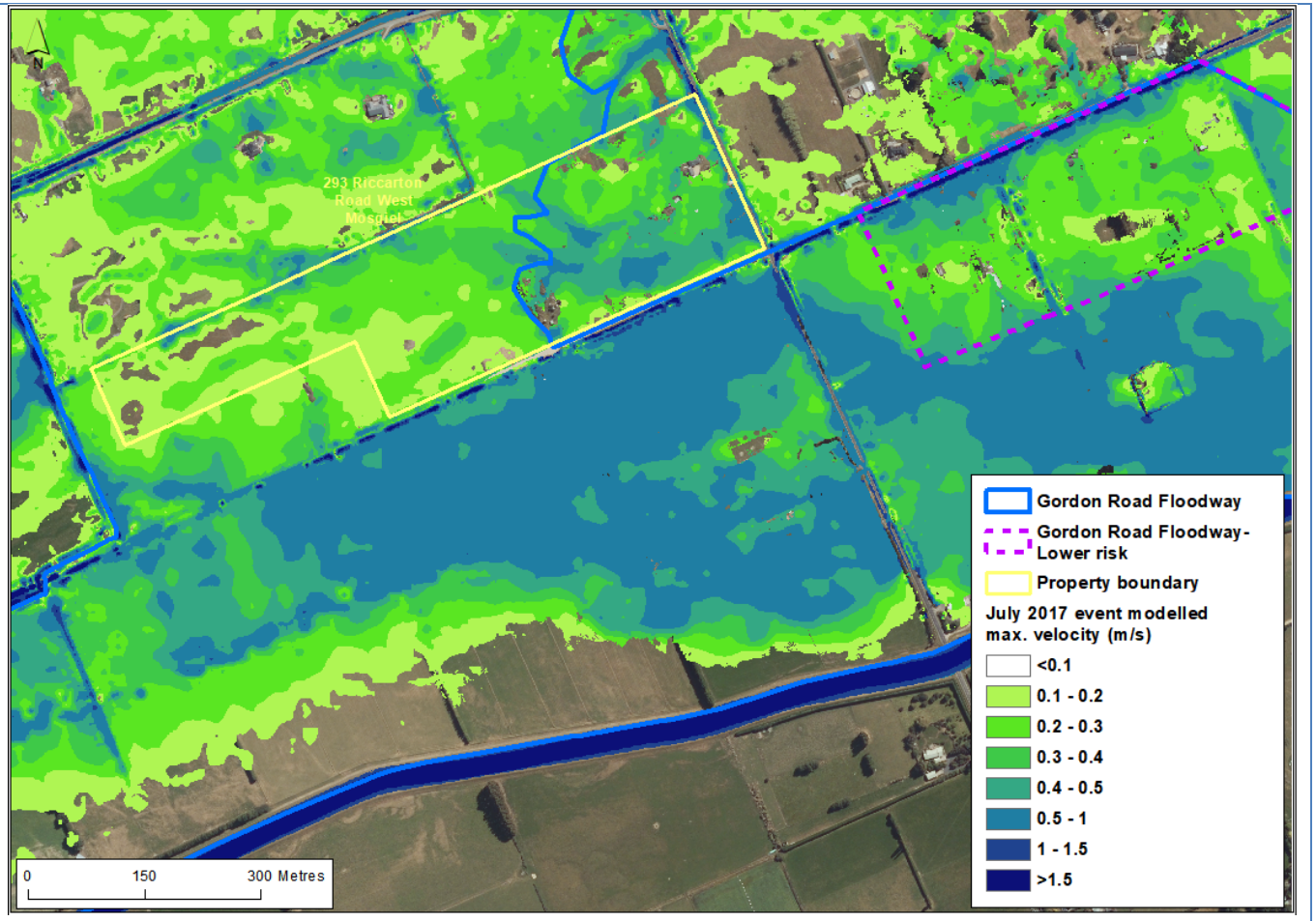


July 2017 event modelled maximum velocity - Maximum velocity is in general between 0.5m/s and 1m/s for most of 255 Riccarton Road West

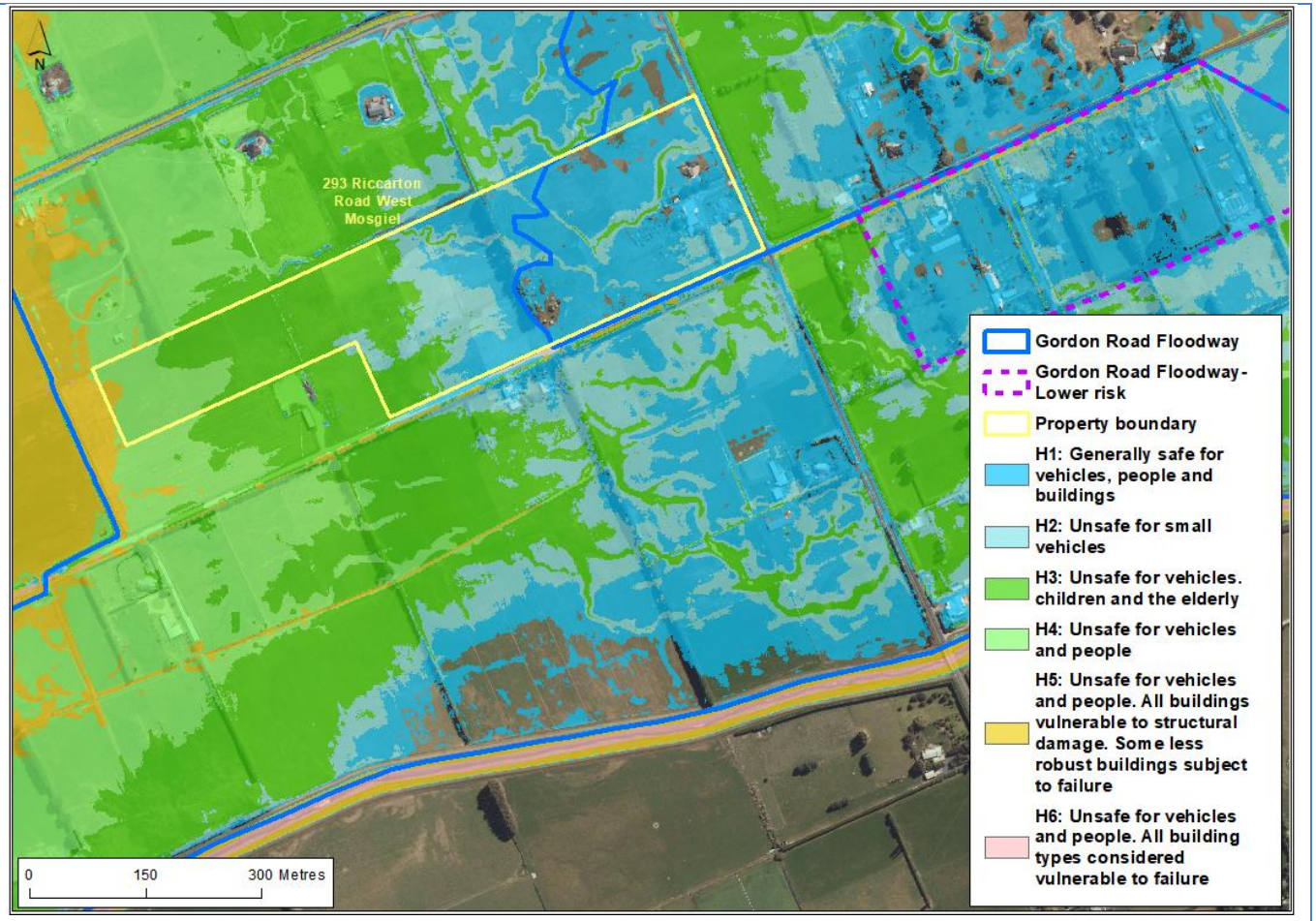


July 2017 flood event flood hazard categories – Most of 255 Riccarton Road West is categorised in H1 and H2. The swales crossing the property East to West are categorised in H3

293 Riccarton Road West/Alice Sinclair (property straddles the Gordon Rd Floodway area. Observations of flooding affecting property outside the area subject to appeal)	21/7/2017 • Flood waters on property • Been asked to evacuate by Police • 1 foot [approx. 0.3m] through the out buildings • Flood waters ripped out huge holes about 2 to foot deep into both driveways on the property • Water got under the house through the vent but never entered the house	 July 2017 flood event modelled maximum depth – Maximum depth is in general less than 0.3m (a foot) for the section of 293 Riccarton Road West located outside of the Gordon Road Floodway area with a maximum depth in the range of 0.6-0.7m localised in the swales crossing the property East to West



July 2017 event modelled maximum velocity - For the section of 293 Riccarton Road West located outside of the Gordon Road Floodway area, the maximum velocity is in general less than 0.4m/s and between 0.4m/s and 0.6m/s in the swales crossing the property East to West and on the driveways

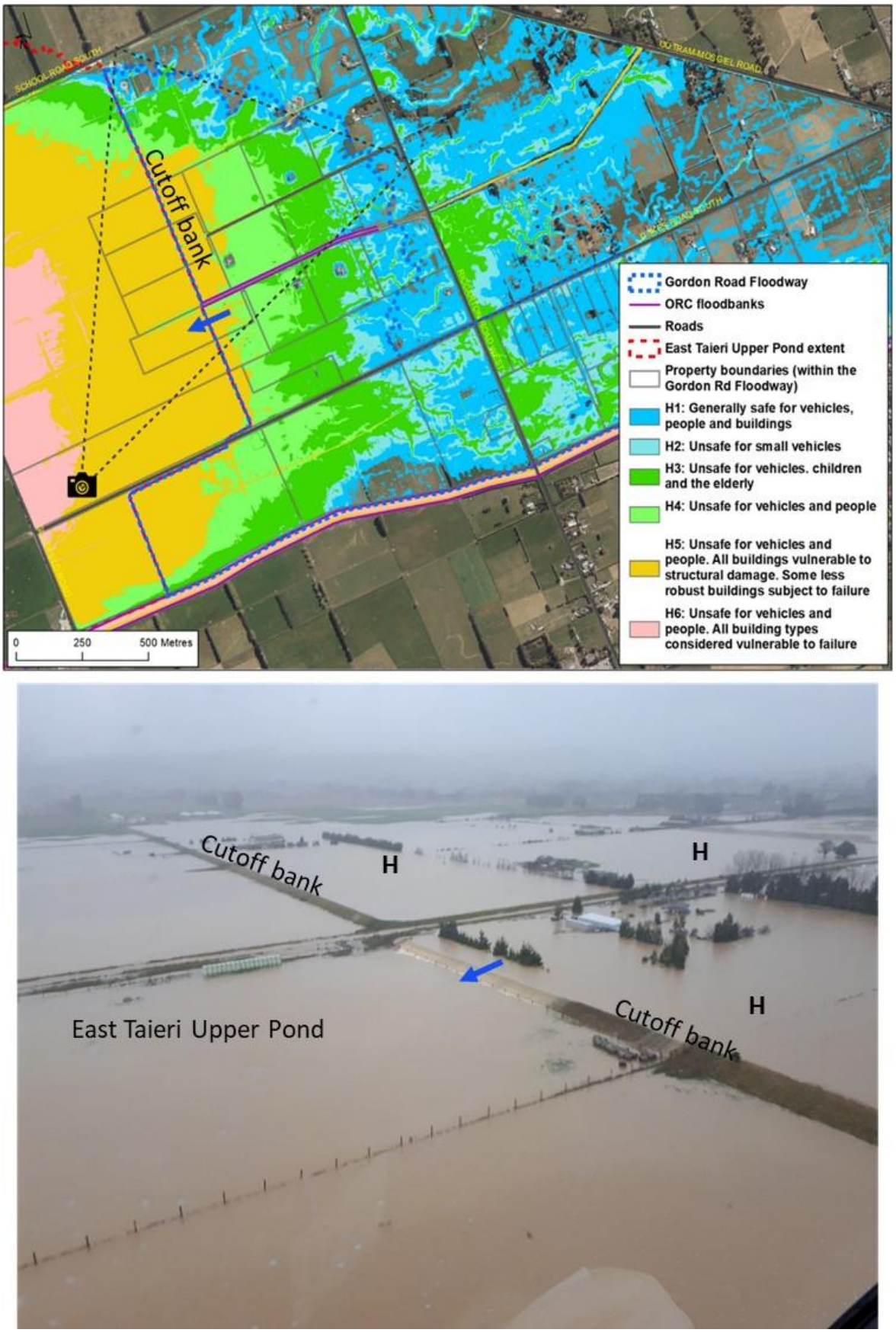


July 2017 flood event flood hazard categories – Most of the section of 293 Riccarton Road West located outside of the Gordon Road Floodway area, is categorised in H1. The swales crossing the property East to West are categorised in H2 or H3

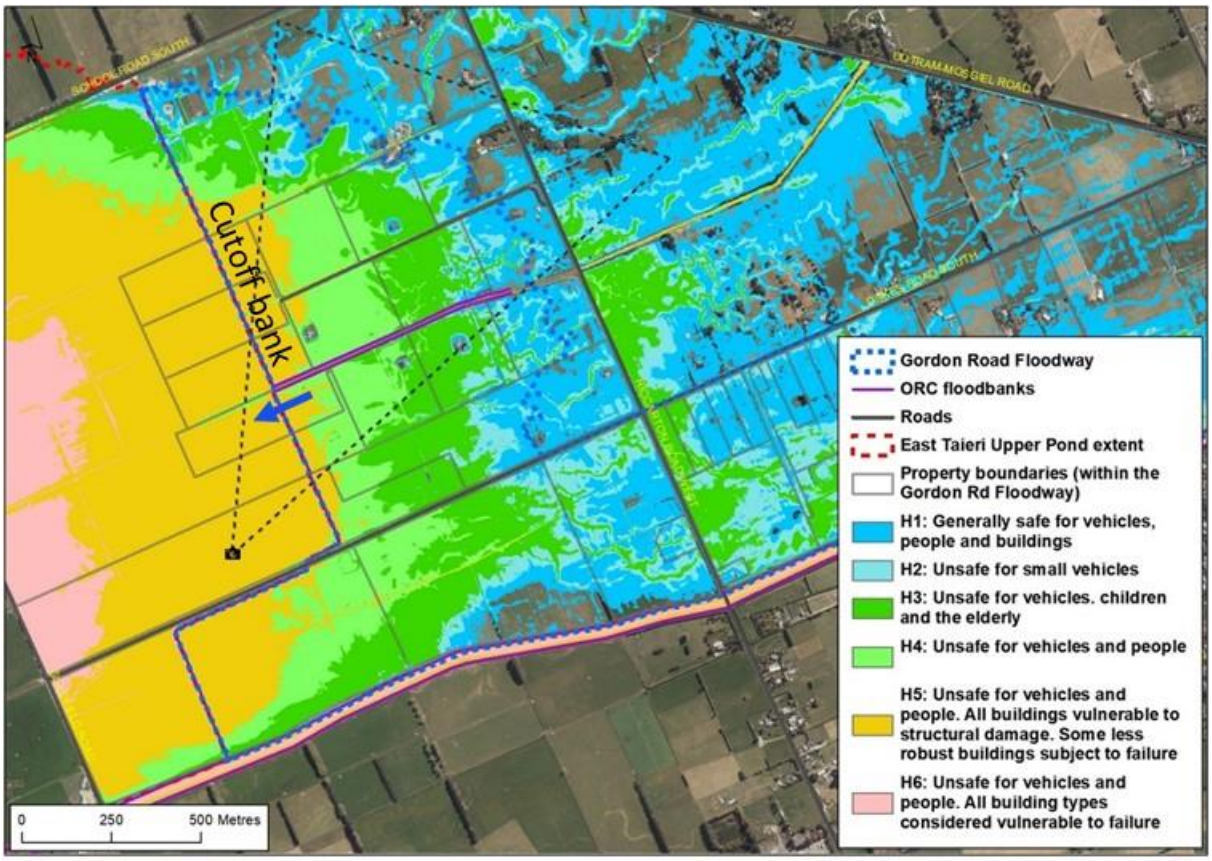
Appendix 2: Selection of photographs from the July 2017 flood event – Gordon Road Floodway

All the photographs were taken on 22 July 2017 between 9am and 9.05am. The photographs were not taken at the peak of the flood and do not represent the maximum extent of flooding that occurred in July 2017. The photographs were taken after the Gordon Road Spillway has stopped operating.

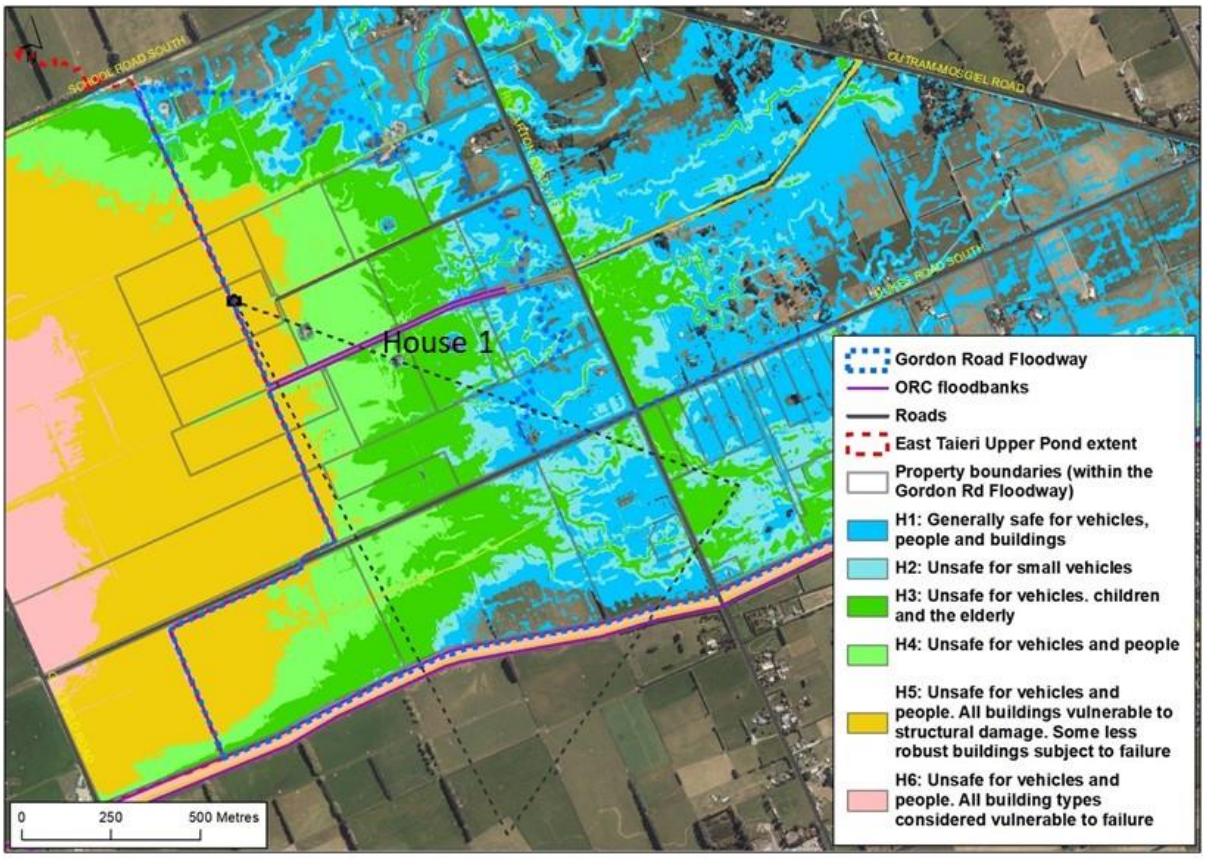
The hazard category map (background map) corresponds to the July 2017 event model results.



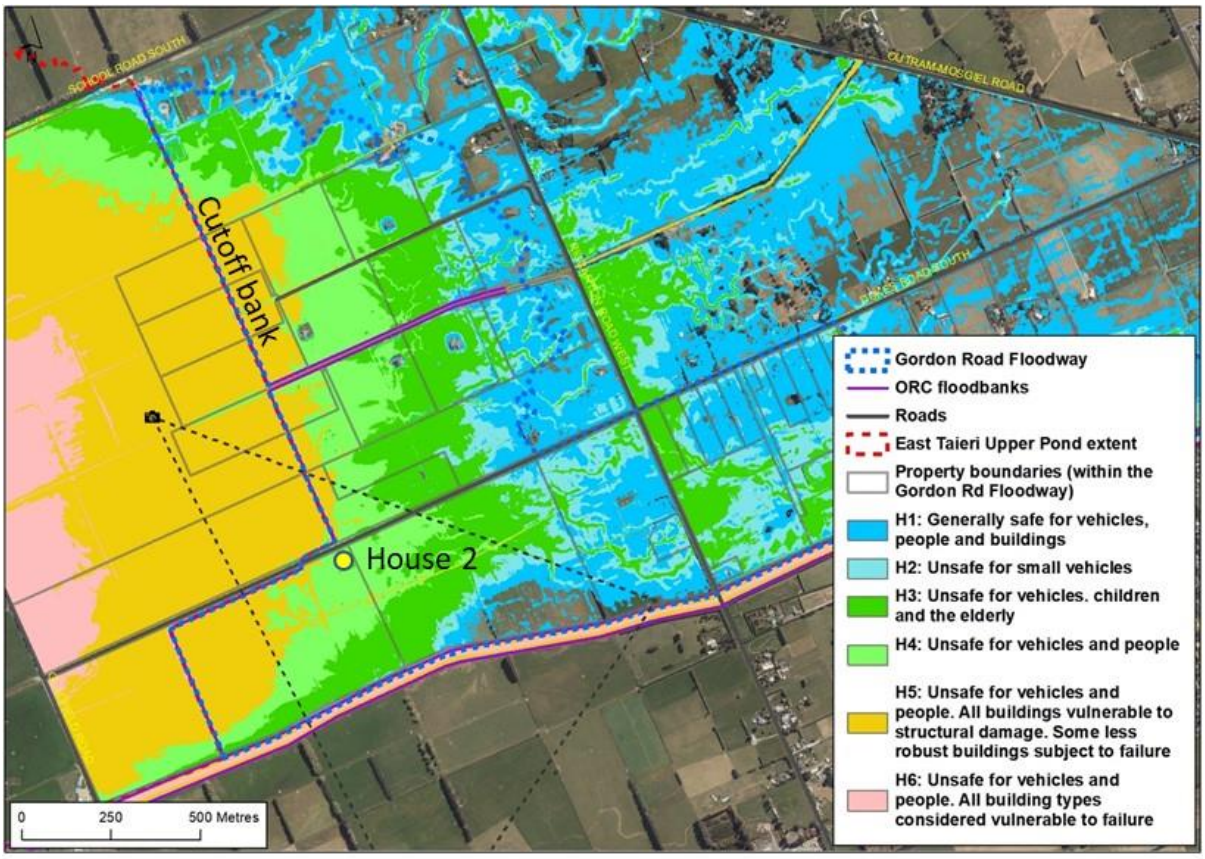
Photograph 1. Gordon Road Floodway higher risk areas (marked by "H" on the photograph) and East Taieri Upper Pond - 22 July 2017 flood event between 9am and 9.05am. Cutoff bank overtopping. The Cutoff bank is approximately 2m high at the location of the overtopping (marked with the blue arrow)

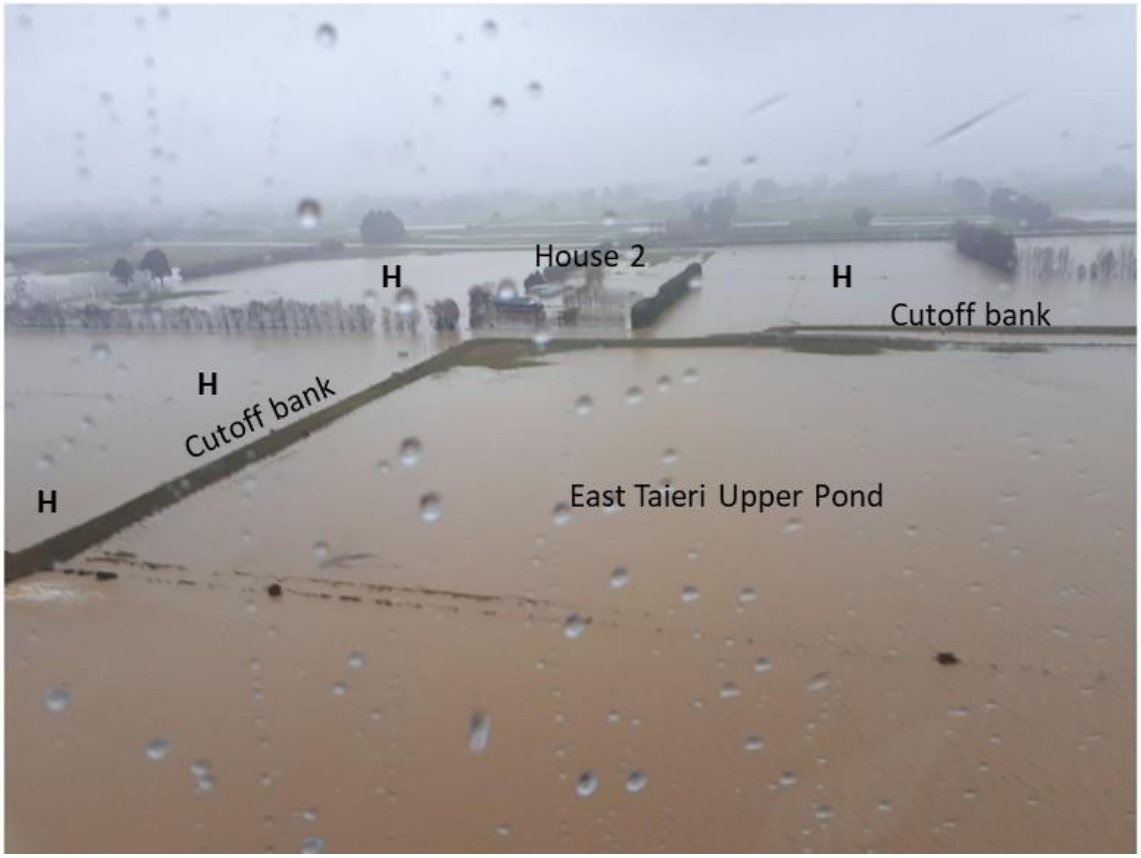


Photograph 2. Gordon Road Floodway higher risk areas (marked by "H" on the photograph) and East Taieri Upper Pond - 22 July 2017 flood event between 9am and 9.05am. Cutoff bank overtopping. The Cutoff bank is approximately 2m high at the location of the overtopping (marked with the blue arrow)

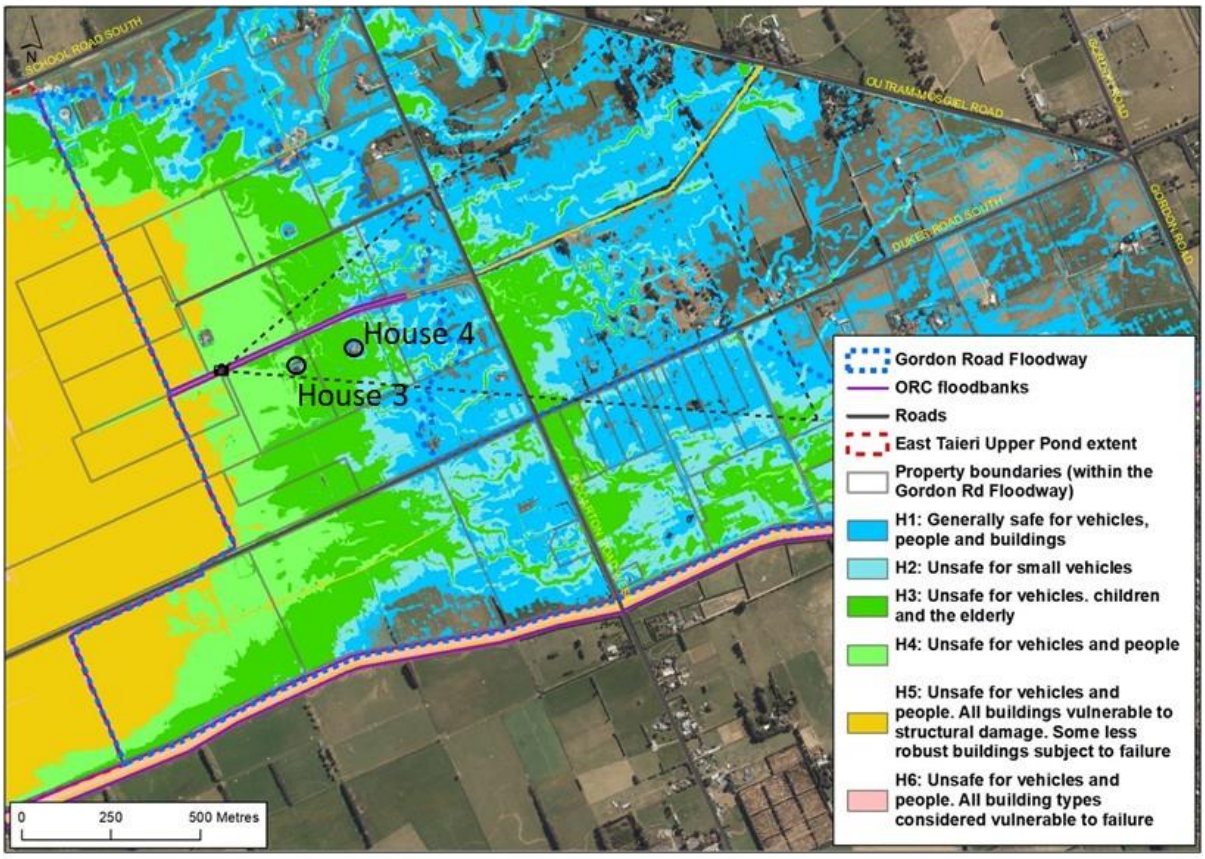


Photograph 3. Gordon Road Floodway higher risk areas (marked by "H" on the photograph) - 22 July 2017 flood event between 9am and 9.05am. House 1 showed to assist orientation

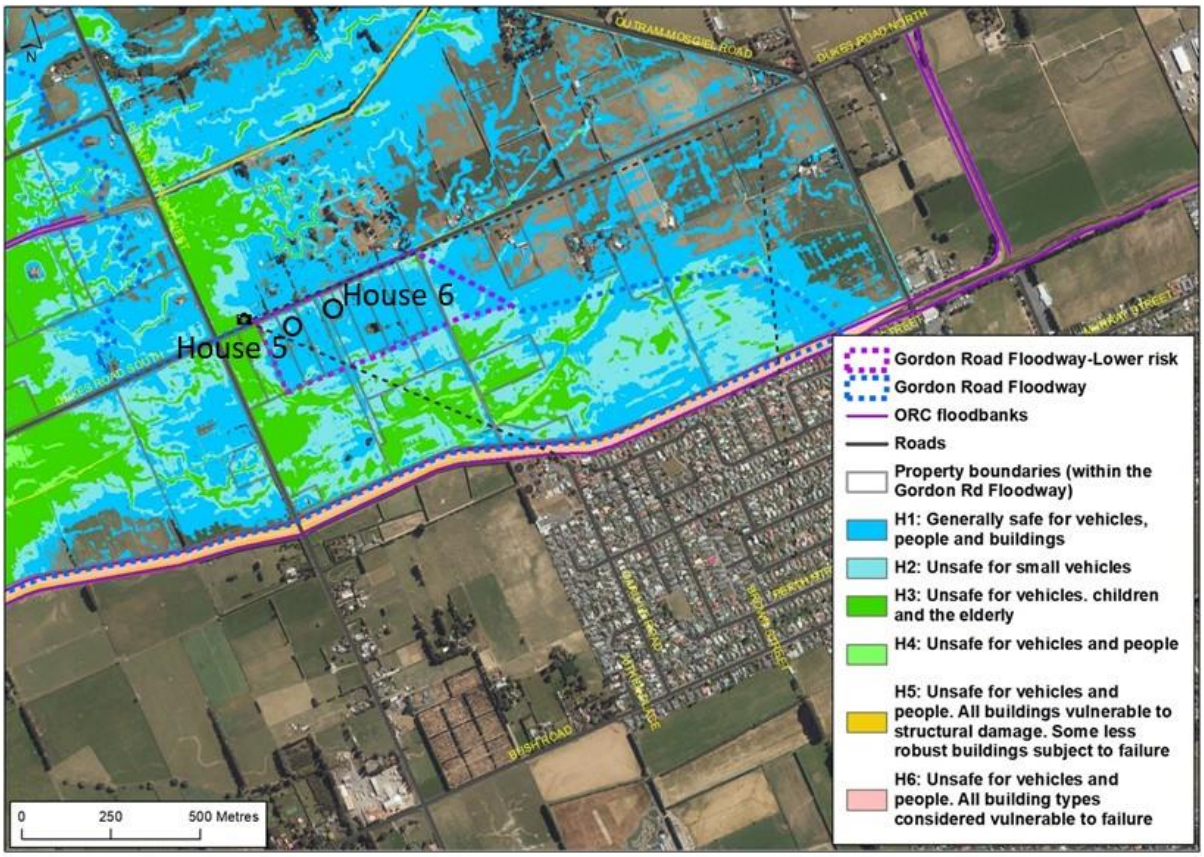


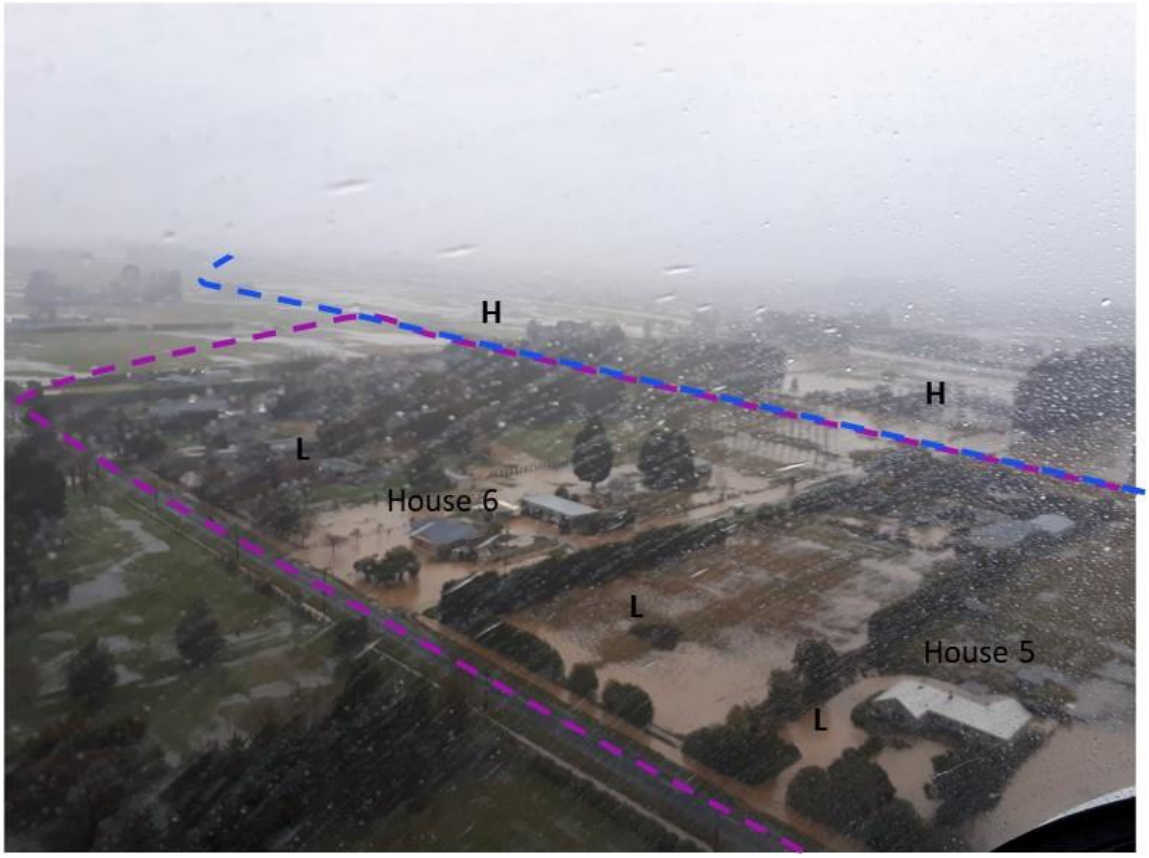


Photograph 4. Gordon Road Floodway higher risk areas (marked by "H" on the photograph) and East Taieri Upper Pond - 22 July 2017 flood event between 9am and 9.05am. House 2 showed to assist orientation

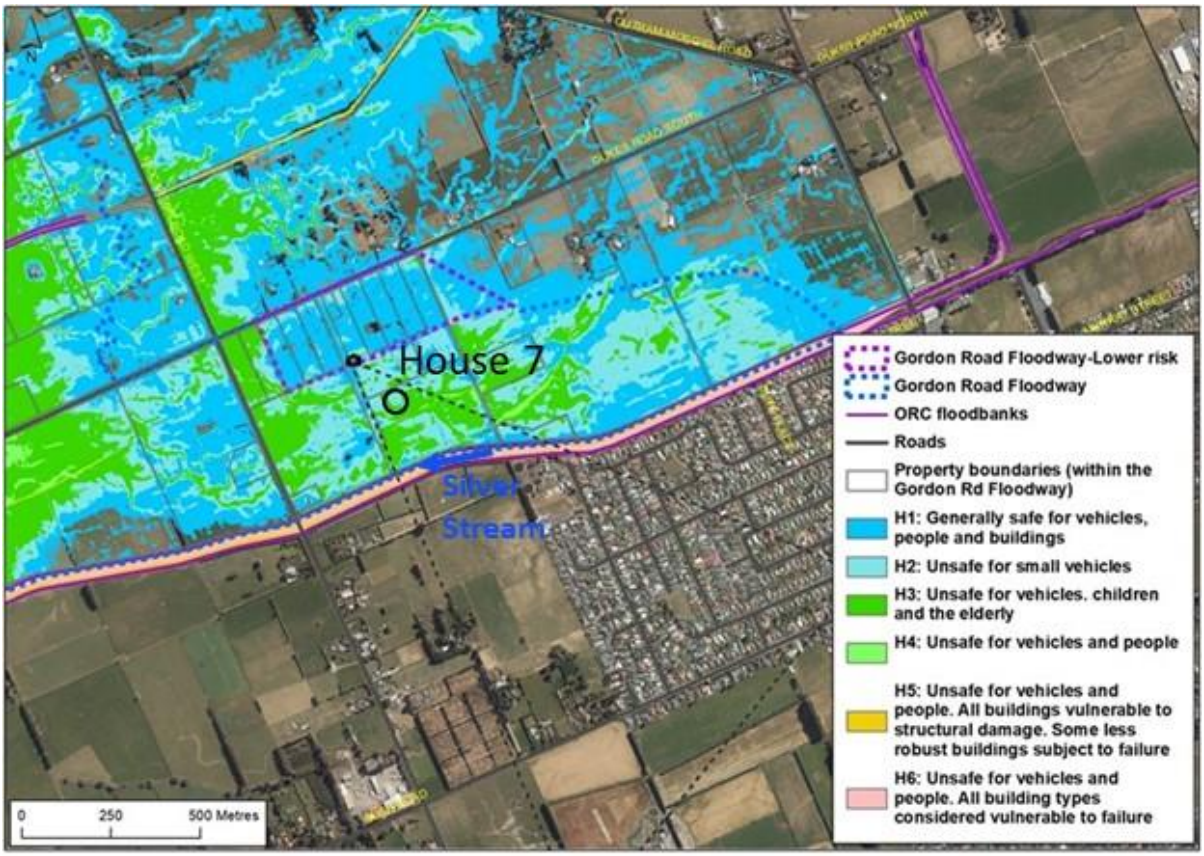


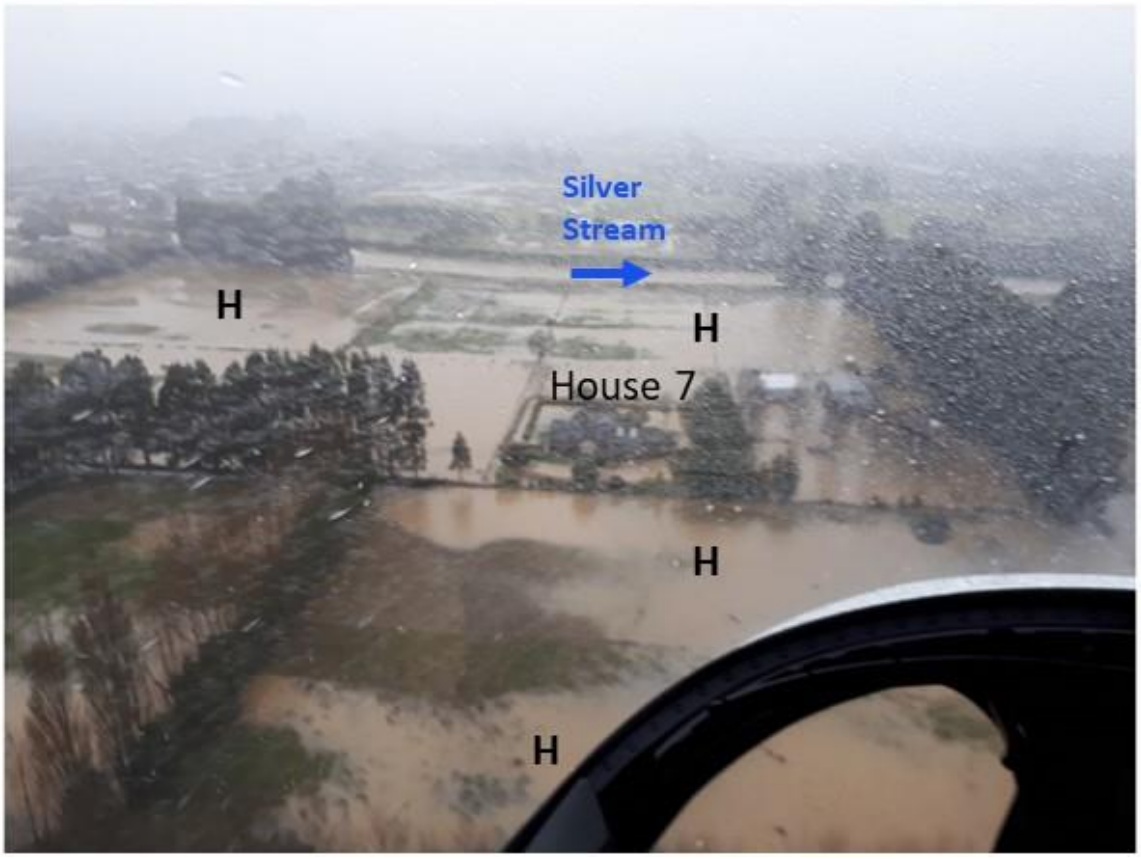
Photograph 5. Gordon Road Floodway higher risk areas (marked by "H" on the photograph) The blue dashed line indicate the approximate eastern extent of the floodway - 22 July 2017 flood event between 9am and 9.05am. House 3 and House 4 showed to assist orientation



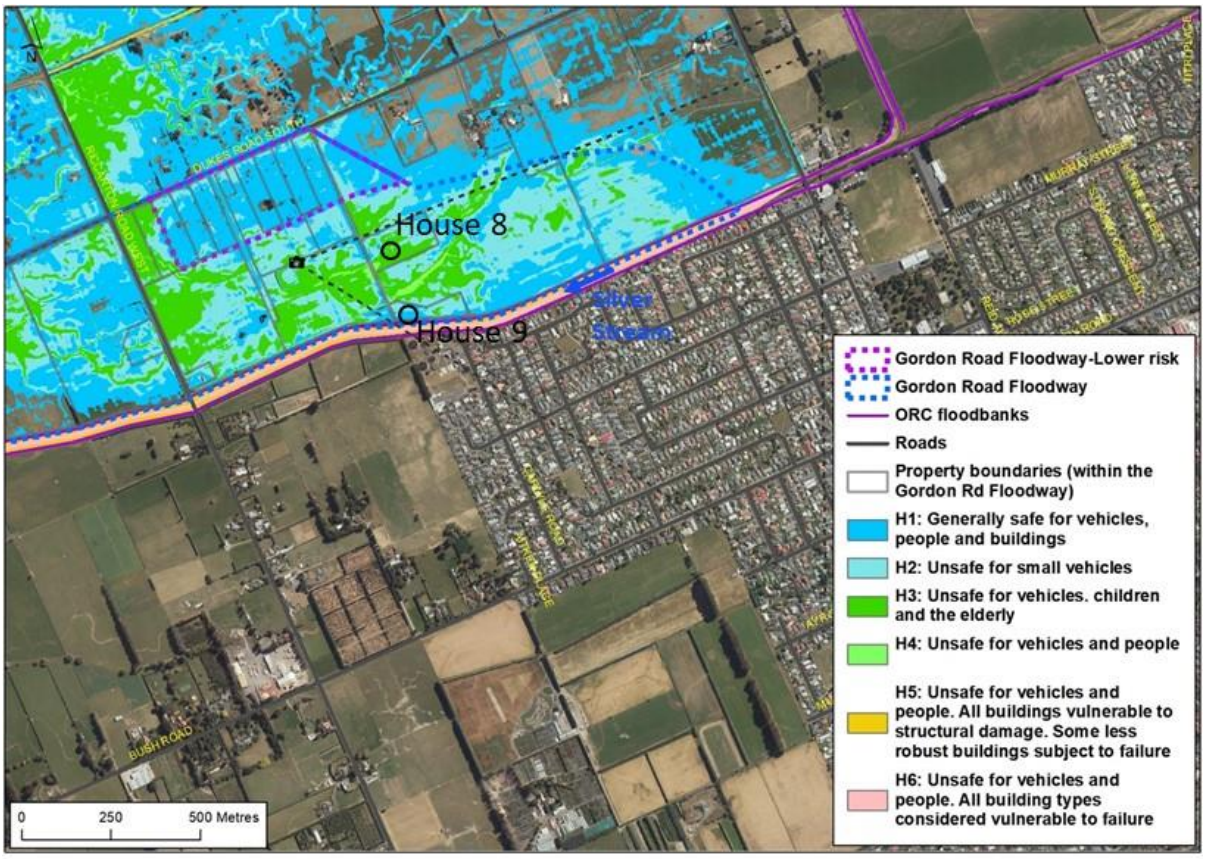


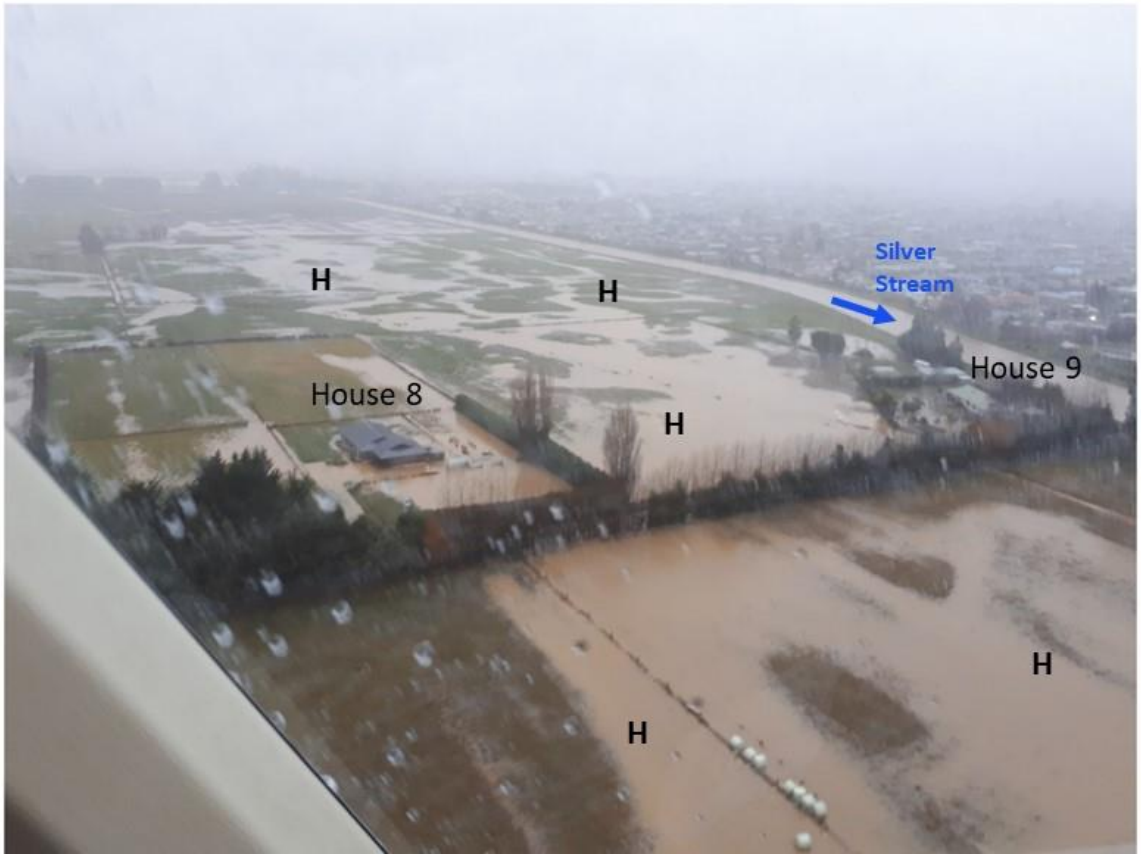
Photograph 6. Gordon Road Floodway higher risk and lower risk areas (marked by "H" and "L" respectively on the photograph) The blue dashed line indicate the approximate extent of the higher risk and lower risk areas respectively - 22 July 2017 flood event between 9am and 9.05am. House 5 and House 6 showed to assist orientation





Photograph 7. Gordon Road Floodway higher risk area (marked by "H" on the photograph) - 22 July 2017 flood event between 9am and 9.05am. House 7 showed to assist orientation. Photograph taken after the Gordon Road Spillway has stopped operating.





Photograph 8. Gordon Road Floodway higher risk area (marked by "H" on the photograph) - 22 July 2017 flood event between 9am and 9.05am. House 8 and House 9 showed to assist orientation. Photograph taken after the Gordon Road Spillway has stopped operating.