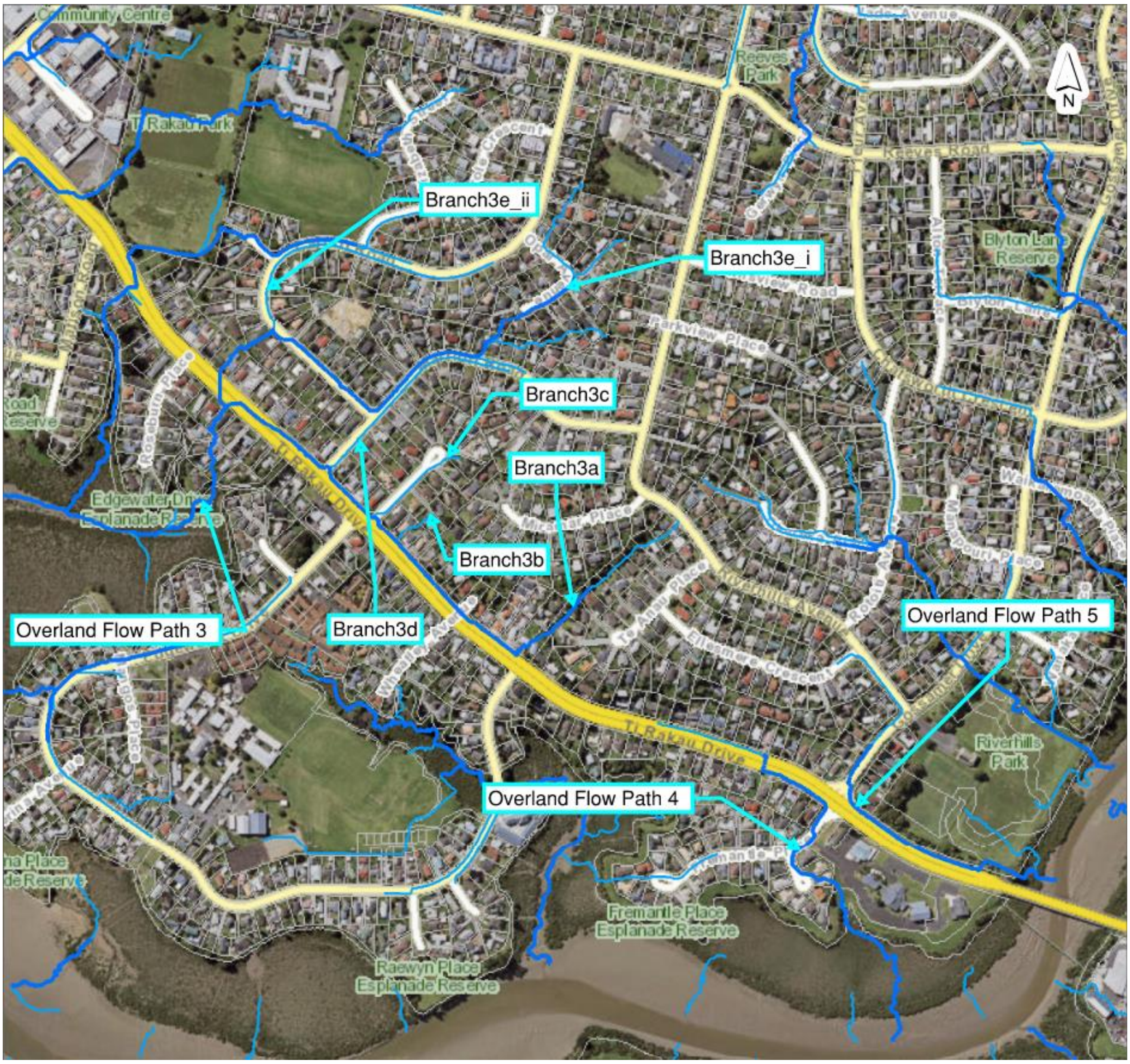

Figure 22: EB3R existing overland flow paths (source AC Geomaps March 2022)

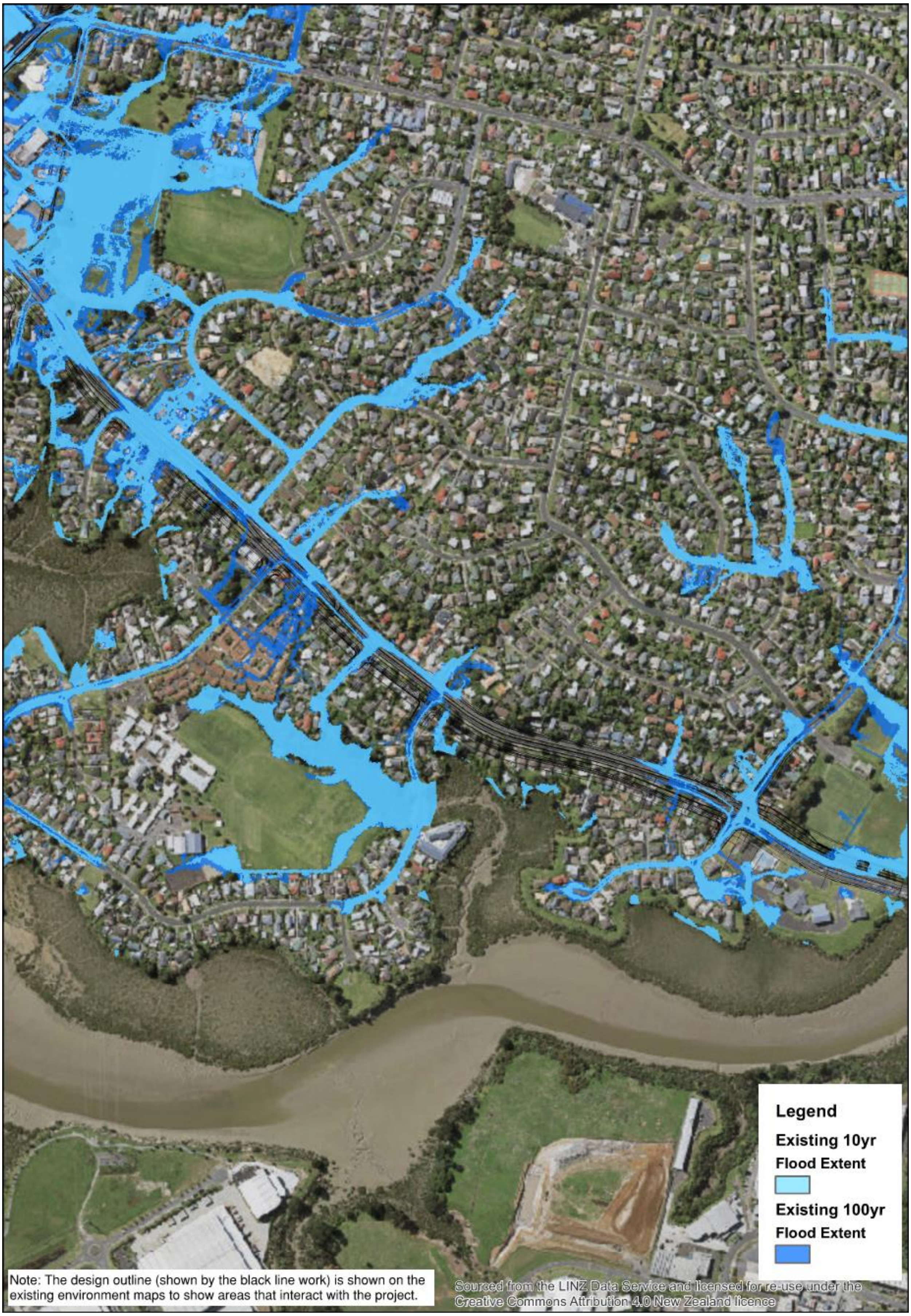

Figure 23: EB3R base case 10 and 100-year flood extents

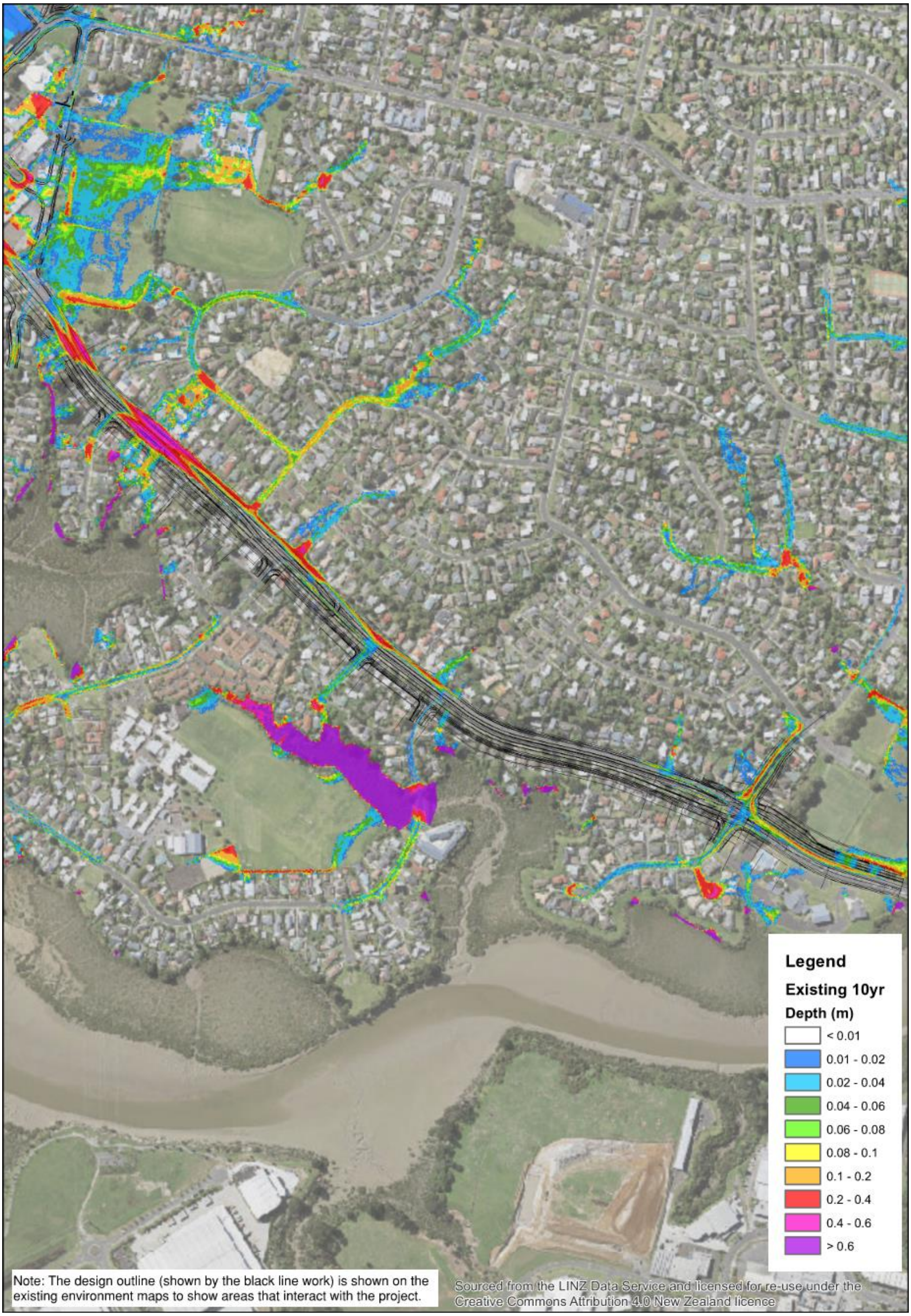

Figure 24: EB3R base case 10-year flood depths

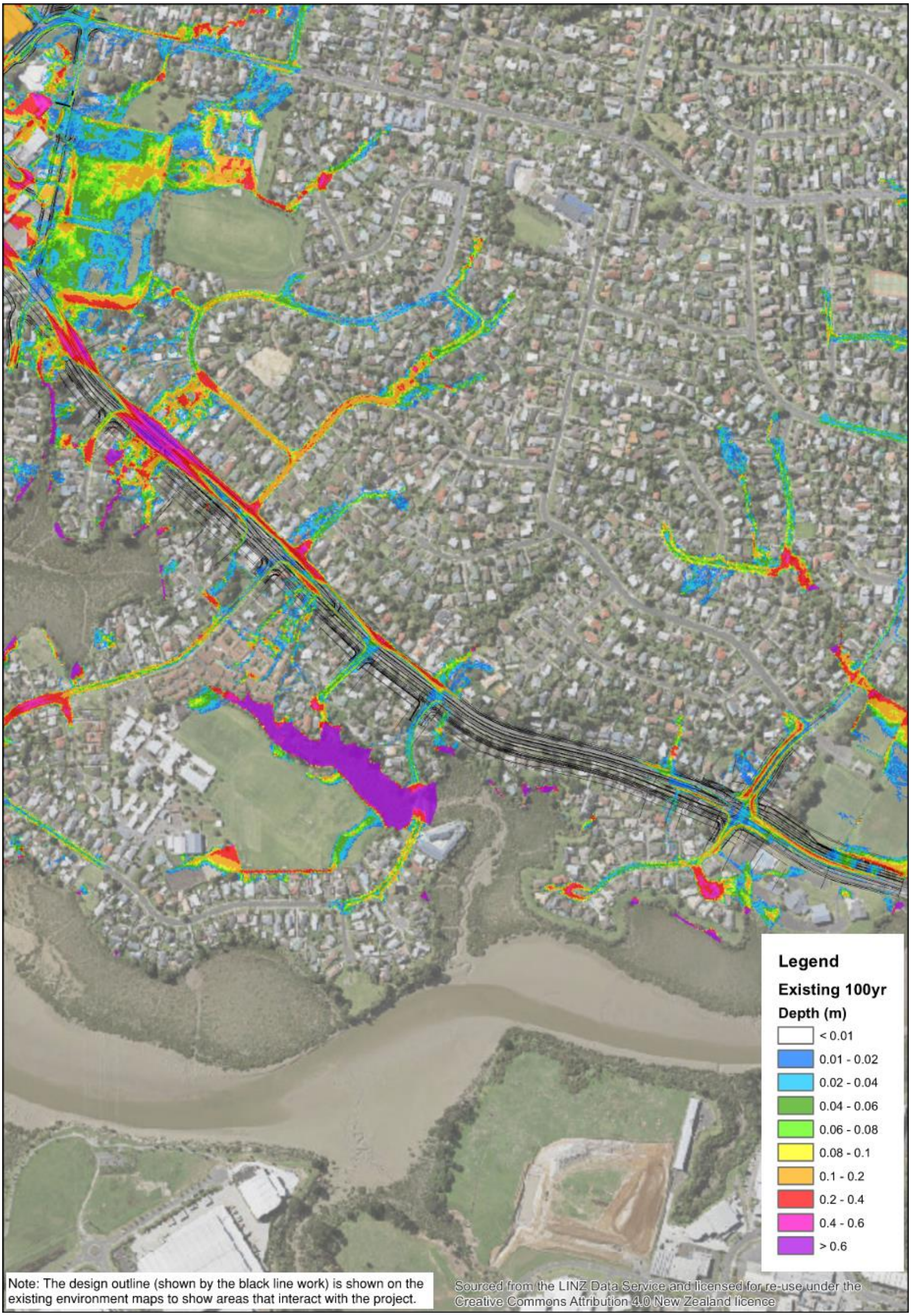

Figure 25: EB3R base case 100-year flood depths

5.2.6 Overland Flow Path Capacity

The Stormwater Code of Practice requires secondary flow (overland flow paths) design to be assessed with the pipe blockages applied to the pipe networks as outlined in Section 4.3. These blockage factors have been applied to the existing pipe network in the base case flood model (see Appendix 3) and the resulting flood extents are provided in Figure 26. As expected, when smaller pipes are 100% blocked, the 10 and 100-year flood extents are very similar and more widespread than for the flooding assessment (i.e., without pipe blockages). The flood depths for the 10 and 100-year ARI events are shown in Figure 27 and Figure 28 respectively. Again, as expected, the flood depths are deeper, and the extents of deeper flooding are larger than without blockages.

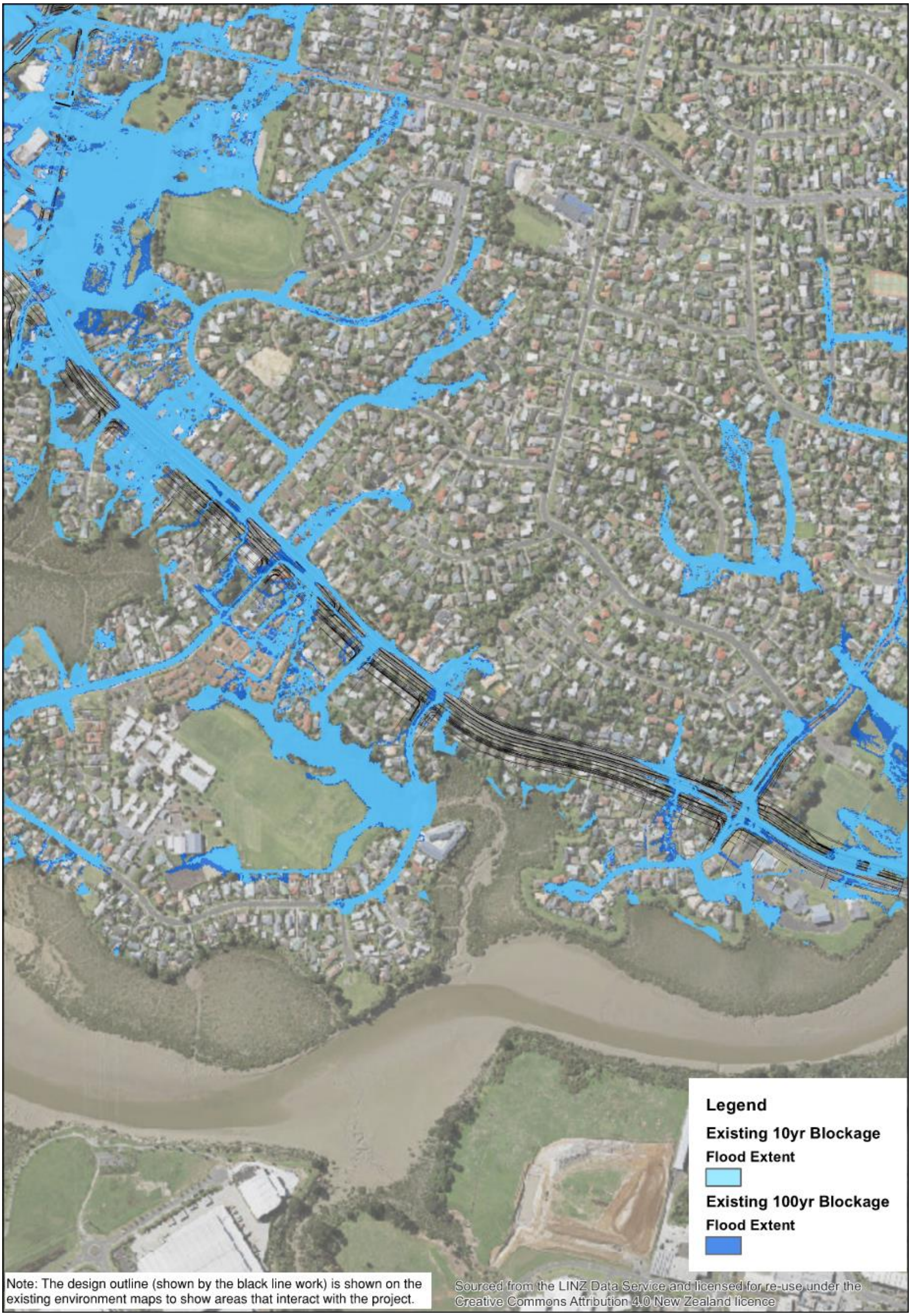

Figure 26: EB3R base case 10 and 100-year flood extents (pipe blockage)

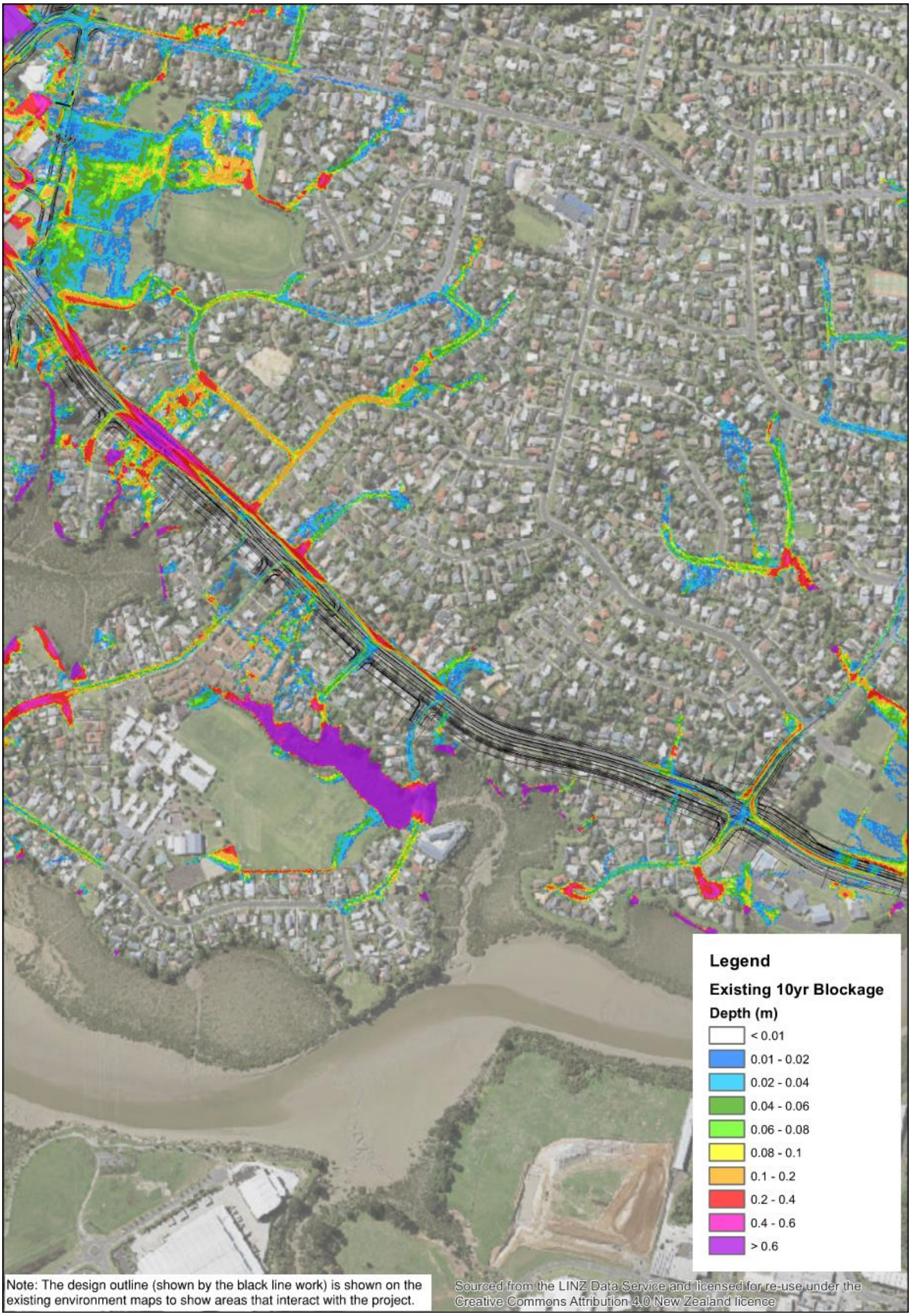

Figure 27: EB3R base case 10-year flood depths (pipe blockage)

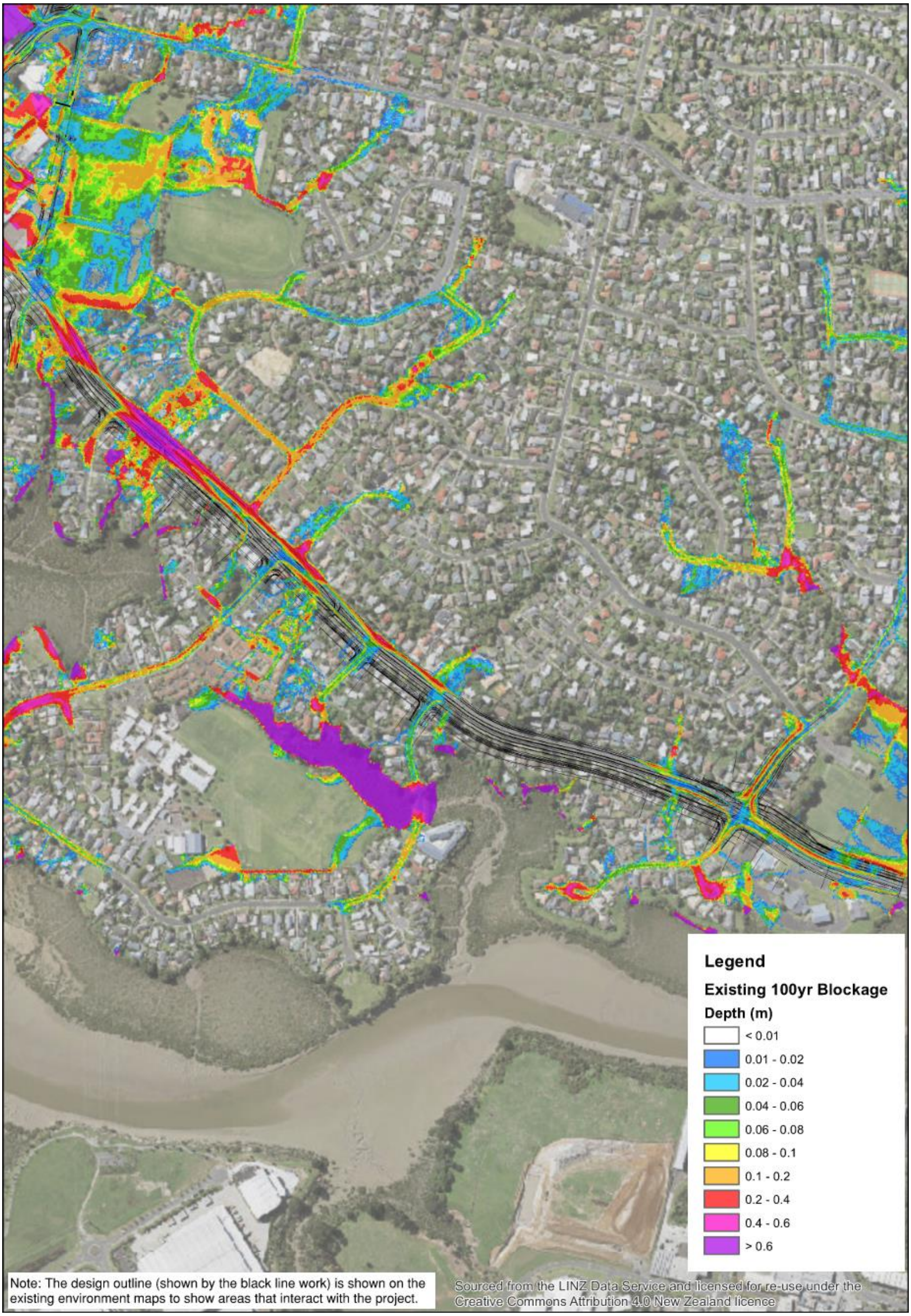

Figure 28: EB3R base case 100-year flood depths (pipe blockage)

6 Stormwater Effects Assessment

Chapter Summary
EB2 Summary of key points/ findings • *The proposed stormwater treatment design reduces the existing overall contaminant load to EB2 outfalls. The predicted reductions are 39% for TSS, 14% for zinc, 18% for copper and 23% for TPH* • *All individual outfalls have their existing contaminant loads from roads reduced except for Outfall MCC_108633 which receives more road catchment as a result of the Project works* • *Whilst outfall MCC_108633 is predicted to receive a reduced TSS contaminant load of 17%, it is predicted to receive small increases for zinc, copper and TPH* • *Modelling shows there are no flood impacts on private property during the 10 and 100-year events as a result of the EB2 stormwater design and Project works. EB2 will result in reduced flooding in large areas throughout the wider catchment that EB2 is located within* • *Modelling shows there are some reduced overland flow path capacities as a result of the EB2 works that the EB2 stormwater network design has not compensated for, based on the secondary flow assessment where pipe blockages are applied to pipes in accordance with the Stormwater Code of Practice. These reduced overland flow path capacities result in predicted small to modest flood impacts on private property during the 10 and 100-year events. Mitigation is proposed for these properties.* *EB3R Summary of key points/ findings* • *The proposed stormwater treatment design reduces the existing overall total contaminant load to EB3R outfalls. The predicted reductions are 59% for TSS, 43% for zinc, 48% for copper and 53% for TPH* • *All individual outfalls have their existing contaminant loads from roads reduced except for Outfall MCC_108707 which receives more road catchment as a result of the Project works* • *Whilst outfall MCC_108707 is predicted to receive a reduced TSS contaminant load of 17%, it is predicted to receive increases of 74% for zinc, 62% for copper and 49% for TPH. This increase is the result of a section of Ti Rakau Drive being diverted from outfall MCC_108713 for flood mitigation reasons since it could not easily be upgraded (it runs under several houses and immediately adjacent to several others)* • *Modelling shows that there are no flood impacts on private property during the 10 and 100-year events as a result of the EB3R stormwater design and Project works. There are large areas of reduced flooding throughout the wider catchment EB3R is located within* • *Modelling shows that there are some reduced overland flow path capacities as a result of the EB3R works that the EB3R stormwater network design has not sufficiently replaced, based on the secondary flow assessment where pipe blockages are applied to pipes in accordance with the Stormwater Code of Practice. These reduced overland flow path capacities result in predicted small to modest flood impacts on private property during the 10 and 100-year events. Mitigation is proposed for these properties.*

6.1 EB2

6.1.1 Construction

The discharge of stormwater during construction is excluded from this technical assessment and is documented in the erosion and sediment control technical assessment, as well as both the Construction Environmental Management Plan (CEMP) and Erosion and Sediment Control Plan (ESCP).

6.1.2 Discharge of Stormwater

The design for EB2 collects stormwater in independent networks that connect to existing networks near their outfalls and, where necessary, the design proposes to upgrade the existing pipes from the connection points to the outfalls. The outfalls proposed to receive Project discharges are summarised in Table 1.

In addition to the outfalls in Table 1, it is possible that EB2 stormwater networks may also need to connect to the following outfall as part of the solution to resolving complex utility clearance challenges for proposed new outfall 89-18:

- MCC_108680 discharges to a natural wetland south of SEART on ramp. Connection to this existing stormwater network is proposed to be incorporated into the final detailed design to eliminate two crossings of the Transpower High Voltage Cable and one crossing of the Hunua 2 watermain by stormwater pipes. The Transpower High Voltage Cable and the Hunua 2 water main are critical infrastructure and stormwater crossings which represent a significant risk. To avoid these crossings, it is proposed to install a flow splitting manhole over the existing pipe across Ti Rakau Drive and provide a high flow connection to the Project stormwater network running along SEART to the proposed new outfall 89-18. Stormwater from the westbound lanes of Ti Rakau Drive and the busway could then be accommodated within the existing stormwater network without pipe capacity upgrades between the western side of Ti Rakau Drive to the outfall. No works to the outfall would be required.

All of the existing, upgraded, and new outfalls that the EB2 stormwater networks propose to connect to are to be authorised by the NDC and discharge to or adjacent to the CMA. In addition, network pipe sizes downstream of the connection point will be upgraded where necessary. As such, there are no flooding or capacity impacts on the receiving environment from any increased discharge rates. The proposed typical outfall detail (see Figure 29), which is a naturalised rip rap-armoured basin without concrete headwalls, provides outfall erosion and scour protection and the required energy dissipation to avoid downstream erosion within the CMA. The proposed outfall detail will be further developed for each location by a multidisciplinary design team, incorporating landscape architects, ecologists, coastal scientists, and stormwater engineers to achieve appropriate form and outcomes for each receiving environment location.

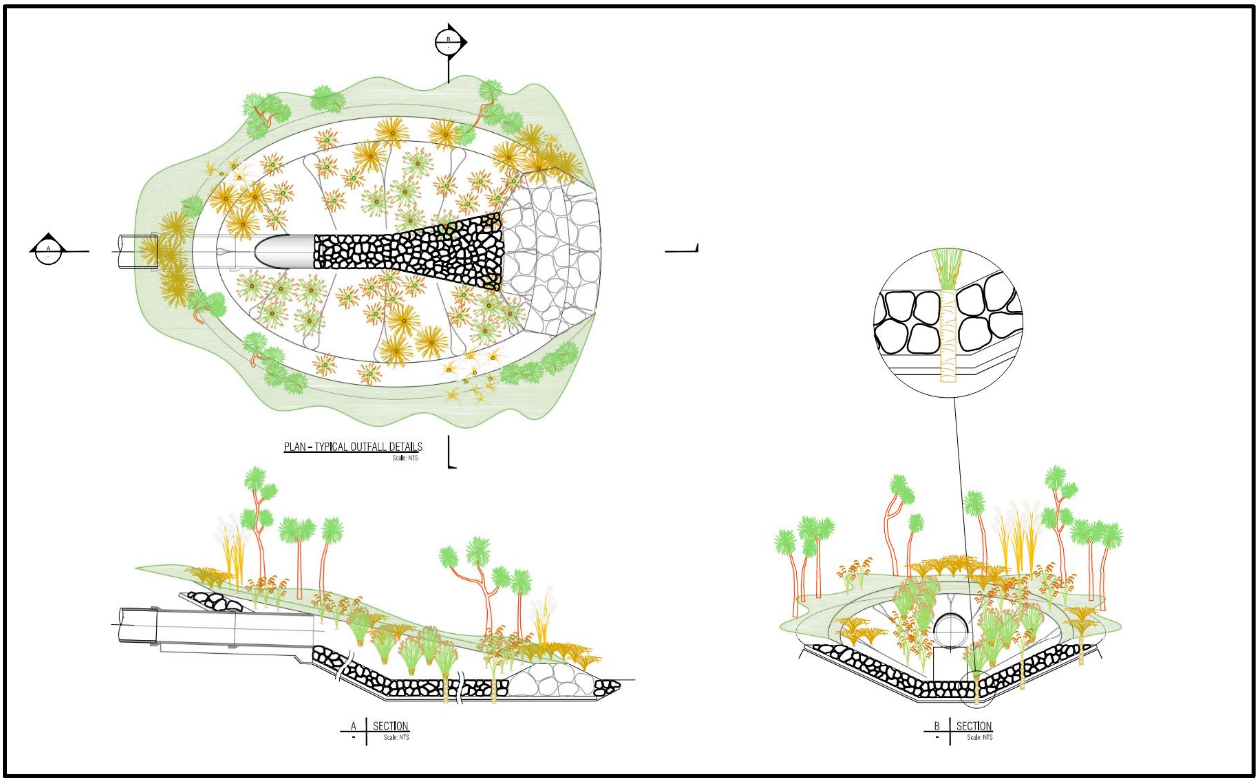

Figure 29: Outfall Concept.

As discussed in the design philosophy (see Section 2.1), the EB2 design is aligned with the Project's stormwater treatment target of achieving a reduction in existing contaminant load contributions from roads discharging to outfalls, on a combined total basis over the whole Project, rather than for individual outfalls. This approach is aligned with the BPO option supported by a SMP within the NDC framework. The final outcomes will be influenced by ongoing joint EBA and Healthy Waters hui with mana whenua. The CLM (see Table 3) currently predicts that the EB2 design will achieve this target, with reductions of 39% for TSS, 14% for zinc, 18% for copper and 23% for TPH. On an individual outfall basis, outfall MCC_108680 achieves reductions due to reduced road catchment areas rather than as a result of providing stormwater treatment, as the design does not currently discharge Project stormwater to this outfall. MCC_108673 (including outfalls 06-05 and 89-18) and MCC_108699 reduce existing contaminant loads as a result of providing stormwater treatment to existing and Project stormwater. Outfall MCC-108633 has not been able to reduce existing contaminant loads from roads, in part, due to diversion of additional catchment to this outfall. However, it is noted these are small increases (see Table 3) and are insignificant compared to the overall positive effect the project presents by achieving much larger contaminant reductions for the collective receiving environments. There is no change to contaminant loads discharging to Outfall MCC-108633 since the Project is not currently proposing the discharge of stormwater to this outfall.

The outcomes for EB2 stormwater treatment are a positive effect on existing contaminant loads from roads, when considered on an EB2 wide basis.

6.1.3 Flooding Assessment

The flood model for the design case (i.e., with the design geometric surface and drainage pipes) predicts reduced flooding extents for the 10 and 100-year ARI events. This is demonstrated by comparing the flood extents in Figure 31 to the existing extents shown in Figure 13. The results show reduced flood depths for the 10-year ARI event (up to 400 mm). This is further demonstrated by comparing Figure 32 to the existing flood depths in Figure 14 (which has a greater than 600 mm maximum depth on Ti Rakau Drive). The results also show reduced extents of the larger depths in the 100-year ARI event. This is demonstrated by comparing Figure 33 to the existing flood depths in Figure 15. For the majority of the modelled area there are no predicted increases in depths or extents for the 10-year ARI event (see Figure 34) and 100-year ARI event (see Figure 35). There are some exceptions as follows:

- The area of increased flooding shown within Ti Rakau Park is contained within an area that Auckland Council Parks have agreed to the construction of a shallow overland flow path channel and these works are part of the mitigation plan for the park.
- There are some areas where dotted increases are mixed with decreases which have since been confirmed to be ‘model noise’ caused by the way the model creates the ground surface mesh from the digital elevation models. The InfoWorks ICM software effectively creates triangulated irregular network surfaces that are slightly different for the existing and design cases even though outside of the design the surface is derived from the same digital elevation model. Innovyze the developer of the InfoWorks ICM flood model software has provided an alternative ‘clip meshing’ method, as opposed to the previous ‘classic’ method, which removes this issue. An example of the correction of this issue is provided in Figure 30 with the left image showing the ‘model noise’ (see yellow and green dots) while the image on the right using the new method has no dotted increases and decreases. The models will be updated with the new model method for developing the ground surface in the models to remove the ‘model noise’ before issuing the final detailed design flood modelling results to Healthy Waters.
- There are some other small areas of increased flood depths and extents predicted in vehicle entrances of some commercial properties adjacent to William Roberts Road in both the 10-year and 100-year events. These areas are associated with how vehicle entrances have been modelled in the geometric design and can be resolved during detailed design by geometric or

drainage design changes. It should be noted that the commercial properties already have existing flooding on their properties during a 10 and 100-year ARI event and the proposed stormwater design provides significant areas of reduced flood depths on the properties. The model will be updated with the refined geometric design prior to submission of the final SMP as part of the EPA process to obtain connection approval under the NDC.

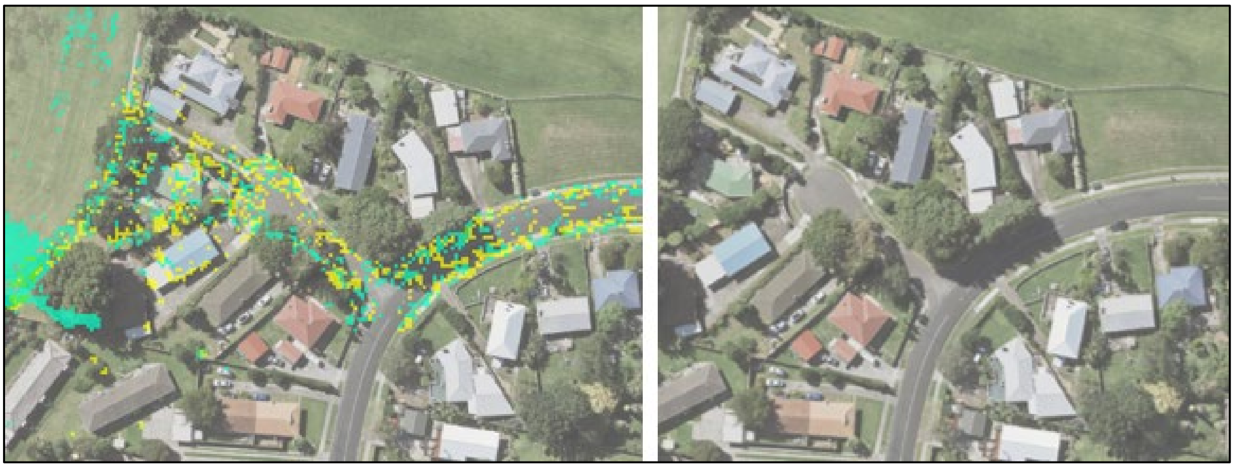

Figure 30: Example of 'model noise'.

Overall, the Project represents a significant positive effect with the proposed works predicted to significantly reduce the flooding frequency, extents, and depths over large parts of EB2, thereby improving the capacity of the networks and resilience against flooding.

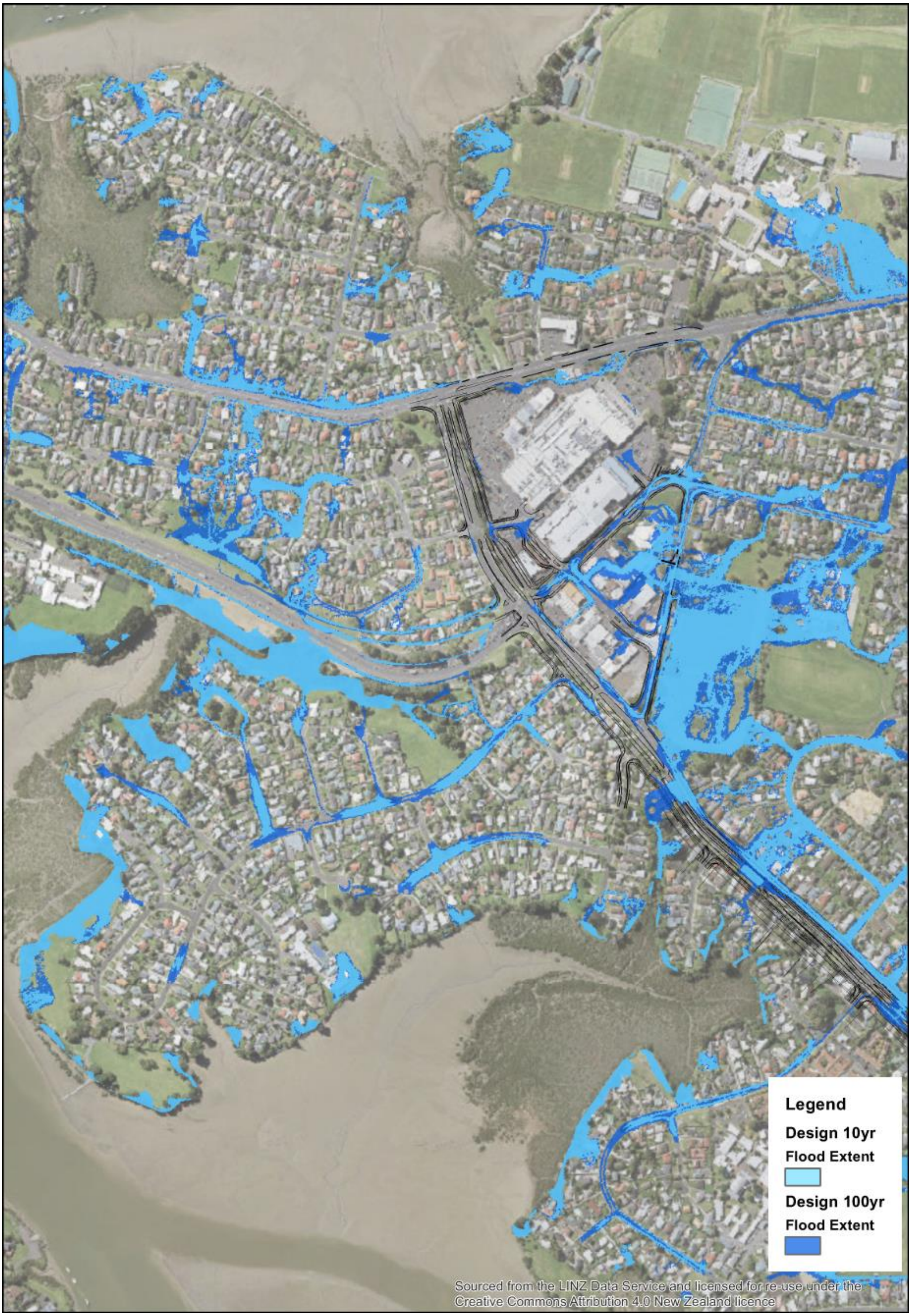

Figure 31: EB2 design case 10 and 100-year flood extents

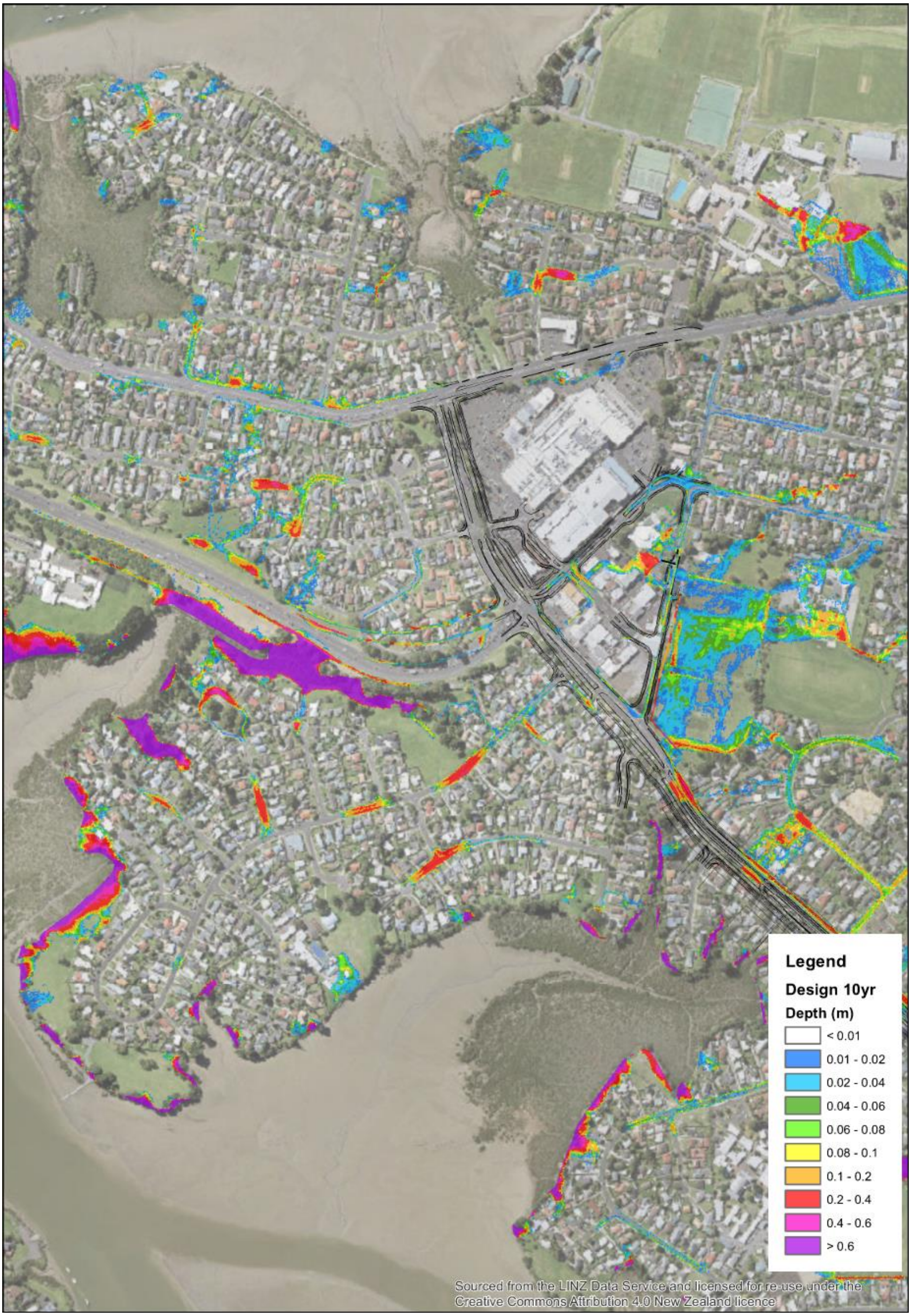

Figure 32: EB2 design Case 10-year flood depths

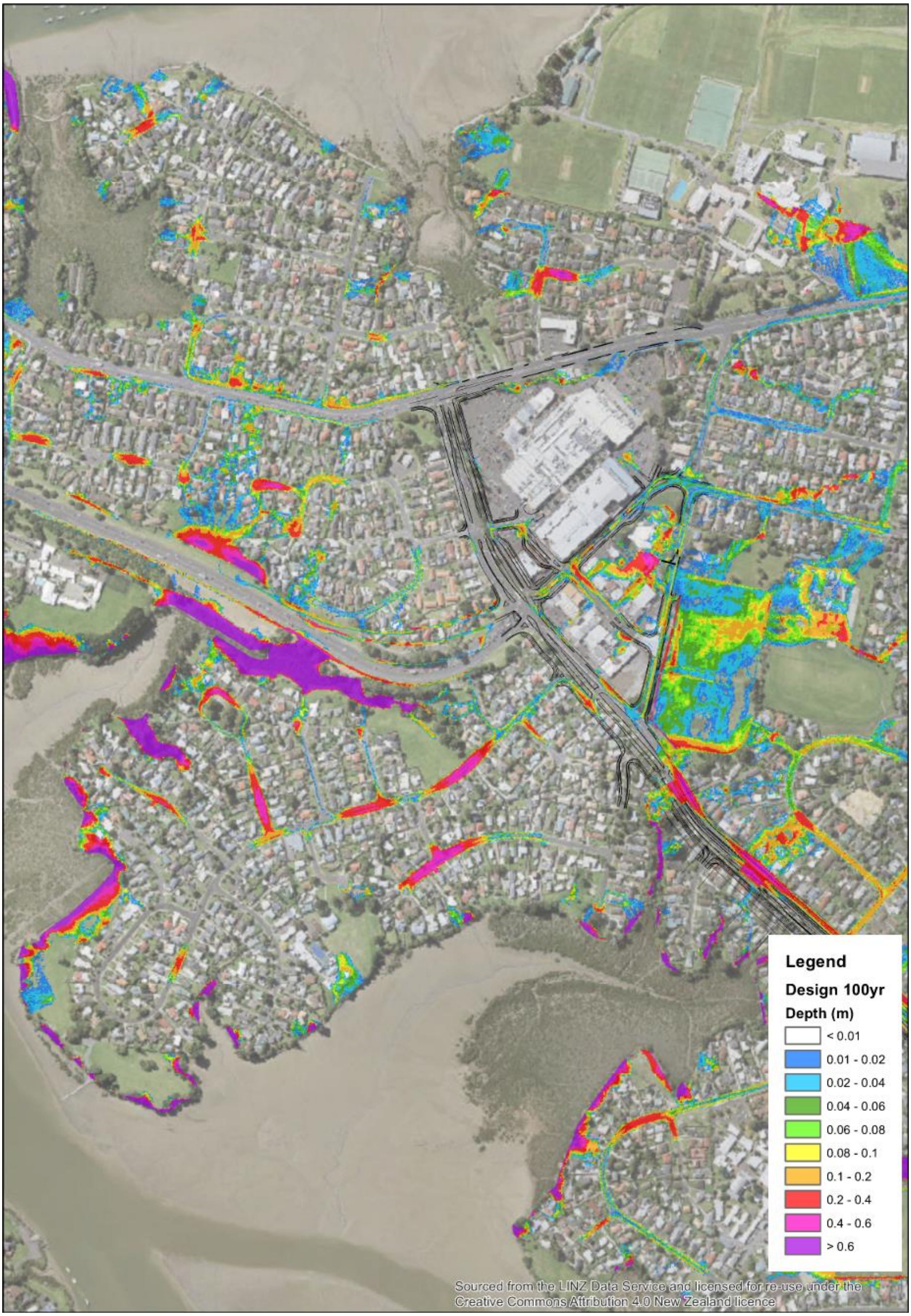

Figure 33: EB2 design case 100-year flood depths

Figure 34: EB2 design case 10-year flood depth difference

Figure 35: EB2 design case 100-year flood depth difference

6.1.4 Overland Flow Path Assessment

The modelled pipe network has had pipe blockages added in accordance with the Stormwater Code of Practice (see Section 4.3.1) to assess overland flow capacity to ensure it has been maintained or replaced by pipes with sufficient capacity when pipe blockages are applied. The 10 and 100-year ARI event overland flow and flooding extents are shown in Figure 36. Again, the 10-year and 100-year flood extents are similar, although the flood extents are more substantial as would be expected when most of the stormwater network capacity is removed via pipe blockages. The 10 and 100-year ARI event overland flow and flooding depths are shown in Figure 37 and Figure 38 respectively. As would be expected given the stormwater network capacity has been significantly reduced, by adding pipe blockages, the flood depths are greater than for the scenario without blockages (see Section 6.1.3). However, there are areas where the overland flow and flooding depths are less than the base case (i.e., existing situation with climate change included) indicating the drainage and geometric designs have increased overland flow capacity in some areas.

The difference between the base case (with blockages applied to pipes) and the design case (with blockages applied to pipes), is shown in Figure 39 and Figure 40 for the 10 and 100-year ARI events respectively. The results show that adding the pipe blockages does not result in widespread increases as a result of the EB2 works. This is because the overland flow path capacity hasn't been reduced in most cases or has been supplemented with network drainage capacity even after pipe blockages are applied (i.e. by using larger pipes between 600 and 1050 mm that only lose 50% of their capacity or pipes greater than 1050 mm that lose 10% of their capacity).

As shown in Figure 39 there are areas of increased overland flow and flooding depths as a result of the Project during the 10-year event. The private properties impacted by these increases are highlighted on Figure 41 for the 10--year event (see private properties with blue boundaries). It is noted that private properties with increased flood depths shown on Figure 41 includes private properties that previously had overland flow and/or flooding within their property in the base case that have increased. The properties with red boundaries have been purchased by the Project and are therefore not considered impacted. The private properties, not purchased by the Project, with increased overland flow and flooding depths when the pipe blockages are applied are:

- 73, 1/75, 2/75, and 105 Pakuranga Road
- 2, 1/8, 2/8, 1/16, 2/16, and 3/16 Latham Avenue
- 1/8, 2/8, 3/8, and 10 Paul Place
- 2, 21, 23, 25, 27, 22/33, 23/33, 24/33, 25/33, 26/33, 41, 1/43, 2/43 45, 47, 47A, 49, 51, 53, 70, 81A, and 81B, Dale Crescent
- 1/3, 2/3, and 5 Palm Avenue
- 2R, 3, 1/5, 2/5, 1/7, 2/7, 1/9, 2/9, 1/11, 2/11, 1/13, 2/13, 1/15, and 2/15 Ti Rakau Drive
- 3 and 13R Reeves Road
- 7G and 9A Mattson Road.

The mitigation that is recommended to be included in the final detail design to address these effects is outlined in Section 7.1.

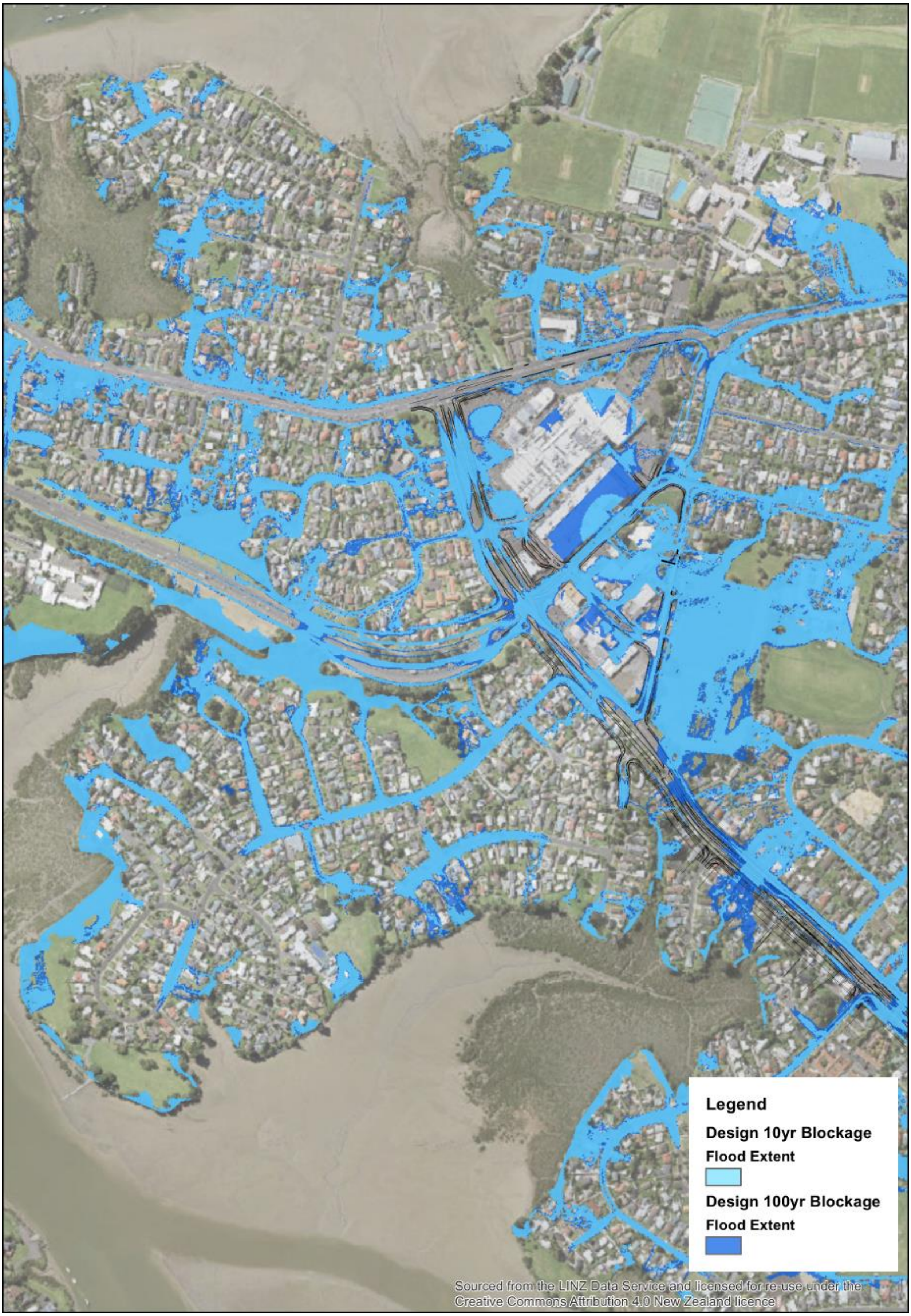

Figure 36: EB2 design case 10 and 100-year flood extents (pipe blockage)

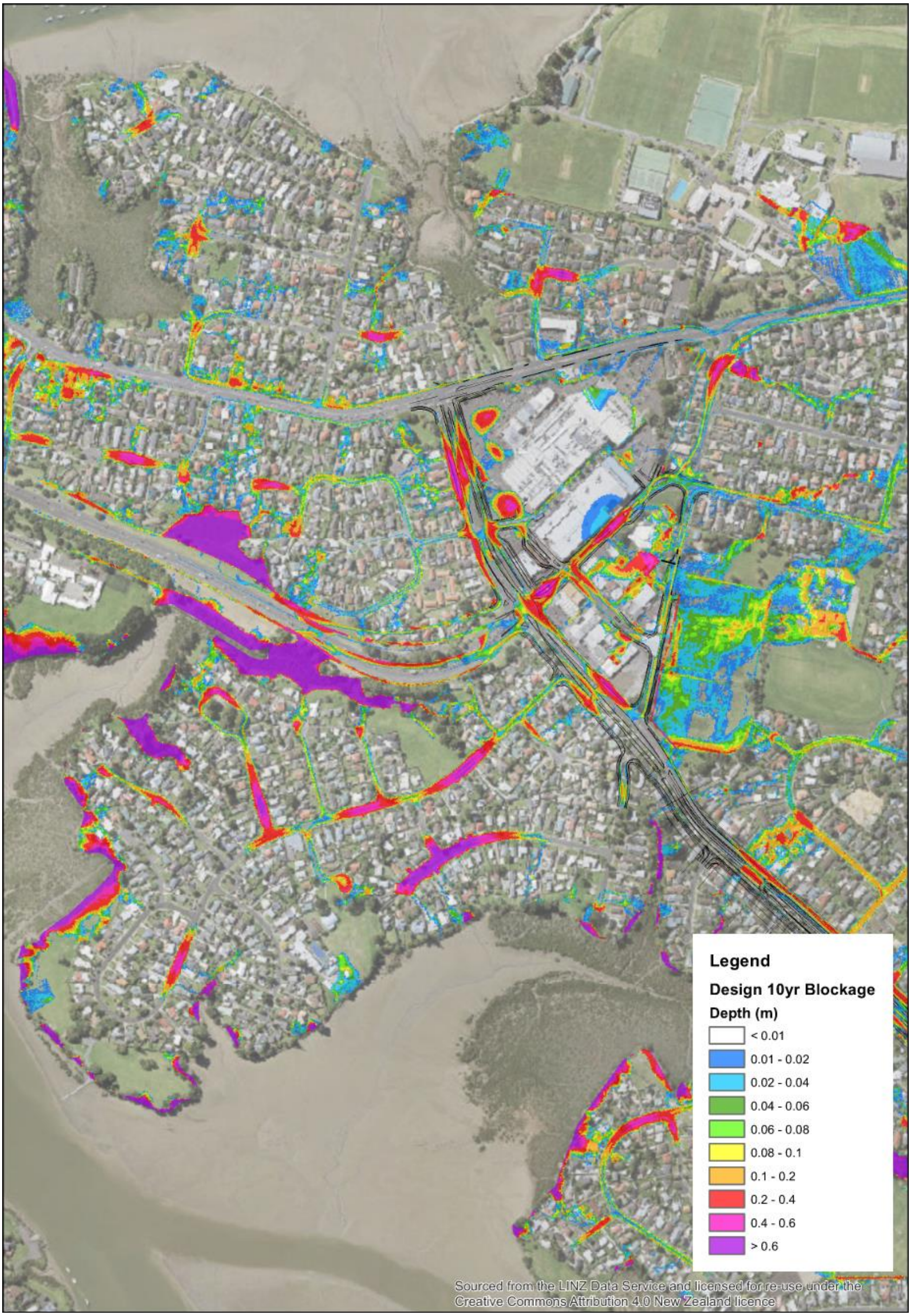

Figure 37: EB2 design case 10-year flood depths (pipe blockage)

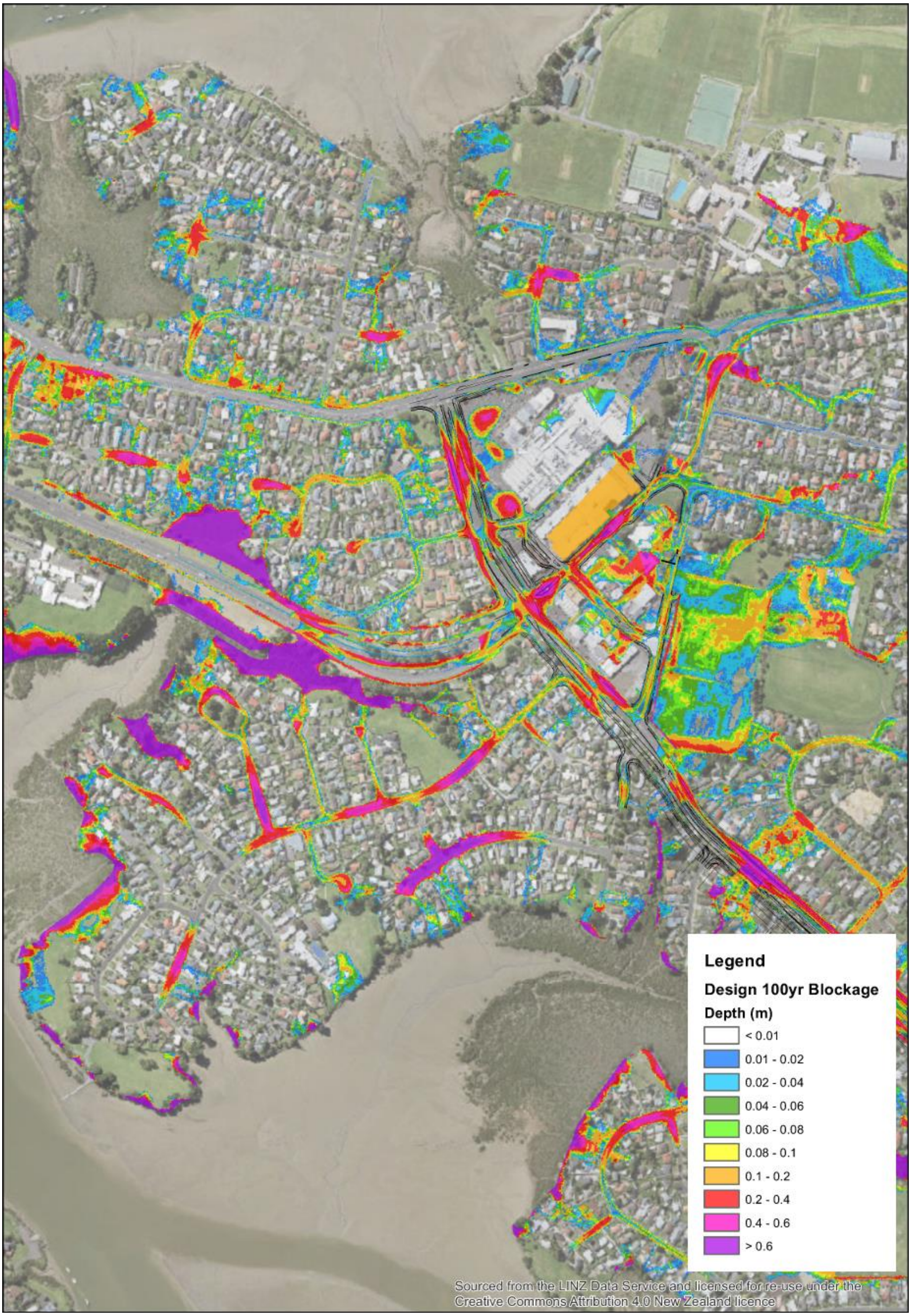

Figure 38: EB2 design case 100-year flood depths (pipe blockage)

Figure 39: EB2 design case 10-year flood depth difference (pipe blockage)

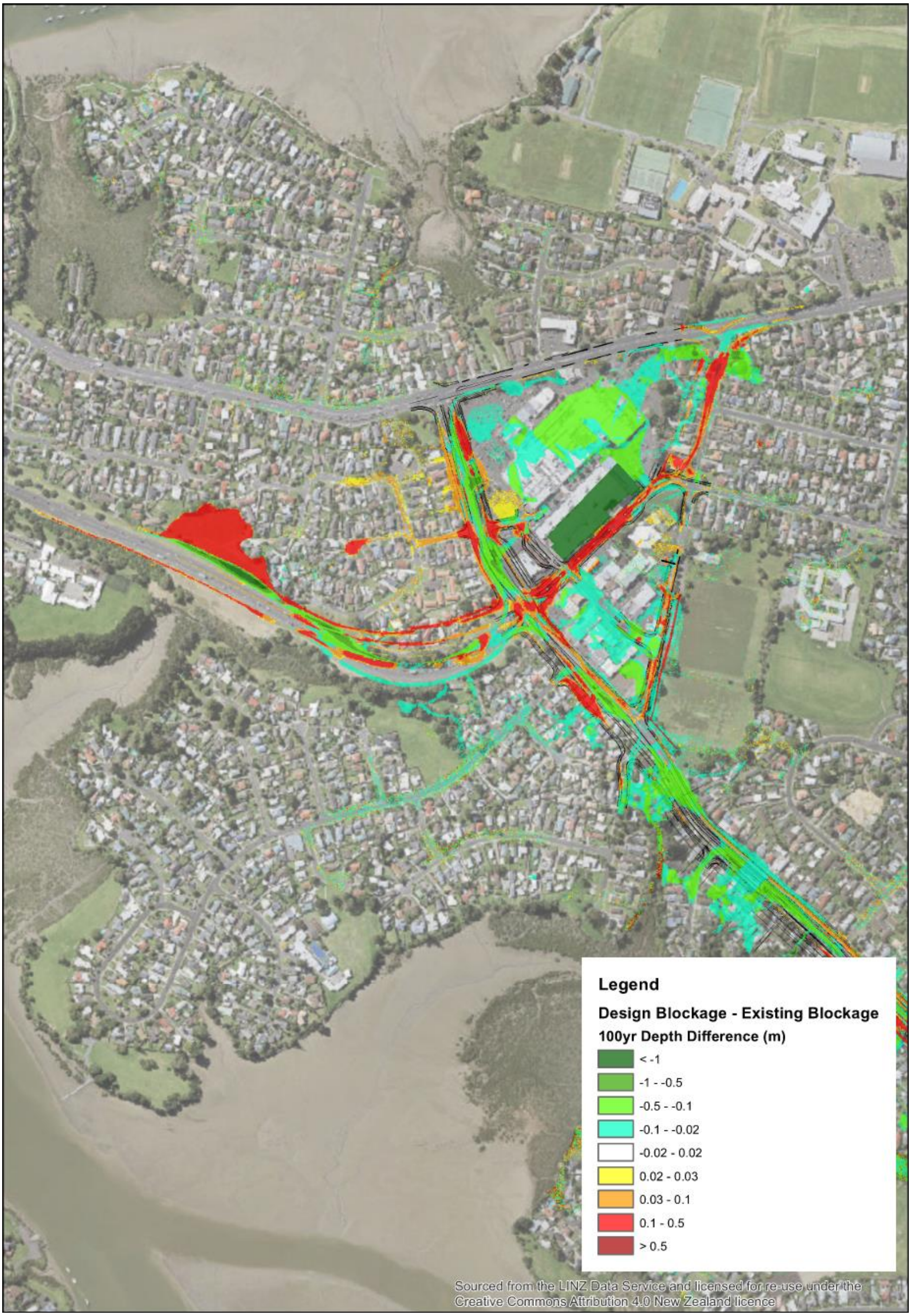

Figure 40: EB2 design case 100-year flood depth difference (pipe blockage)

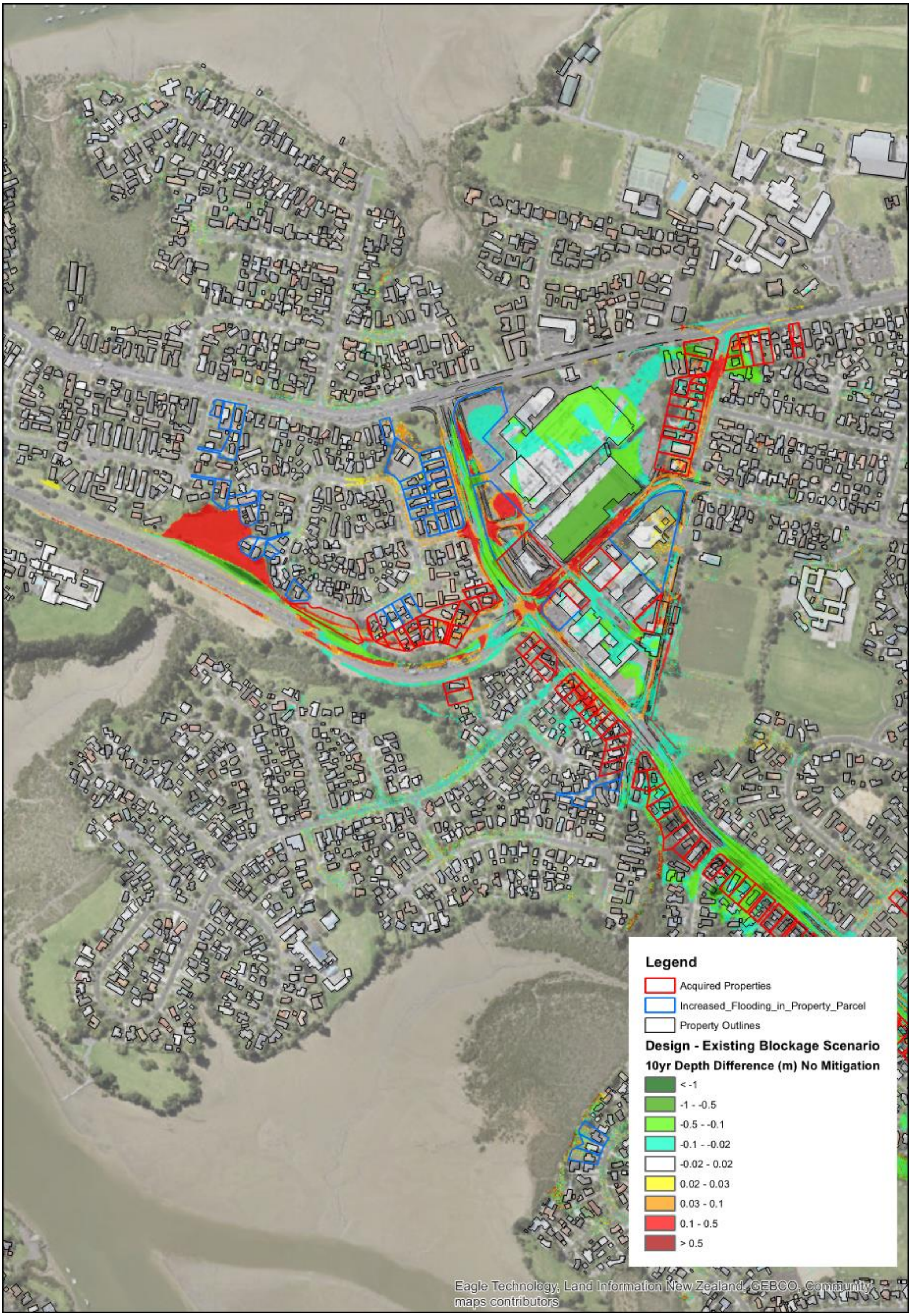

Figure 41: EB2 private properties impacted during 10-year event (pipe blockage)

As shown in Figure 40, there are several areas of increased overland flow and flooding depths as a result of the Project during the 100-year event. The private properties impacted by these increases are highlighted on Figure 42 for the 100-year event (see private properties with blue boundaries). It is noted that private properties with increased flood depths shown on Figure 42 includes private properties that previously had overland flow and/or flooding within the property in the base case. The properties with red boundaries have been purchased by the Project and are therefore not considered impacted. The private properties, not purchased by the Project, with increased overland flow and flooding depths when pipe blockages are applied are:

- 73, 1/75, 2/75, 99, 103 and 105 Pakuranga Road
- 2, 1/8, 2/8, 1/16, 2/16, 20, 1/30, and 2/30 Latham Avenue
- 1/8, 2/8, 3/8, and 10 Paul Place
- 2, 21, 23, 25, 27, 22/33, 23/33, 24/33, 25/33, 26/33, 41, 1/43, 2/43 45, 47, 47A, 49, 51, 53, 55, 57,59, 62, 64, 66, 68, 70, 81A, 81B, and 83 Dale Crescent
- 7, 1/9, 2/9, 10, 1/11, 2/11, 3/11, 11A, 12, 14, and 15 Anthony Place
- 1/3, 2/3, and 5 Palm Avenue
- 2R, 3, 1/5, 2/5, 1/7, 2/7, 1/9, 2/9, 1/11, 2/11, 1/13, 2/13, 1/15, and 2/15 Ti Rakau Drive
- 3 and 13R Reeves Road
- 7G and 9A Mattson Road.

Mitigation for EB2 is proposed for all the properties identified as being affected for the 10 and 100-year events. The mitigation consists of upgrading pipe diameters. The proposed pipe size upgrades and flood modelling results demonstrate that the potential impacts have been fully mitigated and are outlined in Section 7.1. These mitigation measures, or alternative measures that can achieve the same outcomes (such as changes to the road geometric design), will be incorporated into the detailed design which will be verified during the NDC connection approval process via the EPA process once the design is completed.

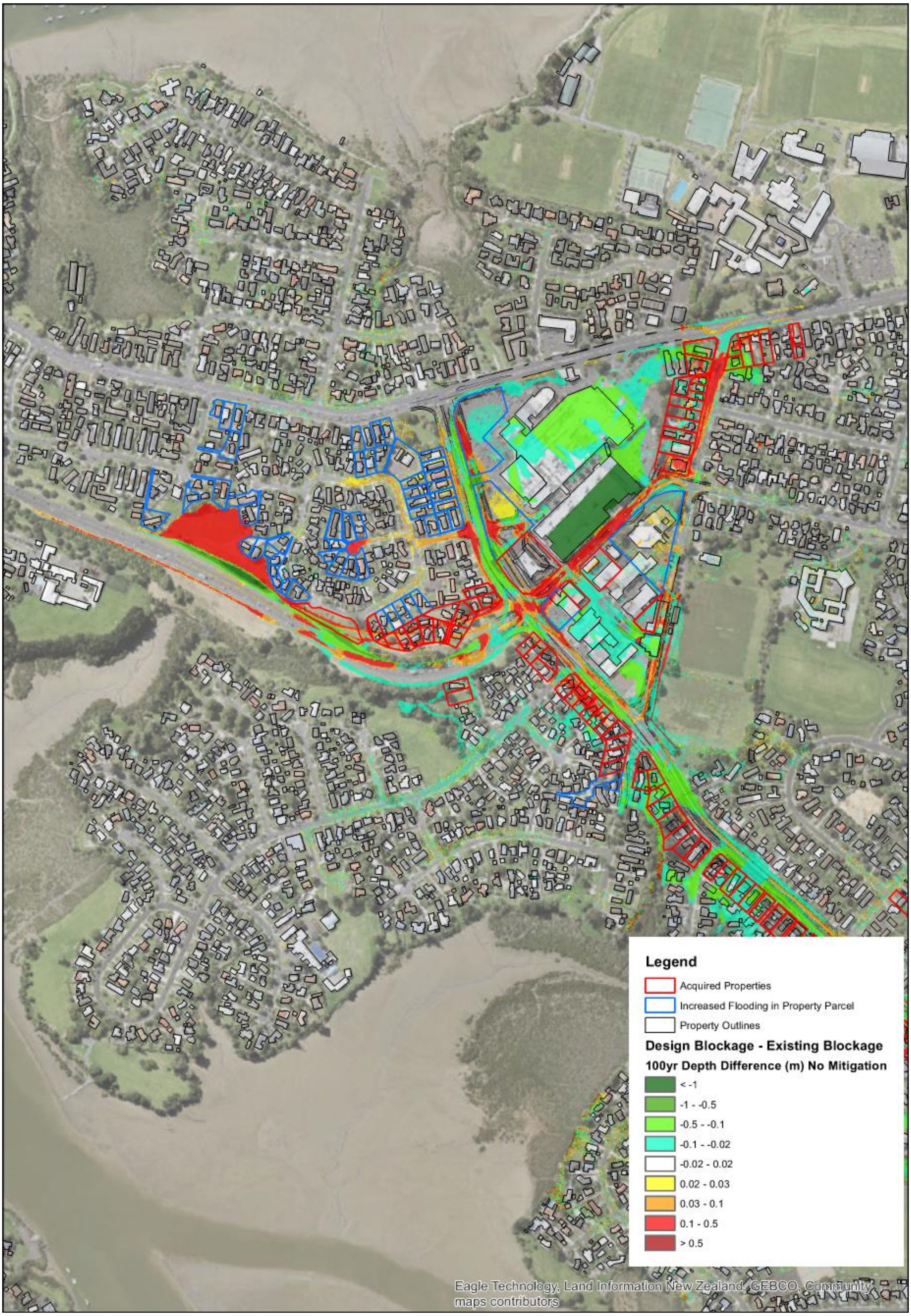

Figure 42: EB2 private properties impacted during 100-year event (pipe blockage)

6.2 EB3R

6.2.1 Construction

The discharge of stormwater during construction is excluded from this technical assessment and is documented in the erosion and sediment control and construction technical assessments, as well as both the CEMP and the ESCP.

6.2.2 Discharge of Stormwater

The design for EB3R collects stormwater in independent networks that connect to the existing networks near their outfalls and where necessary the design proposes to upgrade the existing pipe from the connection point to the outfall. The outfalls proposed to receive Project discharges are summarised in Table 4. All the existing and proposed new outfalls discharge to or adjacent to the CMA and therefore there are no flooding or capacity impacts from any increased discharge rates. The proposed typical outfall detail (see Figure 29) which is a naturalised rip rap armoured basic without concrete headwalls, provides outfall erosion and scour protection and the required energy dissipation to avoid downstream erosion of the CMA. The proposed outfall detail will be further developed for each location by a multidisciplinary design team incorporating landscape architects, ecologists, coastal scientists, and stormwater engineers to achieve appropriate form and outcomes for each receiving environment location.

As discussed in the design philosophy (see Section 2.1) the stormwater treatment target is to achieve a reduction in contaminant load contributions from roads discharging to outfalls, based on the combined total of all the outfalls, rather than for each individual outfall. The final outcomes will be influenced by ongoing joint EBA and Healthy Waters hui with mana whenua. The CLM (see Table 6) currently predicts that the EB3R design will achieve this target, with reductions of 59% for TSS, 43% for zinc, 48% for copper and 53% for TPH. On an individual outfall basis all outfalls except MCC_108707 achieve a reduction in the existing contaminant loads. MCC_108707 is predicted to have increases in contaminant load due to an additional 300 m of Ti Rakau Drive (from MCC_108713) discharging to this outfall as well as receiving busway stormwater. The reason that this outfall is receiving additional catchment from Ti Rakau Drive is due to a combination of the geometric design (to achieve compliance with geometric requirements for the busway) and the fact that the network for MCC_108713 would be difficult and expensive to upgrade due to approximately 160 m of pipe running through private property and under or immediately adjacent to a number of houses. The design has raingardens treating most of the busway and most of Ti Rakau Drive westbound lanes with a GPT located on the southern boundary of the road reserve. The design also treats most of the network's existing roads.

The overall outcomes of the EB3R stormwater treatment design are that there will be a positive effect in reducing existing contaminant loads from roads. The increases predicted for Outfall MCC-108707 are offset across EB3R.

6.2.3 Flooding Assessment

The flood model for the design case (i.e. with the design geometric surface and drainage pipes) predicts reduced flooding extents for the 10 and 100-year ARI events. This is demonstrated by comparing Figure 43 to the existing extents shown in Figure 23. The results show reduced flood depths for the 10-year ARI event (up to 400 mm). This is further demonstrated by comparing Figure 44 to the existing flood depths in Figure 24 (which has a greater than 600 mm maximum depth on Ti Rakau Drive). The results also show reduced extents of areas with larger depths in the 100-year ARI event. This is demonstrated by comparing Figure 45 to the existing flood depths in Figure 15 on Ti Rakau Drive. Overall, there are no increases predicted in depth or extent on private property for the 10-year ARI event (see Figure 46) and 100-year ARI event (see Figure 47). In addition, it is noted that the Project works will reduce the flooding frequency, extents, and depths over large parts of EB3R, thereby improving the capacity of the networks and resilience against flooding.

All areas of increased flood depths are contained within the road reserve or within that part of Riverhills immediately adjacent to the busway where it has been agreed with Auckland Council Parks that a raingarden and overland flow path channel will be constructed. As discussed for EB2 (see Section 6.1.3), areas of dotted increases and decreases have been confirmed as model noise and can be ignored and the models will be updated with the new method for developing the ground surface in the models to remove the model noise before issuing the final detailed design flood modelling results to Healthy Waters for connection approved under the NDC.

Overall, the Project represents a significant positive effect with significant reductions in flood extents and depths throughout the EB3R area.

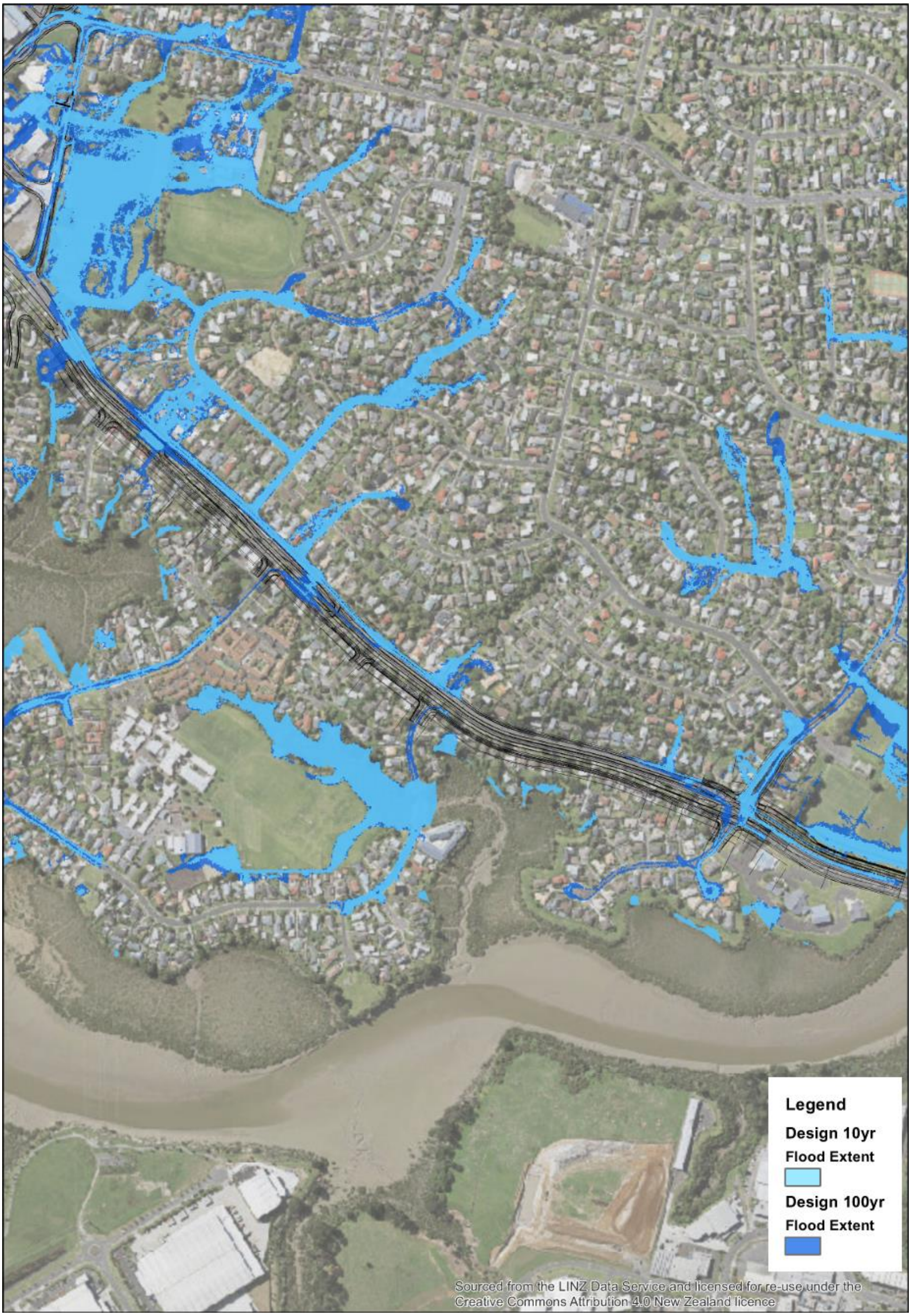

Figure 43: EB3R design case 10 and 100-year flood extents

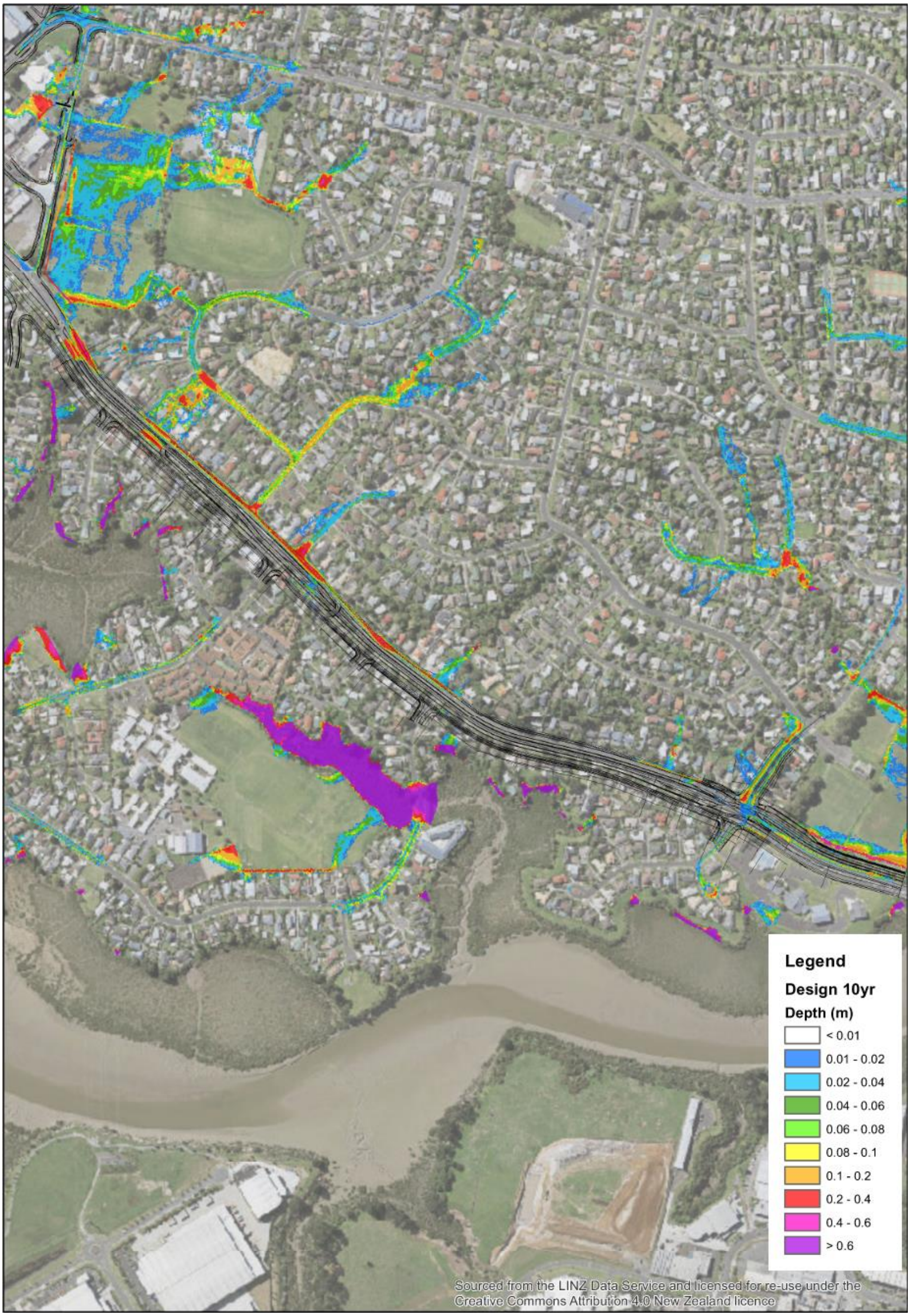

Figure 44: EB3R design case 10-year flood depths

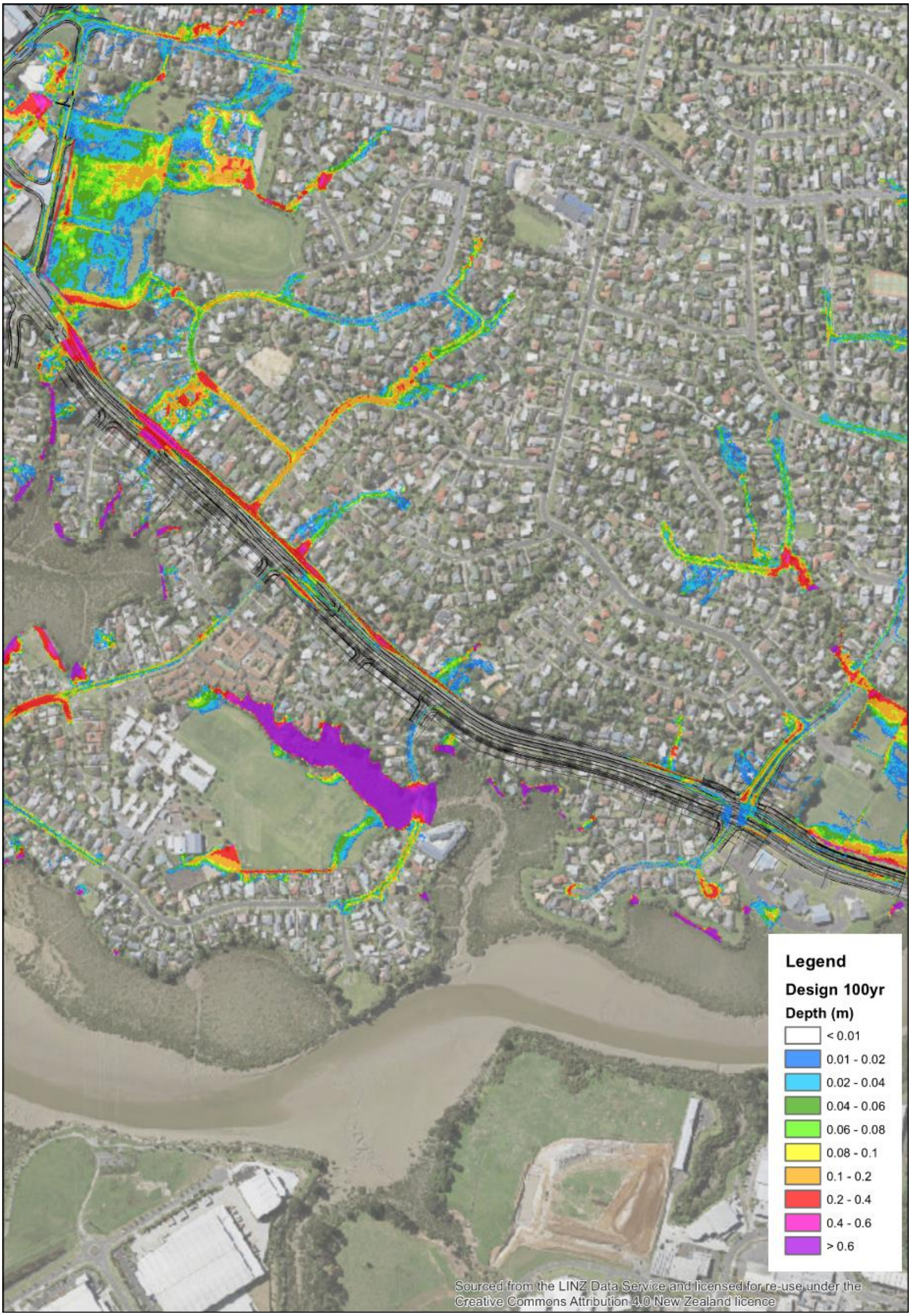

Figure 45: EB3R design case 100-year flood depths