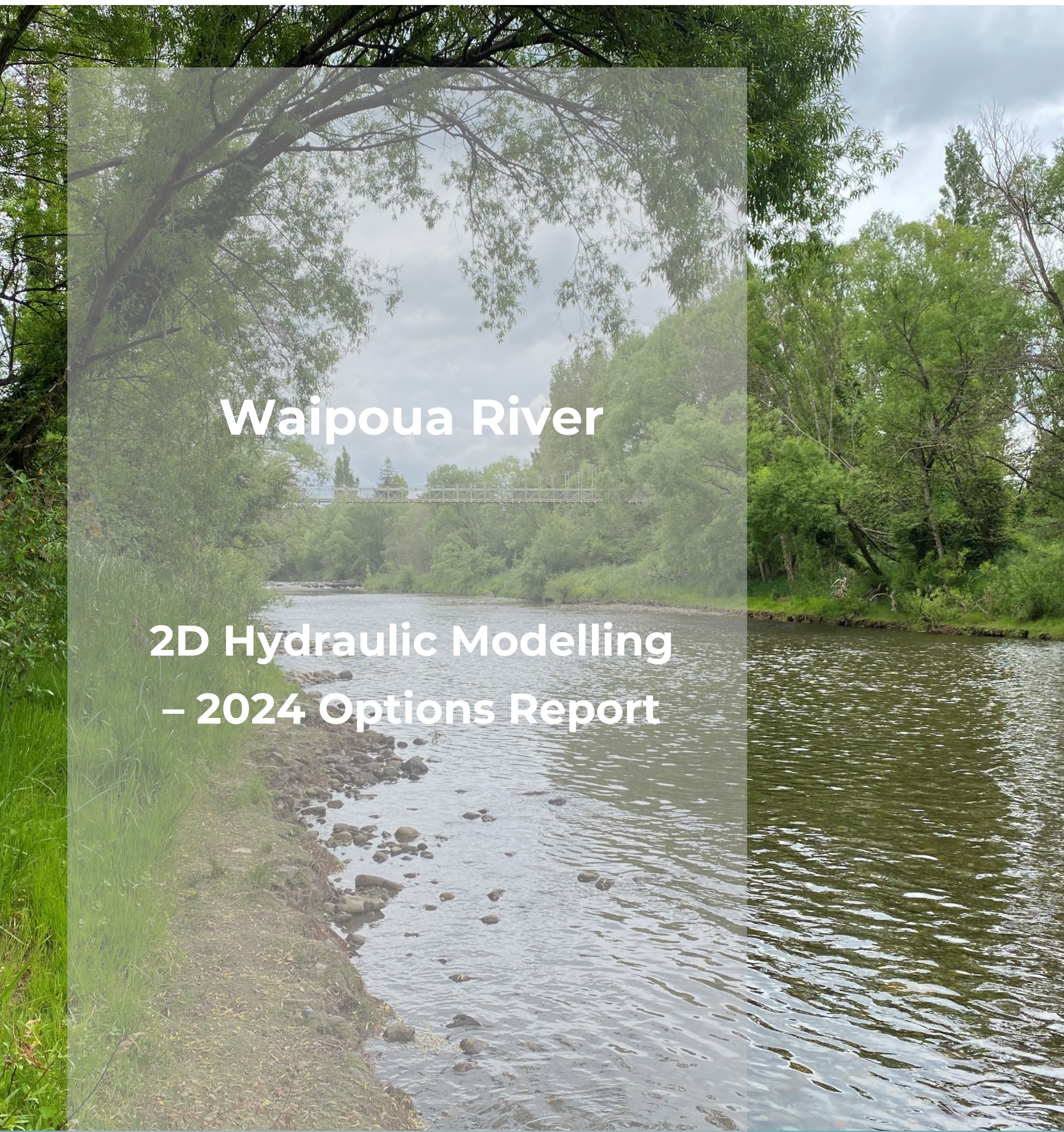
Appendix C 2D Hydraulic modelling – 2024 options report



Waipoua River

2D Hydraulic Modelling – 2024 Options Report

26 March 2025

Client: Greater Wellington Regional Council

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TABLE OF CONTENTS

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1. INTRODUCTION

1.1. BACKGROUND

The Te Kāuru Upper Ruamāhanga Floodplain Management Plan (FMP) provides a long-term framework for floodplain management in the Te Kāuru Upper Ruamāhanga catchment. The plan is a collaborative product of Regional and District Councils, iwi and local community, and aims to promote natural river processes while achieving agreed levels of flood and erosion protection.

A hydraulic model of the Waipoua River and surrounding Masterton area was first built by Greater Wellington Regional Council (GWRC) as part of the FMP. In 2018, Land River Sea Consulting was engaged to conduct an audit of the hydrology and hydraulic modelling components and subsequently implemented the audit's recommendations in 2023 into the upgraded Waipoua Hydraulic Model.

Following the implementation of the audit recommendations, Land River Sea was engaged to model a series of potential options in the model, for which the decision was made to create a purely 2D model, of only the lower reach of the model where the options were to be focused. The advantage of the 2D model is it is quicker to run and simpler to manipulate for the various options.

Initially, a total of 22 options were investigated as were proposed by the Waipoua River Project Team. Further information and results are provided in Section 3.1 of this report.

Following the preliminary modelling of individual options, a further 15 scenarios were simulated to establish a more comprehensive scheme for flood protection/mitigation. The project team curated these combined options based on the impact of the Individual Options. Further information and results are provided in Section 3.2 of this report.

Finally, a further three options (and multiple variations thereof) were investigated as part of the Final Iteration and Final Options investigation. Further information and results for these scenarios are provided in Sections 3.3 and 3.4 of this report. The working group's preferred option is presented in Section 3.5.

For reference, an approximate timeline for the dates when the majority of initial, combined and final model scenarios were run is presented in Table 1-1.

Table 1-1: Timeline of model runs

Model Runs	Date/s
Individual Options	09/07/2024 – 30/07/2024
Combined Options	22/07/2024 – 23/10/2024
Final Iteration Options	24/10/2024 – 04/11/2024
Final Iteration Options (1B, 2B, 3B, 4B, 5, 6, 7)	23/01/2024 – 31/01/2025
Final Options (1C, 2C, 3C, 4C)	26/03/2025
Preferred Option (1D)	26/03/2025

1.2. SCOPE

Land River Sea Consulting has been engaged by GWRC to investigate possible flood mitigation measures for Masterton's existing flood protection scheme, while employing sustainable and resilient river management practices. The scope of this report includes discussion and results for:

- Brief discussion on the model buildAn initial suite of Individual Options (Section 3.1)
- Combined Options based on the performance of initial options (Section 3.2)
- Final Iteration Options as further refinement of the Combined Options (Section 3.3)
- Final Options as further refinement of the Final Iteration Options (Section 3.4)
- Preferred Working Group Option (Section 3.5)

2. 2D MODEL

The 2023 Waipoua Hydraulic Model was used as a basis for these investigations (refer to Land River Sea report dated 03 Mar 2023). The model was simplified into a purely 2D model rather than a 1D/2D coupled model because many of the proposed options lay at the boundary of the 1D/2D model, which would have been challenging and time-consuming to configure. Thus, converting the model into 2D reduced the complexity of the model set-up, calibration and results processing, particularly given the large number of scenarios investigated.

The 2D Waipoua Model construction process is briefly discussed in the following sections.

2.1. 2D MESH GENERATION

While the 2023 flood model used a flexible mesh, the 2D model used for these investigations utilised a fixed regular grid mesh of size 2m which is a significantly higher resolution than used in the base model. The mesh was generated based on the latest LiDAR data and bathymetric channel geometry, which was interpolated using the cross-sectional survey data used in the 2023 Waipoua Hydraulic Model.

2.2. MODEL FEATURES

Several important floodplain features such as stopbanks, bunds and road/rail embankments are represented as ‘dikes’ within the MIKE 2D software. Locations of modelled dikes are presented in Figure 2-1. Modelling these features as ‘dikes’ in the software allows us to ensure the exact crest levels control the flow, rather than taking the height from a sampled DEM which typically underestimate the height of the crest. The ‘dike’ crest levels were set to a height using a combination of the latest LiDAR data and crest level survey data.

A newly included feature in the 2D Model is the Whitipoua swingbridge, which was not present in the 2023 Waipoua Model as it was constructed after model build had started and the LiDAR was flown.

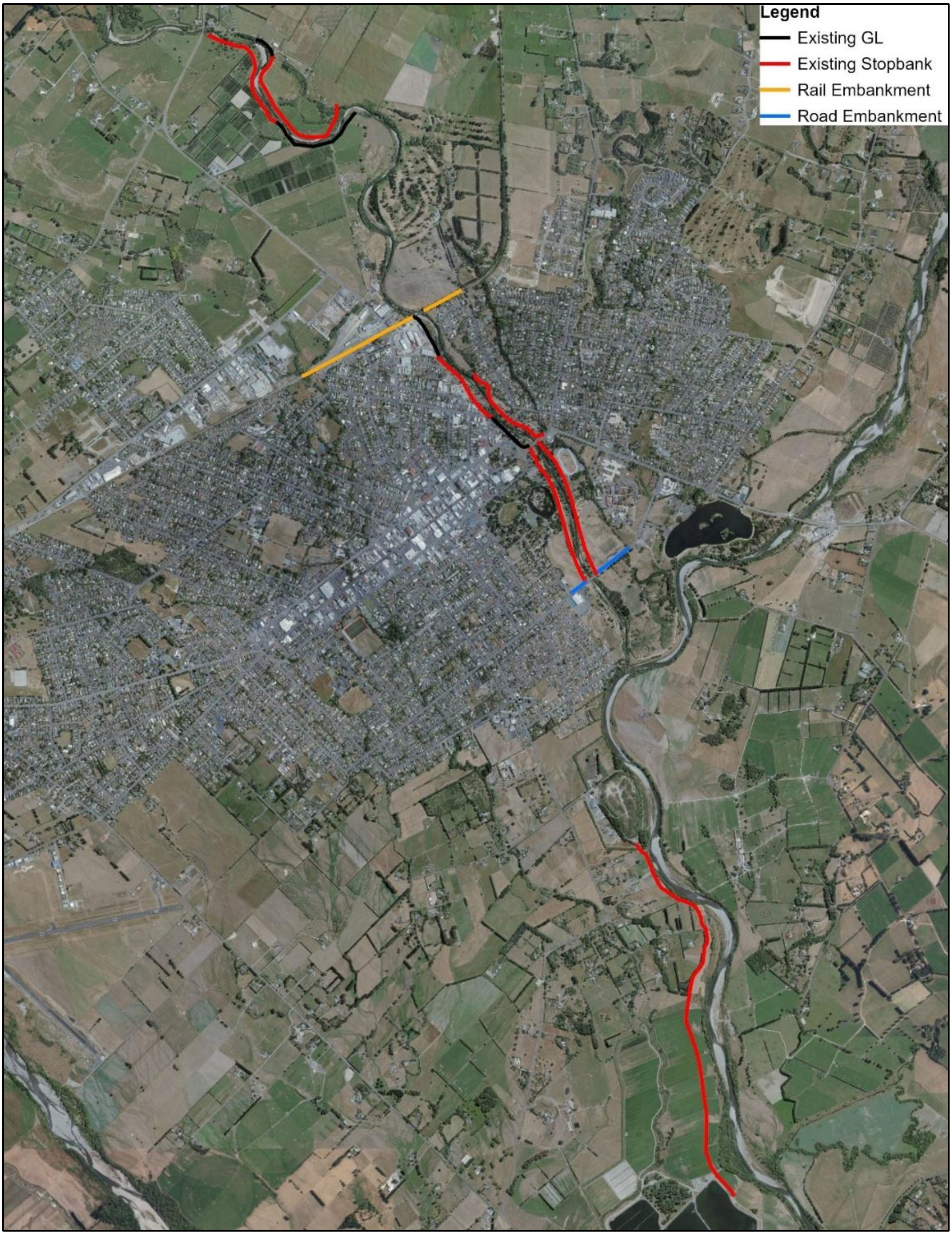

Figure 2-1: Locations of the modelled dikes.

2.3. FLOODPLAIN RESISTANCE

To account for varying roughness – or resistance to flow – across the floodplain, spatially varying Manning's 'n' coefficient values were assigned to areas based on the land-use type, as determined by aerial imagery. For the floodplain, roughness values used in the 2023 model were adopted. A raster of grid size of 1 m was created with each cell assigned a Manning's 'n' value. For the river channel, roughness values were simplified and also reduced on average by 30%, except for immediately upstream and downstream of the Colombo Rd (chainage 31150 to 32059), where the original roughness from the 1D/2D model is used to fit the calibration event.

It is standard practice when converting a 1D model into a 2D model to lower the roughness in the river channel due to the fact that in a 1D model, flow is averaged over the cross-section, therefore Manning's *n* must account for everything, including bed roughness, channel irregularities, bends, turbulence, lateral momentum losses, etc. Since these energy losses aren't explicitly modelled in a 2D model, the *n* value is often inflated to compensate.

In a 2D model, flow is resolved in two horizontal directions (x and y), so it captures lateral momentum exchange, eddies, flow separation, and other complex features directly. Energy losses are modelled inherently via the flow equations (especially with fine grids), and therefore, there is no need to allow for additional energy losses in Manning's *n* as the physical processes are already simulated.

Finer resolution models (such as this one – 2 to 5m), capture small-scale features like:

- Banks and berms
- Minor channel meanders
- Buildings, roads, and banks, ditches and depressions

Whereas a coarse grid (e.g., 10m–30m or more) smooths over those features and the flow "sees" a flatter, more generalised landscape.

It is for this reason that fine grid 2D models use an even lower Manning's 'n' value. A reduction in the order of 30% is within the standard range for a fine resolution 2D model.

2.4. MODEL CALIBRATION – OCTOBER 1998 EVENT

The model was calibrated to the October 1998 event, which had a flow at the upstream Mikimiki gauge of 356 m^3/s which is rated in the order of a 70-year ARI event, however, according to the flow statistics, the return period of the estimated flow of 412 m3/s at the Colombo Rd bridge further downstream only has an ARI in the order of a 20-year event (Gardner, 2023). This 2D model utilised the calibrated flows from the 2023 Hydraulic Model for the Waipoua & Ruamahanga Rivers.

The model calibrated well with the 1998 event with an average error of -0.04m and an absolute average error is 0.04 m. A full comparison of the modelled results and the debris levels is presented in Table 2-1, with cross section locations (and difference in metres) provided in Figure 2-2. This calibration shows an improvement over the 1D/2D model and demonstrates the power of the higher resolution 2D model, compared to the original 1D/2D model.

Table 2-1: Calibrated model results compared to surveyed debris levels from the Oct 1998 flood

River Name	Chainage	Debris level	Modelled WL	Difference	Absolute Difference
WAIPOUA	29224	122.96	122.96	0	0
WAIPOUA	29272	122.96	122.89	-0.07	0.07
WAIPOUA	29598	121	121.02	0.02	0.02
WAIPOUA	29872	119.65	119.63	-0.02	0.02
WAIPOUA	30131	118.73	118.73	0	0
WAIPOUA	30425	117.32	117.31	-0.01	0.01
WAIPOUA	30646	115.41	115.41	0	0
WAIPOUA	30882	114.13	114.11	-0.02	0.02
WAIPOUA	30899	114.13	114.11	-0.02	0.02
WAIPOUA	31150	113.56	113.46	-0.1	0.1
WAIPOUA	31405	112.24	112.03	-0.21	0.21
WAIPOUA	31712	110.78	110.75	-0.03	0.03
WAIPOUA	32020	109.99	109.99	0	0
			Average	**-0.04**	**0.04**

Figure 2-2: Map of the difference (in unit m) between calibrated 2D Waipoua model water levels and the surveyed debris levels from the Oct 1998 flood event

2.5. MODEL VALIDATION – 2023 HYDRAULIC MODEL

In order to validate the 2D model, we have simulated the 1%AEP RP6.0 event and compared the flood extents and depths. Both models give very similar results indicating that the newly created 2D model, is suitable for use in investigating options. A comparison of flood extent in presented in Figure 2-3 below.

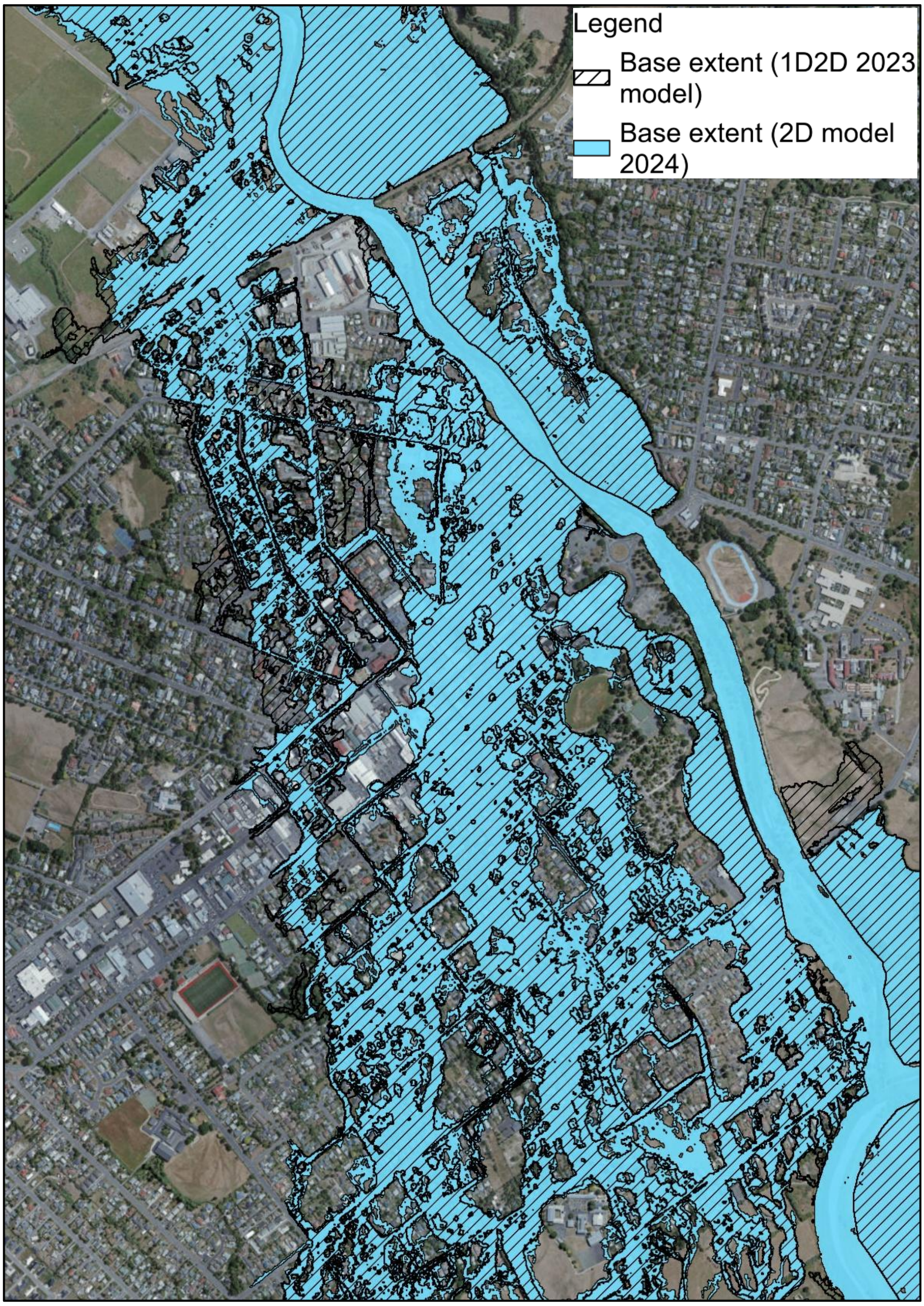

Figure 2-3: The 2D Waipoua Model flood extent for the base scenario (status quo) and a 1% RCP6.0 flow event, compared to the 2023 Waipoua Hydraulic Model

3. SCENARIOS AND RESULTS

Each option has been simulated using a 1% AEP future climate (RCP 6.0) flow event with the results being compared with the base scenario (existing flood protection scheme) for the same flow event.

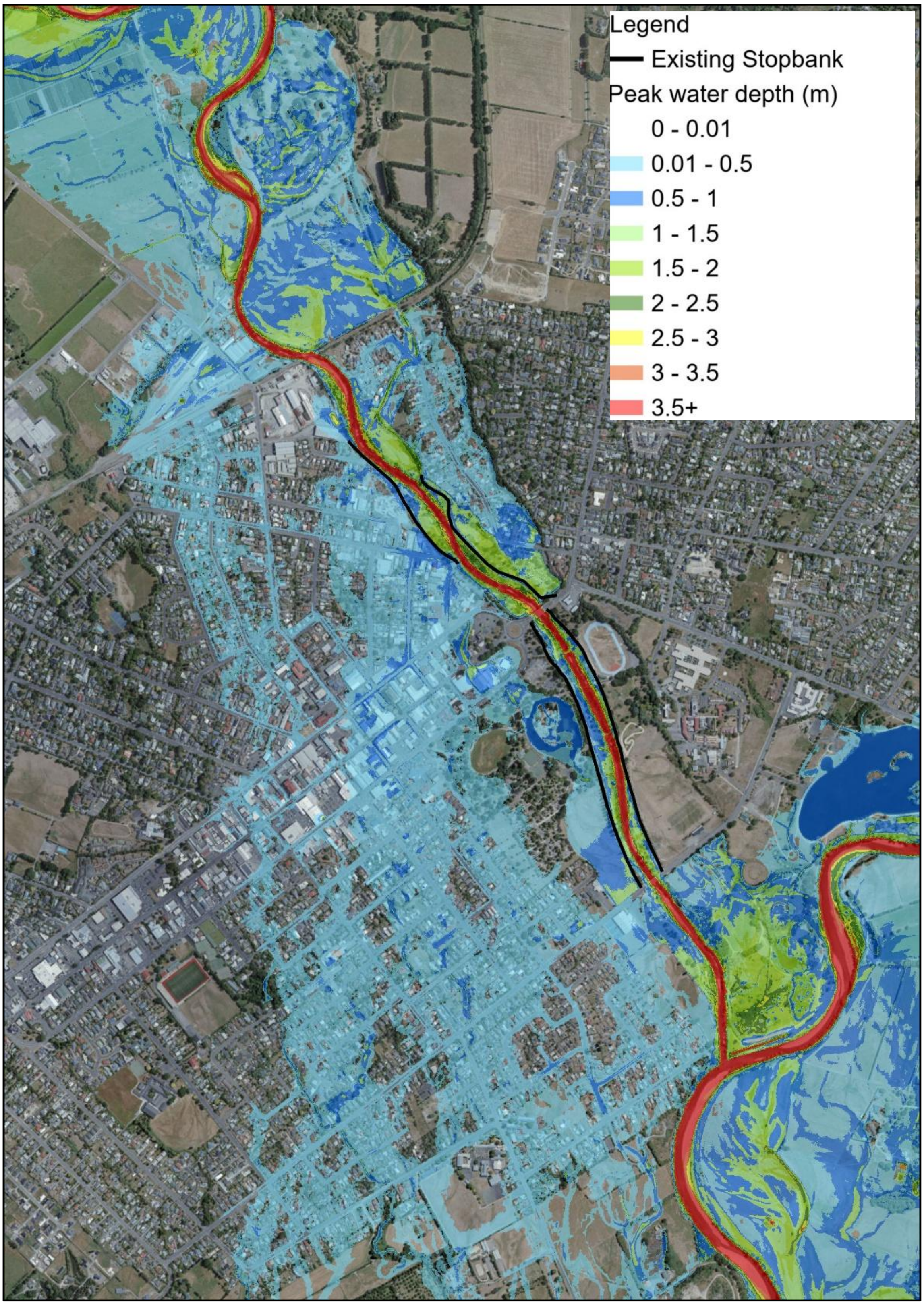

Figure 3-1: Base scenario (existing scheme) 1% AEP RCP6.0 depth map

3.1. INITIAL OPTIONS

A total of 22 individual options were investigated as follows:

1. Forming a stop bank along Mahunga Dr and lowering the nearby wetland by 6 m
   a. Without an inlet from Waipoua River
   b. With an inlet from Waipoua River
2. Cutting a 20 m wide swale from Akura Rd to Waipoua River to divert inland flood waters back into the Waipoua River.
3. Lowering the true left river berm between the railway bridge and Oxford St by 1 m
4. Extending the Mawley Park stop bank approximately 330 m upstream.
5. Building a stopbank along the true right between railway bridge and SH2 bridge
6. Lowering the true left stop bank south of the SH2 bridge by 1 m
7. Providing room for the river (approx. 150 m) along true left bank and forming new stop bank on true left terrace edge between SH2 and Colombo Rd
8. Removing a section of the true left back to direct floodwater into the Pelorus Trust Athletics Track as flood storage, as well as providing a bypass under SH2.
9. Lowering true right stop bank between SH2 and Colombo Rd by 1 m.
10. Combining Individual Options 10 and 11. Removing a section of right stopbank to direct flood waters into QEII. Cutting an outlet swale at the southern end of the QEII fields.
11. See Option 10.
12. Providing a culvert underneath Colombo Rd to direct flood waters towards Ruamahanga River and adjacent wetland.
13. Forming a new stop bank on true right side of Waipoua River between Colombo Rd and Ruamahanga River (to protect Cameron Cres and River Cres)
14. N/A.
15. Forming a new stop bank on the true right side of Waipoua River immediately upstream of railway bridge and 425 m along Akura Rd..
16. Cutting a 20 m wide swale inland of the true left river berm near Oxford St to divert water out of the main channel.
17. Providing room for the river (approx. 150 m) along true left bank between the railway bridge and SH2. Mawley Holiday Park is protected behind the proposed, realigned and extended stopbank.
18. Same as Option 17 except Mawley Holiday Park is **not** protected by the proposed stop bank
    a. Alternate stop bank alignment to protect Mawley Holiday Park
19. Removing a section of the true left stop bank upstream of the BMX track, between SH2 and Colombo Rd to direct flooding onto the BMX track.
20. Lowering a section of the true left stop bank downstream of the BMX track, between SH2 and Colombo Rd, by 1 m
21. Identical to Option 16, except the true left swale is wider.
22. Widening the river channel in multiple sections between the railway line and Colombo St

For the preliminary purposes of this investigation, all proposed stopbanks/floodwalls – unless otherwise stated – were set up in the model as a 'glass-wall' (i.e. infinitely tall) to prevent overtopping and determine their maximum possible impact. Practical stopbank/floodwall heights are expected to be determined during a detailed design stage, once final mitigation options are chosen.

A range of model results can be extracted, including flood depth, speed, flow direction etc. However, to simplify key results, we have provided a depth difference map for each option, which shows the difference in flood level for each modelled option compared to the base scenario (status quo). Maps illustrating the model set up for each option and their results are provided in the following sections.

Options (or variations thereof) that were taken to the next stage of investigation (i.e. modelling of Combined Options) are marked with an asterisk (*).

3.1.1. INDIVIDUAL OPTION 1 *

Option 1 consists of a new stopbank along Mahunga Drive and lowering an area of the wetland next to Mahunga Drive by 6 m to provide additional flood capacity and storage. The stopbank is set up in the model as a 'glass-wall' (GW) for maximum possible impact.

We explored two possible implementations:

A. Lowering half of the wetland by 6 m with no inlet (Figure 3-2)

B. Lowering half of the wetland by 6 m and cutting an inlet/swale at the upstream end, connecting to the main river channel and diverting water into the lowered area (Figure 3-3).

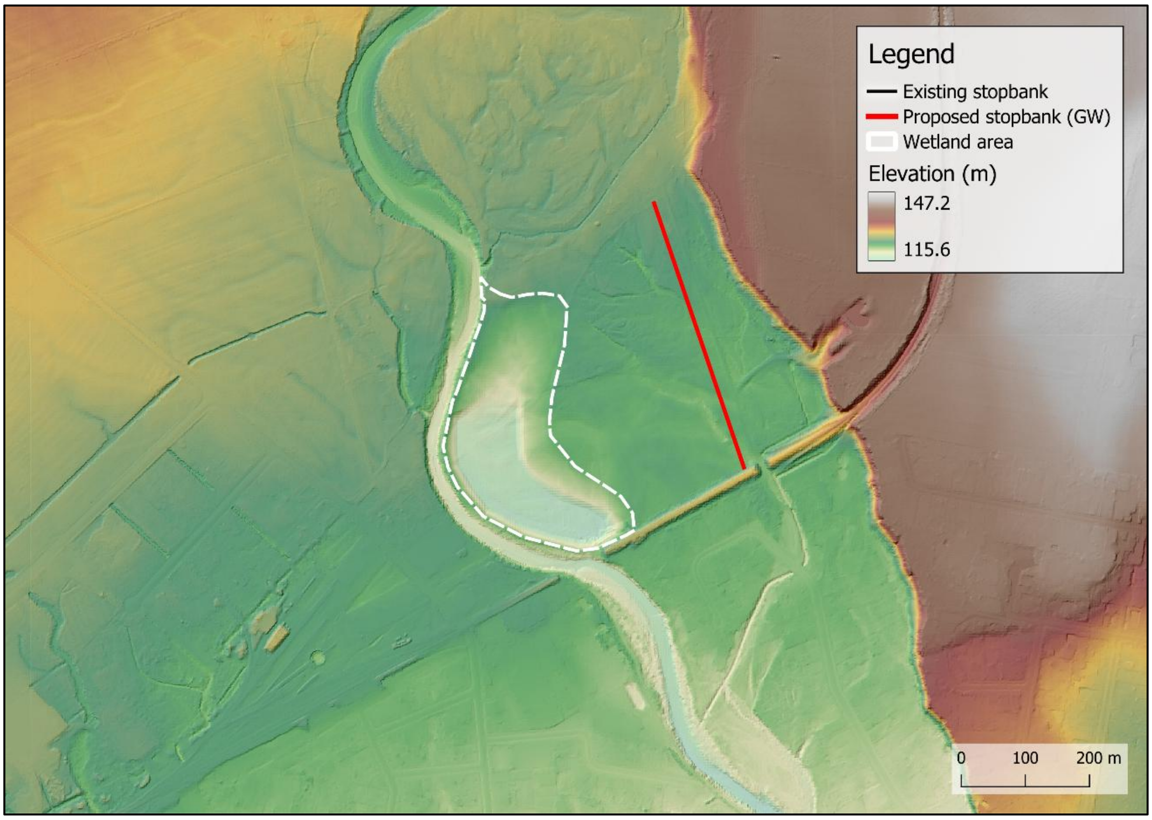

Figure 3-2: Option 1A (without an inlet to Mahunga wetland)

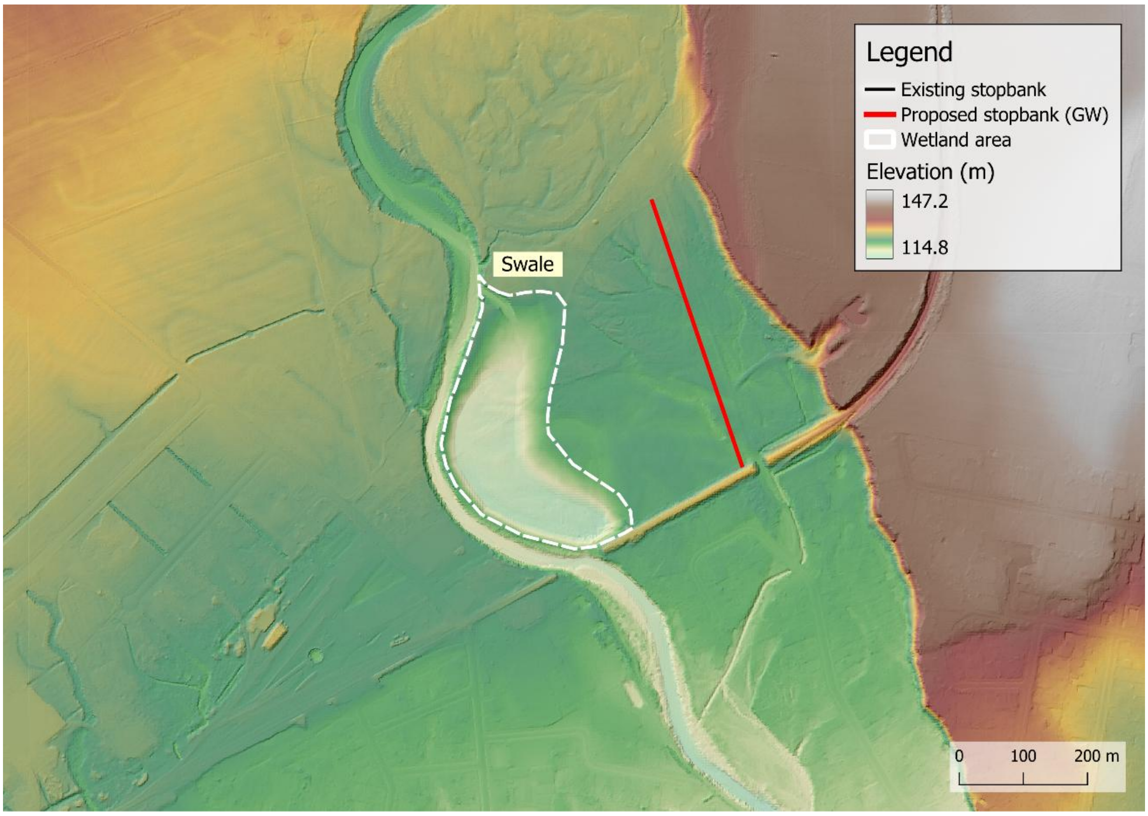

Figure 3-3: Option 1B (with inlet to Mahunga wetland)

The depth difference maps between the base scenario and Options 1A and 1B for a 1% AEP RCP6.0 flow event are presented in Figure 3-4 and Figure 3-5.The results demonstrate the following:

- Both Option 1A and 1B decrease the flood extent downstream of the railway line along Oxford St due to the proposed stopbank at Mahunga Dr.
- Both options decrease peak water levels upstream of the wetland and behind the proposed bank at Mahunga Dr. For Option 1A this reduction is in the order of 0.2-0.8 m. For option 1B this reduction is slightly greater.
- There is a significant decrease in water levels for Option 1B (greater than 0.5 m decrease) in the area of the inlet swale compared to Option 1A (without the inlet).
- An increase in peak water levels of approximately 0.3-0.5 m immediately upstream of the railway bridge; this is greater in Option 1B due to the inlet allowing more water to be stored.

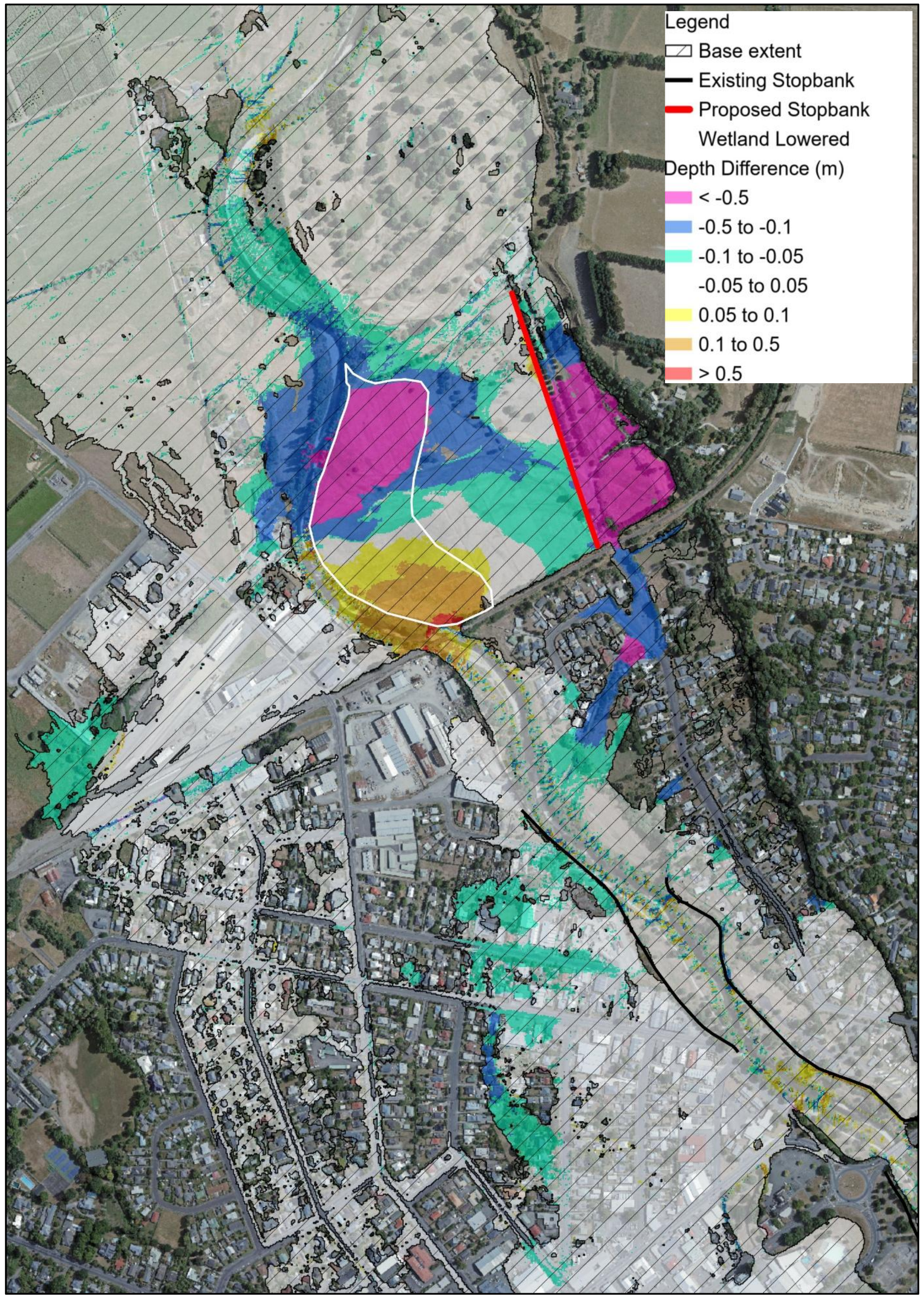

Figure 3-4: Option 1A depth difference

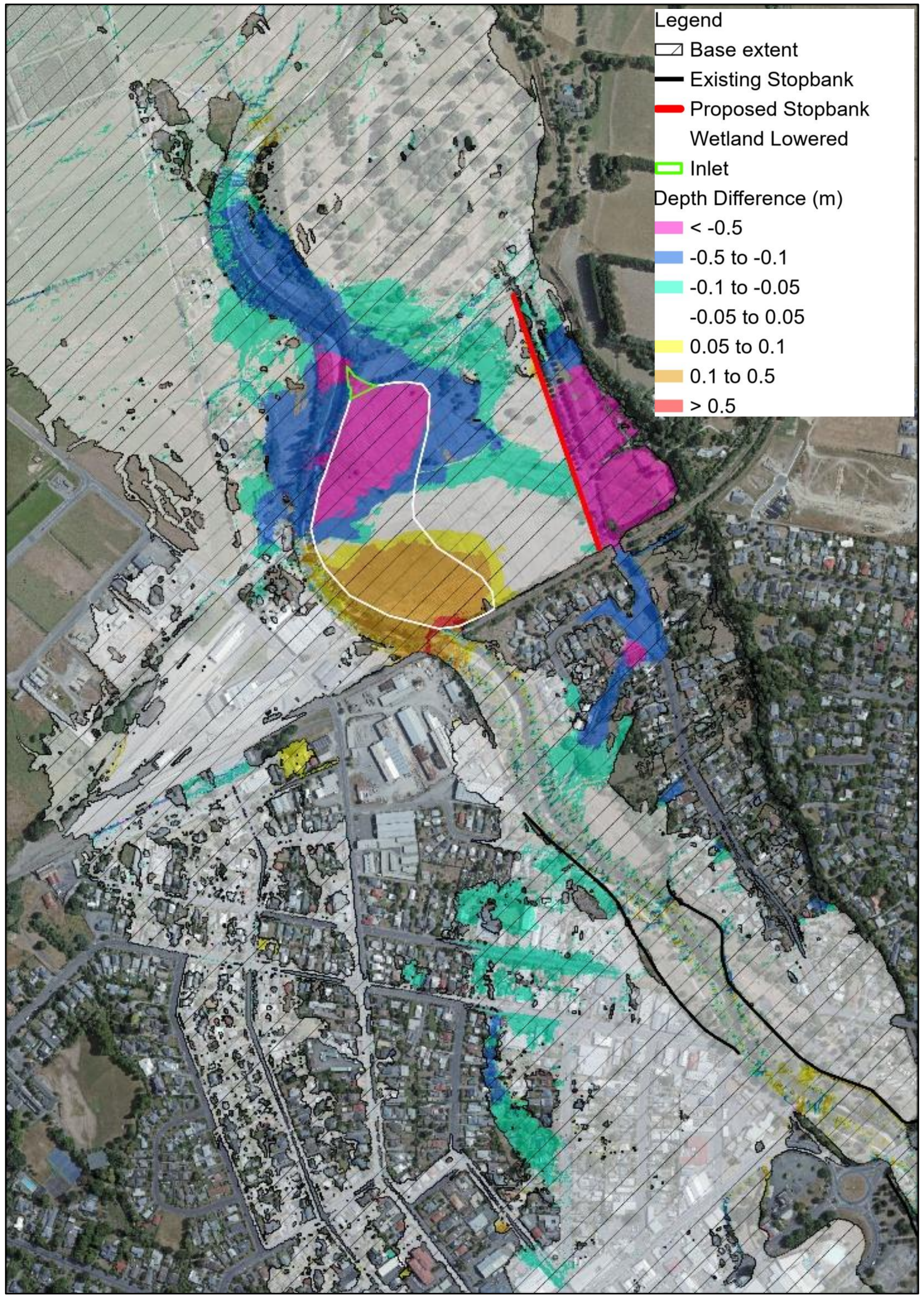

Figure 3-5: Option 1B depth difference

3.1.2. INDIVIDUAL OPTION 2 *

Individual Option 2 considers diverting inland flood waters into the Waipoua River by cutting a 20 m wide and 2 m deep swale east from Akura Rd (Figure 3-6).

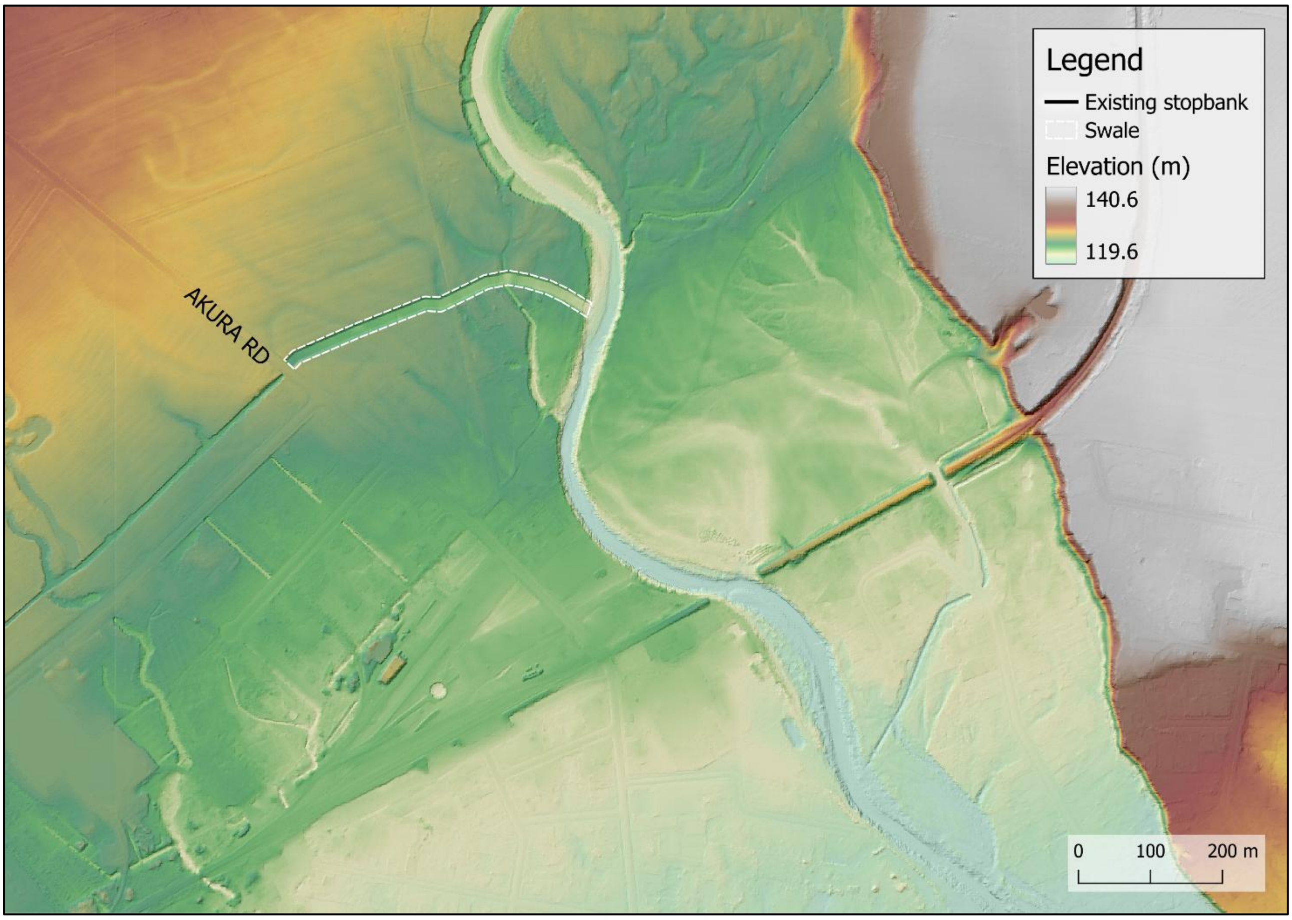

Figure 3-6: Option 2 with swale at Akura

The depth difference map between the base scenario and Option 2 for a 1% AEP RCP6.0 flow event is presented in Figure 3-7 and demonstrates:

- A significant reduction in the flood extent and depths downstream of the railway and on the true right of the river compared to the base scenario.
- A decrease in peak water levels immediately upstream and downstream of the swale in the order of 0.1-0.5 m.

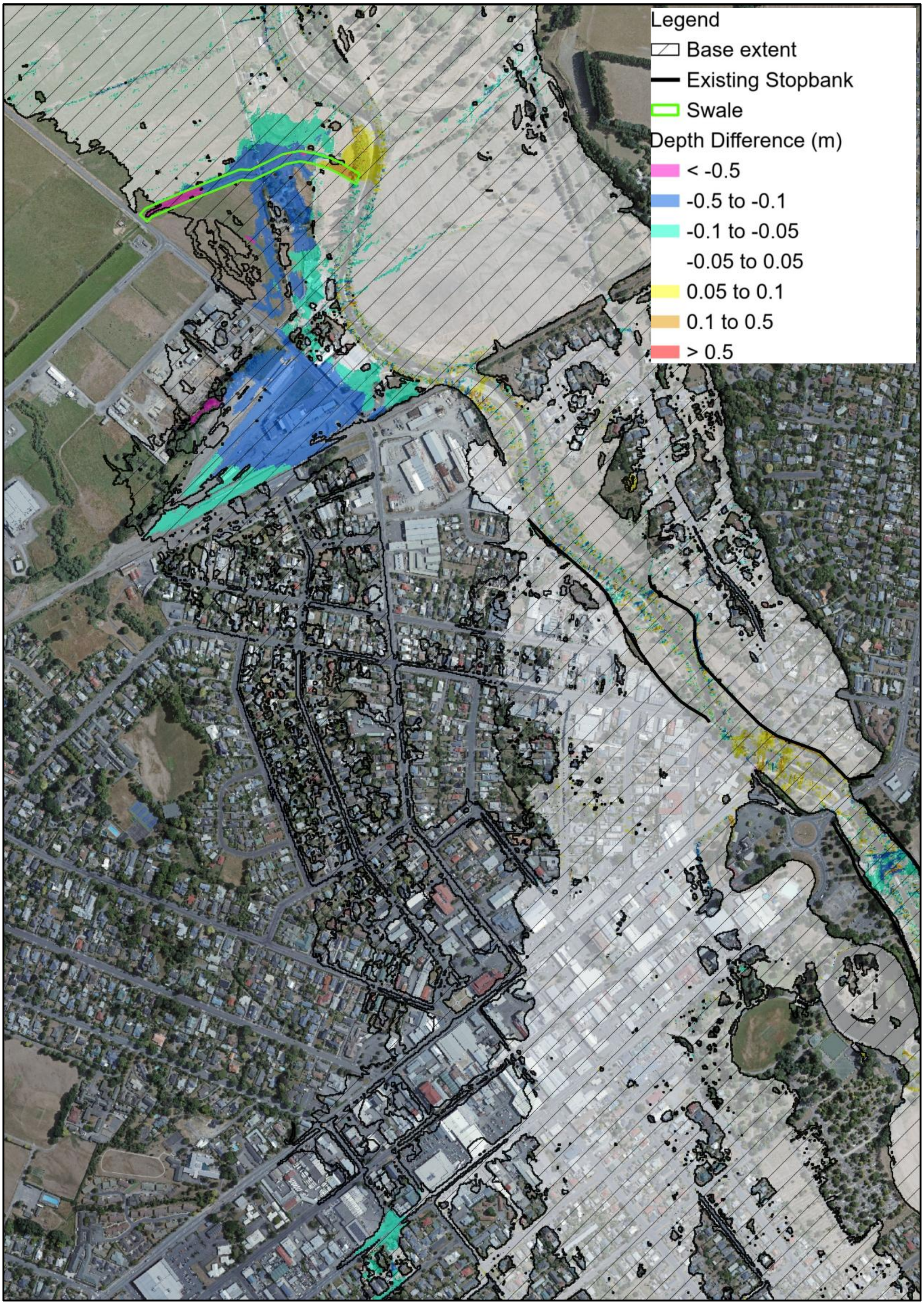

Figure 3-7: Option 2 depth difference.

3.1.3. INDIVIDUAL OPTION 3

Individual option 3 involves lowering the berm by 1 m on the left bank between the railway bridge and the southern end of Oxford Street Figure 3-8). We note that the first iteration of lowering the berm by 0.5 m did not result in any significant change in peak water levels.

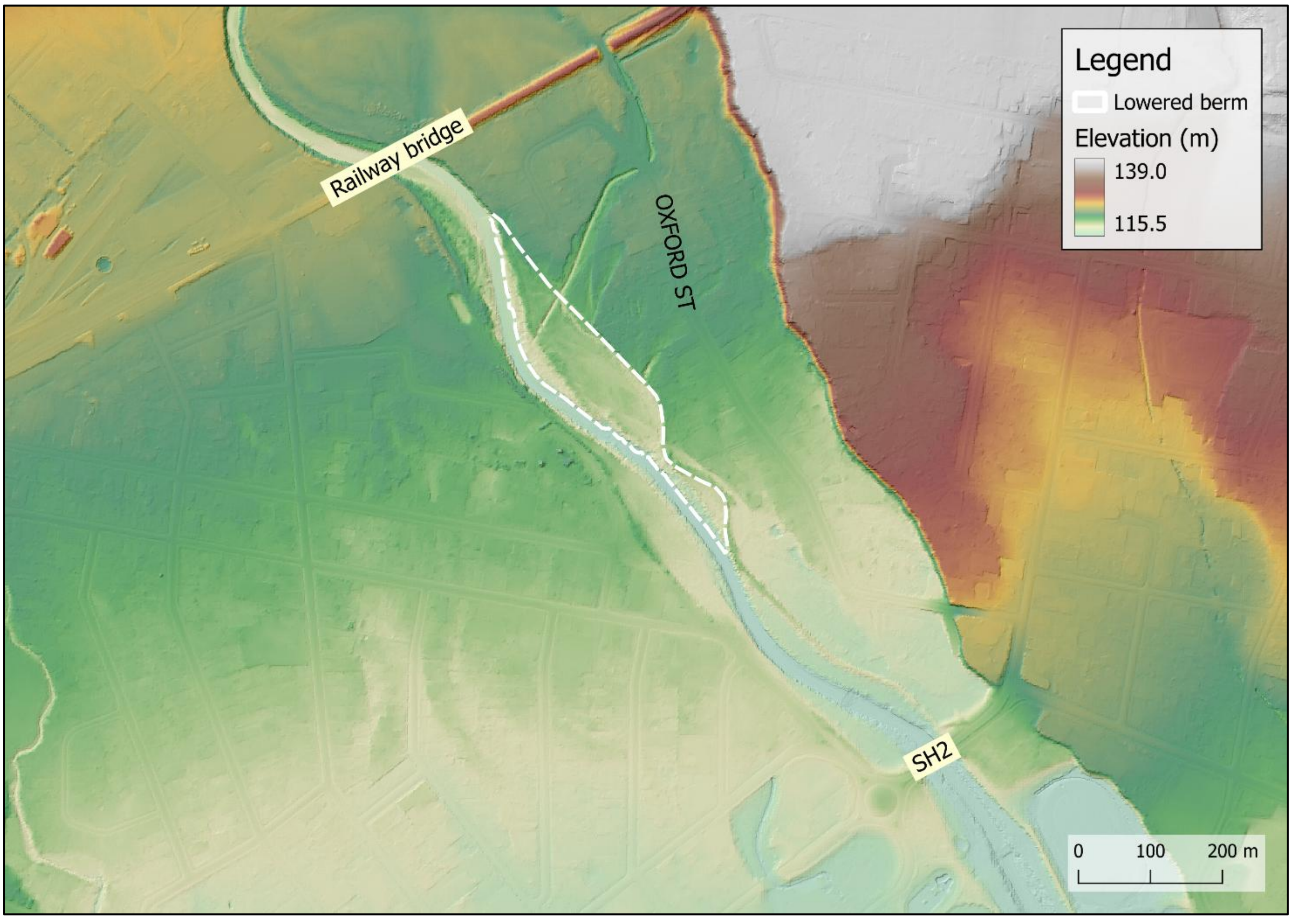

Figure 3-8: Option 3

The depth difference map between the base scenario and Option 3 for a 1% AEP RCP6.0 flow event is presented in Figure 3-9 and demonstrates:

- A significant decrease in the water level in the river channel (0.2-0.9 m) immediately downstream of the railway bridge and across the Mawley Park.
- However, there is a significant increase in flood depth through the township on the true right side of the river in the order of 0.02–0.18m.
- Additionally, there is no observable change in the flood extent compared to the base scenario.

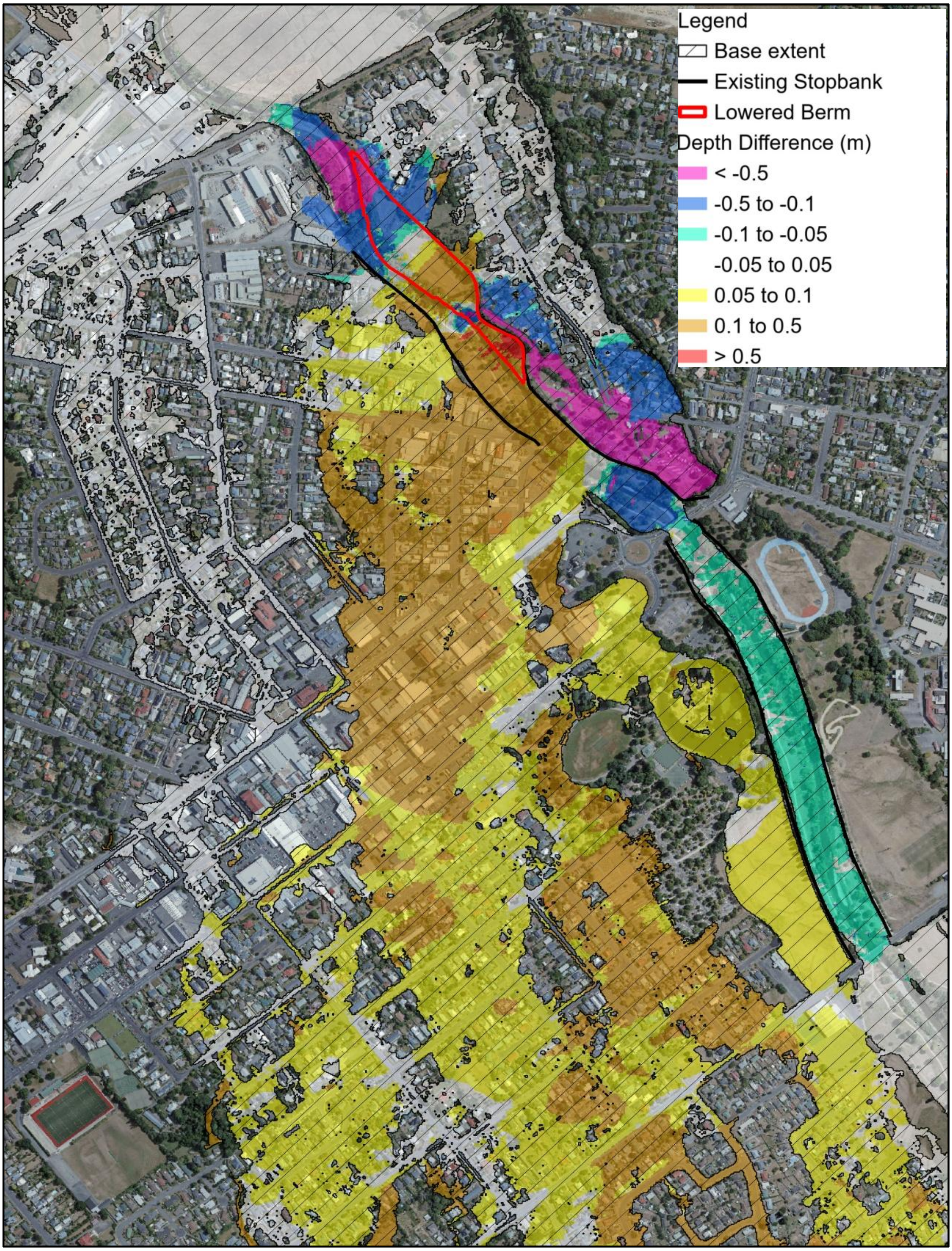

Figure 3-9: 1% AEP flow depth difference layer

3.1.4. INDIVIDUAL OPTION 4

Individual Option 4 considers raising the existing Mawley Park stopbank and extending it approximately 330 m upstream. The stopbank is set up in the model as a 'glass-wall' for maximum possible impact.

The depth difference map between the base scenario and Option 4 for a 1% AEP RCP6.0 flow event is presented in Figure 3-10 and demonstrates:

- A significant decrease in the water level at Mawley Park and upstream of the SH2 bridge in the order of 0.2–1.3 m.
- However, there is a significant increase in water levels through Masterton on the true right side of the channel in the order of 0.05-0.25 m and therefore this option is not recommended in isolation.

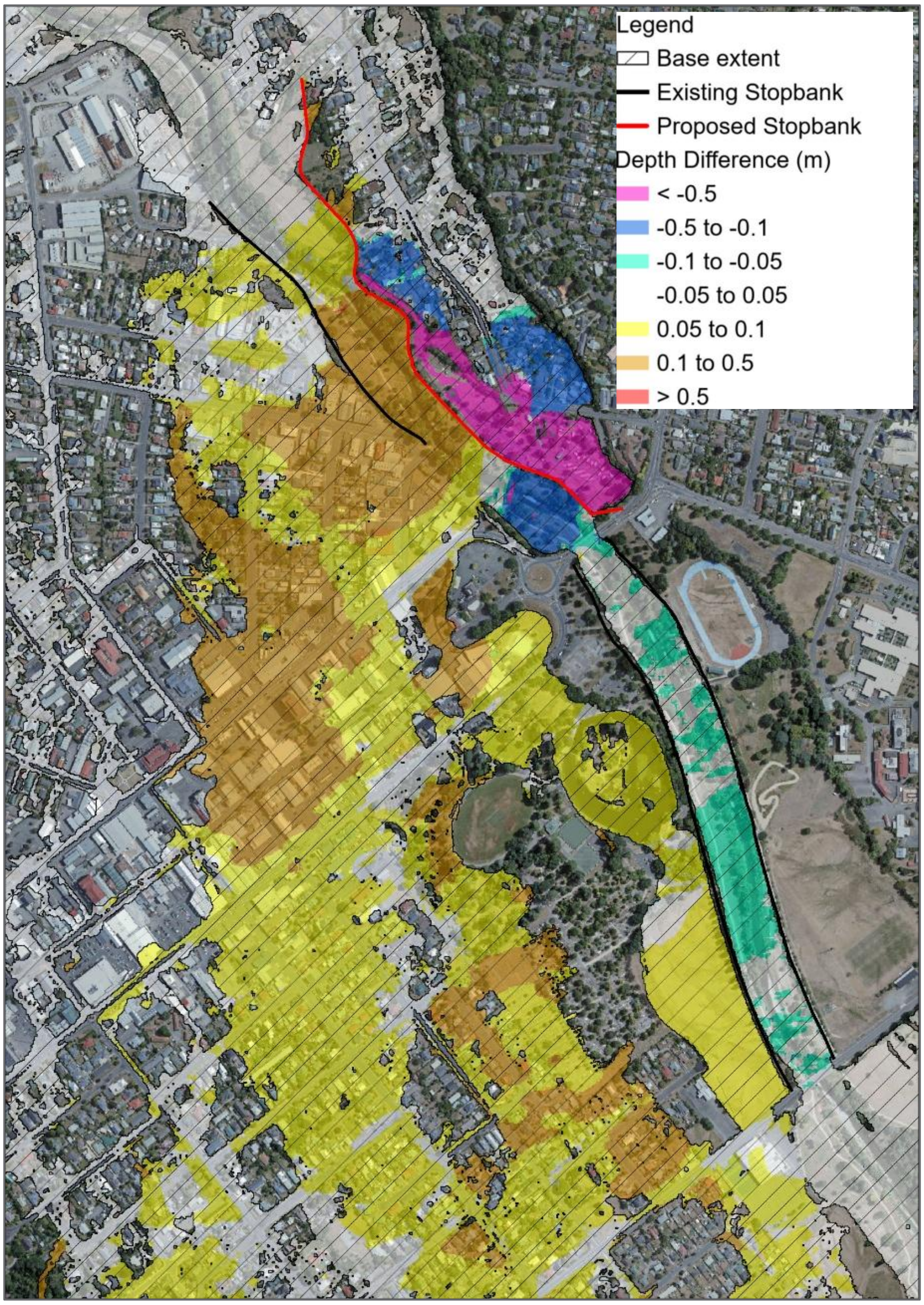

Figure 3-10: Option 4 depth difference map.

3.1.5. INDIVIDUAL OPTION 5 *

Individual option 5 investigates the impact of upgrading the existing stopbank along the true right bank between the railway bridge and the SH2 bridge (Figure 3-11). The proposed stopbank upgrades/floodwall is set up in the model as a 'glass-wall' (GW) for maximum possible impact.

The depth difference map between the base scenario and Option 5 for a 1% AEP RCP6.0 flow event is presented in Figure 3-11 and demonstrates:

- A significant reduction in the flood extent on the true right of the river compared to the base scenario.
- However, there is also an increase in water levels by up to 0.5 m within the Mawley Holiday Park and the channel adjacent to the proposed raised bank.

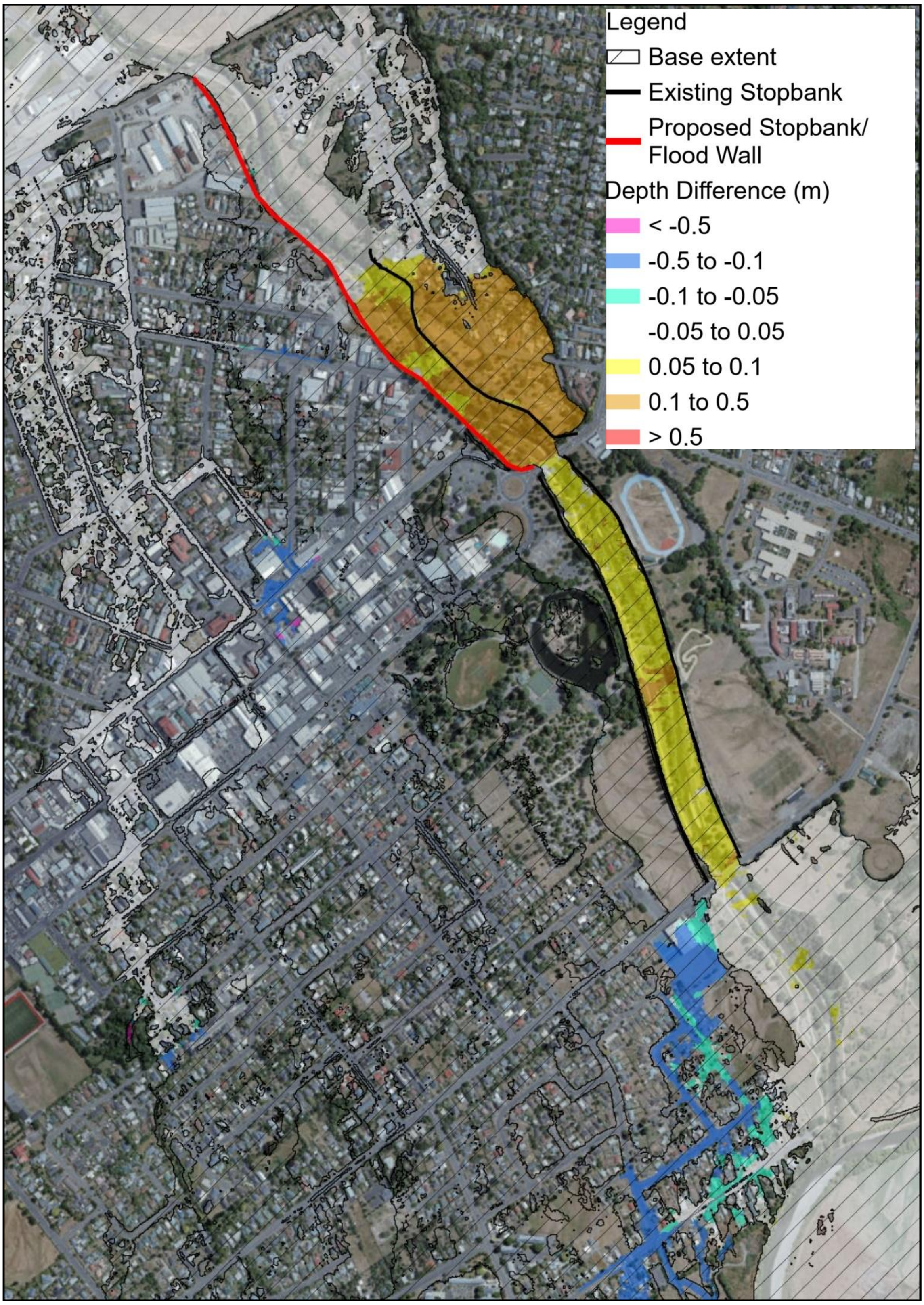

Figure 3-11: Option 5 depth difference map.

3.1.6. INDIVIDUAL OPTION 6

Option 6 investigates lowering the stopbank downstream of the SH2 bridge by 1 m. The depth difference map between the base scenario and Option 3 for a 1% AEP RCP6.0 flow event is presented in Figure 3-12 and demonstrates minimal impact on flood extent/levels, except at the SH2 bridge, where water levels reduce by approximately 0.1 m.

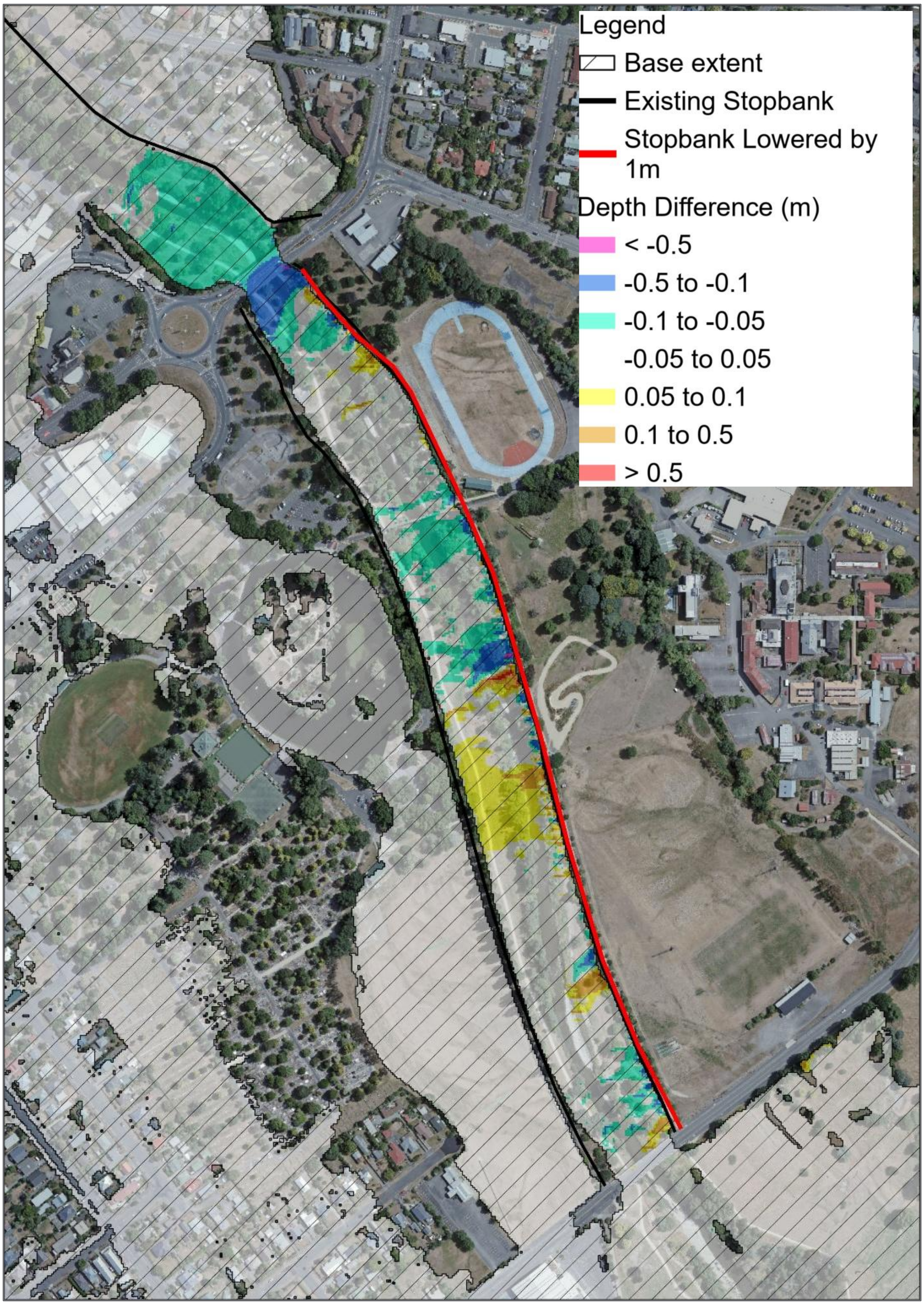

Figure 3-12: Option 6 depth difference map.

3.1.7. INDIVIDUAL OPTION 7 *

Individual Option 7 investigates a 'room for the river' approach by moving a section of the true left bank, between the SH2 bridge and Colombo Rd, inland towards the river terrace edge. It is unlikely that a new bank would necessarily be needed, and simply lining the existing terrace edge may be appropriate. Figure 3-14 provides a colourised presentation of the model DEM with the stopbank removed, which can be compared to the base scenario (Figure 3-13).

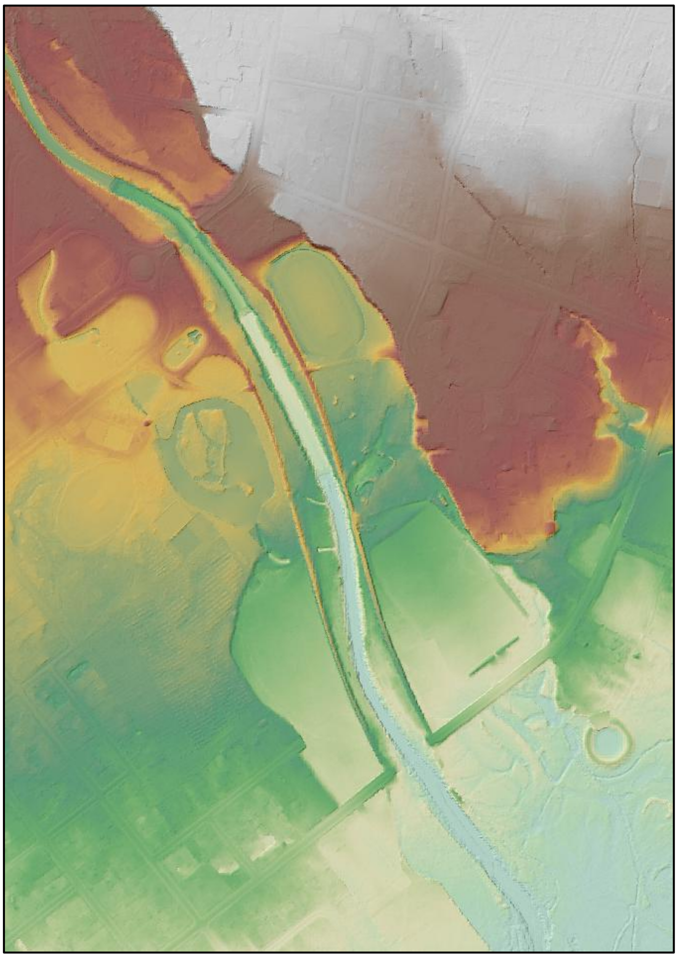

Figure 3-13: Base scenario

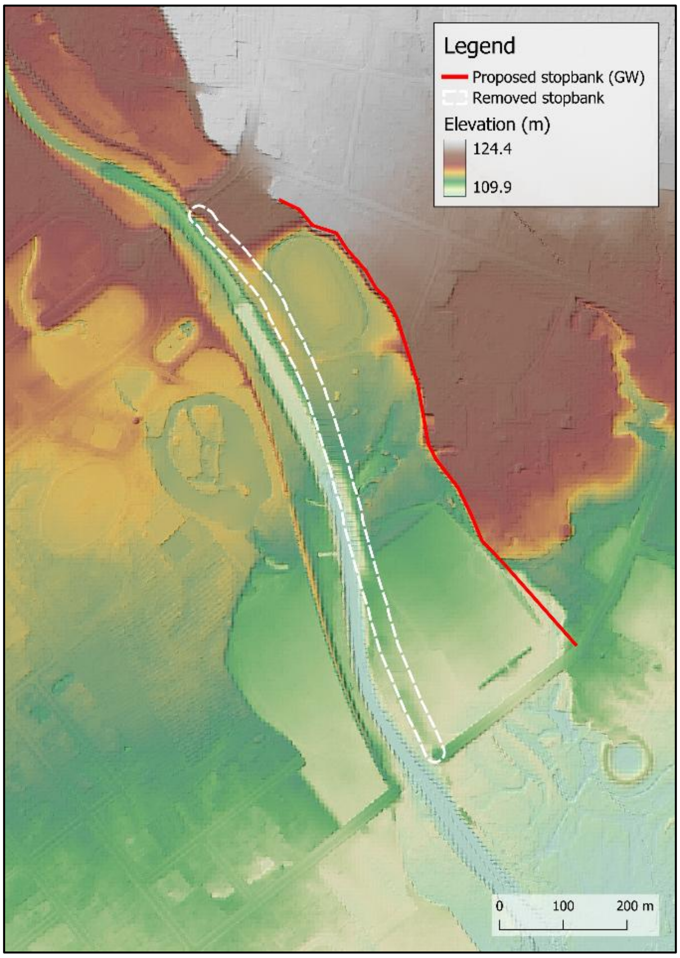

Figure 3-14: Option 7

The depth difference and depth maps for Option 7 and a 1% AEP RCP6.0 flow event are presented in Figure 3-15 and Figure 3-16, and demonstrate:

- Predictably, land to the left of the Waipoua River is inundated with water; up to 0.6 m in the athletics track, up to 1.8 m in the BMX track, and up to 0.5 m adjacent to Colombo Rd.
- However, there is a notable reduction in the water levels in the channel compared to the base scenario at both the SH2 and Colombo Rd bridges (up to 0.15 m at SH2 and 0.25 m at Colombo Rd).

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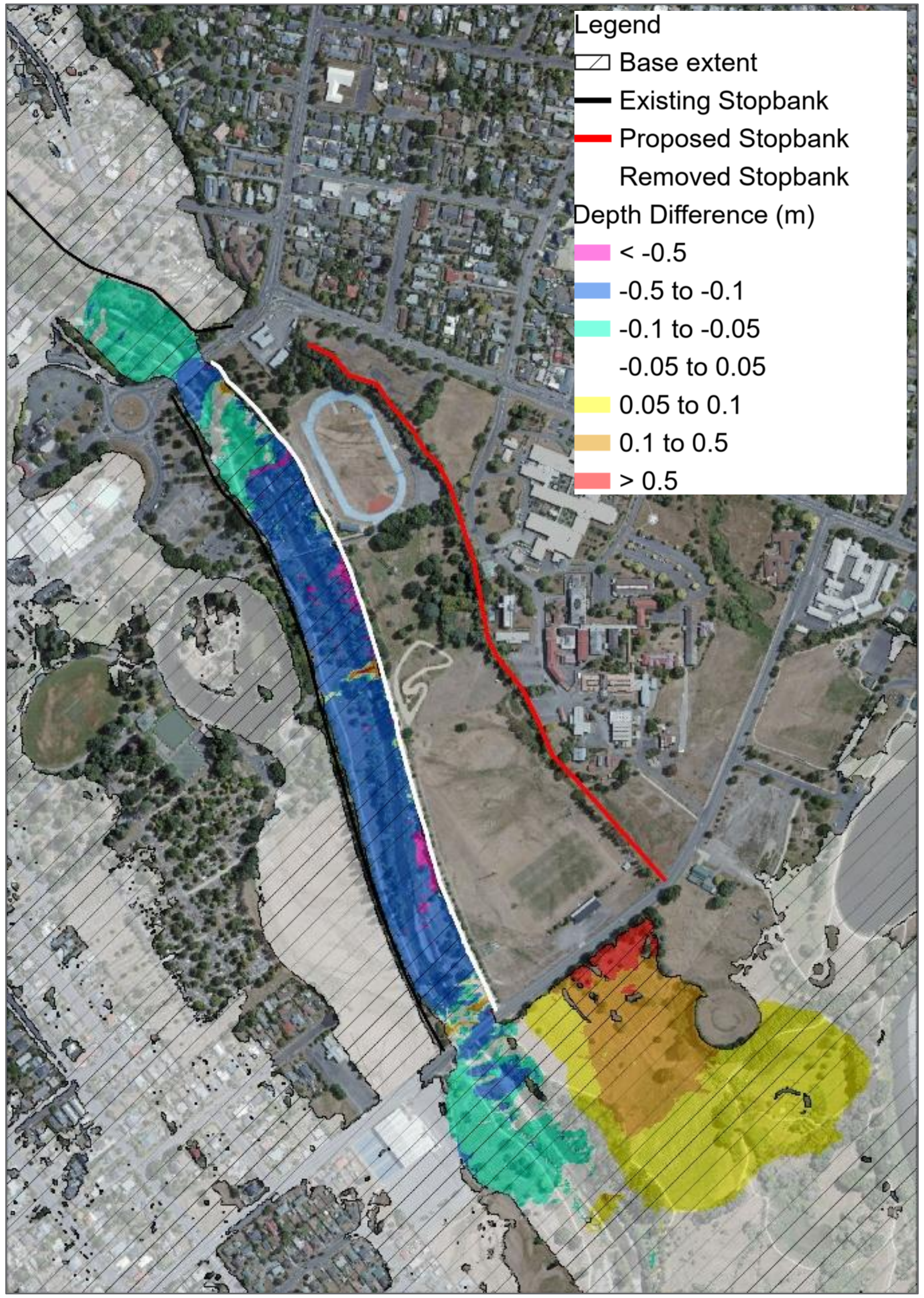

Figure 3-15: Option 7 depth difference map

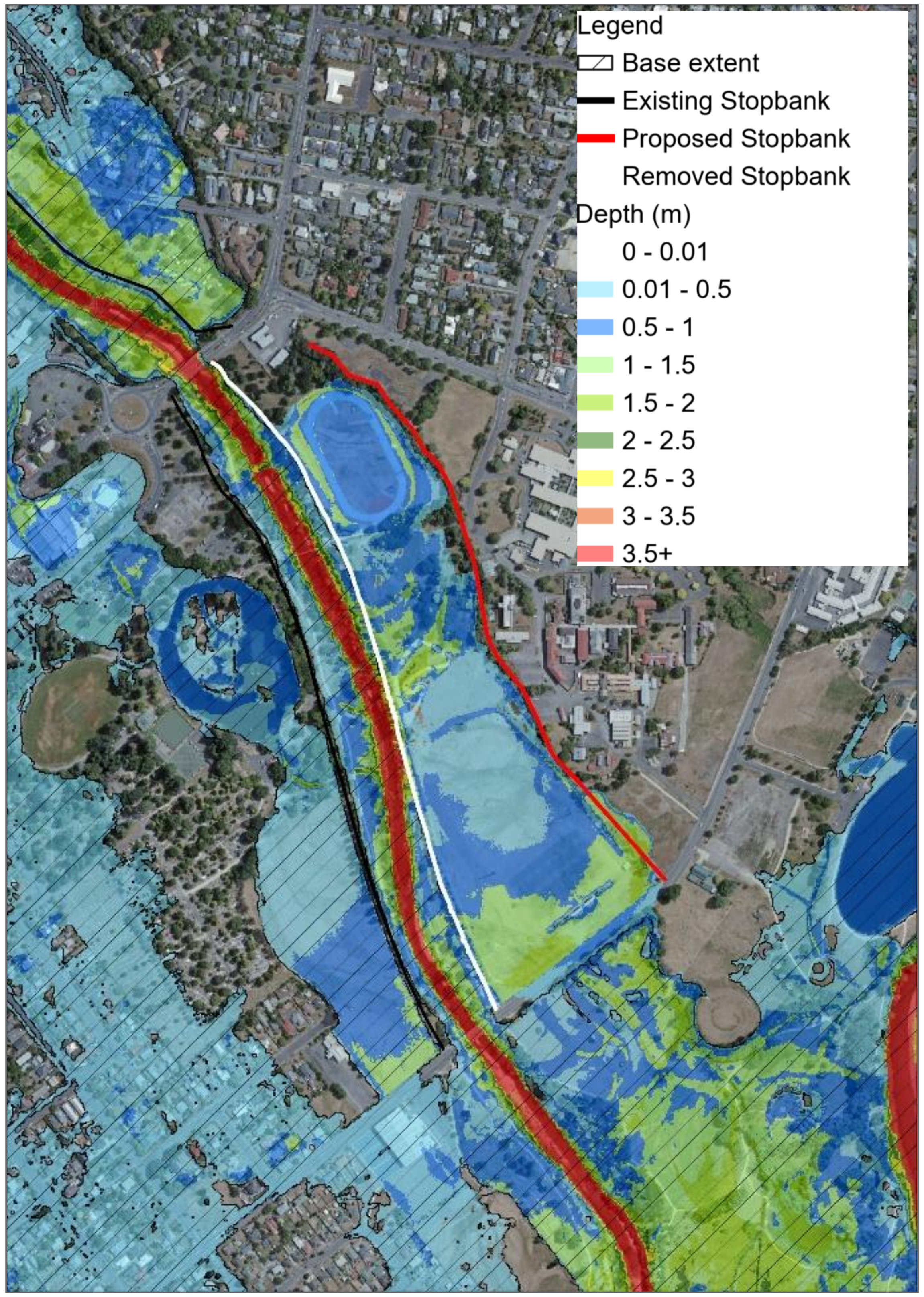

Figure 3-16: Option 7 depth map

3.1.8. INDIVIDUAL OPTION 8

Individual Option 8 investigates the impact of diverting water from Mawley Park into the sports bowl / athletics track (as an area for floodwater storage) by using a culvert (2 m x 3 m) as well as by removing a section of the true left stopbank (Figure 3-17). A stopbank is proposed at the southern end of the sports bowl, which would integrate with the existing true left stopbank.

Figure 3-17: Option 8

The depth and depth difference maps between the base scenario and Option 8 for a 1% AEP RCP6.0 flow event is presented in Figure 3-18 and Figure 3-19. Results demonstrate:

- There is a decrease in flood depths at the southern end of the Mawley Holiday Park – and at the SH2 bridge – by up to 0.15 m, However, flood depths further upstream are largely unchanged from the base scenario.
- The sports bowl experiences new inundation up to 1.0 m deep.
- There is an increase in peak water levels (approx.. 0.25 m) in the channel adjacent to the southern end of the sports bowl.

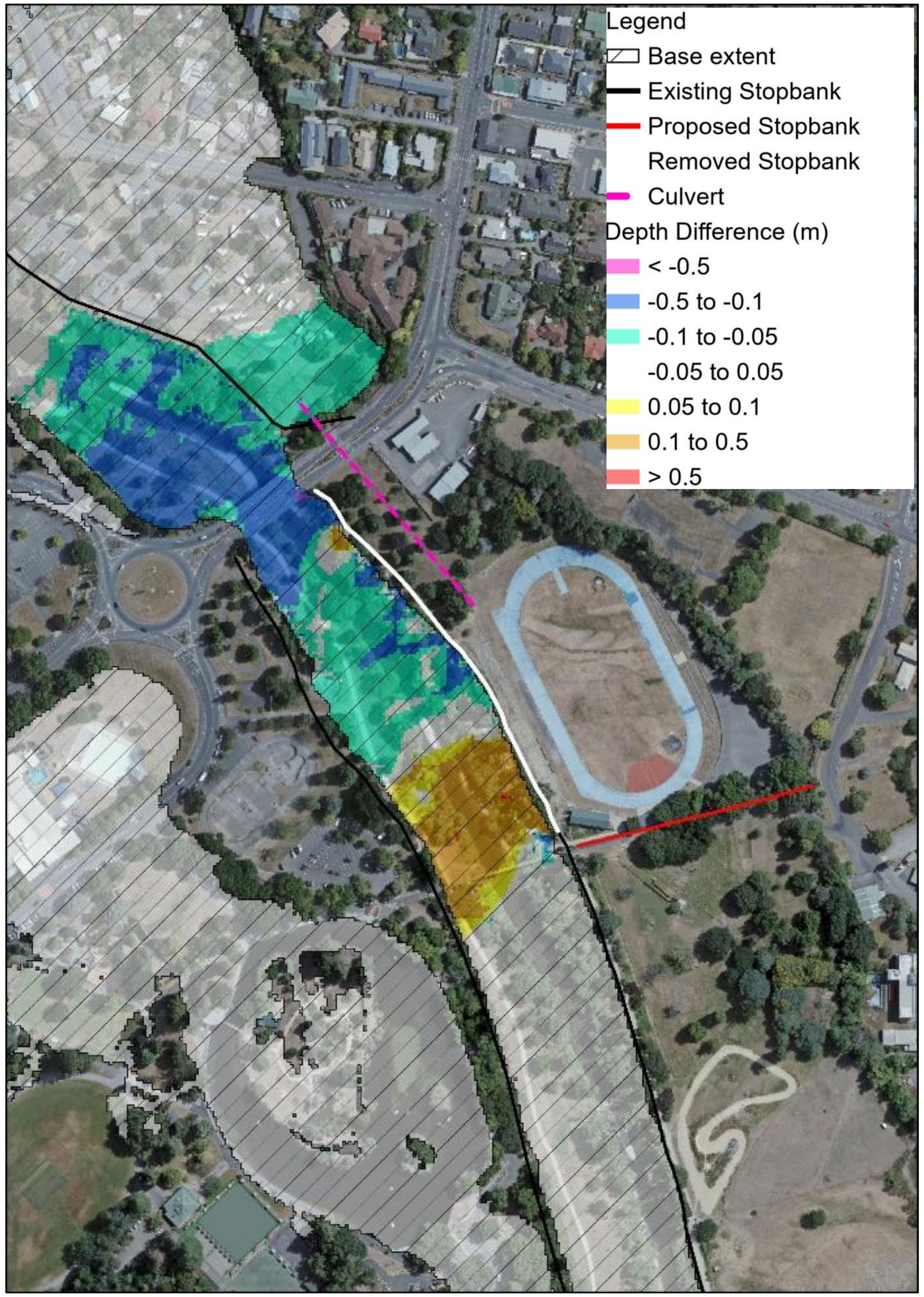

Figure 3-18: Option 8 depth difference map

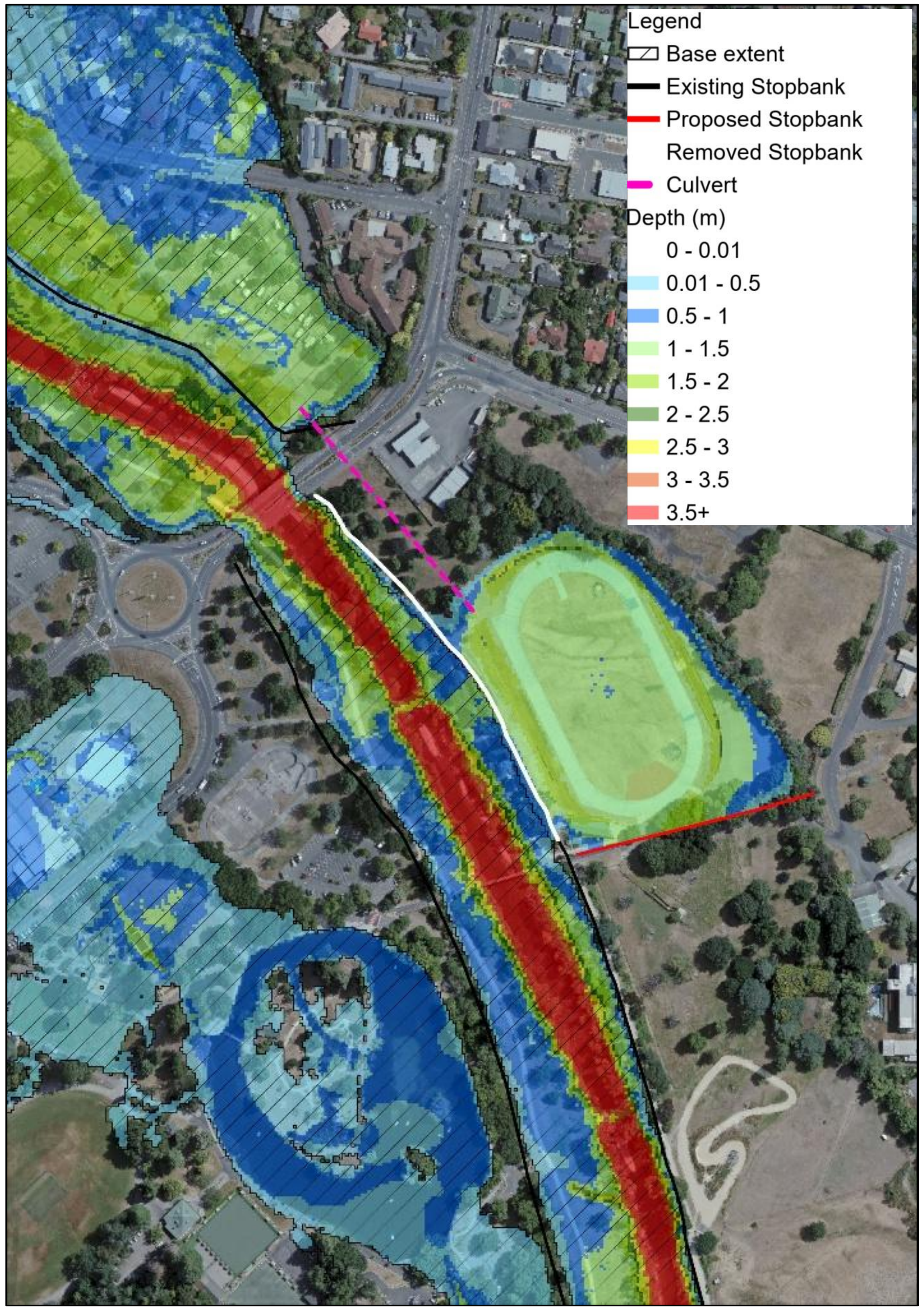

Figure 3-19: Option 8 depth map

3.1.9. INDIVIDUAL OPTION 9

Individual Option 9 investigates the impact of lowering the stopbank on the true right of the river by 1 m. The depth difference map (Figure 3-20) shows that although this option reduces water levels at the SH2 bridge, it also increases flood levels at the Colombo Rd bridge by 0.16-0.2 m.

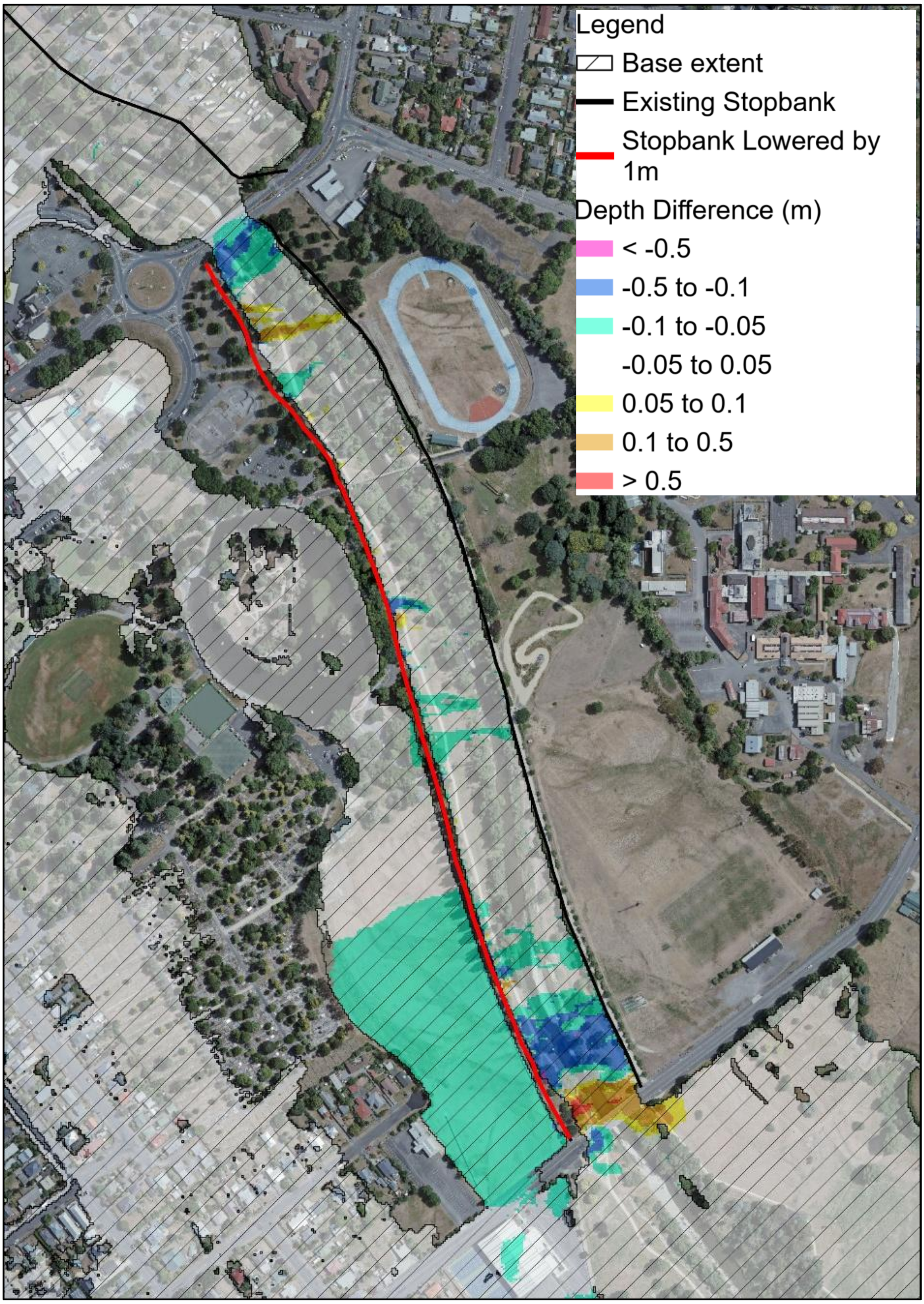

Figure 3-20: Option 9 depth difference map.

3.1.10. INDIVIDUAL OPTION 10 AND 11

Option 10 and 11 combines the two options of flooding QEII park as well as the sports fields to the south, between SH2 and Colombo Road. In the model set up, a section of the true right bank next to QE II was removed, with an outlet swale at the southern end of the fields close to the Colombo Rd bridge (Figure 3-21).

Figure 3-21: Individual Option 10 and 11

The depth difference map between the base scenario and Option 10&11 for a 1% AEP RCP6.0 flow event is presented in Figure 3-22 and demonstrates:

- A notable decrease in flood depth at the southern end of the sports fields and near Cameron Cr (south of Colombo Rd) in the order of 0.05-0.15 m.
- An increase in water levels in the channel at the Colombo Rd bridge by up to 0.2 m due to the outlet swale.

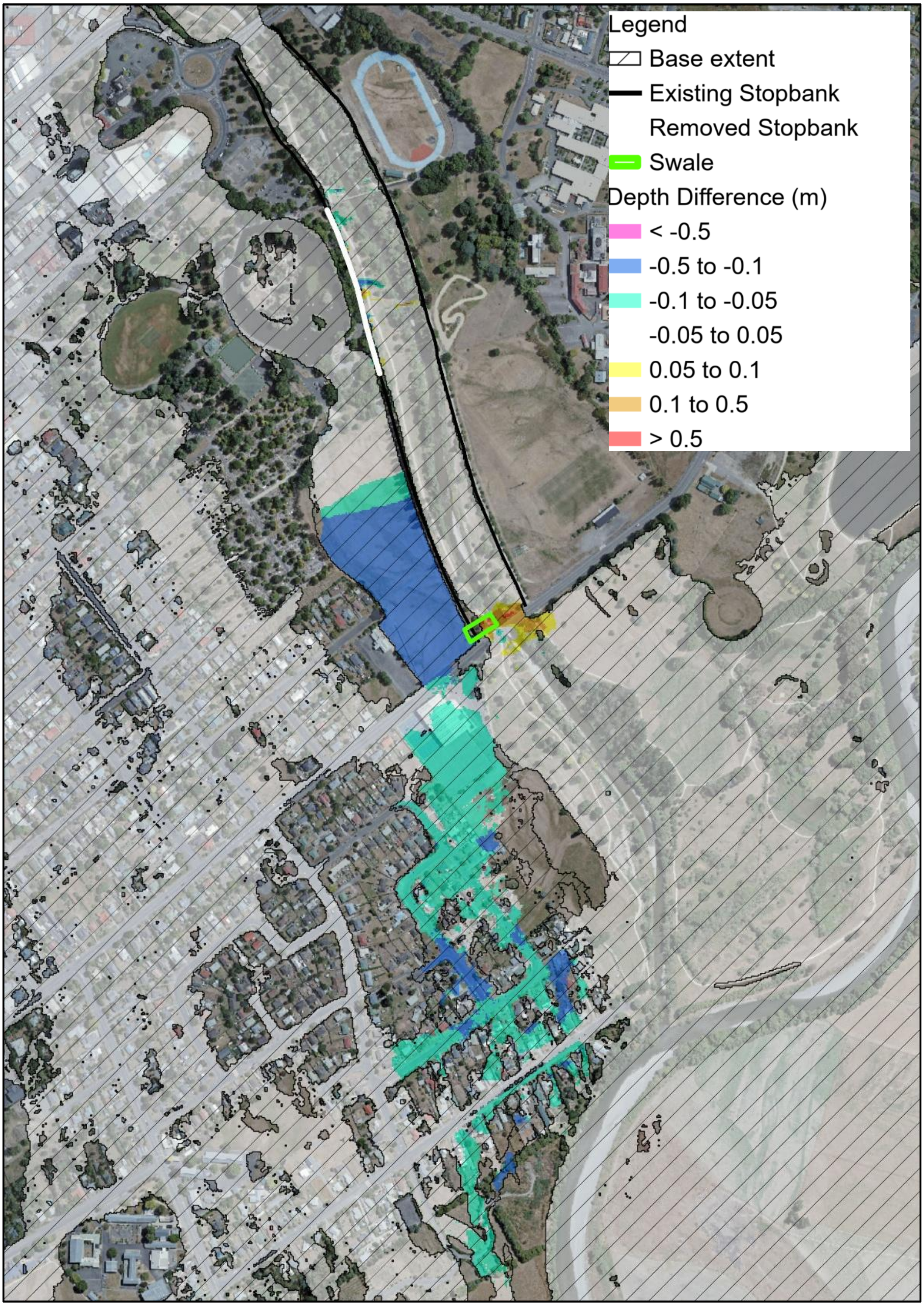

Figure 3-22: Option 10 depth difference map.

3.1.11. INDIVIDUAL OPTION 12

Individual Option 12 utilises the natural storage capacity of wetlands by allowing water into the wetland on the true right of Ruamahanga River via a culvert under Colombo Rd (Figure 3-23).

Figure 3-23: Option 12

For a 1% AEP RCP6.0 flow event, water does not spill over the true left bank upstream of Colombo Rd. Therefore, there is no water for the culvert to divert and results from this model are unchanged from the base scenario.

3.1.12. INDIVIDUAL OPTION 13 *

Individual Option 13 investigates constructing an additional stopbank along the true right bank of Waipoua River to protect Cameron Crescent and River Road (Figure 3-24).

Figure 3-24: Option 13

The depth difference map between the base scenario and Option 13 for a 1% AEP RCP6.0 flow event is presented in Figure 3-25 and demonstrates:

- While flooding still reaches the residential area from upstream, the extent of flooding is greatly reduced at Cameron Cr compared to the base scenario.
- Where flooding does occur, there is a notable decrease in water levels compared to the base scenario at River Rd and Cameron Cr in the order of 0.05-0.15 m.
- This option performs better than Option 10 and 11, which also improves flood levels near in the residential area around Cameron Cr, but to a lesser extent and depth.

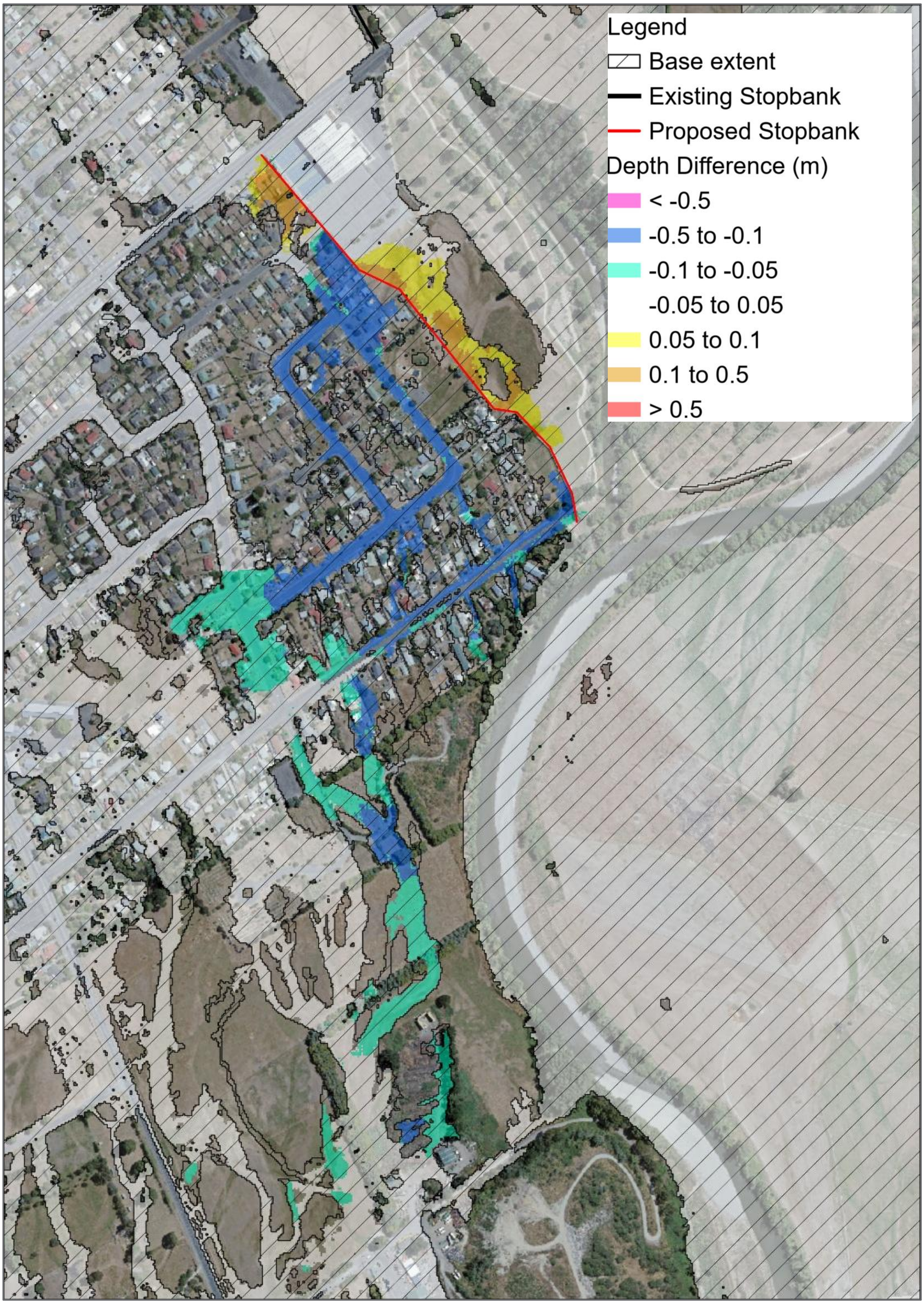

Figure 3-25: Option 13 depth difference map

3.1.13. INDIVIDUAL OPTION 15 *

Individual Option 15 proposes a new stopbank on the right bank immediately upstream of the railway (Figure 3-26) to prevent water spilling over the railway and into the west side of Masterton.

The depth difference map between the base scenario and Option 13 for a 1% AEP RCP6.0 flow event is presented in Figure 3-26 and demonstrates:

- A significant reduction in flood extent in west Masterton compared to the base scenario.
- An increase in flood depth on the river side of the proposed bank in the order of 0.1-0.5 m.

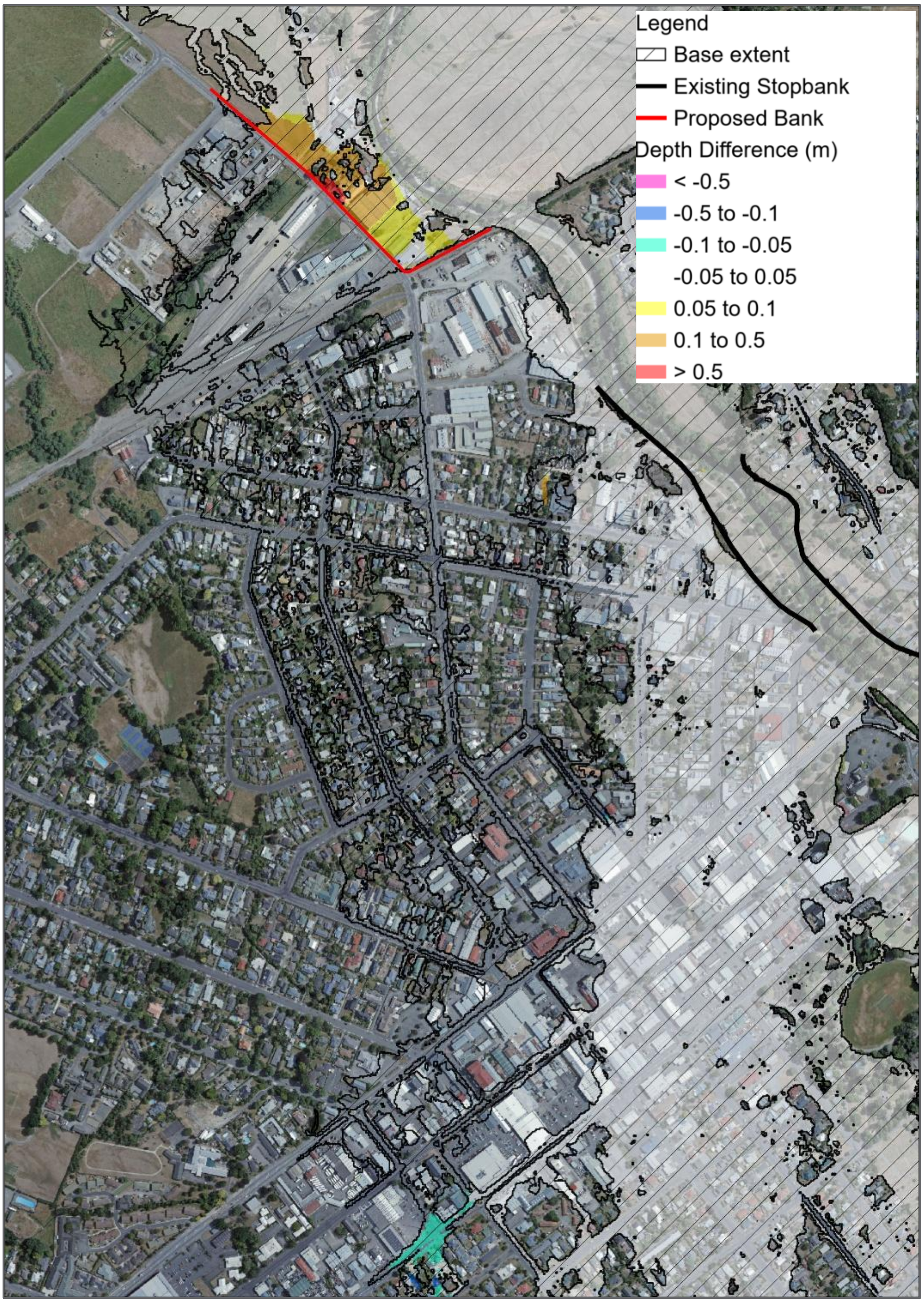

Figure 3-26: Option 15 depth difference map.

3.1.14. INDIVIDUAL OPTIONS 16 AND 21 *

Individual Options 16 and 21, respectively, investigate the effect of cutting a swale into the true left berm near Oxford St to divert water from the main channel and increase the channel capacity in this reach; the swale in Option 16 is presented in Figure 3-27. The swale in Individual Option 21 is wider with a slight change in alignment (Figure 3-28).

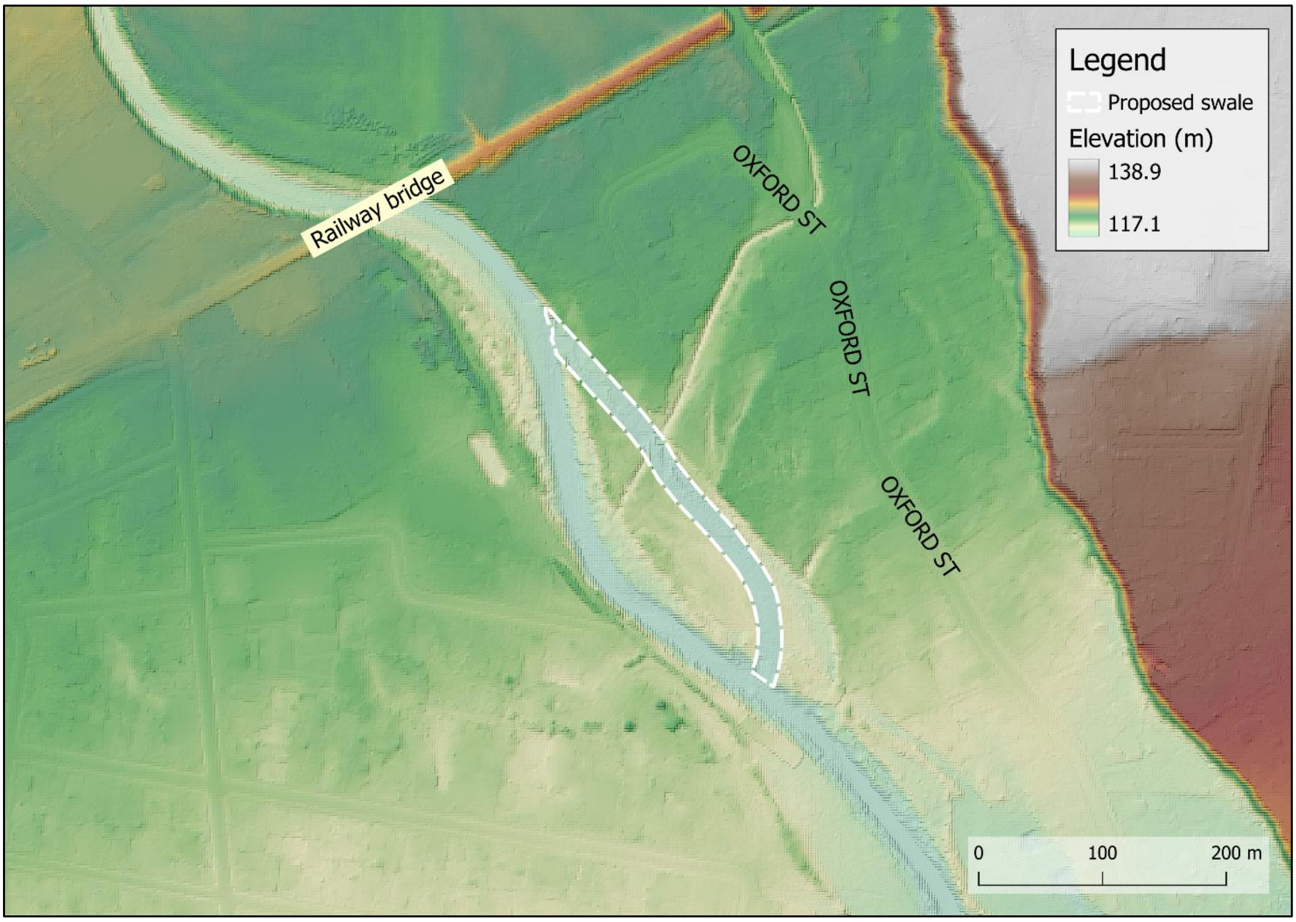

Figure 3-27: Option 16 swale location near Oxford St

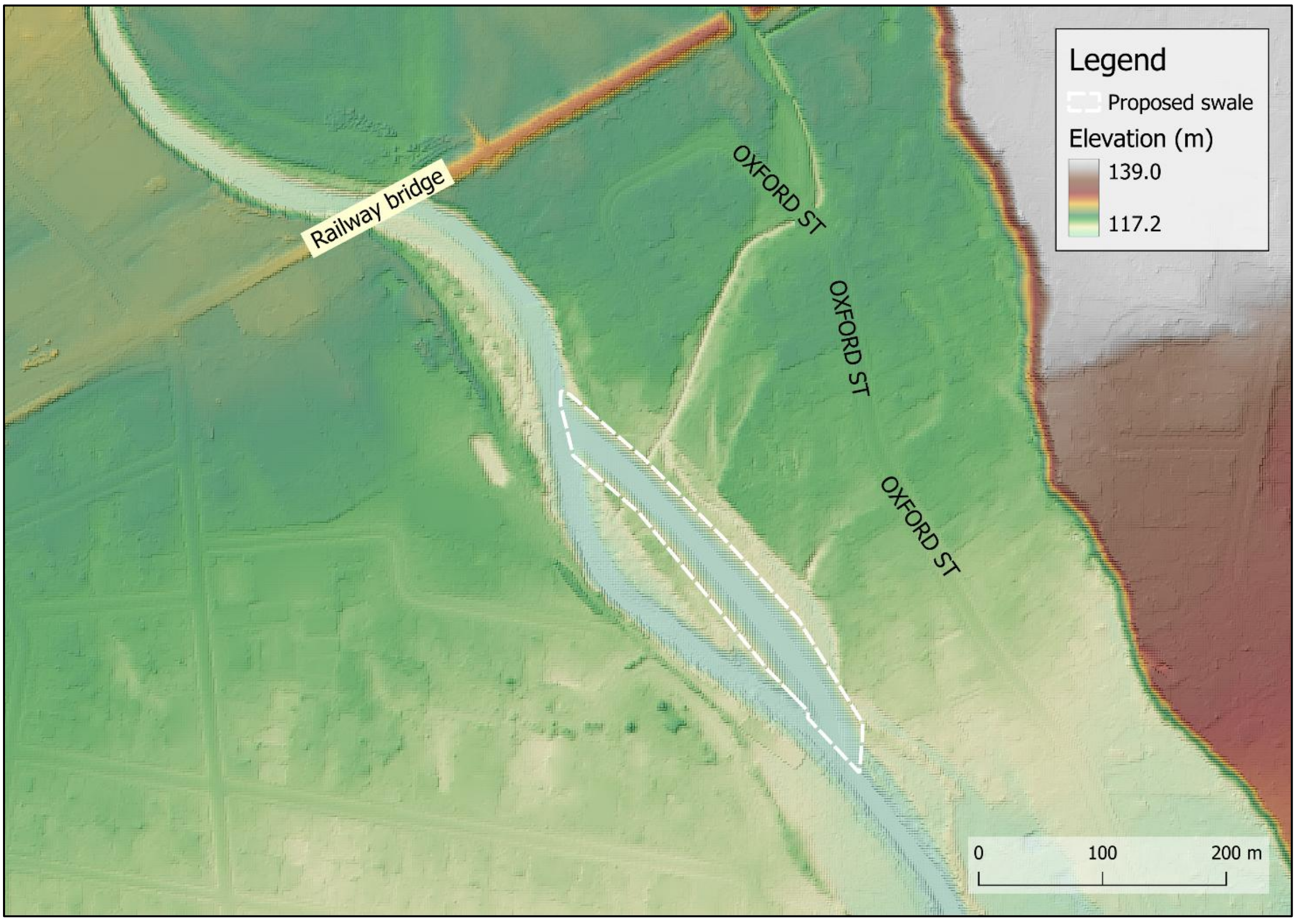

Figure 3-28: Option 21 swale location near Oxford St

The depth difference map between the base scenario and Options 16 and 21 for a 1% AEP RCP6.0 flow event is presented in Figure 3-29 and Figure 3-30 and demonstrate:

- In Option 16, despite the reduction in water levels immediately upstream of the swale inlet, water levels notably increase to a significant extent on the true right of the channel through Masterton township.
- In Option 21, there is a significant decrease (>0.5 m) in flood depth within the main channel adjacent to and upstream of the swale. There is also a significant decrease in flood depth and extent in residential areas along the true left immediately adjacent to the swale by up to 0.5 m.
- In Option 21, there is a notable increase in flood levels at the outlet of the swale as well as in the northern end of Mawley Park and nearby residential properties by up to 0.1 m.

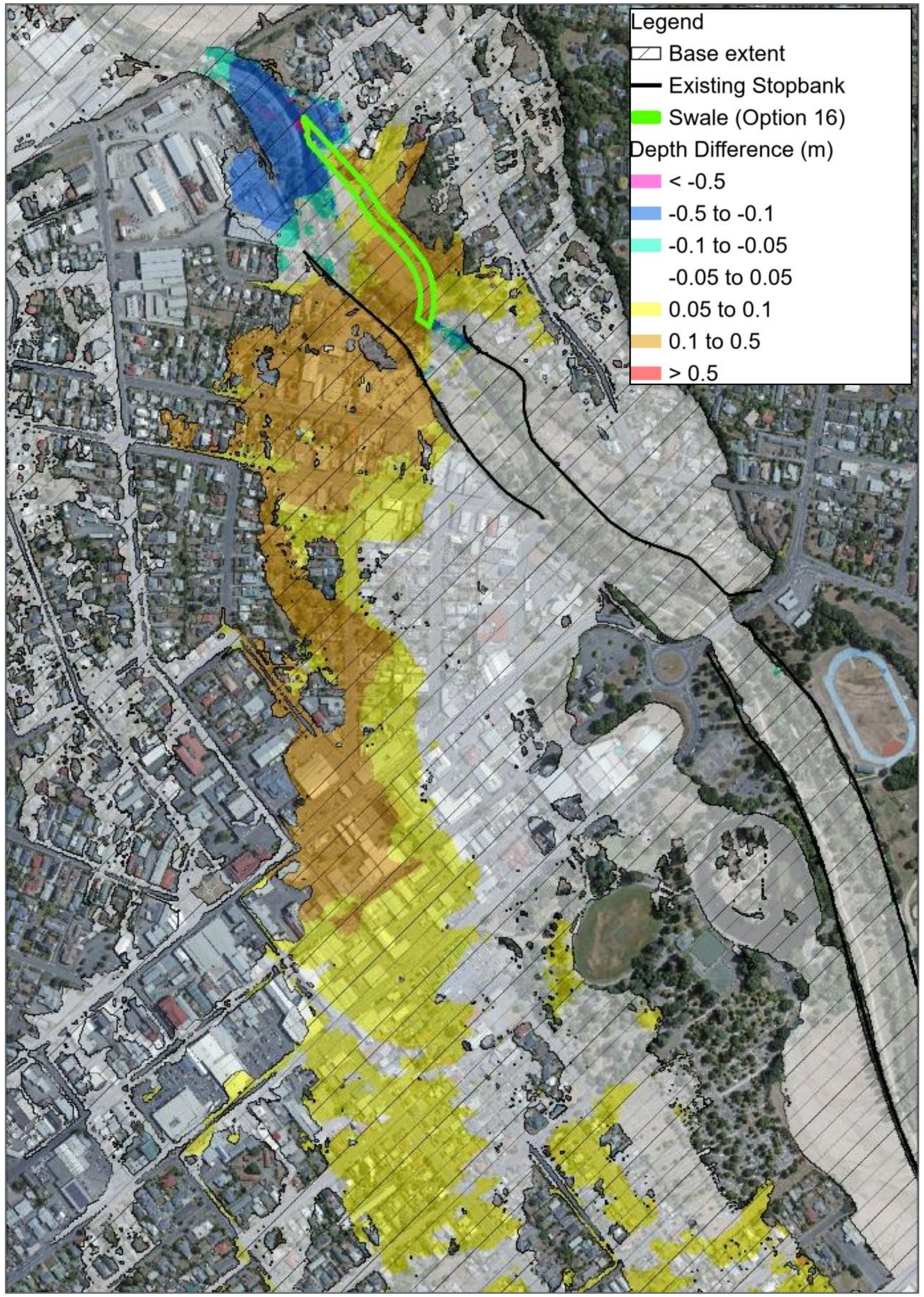

Figure 3-29: Option 16 depth difference map.

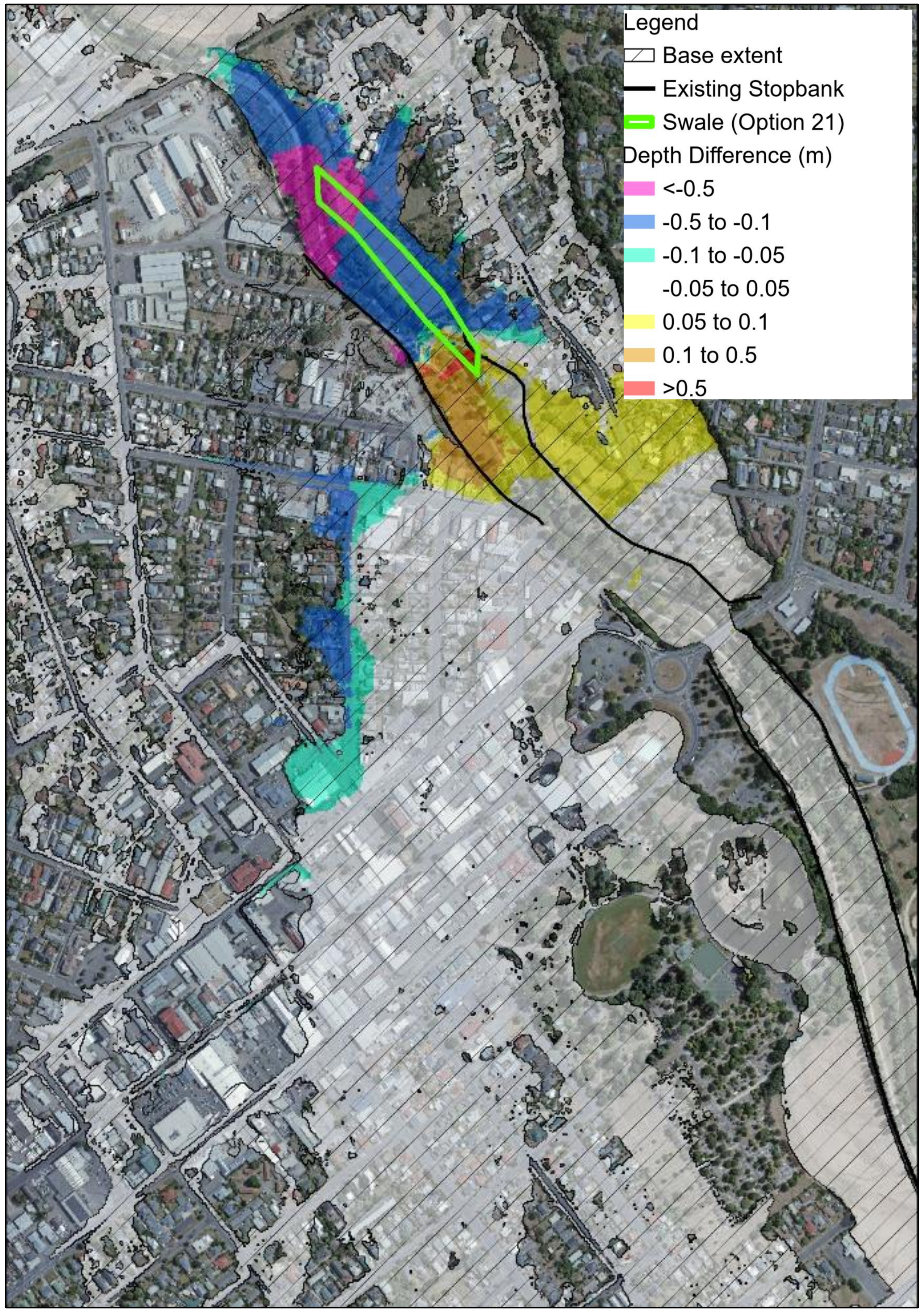

Figure 3-30: Option 21 depth difference map

3.1.15. INDIVIDUAL OPTIONS 17, 18 AND 18A *

Individual Option 17 (Figure 3-31) investigates the protection of Mawley Park by extending the left stopbank upstream. Option 18A offers a slight realignment and extension to Option 17 to keep Mawley Park protected while Option 18 leaves Mawley Park unprotected by placing the stopbank behind the Park. All three options are shown in Figure 3-32 for comparison.

The depth difference maps between the base scenario and Options 17, 18 and 18A for a 1% AEP RCP6.0 flow event are presented in Figure 3-33 to Figure 3-35. Results are summarised in Table 3-1.

Table 3-1: Summary of Individual Option 17, 18 and 18A model results compared to base scenario

	Option 17	Option 18	Option 18A
Right of Waipoua River	• A decrease in flood depth to a notable extent through the township in the order of 0.05-0.1 m.	• A notable decrease in flood depth to a significant extent through the township in the order of 0.05-0.5 m	• A minor decrease in flood depth up near Bentley St in the order of 0.05-0.1 m • An increase in flood depth behind the southern end of the existing stopbank in the order of 0.05-0.5 m.
Left of Waipoua River	• An increase in flood levels in Mawley Park in the order of 0.1-0.5 m. • Notable increase in flooding behind the stopbank (in the order of 0.1-0.5 m) due to water travelling down from Mahunga Dr being prevented from flowing back into the river channel.	• An increase in flood levels in the northern half of Mawley Park in the order of 0.1-0.5 m, due to water still entering this area via Mahunga Dr. • A notable decrease in the southern end of Mawley Park in the order of 0.1-0.5 m. • Increased flooding in the order of 0.1-0.5 m behind the proposed stopbank, ~200 m up Oxford St.	• As per previous, water travelling down Mahunga Dr is prevented from re-entering the main channel, thus significantly increasing flooding (greater than 0.5 m) behind the stopbank along Oxford St and in Mawley Park.
In channel	• A decrease in flood levels in the river channel close to the swing bridge in the order of 0.05-0.2 m. • An increase in flood levels in the river channel immediately upstream of the SH2 bridge in the order of 0.1-0.5 m.	• Similar to Option 17 except the extents of increased and decreased water levels is greater.	• A decrease in flood levels in the river channel immediately upstream and downstream of the SH2 bridge.

Figure 3-31: Option 17

Figure 3-32: Option 17, 18 and 18A

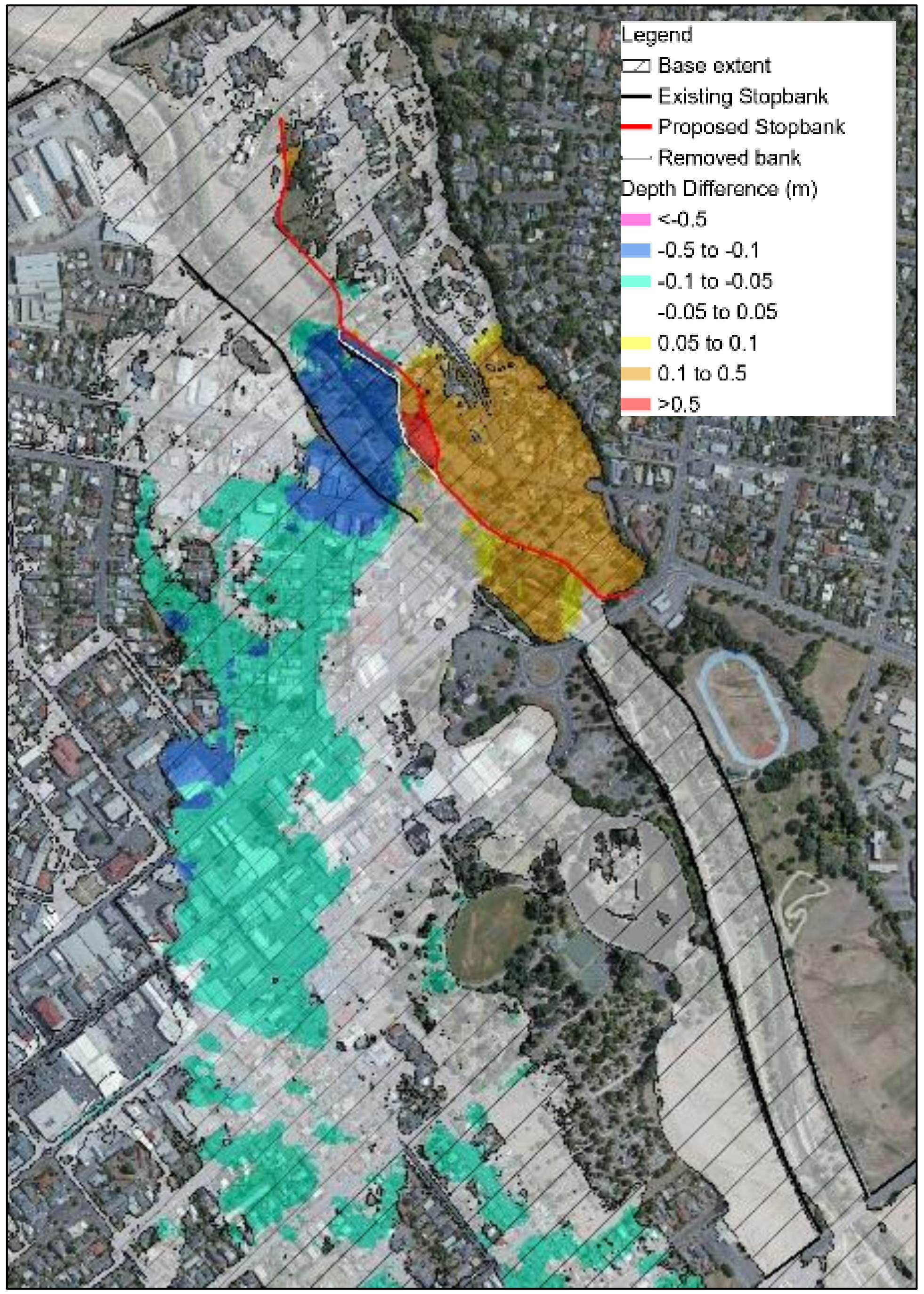

Figure 3-33: Option 17 depth difference map.

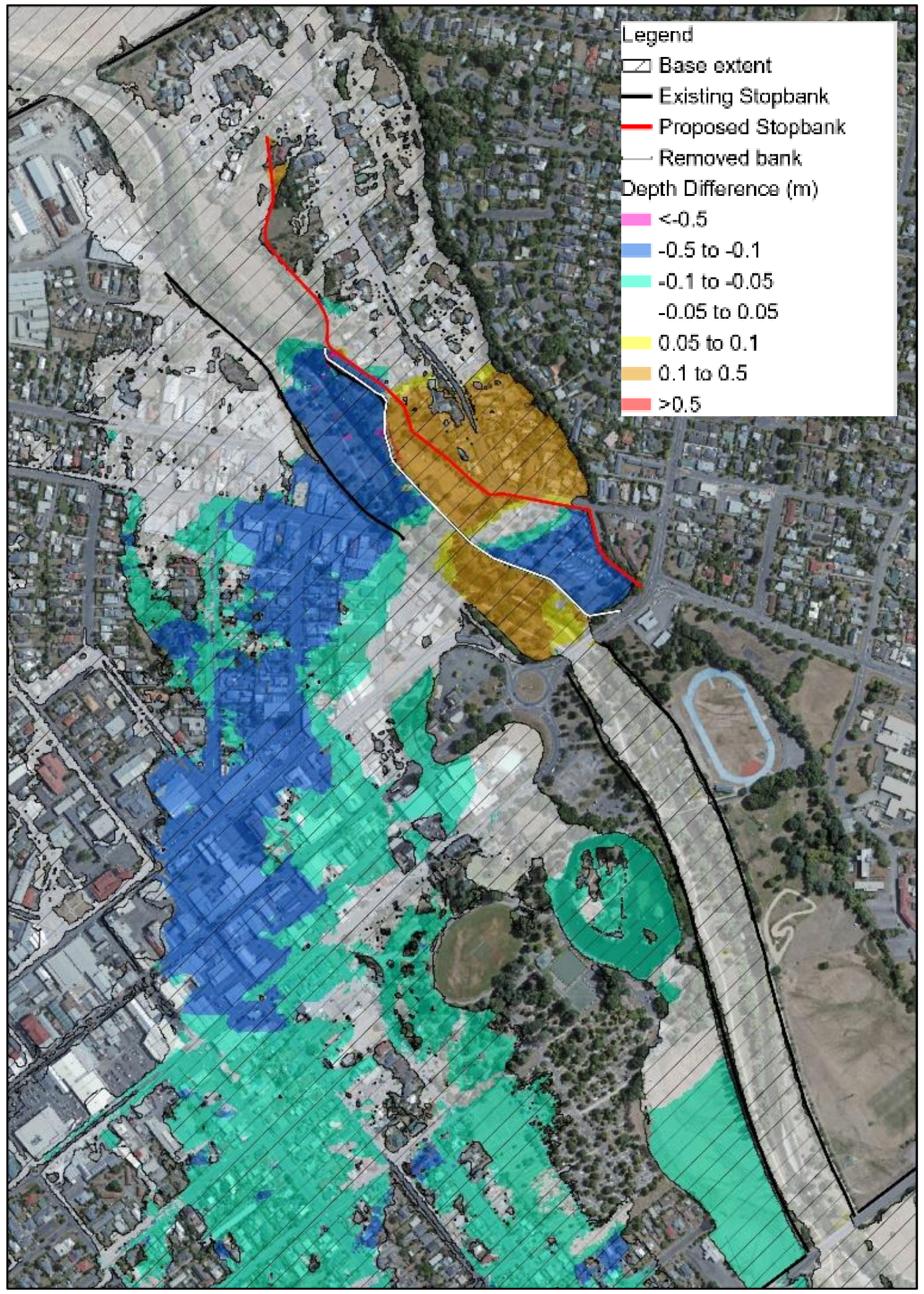

Figure 3-34: Option 18 depth difference map.

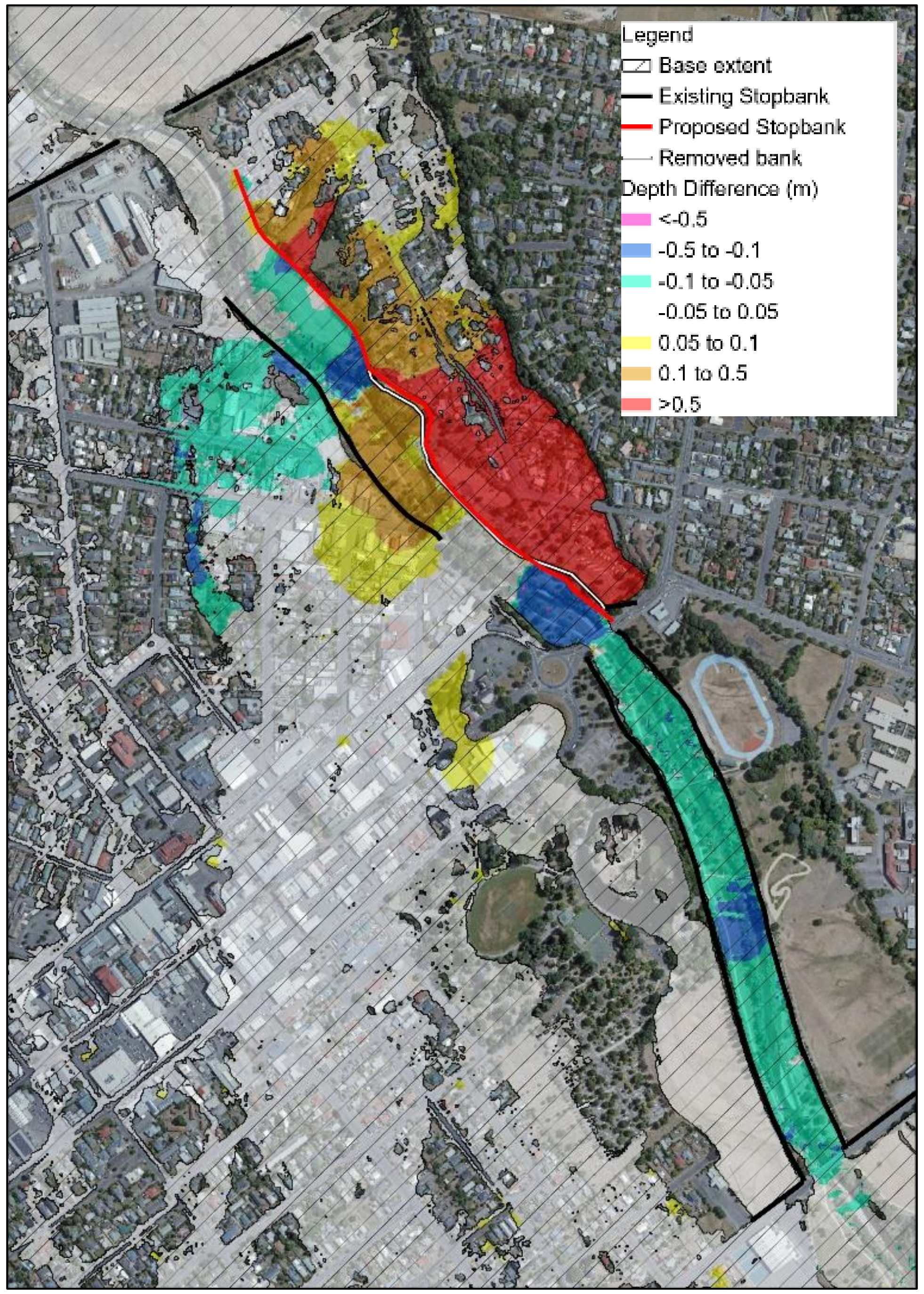

Figure 3-35: Option 18A depth difference map.

3.1.16. INDIVIDUAL OPTION 19

Individual Option 19 was designed to allow water onto the BMX track downstream of the athletics track on the true left side of the river by removing a section of the existing stopbank between SH2 and Colombo Rd (Figure 3-36).

Figure 3-36: Option 19

The depth and depth difference maps between the base scenario and Options 19 for a 1% AEP RCP6.0 flow event are presented in Figure 3-37 and Figure 3-38 and demonstrate:

- A notable decrease in water levels in the river channel between the SH2 bridge and Colombo Rd bridge in the order of 0.1-0.5 m.
- An area of increased water levels in the order of 0.1-0.5 m on the true left downstream of Colombo Rd, compared to the base scenario.
- A peak water depth in the now flooded BMX park (as fields to the south) in the order of 0.15-1.8 m

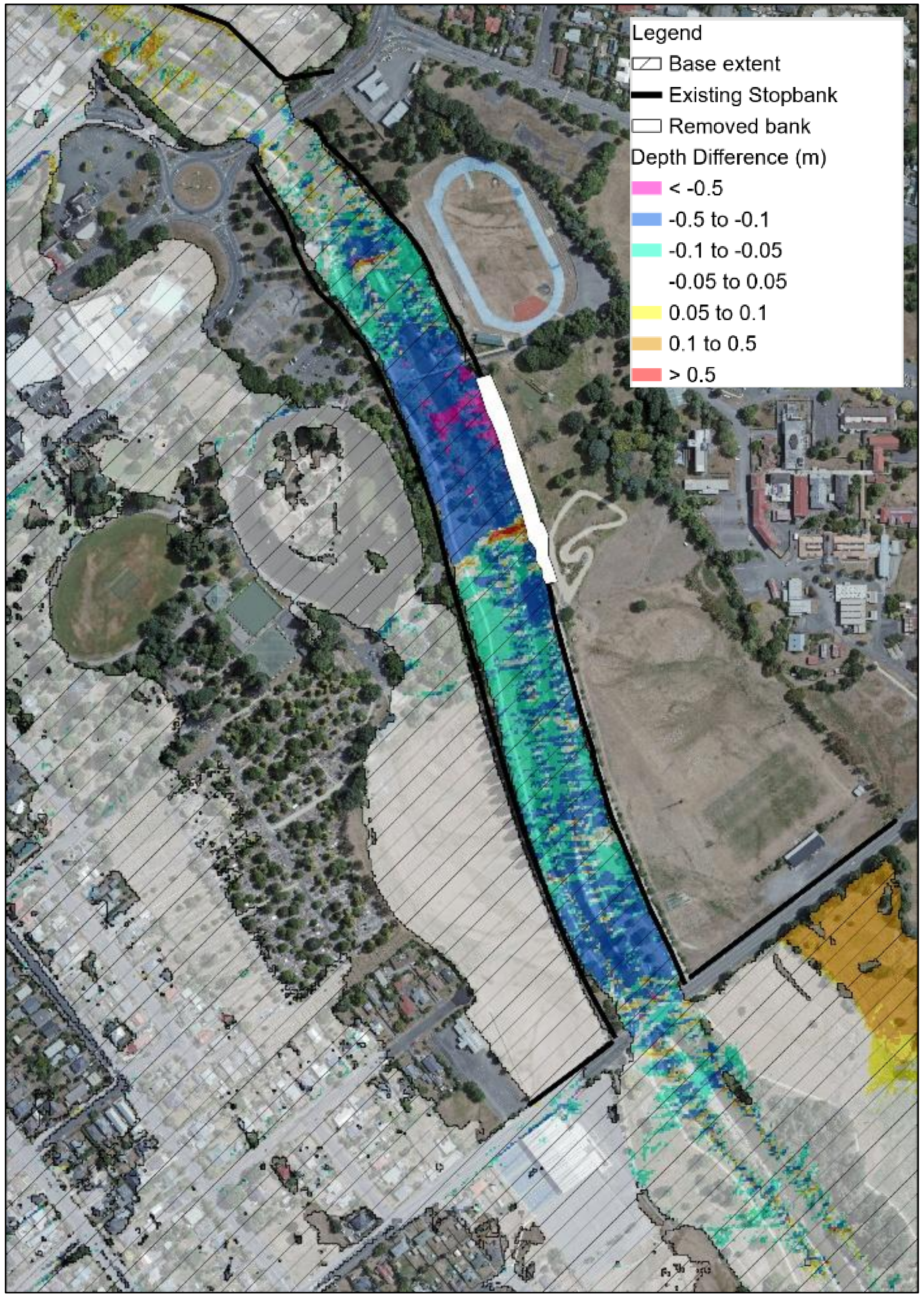

Figure 3-37: Option 19 depth difference map.

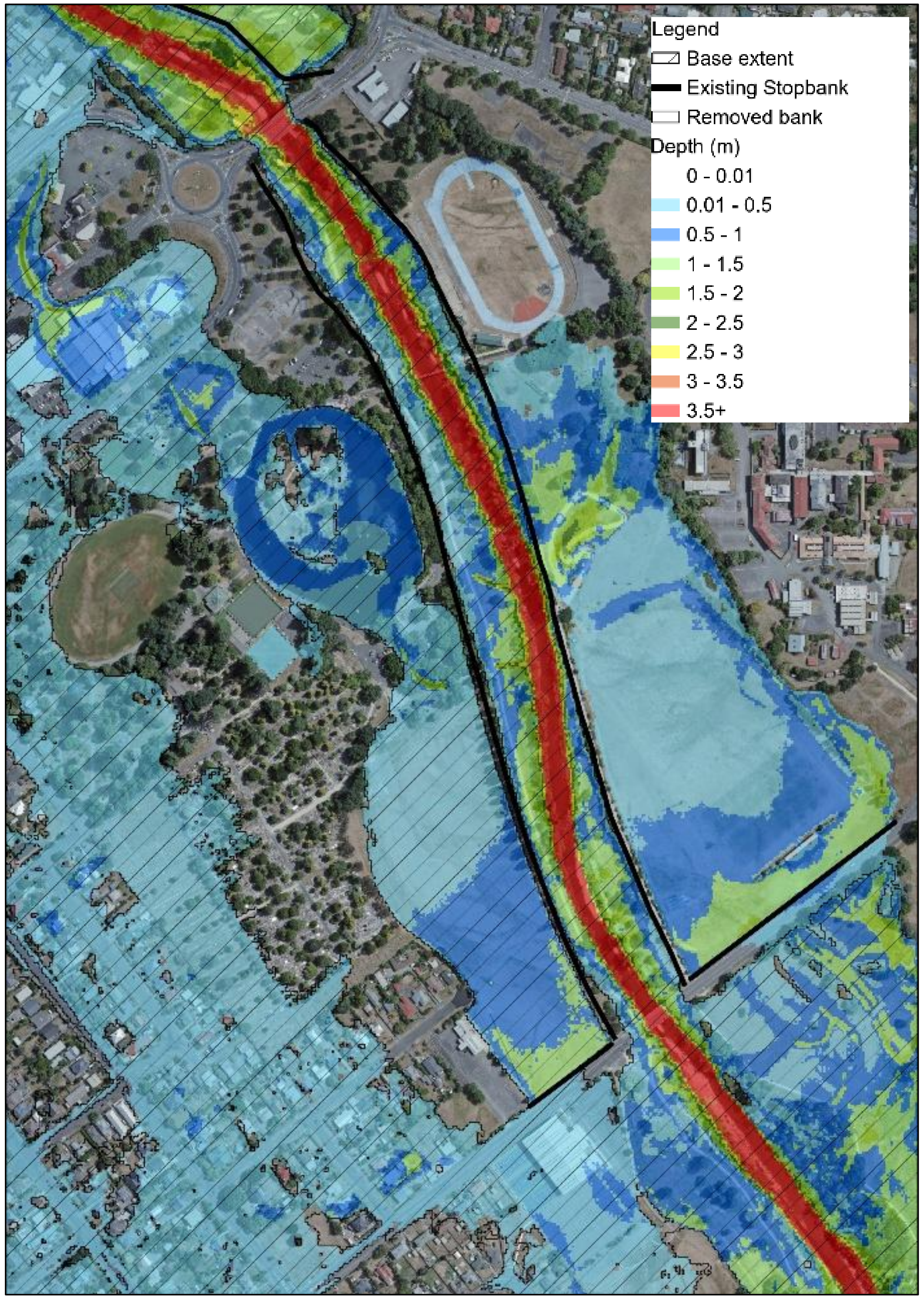

Figure 3-38: Option 19 depth map.

3.1.17. INDIVIDUAL OPTION 20 *

Individual Option 20 investigated lowering a 100 m long section of the true left stopbank immediately downstream of the BMX track by 1 m to allow water to flow onto the land upstream of Colombo Rd.

Depth difference results demonstrate minimal to no impact compared to the base scenario (Figure 3-39) indicating that the bank would need to be lowered by more than 1 m to have any noticeable impact.

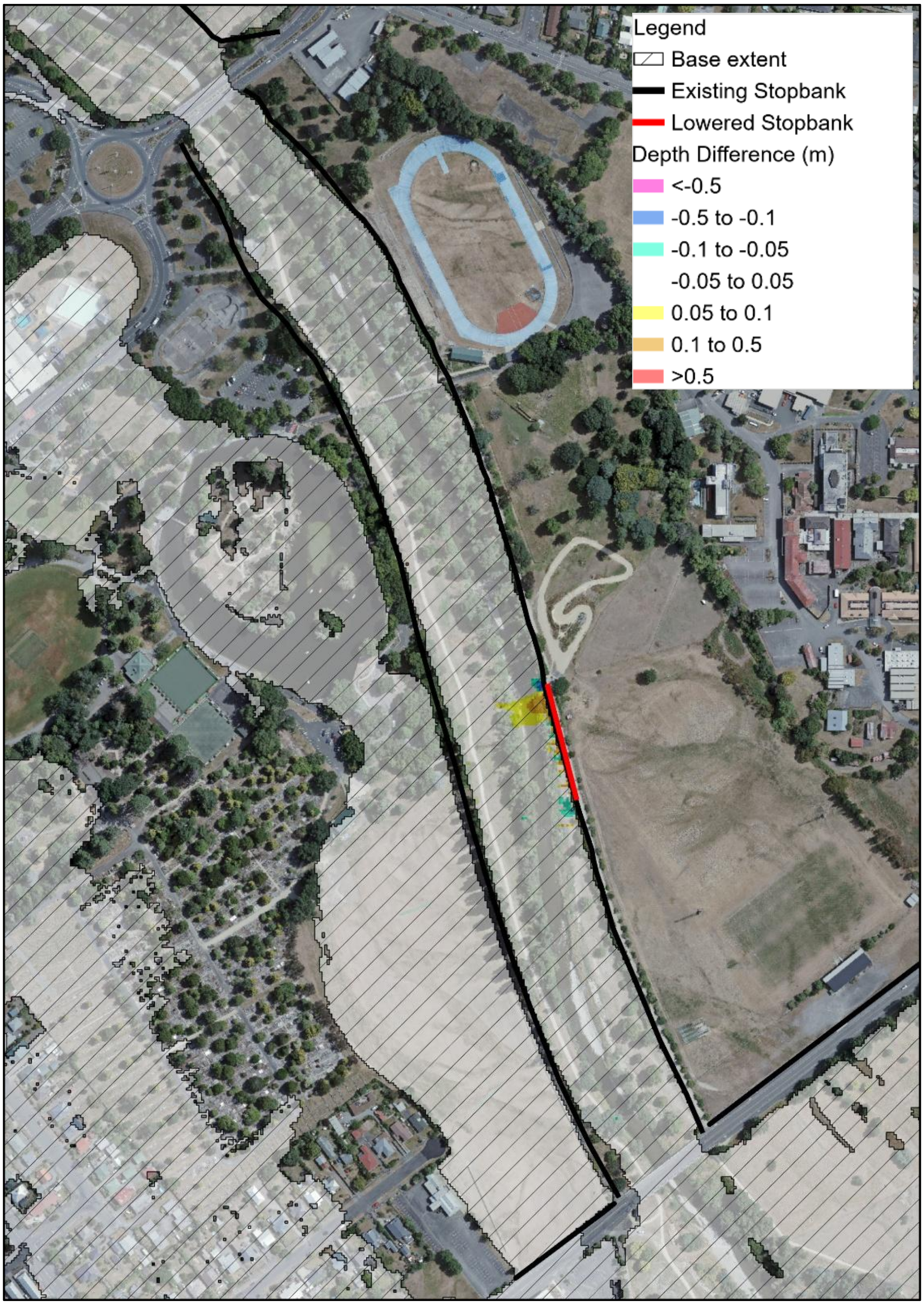

Figure 3-39: Option 20 depth difference map

3.1.18. INDIVIDUAL OPTION 22 *

Individual Option 22 investigates the effect of increasing the channel capacity by widening the river in multiple sections between the railway bridge and Colombo Rd. In this option, the low flow channel, as provided by GWRC, was made wider to the extent of the black dashed lines shown in Figure 3-40. A comparison of the base scenario (existing scheme) DEM and the modified Option 22 DEM is provided in Figure 3-41 and Figure 3-42.

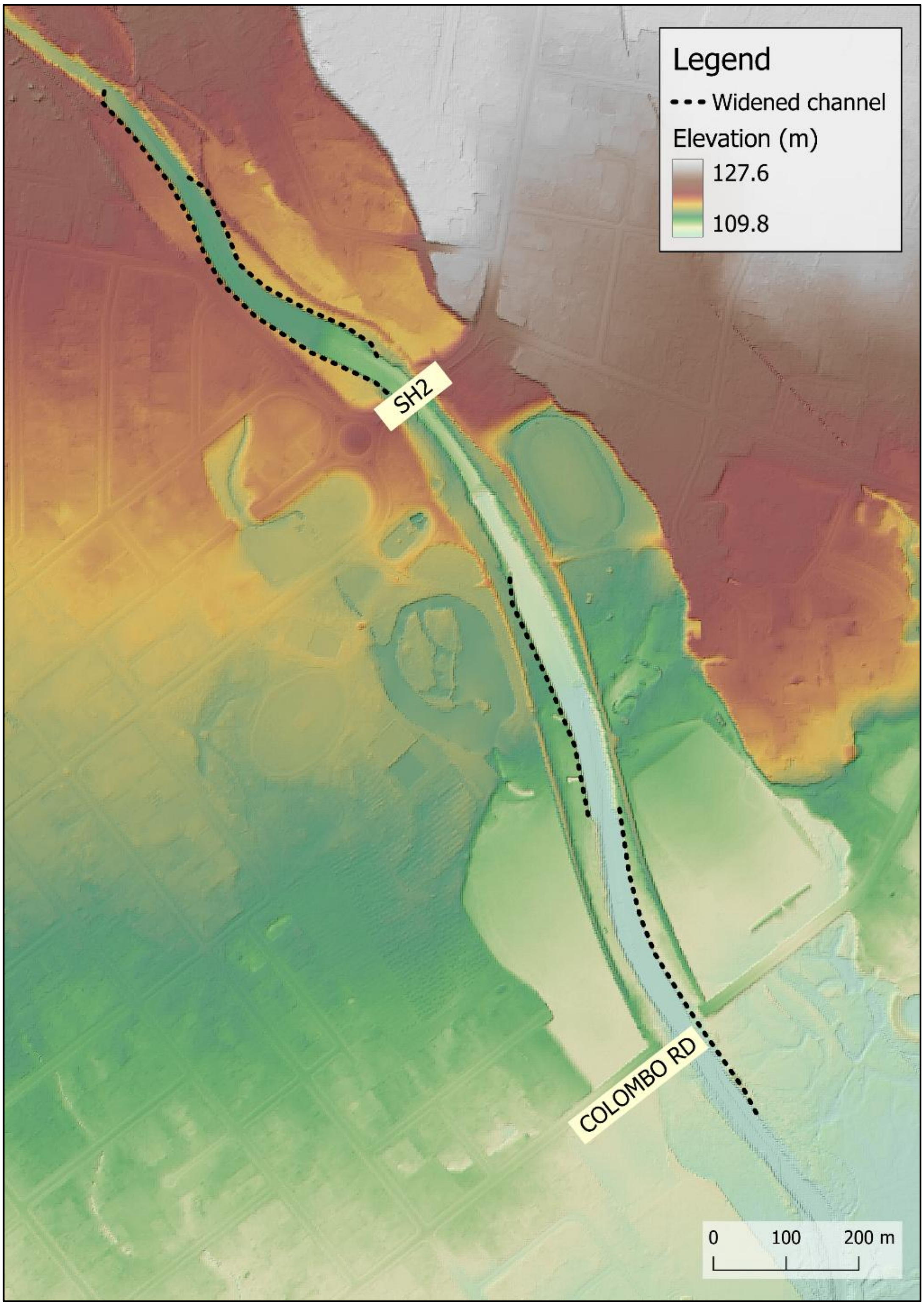

Figure 3-40: Option 22

Figure 3-41: Base scenario DEM with Option 22 widened channel indicated (dashed line)

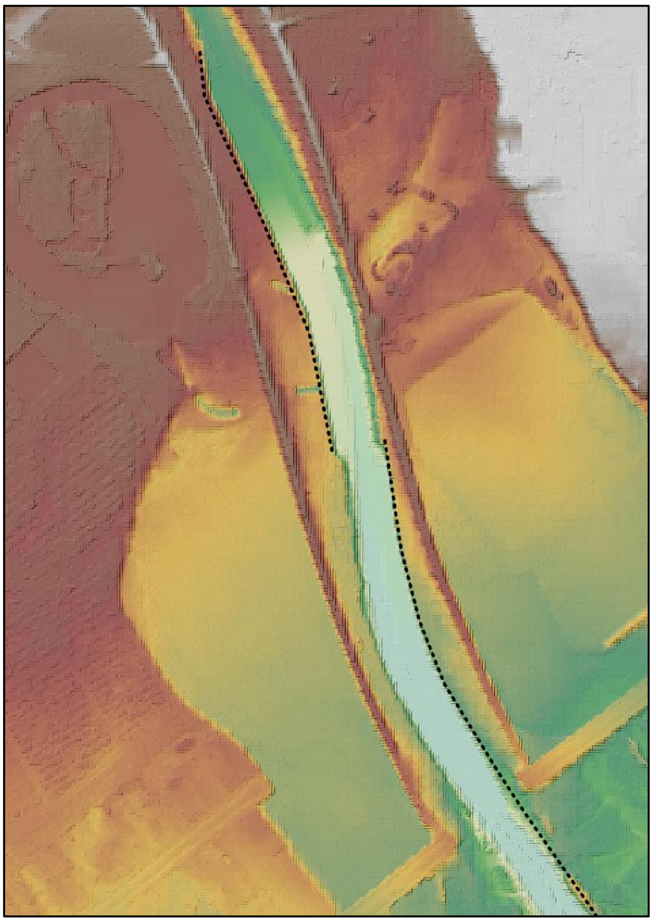

Figure 3-42: Option 22 DEM with widened channel burnt in

The depth difference map between the base scenario and Option 22 for a 1% AEP RCP6.0 flow event is presented in Figure 3-43 and demonstrates:

- A notable decrease in flood depths across Masterton on the right side of the river in the order of 0.1-0.5 m compared to the base scenario.
- A significant decrease in flood depths in Mawley Park and along Oxford St, in the order of 0.05-05 m.
- A significant decrease in the flood depths in the channel except at the bridges. At the SH2 and Colombo Rd bridges, there is an increase in water levels – up to 0.2 m at SH2, and 0.5 m at Colombo Rd bridge.

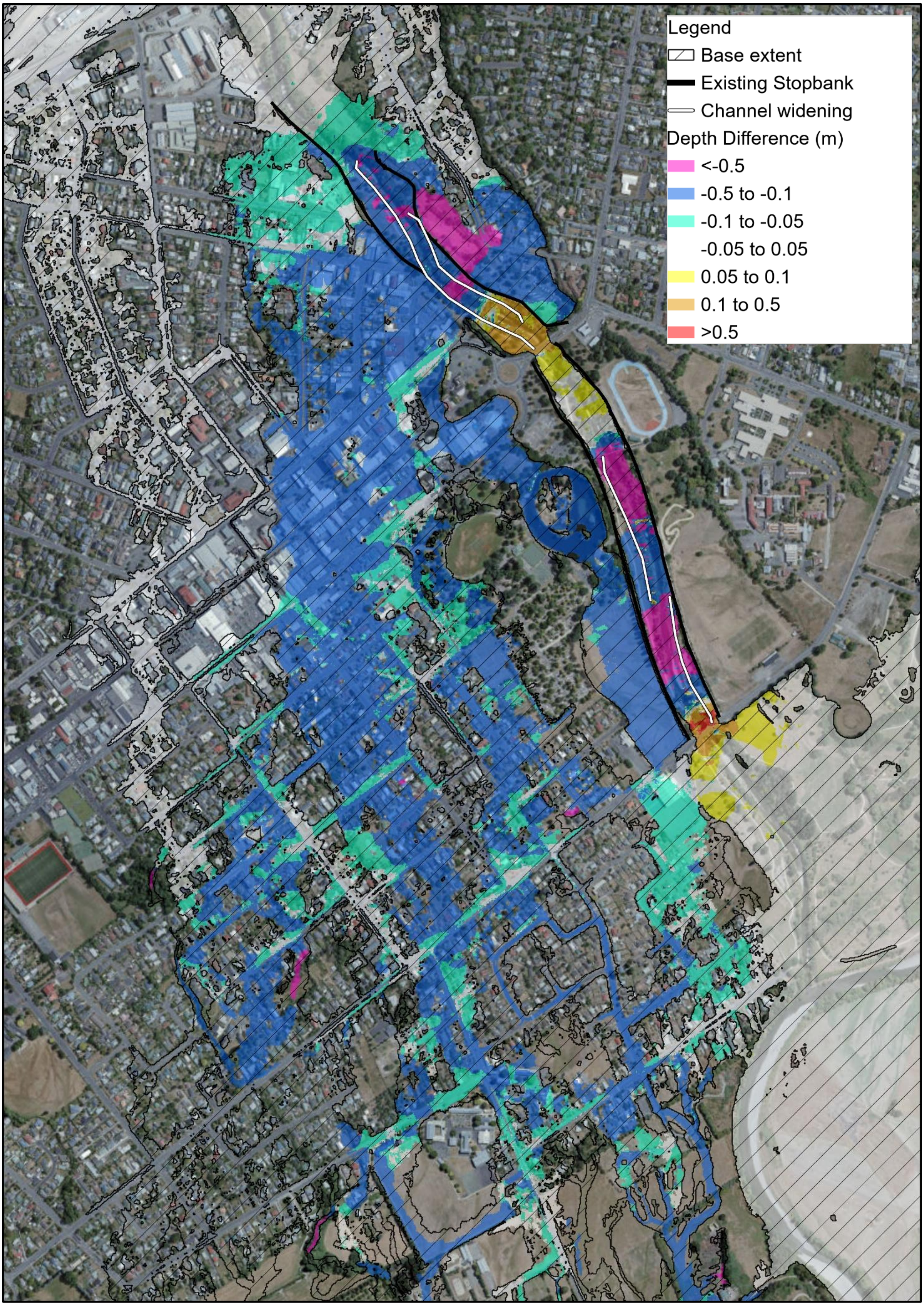

Figure 3-43: Option 22 depth difference map.

3.2. COMBINED OPTIONS

Following the preliminary modelling of individual options, a second suite of scenarios were simulated to establish a more comprehensive scheme for flood protection/mitigation. Combined Options were curated based on the impact of individual options to flooding across Masterton. Descriptions of the Combined Options are listed in Table 3-2.

Table 3-2: Details of the Combined Options simulated in the Waipoua hydraulic model

Combined Option	Individual Options	Model Notes / Variations / Additions
1	1. *Proposed stopbank along Mahunga Dr* 2. *20 m wide swale from Akura Rd to Waipoua River*	Note: Wetland **not** lowered (as it was in Individual Option 1). Two variations of C1: A. With bund on southern bank of proposed Akura swale B. Without bund
2	Combined Option 1 (above), plus Individual Options: 5. *Stopbank on true right between railway line and SH2* 7. *Room for river with new stopbank along true left river terrace, between SH2 and Colombo Rd* 12. *Culvert underneath Colombo Rd on true left of Waipoua River*	Two variations of C2: A. With Akura swale bund B. Without Akura swale bund
3	Combined Option 2 (above), plus Individual Options: 18. *Stopbank alignment along true left moved to river terrace behind Mawley Holiday Park (left unprotected)*	Additions: 1. Upgrade existing true left stopbank along Colombo Rd i.e. modelled as glasswall Two variations of C3: A. With Akura swale bund B. Without Akura swale bund
4	Combined Option 3 (above), plus Individual Options: 13. *New stopbank on true right between Colombo Rd and Ruamahanga River (to protect Cameron Cres) – note alternative alignment.*	Additions: 1. Right stopbank between SH2 and Colombo Rd is removed completely. 2. New cattle underpass (5 x 2 m) underneath

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		SH2 on true right bank
5	Combined Option 4 (above) except Waipoua River flow input reduced by 5%	Two variations of C5: A. With Akura swale bund B. Without Akura swale bund
6	1. *Proposed stopbank along Mahunga Dr* 2. *20 m wide swale from Akura Rd to Waipoua River* 18A. *Stopbank alignment along true left moved to river terrace and protects Mawley Holiday Park* 21. *Swale inland of the true left river berm near Oxford St*	Note: Wetland **not** lowered (as it was in Individual Option 1). Note: Bund at Akura Rd swale
7	Combined Option 6 (above), plus Individual Options: 22. *Waipoua River channel widened*	
8	Combined Option 4	Note: original stopbank alignment parallel to Cameron Cres as per Individual Option 13
9	Combined Option 3, plus Individual Options: *15.* Proposed stopbank on the true right bank immediately upstream of the railway bridge and around the buildings 21. *Swale inland of the true left river berm near Oxford St*	Note: Alternative Option 18 stopbank alignment that provides partial protection to Mawley Park. Note: Alternative Option 15 stopbank alignment that provides partial protection to Akura Rd buildings.
10	Combined Option 9, plus Individual Options: 20. *Lowering section of true left bank downstream of the BMX track to 50-year ARI historic crest level*	Note: Alternative Option 7 stopbank (shortened to southern half).
11	Combined Option 3, plus Individual Options: *13. New stopbank on true right between Colombo Rd and Ruamahanga River to protect Cameron Cr.*	Note: Alternative Option 12: instead of a single culvert underneath Colombo Rd, two culverts (5 m x 1.2 m) were modelled. Two variations of C11: • With Option 21 swale near Oxford St • Without Option 21 swale
12	Combined Option 11, plus Individual Options:	Two variations of C12:

	22. *Waipoua River channel widened*	• With Option 21 swale near Oxford St • Without Option 21 swale
13	None	Status quo modelled (existing stopbanks) with Waipoua River channel widened and berms lowered in sections.
14	Combined Option 12, plus Individual Options: 20. *Lowering section of true left bank downstream of the BMX track to 50-year ARI historic crest level.*	Channel widened and berms lowered in sections, as per C13. Two variations of C14: A. With bund upstream of railway bridge B. Without bund upstream of railway bridge Note Individual Option 20 instead of Option 7. Note: C14 was modelled **without** the swale near Oxford St.
15	Combined Option 12, plus Individual Options: *N/A*	Channel widened and berms lowered in sections as per C13. Two variations of C15: A. With bund upstream of railway bridge B. Without bund upstream of railway bridge Note: C15 was modelled **without** the swale near Oxford St.

3.2.1. COMBINED OPTION 1

Combined Option 1 merges the elements of Option 1 (with an extension to the upstream end) and Option 2 (Figure 3-44) and was modelled two different ways to determine the effect on flooding at the railway bridge:

A. With a bund (glass walled) on the downstream side of the Akura Rd swale
B. Without the bund

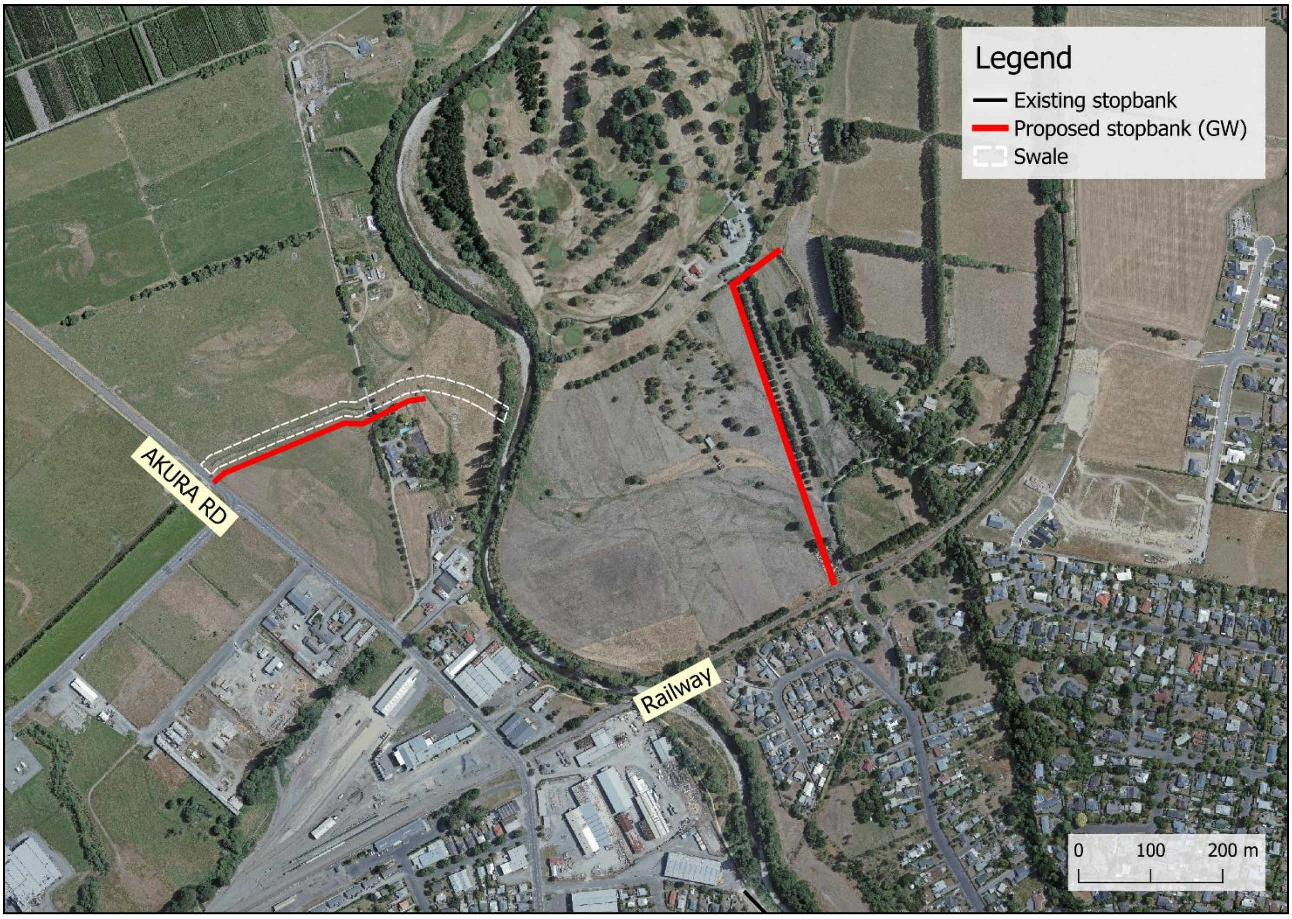

Figure 3-44: Combined Option 1

The depth difference maps between the base scenario and Combined Option 1 for a 1% AEP RCP6.0 flow event are presented in Figure 3-45 and Figure 3-46, which demonstrate:

- Increased flood depths left of the river, upstream of the railway compared to Individual Option 2 due to proposed Mahunga Dr stopbank.
- A considerable decrease in flood extent downstream of the railway on both sides of the river similar to or exceeding those of Individual Options 1 and 2, respectively.
- Option 1A (with the bund) shows a slightly greater reduction in flood extent upstream of the railway line.

All future combined options which include the Akura Rd swale were modelled with and without the adjacent bund to determine its effect on water levels at the railway bridge. However, since there is minimal change based on the presence of the bund, results for the remaining combined options incorporating the Akura Rd swale will only be presented for the scenario with a bund, for brevity, unless otherwise noted.

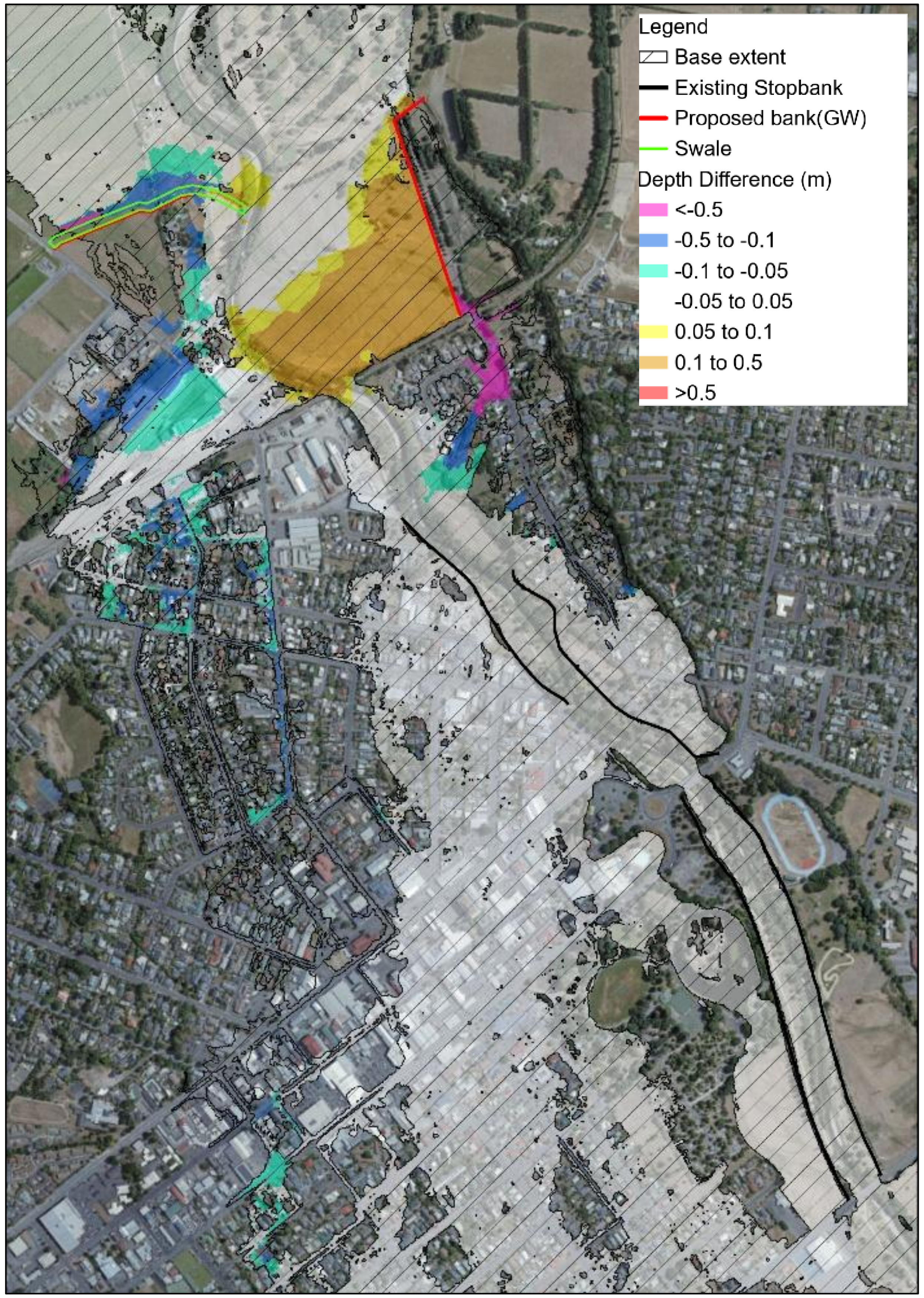

Figure 3-45: Combined Option 1A depth difference map (with bund at Akura Rd swale).

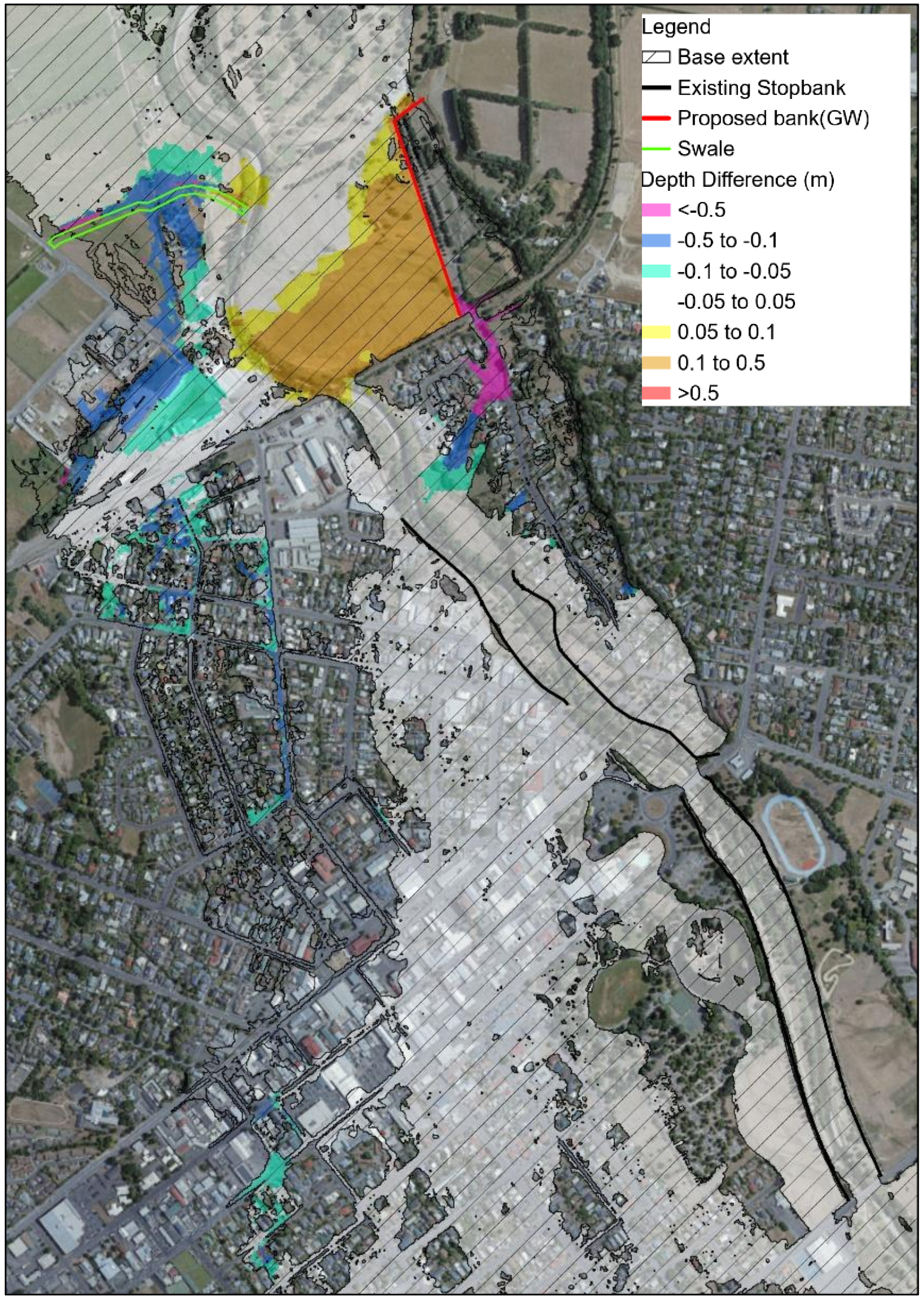

Figure 3-46: Combined Option 1B depth difference map (without bund at Akura Rd swale).

3.2.2. COMBINED OPTION 2

Combined Option 2 merges the elements of Individual Options 1, 2, 5, 7 and 12 (Figure 3-47) and was modelled with and without the proposed bund at Akura Rd.

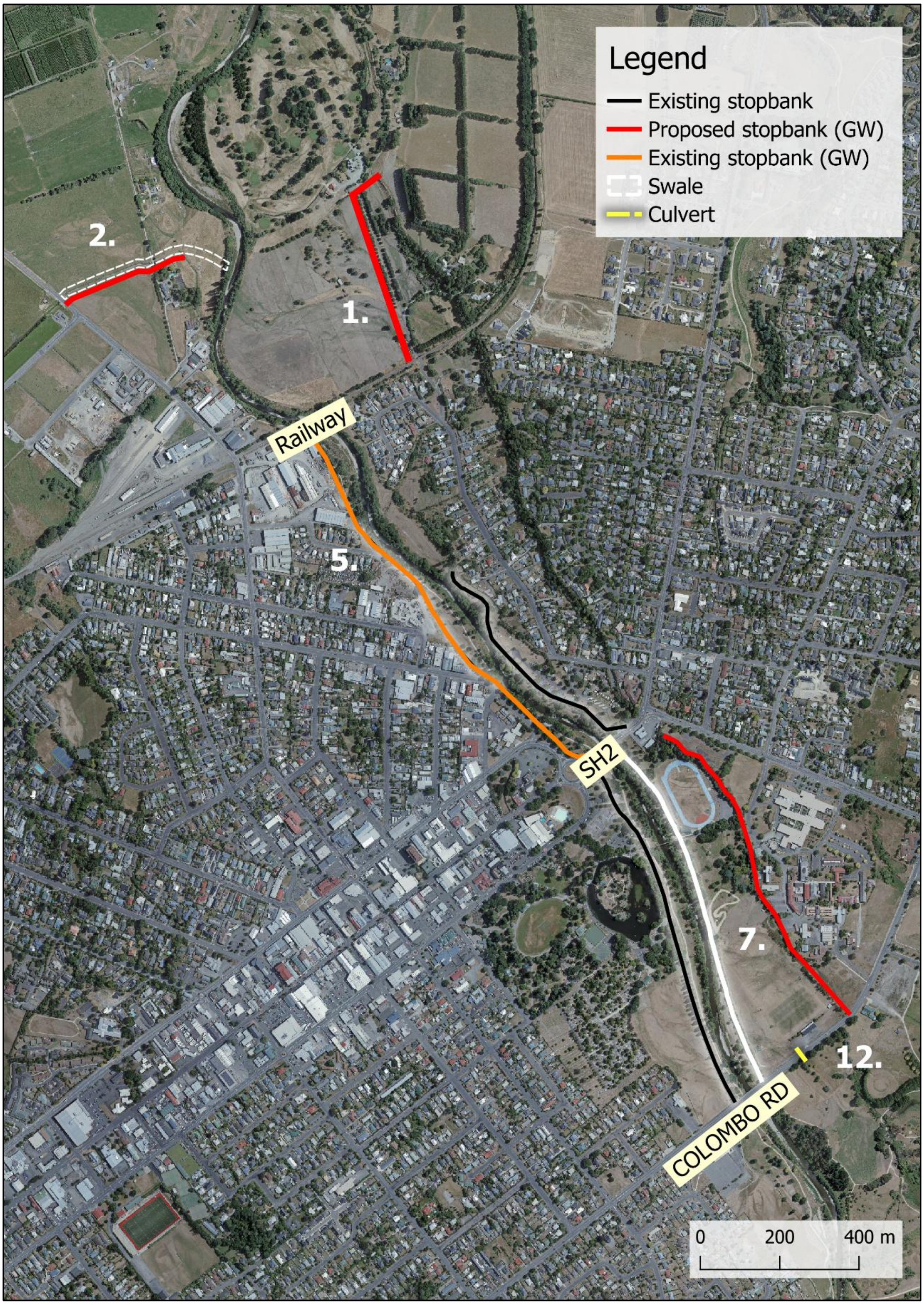

Figure 3-47: Combined Option 2

The depth difference maps between the base scenario and Combined Option 2 for a 1% AEP RCP6.0 flow event, with a bund at the Akura Rd swale is presented in Figure 3-47, and demonstrates:

- A significant decrease in flood extent in the Masterton township west of the river.
- Increased flood depths in Masterton Trails wetland area in the order of 0.05-0.5 m.
- An increase in the peak water levels at the railway, SH2 and Colombo Rd bridges.
- An increase in water levels in Mawley Holiday Park due to the true right stopbank pushing water to the true left side.

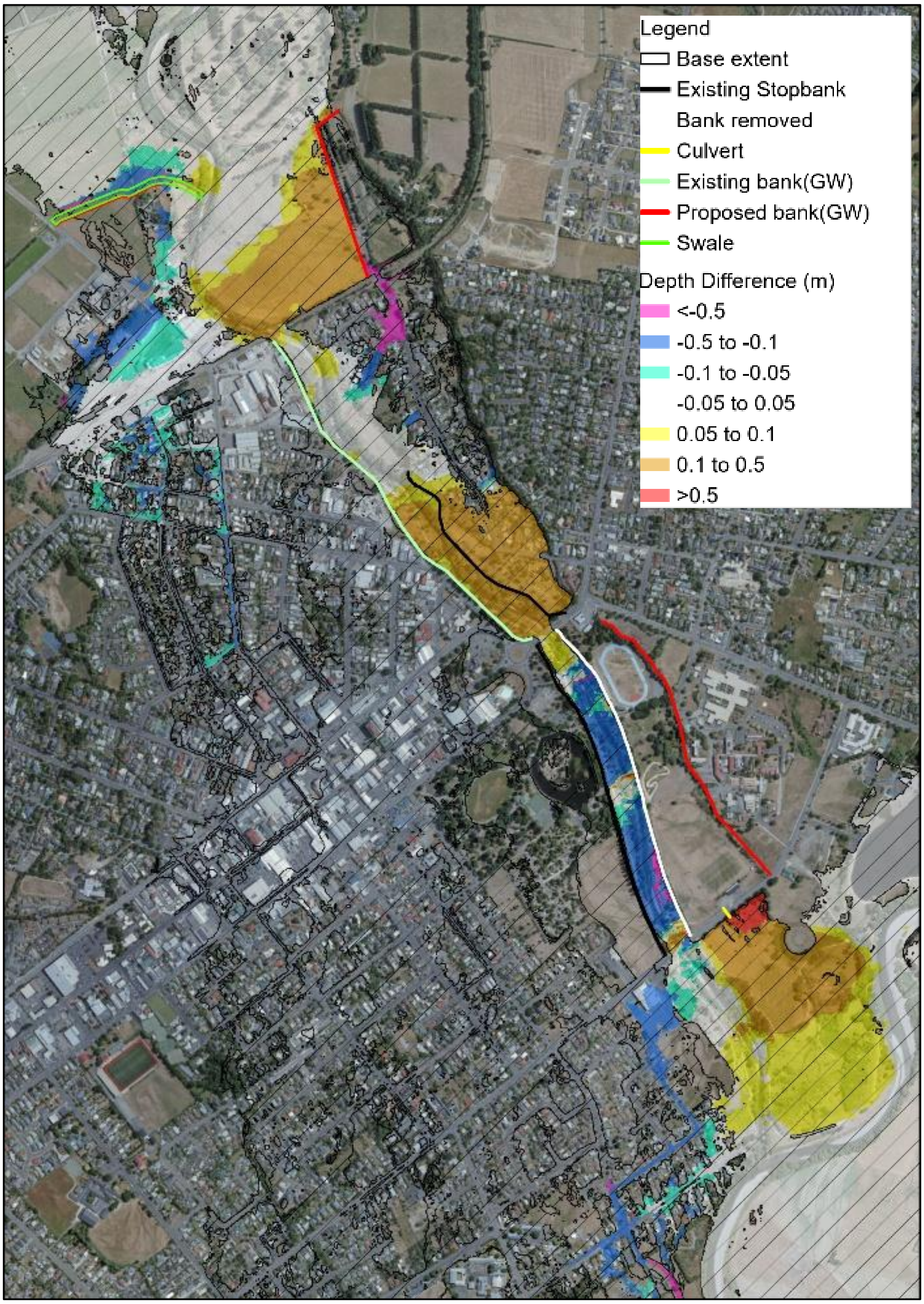

Figure 3-48: Combined Option 2 depth difference map (with bund at Akura).

3.2.3. COMBINED OPTION 3

Combined Option 3 merges the elements of Option 1, 2, 5, 7, 12 and 18 (Figure 3-49); again, modelled with and without the bund at the Akura Rd swale. It also proposes upgrades to the true left stopbank along Colombo Rd, which was modelled as 'glasswall' for maximum impact.

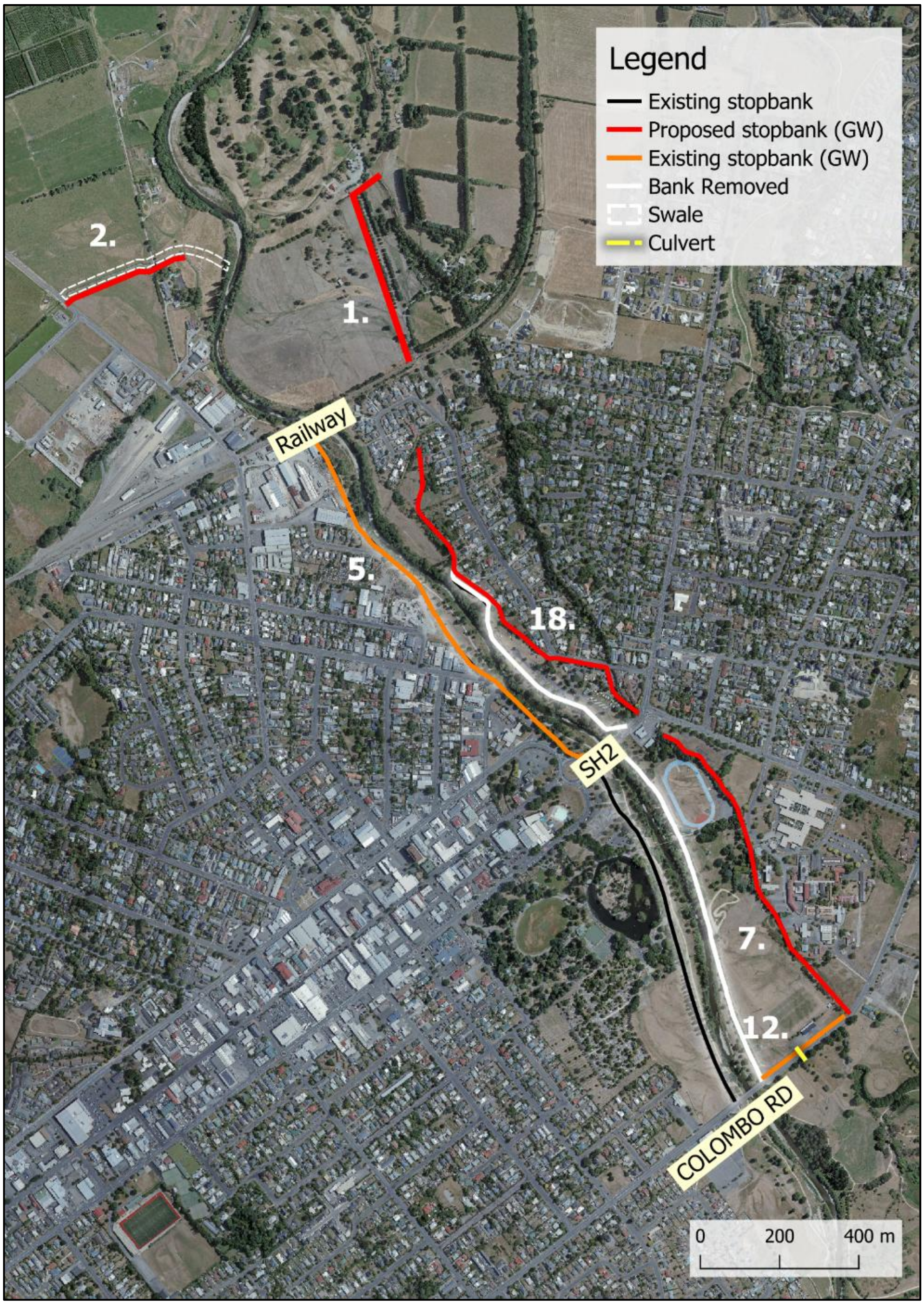

Figure 3-49: Combined Option 3

The depth difference maps between the base scenario and Combined Option 3 for a 1% AEP RCP6.0 flow event, with a bund at the Akura Rd swale, is presented in Figure 3-50. Results are similar to those of Combined Option 2 except water levels at the southern end of Mawley Park are lower (negligible change from the base scenario), and that flood levels in the Masterton Trails wetland area is also reduced.

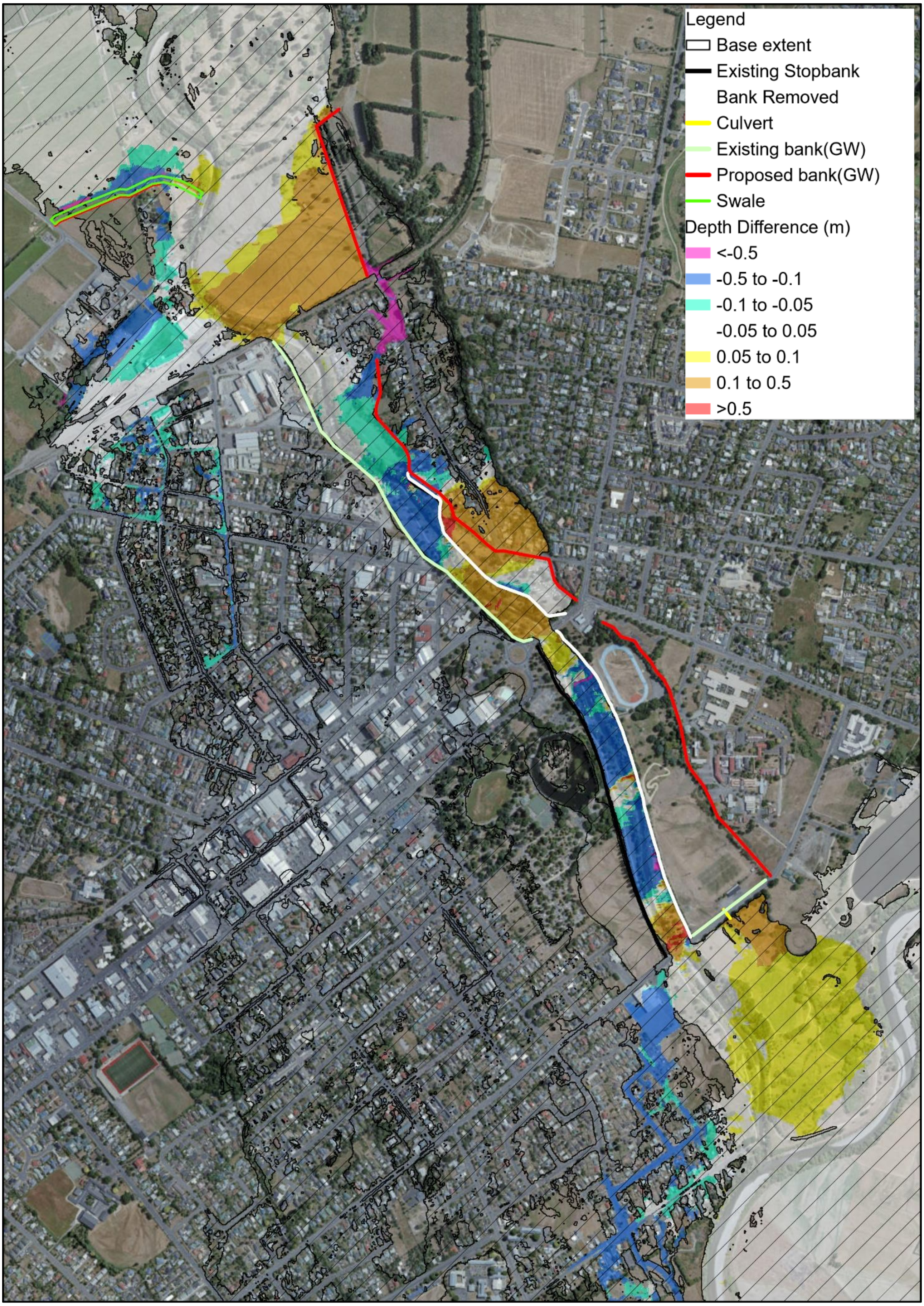

Figure 3-50: Combined Option 3 depth difference map (with bund at Akura).

3.2.4. COMBINED OPTIONS 4 AND 8

Combined Option 4 merges the elements of Option 1, 2, 5, 7, 12 and 18 with an alternative stopbank alignment to that of Option 13. (Figure 3-51). It differs from previous modelling by completely removing the existing true right bank between SH2 and Colombo Rd and includes a proposed cattle underpass (5 m x 2 m) on the right bank of SH2. As with the previous combined options, this was simulated with and without the bund along the Akura Rd swale.

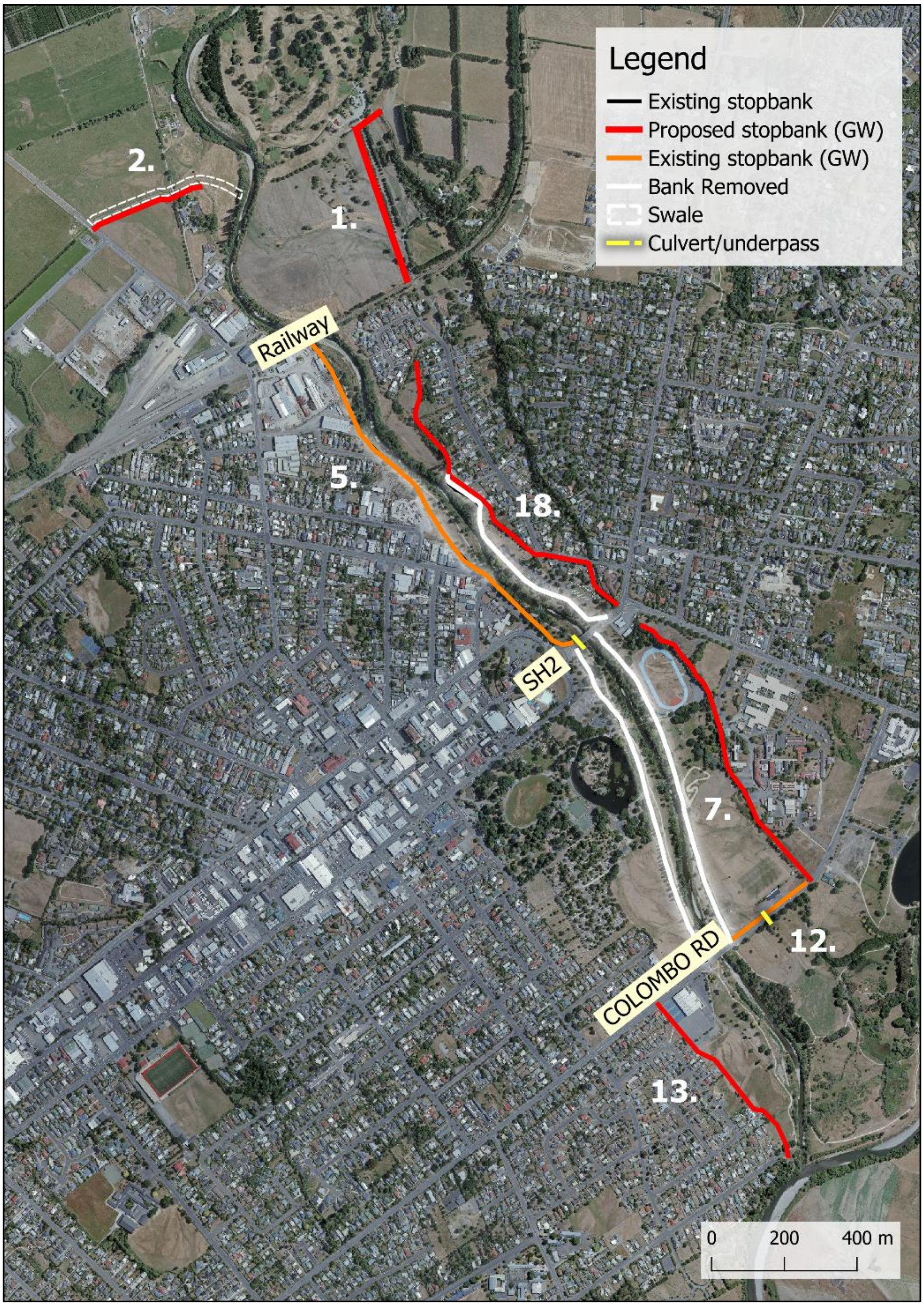

Figure 3-51: Combined Option 4

Combined Option 8 uses an identical model set up to Combined Option 4, except the proposed stopbank parallel to Cameron Cr was as per the original stopbank alignment in Individual Option 13.

The depth difference map between the base scenario and Combined Option 4 and 8, for a 1% AEP RCP6.0 flow event are presented in Figure 3-52 and Figure 3-53. Results for both options demonstrate:

- A significant decrease in flood extent in the Masterton township west of the river, although flooding remains, albeit slightly reduced in depth, near Pownall St and down Lincoln Rd, as per Combined Options 2 and 3.
- An increase in the peak water levels at the railway, SH2 and Colombo Rd bridges.
- An increase in flood depths up- and downstream of Colombo Rd on the true right due to the stopbank removal.

However, Option 8 demonstrates a significant increase in flood depths (>0.5 m in places) in the Cameron Cr area.. This is because the removal of the stopbank on the true right bank upstream of Colombo Rd allows more water into the area which is then prevented from returning to the river by the proposed stopbank protecting Cameron Cr.

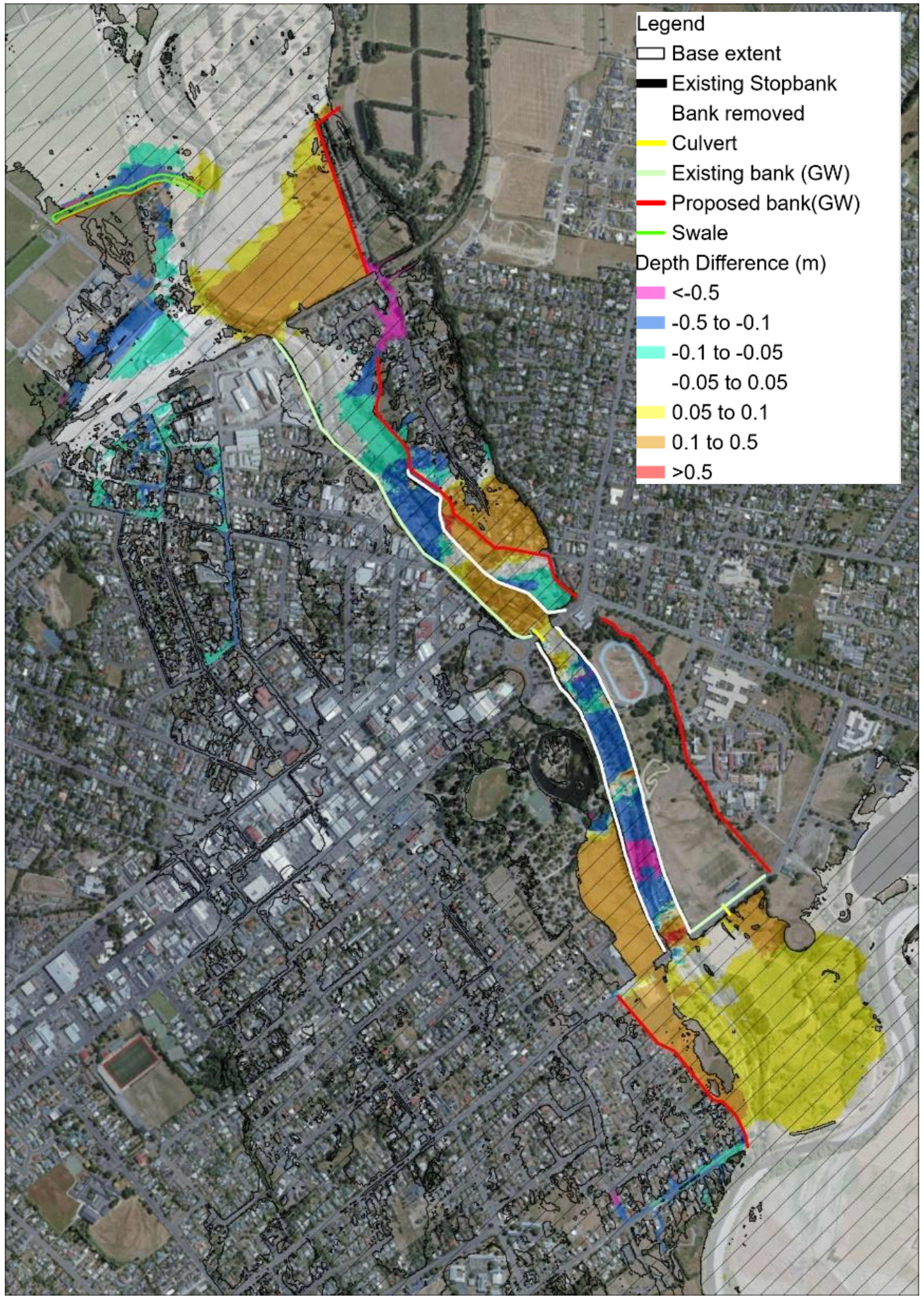

Figure 3-52: Combined Option 4 depth difference map (with bund at Akura).

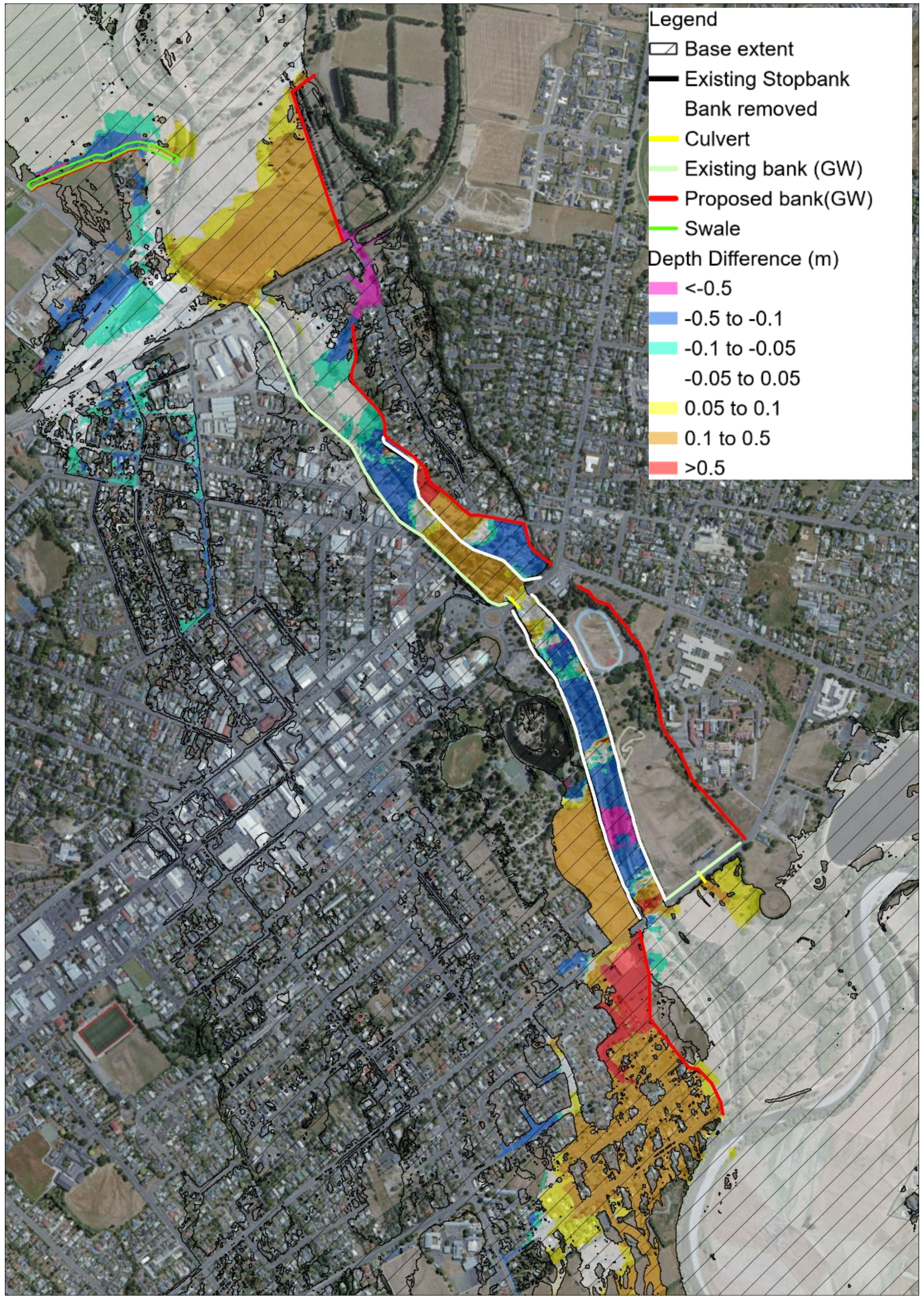

Figure 3-53: Combined Option 8 depth difference map.

3.2.5. COMBINED OPTION 5

Combined Option 5 uses an identical model set up to Combined Option 4, except in this option the inflow for Waipoua River was reduced by 5% to approximate the potential impact of proposed nature-based solutions. As with the previous combined options, this was simulated with and without the bund along the Akura Rd swale.

The depth difference map for this reduced flow scenario, with a bund at the Akura Rd swale, is presented in Figure 3-54 and demonstrates:

- Further decrease in flood extent compared to Combined Option 4, with no flooding on the true right in the vicinity of Grey St, Lincoln Rd, Perry St, Bently St and Villa St.
- As with Combined Option 4, an increase in flood depths up- and downstream of Colombo Rd on the true right as well as at all three bridges.

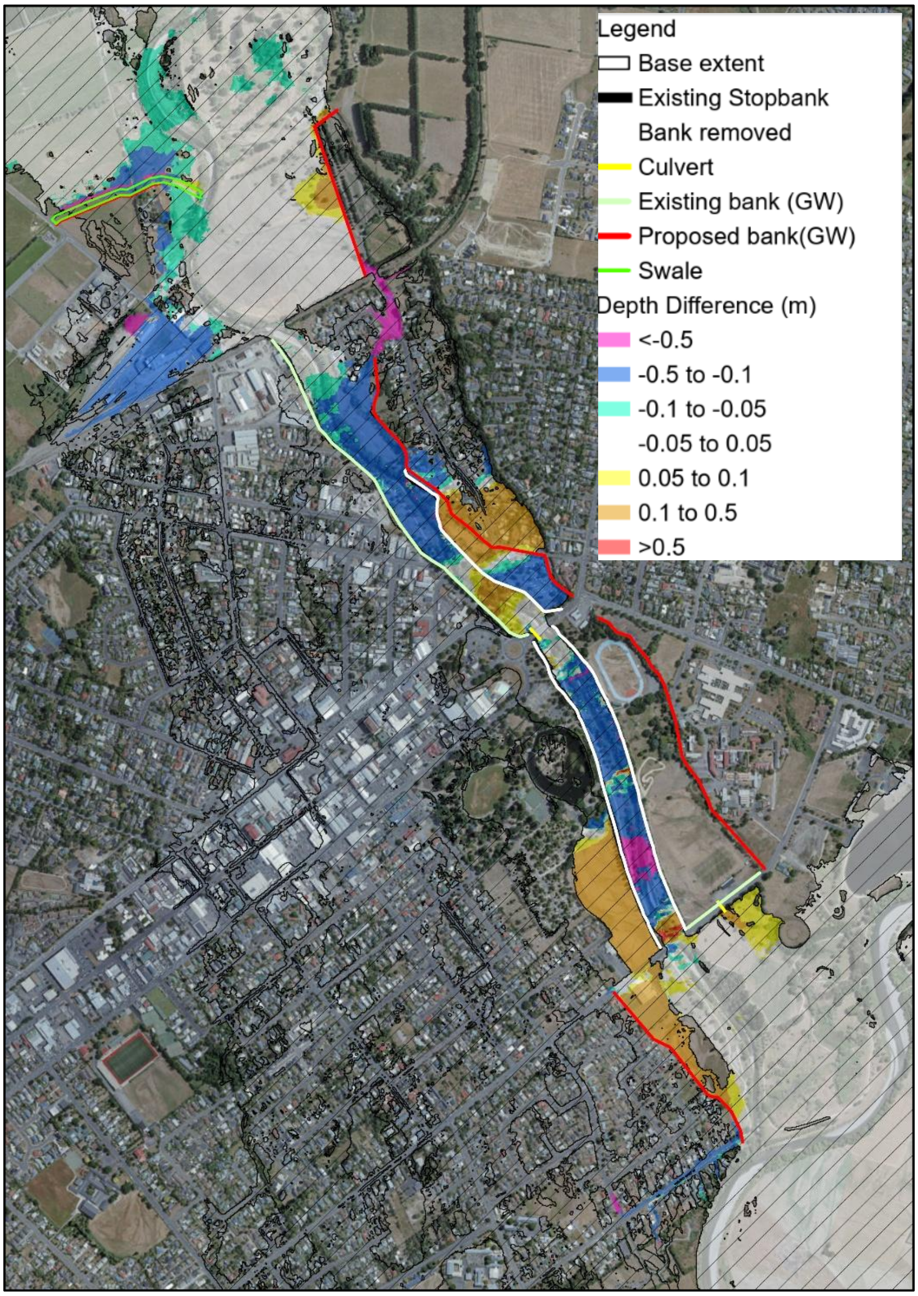

Figure 3-54: Combined Option 5 depth difference map (with bund at Akura).

3.2.6. COMBINED OPTION 6

Combined Option 6 merges the elements of Option 1, 2, 21 and 18A (Figure 3-55).

Figure 3-55: Combined Option 6

The depth difference map between the base scenario and Combined Option 6 for a 1% AEP RCP6.0 flow event is presented in Figure 3-56 and demonstrates:

- The combined effects of the Oxford St swale and the proposed Option 18A stopbank alignment push more water to the true right, resulting in increased flood depths across the township to the right of the river.
- A significant decrease in water level (>0.5 m) at the upstream end of the Oxford St swale as well as through Mawley Park.

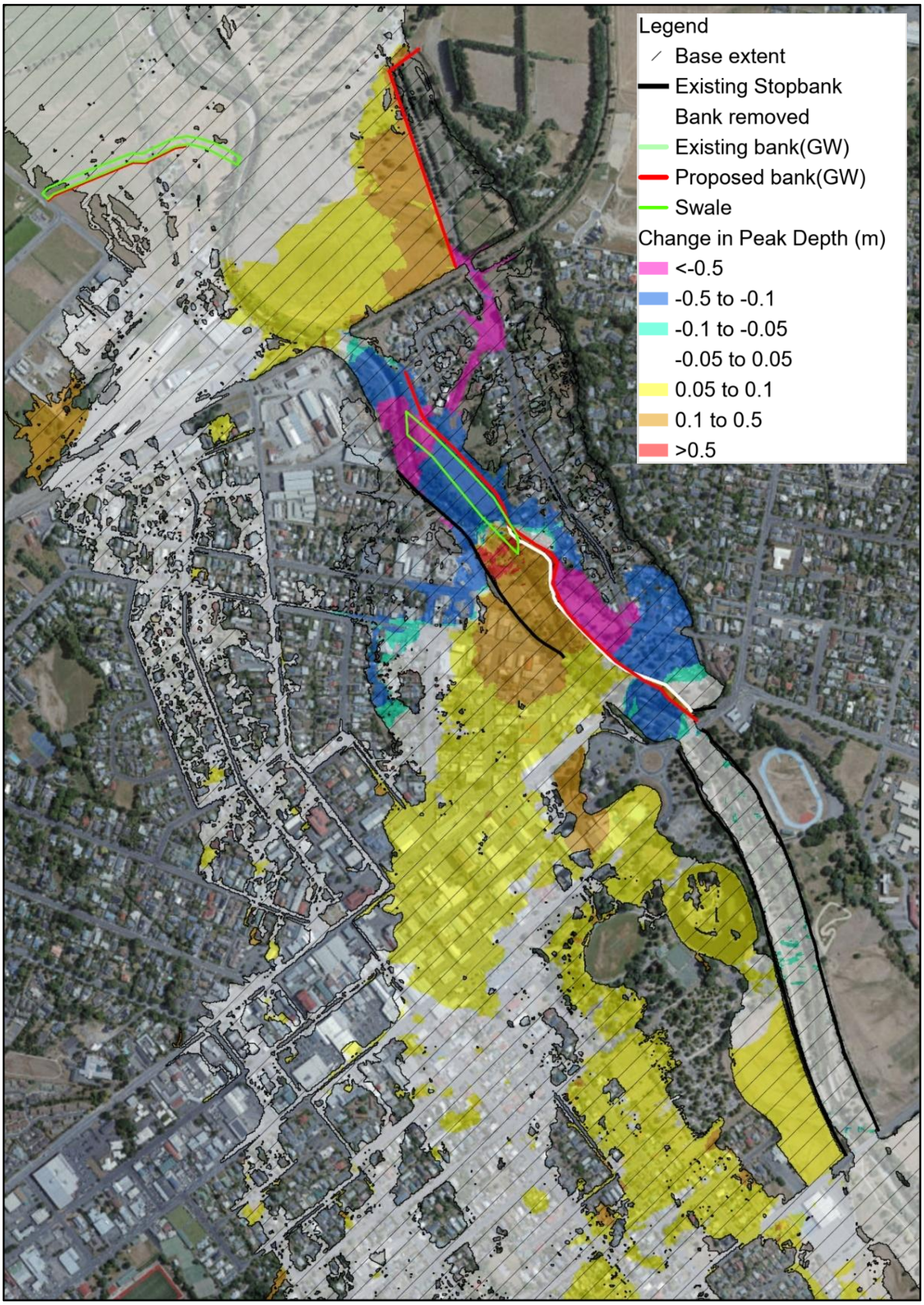

Figure 3-56: Combined Option 6 depth difference map.

3.2.7. COMBINED OPTION 7

Combined Option 7 merges Combined Option 6 and Individual Option 22, which looked at the effect of widening sections of the river between the railway bridge and Colombo Rd.

The depth difference map between the base scenario and Combined Option 6 for a 1% AEP RCP6.0 flow event is presented in Figure 3-57 and demonstrates:

- A significant decrease in water level (>0.5 m) at the upstream end of the Oxford St swale as well as through Mawley Park and widened sections of the channel.
- A notable decrease in flood depths between 0.1 and 0.5 m through Masterton town on the true right of the river.
- An increase in peak water levels at the bridges, most notably at the Colombo bridge in the order of 0.4-0.5 m.

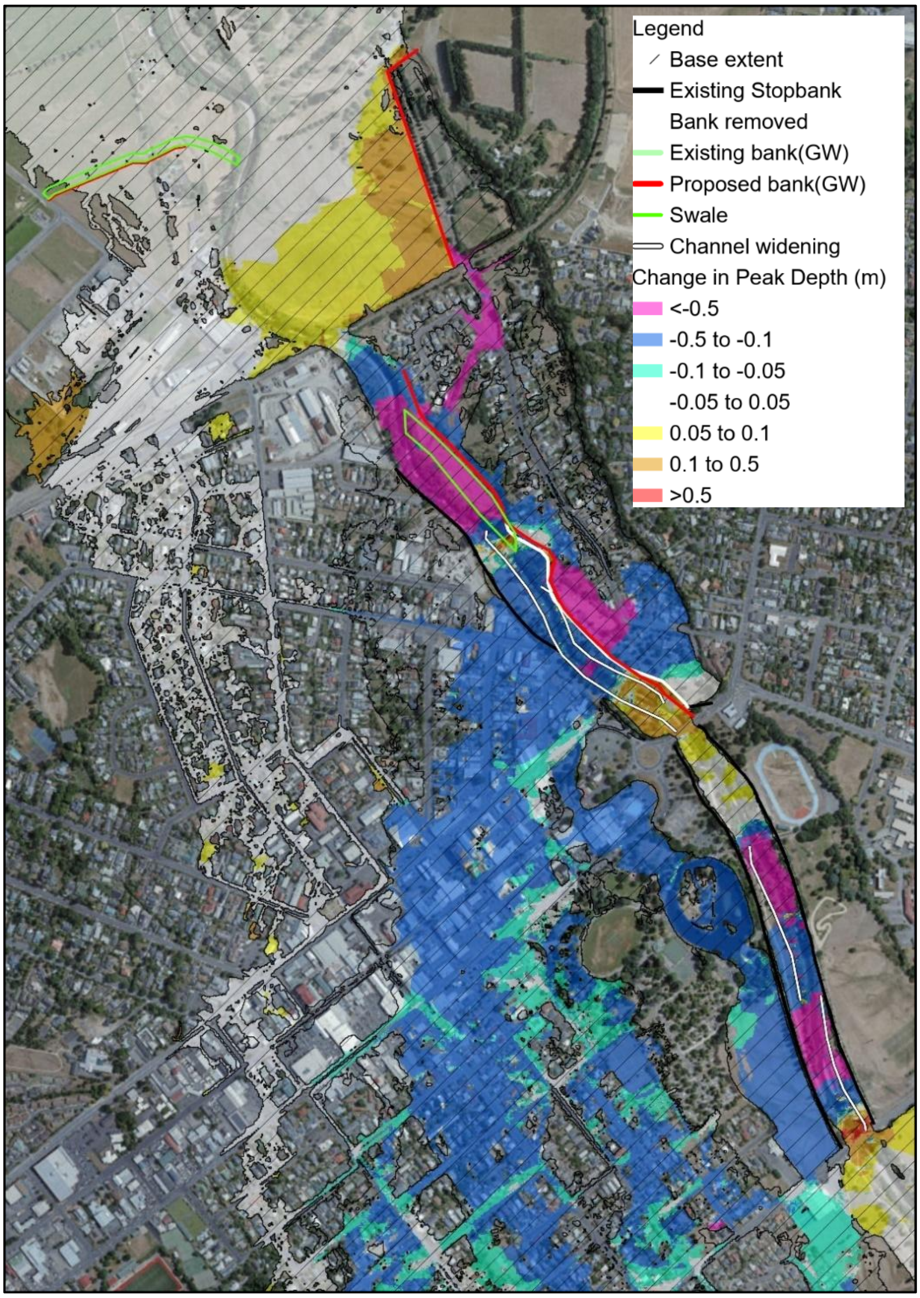

Figure 3-57: Combined Option 7 depth difference map.

3.2.8. COMBINED OPTION 9

Combined Option 9 merges the elements (or variations thereof) of Combined Option 3 and Individual Options 15 and 21 (railway stopbank and Oxford St swale). We note the alternative stopbank alignments to Akura Rd and Mawley Park stopbanks (Figure 3-58).

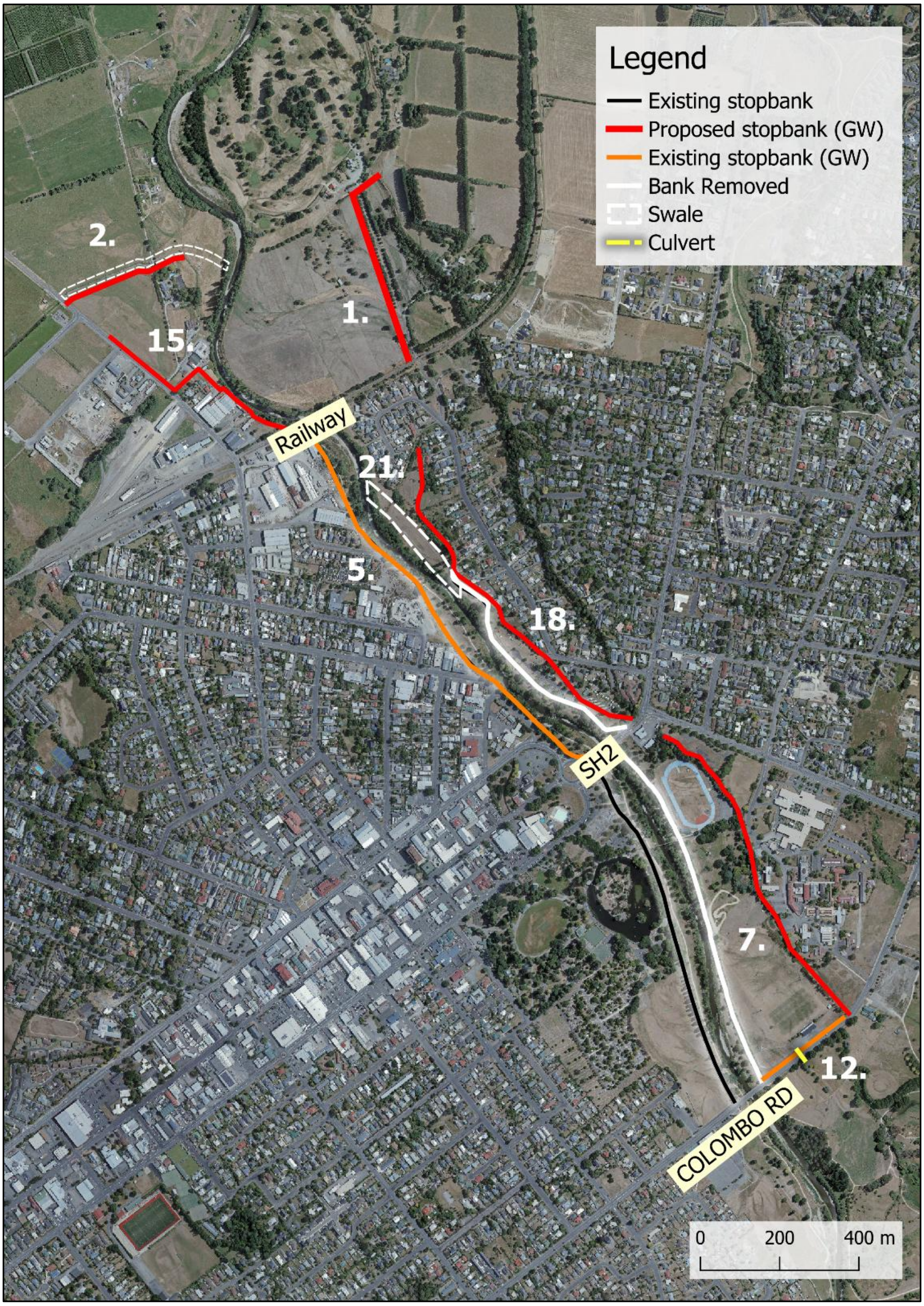

Figure 3-58: Combined Option 9

The depth difference map between the base scenario and Combined Option 9, with the bund at the Akura Rd swale, for a 1% AEP RCP6.0 flow event is presented in Figure 3-59 and demonstrates:

- No flooding on the true right of the river between the railway line and Colombo Rd, nor behind the proposed stopbank along Mawley Park, which is an improvement upon previous Combined Options.
- A decrease in the Cameron Cr area in the order of 0.1-0.5 m.
- An increase in flood depth at the three bridges of up to 0.5 m.
- An increase in flood depths through the Masterton Trails on the true left downstream of Colombo Rd in the order of 0.05-0.1 m.

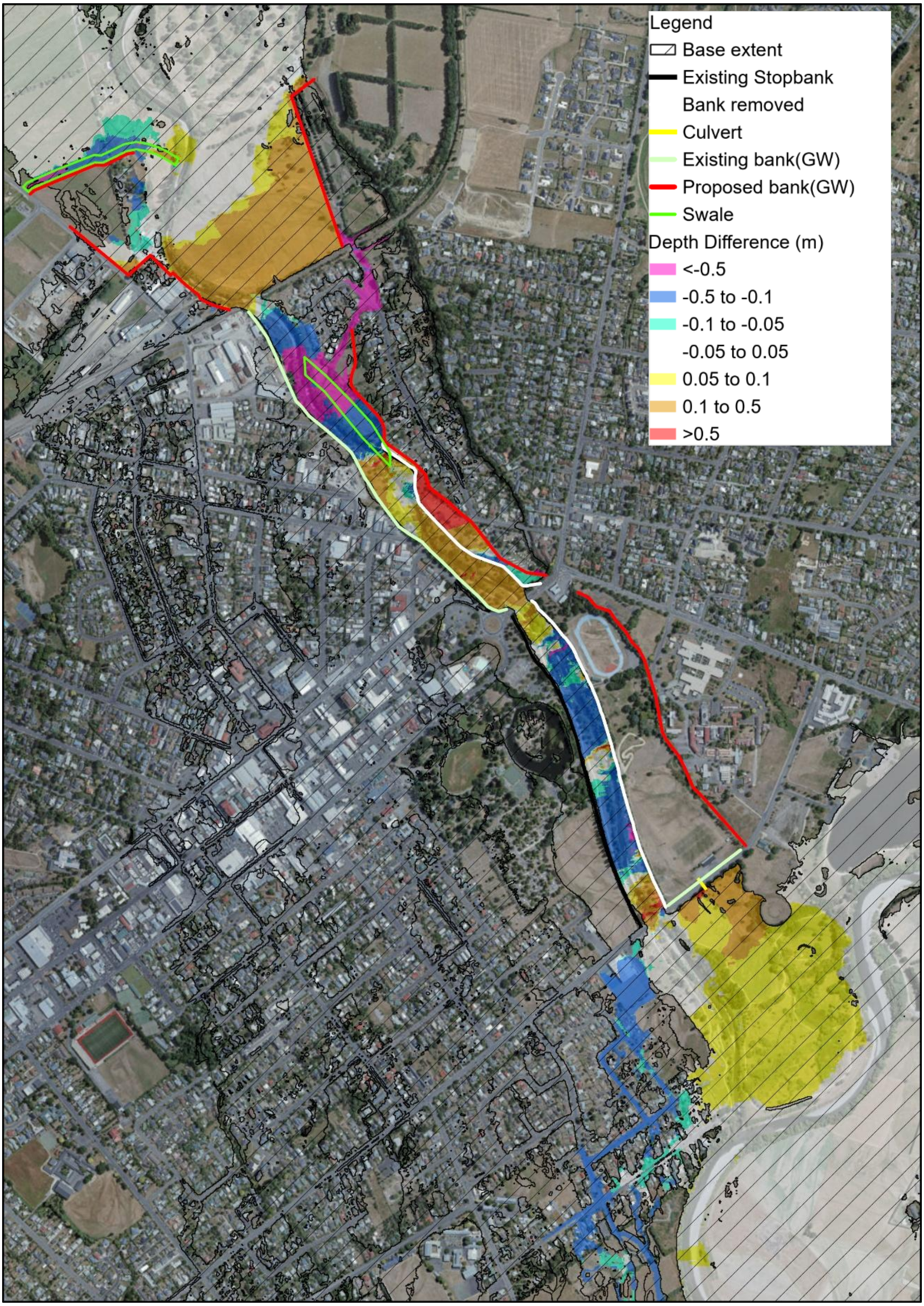

Figure 3-59: Combined Option 9 depth difference map (with bund at Akura).

3.2.9. COMBINED OPTION 10

Combined Option 10 merges the elements (or variations thereof) of Combined Option 9 and Individual Option 20. We note the alternative Option 7 stopbank along the terrace edge (shortened) and the true left stopbank south of the BMX track has been lowered to alignments of providing partial protection to Akura Rd buildings and Mawley Holiday Park (Figure 3-60).

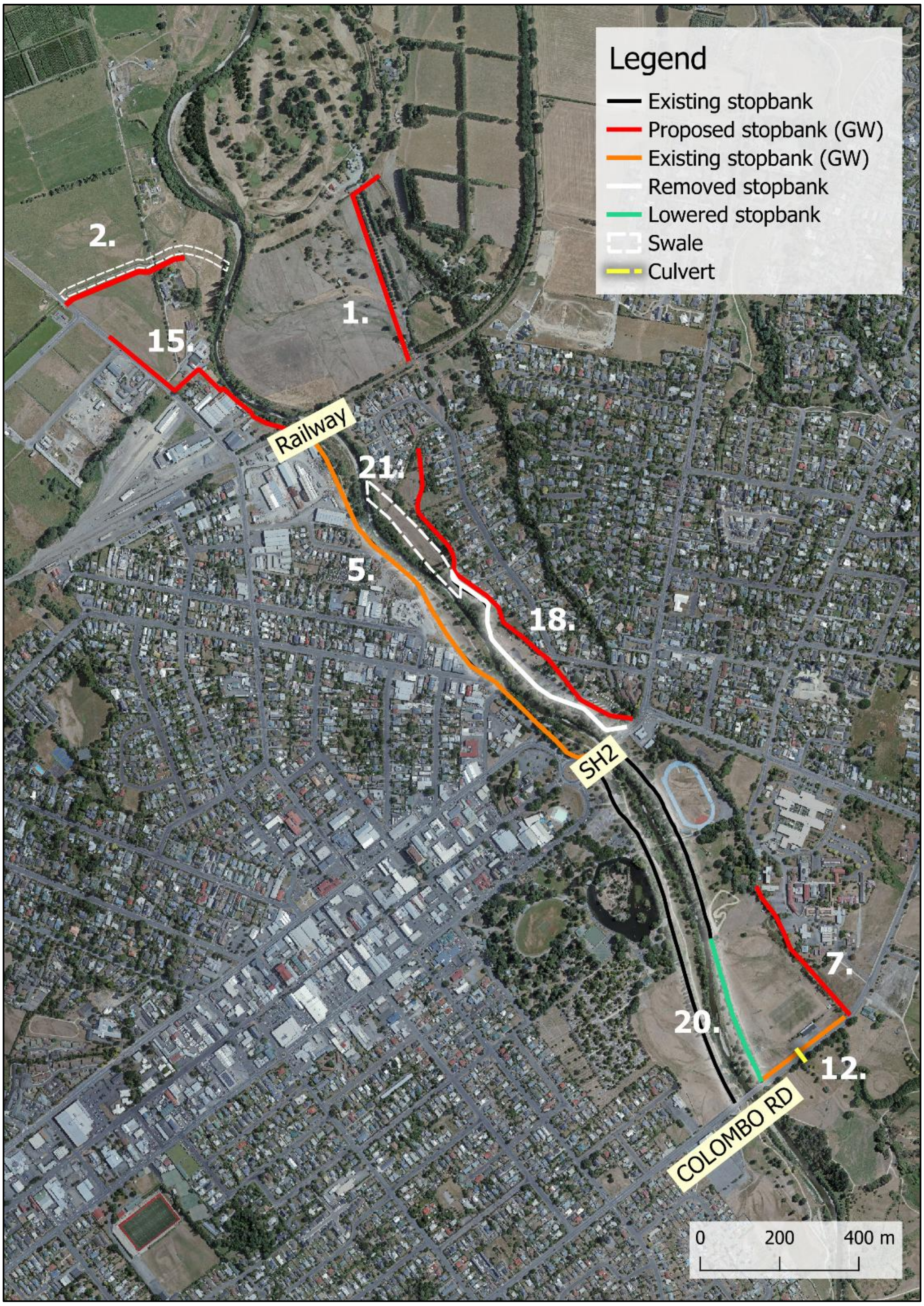

Figure 3-60: Combined Option 10

The depth and depth difference maps between the base scenario and Combined Option 10 for a 1% AEP RCP6.0 flow event are presented in Figure 3-61 and Figure 3-62. Results demonstrate:

- A similar reduction in flooding downstream of the railway as with Combined Options 2 and 3 where the flood extent is significantly reduced in the township west of the river, although flooding remains, albeit slightly reduced in depth, near Pownall St and down Lincoln Rd. Depths in these flooded areas are less than 0.5 m as shown by the depth map.
- Increase in water levels at all three bridges by 0.1-0.3 m, which is slightly lower than with Combined Option 9 (C9) which saw an increase of up to 0.5 m.
- A comparable decrease in water levels around the Oxford St swale to those in C9 results.
- New flooding downstream of the BMX track up to 2.0 m.

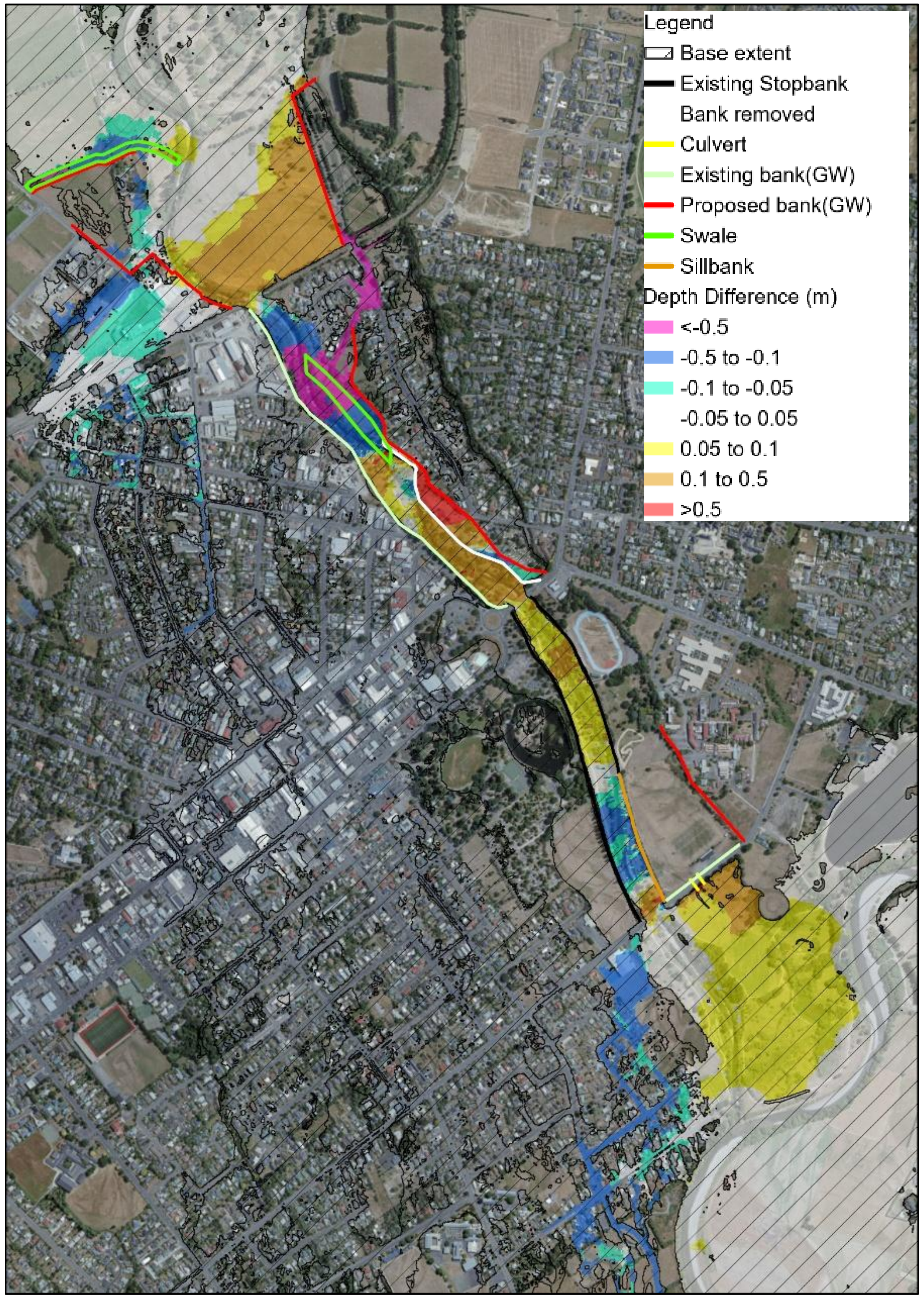

Figure 3-61: Combined Option 10 depth difference map.

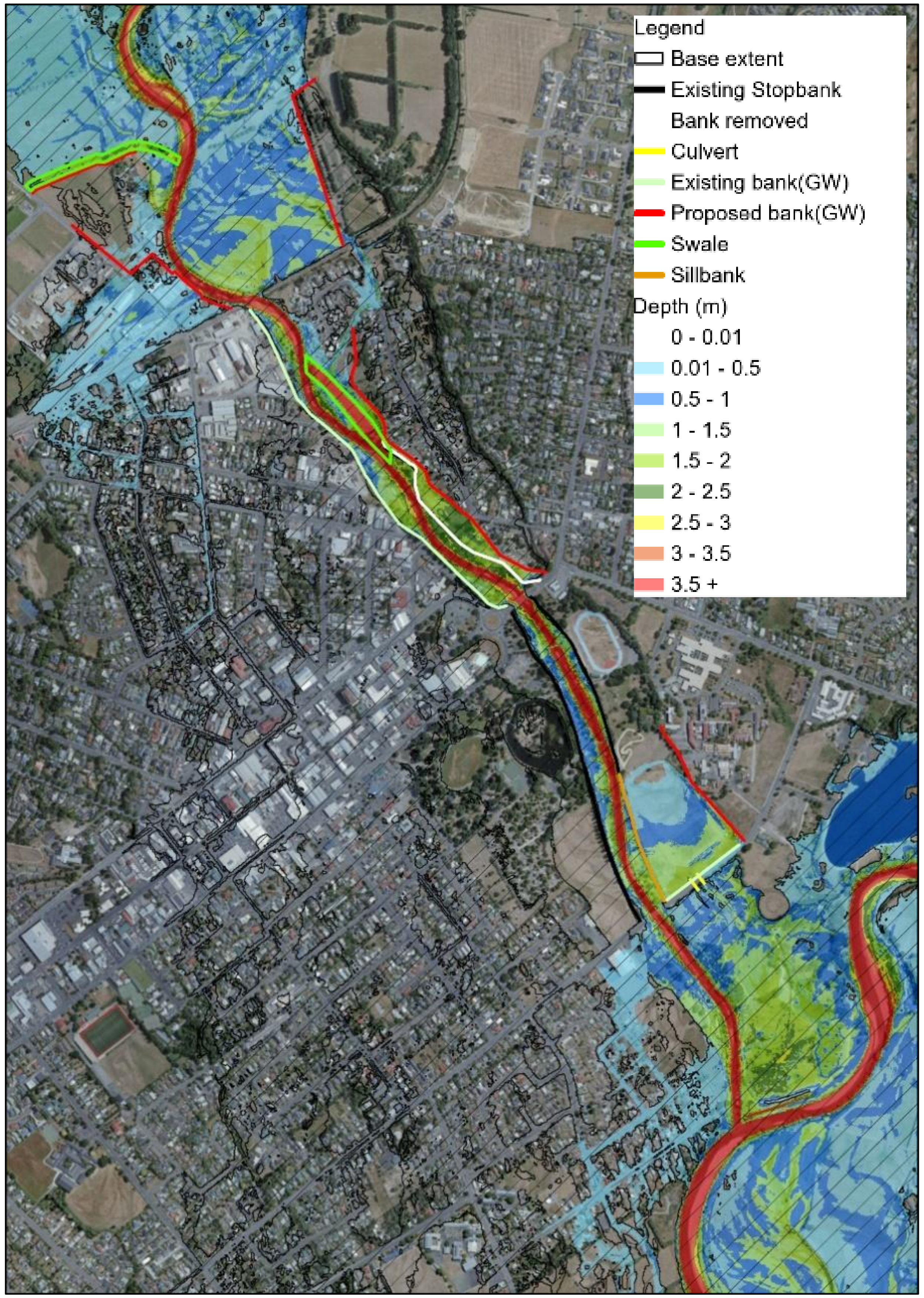

Figure 3-62: Combined Option 10 depth map.

3.2.10. COMBINED OPTION 11

Combined Option 11 merges the elements (or variations thereof) of Combined Option 3 and Individual Option 13. We note the alternative Option 12 culvert beneath Colombo Rd was modelled as two culverts, as well as the alternative Option 18 stopbank alignment providing partial protection to Mawley Holiday Park (Figure 3-63).

The model was set up in two different ways; A) with the swale at Oxford St (Individual Option 21) and B) without the swale at Oxford St.

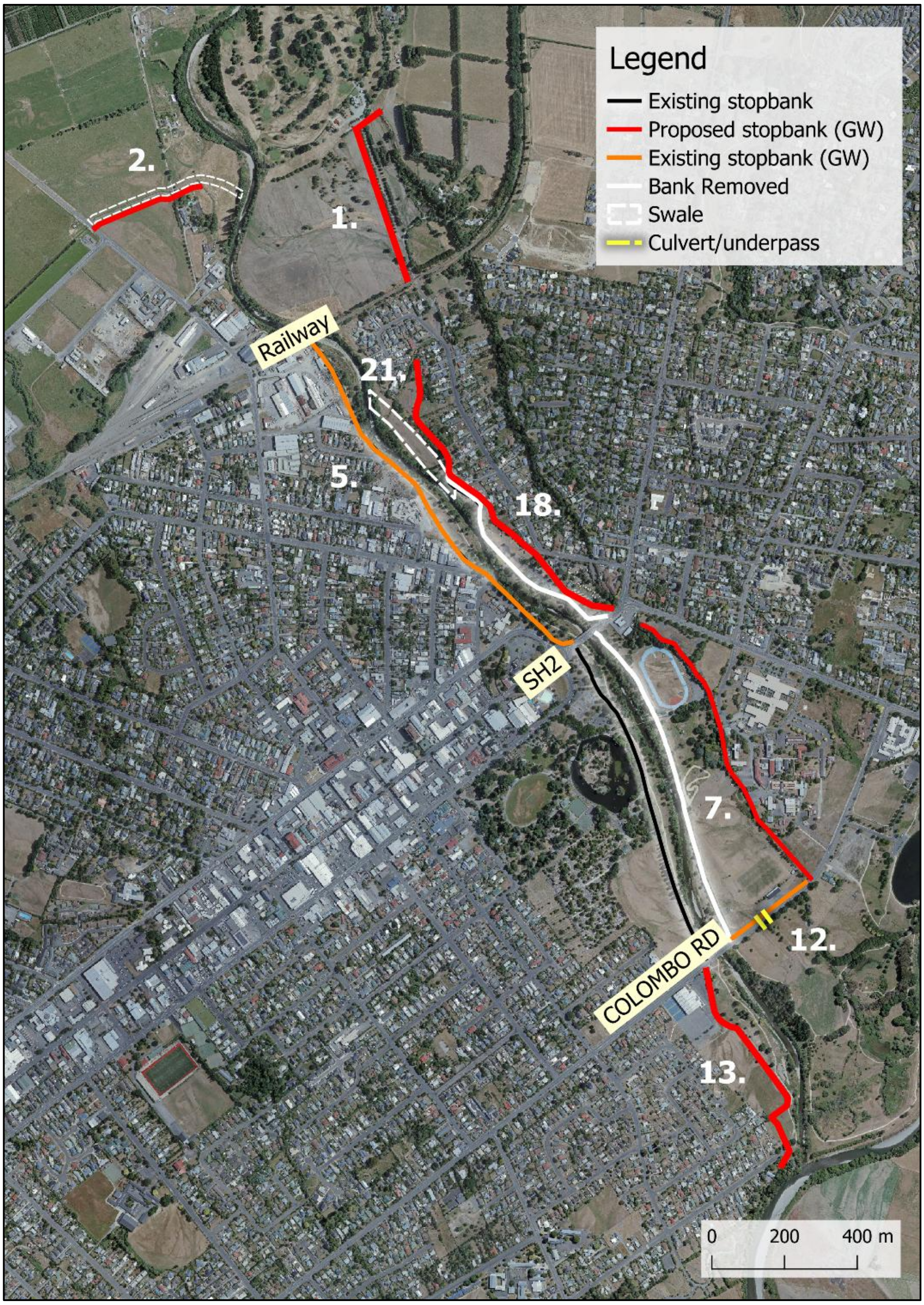

Figure 3-63: Combined Option 11

Land River Sea
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The depth difference maps between the base scenario and Combined Option 11, with and without the bund at the Akura Rd swale, for a 1% AEP RCP6.0 flow event are presented in Figure 3-64 and Figure 3-65, respectively. Results are similar to those of Combined Option 3 in that:

- Both with and without the swale at Oxford St, there is a significant decrease in flood extent through Masterton township west of the river, although flooding remains, albeit slightly reduced in depth, near Pownall St and down Lincoln Rd.
- There is an increase in water levels at all three bridges both with and without the swale.
- Increased flood depths in Masterton Trails wetland area up to 0.5 m.

However, in Combined Option 11, there is no flooding behind the Mawley Park stopbank, at the southern end of Oxford St. Additionally, in-channel water levels and flood levels at the northern end of Oxford St are significantly reduced (>0.5 m) compared to C3.

Notably, in-channel water levels between SH2 and Colombo Rd are significantly reduced with the swale (C11A) than without the swale (C11B).

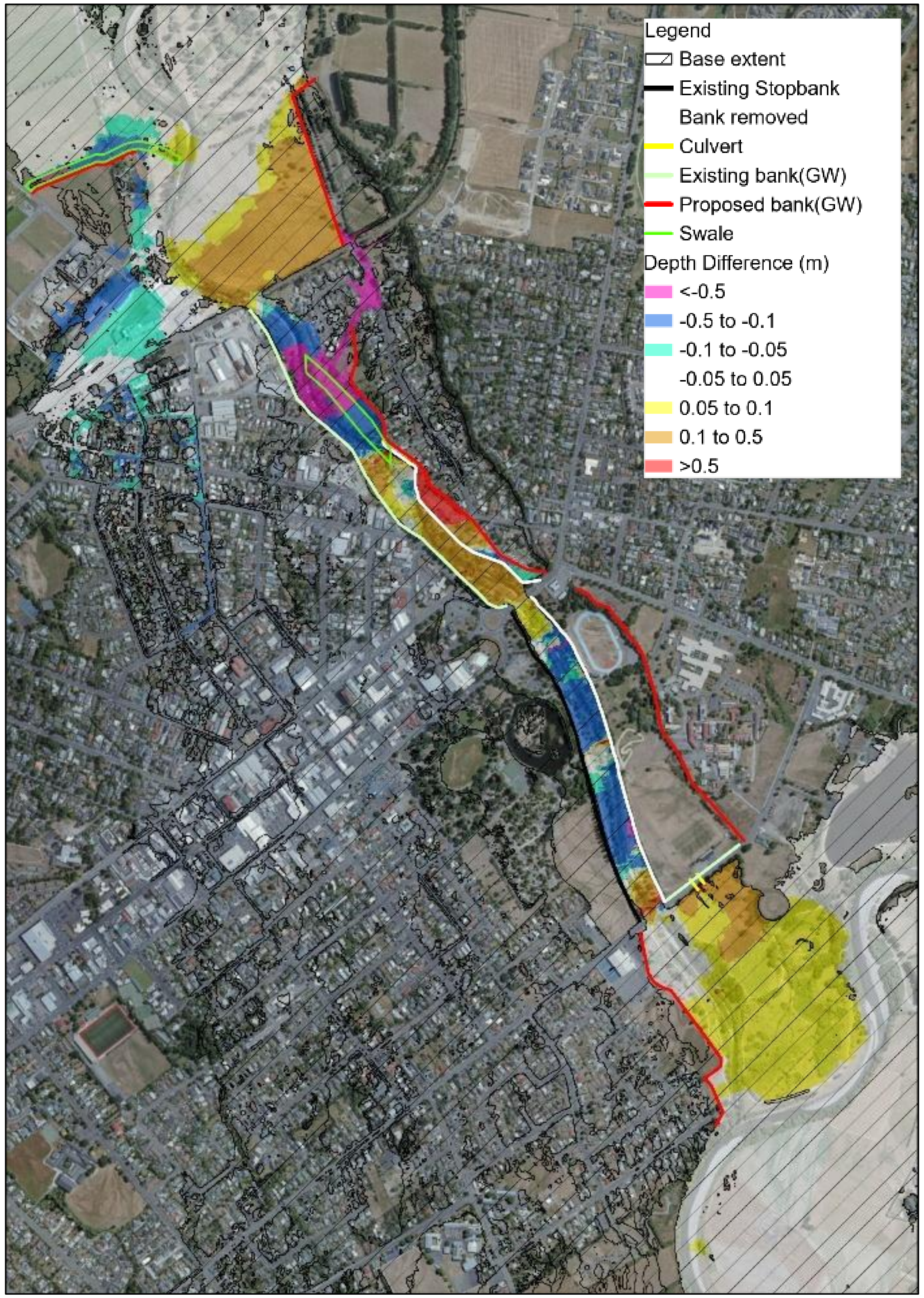

Figure 3-64: Combined Option 11A depth difference map (with swale at Oxford St).

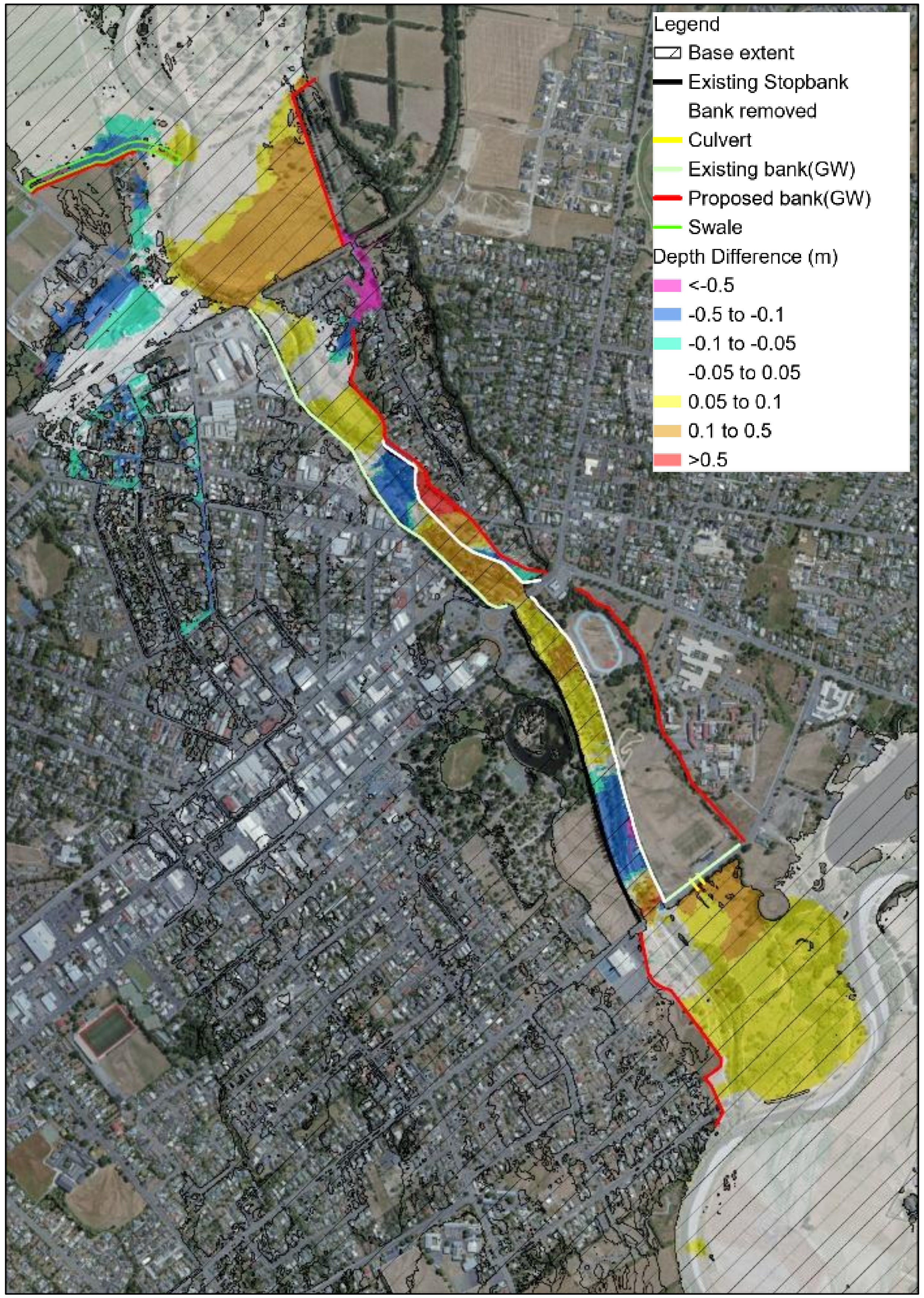

Figure 3-65: Combined Option 11B depth difference map (without swale at Oxford St).

3.2.11. COMBINED OPTION 12

Combined Option 12 merges the elements of Combined Option 11 and Individual Option 22, which investigated widening the Waipoua River channel upstream of SH2 and upstream of Colombo Rd (Figure 3-40). The model was set up in two ways; A) with the swale near Oxford St and B) without the swale.

The depth difference maps between the base scenario and Combined Option 12 for a 1% AEP RCP6.0 flow event, with and without the Oxford St swale are presented in Figure 3-66 and Figure 3-67, respectively.

Results for each scenario are very similar to those of C11, with the most notable difference being between C11B and C12B, whereby the channel widening proposed in Combined Option 12 significantly reduces in-channel water levels between the SH2 and Colombo Rd bridges when the Oxford St swale is excluded from the scheme.

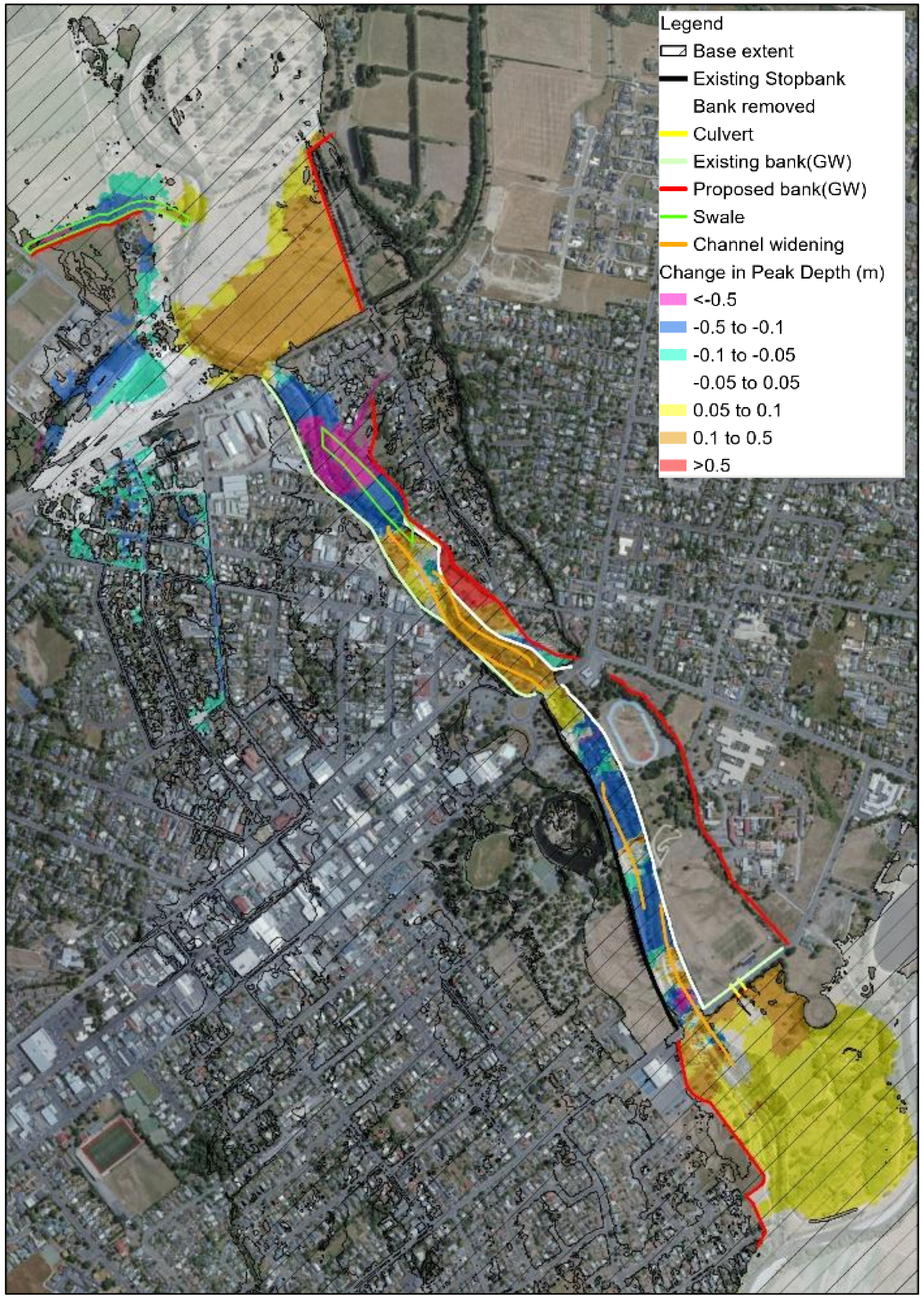

Figure 3-66: Combined Option 12 depth difference map (with swale at Oxford St).

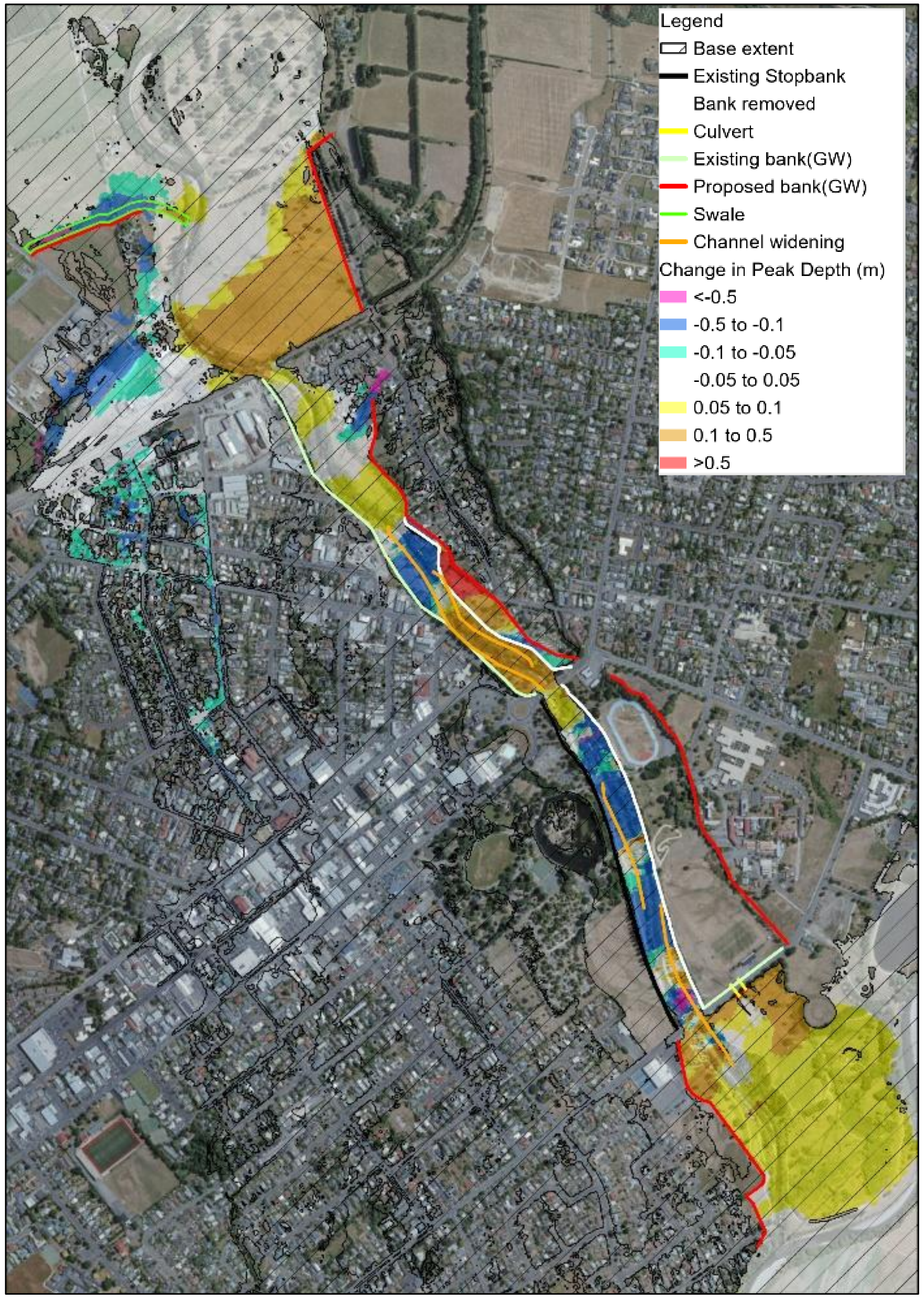

Figure 3-67: Combined Option 12 depth difference map (without swale at Oxford St).

3.2.12. COMBINED OPTION 13

Combined Option 13 modelled the base scenario with the Waipoua River channel widened and berms lowered in reaches between the railway and Colombo Rd. Cross-sectional profiles of the altered channel are provided in Figure 3-68 and Figure 3-69.

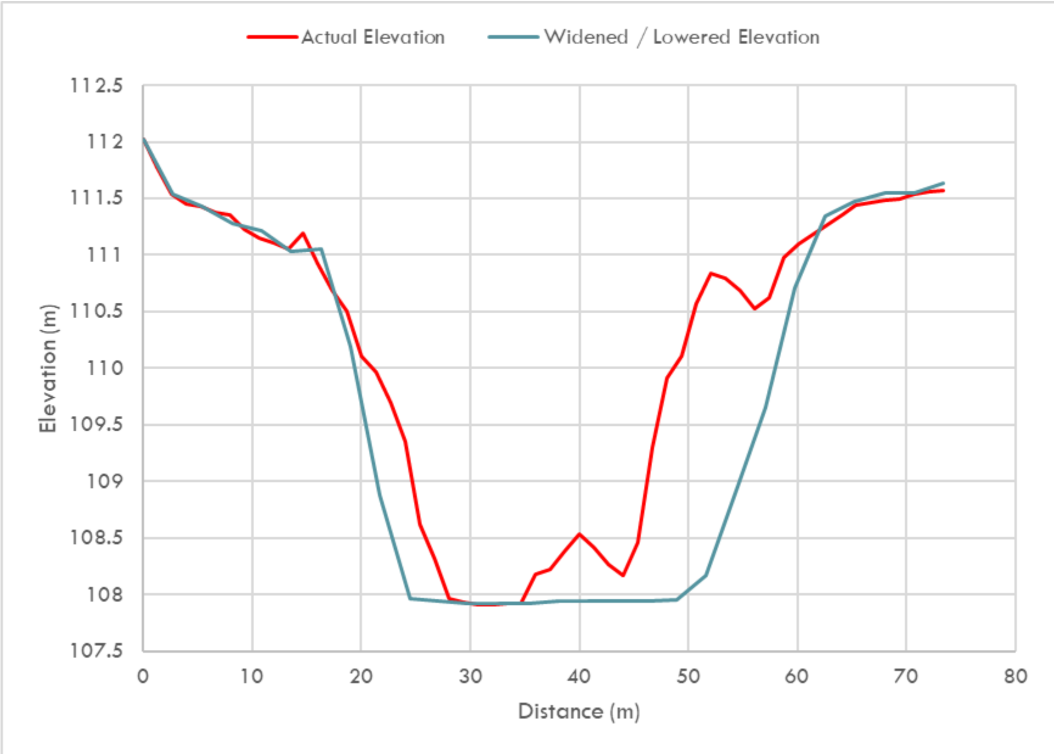

Figure 3-68: Example of channel widening immediately downstream from Colombo Rd Bridge.

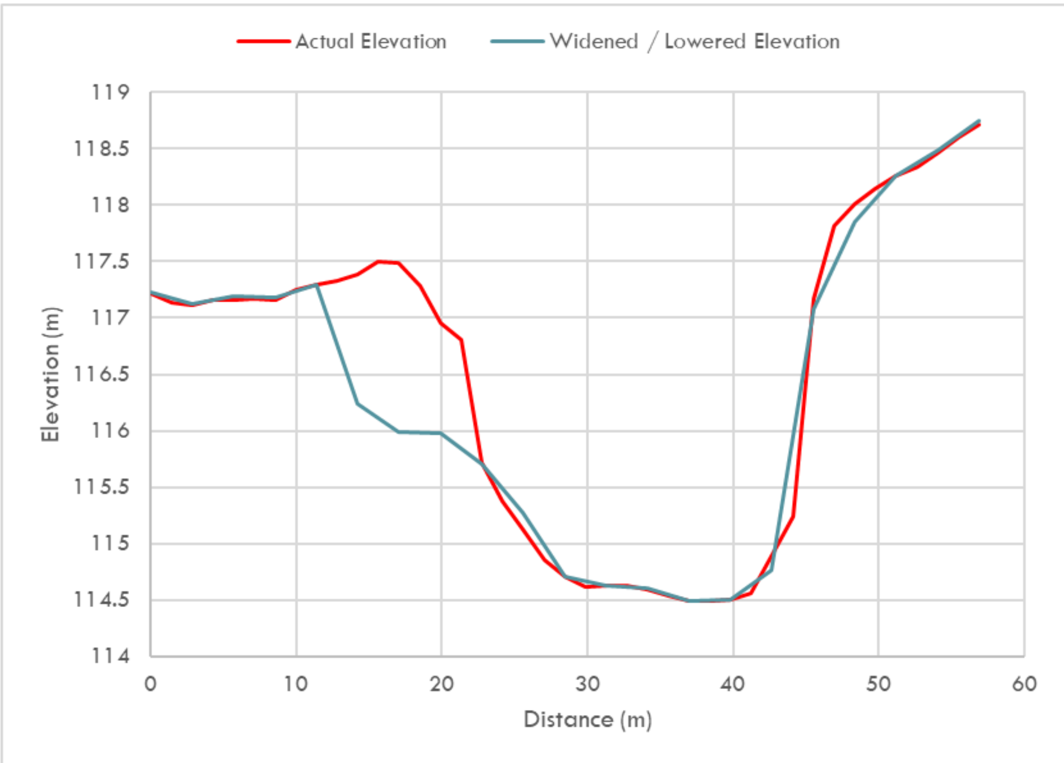

Figure 3-69: Example of berm lowering on left bank adjacent to Mawley Park

The depth difference layer for a 1% AEP flow between the base scenario and Combined Option 13 is presented in Figure 3-70 and demonstrates:

- A significant reduction in flood levels up to 0.5m throughout the town on both sides of the river, and within the channel.
- Water levels are not shown to increase anywhere across Masterton

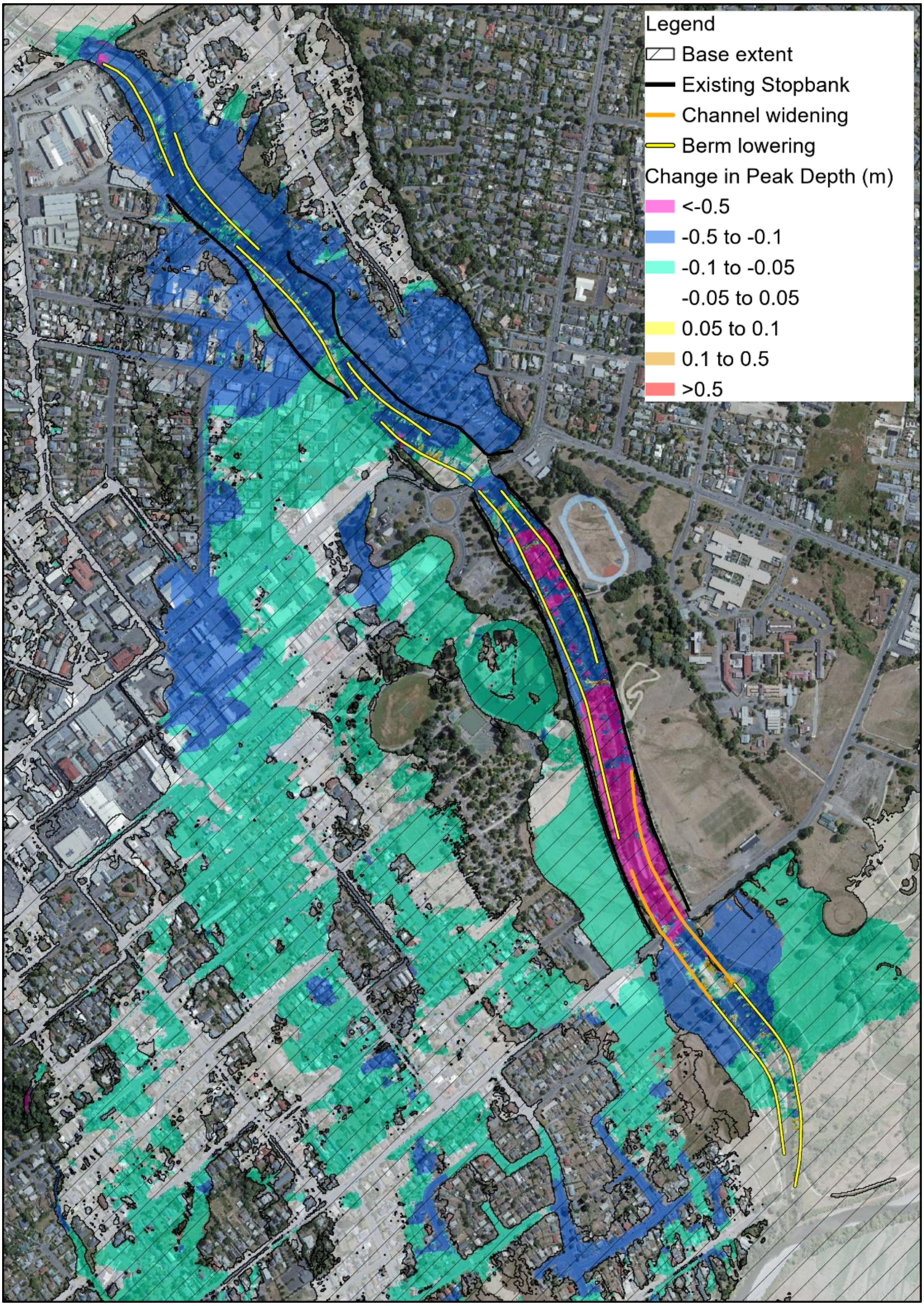

Figure 3-70: Combined Option 13 depth difference map.

3.2.13. COMBINED OPTION 14

Combined Option 14 merges elements of Combined Option 12B (without the Oxford St swale) and Combined Option 13. Note C14 varies from C12 in that the left stopbank between SH2 and Colombo is not entirely removed (as in C12B and I7) but rather partially lowered downstream of the BMX track, as per Individual Option 20.

The model was set up in two ways; A) with a bund around the buildings upstream of the railway, as shown in Combined Option 9 (Figure 3-59) and B) without the aforementioned bund. The depth difference maps between the base scenario and both Combined Option 14 scenarios for a 1% AEP RCP6.0 flow event are presented in Figure 3-71 and Figure 3-72.

Results are similar to those of Combined Option 12 although the reduction in flood levels are generally greater with the widened channel in C14, particularly in-channel levels downstream of the railway line as well as in the Masterton Trails wetland. For example, in-channel water levels between SH2 and Colombo Rd are reduced by >0.5 m in C14 compared to 0.1-0.5 m in C12.

Subsequently, there is also a notable reduction in flood levels at the bridges compared to the base scenario; in the order of 0.1-0.2m at the railway bridge and up to 0.6 m at Colombo Rd. At the SH2 bridge there is still a slight increase in water levels on the left side (0.07 m) but also a decrease on the right side of 0.1-0.14 m.

The inclusion of the bund around buildings upstream of the railway (C14B) slightly increases the flood levels upstream and up to 0.05 m at the railway bridge.

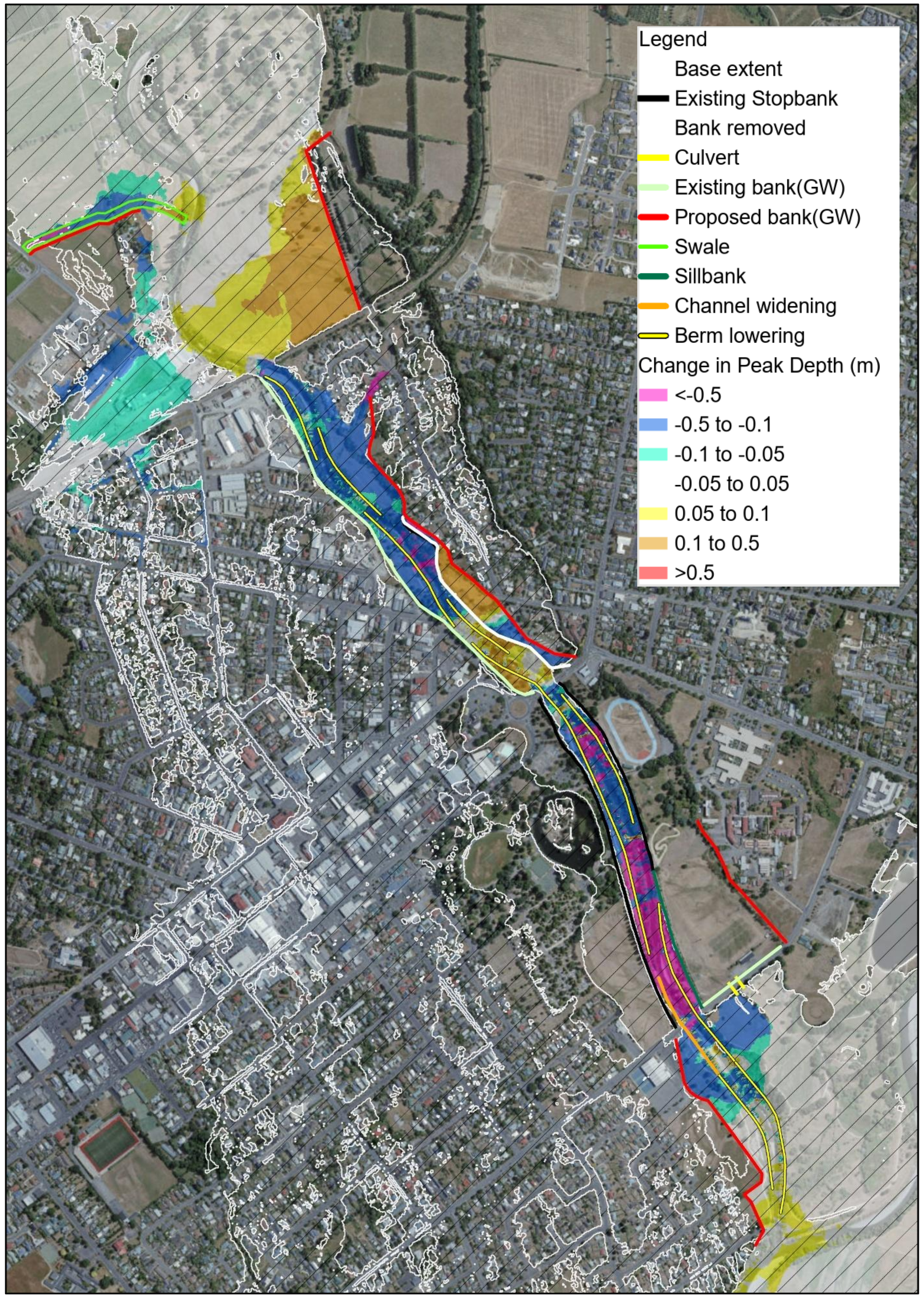

Figure 3-71: Combined Option 14A depth difference map (without bund at Railway bridge).

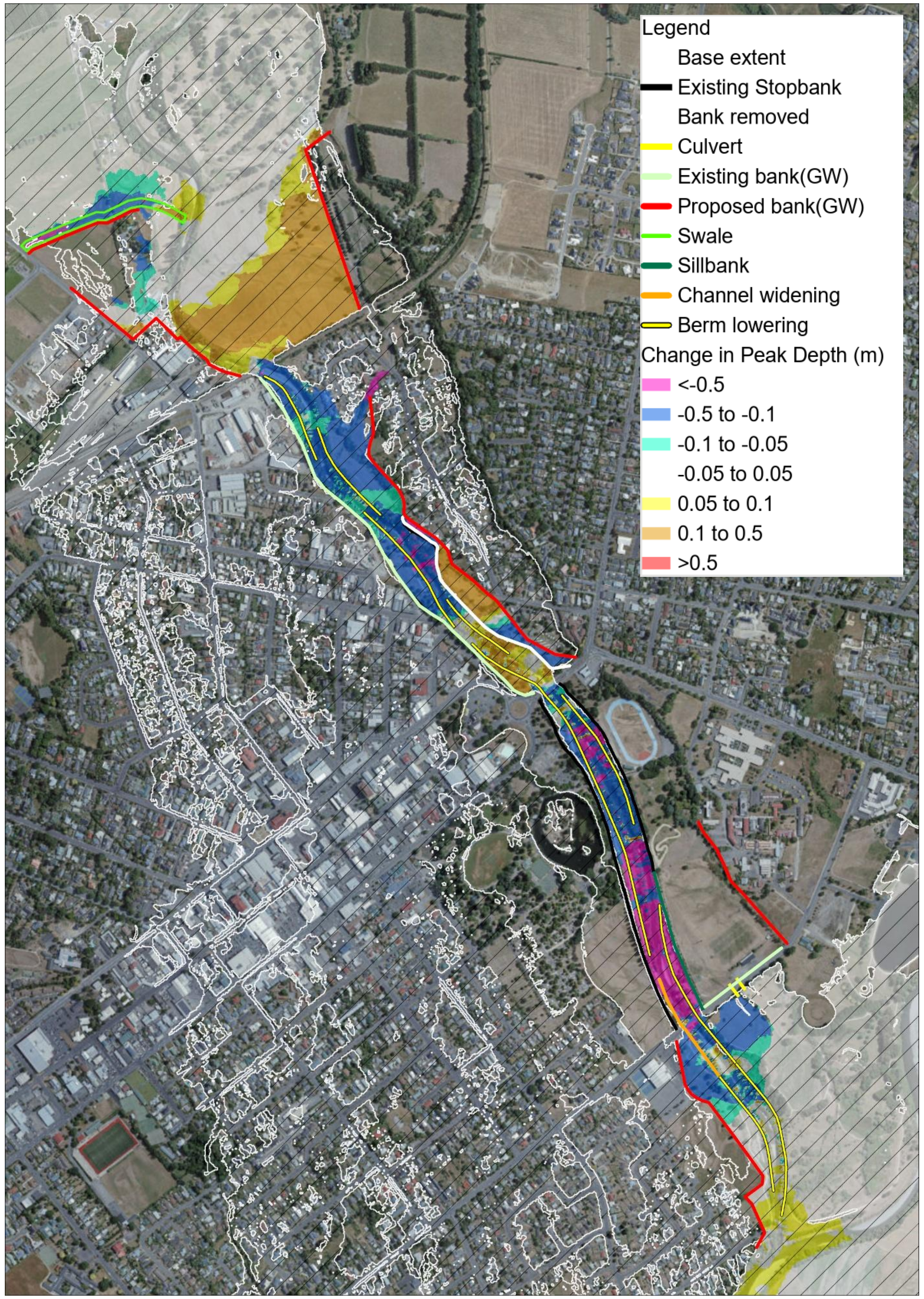

Figure 3-72: Combined Option 14B depth difference map (with bund at Railway bridge).

3.2.14. COMBINED OPTION 15

Combined Option 15 merges elements of Combined Option 12B (without the Oxford St swale) and Combined Option 13, whereby the Waipoua River berm was lowered and channel widened in several places. Note the difference between C14 and C15 is a slight change in alignment of the Mawley Park stopbank as well as the left stopbank removal between SH2 and Colombo Rd.

The model was set up in two ways; A) with a bund around the buildings upstream of the railway and B) without the aforementioned bund.

The depth difference maps between the base scenario and both Combined Option 15 scenarios for a 1% AEP RCP6.0 flow event, with and without the railway bund, are presented in Figure 3-73 and Figure 3-74, respectively. Results demonstrate:

- Similar to C14, there is a significant reduction in flood levels in the channel and at the bridges, although notably more so downstream of SH2 in C15, where effectively the entire reach down to Colombo Rd is reduced by >0.5 m.
- Flood extent in Mawley Park is greater in C15 than C14 due to the change in alignment of the true left stopbank, although still largely reduced in depth in the order of 0.1-0.5 m compared to the base scenario.

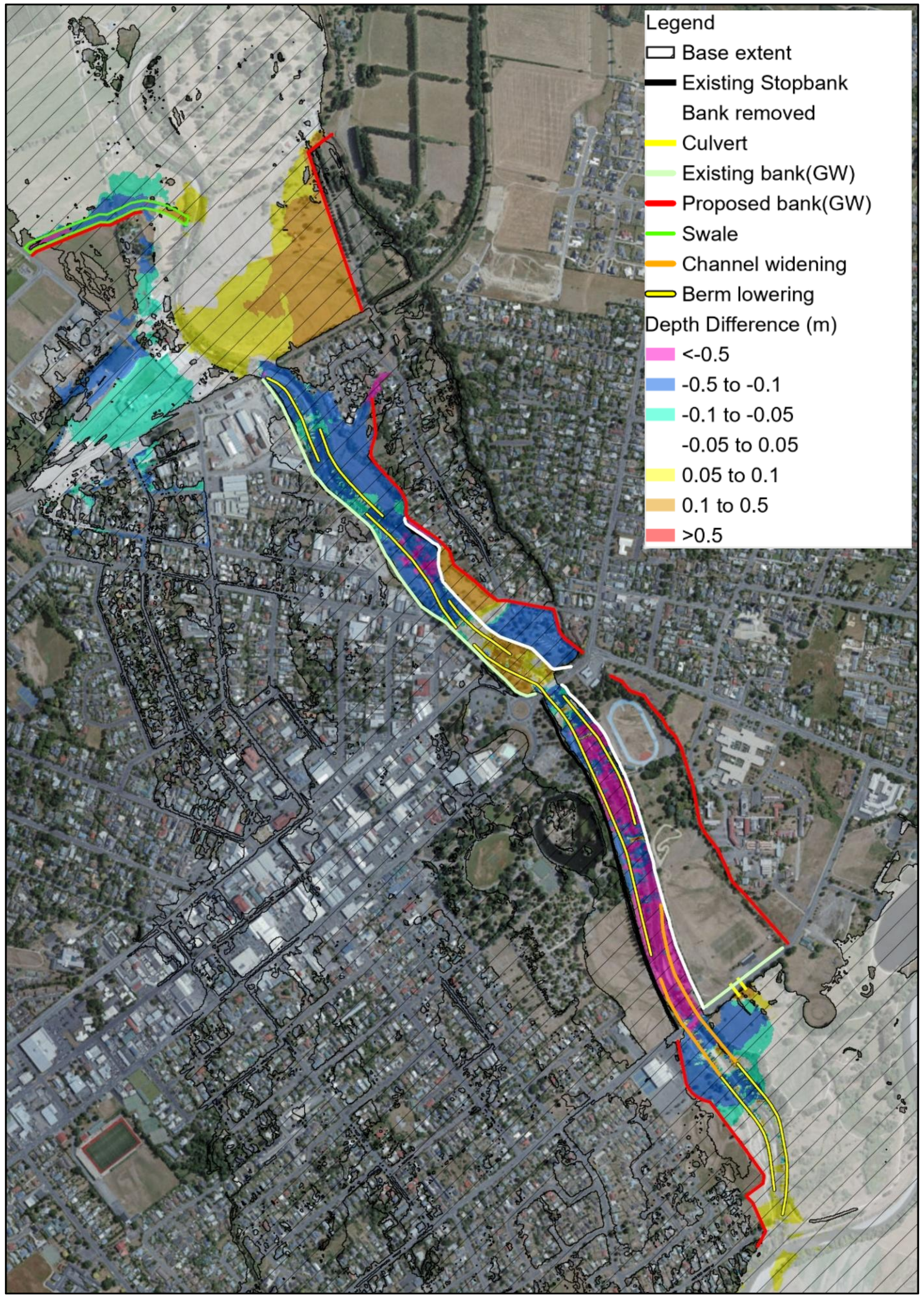

Figure 3-73: Combined Option 15 depth difference map (without bund at Railway bridge).

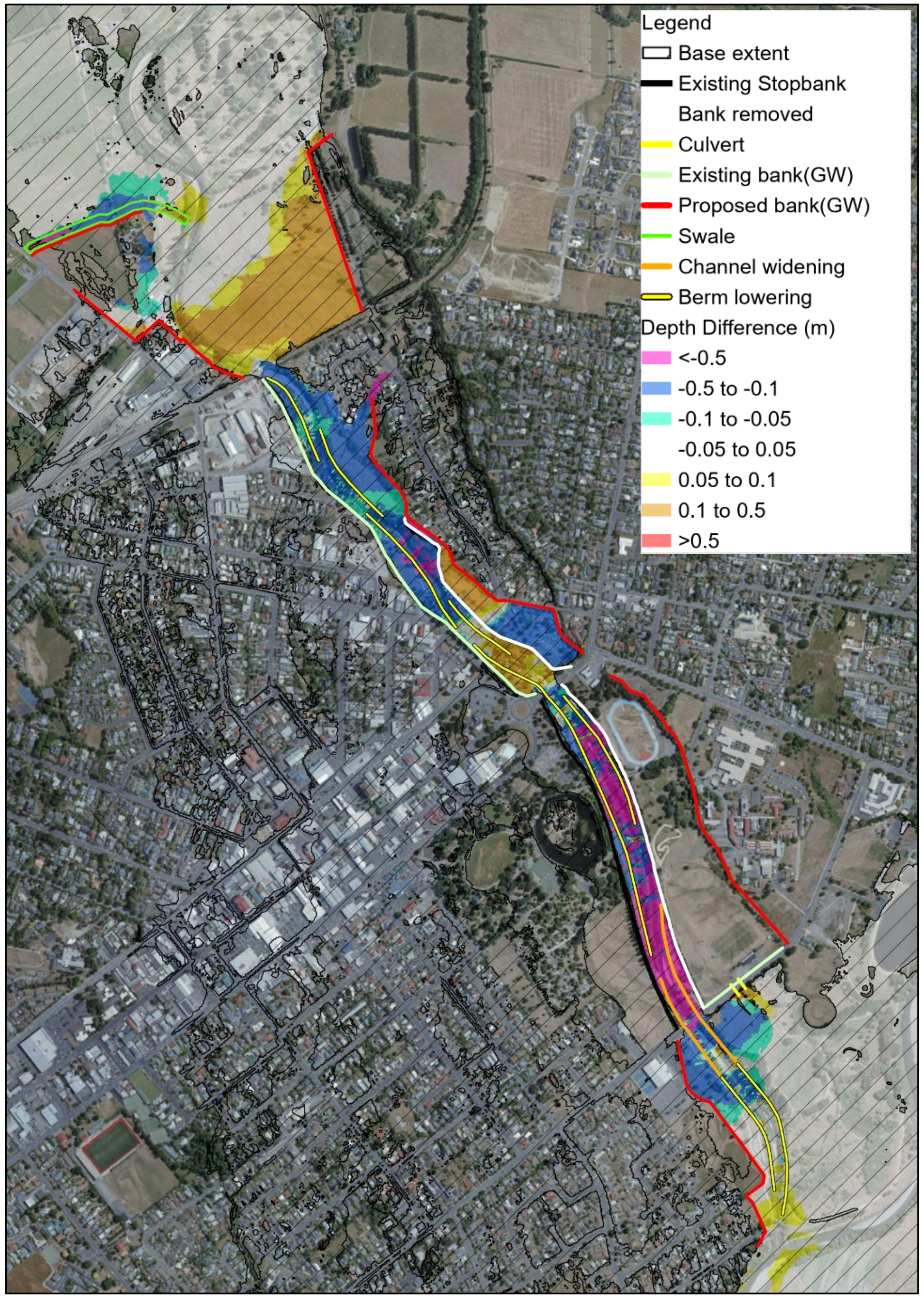

Figure 3-74: Combined Option 15 depth difference map (with bund at Railway bridge).

3.3. FINAL ITERATION OPTIONS

The Final Iteration Options were curated based on the best-performing Combined Options. Descriptions of the Final Iteration Options are listed in Table 3-3.

Table 3-3: Details of the Final Iteration Options simulated in the Waipoua hydraulic model

Final Iteration	Constituent Measures (or variations thereof)	Variations
1	*1. Proposed stopbank along Mahunga Dr* *2. Proposed Akura Rd swale with bund* *5. True right stopbank between railway and SH2 upgraded* *13. Cameron Cr stopbank* *15. True right stopbank upstream of railway line along Akura Rd* *18A (variation of). Stopbank upgrades along current alignments, protecting Mawley Holiday Park* *22. Channel widening in sections*	1B. Extension at northern end of Mawley Park stopbank up to railway embankment
2	Final Iteration Option 1, except: *21. Swale in true left berm near Oxford St* *18A. Different alignment to that used in Final Option 1 (Mawley Holiday Park remains protected)* *C13. Channel widening **and** berm lowering in sections*	2B: Variation of Mawley Park stopbank as per Final Iteration Option 1B
3	Final Iteration Option 1, except: *7. Room for the river with true left stopbank between SH2 and Colombo Rd pushed back to terrace edge.* *18. Stopbank located behind Mawley Park, leaving it unprotected (instead of Option 18A)*	3B: Variation of Mawley Park stopbank as per Final Iteration Option 1B
4	Final Iteration Option 1, except: *5% reduction in flow to approximate upstream nature-based measures*	4B: Variation of Mawley Park stopbank as per Final Iteration Option 1B
5	Final Iteration Option 1, except: *1. Change to the stopbank alignment upstream of the railway line along Akura Rd*	
6	Final Iteration Option 1, except: *1. Change to the Mahunga Dr stopbank alignment*	
7	Final Iteration Option 3, except *7. Proposed bank at terrace edge is not included*	

3.3.1. FINAL ITERATION OPTIONS 1 AND 4

Refer to Table 3-3 for information on the individual options that comprise Final Iteration Option 1. Final Iteration 1B is identical to Final Iteration 1 except it includes an extension to the Mawley Holiday Park stopbank. Maps of Final Iteration Options 1 and 1B are presented in Figure 3-75 and Figure 3-76, respectively.

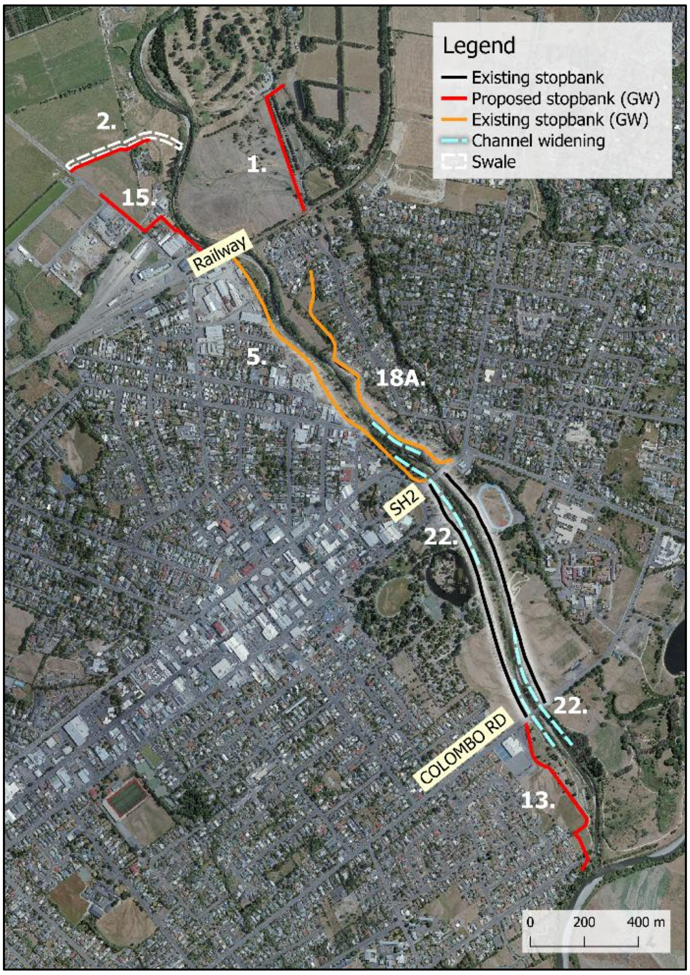

Figure 3-75: Final Iteration Option 1

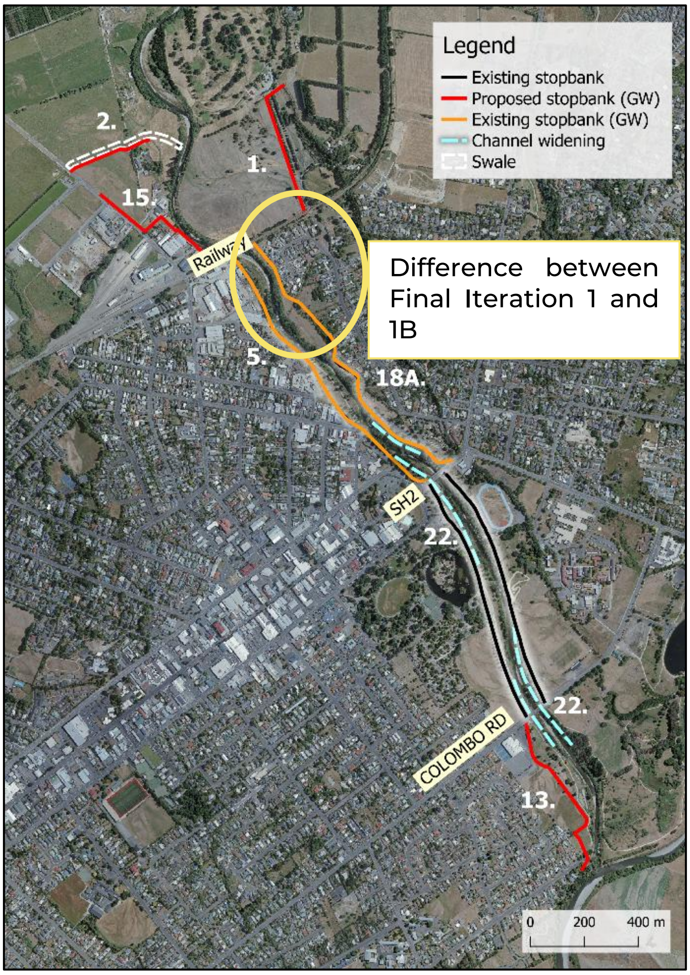

Figure 3-76: Final Iteration Option 1B

Final Iteration 4 is identical to Final Iteration 1 except the model was set up with a 5% flow reduction to simulate the effect of potential nature-based solutions upstream. Final Iteration 4B is identical to Final Iteration 4 except that it includes the extension to the Mawley Park stopbank, as per Final Iteration Option 1B.

The depth difference maps between the base scenario and Final Iterations 1 and 1B, respectively, for a 1% AEP RCP6.0 flow event are presented in Figure 3-77 and Figure 3-78. The flood extents and depths are nearly identical for Final Iterations 1 and 1B, with the difference between results in the order of ±0.05 m.

Compared to the base scenario, both options demonstrate:

- No flooding across the majority of Masterton, except at the northern end of Oxford St (only with Option 1).

- Increased water levels in the Mahunga wetland area immediately upstream of the railway line in the order of 0.1-0.5 m.
- Increased water levels around the Whitipoua Bridge in the order of 0.3-0.5 m.
- Increased water levels in the Masterton Trails wetland area in the order of 0.05-0.1 m.
- Decreased water levels around the SH2 and Colombo Rd bridges by greater than 0.5 m.

The depth difference maps between the base scenario and Final Iteration Options 1 and 4, respectively, for a 1% AEP RCP6.0 flow event are presented in Figure 3-79 and Figure 3-80 for side-by-side comparison. As expected, Final Iteration 4, with 5% less flow, shows decreased flood depths throughout the scheme compared to Final Iteration 1. Differences between the two options are most notable:

- In the Mahunga wetland upstream of the railway where flood depths are 0.1-0.15 m lower with Final Iteration Option 4.
- In the channel where flood depths are in the order of 0.1-0.12 m lower with Final Iteration Option 4.

Elsewhere, in the Masterton Trails wetland and Akura Rd area, flood depths are generally in the order of 0.05 m lower with Final Iteration Option 4.

The flood extents and depths are nearly identical for Final Iteration Option 4 and 4B, with a difference in results of ±0.05 m.

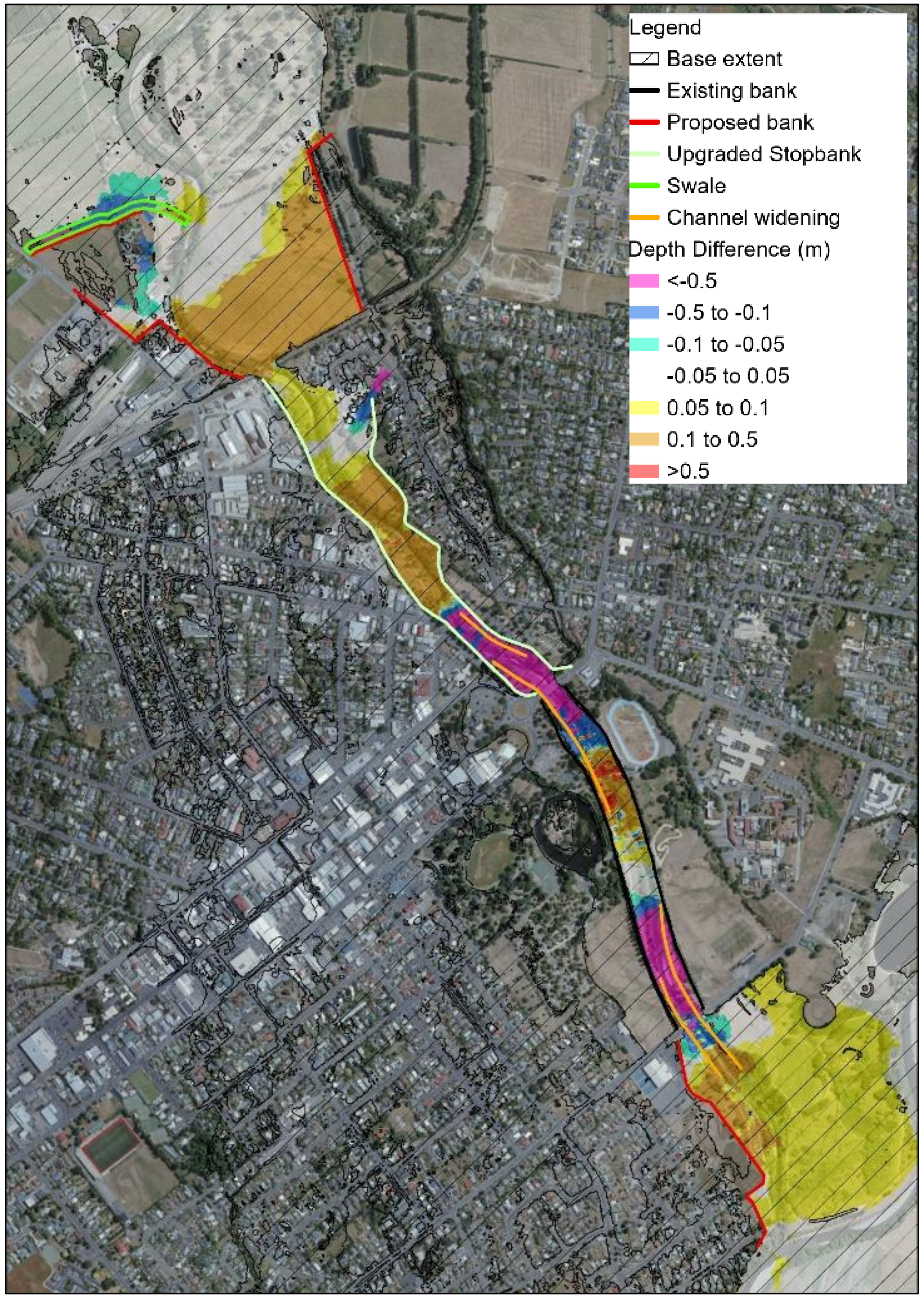

Figure 3-77: Final Iteration Option 1 depth difference map.

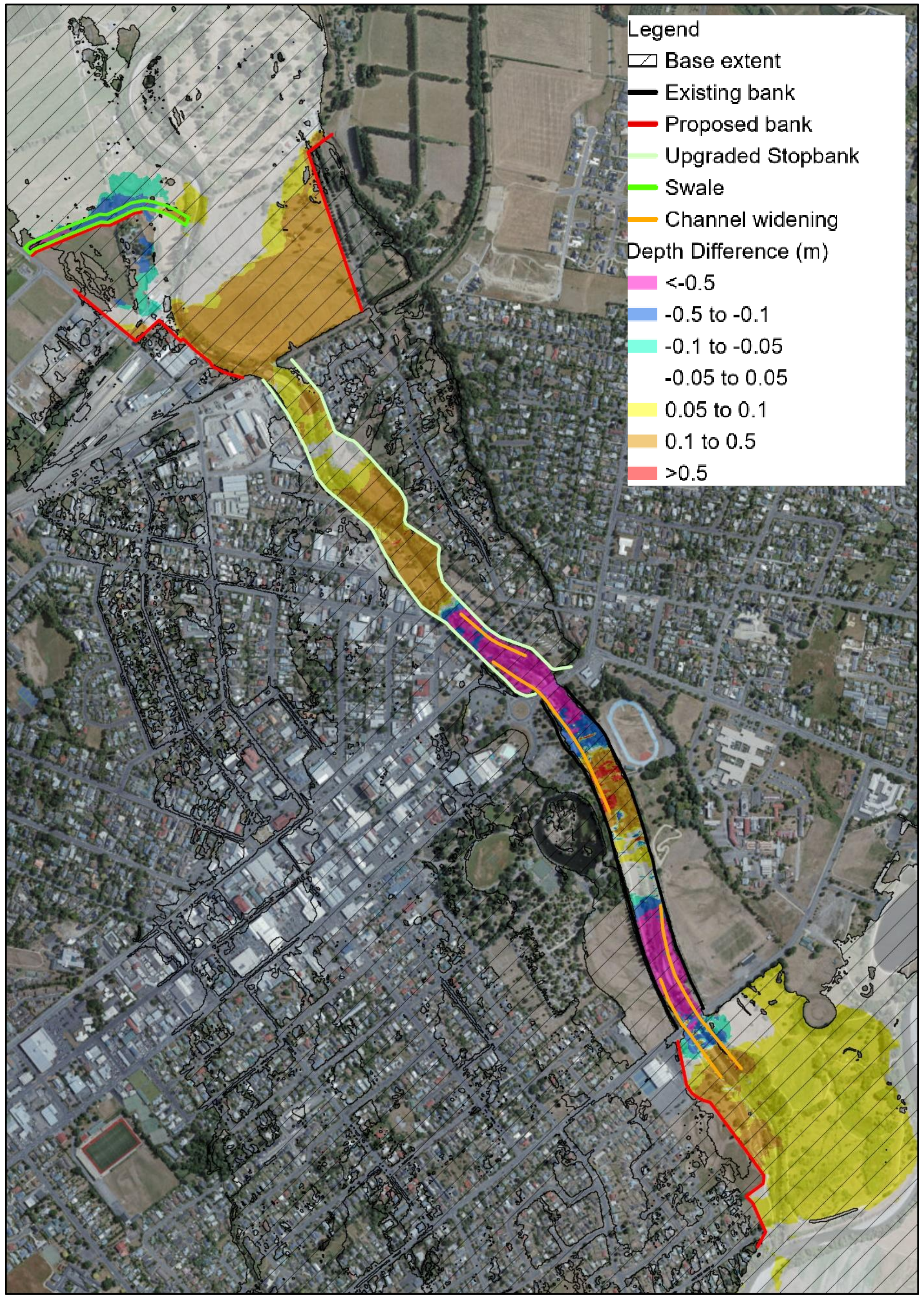

Figure 3-78: Final Iteration Option 1B depth difference map (Mawley Park stopbank extension).

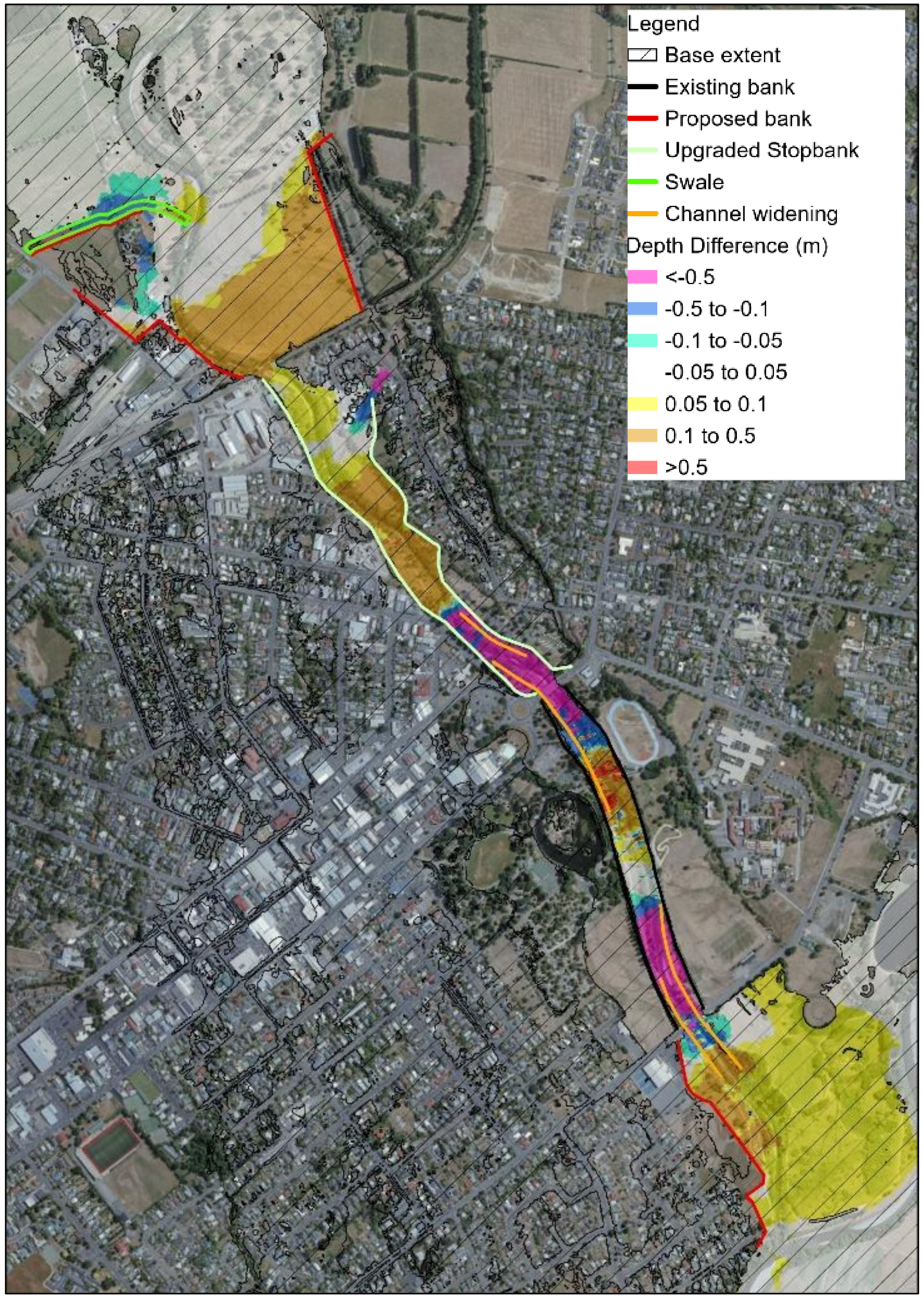

Figure 3-79: Final Iteration Option 1 depth difference map.

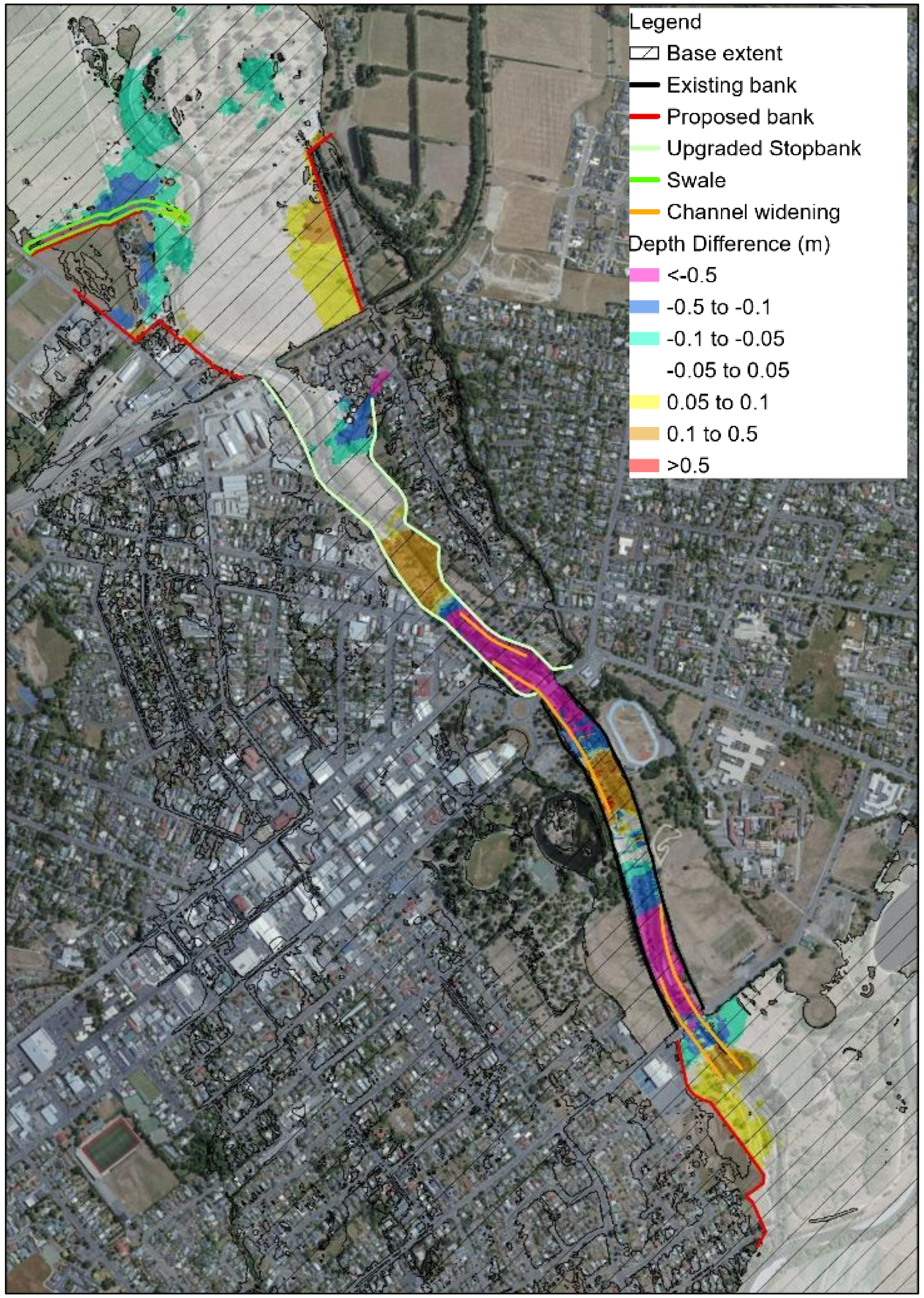

Figure 3-80: Final Iteration Option 4 depth difference map

3.3.2. FINAL ITERATION OPTIONS 5 AND 6

Final Iteration Options 5 and 6 are both slight variations of Final Iteration 1B whereby:

- Final Iteration 5 investigates the effect of a change to the stopbank alignment upstream of the railway line along Akura Rd. The depth difference map (Figure 3-81) shows effectively no change from Option 1B.
- Final Iteration 6 investigates the effect of a change to the Mahunga Dr stopbank alignment. Depth difference map (Figure 3-82) shows effectively no change from Option 1B, except near the Mahunga Dr wetland where flood depths are greater by 0.1-0.5 m.

The depth difference maps between Final Iteration Option 1 and Final Iteration Options 5 and 6, respectively, for a 1% AEP RCP6.0 flow event are presented in Figure 3-81 and Figure 3-82.

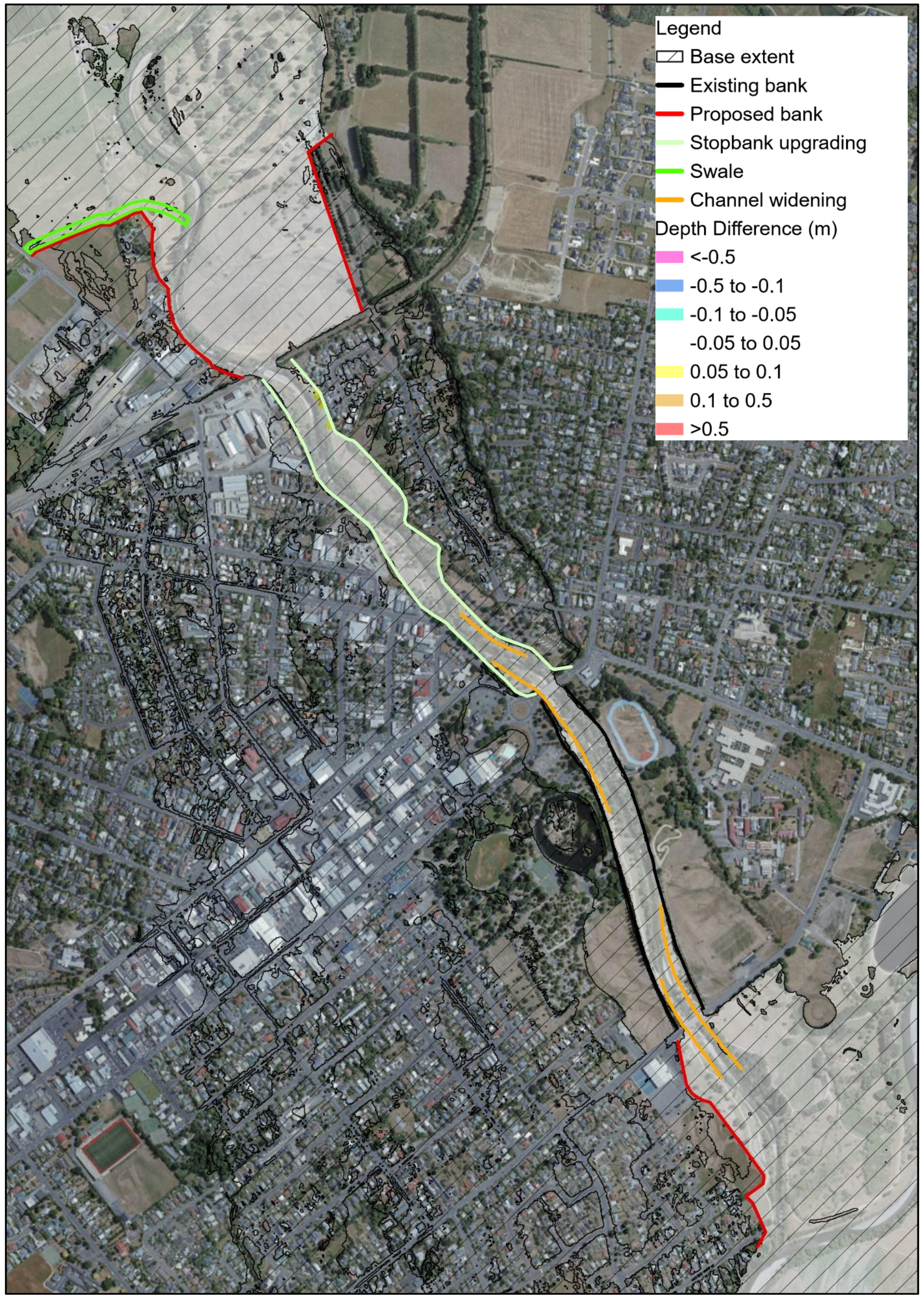

Figure 3-81: Final Iteration Option 5 depth difference with Final Iteration Option 1B

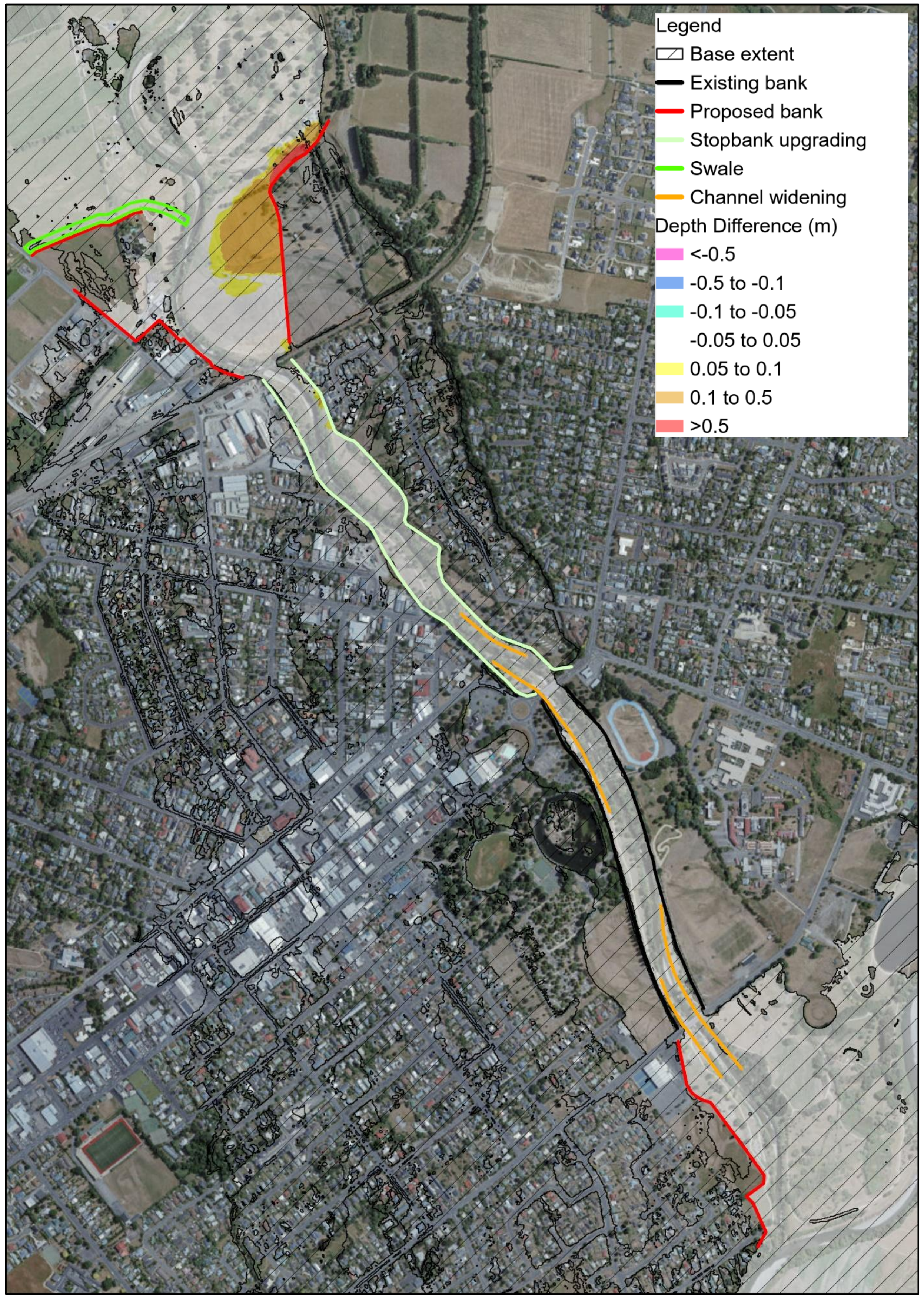

Figure 3-82: Final Iteration Option 6 depth difference map with Final Iteration Option 1B

3.3.3. FINAL ITERATION OPTION 2

A map of the elements of individual (and combined) options that comprise Final Iteration Option 2 are shown in Figure 3-83. Final Iteration 2B is identical to Final Iteration 2 except it includes an extension to the Mawley Holiday Park stopbank, as per Final Iteration Option 1B.

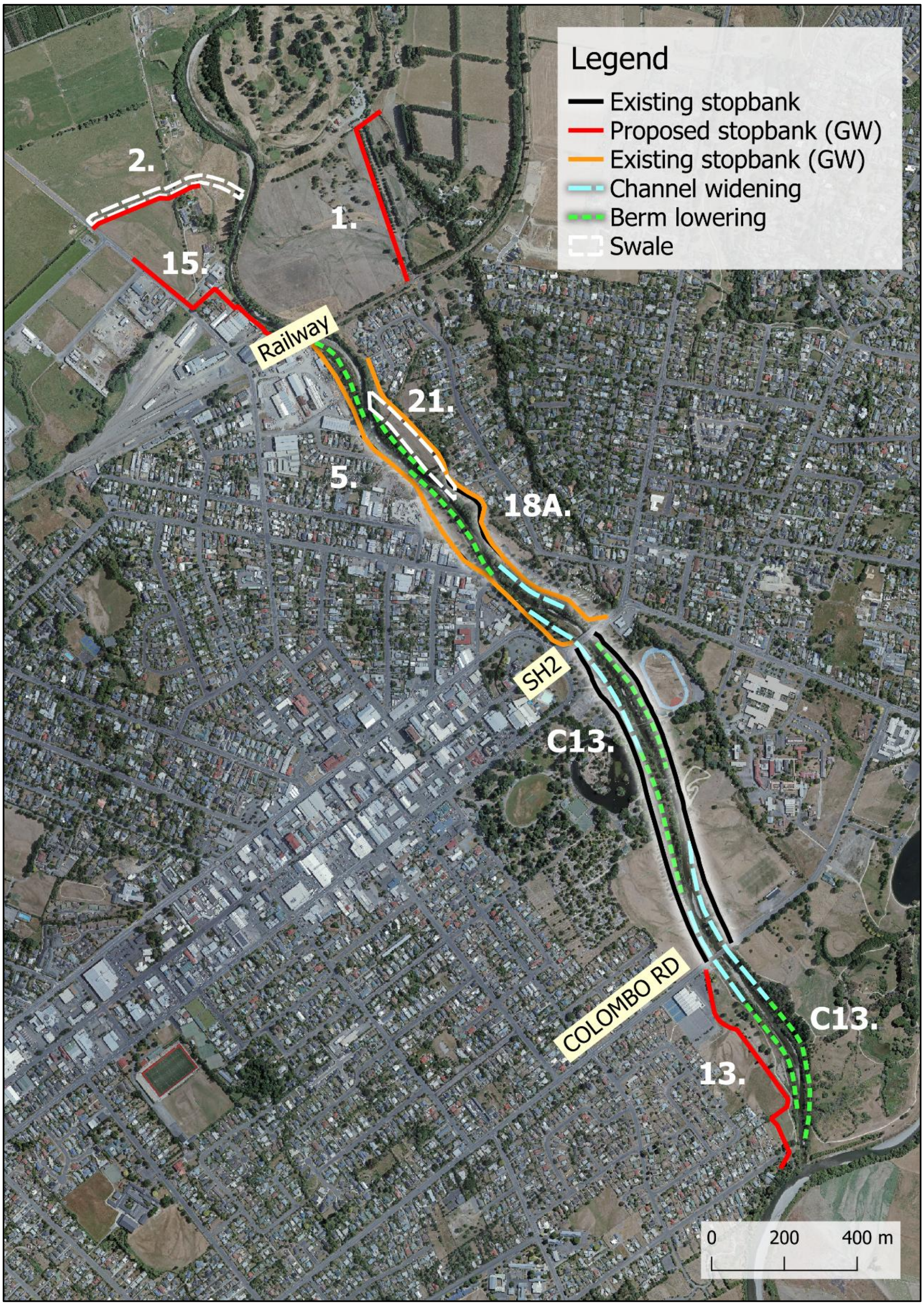

Figure 3-83: Final Iteration Option 2

The depth difference maps between the base scenario and Final Iterations 2 and 2B, respectively, for a 1% AEP RCP6.0 flow event are presented in Figure 3-84 and Figure 3-85. The flood extents and depths are nearly identical for Final Iteration 2 and 2B, with the difference between results in the order of ±0.05 m.

Compared to the base scenario, both options demonstrate:

- No flooding across the majority of Masterton
    - Note that the flooding at the northern end of Oxford St shown in Final Iteration 1 is not shown in Final Iteration 2
- Increased water levels in the Mahunga wetland area immediately upstream of the railway line in the order of 0.05-0.5 m (similar to, although slightly lower than, Option 1).
- Significantly decreased in-channel water levels >0.5 m for the majority of the length from the railway to Colombo Rd.
    - Decreased water levels upstream of the Whitipoua Bridge in the order of 0.3-0.5 m or greater (compared to an increase up- and downstream with Option 1). Although water levels downstream of the bridge increase by 0.3-0.5 m (comparable to Final Iteration 1)
- Decreased water levels in the Masterton Trails wetland immediately downstream of Colombo Rd in the order of 0.05-0.2 m (compared to an increase with Final Iteration 1).
- Marginally increased flooding in Ruamahanga River at the confluence in the order of 0.05-0.1 m.

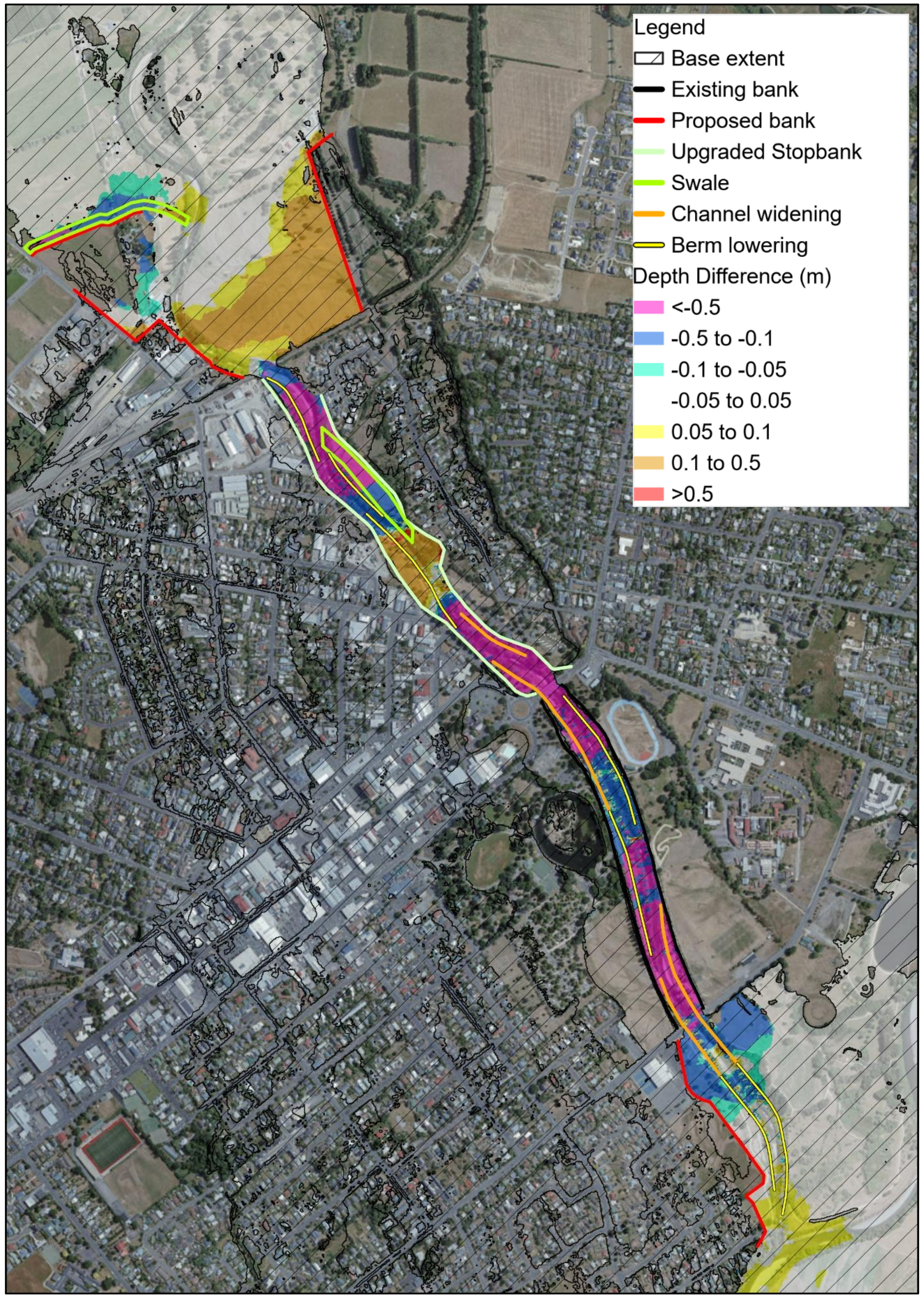

Figure 3-84: Final Iteration Option 2 depth difference map

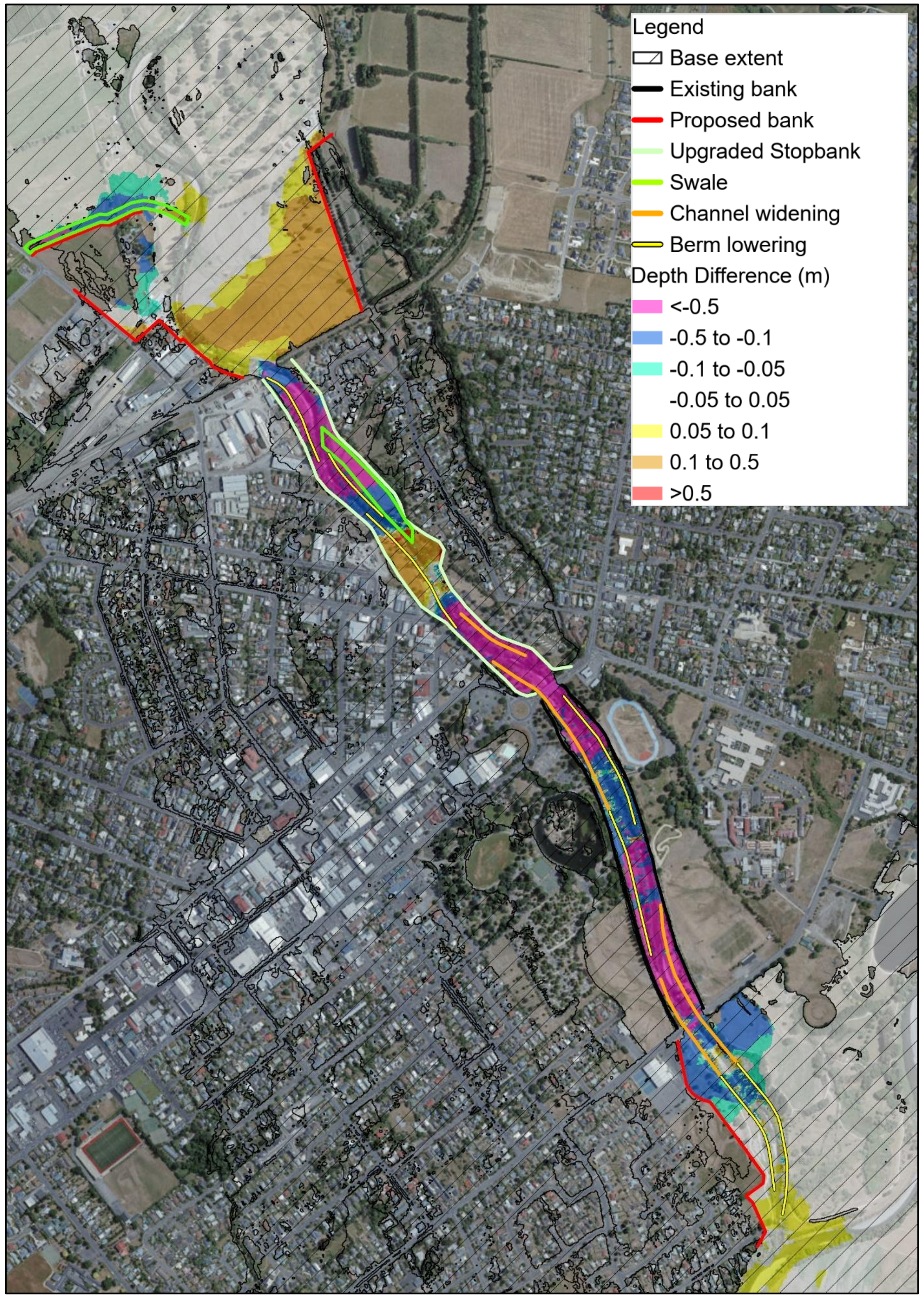

Figure 3-85: Final Iteration Option 2B depth difference map

3.3.4. FINAL ITERATION OPTION 3

A map of the elements of individual options that comprise Final Iteration Option 3 are shown in Figure 3-86. As per previous options, Final Iteration 3B is identical to Final Iteration 3 except it includes the extension to the Mawley Holiday Park stopbank, as per previous Final Iteration Options.

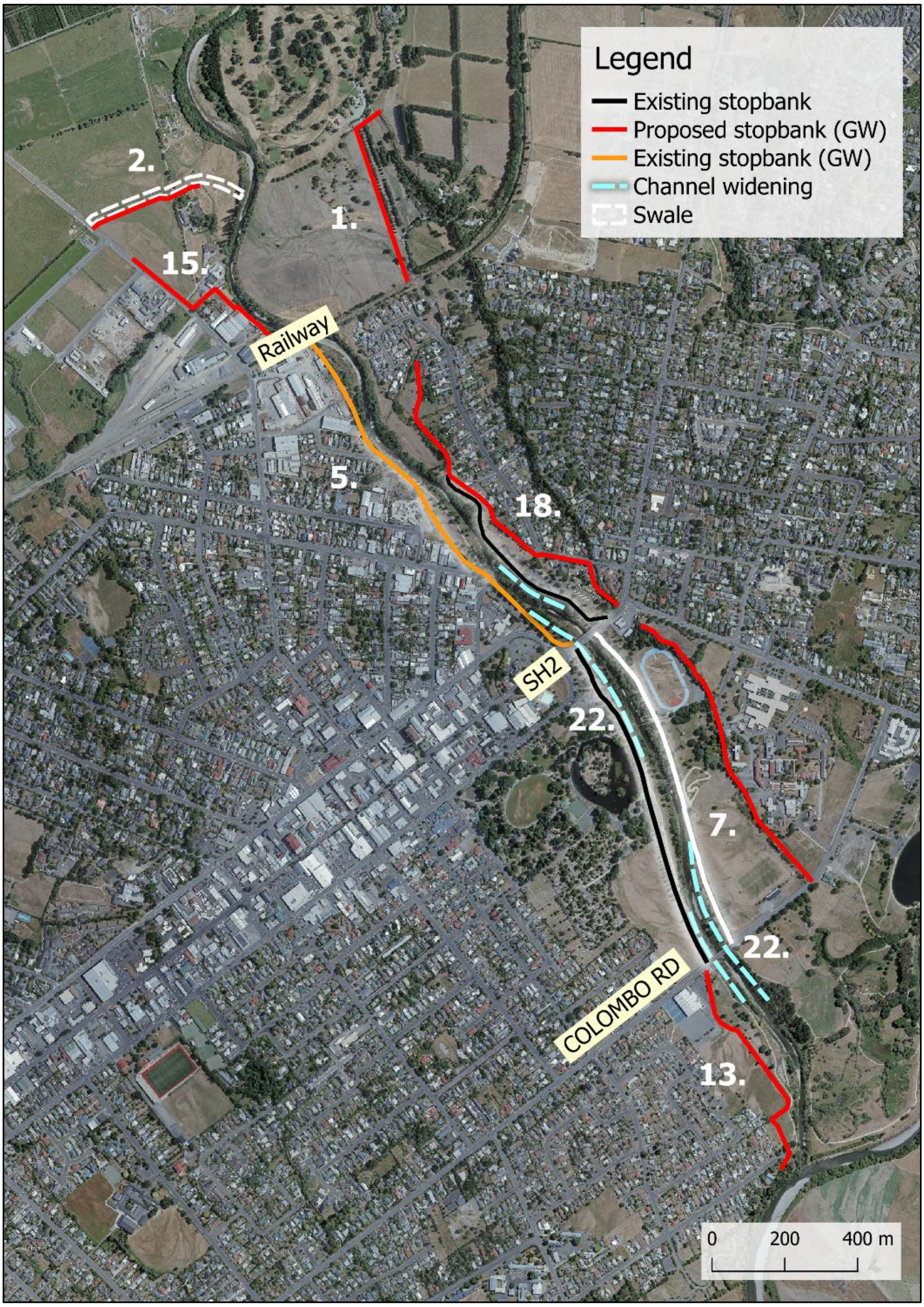

Figure 3-86: Final Iteration Option 3

The depth difference maps between the base scenario and Final Iteration 3 and 3B, respectively, for a 1% AEP RCP6.0 flow event are presented in Figure 3-88 and Figure 3-89Figure 3-78. The flood extents and depths are nearly identical for Final Iteration 3 and 3B, with the difference between results in the order of ±0.05 m.

Compared to the base scenario, both options demonstrate:

- No flooding across the majority of Masterton except at the northern end of Oxford St and the newly flooded athletics track, BMX track, and fields to the south.
    - Flooding at northern end of Oxford St is comparable to that shown in Final Iteration Option 1.
- New flooding in athletics track, BMX track and sports fields in the order of 0.2-1.7 m.
- Increased water levels in the Mahunga wetland area immediately upstream of the railway line are comparable to previous Final Iteration Options.
- Notably decreased in-channel water levels between the Whitipoua Bridge and Colombo Rd in the order of 0.3-0.5 m or greater.
    - Note that previously discussed Final Iteration Options all show an increase in channel water levels in some sections. Final Iteration 2, however, also shows a greater area of reduced water levels compared to Final Iteration 3.
- Increased water levels in the Masterton Trails wetland immediately downstream of Colombo Rd in the order of 0.05-0.2 m (comparable to previous Final Iteration Options).

3.3.5. FINAL ITERATION OPTION 7

Final Iteration Option 7 is identical to Final Iteration 3B except it does not include the proposed terrace edge stopbank between SH2 and Colombo Rd.

The depth difference maps between the base scenario and Final Iteration 7, for a 1% AEP RCP6.0 flow event is presented in Figure 3-90, alongside Final Iteration Options 3 and 3B for side-by-side comparison. The flood extents and depths are nearly identical, with the difference between Final Iteration 7 and Final Iteration 3/3B results in the order of ±0.05 m.

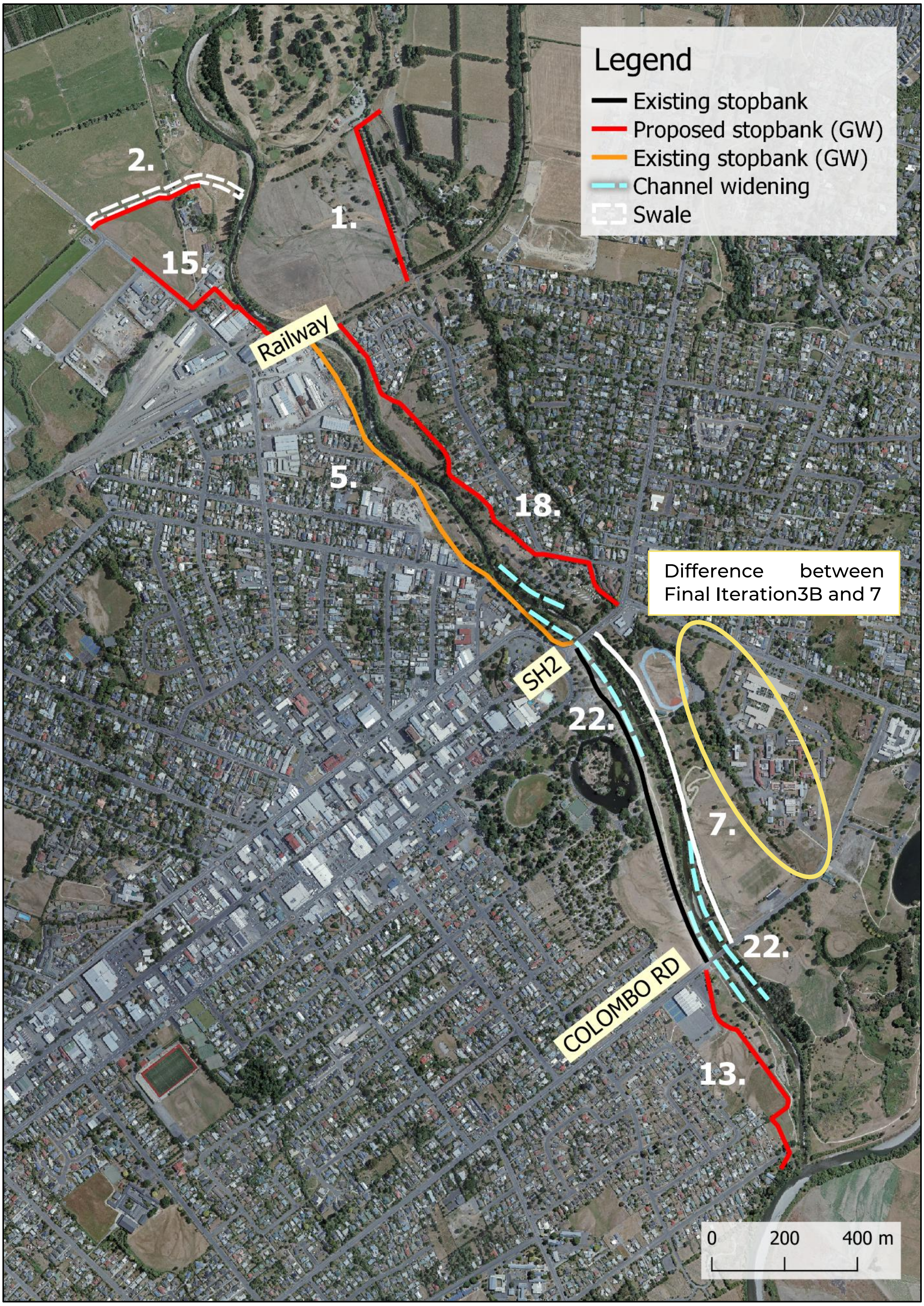

Figure 3-87: Final Option 7 (Option 3B variation)

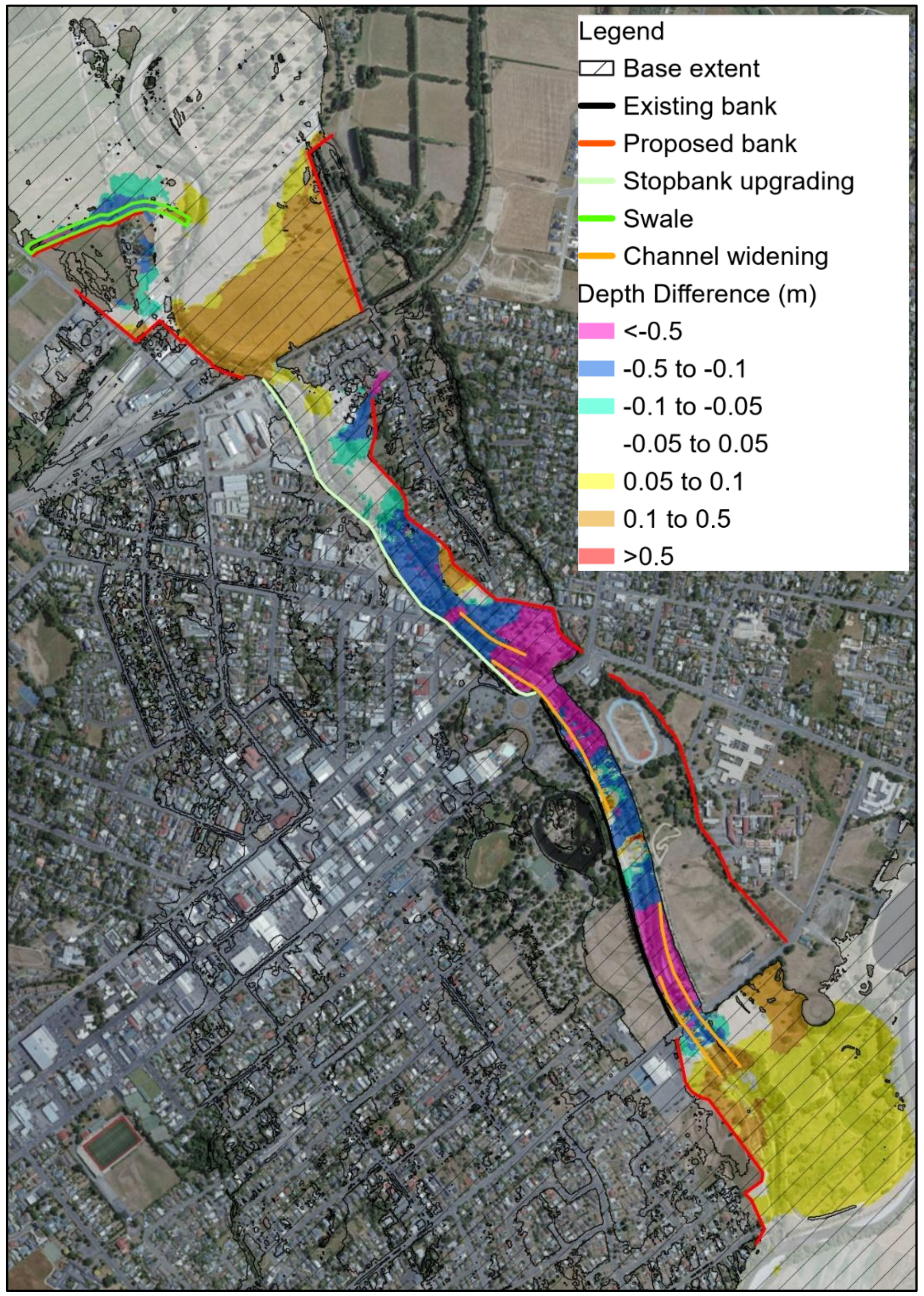

Figure 3-88: Final Option 3 depth difference map

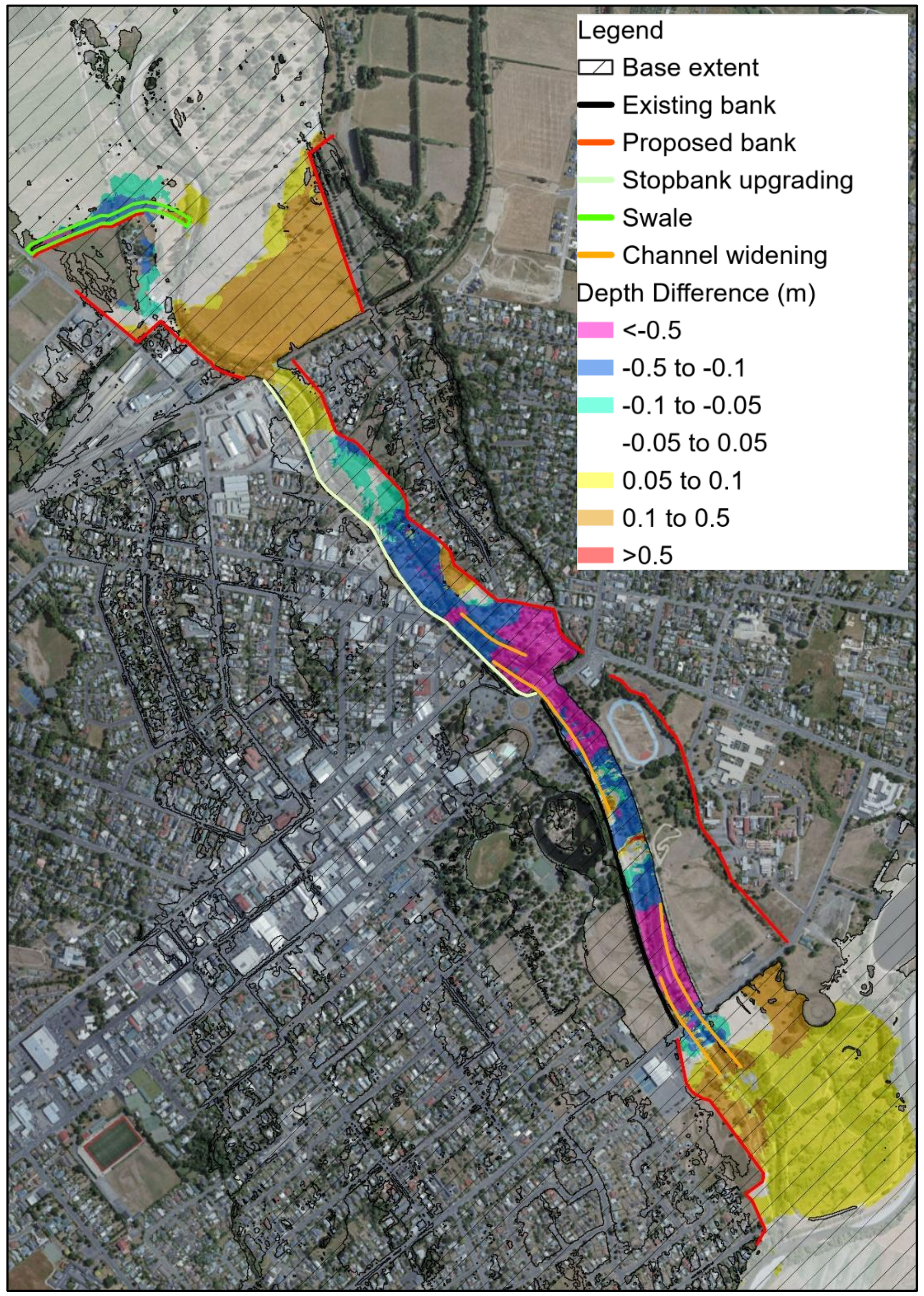

Figure 3-89: Final Option 3B depth difference map

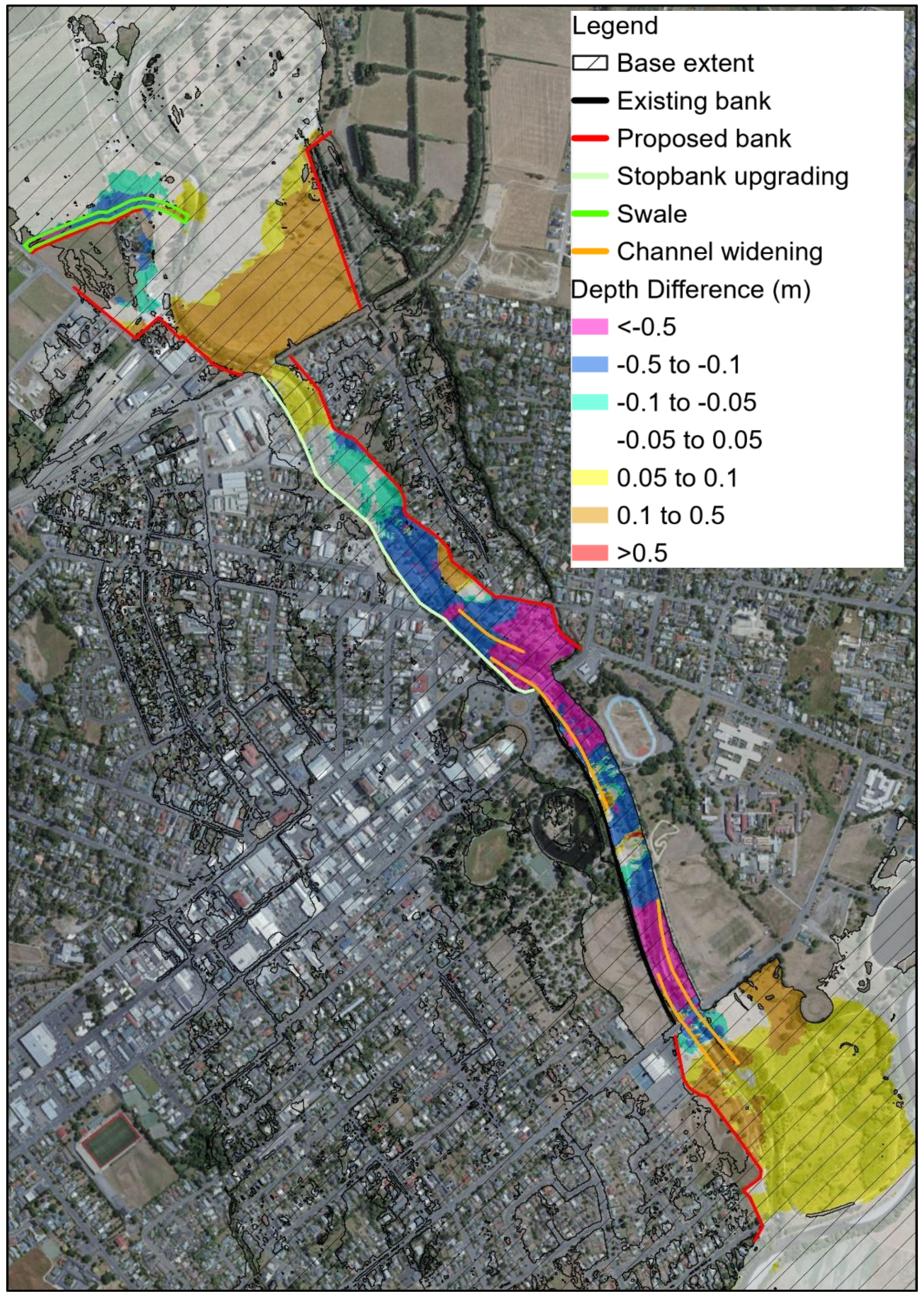

Figure 3-90: Final Option 7 depth difference map

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3.4. FINAL OPTIONS

Final Options 1 to 4 are all variations of Final Iteration Options 1B, 2B, 7, and 4B. Final Option 1 is similar to Final Iteration 1B except it combines the alternative alignments for the Akura Rd stopbank (as shown in Final Iteration 5) and the Mahunga Dr stopbank (as shown in Final Iteration 6). Similarly, Final Option 2 models the alternative alignments for the Mahunga Dr and Akura Rd stopbanks with Final Iteration 2B. And so on for the remaining Final Options.

Maps presenting the results for peak depth, depth difference (relative to base scenario), velocity and velocity difference (relative to base scenario) for each of the Final Options are provided in Appendix A through D.

The depth difference maps for Final Option 1 (Appendix B) shows effectively no change from Iteration 1B downstream of the railway line, and only differs in flood extent/depth upstream, as expected from the proposed change in stopbank alignments (Akura Rd and Mahunga Dr). The same conclusion can be drawn from Final Options 2, 3 and 4 with respect to their counterparts, Final Iteration Option 2B, 7, and 4B. For brevity, we have provided a side-by-side comparison only of Final Option 1 and Iteration 1B, in Figure 3-91 and Figure 3-92, to demonstrate the similarity in depth difference results.

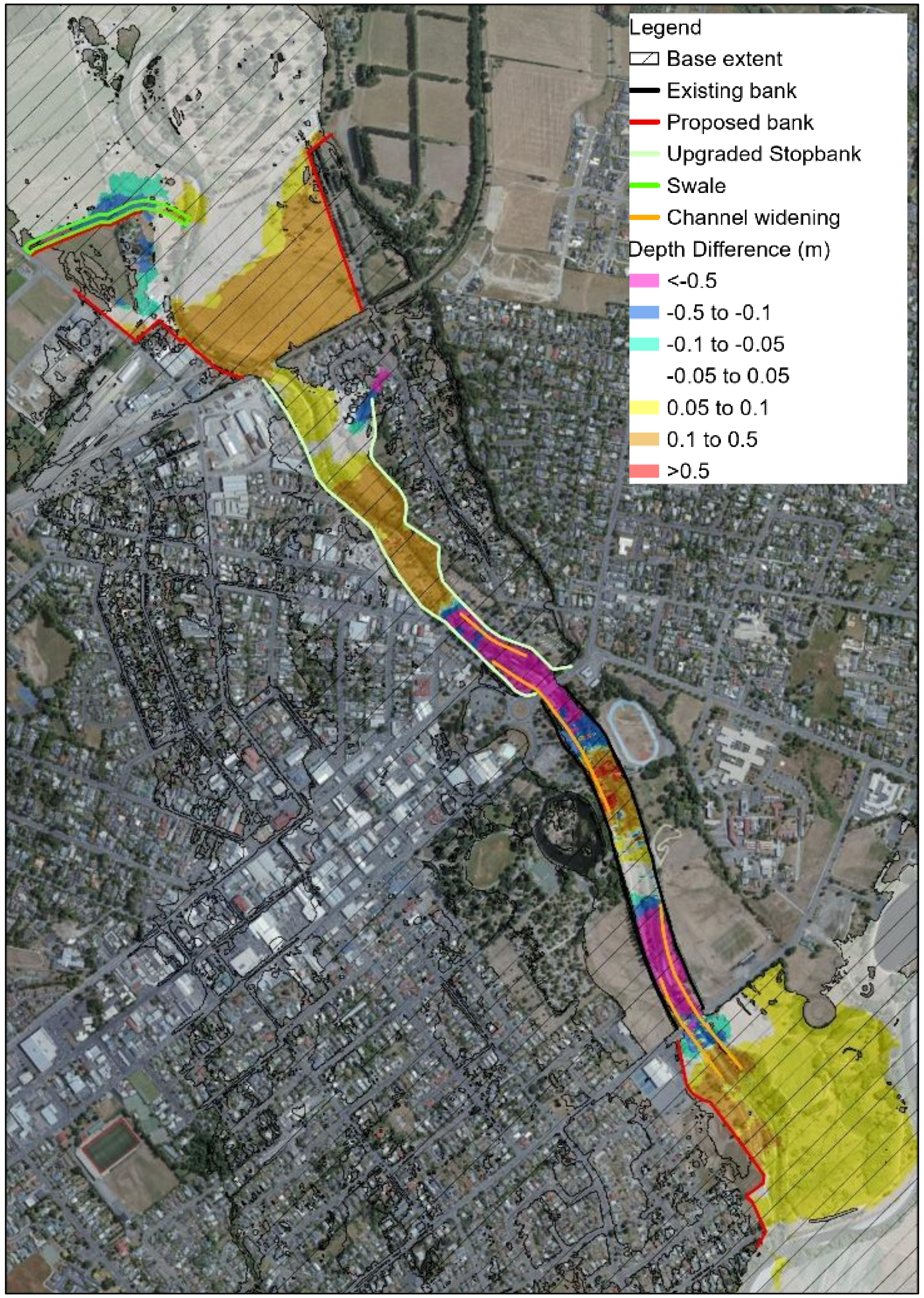


Figure 3-91: Final Iteration 1 depth difference map.

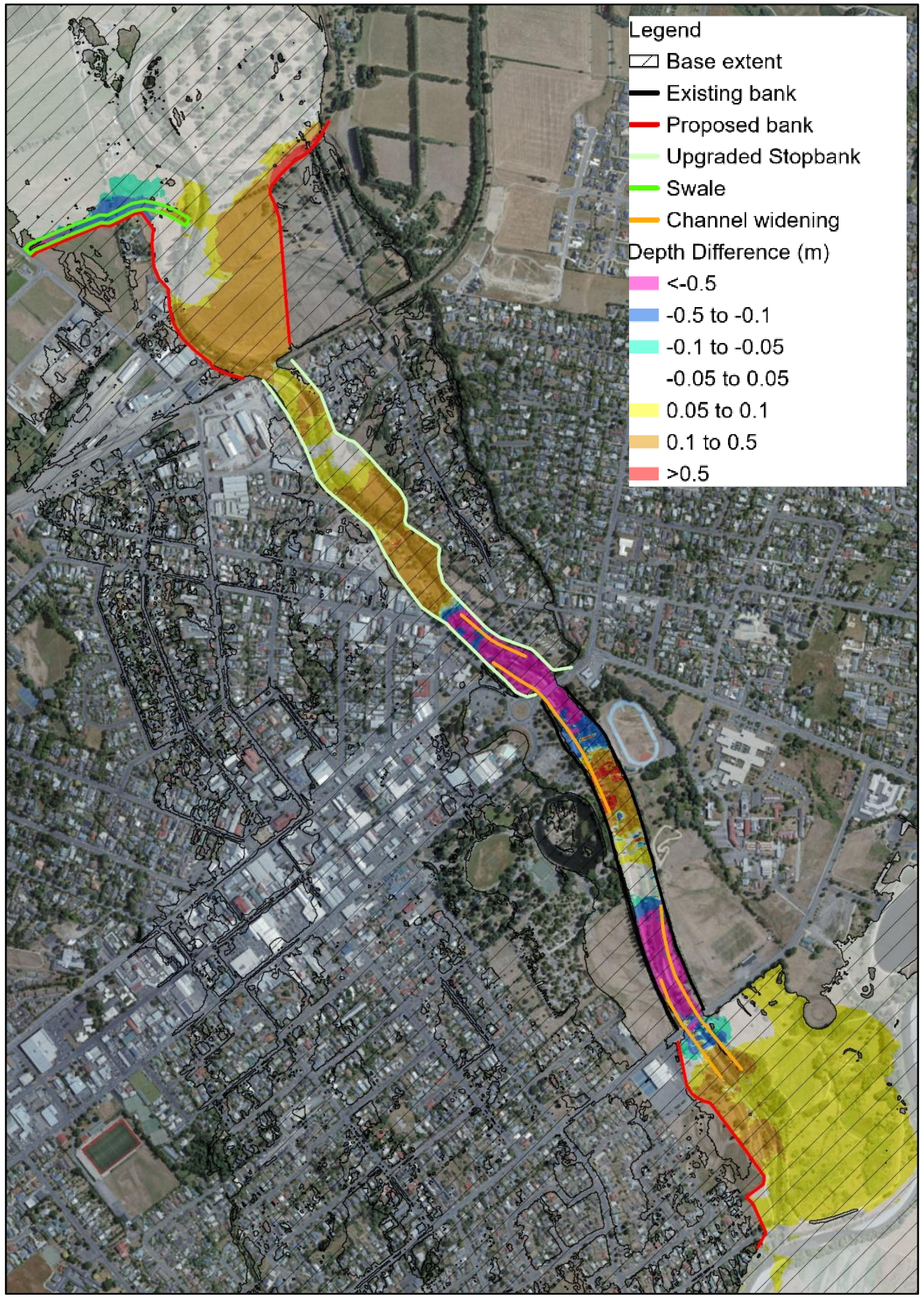


Figure 3-92: Final Option 1 depth difference map.

3.5. WORKING GROUP PREFERRED OPTION

The Final Option currently preferred by the Waipoua Working Group is presented in Figure 3-93.

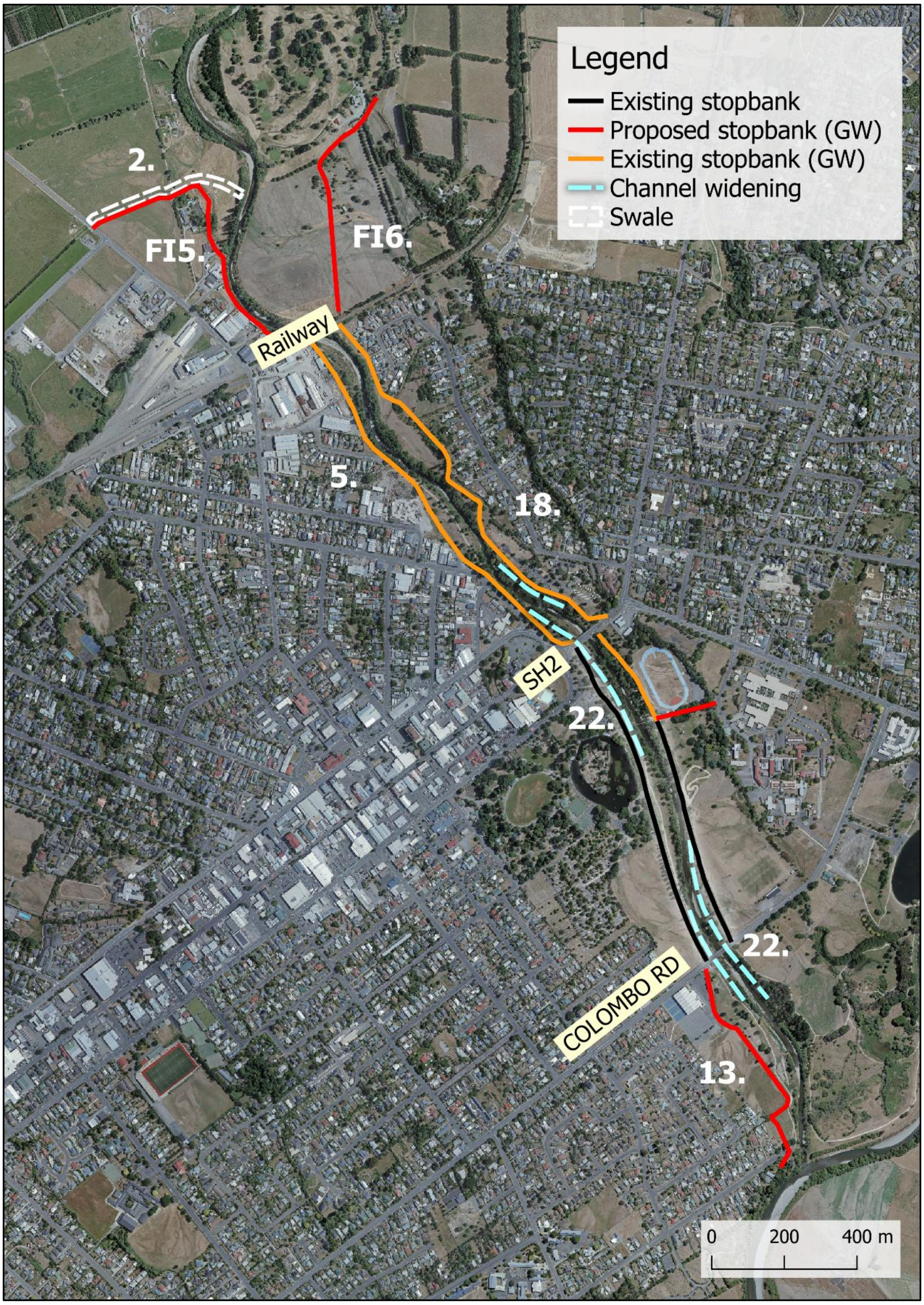


Figure 3-93: Working Group Preferred Option

The depth difference map (Appendix B) for Working Group Preferred Option shows (compared to the base scenario):

- No flooding across the majority of Masterton, including at the northern end of Oxford St (only with Option 1).
- Increased water levels in the Mahunga wetland area immediately upstream of the railway line in the order of 0.1-0.3 m.
- Increased in-channel water levels around the Whitipoua Bridge in the order of 0.1-0.3 m, and 0.3-0.5 m approximately 150 m downstream.
- Significantly decreased in-channel water levels around the SH2 and Colombo Rd bridges by more than 0.5 m.
- Increased in-channel water levels adjacent to the southern end of the athletics track in the order of 0.3-0.5 m.
- Increased water levels in the Masterton Trails wetland area in the order of 0.05-0.1 m.

4. CONCLUSION

This report presents a comprehensive breakdown of the hydraulic modelling completed to-date of flood mitigation strategies for the Waipoua River. The study was in collaboration with the Waipoua River Working Group and involved simplifying the existing model and simulating various scenarios to identify effective flood management options.

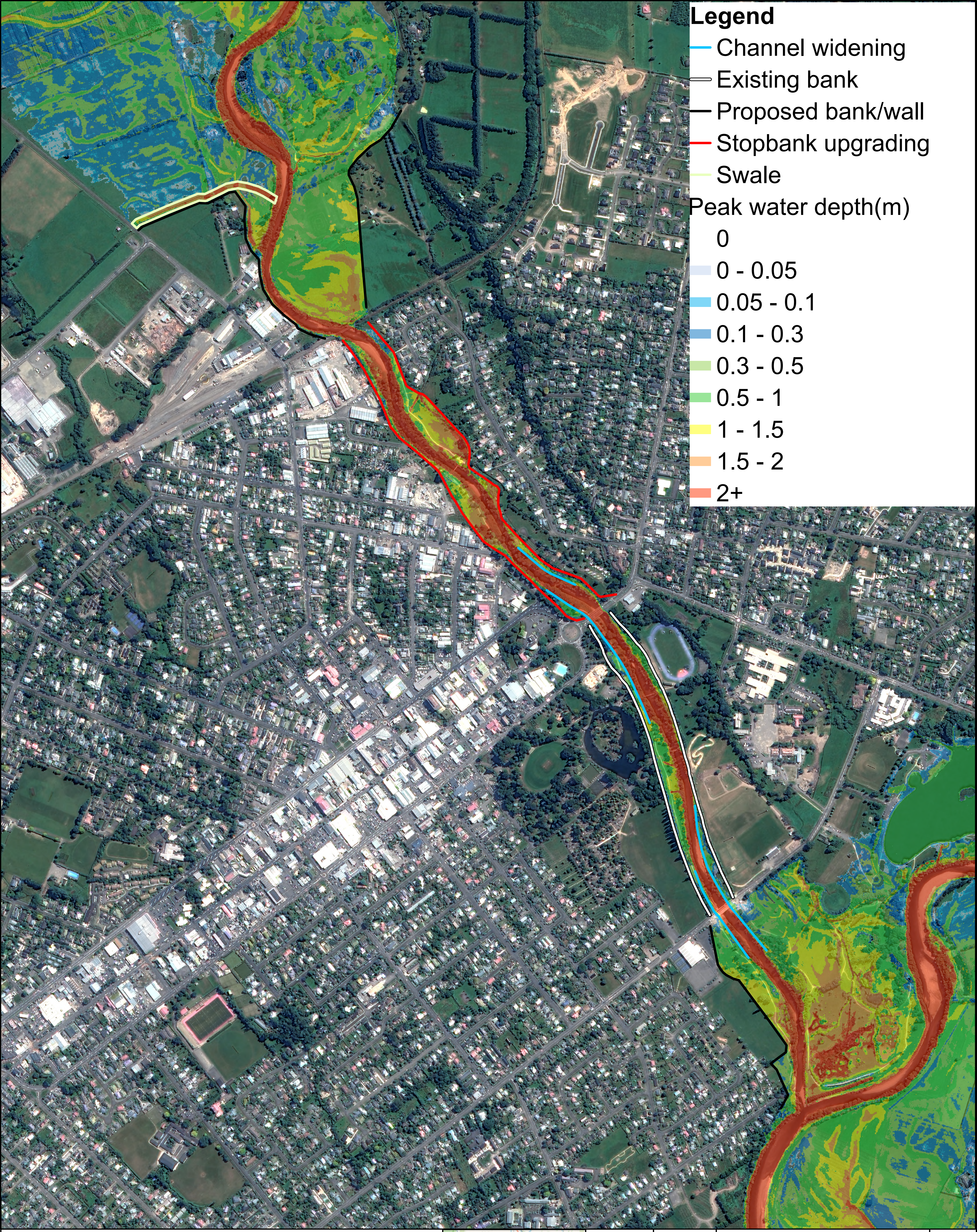
The 2023 Waipoua Hydraulic Model was simplified into a 2D model to facilitate the efficient investigation of multiple scenarios. A total of 22 initial options were explored, focusing on individual flood mitigation measures such as stopbanks, swales, and flood storage areas. Based on the performance of individual options, 15 combined scenarios were simulated to develop more comprehensive flood protection schemes. The best-performing combined options were further refined into four final options, each incorporating different elements and alignments to optimise flood mitigation.

A summary of the four Final Options and Preferred Option is as follows, and any increase/decrease in flooding stated is relative to the base scenario (existing scheme) 1% RCP6.0 flow event:

- All final options significantly reduce flood depths and extent throughout Masterton
- Final Option 1: Investigates stopbank upgrades and some river channel widening works. This option significantly reduces river channel flood levels at the SH2 and Colombo Rd bridges. However, it also shows the greatest area of increased water levels elsewhere along the river channel.
- Final Option 2: Incorporates major river channel works to lower berms and widen the channel. This option significantly reduces river channel flood levels along the majority of the length between the railway bridge and Colombo Rd. However, a notable increase is also shown downstream of the Whitipoua swingbridge.
- Final Option 3: Incorporates a "room for the river" approach by shifting the true left stopbanks further back from the river. This option shows similar or significantly reduced water levels in the river channel compared to the base scenario and results in new flooding to the BMX track and adjacent sports fields. Mawley Holiday Park flooding is significantly reduced although still apparent.
- Final Option 4: Flood depths in the river channel and inundated areas are notably reduced compared to Option 1 but rely on a 5% reduction in flow being achieved by nature-based solutions upstream.
- Working Group Preferred Option: Investigates stopbank provisions upstream of the railway, stopbank upgrades between the railway and SH2 and some river channel widening works. The stopbanks between SH2 and Colombo Rd remain as existing. This option shows significant reduction in river channel flood levels at the SH2 and Colombo Rd bridges. However, it also shows areas of increased water levels elsewhere along the river channel.

The Final Options and the Working Group's Preferred Options provide effective solutions to improve flood protection. Each presents its own set of benefits and challenges regarding long-term river channel adaptability, social outcomes, cultural and environmental effects of channel works, and economic considerations.

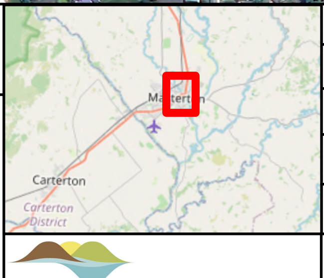
APPENDIX A – FINAL OPTIONS PEAK DEPTH MAPS



PROJECT
Waipoua River Flood Modelling

MAP
PEAK DEPTH MAP
Final Option 1
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner



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DATE	**28/03/2025**
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CREATED BY	SP
REVISED BY	MG

0 125 250 500
Meters
N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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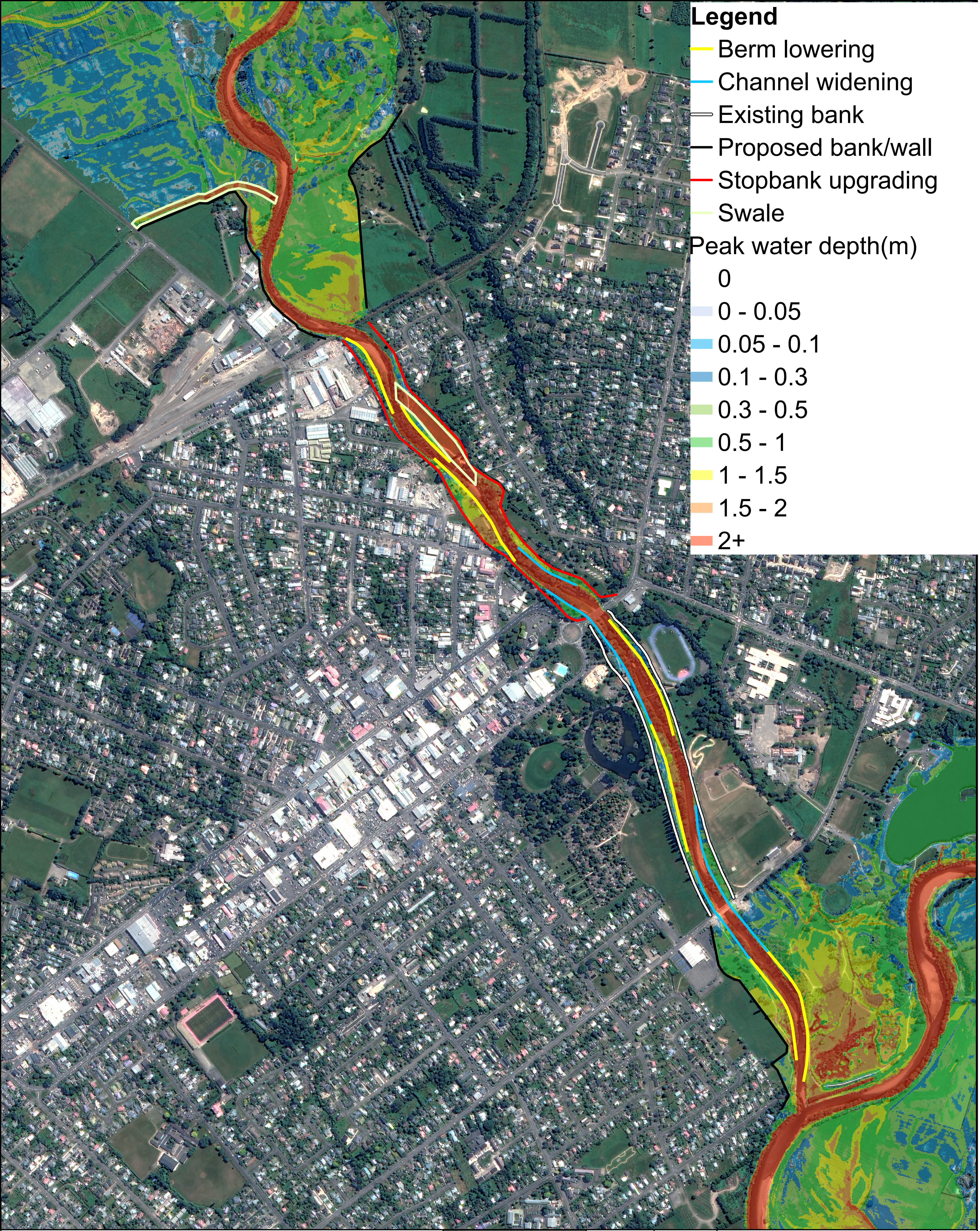

PROJECT
Waipoua River Flood Modelling

MAP
PEAK DEPTH MAP
Final Option 2
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	01
DATE	28/03/2025
A3 SCALE	1:10,000
CREATED BY	SP
REVISED BY	MG

0 125 250 500
Meters

N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

Land River Sea CONSULTING

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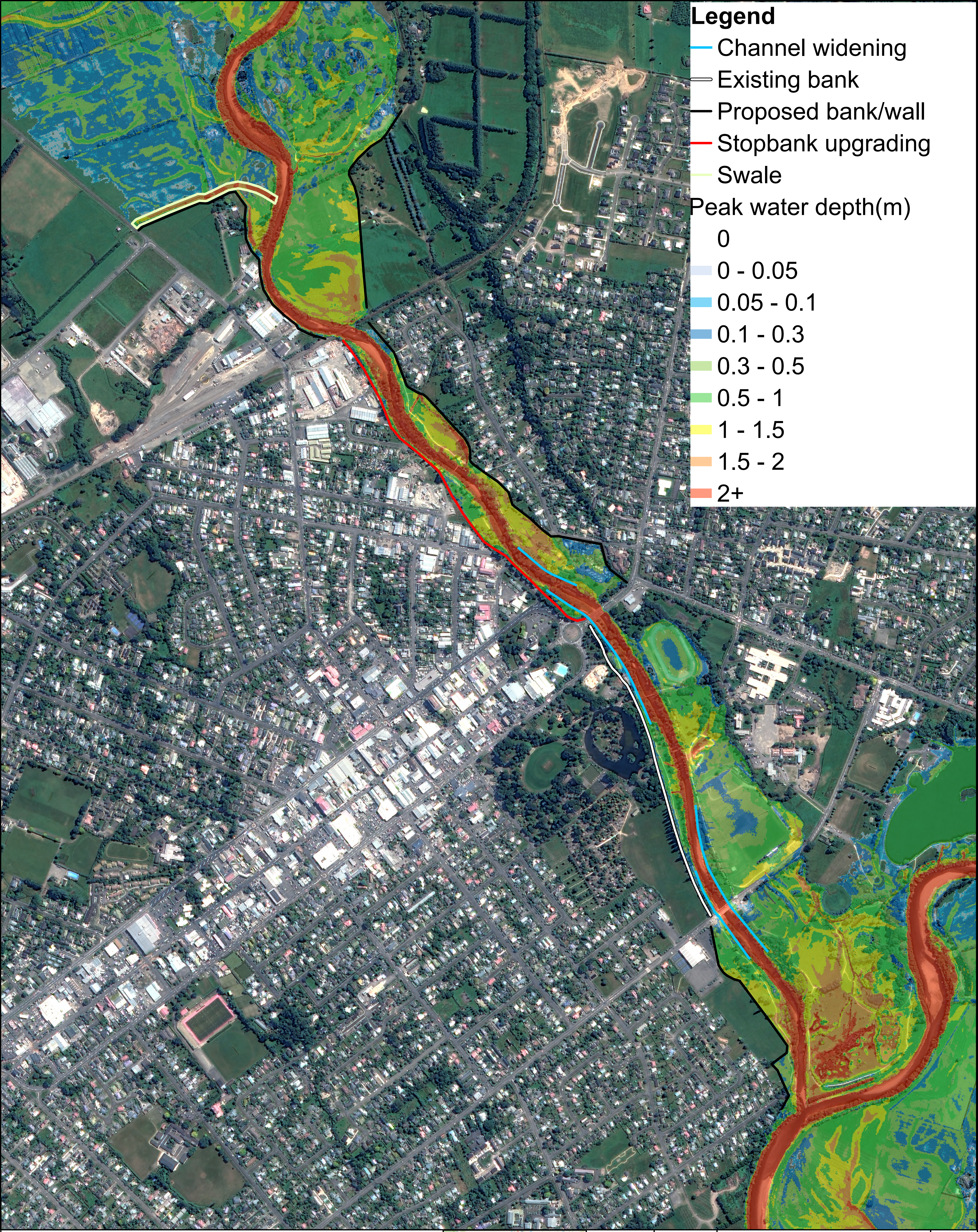
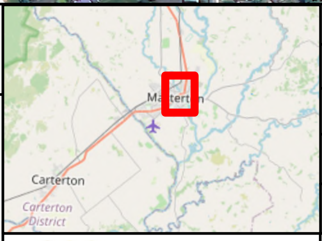


PROJECT
Waipoua River Flood Modelling

MAP
PEAK DEPTH MAP
Final Option 3
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner



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REVISED BY	MG

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Meters

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Model Information:
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Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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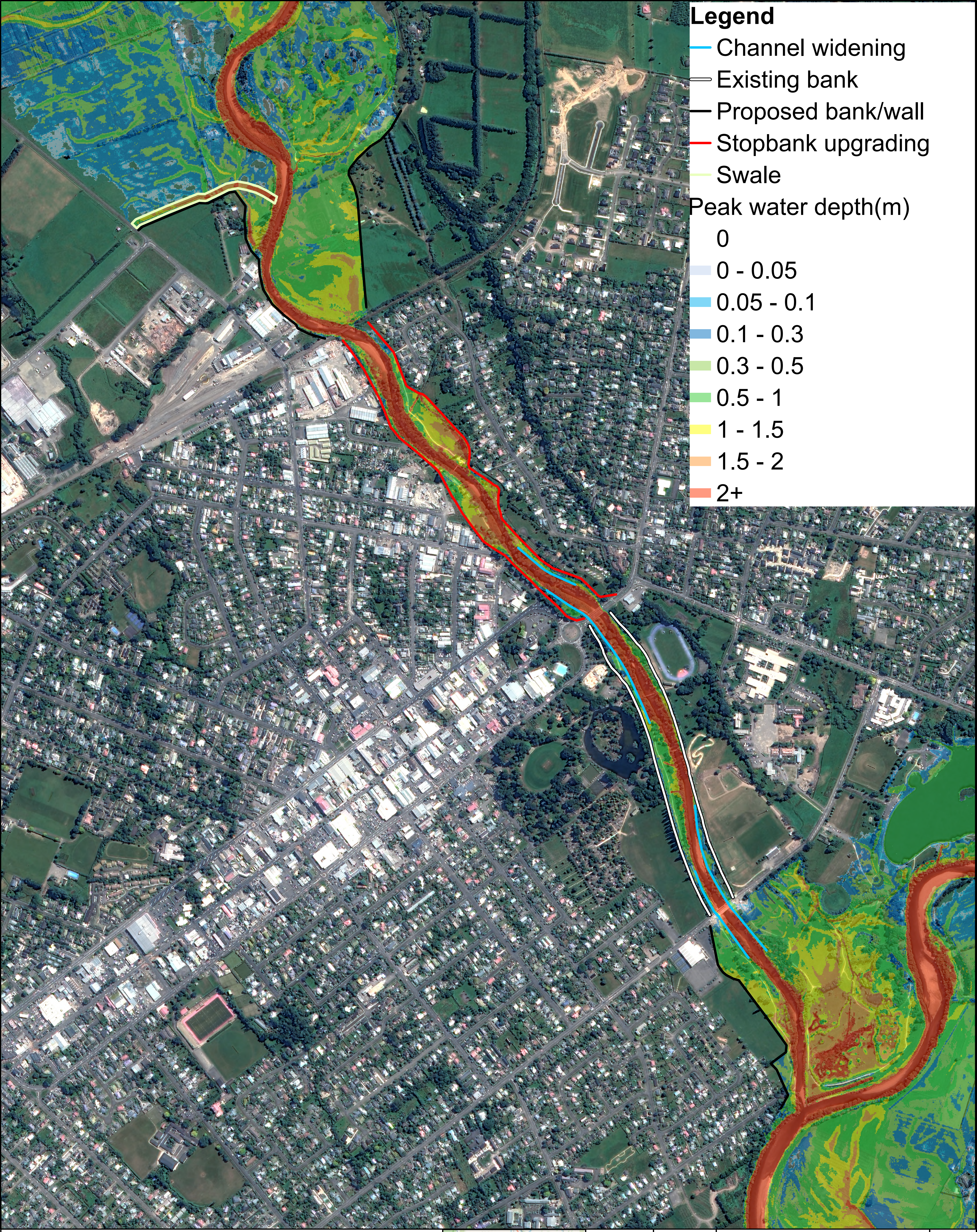

PROJECT
Waipoua River Flood Modelling

MAP
PEAK DEPTH MAP
Final Option 4
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	01
DATE	28/03/2025
A3 SCALE	1:10,000
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REVISED BY	MG

0 125 250 500
Meters
N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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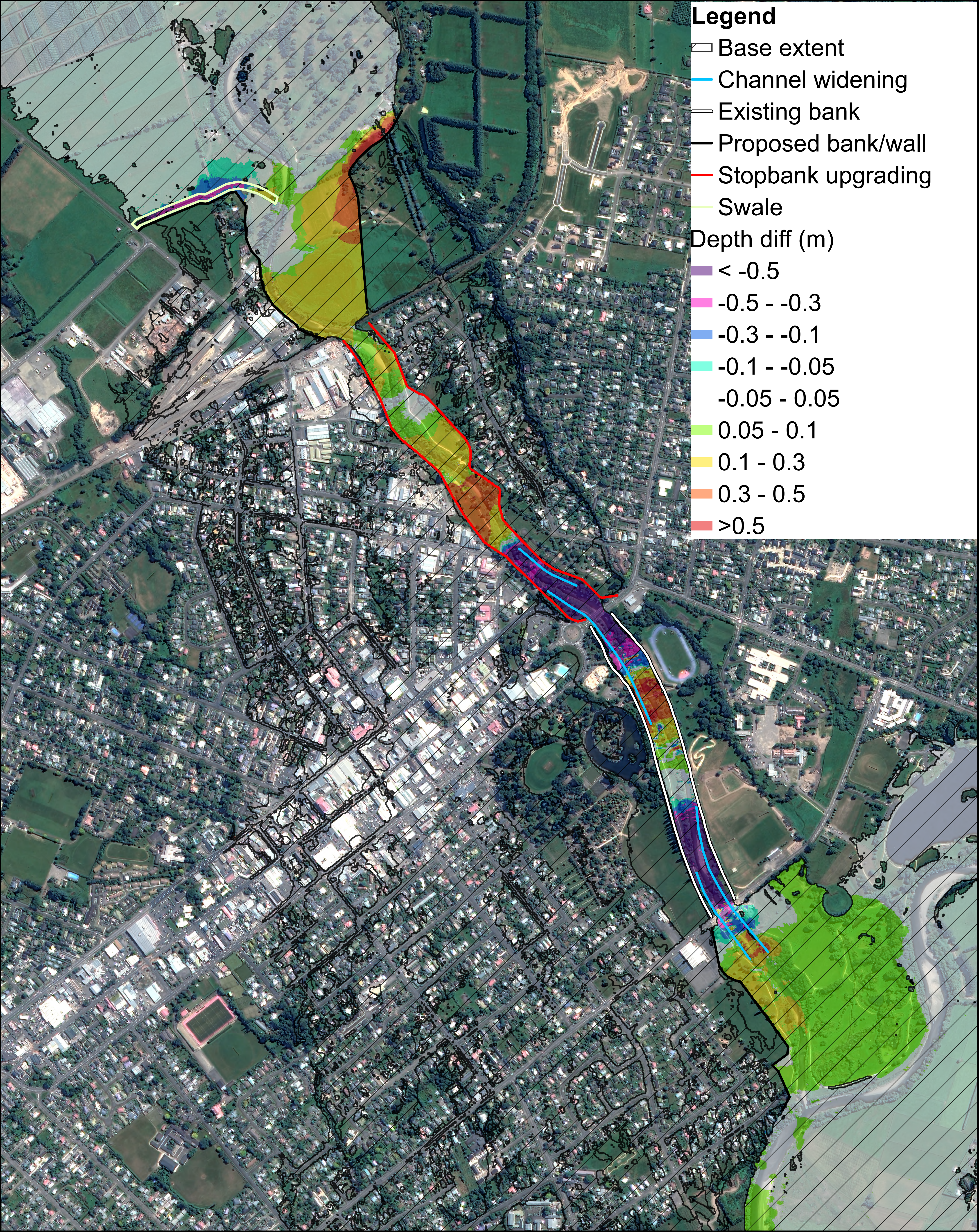
APPENDIX B – FINAL OPTIONS DEPTH DIFFERENCE MAPS



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MAP **DEPTH DIFFERENCE MAP** **Final Option 1** **1% AEP Flow, (Future Climate, RCP6)**		A3 SCALE	1:10,000
		CREATED BY	SP
		REVISED BY	MG
AUTHOR **Saul Preshner**	Land River Sea CONSULTING	Greater Wellington Te Pane Matua Taiao	

0 125 250 500
Meters

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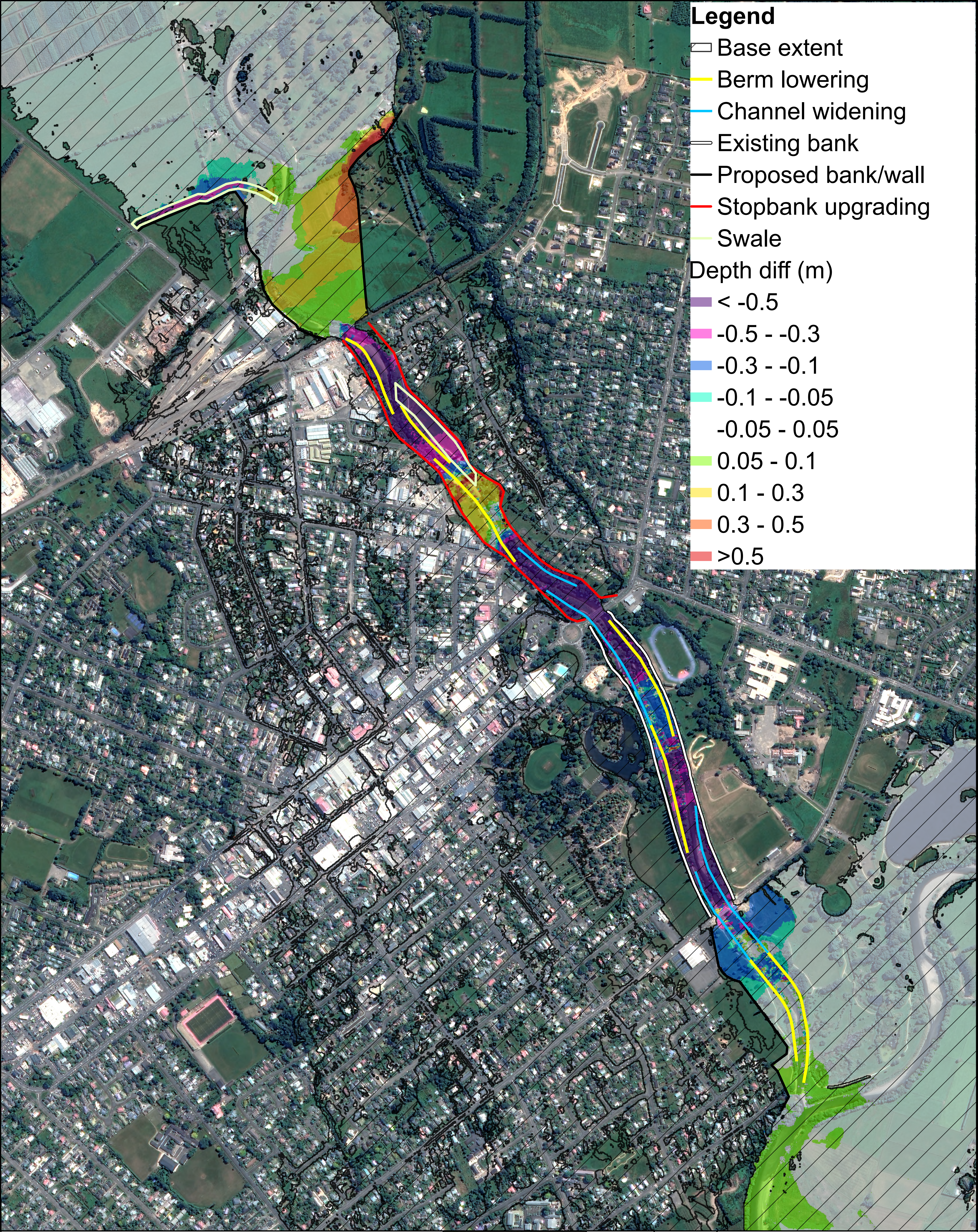
Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

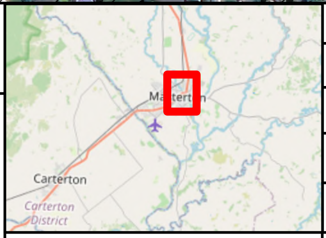
Model Completed: June 2024



PROJECT
Waipoua River Flood Modelling

MAP
DEPTH DIFFERENCE MAP
Final Option 2
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner



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CREATED BY	SP
REVISED BY	MG

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Meters
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Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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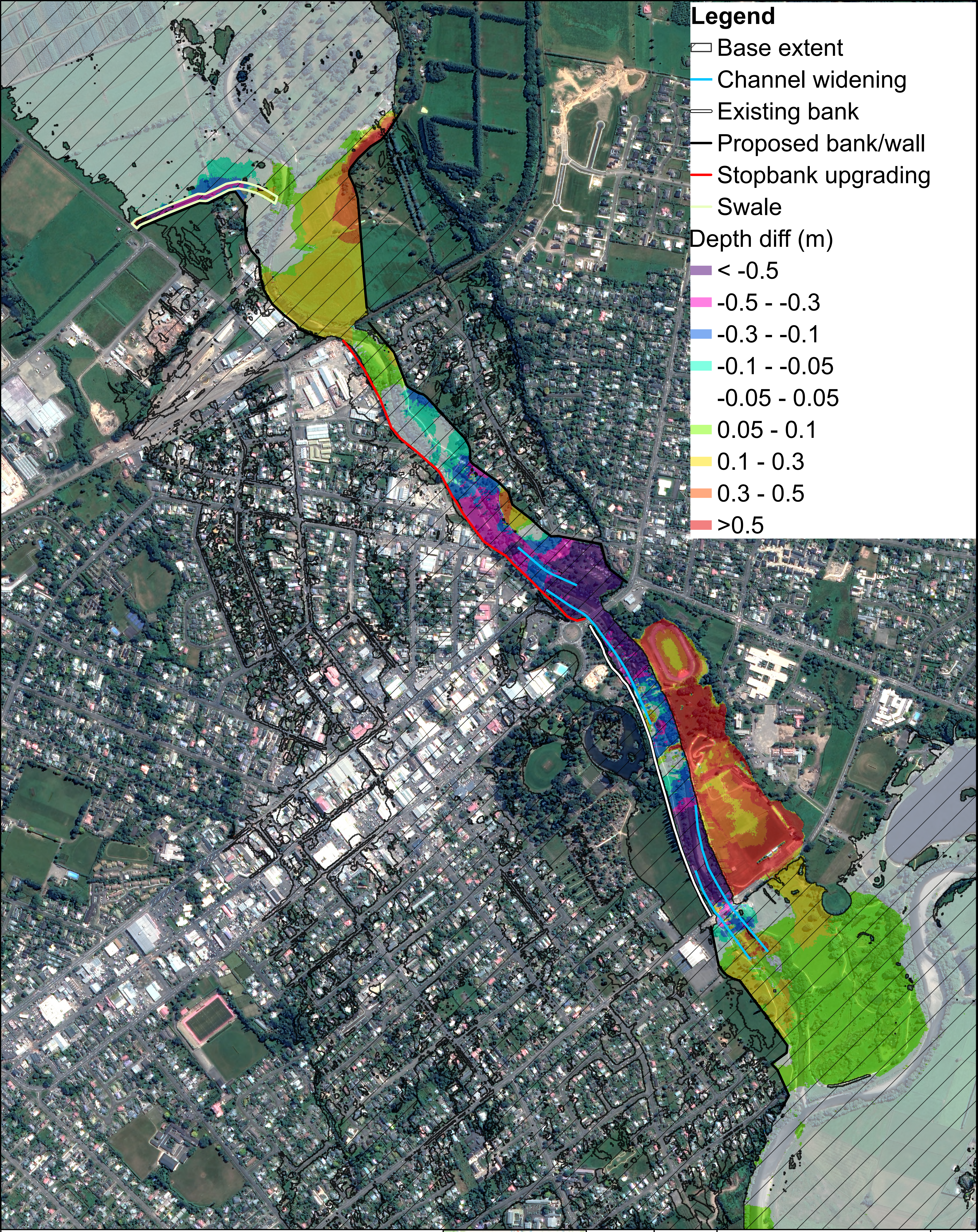

PROJECT
Waipoua River Flood Modelling

MAP
DEPTH DIFFERENCE MAP
Final Option 3
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	01
DATE	28/03/2025
A3 SCALE	1:10,000
CREATED BY	SP
REVISED BY	MG

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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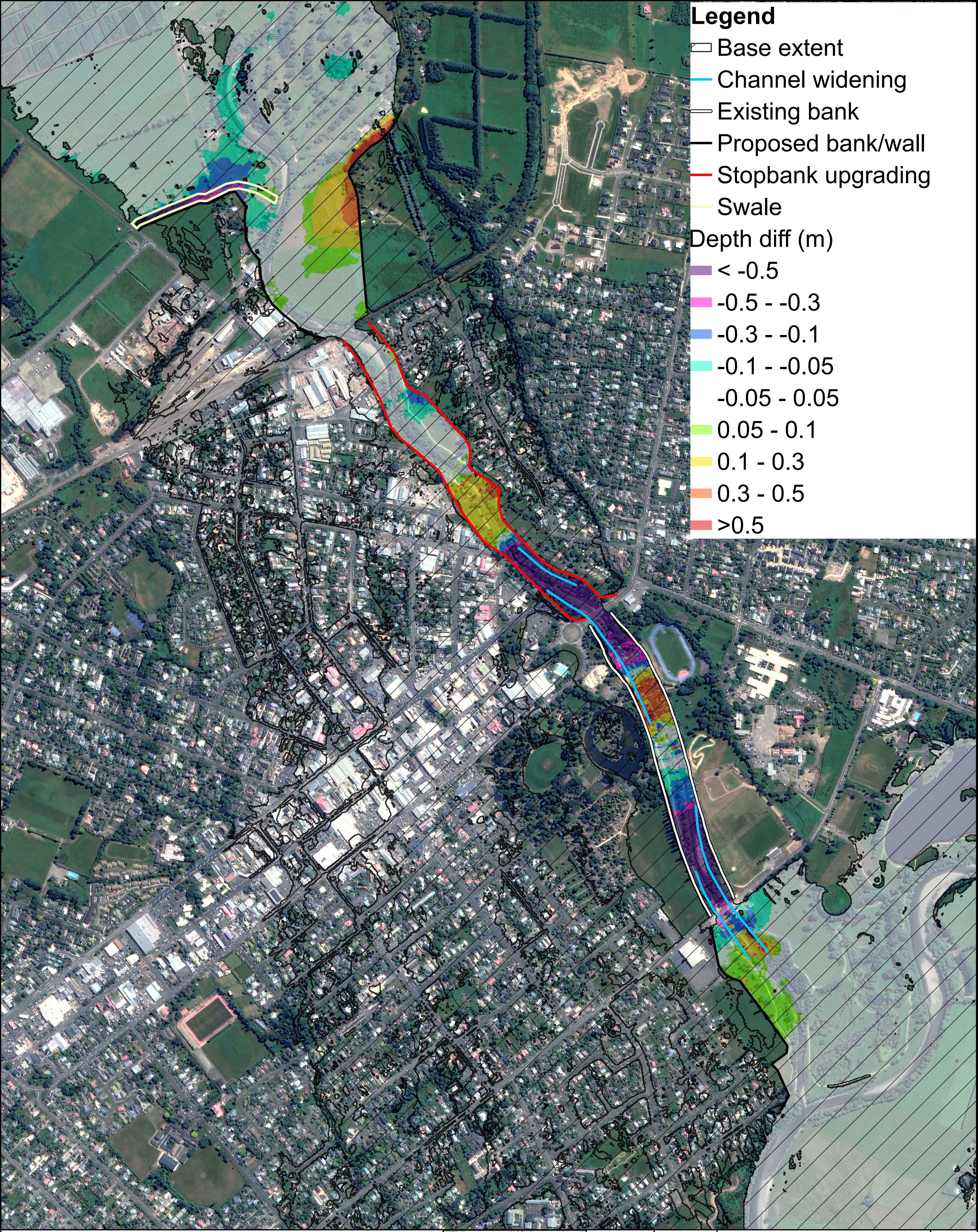

PROJECT
Waipoua River Flood Modelling

MAP
DEPTH DIFFERENCE MAP
Final Option 4
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	01
DATE	28/03/2025
A3 SCALE	1:10,000
CREATED BY	SP
REVISED BY	MG

0 125 250 500
Meters

N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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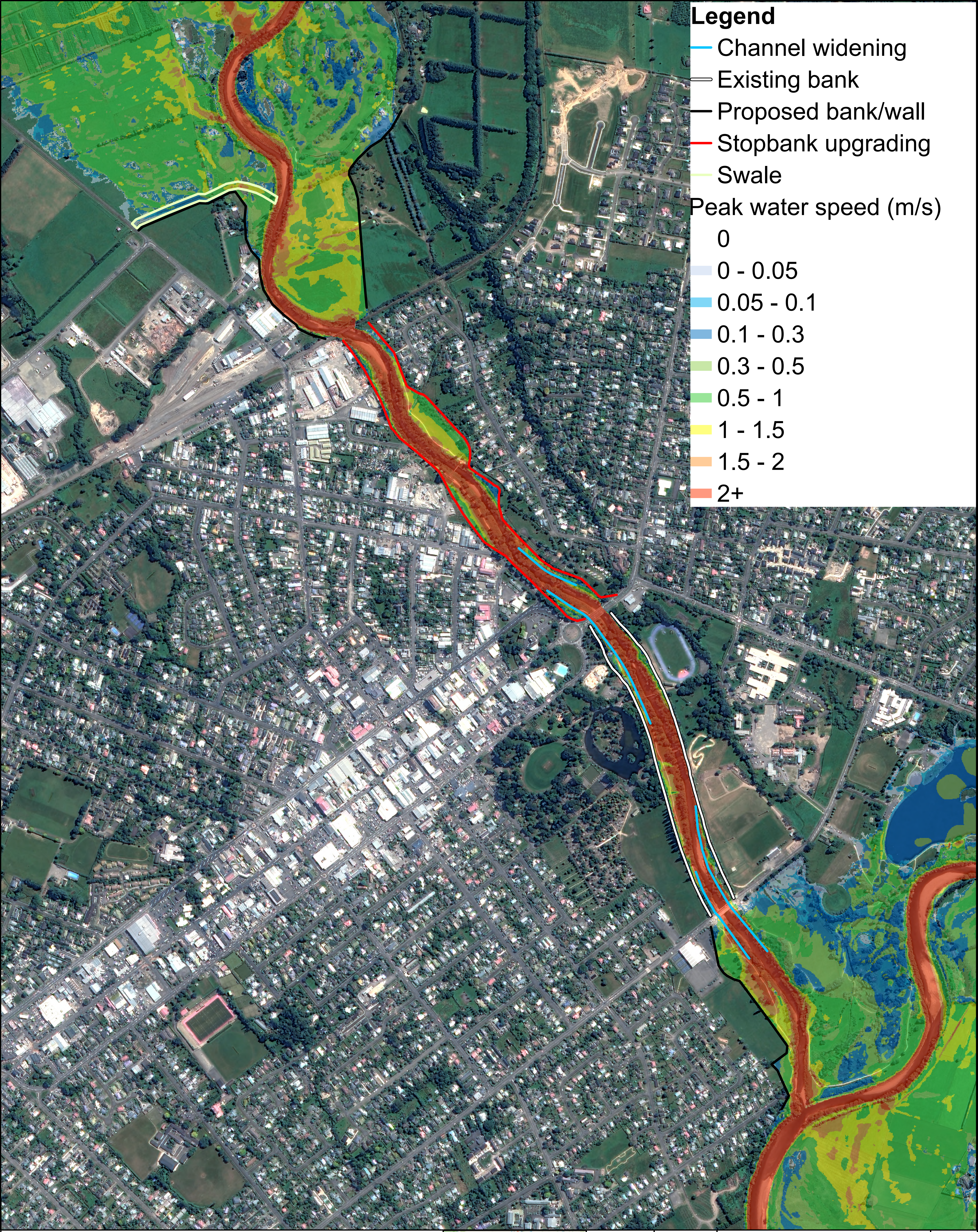
APPENDIX C – FINAL OPTIONS PEAK SPEED MAPS



PROJECT
Waipoua River Flood Modelling

MAP
PEAK SPEED MAP
Final Option 1
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	**01**
DATE	**28/03/2025**
A3 SCALE	**1:10,000**
CREATED BY	SP
REVISED BY	MG

Land River Sea CONSULTING

Greater Wellington Te Pane Matua Taiao

Model Information:
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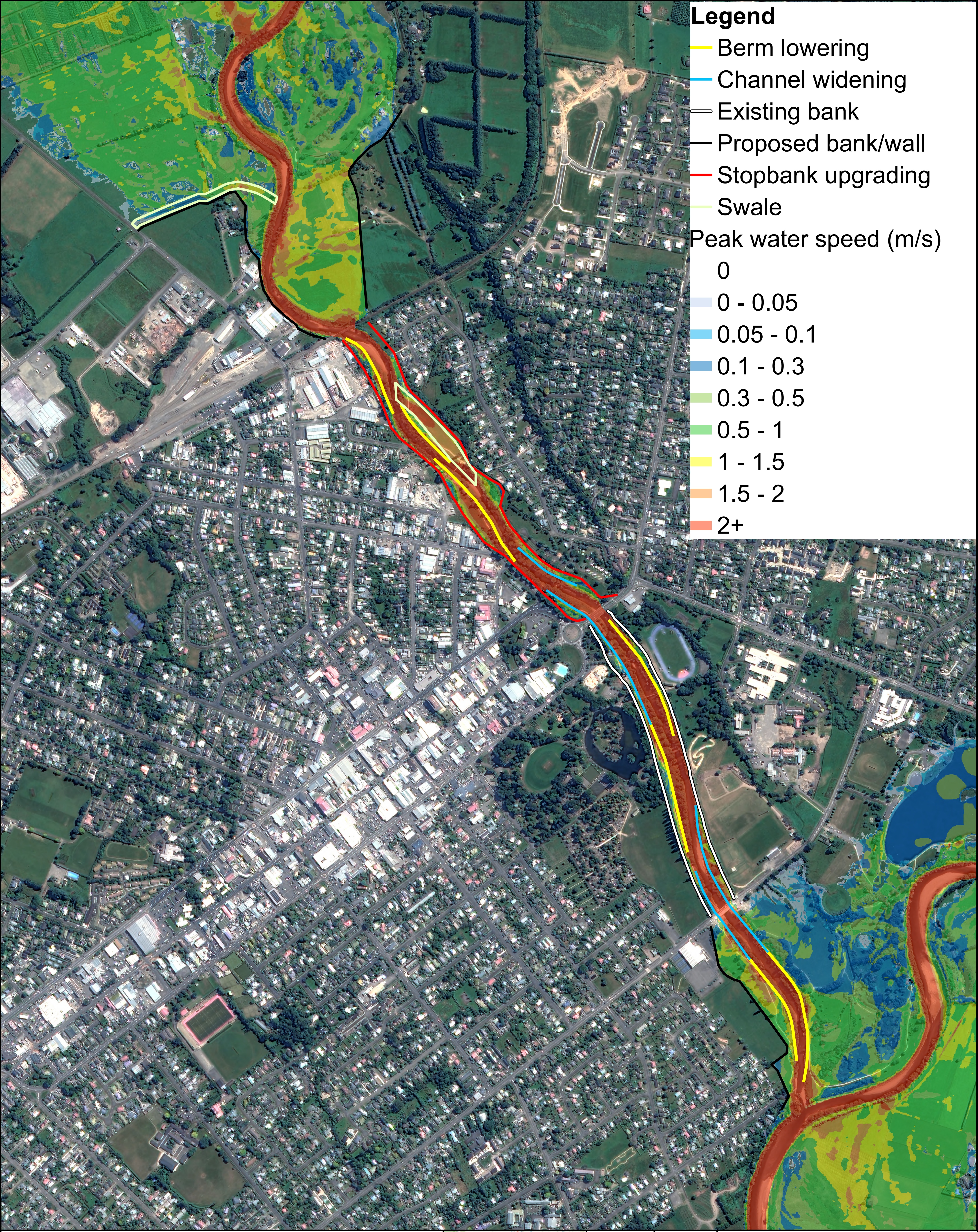
Vertical Datum: Wairarapa Local Datum

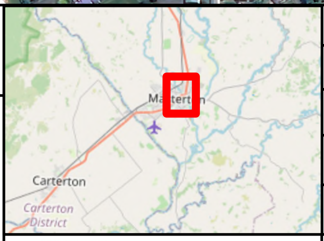
Model Completed: June 2024



PROJECT
Waipoua River Flood Modelling

MAP
PEAK SPEED MAP
Final Option 2
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner



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DATE	28/03/2025
A3 SCALE	1:10,000
CREATED BY	SP
REVISED BY	MG

Model Information:
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Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

Land River Sea CONSULTING

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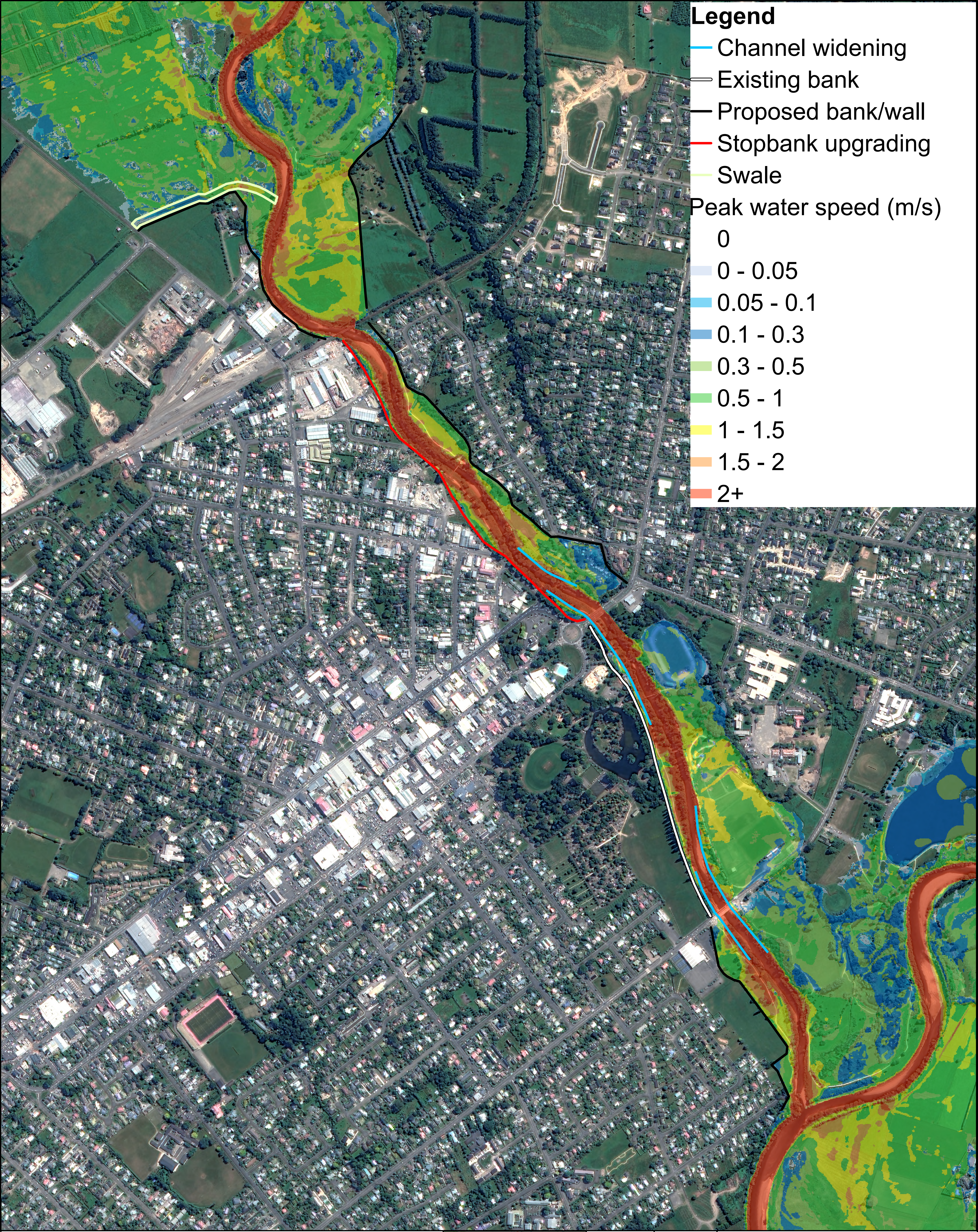
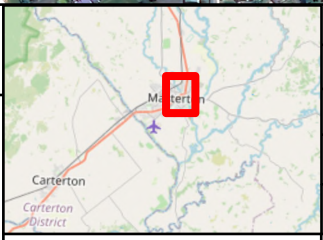


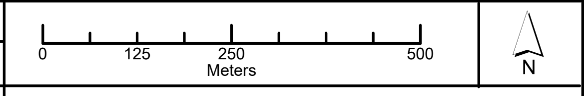
PROJECT
Waipoua River Flood Modelling

MAP
PEAK SPEED MAP
Final Option 3
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner



REVISION	**01**
DATE	**28/03/2025**
A3 SCALE	**1:10,000**
CREATED BY	SP
REVISED BY	MG



Model Information:
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Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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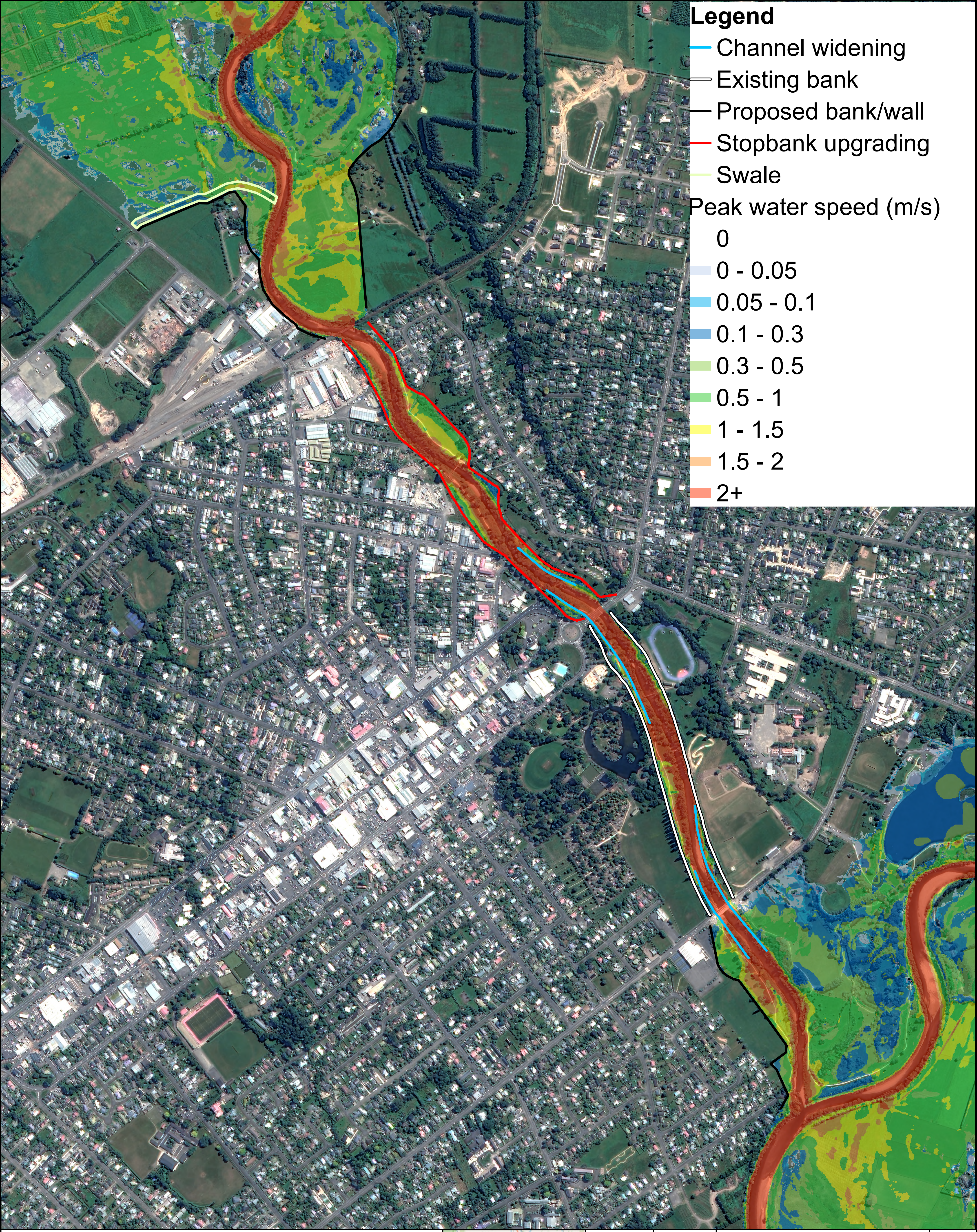

PROJECT
Waipoua River Flood Modelling

MAP
PEAK SPEED MAP
Final Option 4
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	**01**
DATE	**28/03/2025**
A3 SCALE	**1:10,000**
CREATED BY	SP
REVISED BY	MG

0 125 250 500
Meters

N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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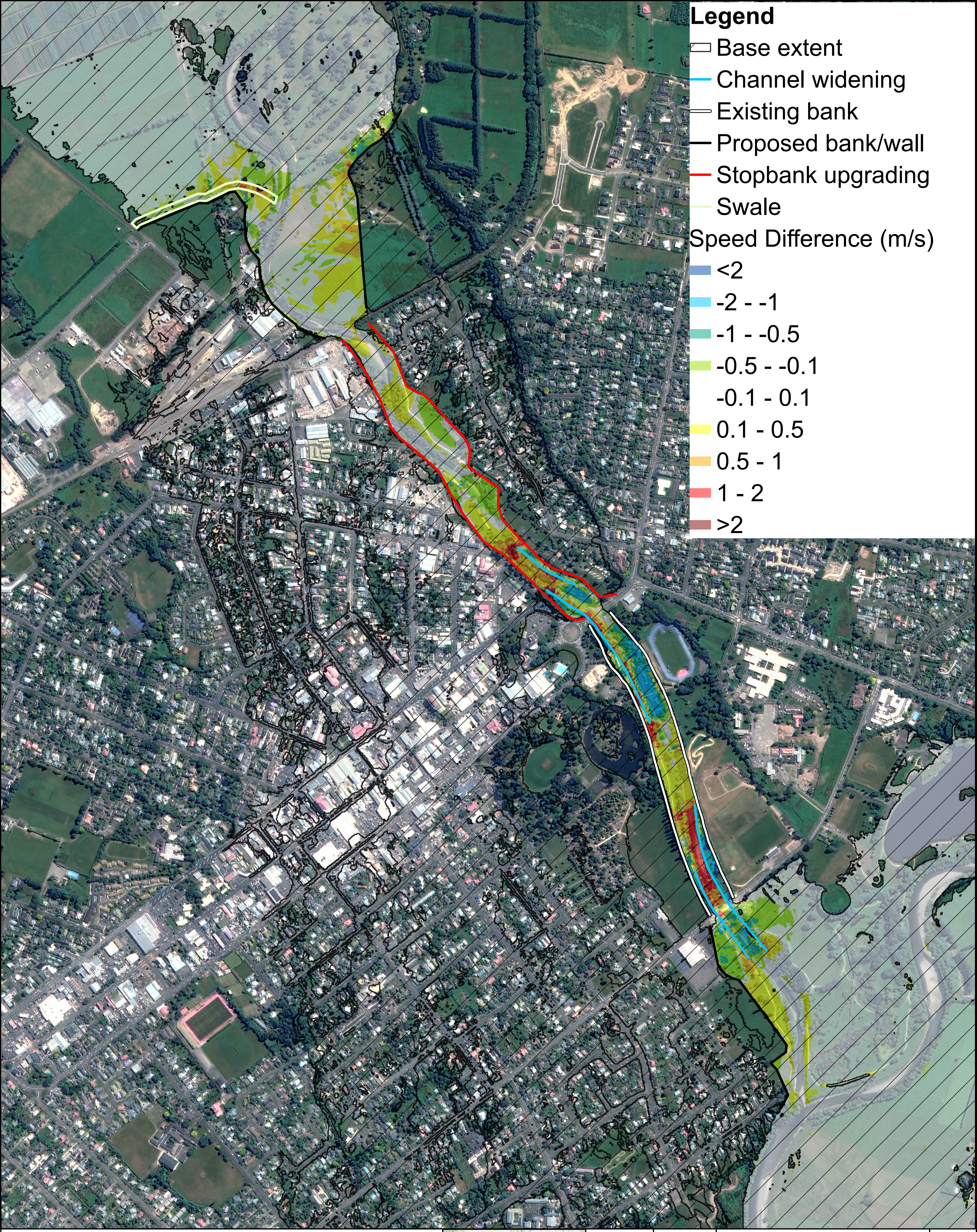
APPENDIX D – FINAL OPTIONS SPEED DIFFERENCE MAPS



PROJECT
Waipoua River Flood Modelling

MAP
SPEED DIFFERENCE MAP
Final Option 1
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	01
DATE	28/03/2025
A3 SCALE	1:10,000
CREATED BY	SP
REVISED BY	MG

0 125 250 500 Meters

N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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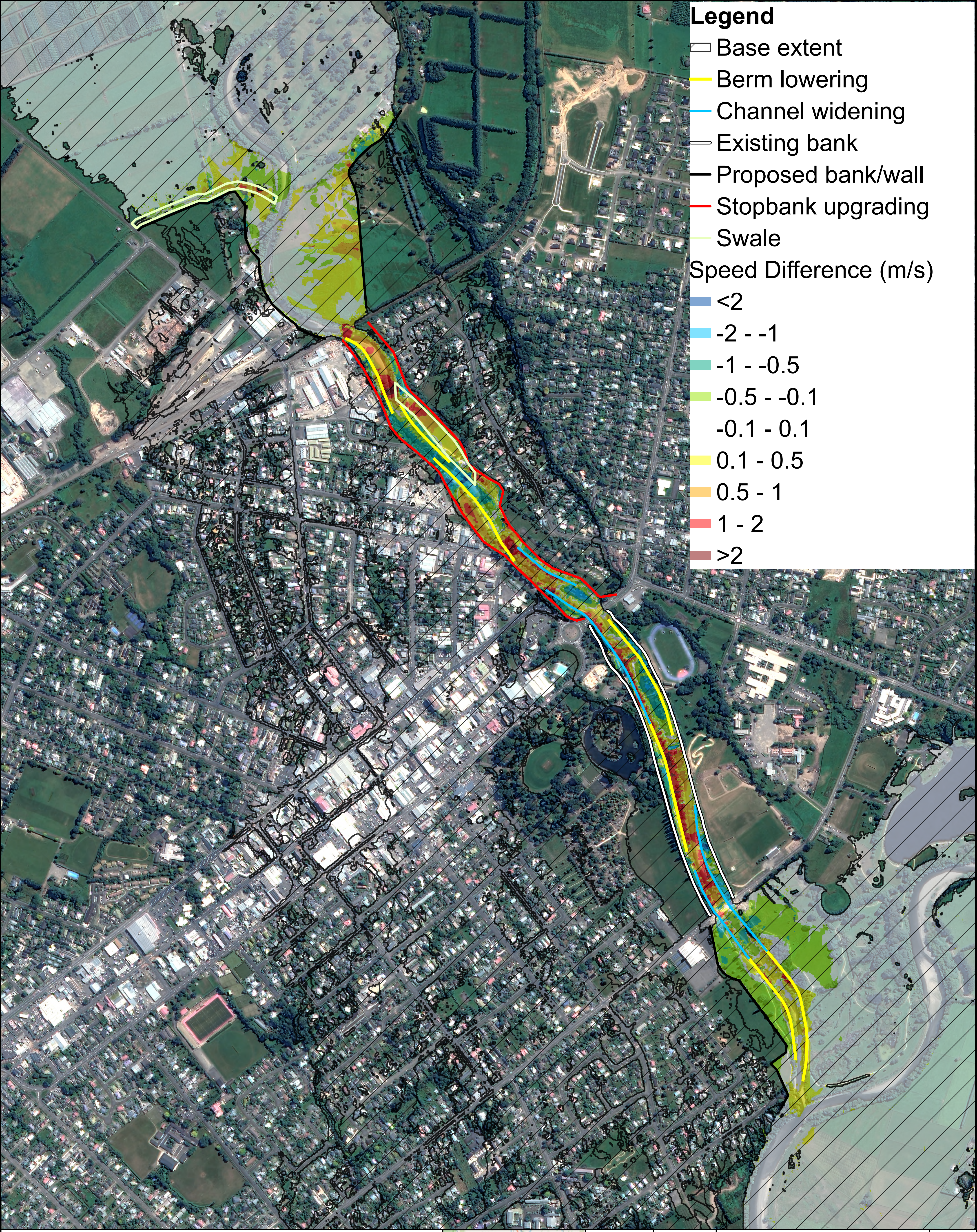
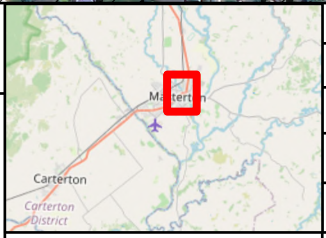


PROJECT
Waipoua River Flood Modelling

MAP
SPEED DIFFERENCE MAP
Final Option 2
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner



REVISION	01
DATE	28/03/2025
A3 SCALE	1:10,000
CREATED BY	SP
REVISED BY	MG

0 125 250 500
Meters

N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

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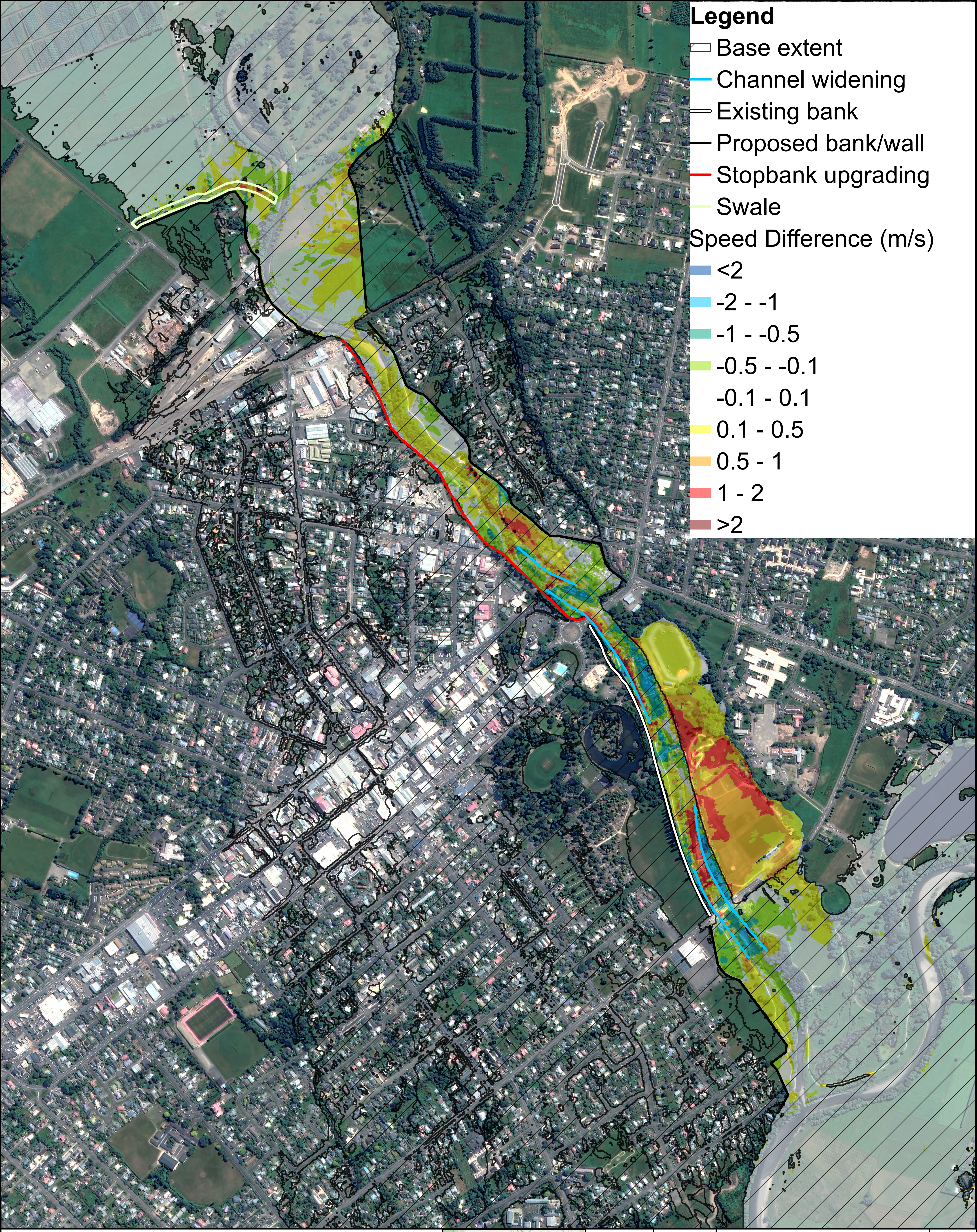
Greater Wellington Te Pane Matua Taiao



PROJECT **Waipoua River Flood Modelling**	REVISION	01	0 125 250 500 Meters; N
MAP **SPEED DIFFERENCE MAP** **Final Option 3** **1% AEP Flow, (Future Climate, RCP6)**	DATE	28/03/2025	
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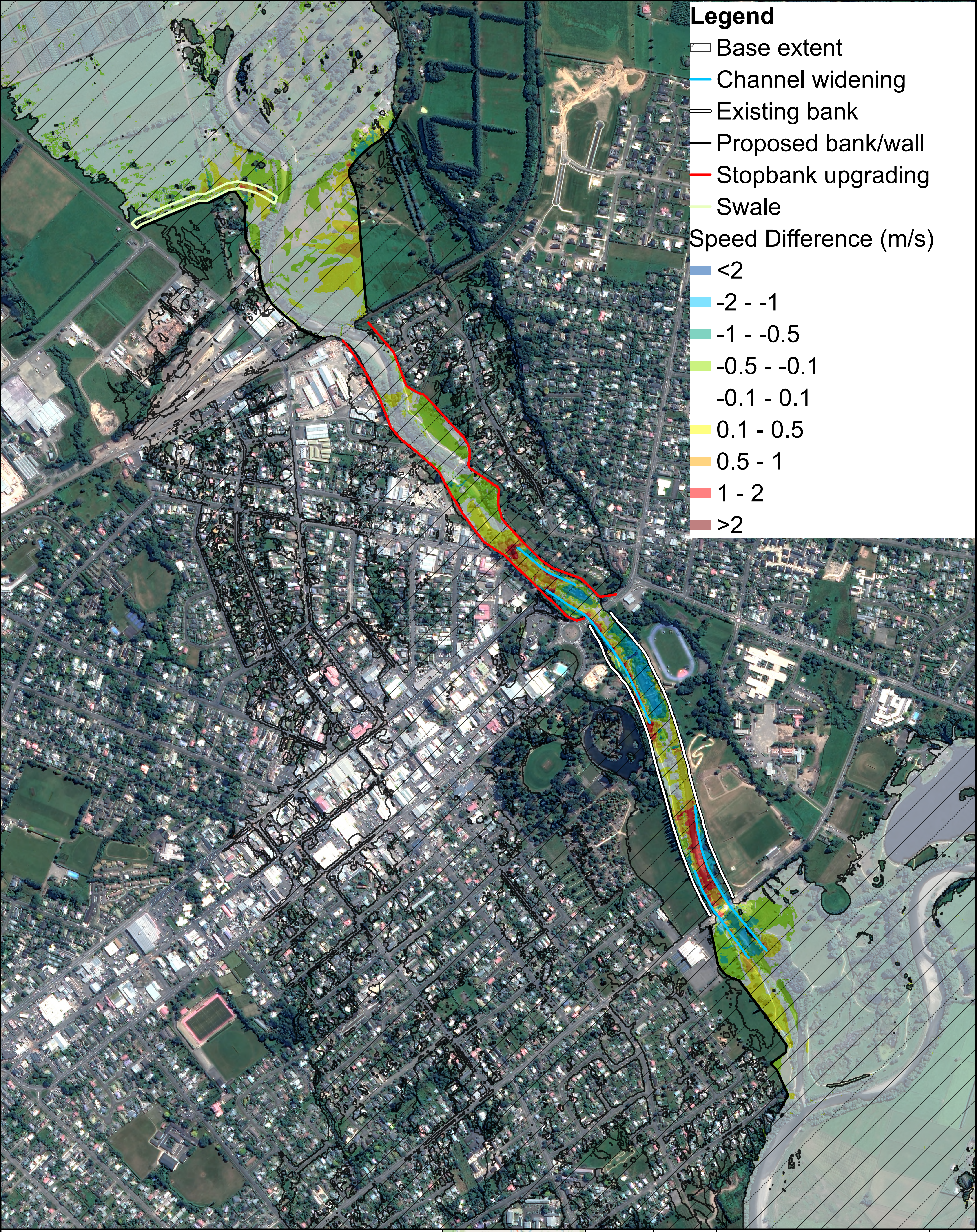
	CREATED BY	SP	
	REVISED BY	MG	Model Completed: June 2024
AUTHOR **Saul Preshner**	Land River Sea CONSULTING	Greater Wellington Te Pane Matua Taiao	



PROJECT **Waipoua River Flood Modelling**	REVISION	01	0 125 250 500 Meters N
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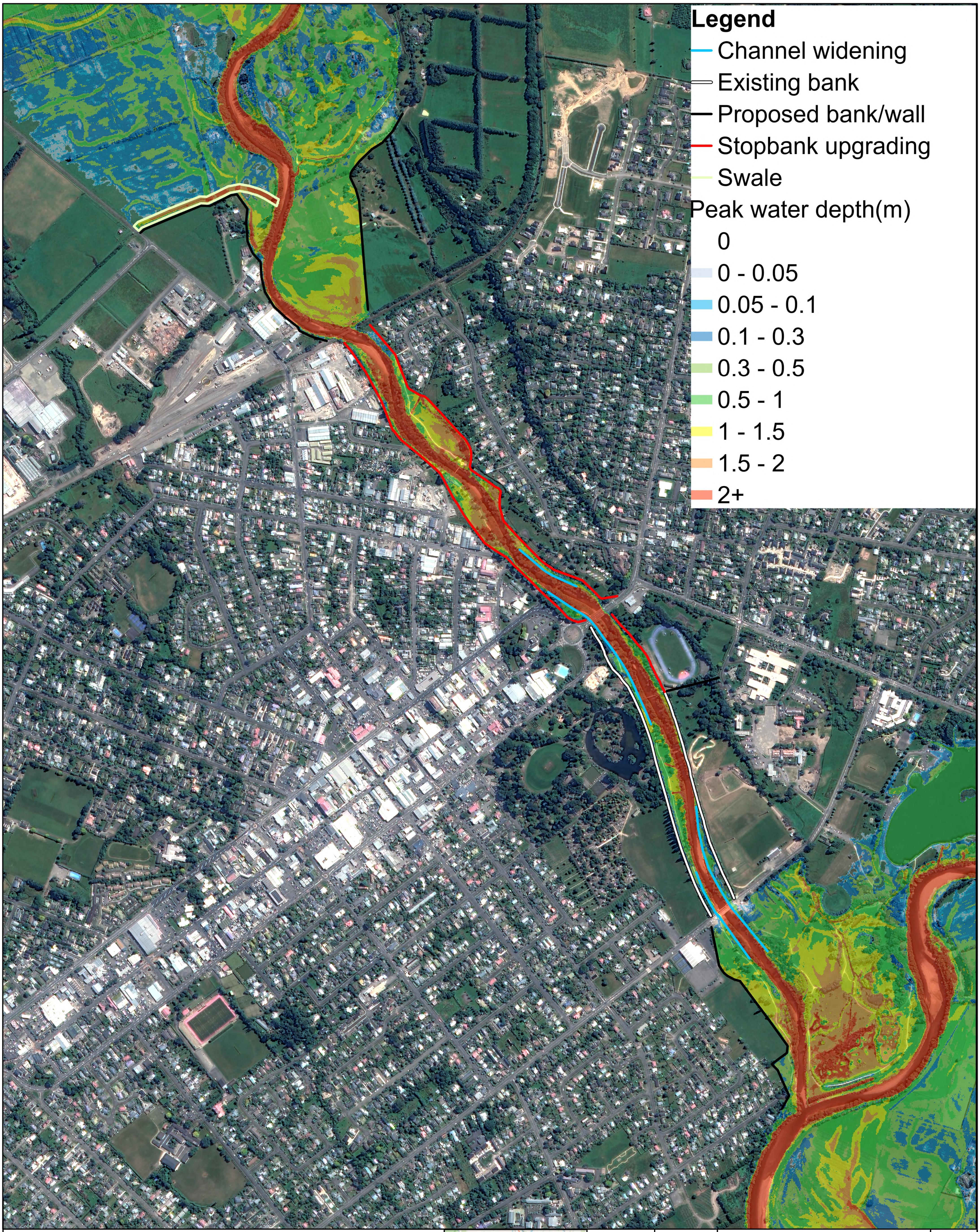
	CREATED BY	SP	
	REVISED BY	MG	Model Completed: June 2024
AUTHOR **Saul Preshner**	Land River Sea CONSULTING	Greater Wellington Te Pane Matua Taiao	

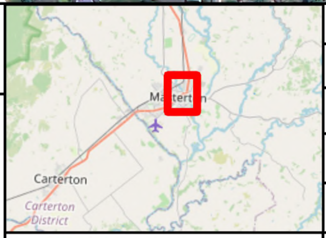
APPENDIX E – PROJECT GROUP PREFERRED OPTION MAPS



PROJECT
Waipoua River Flood Modelling

MAP
PEAK DEPTH MAP
Project Group Preferred Option
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner



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CREATED BY	SP
REVISED BY	MG

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Meters

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Model Information:
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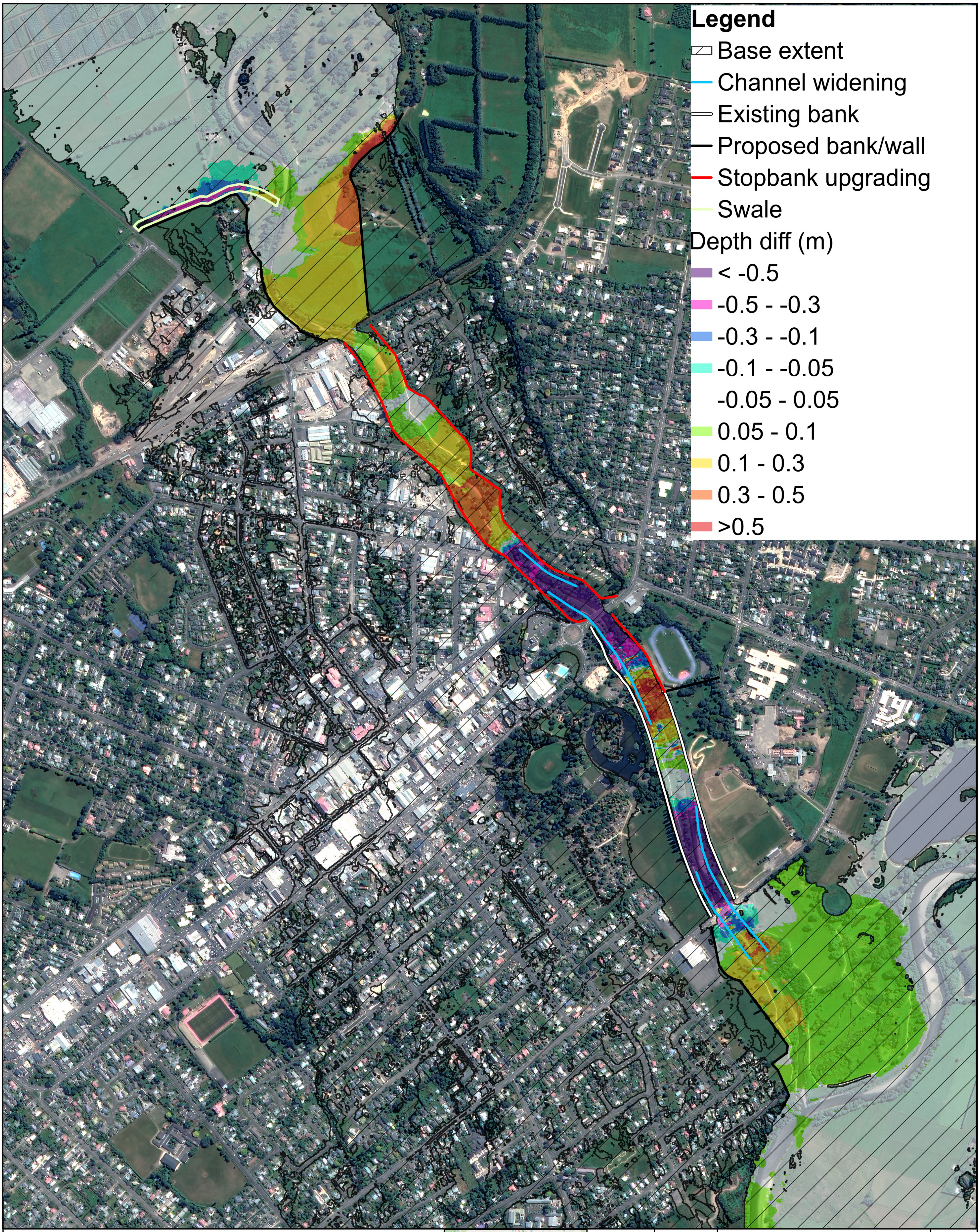
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

Land River Sea CONSULTING

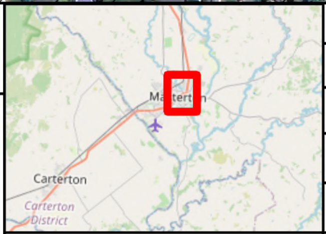
Greater Wellington Te Pane Matua Taiao



PROJECT
Waipoua River Flood Modelling

MAP
DEPTH DIFFERENCE MAP
Project Group Preferred Option - Base Run
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner



REVISION	01
DATE	28/03/2025
A3 SCALE	1:10,000
CREATED BY	SP
REVISED BY	MG

0 125 250 500
Meters

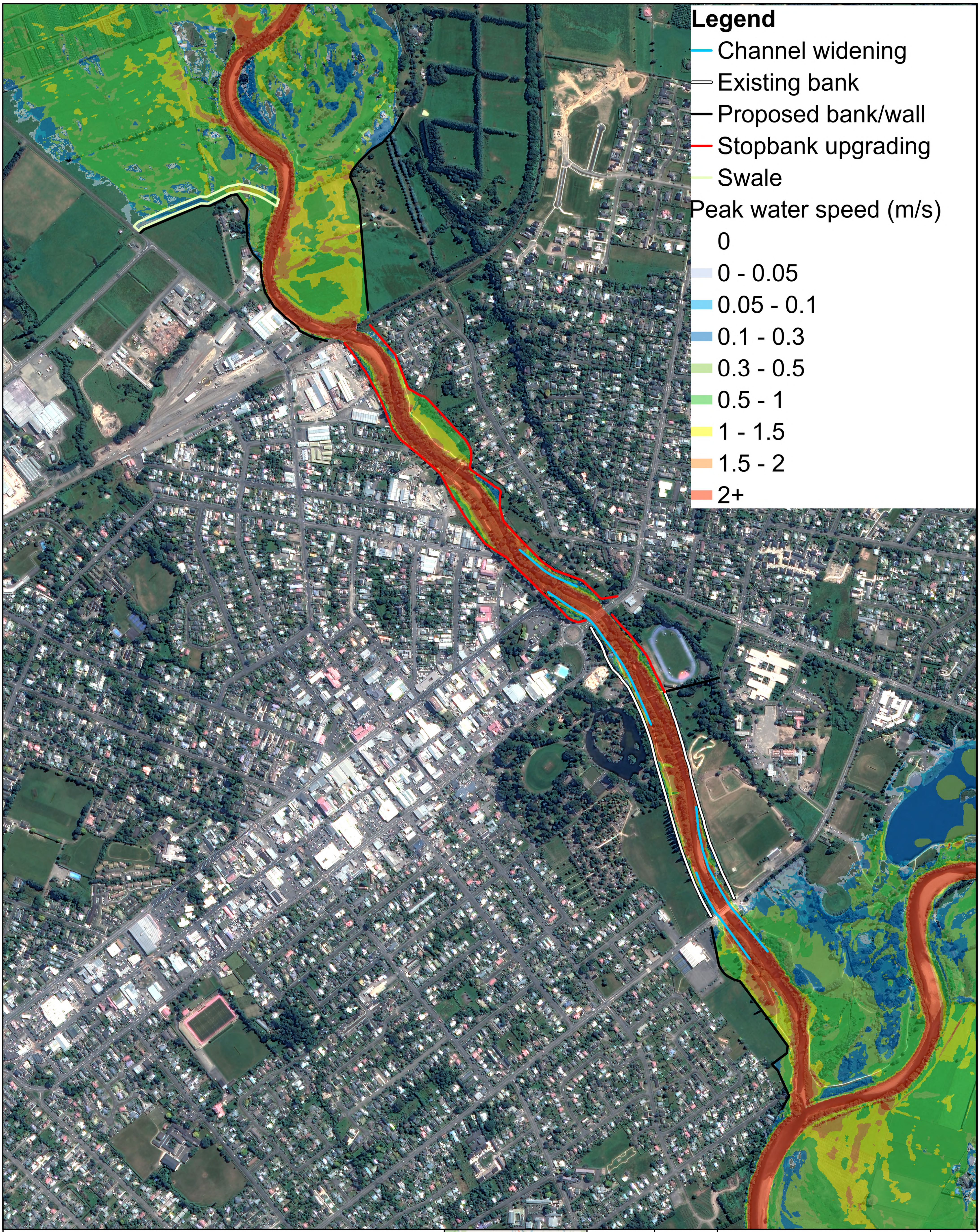
N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

Land River Sea CONSULTING

Greater Wellington Te Pane Matua Taiao



PROJECT
Waipoua River Flood Modelling

MAP
PEAK SPEED MAP
Project Group Preferred Option
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	01
DATE	28/03/2025
A3 SCALE	1:10,000
CREATED BY	SP
REVISED BY	MG

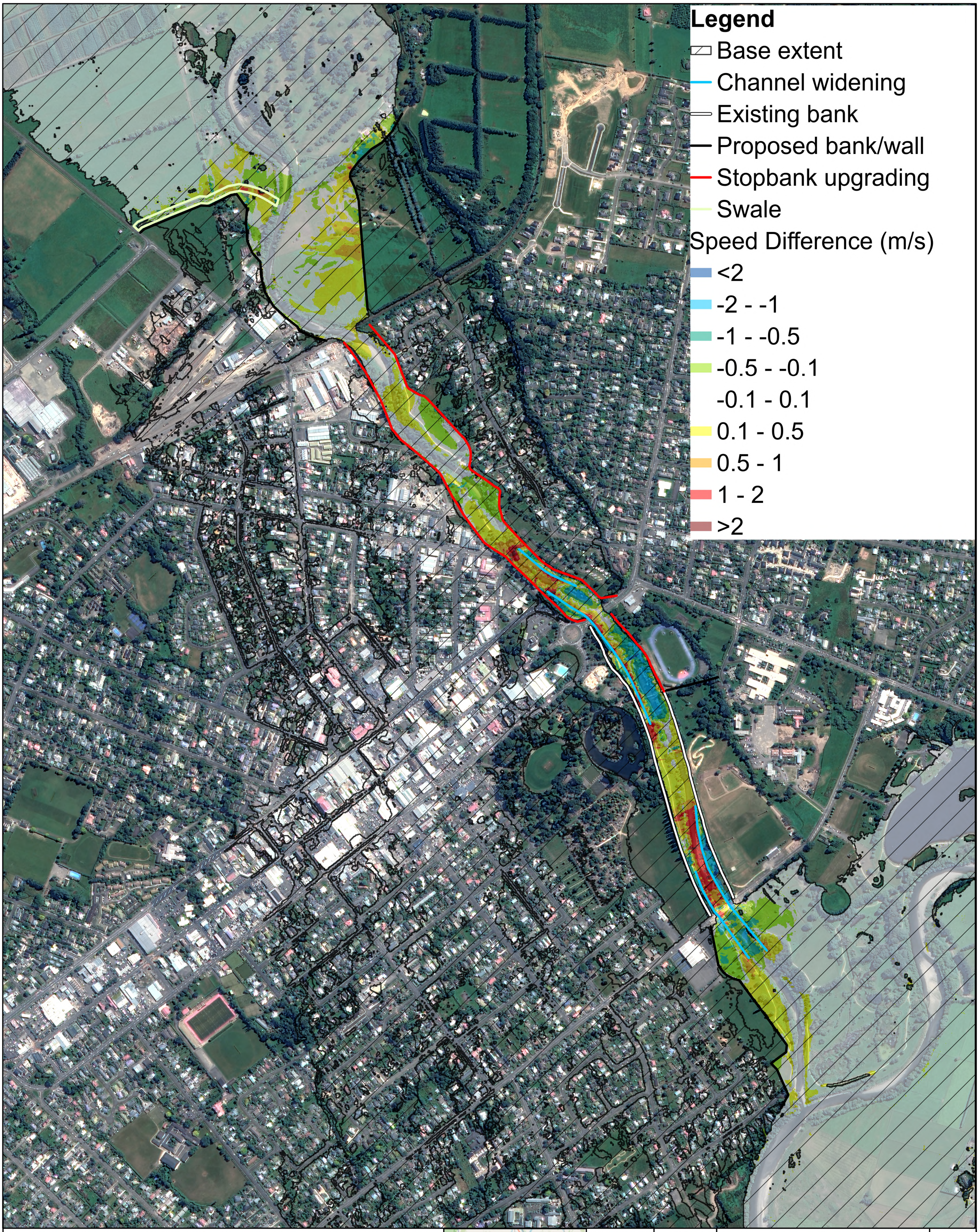
0 125 250 500
Meters
N

Model Information:
Coordinate System: New Zealand Transverse Mercator
Vertical Datum: Wairarapa Local Datum

Model Completed: June 2024

Land River Sea CONSULTING

Greater Wellington Te Pane Matua Taiao



PROJECT
Waipoua River Flood Modelling

MAP
SPEED DIFFERENCE MAP
Project Group Preferred Option - Base Run
1% AEP Flow, (Future Climate, RCP6)

AUTHOR
Saul Preshner

REVISION	01
DATE	28/03/2025
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