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Memorandum

Date	23 June 2016
Attention	Alistair Allan
From	Peter Kinley
Subject	**Pinehaven Developments Scenarios 1 and 2**
Copies to	Ben Fountain Michael Hall

1. Background

Greater Wellington Regional Council (GWRC) and Upper Hutt City Council (UHCC) have requested that Jacobs provide updated model results for the future development scenario for the Pinehaven catchment flood model and investigate two development scenarios for land in the upper reaches of the catchment. The request to update model results for the future development scenario originates from the review undertaken by Beca in 2015. The development scenarios are based on data contained in a report prepared by Boffa Miskell for a private landowner, also in 2015.

The base model, which has been used to update the results of the future development scenario and to investigate two development scenarios, is the model that was developed for the report **Pinehaven Stream Flood Hazard Assessment: Volumes 1 (Modelling Report) and 2 (Flood and Hazard Maps)**, SKM, 25 May 2010.

The purposes of the modelling are to:

- Resolve the "Future Development" item in Table 4.1 – Hydraulic Modelling in Section 4.2 of the report **Pinehaven Stream – Flood Mapping Audit,** Beca, 13 July 2015.

- Investigate the impacts of a theoretical worst case development scenario of 1,665 new residential dwellings with an average lot size of 750m^2 and 40% imperviousness, in the upper reaches of the Pinehaven catchment. This is referred to as Development Scenario 1 (DS1)

- Investigate the impacts of a lower level of development across a reduced area of the upper reaches of the Pinehaven catchment. This is referred to as Development Scenario 2 (DS2). The density of housing and the hydrological characteristics of those areas are assumed to remain the same as those modelled in the worst case development scenario described above. Figure 1 below and shows the areas assumed to be excluded from development, in yellow.

2. Methodology

The hydrological modelling of scenarios and generation of the hydrographs was undertaken by GWRC and provided to Jacobs. The supplied hydrographs were not altered except to divide the flow of three subcatchments (H, J and O) between inflow points in these subcatchments; this was done to ensure consistency with the methodology used in the modelling undertaken to support the report Pinehaven Stream Flood Hazard Assessment (SKM, 2010). Figure 1 below shows the locations and extents of the subcatchments used for the modelling.

The hydraulic network model used is the model developed for the Pinehaven Stream Flood Hazard Assessment (SKM, 2010). The storm event applied to the hydraulic model was for the two hour duration, 100 year ARI rainfall.

The first scenario (DS1) represents a higher level of development within the upper Pinehaven catchment while the second scenario (DS2) represents a lower intensity of development in the upper Pinehaven catchment.

The model was updated to include the revised inflows and re-run for each scenario.

A comparison to an Original Scenario (OS) has been made to allow the effects of the proposed development scenarios to be assessed. The OS used for the comparison is the two hour, 100 year ARI storm event with the existing hydraulic network configuration, with no additional development in the upper catchment. All scenarios have been modelled without including effects of discussed stormwater neutrality provisions that are recommended by the Pinehaven Stream Floodplain Management plan.

The network hydraulics of the model and rainfall inputs are identical for all model runs completed for this work package.

3. Results and Discussion

3.1 Comparison of Flows and Volumes

Table 1 below shows the peak runoff flowrates and total volumes from each of the subcatchments for the OS, DS1 and DS2.

	Peak Runoff (m^3/s)			Total Volume (m^3)		
Subcatchment	OS	DS1	DS2	OS	DS1	DS2
A	2.258	2.258	2.270	21,780	21,780	21,990
B	2.751	2.832	2.774	33,080	35,060	33,560
C	1.430	1.466	1.438	11,340	12,030	11,460
D	1.905	1.905	1.908	18,920	18,920	18,990
E	2.000	2.056	2.014	18,010	19,020	18,220
F	2.434	2.434	2.434	28,360	28,360	28,360
G	1.582	1.582	1.582	13,240	13,240	13,240
H	1.684	1.684	1.684	13,300	13,300	13,300
I	0.843	0.860	0.848	4,830	5,120	4,890
J	1.342	1.342	1.342	9,510	9,510	9,510
K	1.455	1.455	1.455	12,310	12,310	12,310
L	1.079	1.079	1.079	7,130	7,130	7,130
M	0.666	0.666	0.666	3,870	3,880	3,880
N	0.765	0.765	0.765	4,330	4,330	4,330
O	0.465	0.465	0.465	2,440	2,440	2,440
Total				**202,450**	**206,430**	**203,610**

Table 1. Peak Flowrates and Total Volumes for Pinehaven Subcatchments

The peak flowrates are the same in the OS when compared to DS1 for 11 subcatchments, while for the other four subcatchments (B, C, E and I) the peak flows in DS1 are greater than the peak flow for the OS.

The peak flowrates are the same in the OS, when compared with DS2 for nine subcatchments, while for the other six subcatchments (A, B, C, D, E and I) the peak flows in DS2 are greater than the peak flow for the OS. The increase in peak runoff from subcatchments A and D is not expected, as there is

no increase in development in these subcatchments. However, in both subcatchments the increase is minor and may be due to the interaction between slight changes in the timing of peak flows within the hydrological model and the temporal interval used in the results provided to Jacobs.

As expected, the total runoff volumes from each of the subcatchments show the same trends as the peak flowrates, and the overall total runoff volumes are lowest for the OS and highest for the more intense development scenario, DS1, with the less intense development of DS2 having a total runoff volume between the OS and DS1. The subcatchment hydrographs for DS1 and DS2 are shown in Figure 2 and Figure 3 respectively.

3.2 Comparison of Peak Flood Depths

This report only assesses changes in depth and extent for the two development scenarios compared to the OS. Changes to flood hazard and changes to the risk of floor level flooding for DS1 and DS2 was out of the scope of the project.

A comparison between the original flood depths and the new flood depths for both Development Scenarios show that for most of the catchment, and for most of the flooded area, the change in flooding resulting from the development is very small. Changes of water level of less than ±0.05m that occur in areas that are already flooded in the OS and remain flooded in the relevant DS do not affect overall flood extents at a catchment scale.

For DS1, where depth changes have occurred in the model, the depth changes range from an increase in depth of 0.74m to decreases in depth of 0.17m. Likewise, for DS2 the change in depths ranges from an increase of up to 0.74m to a decrease of up to 0.32m. The median increase in water level for DS1 is 0.02m and for DS2 it is 0.01m.

The change in flooding depths and extents for DS1 are shown in Figure 4 and the change in flooding depths and extents for DS2 are shown in Figure 7. This is described further below:

- There is one area which did not flood in the OS which is now identified as a potential flood area for both developed scenarios. This area is between the southern end of Pinehaven Reserve and Forest Road – the flood extents and depths in this area can be seen in Figure 5 for DS1 and Figure 8 for DS2. For both Developed Scenarios the maximum flood depth in this new flood area is 0.2 m.

- For DS1 this new flood area could be expected due to the subcatchments B and C having greater peak flows than the OS and the subcatchments being located upstream of this area. Likewise, for DS2 subcatchments B, C and D also have greater flows and are upstream of the new flood area so could also be expected to result in increased flooding in this area.

- There is an area to the west of the intersection of Whitemans Road and Blue Mountains Road in the area of the Silverstream Reform Church which has greater flood depths and new flood areas in the DS1 (Figure 6) and DS2 (Figure 9) compared to the OS. Depth increases are up to 0.74m for both developed scenarios indicating a significant increase in depths in some locations.

- The results of DS2 show some small areas at the downstream end of the catchment which no longer flood but flood in the original model (Figure 10) and in DS1. In the original model the maximum flood depth in these areas is 0.18 m.

- There are some other small areas which now experience flooding in the developed scenarios which previously did not in the original scenario. Conversely, there are other areas which

previously flooded which now no longer flood. These are expected to be due to minor differences in the timing and increase in volume of peak flows in each scenario.

The scenario maps below do not include an uncertainty allowance and have been generated for this document for comparative purposes. They should not be relied upon for any other purpose.

4. Conclusions

The results of this work package demonstrate that the conclusions of the Flood Management Plan are valid, and show it is necessary to control stormwater in the Pinehaven catchment.

The results also confirm that the response to the Flood Mapping Audit was valid.

References

Pinehaven Stream Flood Hazard Assessment: Volumes 1 (Modelling Report) and 2 (Flood and Hazard Maps), SKM, 2010.

Pinehaven Stream – Flood Mapping Audit, Beca, 2015

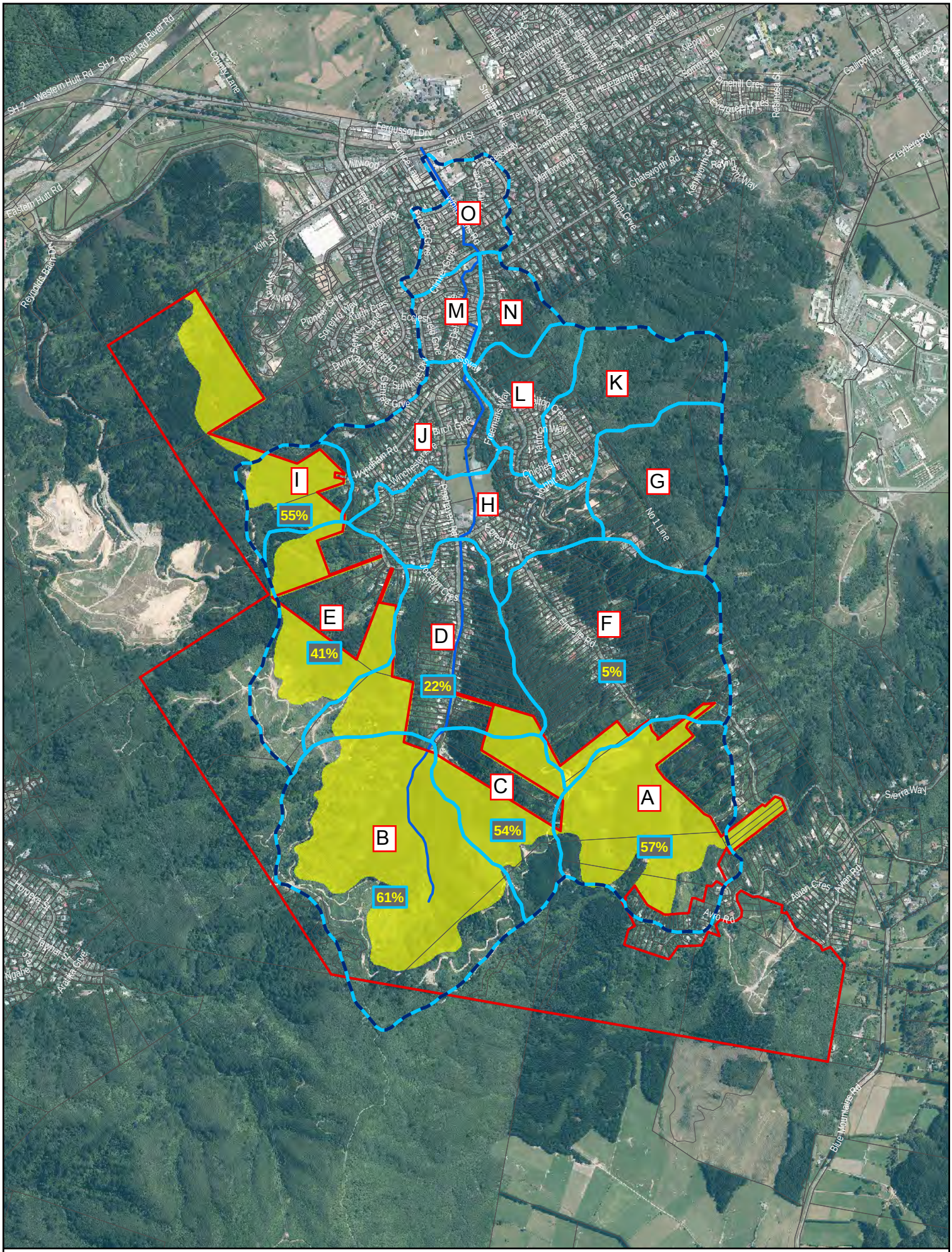


FIGURE 1 **FLOODPLAIN MANAGEMENT**

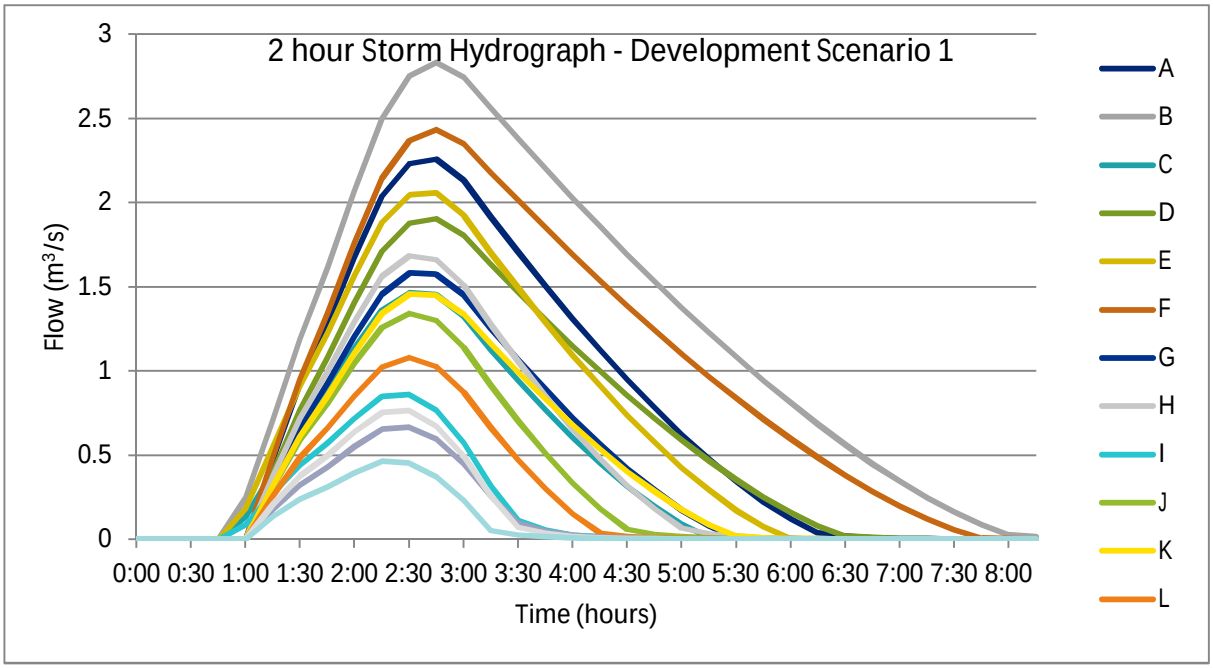


Figure 2: Subcatchment Hydrographs for Development Scenario 1.

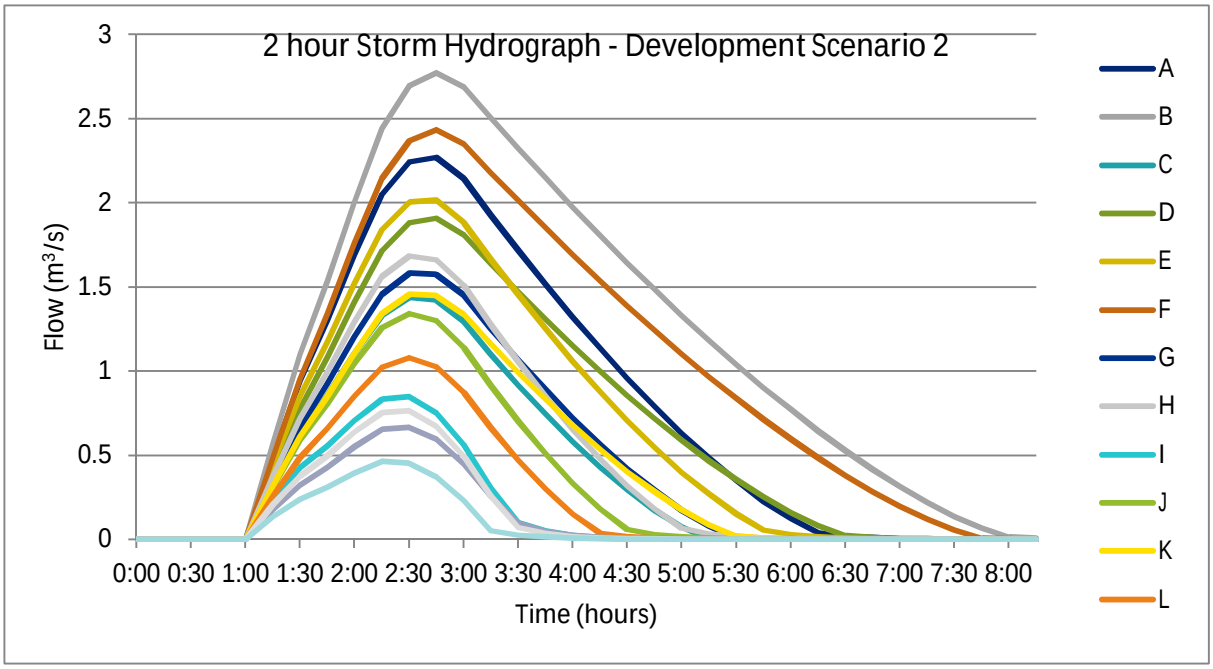
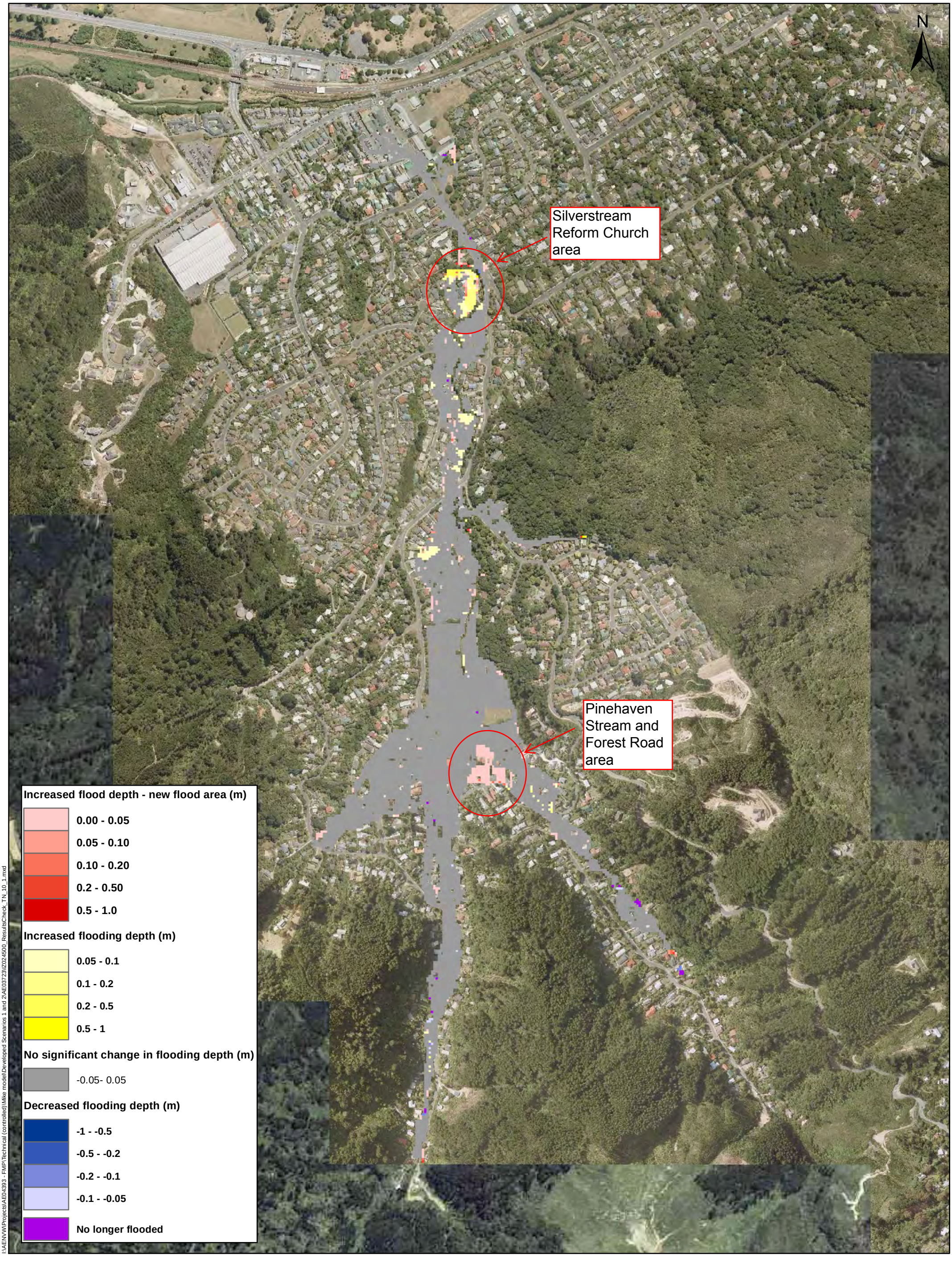


Figure 3: Subcatchment Hydrographs for Development Scenario 2.



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PROJECT: Pinehaven Flood Management Plan	
SCALE: 1:7,473 @ A3	PROJECT CODE: AE04393
PROJECT MANAGER: MH	DRAWN: TN
PROJECT DIRECTOR: JHW	DATE: 21/03/2016

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Figure 4: Development Scenario 1 less Original Scenario

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CLIENT: GWRC and UHCC	
PROJECT: Pinehaven Flood Management Plan	
SCALE: 1:1,067 @ A3	PROJECT CODE: AE04393
PROJECT MANAGER: MH	DRAWN: TN
PROJECT DIRECTOR: JHW	DATE: 30/05/2016

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Figure 5: Development Scenario 1 less Original Scenario - New flood area between Pinehaven Reserve and Forest Road

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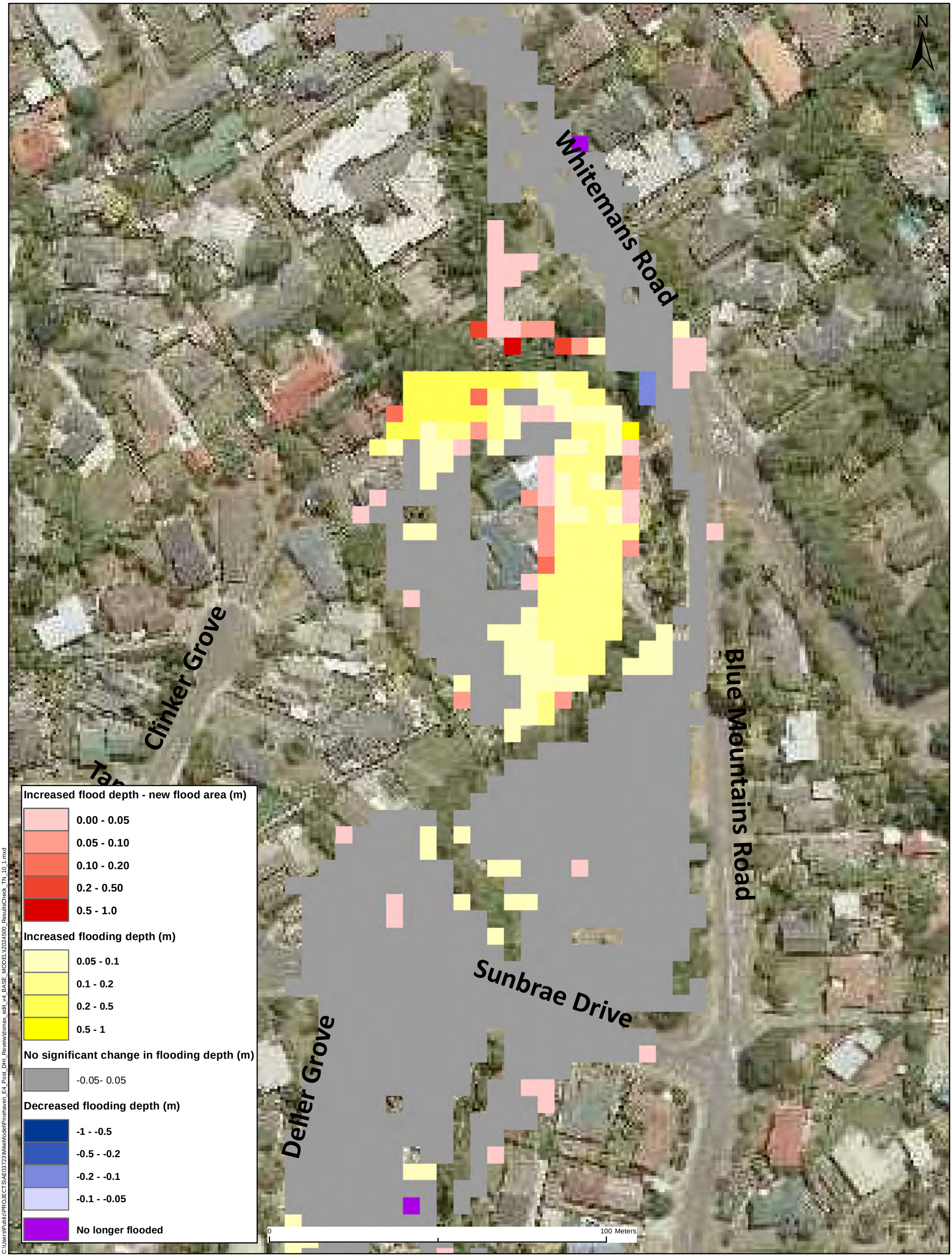

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PROJECT: Pinehaven Flood Management Plan	
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Figure 6: Development Scenario 1 less Original Scenario - New flood and deeper flood area near Silverstream Reform Church

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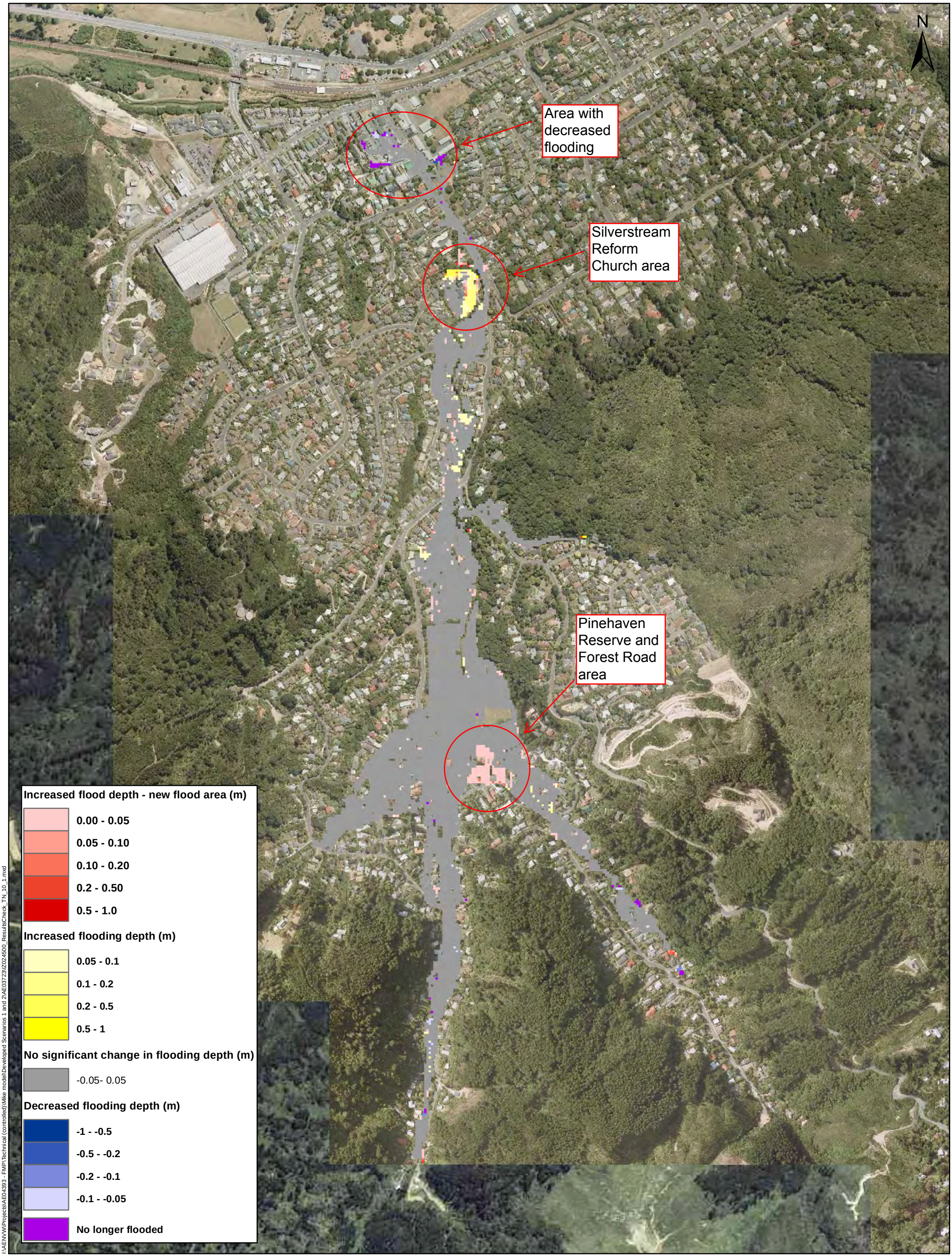

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Figure 7 Development Scenario 2 less Original Scenario

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CLIENT: GWRC and UHCC	
PROJECT: Pinehaven Flood Management Plan	
SCALE: 1:1,067 @ A3	PROJECT CODE: AE04393
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Figure 8: Development Scenario 2 less Original Scenario - New flood area between Pinehaven Reserve and Forest Road

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N

Whitemans Road

Blue Mountains Road

Sunbrae Drive

ker Grove

eller Grove

ve

Increased flood depth - new flood area (m)

0.00 - 0.05

0.05 - 0.10

0.10 - 0.20

0.2 - 0.50

0.5 - 1.0

Increased flooding depth (m)

0.05 - 0.1

0.1 - 0.2

0.2 - 0.5

0.5 - 1

No significant change in flooding depth (m)

-0.05- 0.05

Decreased flooding depth (m)

-1 - -0.5

-0.5 - -0.2

-0.2 - -0.1

-0.1 - -0.05

No longer flooded

0 100 Meters

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PROJECT: Pinehaven Flood Management Plan	
SCALE: 1:869 @ A3	PROJECT CODE: AE04393
PROJECT MANAGER: MH	DRAWN: TN
PROJECT DIRECTOR: JHW	DATE: 30/05/2016

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Figure 9: Development Scenario 2 less Original Scenario - New flood and deeper flood area near Silverstream Reform Church

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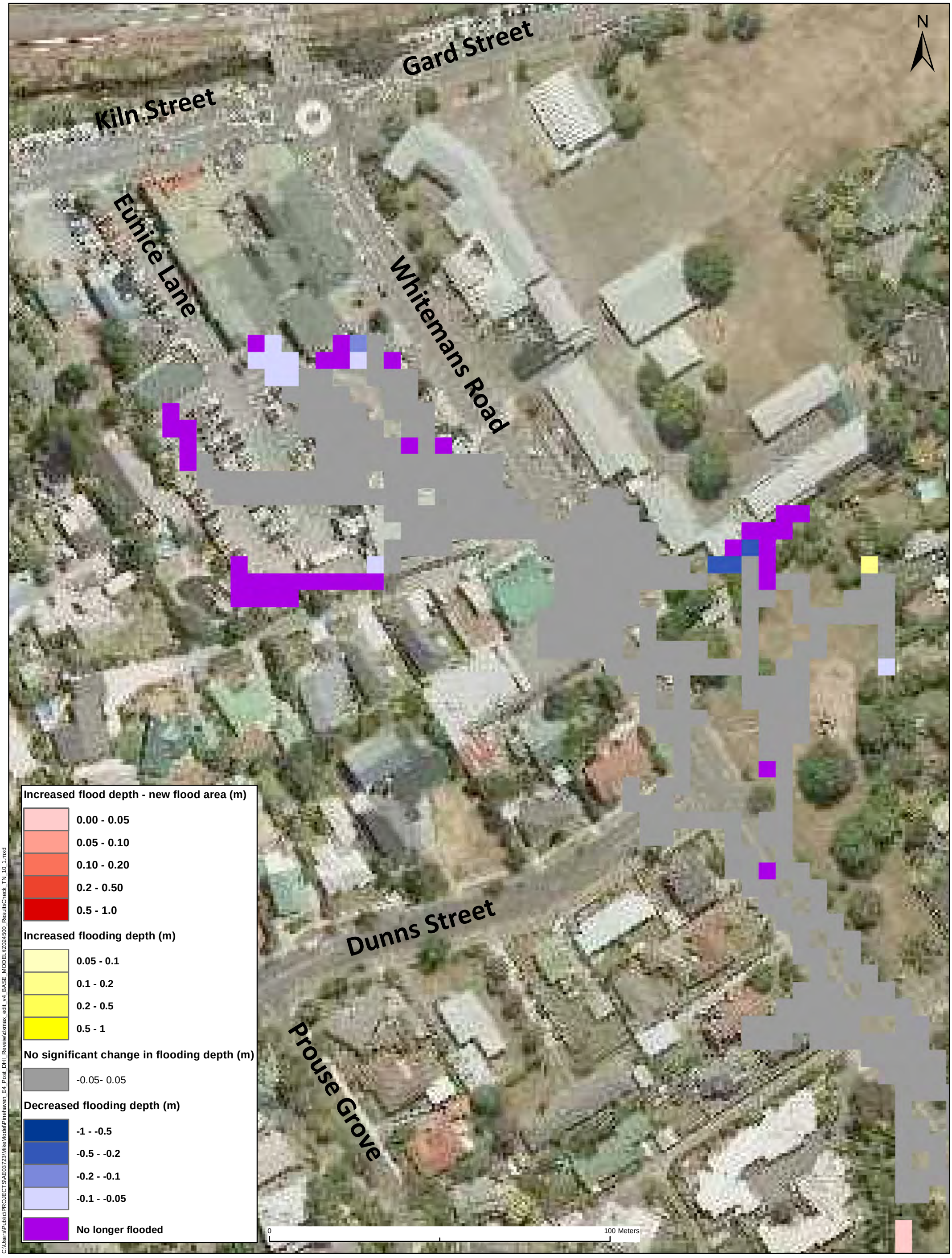

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PROJECT: Pinehaven Flood Management Plan	
SCALE: 1:990 @ A3	PROJECT CODE: AE04393
PROJECT MANAGER: MH	DRAWN: TN
PROJECT DIRECTOR: JHW	DATE: 30/05/2016

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Figure 10: Development Scenario 2 less Original Scenario - Areas which no longer flood

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