# EXHIBIT STATEMENT OF EVIDENCE OF KATHLEEN THIEL-LARDON

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## **Maps of Site Context**

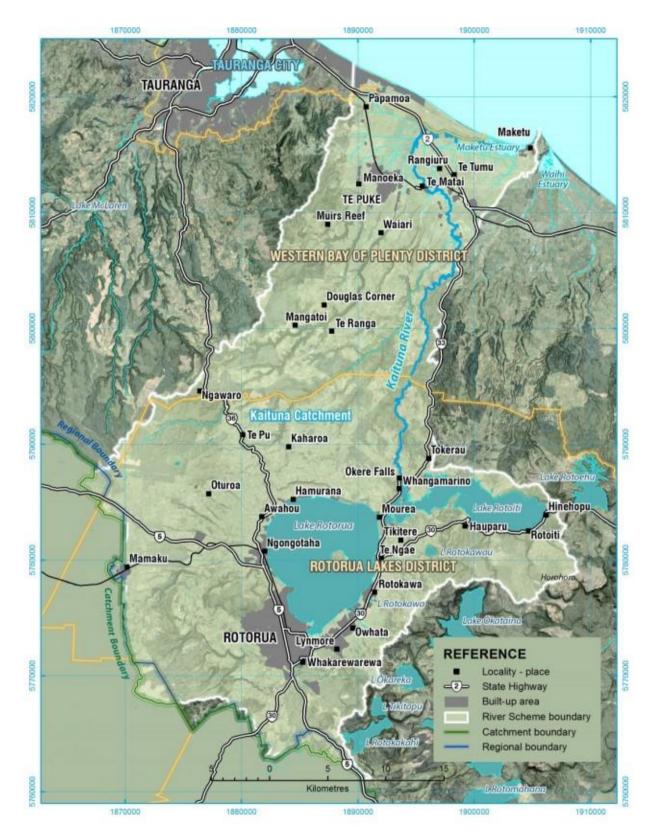


Figure 1: Kaituna Catchment

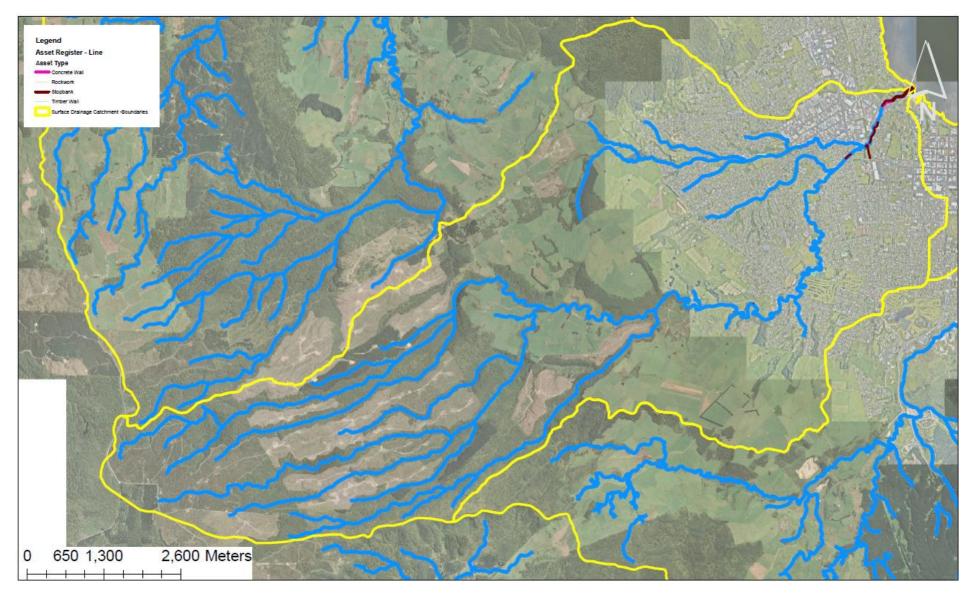


Figure 2: Utuhina Catchment

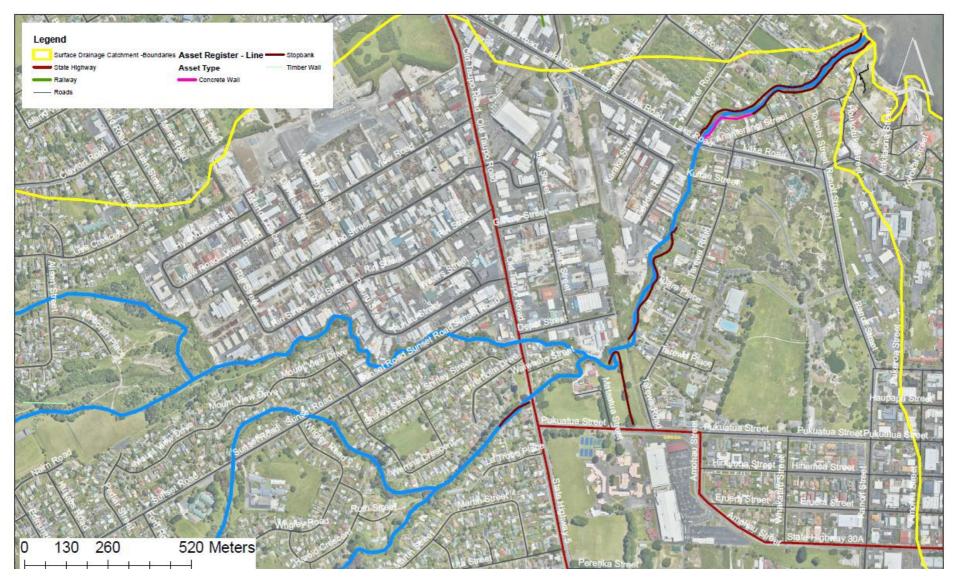


Figure 3: Lower Utuhina Flood Protection Assets

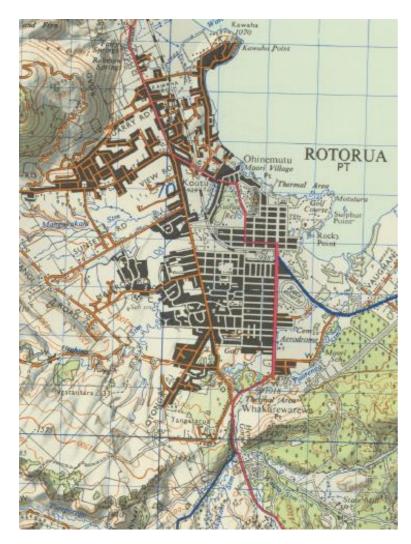


Figure 4: NZ Historical Topo Map NZMS1 – 1979

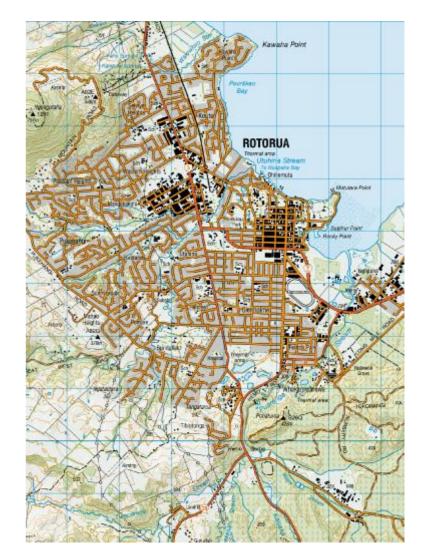
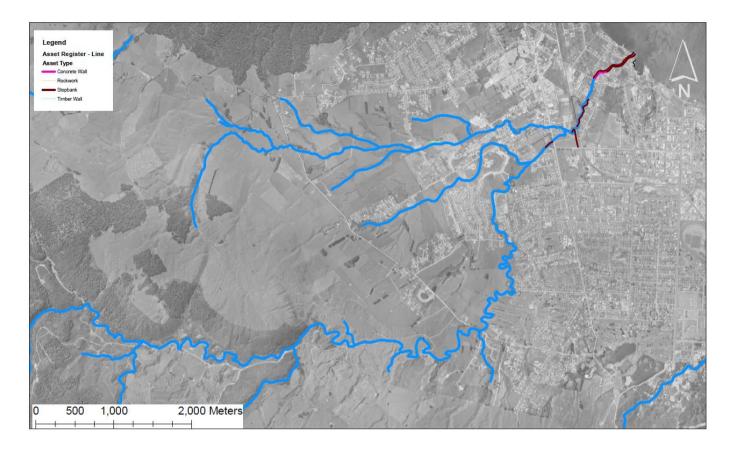
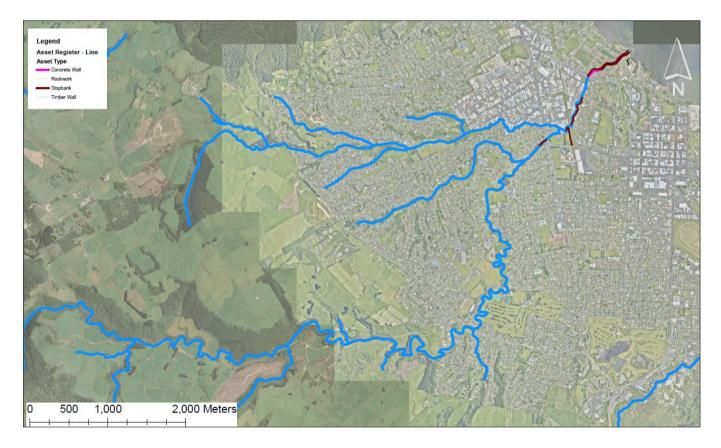


Figure 5: NZ Topo Map NZTM - 2019



#### Figure 6: Aerial Image 1966-1969



#### Figure 7: Aerial Image 2015-2018

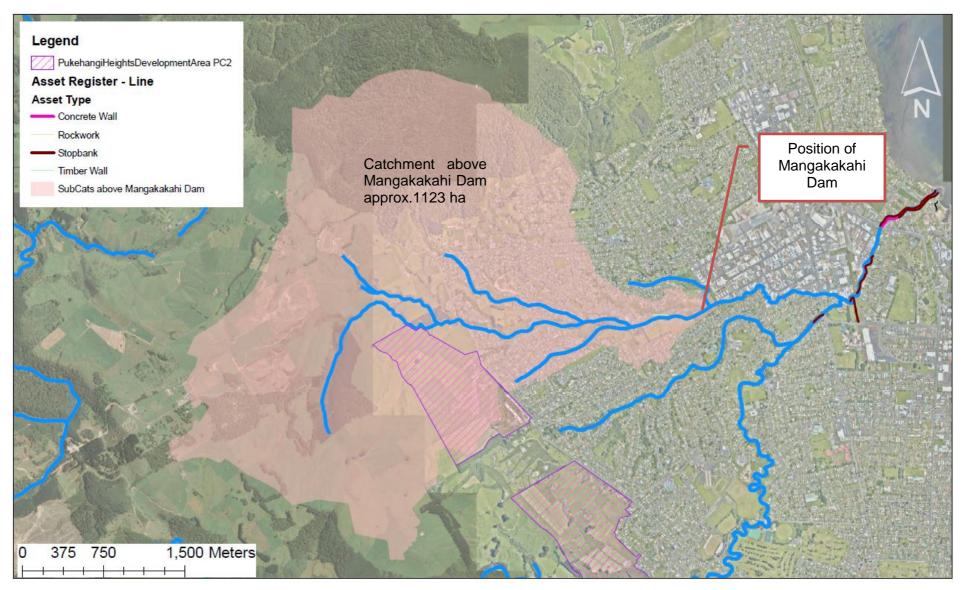


Figure 8: Mangakakahi Dam Catchment

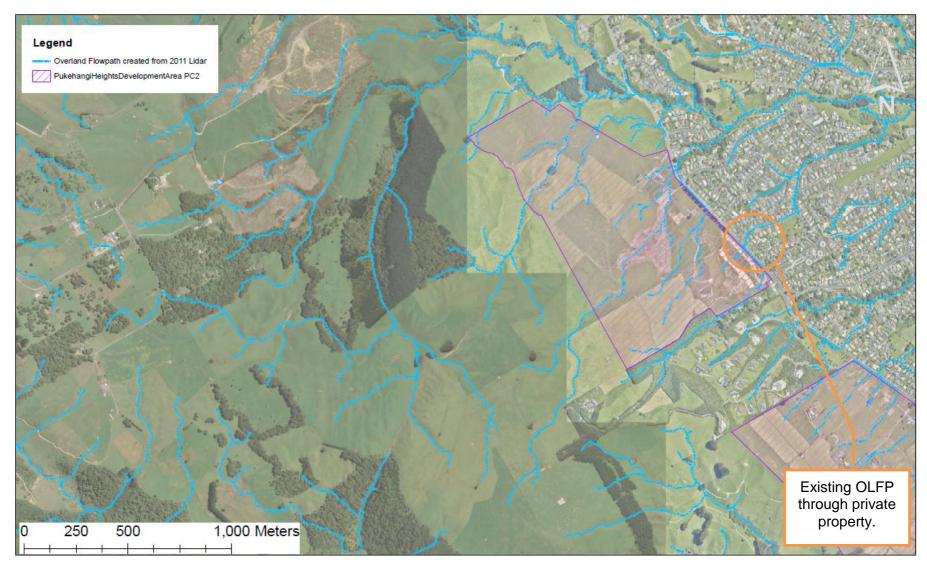


Figure 9: Pukehangi Plan Change Area – Overland flow path (OLFP) West

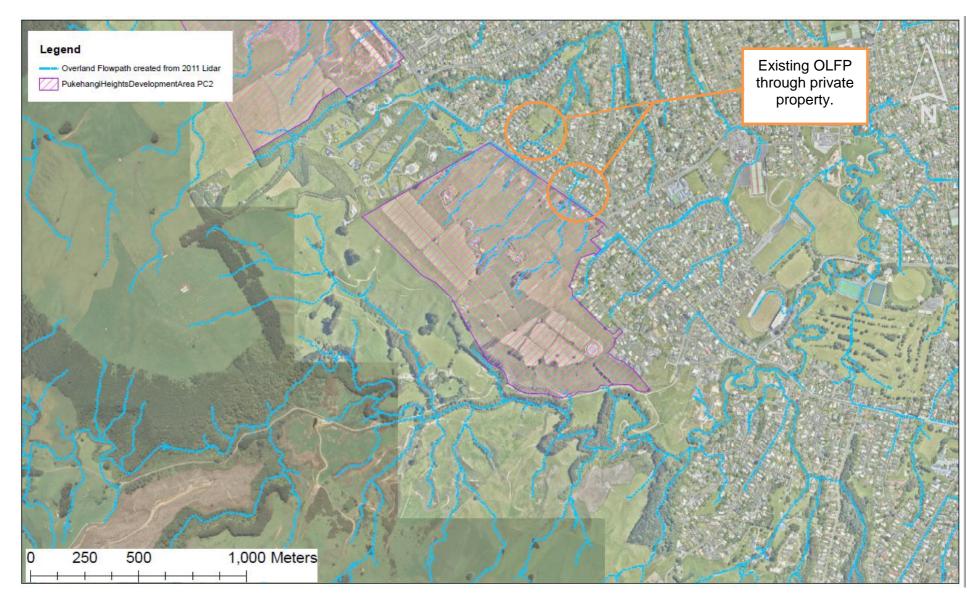


Figure 10: Pukehangi Plan Change Area – Overland Overland flow path (OLFP) East

## Maps – Overview of Flood Models

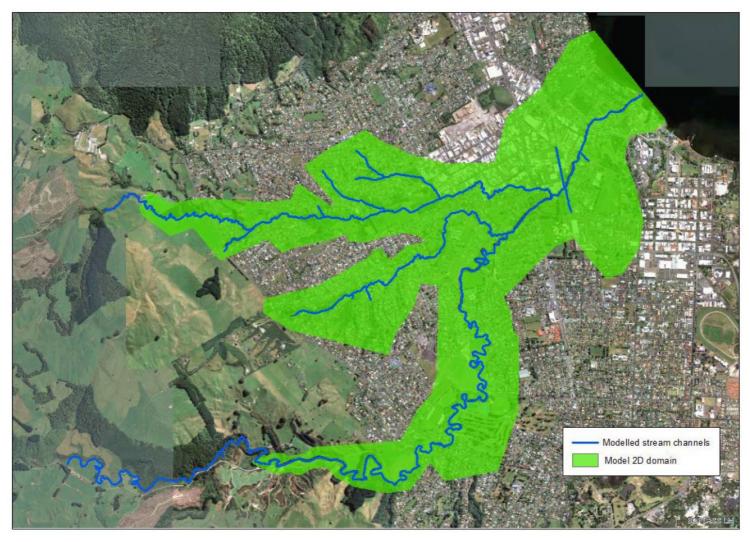


Figure 11: GUCM - Hydraulic Model layout (Mr Wallis)

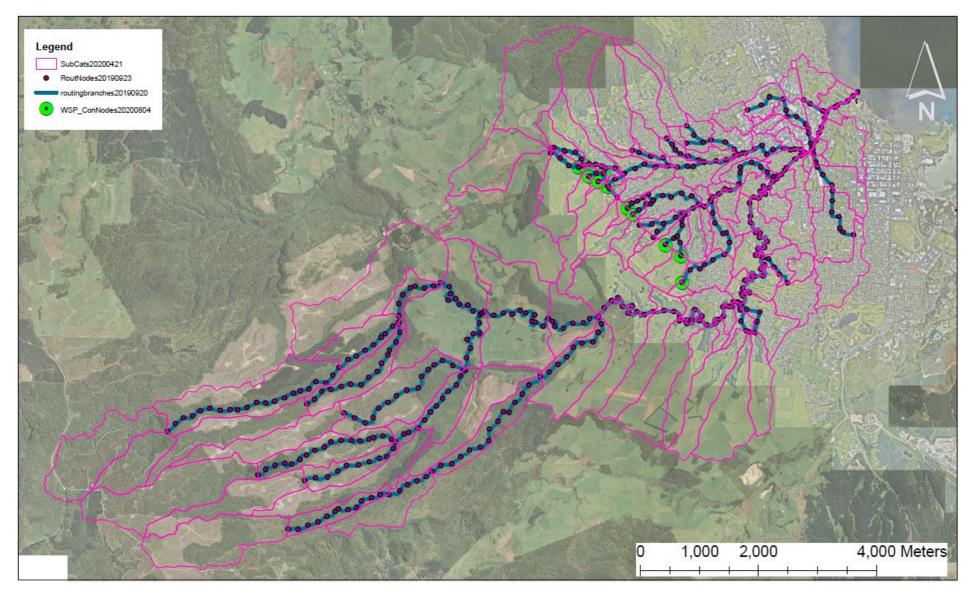


Figure 12: GUCM NRL Hydrological Model Layout (Mr West)

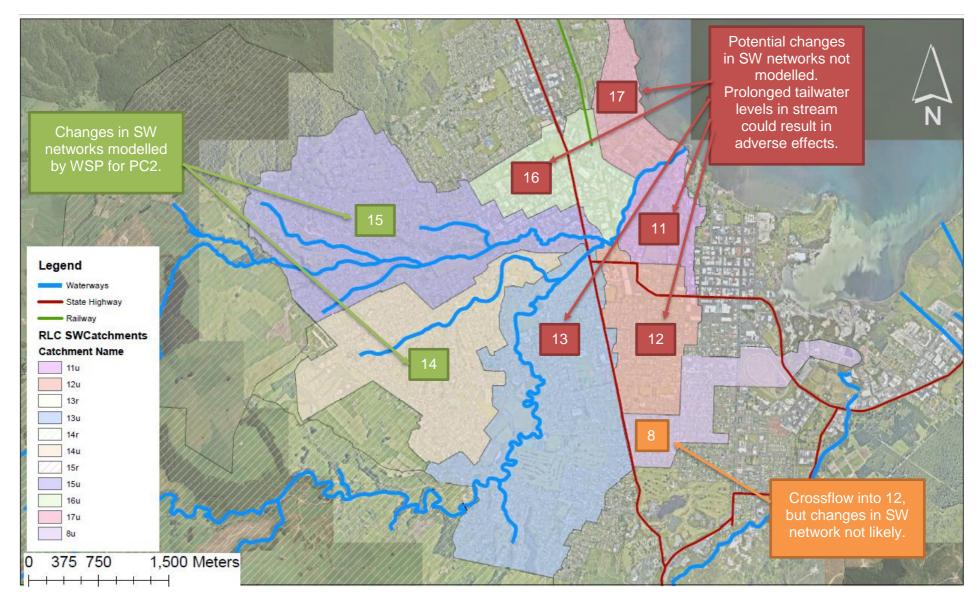


Figure 13: Rotorua Lakes Councils Stormwater Catchments

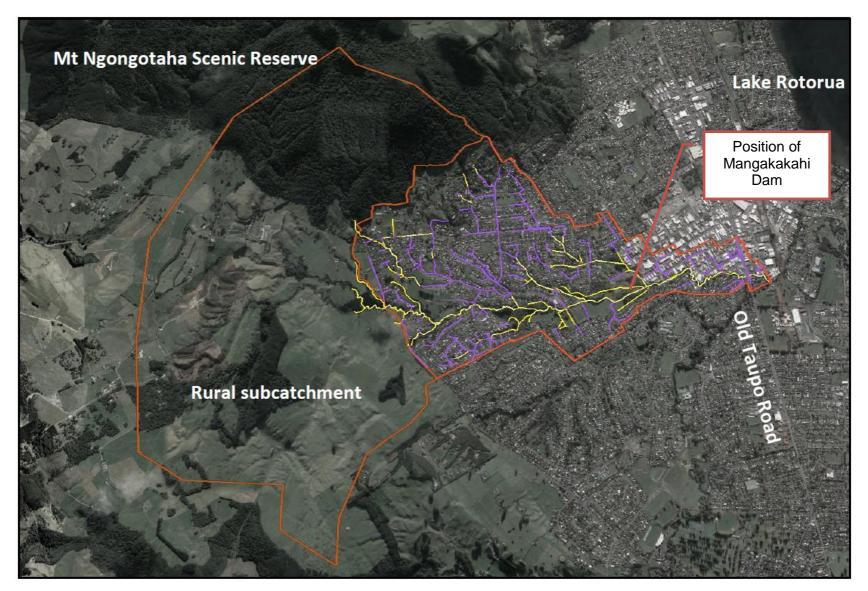
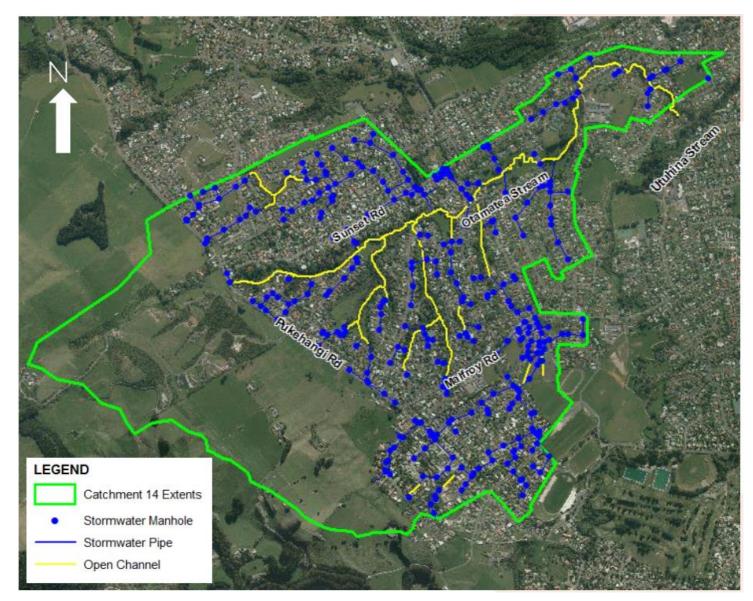


Figure 14: Rotorua Lakes Council – Catchment 15 model (RLC Stormwater Catchment 15 - Model Development Memo & System Performance Report)





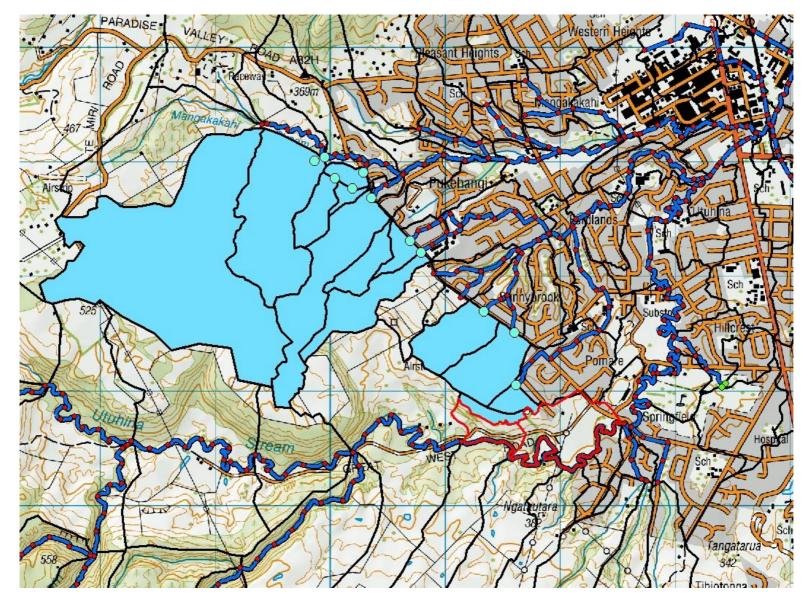


Figure 16: Rotorua Lakes Council – WSP Plan Change 2 model extent



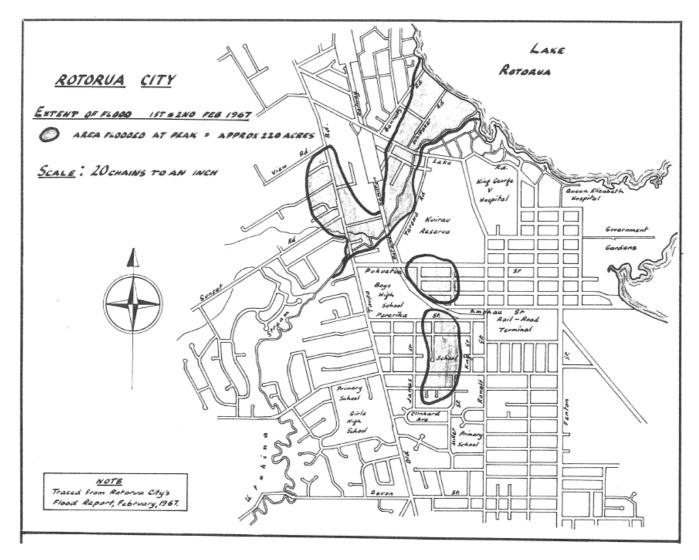
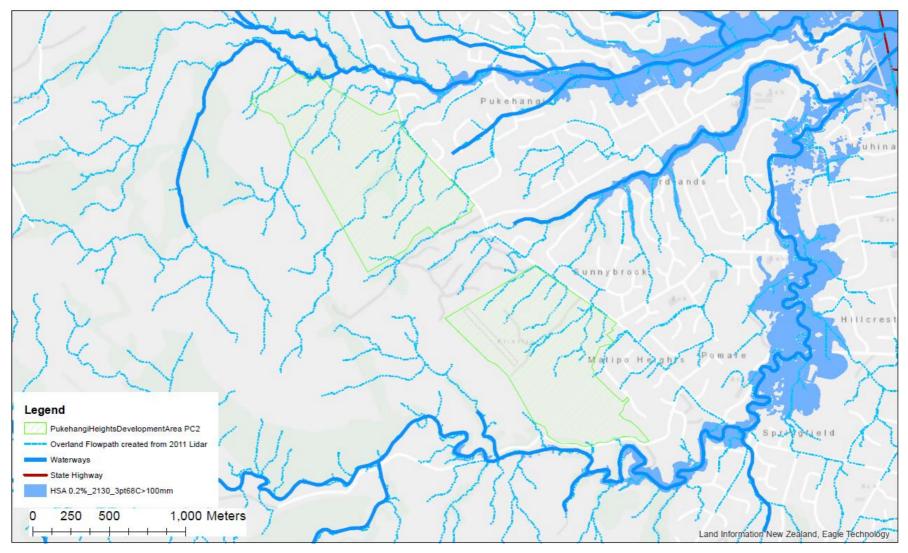


Figure 17: Extract from Kaituna River Major Scheme: Volume 5 - Plans Lakes Rotorua and Rotoiti

### **Overview of Existing Flood Risk**





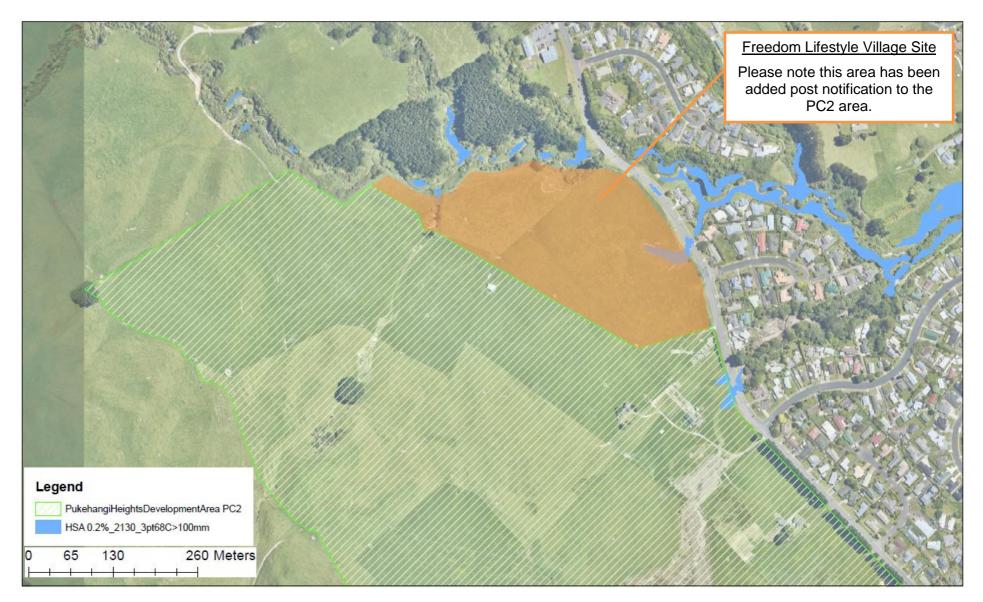


Figure 19: Flood Susceptibility Area (HSA) - 0.2% AEP 2130 >100mm flood extent from GUCM only– existing urban environment – Mangakakahi



Figure 20: Flood Susceptibility Area (HSA) - 0.2% AEP 2130 >100mm flood extent from GUCM only- existing urban environment - Utuhina

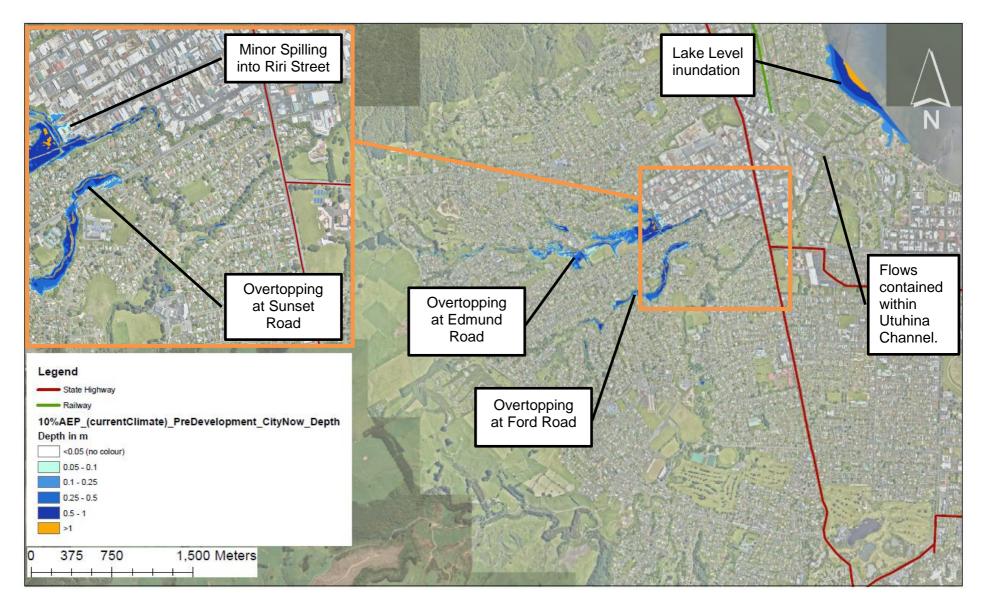


Figure 21: 10% AEP current climate pre-development flood extent from GUCM (Lower Utuhina) – existing urban environment – Depth

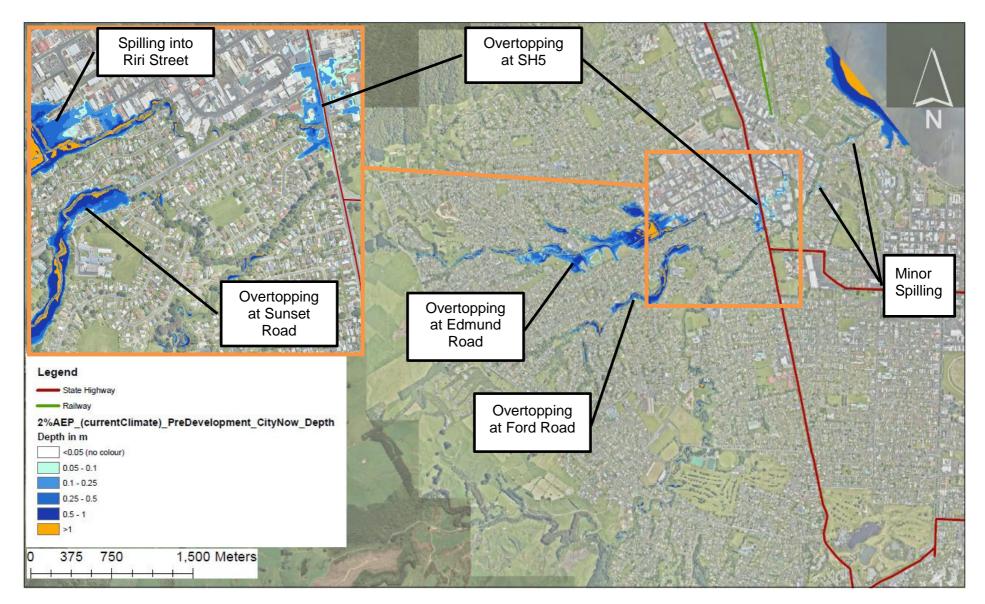


Figure 22: 2% AEP current climate pre-development flood extent from GUCM (Lower Utuhina) – existing urban environment – Depth

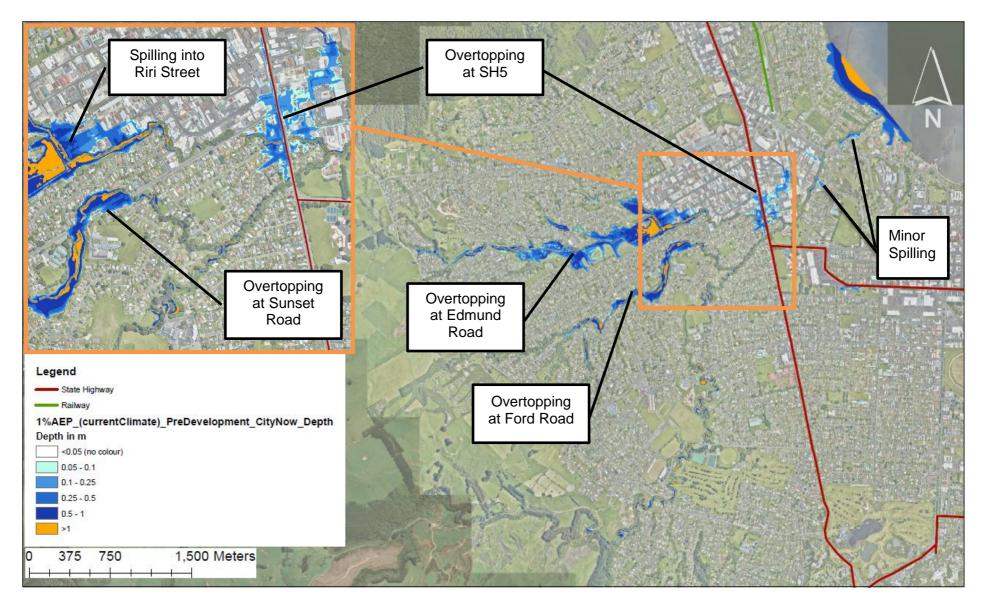


Figure 23: 1% AEP current climate pre-development flood extent from GUCM (Lower Utuhina) – existing urban environment – Depth

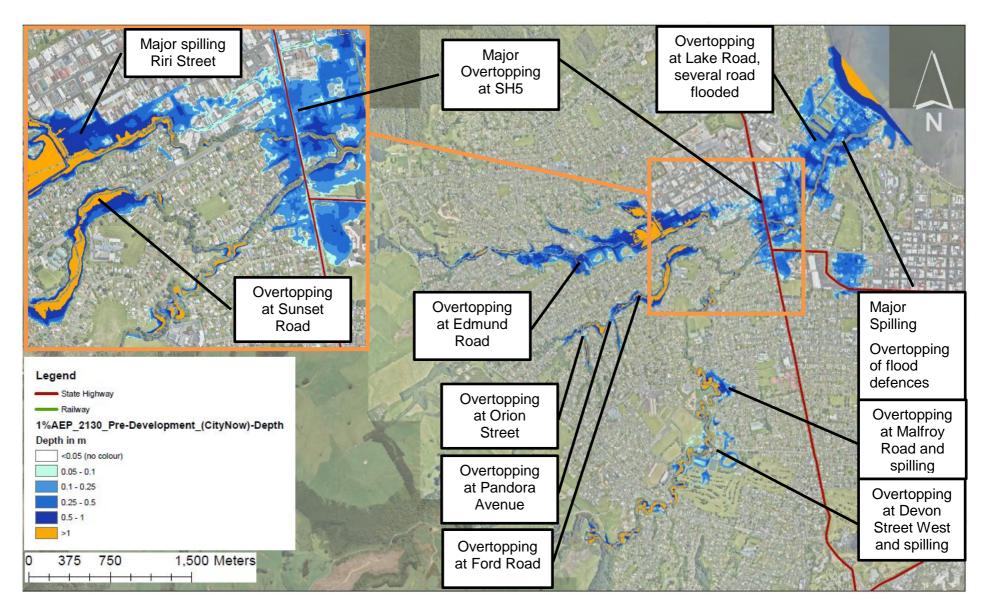


Figure 24: 1% AEP 2130 pre-development flood extent from GUCM (Lower Utuhina) – existing urban environment – Depth

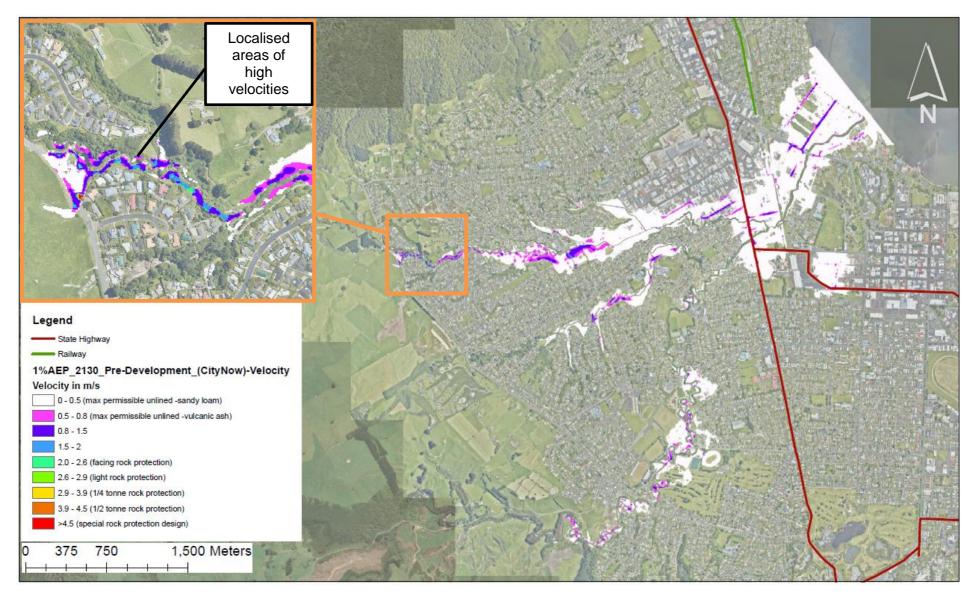


Figure 25: 1% AEP 2130 pre-development flood extent from GUCM (Lower Utuhina) – existing urban environment – Velocity

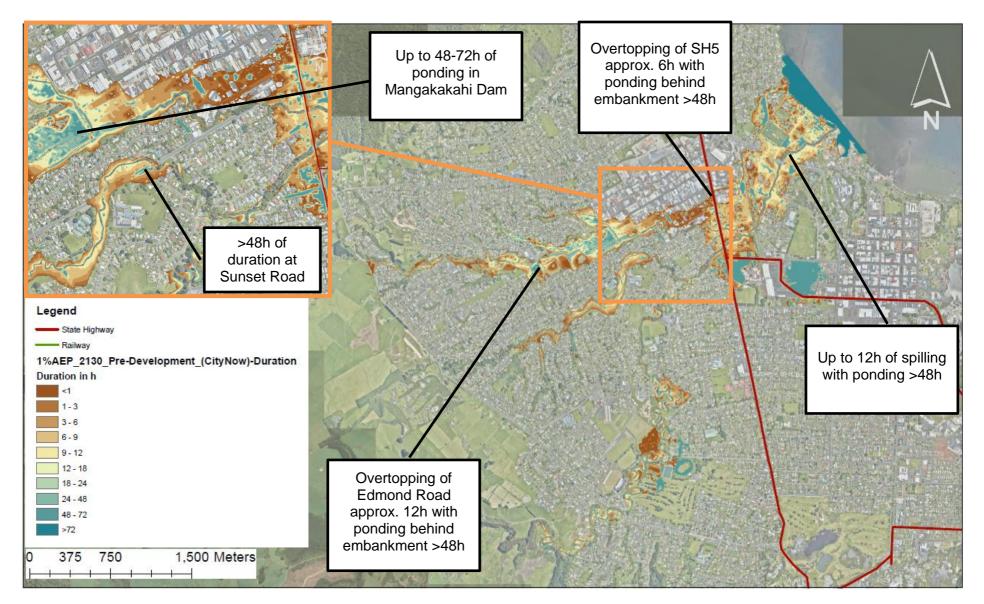


Figure 26: 1% AEP 2130 pre-development flood extent from GUCM (Lower Utuhina) – existing urban environment – Duration

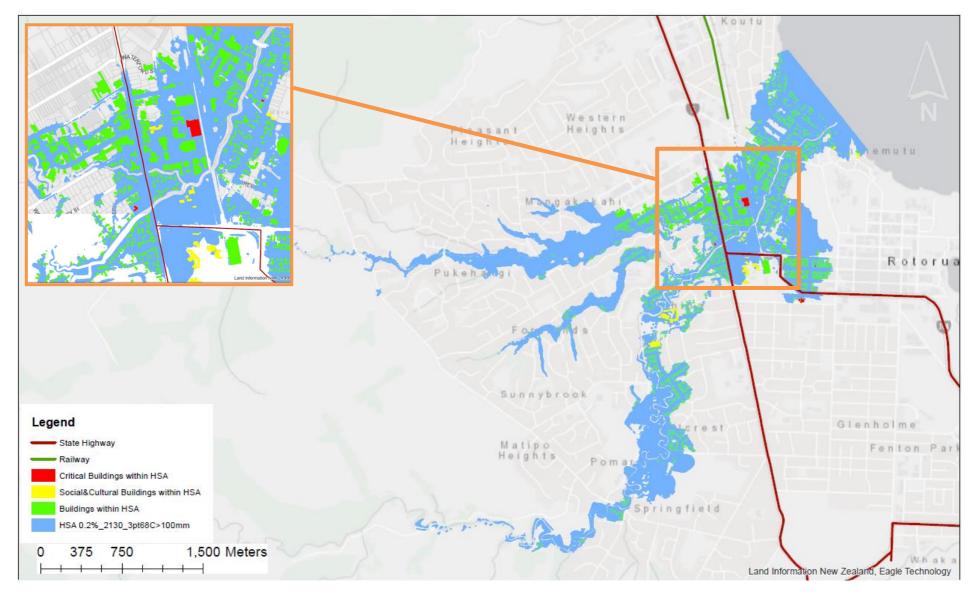


Figure 27: Hazard Susceptibility Area (fluvial flooding only) > 100mm peak during 0.2% AEP 2130 – existing urban environment

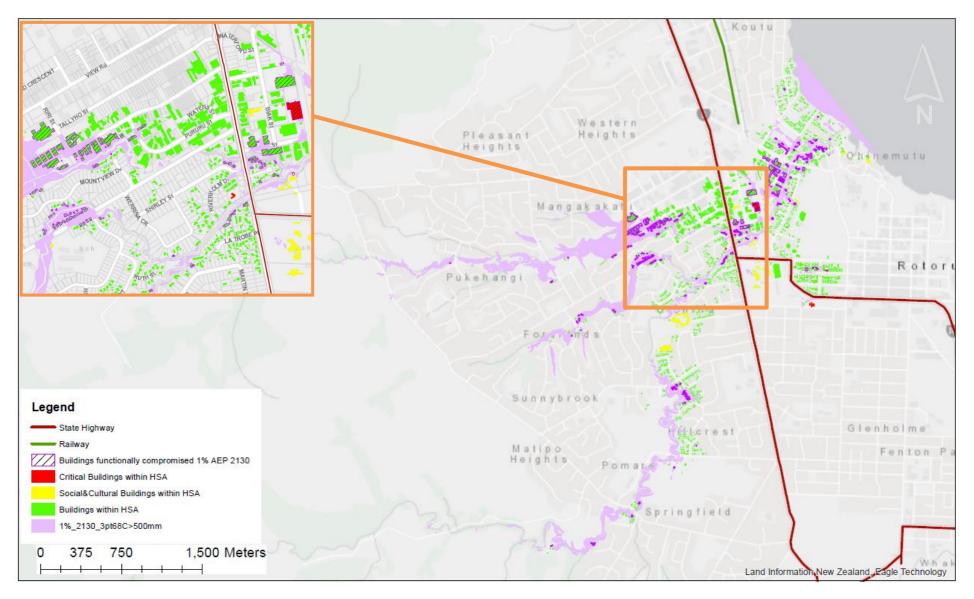


Figure 28: Primary Hazard Analysis Area (fluvial flooding only) > 500mm peak during 1% AEP 2130 – existing urban environment

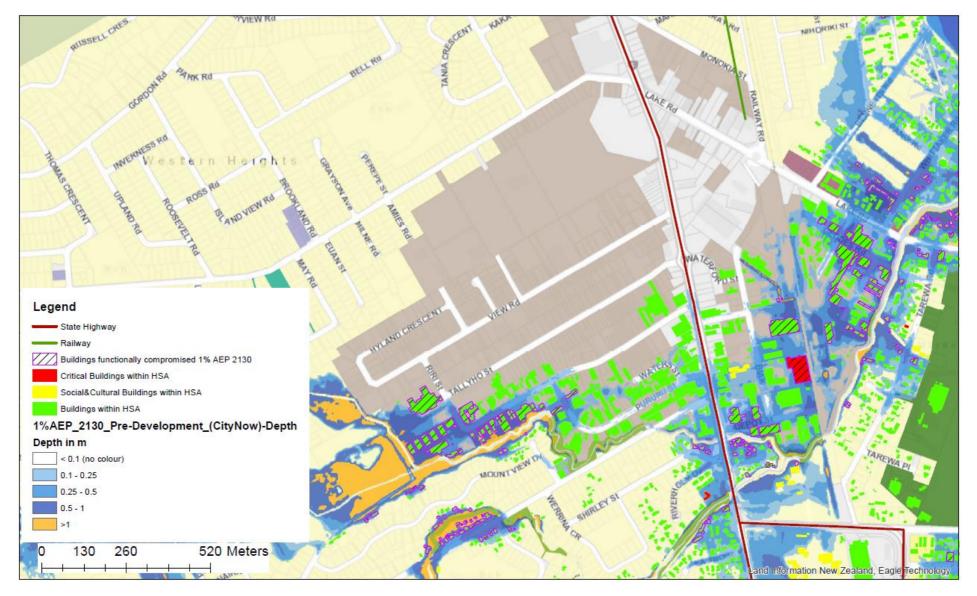


Figure 29: 1% AEP 2130 – existing urban environment – industrial zone

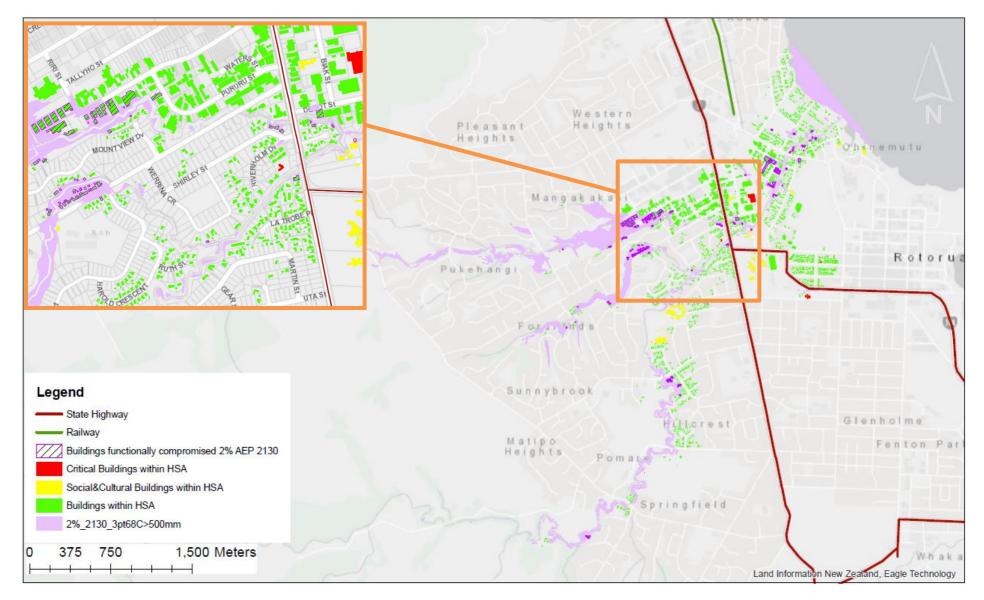


Figure 30: Secondary Hazard Analysis Area (fluvial flooding only) > 500mm peak during 2% AEP 2130 – future urban environment

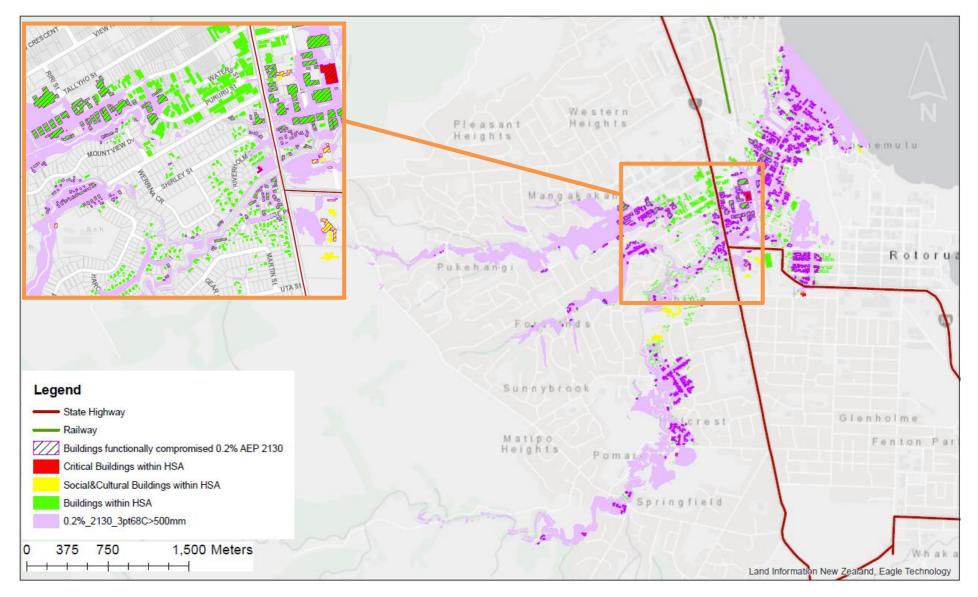
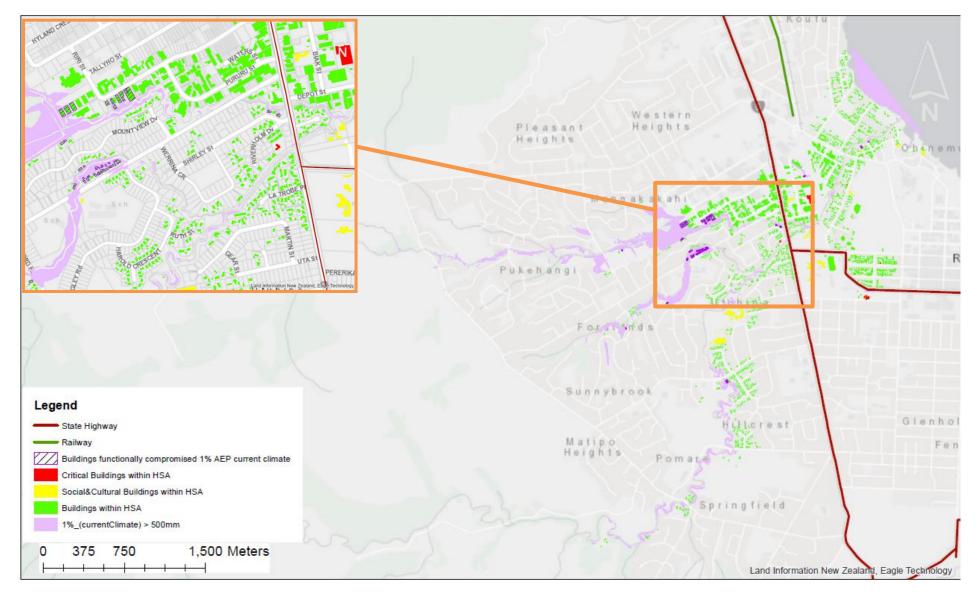


Figure 31: Secondary Hazard Analysis Area (fluvial flooding only) > 500mm peak during 0.2% AEP 2130 – future urban environment



#### Figure 32: Primary Hazard Analysis Area (fluvial flooding only) > 500mm peak during 1% AEP 2020 – existing urban environment

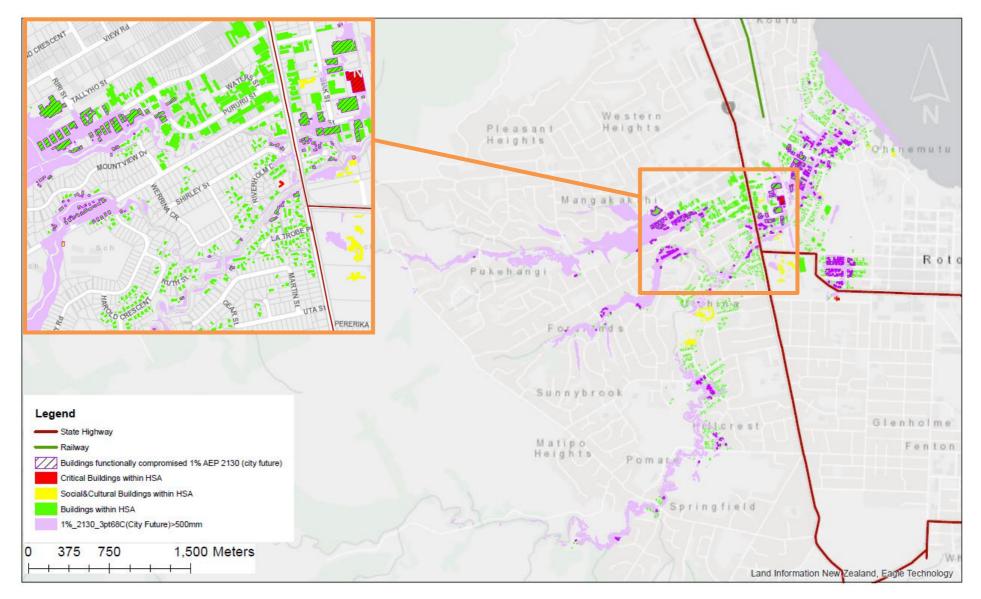


Figure 33: Primary Hazard Analysis Area (fluvial flooding only) > 500mm peak during 1% AEP 2130 – future urban environment

HSA - area covered in flooding greater than 100mm during the 0.2% City Now 2130

#### City Now with 100yr Climate Change (+10yr plan timeframe)

Functionally compromised building counts for different events (2130 Climate + existing urban environment)

		Finished Floor Level				Finished Floor Level					Finished Floor L	evel		
			On Piles*		50 year		On Piles*		100 year		On Piles*		500 year	
					Likelihood				Likelihood				Likelihood	
			50yr 2130 > 0.	5m	>=2% AEP		100yr 2130 > 0.	5m	<2-1% AEP		500yr 2130 > 0.	5m	<1-0.1	
Building Type	Total No. in HSA	No.	% compromised	Consequence Level	Risk Level	No.	% compromised	Consequence Level	Risk Level	No.	% compromised	Consequence Level	Risk Level	Overall Risk
miscellaneous														
buildings	1687	111	6.58%	minor	medium	241	14.29%	moderate	medium	865	51.27%	catastrophic	high	
social/cultural														high
buildings	46	3	6.52%	moderate	medium	4	8.70%	moderate	medium	16	34.78%	catastrophic	high	mgn
critical														
buildings	6	0	0.00%	insignificant	low	1	16.67%	major	medium	3	50.00%	catastrophic	high	

\* count will under predict in industrial areas where slab on ground is more likely

#### Figure 34: Risk Assessment Overview - Primary and Secondary Hazard Analysis 2130 (fluvial flooding only)

HSA - area covered in flooding greater than 100mm during the 0.2% City Now 2130

#### City Now with current climate

Functionally compromised building counts for different events (Current Climate + existing urban environment)

			On Piles *		100 year	
		1	.00yr 2020 > 0.5		Likelihood	
			.00yi 2020 > 0.5i		<2-1% AEP	
	Total No. in		%	Consequence	Risk Level	Overall Risk
Building Type	HSA	No.	compromised	Level	NISK LEVEL	Overall Nisk
miscellaneous						
buildings	1687	44	2.61%	minor	low	
social/cultural						low
buildings	46	1	2.17%	minor	low	1044
critical						
buildings	6	0	0.00%	insignificant	low	

#### City Now with 100yr Climate Change (+10yr plan timeframe)

Functionally compromised building counts for different events (2130 Climate + existing urban environment)

			On Piles*		100 year	
					Likelihood	
		1	100yr 2130 > 0.5	m	<2-1% AEP	
	Total No. in		%	Consequence	Risk Level	Overall Risk
Building Type	HSA	No.	compromised	Level	NISK LEVEI	Overall Kisk
miscellaneous						
buildings	1687	241	14.29%	moderate	medium	
social/cultural						medium
buildings	46	4	8.70%	moderate	medium	mealum
critical						
buildings	6	1	16.67%	major	medium	

#### City Future with 100yr Climate Change (+10yr plan timeframe)

Functionally compromised building counts for different events (2130 Climate + future urban environment)

	HSA (worst	Fi	inished Floor Lev	el		
	case)		On Piles*		100 year	
					Likelihood	
		1	.00yr 2130 > 0.5	m	<2-1% AEP	
	Total No. in		%	Consequence	Risk Level	Overall Risk
Building Type	HSA	No.	compromised	Level	RISK LEVEL	Overall Kisk
miscellaneous						
buildings	1687	271	16.06%	moderate	medium	
social/cultural						hiah
buildings	46	5	10.87%	moderate	medium	high
critical						
buildings	6	2	33.33%	catastrophic	high	

\* count will under predict in industrial areas where slab on ground is more likely

Figure 35: Risk Assessment Overview – Comparative Primary Hazard Analysis (fluvial flooding only)

	Consequences						
Likelihood (ARI - years)	Insignificant	Minor	Moderate	Major	Catastrophic		
>=2	low	medium	medium	high	high		
<2 <b>-</b> 1	low	low	medium	medium	high		
<1-0.1	low	low	medium	medium	high		
<0.1-0.04	low	low	low	low	medium		
<0.04	low	low	low	low	medium		

0.2% AEP = 1 in 500 year event	Secondary Analysis
1% AEP = 1 in 100 year event	Primary Analysis
2% AEP = 1 in 50 year event	Secondary Analysis
5% AEP = 1 in 20 year event	
10% AEP = 1 in 10 year event	
20% AEP = 1 in 5 year event	
50% AEP = 1 in 2 year event	
100% AEP = Happens every year	

# Quantitative analysis of consequence

Table 21 Consequence table with qualitative and quantitative descriptions.

	Built				
Buildings C	Critical buildings	Lifelines utilities	Health & safety		
social/cultural significance hazard assessment area within hazard assessment have functionality area have		A iffetine utility service is out for > 1 month (affecting > 20% of the toemicity population) QR out for > 8 months (affecting < 20% of the toemicity population).	>101 dead and/or >1001 injurid		
hazard assessment buil have functionality ass	ildings within hazard	A lifetine utility service is out for 1 week - 1 a out (affacting 2.20% of the townody poculation for it weeks to 6 rooming (affacting < 2000 on lownibity copulation).	11–100 (Bead ancive 101–1000 injured		
hazard assessment within have functionality are	in hazard assessment	A liteline utility service is dut for the T week (affecting 2.20% of the townicity of the townicity CP out for 1 week to 5 weeks (affect - 20% of the townicity popular))	2-10 dead and/or 11-100 injured		
d assessment area within ve functionality are	in hazard assessment	A lifetime utility service of for 2 hours to 1 day rathering 2 20% of the only population) CR out for 1 day to 1 week population; 20% of the townicity population;	s1 devid and/oc 1–10 injuriid		
d assessment area ass ve functionality		A lifetime utility service is out for up to 2 hours (affecting 2 20% of the rewricity population) QR out for up to 1 day (affecting = 20% of the tensicity population).	No dead. No injured		
	of buildings within a seesament area we functionality ompromised. 49% of buildings mazard assessment have functionality ompromised. 20% of buildings mazard assessment area ompromised. 4 buildings within a seesament area ompromised. 1-5 we functionality ompromised.	of buildings within assessment area within hazard assessment area have functionality compromised. 225% of critical buildings within hazard assessment area have functionality compromised.   49% of buildings mazerd assessment have functionality compromised. 11–24% of critical buildings within hazard assessment assessment area fave functionality compromised.   20% of buildings within hazard assessment area have functionality compromised. 6–10% of critical buildings within hazard assessment area have functionality compromised.   of buildings within assessment area within hazard assessment assessment area within hazard assessment assessment area, fully functional. 1–5% of critical buildings within hazard assessment assessment area, fully functional.   No damsge within assessment area, fully functional. No damsge within hazard assessment area, fully functional.	of buildings within a seessment area we functionality compromised.   225% of critical buildings within hazard assessment area have functionality compromised.   A theine utility service is out for > 1 month (affecting > 20% of the townisty pocketon)     49% of buildings marand assessment have functionality compromised.   11–24% of critical buildings within assessment area have functionality compromised.   A theine utility service is out for 1 week - 1 buildings within assessment area have functionality compromised.     20% of buildings asard assessment have functionality compromised.   6–10% of critical buildings within hazard assessment assessment area within hazard assessment area have functionality compromised.   A theine utility service is out for 1 week - 1 to the week of fronting tubering and the functionality compromised.     of buildings within hazard assessment area have functionality compromised.   1–5% of critical buildings within hazard assessment area have functionality compromised.   A theine utility service is out for 1 week of buildings within assessment area solve functionality compromised.     of buildings within assessment area whon contexplay   1–5% of critical buildings within hazard assessment area have functionality compromised.   A theine utility service is out for 2 hours to 1 day for 1 week and the promote of the townicity compromised.     of buildings within assessment area whon contexplay   1-5% of critical buildings assessment area assessment area whon contexplay   A theine utility service is out for up to 2 hours assessment area and the second of the townicity propulation) Of our assessment area aspontexplay		

NB for the purpose of Table 21:

 the term "town/city population" means the catchment of people within the hazard assessment area that is served by the lifeline utility, except that with respect to a lifeline utility that predominantly or exclusively serves a population outside the hazard assessment area, it means the population in the area served by the Meline utility.

· the applicable consequence level will be the one that corresponds to the row that represents the highest measured or estimated consequence.

Figure 36: Risk Assessment Overview – Risk Matrix and Consequence Table



Figure 37: Hazard Vulnerability Classification DxV 1% AEP 2020 pre-development – existing urban environment

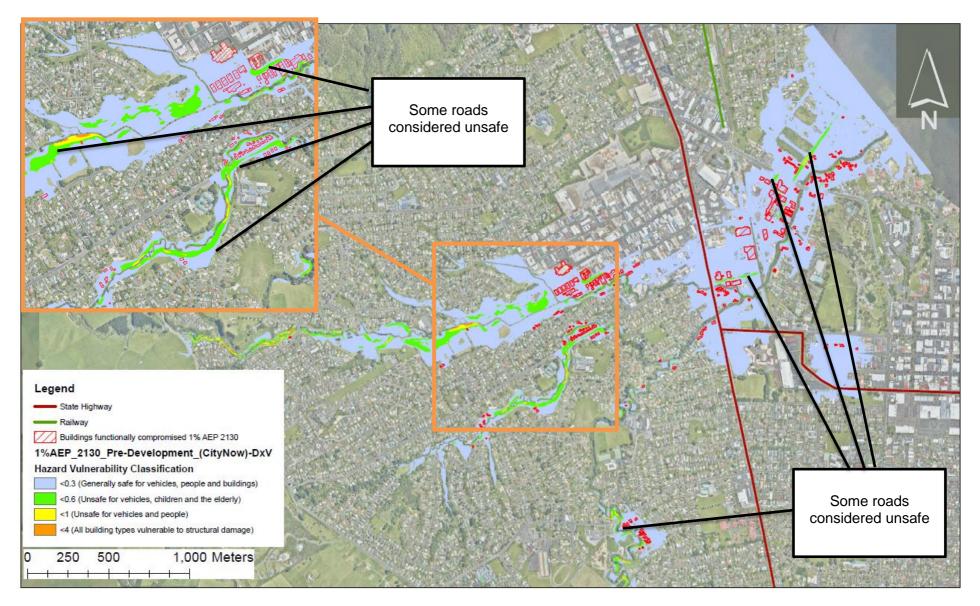


Figure 38: Hazard Vulnerability Classification DxV 1% AEP 2130 pre-development – existing urban environment

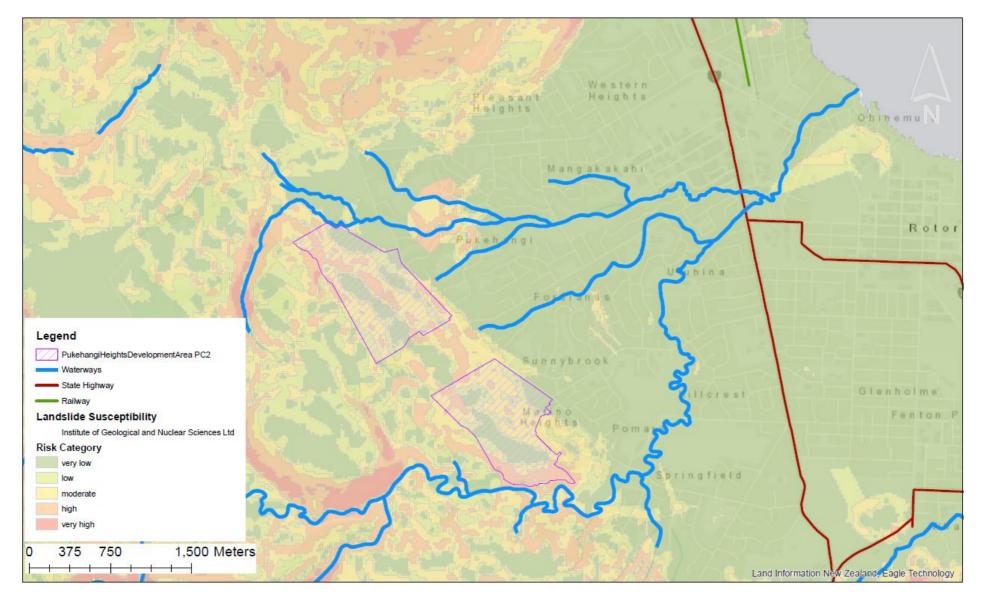
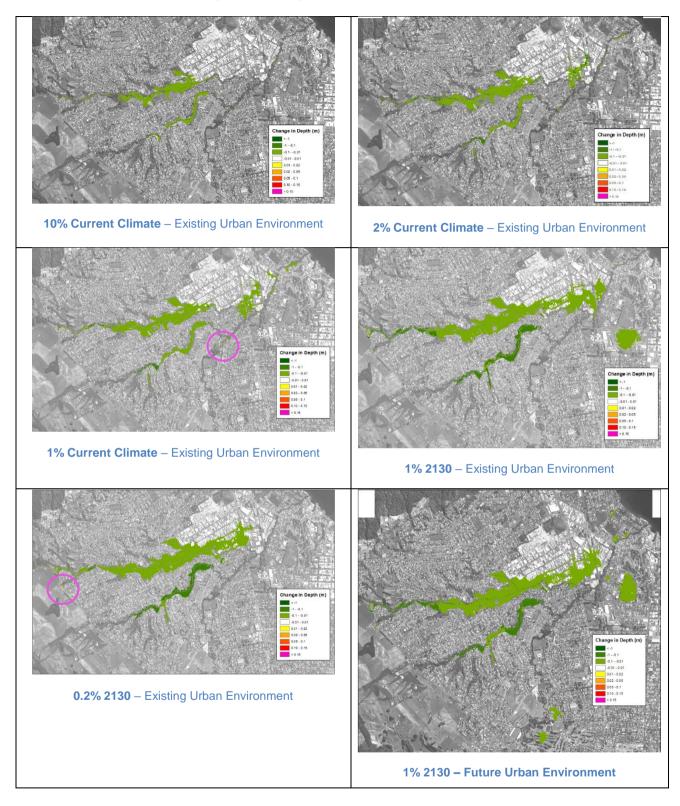


Figure 39: Landslide Susceptibility

## **Overview of Post Development Impact**





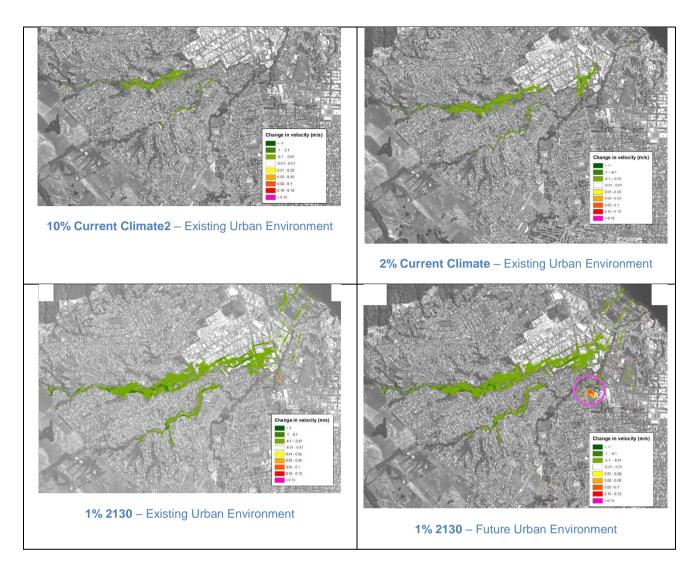


Figure 41: GUCM Scenario 15 Velocity Impact

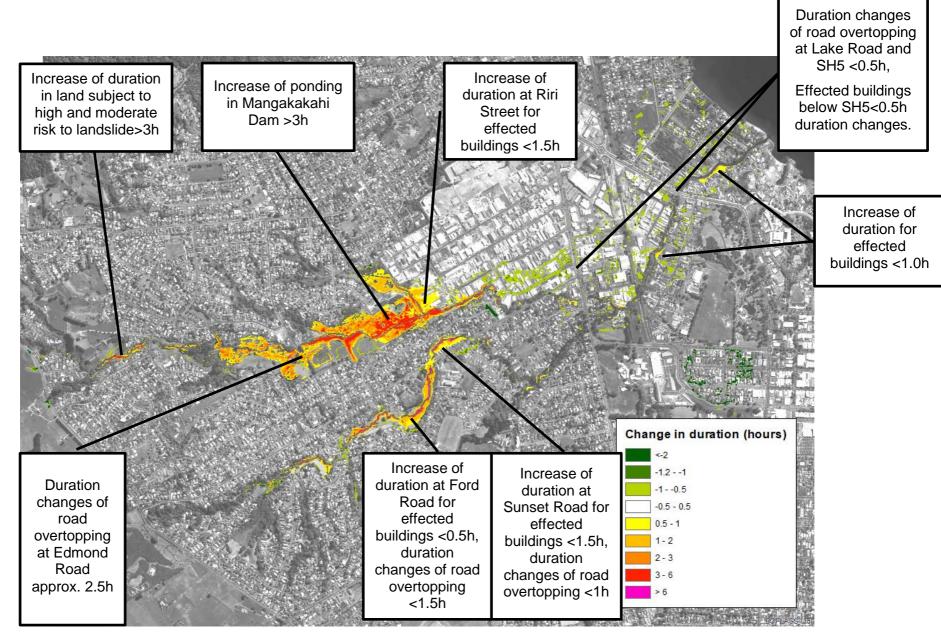


Figure 42: GUCM 1% 2130 – Existing Urban Environment Scenario 15 Duration Impact



Figure 43: Hazard Vulnerability Classification DxV 1% AEP 2020 post-development – existing urban environment

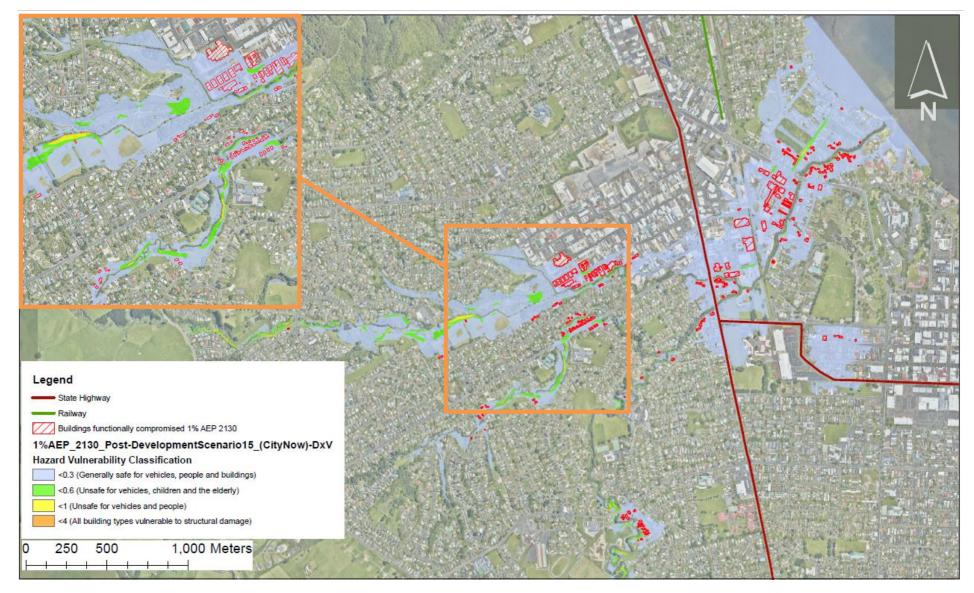


Figure 44: Hazard Vulnerability Classification DxV 1% AEP 2130 post-development – existing urban environment

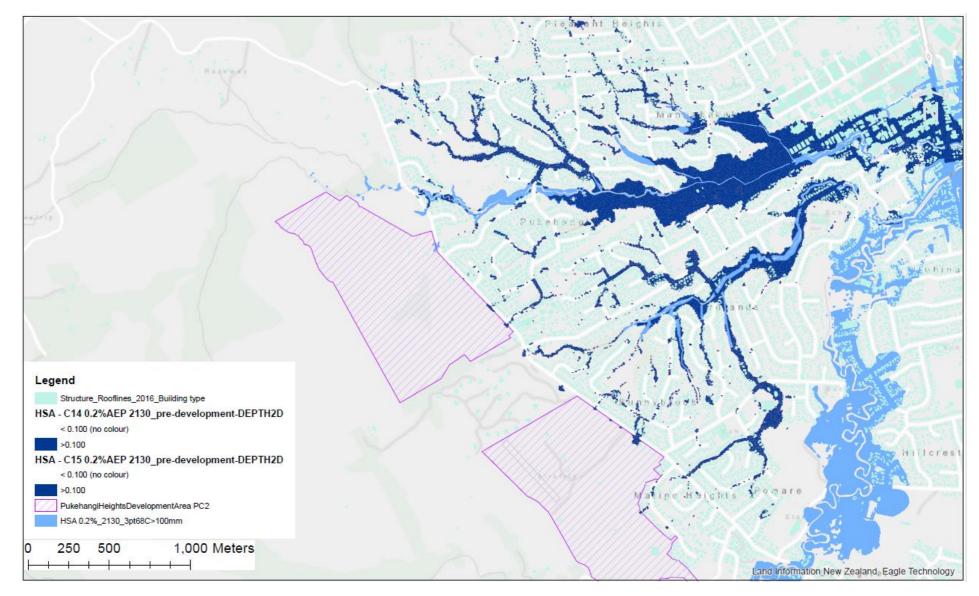


Figure 45: HSA 0.2% AEP 2130 >100mm pre- development flood extent- existing urban environment



Figure 46: HSA 0.2% AEP 2130 >100mm pre- development flood extent- existing urban environment- Immediately Downstream of PC2

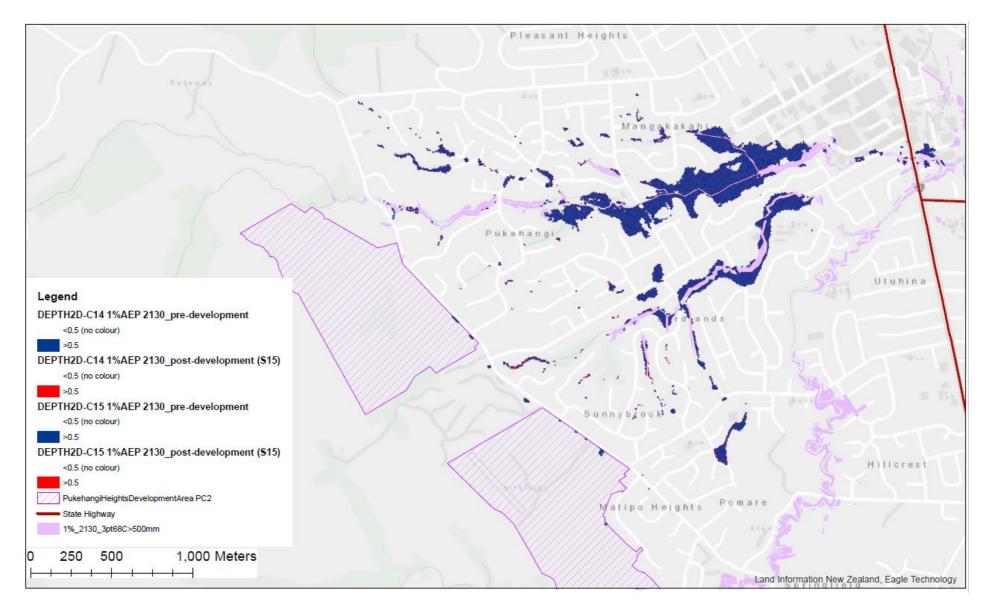


Figure 47: 1% AEP 2130 >500mm pre- and post-development flood extent- existing urban environment

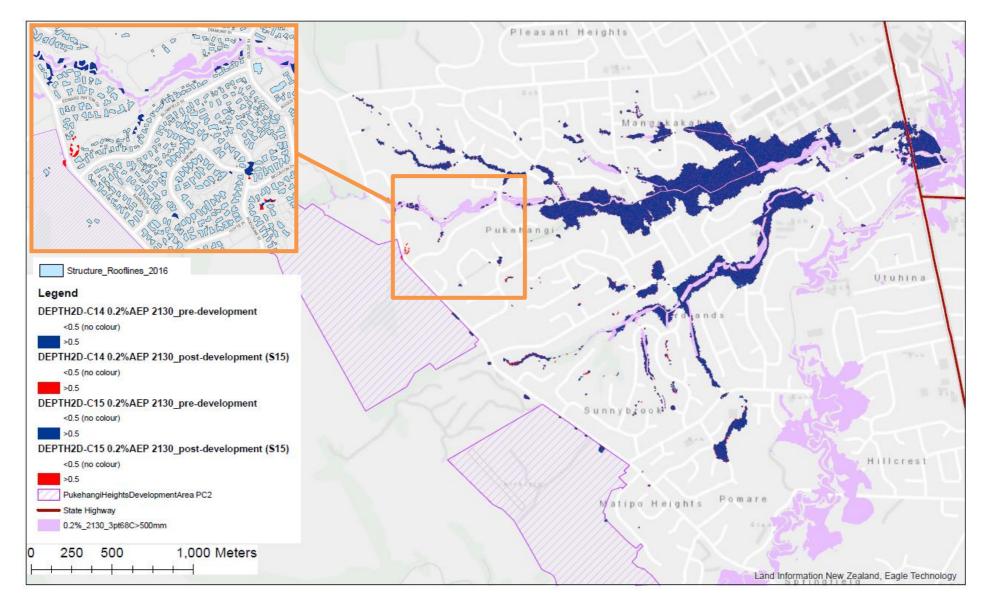


Figure 48: 0.2% AEP 2130 >500mm pre- and post-development flood extent- existing urban environment

## Limitation on Addressing Existing Flood Risk

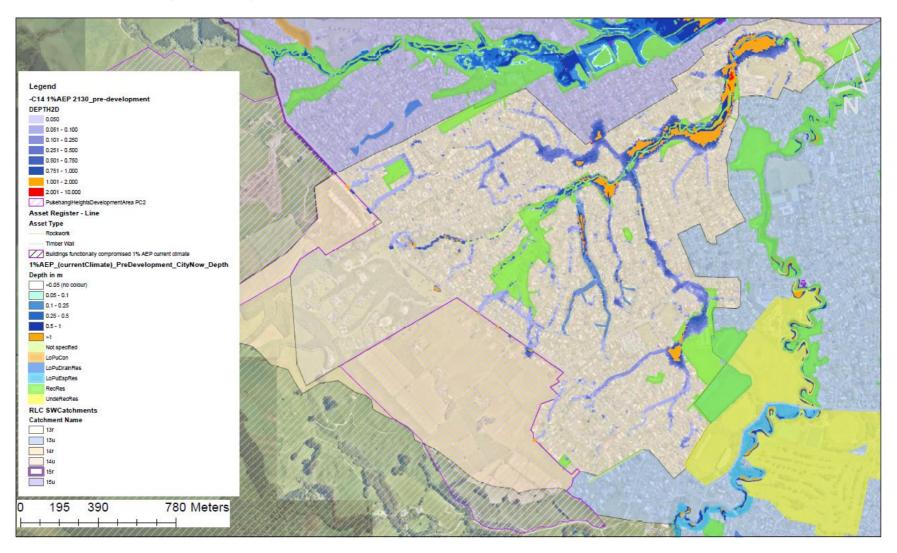


Figure 49: Otamatea – limited offside mitigation option

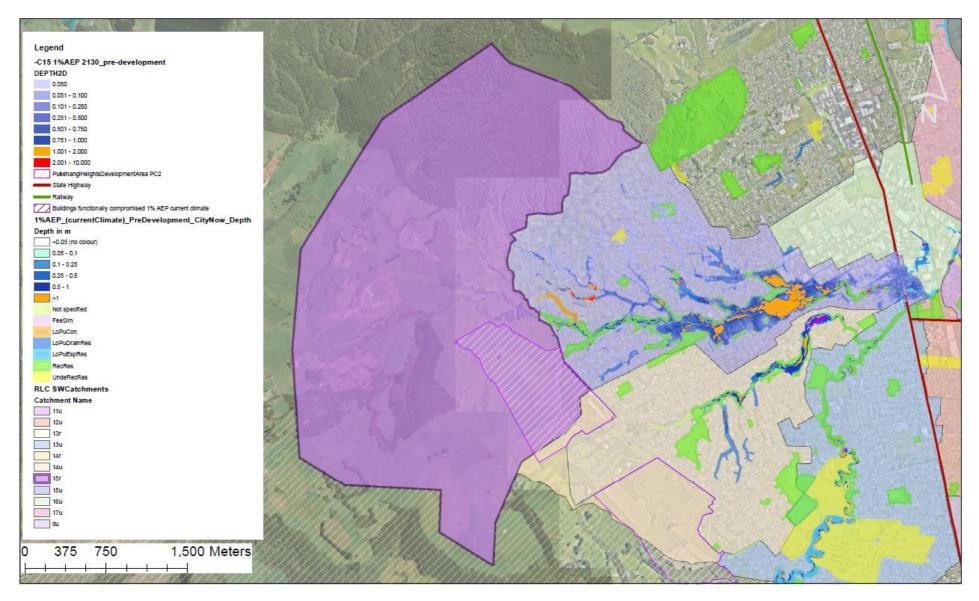
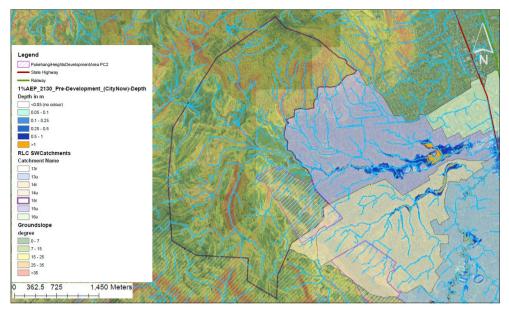
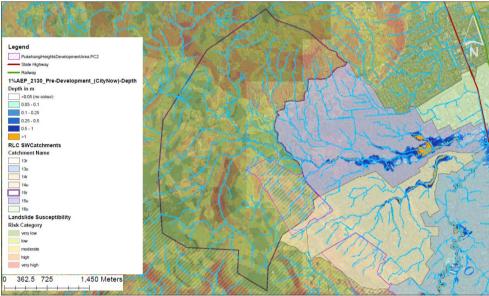


Figure 50: Mangakakahi– limited offside mitigation option





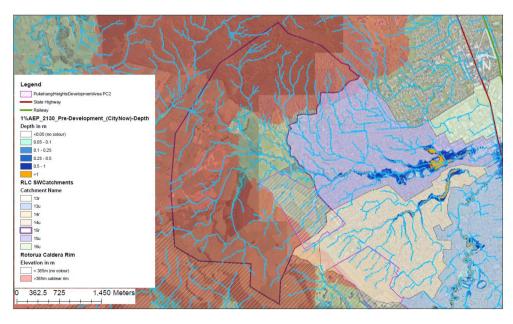


Figure 51: Mangakakahi- constraints/limited upstream mitigation opportunities