

FLOOD MODELLING REPORT



Sunfield – Fast-Track Approvals Application

Ardmore, Auckland

PROJECT INFORMATION

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CONTENTS

1	INTRODUCTION	1
1.1	PROJECT	1
1.2	BACKGROUND	2
1.3	MODELLING APPROACH	8
1.4	DESIGN FLOW REQUIREMENTS	10
1.5	SCENARIOS MODELLED	11
1.6	SOURCES OF DATA	15
1.7	REFERENCE TECHNICAL DOCUMENTS	15
2	HYDROLOGICAL MODELLING WITH HEC-HMS WESTERN CATCHMENT	16
2.1	METHODOLOGY	16
2.2	RAINFALL DEPTH	16
2.3	RAINFALL HYETOGRAPH	17
2.4	SCENARIOS AND CATCHMENTS	18
2.5	SOILS PARAMETERS	19
2.6	LAND-USE	23
2.7	CHANNELISATION FACTORS AND TIME OF CONCENTRATION	23
2.8	SUBBASIN PARAMETERS	24
2.9	HEC-HMS MODEL	24
2.10	CATCHMENT STORAGE AND ATTENUATION	25
2.11	INFLOW HYDROGRAPHS	26
3	WESTERN CATCHMENT	27
	HYDRAULIC MODELLING WITH TUFLOW	27
3.1	METHODOLOGY	27
3.2	TUFLOW MODEL LAYOUT	27
3.3	HYDRAULIC STRUCTURES AND CULVERTS	29
3.4	BOUNDARY CONDITIONS	31
3.5	CLIMATE CHANGE FACTOR INCREASE – BASELINE SCENARIO	32
3.6	RESULTS – FLOOD MAPPING	32
3.7	RESULTS - AWAKERI WETLANDS PEAK FLOW DEPTHS	33
3.8	RESULTS - UPPER MCLENNAN WETLAND	37
3.9	RESULTS – WESTERN CATCHMENT PEAK FLOW	40
3.10	WESTERN CATCHMENT ATTENUATION VOLUMES	41
3.11	CONCLUSION – WESTERN CATCHMENT	42
4	HYDROLOGICAL MODELLING WITH HEC-HMS EASTERN CATCHMENT	43
4.1	METHODOLOGY	43

4.2	RAINFALL DEPTH.....	43
4.3	EASTERN CATCHMENTS	44
4.4	RAINFALL HYETOGRAPH.....	47
4.5	SOILS PARAMETERS.....	49
4.6	LAND-USE.....	49
4.7	CHANNELISATION FACTORS AND TIME OF CONCENTRATION.....	49
4.8	SUBBASIN PARAMETERS	49
4.9	STORAGE AND ATTENUATION.....	49
4.10	INFLOW FOR TUFLOW	51
5	EASTERN CATCHMENT	52
	HYDRAULIC MODELLING WITH TUFLOW	52
5.1	METHODOLOGY	52
5.2	TUFLOW MODEL LAYOUT	52
5.3	MODEL CALIBRATION	54
5.4	BOUNDARIES	56
5.5	CRITICAL STORM DURATION ANALYSIS	56
5.6	HYDRAULIC STRUCTURES.....	57
5.7	STORMWATER POND 5 & 6.....	58
5.8	EASTERN CATCHMENT PEAK FLOW RESULTS.....	58
5.9	RESULTS - EASTERN CATCHMENT DOWNSTREAM PEAK FLOW LEVEL AT OUTFLOW 1.....	61
5.10	RESULTS - PAKAKURA STREAM EFFECTS	61
5.11	EASTERN CATCHMENT ATTENUATION DEVICES	76
5.12	EASTERN CATCHMENT OUTFLOW 1 PASS FORWARD FLOW	77
5.13	CONCLUSION – EASTERN CATCHMENT	78

APPENDIX

1	CATCHMENT PLANS
2	CRITICAL STORM CHECK
3	HMS WESTERN MODEL SETUP
4	HMS WESTERN MODEL RESULTS
5	HMS SUBBASIN PARAMETERS
6	TUFLOW WESTERN MODEL & RESULTS
7	TUFLOW EASTERN MODEL & RESULTS
8	HMS EASTERN INFLOW HYDROGRAPHS
9	ZONING
10	STAGE 2 & 3 AWAKERI WETLANDS REQUIREMENTS
11	STAGE 1 AWAKERI WETLANDS DESIGN REPORT
12	AUCKLAND COUNCIL 2019 MCLENNAN WETLAND SPILLWAY ASSESSMENT
13	AUCKLAND COUNCIL 2016 TSWCC – STORMWATER REPORT
14	AUCKLAND UNITARY PLAN E36 ASSESSMENT



Executive Summary

For the proposed development area both the western and eastern catchments had the flood effects modelled for the key storm events such as 50%, 10%, and 1% Annual Exceedance Probability (AEP) rainfalls.

- All modelling considered the Auckland Council SWCoP version 4 climate change factors.
- A comparison was completed of the pre-development and post development peak flows and flood levels.
- The analysis focused on managing stormwater flows and flood impacts through strategic attenuation design for the development across the different storm event scenarios.
- No negative effects were highlighted in any of the modelling results.
- An Auckland Unitary Plan E36 Assessment has been carried out and may be found in Appendix 14.

1 INTRODUCTION

1.1 PROJECT

This report outlines stormwater modelling that was undertaken by Maven Associates to support Sunfield Developments Limited's proposed Sunfield Fast-track Approvals Act (FAA) application.

The modelling outlines the proposed overall stormwater mitigation strategy for the site in terms of incoming flows and mitigation through conveyance channels. The latest Masterplan has been incorporated as shown in the image below.

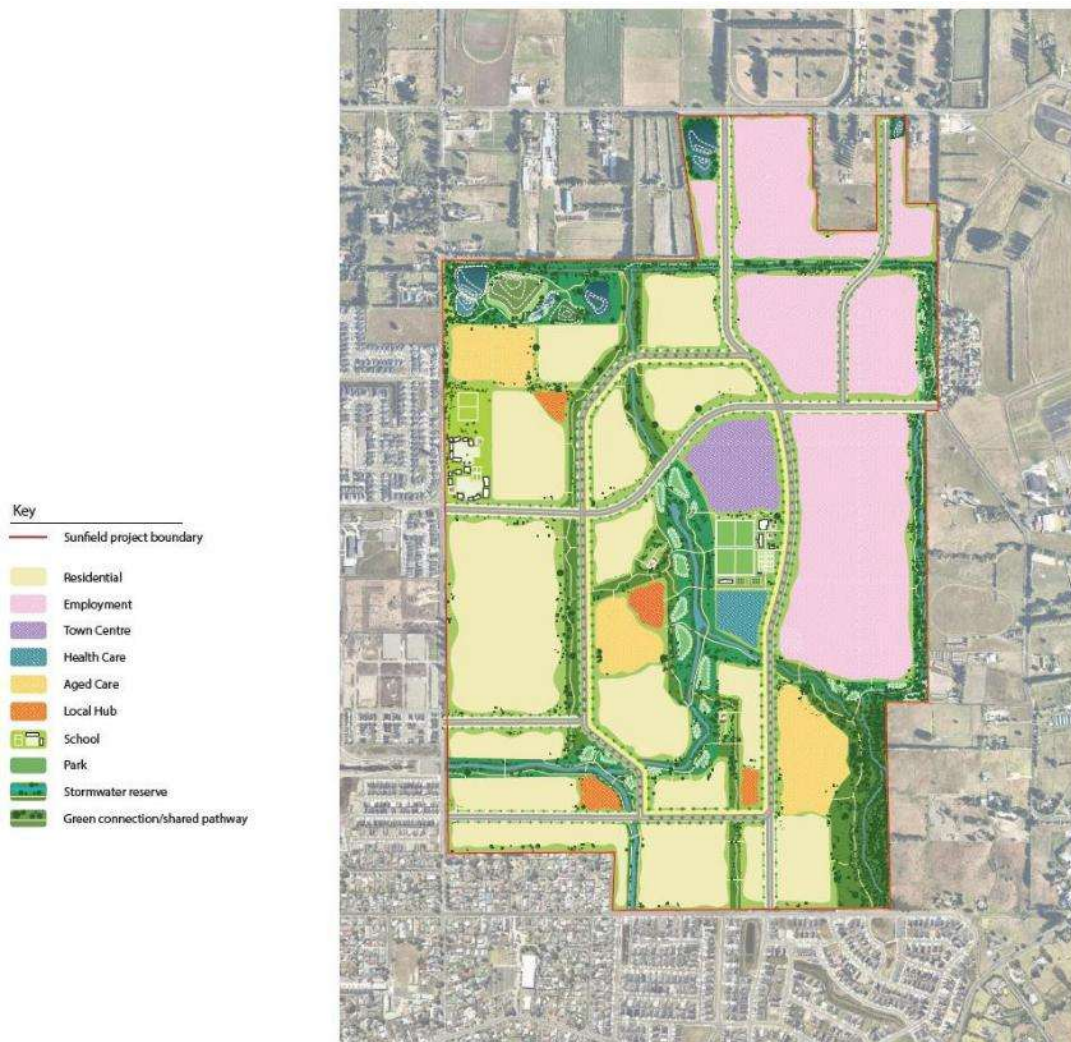


Figure 1.1 – Masterplan

1.2 BACKGROUND

The application was lodged based on a total site area of 244.5 hectares (Ha). It should be noted that subsequent to the lodgement of the application, a 19.7 Ha portion of the site was designated to NZ Transport Agency (NZTA) Waka Kotahi for the construction of the new MR2 public road. This has resulted in a revised net site area of 204.8 Ha. The site is located within two stormwater catchments as shown in Figure 1.2 below. The northern portion of the site, with an area of 188.0 Ha, is located within the Papakura Stream catchment and the southern portion, with an area of 56.5 Ha, within Pahurehure Inlet Catchment. Both catchments discharge into the Manukau Harbour. For the purposes of this report the portion of site within the Papakura Stream Catchment shall be referred to as the Eastern Catchment and the portion within the Pahurehure Inlet Catchment as the Western Catchment.

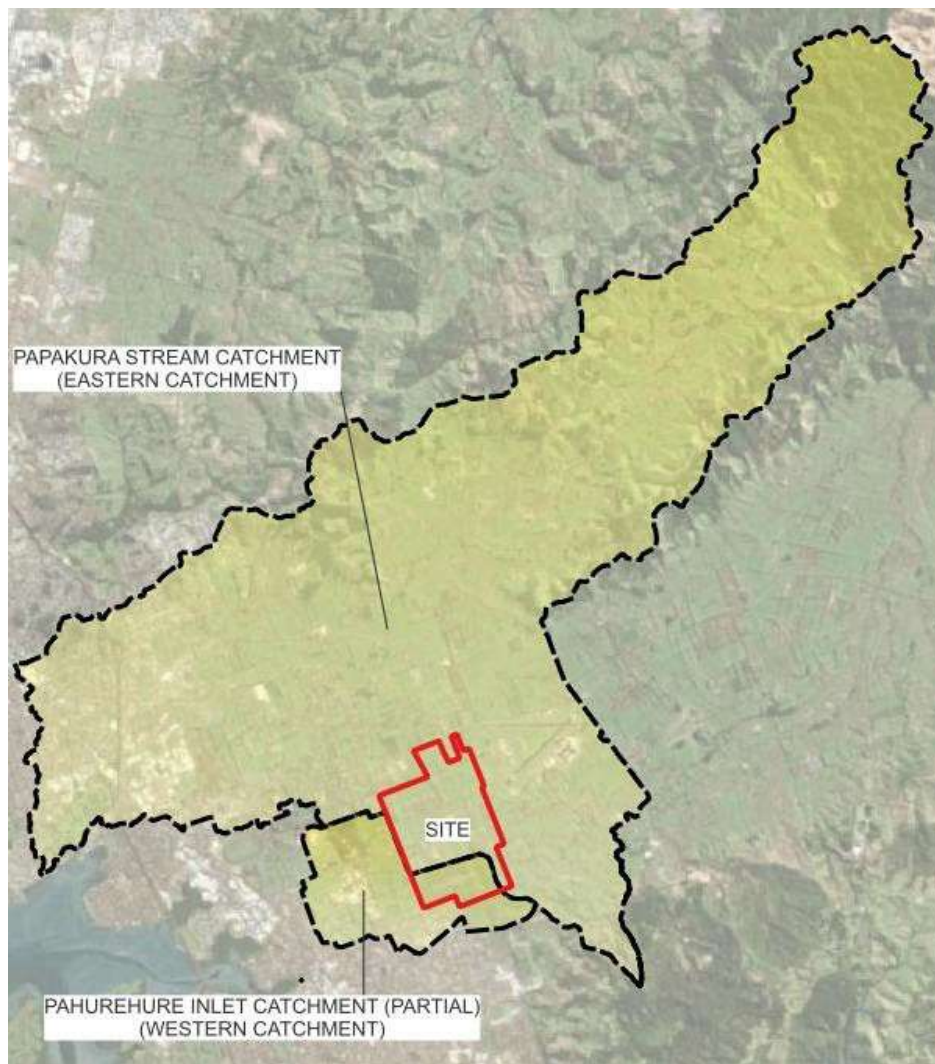


Figure 1.2 Stormwater Catchments

As shown in Figure 1.3 below, Auckland Council Geomaps shows a large portion of the site to be located within a 1% AEP floodplain (3.8°C climate change factor applied). It should be noted that the floodplain within the Western Catchment is located within the catchment area of the Takanini Stormwater Conveyance Channel (TSWCC). The final stages of the TSWCC are part of a separate resource consent application and once completed shall provide stormwater management for the site's western catchment and significantly reduce the flood plain shown.

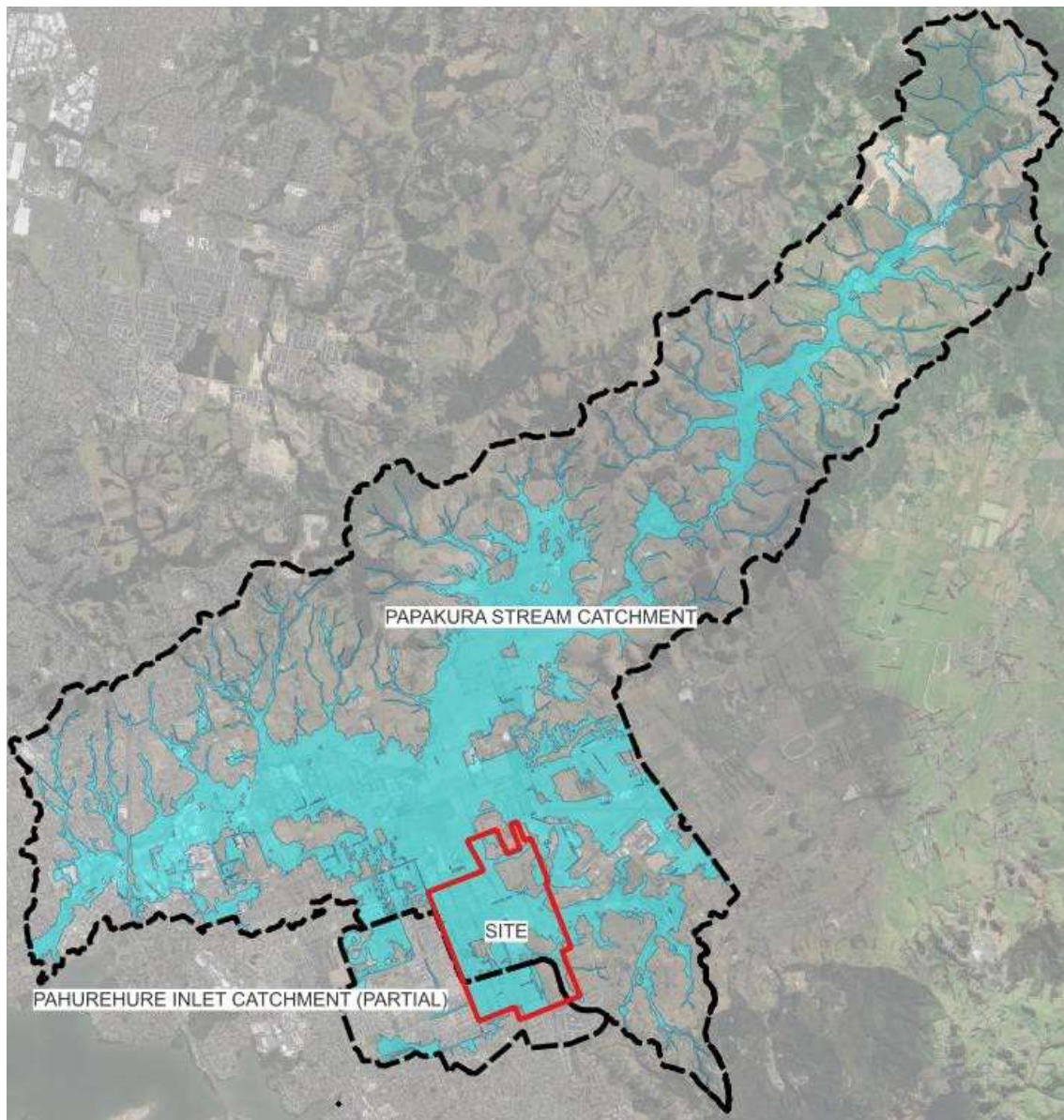


Figure 1.3 Auckland Council Geomaps Floodplain

Takanini Stormwater Conveyance Channel

Central to the strategy of the proposed stormwater management of the Western Catchment is the Awakeri Wetlands, Stages 1, 2 and 3. The Awakeri Wetlands is a part of the TSWCC, the TSWCC was proposed by Auckland Council in 2014 to provide stormwater servicing for the Takanini south-east area.

The Awakeri Wetlands is designed to pass forward flows from Old Wairoa Road, Cosgrave Road, Walters Road and Grove Road, to a box culvert at Grove Road. The Grove Road Box Culvert conveys flows to the McLennan Wetland. During large storm events, flow is attenuated in the Upper McLennan Wetland before being discharged to the Pahurehure inlet via the proposed Artillery Drive Tunnel. At the time of the writing of this report the construction of the Artillery Drive Tunnel, the Grove Road box culvert and Stage 1 of the Awakeri Wetlands have been completed (ie all the SW infrastructure to the west of Cosgrave Road). The remaining Stages 2 and 3 are proposed to be constructed separate to this application.

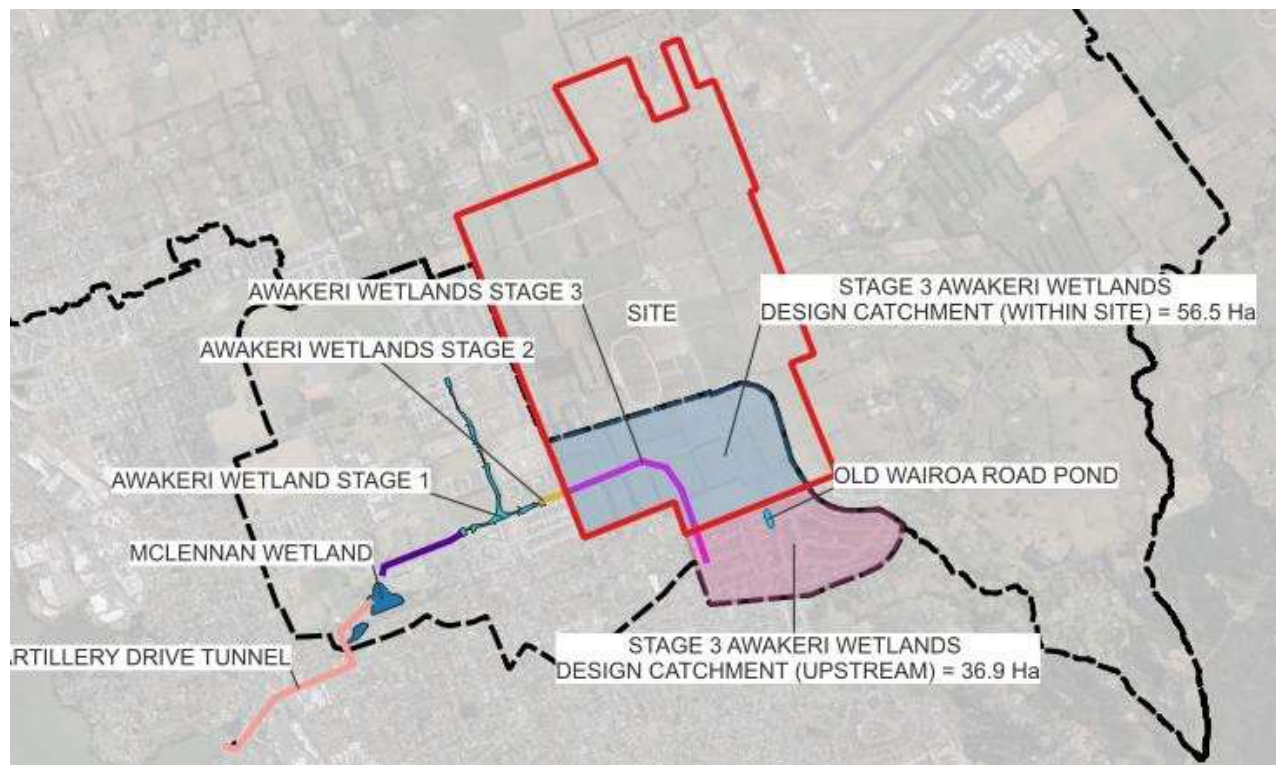


Figure 1.4 Takanini Stormwater Conveyance Channel Scheme

As shown in Figure 1.4 (and outline in the Awakeri Stage 1 design report which may be found in Appendix 11), 56.5 Ha of the site is located within the designed catchment area of the Awakeri Wetlands. An upstream catchment on the southern side of Old Wairoa Road with an area of 36.9 Ha also discharges into Stage 3 of the Awakeri Wetlands which then discharges into Stage 2. The Awakeri Wetlands have been designed to convey the upstream catchments post development flows. Details of the peak flows and conveyance capacity of Awakeri Wetlands Stages 2 and 3 may be found in Appendix 10.

Western Catchment Strategy

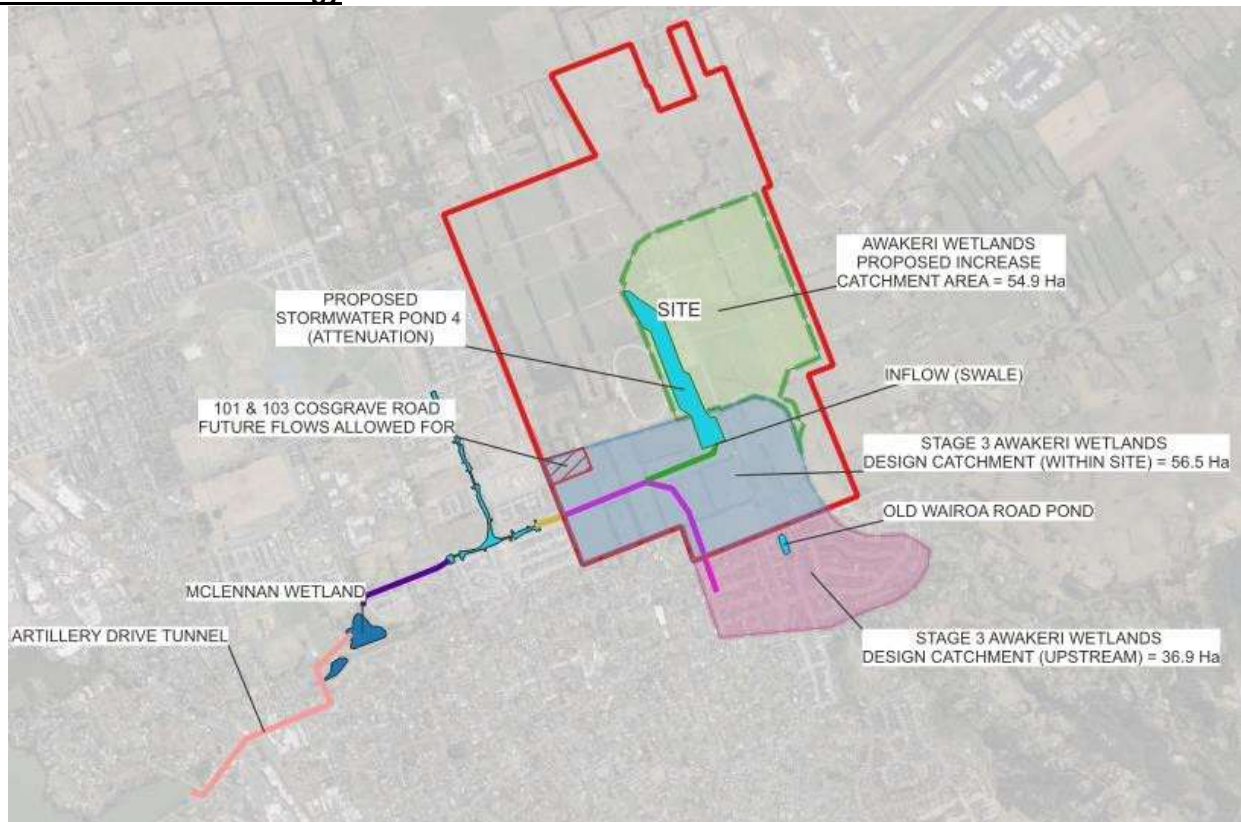


Figure 1.5 Proposed Western Catchment Strategy

The proposed stormwater management strategy for the Western Catchment aims to manage stormwater runoff and mitigate flood hazards within the site without increasing any flooding to upstream and downstream properties. The strategy will also maximise utilisation of the recently developed stormwater infrastructure adjacent to the site, particularly the Awakeri Wetlands and the McLennan Upper Wetland. The development proposes to increase the catchment area discharging to the Stage 3 channel without increasing flows or water levels within the channel upstream or downstream including within the McLennan Upper Wetland (refer to section 1.4 for more detail). An additional catchment of 54.9 Ha is proposed to convey flows to the Awakeri Wetlands as shown in figure 1.5 above (ie 54.9 Ha of the pre-development Eastern Catchment is to be diverted to the Western Catchment and into the Awakeri Wetlands). The catchment diversion is proposed to help managed flows to the Eastern Catchment where there are existing issues with the extents of flooding. Flows from the increased Western Catchment are to be attenuated via a stormwater pond before discharging into the Awakeri Wetlands.

Details of analysis of the proposed solution and assessment of the capacity and performance of the downstream infrastructure including the Stage 1 and McLennan Wetland may be found in Sections 2 and 3 of the report.

Eastern Catchment Strategy

The proposed stormwater management strategy for the Eastern Catchment of the site aims to manage flood hazards within the site without increasing any flooding to downstream properties. No formal existing stormwater infrastructure is located within the eastern portion of the site. There are existing Overland Flow Paths (OLFPs) entering the site across the eastern boundary and exiting across the northern boundary, these OLFP's include flows generated within the site boundary.

The post development strategy is to divert the upstream catchments (Catchment C and a portion of Catchment D1 as shown in figure 1.7 and 1.8) around the perimeter of the site to discharge location at Northern Outflow 1 (adjacent SW Pond 1). SW Pond 1 provides peak flow diversion storage for this upstream flow to maintain the peak flow across Northern Outflow 1. As discussed later in the report (section 4) peak flows across the northern boundary are governed by this upstream flow which arrives at the site after site discharges. The post development catchment discharging to northern outflow 1 (adjacent SW Pond 1) is proposed to be passed forward. Catchments discharging to Northern Outflow 2 and 3 area proposed to be attenuated to pre development. Details of analysis and proposed solution may be found in Section 4 and 5 of the report.

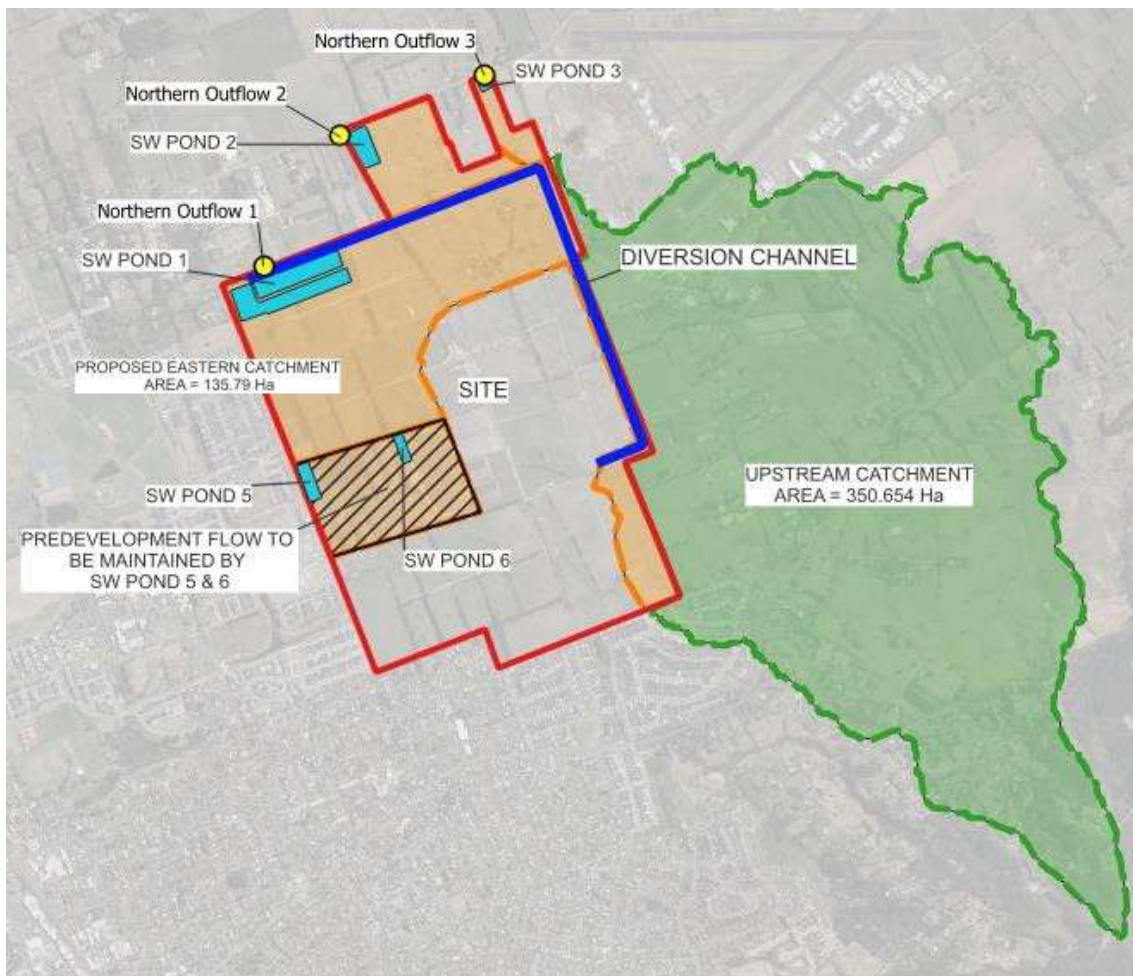


Figure 1.6 Proposed Eastern Catchment Strategy

Catchment Changes

The figures below show the overall catchments pre development and post development.



Figure 1.7 Predevelopment Catchments

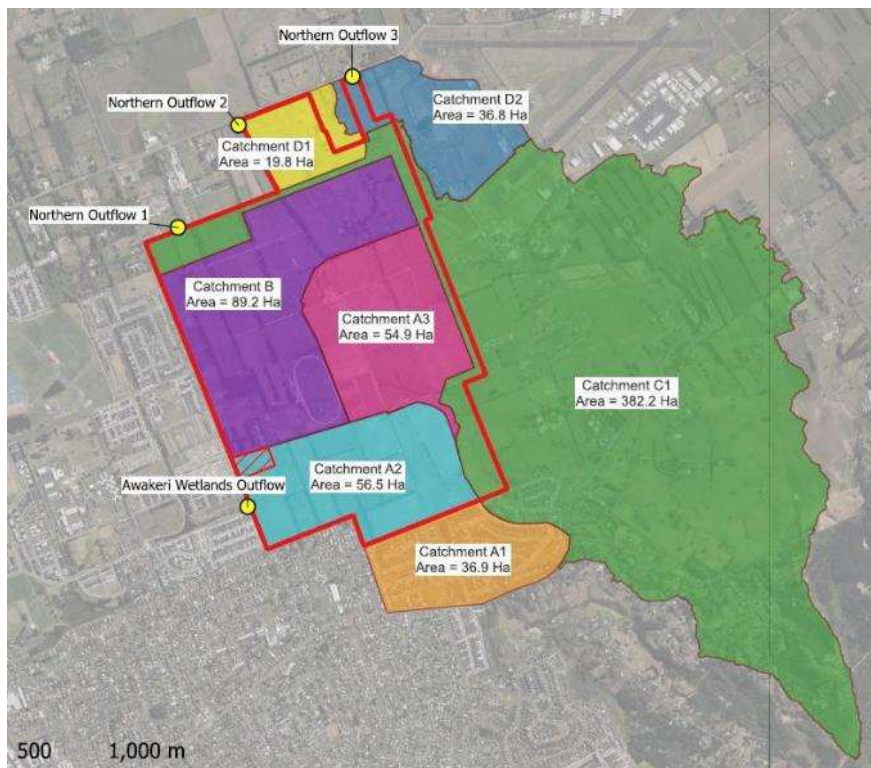


Figure 1.8 Post development Catchments

1.3 MODELLING APPROACH

The software packages HEC HMS and TUFLOW have been used for hydrological and hydraulic assessment. All analysis has been completed in accordance with TP108 and in accordance with guidelines of the Auckland Council Stormwater Code of Practice.

TP108 has been adopted to be consistent with what stormwater modelling analysis has been undertaken in the area for recent projects, in particular – the design of Awakeri Wetlands Stages 1,2 and 3 and the McLennan Wetland Spillway Options Modelling, 2021.

Level Datum

All levels included in this modelling report are New Zealand Vertical Datum 2016.

Levels in this report can be transformed from New Zealand Vertical Datum 2016 into Auckland Vertical Datum 1946 by applying an offset value of 0.28 m.

For example:

$$\text{HAUK}_{1946} = \text{HNZVD}_{2016} + \text{Offset Value}$$

Western Catchment

For the Western Catchment HEC HMS was used to develop inflow hydrographs boundary conditions and TUFLOW was used to model the hydraulics and finalise the solution.

The analysis was done using the following steps:

HEC HMS (hydrological modelling)

1. Delineate the catchments and sub-basins,
2. Use TP108 to calculate parameters,
3. Compute inflow hydrographs for catchments

TUFLOW (hydraulic modelling)

4. Delineate the perimeter for the grid,
5. Create grid and sub-grid areas,
6. Input flow hydrographs and other boundaries
7. Input structures,
8. Run scenarios.

Eastern Catchment

For the Eastern Catchment a TUFLOW model was prepared as part of the initial application. Due to the significant simulation run times of the modelling the model has been transferred to the software package TUFLOW.

A TUFLOW model was used to model pre and post development flows and finalise the solution.

Auckland Council Healthy Waters has provided flood information associated with the site from the latest 2D flood model. The AC model result was based on MPD condition and rainfall with climate change for 3.8 °C increase. Maven's flood model has run a scenario with the above condition for validation. The result shows satisfactory comparisons with flows to be in general accordance with HWs model (+/- 5%).

As part of the section 67 process of the fast track application additional modelling scenarios were required

An existing flow gauge located within the Papakura Stream was used to calibrate the model against the January 2023 Auckland Anniversary flood event. A series of storm durations using NIWA HIRDS rainfall patterns were compared with the TP108 nested storm to confirm the critical storm of the catchment has been assessed (confirming suitability of the TP108 method used).

The analysis was done using the following steps:

HEC HMS (hydrological modelling) for Critical Storm analysis

1. Delineate the catchments and sub-basins
2. Use TP108 to calculate parameters,
3. Compute inflow hydrographs for catchments

TUFLOW (hydraulic modelling)

4. Delineate the perimeter for the grid,
5. Create grid and sub-grid areas,
6. Calibrate model against historical storm (Jan 2023 Auckland Anniversary Flood event)
7. Assess critical storm
8. Input flow hydrographs and other boundaries
9. Input structures,
10. Run scenarios.

TP108 Modelling Limitations

Areal reduction has not been applied for the subbasins. The reduction factor should be based on sub catchment size not the size of the entire catchment (Shamseldin,2008). The largest sub catchment used is Catchment C with an area of 3.7 km².

1.4 DESIGN FLOW REQUIREMENTS

The proposed development of the site shall increase stormwater runoff generated from the site due to an increase of impervious area. Overall, the stormwater management strategy for both the Eastern and Western Catchments aim to manage this increase in stormwater runoff within the site and eliminate any flood hazard adverse effects which would result from the development of the site. Peak flows, water levels and entry and exit locations of overland flow paths shall be maintained to ensure upstream and downstream properties of the site are not adversely affected by the development.

Takanini Stormwater Conveyance Channel (TSWCC)

The western catchment is proposed to be discharged into the Awakeri Wetlands Stage 3 channel, which discharges to Stage 1 Awakeri Wetlands. Flow from the Awakeri Wetlands is then conveyed to the Upper McLennan Wetland via a box culvert at Grove Road. The Upper McLennan Wetland is designed to attenuate flows upto and including 1% AEP flows which are then drained by the Artillery Drive Stormwater Tunnel (ADST) to a coastal outlet at Gills Avenue. A spillway assessment was completed by Tonkin & Taylor in 2021 for Auckland Council (refer to Appendix 12).

For the 50% and 10% AEP flow event an assessment has been undertaken to demonstrate proposed development does not result in increased peak water levels within the Awakeri Wetlands. This assessment demonstrates there are no adverse impacts on the existing primary networks discharging into the Awakeri Wetlands.

For the 1% AEP flow event assessment has been undertaken to demonstrate the existing downstream infrastructure, specifically Awakeri Stage 1 and McLennan Upper Wetland no increase in loading shall be placed on the infrastructure as a result of the proposed development.

1.5 SCENARIOS MODELLED

Table 1.1 and 1.2 shows the scenarios modelled. Further details of the scenarios may be found in section 2.2.

Western Catchment (14 scenarios)

Table 1.1 – Western Catchment Scenarios modelled

Scenario	AEP*	Land-use	Catchment	Rainfall	Peat CN
1	50%	Existing	Predevelopment	24-hour, climate change	74
2	50%	Developed	Proposed	24-hour, climate change	74
3	20%	Existing	Predevelopment	24-hour, climate change	74
4	20%	Developed	Proposed	24-hour, climate change	74
5	10%	Existing	Predevelopment	24-hour, climate change	74
6	10%	Developed	Proposed	24-hour, climate change	74
7	5%	Existing	Predevelopment	24-hour, climate change	74
8	5%	Developed	Proposed	24-hour, climate change	74
9	2%	Existing	Predevelopment	24-hour, climate change	74
10	2%	Developed	Proposed	24-hour, climate change	74
11	1%	Existing	Predevelopment	24-hour, climate change	74
12	1%	Developed	Proposed	24-hour, climate change	74
13	1%	Existing	Predevelopment with Old Wairoa Road Upgrade	24-hour, climate change	74
14	1%	Developed	Predevelopment with Old Wairoa Road Upgrade	24-hour, climate change	74

*AEP (Annual Exceedance Probability)

Eastern Catchment (68 scenarios)

Table 1.2 – Eastern Catchment Scenarios modelled

Scenario	AEP*	Land-use	Catchment	Rainfall	Peat CN and Other Assumptions
1	50%	Existing	Predevelopment	24-hour, climate change	74
2	50%	Developed	Proposed	24-hour, climate change	74
3	50%	Existing	Predevelopment	30-min, climate change	74
4	50%	Developed	Proposed	30-min, climate change	74
5	50%	Existing	Predevelopment	60-min, climate change	74
6	50%	Developed	Proposed	60-min, climate change	74
7	10%	Existing	Predevelopment	24-hour, climate change	74
8	10%	Developed	Proposed	24-hour, climate change	74
9	10%	Existing	Predevelopment	30-min, climate change	74
10	10%	Developed	Proposed	30-min, climate change	74
11	10%	Existing	Predevelopment	60-min, climate change	74
12	10%	Developed	Proposed	60-min, climate change	74
13	1%	Existing	Predevelopment	24-hour, climate change	74
14	1%	Developed	Proposed	24-hour, climate change	74
15	1%	Existing	Predevelopment	30-min, climate change	74
16	1%	Developed	Proposed	30-min, climate change	74
17	1%	Existing	Predevelopment	60-min, climate change	74
18	1%	Developed	Proposed	60-min, climate change	74
19	50%	Existing	Predevelopment	24-hour, climate change	74 & Spatial Rainfall
20	50%	Developed	Proposed	24-hour, climate change	74 & Spatial Rainfall
21	10%	Existing	Predevelopment	24-hour, climate change	74 & Spatial Rainfall
22	10%	Developed	Proposed	24-hour, climate change	74 & Spatial Rainfall
23	1%	Existing	Predevelopment	24-hour, climate change	74 & Spatial Rainfall
24	1%	Developed	Proposed	24-hour, climate change	74 & Spatial Rainfall
25	50%	Existing	Predevelopment	24-hour, climate change	61
26	50%	Developed	Proposed	24-hour, climate change	61
27	50%	Existing	Predevelopment	30-min, climate change	61

Scenario	AEP*	Land-use	Catchment	Rainfall	Peat CN and Other Assumptions
28	50%	Developed	Proposed	30-min, climate change	61
29	50%	Existing	Predevelopment	60-min, climate change	61
30	50%	Developed	Proposed	60-min, climate change	61
31	10%	Existing	Predevelopment	24-hour, climate change	61
32	10%	Developed	Proposed	24-hour, climate change	61
33	10%	Existing	Predevelopment	30-min, climate change	61
34	10%	Developed	Proposed	30-min, climate change	61
35	10%	Existing	Predevelopment	60-min, climate change	61
36	10%	Developed	Proposed	60-min, climate change	61
37	1%	Existing	Predevelopment	24-hour, climate change	61
38	1%	Developed	Proposed	24-hour, climate change	61
39	1%	Existing	Predevelopment	30-min, climate change	61
40	1%	Developed	Proposed	30-min, climate change	61
41	1%	Existing	Predevelopment	60-min, climate change	61
42	1%	Developed	Proposed	60-min, climate change	61
43	50%	Existing	Predevelopment	24-hour, climate change	61 & Spatial Rainfall
44	50%	Developed	Proposed	24-hour, climate change	61 & Spatial Rainfall
45	10%	Existing	Predevelopment	24-hour, climate change	61 & Spatial Rainfall
46	10%	Developed	Proposed	24-hour, climate change	61 & Spatial Rainfall
47	1%	Existing	Predevelopment	24-hour, climate change	61 & Spatial Rainfall
48	1%	Developed	Proposed	24-hour, climate change	61 & Spatial Rainfall
49	1%	Developed	Proposed	24-hour, climate change	74 & Culverts Blocked
50	50%	Developed	Proposed	24-hour, climate change	74 & Airfield Road Culverts Upgraded
51	50%	Developed	Proposed	30-min, climate change	74 & Airfield Road Culverts Upgraded
52	50%	Developed	Proposed	60-min, climate change	74 & Airfield Road Culverts Upgraded
53	10%	Developed	Proposed	24-hour, climate change	74 & Airfield Road Culverts Upgraded
54	10%	Developed	Proposed	30-min, climate change	74 & Airfield Road Culverts Upgraded

Scenario	AEP*	Land-use	Catchment	Rainfall	Peat CN and Other Assumptions
55	10%	Developed	Proposed	60-min, climate change	74 & Airfield Road Culverts Upgraded1%
56	1%	Developed	Proposed	24-hour, climate change	74 & Airfield Road Culverts Upgraded
57	1%	Developed	Proposed	30-min, climate change	74 & Airfield Road Culverts Upgraded
58	1%	Developed	Proposed	60-min, climate change	74 & Airfield Road Culverts Upgraded1%
59	1%	Developed	Proposed	24-hour, climate change	61 & Culverts Blocked
60	50%	Developed	Proposed	24-hour, climate change	61 & Airfield Road Culverts Upgraded
61	50%	Developed	Proposed	30-min, climate change	61 & Airfield Road Culverts Upgraded
62	50%	Developed	Proposed	60-min, climate change	61 & Airfield Road Culverts Upgraded
63	10%	Developed	Proposed	24-hour, climate change	61 & Airfield Road Culverts Upgraded
64	10%	Developed	Proposed	30-min, climate change	61 & Airfield Road Culverts Upgraded
65	10%	Developed	Proposed	60-min, climate change	61 & Airfield Road Culverts Upgraded
66	1%	Developed	Proposed	24-hour, climate change	61 & Airfield Road Culverts Upgraded
67	1%	Developed	Proposed	30-min, climate change	61 & Airfield Road Culverts Upgraded
68	1%	Developed	Proposed	60-min, climate change	61 & Airfield Road Culverts Upgraded

*AEP (Annual Exceedance Probability)

1.6 SOURCES OF DATA

Table 1.3 – Source of Data

Attribute	Organisation
Catchment Plans	Maven Associates and Auckland Council Geomaps
Contours	GHD & Healthy Waters (previous design level / Stage 1 channel design) Maven Associates Design (Stage 2&3) LINZ LiDAR data captured between 2016 – 2018
Flow & WL data	Auckland Council's State of the Environment monitoring programme (Historic Storm January 2023 river and rain gauge and
Flood level evidence	None

1.7 REFERENCE TECHNICAL DOCUMENTS

- AUCKLAND COUNCIL CODE OF PRACTICE FOR LAND DEVELOPMENT AND SUBDIVISION. CHAPTER4 – STORMWATER, VERSION 4.00
- AUCKLAND COUNCIL TP108
- ACCEPTABLE SOLUTIONS AND VERIFIABLE METHODS, DOCUMENT E1 SURFACE WATER, MINISTRY OF BUSINESS, INNOVATION AND EMPLOYMENT,
- AWAKERI WETLANDS STAGE 2, COSGROVE CULVERT, HEALTHY WATERS, 1 JULY 2019
- TAKANINI STORMWATER CONVEYANCE CHANNEL, HILL YOUNG COOPER, APRIL 2016
- MCLENNAN WETLAND SPILLWAY OPTIONS MODELLING, AUCKLAND COUNCIL, JUNE 2021

2 HYDROLOGICAL MODELLING WITH HEC-HMS WESTERN CATCHMENT

2.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the catchments,
2. Use TP108 to calculate parameters,
3. Use HEC-HMS to create a rainfall hyetograph for various rainfall events and catchment hydrographs,

2.2 RAINFALL DEPTH

TP108 gives the following rainfall depths which have then been adjusted for climate change as shown in Table 2.1. The climate change factors from Stormwater Code of Practice (SWCOP) Version 4 have been adopted:

Table 2.1 Western Catchment rainfall depths

Rain event	TP108 24 hr rainfall (not including climate change) (mm)	CoP v3 24 hr design rainfall including climate change (mm)	CoP v4 24 hr design rainfall including climate change (mm)
1% AEP	220	257 (+16.8%)	291.9 (+32.7%)
2% AEP	200	159 (+13.2%)	235.2 (+17.6%)
5% AEP	167	76 (+9.0%)	195.7 (+17.2%)
10% AEP	140	159 (+13.2%)	163.8 (+17.0%)
20% AEP	115	128 (+11.3%)	133.9 (+16.4%)
50% AEP	75	76 (+9.0%)	86.3 (+15.1%)

It is noted the TP108 rainfall depths used are conservative in comparison to that on NIWA Hirds version 4. (the total rainfall depth 24 hour for a 100year storm event for the climate change scenario RCP8.5 scenario on HIRDSv4 is 206mm, 86mm less than the modelled TP108 depth CoP v4 1%AEP depth).

2.3 RAINFALL HYETOGRAPH

The normalised 24-hour temporal rainfall intensity profiles for future climate change condition were used in accordance with Auckland Council SWCoP V4 Section 4.2.10 - Table 2.

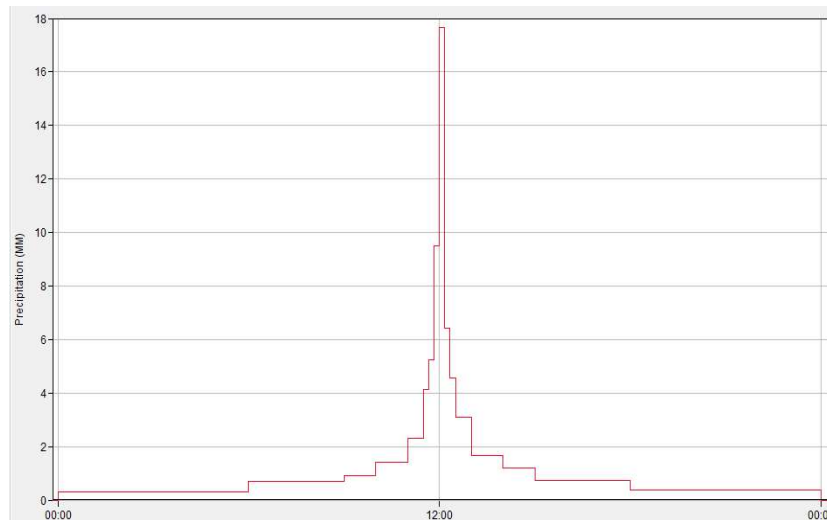


Figure 2.1 shows the 10%AEP future climate change – 2.1° TP108 normalised rainfall intensity (I/I24) from SWCoP version 4

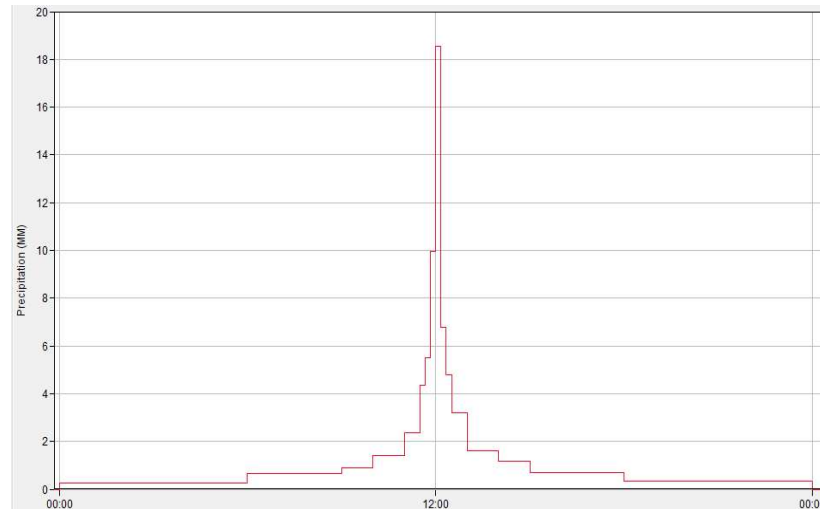


Figure 2.2 shows the 1%AEP future climate change – 3.8° TP108 normalised rainfall intensity (I/I24) from SWCoP version 4

2.4 SCENARIOS AND CATCHMENTS

For the purposes of this assessment the baseline scenario that has been adopted includes the completed Takanini Stormwater Conveyance Channel (TSWCC). The scheme design was developed by GHD in July 2016 as part of a Resource Consent process and is described in the Awakeri Wetlands Design Report and the Takanini Stormwater Conveyance Channel Stormwater Report. Review of the Awakeri design documentation (Appendix 11 and 13) show the catchments 2B4_1, 2B4_2 and 2B4_3 are accounted for in the design of the TSWCC scheme with FUZ (Future Urban Zoning) impervious coverage of 60% maximum impervious area.

It is noted that Auckland Council's assessment of the McLennan Wetland Spillway Options included Stages 2 and 3 of the Awakeri Wetlands catchments in the assessment.

Figures 2.3 and 2.4 below show the catchment areas used in the HEC HMS model to generate inflow hydrographs for the baseline scenario and proposed scenario.

The subcatchment areas and naming convention for the baseline scenario have been extracted from the existing design report. The area shown in yellow hatch indicates the 2d flow area used to model flows and water depths (refer to section 3 for more details). The post development scenario proposed subcatchments including the additional 54.9 Ha discharging from the post development Western Catchment.

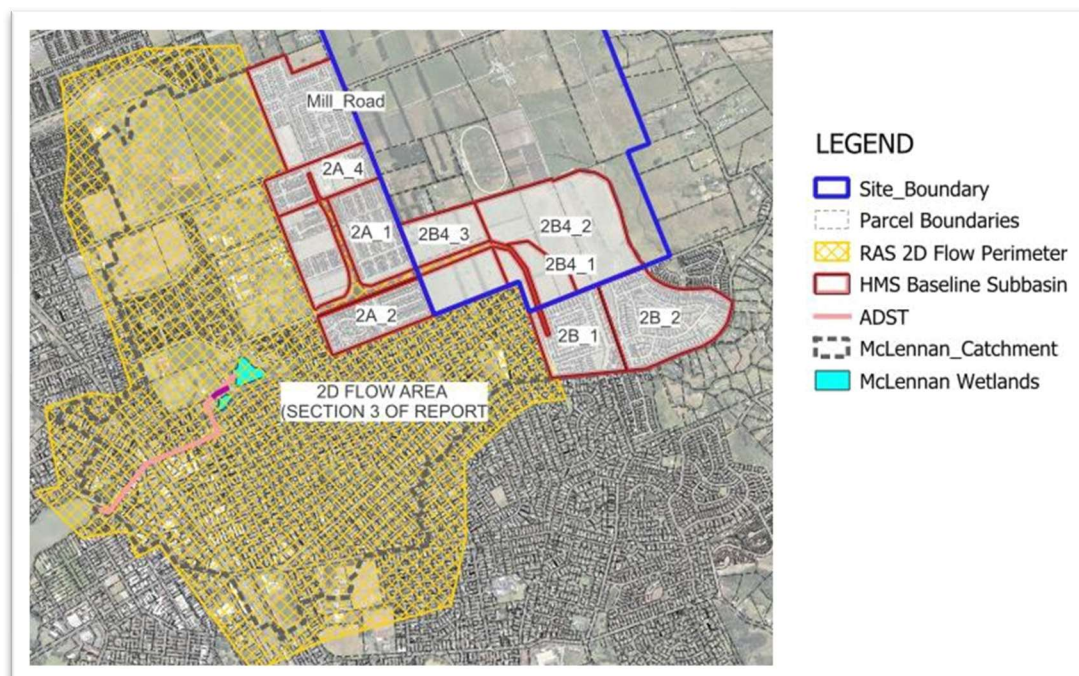


Figure 2.3 HEC HMS model extents for Western Catchment baseline scenario

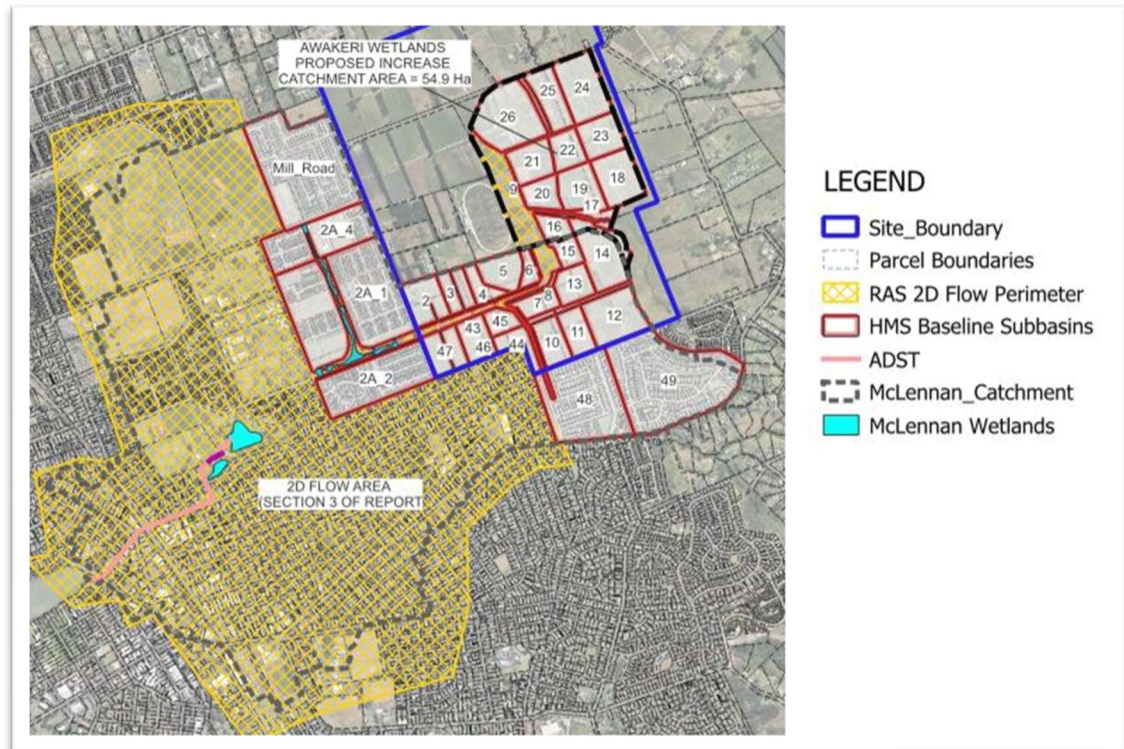


Figure 2.4 HEC HMS model extents for western catchment post development scenario

2.5 SOILS PARAMETERS

A Curve Number (CN) value of 74 has been adopted in the flood modelling to ensure consistency with design parameters previously applied in the Awakeri Wetlands Stage 1 and the Papakura Integrated Catchment Management Plan (ICMP). This value also appropriately reflects the hydrological behaviour of the underlying peat soils within the catchment.

Geotechnical investigations indicate that the upper layer of peat soil tends to harden upon exposure to oxygen, which reduces infiltration capacity and increases surface runoff. This characteristic supports the use of a relatively high CN value, as it accounts for the soil's tendency to shed water rather than absorb it.

We don't believe that CN values of 39 and 98 are appropriate for sensitivity analysis in flood modelling using TP108, particularly in catchments underlain by peat soils. Peat exhibits complex hydrologic behaviour—characterised by high initial infiltration capacity followed by rapid saturation—which is not accurately represented by either of these extreme CN values. A CN of 39 reflects exceptionally low runoff potential typical of dry, well-drained forest soils, which is inconsistent with the moisture-retentive and seasonally saturated nature of peat. Conversely, a CN of 98 assumes near-total imperviousness, significantly overestimating runoff from peatlands that still allow infiltration and storage. Including these extremes introduces unrealistic boundary conditions that can distort model outputs and misrepresent

flood risk.

CN values of 61 and 74 have been adopted for modelling, consistent with TP108 classifications for Group B and Group C soils respectively. These values are considered more representative of the hydrologic behaviour of peat soils, which exhibit a transitional response—initially allowing infiltration but quickly reaching saturation, resulting in increased surface runoff. A CN value of 74, in particular, reflects this dual nature and has been specifically selected to maintain alignment with design parameters previously applied in the Awakeri Wetlands Stage 1 and the Papakura Integrated Catchment Management Plan (ICMP). As stated in the Awakeri Wetlands Stage 1 Design Report, geotechnical investigations indicated that the upper layer of peat tends to harden upon exposure to oxygen, reducing infiltration capacity and increasing surface runoff. This characteristic supports the use of a relatively high CN value, as it accounts for the soil's tendency to shed water rather than absorb it.

Geotechnical advice has been provided by LDE, which supports the classification of Takanini peat soils as Class B or C. This conclusion is based on both a desktop review (Auckland Council Technical Report 2013/040) and prior site-specific testing. Although one soakage test suggested Class D characteristics, this result is considered an outlier due to natural variability across the site. Therefore, the curve number assumptions applied in the stormwater modelling are consistent with regional precedent and geotechnical interpretation.

The CN 74 value is based on calibrated modelling inputs that have been previously accepted by Auckland Council and other regulatory authorities. These inputs were derived from local land use, soil characteristics, and observed hydrologic responses. Its application in existing infrastructure, such as the Awakeri Wetlands Stage 1, has demonstrated reliable performance across a range of storm events. Maintaining this CN value ensures alignment with catchment-wide planning assumptions and provides a realistic, conservative basis for estimating runoff volumes in the context of flood hazard modelling.

Snippet from Papakura Integrated Catchment Management Plan (ICMP) below:

Runoff Curve Numbers

Typical runoff curve numbers were provided in TP108 for a range of land cover types and typical soils in the Auckland Region. At Central Papakura, typical surficial soil types include the Puketoka Formation and the Takanini Black Swampy Peat. The Puketoka formation is of alluvium including volcanic ash, sands, gravel and East Coast Bays Formation soils. The Takanini Black Swampy Peat is known to have the characteristics of typical silty clay soil, with typical hydraulic conductivity K values ranging from 1×10^{-8} to 1×10^{-9} m/s from on site tests undertaken recently. A runoff curve number of **61** was selected for the Puketoka Formation soils and **74** for the Peat soils. A runoff curve number of **98** was chosen for all impervious surfaces.

In the TP108 runoff model, the runoff hydrograph is calculated using the standard SCS synthetic unit hydrograph as in the original TR55.

Snippet from Auckland Council's Awakeri Wetlands Stage 1 Design report below:

Design curve numbers

An SCS Curve Number (CN) of 74 has been used for peat soils for the predevelopment scenario as per the Papakura ICMP, as per TP108. The post-developed scenario also uses a CN of 74 for pervious areas based on likely imported fill characteristics or existing peat soils as per above.

This aligns with the curve numbers being used by developers in the catchment.

Geotechnical observations indicate that the top crust of the soil can harden when exposed to oxygen and sheds water. This gives further support to using a curve number of 74.

Storm Duration:

Although standard stormwater modelling assessments typically adopt a 24-hour design storm duration, shorter durations of 30-minute and 60-minute events have been incorporated into this study at the request of Auckland Council's Healthy Waters team. This approach was adopted to align with the methodology used by WSP in their Papakura Stream Plan Change Modelling Support – Sunfield Development report (WSP, 2025). It is important to note that peak discharge rates from the 30-minute and 60-minute events are significantly lower than those from the 24-hour duration. As a result, the ultimate loading effects on the downstream network are considerably reduced when compared to the standard 24-hour design storm.

Spatial Rainfall:

Although spatially varying rainfall is not typically included in standard stormwater modelling assessments, it has been incorporated into this study at the request of Auckland Council's Healthy Waters team. This approach was adopted to align with the methodology used by WSP in their Papakura Stream Plan Change Modelling Support – Sunfield Development report (WSP, 2025).

Stormwater Modelling Results Summary – Eastern Catchment

Stormwater modelling has been undertaken to assess the downstream effects of the proposed development within the eastern catchment under a comprehensive range of scenarios, including sensitivity testing as requested by Auckland Council's Healthy Waters team. The original modelling was based on a CN value of 74, a 24-hour storm duration, and non-spatial rainfall. To provide a more robust assessment, additional modelling has now been completed for:

- CN value of 61, representing lower runoff potential and increased infiltration;
- Shorter storm durations of 30 minutes and 60 minutes.
- Spatial rainfall distribution, reflecting realistic storm variability across the catchment.

Key Findings:

1. Downstream Effects Are Generally Reduced

Across all scenarios, post-development discharges are consistently lower than pre-development values, particularly under the 24-hour duration. This demonstrates that the proposed attenuation devices are effective in managing stormwater and mitigating downstream flood risk within the eastern catchment.

2. Minimal Effects Where Increases Occur

In a limited number of scenarios—primarily under CN 61 and shorter durations or spatial rainfall—slight increases in discharge were observed. These effects are less than minor and remain contained within existing private farm drains, with no predicted adverse impacts on public infrastructure or habitable buildings. Refer to the flood extent maps in the appendices for visual confirmation of containment.

Importantly, while these scenarios show slight increases, the impacts are significantly lower than those associated with the ultimate case, which is the 24-hour storm event — the typical and most conservative stormwater modelling method accepted by Auckland Council. Under the 24-hour scenario, all post-development flows are reduced compared to pre-development, confirming the effectiveness of the proposed stormwater management approach.

3. Ultimate Loading from 24-Hour Duration

The 24-hour storm duration represents the ultimate loading condition and is the most conservative scenario. It is the typical modelling practice accepted by Auckland Council as it captures the full extent of potential flooding impacts. The modelling shows that flows under this condition are significantly reduced post-development, which is a positive outcome for the Papakura catchment, an area known to experience downstream flooding issues.

4. Flood Depth Considerations

A small number of scenarios flagged potential increases in flood depth immediately downstream of Pond 1. These are localized and are not expected to result in adverse impacts. Further hydraulic analysis of the downstream conveyance channels is recommended to confirm capacity and ensure long-term resilience.

5. Alignment with Council Methodology

The modelling approach aligns with WSP's methodology in the Papakura Stream Plan Change Modelling Support – Sunfield Development report (WSP, 2025), including the use of spatially varying rainfall and peat CN sensitivity testing. This ensures consistency with Council's expectations and provides a high level of confidence in the results.

6. Targeted Upgrades to Airfield Road

As part of the Sunfield development, targeted upgrades are proposed for Airfield Road to address existing flooding issues, particularly during the 2-year Average Recurrence Interval (ARI) storm events. The improvement involves installing a series of 300 mm stormwater pipes beneath the road corridor to enhance conveyance and replicate

current surface flow patterns, thereby reducing flood risk without increasing downstream impacts. These upgrades will ensure the road remains passable during storm events, improving safety and accessibility for future residential and transport use. Additionally, the design is compatible with NZTA's Mill Road Stage 2 Project, supporting a coordinated, catchment-wide flood resilience strategy.

2.6 LAND-USE

For the purposes of analysis Table 2.2 following shows the impervious percentages used for the proposed zoning and existing zoning within the model extents. Appendix 9 shown plan of the zoning

Table 2.2 – Impervious percentage for Zoning

Zone	Impervious %
Commercial, Town Center	100
Industrial	90
Residential, retirement village	60
Road	85
Open space	10
SW channel (Awakeri Wetlands)	10

2.7 CHANNELISATION FACTORS AND TIME OF CONCENTRATION

The channelisation factors in Table 2.3 were used for each of the storm events respectively.

For the 50% & 10%AEP storms the channelisation factors of 0.6 have been used for impervious areas. This factor reflects the piped stormwater systems. For pervious areas a factor of 0.8 has been used to reflect the use of open stormwater systems for pervious areas

For the 1%AEP storms the channelisation factors of 0.8 have been used for impervious areas. This factor reflects the swales and green corridors used for overland flow paths. For the previous areas a factor of 1.0 to reflect the sheet overland flow.

Table 2.3 – Channelisation factors

Channelisation Factor	Storm event	
	50% & 10% AEP Storm	1% AEP Storm
Impervious	0.6	0.8
Pervious	0.8	1.0

Time of concentration

The values for flow length and time of peak flow have been derived from calculations based on the TP108 methodology. The slopes and catchment lengths consider the developed slopes of the catchment draining to the proposed channel.

2.8 SUBBASIN PARAMETERS

Please refer to Appendix 3 for a summary of the HEC HMS parameters.

2.9 HEC-HMS MODEL

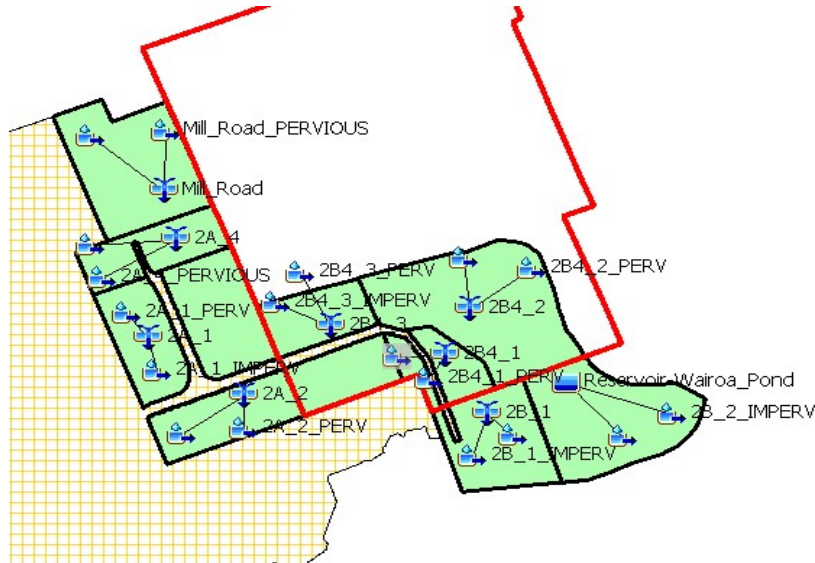


Figure 2.5 –Western Catchment HEC-HMS Model Set-Up – Baseline

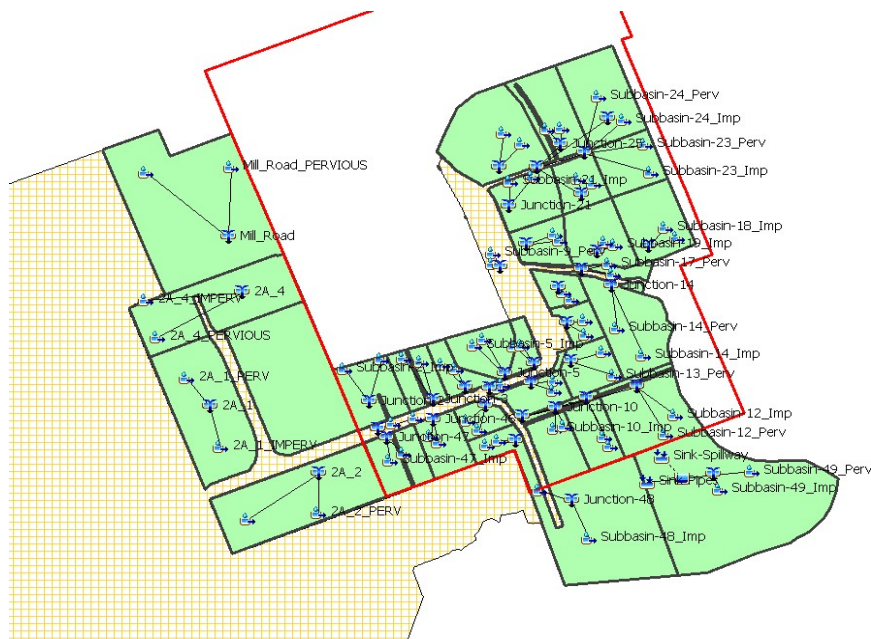


Figure 2.6 –Western Catchment HEC-HMS Model Set-Up -Post Development

2.10 CATCHMENT STORAGE AND ATTENUATION

Please refer to Appendix 3 for a summary of HEC HMS pair and cross section parameters data associated with the existing attenuation reservoir.

2.1.1 Existing Upstream Old Wairoa Road Pond Attenuation (Subbasin-49)

Generally, there is limited attenuation in the existing western catchment, as noted in the Awakeri Wetlands Design report (Appendix 11), the proposed wetland channel was designed to convey post-development flows. The exception is for the sub-catchment 49 (sub catchment 2B_2 in baseline scenario). Auckland Council Geomaps shows the pond as a stormwater treatment facility named “Old Wairoa Road Pond”. Geomaps shows the pond to have a volume to spill of 9,919 m³ with a 1200mm concrete pipe outlet. The pond has been modelled as a reservoir in the model, with a culvert outlet and spillway (outlet information was obtained from Geomaps and contours). Reservoir initial condition was set to outflow = inflow. Generated hydrograph discharge was used as inflow to the TUFLOW model (outlined in section 3).

2.1.2 Proposed Stormwater Pond 4 (Subbasin-9 & 14 to 26)

Runoff from 63.4 Ha of the site is proposed to drain into stormwater pond 4. Flows shall be attenuated prior to discharge into the Awakeri Wetlands. The basin shall have an outlet and swale to connect to the Awakeri wetlands channel. This pond has not been included in the HEC HMS model. To allow for any hydraulic influence of tailwater in the channel the stormwater pond shall be modelled in section 3 (using TUFLOW software).

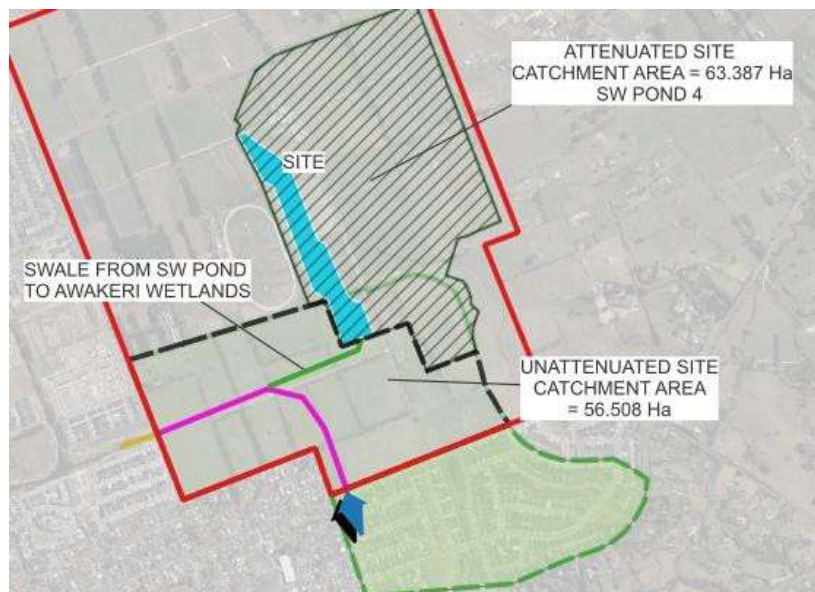


Figure 2.7 –Western Catchment proposed Stormwater attenuation Pond

2.11 INFLOW HYDROGRAPHS

Inflows generated from the HEC HMS model were then transferred to TUFLOW as inflow boundary conditions, the TUFLOW modelling shall incorporate stormwater hydraulics into the modelling. Please refer to section 3 for hydraulic modelling.

3 WESTERN CATCHMENT HYDRAULIC MODELLING WITH TUFLOW

3.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the perimeter for the grid,
2. Create a grid and sub-grid areas,
3. Input flow hydrographs and other boundaries
4. Input structures,
5. Run scenarios.

3.2 TUFLOW MODEL LAYOUT

A 2D model was developed using design terrain of Awakeri Wetlands Stage 1 and proposed design contours of Awakeri Stages 2 and 3 (no deviations from the original Stages 2 and 3 Design). A Manning's n of 0.03 was used for the low flow areas and 0.045 for the rest of the channel. (Manning values have been used in consistency with previous modelling by Healthy Waters).

Hydraulic structures were added as outlined in section 3.4. A triangle mesh with cell size generally between 2m and 5m was used to model the 2D flow area. Figure 3.1 and 3.2 shows the grids and its boundary conditions.

TUFLOW software was used to generate water levels within the main channels, the proposed stormwater pond 4 and the McLennan Wetland.

McLennan Wetland Spillway

The McLennan Wetland spillway has been topographically surveyed. The existing spillway level has a general elevation of 14.86 mRL. The surveyed terrain of the spillway has been incorporated into the model terrain for all scenarios.

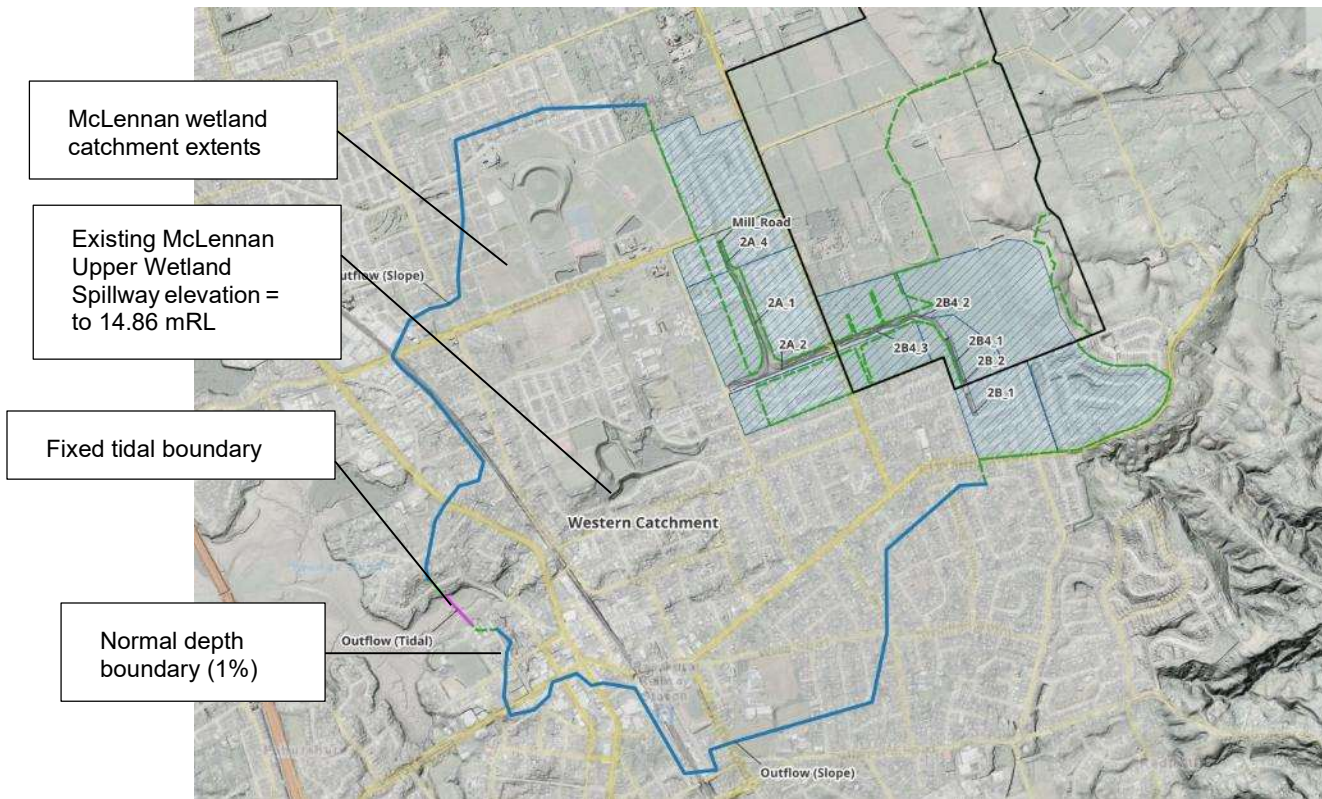


Figure 3.1 – TUFLOW Western model set-up – Baseline

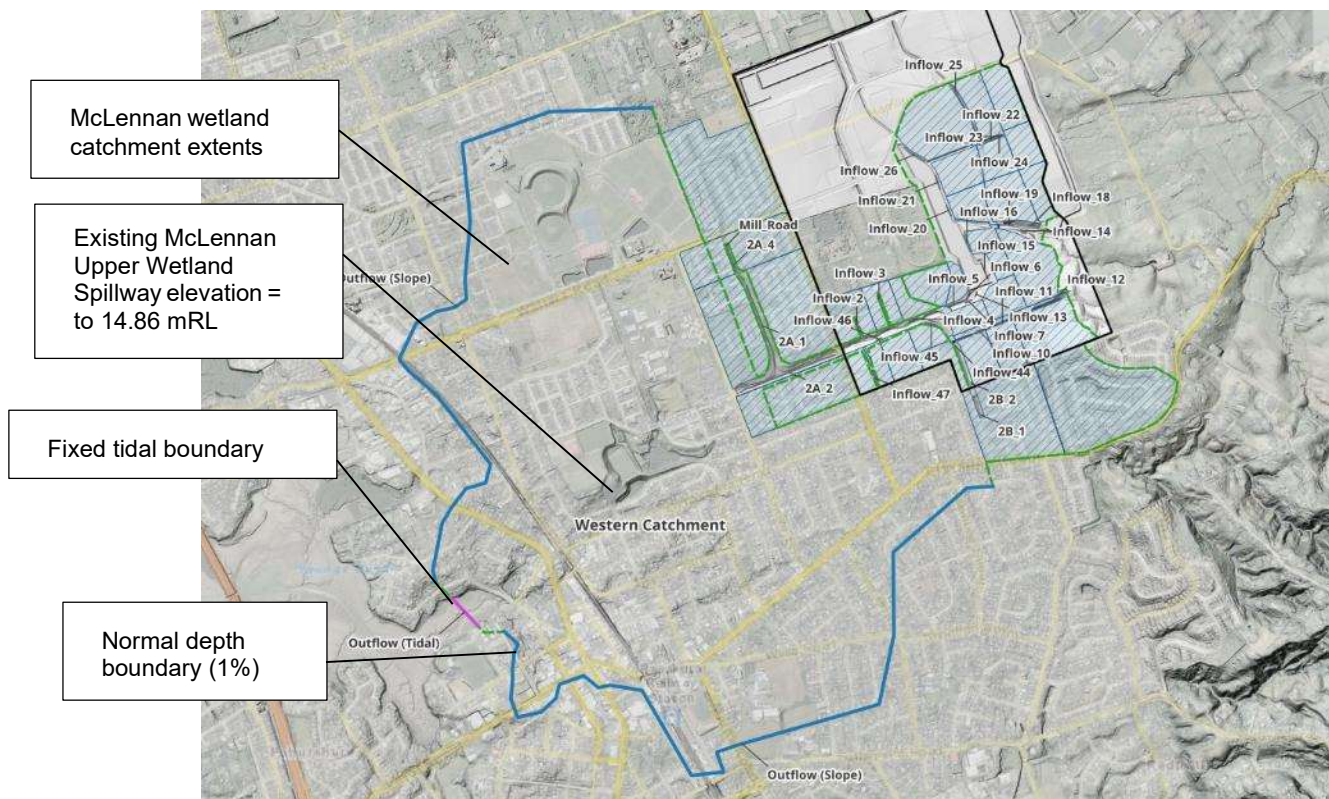


Figure 3.2 – TUFLOW Western model set-up - Post development

3.3 HYDRAULIC STRUCTURES AND CULVERTS

Within the Awakeri Wetlands hydraulic structures have been incorporated in general accordance with the Healthy Waters design of the Awakeri Wetlands (shown in Appendix 10). Design deviations include the addition of a swale connecting stormwater pond 4 to the Awakeri Wetlands and update of the culvert at chainage 1140 to match the proposed road layout. Downstream of the site a major pipes have been incorporated in the modelling including the Artillery Drive Tunnel within the Upper McLennan wetland. Two types of structures are present, weirs and culverts. As per outlined in the Awakeri Wetlands design reports, the weirs function is to keep a permanent water level in the channel.

A total of ten culverts have been included in the model as well as weir structures. A summary of the structures is included in Table 3.1 following.

Culverts structures

Table 3.1 – Western Catchment Culvert summary

Name	Chainage	Size
Stage 2 Awakeri Wetlands	550	3 x Box culvert 1.5m x 2.5m
Proposed Chainage 1140 Culvert	1140	2 x Box culvert 1.5m x 2.0m
Existing Wairoa Road Culvert	1400	2 x 1500ø
Stage 4 Attenuation Pond Culvert	-	1 x Box culvert 1.0m x 1.0m
Grove Road Culvert	0	2.5 x 3.5 Box Culvert
Artillery Drive Stormwater Tunnel	-	QH Curve from McLennan Spillway Modelling (Appendix 12)
Battalion Road Culvert (SAP ID 3000092665)	-	1.2m Circular Pipe
Battalion Road Culvert (SAP ID 3000049172)	-	1.05m Circular Pipe
Walsh Road Pipe (SAP ID 3000034935)	-	0.75m Circular Pipe
Walters Road Pipe (SAP ID 2001081576)	-	0.6m Circular Pipe

Awakeri Wetlands Weir structures

Table 3.2 – Western Catchment weir summary

Chainage	Height mRL (NZVD2016)
0	20.41
80A	20.62
100B	21.25
180B	21.07
260B	21.43
330A	21.52
340B	21.60
440A	21.97
480B	21.70
580A	22.31
610A	22.65
690A	22.88
800A	23.11
900A	23.34
950A	23.57
1160	23.80
1240	24.03
1300	24.26
1460A	24.49



Figure 3.3 Awakeri Stage 1 Existing weirs and Stages 2 and 3 design weirs

3.4 BOUNDARY CONDITIONS

The below boundary conditions were used in the model:

- A 2d grid – as per figure 3.1 and 3.2

The grid extents include the proposed stormwater pond 4 located within the site, the Awakeri Wetlands, the McLennan Wetland and its contributing area and the outlet area of the Artillery Drive Stormwater Tunnel (ADST).

- Rain on grid – Precipitation has been applied across the 2d grid
- Inflow hydrographs imported from HEC HMS (outlined in section 2)
- Permanent water levels – Initial water elevations were set at the top of weir levels
- The downstream outflow boundary condition has been setup at the sea boundary as a constant stage elevation of mRL 2.34 mRL AUK1946 (2.06 mRL NZVD2016). This was selected for consistency with the level Auckland Council requested T&T to use in the McLennan wetland spillway options modelling, June 2021, appendix 12.
- The ADST and inlet structures have been modelled using a discharge-stage (QH) relationship extracted from Auckland Council's 2019 McLennan Spillway report (refer to appendix 12). The QH includes allowances for the tailwater condition and hydraulic losses at the inlets, outlet, pipe bends and roughness. QH curve may be found in figure below.

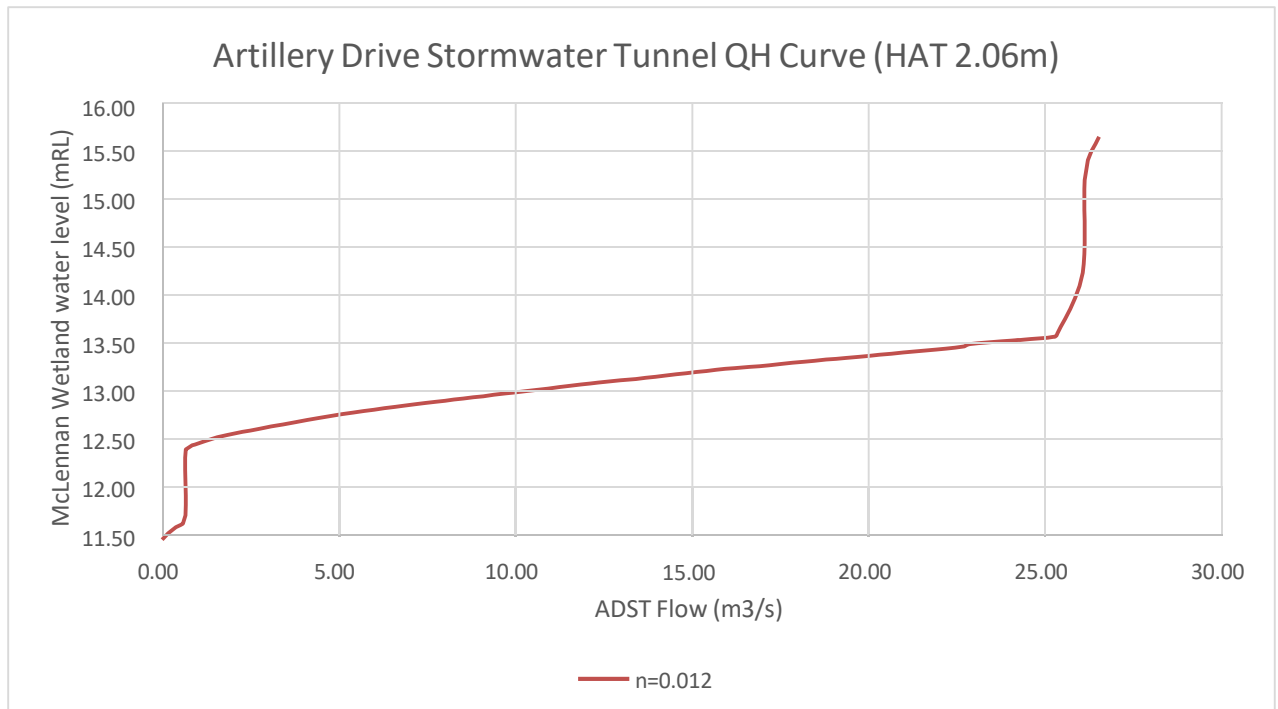


Figure 3.4 QH curves for ADST and inlet structures.

3.5 CLIMATE CHANGE FACTOR INCREASE – BASELINE SCENARIO

At the time of the writing of this report Auckland Council is transitioning from Auckland Council Stormwater Code of Practice (SWCoP) version 3 to version 4. One key change included in the transition is the increase in the climate change factor, where new climate change factors are incorporated. This change in design assumption increases the design rainfall depth as well as temporal rain profiles. It should be noted that the Awakeri Wetlands Design report flows assume a the SWCoP version 3 climate change factors. However, the assessment of this report assumes the updated climate change factors . It is noted that this will increase the inflows into the Awakeri Wetlands.

To account to the updated climate change factors a baseline scenario model was developed for three storm events (50%, 10% and 1% AEP) showing the flows and water levels in the Awakeri Wetlands and downstream with the updated climate change factor outlined in AC SWCoP version 4.

Topographical survey was undertaken to confirm the existing elevation of the Upper McLennan wetland. This was surveyed to be generally 14.86 mRL (NZVD2016)

3.6 RESULTS – FLOOD MAPPING

Figure 3.5 below shows the modelled flooding depth of the proposed development for a 1% AEP storm. Flood mapping for each of the modelled scenarios may be found in appendix 6.

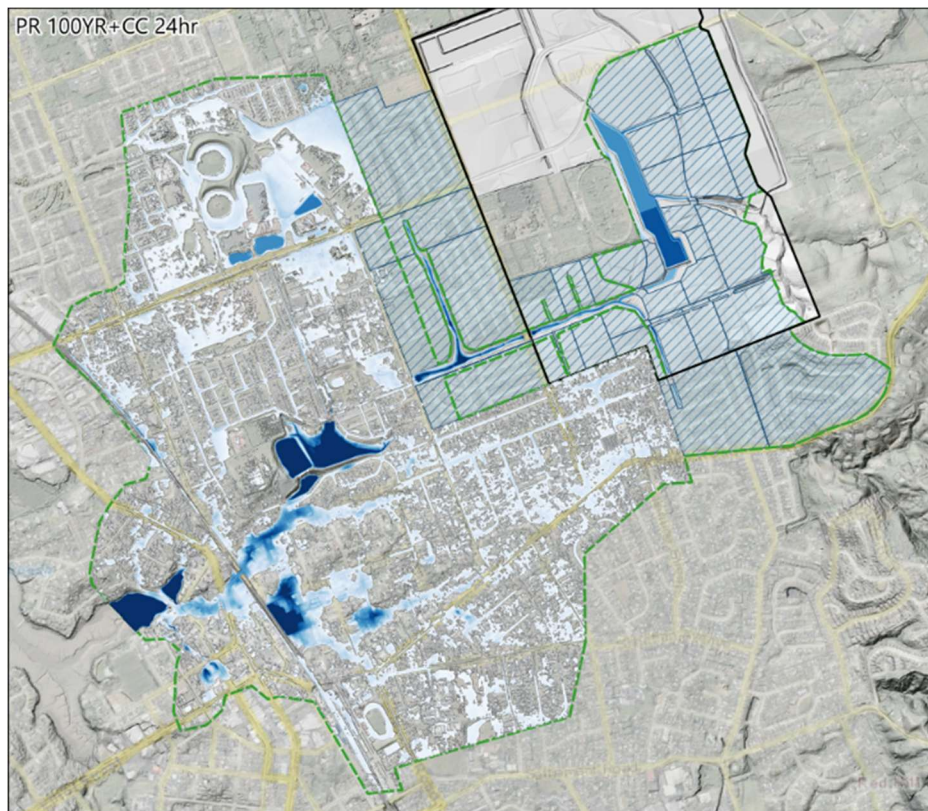


Figure 3.5 Flood depth map of 1%AEP storm (SWCoP version 4 climate change factors)

3.7 RESULTS - AWAKERI WETLANDS PEAK FLOW DEPTHS

Peak post development 1%, 2%, 5%, 10%, 20% and 50% AEP water levels within the Awakeri Wetlands for the baseline scenario are shown in figure 3.6 and for the post development scenario are shown from figure 3.7 to 3.12. Review of the modelling results from the western catchment are shown below. Flood level difference maps may be found in Appendix 6. The flood level difference maps show a minor reduction in water level downstream of the site within the Awakeri Wetlands and upstream to remain unchanged.



Figure 3.6 Long section location within Awakeri wetlands

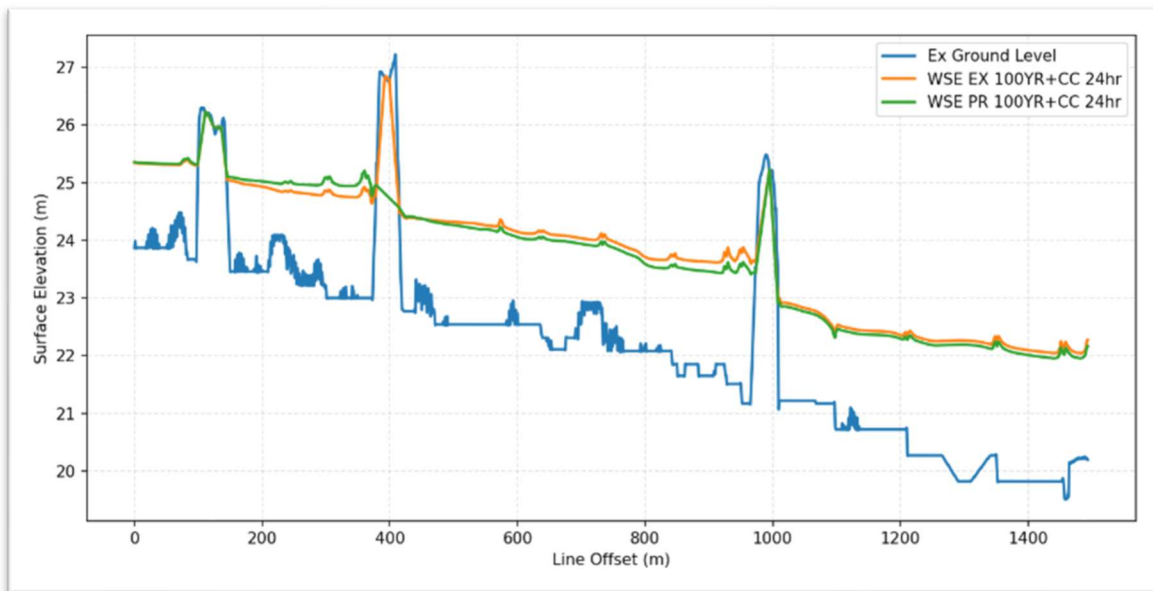


Figure 3.7 Long section of pre and post development 1% AEP peak water levels within Awakeri wetlands

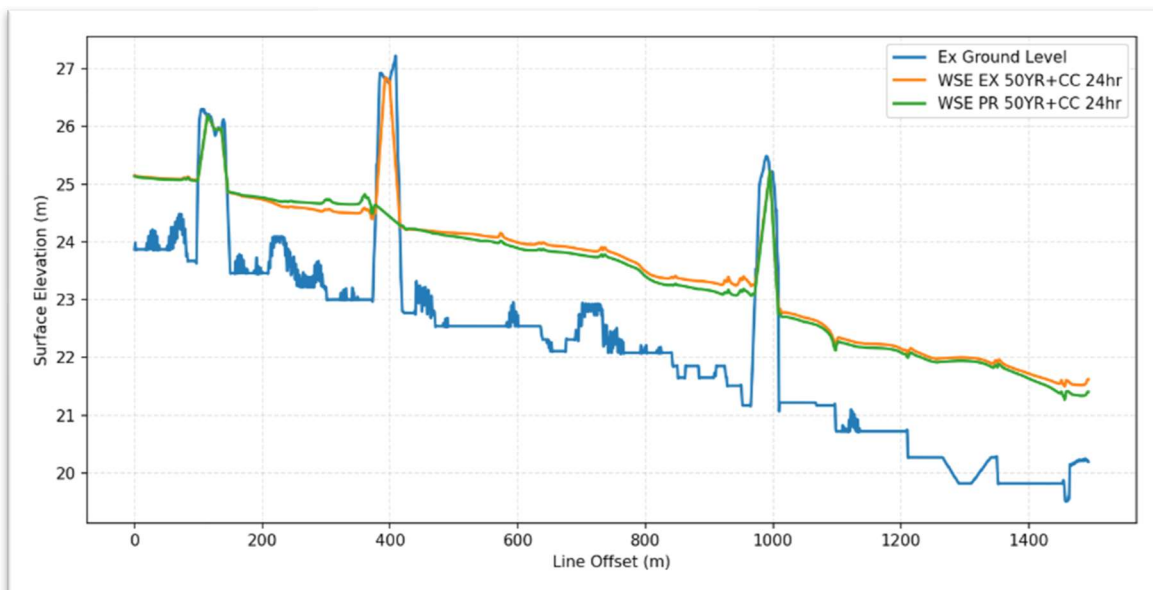


Figure 3.8 Long section of pre and post development 2% AEP peak water levels within Awakeri wetlands

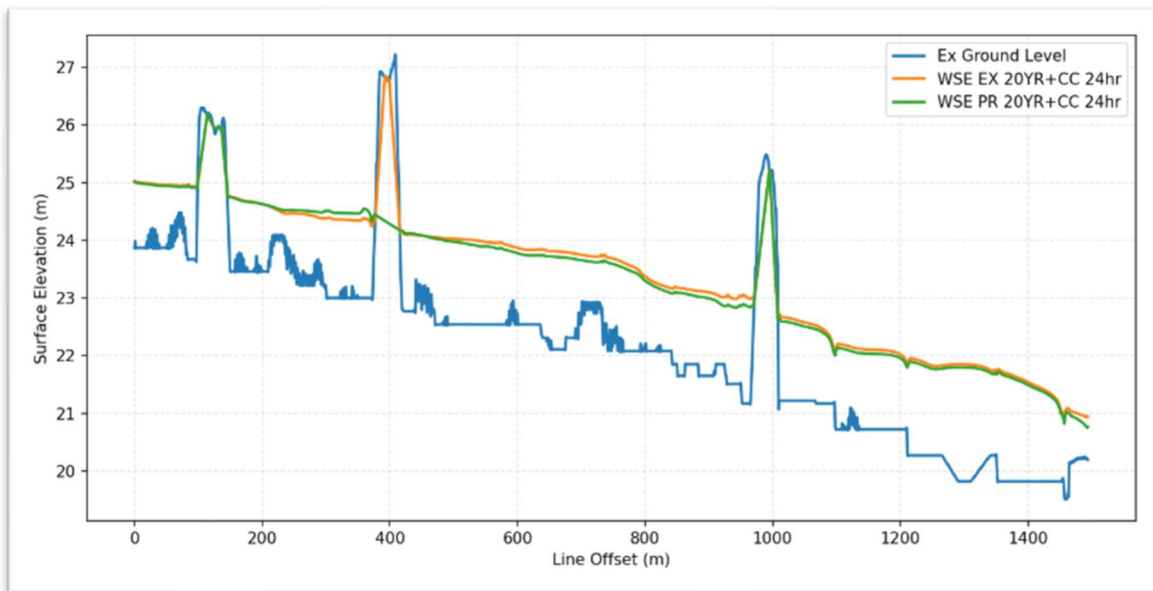


Figure 3.9 Long section of pre and post development 5% AEP peak water levels within Awakeri wetlands

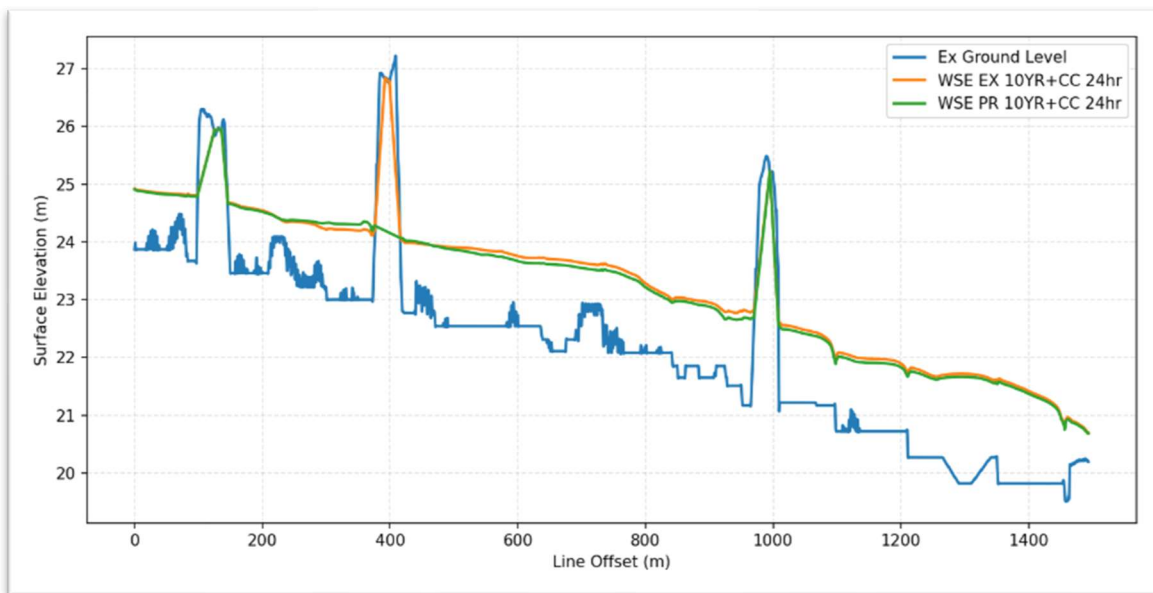


Figure 3.10 Long section of pre and post development 10% AEP peak water levels within Awakeri wetlands

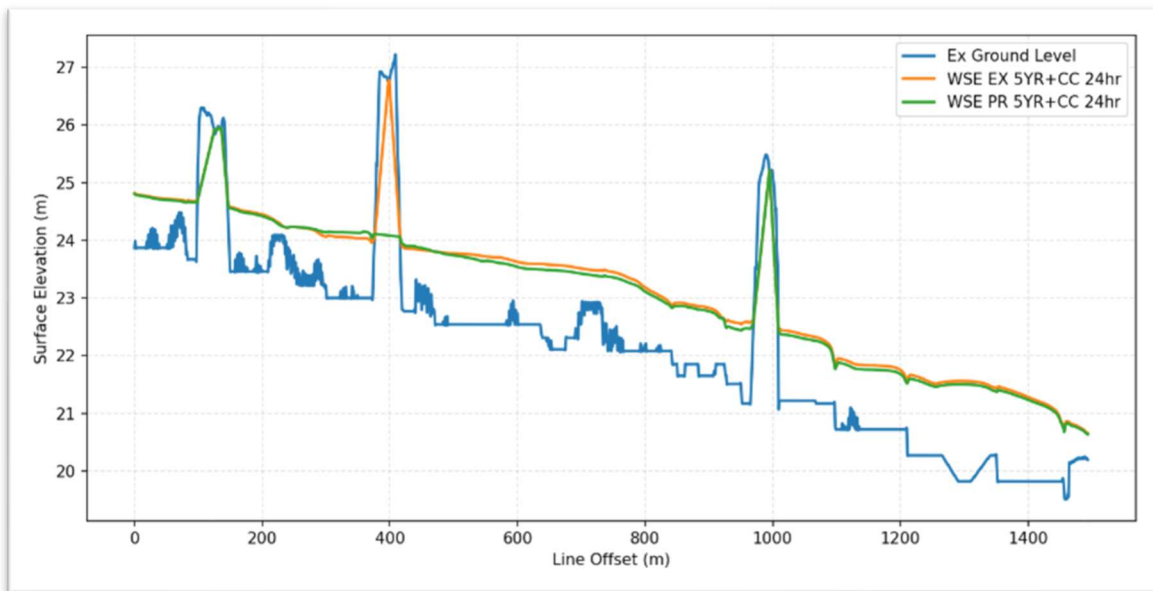


Figure 3.11 Long section of pre and post development 20% AEP peak water levels within Awakeri wetlands

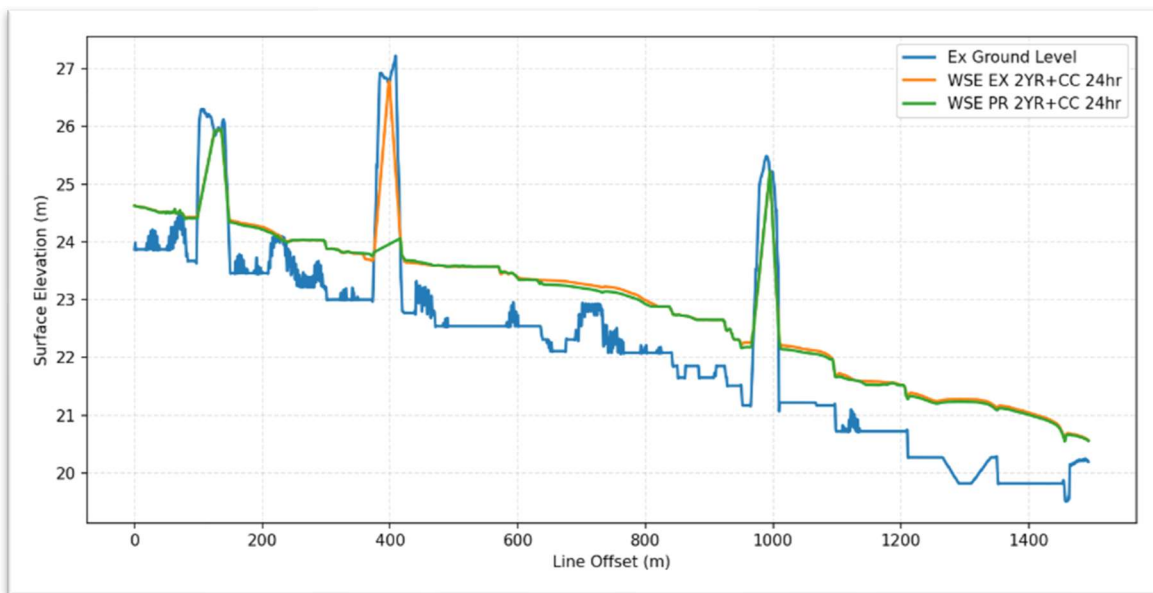


Figure 3.12 Long section of pre and post development 50% AEP peak water levels within Awakeri wetlands

3.8 RESULTS - UPPER MCLENNAN WETLAND

The ADST was built in 2017 to facilitate growth in the catchment upstream of McLennan Wetland without increased flood risk to downstream properties. One of the design objectives of the ADST was to prevent the spillway from the upper McLennan wetland storage area being activated in a 1% Annual Exceedance Probability (AEP) rainfall event, including allowance for climate change (CC) and Maximum Probable Development (MPD). Topographical survey of the Upper McLennan spillway found the elevation to be 14.86 mRL (NZVD2016). It is noted that at the time of the ADST design and construction a smaller climate change factor was applied to the design rainfall. Results are summarised in Figure 3.13 - 3.15 and Table 3.2 below.

Modelling of the baseline 1%AEP baseline scenario shows peak water levels of 15.20mRL. The peak flow exceeds and overtops the existing spillway. The peak flow across the spillway was shown to be 11.93 m³/s.

Modelling of the 1%AEP post development scenario shows peak water levels of 15.18mRL. The peak flow exceeds and overtops the existing spillway. The peak flow across the spillway was shown to be 10.52 m³/s.

In summary, modelling shows the McLennan Wetland is overtopped in both the baseline and post development scenario. In the post development scenario a minor decrease in peak flow is shown across the spillway, reducing from 11.93 m³/s to 10.52 m³/s (11.8% reduction).

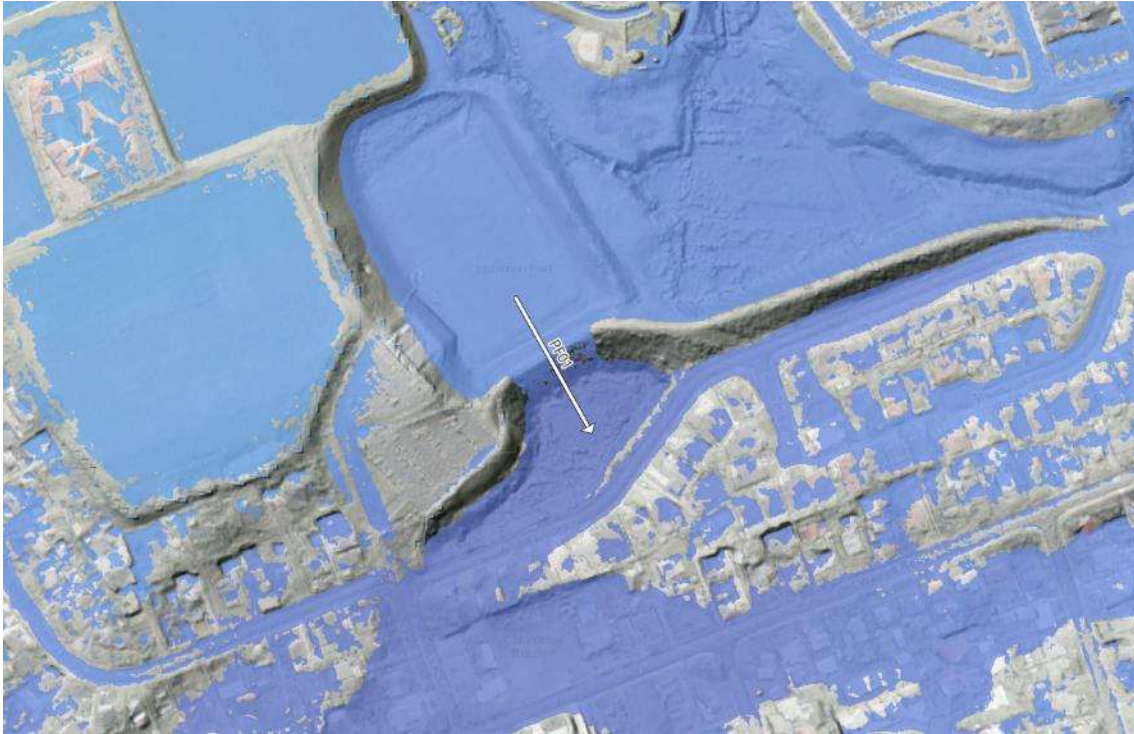


Figure 3.13 Profile line location at the spillway of McLennan Wetland

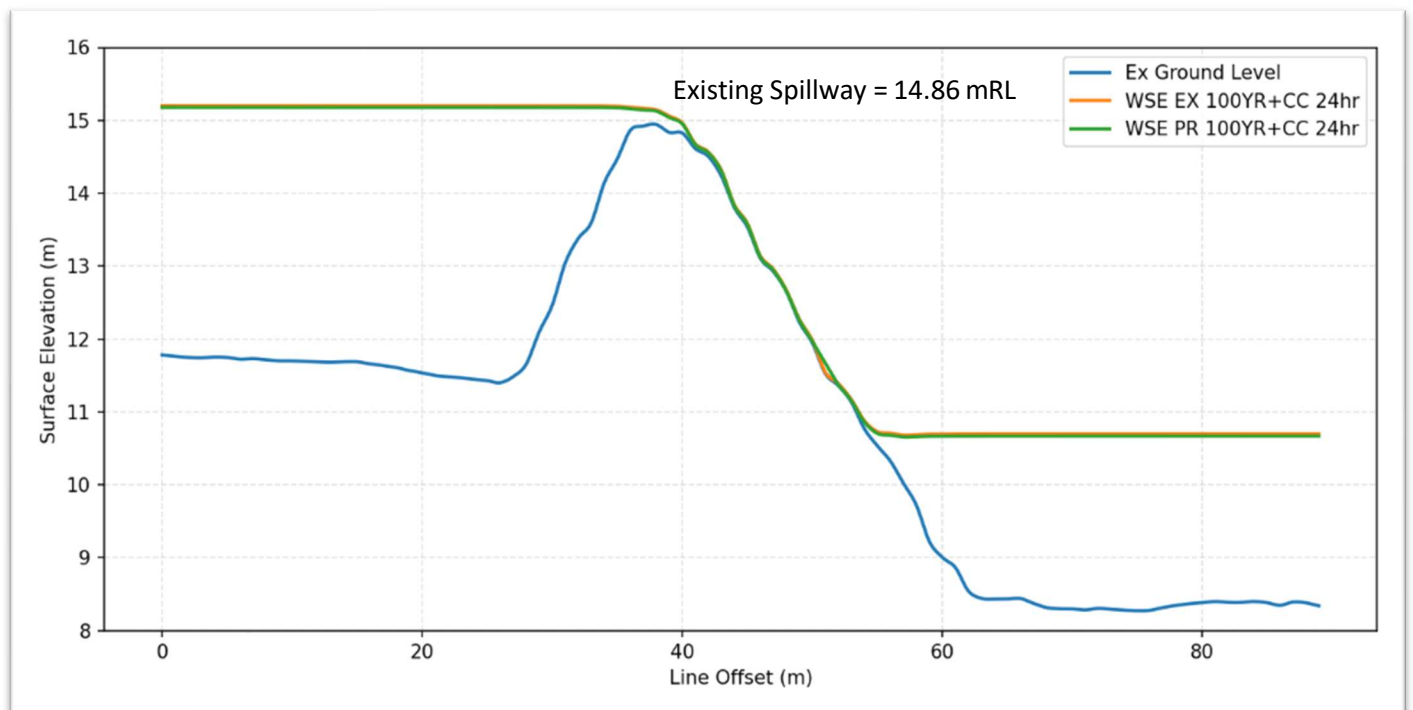


Figure 3.14 Profile of pre and post development peak water surface elevation at the spillway of McLennan Wetland (1%AEP)

Table 3.2 – McLennan Wetlands result summary

Event Scenario	MPD 1%AEP (3.8cc Factor)	
	Baseline	Post Development
Peak Water Peak water level in upper McLennan Wetland (m RL)	15.20	15.18
Freeboard to current spillway level (14.86 mRL)	-0.34	-0.32
Peak flow Artillery Drive Stormwater Tunnel (m ³ /s)	24.23	24.21
Peak flow over spillway (m ³ /s)	11.93	10.52
Duration for water level above spillway level ((hours:minutes)	1:10	1:15

3.9 RESULTS – WESTERN CATCHMENT PEAK FLOW

A comparison of peak flow rates between the baseline and post development scenarios shows that flow rates either remain unchanged or have a small decrease within the modelled Western Catchment for a 1%AEP storm. A decrease in peak flow rate of 15% is observed at Awakeri Stages 2 and a decrease in peak flow rate of 10% is observed at Grove Road Culvert. This is attributed to the proposed stormwater pond within the site, which is providing attenuation and decreasing peak flows.

Table 3.3 – Awakeri Wetlands Stage 2 peak flow difference from post development site discharge

Storm Event	Baseline Modelled Scenario Peak SWCoPv4 Climate Change factors flow (m3/s)	Post development modelled Peak SWCoPv4 Climate Change factors flow (m3/s)
50% AEP	6.49	5.51
20% AEP	11.24	9.57
10% AEP	14.38	12.52
5% AEP	17.46	15.31
2% AEP	21.05	18.63
1% AEP	26.05	23.56

Table 3.4 – Grove Road Culvert peak flow difference from post development site discharge

Storm Event	Baseline Modelled Scenario Peak SWCoPv4 Climate Change factors flow (m3/s)	Post development modelled Peak SWCoPv4 Climate Change factors flow (m3/s)
50% AEP	11.09	10.02
20% AEP	19.25	17.54
10% AEP	24.42	22.41
5% AEP	29.66	27.50
2% AEP	34.91	32.94
1% AEP	39.22	38.64

3.10 WESTERN CATCHMENT ATTENUATION VOLUMES

Attenuation for the post development scenario is provided by a stormwater pond (SW Pond 4). The configuration of the outlets and storage volumes are summarised in the table below.

Table 3.5 – Western Catchment attenuation volumes

Element	Stormwater Pond 4	Outlet
50% AEP Pond Peak storage Vol (m3)	23,280	Box Culvert 1.0m x 1.0m
10% AEP Pond Peak storage Vol (m3)	51,170	
1% AEP Pond Peak storage Vol (m3)	94,000	

3.11 CONCLUSION – WESTERN CATCHMENT

A flood model has been built to assess flood effects of the proposed development of the site during 50%, 20%, 10%, 5%, 2% and 1% AEP storm events assuming the Auckland Council SWCoP version 4 climate change factors.

The post development scenario was compared to the existing Awakeri Wetlands catchment scheme (baseline scenario).

The proposed development includes an additional 54.9 ha catchment area (increase to the Western Catchment) into the Awakeri Wetlands to help manage flows and downstream flood issues in the Eastern Catchment. Post development flows from the additional catchment are attenuated in a proposed stormwater pond prior to discharge into the Awakeri Wetlands.

Results from the modelling analysis conclude the proposed development will not adversely impact the upstream and downstream properties. Modelled peak flow levels within the TSWCC either remain unchanged or are reduced as a result of the development.

Flood storage in the post development scenario is shown to be contained within the Upper McLennan wetland. Peak flows spilling out of the Upper McLennan Spillway during a 1%AEP storm are shown to be slightly reduced in the post development scenario.

An Auckland Unitary Plan E36 flood risk assessment may be found in Appendix 14.

4 HYDROLOGICAL MODELLING WITH HEC-HMS EASTERN CATCHMENT

4.1 METHODOLOGY

The analysis was done using the following steps:

1. Delineate the catchments where inflow hydrographs required
2. Use TP108 to calculate parameters
3. Use HEC-HMS to create a rainfall hyetograph and flow hydrographs
4. Size attenuation devices for stormwater pond 2 and 3

4.2 RAINFALL DEPTH

TP108 gives the following rainfall depths which have then been adjusted for climate change as shown in Table 2.1. The climate change factor from the Auckland Council version 4 SWCoP have been used.

Rain event	TP108 24 hr rainfall (not including climate change) (mm)	SWCoP v4 24 hr design rainfall including climate change (mm)
1% AEP	225	298
10% AEP	145	170
50% AEP	75	86

Table 2.1 Eastern Catchment rainfall depths

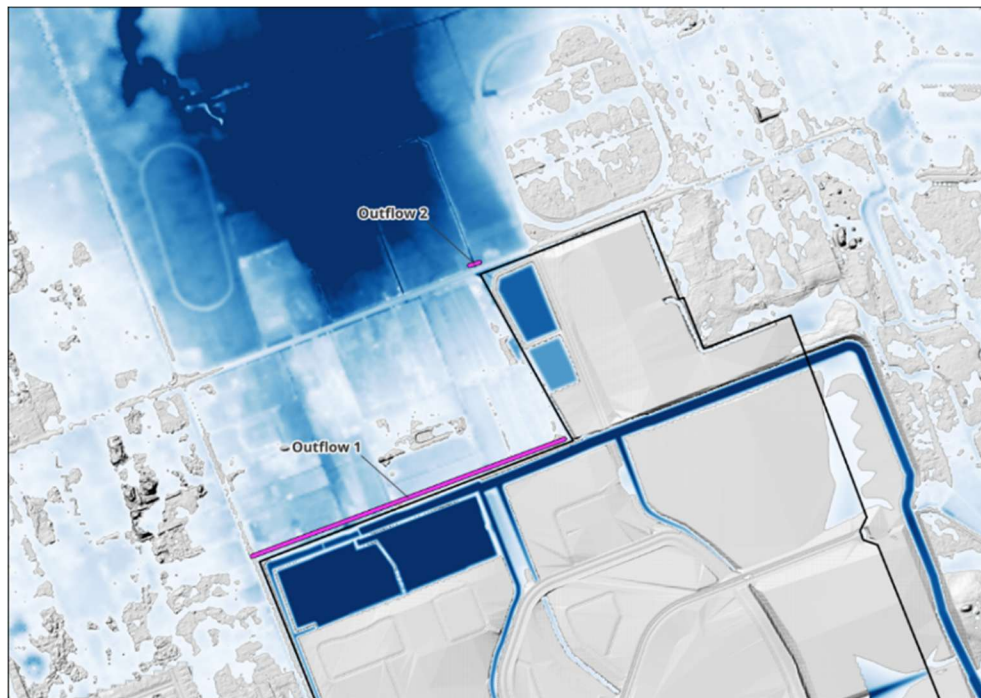
It is noted the TP108 rainfall depths used are conservative in comparison to that on NIWA HIRDS version 4. (the total rainfall depth 24 hour for a 100year storm event for the climate change scenario RCP8.5 scenario on HIRDSv4 is 206mm, 92mm less than the modelled TP108 depth CoP v4 1%AEP depth).

4.3 EASTERN CATCHMENTS

Northern Outflow 1 - (Routed through Stormwater Pond 1)

The catchment area within the site discharging to the Northern outflow 1 via stormwater pond 1 is 109.1 Ha, of this area 29.5 Ha of the site is allocated to stormwater management as either swales or the Stormwater Pond 1. Flow within the stormwater management areas within the site as well as the upstream and downstream catchment shall be modelled in a 2d flow area in TUFLOW (outlined in section 5).

Developed lot catchments within the site discharging to Stormwater Pond 1 have a total area of 64.2ha. Post development subcatchments for this area are delineated by where they discharge into the site's swale network (ie 2d flow area). Flows upstream and downstream of the site are generated from rain on grid (and are detailed in section 5). Figures below shows the HEC HMS subbasin delineations.



Northern Outflow 1/2 Location Plan

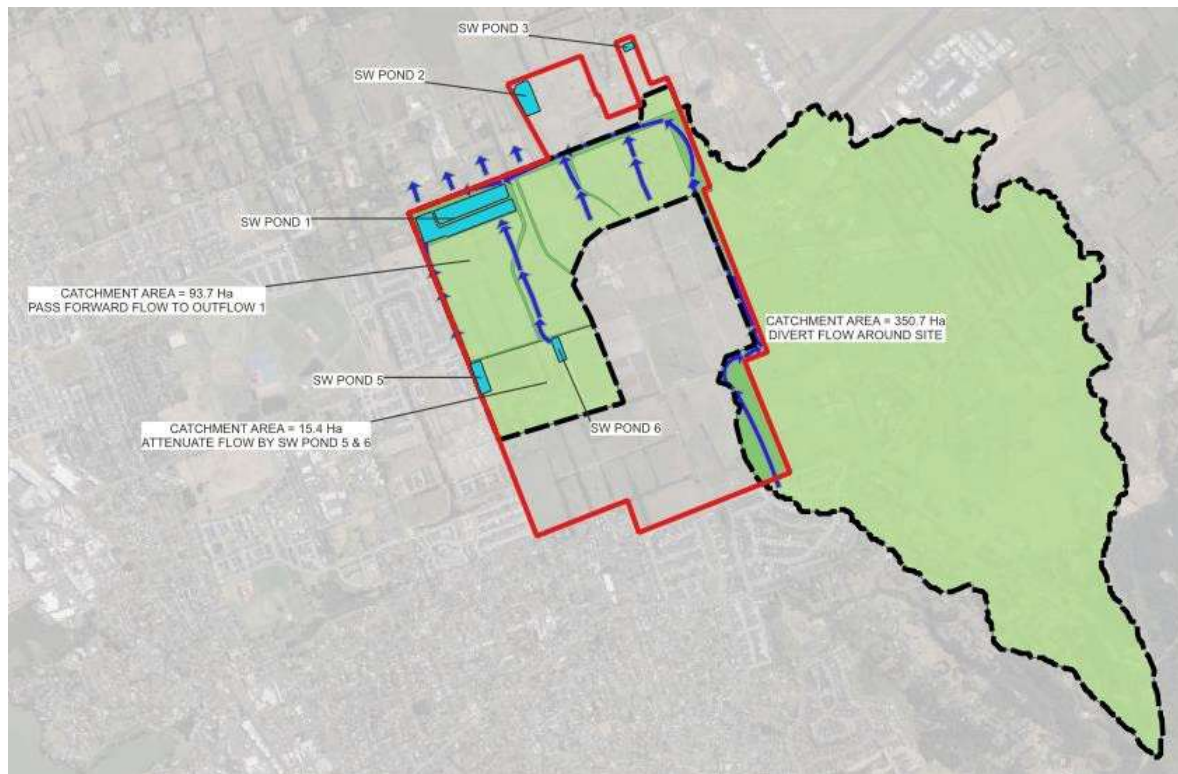


Figure 4.1 Proposed Stormwater Pond 1 Catchment

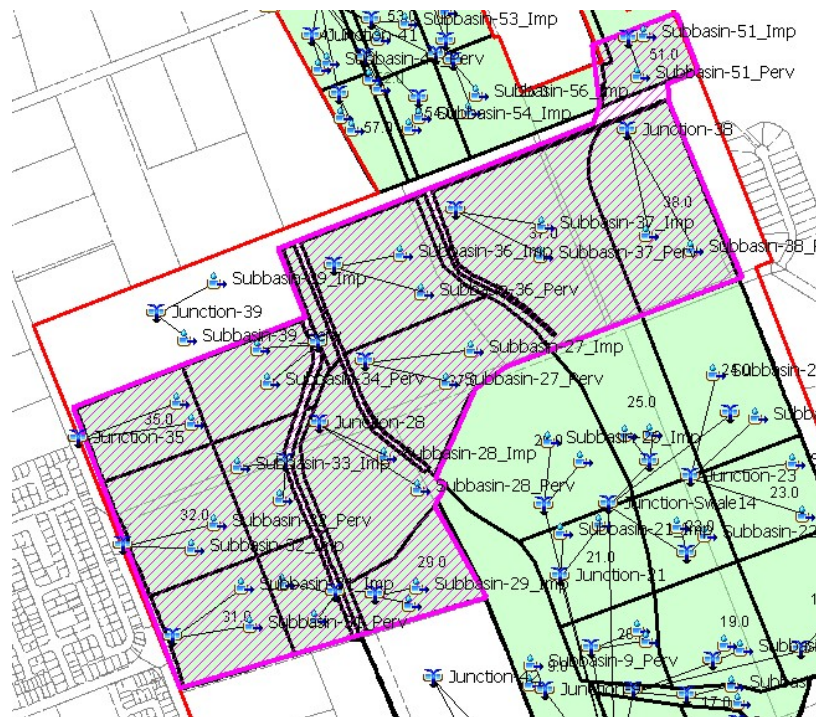


Figure 4.2 –Eastern Catchment Outflow 1 HEC-HMS Model Set-Up for inflow hydrograph

Northern Outflows 2 & 3 (with area routed through Stormwater Ponds 2 & 3)

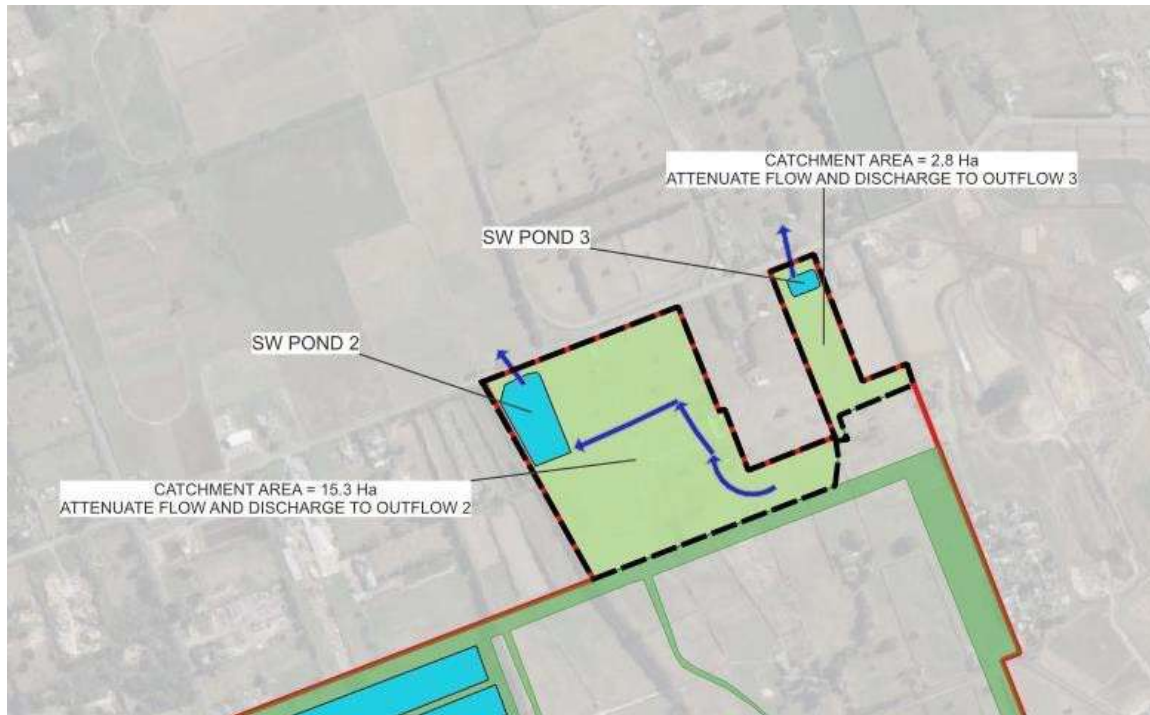


Figure 4.3 Proposed Stormwater Pond 2 & 3 Catchment

For the site area located within Catchments D1 and D2 it is proposed to attenuate post development flows to peak pre-development flows (as shown in Appendix 5) HEC HMS has been used to size the attenuation volume required for the 2%AEP, 10% AEP and 1%AEP storm. The model setup is shown in figure 4.4 below.

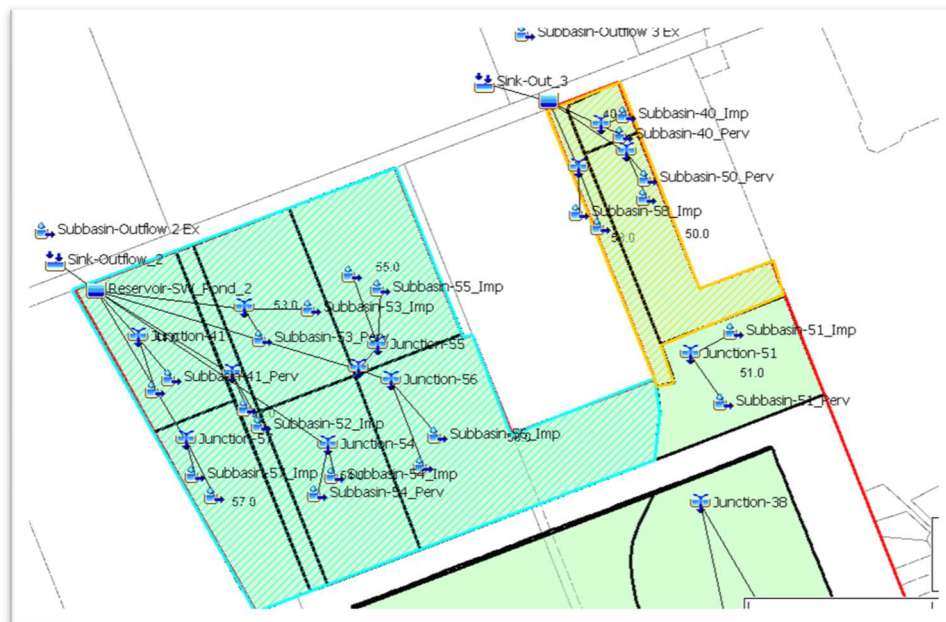


Figure 4.4 –Eastern Catchment 1%AEP HEC-HMS Model Set-Up for Stormwater Pond 2&3

Eastern model

The climate change factor from the Auckland Council version 4 SWCoP has been applied for the Eastern catchment rainfall.

Table 4.1 Eastern Catchment rainfall depths

Rain event	TP108 24 hr rainfall (not including climate change) (mm)	CoP v4 24 hr design rainfall including climate change (mm)
1% AEP	225	298 (32.7% increase according to 3.8°C)
10% AEP	145	170 (17.0% increase according to 2.1°C)
50% AEP	75	86 (15.1% increase according to 2.1°C)

4.4 RAINFALL HYETOGRAPH

The normalised 24-hour temporal rainfall intensity profiles for future climate change condition were used in accordance with Auckland Council code of practice (Version 3 and 4) section 4.2.10 Table 2.

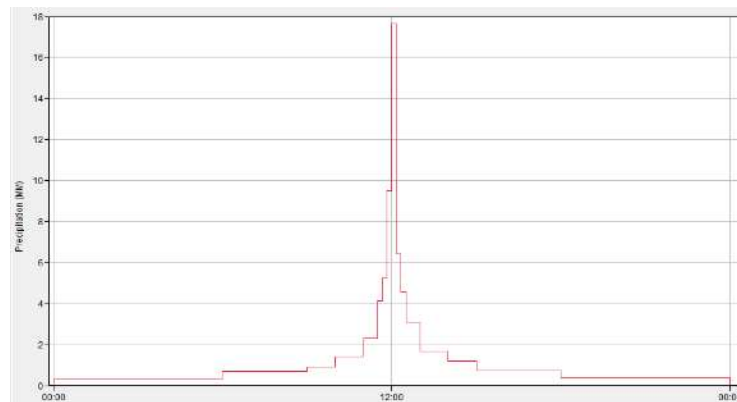


Figure 4.4 shows the 10%AEP future climate change – 2.1° TP108 normalised rainfall intensity (I/I24) from SWCoP version 4

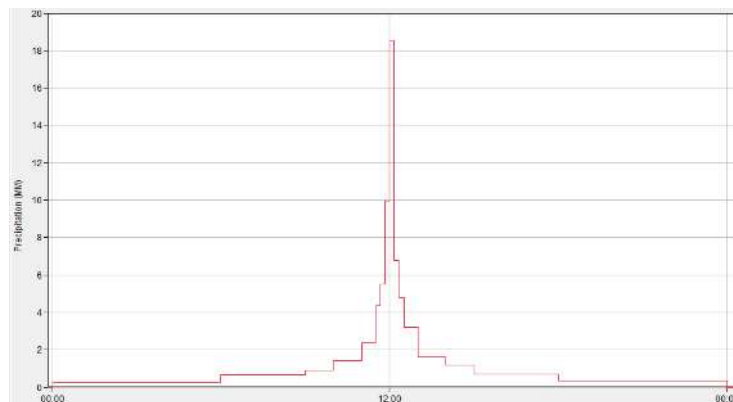
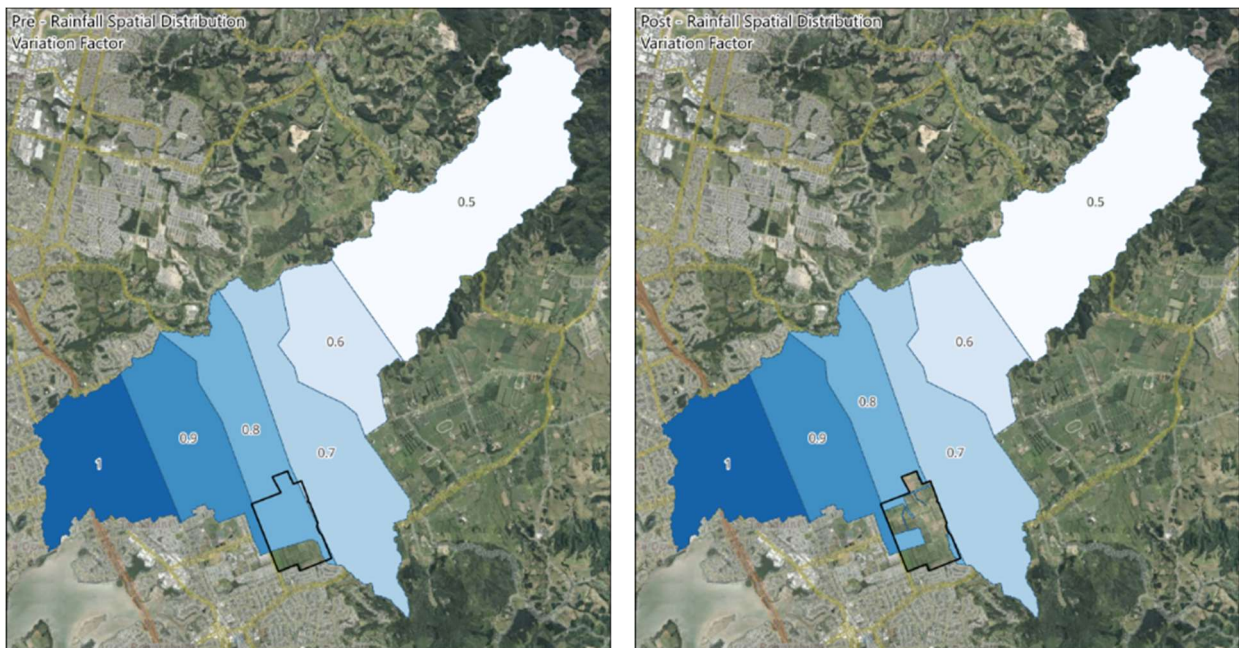


Figure 4.5 shows the 1%AEP future climate change – 3.8° TP108 normalised rainfall intensity (I/I24) from SWCoP version 4

A spatial varying rainfall distribution is applied to eastern catchment model as per HW requests, include description here – see Figures below:



Pre and Post spatial varying rainfall distribution

4.5 SOILS PARAMETERS

Refer to Section 2.5 for details.

4.6 LAND-USE

For the purposes of this analysis the table below shows the impervious percentages of land used for the proposed zoning and existing zoning within the model extents. Appendix 9 shown plan of the zoning.

Table 4.2 – Impervious percentage for Zoning

Zone	Impervious %
Commercial, Town Center	100
Industrial	90
Residential, retirement village	60
Road	85
Open space	10
SW channel (Awakeri Wetlands)	10

4.7 CHANNELISATION FACTORS AND TIME OF CONCENTRATION

The channelisation factors in Table 4.3 were used for each of the storm events respectively.

Table 4.3 – Channelisation factors

Channelisation Factor	Storm event	
	10% AEP Storm	1% AEP Storm
Impervious	0.6	0.8
Pervious	0.8	1.0

Time of concentration

The values for flow length and time of peak flow have been derived from calculations based on the TP108 methodology.

4.8 SUBBASIN PARAMETERS

Please refer to Appendix 8 for a summary of the HEC HMS parameters.

4.9 STORAGE AND ATTENUATION

Calculation for the sizing of the stormwater pond 2 for subbasin 41, 52 to 56 and sizing of the stormwater pond 3 for subbasin 40,50 and 58 are shown in Appendix 8. The ponds have been sized to

attenuate 50%, 10% and 1% AEP to pre-development conditions.

Table 4.4 Eastern Catchment attenuation device peak flow summary

Element	50%AEP Storage Volume (m3)	10%AEP Storage Volume (m3)	1%AEP Storage Volume (m3)	Outlet
Stormwater Pond (Outflow 2)	8,390	13,580	22,290	180mm SMAF outlet 2m Scruffy dome cutout
Stormwater Pond (Outflow 3)	1,030	1,510	1,820	68mm SMAF outlet 700mm weir cutout

Table 4.5 50%AEP Eastern Catchment site discharge pre-development versus post development flow summary

Element	50%AEP Peak flow Pre development(m3/s)	50%AEP Peak flow Post development(m3/s)
Northern Outflow 2	0.82	0.06
Northern Outflow 3	0.18	0.07

Table 4.5 10%AEP Eastern Catchment site discharge predevelopment versus post development flow
summary

Element	10%AEP Peak flow Pre development(m3/s)	10%AEP Peak flow Post development(m3/s)
Northern Outflow 2	2.35	0.64
Northern Outflow 3	0.50	0.49

Table 4.6 1%AEP Eastern Catchment site discharge predevelopment versus post development flow
summary

Element	1%AEP Peak flow Pre development (m3/s)	1%AEP Peak flow Post development (m3/s)
Northern Outflow 2*	4.17	4.14
Northern Outflow 3*	0.90	0.87

4.10 INFLOW FOR TUFLOW

Upstream inflows generated from the HEC HMS model were then transferred to TUFLOW as inflow boundary conditions, the TUFLOW modelling shall incorporate stormwater hydraulics to the modelling. Please refer to section 5 for hydraulic modelling.

5 EASTERN CATCHMENT HYDRAULIC MODELLING WITH TUFLOW

5.1 METHODOLOGY

The analysis was done using the following steps:

6. Delineate the perimeter for the grid,
7. Create a grid and sub-grid areas,
8. Input flow hydrographs and other boundaries
9. Input structures,
10. Run scenarios.

5.2 TUFLOW MODEL LAYOUT

TUFLOW software was used to generate water levels within the diversion channel, stormwater dry pond, wetland, upstream and downstream of the site. A 2D model was developed using a proposed design contour, LINZ Terrain data and site-specific LiDAR and topographical survey. Review of difference in LINZ terrain and topographical survey showed minor levels differences, especially at critical points, no adjustments were required for the import.

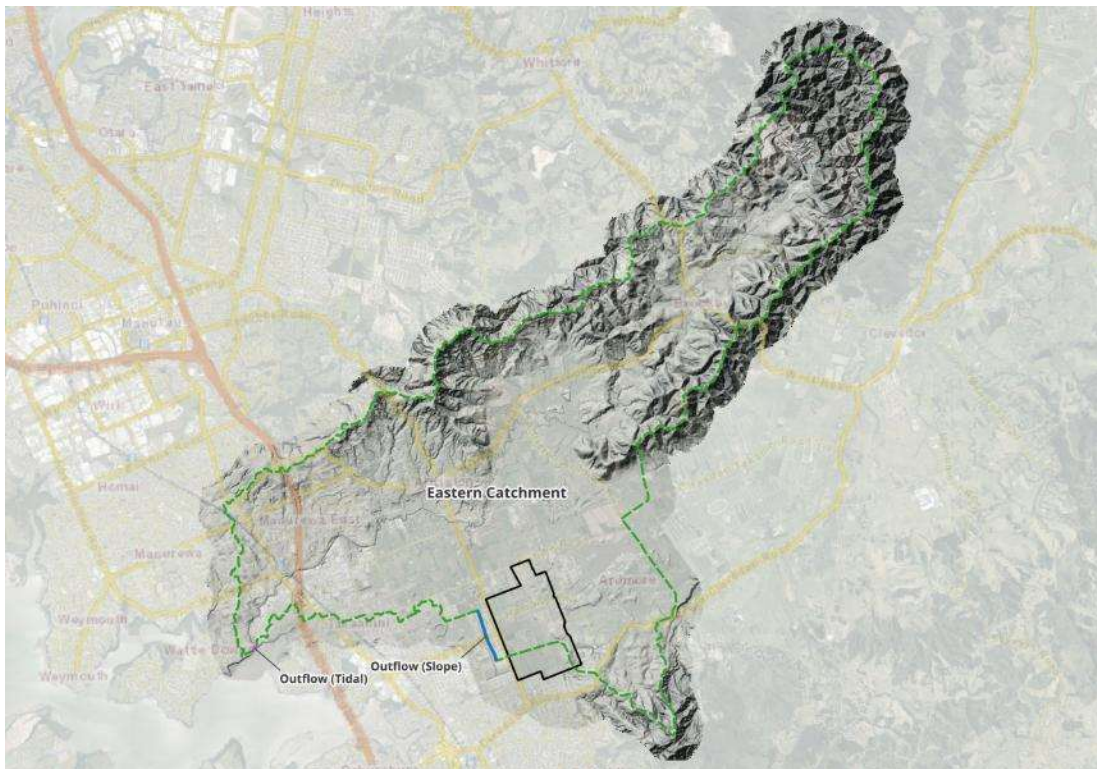


Figure 5.1 – TUFLOW Predevelopment Eastern model set-up

Surface roughness values adopted in the model were based on land use as categorised in Landcare Research's Land Cover Database version 5 (LCDBv5). This database was released in January 2020 and considers land use classification up until the end of 2018. Details of specific roughness values applied to the different land uses are summarised in Table 5.1. In addition to the above, all road centrelines and major watercourse centrelines were buffered to widths shown in aerial. The resulting areas were overlaid with a Manning's *n* roughness of 0.02 and 0.06. Manning roughness values calibration was undertaken against an existing flow gauge in the Papakura Stream as outlined in Section 5.3. A triangular mesh was used for modelled 2D grid with cell sizes ranging between 2m and 5m for refinement regions and 20m grids for floodplains. Break lines were drawn along critical channels and crests within the terrain. Figure 5.1 shows the grid and its boundary conditions. A predevelopment and post development SCS curve number infiltration layer number was used based on the zoning. Appendix 7 shows the model layout.

Table 5.1 Manning Roughness values

Description	Manning's <i>n</i>
Broadleaved Indigenous Hardwoods	0.1
Built-up Area (settlement)	0.2
Deciduous Hardwoods	0.15
Estuarine Open Water	0.022
Exotic Forest	0.1
Forest - Harvested	0.16
Gorse and or Broom	0.08
High Producing Exotic Grassland	0.25
Herbaceous Freshwater Vegetation	0.05
Indigenous Forest	0.15
Lake or Pond	0.04
Low Producing Grassland	0.125
Mangrove	0.02
Manuka and or Kanuka	0.016
Mixed Exotic Shrubland	0.028
Orchard, Vineyard or Other Perennial Crop	0.06
River	0.06
Road	0.02
Short-rotation Cropland	0.1
Surface Mine or Dump	0.09
Transport Infrastructure	0.125
Urban Parkland Open Space	0.035

5.3 MODEL CALIBRATION

An existing flow gauge was identified downstream of the site, located in the Papakura Stream. Data sets were obtained from the Auckland Council Environmental Data Portal which included the flow gauge data from the hydrology station “Papakura @ Great South Road Bridge” and rainfall data from rainfall located within the modelled catchment. River discharge and rainfall data was obtained from the following rainfall gauges for the 2023 Auckland Anniversary flood event, between the dates of 27th and 29th January 2023. The rainfall gauge measured a total rainfall depth of 229.5mm over 72 hours.

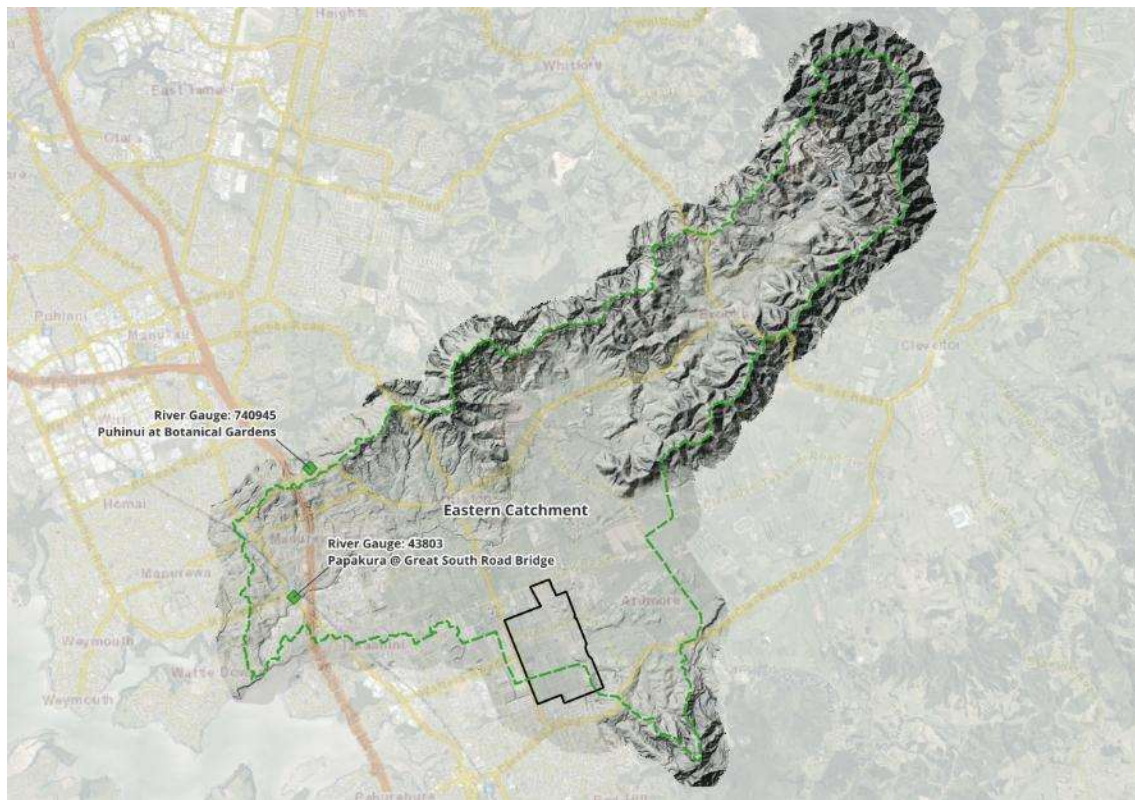


Figure 5.2 – River and Rain gauges location

Table 5.2 River and Rain gauges for calibration

Gauge ID	Gauge Name
43803	Papakura @ Great South Road Bridge
740945	Puhinui at Botanical Gardens

Graphical and statistical comparison between the calibration event and model may be found below.

The calibration achieved a Nash-Sutcliffe value 0.765 which is considered a very good performance rating per the HEC HMS technical reference manual.

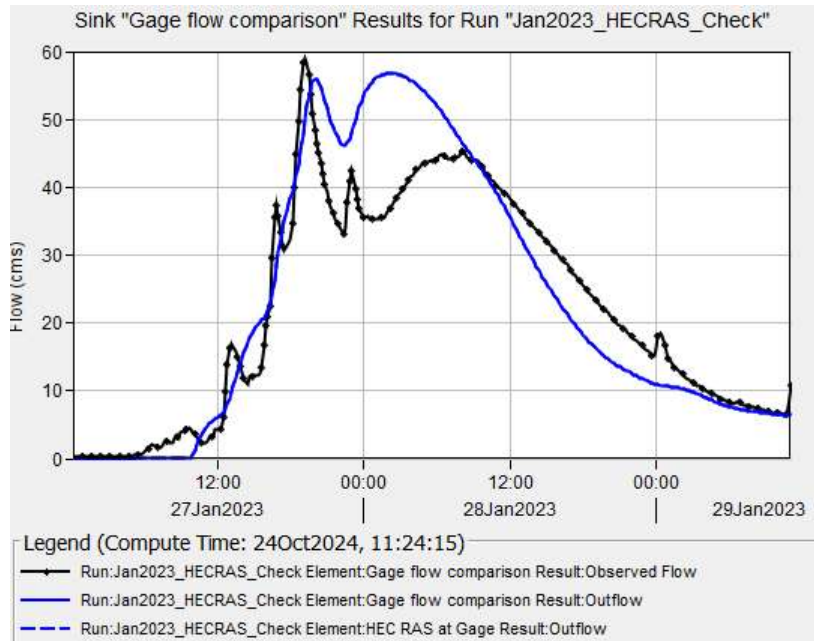
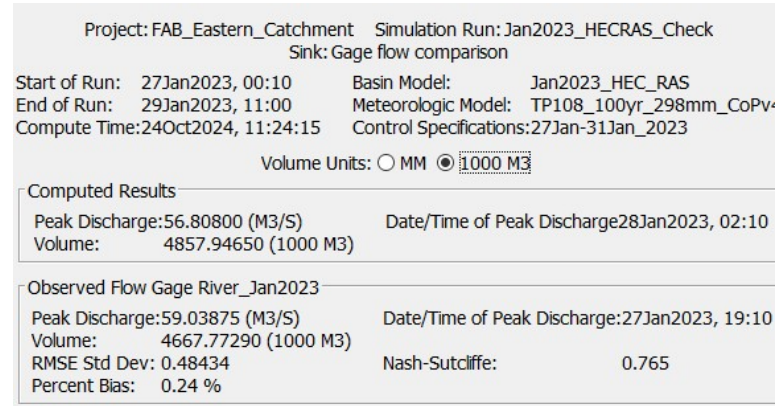


Figure 5.3 – HEC-HMS Papakura Stream Gage calibration statistics

5.4 BOUNDARIES

There are four types of boundaries. These are:

- Rain on grid – as per figure 5.1.
- Inflow hydrographs imported from HEC HMS (outlined in section 2)
HEC HMS subbasins have been used as inflows (please refer to appendix 8 for plan)
- Outflow - Tidal level boundary
- Outflow – Normal depth boundary

Runoff from the eastern catchment eventually discharges to Manukau Harbour.

The downstream boundary was constructed using a fixed stage for the tidal boundary condition at 2.34 mRL (AUK1946) or 2.06 NZVD2016. This level has been used for consistency with the Western Catchment. However, it is noted the tidal boundary is located 7km downstream of the site with an elevation 19m below the site and therefore will not have any effect on this assessment.

5.5 CRITICAL STORM DURATION ANALYSIS

It is noted that the TP108 approach used in this modelling assessment used a nested storm, created from a range of durations up to 24 hours. A critical storm duration analysis was undertaken to verify the suitability of the TP108 storm. Rainfall patterns for the north of the north island from NIWA HIRDSv4 were used for the storm durations 30-minute, 60-minutes, 24-hour. Rainfall depths for each storm were obtained from the NIWA HIRDSv4 for the 10%AEP and 1%AEP events, using the most conservative available climate change assumption of representative concentration pathways 8.5 (RCP 8.5, 2081-2100).

A critical storm check was completed at five locations within the catchment. All checked locations show the critical storm to be the nested TP108 24hr storm. This verifies the TP108 critical storm to be applicable to the site analysis. Hydrographs for each of the checks may be found in Appendix 2

5.6 HYDRAULIC STRUCTURES

At the end of the eastern main diversion channel a lateral weir of length 700m is proposed across the northern site boundary at an elevation ranging between mRL 22.42 to 22.60 to control flow exiting the northern site boundary (Northern Outflow 1). A stormwater pond (Stormwater Pond 1) is located adjacent the channel with proposed invert level 20.70 and mRL has two storage basins to manage the 50%, 10% and 1%AEP storm peak flows. During 50% and 10% AEP peak flows a 340m weir of elevation mRL22.52 diverts the low flow to a box culvert (0.4m x 1.2m) to the 10%AEP storage basin. During 1% AEP peak flows a 410m weir of elevation mRL22.59 diverts flow to the 1%AEP storage basin. Figure 5.4 below shows the proposed configuration (weirs are shown in yellow). Stormwater pipes with check valves shall be installed between storage basins and the diversion swale to allow draindown of storage basins post storm events.

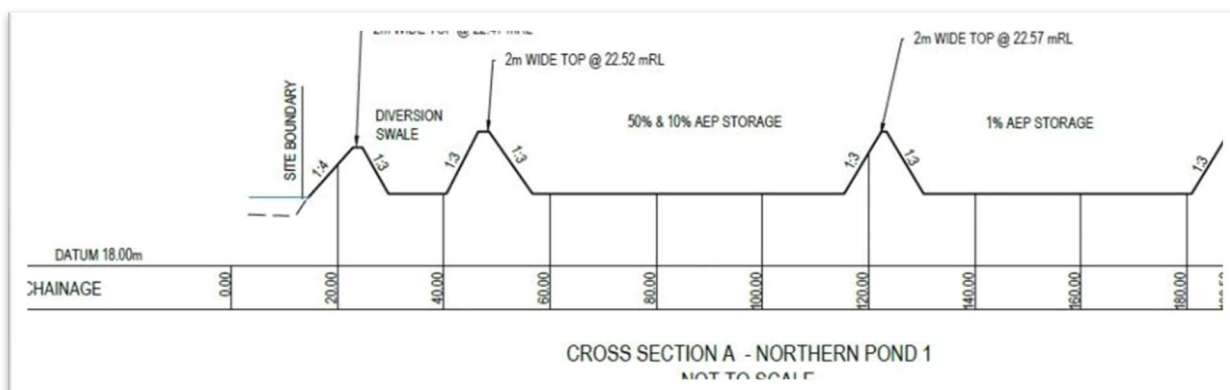


Figure 5.4 – TUFLOW Post development Outflow 1 Configuration

5.7 STORMWATER POND 5 & 6

The properties 119, 119A, 121A, 123, 131 and 143 Cosgrave Road has an area of 24.1Ha. This area is likely to be developed at a later date to the rest of the site. For the purposes of this assessment flows in the post development scenario of this catchment have been modelled with the existing terrain in this area with infiltration based on the existing MPD impervious percentage of 10%. Flows generated from the site are discharged to the site swale network and conveyed to Northern Outflow 1. Stormwater ponds 5 and 6 have been indicatively shown as future development of this catchment shall require stormwater ponds to attenuate flows from the catchment to a pre-development condition.

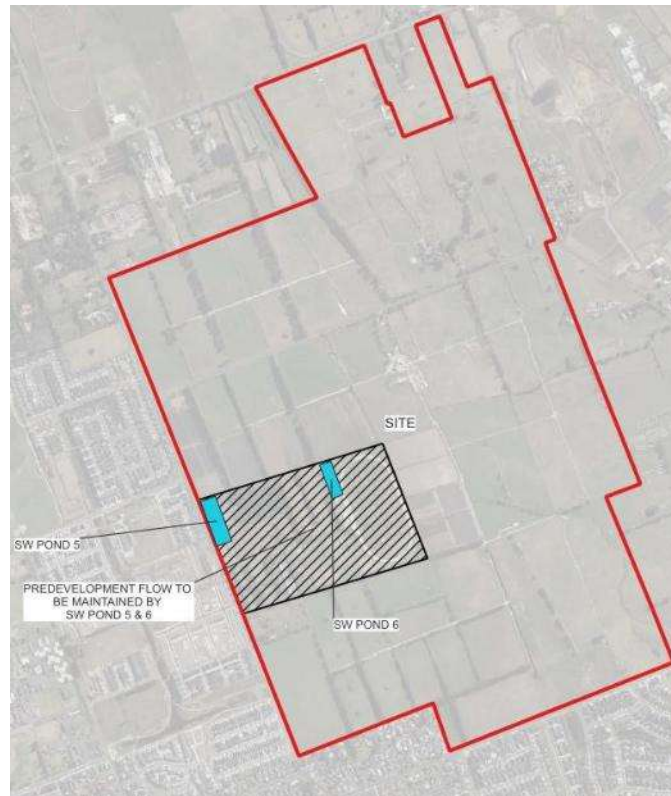


Figure 5.5 – TUFLOW Post development Outflow 1 Configuration

5.8 EASTERN CATCHMENT PEAK FLOW RESULTS

Peak flow results for the Eastern Catchment can be found in the Appendix 7.

Review of the modelling results (at the northern outflow 1), show a predevelopment a peak flow for the 10%AEP and 1%AEP peak flows to remain effectively unchanged post development. Refer to Figures below:

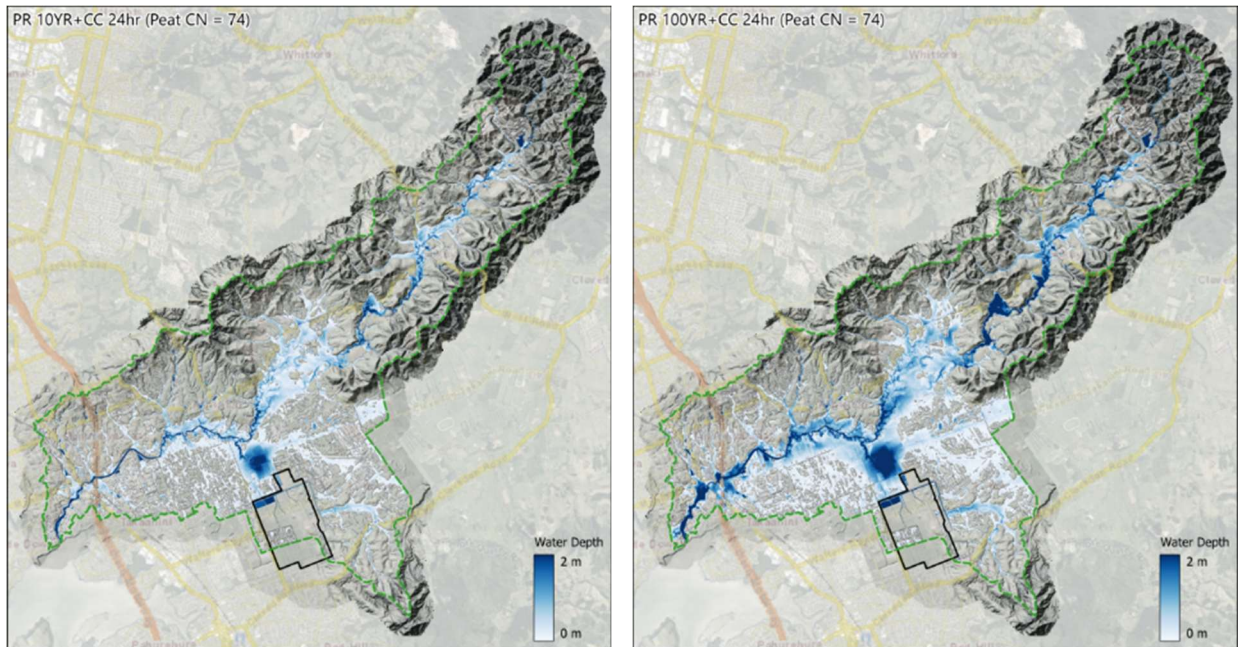


Figure 5.6 10%AEP (left) and 1%AEP (right) modelled post development flood depths

Table 5.6 Outflow 1/2 site discharge pre-development versus post development flow

Stormwater Discharge Summary – Pre vs Post Development (30 min, 60 min, 24 hr Storm Durations) Note: Values shown include runoff calculated using both CN 61 and CN 74.						
ARI	CN	Storm Duration	Rainfall Type	Peak Pre-Development (m ³ /s)	Peak Post-Development (m ³ /s)	Average Difference (m ³ /s)
Northern Outflow 1						
2yr	74	24-hr	Non-Spatial	5.42	2.47	-0.83
10yr	74	24-hr	Non-Spatial	30.61	25.18	0.23
100yr	74	24-hr	Non-Spatial	81.19	70.38	-0.42
2yr	74	30-min	Non-Spatial	0.01	0.01	-0.23
10yr	74	30-min	Non-Spatial	0.02	0.02	-1.78
100yr	74	30-min	Non-Spatial	2.33	1.63	-2.59
2yr	74	60-min	Non-Spatial	0.01	0.01	-0.35
10yr	74	60-min	Non-Spatial	1.14	0.38	0.00
100yr	74	60-min	Non-Spatial	10.44	7.45	-4.49
2yr	61	24-hr	Non-Spatial	3.96	1.911	-2.05
10yr	61	24-hr	Non-Spatial	26.47	22.33	-4.14
100yr	61	24-hr	Non-Spatial	75.2	66.57	-8.63
2yr	61	30-min	Non-Spatial	0	0	0
10yr	61	30-min	Non-Spatial	0.01	0.01	0
100yr	61	30-min	Non-Spatial	1.45	1.02	-0.43
2yr	61	60-min	Non-Spatial	0.01	0.01	0
10yr	61	60-min	Non-Spatial	0.69	0.34	-0.35
100yr	61	60-min	Non-Spatial	7.65	4.25	-3.4
2yr	74	24-hr	Spatial	1.05	1.07	0.02

10yr	74	24-hr	Spatial	14.91	11.62	-3.29
100yr	74	24-hr	Spatial	48.27	43.08	-5.19
2yr	61	24-hr	Spatial	0.63	1.06	0.43
10yr	61	24-hr	Spatial	11.7	9.81	-1.89
100yr	61	24-hr	Spatial	43.2	39.5	-3.7
Northern Outflow 2						
2yr	74	24-hr	Non-Spatial	2.64	1.21	-1.43
10yr	74	24-hr	Non-Spatial	3.3	3.09	-0.21
100yr	74	24-hr	Non-Spatial	4.1	3.69	-0.41
2yr	74	30-min	Non-Spatial	0.01	0.05	0.04
10yr	74	30-min	Non-Spatial	0.15	0.17	0.02
100yr	74	30-min	Non-Spatial	2.01	0.73	-1.28
2yr	74	60-min	Non-Spatial	0.07	0.13	0.06
10yr	74	60-min	Non-Spatial	1.63	0.63	-1
100yr	74	60-min	Non-Spatial	2.84	1.5	-1.34
2yr	61	24-hr	Non-Spatial	2.45	1.13	-1.32
10yr	61	24-hr	Non-Spatial	3.27	3.03	-0.24
100yr	61	24-hr	Non-Spatial	3.99	3.65	-0.34
2yr	61	30-min	Non-Spatial	0.01	0.04	0.03
10yr	61	30-min	Non-Spatial	0.09	0.15	0.06
100yr	61	30-min	Non-Spatial	1.76	0.96	-0.8
2yr	61	60-min	Non-Spatial	0.03	0.11	0.08
10yr	61	60-min	Non-Spatial	1.27	0.53	-0.74
100yr	61	60-min	Non-Spatial	2.69	1.19	-1.5
2yr	74	24-hr	Spatial	1.23	0.78	-0.45
10yr	74	24-hr	Spatial	0	0	0
100yr	74	24-hr	Spatial	0	0	0

Post development flows based on various duration rainfall scenarios indicated a minor reduction or insignificant change in comparison to pre-development flows. Also some minor changes in peak flows in farm drain directly north of Airfield Road in the above scenarios modelling runs were observed.

Based on the results, we suggest that the proposed development has no adverse effects on downstream properties during the modelled 50%, 10% and 1% AEP (or 2yr, 10yr, and 100yr ARI) storm events.

Plans in Appendix 7 show a comparison in flood levels and hydrographs exiting the northern boundary.

5.9 RESULTS - EASTERN CATCHMENT DOWNSTREAM PEAK FLOW LEVEL AT OUTFLOW 1

The modelling results from the eastern catchment are shown on plans in Appendix 7.

The weir outlet along the northern boundary has been iteratively designed to simulate the predevelopment flow exiting the site as much as possible no notable increase in downstream flood levels was observed in the post development model.

5.10 RESULTS - PAPAKURA STREAM EFFECTS

A comparison of peak flow rates between the existing and post development scenarios shows that flow rates and peak flows in the Papakura stream either remain unchanged or have a small decrease. Peak water levels for the 1%AEP storm are reduced by approximately 70mm and peak flows reduced by approximately 5% in the Papakura Stream. This is attributed to the reduced time of concentration of Catchment C. This finding supports the proposed pass-forward strategy for outflow 1 of the site. The modelling results from the eastern catchment are shown on plans in Appendix 7.

Figure 5.6 shows a decrease in peak water levels for both the 10% AEP and 1% AEP storm events

Figure 5.7.1 - 5.7.12 shows the integrated result summary and peak flow comparison for the Papakura stream critical sections under various scenarios described earlier.

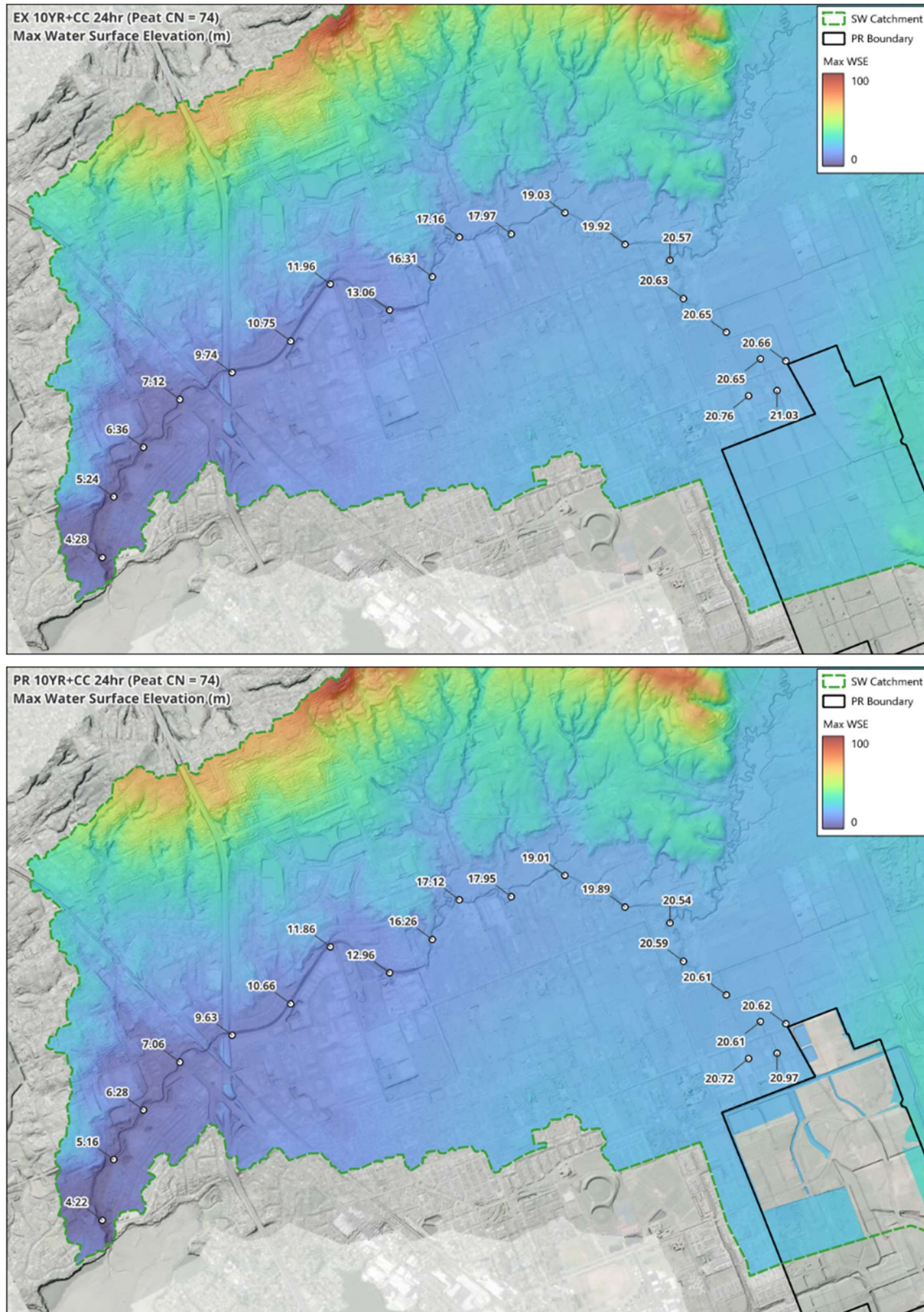


Figure 5.6 10YR ARI modelled post development downstream effects (red is reduction in peak water levels)

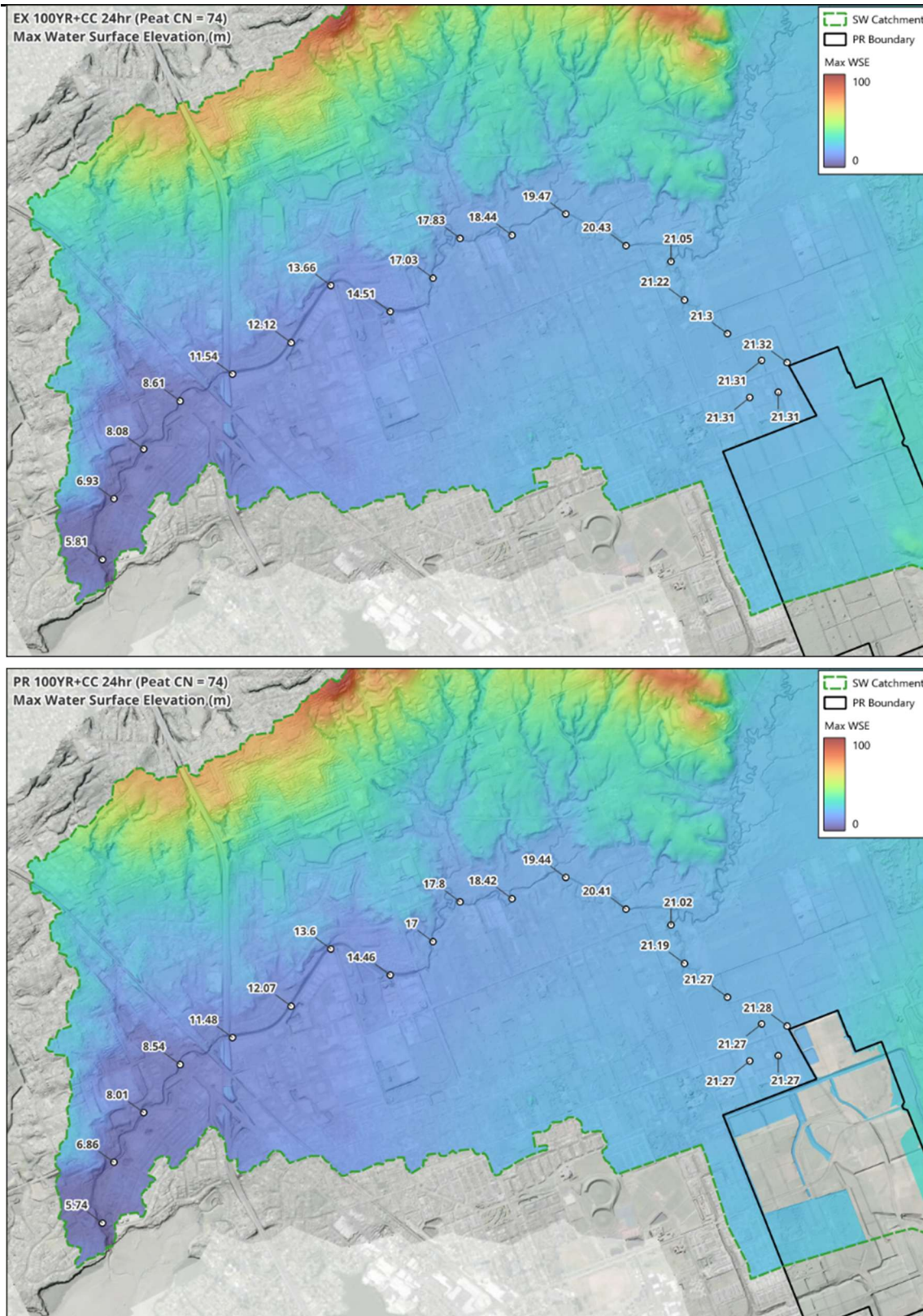


Figure 5.6 100YR ARI modelled post development downstream effects (red is reduction in peak water levels)

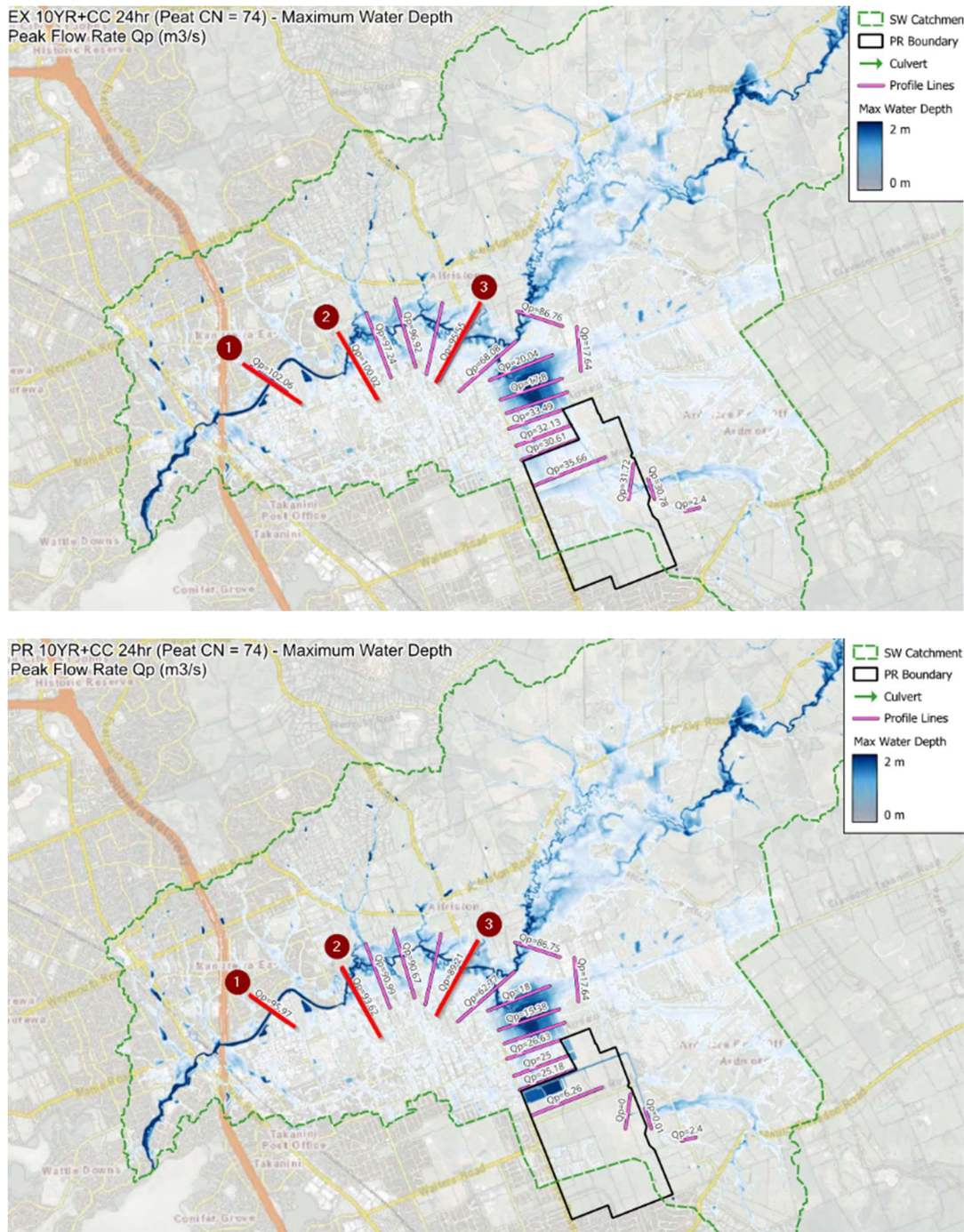


Figure 5.7.1 10YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 74)

Element	10%AEP peak flow existing (m3 /s)	10%AEP peak flow post development (m3 /s)	Change
Cross section 1	102.06	95.97	-1.06 (-1%)
Cross section 2	100.02	93.62	-6.4 (-6%)
Cross section 3	95.55	89.21	-6.3 (-6%)

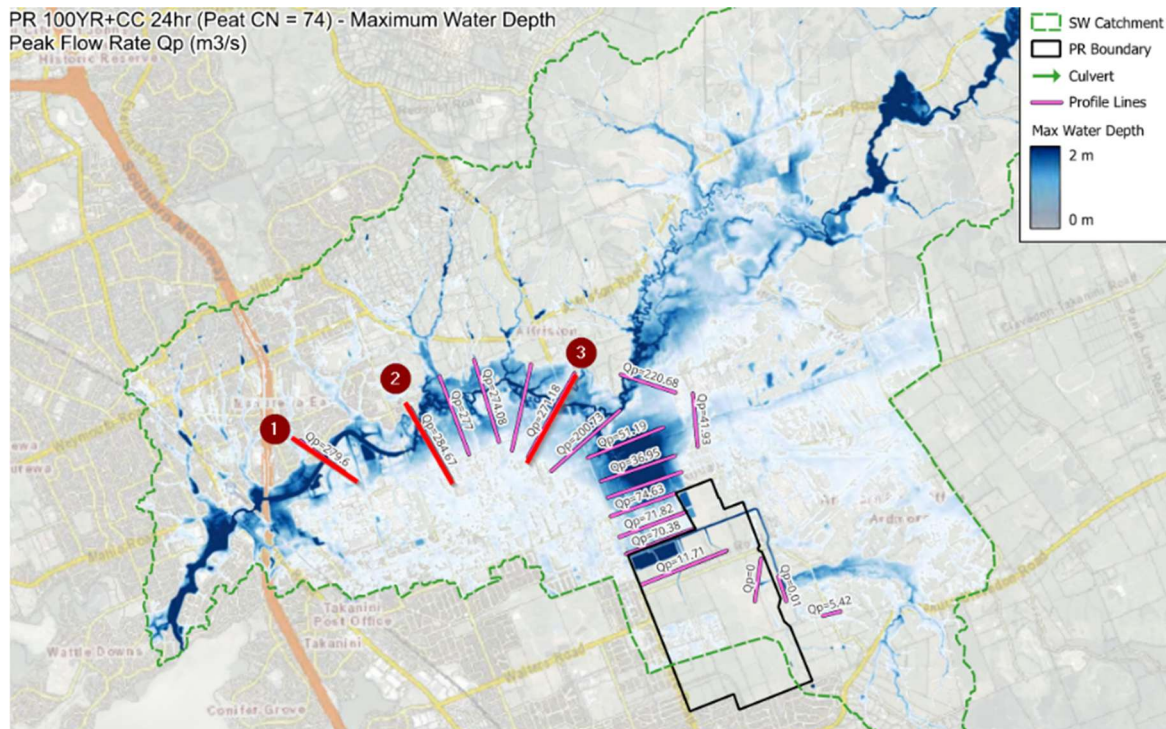
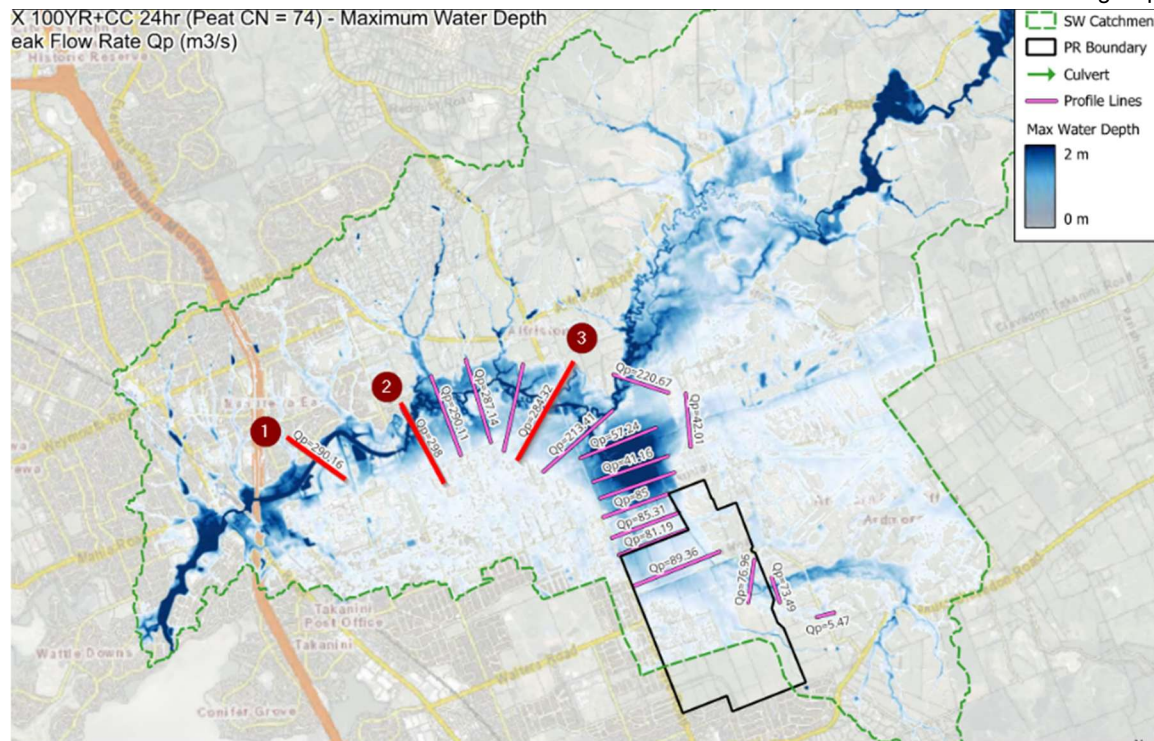


Figure 5.7.2 100YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 74)

Element	1%AEP peak flow existing (m3 /s)	1%AEP peak flow post development (m3 /s)	Change
Cross section 1	290.16	279.60	-10.5 (-4%)
Cross section 2	298.00	284.67	-13.3 (-5%)
Cross section 3	284.32	271.18	-13.1 (-5%)

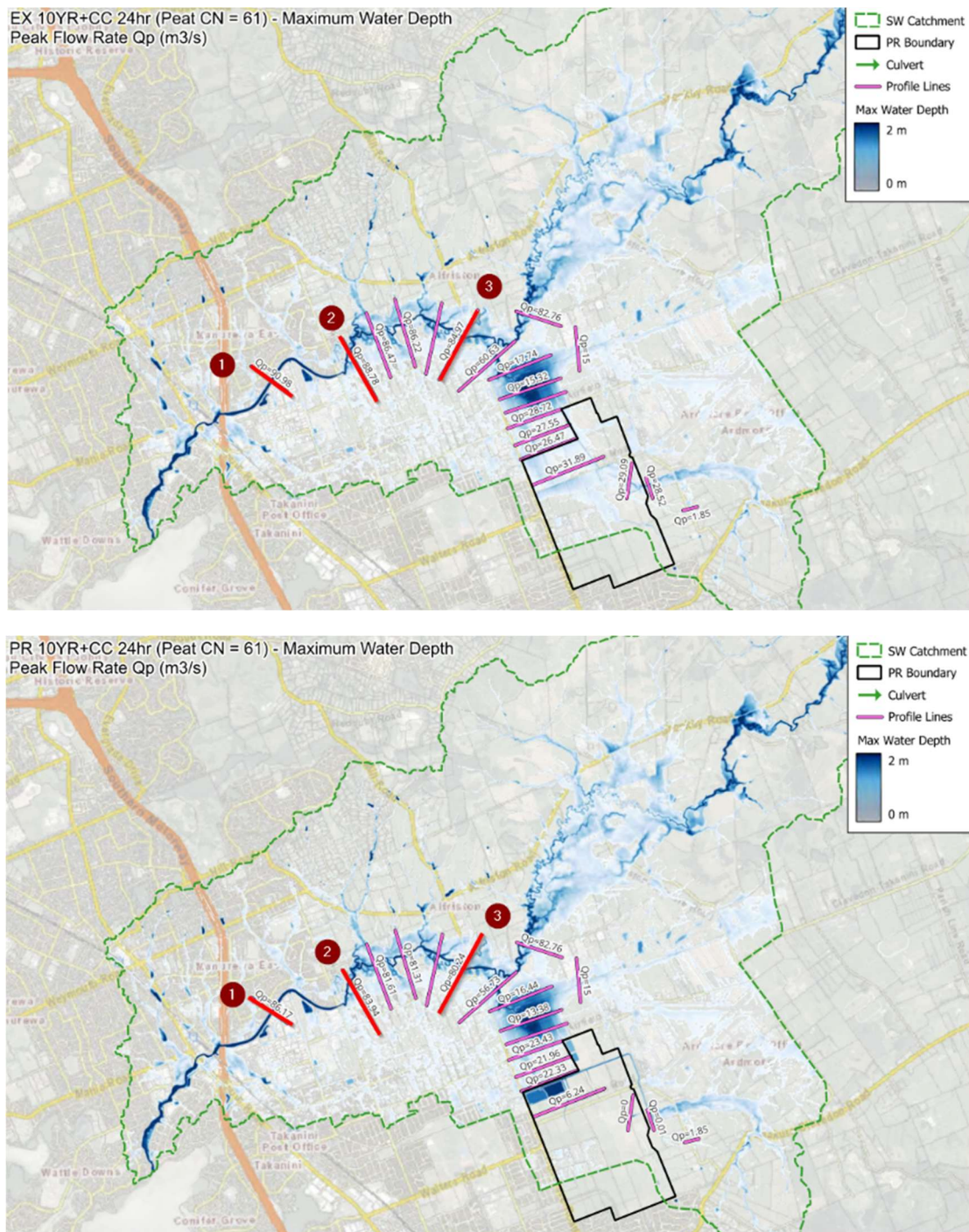


Figure 5.7.3 10YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 61)

Element	10%AEP peak flow existing (m3 /s)	10%AEP peak flow post development (m3 /s)	Change
Cross section 1	90.98	86.17	-4.8 (-5%)
Cross section 2	88.78	83.94	-4.8 (-6%)
Cross section 3	84.97	80.24	-4.7 (-6%)

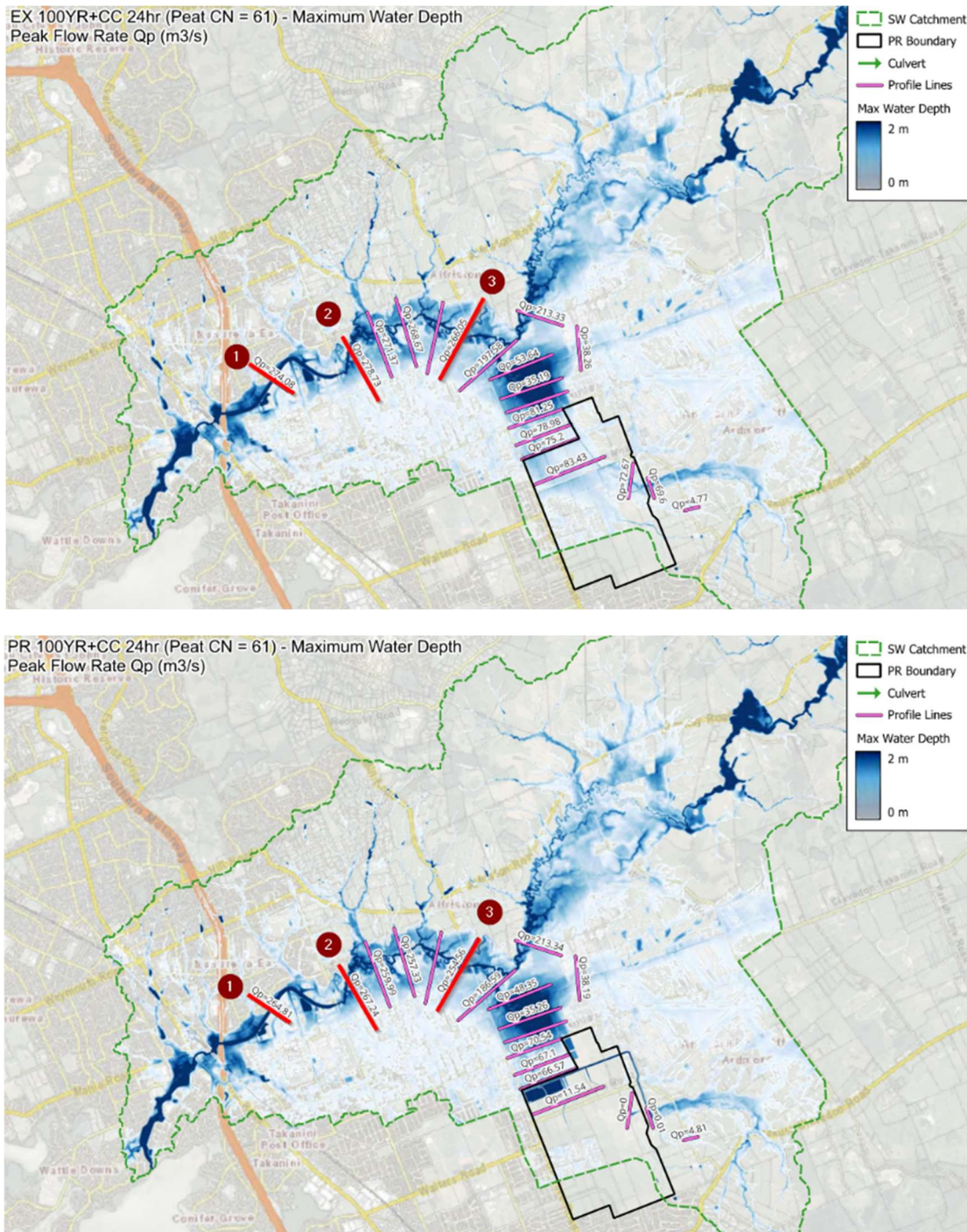


Figure 5.7.4 100YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 61)

Element	1%AEP peak flow existing (m3 /s)	1%AEP peak flow post development (m3 /s)	Change
Cross section 1	274.08	264.81	-9.3(-3%)
Cross section 2	278.73	267.24	-11.5 (-4%)
Cross section 3	266.05	254.56	-11.5 (-4%)

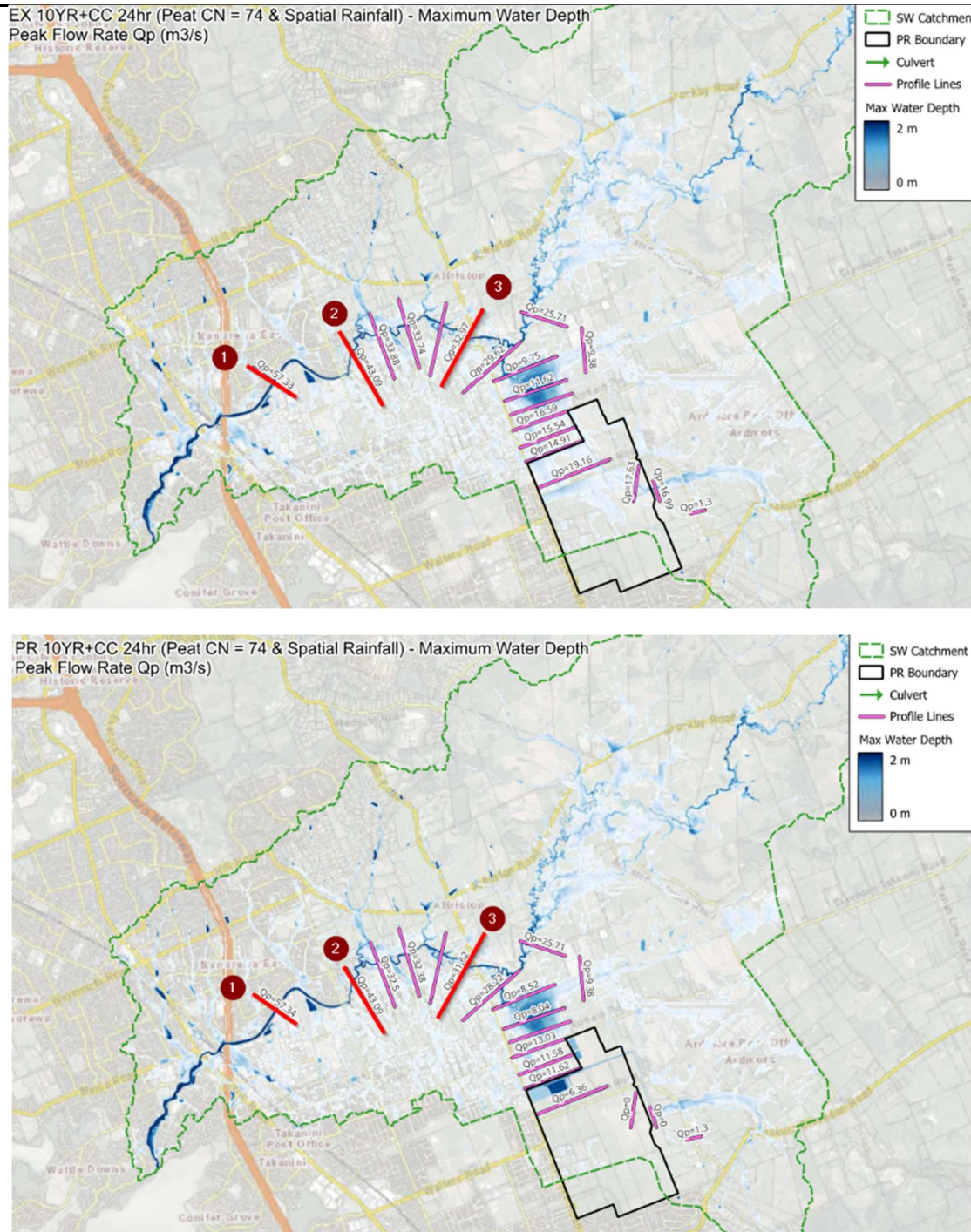


Figure 5.7.5 10YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 74 & Spatial Rainfall)

Element	10%AEP peak flow existing (m3 /s)	10%AEP peak flow post development (m3 /s)	Change
Cross section 1	57.33	57.34	Negligible
Cross section 2	43.09	43.09	Negligible
Cross section 3	32.97	31.62	-0.35 (-1%)

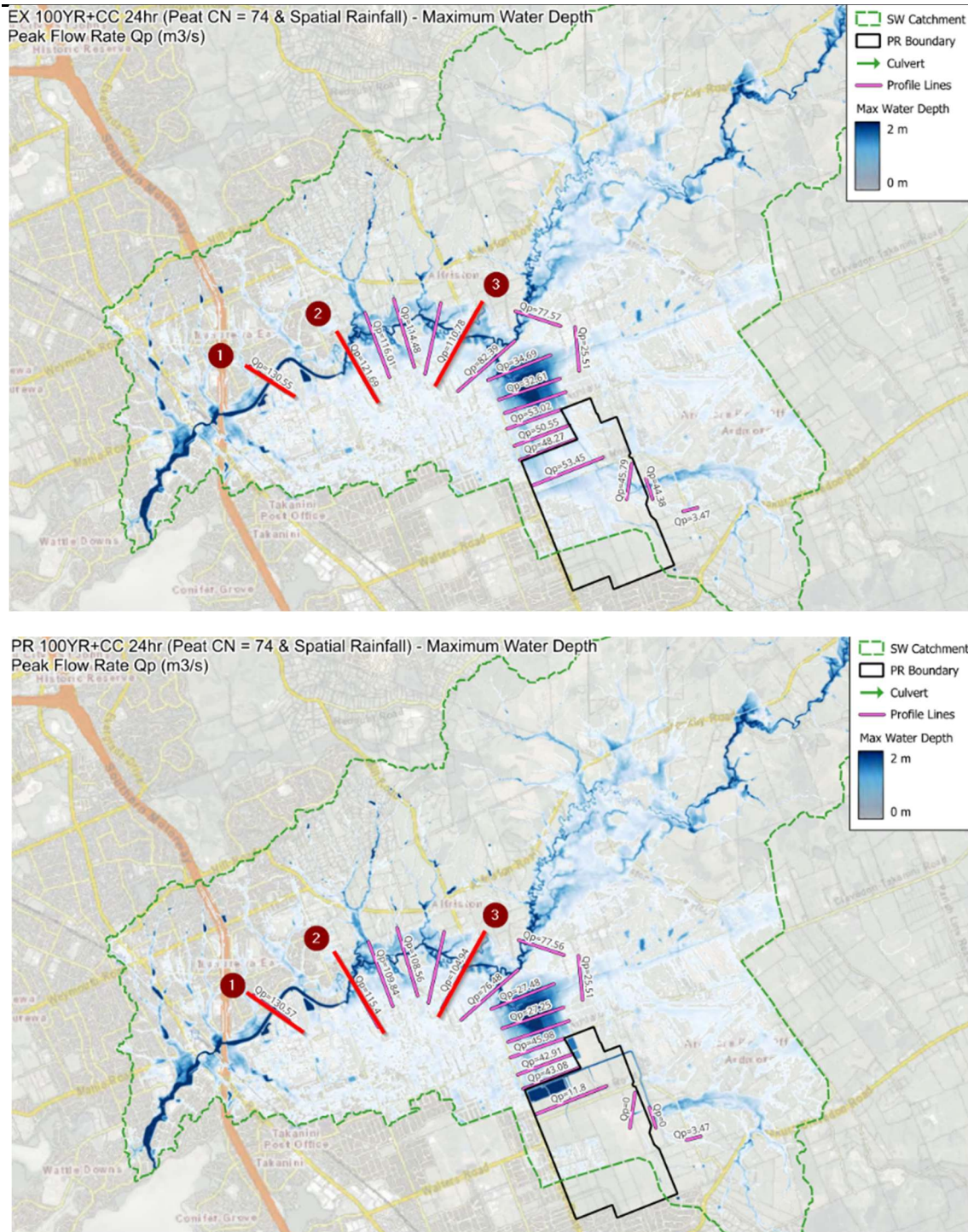


Figure 5.7.6 100YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 74 & Spatial Rainfall)

Element	1%AEP peak flow existing (m3 /s)	1%AEP peak flow post development (m3 /s)	Change
Cross section 1	130.55	130.57	Negligible
Cross section 2	121.69	115.40	-6.3 (-5%)
Cross section 3	110.78	104.94	-5.8 (-5%)

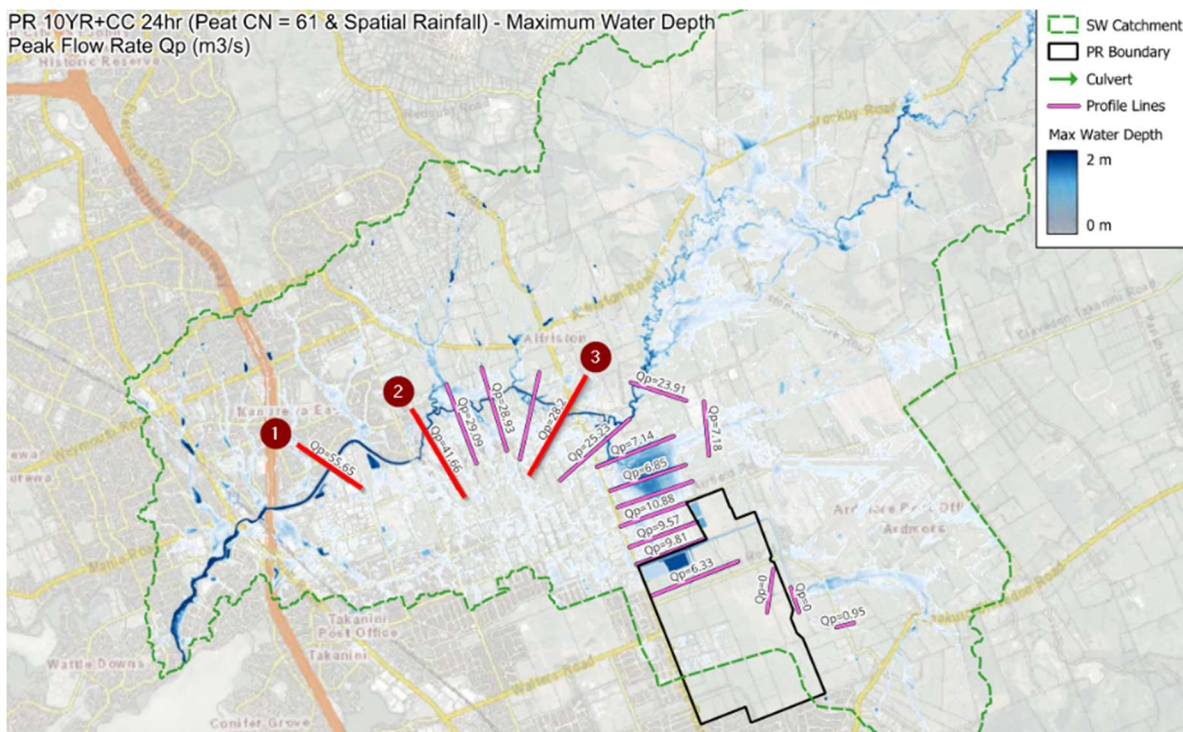
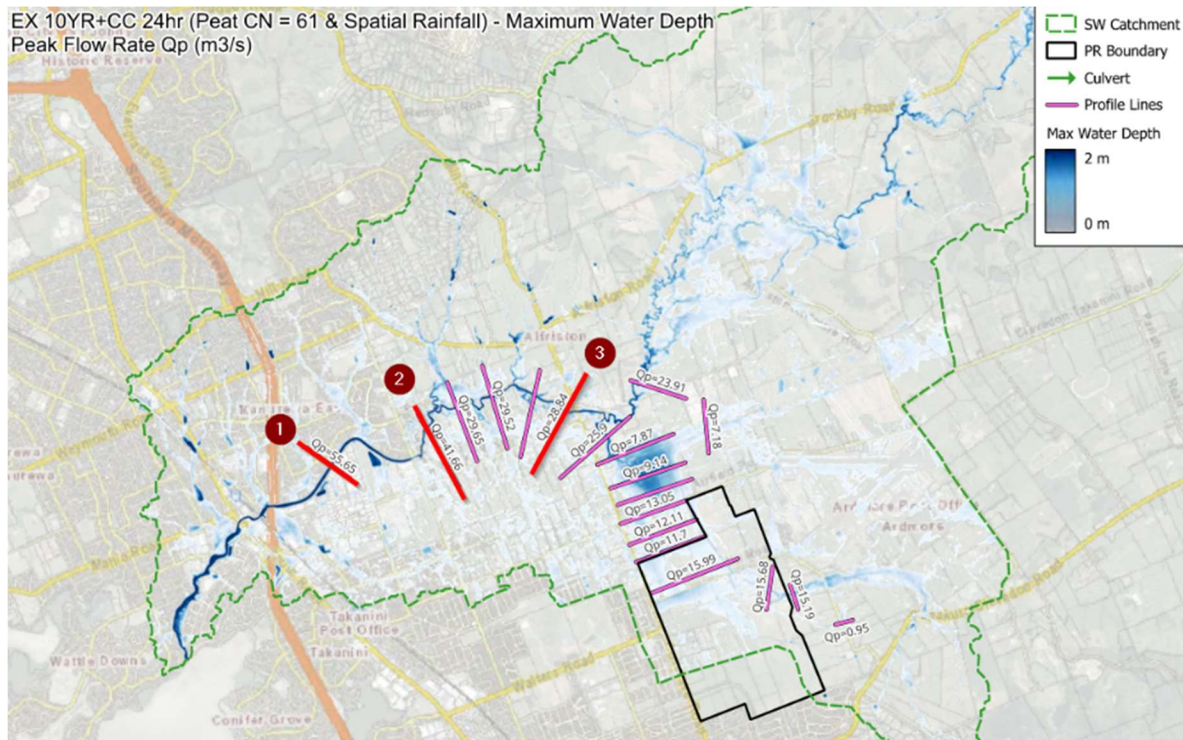


Figure 5.7.7 10YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 61 & Spatial Rainfall)

Element	10%AEP peak flow existing (m3/s)	10%AEP peak flow post development (m3/s)	Change
Cross section 1	55.65	55.65	Unchanged
Cross section 2	41.66	41.66	Unchanged
Cross section 3	28.84	28.20	-0.6 (-2%)

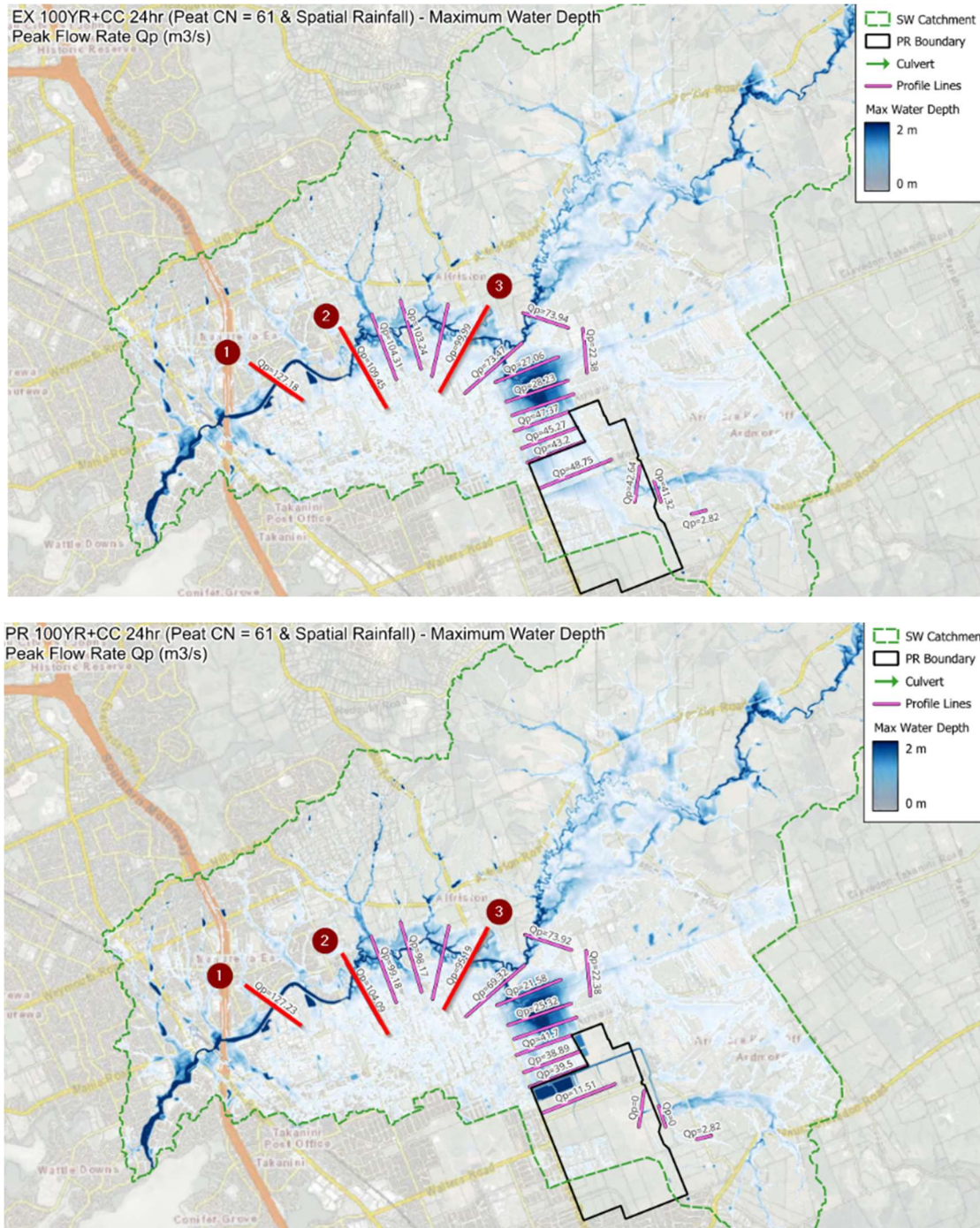


Figure 5.7.8 100YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 61 & Spatial Rainfall)

Element	1%AEP peak flow existing (m3 /s)	1%AEP peak flow post development (m3 /s)	Change
Cross section 1	127.18	127.23	Negligible
Cross section 2	109.45	104.09	-5.4 (-5%)
Cross section 3	99.99	95.19	-4.8 (-5%)

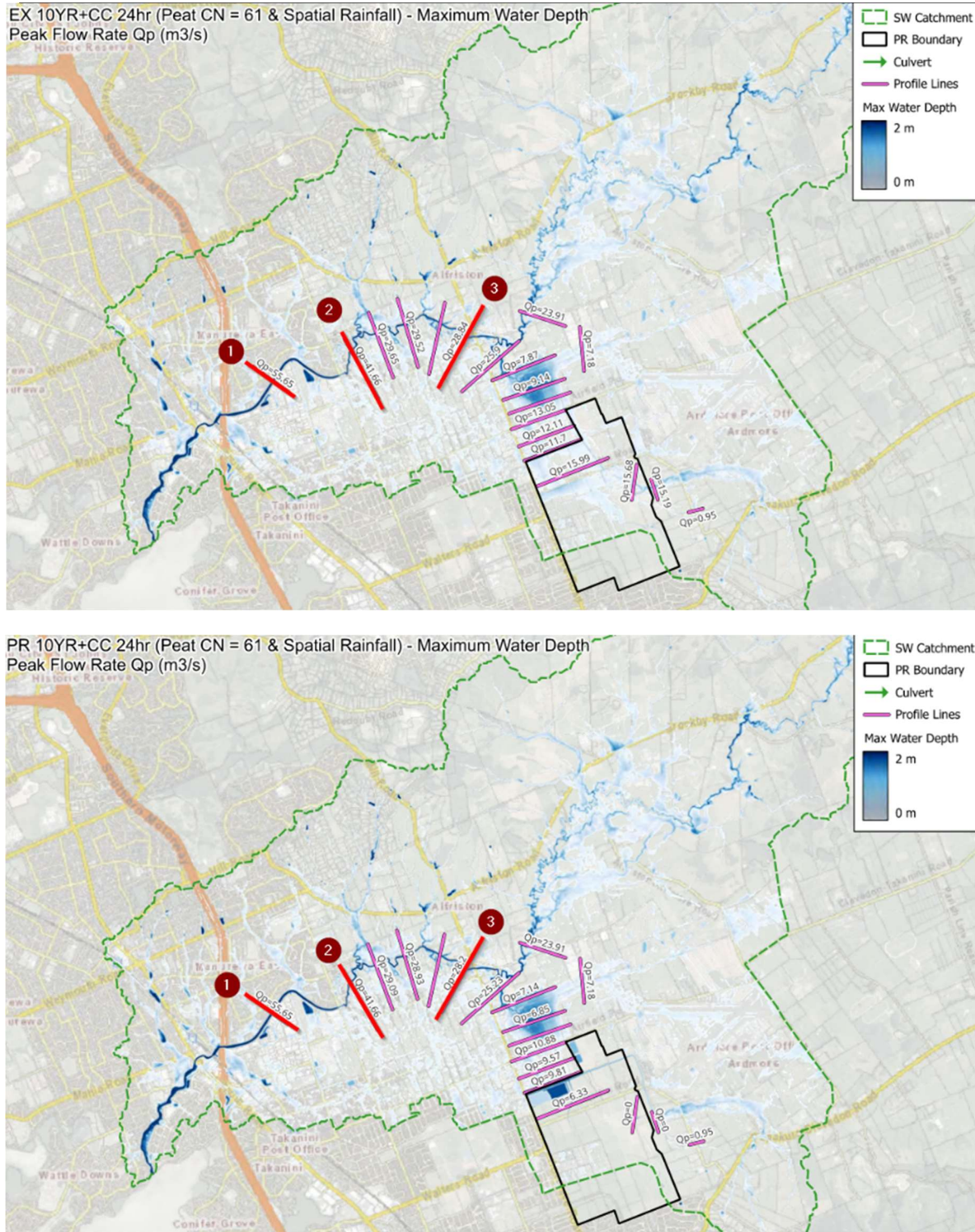


Figure 5.7.9 10YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 61 & Spatial Rainfall)

Element	10%AEP peak flow existing (m3 /s)	10%AEP peak flow post development (m3 /s)	Change
Cross section 1	55.65	55.65	Unchanged
Cross section 2	41.66	41.66	Unchanged
Cross section 3	28.84	28.20	-0.6 (-2%)

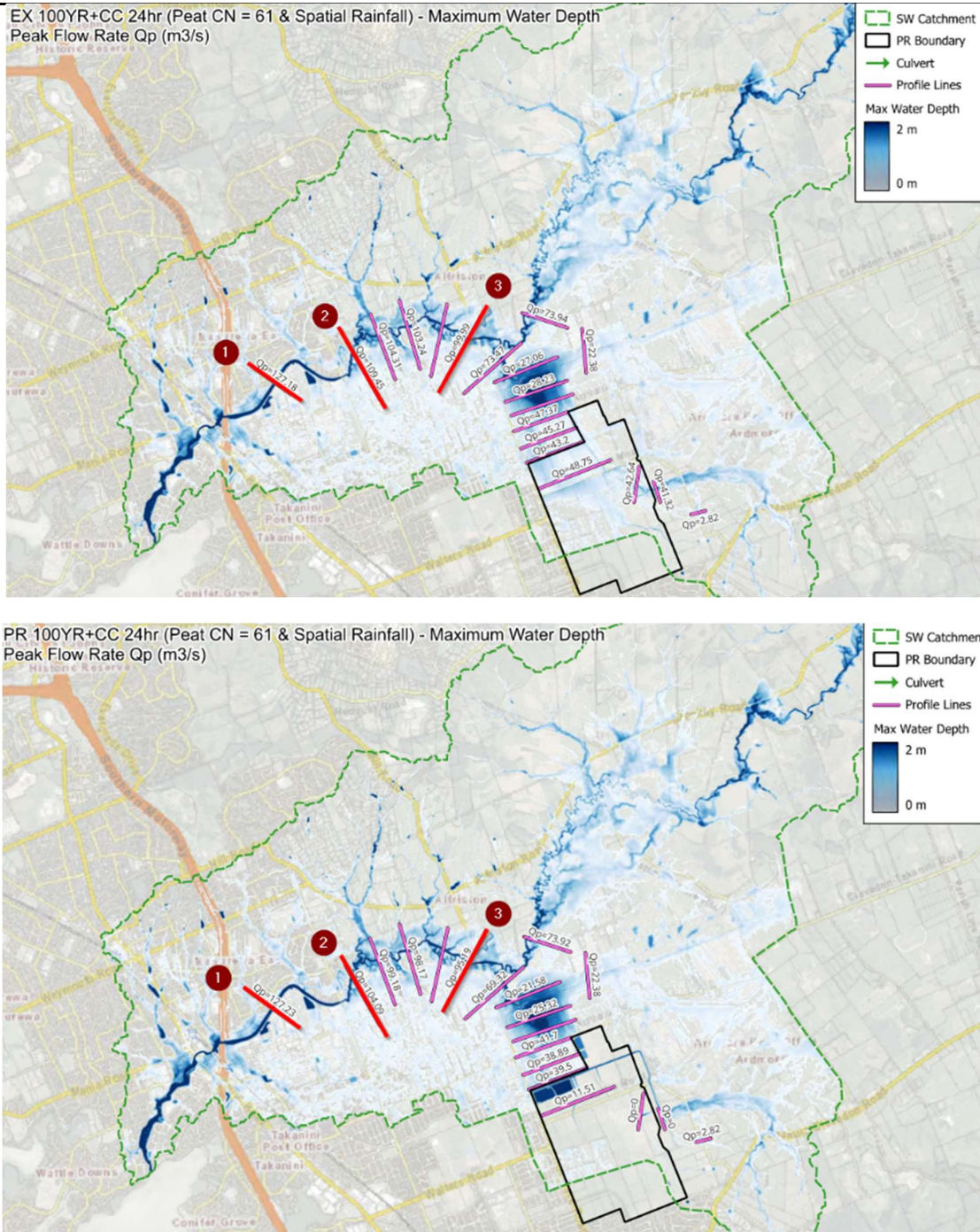


Figure 5.7.10 100YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 61 & Spatial Rainfall)

Element	1%AEP peak flow existing (m3 /s)	1%AEP peak flow post development (m3 /s)	Change
Cross section 1	127.18	127.23	Negligible
Cross section 2	109.45	104.09	-5.4 (-5%)
Cross section 3	99.99	95.19	-4.8 (-5%)

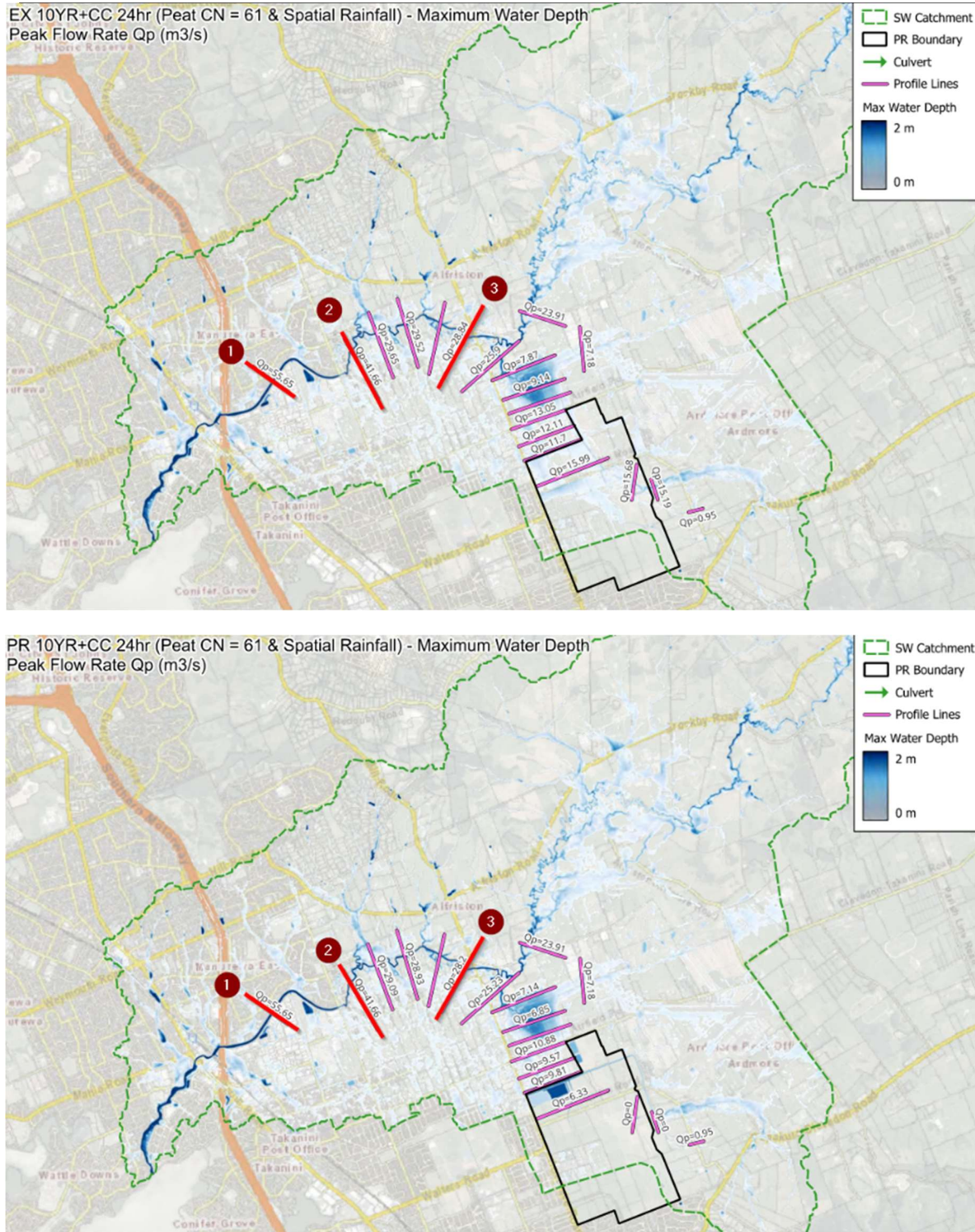


Figure 5.7.11 10YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 61 & Spatial Rainfall)

Element	10%AEP peak flow existing (m3 /s)	10%AEP peak flow post development (m3 /s)	Change
Cross section 1	55.65	55.65	Unchanged
Cross section 2	41.66	41.66	Unchanged
Cross section 3	28.84	28.20	-0.6 (-2%)

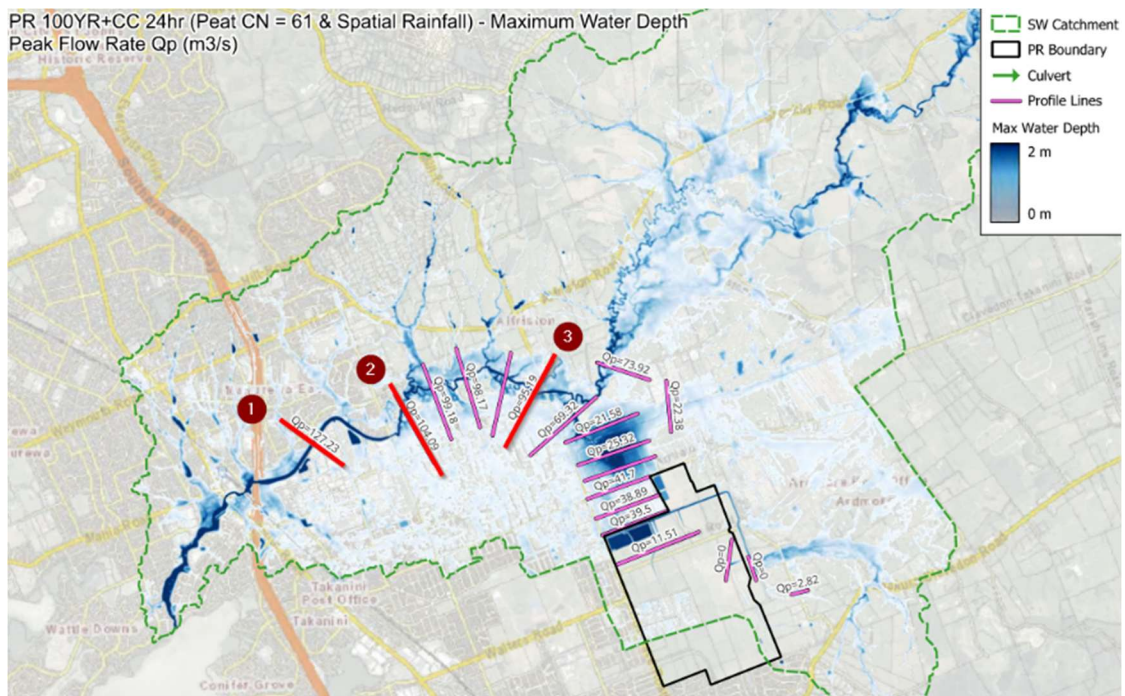
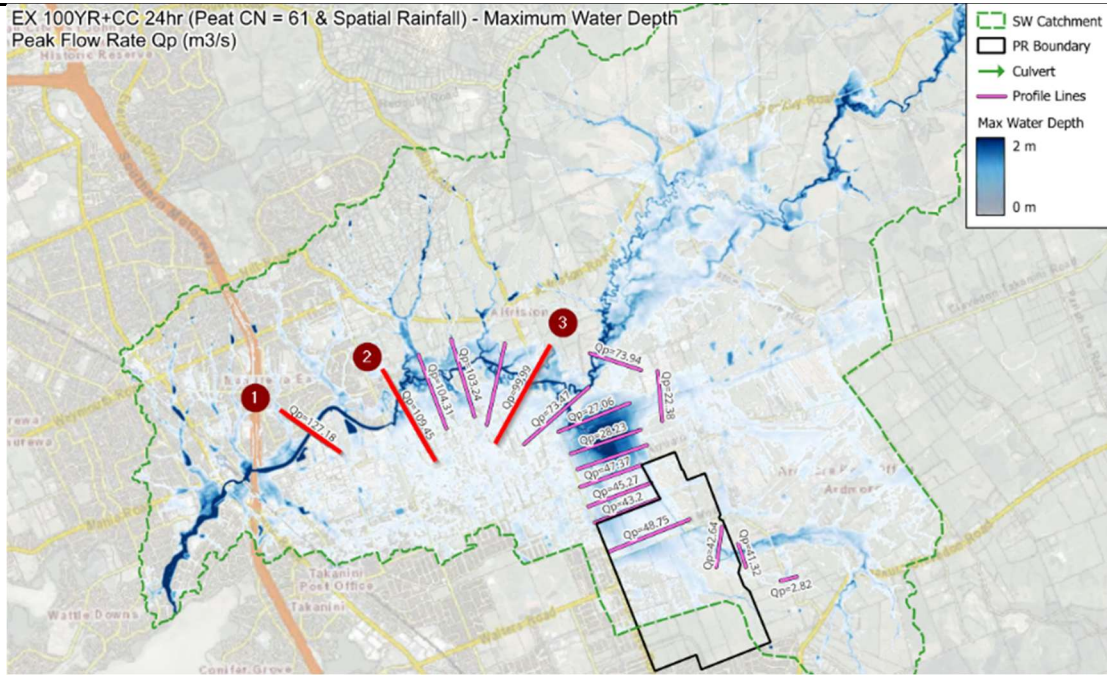


Figure 5.7.12 100YR ARI Papakura stream cross sections for peak flow comparison (PEAT CN = 61 & Spatial Rainfall)

Element	1%AEP peak flow existing (m3 /s)	1%AEP peak flow post development (m3 /s)	Change
Cross section 1	127.18	127.23	Negligible
Cross section 2	109.45	104.09	-5.4 (-5%)
Cross section 3	99.99	95.19	-4.8 (-5%)

5.11 EASTERN CATCHMENT ATTENUATION DEVICES

Table 5.4 summarises the proposed (post development) Eastern Catchment stormwater pond storage and attenuation devices.

Element	50% AEP Storage Volume (m3)	10% AEP Storage Volume (m3)	1% AEP Storage Volume (m3)	Outlet
Stormwater Pond 1 (Outflow 1)	68,000	77,000	141,000	700m weir
Stormwater Pond 2 (Outflow 2)	8,390	13,580	22,290	180mm SMAF outlet 1350mm Scruffy dome
Stormwater Pond 3 (Outflow 3)	1,030	1,510	1,820	68mm SMAF outlet 700mm weir cutout

Table 5.4 Eastern Catchment attenuation device configuration summary

Element	10% AEP Peak flow Pre development(m3/s)	10% AEP Peak flow Post development(m3/s)
Northern Outflow 1	22.0	21.6
Northern Outflow 2*	2.35	0.64
Northern Outflow 3*	0.50	0.49

*Refer to HMS in section 2 for calculations

Table 5.5 10%AEP Eastern Catchment site discharge predevelopment versus post development flow summary

Element	1% AEP Peak flow Pre development(m3/s)	1% AEP Peak flow Post development(m3/s)
Northern Outflow 1	52.0	51.8
Northern Outflow 2*	4.17	4.14
Northern Outflow 3*	0.90	0.87

*Refer to HMS in section 2 for flows

Table 5.6 1%AEP Eastern Catchment site discharge predevelopment versus post development flow summary

5.12 EASTERN CATCHMENT OUTFLOW 1 PASS FORWARD FLOW

A pass-forward flow strategy is proposed for the Northern Out flow 1. This has been assessed to be the best practical option for the large 350.7 Ha of Catchment C due to the smaller time of concentration of site discharges in comparison to the flow from the large upstream catchment. The upstream catchment (350.7 Ha) generates a substantial 1% AEP peak flow of 54 m³/s, which enters the site's eastern boundary at 13:20 (with a time to peak of approximately 80 minutes). Flows generated from the site have an average time of concentration of 20 minutes, the combined peak of the site discharge in the swales has a peak 1% AEP flow of 26 m³/s. Figure 5.8 shows a comparison of the hydrographs. Pass-forward flow shall allow flow from the site, which have a smaller peak flow to that of the upstream, to exit the site before arrival the upstream catchment peak flow reaches the site. It is noted that if an alternative strategy such as peak flow attenuation was applied to the catchment the attenuated from the site exiting via outflow 1 would coincide with the upstream peak flow and result in a larger resultant peak flow. Section 5.11 of the report shows assessment of the effect further downstream of the site in Papakura Stream. No increases in peak flow or water levels were observed as a results of the pass-forward flow of norther outflow 1.

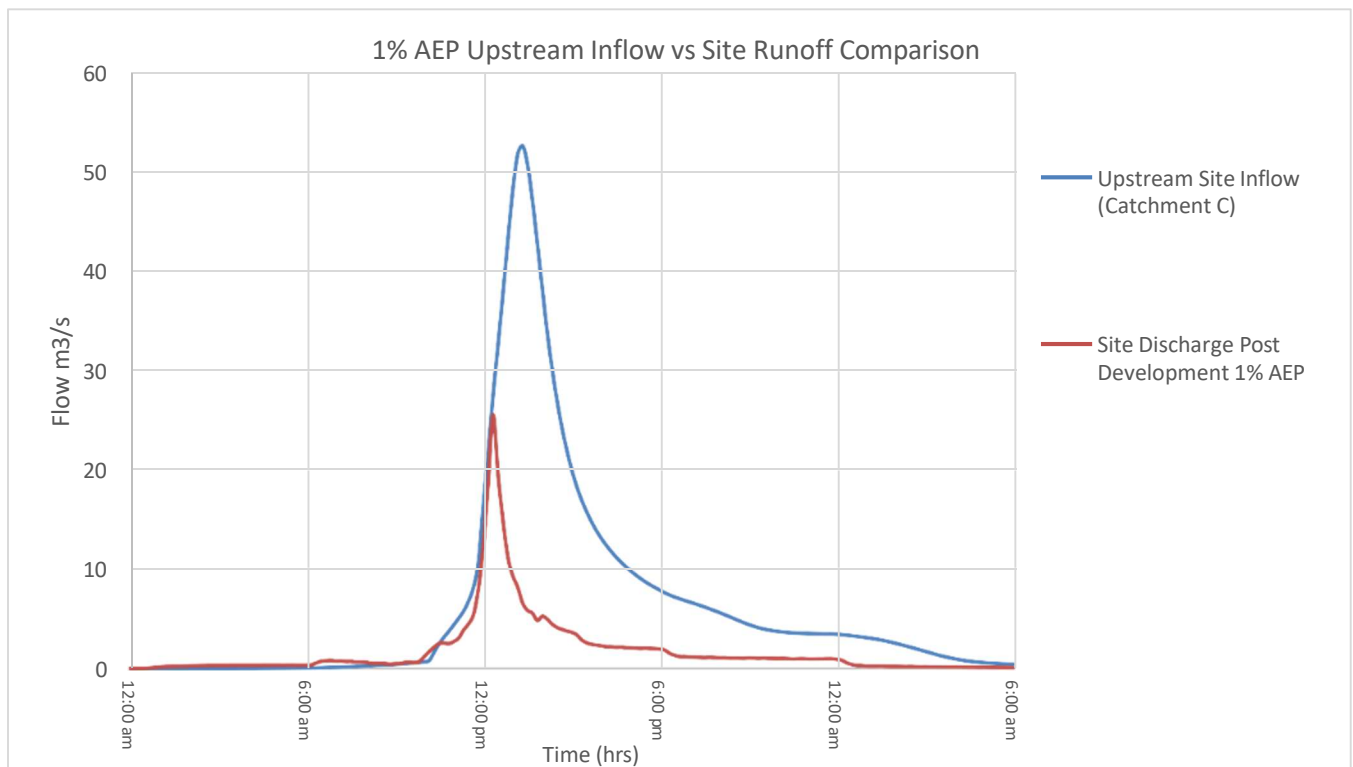


Figure 5.8 Upstream versus site discharge 1% AEP flow hydrograph comparison

5.13 CONCLUSION – EASTERN CATCHMENT

A flood model has been built to assess flood effects of the proposed post development from the Eastern site catchment during the 50%, 10% and 1% AEP storm events assuming the Auckland Council SWCoP version 4 climate change factors.

Flood levels and peak flow post development were compared to the predevelopment flood levels and peak flows. No negative effects were highlighted in any of the modelling results

Site area within the post development catchment D1 (15.3 Ha) and D2 (2.8 Ha) discharge to Outflows 2 and 3 respectively. Flows from these catchments are proposed to be attenuated via stormwater ponds to pre-development flows for the 50%, 10% and 1%AEP storms.

The catchment area within the site discharging to the Northern Outflow 1 via Stormwater Pond 1 is 109.1 Ha, of this area 29.5 Ha of the site is allocated to stormwater management as either swales or Stormwater Pond 1. Peak flow across Northern Outflow 1 is governed by the large upstream catchment to the east of the site. Site discharge across northern outflow 1 is proposed to be passed forward while maintaining the existing peak flows.

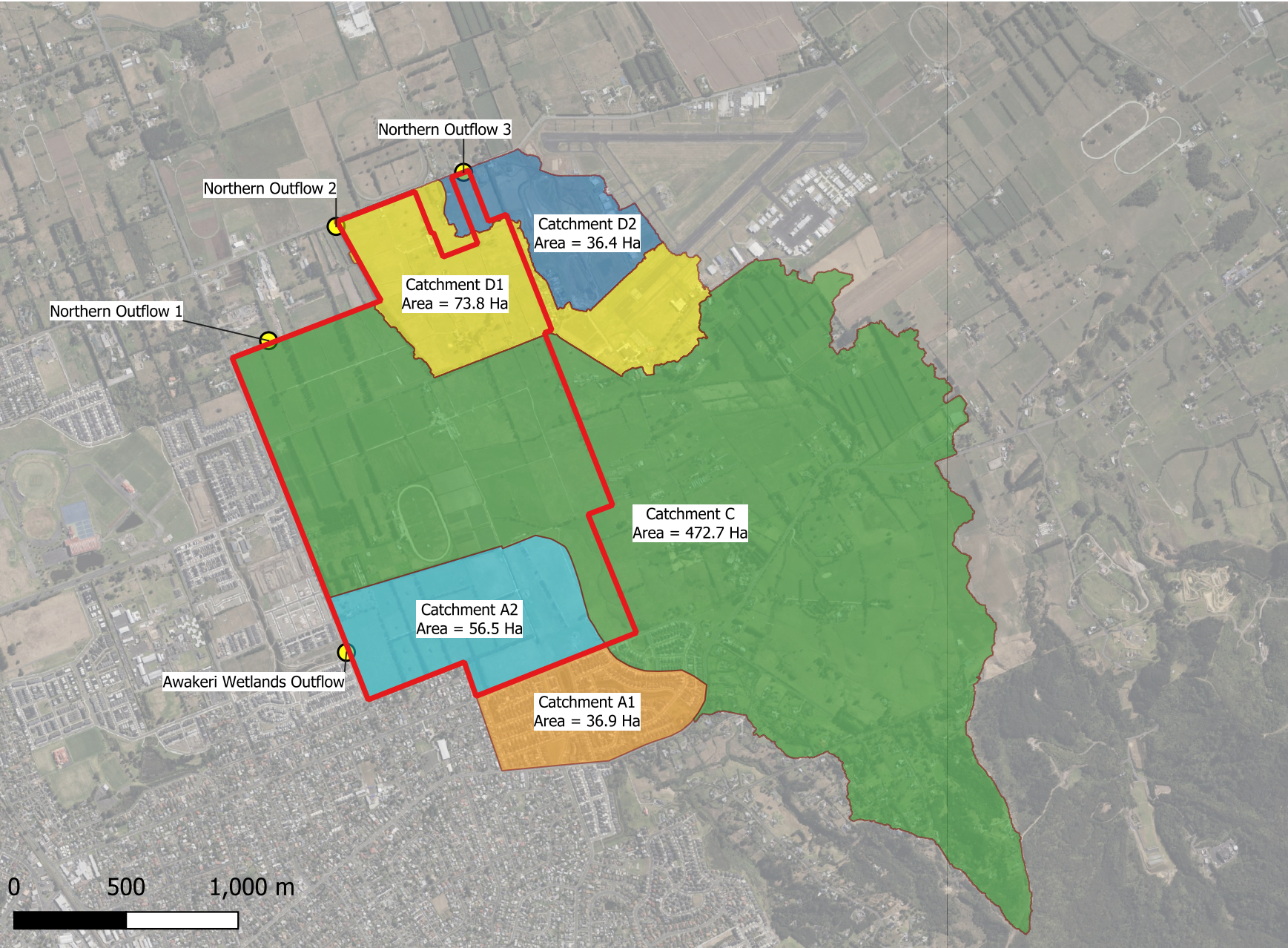
An Auckland Unitary Plan E36 flood risk assessment may be found in Appendix 14.



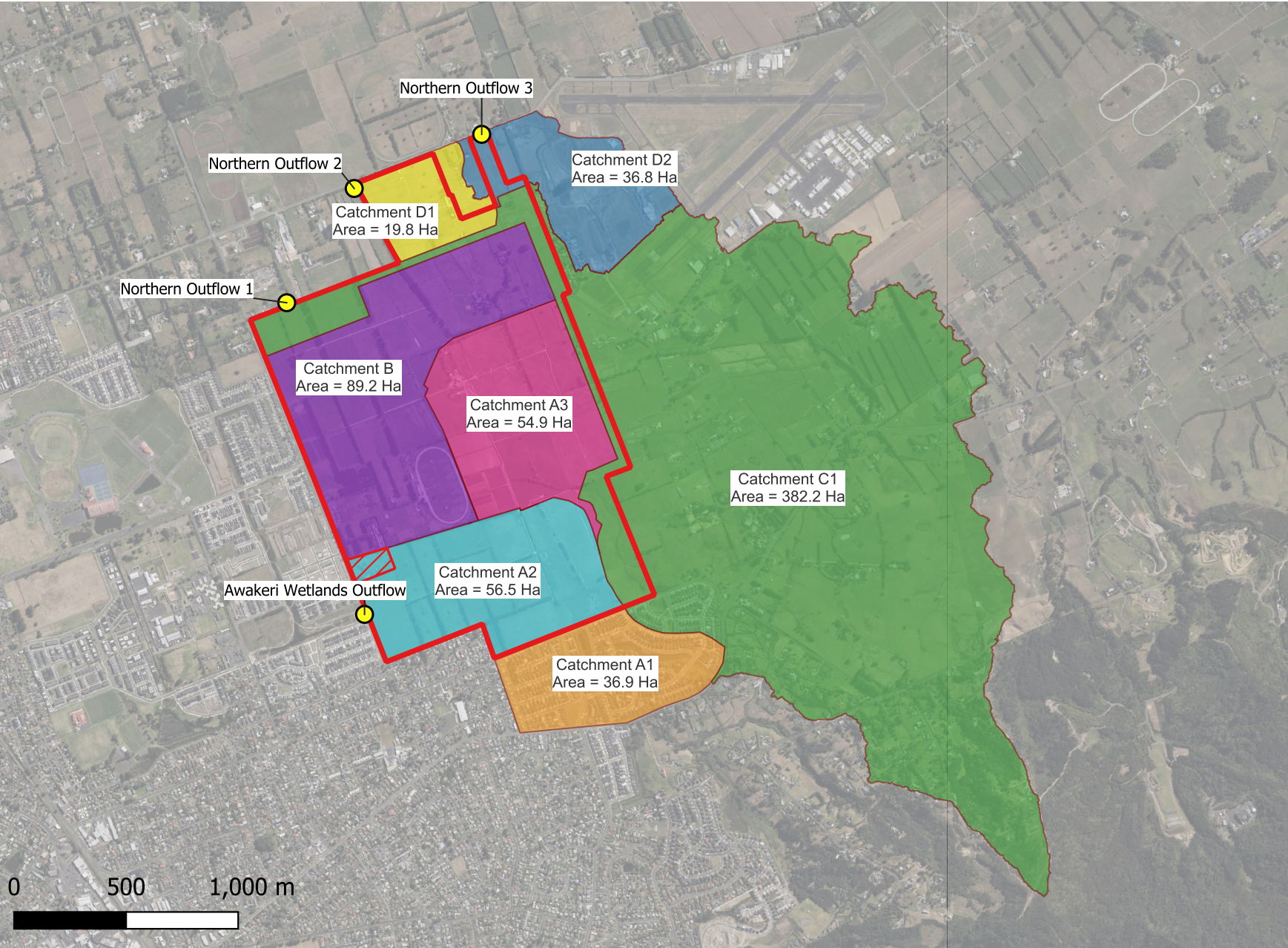
APPENDIX 1 – CATCHMENT PLANS

Pre Development Catchments Overview

Legend



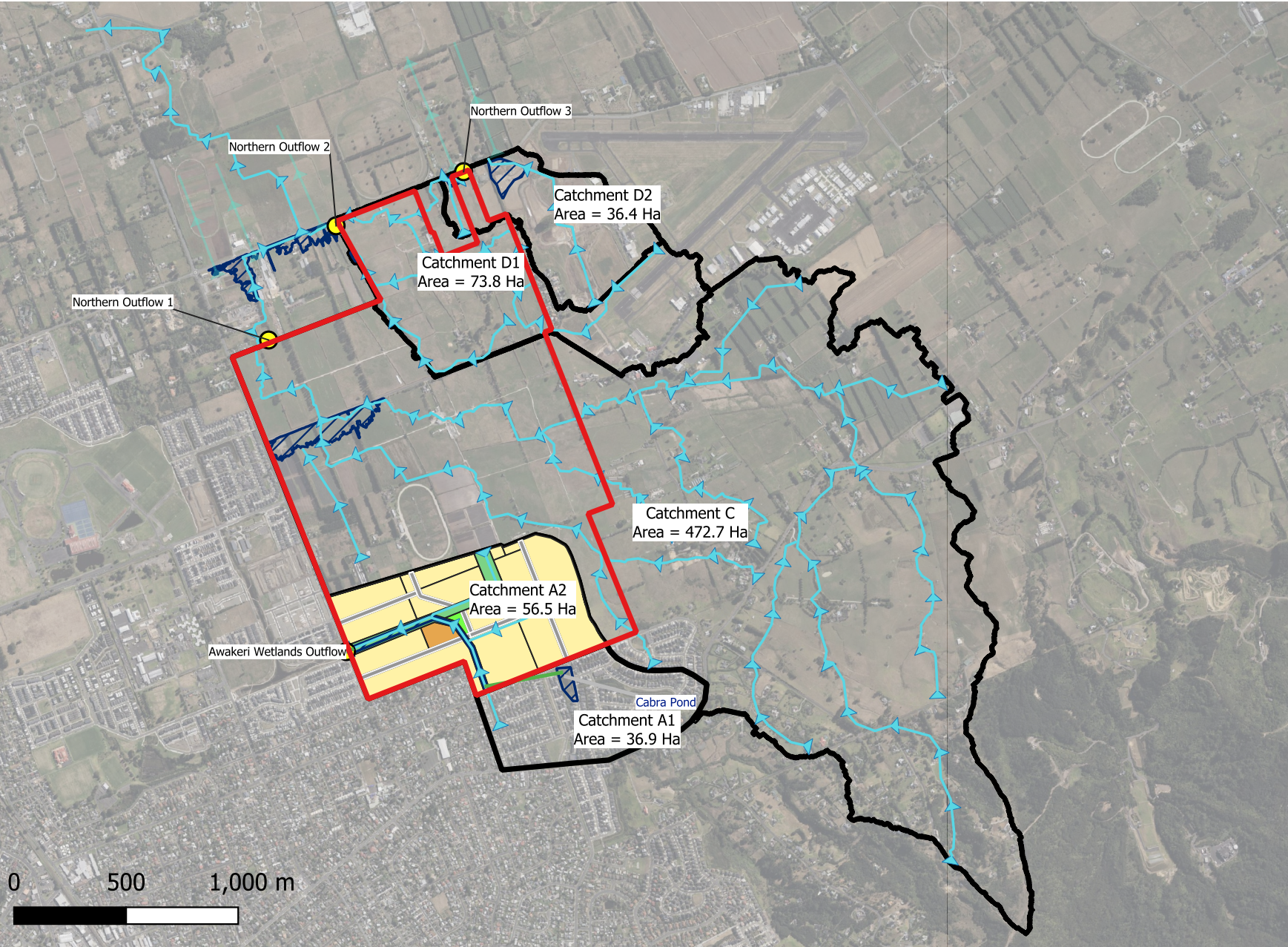
Post Development Catchments



Legend

- Site Boundary
- 101CosgraveRoad
Flow Allowance made
for discharge to
Awakeri wetland

Existing Catchment Flow paths

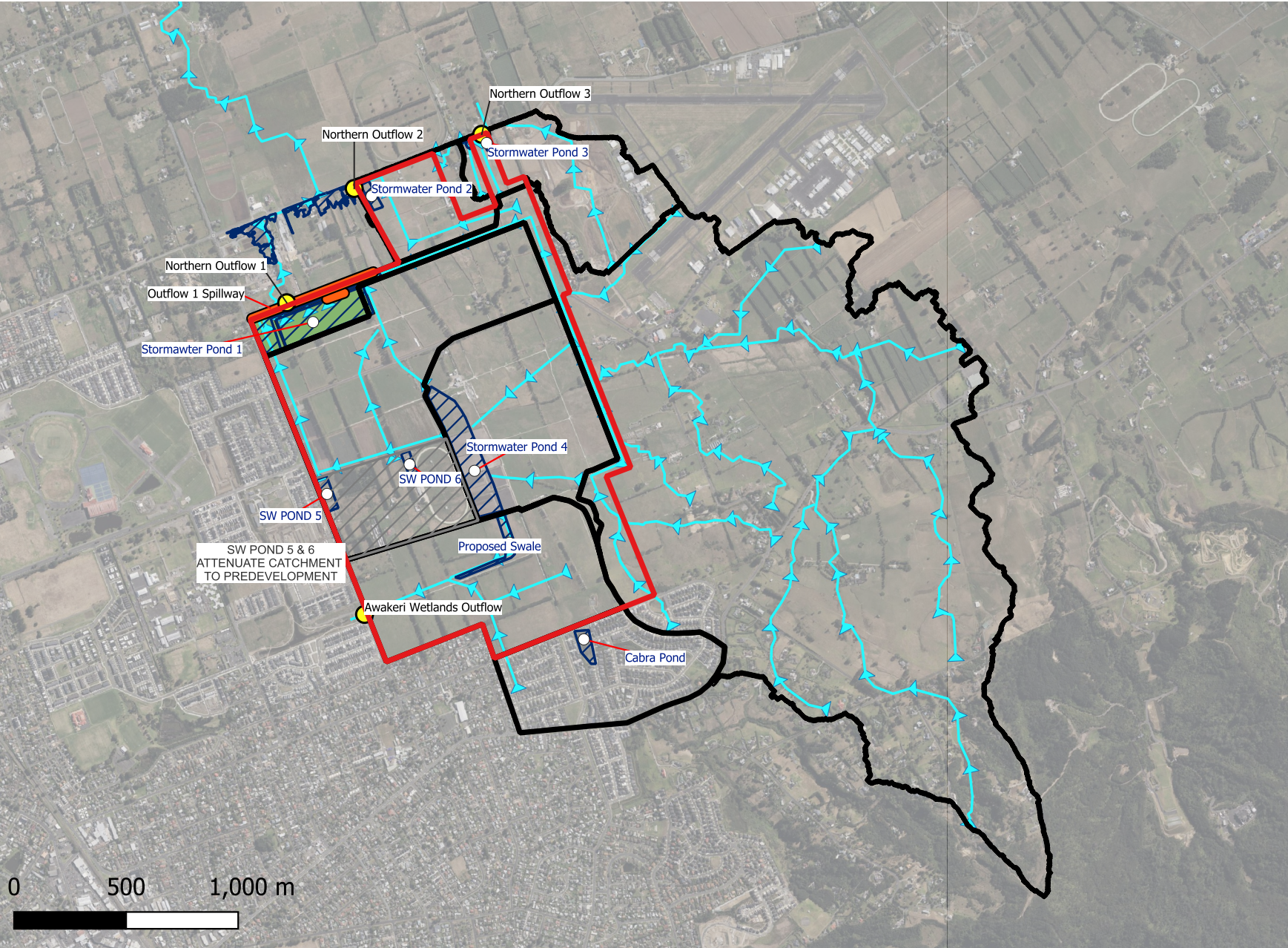


Legend

- Site Boundary
- Predevelopment Catchments
- Catchments
- Existing OLFP
- Existing Flood Prone Storage
- Site Outflow

Proposed Catchment Flow paths

Legend

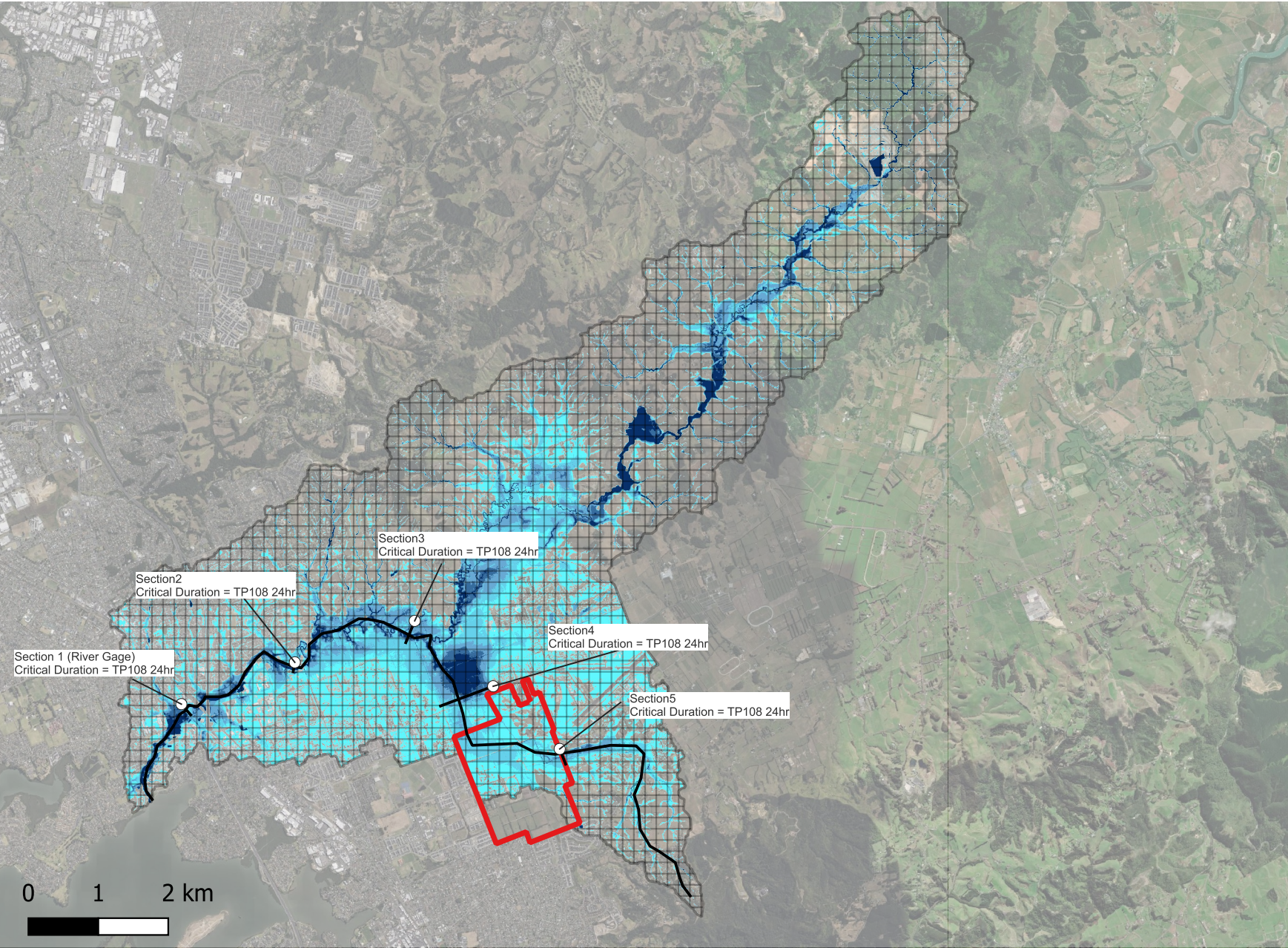


- Site Boundary
- Postdevelopment Catchments
- Proposed OLFP
- Post development Flood Storage
- Proposed SW Pipe
- Catchment to be attenuated to predevelopment (10% Impervious) by SW Pond 5 & 6



APPENDIX 2 – Critical Storm Check

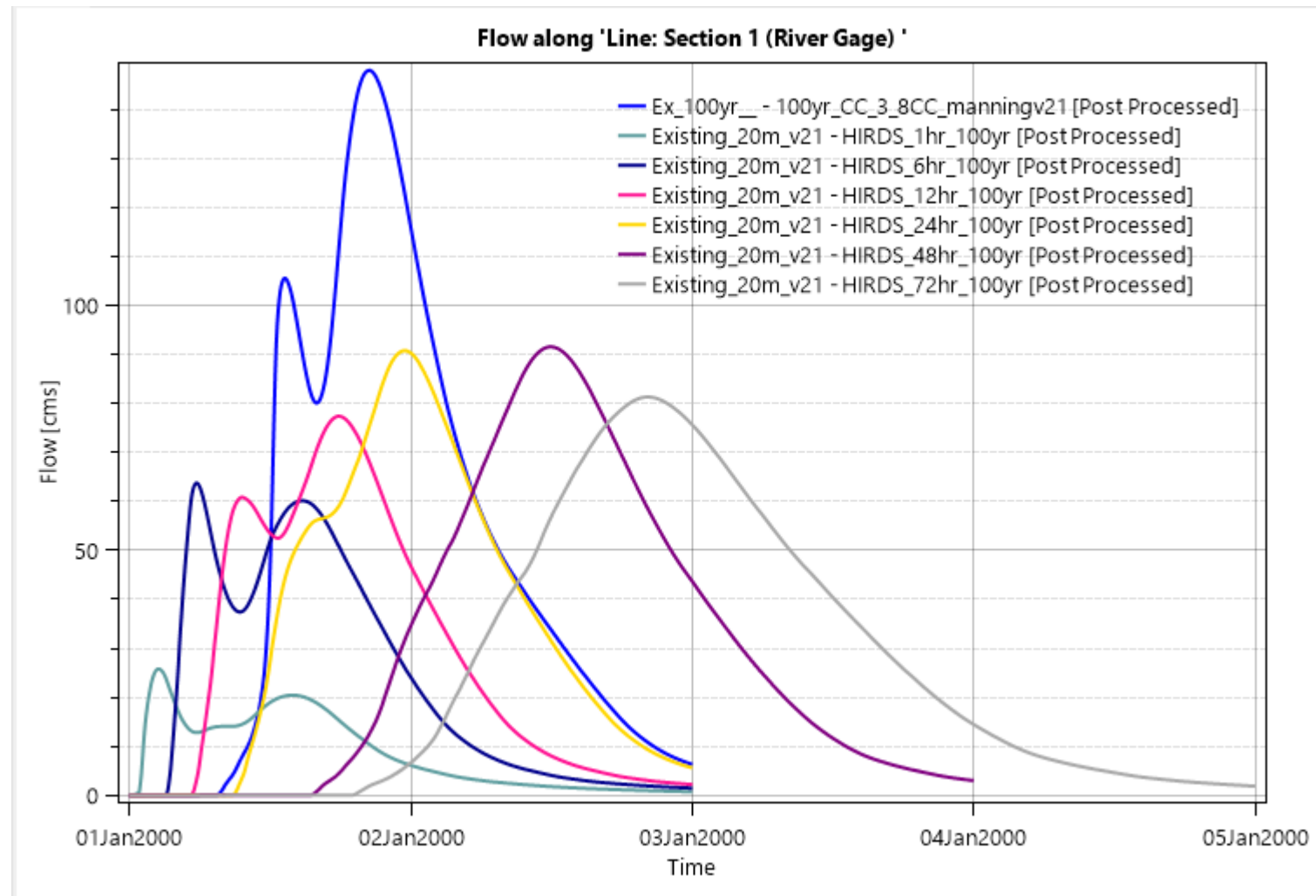
Eastern Catchment Critical Storm Check



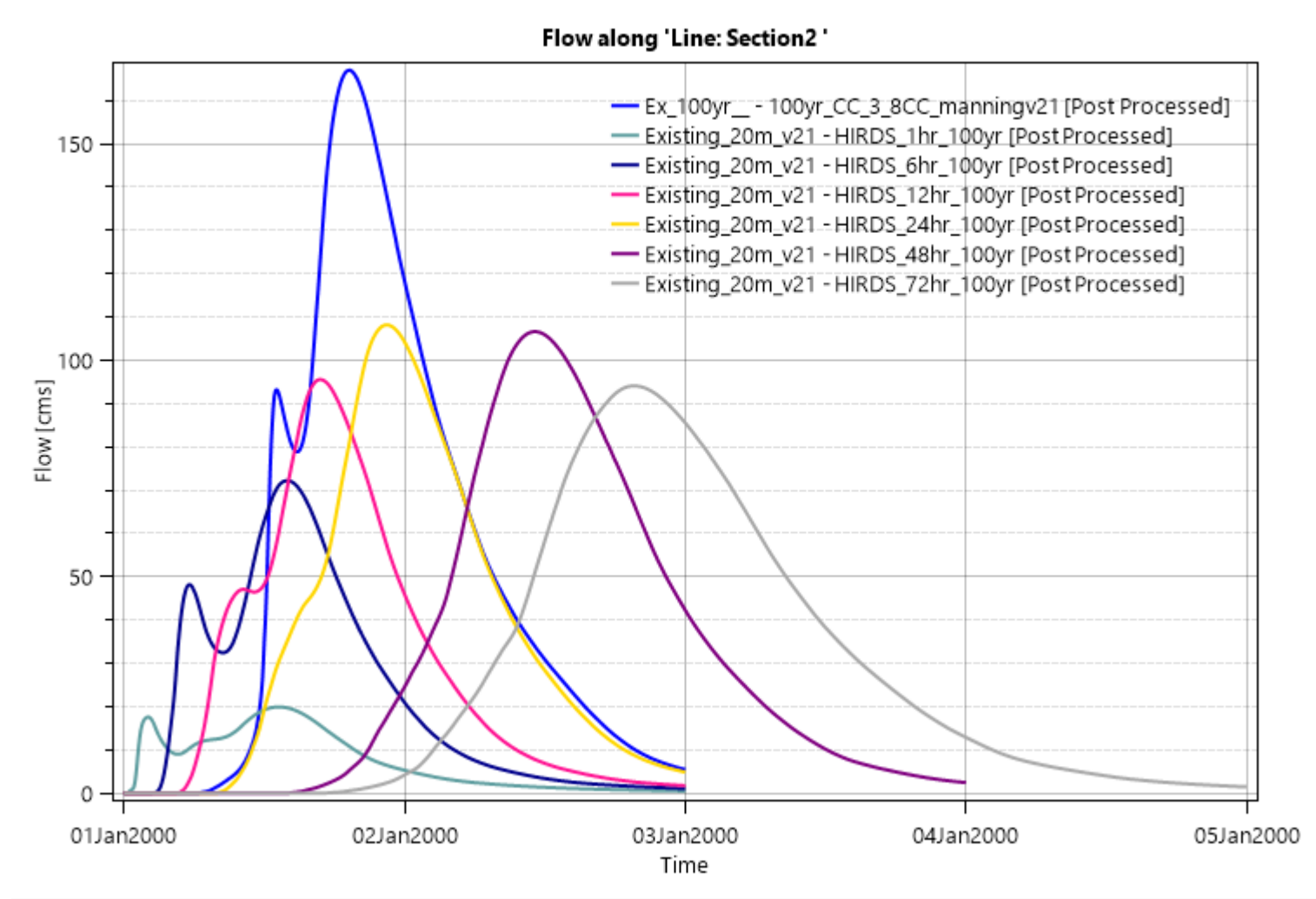
Legend

- Pr-Bdy
- Outflow Boundary Conditions
- Perimeter
- Eastern catchment
Pre development
1% AEP peak flow depths
 - ≤ 0.50000
 - $0.50000 - 1.00000$
 - $1.00000 - 1.50000$
 - $1.50000 - 2.00000$
 - > 2.00000

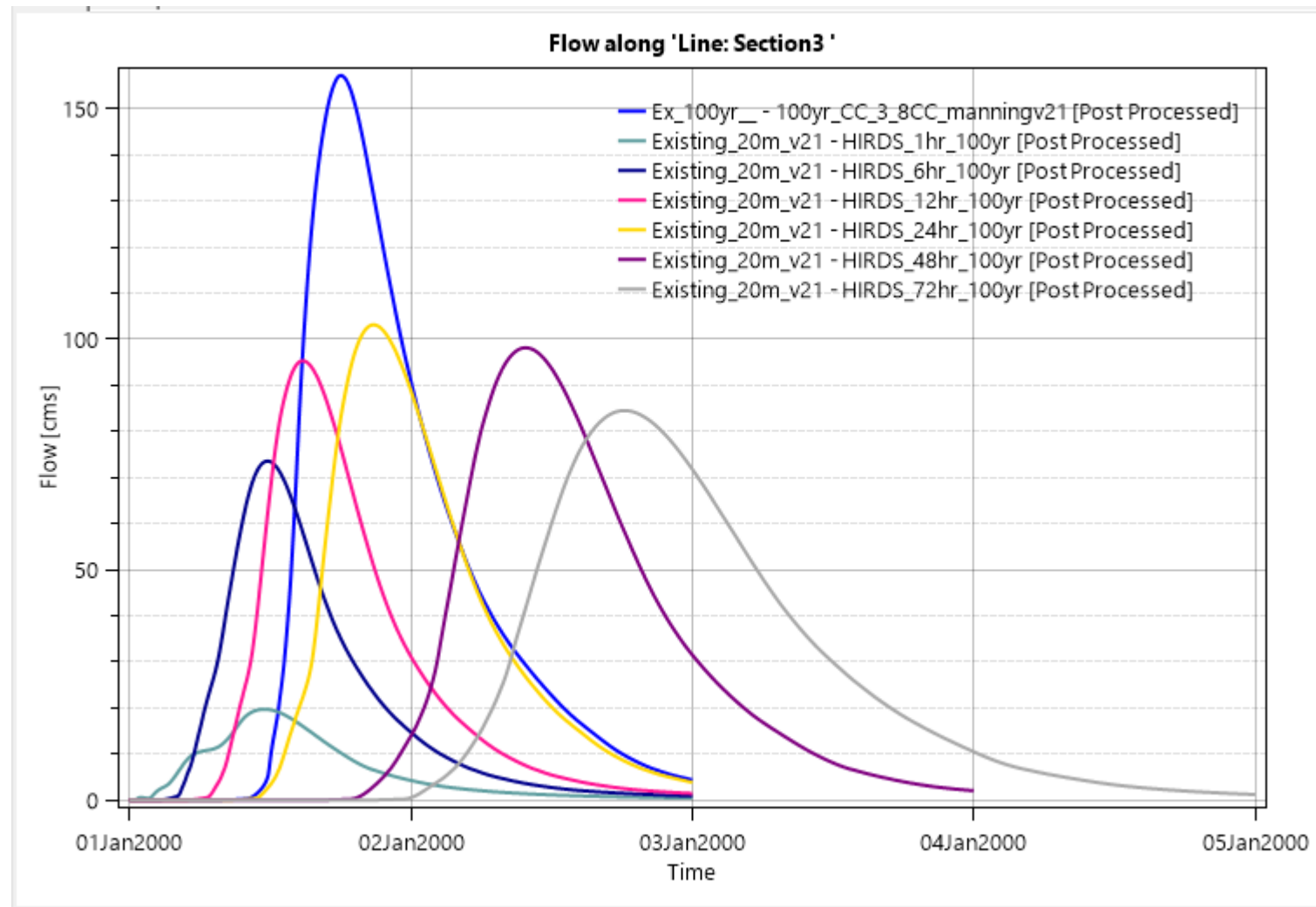
Critical Storm Check – 1%AEP Cross section 1



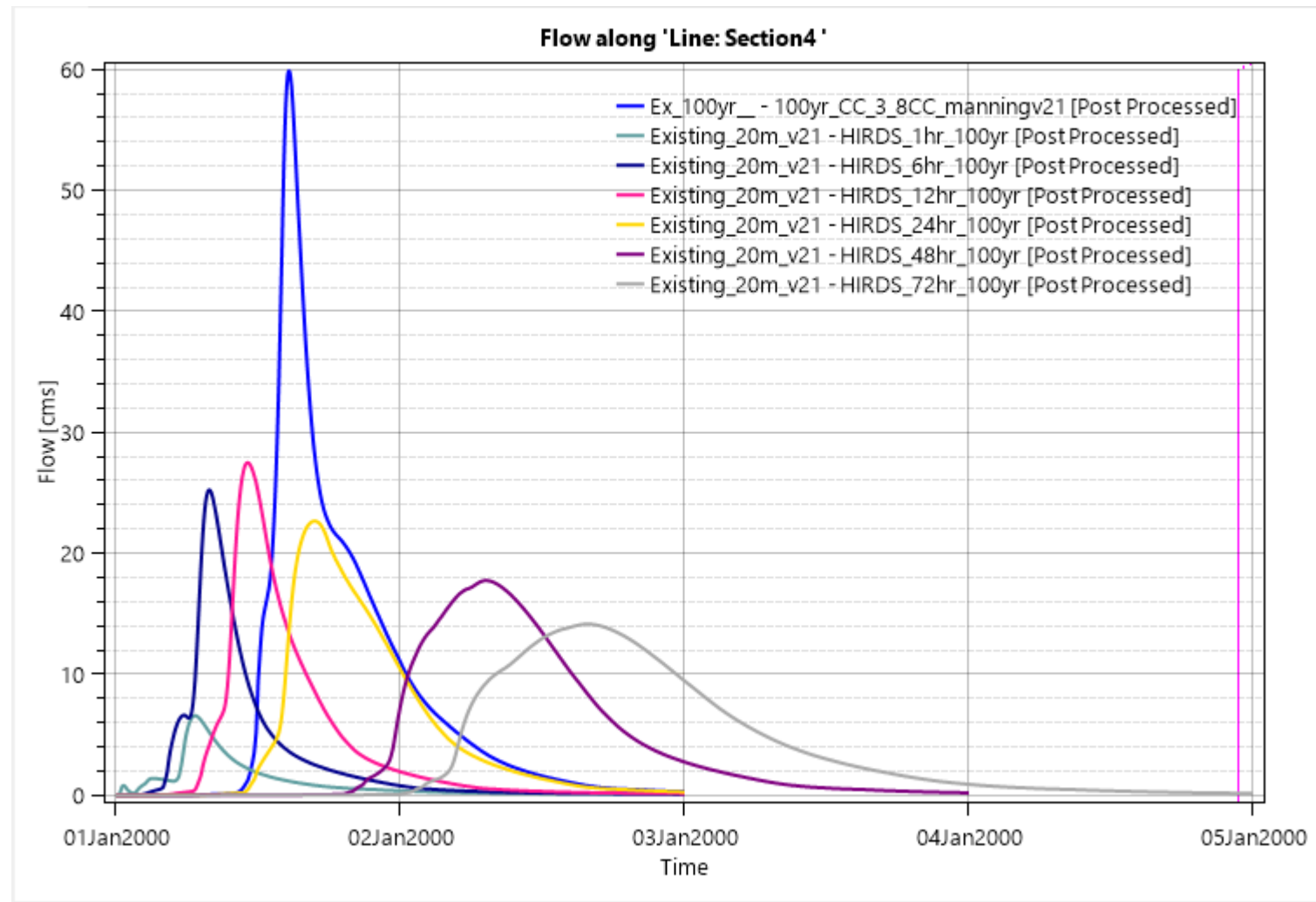
Critical Storm Check – 1%AEP Cross section 2



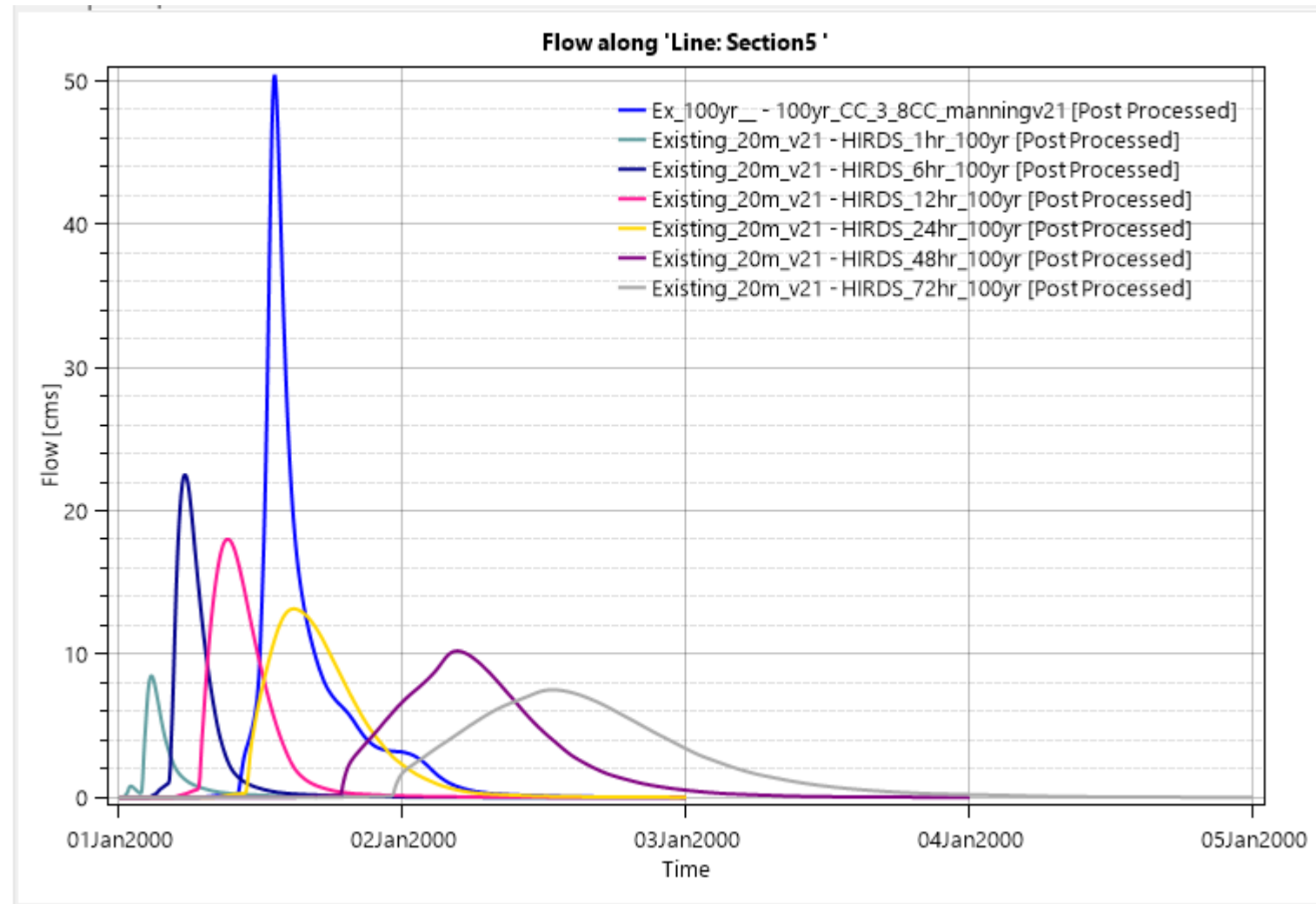
Critical Storm Check – 1%AEP Cross section 3



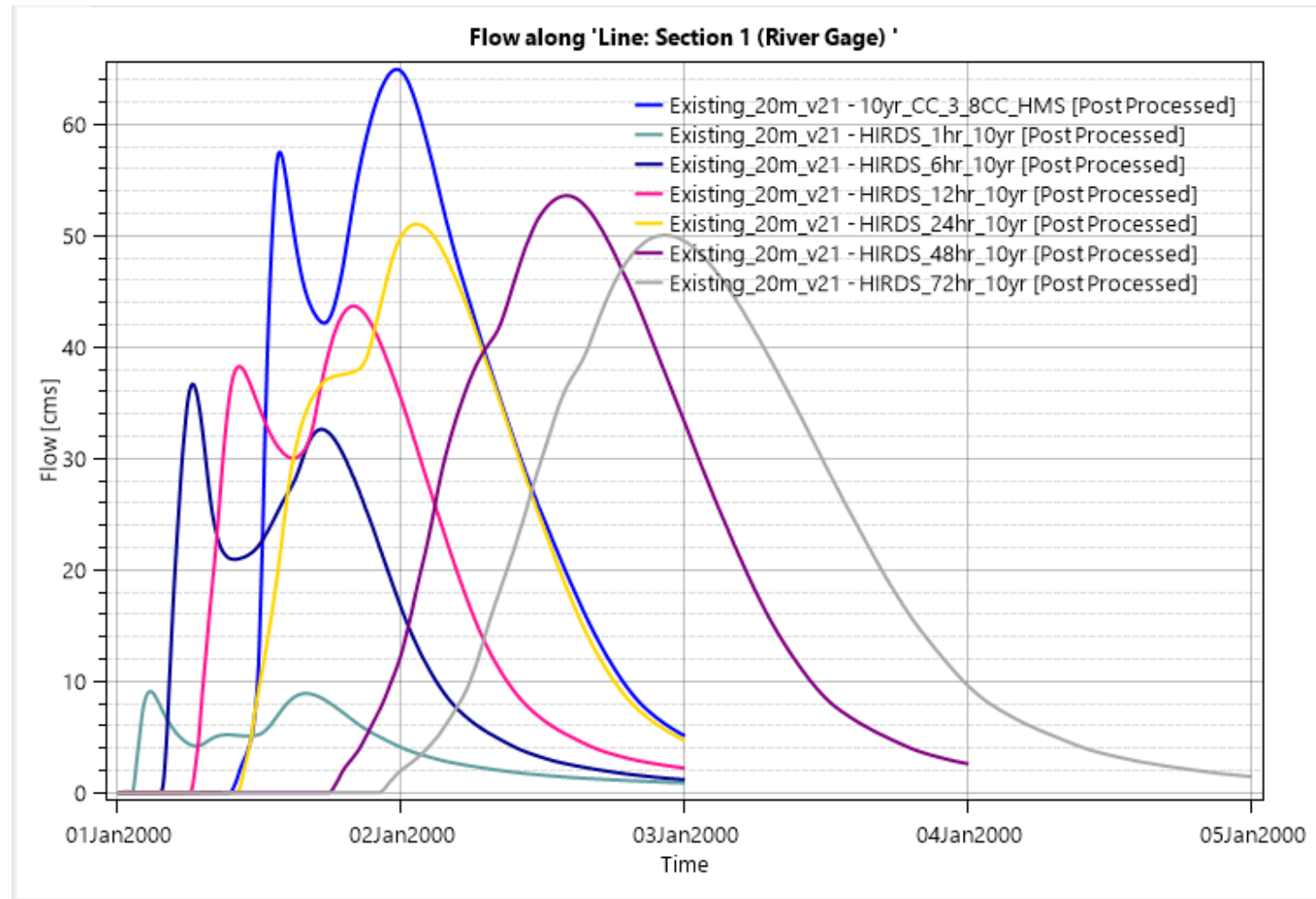
Critical Storm Check – 1%AEP Cross section 4



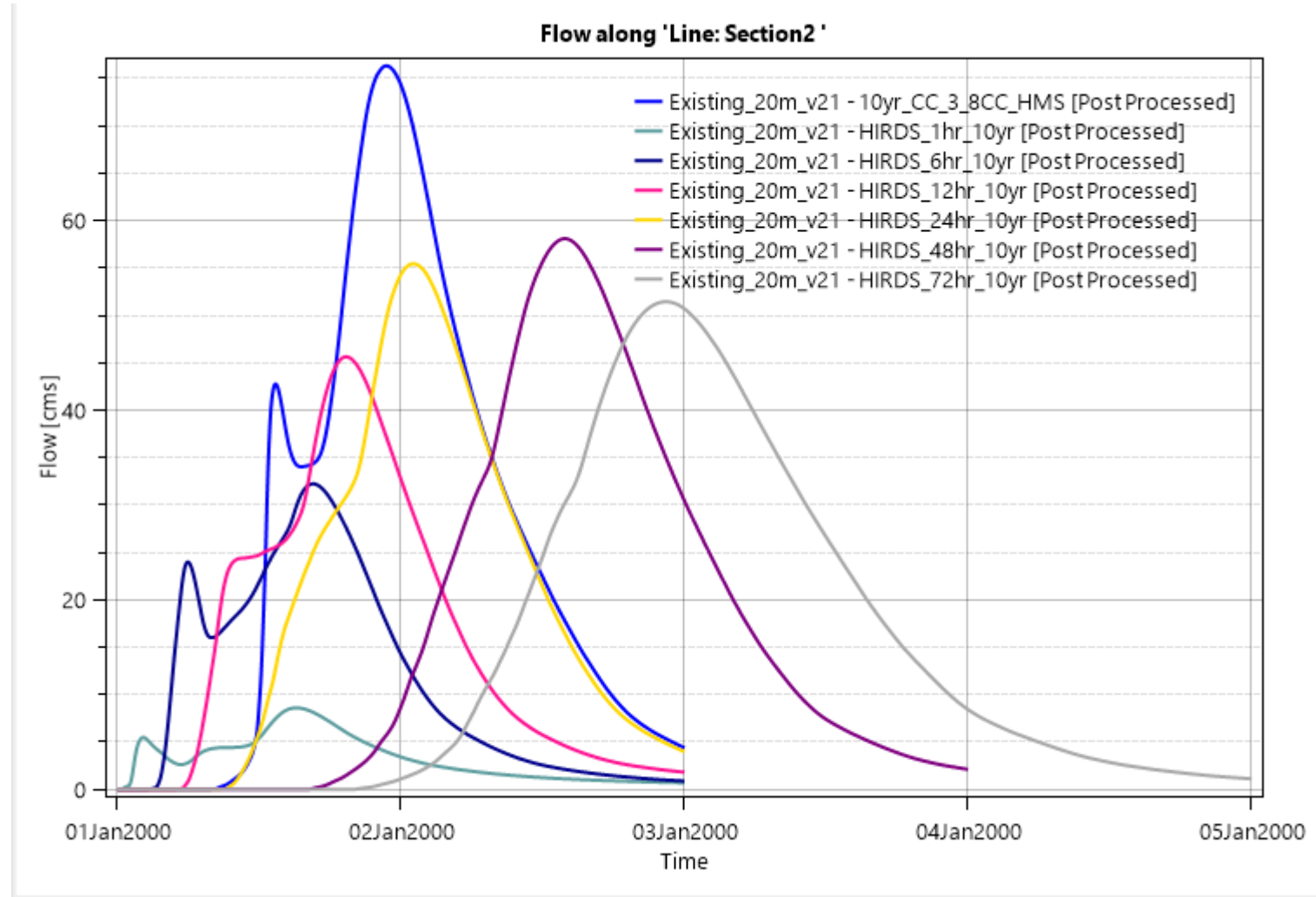
Critical Storm Check – 1%AEP Cross section 5



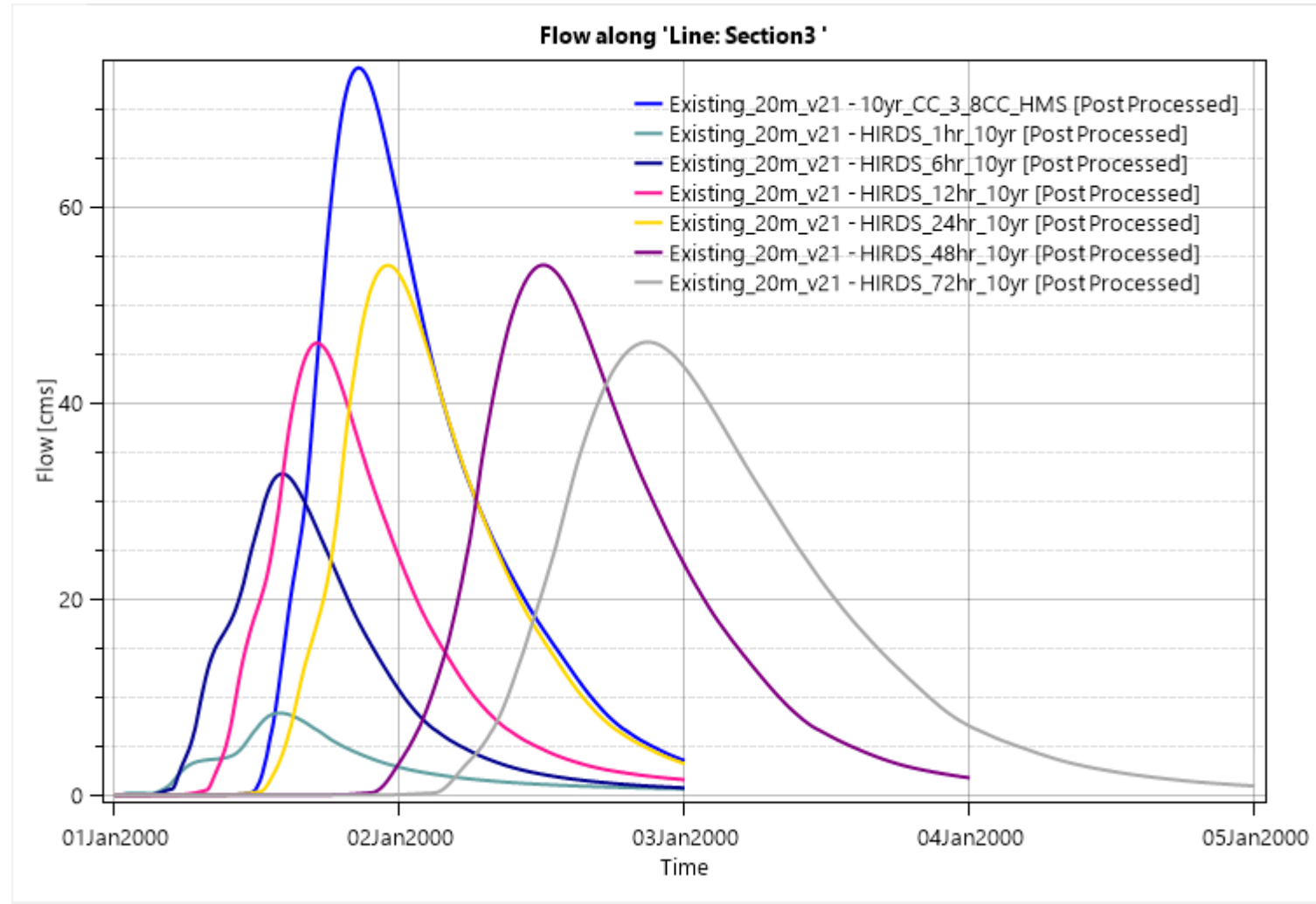
Critical Storm Check – 10%AEP Cross section 1



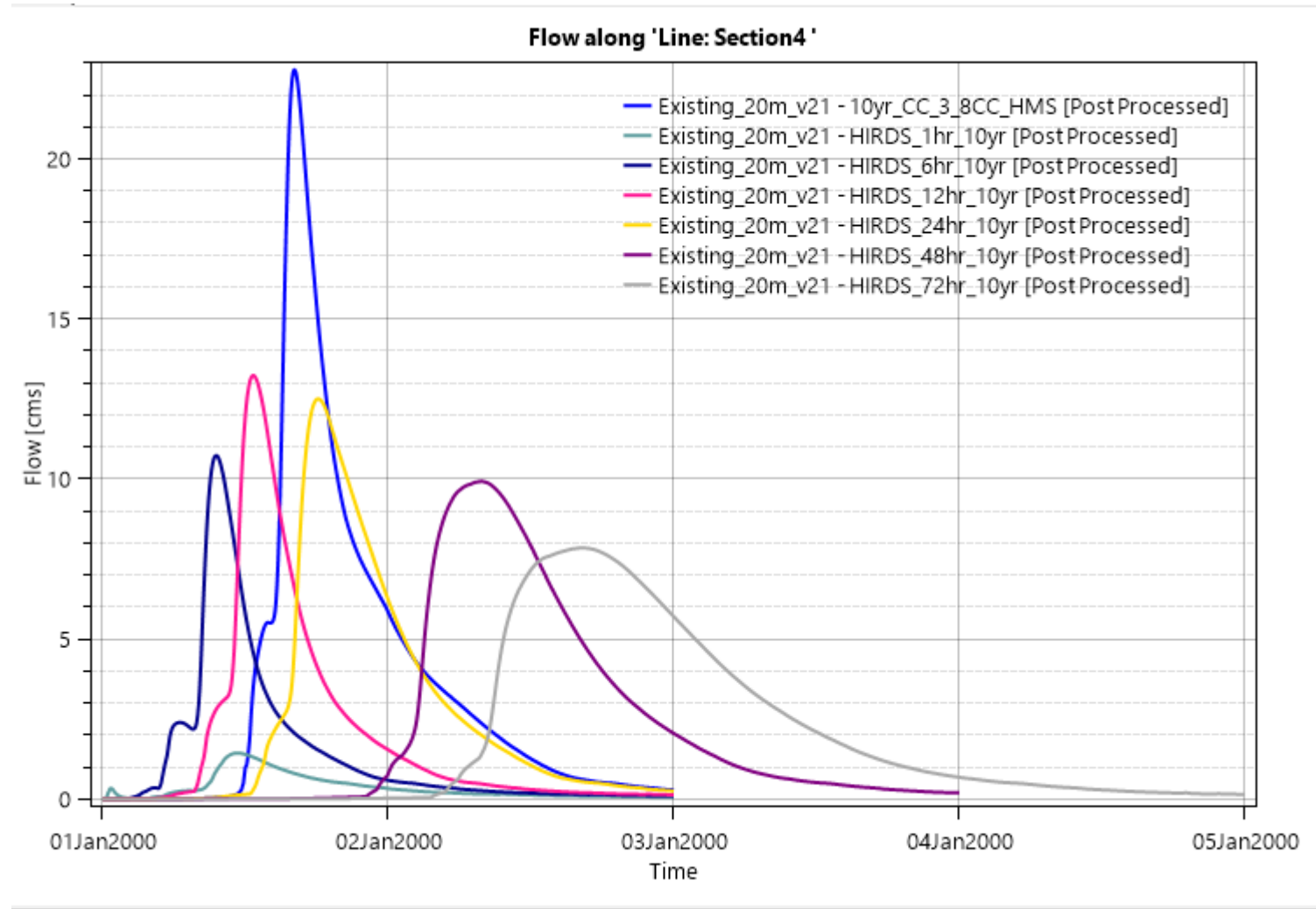
Critical Storm Check – 10%AEP Cross section 2



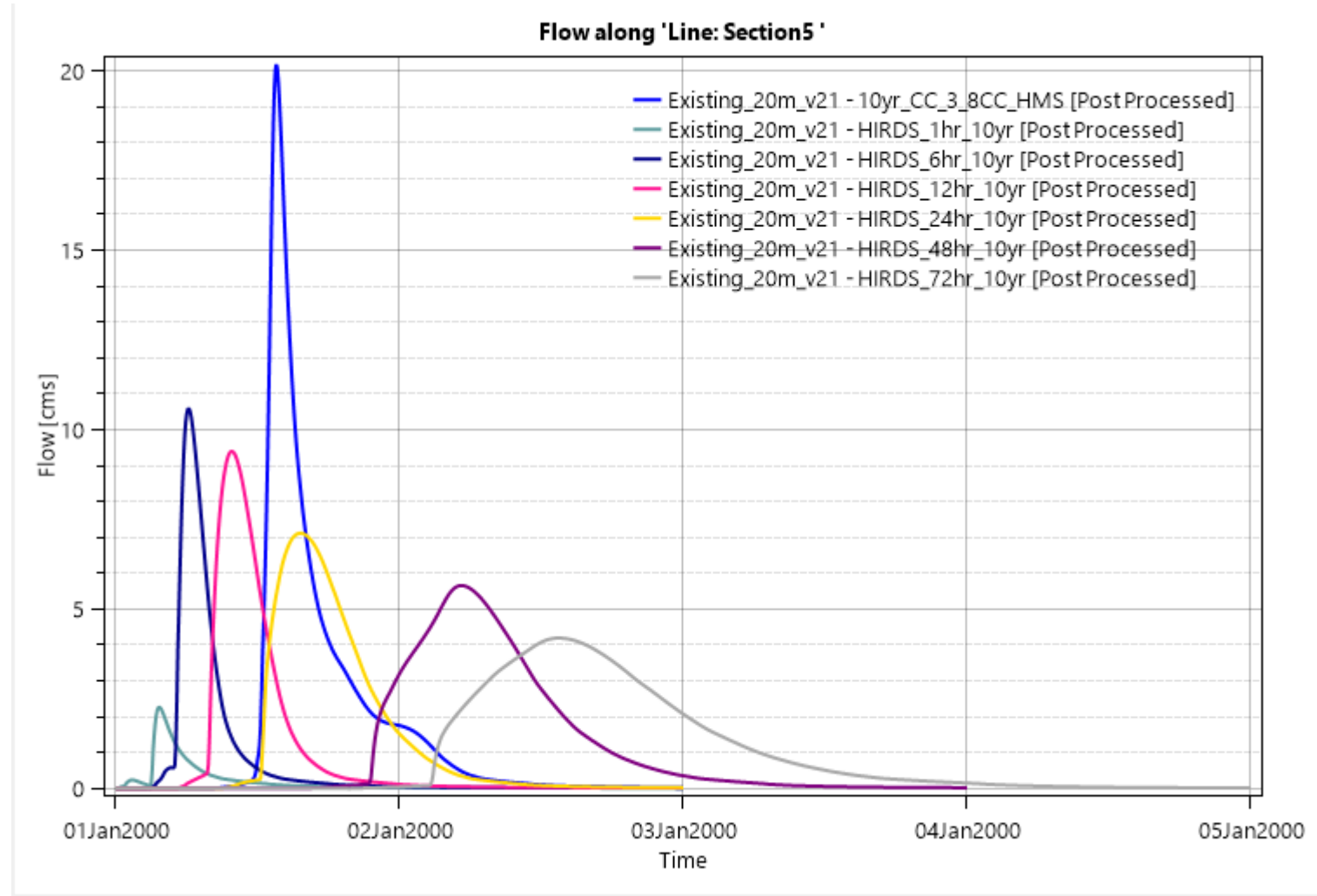
Critical Storm Check – 10%AEP Cross section 3



Critical Storm Check – 10%AEP Cross section 4



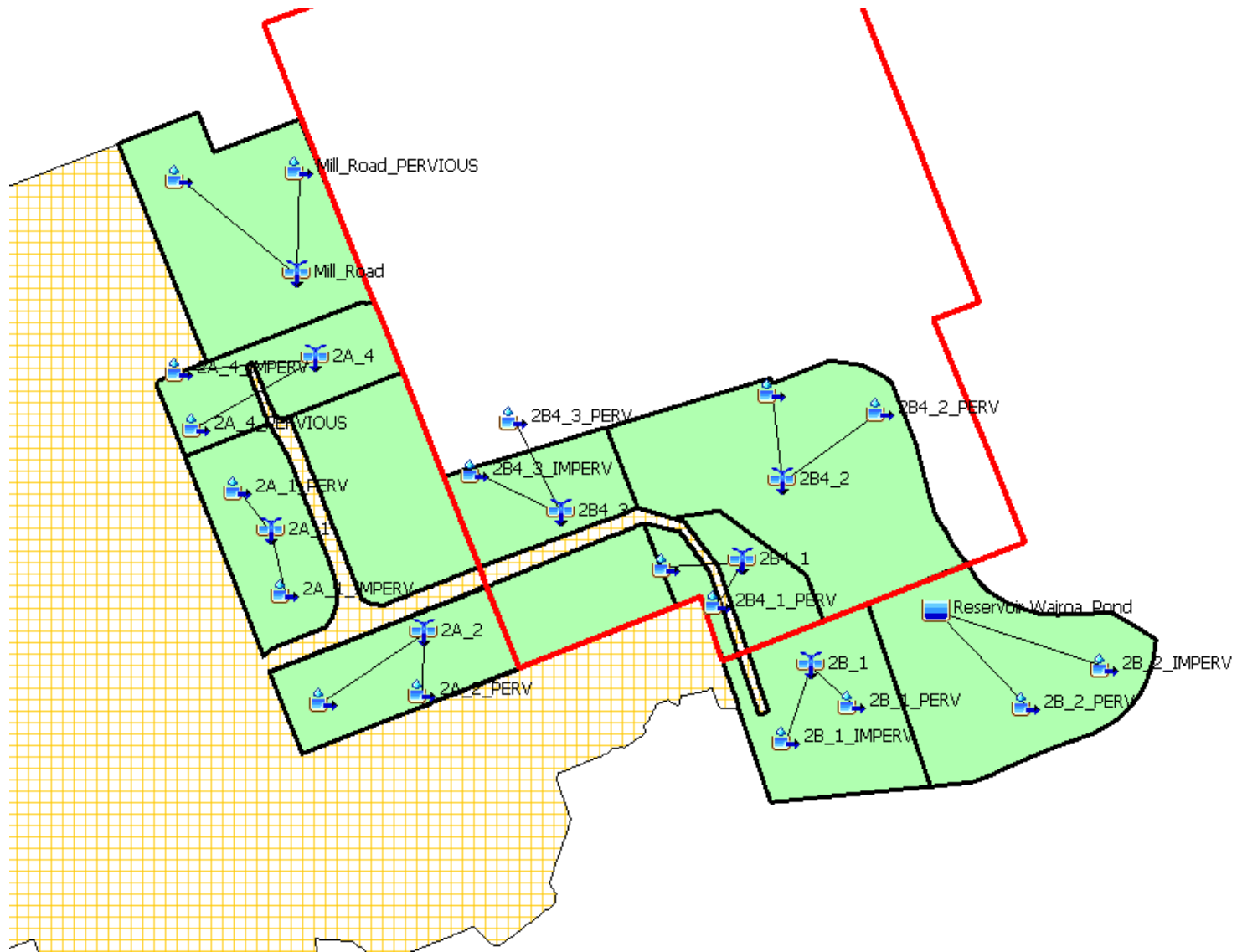
Critical Storm Check – 10%AEP Cross section 5



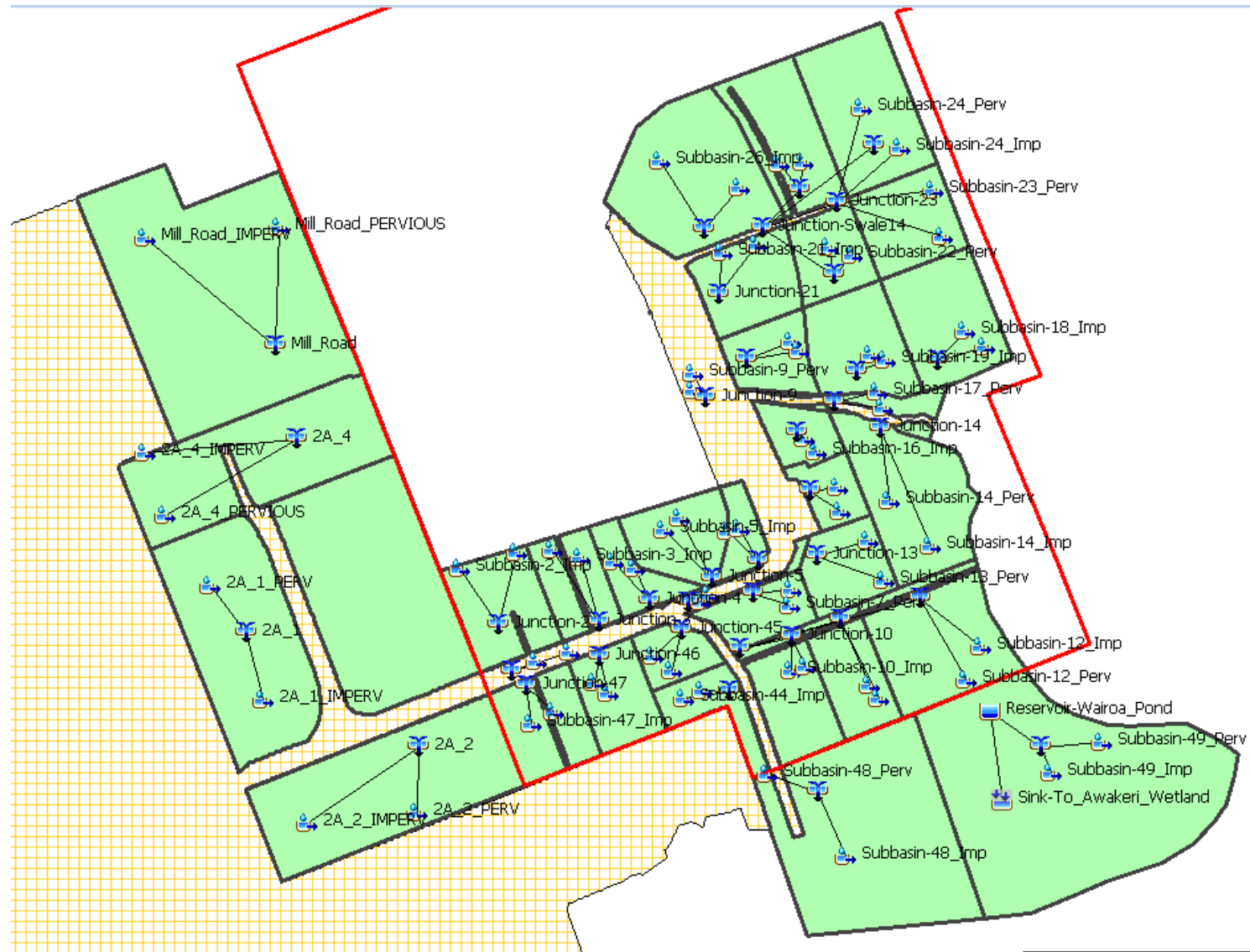


APPENDIX 3 – HMS Western Model Setup

Western Catchment HEC HMS Model (Baseline)



Western Catchment HEC HMS Model (Post Development)



Western Post Development HEC HMS Paired Data

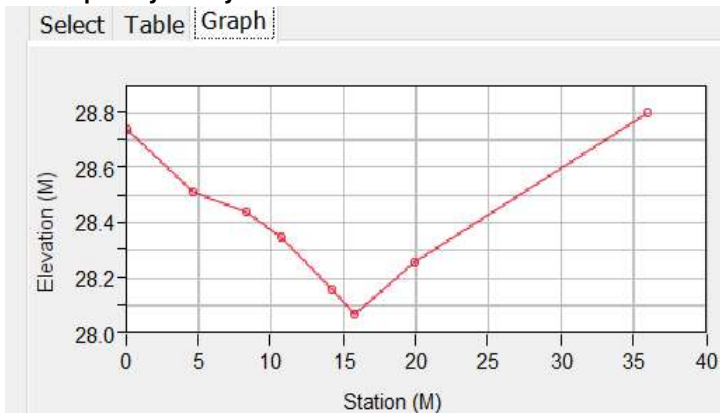
Cabra Pond / Old Wairoa Road Pond

Wairoa Pond	
Components	Compute Results
Paired Data	Table Graph
Elevation (M)	Storage (1000 M3)
26.16	0.000
28.14	9.919
29.00	15.700

Pond Outlet (derived from Geomaps pipes)

Basin Name: Western_Catchment_Report	
Element Name: Reservoir-Wairoa_Pond	
Method:	Culvert Outlet
Direction:	Main
Number Barrels:	1
Solution Method:	Automatic
Shape:	Circular
Chart:	1: Concrete Pipe Culvert
Scale:	1: Square edge entrance with headwall
*Length (M)	17
*Diameter (M)	1.2
*Inlet Elevation (M)	26.16
*Entrance Coefficient:	0.3
*Outlet Elevation (M)	25.93
*Exit Coefficient:	0.5
*Mannings n:	0.013

Pond spillway surveys



Basin Name: Western_Catchment_Report	
Element Name: Reservoir-Wairoa_Pond	
Method:	Non-Level Overflow
Direction:	Auxillary
*Cross Section:	Wairoa Rd Pond Spillway
*Coefficient: (M ^{0.5} /S)	1.66



APPENDIX 4 – HMS Western Model Results

Western Catchment Baseline Scenario– HMS Inflow hydrograph summary 2yr Storm

Global Summary Results for Run "FAB_2yr_GHD 2.1CC"

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Project: FAB_Swale_Sizing Simulation Run: FAB_2yr_GHD 2.1CC

Start of Run: 01Jan2000, 00:00

Basin Model: FAB_GHD_Model 10yr

End of Run: 03Jan2000, 00:00

Meteorologic Model: TP108_2yr_86mm

Compute Time: DATA CHANGED, RECOMPUTE

Control Specifications: 48hr

Show Elements: All Elements

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Box culvert entry	1.58733	11.62078	1 January 2000, 12:26	94.12139
CH0-160	1.58733	11.62078	1 January 2000, 12:26	94.12139
CH0-300A	0.56741	4.80572	1 January 2000, 12:24	33.05414
CH1400-CH1540	0.15052	1.62753	1 January 2000, 12:17	9.11195
CH160-550	0.90522	6.23702	1 January 2000, 12:27	54.02930
CH300A-550A	0.31504	2.53231	1 January 2000, 12:23	17.05075
CH550-950	0.73381	4.91369	1 January 2000, 12:23	43.65282
CH950-1400	0.36897	2.36067	1 January 2000, 12:27	21.65764
Junction-1	0.31504	2.53231	1 January 2000, 12:19	17.05075
Junction-2	0.56741	4.80572	1 January 2000, 12:18	33.05414
Junction-3	0.90522	6.23702	1 January 2000, 12:21	54.02982
Junction-4	0.73381	4.91369	1 January 2000, 12:17	43.65334
Junction-5	0.36897	2.36067	1 January 2000, 12:18	21.65841
Junction-6	0.15052	1.62753	1 January 2000, 12:13	9.11195
Main_Branch_Junction	1.58733	11.62078	1 January 2000, 12:25	94.12148
Mill_Road	0.21322	1.96337	1 January 2000, 12:19	13.52009
Mill_Road_IMPERV	0.14924	1.74389	1 January 2000, 12:18	11.30188
Mill_Road_PERVIOUS	0.06398	0.27944	1 January 2000, 12:30	2.21821
Reservoir-Wairoa_Pond	0.21846	0.93895	1 January 2000, 12:34	12.54647
2A_1	0.25237	2.67835	1 January 2000, 12:15	16.00339
2A_1_IMPERV	0.17666	2.34818	1 January 2000, 12:15	13.37838
2A_1_PERV	0.07571	0.39046	1 January 2000, 12:22	2.62501
2A_2	0.11470	1.32992	1 January 2000, 12:12	7.03804
2A_2_IMPERV	0.07456	1.10953	1 January 2000, 12:12	5.64612
2A_2_PERV	0.04015	0.24798	1 January 2000, 12:16	1.39191
2A_4	0.10182	0.56893	1 January 2000, 12:19	3.53066
2A_4_IMPERV	0.00001	0.00014	1 January 2000, 12:13	0.00076
2A_4_PERVIOUS	0.10181	0.56883	1 January 2000, 12:19	3.52990
2B_1	0.15052	1.62753	1 January 2000, 12:13	9.11195
2B_1_IMPERV	0.09483	1.35121	1 January 2000, 12:13	7.18106
2B_1_PERV	0.05569	0.31900	1 January 2000, 12:18	1.93089
2B_2_IMPERV	0.12450	1.70871	1 January 2000, 12:14	9.42833
2B_2_PERV	0.09395	0.50632	1 January 2000, 12:20	3.25756
2B4_1	0.07383	0.79344	1 January 2000, 12:13	4.37837
2B4_1_IMPERV	0.04430	0.64129	1 January 2000, 12:12	3.35450
2B4_1_PERV	0.02953	0.17299	1 January 2000, 12:18	1.02387
2B4_2	0.29101	2.83900	1 January 2000, 12:16	17.61734
2B4_2_IMPERV	0.18334	2.39260	1 January 2000, 12:15	13.88426
2B4_2_PERV	0.10767	0.54096	1 January 2000, 12:23	3.73308
2B4_3	0.17141	1.78671	1 January 2000, 12:14	10.37700
2B4_3_IMPERV	0.10799	1.49037	1 January 2000, 12:14	8.17804

2B4_3_PERV	0.06342	0.34492	1 January 2000, 12:20	2.19897
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Western Catchment Baseline Scenario– HMS Inflow hydrograph summary 10yr Storm

Global Summary Results for Run "FAB_10yr_GHD 2.1CC"

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Project: FAB_Swale_Sizing Simulation Run: FAB_10yr_GHD 2.1CC

Start of Run: 01Jan2000, 00:00

Basin Model: FAB_GHD_Model 10yr

End of Run: 03Jan2000, 00:00

Meteorologic Model: TP108_10yr_164mm_CoPv4

Compute Time: DATA CHANGED, RECOMPUTE

Control Specifications: 48hr

Show Elements: All Elements

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Box culvert entry	1.58733	26.54177	1 January 2000, 12:26	216.09257
CH0-160	1.58733	26.54177	1 January 2000, 12:26	216.09257
CH0-300A	0.56741	10.95746	1 January 2000, 12:25	76.40574
CH1400-CH1540	0.15052	3.62576	1 January 2000, 12:17	20.74637
CH160-550	0.90522	14.30345	1 January 2000, 12:27	123.74588
CH300A-550A	0.31504	5.98571	1 January 2000, 12:23	40.61083
CH550-950	0.73381	11.42769	1 January 2000, 12:28	100.11977
CH950-1400	0.36897	5.78616	1 January 2000, 12:27	49.95947
Junction-1	0.31504	5.98571	1 January 2000, 12:19	40.61083
Junction-2	0.56741	10.95746	1 January 2000, 12:19	76.40574
Junction-3	0.90522	14.30345	1 January 2000, 12:21	123.74646
Junction-4	0.73381	11.42769	1 January 2000, 12:22	100.12035
Junction-5	0.36897	5.78616	1 January 2000, 12:18	49.96033
Junction-6	0.15052	3.62576	1 January 2000, 12:13	20.74637
Main_Branch_Junction	1.58733	26.54177	1 January 2000, 12:25	216.09267
Mill_Road	0.21322	4.27459	1 January 2000, 12:19	30.24095
Mill_Road_IMPERV	0.14924	3.58658	1 January 2000, 12:18	23.72545
Mill_Road_PERVIOUS	0.06398	0.84338	1 January 2000, 12:29	6.51550
Reservoir-Wairoa_Pond	0.21846	2.52027	1 January 2000, 12:31	29.21396
2A_1	0.25237	5.84658	1 January 2000, 12:15	35.79491
2A_1_IMPERV	0.17666	4.82680	1 January 2000, 12:15	28.08455
2A_1_PERV	0.07571	1.17566	1 January 2000, 12:21	7.71036
2A_2	0.11470	2.95334	1 January 2000, 12:12	15.94105
2A_2_IMPERV	0.07456	2.27986	1 January 2000, 12:12	11.85261
2A_2_PERV	0.04015	0.74435	1 January 2000, 12:16	4.08843
2A_4	0.10182	1.71112	1 January 2000, 12:19	10.36988
2A_4_IMPERV	0.00001	0.00029	1 January 2000, 12:13	0.00159
2A_4_PERVIOUS	0.10181	1.71091	1 January 2000, 12:19	10.36829
2B_1	0.15052	3.62576	1 January 2000, 12:13	20.74637
2B_1_IMPERV	0.09483	2.77702	1 January 2000, 12:13	15.07482
2B_1_PERV	0.05569	0.95965	1 January 2000, 12:18	5.67155
2B_2_IMPERV	0.12450	3.51219	1 January 2000, 12:14	19.79241
2B_2_PERV	0.09395	1.52491	1 January 2000, 12:20	9.56834
2B4_1	0.07383	1.78512	1 January 2000, 12:13	10.04931
2B4_1_IMPERV	0.04430	1.31814	1 January 2000, 12:12	7.04193
2B4_1_PERV	0.02953	0.52026	1 January 2000, 12:17	3.00738
2B4_2	0.29101	6.31356	1 January 2000, 12:16	40.11158
2B4_2_IMPERV	0.18334	4.91907	1 January 2000, 12:15	29.14650
2B4_2_PERV	0.10767	1.62959	1 January 2000, 12:22	10.96507
2B4_3	0.17141	3.97569	1 January 2000, 12:14	23.62669
2B4_3_IMPERV	0.10799	3.06318	1 January 2000, 12:14	17.16773
2B4_3_PERV	0.06342	1.03764	1 January 2000, 12:20	6.45896

Western Catchment Baseline Scenario– HMS Inflow hydrograph summary 100yr Storm

Global Summary Results for Run "FAB_100yr_GHD 3.8CC"

Project: FAB_Swale_Sizing Simulation Run: FAB_100yr_GHD 3.8CC

Start of Run: 01Jan2000, 00:00

Basin Model: FAB_GHD_Model

End of Run: 03Jan2000, 00:00

Meteorologic Model: TP108_100yr_292mm_CoPv4

Compute Time:22Jan2025, 19:29:58

Control Specifications:Control 1

Show Elements: All Elements

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Box culvert entry	1.58733	49.54181	1 January 2000, 12:30	412.30481
CH0-160	1.58733	49.54181	1 January 2000, 12:30	412.30481
CH0-300A	0.56741	19.98902	1 January 2000, 12:28	146.37587
CH1400-CH1540	0.15052	6.20300	1 January 2000, 12:21	39.39808
CH160-550	0.90522	26.69835	1 January 2000, 12:31	235.74940
CH300A-550A	0.31504	10.90382	1 January 2000, 12:27	79.11595
CH550-950	0.73381	21.75444	1 January 2000, 12:36	190.88209
CH950-1400	0.36897	11.98051	1 January 2000, 12:34	95.53585
Junction-1	0.31504	10.90382	1 January 2000, 12:23	79.11595
Junction-2	0.56741	19.98902	1 January 2000, 12:22	146.37587
Junction-3	0.90522	26.69835	1 January 2000, 12:25	235.75000
Junction-4	0.73381	21.75444	1 January 2000, 12:30	190.88270
Junction-5	0.36897	11.98051	1 January 2000, 12:25	95.53674
Junction-6	0.15052	6.20300	1 January 2000, 12:17	39.39808
Main_Branch_Junction	1.58733	49.54181	1 January 2000, 12:29	412.30491
Mill_Road	0.21322	7.41910	1 January 2000, 12:24	56.82434
Mill_Road_IMPERV	0.14924	5.98128	1 January 2000, 12:22	42.81796
Mill_Road_PERVIOUS	0.06398	1.70759	1 January 2000, 12:35	14.00637
Reservoir-Wairoa_Pond	0.21846	6.35935	1 January 2000, 12:28	56.13867
2A_1	0.25237	10.29439	1 January 2000, 12:18	67.25992
2A_1_IMPERV	0.17666	8.19521	1 January 2000, 12:17	50.68495
2A_1_PERV	0.07571	2.40340	1 January 2000, 12:25	16.57498
2A_2	0.11470	5.20410	1 January 2000, 12:16	30.17965
2A_2_IMPERV	0.07456	3.71799	1 January 2000, 12:15	21.39073
2A_2_PERV	0.04015	1.53469	1 January 2000, 12:18	8.78891
2A_4	0.10182	3.50912	1 January 2000, 12:22	22.29161
2A_4_IMPERV	0.00001	0.00046	1 January 2000, 12:18	0.00287
2A_4_PERVIOUS	0.10181	3.50870	1 January 2000, 12:22	22.28874
2B_1	0.15052	6.20300	1 January 2000, 12:17	39.39808
2B_1_IMPERV	0.09483	4.56484	1 January 2000, 12:16	27.20593
2B_1_PERV	0.05569	1.84820	1 January 2000, 12:23	12.19214
2B_2_IMPERV	0.12450	6.20859	1 January 2000, 12:15	35.71989
2B_2_PERV	0.09395	3.31235	1 January 2000, 12:21	20.56909
2B4_1	0.07383	3.25448	1 January 2000, 12:15	19.17372
2B4_1_IMPERV	0.04430	2.28353	1 January 2000, 12:14	12.70876
2B4_1_PERV	0.02953	1.07100	1 January 2000, 12:20	6.46496
2B4_2	0.29101	11.22664	1 January 2000, 12:19	76.17312
2B4_2_IMPERV	0.18334	8.31998	1 January 2000, 12:18	52.60148
2B4_2_PERV	0.10767	3.32846	1 January 2000, 12:26	23.57164
2B4_3	0.17141	7.11826	1 January 2000, 12:17	44.86791
2B4_3_IMPERV	0.10799	5.22982	1 January 2000, 12:16	30.98306

2B4_3_PERV	0.06342	2.12316	1 January 2000, 12:23	13.88485
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Western Catchment Proposed Scenario– HMS Inflow hydrograph summary 2yr Storm

Global Summary Results for Run "2yr_FAB v2"

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Project: FAB_Swale_Sizing Simulation Run: 2yr_FAB v2

Start of Run: 01Jan2000, 00:00

Basin Model: 2yr_Pr v2

End of Run: 03Jan2000, 00:00

Meteorologic Model: TP108_2yr_86mm

Compute Time: 31Jan2025, 15:23:04

Control Specifications: 48hr

Show Elements: All Elements ▾

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic ▾

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Junction-Swale 13	0.108	1.326	1 January 2000, 12:13	7.299
Junction-Swale14	0.177	2.342	1 January 2000, 12:13	12.682
Junction-Swale8	0.136	1.363	1 January 2000, 12:15	8.154
Junction-10	0.036	0.374	1 January 2000, 12:14	2.193
Junction-11	0.032	0.338	1 January 2000, 12:14	1.943
Junction-12	0.067	0.657	1 January 2000, 12:15	4.019
Junction-13	0.030	0.336	1 January 2000, 12:12	1.786
Junction-14	0.067	0.697	1 January 2000, 12:14	4.049
Junction-15	0.017	0.200	1 January 2000, 12:11	1.009
Junction-16	0.018	0.211	1 January 2000, 12:11	1.066
Junction-17	0.012	0.071	1 January 2000, 12:20	0.482
Junction-18	0.051	0.672	1 January 2000, 12:13	3.680
Junction-19	0.044	0.595	1 January 2000, 12:12	3.137
Junction-2	0.041	0.441	1 January 2000, 12:13	2.477
Junction-20	0.026	0.384	1 January 2000, 12:12	1.938
Junction-21	0.037	0.555	1 January 2000, 12:12	2.835
Junction-22	0.028	0.388	1 January 2000, 12:12	1.977
Junction-23	0.103	1.361	1 January 2000, 12:13	7.376
Junction-24	0.000	0.000	31 December 1999, 24:00	0.000
Junction-25	0.046	0.601	1 January 2000, 12:14	3.328
Junction-26	0.085	1.206	1 January 2000, 12:13	6.474
Junction-3	0.027	0.300	1 January 2000, 12:13	1.652
Junction-4	0.020	0.222	1 January 2000, 12:12	1.174
Junction-43	0.001	0.007	1 January 2000, 12:24	0.056
Junction-44	0.022	0.250	1 January 2000, 12:12	1.295
Junction-45	0.017	0.268	1 January 2000, 12:11	1.311
Junction-46	0.031	0.338	1 January 2000, 12:13	1.842
Junction-47	0.035	0.390	1 January 2000, 12:13	2.125
Junction-48	0.149	1.666	1 January 2000, 12:13	9.269
Junction-49	0.220	2.207	1 January 2000, 12:14	13.008
Junction-5	0.033	0.364	1 January 2000, 12:13	2.000
Junction-6	0.014	0.158	1 January 2000, 12:12	0.814
Junction-7	0.024	0.269	1 January 2000, 12:12	1.435
Junction-8	0.004	0.032	1 January 2000, 12:15	0.194
Junction-9	0.000	0.002	1 January 2000, 12:25	0.017
Reservoir-Wairoa_Pond	0.220	0.973	1 January 2000, 12:34	12.869
Sink-To_Awakeri_Wetland	0.220	0.973	1 January 2000, 12:34	12.869
Subbasin-10_Imp	0.023	0.310	1 January 2000, 12:14	1.712
Subbasin-10_Perv	0.014	0.075	1 January 2000, 12:20	0.481
Subbasin-11_Imp	0.020	0.280	1 January 2000, 12:13	1.517
Subbasin-11_Perv	0.012	0.068	1 January 2000, 12:19	0.426
Subbasin-12_Imp	0.042	0.549	1 January 2000, 12:15	3.145

Project: FAB_Swale_Sizing Simulation Run: 2yr_FAB v2

Start of Run: 01Jan2000, 00:00
End of Run: 03Jan2000, 00:00
Compute Time: 31Jan2025, 15:23:04

Basin Model: 2yr_Pr v2
Meteorologic Model: TP108_2yr_86mm
Control Specifications: 48hr

Show Elements: All Elements

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Subbasin-12_Imp	0.042	0.549	1 January 2000, 12:15	3.145
Subbasin-12_Perv	0.025	0.129	1 January 2000, 12:22	0.874
Subbasin-13_Imp	0.018	0.273	1 January 2000, 12:12	1.389
Subbasin-13_Perv	0.011	0.071	1 January 2000, 12:16	0.397
Subbasin-14_Imp	0.042	0.576	1 January 2000, 12:14	3.162
Subbasin-14_Perv	0.026	0.140	1 January 2000, 12:20	0.887
Subbasin-15_Imp	0.010	0.161	1 January 2000, 12:11	0.788
Subbasin-15_Perv	0.006	0.043	1 January 2000, 12:14	0.221
Subbasin-16_Imp	0.011	0.170	1 January 2000, 12:11	0.832
Subbasin-16_Perv	0.007	0.045	1 January 2000, 12:14	0.234
Subbasin-17_Imp	0.001	0.017	1 January 2000, 12:15	0.094
Subbasin-17_Perv	0.011	0.058	1 January 2000, 12:22	0.388
Subbasin-18_Imp	0.046	0.648	1 January 2000, 12:13	3.502
Subbasin-18_Perv	0.005	0.029	1 January 2000, 12:19	0.178
Subbasin-19_Imp	0.039	0.573	1 January 2000, 12:12	2.986
Subbasin-19_Perv	0.004	0.026	1 January 2000, 12:17	0.152
Subbasin-2_Imp	0.026	0.364	1 January 2000, 12:13	1.934
Subbasin-2_Perv	0.016	0.089	1 January 2000, 12:18	0.543
Subbasin-20_Imp	0.026	0.384	1 January 2000, 12:12	1.937
Subbasin-20_Perv	0.000	0.000	1 January 2000, 12:16	0.000
Subbasin-21_Imp	0.037	0.555	1 January 2000, 12:12	2.834
Subbasin-21_Perv	0.000	0.000	1 January 2000, 12:16	0.000
Subbasin-22_Imp	0.025	0.373	1 January 2000, 12:12	1.882
Subbasin-22_Perv	0.003	0.017	1 January 2000, 12:16	0.096
Subbasin-23_Imp	0.034	0.508	1 January 2000, 12:12	2.585
Subbasin-23_Perv	0.004	0.023	1 January 2000, 12:16	0.132
Subbasin-24_Imp	0.059	0.811	1 January 2000, 12:13	4.434
Subbasin-24_Perv	0.007	0.036	1 January 2000, 12:20	0.226
Subbasin-25_Imp	0.042	0.579	1 January 2000, 12:13	3.167
Subbasin-25_Perv	0.005	0.025	1 January 2000, 12:20	0.161
Subbasin-26_Imp	0.085	1.206	1 January 2000, 12:13	6.474
Subbasin-26_Perv	0.000	0.000	1 January 2000, 12:19	0.000
Subbasin-3_Imp	0.017	0.247	1 January 2000, 12:12	1.290
Subbasin-3_Perv	0.010	0.061	1 January 2000, 12:18	0.362
Subbasin-4_Imp	0.012	0.181	1 January 2000, 12:12	0.917
Subbasin-4_Perv	0.007	0.046	1 January 2000, 12:16	0.257
Subbasin-43_Imp	0.000	0.004	1 January 2000, 12:20	0.027
Subbasin-43_Perv	0.001	0.003	1 January 2000, 12:33	0.029
Subbasin-44_Imp	0.013	0.203	1 January 2000, 12:11	1.011
Subbasin-44_Perv	0.008	0.053	1 January 2000, 12:15	0.284
Subbasin-45_Imp	0.017	0.268	1 January 2000, 12:11	1.310
Subbasin-45_Perv	0.000	0.000	1 January 2000, 12:14	0.000

Project: FAB_Swale_Sizing Simulation Run: 2yr_FAB v2

Start of Run: 01Jan2000, 00:00

Basin Model: 2yr_Pr v2

End of Run: 03Jan2000, 00:00

Meteorologic Model: TP108_2yr_86mm

Compute Time: 31Jan2025, 15:23:04

Control Specifications: 48hr

Show Elements: All Elements ▾

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic ▾

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)	
Subbasin-44_Perv	0.008	0.053	1 January 2000, 12:15	0.284	^
Subbasin-45_Imp	0.017	0.268	1 January 2000, 12:11	1.310	
Subbasin-45_Perv	0.000	0.000	1 January 2000, 12:14	0.000	
Subbasin-46_Imp	0.019	0.277	1 January 2000, 12:12	1.438	
Subbasin-46_Perv	0.012	0.069	1 January 2000, 12:17	0.404	
Subbasin-47_Imp	0.022	0.320	1 January 2000, 12:12	1.659	
Subbasin-47_Perv	0.013	0.080	1 January 2000, 12:17	0.466	
Subbasin-48_Imp	0.100	1.419	1 January 2000, 12:13	7.543	
Subbasin-48_Perv	0.050	0.285	1 January 2000, 12:18	1.727	
Subbasin-49_Imp	0.131	1.802	1 January 2000, 12:14	9.943	
Subbasin-49_Perv	0.088	0.476	1 January 2000, 12:20	3.065	
Subbasin-5_Imp	0.021	0.299	1 January 2000, 12:12	1.562	
Subbasin-5_Perv	0.013	0.074	1 January 2000, 12:17	0.438	
Subbasin-6_Imp	0.008	0.128	1 January 2000, 12:11	0.636	
Subbasin-6_Perv	0.005	0.033	1 January 2000, 12:15	0.178	
Subbasin-7_Imp	0.015	0.219	1 January 2000, 12:12	1.120	
Subbasin-7_Perv	0.009	0.056	1 January 2000, 12:16	0.314	
Subbasin-8_Imp	0.001	0.017	1 January 2000, 12:13	0.094	
Subbasin-8_Perv	0.003	0.016	1 January 2000, 12:19	0.100	
Subbasin-9_Imp	0.000	0.001	1 January 2000, 12:19	0.006	
Subbasin-9_Perv	0.000	0.001	1 January 2000, 12:31	0.011	v

Western Catchment Proposed Scenario – HMS Inflow hydrograph summary 10yr Storm

Global Summary Results for Run "10yr_FAB v2"

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Project: FAB_Swale_Sizing Simulation Run: 10yr_FAB v2				
Start of Run: 01Jan2000, 00:00		Basin Model: 10yr_Pr v2		
End of Run: 03Jan2000, 00:00		Meteorologic Model: TP108_10yr_164mm_CoPv4		
Compute Time: 31Jan2025, 16:29:51		Control Specifications: 48hr		
Show Elements: All Elements		Volume Units: ☐ MM ☒ 1000 M3		Sorting: Alphabetic
Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Central_Pond	0.519	1.704	1 January 2000, 13:19	73.241
Junction-Swale 13	0.108	2.820	1 January 2000, 12:13	15.923
Junction-Swale14	0.177	4.902	1 January 2000, 12:13	27.137
Junction-Swale8	0.136	3.043	1 January 2000, 12:15	18.610
Junction-10	0.036	0.834	1 January 2000, 12:14	5.006
Junction-11	0.032	0.755	1 January 2000, 12:14	4.435
Junction-12	0.067	1.462	1 January 2000, 12:15	9.168
Junction-13	0.030	0.754	1 January 2000, 12:12	4.081
Junction-14	0.067	1.555	1 January 2000, 12:14	9.244
Junction-15	0.017	0.450	1 January 2000, 12:11	2.303
Junction-16	0.018	0.473	1 January 2000, 12:11	2.433
Junction-17	0.012	0.201	1 January 2000, 12:20	1.336
Junction-18	0.051	1.406	1 January 2000, 12:13	7.874
Junction-19	0.044	1.245	1 January 2000, 12:12	6.714
Junction-2	0.041	0.984	1 January 2000, 12:13	5.654
Junction-20	0.026	0.789	1 January 2000, 12:12	4.068
Junction-21	0.037	1.141	1 January 2000, 12:12	5.951
Junction-22	0.028	0.814	1 January 2000, 12:12	4.231
Junction-23	0.103	2.850	1 January 2000, 12:13	15.784
Junction-24	0.000	0.000	31 December 1999, 24:00	0.000
Junction-25	0.046	1.257	1 January 2000, 12:14	7.122
Junction-26	0.085	2.480	1 January 2000, 12:13	13.591
Junction-3	0.027	0.672	1 January 2000, 12:13	3.771
Junction-4	0.020	0.497	1 January 2000, 12:12	2.680
Junction-43	0.001	0.017	1 January 2000, 12:25	0.142
Junction-44	0.022	0.562	1 January 2000, 12:12	2.957
Junction-45	0.017	0.550	1 January 2000, 12:11	2.752
Junction-46	0.031	0.756	1 January 2000, 12:13	4.204
Junction-47	0.035	0.872	1 January 2000, 12:13	4.851
Junction-48	0.149	3.676	1 January 2000, 12:13	20.906
Junction-49	0.220	4.953	1 January 2000, 12:14	29.876
Junction-5	0.033	0.815	1 January 2000, 12:13	4.566
Junction-6	0.014	0.355	1 January 2000, 12:12	1.859
Junction-7	0.024	0.602	1 January 2000, 12:12	3.275
Junction-8	0.004	0.080	1 January 2000, 12:15	0.490
Junction-9	0.000	0.006	1 January 2000, 12:26	0.045
Reservoir-Wairoa_Pond	0.220	2.562	1 January 2000, 12:31	29.729
Sink-To_Awakeri_Wetland	0.220	2.562	1 January 2000, 12:31	29.729
Sink-1	0.519	1.704	1 January 2000, 13:19	73.241
Subbasin-10_Imp	0.023	0.638	1 January 2000, 12:14	3.595
Subbasin-10_Perv	0.014	0.225	1 January 2000, 12:20	1.411

Project: FAB_Swale_Sizing Simulation Run: 10yr_FAB v2

Start of Run: 01Jan2000, 00:00
 End of Run: 03Jan2000, 00:00
 Compute Time: 31Jan2025, 16:29:51

Basin Model: 10yr_Pr v2
 Meteorologic Model: TP108_10yr_164mm_CoPv4
 Control Specifications: 48hr

Show Elements: All Elements ▾

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic ▾

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Subbasin-10_Imp	0.023	0.638	1 January 2000, 12:14	3.595
Subbasin-10_Perv	0.014	0.225	1 January 2000, 12:20	1.411
Subbasin-11_Imp	0.020	0.575	1 January 2000, 12:13	3.184
Subbasin-11_Perv	0.012	0.205	1 January 2000, 12:19	1.250
Subbasin-12_Imp	0.042	1.128	1 January 2000, 12:15	6.602
Subbasin-12_Perv	0.025	0.389	1 January 2000, 12:22	2.567
Subbasin-13_Imp	0.018	0.561	1 January 2000, 12:12	2.915
Subbasin-13_Perv	0.011	0.213	1 January 2000, 12:16	1.166
Subbasin-14_Imp	0.042	1.184	1 January 2000, 12:14	6.637
Subbasin-14_Perv	0.026	0.420	1 January 2000, 12:19	2.606
Subbasin-15_Imp	0.010	0.331	1 January 2000, 12:11	1.654
Subbasin-15_Perv	0.006	0.128	1 January 2000, 12:14	0.649
Subbasin-16_Imp	0.011	0.349	1 January 2000, 12:11	1.747
Subbasin-16_Perv	0.007	0.134	1 January 2000, 12:14	0.686
Subbasin-17_Imp	0.001	0.034	1 January 2000, 12:15	0.197
Subbasin-17_Perv	0.011	0.174	1 January 2000, 12:21	1.138
Subbasin-18_Imp	0.046	1.332	1 January 2000, 12:13	7.351
Subbasin-18_Perv	0.005	0.086	1 January 2000, 12:19	0.523
Subbasin-19_Imp	0.039	1.178	1 January 2000, 12:12	6.267
Subbasin-19_Perv	0.004	0.078	1 January 2000, 12:17	0.446
Subbasin-2_Imp	0.026	0.748	1 January 2000, 12:13	4.060
Subbasin-2_Perv	0.016	0.268	1 January 2000, 12:18	1.594
Subbasin-20_Imp	0.026	0.788	1 January 2000, 12:12	4.067
Subbasin-20_Perv	0.000	0.000	1 January 2000, 12:15	0.001
Subbasin-21_Imp	0.037	1.141	1 January 2000, 12:12	5.950
Subbasin-21_Perv	0.000	0.000	1 January 2000, 12:16	0.001
Subbasin-22_Imp	0.025	0.766	1 January 2000, 12:12	3.950
Subbasin-22_Perv	0.003	0.052	1 January 2000, 12:15	0.281
Subbasin-23_Imp	0.034	1.044	1 January 2000, 12:12	5.427
Subbasin-23_Perv	0.004	0.070	1 January 2000, 12:16	0.386
Subbasin-24_Imp	0.059	1.667	1 January 2000, 12:13	9.308
Subbasin-24_Perv	0.007	0.107	1 January 2000, 12:19	0.663
Subbasin-25_Imp	0.042	1.191	1 January 2000, 12:13	6.649
Subbasin-25_Perv	0.005	0.076	1 January 2000, 12:19	0.473
Subbasin-26_Imp	0.085	2.480	1 January 2000, 12:13	13.590
Subbasin-26_Perv	0.000	0.000	1 January 2000, 12:19	0.001
Subbasin-3_Imp	0.017	0.507	1 January 2000, 12:12	2.708
Subbasin-3_Perv	0.010	0.184	1 January 2000, 12:17	1.063
Subbasin-4_Imp	0.012	0.371	1 January 2000, 12:12	1.924
Subbasin-4_Perv	0.007	0.138	1 January 2000, 12:16	0.756
Subbasin-43_Imp	0.000	0.008	1 January 2000, 12:20	0.057

Project: FAB_Swale_Sizing Simulation Run: 10yr_FAB v2

Start of Run: 01Jan2000, 00:00
 End of Run: 03Jan2000, 00:00
 Compute Time: 31Jan2025, 16:29:51

Basin Model: 10yr_Pr v2
 Meteorologic Model: TP108_10yr_164mm_CoPv4
 Control Specifications: 48hr

Show Elements: All Elements ▾

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic ▾

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Subbasin-43_Imp	0.000	0.008	1 January 2000, 12:20	0.057
Subbasin-43_Perv	0.001	0.010	1 January 2000, 12:32	0.085
Subbasin-44_Imp	0.013	0.416	1 January 2000, 12:11	2.123
Subbasin-44_Perv	0.008	0.158	1 January 2000, 12:15	0.834
Subbasin-45_Imp	0.017	0.550	1 January 2000, 12:11	2.751
Subbasin-45_Perv	0.000	0.000	1 January 2000, 12:14	0.001
Subbasin-46_Imp	0.019	0.569	1 January 2000, 12:12	3.019
Subbasin-46_Perv	0.012	0.208	1 January 2000, 12:17	1.185
Subbasin-47_Imp	0.022	0.657	1 January 2000, 12:12	3.483
Subbasin-47_Perv	0.013	0.240	1 January 2000, 12:17	1.368
Subbasin-48_Imp	0.100	2.917	1 January 2000, 12:13	15.834
Subbasin-48_Perv	0.050	0.858	1 January 2000, 12:18	5.072
Subbasin-49_Imp	0.131	3.704	1 January 2000, 12:14	20.873
Subbasin-49_Perv	0.088	1.435	1 January 2000, 12:20	9.003
Subbasin-5_Imp	0.021	0.614	1 January 2000, 12:12	3.278
Subbasin-5_Perv	0.013	0.223	1 January 2000, 12:17	1.287
Subbasin-6_Imp	0.008	0.262	1 January 2000, 12:11	1.335
Subbasin-6_Perv	0.005	0.100	1 January 2000, 12:15	0.524
Subbasin-7_Imp	0.015	0.451	1 January 2000, 12:12	2.352
Subbasin-7_Perv	0.009	0.168	1 January 2000, 12:16	0.923
Subbasin-8_Imp	0.001	0.036	1 January 2000, 12:13	0.196
Subbasin-8_Perv	0.003	0.049	1 January 2000, 12:19	0.294
Subbasin-9_Imp	0.000	0.002	1 January 2000, 12:19	0.013
Subbasin-9_Perv	0.000	0.004	1 January 2000, 12:31	0.032

Western Catchment Proposed Scenario – HMS Inflow hydrograph summary 100yr Storm

Global Summary Results for Run "100yr_FAB v2"

Project: FAB_Swale_Sizing Simulation Run: 100yr_FAB v2				
Start of Run: 01Jan2000, 00:00		Basin Model: 100yr_Pr v2		
End of Run: 03Jan2000, 00:00		Meteorologic Model: TP108_100yr_292mm		
Compute Time: 31Jan2025, 16:31:06		Control Specifications: 48hr		
Show Elements: All Elements		Volume Units: ☐ MM ☒ 1000 M3		Sorting: Alphabetic
Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Central_Pond	0.535	2.405	1 January 2000, 14:14	133.026
Junction-Swale 13	0.108	4.956	1 January 2000, 12:15	29.464
Junction-Swale14	0.177	8.505	1 January 2000, 12:15	49.598
Junction-Swale8	0.136	5.445	1 January 2000, 12:18	35.389
Junction-10	0.036	1.500	1 January 2000, 12:17	9.522
Junction-11	0.032	1.363	1 January 2000, 12:16	8.435
Junction-12	0.067	2.608	1 January 2000, 12:19	17.432
Junction-13	0.030	1.386	1 January 2000, 12:14	7.768
Junction-14	0.067	2.796	1 January 2000, 12:17	17.581
Junction-15	0.017	0.838	1 January 2000, 12:13	4.380
Junction-16	0.018	0.880	1 January 2000, 12:13	4.628
Junction-17	0.012	0.403	1 January 2000, 12:24	2.803
Junction-18	0.051	2.443	1 January 2000, 12:16	14.391
Junction-19	0.044	2.189	1 January 2000, 12:14	12.270
Junction-2	0.041	1.783	1 January 2000, 12:16	10.755
Junction-20	0.026	1.389	1 January 2000, 12:13	7.342
Junction-21	0.037	1.987	1 January 2000, 12:14	10.740
Junction-22	0.028	1.446	1 January 2000, 12:13	7.733
Junction-23	0.103	4.943	1 January 2000, 12:15	28.848
Junction-24	0.000	0.000	31 December 1999, 24:00	0.000
Junction-25	0.046	2.176	1 January 2000, 12:16	13.016
Junction-26	0.085	4.248	1 January 2000, 12:15	24.528
Junction-3	0.027	1.221	1 January 2000, 12:15	7.173
Junction-4	0.020	0.913	1 January 2000, 12:14	5.097
Junction-43	0.001	0.033	1 January 2000, 12:31	0.286
Junction-44	0.022	1.034	1 January 2000, 12:13	5.624
Junction-45	0.017	0.982	1 January 2000, 12:12	4.967
Junction-46	0.031	1.378	1 January 2000, 12:15	7.996
Junction-47	0.035	1.587	1 January 2000, 12:15	9.226
Junction-48	0.149	6.603	1 January 2000, 12:16	39.478
Junction-49	0.220	8.917	1 January 2000, 12:17	57.024
Junction-5	0.033	1.481	1 January 2000, 12:15	8.684
Junction-6	0.014	0.656	1 January 2000, 12:13	3.535
Junction-7	0.024	1.105	1 January 2000, 12:14	6.229
Junction-8	0.004	0.155	1 January 2000, 12:18	0.986
Junction-9	0.000	0.011	1 January 2000, 12:32	0.093
Reservoir-Wairoa_Pond	0.220	6.253	1 January 2000, 12:30	56.873
Sink-To_Awakeri_Wetland	0.220	6.253	1 January 2000, 12:30	56.873
Sink-1	0.535	2.405	1 January 2000, 14:14	133.026
Subbasin-10_Imp	0.023	1.092	1 January 2000, 12:16	6.488
Subbasin-10_Perv	0.014	0.461	1 January 2000, 12:23	3.034

Project: FAB_Swale_Sizing Simulation Run: 100yr_FAB v2

Start of Run: 01Jan2000, 00:00

Basin Model: 100yr_Pr v2

End of Run: 03Jan2000, 00:00

Meteorologic Model: TP108_100yr_292mm

Compute Time: 31Jan2025, 16:31:06

Control Specifications: 48hr

Show Elements: All Elements

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Subbasin-10_Imp	0.023	1.092	1 January 2000, 12:16	6.488
Subbasin-10_Perv	0.014	0.461	1 January 2000, 12:23	3.034
Subbasin-11_Imp	0.020	0.988	1 January 2000, 12:15	5.747
Subbasin-11_Perv	0.012	0.420	1 January 2000, 12:22	2.688
Subbasin-12_Imp	0.042	1.911	1 January 2000, 12:17	11.914
Subbasin-12_Perv	0.025	0.793	1 January 2000, 12:26	5.518
Subbasin-13_Imp	0.018	0.985	1 January 2000, 12:13	5.261
Subbasin-13_Perv	0.011	0.439	1 January 2000, 12:18	2.507
Subbasin-14_Imp	0.042	2.028	1 January 2000, 12:16	11.979
Subbasin-14_Perv	0.026	0.861	1 January 2000, 12:23	5.602
Subbasin-15_Imp	0.010	0.590	1 January 2000, 12:12	2.984
Subbasin-15_Perv	0.006	0.266	1 January 2000, 12:16	1.396
Subbasin-16_Imp	0.011	0.621	1 January 2000, 12:12	3.153
Subbasin-16_Perv	0.007	0.279	1 January 2000, 12:16	1.475
Subbasin-17_Imp	0.001	0.058	1 January 2000, 12:17	0.356
Subbasin-17_Perv	0.011	0.356	1 January 2000, 12:25	2.447
Subbasin-18_Imp	0.046	2.289	1 January 2000, 12:15	13.266
Subbasin-18_Perv	0.005	0.176	1 January 2000, 12:22	1.125
Subbasin-19_Imp	0.039	2.048	1 January 2000, 12:14	11.311
Subbasin-19_Perv	0.004	0.160	1 January 2000, 12:20	0.959
Subbasin-2_Imp	0.026	1.287	1 January 2000, 12:15	7.328
Subbasin-2_Perv	0.016	0.551	1 January 2000, 12:21	3.427
Subbasin-20_Imp	0.026	1.389	1 January 2000, 12:13	7.340
Subbasin-20_Perv	0.000	0.000	1 January 2000, 12:18	0.002
Subbasin-21_Imp	0.037	1.987	1 January 2000, 12:14	10.737
Subbasin-21_Perv	0.000	0.000	1 January 2000, 12:18	0.002
Subbasin-22_Imp	0.025	1.349	1 January 2000, 12:13	7.129
Subbasin-22_Perv	0.003	0.108	1 January 2000, 12:17	0.604
Subbasin-23_Imp	0.034	1.827	1 January 2000, 12:13	9.795
Subbasin-23_Perv	0.004	0.145	1 January 2000, 12:18	0.830
Subbasin-24_Imp	0.059	2.853	1 January 2000, 12:16	16.799
Subbasin-24_Perv	0.007	0.219	1 January 2000, 12:23	1.424
Subbasin-25_Imp	0.042	2.038	1 January 2000, 12:16	11.999
Subbasin-25_Perv	0.005	0.157	1 January 2000, 12:23	1.017
Subbasin-26_Imp	0.085	4.247	1 January 2000, 12:15	24.526
Subbasin-26_Perv	0.000	0.000	1 January 2000, 12:22	0.002
Subbasin-3_Imp	0.017	0.878	1 January 2000, 12:14	4.887
Subbasin-3_Perv	0.010	0.379	1 January 2000, 12:20	2.286
Subbasin-4_Imp	0.012	0.653	1 January 2000, 12:13	3.473
Subbasin-4_Perv	0.007	0.285	1 January 2000, 12:18	1.624

Project: FAB_Swale_Sizing Simulation Run: 100yr_FAB v2

Start of Run: 01Jan2000, 00:00
 End of Run: 03Jan2000, 00:00
 Compute Time: 31Jan2025, 16:31:06

Basin Model: 100yr_Pr v2
 Meteorologic Model: TP108_100yr_292mm
 Control Specifications: 48hr

Show Elements: All Elements ▾

Volume Units: ☐ MM ☒ 1000 M3

Sorting: Alphabetic ▾

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (1000 M3)
Subbasin-4_Imp	0.012	0.653	1 January 2000, 12:13	3.473
Subbasin-4_Perv	0.007	0.285	1 January 2000, 12:18	1.624
Subbasin-43_Imp	0.000	0.014	1 January 2000, 12:24	0.103
Subbasin-43_Perv	0.001	0.021	1 January 2000, 12:38	0.183
Subbasin-44_Imp	0.013	0.734	1 January 2000, 12:13	3.832
Subbasin-44_Perv	0.008	0.326	1 January 2000, 12:17	1.792
Subbasin-45_Imp	0.017	0.981	1 January 2000, 12:12	4.964
Subbasin-45_Perv	0.000	0.000	1 January 2000, 12:16	0.002
Subbasin-46_Imp	0.019	0.990	1 January 2000, 12:14	5.448
Subbasin-46_Perv	0.012	0.428	1 January 2000, 12:19	2.548
Subbasin-47_Imp	0.022	1.142	1 January 2000, 12:14	6.286
Subbasin-47_Perv	0.013	0.492	1 January 2000, 12:19	2.940
Subbasin-48_Imp	0.100	5.035	1 January 2000, 12:15	28.576
Subbasin-48_Perv	0.050	1.758	1 January 2000, 12:21	10.902
Subbasin-49_Imp	0.131	6.316	1 January 2000, 12:16	37.671
Subbasin-49_Perv	0.088	2.931	1 January 2000, 12:23	19.353
Subbasin-5_Imp	0.021	1.067	1 January 2000, 12:14	5.917
Subbasin-5_Perv	0.013	0.458	1 January 2000, 12:20	2.767
Subbasin-6_Imp	0.008	0.464	1 January 2000, 12:13	2.408
Subbasin-6_Perv	0.005	0.207	1 January 2000, 12:17	1.126
Subbasin-7_Imp	0.015	0.788	1 January 2000, 12:13	4.244
Subbasin-7_Perv	0.009	0.345	1 January 2000, 12:18	1.985
Subbasin-8_Imp	0.001	0.062	1 January 2000, 12:15	0.355
Subbasin-8_Perv	0.003	0.100	1 January 2000, 12:21	0.631
Subbasin-9_Imp	0.000	0.003	1 January 2000, 12:23	0.023
Subbasin-9_Perv	0.000	0.008	1 January 2000, 12:37	0.070



APPENDIX 5 – HMS Subbasin Parameters

HMS Subbasin Parameters

										2& 10yr		100yr	
				10 yr Channelis ation	100 yr Channelis ation								
Subbasin Name	Area KM2	Ia	CN			Slope	Length	Tc (hr)	Tp (hr)	Tp (min)	Tc (hr)	Tp (hr)	Tp (min)
Subbasin-3_Imp	0.017033298	0	98	0.6	0.8	0.005	249	0.17	0.11	6.7	0.22	0.15	9.0
Subbasin-3_Perv	0.010439763	5	74	0.8	1	0.005	249	0.29	0.20	11.8	0.37	0.24	14.7
Subbasin-4_Imp	0.012104485	0	98	0.6	0.8	0.005	199	0.15	0.10	5.8	0.19	0.13	7.7
Subbasin-4_Perv	0.007418878	5	74	0.8	1	0.005	199	0.25	0.17	10.1	0.32	0.21	12.7
Subbasin-5_Imp	0.020622708	0	98	0.6	0.8	0.005	248	0.17	0.11	6.7	0.22	0.15	8.9
Subbasin-5_Perv	0.012639724	5	74	0.8	1	0.005	248	0.29	0.20	11.7	0.37	0.24	14.7
Subbasin-6_Imp	0.008394651	0	98	0.6	0.8	0.005	168	0.13	0.09	5.2	0.17	0.12	6.9
Subbasin-6_Perv	0.005145109	5	74	0.8	1	0.005	168	0.23	0.15	9.1	0.28	0.19	11.3
Subbasin-7_Imp	0.014793379	0	98	0.6	0.8	0.005	208	0.15	0.10	6.0	0.20	0.13	8.0
Subbasin-7_Perv	0.009066909	5	74	0.8	1	0.005	208	0.26	0.17	10.4	0.33	0.22	13.0
Subbasin-8_Imp	0.001235953	0	98	0.6	0.8	0.005	292	0.19	0.12	7.5	0.25	0.17	10.0
Subbasin-8_Perv	0.002883891	5	74	0.8	1	0.005	292	0.33	0.22	13.1	0.41	0.27	16.3
Subbasin-9_Imp	7.95984E-05	0	98	0.6	0.8	0.005	772	0.35	0.24	14.2	0.47	0.32	18.9
Subbasin-9_Perv	0.000318394	5	74	0.8	1	0.005	772	0.62	0.41	24.8	0.78	0.52	31.0
Subbasin-10_Imp	0.022613315	0	98	0.6	0.8	0.005	341	0.21	0.14	8.3	0.28	0.18	11.0
Subbasin-10_Perv	0.013859773	5	74	0.8	1	0.005	341	0.36	0.24	14.5	0.45	0.30	18.1
Subbasin-11_Imp	0.020031255	0	98	0.6	0.8	0.005	309	0.19	0.13	7.8	0.26	0.17	10.3
Subbasin-11_Perv	0.012277221	5	74	0.8	1	0.005	309	0.34	0.23	13.6	0.42	0.28	16.9
Subbasin-12_Imp	0.041525483	0	98	0.6	0.8	0.005	413	0.23	0.16	9.4	0.31	0.21	12.5
Subbasin-12_Perv	0.025205998	5	74	0.8	1	0.005	413	0.41	0.27	16.4	0.51	0.34	20.5
Subbasin-13_Imp	0.018336621	0	98	0.6	0.8	0.005	202	0.15	0.10	5.9	0.20	0.13	7.8
Subbasin-13_Perv	0.011450669	5	74	0.8	1	0.005	202	0.26	0.17	10.2	0.32	0.21	12.8
Subbasin-14_Imp	0.041751729	0	98	0.6	0.8	0.005	328	0.20	0.13	8.1	0.27	0.18	10.8
Subbasin-14_Perv	0.025589769	5	74	0.8	1	0.005	328	0.35	0.23	14.1	0.44	0.29	17.6
Subbasin-15_Imp	0.010402251	0	98	0.6	0.8	0.005	141	0.12	0.08	4.6	0.15	0.10	6.2
Subbasin-15_Perv	0.006375573	5	74	0.8	1	0.005	141	0.20	0.13	8.1	0.25	0.17	10.1
Subbasin-16_Imp	0.010989676	0	98	0.6	0.8	0.005	147	0.12	0.08	4.7	0.16	0.11	6.3
Subbasin-16_Perv	0.006735608	5	74	0.8	1	0.005	147	0.21	0.14	8.3	0.26	0.17	10.4
Subbasin-17_Imp	0.00124184	0	98	0.6	0.8	0.005	398	0.23	0.15	9.2	0.31	0.20	12.2
Subbasin-17_Perv	0.01117656	5	74	0.8	1	0.005	398	0.40	0.27	16.0	0.50	0.33	20.0
Subbasin-18_Imp	0.046238727	0	98	0.6	0.8	0.005	304	0.19	0.13	7.7	0.26	0.17	10.2
Subbasin-18_Perv	0.005137636	5	74	0.8	1	0.005	304	0.34	0.22	13.4	0.42	0.28	16.8
Subbasin-19_Imp	0.03942415	0	98	0.6	0.8	0.005	244	0.17	0.11	6.6	0.22	0.15	8.8
Subbasin-19_Perv	0.004380461	5	74	0.8	1	0.005	244	0.29	0.19	11.6	0.36	0.24	14.5
Subbasin-20_Imp	0.025583108	0	98	0.6	0.8	0.005	190	0.14	0.09	5.6	0.19	0.13	7.5
Subbasin-20_Perv	0.00001	5	74	0.8	1	0.005	190	0.25	0.16	9.8	0.31	0.20	12.3
Subbasin-21_Imp	0.037425015	0	98	0.6	0.8	0.005	212	0.15	0.10	6.0	0.20	0.13	8.1
Subbasin-21_Perv	0.00001	5	74	0.8	1	0.005	212	0.26	0.18	10.6	0.33	0.22	13.2
Subbasin-22_Imp	0.024847836	0	98	0.6	0.8	0.005	189	0.14	0.09	5.6	0.19	0.12	7.5
Subbasin-22_Perv	0.002760871	5	74	0.8	1	0.005	189	0.24	0.16	9.8	0.31	0.20	12.2
Subbasin-23_Imp	0.034139092	0	98	0.6	0.8	0.005	205	0.15	0.10	5.9	0.20	0.13	7.9
Subbasin-23_Perv	0.003793232	5	74	0.8	1	0.005	205	0.26	0.17	10.3	0.32	0.22	12.9
Subbasin-24_Imp	0.058550445	0	98	0.6	0.8	0.005	326	0.20	0.13	8.0	0.27	0.18	10.7
Subbasin-24_Perv	0.006505605	5	74	0.8	1	0.005	326	0.35	0.23	14.0	0.44	0.29	17.6
Subbasin-25_Imp	0.041822229	0	98	0.6	0.8	0.005	324	0.20	0.13	8.0	0.27	0.18	10.7
Subbasin-25_Perv	0.004646914	5	74	0.8	1	0.005	324	0.35	0.23	14.0	0.44	0.29	17.5
Subbasin-26_Imp	0.085485204	0	98	0.6	0.8	0.005	296	0.19	0.13	7.5	0.25	0.17	10.1
Subbasin-26_Perv	0.00001	5	74	0.8	1	0.005	296	0.33	0.22	13.2	0.41	0.27	16.5
Subbasin-27_Imp	0.039518373	0	98	0.6	0.8	0.005	474	0.26	0.17	10.3	0.34	0.23	13.7
Subbasin-27_Perv	0.024220939	5	74	0.8	1	0.005	474	0.45	0.30	18.0	0.56	0.37	22.5
Subbasin-28_Imp	0.037213715	0	98	0.6	0.8	0.005	318	0.20	0.13	7.9	0.26	0.18	10.5
Subbasin-28_Perv	0.022808406	5	74	0.8	1	0.005	318	0.35	0.23	13.8	0.43	0.29	17.3
Subbasin-29_Imp	0.020485589	0	98	0.6	0.8	0.005	228	0.16	0.11	6.3	0.21	0.14	8.5
Subbasin-29_Perv	0.012555683	5	74	0.8	1	0.005	228	0.28	0.18	11.1	0.35	0.23	13.9
Subbasin-30_Imp	0.01713693	0	98	0.6	0.8	0.005	208	0.15	0.10	6.0	0.20	0.13	8.0
Subbasin-30_Perv	0.010503279	5	74	0.8	1	0.005	208	0.26	0.17	10.4	0.33	0.22	13.0
Subbasin-31_Imp	0.0266613	0	98	0.6	0.8	0.005	284	0.18	0.12	7.3	0.24	0.16	9.8
Subbasin-31_Perv	0.016340796	5	74	0.8	1	0.005	284	0.32	0.21	12.8	0.40	0.27	16.0
Subbasin-32_Imp	0.032406998	0	98	0.6	0.8	0.005	320	0.20	0.13	7.9	0.26	0.18	10.6
Subbasin-32_Perv	0.019862354	5	74	0.8	1	0.005	320	0.35	0.23	13.9	0.43	0.29	17.3
Subbasin-33_Imp	0.020363444	0	98	0.6	0.8	0.005	275	0.18	0.12	7.2	0.24	0.16	9.6
Subbasin-33_Perv	0.01248082	5	74	0.8	1	0.005	275	0.31	0.21	12.6	0.39	0.26	15.7
Subbasin-34_Imp	0.023545281	0	98	0.6	0.8	0.005	298	0.19	0.13	7.6	0.25	0.17	10.1
Subbasin-34_Perv	0.014430979	5	74	0.8	1	0.005	298	0.33	0.22	13.2	0.41	0.28	16.5
Subbasin-35_Imp	0.021359882	0	98	0.6	0.8	0.005	263	0.17	0.12	7.0	0.23	0.15	9.3
Subbasin-35_Perv	0.013091541	5	74	0.8	1	0.005	263	0.30	0.20	12.2	0.38	0.25	15.2

HMS Subbasin Parameters

Subbasin Name	Area KM2	Ia	CN	10 yr Chan	100 yr Cha	Slope	Length	Tc (hr)	Tp (hr)	2& 10yr		100yr	
										Tp (min)	Tc (hr)	Tp (hr)	Tp (min)
Subbasin-36_Imp	0.039314092	0	98	0.6	0.8	0.005	397	0.23	0.15	9.1	0.30	0.20	12.2
Subbasin-36_Perv	0.024095734	5	74	0.8	1	0.005	397	0.40	0.27	16.0	0.50	0.33	20.0
Subbasin-37_Imp	0.090018313	0	98	0.6	0.8	0.005	556	0.29	0.19	11.4	0.38	0.25	15.2
Subbasin-37_Perv	0.010002035	5	74	0.8	1	0.005	556	0.50	0.33	20.0	0.62	0.42	25.0
Subbasin-38_Imp	0.06471901	0	98	0.6	0.8	0.005	389	0.23	0.15	9.0	0.30	0.20	12.0
Subbasin-38_Perv	0.007191001	5	74	0.8	1	0.005	389	0.39	0.26	15.8	0.49	0.33	19.7
Subbasin-39_Imp	0.000807606	0	98	0.6	0.8	0.005	3013	0.87	0.58	34.9	1.16	0.77	46.5
Subbasin-39_Perv	0.001884414	5	74	0.8	1	0.005	3013	1.52	1.02	60.9	1.90	1.27	76.2
Subbasin-40_Imp	3.53456E-06	0	98	0.6	0.8	0.005	70	0.07	0.05	2.9	0.10	0.06	3.9
Subbasin-40_Perv	0.003531027	5	74	0.8	1	0.005	70	0.13	0.08	5.1	0.16	0.11	6.4
Subbasin-41_Imp	1.84914E-05	0	98	0.6	0.8	0.005	206	0.15	0.10	5.9	0.20	0.13	7.9
Subbasin-41_Perv	0.018472944	5	74	0.8	1	0.005	206	0.26	0.17	10.4	0.32	0.22	13.0
Subbasin-42_Imp	4.34312E-05	0	98	0.6	0.8	0.005	393	0.23	0.15	9.1	0.30	0.20	12.1
Subbasin-42_Perv	0.000390881	5	74	0.8	1	0.005	393	0.40	0.26	15.9	0.50	0.33	19.9
Subbasin-43_Imp	0.000358811	0	98	0.6	0.8	0.005	831	0.37	0.25	14.9	0.50	0.33	19.9
Subbasin-43_Perv	0.000837226	5	74	0.8	1	0.005	831	0.65	0.43	26.0	0.81	0.54	32.6
Subbasin-44_Imp	0.013356467	0	98	0.6	0.8	0.005	173	0.13	0.09	5.3	0.18	0.12	7.1
Subbasin-44_Perv	0.008186221	5	74	0.8	1	0.005	173	0.23	0.15	9.2	0.29	0.19	11.6
Subbasin-45_Imp	0.017303138	0	98	0.6	0.8	0.005	143	0.12	0.08	4.7	0.16	0.10	6.2
Subbasin-45_Perv	0.00001	5	74	0.8	1	0.005	143	0.20	0.14	8.2	0.25	0.17	10.2
Subbasin-46_Imp	0.018989449	0	98	0.6	0.8	0.005	237	0.16	0.11	6.5	0.22	0.14	8.7
Subbasin-46_Perv	0.011638694	5	74	0.8	1	0.005	237	0.28	0.19	11.4	0.36	0.24	14.2
Subbasin-47_Imp	0.021910077	0	98	0.6	0.8	0.005	239	0.16	0.11	6.5	0.22	0.15	8.7
Subbasin-47_Perv	0.013428757	5	74	0.8	1	0.005	239	0.29	0.19	11.4	0.36	0.24	14.3
Subbasin-48_Imp	0.02289379	0	98	0.6	0.8	0.007	320	0.18	0.12	7.2	0.24	0.16	9.6
Subbasin-48_Perv	0.014031677	5	74	0.8	1	0.007	320	0.31	0.21	12.5	0.39	0.26	15.7
Subbasin-49_Imp	0.02289379	0	98	0.6	0.8	0.023	687	0.21	0.14	8.3	0.28	0.18	11.1
Subbasin-49_Perv	0.014031677	5	74	0.8	1	0.023	687	0.36	0.24	14.5	0.45	0.30	18.2
Subbasin-50_Imp	0.015564955	0	98	0.6	0.8	0.005	295	0.19	0.13	7.5	0.25	0.17	10.0
Subbasin-50_Perv	0.001729439	5	74	0.8	1	0.005	295	0.33	0.22	13.1	0.41	0.27	16.4
Subbasin-51_Imp	0.01739647	0	98	0.6	0.8	0.005	186	0.14	0.09	5.5	0.18	0.12	7.4
Subbasin-51_Perv	0.001932941	5	74	0.8	1	0.005	186	0.24	0.16	9.7	0.30	0.20	12.1
Subbasin-52_Imp	0.006789462	0	98	0.6	0.8	0.005	260	0.17	0.12	6.9	0.23	0.15	9.2
Subbasin-52_Perv	0.00119814	5	74	0.8	1	0.005	260	0.30	0.20	12.1	0.38	0.25	15.1
Subbasin-53_Imp	0.01968575	0	98	0.6	0.8	0.005	196	0.14	0.10	5.7	0.19	0.13	7.7
Subbasin-53_Perv	0.002187306	5	74	0.8	1	0.005	196	0.25	0.17	10.0	0.31	0.21	12.5
Subbasin-54_Imp	0.02003173	0	98	0.6	0.8	0.005	210	0.15	0.10	6.0	0.20	0.13	8.0
Subbasin-54_Perv	0.002225748	5	74	0.8	1	0.005	210	0.26	0.18	10.5	0.33	0.22	13.1
Subbasin-55_Imp	0.021908226	0	98	0.6	0.8	0.005	206	0.15	0.10	5.9	0.20	0.13	7.9
Subbasin-55_Perv	0.002434247	5	74	0.8	1	0.005	206	0.26	0.17	10.4	0.32	0.22	13.0
Subbasin-56_Imp	0.036180878	0	98	0.6	0.8	0.005	423	0.24	0.16	9.5	0.32	0.21	12.7
Subbasin-56_Perv	0.004020098	5	74	0.8	1	0.005	423	0.42	0.28	16.7	0.52	0.35	20.8
Subbasin-57_Imp	0.015826636	0	98	0.6	0.8	0.005	193	0.14	0.09	5.7	0.19	0.13	7.6
Subbasin-57_Perv	0.001758515	5	74	0.8	1	0.005	196	0.25	0.17	10.0	0.31	0.21	12.5
Subbasin-58_Imp	0.005716976	0	98	0.6	0.8	0.005	263	0.17	0.12	7.0	0.23	0.15	9.3
Subbasin-58_Perv	0.001008878	5	74	0.8	1	0.005	263	0.30	0.20	12.2	0.38	0.25	15.2
Mill_Road_IMPERV	0.149238427	0	98	0.6	0.8	0.005	700	0.33	0.22	13.3	0.44	0.30	17.7
Mill_Road_PERVIOUS	0.063977979	5	74	0.8	1	0.005	700	0.58	0.39	23.3	0.73	0.48	29.1
2A_1_IMPERV	0.176659119	0	98	0.6	0.8	0.005	400	0.23	0.15	9.2	0.31	0.20	12.3
2A_1_PERV	0.075710806	5	74	0.8	1	0.005	400	0.40	0.27	16.1	0.50	0.33	20.1
2A_2_IMPERV	0.074556397	0	98	0.6	0.8	0.008	250	0.15	0.10	5.9	0.20	0.13	7.9
2A_2_PERV	0.040145831	5	74	0.8	1	0.008	250	0.26	0.17	10.3	0.32	0.21	12.9
2A_4_IMPERV	0.00001	0	98	0.6	0.8	0.005	400	0.23	0.15	9.2	0.31	0.20	12.3
2A_4_PERVIOUS	0.101798013	5	74	0.8	1	0.005	400	0.40	0.27	16.1	0.50	0.33	20.1
2B_1_IMPERV	0.0996	0	98	0.6	0.8	0.007	320	0.18	0.12	7.2	0.24	0.16	9.6
2B_1_PERV	0.0498	5	74	0.8	1	0.007	320	0.31	0.21	12.5	0.39	0.26	15.7
2B_2_IMPERV	0.1313	0	98	0.6	0.8	0.023	687	0.21	0.14	8.3	0.28	0.18	11.1
2B_2_PERV	0.0884	5	74	0.8	1	0.023	687	0.36	0.24	14.5	0.45	0.30	18.2
2B4_1_IMPERV	0.044295802	0	98	0.6	0.8	0.005	250	0.17	0.11	6.7	0.22	0.15	9.0
2B4_1_PERV	0.029530534	5	74	0.8	1	0.005	250	0.29	0.20	11.8	0.37	0.25	14.7
2B4_2_IMPERV	0.183337146	0	98	0.6	0.8	0.014	700	0.24	0.16	9.8	0.33	0.22	13.0
2B4_2_PERV	0.107674197	5	74	0.8	1	0.014	700	0.43	0.28	17.1	0.53	0.36	21.3
2B4_3_IMPERV	0.107990324	0	98	0.6	0.8	0.0075	400	0.20	0.14	8.1	0.27	0.18	10.9
2B4_3_PERV	0.063422889	5	74	0.8	1	0.0075	400	0.36	0.24	14.2	0.44	0.30	17.8
SW Pond 2 Ex													
Subbasin-SW Pond 2 Ex_Perv	0.152738169	5	74	0.8	1	0.009	650	0.46	0.31	18.6	0.58	0.39	23.2
SW Pond 3 Ex													
Subbasin-SW Pond 2 Ex_Perv	0.003531027	5	74	0.8	1	0.008	330	0.31	0.20	12.3	0.38	0.26	15.4

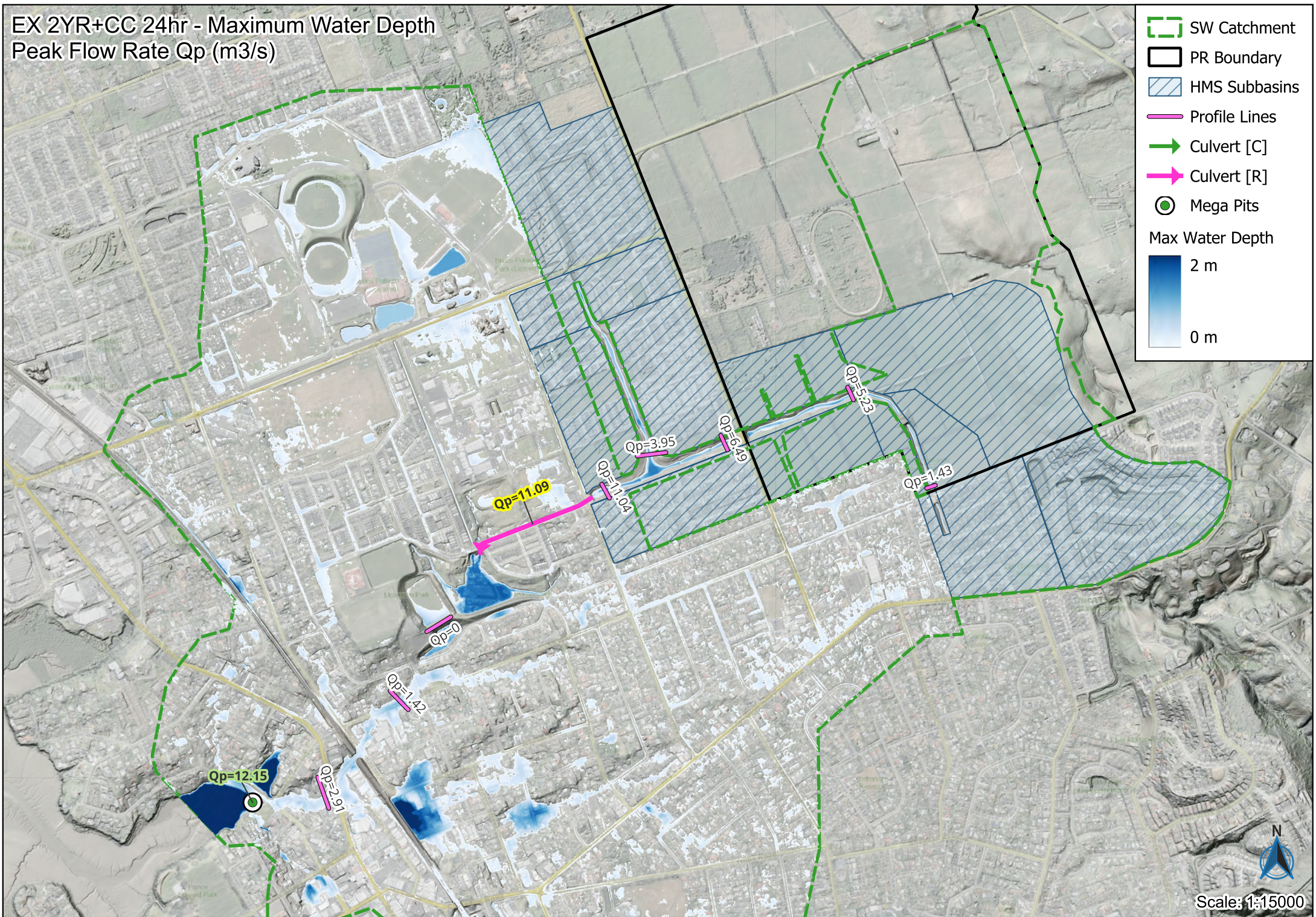


APPENDIX 6 – TUFLOW Western Model & Results



TUFLOW Western Model Overview & Results

EX 2YR+CC 24hr - Maximum Water Depth
Peak Flow Rate Qp (m3/s)



Scale: 1:15000