Stormwater Assessment Report

Drury Centre

Stage 2
Kiwi Property Group Ltd
21/03/2025
Final

Document Control

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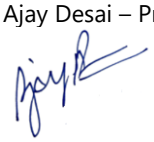
Reviewer	Pranil Wadan – General Manager – Water Infrastructure & Planning  Ajay Desai – Principal Engineer - Water Infrastructure & Planning 
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Contents

1. Executive Summary

Background

Kiwi Property No. 2 Limited ("Kiwi Property") has engaged Woods to prepare a stormwater assessment in support of a fast-track application for the subdivision and development of land as Stage 2 of the Drury Metropolitan Centre. Stage 2 compliments the development and activities approved in Stage 1 by proposing a range of commercial, retail, accommodation and community buildings and activities.

Private Plan Changes and relevant reporting

Three Plan Change applications have been approved to rezone the land within Drury East as follows:

- *Plan Change 48 (Kiwi* Property) – to rezone the Drury Centre Plan Change area (consisting of approximately 90ha) from Future Urban to Metropolitan Centre, Business – Mixed-Use and Open Space Informal Recreation zones
- *Plan Change 49 (Fulton Hogan Land Development)* - to rezone the Drury East Plan Change area comprising approximately 184 ha from Future Urban Zone to a mixture of Residential zones
- *Plan Change 50 (Oyster Capital)* – to rezone the proposed Waihoehoe Plan Change area from Future Urban Zone to Residential – Terrace Housing and Apartment Building zone.

PC48 and PC49 are located within the Hingaia Stream catchment, while PC50 falls within the Slippery Creek catchment. Based on feedback from Healthy Waters, an integrated Stormwater Management Plan (SMP) has been prepared for PC48 and PC49, herein referred to as Drury Centre and Drury East SMP, while PC50 has a separate SMP.

PC48 supports Auckland Council's Drury-Opaheke Structure Plan, with a key goal of developing a metropolitan centre near the fully funded Drury Central Train Station, set for completion in 2025.

There are several related reporting providing background information as follows:

- *Drury Centre and Drury East Stormwater Management Plan (Sept 2024),* Drury Centre and Drury East SMP:
    - Supports PC48 and PC49, aligning with regulatory requirements (Regionwide Network Discharge Consent (NDC)), Auckland Unitary Plan (AUP) guidelines
    - At the time of writing this report, Drury Centre and Drury East SMP is yet to be provisionally approved by Auckland Council and formally adopted under the NDC approval under the Network Discharge Consent (NDC).
- *Drury Centre Stormwater Assessment (Nov 2022):*
    - Focuses on stormwater management for PC48 and Stage 1, prepared under the Covid-19 Fast-track Consenting Act 2020.
- *Stormwater Implementation Management Plan for Drury Centre Stage 1 (Sept 2024):*
    - Details stormwater implementation strategies for initial developments.

Purpose

As the Drury Centre and Drury East SMP is yet to be approved by Auckland Council, the purpose of this report is to summarise the proposed stormwater management measures for Stage 2 of the Precinct. It has been prepared in accordance with the AUP, requirements of the NDC and the Drury Centre and Drury East SMP.

Existing catchment and receiving environment

The Precinct currently discharges to two different streams, with approximately 48.6 hectares discharging to Fitzgerald Stream, which is a tributary of the Hingaia Stream. The remaining 49.5 hectares drains south towards Hingaia Stream. The Fitzgerald Stream flows east to west through the northern part of the

Precinct, discharging into the Hingaia Stream via culverts at Flannagan Road, Great South Road, and the railway. It is fed by small intermittent streams from the Drury Centre and Drury East Precincts.

Stream A, a tributary of Fitzgerald Stream, spans approximately 400 meters with both intermittent and permanent reaches. It begins in a paddock, forming a permanent channel that flows south to north before connecting to Fitzgerald Stream via a short, piped section.

The Hingaia Stream runs along the Precinct's western boundary in a northerly direction, receiving inflows from two tributaries within the Precinct. Its floodplain follows the western boundary of the Drury Centre Precinct, while the Fitzgerald Stream floodplain extends through the area.

Proposed development

The project includes the development of buildings and structures for a variety of commercial, retail, accommodation and community activities with ancillary car parking. The project also involves associated enabling bulk earthworks, the creation of open spaces and stream enhancements, installation of three waters infrastructure and establishment of a roading network.

Stakeholder engagement and consultation

A session has been held with Healthy Waters to discuss the proposed stormwater management approach for Stage 2. The outcomes of the session have been incorporated into the design and are summarised in Section 6 of this report.

Proposed stormwater management

The proposed stormwater management for Stage 2 has been split across two areas with approximately 14.7 ha draining to Fitzgerald Stream (Area 1) and 9.9 ha draining to Hingaia Stream (Area 2).

A summary of the stormwater management for the two areas is outlined in Figures E1 and E2 below.

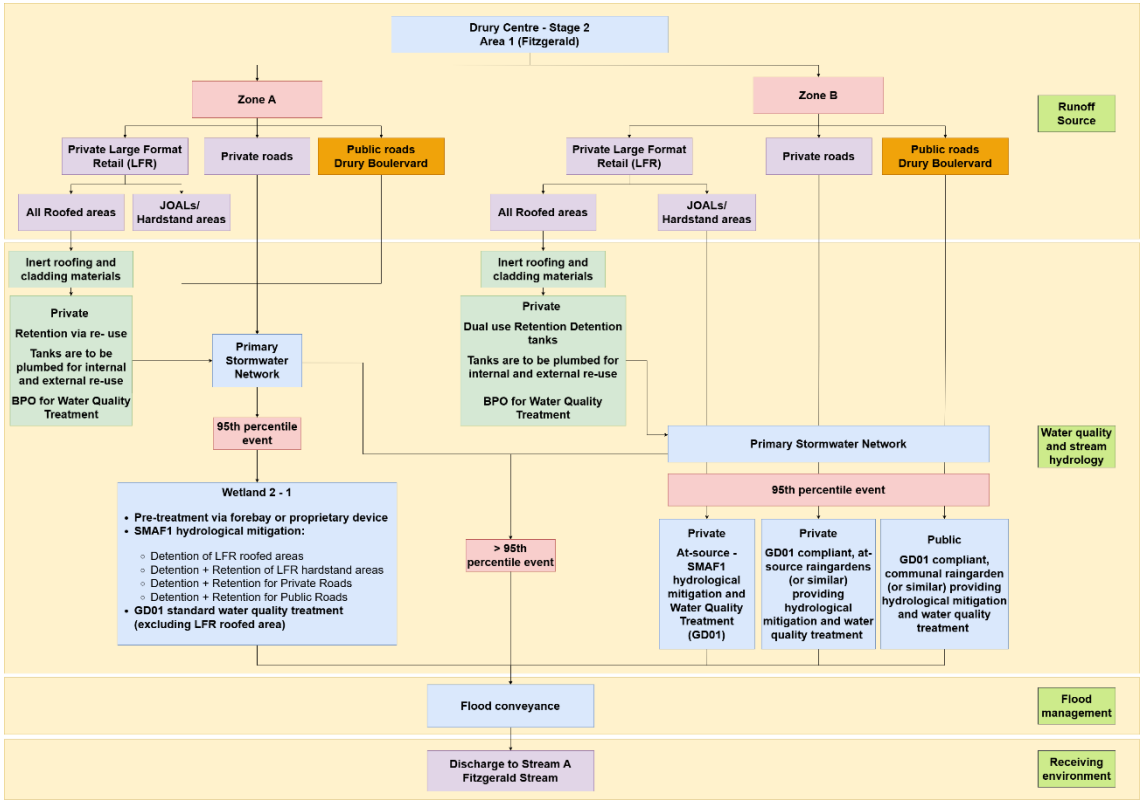

Figure E1: Area 1 – Stormwater Management

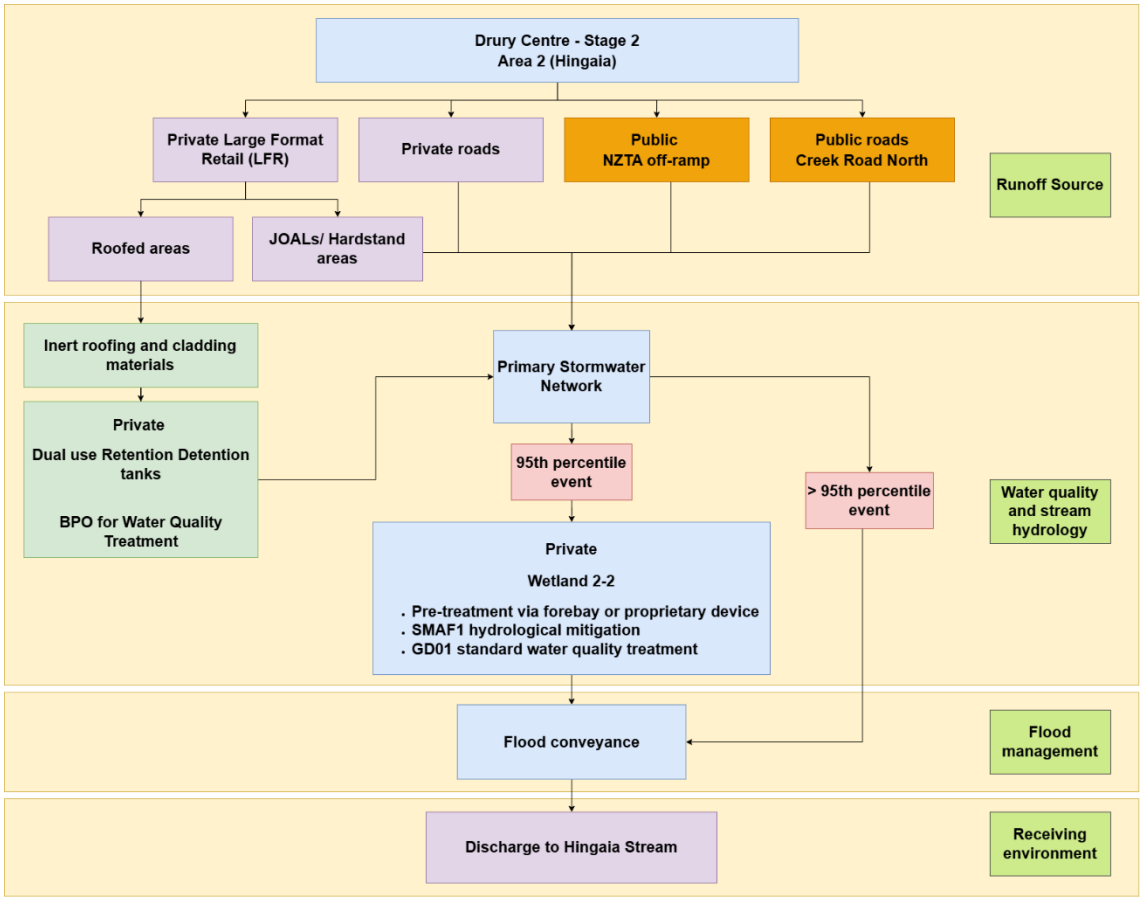

Figure E2: Area 2 – Stormwater Management

Flood modelling and flood management

To assess effects resulting from Stage 2 of Drury Centre development, a cutdown model has been developed, referred to as the 'Fitzgerald Stream Local Catchment' model using InfoWorks ICM. This has been developed based on the DHI Healthy Waters Hingaia catchment model (Model ID supplied 1318). This model has been built using InfoWorks ICM version 2025.3, using inflows and boundary conditions from the DHI model.

A summary of the modelled scenarios is provided in Table E1 below.

Table E1: Summary of modelled scenarios

Scenario	Storm Event (ARI)	Climate Change	Land use and Landform
Pre-development	2-year	2.1°C	• Drury Train Station – Landform + 100% imperviousness • LiDAR 2016 DEM data + existing imperviousness across model extent
	10-year		
	100-year		
Post-development	2-year	2.1°C	• Drury Train Station – Landform + 100% imperviousness • Drury Centre Stage 1 – design landform + 100% imperviousness

Scenario	Storm Event (ARI)	Climate Change	Land use and Landform
	10-year		• Drury Centre Stage 2 – Land use and landform adopted as per master plan • Fulton Hogan Stage 1 - Landform + existing Imperviousness • Fulton Hogan Stage 2 and 3 – Land use and landform adopted as per master plan • LiDAR 2016 DEM data + existing imperviousness across model extent Structures along Fitzgerald Tributary have been retained as per the pre-development scenario, except for Fielding Road culvert which is upgraded as part of the Fulton Hogan Stages 2 and 3 development.
	100-year		
Resilience Assessment	100-year	3.8°C	• Drury Train Station – Landform + 100% imperviousness • Drury Centre Stage 1 - Landform as per master plan + 100% imperviousness • Drury Centre Stage 2 - Land use and landform adopted as per master plan • Fulton Hogan Stage 1 – Landform + MPD Imperviousness • Fulton Hogan Stage 2 and 3 and Stages 4-7 – Land use and landform adopted as per master plan • LiDAR 2016 DEM data + MPD Imperviousness across model extent All structures along Fitzgerld Tributary upgraded as per the catchment wide flood management strategy to enable the conveyance of flood flows as documented in the Drury-Opāheke Draft Stormwater Management Plan andDrury Centre and Drury East SMP.

The model results indicate that the post development water levels generally decrease when compared to the pre-development scenario which is noted to be predominantly as result of the works completed as part of Drury Centre Stage 1. This results in a reduction to the contributing catchment discharging to Fitzgerald Stream and therefore reducing water levels. The modelling also indicates there will be no increased risk of flooding to third party land as a result of the development.

Area 1, discharges to Fitzgerald Stream which is noted to be restricted due to capacity of downstream culverts. The Drury Centre and Drury East SMP discusses temporary measures may be necessary for areas discharging to Fitzgerald Stream. Therefore, attenuation of Area 1 has also been considered as an interim measure as a potential flood management strategy in Area 1. However, modelling undertaken has determined that attenuation causes increased water levels downstream and therefore has been discounted.

2. Introduction

2.1. Background

This report is prepared in support of a fast-track application submitted by Kiwi Property No. 2 Limited ("Kiwi Property") for the subdivision and development of land as Stage 2 of the Drury Metropolitan Centre. This application follows the resource consent granted for the subdivision and development of Stage 1 in Drury Centre directly to the south of the project area which adopts and implements an integrated stormwater management approach.

Stage 2 of the Drury Centre compliments the development and activities approved in Stage 1 by proposing a range of commercial, retail, accommodation and community buildings and activities ("the project"). The

project also includes the creation of open spaces, bulk earthworks, installation of infrastructure and roading network.

2.2. Private Plan Changes and Reporting

Three different Plan Change applications have been approved to rezone the land at Drury East, and granted, as follows which provides the relevant background for stormwater management in Drury East and within the project area in particular:

- Plan Change 48 (Kiwi Property) – to rezone the Drury Centre Plan Change area (consisting of approximately 90ha) from Future Urban to Metropolitan Centre, Business – Mixed-Use and Open Space Informal Recreation zones
- Plan Change 49 (Fulton Hogan Land Development) - to rezone the Drury East Plan Change area comprising approximately 184 ha from Future Urban Zone to a mixture of Residential – Terrace Housing and Apartment Building, Residential – Mixed Housing Urban, Residential – Mixed Housing Suburban and Neighbourhood Centre zones
- Plan Change 50 (Oyster Capital) – to rezone the proposed Waihoehoe Plan Change area from Future Urban Zone to Residential – Terrace Housing and Apartment Building zone.

PC48 and PC49 areas are located within the Hingaia Stream catchment, while PC50 is located within the Slippery Creek catchment. Following feedback from Healthy Waters, an integrated Stormwater Management Plan has been prepared for PC48 and 49 areas whilst a separate Stormwater Management Plan has been prepared for PC50.

PC48 gave effect to Auckland Council's Drury-Opaheke Structure Plan, where a key component is to develop a metropolitan centre in Drury East directly adjacent to the existing railway network and the consented Drury Central Train Station.

The zoning plan of the Drury Centre Precinct, highlighting Stage 1 and 2, is highlighted in Figure 1 below.

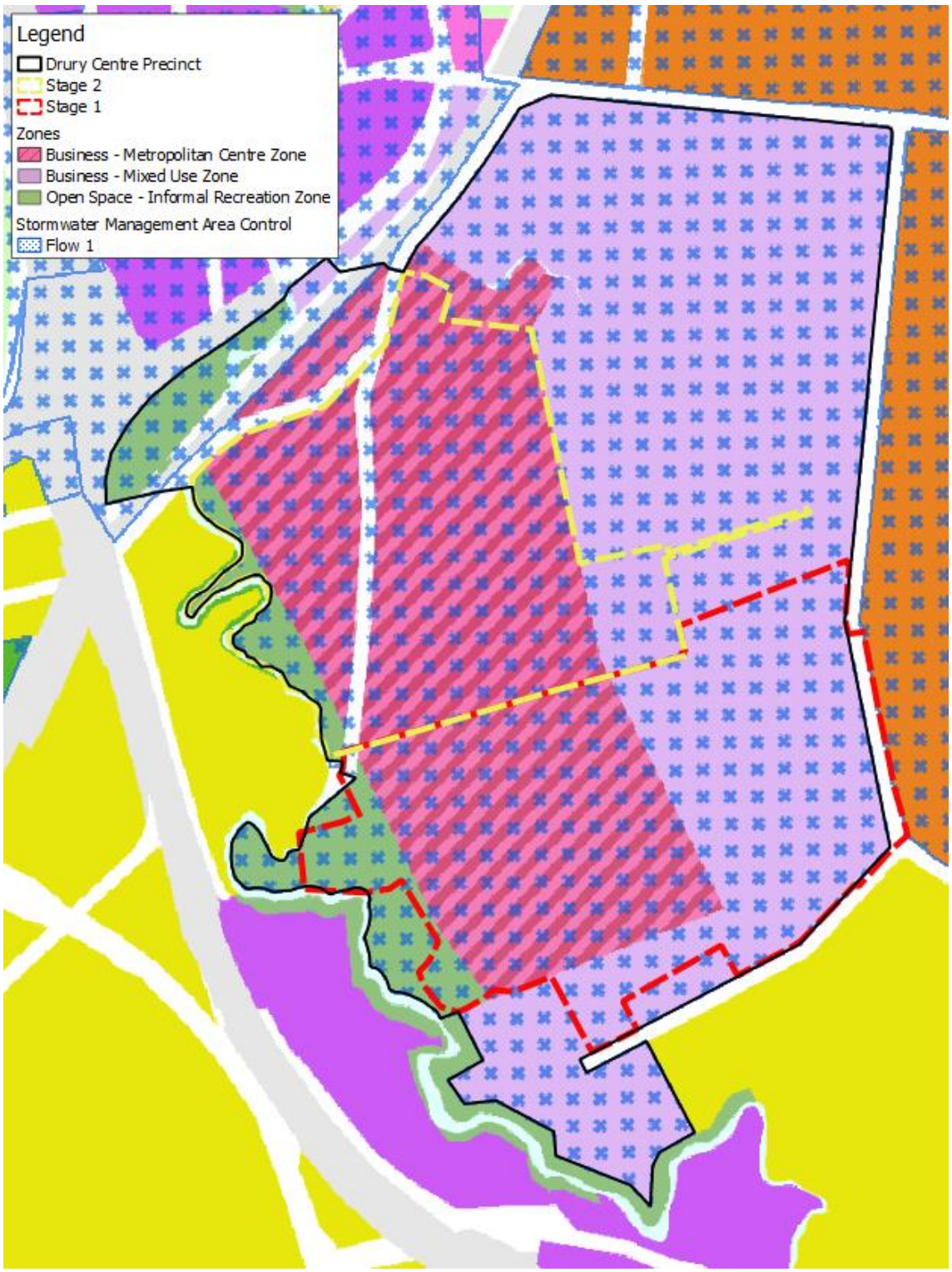

Figure 1: Drury Centre Precinct

The rezoning enables the development of a new transit-oriented metropolitan centre around the approved and fully funded Drury Central train station, set to be completed in 2025. The primary goal of the Drury Centre Precinct is to create a well-planned and transit-oriented centre in Drury, fostering a high-quality compact form.

2.3. Related reporting

There are several related reporting and memorandums providing background information as follows:

- Report: The Drury Centre and Drury East Stormwater Management Plan for (Tonkin & Taylor Ltd and Woods, Rev C September 2024), here in referred to as the Drury Centre and Drury East SMP
    - This report has been prepared to support PC48 and PC49 and is consistent with regulatory and stormwater specific guidelines
    - It has been prepared in accordance with Auckland Unitary Plan - Operative in Part (AUP) and requirements as set out in the Regionwide Network Discharge Consent (NDC)
    - It is intended to inform stormwater management approaches and design for future Resource Consents and Engineering Plan Approvals of proposed developments
    - At the time of writing this report, the Drury Centre and Drury East SMP is yet to be provisionally approved by Auckland Council and formally adopted under the NDC.
- Report: The Drury Centre Stormwater Assessment (Tonkin & Taylor Ltd, Nov 2022)
    - This report has been prepared for the Stage 1 Drury Centre Precinct project in support of the Fast-track application approved under the Covid-19 (Fast Track Consenting) Act 2020
    - It summarises the stormwater management requirements of PC48 area and in particular, stormwater management approach for the Stage 1 area in further details and is in accordance with the Drury East SMP
    - The report describes the stormwater management strategy and the proposed best practicable option (BPO) for the development
- Report: Stormwater Implementation Management Plan for Drury Centre Stage 1 (Woods, September 2024)
    - This report has been prepared to support the EPA for Stage 1 Drury Centre and describes the stormwater management measures designed to support the application
    - It has been accepted and approved by Healthy Waters

2.4. Purpose and objectives

The Drury Centre and Drury East SMP is yet to be provisionally approved by Auckland Council. This report has been prepared in accordance with the AUP, requirements of the NDC and the Drury Centre and Drury East SMP. It summarises the proposed stormwater management measures for Stage 2 of the Precinct.

The overall purpose of this report is to provide guidance to the applicant and inform Auckland Council on how stormwater will be managed for the subdivision and development of land located within Stage 2 of the Drury Centre development.

The overarching objectives are as follows:

- Meet requirements of Schedule 4 of the NDC and the Drury Centre and Drury East SMP
- Incorporate a water sensitive design approach promoting at-source stormwater management to improve the quality of water being discharged
- Provide stormwater management guidelines for the project within the Drury Centre Precinct to ensure runoff will be conveyed in a safe manner to the receiving environment through the primary and secondary networks
- Provide betterment for the receiving environment via stormwater quality treatment guidelines and avoidance of high contaminant yielding roof and cladding materials

3. Statement of qualifications and experience

Colin Dryland

I am a Principal Engineer and the General Manager of Engineering at Wood and Partners Consultants Limited ("Woods"). Woods is a multi-disciplinary consultancy specialising in planning, urban design, engineering, water infrastructure, and surveying. I have been employed at Woods since 2012.

I hold a National Diploma of Architectural Technology (Unitec Institute of Technology, 2002), a New Zealand Diploma of Civil Engineering (Unitec Institute of Technology, 2011), and an Applied Diploma of Civil Engineering (Infratrain, 2014). I am a Chartered Professional Engineer (CPEng) and a member of Engineering New Zealand (CMEngNZ), Engineering New Zealand Transportation Group, New Zealand Society of Construction Law and Water New Zealand. In addition, I am also a qualified Independent Hearings Commissioner and am appointed to the Palmerston North City Council Commissioner Pool until November 2026.

I have 23 years of experience in all aspects of land development engineering design, construction and contract management.

I have been the principal designer, report author and lead engineer for a wide range and scale of land development projects, including but not limited to: earthworks and erosion and sediment control; civil infrastructure servicing; stormwater modelling and green infrastructure; on-site stormwater and wastewater disposal; roading, transport, pavement engineering and geometric design; streamworks and culverting; and all aspects of land development Resource Consenting and Engineering Plan Approval design and compliance.

I confirm that, in my capacity as approver of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Pranil Wadan

I am a Technical Director and the General Manager of Water Infrastructure & Planning at Wood and Partners Consultants Limited ("Woods"). Woods is a multi-disciplinary consultancy specialising in planning, urban design, engineering, water infrastructure, and surveying. I have been employed at Woods since 2012.

I hold a Bachelor of Engineering degree from the University of Auckland, which I completed in 2007. I am a Chartered Professional Engineer (CPEng) and a member of Engineering New Zealand (CMEngNZ) and Water New Zealand. In addition, I also hold the following qualifications and affiliations:

- International Professional Engineer (IntPe(NZ))
- Certified Independent Hearing Commissioner
- Certificate in Company Direction & Governance

I have over 16 years of experience in stormwater design, hydrodynamic modelling, flood risk assessments, water infrastructure and stormwater management for land development.

I have been the principal author and lead stormwater engineer for a wide range of stormwater management plans and flood modelling reports to support Woods' land development, urban design and planning teams. I have been involved in and prepared numerous catchment scale flood models, detailed stormwater pipe models and integrated catchment management plans for private clients as well as for district and regional councils.

I confirm that, in my capacity as approver of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Ajay Desai

I am a Principal Engineer at Wood and Partners Consultants Limited ("Woods"). Woods is a multi-disciplinary consultancy specialising in planning, urban design, engineering, water infrastructure, and surveying. I have been employed at Woods since 2012.

I hold a Bachelor's and master's in civil engineering. I am a Fellow Civil Engineer (CEng FICE), Chartered Professional Engineer (CPEng) and a member of Engineering New Zealand (CMEngNZ) and Water New Zealand. In addition, I also hold the following qualifications and affiliations:

- International Professional Engineer (IntPe(NZ))
- Certified Independent Hearing Commissioner

I have around 15 years of experience in three waters design, hydrodynamic modelling, flood risk assessments, civil infrastructure and catchment planning for various Councils and land development.

I have been the principal author and lead three waters engineer as well as a technical reviewer for a wide range of stormwater management plans and flood modelling reports to support Woods as well as Council teams. I have been involved in and prepared numerous catchment scale flood models, detailed stormwater pipe models and integrated catchment management plans for private clients as well as for district and regional councils.

I confirm that, in my capacity as reviewer of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023

Bidara Pathirage

I am a Senior Associate Engineer in the Water Infrastructure & Planning at Wood and Partners Consultants Limited ("Woods"). Woods is a multi-disciplinary consultancy specialising in planning, urban design, engineering, water infrastructure, and surveying. I have been employed at Woods since 2017.

I hold a Bachelor of Engineering degree from the University of Auckland, which I completed in 2007. I am a Chartered Professional Engineer (CPEng) and a member of Engineering New Zealand (CMEngNZ) and Water New Zealand.

I have over 12 years of experience in stormwater design, flood risk assessments, water infrastructure and stormwater management.

I have been the principal author and lead stormwater engineer for a wide range of stormwater management plans and flood modelling reports to support various projects.

I confirm that, in my capacity as lead author of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

Jasmin Moll

I am a Water Engineer at Wood and Partners Consultants Ltd ("Woods"). Woods is a multi-disciplinary consultancy specialising in planning, urban design, engineering, water infrastructure, and surveying. I have been employed at Woods since June 2024.

I hold a Bachelor of Engineering from University of Applied Science Konstanz (Germany), which I completed in 2019, and I hold a Master degree of Science from Hamburg University of Technology (Germany), which I completed in 2022.

I have 4 years of professional experience in the water engineering field. My experience includes stormwater management, flood management and modelling, hydrological and hydraulic assessment, and design of urban drainage infrastructure.

I confirm that, in my capacity as author of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023

Simran Bassan

I am an Intermediate 3-Waters Engineer at Wood and Partners Consultants Ltd ("Woods"). Woods is a multi-disciplinary consultancy specialising in planning, urban design, engineering, water infrastructure, and surveying. I have been employed at Woods since January 2022.

I hold a Bachelor of Engineering degree with honours from the University of Auckland, which I completed in 2021. I am an Emerging Professional member of Engineering NZ and a member of Water New Zealand.

I have 3 years of professional experience within the water engineering field. My key areas of expertise includes stormwater management, flood management and modelling and hydrological and hydraulic assessments.

I confirm that, in my capacity as author of this report, I have read and abide by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses Practice Note 2023.

4. Existing catchment and receiving environment

The development of Drury Centre comprises two stages, with Stage 1 being approved and currently under construction.

The Precinct currently discharges to two different streams, with approximately 48.6 hectares discharging to Fitzgerald Stream, which is a tributary of the Hingaia Stream. The remaining 49.5 hectares drains south and west towards Hingaia Stream. The existing features are summarised in Figure 2 below.

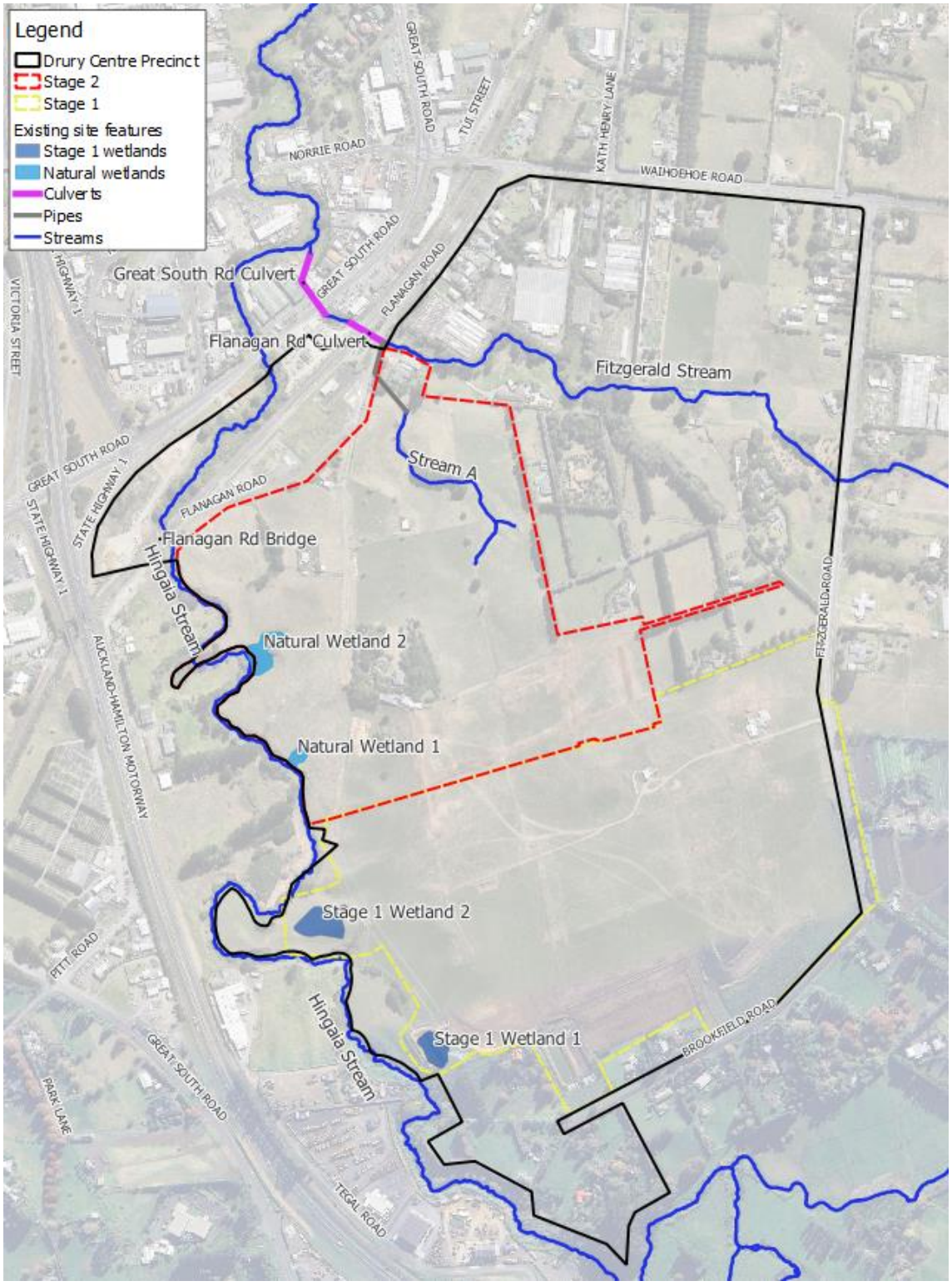

Figure 2: Existing features

The Fitzgerald Stream flows from east to west, passing through the northern part of the Precinct and eventually discharging into the Hingaia Stream via the existing Flannagan Road, Great South Road and Railway culverts as can be seen in Figure 2. This stream is fed by small, unnamed intermittent streams originating in the Drury Centre and Drury East Precinct upstream.

Stream A, a tributary of Fitzgerald Stream, includes intermittent and permanent reaches spanning approximately 400 meters. It originates in a paddock through a series of small intermittent tributaries before forming a permanent channel. This channel flows south to north and connects to the Fitzgerald Stream via a short, piped section (Figure 2).

The Hingaia Stream runs along the Precinct's western boundary in a northerly direction, fed by two tributaries within the Precinct.

The Hingaia Stream floodplain runs along the western boundary of the Drury Centre Precinct, while the Fitzgerald Stream floodplain extends through the Precinct. Undersized culverts along the Fitzgerald Stream, particularly those beneath Fitzgerald Road and the railway, contribute to upstream flooding.

5. Proposed development

The project for the Stage 2 subdivision and development of land within Drury Centre is shown on the architectural plans submitted with the application and described in detail within the Assessment of Effects report prepared by B&A. In summary, the project includes the development of buildings and structures for a variety of commercial, retail, accommodation and community activities with ancillary car parking. The project also involves associated enabling bulk earthworks, the creation of open spaces and stream enhancements, installation of three waters infrastructure and establishment of a roading network.

From a stormwater management perspective, the project includes:

- Design of two wetlands (to remain in private ownership)
- Design of one large communal raingarden (to be vested to Auckland Council)
- Design of eight at-source raingardens (to remain in private ownership)
- Daylighting of downstream portion of Stream A that is currently piped

6. Regulatory and technical guidance

A summary of the regulatory and technical guidance documents used in this report is provided in Table 1.

6.1. Regulatory and design requirements

Table 1: Summary of guidance documents

Document	Summary	Relevant for this report
Auckland Unitary Plan – Operative in Part (AUP)	Covers policies regarding stormwater	Yes
Regionwide stormwater network discharge consent (NDC)	Tool for managing and integrating land use, stormwater discharge and the region's natural water assets to mitigate the impacts of climate change and flooding	Schedule 2 and Schedule 4 – greenfield development requirements
Drury Centre and Drury East Stormwater Management Plan, Rev C, September 2024	Prepared for the wider Drury East area outline the stormwater management strategy.	Yes – same stormwater approach to be followed

Document	Summary	Relevant for this report
Drury-Opāheke Structure Plan, August 2019	Outlines Auckland Council's strategic direction for growth in the Future Urban Zone at Drury- Opāheke	Yes – guidelines to be followed
Drury-Opāheke Draft Stormwater Management Plan, August 2019 (FUZ SMP)	Document prepared to support the Drury-Opāheke Structure Plan Details the flood management strategy	Yes – guidelines to be followed
Stormwater management devices in the Auckland Region – Guideline Document 2017/001 (GD01)	Technical guidance on design criteria for stormwater management devices	Yes – provides guidance for design of stormwater management devices
Design Guideline Manual for Stormwater Treatment Devices – Technical Publication 10 (2003). Auckland Regional Council. Chapter 5.	Legacy document for technical guidance on the design criteria for stormwater management devices	Yes – but superseded by GD01
Auckland Unitary Plan stormwater management provisions: technical basis of contaminant and volume management requirements– Technical Report 2013/035 (2013). Auckland Council.	Auckland Council document that outlines the key aspects of the Stormwater Management approach in the PAUP	Yes – provides guidance
Auckland Code of Practice: For Land Development and Subdivision (Chapter 4 - Stormwater) – Version 3.0 (January 2022). Auckland Council (Operative SWCOP)	Currently operative and provides minimum standards for the design and construction of stormwater systems for land development and subdivision	Yes – Guidance to be followed
Auckland Code of Practice: For Land Development and Subdivision (Chapter 4 - Stormwater) – Version 4.0 (March 2024). Auckland Council (SWCOP Draft)	Future code of practice that is currently not operative. Provides guidance on potential future minimum standards for the design and construction of stormwater systems for land development and subdivision	Yes, provides: • Guidance for network design, with allowance for 2.1^{0}C climate change • Information only - Provides guidance on 3.8^{o}C climate change factors to be used in resilience assessment
Auckland Council Stormwater Flood Modelling Specifications (2023). Auckland Council.	Technical specification document for stormwater flood modelling	Yes - Provides guidance for build of stormwater flood models
Water Sensitive Design for Stormwater – Guidance Document 2015/004 (March 2015). Auckland Council.	Guidance document for the application of Water Sensitive Design (WSD)	Yes - outlines the WSD approach for the site. WSD works alongside the urban design solution

7. Stakeholder engagement and consultation

A session was held with Healthy Waters to discuss the stormwater management approach for Drury Stage 2 development as part of the Fast-Track application. The outcomes from the session are summarised in Table 2 with minutes included in Appendix G for reference.

Table 2: Summary of consultation with Health Waters

Date	Summary of discussions

12/12/2024	• Meeting with Healthy Waters to provide an overview of Drury Stage 2 development and stormwater approach.
	• A combination of at source and communal devices is proposed for meeting stormwater management requirements. This includes two private wetlands within Stage 2 development and a combination of private and public at-source raingardens. Healthy Waters noted that at-source raingardens are not preferred and an additional communal device to be considered if possible.
	  ○ Following the meeting, Woods have amended the design by consolidating the public at-source raingardens to a communal raingarden. This is further discussed in Section 9 and Section 10.
	• Flood management strategy enables the conveyance of flows for the catchment draining to Hingaia Stream and an interim flood management strategy for the catchment draining to Stream A/ Fitzgerald Stream is being assessed. It is noted that flow conveyance maybe appropriate here given the timing of the flows in the Hingaia Stream and backwater effects as a result of timing with attenuated flows.
	  ○ Following the meeting, the flood management strategy for the catchment draining to Fitzgerald stream has been amended, as modelling has indicated less favourable results for attenuation scenarios compared to scenarios the conveyance of flows. This is further discussed in Section 12.
	• It was noted that 2.1^{0}C climate change uplift is to be used for modelling and undertaking the effect assessment as per the currently operative SWCOP (V3, June 2022). However, a resilience assessment is being undertaken using 3.8^{0}C climate change uplift. Overland flow path will be designed for 3.8^{0}C climate change uplift.

Additionally, several huis had been held with mana whenua partners in regards to the project and stormwater to date. A specific hui to present the proposed landscaping, stormwater management and ecology to Ngaati Te Ata Waiohua, was held on the 12/03/2025. The presentation slides are included in Appendix H.

8. Stormwater management requirements and approach

8.1. Drury Centre and Drury East Stormwater Management Plan

The Drury Centre and Drury East SMP has been prepared in accordance with regulatory and technical guidelines, and requirements of the AUP, Drury-Opāheke Structure Plan and NDC requirements. The proposed stormwater management as outlined in the Drury Centre and Drury East SMP is considered the best practicable option, given the existing site features and future land use.

This document has supported the successful rezoning of land in PC48 and PC49 and forms an integrated approach.

Whilst the Drury Centre and Drury East SMP has yet to be adopted, the document still sets out the stormwater strategy as follows and is relevant to the stormwater management approach for this project:

- Facilitate urban development and optimise available land
- Recognise the key constraints and opportunities on site and in the Hingaia and Slippery Creek catchments
- Develop a set of best practicable options (BPO) for stormwater that can be incorporated into the development
- Emphasise a water sensitive design approach that:
    - Manages the impact of land use change from rural to urban
    - Minimises or mitigates the adverse effects on water quality, freshwater systems, stream health, and ecological values of the receiving environment through the implementation of stormwater management devices; this includes tributaries of the Hingaia Stream and Slippery Creek.
    - Protects and enhances stream systems and riparian margins
- Minimise the generation and discharge of contaminants/ sediments into the sensitive receiving environment of the Drury Creek and Manukau Harbour, including changes in water temperature caused by stormwater discharges.
- Recognise a Blue-Green network approach with the stormwater management system to integrate “blue” aspects of the PCA (the streams and flood plains) and the “green” aspects of the environment (indigenous biodiversity, areas of ecological significance, and the parks and reserves).
- Protect key infrastructure, people and the environment from significant flooding events and not worsen downstream flooding.
- Flood management approach confirms that flooding within the Drury Township occurs as a result of larger peak flows from upstream rural catchments and not by developments within Drury Centre or Drury East Precincts or the other adjacent, urban areas currently being developed.
    - The flood management strategy therefore is to enable the conveyance of flows in larger storm events, without attenuation.
    - This approach requires upgrades of selected culverts located along the Fitzgerald Stream along with an additional culvert at the Great South Road & Railway Culvert. It is noted this is to be undertaken in the long term.
    - Section 8.2.7.2.2 of the Drury Centre and Drury East SMP notes that early development may occur ahead of planned culvert upgrades. However, these should demonstrate that the approach to enabling the conveyance of flow remains suitable, or that an interim flood management approach is required.

- Interim flood management measures, by way of attenuation, have been considered for areas draining to Fitzgerald Stream of Stage 2. This is further discussed in Section 11.3.1 of this report.

8.2. Stage 1 Fast-track consent

The decision and consent conditions for the Stage 1 fast-track consent include specific conditions in relation to stormwater management for the project as follows:

Stormwater Management Works

7. *The management of stormwater must be in accordance with the Drury Centre Stormwater Assessment prepared by Tonkin & Taylor dated November 2022 and the following design requirements*

Activity/ land use	***Design requirement***			***Best Practical Options for Stormwater Management***
	Water quality treatment	***Hydrological mitigation***	***Flooding and overland flows***	
Private land (super lots)	*Risk based treatment* ***Low risk*** *JOAL/ Private Road servicing less than 10 carparks* ***Mixed Risk*** *JOAL/ Private Road servicing 10 and up to 29 carparks* ***High Risk*** *JOAL/ Private Road servicing 30 or more carparks*	*SMAF 1 hydrological mitigation as per AUP(OP) Table E10.6.3.1.1.* *For JOALs and private roads up to 18% of the superlot site area to be provided by communal gardens*	• *Maintain sub-catchment drainage paths where possible and/ or provide area reduction or flow controls where required to limit flows to sensitive receiving tributaries.* • *Maintenance of similar surface water catchments into the wetlands, ensuring the hydraulic neutrality of wetlands between pre and post development* • *Enable conveyance of flows (no attenuation required)* • *Design of all overland flow paths (and stormwater infrastructure) shall be based on climate change temperature increase of 3.8^{0}C*	***All roofs/ building materials (Low Risk)*** • *Buildings to use inert building materials for building roofing, spouting, external wall cladding and architectural and external walls, and to have rainwater harvesting tanks or alternative stormwater devices to achieve hydrological mitigation* ***JOALs/ Private roads*** • *Preference for discharges to be directed to large (communal) bioretention devices to have gross pollutant pre-treatment as a minimum provided through screened catchpits.* *Alternatively, at-source options as follows for JOALs, private roads and car parks:* ***Low risk*** • *Screened catchpits with a grate, sump volume and submerged outlet at as a minimum or any other devices as outlined in Mixed or High Risk.* ***Mixed risk*** • *Bioretention device (Raingarden, tree pit)* • *Swale* ***High risk*** • *Bioretention device (Raingarden, tree pit)* • *Swale; or* • *GD01 equivalent device2*

Activity/ land use	***Design requirement***			***Best Practical Options for Stormwater Management***
	Water quality treatment	***Hydrological mitigation***	***Flooding and overland flows***	
Private land (Large Format Retail)	*Treatment to GD01 by private devices for all contaminant producing impervious surfaces including carparks and roads*			***All roofs/ building materials (Low risk)*** • *Buildings to use inert building materials for building roofing, spouting, external wall cladding.* • *Commercial buildings to have rain tanks with harvesting of stormwater for non-potable re-use if requirement is demonstrated or provides additional detention within the tank.* ***Car parks and private roads (High risk)*** • *Use bioretention devices (raingarden, tree pit)*
Public road corridors and up to 18% of superlot areas (to JOALs and driveways for communal bioretention devices only)	*Treatment to GD01 for all roads and car parks*			*Mix of large (communal) bioretention devices and road catchpits with gross pollutant pre-treatment as a minimum provided through screened catchpits, or alternatives approved via Condition 8.*
Reserves	*None*			*Stormwater outfalls to be green outfalls which comprise planted soil filled rock rip-rap. The design consistent with Condition 6 "Stormwater Outfall Structures"*

8.3. Stormwater management requirements - Stage 2

The stormwater requirements for Stage 2 have been summarised below. These are in accordance with the NDC, AUP and the Drury Centre and Drury East SMP.

- **Water quality treatment**
    - Eliminating and minimising the generation of contaminants for all contaminant generating impervious areas
    - New buildings and additions to buildings to be constructed using inert cladding, roofing and spouting materials
    - Treatment of all impervious areas by a stormwater management device designed in accordance with GD01/ TP10 for relevant contaminants.
- **Stream hydrology**
    - The site is located within the Stormwater Management Area Flow 1 (SMAF 1) overlay
    - Achieve equivalent hydrology (infiltration, runoff volume, peak flow) to pre-development (grassed state) levels:
        - Provide retention (volume reduction) of a minimum of 5mm runoff depth for all impervious surfaces; and
        - Provide detention (temporary storage) with a drain down period of 24 hours for the difference between pre-development (grassed state) and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus the retention volume for all impervious areas
- **Flooding – Property/ pipe capacity 10% AEP event**
    - Ensure sufficient capacity in downstream network
    - As there are currently no piped stormwater network within the development area, the proposed network will be designed in accordance with operative SW COP Version 3, Jan 2022
- **Flooding – Buildings 1% AEP event**
    - Ensuring development manages flooding effects so as to not worsen flood risk to people and property upstream or downstream of the Precinct
    - To be developed to the operative SW COP Version 3, Jan 2022

9. Proposed stormwater management

The proposed stormwater management for the project has been split across two areas with approximately 14.7 ha draining to Fitzgerald Stream (Area 1) and 9.9 ha to Hingaia Stream (Area 2) as can be seen in Figure 3.

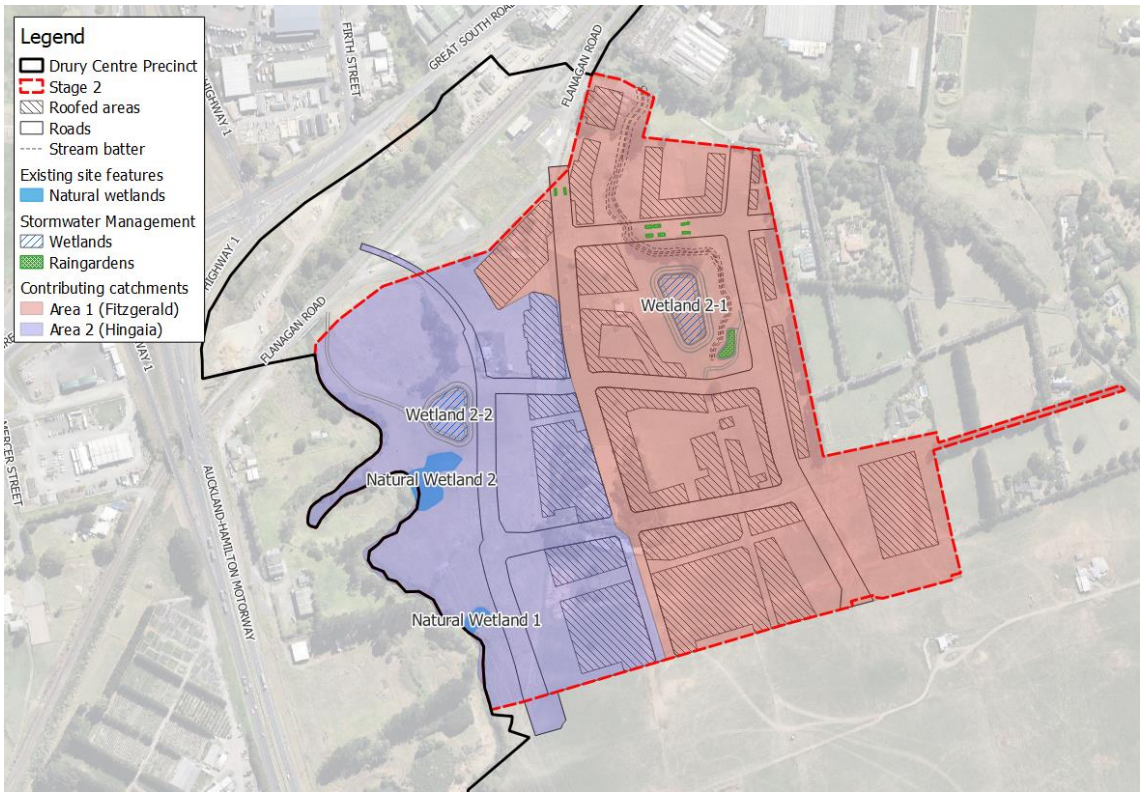

Figure 3: Stormwater management devices and areas

The contributing catchments discharging to Hingaia Stream and Stream A for pre- and post-development are summarized in Table 3.

Table 3: Contributing catchment pre- and post-development

Discharge Stream	Catchment / Area	Pre-development catchment area (ha)	Post-development catchment area (ha)
Stream A / Fitzgerald Stream	1	15.15	14.55
Hingaia Stream	2	9.12	9.72

9.1. Area 1

Area 1 drains to Stream A, which then drains to Fitzgerald Stream, a tributary of the wider Hingaia Stream. As discussed in Section 3 of this report, the existing culverts along Fitzgerald Stream are currently undersized for larger flows i.e., 100-year. In order to meet the flood management strategy and enable the conveyance of flows, as outlined in the FUZ SMP and the Drury Centre and Drury East SMP, these culverts are required to be upgraded to supplement the existing 2100mm diameter culvert beneath the railway, which is located immediately downstream of Stream A. However, flood modelling undertaken as part of this assessment has demonstrated that the culvert upgrade is not a dependency to enable Stage 2 development of Drury Centre. Therefore, the adopted strategy to enable the conveyance of flows is considered appropriate, as it shows more favourable outcomes. This is further discussed in Section 12.

Area 1 has been split across two zones as can be seen in Figure 4. The proposed stormwater management for both zones is outlined below.

Zone A:

- All stormwater runoff up to the 95th percentile from Zone A is proposed to be directed to Wetland 2-1
- Wetland 2-1 is designed in accordance with GD01 and provides water quality treatment and SMAF 1 level hydrology mitigation
- The roofed areas of the Large Format Retail (LFR) areas are proposed to provide retention via re-use for non-potable use. It is noted this is also considered BPO for water quality treatment for roofed areas.
- All flows greater than the 95th percentile is proposed to bypass the wetland and discharge directly to Stream A, along 5 outfall locations

Zone B:

- All stormwater runoff up to the 95th percentile from public roads is proposed to be directed to a large communal raingarden
- All stormwater runoff from private roads are proposed to be directed to at-source private raingardens
- All raingardens are designed in accordance with GD01 and provide water quality treatment and SMAF 1 level hydrology mitigation
- Hardstand areas of the LFR areas are proposed to provide at-source water quality treatment and SMAF 1 level hydrology mitigation
- Retention and detention of the roofed areas of the LFR areas are proposed to be met via dual purpose tanks. This is also considered BPO for water quality treatment for roofed areas.
- All flows greater than the 95th percentile is proposed to bypass the raingardens and discharge directly to Stream A, along 5 outfall locations

The proposed stormwater management for Area 1, draining to the Fitzgerald Stream is shown in Figure 4 and Figure 5.

Details of the catchments are also included in the civil drawings prepared by Woods, submitted as part of this application.

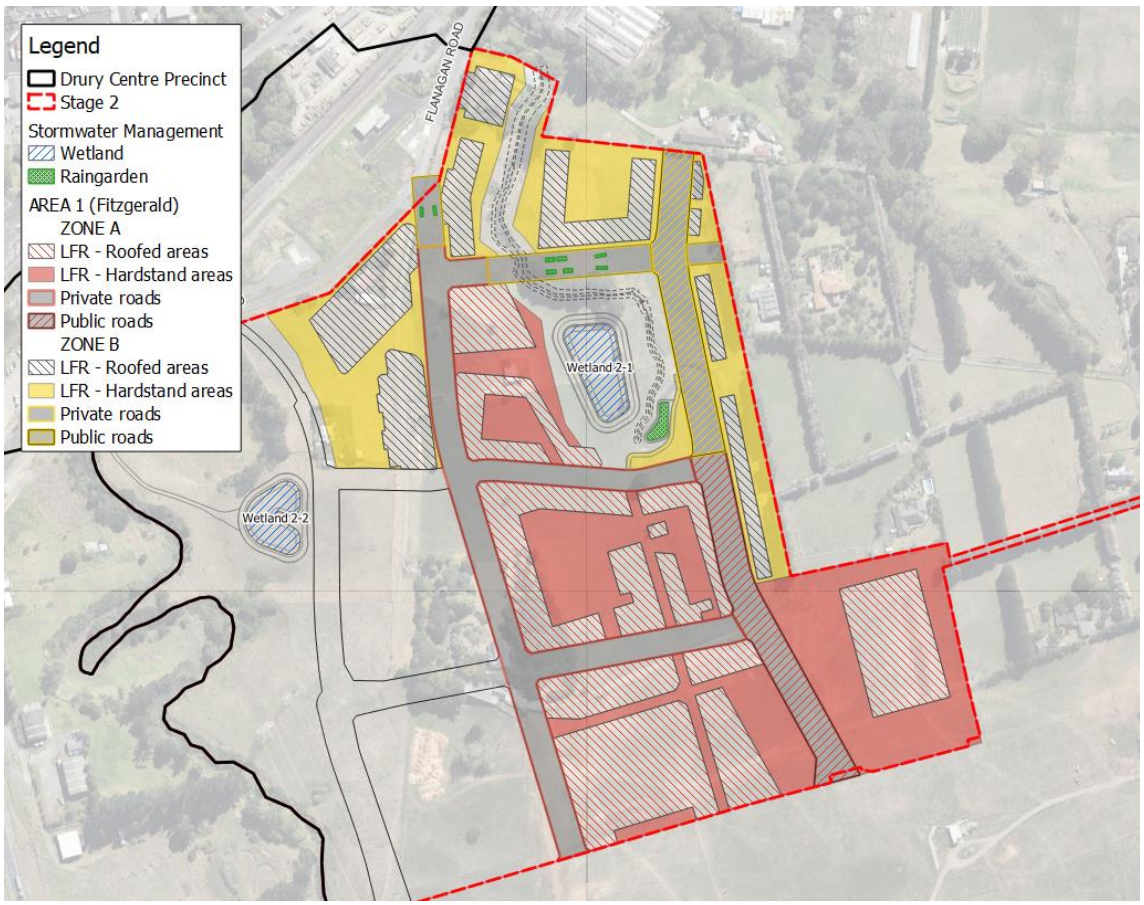

Figure 4: Area 1 - catchments

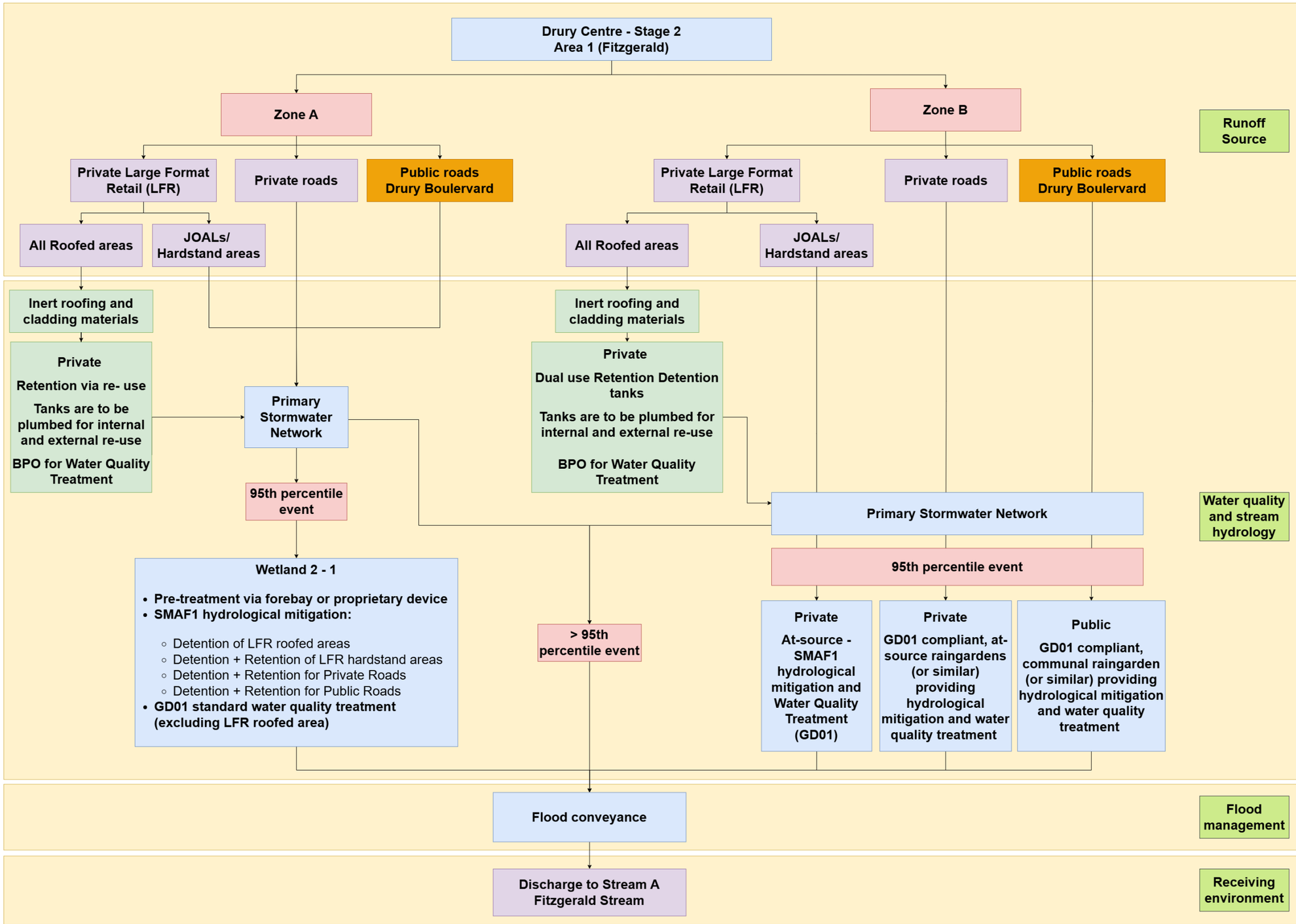

Figure 5: Area 1 – Stormwater Management

9.2. Area 2

The proposed stormwater management for Area 2 is as follows:

- All stormwater runoff up to the 95th percentile is proposed to be directed to Wetland 2-2
- Wetland 2-2 is designed in accordance with GD01 and provides water quality treatment and SMAF 1 level hydrology mitigation
- Retention and detention of the roofed areas of the LFR areas are proposed to be met via dual purpose tanks. This is also considered BPO for water quality treatment
- All flows greater than the 95th percentile is proposed to bypass the Wetland 2-2 and discharge directly to the natural wetland

The proposed stormwater management for Area 2, draining to the Hingaia Stream is shown in Figure 6 and Figure 7.

It is noted that during the larger storm events, areas discharging to Hingaia Stream are able to convey flows as outlined in the FUZ SMP and Drury Centre and Drury East SMP. This is further discussed in Section 12 of this report.

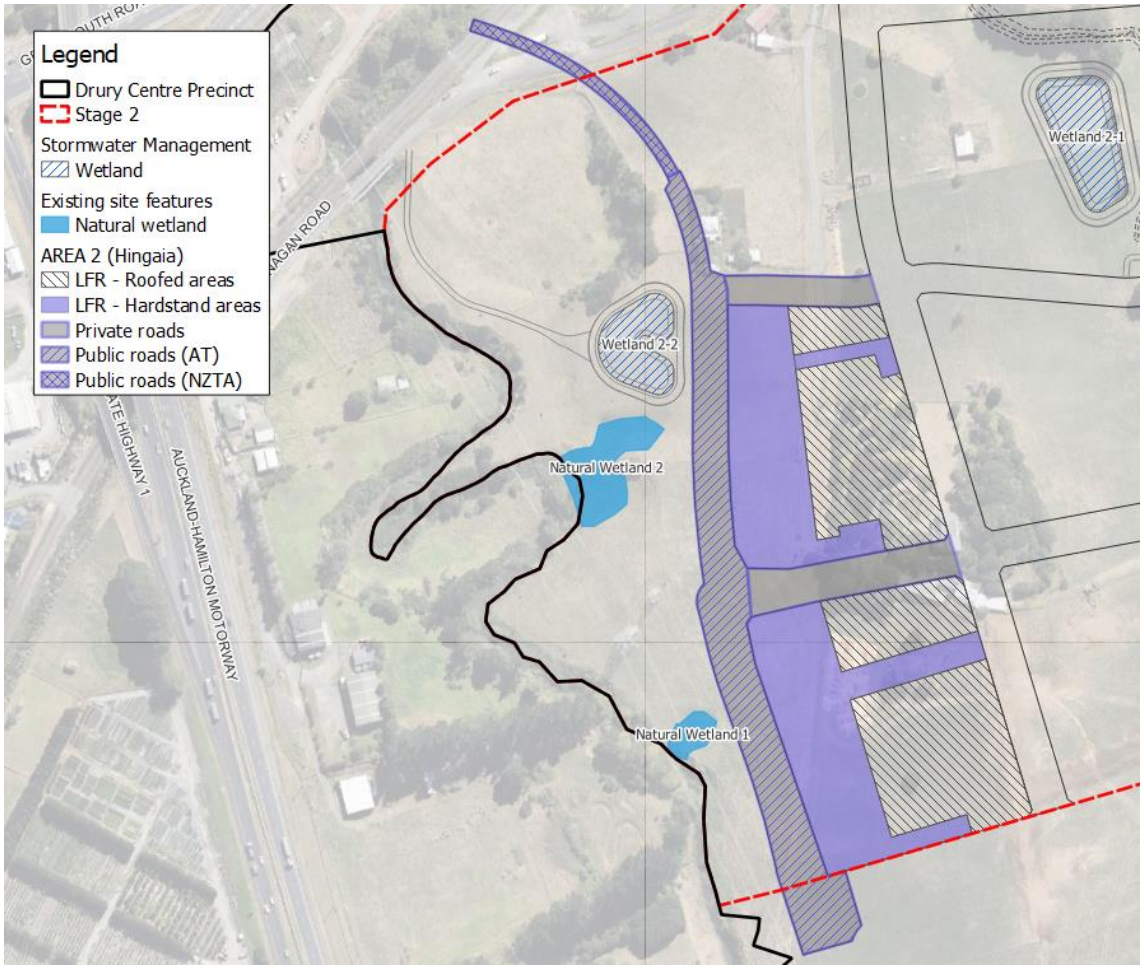

Figure 6: Area 2 - catchments

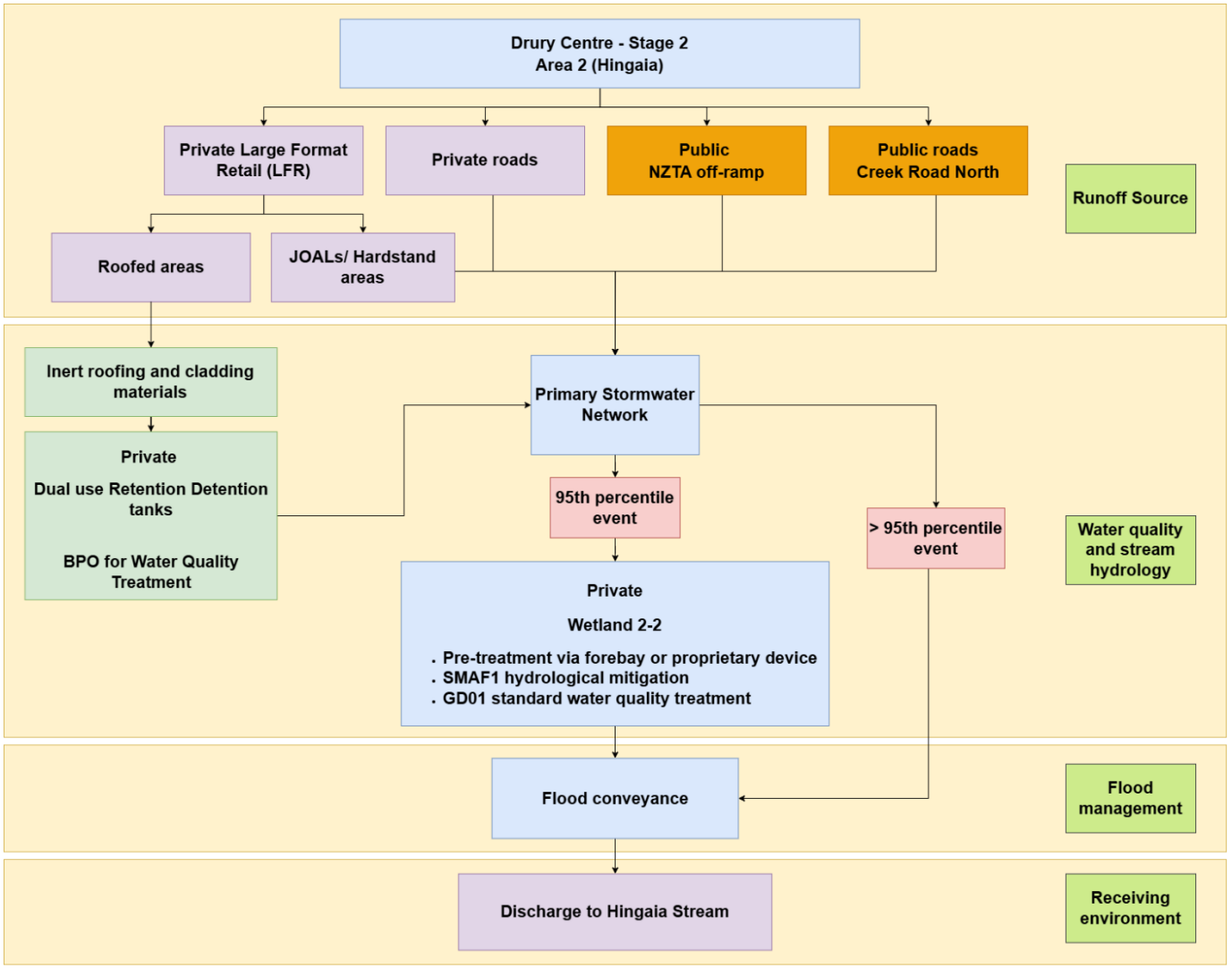

Figure 7: Area 2 – Stormwater Management

10. Stormwater management devices

The proposed locations of the stormwater management devices outlined in Section 8 above is shown in Figure 8. A summary of the proposed devices is provided in this section.

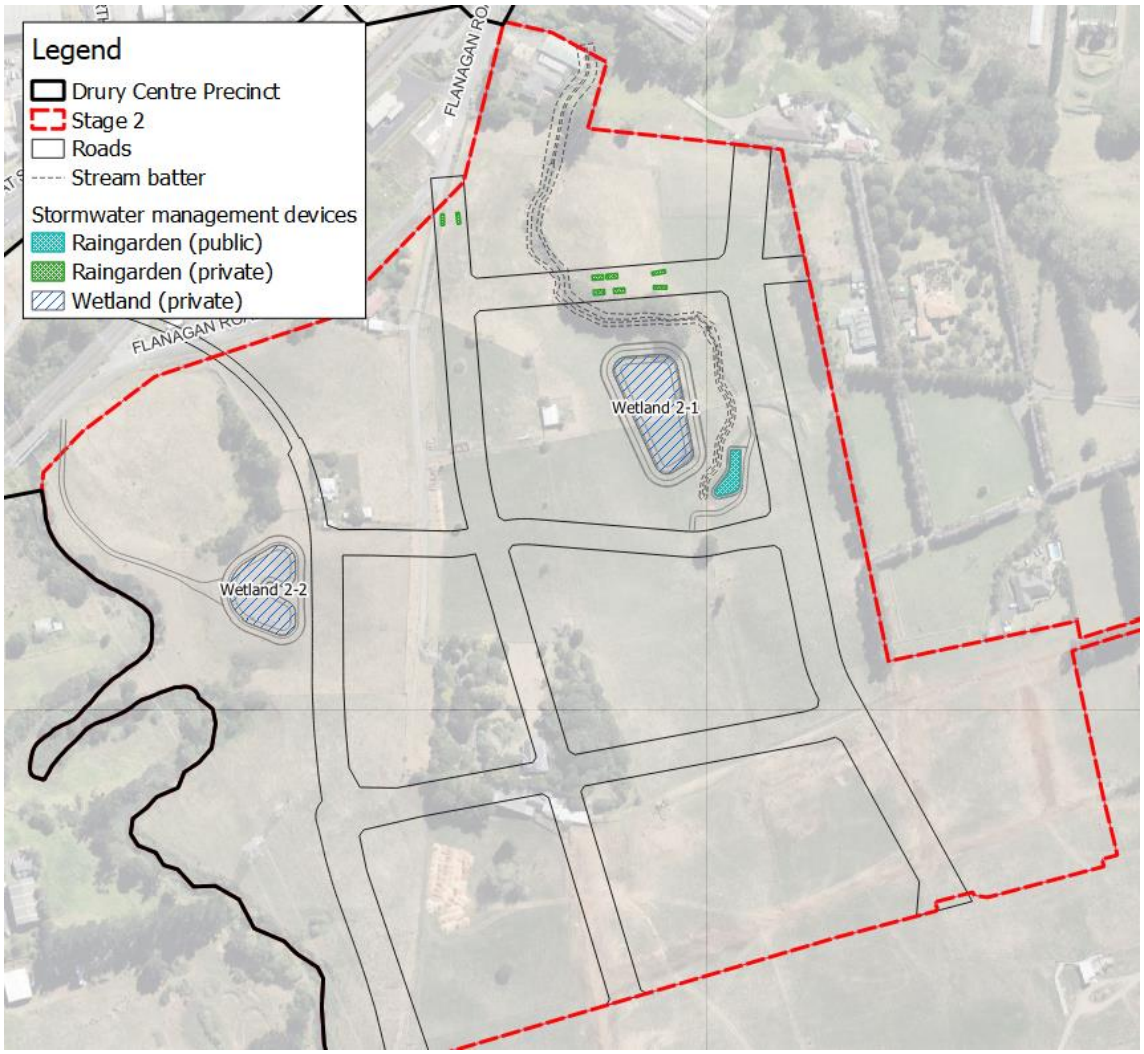

Figure 8: Proposed stormwater management devices

10.1. Wetlands

Two private wetlands are proposed for meeting stormwater management requirements within Stage 2. These devices, whilst taking runoff from public roads and NZTA off ramp, are proposed to remain in private ownership and therefore are not proposed to be vested.

10.1.1. Sizing requirements

Both wetlands have been sized to provide water quality and SMAF 1 mitigation volumes in accordance with GD01.

A summary of the contributing catchment areas, along with volume requirements are shown in Table 4 and Table 5 below.

Table 4: Contributing catchment summary

	Wetland 2-1 Contributing Catchment	Wetland 2-2 Contributing Catchment
Impervious area (ha)	8.98	2.74
Pervious area (ha)	0.23	0.14
Total (ha)	**9.21**	**2.88**

Table 5: Summary of wetland volumes

	Water Quality volume (m^3)	Final Water Quality volume (reduced by half) (m^3)	Forebay volume (15% of WQV) (m^3)	Permanent Water Volume (PWV) (m^3)	Total Hydrology Mitigation volume (m^3)
Wetland 2-1	1,106	553	166	719	1,774
Wetland 2-2	573	287	86	373	599

10.1.2. Geometric design

The geometric design of the wetlands has been undertaken in accordance with GD01. The bathymetry of the wetlands below the permanent water level (PWL) consists of various alternating marshes/ zones such as shallow marsh, deep marsh, intermittent pool and outlet pool. The permanent water volume (PWV) is contained below the PWL and is provided within these marshes/zones. This also includes a provision for the forebay volume that is designed to provide pre-treatment of runoff.

The PWL and SMAF detention levels have been estimated as per the requirements in Table 5 and the geometric design of the wetlands

Table 6 below provides a summary of the PWL, water quality and detention water levels and volumes for both wetlands.

The geometric design of the wetlands has been undertaken iteratively using 12d modelling software. The stage-storage/ elevation-volume relationship outputs from 12d have guided the design of the wetland outlet structures. These outputs are included in Appendix A for reference.

Table 6: Summary of water quality and detention requirements

	Wetland 2-1		Wetland 2-2	
	Required volume (m^3)	Designed volume (m^3)	Required volume (m^3)	Designed volume (m^3)
Permanent Water Volume (PWV) (m^3)	719	744	372	383
Permanent Water Level (PWL) (mRL)	N/A	10.84	N/A	12.34
Live storage volume (LSV) (m^3)	1,774	1,806	599	613
Live storage level (LSV) (mRL)	N/A	11.60	N/A	12.76

10.1.3. Design methodology

The outlet structures have been designed using HEC HMS modelling software and technical spreadsheets. The spreadsheets have been used to compute outflow curves as a function of the stage-storage outputs generated from 12d. The technical spreadsheets make allowances for the use of various hydraulic structures, either individually or in combination, including orifices, notches, weirs, manhole rims, and outlet pipes. The spreadsheet applies the equations as originally outlined in Auckland Regional Council (ARC) TP10 and provides outflows for each hydraulic structure as a function of head. It should be noted that for calculation purposes, the volume below PWL (or PWV) has been considered as dead storage. The calculation spreadsheet is included in Appendix B for reference.

HEC HMS modelling has been undertaken to ensure the designed wetland outlet structures meet the 24-hour detention requirements. A basin model has been setup in HEC HMS using SCS runoff methodology with time of concentration estimated using equal-area method (as per TP108). The rainfall depths in the meteorological model are consistent with the TP108 rainfall contour maps,

The HEC HMS model has been simulated with 1-minute timesteps. Table 7 contains a summary of the parameters used in the basin model.

Table 7: Summary of parameters

	Pervious	**Impervious**
CN	74	98
Ia (mm)	5	0
Time of Concentration	Varies – Equal-area method	

The wetlands have been modelled as a reservoir in the HEC HMS model with “outflow curve” method. The 12d stage-storage relationship outputs have been used for “elevation-storage function” and the outflow curve generated from the technical spreadsheets has been used as the “storage-discharge" function. The initial condition has been set to “Elevation” with the PWL used as the initial elevation.

This process has been repeated with the configuration of outlet structures iteratively refined throughout the design process, optimising the solution that best fits with the constraints of the site. The selected outlet structure configuration for the proposed wetlands have been discussed in the following section.

10.1.4. Outlet Design

The outlet structure for the wetlands includes several features placed within a manhole control chamber as described below.

- Wetland 2-1 Outlet Configuration
    - An orifice, set at a level above PWL and sized suitably to discharge the SMAF detention volume, stored within the wetland, over 24 hours.
    - A scruffy dome inlet, set at the top of the detention volume level, and only operates in an event greater than the 95th percentile.
    - An outlet pipe discharging flows from the manhole chamber out to the final discharge point.
    - An emergency spillway with the invert level set 100mm above the SMAF detention level.
- Wetland 2-2 Outlet Configuration
    - An orifice, set at a level above PWL and sized suitably to discharge the SMAF detention volume, stored within the wetland, over 24 hours.
    - A scruffy dome inlet, set at the top of the detention volume level, and only operates in an event greater than the 95th percentile.

- An outlet pipe discharging flows from the manhole chamber out to the final discharge point.
- An emergency spillway with the invert level set 100mm above the SMAF detention level.

Details of the above structures are provided in Table 8.

Table 8: Details of outlets

		Wetland 2-1		Wetland 2-2	
	Structure	**Dimension**	**Invert Level (mRL)**	**Dimension**	**Invert Level (mRL)**
1	Circular orifice	150mm Dia	10.85	100mm Dia	12.35
2	Scruffy dome inlet	1050mm	11.60	1050mm	12.80
3	Outlet pipe	DN750	10.30	DN500	11.76
4	Emergency spillway	Length: 25m	11.85	Length: 15m	12.90

Details of the proposed wetland designs are shown in Figure 9 and Figure 10.

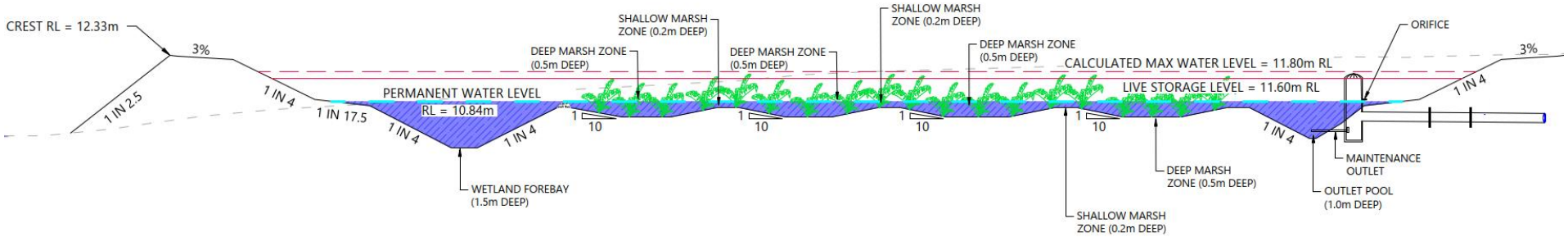

Figure 9: Wetland 2-1 Cross-section A, DWG No. P24-447-01-3603-DR

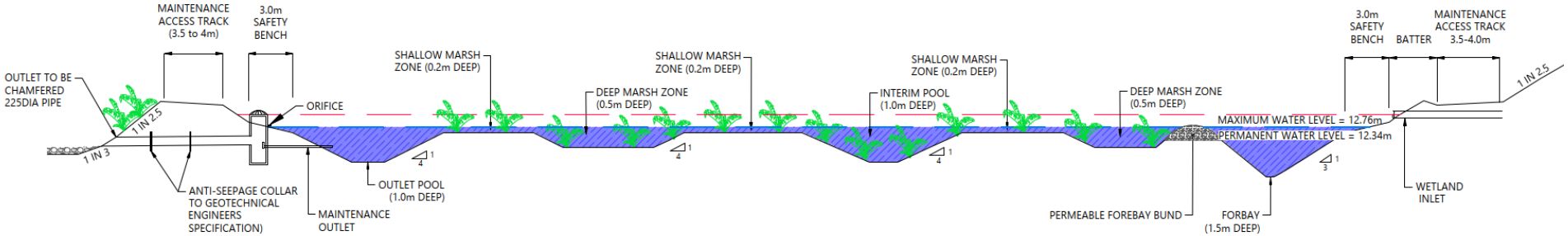

Figure 10: Wetland 2-2 Cross-section C, DWG No. P24-447-01-3604-DR

10.2. Raingardens

At-source bioretention raingardens designed in accordance with GD01 are proposed for providing SMAF1 hydrological mitigation and water quality treatment of private roads. SMAF1 and treatment of public roads is to be achieved through the use of a single communal raingarden as can be seen in Figure 11.

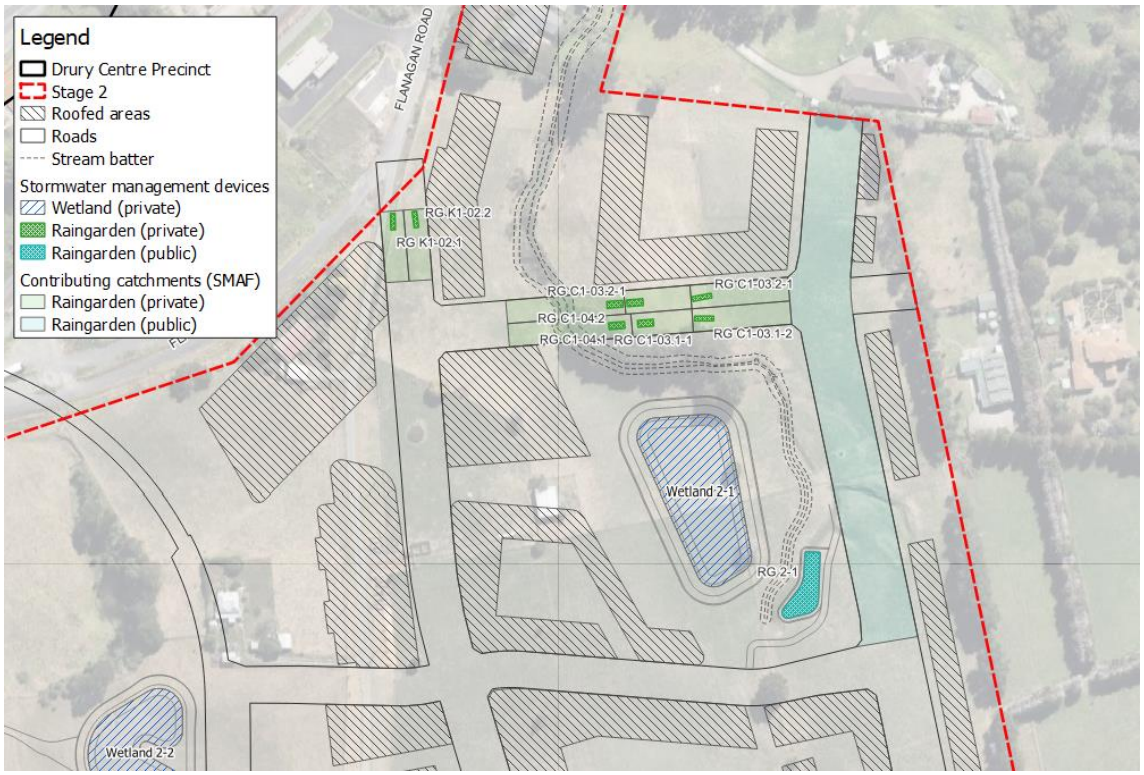

Figure 11: Locations of proposed raingardens

A summary of the proposed sizing and contributing catchments of the public and private raingardens are contained in Table 9 and Table 10.

Table 9: Summary of raingardens – Public – Communal Raingarden

	Contributing catchment area (m^2)	Impervious allowance (%)	Required ponding footprint (m^2)	Ponding footprint (m^2)	Aligning with GD01 requirement*
RG 2-1	5441	90	245	255	yes

* Ponding footprint ≥5% as a proportion of the catchment's total impervious area

Table 10: Summary of raingardens - Private – Roadside Raingardens

	Contributing catchment area (m^2)	Impervious allowance (%)	Required ponding footprint (m^2)	Ponding footprint (m^2)	Aligning with GD01 requirement*
RG K1-02.1	316	90	14.2	14.5	yes
RG K1-02.2	320	90	14.4	14.5	yes
RG C1-03.1-1	412	90	18.5	18.5	yes
RG C1-03.1-2	412	90	18.5	19.2	yes
RG C1-03.2-1	612	90	27.5	28.5	yes
RG C1-03.2-2	354	90	15.9	16.1	yes
RG C1-04.1	605	90	27.2	28.2	yes
RG C1-04.2	609	90	27.4	27.7	yes

* Ponding footprint ≥5% as a proportion of the catchment's total impervious area

11. Stormwater network (Primary Network)

A new public stormwater reticulation system is proposed to be installed to service the proposed development. The network is to be designed in accordance with the currently operative SWCOP V3 Jan 2022, with allowance for 2.1^0C climate change.

Details regarding the primary and secondary network is included in the infrastructure memo and accompanies drawings prepared by Woods, submitted as part of this application.

12. Flood management

12.1. Flood management strategy

The flood management approach for the Precinct has been outlined in the Drury Centre and Drury East SMP and the FUZ SMP.

The FUZ SMP outlines, that for catchments within the Hingaia Stream, the strategy is to enable conveyance of flows during larger storm events. The flood management approach as outlined in the Drury Centre and Drury East SMP has demonstrated that flooding within the Drury Township occurs as a result of larger peak flows from upstream rural catchments, not by developments within Drury Centre or Drury East Precincts.

Drury Centre and Drury East SMP further outlines the detailed 1D-2D flood modelling work that has been undertaken to confirm the flood management approach for the plan change areas. The general approach to enabling the conveyance of flows is contingent on upgrades to the Fitzgerald Road culvert and the Great South Road/ Railway Culvert.

It is noted that the effects from Drury Centre precinct have been assessed in conjunction with the adjacent development within Drury East precinct. This includes Stages 2 and 3 of Fulton Hogan development areas which discharge to the Fitzgerald Stream as this application has already been consented. Development of remaining Drury East precinct areas are contingent on the supplementary downstream culvert and infrastructure upgrades to enable implementation of the flood management strategy and have therefore not been considered as part of this assessment.

Figure 12 outlines the extents of the development areas and the structures as referred to within the rest of this section.

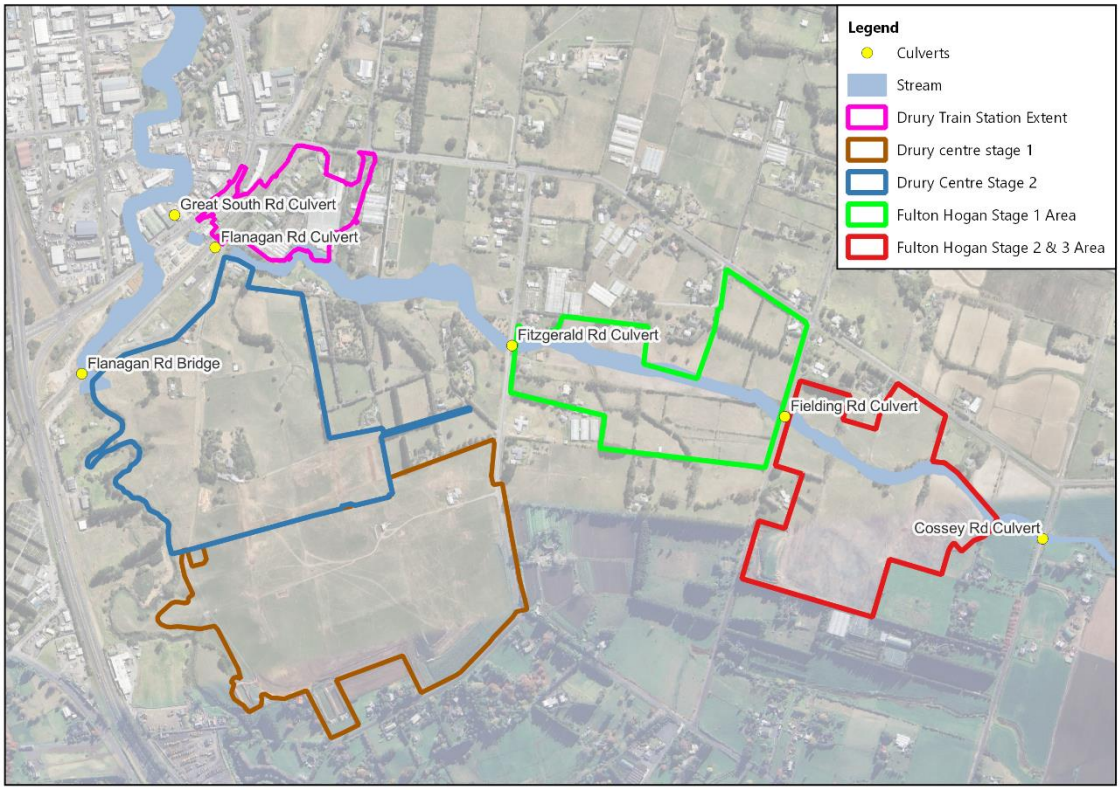

Figure 12: Development Areas

12.2. Model Background

To assess effects from this development, a cutdown model has been developed, referred to as the 'Fitzgerald Stream Local Catchment' model using InfoWorks ICM. This has been developed based on the DHI Healthy Waters Hingaia catchment model (Model ID supplied 1318). This cutdown ICM model has been used to assess flood risk within these stages and any flood effects resulting from the development. This model has been built using InfoWorks ICM version 2025.3, using inflows and boundary conditions from the DHI model.

Details for this model are provided in "Fitzgerald Stream Local Catchment Model – Stormwater Model Conversion and Update Report" included in Appendix D.

12.2.1. Model Updates

The purpose of this model is to assess the impact of the proposed development of Drury Centre Stage 2. As part of this assessment, the following amendments have been made to the model.

12.2.1.1. Pre-development Scenario

The purpose of this model is to establish a baseline scenario to assess the impact of the proposed developments within Drury Centre Stages 1 and 2 and Fulton Hogan Stages 2 and 3. The pre-development scenario establishes a baseline for assessing flood effects between scenarios. The pre-development model has been updated from the Fitzgerald Stream Local Catchment ICM model.

As part of this assessment, the following amendments have been made to the base model:

- Land-use updated as per Figure 13
- The landform has been updated to include Drury Train station design surface and LiDAR2016 DEM
- Drury creek, represented as a 1-D river reach has been truncated and a boundary condition for Drury Creek has been applied as a level file.
- Hydraulic structures along the Fitzgerald Tributary have been retained as per the base model:

- Cossey Road Culvert – Existing
- Fielding Road Culvert – Existing
- Fitzgerald Culvert – Existing
- Flanagan Road Culvert – Existing
- Great South Road Culvert – Existing

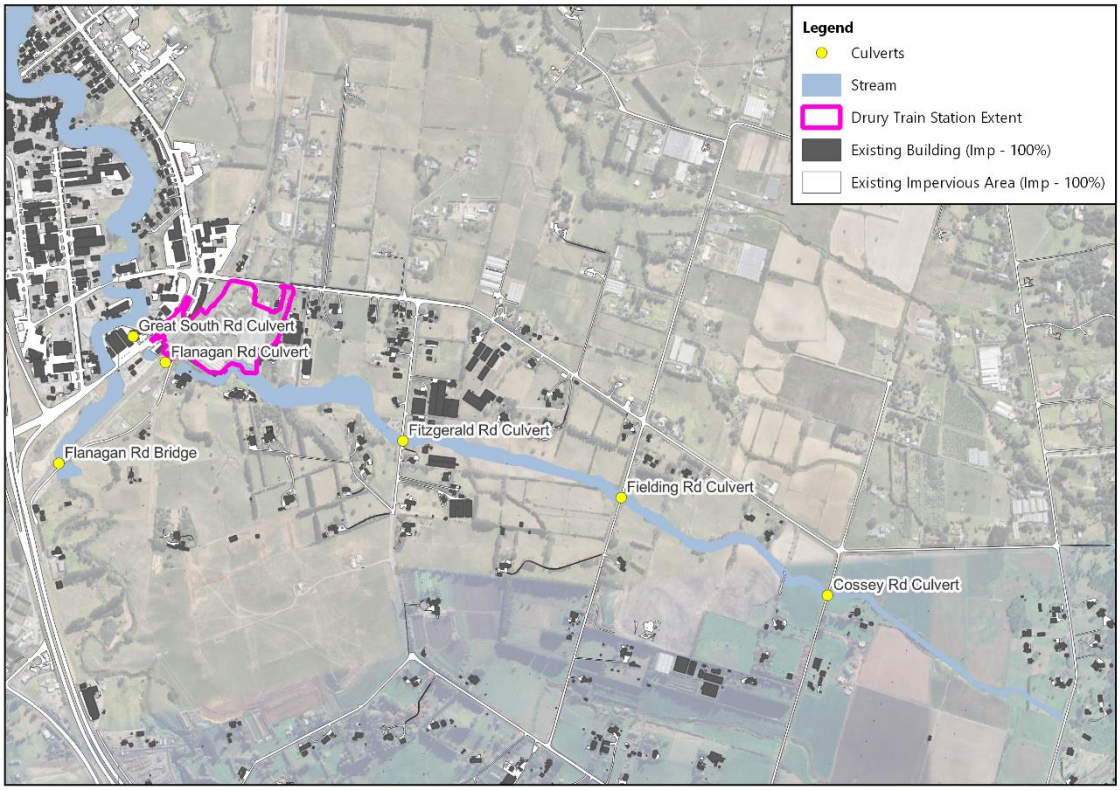

Figure 13: Pre-development Land-use

Pre-development results are discussed in Section 12.3.

12.2.1.2. Post-development Scenario

The post development model has been used to assess the effects of the proposed development within Drury Centre Stages 1 and 2 and Stages 2 and 3 of Fulton Hogans development areas. To represent the post development scenario, the following amendments have been made to the pre-development model:

- Incorporate proposed landforms within Drury Centre and Stages 2 and 3 of Fulton Hogan development area based on the latest design surfaces. The post-development scenario includes the temporary storage areas within Stage 1 of Fulton Hogan development area.
- Incorporate proposed land-use within Drury Centre and Stages 2 and 3 of Fulton Hogans development area, as per the land-use plan shown in Figure 14.
- Sub catchments have been re-delineated as illustrated in Figure 15. Areas associated with catchment discharging to Wetland 2-2 have been removed from the modelled catchments and represented as inflow source points from HEC-HMS model. For more information regarding the HEC-HMS modelling parameters and outputs. This is detailed in earlier sections in this report with outputs included in Appendix C.
- Hydraulic structures along the Fitzgerald Tributary have been modelled as follows.
    - Cossey Road Culvert – Existing
    - Fielding Road Culvert – Structure modelled to enable the conveyance of flows

- Fitzgerald Culvert – Existing
- Flanagan Road Culvert - Existing
- Great South Road Culvert – Existing

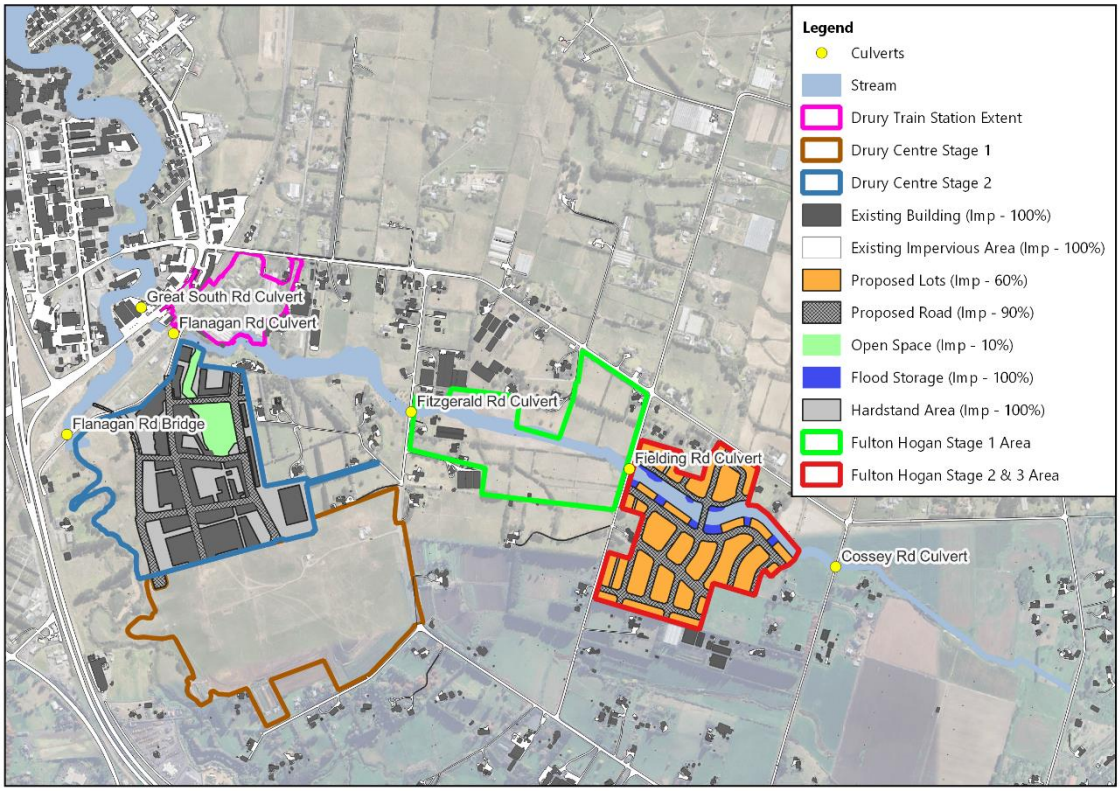

Figure 14: Post Development Land-use

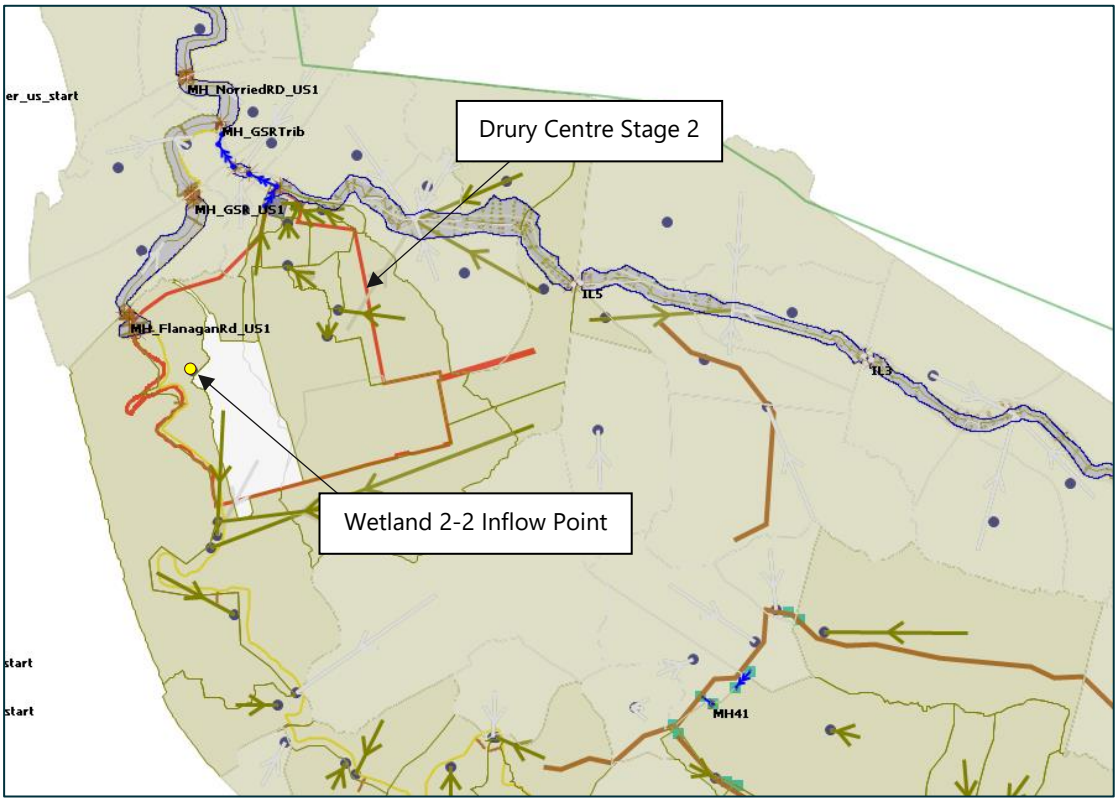

Figure 15: Post Development Catchment Plan

Post-development results are discussed in Section 12.3.

12.2.1.3. Flood Resilience Assessment (Future Climate Change 3.8°C)

A flood resilience model has been simulated to assess development's resilience against future climate change. The resilience model has been created in accordance with the flood management strategy of the wider plan change area and the Drury Centre and Drury East SMP. As part of this assessment, the following amendments have been made to the post-development model:

- Incorporate proposed land-use and landform within Stages 4-7 of Fulton Hogan development area, as illustrated in Figure 16.
- All remaining areas outside the development extent have been adopted as per the MPD proposed land-use in accordance with the AUP.
- The following hydraulic structures along the Fitzgerald tributary have been updated in the model to align with the flood management strategy in the Drury Centre and Drury East SMP:
    - Cossey Road Culvert – Structure modelled to enable the conveyance of flows
    - Fielding Road Culvert – Structure modelled to enable the conveyance of flows
    - Fitzgerald Culvert – Structure modelled to enable the conveyance of flows
    - Flanagan Road Culvert – Existing
    - Great South Road Culvert - Existing
    - Supplementary GSR Culvert – Diversion to Hingaia Stream included

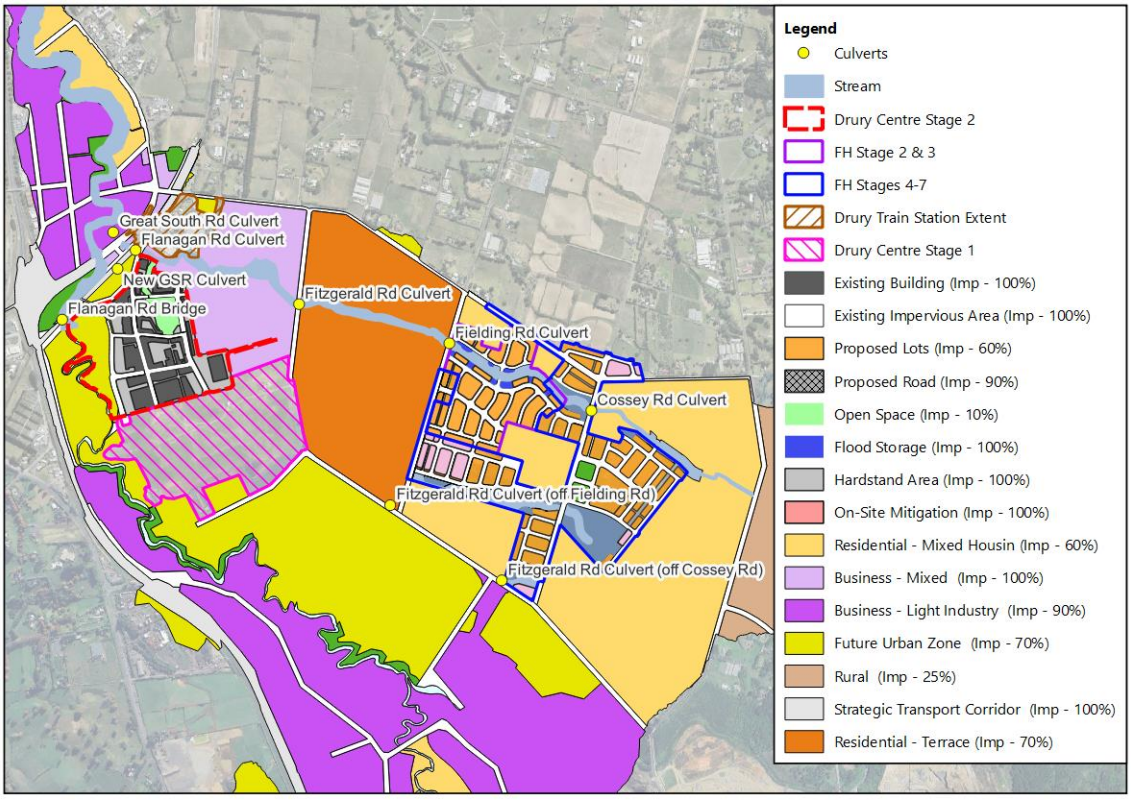

Figure 16: Resilience Model Land-use

12.2.2. Modelled Scenarios

Seven scenarios have been developed based on the Fitzgerald Stream Local Catchment model to assess the impact of the proposed development. These scenarios are as listed in Table 11.

Table 11: Modelled scenarios

Scenario	Storm Event (ARI)	Climate Change	Land use and Landform
Pre-development	2-year 10-year 100-year	2.1°C	• Drury Train Station – Landform + 100% imperviousness • LiDAR 2016 DEM data + existing imperviousness across model extent
Post-development	2-year 10-year 100-year	2.1°C	• Drury Train Station – Landform + 100% imperviousness • Drury Centre Stage 1 – design landform + 100% imperviousness • Drury Centre Stage 2 – Land use and landform adopted as per master plan • Fulton Hogan Stage 1 - Landform + existing Imperviousness • Fulton Hogan Stage 2 and 3 – Land use and landform adopted as per master plan • LiDAR 2016 DEM data + existing imperviousness across model extent Structures along Fitzgerald Tributary have been retained as per the pre-development scenario, except for Fielding Road culvert which is upgraded as part of the Fulton Hogan Stages 2 and 3 development.
Resilience Assessment	100-year	3.8°C	• Drury Train Station – Landform + 100% imperviousness • Drury Centre Stage 1 - Landform as per master plan + 100% imperviousness • Drury Centre Stage 2 - Land use and landform adopted as per master plan • Fulton Hogan Stage 1 – Landform + MPD Imperviousness • Fulton Hogan Stage 2 and 3 and Stages 4-7 – Land use and landform adopted as per master plan • LiDAR 2016 DEM data + MPD Imperviousness across model extent All structures along Fitzgerld Tributary upgraded as per the flood management approach in the Drury Centre and Drury East SMP.

12.3. Summary of findings (flood management)

The purpose of the flood modelling is to conduct a flood assessment for the proposed Drury Centre Stage 2 development. The model results have been analysed in terms of peak water levels and flood depths for each scenario to provide an understanding of the changes to flood risk as a result of the proposed development.

Flood maps showing flood extents and maximum depth for all modelled scenarios are included in Appendix E. Flood depth maps for the 100 year pre-development and post-development scenario, inclusive of a 2.1°C climate change uplift factor, are shown in Figure 17 and Figure 18 respectively.

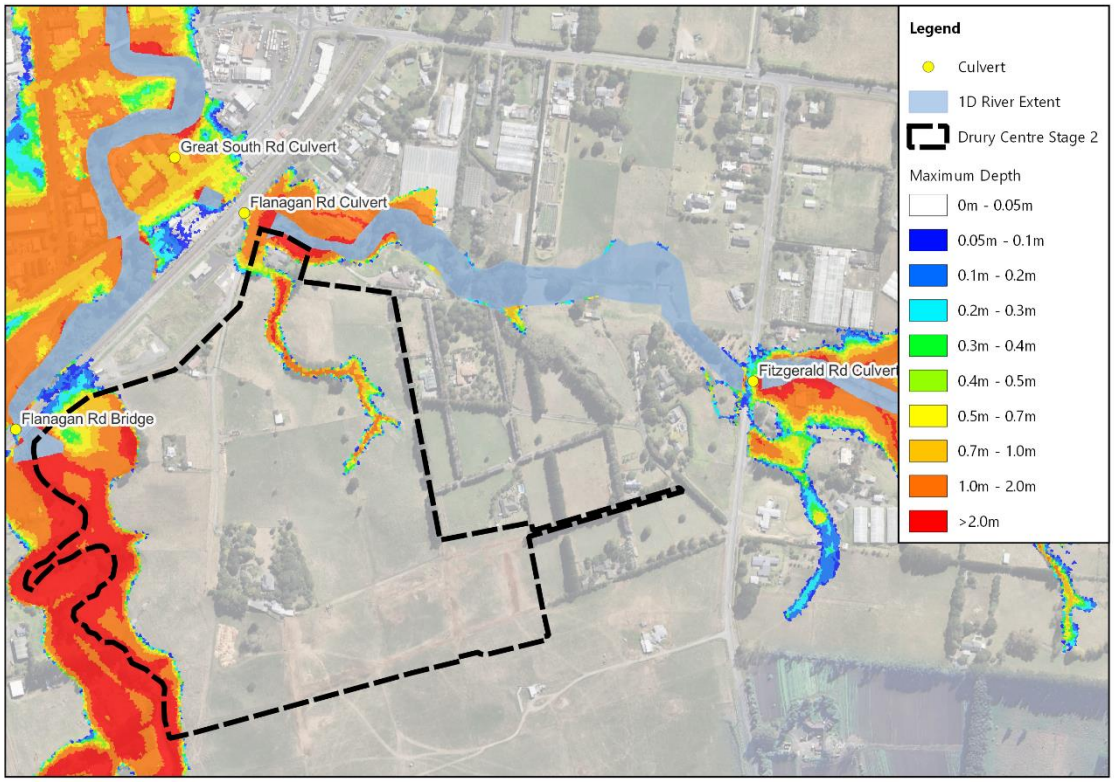

Figure 17: Maximum Depth - Pre-Development 100-year ARI (including 2.1°C Climate Change Uplift)

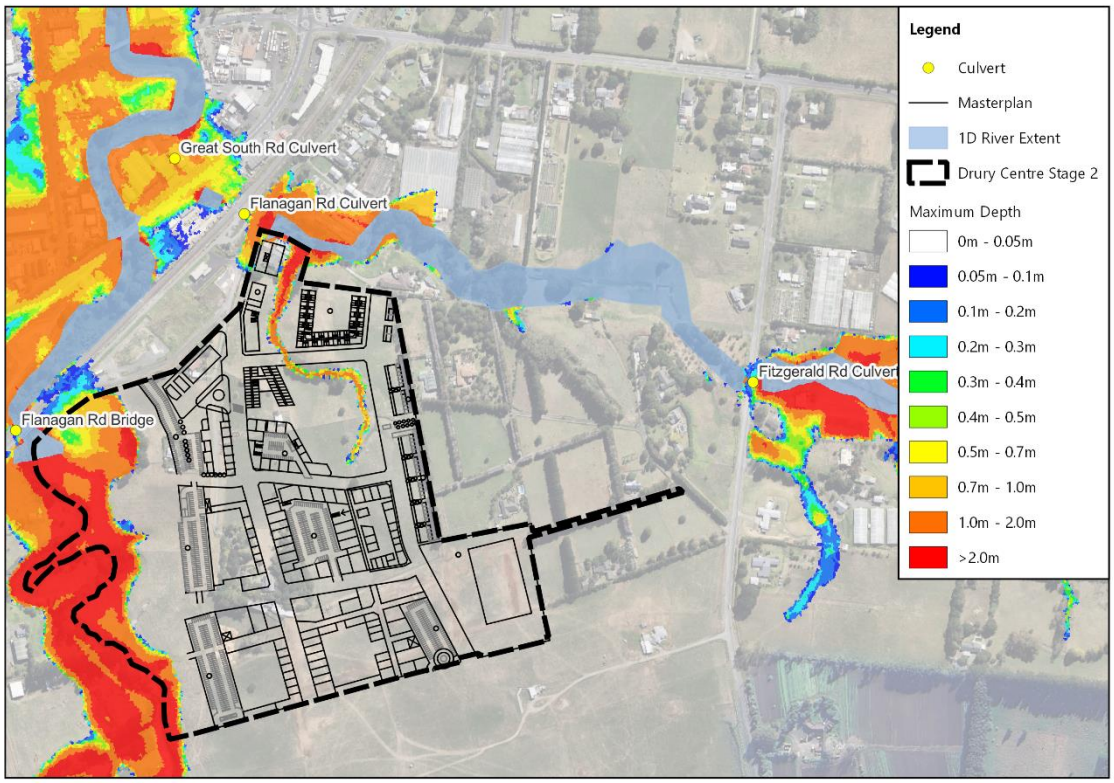

Figure 18: Maximum Depth - Post-Development 100-year ARI (including 2.1°C Climate Change Uplift)

As discussed in Section 8 of this report, Stage 2 has been split across two stormwater management areas with Area 1 discharging to Fitzgerald Stream and Area 2 discharging to Hingaia Stream. Both stormwater management areas enable the conveyance of flows during larger storm events in accordance with the flood management strategy of the wider plan change area and the Drury Centre and Drury East SMP.

Comparison of the modelled results shows negligible change in the overall flood extent in areas immediately downstream of Area 1 and Area 2. Flood extents within the development are limited to Stream A, discharging to Fitzgerald Stream, and do not encroach into any proposed lots.

Water level difference (afflux) plots were generated for all the modelled scenarios. These are included in Appendix E. Flood effects from the 100-year scenario inclusive of a 2.1°C climate change uplift factor is shown in Figure 19.

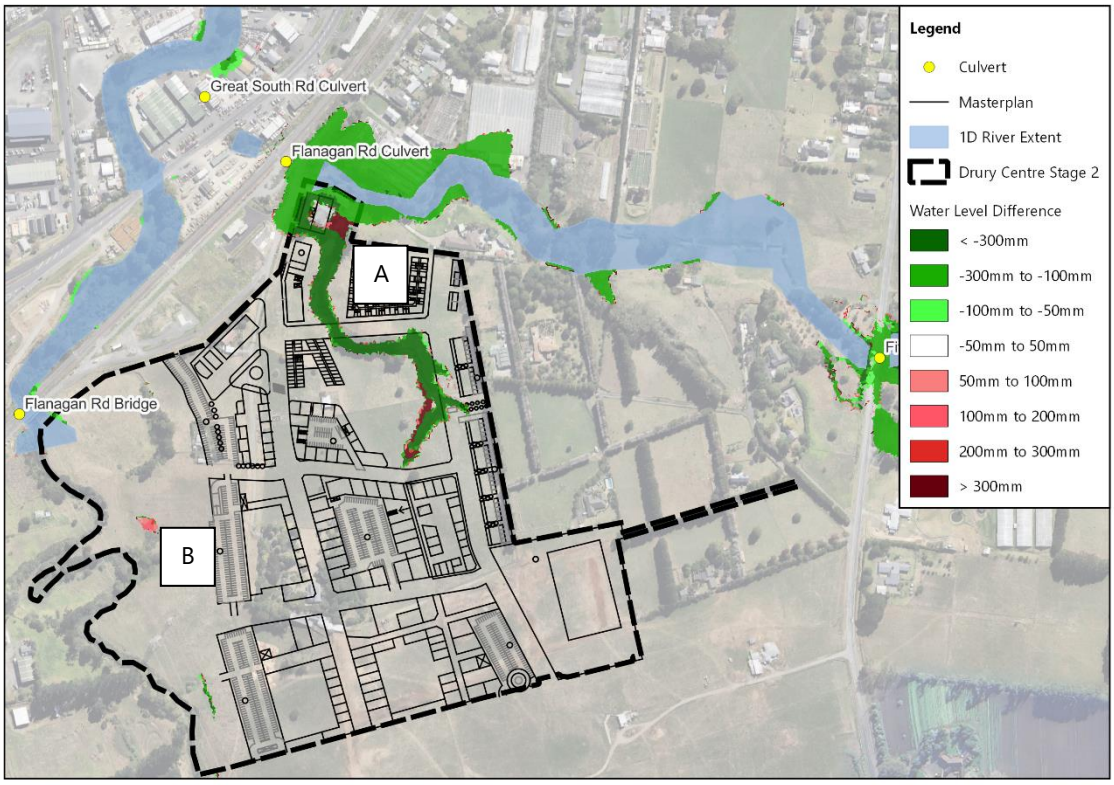

Figure 19: Site - Water Level Difference 100-year ARI (Including 2.1°C Climate Change Uplift)

The results indicate that the post development flood levels generally decrease when compared to the pre-development scenario which is noted to be predominantly as result of the works completed as part of Drury Centre Stage 1 resulting in a reduction to the contributing catchment discharging to Fitzgerald Stream and therefore reducing water levels.

Flood modelling undertaken for the site predicts there will be no increased risk of flooding to third party land as a result of the development. Minor increases in water levels are noted in the northern (A) and western (B) portions of the site. Increases at point A are in excess of 2500mm and can be attributed to the proposed stream daylighting in this area. These increases are not considered to pose any threat to the proposed development as they do not encroach any proposed building footprints and is contained within the stream. The flood level within area B increase up to 300mm and is related to the model representation of Wetland 2-2.

The lots have been designed to be located outside of the future 100-year floodplain inclusive of climate change (3.8°C). A resilience assessment has been undertaken to assess the development's resilience against future climate change scenarios. This assessment has adopted the flood management strategy of the wider plan change area. Results from the resilience assessment show that the proposed development and associated lots are located outside the modelled flood extent as can be seen in Figure 20.

A complete set of the model results is included in Appendix E.

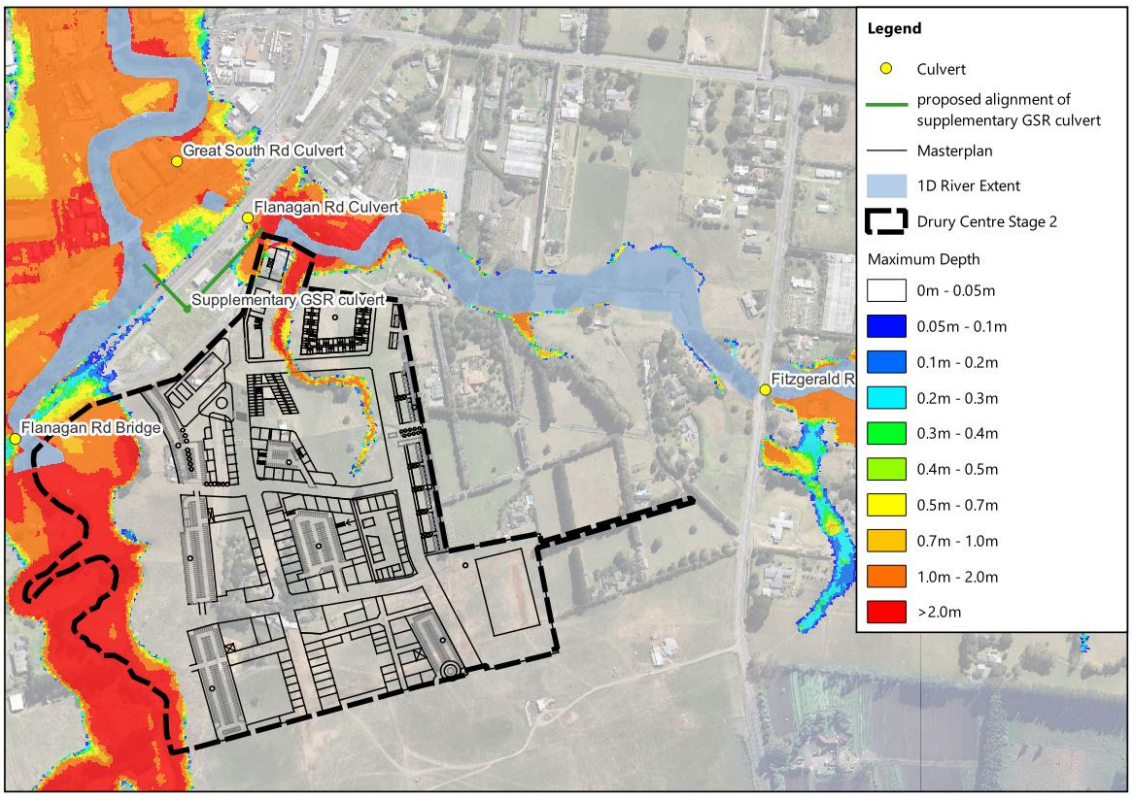

Figure 20: Maximum Depth - Post-Development 100-year ARI (including 3.8°C Climate Change Uplift)

12.3.1. Area 1 - Attenuation Considerations

As noted in the Drury Centre and Drury East SMP, the general flood management strategy to enable the conveyance of flows for areas draining to Fitzgerald Stream is dependent on selected culvert upgrades. Therefore, attenuation has been considered as a potential flood management strategy in Area 1.

With existing infrastructure constraints at the existing Flanagan Road and Great South Road Culverts, an assessment has been undertaken to determine if attenuation for Area 1 of Stage 2 was required. The assessment and modelling undertaken have indicated that attenuation of flows at this location results in downstream flood depth increases compared to enabling the conveyance of flows for the contributing Drury Stage 2 catchment area.

As a result of the preliminary model results, the approach to adopt attenuation has been discounted.

A summary of the assessment and findings are as follows:

- Peak water levels upstream of the Great South Road Culvert, along Fitzgerald Stream, are controlled by the water levels of Hingaia Stream due to backwater effects.
- A series of analysis point were taken to understand the effects of coinciding peaks as illustrated in Figure 21.
- Results from the analysis (Figure 22 - Figure 24) show the time to peak (Tp) in Hingaia Stream plotted on the graphs for comparative purposes.
- Flood modelling has demonstrated that the attenuation of flows from Area 1 results in higher peak water levels in Fitzgerald Stream due to the effects of timing.
- Given the increased water level as a result of attenuation, this has been discounted as a flood management option for Drury Centre Stage 2.

It is noted that, while an assessment has been undertaken to determine the feasibility for attenuation, as shown in the model results in Section 12.3, enabling the conveyance of flows from Drury Centre Stage 2 prior to installation of the downstream culverts does not cause any downstream effects. Therefore, Stage 2 does not trigger the need for a supplementary GSR culvert to address the stormwater effects of this development.

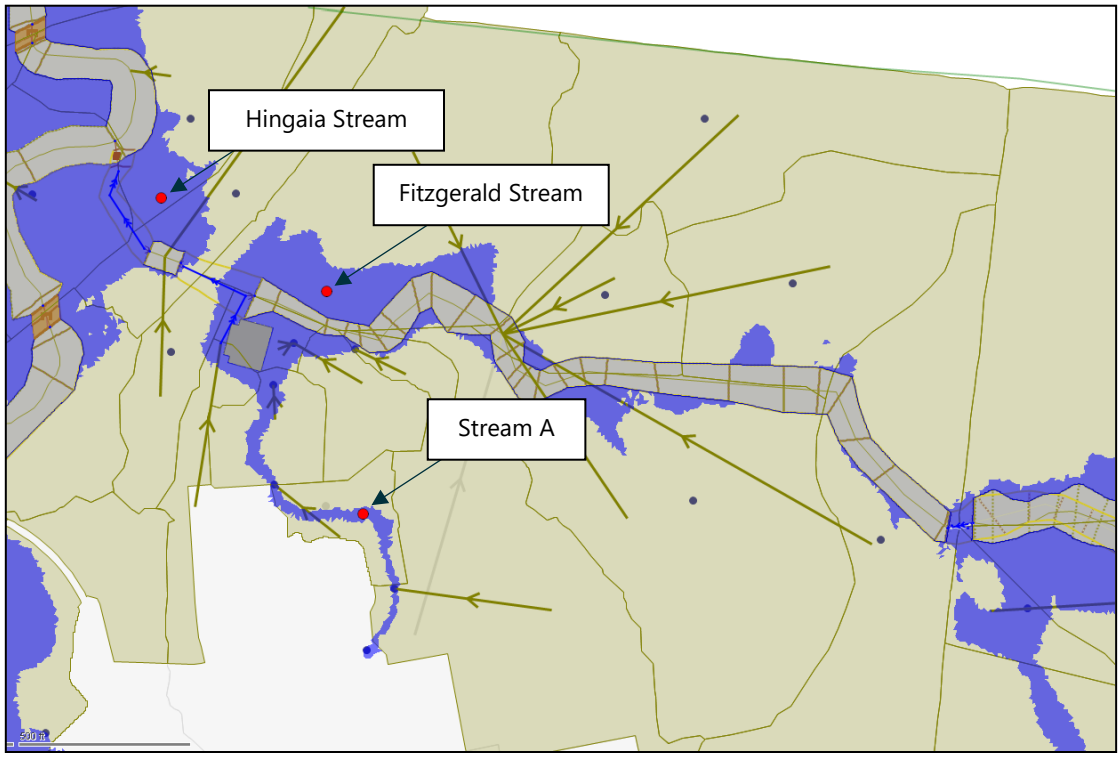

Figure 21: Attenuation Consideration - Analysis Points

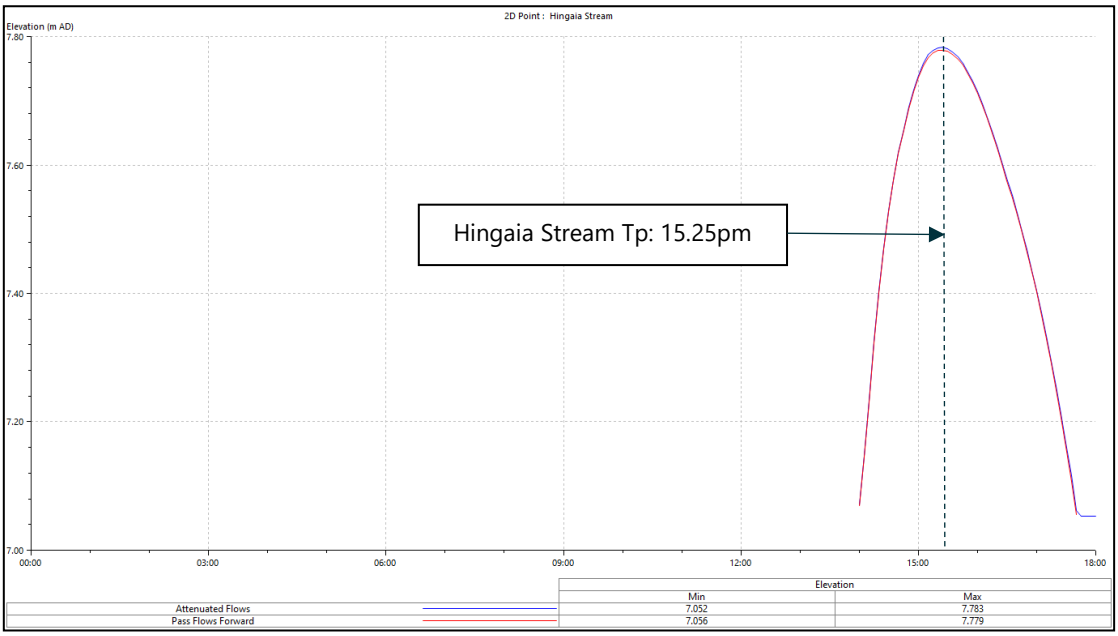

Figure 22: Hingaia Stream Water Level Time Series

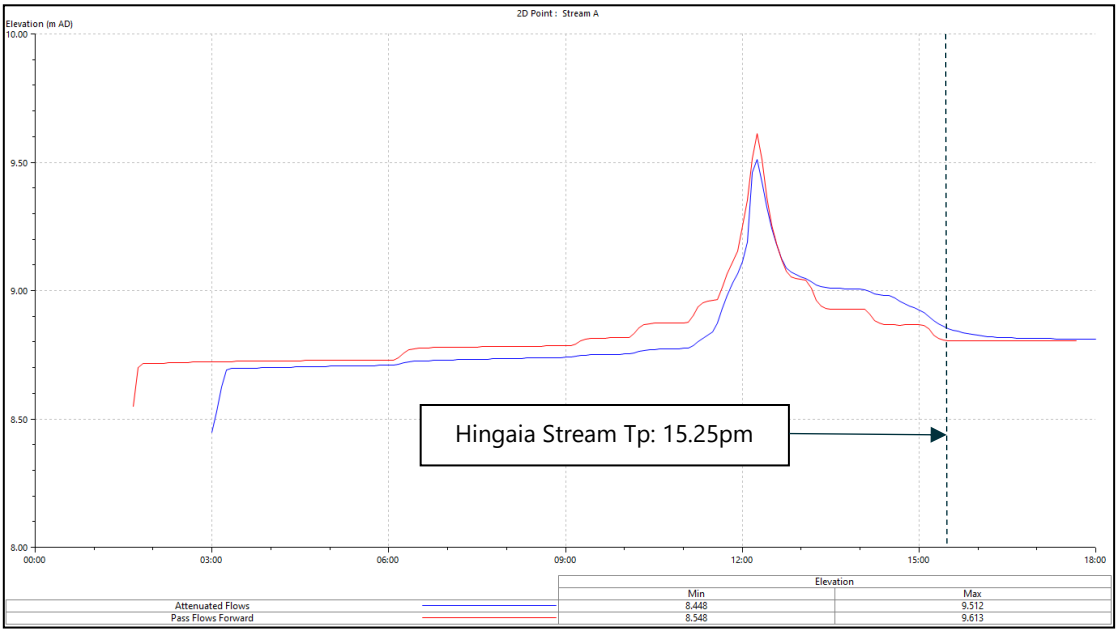

Figure 23: Stream A Water Level Time Series

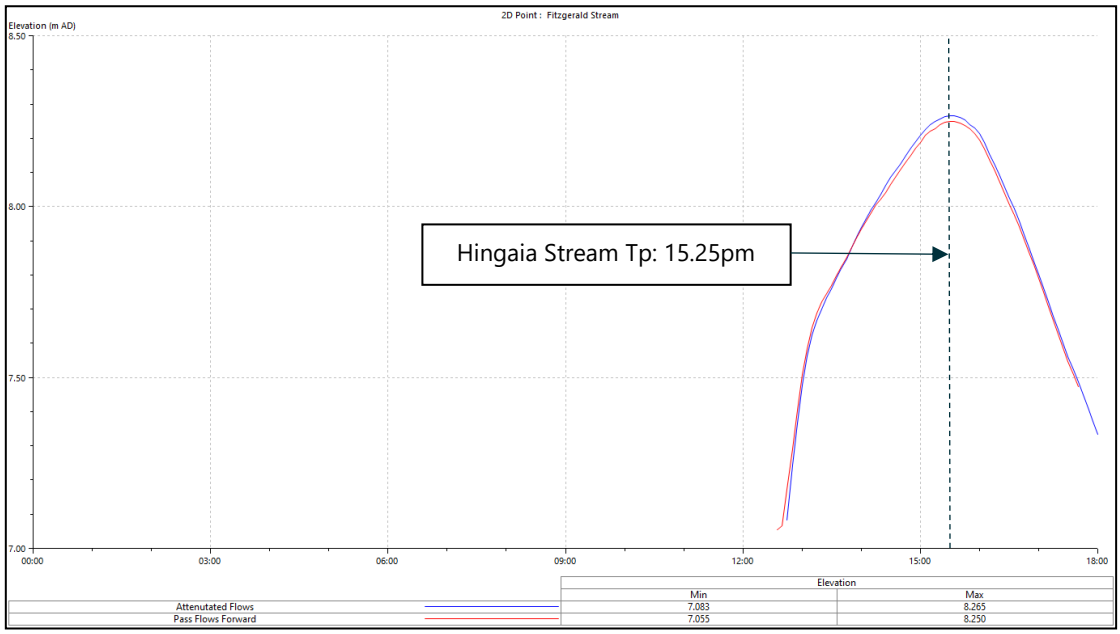

Figure 24: Fitzgerald Stream Water Level Time Series

12.3.2. Flood Risk Assessment

A flood hazard risk assessment for the site has been carried out in accordance with section E36.9 Special information requirements of the Auckland Unitary Plan (AUP) to assess flood risk for the proposed development. A copy of this assessment is included in Appendix F, which confirms that there is no change in the level of risk resulting from the development for areas within and outside Drury Centre respectively.

The flood management strategy for Stage 2 is proposed to enable the conveyance of flows during larger storm events. Flood modelling undertaken for the site predicts that there are no third-party effects expected downstream of development as a result of Stage 2 development. External OLFP entering the site and internal OLFP are to be conveyed within the proposed road corridor and conveyance structures, therefore considered as low risk.

The finished floor level for residential lots will be designed in accordance with the operative Stormwater Code of Practice, Version 3, January 2022 to ensure there are no risks to any habitable floors.

12.3.3. Model Limitations and Assumptions

- The models are updated based on existing imperviousness as per the Council's impervious surface layers (2017) available on Auckland Council Geomaps outside of the site and proposed land uses for areas within the plan change areas.
- The methodology applied to the model assumes that the piped network is fully blocked and therefore sub-catchments are loaded directly to the stream as per DHI model. This does not allow for local storage within the primary network and/or surface and therefore the assessment is considered conservative.
- This model has been prepared to guide flood levels and depths within the modelled catchment area for the modelled scenario. The modelling process relies on a range of assumptions and simplifications and may be subject to errors and inaccuracies. The compounding effects of the uncertainties in the TP108 rainfall model (Auckland Regional Council ('ARC'), 1999), the uncertainties in the LiDAR data and the uncertainties in hydraulic parameters such as roughness could result in the water level varying from the mapped levels.
- The flood model developed is dynamic in nature but used a constant sea level of Mean High-Water Springs (MHWS) 10 percentile + Tidal Amplitude with additional 1m for sea level rise in future climate change scenarios. This is consistent with the boundary conditions applied by Healthy Waters for the MPD Model. This is considered conservative as this MHWS level is applied

as a constant level throughout the 24-hour simulation, whereas in reality, this level would subside approximately every 6 hours.

- The LiDAR 2016 data (Auckland Vertical Datum 1946) used in the model has an absolute vertical accuracy of +/- 0.10m. Deviations in vertical accuracy can occur in areas of dense vegetation. Below-water ground levels are not reliably represented in the LiDAR data.
- There is no measured flow data in the catchment; therefore, it was only possible to check the model against measured peak water levels, anecdotal evidence and previous modelling.
- Model assumes a conservative Curve Number (CN) of 74 for all pervious areas. This potentially overestimates flood risks at locations, it is therefore recommended that specific localised flood risks be assessed on a case-by-case basis.

13. Conclusion

Stage 2 development of the Drury Metropolitan Centre, led by Kiwi Property, includes the development of buildings and structures for a variety of commercial, retail, accommodation and community activities with ancillary car parking. The project also involves associated enabling bulk earthworks, the creation of open spaces and stream enhancements, installation of three waters infrastructure and establishment of a roading network.

As the Drury Centre and Drury East SMP is yet to be approved by Auckland Council, the purpose of this report is to summarise the proposed stormwater management measures for Stage 2 of the Precinct. It has been prepared in accordance with the AUP, requirements of the NDC and the Drury Centre and Drury East SMP.

The proposed stormwater management strategy is summarised below:

- As Stage 2 development area discharges to two different streams the proposed stormwater management has been split across two areas
- Proposed stormwater management concept for Area 1, which is discharging to Stream A resp. Fitzgerald stream, involves a communal wetland, communal raingarden and eight roadside raingardens.
- Proposed stormwater management concept for Area 2, which is discharging to Hingaia stream, involves a communal raingarden.

Flood modelling was undertaken to assess the impacts of the proposed development. It is noted that the effects from Drury Centre precinct have been assessed in conjunction with the consented adjacent development areas within the Drury East precinct. The results generally show a reduction in flood levels through and downstream of the development. These decreased are noted to be predominantly as result of the works completed as part of Drury Centre Stage 1. The flood modelling demonstrates that there will be no increased risk of flooding to third party land as a result of the development.

Appendix A

12d outputs

Volume Exact Storage Calculations Report

Project: P23315 Drury Stg 2 Wetland

Directory: C:\12dSynergy\data\WP-PEN-APP-01\P24-447 - Drury Centre - Stage 2_22140\03 Model\01 Eng\12d\P23315 Drury Stg 2 Wetland.12dmodel

User: sinef

Created: 2025-01-31T14:11:37

PANEL SETTINGS

Tin Wetland 1

Minimum height 9.340

Maximum height 12.330

Height increment 0.010

Fence name DrainBatterTopl

Fence model Design Strings Wetland 1

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
12.330	0.010	4808.078	41.420	4162.855	41.671	4216.986	41.746
12.320	0.010	4766.658	41.004	4121.184	41.497	4175.240	41.572
12.310	0.010	4725.654	40.590	4079.687	41.323	4133.668	41.397
12.300	0.010	4685.063	39.972	4038.365	82.122	4092.271	82.159
12.290	0.010	4645.091	39.155	3956.243	81.424	4010.112	81.461
12.280	0.010	4605.936	38.344	3874.819	80.727	3928.651	80.763
12.270	0.010	4567.592	37.540	3794.092	80.029	3847.889	80.065
12.260	0.010	4530.052	36.743	3714.063	79.331	3767.824	79.367
12.250	0.010	4493.309	35.954	3634.732	78.634	3688.457	78.669
12.240	0.010	4457.355	35.171	3556.098	77.936	3609.788	77.971
12.230	0.010	4422.184	34.395	3478.162	77.238	3531.816	77.273
12.220	0.010	4387.790	33.626	3400.924	76.541	3454.543	76.575
12.210	0.010	4354.164	32.864	3324.383	75.843	3377.968	75.877
12.200	0.010	4321.300	32.192	3248.540	42.167	3302.091	42.323
12.190	0.010	4289.108	32.019	3206.372	9.007	3259.768	9.285
12.180	0.010	4257.089	31.929	3197.365	8.997	3250.483	9.274
12.170	0.010	4225.161	31.839	3188.367	8.987	3241.208	9.264
12.160	0.010	4193.322	31.749	3179.380	8.977	3231.944	9.254

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
12.150	0.010	4161.573	31.659	3170.403	8.967	3222.691	9.243
12.140	0.010	4129.914	31.570	3161.436	8.957	3213.447	9.233
12.130	0.010	4098.344	31.480	3152.478	8.947	3204.214	9.223
12.120	0.010	4066.864	31.391	3143.531	8.937	3194.992	9.212
12.110	0.010	4035.474	31.301	3134.594	8.927	3185.780	9.202
12.100	0.010	4004.172	31.212	3125.667	8.917	3176.578	9.192
12.090	0.010	3972.960	31.123	3116.750	8.907	3167.386	9.181
12.080	0.010	3941.837	31.034	3107.843	8.897	3158.205	9.171
12.070	0.010	3910.803	30.945	3098.946	8.887	3149.034	9.160
12.060	0.010	3879.858	30.856	3090.059	8.877	3139.874	9.150
12.050	0.010	3849.002	30.767	3081.183	8.867	3130.724	9.140
12.040	0.010	3818.235	30.679	3072.316	8.857	3121.584	9.129
12.030	0.010	3787.556	30.590	3063.459	8.847	3112.454	9.119
12.020	0.010	3756.965	30.502	3054.612	8.837	3103.335	9.109
12.010	0.010	3726.464	30.414	3045.776	8.827	3094.227	9.098
12.000	0.010	3696.050	30.325	3036.949	8.817	3085.128	9.088
11.990	0.010	3665.724	30.237	3028.133	8.806	3076.040	9.078
11.980	0.010	3635.487	30.149	3019.326	8.796	3066.963	9.067
11.970	0.010	3605.338	30.061	3010.530	8.786	3057.895	9.057
11.960	0.010	3575.277	29.974	3001.743	8.776	3048.839	9.047
11.950	0.010	3545.303	29.886	2992.967	8.766	3039.792	9.036
11.940	0.010	3515.417	29.798	2984.201	8.756	3030.756	9.026
11.930	0.010	3485.619	29.711	2975.444	8.746	3021.730	9.015
11.920	0.010	3455.908	29.623	2966.698	8.736	3012.714	9.005
11.910	0.010	3426.285	29.536	2957.962	8.726	3003.709	8.995
11.900	0.010	3396.749	29.449	2949.236	8.716	2994.714	8.984
11.890	0.010	3367.300	29.362	2940.520	8.706	2985.730	8.974
11.880	0.010	3337.939	29.275	2931.814	8.696	2976.756	8.964
11.870	0.010	3308.664	29.188	2923.118	8.686	2967.792	8.953
11.860	0.010	3279.476	29.101	2914.432	8.676	2958.839	8.943
11.850	0.010	3250.375	29.014	2905.756	8.666	2949.896	8.933
11.840	0.010	3221.361	28.928	2897.090	8.656	2940.963	8.922
11.830	0.010	3192.433	28.841	2888.434	8.646	2932.041	8.912
11.820	0.010	3163.592	28.755	2879.788	8.636	2923.129	8.902
11.810	0.010	3134.838	28.668	2871.153	8.626	2914.227	8.891
11.800	0.010	3106.169	28.582	2862.527	8.616	2905.336	8.881
11.790	0.010	3077.587	28.496	2853.911	8.606	2896.455	8.871
11.780	0.010	3049.091	28.410	2845.306	8.596	2887.585	8.860
11.770	0.010	3020.681	28.324	2836.710	8.585	2878.725	8.850
11.760	0.010	2992.357	28.238	2828.125	8.575	2869.875	8.839
11.750	0.010	2964.118	28.153	2819.549	8.565	2861.035	8.829

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
11.740	0.010	2935.966	28.067	2810.984	8.555	2852.206	8.819
11.730	0.010	2907.899	27.982	2802.428	8.545	2843.388	8.808
11.720	0.010	2879.917	27.896	2793.883	8.535	2834.579	8.798
11.710	0.010	2852.021	27.811	2785.348	8.525	2825.781	8.788
11.700	0.010	2824.210	27.726	2776.823	8.515	2816.993	8.777
11.690	0.010	2796.485	27.641	2768.308	8.505	2808.216	8.767
11.680	0.010	2768.844	27.556	2759.802	8.495	2799.449	8.757
11.670	0.010	2741.288	27.471	2751.307	8.485	2790.693	8.746
11.660	0.010	2713.818	27.386	2742.822	8.475	2781.946	8.736
11.650	0.010	2686.432	27.301	2734.347	8.465	2773.210	8.726
11.640	0.010	2659.131	27.217	2725.882	8.455	2764.485	8.715
11.630	0.010	2631.914	27.132	2717.427	8.445	2755.770	8.705
11.620	0.010	2604.782	27.048	2708.983	8.435	2747.065	8.694
11.610	0.010	2577.735	26.963	2700.548	8.425	2738.370	8.684
11.600	0.010	2550.771	26.879	2692.123	8.415	2729.686	8.674
11.590	0.010	2523.892	26.795	2683.708	8.405	2721.012	8.663
11.580	0.010	2497.097	26.711	2675.304	8.395	2712.349	8.653
11.570	0.010	2470.386	26.627	2666.909	8.385	2703.696	8.643
11.560	0.010	2443.759	26.543	2658.525	8.375	2695.053	8.632
11.550	0.010	2417.215	26.460	2650.150	8.364	2686.421	8.622
11.540	0.010	2390.756	26.376	2641.785	8.354	2677.799	8.612
11.530	0.010	2364.380	26.293	2633.431	8.344	2669.187	8.601
11.520	0.010	2338.087	26.209	2625.087	8.334	2660.586	8.591
11.510	0.010	2311.878	26.126	2616.752	8.324	2651.995	8.581
11.500	0.010	2285.752	26.043	2608.428	8.314	2643.415	8.570
11.490	0.010	2259.709	25.960	2600.114	8.304	2634.844	8.560
11.480	0.010	2233.750	25.877	2591.810	8.294	2626.284	8.550
11.470	0.010	2207.873	25.794	2583.515	8.284	2617.735	8.539
11.460	0.010	2182.079	25.711	2575.231	8.274	2609.196	8.529
11.450	0.010	2156.368	25.628	2566.957	8.264	2600.667	8.518
11.440	0.010	2130.740	25.546	2558.693	8.254	2592.149	8.508
11.430	0.010	2105.195	25.463	2550.439	8.244	2583.641	8.498
11.420	0.010	2079.731	25.381	2542.195	8.234	2575.143	8.487
11.410	0.010	2054.351	25.298	2533.961	8.224	2566.655	8.477
11.400	0.010	2029.052	25.216	2525.738	8.214	2558.178	8.467
11.390	0.010	2003.836	25.134	2517.524	8.204	2549.712	8.456
11.380	0.010	1978.702	25.052	2509.320	8.194	2541.255	8.446
11.370	0.010	1953.649	24.970	2501.126	8.184	2532.809	8.436
11.360	0.010	1928.679	24.889	2492.943	8.174	2524.374	8.425
11.350	0.010	1903.791	24.807	2484.769	8.164	2515.949	8.415
11.340	0.010	1878.984	24.725	2476.606	8.154	2507.534	8.405

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
11.330	0.010	1854.258	24.644	2468.452	8.143	2499.129	8.394
11.320	0.010	1829.615	24.562	2460.309	8.133	2490.735	8.384
11.310	0.010	1805.052	24.481	2452.175	8.123	2482.351	8.373
11.300	0.010	1780.571	24.400	2444.052	8.113	2473.978	8.363
11.290	0.010	1756.171	24.319	2435.938	8.103	2465.615	8.353
11.280	0.010	1731.852	24.238	2427.835	8.093	2457.262	8.342
11.270	0.010	1707.614	24.157	2419.742	8.083	2448.920	8.332
11.260	0.010	1683.457	24.076	2411.659	8.073	2440.588	8.322
11.250	0.010	1659.381	23.996	2403.586	8.063	2432.266	8.311
11.240	0.010	1635.386	23.915	2395.522	8.053	2423.954	8.301
11.230	0.010	1611.471	23.834	2387.469	8.043	2415.654	8.291
11.220	0.010	1587.636	23.754	2379.426	8.033	2407.363	8.280
11.210	0.010	1563.882	23.674	2371.393	8.023	2399.083	8.270
11.200	0.010	1540.208	23.594	2363.370	8.013	2390.813	8.260
11.190	0.010	1516.615	23.514	2355.358	8.003	2382.553	8.249
11.180	0.010	1493.101	23.434	2347.355	7.993	2374.304	8.239
11.170	0.010	1469.668	23.354	2339.362	7.983	2366.065	8.228
11.160	0.010	1446.314	23.274	2331.379	7.973	2357.837	8.218
11.150	0.010	1423.040	23.194	2323.407	7.963	2349.619	8.208
11.140	0.010	1399.846	23.115	2315.444	7.953	2341.411	8.197
11.130	0.010	1376.731	23.035	2307.491	7.943	2333.213	8.187
11.120	0.010	1353.696	22.956	2299.549	7.933	2325.026	8.177
11.110	0.010	1330.740	22.877	2291.616	7.922	2316.850	8.166
11.100	0.010	1307.863	22.797	2283.694	7.912	2308.683	8.156
11.090	0.010	1285.066	22.718	2275.781	7.902	2300.527	8.146
11.080	0.010	1262.348	22.639	2267.879	7.892	2292.382	8.135
11.070	0.010	1239.708	22.560	2259.987	7.882	2284.246	8.125
11.060	0.010	1217.148	22.482	2252.104	7.872	2276.121	8.115
11.050	0.010	1194.666	22.403	2244.232	7.862	2268.007	8.104
11.040	0.010	1172.263	22.324	2236.370	7.852	2259.903	8.094
11.030	0.010	1149.939	22.246	2228.518	7.842	2251.809	8.084
11.020	0.010	1127.693	22.168	2220.676	7.832	2243.725	8.073
11.010	0.010	1105.525	22.089	2212.844	7.822	2235.652	8.063
11.000	0.010	1083.436	22.011	2205.022	7.812	2227.589	8.052
10.990	0.010	1061.425	21.933	2197.210	7.802	2219.537	8.042
10.980	0.010	1039.492	21.855	2189.408	7.792	2211.495	8.032
10.970	0.010	1017.637	21.777	2181.616	7.782	2203.463	8.021
10.960	0.010	995.859	21.699	2173.834	7.772	2195.442	8.011
10.950	0.010	974.160	21.622	2166.062	7.762	2187.431	8.001
10.940	0.010	952.538	21.544	2158.301	7.752	2179.430	7.990
10.930	0.010	930.994	21.467	2150.549	7.742	2171.440	7.980

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
10.920	0.010	909.527	21.389	2142.807	7.732	2163.460	7.970
10.910	0.010	888.138	21.312	2135.076	7.722	2155.490	7.959
10.900	0.010	866.826	21.203	2127.354	20.566	2147.531	20.713
10.890	0.010	845.623	20.901	2106.788	33.286	2126.818	33.345
10.880	0.010	824.722	20.569	2073.502	33.112	2093.473	33.173
10.870	0.010	804.152	20.239	2040.390	32.937	2060.300	33.001
10.860	0.010	783.913	19.911	2007.454	32.762	2027.298	32.829
10.850	0.010	764.003	19.584	1974.692	32.587	1994.469	32.658
10.840	0.010	744.419	19.259	1942.105	32.412	1961.811	32.486
10.830	0.010	725.160	18.936	1909.693	32.237	1929.326	32.314
10.820	0.010	706.224	18.614	1877.456	32.062	1897.012	32.142
10.810	0.010	687.610	18.294	1845.394	31.887	1864.870	31.970
10.800	0.010	669.316	17.976	1813.507	31.712	1832.900	31.798
10.790	0.010	651.339	17.660	1781.794	31.537	1801.102	31.626
10.780	0.010	633.679	17.346	1750.257	31.363	1769.476	31.454
10.770	0.010	616.334	17.033	1718.894	31.188	1738.022	31.282
10.760	0.010	599.301	16.722	1687.707	31.013	1706.739	31.111
10.750	0.010	582.579	16.413	1656.694	30.838	1675.629	30.939
10.740	0.010	566.166	16.105	1625.856	30.663	1644.690	30.767
10.730	0.010	550.061	15.799	1595.193	30.488	1613.923	30.595
10.720	0.010	534.262	15.495	1564.705	30.313	1583.329	30.423
10.710	0.010	518.767	15.193	1534.392	30.138	1552.906	30.251
10.700	0.010	503.574	14.898	1504.254	26.650	1522.655	26.834
10.690	0.010	488.675	14.665	1477.604	22.518	1495.821	22.764
10.680	0.010	474.010	14.431	1455.086	24.276	1473.057	24.516
10.670	0.010	459.579	14.179	1430.810	26.035	1448.542	26.268
10.660	0.010	445.400	13.910	1404.774	27.794	1422.274	28.019
10.650	0.010	431.490	13.624	1376.980	116.491	1394.255	116.709
10.640	0.010	417.866	12.467	1260.490	27.477	1277.546	27.764
10.630	0.010	405.399	12.194	1233.013	27.214	1249.782	27.499
10.620	0.010	393.205	11.923	1205.799	26.952	1222.283	27.234
10.610	0.010	381.282	11.655	1178.848	26.689	1195.048	26.970
10.600	0.010	369.627	11.389	1152.159	26.426	1168.079	26.705
10.590	0.010	358.238	11.126	1125.732	26.164	1141.374	26.440
10.580	0.010	347.112	10.866	1099.568	25.901	1114.934	26.175
10.570	0.010	336.246	10.608	1073.667	25.639	1088.759	25.910
10.560	0.010	325.637	10.353	1048.028	25.376	1062.849	25.646
10.550	0.010	315.284	10.101	1022.651	25.114	1037.203	25.381
10.540	0.010	305.184	9.851	997.537	24.851	1011.822	25.116
10.530	0.010	295.333	9.604	972.686	24.589	986.707	24.851
10.520	0.010	285.729	9.359	948.097	24.326	961.855	24.586

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
10.510	0.010	276.370	9.117	923.770	24.064	937.269	24.321
10.500	0.010	267.253	8.878	899.706	23.801	912.948	24.057
10.490	0.010	258.375	8.641	875.905	23.539	888.891	23.792
10.480	0.010	249.734	8.407	852.366	23.276	865.099	23.527
10.470	0.010	241.327	8.176	829.090	23.014	841.572	23.262
10.460	0.010	233.151	7.947	806.076	22.751	818.310	22.997
10.450	0.010	225.204	7.721	783.324	22.489	795.313	22.733
10.440	0.010	217.484	7.497	760.836	22.226	772.580	22.468
10.430	0.010	209.987	7.276	738.609	21.964	750.112	22.203
10.420	0.010	202.711	7.058	716.645	21.701	727.910	21.938
10.410	0.010	195.653	6.842	694.944	21.439	705.971	21.673
10.400	0.010	188.811	6.629	673.505	21.176	684.298	21.408
10.390	0.010	182.182	6.418	652.329	20.914	662.890	21.144
10.380	0.010	175.763	6.211	631.415	20.651	641.746	20.879
10.370	0.010	169.553	6.005	610.764	20.389	620.867	20.614
10.360	0.010	163.547	5.803	590.375	20.126	600.253	20.349
10.350	0.010	157.744	5.603	570.248	255.143	579.904	255.363
10.340	0.010	152.141	3.131	315.106	4.000	324.541	4.135
10.330	0.010	149.010	3.091	311.106	3.977	320.406	4.112
10.320	0.010	145.919	3.051	307.129	3.955	316.294	4.089
10.310	0.010	142.868	3.012	303.173	3.933	312.206	4.066
10.300	0.010	139.856	2.973	299.240	3.911	308.140	4.043
10.290	0.010	136.883	2.934	295.330	3.889	304.097	4.020
10.280	0.010	133.949	2.895	291.441	3.866	300.077	3.997
10.270	0.010	131.054	2.857	287.575	3.844	296.080	3.974
10.260	0.010	128.197	2.818	283.730	3.822	292.106	3.951
10.250	0.010	125.379	2.780	279.909	3.800	288.156	3.928
10.240	0.010	122.599	2.742	276.109	3.777	284.227	3.905
10.230	0.010	119.857	2.705	272.331	3.755	280.322	3.882
10.220	0.010	117.152	2.667	268.576	3.733	276.440	3.859
10.210	0.010	114.485	2.630	264.843	3.711	272.581	3.836
10.200	0.010	111.856	2.593	261.132	3.689	268.745	3.813
10.190	0.010	109.263	2.556	257.444	3.666	264.931	3.790
10.180	0.010	106.707	2.520	253.777	3.644	261.141	3.767
10.170	0.010	104.187	2.483	250.133	3.622	257.374	3.744
10.160	0.010	101.704	2.447	246.511	3.600	253.629	3.722
10.150	0.010	99.257	2.411	242.912	3.577	249.908	3.699
10.140	0.010	96.846	2.376	239.334	3.555	246.209	3.676
10.130	0.010	94.470	2.340	235.779	3.533	242.534	3.653
10.120	0.010	92.130	2.305	232.246	3.511	238.881	3.630
10.110	0.010	89.825	2.270	228.735	3.489	235.251	3.607

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
10.100	0.010	87.555	2.235	225.247	3.466	231.644	3.584
10.090	0.010	85.320	2.201	221.780	3.444	228.061	3.561
10.080	0.010	83.119	2.166	218.336	3.422	224.500	3.538
10.070	0.010	80.953	2.132	214.915	3.400	220.962	3.515
10.060	0.010	78.821	2.098	211.515	3.377	217.447	3.492
10.050	0.010	76.723	2.065	208.137	3.355	213.955	3.469
10.040	0.010	74.658	2.031	204.782	3.333	210.486	3.446
10.030	0.010	72.627	1.998	201.449	3.311	207.040	3.423
10.020	0.010	70.629	1.965	198.139	3.289	203.616	3.400
10.010	0.010	68.664	1.932	194.850	3.266	200.216	3.377
10.000	0.010	66.732	1.900	191.584	3.244	196.839	3.354
9.990	0.010	64.832	1.867	188.340	3.222	193.485	3.331
9.980	0.010	62.965	1.835	185.118	3.200	190.153	3.308
9.970	0.010	61.130	1.803	181.918	3.177	186.845	3.285
9.960	0.010	59.327	1.772	178.741	3.155	183.559	3.263
9.950	0.010	57.555	1.740	175.586	3.133	180.297	3.240
9.940	0.010	55.815	1.709	172.453	3.111	177.057	3.217
9.930	0.010	54.106	1.678	169.342	3.088	173.840	3.194
9.920	0.010	52.428	1.647	166.254	3.066	170.647	3.171
9.910	0.010	50.781	1.617	163.187	3.044	167.476	3.148
9.900	0.010	49.164	1.586	160.143	3.022	164.328	3.125
9.890	0.010	47.578	1.556	157.122	3.000	161.203	3.102
9.880	0.010	46.022	1.526	154.122	2.977	158.101	3.079
9.870	0.010	44.495	1.497	151.145	2.955	155.022	3.056
9.860	0.010	42.999	1.467	148.189	2.933	151.966	3.033
9.850	0.010	41.532	1.438	145.257	2.911	148.933	3.010
9.840	0.010	40.094	1.409	142.346	2.888	145.923	2.987
9.830	0.010	38.685	1.380	139.457	2.866	142.936	2.964
9.820	0.010	37.304	1.352	136.591	2.844	139.972	2.941
9.810	0.010	35.953	1.323	133.747	2.822	137.031	2.918
9.800	0.010	34.629	1.295	130.925	2.800	134.112	2.895
9.790	0.010	33.334	1.267	128.126	2.777	131.217	2.872
9.780	0.010	32.067	1.240	125.348	2.755	128.345	2.849
9.770	0.010	30.827	1.212	122.593	2.733	125.495	2.827
9.760	0.010	29.615	1.185	119.860	2.711	122.669	2.804
9.750	0.010	28.430	1.158	117.150	2.688	119.865	2.781
9.740	0.010	27.272	1.131	114.461	2.666	117.084	2.758
9.730	0.010	26.140	1.105	111.795	2.644	114.327	2.735
9.720	0.010	25.036	1.078	109.151	2.622	111.592	2.712
9.710	0.010	23.957	1.052	106.529	2.600	108.880	2.689
9.700	0.010	22.905	1.026	103.930	2.577	106.191	2.666

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
9.690	0.010	21.879	1.001	101.353	2.555	103.525	2.643
9.680	0.010	20.878	0.975	98.798	2.533	100.882	2.620
9.670	0.010	19.903	0.950	96.265	2.511	98.262	2.597
9.660	0.010	18.953	0.925	93.754	2.488	95.665	2.574
9.650	0.010	18.028	0.900	91.266	6.288	93.091	6.373
9.640	0.010	17.127	0.840	84.978	1.962	86.719	2.025
9.630	0.010	16.287	0.820	83.016	1.951	84.693	2.014
9.620	0.010	15.467	0.801	81.064	1.941	82.679	2.003
9.610	0.010	14.666	0.782	79.124	1.930	80.676	1.992
9.600	0.010	13.884	0.762	77.194	1.919	78.684	1.981
9.590	0.010	13.122	0.743	75.275	1.908	76.704	1.969
9.580	0.010	12.379	0.724	73.367	1.897	74.735	1.958
9.570	0.010	11.655	0.705	71.470	1.886	72.776	1.947
9.560	0.010	10.949	0.686	69.584	1.875	70.830	1.936
9.550	0.010	10.263	0.668	67.708	1.865	68.894	1.925
9.540	0.010	9.595	0.649	65.844	1.854	66.969	1.913
9.530	0.010	8.946	0.631	63.990	1.843	65.056	1.902
9.520	0.010	8.315	0.612	62.147	1.832	63.154	1.891
9.510	0.010	7.703	0.594	60.315	1.821	61.263	1.880
9.500	0.010	7.109	0.576	58.494	1.810	59.383	1.868
9.490	0.010	6.533	0.558	56.684	1.799	57.515	1.857
9.480	0.010	5.975	0.540	54.884	1.789	55.658	1.846
9.470	0.010	5.435	0.522	53.096	1.778	53.811	1.835
9.460	0.010	4.913	0.504	51.318	1.767	51.977	1.824
9.450	0.010	4.409	0.487	49.551	1.756	50.153	1.812
9.440	0.010	3.922	0.469	47.795	1.745	48.340	1.801
9.430	0.010	3.453	0.452	46.050	1.734	46.539	1.790
9.420	0.010	3.001	0.435	44.316	1.723	44.749	1.779
9.410	0.010	2.567	0.417	42.592	1.713	42.970	1.768
9.400	0.010	2.149	0.400	40.880	1.702	41.203	1.756
9.390	0.010	1.749	0.383	39.178	1.691	39.446	1.745
9.380	0.010	1.366	0.366	37.487	1.680	37.701	1.734
9.370	0.010	0.999	0.350	35.807	1.669	35.967	1.723
9.360	0.010	0.650	0.333	34.138	1.658	34.244	1.712
9.350	0.010	0.317	0.317	32.480	32.480	32.533	32.533
9.340	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9.340		0.000		0.000		0.000	

Summary

Polygon plan area: 4162.855

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Volume Exact Storage Calculations Report

Project: P23315 CREEK ROAD NORTH
Directory: c:\12dS\data\WP-AKL-APP-02\P23-315_1 - Creek Road_21792\03 Model\01 Eng\12d\P23315 CREEK ROAD NORTH.12dmodel
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PANEL SETTINGS

Tin WETLAND 2 2
Minimum height 10.677
Maximum height 13.313
Height increment 0.010
Fence name EDGEr
Fence model Design Strings WETLAND 2 2 DESIGN

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
13.313	0.003	2051.730	7.937	2654.091	18.541	2703.173	18.583
13.310	0.010	2043.793	26.020	2635.551	67.051	2684.589	67.195
13.300	0.010	2017.774	25.353	2568.500	66.246	2617.394	66.391
13.290	0.010	1992.421	24.695	2502.254	65.442	2551.003	65.587
13.280	0.010	1967.726	24.044	2436.811	64.638	2485.417	64.783
13.270	0.010	1943.682	23.402	2372.173	63.834	2420.634	63.978
13.260	0.010	1920.280	22.768	2308.339	63.030	2356.656	63.174
13.250	0.010	1897.512	22.141	2245.309	62.226	2293.481	62.370
13.240	0.010	1875.371	21.523	2183.083	61.422	2231.111	61.566
13.230	0.010	1853.848	20.913	2121.660	60.618	2169.545	60.762
13.220	0.010	1832.935	20.311	2061.043	59.814	2108.783	59.958
13.210	0.010	1812.624	19.717	2001.229	62.070	2048.825	62.214
13.200	0.010	1792.908	19.362	1939.159	5.932	1986.611	6.248
13.190	0.010	1773.546	19.303	1933.227	5.927	1980.364	6.241
13.180	0.010	1754.243	19.243	1927.300	5.921	1974.123	6.235
13.170	0.010	1735.000	19.184	1921.379	5.915	1967.887	6.229
13.160	0.010	1715.816	19.125	1915.464	5.909	1961.658	6.223
13.150	0.010	1696.691	19.066	1909.554	5.904	1955.434	6.217

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
13.140	0.010	1677.625	19.007	1903.651	5.898	1949.217	6.211
13.130	0.010	1658.617	18.948	1897.753	5.892	1943.006	6.205
13.120	0.010	1639.669	18.889	1891.860	5.886	1936.801	6.199
13.110	0.010	1620.780	18.830	1885.974	5.881	1930.602	6.193
13.100	0.010	1601.950	18.772	1880.093	5.875	1924.409	6.187
13.090	0.010	1583.178	18.713	1874.218	5.869	1918.222	6.181
13.080	0.010	1564.466	18.654	1868.349	5.863	1912.041	6.175
13.070	0.010	1545.811	18.596	1862.486	5.858	1905.866	6.169
13.060	0.010	1527.216	18.537	1856.628	5.852	1899.698	6.163
13.050	0.010	1508.679	18.479	1850.776	5.846	1893.535	6.157
13.040	0.010	1490.200	18.420	1844.930	5.840	1887.378	6.151
13.030	0.010	1471.780	18.362	1839.090	5.835	1881.228	6.145
13.020	0.010	1453.418	18.303	1833.255	5.829	1875.083	6.138
13.010	0.010	1435.115	18.245	1827.426	5.823	1868.945	6.132
13.000	0.010	1416.870	18.187	1821.603	5.817	1862.812	6.126
12.990	0.010	1398.683	18.129	1815.785	5.812	1856.686	6.120
12.980	0.010	1380.554	18.071	1809.974	5.806	1850.566	6.114
12.970	0.010	1362.483	18.013	1804.168	5.800	1844.451	6.108
12.960	0.010	1344.471	17.955	1798.368	5.794	1838.343	6.102
12.950	0.010	1326.516	17.897	1792.573	5.789	1832.241	6.096
12.940	0.010	1308.619	17.839	1786.785	5.783	1826.145	6.090
12.930	0.010	1290.780	17.781	1781.002	5.777	1820.055	6.084
12.920	0.010	1272.999	17.723	1775.225	5.771	1813.971	6.078
12.910	0.010	1255.276	17.666	1769.453	5.766	1807.893	6.072
12.900	0.010	1237.610	17.608	1763.688	5.760	1801.821	6.066
12.890	0.010	1220.002	17.551	1757.928	5.754	1795.756	6.060
12.880	0.010	1202.452	17.493	1752.174	5.748	1789.696	6.054
12.870	0.010	1184.959	17.436	1746.425	5.743	1783.642	6.048
12.860	0.010	1167.523	17.378	1740.683	5.737	1777.595	6.042
12.850	0.010	1150.145	17.321	1734.946	5.731	1771.553	6.035
12.840	0.010	1132.824	17.264	1729.215	5.725	1765.518	6.029
12.830	0.010	1115.561	17.206	1723.489	5.720	1759.488	6.023
12.820	0.010	1098.354	17.149	1717.770	5.714	1753.465	6.017
12.810	0.010	1081.205	17.092	1712.056	5.708	1747.447	6.011
12.800	0.010	1064.113	17.035	1706.348	5.702	1741.436	6.005
12.790	0.010	1047.078	16.978	1700.645	5.697	1735.431	5.999
12.780	0.010	1030.100	16.921	1694.949	5.691	1729.432	5.993
12.770	0.010	1013.179	16.864	1689.258	5.685	1723.439	5.987
12.760	0.010	996.315	16.807	1683.573	5.679	1717.452	5.981
12.750	0.010	979.508	16.751	1677.894	5.674	1711.471	5.975
12.740	0.010	962.757	16.694	1672.220	5.668	1705.496	5.969

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
12.730	0.010	946.063	16.637	1666.552	5.662	1699.527	5.963
12.720	0.010	929.426	16.581	1660.890	5.656	1693.564	5.957
12.710	0.010	912.846	16.524	1655.234	5.651	1687.608	5.951
12.700	0.010	896.321	16.468	1649.583	5.645	1681.657	5.945
12.690	0.010	879.854	16.411	1643.938	5.639	1675.712	5.939
12.680	0.010	863.443	16.355	1638.299	5.633	1669.774	5.932
12.670	0.010	847.088	16.299	1632.666	5.628	1663.841	5.926
12.660	0.010	830.789	16.242	1627.038	5.622	1657.915	5.920
12.650	0.010	814.547	16.186	1621.417	5.616	1651.995	5.914
12.640	0.010	798.361	16.130	1615.800	5.610	1646.080	5.908
12.630	0.010	782.231	16.071	1610.190	8.153	1640.172	8.408
12.620	0.010	766.160	15.941	1602.037	16.024	1631.764	16.173
12.610	0.010	750.220	15.779	1586.013	26.115	1615.592	26.304
12.600	0.010	734.441	15.517	1559.898	16.318	1589.288	16.800
12.590	0.010	718.924	15.354	1543.580	16.291	1572.488	16.762
12.580	0.010	703.570	15.192	1527.289	16.263	1555.726	16.725
12.570	0.010	688.378	15.029	1511.026	16.235	1539.001	16.688
12.560	0.010	673.349	14.867	1494.792	16.207	1522.313	16.650
12.550	0.010	658.482	14.705	1478.585	16.179	1505.663	16.613
12.540	0.010	643.777	14.543	1462.405	16.151	1489.050	16.576
12.530	0.010	629.234	14.382	1446.254	16.123	1472.474	16.538
12.520	0.010	614.852	14.221	1430.131	16.095	1455.936	16.501
12.510	0.010	600.631	14.060	1414.035	16.068	1439.435	16.464
12.500	0.010	586.571	13.899	1397.968	16.040	1422.971	16.426
12.490	0.010	572.672	13.739	1381.928	16.012	1406.545	16.389
12.480	0.010	558.933	13.579	1365.916	15.984	1390.156	16.352
12.470	0.010	545.353	13.420	1349.932	15.956	1373.804	16.314
12.460	0.010	531.934	13.260	1333.976	15.928	1357.490	16.277
12.450	0.010	518.674	13.101	1318.048	15.900	1341.213	16.240
12.440	0.010	505.573	12.942	1302.147	15.872	1324.974	16.202
12.430	0.010	492.631	12.784	1286.275	15.845	1308.771	16.165
12.420	0.010	479.847	12.625	1270.430	15.817	1292.607	16.128
12.410	0.010	467.222	12.467	1254.614	15.789	1276.479	16.090
12.400	0.010	454.755	12.309	1238.825	15.761	1260.389	16.053
12.390	0.010	442.445	12.152	1223.064	15.733	1244.336	16.016
12.380	0.010	430.293	11.995	1207.331	15.705	1228.320	15.978
12.370	0.010	418.299	11.838	1191.625	15.677	1212.342	15.941
12.360	0.010	406.461	11.681	1175.948	15.650	1196.401	15.903
12.350	0.010	394.780	11.525	1160.298	15.622	1180.498	15.866
12.340	0.010	383.255	11.369	1144.677	15.594	1164.632	15.829
12.330	0.010	371.886	11.213	1129.083	15.566	1148.803	15.791

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
12.320	0.010	360.673	11.057	1113.517	15.538	1133.012	15.754
12.310	0.010	349.616	10.902	1097.979	15.510	1117.257	15.717
12.300	0.010	338.713	10.747	1082.469	15.482	1101.541	15.679
12.290	0.010	327.966	10.593	1066.987	15.454	1085.861	15.642
12.280	0.010	317.374	10.438	1051.532	15.427	1070.219	15.605
12.270	0.010	306.935	9.498	1036.106	335.732	1054.614	335.938
12.260	0.010	297.437	6.958	700.373	9.232	718.676	9.550
12.250	0.010	290.480	6.866	691.142	9.171	709.126	9.487
12.240	0.010	283.614	6.774	681.970	9.111	699.639	9.425
12.230	0.010	276.840	6.683	672.859	9.050	690.214	9.362
12.220	0.010	270.157	6.593	663.809	8.990	680.852	9.300
12.210	0.010	263.564	6.503	654.819	8.929	671.552	9.237
12.200	0.010	257.060	6.415	645.890	8.869	662.314	9.175
12.190	0.010	250.646	6.326	637.021	8.808	653.140	9.112
12.180	0.010	244.319	6.238	628.213	8.748	644.028	9.050
12.170	0.010	238.081	6.151	619.465	8.687	634.978	8.987
12.160	0.010	231.930	6.065	610.777	8.627	625.991	8.925
12.150	0.010	225.865	5.979	602.150	8.566	617.066	8.862
12.140	0.010	219.887	5.893	593.584	8.506	608.204	8.799
12.130	0.010	213.993	5.809	585.078	8.445	599.405	8.737
12.120	0.010	208.185	5.724	576.633	8.385	590.668	8.674
12.110	0.010	202.461	5.641	568.248	8.324	581.993	8.612
12.100	0.010	196.820	5.558	559.923	8.264	573.381	8.549
12.090	0.010	191.262	5.476	551.659	8.204	564.832	8.487
12.080	0.010	185.786	5.394	543.456	8.143	556.345	8.424
12.070	0.010	180.393	5.313	535.313	8.083	547.921	8.362
12.060	0.010	175.080	5.232	527.230	8.022	539.559	8.299
12.050	0.010	169.848	5.152	519.208	7.962	531.260	8.237
12.040	0.010	164.696	5.073	511.246	7.901	523.023	8.174
12.030	0.010	159.623	4.994	503.345	7.841	514.849	8.112
12.020	0.010	154.628	4.916	495.505	7.780	506.738	8.049
12.010	0.010	149.712	4.839	487.725	7.720	498.689	7.987
12.000	0.010	144.874	4.762	480.005	7.659	490.702	7.924
11.990	0.010	140.112	4.685	472.346	7.599	482.778	7.861
11.980	0.010	135.427	4.610	464.747	7.538	474.917	7.799
11.970	0.010	130.817	4.535	457.209	7.478	467.118	7.736
11.960	0.010	126.282	4.460	449.731	7.417	459.382	7.674
11.950	0.010	121.822	4.386	442.314	7.357	451.708	7.611
11.940	0.010	117.436	4.313	434.957	7.296	444.096	7.549
11.930	0.010	113.123	4.240	427.661	7.236	436.548	7.486
11.920	0.010	108.882	4.168	420.425	7.175	429.061	7.424

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
11.910	0.010	104.714	4.097	413.250	7.115	421.638	7.361
11.900	0.010	100.617	4.026	406.135	7.054	414.277	7.299
11.890	0.010	96.591	3.956	399.081	6.994	406.978	7.236
11.880	0.010	92.635	3.886	392.087	6.933	399.742	7.174
11.870	0.010	88.749	3.817	385.154	6.873	392.569	7.111
11.860	0.010	84.932	3.749	378.281	6.812	385.458	7.048
11.850	0.010	81.183	3.681	371.469	6.752	378.409	6.986
11.840	0.010	77.503	3.614	364.717	6.691	371.423	6.923
11.830	0.010	73.889	3.547	358.025	6.631	364.500	6.861
11.820	0.010	70.342	3.481	351.394	6.570	357.639	6.798
11.810	0.010	66.861	3.416	344.824	6.510	350.841	6.736
11.800	0.010	63.445	3.351	338.314	6.449	344.105	6.673
11.790	0.010	60.094	3.287	331.865	6.389	337.432	6.611
11.780	0.010	56.808	3.223	325.476	6.328	330.821	6.548
11.770	0.010	53.585	2.869	319.147	151.577	324.273	151.774
11.760	0.010	50.716	1.659	167.570	3.373	172.499	3.486
11.750	0.010	49.057	1.625	164.197	3.339	169.012	3.451
11.740	0.010	47.432	1.592	160.859	3.305	165.561	3.416
11.730	0.010	45.840	1.559	157.554	3.271	162.145	3.381
11.720	0.010	44.280	1.527	154.283	3.236	158.764	3.346
11.710	0.010	42.754	1.494	151.047	3.202	155.419	3.310
11.700	0.010	41.259	1.463	147.845	3.168	152.108	3.275
11.690	0.010	39.797	1.431	144.676	3.134	148.833	3.240
11.680	0.010	38.366	1.400	141.542	3.100	145.593	3.205
11.670	0.010	36.966	1.369	138.442	3.066	142.389	3.169
11.660	0.010	35.597	1.339	135.376	3.032	139.219	3.134
11.650	0.010	34.258	1.308	132.344	2.998	136.085	3.099
11.640	0.010	32.950	1.279	129.347	2.964	132.986	3.064
11.630	0.010	31.671	1.249	126.383	2.930	129.922	3.029
11.620	0.010	30.422	1.220	123.454	2.895	126.894	2.993
11.610	0.010	29.202	1.191	120.558	2.861	123.900	2.958
11.600	0.010	28.011	1.163	117.697	2.827	120.942	2.923
11.590	0.010	26.848	1.135	114.870	2.793	118.019	2.888
11.580	0.010	25.713	1.107	112.076	2.759	115.132	2.852
11.570	0.010	24.606	1.080	109.317	2.725	112.279	2.817
11.560	0.010	23.527	1.052	106.593	2.691	109.462	2.782
11.550	0.010	22.474	1.026	103.902	2.657	106.680	2.747
11.540	0.010	21.449	0.999	101.245	2.623	103.933	2.712
11.530	0.010	20.449	0.973	98.622	2.589	101.222	2.676
11.520	0.010	19.476	0.948	96.034	2.554	98.545	2.641
11.510	0.010	18.529	0.922	93.479	2.520	95.904	2.606

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
11.500	0.010	17.606	0.897	90.959	2.486	93.298	2.571
11.490	0.010	16.709	0.872	88.473	2.452	90.728	2.535
11.480	0.010	15.837	0.848	86.021	2.418	88.192	2.500
11.470	0.010	14.989	0.824	83.603	2.384	85.692	2.465
11.460	0.010	14.165	0.800	81.219	2.350	83.227	2.430
11.450	0.010	13.364	0.777	78.869	2.316	80.797	2.395
11.440	0.010	12.587	0.754	76.553	2.282	78.403	2.359
11.430	0.010	11.833	0.731	74.272	2.248	76.044	2.324
11.420	0.010	11.102	0.709	72.024	2.213	73.720	2.289
11.410	0.010	10.392	0.687	69.811	2.179	71.431	2.254
11.400	0.010	9.705	0.666	67.632	2.145	69.177	2.218
11.390	0.010	9.040	0.644	65.486	2.111	66.959	2.183
11.380	0.010	8.395	0.623	63.375	2.077	64.775	2.148
11.370	0.010	7.772	0.603	61.298	2.043	62.628	2.113
11.360	0.010	7.169	0.582	59.255	2.009	60.515	2.078
11.350	0.010	6.587	0.563	57.247	1.975	58.437	2.042
11.340	0.010	6.024	0.543	55.272	1.941	56.395	2.007
11.330	0.010	5.481	0.524	53.331	1.906	54.388	1.972
11.320	0.010	4.958	0.505	51.425	1.872	52.416	1.937
11.310	0.010	4.453	0.486	49.552	1.838	50.480	1.901
11.300	0.010	3.966	0.468	47.714	1.804	48.578	1.866
11.290	0.010	3.498	0.450	45.910	1.770	46.712	1.831
11.280	0.010	3.048	0.433	44.140	1.736	44.881	1.796
11.270	0.010	2.615	0.356	42.404	31.221	43.085	31.272
11.260	0.010	2.259	0.110	11.183	0.363	11.813	0.384
11.250	0.010	2.149	0.106	10.820	0.357	11.429	0.378
11.240	0.010	2.043	0.103	10.462	0.351	11.051	0.372
11.230	0.010	1.940	0.099	10.111	0.345	10.679	0.365
11.220	0.010	1.841	0.096	9.766	0.339	10.314	0.359
11.210	0.010	1.745	0.093	9.426	0.333	9.955	0.353
11.200	0.010	1.652	0.089	9.093	0.327	9.602	0.346
11.190	0.010	1.563	0.086	8.766	0.321	9.256	0.340
11.180	0.010	1.477	0.083	8.444	0.315	8.916	0.334
11.170	0.010	1.394	0.080	8.129	0.309	8.582	0.327
11.160	0.010	1.314	0.077	7.819	0.303	8.255	0.321
11.150	0.010	1.237	0.074	7.516	0.297	7.934	0.315
11.140	0.010	1.164	0.071	7.219	0.291	7.619	0.308
11.130	0.010	1.093	0.068	6.927	0.285	7.311	0.302
11.120	0.010	1.025	0.065	6.642	0.279	7.009	0.296
11.110	0.010	0.960	0.062	6.362	0.274	6.713	0.289
11.100	0.010	0.898	0.060	6.089	0.268	6.424	0.283

Height	Delta height	Volume to height	Delta volume	Plan area	Delta plan	Slope area	Delta slope
11.090	0.010	0.838	0.057	5.821	0.262	6.141	0.277
11.080	0.010	0.781	0.054	5.560	0.256	5.864	0.270
11.070	0.010	0.727	0.052	5.304	0.250	5.594	0.264
11.060	0.010	0.675	0.049	5.054	0.244	5.330	0.258
11.050	0.010	0.626	0.047	4.811	0.238	5.072	0.251
11.040	0.010	0.579	0.045	4.573	0.232	4.821	0.245
11.030	0.010	0.535	0.042	4.342	0.226	4.575	0.239
11.020	0.010	0.492	0.040	4.116	0.220	4.337	0.232
11.010	0.010	0.452	0.038	3.896	0.214	4.104	0.226
11.000	0.010	0.414	0.036	3.683	0.208	3.878	0.220
10.990	0.010	0.378	0.034	3.475	0.202	3.658	0.213
10.980	0.010	0.345	0.032	3.273	0.196	3.445	0.207
10.970	0.010	0.313	0.030	3.078	0.190	3.238	0.201
10.960	0.010	0.283	0.028	2.888	0.184	3.037	0.194
10.950	0.010	0.255	0.026	2.704	0.178	2.842	0.188
10.940	0.010	0.229	0.024	2.526	0.172	2.654	0.182
10.930	0.010	0.205	0.023	2.355	0.166	2.472	0.176
10.920	0.010	0.182	0.021	2.189	0.160	2.297	0.169
10.910	0.010	0.161	0.020	2.029	0.154	2.128	0.163
10.900	0.010	0.141	0.018	1.875	0.148	1.965	0.157
10.890	0.010	0.123	0.017	1.727	0.142	1.808	0.150
10.880	0.010	0.107	0.015	1.586	0.136	1.658	0.144
10.870	0.010	0.092	0.014	1.450	0.130	1.514	0.138
10.860	0.010	0.078	0.013	1.320	0.124	1.377	0.131
10.850	0.010	0.065	0.011	1.196	0.118	1.246	0.125
10.840	0.010	0.054	0.010	1.078	0.112	1.121	0.119
10.830	0.010	0.044	0.009	0.966	0.106	1.002	0.112
10.820	0.010	0.035	0.008	0.860	0.100	0.890	0.106
10.810	0.010	0.026	0.007	0.760	0.094	0.784	0.100
10.800	0.010	0.019	0.006	0.666	0.088	0.684	0.093
10.790	0.010	0.013	0.005	0.578	0.082	0.591	0.087
10.780	0.010	0.008	0.005	0.496	0.076	0.504	0.081
10.770	0.010	0.003	0.003	0.420	0.420	0.424	0.424
10.760	0.010	0.000	0.000	0.000	0.000	0.000	0.000
10.750		0.000		0.000		0.000	

Summary

Polygon plan area: 2760.244

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Appendix B

Design spreadsheet

PROJECT: DRURY CENTRE - Stage 2
DATE: 4/02/2025
BY: JM

	IMP AREA (HA)	PER AREA (HA)	TOTAL AREA (ha)	IMP%	WATER QUALITY VOLUME (WQV) (m3)	FOREBAY VOLUME (m3)	WQV (ALLOWS FOR 50% REDUCTION) (m3)	FINAL WATER QUALITY VOLUME (m3)	HYDROLOGY MITIGATION VOLUME - PRE DEVELOPMENT (m3)	HYDROLOGY MITIGATION VOLUME - POST DEVELOPMENT (m3)	RETENTION VOLUME (PROVIDED FOR ROOF AREAS) (m3)	HYDROLOGY MITIGATION VOLUME (DIFFERENCE FROM PRE DEVELOPMENT) (m3)	TOTAL VOLUME (m3)
WETLAND 2-1	9.00	0.23	9.23	97%	1106	166	553	719	616	2581	191	1774	2493
WETLAND 2-2	2.74	0.14	2.88	95%	572	86	286	372	193	791	0	598	970

Wetland 2-1 - Pre Development

Project P24-447 **By** JM **Date** 4/02/2025

Location DRURY CENTRE - Stage 2

Basin Wetland 2-1

1.1 Runnoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number [*CN*]*	Area (ha)	Product of CN x area
Group C	Pasture, lightly grazed	74	9.21	681.4
* from Appendix B - TP108		Totals =	9.21	681.4

Pervious Areas:

$$CN_{(pervious)} = \frac{pervious\ product}{pervious\ area} = \frac{681.4}{9.2} = 74.0$$

$$Ia_{(pervious)} = 5.00$$

Impervious Areas:

$$CN_{(impervious)} = 98.0$$

$$Ia_{(impervious)} = 0.00$$

Overall:

$$CN_{(average)} = \frac{total\ product}{total\ area} = \frac{681.4}{9.2} = 74.0$$

$$Ia_{(average)} = \frac{5\ x\ pervious\ area}{total\ area} = \frac{46.04}{9.2} = 5.00$$

1.2 Time of Concentration

Channelisation factor	C =	0.8		*(from Table 4.2 TP108)*
Catchment length	L =	0.43	km	
Catchment slope	Sc =	0.017	m/m	
Curve Number	CN =	74.00		

Runoff factor $\dfrac{CN_{(average)}}{200 - CN_{(average)}} = \dfrac{74.0}{126.0} = 0.59$

tc = $0.14\ C\ L^{0.66}\ (Runoff\ Factor)^{-0.55}\ Sc^{-0.30}$

= 0.2919 hrs

lag = $0.67\ tc$

= 0.1956 hrs

1.3 Pre Development Volume

Rainfall Depth	P_{24} =	33.00	mm
Soil Storage	S =	89.24	mm
Runoff Depth	Q_{24} =	6.69	mm
Runoff Volume	V_{24} =	615.76	m^3

Wetland 2-1 - Post Development

Project P24-447 **By** JM **Date** 4/02/2025

Location DRURY CENTRE - Stage 2

Basin Wetland 2-1

2.1 Runnoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number [*CN*]*	Area (ha)	Product of CN x area
Group C	Urban lawns	74	0.23	17.1
Group C	Sealed roads, roofs	98	9.00	881.6
* from Appendix B - TP108		Totals =	9.23	898.7

Pervious Areas:

$CN_{(pervious)} = \frac{pervious\ product}{pervious\ area} = \frac{17.1}{0.2} =$ 74.0

$Ia_{(pervious)} =$ 5.00

Impervious Areas:

$CN_{(impervious)} =$ 98.0

$Ia_{(impervious)} =$ 0.00

Overall:

$CN_{(average)} = \frac{total\ product}{total\ area} = \frac{898.7}{9.2} =$ 97.4

$Ia_{(average)} = \frac{5\ x\ pervious\ area}{total\ area} = \frac{1.15}{9.2} =$ 0.13

2.2 Time of Concentration

Channelisation factor	C =	0.6	*(from Table 4.2 TP108)*
Catchment length	L =	0.40	km
Catchment slope	Sc =	0.013	m/m
Curve Number	CN =	97.40	

Runoff factor $\frac{CN_{(average)}}{200 - CN_{(average)}} = \frac{97.4}{102.6} = 0.95$

tc = $0.14\ C\ L^{0.66}\ (Runoff\ Factor)^{-0.55}\ Sc^{-0.30}$

= 0.1711 hrs

lag = $0.67\ tc$

= 0.1146 hrs

2.3 Water Quality Volume

	Pervious Component	Impervious Component
1/3 of the 24 hour Rainfall Depth in 2 Year Event (mm) [P_{24}]	25.0	
Component Area (ha) [A]	0.2	5.3
Curve Number [CN]	74.0	98.0
Initial Abstraction (mm) [Ia]	5.0	0.0
Soil Storage (mm) [$S = 25.4(1000/CN - 10)$]	89.2	5.2
Runoff Depth (mm) [$Q_{24} = (P_{24} - Ia)^2 / (P_{24} - Ia + S)$]	3.7	20.7
Runoff Volume (m³) [$V_{24} = 1000\ Q_{24}\ A$]	8	1,097
Combined Runoff Volume (m³)	1,106	

2.4 Extended Detention Volume

	Pervious Component	Impervious Component
Rainfall Depth (mm) [P_{24}]	33.0	
Component Area (ha) [A]	0.2	9.0
Curve Number [CN]	74.0	98.0
Initial Abstraction (mm) [Ia]	5.0	0.0
Soil Storage (mm) [$S = 25.4(1000/CN - 10)$]	89.2	5.2
Runoff Depth (mm) [$Q_{24} = (P_{24} - Ia)^2 / (P_{24} - Ia + S)$]	6.7	28.5
Runoff Volume (m³) [$V_{24} = Q_{24} A$]	15	2,566
Combined Runoff Volume (m³)	2,581	

Combined Runoff Volume (difference Pre and Post-Development) (m³)	1,965

2.5 Retention Volume Roofs

Rainfall Depth	=	5	mm
Roof Area	=	38189	m2
Retention Volume	=	191	m3

2.6 Final Detention Volume

Combined Runoff Volume (difference Pre and Post-Development minus 5mm Retention) (m³)	1,774

Wetland 2-1 - Stormwater Quality Pond Design Summary

Project	P24-447	**By**	JM	**Date**	4/02/2025
Location	DRURY CENTRE - Stage 2				

3.1 Water Quality Volume

Sub-catchment Name	Area (ha)	Storage Required (m^3)
Wetland 2-1	5.53	1,106
	Total Water Quality Volume Required	**1,106**

Minimum Forebay Volume (15%):	166 m^3
An Extended Detention Overlay will be provided, reducing the Permanent Water Volume to:	553 m^3

Wetland 2-1 - Pond Outlet Details

Project P24-447 **By** JM **Date** 4/02/2025

Location DRURY CENTRE - Stage 2

RL (m)	Outlet Element Discharge Rate (m³/s)					Total Discharge (m³/s)	Pond Volume (m³)	Storm Event	
	Outlet 1 Circular Oriffice	Outlet 2 Notch	Outlet 3 Top of Manhole	Outlet 4 Spillway	Outlet Pipe Subtotal				**OUTLETS IL**
10.84	0.000	0.000	0.000	0.000	0.000	0.0000	744.42	PW	**OUTLET 1 - CIRCULAR ORIFICE**
10.90	0.005	0.000	0.000	0.000	0.005	0.0050	866.83		
11.00	0.013	0.000	0.000	0.000	0.013	0.0133	1083.44		
11.10	0.020	0.000	0.000	0.000	0.020	0.0203	1307.86		
11.20	0.025	0.000	0.000	0.000	0.025	0.0254	1540.21		
11.30	0.030	0.000	0.000	0.000	0.030	0.0297	1780.57		
11.40	0.033	0.000	0.000	0.000	0.033	0.0334	2029.05		
11.50	0.037	0.000	0.000	0.000	0.037	0.0368	2285.75		
11.60	0.040	0.000	0.000	0.000	0.040	0.0399	2550.77	ED	**OUTLET 2 - TOP OF MANHOLE**
11.70	0.043	0.000	0.177	0.000	0.220	0.2200	2824.21		
11.80	0.045	0.000	0.501	0.000	0.547	0.5469	3106.17		
11.90	0.048	0.000	0.921	0.474	0.969	1.4434	3396.75		
12.00	0.050	0.000	1.418	2.503	1.338	3.8412	3696.05		
12.10	0.053	0.000	1.982	5.470	1.393	6.8630	4004.17		
12.20	0.055	0.000	2.606	9.201	1.445	10.6464	4321.30		
12.30	0.057	0.000	3.284	13.617	1.496	15.1133	4685.06		
12.33	0.058	0.000	3.497	15.068	1.511	16.5795	4808.08	Bank RL	

Outlet 1 Details - Circular Oriffice

Bottom RL: 10.85
Diameter / Width: 0.150
Height: 0.000
Spillway Side Slope: xxx
Discharges to Outlet Pipe

Outlet 2 Details - Notch

Bottom RL: xxx
Diameter / Width: 0.000
Height: xxx
Spillway Side Slope: xxx
Discharges to Outlet Pipe

Outlet 3 Details - Top of Manhole

Bottom RL: 11.60
Diameter / Width: 1.050
Height:
Spillway Side Slope:
Discharges to Outlet Pipe

Outlet 4 Details - Spillway

Bottom RL: 11.85
Diameter / Width: 25.000
Height: 0.000
Spillway Side Slope: 5.0
Discharges Directly to Stream

Outlet Pipe Details

Pipe Diameter: 0.750
Inlet Invert Level: 10.300
Outlet Invert Level: 9.85
Pipe Length: 30.00

Wetland 2-2 - Pre Development

Project P24-447 **By** SS **Date** 9/01/2025

Location DRURY CENTRE - Stage 2

Basin WETLAND 2-2

1.1 Runnoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number [*CN*]*	Area (ha)	Product of CN x area
Group C	Pasture, lightly grazed	74	2.89	213.9
Group C	Sealed roads, roofs	98		
		Totals =	2.89	213.9

* from Appendix B - TP108

Pervious Areas:

$$CN_{(pervious)} = \frac{pervious\ product}{pervious\ area} = \frac{213.9}{2.9} = 74.0$$

$$Ia_{(pervious)} = 5.00$$

Impervious Areas:

$$CN_{(impervious)} = 98.0$$

$$Ia_{(impervious)} = 0.00$$

Overall:

$$CN_{(average)} = \frac{total\ product}{total\ area} = \frac{213.9}{2.9} = 74.0$$

$$Ia_{(average)} = \frac{5\ x\ pervious\ area}{total\ area} = \frac{14.45}{2.9} = 5.00$$

1.2 Pre Development Volume

Rainfall Depth	P_{24} =	33.00	mm
Soil Storage	S =	89.24	mm
Runoff Depth	Q_{24} =	6.69	mm
Runoff Volume	V_{24} =	193.25	m^3

Wetland 2-2 - Post Development

Project P24-447 **By** SS **Date** 9/01/2025

Location DRURY CENTRE - Stage 2

Basin WETLAND 2-2

2.1 Runnoff Curve Number (CN) and Initial Abstraction (Ia)

Soil name and classification	Cover description (cover type, treatment, and hydrologic condition)	Curve Number [*CN*]*	Area (ha)	Product of CN x area
Group B	Urban lawns	74	0.14	10.4
Group B	Sealed roads, roofs	98	2.74	268.5
		98		
* from Appendix B - TP108		Totals =	2.88	278.9

Pervious Areas:

$$CN_{(pervious)} = \frac{pervious\ product}{pervious\ area} = \frac{10.4}{0.1} = 74.0$$

$$Ia_{(pervious)} = 5.00$$

Impervious Areas:

$$CN_{(impervious)} = 98.0$$

$$Ia_{(impervious)} = 0.00$$

Overall:

$$CN_{(average)} = \frac{total\ product}{total\ area} = \frac{278.9}{2.9} = 96.8$$

$$Ia_{(average)} = \frac{5 \times pervious\ area}{total\ area} = \frac{0.70}{2.9} = 0.24$$

2.3 Water Quality Volume

	Pervious Component	Impervious Component
1/3 of the 24 hour Rainfall Depth in 2 Year Event (mm) [P_{24}]	25.0	
Component Area (ha) [A]	0.1	2.7
Curve Number [CN]	74.0	98.0
Initial Abstraction (mm) [Ia]	5.0	0.0
Soil Storage (mm) [$S = 25.4(1000/CN - 10)$]	89.2	5.2
Runoff Depth (mm) [$Q_{24} = (P_{24} - Ia)^2 / (P_{24} - Ia + S)$]	3.7	20.7
Runoff Volume (m^3) [$V_{24} = 1000\, Q_{24}\, A$]	5	567
Combined Runoff Volume (m^3)	572	

2.4 Extended Detention Volume

	Pervious Component	Impervious Component
Rainfall Depth (mm) [P_{24}]	33.0	
Component Area (ha) [A]	0.1	2.7
Curve Number [CN]	74.0	98.0
Initial Abstraction (mm) [Ia]	5.0	0.0
Soil Storage (mm) [$S = 25.4(1000/CN - 10)$]	89.2	5.2
Runoff Depth (mm) [$Q_{24} = (P_{24} - Ia)^2 / (P_{24} - Ia + S)$]	6.7	28.5
Runoff Volume (m³) [$V_{24} = Q_{24} A$]	9	781
Combined Runoff Volume (m³)	791	

Combined Runoff Volume (difference Pre and Post-Development) (m³)	598

2.4 Retention Volume Roofs

Rainfall Depth	=	5 mm
Roof Area	=	m2
Retention Volume	=	m3

2.5 Final Detention Volume

Combined Runoff Volume (difference Pre and Post-Development minus 5mm Retention) (m³)	598

Wetland 2-2 - Stormwater Quality Pond Design Summary

Project	P24-447	**By**	SS	**Date**	9/01/2025
Location	DRURY CENTRE - Stage 2				

3.1 Water Quality Volume

Sub-catchment Name	Area (ha)	Storage Required (m^3)
WETLAND 2-2	2.88	572
	Total Water Quality Volume Required	**572**

Minimum Forebay Volume (15%):	86 m^3
An Extended Detention Overlay will be provided, reducing the Permanent Water Volume to:	286 m^3

Wetland 2-2 - Pond Outlet Details

Project P24-447 **By** SS **Date** 9/01/2025

Location DRURY CENTRE - Stage 2

RL (m)	Outlet Element Discharge Rate (m³/s)					Total Discharge (m³/s)	Pond Volume (m³)	Storm Event
	Outlet 1 Circular Oriffice	Outlet 2 Notch	Outlet 3 Top of Manhole	Outlet 4 Spillway	Outlet Pipe Subtotal			
12.34	0.000	0.000	0.000	0.000	0.000	0.0000	383.26	PW
12.40	0.000	0.000	0.000	0.000	0.000	0.0000	454.76	
12.50	0.007	0.000	0.000	0.000	0.007	0.0068	586.57	
12.60	0.010	0.000	0.000	0.000	0.010	0.0096	734.44	
12.70	0.012	0.000	0.000	0.000	0.012	0.0118	896.32	
12.76	0.013	0.000	0.000	0.000	0.013	0.0129	996.00	ED
12.90	0.015	0.000	0.177	0.000	0.193	0.1925	1237.61	
13.00	0.017	0.000	0.501	0.820	0.517	1.3366	1416.87	
13.10	0.018	0.000	0.921	2.379	0.545	2.9234	1601.95	
13.20	0.019	0.000	1.418	4.481	0.571	5.0517	1792.91	
13.30	0.020	0.000	1.982	7.069	0.596	7.6650	2017.78	Bank RL
13.31	0.021	0.000	2.060	7.439	0.600	8.0388	2050.40	

OUTLETS IL

OUTLET 1 - CIRCULAR ORIFICE

OUTLET 2 - TOP OF MANHOLE

Outlet 1 Details - Circular Oriffice

Bottom RL:	12.35
Diameter / Width:	0.100
Height:	0.000
Spillway Side Slope:	xxx

Discharges to Outlet Pipe

Outlet 2 Details - Notch

Bottom RL:	xxx
Diameter / Width:	0.000
Height:	xxx
Spillway Side Slope:	xxx

Discharges to Outlet Pipe

Outlet 3 Details - Top of Manhole

Bottom RL:	12.80
Diameter / Width:	1.050
Height:	
Spillway Side Slope:	

Discharges to Outlet Pipe

Outlet 4 Details - Spillway

Bottom RL:	12.90
Diameter / Width:	15.000
Height:	0.000
Spillway Side Slope:	5.0

Discharges Directly to Stream

Outlet Pipe Details

Pipe Diameter:	0.500
Inlet Invert Level:	11.760
Outlet Invert Level:	11.61
Pipe Length:	15.00

Appendix C

HEC-HMS Outputs

HEC HMS OUTPUT - WETLAND 2-2

RAINFALL EVENT: 10YR 2.1CC

DATE	TIME	OUTFLOW (M3/S)
1-Jan-00	0:00	0
1-Jan-00	0:01	0
1-Jan-00	0:02	0
1-Jan-00	0:03	0
1-Jan-00	0:04	0
1-Jan-00	0:05	0.0001
1-Jan-00	0:06	0.0001
1-Jan-00	0:07	0.0002
1-Jan-00	0:08	0.0004
1-Jan-00	0:09	0.0005
1-Jan-00	0:10	0.0007
1-Jan-00	0:11	0.0009
1-Jan-00	0:12	0.001
1-Jan-00	0:13	0.0013
1-Jan-00	0:14	0.0015
1-Jan-00	0:15	0.0017
1-Jan-00	0:16	0.0019
1-Jan-00	0:17	0.0021
1-Jan-00	0:18	0.0023
1-Jan-00	0:19	0.0026
1-Jan-00	0:20	0.0028
1-Jan-00	0:21	0.003
1-Jan-00	0:22	0.0032
1-Jan-00	0:23	0.0034
1-Jan-00	0:24	0.0036
1-Jan-00	0:25	0.0038
1-Jan-00	0:26	0.004
1-Jan-00	0:27	0.0042
1-Jan-00	0:28	0.0044
1-Jan-00	0:29	0.0046
1-Jan-00	0:30	0.0048
1-Jan-00	0:31	0.005
1-Jan-00	0:32	0.0052
1-Jan-00	0:33	0.0054
1-Jan-00	0:34	0.0056
1-Jan-00	0:35	0.0058
1-Jan-00	0:36	0.0059
1-Jan-00	0:37	0.0061
1-Jan-00	0:38	0.0063
1-Jan-00	0:39	0.0065
1-Jan-00	0:40	0.0066
1-Jan-00	0:41	0.0068
1-Jan-00	0:42	0.007

1-Jan-00	0:43	0.0071
1-Jan-00	0:44	0.0073
1-Jan-00	0:45	0.0074
1-Jan-00	0:46	0.0076
1-Jan-00	0:47	0.0077
1-Jan-00	0:48	0.0079
1-Jan-00	0:49	0.008
1-Jan-00	0:50	0.0082
1-Jan-00	0:51	0.0083
1-Jan-00	0:52	0.0085
1-Jan-00	0:53	0.0086
1-Jan-00	0:54	0.0087
1-Jan-00	0:55	0.0089
1-Jan-00	0:56	0.009
1-Jan-00	0:57	0.0091
1-Jan-00	0:58	0.0093
1-Jan-00	0:59	0.0094
1-Jan-00	1:00	0.0095
1-Jan-00	1:01	0.0096
1-Jan-00	1:02	0.0098
1-Jan-00	1:03	0.0099
1-Jan-00	1:04	0.01
1-Jan-00	1:05	0.0101
1-Jan-00	1:06	0.0102
1-Jan-00	1:07	0.0104
1-Jan-00	1:08	0.0105
1-Jan-00	1:09	0.0106
1-Jan-00	1:10	0.0107
1-Jan-00	1:11	0.0108
1-Jan-00	1:12	0.0109
1-Jan-00	1:13	0.011
1-Jan-00	1:14	0.0111
1-Jan-00	1:15	0.0112
1-Jan-00	1:16	0.0113
1-Jan-00	1:17	0.0114
1-Jan-00	1:18	0.0115
1-Jan-00	1:19	0.0116
1-Jan-00	1:20	0.0117
1-Jan-00	1:21	0.0118
1-Jan-00	1:22	0.0119
1-Jan-00	1:23	0.012
1-Jan-00	1:24	0.0121
1-Jan-00	1:25	0.0122
1-Jan-00	1:26	0.0123
1-Jan-00	1:27	0.0124
1-Jan-00	1:28	0.0125
1-Jan-00	1:29	0.0126
1-Jan-00	1:30	0.0126

1-Jan-00	1:31	0.0127
1-Jan-00	1:32	0.0128
1-Jan-00	1:33	0.0129
1-Jan-00	1:34	0.013
1-Jan-00	1:35	0.0131
1-Jan-00	1:36	0.0131
1-Jan-00	1:37	0.0132
1-Jan-00	1:38	0.0133
1-Jan-00	1:39	0.0134
1-Jan-00	1:40	0.0135
1-Jan-00	1:41	0.0135
1-Jan-00	1:42	0.0136
1-Jan-00	1:43	0.0137
1-Jan-00	1:44	0.0138
1-Jan-00	1:45	0.0138
1-Jan-00	1:46	0.0139
1-Jan-00	1:47	0.014
1-Jan-00	1:48	0.014
1-Jan-00	1:49	0.0141
1-Jan-00	1:50	0.0142
1-Jan-00	1:51	0.0142
1-Jan-00	1:52	0.0143
1-Jan-00	1:53	0.0144
1-Jan-00	1:54	0.0144
1-Jan-00	1:55	0.0145
1-Jan-00	1:56	0.0146
1-Jan-00	1:57	0.0146
1-Jan-00	1:58	0.0147
1-Jan-00	1:59	0.0148
1-Jan-00	2:00	0.0148
1-Jan-00	2:01	0.0149
1-Jan-00	2:02	0.015
1-Jan-00	2:03	0.015
1-Jan-00	2:04	0.0151
1-Jan-00	2:05	0.0151
1-Jan-00	2:06	0.0152
1-Jan-00	2:07	0.0152
1-Jan-00	2:08	0.0153
1-Jan-00	2:09	0.0154
1-Jan-00	2:10	0.0154
1-Jan-00	2:11	0.0155
1-Jan-00	2:12	0.0155
1-Jan-00	2:13	0.0156
1-Jan-00	2:14	0.0156
1-Jan-00	2:15	0.0157
1-Jan-00	2:16	0.0157
1-Jan-00	2:17	0.0158
1-Jan-00	2:18	0.0158

1-Jan-00	2:19	0.0159
1-Jan-00	2:20	0.0159
1-Jan-00	2:21	0.016
1-Jan-00	2:22	0.016
1-Jan-00	2:23	0.0161
1-Jan-00	2:24	0.0161
1-Jan-00	2:25	0.0162
1-Jan-00	2:26	0.0162
1-Jan-00	2:27	0.0163
1-Jan-00	2:28	0.0163
1-Jan-00	2:29	0.0164
1-Jan-00	2:30	0.0164
1-Jan-00	2:31	0.0165
1-Jan-00	2:32	0.0165
1-Jan-00	2:33	0.0165
1-Jan-00	2:34	0.0166
1-Jan-00	2:35	0.0166
1-Jan-00	2:36	0.0167
1-Jan-00	2:37	0.0167
1-Jan-00	2:38	0.0168
1-Jan-00	2:39	0.0168
1-Jan-00	2:40	0.0168
1-Jan-00	2:41	0.0169
1-Jan-00	2:42	0.0169
1-Jan-00	2:43	0.017
1-Jan-00	2:44	0.017
1-Jan-00	2:45	0.0171
1-Jan-00	2:46	0.0171
1-Jan-00	2:47	0.0171
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1-Jan-00	21:59	0.0302
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1-Jan-00	23:57	0.0303
1-Jan-00	23:58	0.0303
1-Jan-00	23:59	0.0303
2-Jan-00	0:00	0.0303

HEC HMS OUTPUT - WETLAND 2-2

RAINFALL EVENT: 100YR 2.1CC

DATE	TIME	OUTFLOW (M3/S)
1-Jan-00	0:00	0
1-Jan-00	0:01	0
1-Jan-00	0:02	0
1-Jan-00	0:03	0
1-Jan-00	0:04	0.0001
1-Jan-00	0:05	0.0002
1-Jan-00	0:06	0.0004
1-Jan-00	0:07	0.0007
1-Jan-00	0:08	0.001
1-Jan-00	0:09	0.0014
1-Jan-00	0:10	0.0019
1-Jan-00	0:11	0.0024
1-Jan-00	0:12	0.0029
1-Jan-00	0:13	0.0034
1-Jan-00	0:14	0.004
1-Jan-00	0:15	0.0046
1-Jan-00	0:16	0.0051
1-Jan-00	0:17	0.0057
1-Jan-00	0:18	0.0063
1-Jan-00	0:19	0.0068
1-Jan-00	0:20	0.0074
1-Jan-00	0:21	0.0079
1-Jan-00	0:22	0.0085
1-Jan-00	0:23	0.009
1-Jan-00	0:24	0.0095
1-Jan-00	0:25	0.01
1-Jan-00	0:26	0.0105
1-Jan-00	0:27	0.011
1-Jan-00	0:28	0.0115
1-Jan-00	0:29	0.0119
1-Jan-00	0:30	0.0124
1-Jan-00	0:31	0.0128
1-Jan-00	0:32	0.0132
1-Jan-00	0:33	0.0137
1-Jan-00	0:34	0.0141
1-Jan-00	0:35	0.0145
1-Jan-00	0:36	0.0149
1-Jan-00	0:37	0.0152
1-Jan-00	0:38	0.0156
1-Jan-00	0:39	0.016
1-Jan-00	0:40	0.0163
1-Jan-00	0:41	0.0167
1-Jan-00	0:42	0.017

1-Jan-00	0:43	0.0174
1-Jan-00	0:44	0.0177
1-Jan-00	0:45	0.018
1-Jan-00	0:46	0.0183
1-Jan-00	0:47	0.0186
1-Jan-00	0:48	0.0189
1-Jan-00	0:49	0.0192
1-Jan-00	0:50	0.0195
1-Jan-00	0:51	0.0198
1-Jan-00	0:52	0.02
1-Jan-00	0:53	0.0203
1-Jan-00	0:54	0.0206
1-Jan-00	0:55	0.0208
1-Jan-00	0:56	0.0211
1-Jan-00	0:57	0.0213
1-Jan-00	0:58	0.0216
1-Jan-00	0:59	0.0218
1-Jan-00	1:00	0.0221
1-Jan-00	1:01	0.0223
1-Jan-00	1:02	0.0225
1-Jan-00	1:03	0.0227
1-Jan-00	1:04	0.0229
1-Jan-00	1:05	0.0232
1-Jan-00	1:06	0.0234
1-Jan-00	1:07	0.0236
1-Jan-00	1:08	0.0238
1-Jan-00	1:09	0.024
1-Jan-00	1:10	0.0242
1-Jan-00	1:11	0.0244
1-Jan-00	1:12	0.0245
1-Jan-00	1:13	0.0247
1-Jan-00	1:14	0.0249
1-Jan-00	1:15	0.0251
1-Jan-00	1:16	0.0252
1-Jan-00	1:17	0.0254
1-Jan-00	1:18	0.0256
1-Jan-00	1:19	0.0257
1-Jan-00	1:20	0.0259
1-Jan-00	1:21	0.0261
1-Jan-00	1:22	0.0262
1-Jan-00	1:23	0.0264
1-Jan-00	1:24	0.0265
1-Jan-00	1:25	0.0267
1-Jan-00	1:26	0.0268
1-Jan-00	1:27	0.027
1-Jan-00	1:28	0.0271
1-Jan-00	1:29	0.0272
1-Jan-00	1:30	0.0274

1-Jan-00	1:31	0.0275
1-Jan-00	1:32	0.0276
1-Jan-00	1:33	0.0278
1-Jan-00	1:34	0.0279
1-Jan-00	1:35	0.028
1-Jan-00	1:36	0.0282
1-Jan-00	1:37	0.0283
1-Jan-00	1:38	0.0284
1-Jan-00	1:39	0.0285
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1-Jan-00	2:02	0.0309
1-Jan-00	2:03	0.0309
1-Jan-00	2:04	0.031
1-Jan-00	2:05	0.0311
1-Jan-00	2:06	0.0312
1-Jan-00	2:07	0.0313
1-Jan-00	2:08	0.0314
1-Jan-00	2:09	0.0314
1-Jan-00	2:10	0.0315
1-Jan-00	2:11	0.0316
1-Jan-00	2:12	0.0317
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1-Jan-00	2:15	0.0319
1-Jan-00	2:16	0.032
1-Jan-00	2:17	0.0321
1-Jan-00	2:18	0.0321

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1-Jan-00	2:20	0.0323
1-Jan-00	2:21	0.0323
1-Jan-00	2:22	0.0324
1-Jan-00	2:23	0.0325
1-Jan-00	2:24	0.0325
1-Jan-00	2:25	0.0326
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1-Jan-00	2:27	0.0327
1-Jan-00	2:28	0.0328
1-Jan-00	2:29	0.0329
1-Jan-00	2:30	0.0329
1-Jan-00	2:31	0.033
1-Jan-00	2:32	0.0331
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1-Jan-00	2:34	0.0332
1-Jan-00	2:35	0.0332
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1-Jan-00	2:44	0.0337
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1-Jan-00	2:56	0.0343
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1-Jan-00	3:01	0.0346
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1-Jan-00	3:03	0.0346
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1-Jan-00	3:06	0.0348

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1-Jan-00	3:12	0.035
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1-Jan-00	3:17	0.0352
1-Jan-00	3:18	0.0353
1-Jan-00	3:19	0.0353
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1-Jan-00	3:43	0.0361
1-Jan-00	3:44	0.0361
1-Jan-00	3:45	0.0362
1-Jan-00	3:46	0.0362
1-Jan-00	3:47	0.0362
1-Jan-00	3:48	0.0363
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1-Jan-00	4:01	0.0366
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1-Jan-00	4:24	0.0372
1-Jan-00	4:25	0.0372
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Appendix D

Fitzgerald Stream Local Catchment Model – Stormwater Model Conversion and Update Report

Fitzgerald Stream Local Catchment Model

Stormwater Model Conversion and Update Report

Fulton Hogan Land Development/Kiwi Property

Final

Document Control

Project Number	P24-646
Project Name	Fitzgerald Stream Local Catchment Model
Client	Fulton Hogan Land Development/Kiwi Property
Date	18/02/2025
Version	V2
Issue Status	Final
Originator	Simran Bassan – Intermediate Engineer  Rahul Nair – Associate Engineer 
Reviewer	Ajay Desai – Principal Engineer 
Approval	Pranil Wadan – GM Water Infrastructure and Planning 
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1. Purpose and Activities

This report documents the process of developing a local hydraulic model covering the Fitzgerald Stream Local catchment by converting and truncating the Hingaia catchment Model (Model ID supplied 1318) provided by Healthy Waters (HW) from Mike by DHI version of v2020 Update 1 to InfoWorks ICM Version 2025.3. The model has also been updated with the latest information including imperviousness, topography and infrastructure upgrades. This converted cut-down model was developed to reduce model simulation times and used to test design options for landform changes and proposed pipe networks.

The converted model will be used to assess the potential flooding effects (if any) from the proposed development within the Drury Centre and Drury East Precinct projects, which involves the construction of commercial and residential lots including 3 waters infrastructure, roading and re-alignment.

Following the model update and conversion exercise, the updated model can be used to understand flood risk within the project site and wider catchment as well as to develop and test flood mitigation options to assess flood effects on third-party land upstream and downstream of the development.

2. Background Information

The Drury Centre Stage 1 Development DHI Model prepared and submitted in support of the Drury Centre Stage 1 SIMP has been adopted as the baseline for the model conversion.

The Drury Centre Stage 1 Development Model was developed from the Hingaia catchment Model (Model ID supplied 1318) provided by HW and the key assumptions/changes are listed below. For additional information please refer to the flood assessment memo completed by Woods and submitted on 22/01/2024[1].

- The Flood model developed using Mike by DHI (Mike 11 and Mike 21FM coupled model) with hydrology loaded directly to streams (i.e. not a 2D rain on-grid model) and includes key river reaches and does not include existing or proposed pipe network
- The model uses Auckland Vertical Datum 1946 (AUK1946)
- The model uses NZGD2000 / New Zealand Transverse Mercator (NZTM) 2000 Coordinate reference system
- Boundary conditions are as per the Hingaia Stream catchment model (inflows and tailwater/tide levels based on Existing Development (ED) scenario without climate change)
- The imperviousness across the catchment (except for Drury Centre Stage 1) based on existing imperviousness as per Auckland Council's impervious surface layers
- The topography used in the model is based on LiDAR2016_DEM and includes the Drury Train station design surface and design surface for the Drury Centre Stage 1 development extent.
- The Land use within the Drury Centre Stage 1 development was updated to include MPD impervious allowance (100%)

[1] Drury Centre -Stage 1 Flood Assessment memo, Woods, 22/01/2024

3. Model conversion – Mike by DHI to InfoWorks ICM

The process of converting the Drury Centre Stage 1 model from Mike by DHI to InfoWorks ICM Version 2025.3 is summarised in this section.

3.1 Stormwater network

The Drury Centre Stage 1 generally includes a system of streams, tributaries and a combination of bridges and culverts along this network. These streams, major overland flow paths and critical structures are modelled in the Mike 11 model as 1D elements and coupled to 2D topography represented in Mike 21FM which is coupled with the Mike Flood model. The cutdown ICM model follows the same methodology.

3.2 Model topography

The existing DHI model 2D extent was created using a flexible mesh approach. The mesh resolution was set to a maximum of $10m^2$. The DHI model 2D extends approximately 8500m length of the Hingaia stream as shown in Figure 1.

The cut-down ICM model covers only the Fitzgerald Stream Local catchment as shown in Figure 1. The ICM model topography is based on the same DEM data as the DHI model. The boundary condition for the 2D zone was set to a 'vertical wall' in line with the 'land' boundary set within the DHI model. This is appropriate as the flows are all directed towards the stream network and discharges towards Drury Creek estuary modelled in 1D that extends to the coast.

The mesh was generated using the terrain-sensitive meshing option, with clip meshing and resolution set to a maximum of $10m^2$ which is considered suitable to represent flow paths and floodplains. Mesh zones with a minimum area of $20m^2$ were applied to retain uniformity in invert/ground levels between the outfall and 2D mesh elements.

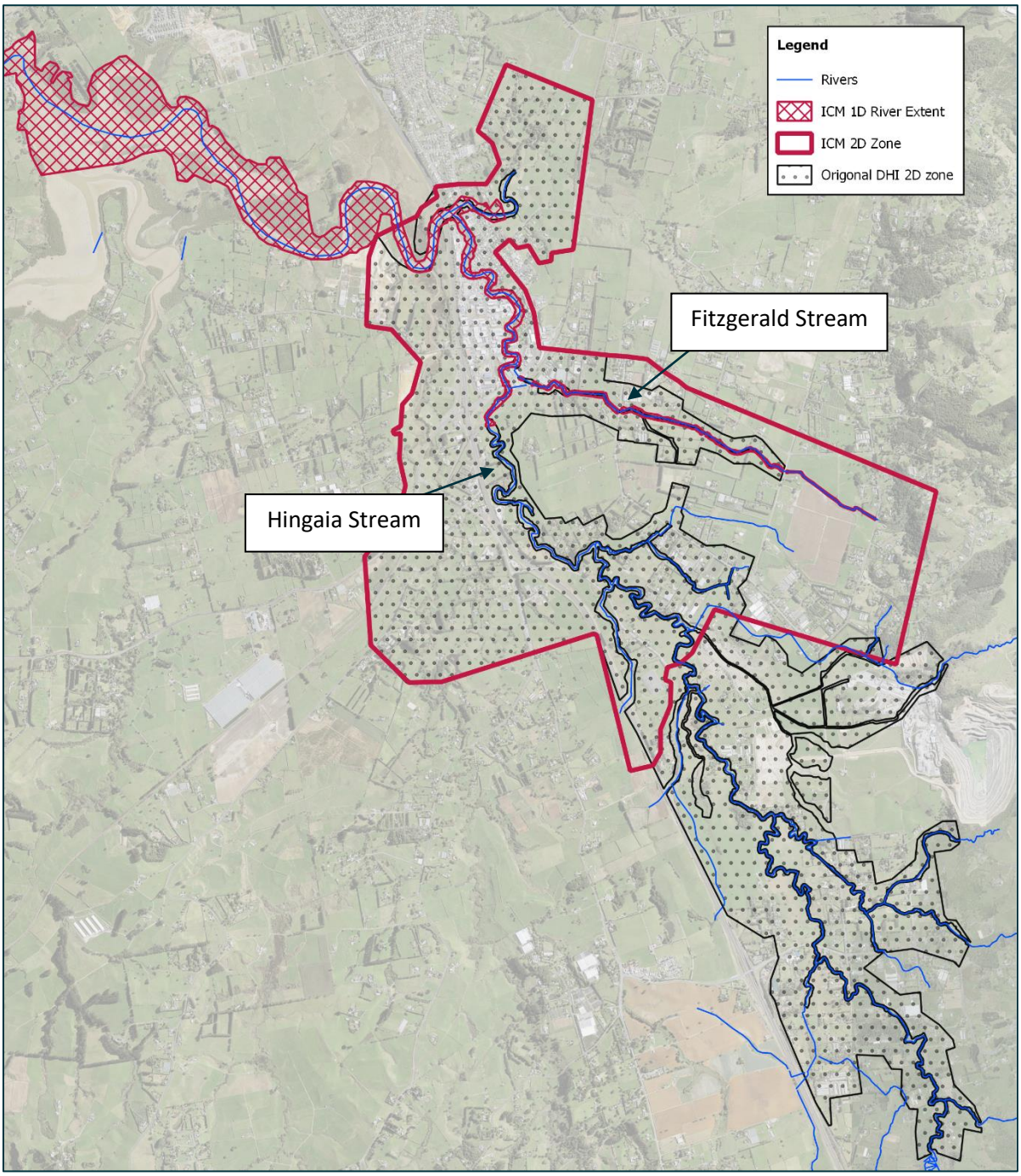

Figure 1: 2D zone extent

3.3 Boundary conditions

3.3.1 Downstream water level

The downstream water level boundary was modelled as per the DHI Mike 11 model and set to a constant level of 2.3mRL (Mean High Waters Springs 95%ile). The boundary condition was further updated to incorporate sea level rise and a level of 3.3mRL was used in modelling to take climate change into account.

3.3.2 Rainfall

Rainfall time series were modelled as per the DHI model that included 24-hour rainfall depths for the 2-year, 10-year, and 100-year Average Recurrence Interval (ARI) design storms from the Auckland Council TP108[2] design rainfall isohyets graphs. The model had assigned rainfall zones based on the TP108 contours for the 2-year, 10-year, and 100-year ARIs. Those zones were translated into ICM within the subcatchments' rainfall profile. For example, for the 100 ARI five (5) rainfall contours were distributed as shown in Figure 2.

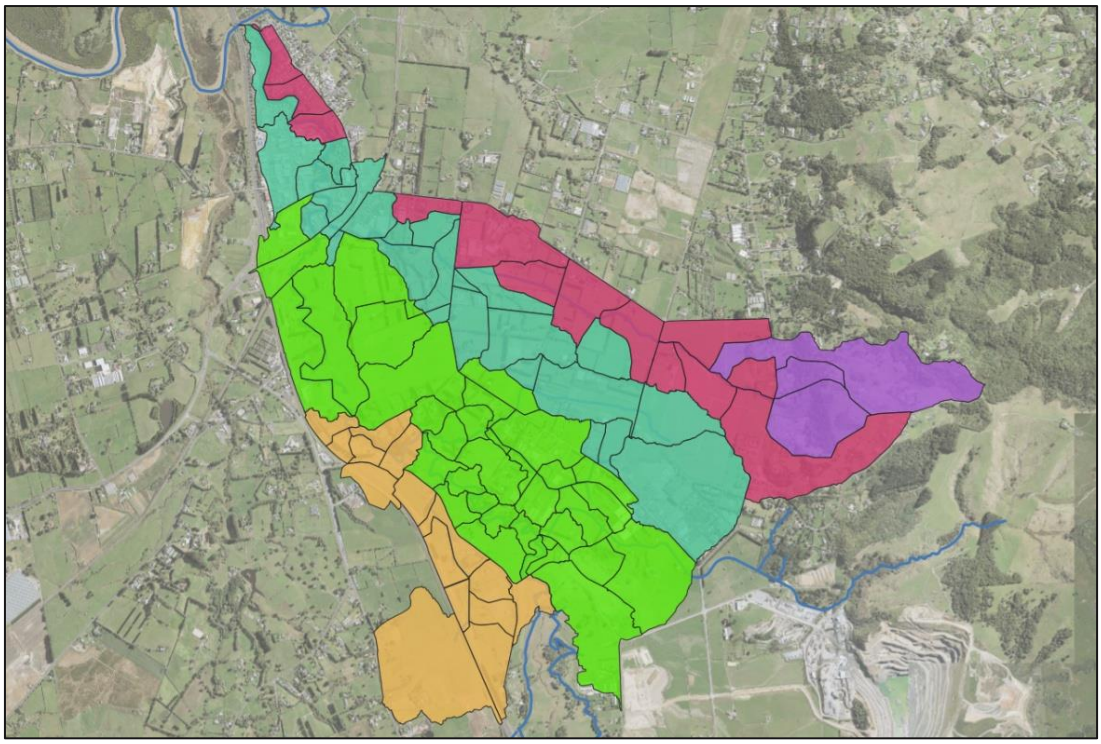

Figure 2: 100 ARI CC, 5 rainfalls TP108 depths (185,188,192,196 and 200mm) for the Fitzgerald Stream Local catchment

The rainfall data used in the DHI model is provided in Table 1. The rainfall included in the model includes a percentage increase in the 24-hour depth due to Climate Change (2.1-degree temperature increase). These percentage increases due to Climate Change (CC) align with the values provided in Table 1 of the Stormwater Code of Practice3, and therefore have been retained in the InfoWorks ICM model. The 24-hour rainfall depth including percentage increase due to CC associated with a 3.8-degree temperature increase has also been added to the InfoWorks ICM model. These updated 24-hour rainfall depths are also included in Table 1.

Table 1: 24-hour rainfall depths

Average Recurrence Interval (ARI)	24-hour rainfall depth (mm)	% increase due to Climate Change 2.1 degrees	24-hour rainfall depth with Climate Change (mm) 2.1 degrees	% increase due to Climate Change 3.8 degrees	24-hour rainfall depth with Climate Change (mm) 3.8 degrees
2 year	51,56,60	9.0%	56,61,65	27.4%	66,71,76
10 year	112,115,119	13.2%	126, 130, 134	30.8%	146, 150, 155
100 year	185,188,192,196,200	16.8%	216,220,224,229,234	32.7%	245,249,255,260,266

For all the above rainfall data, an aerial reduction factor of 0.92 is applied in ICM data as per the DHI model.

[2] Guidelines for stormwater runoff modelling in the Auckland Region TP108. Auckland Regional Council, April 1999

[3] The Auckland Code of Practice for Land Development and Subdivision Version 3.0, Chapter 4, Stormwater. Auckland Council, January 2022

3.3.3 Inflows

The inflows from Slippery Creek, Whangapouri Creek, Oira Creek, and Ngakaroa Stream were modelled as per the inflows modelled in the DHI model.

In addition, two inflows were modelled upstream along the Hingaia Stream and the Quarry Road Stream to represent the upstream flows along the Hingaia Stream. These are shown in Figure 3.

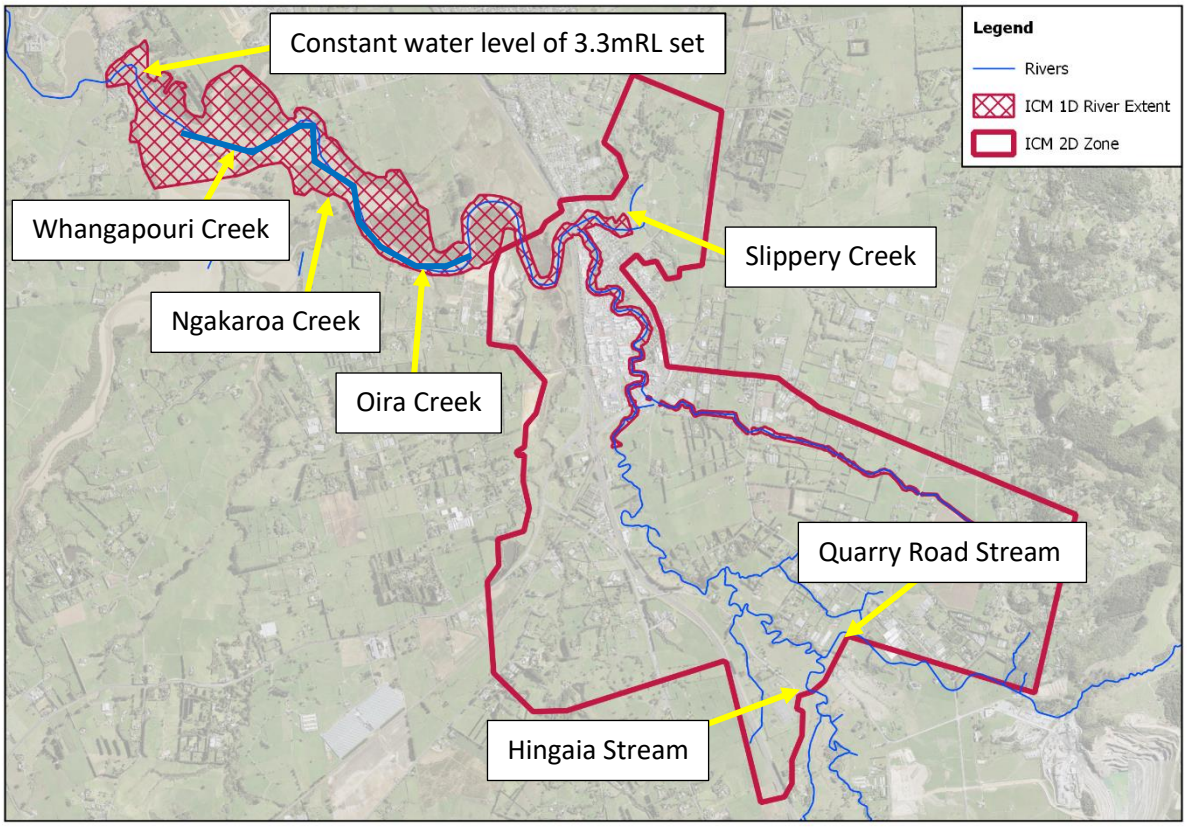

Figure 3: Inflow Locations

3.4 Hydrology

The DHI model has a total of 836 subcatchments delineated based on 2016 LiDAR ranging in size between 0.01 to 118.76 ha. The pervious and impervious subcatchments were represented separately, i.e., 418 pervious subcatchments and 418 impervious subcatchments. Out of these 91 subcatchments which overlap the Fitzgerald Stream Local catchment are modelled in the ICM cutdown model. The DHI model received followed the soil conservation services (SCS) method to convert rainfall into runoff and this method has been retained in the ICM model. For the ICM subcatchments the following parameters are retained from the DHI model.

- Total area and Subcatchment delineation
- Time of concentration (Tc)
- Land use and impervious assumptions
- Curve number (CN)
- Initial abstraction

Refer to Section 4 for more information on updates to model hydrology.

The subcatchment loading in the converted InfoWorks ICM model are shown in Figure 4.

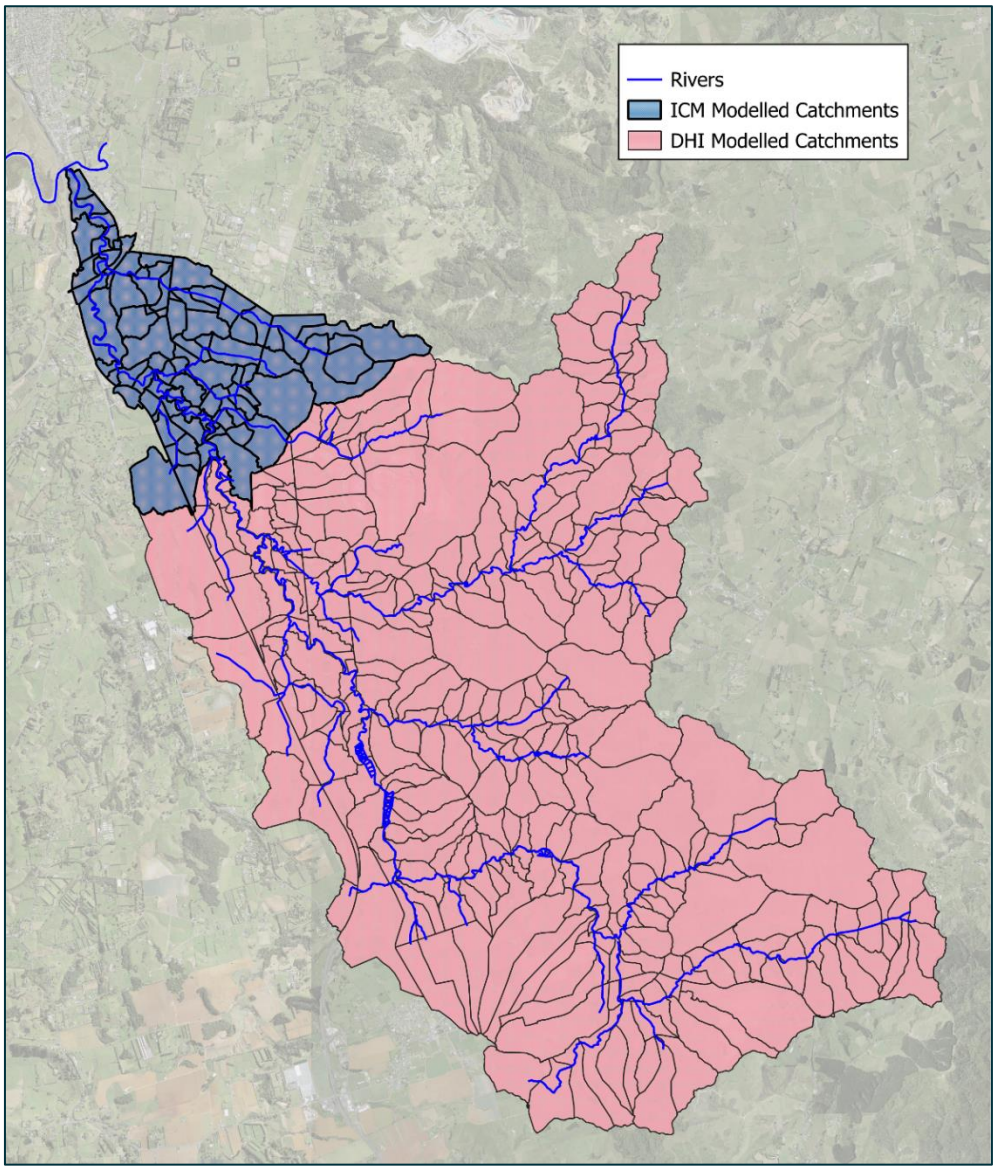

Figure 4: Modelled Catchments

4. Model Updates

4.1 Topography updates

The topography in the InfoWorks ICM model was modelled using the DHI DEM data with a resolution of 1m. Minor adjustments were undertaken to represent inlet and outlet levels in the topography.

4.2 2D source points

The subcatchments imported from DHI model were loaded to 2D source points in ICM model only. The flows are expected to follow the overland flow paths towards the stream network modelled as river reaches in 1D. The source points were checked using the overland flow paths (OLFP) developed using the 2016 LiDAR. Where required, the source points were moved to ensure they are intercepting the OLFPs. This representation is shown in Figure 5.

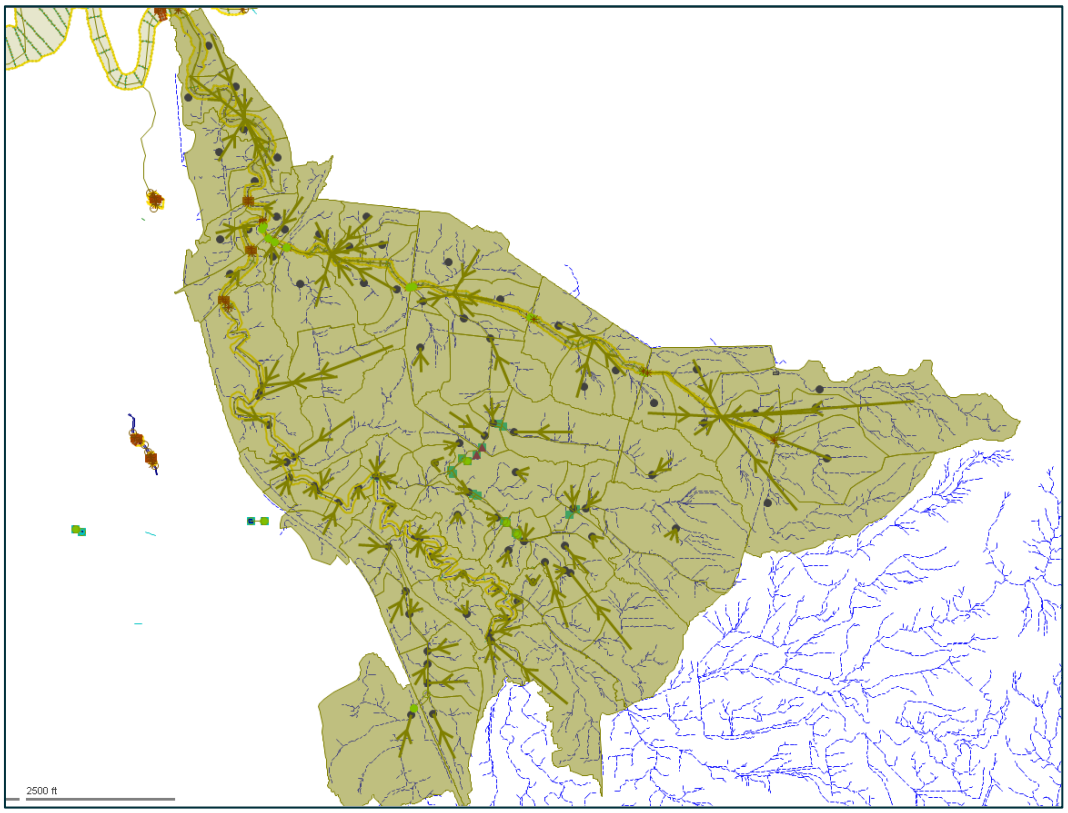

Figure 5: 2D loading nodes in ICM

4.3 Energy Losses

The hydraulic roughness Manning's n values over the 2D model domain were assigned based on various land uses as follows:

- Buildings – 1.0
- Roads – 0.02
- Everywhere else – 0.1
- Stream cross sections – used the roughness applied in the original catchment model where available, all new cross sections have a roughness of 0.05 applied
- Structures - used the roughness as applied in the catchment model

4.4 MIKE 11 Rivers to ICM River Reach conversion

The river reaches have been modelled in the ICM model using a combination of survey and LiDAR interpolated cross sections. All surveyed cross-sections have been included in the ICM model. The 1D river reaches have been connected to the 2D model through lateral and inline banks and the reaches which have been converted to 2D are shown in Figure 5.

4.5 Culvert modelling

Two types of culvert representation have been used in the converted InfoWorks ICM model:

- Conduit type (Culverts) for large culverts within the 1D river reaches. These culverts have been assigned entry and exit losses by US Federal Highway Administration (FHWA). The representation of culverts as a conduit type is available from ICM version 2025.3. An example of this type of culvert representation is shown in Figure 6.

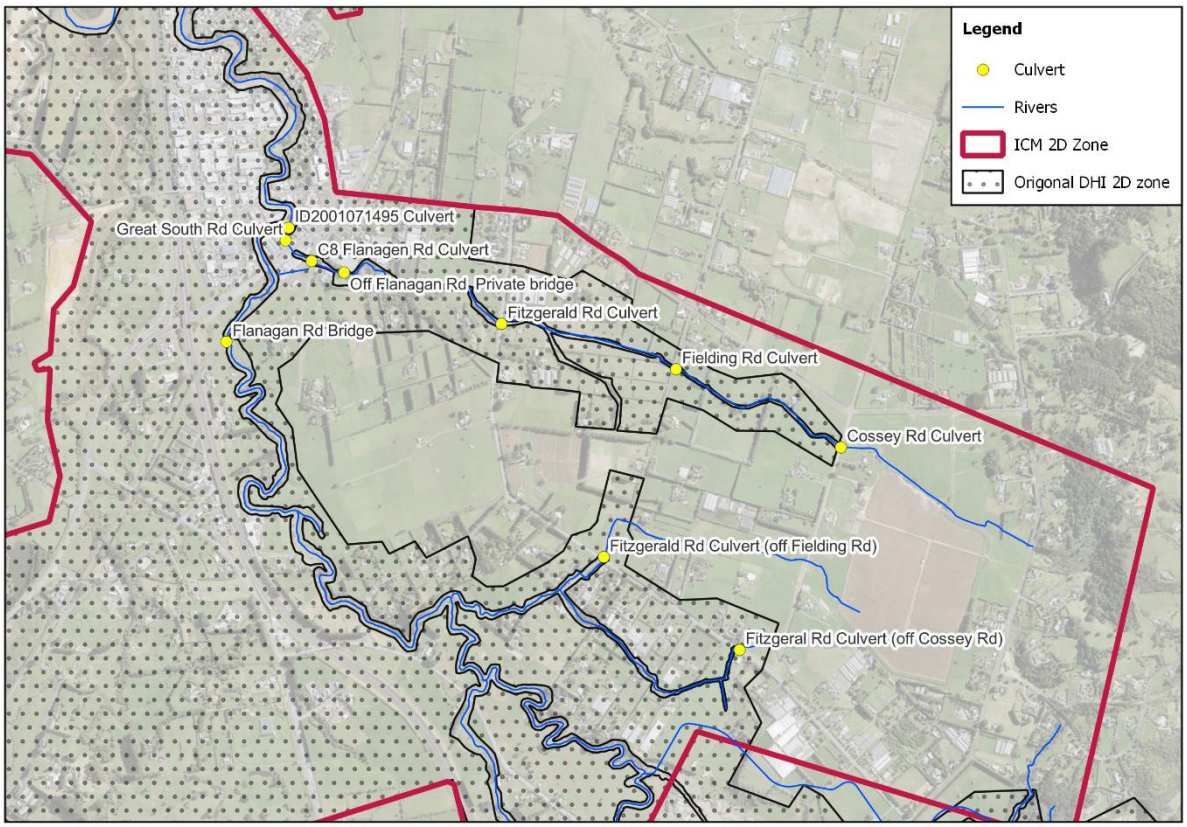

Figure 6: Modelled Culverts

5. Model checks

5.1 Flood extent comparison

The converted ICM model has been run for the 100-year scenario with climate change (2.1 degrees). The resulting flood extents were compared to the original DHI model results to understand if there are any major differences through Fitzgerald Stream with the change in the modelling package model. The results are shown in Figure 6 below.

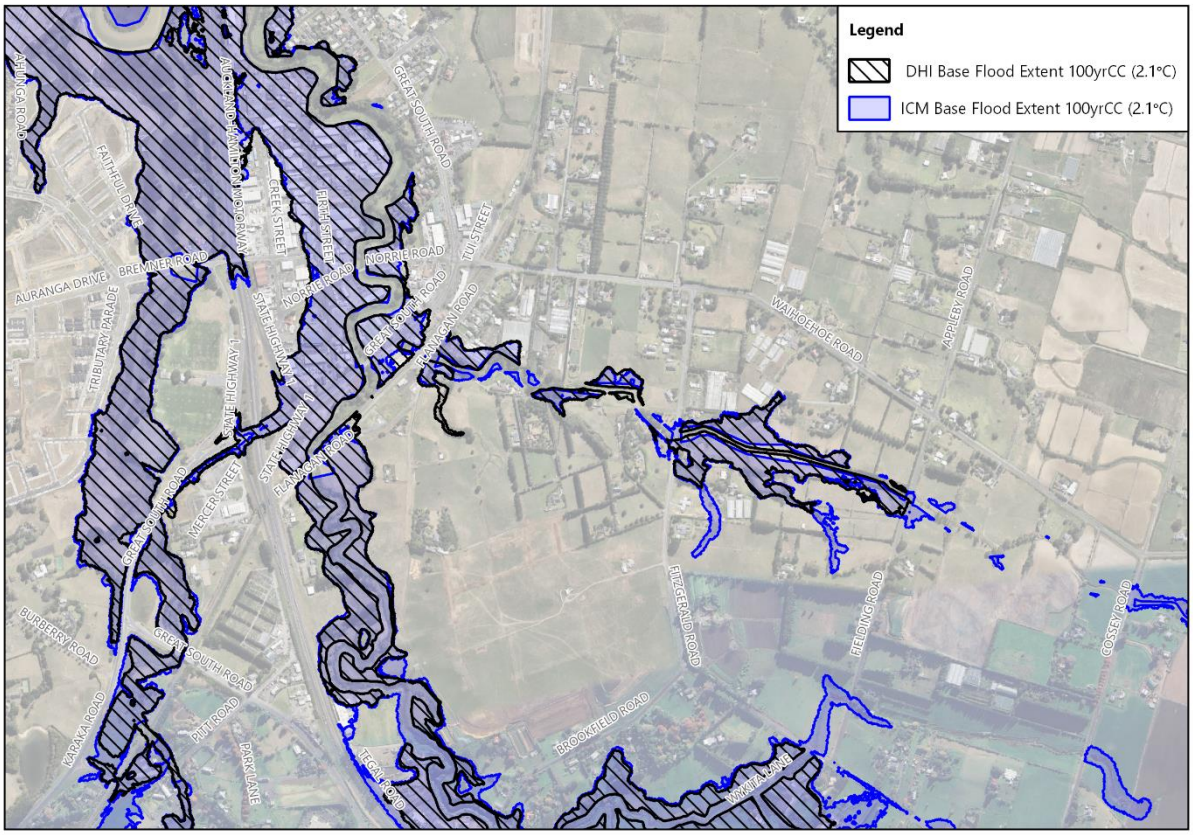

Figure 6: DHI vs ICM Flood Extent Comparison

Overall, there was a good correlation between the DHI and ICM flood extents. For most of the catchment, the comparison shows no significant difference in flood extent, however, there are some differences between the two model results observed outside of the Drury East development extents. These differences can be attributed to the model update process including:

- Location of 2D source points as detailed in Section 4.2.
- Updated terrain and terrain-sensitive meshing approach in ICM compared to DHI
- Application of 2D roughness values
- Updates to the ICM 1D river reaches as a part of the conversion

6. Limitations

The following key limitations in relation to the Fitzgerald Stream Local catchment ICM cutdown model are noted below:

- This model has been prepared to guide flood levels and depths within the modelled catchment area for the modelled scenario. The modelling process relies on a range of assumptions and simplifications and may be subject to errors and inaccuracies. The compounding effects of the uncertainties in the TP108 rainfall model (ARC, 1999), the uncertainties in the LiDAR data and the uncertainties in hydraulic parameters such as roughness could result in the water level varying from the mapped levels.
- The LiDAR data has an absolute vertical accuracy of +/- 0.10m. Deviations in vertical accuracy can occur in areas of dense vegetation. Below-water ground levels are not reliably represented in the LiDAR data.
- No additional survey was carried out as a part of this model conversion and update exercise.
- There is no measured flow data in the catchment; therefore, it was only possible to check the model against measured peak water levels, anecdotal evidence and previous modelling.
- Due to the rate of development in the catchment, recently installed stormwater infrastructure, and modifications to the ponds, culverts and bridges may not be captured in latest Council GIS data or available survey, and therefore may not be represented in the model.
- Stormwater pipe network was excluded from the model as per the DHI model.
- The model has been developed to be used to support ongoing development within Drury East catchment along Fitzgerald tributary only. The model may not be suitable in areas outside of this extent.

Appendix A: Model Update Summary

Item	Hingaia Stream Drury Centre Stage 1 (Mike by DHI version of v2020 Update 1)	Fitzgerald Stream Local catchment (InfoWorks ICM Version 2025.3)
Hydrology Updates		
Subcatchments	• Total number subcatchments: 836. • Pervious and impervious subcatchments are represented separately, i.e., 418 pervious subcatchments and 418 impervious subcatchments.	• ICM has 91 Subcatchments with 2 land uses. 1 Impervious CN98 and 2 Pervious CN74
Impervious	• imperviousness across the catchment (except for Drury Centre Stage 1) based on existing imperviousness as per Auckland Council's impervious surfaces layers	• Impervious assumption retained from the DHI Model
Curve numbers	• CN of 74 applied for pervious area • CN of 98 applied for impervious areas	• CN of 74 retained for pervious areas • CN of 98 retained for impervious areas
Initial abstraction	• Pervious areas Ia= 5mm • Impervious areas Ia = 0	• No changes
Time of Concentration	• Subcatchment Tc ranges from 10 to 37mins	• No changes, original Tc have been retained in the ICM model
Topography		
Terrain model	• The terrain model was developed from 2016 LiDAR.	• Terrain model updated with LiDAR 2016. • Mesh triangles generated using Terrain Sensitive Clip meshing with a maximum size of 10m^2. • Mesh zones with an area of 20m2 were applied to retain uniformity in invert/ground levels between the outfall and 2D mesh elements.
• Roughness zones	• 0.02, 0.35 and 0.035 to 0.05 Manning's n applied to Impervious surfaces, building footprints, and remaining parcel / pervious areas respectively • Manning's n 0.04 to 0.08 was used for the Mike11 river reaches	• 0.02, 1.0 and 0.1 Manning's n applied to Impervious surfaces, building footprints, and remaining parcel / pervious areas respectively • Manning's n 0.05 was used for the ICM 1D river reaches
Stormwater Network		
River Reaches and open channels	• 104 open channels represented Mike11.	• A number of open channels previously represented in Mike11 were not converted to 1D river reaches in ICM and instead were modelled as 2D using terrain-sensitive meshing. • 20 River Reaches have been generated for use in the converted ICM model using a combination of survey cross sections and LiDAR interpolated cross sections. • Manning's n 0.05 was used for the ICM 1D river reaches.
Boundary Conditions		
Water Levels	• Downstream water level boundary in the MIKE 11 branch Drury Creek at chainage 9081.5 = 2.3m	• Boundary condition updated to 3.3m AD to reflect the climate change factors

<table>
<tr><td>Inflows</td><td>The inflows from Slippery Creek, Whangapouri Creek, Oira Creek, Ngakaroa Stream were modelled in the DHI model.</td><td>The inflows from Slippery Creek, Whangapouri Creek, Oira Creek, Ngakaroa Stream were modelled as per the inflows modelled in the DHI model.

In addition, two inflows were modelled upstream along Hingaia Stream and Quarry Road stream to represent the upstream flows along Hingaia Stream.</td></tr>
<tr><td>Rain Events</td><td>• Rainfall zones assigned based on the TP108 contours for the 2,10- and 100-Years Average Recurrence Interval (ARI).
• 24-hour rainfall depth obtained from TP108 guidelines and % increase in climate change as shown below:
<table>
<tr><th>Average Recurrence Interval (ARI)</th><th>24-hour rainfall depth (mm)</th><th>% increase due to CC 2.1 degrees</th><th>% increase due to Climate Change 3.8 degrees</th></tr>
<tr><td>2 year</td><td>51,56,60</td><td>9.0%</td><td>27.4%</td></tr>
<tr><td>10 year</td><td>112,115,119</td><td>13.2%</td><td>30.8%</td></tr>
<tr><td>100 years</td><td>185,188,192,196,200</td><td>16.8%</td><td>32.7%</td></tr>
</table></td><td>• Additional rainfall scenarios with 24-hour depths adjusted to allow for 3.8 degrees and 2.1 degrees Climate change retained in InfoWorks ICM model</td></tr>
<tr><td colspan="3">Modelled Scenarios</td></tr>
<tr><td>Scenarios to simulate</td><td>
<table>
<tr><th>Land Use</th><th>Design Storm Event</th><th>Rainfall</th></tr>
<tr><td>ED</td><td>2 Year ARI</td><td>Future 2.1CC</td></tr>
<tr><td>ED</td><td>10 Year ARI</td><td>Future 2.1CC</td></tr>
<tr><td>ED</td><td>100 Year ARI</td><td>Future 2.1CC</td></tr>
<tr><td>ED</td><td>2 Year ARI</td><td>Future 3.8CC</td></tr>
<tr><td>ED</td><td>10 Year ARI</td><td>Future 3.8CC</td></tr>
<tr><td>ED</td><td>100 Year ARI</td><td>Future 3.8CC</td></tr>
</table></td><td>• No changes</td></tr>
</table>

Appendix B: Flood Maps

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	09/12/2024	DESIGNED	-
-	-	-	-	DRAWN	SB
-	-	-	-	CHECKED	RN
				APPROVED	AD

8 NUGENT ST,
GRAFTON,
AUCKLAND 1023

WOODS.CO.NZ

WOODS Est.1970

Fitzgerald Stream Local Catchment Model
Modelled Results
Maximum Depth Base 2yr CC (2.1°C)

STATUS	ISSUED FOR INFORMATION	REV
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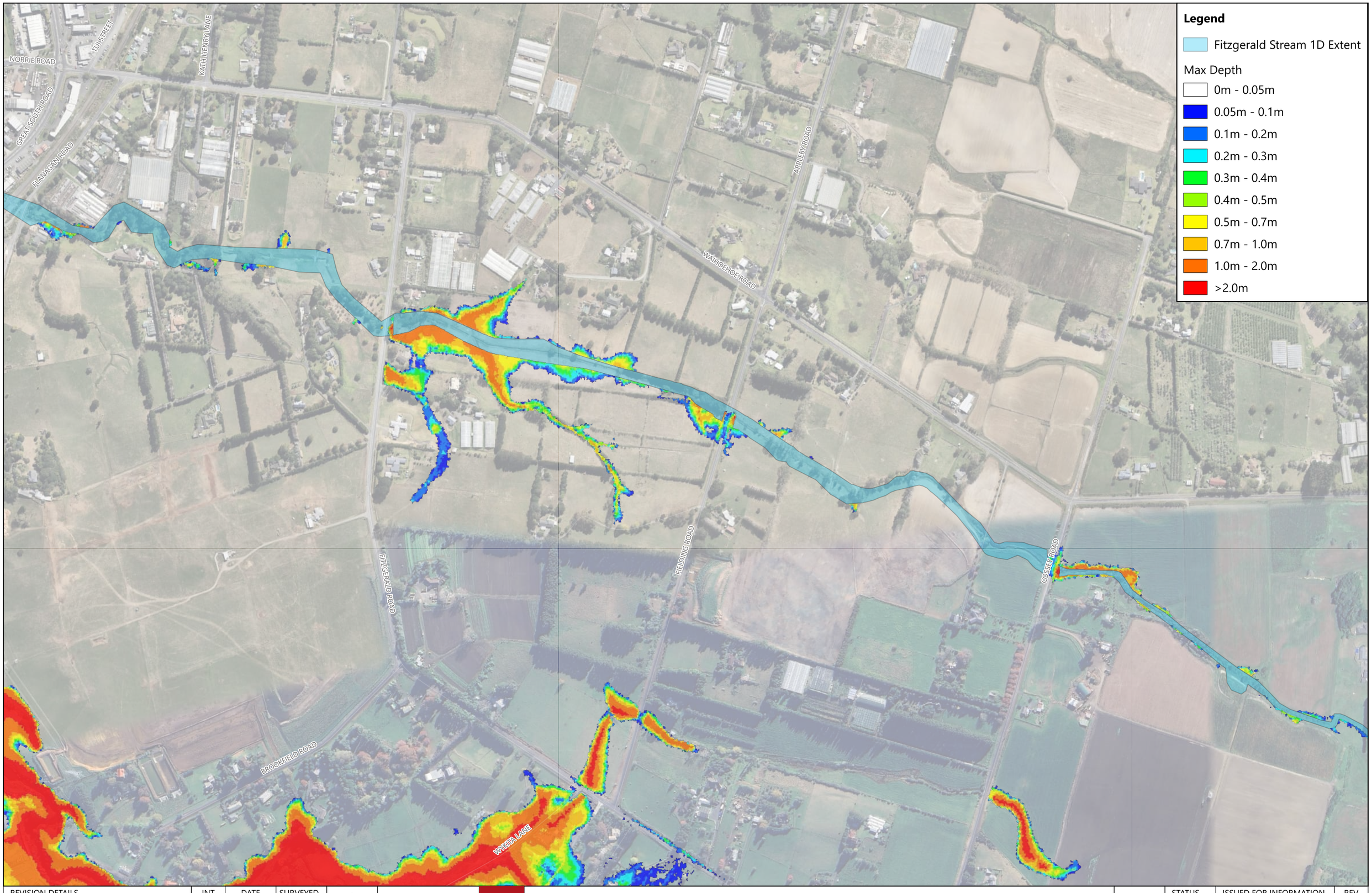
COUNCIL	AUCKLAND COUNCIL	
SHEET	SHEET 1 of 3	



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				APPROVED	AD

8 NUGENT ST,
GRAFTON,
AUCKLAND 1023

WOODS
Est.1970

WOODS.CO.NZ

Fitzgerald Stream Local Catchment Model
Modelled Results
Maximum Depth Base 10yr CC (2.1°C)

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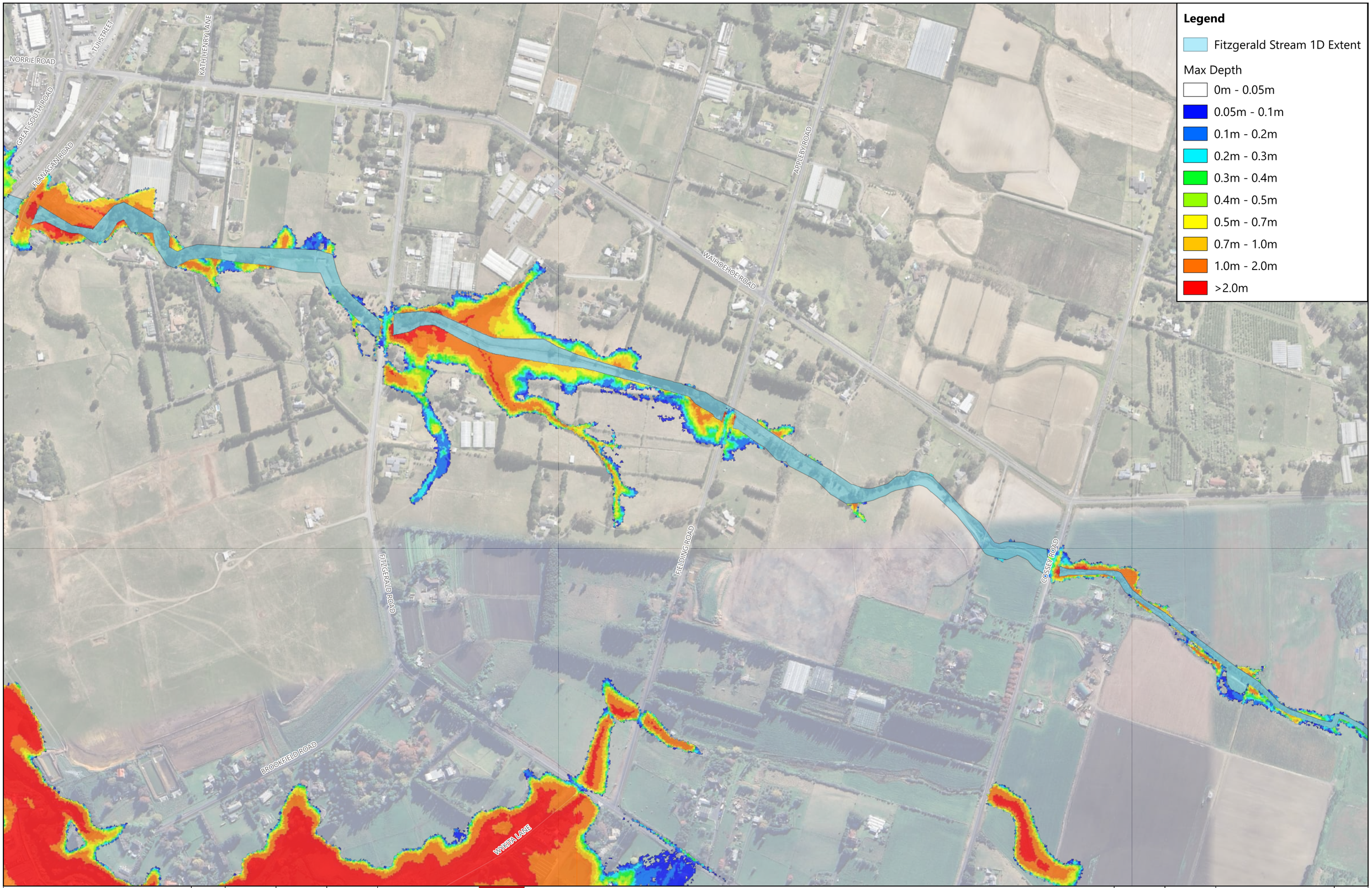

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-	-	-	-	DRAWN	SB	
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WOODS Est.1970

Fitzgerald Stream Local Catchment Model
Modelled Results
Maximum Depth Base 100yr CC (2.1ºC)

STATUS	ISSUED FOR INFORMATION	REV
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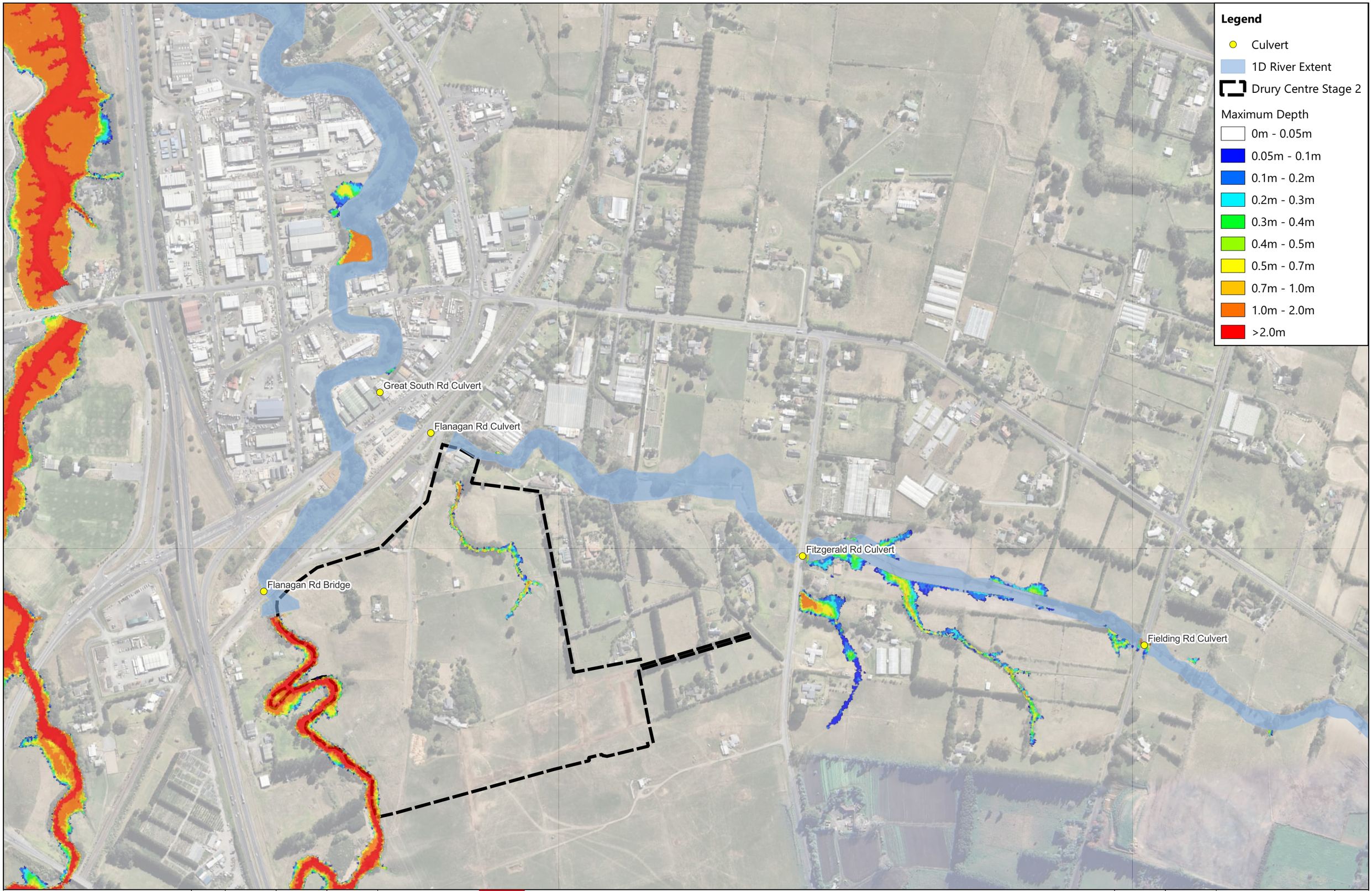
SHEET	SHEET 3 of 3	

Appendix E

Flood Model Results



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				APPROVED	AD

8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

WOODS.CO.NZ

P24-646 - Drury Centre - Stage 2 Fast Track
Maximum Depth
Pre Development 2yr CC (2.1°C)

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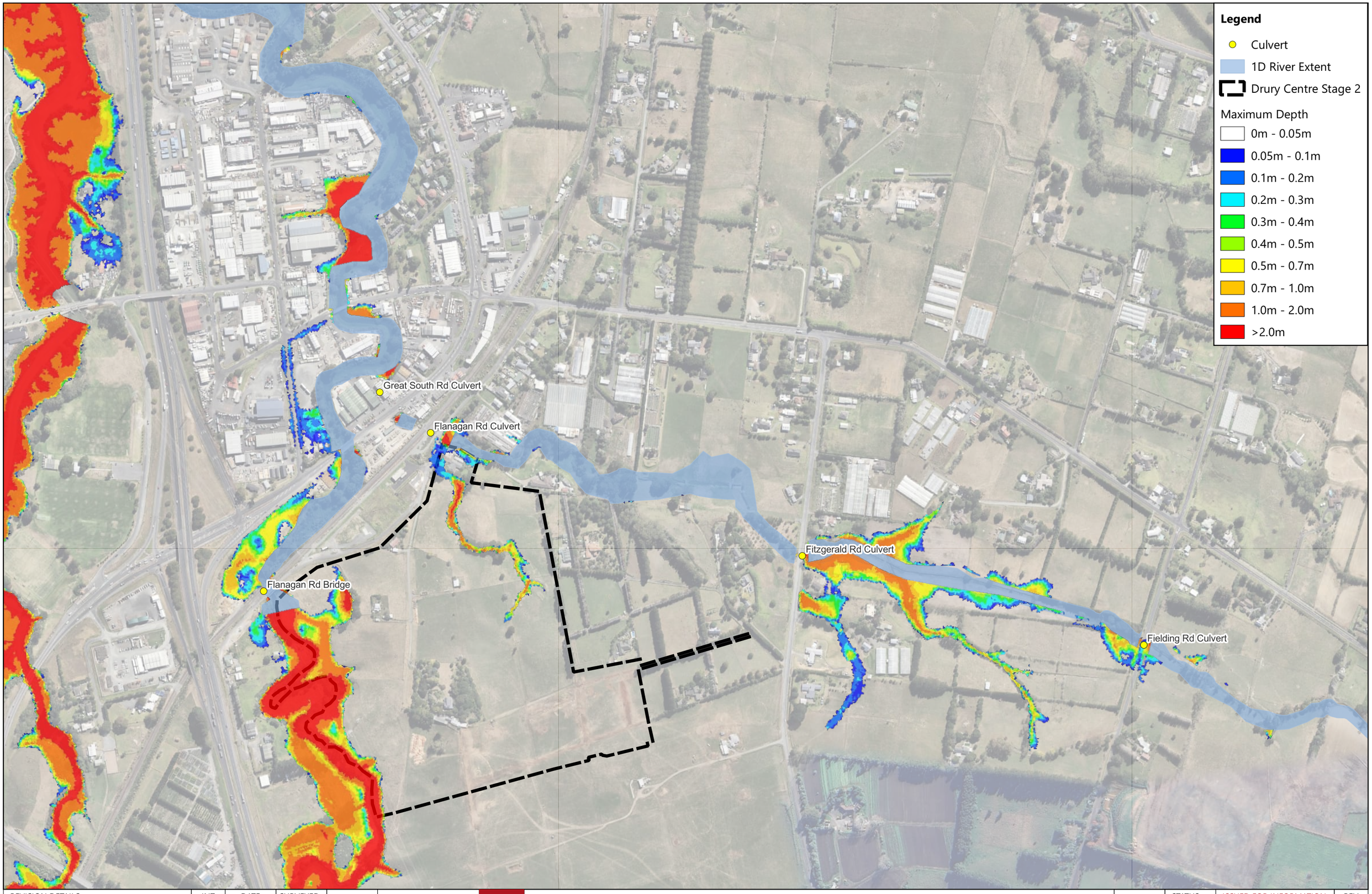

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WOODS Est.1970

P24-646 - Drury Centre - Stage 2 Fast Track
Maximum Depth
Pre Development 10yr CC (2.1°C)

STATUS	ISSUED FOR INFORMATION	REV
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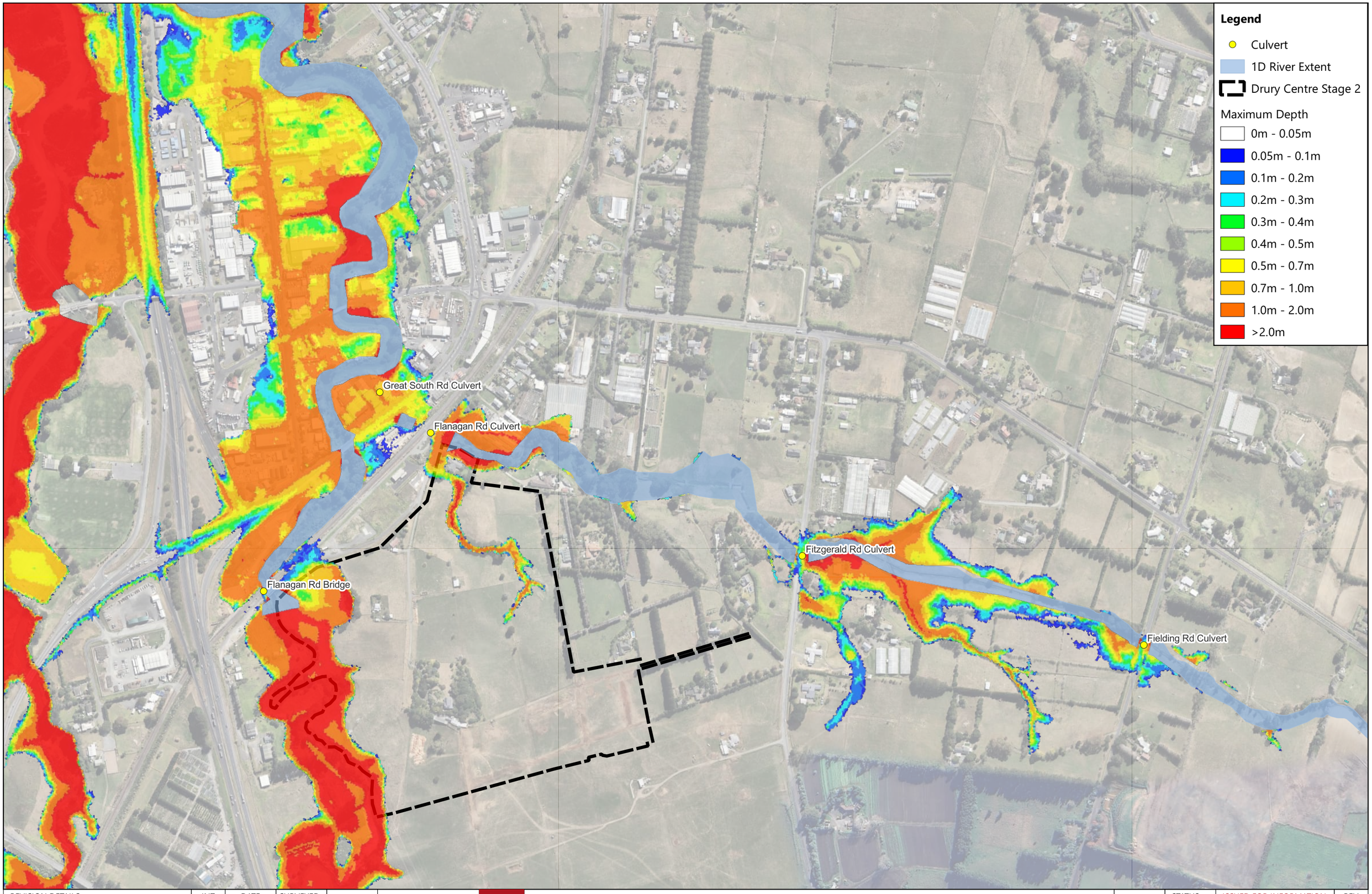

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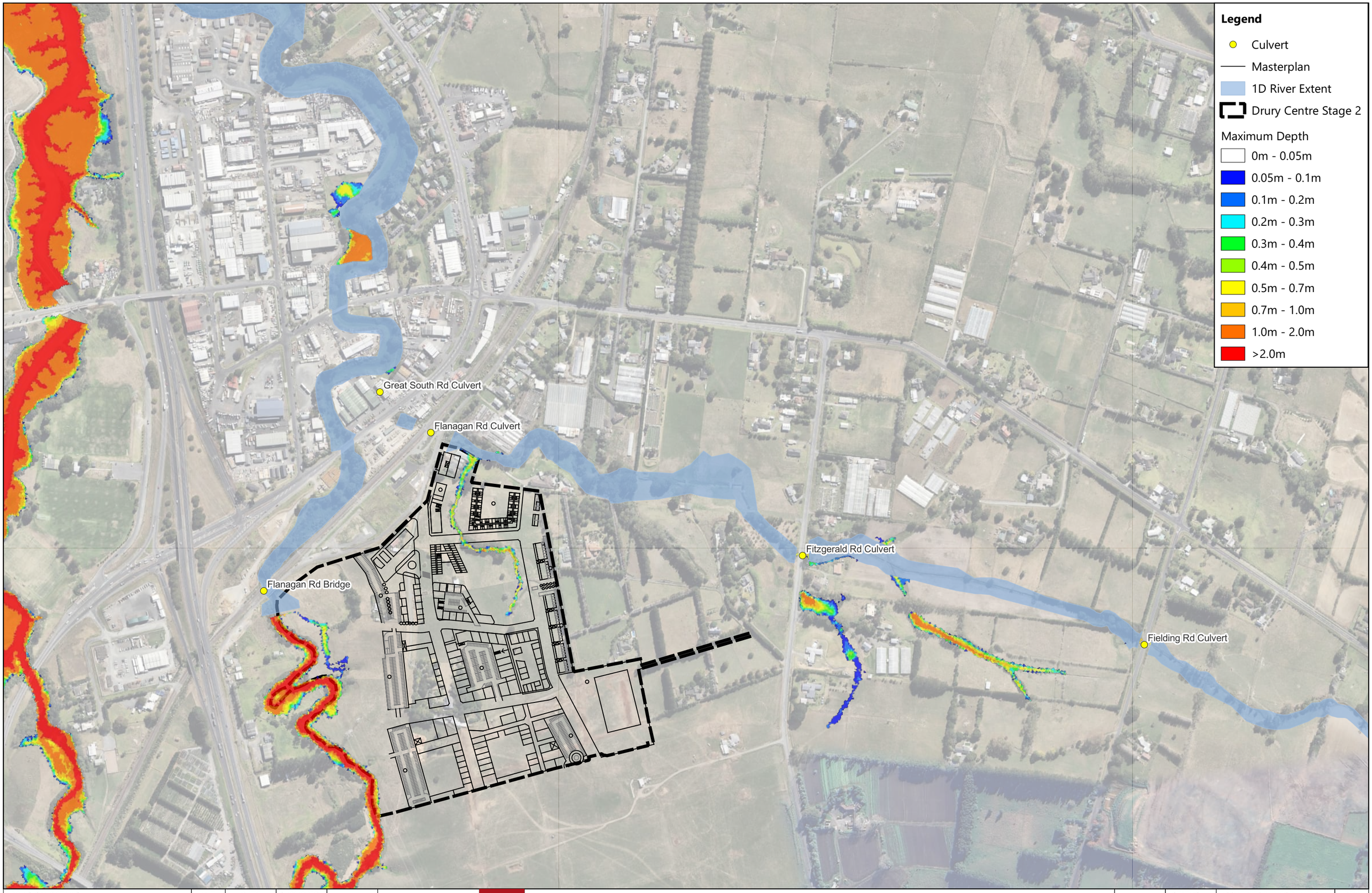
				APPROVED	AD	WOODS.CO.NZ					



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8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

WOODS.CO.NZ

P24-646 - Drury Centre - Stage 2 Fast Track
Maximum Depth
Post Development 2yr CC (2.1°C)

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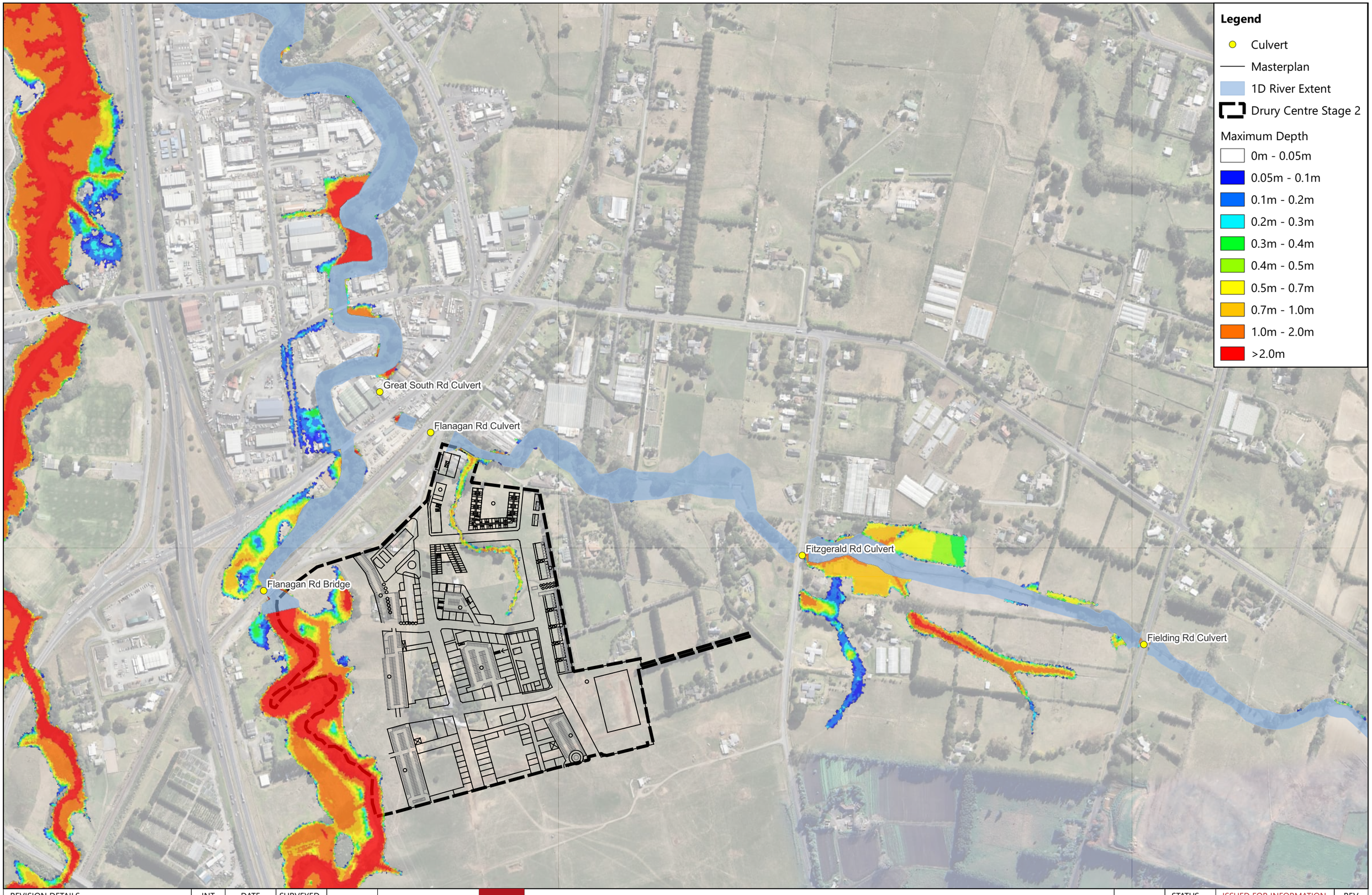

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8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

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P24-646 - Drury Centre - Stage 2 Fast Track
Maximum Depth
Post Development 10yr CC (2.1°C)

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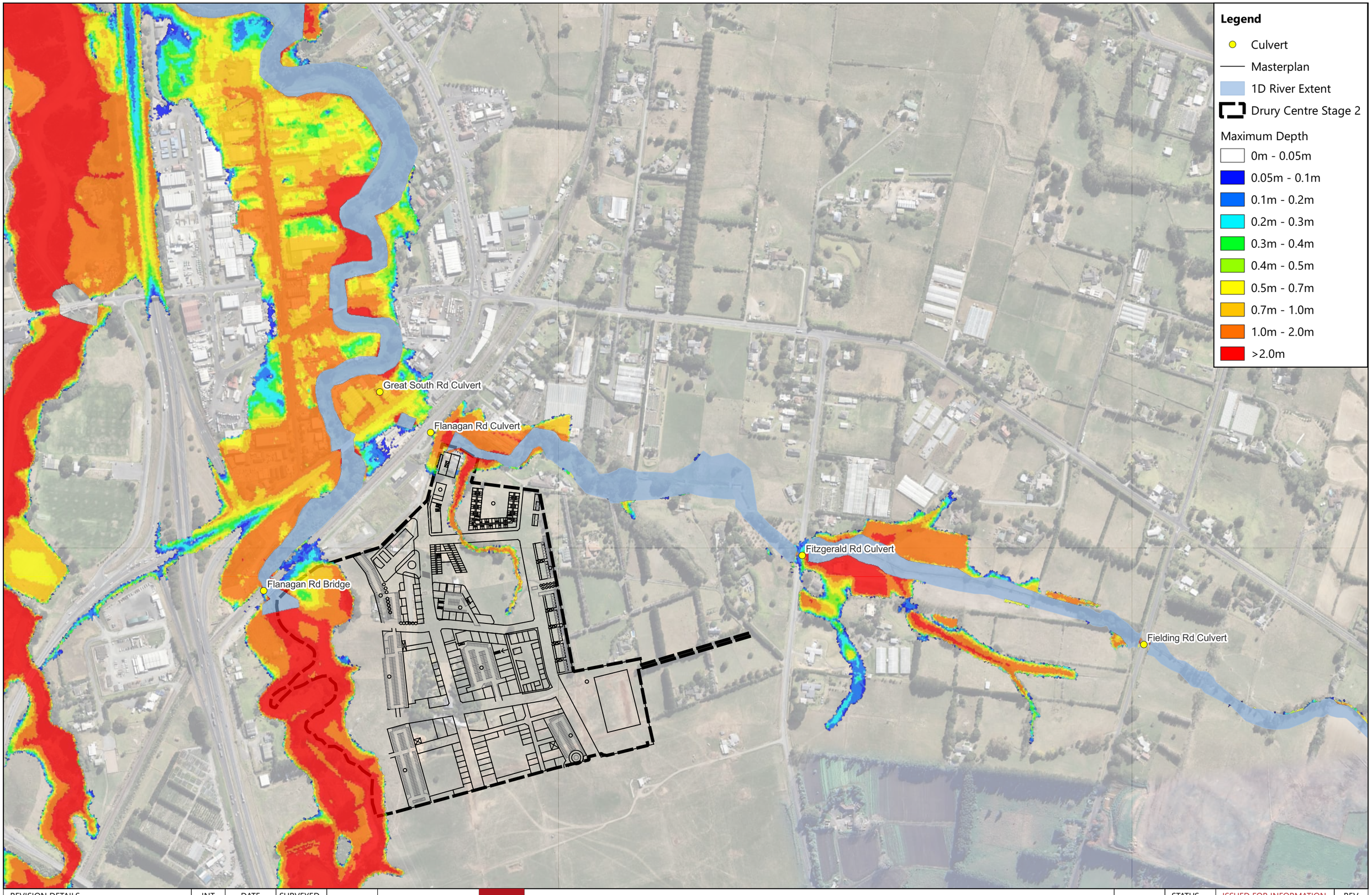

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WOODS Est.1970

P24-646 - Drury Centre - Stage 2 Fast Track
Maximum Depth
Post Development 100yr CC (2.1°C)

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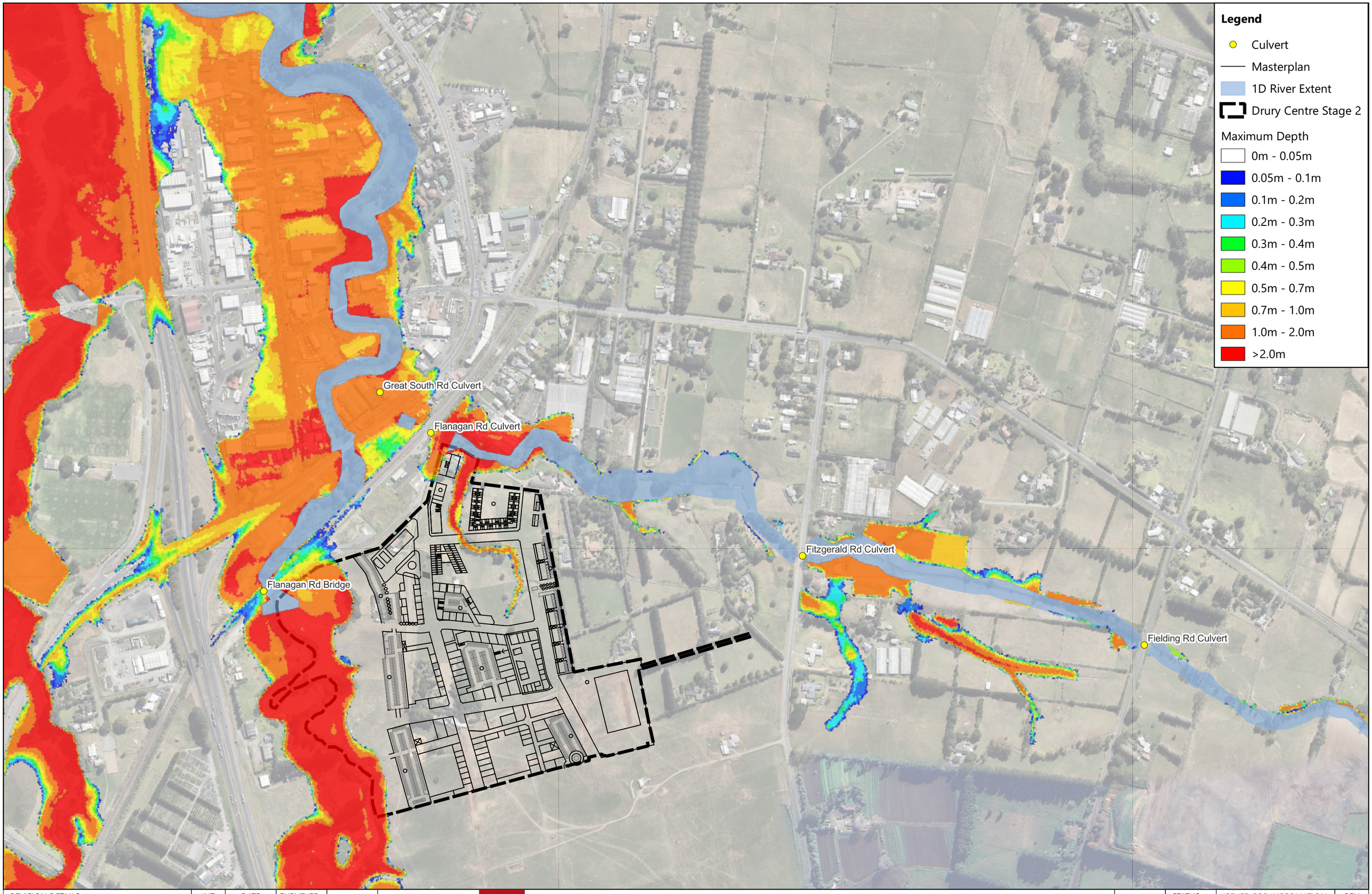

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8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

WOODS.CO.NZ

WOODS Est.1970

P24-646 - Drury Centre - Stage 2 Fast Track
Maximum Depth
Resilience Assessment 100yr CC (3.8°C)

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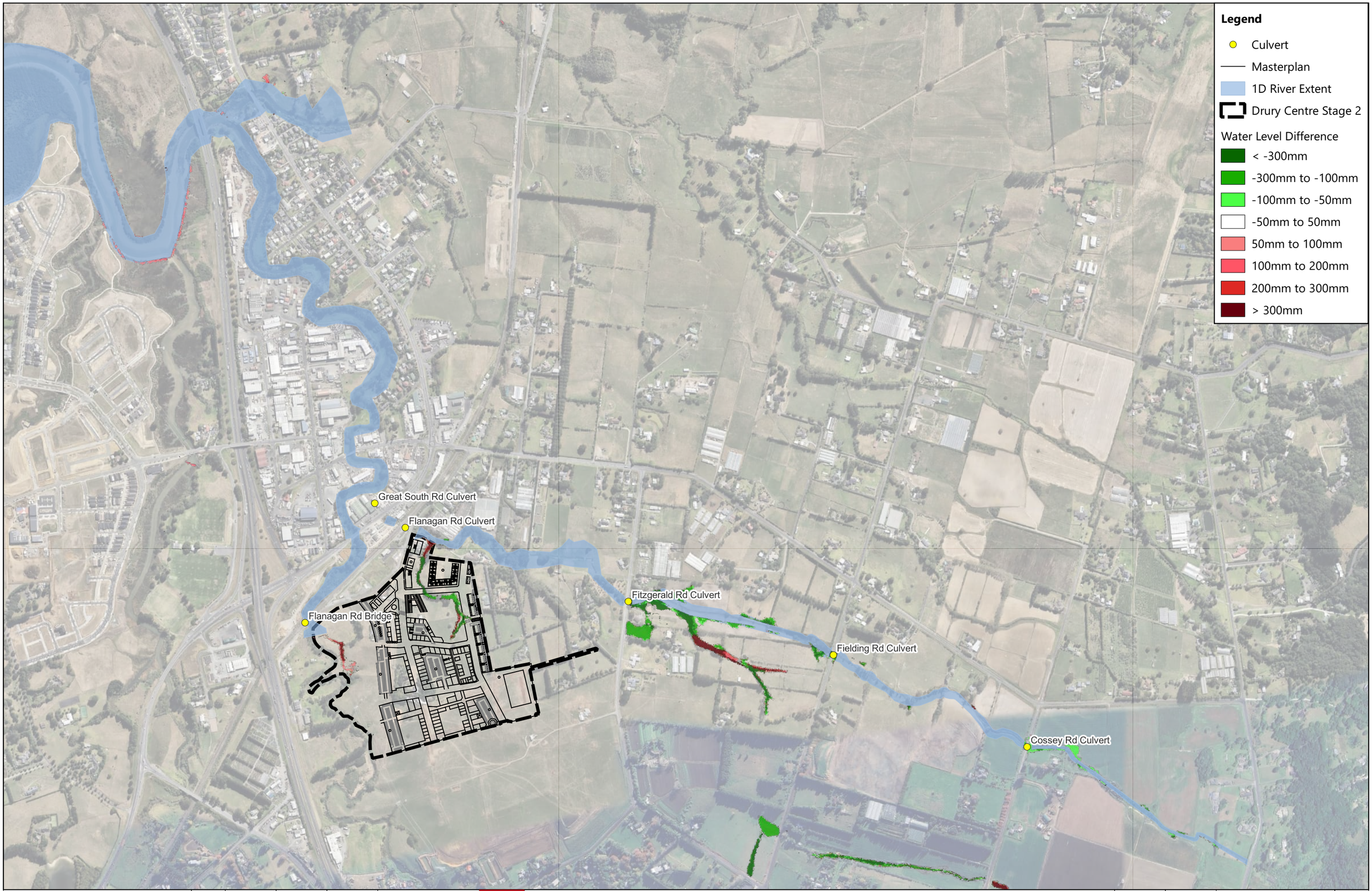

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8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

WOODS.CO.NZ

WOODS EST.1970

P24-646 - Drury Centre - Stage 2 Fast Track
Water Level Difference
Post Development vs Pre Development 2yr CC (2.1°C)

STATUS	ISSUED FOR INFORMATION	REV
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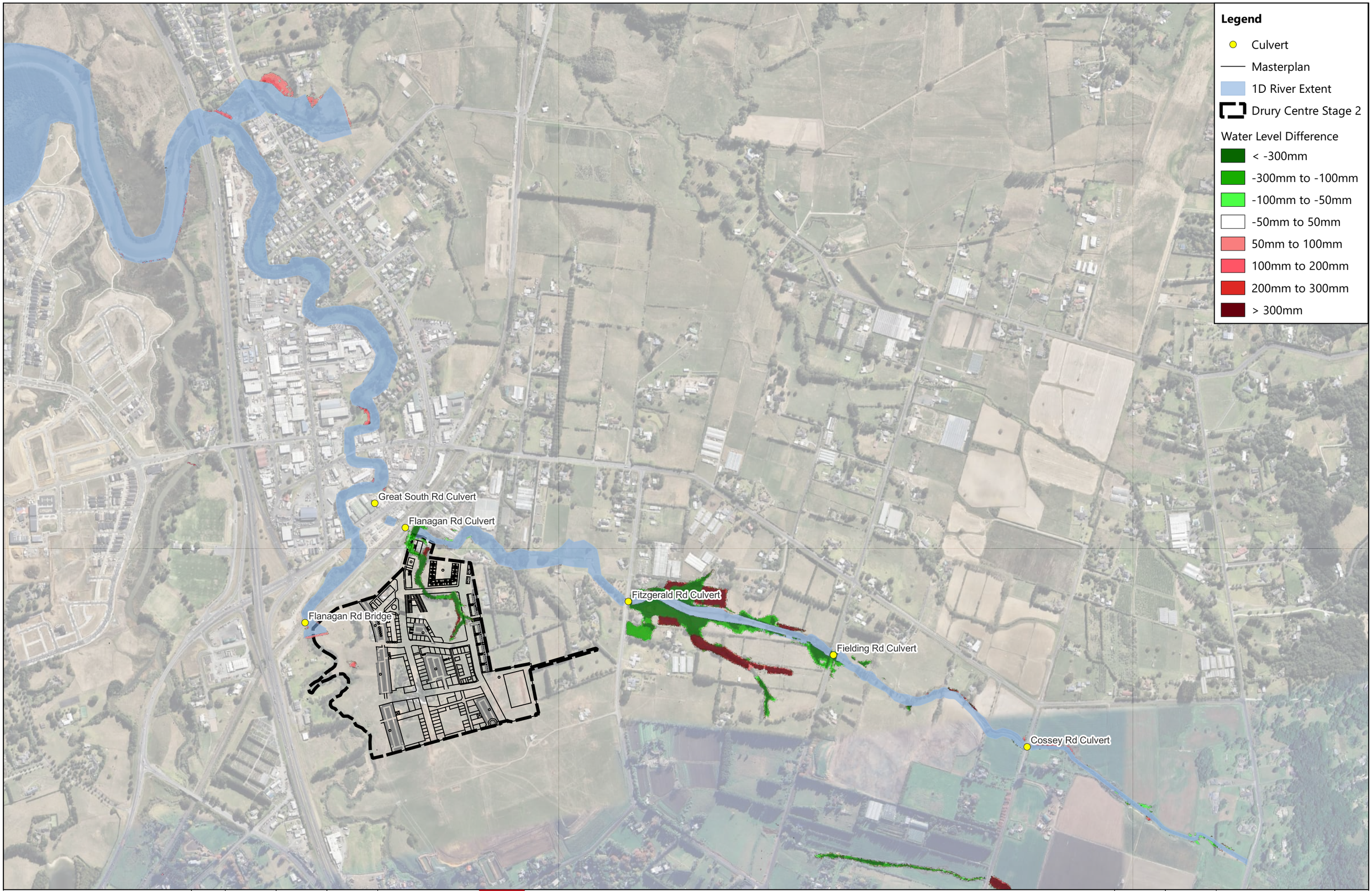

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GRAFTON,
AUCKLAND 1023

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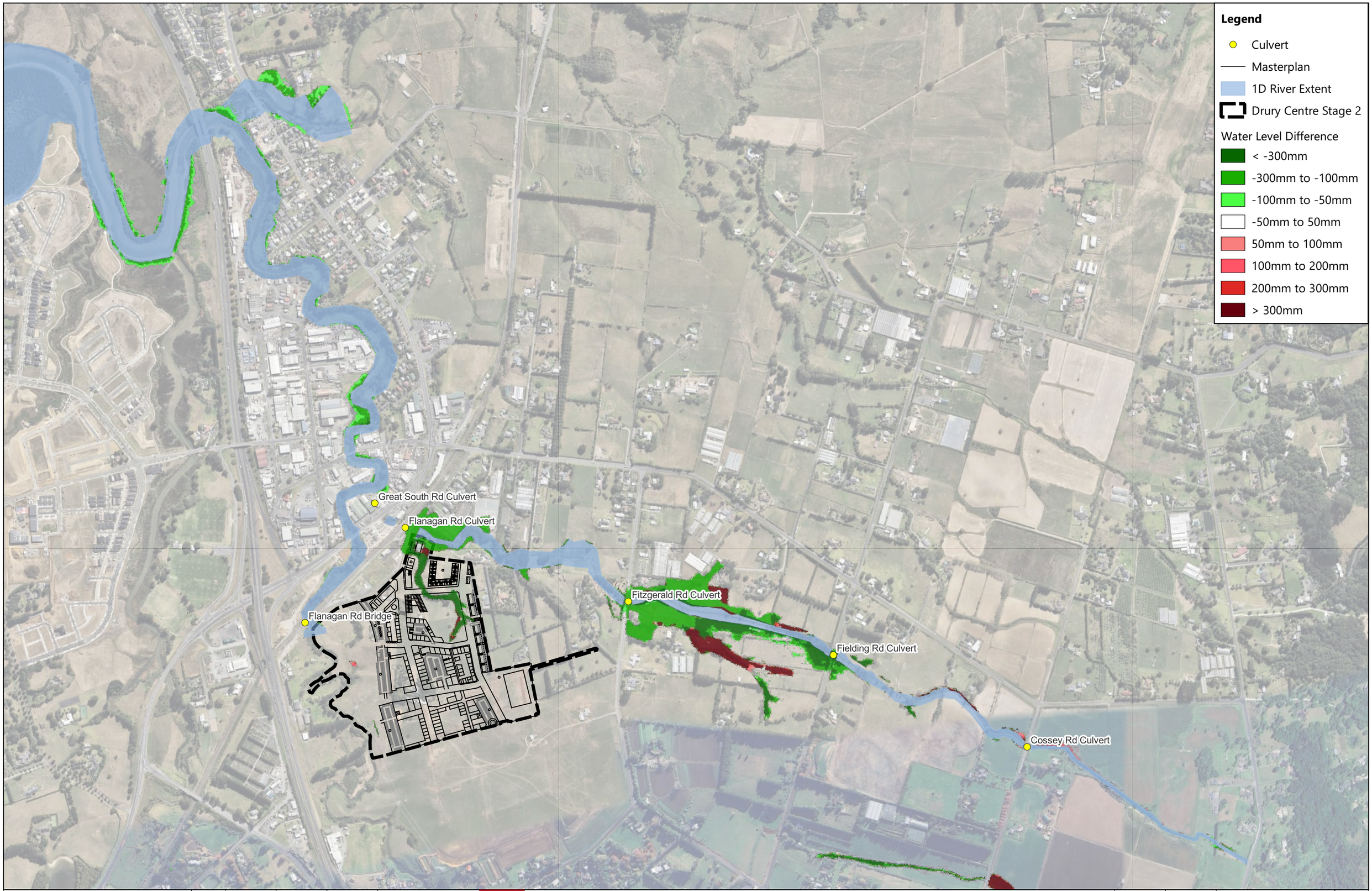
WOODS EST.1970

P24-646 - Drury Centre - Stage 2 Fast Track
Water Level Difference
Post Development vs Pre Development 10yr CC (2.1°C)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
SHEET	SHEET 2 OF 3	



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-	-	-	-	CHECKED	RN
				APPROVED	AD

8 NUGENT STREET,
GRAFTON,
AUCKLAND 1023

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WOODS Est.1970

P24-646 - Drury Centre - Stage 2 Fast Track
Water Level Difference
Post Development vs Pre Development 100yr CC (2.1°C)

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	AUCKLAND COUNCIL	
SHEET	SHEET 3 OF 3	

Appendix F

E36.9 Food Risk Assessment

AUP Chapter E36.9 Flood Hazard Risk Assessment Report

Prepared by (company name): Wood and Partners Consultants Ltd

Site Address: Drury Centre - Stage 2

Application No: TBC

		Select level of assessed risk from drop down list attached to each cell below
(a) The frequency, duration and scale of the flooding hazard;		
State If the site being developed will be impacted by flooding in more frequent events than 1 % AEP If assessment is for overland flow, determine trigger event as well as 1% AEP scenario. An assessment of the duration of the flooding hazard for the 1 % AEP event should be made supported with a study of the hydrology of the contributing sub catchments that is appropriate for the scale of the risk. Describe extent of flooding on site along with discharge rates, depths and velocities at critical points on the developed site.*	*Stage 2 has been identified on Auckland Council's Geomaps as being partially within a 100 year ARI floodplain. The flood management strategy for Stage 2 is proposed to enable the conveyance of flows during larger storm events. Flood modelling undertaken for the site predicts that there are no third party effects expected downstream of development as a result of Stage 2 development. External OLFP entering the site and internal OLFP are to be conveyed within the proposed road corridor and conveyance structures, therefore considered as low risk.*	low
(b) the type of activity being undertaken and its vulnerability to flooding events;		
Identify the activity or activities incorporated in the proposed development as listed in table E36.4.1. Described the vulnerability (exposure) of the activity or activities to the flood events determined by the investigation into the flooding hazards impacting the site described in E36.9(a). This should include whether the building footprint , any vehicle parking area and means of egress are within the flooding extent	*The proposed development for the site includes buildings and structures for a variety of commercial, retail, accommodation and community activities with ancillary car parking. The finished floor level (FFL) will be designed in accordance with the Stormwater Code of Practice, Version 3, January 2022. Thus there are no risks to any habitable floors.*	low
(c) the consequences of a flooding event in relation to the proposed activity and the people likely to be involved in that activity;		
Identify the impacts on the proposed activity during a flood event e.g. if the building footprint is fully or partially within the flooded area what level will the flooding reach in respect to the living areas and other components of the dwelling. If egress from the building will be flooded . . to what depth and for what period of time. Identify any potential for damage to, or deterioration of, the structural and functional integrity of the building resulting from the intensity and or frequency of flooding.	*All building footprints are to be located outside the flood plain. The external and internal OLFP are to be conveyed within the proposed road corridors and conveyance structures. The finished floor level (FFL) will be designed in accordance with the Stormwater Code of Practice, Version 3, January 2022. There are no risks to any habitable floors.*	low
(d) the potential effects on public safety and on other property;		
Describe effects on public safety if the activity will include public use. Identify any potential flooding of upstream or downstream properties that may be affected by the proposed activity	*Flood modelling undertaken for the site has determined that there are no increases in downstream floodplain depth and extents. Therefore, the activity is deemed to not increase any effects on public safety or existing property and any effects on public safety are considered low.*	low
(e) Any exacerbation of an existing flooding hazard risks or creation of a new flooding hazard risk;		
Describe results of investigation into any potential effects on other property if the activity results in diversion of flood flow or overland flow. Identify any new activity that results in an increase to the number of people exposed to an existing flood risk.	*The proposal does not change any external overland flow path, or the general function of the flood plain. No changes to neighbouring properties is intended. The proposal will not create any new flooding hazards.*	low
(h) the design and construction of buildings and structures to mitigate the effects of flooding		
Describe how the potential flooding effects identified above, determined by investigation and described in detail in a flooding report, will be mitigated by the design and materials of the building.	*The existing internal and external overland flow paths are an existing risk that is unaltered by the proposed development. Mitigation of the flood risk will be provided by way of a minimum freeboard provided in accordance with the Stormwater Code of Practice, Version 3, January 2022 above the flood levels. Therefore considered as low risk.*	low
(j) site layout and management to avoid or mitigate the adverse effects of flooding hazard, including access and exit during a flooding event;		
Describe how the potential flooding effects identified above, including any effects on upstream and downstream properties, determined by investigation and described in detail in a flooding report, will be mitigated by the design form of any structures and site works. Describe measures proposed to provide safe egress from property	*Same as item (h)*	low
(l) any measures and/ or plans proposed to mitigate the flooding hazard or the effects of the flooding hazard.		
Describe any other measures to mitigate the flooding hazard which can include information about future works planned by Auckland Council in the wider catchment that will reduce the flooding risk. Include any other measures to mitigate effects that are not described above.	*No additional measures proposed, as discussed above. The freeboards discussed above are in accordance with the Stormwater Code of Practice, Version 3, January 2022 are considered to mitigate and create a low-risk environment for the development.*	low

Appendix G

Healthy Waters Consultation

Minutes

Project: Drury Metropolitan Centre Stage 2 – Healthy Waters Meeting

Date: 12 December 2024

Time: 1:00-2:00pm

Location: Online via MS Teams

Attendees:

Name	Role/Organisation
Russell Butchers (RB)	Auckland Council
Masato Nakamura (MN)	CoLab Planning (on behalf of Auckland Council)
Carmel O'Sullivan (CO)	Auckland Council – Healthy Waters
Nicholas Vigar (NV)	Auckland Council – Healthy Waters
Tom Dawson (TD)	Auckland Council – Healthy Waters
Maria Baring (MB)	Auckland Council – Development Engineer
David Schwartfeger (DS)	Kiwi Property
Tony Osborne (TO)	Kiwi Property
Pranil Wadan (PW)	Woods
Colin Dryland (CD)	Woods
Jasmin Moll (JM)	Woods
Nick Roberts (NR)	Barker & Associates
Cosette Pearson (CP)	Barker & Associates

Item	Detail	Action
1	**Introductions**	
2	**Context Overview** DS provided an overview of the consented works surrounding the Stage 2 area (as shown in the presentation at **Attachment 1**): • Drury Centre Stage 1 consented under the COVID-19 fast-track process + an additional 8,000m^2 GFA; • Drury Access Ramp; and • Drury Centre Train Station and Interchange Facilities etc.	
3	**Drury Centre Stage 2** DS provided an overview of how the Drury Centre Stage 2 application will integrate with Stage 1 and the Drury Centre train station, providing a finer grained retail town centre leading towards	

	the train station. Stage 2 completes the development across the Kiwi Property owned site. DS provided overview of how the Stage 2 development integrates with the AUP zones and the Structuring Elements Precinct Plan. DS identified the two stormwater devices (wetlands) in the Stage 2 area – both of which will be privately owned and maintained (by Kiwi Property). The larger central wetland will be a central feature of the development, with a hotel and F&B wrapped around it. Part of this proposal includes the revegetation of the currently degraded Stream A (including daylighting the culverted section, planting and providing shading and maintaining base flows – will hopefully bring ecology back to the stream). Second stormwater wetland (along Hingaia) will also be privately owned and maintained).	
4	Stormwater Management Approach PW provided an overview of the two catchments which discharge to the Hingaia Stream and the Fitzgerald tributary (split). PW provided an overview of the two proposed wetlands within Stage 2 (1 in each catchment). PW noted that there is a mix of at source and communal mitigation PW noted that there are some public rain gardens proposed (managed road runoff at source) as a result of being unable to get this area to grade to the communal wetlands. PW noted that the flood management strategy is passing flows forward for Hingaia Stream and interim flood management is being worked through for the Fitzgerald and that pass flows forward here may be appropriate given the timings of the flows in the Hingaia and backwater as a result of timings with attenuated flows. PW confirmed the effects assessment will be assessed as per the currently operative stormwater code of practice (V3, June 2021), however a resilience assessment is being undertaken using 3.8degrees, also overland flows will also be designed for 3.8oc to ensure future resilience.	
5	Questions and Discussion Rain gardens – NV/RB noted that the preference from an AT perspective is that roads to be vested with AT do not have rain gardens included. This is noting the increased maintenance issues and costs associated with this form of at source treatment. It was also noted that regardless of the outcome of the Fast Track consent, whether such an asset could be vested would be dependent on AT as the asset owner. Wetlands are preferred. RB and MN advised that a detailed assessment and analysis demonstrating that rain gardens are the best practicable option (including life cycle costs) were typically required for such an approach. CD noted the	

	topographical constraints within the site and difficulty with getting water to the devices. NV queried if the raingardens were to be consolidated into a third smaller device (which would be AT/HWs preference) – where would these be located. PW confirmed Woods to go away and give this some consideration. RB noted that this has been listed as a referred project under FT and AC and AT will be invited to comment. CO queried whether the proposed culvert under the GSR carriageway is proposed to be built over? DS confirmed no, this is not part of this application and PW clarified that modelling has not allowed for this culvert upgrade being in place. NV queried where the rock shoot is located (below wetland 2). NV expressed HW's preference to flow to the old wetland and follow the natural OLFP as opposed to a structure. DS confirmed conversations are underway with NZTA and mana whenua about returning flows to the old wetland and reinvigorating it through the feeding of water. DS queried how the SMP is progressing, CO confirming this is sitting on her desk currently marking up comments. PW noted that more detailed work is being undertaken, and demonstration of the flood management for flows discharging to the Fitzgerald will be covered in the reporting – PW happy to take HW's team through this. CO expressed that the reduced number of devices is preferred and acknowledged effort to minimise number of devices for this development.	

Appendix H

Mana Whenua engagement

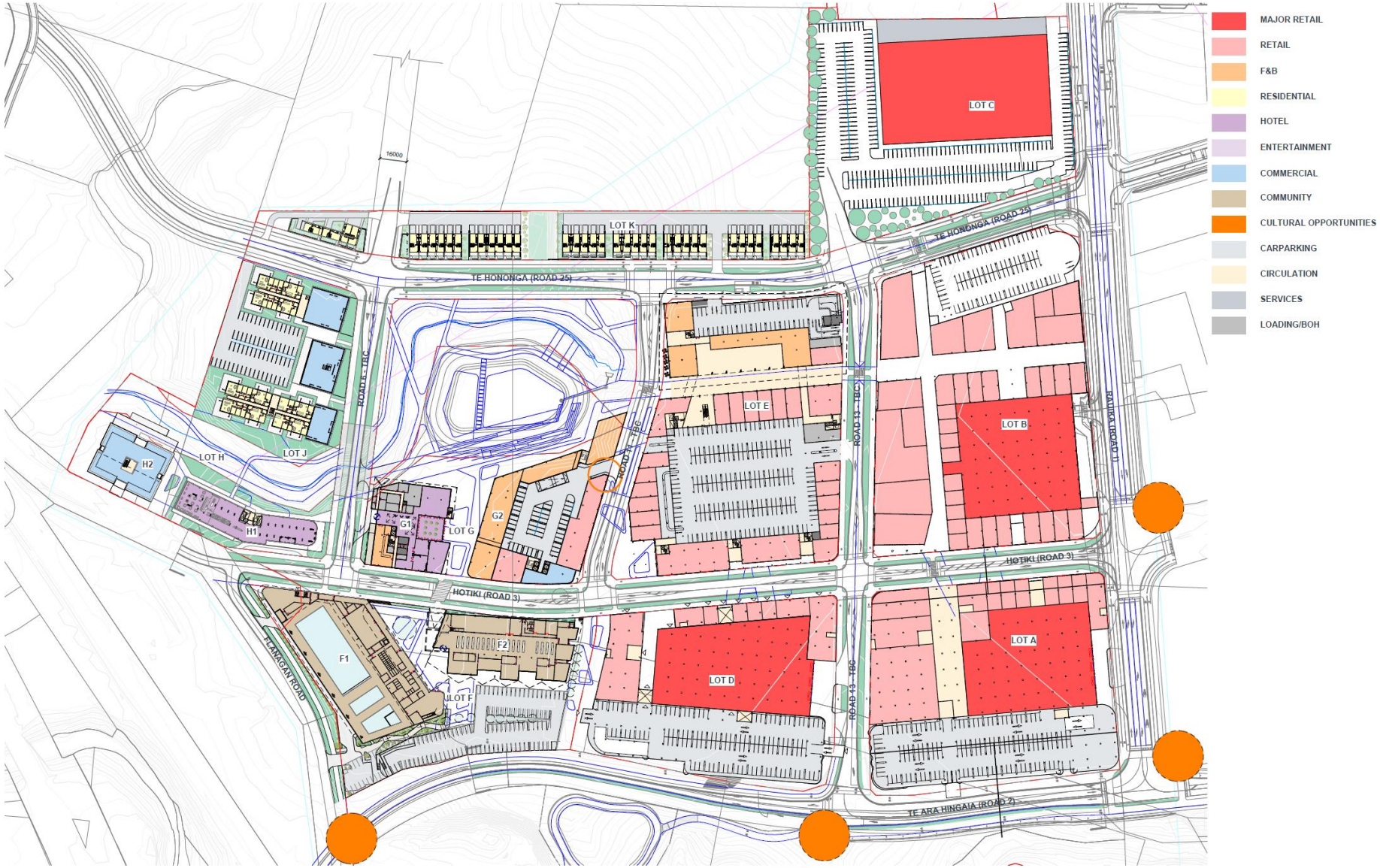
Kiwi Property – Drury Metropolitan Centre (Stage 2)

Ngaati Te Ata Waiohua Pre-Lodgement Workshop Hui

12 March 2025

B&A

Urban & Environmental



Drury Centre Stage 2 – Masterplan

B&A
Urban & Environmental

Drury Centre Stage 2 – WIP Render

B&A
Urban & Environmental

Boffa Miskell

DRURY METROPOLITAN CENTRE | STAGE 2 LANDSCAPE

HUI WITH NGAATI TE ATA WAIOHUA

MARCH 2025

KEY DESIGN MOVES

ROAD HIERARCHY AND LANDSCAPE DESIGN RESPONSE

Integrating streetscapes to reflect functionality, connectivity, and community character.

GREEN LINKAGES AND ENVIRONMENTAL NETWORK

Connecting recreation, sustainability, and ecology through an integrated green network.

STAGE 2 LANDSCAPE MASTERPLAN

DRURY EAST OVERARCHING CULTURAL NARRATIVE

COLLABORATIVELY DEVELOPED BY THE DRURY EAST MANA WHENUA GROUP

Connection and Meetings

The design will recognise the site's historical role as a place of gathering, trade, and interaction, recognising key paa and papakaainga sites, and seasonal settlements that illustrate the region's function as a hub for social and cultural exchange.

Water Health Mauri

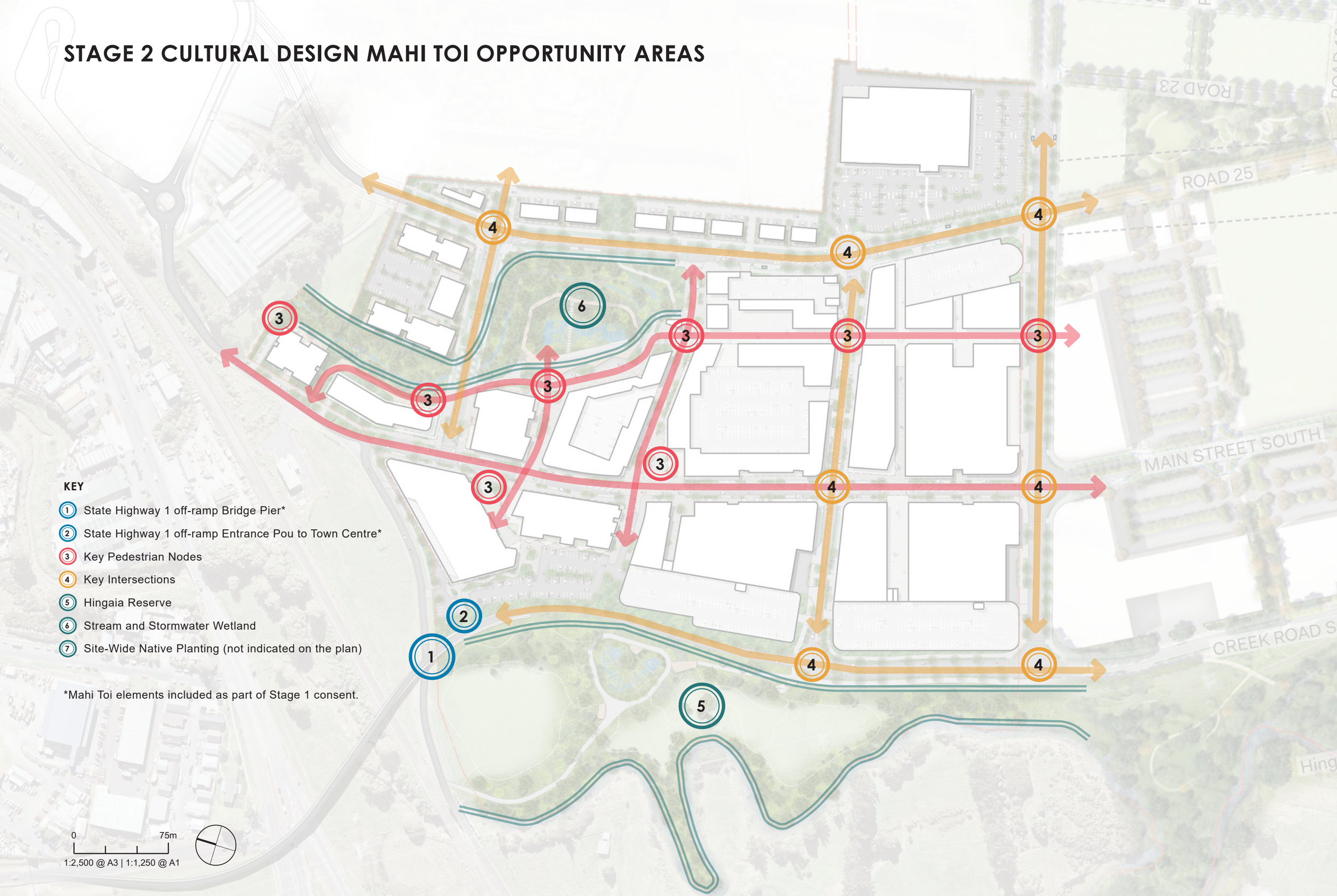
Waterways are central to the Drury East Plan Changes, both historically and today. The design will prioritise the health of the awa and repo, ensuring they are protected and celebrated as sources of mahinga kai, trade opportunities, and spiritual connection.

Movement

Reflecting on the area's history as a network of transport routes, the design will incorporate elements that honour movement through the landscape.

NOT TO SCALE

STAGE 2 CULTURAL DESIGN MAHI TOI OPPORTUNITY AREAS



KEY

1. State Highway 1 off-ramp Bridge Pier*
2. State Highway 1 off-ramp Entrance Pou to Town Centre*
3. Key Pedestrian Nodes
4. Key Intersections
5. Hingaia Reserve
6. Stream and Stormwater Wetland
7. Site-Wide Native Planting (not indicated on the plan)

*Mahi Toi elements included as part of Stage 1 consent.

0 75m

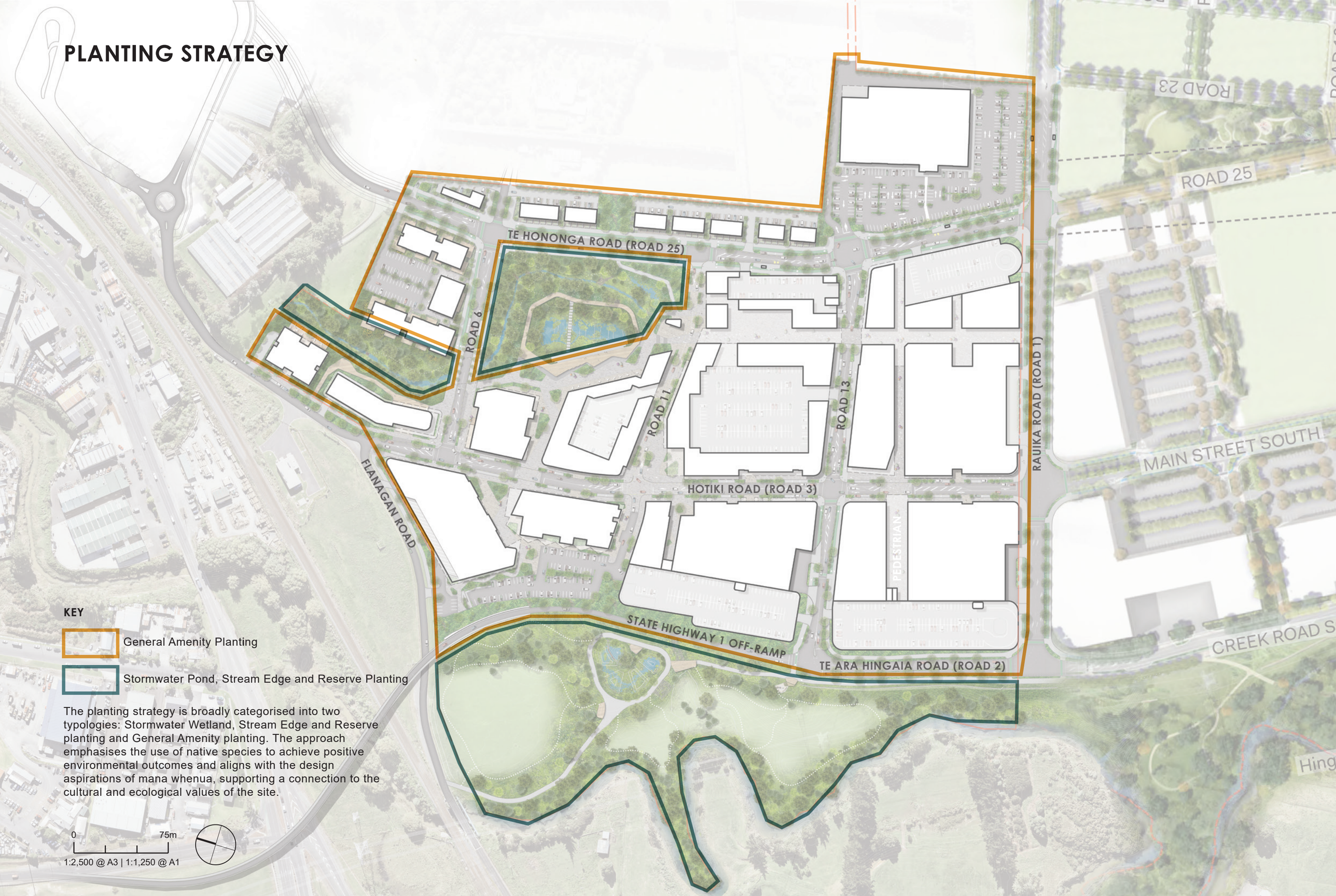
1:2,500 @ A3 | 1:1,250 @ A1

STAGE 2 CULTURAL DESIGN PRECEDENT IMAGES

Boffa Miskell

PLANTING STRATEGY

PLANTING STRATEGY



KEY

General Amenity Planting

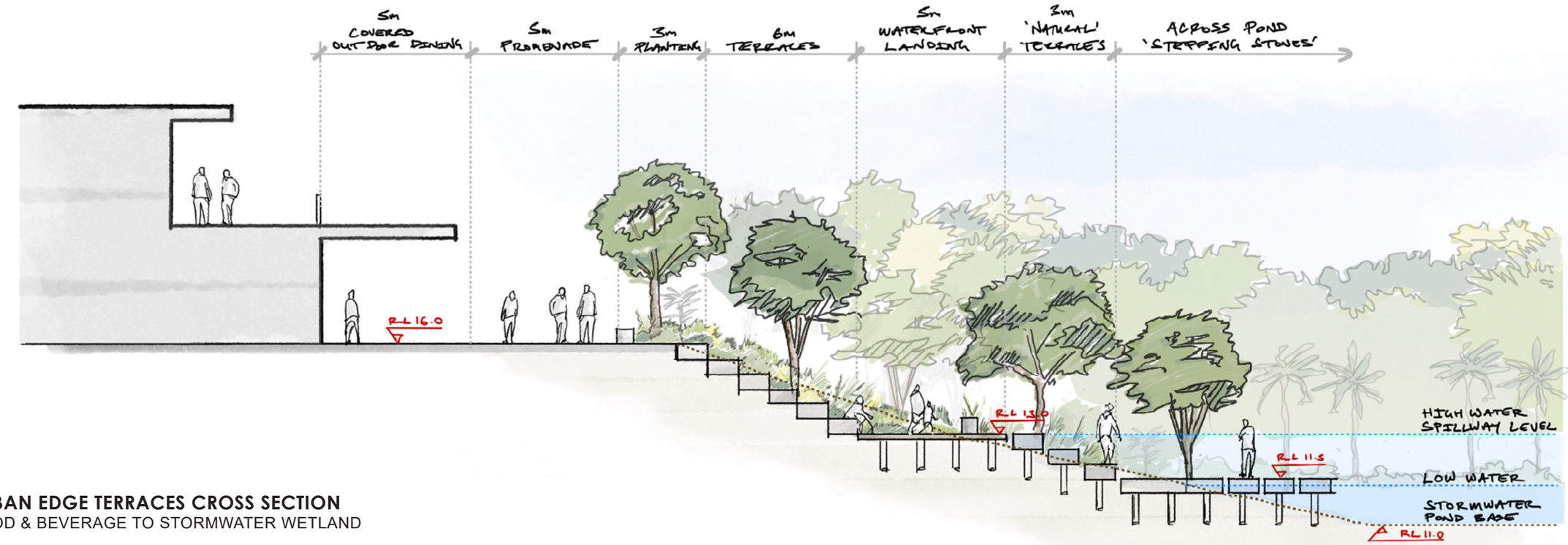
Stormwater Pond, Stream Edge and Reserve Planting

The planting strategy is broadly categorised into two typologies: Stormwater Wetland, Stream Edge and Reserve planting and General Amenity planting. The approach emphasises the use of native species to achieve positive environmental outcomes and aligns with the design aspirations of mana whenua, supporting a connection to the cultural and ecological values of the site.

0 75m

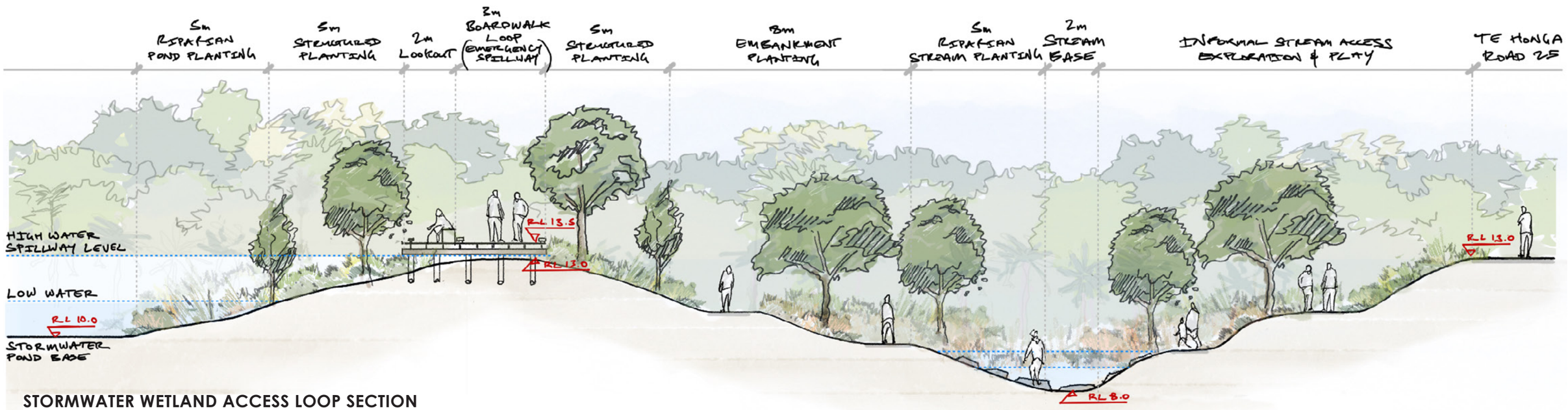
1:2,500 @ A3 | 1:1,250 @ A1

CROSS SECTION EXPLORATIONS



URBAN EDGE TERRACES CROSS SECTION
FOOD & BEVERAGE TO STORMWATER WETLAND

1:75 @ A1 ; 1:150 @ A3



STORMWATER WETLAND ACCESS LOOP SECTION
STORMWATER WETLAND TO STREAM

1:75 @ A1 ; 1:150 @ A3

INDICATIVE PLANTING PALETTE

STORMWATER POND, STREAM EDGE AND RESERVE : TREES

TREES

Cordyline australis
tī kōuka

Corynocarpus laevigatus
karaka

Dacrycarpus dacridioides
kahikatea

Geniostoma ligustrifolium
hangehange

Kunzea robusta
Kānuka

Leptospermum scoparium
mānuka

Melicytus ramiflorus
māhoe

Plagianthus regius
ribbonwood

Podocarpus totara
tōtara

Pseudopanax arboreus
Five Finger

Rhopalostylis sapida
nikau

Schefflera digitata
pate

Sophora microphylla
kōwhai

Vitex lucens
puriri

INDICATIVE PLANTING PALETTE

STORMWATER POND, STREAM EDGE AND RESERVE : SHRUBS AND GROUNDCOVERS

SHRUBS AND GROUNDCOVERS

Austroderia fulvida
toetoe

Blechnum novae-zealandiae
kiokio

Carex dissata
forest sedge

Carex germinata
rautahi

Carex lessoniana
rautahi

Carex secta
purei

Carex virgata
pukio

Coprosma propinqua
mingimingi

Coprosma robusta
karamu

Coprosma tenuicaulis
hukihuki

Cyperus ustulatus
giant umbrella sedge

Daniella nigra
inkberry

Eleocharis acuta
sharp spike sedge

Eleocharis spacelata
kuta

Geniostoma ligustrifolium var. ligustrifolium
Hangehange

Machaerina articulata
jointed twig rush

Machaerina rubiginosa
baumea

Phormium cookianum
whaririki

INDICATIVE PLANTING PALETTE

STORMWATER POND, STREAM EDGE AND RESERVE : SHRUBS AND GROUNDCOVERS

SHRUBS AND GROUNDCOVERS

Phormium tenax
harakeke

Schoenoplectus tabernaemontani
lake clubrush

Typha orientalis
raupō

Veronica stricta
koromiko

Aceana inermis purpurea
Purple Bidibidi

Coprosma acerosa
sand dune coprosma

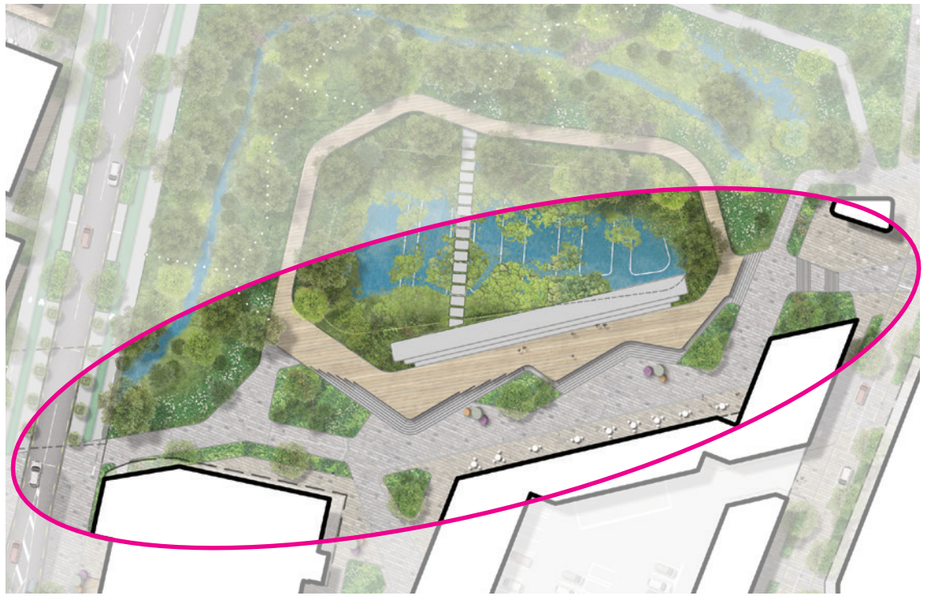
Lobelia angulata
pānakenake

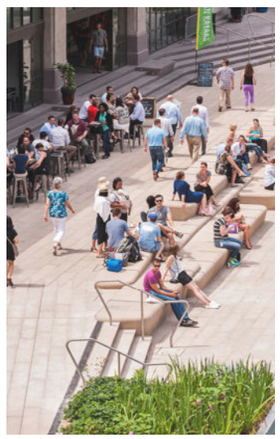
Muehlenbeckia complexa
pohuehue

Boffa Miskell

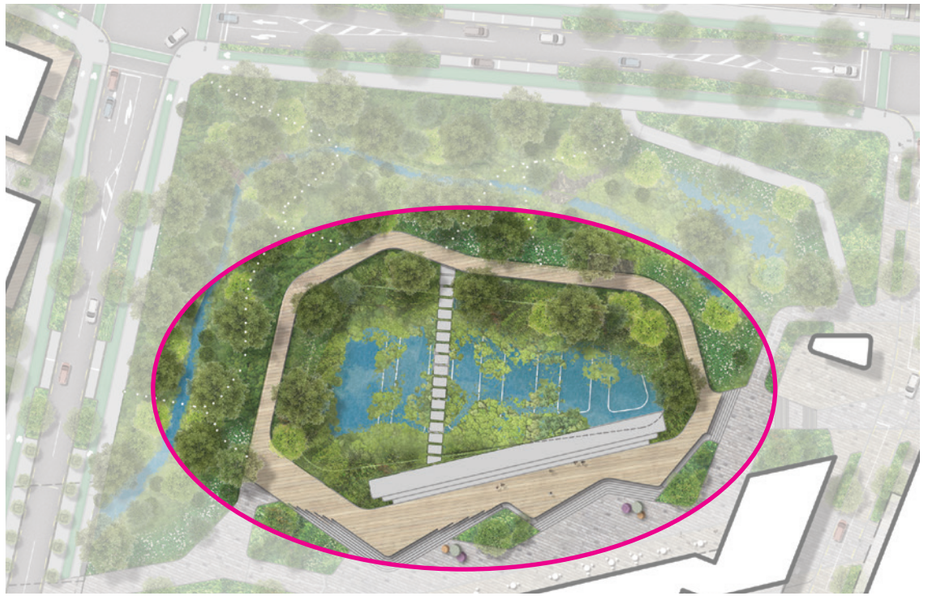
PRECEDENT IMAGES

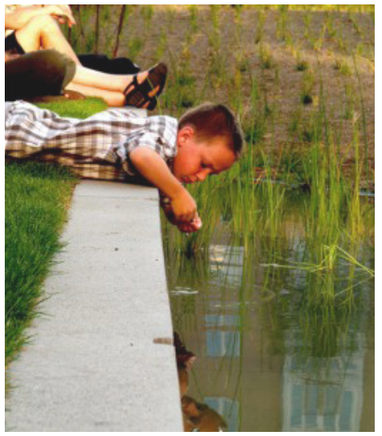
PROMENADE



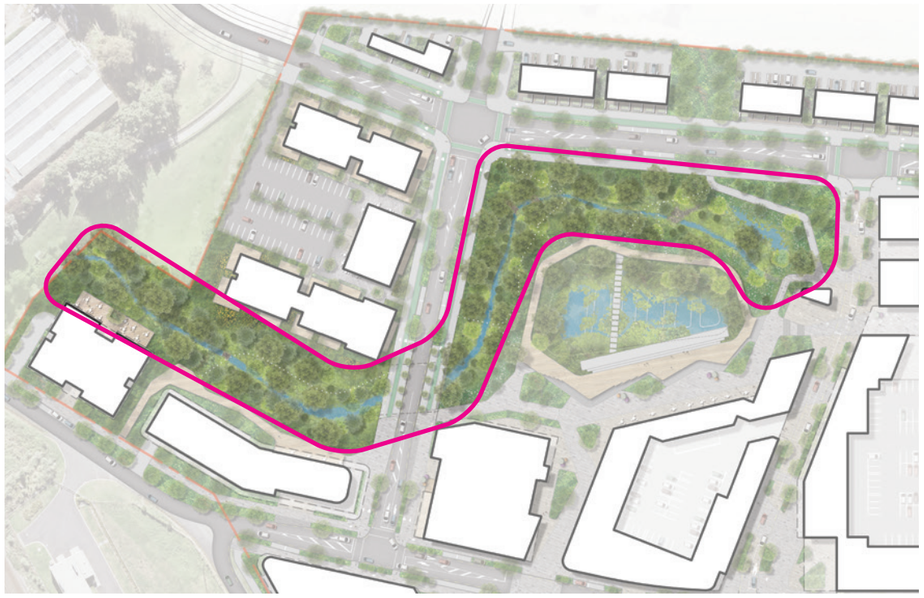


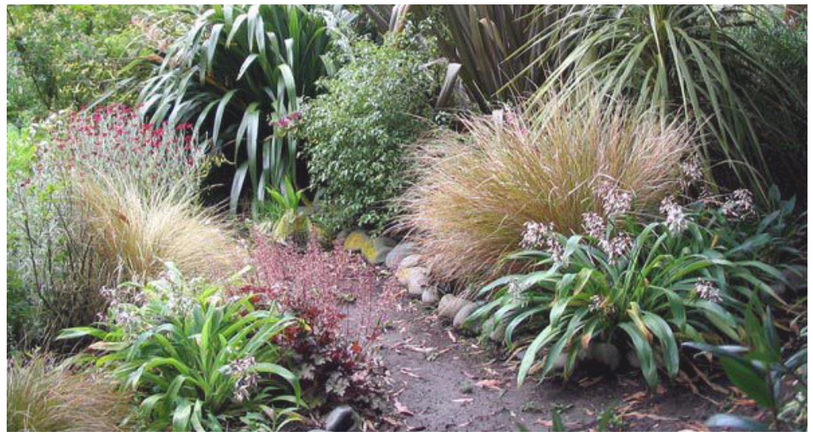
STORMWATER WETLAND





STREAM EDGE LANDSCAPE





Drury Centre Stage 2 - Stormwater

Kiwi Property Group Ltd

10/03/2025

Agenda

- Stormwater management requirements
- Proposed stormwater management
  - Area 1
  - Area 2

Stormwater management requirements

Water quality treatment

- Eliminating and minimising the generation of contaminants for all contaminant generating impervious areas
- Treatment of all impervious areas by a stormwater management device designed in accordance with GD01/TP10

Stream hydrology:

- The site is located within a Stormwater Management Area Flow (SMAF) overlay
- Achieve equivalent hydrology to pre-development (grassed state) level
    - Provide retention (volume reduction, stormwater re-use)
    - Provide detention (temporary storage)

Flooding – Property/pipe capacity 10% AEP event

- Ensure sufficient capacity in downstream network
- Proposed network within development area will be designed in accordance with Auckland Council Stormwater Code of Practice

Flooding – Building 1% AEP event

- Ensuring development manages flooding effects so as to not worsen flood risk to people and property upstream or downstream of the Precinct
- To be developed to Auckland Council Stormwater Code of Practice

Proposed stormwater management

- Stormwater requirements are in accordance with the NDC, AUP and the Drury Centre and Drury East SMP
- Two stormwater management Areas
  - Area 1 drains to Stream A / Fitzgerald Stream (~14.6ha)
  - Area 2 drains to Hingaia Stream (~9.7ha)
- Two private wetlands, 8 private raingardens and on public raingarden are proposed for Water Quality treatment and SMAF 1 Hydrology Mitigation
- A mix of at source treatment is proposed for remaining hardstands and roofed areas

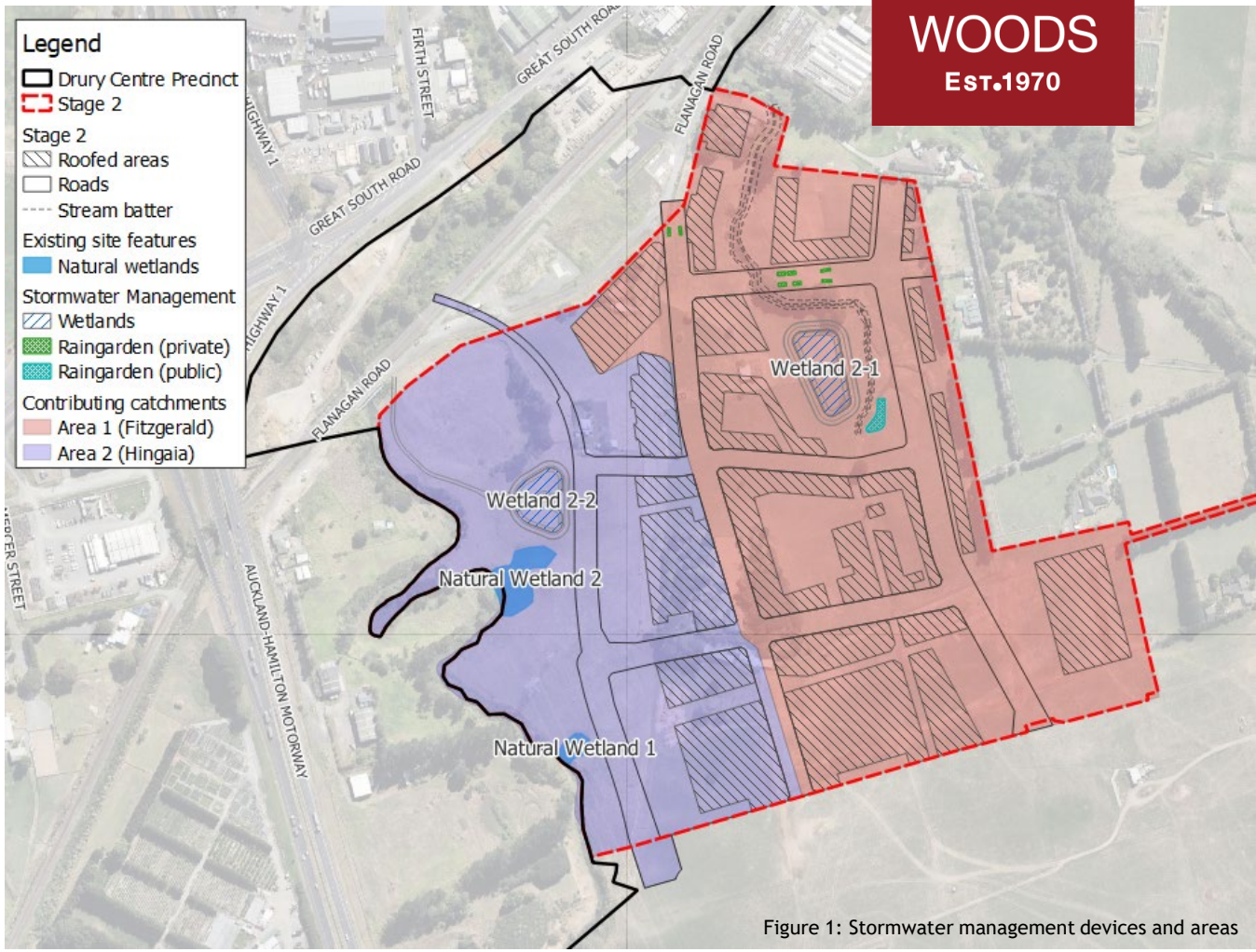


Figure 1: Stormwater management devices and areas

Proposed stormwater management

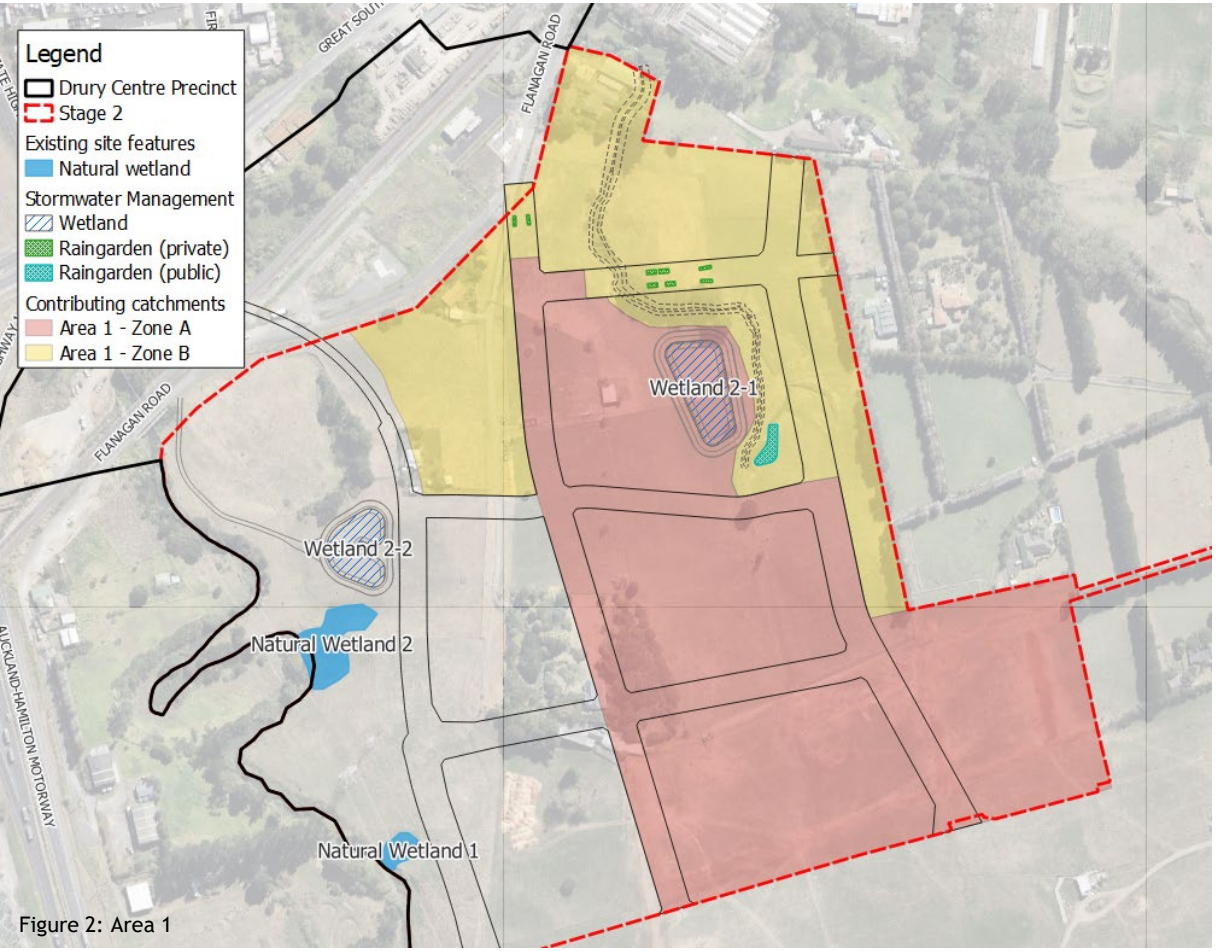


Figure 2: Area 1

Area 1

- Drains to Stream A/Fitzgerald Stream

Zone A

- Private and public roads, hardstands and roofed areas to be treated in private Wetland 2-1

Zone B

- Private roads to be treated in private Raingardens
- Public roads to be treated in communal public Raingarden
- Hardstands and roofed areas to be treated at source

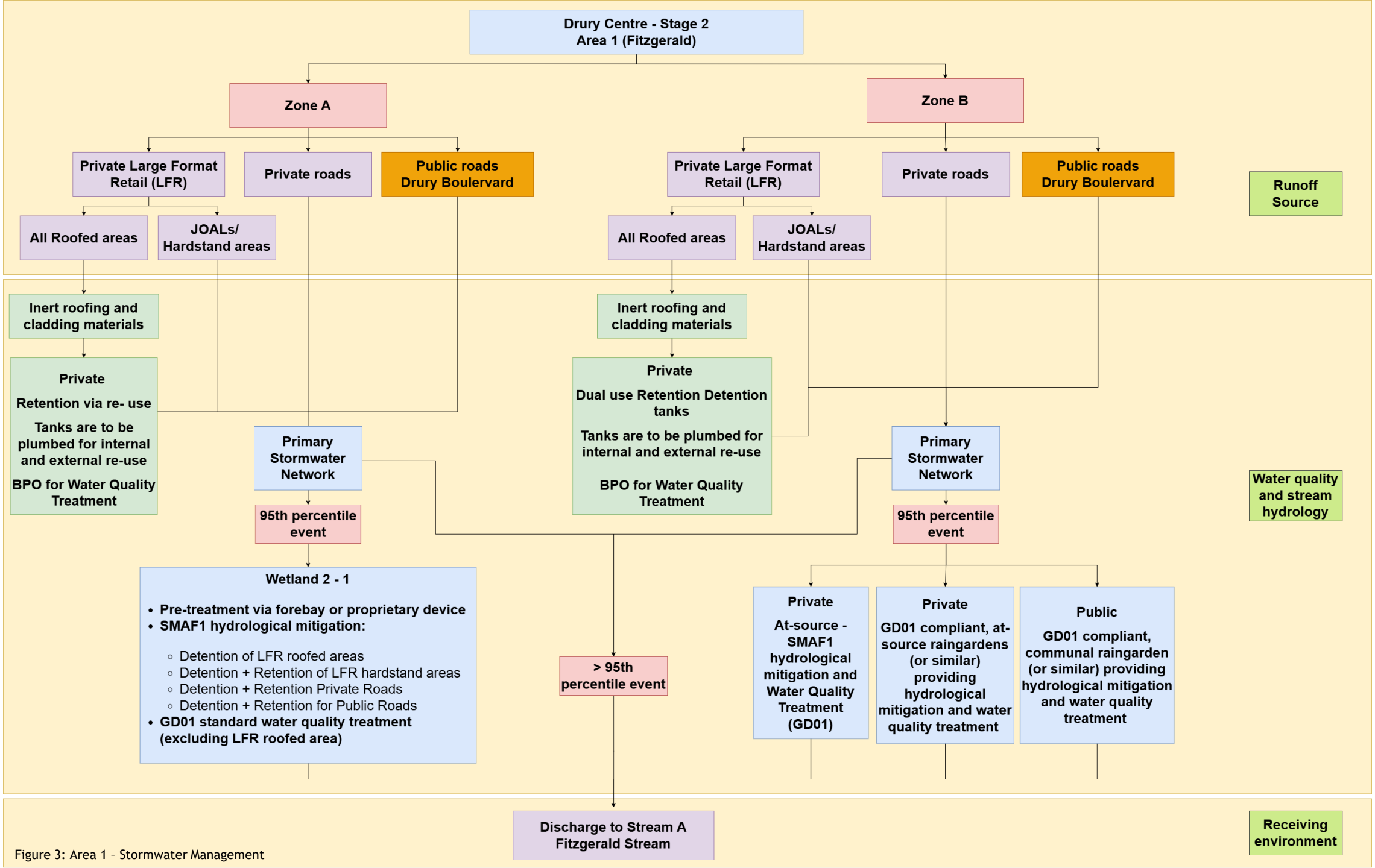


Figure 3: Area 1 – Stormwater Management

Proposed stormwater management

Wetland 2-1

- Sized to provide water quality and SMAF 1 mitigation volumes for Zone A (Area 1) in accordance with GD01
- Upstream Gross Pollutant Trap (GPT) proposed
- Wetland outlet discharges to the top of Stream A up to the 95th percentile storm event
- Storm events >95th percentile bypass the wetland and discharge straight to Stream A

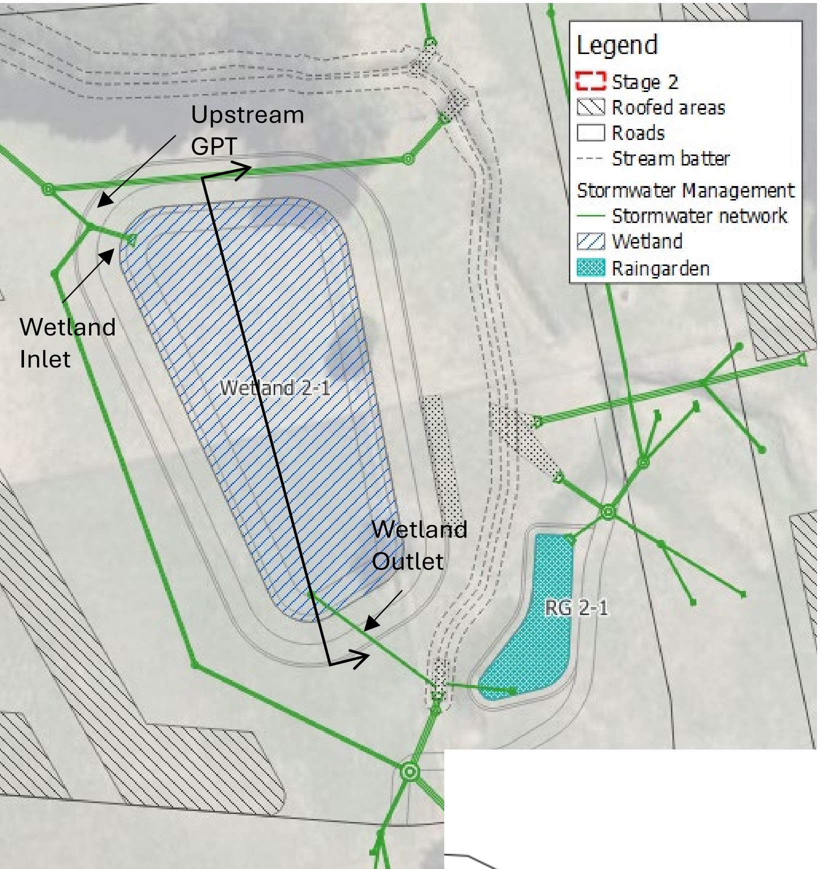


Figure 4: Wetland 2-1

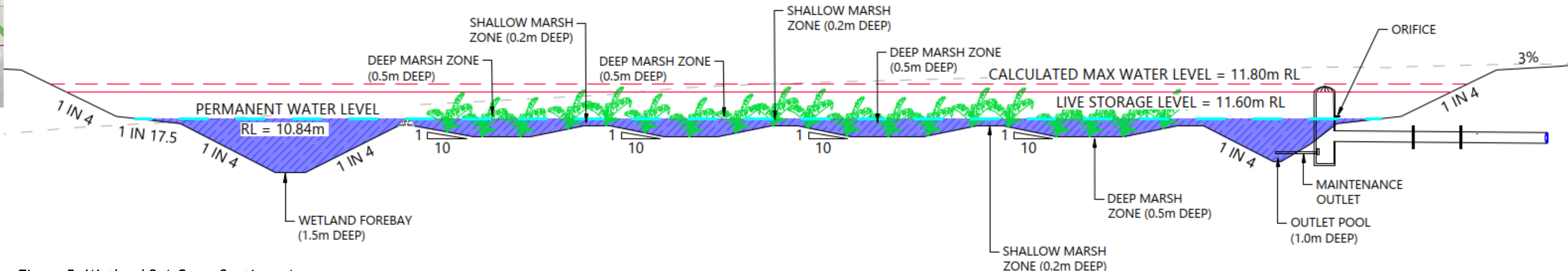


Figure 5: Wetland 2-1 Cross-Section - A

Proposed stormwater management

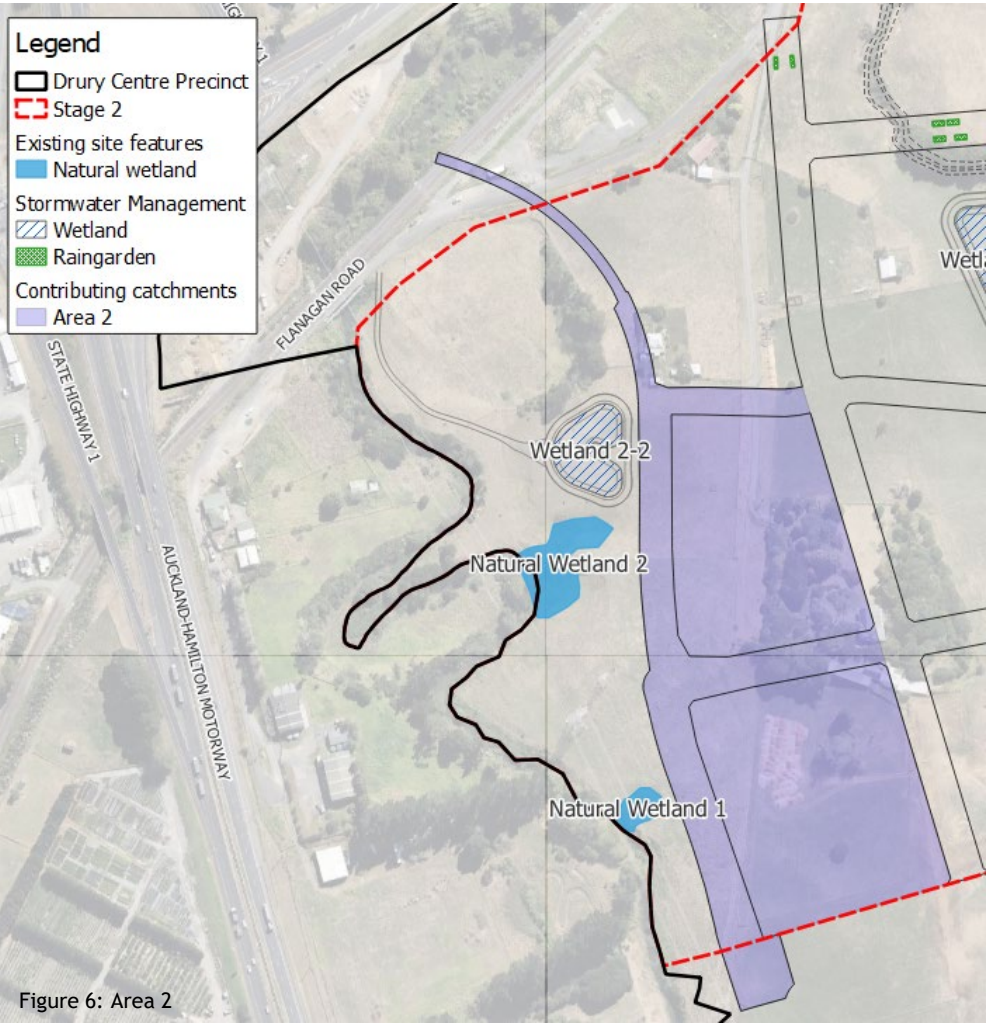


Figure 6: Area 2

Area 2

- Drains to Hingaia Stream
- Private and public roads and hardstands to be treated in private Wetland 2-2
- Roofed areas to be treated at source

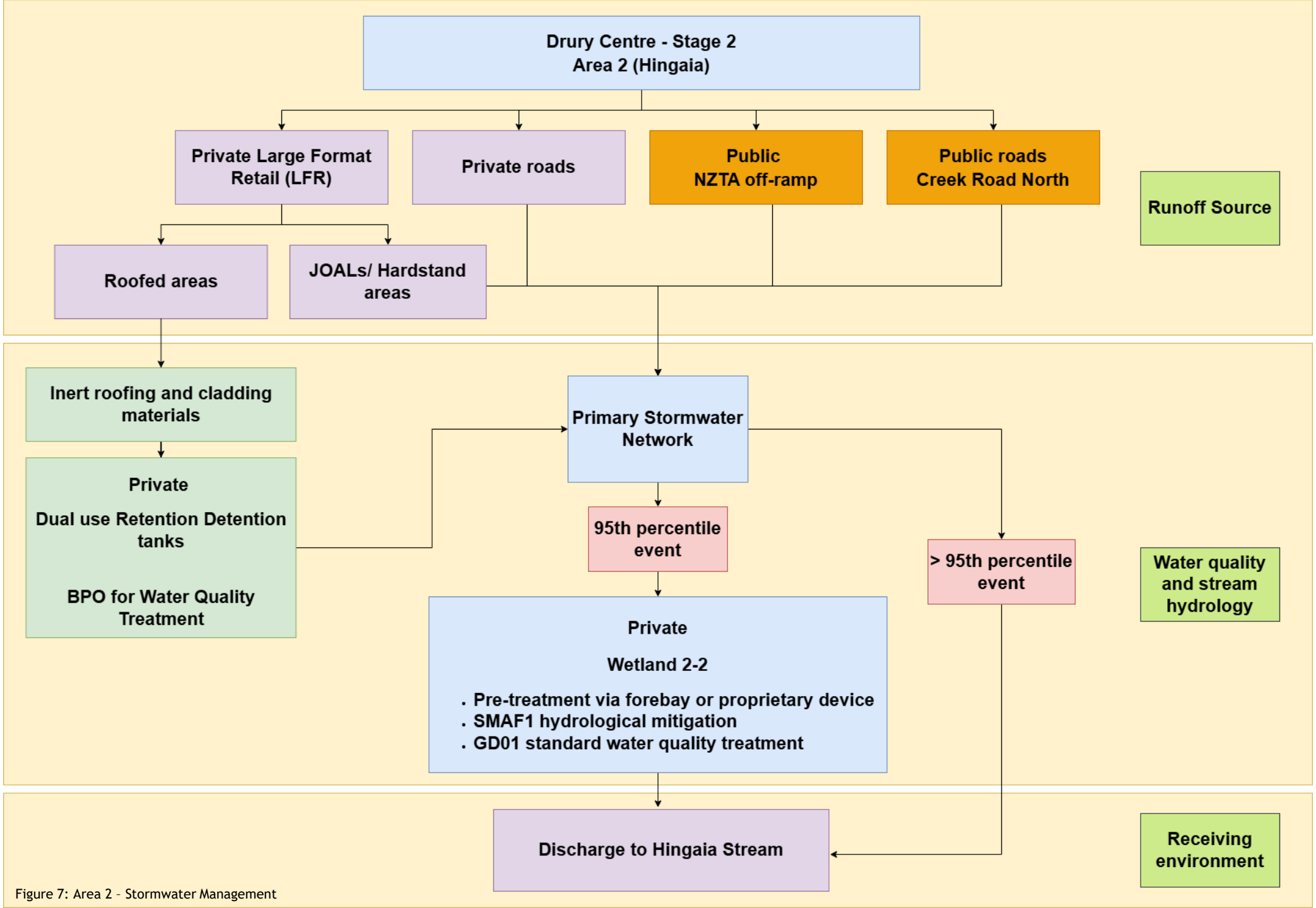


Figure 7: Area 2 – Stormwater Management

Proposed stormwater management

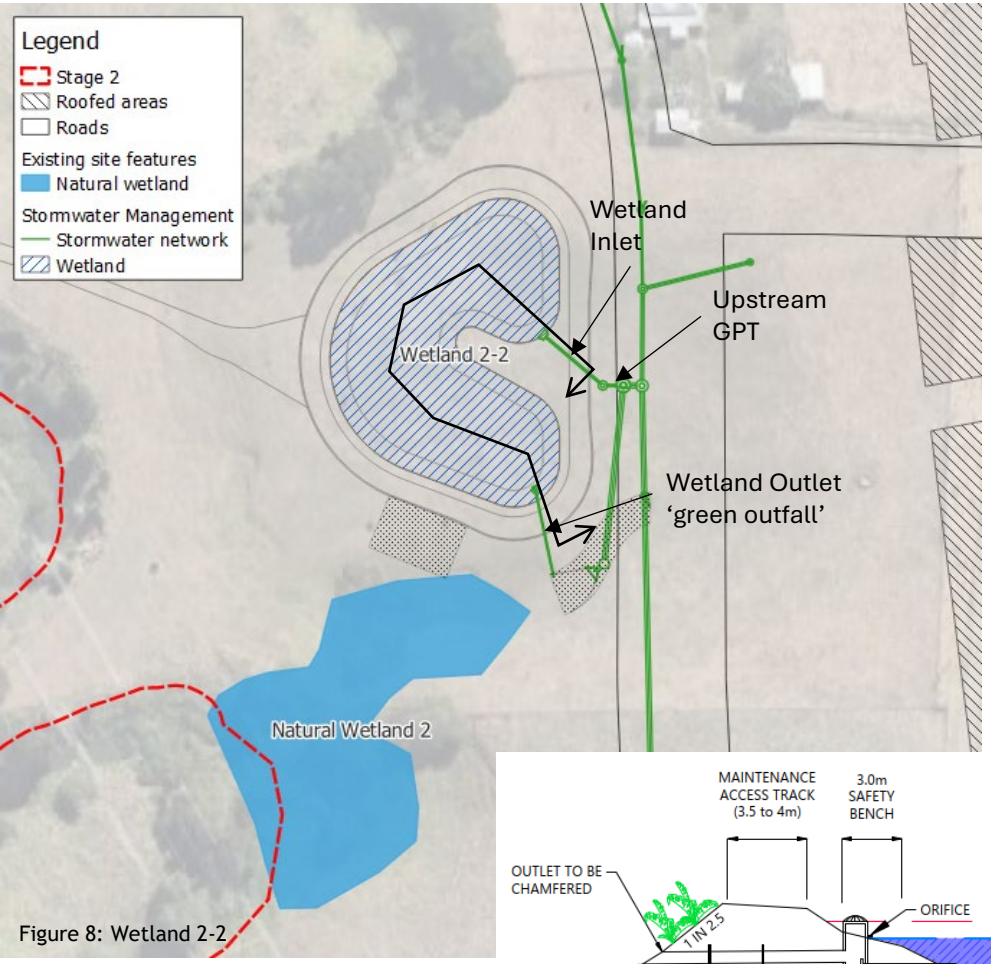


Figure 8: Wetland 2-2

Wetland 2-2

- Sized to provide water quality and SMAF 1 mitigation volumes for Area 2 in accordance with GD01
- Upstream Gross Pollutant Trap (GPT) proposed
- Wetland outlet discharges to the existing natural wetland up to the 95th percentile storm event
- 'Green outfall' is proposed
- Storm events >95th percentile bypass the wetland and discharge directly to existing natural wetland

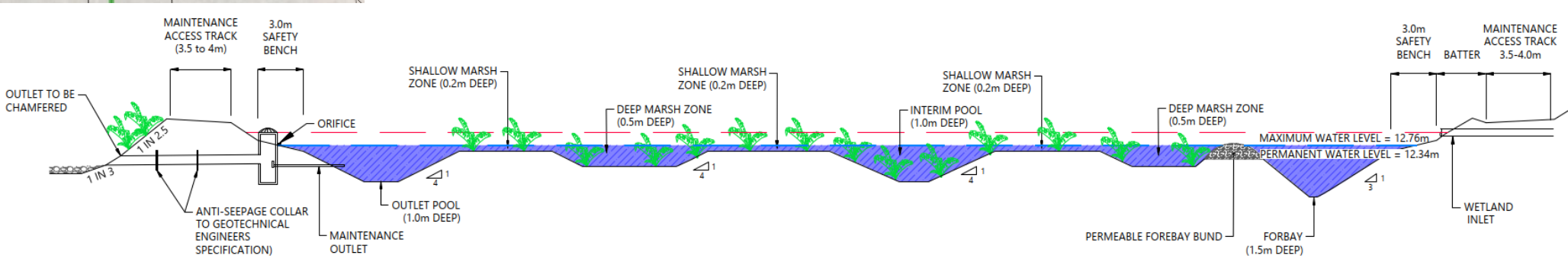
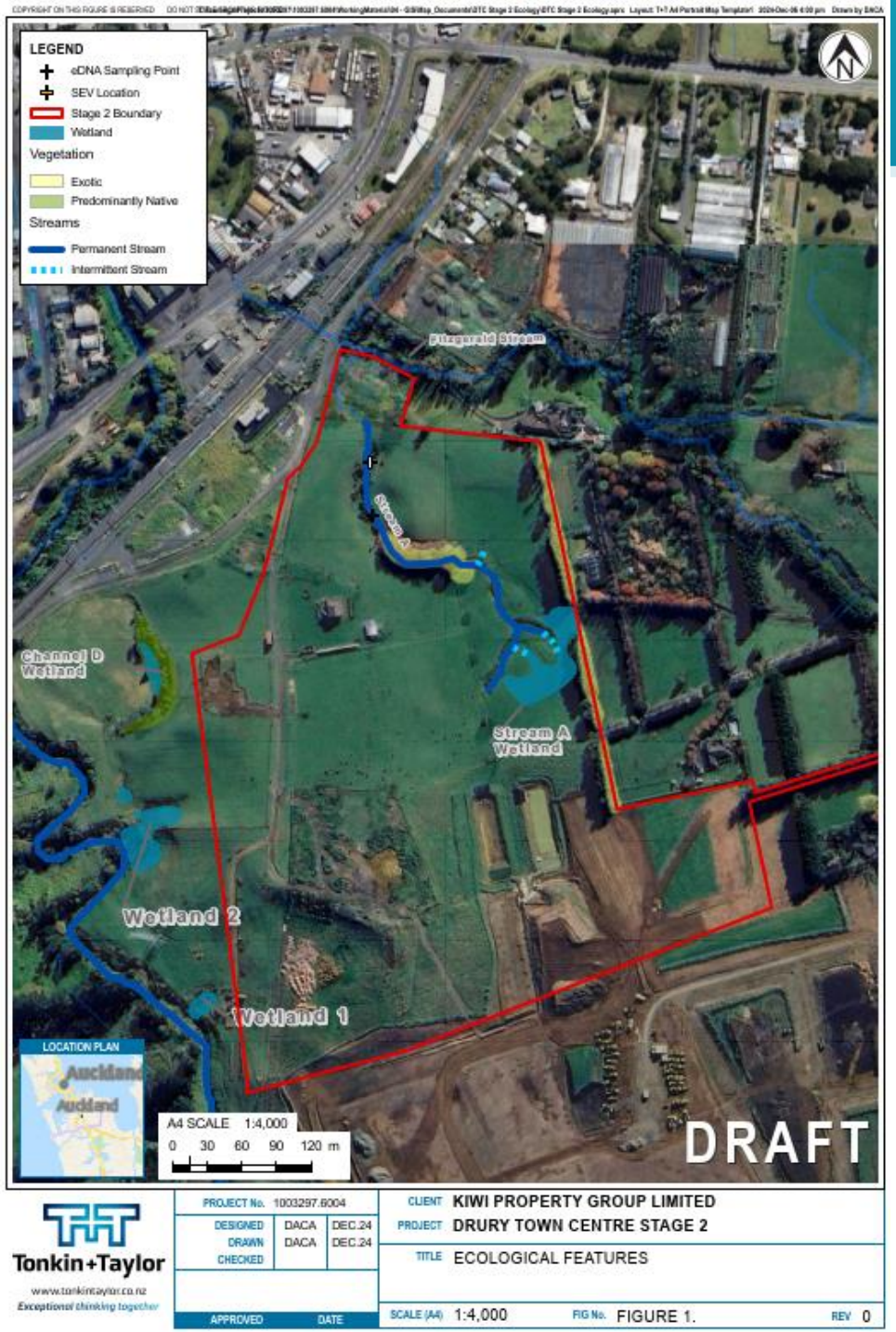


Figure 9: Wetland 2-2 Cross-Section - C

Drury Metropolitan Centre Stage 2 - Ecology

Kiwi Property Group Ltd

Tonkin+Taylor



Ecological features

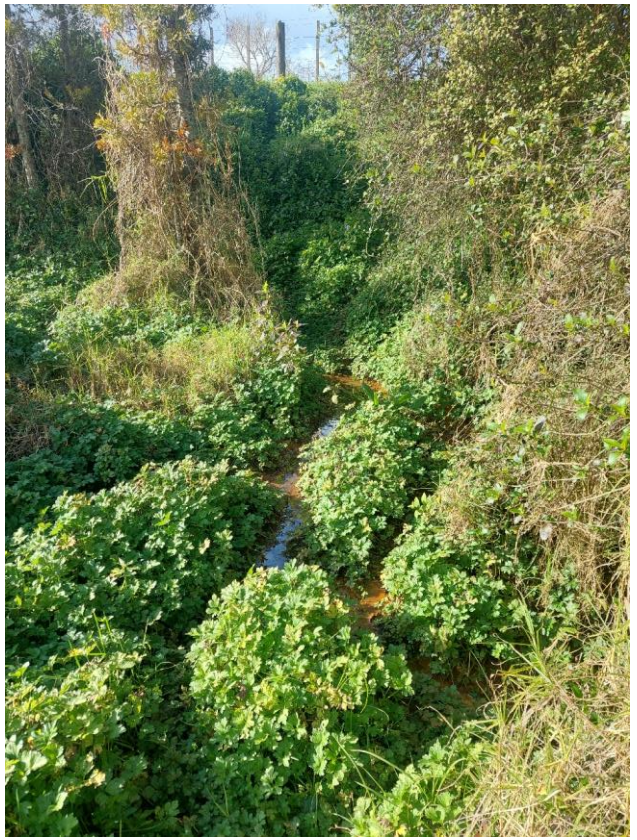
- Site assessments 2018 – 2024
- Agricultural land, minimal areas of terrestrial vegetation
- Located in lower reaches of Hingaia Stream catchment.
- Discharges to Drury Creek and the Pāhurehure Inlet (marine SEAs)

Hingaia Stream

Wetlands along Hingaia Stream

Wetland 1

Wetland 2

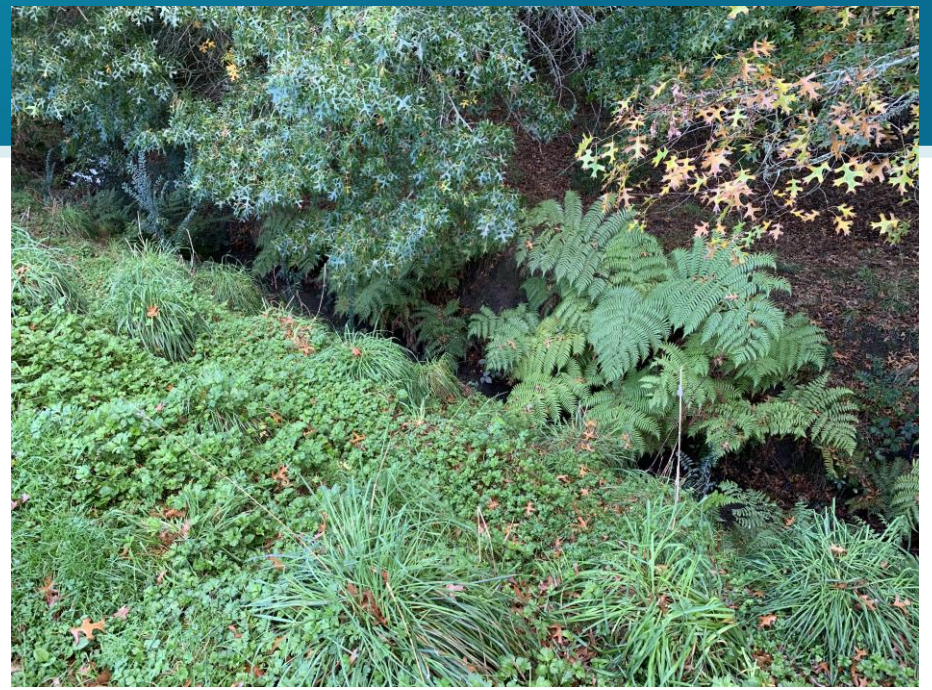


Channel D Wetland

Headwaters - Stream A

Upper Stream A

Stream A - mid reaches

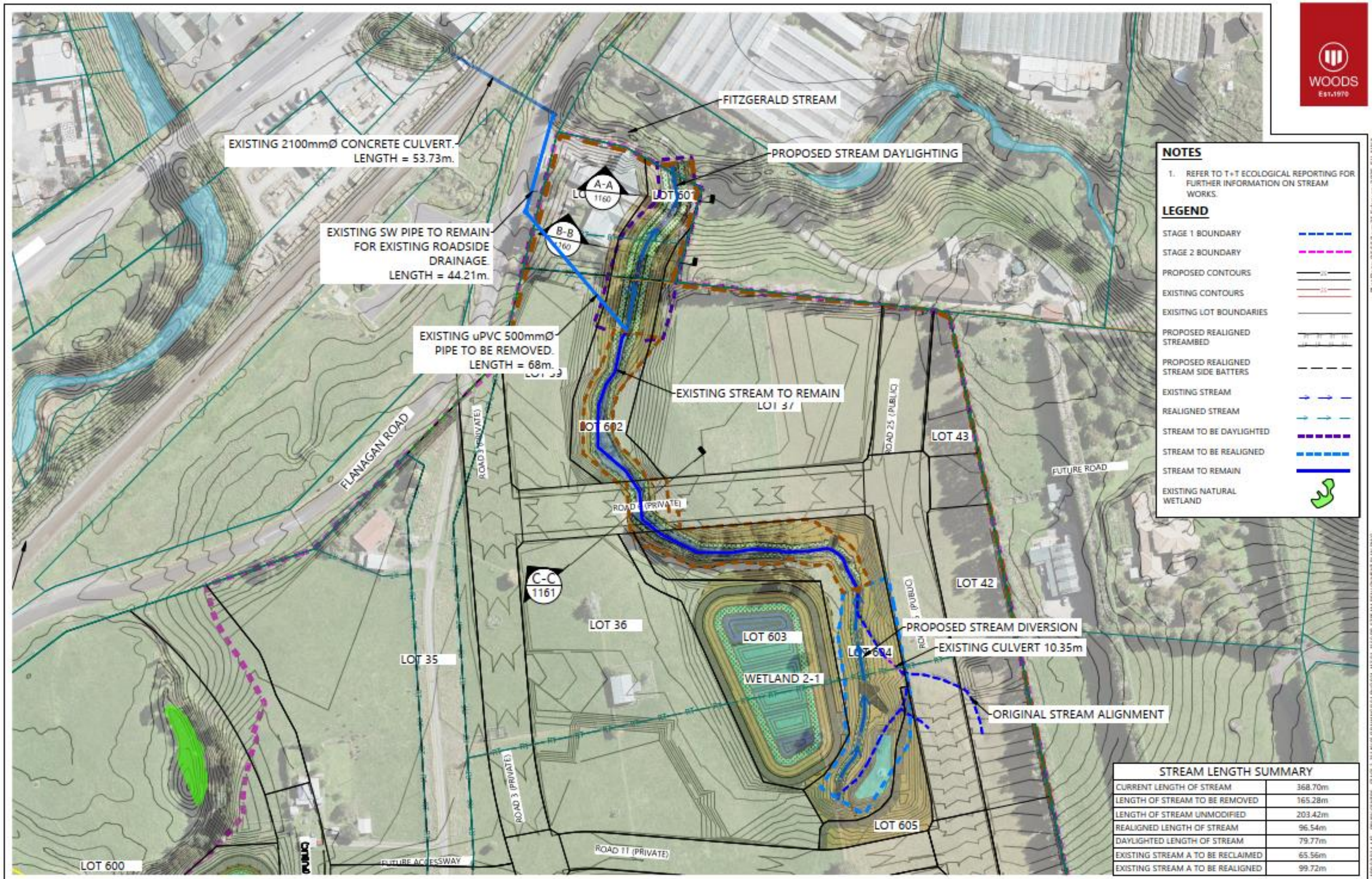


Stream A - lower reaches

Stream A Wetland

Proposed Works

- Works within/within proximity of wetlands
  - Earthworks within 10 or 100 m of Hingaia Stream Wetlands
  - Reclamation of Stream A Wetland
- Stream modification
  - Daylighting lower reaches of Stream A
  - Re-aligning upper reaches of Stream A
  - Reclamation of tributaries of upper Stream A
- Modification of flows to Stream A



STREAM LENGTH SUMMARY	
CURRENT LENGTH OF STREAM	368.70m
LENGTH OF STREAM TO BE REMOVED	165.28m
LENGTH OF STREAM UNMODIFIED	203.42m
REALIGNED LENGTH OF STREAM	96.54m
DAYLIGHTED LENGTH OF STREAM	79.77m
EXISTING STREAM A TO BE RECLAIMED	65.56m
EXISTING STREAM A TO BE REALIGNED	99.72m

REVISION DETAILS		INT	DATE	SURVEYED	
3	STREAM LENGTHS ADDDED TO PLAN	SF	22/01/24	DESIGNED	EW
4	ADDITIONAL STREAM LENGTHS ADDED TO PLAN	SF	22/01/24	DRAWN	EW
5	ISSUED FOR 99% SUBMISSION	MF-E	10/02/25	CHECKED	GW
6	ISSUED FOR FAST TRACK CONSENT	EW	21/02/25	APPROVED	CD

BUILDING B, LEVEL 1
8 NUGENT ST, GRAFTON,
AUCKLAND 1023
+64 9 308 9229
WOODS.CO.NZ

Kiwi Property

DRURY CENTRE-STAGE 2

STREAM WORKS
LAYOUT PLAN

STATUS	FOR FAST TRACK CONSENT	REV
SCALE	1:1500 @ A3	6
COUNCIL	AUCKLAND COUNCIL	
DWG NO	P24-447-01-1151-DR	

Effects management measures

- Erosion and sediment controls
- Removal of existing fish passage barriers within Stream A and arch culvert for new road crossing
- Creation of new stream length (176 m/247 m^2) comprising realigned and daylighted open channel
- Riparian planting along stream length
- Stormwater quality and quantity management via stormwater devices
- Baseflow provision to Stream A via subsoil drainage and stormwater devices
- Native Fish Relocation Plan, Bat Management Plan, Avifauna Management Plan and Lizard Management Plan

- Overall low or very low level of ecological effect for most ecological values

- Residual adverse effects not addressed:
  - Loss of 2,172 m^2 natural inland wetland
  - 48 m^2 open stream channel and 56 m^2 piped stream

Stream A

- The proposal does result in a net loss of ecological values and extent of Stream A.

Mana Whenua Principles achieved by the proposal:

- Base Flows maintained;
- Maintain natural route of the stream and topography;
- Excellent stormwater outcomes;
- Native riparian planting;
- Enhanced amenity; and
- Improved fish passage.

Stream A Wetland

- The proposal includes the reclamation of 2172 m2 of degraded natural inland wetland, which was agreed at on-site with mana whenua to have low ecological value.
- This wetland could not be retained due to the location of the road, required by the Drury Centre Precinct.
- In addition, the change of impervious surface across the site would have impacted the hydrological function of this wetland if retained.

- The proposal includes a new stormwater wetland at the head of Stream A, which will be planted, provide high amenity to the heart of the centre and will ensure base flows are maintained within Stream A. This will provide some ecological function (however it is a treatment device as opposed to ecological offset).
- In addition, wetland 1 and wetland 2 along the Hingaia Awa are being restored and enhanced.