Before the Independent Hearing Panel
Appointed by the Christchurch District Council

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| Under | The Resource Management Act 1991 |
| In the matter of | Plan Change 14 (Housing and Business Choice) to the Christchurch District Plan |
| | Cashmere Park Limited, Hartward Investment Trust and Robert Brown |
| | Submitter ID: 593 |

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**Evidence of Gregory Mark Whyte**

20 September 2023

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## Introduction

1 My name is Gregory Mark Whyte.

2 I hold a Bachelor of Civil Engineering degree from the University of Canterbury, which I gained in 1996. I am also a Chartered Professional Engineer with the Engineering New Zealand (ENZ), which I have held since 2003.

3 I hold the position of Managing Director at DHI Water & Environment (**DHI**). I have been in this position since February 2020 and with DHI since March 2008.

4 I have over 28 years of experience in urban water and water resources engineering and modelling. I have experience within both local government and consulting environments. I have led studies and been involved in hydrological and hydraulic modelling across New Zealand, Australia and the United Kingdom. My current role involves managing and running DHI New Zealand, with small teams in Australia and the United States, with various roles, including project director, project manager, modelling technical expert, hydrological and hydraulic investigations, peer reviewing, and strategic advice on modelling and modelling training.

5 I have a long history of stormwater modelling with Christchurch City Council (**CCC)**. I began my career in 1996 working for CCC for 6 months doing some basic stormwater modelling. I returned to CCC and worked for them as a stormwater engineer from 1999 – 2003, carrying out modelling investigations and stormwater design. From 2006 to the present day I have continued to be involved in CCC's stormwater modelling, provided services as a consultant. We (DHI) have been closely involved in the Avon and Heathcote models as model custodians, but we have also provided peer reviews and been an expert witness for CCC several times. We are currently model custodians for the Heathcote City Wide model.

6 DHI has prepared a flood risk assessment supporting the submission of Cashmere Park Ltd, Hartward Investment Trust and Robert Brown (the **Submitters**), seeking to rezone the below sites (the **Site**) from Residential New Neighbourhood (**RNN**) and Rural Urban Fringe (**RUUF**) zones to Medium Density Residential Zone (**MDRZ**):

(a) 126 Sparks Road (Lot 1 DP 412488)

(b) 17 Northaw Street (Lot 2 DP 412488)

(c) 36 Leistrella Road (Lot 3 DP 412488)

(d) 240 Cashmere Road (Lot 23 DP 3217)

(e) 236 Cashmere Road (RS 41613)

(f) 200 Cashmere Road (Lot 1 DP 547021)

7 A site visit was undertaken by Antoinette Tan and Greg Whyte on 8 September 2023.

**Code of Conduct for Expert Witnesses**

8 While this is not a hearing before the Environment Court, I confirm that I have read the Code of Conduct for expert witnesses contained in the Environment Court of New Zealand Practice Note 2023 and that I have complied with it when preparing my evidence. Other than when I state I am relying on the advice of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions that I express.

**Scope of evidence**

9 I have prepared evidence in relation to Cashmere Park Extension Stormwater modelling (the **Modelling**), used to assess the flooding pre and post development of the Site.

10 DHI's full report, dated 28 February 2023, is **attached** as Appendix 1.

**Executive summary**

*Modelling*

11 DHI has undertaken three versions of modelling:

(a) Base Model/Phase 2 Model – Reflects the catchment prior to the proposed development and does not include the latest land developments in the area.

(b) Updated Phase 2 Model – The Base model was updated to include the ground levels of the existing Cashmere Park development.

(c) Development Model – Includes the proposed medium density residential development of the Site.

12 The Modelling was carried out in January/February 2023 using the Heathcote City Wide model version 22, which is also referred to as the Base model or the Phase 2 model.

13 The Phase 2 model is a MIKE FLOOD model that has three main components, MIKE 11 for rivers and open channels, MIKE URBAN for pipes and sumps and MIKE 21 for floodplain areas. It is commonly referred to as a 3-way coupled model, that represents all key elements of a stormwater network.

14 The Phase 2 model is an independently peer reviewed model. This model was built based on CCC's Model Schematisation – Avon/Estuary, Heathcote and Sumner – Rev 5 Report. This report is a specification for modelling. Any changes made to the Phase 2 model follow the Model Schematisation specification.

15 The Phase 2 model has been updated to include the existing Cashmere Park development and its associated stormwater detention ponds to the south, in order to have a current baseline model of the stormwater system in this area. (**Updated Phase 2 model**).

16 A further version of the model has been created to compare to the Updated Phase 2 model, by including the proposed development on the Site (**the Development model**). Comparisons were then made between the Updated Phase 2 model and the Development model.

17 A number of assumptions have been made within the modelling, as identified in the DHI report at Appendix 1. I consider the assumptions are appropriate and do not compromise the model accuracy.

*Stormwater system for the proposed development*

18 The stormwater system in the proposed development area is described in the evidence of Stephany Pandrea. Key components, shown in Figure 1 below, include:

(a) Construction of a new stream (Cashmere Park Stream) to replace Timber Lined Drain (part of Stillwells Drain), and diversion pipe from Timber Lined Drain to this new stream. Timber Lined Drain is blocked from taking flow south.

(b) Added pipe drainage between Cashmere Park Stream and the west wetland, and between the first flush detention basin and the downstream detention basin

(c) Filled and lowered land levels at126 Sparks Road, 17 Northaw Street and 36 Leistrella Street [1]

(d) Two detention basins on 240 Cashmere Road[2] , one at the north-west end and one at the south-west end.

(e) There is a small detention basin located on the land immediately east of 240 Cashmere Road, at 236 Cashmere Road[3]

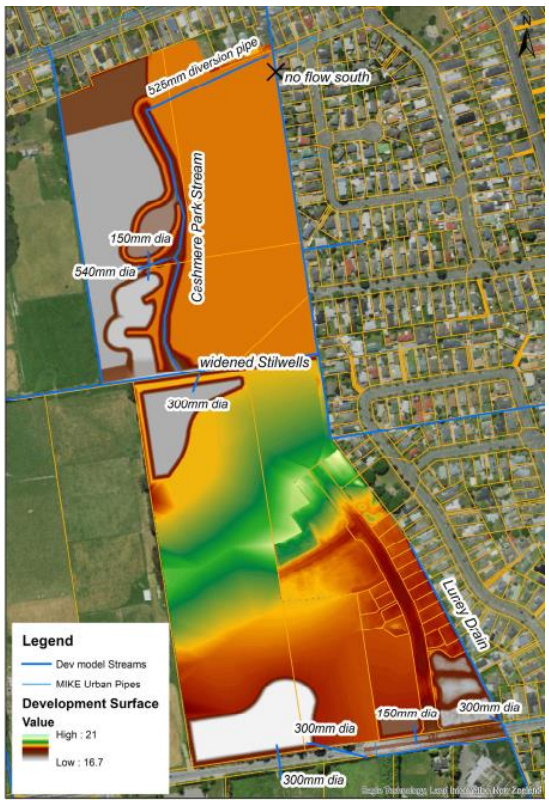


*Figure 1: 1D features in the Development Model*

19 The above described stormwater system components within the proposed development are conceptual and it is expected would need to be remodelled during the detailed design stage.

## *Modelling*

[1] Lots 1-3 DP 412488.

[2] Lot 23 DP 3217.

[3] RS41613.

20 The 1 in 200 year design rainfall event for present day of a 24 hour duration was simulated for both the Updated and Development model setups and maximum water level results were compared. The 24 hour duration storm reflects the critical duration in the area, based on previous modelling.

21 The model results show that the proposed development has a minimal impact on the surrounding flood levels. A comparison of the Base Model and Development Model maximum water level differences is shown below.

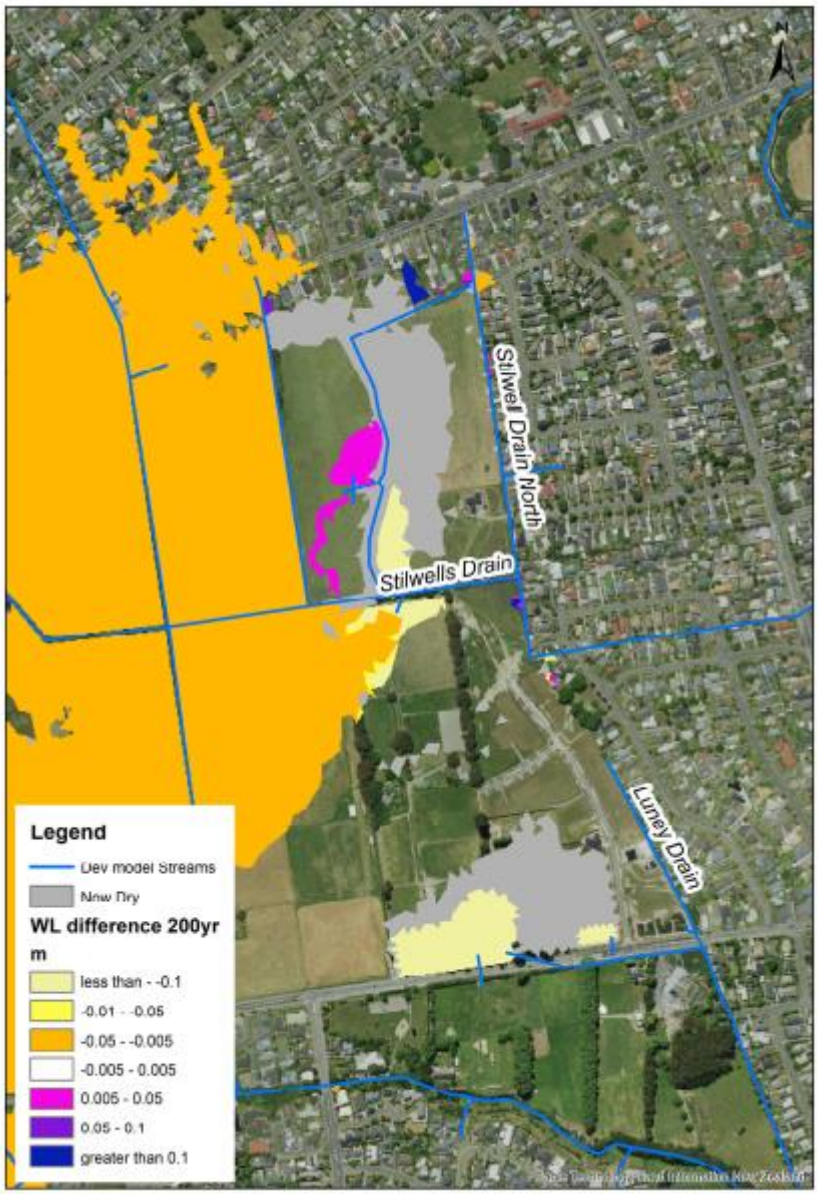


*Figure 2 – Maximum water level difference, Development - Base*

22 Water levels outside of the proposed developed land area benefit by a reduction in flood levels of between 5 and 50 millimetres, with a typical reduction of 10 millimetres, across the wider Henderson's basin area. Within the proposed development area water level increases are mostly

less than 50 millimetres but there is one isolated area that has an increase of more than 100 millimetres. Water level increases within the development area are expected to be addressed at detailed design.

23 The flood flow into Luney's Drain is increased by 6 l/s at the peak and Stillwell's pipe (which discharges into the Heathcote River) is increased by 50 l/s. Any increases in downstream water level due to increased discharges are less than 5 millimetres.

**Conclusion**

24 I am satisfied that the proposed development of the Site will provide a better outcome than the status quo for managing floodwater both on the Site and in the vicinity.

25 The proposed medium density development of the Site, which will introduce an effective stormwater storage system, will decrease flood levels for the 1 in 200 year design rainfall event, in the wider Henderson's Basin area, by 10 millimetres.

Dated this 20th day of September 2023

**Gregory Mark Whyte**

# MEMO

| | |
|---|---|
| To: | Warren Lewis, Geoff Ward, Robert Brown |
| Cc: | Bryan McGillan (ES) |
| From: | Antoinette Tan (DHI) |
| Project | 44801992 |
| Date: | 28th February 2023 |
| Subject: | Cashmere Park Extension modelling Jan 2023 |

This memo is to report on the modelling, of the Cashmere Park Extension, completed by DHI in February 2023. The modelling covers a group of proposed developments at the eastern edge of the Henderson's Basin, in Christchurch. The Heathcote City Wide model has been used to assess the flooding pre and post development. This modelling will support a private plan change application for the area.

**Modelling**

The Heathcote City Wide model version 22, also referred to as the Phase 2 model, was used in this investigation as the base. This model does not include additional updates currently being undertaken around Eastman's basin and does not have the finalised logic for the upper catchment basin control gates. The impact of this is that the final baseline flood levels in the area are subject to change. However, a comparative assessment of differences between the baseline and post development should still be reliable.

**Base model**

The base model reflects the catchment prior to the proposed development. The Heathcote Phase 2 model did not include the latest land developments in the area. These included the existing Cashmere Park Development and its stormwater ponds to the south. The base model was updated to include the ground levels of the existing Cashmere Park development using the 2021 LiDAR survey. CCC (Christchurch City Council) asset data also showed an additional stormwater pipe network for the development, however, this was not included in the current modelling, due to time constraints and given that the event being simulated is a 1 in 200 year event, which would quickly overwhelm the pipe system.

The following updates were completed for the base model for the existing cashmere park development, Figure 1.

- Added roads and basin outlines to the mesh
- Updated the 2D surface roughness definition
- Updated the infiltration and groundwater depth (based on new ground levels)
- Updated the mesh ground levels using the 2021 LiDAR
- Added a dummy outlet from the stormwater ponds into Luney Drain (southeast of basins), a 300mm diameter pipe with no backflow. No details were available in the CCC asset data for this outlet, so the values were estimated.
- Added 2D dike structures to represent basin overflow points


**Figure 1: Modelled ground levels, base using LiDAR and development using design surface**

## Development model

The development model includes the proposed developments in the three areas adjacent to the existing Cashmere Park Development, Figure 2. A proposed surface for the development area was provided by Elliot Sinclair and used to define the areas in the model.

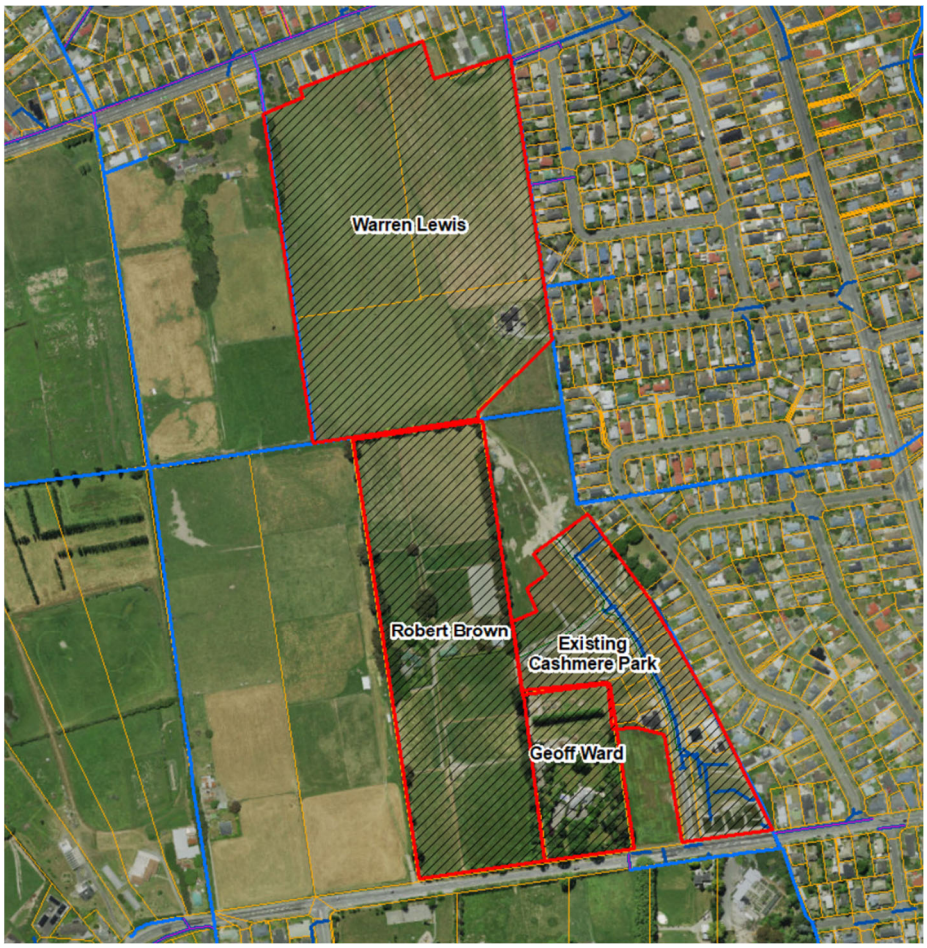


**Figure 2: Development areas**

The following updates were made to the development model, Figure 3.

- Used updated base model as a starting point
- Added new stream and diversion pipe from the north Stilwell's drain, used cross sections extracted from the development surface. Included backflow prevention on diversion pipe.
- Added pipe structures between the Cashmere Park Stream and the west wetland, and between the first flush basin and downstream pond.
- Blocked the North section of Stilwell's drain from taking flow south
- Updated cross sections along Stilwell's drain within the development area
- Updated mesh to include basin outlines and stream blockout
- Updated mesh levels to reflect the proposed design levels
- Added dummy outlet pipes from basins as indicated in Figure 3. Backflow prevention is included in all basin outflow pipes, except the inter basin pipes in the northwest wetland.
- Updated 2D surface roughness definition
- Updated infiltration based on land use type, area marked as residential development set to 50% of the base infiltration rate, road area set to 0 infiltration rate.
- Updated groundwater depth based on new levels.
- Added 2D dike structures to represent basin overflow levels

- Opened up the west embankment around the central pond directly south of Stillwells drain, allowing water to fill the pond from the western floodplain. Also, increased invert of this pond from the original design 16.8m RL to 17.4m RL.
- Added a culvert beneath Cashmere road to allow the southern floodplain water to enter into the large southern pond. This culvert is one way into the pond.
- Adjusted storage area slightly from DEM in Figure 3, to include storage on the left bank of Cashmere Park stream, and reduce storage at the top west of the DEM.

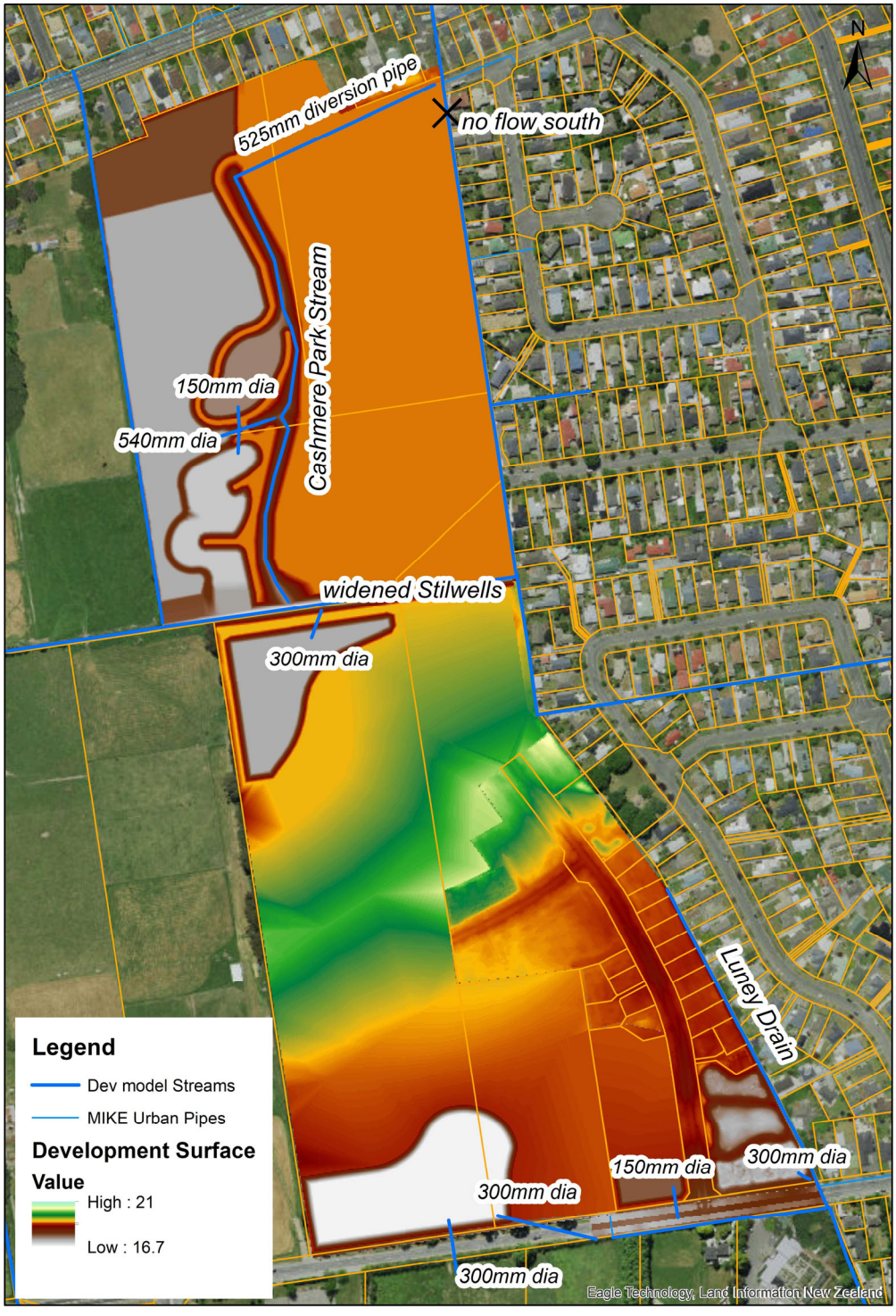


**Figure 3: 1D features in the development model**

## Assumptions

The following assumptions and simplifications were made in the modelling to account for the limited data available at this stage of the design process and to allow for an efficient model build without compromising model accuracy.

1. The stormwater pipe network was not included for the proposed development area, as this has not yet been designed.
2. The stormwater pipe network was not included for the existing Cashmere Park area, as this would have limited capacity in the 200 year event. Note that this can be included in subsequent modelling, especially if lower ARI events modelling will be required.
3. Basin outlet sizes were all assumed; these were just included to allow the basins to drain and would need to be updated in the model once the actual design is known. The outlet from the south basin, on the Robert Brown site, was connected to Luney Drain further downstream to allow the basin to drain properly, as the basin invert level is lower than the nearest waterway.
4. Road, gutter/crest were not explicitly modelled in mesh ground levels within the existing Cashmere Park area. In the City Wide modelling methodology, the road levels are set to a minimum along the road gutter and at a maximum level along the crest. This allows for more efficient conveyance along the road corridor and allows water to enter into sumps more easily. As the pipe network is not included, this aspect is less important for this modelling stage, and the levels could be updated later when the pipe network is added.
5. Additional roads within the development areas were not included in the mesh structure
6. No bridge was included on Stillwells drain to represent the proposed road crossing. The road is currently modelled to be flush with the development levels, i.e. all levels at RL 19m, which means the road is not acting as an explicit overland flow path in the current surface design. This is less important because the water depth on the site is less than 50mm.

## Model simulations

The model was simulated for the 1 in 200 year return period event, using the current climate conditions. The 24 hour duration storm was used, which reflects the critical duration in the area, based on previous modelling.

## Results

The model results show that the proposed development has a minimal impact on the surrounding flood levels. Figure 4 and Figure 5 show the flood depth pre and post development, and Figure 6 and Figure 7 show the water level difference, Development minus Base model results. Aside from the local runoff, floodwaters enter into the north wetland via Henderson's basin from the west. In the south, water can cross Cashmere road and enter the larger basin via the culvert. Allowing flow to enter this basin from the south results in essentially no change in the south floodplain; if the flow was not able to enter, a slight increase in flood levels might be expected.

The diversion from the north Stilwell's drain into the new Cashmere Park Stream allows all flow to be diverted into this new stream. This indicates that the pipe size is sufficient for the 1 in 200 year flow.

The basin at the right bank of Stilwell's drain is helping to reduce the levels in the Henderson basin floodplain slightly. The levels here are reduced by around 10mm.

The impact of the development on surrounding levels is less than +5mm in almost all areas. There are minor areas with more than 100mm depth increase that can be addressed at detailed design. The flow into Luney's Drain is increased by 6l/s at the peak, while the flow into Stilwell's pipe (which exits into the Heathcote River) is increased by 50l/s.

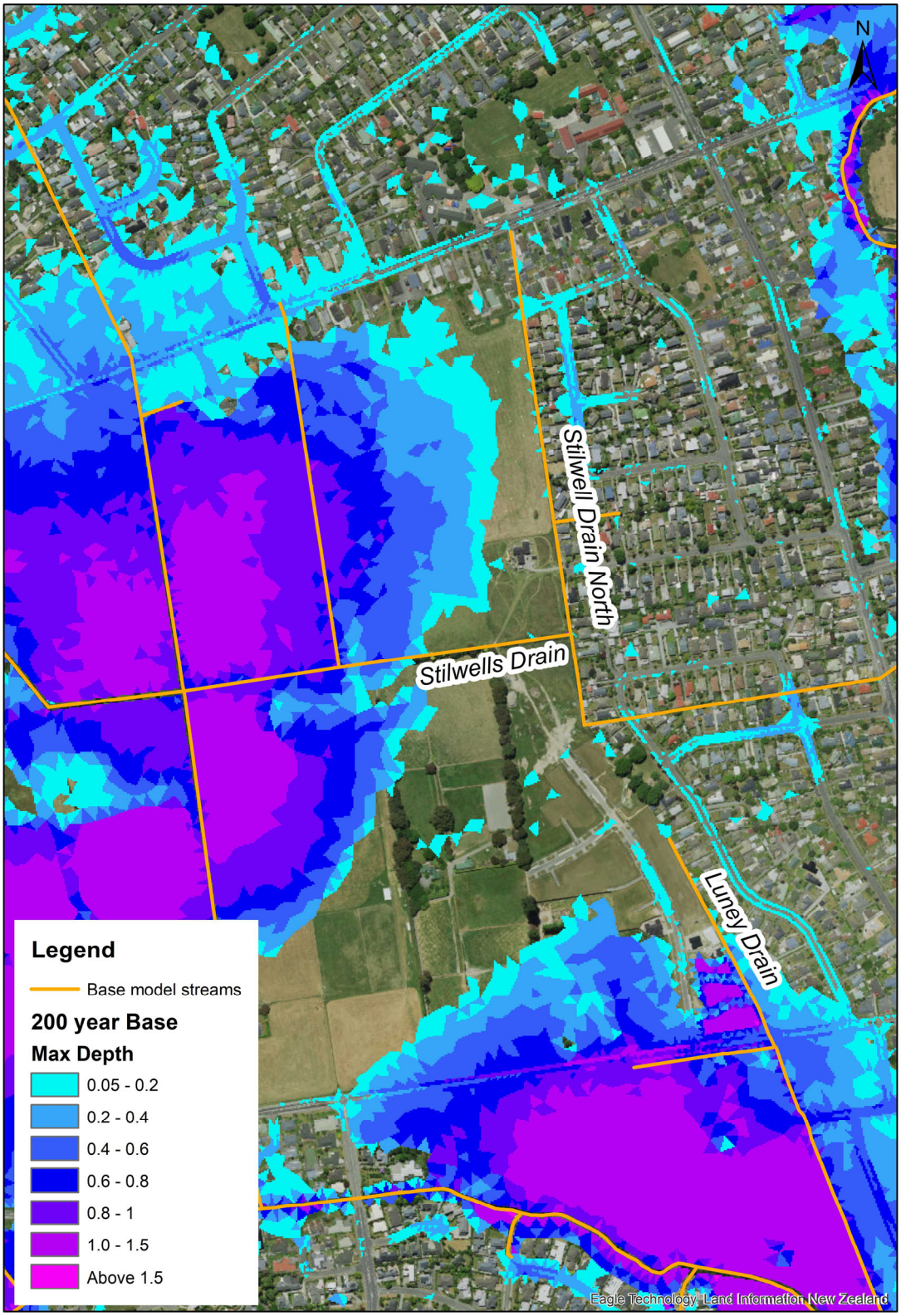


**Figure 4: 200 year 24 hour, base model maximum depth**

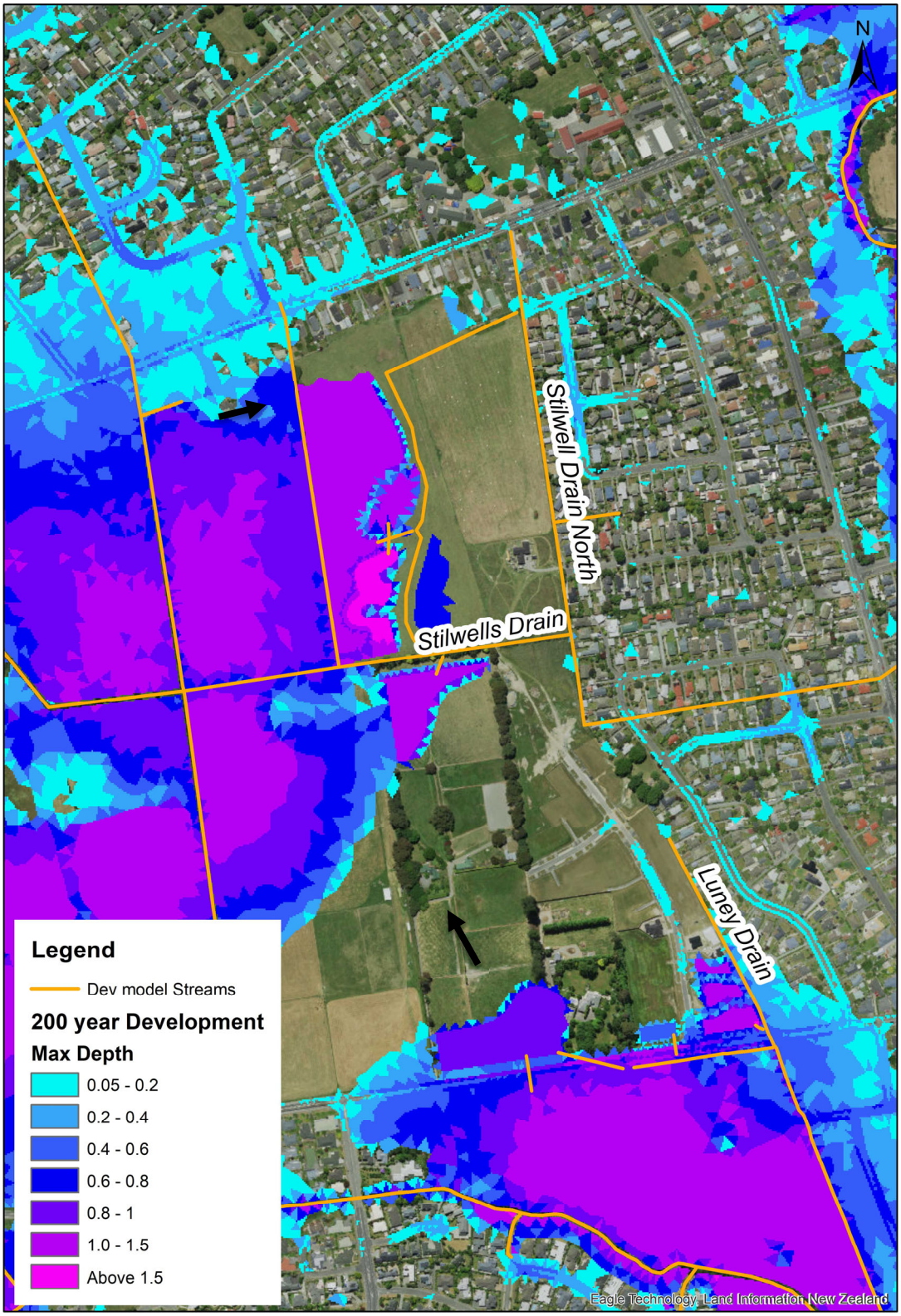


**Figure 5: 200 year 24 hour development model maximum depth**

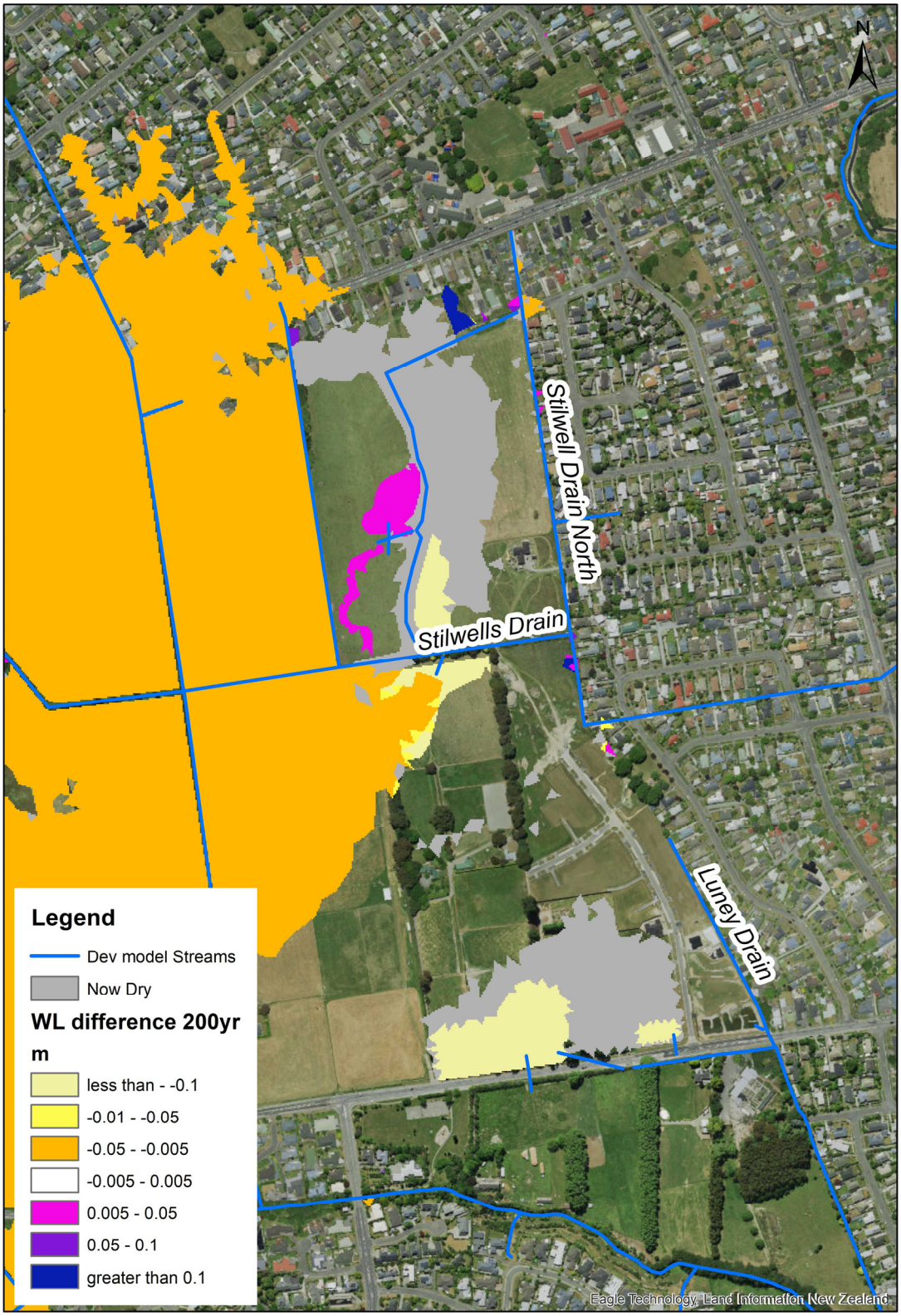


**Figure 6: Development - Base, Max Water Level Difference**

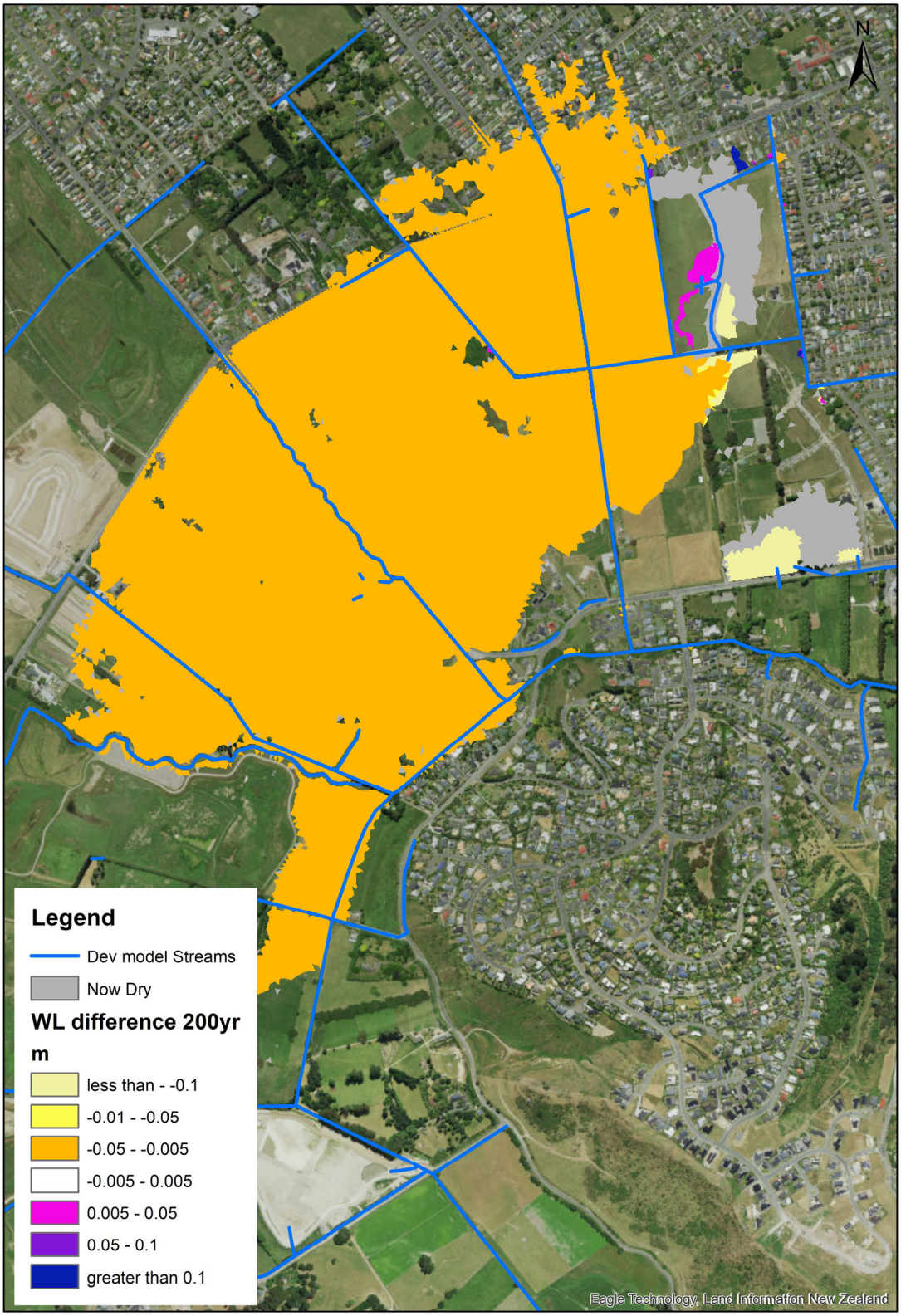


**Figure 7: Development - Base, Max Water Level Difference – zoomed out**