09 September 2025

Official information request 8140017096
(Please quote this in any correspondence)

s7(2)(a) Privacy

Tēnā koe s7(2)(a) Privacy

Local Government Official Information and Meetings Act 1987 (LGOIMA)
Flood Resilience in Wairau

Thank you for your information request dated 26 August for information about the flood resilience design options that have been assessed as part of the Wairau flood resilience project.

The specific details of your request and our response is below.

> **The Healthy Waters Department of Auckland Council has mentioned that "over 100 flood mitigation options were assessed."**
>
> **At the Kaipātiki Local Board Workshop on 21 July 2025, and Devonport Takapuna Board Members Busch and Wood requested details on the over 100 options. Sara Zwart, the Principal Project Manager, stated that she would send this information. It is my understanding that this information has not been presented to Members Busch and Wood.**
>
> **I request detailed information regarding these over 100 options.**

We are providing following documents in response to your request:

- Wairau Catchment Flood Reduction Options Summary (prepared by WSP).
- WSP Memo in respect to Shoal Bay Diversion
- Tonkin and Taylor Memo in respect to Shoal Bay Diversion

Table 1 and Appendix A in the options summary report outline the many design options and flood model iterations that were investigated to reduce flood risk in the Wairau Catchment prior to the business case being submitted in April. There were additional options that were reviewed but discounted and not included in this summary report.

Four further options presented by North Shore Takapuna Golf Ltd. (NSTG) and their partners have also been assessed following the completion of the attached options report.

For completeness we have also attached the additional assessment of the Shoal Bay diversion option and the peer reviewed report from Tonkin and Taylor. You can also find the concept feasibility assessment report which includes assessment of two further options presented by NSTG on the project website: Wairau flood resilience project

Because there is a large amount of information, we are releasing it to you in a OneDrive folder. The link to your folder is below.

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You will be prompted to request a verification code. Once you have entered this code you should be able to access the information. Check your junk mail folder because sometimes the message with the code will end up there. Please let us know if you have any difficulties with this process.

This information has been provided to Members Wood and Busch on 26 August, and the options assessment was originally provided alongside the business case for approval at the Transport Resilience and Infrastructure Committee meeting on 3 April 2025:
Item 11 Report on Making Space for Water – Wairau Blue-Green Network Stage 1 and 2 Business Case

Report Item 11, page 21 (the covering report for confidential report is on page 35)
Open attachments page 259 - 270
Open Minutes
Video recording

Please note that portions of the Wairau Catchment Flood Reduction Options Summary (WSP report) have been redacted. This is to protect the privacy of natural persons (section 7(2)(a)) and where release would be likely unreasonably to prejudice the commercial position of the person who supplied or who is the subject of the information (section 7(2)(b)(ii). Given the commercially sensitive and confidential nature of this report, as indicated by WSP, we have carefully reviewed the document to ensure compliance with the LGOIMA while respecting these confidentiality requirements.

The decision by Auckland Council to release the information contained in this response was made by Tom Mansell, Head of Sustainable Partnerships, Healthy Waters and Flood Resilience.

You have the right to seek an investigation and review of this response by the Ombudsman. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

You have the right to complain to the Ombudsman if you believe we have not responded appropriately to your request. Information about how to make a complaint is available at www.ombudsman.parliament.nz or freephone 0800 802 602.

If you have any questions, please contact on me on 09 301 0101 or at – Officialinformation@aucklandcouncil.govt.nz

Ngā mihi

Joanne Kearney
Senior Business Partner, Privacy & Official Information
Te Wheako ā-Kirihoko me ngā Ratonga Matihiko | Customer Experience & Digital Services

Tonkin+Taylor

14 August 2025
Job No: 1099782.0000

Auckland Council
Private Bag 92300
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Attention: Tom Mansell

Dear Tom

Wairau Valley - Shoal Bay Diversion Option
Review of WSP Assessment

Tonkin & Taylor (T+T) has been engaged to provide independent review of a WSP assessment of an option to divert Wairau Creek flood flows to Shoal Bay, referred to as the "Shoal Bay diversion option". The WSP assessment is detailed in a memorandum addressed to Auckland Council Director Resilience and Infrastructure, dated 13 August 2025.

1 Background and scope

The background to the "Shoal Bay diversion option" is provided in the WSP memorandum.

The scope of T+T's review relates only to the "Shoal Bay diversion option" [*the option*] and it does not include an assessment of advantages and disadvantages in comparison with other options. Although not specifically described in the WSP memo, we understand that *the option* is characterised by:

- A spillway diversion from the Wairau Creek passing through wetlands and a 700m conveyance channel[1] running along the northern side of AF Thomas Park.
- A large diameter stormwater tunnel (~2500 mm dia.) that conveys flood flows from an inlet in AF Thomas Park to an outlet located in Hillcrest Creek, on the eastern side of the State Highway 1 (SH 1) in Barry's Point Reserve (~ 840m) . The tunnel alignment passes underneath Northcote Road, North Harbour Netball Centre, Smiths Bush, Kitewao Reserve, SH 1 and the Northern Busway.

2 Review

Floodwater diversion schemes are an established option to mitigate flood risk, where risk to downstream properties is reduced by an upstream diversion of flood peaks.

WSP assessed *the option* within a framework of eight themes; the seven that are relevant are reviewed below.

[1] Concrete lined to a depth of ~2m (vegetated above 2m)

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1 **Flood benefits**

We agree with the comments from WSP and highlight their comment that "*it could offer similar flood mitigation benefits to the Stage 1 storage scheme proposed for AF Thomas Park*". We understand that the flood mitigation benefit is considered in relation to the areas that were severely flooded and damaged in the 2023 Auckland Anniversary floods (i.e. Tōtara Vale, Nile Road, commercial areas on Wairau Road and upstream of A F Thomas Park).

We also highlight WSP's comment, that the channel and/or tunnel will need to be nominally larger than *the option* characterised in Section 1 in order to achieve similar flood mitigation benefits. This can also be interpreted to mean that without increases to the channel and/or tunnel the flood mitigation benefits will be less than other options.

The option has flood impacts downstream of the diversion that are covered in Theme 5.

2 **Maintenance**

We agree with the maintenance issues identified by WSP and provide some additional comment:

- Standing water in the inverted siphon will be stagnant for long periods of time which increases the likelihood of water quality-related issues and corrosion. Despite the outlet being above mean high water springs, the outlet will overtop by seawater numerous times a year, increasing with sea level rise.
- Sedimentation of the inverted siphon will likely occur from flood and marine sources.
- Confined space entry occurs along all the tunnel (i.e. not only inverted siphon) and dewatering of the inverted siphon will be necessary for maintenance, which increases the risk, complexity and cost of maintenance.
- WSP do not comment on the maintenance of the conveyance channel and debris management screens. We consider the maintenance in the conveyance channel will be in line with "normal" maintenance practice for high criticality assets.

3 **Resilience / blockage**

We agree with WSP, whilst noting that AF Thomas Park and the inlet area are likely to provide a number of suitable locations for debris management screens/controls. While debris management can be designed, the reliance on it does increase the performance risk and operational costs.

4 **Construction risks**

We agree with the comments from WSP in relation to major construction risks and also note that:

- No specific geotechnical investigations have been undertaken for *the option* which is highly dependent on geological conditions.
- Access for geotechnical investigations in Smiths Bush and in the SH 1 corridor will be restricted increasing the risk of unforeseen ground conditions.
- The acute angle of the tunnel alignment under SH 1 and Northern Busway increases the exposed length and likelihood for potential carriageway repairs. A perpendicular alignment would be best practice and the expectation of NZTA. There is a risk of settlement to SH 1 and Northern Busway due to low cover, mixed ground, and uncertainty of existing fill type. SH 1 in this area carries ~100,000 vehicles per day[2] and with the Northern Busway are critical infrastructure for function of Auckland including as lifelines.
- There are likely to be temporary construction site risks, particularly due to heavy equipment, soft ground and working below stream levels at the Barrys Point launch site.
- There is a risk of settlement at the Netball Centre and for Northcote Road utilities. There is some small risk of a tunnelling-induced sinkhole developing during construction.

[2] NZTA state highway traffic monitoring sites 01N20420 and 01N10420 (51,598 AADT and 51,566 AADT respectively)

- Tunnelling (through pipe-jacking) 2.5 m to 3 m ID pipes is approaching the limit of standard industry practice and readily available equipment, so is feasible. However, increasing the diameter would impact risk and cost.

5 **Downstream flood impacts**

We agree with the comments made by WSP in relation to likely downstream flood impacts. We highlight the adverse impacts of diverted flows on SH 1 and the Northern Busway which are both real risks and consenting risks.

6 **Consenting impacts**

We agree with the comments made by WSP and note the following:

- Watercare's support would be required to tunnel underneath their wastewater and water assets on Northcote Road.
- NZTA's approval would be required to tunnel under SH 1. We note that this has been done before but requires significant engineering effort to prove and de-risk the work.
- The potential long-term impact on groundwater levels needs evaluating because of the potential negative impact on Significant Ecological Areas but is probably able to be mitigated.
- Environmental protection during construction (e.g. from tunnelling lubrication fluids/muds) will be an issue but can probably be mitigated.
- We highlight and support WSP's comment that "consent would be unlikely without support from NZTA and Auckland Transport" (refer Theme 5) and "a consent risk associated with feedback provided by the mandated Mana Whenua working group" who have indicated "a lack of support for options which transfer flows from one catchment to another".

7 **Cost**

We agree with the cost comments made by WSP, noting that their costing advice has come from Alta. We have not carried out a review of the AF Thomas Park storage scheme and are therefore unable to comment on cost comparisons. In addition to WSP's comments, we note the following:

- The costs for additional works downstream from the tunnel outfall, particularly to mitigate flood effects on SH 1 and the Northern Busway, will likely be significant for comparative purposes with other options. These are currently excluded from the cost estimate.
- WSP identify that "the channel and/or tunnel will need to be nominally larger than what has been proposed" however this has not been accounted for in the P50 cost estimate. This suggests that the upper range of the $65-$75M P50 cost estimate may be more appropriate, if the increases are only "nominally larger".

In addition to the theme reviews by WSP we note:

- **Programme** - We consider that it is likely to take a minimum of 18 months before construction could commence to allow for concept design development, investigations, consent application and processing, detailed design and construction procurement. This could be significantly longer if the project is publicly notified and a consent hearing is required, or if third party approvals are not forthcoming. The programme may also be reduced if it was fast tracked consented.
- **Lifecycle costs** – the lifecycle costs of *the option* have not been considered. These would need to include the maintenance, repair and replacement costs for *the option* to help provide useful comparisons with other options, whilst also considering the life span of the asset. It would also be beneficial to provide a carbon assessment of *the option* including embodied and

operational carbon. This will help to support a review of the options with the goals and action areas of Auckland's Climate Plan.

3 Conclusion

T+T has carried out an independent review of a WSP assessment of a flood diversion option from Wairau Creek to Shoal Bay, referred to as the "Shoal Bay diversion option" *[the option] dated 13 August 2025*. We have not provided comment on comparisons with other options as other options are outside the scope of our review.

Overall, WSP provides seven reasons to support their conclusion that "*a Shoal Bay diversion option is not considered the preferred option for addressing flooding to the community*". Based on our experience, we support the technical basis for their assessment but do not make the comparison to other options. Where appropriate, we have provided additional review commentary, which in general supports their points.

Whilst we consider the option technical feasible, due to the high-risk nature of *the option* in consenting, construction and operation, we consider that there would need to be an absence of lower risk alternative options, or *the option* would need to have significant advantages over lower risk alternatives, to become a preferred option.

4 Applicability

This report has been prepared for the exclusive use of our client Auckland Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:

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Jon Rix
Principal Flood Risk Consultant

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John Cooper
Principal - Major Project Specialist

Authorised for Tonkin & Taylor Ltd by:

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Tim Fisher
Project Director
Technical Director - Water Engineering

14-Aug-25
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MEMORANDUM

To	Barry Potter – Director Resilience and Infrastructure
Copy	Sara Zwart, Rowan Carter, Tom Mansell, Craig McIlroy – Healthy Waters
From	Josh Irvine – Technical Principal - Stormwater
Date	13 August 2025
Subject	Shoal Bay diversion option

Background

WSP have been requested to provide a high-level assessment of the option to divert Wairau Creek catchment flood flows to Shoal Bay, as well as considering the 'Shoal Bay Solution' option recently presented to Auckland Council by a technical reference group working with North Shore Takapuna Golf Limited (NSTG).

As part of the option assessment process, the option was considered in early 2025. Four primary options involving diversion of flows to Shoal Bay were considered at that time. Each included construction of a similar open channel as proposed in the 'Shoal Bay Solution' in AF Thomas Park, combined with an open channel and a tunnel option both discharging to Kitewao Esplanade Reserve, a tunnel option discharging to Tuff Crater, and a tunnel closely resembling the current proposal discharging to Barry's Point Reserve. This was briefly summarised in the Options Summary Report (Option N) dated 18 March 2025 (note: not all options considered were included in the Options Summary Report).

At that time, the Shoal Bay diversion options were discounted due to significant consenting issues and high estimated costs. We have undertaken the following further analysis to review this option:

- 3D ground and pipe modelling to understand shaft and tunnel depths, tunnel gradients and lengths, cover depths.
- Examination of published geotechnical information from the New Zealand Geotechnical Database.
- Hydraulic calculations to estimate open channel and tunnel sizing.
- Identification of the flood benefits and impacts of a diversion option to Shoal Bay in the detailed catchment flood models.
- Consulting with experts in trenchless technology, geotechnical engineering and ecology.
- Revision of cost estimate by Alta.

In addition to this, we have also reviewed the 'Shoal Bay Solution' proposed by the technical reference group to determine whether it presents any notable differences or introduces new considerations not previously assessed.

Based on the information provided, the 'Shoal Bay Solution' option closely resembles one of the previously evaluated options in terms of alignment, tunnel length and discharge location. Expanding on the assessment presented in the March options report, a more detailed summary of assessment notes is provided below. These relate to features common to both the 'Shoal Bay Solution' and the previously evaluated options.

Assessment

The following summarises the assessment of a potential diversion of flood flows to Shoal Bay:

- **Flood benefits** – In principle, a tunnel could convey the required peak flow, assuming additional inlet capacity is provided. It could offer similar flood mitigation benefits to the Stage 1 storage

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scheme proposed for AF Thomas Park. However, initial modelling suggests that to achieve flood benefits equivalent to storage at AF Thomas Park, the channel and/or tunnel will need to be nominally larger than what has been proposed by the technical reference group – resulting in increased costs.

- **Future works** – Diversion to Shoal Bay does not eliminate the need for Stage 2 works. Stage 2 involves flood mitigation at Totaravale Reserve and Nile Road, as well as upgrades to existing detention schemes in the upper catchment. These areas have unique flood risk issues and the benefits of these projects are predominately for local communities. A diversion scheme to Shoal Bay will not influence flood risk in these areas. A diversion to Shoal Bay does not affect the ability to carry out Stage 3 works.
- **High cost** – A Strategic Assessment (Class 5) cost estimate has been developed for the Shoal Bay diversion scheme, indicating a P50 cost of $65-75 million. This is $10-20 million higher than the AF Thomas Park storage scheme, which has been estimated at a P50 cost of $55 million. There is no cost allowance for any additional works which may be required downstream from the tunnel outfall.
- **Maintenance** – The proposed option requires an unconventional inverted siphon to achieve sufficient cover beneath SH1. This results in permanent ponding within the tunnel and introduces confined space conditions, both of which complicate maintenance activities, increasing safety risks and cost.
- **Resilience / blockage** – Pipe inlets are prone to blockage, especially when fitted with grilles. For safety reasons, grilles would be required at both the inlet and outlet to prevent people entering the tunnel, however they would inherently increase the risk of blockage. While debris preventative measures may limit the build-up of larger debris at the inlet or entry into the tunnel, smaller materials are still likely to accumulate in the pipeline, potentially causing blockages or requiring removal.
- **Construction risks** – Pipe-jacking introduces risks such as settlement, heaving and frac-outs, particularly when encountering variable geologies and shallow cover. Published geological maps show the proposed site may be located in a potentially variable geological setting encompassed by volcanic soils, alluvial deposits and the East Coast Bays formation rock and residual soils. Historic geotechnical investigations in the area have not found basalt but this would need to be confirmed by further investigations. Although these risks can potentially be mitigated, the consequences if these risks occur (especially to SH1) would be significant.

  The southern end of the proposed alignment may be located in an old landfill (Barry's Point Landfill). Soil and groundwater contamination may be an issue, increasing costs and environmental risk.
- **Downstream flood impacts** – Initial modelling indicates that discharging flows to Barry's Point Reserve could increase downstream flood levels by 100-400mm in a 1% AEP event. It would reduce the ability of the Hillcrest culvert to convey flow beneath the motorway increasing flooding of SH1 by 100-350mm, exacerbate flooding of the busway and its associated collector roads, and Fred Thomas Drive and part of Esmonde Road by 300mm – all of which are critical transport links. This is highly likely to be deemed unacceptable from a consenting perspective or would require expensive mitigation not currently allowed for in the project estimate.
- **Consenting impacts** – Given the potential flood impacts and construction risks on the northern motorway, northern busway and local roads, consent would be unlikely without support from NZTA and Auckland Transport.

  We have sought ecological consenting advice from Connor Whiteley (Manager Wai Ora Urban Partnerships in Healthy Waters). He has advised:

  > *The proposed Shoal Bay diversion's receiving environment in Barry's Point Reserve is expected to contain natural inland wetland – predominantly mangrove swamp – located above the coastal marine area boundary and therefore subject to the National Environmental Standards for Freshwater (NES FW) and the National Policy Statement for Freshwater. This presents a notable consenting risk due to the NES FW's "avoid" requirement for adverse effects, with potential effects including hydrological change, increased erosion, and impacts to threatened fauna, noting that these effects could be avoided under the AF Thomas Park Storage option.*
  >
  > *In addition to this, the option will likely affect existing streams within AF Thomas Park that are afforded protection under the Auckland Unitary Plan, triggering associated consent, particularly where base flows are redirected from the current Milford outlet. There will also*

be additional reporting required to demonstrate no impact to the Significant Ecological Areas in Smiths Bush, Kitewao Reserve and Shoal Bay. These include kahikatea swamp forest wetlands which may trigger requirements under the National Environmental Standard for Freshwater (NES FW) depending on design and construction methodology.

We understand there is also a consent risk based on feedback provided by the mandated Mana Whenua working group. They have indicated in writing a lack of support for options which transfer flows from one catchment to another or restrict and control the natural flow of water.

A Shoal Bay diversion option is not considered the preferred option for addressing flooding to the community as:

- It is estimated to be $10-20 million more expensive than the preferred option.
- A pipe option introduces a potential for blockage which could compromise flood risk reduction during critical events.
- It is predicted to increase flood risk to critical transport infrastructure downstream – an outcome that is highly unlikely to be acceptable.
- The option presents substantial maintenance demands, cost and associated safety risks.
- It is expected to result in environmental impacts that may not be consentable.
- It relies on favourable geotechnical conditions, which are uncertain, with potentially significant consequences – particularly beneath the motorway.

Auckland Council

WAIRAU CATCHMENT FLOOD REDUCTION OPTIONS

OPTIONS SUMMARY

18 MARCH 2025

CONFIDENTIAL

WAIRAU CATCHMENT FLOOD REDUCTION OPTIONS
OPTIONS SUMMARY

Auckland Council

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REV	DATE	DETAILS
00	28 January 2025	Draft
01	18 March 2025	Draft – following client review

	NAME	DATE	
Prepared by:	Mathew Chandran, James French	18 March 2025	
Reviewed by:	James Reddish	18 March 2025	
Approved by:	James Reddish	18 March 2025	

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EXECUTIVE SUMMARY

The 27 January 2023 storm event resulted in widespread flooding across Auckland. The Wairau catchment was particularly hard hit. Many dwellings were subject to above floor level flooding and residents were left unable to safely evacuate due to deep and fast-moving floodwaters. Within the catchment, 350 dwellings are predicted to have an intolerable risk of flooding while a further 973 dwellings are exposed to flood risk.

A catchment-wide flood risk options review has been undertaken. The Tōtara Vale, Nile Road, and Wairau Road areas within the catchment had the largest concentrations of dwellings exposed to flood risk, and is the particular focus of this options summary report, with 186 dwellings predicted to have an intolerable risk of flooding, and 369 dwellings exposed to flood risk.

A number of options have been considered for the areas impacted by the 27th January 2023 storm event and are described in this report. The options recommended to be taken forward include:

- Stream naturalisation, widening and flood storage improvements at Tōtara Vale;
- Daylighting existing culverts at Nile Road to create flood resilient blue green corridors;
- Flood storage at AF Thomas Park to reduce peak flows in the Wairau Creek;
- Wairau Creek widening to create a blue green corridor along Wairau Road that reduces flood risk to the commercial area;
- Wairau Creek widening to create a blue green corridor from Forest Hill Road to Kitchener Road that reduces flood risk through this residential area;
- Removal of Woodbridge Lane access bridge, if no longer required due to property buy out, to reduce flood levels along the Wairau Creek caused by this constriction;
- Upgrading of existing road bridges across Wairau Creek (Waterloo Road, Alma Road and Kitchener Road) to reduce flood levels along the Wairau Creek caused by these constrictions;
- Upgrades to the existing storage schemes through the catchment to improve flood resilience during frequent storm events.

The recommended options have been tested using Auckland Council's catchment hydraulic model to understand the benefits. Work is ongoing to validate these benefits, as rainfall statistics for the Auckland Region have changed as a result of the extreme nature of the rainfall in January 2023, meaning existing models may under-predict future flood risk.

These recommended options adopt a blue-green approach, consistent with the Making Space for Water initiative. Further work would be required to co-ordinate these into a holistic catchment solution that also unlocks potentially wide-ranging additional benefits across a range of values beyond flood management.

1 PROJECT BACKGROUND

1.1 OVERVIEW

The Wairau Catchment on the North Shore experienced significant flooding during the Auckland Anniversary rainfall event in early 2023. Flooding effects were felt in all suburbs within the catchment – Glenfield (Tōtara Vale), Hillcrest, Sunnynook, Wairau Road commercial area, Forrest Hill (Nile Road area) and Milford (Wairau Creek). Property buy-outs are underway across the catchment for those properties that registered, have been assessed as having an Intolerable Risk to Life, and have no feasible risk reduction solution, in the short term.

Beyond this process there will remain a large number of properties at risk of flooding, including habitable floor flooding, as well as vulnerable infrastructure. Three of the areas with the largest concentration of properties that remain at risk are the Tōtara Vale area, Wairau Valley commercial area, and the Forrest Hill (Nile Road area)/Milford (Wairau Creek) area. WSP, with input from Boffa Miskell and Alta have prepared a plan to address flood risk in these worst affected areas.

The purpose of this document is to support Auckland Council's business case by providing the background to the flooding issues (the problem), options considered in developing the proposed flood risk reduction plan (the solution).

1.1.1 SCOPE

As part of ongoing Wairau catchment planning WSP has been engaged to investigate options to mitigate the flooding in the key study areas. This will inform preparation of a Healthy Waters business case to support decision making. The following tasks were undertaken to investigate the options:

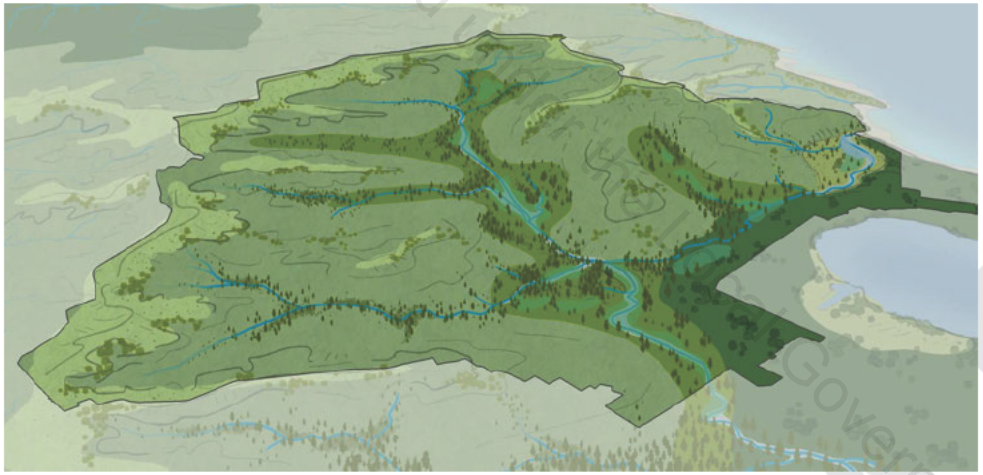
- Update the existing Wairau catchment hydraulic model and testing validation against conditions observed during the January 2023 flood event. Validation work is ongoing. Section 4 provides further information on hydraulic modelling and associated assumptions and limitations.
- Use the hydraulic model to establish a baseline representing the future 100-year ARI flood event with allowance for maximum probable development and climate change (the design event).
- Use the hydraulic model to develop and test options.
- 3D model key options to inform required the works and associated costs (e.g. cut and fill).
- Input from other parties on urban design, quantity surveying and cost estimating.
- Identify and engage with key stakeholders as appropriate, including Mana Whenua, Local Board, and asset owners including Watercare, Vector, Chorus and Auckland Transport. Stakeholder engagement is ongoing.

Specific exclusions include survey, physical site investigations, and transport planning. Staging of recommended options is not covered in this report, as it will be subject to available funding, however dependencies between recommended options are identified to support decision making. Further flood modelling will also be required.

1.2 CATCHMENT CONTEXT

A high-level overview of the Wairau catchment is outlined below.

- Urban development across the 1,450ha Wairau catchment over the last 60 years has encroached into the natural wetlands, flow paths, and floodplain of the Wairau Creek and its tributaries (refer figures 1 to 4).
- The catchment is now highly urbanised. Home to 50,000 people, 15 schools, 4 commercial areas, and essential transport and lifeline infrastructure (e.g. Transpower substation). North Shore Hospital is directly adjacent to the catchment and requires safe access through Wairau.
- Over time impervious surfaces have continually increased, resulting in higher peak flows when extreme rainfall events occur. Combined with restriction in the conveyance capacity of the stream, this means the flooding beyond the banks of the creek can occur more regularly and have higher consequences when it does occur.
- The Northern Motorway (State Highway 1) bisects the catchment and is a significant impediment to the natural flow of water. Culverts and bridges convey stormwater in both directions across the motorway at different points.
- The Northern Motorway is a barrier to stormwater flow in the Tōtara Vale and Sunnynook areas, with under capacity culverts and a high risk of blockage, creating flood prone areas, as experienced during the January 2023 storm event.
- The natural stream has been enclosed in pipe or engineered with concrete walls along much of its length through the upper (Glenfield, Hillcrest, Forrest Hill) and mid catchment (Wairau Valley) to enable residential and commercial development. This has reduced the capacity of the stream and its floodplain to convey floodwater.
- Through the Wairau Road area the stream has been partially bifurcated so capacity could be accommodated in smaller channels either side of the road. This decision, along with numerous access bridges over these channels to private property, contribute to a restriction to conveyance capacity, as experienced in January 2023 where the commercial area was inundated.
- A series of detention schemes have been created over time within the catchment to partially control flood effects, these include multi-purpose open space in Sunnynook Park, Becroft Park, Rewi Alley and Knightsbridge Reserves. Detention ponds have also been created at Link Road and Croftfield Lane when this area was developed in the 1980s.
- Although a larger engineered channel has been maintained in the downstream section of the Wairau Creek, between Wairau Road and the sea, the floodplain has been restricted, and bridges, such as at Alma Road and Woodbridge Lane, contribute to restricting flow and raising water levels. When water does spill out of the banks it follows overland flow path routes that can take it away from the main channel.



Pre-human Settlement

1950s

Current State

Current State with floodplain

Figure 1, Figure 2, Figure 3, Figure 4: Evolution of development in the Wairau Catchment

2 WAIRAU'S FLOODING PROBLEM

2.1 PREDICTED FLOOD RISK

Figure 5 shows the indicative flooding extent across the Wairau catchment, and the properties at risk in the predicted 1% AEP event, considering maximum probable development and climate change with 3.8 degree increase in temperature (MPD and 3.8^{0} CC). Work is ongoing to improve understanding of future flood risk using new rainfall statistics following the January 2023 storm (refer Section 4).

2.2 AUCKLAND FLOODS

The 27 January 2023 storm event resulted in widespread flooding across Auckland. The Wairau Catchment was particularly hard hit. Many dwellings were subject to above floor level flooding and residents were left unable to safely evacuate due to deep and fast-moving floodwaters.

Two people died in floodwaters in the Wairau catchment.

Within the Wairau catchment:

1. 48 properties were yellow or red stickered immediately after the event.
2. 323 properties registered for categorisation.
3. As at February 2025, 179 properties had been assigned Category 3, however this number is expected to increase.

Figures 6 to 9 shows the affected neighbourhoods in the Tōtara Vale, Wairau Road and Nile Road areas, including the indicative extent of flooding and the localised flood prone area (potential ponding area) where the deepest flooding occurred.

S 7(2)(b)(ii) 3rd Party Commercial Position

Figure 5: Wairau Catchment predicted flood risk

2.2.1 TŌTARA VALE

In Tōtara Vale, the Auckland Anniversary flood event led to severe flooding, erosion and property damage. Several homes were evacuated as a precaution. The community faced power outages and disruptions to essential services. Flooding experienced in the area included:

1. The Trias Pond overtopped and caused significant damage to the road embankment at Trias Road.
2. The culvert at Tōtaravale Drive overtopped, flowed down the road and water entered low-lying properties.
3. The culvert beneath State Highway 1 did not have the capacity to convey the floodwater and the two culvert inlets were significantly blocked with debris, further restricting its capacity.
4. State Highway 1 acted as a dam resulting in large flood depths. Residential properties in the area experienced flooding of up to 2m deep.

Figure 6: Tōtara Vale flooding

2.2.2 WAIRAU ROAD

Wairau Road and businesses were heavily affected by the Auckland Anniversary flood event. Floodwaters caused extensive damage to infrastructure, including roads and bridges. Businesses along Wairau Road suffered substantial losses due to water damage. Emergency crews were deployed to clear debris and restore access. Tragically, two people lost their lives in the Wairau Valley area.

Flooding experienced in the area included:

1. The wetland at Croftfield Lane overtopped Tristram Avenue and flowed into the Wairau Road commercial area and exacerbated flooding of the Forrest Hill Tennis Centre and Badminton North Harbour at Bond Reserve.
2. The concrete channels either side of Wairau Road did not have enough capacity to convey floodwaters and overtopped onto Wairau Road and the surrounding commercial properties including Pak n Save and many car sale yards.
3. The majority of commercial properties along Wairau Road are located at a similar or lower level than Wairau Road so are at risk of flooding when the channel capacity is exceeded. The flood depth on the road was approximately 800mm deep during the Auckland Anniversary flood event.
4. Numerous access bridges cross the concrete channel to commercial properties. The bridges can partially restrict the capacity of the channels, increasing the risk of the channels overtopping and flooding businesses.

Figure 7: Wairau Road flooding

2.2.3 AF THOMAS PARK

A F Thomas Park and neighbouring businesses were inundated during the Auckland Anniversary Flood event. Flooding experienced in the area included:

1. The stream from Sunnybrae Road overtopped its banks and flooded the North Shore Event Centre and into A F Thomas Park.
2. The wastewater pipe crossing the stream potentially exacerbated the overtopping of the stream into AF Thomas Park and flooding of the North Shore Events centre.
3. The Vector substation next to the A F Thomas Park flooded up to 1.5m deep, causing damage however power was maintained.
4. The natural depression in A F Thomas Park provided some storage before floodwaters flowed into the Wairau Creek.

Figure 8: A F Thomas Park flooding

2.2.4 NILE ROAD

The Nile Road area faced significant flooding, with water levels rising rapidly, inundating homes and businesses. The road became impassable, and residents had to be evacuated. Emergency services rescued stranded people. Temporary shelters were provided. Flooding experienced in the area included:

1. Overland flow from Knightsbridge Reserve flowed down Nile Road at a depth of up to 1.5m.
2. Floodwater from a local stream channel overtopped the culverts beneath Nile Road and flowed through properties on its way to the Wairau Creek.
3. Overland flow from Nile Road flooded properties and flowed into low-lying land, flooding some properties up to 2m deep, before overtopping into the Wairau Creek.
4. Water level in Wairau Creek did not go over the top of Waterloo Road.
5. Wairau Creek overtopped Alma Road bridge and flowed towards Nile Road and Woodbridge Lane, flooding properties.
6. Alma Road Pump station overflowed discharging sewage into neighbouring properties along Woodbridge Lane.
7. Floodwater filled the low-lying depression around Woodbridge Lane. The access bridge for some Woodbridge Lane properties across Wairau Creek was overtopped and caused floodwater to back up and flood the properties along Woodbridge Lane. Some residents tried to cross the bridge during the storm as it was their only access route.
8. Kitchener Road bridge in Milford town centre did not overtop during the Auckland Anniversary Flood event.

Figure 9: Nile Road flooding

3 FLOOD REDUCTION OPTIONS

3.1 TYPE OF OPTIONS

Flooding risk in Auckland, including in the Wairau catchment, has been exacerbated by encroachment on stream corridors by development, reducing their capacity with engineered channels, and development on the floodplain. The floodplain is a critical asset to the community during extreme events. Restoring these natural features, as far as practicable, in critical flood risk areas is a key initiative of Auckland's Making Space for Water programme.

The type of options considered in the Wairau catchment have included:

1. Attenuation of floodwater in multi-functional open space, typically in the upper catchment.
2. Increasing conveyance capacity of Wairau's engineered channels through naturalising and widening them.
3. Diversion of flood flows through safer overland routes (e.g. to Shoal Bay and the Hillcrest catchment).
4. Upgrades, replacement or removal of infrastructure that exacerbates flood risk (e.g. bridges, daylighting culverts, etc).
5. Retreating (property purchase) for the most at risk people and properties (Intolerable Risk to Life).
6. Upgrades to the existing storage schemes through the catchment to improve flood resilience during frequent storm events.
7. Thinking whole of catchment, transformative, and long term. Recognising that some of the best solutions may take a long time to implement but can deliver inter-generational benefits.
8. Maintaining the status quo (do minimum) has also been considered as a baseline scenario.

Below ground stormwater infrastructure such as pipes and tanks have generally not been considered as they are typically only suitable for more frequent storm events, are not suitable for the scale of flooding issues in the Wairau catchment and have few co-benefits.

3.2 OPTIONS CONSIDERED

Table 1 summarises the options identified and assessed. The assessment has primarily focused on flooding benefits, but co-benefits have also been identified. Co-benefits relate to creating thriving, resilient places for people by considering the long-term health of the environment and the community. The co-benefits include potential land re-use for housing and recreation, improved connectivity and increase in land value as a result of the proposed works. These co-benefits may enable co-funding or alternate funding mechanisms and are intended to be further explored through subsequent design phases.

Monetised benefits are not included in this Options Summary report however will be described for the recommended options and associated staging in the Business Case.

All the options recommended will require further investigation and refinement through a subsequent design process. Due to the significant impact on local communities and stakeholders it is intended to seek and incorporate their input, experience and feedback into project designs and outcomes. It may be necessary to refine, alter, or replace elements of the identified option to optimise flood benefits, co-benefits and cost. Recommended options are shown in Figure 10.

3.3 OPTIONS ANALYSIS

Auckland Council's Wairau Catchment Flood Hazard Model (ID1416) has been used to test potential options and understand potential flood benefits. Appendix A includes a list of options tested. The model was developed in 2023 by AECOM and is in draft format (4th draft). The model uses Infoworks ICM version 2024.2 software and is in Auckland 1946 vertical datum. Refer to the Wairau Valley Catchment Stormwater Modelling, Model Build and Validation Report (AECOM, 2023) for further details on the catchment model.

Localised updates to the Wairau Catchment model by WSP have been made to improve confidence in the model results within the Nile Road area. Updates have been made based on previous peer review comments (by Auckland Council) that at the time hadn't been incorporated into the catchment model and general model checks. Only updates to the model that might directly affect results relating to the Nile Road study area have been considered and are listed below:

- 1D channel cross sections along Wairau Creek between Wairau Road Bridge and Kitchener Road bridge have been widened by 2m on either side and the channel bank point spacing reduced from a point spacing of approximately 20m to a spacing of 2m along both sides of Wairau Creek.
- Representation of Wairau Creek immediately downstream of Kitchener Road Bridge has been updated from a 1D conduit with cross-sectional geometry to a 1D River Reach with cross sections from 2016 LiDAR.
- Several cross sections immediately downstream of Wairau Road Bridge and Alma Road Bridge have been updated to better represent walls along the channel at these locations.
- Woodbridge Lane access bridge has been included in the model as a 1D Bridge structure. The bridge opening geometry and dimensions have been assumed from photographs. The bridge deck level has been assumed to approximately represent the top of the solid rail.
- The roughness coefficient defined in the 2D Zone has been updated from 0.05 to 0.1 for the remaining area outside roads, buildings and other impervious areas.
- A mesh level zone has been included in the model on Wairau Road beneath the Northern Motorway to remove artifacts in the DEM from the motorway and allow flow along Wairau Road.
- Several mesh level zones in the Wairau Valley commercial areas that represent bridge decks have been adjusted to snap to the adjacent 'void' polygon due to meshing errors.

The updated base model has been run for the 27th January 2023 storm event and the results compared to observed flood levels where available. This comparison has shown that further work is required to update the base model and improve model prediction for the 27th January event. Despite the model under predicting flood levels for the 27th January event, the updated model has

been used to test potential options and is considered suitable for assessing relative benefits of options. Further updates and refinement to the base model are expected in future stages of this project following a more in-depth review of the model validation.

Figure 10: Wairau Catchment Options

Table 1: Summary of options

Option	Name	Description	Flood Benefits	CAPEX Estimate[1] (P50)	Co-Benefits	Option Key Risks & Constraints	Summary and Dependencies
0	Do Minimum	Activities that form part of the Auckland Unitary Plan, Healthy Waters Annual Plan or other funded initiatives in the Making Space for Water programme, such as: • Property purchase of Category 3 properties. • Develop operational and maintenance plan outlining inspection frequencies for the critical assets in the catchment. • Education, awareness with community on improving flood resilience (underway). • Guidance to businesses on improving flood resilience.	• Reduce the consequences of flooding when it does occur (e.g. damage to contents, increased speed of recovery, reduced likelihood of fatality or injury). • Reduced blockage of culverts and channels leading to improved operation of the stormwater assets in a flood.	• More than $100 million + in Wairau catchment for Category 3 property purchase	• No major co-benefits apart from reduction in nuisance flooding if assets are maintained regularly.	• $500million+[2] predicted damages in a 1% AEP event in the future (MPD + 3.8 degrees climate change). • Significant flood effects continue for the community and become worse as a result of climate change. • A larger storm than Jan 23 (e.g. 1% AEP) results in greater effects. • Cat 3 properties become unused and a safety and public perception liability. • Misalignment with community and partner expectations.	• Opportunity missed to both improve flood resilience and create transformational spaces for the community that deliver multiple co-benefits. • This option is not recommended.
A	Tōtara Vale	Additional storage, stream naturalisation and debris rack to reduce flood flows and levels: • Naturalise stream by removing concrete channel to help slow down flood flows • Debris rack and screen to trap debris and reduce chance of blockage of the downstream SH1 culvert • Excavate ground adjacent to the stream to increase potential storage and lower flood levels in the area • Floodwall option to improve flood storage at Rewi Alley Reserve (to be further explored). • Raise some Category 3 land out of the floodplain	• Reduced flood levels by approximately 200 mm in 1% AEP MPD3.8CC event. • Reduced likelihood of culvert blockage.	• $17.0 million	• Opportunity for significant transformation of public land • Creation of high amenity park and reserve land adjacent to the stream with shared path connection (including Northern Cycleway) for transport and recreational purposes. • Enhanced ecological corridor for the restored stream channel and potential to create a wetland environment coupled with flood benefits. • Enable surrounding growth and development potential. • Potential to deliver in coordination with existing HW growth project (co-funded)	• Optimised scheme requires additional land acquisition and coordination with Kāinga Ora land holdings. • Relocation of services • Groundwater induced settlement • Potential classification of the storage areas as a dam	• Options to be developed in collaboration with Kāinga Ora. Can be delivered in stages based on required property purchase beyond Cat 3, to support faster implementation timeframe. • Reduction in flood flows and levels using a blue green corridor and enhanced amenity features for the community. • Potential to reconfigure existing open space to offset costs and improve safety. • This option is a recommended solution with further exploration of staging and co-funding /

[1] Excludes property acquisition costs, which are covered separately in the business case.
[2] High level estimate using NIWA Riskscape model and predicted depth for the 1% AEP 3.8degCC event.

Option	Name	Description	Flood Benefits	CAPEX Estimate[1] (P50)	Co-Benefits	Option Key Risks & Constraints	Summary and Dependencies
					• Increased land value resulting from amenity uplift.		delivery with Kāinga Ora required.
B	Alma Road Bridge Upgrade	• Widen bridge to reduce restriction. • Adjust underground pipes and utilities to align with bridge level and width.	• Reduced flooding of properties on Nile Road, Alma Road and Woodbridge Lane by approximately 200-300 mm in 1% AEP MPD3.8CC event in combination with channel widening. • Improved resilience of Alma Road.	• $8 million	• New resilient open channels less prone to blockage • Critical services less prone to washout with lowered flood levels around the bridge	• AT approval. • Asset owner approvals required for relocation or adjustment of utilities • Road closure to undertake works	• Unlikely to require additional property purchase beyond Cat 3. • Undertaken in collaboration with Auckland Transport. • This option is a recommended solution, however should be undertaken in combination with Wairau stream widening to maximise benefit realisation.
C	Woodbridge Lane bridge removal	• Remove bridge that is no longer required due to property buy out. • Minor works to Woodbridge Lane to terminate accessway.	• Remove risk of blockage and improve flood flow conveyance, reducing risk to properties.	• $1 million	• New resilient open channels less prone to blockage	• Asset owner approvals required for relocation or adjustment of utilities	• Doesn't require additional property purchase beyond Cat 3 – potential early works • This option is a recommended solution.
D, E, F, G	Upgrade existing flood storage schemes	• Optimise attenuation capacity within existing attenuation schemes or provide minor upgrades to increase storage.	• Reduced flood risk for frequent storm events (more frequent than 1% AEP).	• $17 million	• Opportunity to de-silt the existing ponds and/or plant native vegetation and create amenity spaces as part of upgrades.	• Benefits for more frequent events require further investigation and refinement. • Relocation of services • Limited opportunity to increase storage and height so that it doesn't become classified as a large dam	• Doesn't require additional property purchase beyond Cat 3 - potential early works • This option is recommended for further investigation to confirm benefits for more frequent events.
H	AF Thomas Park Detention Scheme	• Excavate part of the park to provide flood storage. • Formalise the wetland that will naturally form in the park as a result of the works. • Construct a new channel linking the main channel to A F Thomas Park, potentially using an actively controlled gate to optimise the	• Improved frequency and depth of road flooding for Wairau, Alma, Waterloo and Nile Road area. • Reduced flooding on commercial properties up to Archers Road by approximately 150-100 mm in 1% AEP MPD3.8CC event and up to 150	• $58 million	• Creation of high-amenity and ecological wetland reserve, increase urban forest, reduce carbon, heat island effect and increased biodiversity. • Critical services less prone to washout from lower flood levels in Wairau Creek. • Improved water quality.	• Groundwater induced settlement on adjacent buildings and assets • Contamination and risk of excess material being carted off to landfill • Temporary impacts to assets and events centre • Storage inflow/outflow area near Transpower substation and cables.	• Provides flood benefits to downstream residential areas. • Potential to be adapted in the future to reduce flood risk to commercial area, if stream widening upstream occurs.

Option	Name	Description	Flood Benefits	CAPEX Estimate[1] (P50)	Co-Benefits	Option Key Risks & Constraints	Summary and Dependencies
		storage and release of flood flows in the park to maximise benefits. • Leave area above wastewater pipe intact and allow for spill across the wetland cell. • Construct a new culvert from A F Thomas Park to the stream channel so that the available flood storage is not prematurely used. • Reshape ground to convey flood flows between the areas proposed for raising. • Reuse cut material to raise and reshape the ground.	mm on residential properties in Nile Road, Alma Road and Woodbridge Lane. Reduction in flooding of approximately 350 mm on residential properties upstream of Waterloo Road. • Reduced flood risk to wastewater pump station in Wairau Road and Vector substation (wider benefits to lifeline infrastructure such as hospital). • Reduced flood flows and flood levels to the downstream residential area and small reduction in flood levels in the commercial area up to Archers Road. Flood level reduction for 200 properties.		• Improved community wellbeing. • Improved equitable access and recreation opportunities in the park including walking and cycling • Connecting people to place through social outcomes, local community play and active role in the care, protection and regeneration of Wairau. • Potential for local food sovereignty through productive landscapes.	• Consultation on future use of AF Thomas Park. • Designing to avoid large dam classification.	• Doesn't require additional property purchase beyond Cat 3. • Potential for significant co-benefit opportunity to restore the land to a wetland reserve. • Coordination with various stakeholders (Vector, Watercare, Events Centre etc) will be required to finalise the design and proceed to construction. • This option is a recommended solution.
I	Nile Road stream daylighting	• Reinstate historic streams from Nile Road to Wairau Creek to safely convey flows. • Remove existing under-capacity culverts. • Formalise an overland flow path along Woodbridge Lane to Wairau Creek to reduce flooding in the area. • Potential to raise land above predicted flood levels.	• Improved frequency and depth of Nile Road flooding of up to 300 mm in 1% AEP MPD3.8CC event. • Safely convey flow to Wairau Creek via stream and formalised overland flow path. • Reduce risk by raising land above predicted flood levels. • Reduced flood risk to homes – an estimated 15 properties no longer have an intolerable flood risk.	• $14 million	• New resilient open channels less prone to blockage. • Creation of ecological corridor, reinstating historic stream. • New amenity and recreation for the community (note that this is an area with identified open space and recreation need). • Improved water quality. • Improved walking and cycling connectivity. • Improved community wellbeing. • Enable broader redevelopment and intensification in surrounding areas. • Increased land value resulting from amenity uplift.	• Additional property purchase may be required due to current uncertainty on final property categorisation. • Early-stage cost uncertainty (30% contingency included). • Relocation of services around the new stream extent.	• Provides significant local flood benefit to Nile Road area. • Potential for significant co-benefit through linear parkland and support future development, that requires further exploration. • Additional property purchase likely required, which will impact staging. • Coordination with various stakeholders (utility owners e.g. Watercare) will be required to finalise the design and proceed to construction. • This option is a recommended solution.

Option	Name	Description	Flood Benefits	CAPEX Estimate[1] (P50)	Co-Benefits	Option Key Risks & Constraints	Summary and Dependencies
J-1	Wairau Creek widening (Forest Hill Road to Kitchener Road)	• Widen Wairau Creek in residential area (from Forrest Hill Road to Kitchener Road) to convey flood water and lower flood levels in the area. • Upgrade Waterloo and Kitchener Rd bridges. • Purchase properties, or implement easements, to allow for proposed works to be constructed and maintained through commercial and residential areas.	• Reduced flooding depths for, Alma, Waterloo and Nile Road • Reduction in flood risk to residential properties in the lower catchment by approximately 400-1000 mm upstream of Waterloo Road and between 150-400 mm in Nile Road,, Alma Road and Woodbridge Lane in 1% AEP MPD3.8CC event. • Reduced flood risk to critical assets such as the wastewater pumpstations and bridges. • Estimated 22 properties no longer at intolerable flood risk.	• $85 million	• New resilient open channels less prone to blockage. • Critical services less prone to washout from lower flood levels in Wairau Creek • Significant opportunity for a waterfront shared path connecting the important suburbs and commercial zones. • Equitable amenity and recreation for the community. • Improved water quality. • Improved connectivity. • Improved community wellbeing. • Increased land value resulting from amenity uplift.	• Has significant challenges to deliver, including significant additional property purchase, transport corridor disruption and relocation of services adjacent to the creek	• Potentially transformative urban project for Auckland. • Provides significant flood benefit to residential properties along the Wairau Creek corridor. • Potential for significant co-benefit through linear parkland and support future development, that requires further exploration. • Coordination with various stakeholders (dry utility owners, Watercare etc). • This option is recommended for further investigation as the risks and constraints to delivery will require time to address, therefore should be considered as a longer-term option.
J-2	Wairau Creek widening (Wairau Road in Commercial area)	• Widen existing concrete channels (adjacent to Wairau Road) in commercial area (from Tristram Ave to Forrest Hill Road) to convey flood water and lower flood levels in the area. • Alternatively create a single blue-green corridor on one side of Wairau Road through the commercial area through significant additional property purchase (not costed). • Widen existing culverts (to be confirmed) under Wairau Road to accommodate the channel widening. • Upgrade the many existing access bridges and road bridges (at Archers Road and Porana Road) to accommodate channel widening and lower flood levels.	• Reduction in flood risk to commercial properties • Reduced flood risk to critical assets such as the wastewater pumpstations and bridges. • Reduced flooding frequency for regionally important Wairau Road.	• $90million	• New resilient open channels less prone to blockage. • Critical services less prone to washout from lower flood levels in Wairau Creek • Significant opportunity for a shared path connecting the important suburbs and commercial zones. • Equitable amenity and recreation for the community. • Improved water quality. • Improved walking and cycling connectivity. • Improved community wellbeing. • Enable broader redevelopment and	• Has significant challenges to deliver, including significant additional property purchase, business continuity within commercial area, and transport corridor disruption and relocation of services adjacent to the creek.	• Potential for transformative urban project for Auckland. • Provides significant flood benefit to commercial properties along the Wairau Creek corridor. • Potential for co-benefit through linear parkland and support future development, that requires further exploration. • Coordination with various stakeholders (dry utility owners, Watercare etc, Auckland Transport). • This option is recommended for further investigation as the risks

Option	Name	Description	Flood Benefits	CAPEX Estimate[1] (P50)	Co-Benefits	Option Key Risks & Constraints	Summary and Dependencies
		• Remove existing culverts as part of widening. • Purchase properties, or implement easements, to allow for proposed works to be constructed and maintained through commercial and residential areas.			intensification, including commercial investment confidence.		and constraints to delivery will require time to address, therefore should be considered as a longer-term option.
K	Minor open space reconfiguration – CAT3 buyout properties	• Includes rationalisation of residual areas of open space resulting from CAT 3 buyouts which have potential to deliver minor flood benefits alongside broader co-benefits • Key areas include Bryan Brynes Reserve, Sunnynook and Nile Road area	• Properties that experienced flooding during the anniversary weekend (2023) and that have opted in will be removed due to CAT 3 buyouts • New reserve areas could be used to attenuate flows by formalising lower depression areas in the reserves	• TBC for Wairau Catchment	• Potential new open space could be raised to avoid flooding, converted to drainage reserve and/or coupled with recreational purposes.	• Services abandonment/relocation or protection will be required to support the properties that remain within the area	• This option is to be further explored once the final CAT3 buyouts are confirmed.
L	Lowering of Nile Road	• Lower Nile Road to convey overland flows from the residential area to Nile Road.	• Reduction in flood levels around the residential areas however the depth of the flooding in Nile Road increased. Nile Road is the primary egress route for the residents and therefore the increased depth along the road will worsen the flood risk outside the properties.	• Not considered	• Not considered	• AT approval to lower Nile Road • Significant diversion of assets on the road reserve • Adjustment of driveways or Vehicle crossing to properties facing Nile Road	• This option is not recommended due to increase in flood depths along Nile Road and significant challenges to deliver as outlined in the risks.
M	Storage/Detention Scheme along Wairau Road	• Excavation of land adjacent to the creek to provide for flood storage and reduce flood levels.	• Flood level reduction in Wairau Road and around commercial properties	• Not considered	• Opportunity to incorporate shared path facilities and reserve land around commercial properties	• Groundwater settlement on adjacent buildings and assets • Contamination and risk of excess material being carted off to landfill • Temporary and permanent impacts on existing assets	• This option is not currently recommended, as the space available does not provide significant flood benefit compared to the large amount of commercial property purchase and significant relocation of services. It could be further considered if Option J-2 (Wairau widening) through the commercial area is undertaken.
N	Diversion to Hillcrest catchment (Shoal Bay) via Smiths Bush Reserve	• Construction of a new channel in AF Thomas and Smiths Bush Reserve to divert flows from commercial area to Hillcrest catchment	• Flood level reduction in Wairau Road and around residential properties downstream	• Not considered	• Similar co-benefits as A F Thomas Park	• Diversion of flows to Shoal Bay is likely to be a major consenting issue relating to freshwater, groundwater, flooding impacts (e.g. motorway) and ecology (Significant	• This option is not currently recommended, due to the complex nature and significant works required to construct the option. This option is likely to be

Option	Name	Description	Flood Benefits	CAPEX Estimate[1] (P50)	Co-Benefits	Option Key Risks & Constraints	Summary and Dependencies
		• Potentially requires specific design around Vector substation to link the flows from the commercial area to AF Thomas • Requires new culvert or bridge under Northcote Road and may require upgrade to existing culvert under SH1 • Option can be combined with storage in A F Thomas				Ecological Areas) and associated cultural impacts/considerations • Significant works required around the WW Transmission line in A F Thomas and Smiths Bush Reserve • Significant deep excavations (or tunnel) required to obtain a positive gradient for the channel from AF Thomas Park to Smiths Bush Reserve • Potential major disruption to traffic due to new or upgrade of existing culvert crossings • Underlying geology (ie basalt rock restricting ability to excavate for a channel or require expensive tunnelling for a piped option • Contamination and risk of excess material being carted off to landfill • Temporary and permanent impacts on existing asset	costly and have major consenting issues.
O	Significant upgrade of existing detention schemes	• Excavation of existing storage areas to increase additional storage. • Floodwalls and/or bunding of storage areas to increase storage and reduce overtopping flows	• Flood level reductions immediately downstream however no major benefits to the commercial or the residential areas along Nile Road are likely	• Not considered	• Plant native vegetation and create amenity spaces as part of the upgrade	• Relocation of services and subsoil drains • Groundwater settlement and contamination risk. • Potential for design, consenting and operational requirements associated with Large Dam classification.	• This option is not recommended as cost is likely to be disproportionate to likely benefits. Major changes are also likely to have large dam implications increasing operations and maintenance costs. Smaller changes are recommended as part of options D, E, F, G.

4 ASSUMPTIONS & RISKS

4.1 FLOOD MODEL

Auckland Council's Wairau Catchment Flood Hazard Model (ID1416) has been used to test potential options. Localised updates have been made to the model to improve confidence in model results within the Nile Road study area. These updates have been made to provide a more accurate representation of the hydraulic mechanisms.

Overall, the model is considered a suitable tool for informing decision making on the benefits of potential options, noting the limitations discussed further in this section. This model provides an understanding of the relative benefits (e.g. reduction in flood level) of an intervention. Further work is required to improve the precision of model levels to represent the flood event that occurred in January 2023, and predicted future flood extents, with consideration of climate change.

4.2 KEY ASSUMPTIONS

The key assumptions of this work include:

- The identified options are subject to further stakeholder input, design and investigation. It may be necessary to refine, alter, or replace elements of the identified option to optimise flood benefits, co-benefits and cost.
- It is assumed co-benefits will be further explored to improve the option outcomes.
- Maximum probable development has been based on the Unitary Plan zoning. 1% AEP event considers maximum probable development and climate change of 3.8 degrees.
- Where observed flooding during the events of Jan/Feb 2023 exceeds the flooding predicted by the 1% AEP event, the greater of the two scenarios has been used to map Indicative Flooding Extent. This does not necessarily align with the 1% AEP MPD3.8CC event and some differences may be observed.
- As part of the options development process and to measure benefits, WSP applied the following definitions in agreement with Auckland Council:
    - Building Exposed to Intolerable Risk to Life (category 3) are residential properties with >500mm habitable floor flooding, or any habitable floor flooding with depth >500mm or depth x velocity >0.4m²/s along evacuation routes in a 1% AEP MPD 3.8 degrees climate change event.
    - Habitable floor flooding are residential properties with predicted habitable floor flooding in a 1% AEP MPD 3.8 degrees climate change event, not meeting the intolerable risk criteria.
    - Building Exposed to Flood Risk are residential properties where the 1% AEP MPD 3.8 degrees climate change event intersects the building footprint, not meeting habitable floor flooding criteria.

- Commercial Building Floor Flooding are non-residential buildings (e.g., industrial, community) with predicted floor flooding in a 1% AEP MPD 3.8 degrees climate change event.
- Section Exposed to Flood Risk are properties where the 1% AEP MPD 3.8 degrees climate change floodplain intersects the property boundary but not the building footprint, not meeting other flood risk criteria.

- Where property floor levels are not known, floor levels have been taken from the maximum ground level (from DEM). Any properties with a >300mm difference between the average and maximum ground levels were reviewed and a judgement made on an appropriate ground level. A 150mm factor has been applied to the predicted ground level to assume the floor level (freeboard above ground as per the Building Act).
- Benefits have been assessed independently for each option. Where multiple options combine to form a stage (e.g. a Stage 1), the total benefit does not necessarily represent the combination benefits of both stages individually.
- Benefits include those related to required property acquisitions to enable a proposed scheme.
- Only properties that intersect the 1% AEP MPD 3.8 degrees model results have been considered in the benefits assessment. The extent of properties included in this assessment do not necessarily align with the baseline indicative flooding extent as this has been adjusted in places (i.e. Nile Road / Woodbridge Lane) to extend to overserved flooding during the Jan/Feb 2023 events.
- Updates to the Wairau Catchment model to date are limited to the Nile Road study area. Further updates to the model are planned following testing and refinement of model parameters as part of a more in-depth model validation exercise.
- Some of the model updates improve overall representation of key items however don't necessarily improve model validation. Despite the model not validating initially to the 27th January event, it is still considered an appropriate tool for assessing the relative benefit of options in terms of water level reduction.

4.3 RISKS & UNCERTAINTIES

The key risks and uncertainties of this work include:

- Properties purchased as part of the voluntary buyout scheme are likely to be finalised in April 2025. Until this time there is uncertainty as to how many additional properties would need to be acquired in order to enable the proposed works for Nile Road and Totara Vale.
- The design rainfalls for the region are currently being revised considering the recent extreme events. This is likely to show the scale of the flooding is worse, with more properties at risk, and the level of protection that can be provided to the houses post works may be less. Once the preferred solution is run through the updated base model, the flooded building count may change, however the relative benefits (number of properties that benefit) are expected to remain similar.
- Further model validation is underway to represent events from 2023, the current model may over/understate predicted flooding effects in the design model.

- Site conditions, such as variable ground conditions, may not be suitable for proposed designs or result in increased costs. Site-specific investigations and assessments will be required as design progresses (e.g. critical asset survey, geotechnical and contaminated land).
- Securing the contiguous land holding (e.g. in the Nile Road area), in a reasonable timeframe.
- Lack of community support for the proposed options, in particular AF Thomas Park and Nile Road, risks extending timelines and incurring additional cost.
- Refer to the Blue Green programme risk register for additional risk and impact information. Option-specific key risks are identified in Table 1.

5 CONCLUSIONS AND RECOMMENDATIONS

The assessment documented in this report shows there are solutions available to reduce the existing flood risk, and the impact of events like that which occurred in January 2023 in the Wairau catchment.

There remain uncertainties associated with what future flood risk looks like, as rainfall statistics require updating following the extreme January 2023 event. Although there may be uncertainty regarding the level of risk, the scale of benefits tested using the existing catchment hydraulic model are expected to remain similar.

The following are recommendations from this phase of work:

- Use the information in this report, and outputs from hydraulic modelling, to compare benefits and costs as part of a business case that seek funding and approval for the recommended options.
- Consider how the recommended options are staged, taking into consideration success factors, such as flood mitigation benefits, economic benefits, deliverability, alternative revenue opportunities, and option dependencies.
- Improve the validation of the existing hydraulic model to the January 2023 flood event, and use updated rainfall statistics to predict future flood risk in the catchment. Use this tool to verify benefits and inform the next design stage of options that are taken forward.
- Develop a holistic catchment wide strategy that uses these flood risk management options as a catalyst to unlock potentially wide-ranging additional benefits across a range of values. This can include working with mana whenua, the community and other stakeholders.

6 BIBLIOGRAPHY

— AECOM (2023, May 17). Wairau Valley Catchment Stormwater Modelling, Model Build and Validation Report. Draft report prepared for Auckland Council.

APPENDIX A: OPTION ASSESSMENT MODEL SIMULATIONS

Options assessment – modelled scenarios

OVERVIEW	REFERENCE	DESCRIPTION	ADDITIONAL INFORMATION	DATE MODELLED	EVENT SIMULATED
1. Bridge removal	1a	Remove Waterloo Rd Bridge	Not modelled		
	1b	Remove Alma Rd Bridge	Not modelled		
	1c	Remove Kitchener Rd Bridge	Not modelled		
	1d	Remove Waterloo Rd and Alma Rd Bridges	Remove Waterloo and Alma 1D bridge structure and model as 1D River Reach. Keep US/DS cross sections the same as base model.	Modelled by AECOM	100-yr MPD 3.8dC
	1e	Remove Waterloo Rd, Alma Rd and Kitchener Rd Bridges	Remove all bridges and model as 1D River Reaches	Modelled by AECOM	100-yr MPD 3.8dC
2. Channel and Bridge Removal	2a	Alma Rd to Kitchener Rd	Adding a shelf on the true left-hand bank between Alma and Kitchener. Remove Kitchener Bridge, Woodbridge Bridge and Alma Bridge - model as River Reach. Shelf Approximately 17m wide. Created from base cutdown model.	30/04/2024	100-yr MPD 3.8dC
	2b	Waterloo Rd to Kitchener Rd	Adding a shelf on the true left-hand bank between Alma and Kitchener. Remove Kitchener Bridge, Waterloo Bridge, Woodbridge Bridge and Alma Bridge - model as River Reach. Shelf Approximately 17m wide. Created from 2a scenario.	30/04/2024	100-yr MPD 3.8dC
	2c	Wairau Rd to Kitchener Rd	Adding a shelf on the true left-hand bank between Alma and Kitchener. Remove Kitchener Bridge, Waterloo Bridge, Woodbridge Bridge and Alma Bridge - model as River Reach. Wairau bridge removed. Shelf Approximately 17m wide. Created from 2b scenario.	30/04/2024	100-yr MPD 3.8dC
	2d	Tristram Ave-Kitchener Rd	Widened channel from Tristram Ave to Kitchener. In commercial area, existing channels were widened on one side only to form a trapezoidal type cross section. Existing channel inverts retained. Channels widened by approximately 10m in commercial area - which provides between 2-3x the existing channel capacity. All culverts/bridges removed from this scenario. Shelf Approximately 17m wide downstream of Wairau Rd. Created from 2c scenario.	2/06/2024	100-yr MPD 3.8dC
	2e	Alma Rd to Kitchener Rd (Alma Rd bridge removed, Kitchener Rd Bridge retained.)	Widened from Alma Rd To Kitchener Rd. Alma Rd Bridge removed, Kitchener Rd Bridge retained Created from 2a scenario.	10/10/2024	100-yr MPD 3.8dC
3. A F Thomas Park Investigation	3a	A F Thomas Park and Sunnybrae channel diversion	Bund surrounding A F Thomas Park with crest level of 15.8m RL. One channel diversion from Sunnybrae Road modelled using an inline bank structure to divert flows from upper area near Archery range to A F Thomas Park. Existing A F Thomas Park culverts retained. Copy of base MPD model used to create this scenario.	13/05/2024	100-yr MPD 3.8dC
	3b	A F Thomas Park Culvert Removal	DS A F Thomas Park culverts removed and culvert embankment burnt through with a 10m flat channel. Mesh edited directly in ICM for this. Copy of base MPD model used to create this scenario.	29/05/2024	100-yr MPD 3.8dC
	3c	A F Thomas Park OLFP & Twin 1800mm	Two walls added (15mRL and 14mRL) within A F Thomas Park and ground model updated with overland flow path from car park accommodated within A F Thomas Park. Two new culverts (1800mm) added in A F Thomas Park and connected to overland flow path. One existing culvert removed and remaining culvert upgraded to 1800mm diameter. 3 culverts in total in A F Thomas Park. 3x sluice gates added downstream of the culverts with dimension to match the culvert size. Real time control added to close gates when downstream channel water level reached 14m RL. Sluice gates were not configured to re-open once closed. Created from Full Base Model (MPD).	29/05/2024	100-yr MPD 3.8dC

	3d	A F Thomas Park Storage (15.8m RL) and Max Diversion	Bund surrounding A F Thomas Park with level of 15.8m RL. Existing ground level within A F Thomas Park retained. 3x culverts (1800m) modelled as per 3c. Sluice gate added downstream of culverts with settings as per 3c scenario except gates now open when downstream channel water level drops below 14m RL. flows at multiple locations diverted to A F Thomas Park - 1d & 2d flows from 3a scenario loaded to line sources within A F Thomas Park - duplicate network/subcatchment removed. Created from 3a scenario.	4/06/2024	100-yr MPD 3.8dC
	3e	A F Thomas Park Storage – 1 x cell, RTC and Flow regulation	1x cell - A F Thomas Park excavated to 11.25m RL (new 3e_DEM surface imported). Channel on the southwest excavated and discharges to Event Centre channel via new culvert (1800m 12.9/12(us/ds inverts). Box channel (8m wide /3m height, 11.25m/10.75m us/ds invert) with RTC which activates to open sluice gate and allow flow into A F Thomas Park when water level in the channel immediately DS of the box culvert reaches 13.5m RL. Flow regulation added to Wairau Road Bridge which caps flow through the bridge to 61.8m3/s when the water level at the bridge reaches 12.8m RL. Flow regulation created from stage-flow from base model. Flood wall surrounding cell in A F Thomas Park (modelled as a porous wall with 20mRL) Copy of base MPD model used to create this scenario	12/06/2024	100-yr MPD 3.8dC
	3f	A F Thomas Park Extended Excavation	3x storage cells in A F Thomas Park (main cell IL 11.1m RL). New culvert DN1800 discharging to Event Centre channel New DN600 culvert between upper cells Box channel (8m wide /3m height), with RTC which activates to open sluice gate and allow flow into A F Thomas Park when water level in the channel immediately DS of the box culvert reaches 13.5m RL Flow regulation added to Wairau Road Bridge which caps flow through the bridge to 61.8m3/s when the water level at the bridge reaches 12.8m RL. Created from 3e scenario.	12/06/2024	100-yr MPD 3.8dC
	3g	A F Thomas Park storage & commercial channels widened	3x storage cells in A F Thomas Park New culvert DN1800 discharging to Event Centre channel New DN600 culvert between upper cells Box channel (8m wide /3m height), with RTC which activates to open sluice gate and allow flow into A F Thomas Park when water level in the channel immediately DS of the box culvert reaches 13.5m RL Commercial channels widened to new A F Thomas Park overflow (Tristan Avenue to culvert - 2000258437.1). Flow regulation at Wairau Bridge removed. Created from 3f scenario.	14/06/2024	100-yr MPD 3.8dC
	3h	A F Thomas Park storage (3x cells), RTC 13.5mRL, existing channels	3x storage cells in A F Thomas Park (main cell IL 11.1m RL). New culvert DN1800 discharging to Event Centre channel New DN600 culvert between upper cells Box channel (8m wide /3m height), with RTC which activates to open sluice gate and allow flow into A F Thomas Park when water level in the channel immediately DS of the box culvert reaches 13.5m RL Existing channel width in commercial / downstream area (no widening, unlike 3g). Flow regulation at Wairau Bridge removed. Created from 3f scenario.	9/09/2024	100-yr MPD 3.8dC
	3i	A F Thomas Park storage (1x cells), RTC 13.5mRL, existing channels	1x cell - A F Thomas Park excavated to 11.25m RL (new 3e_DEM surface imported). Channel on the southwest excavated and discharges to Event Centre channel via new culvert (1800m 12.9/12(us/ds inverts). Box channel (8m wide /3m height, 11.25m/10.75m us/ds invert) with RTC which activates to open sluice gate and allow flow into A F Thomas Park when water level in the channel immediately DS of the box culvert reaches 13.5m RL. Flow regulation at Wairau Bridge removed. Flood wall surrounding cell in A F Thomas Park (modelled as a porous wall with 20mRL) Created from 3e scenario	9/09/2024	100-yr MPD 3.8dC
	3j	A F Thomas Park storage (3x cells), passive control	3x storage cells in A F Thomas Park New culvert DN1800 discharging to Event Centre channel New DN600 culvert between upper cells Passive control between gold course and DS channel: 5m wide, 34m long. Upstream UL = 13mRL, downstream IL = 12.5mRL No DS flow regulation Created from 3h scenario	16/09/2024	100-yr MPD 3.8dC

	3k	A F Thomas Park storage (3x cells), existing culverts	3x storage cells in A F Thomas Park New culvert DN1800 discharging to Event Centre channel New DN600 culvert between upper cells Existing 1350mm & 600mm culverts at DS A F Thomas Park reinstated. No DS flow regulation A F Thomas Park inlets modelled as scruffy domes with GL = 13m RL Created from 3j scenario	19/09/2024	100-yr MPD 3.8dC
	3L	AF Thomas, single cell existing culverts with scruffy domes	1x cell - A F Thomas Park excavated to 11.1m RL (new 3e_DEM surface imported). Channel on the southwest excavated and discharges to Event Center channel via new culvert (1800m 12.9/12 (us/ds inverts). Existing 1350mm & 600mm culverts at DS A F Thomas Park reinstated. A F Thomas Park inlets modelled as scruffy domes with GL = 13m RL Flood wall surrounding cell in A F Thomas Park (modelled as a porous wall with 20mRL) Created from 3i scenario	7/11/2024	100-yr MPD 3.8dC
4. Nile Road Area	4a	Nile Road Daylight (2 channels)	Ground model updated with 2x channels within Nile Rd area diverting overland flow to widened Wairau channel. Some network updated as part of this to tie network into modified DEM. No retreat, i.e. existing ground surface between channels retained. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 2c scenario.	20/05/2024	100-yr MPD 3.8dC
	4b	Nile Road Daylight - retreat (2 channels)	Ground model updated with 2x channels within Nile Rd area diverting overland flow to widened Wairau channel AND retreat in Nile Rd area (raising ground levels). Some network updated as part of this to tie network into modified DEM. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 4a scenario.	20/05/2024	100-yr MPD 3.8dC
	4c	Nile Road Daylight (1 channels)	Ground model updated with 1x channels within Nile Rd area diverting overland flow to widened Wairau channel. Some network updated as part of this to tie network into modified DEM. No retreat, i.e. existing ground surface between channels retained. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 2c scenario.	20/05/2024	100-yr MPD 3.8dC
	4d	Nile Road Daylight - retreat (1 channels)	Ground model updated with 1x channels within Nile Rd area diverting overland flow to widened Wairau channel AND retreat in Nile Rd area (raising ground levels). Some network updated as part of this to tie network into modified DEM. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 4c scenario.	20/05/2024	100-yr MPD 3.8dC
	4e	Knightsbridge	Ground levels lowered in Knightsbridge pond. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 2c scenario.	22/05/2024	100-yr MPD 3.8dC
	4f	Woodbridge Lane OLF	Ground model modified to create overland flow path in Woodbridge Lane to divert overland flow to widened channel. Some network ground level adjustments to tie existing network to OLFP surface. No retreat, i.e. existing ground surface surrounding OLFP retained. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 2c scenario.	22/05/2024	100-yr MPD 3.8dC
	4g	Woodbridge Lane OLF with Retreat	Ground model modified to create overland flow path in Woodbridge Lane to divert overland flow to widened channel and retreat in Woodbridge Lane. Some network ground level adjustments to tie existing network to OLFP surface. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 4f scenario.	24/05/2024	100-yr MPD 3.8dC
	4h	Knightsbridge (20mRL wall applied)	Wall added surrounding Knightsbridge pond with a crest level of 20m RL. Spill way retained on downstream side of pond. Pond lowered as per 4e scenario. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 4e scenario.	24/05/2024	100-yr MPD 3.8dC

	4i	Nile Road Lowered + Daylight	Single channel in Nile Road area and Nile Road lowered. Some network ground level adjustments to tie existing network to OLFP and lowered Nile Rd. No retreat, i.e. existing ground surface between channels retained. Wairau Channel widened from Wairau Rd to Kitchener (Kitchener removed). Created from 4c.	24/05/2024	100-yr MPD 3.8dC
	4j	Nile Road Combined Scenario 1	Widened channel from Alma to Kitchener, Alma Rd bridge removed, Kitchener Rd Bridge retained. Single channel from 4c scenario added in Nile Road area + overland flow path from 4f scenario in Woodbridge Lane area added. No retreat in either Nile Rd or Woodbridge areas (i.e. existing ground levels retained outside of overland flow paths). Created from 2a scenario.	30/05/2024	100-yr MPD 3.8dC
	4k	Nile Road Combined Scenario 2	Widened channel from Alma to Kitchener, Alma Rd bridge removed, Kitchener Rd Bridge retained. Single channel in Nile Road area + lowered Nile Rd (from 4i scenario). Overland flow path from 4f scenario in Woodbridge Lane area added. No retreat in either Nile Rd or Woodbridge areas (i.e. existing ground levels retained outside of overland flow paths). Created from 4j scenario.	30/05/2024	100-yr MPD 3.8dC
	4L	Nile Road Reduced Widening	Widened channel from 30A Wolsey Avenue to Alma Road. Single channel from 4c scenario added in Nile Road area + overland flow path from 4f scenario in Woodbridge Lane area added. No retreat in either Nile Rd or Woodbridge areas (i.e. existing ground levels retained outside of overland flow paths). Created from 4J	3/07/2024	100-yr MPD 3.8dC
	4M	Nile Road Reduced Widening (Extended)	Extended Reduced Widened channel from 24A Wolsey Avenue to Alma Road. Single channel from 4c scenario added in Nile Road area + overland flow path from 4f scenario in Woodbridge Lane area added. No retreat in either Nile Rd or Woodbridge areas (i.e. existing ground levels retained outside of overland flow paths). Created from 4L	10/07/2024	100-yr MPD 3.8dC
	4N	Knightsbridge (22mRL wall applied) plus blocked pipe when 18mRL at 2000847824	Ground levels lowered in Knightsbridge pond (as per 4e DEM). Created a new surface as a combination 4e and Base Wairau. Flood Wall added surrounding Knightsbridge pond with a crest level of 22m RL. Sluice gate added to the downstream of 2000847824.1 link. Gates close when water level at 2000847824 reach 18mRL. Created from Full Base Model.	30/07/2024	100-yr MPD 3.8dC
	4O	Nile Road Daylight (1xchannels) without widening from 2c	Ground model updated with 1x channels within Nile Rd area diverting overland flow to existing Wairau channel. Some network updated as part of this to tie network into modified DEM. No retreat, i.e. existing ground surface between channels retained (as per 4a scenario) Created from Cutdown Base scenario.	1/10/2024	100-yr MPD 3.8dC
	4P	Nile Road Daylight (2x channels) without widening from 2c	Ground model updated with 2x channels within Nile Rd area diverting overland flow to existing Wairau channel. Some network updated as part of this to tie network into modified DEM. No retreat, i.e. existing ground surface between channels retained (as per 4c scenario) Created from Cutdown Base scenario.	1/10/2024	100-yr MPD 3.8dC
	4R	Nile Road Extended Daylight (2 channels with extension of first one)	Ground model updated with 2 channels within Nile Road Area (extension of first channel applied). Create a new surface as a combination 2a (widening Alma Rd to Kitchener Rd) and new surface inc. Nile Road Daylight (2channels from 4a) with extension of first channel (no retreat). Updates of part the network into modified DEM. Created from Cutdown Base scenario.	02/10/204	100-yr MPD 3.8dC
	4S	Knightsbridge	Knightsbridge Reserve excavated with minor storage. DEM modified to represent storage cell. Floodwall added with crest level 18.75m RL; the spillway level in the middle is 500mm higher than current level (modelled as a mesh level zone) Created from Full MPD base model.	07/10/205	10-yr MPD 3.8dC
5. Totara Vale Motorway	5a	Totara Vale Motorway Culvert	Culvert (2000026757) was set to discharge out of model (1D outfall) - in MPD is connected to storm network. Copy of base MPD model used to create this scenario.	13/06/2024	100-yr MPD 3.8dC
	5b	Totara Vale - blocked culvert	Block culvert by deleting culverts inlets (BRK1584_2.1, BRK1584_2.3) and set 3 surrounded manholes (inc. scruffy dome) as a sealed type (from Gully 2D). Copy of base MPD model used to create this scenario.	2/07/2024	100-yr MPD 3.8dC

	5c	Totara Vale_Storage3ponds_2x_Floodwalls	Totara Vale excavated with 3x storage cells. DEM modified to represent storage cells. Also two floodwalls added around two new cells - Rewi Alley Floodwall at 31.8m RL and Trias Reserve Floodwall at 27.5m RL but stepping down at two vertices at 26.7m RL respectively. Created from Full Base Model (MPD)	2/09/2024	100-yr MPD 3.8dC
6 - Beacroft	6a	Becroft Floodwall 20 mRL	Adding a floodwall at 20mRL, setting RTC on pipe flow away from area with turning off when water level at basin reach 16.2mRL. Created from Full Base Model (MPD).	1/08/2024	100-yr MPD 3.8dC
	6b	Becroft Minor Storage with Floodwall 16.7m RL	Becroft Park excavated with 1x storage cell. DEM modified to represent storage cell. Updates of Bankline channels and network within new surface area were required. A floodwall with crest level 16.7m RL was added in south-west of Becroft Park. Created from Full Base Model (MPD)	4/10/2024	10-yr MPD 3.8dC
7 - Sunnynook	7a	Sunnynook excavation and floodwalls	Adding a floodwalls at 24.7mRL and 26.2mRL, setting RTC on pipe flow away from excavation area with turning off when water level reach 24.7mRL. Ground model modified to include excavation area. Created from Full Base Model (MPD)	1/08/2024	100-yr MPD 3.8dC
	7b	Sunnynook minor storage with floodwall 25.2mRL	Sunnynook Park excavated with 1x storage cell. DEM modified to represent storage cell. Floodwall added with crest level 25.2m RL . Updates of Bankline channels within new surface are were required. Created from Full Base scenario.	4/10/2024	10-yr MPD 3.8dC
8 - McFetridge	8a	McFetridge Storage & New culvert	McFetridge Park excavated to 17m RL (new surface combined with base DEM) from the channel's true right bank of 18m RL (we would like to overtop into the excavated area once the water level reaches 18m RL in the channel). Adding a two bunds: first in the channel just downstream of excavated area at 20.5m RL; second on the southern edge of excavated area to divert OLFs directly to the channel rather than filling the excavated area prematurely (bund to be 1m high than its upstream ground level and should fall towards the main channel). Additionally new culvert in the bunded area at the channel 3m (wide) x 2m (high). Created from Full Base Model (MPD)	6/08/2024	100-yr MPD 3.8dC
	8b	McFetridge Maximum Benefit	Adding a bund with infinite height near McFetridge Park to hold water upstream and not pass anything forward. This option is to test if no flow passed forward, what the DS benefit would be. Created from Full Base Model (MPD)	7/08/2024	100-yr MPD 3.8dC
9 - Link Drive / Croftfield Lane	9a	Link Dr Croftfield Lane Combined storage / channel scheme_Floodwall19.6m	Link drive and Croftfield Lane wetland ponds replaced with new BG corridor with wetlands for storage. Floodwall on the western boundary at 19.6m RL . Created from Full Base Model (MPD)	26/08/2024	100-yr MPD 3.8dC
	9b	Link Dr Croftfield Lane Combined storage / channel scheme – No Floodwall	Link drive and Croftfield Lane wetland ponds replaced with new BG corridor with wetlands for storage. Floodwall from 9a scenario removed. Created from 9a scenario.	27/08/2024	100-yr MPD 3.8dC
	9c	Croftfield Culvert Upgrade	Upgrade culvert 2000404638.1 to 6m x 2m box similar to the culvert crossing Tristram Ave and then set the weir height to "no height" and weir width to 6m. Created from Full MPD Scenario. NOTE: there is a difference in the way the DS headloss is represented in the base / 9C option model that could impact results. This is to be revised for future modelling.	2/10/2024	10-yr MPD 3.8dC
	9d	Link Road Wetland Extension	DEM modified to included h additional storage with the carpark removed. Additionally floodwall RL set to 18.8mRL was applied Created from Full Base scenario.	4/10/2024	2-yr MPD 3.8dC
10 – Commercial / Greenway	10a	Tristram Avenue & Currys Lane Storage	Modified DEM with pond between Tristram Avenue and Currys Lane, removing culverts along open channel and replaced with river reaches for channel running along pond. Roughness updated to Mannings n 0.05 within pond. Created from MPD scenario.	27/09/2024	100-yr MPD 3.8dC
	10b	Tristram Avenue & Currys Lane Storage + Widening	Modified DEM with pond between Tristram Avenue and Currys Lane, removing culverts along open channel and replaced with river reaches for channel running along pond. Roughness updated to Mannings n 0.05 within pond. Widening of existing channel (as per 2d scenario) at the section between 91 Wairau Road and 10 Wairau Road (up to crossing with state highway) Created from 10a scenario.	27/09/2024	100-yr MPD 3.8dC

	10c	Tristram Avenue & Currys Lane Storage + Widening + A F Thomas Park (3k scenario)	Modified DEM with pond between Tristram Avenue and Currys Lane, removing culverts along open channel and replaced with river reaches for channel running along pond. Roughness updated to Mannings n 0.05 within pond. Widening of existing channel (as per 2d scenario) at the section between 91 Wairau Road and 10 Wairau Road (up to crossing with state highway) plus all changes within A F Thomas Park as per 3k scenario (New culvert DN1800 discharging to Event Center channel New DN600 culvert between upper cells Existing 1350mm & 600mm culverts at DS A F Thomas Park reinstated. No DS flow regulation A F Thomas Park inlets modelled as scruffy domes with GL = 13m RL A F Thomas Park setup should be the same as 3K. Created from 10b scenario.	27/09/2024	100-yr MPD 3.8dC
	10d	Commercial - Realistic Widening	Modified DEM with realistic widening between Tristram Avenue to motorway, removing culverts and replaced with river reaches within pond areas + realistic widening channel at the section between 91 Wairau Road and 10 Wairau Road (up to crossing with state highway) NOTE: For some culverts near the A F Thomas Park, these have not been widened to match the stream widening. This should be addressed in future modelling. Created from MPD	4/10/2024	100-yr MPD 3.8dC
	10e	Commercial - Realistic Widening & A F Thomas Park storage (3x cells)	Modified DEM with realistic widening between Tristram Avenue to motorway 3x storage cells in A F Thomas Park; removing culverts and replaced with river reaches within pond areas + realistic widening channel at the section between 91 Wairau Road and 10 Wairau Road (up to crossing with state highway) plus all changes within A F Thomas Park as per 3k scenario (New culvert DN1800 discharging to Event Center channel New DN600 culvert between upper cells Existing 1350mm & 600mm culverts at DS A F Thomas Park reinstated. No DS flow regulation A F Thomas Park inlets modelled as scruffy domes with GL = 13m RL NOTE: For some culverts near the A F Thomas Park, these have not been widened to match the stream widening. This should be addressed in future modelling. A F Thomas Park setup should be the same as 3K. Created from 10d scenario.	4/10/2024	100-yr MPD 3.8dC
11. Combined Scenarios	11a	Realistic Combined Master Scenario	1) Commercial Realistic Widening 2) GC Storage with no culvert upgrades near substation 3)Nile Road daylight 2 channels 4)Woodbridge OLF 5)Wairau Creek Widening (Alma to Kitchner) ; Alma Road Bridge Upgrade; NO Kitchner Road Bridge Upgrade 6) Minor detention upgrades - Sunnynook, Becroft, Knightsbridge, Link Road wetland extension(9D) 10e, 4j, 9D, 7B, 6B, 4S	7/10/2024	10-yr MPD 3.8dC / 100-yr MPD 3.8dC
	11b	AF Thomas Park (3x cell) & Nile Rd Daylight (2x channel)	AF Thomas Park excavated with 3x storage cells (3K scenario) and 2x channels excavated within Nile Rd area diverting overland flow to existing Wairau channel (3P scenario). DEM modified to represent storage cells in AF Thomas Park and 2xchannels within Nile Rd. Existing culverts (ID's) downstream of AF Thomas retained and upstream inlet changed from 'culvert inlet' type to scruffy dome setup. Scruffy domes modelled as Gully 2D manholes with Q-H curve from the draft modelling spec. etc ,New culvert DN1800 discharging to Event Center channel New DN600 culvert between upper cells ((3K scenario) Network updates were required due to excavation of 2xchannels in Nile Road, additional to enable to convey transition between updated surface to existing channel mesh zone was used Created from 3k scenario.	31/10/2024	2-yr MPD 3.8dC/10-yr MPD 3.8dC / 100-yr MPD 3.8dC

	11c	Commercial Realistic Widening, AF Thomas Park (3x cell) & Widen Wairau-Kitchener	New combined surface including A F Thomas Park 3cells with realistic widening (10e scenario) and DEM with widening from. Wairau to Kitchener Road DEM (2c scenario). Kitchener Rd Bridge removed. Wairau Rd Bridge retained. Additionally all changes as per 10E&2c scenario Created from 10E scenario. Combined 10E & 2C	1/11/2024	100-yr MPD 3.8dC
	11d	AF Thomas Park (3x cell) & Nile Rd Daylight (2x channel) & Widen Alma-Kitch	New combined surface including A F Thomas Park 3cells + Nile Rd Daylight (2channels) + widening Alma-Kitch (Kitchener removed) plus all changes as per 3k&4P&2a Created from 3k scenario. Combined 3K, 4P & 2A	30/10/2024	100-yr MPD 3.8dC
	11e	Nile Road Daylight (2x channels)&widened Wairau Rd to Kitchener Rd (Kitchener removed) &maximum commercial widening and 3x cell A F Thomas Park with sluice gate	AF Thomas Park excavated with 3x storage cells (3K scenario) and 2x channels excavated within Nile Rd area diverting overland flow to existing Wairau channel (3P scenario) and channel widen between Alma and Kitchener. DEM modified to represent storage cells in AF Thomas Park (3G scenario) and 2xchannels within Nile Rd (3P scenario) and widen channel Wairau Rd to Kitchener Rd (2c scenario). Commercial channels widened to new A F Thomas Park overflow (Tristan Avenue to culvert - 2000258437.1). All bridges were removed and was modelled as a river reach within widened sections (3G&2C). New culvert DN1800 discharging to Event Center channel . New DN600 culvert between upper cells Box channel (8m wide /3m height), with RTC which activates to open sluice gate and allow flow into A F Thomas Park when water level in the channel immediately DS of the box culvert reaches 13.5m RL.. Created from 3G scenario	5/11/2024	100-yr MPD 3.8dC
	11f	Nile Road Daylight (2x channels)&widened Wairau Rd to Kitchener Rd (Kitchener removed) &commercial widening and 3x cell A F Thomas Park	New combined surface including A F Thomas Park 3cells with commercial widening (10E+3K) + Nile Rd Daylight (2channels;4P) + widening Wairau-Kitchener (Kitchener removed;2C), plus all changes as per 10E&4P&2C Created from 10E scenario. Combined 10E&4P&2C	6/11/2024	100-yr MPD 3.8dC