Wellsford North Plan Change

Stormwater Management Plan

Wellsford

Wellsford Welding Club

Final

Document Control

Project Number	P21-395
Project Name	Stormwater Management Plan
Client	Wellsford Welding Club
Date	06/06/2023
Version	V3
Issue Status	Final
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Executive Summary

Wellsford Welding Club is looking to undertake a Private Plan Change (PPC) in the Wellsford North area. The development is classified as a 'greenfields' development under Schedule 4 of Auckland Council's Regionwide Network Discharge Consent (NDC) and requires a stormwater management plan to be compliant with the NDC requirements.

The purpose of this Stormwater Management Plan is to provide guidance to the applicants and Auckland Council on how stormwater will be managed within the PPC area.

The Wellsford North plan change catchment is shown in Figure E1.

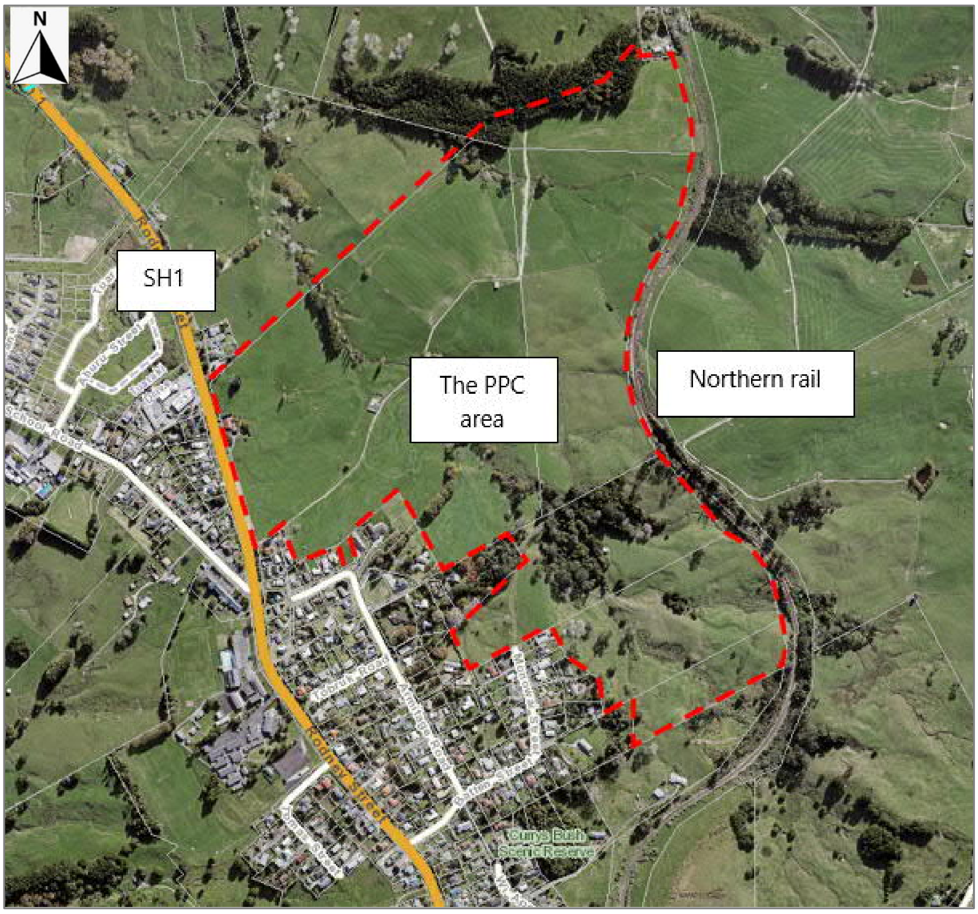


Figure E1: Subject site location (Source: Auckland Council Geomaps)

Several watercourses and wetlands have been identified onsite within the PPC area. The receiving environment for the site is Oruawharo River and Kaipara Harbour.

An integrated stormwater management approach is to be adopted for the Private Plan Change area. A range of stormwater management options have been assessed, and the best practicable option is provided in this report to achieve the required objective under Auckland Unitary Plan regulatory policies, Auckland Council's water sensitive guidelines and Network Discharge Consent requirements.

The proposed stormwater management approach provides design guidelines for proposed developments within the PPC area. The proposed stormwater management approach includes:

- Preserve, protect and enhance water bodies and natural wetlands.
- Eliminate and minimise the generation of contaminants.
- Provide 95th percentile, 24hr, hydrological mitigation.
- Ensure the flooding effects within, upstream and downstream of the PPC area are no more than minor.

- Consider future effects of climate change.

It is proposed that water quality treatment will be provided for all the impervious areas in the development to GD01/TP10 treatment levels. This is consistent with the requirements stated in regionwide NDC.

Selection of stormwater devices were assessed based on the constraints posed by the development site, workability with the masterplan and existing stormwater network. Devices such as large communal wetlands and at source raingardens were ruled out as it was determined that these devices are not feasible for the development, this has been discussed in detail in Section 8 of this report.
Finally, large communal raingardens (or bio-retention devices) were concluded to be the most appropriate device to provide water quality requirements for the development site. Additionally, all the new roofs will be constructed using inert roofing material which will provide a better overall water quality outcome.

The PPC area is not located within a Stormwater Management Area Flow (SMAF) overlay as per the AUP: OiP. However, hydrology mitigation (SMAF-1) is proposed to be implemented for all impervious areas to mitigate any increased stormwater runoff associated with the proposed development as per the regionwide NDC.
As per GD01, it is understood that 95th percentile, 24-hour rainfall event is required to be treated if an equivalent hydrology to pre-development (grassed state) levels is required.
Retention is provided by infiltration to ground (pending geotechnical investigation) or by reuse (limited to roof areas). If this is not possible, retention is to be subsumed by the detention volume. Detention is provided by temporary 24-hour storage of 95th percentile storm event runoff (excluding 5mm retention) in a storage device.
It is proposed that retention for all building roofs will be met using reuse tanks and hydrology mitigation (both retention and detention) for all other impervious areas will be met using large communal raingardens (as mentioned above).

Flood modelling has been undertaken for the PPC and surrounding areas including a preliminary analysis of the culvert on State Highway 1. Flood modelling has been reviewed and accepted by Healthy Waters.

Model results and Water level difference plots indicate flooding is largely contained within existing water courses with flood extents to be similar between pre- and post- development scenarios. The flood depths for the existing and PPC modelled scenarios are generally consistent for the various storm events assessed, the risk profile remains predominantly unchanged with PPC and PC FUZ. This has been discussed with Waka Kotahi/NZTA and the flood risk is associated with the existing culvert being under capacity for larger storm events.

Given the existing risk profile and noting the risk profile remains unchanged with the PPC, it is recommended that Waka Kotahi NZTA undertake required upgrade to the existing culverts under the state highway to mitigate the flood risk and existing hazard.

Overall, our assessment has concluded that the potential effects on stormwater anticipated by the PPC are less than minor and will be appropriately mitigated.

1. Introduction

1.1. Background

Wellsford Welding Club is looking to undertake a Private Plan Change (PPC) in the Wellsford North area. The development is classified as a ‘greenfields’ development under Schedule 4 of Auckland Council’s Regionwide Network Discharge Consent (NDC) and requires a stormwater management plan to be compliant with the NDC requirements.

This report outlines the stormwater management plan (SMP) prepared by Woods in support of a PPC in the Wellsford North area. It has been developed in accordance with the Auckland Unitary Plan: Operative in Part (AUP) and the requirements as set out in the NDC.

The location of the Wellsford north PPC area is shown in Figure 1.

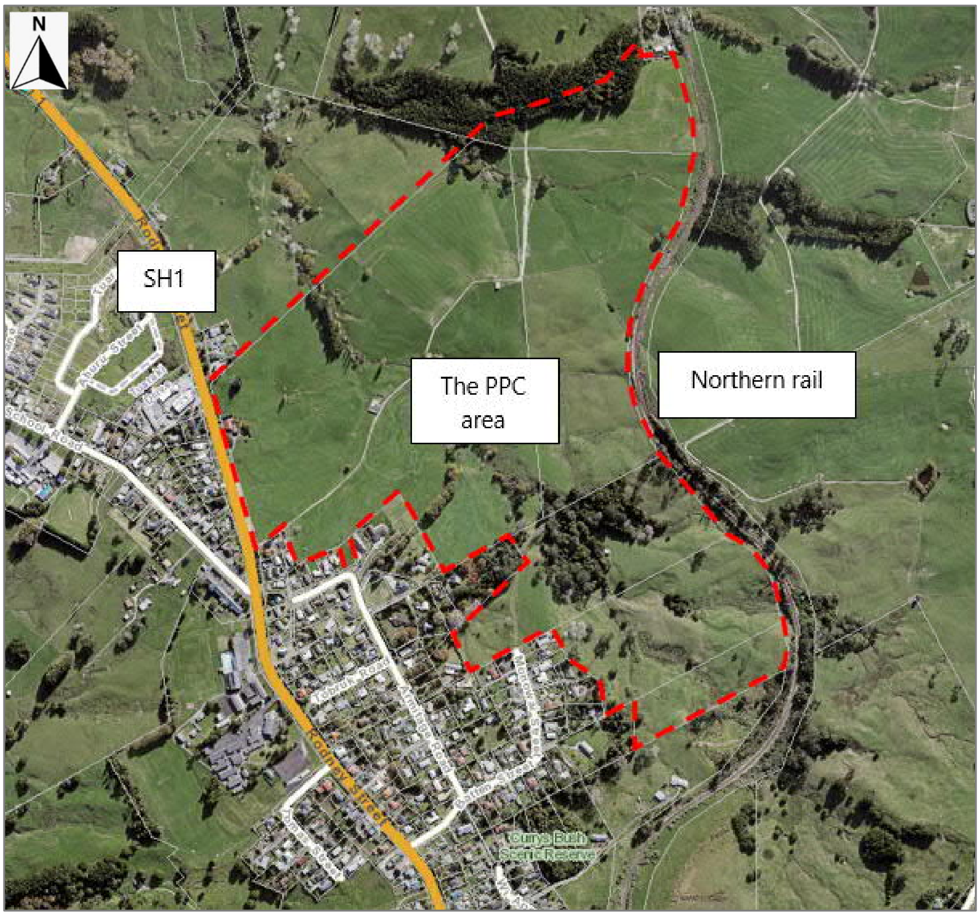


Figure 1: Wellsford North PPC area (Source: Auckland Council Geomaps)

1.2. Purpose and objectives

The overall purpose of this SMP is to provide guidance to the applicant and inform Auckland Council on how stormwater will be managed for the PPC area.

This report highlights how Schedule 4 of the NDC requirements have been met in the development of the SMP. The overarching objectives are to:

- Meet Schedule 4 of the Regionwide NDC;
- Support the PPC;

- Provide stormwater management guidelines for the proposed development and ensure stormwater runoff is to be conveyed in a safe manner to the receiving environment through the primary and secondary networks;
- Provide betterment for the receiving environment via stormwater quality treatment guidelines and avoidance of high contaminant yielding roof and cladding materials; and
- Identify flood risk areas and provide for development without creating adverse flooding effects at properties upstream or downstream of the development site.

2. Existing site appraisal

This section of the report summarises the existing site characteristics and conditions as currently understood and relate to stormwater.

2.1. Summary of data sources and dates

A summary of key background information used in the development of the SMP is provided in Table 1.

Table 1: Data sources and dates

Existing site appraisal item	Source and date of data used
Topography	• Auckland Council supplied LiDAR 2016 • Topographical survey undertaken by Buckton Consulting Surveyors Ltd
Geotechnical / soil conditions	• Auckland Council Soil Maps • Geotechnical Assessment Report by Tonkin & Taylor Ltd
Existing stormwater network	• Auckland Council GeoMaps data • Infrastructure survey undertaken by Woods
Existing hydrological features	• Auckland Council GeoMaps data • Ecological Impact Assessment by Bioresearchers Ltd
Stream, river, coastal erosion	• Auckland Council GeoMaps data
Flooding and flow paths	• Auckland Council GeoMaps data - floodplain layer
Coastal Inundation	• Auckland Council GeoMaps - coastal inundation layer
Ecological / environmental areas	• Ecological Impact Assessment by Bioresearchers Ltd
Cultural and heritage sites	• Archaeological Assessment by Clough & Associated Ltd
Contaminated land	• Preliminary Site Investigation by Environmental Management Solutions Ltd

2.2. Location and general information

The PPC area is located to the north of Wellsford town centre. It is bounded by State Highway 1 (SH1) to the east and Northern rail to the west comprising an area of approximately 58ha.

As per the Auckland Unitary Plan Operative in Part (AUP: OiP), the PPC area is predominantly zoned Future Urban Zone with areas to the south zoned as Rural Countryside Living and area to the northeast zoned as Rural production area. The subject PPC area is located to the east of State Highway 1 and is approximately 80km away from Auckland Central Business District.

Figure 2 shows the existing zoning plan with site elements indicated in Table 2 below.

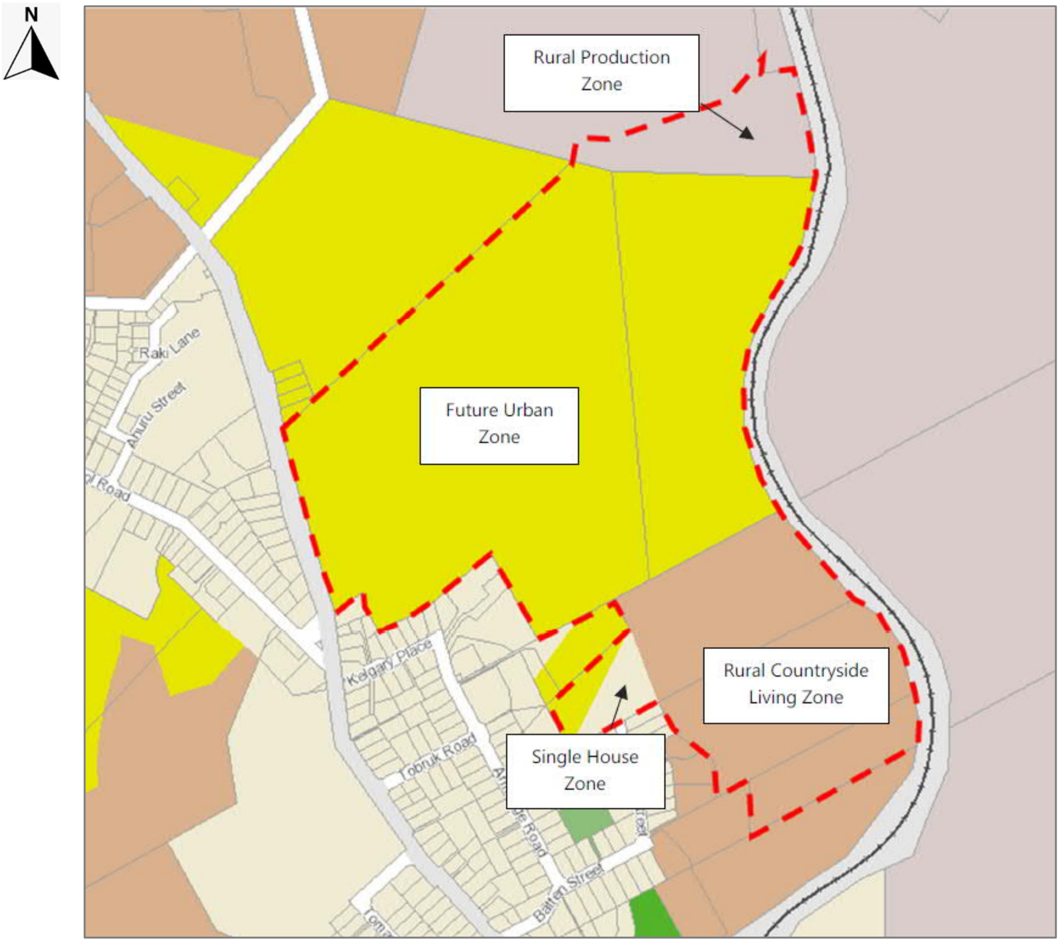


Figure 2: Existing zoning (Source: Auckland Council Geomaps)

Table 2: Existing site element

Existing site element	
Legal description	Pt Sec 25 Blk XVI Otamatea Survey District DP 9682 Pt Lot 2 DP 26722 Pt Lot 4 DP 9919 Pt Allot 117 Psh Of Oruawharo SO 22925 Pt Allot SE118 Psh Of Oruawharo Lot 1 DP 69586
Current Land Use	Grazed pasture Rural Residential
Historical Land Use	Grazed pasture

2.3. Topography

The existing topography of the PPC area consists of steep undulating ridgelines and several watercourses. The elevations generally vary between 50m RL along the northern railway and SH1 falling to approximately 20m RL along the watercourses. The PPC area slopes less than 20% in general, and the watercourses are relatively incised with steep adjacent banks along some locations. The existing contour and site slopes as shown in Figure 3 and Figure 4, respectively.

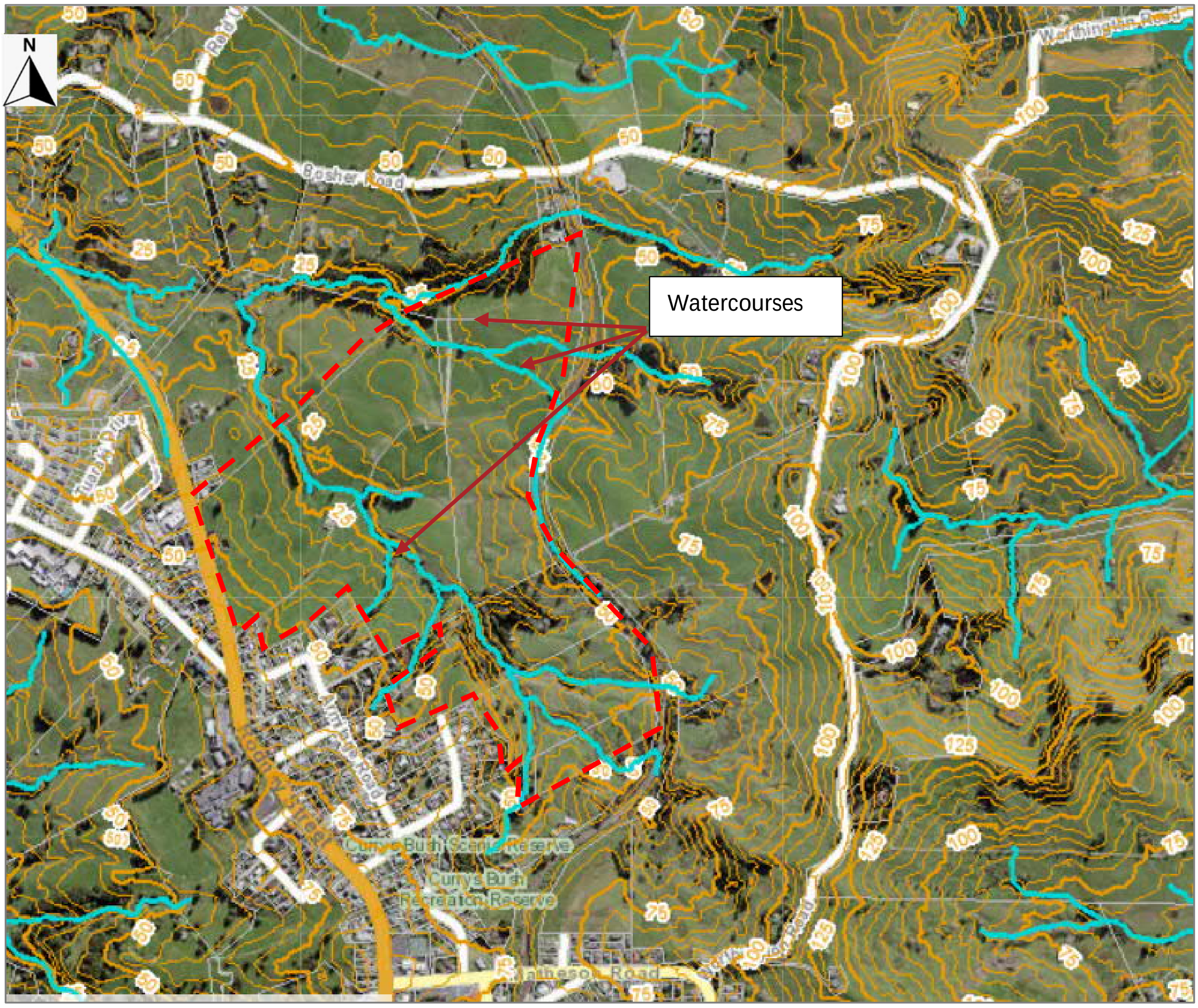


Figure 3: Existing ground contours – (Source: Auckland Council Geomaps)

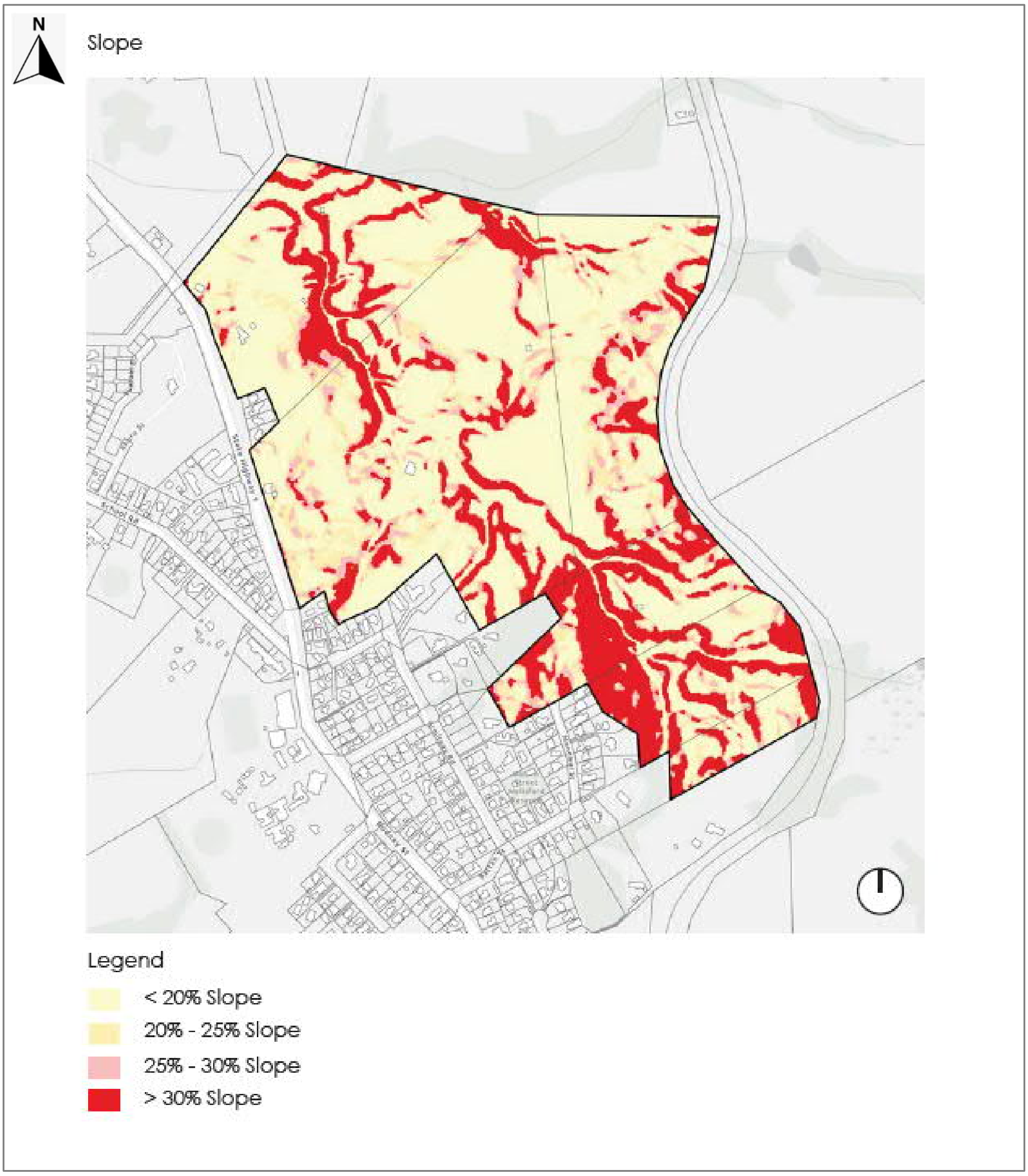


Figure 4: Site terrain (Source: Barker & Associates)

2.4. Geotechnical

Published geological maps for the area obtained from the Auckland Council soils layer indicate the underlying soil to be greywacke and limestone soils with a soil ID C2 which is classified as mudstone/ sandstone as can be seen in Figure 5. Published drainage maps of the PPC area obtained from S-map indicate the subject PPC area is poorly drained, as shown in Figure 6.

A geotechnical assessment prepared by Tonkin & Taylor Ltd indicates that the site is underlain with various lithologies of the Northland Allochthon with surficial alluvial deposits also present. Relic dormant features and active slope deformation features have also been observed on site with slope stability potentially being a risk.

Further information can be found in the geotechnical report submitted with the application.

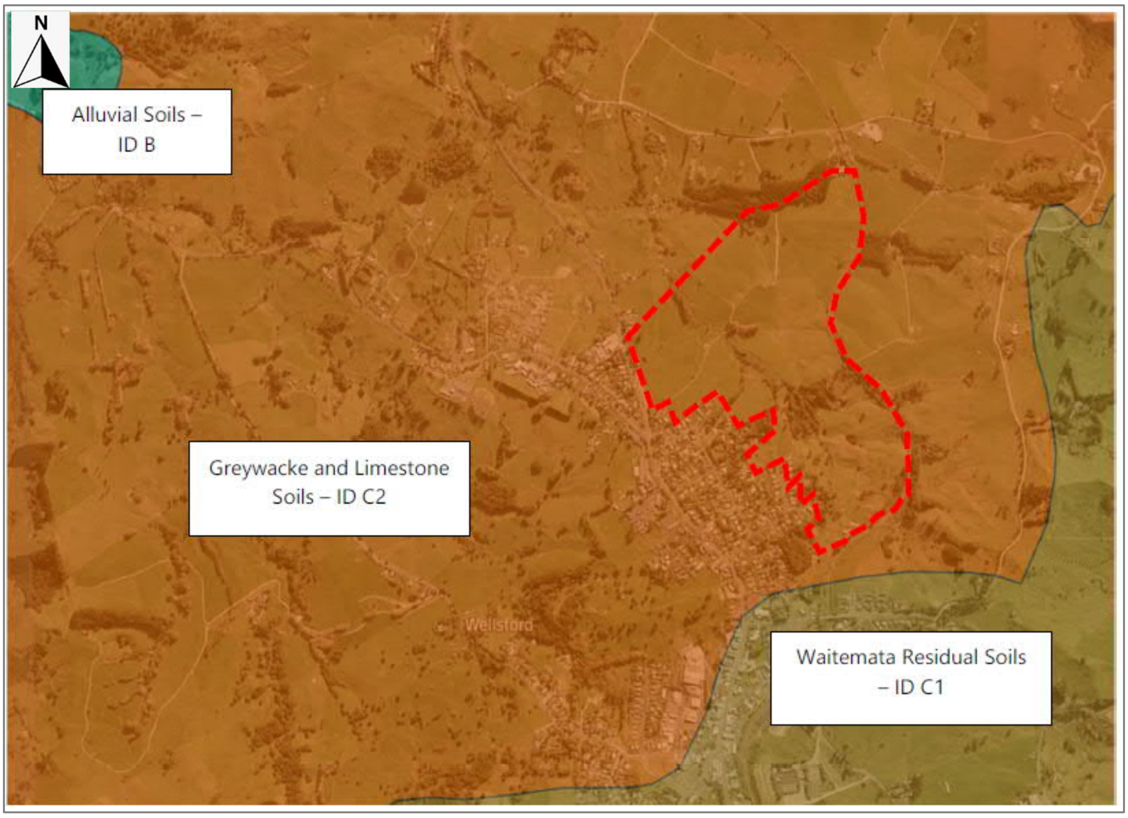


Figure 5: Geology (source: Auckland Council soils layer)

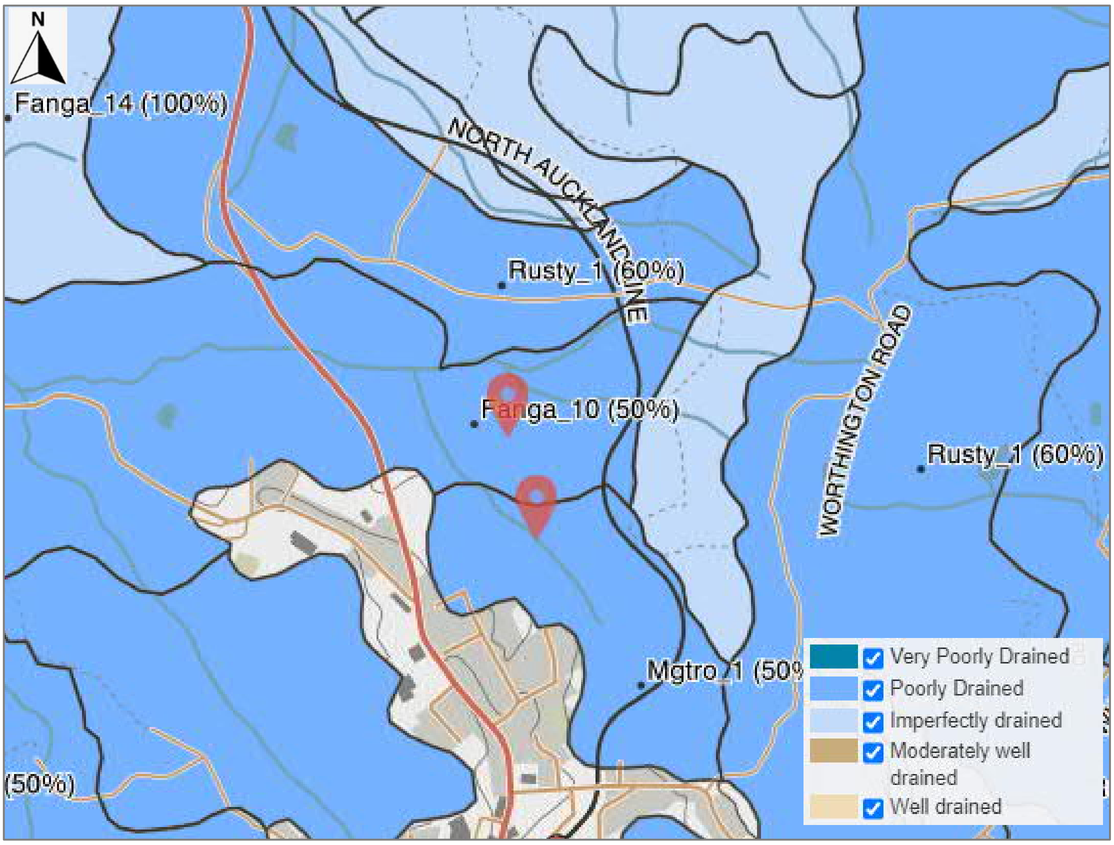


Figure 6: Soil Drainage (Source: S-map)

2.5. Existing drainage features and stormwater infrastructure

2.5.1. Stormwater infrastructure

The primary drainage infrastructure within the PPC area is predominantly provided via existing watercourses and culverts. There are currently several existing private and public culverts/ structures within the PPC area as well as upstream and downstream of the PPC area as shown in Figure 7.

Culverts labelled as 1-3 are located within SH1 whilst culverts/ structures labelled 4-6 are noted to be private. The culverts labelled 7-14 are located along the northern railway line.

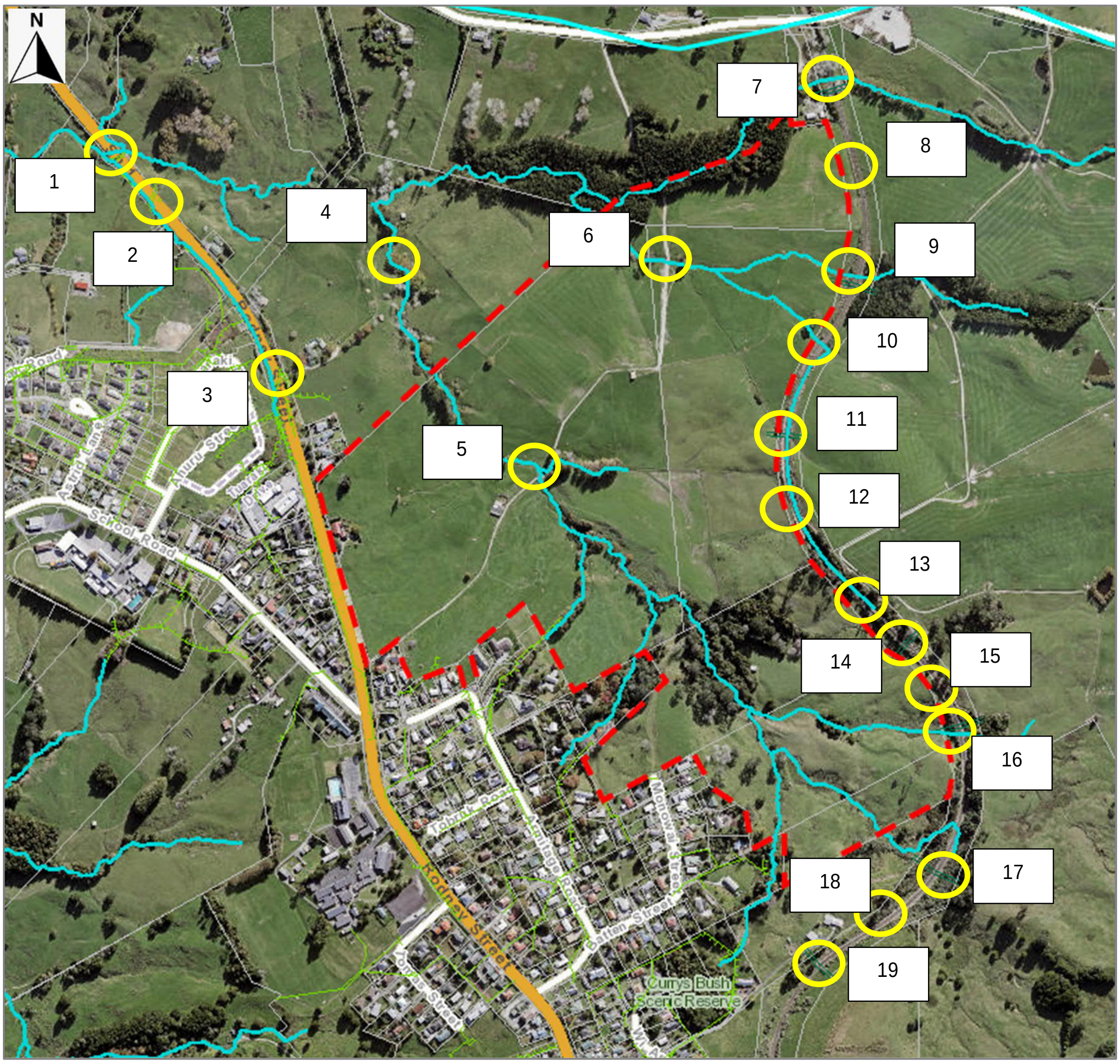


Figure 7: Existing infrastructure (Source: Auckland Council Geomaps)

Woods requested asset information from NZTA, Auckland Council Healthy Waters and Kiwi Rail in regard to the public structures. It is noted culverts/ structures labelled 4-6 are assumed to be private and hence have no public information available.

Auckland Council Healthy Waters have indicated they have no information on the assets other than what is available on Geomaps whilst NZTA and Kiwi Rail have sent through any available information.

Based on the information provided, further survey has been undertaken for key infrastructure. A summary of the information on the key infrastructure is shown in Table 3 below with information and photos of surveyed culverts included in Appendix A.

Table 3: Summary of infrastructure information

Number	Asset type	Asset Owner	Diameter (mm)	Upstream invert level (m RL)	Downstream invert level (m RL)	Source of information	Comments
1	Twin culvert	Waka Kotahi NZTA	2 X 2000	12.69	12.51	Survey Data	-
2	Circular culvert	Waka Kotahi NZTA/ Auckland Transport	450	17.623	16.98	Survey Data	
3	Circular culvert	Waka Kotahi NZTA	450	28.678	27.83	Survey Data	
7	Box Culvert	KiwiRail	1200	35.040	34.72	Survey Data	
8	Circular Culvert	KiwiRail	225	43.755	43.73	Survey Data	
9	Circular Culvert	KiwiRail	450	37.490	36.52	Survey Data	
10	Circular Culvert	KiwiRail	300/375	41.290	38.71	KiwiRail	
11	Circular Culvert	KiwiRail	450	48.932	48.9	Survey Data	
12	Circular Culvert	KiwiRail	225	50.09	49.93	KiwiRail	
13	Circular Culvert	KiwiRail	300	46.61	43.57	Survey Data	
14	Circular Culvert	KiwiRail	300/225	48.980	48.980	KiwiRail	Estimated
15	Circular Culvert	KiwiRail	600	50.25	49.568	Survey Data	
16	Circular Culvert	KiwiRail	450	47.784	45.64	KiwiRail	
17	Circular Culvert	KiwiRail	920	48.05	42.2	KiwiRail	
18	N/A	KiwiRail	300	64.691	61.125	KiwiRail	
19	Circular Culvert	KiwiRail	600	61.795	58.1	Auckland Council Geomaps	

2.5.2. Drainage Feature

Auckland Council Geomaps indicates three major watercourses within the PPC area as can be seen in Figure 8. The three watercourses converge to the north of the PPC area draining northwest across the SH1.

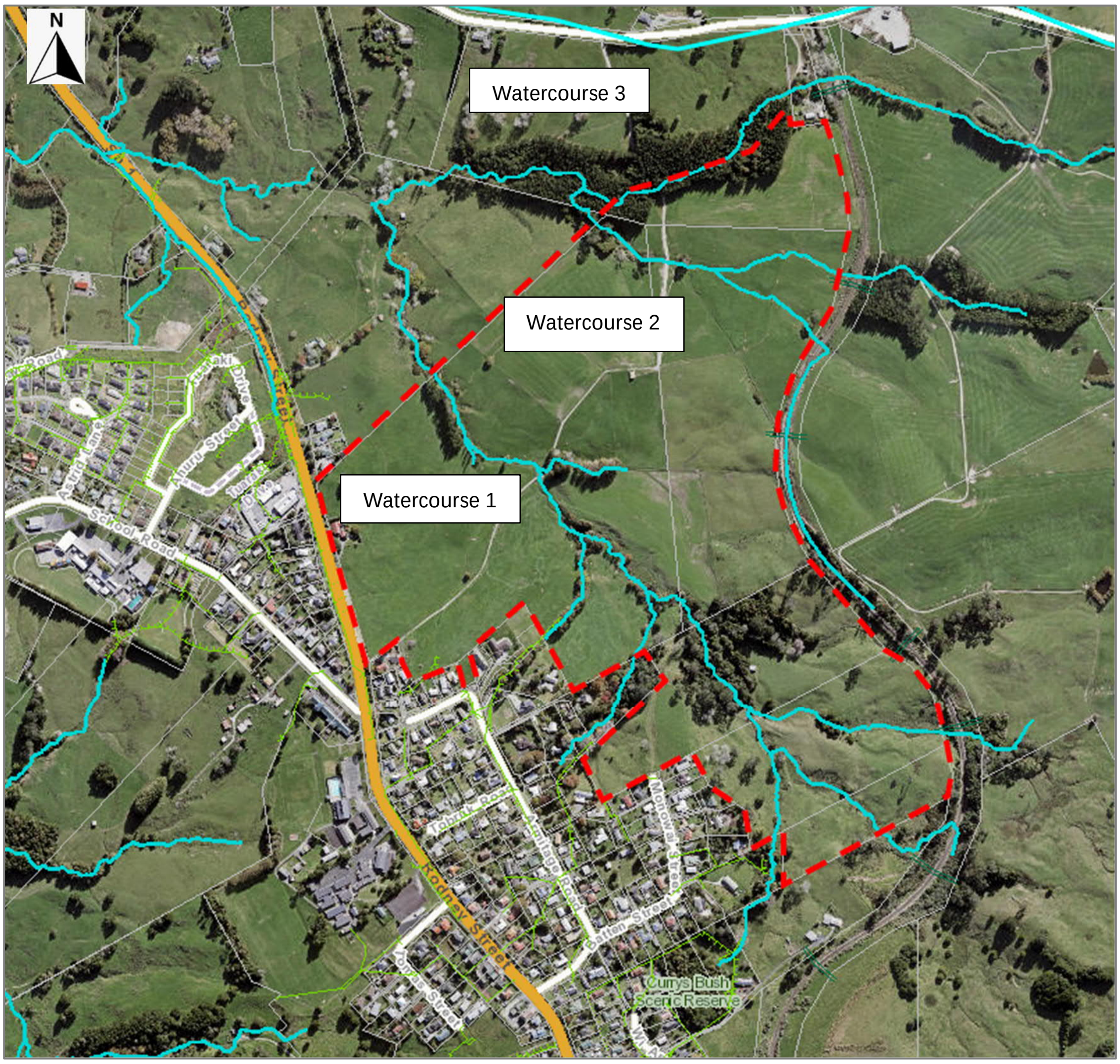


Figure 8: Watercourses (Source: Auckland Council Geomaps)

An Ecological Impact Assessment has been undertaken by Bioresearchers Ltd. Freshwater features, including permanent, intermittent and ephemeral streams and wetland areas have been identified as shown in Figure 9.

Figure 9: Freshwater features identified on site (source: Bioresearchers Ltd)

The assessment notes S-E, S-L and S-B are of high ecological value whilst the remainder are of low ecological value. Further information can be found in the Ecological Impacts Assessment submitted with the application.

2.6. Receiving environment

The PPC area is located within the eastern upper reaches of the Kaipara Wellsford catchment discharging to Kaipara Harbour via Oruawharo River as can be seen in Figure 10 below.

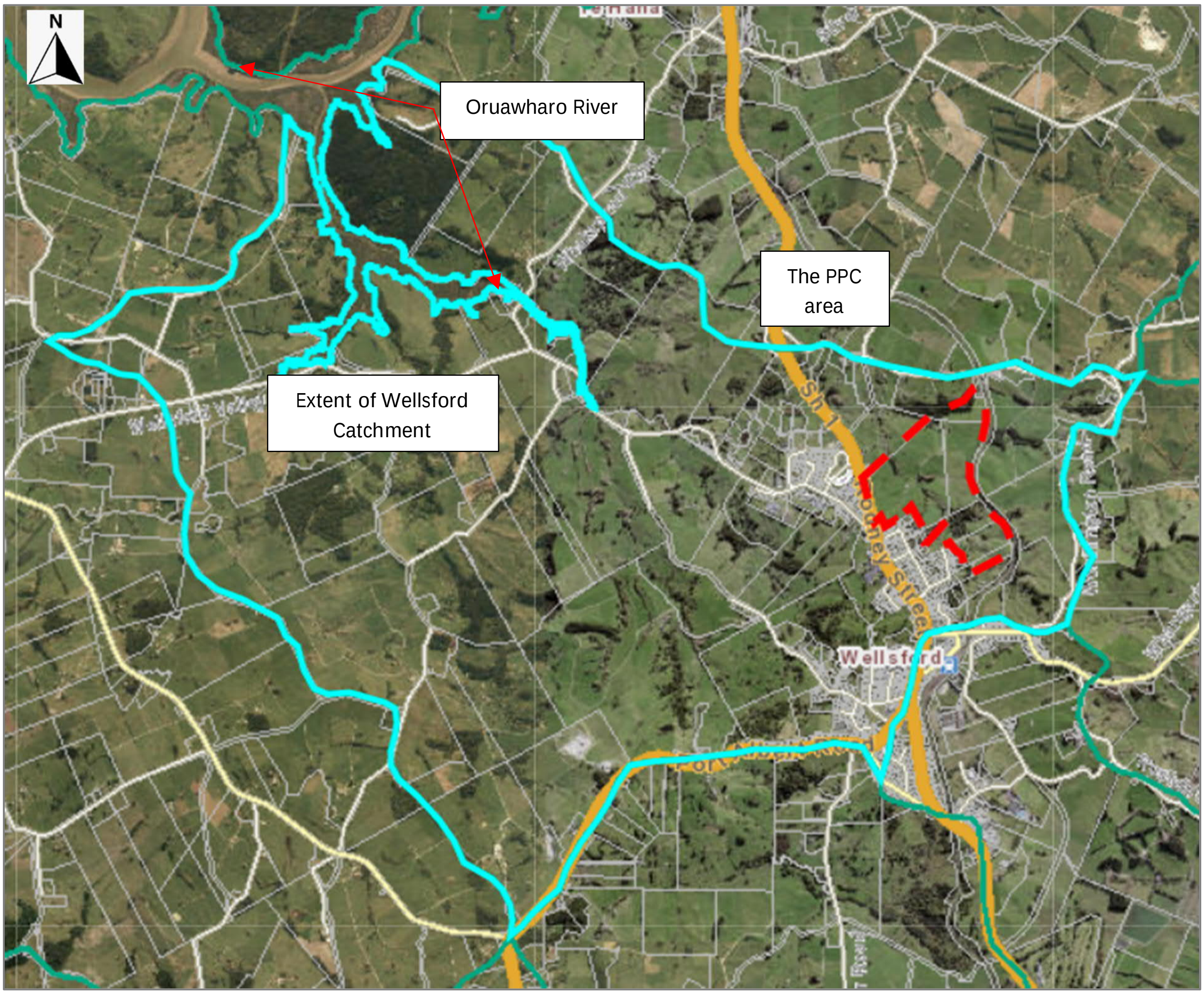


Figure 10: Receiving environment (Source: Auckland Council Geomaps

2.6.1. Oruawharo River

The Oruawharo River flows westward into the Kaipara Harbour west of Wellsford. It forms part of the boundary between the Northland region and the Auckland Region.

The Ecological Impacts Assessment describes Oruawharo River as being a significant high-order stream within Auckland Region.

2.6.2. Kaipara Harbour

Kaipara Harbour is a large enclosed harbour estuary complex connected to the Tasman Sea. Kaipara harbour is the ultimate receiving environment for the subject PPC area and as noted in the Ecological Impacts Assessment, has been negatively impacted by high levels of nutrients and sediments entering the waterways.

2.7. Existing hydrological features

The Ecological Impacts assessment identified four wetlands as shown in Figure 9. These have been identified classified using MfE wetland protocols and guidance. The wetlands are noted to be located within existing streams riparian margins/ adjacent to streams.

Further information can be found in the Ecological Impacts Assessment submitted with the application.

2.8. Flooding and flow paths

Auckland Council Geomaps indicates three major overland flow paths (OLFP) and associated floodplains within the PPC area as can be seen in Figure 11. The three overland flow paths converge to the north of the PPC area draining northwest across the SH1 via Culvert 1 where a flood prone area is indicated. The OLFP and associated is noted to be based on the rapid flood hazard assessment of the Auckland Region published in 2008. The updated flood model results could be found in Section 7.

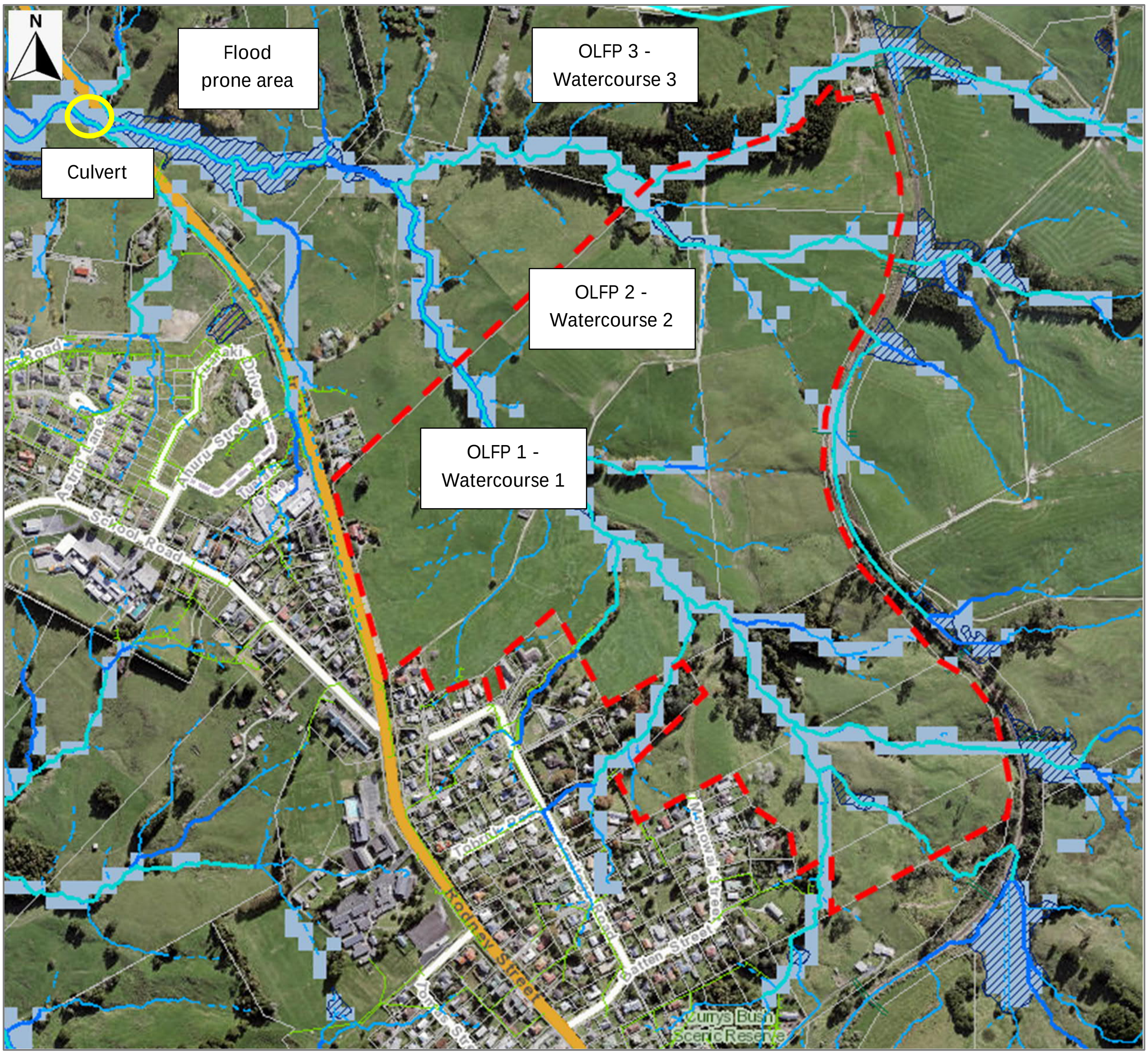


Figure 11: Existing secondary network/ flooding (Source: Auckland Council Geomaps)

2.9. Coastal inundation

The subject site is approximately 38 km east of the Kaipara Harbour. The published flood hazard information in the Auckland Region is documented in Technical Report 2016/017. The stormwater tide elevation adjacent to the subject catchment is shown in Figure 12. The published mean high water spring (MHWS) 10%ile adjacent to the PPC area is shown in Figure 13.

The MHWS and stormwater tide elevation information downstream from the PPC area is shown in Table 4.

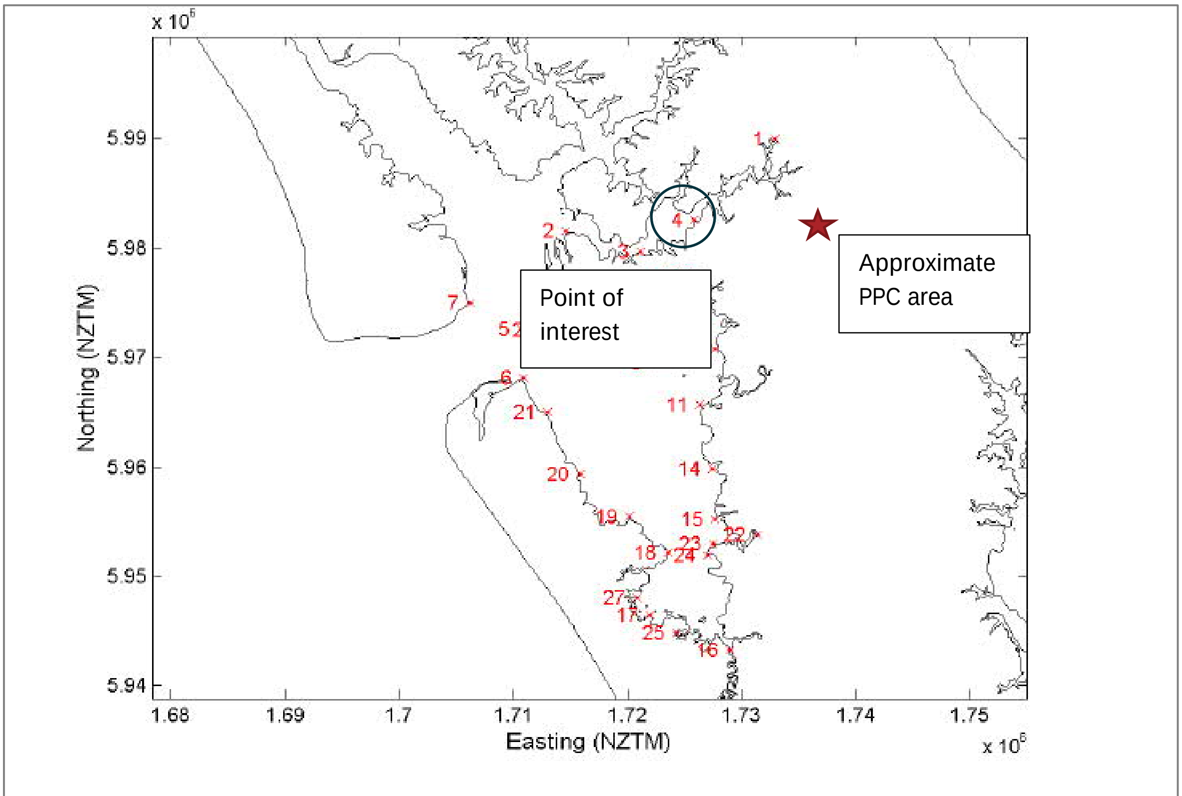


Figure 3-21: Locations of storm-tide model output from the central and southern Kaipara Harbour.

Figure 12: Storm tide model output southern Kaipara Harbour

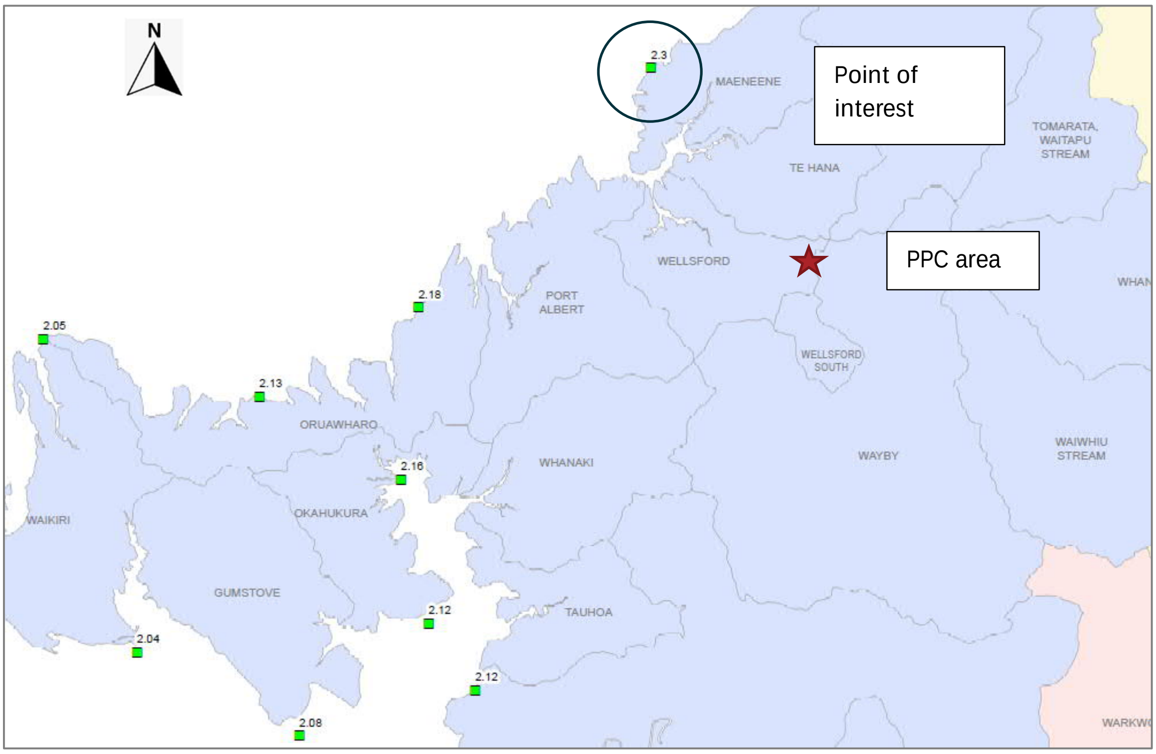


Figure 13: MHWS-Wellsford

Table 4: Costal inundation information

	PPC Area Costal level/ MHWS (AVD-46)
Extreme Sea-level in Kaipara Harbour	2.97 mRL
MHWS	2.3 mRL

2.10. Biodiversity

No significant ecological areas have been identified within the Wellsford North PPC area on the AC GeoMaps AUP management layer.

The stormwater runoff from the subject PPC area ultimately discharges into the Oruawharo River and Kaipara harbour. Oruawharo River is classified as a Significant Ecological Area – Terrestrial as well as a Significant Ecological Area – Marine 2 on the AC GeoMaps AUP management layer.

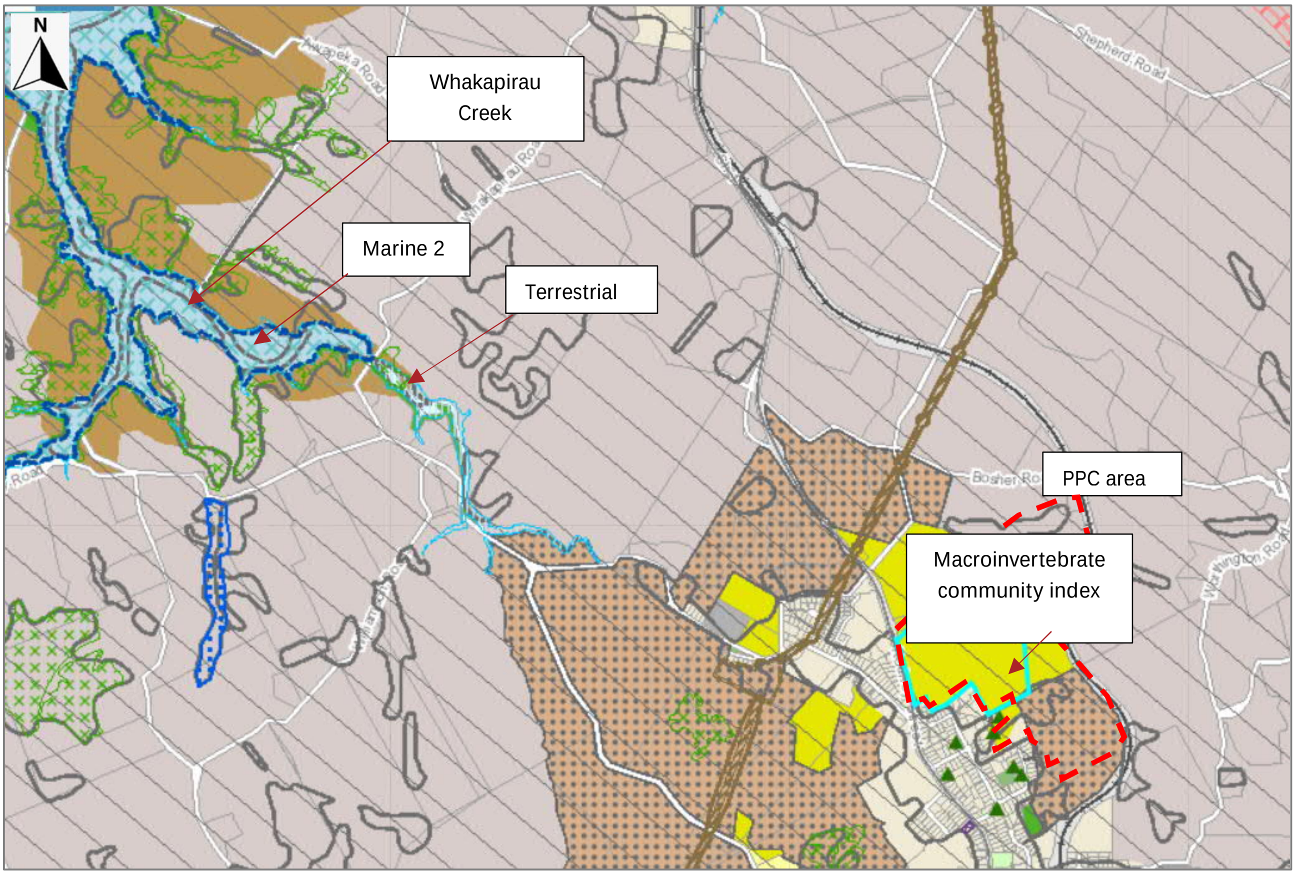


Figure 14: Significant ecological areas – (Sources AC GeoMaps AUP management layer)

Macroinvertebrate community index- exotic and Macroinvertebrate community index- rural are identified within the Wellsford North PPC area on the Auckland Council GeoMaps AUP management layer.

2.11. Cultural and heritage sites

No historical heritage, special character and natural heritage overlayer or places of significance to mana whenua have been identified on the AC GeoMaps AUP management layer within the Wellsford North PPC area. Two notable trees adjacent to the Wellsford North PPC area northern boundary as shown in Figure 15.

Figure 15: Notable trees (Sources AC GeoMaps AUP management layer)

An archaeological assessment has been undertaken which concludes there are no archaeological sites recorded within the PPC area. The area was used for agricultural purposes from the mid-19th century with a few residential subdivisions taking place in the 20th century.

Further information can be found in the Archaeological Assessment report undertaken by Clough & Associated Ltd submitted with the application.

2.12. Contaminated land

A Preliminary Site Investigation (PSI) report has been prepared by Environmental Management Solutions Ltd for the site. The report concludes majority of the land within the area is considered fit for intended land sue. However, there are several areas within the area where HAIL activities may have occurred, however detailed site investigations are required prior to site development.

Further information can be found in the Preliminary Site Investigation Wellsford North report submitted with the application.

3. Development summary and planning context

The requirements of the AUP provision and the requirements of the NDC are discussed in detail in the following subsections.

3.1. Regulatory and design requirements

The relevant regulatory and design requirements have been reviewed and listed in Table 5 below. A summary of each listed requirement or policy is presented in sub-sections below.

Table 5: Regulatory and design requirements

Requirement	Relevant regulatory /design to flow
Natural resources of the Regional Policy Statement	AUP Chapter B7
Significant ecological areas	AUP Chapter D9
Water quality and integrated management	AUP Chapter E1
Lakes, rivers, streams and wetlands	AUP Chapter E3
Stormwater management devices design	GD01
Application of principles of water sensitive design	GD04
Discharge and diversion	AUP Chapter E8
High contaminant generating areas	AUP Chapter E9
Unitary Plan – SMAF hydrology mitigation	AUP Chapter E10
Existing Catchment Management Plan	N/A
Structure Plan	N/A
Auckland Council Regionwide Network Discharge Consent	Schedule 4
Hydrology in Auckland Region	Auckland Regional Council - Guidelines for Stormwater Runoff Modelling in the Auckland Region – Technical Publication 108 (1999)
Design and Construction of Stormwater systems for Land development and Subdivision	Auckland Council - Auckland Code of Practice: For Land Development and Subdivision (Chapter 4 - Stormwater) (SWCOP)
Diversion, discharges, takes and earthworks associated with freshwater systems (stream and wetlands	Ministry for the Environment Resource Management - National Environmental Standards for Freshwater (2020)
Detail on Stormwater Management including WSD, Flood Risk Management, Freeboard allowance	NZS4404 – Land development and Subdivision infrastructure (2010)

3.1.1. Natural resource of the Regional Policy Statement

AUP Chapter B7 sets out the policies for indigenous biodiversity, freshwater systems, coastal water, freshwater and geothermal water, air.

B7.2.2. Policies

(1) Identify and evaluate areas of indigenous vegetation and the habitats of indigenous fauna in terrestrial and freshwater environments considering the following factors in terms of the descriptors contained in Schedule 3 Significant Ecological Areas – Terrestrial Schedule

(2) Include an area of indigenous vegetation or a habitat of indigenous fauna in terrestrial or freshwater environments in the Schedule 3 of Significant Ecological Areas – Terrestrial Schedule if the area or habitat is significant.

(3) Include an area of indigenous vegetation or a habitat of indigenous fauna in the coastal marine area in the Schedule 4 Significant Ecological Areas – Marine Schedule if the area or habitat is significant.

(4) Avoid adverse effects on areas listed in the Schedule 3 of Significant Ecological Areas – Terrestrial Schedule and Schedule 4 Significant Ecological Areas – Marine Schedule.

B7.3.2. Policies

Integrated management of land use and freshwater systems

(1) Integrate the management of subdivision, use and development and freshwater systems

Management of freshwater systems

(2) Identify degraded freshwater systems.

(3) Promote the enhancement of freshwater systems identified as being degraded to progressively reduce adverse effects.

(4) Avoid the permanent loss and significant modification or diversion of lakes, rivers, streams (excluding ephemeral streams), and wetlands and their margins, unless all of the following apply:

(5) Manage subdivision, use, development, including discharges and activities in the beds of lakes, rivers, streams, and in wetlands,

(6) Restore and enhance freshwater systems where practicable when development, change of land use, and subdivision occur

B7.4.2. Policies

Integrated management

(1) Integrate the management of subdivision, use, development and coastal water and freshwater,

National Policy Statement for Freshwater Management

(2) Give effect to the National Policy Statement for Freshwater Management 2014

(3) Integrate Mana Whenua values, mātauranga and tikanga when giving effect to the National Policy Statement for Freshwater Management 2014

Water quality

(4) Identify areas of coastal water and freshwater bodies that have been degraded by human activities

(5) Engage with Mana Whenua

(6) Progressively improve water quality in areas identified as having degraded water quality through managing subdivision, use, development and discharges

(7) Manage the discharges of contaminants into water from subdivision, use and development to avoid where practicable, and otherwise minimise

Sediment runoff

(8) Minimise the loss of sediment from subdivision, use and development, and manage the discharge of sediment into freshwater and coastal water

Stormwater management

(9) Manage stormwater

Freshwater and geothermal water quantity, allocation and use

(14) Enable the harvesting and storage of freshwater and rainwater to meet increasing demand for water and to manage water scarcity conditions, including those made worse by climate change

3.1.2. Significant ecological areas

AUP Chapter D9 sets out the policies for Significant ecological areas.

D9.3. Policies [rcp/rp/dp]

Managing effects on significant ecological areas – terrestrial and marine

(1) Manage the effects of activities on the indigenous biodiversity values of areas identified as significant ecological areas

(2) Adverse effects on indigenous biodiversity values in significant ecological areas that are required to be avoided, remedied, mitigated or offset

(3) Enhance indigenous biodiversity values in significant ecological areas

(4) Enable activities which enhance the ecological integrity and functioning of significant ecological areas

Vegetation management

(5) Enable the following vegetation management activities in significant ecological areas to provide for the reasonable use and management of land

(6) While also applying Policies D9.3(9) and (10) in the coastal environment, avoid as far as practicable the removal of vegetation and loss of biodiversity in significant ecological areas from the construction of building platforms, access ways or infrastructure

(7) Provide for the role of Mana Whenua as kaitiaki in managing biodiversity, particularly in Treaty Settlement areas, and for cultural practices and cultural harvesting in significant ecological areas where the mauri of the resource is sustained

(8) Manage the adverse effects from the use, maintenance, upgrade and development of infrastructure in accordance with the policies above, recognising that it is not always practicable to locate and design infrastructure to avoid significant ecological areas

Protecting significant ecological areas in the coastal environment

(9) Avoid activities in the coastal environment where they will result in any of the following: please refer to AUP Chapter D9 for information;

(10) Avoid (while giving effect to Policy D9.3(9) above) activities in the coastal environment which result in significant adverse effects, and avoid, remedy or mitigate other adverse effects of activities

(11) In addition to Policies D9.3(9) and (10), avoid subdivision, use and development in the coastal environment where it will result in any of the following: please refer to AUP Chapter D9 for information;

(12) Manage the adverse effects of use and development on the values of Significant Ecological Areas – Marine, in addition to the policies above, taking into account all of the following: please refer to AUP Chapter D9 for information;

(13) In addition to Policies D9.3(9) and (10), avoid structures in Significant Ecological Areas – Marine 1 (SEA-M1)

(14) In addition to Policies D9.3(9) and (10), avoid the extension to, or alteration of, any existing lawful structure in Significant Ecological Areas – Marine 1 (SEA-M1)

(15) Avoid mangrove removal within Significant Ecological Areas – Marine where it will threaten the viability or significance of the ecological values identified.

(16) Avoid mangrove removal within Significant Ecological Areas – Marine 1 (SEAM1) unless the removal

3.1.3. Water quality and integrated management

AUP Chapter E1 sets out the policies for Water quality and integrated management.

E1.3. Policies [rp/rcp/dp]

(1) Manage discharges, until such time as objectives and limits are established in accordance with Policy E1.3(7),

(2) Manage discharges, subdivision, use, and development that affect freshwater systems to: please refer to AUP Chapter E1 for information

(3) Require freshwater systems to be enhanced unless existing intensive land use and development has irreversibly modified them such that it practicably precludes enhancement.

(4) When considering any application for a discharge, the Council must have regard to the following matters

(5) When considering any application for a discharge the Council must have regard to the following matters:

(6) Policies E1.3(4) and (5) apply to the following discharges (including a diffuse discharge by any person or animal):

(7) Develop Freshwater Management Unit specific objectives and limits for freshwater with Mana Whenua, through community engagement, scientific research and mātauranga Māori, to replace the Macroinvertebrate Community Index interim guideline and to give full effect to the National Policy Statement for Freshwater Management

(8) Avoid as far as practicable, or otherwise minimise or mitigate, adverse effects of stormwater runoff from greenfield development on freshwater systems, freshwater and coastal water by: please refer to AUP Chapter E1 for information

(9) Minimise or mitigate new adverse effects of stormwater runoff, and where practicable progressively reduce existing adverse effects of stormwater runoff, on freshwater systems, freshwater and coastal waters during intensification and redevelopment of existing urban areas by all of the following: please refer to AUP Chapter E1 for information

(10) In taking an integrated stormwater management approach have regard to all of the following:

(11) Avoid as far as practicable, or otherwise minimise or mitigate adverse effects of stormwater diversions and discharges, having particular regard to: please refer to AUP Chapter E1 for information

(12) Manage contaminants in stormwater runoff from high contaminant generating car parks and high use roads to minimise new adverse effects and progressively reduce existing adverse effects on water and sediment quality in freshwater systems, freshwater and coastal waters

(13) Require stormwater quality or flow management to be achieved on-site unless there is a downstream communal device or facility designed to cater for the site's stormwater runoff

(14) Adopt the best practicable option to minimise the adverse effects of stormwater discharges from stormwater network and infrastructure including road, and rail having regard to all of the following: please refer to AUP Chapter E1 for information

(15) Utilise stormwater discharge to ground soakage in areas underlain by shallow or highly permeable aquifers provided that: please refer to AUP Chapter E1 for information

(26)) Prevent or minimise the adverse effects from construction, maintenance, investigation and other activities on the quality of freshwater and coastal water by: please refer to AUP Chapter E1 for information

3.1.4. Lakes, rivers, streams and wetlands

AUP Chapter E3 sets out the policies for Lakes, rivers, streams and wetlands.

(1) Avoid significant adverse effects, and avoid where practicable or otherwise remedy or mitigate other adverse effects of activities in, on, under or over the beds of lakes, rivers, streams or wetlands within the following overlays: D4,D5,D6,D9 and D8

(2) Manage the effects of activities in, on, under or over the beds of lakes, rivers, streams or wetlands outside the overlays identified in Policy E3.3(1) by: please refer to AUP Chapter E3 for information.

(3) Enable the enhancement, maintenance and restoration of lakes, rivers, streams or wetlands.

(4) Restoration and enhancement actions, which may form part of an offsetting proposal, for a specific activity should: please refer to AUP Chapter E3 for information.

(5) Avoid significant adverse effects, and avoid, remedy or mitigate other adverse effects of activities in, on, under or over the beds of lakes, rivers, streams or wetlands on: please refer to AUP Chapter E3 for information.

(6) Manage the adverse effects on Mana Whenua cultural heritage that is identified prior to, or discovered during, subdivision, use and development by: please refer to AUP Chapter E3 for information.

(7) Provide for the operation, use, maintenance, repair, erection, reconstruction, placement, alteration or extension, of any structure or part of any structure in, on, under, or over the bed of a lake, river, stream or wetland, and any associated diversion of water, where the structure complies with all of the following: please refer to AUP Chapter E3 for information.

(8) Enable the removal or demolition of any structure or part of any structure in, on, under, or over the bed of a lake, river, stream or wetland, and any associated diversion of water, provided adverse effects are avoided, remedied or mitigated.

(9) Provide for the excavation, drilling, tunnelling, thrusting or boring or other disturbance, and the depositing of any substance in, on or under the bed of a lake, river, stream or wetland, where it complies with all of the following: please refer to AUP Chapter E3 for information.

(10) Enable the planting of any plant, excluding pest species, in, on, or under the bed of a lake, river, stream or wetland where it is suitable for habitat establishment, restoration or enhancement, the maintenance and enhancement of amenity values, flood or erosion protection or stormwater runoff control provided it does not create or exacerbate flooding.

(11) Encourage the planting of plants that are native to the area.

(12) Encourage the incorporation of Mana Whenua mātauranga, values and tikanga in any planting in, on, or under the bed of a lake, river, stream or wetland.

(13) Avoid the reclamation and drainage of the bed of lakes, rivers, streams and wetlands, including any extension to existing reclamations or drained areas unless all of the following apply: please refer to AUP Chapter E3 for information.

(14) Avoid more than minor adverse effects on freshwater and coastal water from livestock grazing.

(15) Protect the riparian margins of lakes, rivers, streams, and wetlands from inappropriate use and development and promote their enhancement to through all of the following: please refer to AUP Chapter E3 for information.

(16)) Protect land alongside streams for public access through the use of esplanade reserves and esplanade strips, marginal strips, drainage reserves, easements or covenants where appropriate and for water quality, ecological and landscape protection purposes.

(17) The loss of extent of natural inland wetlands is avoided, their values are protected, and their restoration is promoted, except where: please refer to AUP Chapter E3 for information.

(18) The loss of river extent and values is avoided, unless the council is satisfied

3.1.5. Water sensitive design (GD04)

GD04 is a guidance document by Auckland Council which introduces principles and objectives for Water Sensitive Design (WSD). These include inter-disciplinary design approach, using at-source stormwater management practices to mimic natural systems and protect functions of natural ecosystems. WSD approaches focus on reducing or eliminating stormwater runoff generation through source control and utilising natural systems and processes to manage stormwater quantity and quality effects. The objectives include:

- Reducing stormwater runoff - reduce stormwater runoff volume and peak flow to predevelopment levels.
- Managing stormwater quality - manage stormwater quality to avoid adverse environmental effects.
- Minimising soil disturbance - minimise sediment in stormwater runoff, especially during construction, and protect site soil resources from modification.
- Promoting ecosystem health - promote the health of regional ecosystems and their associated environmental services through the management of stormwater at the catchment and site scale.
- Delivering best practice - deliver best practice urban design and broader community outcomes as part of stormwater management delivery.
- Maximising return on investment - achieve maximum value from stormwater management through the consideration of a broad range of benefits.

3.1.6. Discharge and diversion

AUP Chapter E1 and E2 sets out the policies for stormwater discharge and diversion. All permitted activities, controlled activities and restricted discretionary activities must meet the following standards, except for activity E8.4.1(A1) Stormwater runoff from lawfully established impervious areas directed into an authorised stormwater network or a combined sewer network.

(1) The design of the proposed stormwater management device(s) must be consistent with any relevant precinct plan that addresses or addressed stormwater matters.

(2) The diversion and discharge must not cause or increase scouring or erosion at the point of discharge or downstream.

(3) The diversion and discharge must not result in or increase the following:

(a) flooding of other properties in rainfall events up to the 10 per cent annual exceedance probability (AEP);

(b) inundation of buildings on other properties in events up to the 1 per cent annual exceedance probability (AEP).

(4) The diversion and discharge must not cause or increase nuisance or damage to other properties.

3.1.7. High contaminant generating areas

AUP Chapter E1 sets out the policies for Stormwater quality – High contaminant generating car parks and high use roads. All activities listed as permitted in Table E9.4.1 Activity table must comply with Standard E9.6.1.1 and the specified permitted activity standards for the activity.

Standard E9.6.1.1. General

(1) Any required stormwater management device or system is built generally in accordance with design specifications and is fully operational within three months of commencement of the high contaminant generating car park or high use road. (2) 'As built' plans for any required stormwater management device or system are provided to the Council within three months of the practical completion of the works.

(2) Any required stormwater management device or system is operated and maintained in accordance with best practice for the device or system.

3.1.8. Hydrological mitigation

The subject PPC area is green field development, as per requirements under Schedule 4 of Network Discharge Consent, A method of achieving equivalent hydrology to pre-development (grassed state) levels is to:

- Provide retention (volume reduction) of a minimum of 5mm runoff depth for all impervious areas; and
- Provide detention (temporary storage) with a drain down period of 24 hours for the difference between the pre-development (grassed state) and post-development runoff volumes from the 95th percentile, 24 hour rainfall event minus the retention volume for all impervious areas.

3.1.9. Natural Hazards and flooding

Section E36 sets out the policies for Natural hazards and flooding.

E36.3. Policies

(1) Identify land that may be subject to natural hazards, taking into account the likely effects of climate change, including all of the following: please refer to AUP Chapter E1 for information

(2) Investigate other natural hazards to assess whether risks to people, property or the environment should be managed through the Plan or otherwise.

(3) Consider all of the following, as part of a risk assessment of proposals to subdivide, use or develop land that is subject to natural hazards: please refer to AUP Chapter E1 for information

(4) Control subdivision, use and development of land that is subject to natural hazards so that the proposed activity does not increase, and where practicable reduces, risk associated with all of the following adverse effects:

Floodplains in urban areas

(13) In existing urban areas require new buildings designed to accommodate more vulnerable activities to be located: (a) outside of the 1 per cent annual exceedance probability (AEP) floodplain; or (b) within or above the 1 per cent annual exceedance probability (AEP) floodplain where safe evacuation routes or refuges are provided.

(14) Require redevelopment of sites where existing more vulnerable activities are located within the 1 per cent annual exceedance probability (AEP) floodplain to address all of the following; please refer to AUP Chapter E1 for information

(15) Within existing urban areas, enable buildings containing less vulnerable activities to locate in the 1 per cent annual exceedance probability (AEP) floodplains where that activity avoids, remedies or mitigates effects from flood hazards on other properties.

3.1.10. Network Discharge Consent

A regionwide resource consent (NDC) has been granted by the Auckland Council to use best practice to manage all public stormwater discharges across Auckland region to protect the environment, people and property - and improve water quality. NDC Schedule 4 sets out the connection's requirements for Greenfields development. A stormwater management plan will be required to be prepared addressing all Schedule 4 matters.

Water quality

- Treatment of all impervious areas by a water quality device designed in accordance with GD01/ TP10 for relevant contaminants.

Stream Hydrology

The site is not located within a Stormwater Management Area Flow (SMAF) overlay as per the AUP: OiP. However, as the site discharges to a stream, the following is required:

- Achieve equivalent hydrology (infiltration, runoff volume, peak flow) to pre-development (grassed state) levels:
    - Provide retention (volume reduction) of a minimum of 5mm runoff depth for all impervious surfaces; and
    - Provide detention (temporary storage) with a drain down period of 24 hours for the difference between pre-development (grassed state) and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus the retention volume for all impervious areas.

Flooding – Property/ pipe capacity 10% AEP event

- Ensure sufficient capacity in downstream network
- As there are currently no piped stormwater network within the PPC area, the proposed network will be designed in accordance with Auckland Council Stormwater Code of Practice

Flooding – Buildings 1% AEP event

- To be developed to Auckland Council Stormwater Code of Practice

If the above requirements on water quality, stream hydrology and flooding cannot be met, then an alternative level of mitigation can be determined through a SMP that:

- Applies an Integrated Stormwater Management Approach
- Meets the NDC Objectives and Outcomes in Schedule 2
- Is the BPO for the given project.

3.1.11. National Policy Statement of Freshwater Management

The National Policy Statement (NPS) for Freshwater 2020 provides local authorities with updated direction on how they should manage freshwater under the Resource Management Act 1991. This NPS comes into force on 3 September 2020. The NPS sets out the following policies:

(1) Freshwater is managed in a way that gives effect to Te Mana o te Wai.

(2) Tangata whenua are actively involved in freshwater management (including decision making processes), and Māori freshwater values are identified and provided for.

(3) Freshwater is managed in an integrated way that considers the effects of the use and development of land on a whole-of-catchment basis, including the effects on receiving environments.

(4) Freshwater is managed as part of New Zealand's integrated response to climate change.

(5) Freshwater is managed through a National Objectives Framework to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.

(6) There is no further loss of extent of natural inland wetlands, their values are protected, and their restoration is promoted.

(7) The loss of river extent and values is avoided to the extent practicable.

(8) The significant values of outstanding water bodies are protected.

(9) The habitats of indigenous freshwater species are protected.

(10) The habitat of trout and salmon is protected, insofar as this is consistent with Policy 9.

(11) Freshwater is allocated and used efficiently, all existing over-allocation is phased out, and future over-allocation is avoided.

(12) The national target (as set out in Appendix 3) for water quality improvement is achieved.

(13) The condition of water bodies and freshwater ecosystems is systematically monitored over time, and action is taken where freshwater is degraded, and to reverse deteriorating trends. 10 National Policy Statement for Freshwater Management 2020

(14) Information (including monitoring data) about the state of water bodies and freshwater ecosystems, and the challenges to their health and well-being, is regularly reported on and published.

(15) Communities are enabled to provide for their social, economic, and cultural wellbeing in a way that is consistent with this National Policy Statement.

3.1.12. National Policy Statement on Urban Development

The NPS-Urban Development (UD) aims to ensure that New Zealand's towns and cities are well-functioning urban environments that meet the changing needs of our diverse communities. Major policies in the NPS-UD are the following:

- Intensification: Council plans will need to enable (but not require) greater height and density, particularly in areas of high demand and access.
- Carparking: Councils will no longer be able to require developers to provide car parking through their district and city plans. However, develops can still provide car parking if they wish. Mobility parking is not affected by this direction.
- Responsiveness: Council must consider private plan changes where they would add significantly to development capacity, good outcomes and are well connected by transport corridors.
- Winder outcomes Councils are directed to give greater consideration to ensuring that cities work for all people and communities. Particular focus is given to access, climate change and housing affordability.

4. Mana whenua

Engagement correspondence was sent to the nine iwi authorities who have expressed interest in the Plan Change area on 20 July 2021, outlining the details of the proposal. A response was received from both Ngāti Manuhiri and Ngāti Wai. Representatives of these iwi were met on the site on Wednesday 16 February 2022. Ngāti Manuhiri raised no direct concerns with the proposal verbally and have provided a cultural values assessment report. Ngāti Wai raised no direct concerns with the proposal verbally and did not indicate whether they wish to provide written feedback.

Consultation will be ongoing with both iwi, and it is the intention that they will have the opportunity for consultation and involvement as the development progresses.

5. Stakeholder engagement and consultation

Consultation has been undertaken with various stakeholders with the consultation relevant to stormwater summarised in Table 6 below.

Table 6: Stakeholder engagement

Stakeholders	What is the reason for interest?	What engagement has been completed?	Feedback and response
Auckland Council - Healthy Waters	Early consultation with Healthy Waters. Introduction of project and proposed plan change. Overview of modelling work done to date and SW strategy.	Pre lodgement meeting held on 06/04/2022	In general, Healthy Waters were favourable of the strategy proposed and modelling undertaken, however would need to review the modelling and SMP to provide further comments. A few queries were raised, and additional model scenarios were requested to be simulated (i.e., without climate change) to understand if effects are a result of climate change or development. Woods have simulated the additional scenarios which is discussed further in Section 7. It is noted consultation with Healthy Waters is ongoing.
Waka Kotahi NZTA	Project introduction, Outline work done to date and findings, namely in relation to hazards identified on State Highway 1.	Meeting held on 21/04/2022	Hazards on State Highway 1 were acknowledged to be an existing risk with the proposed development not causing any additional adverse effects with mitigation not required. Model information and associated reporting was required to provide additional comments. Consultation is ongoing.
Auckland Council - Healthy Waters	Model review	Meeting held on 16/11/2022	ICM Model accepted by Healthy Waters
SMP issued to Auckland Council Healthy Waters	-	13/03/2023	Feedback received from Healthy Waters (mentioned below)
Auckland Council – Healthy Waters	RFI	Email correspondence	Since submission, healthy water has issued RFI. A meeting was held with Healthy Waters and a memorandum was

			provided in response (attached as Appendix B to this report).
Auckland Council – Healthy Waters	RFI	Email correspondence	Healthy Waters have issued another RFI. A meeting was held with Healthy Waters and the SMP has been updated based on the queries. A response table has been prepared to provide response (attached as Appendix C to this report).
Auckland Council – Healthy Waters	RFI	Meeting held on 31/05/2023	RFI matters discussed and closed

Relevant minutes and presentations are included in Appendix C for reference.
It is noted consultation with Auckland Transport, Auckland Council Parks and Community Facilities is ongoing.

6. Proposed development

The Wellsford North Plan Change seeks to rezone 62.53ha of Future urban, Residential – Single House and Rural – Countryside Living zoned land to Residential – Large Lot Zone (17.04ha), Residential – Single House Zone (39.64ha), Residential – Mixed Housing Suburban Zone (5.87ha) and Business – Neighbourhood Centre zone (0.89ha).

The Plan Change also seeks to apply the Subdivision Variation Control to the 11.56ha area zoned Rural - Countryside Living.

An extent of the PPC area is shown in Figure 16 below.

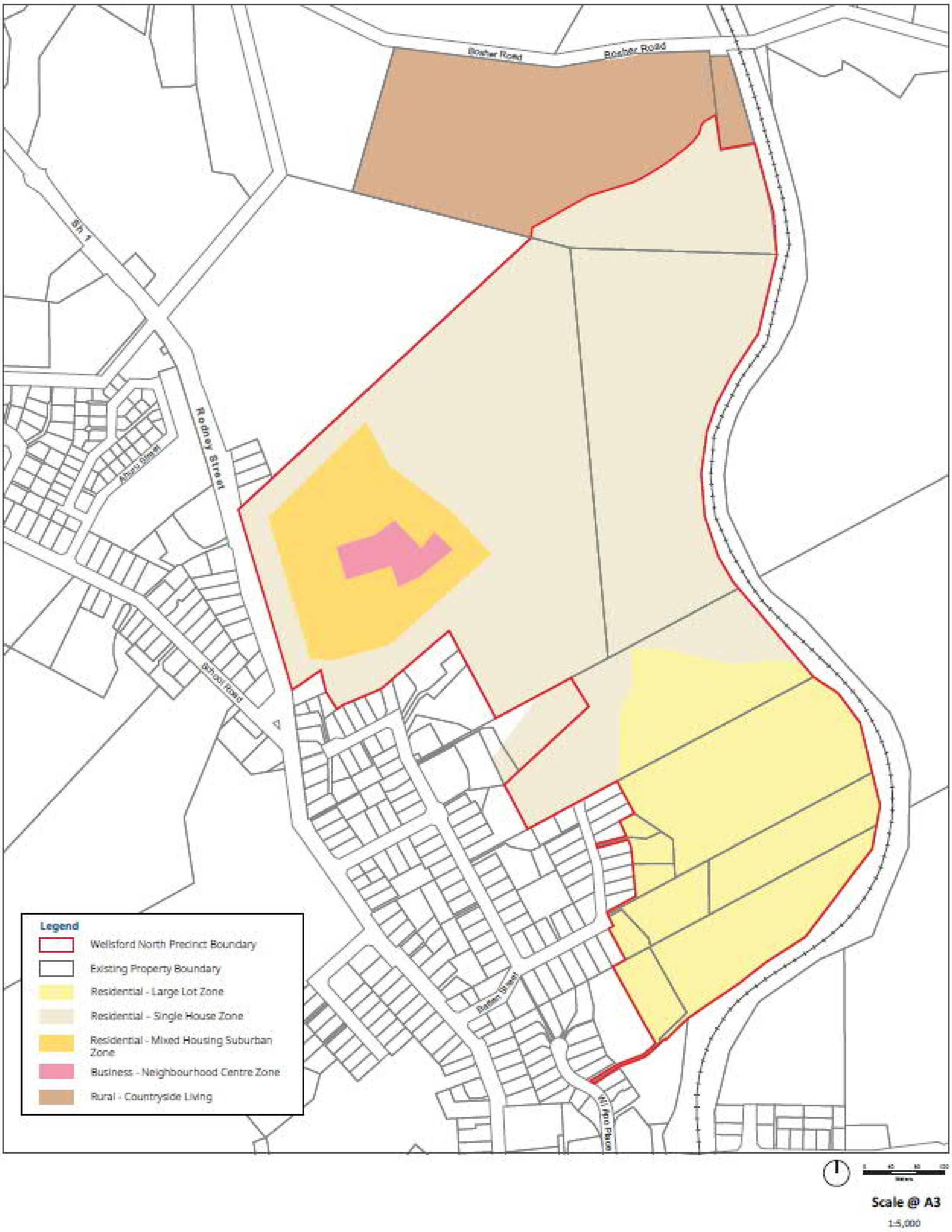


Figure 16: Wellsford North Plan Change

The Wellsford North Structure Plan applies to approximately 77.5ha of land north and east of the existing Wellsford urban area. The Structure Plan has been prepared for the entire area of land zoned Future Urban north of Wellsford, as well as adjacent land zoned Residential – Single House, Rural – Countryside Living and Rural – Rural Production zone and is outlined in Figure 17 below. The extent of the PPC area is located within the Wellsford North Structure Plan area.

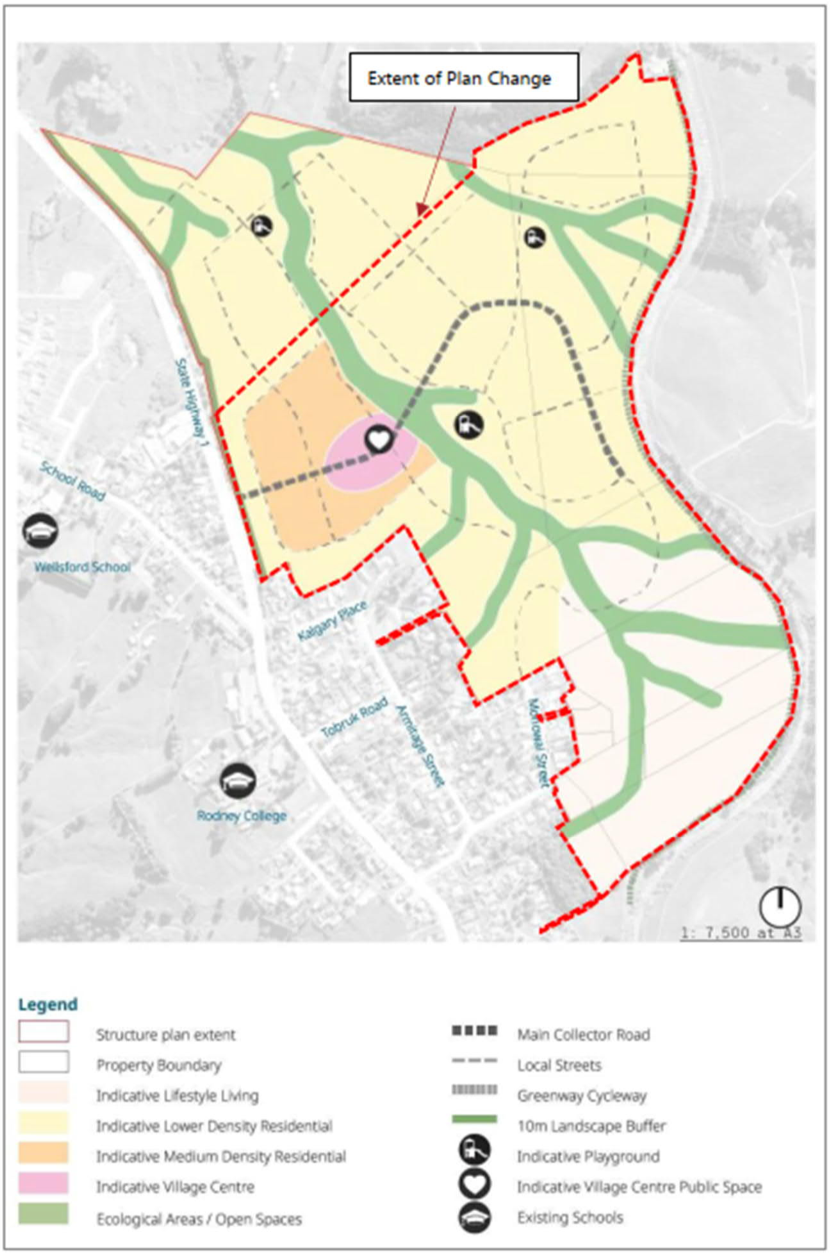


Figure 17: Wellsford North Structure Plan

Flood modelling has been undertaken for the Private Plan Change (PPC) area as well as the Structure Plan area which is detailed in Section 7.

7. Flooding

Woods have undertaken preliminary flood modelling for the PPC and surrounding areas. A preliminary assessment on capacity has been undertaken on key infrastructure, namely Culvert 1 as discussed in 2.5.1.

The flood model has been developed using InfoWorks ICM version 2021. The 1D/ 2D model represents the most relevant open channels in the catchment as 1D river reaches elements, and these were linked to the 1D stormwater network together with 2D mesh surface in the same interface.

Modelling was undertaken for 2-year, 10-year and 100-year ARI scenarios (inclusive of climate change). Following discussions with Healthy Waters, 10- and 100- year ARI scenarios with no climate change has also been simulated.

An overview of scenarios simulated is provided in Table 7 below.

Table 7: Modelled Scenarios

Scenario	Land use	Rainfall	Purpose	Comparison
ED (Base)	Existing impervious coverage	2-, 10- 100-year – no CC	Understand existing flood risk.	-
ED CC		2-, 10-, 100-year - 3.8°C	Understand existing flood risk inclusive of 3.8°C climate change.	-
PPC	Private Plan Change (MPD coverage) + ED (Existing impervious coverage)	2-, 10- 100-year – no CC	Understand flood risk as a result of development within the PPC area only.	Effects assessment Compared to Scenario Base to assess the impacts of development within the PPC area only
PPC CC		2-, 10-, 100-year - 3.8°C	Understand flood risk as a result of development within the PPC area only inclusive of 3.8°C climate change.	Effects assessment Compared to Scenario ED CC to assess the impacts of development within the PPC area only, inclusive of 3.8 °C climate change
PC FUZ	Maximum probable development (MPD as per AUP: OiP) + Private Plan Change	2-, 10- 100-year – no CC	Understand flood risk as a result of the MPD development.	Compared to Scenario Base to understand the cumulative effects as a result of development within the PPC area and MPD coverages in other areas
PC FUZ CC		2-, 10-, 100-year - 3.8°C	Understand flood risk as a result of the MPD development inclusive of 3.8°C.	Compared to Scenario ED CC to understand the cumulative effects as a result of development within the PPC area and MPD coverages in other areas inclusive of 3.8 °C climate change

7.1. Model build

The parameters and data used in the ICM models are presented in the 'Model Build' memorandum included in Appendix D.

The modelled extent is shown in Figure 18 below.

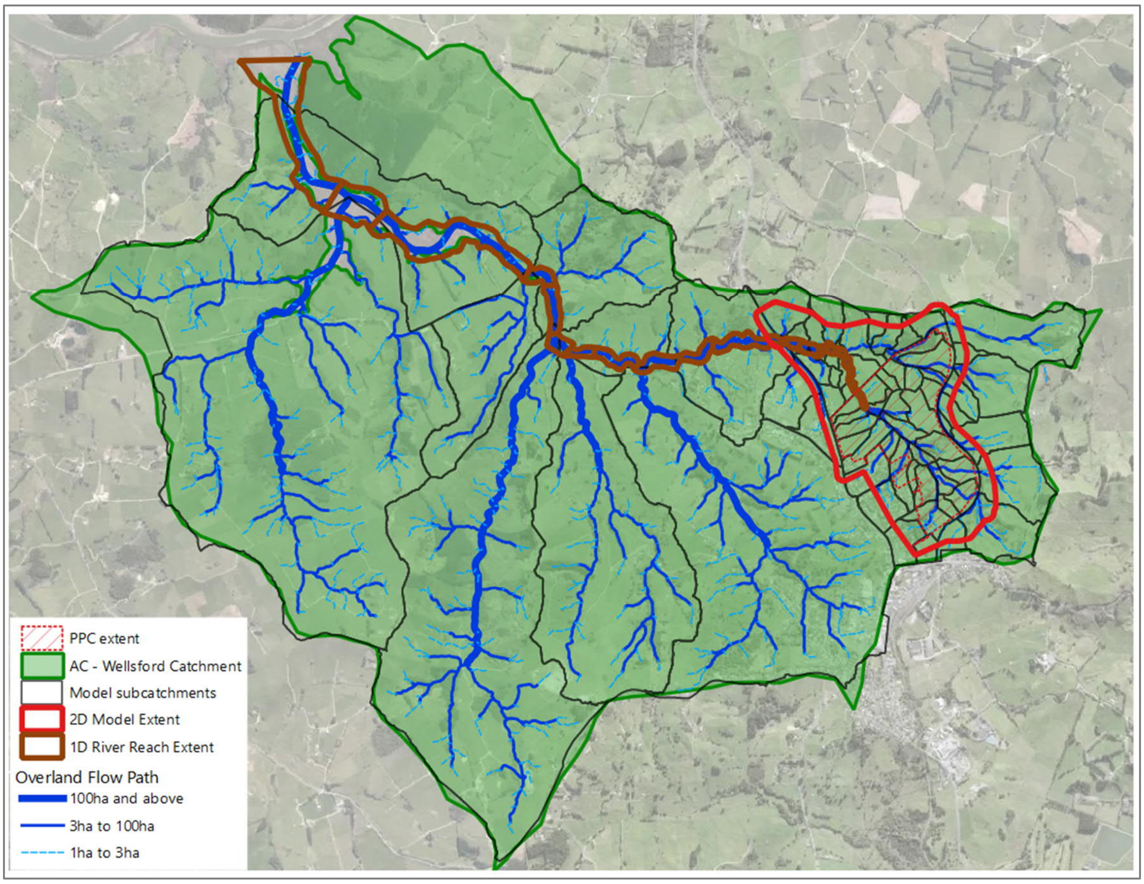


Figure 18: Model extent

7.2. Model Results

Model results were analysed from extracted flood extents and the maximum flood depths for each scenario. This was to better understand flood risk in the pre-and post-development scenarios. Water level difference plans, indicating differences between water levels, were generated to understand the differences in flood impacts.

As can be seen in Figure 18, the modelled extent includes areas downstream of the PPC area discharging to Oruawharo River. However, only model results within the PPC area are discussed in the subsequent sections as there were no observed differences downstream of State Highway 1. Flood depth increases of up to 100mm were noted for some scenarios, however, these were limited to the stream with no increase in flood extents.

A complete set of modelled extents and results of all scenarios are included in Appendix E, with key results discussed in sections below.

It is noted that the masterplan shown in the model results is indicative only and riparian margins shown are subject to change and align with the proposed flood extents. This will be refined at the detailed design stage.

7.2.1. Private Plan Change Scenarios Assessment

These scenarios were simulated to understand and isolate any effects as a result of development within the PPC area only with neighbouring areas at existing development as can be seen in Figure 19 below.

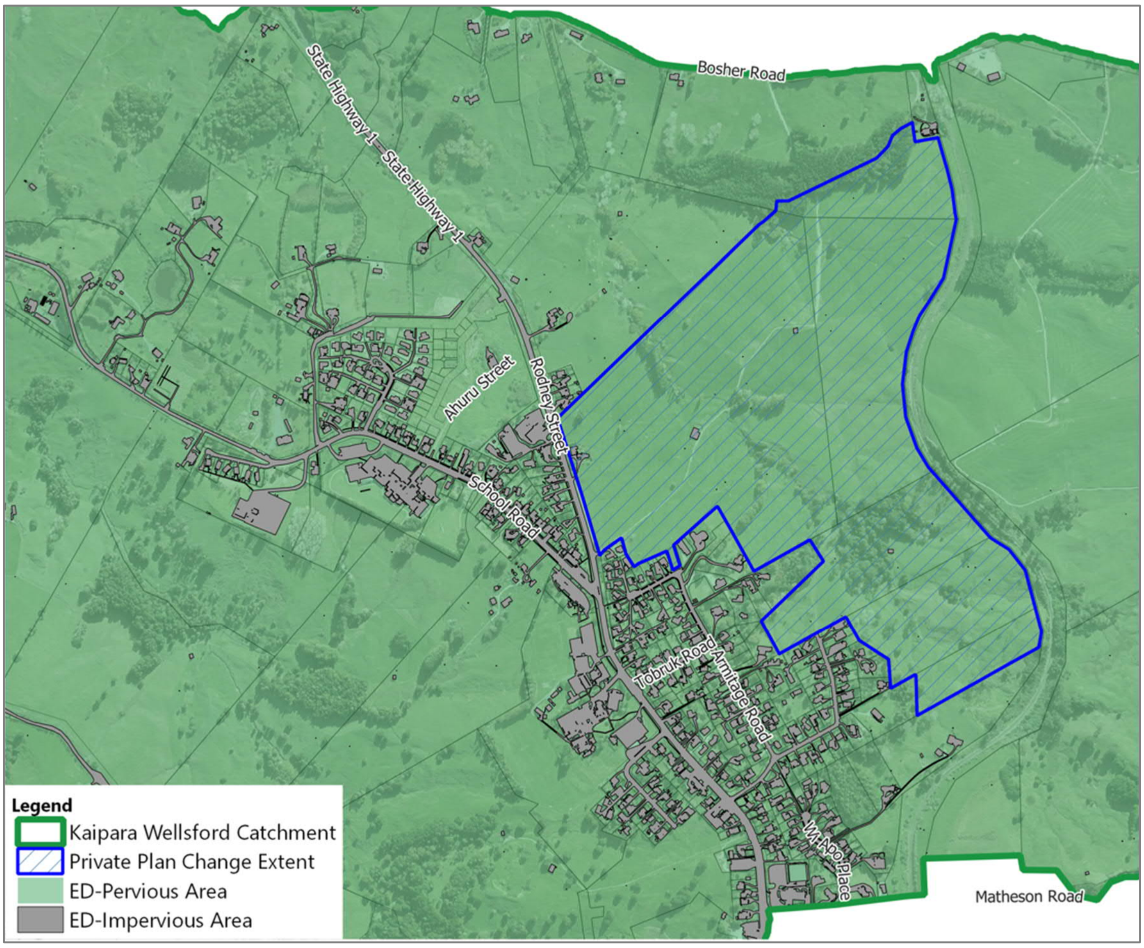


Figure 19: Existing development + Private Plan Change

Flood depth plots for the 100-year event with and without CC is shown in Figure 20 and Figure 21.

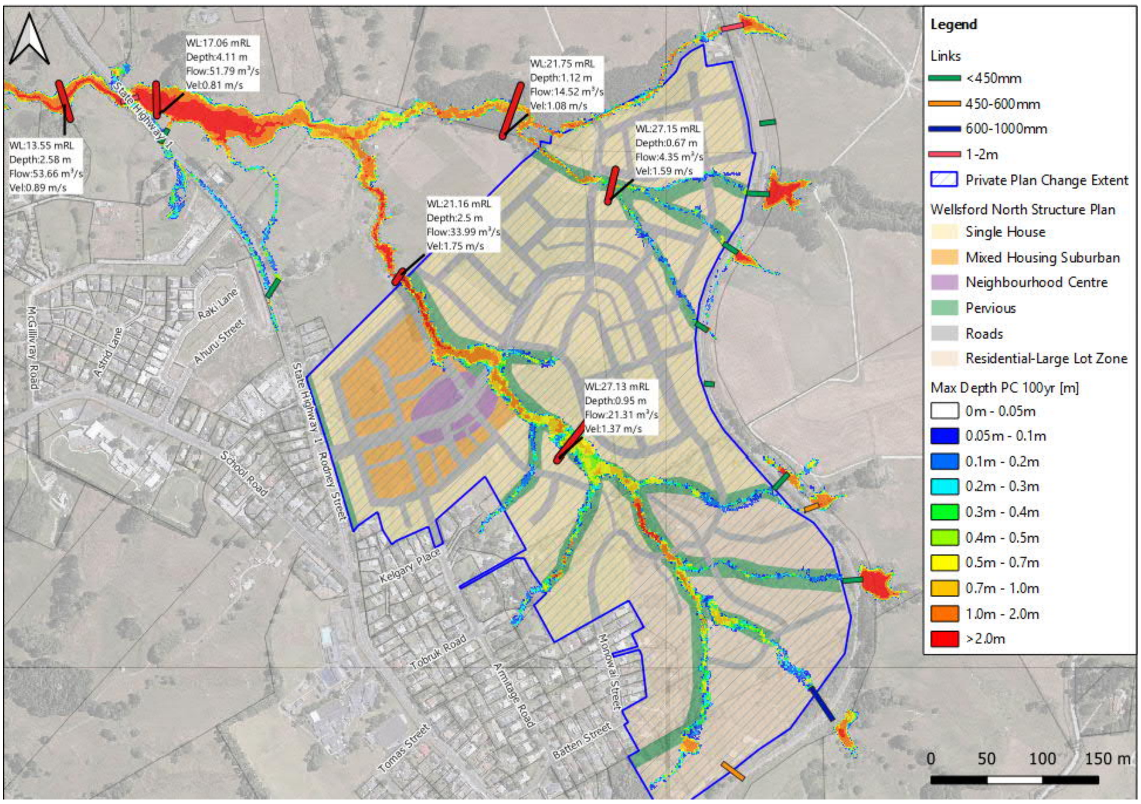


Figure 20: Flood depth- PPC 100-year (No CC)

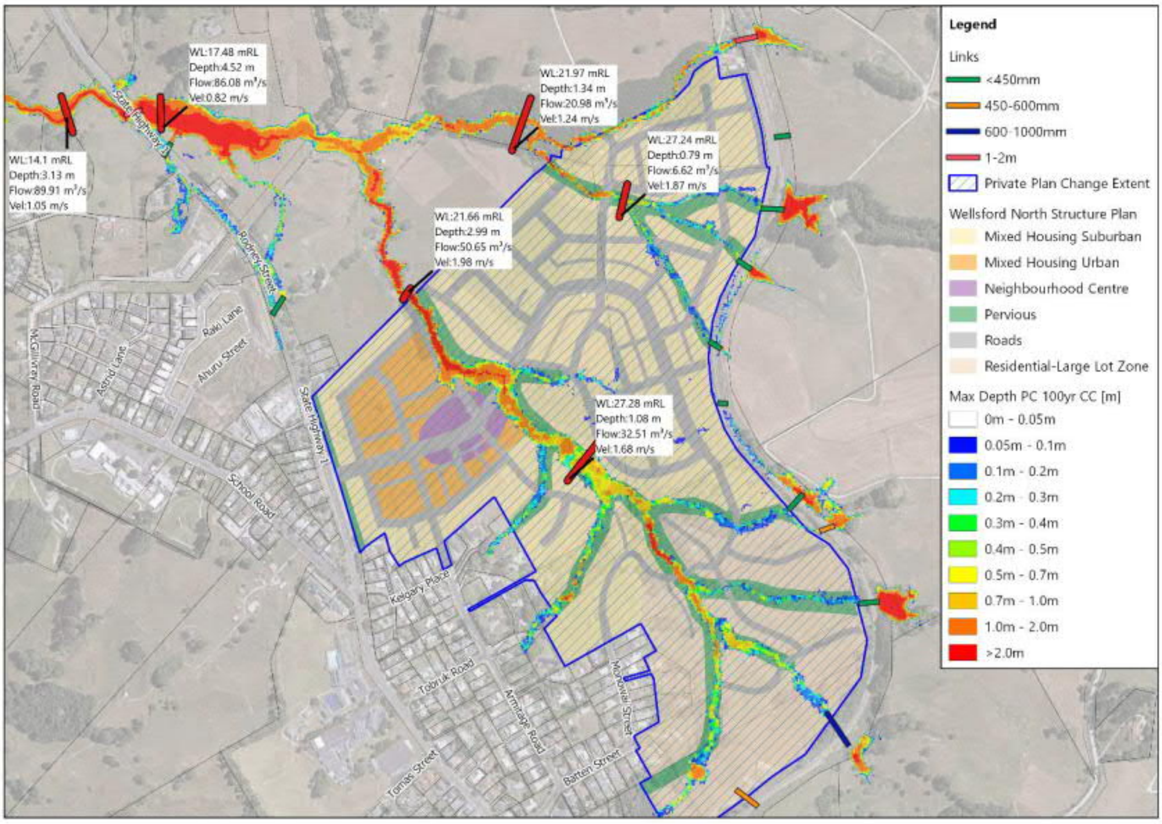


Figure 21: Flood depth- PPC 100-year (3.8^{0}C CC)

The Water level difference plots indicating differences between existing development and PPC, for the 100-year events with and without CC is shown in Figure 22 and Figure 23.

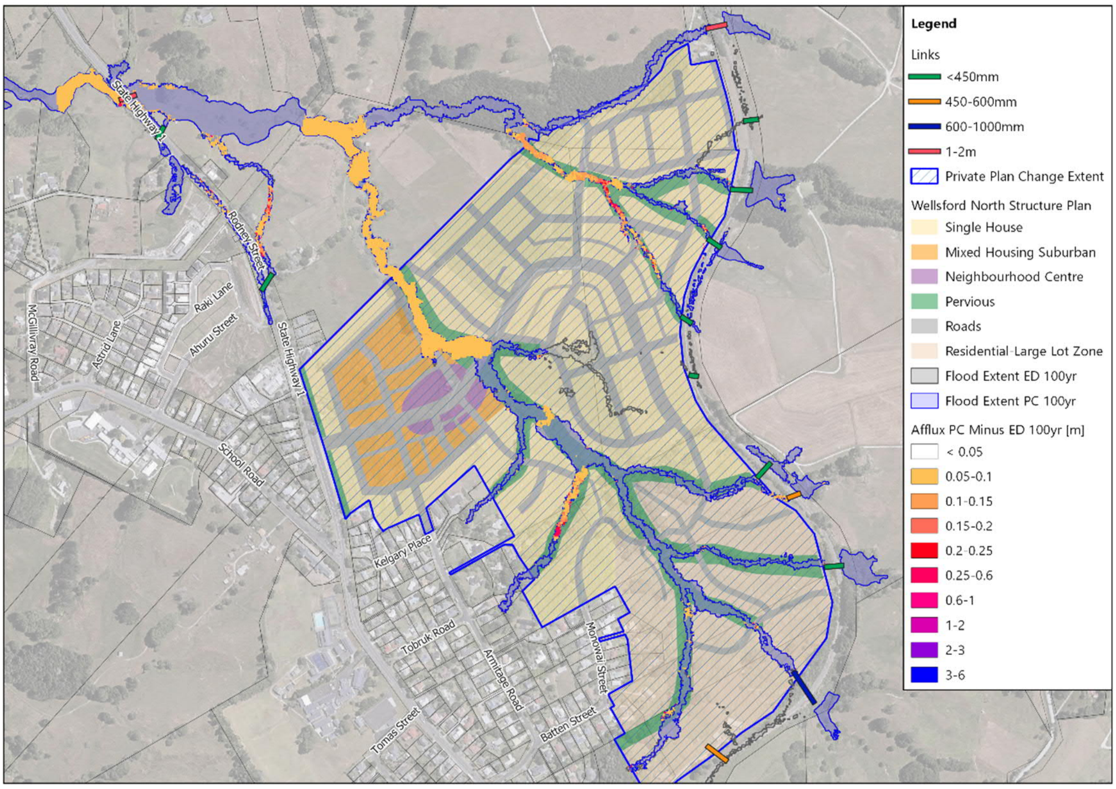


Figure 22: 100-year Water level difference between ED and PPC scenarios (No CC)

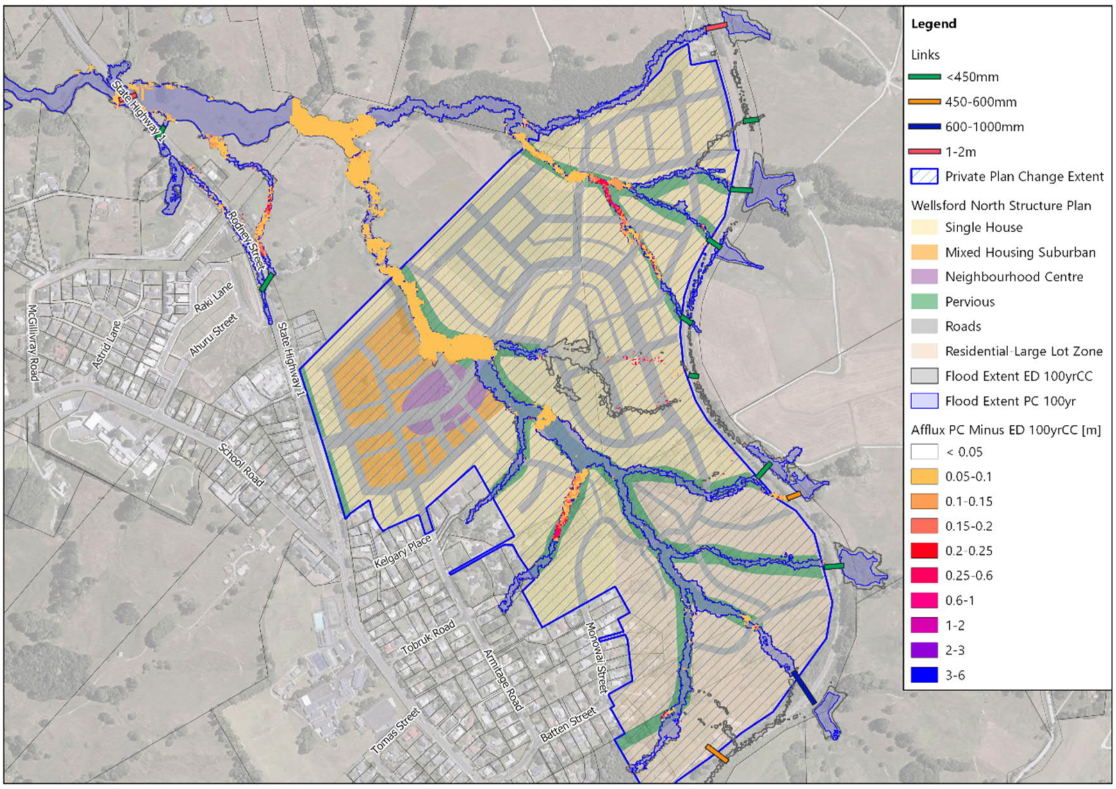


Figure 23: 100-year Water level difference between ED and PPC scenarios (3.8^{0}C CC)

The model results indicate that the flood extents are largely similar between the modelled scenarios, and the flooding is contained within the stream areas. This is as expected given the topography of the surrounding landform and typical stream profiles being generally well incised.

The flood depth results and Water level difference plots for the 10- and 2-year events is included in Appendix E.

Please note that the MPD coverage was implemented for the Private Plan Change area in the model. However, it is expected that the maximum coverage allowed within the Precinct will be lower than the maximum impervious coverage permitted under the AUP OiP. Therefore, the model results are considered to be conservative.

7.2.2. Private Plan Change + FUZ Assessment

These scenarios were simulated to understand any cumulative effects as a result of development within the PPC area with neighbouring FUZ areas at MPD coverages (permitted as per AUP: OiP) as can be seen in Figure 24.

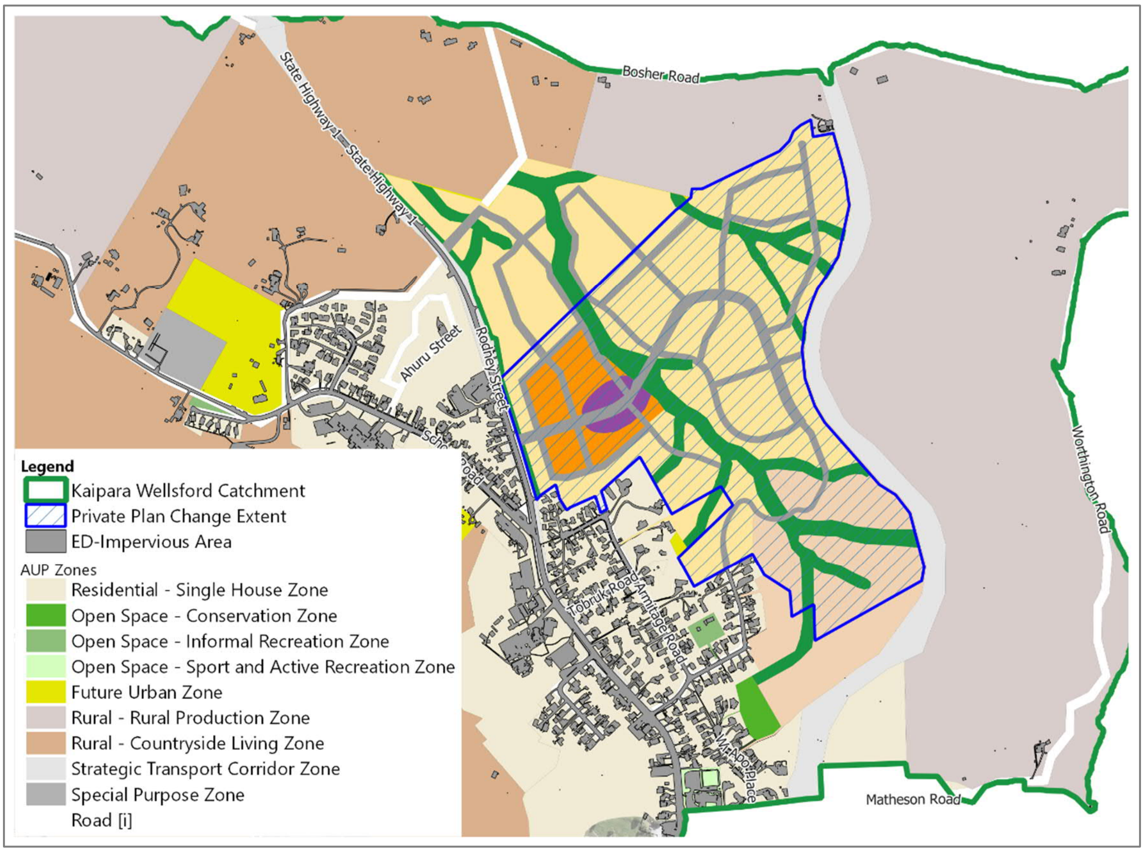


Figure 24: MPD + PPC AUP OiP Zones

Flood depth plots for the 100-year event with and without CC is shown in Figure 25 and Figure 26.

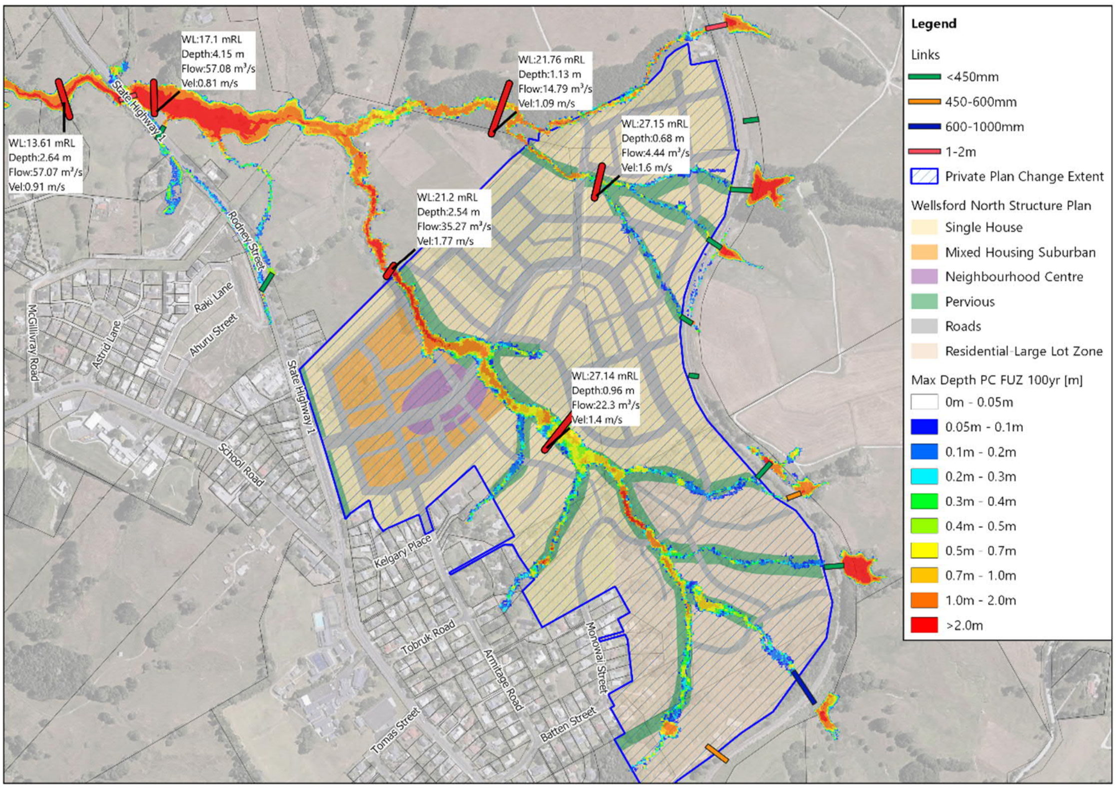


Figure 25: Flood depth- PC FUZ 100-year (No CC)

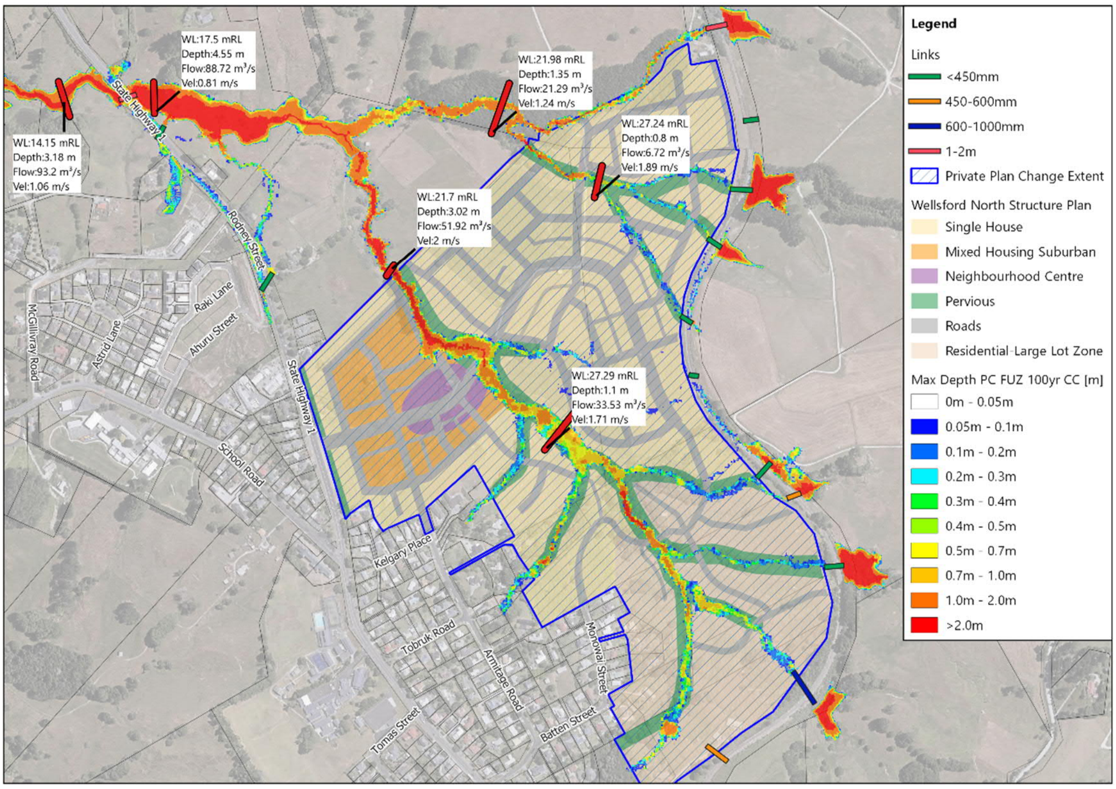


Figure 26: Flood depth- PC FUZ 100-year (3.8^{0}C CC)

The Water level difference plots indicating differences between ED and PPC for the 100-year events with and without CC is shown in Figure 27 and Figure 28.

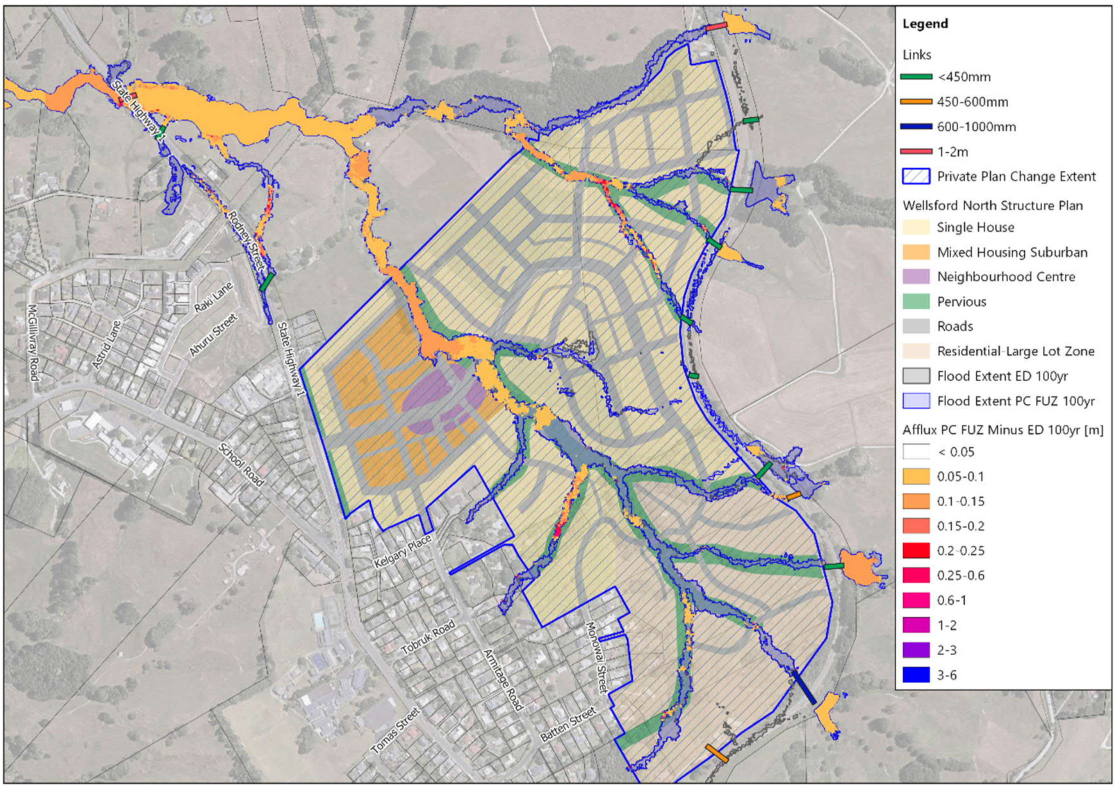


Figure 27: 100-year Water level difference between ED and PC FUZ scenarios (No CC)

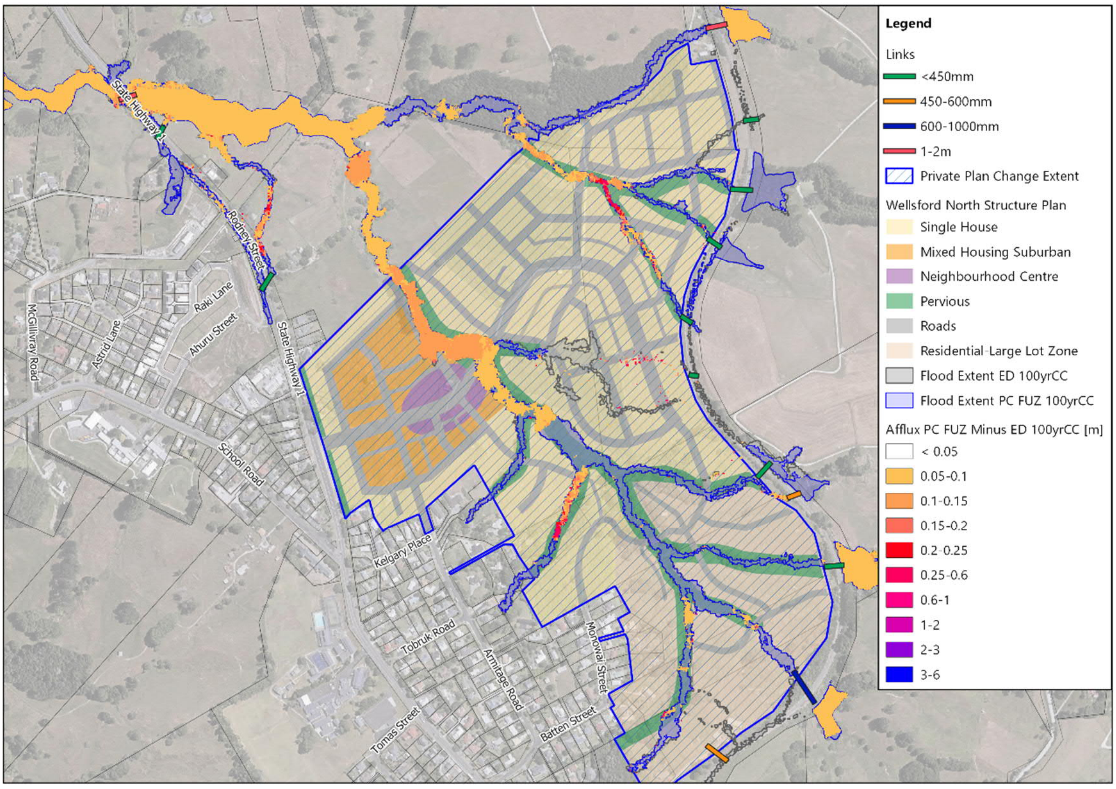


Figure 28: 100-year Water level difference between ED and PC FUZ scenarios (3.8^{0}C CC)

The model results indicate that the flood extents are largely similar between the modelled scenarios and the flooding is contained within the assigned stream. This is as expected given the topography of the surrounding landform and typical stream profiles being generally well incised.

The flood depth results and Water level difference plots for the 10- and 2-year events are included in Appendix E.

7.2.3. SH1 Culvert Performance

A culvert performance assessment was undertaken to understand performance of the SH1 culvert under various rainfall events for the PPC scenarios. The location of the performance assessment undertaken is shown in Figure 29. The outcomes of this assessment are summarised in Table 8.

Figure 29: Analysis Point

Table 8: Culvert Information- PPC Scenarios

Scenario	Water level on SH1 (mRL) Base	Water level on SH1 (mRL) PPC	Depth over SH1 (m) Base	Depth over SH1 (m) PPC	Depth increased in upstream flood level considering PPC (m)	Is culvert overtopping	Freeboard depth (Edge to Seal of WL)	Culvert surcharging frequency and duration of culvert surcharge with freeboard <500mm (min)
2-year – no CC	0	0	0*	0*	0.000	No	1.681	0
2-year – CC	16.43	16.432	0.015*	0.017*	0.002	No	0.938	0
10-year – no CC	16.445	16.446	0.030*	0.031*	0.001	No	0.195	24
10-year – CC	16.777	16.792	0.361	0.376	0.015	Yes	0.000	59
100-year – no CC	16.802	16.812	0.386	0.396	0.010	Yes	0.000	70
100-year - CC	17.036	17.053	0.621	0.638	0.017	Yes	0.000	99

Note: *Water depth on SH is a function of surrounding surface flows

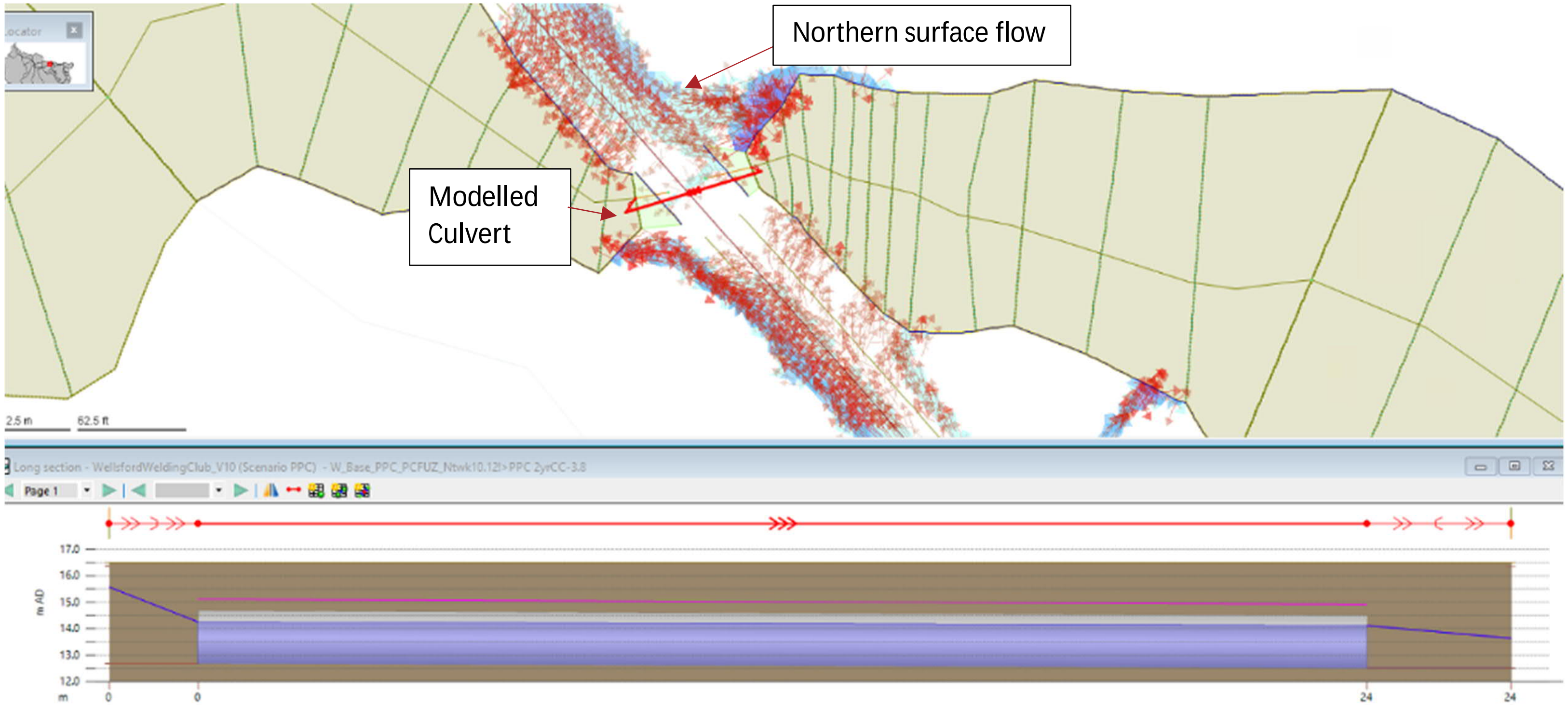


Figure 30: Flow direction - 2-year – CC PPC Scenario

The assessment indicates that the SH1 culvert is unlikely to be overtopped during the 2-year ARI rainfall events with and without CC scenarios and 10—year ARI rainfall without climate change scenarios. However, as shown in Figure 30, in the 2-year cc ARI PPC scenario, it is evident that surface runoff can traverse SH1 prior to the culvert being overtopped. This event is caused by the surface flow from the northern area, as shown in Figure above, rather than overtopping of the culvert.

7.2.4. Effects on State Highway 1

Hazard plots have been created to understand if there are any effects on State Highway 1 using Australian Rainfall-Runoff (ARR) 2019 guidelines to identify areas of high flood safety risks.

ARR defines flood hazard vulnerability into six categories as follows:

- H1 – Generally safe for vehicles, people and buildings
- H2 – unsafe for small vehicles
- H3 – Unsafe for vehicles, children and the elderly
- H4 – Unsafe for vehicles and people
- H5 – Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure
- H6 – Unsafe for vehicles and people. All building types considered vulnerable to failure

A copy of the flood hazard vulnerability curves and criteria is shown in Figure 31 and Table 9.

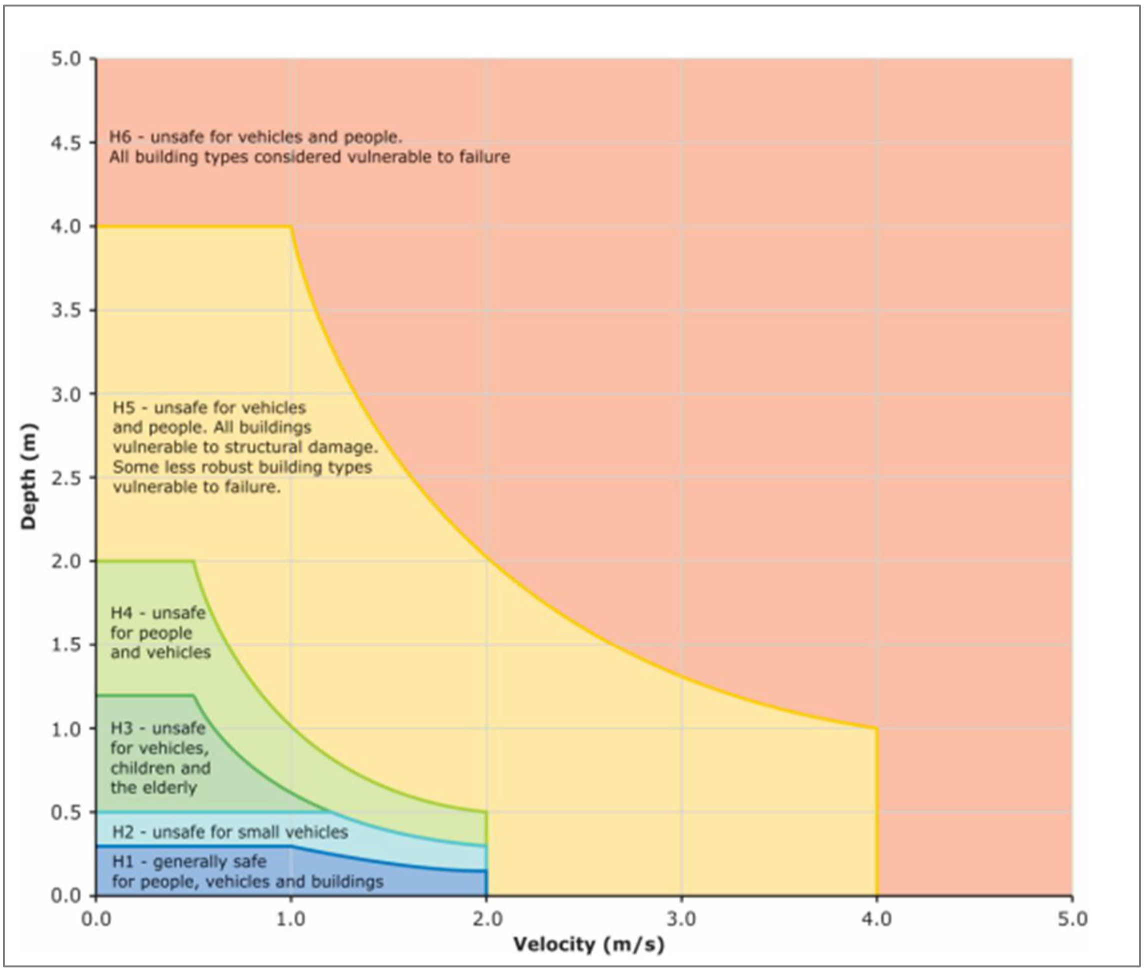


Figure 31: Flood hazard vulnerability curves (source: ARR 2019)

Table 9: Flood hazard criteria (source: ARR 2019)

Hazard Vulnerability Classification	Classification Limit (D & V in combination)	Limiting still water depth (D)	Limiting velocity (V)
H1	D*V≤ 0.3	0.3	2.0
H2	D*V≤ 0.6	0.5	2.0
H3	D*V≤ 0.6	1.2	2.0
H4	D*V≤ 1.0	2.0	2.0
H5	D*V≤ 4.0	4.0	4.0
H6	D*V> 4.0	-	-

The hazard plots for the ED, PPC and PC FUZ are shown in Figure 32 - Figure 37 with a complete set of results included in Appendix F.

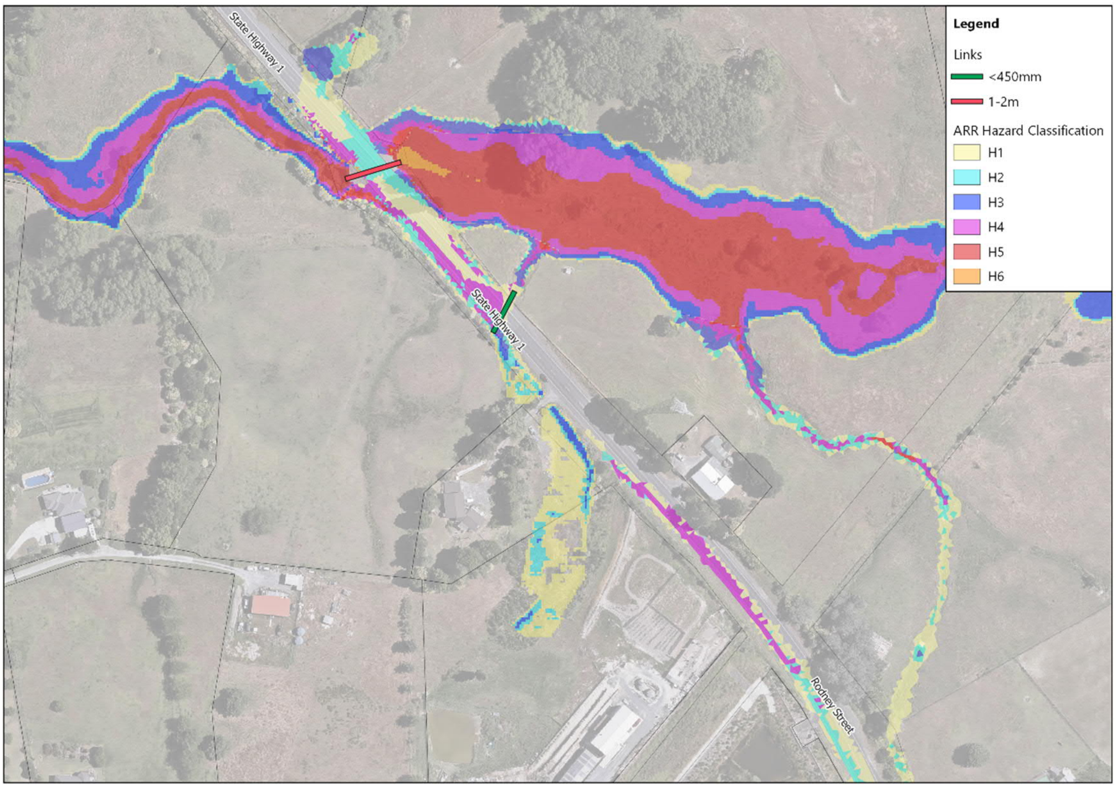


Figure 32: ED 10-year 3.8C CC – ARR flood hazards

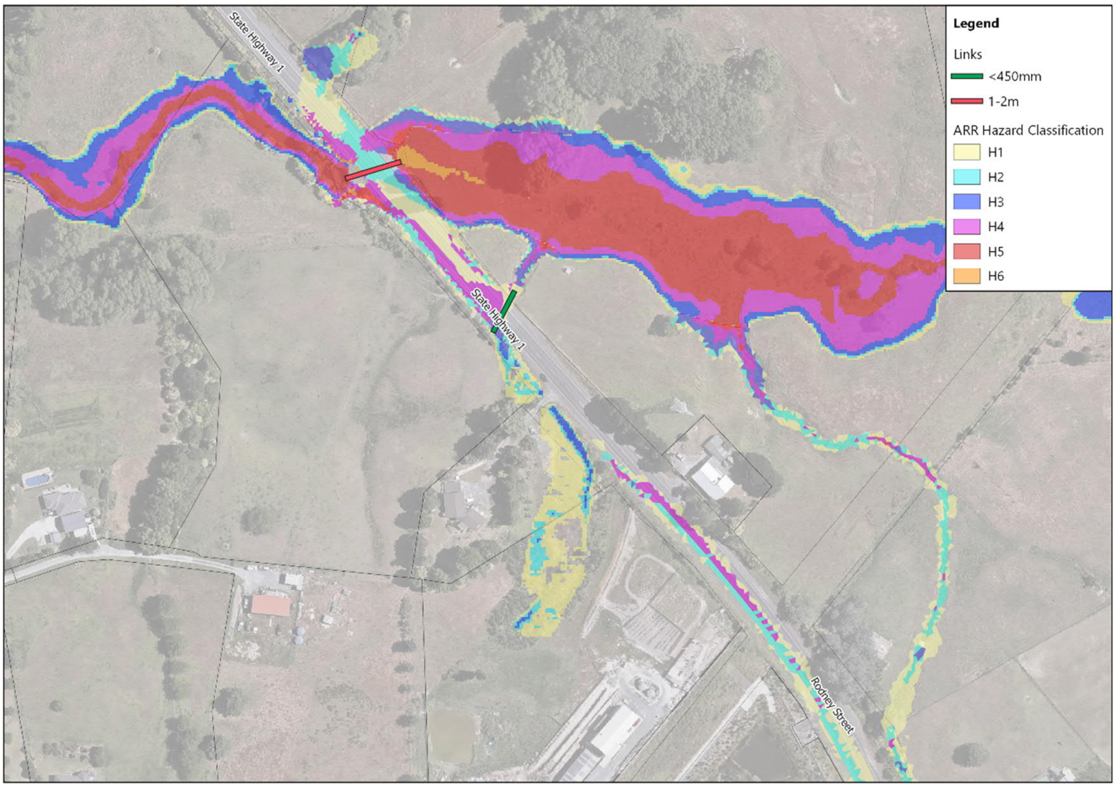


Figure 33: PPC 10-year 3.8C CC – ARR flood hazards

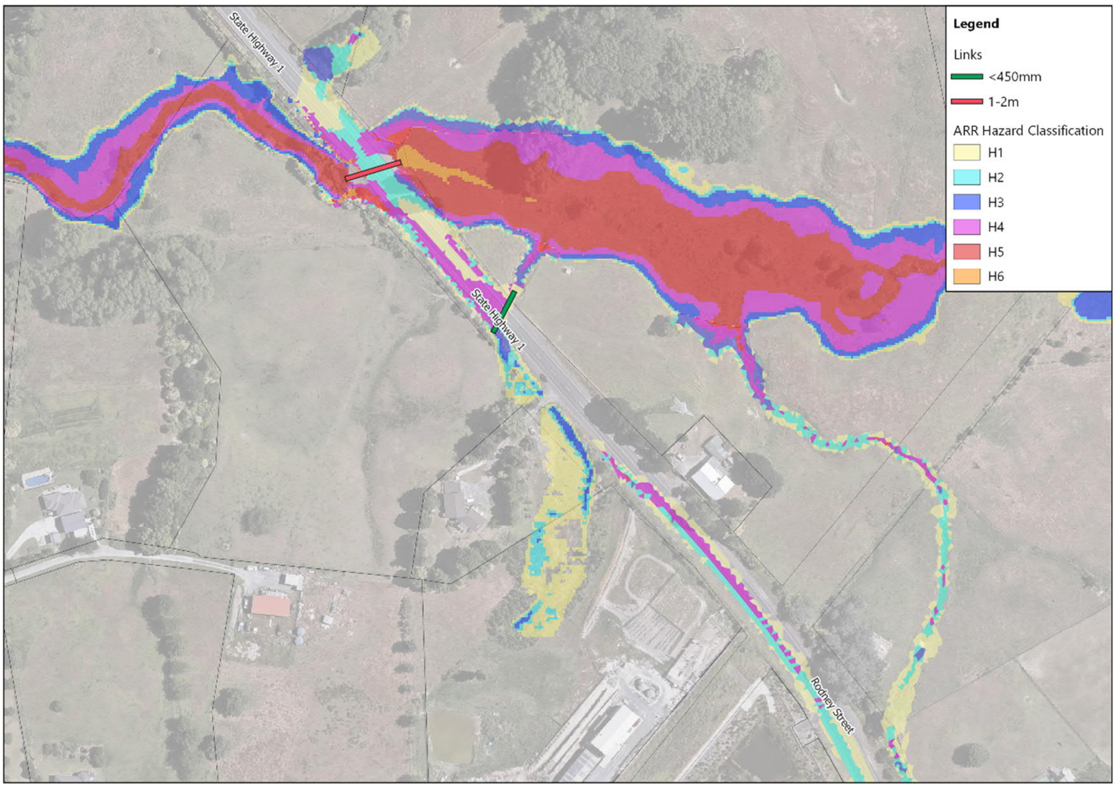


Figure 34: PC FUZ 10-year 3.8C CC – ARR flood hazards

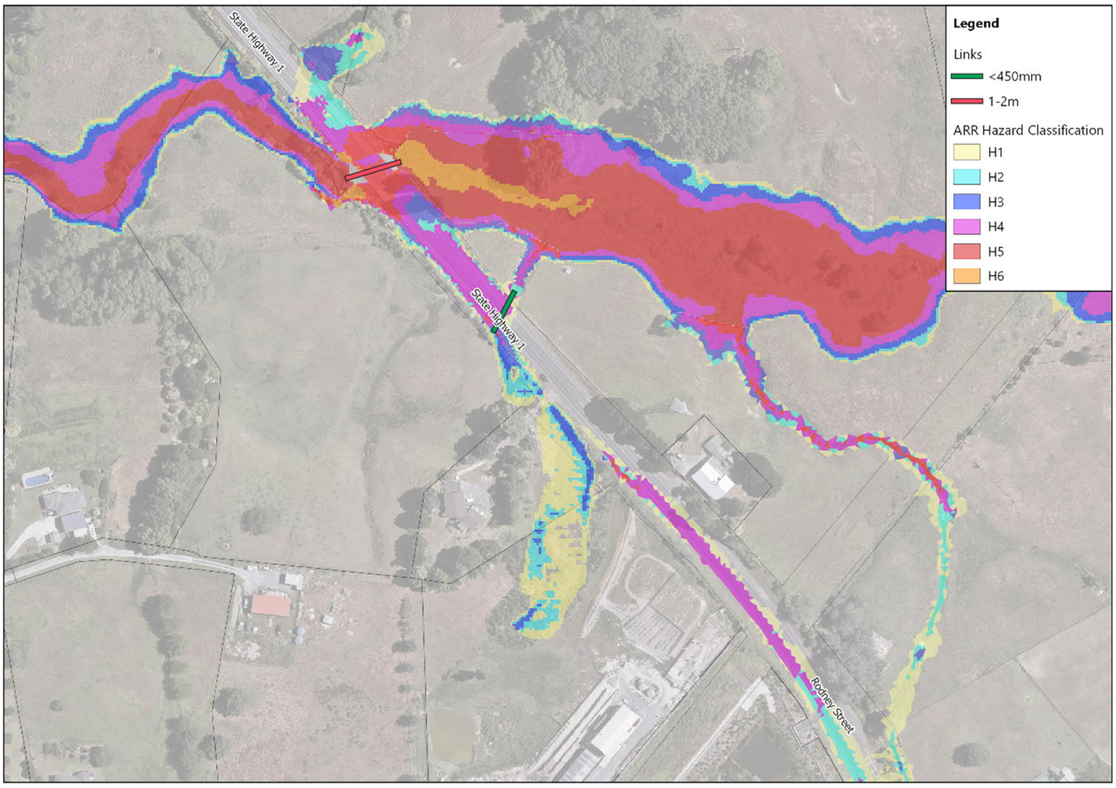


Figure 35: ED 100-year 3.8^{0}C CC – ARR flood hazards

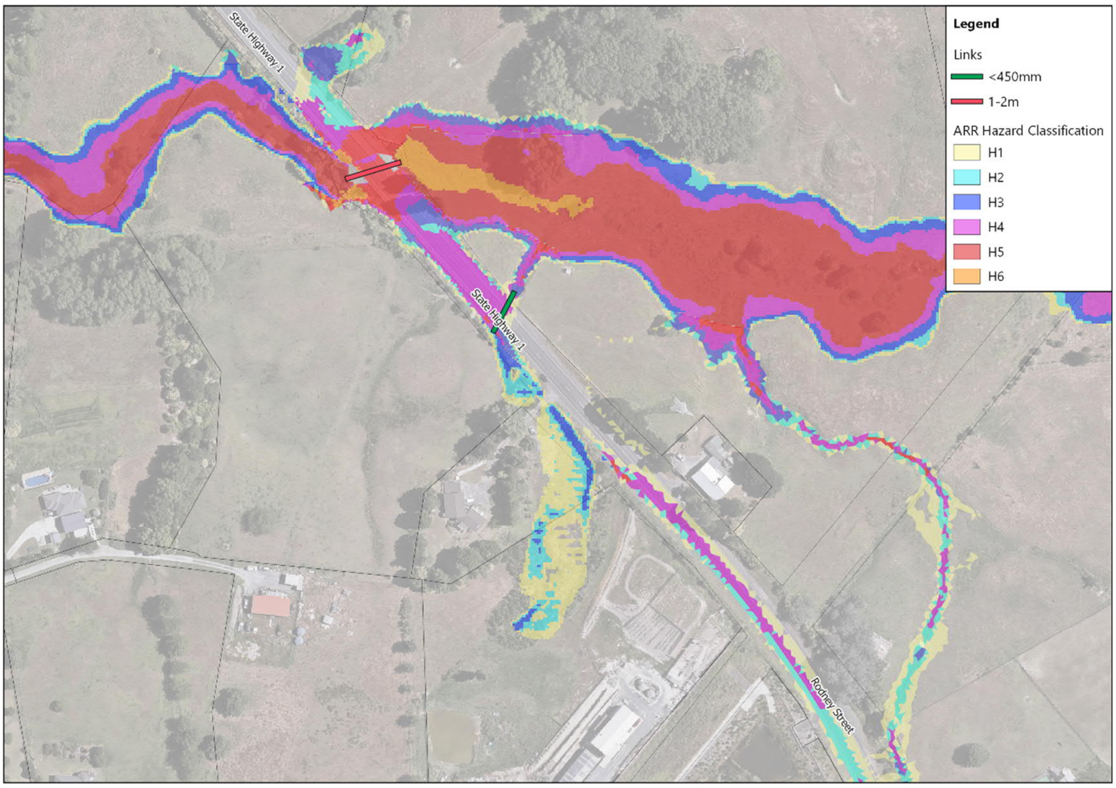


Figure 36: PPC 100-year 3.8^{0}C CC – ARR flood hazards

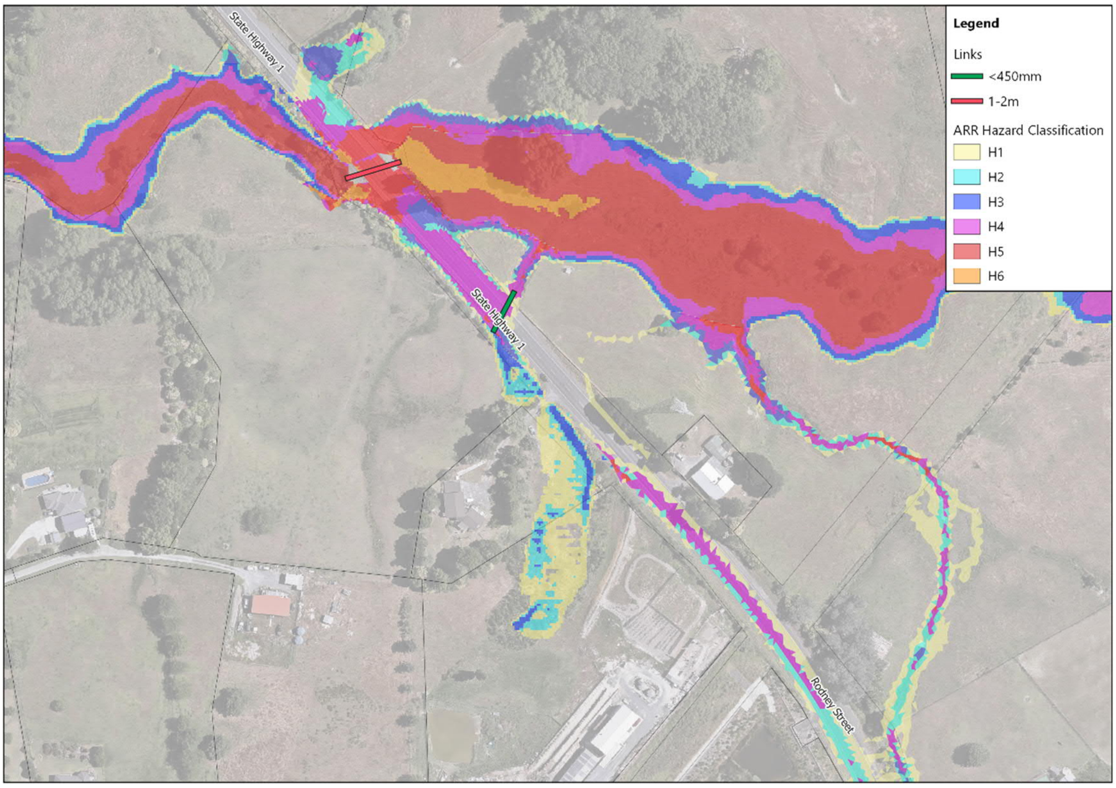


Figure 37: PC FUZ 100-year 3.8^{0}C CC – ARR flood hazards

The hazard plots indicate there is an existing risk at State Highway 1 which is not adversely affected by PPC.

The flood depths for the existing and PPC modelled scenarios are generally consistent for the various storm events assessed, the risk profile remains predominantly unchanged with PPC and PC FUZ. This has been discussed with Waka Kotahi/NZTA and the flood risk is associated with the existing culvert being under capacity for larger storm events.

Water level difference plot show approximately 50-100mm increases in flood depths (within existing flood extents) for the 100-year event (inclusive of climate change) in Figure 38, and Figure 39. Water level difference plots for all other events is included in Appendix G.

Given the existing risk profile and noting the risk profile remains unchanged with the PPC, it is recommended that Waka Kotahi NZTA undertake required upgrade to the existing culverts under the state highway to mitigate the flood risk and existing hazard.

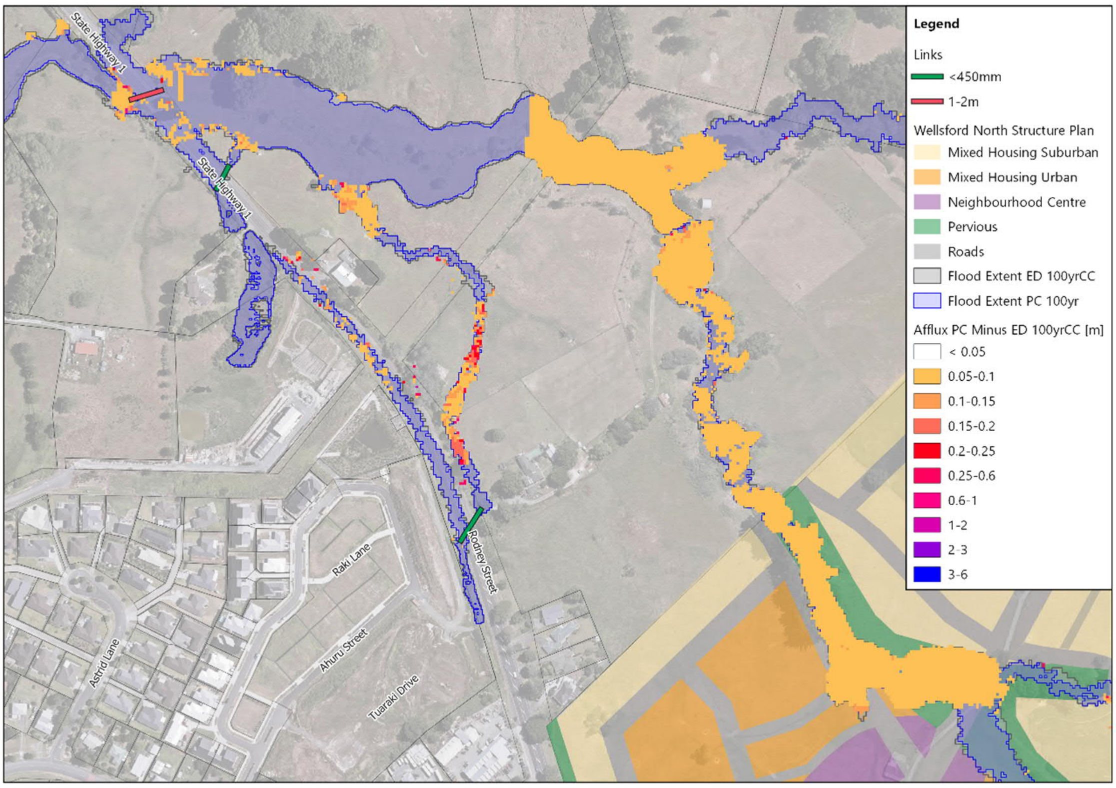


Figure 38: Water level difference – ED vs PPC 100-year 3.8^{0}C CC

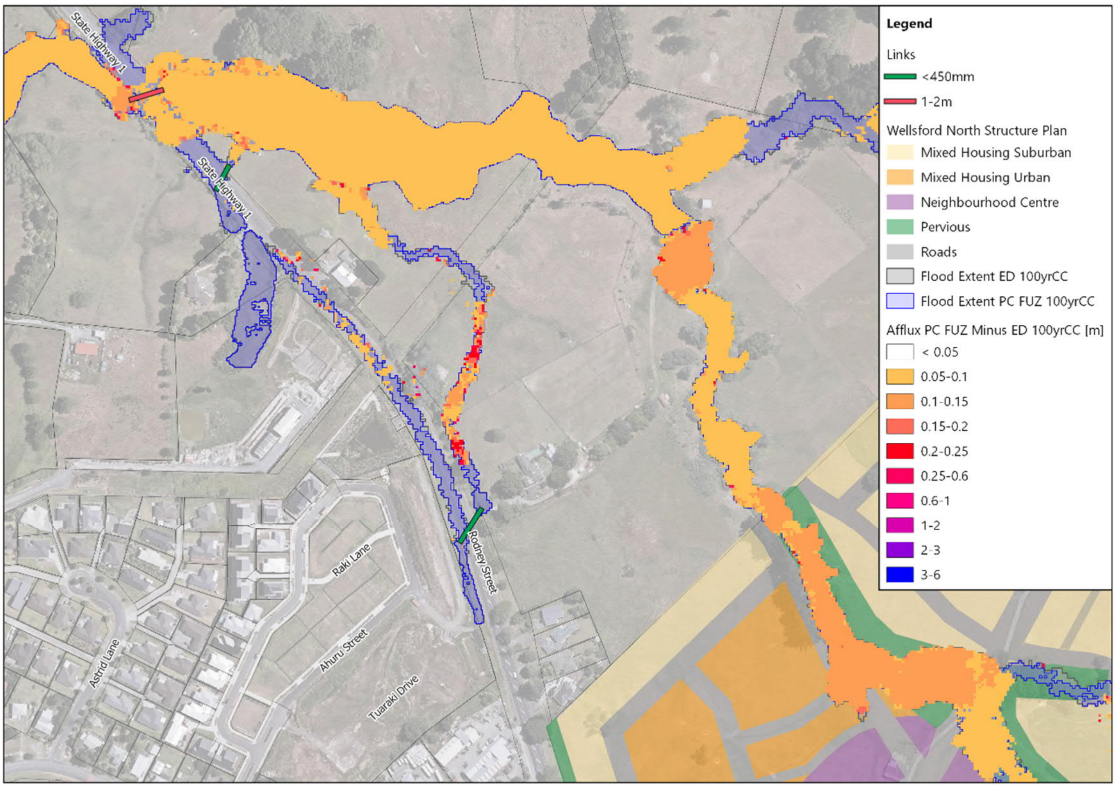


Figure 39: Water level difference - ED vs PC FUZ 100-year 3.8^{0}C CC

8. Stormwater management

This section presents the proposed stormwater management approach for the development. It has been developed to meet the objectives and design requirements of the Regionwide NDC Schedule 4 and the AUP.

This section covers the proposed stormwater discharge, water quality and hydrological mitigation requirements. Flood management is covered in Section 7.

8.1. Principle of stormwater management

The stormwater management principles for the integrated stormwater management approach described below are consistent with:

- The guidance and planning context as identified in Section 3 of this report.
- The AUP policies on integrated stormwater management and the regionwide NDC.

8.1.1. Original principles

The overall objective of the SMP is to implement Best practicable options for stormwater management approach for the PPC area including but not limited to:

- Enabling well-functioning urban environments that meet the changing needs.
- Improving health and well-being of degraded water bodies and freshwater ecosystems and maintaining the health and well-being of all other water bodies and freshwater ecosystems.
- Maintaining the extent of natural inland wetlands is maintained, protecting their values, and their restoration is promoted.
- Minimising the generation and discharge of contaminants, particularly from high contaminant generating car parks and high use roads and into sensitive receiving environments.
- Minimising or mitigating changes in hydrology, including loss of infiltration.
- Where practicable, minimising or mitigating the effects on freshwater systems arising from changes in water temperature caused by stormwater discharges.
- Providing for the management of gross stormwater pollutants,
- Ensuring the upstream and downstream flood effects are no more than minor.

8.1.2. Updated principles

Not applicable for this SMP

8.2. Proposed stormwater management

The proposed stormwater management strategy (mainly water quality and hydrology mitigation requirements) is only proposed for all the impervious areas as provided in the masterplan.

The proposed stormwater management approach is summarised as follows:

8.2.1. Water Quality

Water quality for all impervious areas is proposed to be treated to GD01/TP10 treatment levels, this is consistent with the requirements stated in the regionwide NDC.

Various devices were considered to provide water quality requirements. This included all the devices mentioned in GD01 such as bioretention devices (for e.g., raingardens and swales), wetlands and ponds as well as proprietary devices.

While assessing the suitability of devices, consideration was given to constraints posed by development site, workability with the masterplan and existing stormwater network. The following items were identified during the feasibility study:

- Wetlands and ponds are not considered feasible for the development due to the following reasons:
    - Unstable land present adjacent to the existing incised channel.
    - The entire development site is cut off by streams at various locations. This restricts the use of wetlands which could service the entire development area collectively.
- At source raingarden is not considered feasible for roads because:
    - Auckland Transport has been averse to accepting smaller raingardens likely due to high maintenance and low performance standards.
    - Several of these devices will be required to achieve the water quality requirements, rendering this option to be unfeasible.

Therefore, it is concluded that, large communal raingarden or bioretention devices are the most appropriate means of achieving water quality requirement for the development because:

- As per masterplan, there is sufficient space available to incorporate a communal bio-retention device.
- They can be incorporated at the downstream end of each sub-catchments leading to an acceptable number of units which service the proposed development.
- As mentioned above, treatment will be provided to all the impervious areas, but additionally inert roofing material is also proposed for all the new roof areas which will provide even greater overall water quality benefit to the receiving environment.

Based on the proposal stated above, the SMP meets the water quality requirements stated in Network Discharge Consent (NDC) for Greenfields site.

Conceptual sizing has been undertaken based on the masterplan. The indicative location plans are included in Appendix H.

8.2.2. Stream Hydrology

The PPC area is not located within a Stormwater Management Area Flow (SMAF) overlay as per the AUP: OiP. However, hydrology mitigation is proposed to be implemented for all impervious areas. This is to mitigate any increased stormwater runoff associated with the proposed development.

It is proposed that the development will provide detention of the 95th percentile rainfall event (discharged over 24 hours) coupled with retention of at least 5mm of rainfall depth. It is noted that this is best practice to achieve hydrology mitigation for NDC Greenfields site.

As per GD01, it is understood that 95th percentile, 24-hour rainfall event is required to be treated if an equivalent hydrology to pre-development (grassed state) levels is required.

Retention

- <u>Public Areas and Private Areas (hardstands and driveways only)</u> - Use of bio-retention raingarden with option to infiltrate to ground. This is subject to detailed geotechnical investigation ensuring that ground infiltration rate is more than 2mm/hr. In case this is not feasible, retention volume from these areas will be included with detention volume.
- <u>Private Lots (roofs)</u> – Retention of private roof areas will be provided via reuse. 5mm of rainfall depth will be collected and stored in storage tanks, connected to roofs. Volume collected for reuse can be utilised for household and irrigation purposes, for example toilet flushing or water plants. This proposal is as per the discussion held with Healthy Waters on 31/05/2023.

Detention

- Detention for all the impervious areas in the development will be provided by large communal bioretention devices. It is noted that same device will be used to provide water quality function (as mentioned in Section 8.2.1)

Based on the proposal stated above, the SMP meets the hydrology mitigation requirements stated in Network Discharge Consent (NDC) for Greenfields site.

The indicative bioretention device locations are included in Appendix H.

Stream Erosion

The site investigation and walkover undertaken by the ecologist did not identify stream erosion. The ecologist (Viridis) and Stormwater engineers (Woods) recommend stream erosion mitigation measures for the Plan Change Areas as follows:

- Modification of hydrograph mitigated through stormwater retention/detention (SMAF 1 hydrological mitigation) measures which will slow flows.
- Removal of stock from the site and therefore avoiding active bank de-stabilisation through stock access and pugging.
- Incorporation of green spaces adjacent to stream networks to provide for planting of riparian margins to improve bank stability and reduce erosion potential.
- Incorporation of erosion and scour protection measures at all outfalls to minimise erosion at new structures.
- Targeted in-stream erosion protection measures may be required at the location identified immediately downstream of the southern crossing.

An erosion study will need to be conducted once the conceptual design of the stormwater pipe network is finalised. This study aims to determine whether SMAF 1 is suitable for erosion control or if a higher standard needs to be implemented.

8.2.3. Flooding 10 percent AEP event (Network Capacity)

All the proposed stormwater network will be designed in accordance with SWCOP. Please refer to Section 7 of this report for downstream network capacity assessment.

8.2.4. Flooding 1 percent AEP event (Buildings)

Flooding and habitable floors are to be developed in accordance with SWCOP with adequate freeboards to be provided.

Assessment of the finished floor levels and freeboard requirement for the proposed buildings will be done during the Resource Consent stage.

8.2.5. Overland flow path and floodplain management

The secondary flow, events greater than a 10-year ARI storm event and up to a 100-year ARI storm, will be conveyed along road corridor, conveyance channels as overland flow paths. Overland flow path alignments will be dependent on the overall built environment and maintain existing discharge locations where possible.

The overland flow paths should meet the following design criteria:

- Overland flow paths will be designed with sufficient capacity to accommodate the 100-year ARI storm event for the MPD, including 3.8°C future climate change.
- They will be unobstructed, with regards to the safe velocity and flow values as per AT TDM and Healthy Waters guidelines.

- Overland flows to enter any external properties as a result of the proposed development.
- Overland flows meet the design criteria outlined in Auckland Council SWCOP V3.

8.2.6. Stormwater Management Summary

A summary of the proposed stormwater management is illustrated in the Table 10. The summary provides an overview of how stormwater need to be managed within the subject PPC area. The proposed stormwater management has been discussed and agreed with Healthy Waters on 31/05/2023.

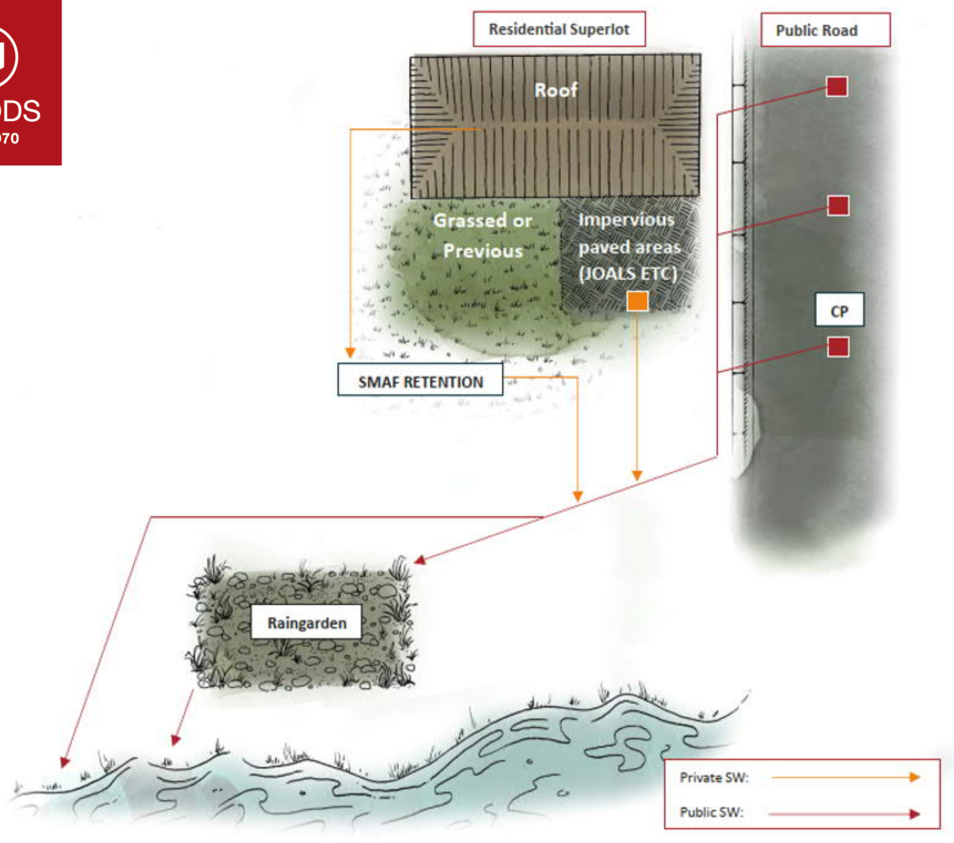


Figure 40: Stormwater Management Schematic

Table 10: Stormwater Management Summary

<table>
<tr><th rowspan="3"></th><th colspan="5">Stormwater Management</th><th rowspan="3">Sizing Criteria</th></tr>
<tr><th rowspan="2">Water Quality</th><th colspan="2">Hydrology Mitigation</th><th rowspan="2">Primary Conveyance</th><th rowspan="2">Secondary Conveyance</th></tr>
<tr><th>Retention</th><th>Detention</th></tr>
<tr><td>Building – Roof areas</td><td>Non-contaminant generating roofing materials
Reuse tanks – provides first flush treatment</td><td>Retention via re-use at source 5mm (limited to roof areas)</td><td>Detention via communal bioretention raingardens</td><td rowspan="2">Convey runoff generated from 10-year ARI (inclusive of 3.8 °C) rainfall events</td><td>FFL to be provided as per SWCOP</td><td>0.5m³/100m² (retention) of roof area to reuse tank, and 21.3m³/100m² (detention) of the roof area to communal raingarden
(minimum 5% of impervious area)</td></tr>
<tr><td>New Public Roads
Private JOALs/ hardstand, carparks, and other private impervious areas</td><td colspan="3">WQ and hydrology mitigation to be provided via
Communal bioretention raingardens</td><td>Convey OLFP from 100-year ARI (inclusive of 3.8 °C) within the road reserves and green spaces</td><td>0.5m³/100m² (retention) + 21.3 m³/100m² (detention) of the impervious area to communal raingarden
(minimum 5% of impervious area)</td></tr>
</table>

8.2.6.1. Attenuation Basins

If required, attenuation basins could be provided to ensure that any additional stormwater runoff associated with the proposed development is discharged to the receiving environment at a rate no greater than the pre-development scenario.

Flood modelling undertaken to date does not highlight a requirement for attenuation given that the flood effects are considered less than minor.

8.2.7. Development staging

The site is to be developed in multiple stages depending on the objective of the landowners. The development staging is to be assessed at detail design stage.

8.3. Hydraulic connectivity

The primary stormwater runoff is to be conveyed through the stormwater network. The conveyance of secondary stormwater runoff through road corridor and conveyance channels.

Hydraulic connectivity is to be addressed at Resource Consent

8.4. Asset ownership

The asset ownership is summarised in Table 11. The preferred stormwater strategy is to use large communal devices which are proposed to be located within reserves – these are to be vested to Auckland Council as the source of runoff will be both private and public (road) runoff.

Table 11: Asset Ownership

	Location	Ownership
Retention via reuse tanks	Private Lots	Lot Owner
Communal Raingardens	Reserves	Auckland Council

The location of these devices along with confirmation of the vesting Council/AT will be confirmed at the appropriate stage which is during the relevant consent/detailed design/EPA stage.

8.5. Ongoing maintenance requirements

Maintenance requirements is to be addressed at Resource Consent

Maintenance and operation manuals for the proposed stormwater management devices are to be provided to Auckland Council for approval as part of the resource consent application. Maintenance for private treatment devices will be the sole responsibility of future lot owners. The publicly vested stormwater infrastructures are expected to be maintained by Auckland Council. Other publicly vested treatment devices within roads and reserves are expected to be maintained by Auckland Transport.

The proposed stormwater management devices are to be maintained in accordance with the maintenance and operation manual.

8.6. Implementation of stormwater network

Stormwater network implementation is to be addressed at Resource Consent

8.7. Risks

The risks to the proposed stormwater management within the PPC area are outlined in Table 12. As the application progresses, it is expected this list will be further populated and updated.

Table 12: Risk assessment

What is the risk to the proposed stormwater management?	How can this be mitigated / managed?	What other management / mitigation could be used?	When does this risk need to be addressed?	What is the resultant level of risk?
Unknown soil infiltration rates	Design using minimum regional rate as set out in the AUP Chapter E10 of 2mm/hr	On-site testing	During the design/ Resource Consent phase and construction phases	Low
Ground stability issues affecting design of large communal devices	Further on-site testing	N/A	During design/ Resource Consent phase	Low – Devices can be relocated as needed.
Overland flow paths	Complete high-level assessment	Reassess during design phase	During design/ Resource Consent phase	Low
Floodplain	Complete high-level assessment	Reassess during design phase	During design/ Resource Consent phase	Low
Streams and watercourses on site are different to GeoMaps	Undertake site investigation and stream classification study		During the planning phase	Low
Communal Raingardens	Preliminary design	Reassess during design phase	During design/ Resource Consent phase	Low – Devices can be relocated as needed.
Stream Erosion	SMAF 1 hydrology mitigation	Erosion Study	During design/ Resource Consent phase	Low

9. Departures from regulatory or design codes

The stormwater management approach proposed for the PPC meets the minimum regulatory or design codes standards and is considered the BPO approach.

10. Conclusions

Woods has been engaged to prepare a stormwater manage plan and the submission of an application for a Private Plan Change (PPC) for the Wellsford Urban Zone to Residential. An integrated stormwater management approach is to be implemented across the PPC area. The objective of the SMP includes:

- Preserve, protect and enhance water bodies and natural wetlands.
- Eliminate and minimise the generation of contaminants.
- Provide 95th percentile, 24hr, hydrological mitigation.
- Ensure the flooding effects within, upstream and downstream of the PPC area are no more than minor.
- Consider the future effects of climate change and impacts of wider development including the surrounding FUZ areas.

The SMP has been prepared to meet the requirements of the regionwide NDC for a Greenfield site.

Flood modelling has been undertaken for the PPC and surrounding areas including a preliminary analysis of the culvert on State Highway 1. Flood modelling has been reviewed and accepted by Healthy Waters.

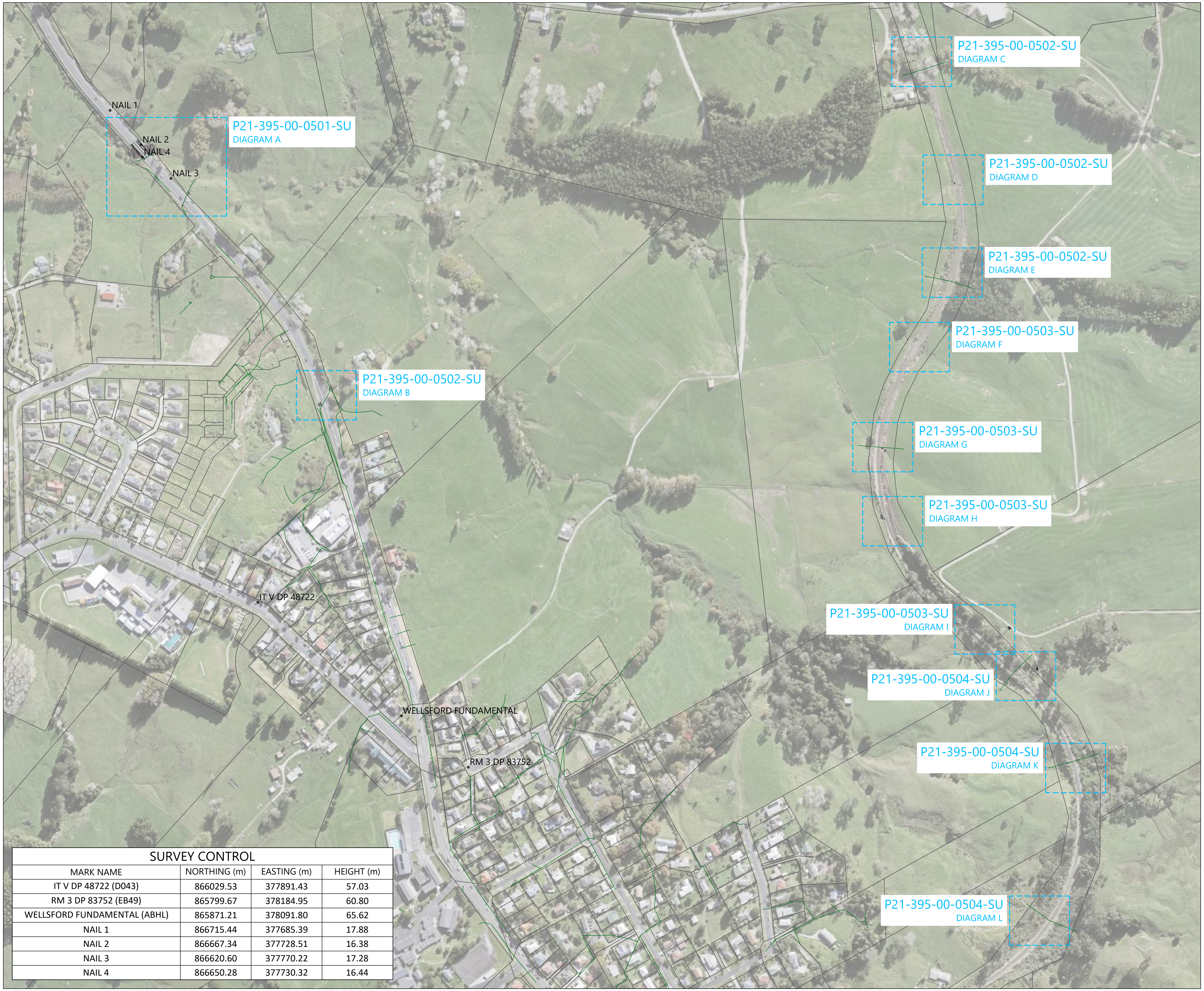
Model results and Water level difference plots indicate flooding is largely contained within existing water courses with flood extents to be similar between pre- and post- development scenarios. The flood depths for the existing and PPC modelled scenarios are generally consistent for the various storm events assessed, the risk profile remains predominantly unchanged with PPC and PC FUZ. This has been discussed with Waka Kotahi/NZTA and the flood risk is associated with the existing culvert being under capacity for larger storm events.

Given the existing risk profile and noting the risk profile remains unchanged with the PPC, it is recommended that Waka Kotahi NZTA undertake required upgrade to the existing culverts under the state highway to mitigate the flood risk and existing hazard.

Overall, our assessment has concluded that the potential effects on stormwater anticipated by the PPC are less than minor and will be appropriately mitigated.

Appendix A

Surveyed Infrastructure



SURVEY CONTROL

MARK NAME	NORTHING (m)	EASTING (m)	HEIGHT (m)
IT V DP 48722 (D043)	866029.53	377891.43	57.03
RM 3 DP 83752 (EB49)	865799.67	378184.95	60.80
WELLSFORD FUNDAMENTAL (ABHL)	865871.21	378091.80	65.62
NAIL 1	866715.44	377685.39	17.88
NAIL 2	866667.34	377728.51	16.38
NAIL 3	866620.60	377770.22	17.28
NAIL 4	866650.28	377730.32	16.44

WOODS
EST. 1970

Plot Date: 2:13:02 pm,2 May 2022, JESSS

LEGEND

XML BOUNDARY	TOP OF BANK
CULVERT INVERT (IL=10.00)	BOTTOM OF BANK
SPOT HEIGHT (10.00)	TOP OF WALL
CESSPIT	BOTTOM OF WALL
GIS STORMWATER (450 CONC)	WATERWAY CENTRELINE
MAJOR CONTOUR	ROAD CENTRELINE
MINOR CONTOUR	ROAD EDGE OF SEAL/METAL
FENCE	ROAD MARKING

NOTES

1. THE SURVEY IS IN TERMS OF GEODETIC DATUM 2000, MT EDEN CIRCUIT. THE ORIGIN OF COORDINATES "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 865871.21 mN 378091.80 mE
2. THE ORIGIN OF LEVELS IS IN TERMS OF THE AUCKLAND VERTICAL DATUM 1946, ORIGIN OF LEVEL "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 65.62 m RL
3. CONTOURS ARE SHOWN AT 0.20 m INTERVALS.
4. FOR EXISTING SUBJECT EASEMENTS, COVENANTS AND ENCUMBRANCES FOR THE PLAN AREA, PLEASE REFER TO THE CURRENT RECORDS OF TITLE.
5. EVERY EFFORT HAS BEEN MADE TO CORRECTLY IDENTIFY TREE TYPES SHOWN. HOWEVER, THESE MAY REQUIRE CONFIRMATION FROM A SUITABLY QUALIFIED PERSON IF CRITICAL.
6. AERIAL PHOTO SHOWN IN BACKGROUND AND INDICATIVE EXISTING STORMWATER SERVICES HAVE BEEN SOURCED FROM THE AUCKLAND COUNCIL GIS. SERVICE PIPES AND COVERS NOT LOCATED BY SURVEY, ARE APPROXIMATE ONLY AND WILL NEED TO BE CONFIRMED ON SITE.
7. CONTRACTOR IS TO LOCATE AND PROTECT ALL EXISTING SERVICES PRIOR TO COMMENCING ANY WORKS. NO EXCAVATION OF ANY KIND IS TO TAKE PLACE WITHOUT PERMISSION FROM THE RELEVANT SERVICE PROVIDER.

DISCLAIMER:
THIS CAD DRAWING IS INTENDED TO BE SOLELY USED AS THE BASE DATA FOR THE PURPOSES OF THE CLIENT. WOODS ACCEPT NO RESPONSIBILITY FOR ANY SUBSEQUENT CHANGES MADE TO THIS DRAWING FILE, THAT ARE DIFFERENT TO THOSE ATTACHED IN THE PDF FORMATTED VERSION SHOWN IN OUR ELECTRONIC CORRESPONDENCE.

SCALEBAR (m) 0 50 100 250
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REVISION DETAILS		BY	DATE
1	ISSUED FOR INFORMATION	JS	02/05/22

SURVEYED	DN	WELLSFORD AUCKLAND NEW ZEALAND
DESIGNED		
DRAWN	JS	
CHECKED	RH	
APPROVED	RH	WOODS.CO.NZ

N

WELLSFORD NORTH PLAN CHANGE

CULVERT TOPOGRAPHIC SURVEY

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5000 @ A3	1
COUNCIL	AUCKLAND COUNCIL	
DWG NO	P21-395-00-0500-SU	

File: C:\12DSYNERGY\DATA\WP-PEN-APP-01\P21-395 - WELLSFORD NORTH PLAN CHANGE_10865\CAD\SURV\P21-395-00-0500-SU_CULVERT TOPOGRAPHIC SURVEY.DWG

DIAGRAM A

WOODS
EST.1970

LEGEND

XML BOUNDARY		TOP OF BANK	
CULVERT INVERT	IL=10.00	BOTTOM OF BANK	
SPOT HEIGHT	10.00	TOP OF WALL	
CESSPIT		BOTTOM OF WALL	
GIS STORMWATER	450 CONC	WATERWAY CENTRELINE	
MAJOR CONTOUR		ROAD CENTRELINE	
MINOR CONTOUR		ROAD EDGE OF SEAL/METAL	
FENCE		ROAD MARKING	

NOTES

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2. THE ORIGIN OF LEVELS IS IN TERMS OF THE AUCKLAND VERTICAL DATUM 1946, ORIGIN OF LEVEL "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 65.62 m RL
3. CONTOURS ARE SHOWN AT 0.20 m INTERVALS.
4. FOR EXISTING SUBJECT EASEMENTS, COVENANTS AND ENCUMBRANCES FOR THE PLAN AREA, PLEASE REFER TO THE CURRENT RECORDS OF TITLE.
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7. CONTRACTOR IS TO LOCATE AND PROTECT ALL EXISTING SERVICES PRIOR TO COMMENCING ANY WORKS. NO EXCAVATION OF ANY KIND IS TO TAKE PLACE WITHOUT PERMISSION FROM THE RELEVANT SERVICE PROVIDER.

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REVISION DETAILS		BY	DATE
1	ISSUED FOR INFORMATION	JS	02/05/22

SURVEYED	DN	WELLSFORD AUCKLAND NEW ZEALAND
DESIGNED		
DRAWN	JS	
CHECKED	RH	
APPROVED	RH	WOODS.CO.NZ

N

WELLSFORD NORTH PLAN CHANGE

CULVERT TOPOGRAPHIC SURVEY

STATUS	ISSUED FOR INFORMATION	REV
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DWG NO	P21-395-00-0501-SU	

Plot Date: 2:13:03 pm,2 May 2022, JESSS

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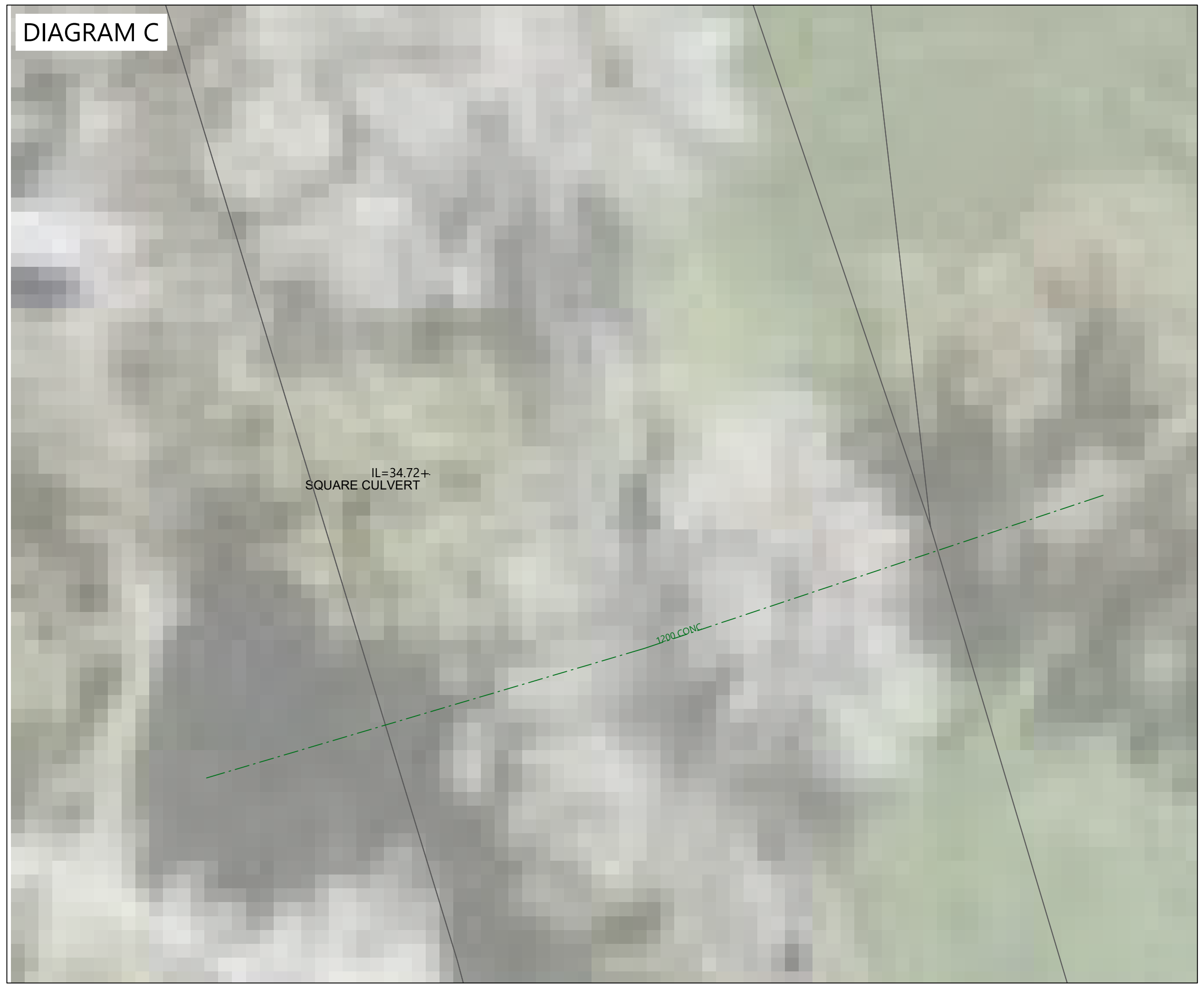

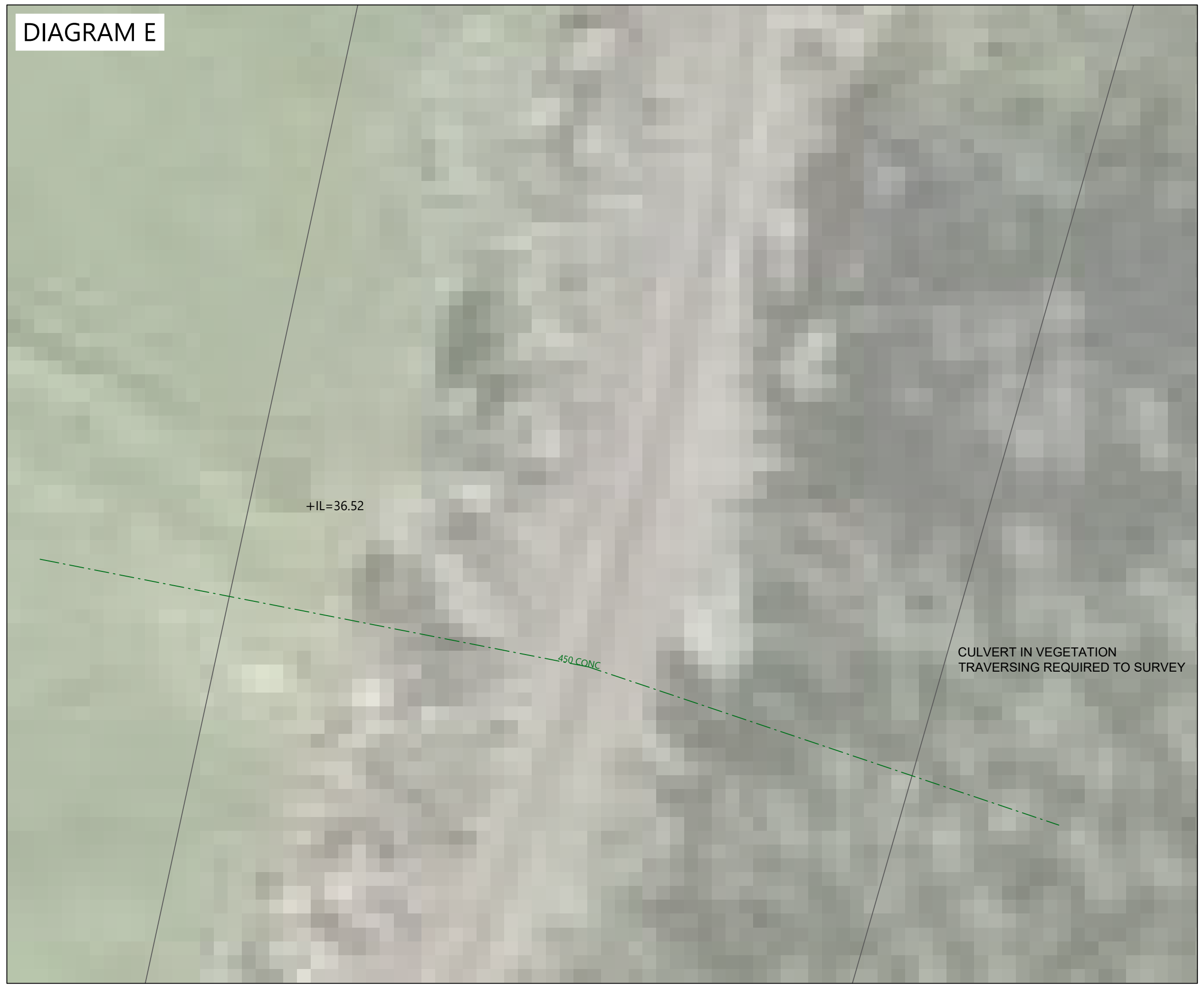

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LEGEND

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MAJOR CONTOUR		ROAD CENTRELINE	
MINOR CONTOUR		ROAD EDGE OF SEAL/METAL	
FENCE		ROAD MARKING	

NOTES

1. THE SURVEY IS IN TERMS OF GEODETIC DATUM 2000, MT EDEN CIRCUIT. THE ORIGIN OF COORDINATES "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 865871.21 mN 378091.80 mE
2. THE ORIGIN OF LEVELS IS IN TERMS OF THE AUCKLAND VERTICAL DATUM 1946, ORIGIN OF LEVEL "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 65.62 m RL
3. CONTOURS ARE SHOWN AT 0.20 m INTERVALS.
4. FOR EXISTING SUBJECT EASEMENTS, COVENANTS AND ENCUMBRANCES FOR THE PLAN AREA, PLEASE REFER TO THE CURRENT RECORDS OF TITLE.
5. EVERY EFFORT HAS BEEN MADE TO CORRECTLY IDENTIFY TREE TYPES SHOWN. HOWEVER, THESE MAY REQUIRE CONFIRMATION FROM A SUITABLY QUALIFIED PERSON IF CRITICAL.
6. AERIAL PHOTO SHOWN IN BACKGROUND AND INDICATIVE EXISTING STORMWATER SERVICES HAVE BEEN SOURCED FROM THE AUCKLAND COUNCIL GIS. SERVICE PIPES AND COVERS NOT LOCATED BY SURVEY, ARE APPROXIMATE ONLY AND WILL NEED TO BE CONFIRMED ON SITE.
7. CONTRACTOR IS TO LOCATE AND PROTECT ALL EXISTING SERVICES PRIOR TO COMMENCING ANY WORKS. NO EXCAVATION OF ANY KIND IS TO TAKE PLACE WITHOUT PERMISSION FROM THE RELEVANT SERVICE PROVIDER.

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REVISION DETAILS		BY	DATE
1	ISSUED FOR INFORMATION	JS	02/05/22

SURVEYED	DN	WELLSFORD AUCKLAND NEW ZEALAND
DESIGNED		
DRAWN	JS	
CHECKED	RH	
APPROVED	RH	WOODS.CO.NZ

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WELLSFORD NORTH PLAN CHANGE

CULVERT TOPOGRAPHIC SURVEY

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:500 @ A3	1
COUNCIL	AUCKLAND COUNCIL	
DWG NO	P21-395-00-0502-SU	

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Plot Date: 2:13:05 pm,2 May 2022, JESSS

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GIS STORMWATER	450 CONC	WATERWAY CENTRELINE	
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DISCLAIMER:
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REVISION DETAILS		BY	DATE
1	ISSUED FOR INFORMATION	JS	02/05/22

SURVEYED	DN	WELLSFORD AUCKLAND NEW ZEALAND
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WELLSFORD NORTH PLAN CHANGE

CULVERT TOPOGRAPHIC SURVEY

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:500 @ A3	1
COUNCIL	AUCKLAND COUNCIL	
DWG NO	P21-395-00-0503-SU	

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DIAGRAM J

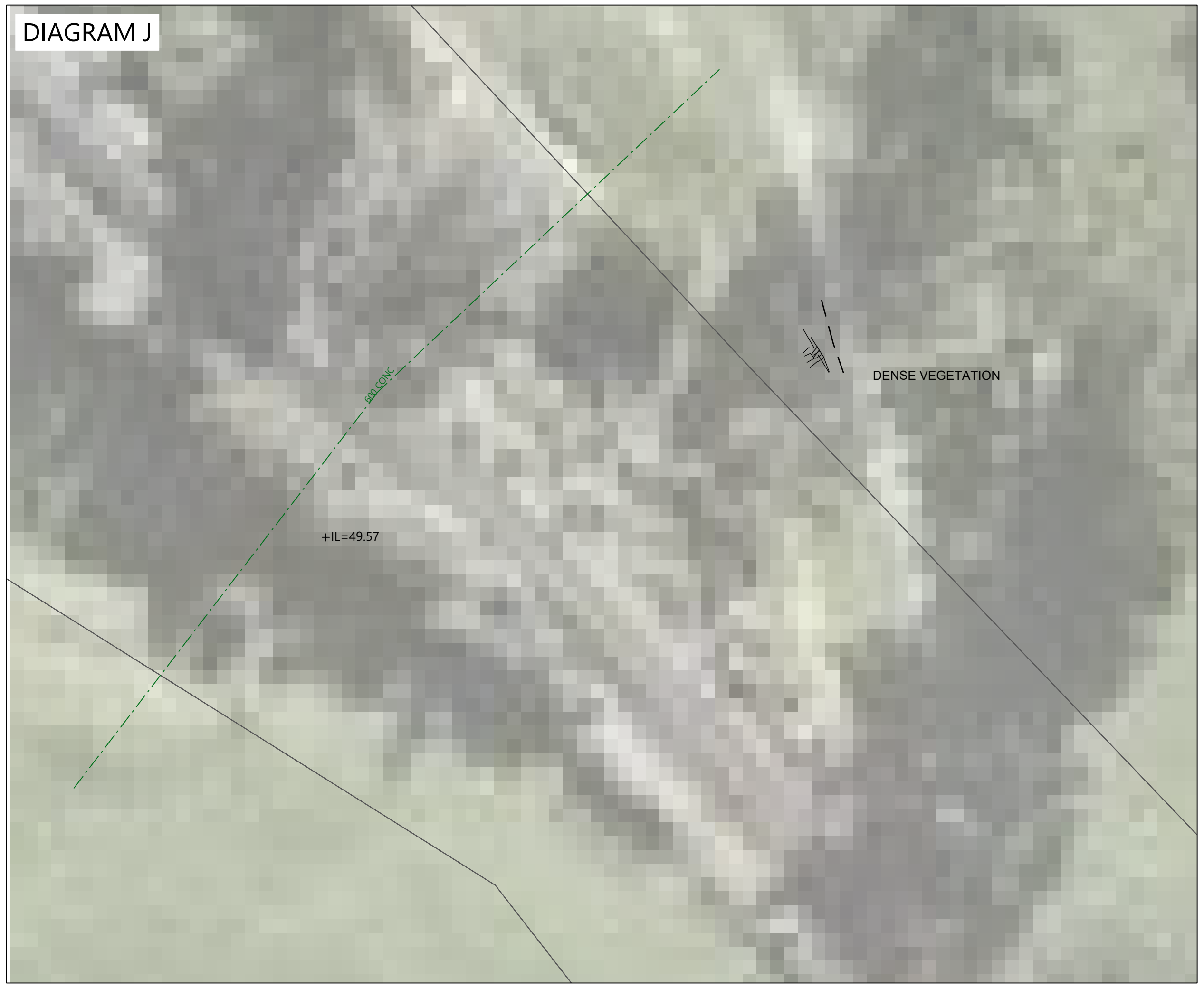

DIAGRAM K

DIAGRAM L

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1	ISSUED FOR INFORMATION	JS	02/05/22

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WELLSFORD NORTH PLAN CHANGE

CULVERT TOPOGRAPHIC SURVEY

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:500 @ A3	1
COUNCIL	AUCKLAND COUNCIL	
DWG NO	P21-395-00-0504-SU	

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Appendix B

Response to Healthy Water RFIs

To

Barker & Associates Ltd

From

Woods
Tony Wang – 3 Waters Engineer

W-REF: P21-395
28 April 2023
Reviewer: Pranil Waden – Three Waters Manager

Memorandum

Response to Request for Further Information

This memo has been prepared in response to Auckland Council's request for further information (dated 12 April 2023).

For ease of reference, Council's requests have been included *below*

1. Item H4

H4 not addressed. Model results over the SH1 over 2000mmøx2 culvert should include scenarios that does not include climate change factors as requested previously. i.e. modelling results to be presented for scenarios ED 2YR, 10YR, 100YR ARI no CC, ED+PPC 2YR, 10YR, 100YR ARI no CC.

- The no climate change (CC) scenarios for 10yr and 100yr ARI rainfall events were simulated.
- The model results for ED 10yr, 100yr, ED+PPC 10yr, and 100yr ARI rainfall events with no CC scenarios are included in Appendix D of the SMP Rev 2.
- The climate change scenarios listed in the response have been provided.
- Water level difference maps were created to compare the effects of a 2yr ARI rainfall event with CC for SH1. The results of the comparison showed that there were very small or insignificant differences between the scenarios that were modelled. As a result, the 2-year ARI rainfall events without CC scenarios were not simulated, as the differences between pre and post development without climate change is expected to be similar to those with CC.
- Given the SMP is a live document, the model results for the 2yr with no CC will be provided in the revised SMP during the development/assessment process.

2. Item H5

How does the SMP demonstrate AUP E1 – integrated stormwater management approach?

The SMP outlines how the development will manage stormwater runoff in a sustainable and integrated manner, demonstrating compliance with AUP E1 - the integrated stormwater management approach.

To meet the requirements of AUP E1, the SMP demonstrates the following:

Site analysis and design: The SMP describes the necessary measures to manage stormwater runoff effectively. This includes identifying suitable stormwater management devices that could be used to meet the Regionwide NDC.

Runoff reduction: The SMP outlines how the development plans to reduce the amount of stormwater leaving the site. The plan proposes hydrology mitigation for the entire plan change area, which will require the use of bioretention devices like tree pits, bioretention swales, and rain gardens. These measures are discussed in sections 8.2.2 and 8.2.7 of the SMP.

Water quality: The SMP outlines measures to prevent pollution from entering the stormwater system, including the use of low-impact treatment devices outlined in GD01/TP10 level of treatment for all impervious areas such as roads, JOAL, and driveways. The plan also emphasizes reducing contaminants at the source by using inert material that does not leach contaminants like copper and zinc. These measures are discussed in sections 8.2.1 and 8.2.7 of the SMP.

By incorporating these elements into the SMP, the development demonstrates its commitment to complying with AUP E1's integrated stormwater management approach.

3. Item H6

How is the toolbox intended to be implemented?

The toolbox presents a range of stormwater management devices and interventions that future lot owners can adopt to meet the objectives and requirements outlined in the SMP/NDC. This provides developers with flexibility and options to comply with the NDC requirements set out in the SMP during the development and consenting phases, please refer to proposed Standard IX.6.4.1(a), (b) and (c).

Regarding public roads, section 8.2.3 of the SMP indicates that at-source devices may not be feasible due to landform. In this case, communal devices along the stream corridor can be used instead.

A BPO assessment can help identify the preferred stormwater management approaches/devices to be implemented by future lot owners. Since the SMP is a dynamic document, the SMP can be updated and refined throughout the development and assessment process to reflect any changes.

4. Item H7

What assets wish to be vested to Council/AT need input now rather than later

Given this response is from Healthy Waters our response is with regards to Stormwater infrastructure. Stormwater assets located within the public road will be vested to AT, and stormwater assets located within the reserve will be vested to the Council. The ownership of the stormwater assets will also be determined by the source of the runoff (private vs public) i.e. communal devices that receive both private and public (road runoff) will be vested to council.

The SMP has been prepared with the intention that communal devices will be used for the treatment of stormwater runoff from the road network, this is consistent with AT's desire to avoid having large numbers of small frequent devices from the road corridor.

The location of these devices along with confirmation of the vesting Council/AT will be confirmed at the appropriate stage which is during the relevant consent/detailed design/EPA stage.

It is further noted that the SMP is a dynamic document that can be refined through the development process.

5. Item H8

There is a layout plan proposed along with the SMP, Stormwater management approach need to be designed based on the plan

The proposed layout plan in the SMP provides a conceptual design, and the stormwater management approach will be designed based on this plan. However, the specific location of communal devices will be confirmed during the detailed consent, detailed design, and EPA stage.

As the SMP is a living document, it will be refined and updated as additional details of the development plan become available. This will include more information on how stormwater will be managed onsite and a high-level plan showing catchment and device sizing.

During the consent, detailed design, and EPA stage, the location of the proposed management devices will be confirmed to ensure they align with the approved plan. Therefore, while the proposed layout plan is a starting point for designing the stormwater management approach, the final details will be confirmed through the detailed design and consent process.

6. Item H9

Modelling/scenarios have been run, but no guidance provided on what each scenario is used for. This should be assessed as part of SMP.

The modelling/scenarios have been discussed in Table 7 of the SMP. The Table has been updated to provide further clarity.

Table 1: Model Scenarios

Scenario	Land use	Rainfall	Purpose	Comparison
Pre-development/ existing development - **ED**	Existing impervious coverage	2-, 10-100-year - 3.8°C	Create a base line scenario with 3.8 °C climate change factor. Understand existing deficiencies in infrastructure and effects i.e., SH1	Use as a comparative model to compare relevant post development PPC and PC FUZ scenarios
		2-,10-100-year - no CC	Create a base line scenario for no climate change Understand existing deficiencies in infrastructure and effects i.e., SH1	Use as a comparative model to compare relevant post development PPC and PC FUZ scenarios
Post-development - **PPC**	Private Plan Change (MPD coverage) + ED (Existing impervious coverage)	2-, 10-100-year - 3.8°C	Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC.	Understand and isolate effects as a result of development within the PPC area only by comparing against the relevant ED scenarios
		2-,10-100-year - no CC	Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC.	Understand and isolate effects as a result of development within the PPC area only by comparing against the relevant ED scenarios
Post-development – **PC FUZ**	Maximum probable development (MPD as per AUP: OiP) + Private Plan Change	2-, 10-100-year - 3.8°C	Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC and MPD coverages	Understand cumulative effects as a result of development within the PPC area and MPD coverages in other areas by comparing against the relevant ED scenarios

		2-, 10-100-year - no CC	Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC and MPD coverages	Understand cumulative effects as a result of development within the PPC area and MPD coverages in other areas by comparing against the relevant ED scenarios

7. Item H10

Assessment on the culvert performance should also be assessed as part of SMP for all the modelled scenarios to inform stormwater management approach, includes:

- *freeboard depth (Edge to Seal of WL)*
- *water level on SH1;*
- *depth over SH1;*
- *culvert surcharging frequency and duration of culvert surcharge with freeboard <500mm;*
- *depth increased in upstream flood level considering PPC.*

Figures showing the depth over SH1 are included in Appendix D of the SMP.

The water level difference maps are included in Appendix E of the SMP. The model results indicated that the SH1 culvert would be overtopped during the ED, PPC, PC FUZ 2yr 10yr, 100yr ARI rainfall events with CC scenarios. The effects on State Highway 1 have been discussed in Section 7.2.3 of SMP rev2.

Information related to the culvert, water level, surcharge state, and hazard has been assessed for all modelled rainfall events.

As noted previously the SMP is a dynamic document, this information can be tabulated in any future revised SMPs.

8. Item H11

Stormwater management with pass-forward approach need solid direction/agreement with NZTA/Waka Kotahi.

Consultation with NZTA is ongoing. NZTA can upgrade the culvert to reduce the existing risk.

Given that the hazard assessment undertaken shows that there is an existing risk at State Highway 1, which is not adversely affected by development. Attenuation on site is not considered as the BPO for the subject site.

If attenuation is deemed required, adequate land would be made available to accommodate this; it is however noted that this would be inefficient given the existing hazard and risk of this structure in its current state.

9. Item H12

Has stream erosion assessment been done? Required to identify erosion hot-spot and propose associated erosion protection/control to enhance the stream and remedy/mitigate erosion risk with the increased runoff volume

The Wellsford Private Plan Change is a greenfield development and the proposed approach for the development is to provide a minimum of Stormwater Management Area control – Flow 1 (SMAF 1) hydrological mitigation (detention and retention) for all impervious surfaces across the entire proposed plan change area.

This responds to Auckland Unitary Plan Operative in part (AUP OP) Policy E1.3.8 that requires minimising or mitigating changes in hydrology including loss of infiltration, to: minimise erosion and associated effects on stream health and values; maintain stream baseflows; and support groundwater recharge. This approach aligns to Auckland Councils Region-wide Network Discharge Consent and GD01.

The minimum hydrological mitigation requirements follow SMAF 1 in AUP OP Table E10.6.3.1.1 as follows:

- Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces where possible with limitations set out in Table E10.6.3.1.1.
- Detention of the 95th percentile event for the difference between the pre-development and post-development runoff volumes from a 95th percentile, 24-hour rainfall event minus the achieved retention volume.

This will assist in mitigating the peakiness result from development flows during frequent rainfall events.

The site investigation and walkover undertaken by the ecologist did not identify stream erosion, given the well-defined stream corridor and planting, with the exception to one area identified immediately downstream of the southern crossing. The ecologist (Viridis) and Stormwater engineers (Woods) recommend stream erosion mitigation measures for the Plan Change Areas as follows:

- Modification of hydrograph mitigated through stormwater retention/detention (SMAF 1 hydrological mitigation) measures which will slow flows.
- Removal of stock from the site and therefore avoiding active bank de-stabilisation through stock access and pugging.
- Incorporation of green spaces adjacent to stream networks to provide for planting of riparian margins to improve bank stability and reduce erosion potential.
- Incorporation of erosion and scour protection measures at all outfalls to minimise erosion at new structures.
- Targeted in-stream erosion protection measures may be required at the location identified immediately downstream of the southern crossing. The location of the area that is potentially at risk of in-stream erosion is shown in Figure 1 below.

Figure 1: Areas subject to the potential risk of erosion

TO:	Wellsford Welding Club Limited	Date:	27 April 2023
COPY TO:	Cosette Saville – Senior Planner, Barker & Associates	Document No:	10078-001-1
FROM:	Mark Delaney – Lead Ecologist, Viridis		

WELLSFORD NORTH PPC – CLAUSE 23 RFI ECOLOGY RESPONSE

Wellsford Welding Club Limited has lodged an application for a Private Plan Change (PPC) for an approximate 72 ha area adjacent to Rodney and Monowai Streets in Wellsford ('the site'). As a part of the PPC application an Ecological Impact Assessment report[1] and a Stormwater Management Plan[2] were prepared for the site. Following a review of the application material, Auckland Council requested additional information under Clause 23 of the Resource Management Act 1991.

This memorandum is in response to a further information request pertaining to the "Healthy Waters" section of the Auckland Council Clause 23 request provided by Barkers & Associates. For ease of reference, the relevant request is reproduced in green below.

H12 Has stream erosion assessment been done? Required to identify erosion hot-spot and propose associated erosion protection/control to enhance the stream and remedy/mitigate erosion risk with the increased runoff volume

The author undertook site assessments on several occasions between 2017 and 2022, the most recent on 7 September 2022. During the site assessments the length of all watercourses within the site were walked. Only one area, with evidence of unnatural or excessive erosion and scouring, was identified within the site (Figure 1). This erosion "hot-spot" was associated with the outlet of an undersized culvert under a farm crossing (Figure 3). The erosion was localised to the immediate area downstream of the culvert outlet, with no evidence of unnatural or excessive erosion and scouring upstream of the culvert and beyond about 15 m downstream of the culvert (Figure 3).

In regard to the erosion hot-spot, the project stormwater engineers (Woods) as well as ourselves recommend the following stream erosion mitigation measures for the PPC site:

- Implementing stormwater retention/detention (SMAF 1 hydrological mitigation) measures that will reduce stream flows, and therefore the potential for erosion.
- Removing stock from site will reduce active bank de-stabilisation through stock access and pugging.
- Incorporating green spaces adjacent to stream networks to provide for planting of riparian margins to improve bank stability and reduce erosion potential.
- Incorporating erosion and scour protection measures at all outfalls to minimise erosion.
- Targeted in-stream erosion protection measures may be required at the location identified immediately downstream of the identified culvert that has exhibited excessive erosion (Figure 1).

We trust the above information answers the relevant query. Feel free to contact the author for any further requests or enquiries.

---

[1] Bioresearches 2022. Wellsford North: Ecological Impact Assessment
[2] Woods 2023. Stormwater Management Plan V2

Figure 1. Area showing evidence of erosion and scouring within the site (red circle).

Figure 2. Culvert outlet and adjacent scouring (left) and excessive erosion downstream (right).

Figure 3. Upstream of culvert (left) and between 20 m and 50 m downstream of culvert (right).

HW Second cl23 Request	Woods Second cl23 Response	Satisfied/Not Satisfied	Outstanding Matters/Information Required	Woods response – 30/05/2023
1. Item H4 *H4 not addressed. Model results over the SH1 over 2000mmøx2 culvert should include scenarios that does not include climate change factors as requested previously. i.e., modelling results to be presented for scenarios ED 2YR, 10YR, 100YR ARI no CC, ED+PPC 2YR, 10YR, 100YR ARI no CC.*	▪ The no climate change (CC) scenarios for 10yr and 100yr ARI rainfall events were simulated. ▪ The model results for ED 10yr, 100yr, ED+PPC 10yr, and 100yr ARI rainfall events with no CC scenarios are included in Appendix D of the SMP Rev 2. ▪ The climate change scenarios listed in the response have been provided. ▪ Water level difference maps were created to compare the effects of a 2yr ARI rainfall event with CC for SH1. The results of the comparison showed that there were very small or insignificant differences between the scenarios that were modelled. As a result, the 2-year ARI rainfall events without CC scenarios were not simulated, as the differences between pre and post development without climate change is expected to be similar to those with CC. ▪ Given the SMP is a live document, the model results for the 2yr with no CC will be provided in the revised SMP during the development/assessment process.	Partially satisfied.	Although the 2-year event (including climate change) scenario has been modelled, the scenario for Existing Development and no climate change has not been run, because the applicant considers that these results would be similar to the climate change effects. This is not considered to be an appropriate response and will not allow for the impacts of development to be assessed. The culverts beneath SH1 represent the main drainage from the PCA and as such it is necessary to understand the impacts on the infrastructure to ensure there are no significant effects regarding the frequency, depth and duration of flooding of the State Highway during lesser design storms as well as higher return periods. Please undertake the 2-year existing development impervious model excluding climate change with and without the proposed PCA development to enable an assessment of the impacts to be considered.	The 2-year ED no CC and 2-year PC no CC events have been simulated. The simulations indicate no effects on SH1. These have been added to the updated SMP V4.
2. Item H5 *How does the SMP demonstrate AUP E1 – integrated stormwater management approach?*	The SMP outlines how the development will manage stormwater runoff in a sustainable and integrated manner, demonstrating compliance with AUP E1 - the integrated stormwater management approach. To meet the requirements of AUP E1, the SMP demonstrates the following: **Site analysis and design**: The SMP describes the necessary measures to manage stormwater runoff effectively. This includes identifying suitable stormwater management devices that could be used to meet the Regionwide NDC. **Runoff reduction**: The SMP outlines how the development plans to reduce the amount of stormwater leaving the site. The plan proposes hydrology mitigation for the entire plan change area, which will require the use of bioretention devices like tree pits, bioretention swales, and rain gardens. These measures are discussed in sections 8.2.2 and 8.2.7 of the SMP. **Water quality**: The SMP outlines measures to prevent pollution from entering the stormwater system, including the use of low-impact treatment devices outlined in GD01/TP10 level of treatment for all impervious areas such as roads, JOAL, and driveways. The plan also emphasizes reducing contaminants at the source by using inert material that does not leach contaminants like copper and zinc. These measures are discussed in sections 8.2.1 and 8.2.7 of the SMP.	Not satisfied – a toolbox approach is not appropriate at the plan change stage as none of the devices have been identified as being feasible.	Section 8.2 of the SMP should present the preferred stormwater management solution for the PCA. Currently the SMP provides a range of potential stormwater management options. Each of the options that are presented indicate that there are potential issues implementing them in the absence of site-specific information. Therefore, it is not possible for Healthy Waters to know if the impacts of development could be successfully mitigated. Table 10 of the SMP sets out the proposed Stormwater Management Toolbox, which sets out At-Source, Communal and End of Pipe options; however, there is no guidance provided on how this table could be implemented, or how devices could be selected. Table 10 of the SMP also provides an applicant's assessment on risk-based activities together with varying management options that could be applied. This is not in alignment with Schedule 2 or 4 of the NDC and will be incredibly difficult to implement by future users of the SMP. The applicant's response states that GD01/TP10 devices will treat all impervious areas such as roads, JOAL, and driveways; however, Table 10 simply says that catchpits with submerged outlets and GPTs or a Best Practicable Option (BPO) shall be used for water treatment. These devices are not stipulated in either GD01 or TP10 and there are no performance criteria associated with their application (e.g., 75% Total Suspended Solids removal) applied. As such it is not clear what stormwater management is to be provided. Table 10 appears to offer future users of the SMP the opportunity to define a BPO of an unqualified nature, so it is not clear what stormwater management will actually be provided, or what the effects will be on the receiving environment, For each surface selected by the applicant, there are water quality, hydrology mitigation, 10% and 1% AEP flood management. Each of these items appears to have different methods of management for at-source, communal and end of pipe solutions. As such it is not clear how an integrated stormwater management solution is to be achieved and instead when considering how this site will develop in stages, this will drive the proliferation of smaller devices that may be costly to maintain and operate for all future land users. Table 10 also promotes the use of proprietary devices, which is not supported in the Stormwater Code of Practice (**SWCoP**) particularly for greenfield development.	The preferred stormwater strategy and indicative conceptual sizing of large communal devices have been undertaken based on the draft masterplan, as shown in the Table 1 below. It is noted the locations and sizing are indicative only and will be subject to earthworks design and geotechnical considerations during subsequent resource consent processes. A indicative device location plan has been prepared and shown in Figure 1 below. Table 10 in the SMP have been simplified and conceptual sizing incorporated to the SMP.

	By incorporating these elements into the SMP, the development demonstrates its commitment to complying with AUP E1's integrated stormwater management approach.		It is required the SMP clearly set out the preferred stormwater management solution for the site, together with concept sizing to ensure that the device(s) can be incorporated into the proposed future urban layout. As it stands there is no clear guidance provided on any preferred option, no sizing provided, and no guidance on how the stormwater infrastructure could be implemented. In the absence of developing a proposed integrated stormwater management solution, it is not possible to assess stormwater discharge impacts on the receiving environment.	
3. Item H6 *How is the toolbox intended to be implemented?*	The toolbox presents a range of stormwater management devices and interventions that future lot owners can adopt to meet the objectives and requirements outlined in the SMP/NDC. This provides developers with flexibility and options to comply with the NDC requirements set out in the SMP during the development and consenting phases, please refer to proposed Standard IX.6.4.1(a), (b) and (c). Regarding public roads, section 8.2.3 of the SMP indicates that at-source devices may not be feasible due to landform. In this case, communal devices along the stream corridor can be used instead. A BPO assessment can help identify the preferred stormwater management approaches/devices to be implemented by future lot owners. Since the SMP is a dynamic document, the SMP can be updated and refined throughout the development and assessment process to reflect any changes.	Not satisfied – the toolbox has no guidance on how it could be successfully implemented, or that any of the devices will be feasible. In addition, the toolbox will promote smaller devices which may not be sustainable from a construction and ongoing maintenance perspective.	Refer to the notes above (re 2. Item H5) regarding the toolbox. Although the applicant notes that the SMP is providing flexibility for future developers, all this will do is drive a proliferation of small devices which may be costly to implement and maintain going forward. An individual developer is unlikely to fund the construction of a large device providing management for a wider area than their site, particularly where vacant lot subdivisions are created. In the instance of vacant lot subdivisions, the road network is usually constructed first and will require the necessary stormwater management to be constructed to facilitate this. It is during this phase that larger communal devices could easily be constructed at the wider plan change area scale that would otherwise be beyond the control of smaller developers, or superlot developers. Section 8.2.3 of the SMP does note that at-source management devices in the road corridor may not be viable; however, it also notes that communal devices may also not be viable due to ground stability. If these two assumptions are realised what will happen to stormwater management? There appears to be no assessment as to what a feasible stormwater management solution is. The BPO solution proposed does not meet the requirements of Schedule 2 or 4 of the NDC and as such cannot be adopted into the regionwide NDC. Although this adoption process falls outside of the RMA provisions regarding private plan change requests, is does provide a clear indicator that there has not been sufficient consideration of stormwater management to demonstrate that effects on the receiving environment of the proposed change in land use can be successfully mitigated,	Same response as above – SMP V4 has been updated to reflect.
4. Item H7 *What assets wish to be vested to Council/AT need input now rather than later.*	Given this response is from Healthy Waters our response is with regards to Stormwater infrastructure. Stormwater assets located within the public road will be vested to AT, and stormwater assets located within the reserve will be vested to the Council. The ownership of the stormwater assets will also be determined by the source of the runoff (private vs public) i.e., communal devices that receive both private and public (road runoff) will be vested to Council. The SMP has been prepared with the intention that communal devices will be used for the treatment of stormwater runoff from the road network, this is consistent with AT's desire to avoid having large numbers of small frequent devices from the road corridor. The location of these devices along with confirmation of the vesting Council/AT will be confirmed at the appropriate stage which is during the relevant consent/detailed design/EPA stage. It is further noted that the SMP is a dynamic document that can be refined through the development process.	Not satisfied.	There is nothing in the SMP to indicate what devices will be vested to Auckland Council, the number of devices, or whether these devices will meet Healthy & Safety or other design criteria. The applicant's response states that communal devices are to be used; however, this is not what is promoted by the toolbox (Table 10) which looks first to at-source management. Leaving device selection to future resource consent and EPA stages presents a high risk re the occurrence of adverse effects, and no ability to understand and assess the effects resulting from the proposed change in land use, as the SMP currently does not confirm that there is an appropriate stormwater management solution that can feasibly be implemented.	Same response as above – SMP V4 has been updated to reflect. The preferred stormwater strategy is to use large communal devices which are proposed to be located within reserves – these are to be vested to Auckland Council as the source of runoff will be both private and public (road) runoff. The location of these devices along with confirmation of the vesting Council/AT will be confirmed at the appropriate stage which is during the relevant consent/detailed design/EPA stage. SMP updated to reflect.

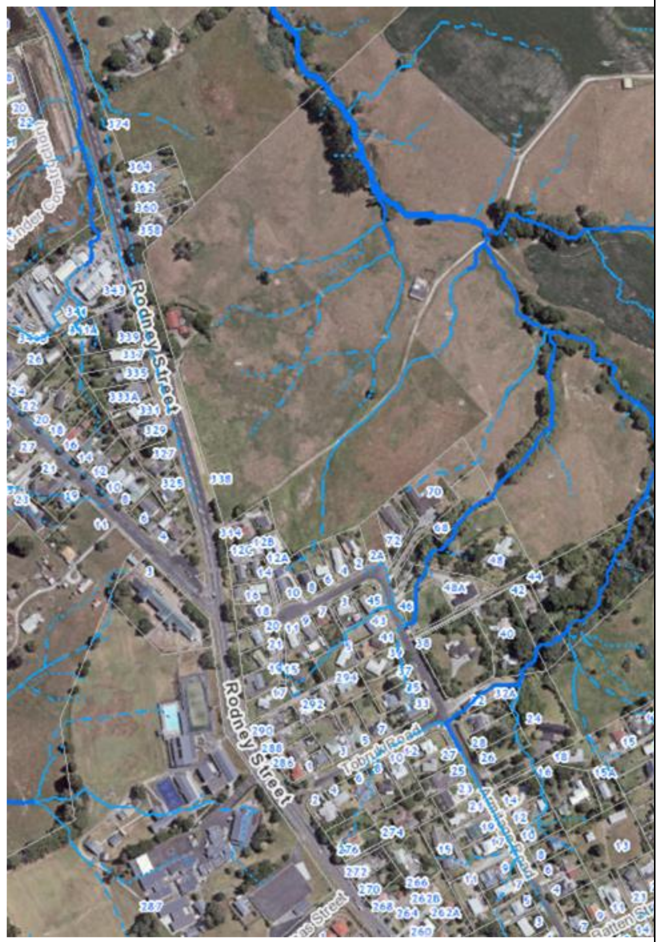
5. Item H8 *There is a layout plan proposed along with the SMP, the Stormwater management approach needs to be designed based on the plan.*	The proposed layout plan in the SMP provides a conceptual design, and the stormwater management approach will be designed based on this plan. However, the specific location of communal devices will be confirmed during the detailed consent, detailed design, and EPA stage. As the SMP is a living document, it will be refined and updated as additional details of the development plan become available. This will include more information on how stormwater will be managed onsite and a high-level plan showing catchment and device sizing. During the consent, detailed design, and EPA stage, the location of the proposed management devices will be confirmed to ensure they align with the approved plan. Therefore, while the proposed layout plan is a starting point for designing the stormwater management approach, the final details will be confirmed through the detailed design and consent process.	Not satisfied – The SMP ignores the proposed site layout and provides no data to confirm that stormwater can be appropriately managed, nor allows for the assessment of effects of the proposed stormwater discharge on the receiving environment.	The SMP is a living document; however, this is with regard to refining the stormwater management through the design process, not supporting complete redesign of stormwater management solutions at each design stage. This is a greenfield plan change and as such should have a feasible stormwater management solution identified that can be accommodated within the future proposed urban landuse. This has not been completed and therefore it is not possible to assess the potential impacts of stormwater discharges from the proposed future zoning/land uses on the receiving environment. The SMP needs to recommend a preferred stormwater management solution and provide sufficient design information to ensure the proposed stormwater management solution can be incorporated into the proposed urban zoning and provide adequate mitigation of effects. Neither of this information is provided in the SMP. As it currently stands, the SMP contains a toolbox of potential management options that are not demonstrated as being capable of implementation or appropriate management of stormwater runoff.	Same as above
6. Item H9 *Modelling/scenarios have been run, but no guidance provided on what each scenario is used for. This should be assessed as part of SMP.*	The modelling/scenarios have been discussed in Table 7 of the SMP. The Table has been updated to provide further clarity.	Not satisfied – It is not clear why every scenario within Table 7 is a baseline. How are the effects of development being assessed?	Table 7 of the SMP contains three primary scenarios considering Existing Development, Private Plan Change and Maximum Probable Development. Each of these scenarios has a then been considered for a range of design storm event with and without climate change effects. The purpose of each of these scenarios is stated as being a baseline with no guidance provided to state what is being looked at, or how the modelling is being used to assess the impacts of development downstream. It is not clear what scenarios are being used to assess the impacts of development, or why they are being used. For example, what scenario is used to establish the existing flood risks and what scenario looks at the potential impact of development that will be enabled by the plan change? The default scenario to be used appears to be the climate change scenario; however, it is not clear whether effects are driven from climate change, or land use changes. Table 7 does not identify how the proposed plan change impacts can be or have been identified or assessed.	Model scenario table has been updated to provide further clarity on what the base line scenario is and what is being used to assess effects as a result of the Plan Change, as shown in Table 2 below. SMP V4 has been updated to reflect.

Table 1: Model Scenarios

Scenario	Land use	Rainfall	Purpose	Comparison
Pre-development/ existing development - **ED**	Existing impervious coverage	2-, 10-100-year - 3.8°C	Create a base line scenario with 3.8 °C climate change factor. Understand existing deficiencies in infrastructure and effects i.e., SH1	Use as a comparative model to compare relevant post development PPC and PC FUZ scenarios
		2-,10-100-year - no CC	Create a base line scenario for no climate change Understand existing deficiencies in infrastructure and effects i.e., SH1	Use as a comparative model to compare relevant post development PPC and PC FUZ scenarios
Post-development - **PPC**	Private Plan Change (MPD coverage) + ED (Existing impervious coverage)	2-, 10-100-year - 3.8°C	Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC.	Understand and isolate effects as a result of development within the PPC area only by comparing against the relevant ED scenarios
		2-,10-100-year - no CC	Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC.	Understand and isolate effects as a result of development within the PPC area only by comparing against the relevant ED scenarios
Post-development - **PC FUZ**	Maximum probable development (MPD as per AUP: OiP) + Private Plan Change	2-, 10-100-year - 3.8°C	Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC and MPD coverages	Understand cumulative effects as a result of development within the PPC area and MPD coverages in other areas by comparing against the relevant ED scenarios

	2-, 10-100-year - no CC			
7. Item H10 *Assessment on the culvert performance should also be assessed as part of SMP for all the modelled scenarios to inform stormwater management approach, includes:* *▪ freeboard depth (Edge to Seal of WL)* *▪ water level on SH1* *▪ depth over SH1* *▪ culvert surcharging frequency and duration of culvert surcharge with freeboard <500mm* *▪ depth increased in upstream flood level considering PPC.*	Figures showing the depth over SH1 are included in Appendix D of the SMP. The water level difference maps are included in Appendix E of the SMP. The model results indicated that the SH1 culvert would be overtopped during the ED, PPC, PC FUZ 2yr 10yr, 100yr ARI rainfall events with CC scenarios. The effects on State Highway 1 have been discussed in Section 7.2.3 of SMP rev2. Information related to the culvert, water level, surcharge state, and hazard has been assessed for all modelled rainfall events. As noted previously the SMP is a dynamic document, this information can be tabulated in any future revised SMPs.	Partially satisfied – There appears to be no specific assessment of the State Highway culverts performance beyond the flood maps presented in Appendix D of the SMP.	The modelling result plans included in Appendix D of the SMP do not provide adequate information to allow an assessment to be undertaken of the impacts of development on the State Highway culverts. It is required that results should be tabulated including the original Healthy Waters request. This is not a difficult request to satisfy as the infrastructure has been surveyed as part of the plan change request. This information is required at the plan change stage so that the effects of land use change can be quantified and assessed. It will also inform the preferred stormwater management that is required to mitigate the impacts of stormwater discharge.	Information on culvert performance has been tabulated and included in the SMP V4.
8. Item H11 *Stormwater management with pass-forward approach need solid direction/agreement with NZTA/Waka Kotahi.*	Consultation with NZTA is ongoing. NZTA can upgrade the culvert to reduce the existing risk. Given that the hazard assessment undertaken shows that there is an existing risk at State Highway 1, which is not adversely affected by development. Attenuation on site is not considered as the BPO for the subject site. If attenuation is deemed required, adequate land would be made available to accommodate this; it is however noted that this would be inefficient given the existing hazard and risk of this structure in its current state.	Not satisfied – The SMP needs to provide a preferred method of stormwater management to mitigate the impacts of land use change. Delaying decisions until later and the consenting and EPA process may result in adverse outcomes for	Because there is an existing hazard associated with the State Highway 1 culverts, this does not mean that the proposed plan change can make it worse. It is not clear how consultation with Waka Kotahi can be ongoing when the current SMP does not contain the information requested above to inform and enable a decision to be made by Waka Kotahi or other stakeholders. The decision around attenuation needs to be made in the SMP, primarily because the only option for this type of management will be through large end of pipe attenuation basins. It is not clear in the SMP whether these basins could be incorporated into the proposed urban layout. The SMP does not allow for the potential impacts on downstream infrastructure to be assessed.	Further consultation with Waka Kotahi is yet to be scheduled. Additional information will be supplied to Waka Kotahi, and pass-forward (preferred) and attenuation approach will be discussed.

		road users and land owners downstream of the proposed PCA.		
9. Item H12 *Has stream erosion assessment been done? Required to identify erosion hot-spot and propose associated erosion protection/control to enhance the stream and remedy/mitigate erosion risk with the increased runoff volume.*	The Wellsford Private Plan Change is a greenfield development and the proposed approach for the development is to provide a minimum of Stormwater Management Area control – Flow 1 (SMAF 1) hydrological mitigation (detention and retention) for all impervious surfaces across the entire proposed plan change area. This responds to Auckland Unitary Plan Operative in part (AUP OP) Policy E1.3.8 that requires minimising or mitigating changes in hydrology including loss of infiltration, to: minimise erosion and associated effects on stream health and values; maintain stream baseflows; and support groundwater recharge. This approach aligns to Auckland Councils Region-wide Network Discharge Consent and GD01. The minimum hydrological mitigation requirements follow SMAF 1 in AUP OP Table E10.6.3.1.1 as follows: ▪ Retention (volume reduction) of at least 5mm of runoff depth from impervious surfaces where possible with limitations set out in Table E10.6.3.1.1. ▪ Detention of the 95th percentile event for the difference between the pre-development and post-development runoff volumes from a 95th percentile, 24-hour rainfall event minus the achieved retention volume. This will assist in mitigating the peakiness result from development flows during frequent rainfall events. The site investigation and walkover undertaken by the ecologist did not identify stream erosion, given the well-defined stream corridor and planting, with the exception to one area identified immediately downstream of the southern crossing. The ecologist (Viridis) and Stormwater engineers (Woods) recommend stream erosion mitigation measures for the Plan Change Areas as follows: ▪ Modification of hydrograph mitigated through stormwater retention/detention (SMAF 1 hydrological mitigation) measures which will slow flows. ▪ Removal of stock from the site and therefore avoiding active bank de-stabilisation through stock access and pugging. ▪ Incorporation of green spaces adjacent to stream networks to provide for planting of riparian margins to improve bank stability and reduce erosion potential.	Partially satisfied – The proposed application of SMAF 1 within the SMP is considered appropriate at the plan change stage; however, the SMP should recommend further erosion studies to inform future design to confirm that SMAF 1 is appropriate for long-term stream bank stability. Urbanisation is likely to result in numerous point discharges that are currently not present, and the concentration of these flows may result in stream bank erosion occurring.	Schedule 4 of the NDC states that for greenfield development a minimum of SMAF 1 equivalent hydrology mitigation is required. The applicant's response has confirmed that under the current runoff regime (i.e., sheet flow runoff into the watercourse) there is no erosion evident. Urbanisation will result in the creation of concentrated point loads that may cause erosion of the stream banks to occur. Although the consideration of SMAF 1 would normally be considered appropriate at the plan change scale, the SMP provides little information on pre- and post-development flows entering the watercourse and instead focuses on at-source volumes only. The SMP contains no information around potential outlets that could be installed and as such it is not possible to assess the potential effects of erosive flows from the development enabled by the plan change could be. The use of riparian margins and greenspaces adjacent to watercourses are generally only effective to mitigate erosion from overland flows. How will the pipe network and outlets be incorporated into the urban layout? If discharges are proposed to be into the base of the watercourse, then green spaces and riparian planting are unlikely to assist in the reduction of erosion risk that may eventuate from concentrated flows. In addition to setting out the preferred stormwater management for a development, the SMP should also identify further investigative works that are required in the later stages of design. One of these specifications should be to require the completion of an erosion study once the stormwater pipe network is conceptually designed to enable an assessment of whether SMAF 1 is appropriate, or whether a higher standard is required. The SMP does not currently confirm whether SMAF 1 will provide adequate erosion protection to the receiving watercourse or guidance to future users of the AUP as to what investigations are required to inform the design process. Leaving everything to the EPA stage could result in adverse outcomes.	The SMP to be updated to reflect that a erosion study to be completed once the stormwater pipe network is conceptually designed to enable an assessment of whether SMAF 1 is appropriate, or whether a higher standard is required

	▪ Incorporation of erosion and scour protection measures at all outfalls to minimise erosion at new structures. ▪ Targeted in-stream erosion protection measures may be required at the location identified immediately downstream of the southern crossing. The location of the area that is potentially at risk of in-stream erosion is shown in Figure 1 below.  Figure 1: Areas subject to the potential risk of erosion			

Appendix C

Stakeholder engagement – Minutes and presentations

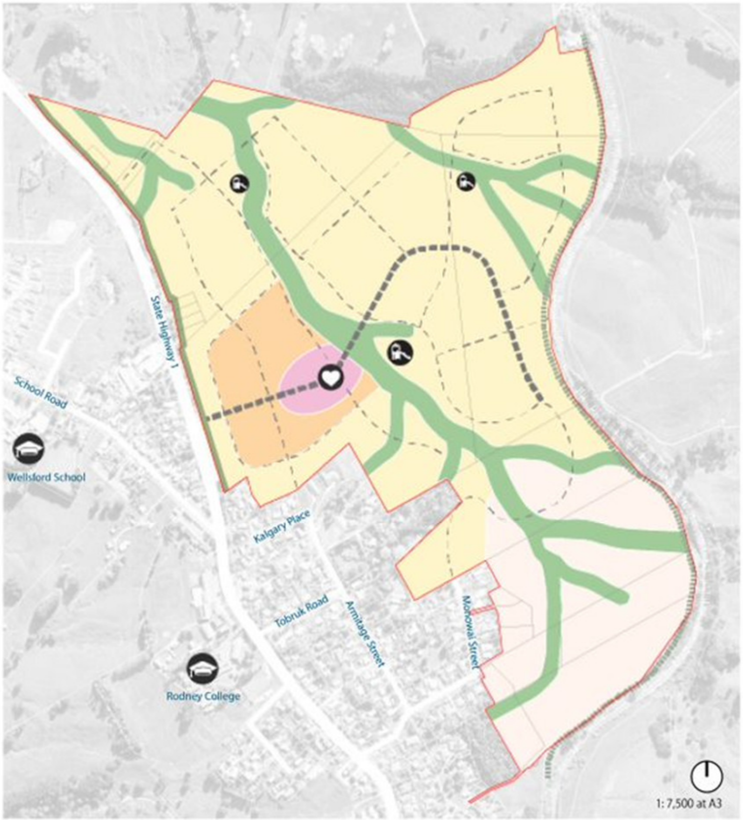
Wellsford Plan Change – Meeting with Healthy Waters 06/04/2022

WOODS
Est.1970

Agenda

- Proposed development
- Work undertaken to date:
  - Flood modelling
  - Stormwater management
  - Draft Stormwater Management Plan
- Other matters

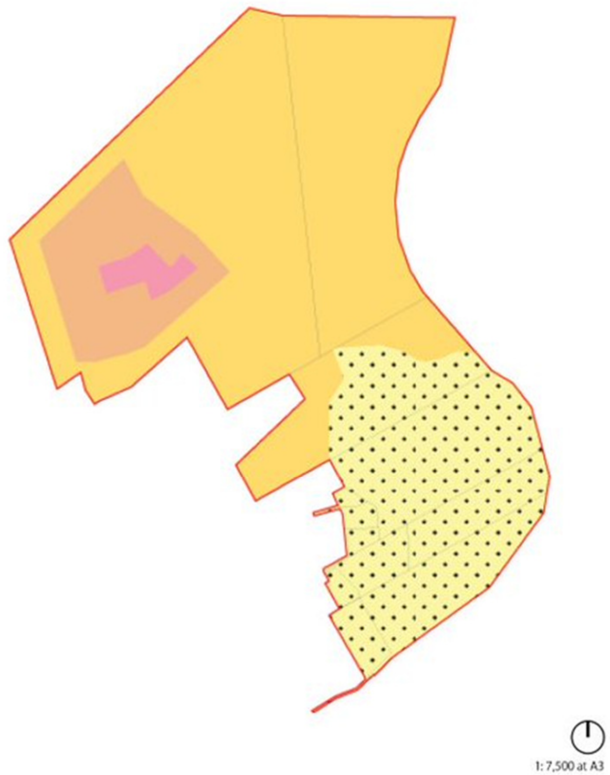
Proposed development



Structure Plan

Legend

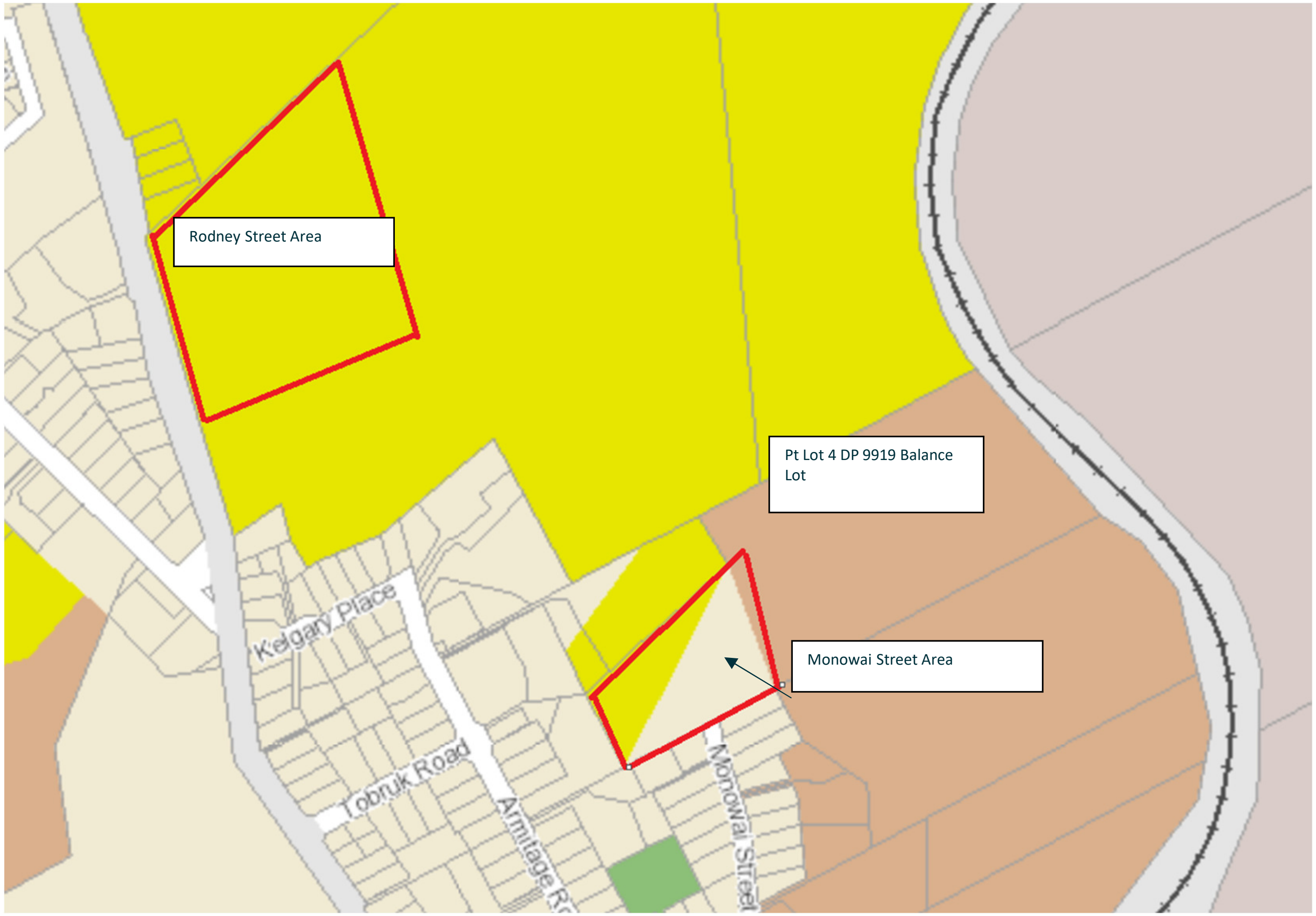
- Structure plan extent
- Property Boundary
- Indicative Lifestyle Living
- Indicative Lower Density Residential
- Indicative Medium Density Residential
- Indicative Village Centre
- Ecological Areas / Open Spaces
- Main Collector Road
- Local Streets
- Greenway Cycleway
- 10m Landscape Buffer
- Indicative Playground
- Indicative Village Centre Public Space
- Existing Schools



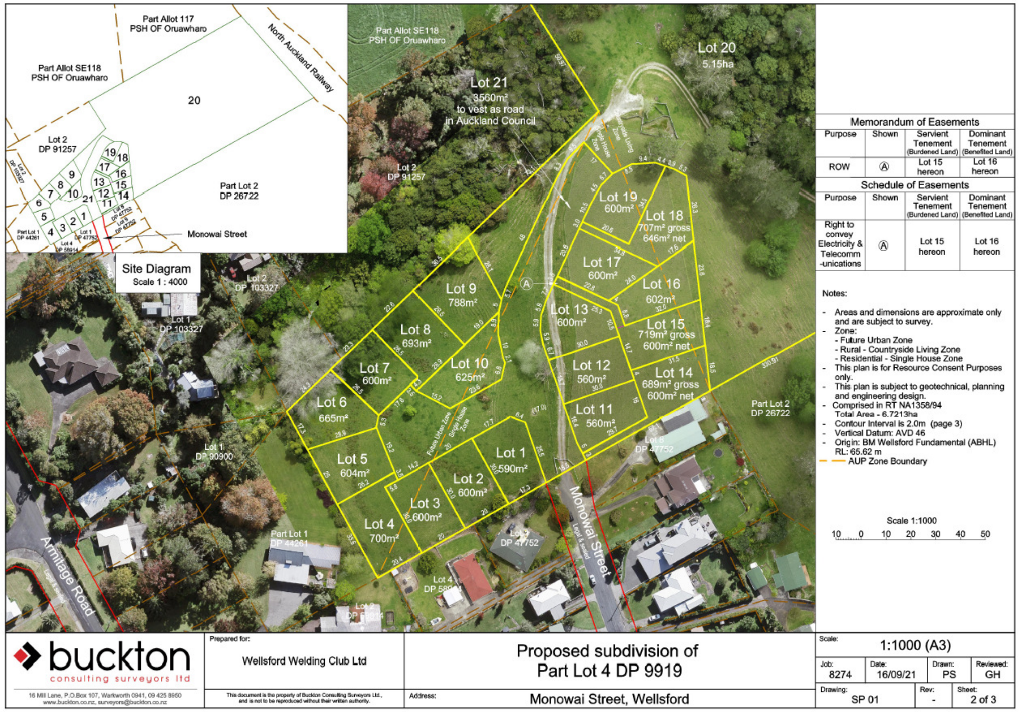
Legend

- Extent
- Existing Property Boundary
- Residential - Large Lot Zone
- Residential - Mixed Housing Suburban Zone
- Residential - Mixed Housing Urban Zone
- Business - Neighbourhood Centre Zone
- Subdivision Variation Control

Fast-Track consent application

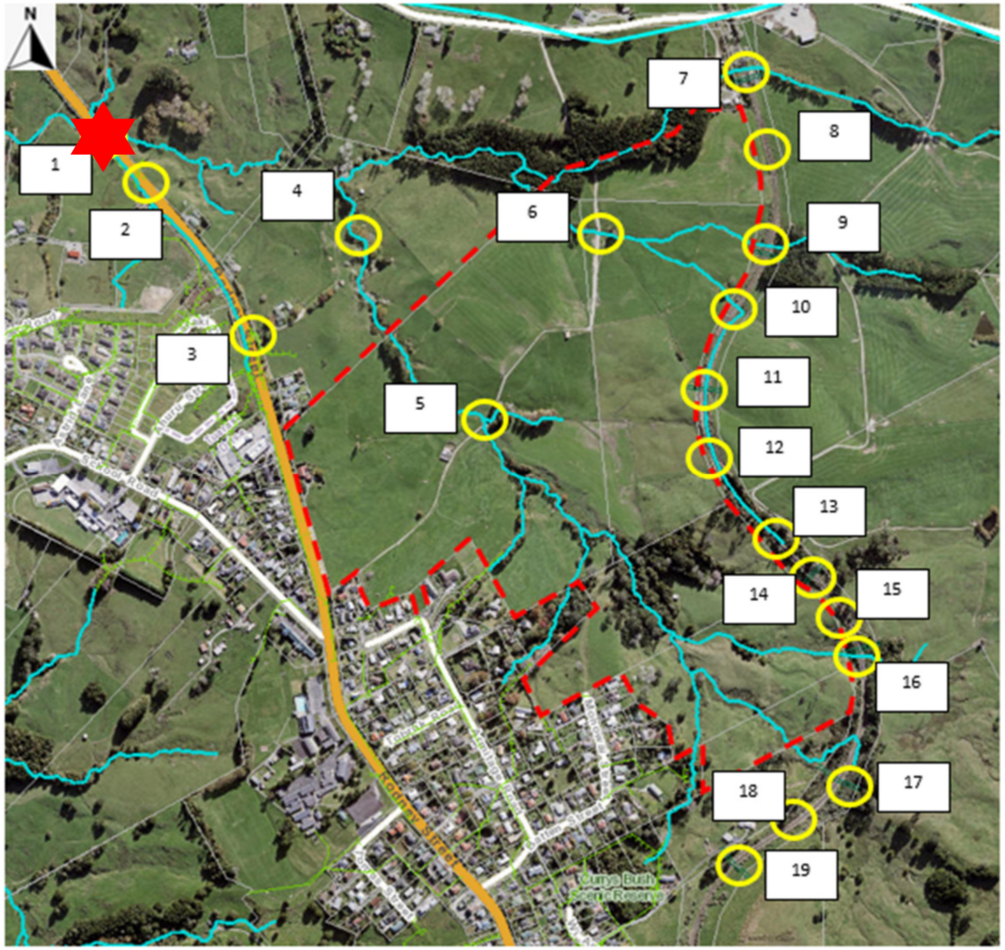


Fast-Track consent application

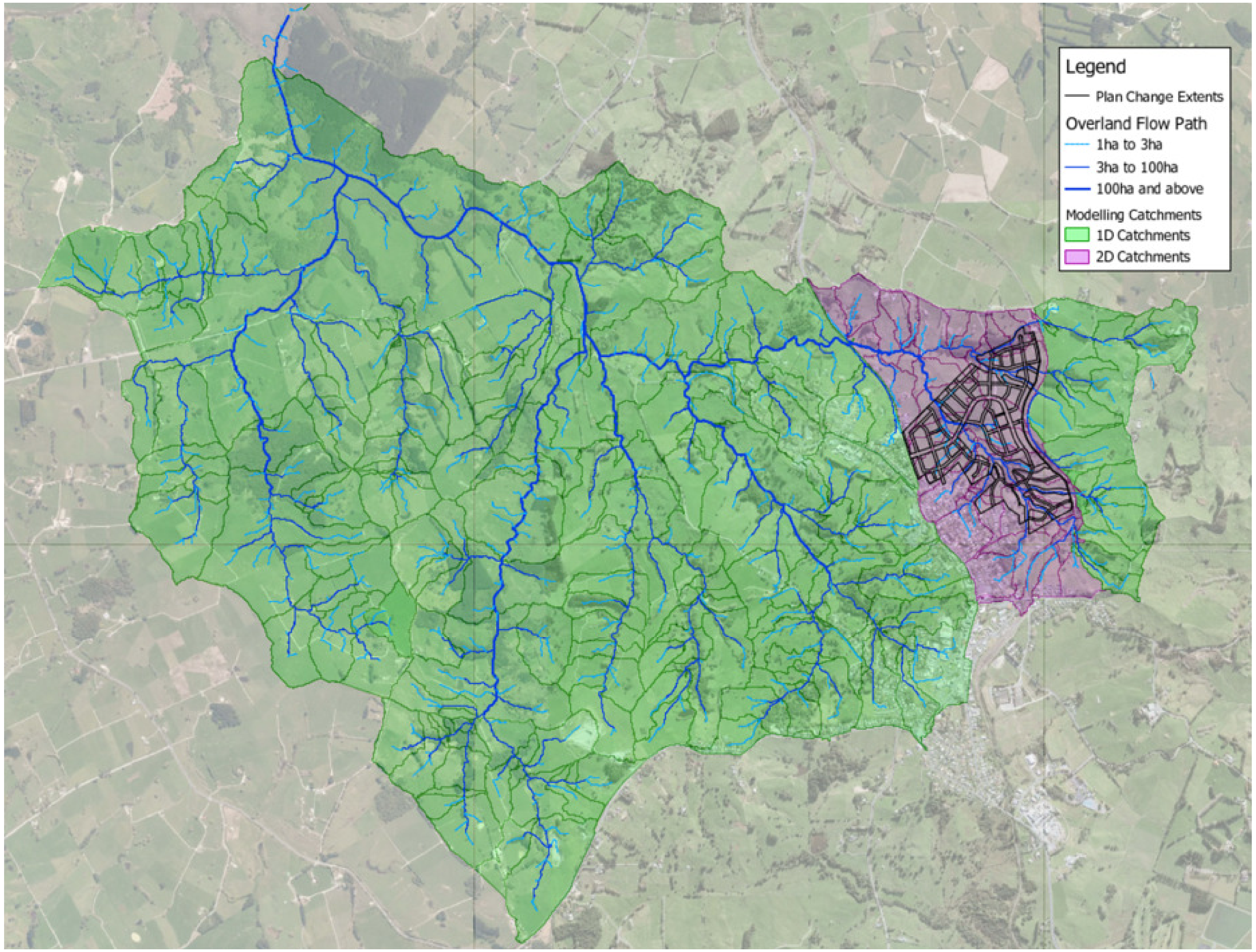


Key infrastructure

- Key infrastructure:
  - 1-3 – NZTA/ Auckland Council/ AT
  - 7-19 – KiwiRail
  - Survey undertaken for SH and Kiwirail culverts where accessible
- Council has no model information for this area
- Flood modelling was therefore undertaken by Woods to assess effects resulting from PPC



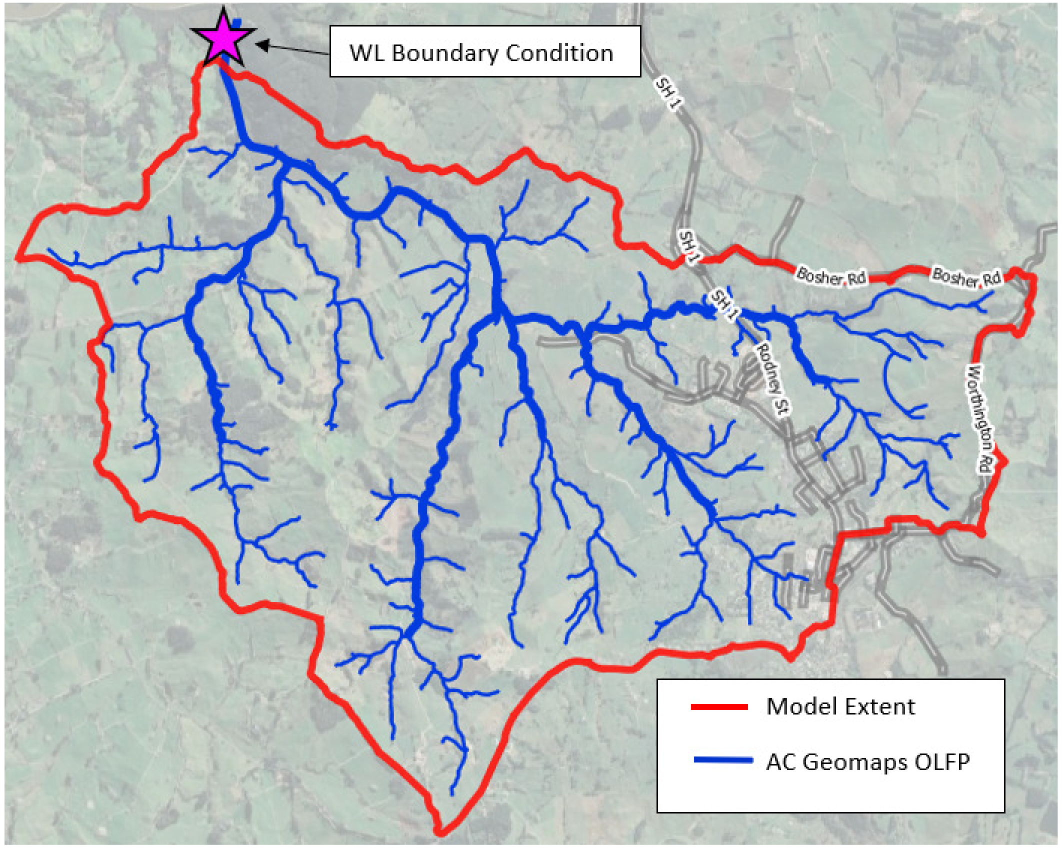
Flood modelling – Extent of model



Flood modelling – Boundary conditions and Rainfall depths

- Coastal tailwater boundary condition applied for all scenarios where Oruawharo River discharges to Kaipara Harbour at a constant water level of 3.3m based on MHWS 10%ile with 1m sea level rise consideration for climate change

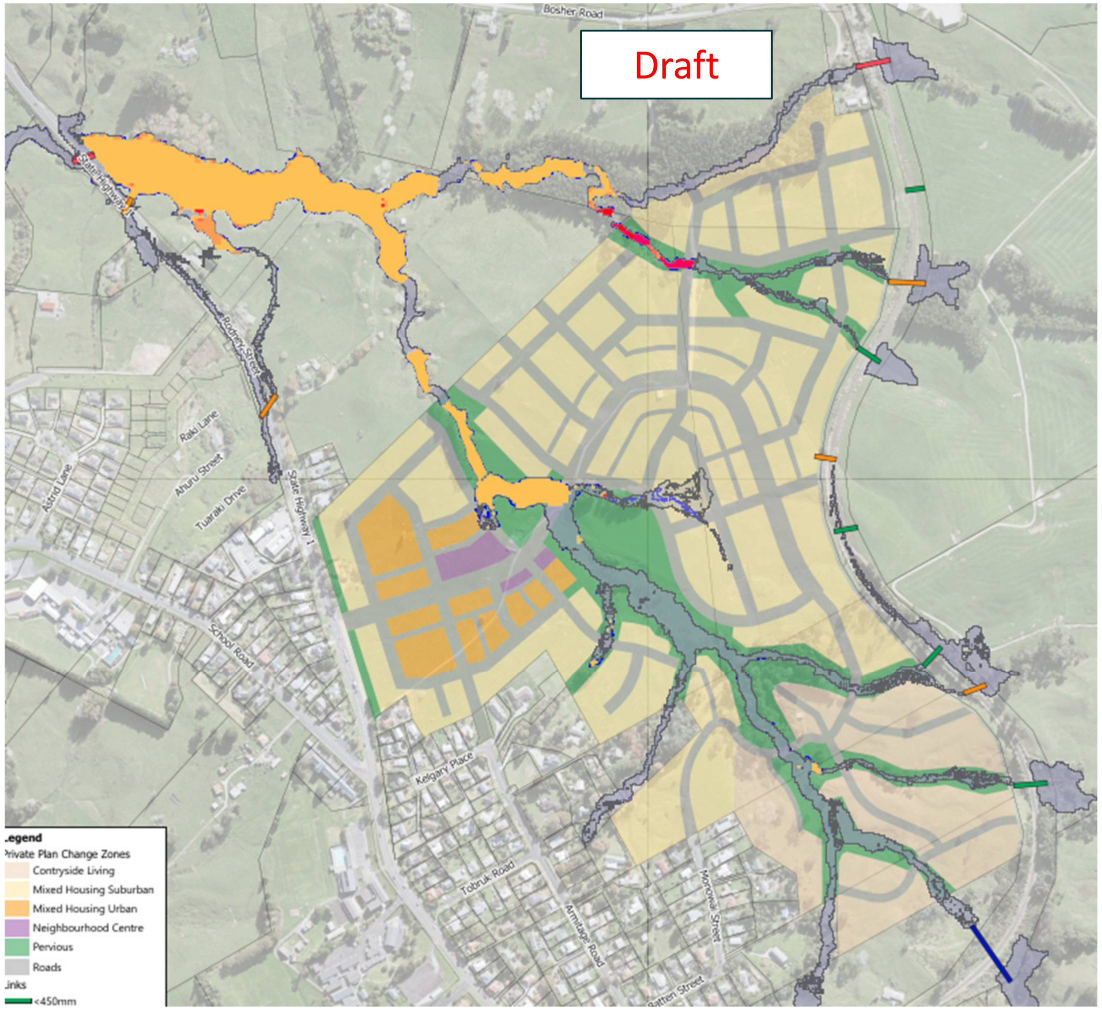
Storm Event	Rainfall Depth (mm)	Rainfall Depth including Climate Change - SWCoP V3 – 3.8^{0}C (mm)
2 year	95	121
10 year	170	222
100 year	260	345

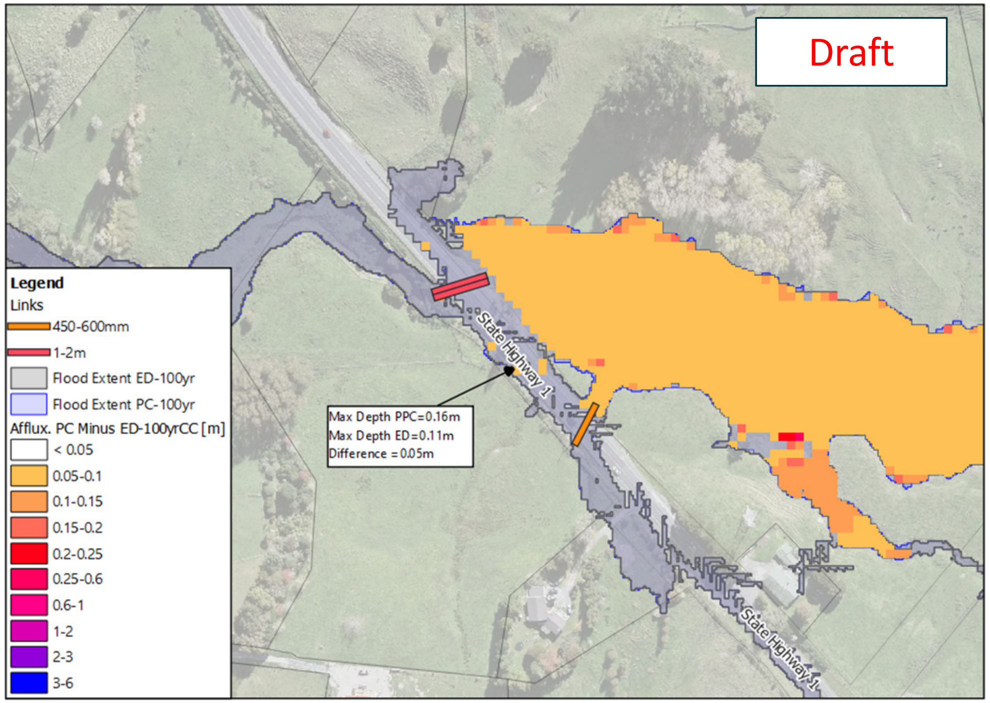


Flood modelling – Modelled scenarios

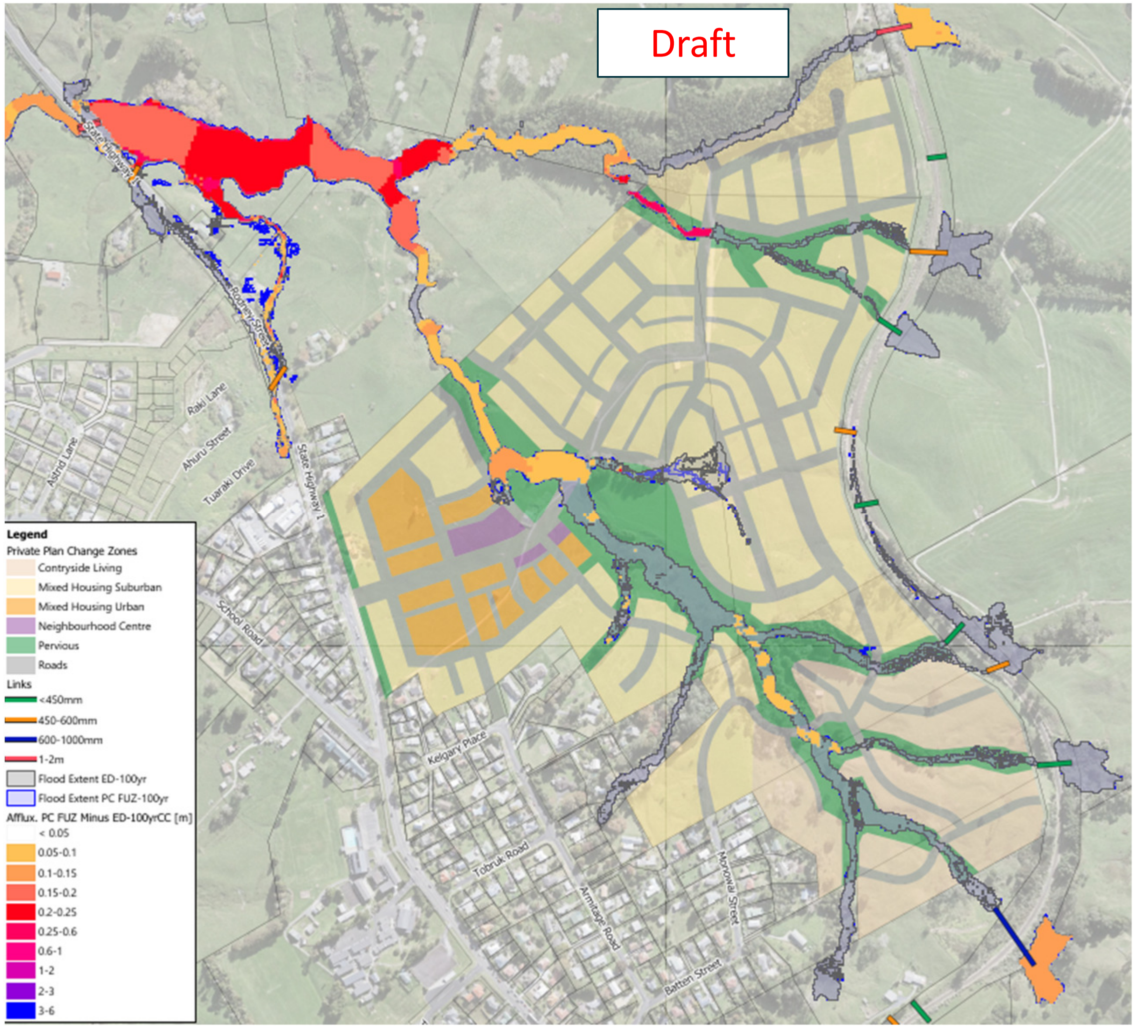
Scenario		Land use	Rainfall	Purpose
Pre-development/ existing development	ED	Existing impervious coverage	2-, 10- 100-year - 3.8°C	Create a base line scenario with 3.8 °C climate change factor. Understand existing deficiencies in infrastructure and effects i.e., SH1 Use as a comparative model to compare relevant post development PPC models.
Post-development	ED + PPC	Existing impervious coverage + Private Plan Change (MPD)	2-, 10- 100-year - 3.8°C	Create a base line scenario with 3.8 °C climate change factor. Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC. Understand and isolate effects as a result of development within the PPC area only with neighbouring areas at the existing development.
Post-development (MPD)	MPD + PPC	Maximum probable development (MPD as per AUP: OiP) + Private Plan Change	2-, 10- 100-year - 3.8°C	Create a base line scenario with 3.8 °C climate change factor Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC and MPD coverages Understand cumulative effects as a result of development within the PPC area and MPD coverages in other areas

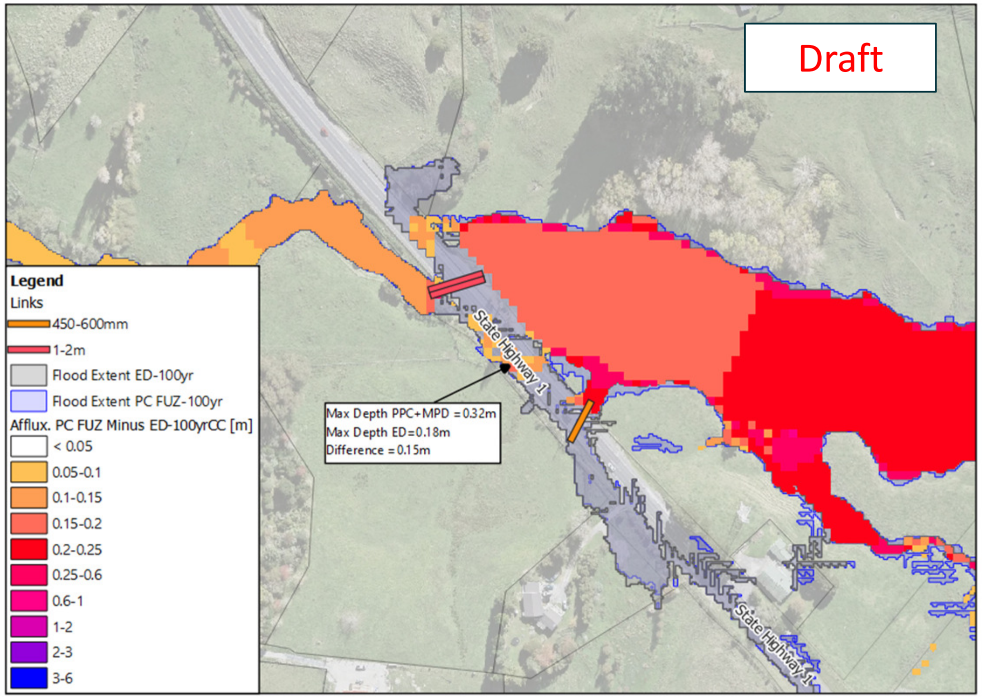
Afflux between ED and ED+ PPC (3.8^{0}C) for 100-year





Afflux between ED and MPD+ PPC (3.8^{0}C) for 100-year





Stormwater management

- In accordance with NDC Schedule 4 for 'greenfields':
  - Water quality for all impervious areas
  - Hydrology mitigation (retention and detention)
- Draft Stormwater Management Plan
- Opportunity to have centralised devices along stream edge

Questions/ Next steps

- Lodging Plan Change by end of April and keen to engage with Healthy Waters up to notification to resolve any issues.
- Currently undertaking consultation on Draft Structure Plan.

- Any questions

Location	MS Teams			
Time & Date	2pm	6/04/2022	Taken by	Bidara Pathirage
Attendees	Initials	Name		Company
	PW	Pranil Wadan		Woods
	BP	Bidara Pathirage		Woods
	CS	Cosette Saville		Barker & Associates
	NR	Nick Roberts		Barker & Associates
	SA	Susan Andrews		Auckland Council
	KL	Kedan Li		Auckland Council

Apologies	Initials	Name	Company
	TW	Tony Wang	Woods

High level Meeting Minutes – 6/04/2022

Wellsford North Plan Change – Meeting with Healthy Waters

1. Introductions around the table
2. NR and CS provides an introduction to the project, proposed Structure Plan and the Plan Change. It is noted the Plan Change area is smaller than the Structure Plan which is proposed for the FUZ zone north of Wellsford. An introduction to the Fast Track sites are also provided (Rodney Street area and Monowai Street area).
    a. Post meeting note from Auckland Council Kedan Li - The proposed plan change is different from the previous provided information, it is more intense at the top of the catchment. Please provide the accurate information in the SMP.
3. SA raises if mana whenua engagement is underway and CS confirms site visits have been undertaken with interested parties and are generally supportive.
4. PW runs through the stormwater work that has been undertaken to date. It is noted there is some key infrastructure in the area i.e., NZTA culvert/ asset under SH1 and Kiwi rail assets. Accessible assets have been surveyed to aid flood modelling. Healthy Waters have informed there is no flood model for the area.
5. PW discusses the extent of the flood model, boundary conditions and rainfall depths. Climate change allowance of 3.8^{0}C has been allowed for. 2, 10 and 100-year scenarios have been simulated with modelled scenarios presented.
6. PW discusses 100-year model results (indicative as the updated flood modelling based on a revised structure plan is currently underway). It is noted the streams are generally incised and results indicate that flooding is generally contained within the streams. Effects on SH1 indicate SH1 already overtops in the existing scenario and with the Plan Change, the increase is only approximately 50mm from existing. When compared with MPD (wider structure plan area), the increase is higher at approximately 150mm from existing. Higher water levels are indicated upstream of the culvert within the stream.
7. KL queries the NZTA culvert and sizing. PW/ BP to issue surveyed information to Auckland Council.

8. KL asks whether simulations have been undertaken without climate change. Woods to simulate models without climate change (10- and 100-year events) to understand if effects are a result of climate change or development. KL confirms 3.8^{0}C runs are adequate and don't require 2.1^{0}C simulations.
9. KL queries if there are any effects on number 10, SH1. Woods to enquire further in the models and issue information.
10. KL requests velocities and flow information to be provided at critical cross sections. Woods to provide this information to Auckland Council.
11. It is agreed that Woods will undertake further simulations as discussed and provide models, model results and model review form to Auckland Council as one package for review. It is noted that model runs are based on LiDAR 2016.
12. PW goes through the stormwater management strategy and is to be in accordance with 'greenfields' Schedule 4 NDC. PW notes there is an opportunity to have centralised devices along the stream edge. KL notes based on the information provided in the Draft SMP, a bit more detail will be required to understand how the BPO for water quality, detention/ retention can be implemented taking into account scour/ erosion, slope and ground stability etc. KL notes further certainty maybe required for the SMP to understand how devices can be incorporated.
13. KL asks about stream classifications. CS confirms and ecology assessment has been undertaken and is to circulate to Auckland Council. PW and CS note the streams align with the structure plan.
14. Next steps are discussed. NR notes lodgement is planned for end of April and is currently undertaking consultation on the Draft Structure Plan. Keen to engage with Healthy Waters via meetings/ workshops from lodgement till hearings to ensure issues are resolved. PW notes model information and the SMP is to be provided to Healthy Waters and if required, can be amended prior to hearings.
15. Woods to issue a complete package of information with model information and the SMP by the end of the month.
16. KL discusses the flooding on SH1 and whether anything is proposed. PW notes at source attenuation was considered; however, as the issue is existing, the increases as a result of the plan change was less than minor and therefore preference is to pass flows forward. KL notes it highlights current network deficiency. Woods to also consult with NZTA on effects.
17. Question raised regarding vesting of riparian areas. This is to be worked through with Healthy Waters and the Parks team.

List of actions

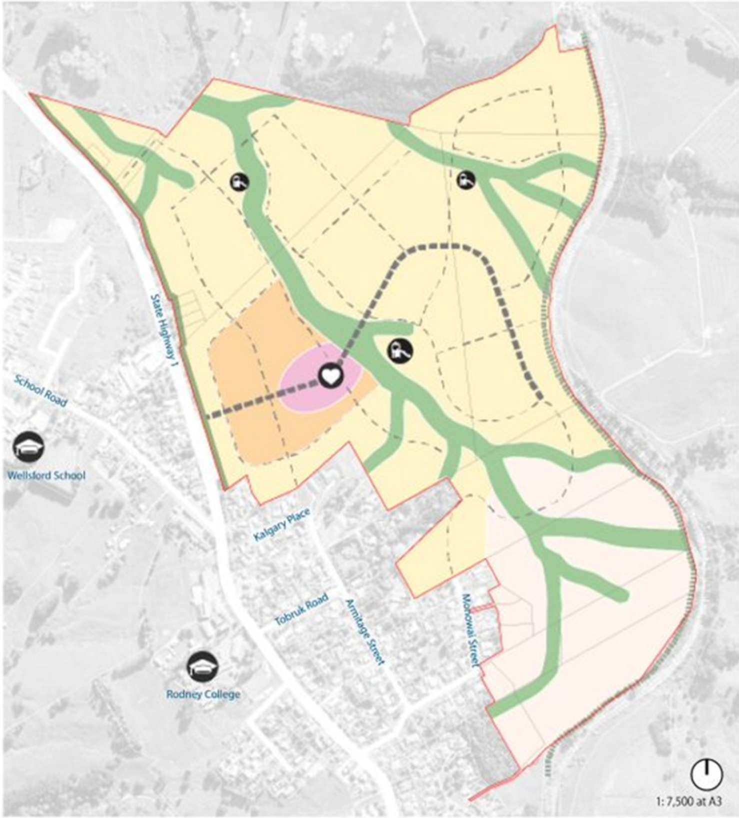
Action	By	When
Issue survey information	PW/ BP	08/04/2022
Issue Ecology report	CS	06/04/2022
Issue model information and SMP	PW/ BP	29/04/2022

Wellsford Plan Change – Meeting with Waka Kotahi NZTA 21/04/2022

Agenda

- Proposed development
- Work undertaken to date:
  - Flood modelling
  - Stormwater management
  - Draft Stormwater Management Plan
- Other matters

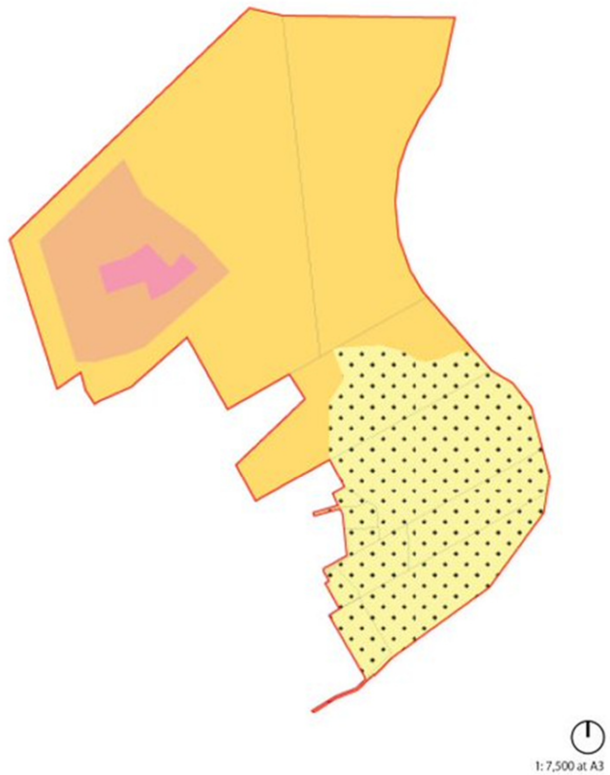
Proposed development



Structure Plan

Legend

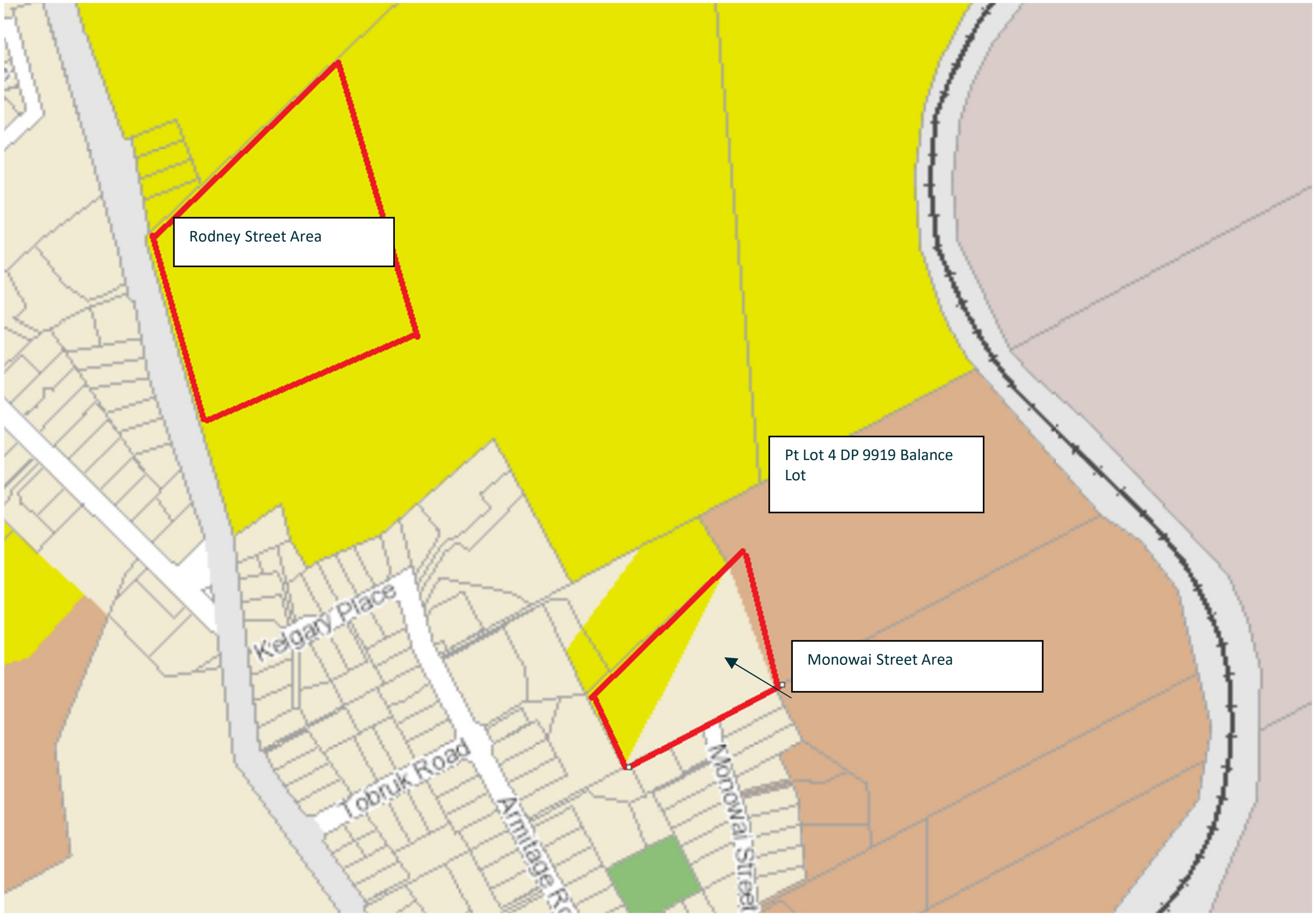
- Structure plan extent
- Property Boundary
- Indicative Lifestyle Living
- Indicative Lower Density Residential
- Indicative Medium Density Residential
- Indicative Village Centre
- Ecological Areas / Open Spaces
- Main Collector Road
- Local Streets
- Greenway Cycleway
- 10m Landscape Buffer
- Indicative Playground
- Indicative Village Centre Public Space
- Existing Schools



Legend

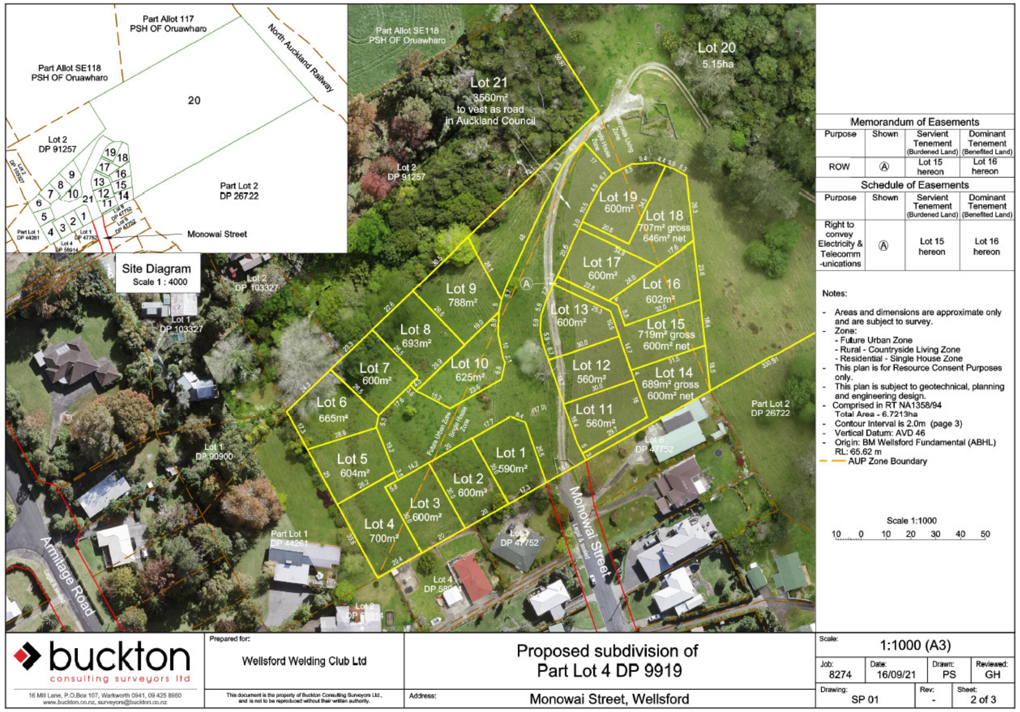
- Extent
- Existing Property Boundary
- Residential - Large Lot Zone
- Residential - Mixed Housing Suburban Zone
- Residential - Mixed Housing Urban Zone
- Business - Neighbourhood Centre Zone
- Subdivision Variation Control

Fast-Track consent application



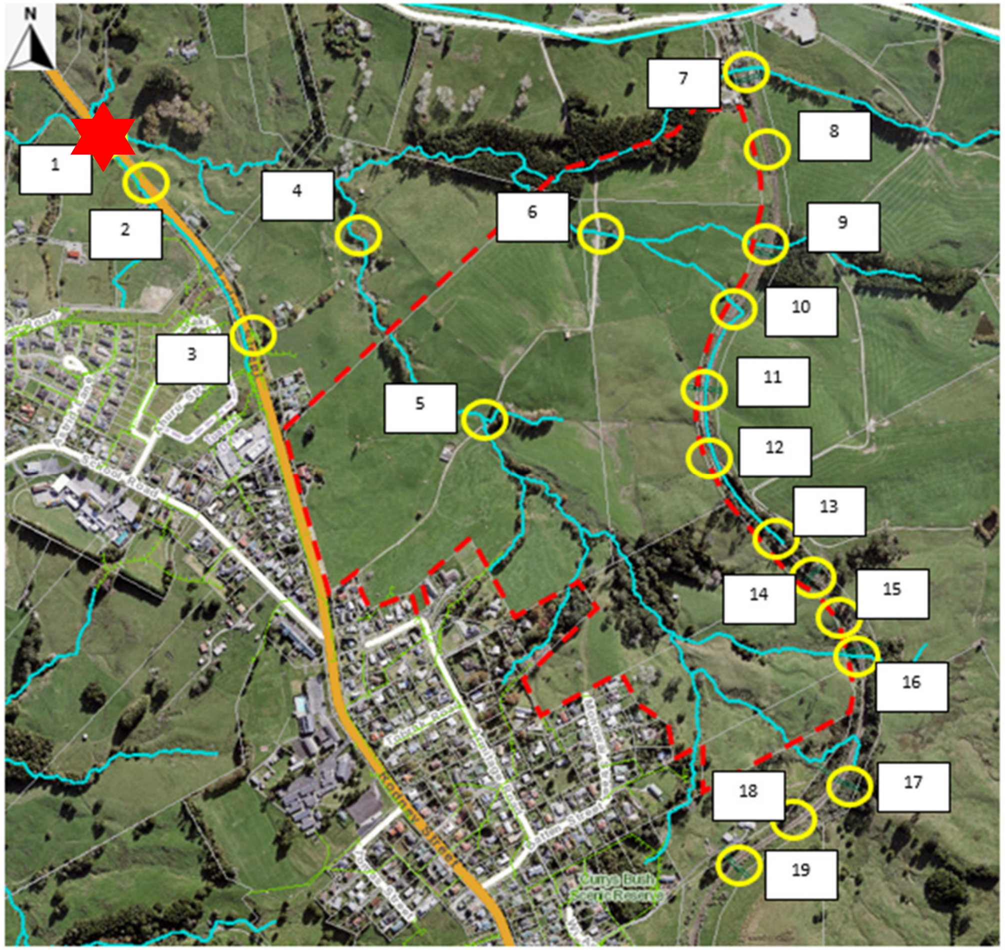
Fast-Track consent application

WOODS
Est.1970



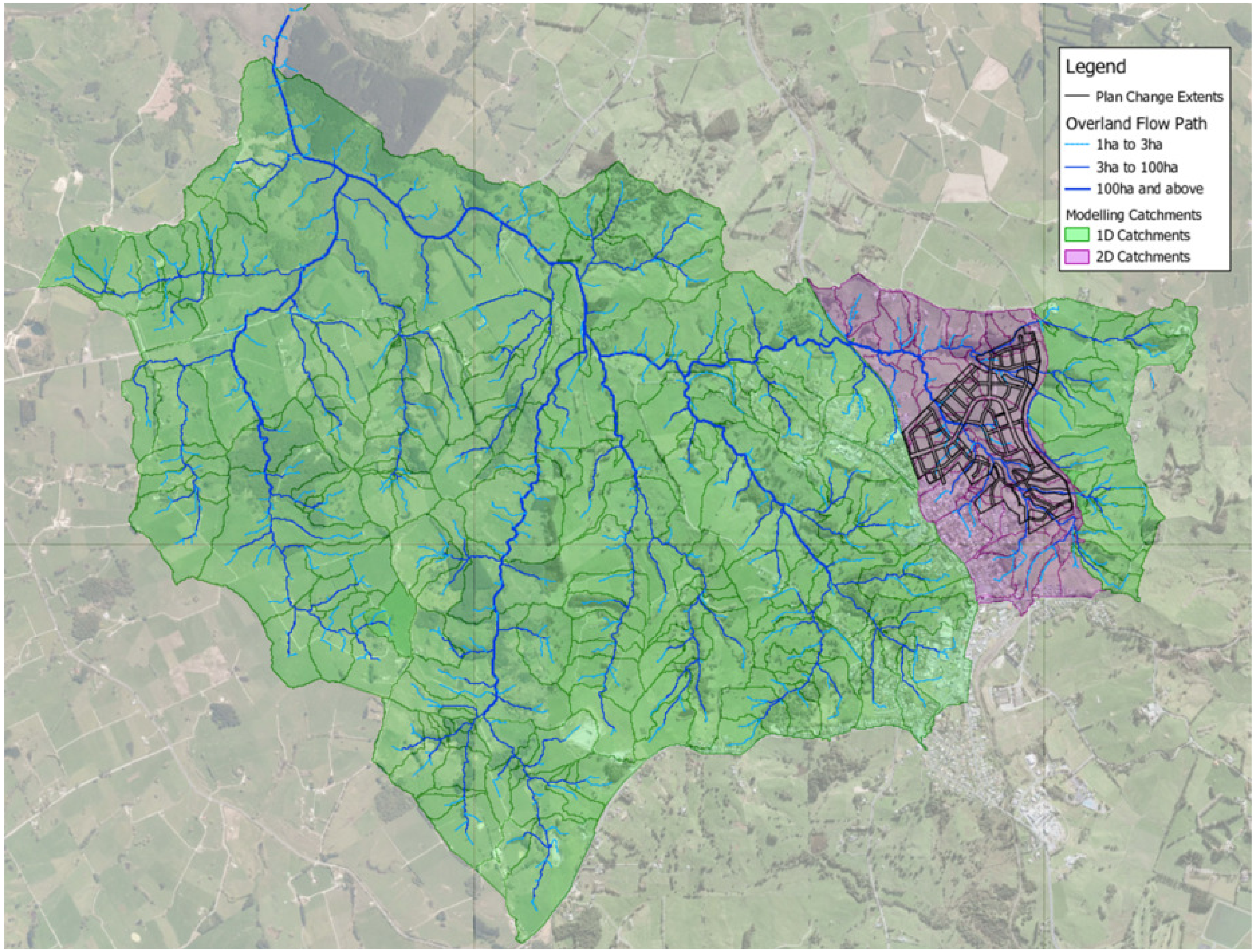
Key infrastructure

- Key infrastructure:
  - 1-3 – NZTA/ Auckland Council/ AT
  - 7-19 – KiwiRail
  - Survey undertaken for SH and Kiwirail culverts where accessible
- Council has no model information for this area
- Flood modelling was therefore undertaken by Woods to assess effects resulting from PPC



WOODS
EST.1970

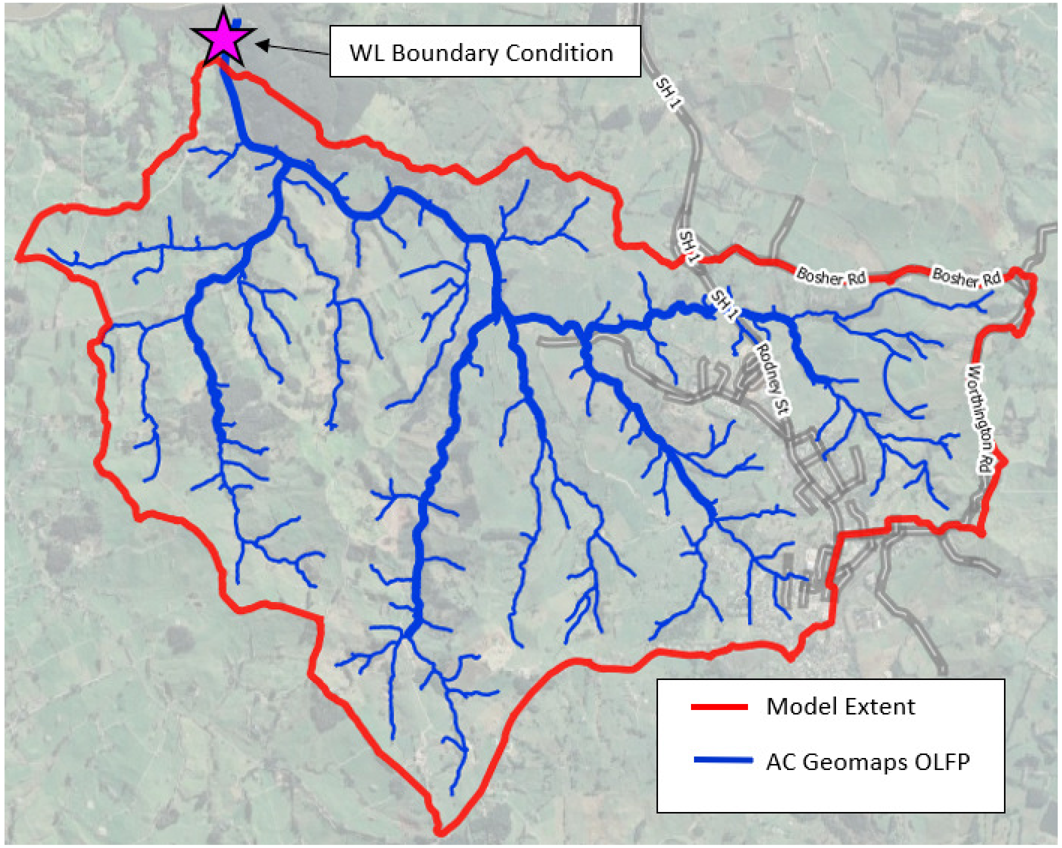
Flood modelling – Extent of model



Flood modelling – Boundary conditions and Rainfall depths

- Coastal tailwater boundary condition applied for all scenarios where Oruawharo River discharges to Kaipara Harbour at a constant water level of 3.3m based on MHWS 10%ile with 1m sea level rise consideration for climate change

Storm Event	Rainfall Depth (mm)	Rainfall Depth including Climate Change - SWCoP V3 – 3.8^{0}C (mm)
2 year	95	121
10 year	170	222
100 year	260	345

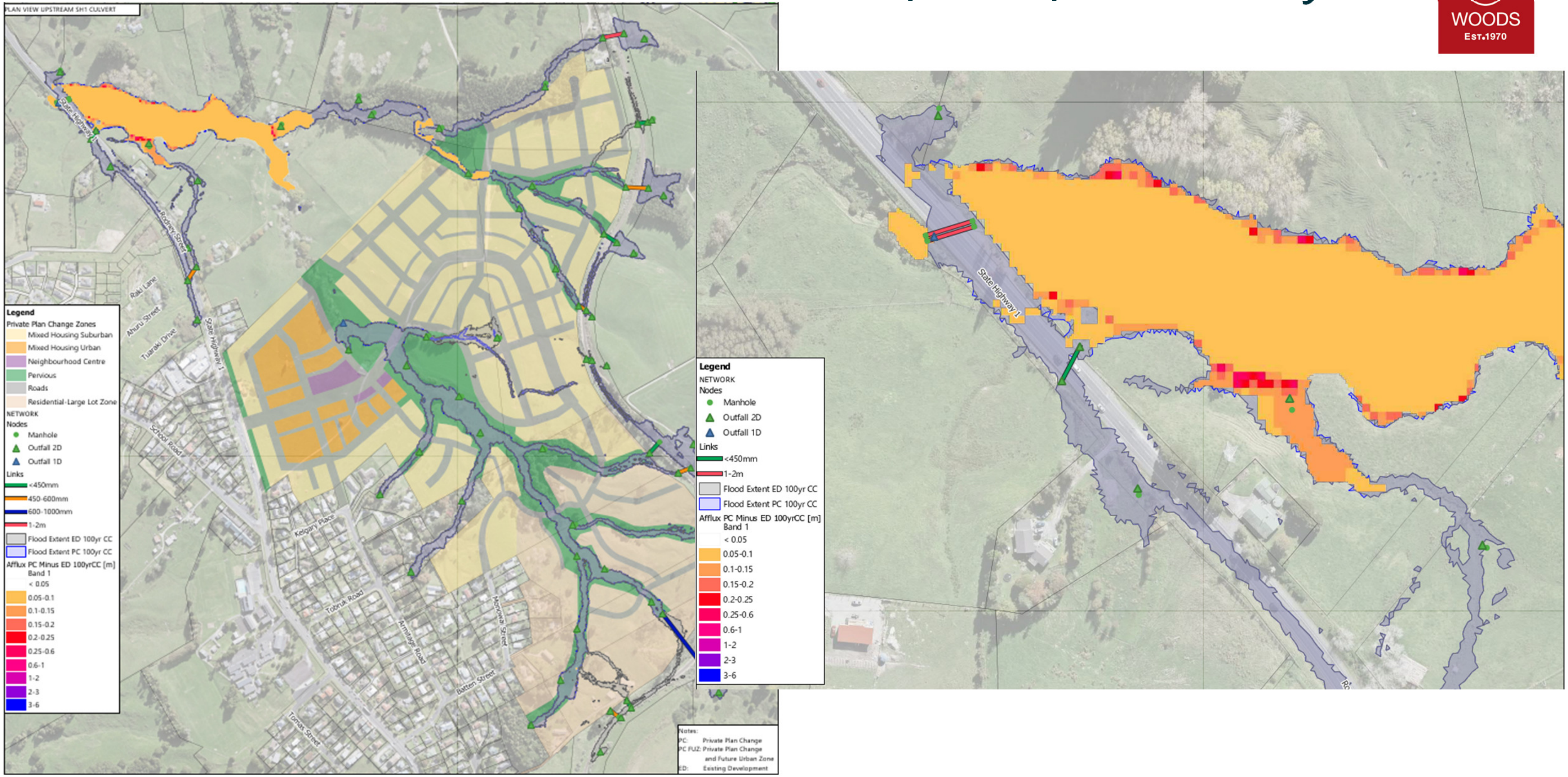


Flood modelling – Modelled scenarios

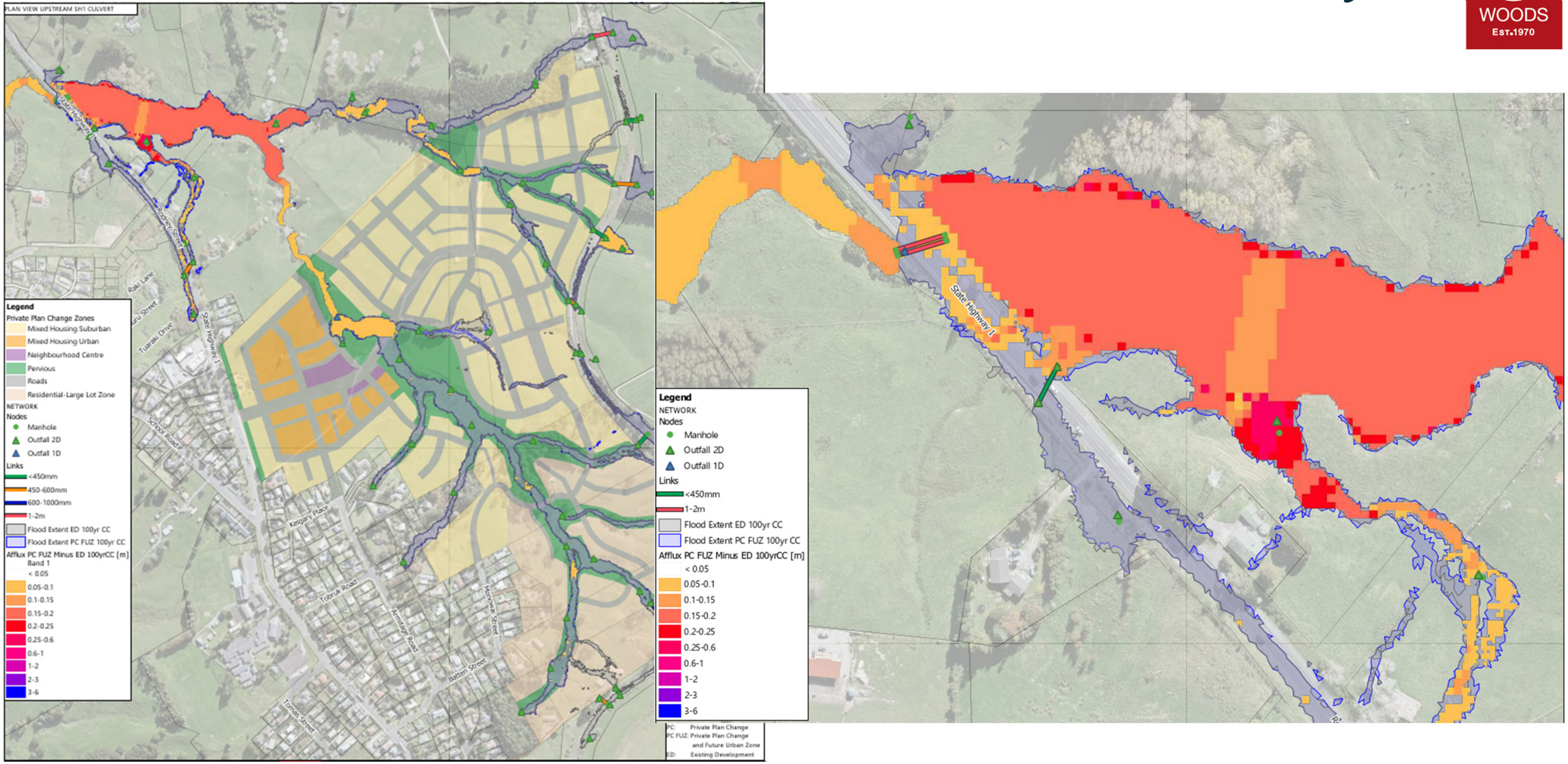
Scenario		Land use	Rainfall	Purpose
Pre-development/ existing development	ED	Existing impervious coverage	2-, 10- 100-year - 3.8°C	Create a base line scenario with 3.8 °C climate change factor. Understand existing deficiencies in infrastructure and effects i.e., SH1 Use as a comparative model to compare relevant post development PPC models.
Post-development	ED + PPC	Existing impervious coverage + Private Plan Change (MPD)	2-, 10- 100-year - 3.8°C	Create a base line scenario with 3.8 °C climate change factor. Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC. Understand and isolate effects as a result of development within the PPC area only with neighbouring areas at the existing development.
Post-development (MPD)	MPD + PPC	Maximum probable development (MPD as per AUP: OiP) + Private Plan Change	2-, 10- 100-year - 3.8°C	Create a base line scenario with 3.8 °C climate change factor Understand deficiencies in infrastructure and effects i.e., SH1 as a result of PPC and MPD coverages Understand cumulative effects as a result of development within the PPC area and MPD coverages in other areas

Afflux between ED and ED+ PPC (3.8^{0}C) for 100-year

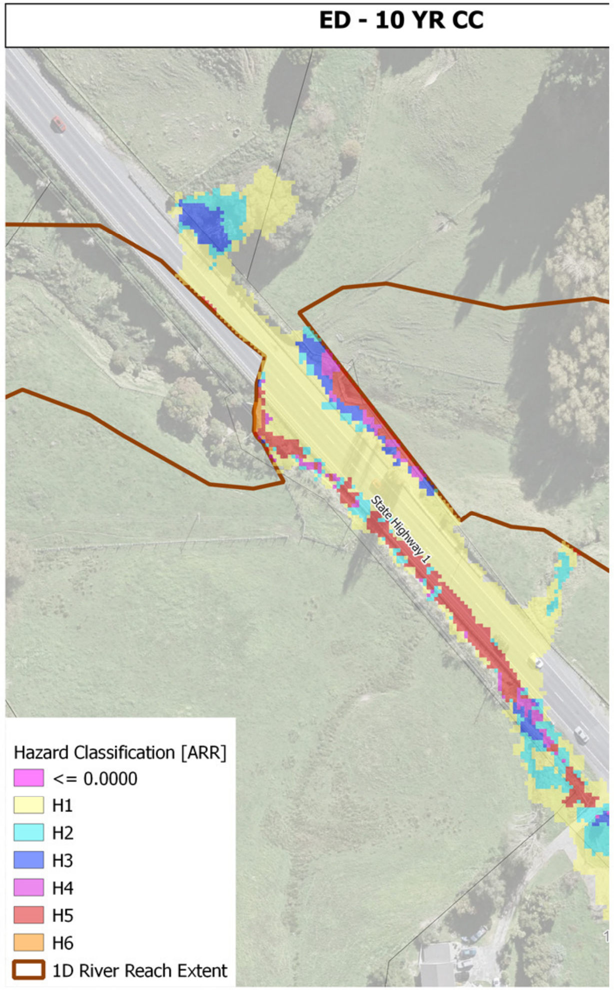
WOODS
EST.1970

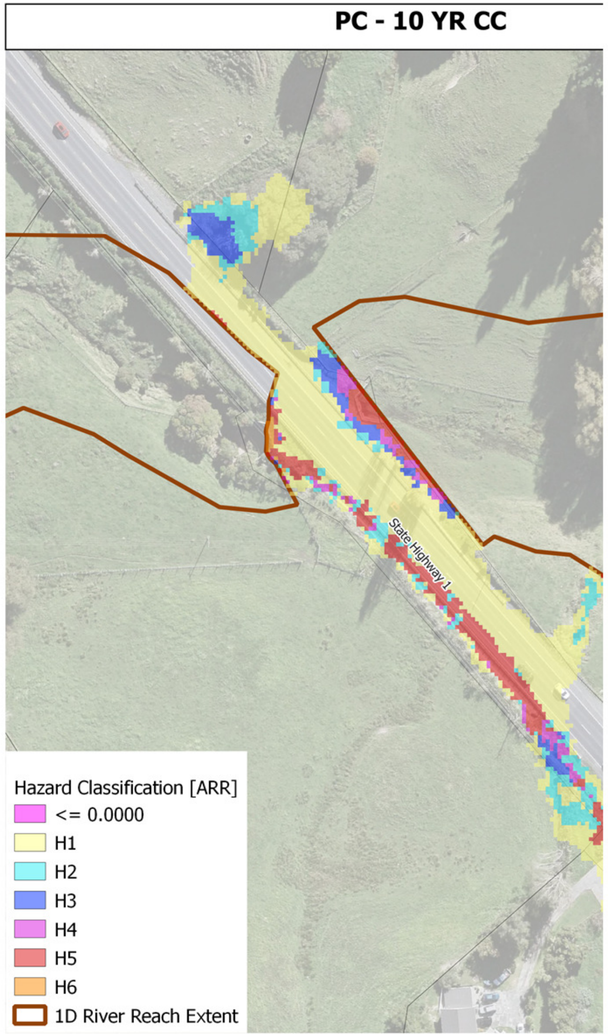


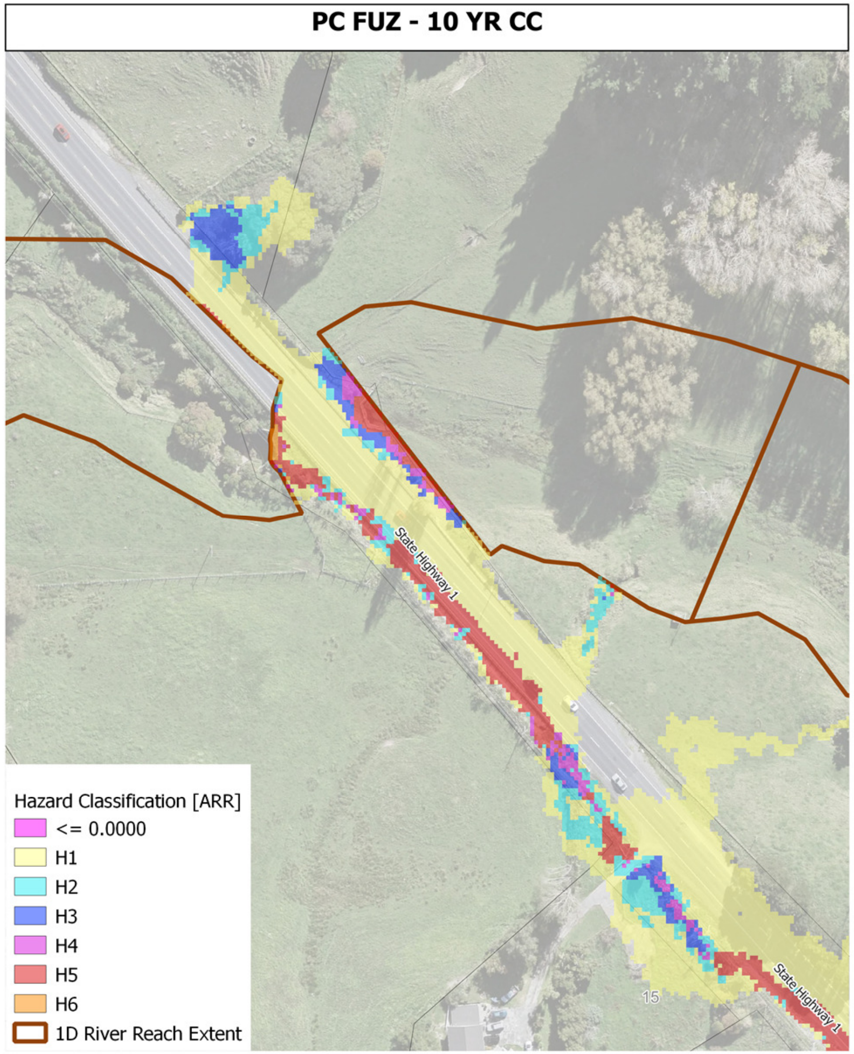
Afflux between ED and MPD+ PPC (3.8^{0}C) for 100-year



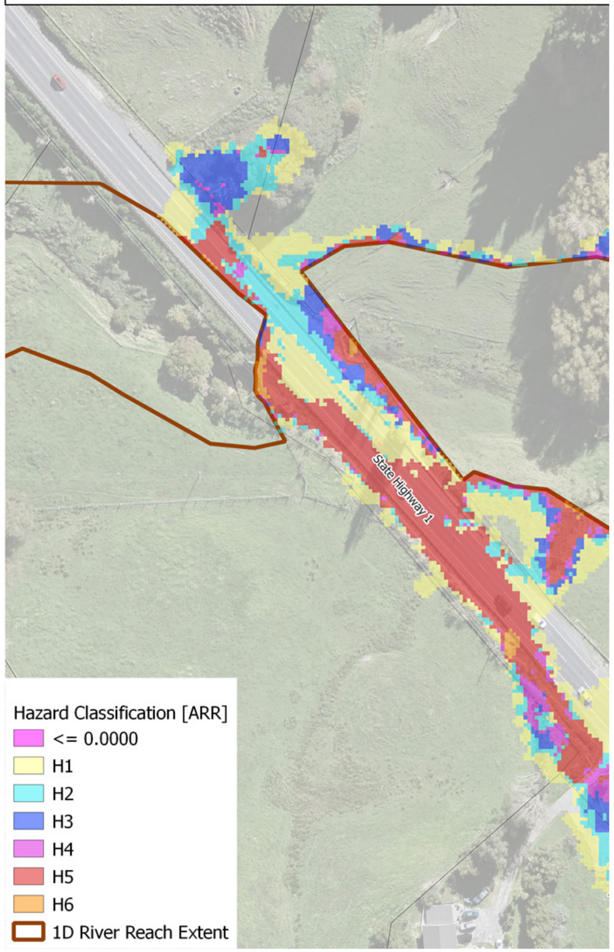
Legend
NETWORK
Nodes
Manhole
Outfall 2D
Outfall 1D
Links
<450mm
1-2m
Flood Extent ED 100yr CC
Flood Extent PC FUZ 100yr CC
Afflux PC FUZ Minus ED 100yrCC [m]
< 0.05
0.05-0.1
0.1-0.15
0.15-0.2
0.2-0.25
0.25-0.6
0.6-1
1-2
2-3
3-6
State Highway 1


ED - 10 YR CC
State Highway 1
Hazard Classification [ARR]
<= 0.0000
H1
H2
H3
H4
H5
H6
1D River Reach Extent

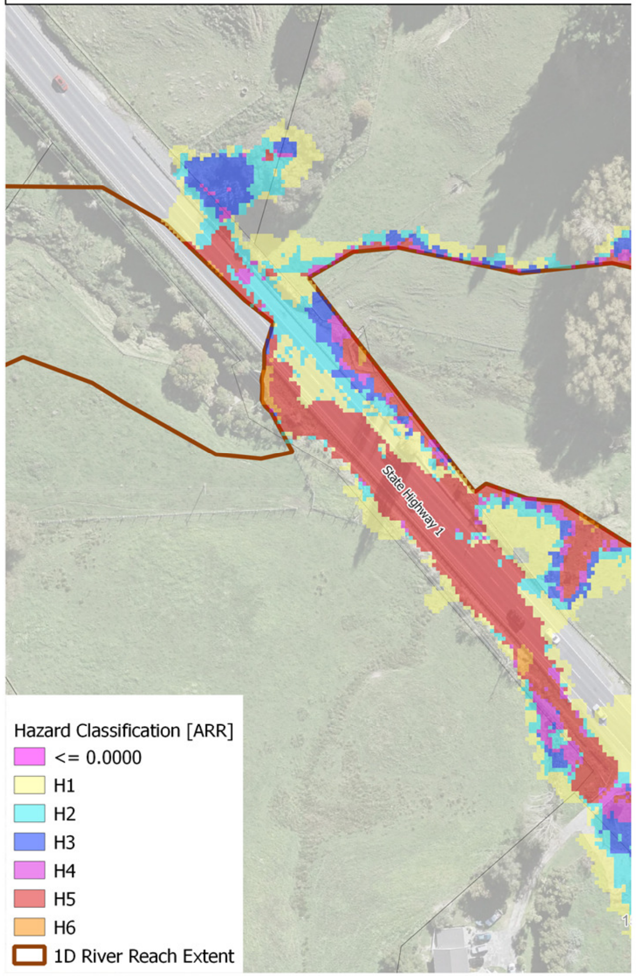

PC - 10 YR CC
State Highway 1
Hazard Classification [ARR]
<= 0.0000
H1
H2
H3
H4
H5
H6
1D River Reach Extent


PC FUZ - 10 YR CC
State Highway 1
Hazard Classification [ARR]
<= 0.0000
H1
H2
H3
H4
H5
H6
1D River Reach Extent

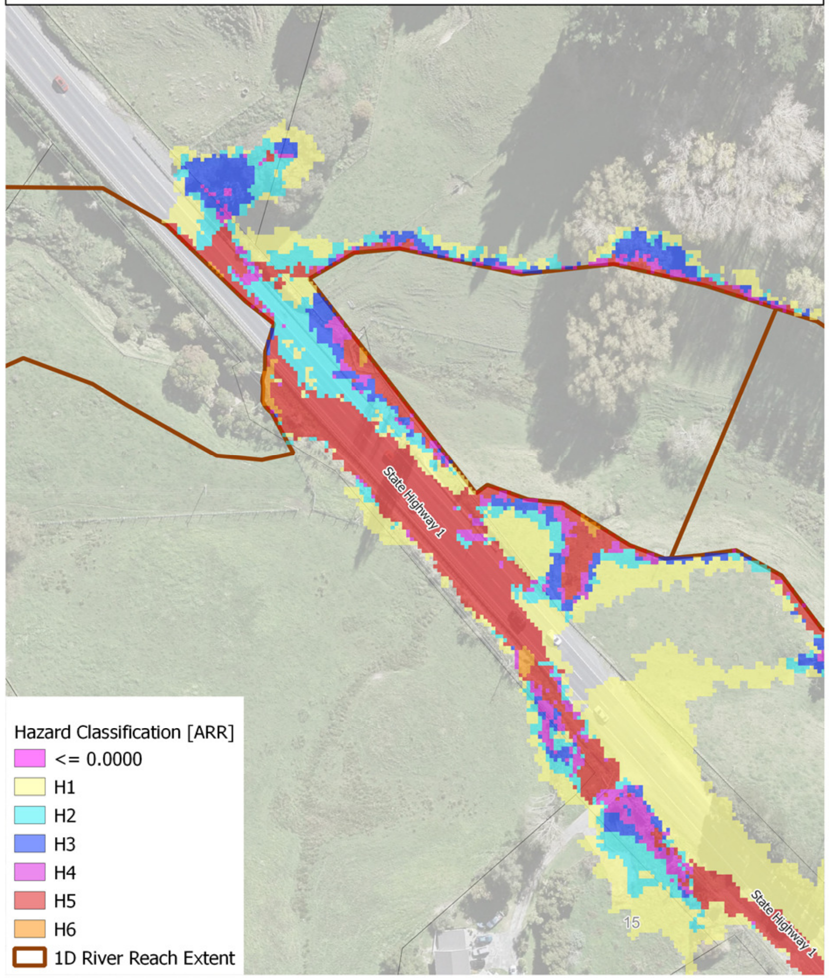
ED - 100 YR CC

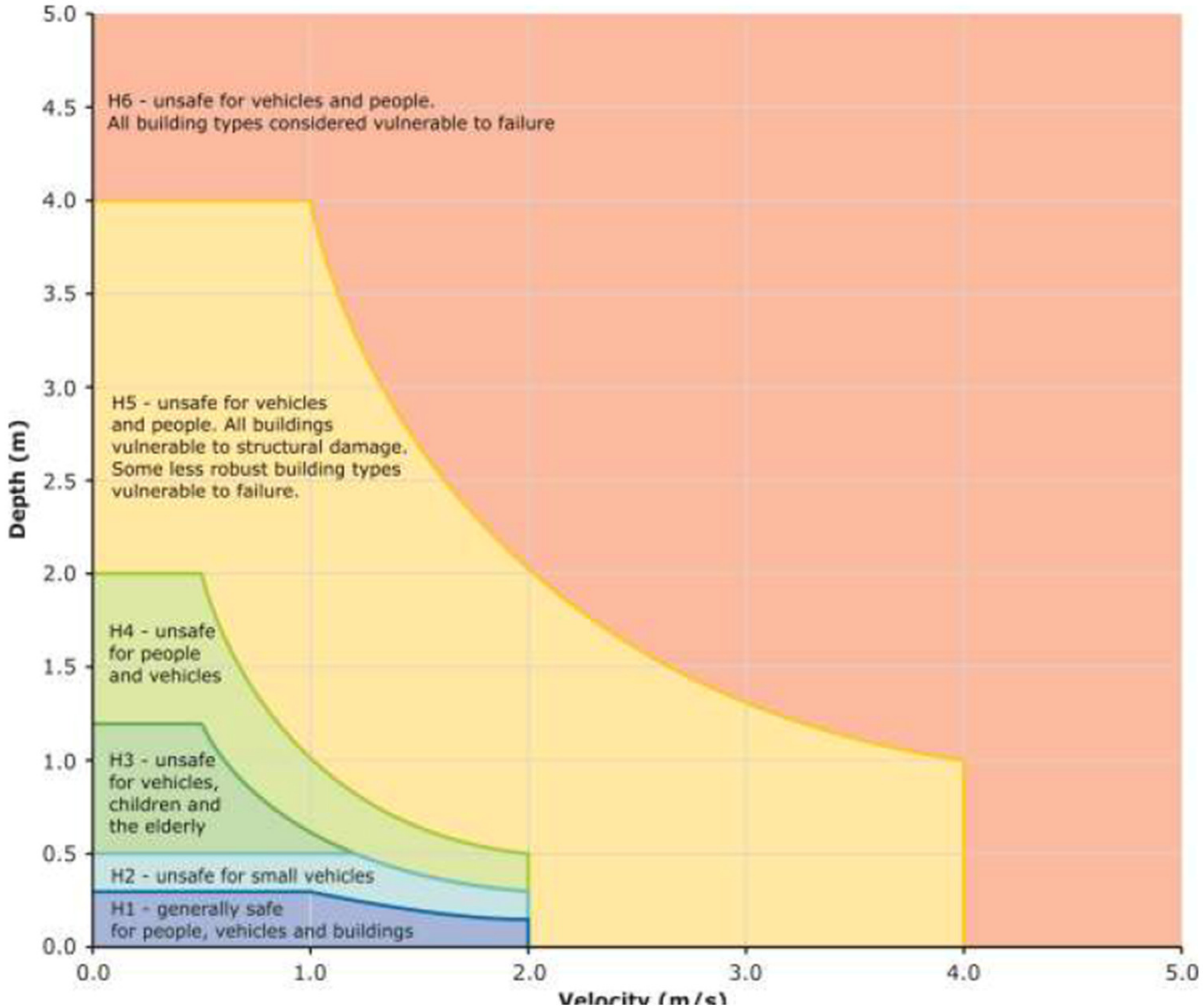


PC - 100 YR CC



PC FUZ - 100 YR CC





H6 - unsafe for vehicles and people.
All building types considered vulnerable to failure
H5 - unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust building types vulnerable to failure.
H4 - unsafe for people and vehicles
H3 - unsafe for vehicles, children and the elderly
H2 - unsafe for small vehicles
H1 - generally safe for people, vehicles and buildings
Depth (m)
Velocity (m/s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0

Stormwater management

- In accordance with NDC Schedule 4 for 'greenfields':
  - Water quality for all impervious areas
  - Hydrology mitigation (retention and detention)
- Draft Stormwater Management Plan
- Opportunity to have centralised devices along stream edge

Questions/ Next steps

- Lodging Plan Change by end of April and keen to engage with Waka Kotahi up to notification to resolve any issues.

- Working with Healthy Waters on the model review and SMP

- Currently undertaking consultation on Draft Structure Plan.

- Any questions

Location	MS Teams			
Time & Date	1pm	22/04/2022	**Taken by**	Bidara Pathirage
Attendees	**Initials**	**Name**		**Company**
	AD	Ajay Desai		Woods
	BP	Bidara Pathirage		Woods
	MH	Miguel Hernandez		Woods
	CS	Cosette Saville		Barker & Associates
	NR	Nick Roberts		Barker & Associates
	DG	David Greig		Waka Kotahi NZTA
	RJ	Rajika Jayaratne		Waka Kotahi NZTA
	SH	Sarah Ho		Waka Kotahi NZTA

Apologies	**Initials**	**Name**	**Company**
	PW	Pranil Wadan	Woods
	VJ	Venelyn Jandayan	Waka Kotahi NZTA

High level Meeting Minutes – 22/04/2022

Wellsford North Plan Change – Meeting with Waka Kotahi NZTA

1. Introductions around the table
2. NR and CS provides an introduction to the project, proposed Structure Plan and the Plan Change. It is noted the Plan Change area is smaller than the Structure Plan which is proposed for the FUZ zone north of Wellsford. An introduction to the Fast Track sites are also provided (Rodney Street area and Monowai Street area).
3. RJ raises where access to the development is proposed. NR confirms one single access is proposed from State Highway 1.
4. SH asks for clarification on the Plan Change area and Structure Plan. NR confirms the Plan Change area is only proposed for the areas the applicant owns, however in accordance with guidelines, the Structure Plan is proposed for areas outside the applicant's ownership i.e., areas to the north (zoned FUZ). The areas not part of the Plan Change will be subject to a future plan change either to be led by Council or relevant property owners.
5. AD runs through the stormwater work that has been undertaken to date. It is noted there is some key infrastructure in the area i.e., NZTA culvert/ asset under SH1 and Kiwi rail assets. Accessible assets have been surveyed to aid stormwater assessments including flood modelling to identify effects of Plan Change. Healthy Waters have informed there is no flood model for the area.
6. AD discusses the extent of the flood model, boundary conditions and rainfall depths. Climate change allowance of 3.8^{0}C (RCP 8.5) to 2110 has been allowed for 2, 10 and 100-year scenarios modelled and presented.
7. AD discusses 100-year water level differences. It is noted the existing streams are generally incised and results indicate that flooding is generally contained within the streams. Flood risk is identified along SH1 which overtops in the existing scenario with climate change and have peak flood depths in excess of 0.6 m. With Plan Change and MPD (wider structure plan area) the increases are approximately 150mm when compared to existing scenario.

8. AD goes through flood risk and hazard assessment undertaken in accordance with Australian Rainfall Runoff Guidelines (ARR, 2016)[1]. Based on the work undertaken, even there is a minimum increase in flood depths with Plan Change, the flood hazards remain similar confirming that there is no increased flood risk. RJ notes there is an existing risk within SH1. RJ asks whether 2.1^{0}C has been simulated, BP notes only 3.8^{0}C and no CC scenarios have been simulated in consultation with Healthy Waters. RJ notes the impact is minimal, however there is an impact with minimal changes in hazard risk.

9. RJ questions the confidence in the model. AD notes model has been validated by HY-8 and is currently undergoing a review process with Healthy Waters for sign off. All parameters and approach including climate change considerations have been agreed with their technical reviewers.

10. The existing culvert size is noted to be a twin 2m dia. Under SH1. DG/ RJ discusses whether culverts can be upgraded by Waka Kotahi NZTA to minimise risk i.e., upsize culvert or bridge long term. AD notes Woods haven't undertaken any optioneering as there are no flood effects from Plan Change and the Plan Change can proceed without any downstream upgrades. This needs to be reassessed for Structure Planning purposes. RJ asks whether 2yr and 5yr events have been simulated. AD and MH confirm in the 2yr scenario, there is no overtopping of SH1.

11. RJ questions where there are any upstream flooding due to the culvert, AD confirms flows overtop these structures and flow downstream back into the stream. RJ also questions other culverts i.e., culverts labelled 2 and 3. However it is noted the capacity restrictions and overtopping are not due to the water coming from these culverts but hasn't been looked at in detail.

12. AD discussed stormwater management plan is being worked through and stormwater management is generally in accordance with Schedule 4 of the Network Discharge Consent (NDC).

13. Next steps are discussed – currently working with Healthy Waters with lodgement planned for end of April/ early May. Consultation is proposed after lodgement prior to hearings to ensure any issues identified are resolved.

14. RJ and DG requests all information to be submitted for review and further comments.

15. DG questions timeframes. CS confirms the first fast track sites proposed to be developed in 2023/2024. With the Plan Change, approximately 3-4 years before construction is expected.

16. DG and RJ to check if any existing flooding has been recorded in Waka Kotahi NZTA systems. AD notes the work undertaken demonstrates the issues are existing and is not due the plan change or structure plan. DG/ RJ note Waka Kotahi to take long term responsibility to whether upgrade culvert or other options to reduce existing risk. AD confirms that these upgrades are now decoupled from the Plan Change demonstrating that there are no increases in flood risk/hazards.

17. RJ asks what information will be issued. AD confirms the SMP, flood model, model build report and model review form to be issued at the same time to Healthy Waters.

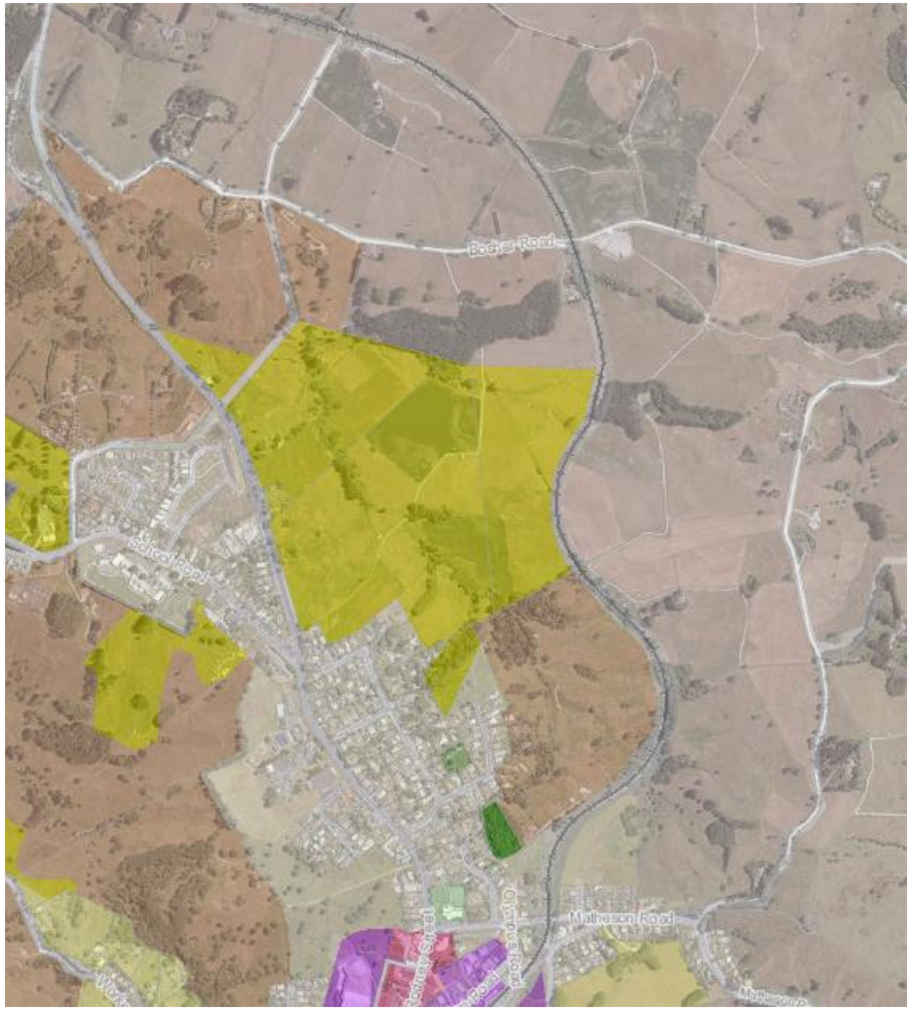
List of actions

Action	By	When
Issue model information and SMP for review	Woods	29/04/2022*

*to be shared along with Healthy Waters submission

[1] ARR Project Reports and Data (arr-software.org)

Wellsford Updated Model Review



Part 1: Model Updates

Overview of Review Findings		
Traffic Light Rating Scores (0 - no issue, 3 - major issue)		
0 - No issue found		
1 - Minor issue or non-standard approach, but unlikely to significantly impact on objectives of the study		
2 - Some concerns, likely to have an impact on model results		
3 - Concerns that may have a significant impact on model results and not meeting the study objectives		
Review Section	**Traffic Light**	**Comments**
A - Overview		
A:1 Deliverables	3	Modelled results presented in the Modelling Memo and model do not align fully. Please provide GIS rasters.
A:2 Previous Review Comments	na	
A:3 Model Speed and Stability	na	
B - Detailed Model Review		
B:1 Model Boundary Conditions	3	Incorrect tailwater used in ED scenarios. 2yr and 10yr rainfall partially incorrect for all scenarios.
B:2 Model Catchments	3	Some incorrect delineation
B:3 Pipe Networks	na	no pipe network been modelled
B:4 Channel / Stream Networks	3	Roughness too low for streams
B:5 Hydraulic Structures and Control Elements	3	Groud level and inlet loss parameters are incorrect for SH culvert
B:6 Other Asset Features	na	
B:7 1D Overland Flow Paths	na	
B:8 2D Model Components	2	SH culvert 1D/2D not well represented
C - Model Results Review		
C:1 Model Results Check	3	Modelled results presented in the Modelling Memmo and model do not align fully. Please provide rasters if have extracted from 1D.
C:2 Model Validation	3	TP108 check not supplied
D - Additional Checks		
D:1 Additional Check Items		

A:1 Deliverable

GIS layers are to be provided post meeting

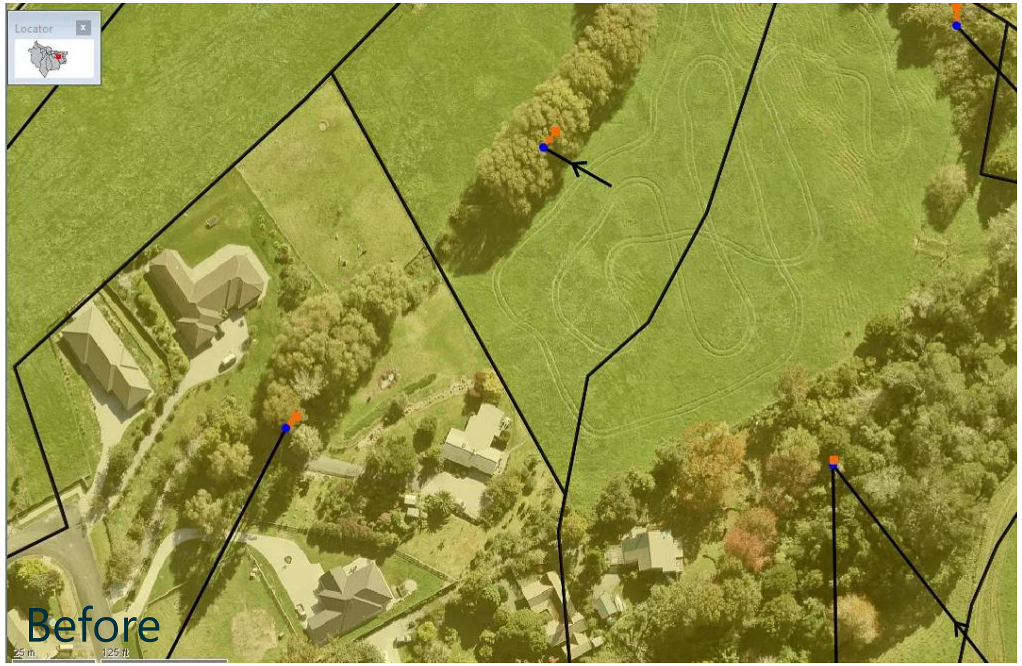
A:3.3: 2d outfall has ground level not equal to downstream invert level

Comments:

Checked ED 100yr 3.8cc. Many 2d outfall has ground level not equal to downstream invert level. Flow reversals.

Response:

Dummy 2D outfalls and pipes modelled for loading catchments replaced with 2D source pipes.



B:1.1 Model boundary conditions

Comments:

Correction required for profile 2: 2yr, 2yr cc events; Correction required for profile 1 in 100yr; 100yr cc events.

Response:

Rainfalls have been corrected. Table below shows the rainfall depths used in the model.

		SWCoPv3 -3.8°c		
	Depth [mm]	% Increment	Depth (mm)	Profile
2 Year	95.0	27.4%	121	1
	88.0		112	2
10 Year	170.0	30.8%	222	1
	160.0		209	2
100 Year	260.0	32.7%	345	1
	250.0		332	2

B:1.2 and B:1.4 Model boundary conditions

Comments:

ED scenarios tailwater level incorrect, should be 2.3mRL.

Response:

Existing development scenario simulated with 2.3mRL.

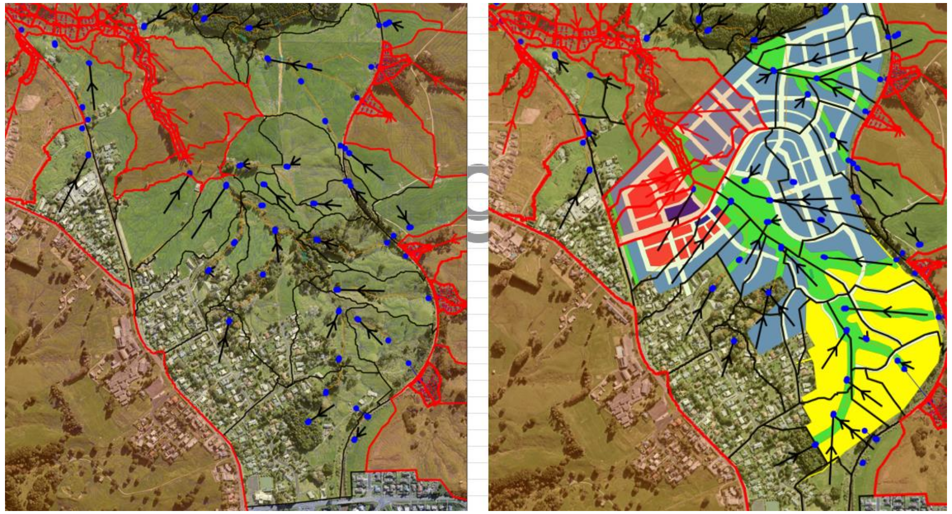
B:2.2 Model Catchment

Comments:

Spot check on subcatchments, the following subcatchments' delineation are not appropriate that either included more than one main stream or included the neighbouring olfp: 104, 117, 137, 112,108, 131.

Response:

Catchment delineation has been reviewed. The total sub-catchments for the ED scenario are 51. The total sub-catchments for future scenarios (PPC and PCFUZ) are 70. The ED sub-catchment delineation follows mainly the terrain surface. The future sub-catchments delineation follows the proposed structure plan shown in Figure below.



B:2.3 Model Catchment

Comments:

spot check on subcatchments, the following loading are not appropriate. 105, 154, 138, 103, 133, 131, 137, 144, 140.

Response:

Subcatchments delineation and loading have been checked. Check has been performed with the latest OLFPs and aerials. Future scenarios subcatchments vary due to proposed design surface.

B:3.14: Pipe Networks

Comments:

Identify any network which has decreasing diameters in a down-stream direction. Checked and no issues found.

Response:

Dummy 2D outfalls and pipes modelled for loading catchments replaced with 2D source pipes.

B:3.18: Pipe Networks

Comments:

Square edge with headwall. Culvert K, Ki too low.

Response:

Culvert 2000811317 (main culvert in the SH1) know is modelled as two barrels culvert. The inlet coefficients are based on Table A7.5 CIRIA(2019) for a Square edge with a headwall. Values were confirmed during the meeting with the AC (09/09/2022).

Table A7.5 *Coefficients for inlet control equations – simple culverts (see Box 11.12)*

Nr	Shape and material	Inlet type	Free flow equation form	Type 1 Free flow		Type 2 Submerged inlet	
				k	*M*	c	*Y*
1	Circular concrete	Square edge with headwall	A	0.0098	2.0	0.0398	0.67
2		Socket end with headwall		0.0018	2.0	0.0292	0.74
3		Socket end, projecting		0.0045	2.0	0.0317	0.69
4	Circular corrugated metal	Headwall	A	0.0078	2.0	0.0379	0.69
5		Mitred to slope		0.0210	1.33	0.0463	0.75
6		Projecting		0.0340	1.5	0.0553	0.54

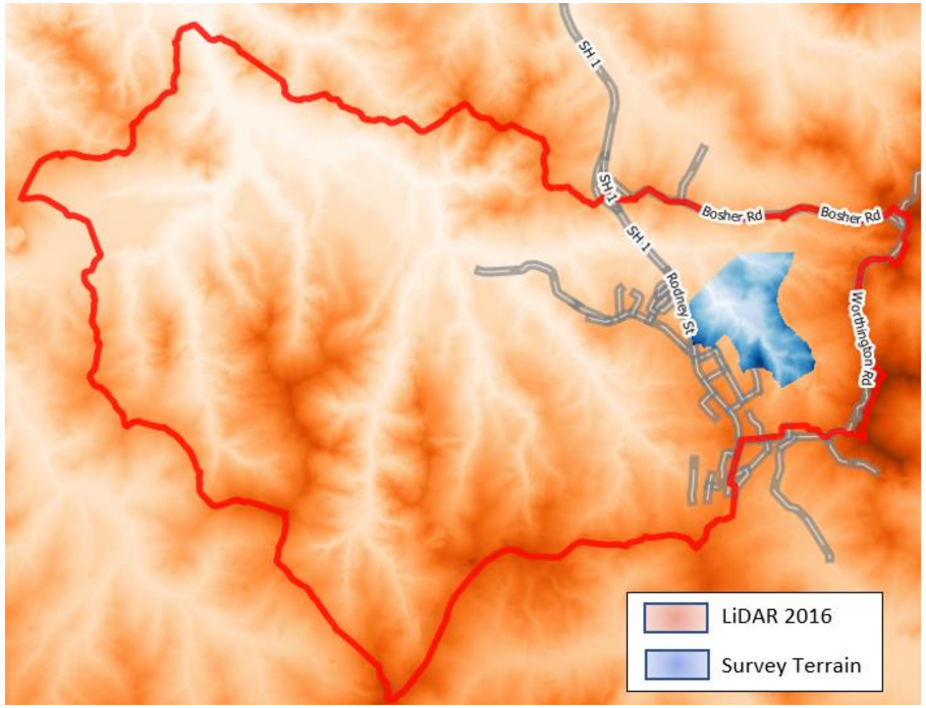
B:4.2: Channel/Stream Networks

Comments:

Where were those applied, model build memo is not clear. Mesh level zone 5 no level change.

Response:

Model build updated with the mesh level zones applied in the model. Also, breaklines were modelled to refine mesh resolution along river path, as shown in Figure B:4.2.



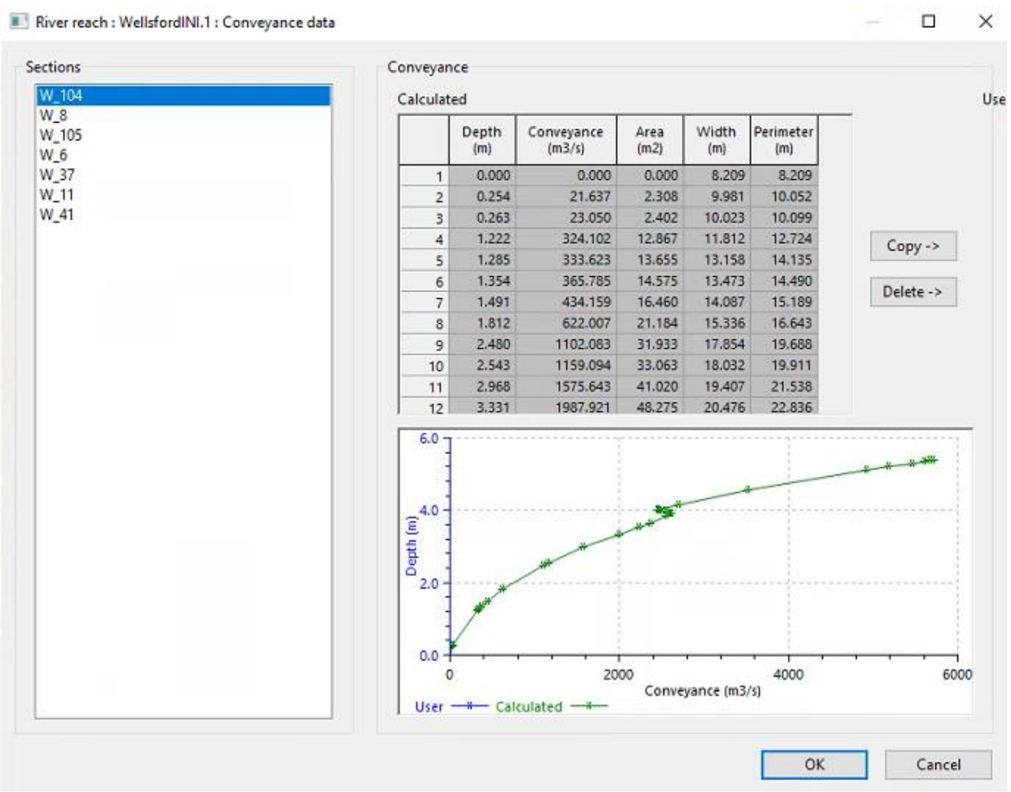
B:4.8: Channel/Stream Networks

Comments:

Panel markers not used appropriately.

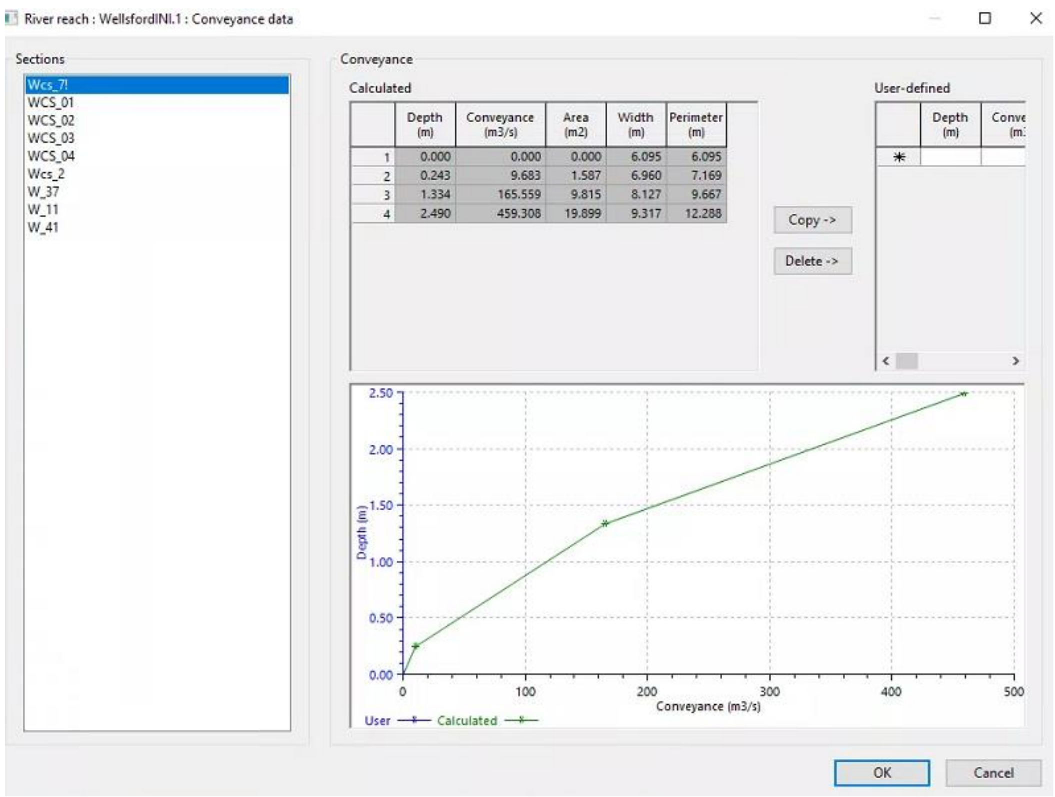
Response:

Conveyance markers have been checked for each river reach.



	Depth (m)	Conveyance (m3/s)	Area (m2)	Width (m)	Perimeter (m)
1	0.000	0.000	0.000	8.209	8.209
2	0.254	21.637	2.308	9.981	10.052
3	0.263	23.050	2.402	10.023	10.099
4	1.222	324.102	12.867	11.812	12.724
5	1.285	333.623	13.655	13.158	14.135
6	1.354	365.785	14.575	13.473	14.490
7	1.491	434.159	16.460	14.087	15.189
8	1.812	622.007	21.184	15.336	16.643
9	2.480	1102.083	31.933	17.854	19.688
10	2.543	1159.094	33.063	18.032	19.911
11	2.968	1575.643	41.020	19.407	21.538
12	3.331	1987.921	48.275	20.476	22.836

Before



	Depth (m)	Conveyance (m3/s)	Area (m2)	Width (m)	Perimeter (m)
1	0.000	0.000	0.000	6.095	6.095
2	0.243	9.683	1.587	6.960	7.169
3	1.334	165.559	9.815	8.127	9.667
4	2.490	459.308	19.899	9.317	12.288

Reviewed

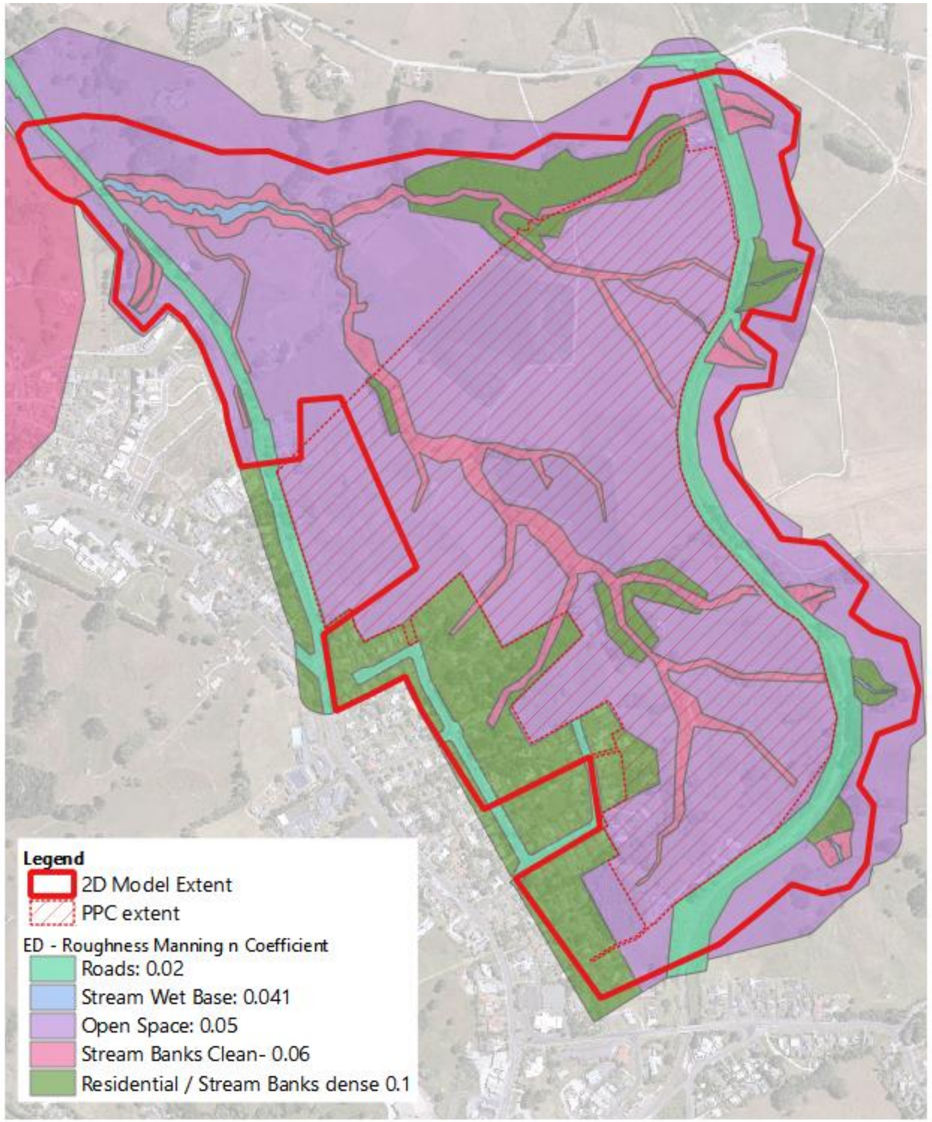
B:4.11: Channel/Stream Networks

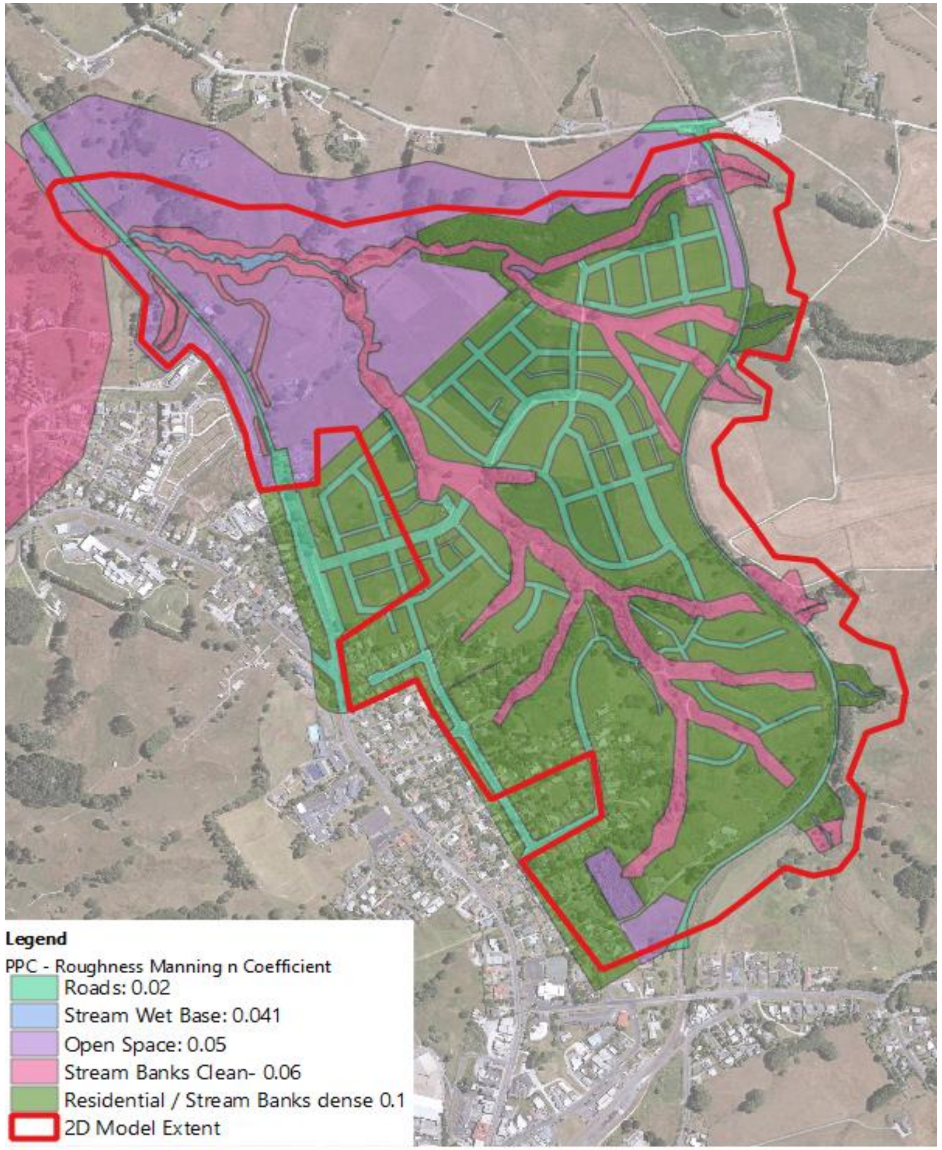
Comments:

Should be using Table 5-2. 0.03 and 0.04 too low.

Response:

Roughness coefficients have been updated with the values agreed upon during the meeting with the AC (09/09/2022). Also, roughness has been edited for the PPC and PCFUZ scenarios. Figures below show the roughness maps.


Legend
2D Model Extent
PPC extent
ED - Roughness Manning n Coefficient
Roads: 0.02
Stream Wet Base: 0.041
Open Space: 0.05
Stream Banks Clean- 0.06
Residential / Stream Banks dense 0.1


Legend
PPC - Roughness Manning n Coefficient
Roads: 0.02
Stream Wet Base: 0.041
Open Space: 0.05
Stream Banks Clean- 0.06
Residential / Stream Banks dense 0.1
2D Model Extent

B:5.3 Hydraulic Structures and Control Elements

Comments:

Spot check on SH culverts. Us and ds break node and manhole node ground level incorrect. Culvert inlet loss incorrect.

Response:

Culvert levels have been reviewed and updated with the survey levels. As per Innovyze's advise, (email dated 15/10/2022), the twin culverts could be modelled single conduit with the 'barrel' field set to 2.

Inlet loss coefficients has been reviewed according to values agreed upon during the meeting with the AC (09/09/2022).

- At the culvert you currently have two conduits and two sets of inlets modelled. I have swapped this out for a single conduit with the 'barrel' field set to 2. I know the levels were slightly different but this will be a more accurate representation of the headloss at this point. Otherwise the headloss calc is really being duplicated (I appreciate you were previously stuck with this approach until we introduced the barrel field).

B:8.7: 2D Model Components

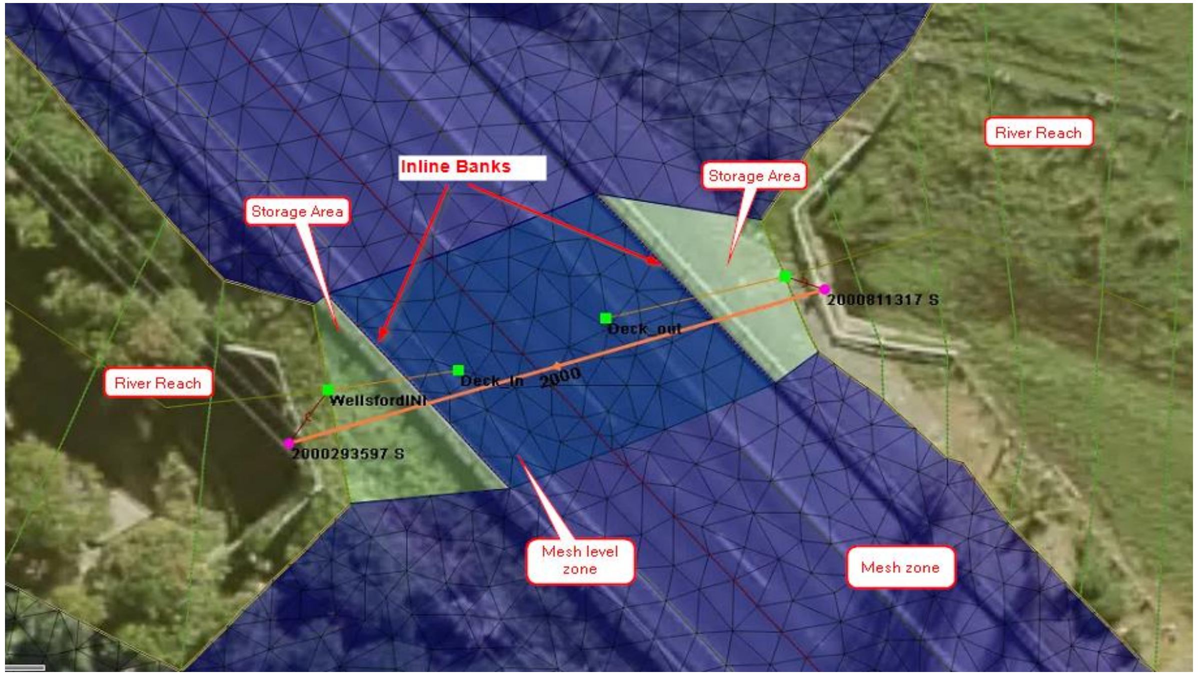
Comments:

SH culvert 1D/2D not well represented

Response:

Culvert representation in the model has been changed to include inline banks and storage areas as recommended by Innovyze. A single conduit with the 'barrel' field set to 2. This is considered as a more accurate representation of the headloss at this point.

Figure below shows the model elements used in the structure crossing.



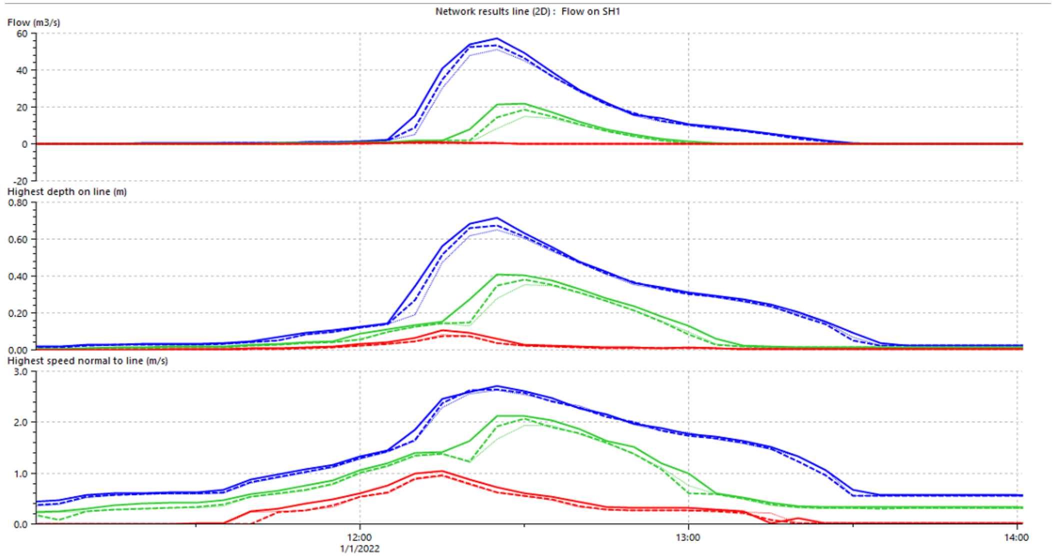
C:1.8: Model Results Check

Comments:

Require remodelling to assess

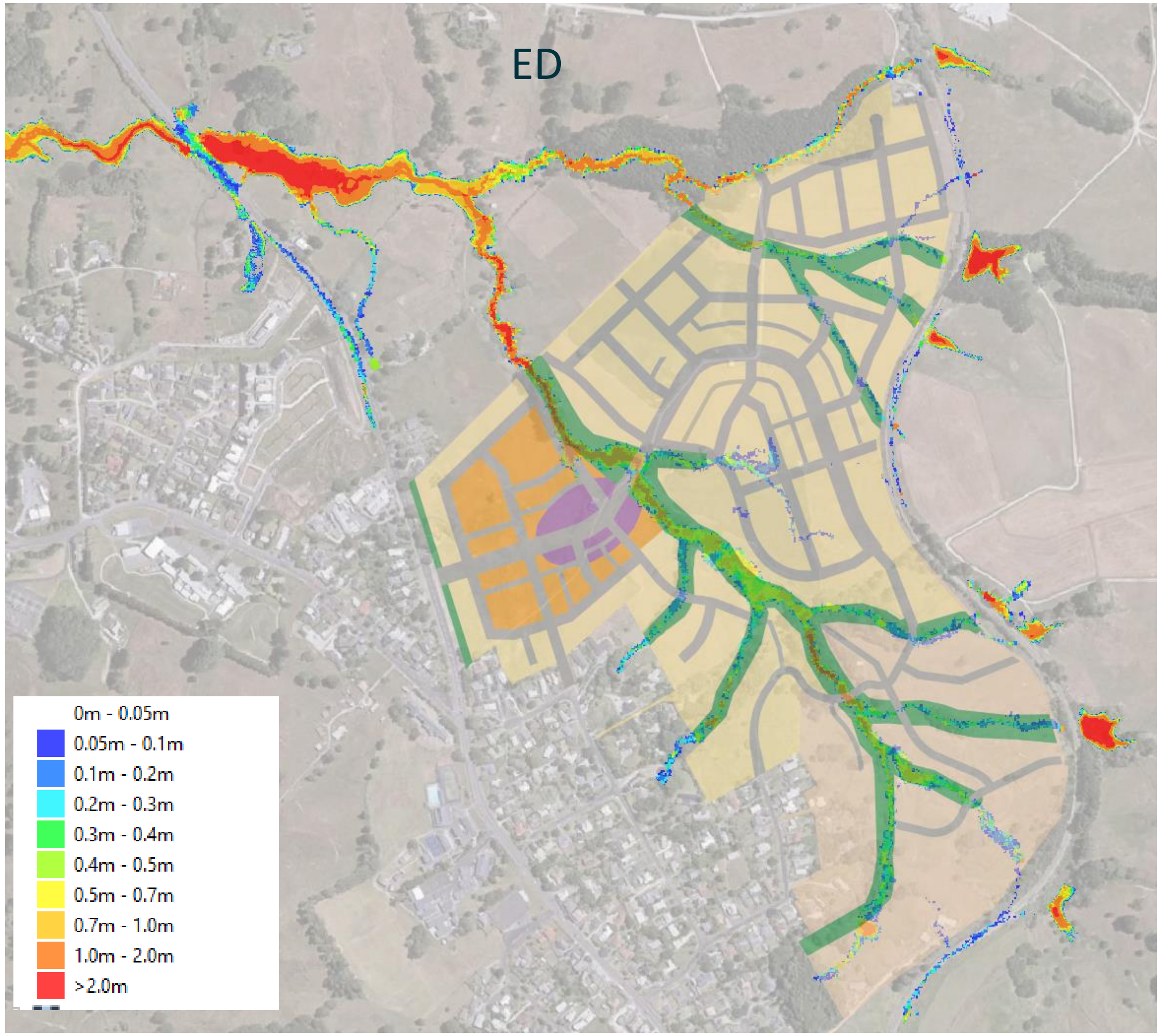
Response:

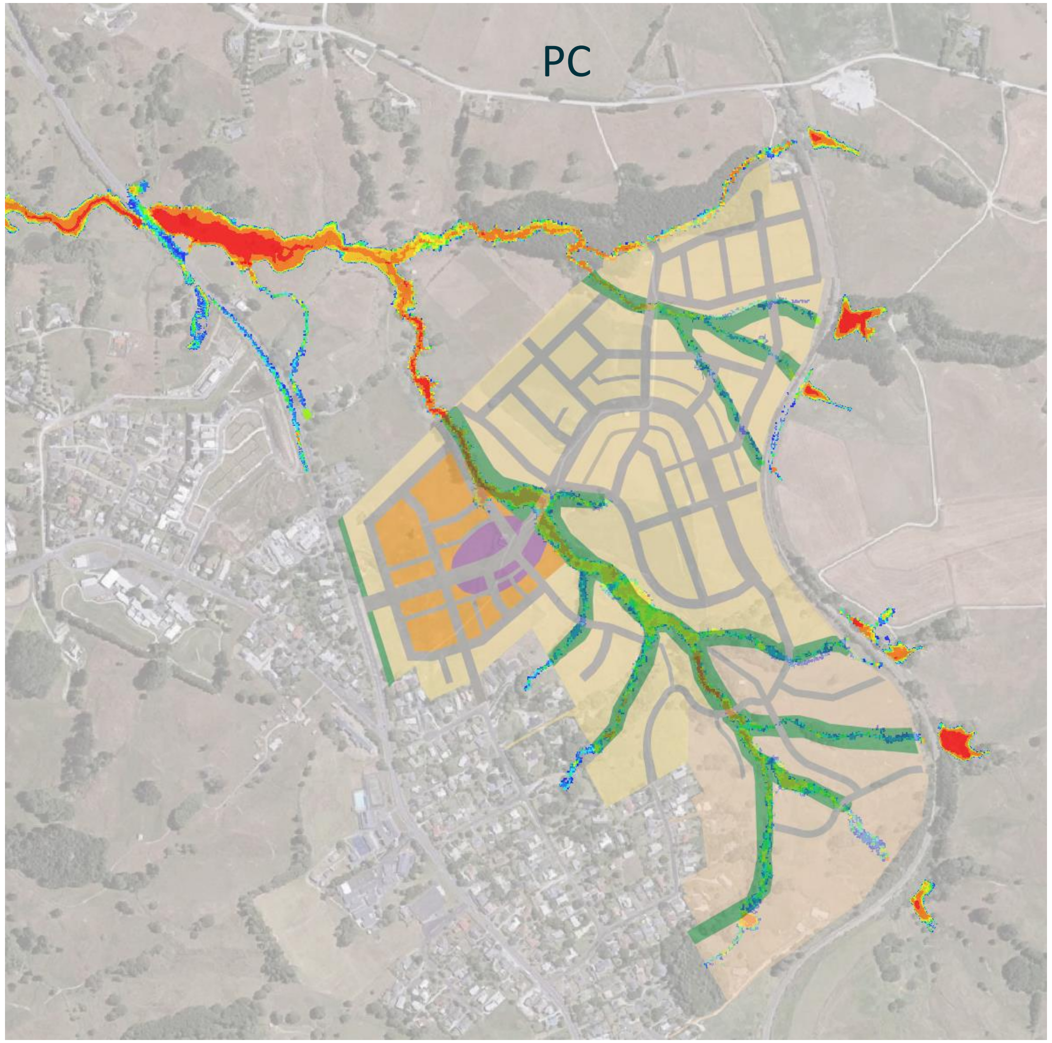
Culvert representation in the model has been changed to include inline banks. Figure above shows the model elements used in the structure crossing. Figure below shows the flows and depths over the 2000mmøx2 culvert.



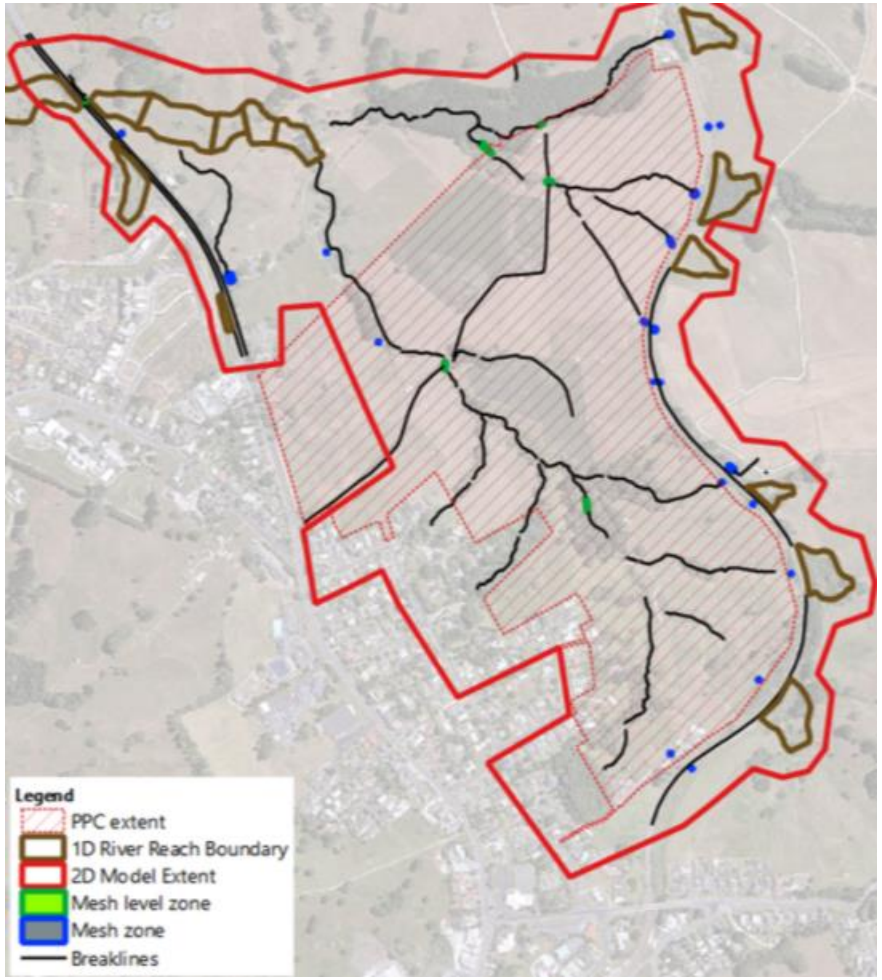
	Flow		Highest depth on line		Highest speed normal to line	
	Min	Max	Min	Max	Min	Max
ED 100yrCC-3.8	0.061	51.295	0.017	0.653	0.384	2.624
ED 10yrCC-3.8	0.002	14.785	0.005	0.355	0.231	1.944
ED 2yrCC-3.8	-0.000	0.629	0.000	0.084	0.000	0.945
PPC 100yrCC-3.8	0.065	53.277	0.016	0.675	0.397	2.654
PPC 10yrCC-3.8	0.000	18.427	0.005	0.382	0.087	2.075
PPC 2yrCC-3.8	0.000	0.656	0.000	0.076	0.000	0.960
PCFUZ 100yrCC-3.8	0.095	57.161	0.019	0.716	0.464	2.709
PCFUZ 10yrCC-3.8	0.007	21.771	0.007	0.410	0.251	2.128
PCFUZ 2yrCC-3.8	-0.000	0.737	0.000	0.106	0.000	1.052

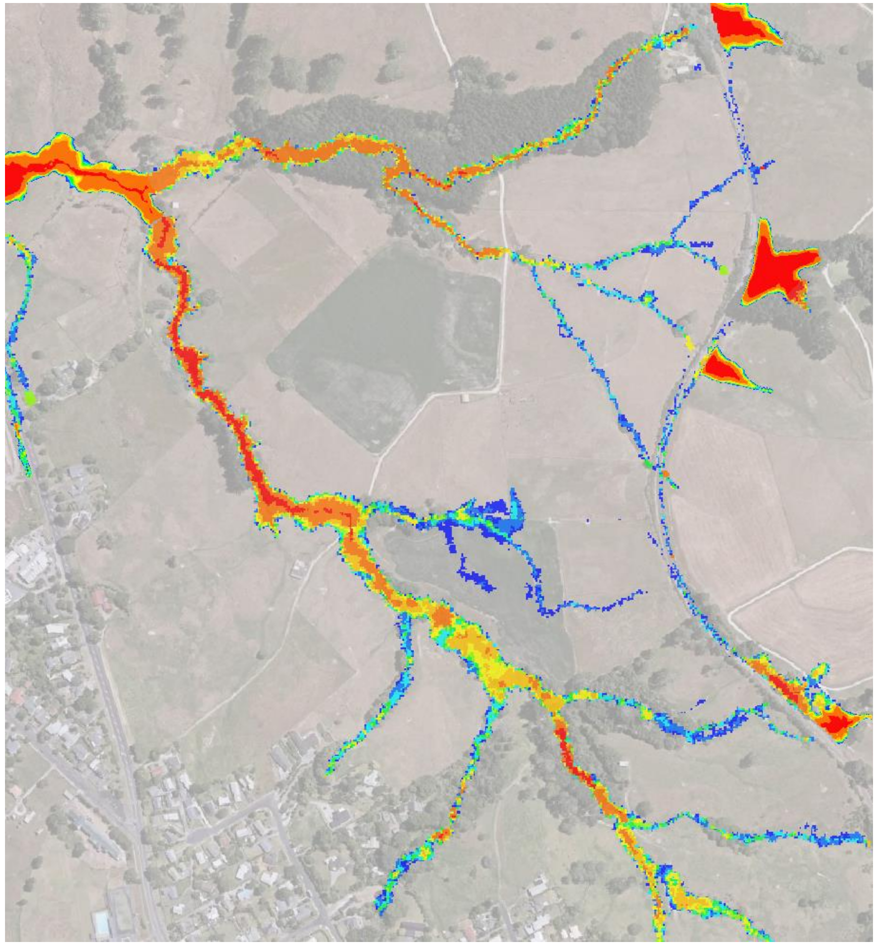
Part 2: Results – 10yrCC (Max Depth)





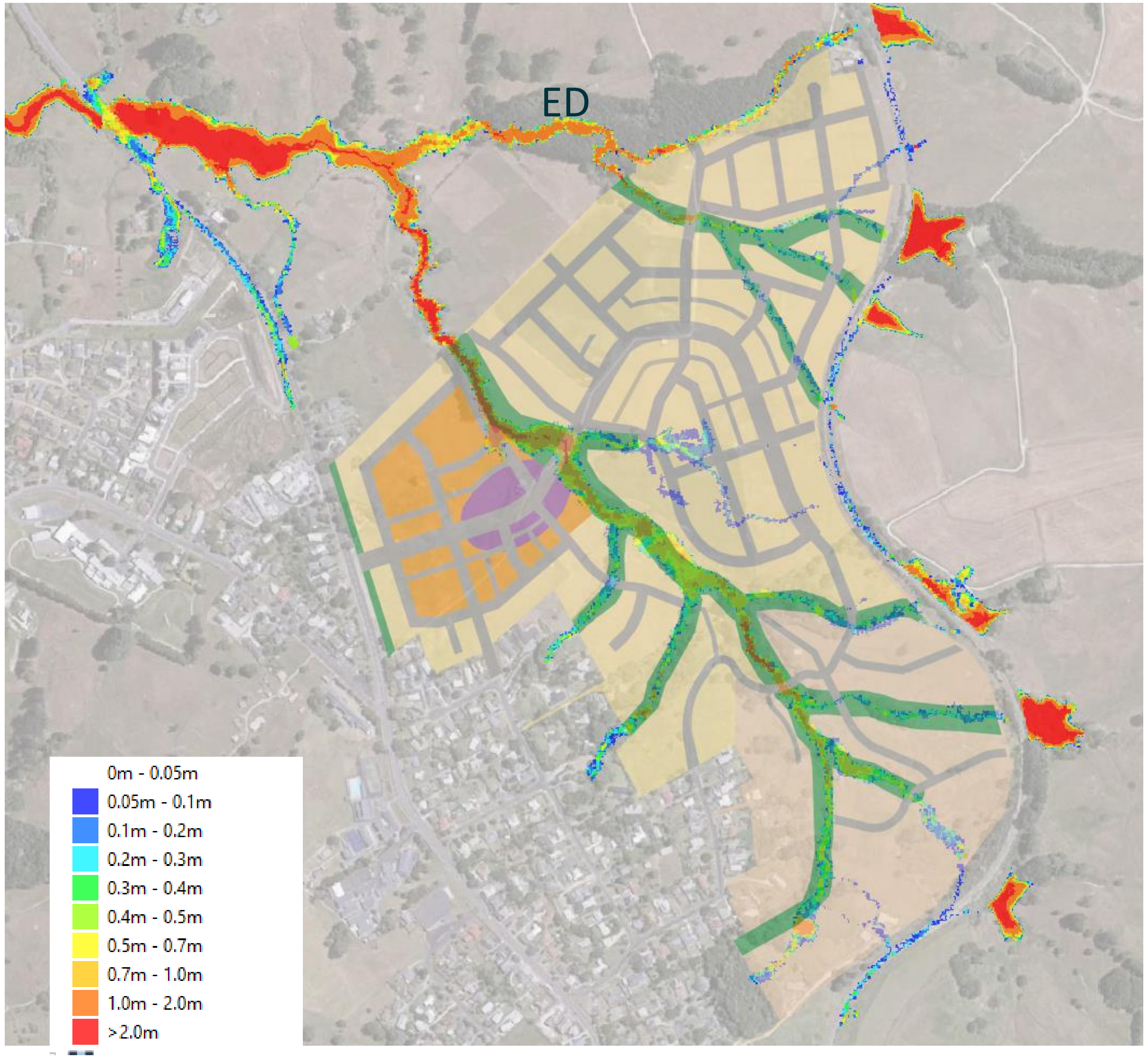
Results

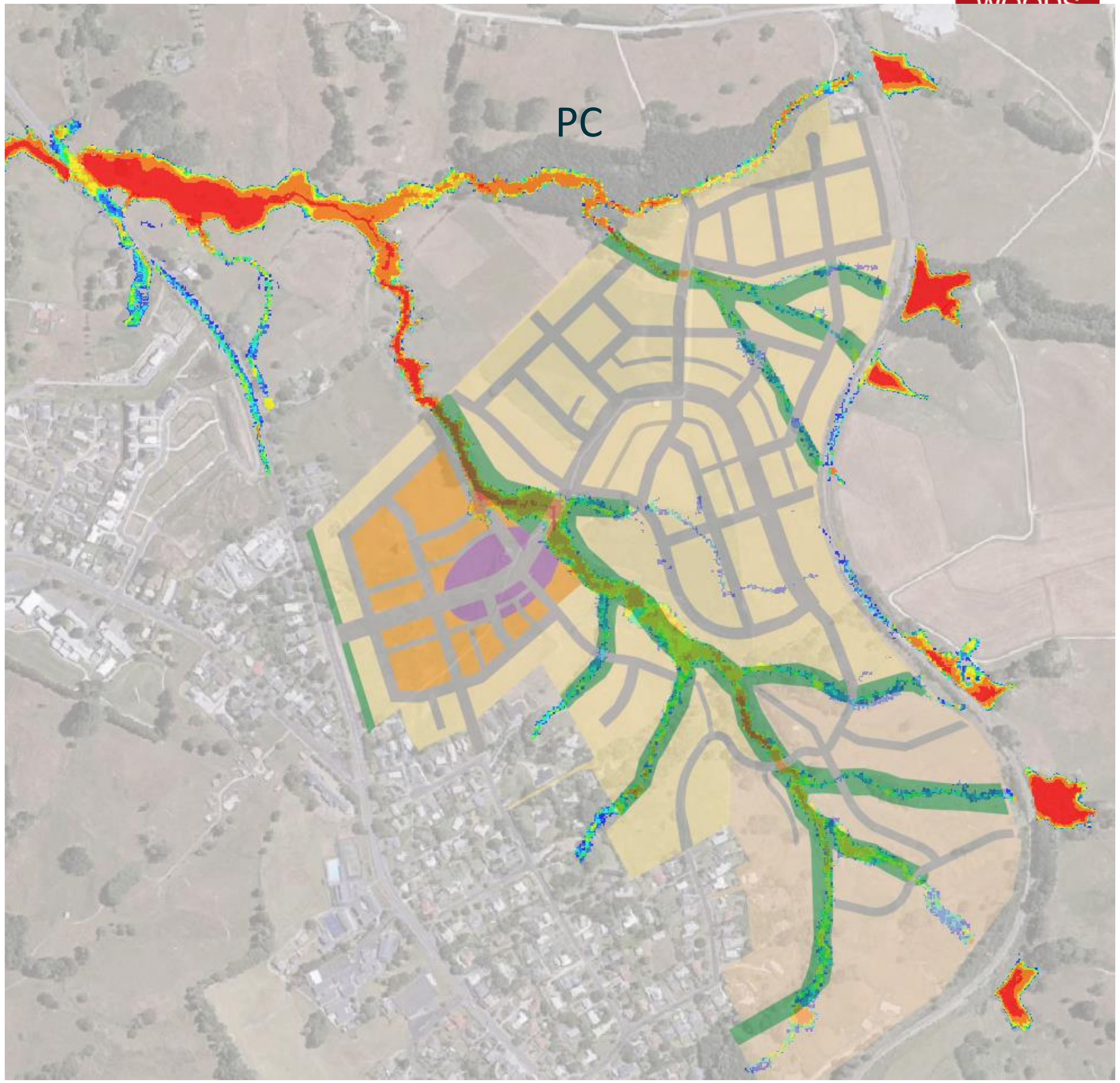

Legend
PPC extent
1D River Reach Boundary
2D Model Extent
Mesh level zone
Mesh zone
Breaklines



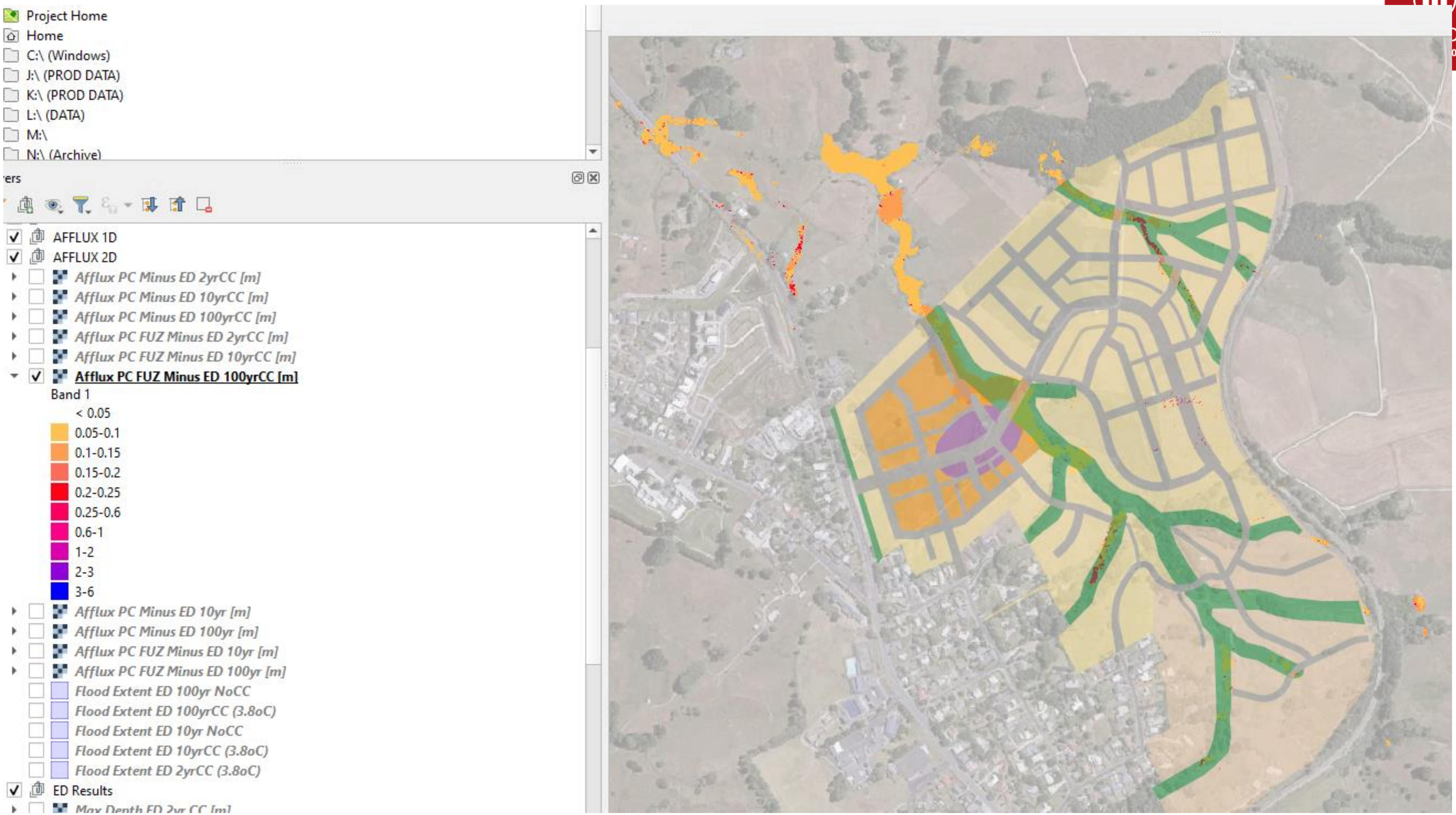
Results – 10yrCC (PPC – ED Afflux)

Results – 100yrCC (Max Depth)

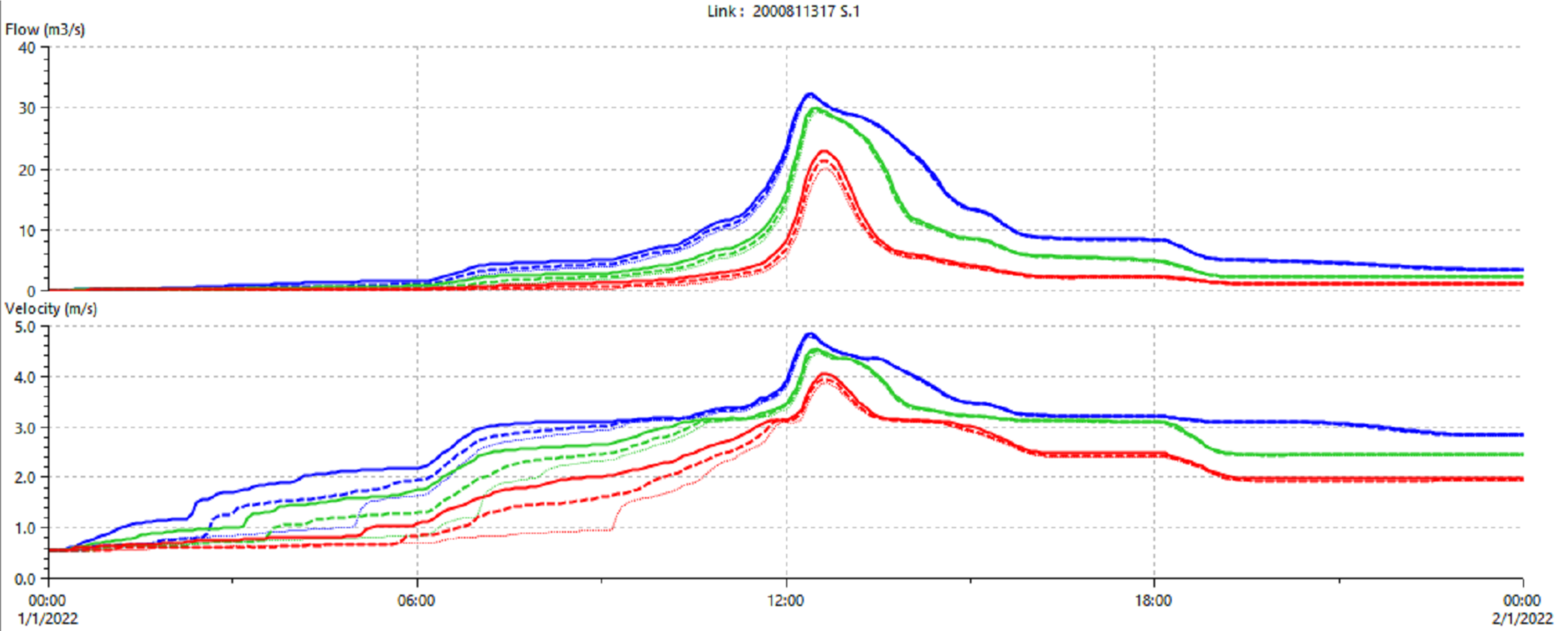




Results – 100yrCC (PPC – ED Afflux)



Results – SH1 Culvert Flows



	Flow		Velocity	
	Min	Max	Min	Max
ED 100yrCC-3.8	0.100	31.871	0.557	4.802
ED 10yrCC-3.8	0.100	29.388	0.557	4.481
ED 2yrCC-3.8	0.100	20.061	0.557	3.871
PPC 100yrCC-3.8	0.100	31.919	0.557	4.798
PPC 10yrCC-3.8	0.100	29.801	0.557	4.535
PPC 2yrCC-3.8	0.100	21.364	0.557	3.950
PCFUZ 100yrCC-3.8	0.100	32.433	0.557	4.871
PCFUZ 10yrCC-3.8	0.100	29.990	0.557	4.557
PCFUZ 2yrCC-3.8	0.100	22.878	0.557	4.047

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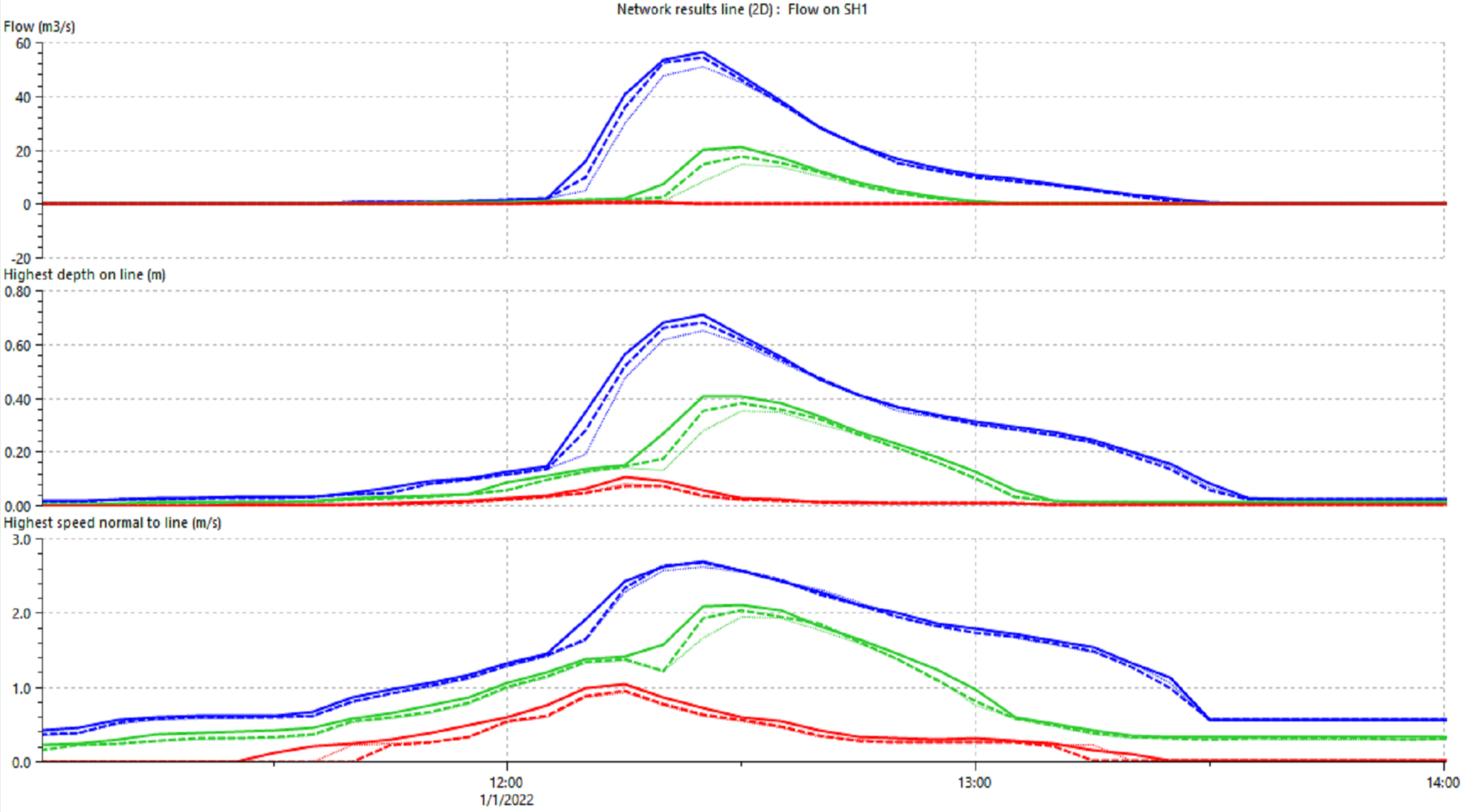
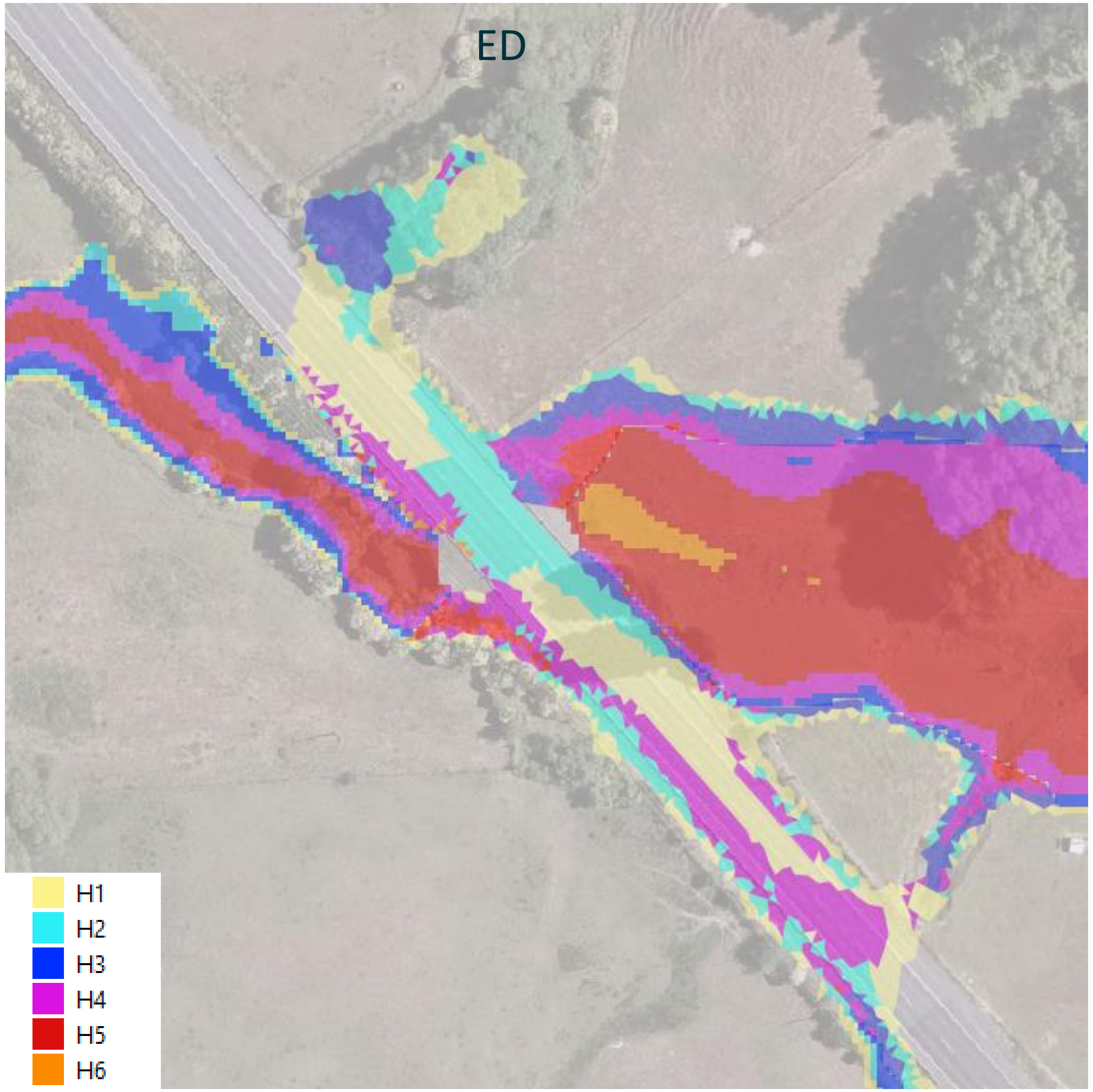
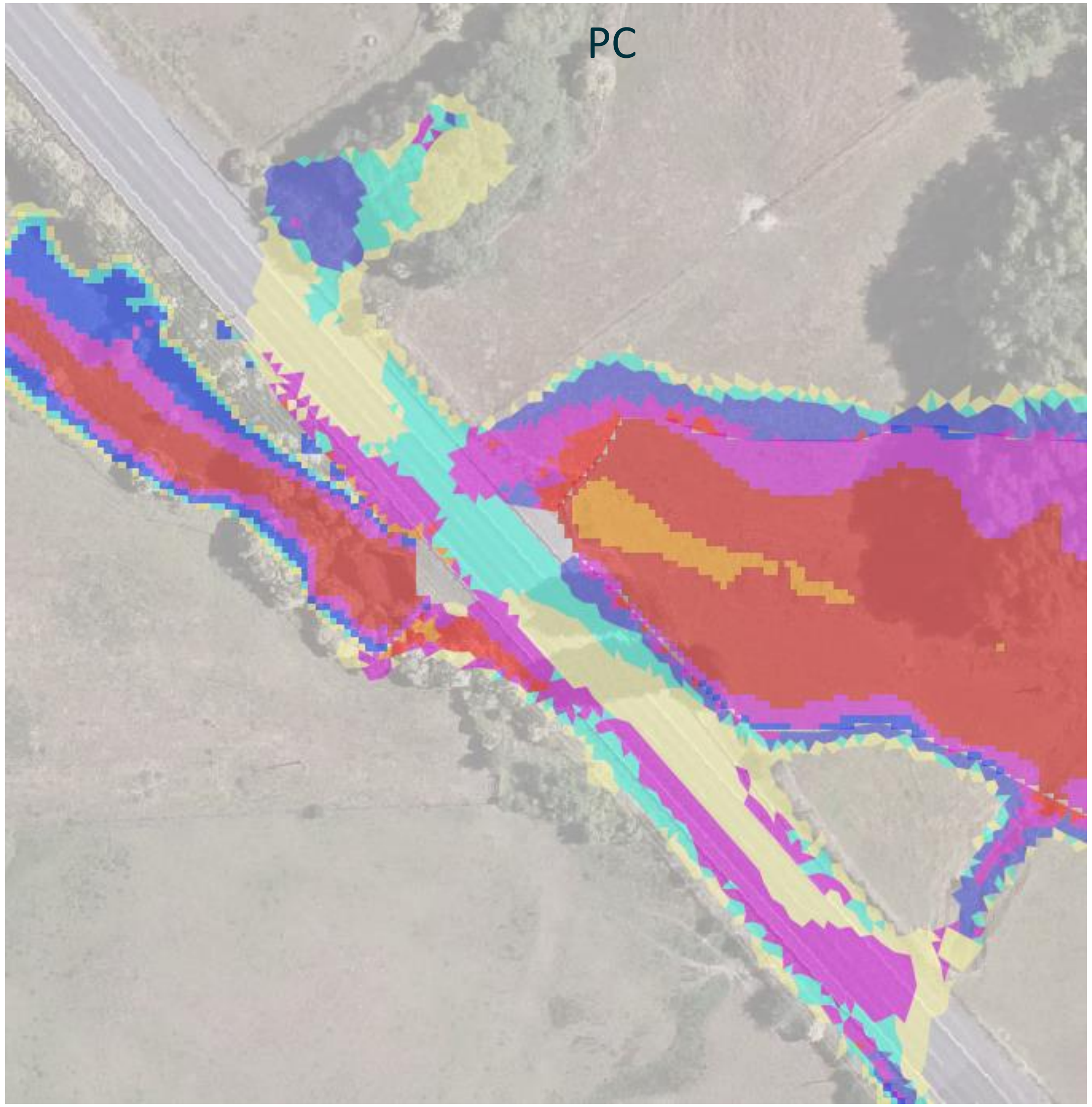
Results – SH1 Overtopping Flows



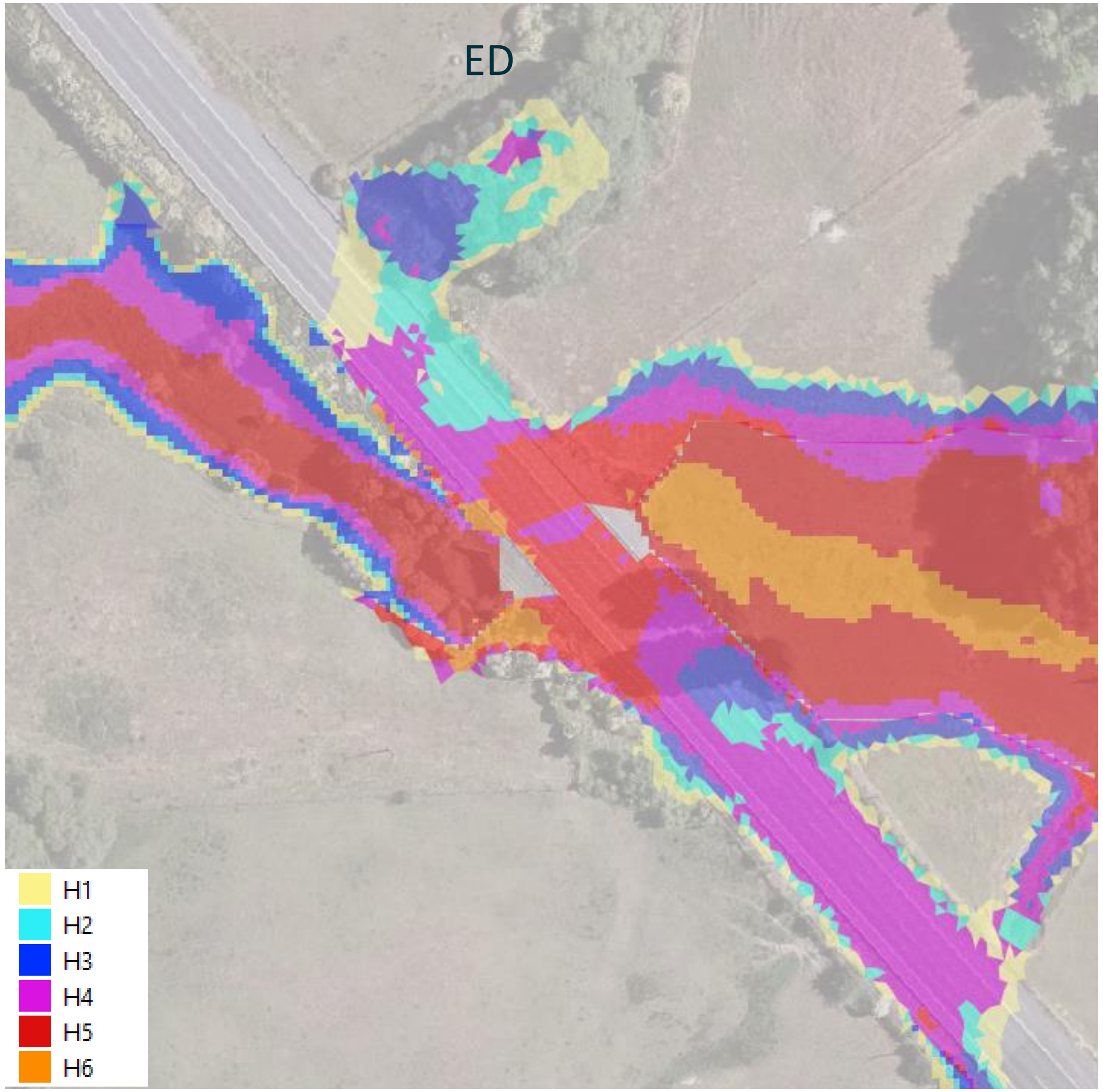
	Flow		Highest depth on line		Highest speed normal to line	
	Min	Max	Min	Max	Min	Max
ED 100yrCC-3.8	0.061	51.295	0.017	0.653	0.384	2.624
ED 10yrCC-3.8	0.002	14.785	0.005	0.355	0.231	1.944
ED 2yrCC-3.8	-0.000	0.629	0.000	0.084	0.000	0.945
PPC 100yrCC-3.8	0.068	54.453	0.016	0.681	0.397	2.675
PPC 10yrCC-3.8	0.002	17.655	0.006	0.385	0.230	2.036
PPC 2yrCC-3.8	-0.000	0.657	0.000	0.075	0.000	0.960
PCFUZ 100yrCC-3.8	0.095	56.543	0.019	0.711	0.464	2.704
PCFUZ 10yrCC-3.8	0.006	21.145	0.007	0.405	0.252	2.107
PCFUZ 2yrCC-3.8	0.000	0.739	0.000	0.106	0.000	1.052

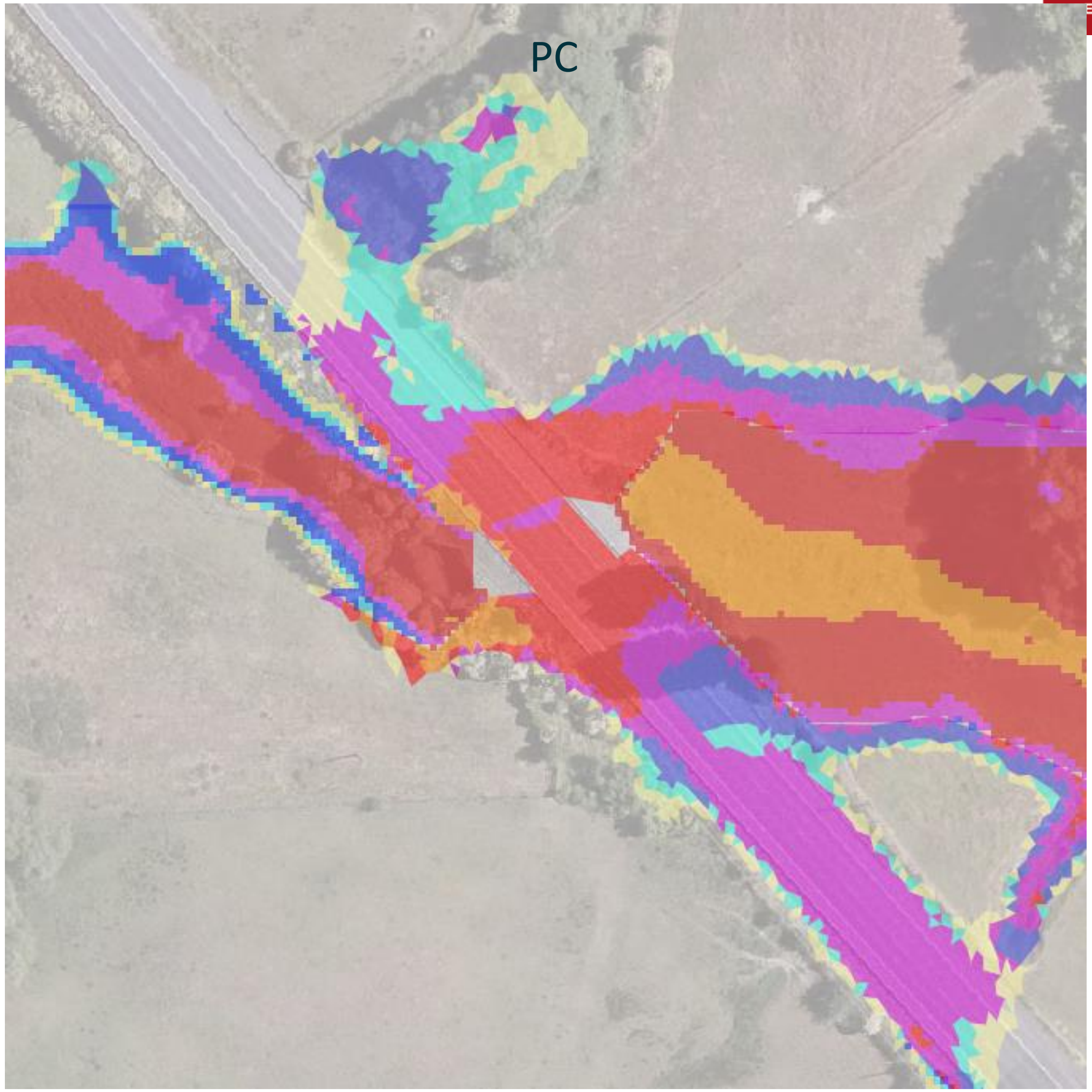
Results – 10yrCC (HAZRAD)





Results – 100yrCC (HAZRAD)

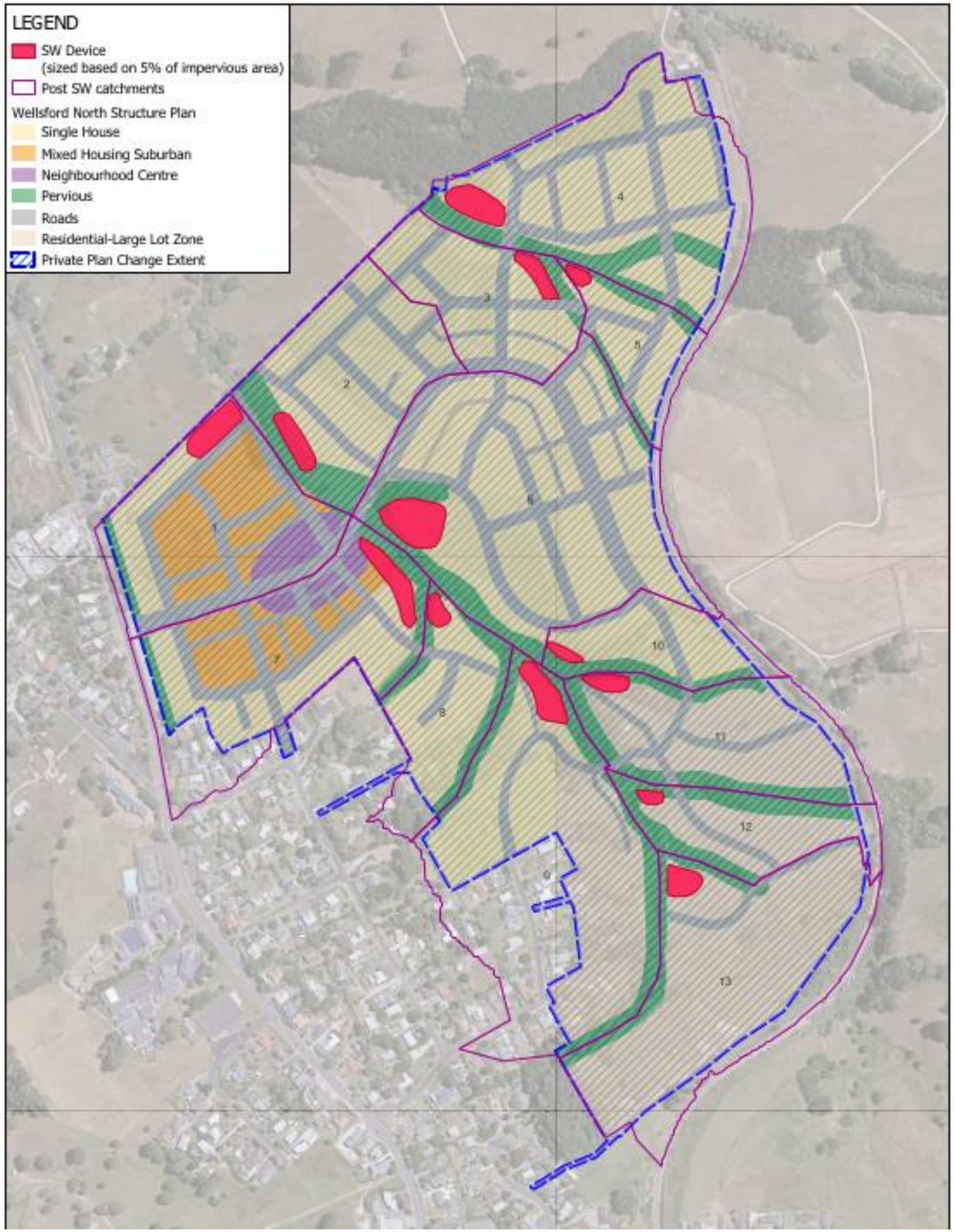




Wellsford Plan Change – Meeting with Healthy Waters 31/05/2023

Agenda

- To discuss the second cl23 Request – in summary:
  - Use of the “toolbox” to identify a range of methods as opposed to identifying a preferred method and adequacy of the SMP and certainty of design options
  - Vesting of SW assets
  - Existing 2-year stormwater event modelling/ Waka Kotahi engagement
  - Applicability of SMAF1 as a minimum
- Update the SMP
- Any other matters



- Indicative communal raingarden device locations
- Approximate sizing based on 5% of total impervious area (includes private lots and public roads)
- Meets SMAF1 and WQ treatment requirements
- The final layout and sizing is dependent on earthworks/ design surface, proposed pipe layouts, and geotechnical considerations and to be confirmed during Resource Consenting
- **Implementation of devices** - stormwater management devices to be constructed prior to any hardstand
- **Vesting** – devices are proposed to be located within reserves and vested to Auckland Council as the source of runoff will be both private and public (road) runoff. To be confirmed during Resource Consenting.

NDC requirements - broad categories
(Schedule 4)

Treatment levels

Groundwaters, erosion, and ecology-SMAF - *small events*

Flooding – *large events and OLFP's*

Asset management, maintenance and BPO

Piped network *(10% and EPA)*

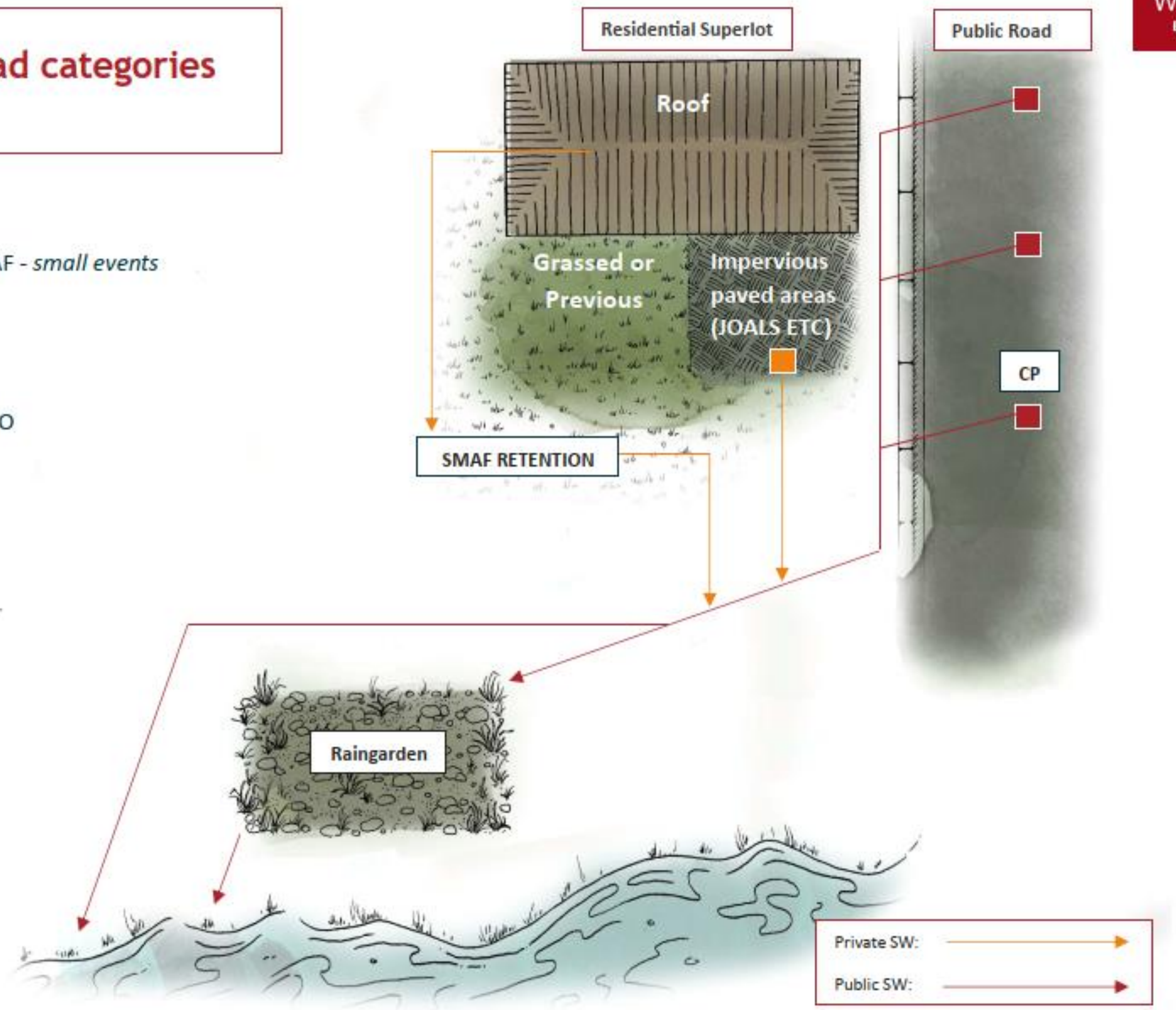


Table 10 from SMP 'Toolbox' - amended and simplified:

<table>
<tr><th rowspan="3"></th><th colspan="5">Stormwater Management</th><th rowspan="3">Sizing</th></tr>
<tr><th rowspan="2">Water Quality</th><th colspan="2">Hydrology Mitigation</th><th rowspan="2">Primary Conveyance</th><th rowspan="2">Secondary Conveyance</th></tr>
<tr><th>Retention</th><th>Detention</th></tr>
<tr><td>Building – Roof areas</td><td>Non-contaminant generating roofing materials
Reuse tanks – provides first flush treatment</td><td>Retention via re-use at source 5mm (limited to roof areas)</td><td>Detention via communal bioretention raingardens</td><td rowspan="2">Convey runoff generated from 10-yr ARI (inclusive of 3.8 °C) rainfall events</td><td>FFL to be provided as per SWCOP</td><td>0.5m³/100m² (retention) of roof area to reuse tank, and 21.3m³/100m² (detention) of the roof area to communal raingarden
(minimum 5% of impervious area)</td></tr>
<tr><td>New Public Roads
Private JOALs/ hardstand, carparks, and other private impervious areas</td><td colspan="3">WQ and hydrology mitigation to be provided via
Communal bioretention raingardens</td><td>Convey OLFP from 100-yr ARI (inclusive of 3.8 °C) within the road reserves and green spaces</td><td>0.5m³/100m² (retention) + 21.3 m³/100m² (detention) of the impervious area to communal raingarden
(minimum 5% of impervious area)</td></tr>
</table>

Applicability of SMAF1 as a minimum:

The site investigation and walkover undertaken by the ecologist did not identify stream erosion. The ecologist (Viridis) and Stormwater engineers (Woods) recommend stream erosion mitigation measures for the Plan Change Areas as follows:

- Modification of hydrograph mitigated through stormwater retention/detention (SMAF 1 hydrological mitigation) measures which will slow flows.

- Removal of stock from the site and therefore avoiding active bank de-stabilisation through stock access and pugging.

- Incorporation of green spaces adjacent to stream networks to provide for planting of riparian margins to improve bank stability and reduce erosion potential.

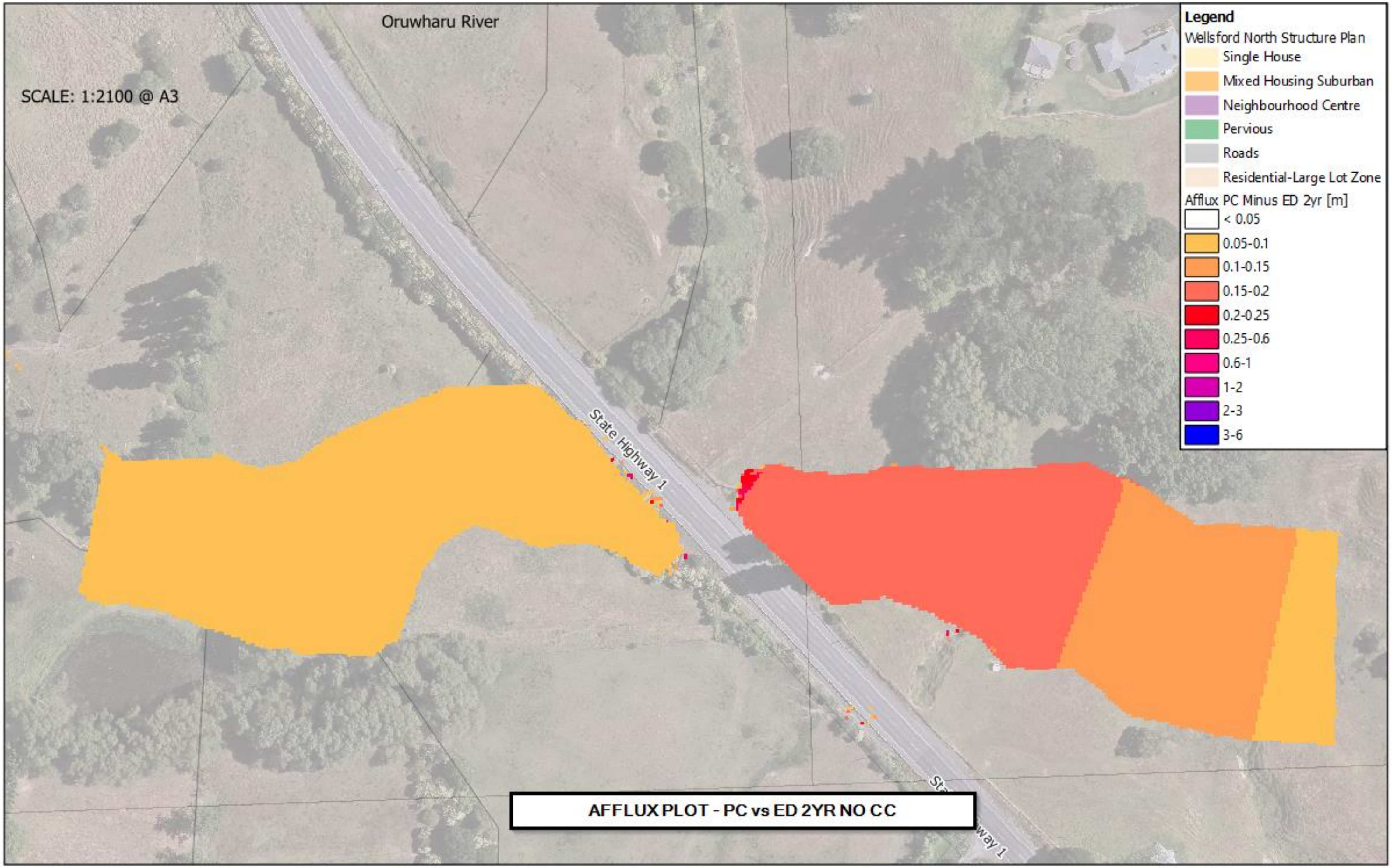
- Incorporation of erosion and scour protection measures at all outfalls to minimise erosion at new structures.

- Targeted in-stream erosion protection measures may be required at the location identified immediately downstream of the southern crossing.

However, as requested, The SMP to be updated to reflect that an erosion study to be completed once the stormwater pipe network is conceptually designed to enable an assessment of whether SMAF 1 is appropriate, or whether a higher standard is required

Model scenarios table amended

Scenario	Land use	Rainfall	Purpose	Comparison
Base	Existing impervious coverage	2-,10- 100-year - no CC	Understand existing flood risk	-
ED CC		2-, 10- 100-year - 3.8°C	Understand existing flood risk inclusive of 3.8 °C climate change	-
PPC	Private Plan Change (MPD coverage) + ED (Existing impervious coverage)	2-,10- 100-year - no CC	Understand flood risk as a result of development within the PPC area only	**Effects assessment** Compared to Scenario Base to assess the impacts of development within the PPC area only
PPC CC		2-, 10- 100-year - 3.8°C	Understand flood risk as a result of development within the PPC area only inclusive of 3.8 °C climate change	**Effects assessment** Compared to Scenario ED CC to assess the impacts of development within the PPC area only, inclusive of 3.8 °C climate change
PC FUZ	Maximum probable development (MPD as per AUP: OiP) + Private Plan Change	2-, 10- 100-year - no CC	Understand flood risk as a result of the MPD development	Compared to Scenario Base to understand the cumulative effects as a result of development within the PPC area and MPD coverages in other areas
PC FUZ CC		2-, 10- 100-year - 3.8°C	Understand flood risk as a result of the MPD development inclusive of 3.8 °C climate change	Compared to Scenario ED CC to understand the cumulative effects as a result of development within the PPC area and MPD coverages in other areas inclusive of 3.8 °C climate change



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Culvert Information – PPC Scenarios

Scenario	Water level on SH1 (mRL) Base	Water level on SH1 (mRL) PPC	Depth over SH1 (m) Base	Depth over SH1 (m) PPC	Depth increased in upstream flood level considering PPC (m)	Is culvert overtopping	Freeboard depth (Edge to Seal of WL)	Culvert surcharging frequency and duration of culvert surcharge with freeboard <500mm (min)
2yr – no cc	0	0	0	0	0.000	No	1.681	0
2yr – cc	16.43	16.432	0.0158	0.0173	0.002	No	0.938	0
10yr – no cc	16.445	16.446	0.03	0.0305	0.001	No	0.195	24
10yr – cc	16.777	16.792	0.361	0.376	0.015	Yes	0.000	59
100yr – no cc	16.802	16.812	0.386	0.396	0.010	Yes	0.000	70
100yr – cc	17.036	17.053	0.621	0.638	0.017	Yes	0.000	99

Any other matters/ Next steps

- SMP to be updated and resubmitted
- Any other matters?

Appendix D

Model Build Memorandum

APPENDIX

To

Wellsford Welding Club

From

Miguel Hernandez – 3-Waters Engineer
Tony Wang – 3 Waters Engineer

W-REF: P21-395

2 June 2023

Reviewer: Ajay Desai – Senior Engineer – 3 Waters

Wellsford North Plan Change – Model Build Memorandum Rev2

1. Introduction

Wellsford Welding Club is planning a Private Plan Change (PPC) in the Wellsford North area. The development is classified as a 'Greenfields' development under Schedule 4 of Auckland Council's Regionwide Network Discharge Consent (NDC) and requires a stormwater management plan to be compliant with the NDC requirements. Woods have undertaken flood modelling for the PPC and surrounding areas which is summarised in this memorandum. This memorandum should be read in conjunction with the Wellsford North Plan Change – Stormwater Management Plan prepared by Woods, dated 02/05/2022.

It is noted that at the time of development, further model refinements will be required to assess effects of development in further detail.

The PPC is located within the wider Kaipara Wellsford catchment. The flood modelling intent is to assess any flood effects resulting from the PPC and any flood risks within the development area while supporting the Stormwater Management Plan. The PPC area location can be seen in Figure 1.

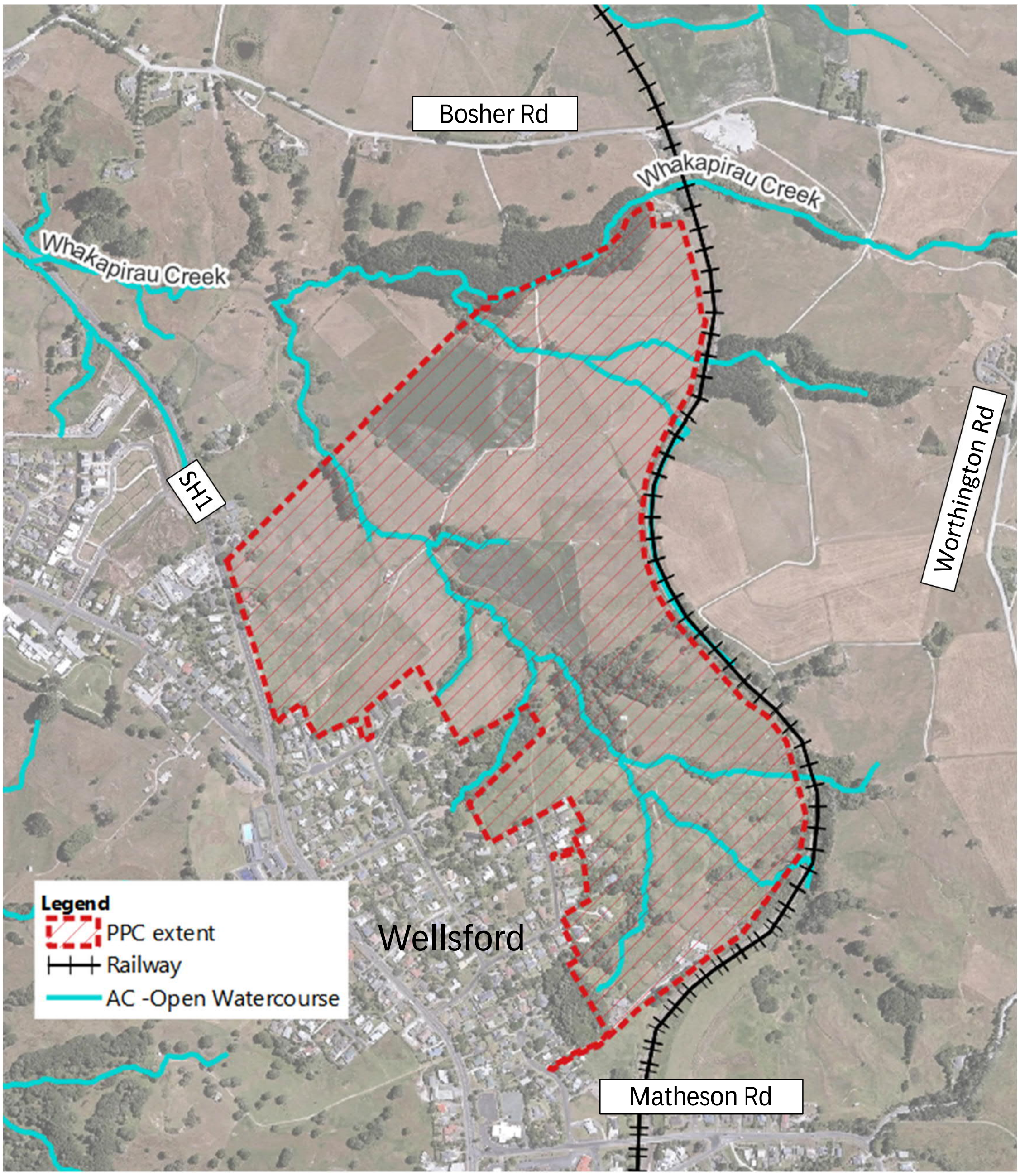

Figure 1: PPC location plan

Woods have developed an InfoWorks ICM model (by Innovyze, version 2021.9) to assess 15 different scenarios, including the updates in the Stormwater Code of Practice (SWCoP) - V3 (January 2022). The ICM model dynamically couples 1-D and 2-D model elements to represent stormwater networks, open channels (1D), and overland flow (2D) focused in the PPC area. The Auckland Council model review form has been populated to document technical details of this model, to assist Healthy Waters (HW) department review process. The model review form is attached in Appendix B.

2. Model Extent

The PPC area is located within the Kaipara Wellsford catchment. The model extent was determined using the Auckland Council Geomaps overland flow path layer to include all the areas contributing to the Wellsford North Plan Change area. The model extent also includes areas downstream of the Wellsford North Plan Change area where catchments contribute to permanent streams and ultimately discharge to the Oruawharo River. The permanent rivers and creeks have been modelled as river reaches 1D elements. The model extent is approximately 1,708 hectares in, as shown in Figure 2.

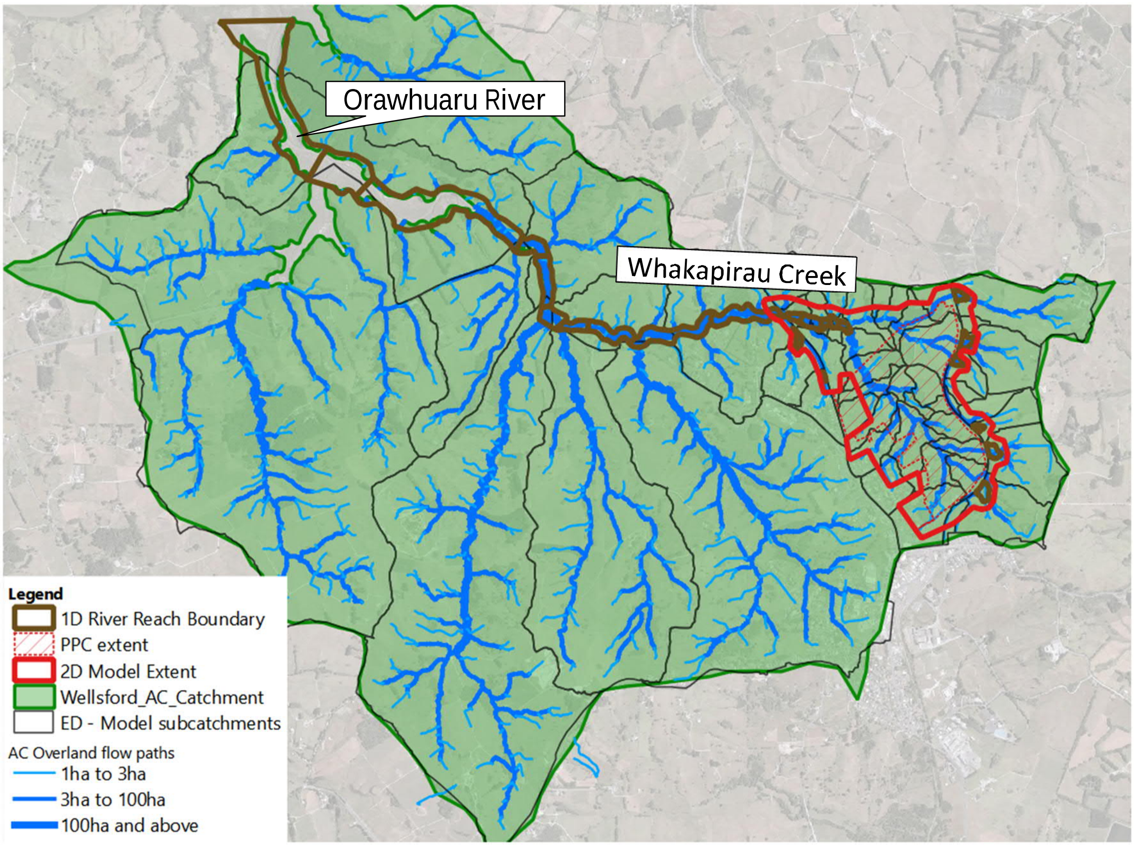

Figure 2: Model extent and subcatchment out of PPC area

2.1. Hydrological Model

The hydrological model was developed using the SCS method based on the TP108 approach and modelled using the Unit Hydrograph Method as per the Stormwater Flood Modelling Specifications (Nov 2011). Overlapping subcatchments were modelled separately for the impervious and pervious areas for the existing development (ED), ED including private plan change (PPC) and maximum probable development (MPD) including PPC. Appendix D shows the hydrology parameters for the existing development.

2.2. Subcatchments

2.2.1. Existing development

The delineation of the subcatchments within the model extent is based on the updated terrain surface (that includes a topo survey and the LiDAR2016) data and the Auckland Council Geomaps overland flow path layer. The modelled subcatchments areas range between 0.7 ha and 433 ha. To represent the flood on the flat PPC area, the subcatchments have been loaded either to the 2D surface through 2D points source or directly to river reaches (1D). A total of 51 subcatchments have been modelled, and part of them are seen in Figure 3. Of the 51 subcatchments, 29 are loaded to the 2D surface and 22 to the river reaches. The highlighted subcatchments in Figure 3 correspond to those that discharge directly to river elements.

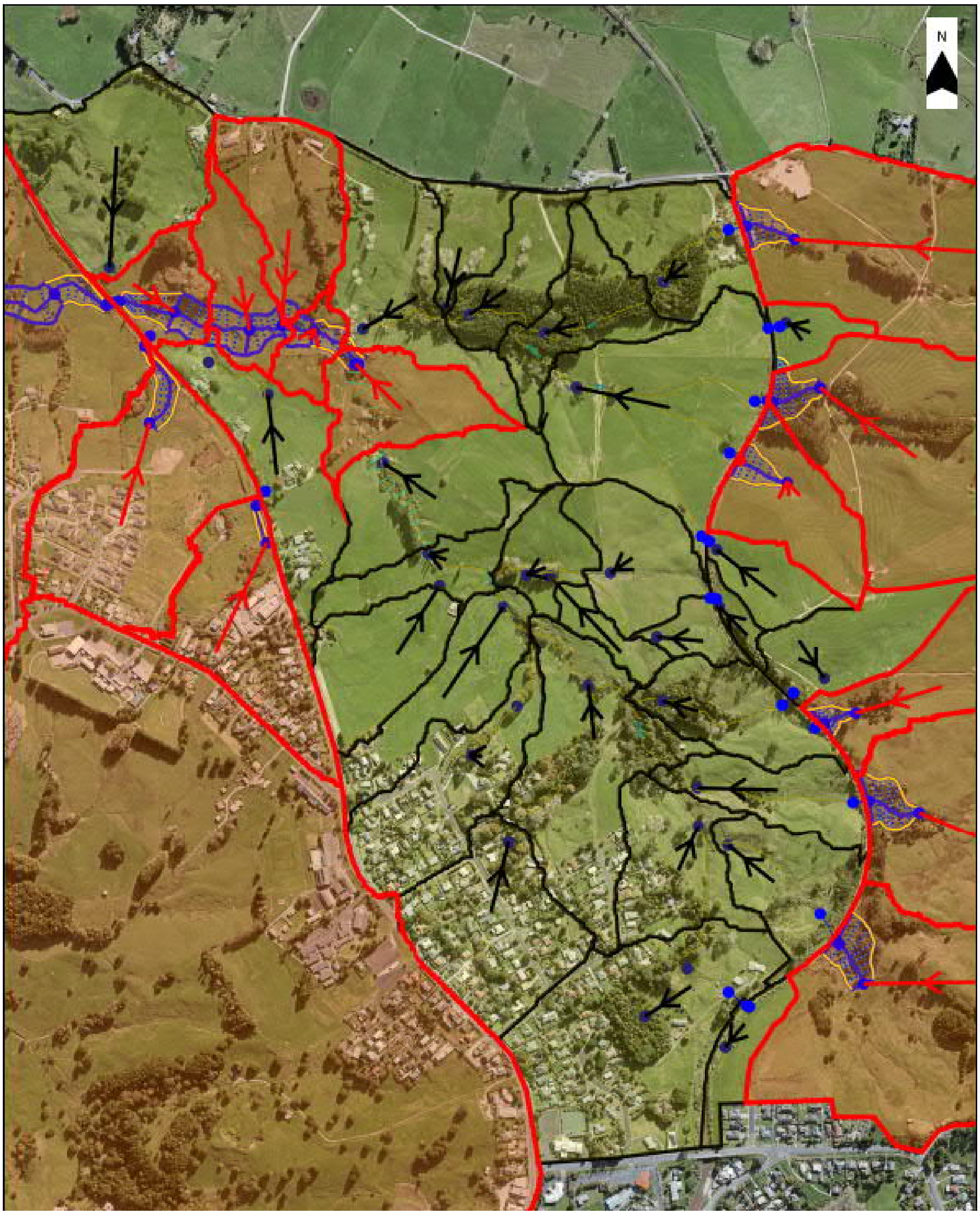

Figure 3: ED Subcatchments location and loading nearby PPC.

2.2.2. Future development

The subcatchment delineation for the future scenario has been created following the PPC proposed structure plan shown in Figure 4, and the updated terrain surface. For this scenario, there is a total of 70 subcatchments, 48 are loaded to the 2D surface, and 22 to the river reaches. Figure 5 shows the subcatchment loadings near the PPC extent. Highlighted in red are the subcatchments that drain directly to river reaches.

Due to the proposed structure plan arrangement, it was assumed that some of the small subcatchments at the east of the railway runoff flow would be piped and then discharged at the main open watercourse within the PPC extent. These subcatchments are Wellsford-1D-PRE-19, Wellsford-1D-PRE-20 and Wellsford-1D-PRE-06, circled in blue in Figure 4.

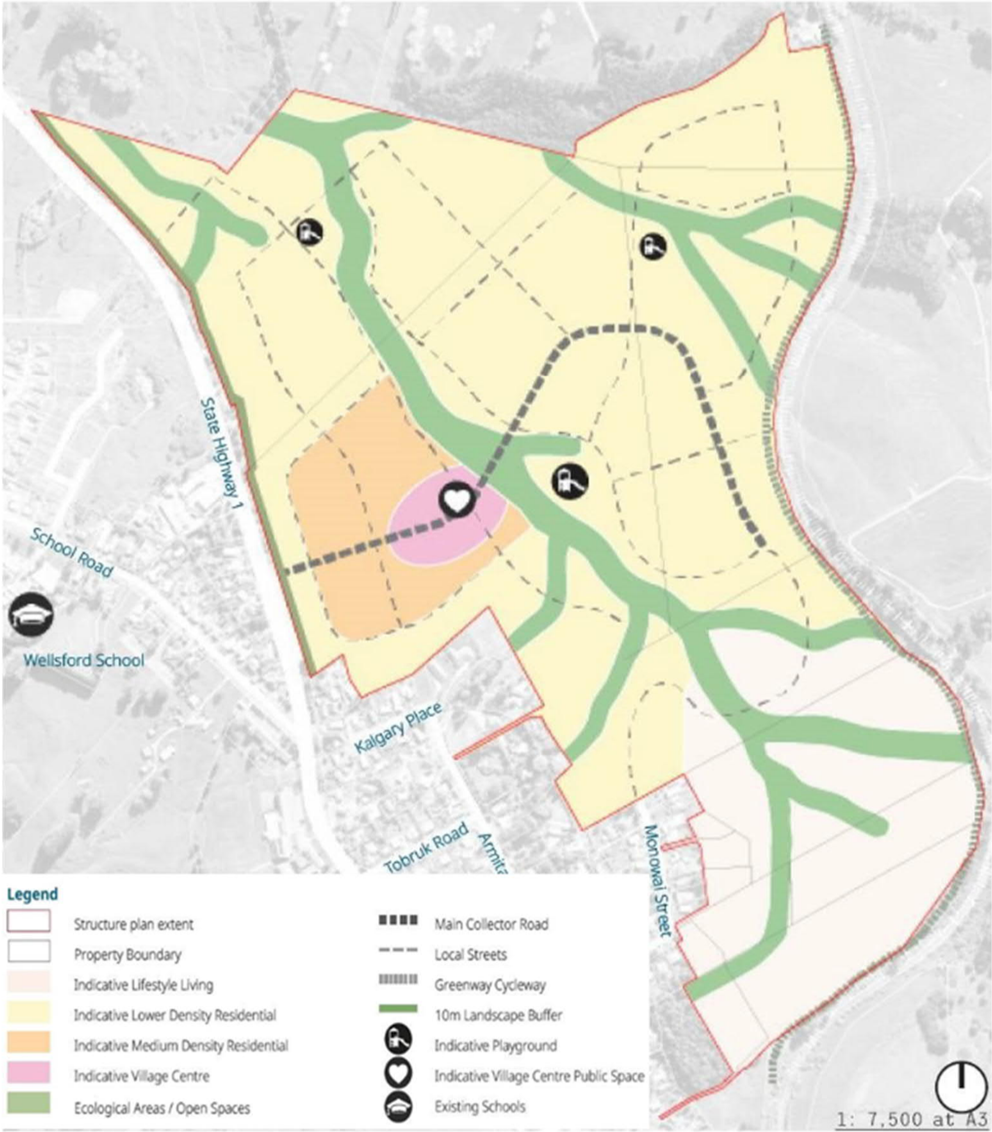

Figure 4: Proposed PPC structure plan

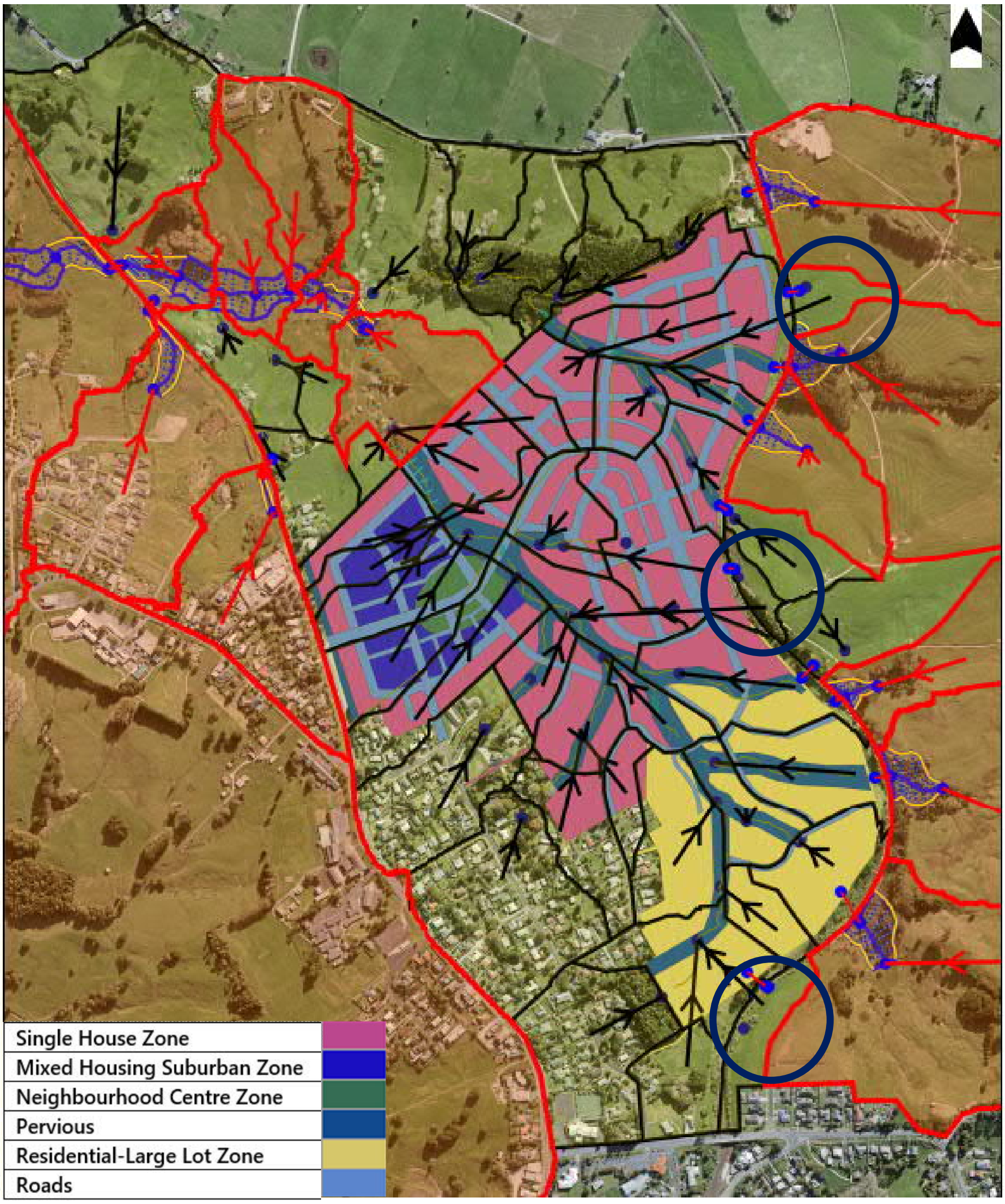

Figure 5. Subcatchment loading in the future scenarios

2.3. Time of concentration

The time of concentration (Tc) has been calculated and ranges from 10 mins to 67 mins. Figure 6 shows the Tc for the existing scenario subcatchments. Calculations are summarized in Appendix D.

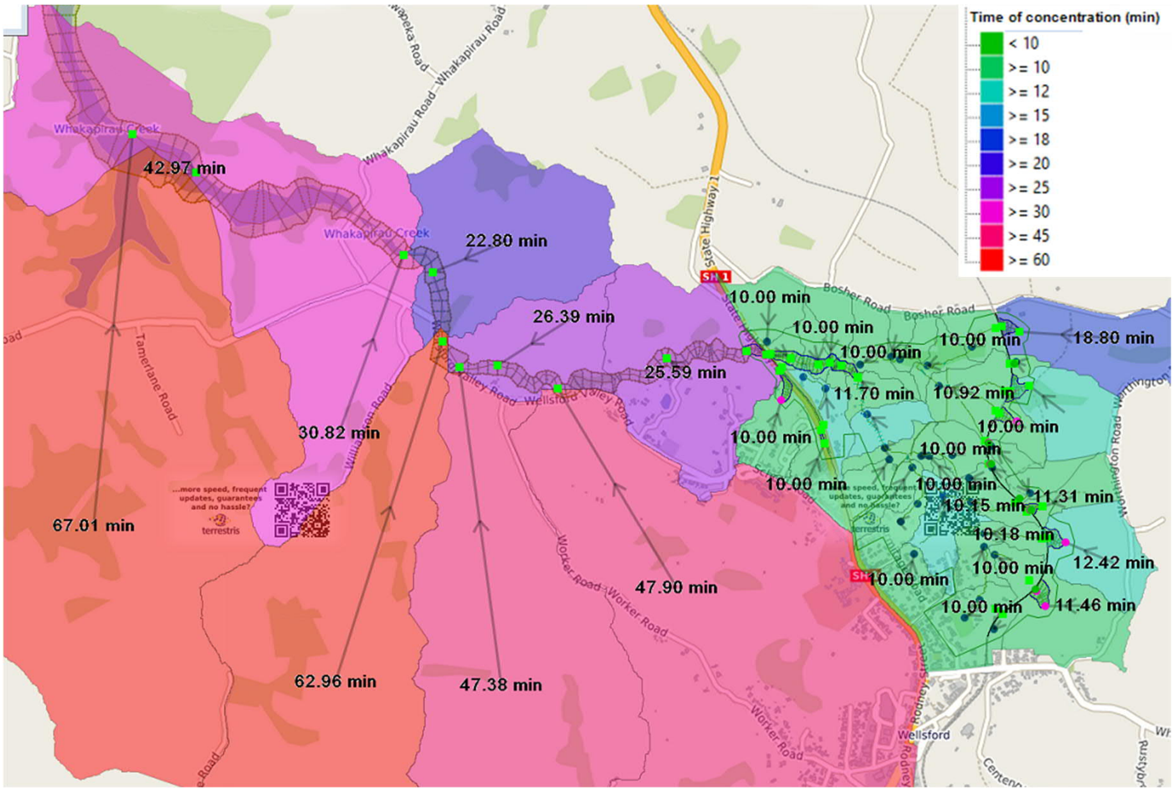

Figure 6. Time of concentration for the ED scenario.

2.4. Initial Abstraction

Impervious areas were given a 0 mm initial abstraction, and pervious areas were given a 5 mm initial abstraction.

2.5. Curve Number

The impervious areas were assigned a Curve Number (CN) value of 98 for all modelled scenarios.

The pervious areas were assigned a Curve Number (CN) value of 74 for all modelled scenarios.

3. Land Use

3.1. Existing Development (ED)

The existing land use for the Kaipara Wellsford catchment is predominantly rural, comprising rural lifestyle blocks and pastures. Nearby the area of interest, there are residential and commercial areas, mainly along Rodney Street (SH1) and southwest of the proposed plan change, as seen in Figure 7. The impervious percentage for the entire model extent is approximately 5.1%. The existing impervious percentage inside the PPC is approximately 3.3%. These values were calculated with the 'impervious surfaces 2008' layer published in GEOMAPS. Figure 8 shows the impervious percentages in the vicinity of the PPC extent.

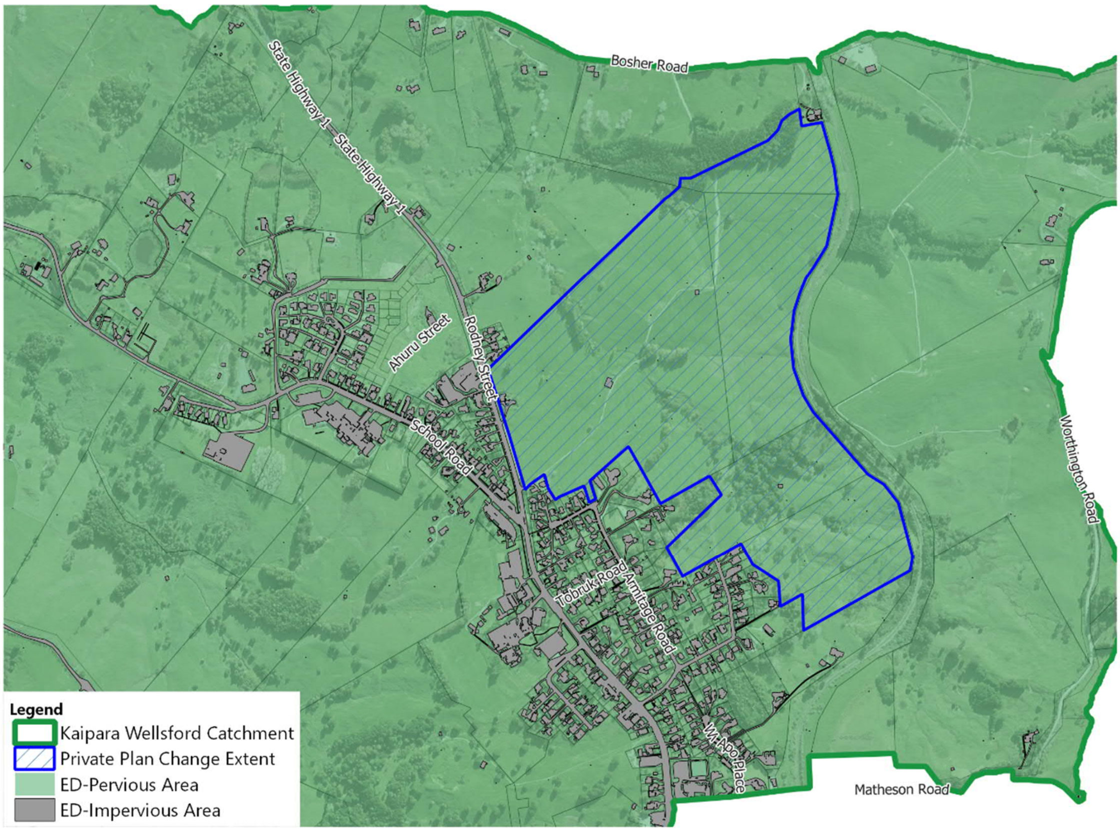

Figure 7. Existing development land use

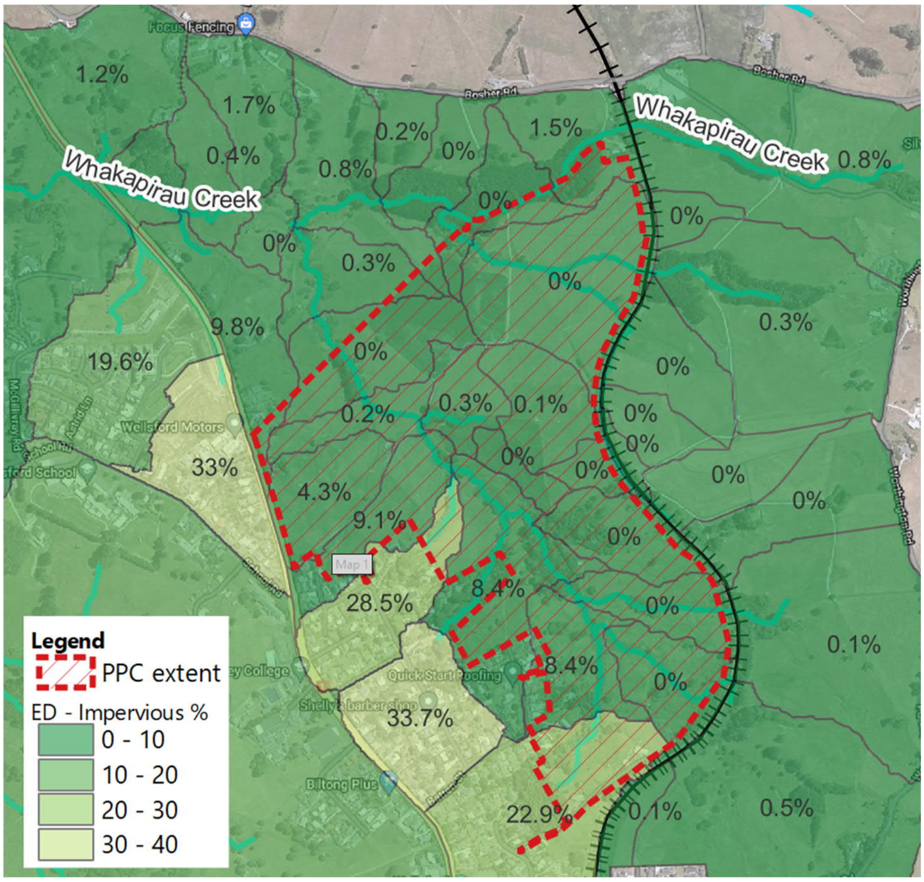

Figure 8. Existing development impervious percentage values

3.2. Existing Development (MPD), including Private Plan Change (PPC)

The PPC is located in an area designated as predominantly Future Urban Zone, with a portion designated as Rural Production Zone, Rural Countryside Living Zone and Single House Use as per the Auckland Unitary Plan – Operative in Part (AUP-OiP). The PPC includes three different residential zones and one small business centre zone, as shown in Figure 9. Outside of the proposed PPC extent, landuse will be unchanged from the ED land use detailed in section 3.1. Figure 10 shows the final PPC land use; within the proposed plan change, roads and future green areas were considered as in the proposed structure plan (Figure 4).

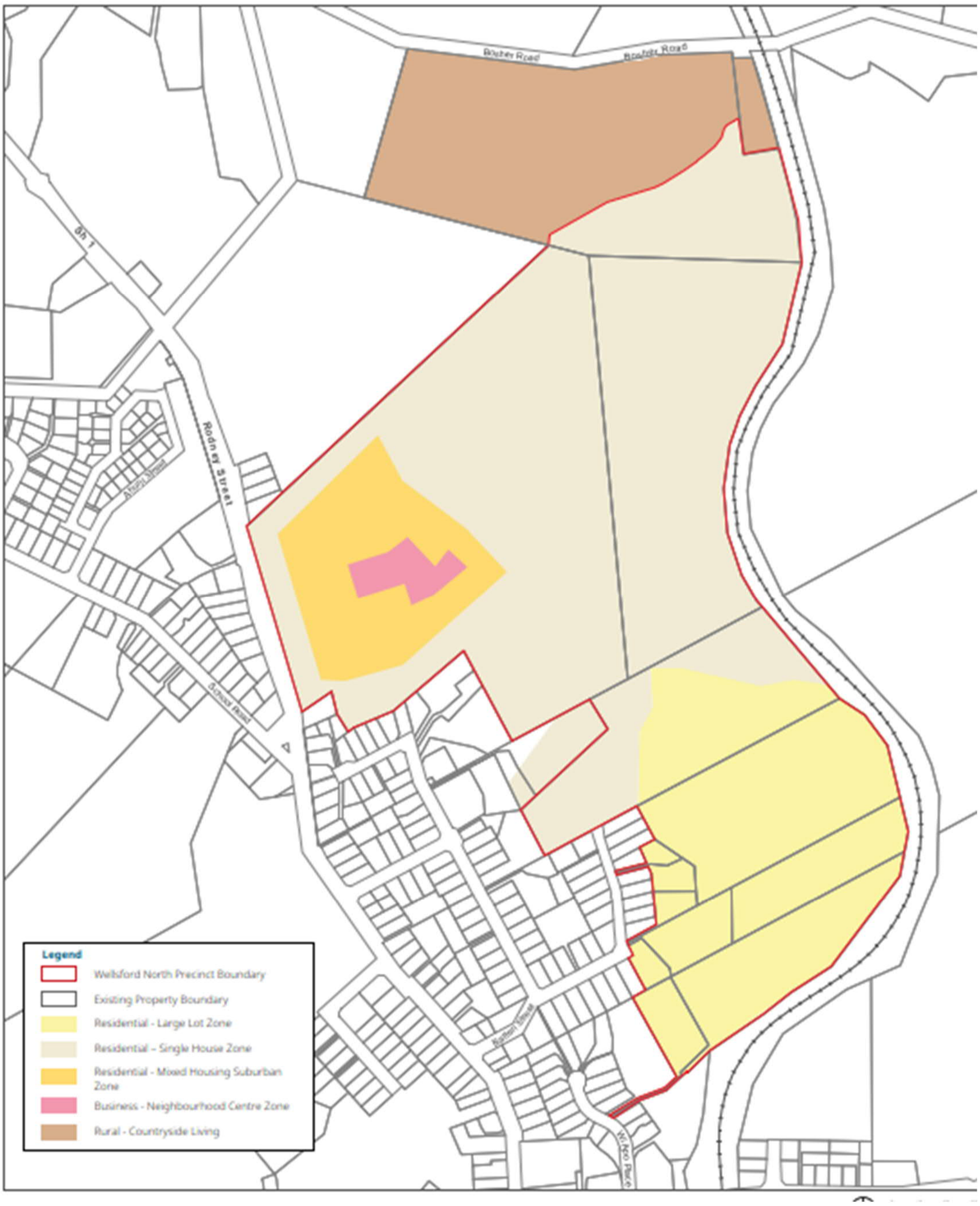

Figure 9. Proposed land use

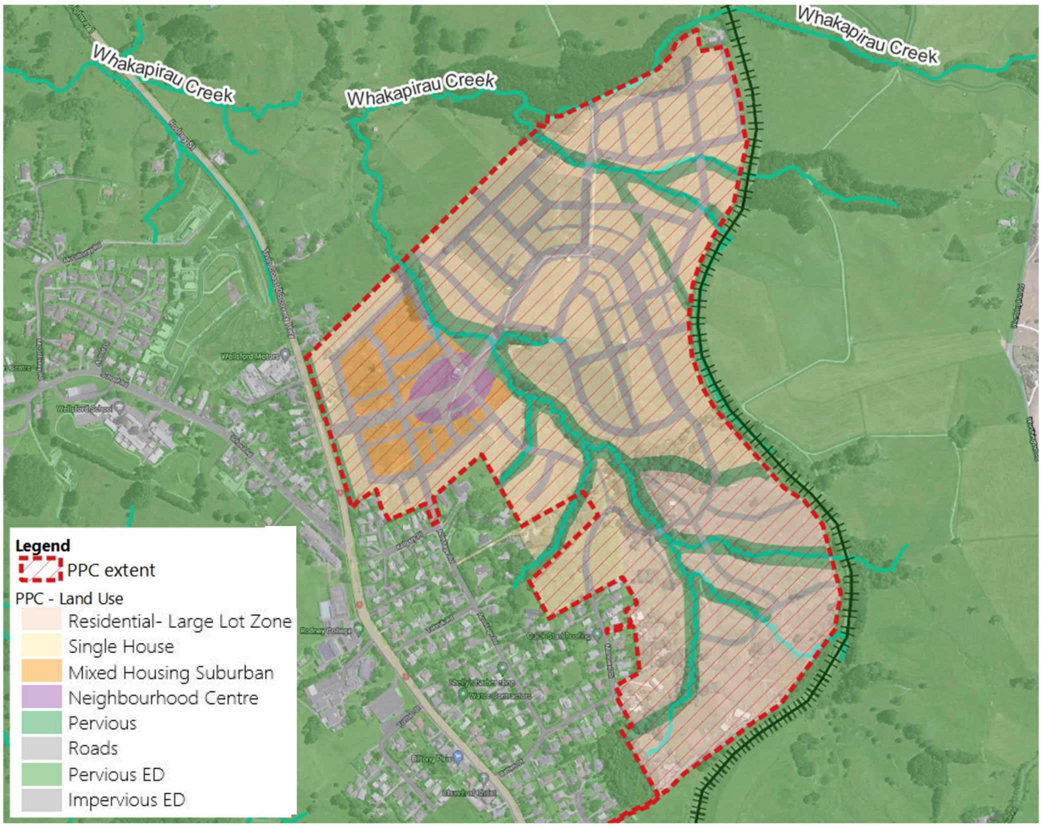

Figure 10. PPC land use scenario

Based on the proposed masterplan land use and Healthy Waters latest imperviousness recommendation (see Appendix F), Table 1 lists the established imperviousness percentage values.

Table 1. Impervious percentages for the Proposed Plan Change (PPC) land use

Source	Zoning	Impervious %
Proposed Plan Change (PPC)	Residential-Large Lot Zone	35
	Single House Zone	60
	Mixed Housing Suburban Zone	60
	Neighbourhood Centre Zone	100
	Pervious [Open Space Conservation Zone]	10
	Roads	90

The PPC impervious percentages in and around the PPC extent are shown in Figure 11. The impervious percentage for the Wellsford catchment is approximately 21.2%, and inside the PPC area is approximately 48.0%.

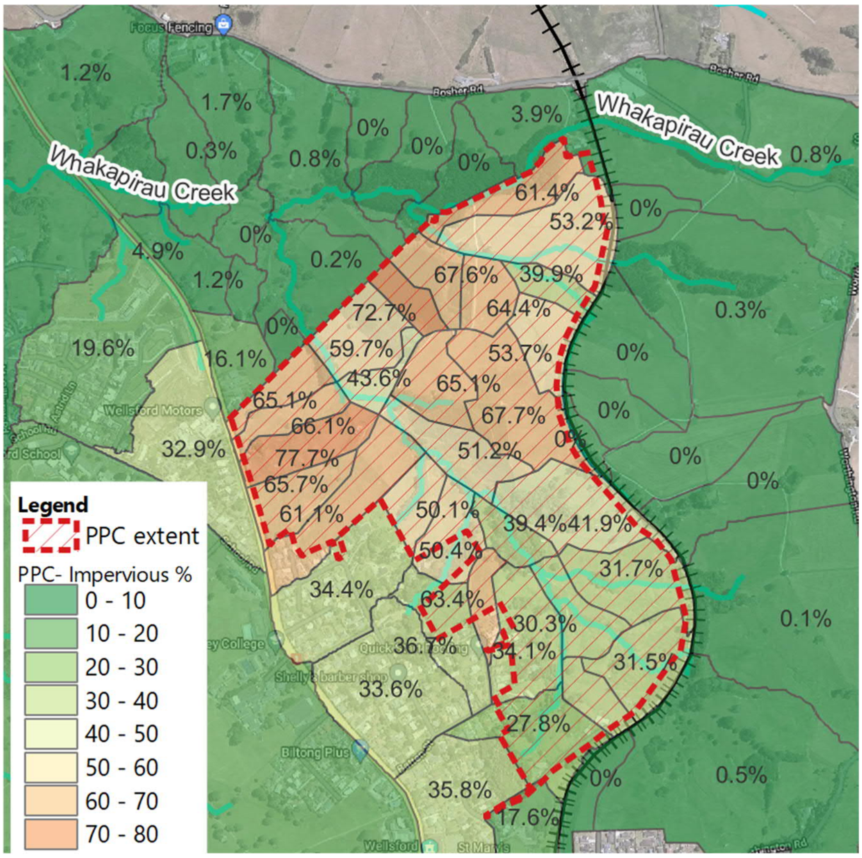

Figure 11. PPC impervious percentage values

3.3. Maximum Probable Development (MPD), including Private Plan Change (PPC)

The MPD land use assumptions for the Kaipara Wellsford catchment were derived from the Auckland Unitary Plan – Operative in Part (AUP-OiP). Inside the PPC extent, there were given the same impervious percentage coverage as previously mentioned in section 3.3. In this document, this land use combination is called PCFUZ.

The impervious assumptions were also updated as per Healthy Waters latest recommended imperviousness table list for each AUP zone, see Appendix F. The final values considered in this scenario are listed in Table 2. Figure 12 shows the land use zones considered in PCFUZ.

Table 2: Zoning areas - maximum impervious assumptions

Source	Zoning	Impervious %
AUP	Residential-Large Lot Zone	35
	Open Space - Conservation Zone	10
	Residential-Single House Zone	60
	Road [i]	90
	Strategic Transport Corridor	100
	Rural - Countryside Living Zone2	25
	Future Urban Zone5	70
	Open Space - Informal Recreation Zone	10
	Rural - Rural Production Zone2	5
	Open Space - Sport and Active Recreation Zone	33

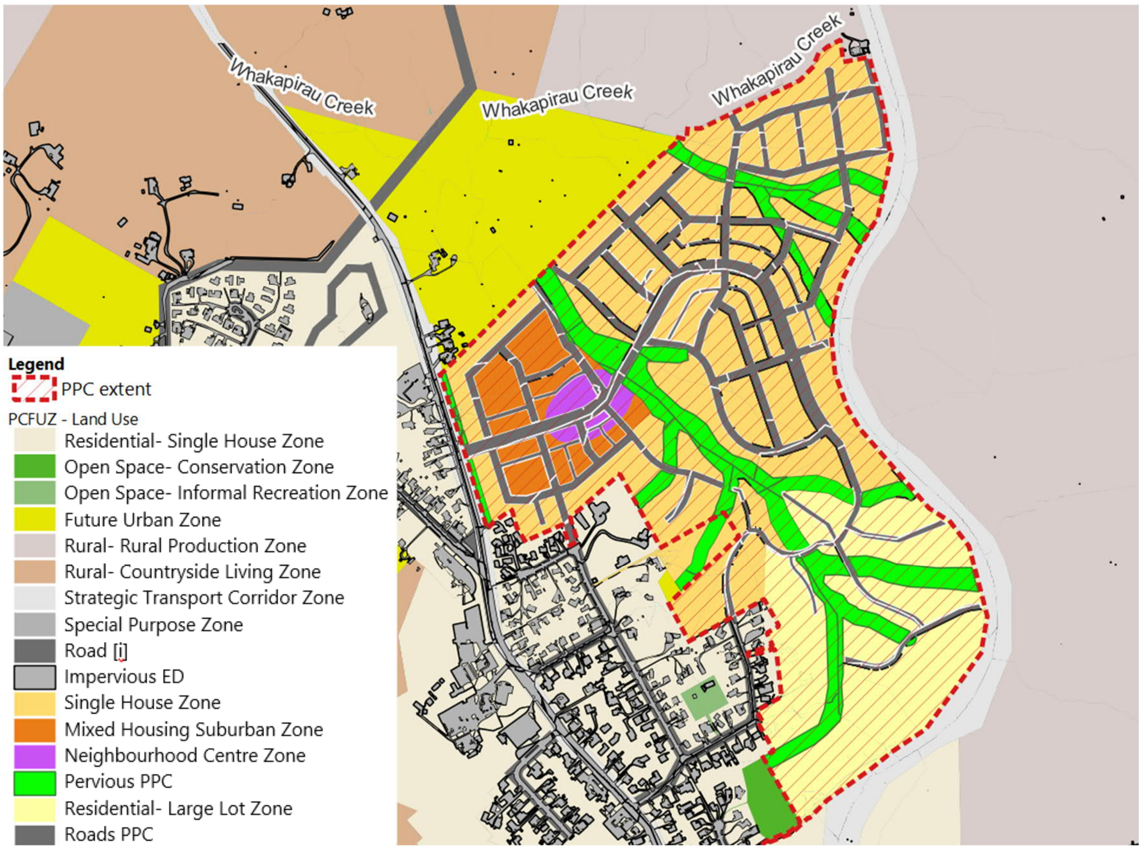

Figure 12. PCFUZ land use as per AUP-OiP

The maximum probable development impervious percentage for the Wellsford catchment is approximately 43.3% and inside the PPC is 48%. Figure 13 shows these percentages within the PPC extent.

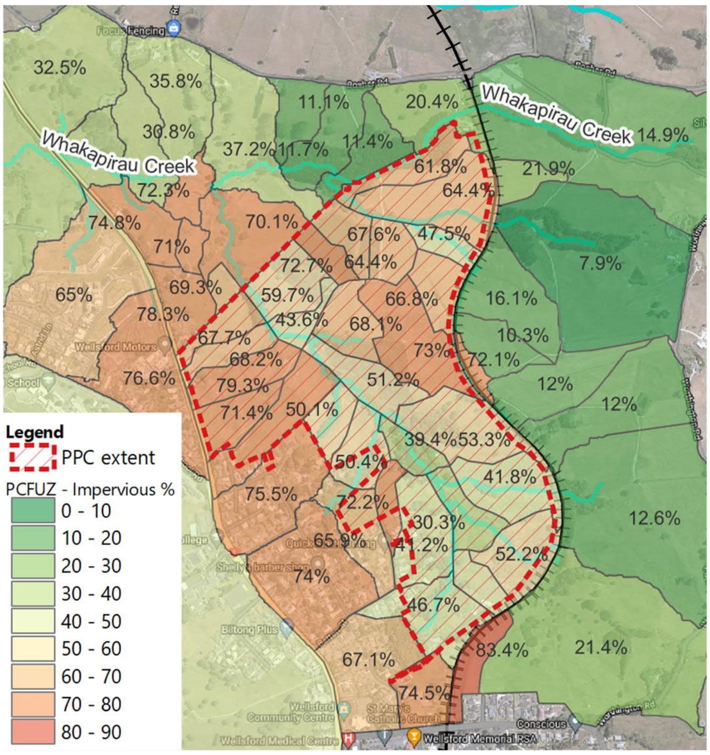

Figure 13. PPCFUZ subcatchments impervious percentage values

4. Terrain Data

LiDAR 2016 DEM data and the terrain survey data provided by Buckton Consulting Surveyors Ltd for the PPC area have been used in the modelling. The surveyed data was received as a DEM raster file, and this was overlaid on top of the LIDAR 2016 DEM. There were gaps in the survey information provided, which were filled with the LiDAR2016 elevation data. Figure 14 shows the terrain data extent used in the model. The final surface was used for all three land use scenarios described in section 3. Appendix B shows the provided topographical information and the difference with the LiDAR2016. The difference map (survey minus LiDAR2016) shows a maximum value of 1.48m, a minimum of -2.5m.

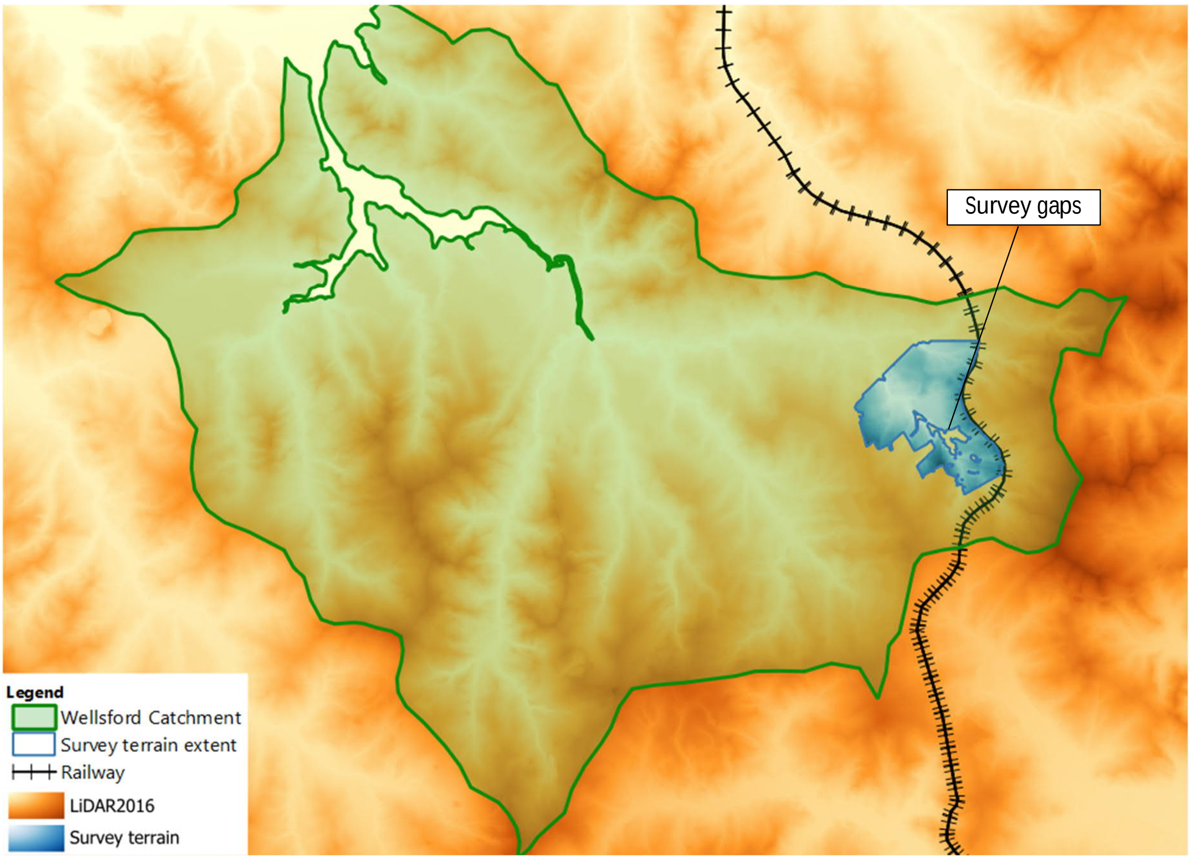

Figure 14: Terrain data sets

5. Hydraulic Model

5.1. One dimensional modelling

5.1.1. Culverts

The primary network for this model consists mainly of existing and private culvert/structures within, upstream, and downstream of the PPC area, as shown in Figure 15. The public assets owners are NZTA, Auckland Council (Healthy Waters) and Kiwi Rail, and details of the information requested can be found in the Wellsford North Plan Change – Stormwater Management Plan.

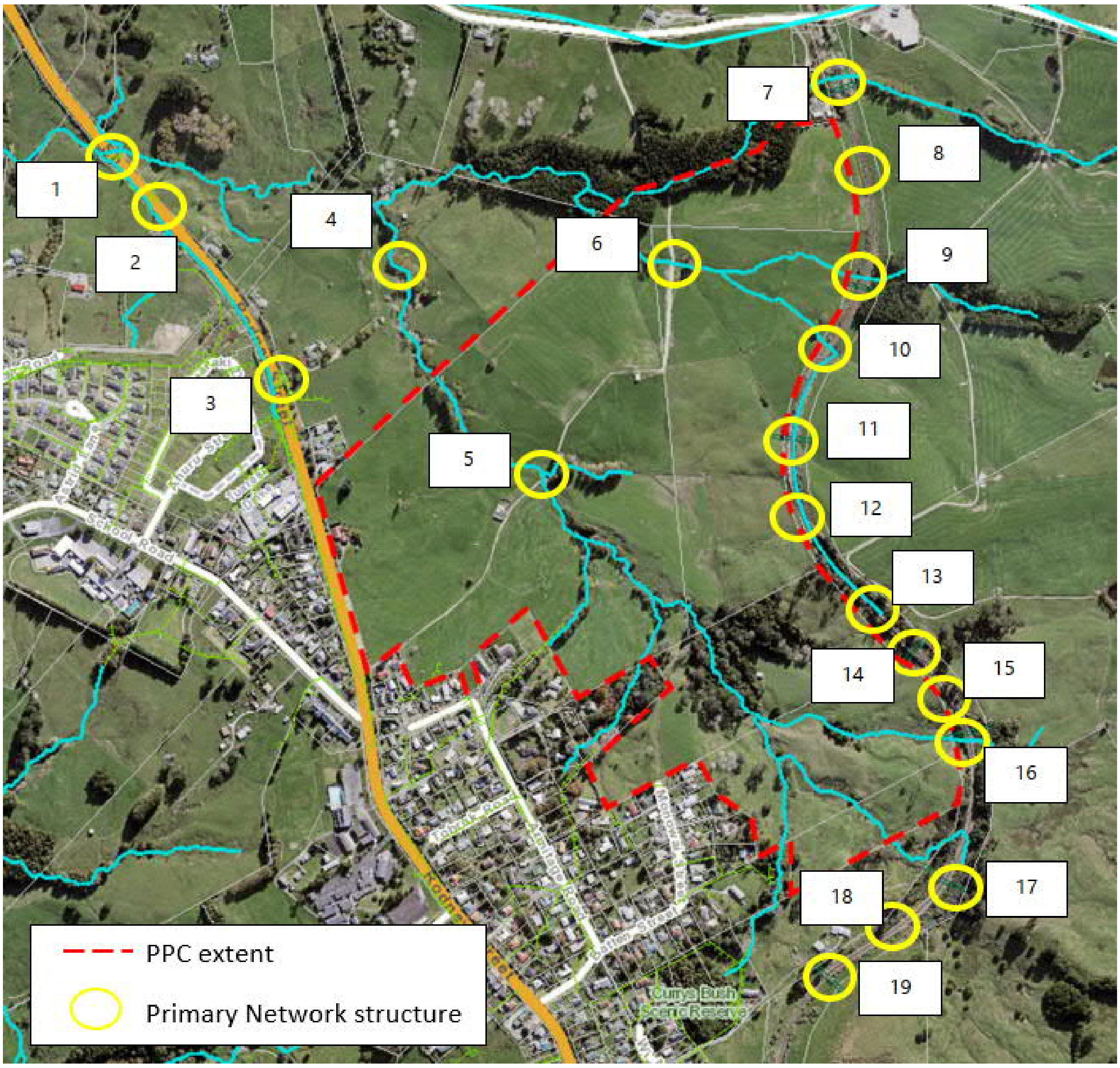

Figure 15: Existing infrastructure (Source: Auckland Council Geomaps)

Due to the limited asset information available, Woods performed a field survey to collect asset data to be included in the flood modelling for better representation and accuracy. Nine sites were visited out of the 19 assets identified as critical, where photos and spot heights were taken. Appendix A shows the survey information. Table 3 shows what assets were visited and highlighted in grey are the assets that were not modelled. In total, 14 culverts were modelled in the 1D domain. The survey information details can be found in Appendix A.

Table 3. Asset information

No	Asset type	Asset Number	Diameter (mm)	Included in the model	Survey and/or Photos
1	Rectangular culvert	2000006345	2000	YES	YES
2	Circular Culvert	2000063746	450	YES	YES
3	Circular Culvert	2000805184	450	YES	YES
4	Circular Culvert	-	-	Adjusted Terrain	NO
5	Circular Culvert	-	-	Adjusted Terrain	NO
6	Circular Culvert	-	-	Adjusted Terrain	NO
7	Box Culvert	2258573	1120	YES	YES
8	Circular Culvert	2258572	225	YES	YES
9	Circular Culvert	2258571	450	YES	YES
10	Circular Culvert	2258570	375	YES	NO
11	Circular Culvert	2258569	450	YES	YES
12	Circular Culvert	2258568	225	YES	NO
13	Circular Culvert	2258567	300	YES	YES
14	Circular Culvert	2258566	300	NO	NO
15	Circular Culvert	2258565	600	YES	YES
16	Circular Culvert	2258564	450	YES	NO
17	Circular Culvert	2258563	920	YES	NO
18	N/A	2258562	300	NO	NO
19	N /A	2258561	600	YES	NO

The stormwater network remained the same for the existing scenario and the future development scenarios. Table 4 summarises the network derived from the culvert's assets.

Table 4: Stormwater network derived from culverts

Node Type	Number
2D Outlets	13
Culvert Inlets	13
Culvert Outlets	1 (corresponding to the culvert 2000006345)
Links	14 (One twin culvert)
Manhole	1 (corresponding to the culvert 2258567)

Culvert 2000006345 (number 1 in Table 3) was modelled as a twin culvert, considering the invert levels of the lowest pipe.

5.1.2. Roughness

Roughness for the stormwater conduits in the model was assigned, as shown in Table 5. Value is taken from the SW Code of practice (January 2022).

Table 5: Stormwater pipe roughness values

Pipe Material	Manning's (n)
Concrete (Normal)	0.013

5.1.3. Head losses

The head losses applied at the inlets and outlets for all modelled scenarios. Details of the inlet loss coefficients are summarised in Appendix C.

5.1.4. River reaches

River reaches were considered to represent the main permanent open water courses inside a 1D model domain. The source of all cross-section elevation is LiDAR2016. Survey points were used to edit critical cross-sections at the inlet and outlets of the modelled culvert outlet, as described in section 5.1.1. Manning's coefficient roughness varies from 0.041 and 0.1, as described in section 5.2.2. Table 6 and Figure 16 shows a description and location of the 24 river reaches modelled for the existing and future scenarios.

Table 6. River reaches properties

Open water course	No River reaches	Length (m)	Slope (%)
Whakapirau Creek Downstream SH1 culvert	11	5181	0.22
Whakapirau Creek Upstream SH1	5	458	0.84
US culvert 2258573	1	89 .0	5.30
US culvert 2258571	1	92.9	5.52
US culvert 2258570	1	91.6	6.88
US culvert 2258565	1	59.9	5.24
US culvert 2258564	1	95.2	6.7
US culvert 2258563	1	90.7	5.33
US culvert 2000063746	1	165.6	3.04
US culvert 20000805184	1	67.9	6.56

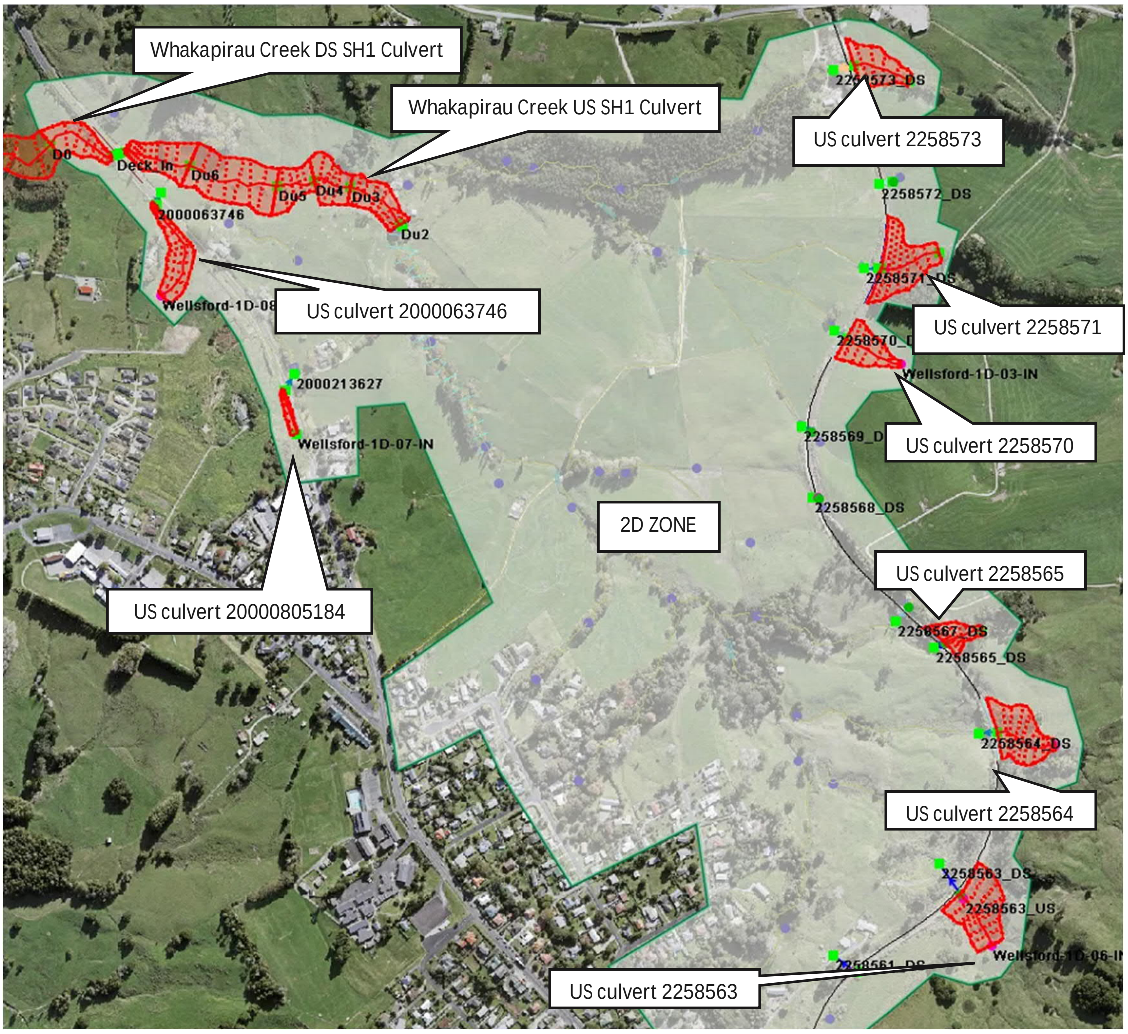

Figure 16. River reaches location

5.2. Two-Dimensional Modelling

5.2.1. Surfaces updates

The 2D model was created in ICM using LiDAR 2016 and terrain survey, as previously mentioned in Section 4, with a flexible mesh approach. The mesh resolution was set to a maximum of 5 $m^{2,}$ (minimum of 2 m^2), which is considered suitable for generating flow paths and floodplains. However, the combined terrain presented areas where ponding was occurring due to presumed missing private infrastructures. Therefore, the terrain was manually adjusted in six areas to represent a free-flow pass forward approach, shown in Figure 17.

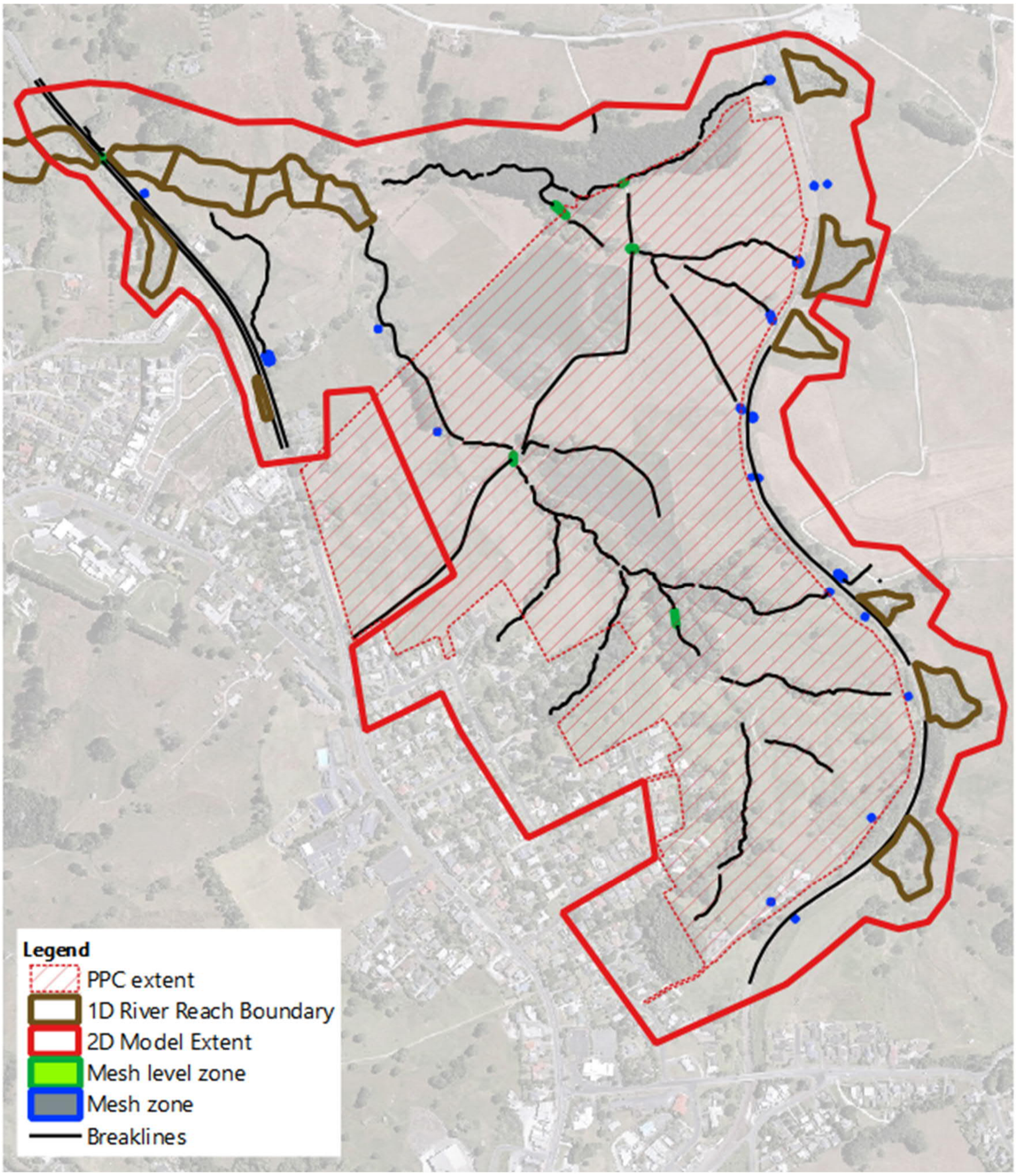

Figure 17: 2D-Modelling extent and adjusted terrain areas

5.2.2. Roughness

The Manning's roughness applied to the 2D model is summarised in Table 7. Survey photos and aerial photography were considered to define these coefficients. Values were taken from the Auckland Council SW Modelling Specification November 2011. Figure 18 and Figure 19 shows the roughness for the existing and future scenarios.

Table 7: Manning roughness values used in ICM models

Land Use	Manning's n	Source
Roads	0.02	Table 4. SWCoP for Overland flow paths along roadways
Residential	0.1	Table 4. SWCoP for Overland flows paths through property parcels
Open Space	0.05	Section 3.3 of the Modelling specifications for RFHA models
Stream banks - Clean	0.06	Table 5.2. Modelling specifications for cleared land – tree stumps and heavy sprouts
Stream banks - dense	0.1	Table 5.2. Modelling specifications for Medium brush
Stream wet base	0.041	Table 5.2. Modelling specifications for Height – varying grass

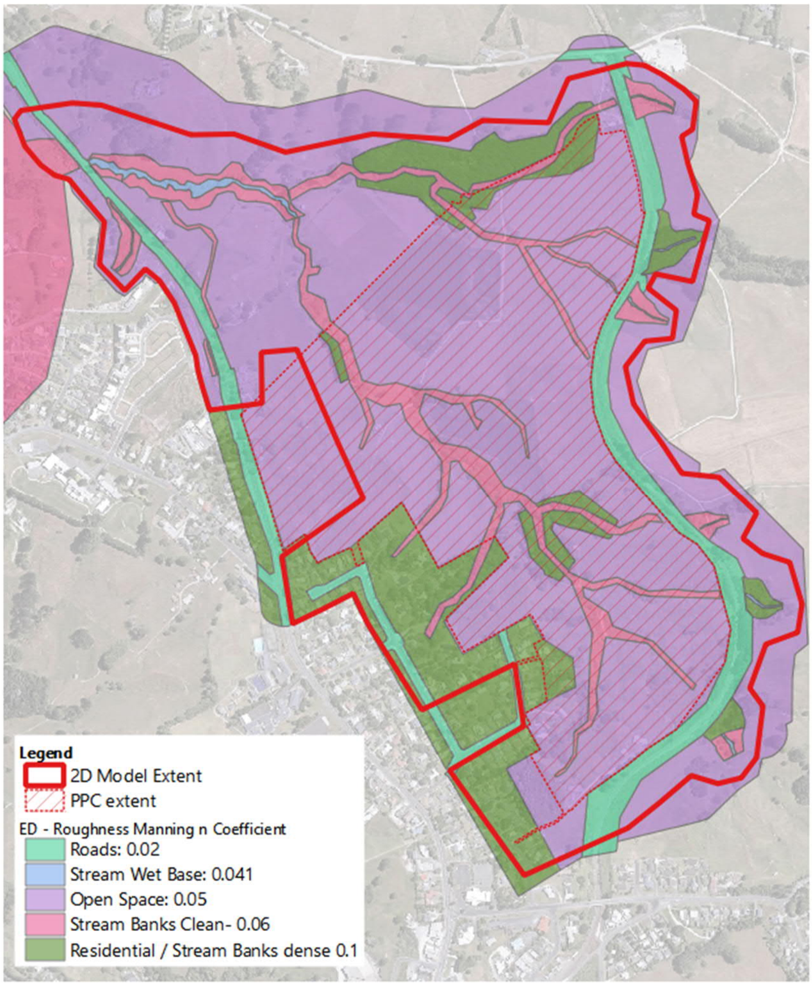

Figure 18. Existing development roughness values on the 2D domain

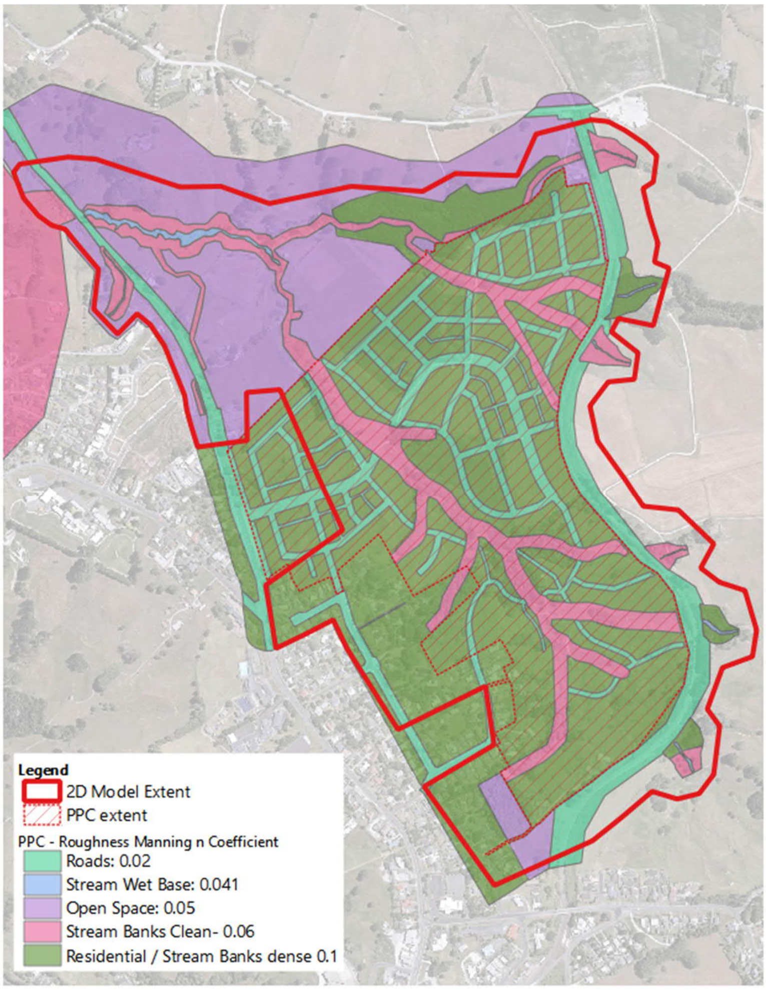

Figure 19. Future roughness values on the 2D domain

6. Boundary Conditions

A total of three storm events with two different profiles and climate change (CC) uplifts were generated based on TP108 design rainfall approach for all modelled scenarios. A summary of the rainfall depths can be seen in Table 8.

Table 8: Rainfall depths summary

	SWCoPv3 -3.8°c CC			
	Depth [mm]	% Increment	Depth (mm)	Profile
2 Year	95.0	27.4%	121	1
	88.0		112	2
10 Year	170.0	30.8%	222	1
	160.0		209	2
100 Year	260.0	32.7%	345	1
	250.0		332	2

A coastal tailwater boundary condition was applied where the Whakapirau River discharges to the Kaipara Harbour at a constant water level of 3.3 m based on the Mean High-Water Springs (MHWS) 10%ile with 1 m sea level rise consideration for climate change. The location at which the coastal tailwater boundary condition was applied can be seen in Figure 20.

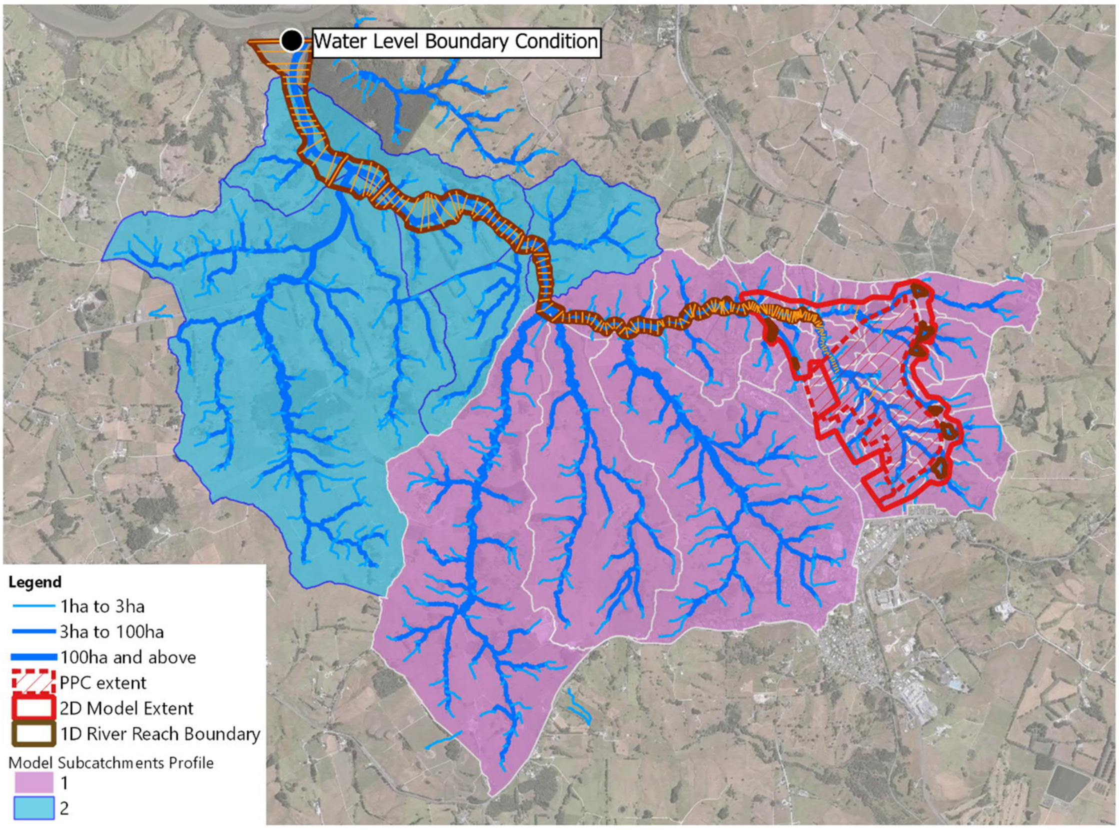

Figure 20: Coastal tailwater boundary condition

7. Model Scenarios

Table 9 shows the fifteen scenarios that have been simulated for three different storm events to assess any flood effects resulting from the PPC and any flood risks within the development area. All scenarios were run over a period of 24 hours.

Table 9. Model scenarios

No	Network	Land use	Storm Event (ARI)	Climate Change	Tide level
1	Existing	Existing Development (ED)	2yr	NO	2.3 mRL (MHWS 10%ile)
2			10yr		
3			100yr		
4			2yr	Yes 3.8°C	2.3 + 1 mRL (MHWS 10%ile)
5			10yr		
6			100yr		
7		Existing Development and proposed Plan Change (PPC)	2yr	NO	2.3 mRL (MHWS 10%ile
8			10yr		
9			100yr		
10			2yr	Yes 3.8°C	2.3 + 1 mRL (MHWS 10%ile)
11			10yr		
12			100yr		
13		Proposed Plan Change and Future Urban Zone (PPC FUZ)	2yr	NO	2.3 mRL (MHWS 10%ile)
14			10yr		
15			100yr		
16			2yr	Yes 3.8°C	2.3 + 1 mRL (MHWS 10%ile)
17			10yr		
18			100yr		

The model results were analysed to extract the flood extents, peak water levels and flood depths for each scenario to have a better understanding of the flood risk for the existing development, existing development including the Private Plan Change Scenario and the maximum probable development, including Private Plan Change scenarios.

The model results are included in the Wellsford North Plan Change - Stormwater Management Plan.

8. Limitations and Assumptions

The following assumptions and limitations are noted:

- This model has been prepared to provide guidance on flood levels and depths within the modelled catchment area for the modelled scenario. The modelling process relies on a range of assumptions and simplifications and may be subject to errors and inaccuracies. The compounding effects of the uncertainties in the TP108 rainfall model (ARC, 1999), the uncertainties in the LiDAR data and the uncertainties in hydraulic parameters such as roughness could result in the water level varying from the mapped levels.
- The LiDAR data has an absolute vertical accuracy of +/- 0.10m. Deviations in vertical accuracy can occur in areas of dense vegetation. Below water ground levels are not reliably represented in the LiDAR data.
- A uniform roughness was assumed along the Whakapirau Creek, and interpolated cross-sections using LiDAR 2016 were created to define it as there was no survey data captured along the open channel.
- Woods have developed the Wellsford North Plan Change model to understand existing flood risks and provide flood assessments for the Private Plan Change extent and not intended for general catchment planning purposes.
- The field survey did not include all culverts along the KiwiRail Northern rail and presumed private infrastructure. Refer to Appendix A and Appendix C for the survey levels taken into account for the model.
- The modelling has been done on the hydrology and hydraulic perspectives, has assumed there are no terrain changes such as filling.
- It is noted that at the time of development, further model refinements will be required to assess the effects of development in further detail.

Appendix A. Structures Survey Information

SURVEY CONTROL

MARK NAME	NORTHING (m)	EASTING (m)	HEIGHT (m)
IT V DP 48722 (D043)	866029.53	377891.43	57.03
RM 3 DP 83752 (EB49)	865799.67	378184.95	60.80
WELLSFORD FUNDAMENTAL (ABHL)	865871.21	378091.80	65.62
NAIL 1	866715.44	377685.39	17.88
NAIL 2	866667.34	377728.51	16.38
NAIL 3	866620.60	377770.22	17.28
NAIL 4	866650.28	377730.32	16.44

WOODS
EST.1970

Plot Date: 2:13:02 pm,2 May 2022, JESSS

LEGEND

XML BOUNDARY		TOP OF BANK	
CULVERT INVERT	IL=10.00	BOTTOM OF BANK	
SPOT HEIGHT	10.00	TOP OF WALL	
CESSPIT		BOTTOM OF WALL	
GIS STORMWATER	450 CONC	WATERWAY CENTRELINE	
MAJOR CONTOUR		ROAD CENTRELINE	
MINOR CONTOUR		ROAD EDGE OF SEAL/METAL	
FENCE		ROAD MARKING	

NOTES

1. THE SURVEY IS IN TERMS OF GEODETIC DATUM 2000, MT EDEN CIRCUIT. THE ORIGIN OF COORDINATES "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 865871.21 mN 378091.80 mE
2. THE ORIGIN OF LEVELS IS IN TERMS OF THE AUCKLAND VERTICAL DATUM 1946, ORIGIN OF LEVEL "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 65.62 m RL
3. CONTOURS ARE SHOWN AT 0.20 m INTERVALS.
4. FOR EXISTING SUBJECT EASEMENTS, COVENANTS AND ENCUMBRANCES FOR THE PLAN AREA, PLEASE REFER TO THE CURRENT RECORDS OF TITLE.
5. EVERY EFFORT HAS BEEN MADE TO CORRECTLY IDENTIFY TREE TYPES SHOWN. HOWEVER, THESE MAY REQUIRE CONFIRMATION FROM A SUITABLY QUALIFIED PERSON IF CRITICAL.
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DESIGNED		
DRAWN	JS	
CHECKED	RH	
APPROVED	RH	WOODS.CO.NZ

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WELLSFORD NORTH PLAN CHANGE

CULVERT TOPOGRAPHIC SURVEY

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DIAGRAM A

WOODS
EST. 1970

LEGEND

XML BOUNDARY	TOP OF BANK
CULVERT INVERT (IL=10.00)	BOTTOM OF BANK
SPOT HEIGHT (10.00)	TOP OF WALL
CESSPIT	BOTTOM OF WALL
GIS STORMWATER (450 CONC)	WATERWAY CENTRELINE
MAJOR CONTOUR	ROAD CENTRELINE
MINOR CONTOUR	ROAD EDGE OF SEAL/METAL
FENCE	ROAD MARKING

NOTES

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APPROVED	RH	WOODS.CO.NZ

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CULVERT TOPOGRAPHIC SURVEY

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DIAGRAM B

DIAGRAM C

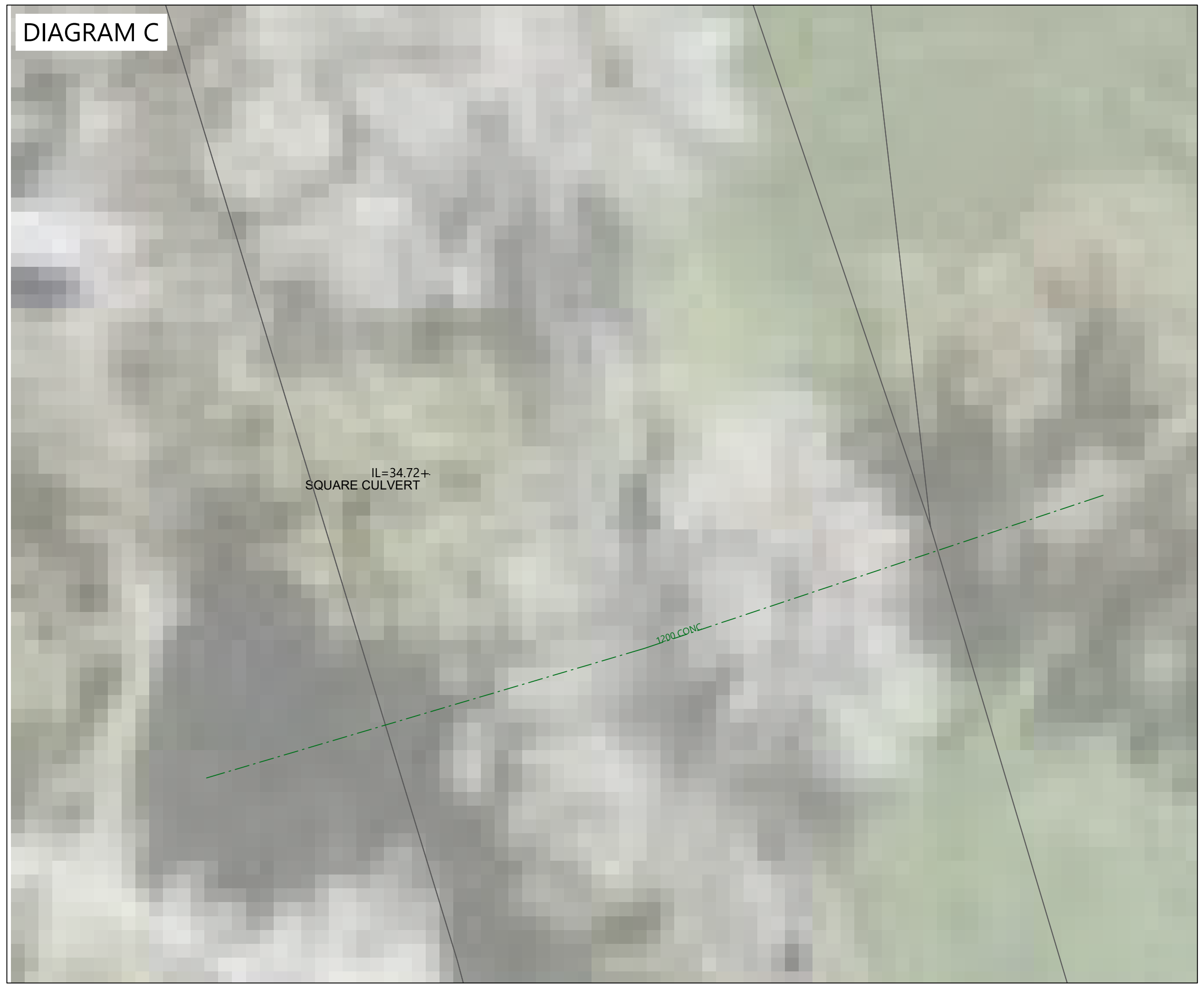
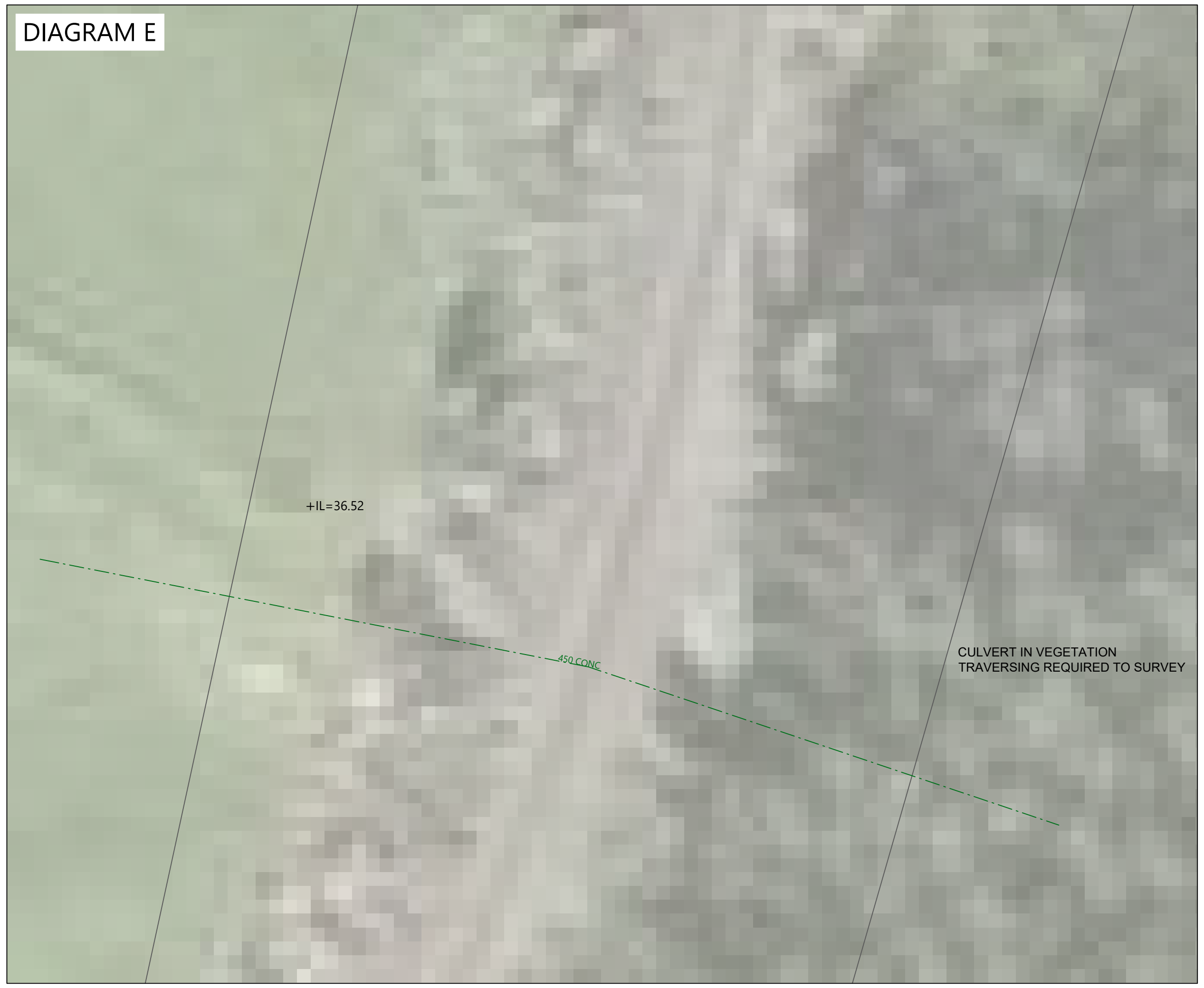


DIAGRAM D

DIAGRAM E



WOODS
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Plot Date: 2:13:04 pm,2 May 2022, JESSS

LEGEND

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CESSPIT	BOTTOM OF WALL
GIS STORMWATER (450 CONC)	WATERWAY CENTRELINE
MAJOR CONTOUR	ROAD CENTRELINE
MINOR CONTOUR	ROAD EDGE OF SEAL/METAL
FENCE	ROAD MARKING

NOTES

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   ~ 65.62 m RL
3. CONTOURS ARE SHOWN AT 0.20 m INTERVALS.
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APPROVED	RH	WOODS.CO.NZ

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WELLSFORD NORTH PLAN CHANGE

CULVERT TOPOGRAPHIC SURVEY

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DIAGRAM F

DIAGRAM G

DIAGRAM H

DIAGRAM I

WOODS
EST.1970

Plot Date: 2:13:05 pm,2 May 2022, JESSS

LEGEND

XML BOUNDARY		TOP OF BANK	
CULVERT INVERT	IL=10.00	BOTTOM OF BANK	
SPOT HEIGHT	10.00	TOP OF WALL	
CESSPIT		BOTTOM OF WALL	
GIS STORMWATER	450 CONC	WATERWAY CENTRELINE	
MAJOR CONTOUR		ROAD CENTRELINE	
MINOR CONTOUR		ROAD EDGE OF SEAL/METAL	
FENCE		ROAD MARKING	

NOTES

1. THE SURVEY IS IN TERMS OF GEODETIC DATUM 2000, MT EDEN CIRCUIT. THE ORIGIN OF COORDINATES "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
~ 865871.21 mN 378091.80 mE
2. THE ORIGIN OF LEVELS IS IN TERMS OF THE AUCKLAND VERTICAL DATUM 1946, ORIGIN OF LEVEL "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
~ 65.62 m RL
3. CONTOURS ARE SHOWN AT 0.20 m INTERVALS.
4. FOR EXISTING SUBJECT EASEMENTS, COVENANTS AND ENCUMBRANCES FOR THE PLAN AREA, PLEASE REFER TO THE CURRENT RECORDS OF TITLE.
5. EVERY EFFORT HAS BEEN MADE TO CORRECTLY IDENTIFY TREE TYPES SHOWN. HOWEVER, THESE MAY REQUIRE CONFIRMATION FROM A SUITABLY QUALIFIED PERSON IF CRITICAL.
6. AERIAL PHOTO SHOWN IN BACKGROUND AND INDICATIVE EXISTING STORMWATER SERVICES HAVE BEEN SOURCED FROM THE AUCKLAND COUNCIL GIS. SERVICE PIPES AND COVERS NOT LOCATED BY SURVEY, ARE APPROXIMATE ONLY AND WILL NEED TO BE CONFIRMED ON SITE.
7. CONTRACTOR IS TO LOCATE AND PROTECT ALL EXISTING SERVICES PRIOR TO COMMENCING ANY WORKS. NO EXCAVATION OF ANY KIND IS TO TAKE PLACE WITHOUT PERMISSION FROM THE RELEVANT SERVICE PROVIDER.

SCALEBAR (m) 0 50 100 250
SCALE | 1:5000 @A3 | 1:2500 @A1|

REVISION DETAILS		BY	DATE
1	ISSUED FOR INFORMATION	JS	02/05/22

SURVEYED	DN	WELLSFORD AUCKLAND NEW ZEALAND
DESIGNED		
DRAWN	JS	
CHECKED	RH	
APPROVED	RH	WOODS.CO.NZ

N

WELLSFORD NORTH PLAN CHANGE

CULVERT TOPOGRAPHIC SURVEY

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:500 @ A3	1
COUNCIL	AUCKLAND COUNCIL	
DWG NO	P21-395-00-0503-SU	

File: C:\12DSYNERGY\DATA\WP-PEN-APP-01\P21-395 - WELLSFORD NORTH PLAN CHANGE_10865\CAD\SURV\P21-395-00-0500-SU_CULVERT TOPOGRAPHIC SURVEY.DWG

DIAGRAM J

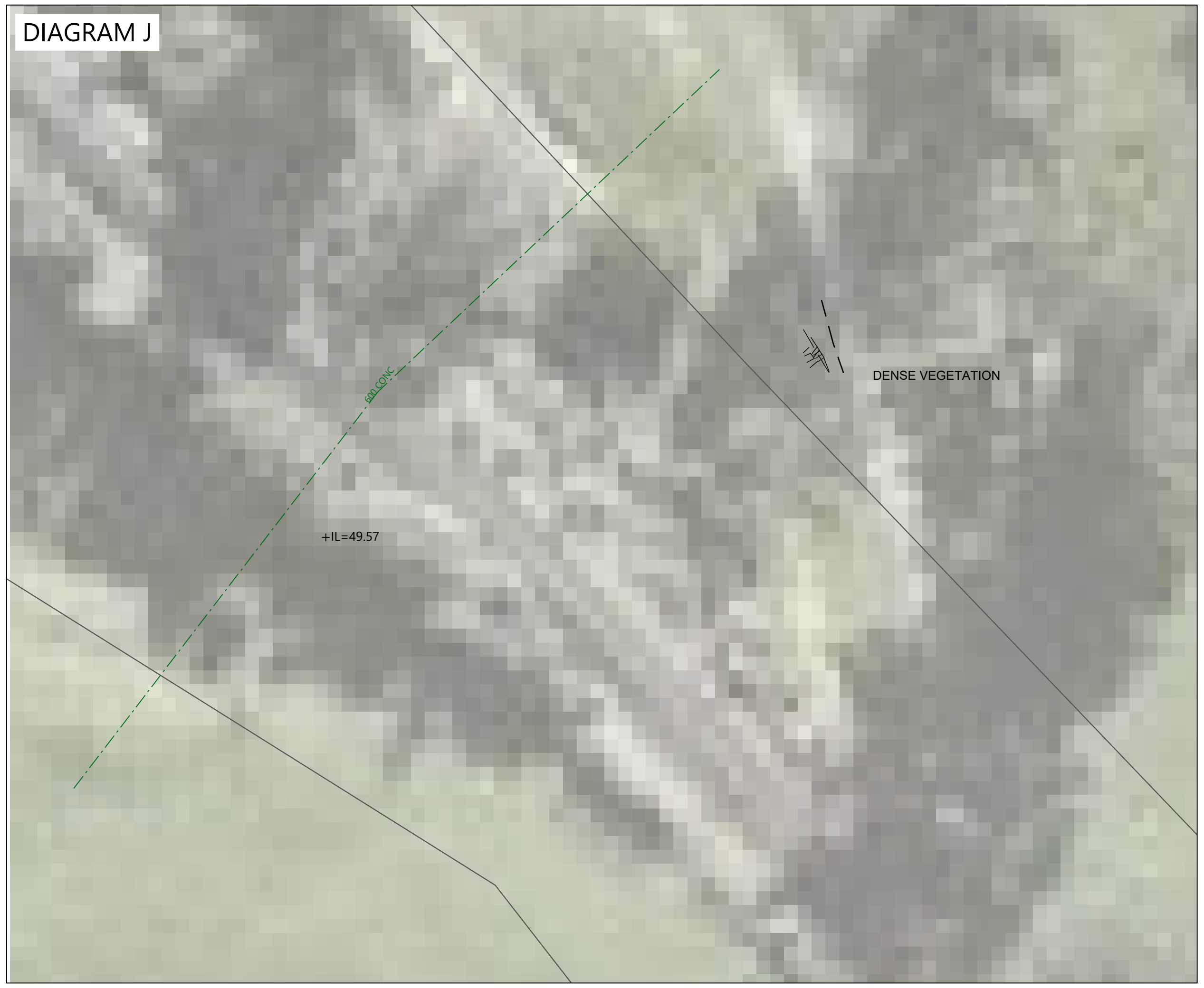


DIAGRAM K

DIAGRAM L

WOODS
EST.1970

LEGEND

XML BOUNDARY		TOP OF BANK	
CULVERT INVERT	IL=10.00	BOTTOM OF BANK	
SPOT HEIGHT	10.00	TOP OF WALL	
CESSPIT		BOTTOM OF WALL	
GIS STORMWATER	450 CONC	WATERWAY CENTRELINE	
MAJOR CONTOUR		ROAD CENTRELINE	
MINOR CONTOUR		ROAD EDGE OF SEAL/METAL	
FENCE		ROAD MARKING	

NOTES

1. THE SURVEY IS IN TERMS OF GEODETIC DATUM 2000, MT EDEN CIRCUIT. THE ORIGIN OF COORDINATES "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 865871.21 mN 378091.80 mE
2. THE ORIGIN OF LEVELS IS IN TERMS OF THE AUCKLAND VERTICAL DATUM 1946, ORIGIN OF LEVEL "WELLSFORD FUNDAMENTAL" (GD CODE ABHL), SOURCED FROM LINZ DATABASE.
   ~ 65.62 m RL
3. CONTOURS ARE SHOWN AT 0.20 m INTERVALS.
4. FOR EXISTING SUBJECT EASEMENTS, COVENANTS AND ENCUMBRANCES FOR THE PLAN AREA, PLEASE REFER TO THE CURRENT RECORDS OF TITLE.
5. EVERY EFFORT HAS BEEN MADE TO CORRECTLY IDENTIFY TREE TYPES SHOWN. HOWEVER, THESE MAY REQUIRE CONFIRMATION FROM A SUITABLY QUALIFIED PERSON IF CRITICAL.
6. AERIAL PHOTO SHOWN IN BACKGROUND AND INDICATIVE EXISTING STORMWATER SERVICES HAVE BEEN SOURCED FROM THE AUCKLAND COUNCIL GIS. SERVICE PIPES AND COVERS NOT LOCATED BY SURVEY, ARE APPROXIMATE ONLY AND WILL NEED TO BE CONFIRMED ON SITE.
7. CONTRACTOR IS TO LOCATE AND PROTECT ALL EXISTING SERVICES PRIOR TO COMMENCING ANY WORKS. NO EXCAVATION OF ANY KIND IS TO TAKE PLACE WITHOUT PERMISSION FROM THE RELEVANT SERVICE PROVIDER.

SCALEBAR (m) 0 50 100 250
SCALE | 1:5000 @A3 | 1:2500 @A1|

REVISION DETAILS		BY	DATE
1	ISSUED FOR INFORMATION	JS	02/05/22

SURVEYED	DN	WELLSFORD AUCKLAND NEW ZEALAND
DESIGNED		
DRAWN	JS	
CHECKED	RH	
APPROVED	RH	WOODS.CO.NZ

N

WELLSFORD NORTH PLAN CHANGE

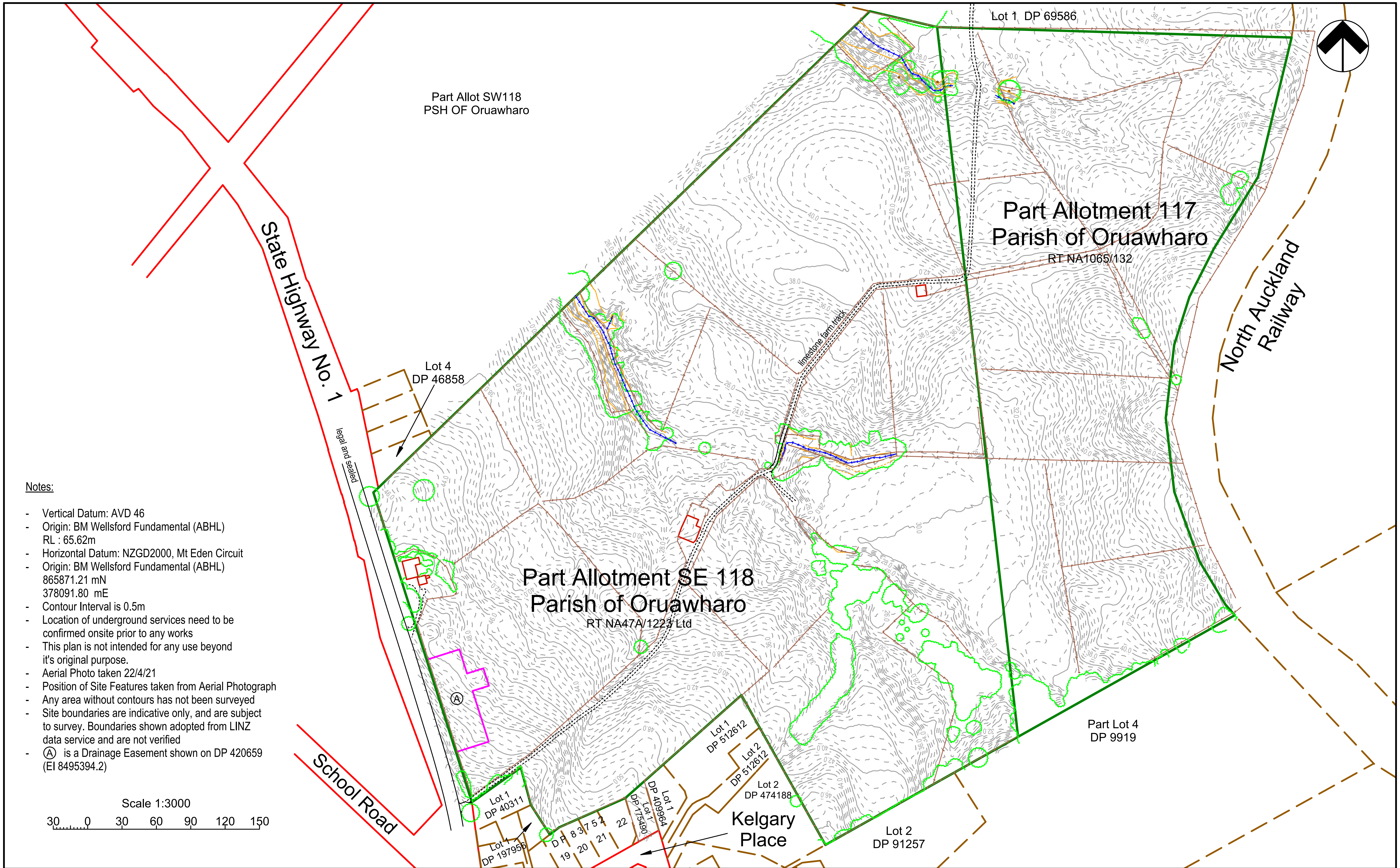
CULVERT TOPOGRAPHIC SURVEY

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:500 @ A3	1
COUNCIL	AUCKLAND COUNCIL	
DWG NO	P21-395-00-0504-SU	

Plot Date: 2:13:06 pm,2 May 2022, JESSS

File: C:\12DSYNERGY\DATA\WP-PEN-APP-01\P21-395 - WELLSFORD NORTH PLAN CHANGE_10865\CAD\SURV\P21-395-00-0500-SU_CULVERT TOPOGRAPHIC SURVEY.DWG

Appendix B. Topographical survey



Notes:

- Vertical Datum: AVD 46
- Origin: BM Wellsford Fundamental (ABHL) RL : 65.62m
- Horizontal Datum: NZGD2000, Mt Eden Circuit
- Origin: BM Wellsford Fundamental (ABHL) 865871.21 mN 378091.80 mE
- Contour Interval is 0.5m
- Location of underground services need to be confirmed onsite prior to any works
- This plan is not intended for any use beyond it's original purpose.
- Aerial Photo taken 22/4/21
- Position of Site Features taken from Aerial Photograph
- Any area without contours has not been surveyed
- Site boundaries are indicative only, and are subject to survey. Boundaries shown adopted from LINZ data service and are not verified
- Ⓐ is a Drainage Easement shown on DP 420659 (EI 8495394.2)

buckton consulting surveyors ltd
16 Mill Lane, P.O.Box 107, Warkworth 0941, 09 425 8950
www.buckton.co.nz, surveyors@buckton.co.nz

Prepared for : Wellsford Welding Club

Topographical Survey of Part Allotment SE 118 and Part Allotment 117, Parish of Oruawharo

Address: 338 Rodney Street, Wellsford

Scale:	1:3000 (A3)		
Job: 8274	Date: 13/5/21	Drawn: GH/SC	Reviewed: JH
Drawing: TP 02	Rev: -	Sheet: 1 of 2	

Notes:

- Vertical Datum: AVD 46
- Origin: BM Wellsford Fundamental (ABHL)
  RL : 65.62m
- Horizontal Datum: NZGD2000, Mt Eden Circuit
- Origin: BM Wellsford Fundamental (ABHL)
  865871.21 mN
  378091.80 mE
- Contour Interval is 0.5m
- Location of underground services need to be confirmed onsite prior to any works
- This plan is not intended for any use beyond it's original purpose.
- Aerial Photo taken 22/4/21
- Position of Site Features taken from Aerial Photograph
- Any area without contours has not been surveyed
- Site boundaries are indicative only, and are subject to survey. Boundaries shown adopted from LINZ data service and are not verified
- Ⓐ is a Drainage Easement shown on DP 420659 (EI 8495394.2)

Scale 1:3000

30 0 30 60 90 120 150

buckton
consulting surveyors ltd

16 Mill Lane, P.O.Box 107, Warkworth 0941, 09 425 8950
www.buckton.co.nz, surveyors@buckton.co.nz

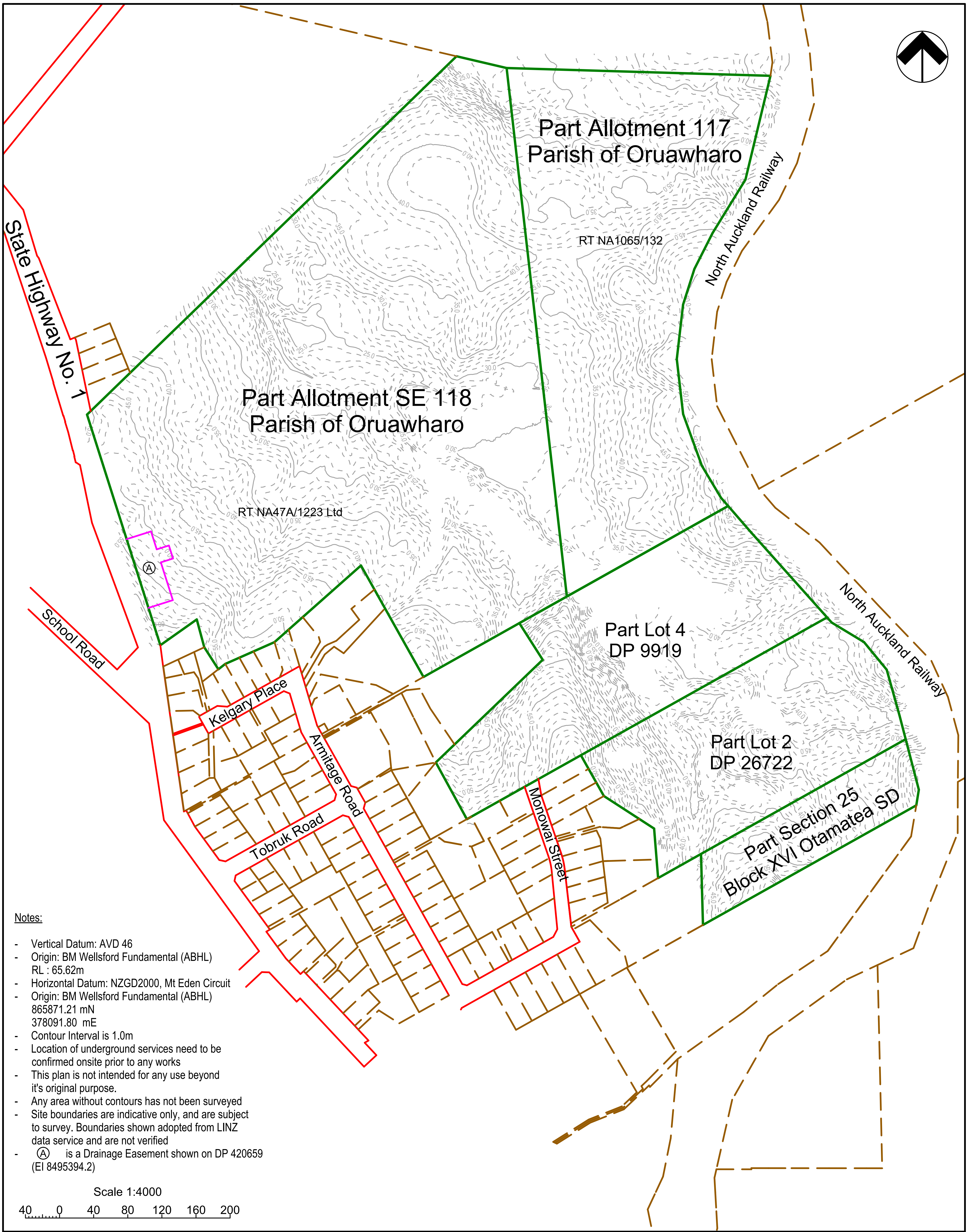
Prepared for :

Wellsford Welding Club

Topographical Survey of Part Allotment SE 118 and Part Allotment 117, Parish of Oruawharo

Address: 338 Rodney Street, Wellsford

Scale: 1:3000 (A3)			
Job: 8274	Date: 13/5/21	Drawn: SC	Reviewed: GH
Drawing: TP 02	Rev: -	Sheet: 2 of 2	



Notes:

- Vertical Datum: AVD 46
- Origin: BM Wellsford Fundamental (ABHL)
  RL : 65.62m
- Horizontal Datum: NZGD2000, Mt Eden Circuit
- Origin: BM Wellsford Fundamental (ABHL)
  865871.21 mN
  378091.80 mE
- Contour Interval is 1.0m
- Location of underground services need to be confirmed onsite prior to any works
- This plan is not intended for any use beyond it's original purpose.
- Any area without contours has not been surveyed
- Site boundaries are indicative only, and are subject to survey. Boundaries shown adopted from LINZ data service and are not verified
- Ⓐ is a Drainage Easement shown on DP 420659 (EI 8495394.2)

Scale 1:4000

40 0 40 80 120 160 200

buckton
consulting surveyors ltd

16 Mill Lane, P.O.Box 107, Warkworth 0941, 09 425 8950
www.buckton.co.nz, surveyors@buckton.co.nz

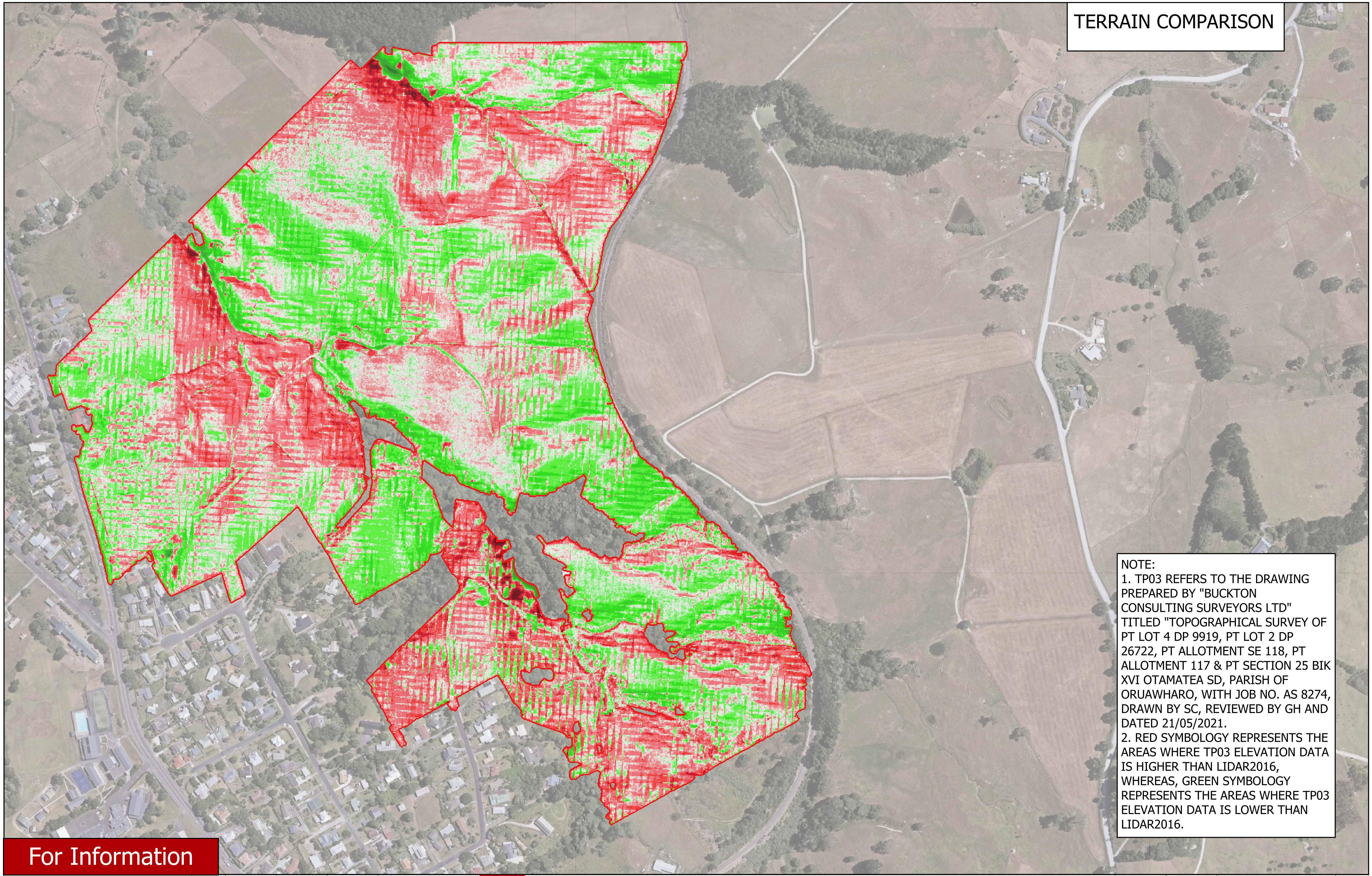
Prepared for :

Wellsford Welding Club

Topographical Survey of Pt Lot 4 DP 9919,
Pt Lot 2 DP 26722, Pt Allotment SE 118,
Pt Allotment 117 & Pt Section 25
BIK XVI Otamatea SD, Parish of Oruawharo

Address :
338 Rodney Street & Monowai Street, Wellsford

Scale: 1:4000 (A3)			
Job: 8274	Date: 21/5/21	Drawn: SC	Reviewed: GH
Drawing: TP 03		Rev: -	Sheet: 1 of 1



REVISION DETAILS		INT	DATE		
1.0	FOR INFORMATION	-	11/11/2022	SURVEYED	-
-	-	-	-	DESIGNED	-
-	-	-	-	DRAWN	SS
				CHECKED	-
				APPROVED	-

LEVEL 8/139 QUAY STREET
AUCKLAND CBD
WOODS.CO.NZ

WOODS Est.1970

WELLSFORD NORTH PLAN CHANGE - P21-395
TERRAIN COMPARISON - TP03 (BUCKTON CONSULTING SURVEY DATA) vs LiDAR2016

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	-
COUNCIL	AUCKLAND COUNCIL	
SHEET	SHEET 1 OF 1	

Appendix C. Culvert information

No	Asset Type	Asset Owner	US Model ID	DS Model ID	Survey Levels	SURVEY PHOTOS	Photo Inlet	Photo Outlet	Upstream invert level (m RL)	Downstream invert level (m RL)	Dia (mm)	Shape and material	INLET COEFF. CONTROL[1]					HY-8	River Reach Upstream
													Nr *	K	M	C	Y		
1	Twin Circular culvert[2]	AC - Stormwater	2000811317 S	2000293597 S	YES	YES	YES	YES	12.69	12.51	2000	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	YES and Downstream*
2	Circular Culvert	AC - Transport	2000063746	2000819719	YES	YES	NO	YES	17.62	16.98	450	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900	Compared with hy-8	YES
3	Circular Culvert	NZTA	2000805184	2000213627	YES	YES	YES	NO	28.68	27.83	450	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900	Compared with hy-8	YES
7	Box Culvert	Kiwi Rail	2258573_US	2258573_DS	YES	YES	NO	NO	35.04	34.72	1120	Rectangular/Headwall	20	0.4950	0.6670	0.0314	0.8200	Compared with hy-8	YES
8	Circular Culvert	Kiwi Rail	2258572_US	2258572_DS	YES	YES	NO	YES	43.755	43.73	225	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	NO
9	Circular Culvert	Kiwi Rail	2258571_US	2258571_DS	YES	YES	NO	YES	37.49	36.52	450	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	YES
10	Circular Culvert	Kiwi Rail	2258570_US	2258570_DS	NO	NO	NO	NO	41.29	38.71	375	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	YES
11	Circular Culvert	Kiwi Rail	2258569_US	2258569_DS	YES	YES	YES	YES	48.93	48.9	450	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	NO
12	Circular Culvert	Kiwi Rail	2258568_US	2258568_DS	NO	NO	NO	NO	50.09	49.93	225	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		NO
13	Circular Culvert	Kiwi Rail	2258567_US	2258567_DS	YES	YES	YES	NO	46.61	43.57	300	Circular Concrete	-	-	-	-	-	Modelled as manhole 2D. 1by1 manhole. 1m2. Photos evidence	NO
15	Circular Culvert	Kiwi Rail	2258565_US	2258565_DS	YES	YES	NO	YES	50.25	49.57	600	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		YES
16	Circular Culvert	Kiwi Rail	2258564_US	2258564_DS	NO	NO	NO	NO	47.784	45.64	450	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		YES
17	Circular Culvert	Kiwi Rail	2258563_US	2258563_DS	NO	NO	NO	NO	48.05	42.2	920	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		YES
19	Circular Culvert	Kiwi Rail	2258561_US	2258561_DS	NO	NO	NO	YES	61.795	58.1	600	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		NO

1. *Coefficients based on 'Culvert, Screen and Outfall Manual. Ciria 2019'. Table A7.5*
2. *Culvert 1 has an outlet loss coefficient of 0.5 based on 'Culvert, Screen and Outfall Manual. Ciria 2019'. Table A7.8 for circular headwall and wingwalls*

Appendix D. Hydrology parameters and validation

TP108 Validation for Existing development scenario No Climate Change

	Hydrology parameters									Graphical Method for Peak Flow Rate								Model results - 100yr No CC		
	Area	Catchment Length	Catchment Slope	Weighted Curve Number	Weighted Initial Abstraction	Channelisation Factor	Time of concentration	Time of concentration	Soil storage parameter	24hr Rainfall depth	Runoff depth	Runoff index		Specific Peak flow	Peak flow rate	Total Peak flow rate		Total Peak flow rate	Total Peak flow rate	Total Peak flow rate
TP108 notation	A	L	Sc	CN	IA	C	Tc	Tc	S	P_{24}	Q_{24}	c*	Column reference from TP108 table	q*	q_p	q_p		q_p	q_p	q_p
Units	ha	km	m/m		mm		Hrs	mins	mm	mm	mm			$m^3/s/(km^2\ mm)$	m^3/s	m^3/s		m^3/s	m^3/s	m^3/s
Wellsford-1D-PRE-01 (IMP)	0.2200	1.025	0.090	98	0	0.8	0.24	14.37	5.2	260	254.9	0.96	93.00	0.154	0.088	8.5		8.2	-0.300	-4%
Wellsford-1D-PRE-01 (PER)	28.1840	1.025	0.090	74	5	0.8	0.31	18.84	89.2	260	188.9	0.58	55.00	0.115	8.397					
Wellsford-1D-PRE-02 (IMP)	0.0430	0.636	0.139	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.019	5.3		5.2	-0.115	-2%
Wellsford-1D-PRE-02 (PER)	15.4430	0.636	0.139	74	5	0.8	0.20	12.07	89.2	260	188.9	0.58	55.00	0.131	5.254					
Wellsford-1D-PRE-03 (IMP)	0.0000	0.31	0.078	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	0.8		0.8	-0.020	-2%
Wellsford-1D-PRE-03 (PER)	2.2360	0.31	0.078	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.800					
Wellsford-1D-PRE-04 (IMP)	0.0000	0.528	0.115	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	2.3		2.2	-0.067	-3%
Wellsford-1D-PRE-04 (PER)	6.6280	0.528	0.115	74	5	0.8	0.19	11.31	89.2	260	188.9	0.58	55.00	0.134	2.311					
Wellsford-1D-PRE-04_2 (IMP)	0.0000	0.424	0.115	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	1.5		1.5	-0.038	-3%
Wellsford-1D-PRE-04_2 (PER)	4.2230	0.424	0.115	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.510					
Wellsford-1D-PRE-05 (IMP)	0.0180	0.654	0.135	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.008	6.0		5.8	-0.177	-3%
Wellsford-1D-PRE-05 (PER)	17.5410	0.654	0.135	74	5	0.8	0.21	12.42	89.2	260	188.9	0.58	55.00	0.131	5.968					
Wellsford-1D-PRE-06 (IMP)	0.0930	0.598	0.144	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.040	6.1		6.0	-0.126	-2%
Wellsford-1D-PRE-06 (PER)	17.6220	0.598	0.144	74	5	0.8	0.19	11.47	89.2	260	188.9	0.58	55.00	0.132	6.069					
Wellsford-1D-PRE-07 (IMP)	2.3310	0.521	0.050	98	0	0.6	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	1.010	2.7		2.6	-0.021	-1%
Wellsford-1D-PRE-07 (PER)	4.7450	0.521	0.050	74	5	0.6	0.18	10.81	89.2	260	188.9	0.58	55.00	0.134	1.654					
Wellsford-1D-PRE-08 (IMP)	2.1190	0.614	0.084	98	0	0.6	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.918	4.0		3.9	-0.057	-1%
Wellsford-1D-PRE-08 (PER)	8.7140	0.614	0.084	74	5	0.6	0.17	10.29	89.2	260	188.9	0.58	55.00	0.136	3.076					
Wellsford-1D-PRE-09 (IMP)	2.8490	1.133	0.039	98	0	0.8	0.33	19.80	5.2	260	254.9	0.96	93.00	0.139	1.029	15.2		14.8	-0.402	-3%
Wellsford-1D-PRE-09 (PER)	54.6020	1.133	0.039	74	5	0.8	0.43	25.95	89.2	260	188.9	0.58	55.00	0.100	14.200					
Wellsford-1D-PRE-10 (IMP)	27.5450	3.203	0.044	98	0	0.8	0.63	37.71	5.2	260	254.9	0.96	93.00	0.104	7.483	49.5		48.6	-0.826	-2%
Wellsford-1D-PRE-10 (PER)	218.3450	3.203	0.044	74	5	0.8	0.82	49.43	89.2	260	188.9	0.58	55.00	0.074	41.984					
Wellsford-1D-PRE-11 (IMP)	0.3430	1.267	0.046	98	0	0.8	0.34	20.20	5.2	260	254.9	0.96	93.00	0.137	0.122	7.5		7.3	-0.170	-2%
Wellsford-1D-PRE-11 (PER)	28.7070	1.267	0.046	74	5	0.8	0.44	26.48	89.2	260	188.9	0.58	55.00	0.099	7.389					
Wellsford-1D-PRE-12 (IMP)	0.1860	1.203	0.068	98	0	0.8	0.29	17.40	5.2	250	244.9	0.96	93.00	0.144	0.067	16.9		16.5	-0.395	-2%
Wellsford-1D-PRE-12 (PER)	64.6350	1.203	0.068	74	5	0.8	0.38	22.81	89.2	250	179.6	0.57	54.00	0.104	16.876					
Wellsford-1D-PRE-13 (IMP)	1.1860	3.012	0.044	98	0	0.8	0.60	36.22	5.2	260	254.9	0.96	93.00	0.106	0.327	32.4		32.0	-0.384	-1%
Wellsford-1D-PRE-13 (PER)	163.8310	3.012	0.044	74	5	0.8	0.79	47.48	89.2	260	188.9	0.58	55.00	0.075	32.098					
Wellsford-1D-PRE-14 (IMP)	1.9410	4.067	0.033	98	0	0.8	0.80	48.13	5.2	260	254.9	0.96	93.00	0.092	0.465	45.2		44.7	-0.438	-1%
Wellsford-1D-PRE-14 (PER)	264.6540	4.067	0.033	74	5	0.8	1.05	63.09	89.2	260	188.9	0.58	55.00	0.065	44.714					
Wellsford-1D-PRE-15 (IMP)	1.4910	1.732	0.054	98	0	0.8	0.40	23.70	5.2	250	244.9	0.96	93.00	0.128	0.477	11.9		11.7	-0.249	-2%
Wellsford-1D-PRE-15 (PER)	50.0540	1.732	0.054	74	5	0.8	0.52	31.07	89.2	250	179.6	0.57	54.00	0.092	11.458					
Wellsford-1D-PRE-16 (IMP)	1.3800	2.482	0.040	98	0	0.8	0.55	32.88	5.2	250	244.9	0.96	93.00	0.111	0.384	26.1		25.9	-0.172	-1%
Wellsford-1D-PRE-16 (PER)	131.1890	2.482	0.040	74	5	0.8	0.72	43.10	89.2	250	179.6	0.57	54.00	0.078	25.689					
Wellsford-1D-PRE-17 (IMP)	3.6190	4.133	0.028	98	0	0.8	0.85	51.24	5.2	250	244.9	0.96	93.00	0.089	0.808	67.7		67.0	-0.708	-1%
Wellsford-1D-PRE-17 (PER)	429.6710	4.133	0.028	74	5	0.8	1.12	67.17	89.2	250	179.6	0.57	54.00	0.062	66.867					
Wellsford-1D-PRE-18 (IMP)	0.0000	0.285	0.085	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	1.6		1.6	-0.041	-2%
Wellsford-1D-PRE-18 (PER)	4.5990	0.285	0.085	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.645					
Wellsford-1D-PRE-19 (IMP)	0.0000	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	0.2		0.2	-0.006	-2%
Wellsford-1D-PRE-19 (PER)	0.6800	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.243					
Wellsford-1D-PRE-20 (IMP)	0.0000	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	0.5		0.5	-0.012	-2%
Wellsford-1D-PRE-20 (PER)	1.3280	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.475					
Wellsford-1D-PRE-21 (IMP)	0.0010	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	0.6		0.6	-0.016	-2%
Wellsford-1D-PRE-21 (PER)	1.7980	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.643					
Wellsford-2D-PRE-01 (IMP)	2.9000	0.568	0.096	98	0	0.6	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	1.256	4.8		4.6	-0.114	-2%
Wellsford-2D-PRE-01 (PER)	9.7850	0.568	0.096	74	5	0.6	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	3.500					
Wellsford-2D-PRE-02 (IMP)	0.0000	0.374	0.087	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	1.5		1.5	-0.038	-2%
Wellsford-2D-PRE-02 (PER)	4.3220	0.374	0.087	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.546					
Wellsford-2D-PRE-03 (IMP)	0.4010	0.239	0.136	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.174	1.7		1.7	-0.043	-2%
Wellsford-2D-PRE-03 (PER)	4.3690	0.239	0.136	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.563					
Wellsford-2D-PRE-04 (IMP)	0.0000	0.407	0.092	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	1.3		1.3	-0.038	-3%
Wellsford-2D-PRE-04 (PER)	3.6490	0.407	0.092	74	5	0.8	0.17	10.18	89.2	260	188.9	0.58	55.00	0.138	1.305					
Wellsford-2D-PRE-05 (IMP)	0.7690	0.564	0.071	98	0	0.8	0.17	10.42	5.2	260	254.9	0.96	93.00	0.165	0.329	3.1		3.0	-0.099	-3%
Wellsford-2D-PRE-05 (PER)	8.3480	0.564	0.071	74	5	0.8	0.23	13.66	89.2	260	188.9	0.58	55.00	0.128	2.773					

	Hydrology parameters									Graphical Method for Peak Flow Rate							Model results - 100yr No CC		
	Area	Catchment Length	Catchment Slope	Weighted Curve Number	Weighted Initial Abstraction	Channelisation Factor	Time of concentration	Time of concentration	Soil storage parameter	24hr Rainfall depth	Runoff depth	Runoff index		Specific Peak flow	Peak flow rate	Total Peak flow rate	Total Peak flow rate	Total Peak flow rate	Total Peak flow rate
TP108 notation	A	L	Sc	CN	IA	C	Tc	Tc	S	P_{24}	Q_{24}	c*	Column reference from TP108 table	q*	q_p	q_p	q_p	q_p	q_p
Units	ha	km	m/m		mm		Hrs	mins	mm	mm	mm			$m^3/s/(km^2 mm)$	m^3/s	m^3/s	m^3/s	m^3/s	m^3/s
Wellsford-2D-PRE-06 (IMP)	2.4470	0.387	0.095	98	0	0.6	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	1.060	2.8	2.7	-0.065	-2%
Wellsford-2D-PRE-06 (PER)	4.8110	0.387	0.095	74	5	0.6	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.721				
Wellsford-2D-PRE-07 (IMP)	0.0000	0.351	0.067	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	1.5	1.4	-0.041	-3%
Wellsford-2D-PRE-07 (PER)	4.0690	0.351	0.067	74	5	0.8	0.17	10.15	89.2	260	188.9	0.58	55.00	0.138	1.455				
Wellsford-2D-PRE-08 (IMP)	1.8070	0.523	0.069	98	0	0.6	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.783	2.4	2.3	-0.057	-2%
Wellsford-2D-PRE-08 (PER)	4.5370	0.523	0.069	74	5	0.6	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.623				
Wellsford-2D-PRE-09 (IMP)	0.0000	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	0.4	0.4	-0.011	-2%
Wellsford-2D-PRE-09 (PER)	1.2120	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.433				
Wellsford-2D-PRE-10 (IMP)	0.0060	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.003	0.8	0.8	-0.020	-2%
Wellsford-2D-PRE-10 (PER)	2.2620	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.809				
Wellsford-2D-PRE-11 (IMP)	0.4240	0.479	0.106	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.184	1.7	1.6	-0.025	-1%
Wellsford-2D-PRE-11 (PER)	4.2460	0.479	0.106	74	5	0.8	0.18	10.86	89.2	260	188.9	0.58	55.00	0.134	1.480				
Wellsford-2D-PRE-12 (IMP)	0.1910	0.368	0.126	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.083	1.6	1.6	-0.040	-2%
Wellsford-2D-PRE-12 (PER)	4.2960	0.368	0.126	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.536				
Wellsford-2D-PRE-13 (IMP)	0.0060	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.003	1.0	1.0	-0.026	-2%
Wellsford-2D-PRE-13 (PER)	2.8990	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.037				
Wellsford-2D-PRE-14 (IMP)	0.0000	0.406	0.072	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	3.7	3.6	-0.075	-2%
Wellsford-2D-PRE-14 (PER)	10.6690	0.406	0.072	74	5	0.8	0.18	10.92	89.2	260	188.9	0.58	55.00	0.134	3.719				
Wellsford-2D-PRE-15 (IMP)	0.0000	0.434	0.057	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	2.1	2.0	-0.053	-3%
Wellsford-2D-PRE-15 (PER)	6.1620	0.434	0.057	74	5	0.8	0.20	12.23	89.2	260	188.9	0.58	55.00	0.131	2.096				
Wellsford-2D-PRE-16 (IMP)	0.6220	0.628	0.061	98	0	0.8	0.20	11.72	5.2	260	254.9	0.96	93.00	0.161	0.260	2.1	2.0	-0.073	-3%
Wellsford-2D-PRE-16 (PER)	5.7310	0.628	0.061	74	5	0.8	0.26	15.36	89.2	260	188.9	0.58	55.00	0.123	1.837				
Wellsford-2D-PRE-17 (IMP)	0.0740	0.305	0.118	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.032	1.7	1.7	-0.043	-2%
Wellsford-2D-PRE-17 (PER)	4.7950	0.305	0.118	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.715				
Wellsford-2D-PRE-18 (IMP)	0.0000	0.407	0.118	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	1.5	1.4	-0.037	-2%
Wellsford-2D-PRE-18 (PER)	4.1180	0.407	0.118	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.473				
Wellsford-2D-PRE-19 (IMP)	0.0000	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	1.2	1.2	-0.030	-2%
Wellsford-2D-PRE-19 (PER)	3.3230	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.188				
Wellsford-2D-PRE-20 (IMP)	0.0040	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.002	0.7	0.7	-0.018	-2%
Wellsford-2D-PRE-20 (PER)	2.0680	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.740				
Wellsford-2D-PRE-21 (IMP)	0.0510	0.387	0.102	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.022	2.4	2.3	-0.058	-2%
Wellsford-2D-PRE-21 (PER)	6.5100	0.387	0.102	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	2.328				
Wellsford-2D-PRE-22 (IMP)	0.0120	0.447	0.071	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.005	1.5	1.5	-0.039	-3%
Wellsford-2D-PRE-22 (PER)	4.3210	0.447	0.071	74	5	0.8	0.20	11.71	89.2	260	188.9	0.58	55.00	0.132	1.488				
Wellsford-2D-PRE-23 (IMP)	0.0000	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	0.5	0.5	-0.013	-2%
Wellsford-2D-PRE-23 (PER)	1.4540	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.520				
Wellsford-2D-PRE-24 (IMP)	0.0880	0.377	0.127	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.038	1.9	1.8	-0.046	-2%
Wellsford-2D-PRE-24 (PER)	5.1310	0.377	0.127	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.835				
Wellsford-2D-PRE-25 (IMP)	0.0120	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.005	1.2	1.2	-0.030	-2%
Wellsford-2D-PRE-25 (PER)	3.3290	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.191				
Wellsford-2D-PRE-26 (IMP)	0.0840	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.036	0.9	0.9	-0.023	-2%
Wellsford-2D-PRE-26 (PER)	2.5160	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.900				
Wellsford-2D-PRE-27 (IMP)	0.1080	0.442	0.140	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.047	3.2	3.1	-0.078	-2%
Wellsford-2D-PRE-27 (PER)	8.6970	0.442	0.140	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	3.110				
Wellsford-2D-PRE-29 (IMP)	0.0030	0.229	0.098	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.001	1.5	1.5	-0.037	-2%
Wellsford-2D-PRE-29 (PER)	4.1950	0.229	0.098	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	1.500				
Wellsford-2D-PRE-30 (IMP)	0.0000	0.1	0.005	98	0	0.8	0.17	10.02	5.2	260	254.9	0.96	93.00	0.167	0.000	0.5	0.4	-0.011	-2%
Wellsford-2D-PRE-30 (PER)	1.2730	0.1	0.005	74	5	0.8	0.17	10.02	89.2	260	188.9	0.58	55.00	0.138	0.455				

Appendix E. Auckland Council model review form

Auckland Council Model Review
USER GUIDE

Please READ prior to carrying out the review

About the Review Form

The Auckland Council Model Review form is created to support the Quality Assurance procedures for Council owned stormwater models. The Model Review form is required as part of the model deliverables for Council approvals and model registration.
On model delivery from The Modeller, Auckland Council will assign The Reviewer to go through necessary checks and perform the Council Review using this Model Review form. The Council Review is carried out as Auckland Council's due diligence before accepting the model for subsequent floodplain publication and/or catchment planning activities.
The Council Review is NOT a replacement for any internal reviews required from The Modeller. Model deliverables are expected to have been internally reviewed within the Modeller's company and relevant sections of the Model Review form completed, prior to the model delivery. The quality and reliability of all modelling work undertaken as part of the project is the responsibility of The Modeller. As such, Auckland Council reserves the right to bring to the attention of The Modeller for necessary corrective action on any issues found at any time during the project.

Review Holding Point

A review holding point has been introduced to the review. The model review should be put on-hold until all issues raised in *A - General Information Review* have been addressed by The Modeller, and accepted by Auckland Council.

The Tabs

The Model Review form is made up of three main tabs or sections:
Tab 1 - Model Metadata, provides a quick summary of key model characteristics, files and documentation and model metadata. This tab is for The Modeller to complete and is highlighted in yellow.
Tab 2 - Review Summary, provides a quick summary of the review findings, document controls and review scoring. This tab is for The Reviewer to complete.
Tab 3 - Detailed Review Check List, provides an extensive list of all the check and review questions that both The Modeller and The Reviewer should go through. On delivery of the DRAFT model, the Modeller should have completed the "Modeller's Initial Notes" column under Tab 3 in addition to Tab 1. There are three detailed review tabs, each corresponding with one type of model (FHM, FWM or RFHM, as defined below). Only one of these tabs needs to be filled, based on the model type.

Types of Model

The type of model is categorised by the levels of detail as well as modelling methodology, rather than the project objectives and purpose. For example, a model used for testing options could be either an detailed FHM model, an FWM model or an RFHM model. Therefore the review check list for an options model review is dependant on which category the options model falls under.
Flood Hazard Models (FHM) - Flood Hazard Models are detailed models that are either 1D only or 1D/2D coupled. The subcatchment sizes of these models are generally less than 3ha and the primary drainage systems are modelled extensively. These models are generally suitable for floodplain publication purposes for the whole model extent.
Framework Models (FWM) - Framework models generally focus on representing trunk primary drainage system of a catchment. These may include large diameter pipes, main streams and river systems, etc. The average subcatchment size for framework models are typically larger compared to FHM models. Framework models could be 1D only or 1D/2D coupled.
Rapid Flood Hazard Models (RFHM) - Rapid Flood Hazard Models are generally 2D rain-on-grid models that utilises direct/effective rainfall and terrain to route flow. RFHM models are predominately 2D and may include structures along main streams and limited 1D pipe networks, etc. Small depressions may be filled prior to final flood simulation in RFHM models for conservativeness.
All Other Models - There may be models with mixed levels of detail and/or mixed methodology for different areas of the model. In that case the review should be carried out using the most extensive check list covering all features of the model.

Types of Review

Standard Review - Full review which includes both 1) review on whether the model meets the project purpose and objectives (fit for purpose); whether the model is schematised appropriately; whether the model is consistent with report; 2) go through the corresponding check list, and check/spot check model features against the modelling spec requirements.
Partial Review - A review which only focuses on one or more aspects of the modelling work. For example, a review on hydrological model only, or review of the options modelled only, or a review on the model build only (not on the results), etc.

Glossary

The Modeller - The company engaged by Auckland Council to carry out modelling work.
The Reviewer - A model reviewer appointed by Auckland Council to carry out the Council Review. The reviewer could be an in-house modeller or from a consultant company.
Council Review - the due diligence review based on this model review template, on behalf of Auckland Council, before the model is accepted for floodplain publication or other catchment planning activities.

Auckland Council Model Review

Section 1 - Model Metadata

General Model Info	
Main Consolidated SW Catchment:	**Wellsford**
Council Project Manager	
Other SW Catchment within Model Extent:	None
Other relevant SW Catchment for model inputs:	N/A
Model Name:	Wellsford
Model Horizon ID:	
Model Software, AND Version:	Infoworks ICM 2021.6
Type of Model:	Flood Hazard Model (FHM)
Model Created By (Person/Organisation):	Miguel Hernandez, Woods
Is this model an update based on a previous model?	NO
Is the model built as per the SW Modelling Specs?	YES
Model Description:	1D/2D model of Wellsford catchment. The 2D model extent covers the northeast part of this catchment. The model includes a 1D representation of the Whakapirau river. Main culverts along SH1 and the railway were included to represent the connection between the floodplain areas. Model extent is shown in Figure 0:1.
Model Purpose / Objectives:	Make a flood assessment for the proposed development located in the northeast part of the Wellsford urban area. The model is focused on the flood impact near open channels and creeks and the flood over the SH1. The development considers a future urban plan change. The model is the primary tool to compare the effects of the new urban implementation in the area.
Limitations specific to this model:	- Survey was carried out as a part of this study only for the main structures on the open channels inside the interest area. Survey campaign made in January 2022. -The model do not consider the urban stormwater network at the eastern side of the SH1. - The LiDAR data has an absolute vertical accuracy of +/- 0.10m. Deviations in vertical accuracy can occur in areas of dense vegetation. Below water ground levels are not reliably represented in the LiDAR data - There is no new measured flow data in the catchment; therefore, it was only possible to check the model against measured peak water levels, anecdotal evidence and previous modelling - Updates were completed to some of the culverts through the SH1. -The model simplifies the subcatchments to represent post-development considerations. - Subcatchments are loading directly to the open channels.
Is this model fit for producing floodplain for publication?	NO
If answered "NO" for the above question, why not?	Model created for the private plan change purpose.

Model Files and Documentation	
File directory for model deliverables (MUST COMPLETE): (All model deliverables are to be stored at respective catchment folder(s) under "U:\COO\IES \StormWaterModels\00 Model DELIVERABLES\...")	
Is model report supplied (must have, but can be draft):	YES
Is model extent polygon supplied (must have):	YES
Is model schematisation map supplied (must have):	YES
Is model data flag file supplied:	YES
Are model results supplied:	YES
List out all scenarios modelled (design storm events, validation events, sensitivity analysis runs, etc.)	A total of 15 scenarios were modelled. Climate change (CC) includes a temperature increase of 3.8°. -ED with CC for 2yr, 10yr and 100yr ARI -ED no CC for 10yr and 100yr ARI -Plan Change with CC for 2yr, 10yr and 100yr ARI (PC) -Plan Change no CC fo 10yr and 100yr ARI (PC) -Plan Change and MPD with CC for 2yr, 10yr and 100yr ARI (PC FUZ) -Plan Change and MPD no CC for 10yr and 100yr ARI (PC FUZ)

Auckland Council Model Review

Section 1 - Model Metadata

List relevant input/calculation files supplied:	-LiDAR 2016 -Survey points
Is WaterRIDE file supplied (only at FINAL delivery):	NO
Model Metadata	
Hydrology Method	TP108
LiDAR Source (2016, 2013, 2006-2010, etc.)	2016
Any DEM modifications? If yes, describe in more detail.	Yes. Six mesh level zones polygonos were considered to represent connection in a open channel. See Figure B:8.5
Mesh Type	Flexible Triangular Mesh
Mesh Size	2 m^2 to 5 m^2
Soakage representation	No additional infiltration is represented in the model. There is no exising soakage assets in the interest area.
Pipe network modelled (e.g. all pipes >=300mm, etc.)	14 pipes in total between
Key structures modelled? Describe type and number	14 1D culverts
Open channel / stream representation description	2D mesh
MPD representation (Unitary Plan, District Plan, etc.)	Proposed plan changes were modelled together with the AC Unitary Plan Operative in part
Climate change allowances	RCP8.5 (2101-2120)
Tide Boundary Level (current and future)	2.3mRL at the end of Whakapirau Creek for the exising scenarios 3.3m RL at the end of Whakapirau Creek for the future scenarios
Simulation Duration (24hrs, etc.)	24 hrs
Simulation Timesteps	1440min
Model Run Time (How long did it take to run)	0.4-0.8 hrs

Auckland Council Model Review

Section 2 Review Summary

Review Summary	
Reviewed By (Person/Organisation):	
Type of Review (Standard Review or Partial Review)	
Review Scope Description:	
Summarise Key Findings of the Review:	

Document Control

Model Revision	Delivery Date	Review Version	Review Date	Review Completed By, Company
1	20/04/2022	v1		
63	4/05/2022	v3	25/05/2022	Kedan Li, AC
		v4	9/01/2023	Kedan Li, AC

Overview of Review Findings

Traffic Light Rating Scores (0 - no issue, 3 - major issue)

- 0 - No issue found
- 1 - Minor issue or non-standard approach, but unlikely to significantly impact on objectives of the study
- 2 - Some concerns, likely to have an impact on model results
- 3 - Concerns that may have a significant impact on model results and not meeting the study objectives

Review Section	Traffic Light	Comments
A - Overview		
A:1 Deliverables	3	Modelled results presented in the Modelling Memo and model do not align fully. Please provide GIS rasters.
A:2 Previous Review Comments	na	
A:3 Model Speed and Stability	na	
B - Detailed Model Review		
B:1 Model Boundary Conditions	3	Incorrect tailwater used in ED scenarios. 2yr and 10yr rainfall partially incorrect for all scenarios.
B:2 Model Catchments	3	Some incorrect delineation
B:3 Pipe Networks	na	no pipe network been modelled
B:4 Channel / Stream Networks	3	Roughness too low for streams
B:5 Hydraulic Structures and Control Elements	3	Groud level and inlet loss parameters are incorrect for SH culvert
B:6 Other Asset Features	na	
B:7 1D Overland Flow Paths	na	
B:8 2D Model Components	2	SH culvert 1D/2D not well represented
C - Model Results Review		
C:1 Model Results Check	3	Modelled results presented in the Modelling Memo and model do not align fully. Please provide rasters if have extracted from 1D.
C:2 Model Validation	3	TP108 check not supplied
D - Additional Checks		
D:1 Additional Check Items		

Auckland Council Model Review

Section 3 Review Details

Instruction Notes:

1. About FIGURES *-- Please note figures should be clearly* ***labelled*** *and included the FIGURES tab and* ***referenced*** *in the review comments.*

2. Traffic Light Rating Scores *(0 - no issue, 3 - major issue)*

0 - No issue found

1 - Minor issue or non-standard approach, but unlikely to significantly impact on objectives of the study

2 - Some concerns, likely to have an impact on model results

3 - Concerns that may have a significant impact on model results and not meeting the study objectives

A - General Information Review

A:1 - Deliverables

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	9th Jan Reviewer's Comments
A:1.1	Is tab "Section 1 - Model Metadata" filled in and does it provide an accurate summary of the supplied model data.	0	ok		
A:1.2	Have all agreed deliverables been provided – Reporting, Model Database, Survey etc.	0	ok		
A:1.3	Is the model delivered in the required software version?	0	ok	GIS layers packaged up along with the model	
A:1.4	Are all associated model input files supplied in specified format, i.e. as part of the icmt file or in folders with appropriate naming conversion if using other software.	0	ok		
A:1.5	Are all required modelled scenarios included in the deliverable? Does the model database include result files for all the scenarios?	0	ok		

A:2 - Previous Review Comments

Item	Description	Rating Score	Reviewer's Comments	Modellers Response
A:2.1	Confirm that all previous review comments have been incorporated or resolved, if any (such as MEDAR recommendations, etc.). List any that have not, and comment on impact to model usability.		na	
A:2.2	Assess model against any other review recommendations produced during the model development. If there was no formal process for resolving the reviewers comments, then each item should be listed below and a comment made as to whether or not the issue has been resolved, and if it has significant impacts.		na	
A:2.3	Identify and document any agreed divergence from spec and adopted model build process	0	OK	

A:3 - Model Speed and Stability

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	
A:3.1	Check model simulation period and time steps, including result time steps.	0	OK		
A:3.2	Comment on run time expected in terms of the catchment size and complexity.	0	OK		
A:3.3	Check model validation errors and warning messages.	2	Checked ED 100yr 3.8cc. Many 2d outfall has ground level not equal to downstream invert level. Flow reversals.	Oct 18-2022: Dummy 2D outfalls and pipes modelled for loading catchments replaced with 2D source points as recommended by Innovyze	ok
A:3.4	Assess model stability i.e. identify time step critical locations. Any apparent issues in model results caused by model instabilities? Is peak impacted by instabilities?	0	no	Oct 18-2022: To reduce the instabilities, the SH1 crossing has been reconfigured in discussion with Innovyze	ok
A:3.5	Review mass balance (<1%, if more than 1%, find out why & whether improvements should be made, discuss with AC if mass balance error cannot be reduced)	0	OK		

Review Hold Point – if there is any corrective action required as a result of the above – the review is to be halted until the issue is resolved to the satisfaction of the appointed reviewer and

B - Detailed Model Review

B:1 - Model Boundary Conditions

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	
B:1.1	Confirm rainfall values and profiles used are appropriate, and that modelled values are equivalent to what is included in the associated reporting.	3	Correction required for profile 2: 2yr, 2yr cc events; Correction required for profile 1 in 100yr; 100yr cc events.	Oct 18-2022: Rainfalls have been updated. Table B1.1 shows the rainfall depths used in the model.	ok
B:1.2	Assess downstream water levels with reference to coastal marine boundary or other software	3	ED scenarios tailwater level incorrect, should be 2.3mRL.	Oct 18-2022: Existing development scenario simulated with 2.3mRL	ok
B:1.3	Describe and review any inflow boundary conditions		na		
B:1.4	Check how model initial conditions are applied for both 1D and 2D. The use of model features such as initial condition zone for tidal areas and ponds, etc.	3	ED scenarios tailwater level incorrect, should be 2.3mRL.	Oct 18-2022: Existing development scenario simulated with 2.3mRL	ok
B:1.5	Check time varying inputs and make sure their start and finish time aligns with simulation setting.	0	ok		
B:1.6	How is climate change applied? Check rainfall and tide boundary	0	ok		

B:2 - Model Catchments

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	
B:2.1	Review modelled catchment extent. Confirm that it follows contours, and incorporates or excludes any additional primary network which is not consistent with the contours. Any flow transfers across catchment boundaries?	0	ok		
B:2.2	Subcatchment extents and sizes. Comment on methodology used for subcatchments delineation – is it appropriate, are there any limitations? Any impact on model usefulness.	3	spot check on subcatchments, the following subcatchments' delineationare not approperiate that either inlcuded more than one main stream or included the neighbouring olfp: 104, 117, 137, 112,108, 131	Oct 18-2022: Catchment delineation has been reviewed. The total sub-catchments for the ED scenario are 51. The total sub-catchments for future scenarios (PPC and PCFUZ) are 70(See Figure B:2.1). The ED sub-catchment delineation follows terrain surface. The future sub-catchments delineation follows the proposed structure plan shown in Figure B:2.2	ok
B:2.3	Spot check subcatchment loading nodes are assigned properly.	3	spot check on subcatchments, the following loading are not appropriate. 105, 154, 138, 103, 133, 131, 137, 144, 140	Oct 18-2022: Subcatchments delineation and loading have been checked. Check has been performed with the latest OLFPs and aerials. Future scenarios subcatchments vary due to proposed design surface.	ok
B:2.4	Check hydrological method used	0	ok		
B:2.5	Identify the curve numbers used in the model. Compare to Auckland Council Soil Maps to confirm appropriate use of curve number for pervious land use.	0	ok		

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	Reviewer's Comments
B:2.6	Check impervious coverage and compare numbers extracted from model with reported figures. Spot check ED imperviousness using existing impervious layers and aerial photographs – include a screen dump of any issues identified. Review approach for defining MPD.	**0**	ok		
B:2.7	Spot check and document time of concentration for catchments, comparing to TP108 graphical calculations.	**0**	ok		
B:2.8	Check initial abstraction (Ia) ranges in existing / future scenarios.	**0**	ok		

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	Reviewer's Comments
B:2.9	Check catchment length, slope and Tc are correctly assigned.	0	ok		

B:3 - Pipe Networks

Item	Description	Rating Score	Reviewer's Comments	Modellers Response		
B:3.1	Confirm all critical network and structures are included in model (trunk network, known flooding points, key structures, etc.)	0	ok			
B:3.2	Check if the model extent is suitable for generating floodplains, i.e. does it extend far enough upstream and include all flood prone areas.		na			
B:3.3	Check asset naming convention. Can model ID be linked to assets in the GIS	0	ok			
B:3.4	Confirm node/manhole data source flagging and if it is documented for attributes such as lid level, invert level, shaft area, flood type, etc.	0	ok			
B:3.5	Confirm pipe asset data source flagging and if it is documented for attributes like shape, diameter / width/ height, material, upstream and downstream inverts, etc.	0	ok			
B:3.6	Spot check data entry of asset inspection/survey records for 5 locations	0	ok			
B:3.7	Spot check node attributes (diameter, shaft area, invert level and lid level) match asset data or are interpolated appropriately.	1	shaft less than 1	Oct 18-2022: Model node levels have been reviewed. No issues founded.	ok	
B:3.8	Compare node lid levels to LiDAR	1	Culvert ground level higher than lid level	Oct 18-2022: Checked. Model node levels have been reviewed, no issues.	ok	
B:3.9	Check cover types are appropriate i.e. sealed, stored, 2D, etc.	1	2258568_US not sealed	Oct 18-2022: Manhole flood type checked	why 2258567_US not using nodes and culvert inlet but manhole?	The culvert was setting up without inlet losses, It will be amended within following modelling stages. Also the culvert does not have capacity for the 2 ARI CC is surcharging.
B:3.10	Check pipe attributes (diameter, shape, length, material, invert levels) match asset data or are interpolated sensibly	1	invert level slightly different from survey data provided in the report, although same as CAD file	Oct 18-2022: Checked. Survey drawings match with model	ok	
B:3.11	Check pipe long section and gradient for steep, zero and negative grades.	0	ok			
B:3.12	Check if continuation pipe is matched using soffit levels	0	ok			
B:3.13	Ground cover. Identify pipes that have insufficient cover – less than 300mm.	0	ok			
B:3.14	Identify any network which has decreasing diameters in a down-stream direction.	2	wellsford-2D_pre_11_Imp; Wellsford-1D-PRE-05-IMP; Wellsford-2D-PRE-02-IMP; Wellsford-2D-PRE-06-IMP; Wellsford-2D-PRE-17-IMP	Oct 18-2022: Checked. The catchment loading method has been changed by using 2D point source that avoid the use of dummy pipes.	ok	
B:3.15	Check pipe lengths less than 10m, and if any actions required.	0	ok			
B:3.16	Check pipe roughness assumptions appropriate for material and condition	0	ok			
B:3.17	Check manhole headlosses in the model.	0	ok			
B:3.18	Check entry and exit losses of pipes and any minor losses caused by bends, side connections or joint defects, etc.	3	Square edge with headwall. Culvert K, Ki too low.	Oct 18-2022: Culvert 2000811317 (main culvert in the SH1) now is modelled as two barrels culvert. The inlet coefficients are based on Table A7.5 CIRIA(2019) for a Square edge with a headwall. Values were confirmed during the meeting with the AC (09/09/2022).	ok	
B:3.19	Check natural depression areas or dry pond are modelled with proper outlet configuration i.e. it drains properly after flooding.	0	ok			
B:3.20	How is storage compensation applied to any trimmed network.	0	ok			

B:4 - Channel/Stream Networks

Auckland Council Model Review

Section 3 Review Details

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	Reviewer's Comments
Item	Description	Rating Score	Reviewer's Comments	Modellers Response	
B:4.1	Are channels modelled appropriately? (in 2D or as 1D river reaches)	0	ok		
B:4.2	In case of burning surveyed cross-sections in 2D, spot check cross-sections from 2D bathymetry compared to the surveyed cross-sections.	2	? Where were those applied, model build memo is not clear. Mesh level zone 5 no level change.	Oct 18-2022: Model build updated with the mesh level zones applied in the model. Also, breaklines were modelled to refine mesh resolution along river path, as shown in Figure B:4.2.	ok
B:4.3	Spot check modelled cross-sections and banklines with LiDAR	0	ok		
B:4.4	Is location and spacing between cross sections appropriate? (e.g. maximum dx in MIKE11)	0	ok		
B:4.5	Spot check of modelled cross-sections whether it includes low flow channel.	0	ok		
B:4.6	Spot check data entry of survey records for 5 locations				
B:4.7	Identify any topography which may cause instabilities – such as flat sections.				
B:4.8	Review the use of “channel markers” or “new panels”.	2	panel markers not used appoperiately	Oct 18-2022: Conveyance markers have been checked for all cross sections.	ok
B:4.9	Identify if cross sections are drawn properly: - check length and extents sufficient to cover flood flows - any sections which are not perpendicular to the direction of flow. - are sections straight lines? Comment on the impact to the conveyance, and to the model results.	0	ok		
B:4.10	Check locations where flooding extends from the channel to the 2D mesh – comment on merging of 1D/2D representation.	N/A	ok		
B:4.11	Comment on application of roughness values.	3	Should be using Table 5-2. 0.03 and 0.04 too low.	Oct 18-2022: Roughness coefficients have been updated with the values agreed during the meeting with the AC (09/09/2022). Also, roughness has been edited for the PPC and PCFUZ scenarios. Figures B:8.5a and B:8.5b show the roughness maps.	ok
B:4.12	Identify any double counting of volumes, in overland flow paths basins other cross sections	0			
B:4.13	Check gradient for steep, zero and negative grades.	0			
B:4.14	Confirm no double counting of flood storage volumes, at locations such as basins or connection nodes at the ends of channels, , etc.	0			

B:5 - Hydraulic Structures and Control Elements

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	
B:5.1	Are inlets represented correctly? Do they align with surrounding terrain and have correct inlet control/headloss parameters?	0	ok		
B:5.2	Check outlet and/or outfall representations. Do they align with surrounding terrain or connect appropriately with downstream features?	0	ok		
B:5.3	Check representation of culverts. Shape, number of barrels, inlet/outlet losses, roughness, gradient, etc.	3	Spot check on SH cuvlerts. Us and ds break node and manhole node ground level incorrect. Culvert inlet loss incorrect.	Oct 18-2022: Culvert levels have been reviewed and updated with the survey levels. As per Innovyze's advise, (email dated 15/10/2022), the twin culverts are modelled as single conduit with the 'barrel' field set to 2. For the twin culvert (2000811317), the survey level of the lowest culvert was adopted. Inlet loss coefficients have been reviewed according to values agreed upon during the meeting with the AC (09/09/2022).	ok
B:5.4	Review bridges representation: - cross sections - contraction and expansion losses - bridge deck, profile and coefficients - bridge skew - bridge opening, gradient, inlet and outlet losses - bridge piers or other obstructions				
B:5.5	Check representation of storages, depressions, dams or constructed ponds: - stage storage relationship - any controls - inlets and outlets - initial or permanent water levels - overtopping arrangements (single level or irregular shape; weir coefficients; 2D mesh / breaklines);				
B:5.6	Check pump configurations. On/off levels, pump type, pump curve, pump controls, etc.				

B:6 - Other Asset Features

Item	Description	Rating Score	Reviewer's Comments	Modellers Response
B:6.1	Soakage modelling methods and representation in the model.			
B:6.2	How is the soakage outlet capacity modelled. The assumptions, e.g. ARIs, etc.			
B:6.3	Review the use of weir units in the model. Comment on the weir representation and coefficients used			
B:6.4	Review the use of orifice units in the model, comment on the associated coefficients applied.			
B:6.5	Check representation of tunnels/underpasses			

B:7 - 1D Overland Flow Paths

Item	Description	Rating Score	Reviewer's Comments	Modellers Response
B:7.1	Modelled overland flow paths locations and downstream connectivity.			
B:7.2	Comment on application of roughness values applied to 1D overland flow paths.			
B:7.3	Review section shape for 1D overland flow paths			
B:7.4	Check OLFP gradient and levels			

B:8 - 2D Model Components

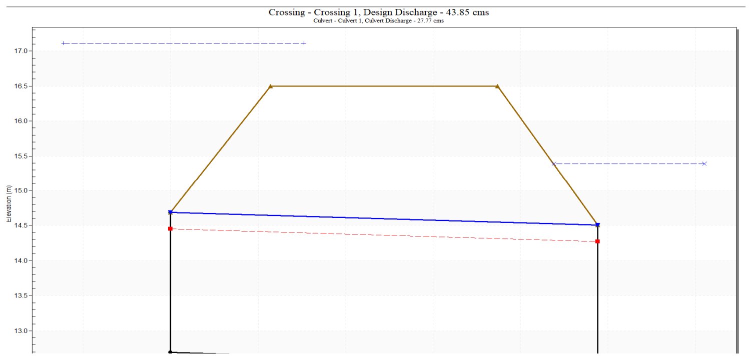
Item	Description	Rating Score	Reviewer's Comments	Modellers Response	
B:8.1	Review 2D extent and mesh sizes (any terrain sensitive meshing, and no extremely large or small meshes) Are mesh sizes appropriate at inlets and outlets.	0	ok		
B:8.2	How have building footprints been represented	1	no buildings represented	Oct 18-2022: Buildings representation as roughness coefficients value in the 2D Zone with a value of 0.1 (n Manning) for overland flows through property parcels.	ok
B:8.3	Review DEM and identify if any errors in DEM, e.g. around buildings	0	ok		

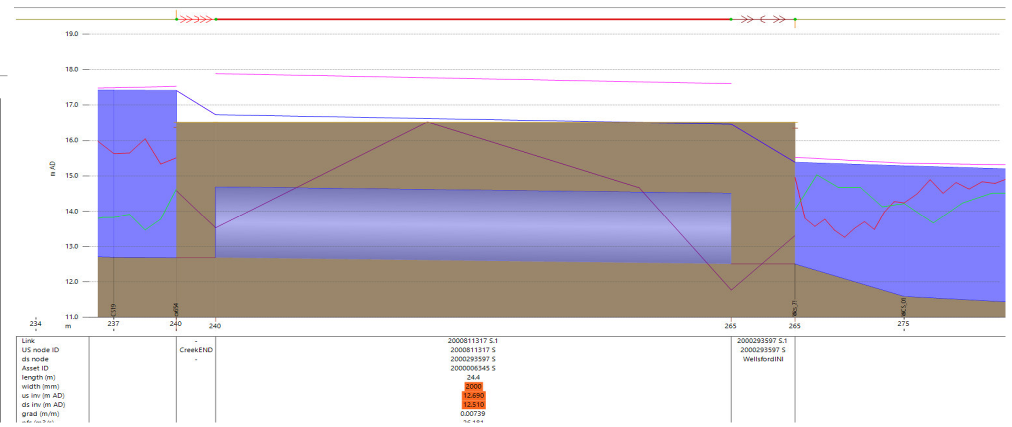
Item	Description	Rating Score	Reviewer's Comments	Modellers Response	Reviewer's Comments
B:8.4	Check representation of any key obstructions	0	ok		
B:8.5	Check roughness zones and values	0	ok		
B:8.6	Review and check double countings between 1D and 2D model components. For example 2D cells not blocked out where flow is represented in 1D.	0	ok		
B:8.7	Check 1D/2D interface and coupling method is appropriate. Check appropriate 1D/2D connections are applied at 2D nodes, inline banks, river reach banks, etc. E.g. appropriate Qmax at 2D manhole, RESERVOIRHEIGHT= 100m, M21_AS_GROUNDLEVEL=0 in dhiapp.in file	2	SH culvert 1D/2D not well represented	Oct 18-2022: Culvert representation in the model has been changed to include inline banks and storage areas as recommended by Innovyze. A single conduit with the 'barrel' field set to 2. This is considered as a more accurate representation of the headloss at this point. Figure B:8.7.a shows the model elements used in the structure crossing.	ok

C - Model Results Review

C:1 - Model Results Check

Item	Description	Rating Score	Reviewer's Comments	Modellers Response		
C:1.1	Have all events been simulated and results provided?	0	ok			
C:1.2	All correct input data assigned to the run file for each simulation? and check simulation start and stop times.	0	ok			
C:1.3	Check if flow, level and velocity are within reasonable range for pipes. - Identify Pipes with velocities >6m/s; - Check if inlet control should be included.	0	ok			
C:1.4	Check if flow, level and velocities are within reasonable range for overland flow paths, open channels and floodplain	0	ok			
C:1.5	Is there any depression area or ponding not drained at the end of simulation? Check outlet configuration for depression.	0	ok			
C:1.6	Are predicted losses at manhole and pipe connections within reasonable range and as expected?	0	ok			
C:1.7	Are predicted losses at inlet and outlet within reasonable range and as expected?	0	ok			
C:1.8	Culvert Performance: - Is culvert operating as expected? Headlosses within reasonable range. - Is flow limiting observed for 1D/2D connection at inlet/outlet? - Spot Check with HY8 and manuals calcs at least 2 locations, more maybe required if model includes large number of	3	Require remodelling to assess	Oct 18-2022: Culvert representation in the model has been changed to include inline banks. Figure B:8.7a shows the model elements used in the structure crossing. Figure B:8.7b shows the flows and depths over the 2000mmøx2 culvert. Two culvert barrels were used in the updated model.	HY8 checked and are agreeing with ICM model when tailwater is lower than 15mRL. When tailwater level is higher than 15mRL, less flow would be able to conveny as shown in HY8.	For the 100 yr CC the Culvert has outlet control hydraulic condition that is mainly caused by the Tailwater. The ICM culvert is representing that condition because there is less capacity to convey the max flow from the upstream river Also that condition was recalculated in HY8 and it shows similar water
C:1.9	Bridge Performance: - Is bridge operating as expected? - Are contraction and expansion losses within reasonable range.					
C:1.10	Check if 1D / 2D flow transfers as expected. Any location with significant instabilities, unexpected headloss or flow limiting.	0	ok			
C:1.11	Check if pump operation as expected					





C:2 - Model Validation

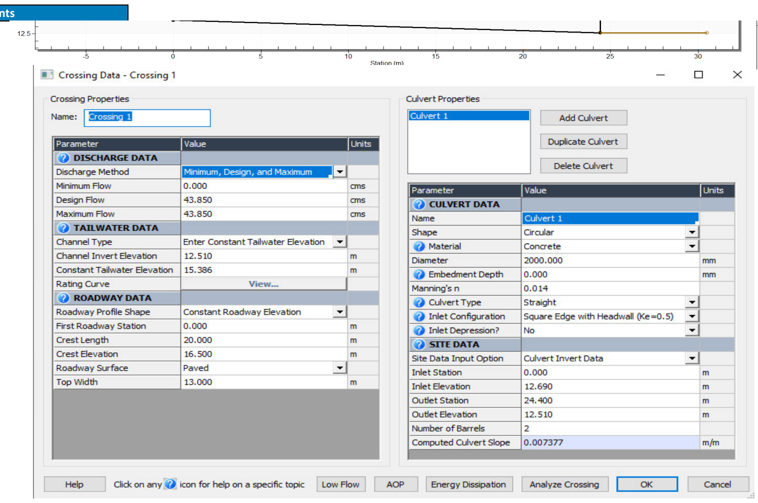
Item	Description	Rating Score	Reviewer's Comments	Modellers Response	
C:2.1	Compare TP108 graphical and modelled peak flows at a range of key locations, comment on any significant differences, and the impact on model predicted flows.	0	Not provided	Provided in model build report	ok
C:2.2	Check if overall flood extent sensible. Compare new flood extent with any previous floodplains.	0	ok		
C:2.3	Validation against RFS records, anecdotal evidence?				
C:2.4	Validation against gauged data or flood surveys?				

Item	Description	Rating Score	Reviewer's Comments	Modellers Response	Reviewer's Comments

D - Additional Checks

D:1 - Additional Check Items

Item	Description	Rating Score	Reviewer's Comments	Modellers Response
D:1.1	Does the model report provides adequate documentation on: - project objectives and purpose; - data analysis and model schematisation; - modelling methodology for key model components - assumptions and limitations.		please correct the above comments	updated
D:1.2	If applicable, are options represented adequately with appropriate levels of details? Comment on confidence level based on both model setup and model results.	0	please correct the above comments	updated
D:1.3	Should any aspects of the model be refined or redone in order to further investigate flooding effects?	0	please correct the above comments	updated
D:1.4	Which scenarios are modelled? Comment on the adequacy of scenarios modelled for achieving the project objectives	0	ok	
D:1.5	Any other assumptions used in the model that may have an impact on the overall model performance and meeting project objectives?	0	ok	
D:1.6	Describe any additional checks or issues to raise	N/A		



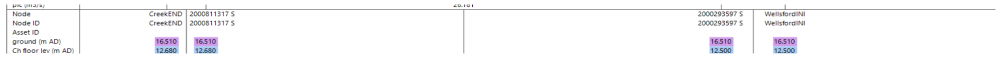


Figure 0:1 **Model extent**

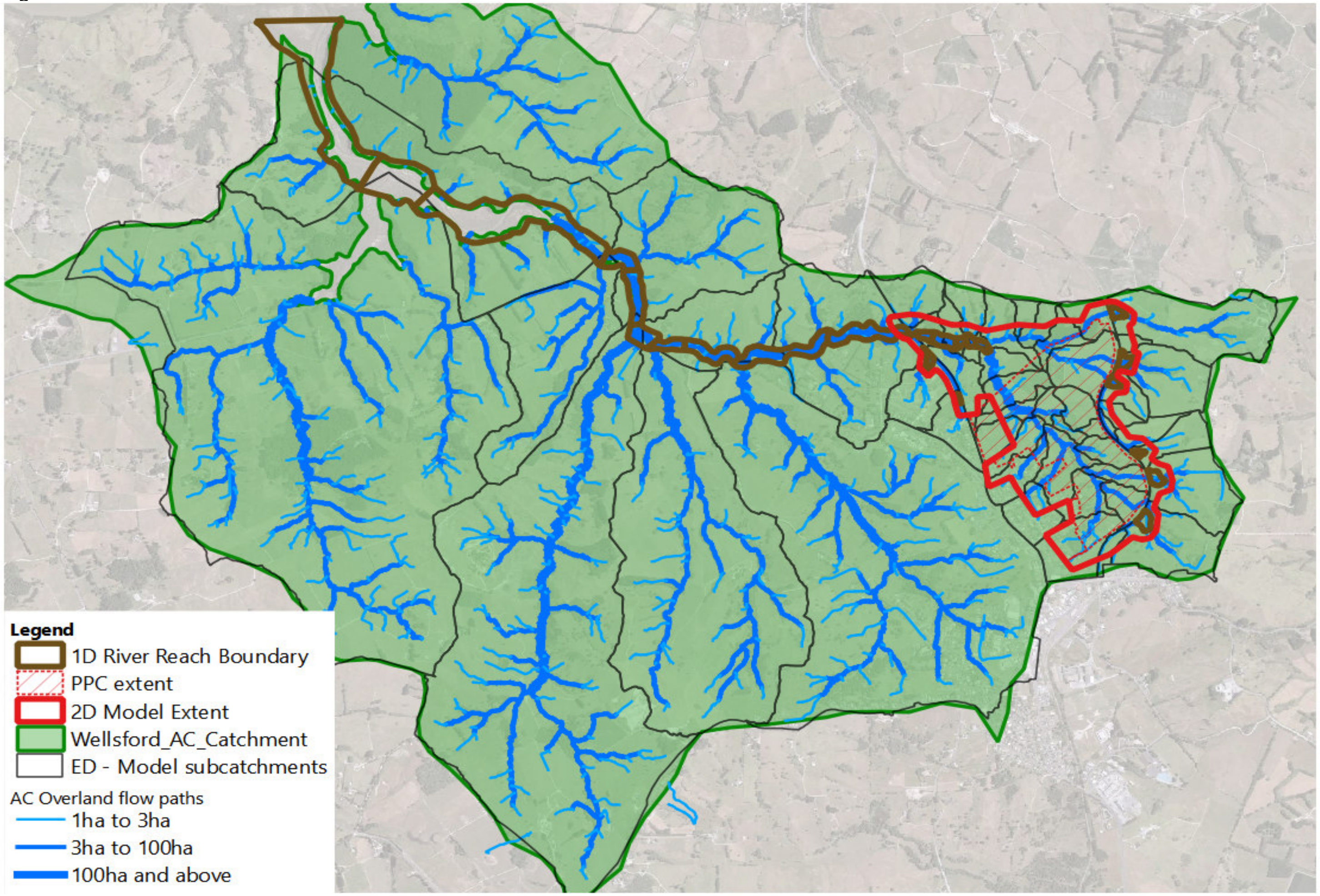
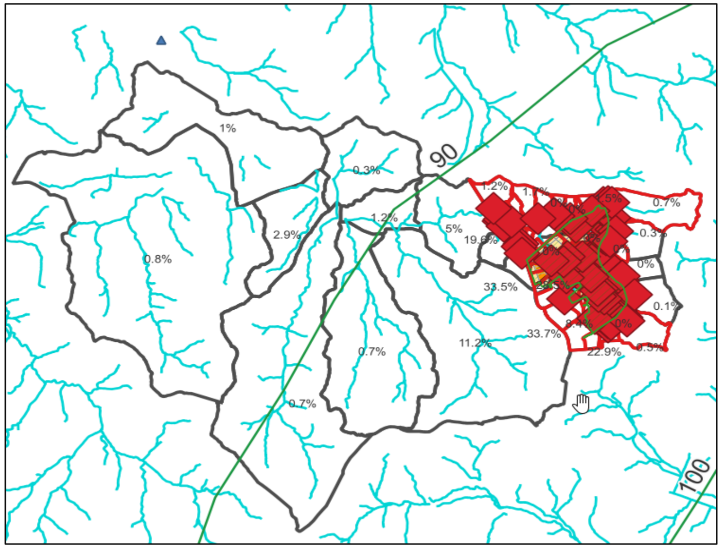
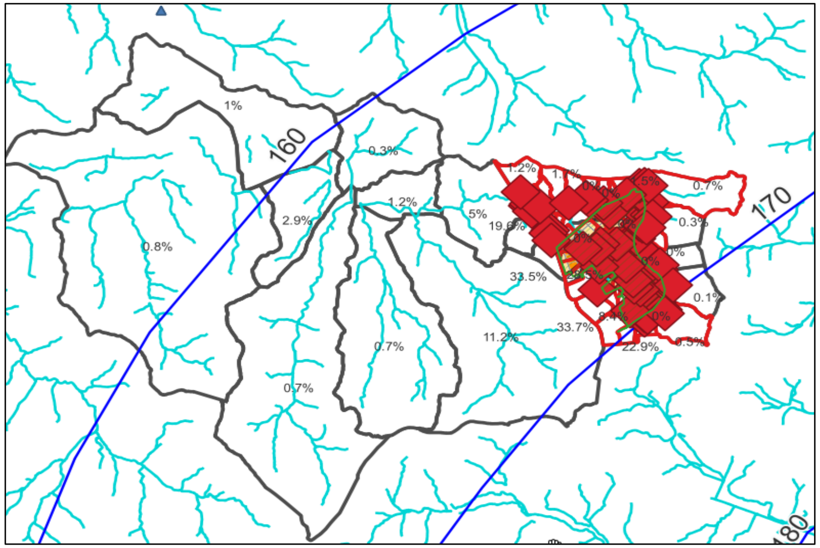


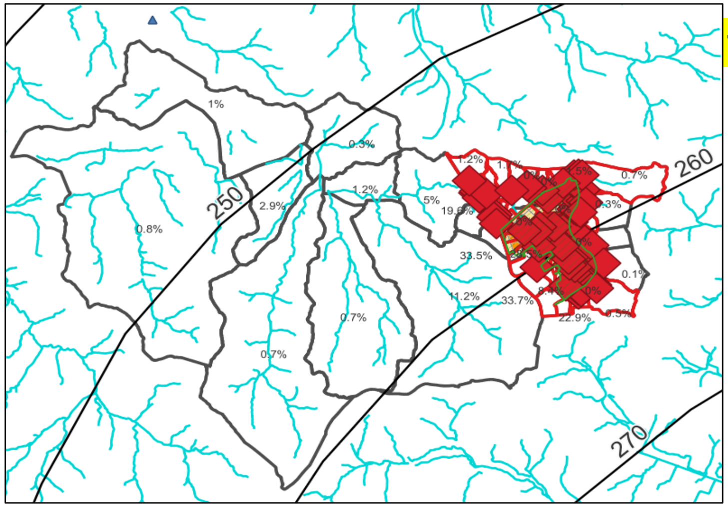
Figure B:1.1 **Modelled scenarios**

2 YR



10 YR





100 YR

Table B:1.1 **Modelled scenarios**

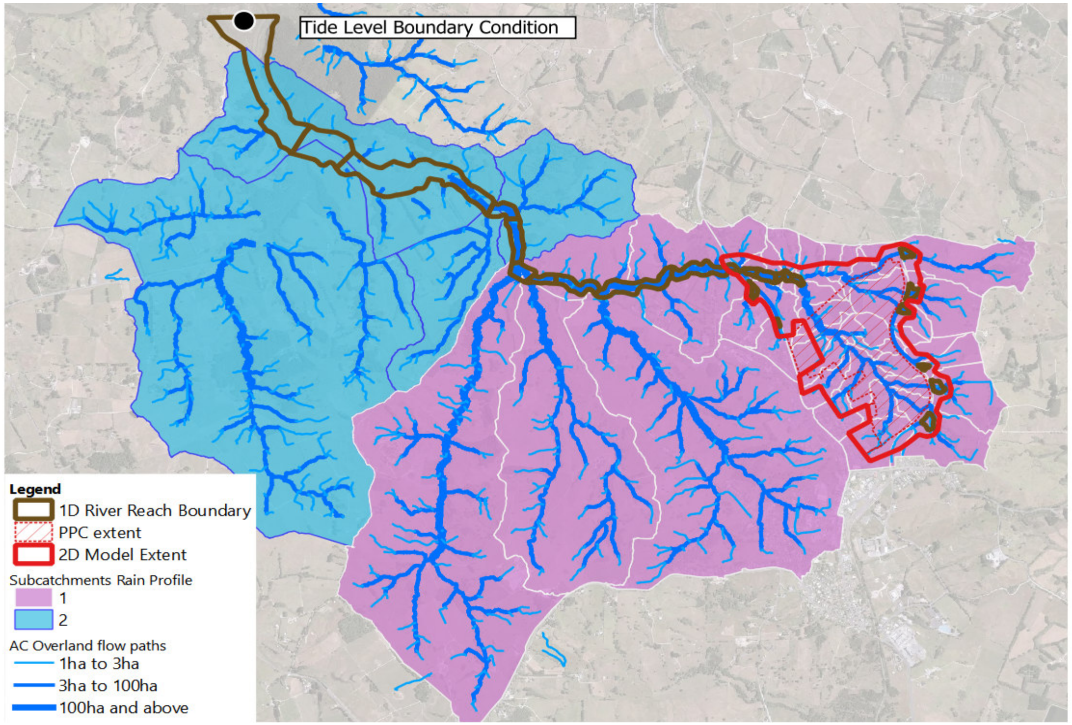
Table 8: Rainfall depths summary

		SWCoPv3 -3.8°c		
	Depth [mm]	% Increment	Depth (mm)	Profile
2 Year	95.0	27.4%	121	1
	88.0		112	2
10 Year	170.0	30.8%	222	1
	160.0		209	2
100 Year	260.0	32.7%	345	1
	250.0		332	2

Table A:1.2 **Modelled scenarios**

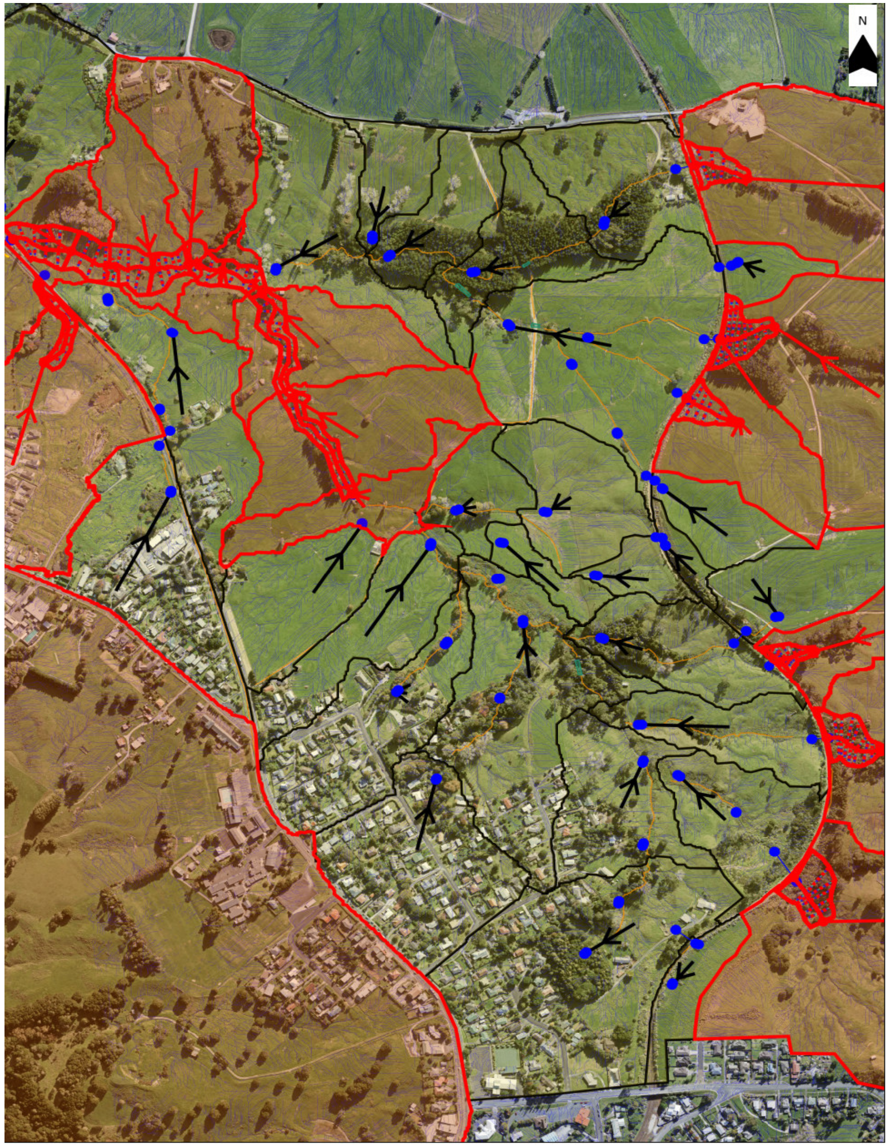
No	Network	Land use	Storm Event (ARI)	Climate Change	Tide level
1	Existing	Existing Development (ED)	10yr	NO	2.3 mRL (MHWS 10%ile)
2			100yr		
3			2yr	Yes 3.8°C	2.3 + 1 mRL (MHWS 10%ile)
4			10yr		
5			100yr		
6		Existing Development and proposed Plan Change (PPC)	10yr	NO	2.3 mRL (MHWS 10%ile
7			100yr		
8			2yr	Yes 3.8°C	2.3 + 1 mRL (MHWS 10%ile)
9			10yr		
10			100yr		
11		Proposed Plan Change and Future Urban Zone (PPC FUZ)	10yr	NO	2.3 mRL (MHWS 10%ile)
12			100yr		
13			2yr	Yes 3.8°C	2.3 + 1 mRL (MHWS 10%ile)
14			10yr		
15			100yr		

Figure B:1.4 **Boundary conditions**



Te Kaunihera o Tāmaki Makaurau

Figure B:2.1. **Subcatchements**



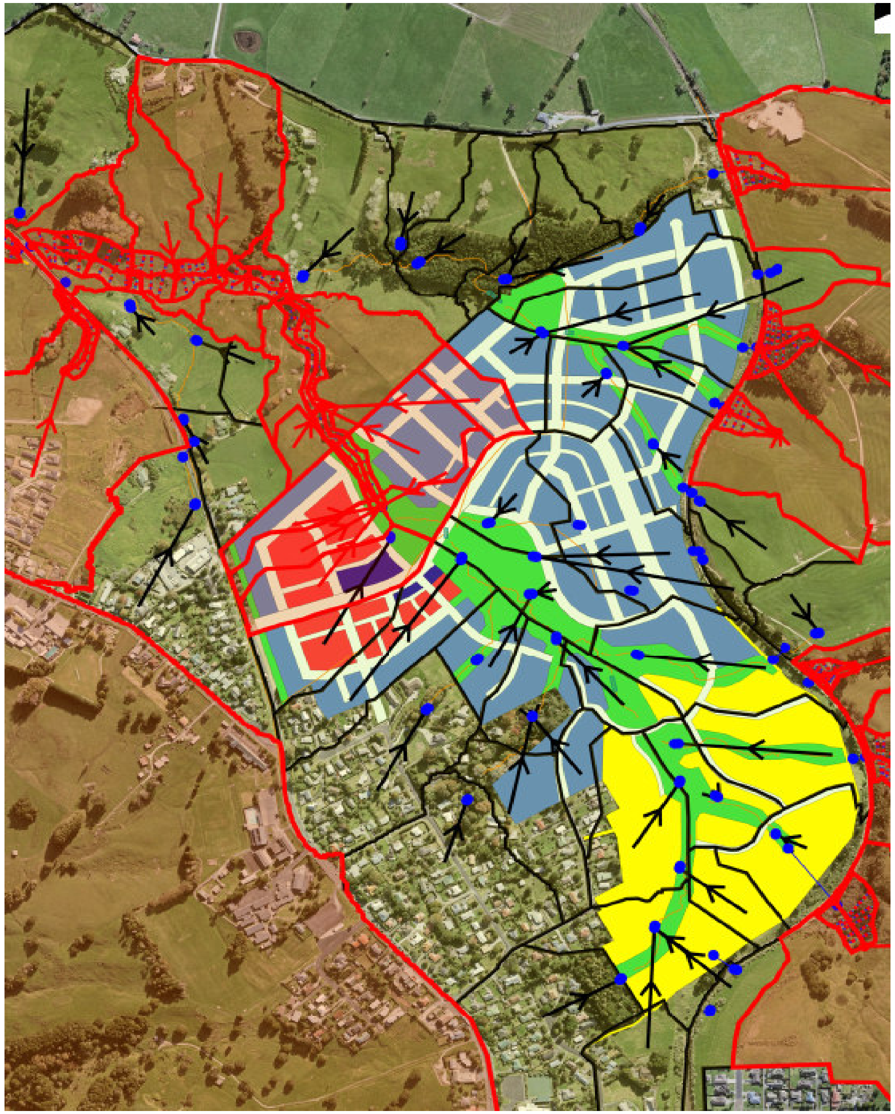


Figure B:2.6 **Proposed structure plan**

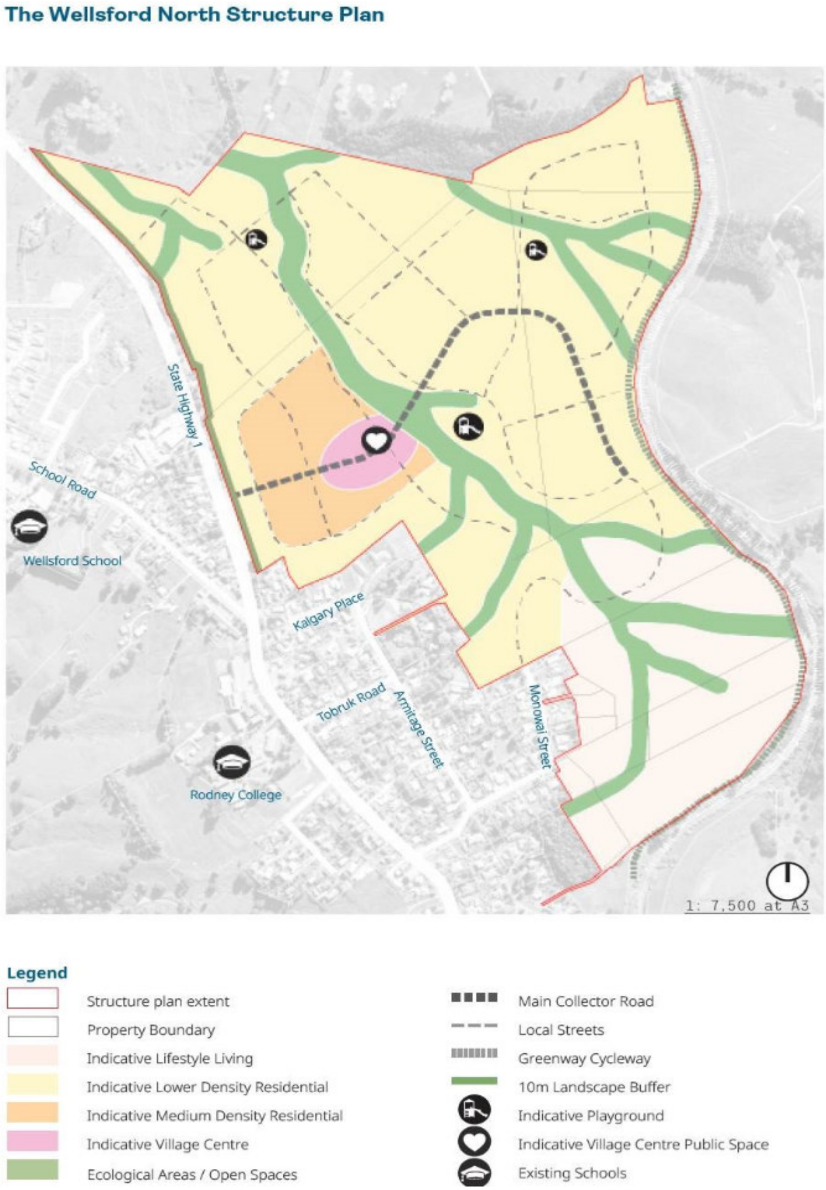


Figure B:2.6 **Imperviousness values**

Source	Zoning	Impervious %
Proposed Plan Change (PPC)	Residential-Large Lot Zone	35
	Mixed Housing Suburban Zone	60
	Mixed Housing Urban Zone	60
	Neighbourhood Centre Zone	100
	Pervious [Open Space Conservation Zone]	10
	Roads	90

Source	Zoning	Impervious %
AUP	Residential-Large Lot Zone	35
	Open Space - Conservation Zone	10
	Residential-Single House Zone	60
	Road [i]	90
	Strategic Transport Corridor	100
	Rural - Countryside Living Zone2	25
	Future Urban Zone5	70
	Open Space - Informal Recreation Zone	10
	Rural - Rural Production Zone2	5
	Open Space - Sport and Active Recreation Zone	33

Table B:3.2 - Table with coefficients

No	Asset Type	Asset Owner	US Model ID	DS Model ID	Survey Levels	SURVEY PHOTOS	Photo Inlet	Photo Outlet	Upstream invert level (m RL)	Downstream invert level (m RL)	Diam (mm)	Shape and material	INLET COEFF. CONTROL[1]					HY-8	River Reach Upstream
													Nr *	K	M	C	Y		
1	Twin Circular culvert[2]	AC - Stormwater	2000811317 S	2000293597 S	YES	YES	YES	YES	12.69	12.51	2000	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	YES and Downstream*
2	Circular Culvert	AC - Transport	2000063746	2000819719	YES	YES	NO	YES	17.62	16.98	450	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900	Compared with hy-8	YES
3	Circular Culvert	NZTA	2000805184	2000213627	YES	YES	YES	NO	28.68	27.83	450	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900	Compared with hy-8	YES
7	Box Culvert	Kiwi Rail	2258573_US	2258573_DS	YES	YES	NO	NO	35.04	34.72	1120	Rectangular/Headwall	20	0.4950	0.6670	0.0314	0.8200	Compared with hy-8	YES
8	Circular Culvert	Kiwi Rail	2258572_US	2258572_DS	YES	YES	NO	YES	43.755	43.73	225	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	NO
9	Circular Culvert	Kiwi Rail	2258571_US	2258571_DS	YES	YES	NO	YES	37.49	36.52	450	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	YES
10	Circular Culvert	Kiwi Rail	2258570_US	2258570_DS	NO	NO	NO	NO	41.29	38.71	375	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	YES
11	Circular Culvert	Kiwi Rail	2258569_US	2258569_DS	YES	YES	YES	YES	48.93	48.9	450	Circular Concrete	1	0.0098	2.0000	0.0398	0.6700	Compared with hy-8	NO
12	Circular Culvert	Kiwi Rail	2258568_US	2258568_DS	NO	NO	NO	NO	50.09	49.93	225	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		NO
13	Circular Culvert	Kiwi Rail	2258567_US	2258567_DS	YES	YES	YES	NO	46.61	43.57	300	Circular Concrete	-	-	-	-	-	Modelled as manhole 2D. 1by1 manhole. 1m2. Photos evidence	NO
15	Circular Culvert	Kiwi Rail	2258565_US	2258565_DS	YES	YES	NO	YES	50.25	49.57	600	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		YES
16	Circular Culvert	Kiwi Rail	2258564_US	2258564_DS	NO	NO	NO	NO	47.784	45.64	450	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		YES
17	Circular Culvert	Kiwi Rail	2258563_US	2258563_DS	NO	NO	NO	NO	48.05	42.2	920	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		YES
19	Circular Culvert	Kiwi Rail	2258561_US	2258561_DS	NO	NO	NO	YES	61.795	58.1	600	Circular Concrete	3	0.0045	2.0000	0.0317	0.6900		NO

1. *Coefficients based on 'Culvert, Screen and Outfall Manual. Ciria 2019'. Table A7.5*
2. *Culvert 1 has an outlet loss coefficient of 0.5 based on 'Culvert, Screen and Outfall Manual. Ciria 2019'. Table A7.8 for circular headwall and wingwalls*

Figure B:4.2 **Surface terrain**

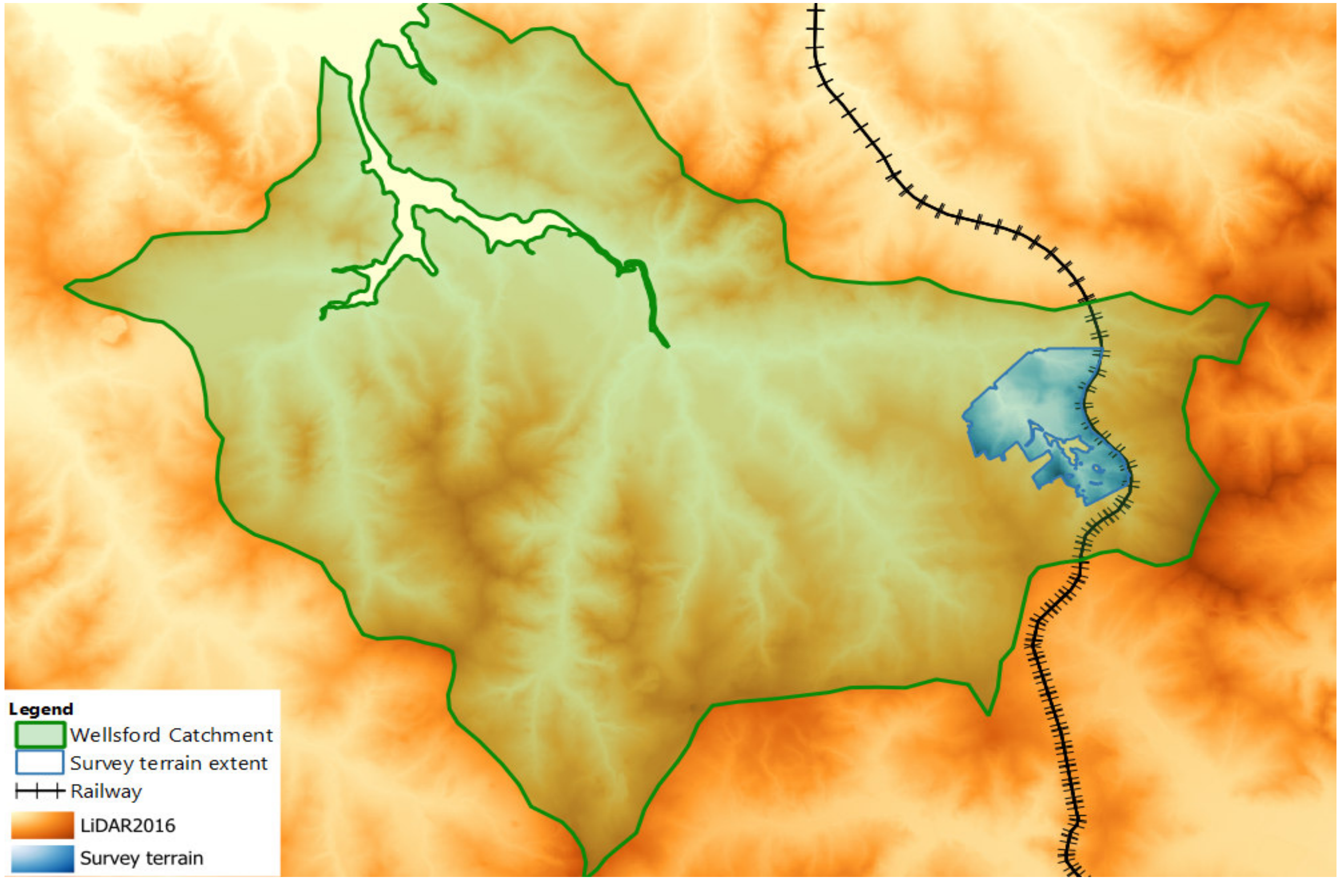


Figure B:8.5 2D Mesh update elements

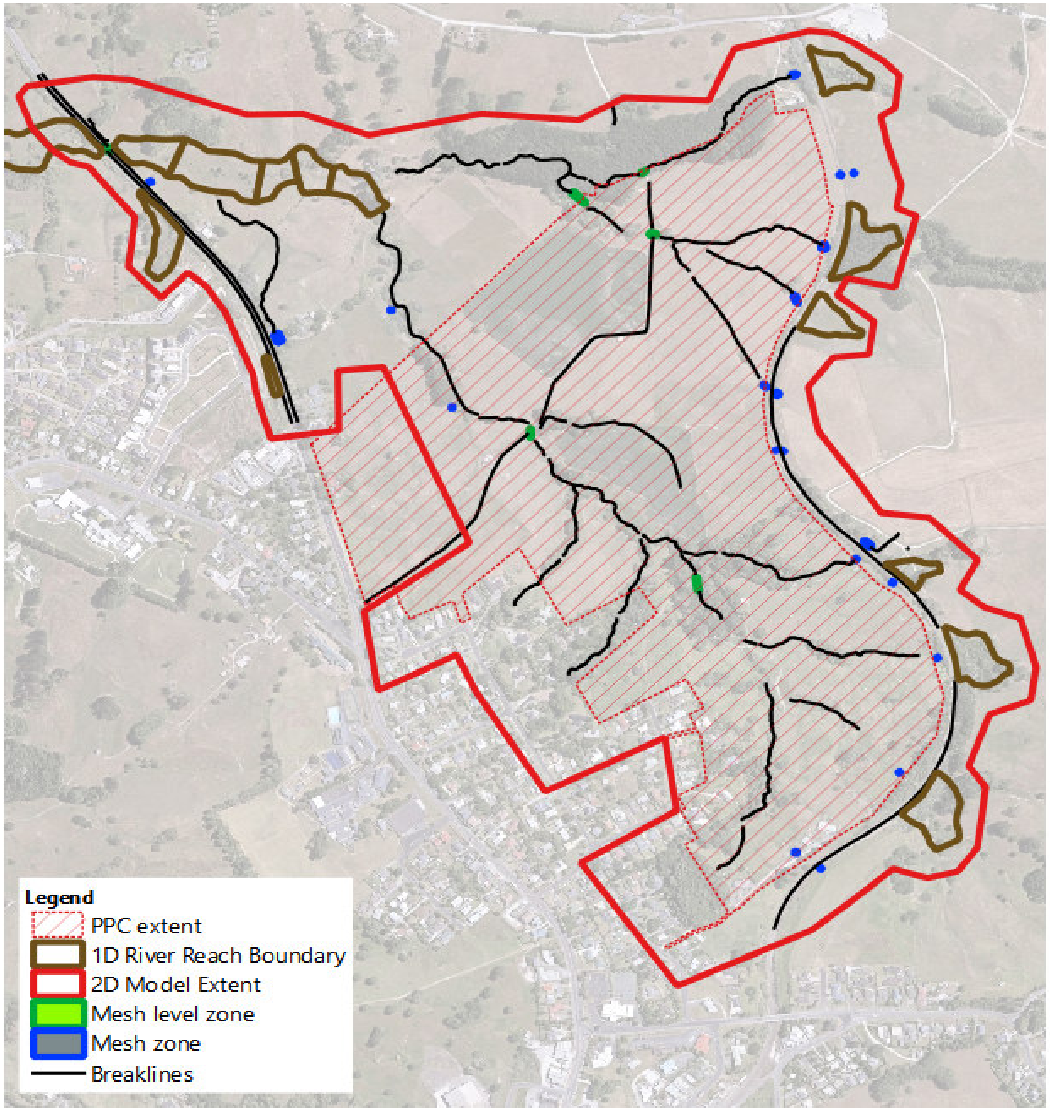
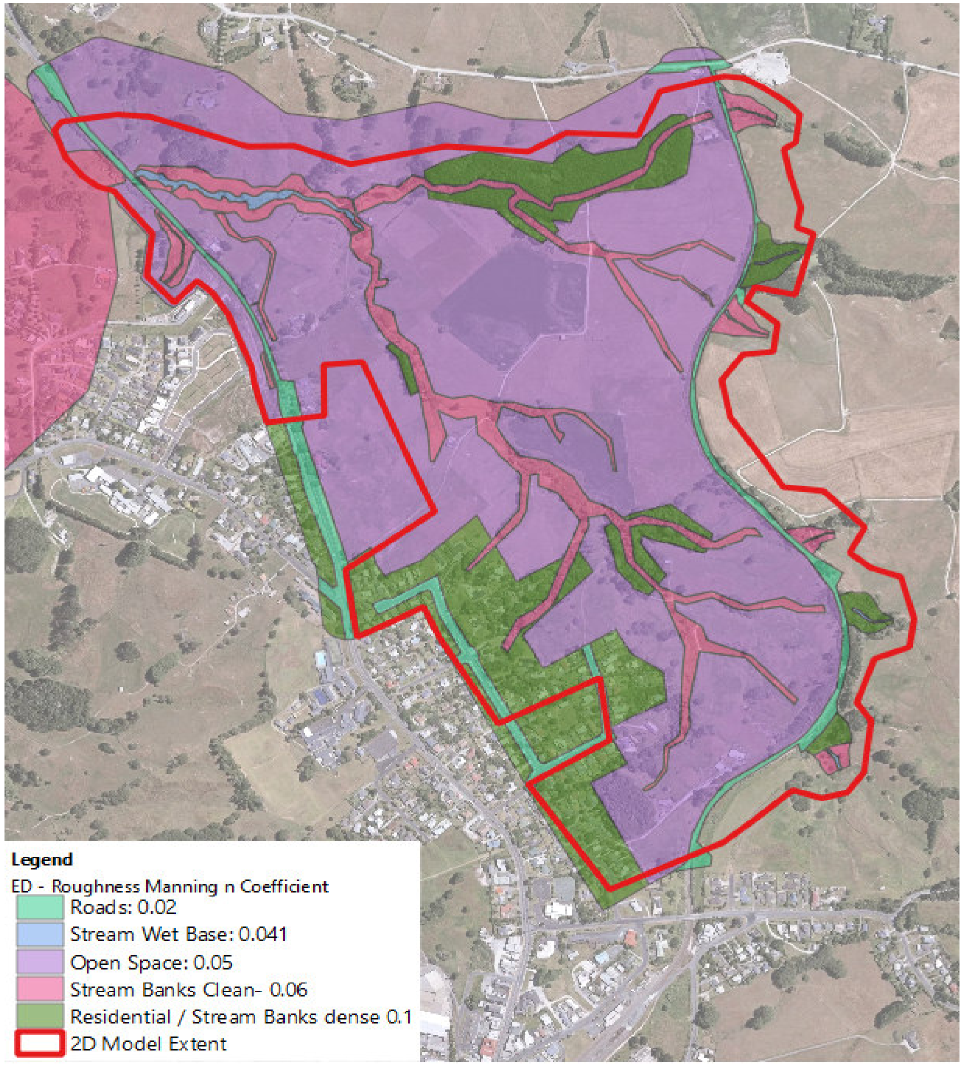


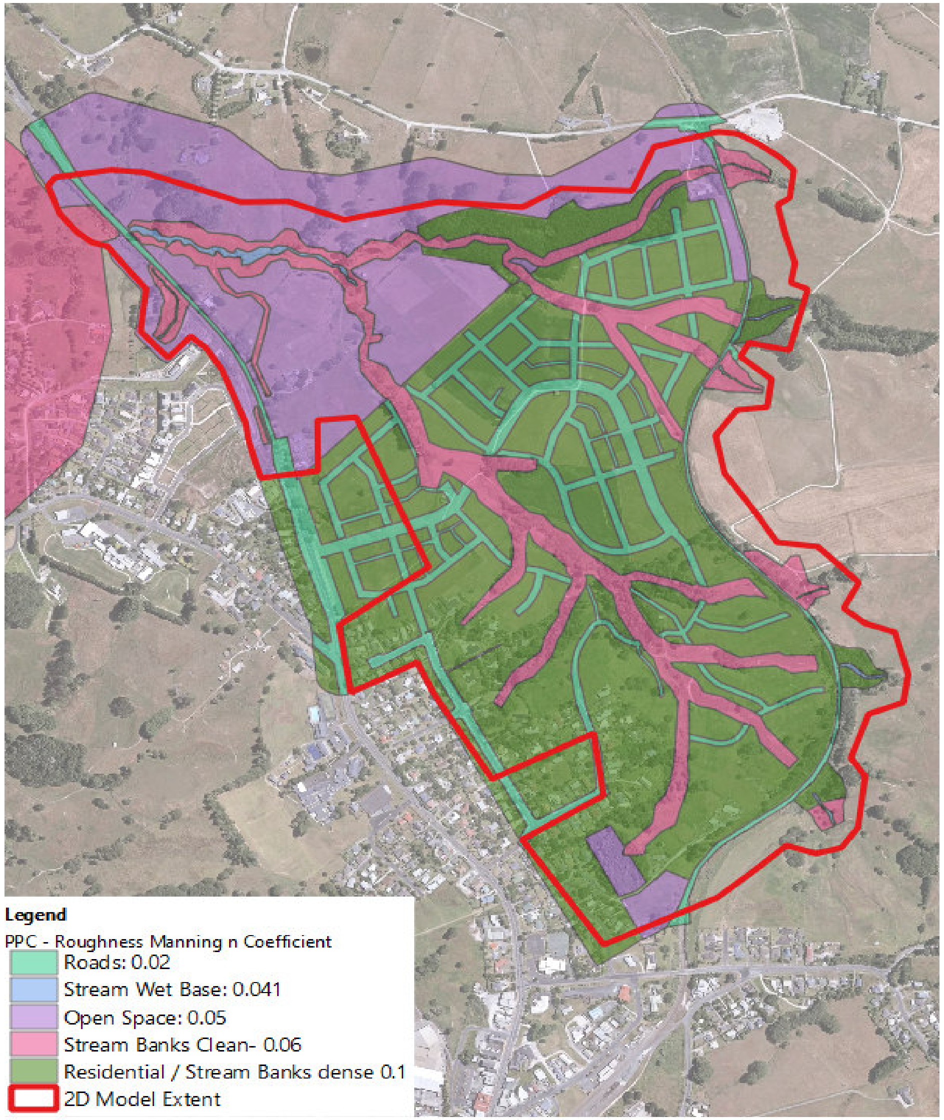
Figure B:8.5a Roughness -ED



Land Use	Manning's n	Source
Roads	0.02	Table 4. SWCoP for Overland flow paths along roadways
Residential	0.1	Table 4. SWCoP for Overland flows paths through propoerty parcels
Open Space	0.05	Section 3.3 of the Modelling specifications for RFHA models
Stream banks - Clean	0.06	Table 5.2. Modelling specifications for cleared land – tree stumps and heavy prouts
Stream banks - dense	0.1	Table 5.2. Modelling specifications for Medium brush
Stream wet base	0.041	Table 5.2. Modelling specifications for Height – varying grass

Photo taken during survey looking upstream culvert on SH1.

Figure B:8.5b **Roughness -Future**

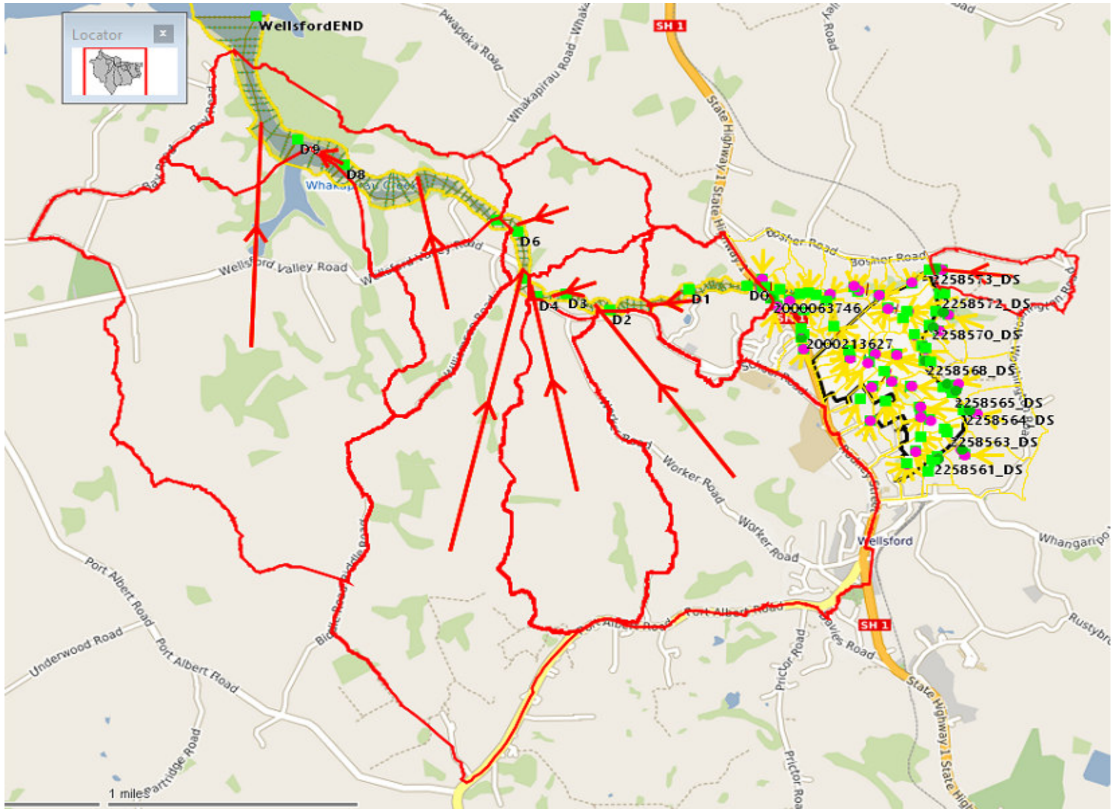


Pipe Material	Manning's (n)
Concrete (Normal)	0.013

Land Use	Manning's n	Source
Roads	0.02	Table 4. SWCoP for Overland flow paths along roadways
Residential	0.1	Table 4. SWCoP for Overland flows paths through propoerty parcels
Open Space	0.05	Section 3.3 of the Modelling specifications for RFHA models
Stream banks - Clean	0.06	Table 5.2. Modelling specifications for cleared land – tree stumps and heavy prouts
Stream banks - dense	0.1	Table 5.2. Modelling specifications for Medium brush
Stream wet base	0.041	Table 5.2. Modelling specifications for Height – varying grass

Pipe Material	Manning's (n)
Concrete (Normal)	0.013

Figure B:2.7 **Time of concentration**



Subcatchment ID	AREA (ha)	Tc (min)
Wellsford-1D-PRE-16	132.503	260.04
Wellsford-1D-PRE-17	433.247	68.19
Wellsford-1D-PRE-14	266.599	63.08
Wellsford-1D-PRE-10	245.942	50.36
Wellsford-1D-PRE-13	165.018	48.36
Wellsford-1D-PRE-15	51.546	31.66
Wellsford-1D-PRE-11	29.05	26.9
Wellsford-1D-PRE-09	57.45	26.41
Wellsford-1D-PRE-12	64.822	23.21
Wellsford-151	28.489	14.8

Figure B:8.7a **Culvert representation in SH1**

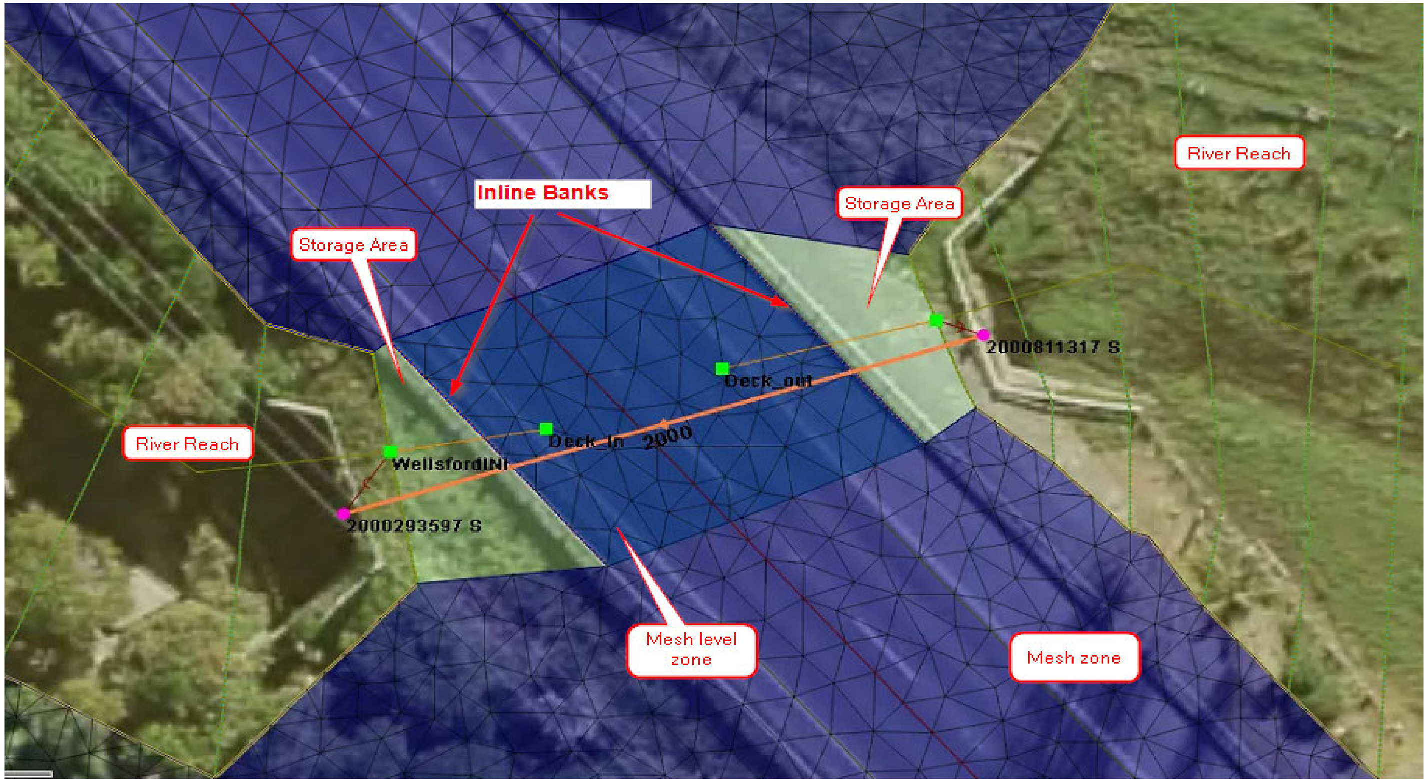
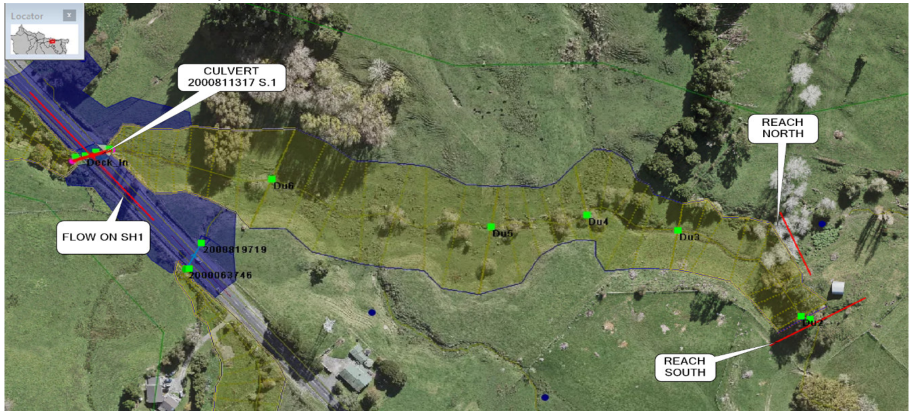
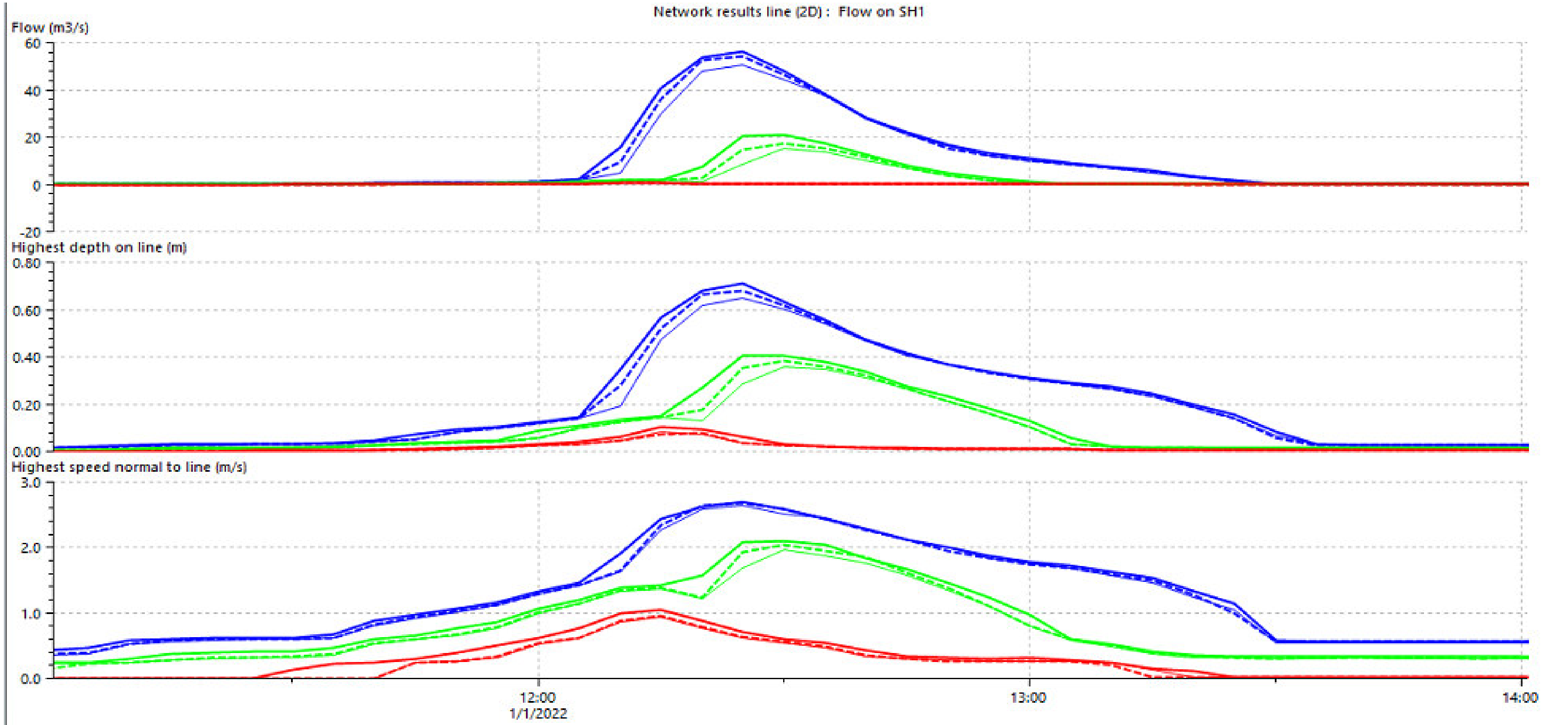


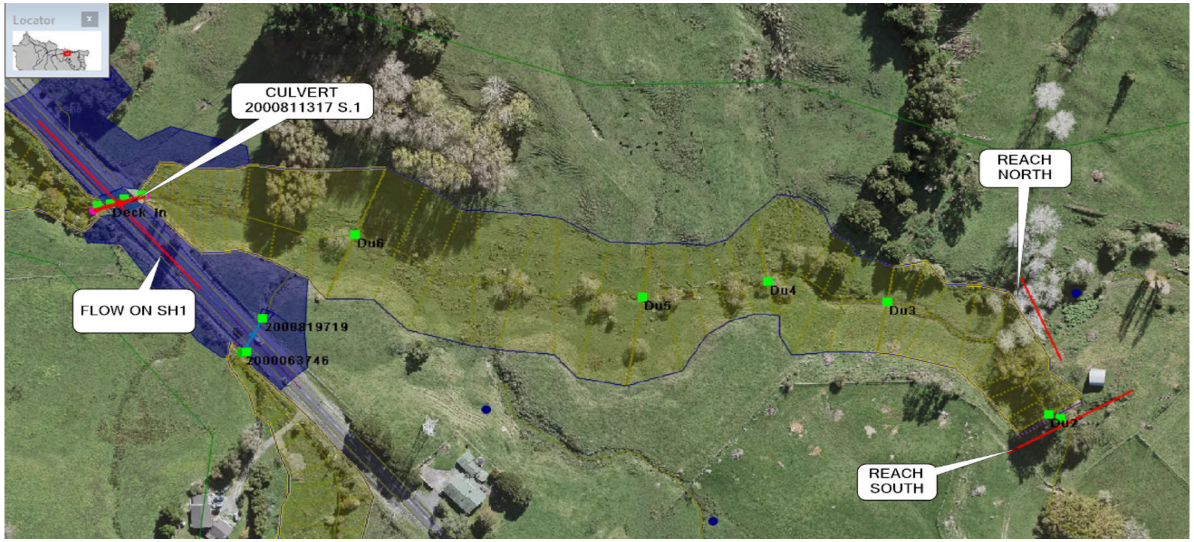
Figure B:8.7.b **Model results over the SH1 over 2000mmøx2 culvert**

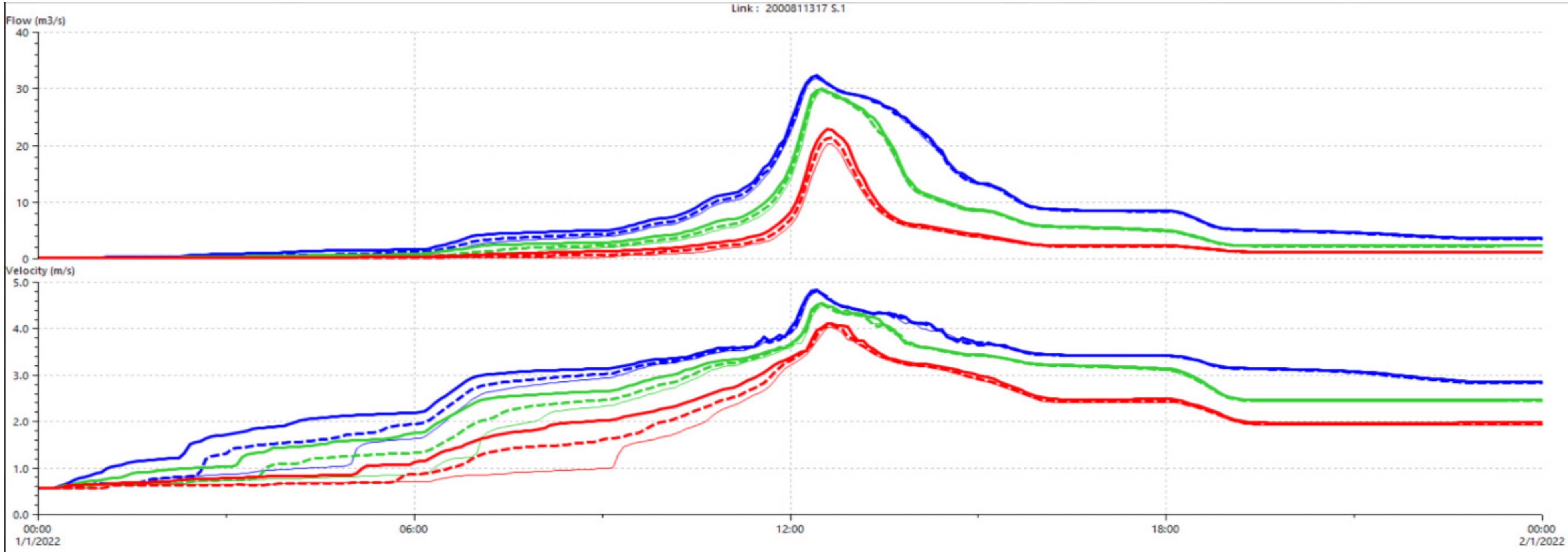




		Flow		Highest depth on line		Highest speed normal to line	
		Min	Max	Min	Max	Min	Max
ED 100yrCC-3.8		0.061	50.792	0.017	0.649	0.384	2.651
ED 10yrCC-3.8		0.001	15.245	0.006	0.356	0.222	1.965
ED 2yrCC-3.8		0.000	0.629	0.000	0.084	0.000	0.945
PC 100yrCC-3.8		0.068	54.453	0.016	0.681	0.397	2.675
PC 10yrCC-3.8		0.002	17.655	0.006	0.385	0.230	2.036
PC 2yrCC-3.8		-0.000	0.657	0.000	0.075	0.000	0.960
PCFUZ 100yrCC-3.8		0.095	56.543	0.019	0.711	0.464	2.704
PCFUZ 10yrCC-3.8		0.006	21.145	0.007	0.405	0.252	2.107
PCFUZ 2yrCC-3.8		0.000	0.739	0.000	0.106	0.000	1.052

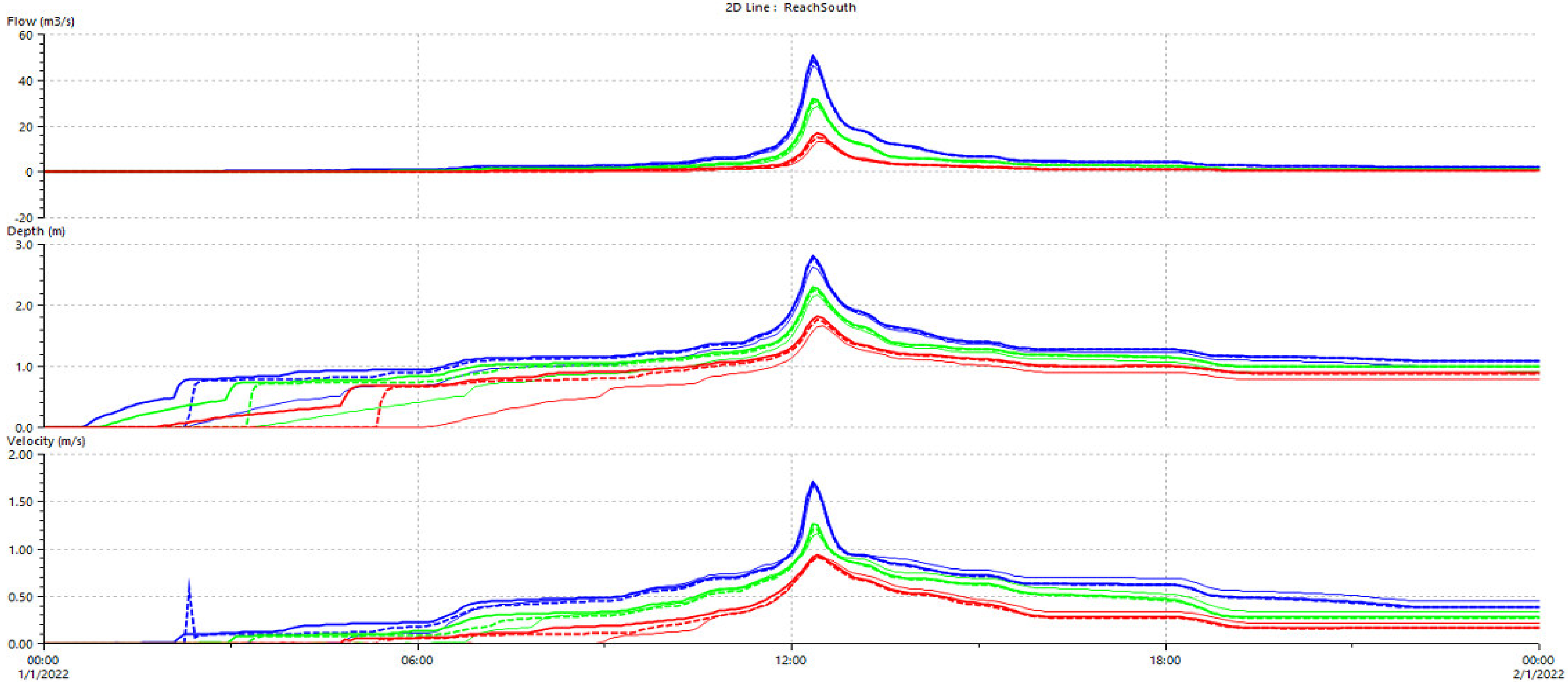
FLOW AND VELOCITY WITHIN MAIN CULVERT





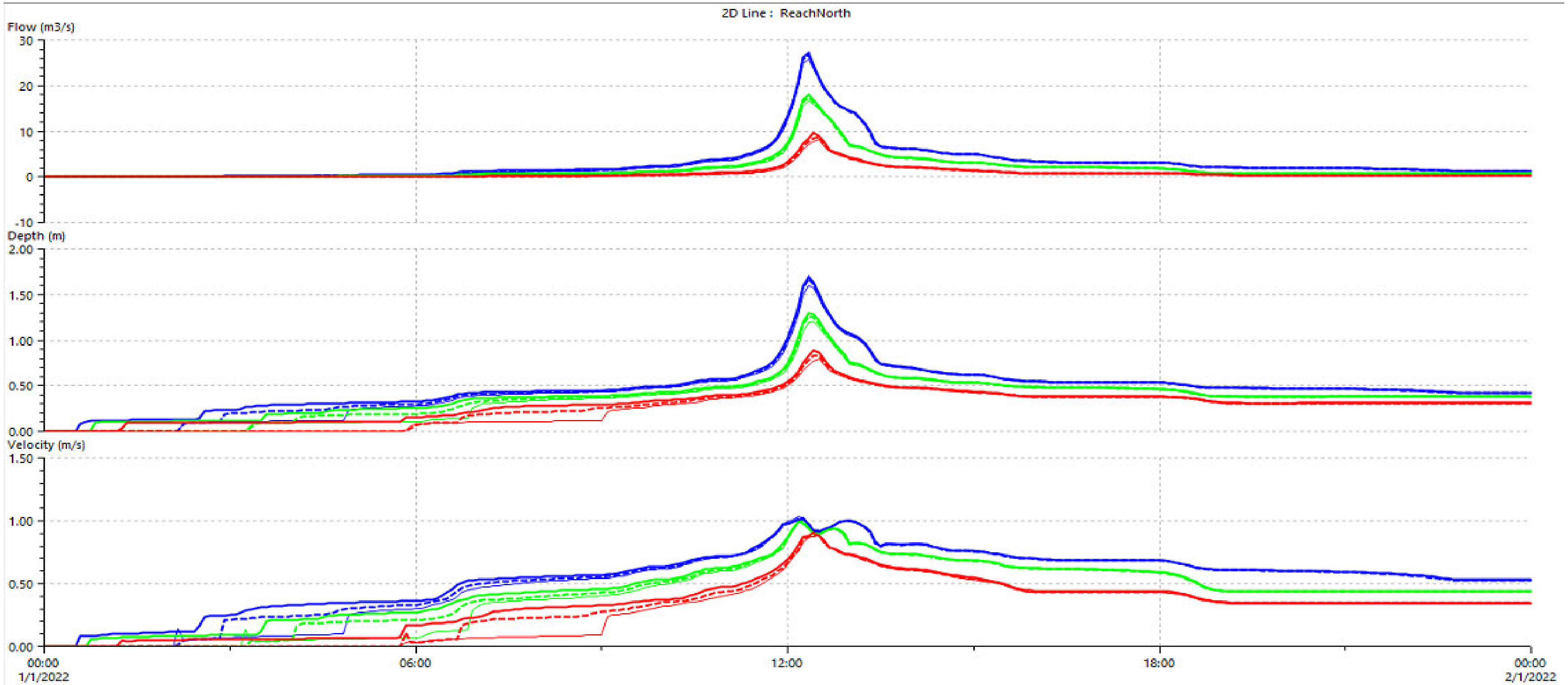
		Flow		Velocity	
		Min	Max	Min	Max
ED 100yrCC-3.8		0.100	31.899	0.566	4.788
ED 10yrCC-3.8		0.100	29.531	0.566	4.499
ED 2yrCC-3.8		0.100	20.225	0.566	4.037
PPC 100yrCC-3.8		0.100	31.969	0.566	4.799
PPC 10yrCC-3.8		0.100	29.823	0.566	4.535
PPC 2yrCC-3.8		0.100	21.388	0.566	4.091
PCFUZ 100yrCC-3.8		0.100	32.290	0.566	4.844
PCFUZ 10yrCC-3.8		0.100	29.990	0.566	4.554
PCFUZ 2yrCC-3.8		0.100	22.907	0.566	4.112

2D LINE US MAIN RIVER REACH - INPUTS SOUTH



	Flow (m3/s)			Highest depth (m)		Highest speed (m/s)	
	Min	Max	Volume (m3)	Min	Max	Min	Max
ED 100yrCC-3.8	-0.006	46.241	363742.868	0.000	2.629	0.000	1.662
ED 10yrCC-3.8	-0.010	28.771	210991.254	0.000	2.170	0.000	1.164
ED 2yrCC-3.8	-0.005	13.381	91507.398	0.000	1.666	0.000	0.921
PPC 100yrCC-3.8	0.000	49.342	382211.866	0.000	2.768	0.000	1.684
PPC 10yrCC-3.8	0.000	30.422	227982.811	0.000	2.251	0.000	1.214
PPC 2yrCC-3.8	0.000	15.276	105577.609	0.000	1.765	0.000	0.914
PCFUZ 100yrCC-3.8	-0.006	50.676	399366.338	0.000	2.802	0.000	1.712
PCFUZ 10yrCC-3.8	-0.002	31.960	243157.157	0.000	2.296	0.000	1.261
PCFUZ 2yrCC-3.8	-0.005	16.849	117757.213	0.000	1.824	0.000	0.939

2D LINE US MAIN RIVER REACH - INPUTS NORTH



	Flow (m3/s)			Highest depth (m)		Highest speed (m/s)	
	Min	Max	Volume (m3)	Min	Max	Min	Max
ED 100yrCC-3.8	0.000	25.894	244668.830	0.000	1.606	0.000	1.034
ED 10yrCC-3.8	0.000	16.589	140887.048	0.000	1.200	0.000	1.016
ED 2yrCC-3.8	-0.001	8.315	60453.620	0.000	0.796	0.000	0.892
PPC 100yrCC-3.8	0.000	26.772	250322.460	0.000	1.671	0.000	1.023
PPC 10yrCC-3.8	-0.000	17.464	146416.335	0.000	1.261	0.000	0.997
PPC 2yrCC-3.8	-0.000	8.649	65086.166	0.000	0.833	0.000	0.889
PCFUZ 100yrCC-3.8	0.000	27.222	259413.128	0.000	1.695	0.000	1.017
PCFUZ 10yrCC-3.8	0.000	17.968	154286.888	0.000	1.294	0.000	0.995
PCFUZ 2yrCC-3.8	0.000	9.634	71472.009	0.000	0.889	0.000	0.903

Appendix F. Healthy Waters recommended imperviousness memo

Auckland Council
Te Kaunihera o Tāmaki Makaurau

Memorandum

04/09/2019

To: Nick Brown

CC: Dukessa Blackburn-Huettner; Kieren Daji; Scott Speed; Mark Iszard; Paula Vincent; Shaun McAuley

Subject: Land Use Zone Imperviousness for Hydraulic Modelling based on the Auckland Unitary Plan Operative in Part (AUP OiP)

From: Cheryl Bai

Contact information: cheryl.bai@aucklandcouncil.govt.nz

Purpose

1. The purpose of the memo is to address the current inconsistencies regarding the percentage imperviousness applied for hydraulic modelling using the Auckland Unitary Plan provisions. The memo provides a table of percentage imperviousness for the Maximum Probable Development (MPD) scenarios based on the rules provided in the AUP Operative in Part.

Summary

2. This imperviousness table lists out recommended percentage imperviousness for each AUP zone, as well as the data source and rationale for deriving the percentage numbers. An upper percentage allowance has also been provided for the Rural Countryside Living Zone and some Business Zones. This is to cover both the likely situation as well as the maximum allowable situation as per the AUP.

Context

3. Additional notes and recommendations are listed below.

   1) The recommended percentage imperviousness numbers given in the table are provided for consistency purposes for hydraulic modelling. The table should be used as a reference or "starting point" when determining what future imperviousness is to be used for a specific study. The information given above is not a replacement for project specific analysis. Variations/deviations from the imperviousness numbers given in the table should be noted and rationale provided, with approval sought from Auckland Council.

   2) Rural Zones: As maximum percentage imperviousness is not specified in AUP for rural zones, the imperviousness numbers were worked out based on the minimum site size requirement (E39) and the stormwater discharge and diversion rule E8 (A7). However, for some rural zones, existing lots may have a size smaller than the current AUP subdivision requirements. It is therefore important to carry out project specific analysis and verify the imperviousness for rural zones before applying the number in subsequent hydraulic modelling activities.

   3) Business Zones: Only Business Park Zone has a maximum imperviousness specified in AUP. According to advice from planning, theoretically all other business zones could develop up to 100% impervious. However, practically with the riparian rules and existing green features, a likely percentage imperviousness was determined based on definitions and objectives for each individual land use zone.

   4) Special Purpose - Airports and Airfields Zone: the specified 80% imperviousness is based on a Planner's recommendation. It could be conservative for most of the airport/airfields

zones, therefore site-specific imperviousness analysis is recommended on a case by case basis. Precinct rules would also apply for specific airport zones.

5) More detailed zoning is to be used for Future Urban Zones, when and if it becomes available through structure planning activities.

6) Sensitivity analysis is recommended to test impact of % imperviousness greater than allowed by AUP for Residential - Terrace Housing and Apartment Buildings Zone, Residential - Mixed Housing Urban Zone and Residential - Mixed Housing Suburban Zone.

Attachments

The attached table shows the percentage imperviousness coverage of each AUP zones for hydraulic modelling purposes.

Cheryl Bai | Principal - Hydraulic Modelling Delivery | Catchment Planning Team
Healthy Waters | Infrastructure & Environmental Services

Auckland Council, Level 3 South, 24 Wellesley Street, Auckland Central
Visit our website: www.aucklandcouncil.govt.nz

ZONE ID	Zone Description	Recommended MPD % impervious coverage based on AUP OiP for hydraulic modelling[1]	Upper % impervious coverage allowed by AUP OiP for hydraulc modelling[1]	Notes extracted from AUP Document	Data Source & Rationale
1	Business - Business Park Zone	80	-	80% max imperviousness	Max imperviousness as per H15.6.4. The Business – Business Park Zone enables moderate to intensive office activity and some ancillary services such as gymnasiums, child care and food and beverage outlets.
3	Rural - Countryside Living Zone[2]	25	50	Min net site area mostly in the range of 1-2 ha, most at 2ha, except Swanson & Okura West at 4ha, and point wells at 5,000m2, without transferable rural site subdivision. If transferable rural site subdivision is considered, the minimum net site area would be reduced to 8,000m2 and average minimum to 1ha for most specified locations.	Minimum net site area as per Table E39.6.5.2.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
4	Future Urban Zone[5]	70	-	NA	Minimum 70% impervious assumed in all future urban areas. The make of the future urban zone is assumed to be mostly residential with some business zones, approx 25% road corridors and 10% open spaces, etc.
5	Business - Heavy Industry Zone[3]	90	100	NA	Assumed to have small pockets of green areas. 'Imperviousness assumed between Business Park Zone and City, Metropolitan, Town Centre Zones. Based on advises from planning.
7	Business - Local Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Provides for the local convenience needs of surrounding residential areas, including local retail, commercial services, offices, food and beverage, and appropriately scaled supermarkets.
8	Residential - Terrace Housing and Apartment Buildings Zone[6]	70	-	max 70% impervious	Max imperviousness as per H6.6.10
10	Business - Metropolitan Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Applies to centres located in different subregional catchments of Auckland.
11	Rural - Mixed Rural Zone[2]	10	-	min site size 40-50ha	Minimum site sizes as per Table E39.6.5.1.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
12	Business - Mixed Use Zone[3]	80	100	NA	Assumed to be the same as H15 Business Park Zone. Typical transition zone between residential zone and city, metropolitan, town centre zones. Supposingly larger green areas compared to other business zones, based on zone definition. However from spot checks on GeoMap the % imperviousness could be up to 100% depending on locations.
15	Rural - Rural Conservation Zone[2]	10	-	min site size 10-20ha	Minimum site sizes as per Table E39.6.5.1.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
16	Rural - Rural Production Zone[2]	5	-	min site size 80-100ha	Minimum site sizes as per Table E39.6.5.1.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
17	Business - Light Industry Zone[3]	90	100	NA	Assumed to have small pockets of green areas. 'Imperviousness assumed between Business Park Zone and City, Metropolitan, Town Centre Zones
18	Residential - Mixed Housing Suburban Zone[6]	60	-	max 60% impervious	Max imperviousness as per H4.6.8
19	Residential - Single House Zone	60	-	max 60% impervious	Max imperviousness as per H3.6.9
20	Residential - Rural and Coastal Settlement Zone	35	-	35% or 1400m2, whichever is lesser	Max imperviousness as per H2.6.8
22	Business - Town Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Applies to suburban centres throughout Auckland, the satellite centres of Warkworth and Pukekohe, and the rural towns of Helensville and Wellsford.
23	Residential - Large Lot Zone	35	-	35% or 1400m2, whichever is lesser	Max imperviousness as per H1.6.6.
25	Water [i]	100	-	NA	Water is effectively impervious
26	Strategic Transport Corridor	100	-	NA	Assumed to be completely impervious. These areas will be the minority in any catchment and variations in assumptions are not likely to significantly affect modelling outcomes.
27	Road [i]	90	-	NA	Assumption. Road corridor instead of just areas between kerblines. Includes berm, footpath, etc.
30	Coastal - General Coastal Marine Zone [rcp]	100	-	NA	Coastal areas mostly covered by water and esturay
31	Open Space - Conservation Zone	10	-	lesser of 10% or 5000m2	Maximum Impervious Areas as per H7.11.7
32	Open Space - Informal Recreation Zone	10	-	lesser of 10% or 5000m2	Maximum Impervious Areas as per H7.11.7
33	Open Space - Sport and Active Recreation Zone	40	-	40% max imperviousness	Maximum Impervious Areas as per H7.11.7
34	Open Space - Community Zone	70	100	70% or no limit depending on adjacent zone	Maximum Impervious Areas as per H7.11.7, 70 per cent where the adjacent zone is a residential zone, Business – Business Park Zone or Business – General Business Zone. No limit in the Business – Mixed Use Zone or the business centre zones.
35	Business - City Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Applies to centres located in different subregional catchments of Auckland.
37	Coastal - Minor Port Zone [rcp/dp]	100	-	NA	Water, and heavily paved land areas.
39	Coastal - Defence Zone [rcp/dp]	100	-	NA	Water, and heavily paved land areas.
40	Coastal - Marina Zone [rcp/dp]	100	-	NA	Water, and heavily paved land areas.
41	Coastal - Mooring Zone [rcp]	100	-	NA	Water.
43	Hauraki Gulf Islands	*Per project basis*	-	NA	Special consideration required
44	Business - Neighbourhood Centre Zone	100	-	NA	Assumption that green areas are not significant in all business centre zones. Single corner stores or small shopping strips located in residential neighbourhoods.
45	Coastal - Ferry Terminal Zone [rcp/dp]	100	-	NA	Very few green areas in such areas
46	Rural - Rural Coastal Zone[2]	10	-	min site size 40-50ha	Minimum site sizes as per Table E39.6.5.1.1. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
49	Business - General Business Zone[3]	80	100	NA	Assumed to be the same as H15 Business Park Zone. Based on zone definition, supposingly larger green areas compared to other business zones. This zone provides for business activities from light industrial to limited office, large format retail and trade suppliers.
51	Special Purpose - Quarry Zone	80	-	NA	Assuming quarry surfaces are mostly impervious, with some green areas remained in the fringe of the zone.

ZONE ID	Zone Description	Recommended MPD % impervious coverage based on AUP OiP for hydraulic modelling[1]	Upper % impervious coverage allowed by AUP OiP for hydraulc modelling[1]	Notes extracted from AUP Document	Data Source & Rationale
52	Special Purpose - Maori Purpose Zone	60	-	60% max imperviousness	Max imperviousness as per H27.6.6
53	Special Purpose - Cemetery Zone	60	-	60% max imperviousness	Max imperviousness as per H24.6.7
54	Special Purpose - Major Recreation Facility Zone	80	-	NA	Assuming sports field with underdrains as impervious. Assuming a higher % imperviousness based on analysis from aerial phots. This zone applies to major recreation facilities include sports arenas, showgrounds, events centres, racecourses, motor-racing tracks, the Auckland Zoo, and Museum of Transport and Technology (MOTAT).
55	Special Purpose - Healthcare Facility and Hospital Zone	80	-	80% max imperviousness	Max imperviousness as per H25.6.4
56	Special Purpose - Airports and Airfields Zone[4]	80	-	NA	Based on numbers given by Planner (Email dated 24/09/2014), 80%. Precinct rules apply for specific airport zones. Site specific analysis may be required to determine % imperviousness on a case by case basis.
59	Coastal - Coastal Transition Zone	10	-	NA	Coastal fringe areas unlikely to be developed, mostly green spaces
60	Residential - Mixed Housing Urban Zone[6]	60	-	max 60% impervious	Max imperviousness as per H5.6.9.
61	Green Infrastructure Corridor (Operative in somne Special Housing Areas)	10	-	NA	Based on numbers given by planner (Email dated 24/09/2014), lesser of 10% or 5000m2. Assumed to be mostly green with minimal imperviousness
62	Open Space - Civic Spaces Zone	100	-	no limit	Max impervious Areas as per H7.11.7
63	Special Purpose - School Zone	70	-	70% max imperviousness	Max imperviousness as per H29.6.5
64	Special Purpose - Tertiary Education Zone	70	-	NA	No max imperviousness defined in H30 but assumed to the same as school zone, as building coverage requirement is the same as 50%
68	Rural - Waitakere Foothills Zone[2]	12.5	-	min site size 4ha	Minimum lot sizes as per Table E39.4.5, (A31) Table H20.4.1, >25% non compliant. % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.
69	Rural - Waitakere Ranges Zone[2]	25	-	min net site area 2ha	Minimum net site area as per E39.6.5.3 (3), H21 (>15% non compliant). % imperviousness worked out based on minimum lot size and rule E8 (A7) "Diversion and discharge of stormwater runoff from impervious areas up to 5,000m2 outside an urban area that complies with Standard E8.6.1 and Standard E8.6.2.4" is a permitted activity.

1 The % imperviousness numbers given in the above table are provided for consistency purposes for hydraulic modelling. The table should be used as a reference or "starting point" when determining what MPD % imperviousness is to be used for a specific study. The information given above is not a replacement for project specific analysis. Variations/deviations from the % imperviousness numbers given in the above table should be noted, rationale provided, with approval sought from Auckland Council.

2 Rural Zones: As max % imperviousness is not specified in AUP for rural zones, the above % imperviousness was worked out based on the minimum lot size requirement (E39) and the stormwater discharge and diversion rule E8 (A7). However, for some rural zones, the existing lots may be a smaller size than the current AUP subdivision requirements. It is therefore important to carry out project specific analysis and verify the above % imperviousness for rural zones before applying the number in subsequent hydraulic modelling activities.

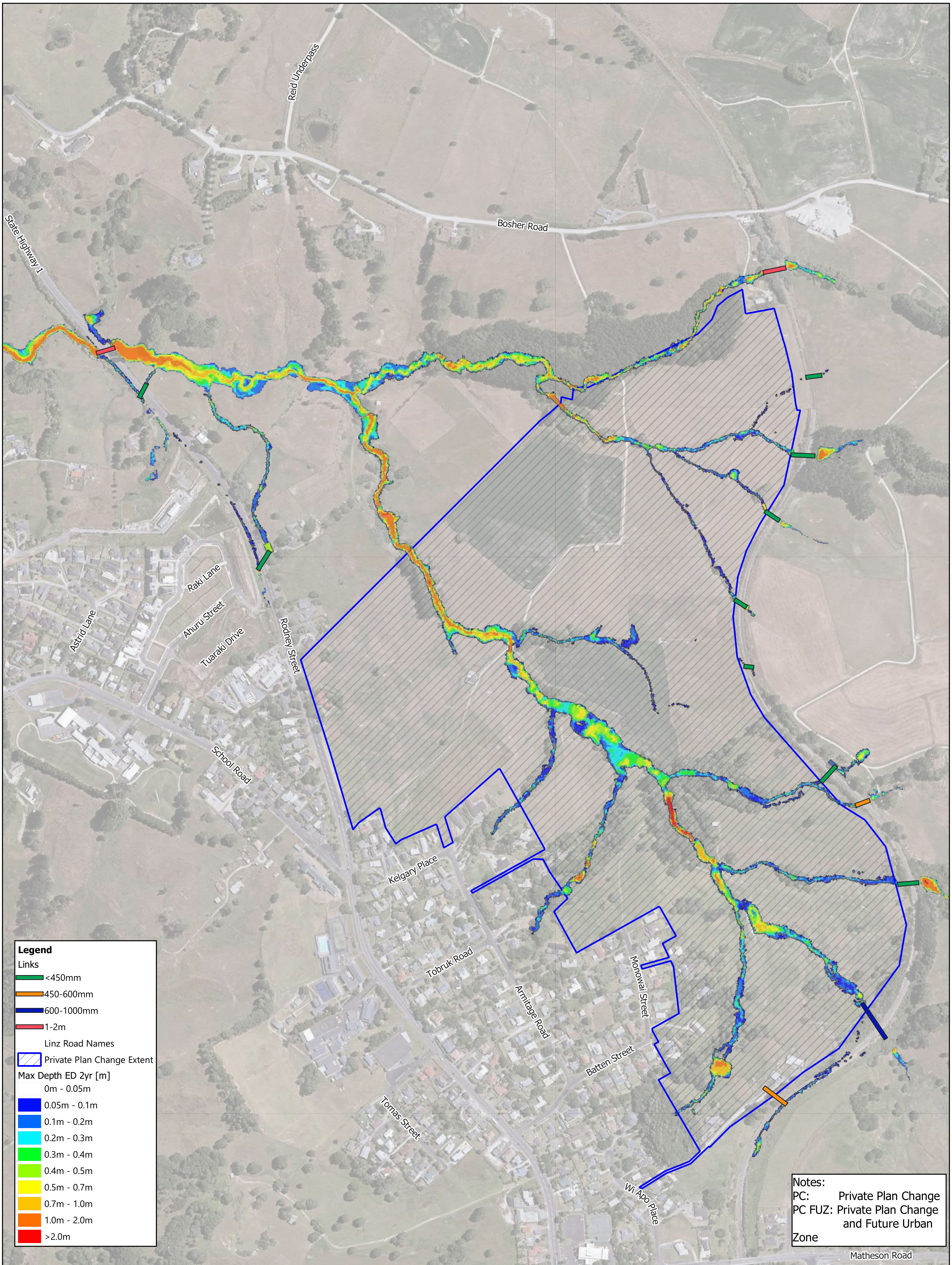
3 Business Zones: Only Business Park Zone has a max % imperviousness specified in AUP. According to advises from planning, theoretically all other business zones could develop up to 100% impervious. However, practically with the riparian rules and existing green features, a likely % imperviousness is provided based on definitions and objectives for each individual zone.

4 Special Purpose - Airports and Airfields Zone: the specified 80% imperviousness is based on a Planner's recommendation. It could be conservative for most of the airport/airfields zones, and site specific imperviousness analysis is recommended on a case by case basis. Precinct rules would apply for specific airport zones.

5 More detailed zoning is to be used for Future Urban Zones, when and if it becomes available through structure planning activities.

6 Sensitivity analysis is recommended to test impact of % imperviousness greater than allowed by AUP for Residential - Terrace Housing and Apartment Buildings Zone, Residential - Mixed Housing Urban Zone and Residential - Mixed Housing Suburban Zone.

Appendix G. Model Results



REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	WOODS Est.1970	Wellsford North Plan Change Stormwater Model Results Max. Water Depth [m]. ED 2yr No CC	STATUS	ISSUED FOR INFORMATION	REV
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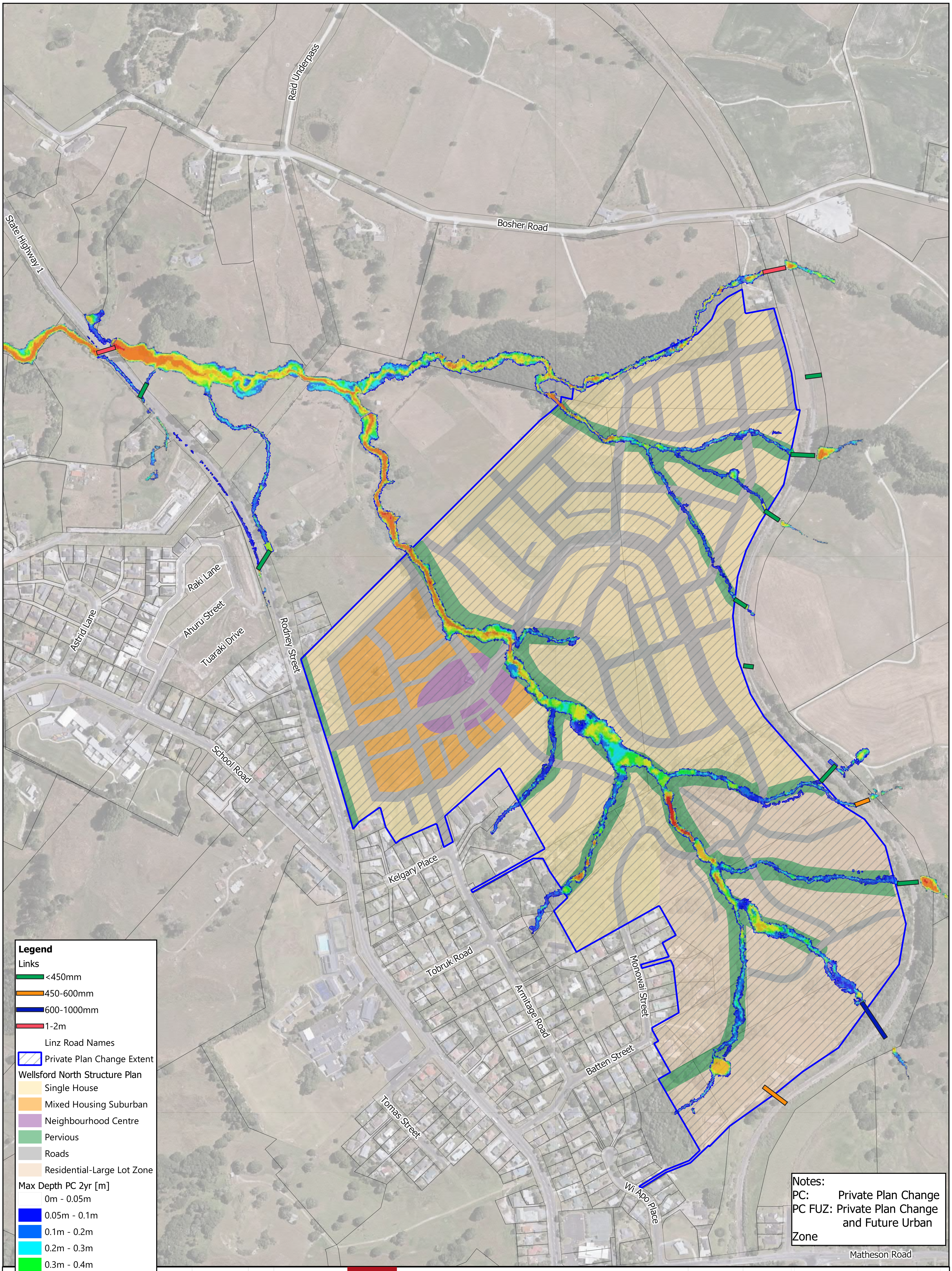

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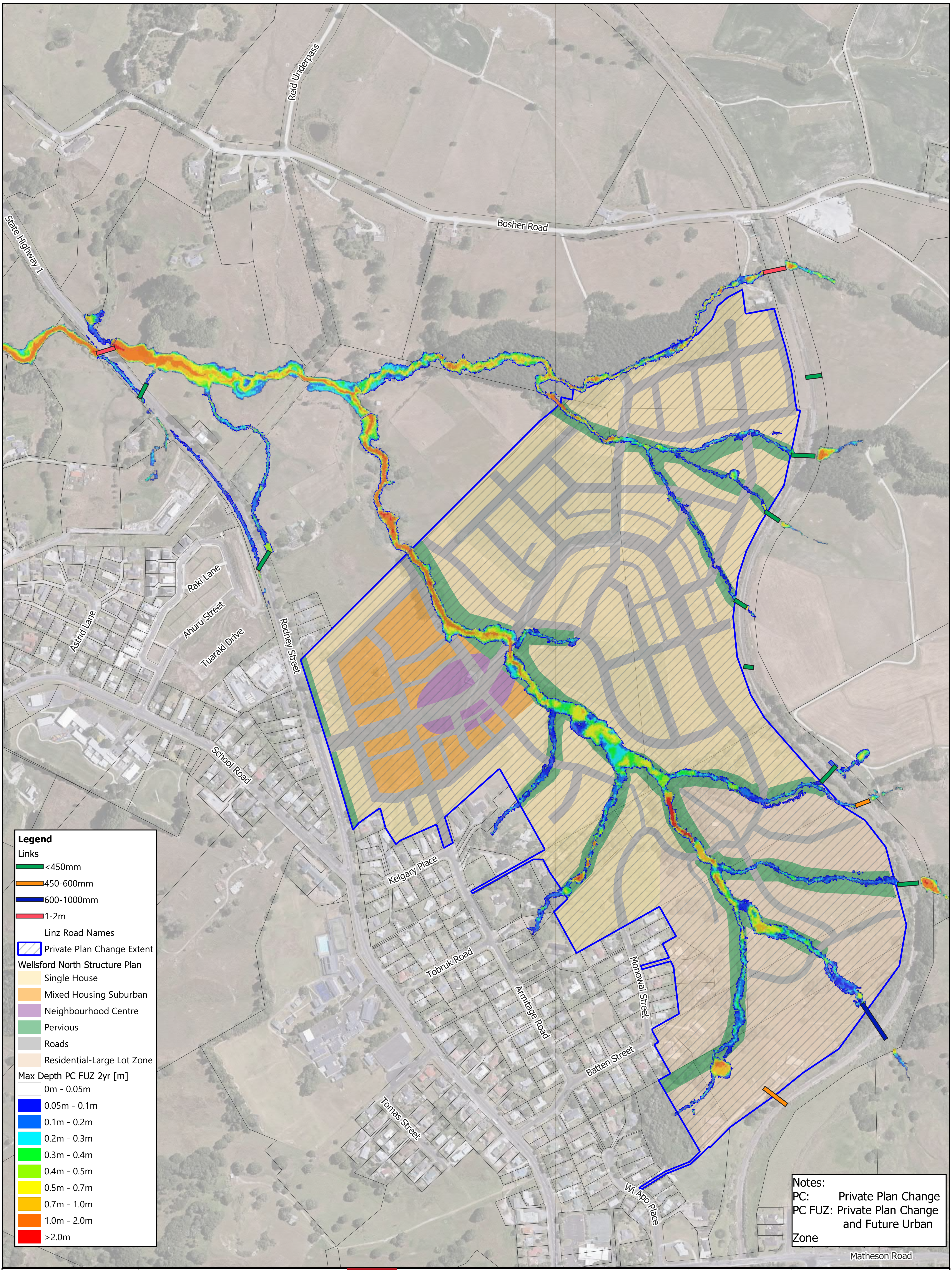

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-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Max. Water Depth [m]. PC FUZ 2yr No CC

STATUS	ISSUED FOR INFORMATION	REV
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COUNCIL	AUCKLAND COUNCIL	
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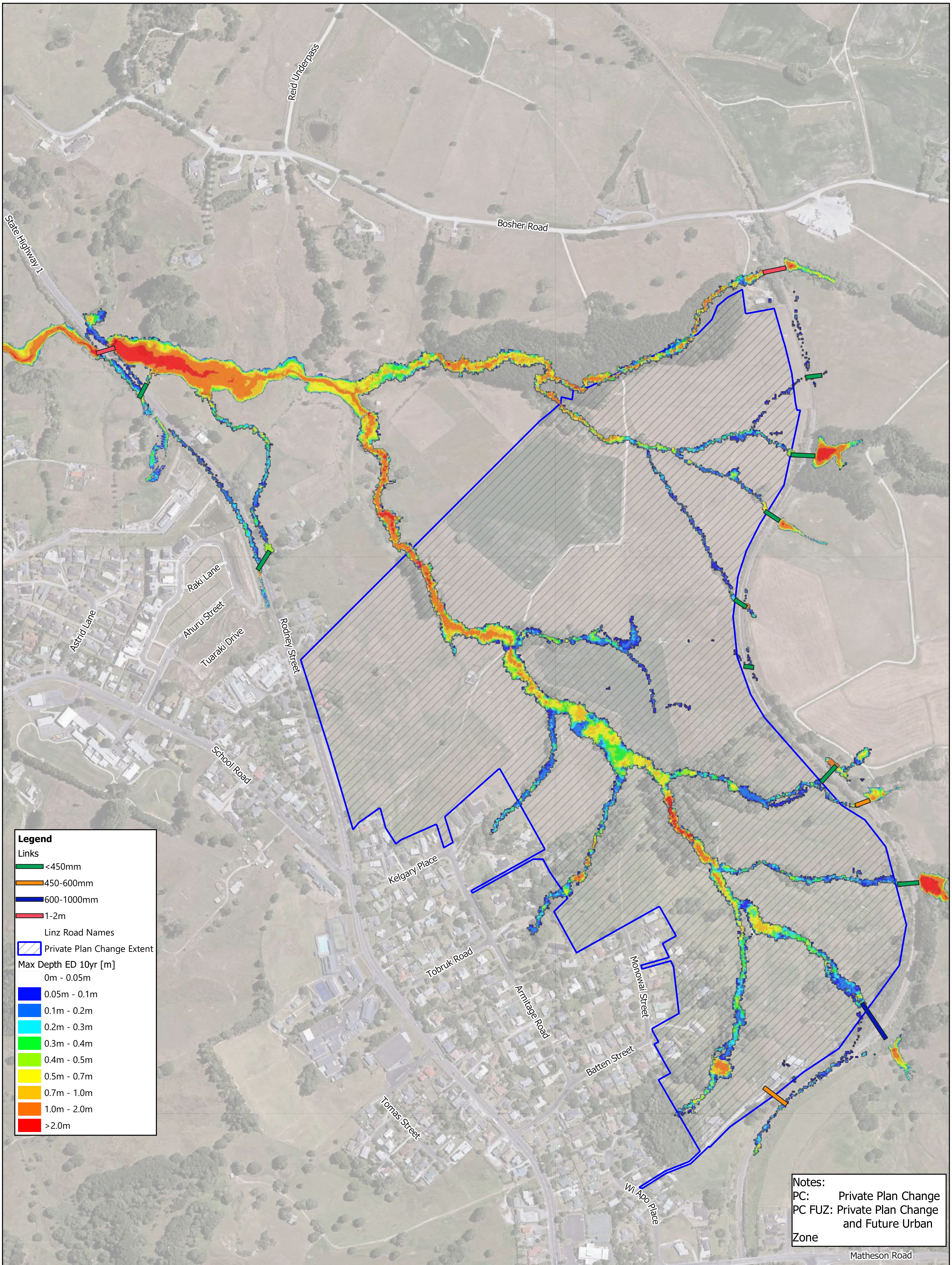

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WOODS Est. 1970

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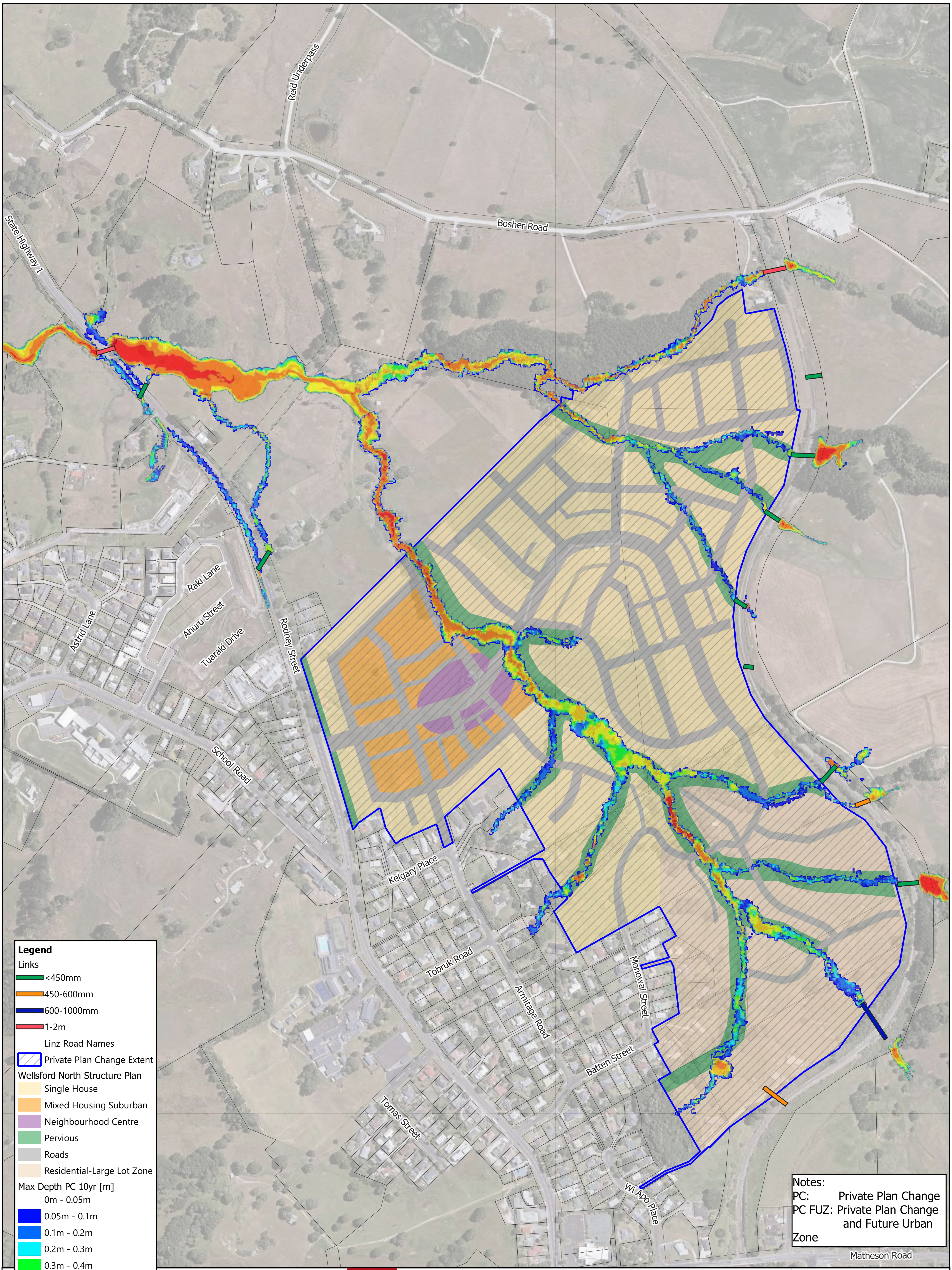

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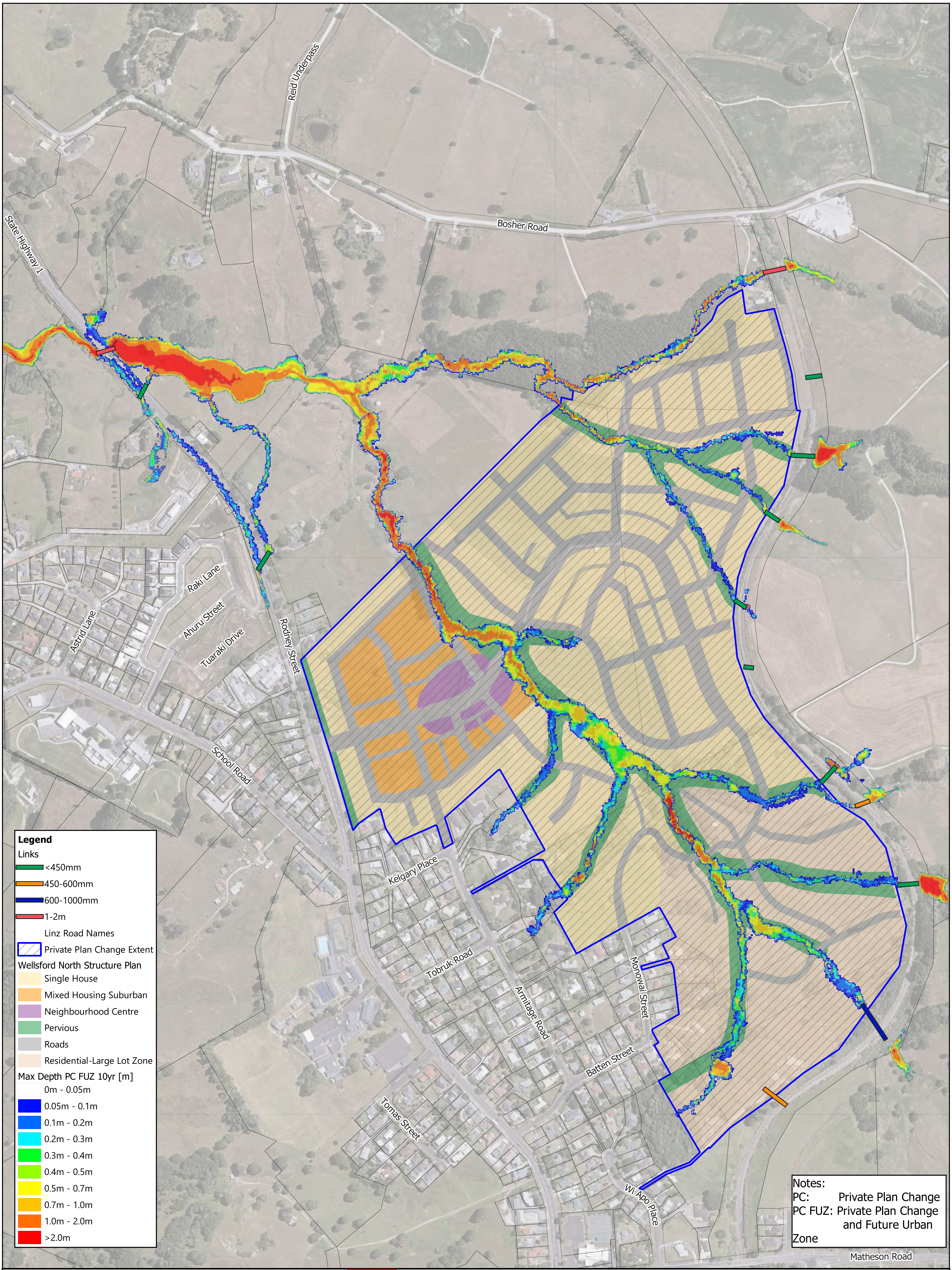

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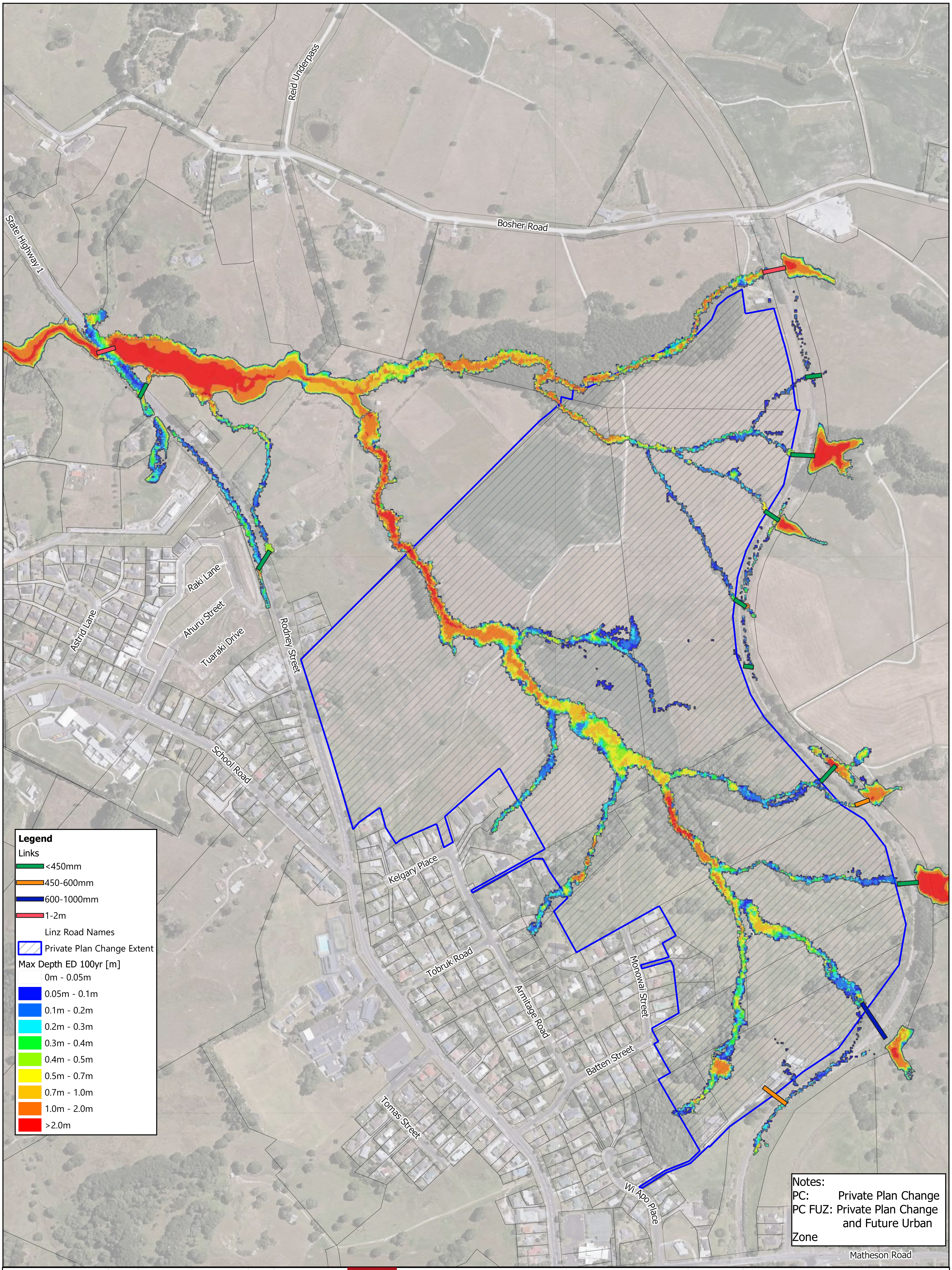

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-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Max. Water Depth [m]. ED 100yr No CC

STATUS	ISSUED FOR INFORMATION	REV
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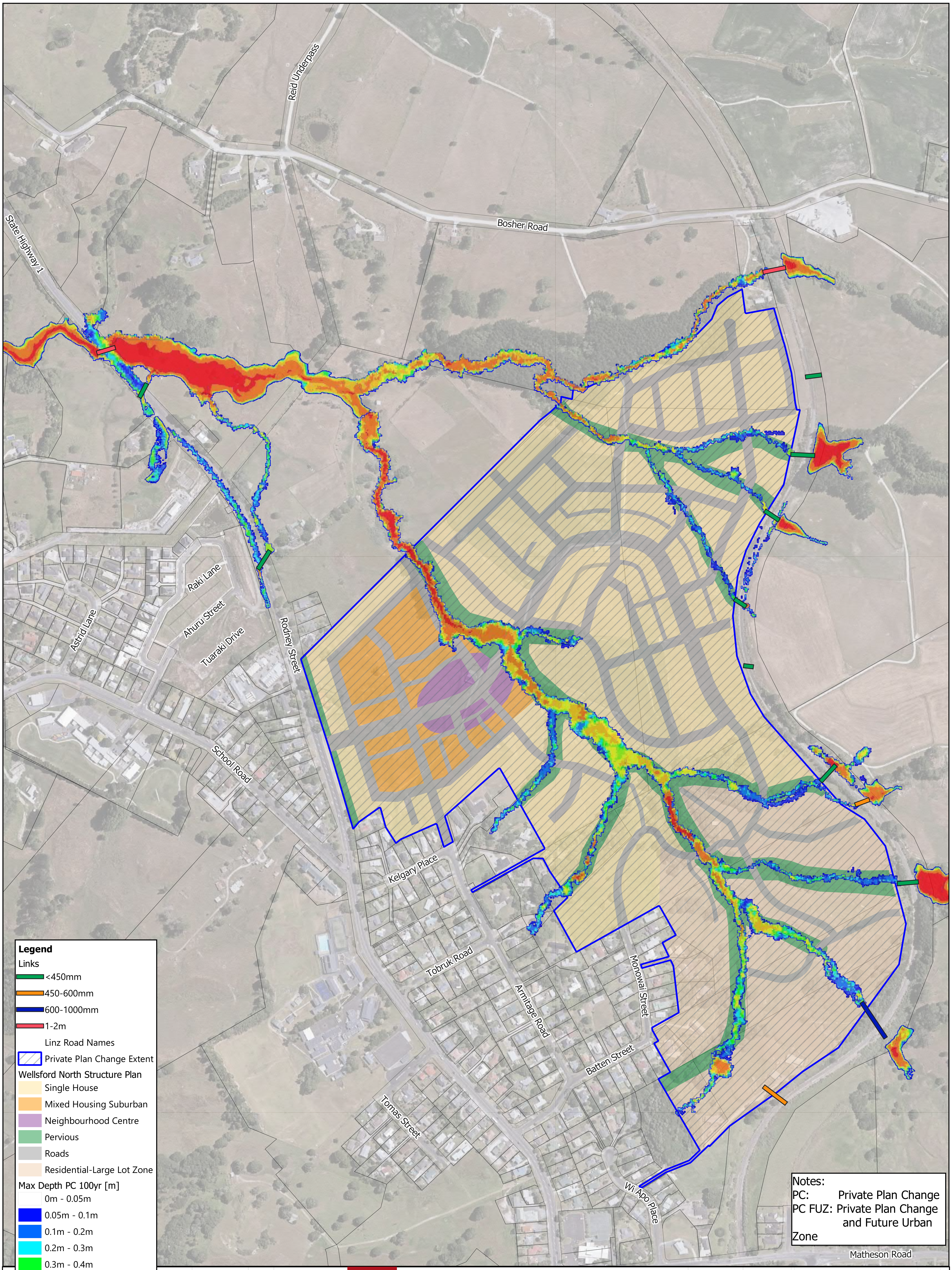

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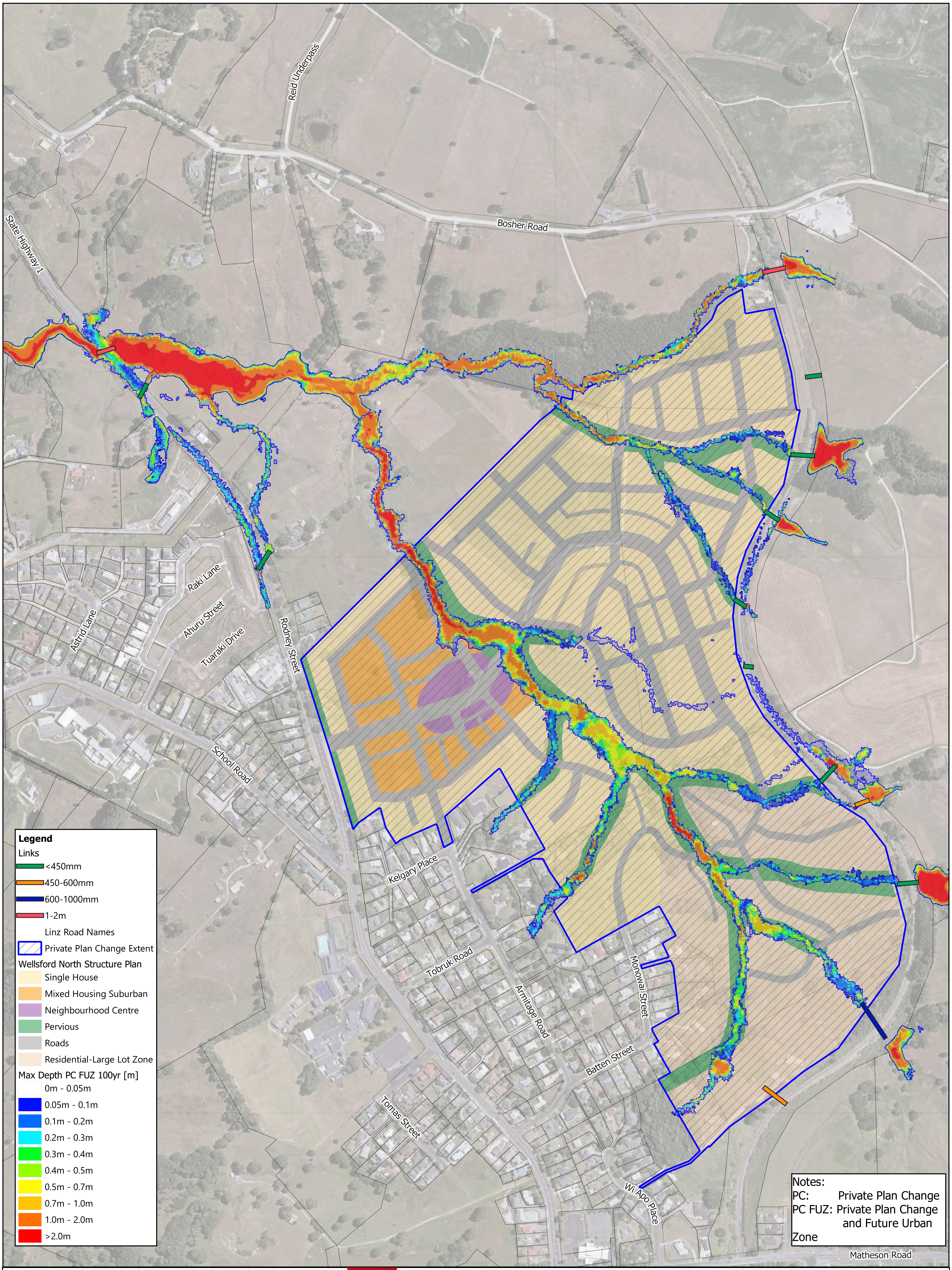

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-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Max. Water Depth [m]. PC FUZ 100yr No CC

STATUS	ISSUED FOR INFORMATION	REV
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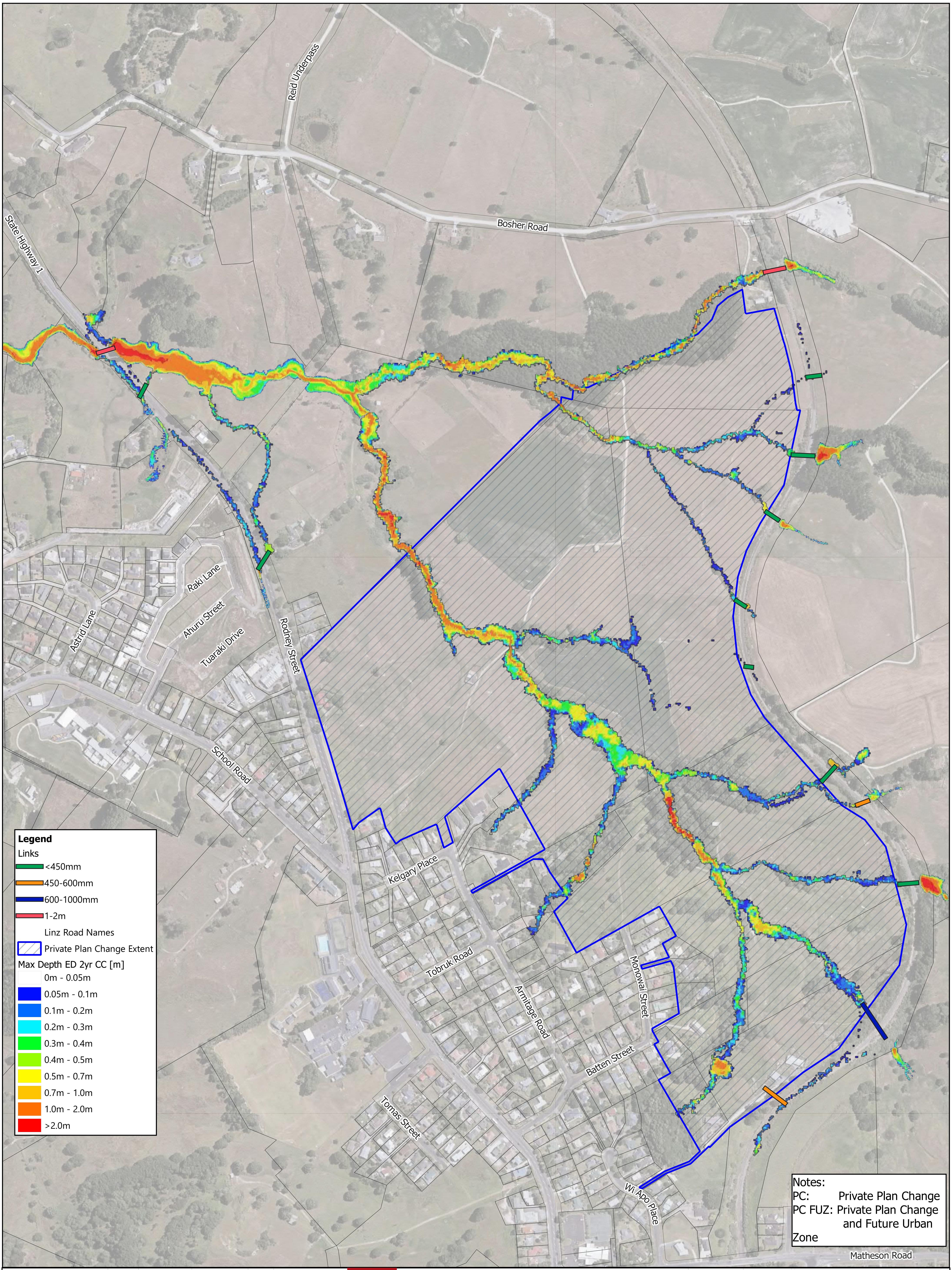

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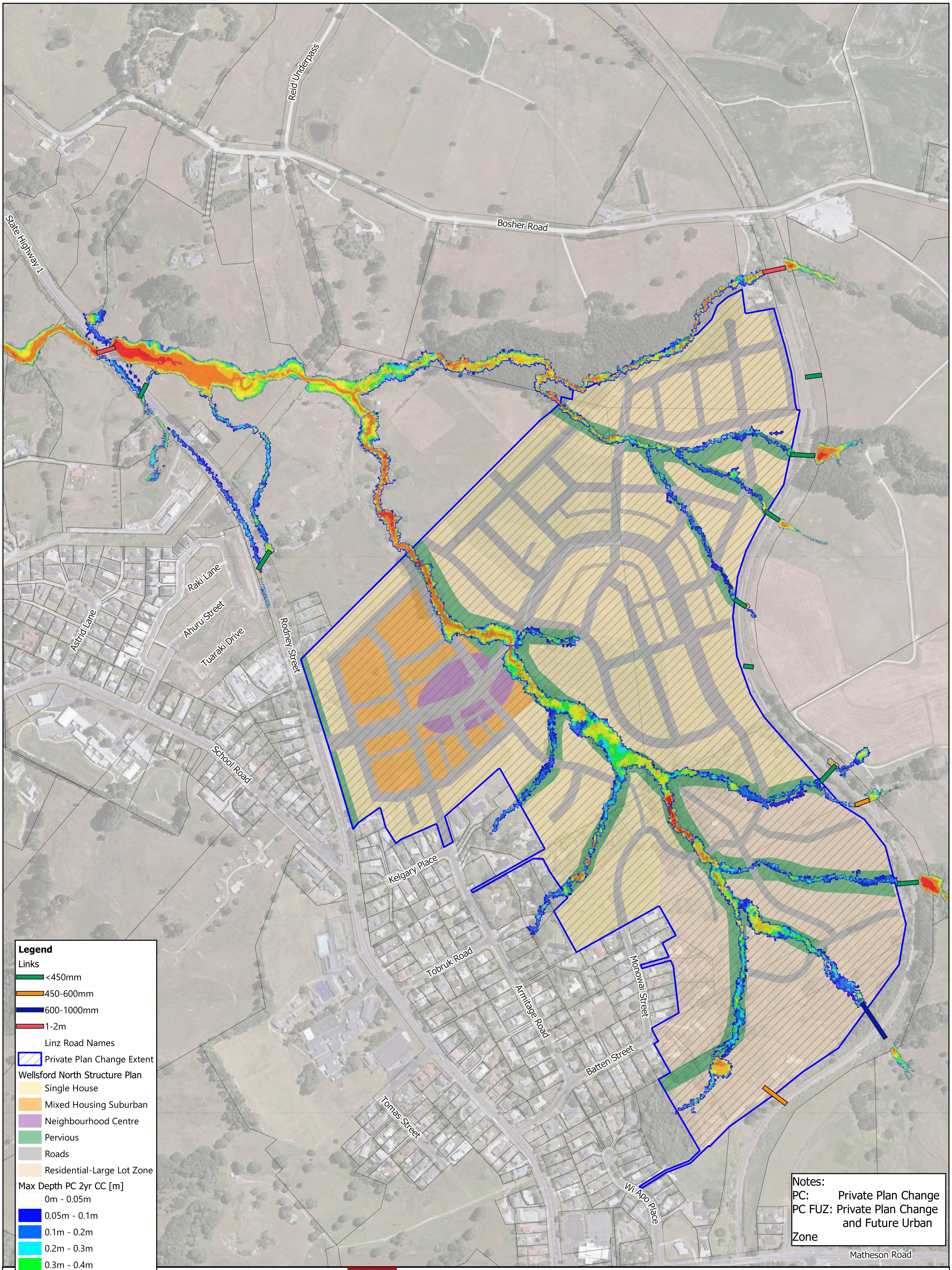

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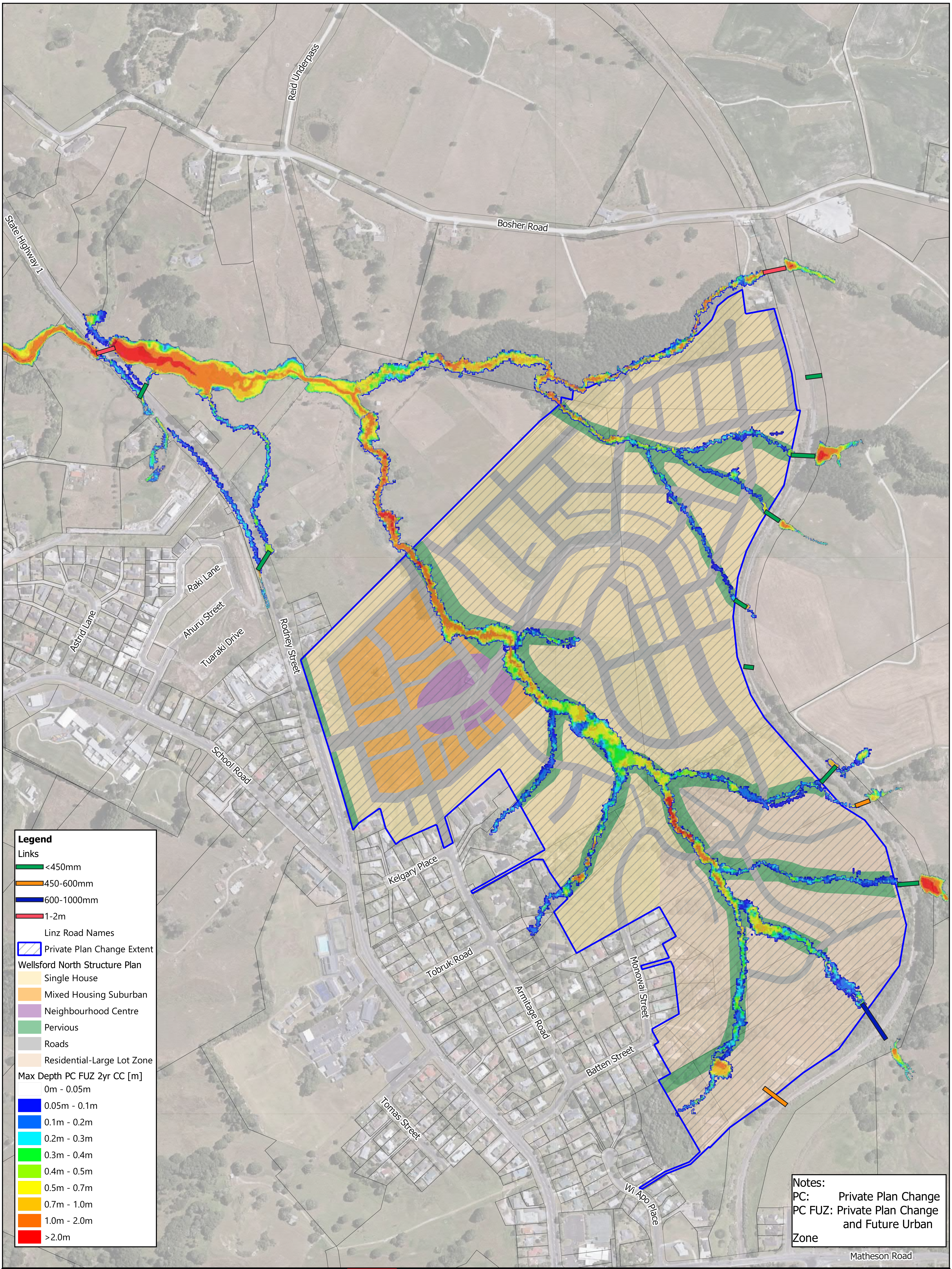

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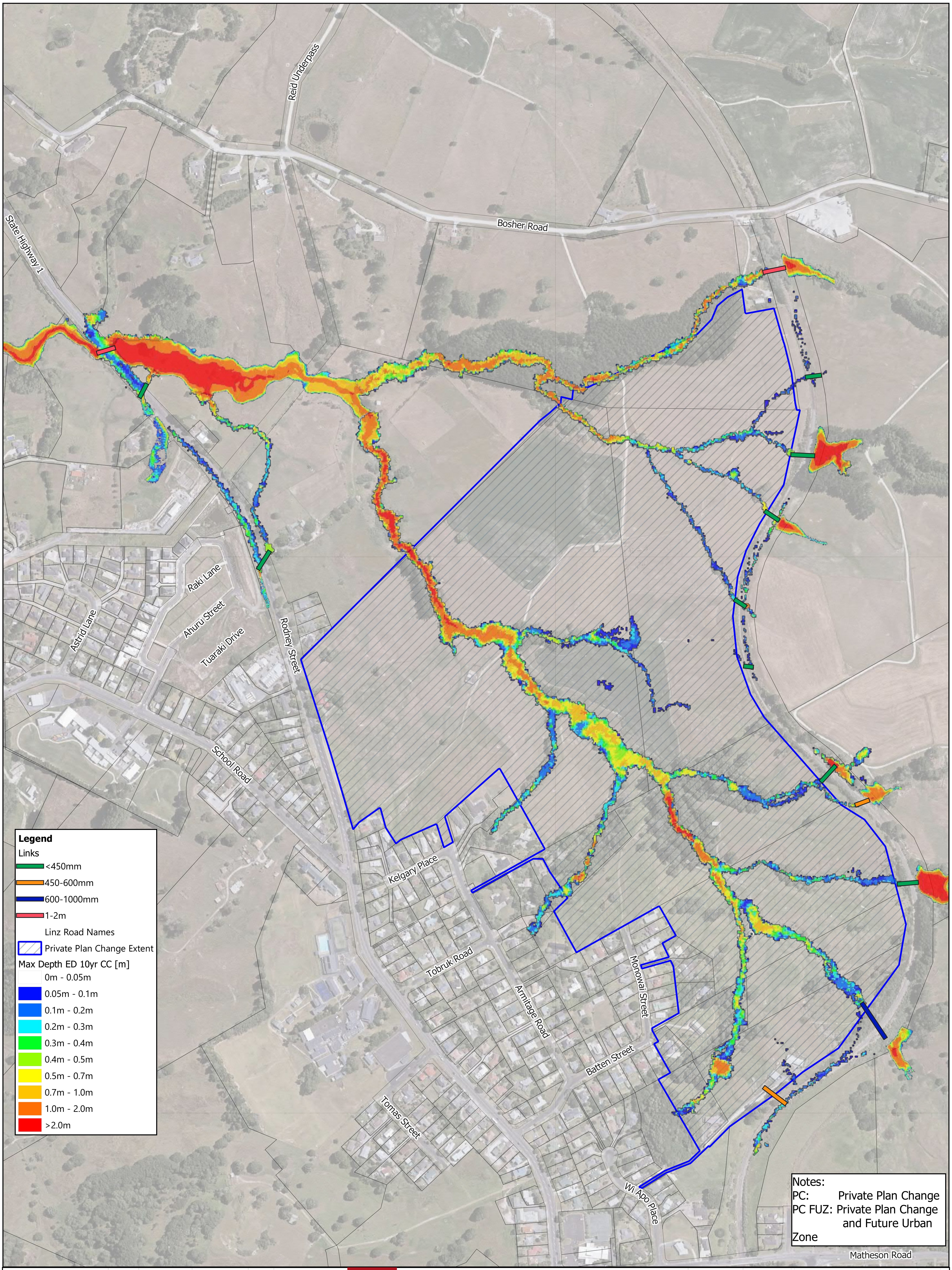

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WOODS Est.1970

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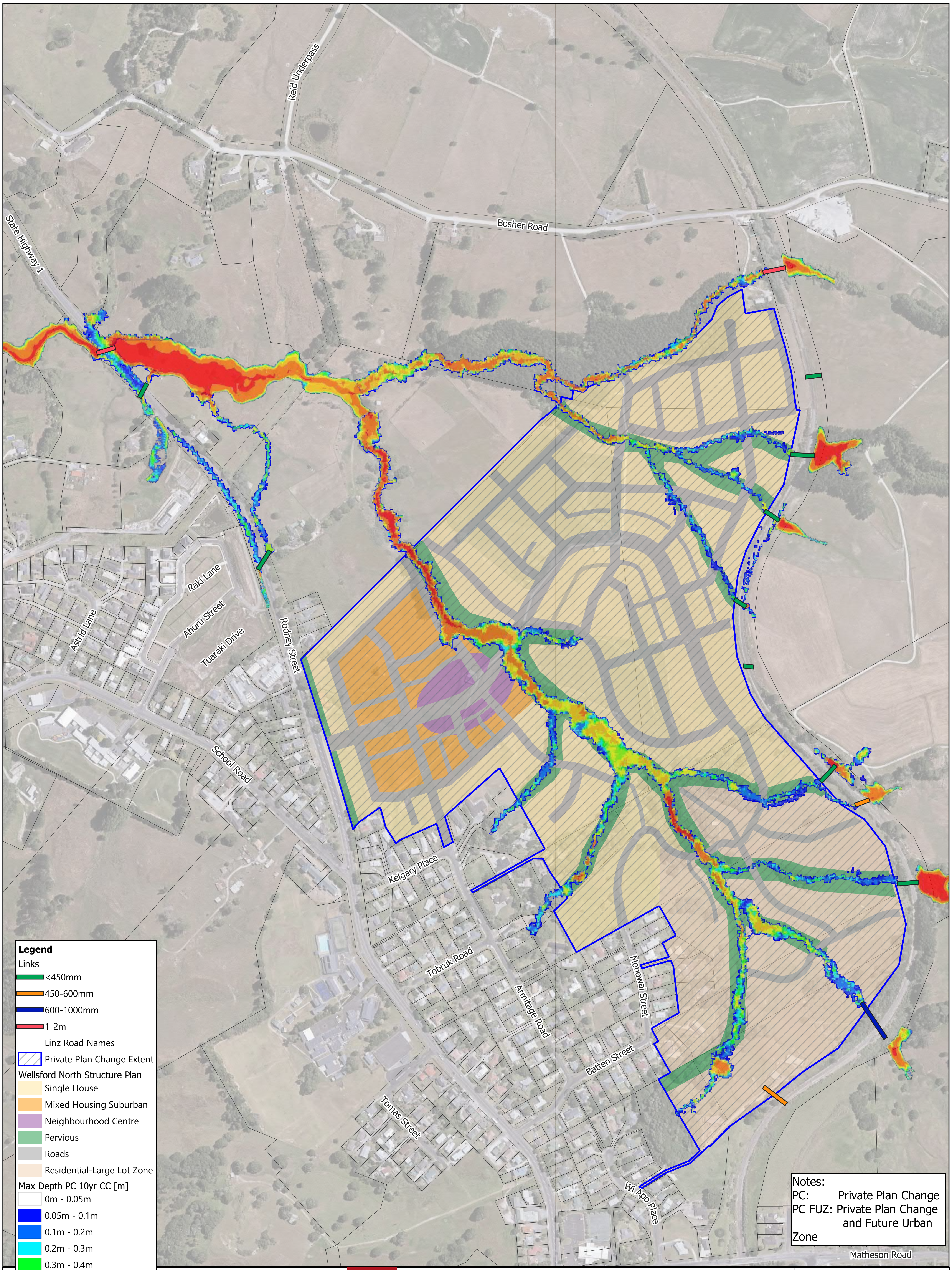

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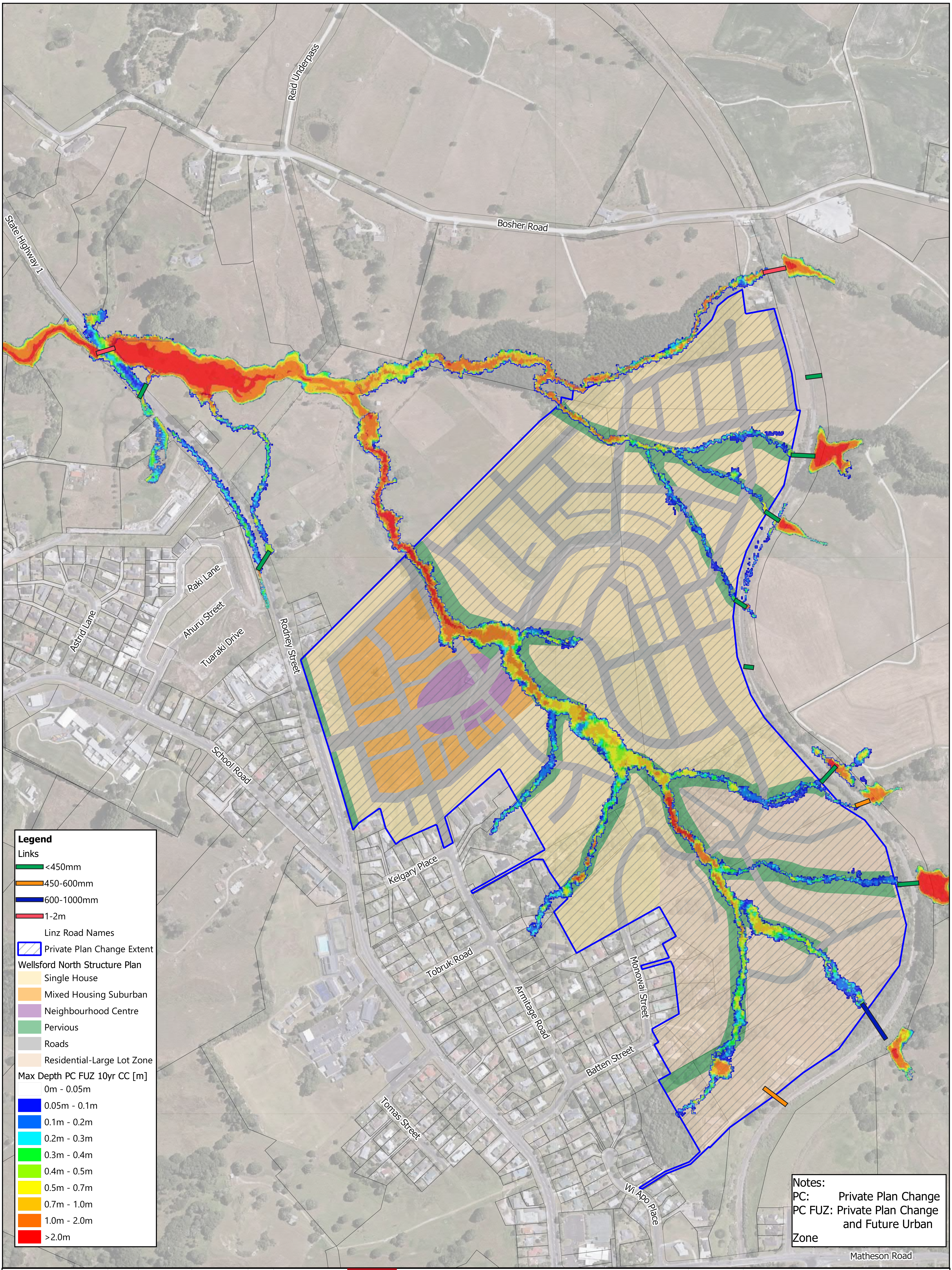

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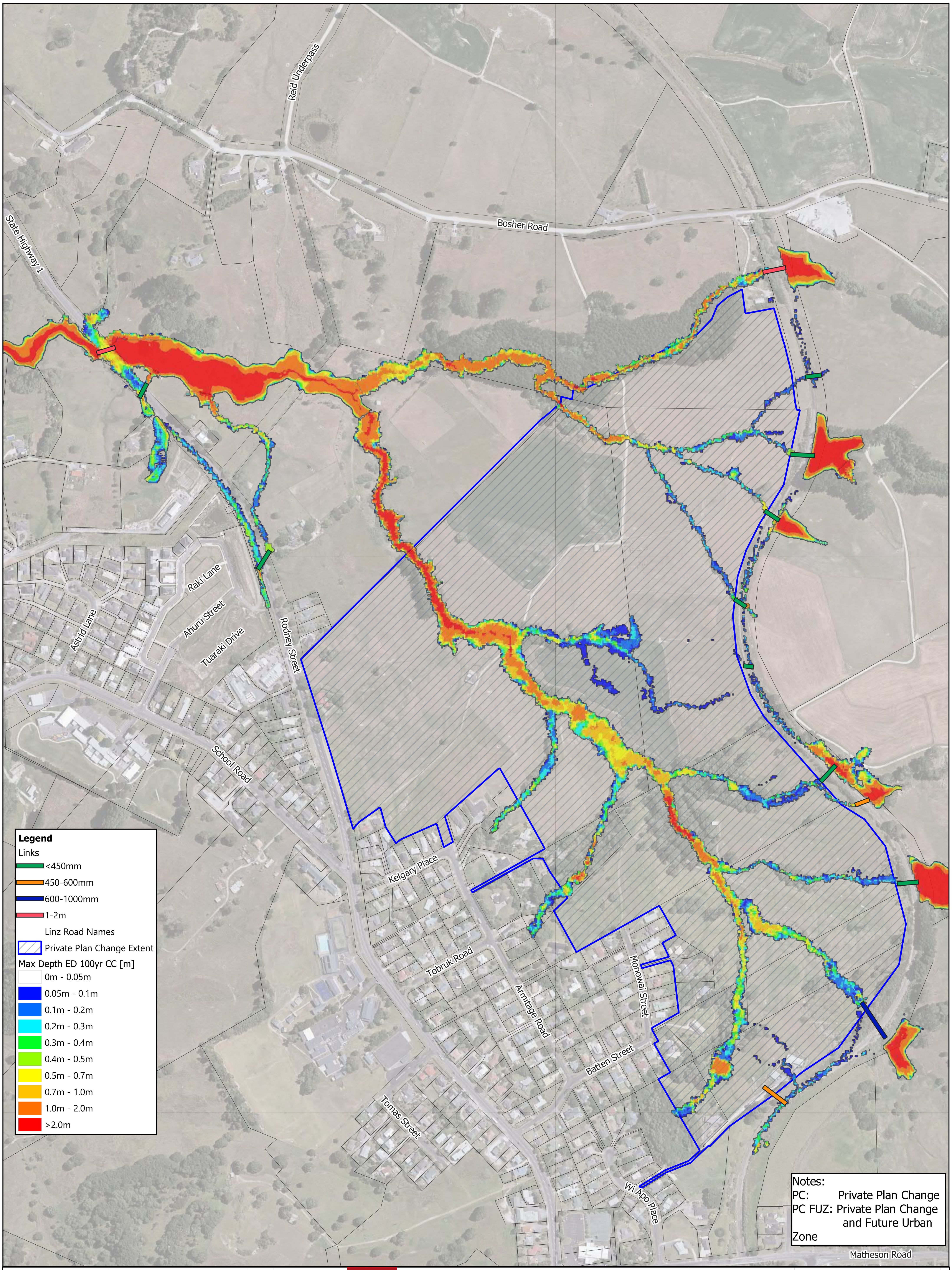

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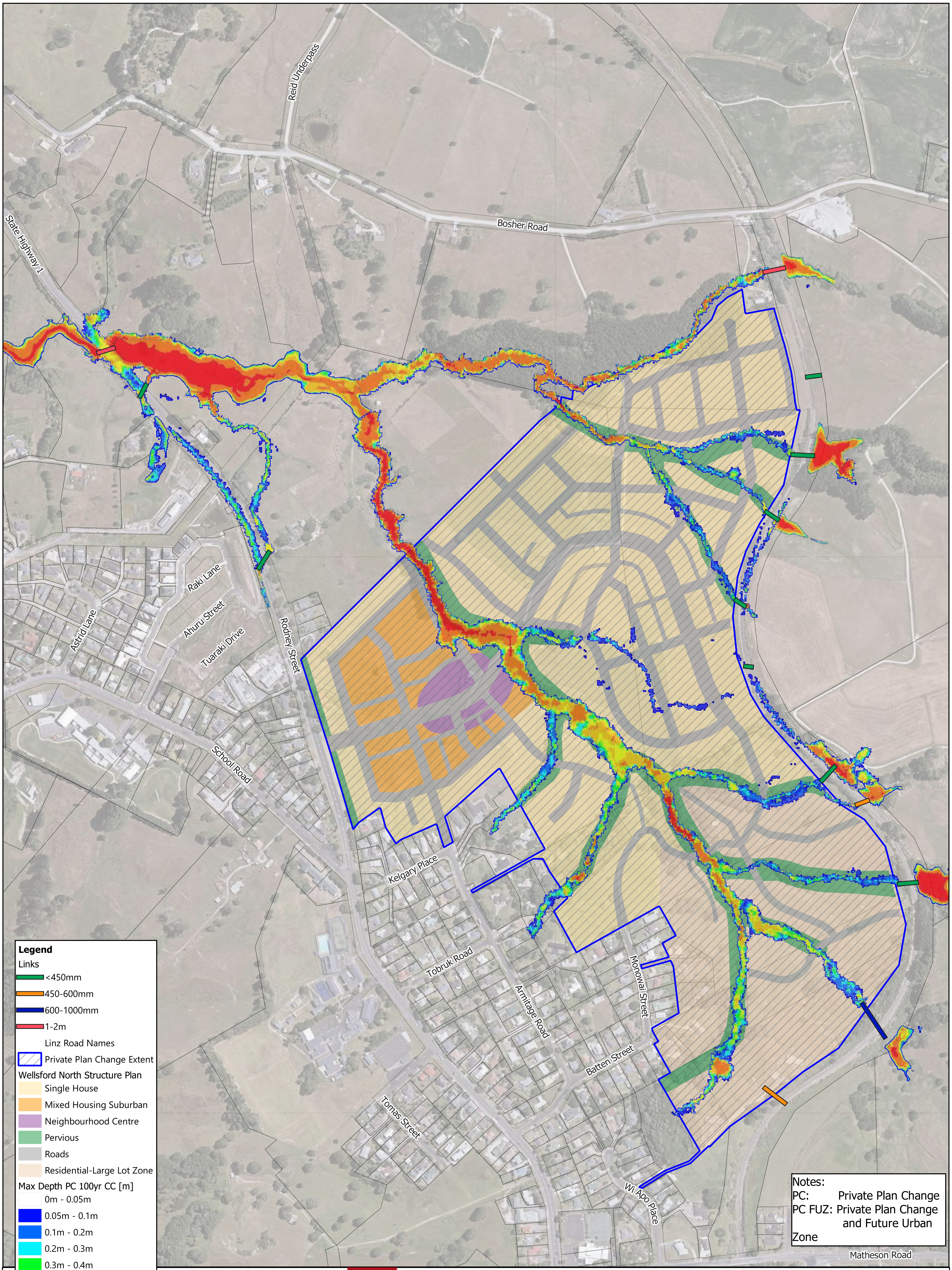

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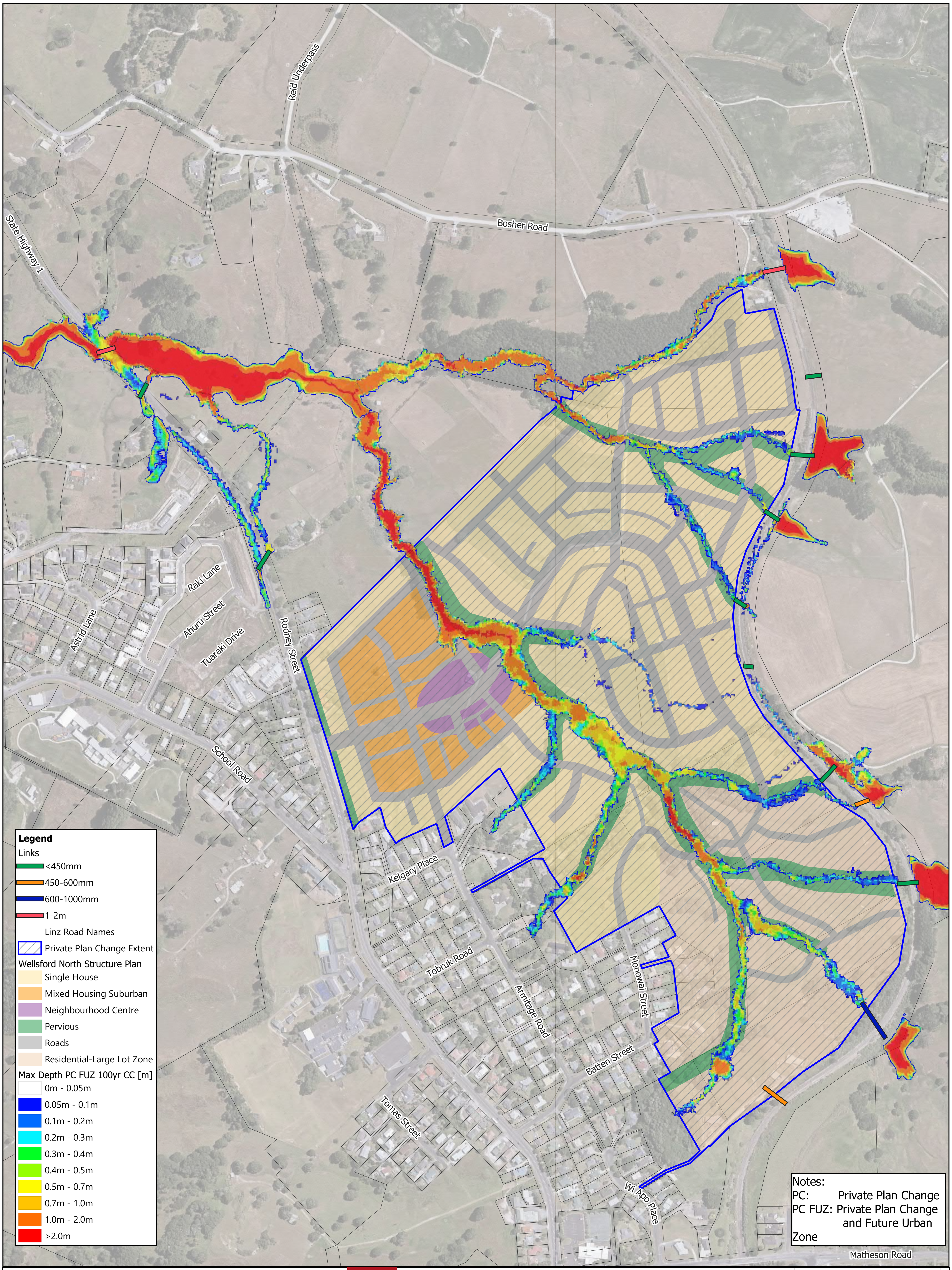

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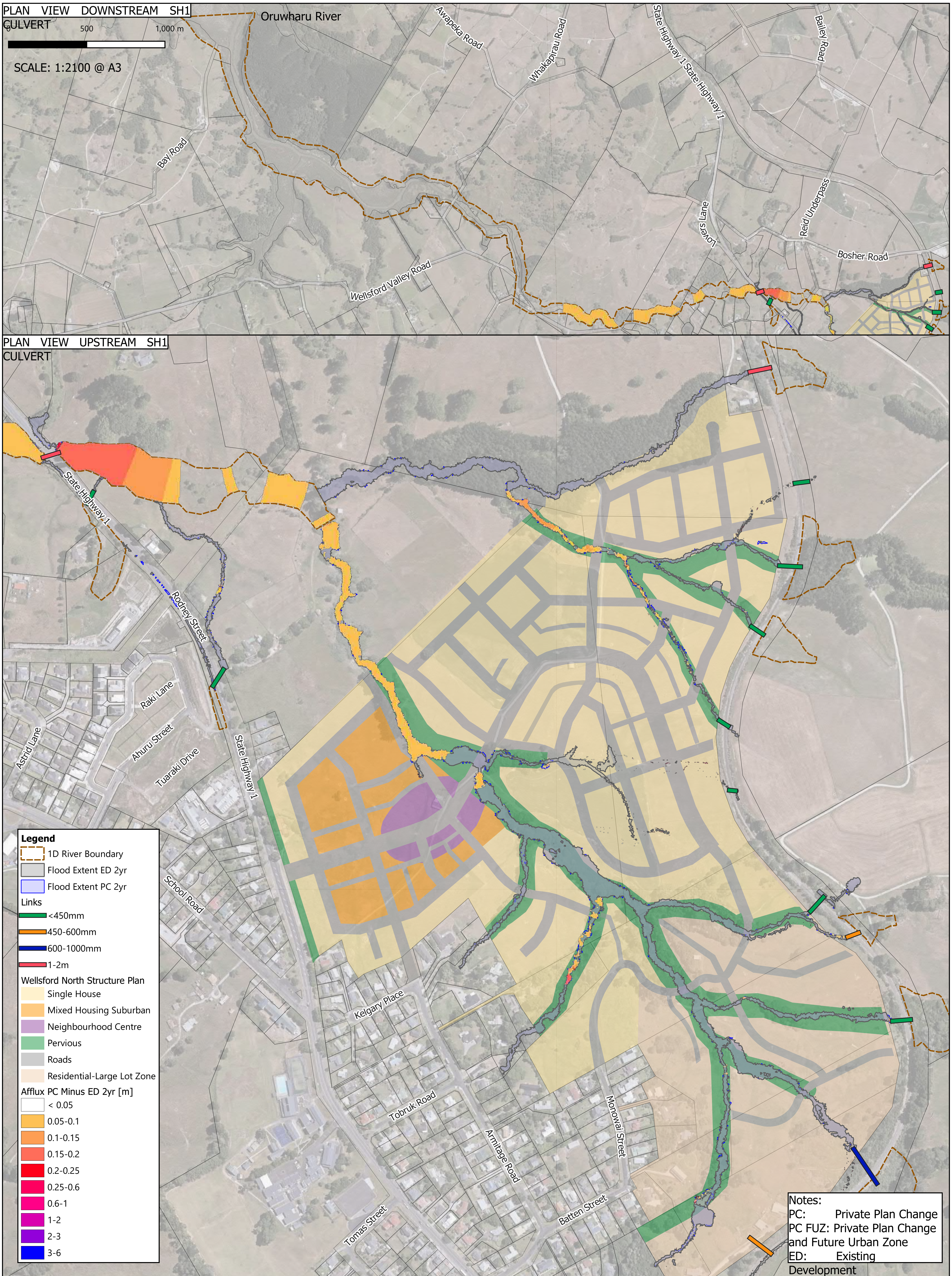

REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Afflux Plot - ED Vs PC 2yr No CC	STATUS	ISSUED FOR INFORMATION	REV
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WOODS Est.1970

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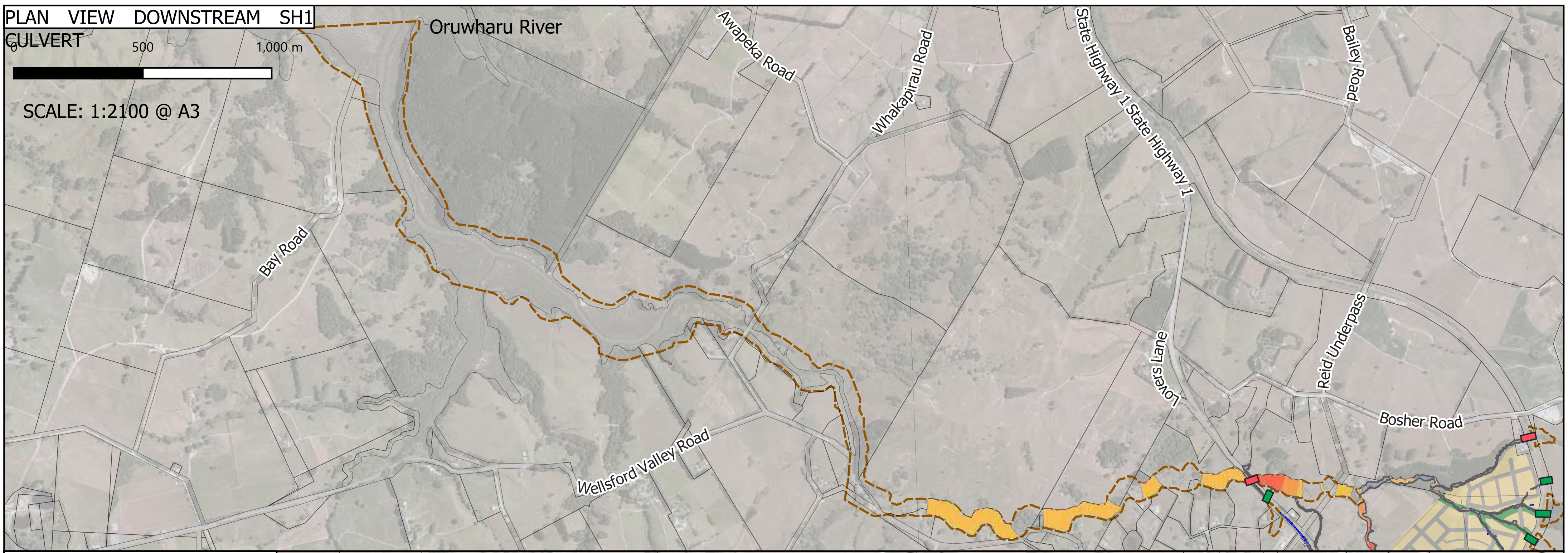

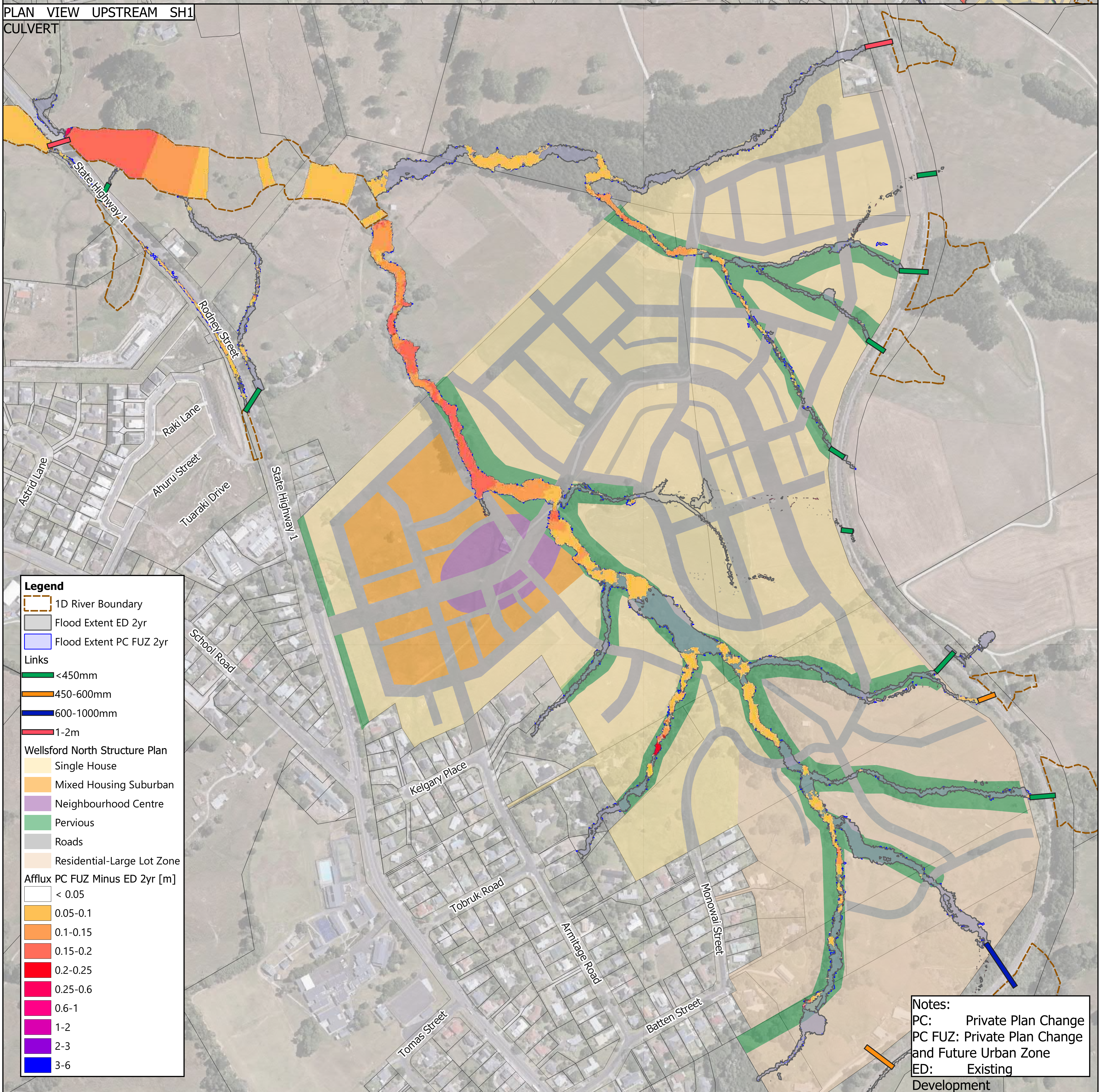

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Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC FUZ 2yr No CC

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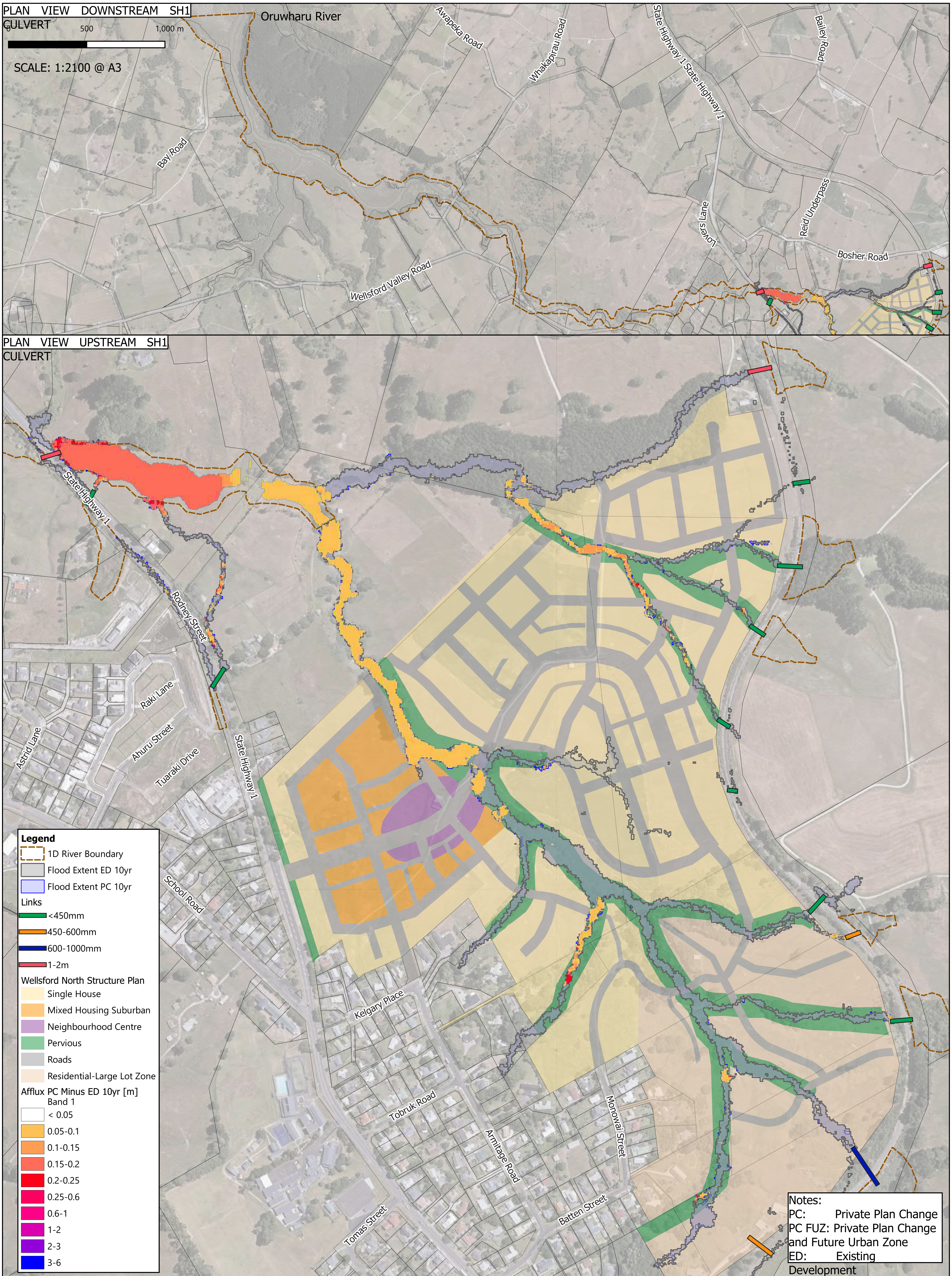

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-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-0003	
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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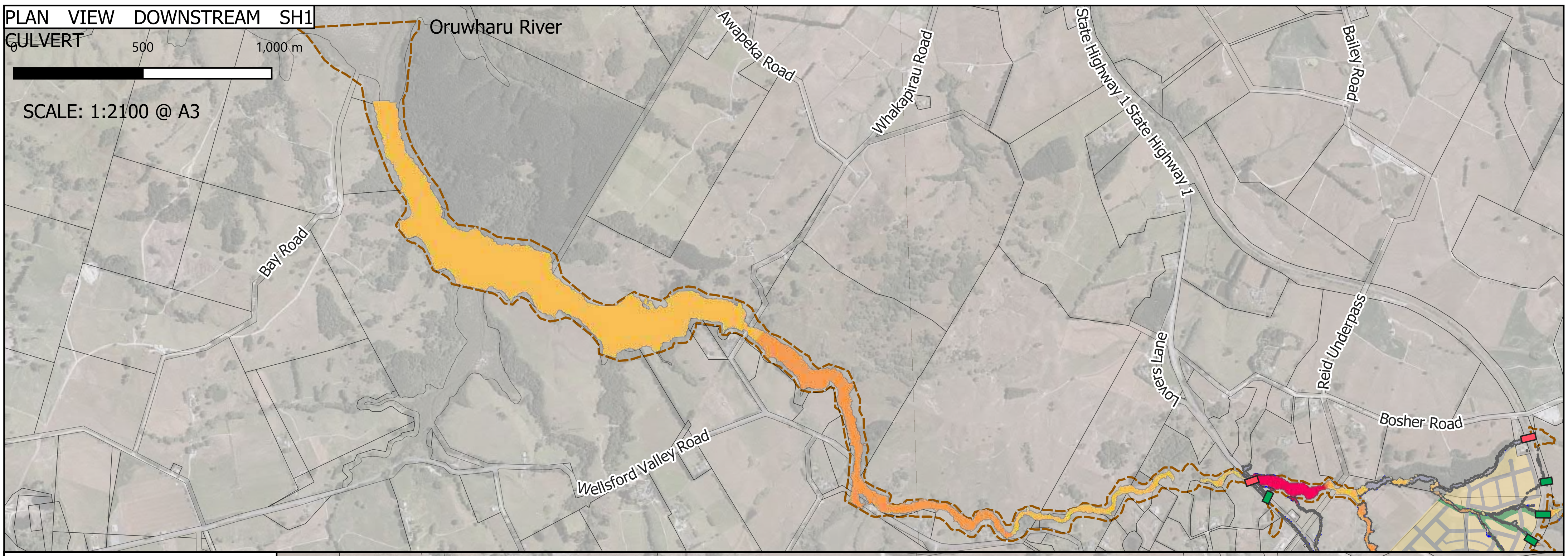

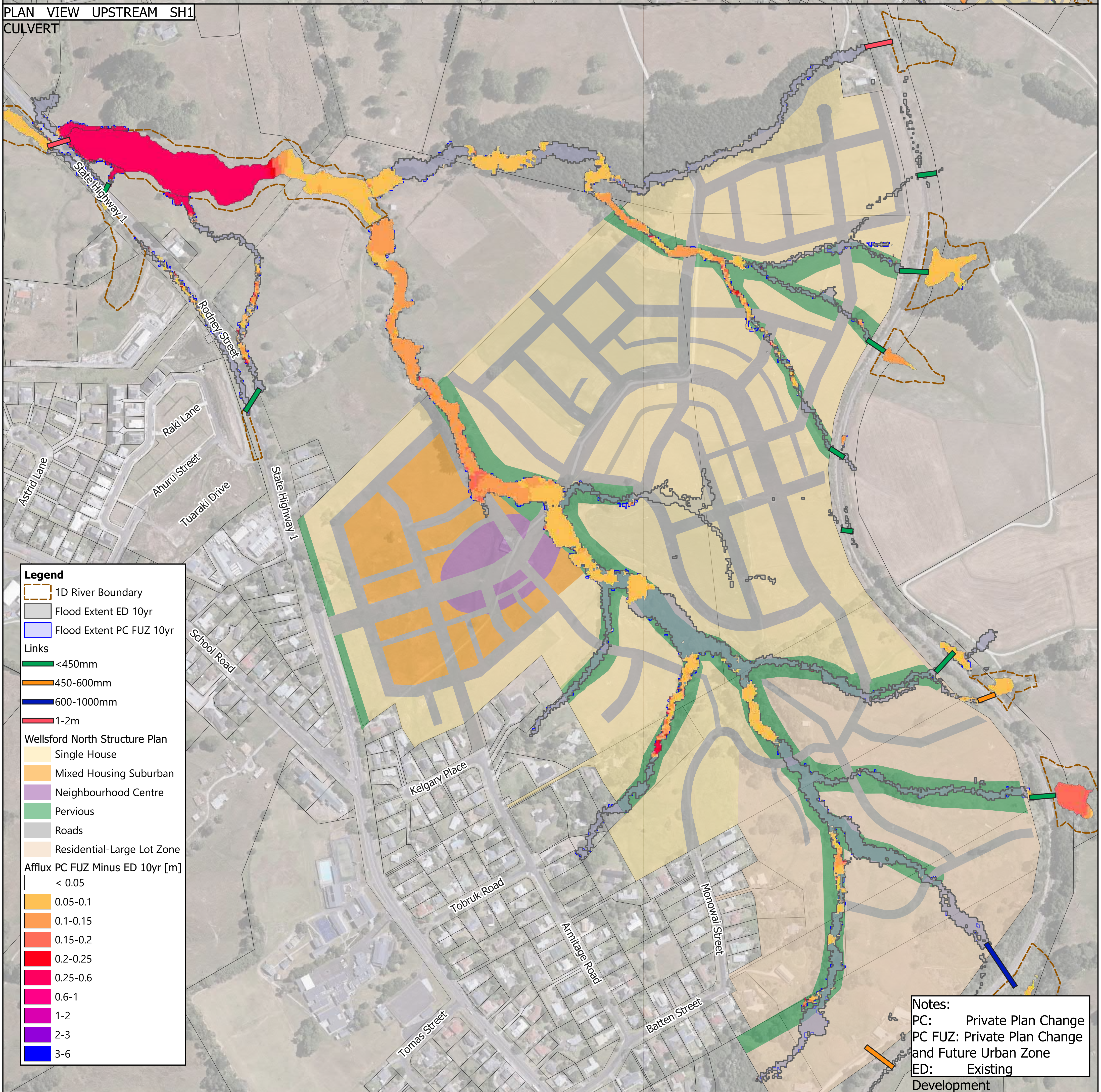

REVISION DETAILS	INT	DATE	SURVEYED	-			STATUS	ISSUED FOR INFORMATION	REV
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- -	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-0004	
- -	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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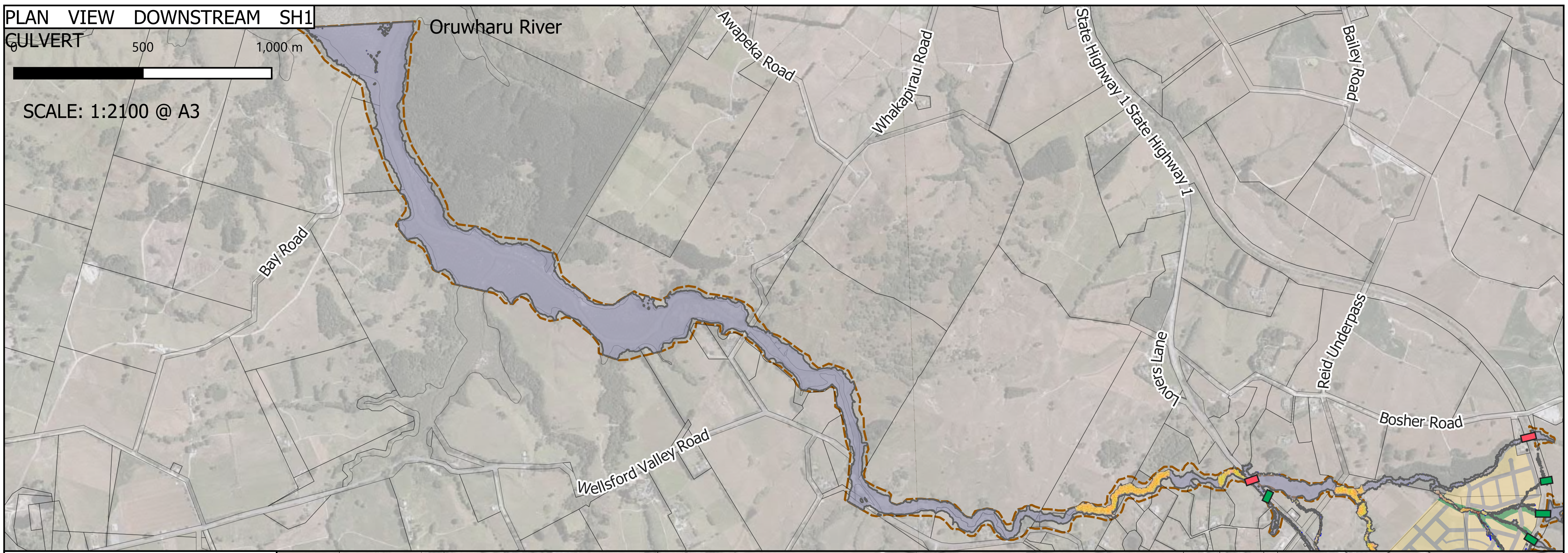
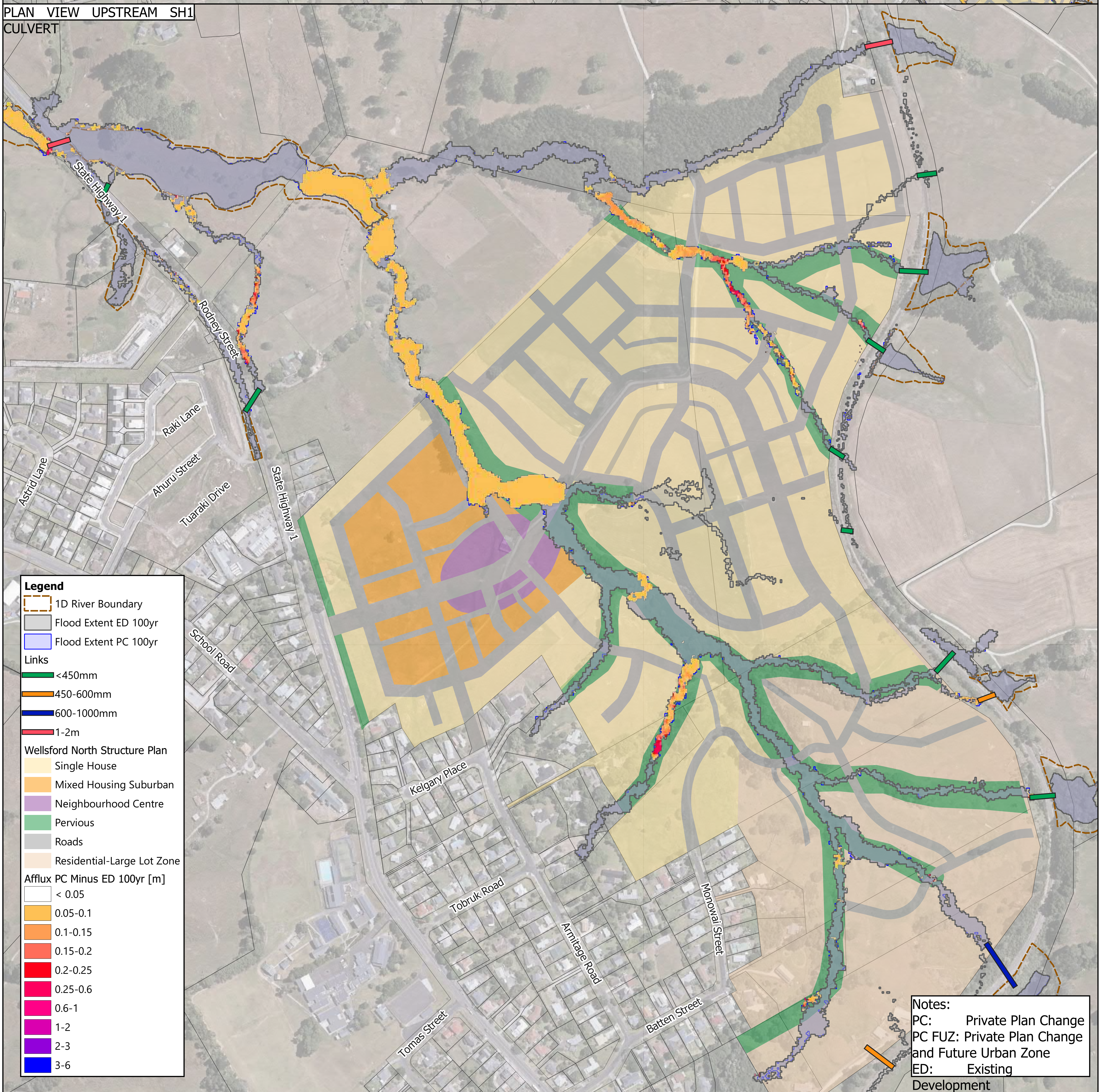
PLAN VIEW DOWNSTREAM SH1 CULVERT



PLAN VIEW UPSTREAM SH1 CULVERT



Notes:
PC: Private Plan Change
PC FUZ: Private Plan Change and Future Urban Zone
ED: Existing Development

REVISION DETAILS		INT	DATE		
1.0	FOR INFORMATION	PW	30/05/2023	SURVEYED	-
-	-	-	-	DESIGNED	MH
-	-	-	-	DRAWN	HC
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC 100yr No CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-0005	

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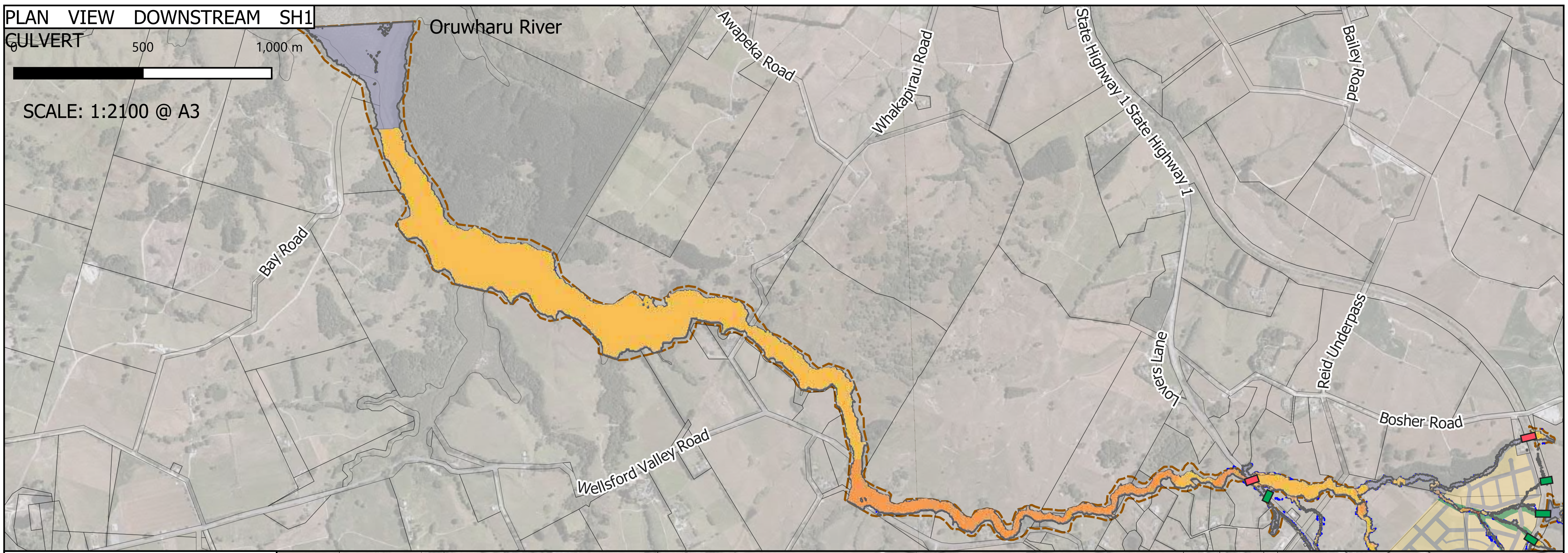
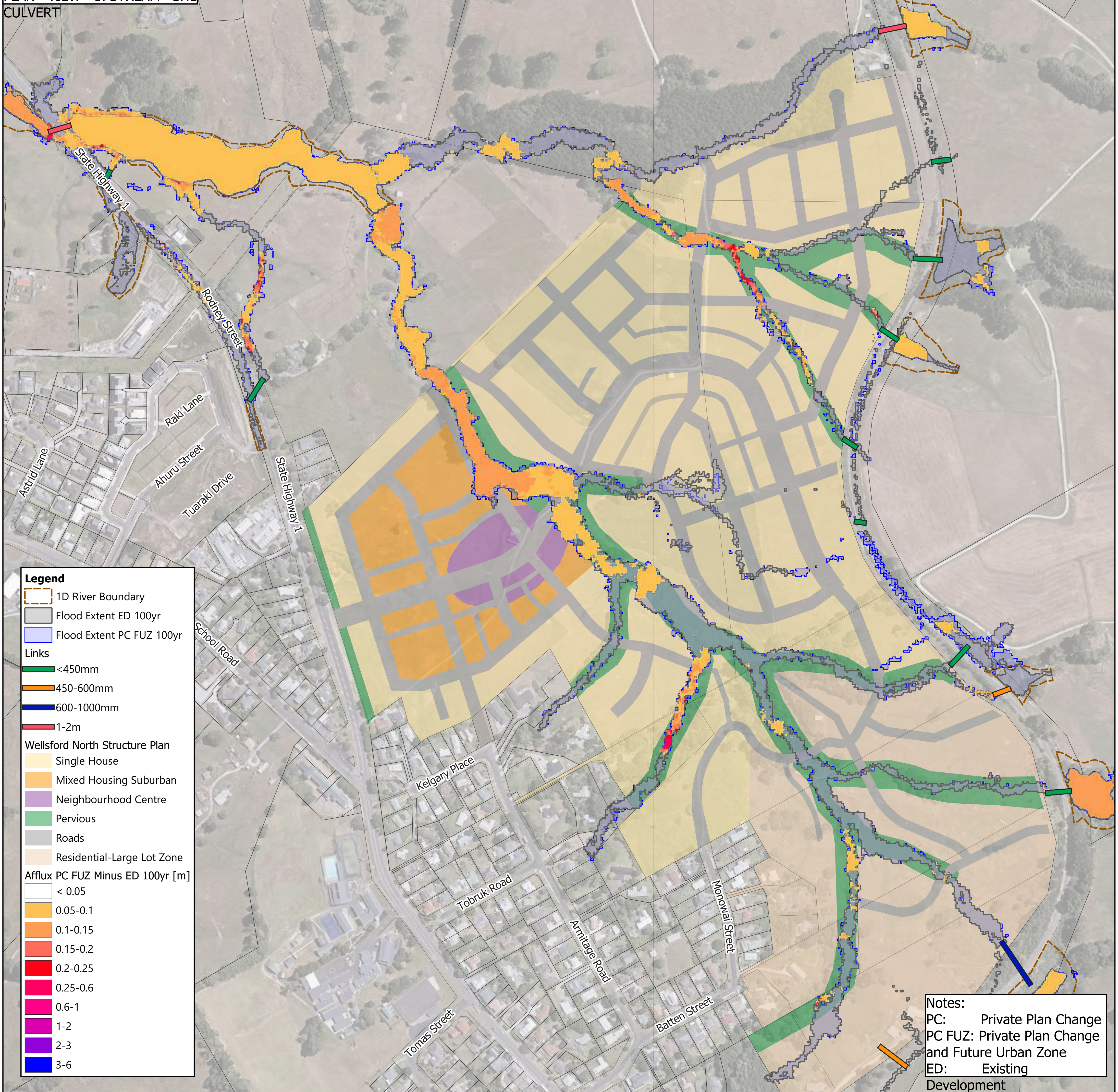


PLAN VIEW UPSTREAM SH1 CULVERT



REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Afflux Plot - ED Vs PC FUZ 100yr No CC	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	HC			COUNCIL	AUCKLAND COUNCIL	
-	-	-	-	CHECKED	TW					
-	-	-	-	APPROVED	-	WOODS.CO.NZ		DWG NO.	P21-395-SKT-0006	

WOODS Est.1970

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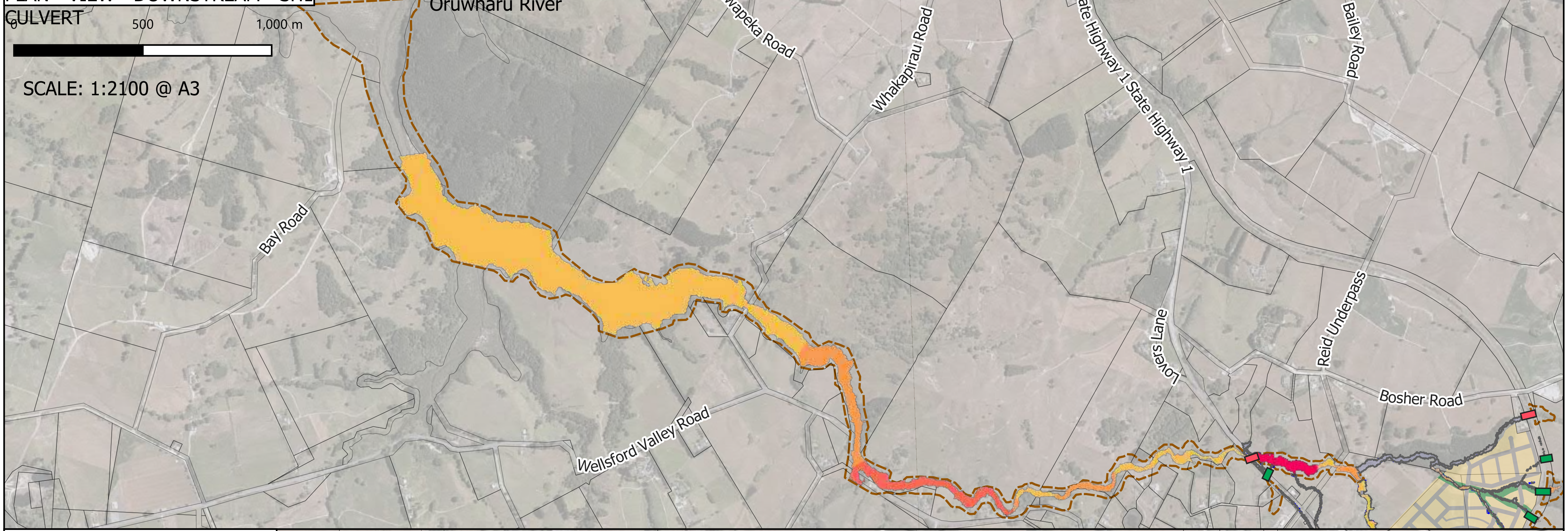
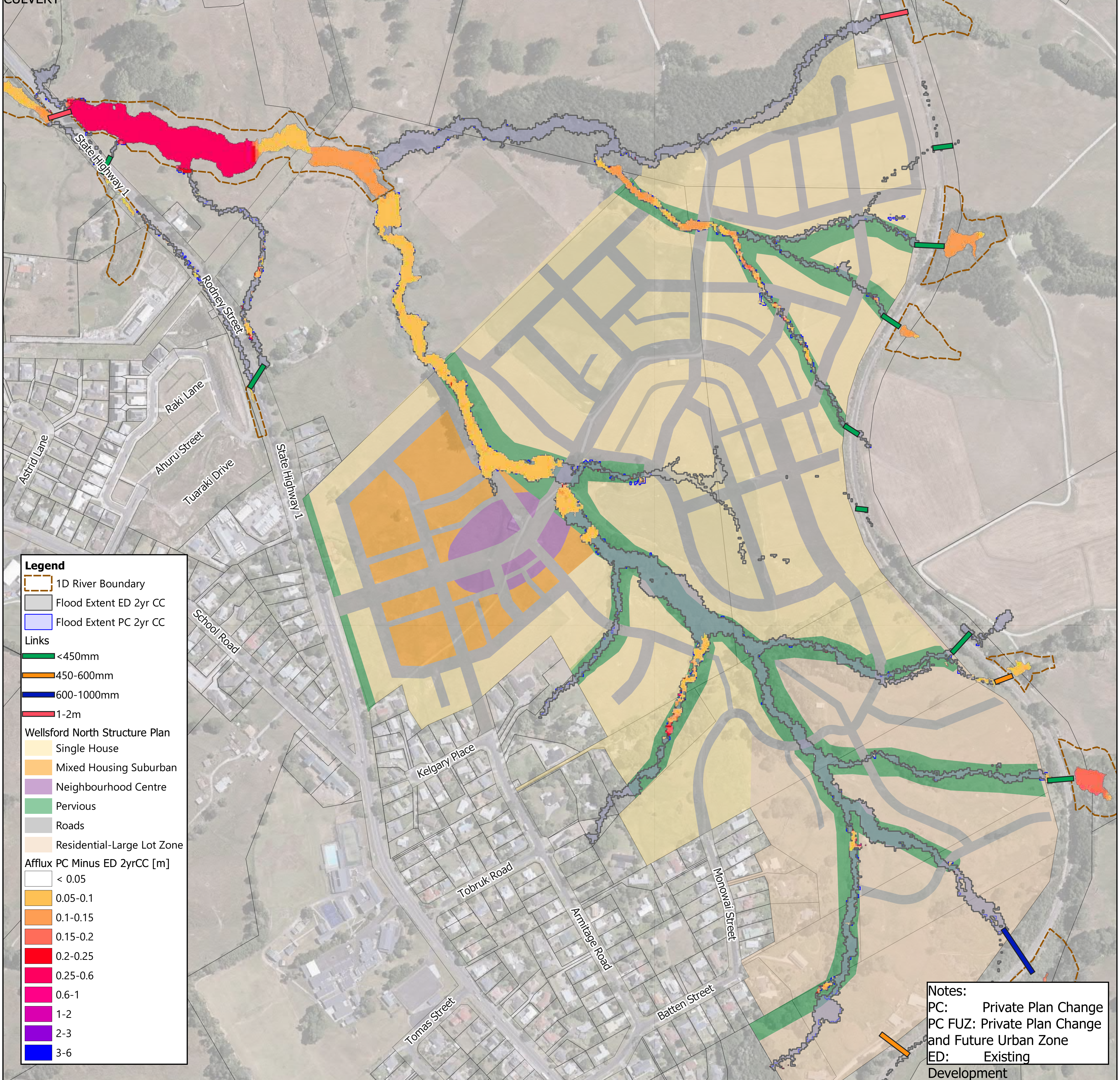
PLAN VIEW DOWNSTREAM SH1 CULVERT



PLAN VIEW UPSTREAM SH1 CULVERT



Notes:
PC: Private Plan Change
PC FUZ: Private Plan Change and Future Urban Zone
ED: Existing Development

REVISION DETAILS		INT	DATE		
1.0	FOR INFORMATION	PW	30/05/2023	SURVEYED	-
-	-	-	-	DESIGNED	MH
-	-	-	-	DRAWN	HC
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139 Quay Street Auckland CBD
WOODS.CO.NZ
WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC 2yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-0007	

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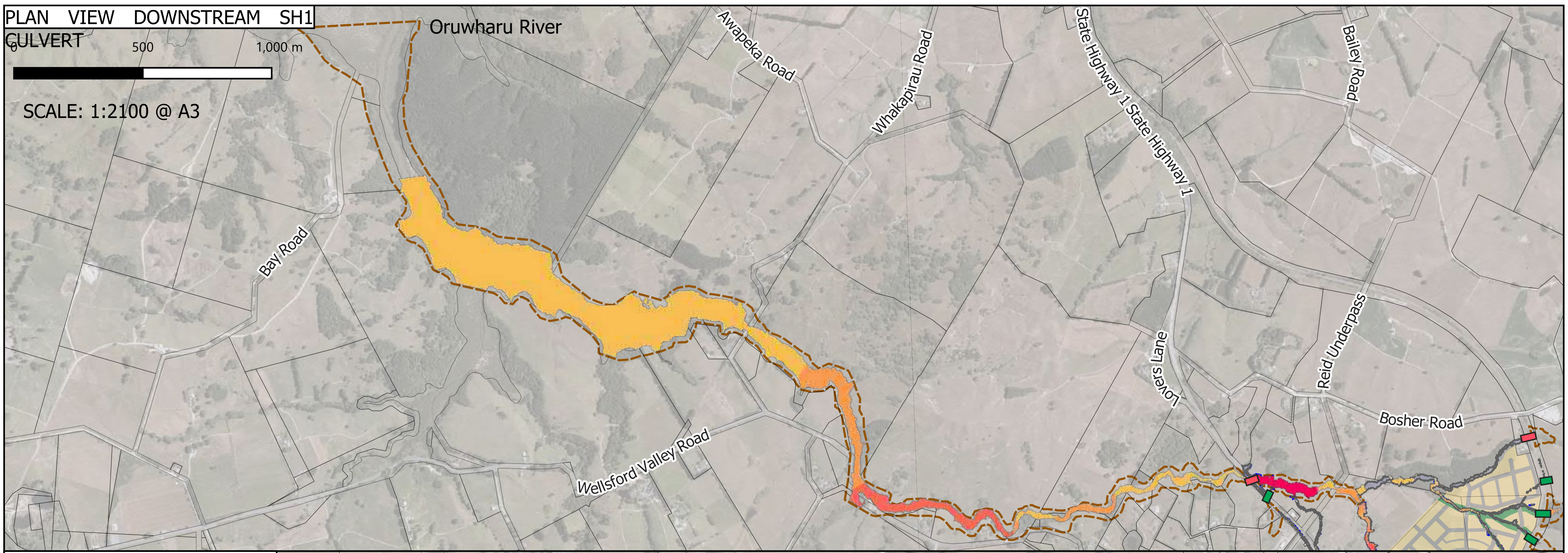

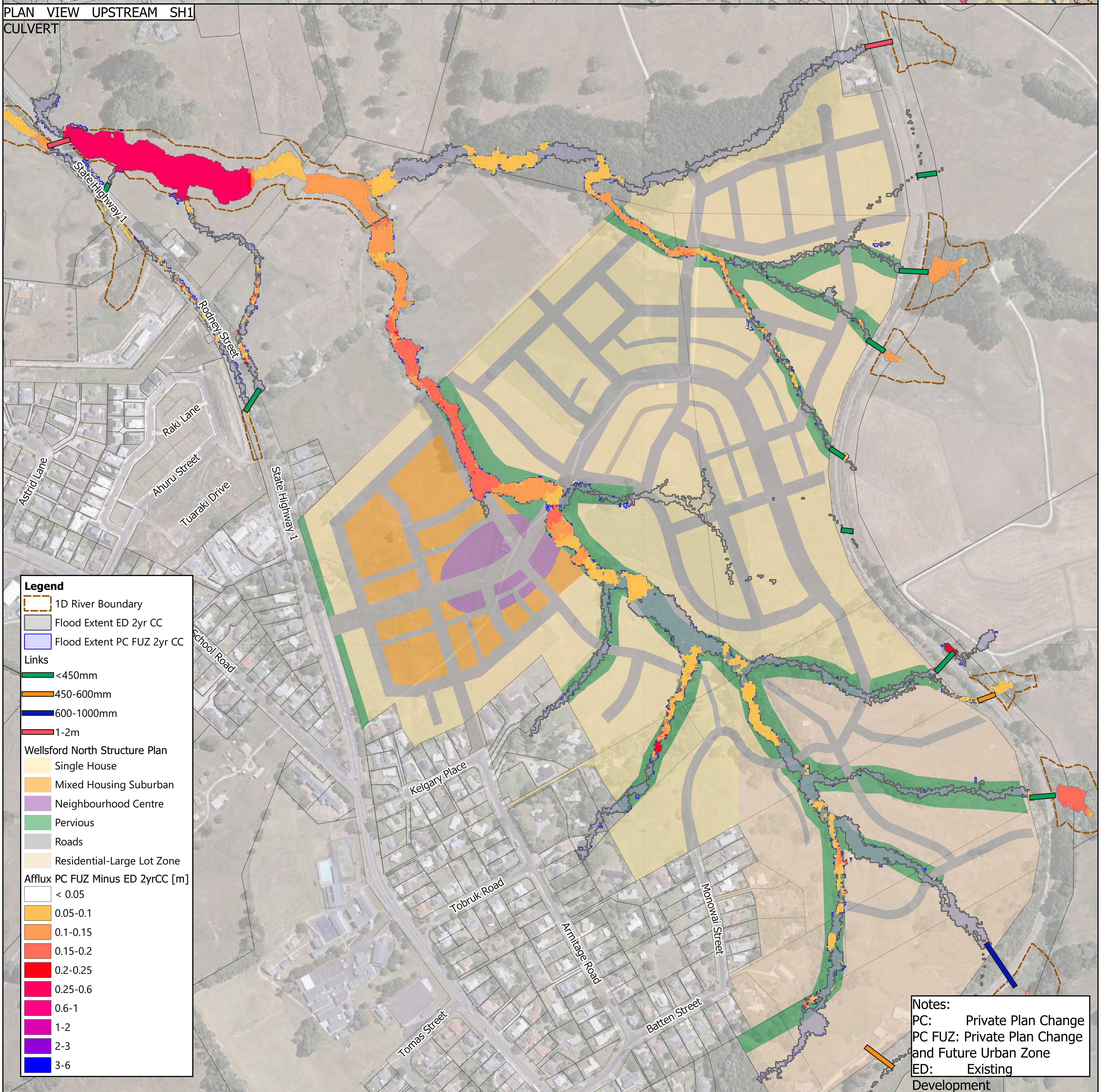

REVISION DETAILS	INT	DATE	SURVEYED	-
1.0 FOR INFORMATION	PW	30/05/2023	DESIGNED	MH
- -	-	-	DRAWN	HC
- -	-	-	CHECKED	TW
- -	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC FUZ 2yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-0008	

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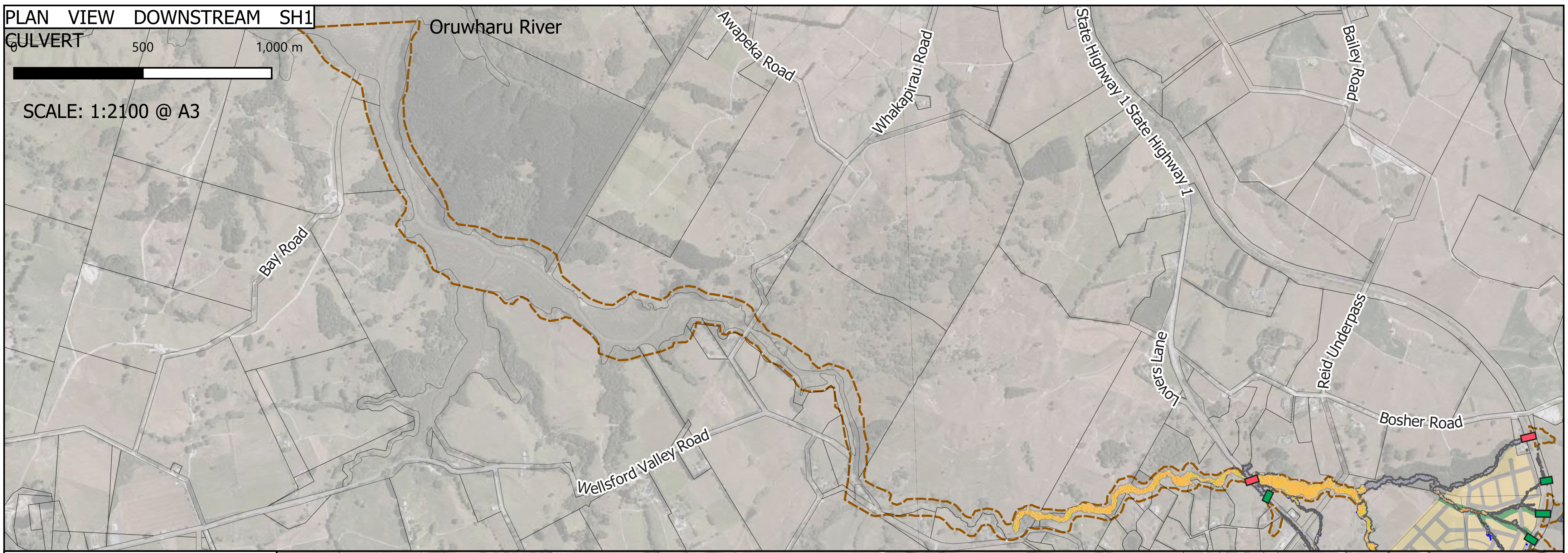
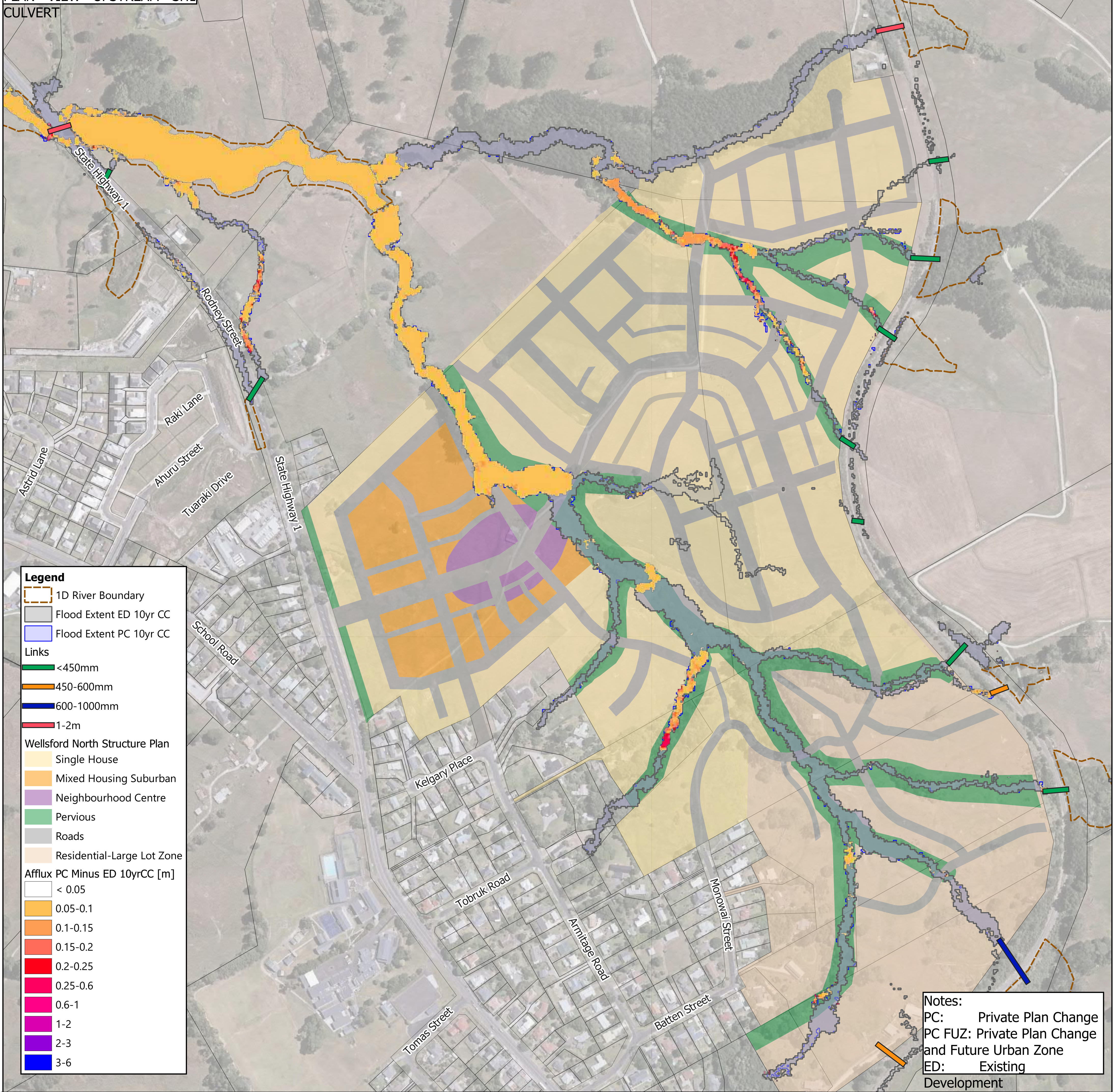
PLAN VIEW DOWNSTREAM SH1 CULVERT



PLAN VIEW UPSTREAM SH1 CULVERT



Notes:
PC: Private Plan Change
PC FUZ: Private Plan Change and Future Urban Zone
ED: Existing Development

REVISION DETAILS		INT	DATE		
				SURVEYED	-
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH
-	-	-	-	DRAWN	HC
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139 Quay Street Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC 10yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
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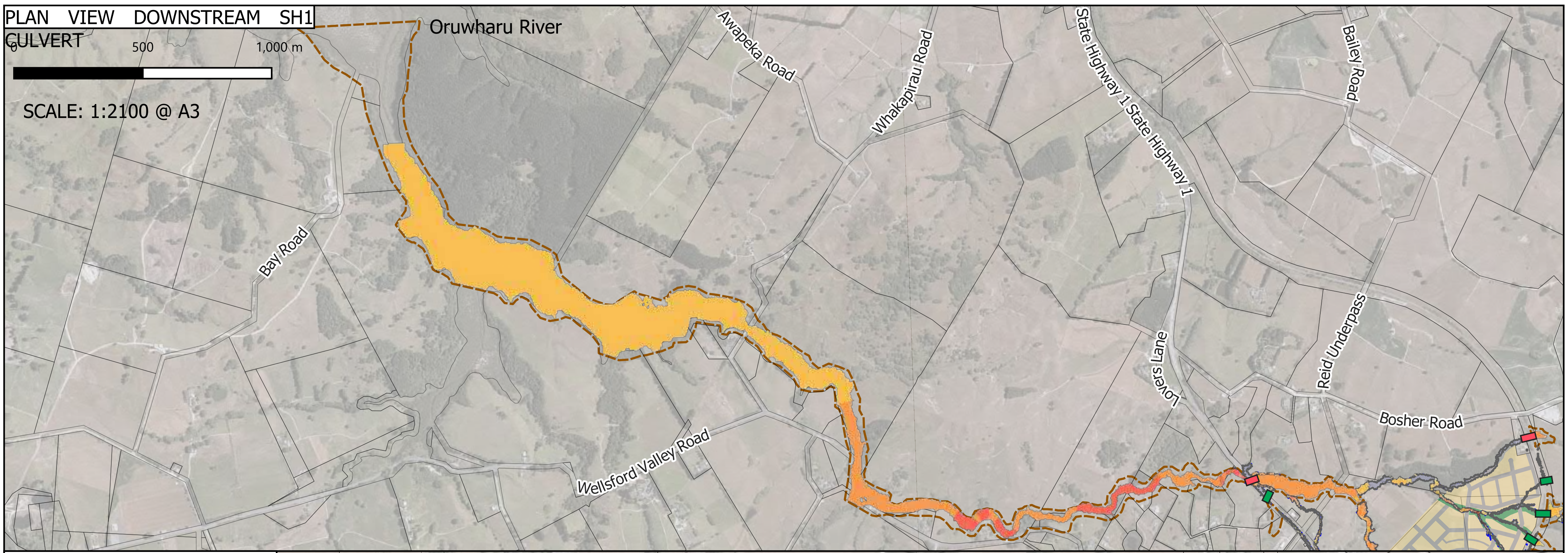

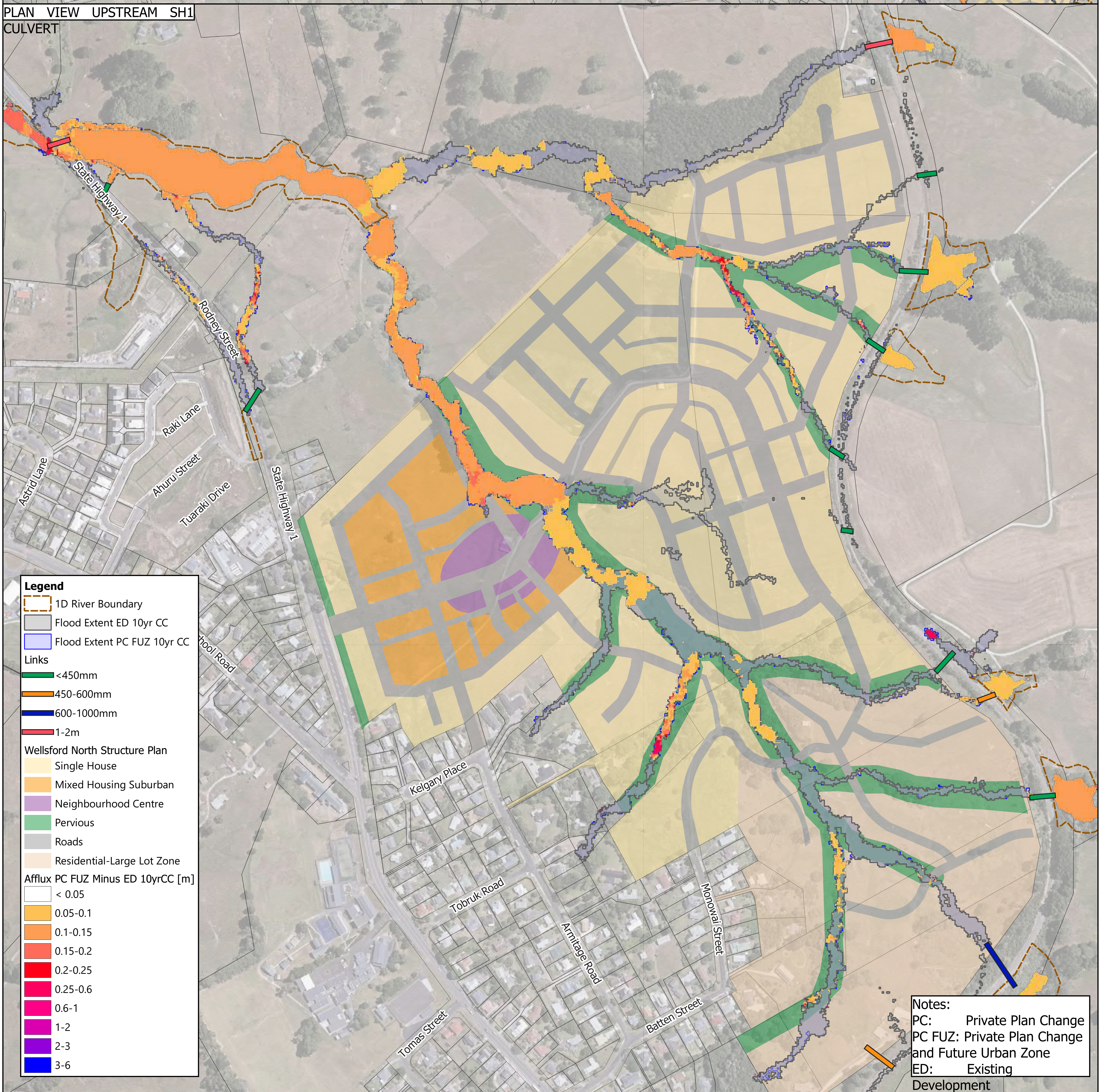

REVISION DETAILS		INT	DATE	SURVEYED	-	
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-	-	-	-	CHECKED	TW	
-	-	-	-	APPROVED	-	

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC FUZ 10yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
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COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-00010	

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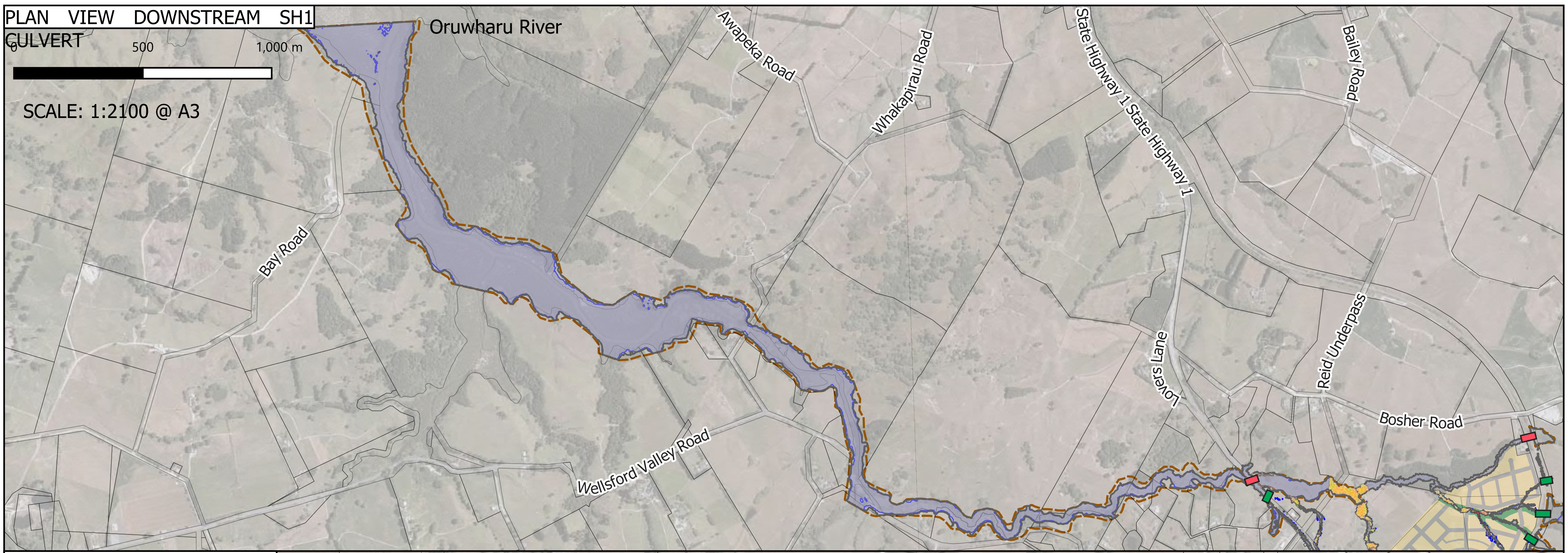
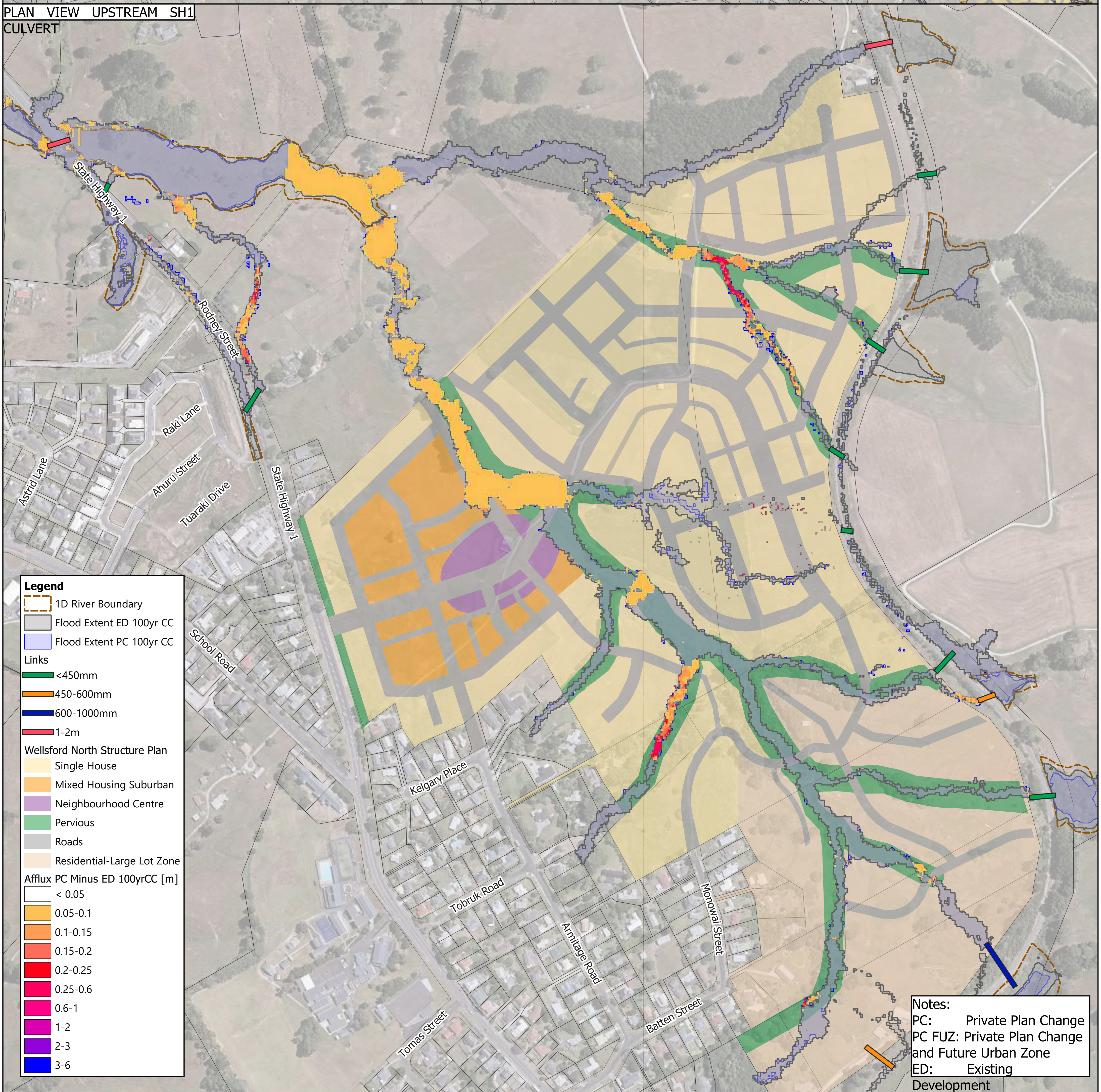


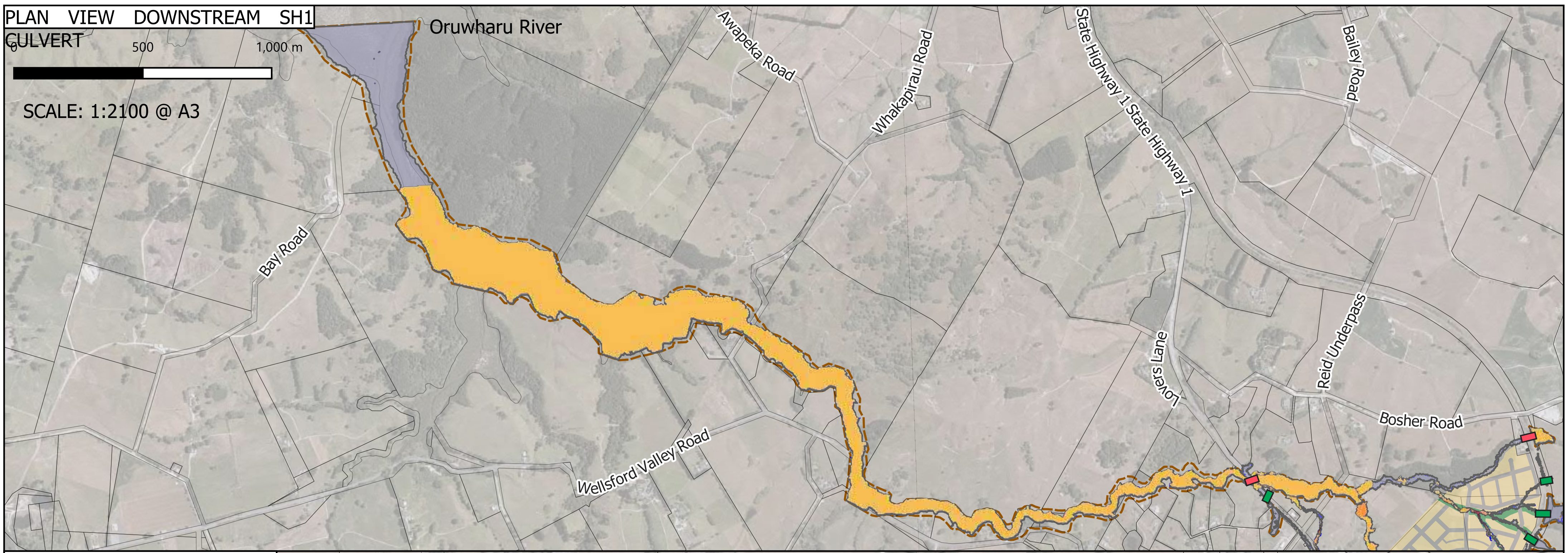


REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Afflux Plot - ED Vs PC 100yr CC (SWCoPv3-3.8°c)	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	HC			COUNCIL	AUCKLAND COUNCIL	
-	-	-	-	CHECKED	TW					
-	-	-	-	APPROVED	-	WOODS.CO.NZ		DWG NO.	P21-395-SKT-00011	

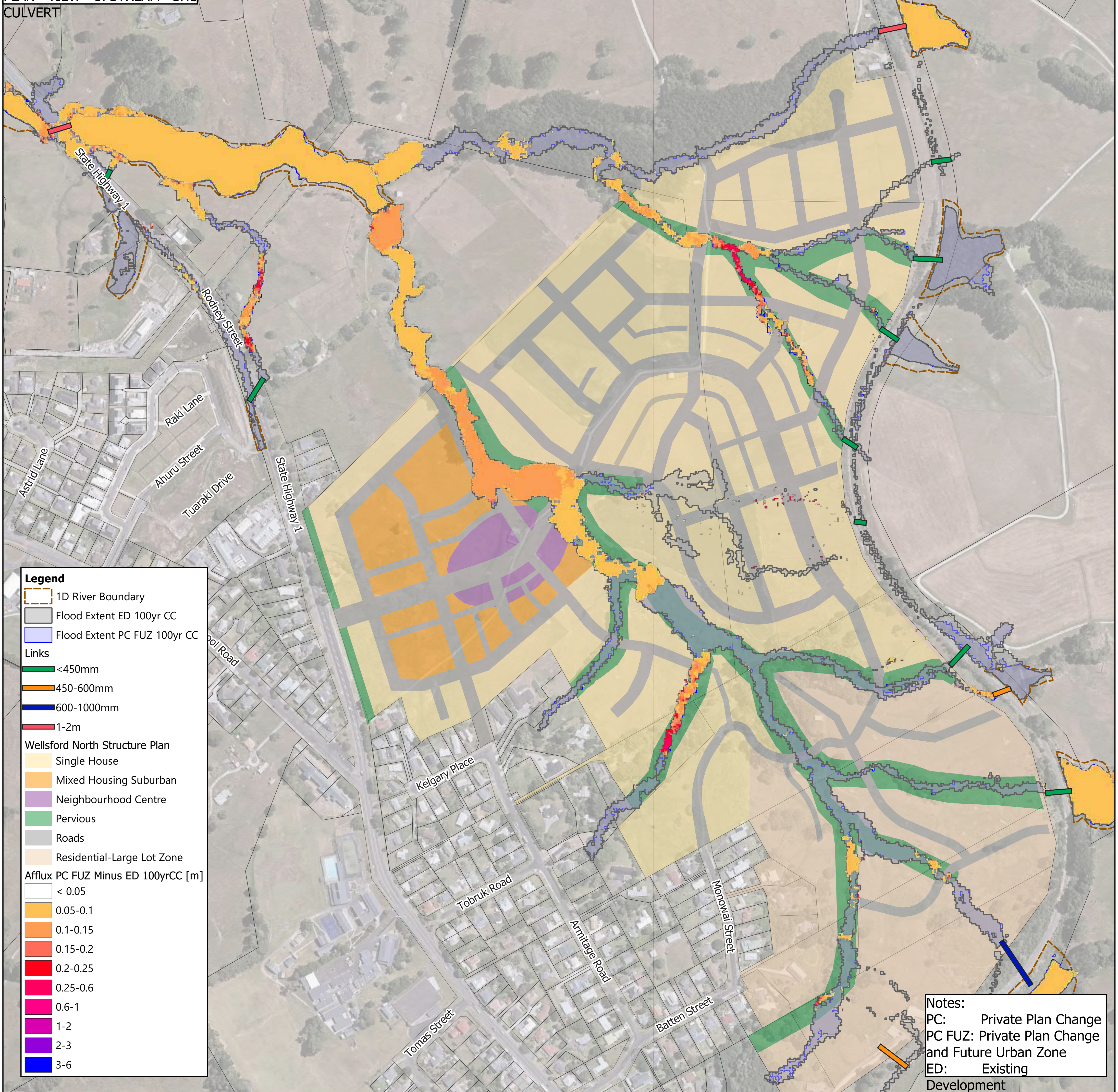
WOODS Est.1970

This drawing was generated from QGISX:\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz

PLAN VIEW DOWNSTREAM SH1 CULVERT



PLAN VIEW UPSTREAM SH1 CULVERT



REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Afflux Plot - ED Vs PC FUZ 100yr CC (SWCoPv3-3.8°c)	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	HC			COUNCIL	AUCKLAND COUNCIL	
-	-	-	-	CHECKED	TW	WOODS Est.1970				
-	-	-	-	APPROVED	-	WOODS.CO.NZ		DWG NO.	P21-395-SKT-00012	

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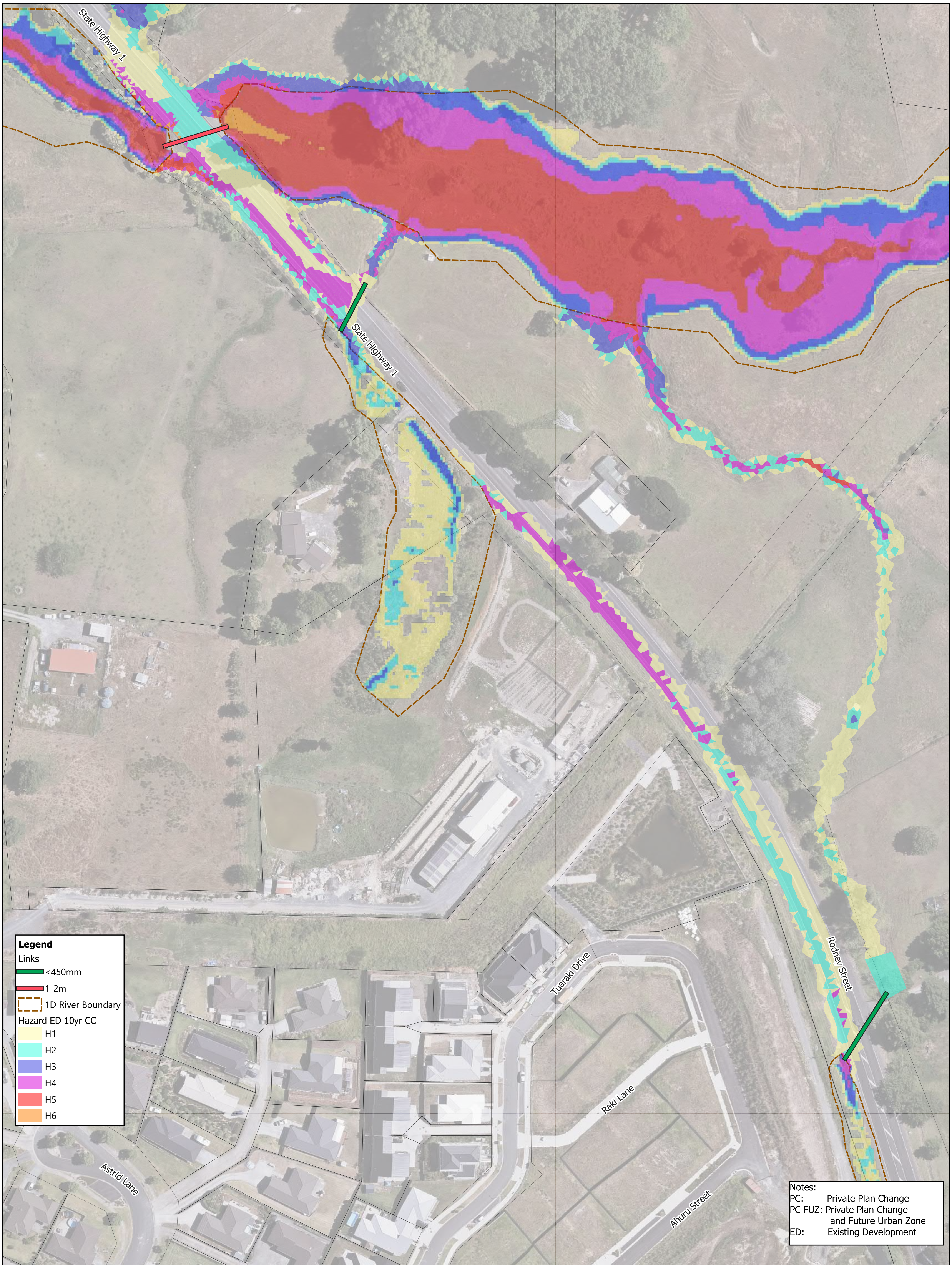

REVISION DETAILS		INT	DATE	SURVEYED	-			STATUS	ISSUED FOR INFORMATION	REV
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-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-2001	
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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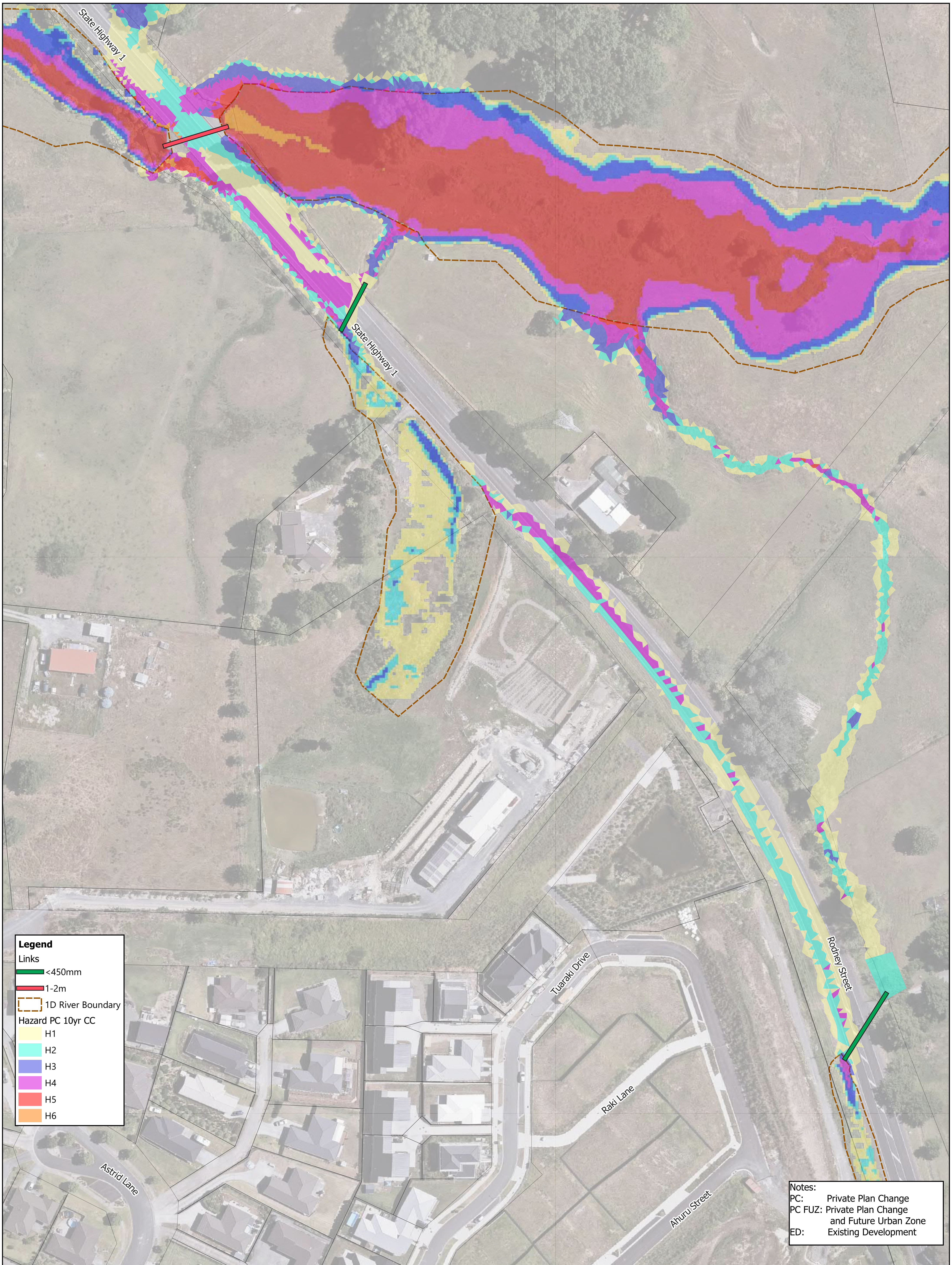

REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results ARR Hazard - PC 10yr CC (SWCoPv3-3.8°c)	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	05/12/2022	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	MH			COUNCIL	AUCKLAND COUNCIL	
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-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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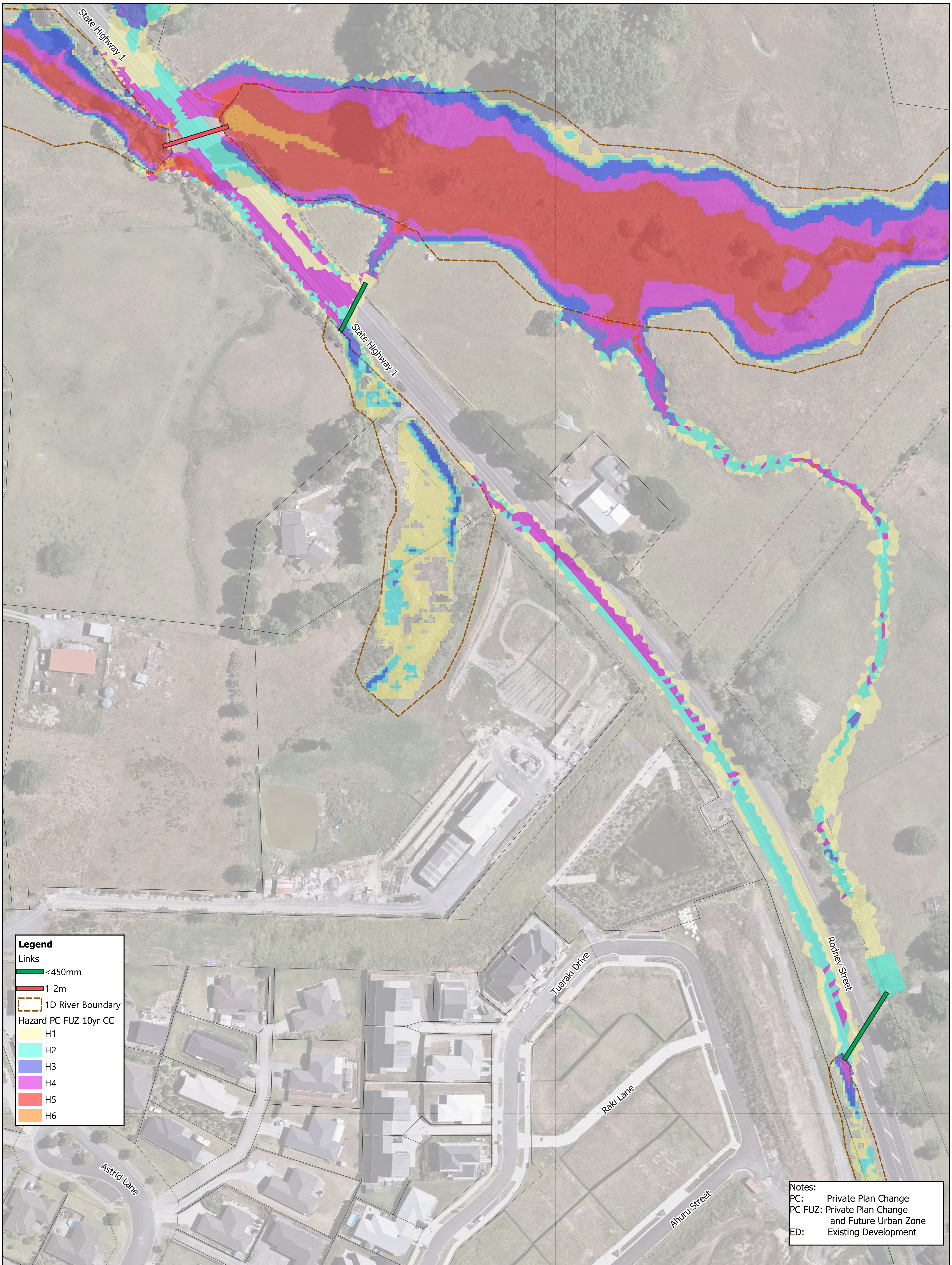

REVISION DETAILS		INT	DATE	SURVEYED	-
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-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
ARR Hazard - PC FUZ 10yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-2003	

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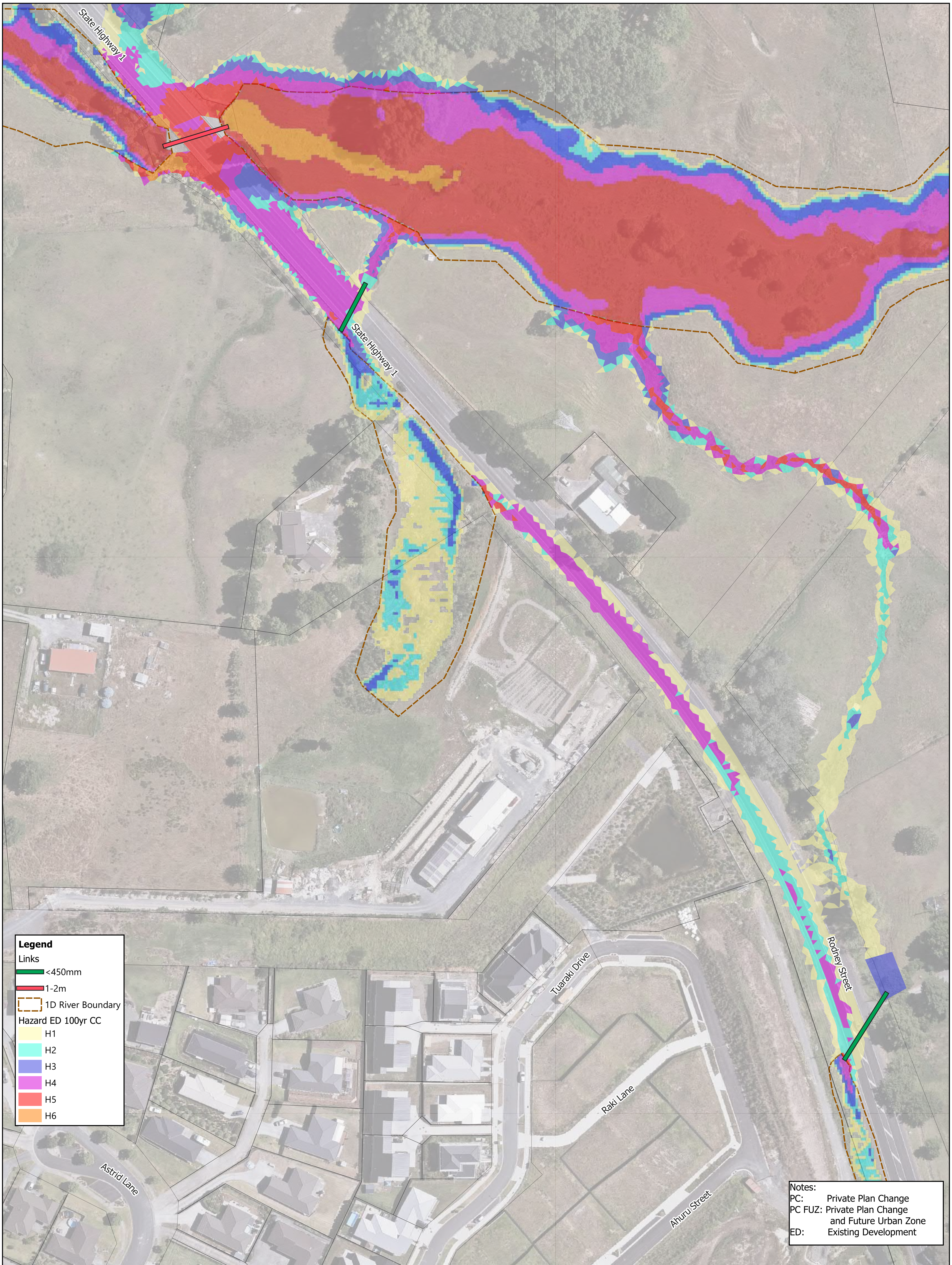

REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	WOODS Est.1970	Wellsford North Plan Change Stormwater Model Results ARR Hazard - ED 100yr CC (SWCoPv3-3.8°c)	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	05/12/2022	DESIGNED	MH				SCALE	1:5300 @ A3	1.0
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-	-	-	-	CHECKED	TW				DWG NO.	P21-395-SKT-2004	
-	-	-	-	APPROVED	-	WOODS.CO.NZ					

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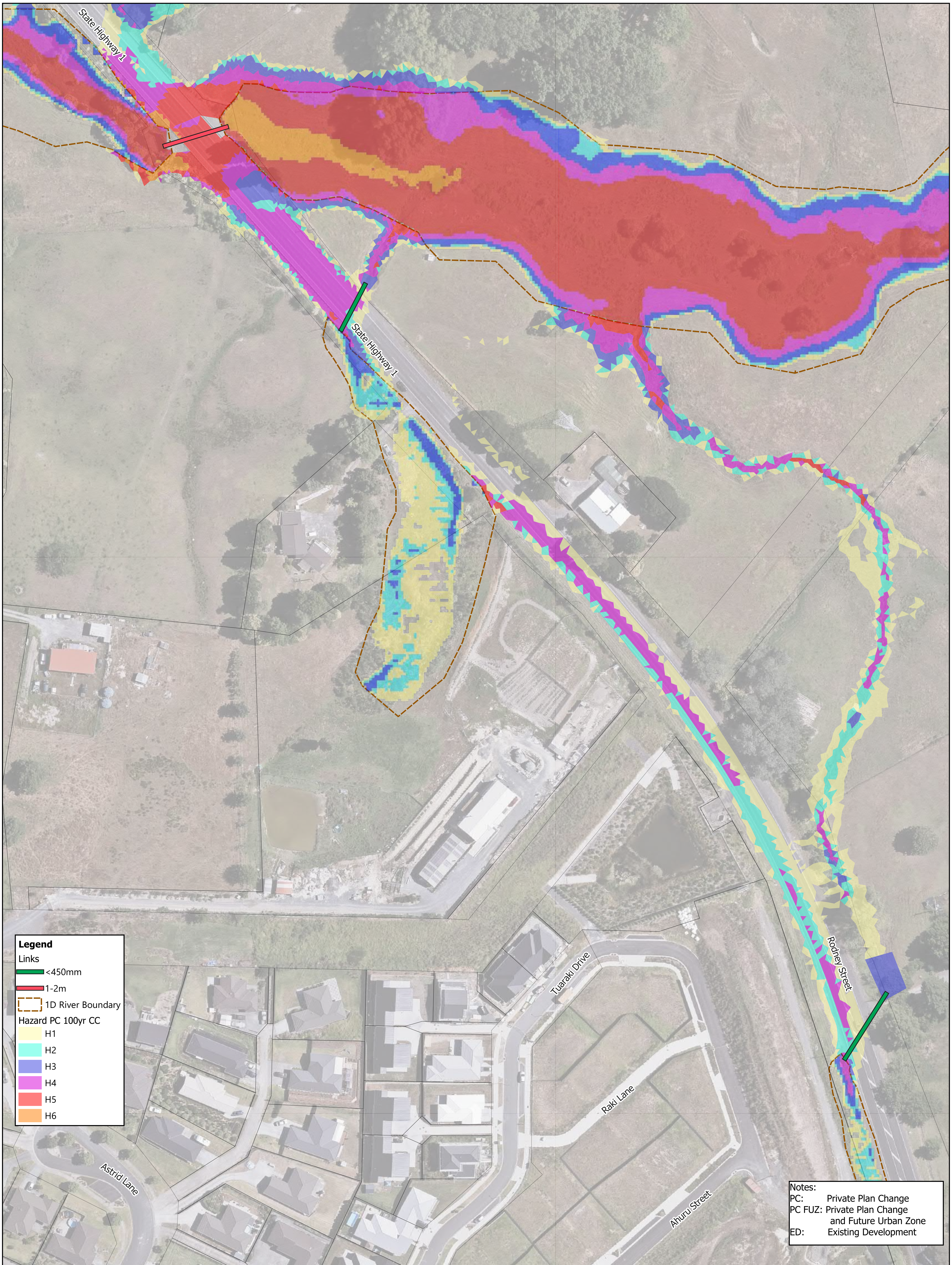

REVISION DETAILS		INT	DATE		
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-	-	-	-	DRAWN	MH
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
ARR Hazard - PC 100yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-2005	

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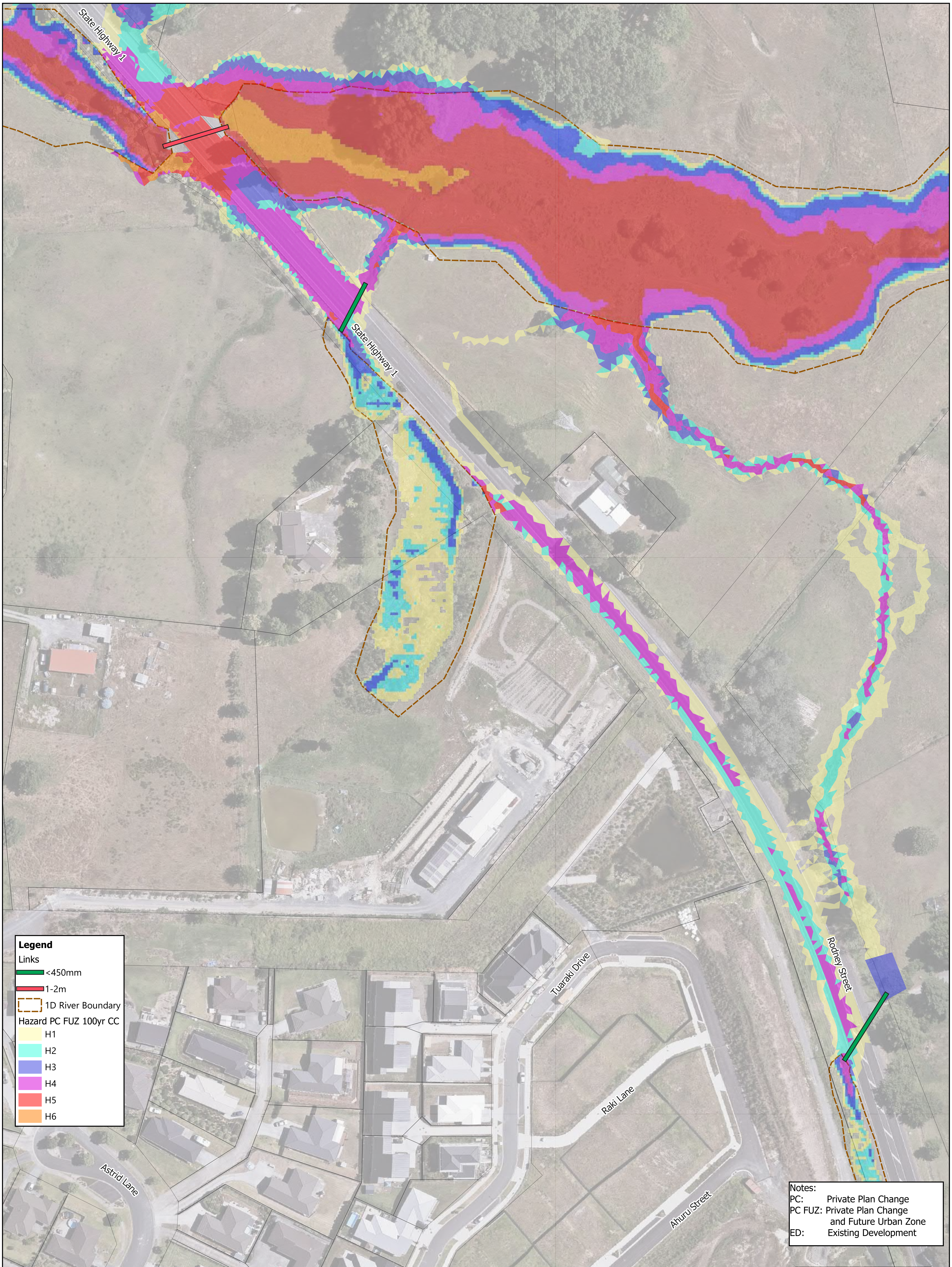


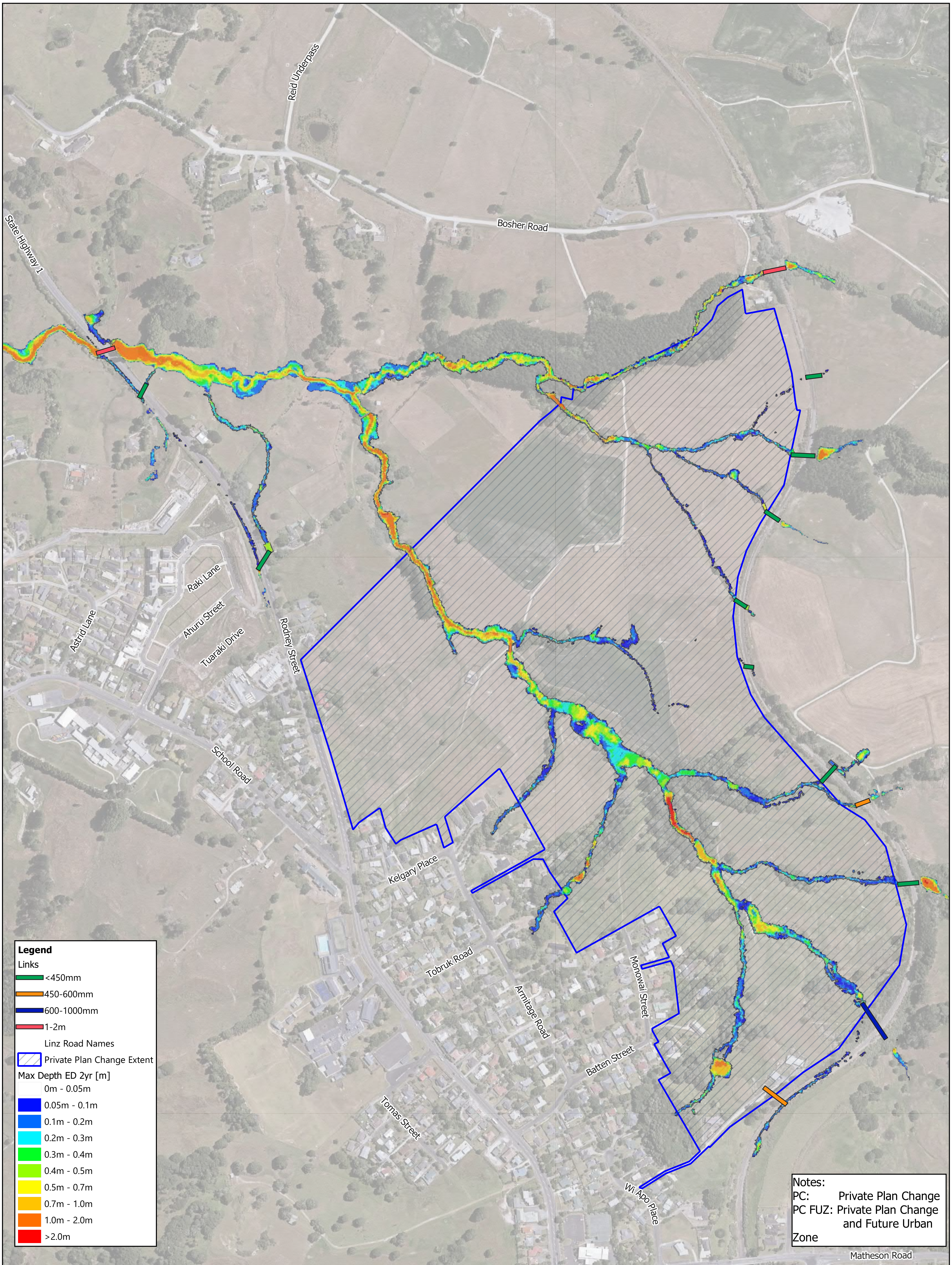
REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results ARR Hazard - PC FUZ 100yr CC (SWCoPv3-3.8°c)	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	05/12/2022	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	MH			COUNCIL	AUCKLAND COUNCIL	
-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-2006	
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

This drawing was generated from QGIS\\wapco.local\dfs\Stormwater\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz

Appendix E

Model Results



REVISION DETAILS	INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Max. Water Depth [m]. ED 2yr No CC	STATUS	ISSUED FOR INFORMATION	REV
1.0 FOR INFORMATION	PW	2/06/2023	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
- -	-	-	DRAWN	HC			COUNCIL	AUCKLAND COUNCIL	
- -	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-1001	
- -	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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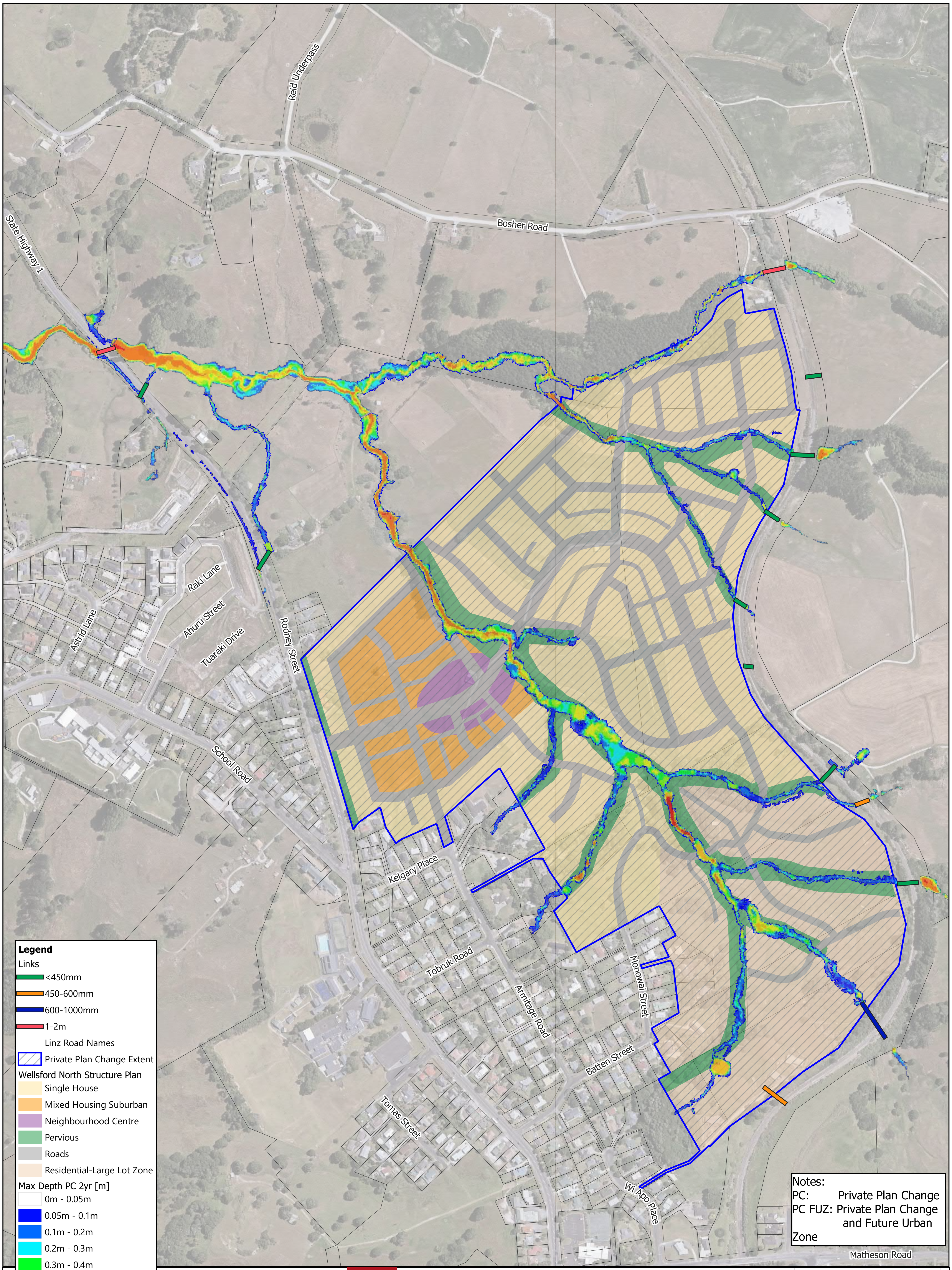
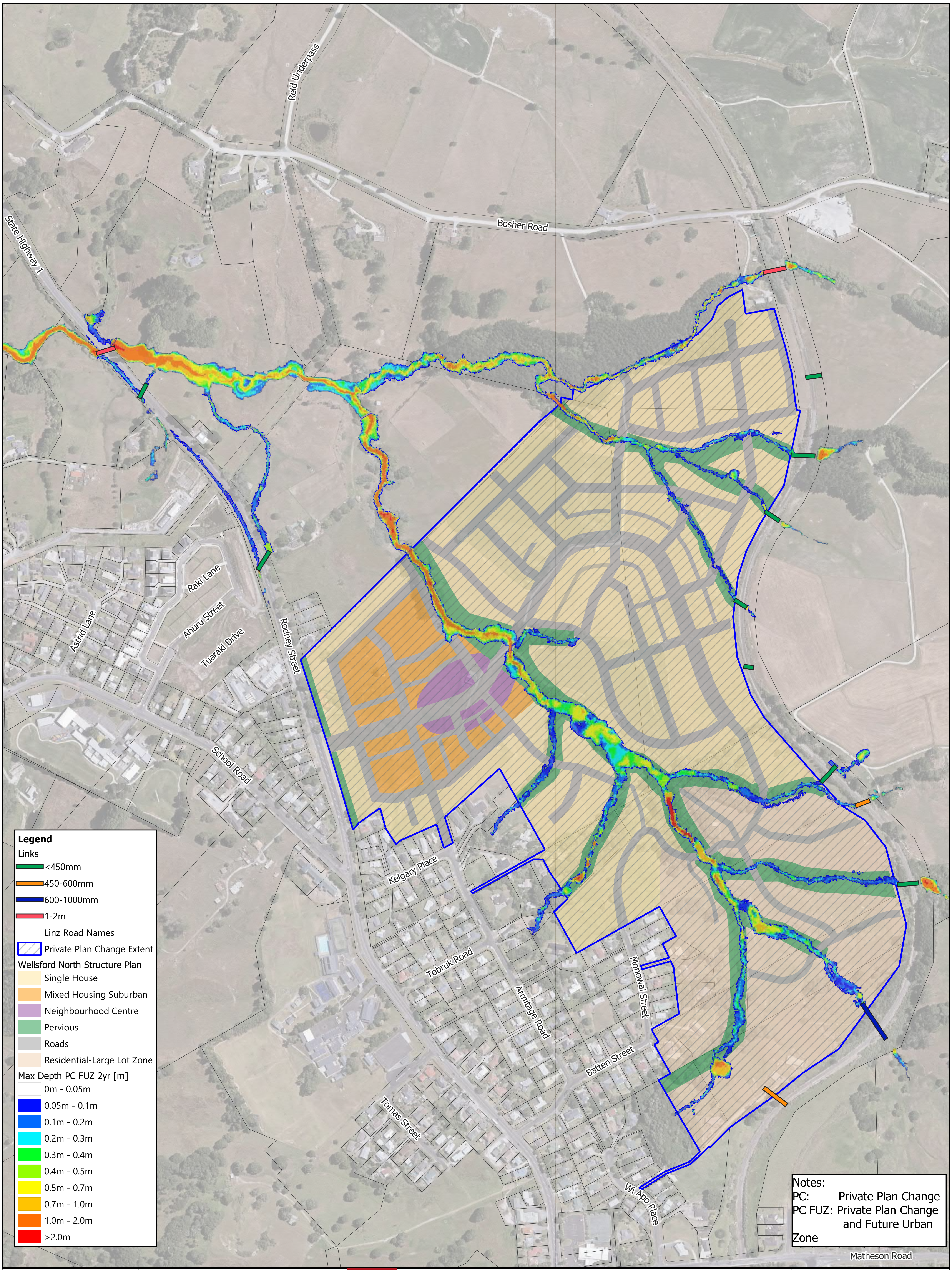


R		DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	WOODS Est.1970	Wellsford North Plan Change Stormwater Model Results Max. Water Depth [m]. PC 2yr No CC	STATUS	ISSUED FOR INFORMATION	REV
1.0		06/2023	DESIGNED	MH				SCALE	1:5300 @ A3	1.0
-		-	DRAWN	HC				COUNCIL	AUCKLAND COUNCIL	
-		-	CHECKED	TW				DWG NO.	P21-395-SKT-1002	
-		-	APPROVED	-	WOODS.CO.NZ					

GIS\\wapco.local\dfs\Stormwater\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz



REVISION DETAILS		INT	DATE	SURVEYED	-			STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	2/06/2023	DESIGNED	MH	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Max. Water Depth [m]. PC FUZ 2yr No CC	SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	HC			COUNCIL	AUCKLAND COUNCIL	
-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-1003	
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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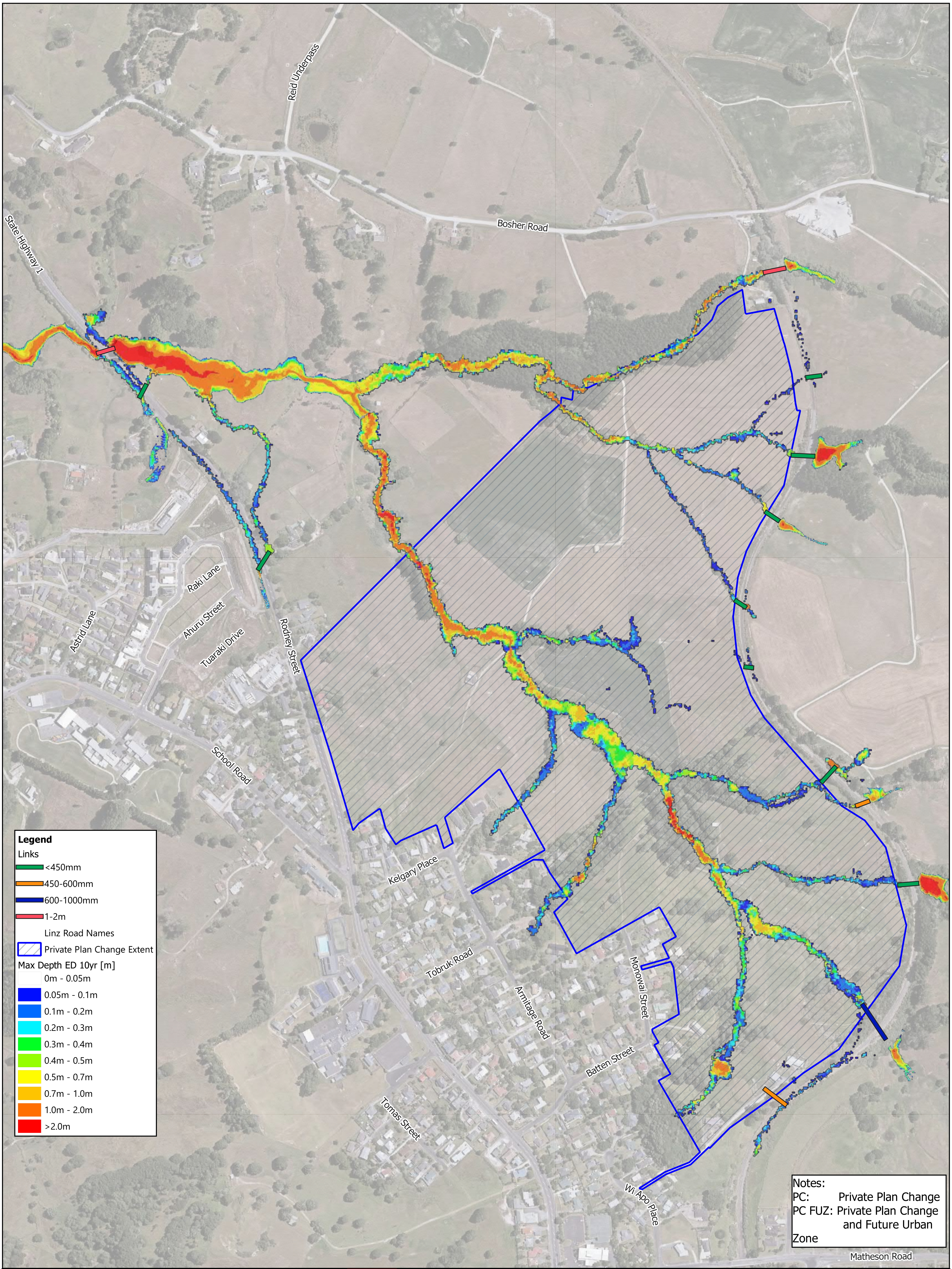
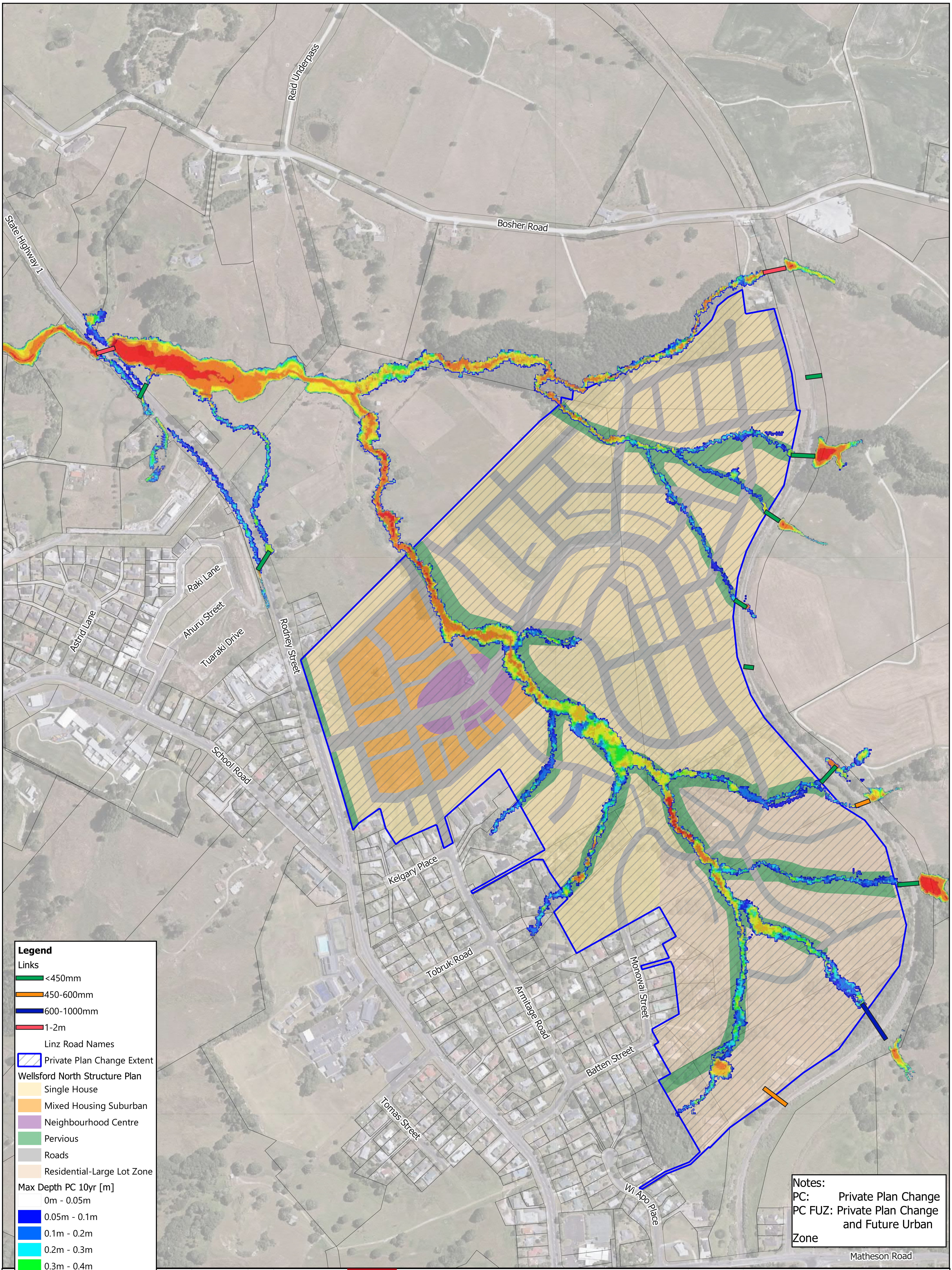


REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Max. Water Depth [m]. ED 10yr No CC	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	2/06/2023	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	HC			COUNCIL	AUCKLAND COUNCIL	
-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-1004	
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est. 1970

This drawing was generated from QGIS\\wapco.local\dfs\Stormwater\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz



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-	-	DRAWN	HC				COUNCIL	AUCKLAND COUNCIL
-	-	CHECKED	TW				DWG NO.	P21-395-SKT-1005
-	-	APPROVED	-	WOODS.CO.NZ				

REV 1.0

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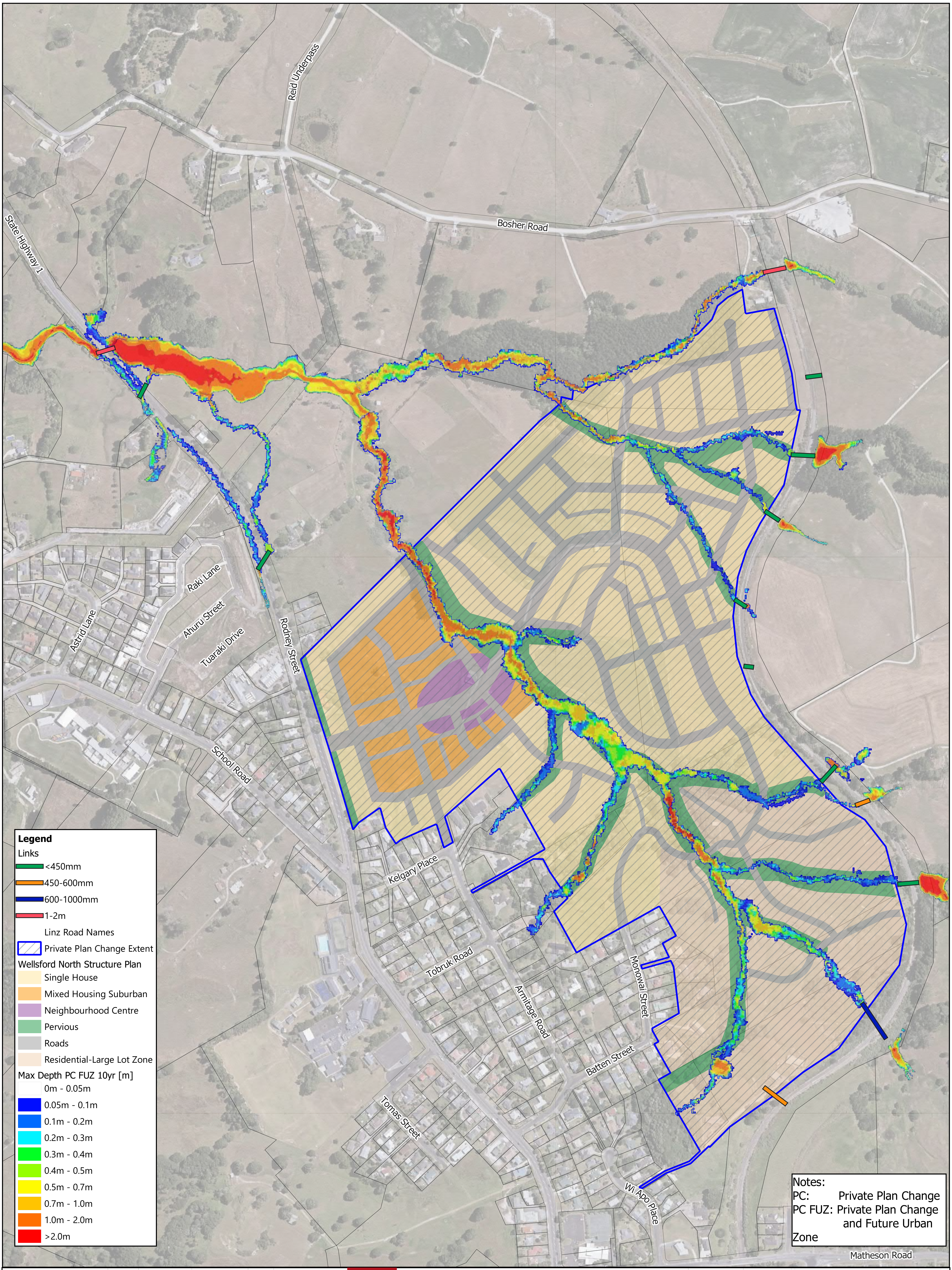

REVISION DETAILS	INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change	STATUS	ISSUED FOR INFORMATION	REV
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- -	-	-	DRAWN	HC		Max. Water Depth [m]. PC FUZ 10yr No CC	COUNCIL	AUCKLAND COUNCIL	
- -	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-1006	
- -	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est. 1970

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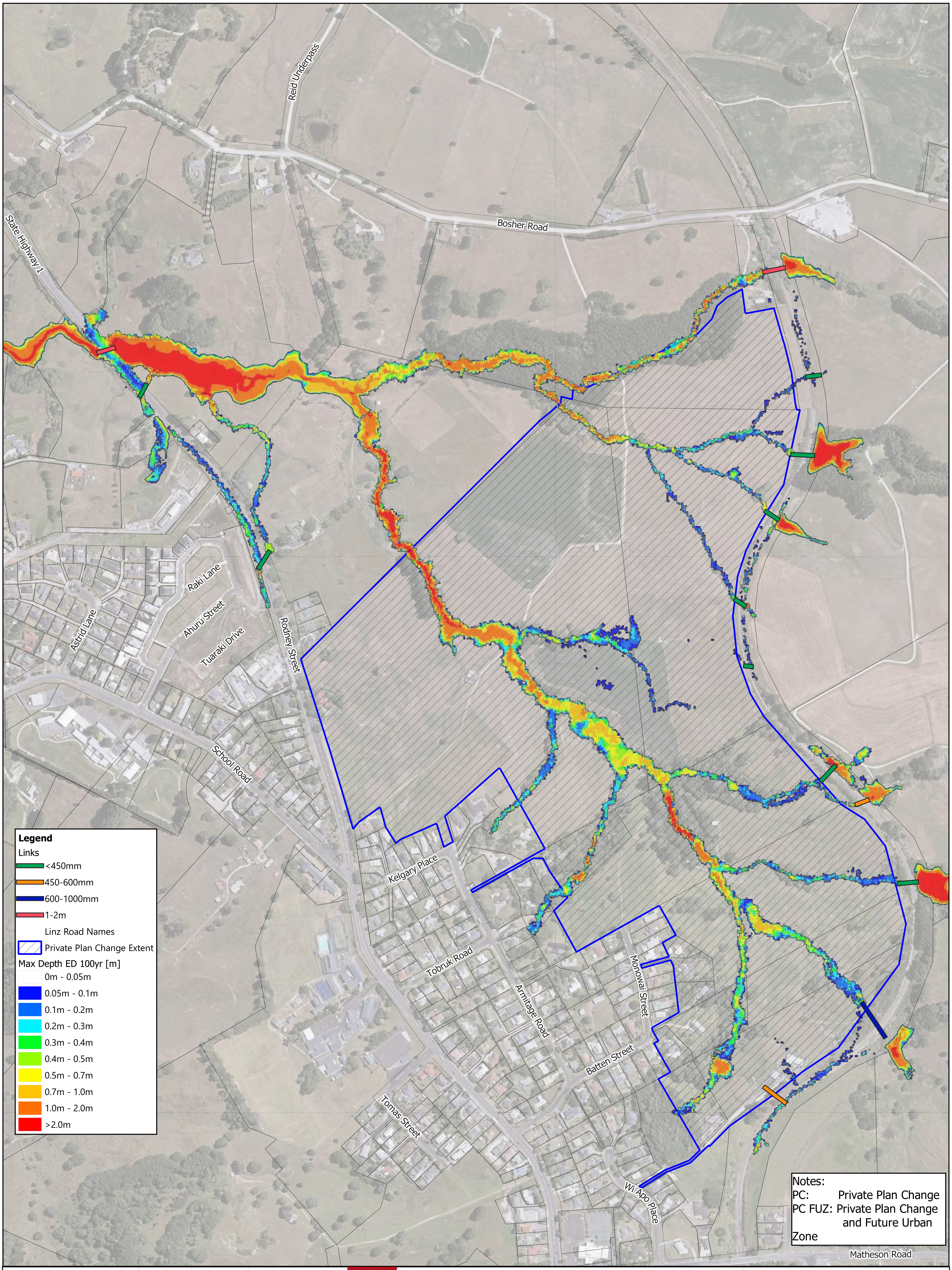

REVISION DETAILS		INT	DATE		
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-	-	-	-	DRAWN	HC
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Max. Water Depth [m]. ED 100yr No CC

STATUS	ISSUED FOR INFORMATION	REV
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COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-1007	

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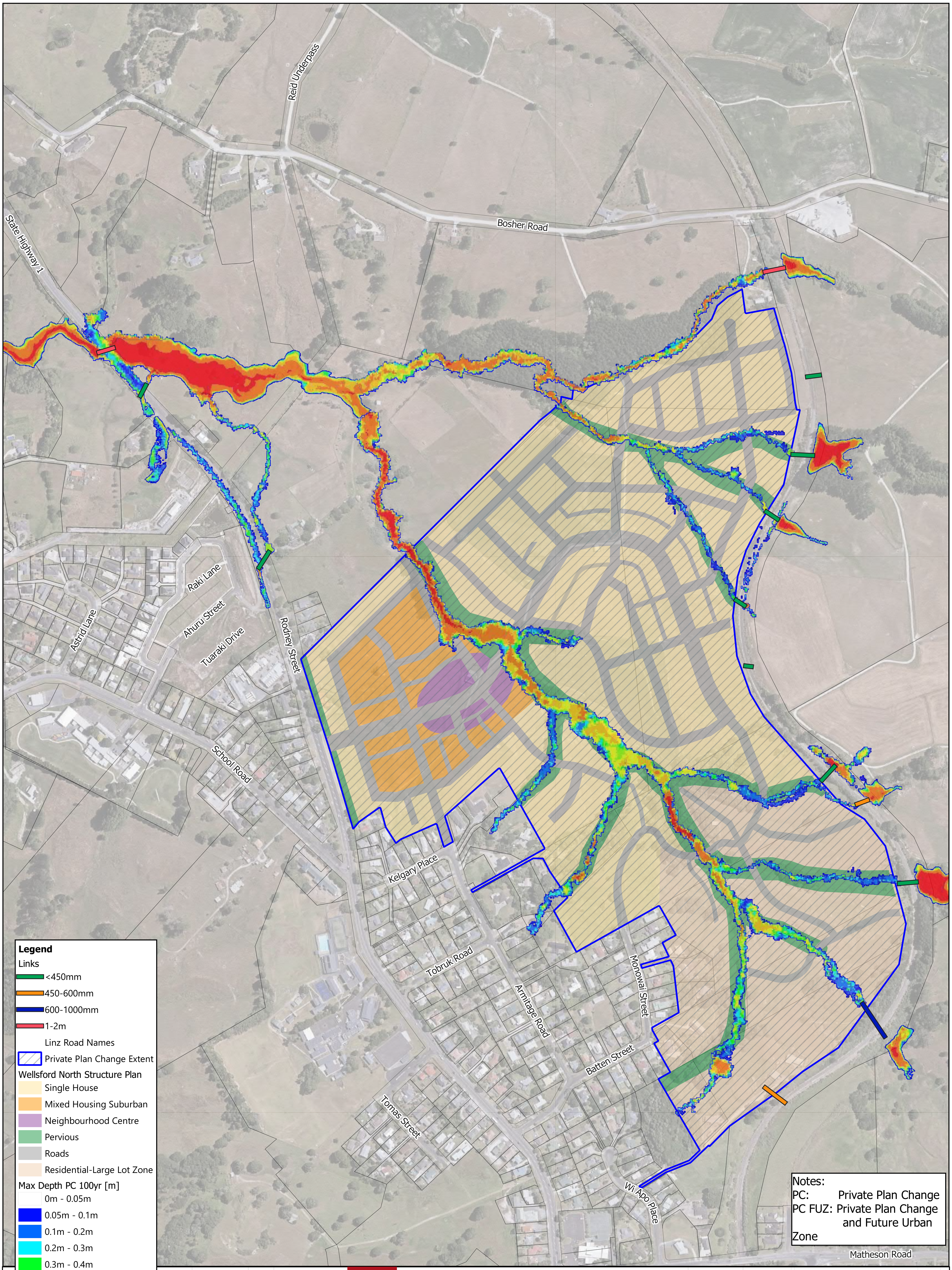

R	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	WOODS Est.1970	Wellsford North Plan Change Stormwater Model Results Max. Water Depth [m]. PC 100yr No CC	STATUS	ISSUED FOR INFORMATION	REV
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-	-	CHECKED	TW				DWG NO.	P21-395-SKT-1008	
-	-	APPROVED	-	WOODS.CO.NZ					

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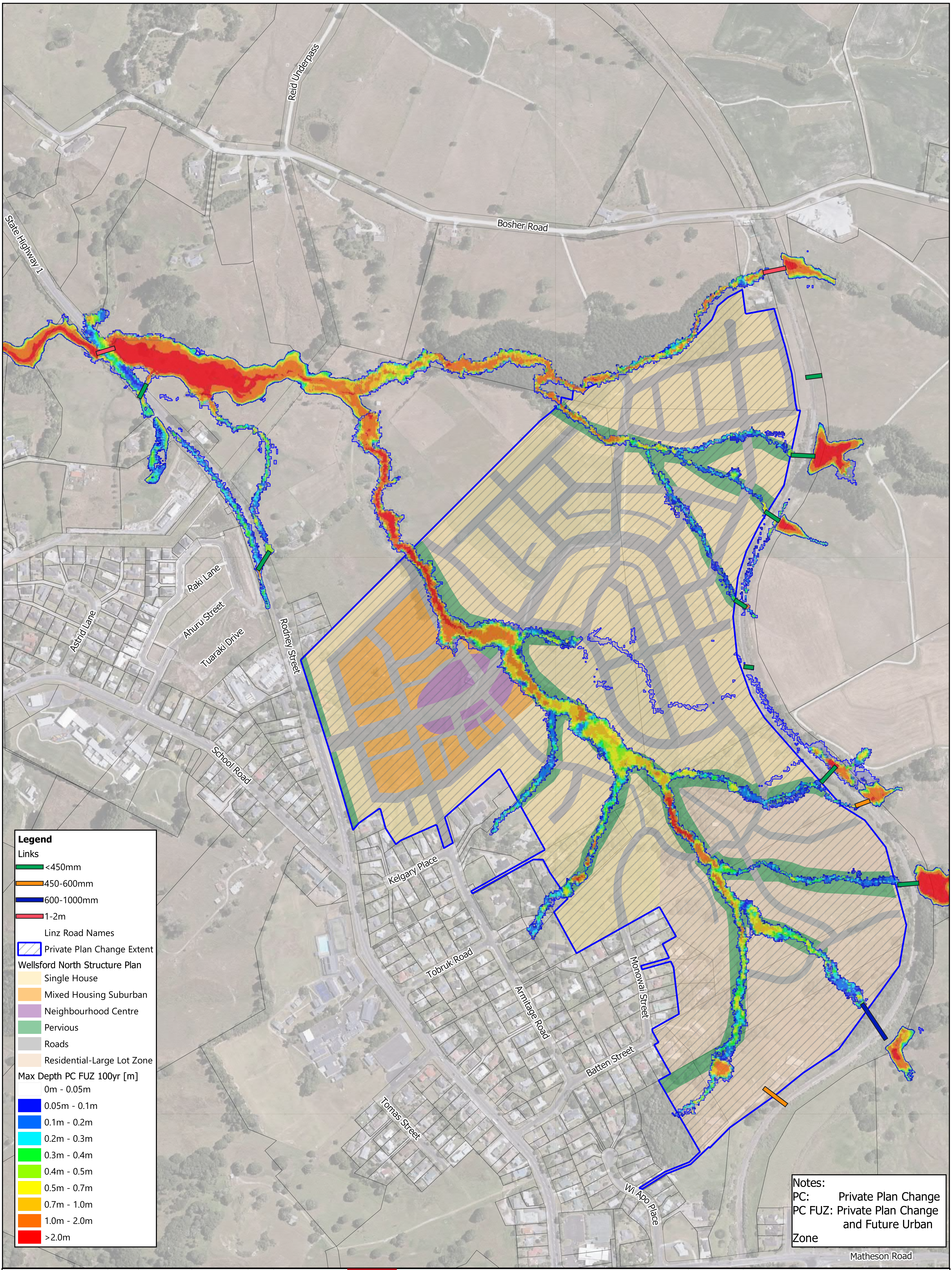

REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change	STATUS	ISSUED FOR INFORMATION	REV
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-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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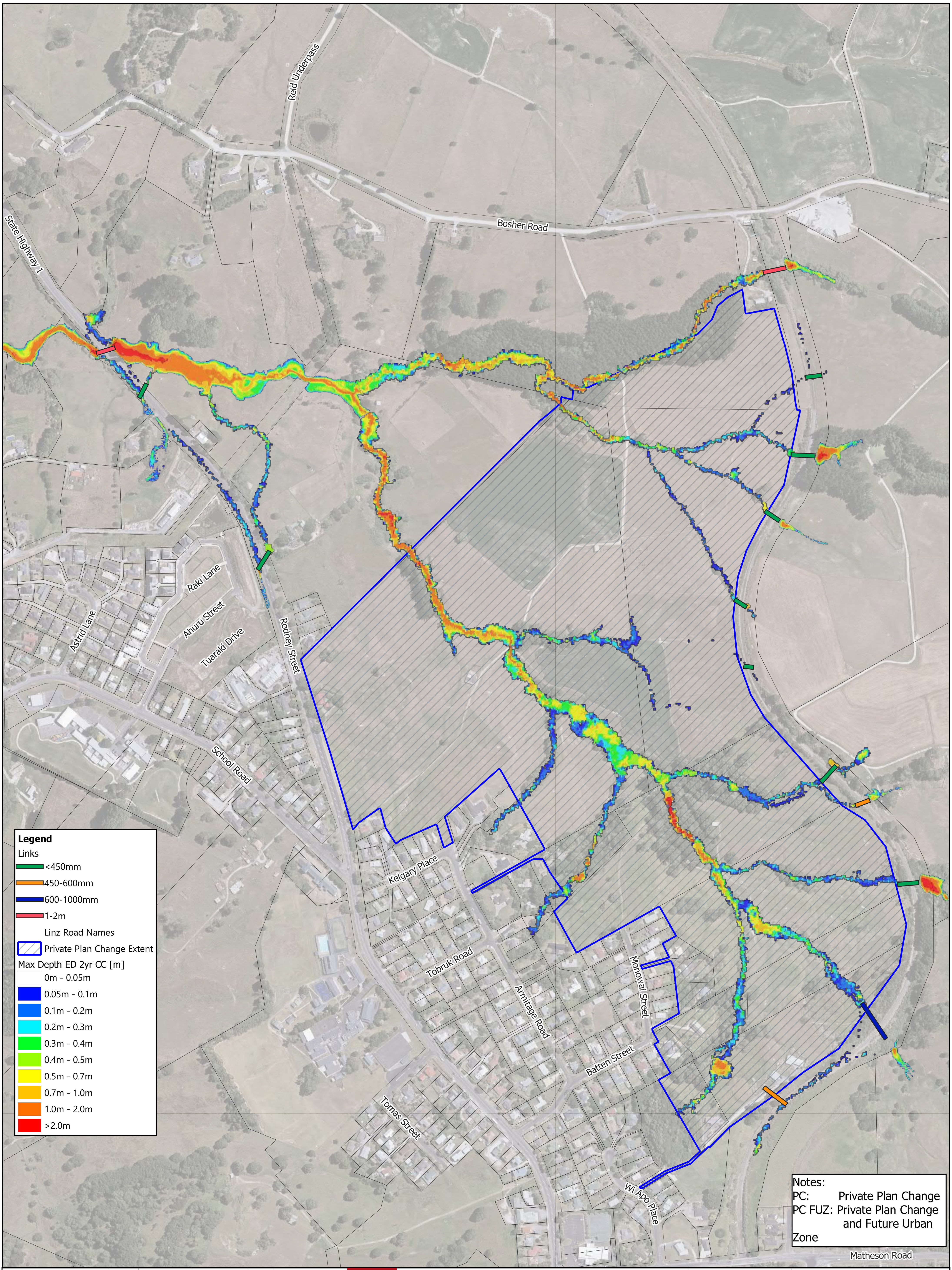

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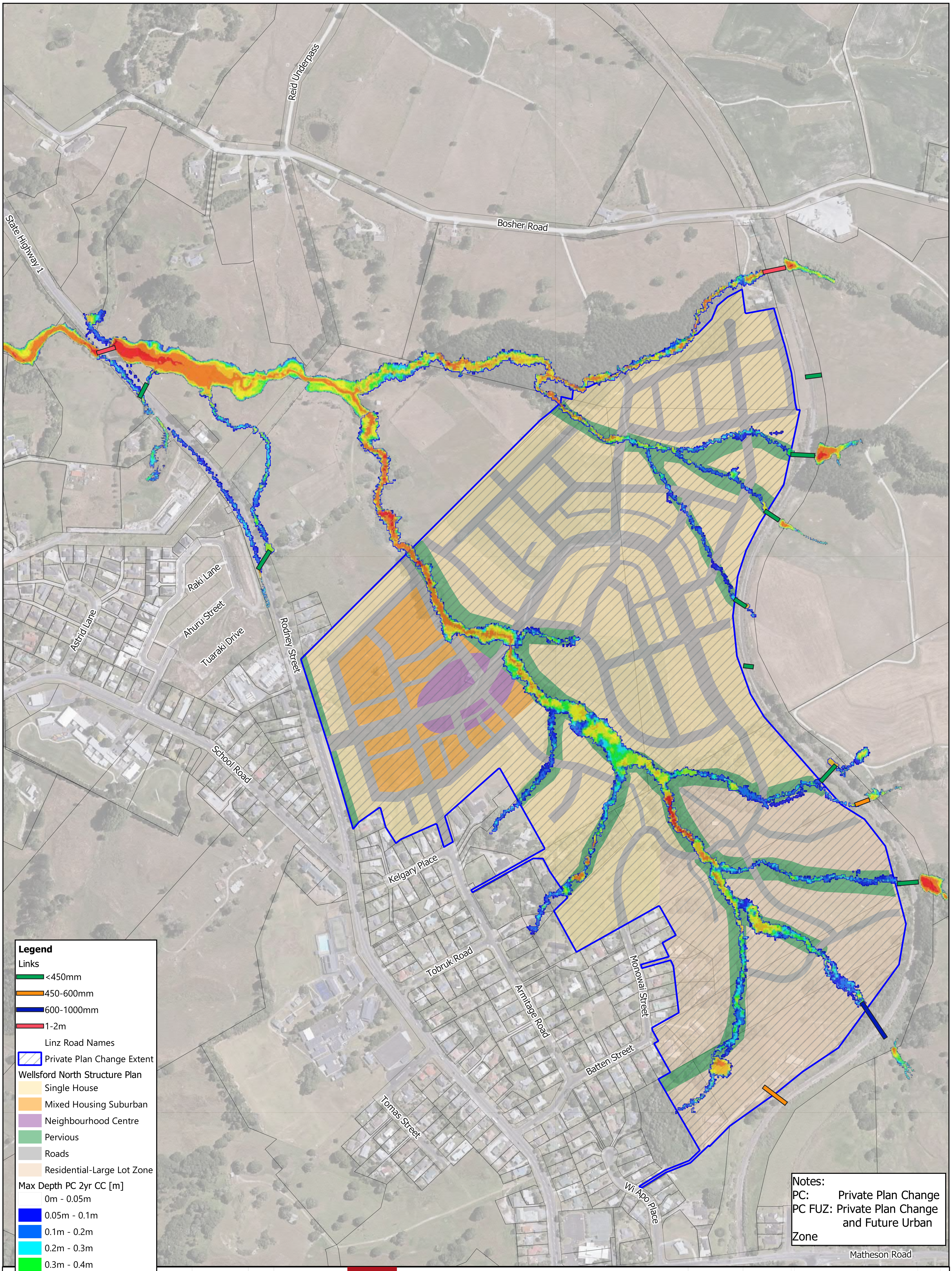

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-	-	APPROVED	-	WOODS.CO.NZ					

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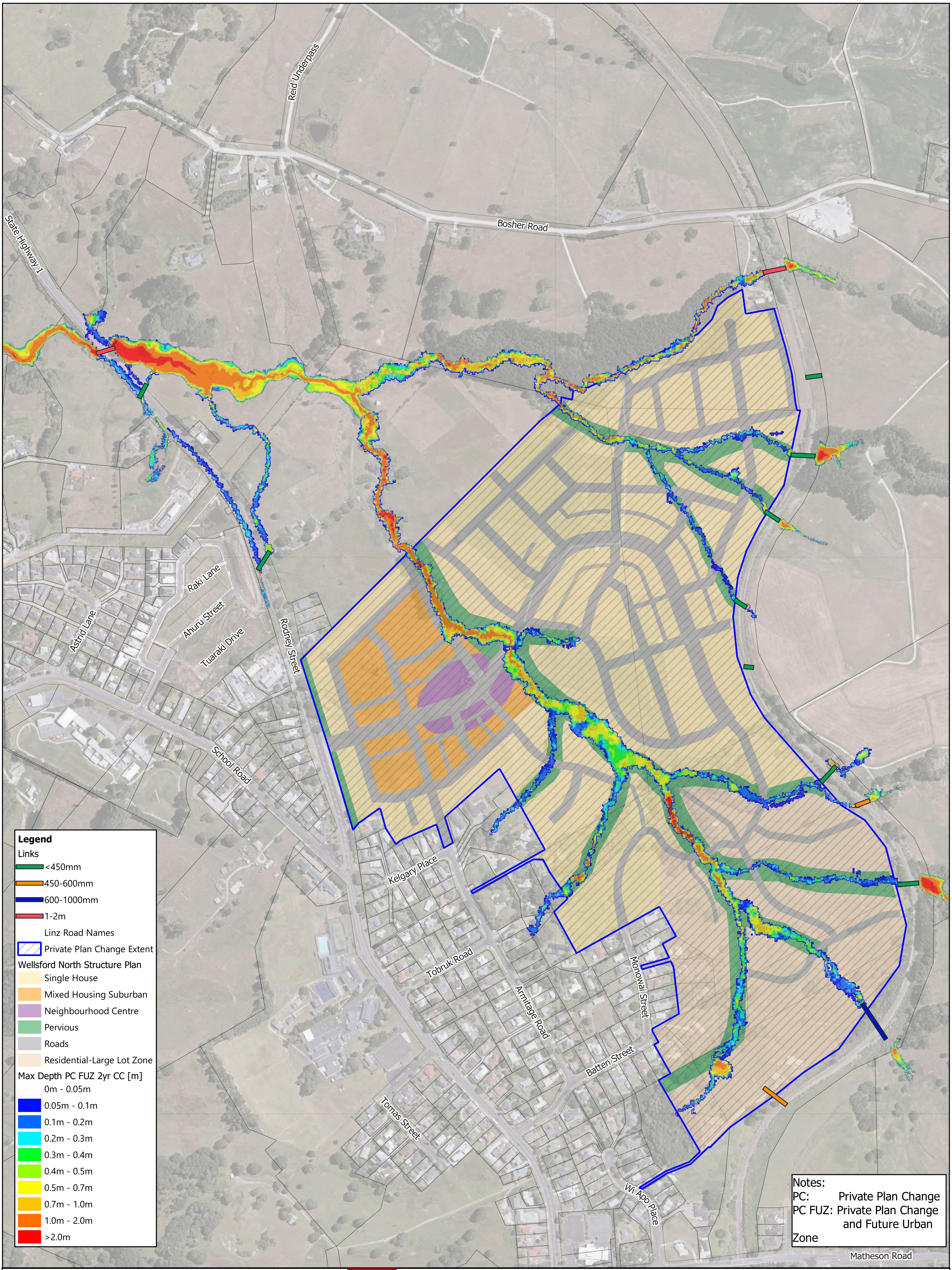

REVISION DETAILS	INT	DATE	SURVEYED	-
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- -	-	-	DRAWN	HC
- -	-	-	CHECKED	TW
- -	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Max. Water Depth [m]. PC FUZ 2yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
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DWG NO.	P21-395-SKT-10012	

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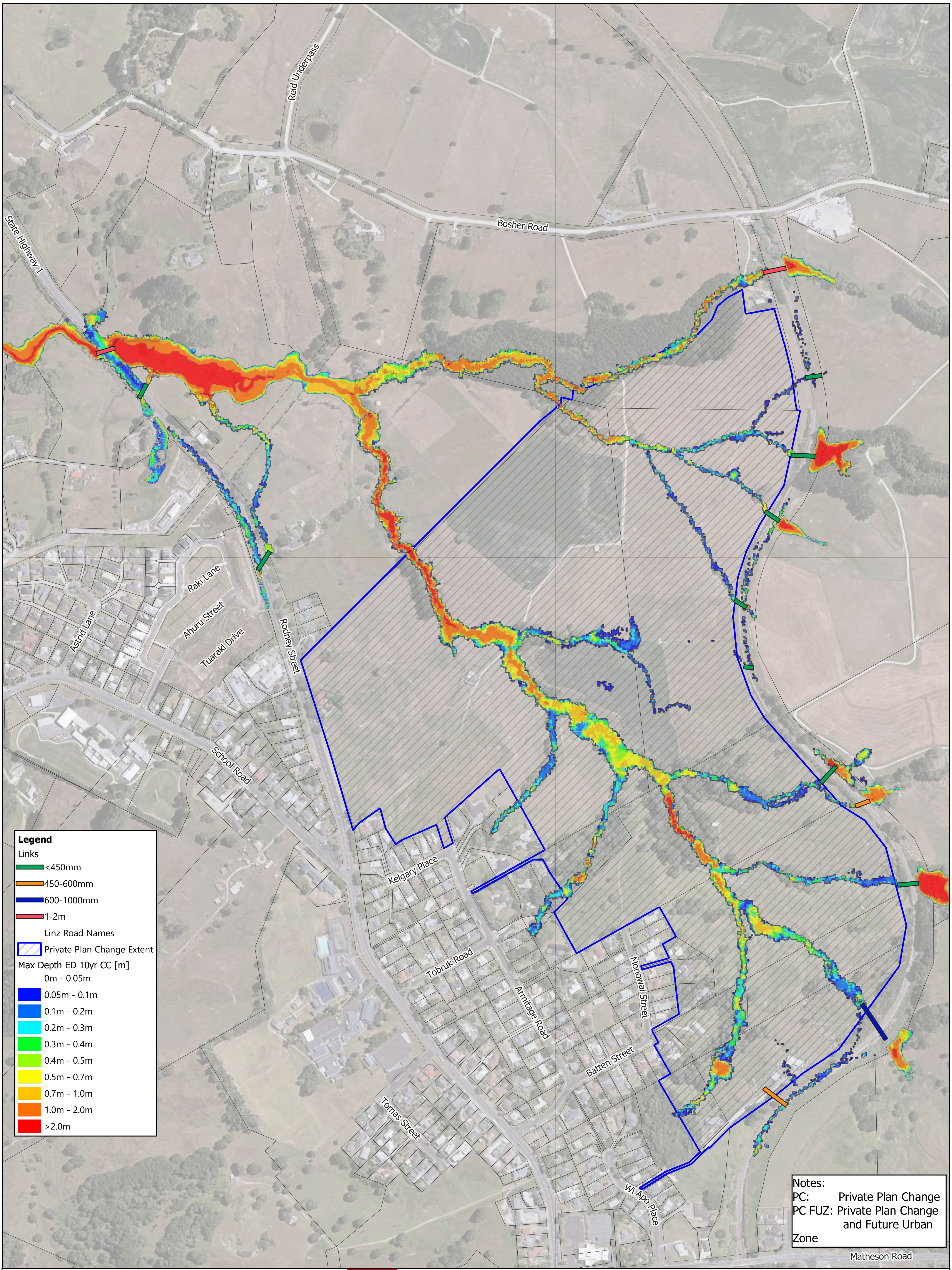

REVISION DETAILS	INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	WOODS Est.1970	Wellsford North Plan Change	STATUS	ISSUED FOR INFORMATION	REV
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- -	-	-	CHECKED	TW				DWG NO.	P21-395-SKT-10013	
- -	-	-	APPROVED	-	WOODS.CO.NZ					

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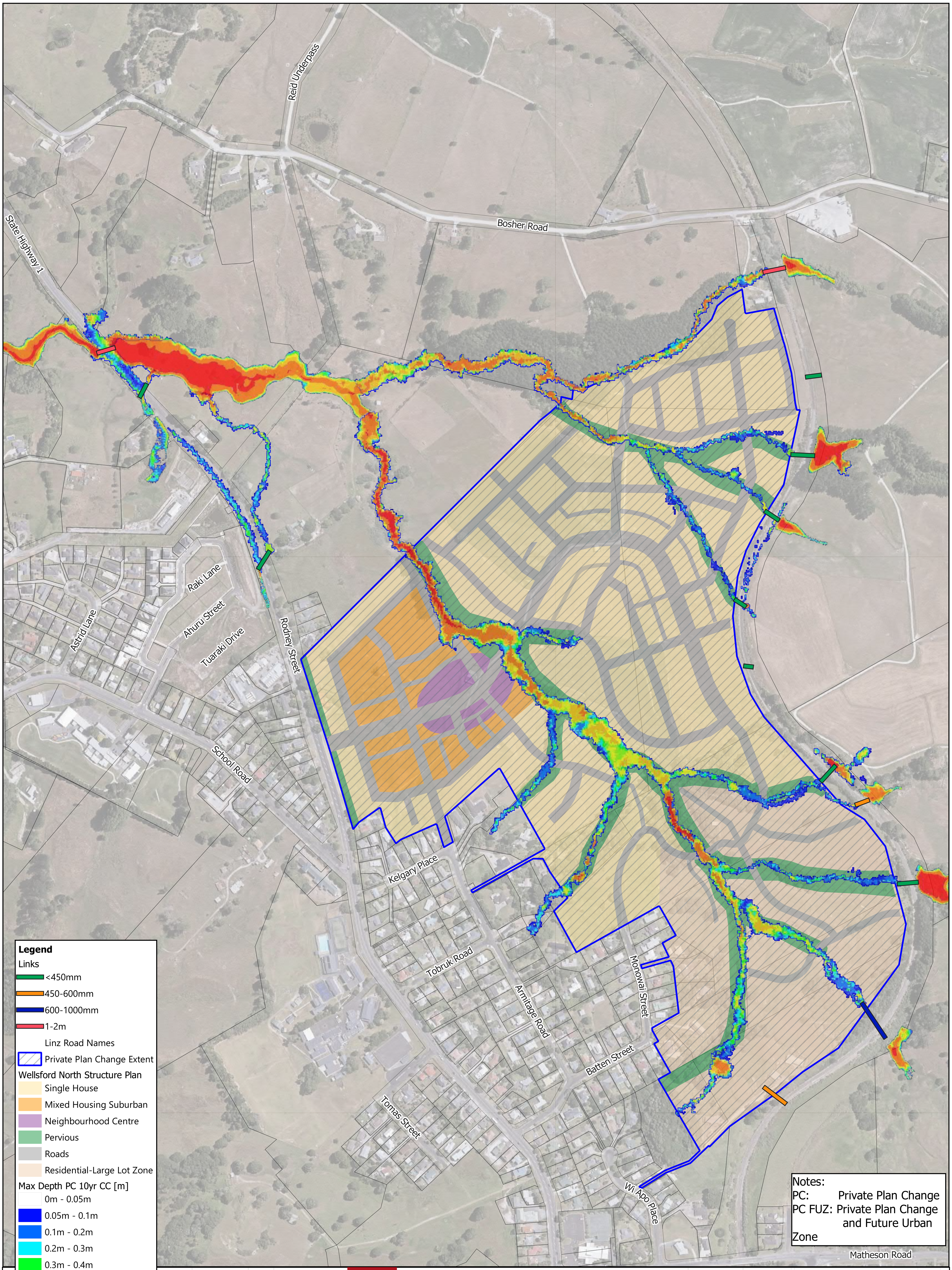

R	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	WOODS Est.1970	Wellsford North Plan Change	STATUS	ISSUED FOR INFORMATION	REV
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-	-	DRAWN	HC			Max. Water Depth [m]. PC 10yr CC (SWCoPv3-3.8°c)	COUNCIL	AUCKLAND COUNCIL	
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-	-	APPROVED	-	WOODS.CO.NZ					

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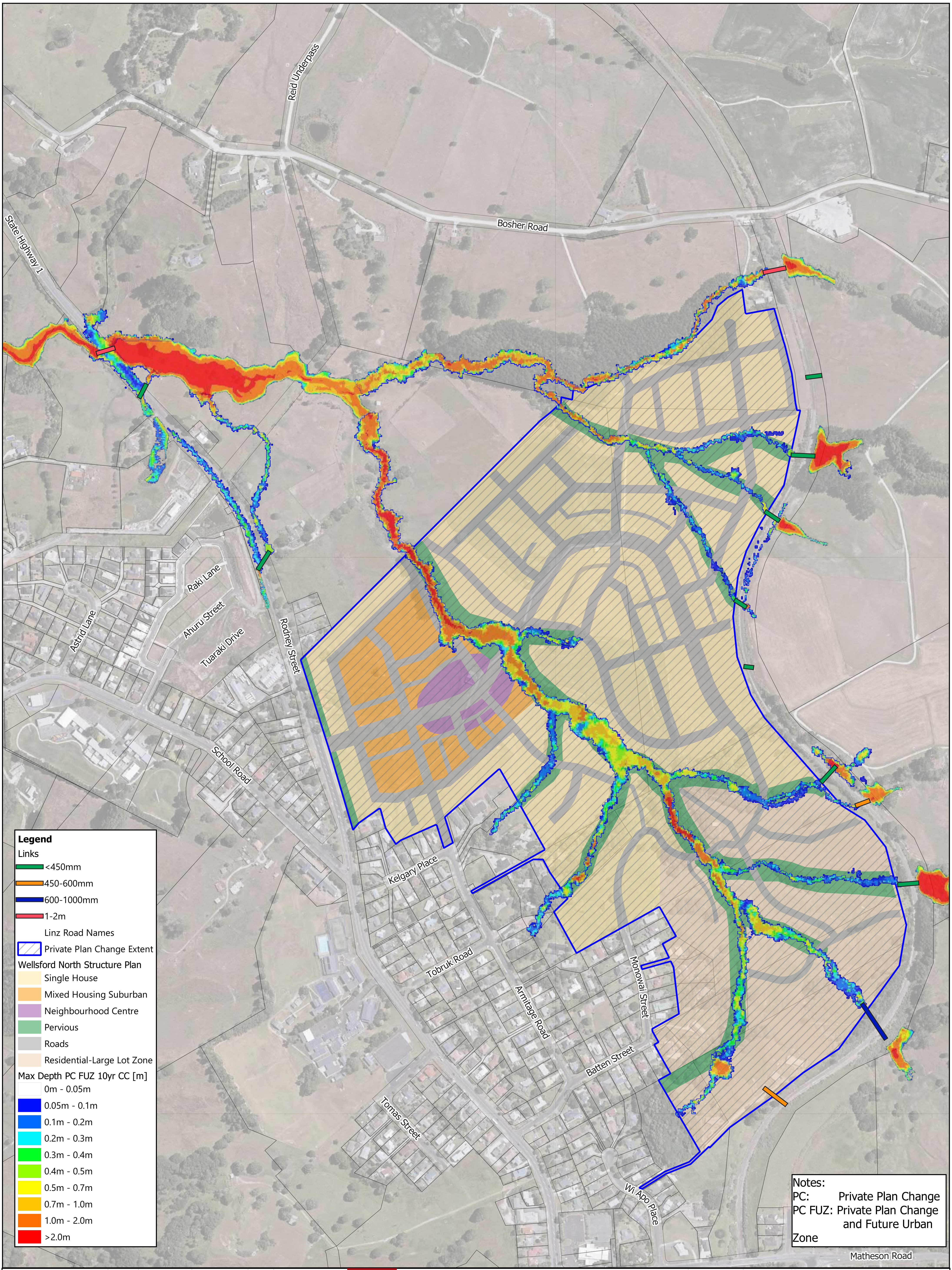

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-	-	-	-	APPROVED	-	WOODS.CO.NZ					

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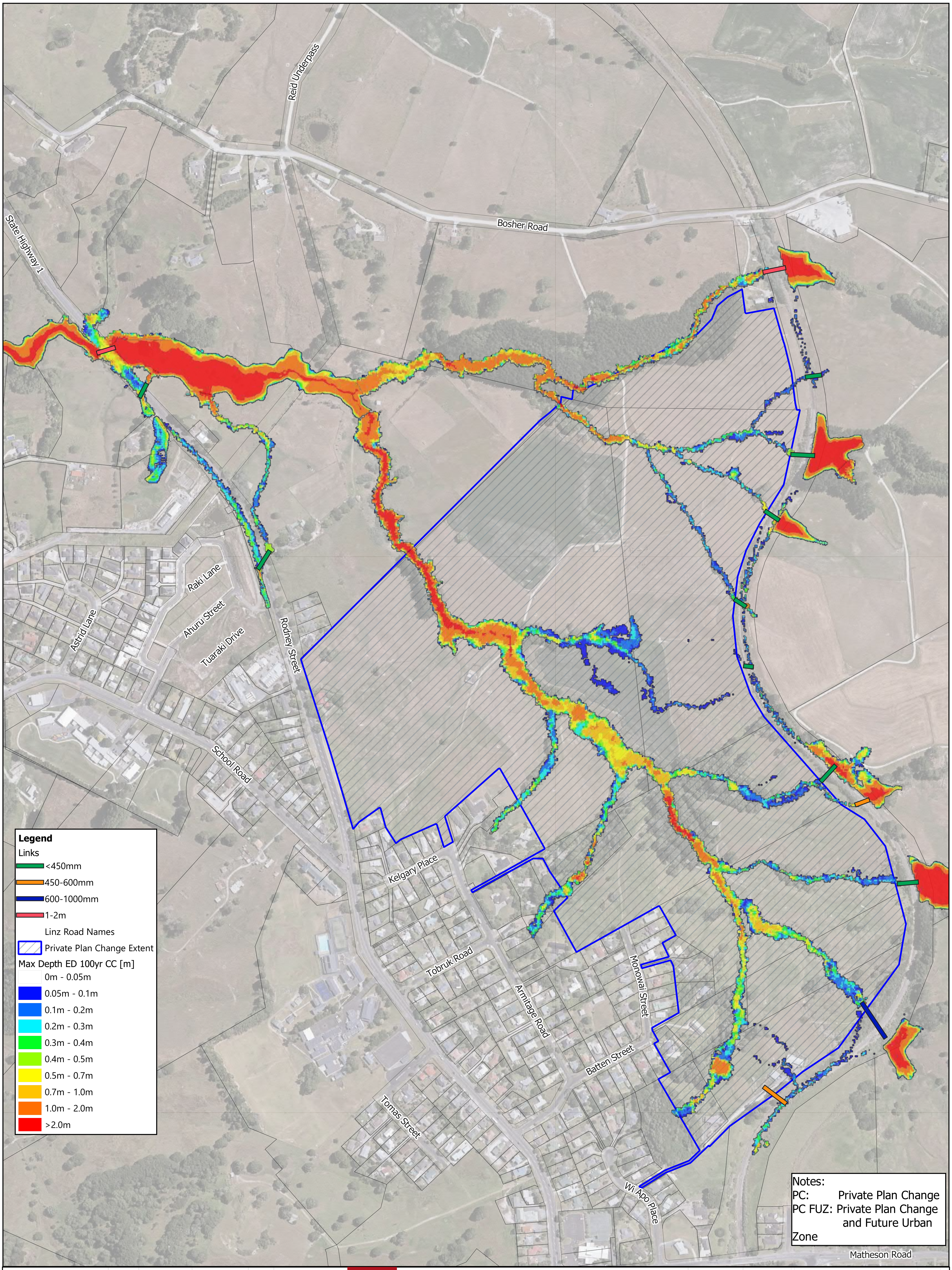

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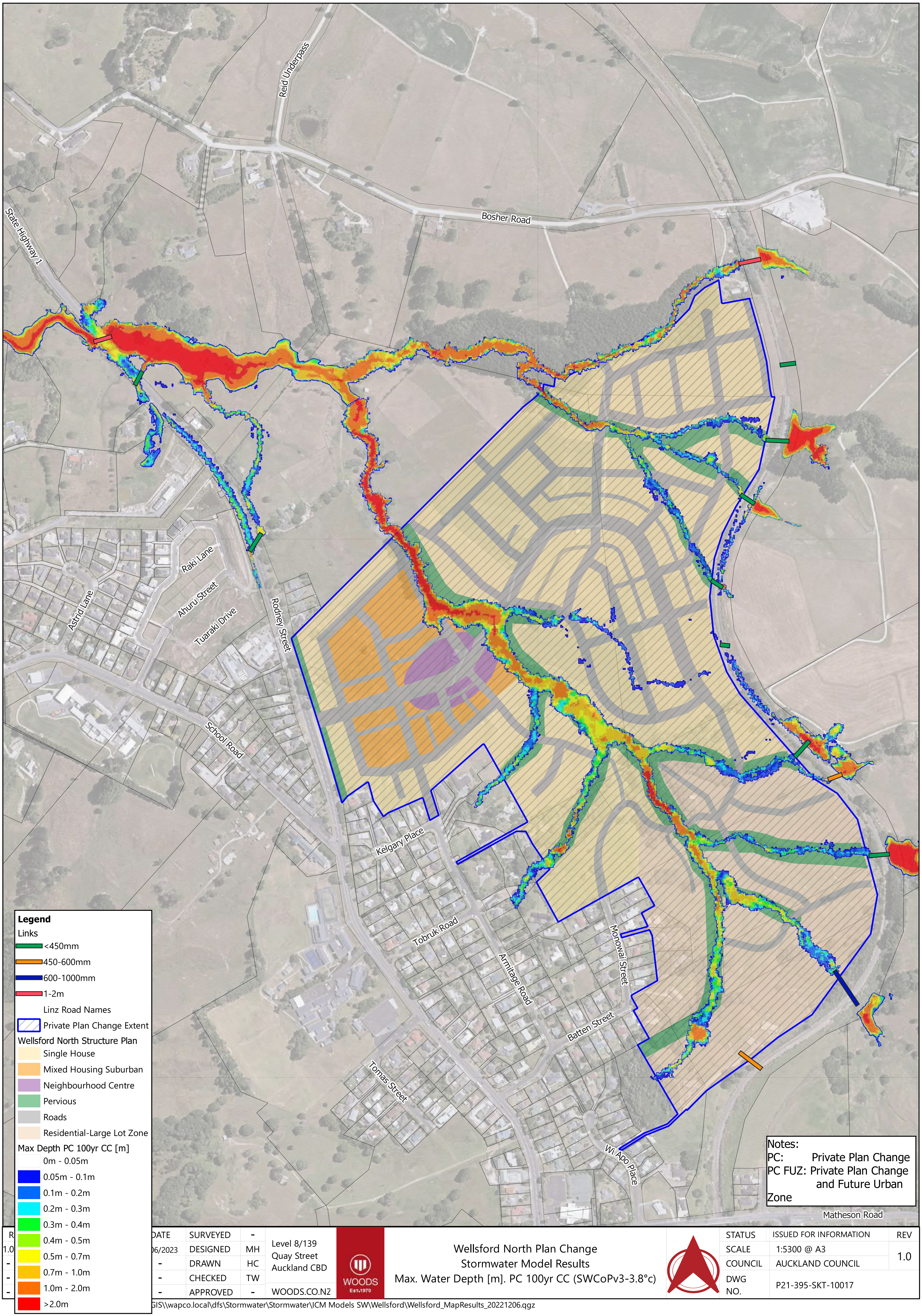

DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	STATUS	ISSUED FOR INFORMATION
06/2023	DESIGNED	MH		SCALE	1:5300 @ A3
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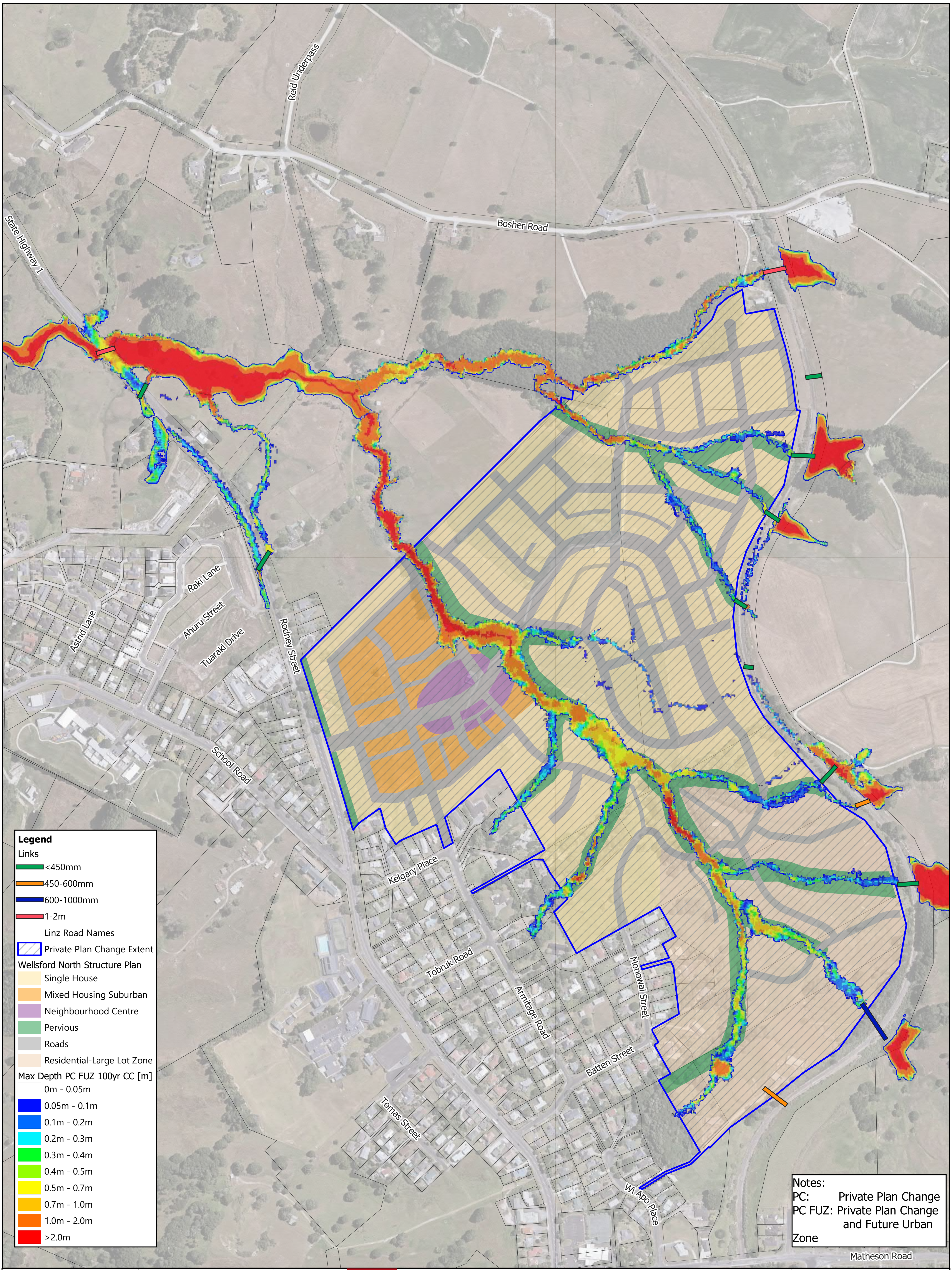
-	CHECKED	TW		DWG NO.	P21-395-SKT-10017
-	APPROVED	-	WOODS.CO.NZ	REV	1.0

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Max. Water Depth [m]. PC 100yr CC (SWCoPv3-3.8°c)

GIS\\wapco.local\dfs\Stormwater\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz



REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	WOODS Est.1970	Wellsford North Plan Change Stormwater Model Results Max. Water Depth [m]. PC FUZ 100yr CC (SWCoPv3-3.8°c)	STATUS	ISSUED FOR INFORMATION	REV
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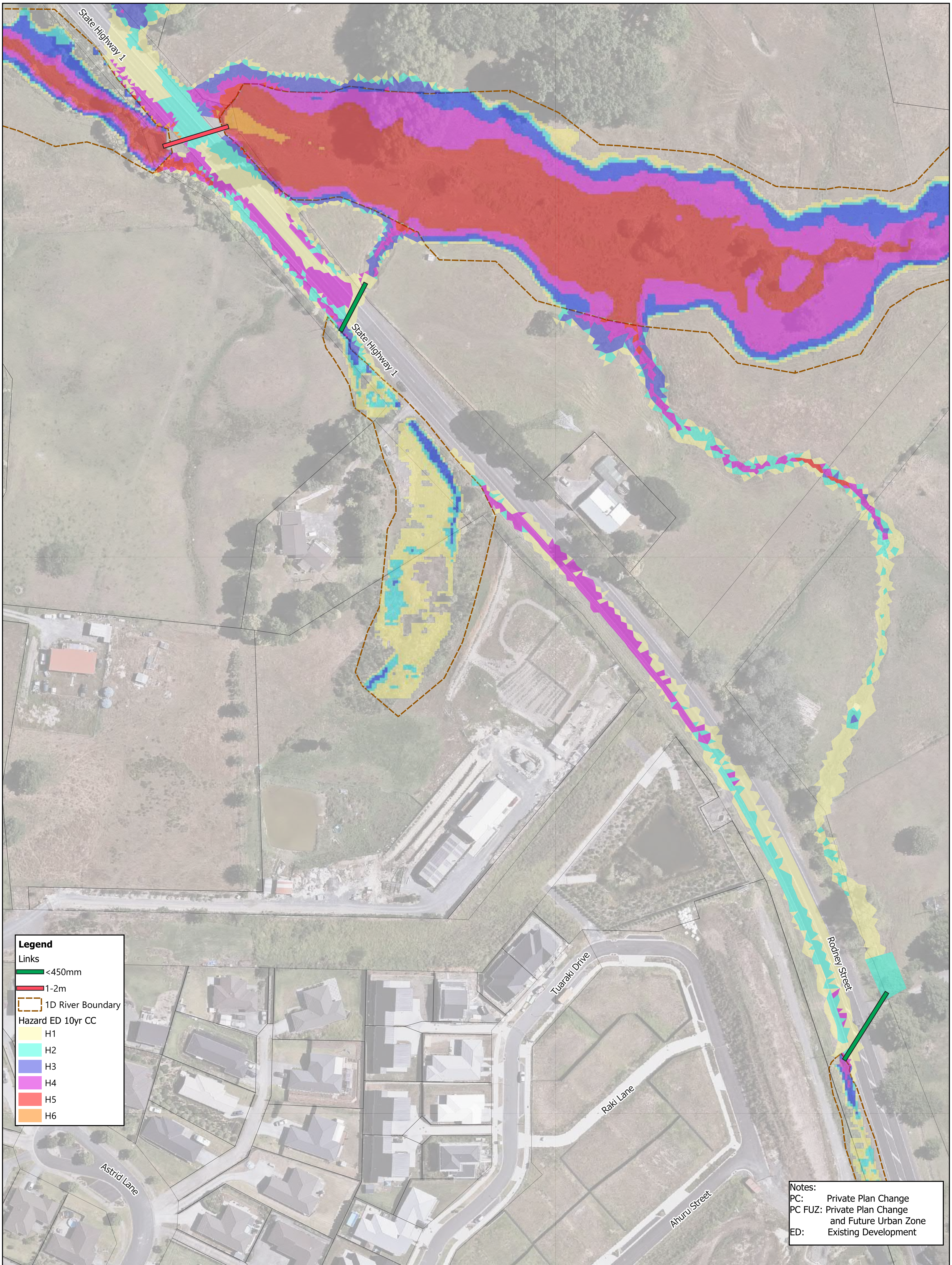
-	-	-	-	APPROVED	-						

This drawing was generated from QGIS\\wapco.local\dfs\Stormwater\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz

Appendix F

State Highway 1 - Hazard Plots



REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	WOODS Est.1970	Wellsford North Plan Change Stormwater Model Results ARR Hazard - ED 10yr CC (SWCoPv3-3.8°c)	STATUS	ISSUED FOR INFORMATION	REV
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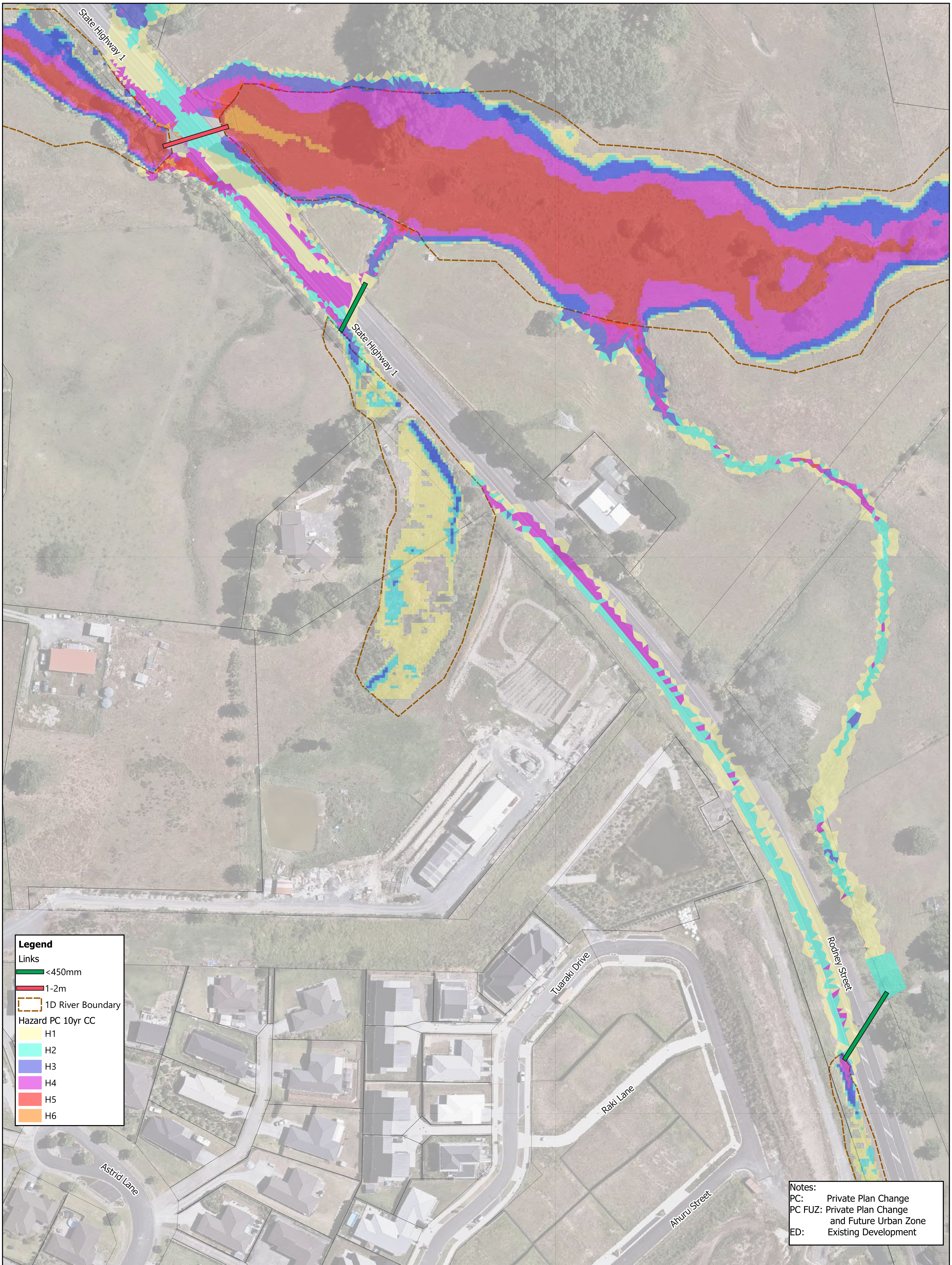

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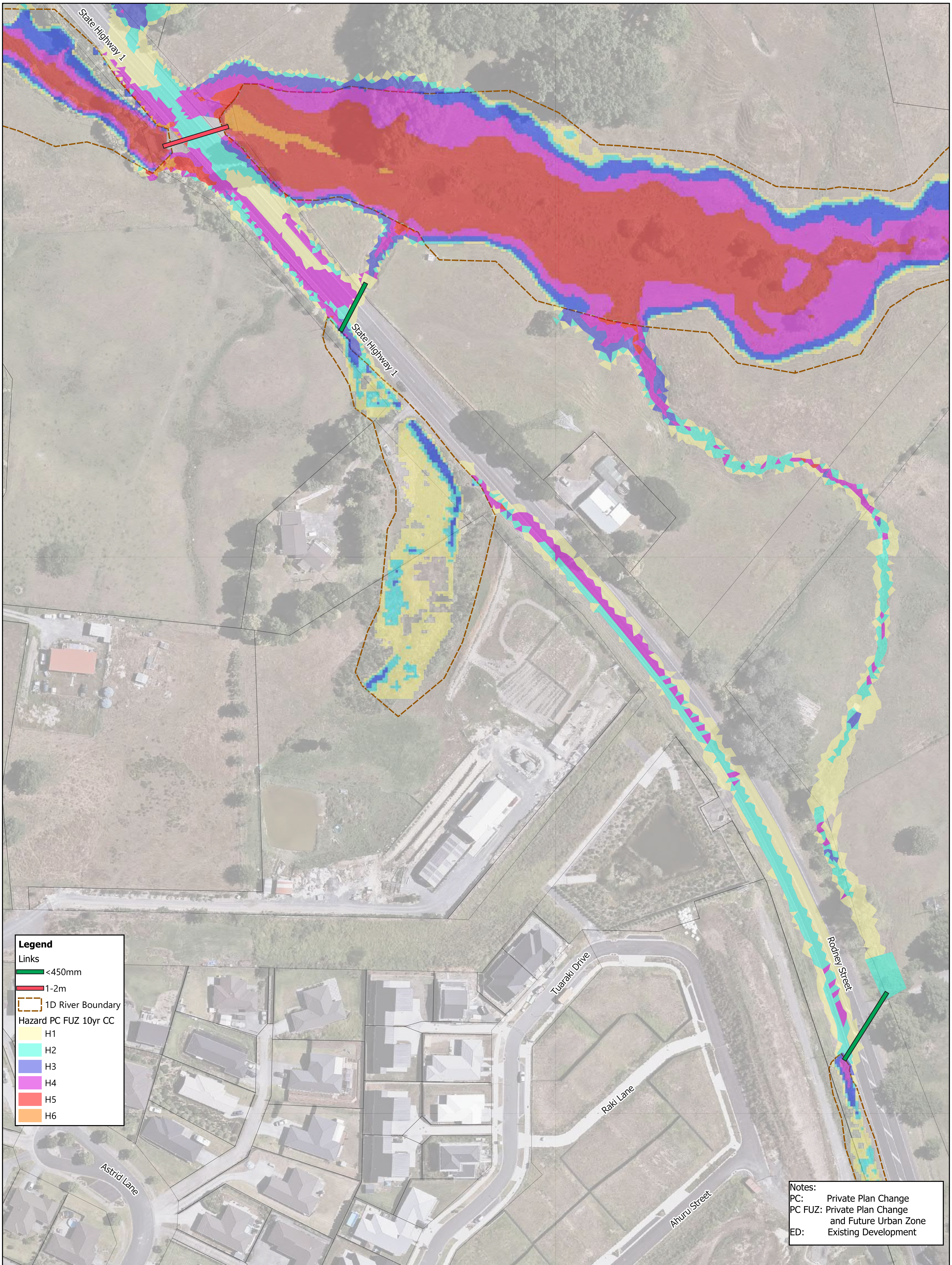

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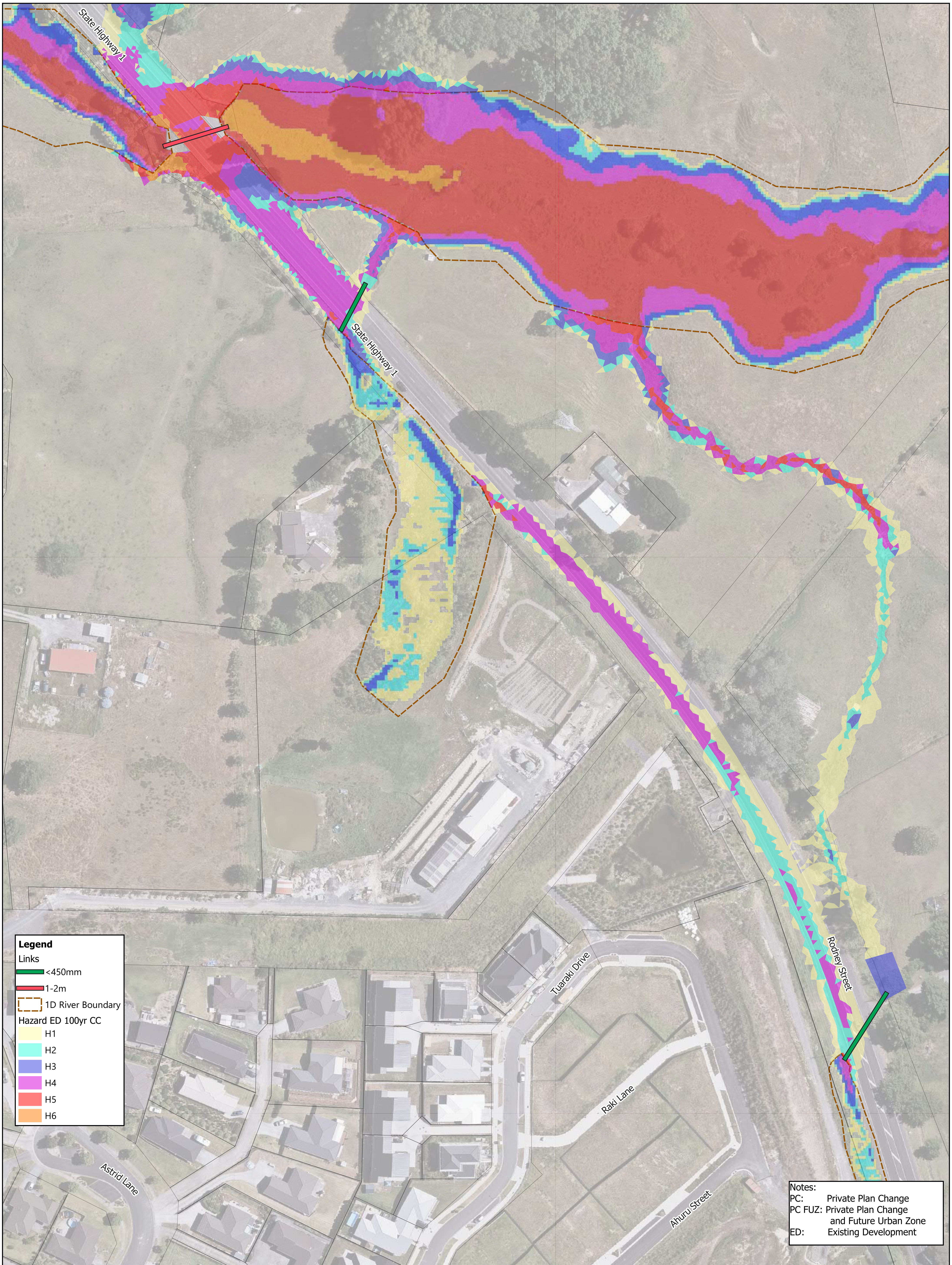

REVISION DETAILS		INT	DATE	SURVEYED	-
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-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
ARR Hazard - ED 100yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
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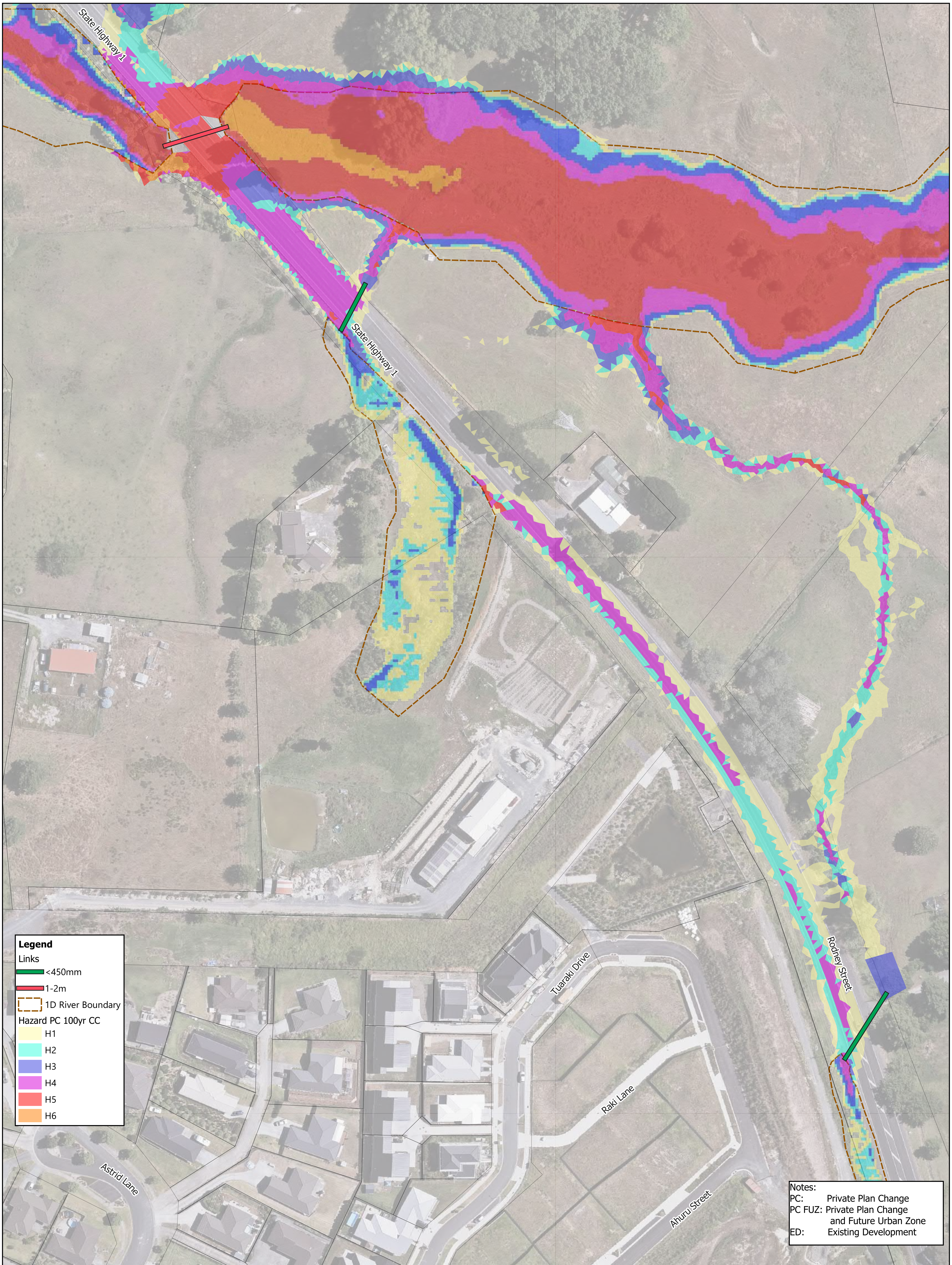

REVISION DETAILS		INT	DATE	SURVEYED	-		STATUS	ISSUED FOR INFORMATION	REV
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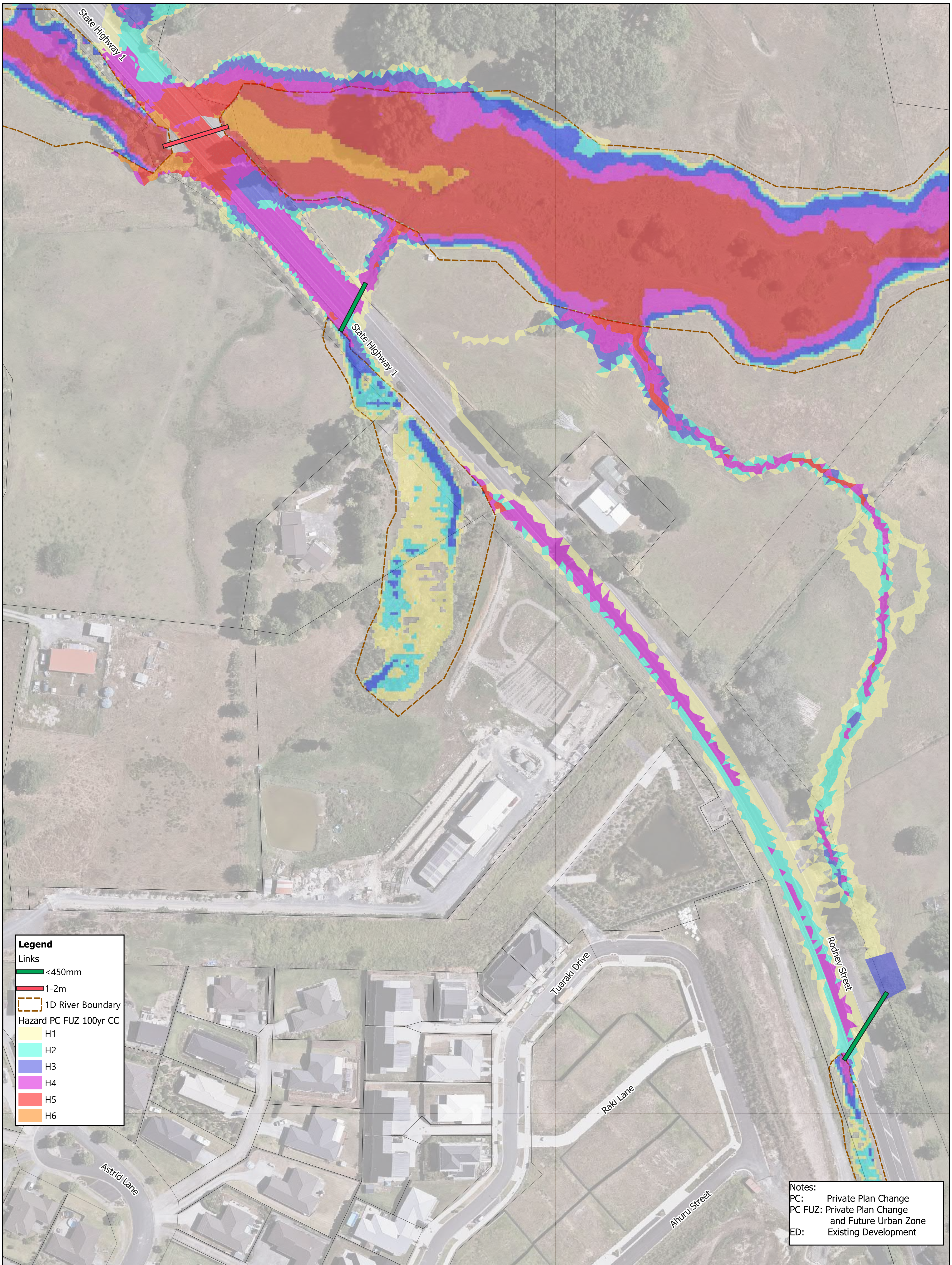
-	-	-	-	CHECKED	TW		DWG NO.	P21-395-SKT-2005	
-	-	-	-	APPROVED	-	WOODS.CO.NZ			

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
ARR Hazard - PC 100yr CC (SWCoPv3-3.8°c)

This drawing was generated from QGIS\\wapco.local\dfs\Stormwater\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz



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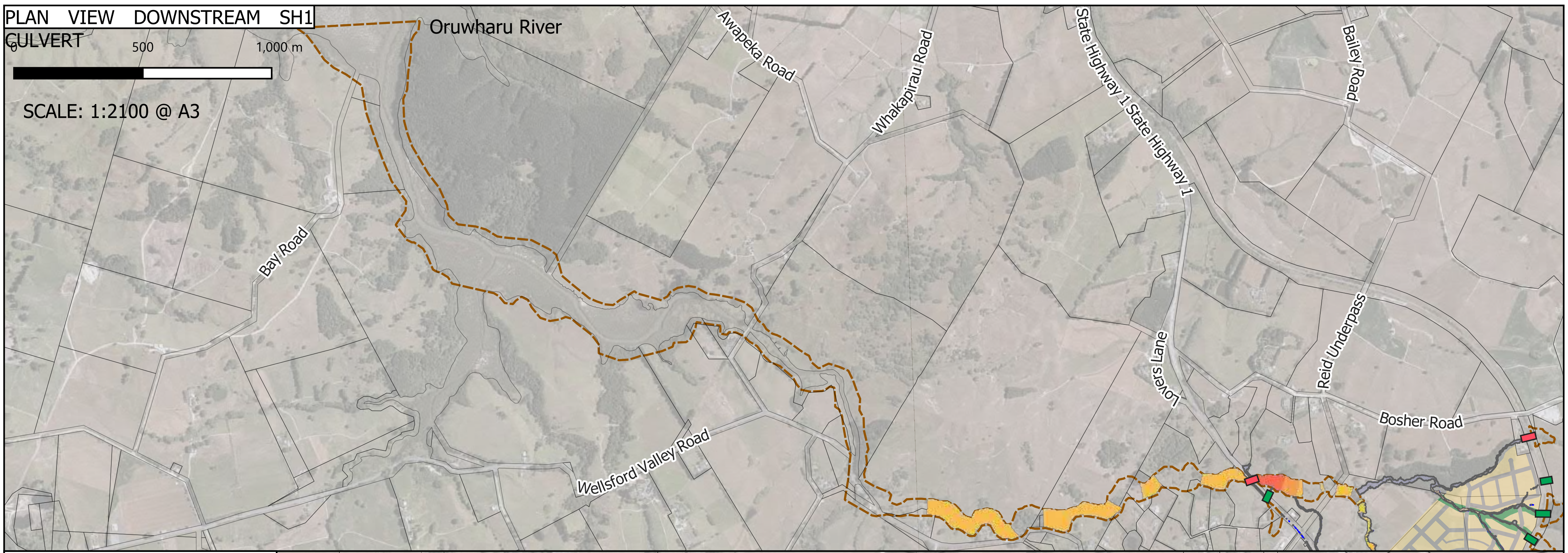
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

This drawing was generated from QGIS\\wapco.local\dfs\Stormwater\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz

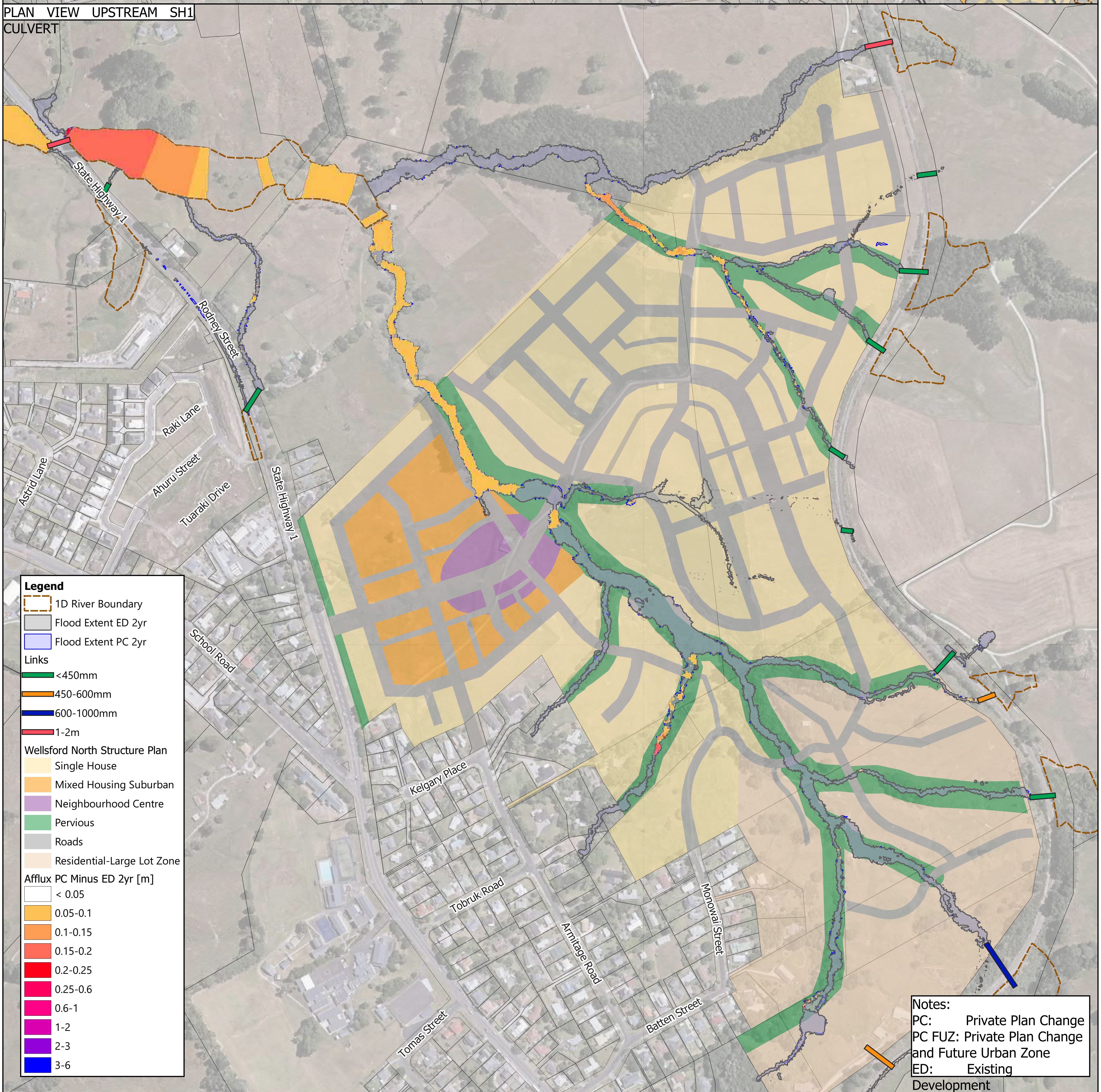
Appendix G

State Highway 1 – Water level difference plots

PLAN VIEW DOWNSTREAM SH1 CULVERT



PLAN VIEW UPSTREAM SH1 CULVERT



Notes:
PC: Private Plan Change
PC FUZ: Private Plan Change and Future Urban Zone
ED: Existing Development

REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Afflux Plot - ED Vs PC 2yr No CC	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
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-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-0001	
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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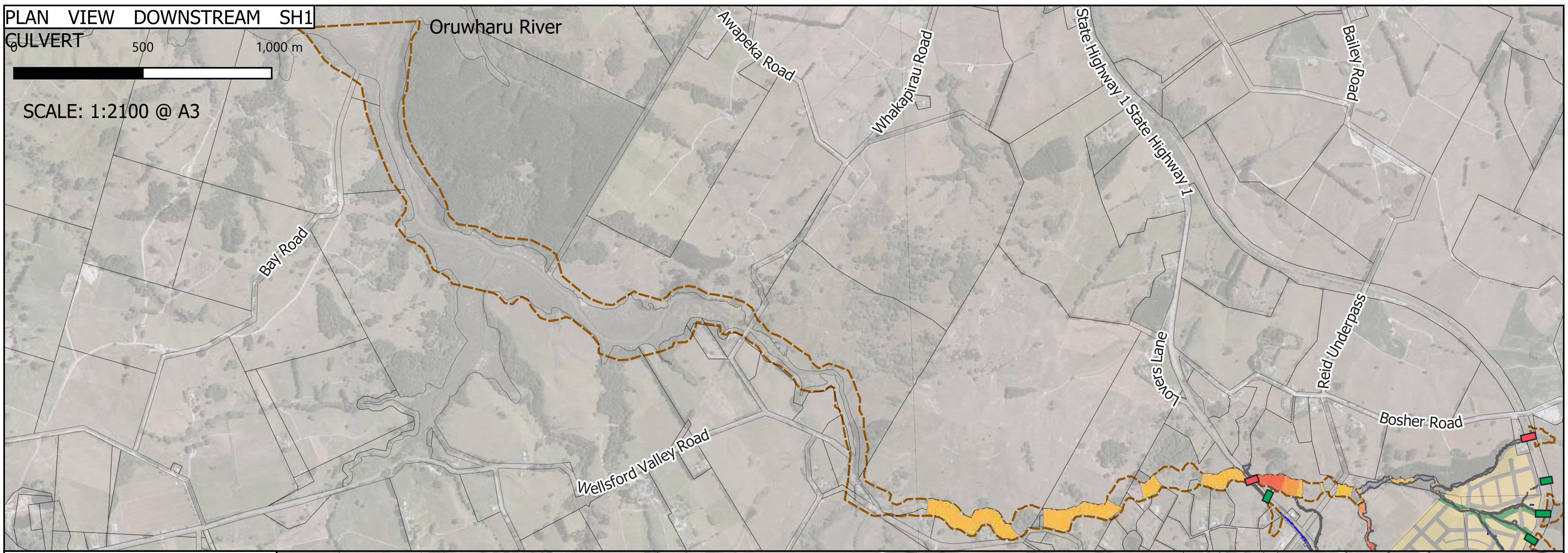

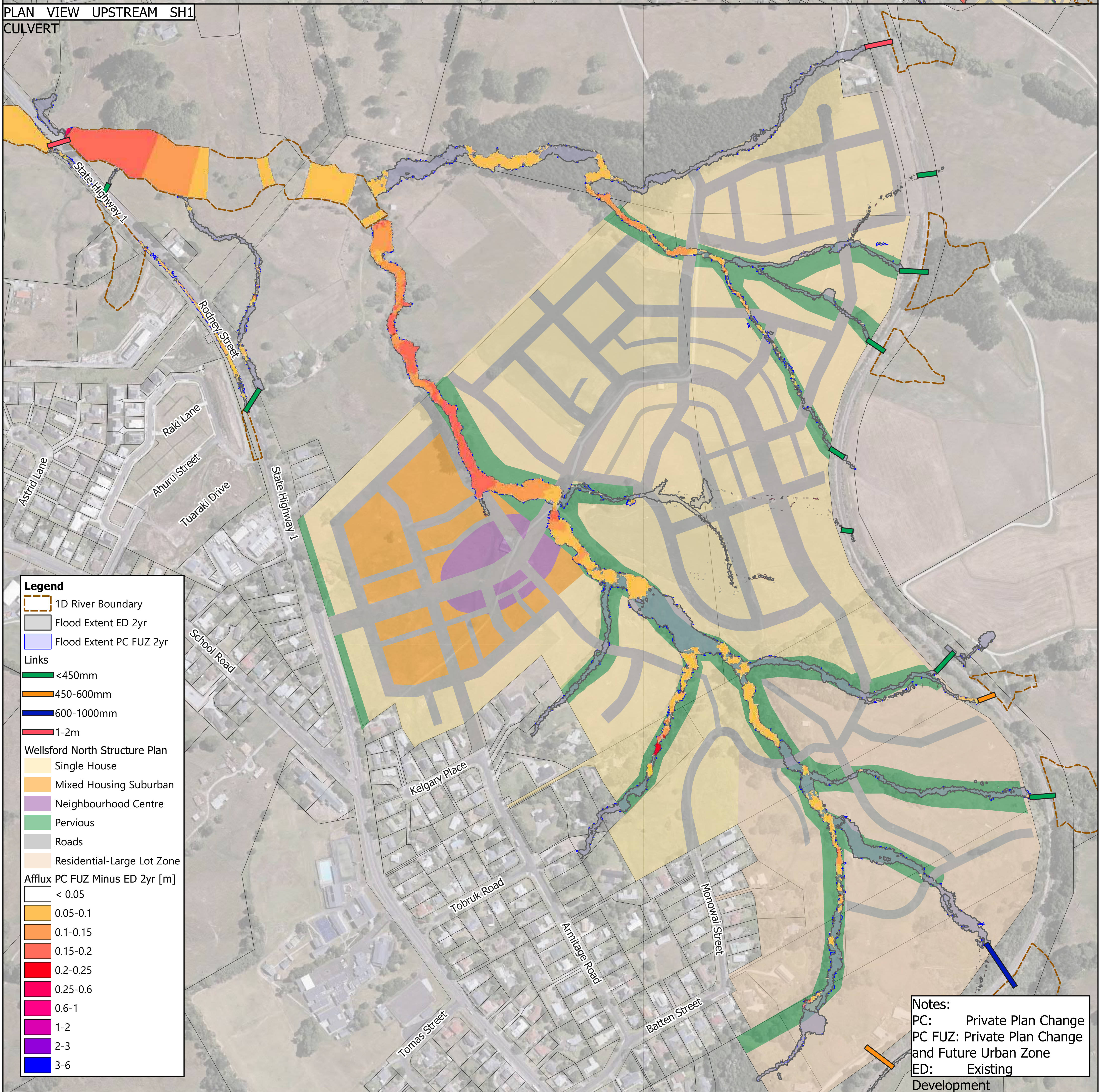

REVISION DETAILS		INT	DATE	SURVEYED	-			STATUS	ISSUED FOR INFORMATION	REV
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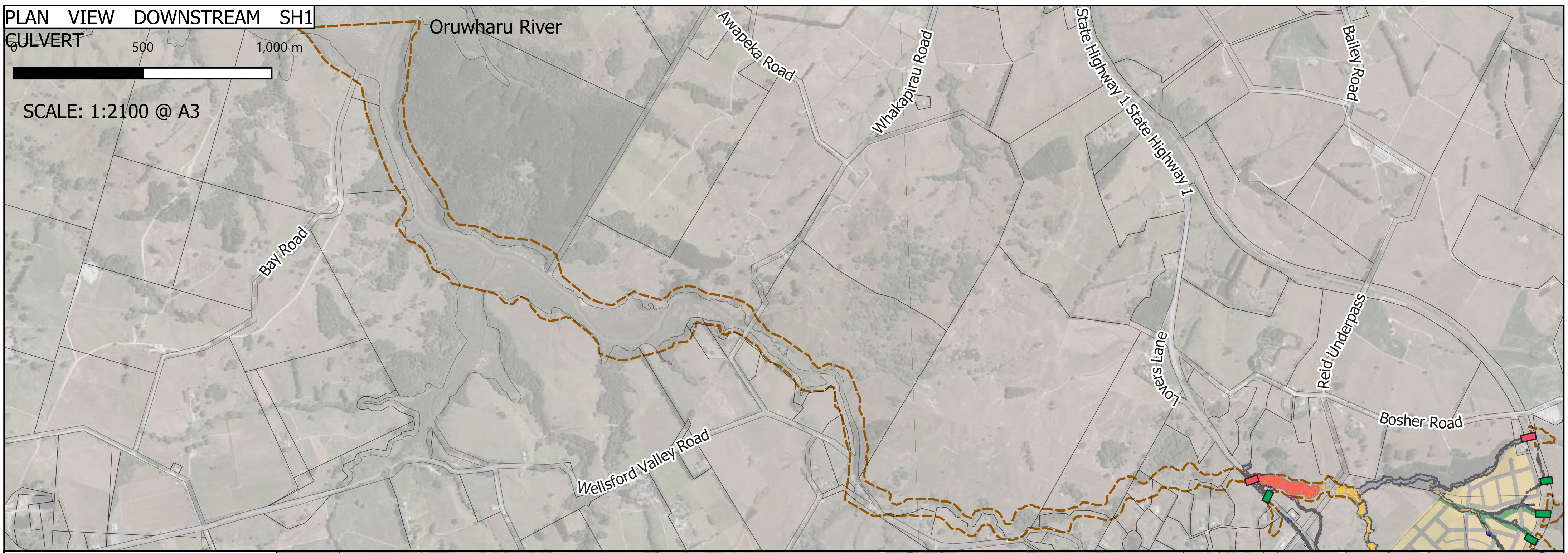
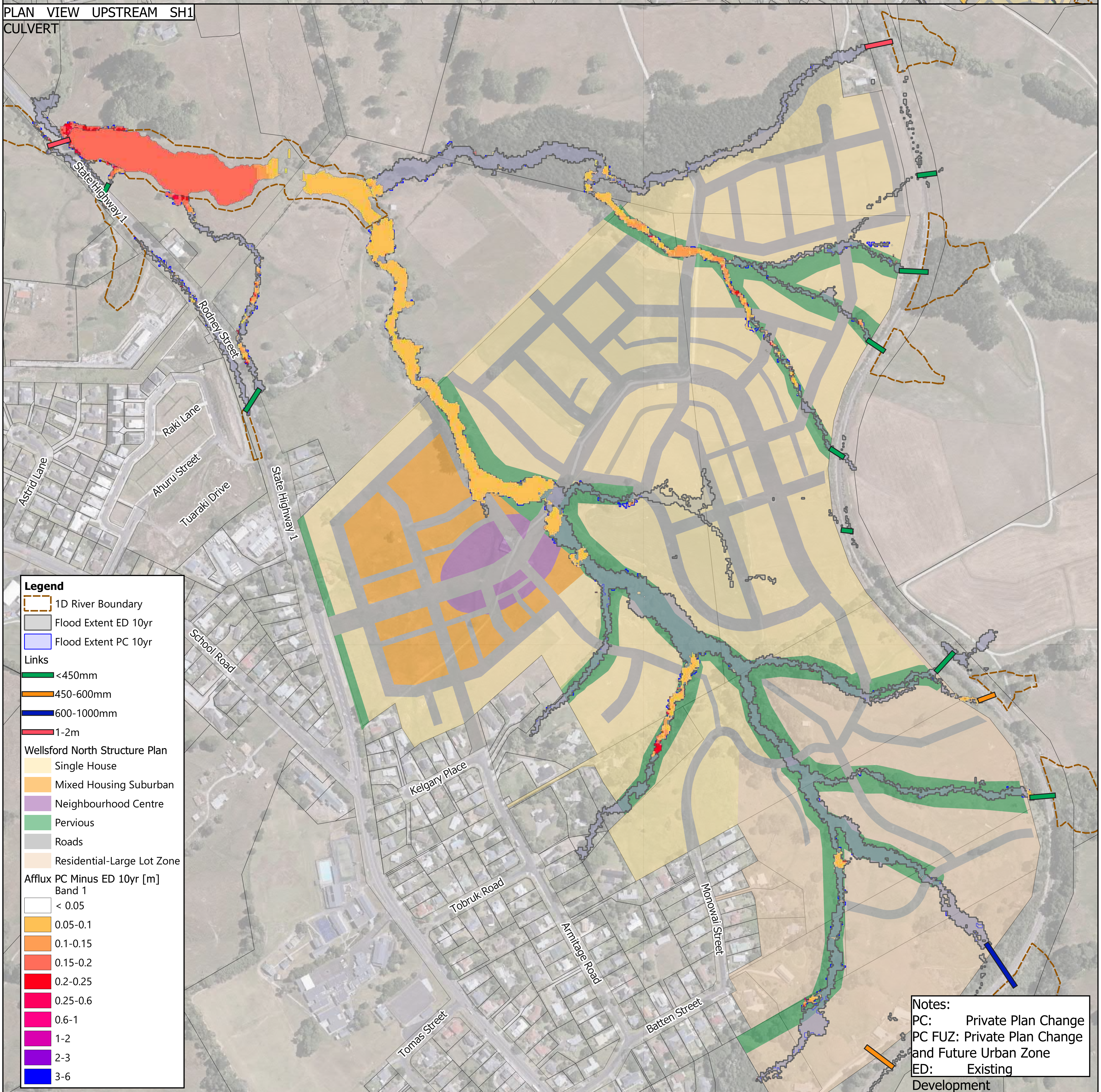
-	-	-	-	CHECKED	TW					
-	-	-	-	APPROVED	-	WOODS.CO.NZ		DWG NO.	P21-395-SKT-0002	

WOODS Est.1970

This drawing was generated from QGISX:\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz





REVISION DETAILS		INT	DATE						
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-	-	-	-	DESIGNED	MH			SCALE	1:5300 @ A3
-	-	-	-	DRAWN	HC			COUNCIL	AUCKLAND COUNCIL
-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-0003
				APPROVED	-	WOODS.CO.NZ		REV	1.0

WOODS Est.1970

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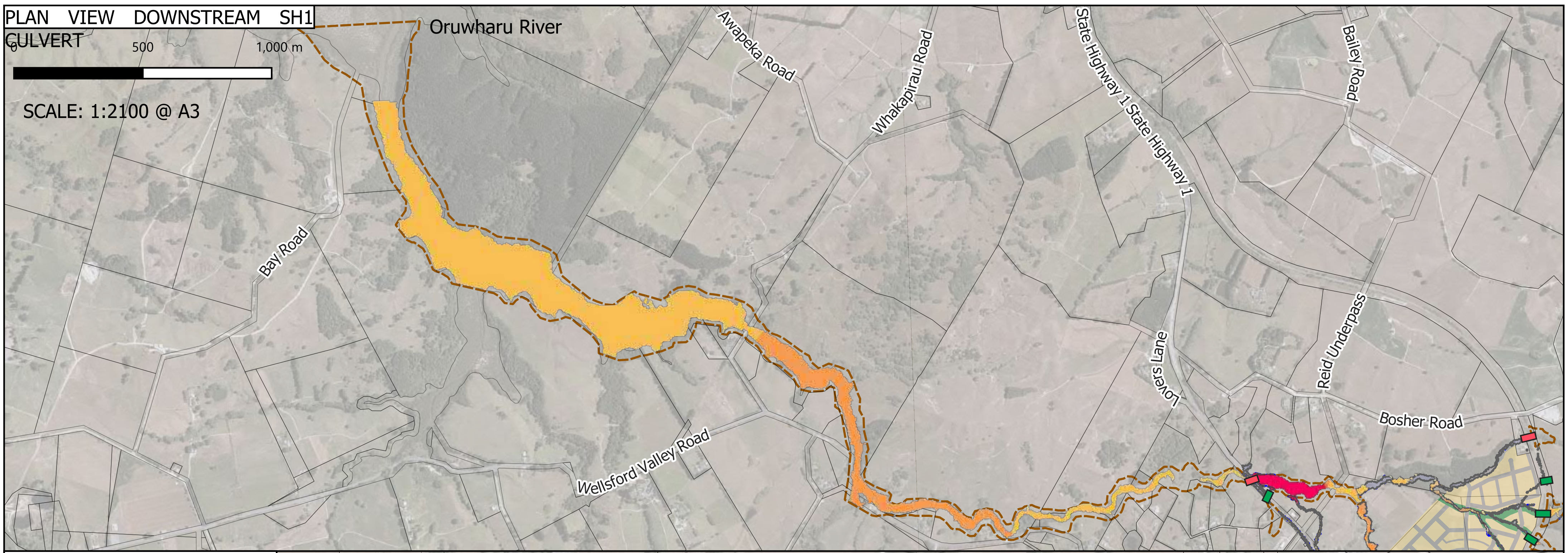

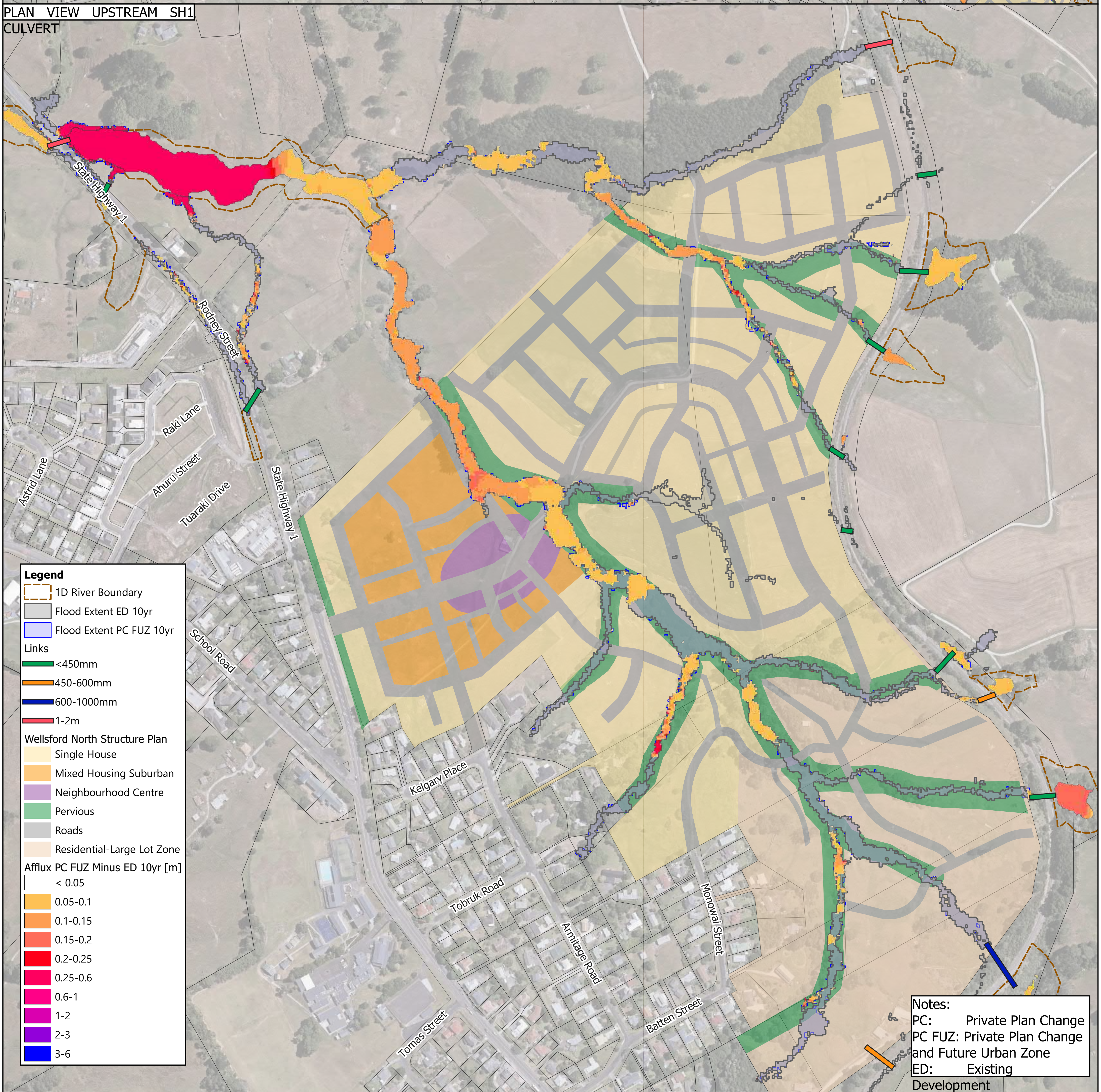

REVISION DETAILS		INT	DATE		
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-	-	-	-	DRAWN	HC
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC FUZ 10yr No CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-0004	

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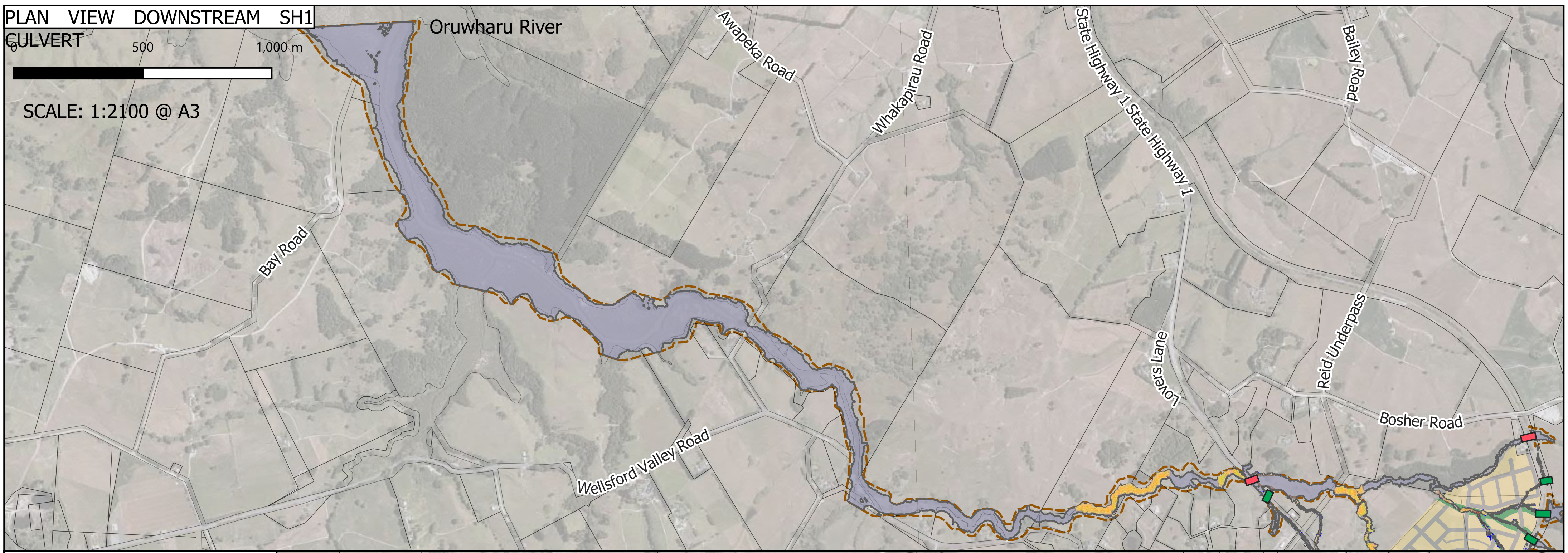

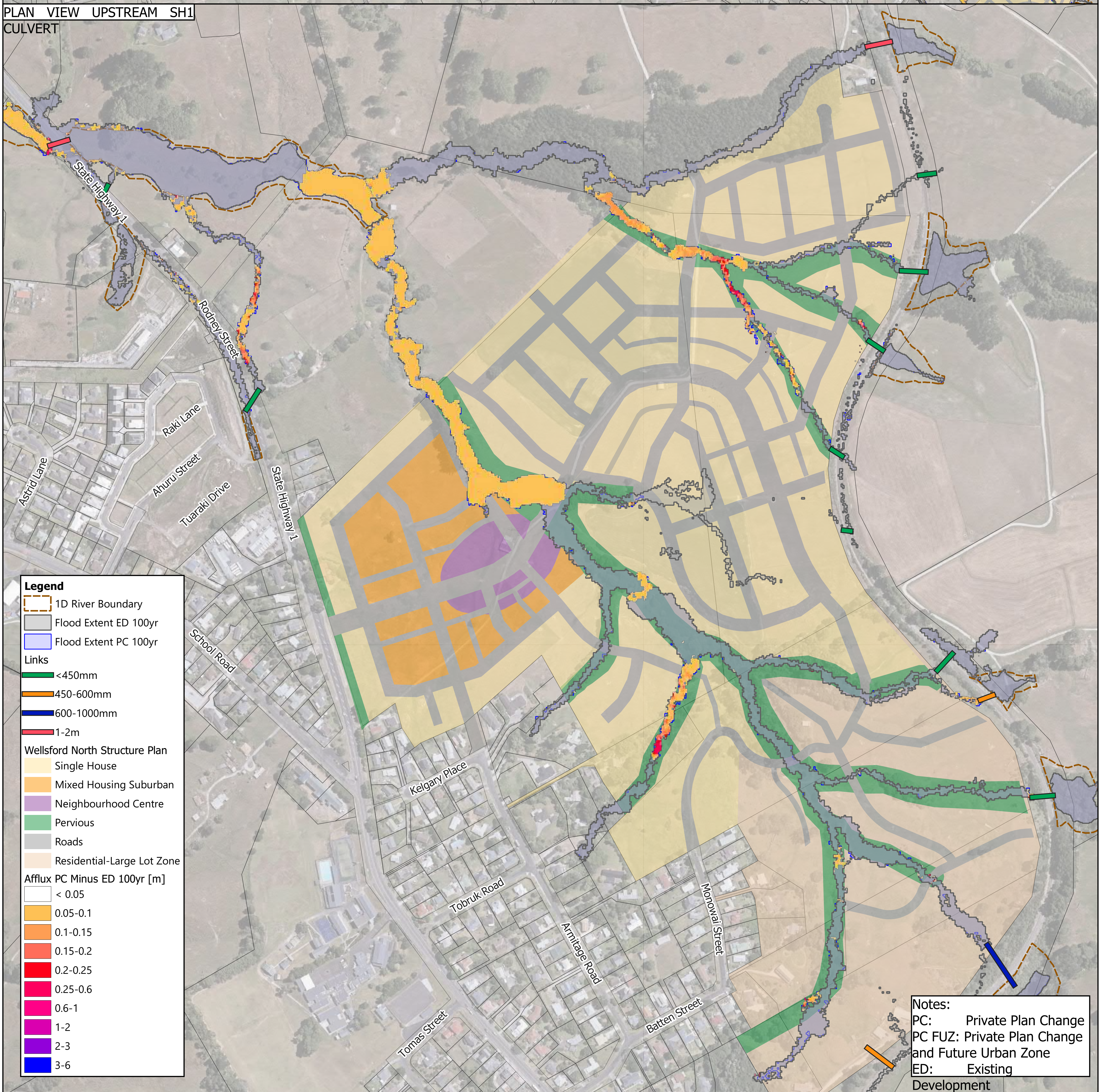

REVISION DETAILS	INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change Stormwater Model Results Afflux Plot - ED Vs PC 100yr No CC	STATUS	ISSUED FOR INFORMATION	REV
1.0 FOR INFORMATION	PW	30/05/2023	DESIGNED	MH			SCALE	1:5300 @ A3	1.0
- -	-	-	DRAWN	HC			COUNCIL	AUCKLAND COUNCIL	
- -	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-0005	
- -	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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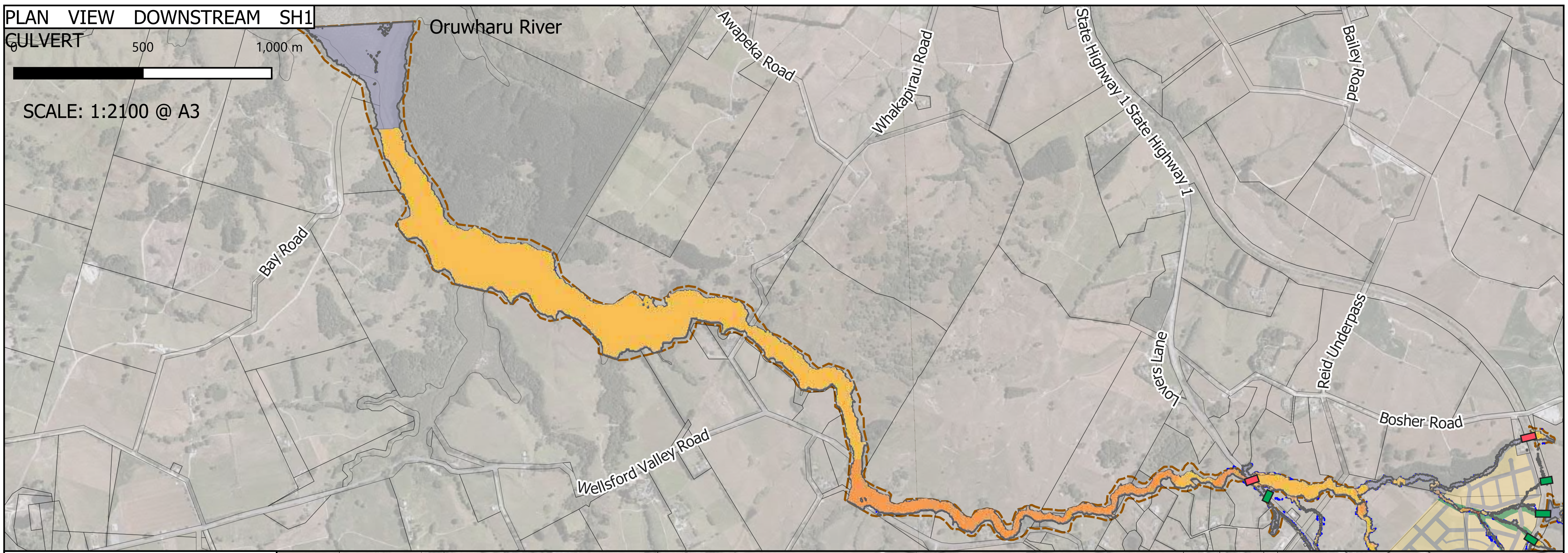
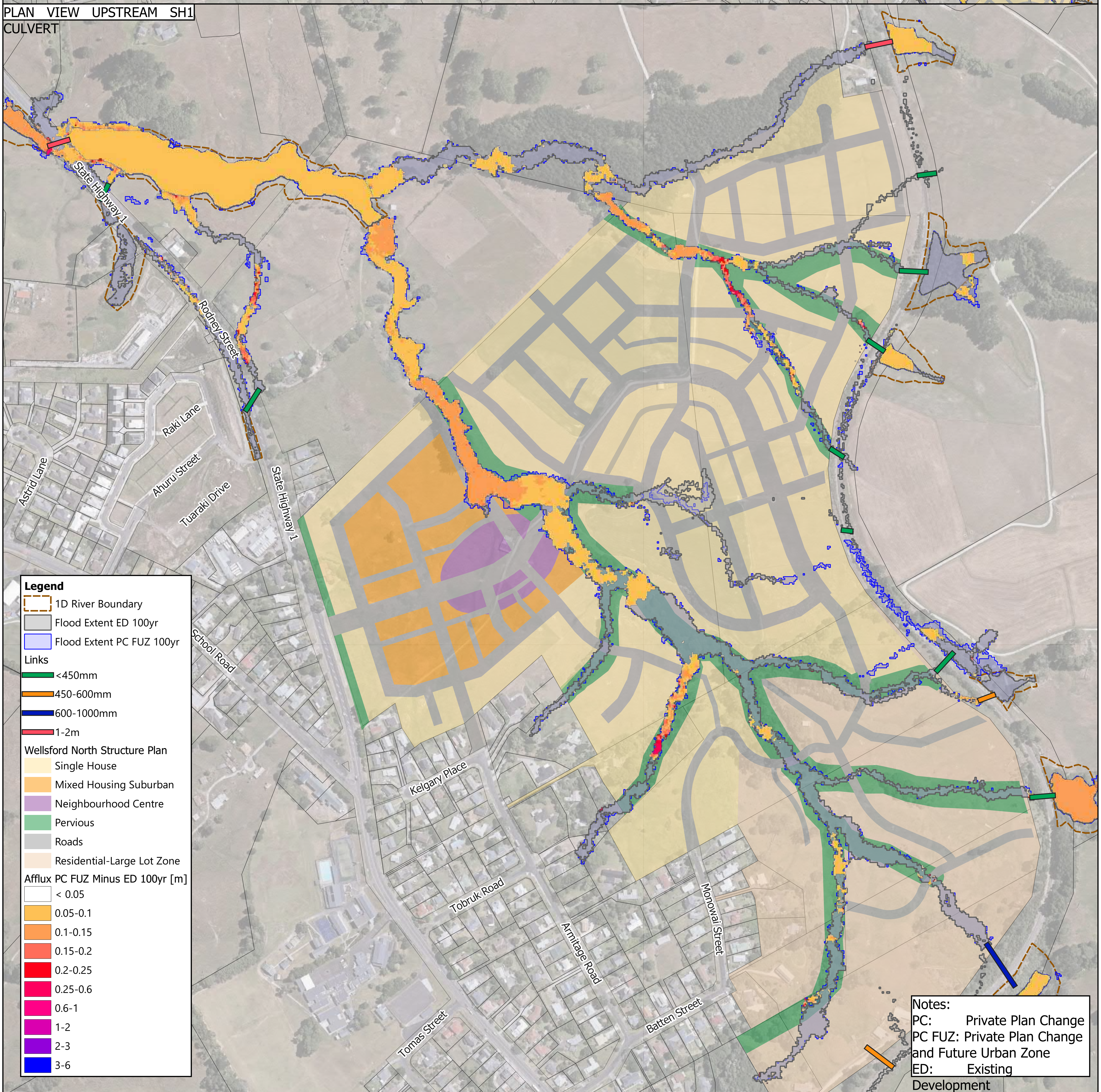
PLAN VIEW DOWNSTREAM SH1 CULVERT



PLAN VIEW UPSTREAM SH1 CULVERT



REVISION DETAILS		INT	DATE		
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-	-	-	-	DRAWN	HC
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC FUZ 100yr No CC

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-0006	

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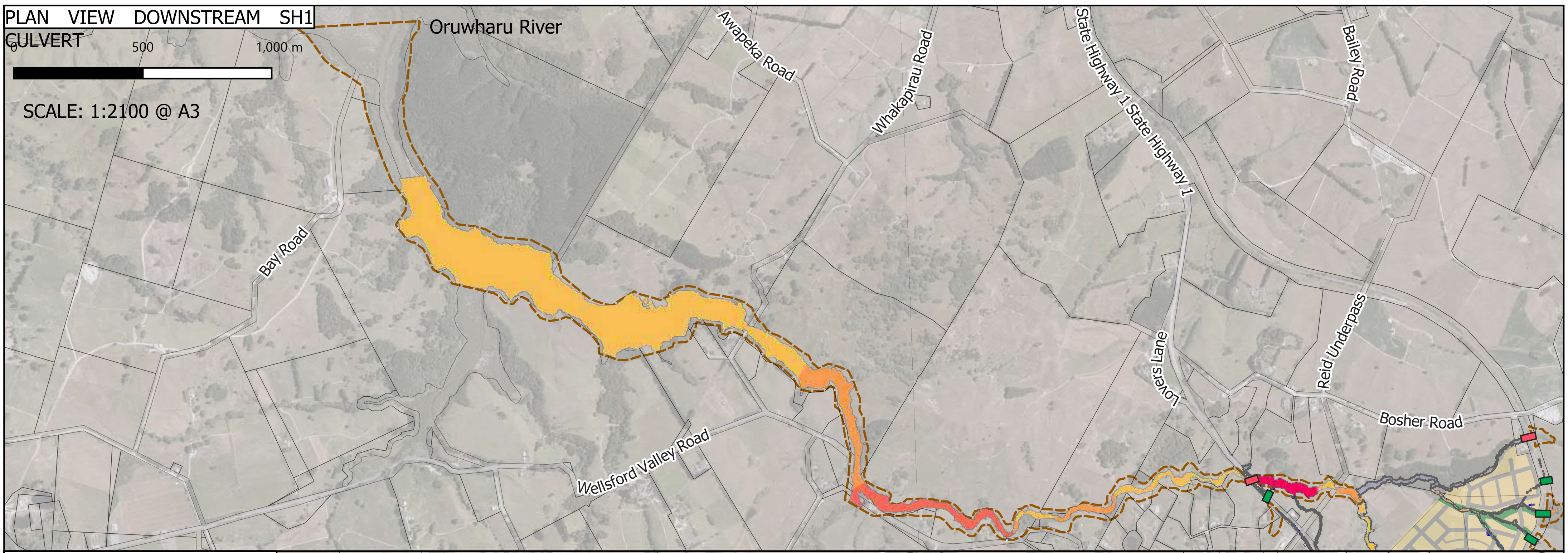

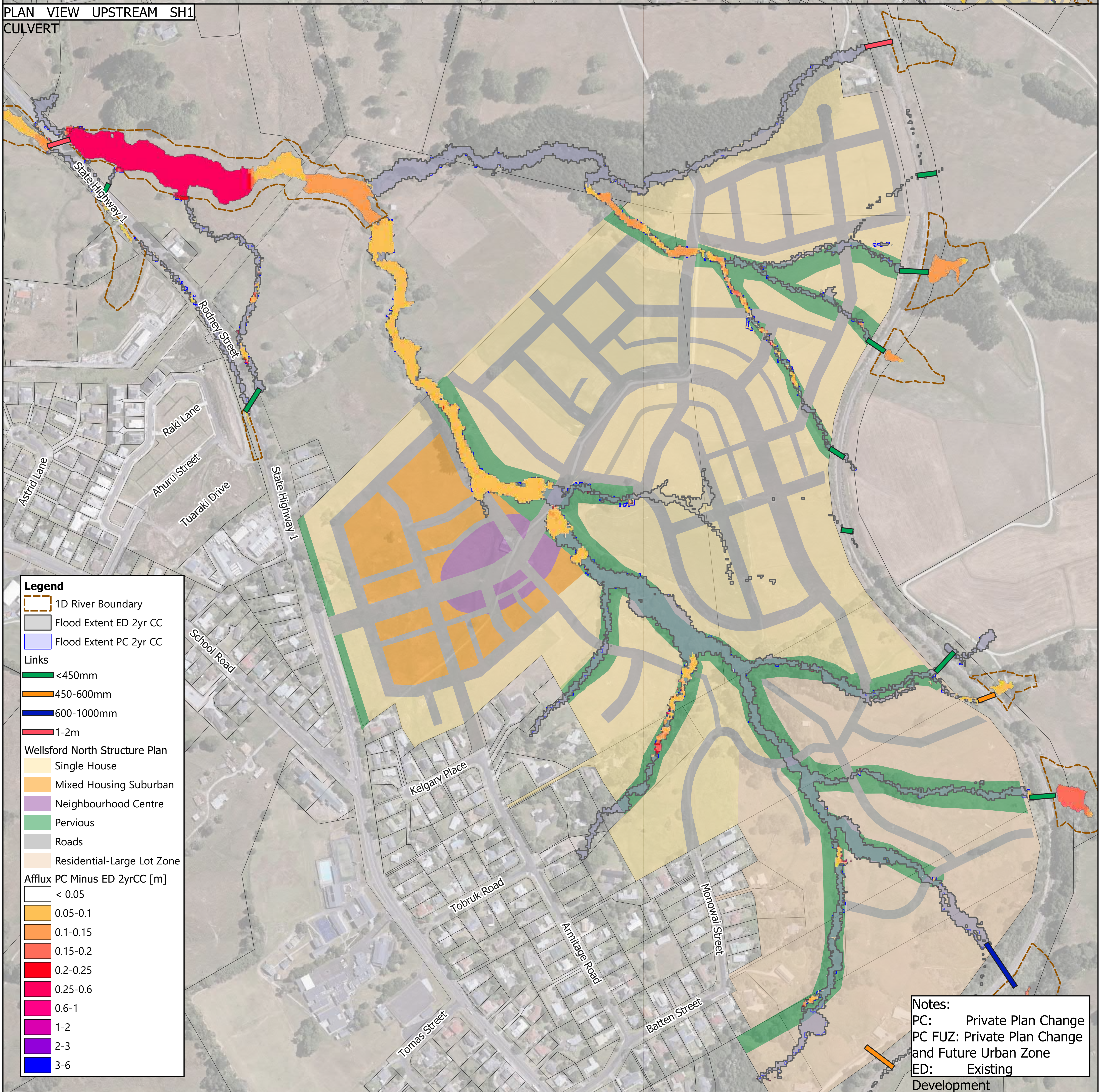

REVISION DETAILS		INT	DATE	SURVEYED	-	Level 8/139 Quay Street Auckland CBD	Wellsford North Plan Change	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH		Stormwater Model Results	SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	HC		Afflux Plot - ED Vs PC 2yr CC (SWCoPv3-3.8°c)	COUNCIL	AUCKLAND COUNCIL	
-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-0007	
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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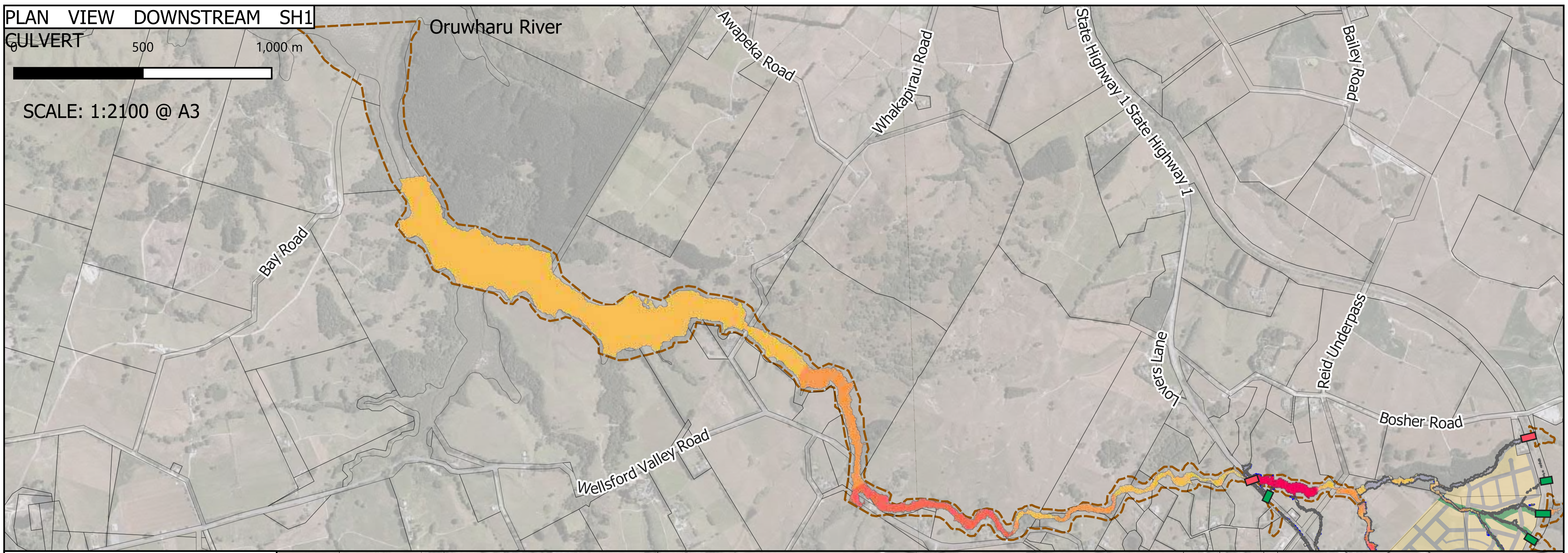

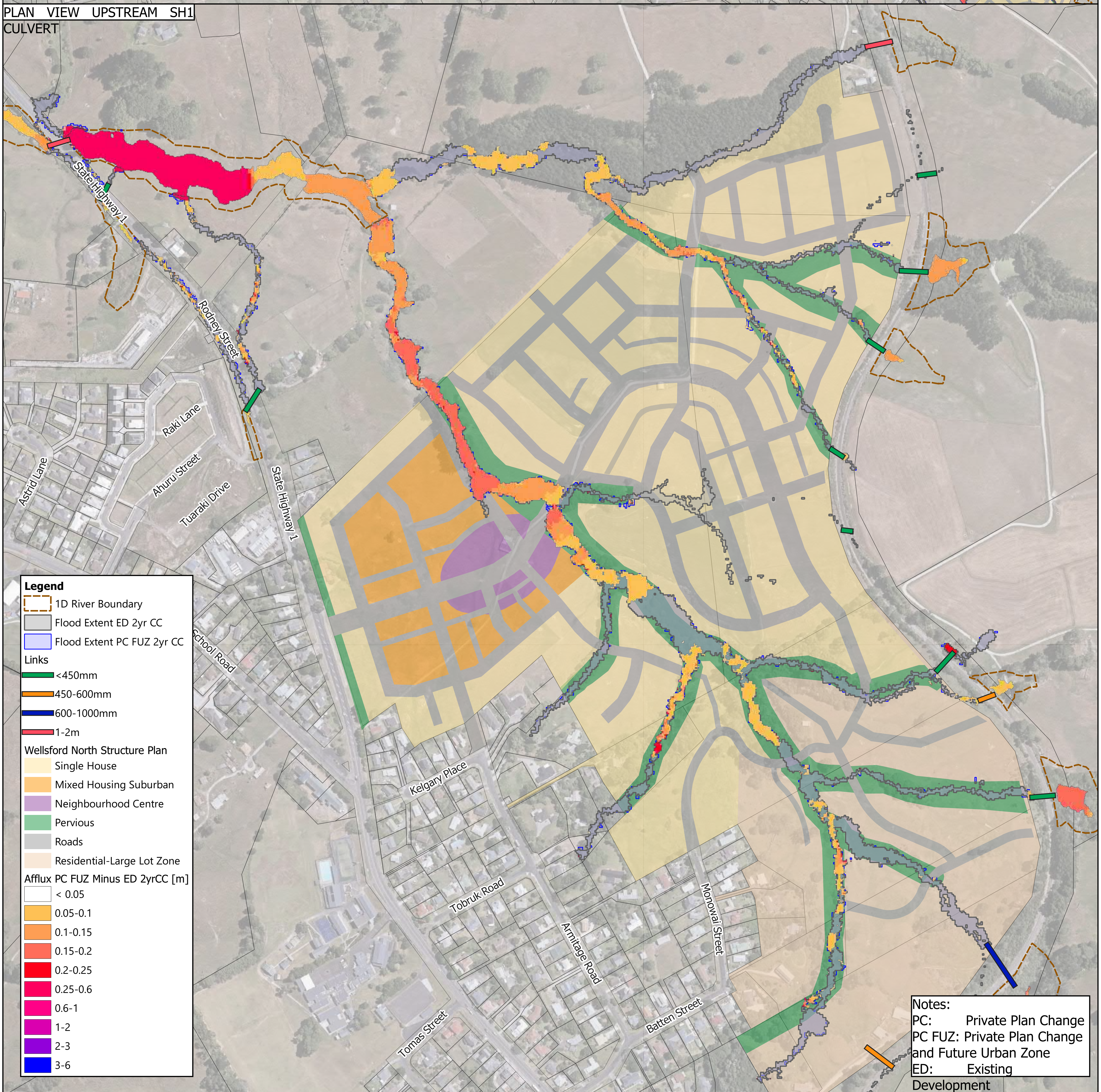

REVISION DETAILS	INT	DATE	SURVEYED	-
1.0 FOR INFORMATION	PW	30/05/2023	DESIGNED	MH
- -	-	-	DRAWN	HC
- -	-	-	CHECKED	TW
- -	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC FUZ 2yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-0008	

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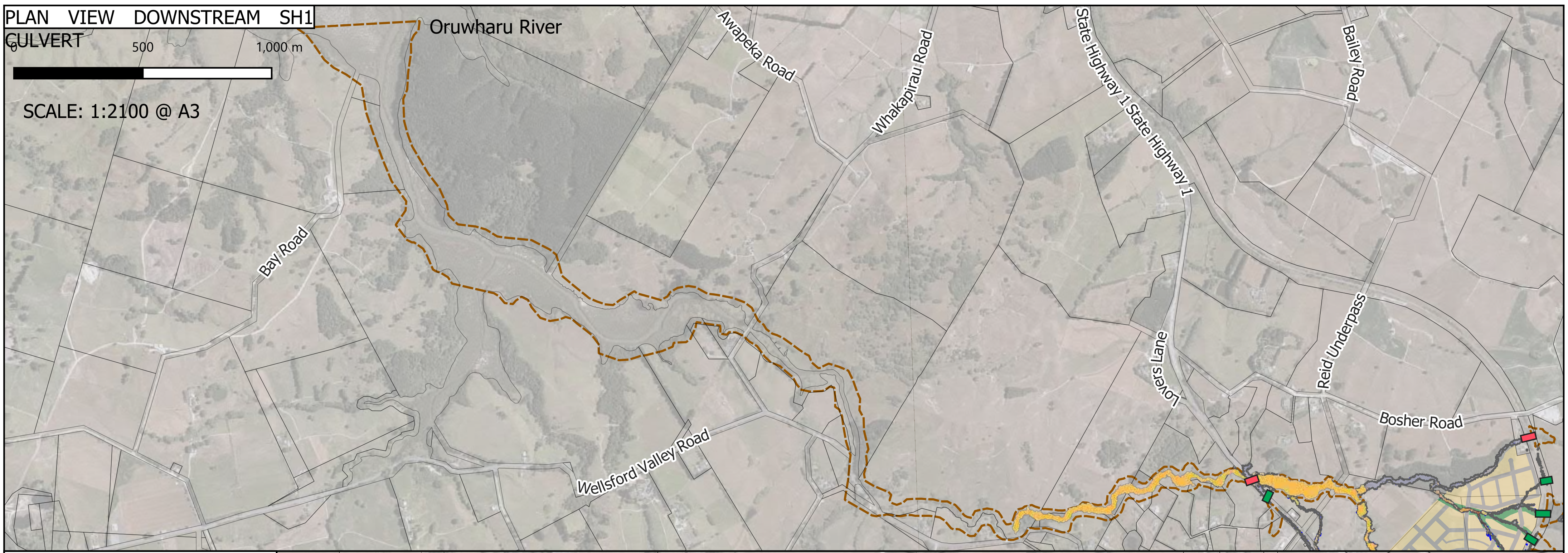

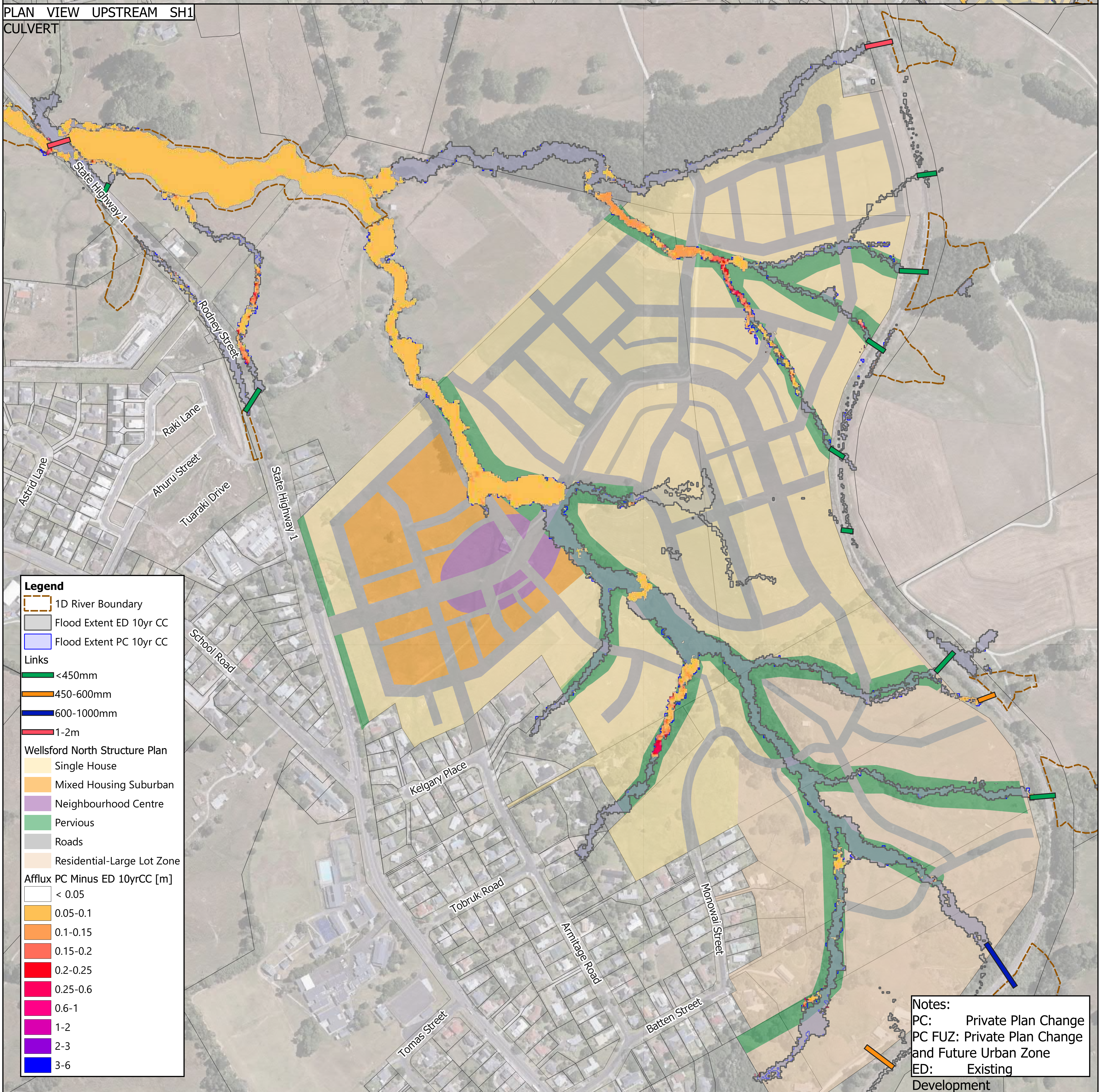

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH
-	-	-	-	DRAWN	HC
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD

WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC 10yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-0009	

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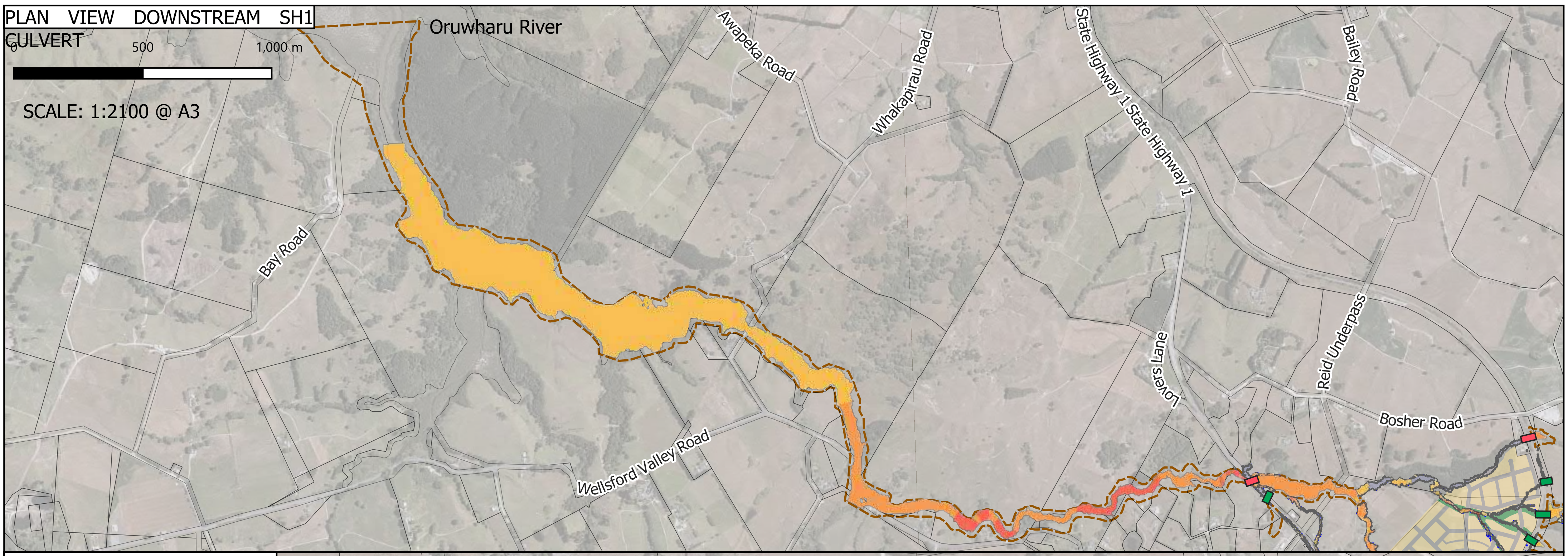

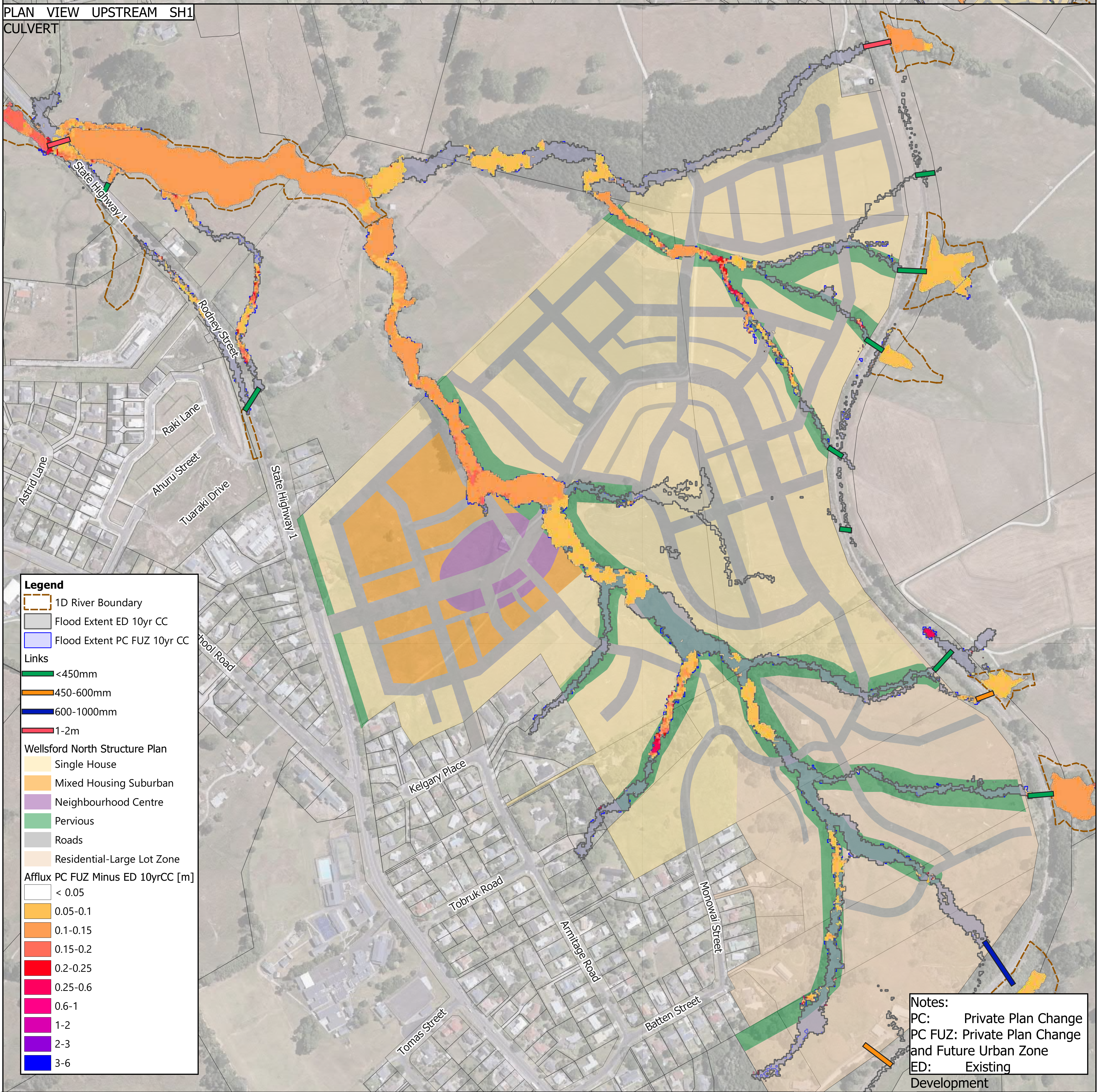

REVISION DETAILS		INT	DATE	SURVEYED	-		Wellsford North Plan Change	STATUS	ISSUED FOR INFORMATION	REV
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH	Level 8/139 Quay Street Auckland CBD	Stormwater Model Results	SCALE	1:5300 @ A3	1.0
-	-	-	-	DRAWN	HC		Afflux Plot - ED Vs PC FUZ 10yr CC (SWCoPv3-3.8°c)	COUNCIL	AUCKLAND COUNCIL	
-	-	-	-	CHECKED	TW			DWG NO.	P21-395-SKT-00010	
-	-	-	-	APPROVED	-	WOODS.CO.NZ				

WOODS Est.1970

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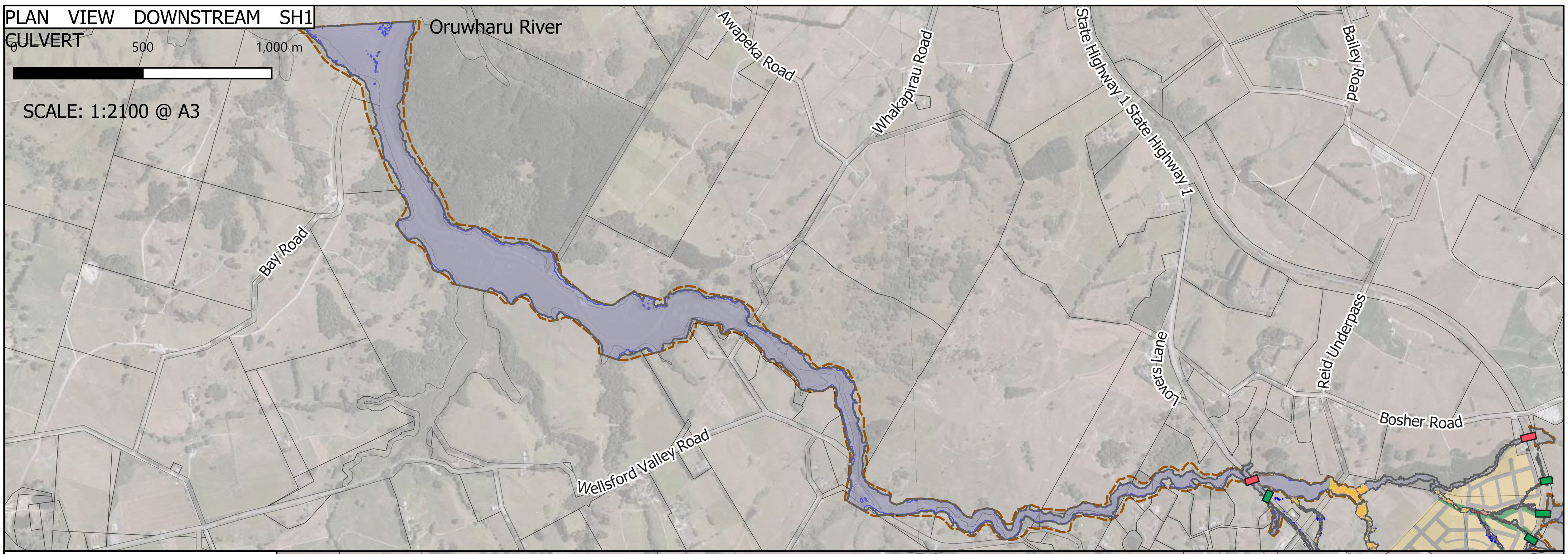

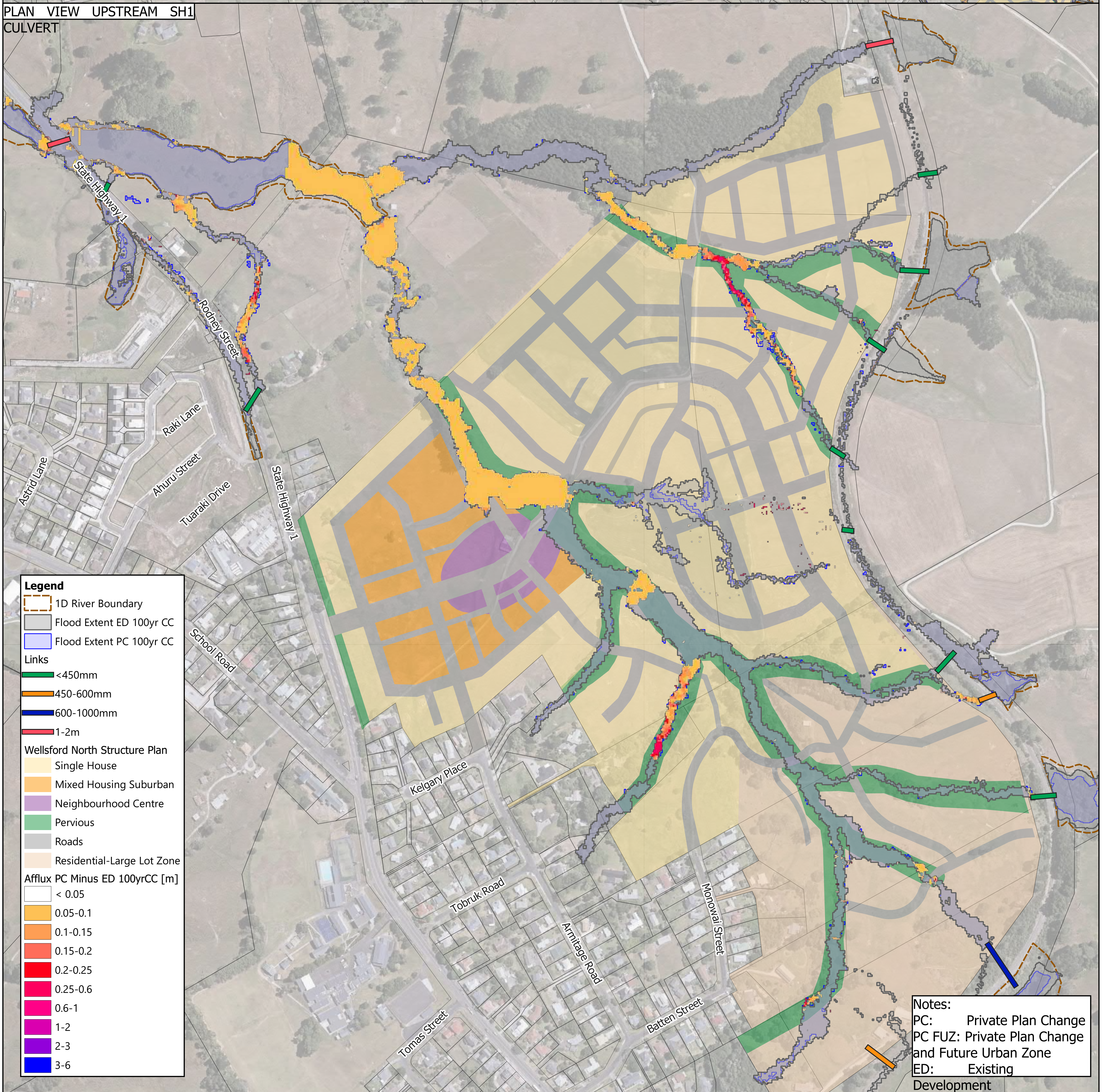

REVISION DETAILS		INT	DATE		
1.0	FOR INFORMATION	PW	30/05/2023	SURVEYED	-
-	-	-	-	DESIGNED	MH
-	-	-	-	DRAWN	HC
-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC 100yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-00011	

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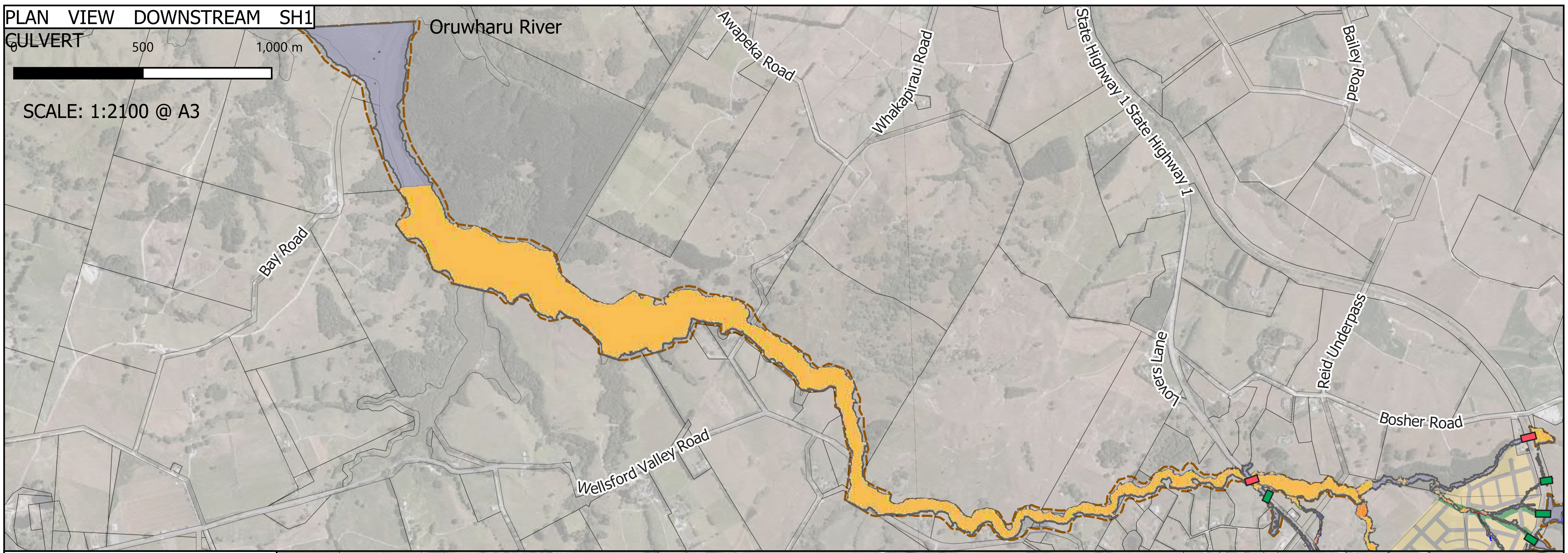

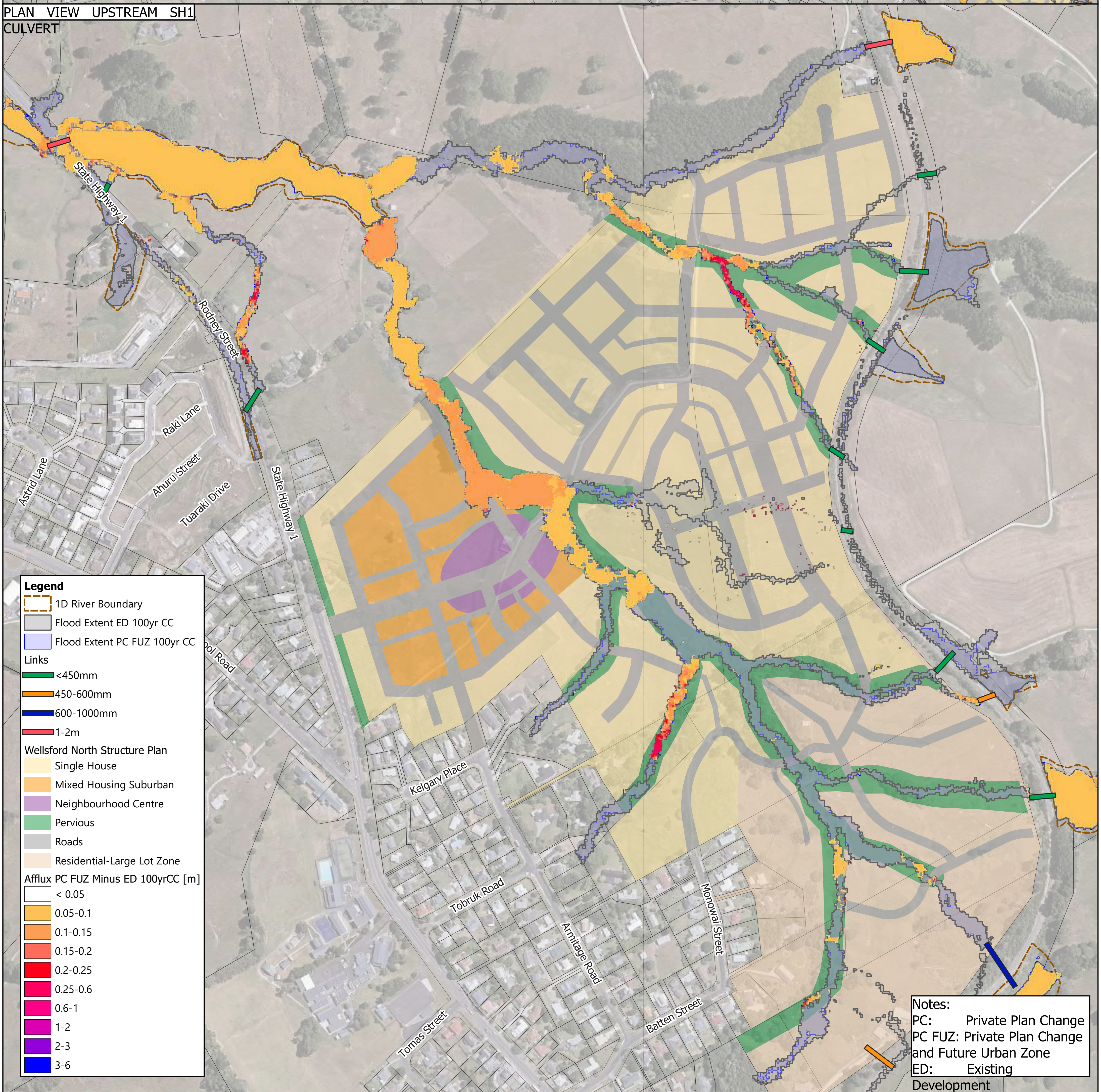

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	FOR INFORMATION	PW	30/05/2023	DESIGNED	MH
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-	-	-	-	CHECKED	TW
-	-	-	-	APPROVED	-

Level 8/139
Quay Street
Auckland CBD
WOODS.CO.NZ

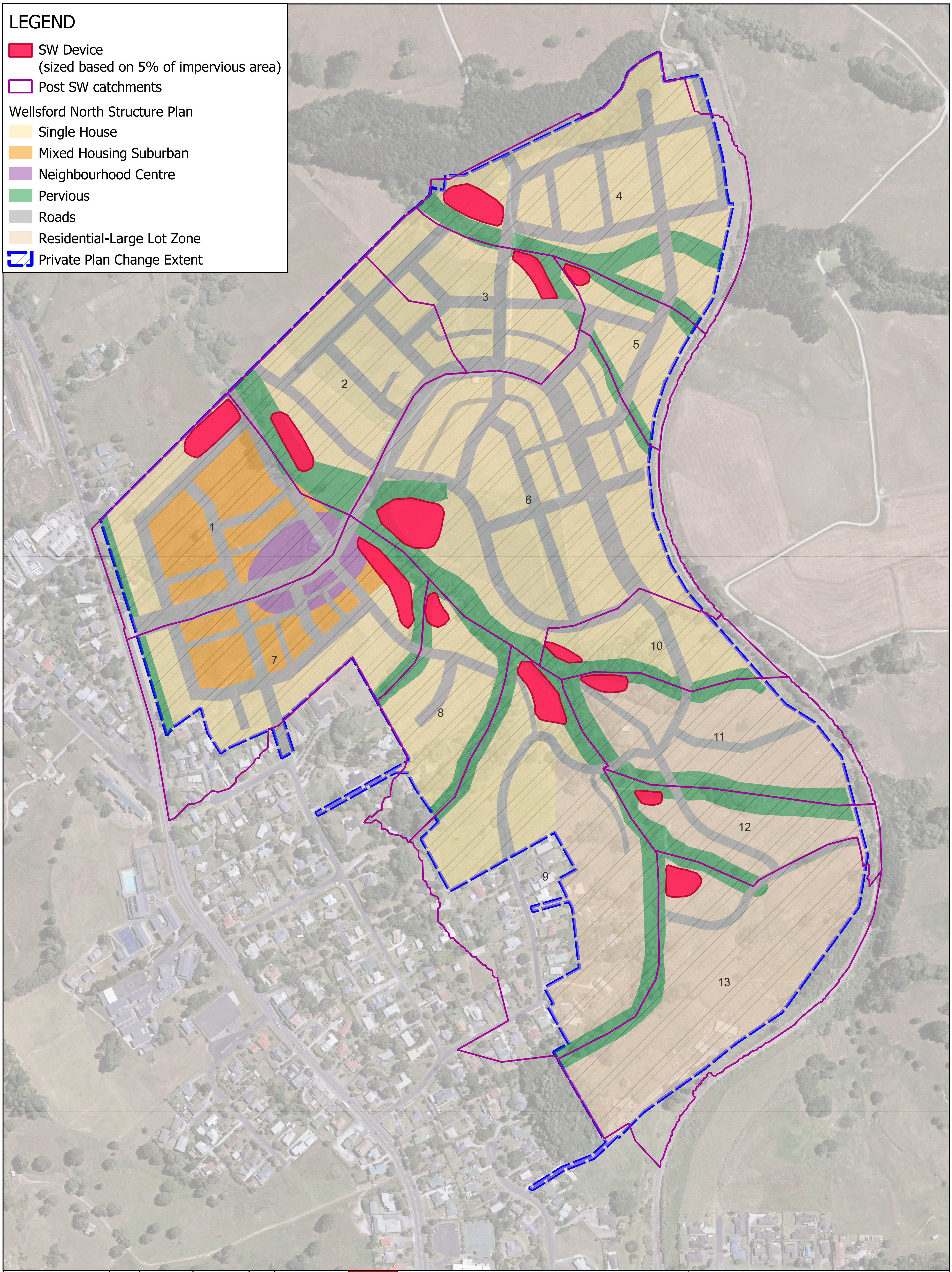
WOODS Est.1970

Wellsford North Plan Change
Stormwater Model Results
Afflux Plot - ED Vs PC FUZ 100yr CC (SWCoPv3-3.8°c)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:5300 @ A3	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	P21-395-SKT-00012	

This drawing was generated from QGISX:\Stormwater\ICM Models SW\Wellsford\Wellsford_MapResults_20221206.qgz

Appendix H
Device Plan and SMAF calculations



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-	-	-	-	CHECKED	-
-	-	-	-	APPROVED	-

BUILDING B, LEVEL - 1, NUGENT STREET, GRAFON, AKL - 1023

WOODS.CO.NZ

WOODS Est.1970

P21-395 WELLSFORD NORTH PLAN CHANGE
STORMWATER DEVICES- PROPOSED LOCATION

STATUS	ISSUED FOR PLAN CHANGE	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
DWG NO.	SHEET 1 OF 1	

PROJECT NUMBER: P21-460
ADDRESS: Wellsford
BY: TW
DATE: 3/12/2021

SMAF 1

SMAF TYPE	1	
RAINFALL EVENT:	95th Percentile	
RAINFALL DEPTH:	41.5	mm

	CN	S (mm)	Ia (mm)	Q (mm)
Permeable	74	89.24	5	10.60
Impermeable	98	5.18	0	36.89

Total Depth	26.3	mm
Retention Depth	5.0	mm
Detention Depth	21.3	mm

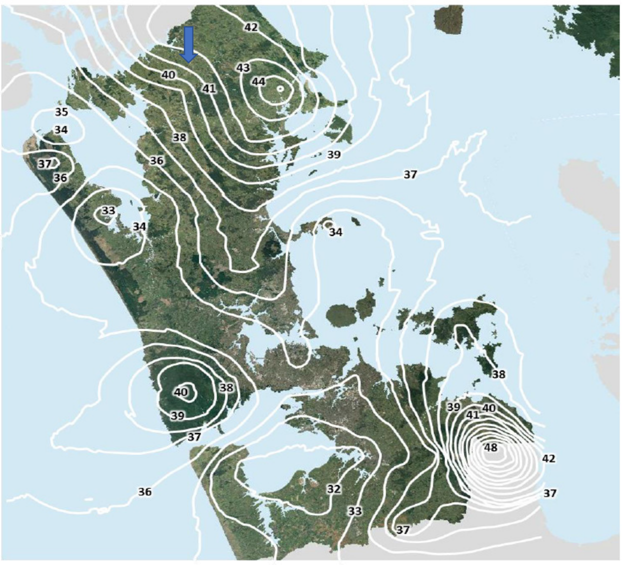

Figure 6: Map of 95th percentile 24-hour rainfall event
Source: Auckland Council TR 2013/035[10]

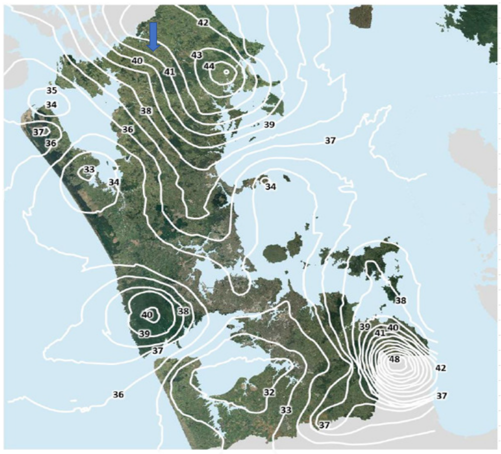

Figure 6: Map of 95th percentile 24-hour rainfall event
Source: Auckland Council TR 2013/035[10]