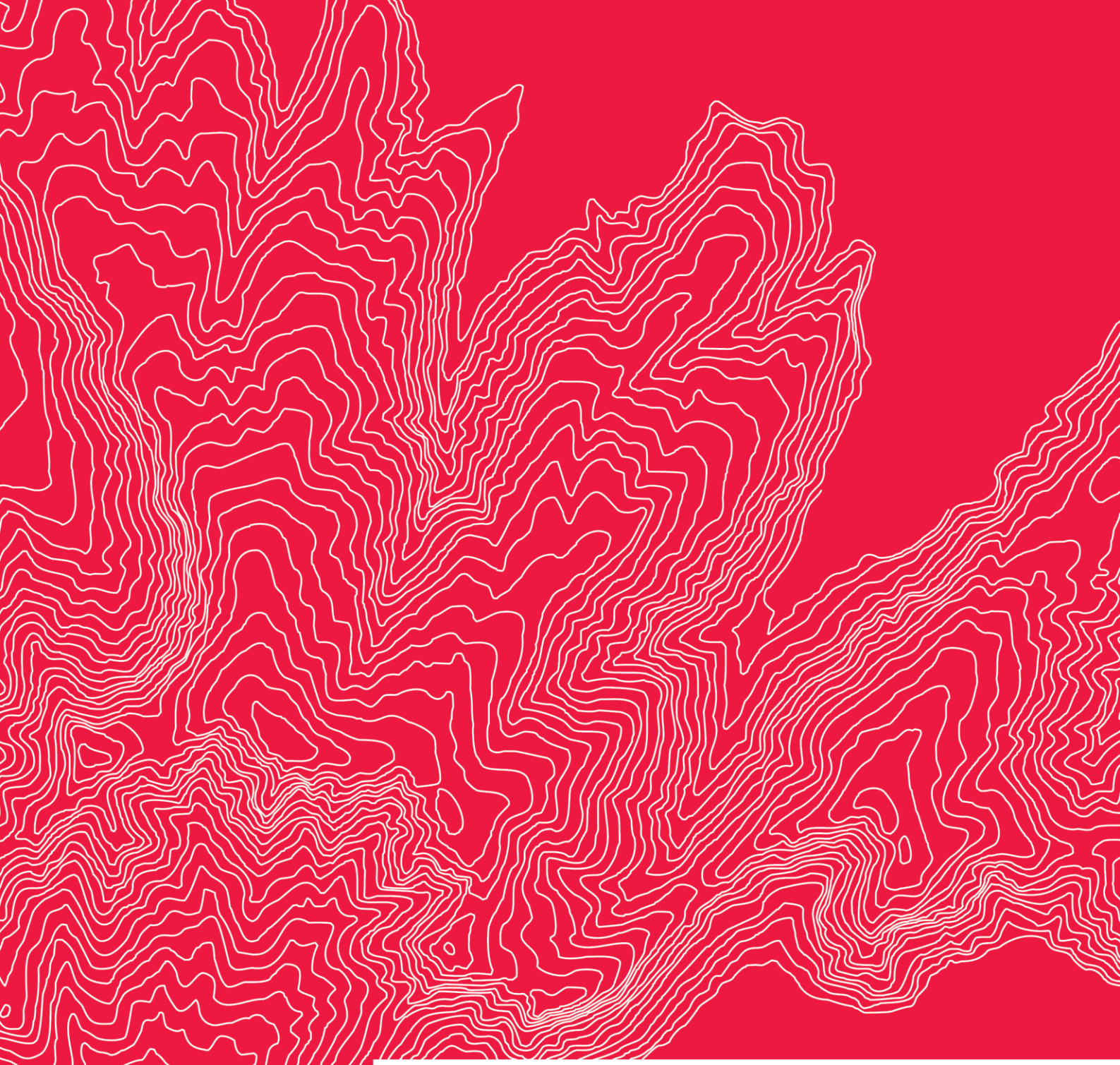

Flood Impact Assessment

Version A

eliot sinclair

Subject

Prepared for CVI Projects Limited

511185

Flood Impact Assessment

Subject

Prepared for CVI Projects Limited

511185

Quality Control Certificate

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Version History

Status	Description	Author	Release Date
A	Plan Change Issue	J. Manandhar	10 October 2023

Contents

1. Introduction

Eliot Sinclair have been engaged by CVI Projects Limited, to compile a Flood Impact Assessment to support a plan change application from rural to residential land use for the site located at 518 Rangiora Woodend Road and 4 Golf Links Road, Rangiora. The proposed residential development comprises of new residential allotments, new carriageways, and two new stormwater management areas.

2. Scope of works

Eliot Sinclair has prepared this Flood Impact Assessment for the proposed subdivision to support the application for land use plan change. The report has been prepared to provide an assessment of the flooding effects of the proposed development on:

- Existing overland flow paths
- Flooding at surrounding properties
- Accessibility within proposed new carriageways
- Accessibility within existing council vested carriageways

3. Site description

The site is located at 518 Rangiora Woodend Road and 4 Golf Links Road as shown in Figure 1. Refer to Appendix A for proposed site development plan. The site area is approximately 11.3 ha and consists of the following legal allotments:

- Lot 2 DP16884
- Part RS 1054

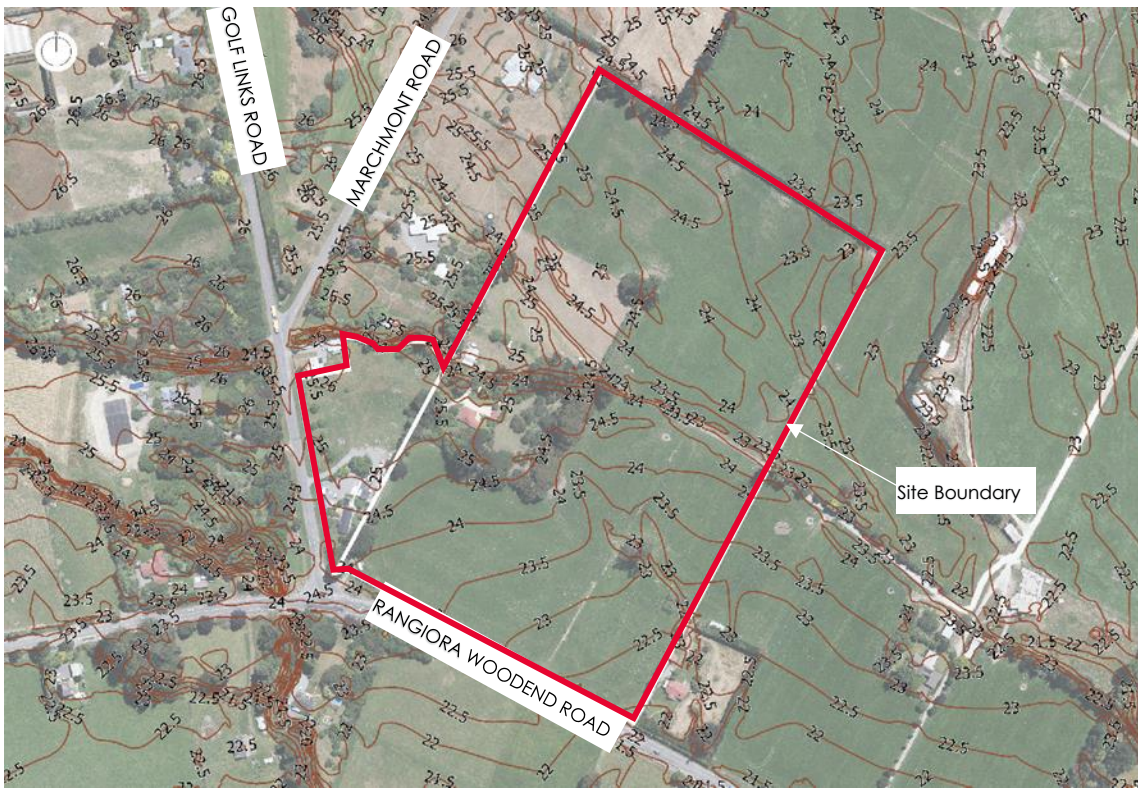

Figure 1. Site Location Plan

There are two existing residential dwellings with various associated structures on-site and the remainder of the site is pasture. The North part of the site falls from the North-west to the North-east and the South part of the site falls from the North-west to the South-east.

The Cam River/ Ruataniwha crosses the Rangiora Woodend Road to the West of the site. An existing Waimakariri District Council (WDC) owned natural stormwater channel (Taranaki Stream) runs adjacent to the northern boundary of 4 Golf Link Road and through the centre of 518 Rangiora Woodend Road. An existing ephemeral tributary of Taranaki stream crosses the site from North-west and converges to Taranaki stream at approximately central location of 518 Rangiora Woodend Road. Refer to Figure 2 for existing waterways within and nearby the site.

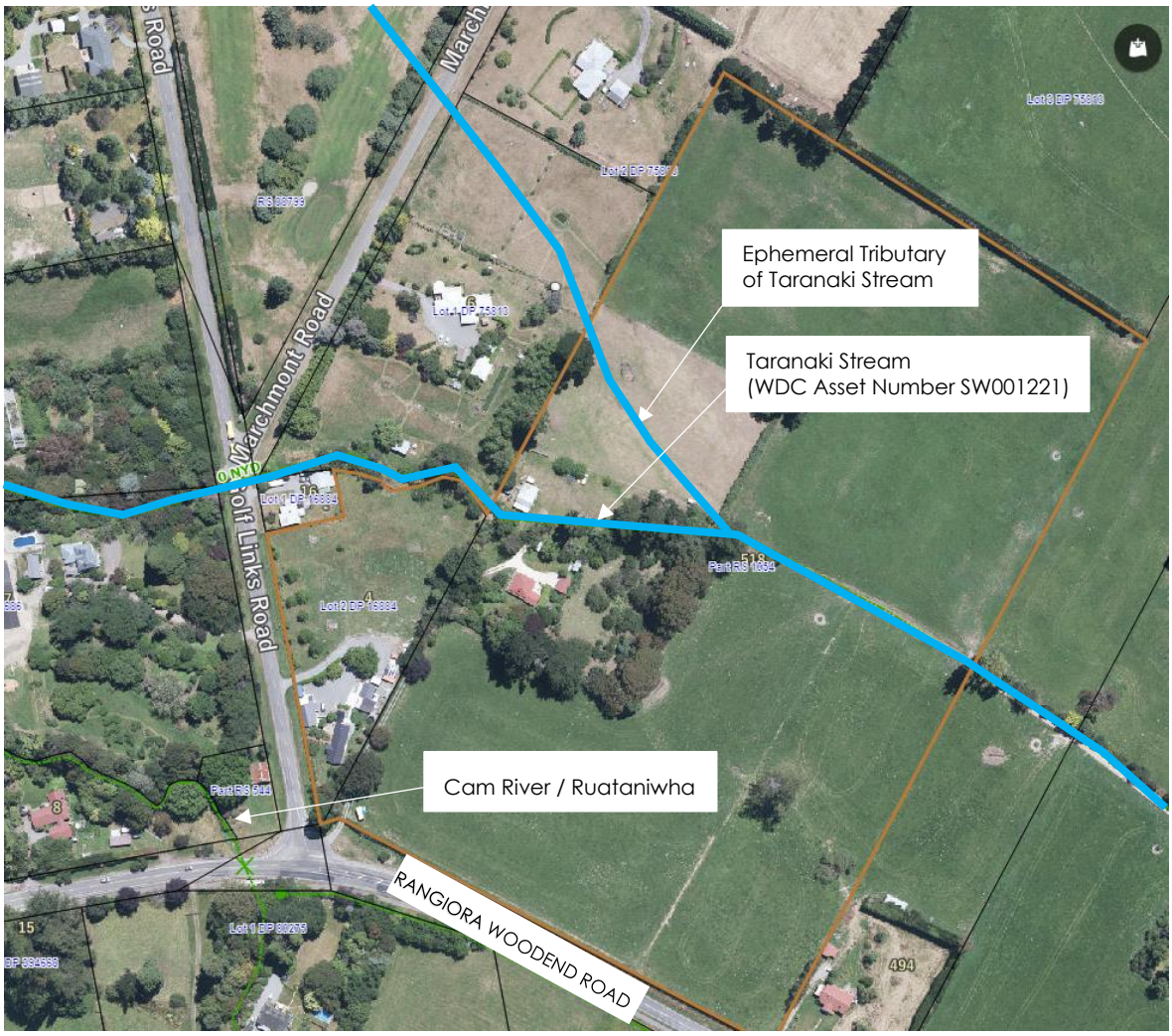

Figure 2. Existing Waterways

4. Waimakariri Flood Hazard Maps

The Waimakariri Flood Hazard Map also gives the predicted flood depths at the site from the 200yr ARI rainfall event as shown in Figure 3. As indicated, Taranaki Stream and a tributary of Taranaki stream, combine into one overland flow path crossing the site from West to East. Additionally, some minor secondary overland flow paths cross the site from the North to the East boundary.

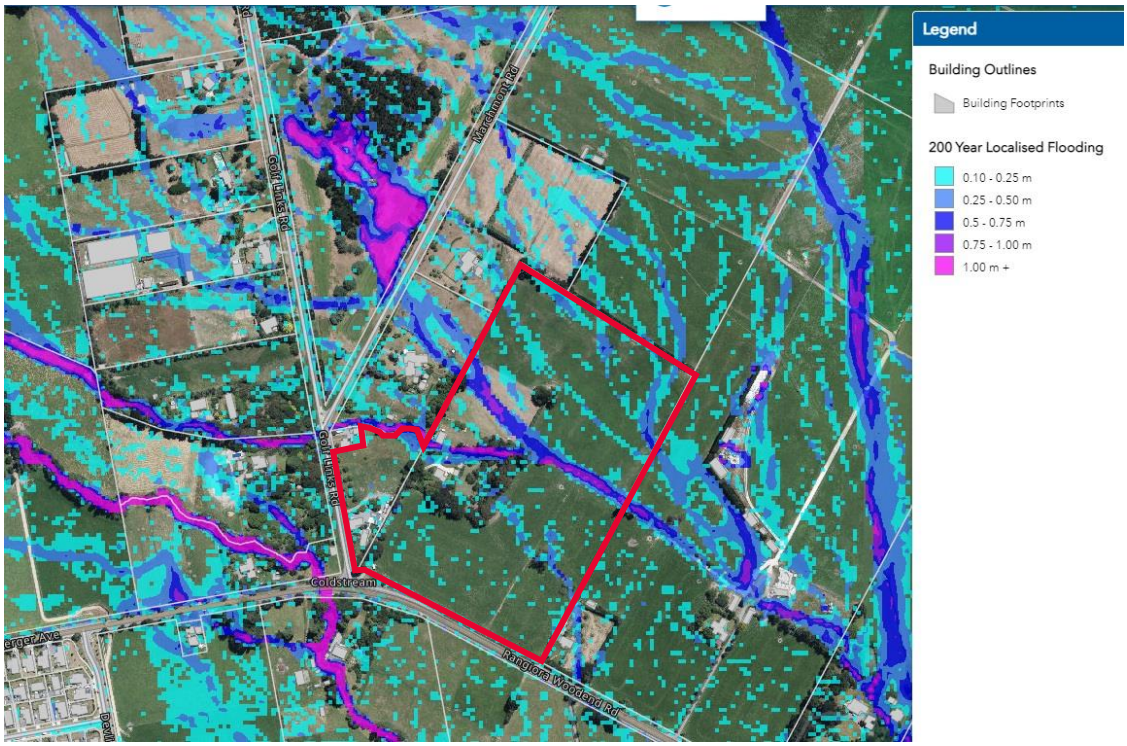

Figure 3. Predicted 200 Year ARI Flood Depths (Source: Waimakariri Flood Model)

Figure 4 indicates that within the Taranaki Stream the flood hazard is Low to Medium.

Figure 4. Current Level of Flood Hazard at the Site (Source: Waimakariri Flood Hazard Map)

5. HEC RAS Flood Modelling

200yr ARI Flood modelling has been carried out using the U.S Army Corps of Engineers' Hydrologic Engineering Center (HEC) River Analysis System (RAS) software to determine the effects of the proposed development at 4 Golf Links Road and 518 Rangiora Woodend Road, Rangiora.

HEC RAS has been used to model the pre and post-development flood flow patterns within the proposed development area and surrounding properties. Figure 5 shows the extent of the model layout.

Figure 5. Flood Model Extents

5.1. Modelling Parameters and Data

5.1.1. Boundary Conditions

The HEC RAS pre-development model was calibrated visually against Waimakariri 200-year Flood Map. The flood waters flow towards the South-east and therefore the flow in the HEC RAS model was applied in the same direction.

The 200 year flow hydrograph provided by Waimakariri District Council, shown in Figure 7, was applied to the catchment along the upstream boundary condition. A precipitation hyetograph for the 200 year ARI 24-hour duration was generated from Chicago Nested Rainfall Distribution as shown in Figure 6, and applied as rain on grid across the modelled catchment.

The pre-development flood depths were calibrated with the Waimakariri Flood Map depths. The same flow and rainfall depths were applied in the post-development model.

The downstream boundary condition was set to normal depth with the slope of the downstream LiDAR surface.

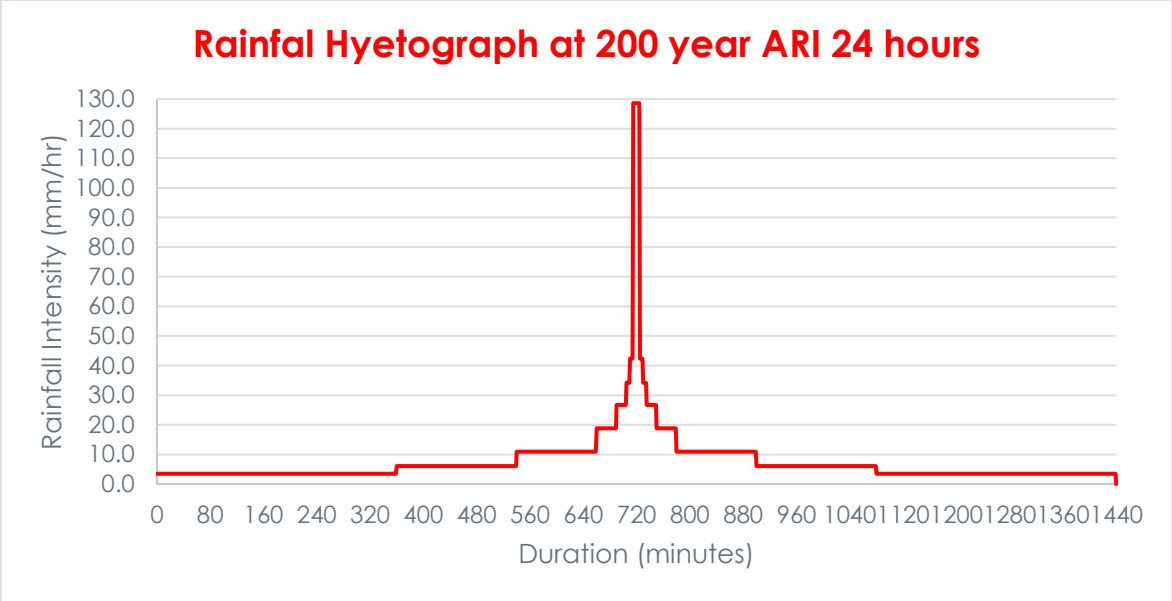

Figure 6. Rainfall Hyetograph for 200 year ARI 24 hrs Duration

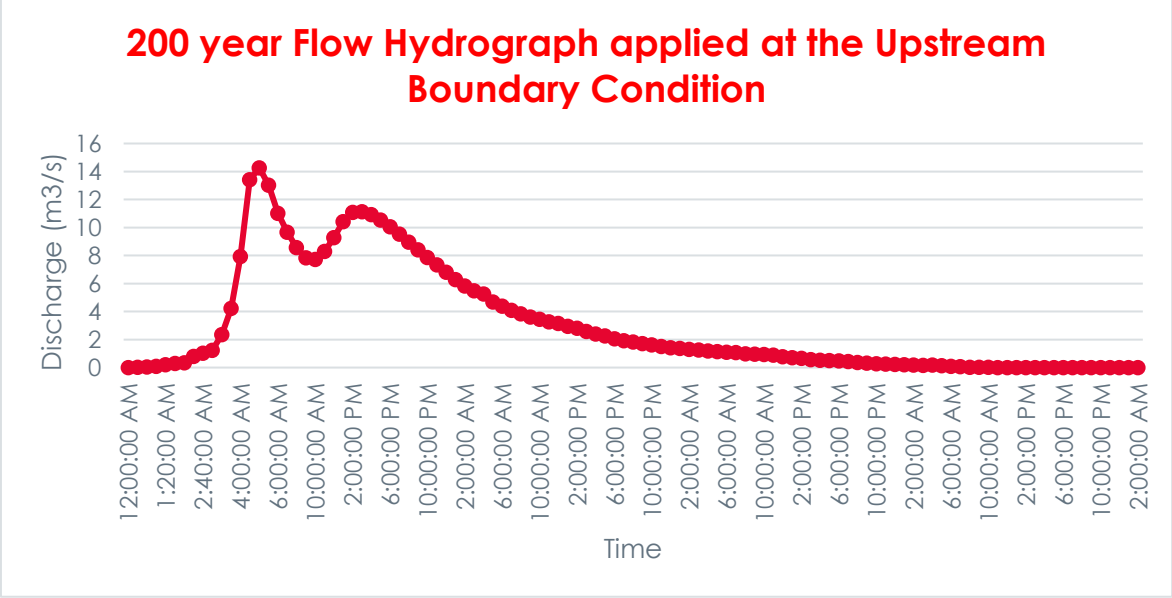

Figure 7. 200 year ARI flow Hydrograph Provided by Waimakariri District Council

5.1.2. Pre-development model surface

The pre-development model surface was based on the most recent LINZ LiDAR data (2020-2022) as shown in Figure 8. The existing bridge across Rangiora Woodend Road and existing culvert across Golf Links Road were included in the model as shown in Figure 8. The Golf Links Road culvert diameter was assumed to be 1.050m, and the Rangiora Woodend Road bridge was assumed to be 2.5m high and 1.5m wide. These assumptions were made by visually calibrating the obtained flood depths against the WDC Flood Map.

A default roughness coefficient of 0.06 for short grass was applied for the pre-development scenario.

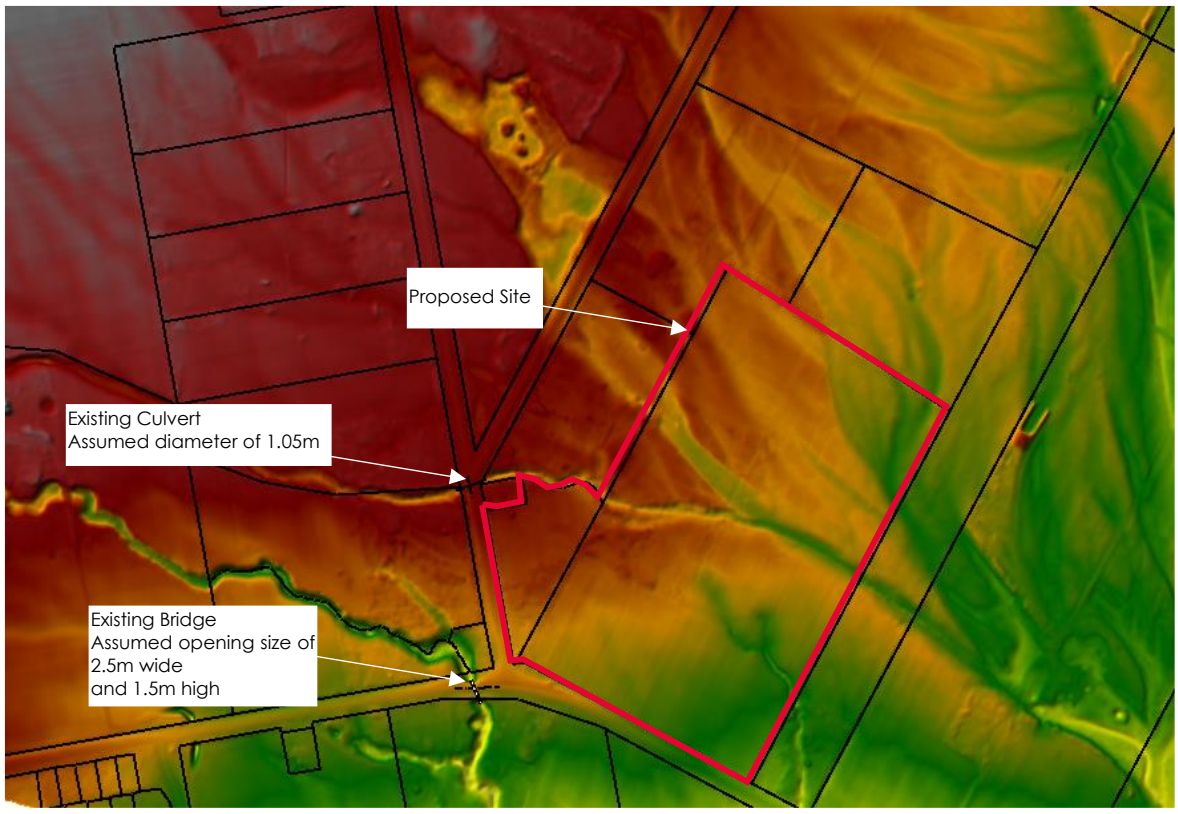

Figure 8. Pre-development 3D Topographical Surface

5.1.3. Post-development model surface

The post-development model surface was based on combination of most recent LINZ LiDAR (2020-2022) and the conceptual phase design surface, including new carriageways, new stormwater management areas and raised lot levels, as shown in Figure 9. The proposed model surface also includes the following:

- A new box culvert 8m wide and 0.5m high crossing the tributary of Taranaki stream.
- A new box culvert 8.5m wide and 0.5m high crossing Taranaki stream.
- A new 450mm diameter culvert at vehicular crossing to Rangiora Woodend Road, located at South-east part of site.
- A swale at the North-west boundary to divert existing overland flow paths.
- A swale at North-east and North boundary to divert existing overland flow paths.

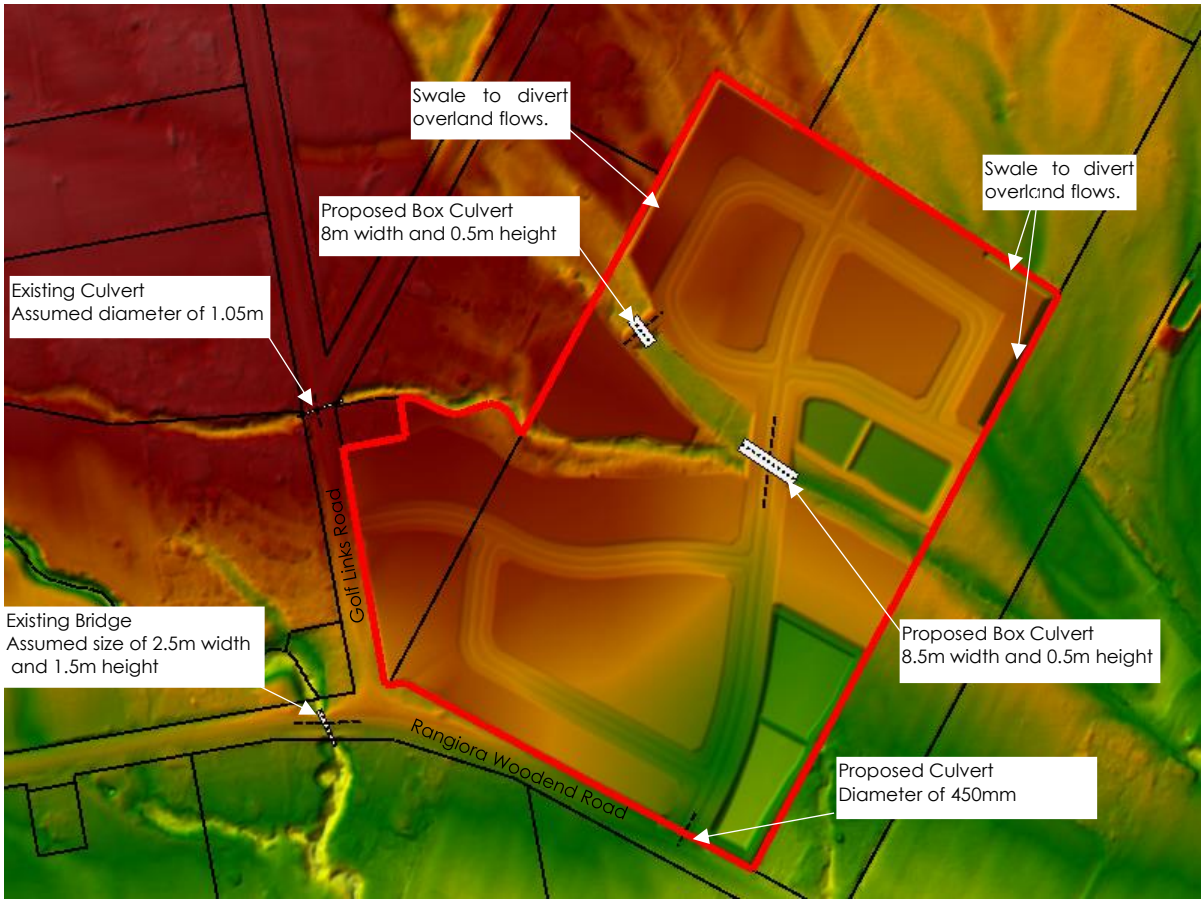

Figure 9. Post-development 3D Topographical Surface

A roughness coefficient of 0.01 was applied for the carriageways in the post-development scenario.

5.1.4. Modelling Computation

Both pre-development and post-development models were computed with time step of 4 seconds. A grid size of 10m x 10m was used for areas outside the development site and a refined region were used within the development site with a grid size of 3m x 3m grid.

5.1.5. Soil Infiltration

Soil infiltration was not included within the modelling therefore, it is assumed that the ground is fully saturated throughout the simulation.

5.1.6. Margin of Error

The pre and post-development flood modelling will have an unknown margin of error resulting from the following:

- The flow hydrograph provided by Waimakariri District Council was applied at the upstream boundary condition and was used to produce flood depths that match the Waimakariri Flood map depths. The flood depths were calibrated visually against Waimakariri Flood Maps.
- Exclusion of fence lines, trees and other potential obstruction to the flood passage.
- Accuracy of the LINZ LiDAR Surface
- The size of the grid used throughout the catchment and timesteps will incorporate a level of sensitivity error.
- Soils infiltration has not been included

- The size of existing culvert and bridge is an assumed size, and the inverts are adopted from existing LiDAR surface.

5.2. HEC RAS Flood Modelling Results

5.2.1. Effects on Overland Flow Path

Figure 10 shows the existing overland flow paths conveyed through the site. As indicated, a tributary of Taranaki stream merges into Taranaki stream within the site, and a number of small overland flows from North and North-west of site converge into Taranaki stream and flow in a South-east direction.

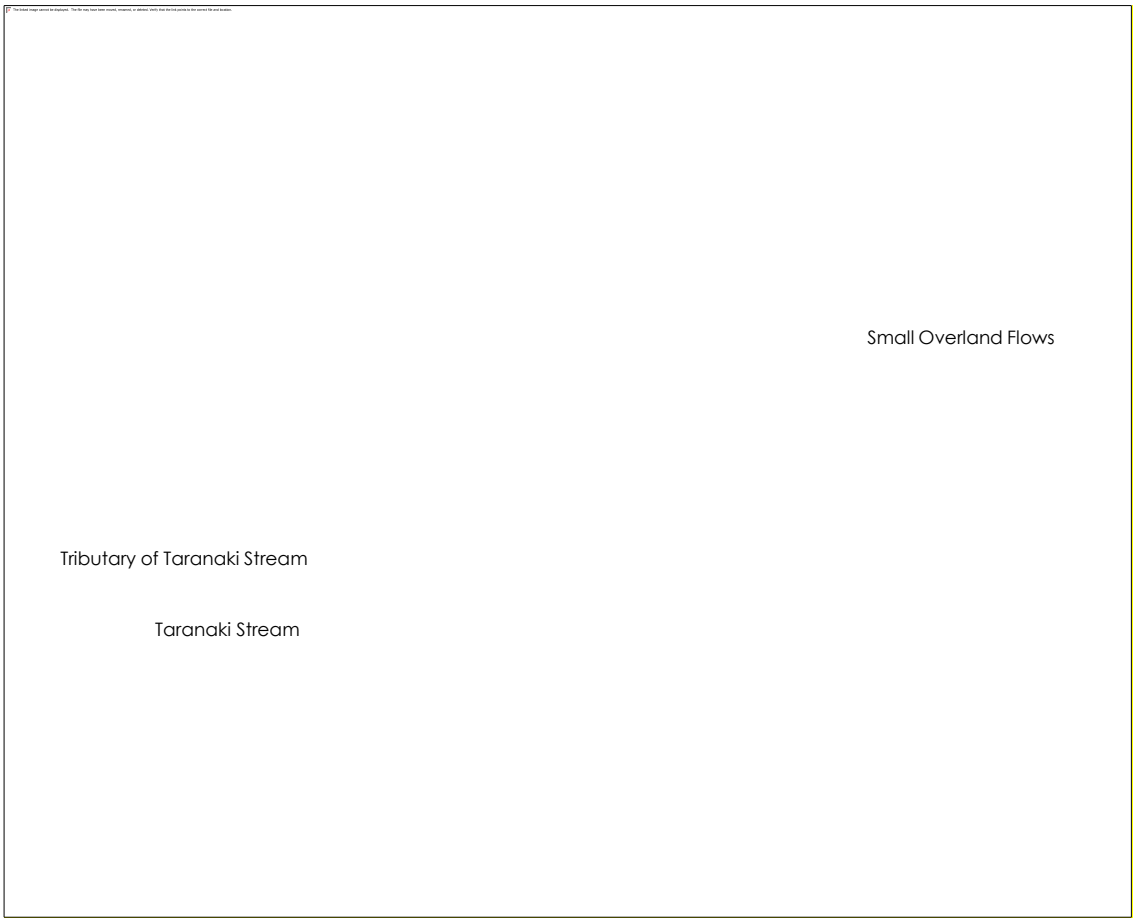

Figure 10. Pre-development Overland Flow Paths

Figure 11 shows the post-development overland flow paths.

As shown in Figure 11, the existing flow paths from Taranaki stream and a tributary of Taranaki stream are maintained and flows are conveyed within the development site with culverts and some overflow across the proposed new road. Accessibility is discussed further in Section 5.2.4.

The smaller overland flow paths from North-west and North, are diverted and conveyed by swales along the boundary of site to the tributary of Taranaki stream.

All overland flow paths, South of Taranaki Stream are diverted to the new basin located at South-east corner of site. The basin overflow discharges to the road side channel along Rangiora-Woodend Road. The capacity of this channel is exceeded in the 200 year flood event and the flows cross the road towards Lot 1 DP 452196.

The proposed culvert across Taranaki Stream, located centrally within the site will be designed for 50 year ARI flows, and during the 200 year flood event, the road will be designed with a spillway to allow 200 year flows to spill over the road into new basin located North of Taranaki stream.

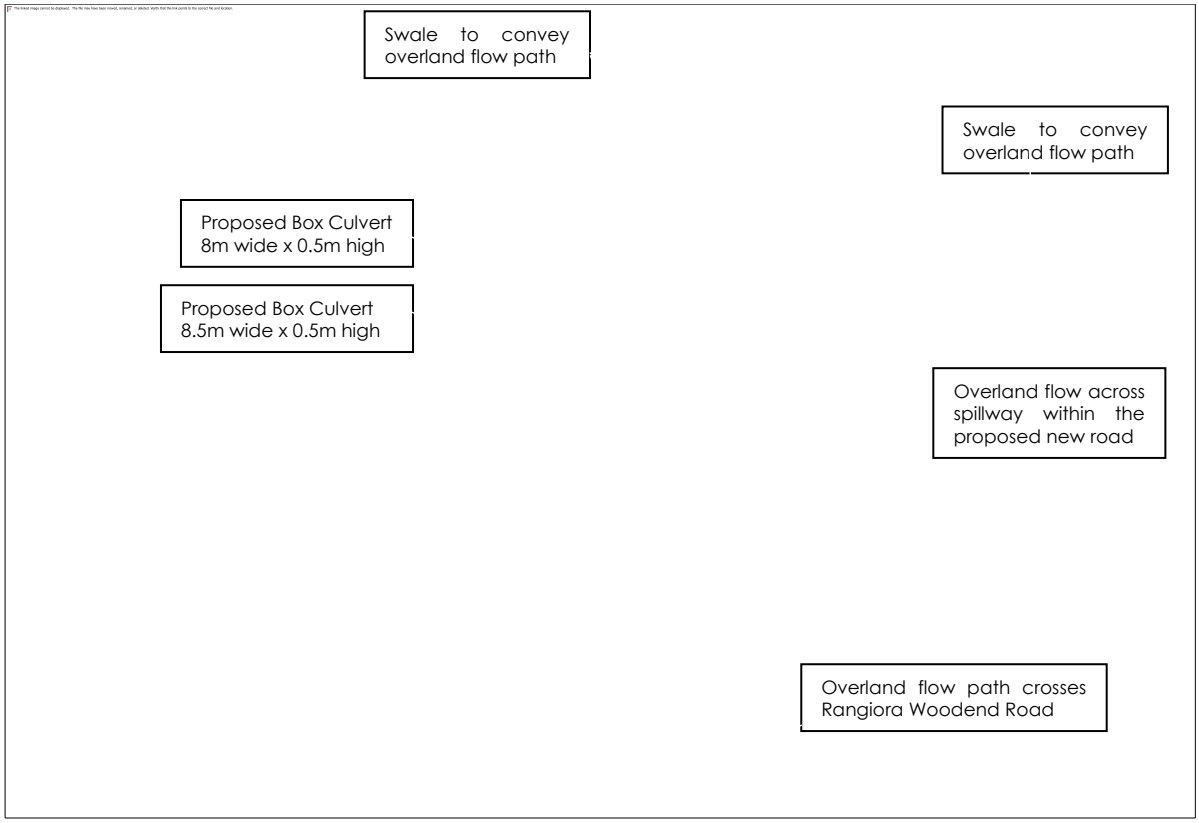

Figure 11. Post-development Overland Flow Paths

5.2.2. 200 Year Flood Depths

Figure 12 provides the HEC RAS pre-development flood depth results map. As shown the pre-development flood depths generally match the Waimakariri 200yr Flood Map depths shown in Figure 3.

Figure 12. Pre-development 200 Year Flood Depths (m)

It should be noted that the WDC flood hazard map (Figure 3) does not include flood depths less than 100mm, whereas the HEC RAS pre-development model flood depths include flooding less than 100mm.

The post-development flood depths result map is shown in Figure 13.

Note: The post-development flood depths less than 10mm are not shown.

The proposed lots within the development site are above the 200 year flood level as required. There is up to 300mm flood depth within the proposed roads.

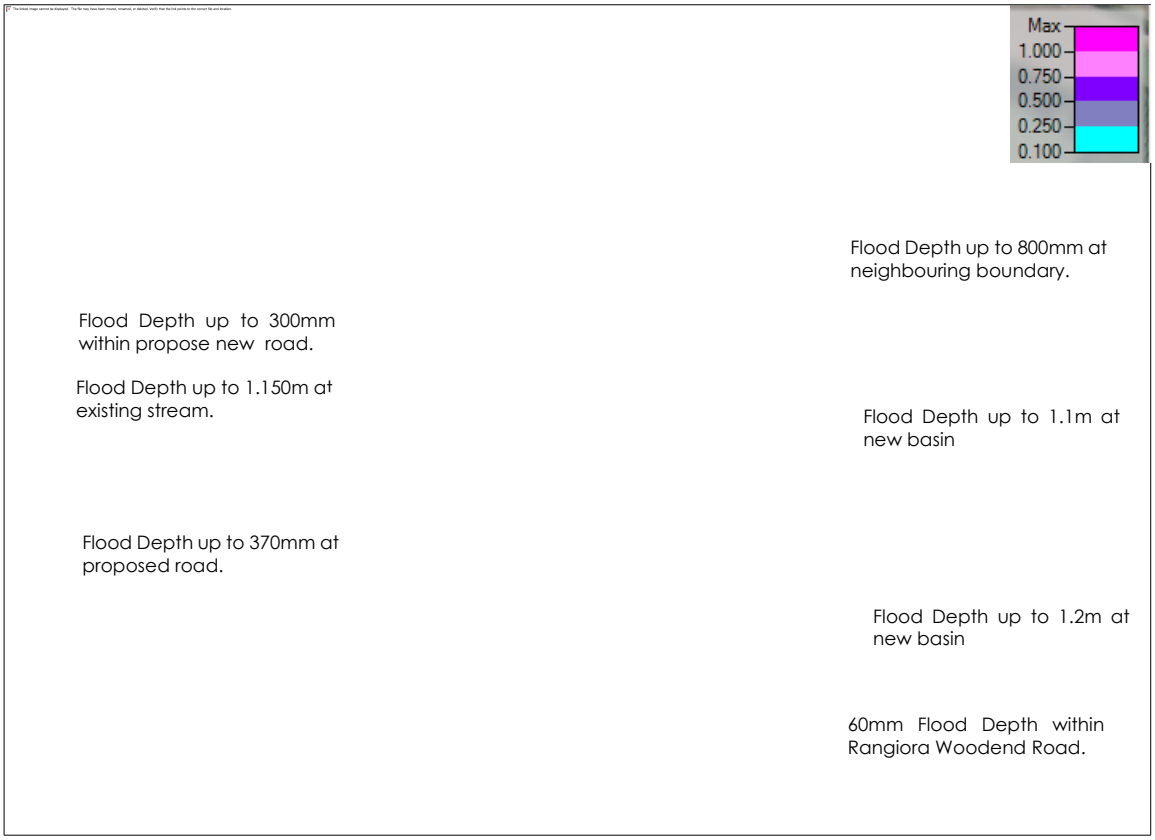

Figure 13. Post-development 200 Year Flood Depths (m)

Figure 14 shows the difference between the pre-development and post-development flood depths and the flood effects associated with the proposed development.

Note: The differences less than 5mm are not shown on the results map.

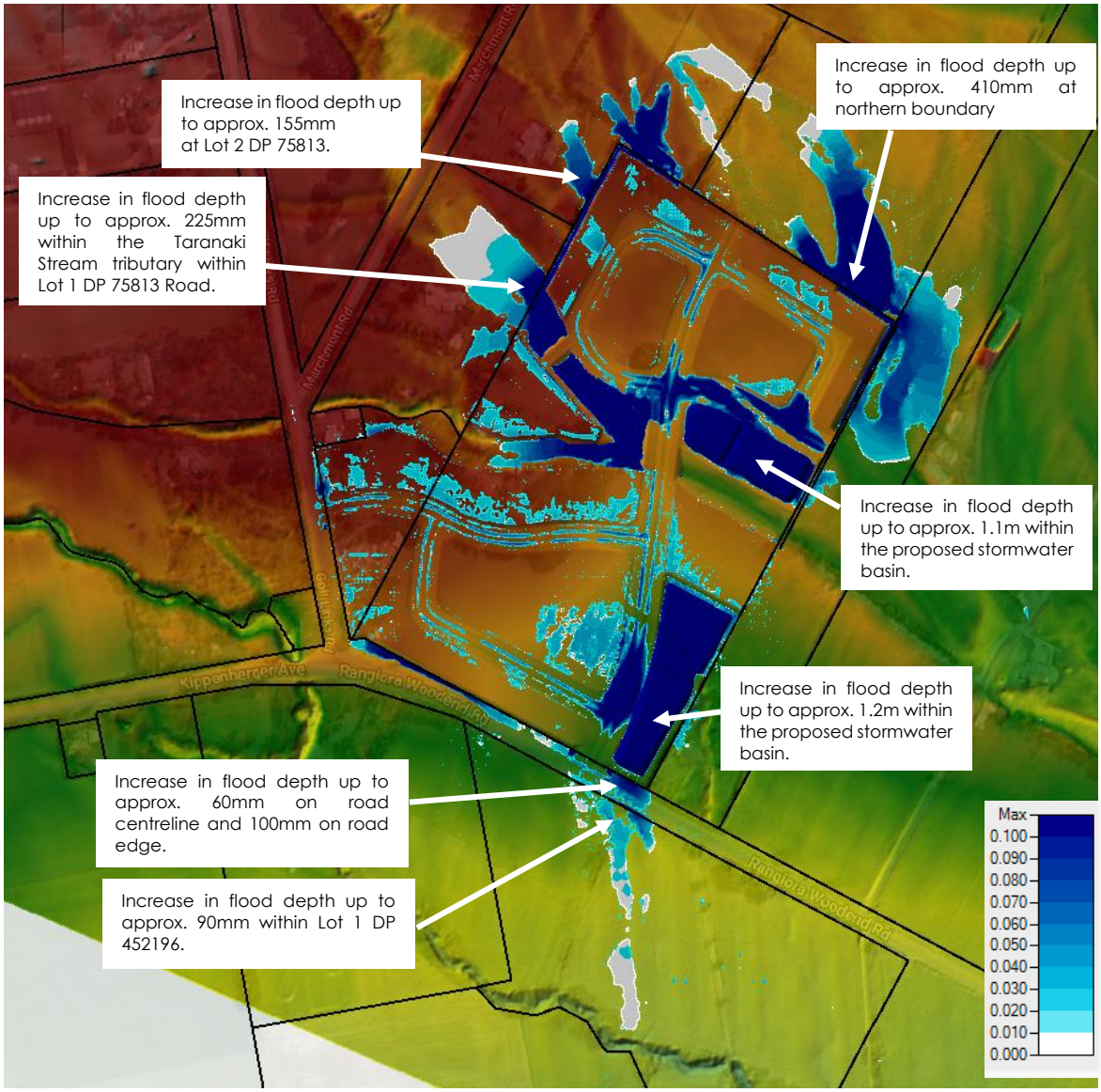

Figure 14. Post-development vs Pre-development Difference Map

As shown in Figure 14, generally the flood effects due to the proposed subdivision are as follows:

- The basin areas capture the majority of the flood flow
- There is an increase of flood depths to the north of the development site where some existing secondary flow paths have now been diverted via new swales along the development boundary to Taranaki Stream. The increase in flood depth does not occur at existing dwellings. However, the flood depth within pasture land has increased as shown.
- There is an increase in the flood depth within Taranaki Stream and its tributary due to the proposed new road crossings however this increase is mainly contained within the development site. There is up to 225mm increase within Lot 1 DP 75813 however this does not affect the existing dwelling.
- Within Rangiora Woodend Road, the water depth increase is approximately 60mm at the road centreline and up to 100mm at the road edge. This is due to the overland flow path to the south of the development exceeding the capacity of the Rangiora Woodend Road roadside channel and crossing the road.

5.2.3. Effects on Surrounding Properties

Figure 15 shows the surrounding properties (highlighted in light blue) that are affected by the post-development flood effects.

Figure 15. Surrounding Properties considered for flood effect (highlighted in blue)

Table 1 provides the flood depths increase at surrounding properties.

Table 1. Flood Depth Effects at Surrounding Properties

Property Address	Increase in Flood Depths (mm)	Comments
Lot 1 DP 75813	0-225	As shown in Figure 14, the increase in flood depth has not affected any dwellings and this depth increase is within the tributary of Taranaki Stream within pastured area of the property.
Lot 2 DP 75813	0-155	As shown in Figure 14, the increase in flood depth has not affected any dwellings and this depth increase is within the pastured area of property. A swale is provided along the North-West boundary of proposed site to divert the overland flow path towards the Taranaki Stream tributary.
Lot 3 DP 75813	0-410	As shown in Figure 14, the increase in flood depth is within the pastured area of the property. A swale is provided along the North-East boundary of the proposed site to divert the overland flow path around the development site.
Lot 1 DP 452196	0-90	As shown in Figure 14, the increase in flood depth has not affected any dwellings and this depth increase is within the pastured area of property.
RS 2332	0-100	As shown in Figure 14, the increase in flood depth has not affected any dwelling and this increase in flood depth is within the pastured area of property.

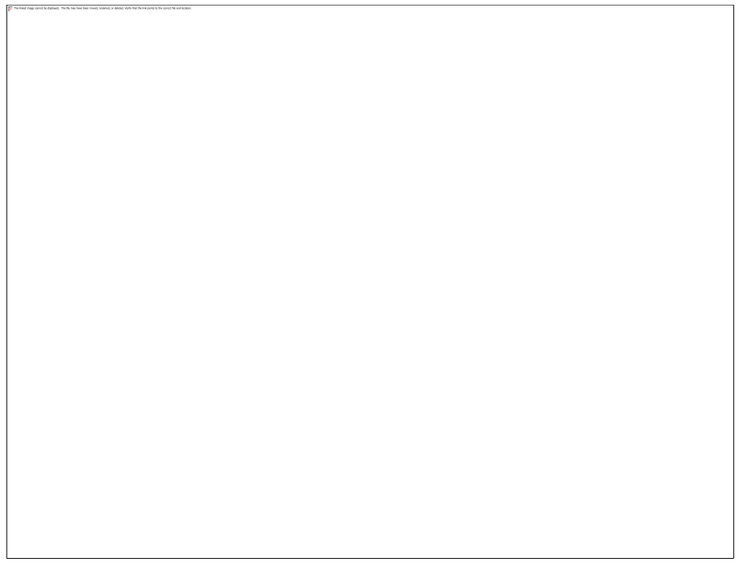

Figure 16. Long-section location at North-west Boundary of site

Figure 17. Long-section at North-west Boundary of site

As shown in Figure 17, the flood depth along North-west boundary has a depth increase of approximately 70mm along chainage 50-70m. As indicated, the water depth in the existing tributary of Taranaki stream has a flood depth increase of 225mm between chainage 70-120m. There is a flood depth increase of approximately 50-155mm from chainage 100-120m and 190-215m.

Figure 18. Long-section Location at North Boundary of site.

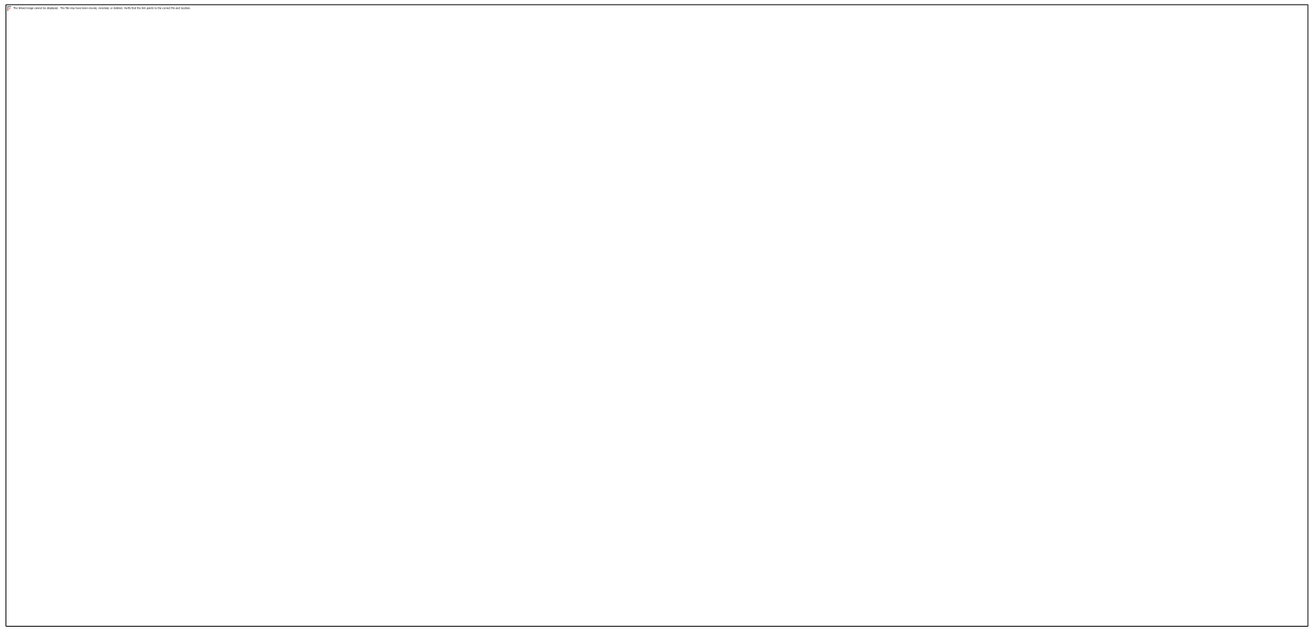

Figure 19. Long-section at North Boundary of site.

As shown in Figure 19, the increase in flood depth is approximately 150mm between chainage 0 to 55m. There is increase in flood depth of approximately 100 to 410mm along chainage 150-240m.

Figure 20. Long-section Location at North-east Boundary of site

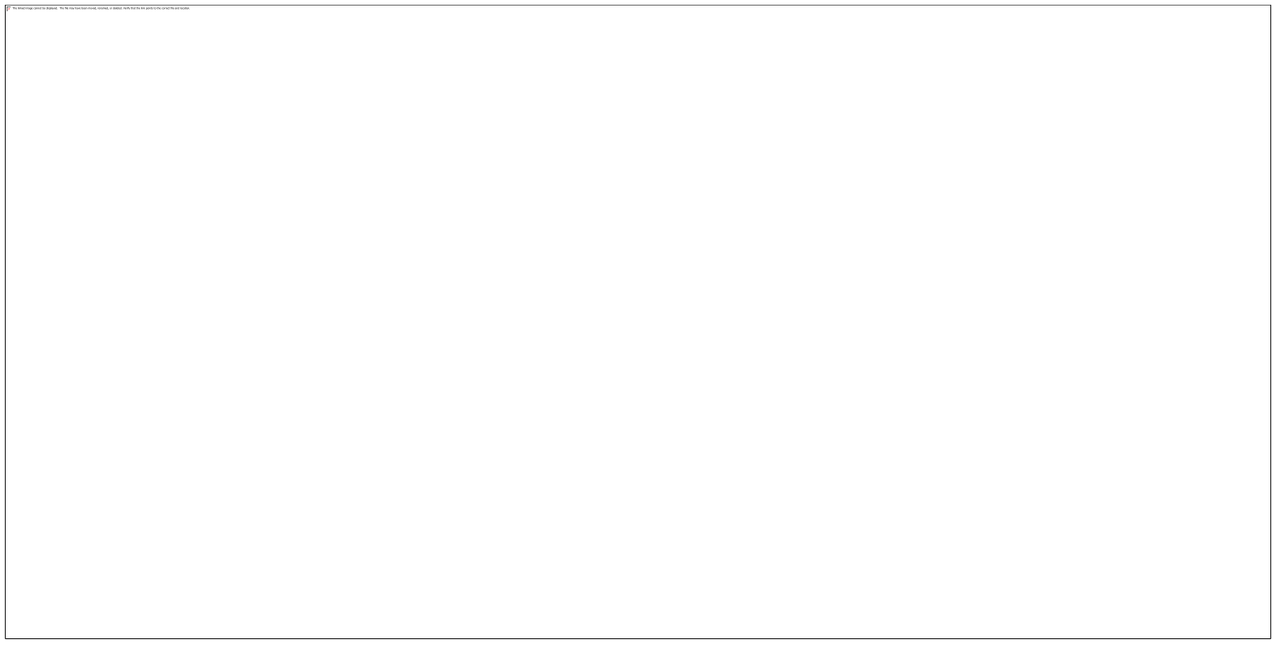

Figure 21. Long-section at North-east Boundary of site

As shown in Figure 21, there is a decrease in flood depth of approximately 100-150mm along chainage 80-105m. There is an increase in flood depth of approximately 50-100mm along chainage 110-190m.

5.2.4. Egress Hazard Assessment

Austroads Guide to Road Design, Part 5: Drainage Design specifies that the maximum pedestrian safety criteria within flood waters is 0.4 m^2/s (also known as angular momentum). Where pedestrian safety is not of concern, the maximum value for vehicle safety is 0.6 m^2/s.

Figure 22 shows a map of depth x velocity for the post-development scenario. As indicated the values within the proposed carriageways and Rangiora Woodend Road are less than 0.4 m^2/s. Values higher than 0.4 m^2/s are only indicated within the waterways.

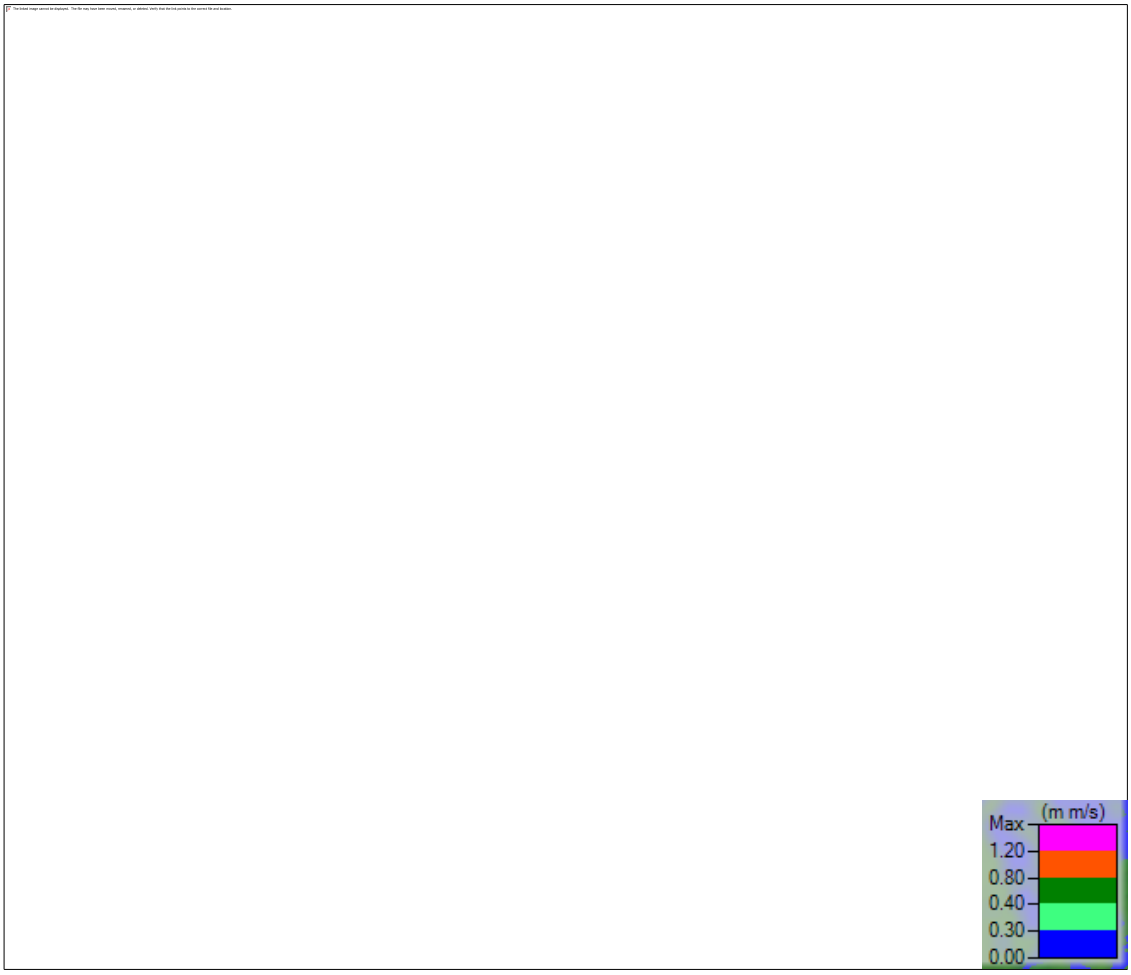

Figure 22. Post-development Map of Depth x Velocity

As shown in Figure 23, the depth x velocity values along the centreline of Rangiora Woodend Road have increased from pre-development to post-development scenario with a maximum value of 0.017m^2/s, which is less than the maximum pedestrian safety criteria and vehicle safety criteria.

Figure 23. Depth x Velocity along Rangiora Woodend Road

As shown in Figure 25, the depth x velocity value along the centreline of proposed carriageway is a maximum value of 0.066m^2/s, which is less than the maximum pedestrian safety criteria and vehicle safety criteria. The location of the long section for Angular momentum (depth x velocity) check is shown in Figure 24.

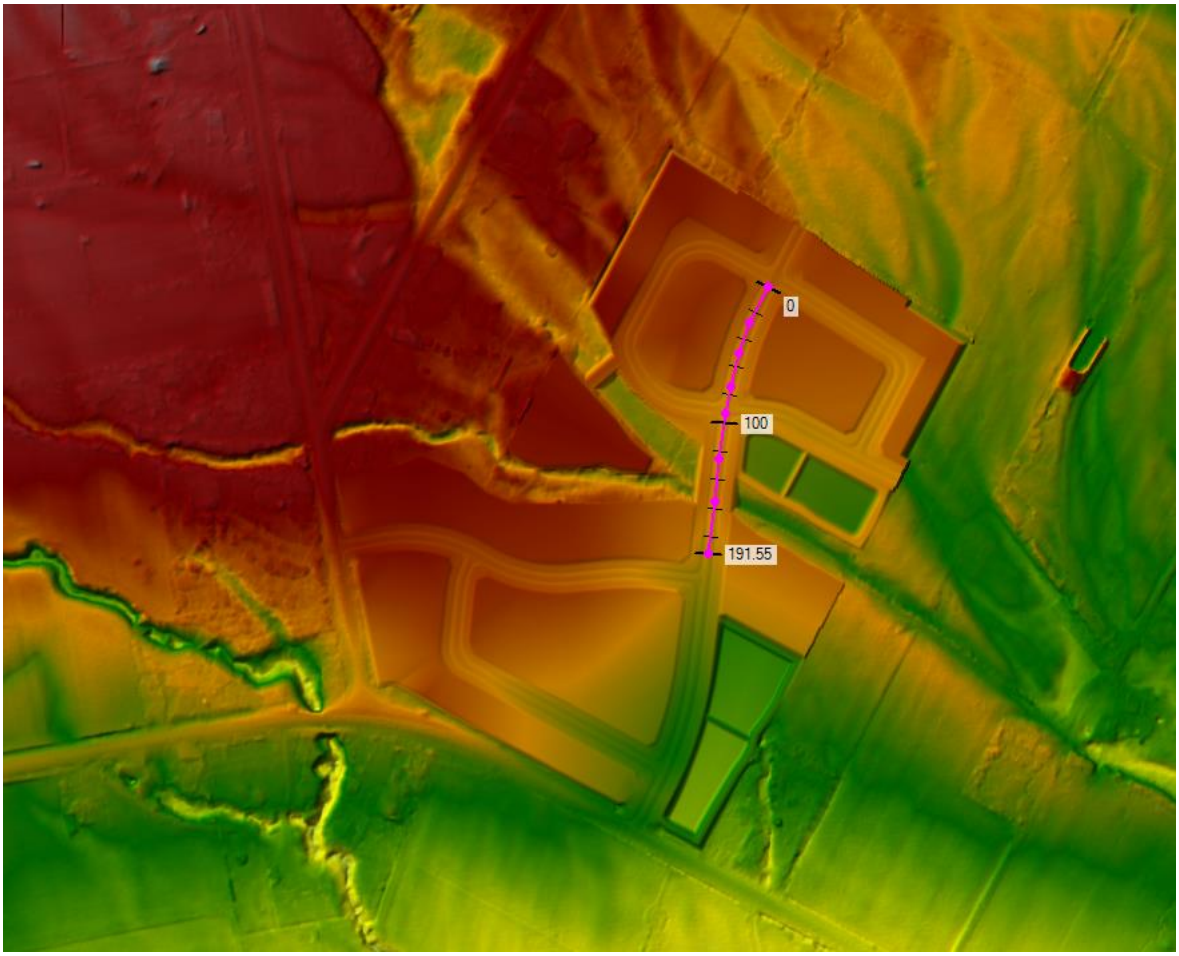

Figure 24. Longsection along the proposed new road for Angular Momentum Check

Figure 25. Depth x Velocity along Proposed Carriageway

Therefore the angular momentum within the development roadways, footpaths paths and Rangiora Woodend Road adhere with the Austroads safety criteria for pedestrians and vehicles.

6. Proposed Building Finished Floor Level

The Waimakariri District Council (WDC) requires that the proposed building finished floor level be 500mm above the 200yr ARI flood level in a Medium Hazard Flood area and 400mm above the 200yr ARI flood level in a Low Hazard Flood area.

In accordance with the Waimakariri District Flood classification, areas with flood depths less than 0.3m are considered Low Hazard Flood areas and with flood depths between 0.3-1m are considered Medium Hazard.

The post-development flood model for the proposed site (as shown in section 6) has maximum flood depths of 0.3m along the carriageways and depths greater than 0.3m within the existing waterways, therefore it is considered that parts of the site are Low Hazard and parts Medium Hazard Flood areas. Therefore, it is proposed that all the residential dwellings should be 500mm above the 200yr ARI flood level.

7. Conclusion

HEC RAS flood modelling has been carried out to determine the 200 year flood effects of the proposed development at 4 Golf Links Road and 518 Rangiora Woodend Road on the surrounding properties and roads.

Pre and post-development scenarios were modelled within the proposed development area and surrounding properties. The pre-development flood depths were calibrated against the Waimakariri flood model. The post-development model surface includes the new carriageways, new stormwater management areas and raised lot levels within the development site.

A comparison between pre and post-development 200 year flood depths, indicate the following flood increases within the Rangiora Woodend Road and the neighbouring properties:

- Within properties to the North-west, there is a flood depth increase varying between 5mm and 230mm.
- Within properties to the North and North-east, there is a flood depth increase varying between 5mm and 410mm.
- Within Rangiora Woodend Road, there is a flood depth increase of approximately 60mm at the road centreline and up to 100mm at the road edge.
- Within properties to the South of Rangiora Woodend Road, there is a flood depth increase varying between 5mm and 90mm.

Accessibility has been considered and although the angular momentum values have increased along Rangiora Woodend Road, the highest value is 0.0165 m2/s which is less than the Austroads safety criteria for pedestrians and vehicles..

8. Disclaimer

This report has been prepared by Eliot Sinclair & Partners Limited ("Eliot Sinclair") only for the intended purpose as a Flood Impact Assessment Report.

The report is based on:

- Lidar data (2020-2022) obtained from LINZ
- Waimakariri Flood Hazard maps
- Flow hydrograph obtained from Waimakariri District Council

Where data supplied by CVI Projects Limited or other external sources, including previous site investigation reports, have been relied upon, it has been assumed that the information is correct unless otherwise stated. No responsibility is accepted by Eliot Sinclair for incomplete or inaccurate data supplied by other parties.

Whilst every care has been taken during our investigation and interpretation of Lidar data and the District flood maps to ensure that the conclusions drawn, and the opinions and recommendations expressed are correct at the time of reporting, the accuracy of the flood model and results is based on the accuracy of the Lidar data and a calibration of that data against the Waimakariri Flood Hazard maps. As such, the post-development flood modelling may include a margin of error, the extent of which is unknown at the time of writing this report.

Eliot Sinclair does not provide any warranty, either express or implied, that all conditions will conform exactly to the assessments contained in this report. The exposure of conditions that vary from those described in this report, or any update to Lidar data or Waimakariri flood maps may require a review of our recommendations. Eliot Sinclair should be contacted to confirm the validity of this report should any of these occur.

This report has been prepared for the benefit of CVI Projects Limited and Waimakariri District Council for the purposes as stated above. No liability is accepted by Eliot Sinclair or any of their employees with respect to the use of this report, in whole or in part, for any other purpose or by any other party.