WOODS

STORMWATER MANAGEMENT PLAN

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W-REF	P25-496
FOR	CDL Land New Zealand Limited
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Statement of Qualifications & Experience

The following is a statement of the qualifications and experience of the experts involved in preparing this Report.

Ricky Kiddle – Intermediate Engineer, Wood & Partners Consultants Limited

I am an Intermediate 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 February 2024.

I hold the qualifications of Bachelor of Engineering with Honours from the University of Canterbury, which I completed in 2023. I am an Engineering NZ emerging professional member. I have 2 years of professional experience in the water engineering field. My experience includes stormwater management, flood management, and stormwater modelling.

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.

Sakti Gounder – Senior Associate, Wood & Partners Consultants Limited

I am a Senior Associate Engineer in the Water Infrastructure and Planning team at Woods. Woods is a multi-disciplinary consultancy specialising in planning, urban design, engineering, water infrastructure and surveying. I have been employed at Woods since 2023.

I hold a Bachelor of Engineering degree from the University of Auckland, which I completed in 2010. I am a Chartered Professional Engineer (CPEng) and a Chartered Member of Engineering New Zealand (CMEngNZ) and Water New Zealand.

I have over 15 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 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.

Timothy Rickards – Principal Engineer, Wood & Partners Consultants Limited

I am a Principal Civil 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 Feb 2013.

I hold the qualifications of Bachelor of Engineering (Technology), which I completed in 2008. I am a Chartered Professional Engineer of Engineering New Zealand.

I have 20 years of professional experience in the engineering industry. My experience includes the design and construction observation of a range of land development projects, including the design of large-scale stormwater systems, stormwater management devices and overland flow paths as well as undertaking flood risk assessments and flooding effects assessments.

I confirm that, in my capacity as the reviewer/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.

1.0 Introduction

This Stormwater Report has been prepared by Woods on behalf of CDL Land New Zealand Limited (CDL | the Applicant) in support of a Substantive Application for the Middle Road Project under the Fast-track Approvals Act 2024 (FTAA) to be lodged with the Environmental Protection Agency (EPA).

The Project comprises a comprehensively planned residential development of approximately 317 lots, supported by integrated transport, three waters infrastructure and open space, including stormwater management designed in accordance with best-practice treatment and attenuation principles.

1.2 Purpose

This report has been prepared in support of the application by CDL for a Fast Track Substantive application.

The purpose of this report is to outline options for managing stormwater on site and demonstrate that stormwater can be adequately managed on site without creating material adverse effects upstream or downstream of the site.

The overarching objectives are as follows:

- Demonstrate that stormwater and flooding can be managed in accordance with the requirements of Hastings District Council (HDC) and Hawke's Bay Regional Council (HBRC);
- Incorporate a Water Sensitive Design (WSD) approach that manages the impact of land use change from rural to urban;
- Provide stormwater management standards for the proposed development and ensure stormwater runoff is to be conveyed in a safe manner to the receiving environment through the primary and secondary network;
- Provide appropriate treatment of runoff prior to discharge to the receiving environment through WSD practices;
- Identify flood risk areas and ensure development is outside of the 1% AEP floodplain without creating effects upstream or downstream of the site; and
- Understand mana whenua values and incorporate these values into the stormwater management approach for the development.

2.0 Description of Application Site

The application site is located at 92, 108, 148 Middle Road and 139 Te Aute Road in Havelock North (site). The site is held in five separate titles and consists of a combined area of approximately 30.6ha. The site is relatively flat and currently used for rural residential and grazing purposes with four existing dwellings. Figure 1 shows the site extent within the context of Havelock North.

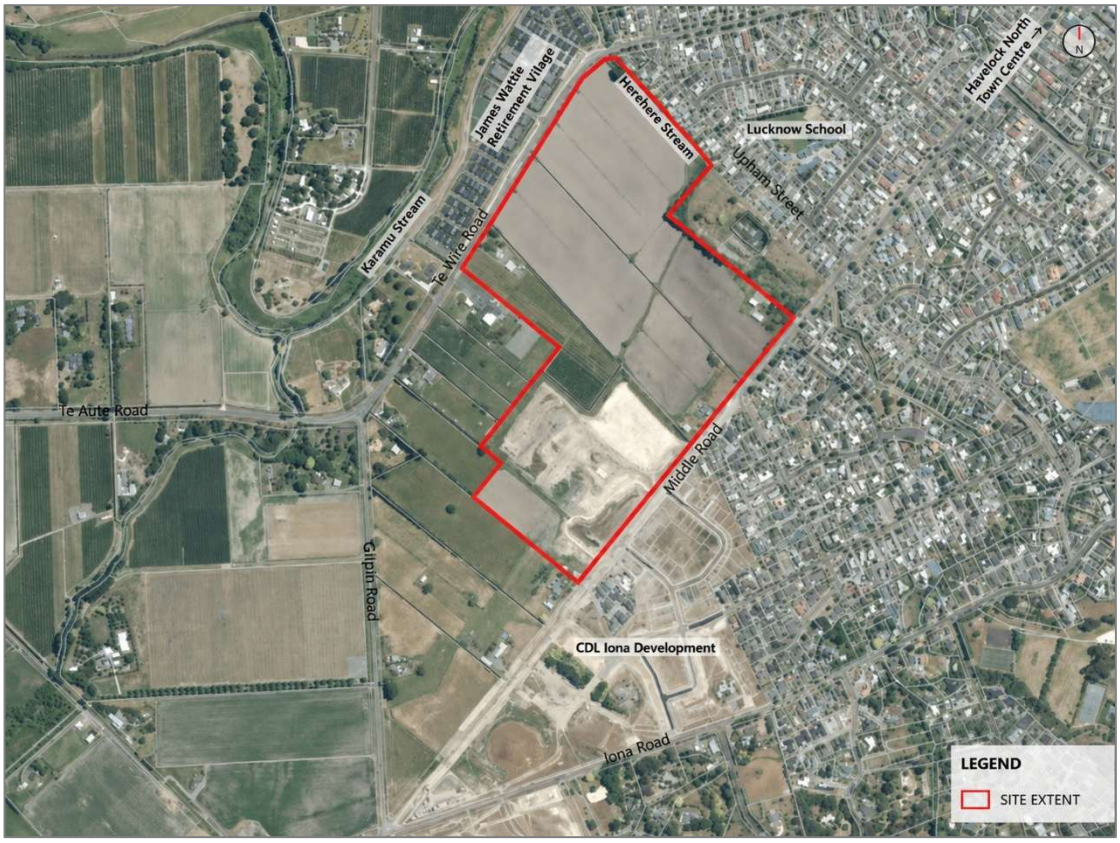


Figure 1: Site plan

The site is on the southwest side of Havelock North, approximately 900m south of the town centre, which contains a range of retail and commercial uses. The wider land uses to the north, east and west of the site are predominantly suburban residential in character, with a retirement village to the northwest and larger rural landholdings to the southwest.

The Planning Report and other technical assessments prepared to support the substantive application under the FTAA provides a comprehensive description of the site and its context.

2.1 Relevant Neighbouring Properties

There are several neighbouring properties that interface with the site and are discussed within this report. Consultation has been undertaken with the owners of these properties, the details of which can be found in the Planning Report and subsequent documents.

2.1.2 McKenna Block

The McKenna Block is a rural residential landholding held in two titles at 80 & 84 Middle Road (Lot 1 & 2 DP 626608) located immediately east of the application site, adjoining the Herehere Stream corridor. The land is held in separate ownership.

The block comprises a lifestyle property with existing dwellings, associated outbuildings, and established vegetation, including several mature trees. Part of the existing Bake land drain traverses the north section of this property.

2.1.3 Village Baptist Church

Located immediately west of the site is the Village Baptist Church property which encompasses three titles. The lot located immediately adjacent to the shared boundary is occupied by the commercial church buildings and expansive at grade parking area. The remaining two lots are unoccupied and covered in scrub and pasture.

A land drain passes between the development extent and the Baptist Church that currently captures runoff from the Church and the land within the development extent. The drain ties in with one running along Te Aute Road, which captures and conveys overflows from the Te Aute Road carriageway into the church drain. The church drain directs flows to the Gilpin for discharge into the Karamū Stream.

3.0 Description of the Proposal

The Middle Road project will provide for the residential subdivision of the site to enable the development of approximately 317 residential lots. The intended subdivision layout will provide for a range of lot sizes to enable conventional residential development along with medium density development opportunities. A masterplan has been prepared to inform the substantive application and is provided as Figure 2. The development is supported by a suite of technical assessments addressing key environmental matters, including infrastructure, stormwater, geotechnical, groundwater, landscape, transport, ecology, contamination, productive land, noise, archaeology and urban design.

A full description of the Middle Road Project is provided in the Planning Report submitted in support of the Substantive Application. Sections 3.1 to 3.3 below outline site specific features related to stormwater.



Figure 2. Image of Masterplan

3.2 Topography

The site falls gradually east to west towards Te Aute Road, as shown in **Figure 3**. The northern part of the site, adjacent to the Herehere Stream, is relatively flat, with minimal fall towards the western boundary.

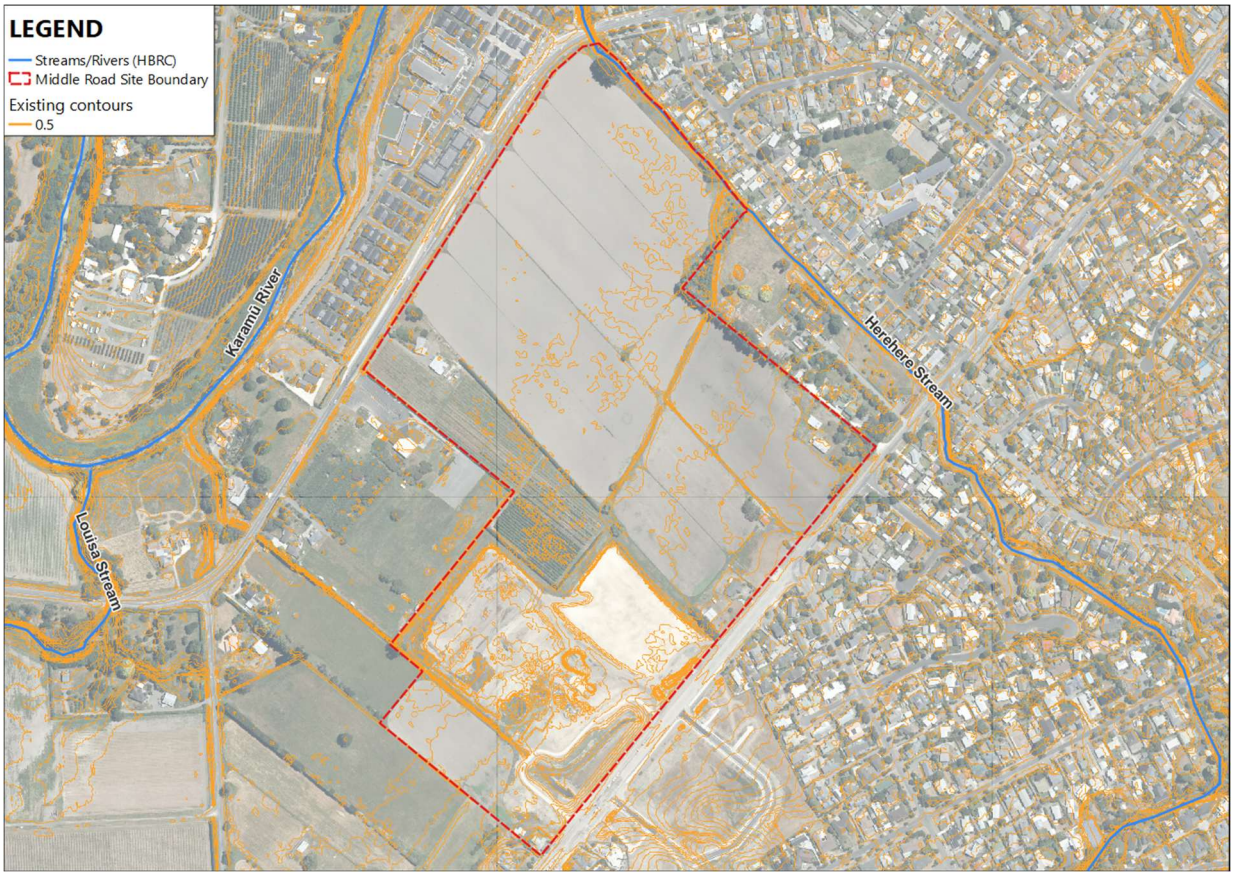


Figure 3: Existing topography (LiDAR 2024 + Woods Survey Topography 2026)

3.3 Geotechnical/Soil Conditions

Published soil data obtained from S-maps was reviewed to assess the site's drainage capacity. As shown in **Figure 4**, the soils underlying most of the site are classified as poorly or imperfectly drained.

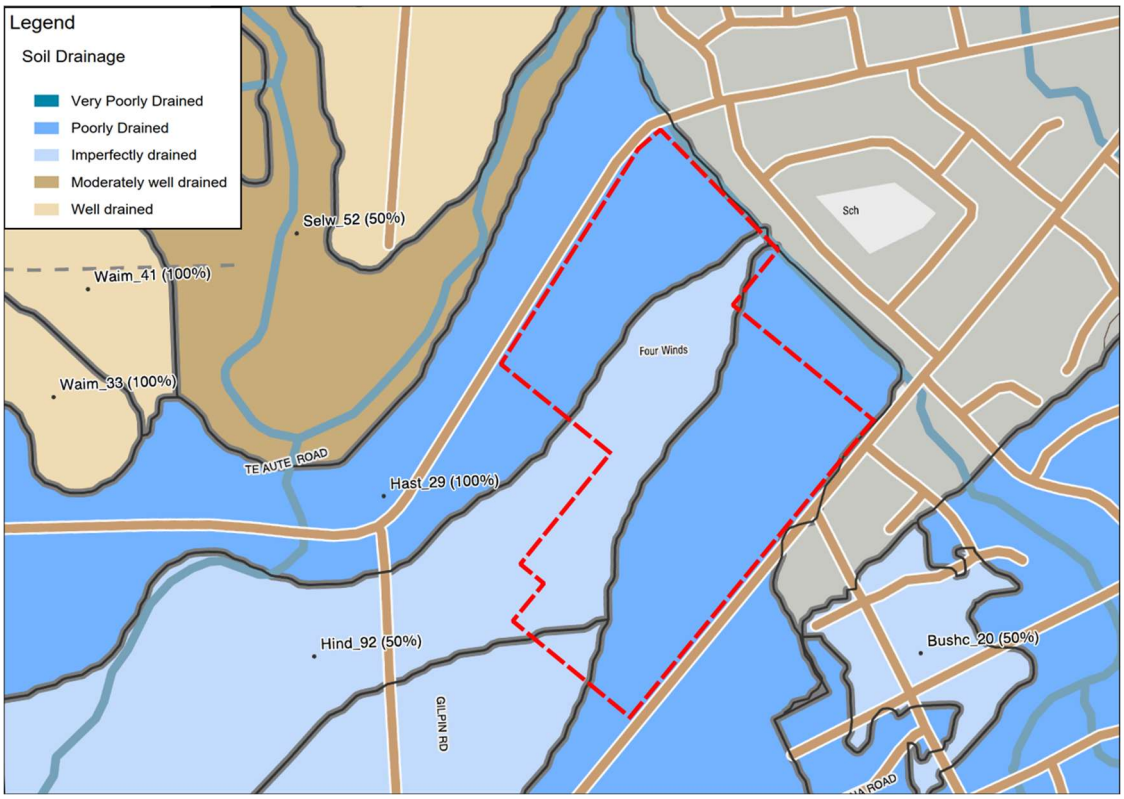


Figure 4: Soil drainage (source: S-maps)

A site-specific geotechnical investigation undertaken by CMW Geosciences, which is included with the FastTrack application, supports this classification. The investigation identified a subsurface profile of interbedded silt and sand units, with the fine-grained silt layers.

Combined with relatively high groundwater levels recorded at the site, this is consistent with the classification identified from the S-Maps data.

3.4 Existing Stormwater Network/Hydrological Features

There are several hydrological features in the vicinity of the site, which are discussed in the following subsections.

3.4.1 Land Drains

There are several land drains that run within the site (**Figure 5**), which are owned and maintained by HBRC.

The Pomeroy and Bake drains pass through the site and discharge to the Herehere Stream along the northern property boundary. A portion of the Bake drain alignment passes through the McKenna Block. There is an existing culvert along the Bake drain that discharges to the Herehere Stream.

The Gilpin drains receive and convey flows from the following areas:

- The consented Iona basin, within the site boundaries, which services the Iona development south of Middle Road; and
- Existing sites to the south of the development, which include part of 147 Te Aute Road, 167 Te Aute Road and part of 169 Te Aute Road.

The Gilpin drain discharges directly to the Karamū Stream. There is an existing culvert under Te Aute Road prior to discharge to the Karamū Stream.

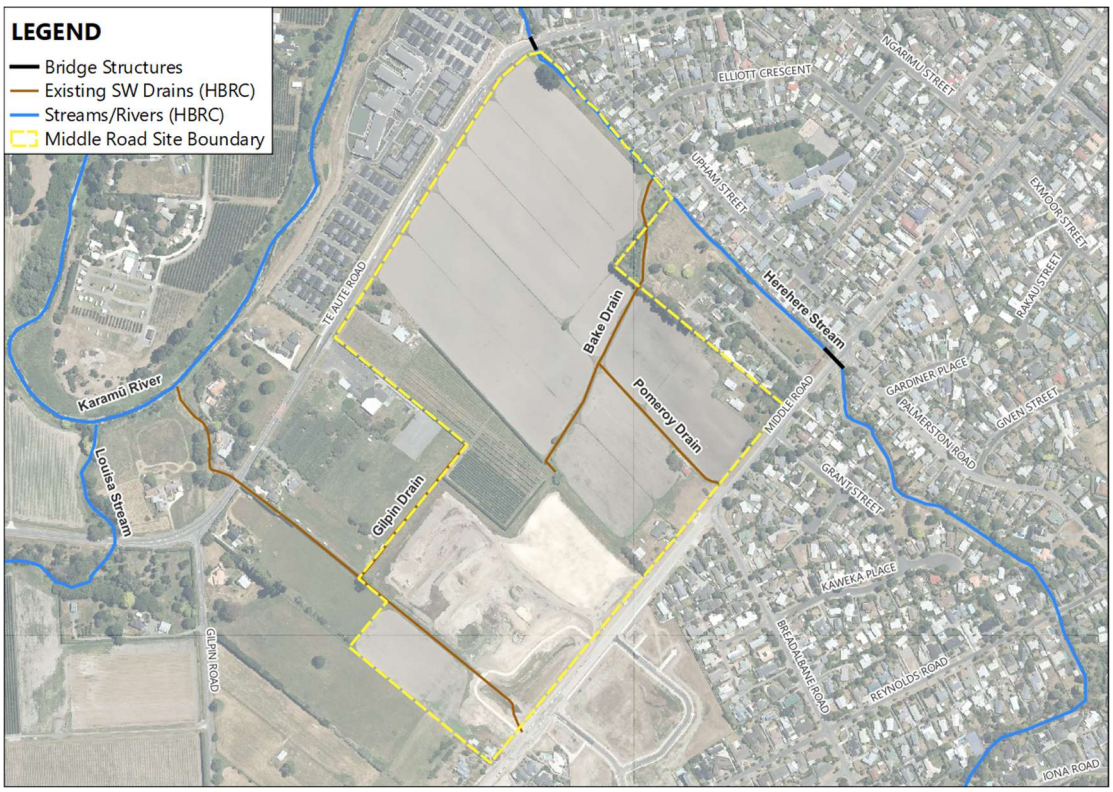


Figure 5: Land drains (brown) and streams (blue) (source: HBRC GIS)

3.4.2 Streams

Several streams are positioned in the vicinity of the site.

The Karamū Stream sits to the west of the site and is separated from the site by Te Aute Road and other private properties. The Karamū Stream flows towards the north and is the ultimate receiving environment for all stormwater flows from the site.

The Herehere Stream (owned and maintained by HDC) runs along the northern boundary of the site, which discharges to the Karamū Stream to the north. There is an existing bridge allowing the stream to pass under Middle Road upstream (East) of the site boundary, and another existing bridge allowing it to pass under Te Aute Road downstream (North) of the site.

It is noted that following erosion that occurred during Cyclone Gabrielle in 2023, HBRC undertook bank stabilisation works on the section of the stream just north of the site, separated by the Te Aute Road bridge. These works included the installation of gabion baskets and the application of shotcrete to protect and stabilise the stream banks.

HDC have commissioned a Stream Erosion review for Havelock North, which has identified observed stream erosion risk in the Herehere Stream (Figure 6).



Figure 6: Observed stream erosion risk (Karanema Havelock North Streams Erosion Review 2025; WSP)

The identified areas along the Herehere Stream are localised to upstream of where the Bake drain currently discharges adjacent to the McKenna Block. The erosion risk has been classified as moderate to high.

The HDC published velocity bands for the Herehere Stream show no difference in bands for the 2% and 1% AEP events. These have been pictured in **Figure 7**. The bands show that significant stretches of the Herehere Stream are subject to velocities greater than 2m/s in these events.



Figure 7: Velocity bands for the 2% and 1% AEP storm events (source: HDC landowner tools and guides)

3.4.3 Existing Piped Network

The existing pipe network obtained from the HDC Open Data Portal is shown in **Figure 8** below. Although the network was not directly modelled, flows entering the development area

via the existing pipe network are represented in the model as a time-series flow hydrograph applied as a point inflow. Further details on this approach are provided in Section 6.2.3.

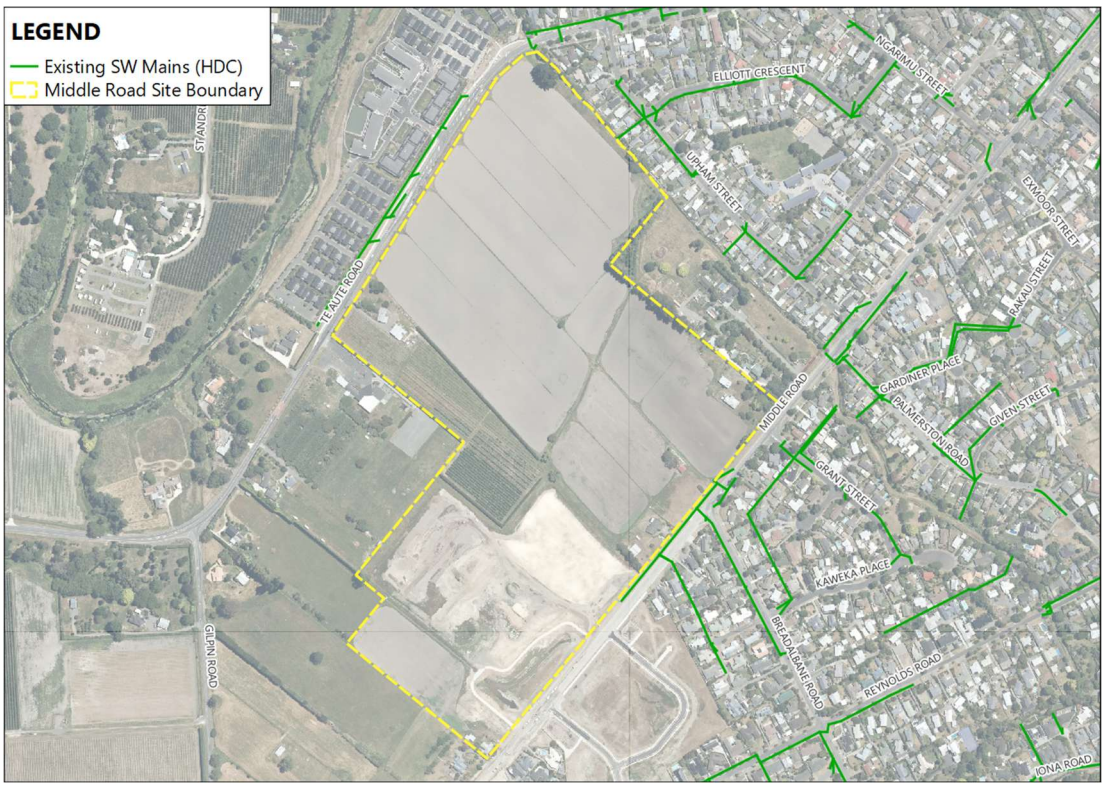


Figure 8. Existing pipe network (HDC, Open Data Portal)

It is understood that HDC currently hold a global discharge consent for the urban stormwater network. The Middle Road development is not covered by this discharge consent. CDL will instead seek a separate, privately held discharge consent from HBRC. In due course, this consent is intended to be surrendered, with the stormwater network and devices vested in HDC and absorbed into HDC's existing discharge consent.

3.4.4 Floodplains

The HBRC Hazard Portal has published flood risk areas on the Hawke's Bay Hazard Portal. The published maps have corresponding depths across the site, which align with the land drains and streams along the site.

2% AEP flood levels have been quantified as follows:

- Within the Bake and Pomeroy drains - 8.80mRL;
- Within the Gilpin drains - 8.30mRL;
- Within the Karamū Stream – 6.90mRL.

Flood levels within the Herehere Stream have been quantified at 9.80mRL for an unknown return period.

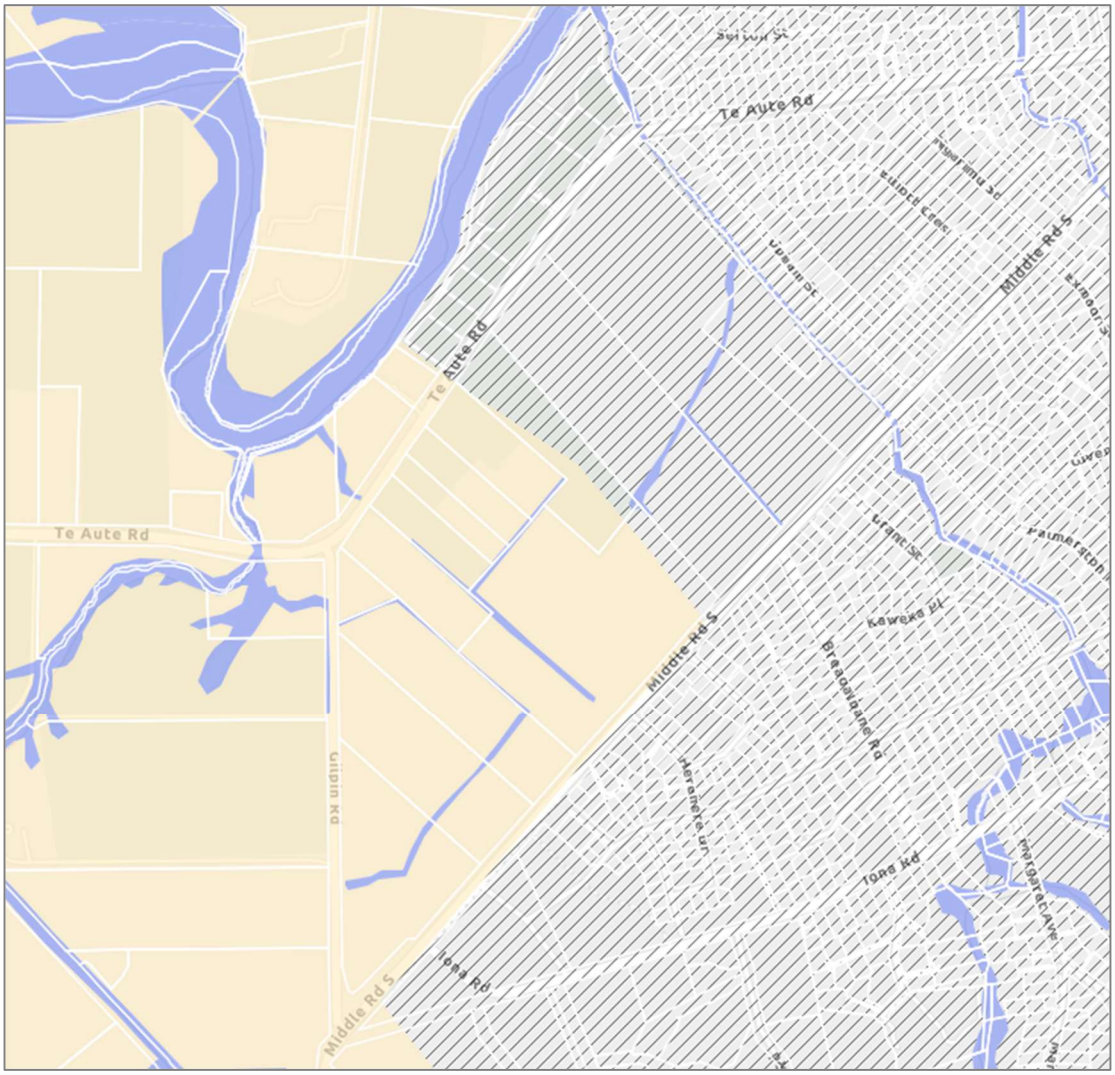


Figure 9: Flooding - 2% AEP (source: HBRC Hazards Portal)

It is noted that part of the site draining to the Pomeroy and Bake drains have been identified as not being within a flood risk study area and part of the site draining to the Gilpin drains are within a low-risk area.

Outside of the site, HDC have noted that flooding on Upham Street is a known issue and can be attributed to the Herehere Stream. Further, it is HDC's understanding that the Bake drain is affected by tailwater conditions in the Herehere Stream and is a source of erosion in smaller storm events. HDC further noted that the tailwater conditions abated closer to the Te Aute bridge and suggested this might be a more appropriate location for a discharge point rather than the existing outlet via the Bake drain.

Woods have undertaken flood modelling to quantify flood risk at the site, which is discussed in Section 6.

3.4.5 Dams

The Herehere Dam has been identified upstream of the site, which may impact the development (Figure 10).

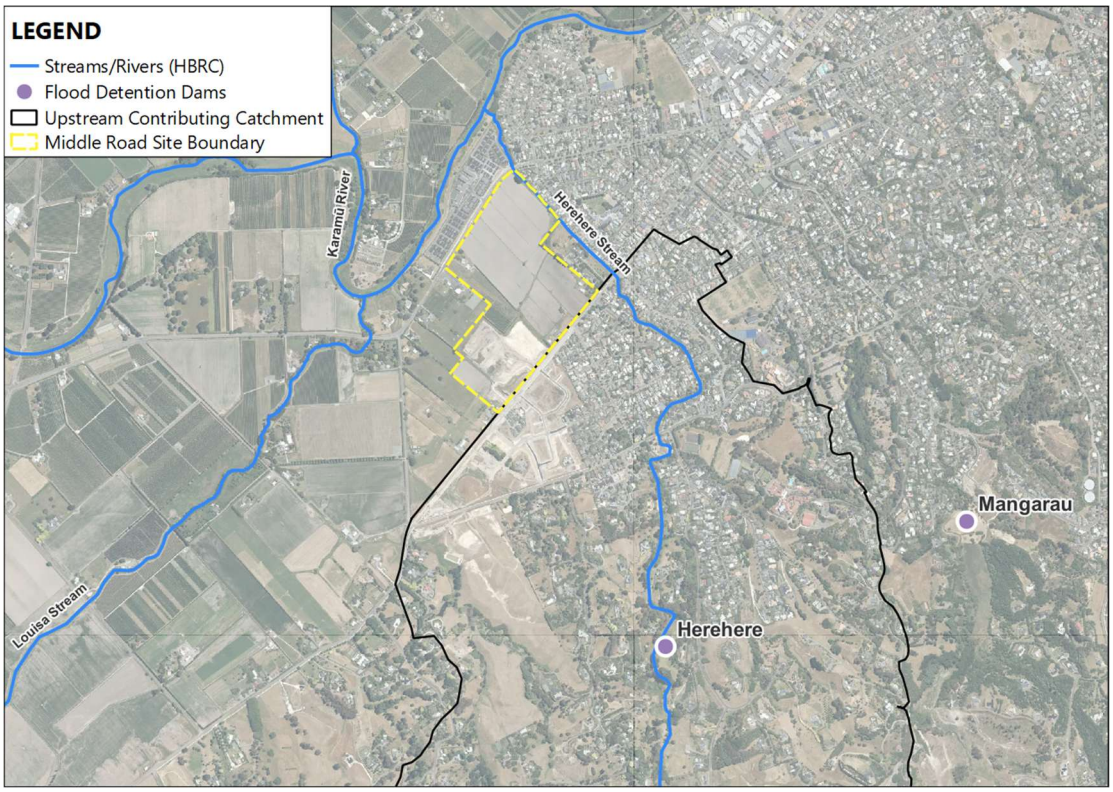


Figure 10: Dam locations

The HBRC Hazard Portal shows the ponding areas and hazard zones associated with dam failure inundation modelling for both dams in the vicinity of the site (Figure 11). These zones represent areas at risk of damage from water cascading downstream in the event of a dam failure, and HBRC modelling indicates that the site itself is not at risk of inundation under this scenario, with flows from the Herehere dam contained within the portion of the Herehere Stream running along the northern boundary.

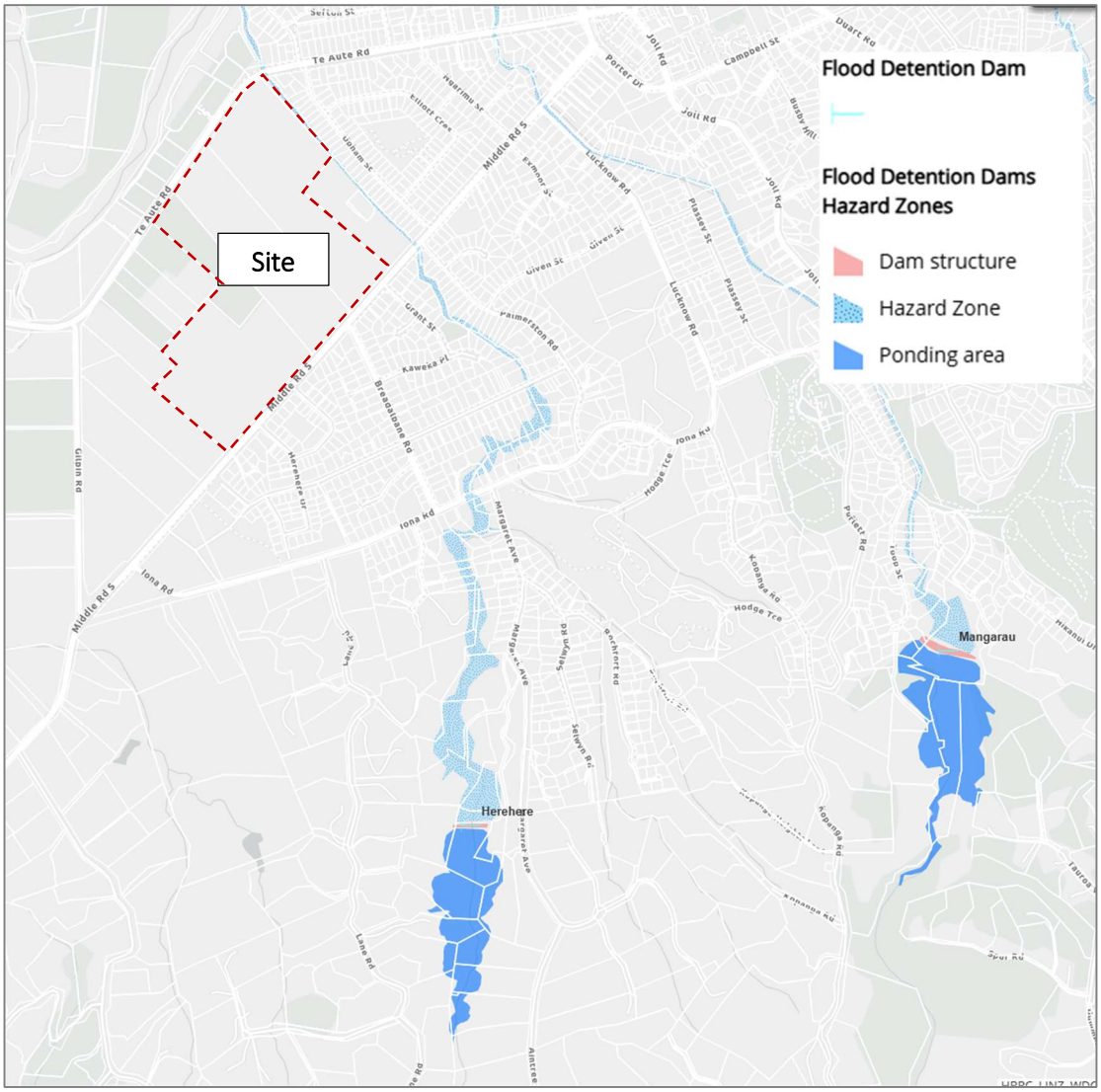


Figure 11: Dam ponding areas and hazard zones

3.4.6 Upstream Development

CDL have consented for development to occur upstream of the site as part of the Iona Structure Plan. A stormwater management device, referred to as the Iona Pond, which services the upstream development, is located within the site extent (Figure 12) and discharges to the Gilpin drain. This device provides attenuation for Stages 1A, 1B and Stapleford Park in the Iona Development.

The device has been consented for and constructed within the site (consent reference RMA20220188). Design drawings have been provided by CDL for the spillway from the device.



Figure 12: Iona Pond

The intention is that both service outlet and emergency flows from the Iona pond will be conveyed through the development to discharge to the Gilpin drain as per the consented arrangements.

Design outflows from the Iona Pond have been incorporated into the flood modelling for the development. These have been provided for the 2-, 10- and 100-year events, which have been incorporated into the flood modelling. Assumptions have been made around modelling events that flows haven't been provided for, which are further discussed in Section 7.

4.0 Development Summary and Planning Context

A review of the relevant stormwater guidelines and policies has been undertaken to formulate the stormwater management strategy for the site. These are summarised in Table 1.

Table 1: Guidance summary

Guidance Document	Summary	Relevance
Hastings District Council – Engineering Code of Practice (2020)	Sets out HDC expectations for developers to ensure RMA and District Plan requirements are met.	Yes – provides guidance for subdivision and land development.
Hastings District Council – IntraMaps HDC	Provides information on stormwater infrastructure, including pipe network and land drains within the district.	Yes – provides information on infrastructure.

Guidance Document	Summary	Relevance
Hawke's Bay Regional Council – Waterway Guidelines Stormwater Management (2009)	Provides an outline of HBRC's approach to stormwater management at a catchment scale and the design of stormwater management devices.	Yes – provides guidance on water quality and quantity devices.
Hawke's Bay Regional Council – Waterway Guidelines Low Impact Design (2009)	Provides an alternative approach to site design and development for stormwater management.	Yes – provides guidance on mitigating effects of developments to avoid, remedy or mitigate environmental effects.
Hawke's Bay Regional Council – TANK Plan Change	Provisions in managing the land and waterways of the Tūtaekuri, Ahuriri, Ngaruroro and Karamū (TANK) catchments	Yes – provides objectives for managing water quality and quantity within the Karamū catchment.
Hawke's Bay Regional Council – Hazard Portal	Provides information on flood hazard risks associated with rainfall events or dam break scenarios.	Yes – provides an understanding on the level of risk
National Policy Statement for Freshwater Management 2020 (amended 2025) (NPS-FM)	Tool for managing and improving conditions of New Zealand's freshwater and coastal systems.	Yes – outlines strategic objectives to be considered.
National Environmental Standards – Freshwater 2020 (amended 2025)	Provides a set of regulations under the RMA to control activities that could harm freshwater and freshwater ecosystems in New Zealand.	Yes – outlines standards that the development must meet prior to discharge into rivers, streams and wetlands.
National Policy Statement – Natural Hazards 2025	Provides national direction under the RMA for assessing and managing natural hazard risk in land use, subdivision and development.	Yes – outlines how development will manage natural hazard risks, including the effects of climate change.

5.0 Proposed Development

The Middle Road project will provide for the residential subdivision of the site to enable the development of approximately 317 lots. The intended subdivision layout will provide for a range of lot sizes to enable conventional residential development along with medium density development opportunities.

The development will be supported by integrated three-waters and transport infrastructure and an open space network. A planning framework is proposed to guide future residential development. A full description of the Middle Road Project is provided in the Planning Report submitted as part of the Substantive Application.

A Masterplan has been prepared to inform the Substantive application and has previously been provided as **Figure 2** consisting of 317 lots.

With respect to matters relating to stormwater management, further aspects of the stormwater strategy for the Middle Road development are provided in the following sections of this report:

- Stormwater Management – 6.0
- Flood Modelling – 7.0

These sections are to be read in conjunction with the supporting technical assessments including the Infrastructure Report appended to the Planning Report.

6.0 Proposed Stormwater Management

This section discusses the intended stormwater management strategy for the site based on the indicative concept plan. The strategy has been developed to meet the objectives and design requirements of HDC and HBRC and seeks to:

- Manage and mitigate existing flood risk on the site.
- Develop a set of best practicable options (BPO) for stormwater that can be incorporated into the development.
- Prioritise a water sensitive design approach that:
    - Manages the impact of land use changes.
    - Retains natural landform and hydrological processes, as much as practicable, to reduce stormwater quantity related impacts upstream and downstream of the development site.
    - Minimises or mitigates adverse effects on water quality, stream health and ecological values of the receiving environment through stormwater management devices.
    - Avoids exacerbating existing erosion/changes to stream geomorphology in the Herehere Stream.
    - Addresses mana whenua values.
- Minimise the generation and discharge of contaminants/sediments into a sensitive receiving environment, including changes in temperature.
- Facilitate urban development and protect key infrastructure, people and the environment.
- Consider climate change in the design of stormwater infrastructure and management devices per HDC guidelines.

The Middle Road Project is proposed to be split into two catchment areas based on the discharge locations of the land drains within the site. These areas have been split into Zone 1 (discharge to the Herehere Stream) and Zone 2 (discharge to the Karamū Stream via the Gilpin Drains).

A preliminary finished surface has been generated to reflect the proposed master plan. This revised surface changes the post development catchment configuration in comparison to the existing scenario. The revised post development boundaries are shown in **Figure 13**. Additional details are in subsequent sections of this report.

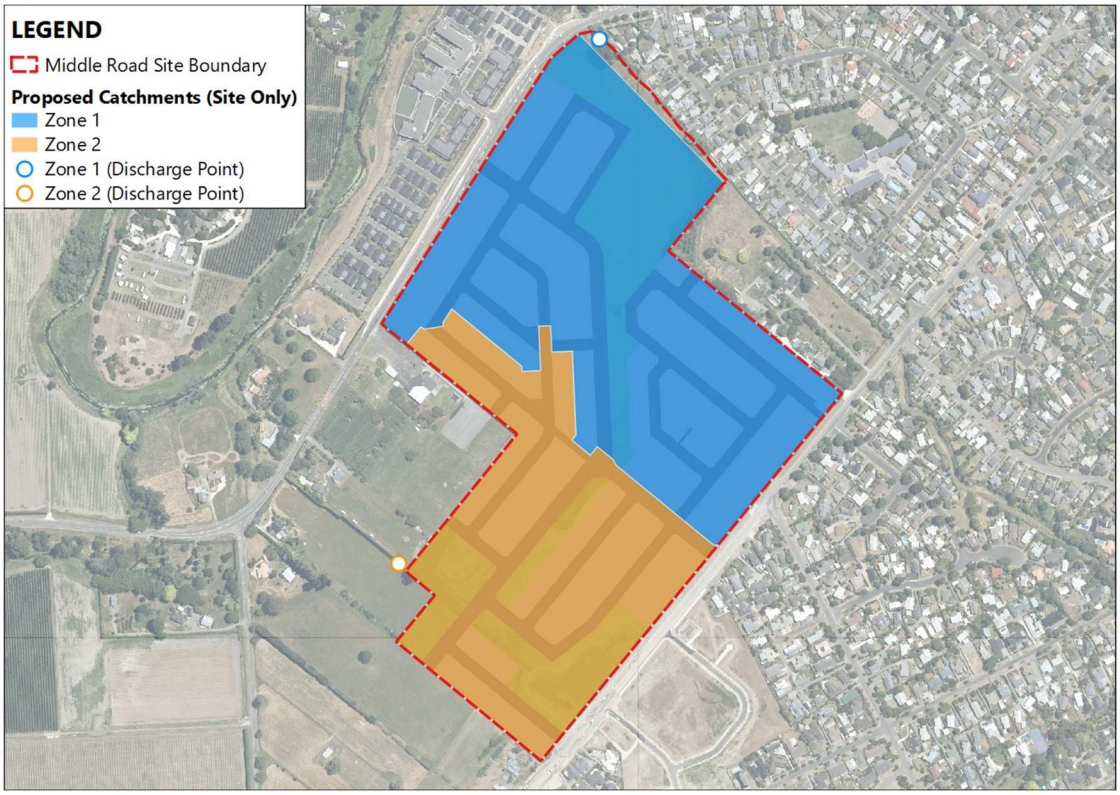


Figure 13. Proposed development catchment boundaries

The McKenna Block extension has not been included within the Zone 1 catchment for the purposes of this assessment; however, consideration has been given within the design as to how this site could be developed in conjunction with the proposed development of the site.

6.1 Water Quality Management

HDC guidelines currently do not require any water quality treatment to be provided for stormwater runoff being discharged to its network; however, HBRC guidelines require any stormwater discharging to an HBRC owned and maintained network to be treated to 75% TSS removal. We also understand from early engagement with Mana Whenua that the stream network is a sensitive environment.

As a private discharge consent is being sought, and to address Mana Whenua concerns, the development will provide water quality treatment for site generated stormwater runoff.

Water quality treatment is intended to be provided through water sensitive devices or through proprietary treatment devices to the equivalent of 75% TSS removal using a treatment train approach.

The overall removal of sediment for two or more stormwater management devices in series is defined under the Waikato Stormwater Management Guideline, which draws from the same source material as the Hawke's Bay Regional Council Stormwater Management Guidelines. The sediment removal efficacy is outlined in

Table 2 which shows that the treatment rate exceeds the minimum requirement of 75%.

Table 2: Treatment train sediment removal efficacy

Device	TSS Removal Rate %
Baffle Box Proprietary Device (or similar)	73%
Dry Basin	40%
Overall	84%

Consultation with HBRC raised the issue of temperature as a contaminant of concern for the Herehere Stream catchment.

A literature review was conducted to understand the performance of the proposed treatment device with respect to temperature management. As documented in Auckland Regional Council Technical Publication 10 (TP10), the extended detention dry basin typically does not provide a temperature increase. Additionally, Auckland Council Guideline Documents 01 (GD01) suggests that dry basins are effective at controlling temperature.

The HBRC Waterway Guidelines suggests a dry basin may not be suitable if the receiving water is temperature sensitive, as detention basin do not detain water long enough to reduce temperatures from impervious surfaces.

Vegetation is proposed on the batter slopes and within the low flow channel of the dry basin. The grades within the basin are shallow, therefore water is likely to be detained and drained to ground during smaller storm events. Any potential temperature increase is anticipated to be managed on site appropriately prior to discharge.

6.2 Water Quantity Management

Stormwater for the development is proposed to be managed in dry basins that are designed for the following:

- Extended detention to address stream erosion risk in the Herehere Stream;
- Attenuation to pre-development peak flow rates for the 2-, 10- and 100-year storm events; and
- Maintaining the floodplain storage offered by the sites bounded by Te Aute, Middle and Gilpin Road to avoid effects on properties outside of the development boundaries.

Stormwater within the northern part of the site currently discharges to the Herehere Stream via the Bake and Pomeroy drains. Stormwater within the southern part of the site discharges to the Karamū Stream via the Gilpin Drains.

The following landform modifications are proposed within the development boundaries:

- The removal of most of the Bake drain (except for the portion that runs within the McKenna Block) and the Pomeroy drain;
- Stormwater will be conveyed through the (primary) network to discharge to stormwater management basins prior to discharge to the Herehere Stream;
- The proposed outlet into the Herehere Stream is closer to the Te Aute Road bridge than the existing Bake drain outlet. This takes advantage of the lower tailwater conditions in the Herehere Stream reducing backwater effects; and
- The tributary of the Gilpin Drain within the development boundaries will be removed and a section of the Gilpin drain within the site that conveys flows between Middle

Road to Te Aute Road will be modified to convey runoff from the Iona pond to its existing discharge point. No changes to the Gilpin drain are proposed outside of the development extent.

All basins within the development are designed to temporarily store runoff, attenuate peak flows and control discharge to the receiving environment, with sizing confirmed such that post-development peak flow rates do not create adverse effects on third-party land. This has been achieved through modelling in XPSWMM, which informed the basin geometry and confirmed the sizing of the outlet structures discharging to the Gilpin Drain and Herehere Stream.

The dry basins will feature outlet structures that have been sized to provide attenuation for post development site generated flows as well as external flows entering the subject site. The basins will outlet into the Herehere Stream and Gilpin Drain separately but will function as one when peak flows rates overtop the Herehere Stream into the site during extreme events.

Both basins have been designed with spillways to control the amount of water discharging to the receiving environment during design storm events. These will also function as emergency spillways during extreme storm events or in the instance that the primary outlet structure is blocked.

The flood model demonstrates that the basins perform as intended, storing the required extended detention volume and attenuating site generated flows to below pre-development rates. As a result of tailwater conditions in the Herehere and the Gilpin drains, the development discharges at peak flow rates well below the existing rates that currently discharge to the Herehere Stream and Gilpin drain.

It is noted that the modelling presented in this report focuses on worst case scenario conditions, where widespread rainfall is experienced in and around the site as well as the catchments directly upstream of the site. These conditions result in elevated water levels in the Herehere Stream and Gilpin drain, which restrict the amount of water exiting the basins. Backflow preventers will be required at the piped outlets, for which further detail has been provided in the Middle Road Infrastructure Report.

6.3 Dry Basin Connections

The dry basin network servicing the site comprises six hydraulically connected basin areas. Three basin areas drain north (basin area 1-3) to the Herehere Stream, while the remaining three (basin areas 4-6) discharge to the Gilpin drain. For the purposes of stormwater reporting, these have been referred to as the Herehere and Gilpin Basins.

A high point occurs at the centre of the network, coinciding with a road crossing. A culvert at this location provides the hydraulic connection between the two sides of the basin network. This can be seen in Figure 14.

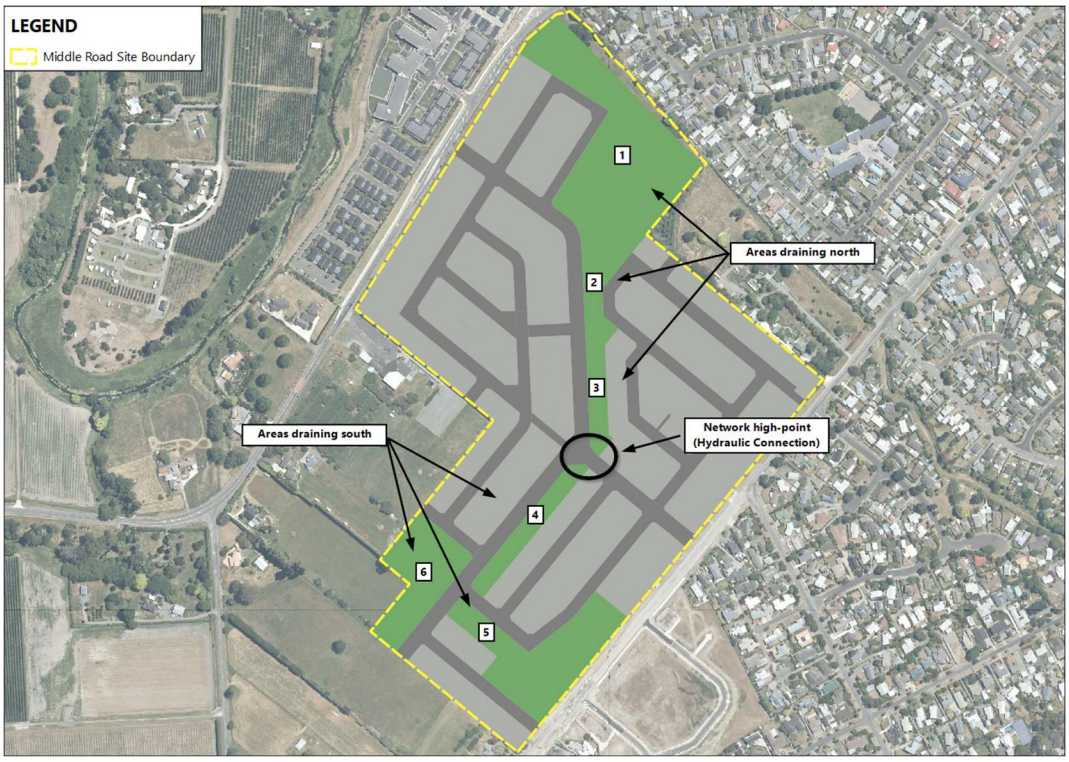


Figure 14: Basin connection plan

6.4 Extended Detention

Extended detention is proposed to address stream erosion downstream from the site. The extended detention volumes have been calculated using the 90th percentile storm event, as found in Figure 6-5 of the Hawke's Bay Regional Council Waterway Design Guidelines (2009).

Post development catchments have been separated based on areas discharging to the Herehere Basin and those discharging to the Gilpin Basin. The required EDV is designed to be stored and released slowly into the receiving environment.

Table 3: Extended Detention Volume

Basin	Volume
Herehere Basin	1,645
Gilpin Basin	1,125

6.5 Herehere Stream Treatment

It is proposed the existing bank of the Herehere Stream is flattened to gradients of 1:3 (33%). This wider stream corridor increases the flow capacity of the stream and provides a safer and more stable bank slope. The new slope will be stabilised with a biodegradable matting and will be planted with riparian planting as per the Boffa Miskell landscaping design. This proposal has undergone preliminary discussions with HDC, HBRC and the Tamatea Pōkai Whenua Iwi and all parties have shown support for the proposed design.

A stream assessment has been undertaken which is included in Appendix 2: Herehere Stream Assessment Memo. The assessment found that for the reach of the Herehere Stream that was

analysed, the modelled shear stress exceeds the adopted critical shear stress, thereby placing the stream at risk of erosion.

The assessment concluded that the proposed channel widening works is predicted to reduce flow velocities overall, which is a net benefit for bed and bank stability, however the benefits will mostly be localised to the left bank, where the proposed works are.

6.6 Discharge Outlets

Stormwater discharge from the northern basin to the Herehere Stream will be via a wingwall outlet and riprap basin incorporating baffle blocks. Discharge from the southern basin to the Gilpin Drain will be via a wingwall outlet and riprap apron. Both outlet structures provide energy dissipation for flows leaving the respective wingwalls.

The stormwater outlets to each existing watercourse have been designed in accordance with the HBRC Stormwater Management Guidelines. The outlet structures and associated erosion control measures (riprap and stilling basins) have been sized to convey the design flows while minimising scour and erosion to the banks and bed of the receiving watercourses.

Further details regarding the outlet design specifications can be found in the Infrastructure Report.

6.7 Groundwater Assessment

A Groundwater Assessment has been undertaken by Williamson Water & Land Advisory (WWLA, August 2026). The assessment anticipates extended period of high ground water across the site which will limit soakage to ground and is likely to result in inflow of groundwater to the basins. A summary of the key findings is presented in Figure 15 and Table 4.



Figure 15. Depth to groundwater and saturated areas across the proposed development area during average (L) and peak flow (R) conditions. - (WWLA, 2026)

Table 4. Summary of Groundwater Results (WWLA, 2026)

Basin	Average Conditions - Groundwater Inflow (L/s)	Average Conditions - Groundwater Interaction Area	Peak Conditions - Groundwater Inflow (L/s)	Peak Conditions - Groundwater Interaction Area
Basin 1 - Northern	2.5	0%	9	24%
Basin 2 - Northern		0%		45%
Basin 3 - Northern		22%		45%
Basin 4 - Southern	0.9	17%	2.5	40%
Basin 5 - Southern		7%		49%
Basin 6 - Southern		0%		1%

Based on information provided by WWLA, groundwater ingress under peak flow conditions can be managed and conveyed to the basin outlets via the low flow channels that run along the basins.

On this basis, groundwater inflows have not been explicitly incorporated into the stormwater model, as their effect on basin performance can be considered negligible. The orifice design

will be refined at detailed design stage to pass the average basin inflow flow rates to the receiving environment.

It is further noted that seasonal ground water levels will affect how much groundwater infiltration occurs through the dry basins.

7.0 Stormwater and Flood Modelling

Preliminary stormwater and flood modelling has been undertaken using the XPSWMM version 2024.2 software. The flood modelling has been carried out with Hawke's Bay 2000 projection and New Zealand Vertical Datum 2016 (NZVD16).

7.2 Rainfall

HIRDs rainfall data has been converted to a 24-hour design storm event using the alternating block method. Rainfall data for RCP6.0 for a climate horizon to the year 2100 was converted to a 24-hour design storm. All simulated within the flood model have used this rainfall profile to generate runoff.

The 24-hour rainfall depths adopted in the modelling derived from NIWA's HIRDS v4 are summarised in Table 5.

Table 5. 24-hour rainfall depths

Storm Event	24 Hour Rainfall Depth (mm)	
	No CC (2081-2100)	**RCP6.0 (2081-2100)**
90th Percentile Event	17.5[1]	
2-Year	67	74.8
5-Year	88.2	99.4
10-Year	104	118
50-Year	142	162
100-Year	159	182

7.2.2 Climate Change

Climate change has been incorporated into the design and assessment of the proposed stormwater management system to ensure that the development remains appropriately resilient to future increases in rainfall intensity and flood risk.

A decision has been made to use RCP6.0 as the basis for the stormwater and flood modelling on the project. This has been drawn from the applicable HDC and HBRC guidance and available regional climate projections. Different datasets and design inputs adopt different climate change scenarios and assessment horizons. The assumptions used for each component of the assessment, and their relative conservatism, are outlined below.

[1] No climate change applicable to this depth

HBRC have provided boundary conditions for an RCP8.5 scenario to the year 2050 in the absence of flood modelling results for RCP6.0. The provided boundary conditions are discussed in Section 7.3.3. The design and flood modelling assumes a rainfall profile based on RCP6.0 to the year 2100.

A literature review of the second edition of NIWA's Climate Change Projects Report has found that RCP6.0 to the year 2100 generally has a higher projected temperature increase than RCP8.5 to the year 2050 for the Hawke's Bay region. This is summarised in Table 6.

Table 6: Hawke's Bay – Projected temperature changes relative to RCPs

	RCP8.5 (2050)	RCP6.0 (2100)
Summer	1.1	1.9
Autumn	1.1	1.9
Winter	1.1	1.9
Spring	1.0	1.7
Annual projected increase	1.1	1.9

The consequences of using RCP6.0 for the design of stormwater infrastructure will result in stormwater management devices that are more resilient to climate change related flood risk.

The climate change assumptions in the HDC boundary conditions (RCP6.0), which includes the Herehere Stream, aligns with the rainfall profiles that have been used in the modelling. The alternating block method has been used to generate a 24-hour rainfall profile using the RCP6.0.

The design outflows from the Iona Pond have been included in the flood model. The climate change assumptions used in the design of the Iona Pond are based on HBRC's Waterway Design Guideline for an increase in annual mean temperature of 2.1°C to the year 2090. This is a greater temperature increase than the RCP6.0 projection but less than the RCP8.5 for the Hawke's Bay region. The Iona Pond outflows have been used to design a conveyance channel and has been used in the flood modelling. These outflows are a conservative estimate of outflows from the pond in comparison to RCP6.0.

7.3 Hydrological Model

Table 7 states the input parameters used to model the hydrological aspects of the flood models.

Table 7. Input parameters

Attribute	Value
CN (Pervious) – existing/pre dev	61
CN (Pervious) – compacted/post dev	74
CN (Impervious)	98
Ia (Pervious)	5 mm
Ia (Impervious)	0 mm
Slope calculation	Equal-Area Method
Tc method	TP108 method (minimum of 10 minutes)

The sub catchment delineation for the pre- and post-development model scenario differs around the development site areas due to the proposed design adjusting site levels. The sub catchment delineation outside the Middle Road development extent has remained unchanged.

Figure 16 and Figure 17 show the sub catchments delineation around the site area for pre- and post-development model scenarios.

For areas outside of the area bound by Gilpin, Te Aute and Middle Roads, the catchment delineation remains the same. It should be noted that sites to the west of Te Aute Road have been loaded directly to the Karamū Stream.

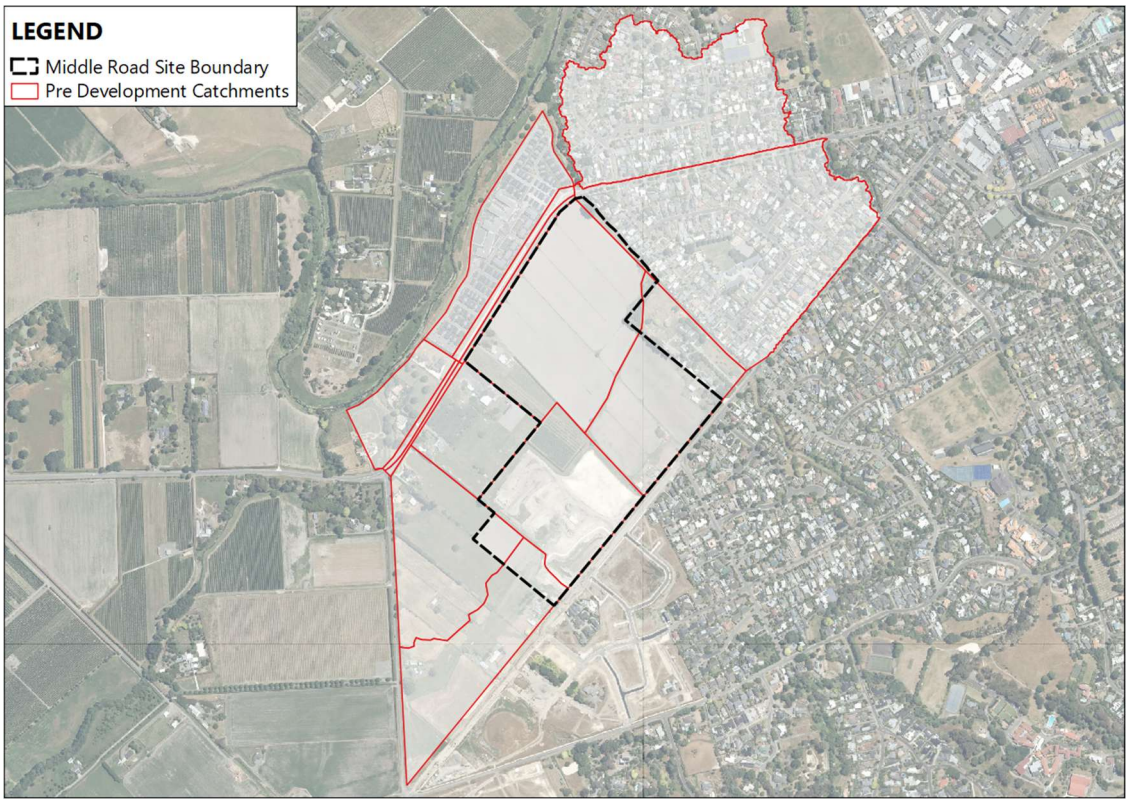


Figure 16. Pre-development catchment delineation

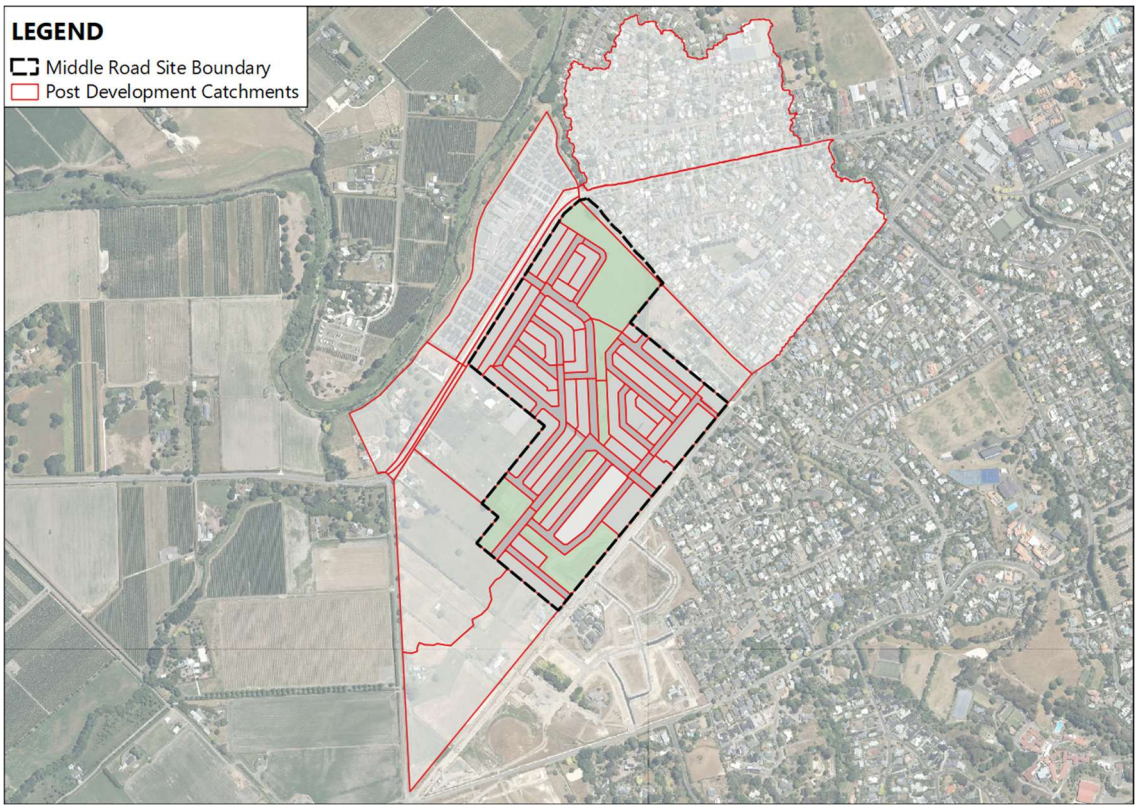


Figure 17. Post development catchment delineation

7.3.2 Land use

The assumed impervious coverages within the development extent are as shown in Table 8.

Table 8. Impervious coverage by land use

Land use	Impervious coverage
Roads	90%
Lots	60%
Reserve / Basin Area	5%
McKenna Block	13% (calculated based on existing coverage)

7.4 Hydraulic Flood Model

This section describes the 1D and 2D model parameters used in the flood model.

7.4.2 1D Elements

The pre- and post-development models include three existing stormwater culverts which are currently in place along Gilpin Road and Te Aute Road, near the development area. Figure 18 shows the culvert locations as well as their respective dimensions.

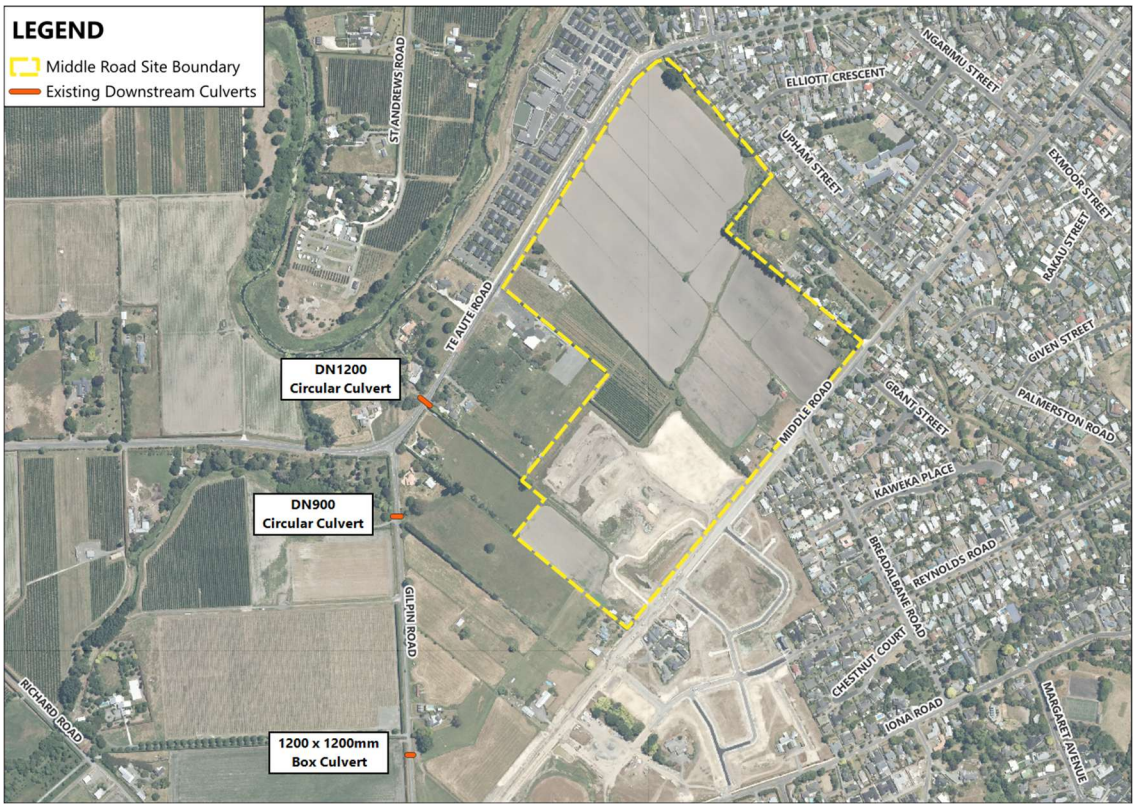


Figure 18. Modelled existing downstream culverts

The 1D parameters for the modelled culverts incorporate energy and friction losses. These are shown below:

- Entrance loss coefficient of 0.3
- Exit loss coefficient of 0.5
- Friction losses (manning's 'n' value) of 0.014

The modelling discussed in this Substantive Application only represents the outlet structures, including the basin outlets in the 1D. Internal and external pipe networks have not been modelled. Modelling of the pipe network may be revisited prior to engineering plan approval. For the purposes of the Substantive Application, not including the pipe network can be considered a blockage scenario, and therefore presents a worst case scenario of flooding.

7.4.3 2D Elements

The pre-development model scenario includes a surface developed using topo survey data collected by Woods and LiDAR 2024 to represent the existing topographical conditions. The post development model scenario further includes the proposed landform design for the Middle Road development. **Figure 19** shows the different topography datasets extents used to create the flood model surface.

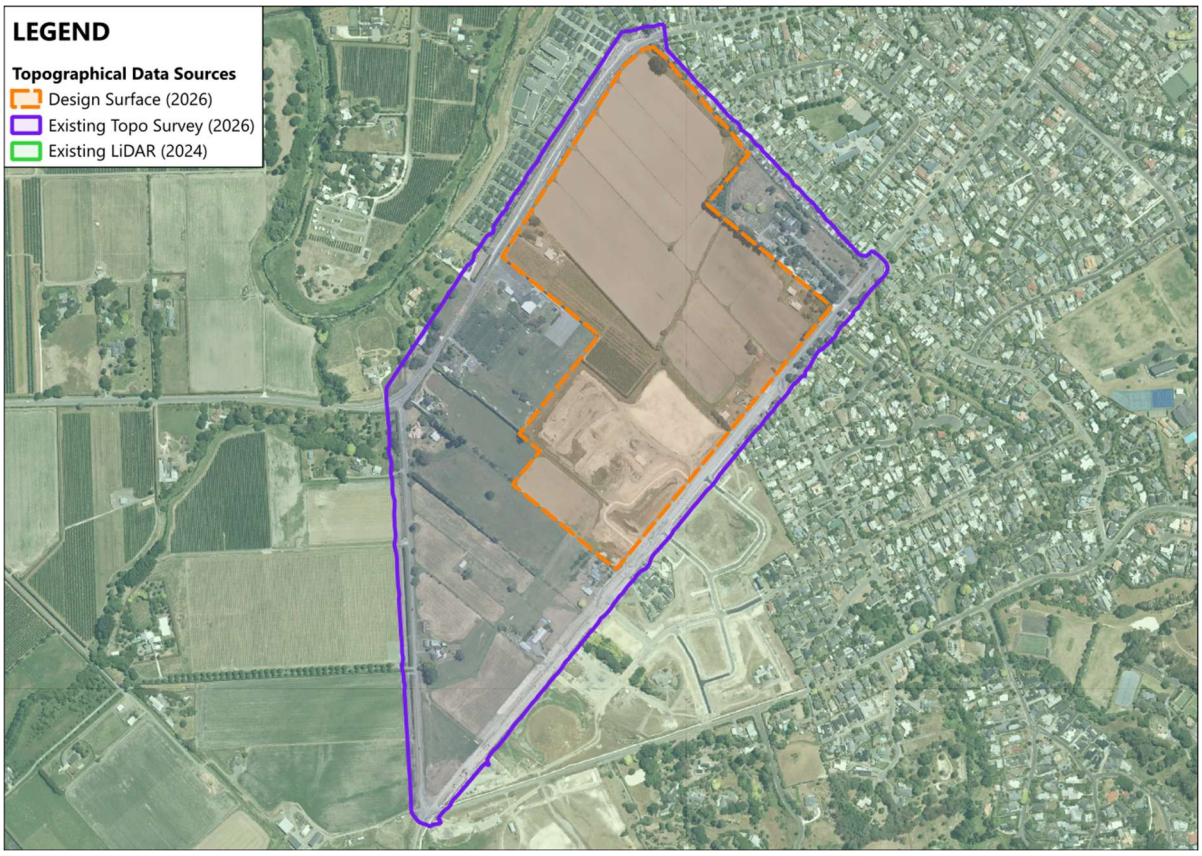


Figure 19. Topo survey extents

7.4.3.2 2D model losses

2D model parameters for the losses as an effect of runoff traversing overland are as follows:

- A manning's 'n' value of 0.02 has been used to represent losses from roads and lots.
- A value of 0.03 has been used to represent losses through the Karamū stream bed.
- A value of 0.06 has been used to represent losses through the Karamū stream banks
- A value of 0.08 has been used to represent losses for all remaining modelled areas.

7.4.4 Boundary Conditions

Inflow boundary conditions for the modelling have been supplied from three sources, as follows:

- HDC provided inflow boundaries along Middle Road, including the Herehere Stream;
- HBRC provided inflows and water level boundaries along the Karamū Stream; and
- Design flows for three storm events for the Iona Pond that sits within the current site boundaries.

This information has been summarised in Table 9.

Table 9. Received Boundary Conditions

Boundary Condition Type	Supplier	Storm Events
Middle Road & Herehere Stream Inflows	HDC	2YR ARI; RCP6.0
		5YR ARI; RCP6.0
		10YR ARI; RCP6.0
		50YR ARI; RCP6.0
		100YR ARI; RCP6.0
Karamū Stream Inflows & Water Levels	HBRC	5YR ARI; RCP8.5 & No CC
		50YR ARI; No CC
		100YR ARI; RCP8.5 & No CC
Iona Pond Outflows	CKL	2YR ARI; 2.1°C (2090)
		10YR ARI; 2.1°C (2090)
		100YR ARI; 2.1°C (2090)

The design inflows from HBRC and HDC are further discussed in the following sub-sections.

7.4.4.2 Middle Road/Herehere Stream Boundaries (HDC)

Inflow boundary conditions supplied by HDC were incorporated into the model as flow hydrograph time series to represent upstream contributions to the site. The hydrographs were generated by HDC using rainfall profiles provided by Woods. These rainfall profiles included existing and future (RCP6.0) rainfall events.

The inflows were applied as point loadings and line loadings. Two-point inflows representing the upstream 1D pipe network were applied directly using the hydrographs supplied by HDC. The 2D overland flows entering from the Middle Road corridor were represented as line loadings.

HDC initially provided 2D inflows at 17 locations along Middle Road. For modelling, these were consolidated into five 2D inflow lines aligned with the primary overland flow paths entering the site.

Inflows from northern properties adjacent to the Herehere Stream were not clearly identifiable in the information provided. Woods delineated and modelled upstream catchments in this area to represent these flows for the modelled storm events. The model does not include the primary network servicing the properties to the north.

Figure 20 shows the locations of the boundary conditions included in the model.



Figure 20. Modelled inflow boundary condition locations – point and line loadings (proposed development)

7.4.4.3 Karamū Stream Boundaries (HBRC)

Upstream boundary conditions were applied to the Karamū Stream and its adjacent tributary, the Louisa drain, to represent inflow conveyance through the model domain, with time-series inflow hydrographs adopted for all modelled storm events. A free outfall boundary condition was applied at the downstream extent of the model grid along the Karamū Stream, with a corresponding time-series head (water level) condition adopted for all modelled storm events.

Figure 21 shows the locations of the inflow and free outfall boundary conditions along the Karamū Stream.

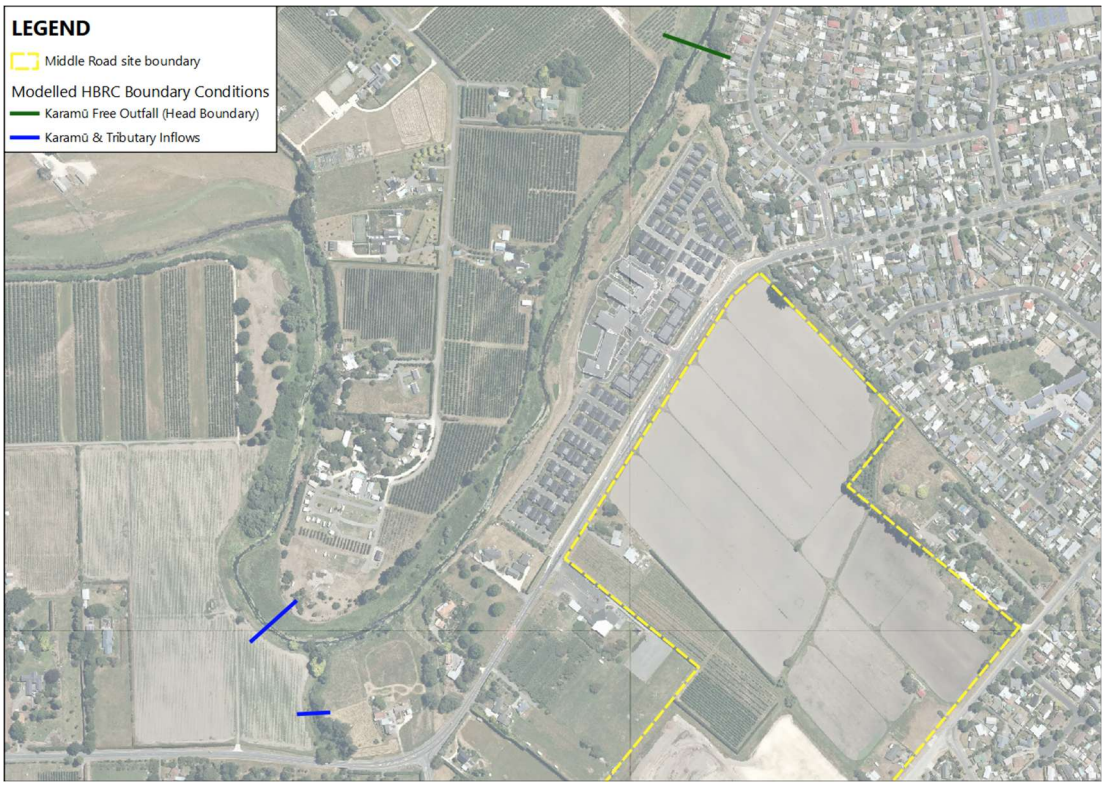


Figure 21. Modelled inflow and head boundary condition locations – Karamū Stream

With regards to quantifying effects, the HBRC provided boundary conditions are localised to the Karamū Stream. It is understood, based on discussions with HBRC, that the Karamū Stream has a significant lag time given the size of the contributing catchment. The stream has been described as slow to respond to rainfall events and a greater inundation risk to the site is posed by the Herehere Stream rather than the Karamū Stream.

7.5 Modelled Scenarios

The pre-development model scenario reflects the existing conditions. The model scenario has been developed to provide a baseline guide which is used to assess if the proposed development will result in material adverse flood effects outside the site.

The post development model scenario represents the changes proposed within the Middle Road development extent. The model results of the post development scenario have been used to evaluate the proposed design and assess any flood effects as a result of the proposed development. Table 10 provides a brief description of the assumptions and the parameters used to develop the model scenarios.

Table 10. Model scenarios

Scenario	Storm event	Landform	Iona Pond Boundary	HDC Boundary	HBRC Boundary	Purpose
Pre-development	5 year ARI; RCP 6.0	Existing surface (2024 LiDAR + 2026 Topo survey)	10 year + CC	5 year ARI; RCP 6.0	5 year ARI; RCP8.5	*Assessment of Effects*- Baseline Scenario
	50 year ARI; RCP 6.0		100 year + CC	50 year ARI; RCP 6.0	50 year ARI; RCP 8.5	*Assessment of Effects*- Baseline Scenario
	100 year ARI; RCP6.0		100 year + CC	100 year ARI; RCP6.0	100 year ARI; RCP8.5	*Assessment of Effects* - Baseline Scenario
Post development (Assessment of Effects)	5 year ARI; RCP 6.0	Design surface within development extent + existing surface (2024 LiDAR + 2026 Topo survey)	10YR + CC	5 year ARI; RCP 6.0	5 year ARI; RCP8.5	*Assessment of Effects*- Development Scenario
	50 year ARI; RCP 6.0		100 year + CC	50 year ARI; RCP 6.0	50 year ARI; RCP 8.5	*Assessment of Effects*- Development Scenario
	100 year ARI; RCP6.0		100 year + CC	100 year ARI; RCP 6.0	100 year ARI; RCP8.5	*Assessment of Effects*- Development Scenario
Post development (Channel Design)	2 year ARI; RCP6.0	Design surface within development extent + existing surface (2024 LiDAR + 2026 Topo survey)	2 year + CC	2 year ARI: RCP 6.0	5 year ARI; RCP8.5	*Design runs*- Conveyance Channel Design
	10 year ARI; RCP 6.0		10 year + CC	10 year ARI: RCP 6.0	5 year ARI; RCP8.5	*Design runs*- Conveyance Channel Design

7.6 Model Results

Maximum flood levels were extracted from the flood models. The extracted models have been further processed to create difference plots (afflux plots) to investigate any flooding effects resulting from the proposed development.

7.6.1 Pre-Development Model Scenario

Figure 22 and Figure 23 show the maximum modelled flood depths for the pre-development model scenario during a 50- and 100-year ARI storm event (with allowance for RCP6.0 future climate change), respectively. These depths have been filtered for depths less than 20mm, which is within modelling tolerances.

The pictured model results show the existing floodplain extents within and in the vicinity of the development. Of note is the flooding to the north of Herehere Stream, localised to Upham Street and private properties to the south of the development, bound by Middle Road, Te Aute Road and Gilpin Road.

Plans showing the pre-development depths and water level extents across the modelled scenarios are included in Appendix 1.

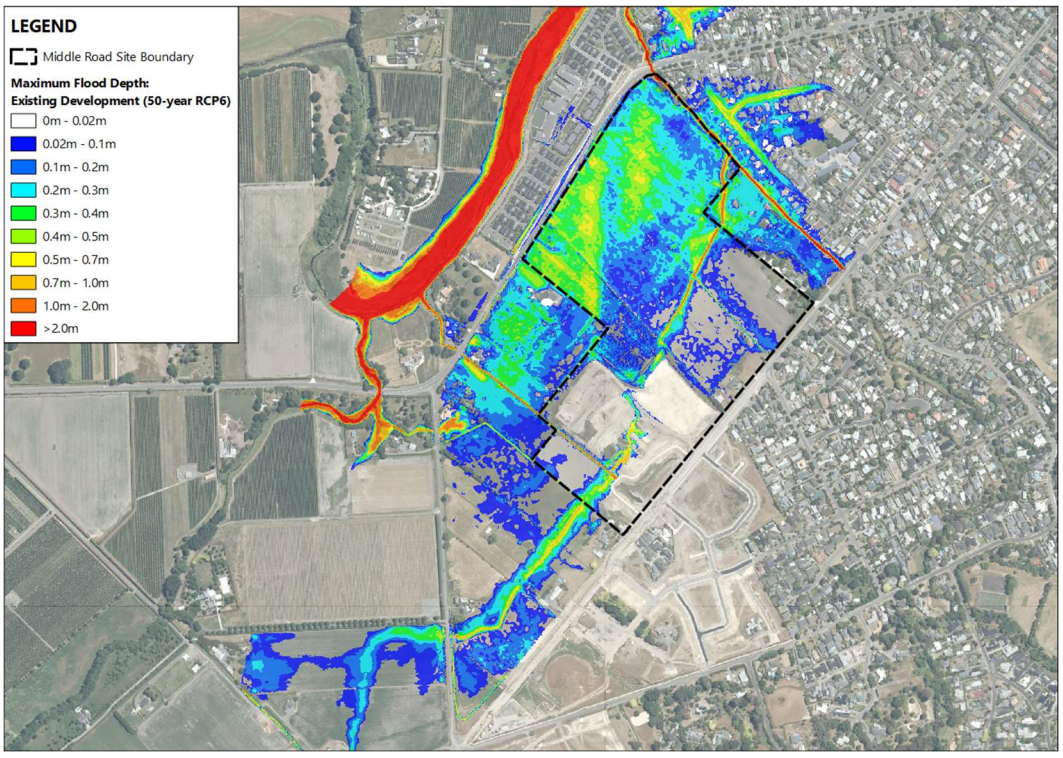


Figure 22. Pre-development 50-year ARI RCP6.0 Max Depth

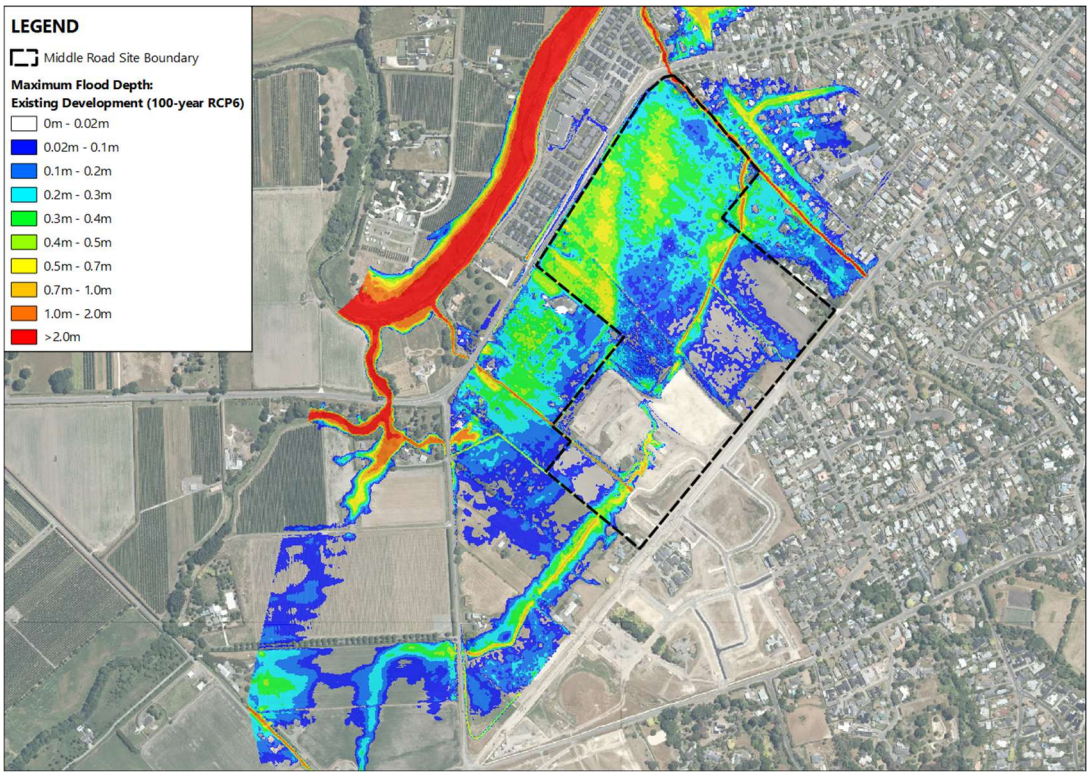


Figure 23. Pre-development 100-year ARI RCP6.0 Max Depth

7.6.1.1 Pre-development – Northern Outflows

Flows in the pre-development enter the site via the boundary shared with McKenna Block and exit the site into the Herehere Stream via a natural bund. This can be seen in Figure 24, which shows velocity arrows for a visual indication of flows entering and leaving along the Herehere Stream.

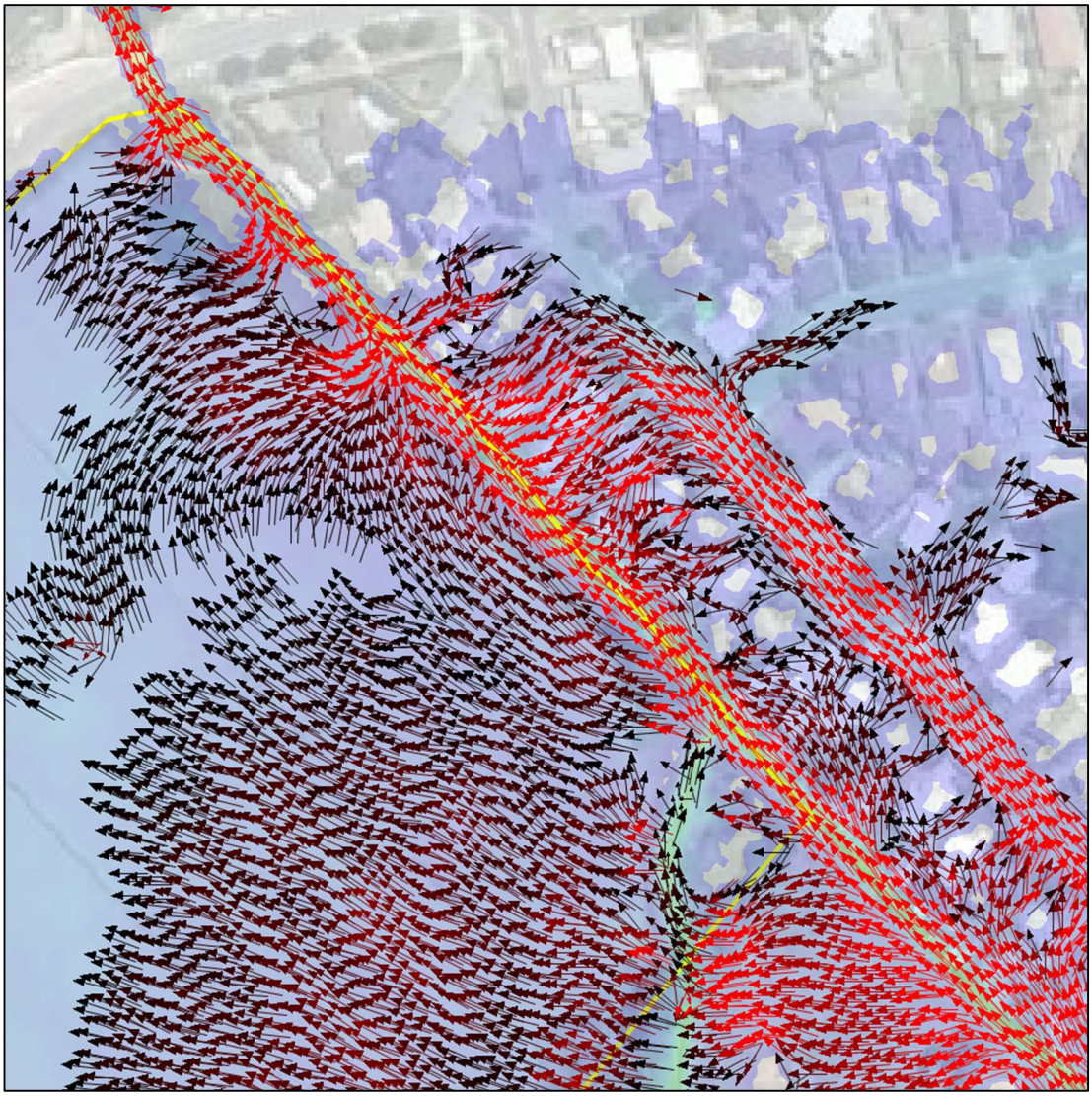


Figure 24. Pre-development northern outflows - velocity arrows showing discharge to the Herehere Stream

The 100-year ARI RCP6.0 pre-development outflow hydrographs into the Herehere Stream can be seen in **Figure 25**. The result shows a peak flow of 4.2m³/s discharging into the Herehere Stream.

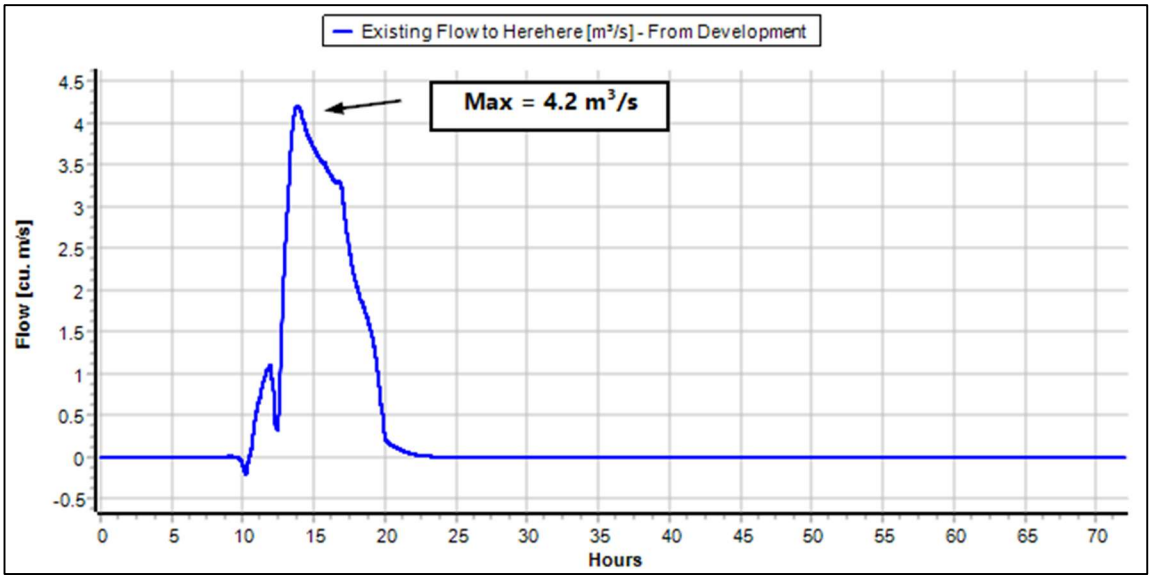


Figure 25. Existing discharge into the Herehere (100 year ARI RCP6.0)

7.6.1.2 Pre-development – Southeastern Outflows

Outflows from the southeastern part of the site is controlled by the existing culverts in **Figure 18**, primarily the DN1200 under Te Aute and the DN900 under Gilpin Road. These culverts discharge to tributaries/drains that ultimately convey flows to the Karamū Stream.

Pre-development outflow hydrographs for the 100 year ARI RCP6.0 event for the culverts under Te Aute Road and Gilpin Road can be seen in **Figure 26** and **Figure 27**. It is important to note that flows from the site do not overtop onto either road in the 100-year ARI RCP6.0 scenario.

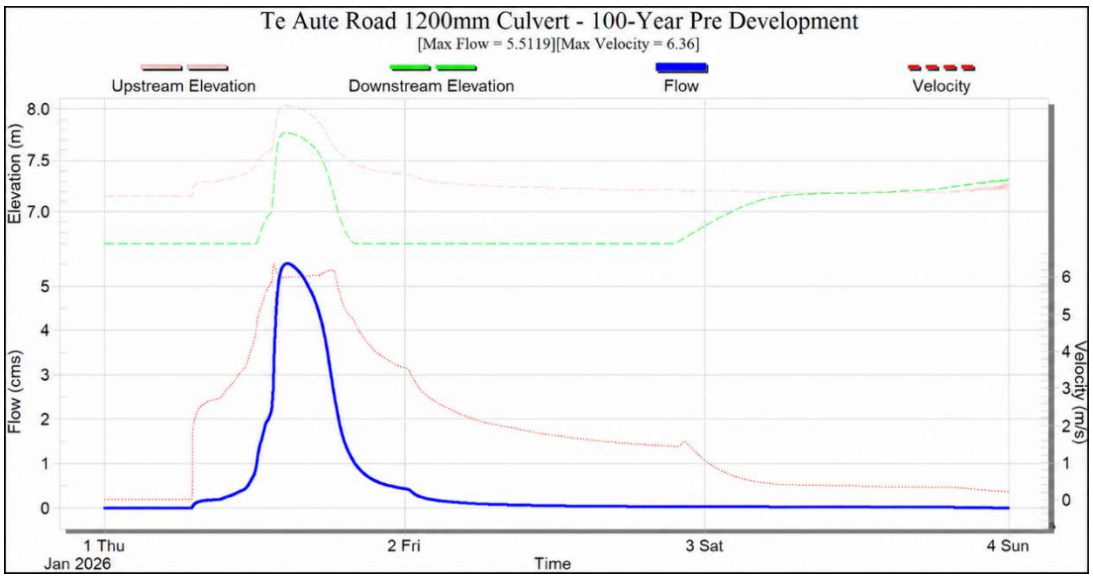


Figure 26: Pre-development Te Aute Road culvert outflows - 100 year RCP6.0

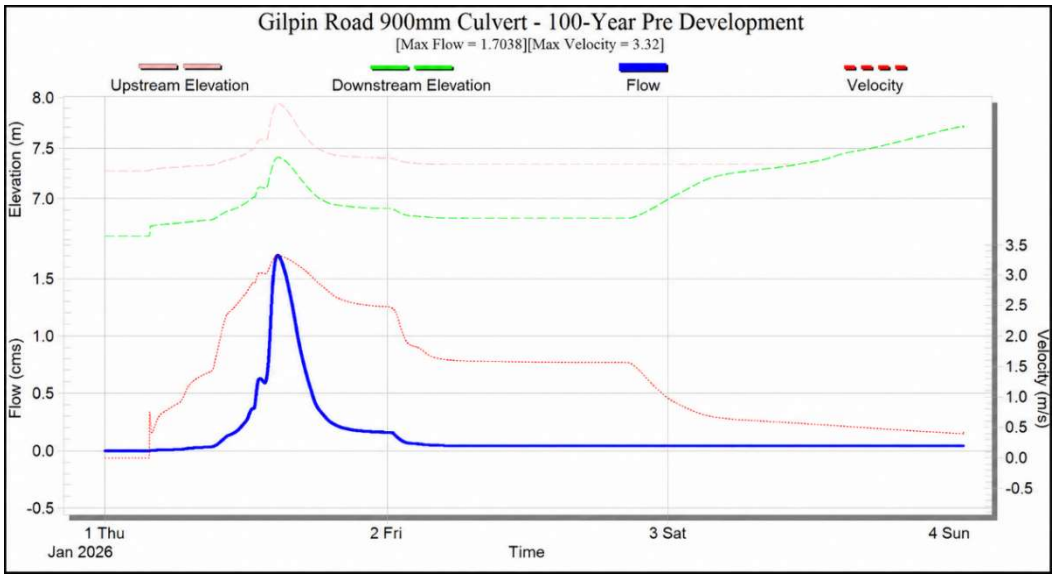


Figure 27: Pre-development Gilpin Road culvert outflows - 100 year RCP6.0

7.6.2 Post Development Model Scenario

Figure 28 and Figure 29 show the maximum modelled flood depths for the pre-development model scenario during a 50- and 100-year ARI RCP6.0 storm event, respectively. These depths have been filtered for depths less than 20mm, which is within modelling tolerances.

Plans showing the post development depths and water level extents are included in Appendix 1.

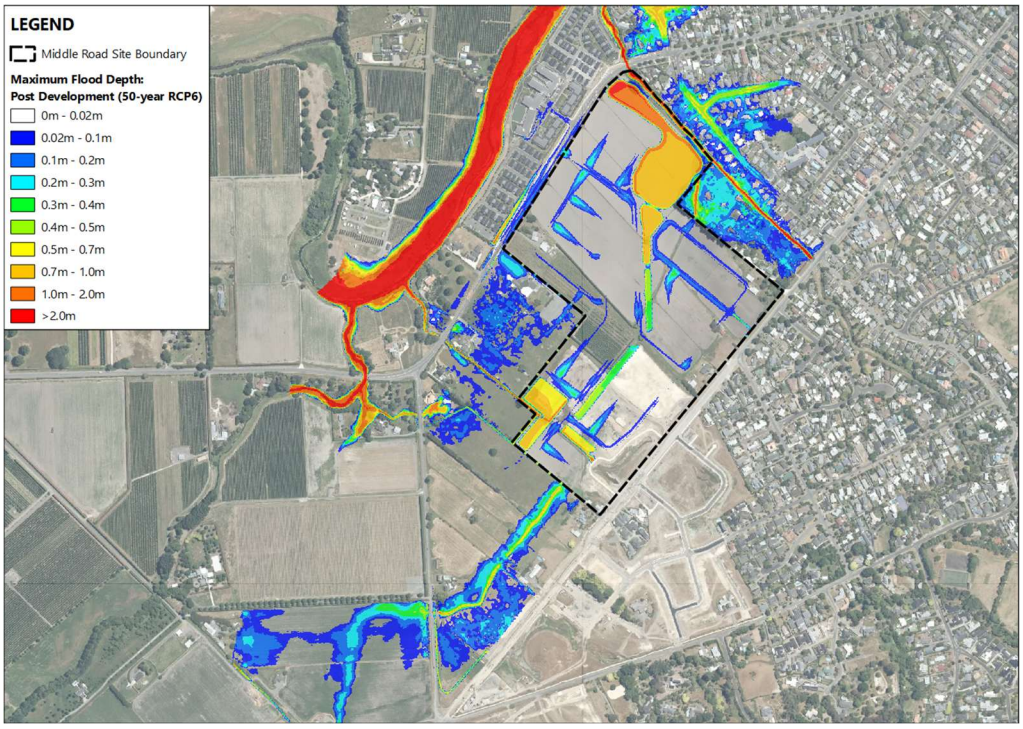


Figure 28. Post development Max Depth - 50-year ARI RCP6.0

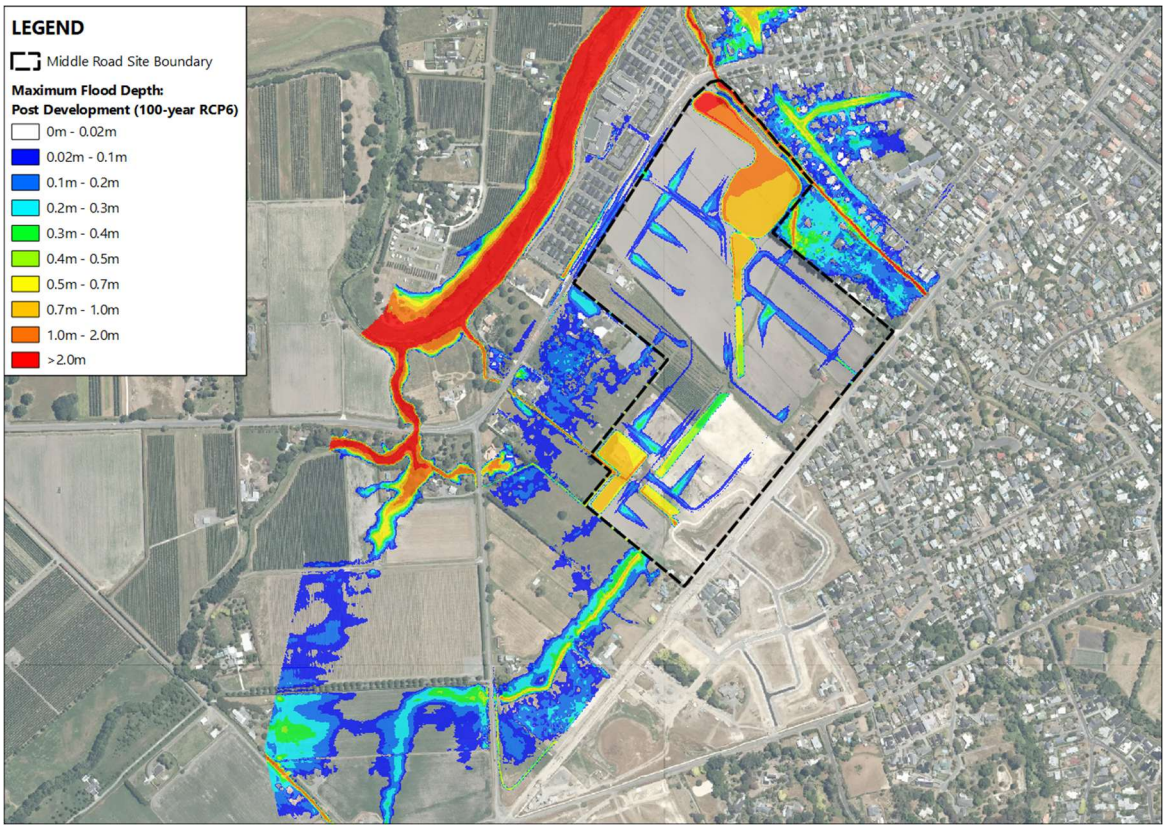


Figure 29. Post development Max Depth - 100-year ARI RCP6.0

7.6.2.2 Post Development – Northern Outflows

The landform in the post development has been designed to control the amount of water entering and leaving the site via spillways. The flood results demonstrate that in the 50- and 100-year ARI storm events, flows exit the site through the outlet structure manhole and by overtopping via the proposed spillway.

100-year ARI outflow hydrographs into the Herehere Stream via the outlet structure manhole is shown in Figure 30. The hydrograph demonstrates that tailwater effects dictate how much flow discharges from the outlet manhole into the receiving environment. The outlet manhole hydrographs show that outflows drop to $0m^3/s$ at various points during the simulation. A backflow preventer will be used at this outlet.

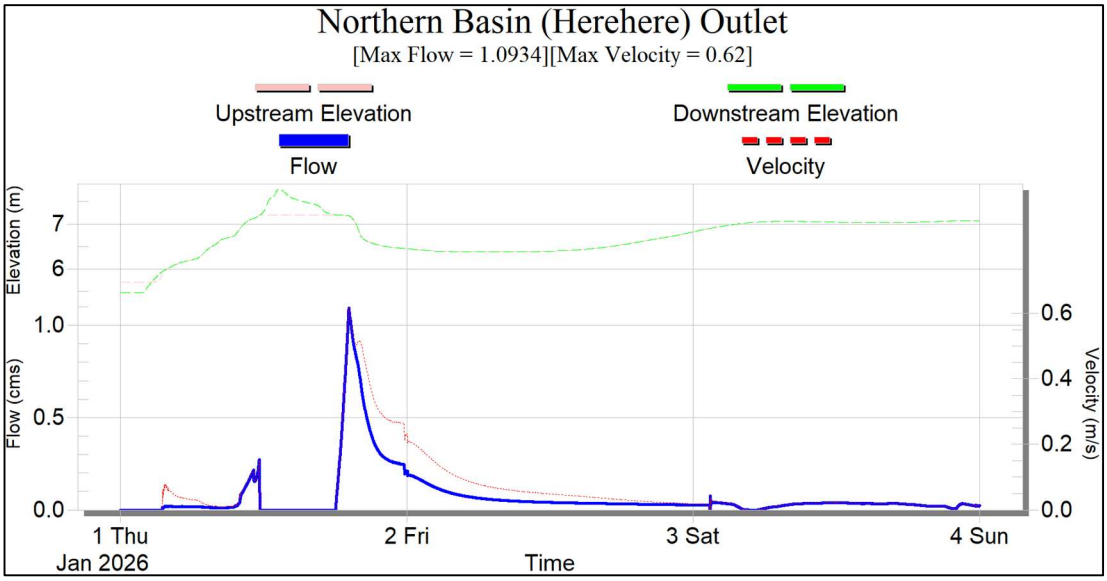


Figure 30. Post Development Herehere Basin outflow hydrograph – 100 year ARI RCP6.0

The 100-year ARI RCP6.0 post development flows over the Herehere basin spillway can be seen in **Figure 31**.

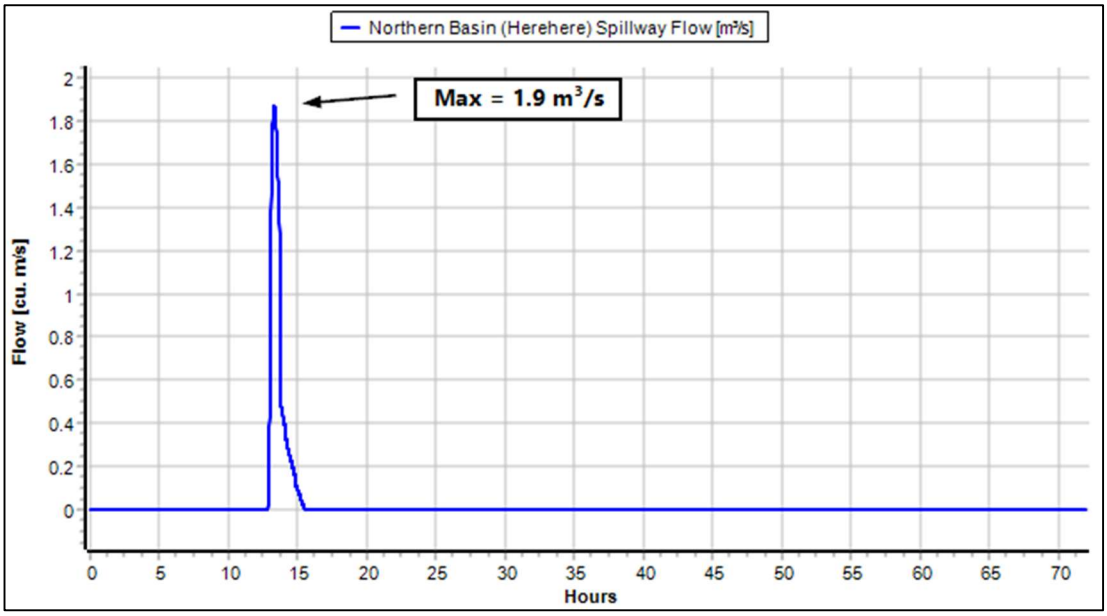


Figure 31. Post Development Herehere Basin Spillway hydrograph –100-year ARI RCP6.0

The hydrographs demonstrate that the cumulative peak flow rates discharging to the Herehere Stream is less than the pre-development peak flow rate (4.2m^3/s) into the Herehere Stream.

7.6.2.3 Post Development – Southeastern Outflows

As with the Herehere Stream outlet, the flows the of Gilpin Drain downstream of the site are managed by an outlet manhole structure and spillway. Tailwater effects are also present at this outlet, which will be fitted with a backflow preventer. 100-year ARI outflow hydrographs into the Herehere Stream via the outlet structure manhole is shown in **Figure 32**.

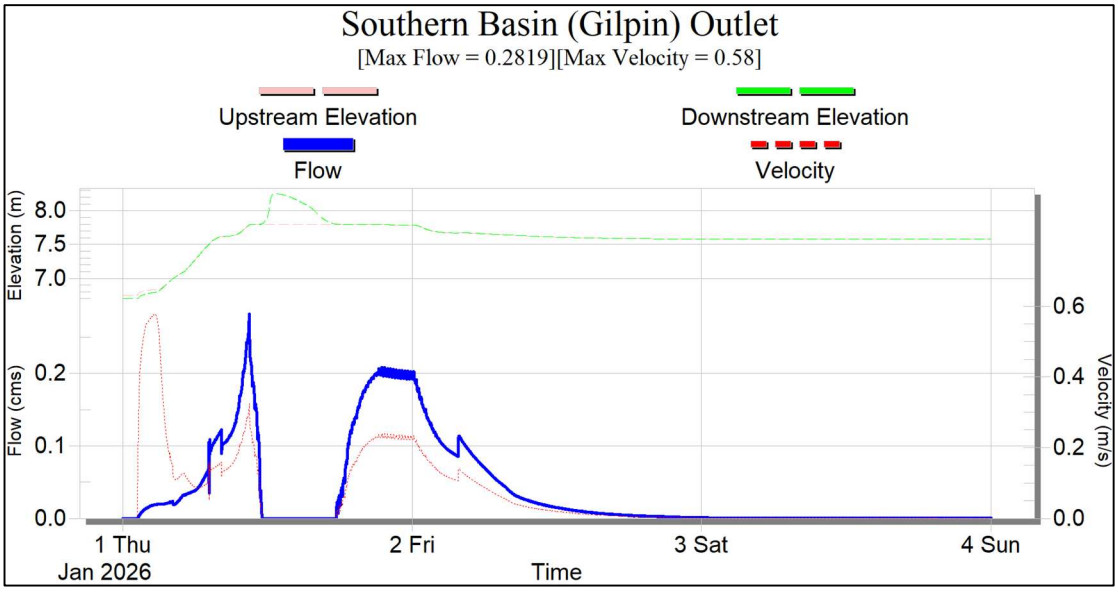


Figure 32. Gilpin Basin outflow hydrograph - 100-year ARI RCP6.0

The 100-year ARI RCP6.0 post development flows over the Gilpin Basin spillway can be seen in Figure 33.

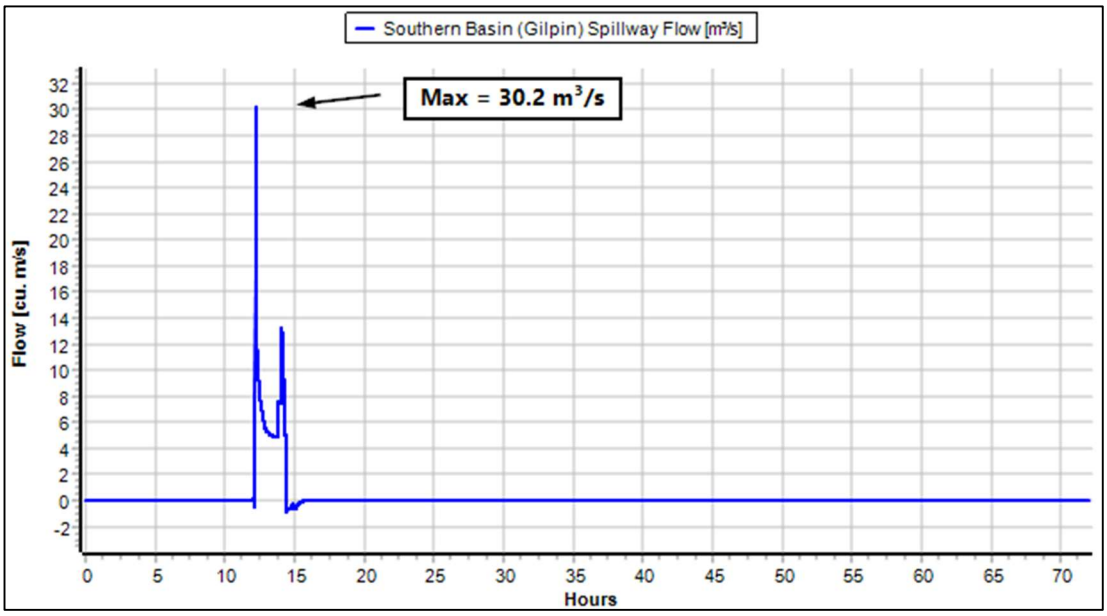


Figure 33. Gilpin Basin spillway hydrograph – Post Dev 100-year ARI RCP6.0

As discussed in the pre-development section, the flows leaving the southeastern portion of the area bound by Gilpin and Te Aute Road is controlled by the culverts under these roads. The post development flow hydrographs for the 100-year RCP6.0 event can be seen in Figure 34 and Figure 35.

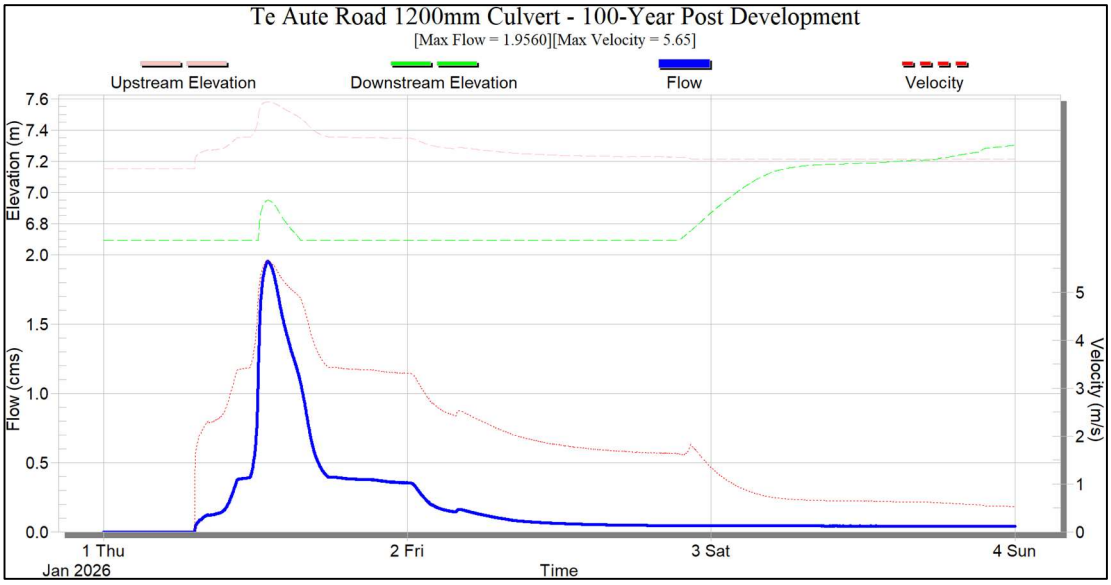


Figure 34: Post development Te Aute Road culvert outflows – 100 year RCP6.0

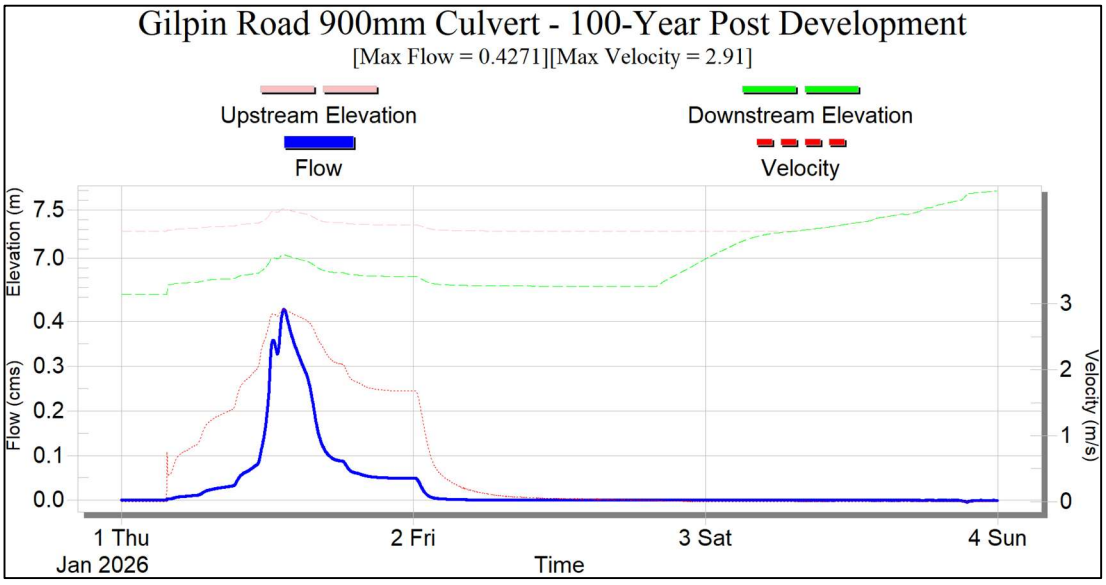


Figure 35. Post development Gilpin Road culvert outflows – 100 year RCP6.0

The flow hydrographs show that the amount of water through both the culverts has decreased significantly because of the Gilpin Basin. The afflux plots show no changes to the existing floodplain extent downstream of these culverts.

7.6.3 Hazard Assessment

Site generated flows are directed via the internal road network to the basins. This presents a potential risk to people and cars encountering flooding. This section outlines a hazard assessment for trafficability and pedestrian safety in accordance with the Australian Rainfall-Runoff 2019 manual (ARR) methodology, which is considered best practice in Australia and New Zealand to assess flood hazard risk.

ARR defines flood hazard vulnerability as being divided into six categories as follows:

- H1: Generally safe for vehicles, people and buildings.

- H2: Unsafe for small vehicles.
- H3: Unsafe for vehicles, children and elderly
- H4: Unsafe for vehicles and people
- H5: Unsafe for vehicles and people. All building types vulnerable to structural damage. Some less robust building types vulnerable to failure.
- H6: Unsafe for vehicles and people. All building types considered vulnerable to failure.

A copy of the flood hazard vulnerability curves and criteria are shown in Figure 36 and

Table 11, respectively.

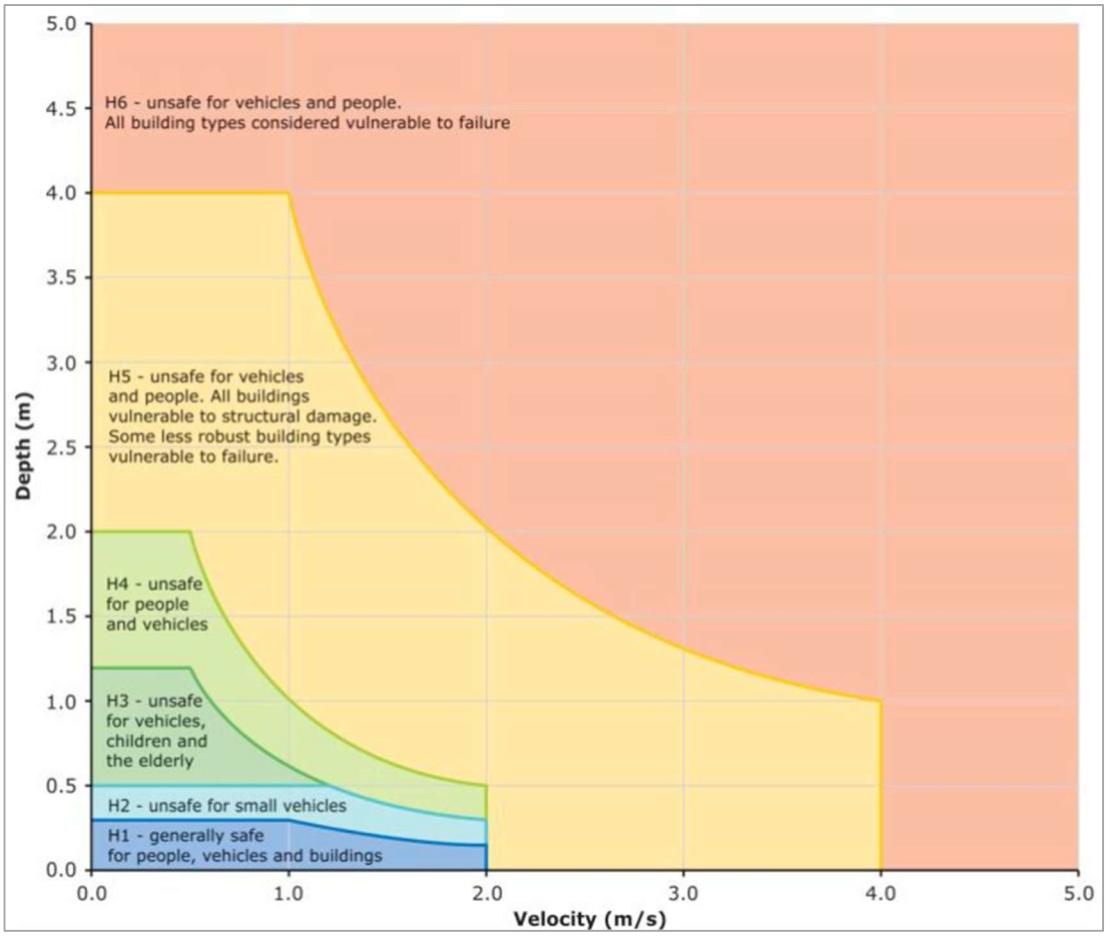


Figure 36. General Flood Hazard Vulnerability Curves (ARR)

Table 11. Vulnerability Threshold Classification Limits (ARR)

Hazard Vulnerability Classification	Classification Limit (D & V in Combination), m²/s	Limiting Still Water Depth (D), m	Limiting Velocity (V), m/s
H1	D*V ≤ 0.3	0.3	2.0
H2	D*V ≤ 0.6	0.5	2.0
H3	D*V ≤ 0.6	1.2	2.0
H4	D*V ≤ 1.0	2.0	2.0
H5	D*V ≤ 4.0	4.0	4.0
H6	D*V > 4.0	-	-

An assessment of the 100-year ARI flood event based on the ARR methodology for the proposed development was undertaken to quantify the flood risk. Results from this analysis for the 100-year ARI post-development scenario is included in **Figure 37.**

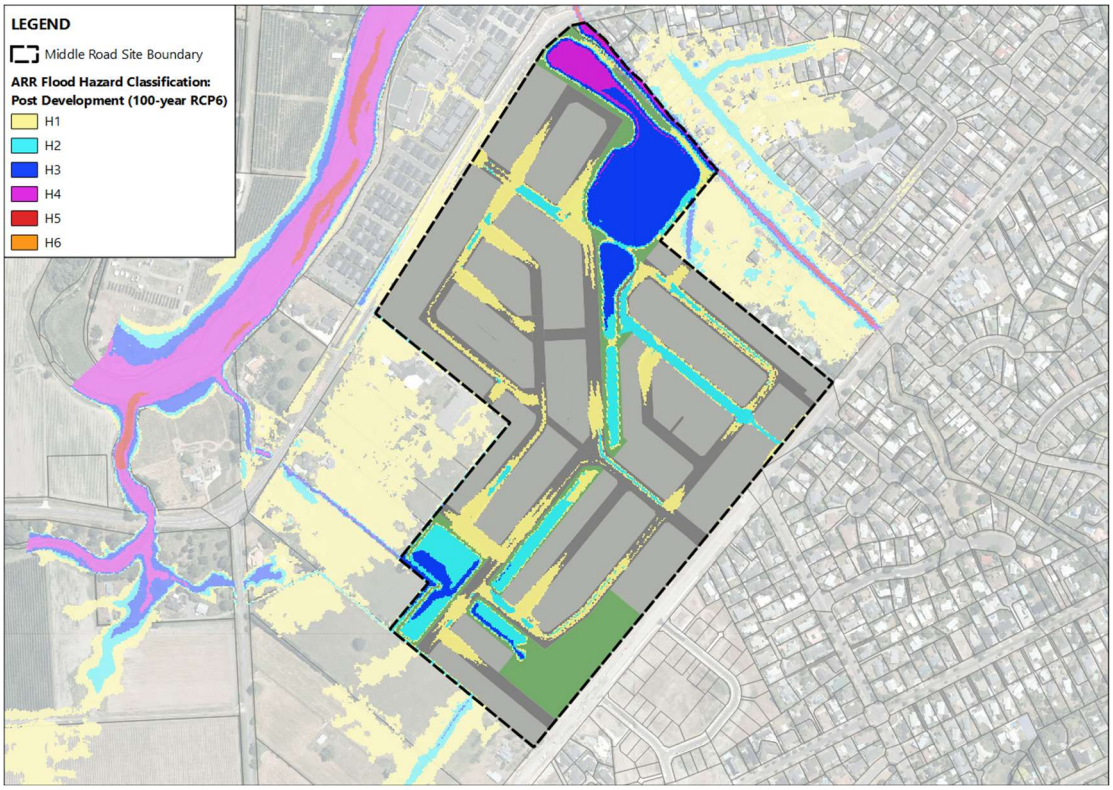


Figure 37. ARR Flood Hazard - Post Development 100-Year RCP6.0

The flood hazard assessment shows that the flood hazard within the development's internal road carriageways remains low overall, with much of the roading network experiencing no more than an H1 hazard classification. An H1 classification is generally safe for people, vehicles, and buildings.

A limited extent of the roading network reaches an H2 classification, which may affect small passenger vehicle trafficability, but will remain safe for people. Trafficability for large passenger and emergency vehicles remains unaffected.

Basins 1 and 2 are divided by a pedestrian walkway, where the hazard criteria is a maximum of H2 classification. This classification is safe for pedestrians. Within the basins, the hazard is classified as H3. This classification is unsafe for vehicles, children and the elderly. Signage will be put up that the dry basins must be vacated during extreme rainfall events.

Cross-sections showing flood depths on the roading network can be found in the Infrastructure Report.

7.6.4 Floodplain Storage

The modelling demonstrates that adequate floodplain storage has been provided in the basin system. This is corroborated by afflux plots showing flood depth decreases in green within and outside of the site, save for the minor differences discussed in the following section.

Notably the flood depth differences for the Upham Street properties demonstrate that flooding to the north of the Herehere Stream is alleviated. Similar decreases in flood depth are noted for the areas downstream of the Gilpin Basin.

7.6.5 Flood Effects Assessment

Plots showing the maximum modelled flood depth differences (afflux plots) between the pre and post development model scenarios have been generated to assess any flood effects that may arise from the development. Negative values indicate a net reduction in green and positive values show a net increase in red relative to pre-development flood depths.

To quantify effects off-site, the discussion around affluxes in this section focuses on the 100-year storm event, as internal and external flows for smaller events are managed in the proposed basins. Afflux plots for the smaller events are provided in Appendix 1.

Figure 38 and Figure 39 show afflux plots between the pre-development and post development model scenarios in the 50- and 100-year ARI RCP6.0 events respectively.

The flood modelling indicates significant reductions in flooding across third-party land with some localised increases, which are discussed in subsequent sections.

Three areas exhibit particularly significant improvement:

- The area southwest of the development, bound by Te Aute Road and Gilpin Road;
- Residential properties north of Herehere Stream in the vicinity of Elliot Cresent and Upham Street; and
- The western side of the McKenna Block.

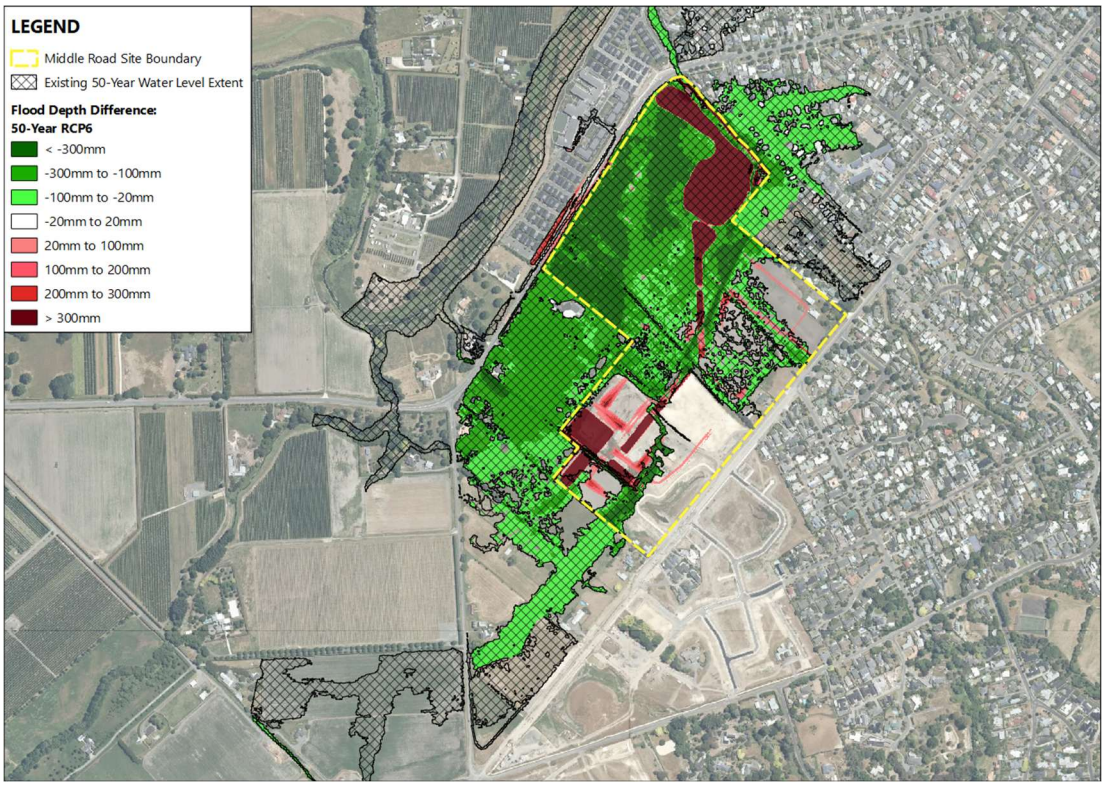


Figure 38. Post development minus pre-development flood levels (50-year RCP6.0)

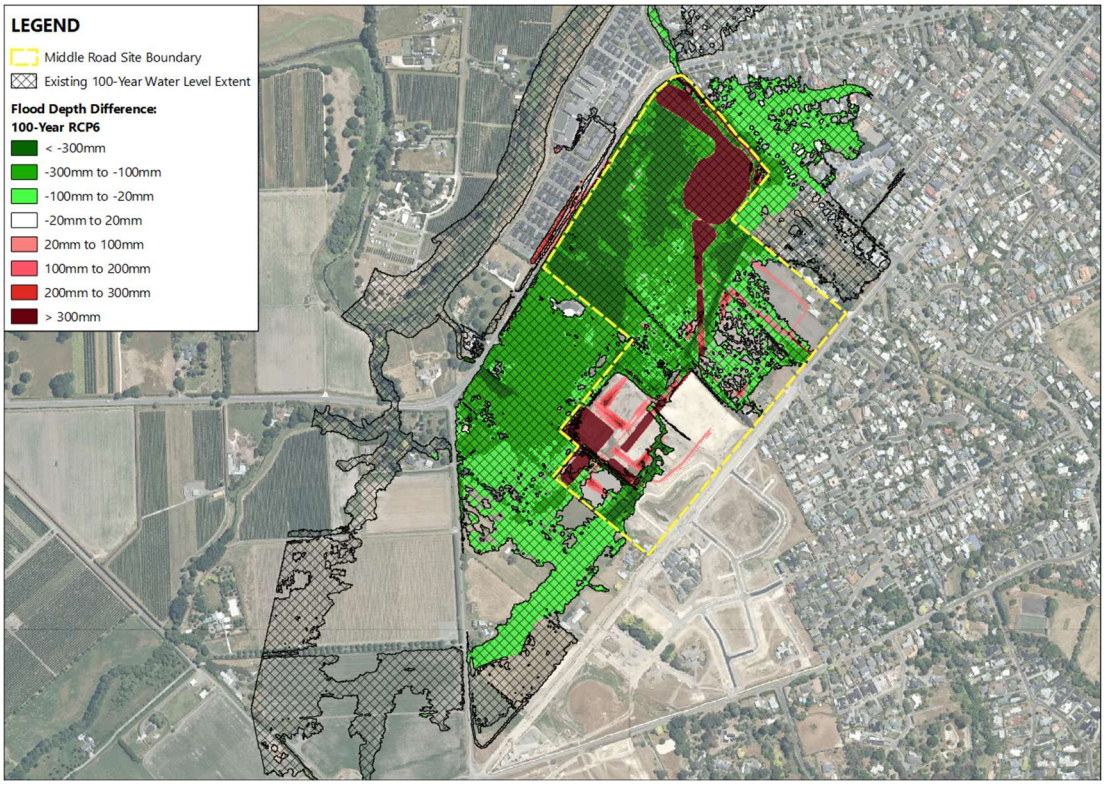


Figure 39. Post development minus pre-development flood levels (100-year RCP6.0)

A blockage scenario has been modelled for the post-development 100-year ARI RCP6.0 event, comprising full blockage of the two basin outlets, to assess the resulting flooding effects.

Figure 40 shows the afflux plot comparing the pre-development and post-development blockage model scenario for the 100-year ARI RCP6.0 event.

The results demonstrate that significant improvements to flooding external to the development are retained under this blockage scenario. One noticeable change is an increase in depths observed through the Herehere Stream. This result was expected, as the blocked outlets result in greater reliance on the emergency spillway, and hence increased flows discharging to the Herehere Stream during the peak of the storm event. Despite this, the increase in depth remains within the existing flood extents.

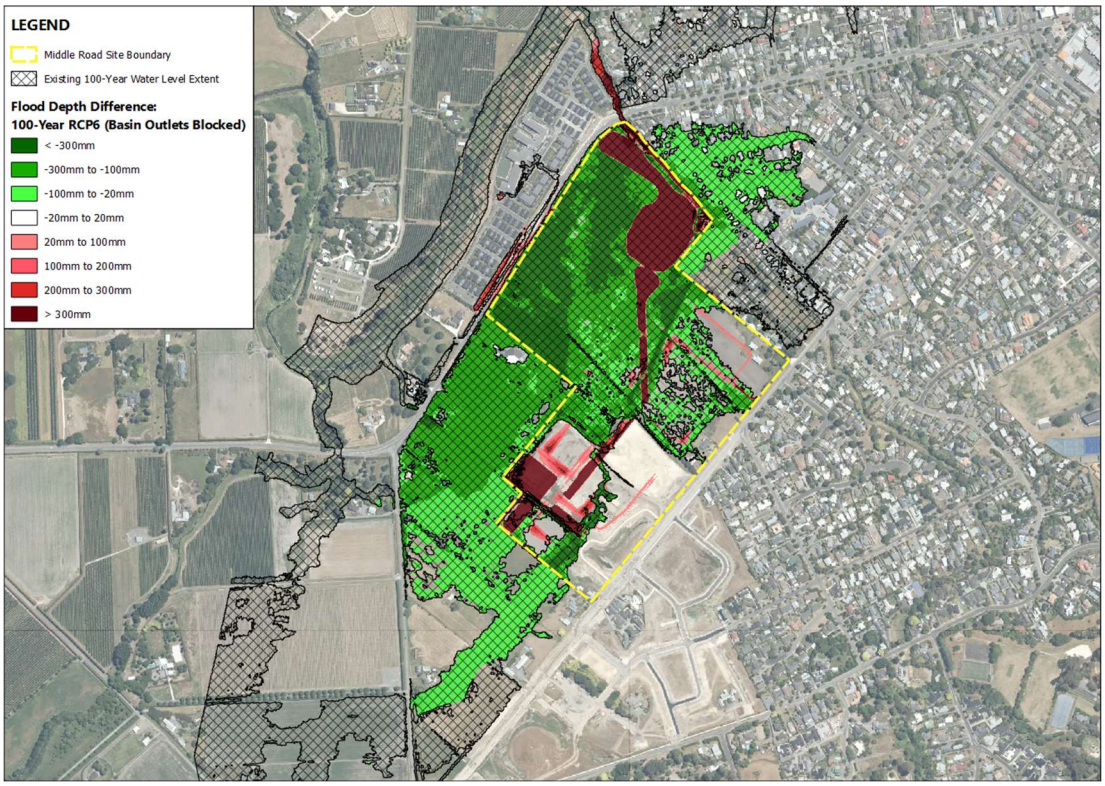


Figure 40. Post development (with Basin outlets fully blocked) minus pre-development flood levels (100-year RCP6.0)

7.6.5.2 McKenna Block

The flood modelling undertaken shows that during larger storm events, the Herehere Stream overtops into the development extent mostly via the McKenna Block. As the McKenna Block is outside of the development extents, no changes to the ground level are proposed here and flows will continue to enter the subject site along the McKenna Block boundary.

Some minor increases in flood depth are observed along the boundary shared with the development extent (denoted in red). Within the area of observed increases, the maximum flood depth is approximately 140mm in the pre-development scenario, increasing to approximately 190mm in the post-development scenario. These increases are in the range of approximately 60mm or less (Figure 41), nestled within the existing floodplain extent. This area is also located away from buildings and therefore does not impact freeboard to habitable floors.

The afflux on the McKenna Block largely exhibits significant reductions in flood depth in post-development scenarios, shown in green. This is the result of landform changes within the

development extent to improve flood conveyance into the proposed basin to the north of the McKenna Block.

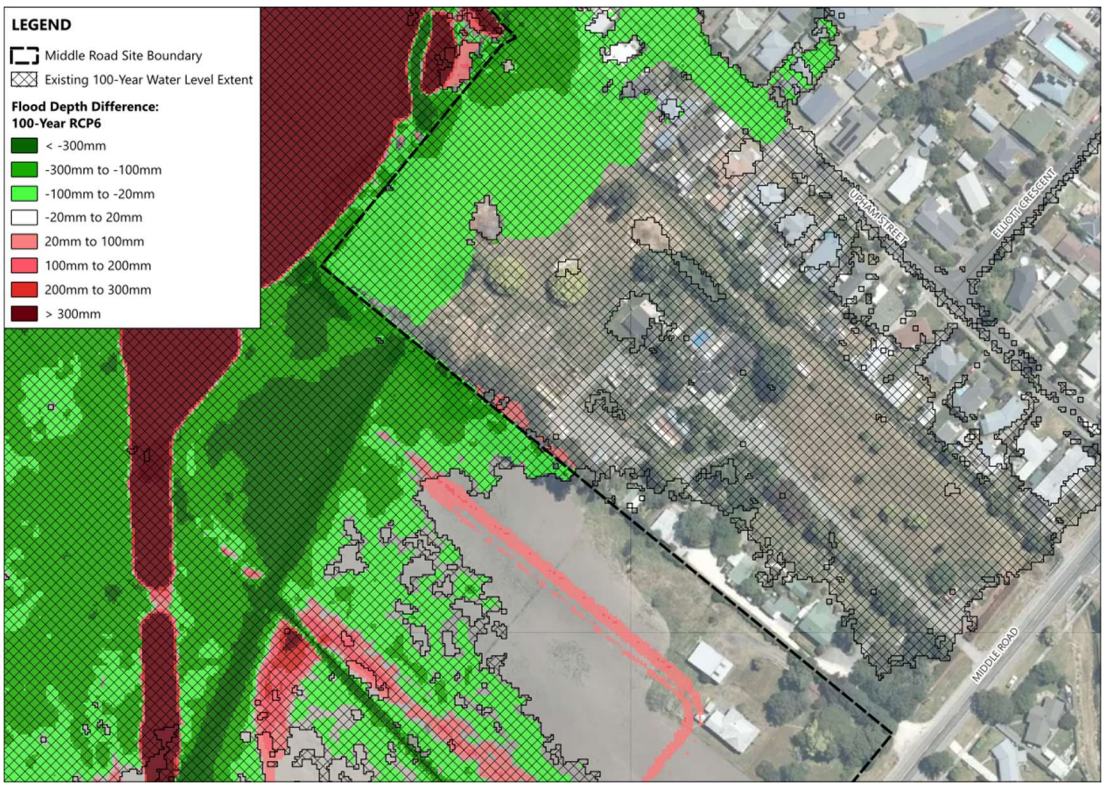


Figure 41. McKenna Block – Post minus Pre Flood Depths (100-Year RCP6.0)

7.6.5.3 Te Aute Road

An existing scruffy dome on the western berm of Te Aute Road discharges via a 375mm pipe to a downstream Up-Flo filter manhole, before ultimately discharging to the Karamū Stream. This structure has not been included in the flood model and has therefore been conservatively assumed to be fully blocked for the purposes of this assessment. As the pump provides an additional discharge pathway that is not credited in the modelling, actual flood depths and hazard along Te Aute Road are expected to be equal to or better than the modelled results presented below.

A scruffy dome structure with a 675mm outlet is proposed along the eastern channel, alongside Te Aute Road. This structure will discharge flows to an existing roadside drain within Te Aute Reserve, improving conveyance and assisting in reducing flood depths along Te Aute Road.

Figure 42 shows the show afflux plots between the pre-development and post development model scenarios in the 100-year RCP6.0 event along Te Aute Road.

The maximum flood depth within the Te Aute Road carriageway is approximately 140mm in the existing scenario, increasing to approximately 170mm in the post-development scenario. This represents a difference of 30mm, which is negligible and does not affect the hazard or trafficability along the carriageway.



Figure 42. Te Aute Road - Post minus Pre Flood Depths (100-Year RCP6.0)

Figure 43 shows the H1 hazard classification along Te Aute Road under the post-development scenario for the 100-year storm event, with allowance for RCP6.0. The increase in flood depth observed along Te Aute Road has been assessed, in accordance with the ARR methodology, as carrying an H1 flood hazard classification across the carriageway. This classification indicates that the flooding is generally safe for people, vehicles and buildings. This classification is consistent with the existing (pre-development) hazard condition along Te Aute Road, indicating that the development does not result in a worsening of flood hazard at this location.

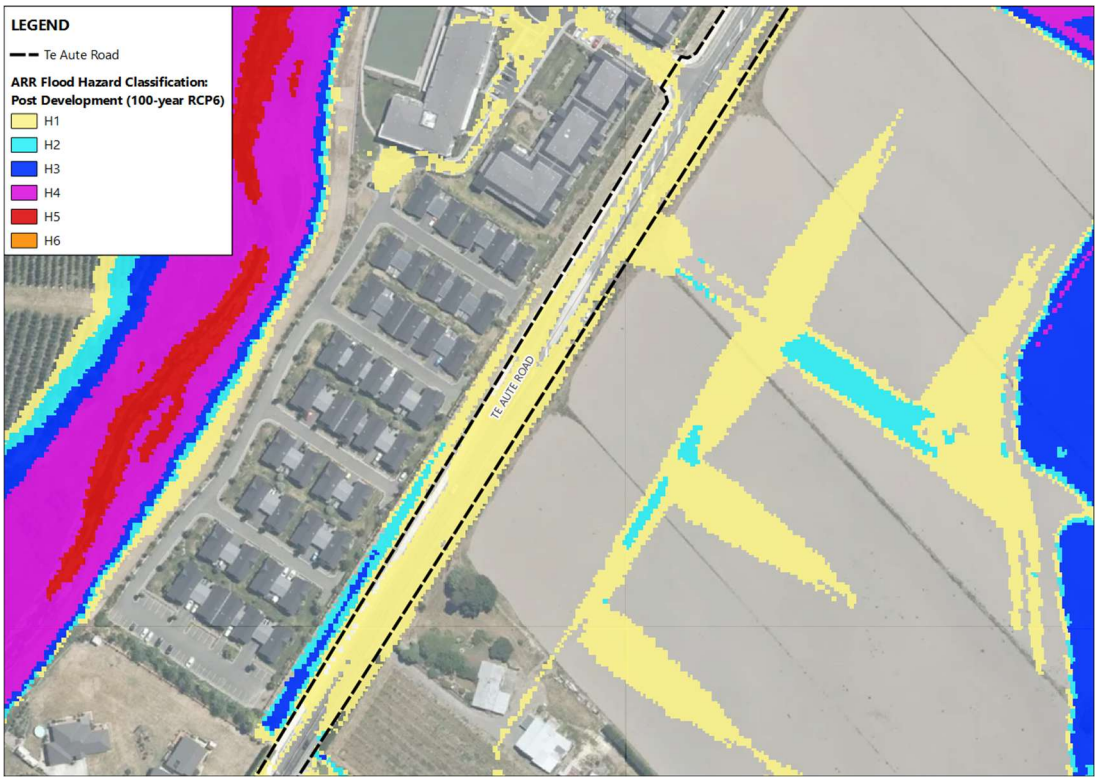


Figure 43. Te Aute Road Flood Hazard (H1) - Post Development 100-Year RCP6.0

7.6.5.4 James Wattie Retirement Village

A potential third-party effect has been identified within the James Wattie Retirement Village, comprising an increase in flood depth of no more than 40mm across a small section of the internal road carriageway at the James Wattie Retirement Village (**Figure 44**). This increase is below expected modelling tolerances and is nestled within the existing floodplain extent.

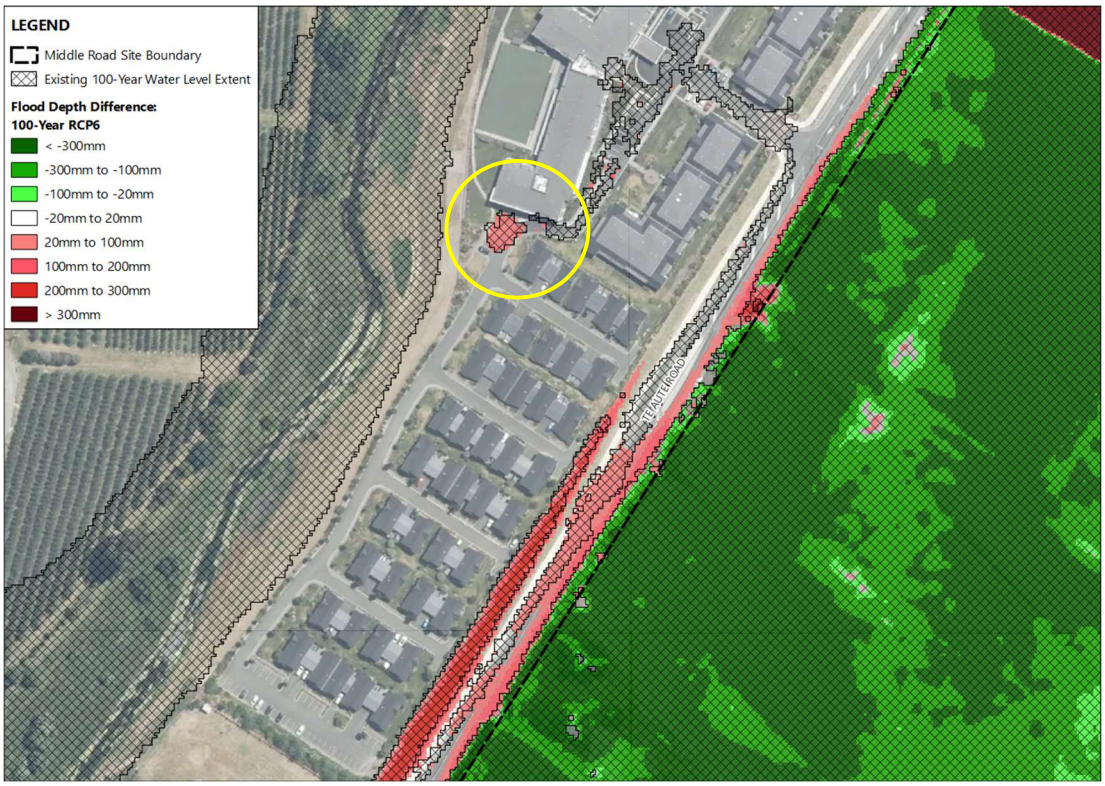


Figure 44. James Wattie Retirement Village – Post minus Pre Flood Depths (100-Year RCP6.0)

The flows entering the village were also assessed for the pre-development and post-development scenarios under the 100-year ARI RCP6.0 storm event. As shown in Figure 45 the pre-development scenario generates a peak flow of 0.022m³/s entering the village, compared to 0.024m³/s in the post-development scenario. This represents an increase of approximately 2 l/s, which is considered negligible and unlikely to result in any noticeable increase in flood risk to the village.

Given that the additional flow to the village is negligible and the identified increase in flood depth is below the tolerance level of the model, and negligible in its extent and amplitude, it is expected that this effect is a modelling anomaly and it hasn't been considered as a true effect of the development.



Figure 45. Flows entering James Wattie Retirement Village - 100 Year RCP6 Pre and Post Development

7.6.6 Finished Floor Levels

As per the HBRC Waterway Guidelines for Stormwater Management, habitable building floor levels are required to include a contingency freeboard above the 1% AEP flood level. In accordance with NZS 4404:2010, a minimum freeboard of 0.5 metres above the computed top water level for the 1% AEP design stormwater event is required for habitable dwellings, including attached garages.

8.0 Conclusion

This report has been prepared to support a Fast-track Substantive Application for CDL Land New Zealand Limited's Middle Road development, comprising approximately 317 residential lots. The proposed stormwater management strategy has been developed to achieve hydraulic neutrality and improved flood outcomes across the 30.6ha site.

The approach has been developed to meet the objective and design requirements of Hastings District Council and Hawkes Bay Regional Council and demonstrates that stormwater and flood risk can be appropriately managed within the development. The proposed stormwater management strategies are as follows:

- Water quality has been addressed through a treatment train approach combining a baffle box and dry basins for an overall expected 84% TSS removal rate against HBRC's 75% minimum requirement. Temperature effects on the sensitive Herehere Stream receiving environment have been specifically considered, with vegetation on the batter slopes and shallow basin grades expected to detain and drain runoff to ground during more frequent storm events, adequately managing any potential temperature increase prior to discharge.
- Stream bank widening works are proposed along the Herehere Stream to address existing erosion concerns upstream of the Te Aute Road bridge. Further, extended detention will be provided within the proposed basins to prevent stream erosion.
- The existing site provides floodplain storage for flows that overtop from the Herehere Stream. Water quantity will be managed in dry basins that have been sized for site generated runoff and floodplain storage. Modelling demonstrates that flows leaving the site are generally less than the pre-development flow rates exiting the site.
- Flood modelling under RCP6.0 climate change projections shows a net improvement in flooding across most of the surrounding catchment, with reductions in flood depths southwest of the development, north of the Herehere Stream, and the McKenna Block. Small, localised increases have been identified at the McKenna Block boundary, along Te Aute Road, and at the James Wattie Retirement Village. These increases are localised to within the existing floodplain extent or within modelling tolerances.

Proposed works to the Herehere Stream, including bank re-grading with riparian planting, address the erosion risk identified in HDC's Stream Erosion Review and have received in-principal support from HDC, HBRC and Tamatea Pōkai Whenua Iwi.

Stormwater has been carefully managed to align with HDC and HBRC objectives, while protecting the receiving environment. The design demonstrates that stormwater can be adequately managed to accommodate the proposed development of 317 lots at Middle Road. Overall, the proposed stormwater management approach ensures that runoff from the development is appropriately attenuated, treated, and conveyed, with less than minor effects on the receiving environment, or on third party land.

APPENDIX 1: FLOOD MAPS

LEGEND

Middle Road Site Boundary

Maximum Modelled Flood Depth:
Existing Development
5-Year RCP6.0

- 0m - 0.02m
- 0.02m - 0.1m
- 0.1m - 0.2m
- 0.2m - 0.3m
- 0.3m - 0.4m
- 0.4m - 0.5m
- 0.5m - 0.7m
- 0.7m - 1.0m
- 1.0m - 2.0m
- >2.0m

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/09/2026	DESIGNED	-
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				APPROVED	TR

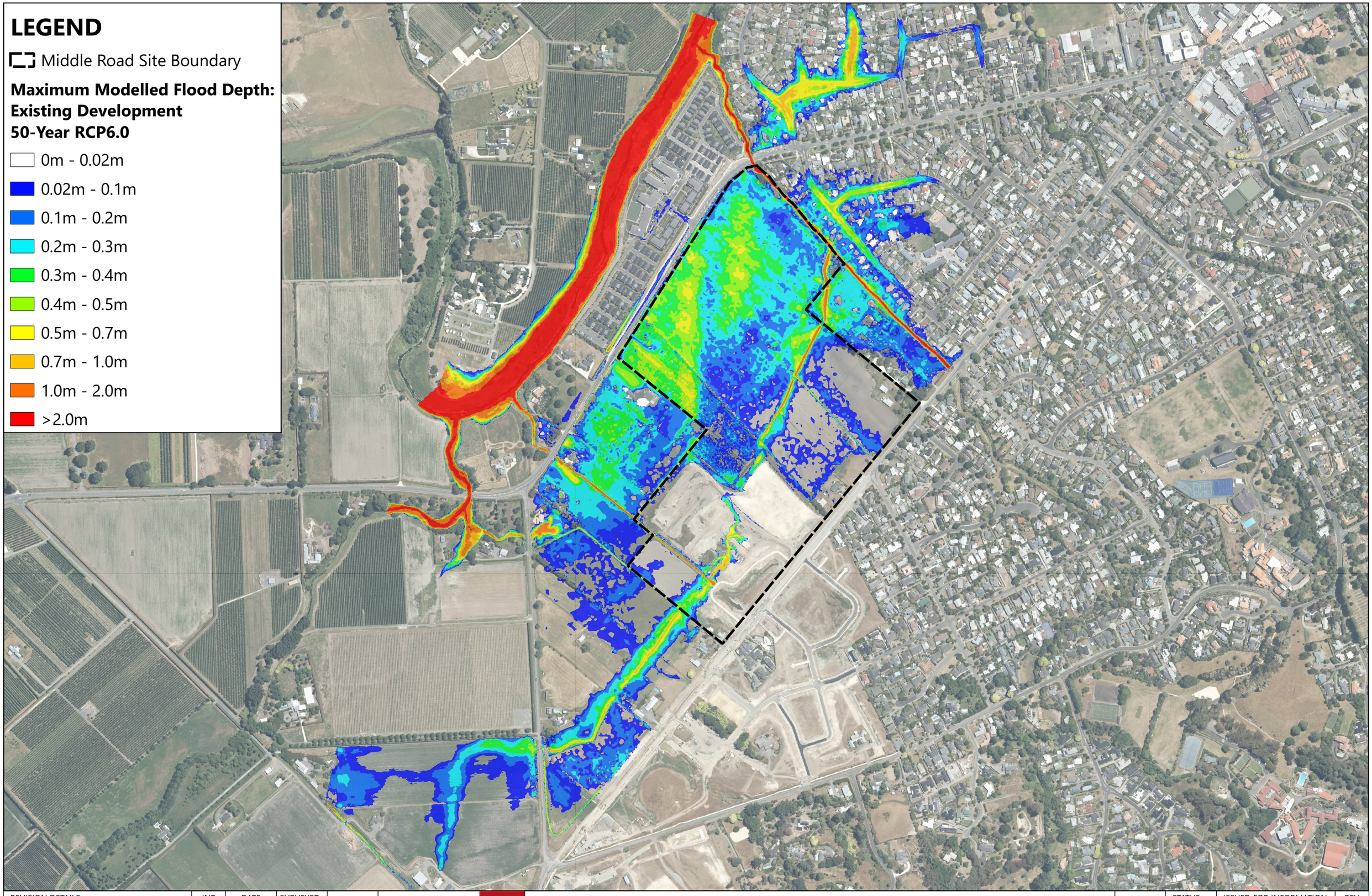
8 NUGENT STREET,
GRAFTON,
AUCKLAND

WOODS
Est.1970

WOODS.CO.NZ

P25-496 - MIDDLE ROAD SUBSTANTIVE
MAXIMUM MODELLED FLOOD DEPTH:
EXISTING DEVELOPMENT
5-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 1 OF 11	

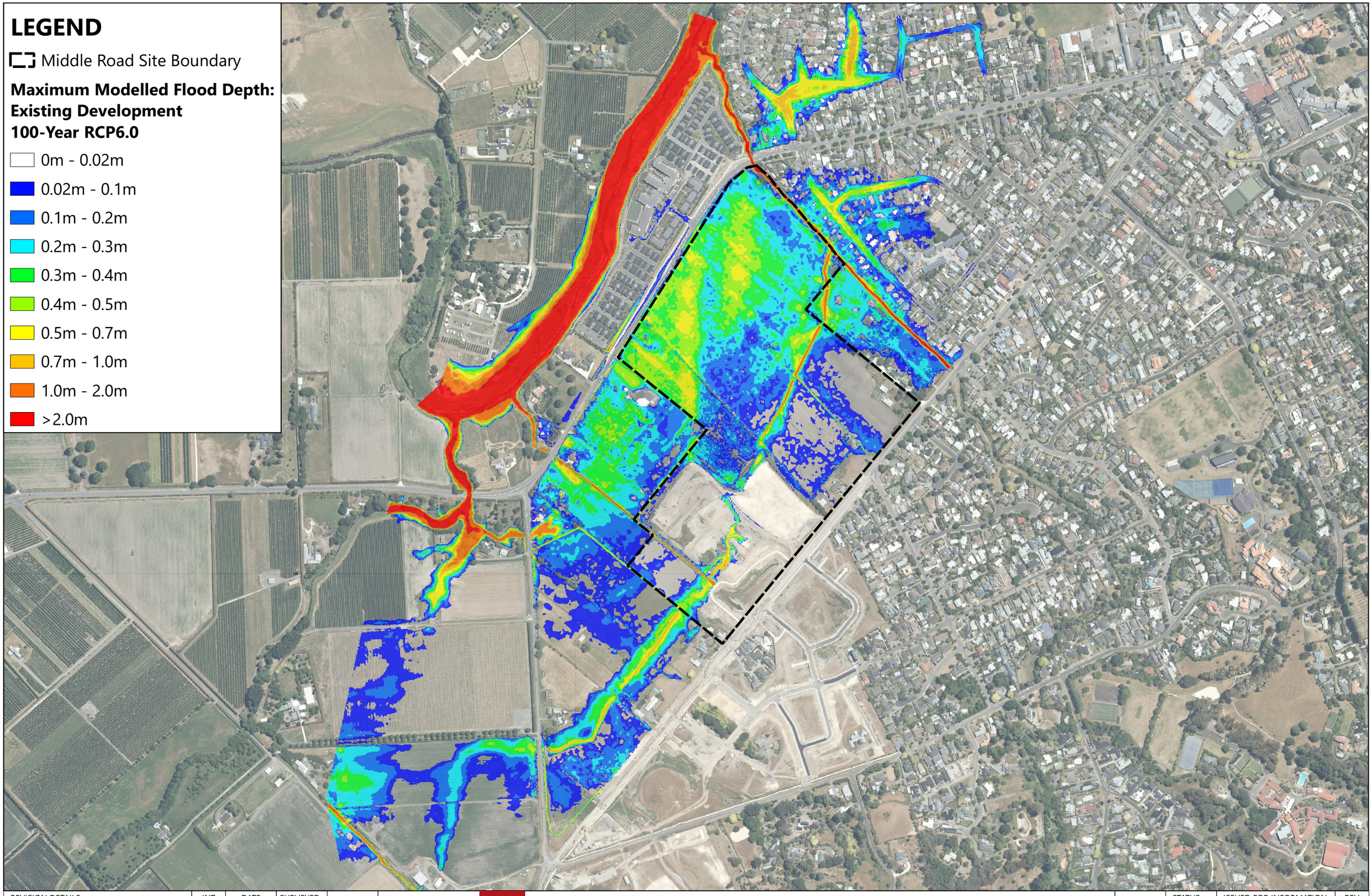


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P25-496 - MIDDLE ROAD SUBSTANTIVE
MAXIMUM MODELLED FLOOD DEPTH:
EXISTING DEVELOPMENT
50-YEAR WITH ALLOWANCE FOR RCP 6.0

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SHEET	SHEET 2 OF 11	

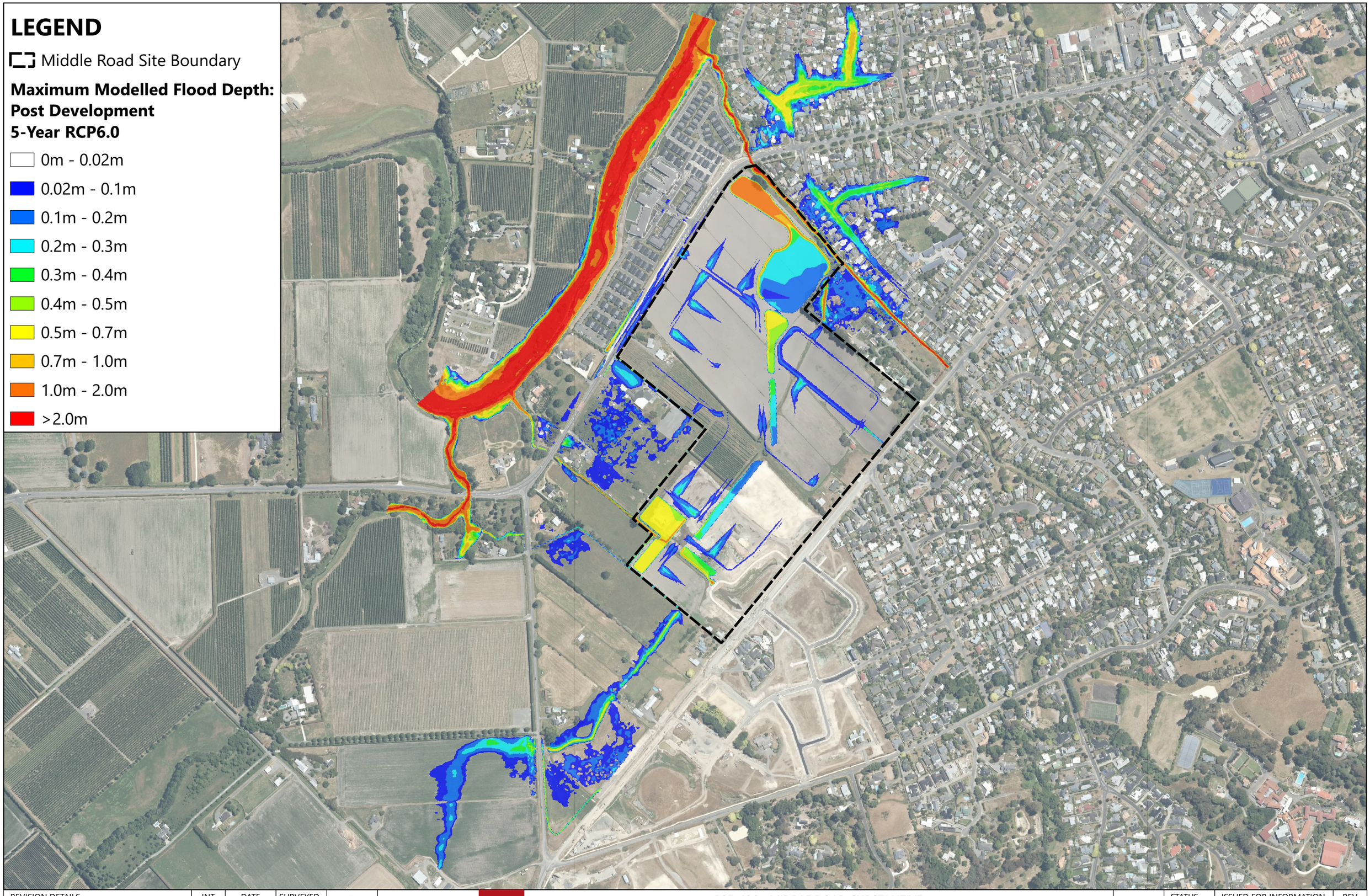


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				APPROVED	TR	WOODS.CO.NZ

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P25-496 - MIDDLE ROAD SUBSTANTIVE
MAXIMUM MODELLED FLOOD DEPTH:
EXISTING DEVELOPMENT
100-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
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P25-496 - MIDDLE ROAD SUBSTANTIVE
MAXIMUM MODELLED FLOOD DEPTH:
POST DEVELOPMENT
5-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 4 OF 11	

LEGEND

Middle Road Site Boundary

Maximum Modelled Flood Depth:
Post Development
50-Year RCP6.0

- 0m - 0.02m
- 0.02m - 0.1m
- 0.1m - 0.2m
- 0.2m - 0.3m
- 0.3m - 0.4m
- 0.4m - 0.5m
- 0.5m - 0.7m
- 0.7m - 1.0m
- 1.0m - 2.0m
- >2.0m

REVISION DETAILS		INT	DATE	SURVEYED	-
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P25-496 - MIDDLE ROAD SUBSTANTIVE
MAXIMUM MODELLED FLOOD DEPTH:
POST DEVELOPMENT
50-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 5 OF 11	

LEGEND

Middle Road Site Boundary

Maximum Modelled Flood Depth:
Post Development
100-Year RCP6.0

- 0m - 0.02m
- 0.02m - 0.1m
- 0.1m - 0.2m
- 0.2m - 0.3m
- 0.3m - 0.4m
- 0.4m - 0.5m
- 0.5m - 0.7m
- 0.7m - 1.0m
- 1.0m - 2.0m
- >2.0m

REVISION DETAILS		INT	DATE	SURVEYED	-
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P25-496 - MIDDLE ROAD SUBSTANTIVE
MAXIMUM MODELLED FLOOD DEPTH:
POST DEVELOPMENT
100-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 6 OF 11	

LEGEND

Middle Road Site Boundary

Maximum Modelled Flood Depth:
Post Development (Blocked Basin Outlets)
100-Year RCP6.0

- 0m - 0.02m
- 0.02m - 0.1m
- 0.1m - 0.2m
- 0.2m - 0.3m
- 0.3m - 0.4m
- 0.4m - 0.5m
- 0.5m - 0.7m
- 0.7m - 1.0m
- 1.0m - 2.0m
- >2.0m

REVISION DETAILS		INT	DATE	SURVEYED	-
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P25-496 - MIDDLE ROAD SUBSTANTIVE
MAXIMUM MODELLED FLOOD DEPTH:
POST DEVELOPMENT
100-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 7 OF 11	

LEGEND

- Middle Road Site Boundary
- Existing 5-Year Water Level Extent

Flood Depth Difference:
5-Year RCP6.0

- < -300mm
- -300mm to -100mm
- -100mm to -20mm
- -20mm to 20mm
- 20mm to 100mm
- 100mm to 200mm
- 200mm to 300mm
- > 300mm

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1.0	For Information	-	22/09/2026	DESIGNED	-
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P25-496 - MIDDLE ROAD SUBSTANTIVE
FLOOD DEPTH DIFFERENCE:
POST MINUS EXISTING
5-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 8 OF 11	

LEGEND

- Middle Road Site Boundary
- Existing 50-Year Water Level Extent

Flood Depth Difference:
50-Year RCP6.0

- < -300mm
- -300mm to -100mm
- -100mm to -20mm
- -20mm to 20mm
- 20mm to 100mm
- 100mm to 200mm
- 200mm to 300mm
- > 300mm

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/09/2026	DESIGNED	-
-	-	-	-	DRAWN	RK
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P25-496 - MIDDLE ROAD SUBSTANTIVE
FLOOD DEPTH DIFFERENCE:
POST MINUS EXISTING
50-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 9 OF 11	

LEGEND

- Middle Road Site Boundary
- Existing 100-Year Water Level Extent

Flood Depth Difference:
100-Year RCP6.0

- < -300mm
- -300mm to -100mm
- -100mm to -20mm
- -20mm to 20mm
- 20mm to 100mm
- 100mm to 200mm
- 200mm to 300mm
- > 300mm

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/09/2026	DESIGNED	-
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P25-496 - MIDDLE ROAD SUBSTANTIVE
FLOOD DEPTH DIFFERENCE:
POST MINUS EXISTING
100-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 10 OF 11	

LEGEND

- Middle Road Site Boundary
- Existing 100-Year Water Level Extent

Flood Depth Difference (Blocked Outlets): 100-Year RCP6.0

- < -300mm
- -300mm to -100mm
- -100mm to -20mm
- -20mm to 20mm
- 20mm to 100mm
- 100mm to 200mm
- 200mm to 300mm
- > 300mm

REVISION DETAILS		INT	DATE	SURVEYED	-
1.0	For Information	-	22/09/2026	DESIGNED	-
-	-	-	-	DRAWN	RK
-	-	-	-	CHECKED	SG
				APPROVED	TR

8 NUGENT STREET,
GRAFTON,
AUCKLAND

WOODS
EST.1970

WOODS.CO.NZ

P25-496 - MIDDLE ROAD SUBSTANTIVE
FLOOD DEPTH DIFFERENCE:
POST (BLOCKED BASIN OUTLETS) MINUS EXISTING
100-YEAR WITH ALLOWANCE FOR RCP 6.0

STATUS	ISSUED FOR INFORMATION	REV
SCALE	NTS	1.0
COUNCIL	HDC	
SHEET	SHEET 11 OF 11	

APPENDIX 2: HEREHERE STREAM ASSESSMENT MEMO

MEMORANDUM

To	From
Fast Track Consent Commissioner	Woods Danny Baucke – Fluvial Geomorphologist Ricky Kiddle – Intermediate 3 Waters Engineer Jam Ortega – Graduate 3 Waters Engineer
	W-REF: P25-496 2/09/2026 Reviewer: Boniface Kinnear – Principal Engineer

Middle Road – Herehere Stream Assessment

Statement of Qualifications & Experience

Ricky Kiddle – Intermediate Engineer, Wood & Partners Consultants Limited

I am an Intermediate 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 February 2024.

I hold the qualifications of Bachelor of Engineering with Honours from the University of Canterbury, which I completed in 2023. I am an Emerging Professional member of Engineering NZ, with two years of professional experience in the water engineering sector. My experience spans stormwater management, flood risk assessment, environmental and water quality management, and stormwater modelling.

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.

Jam Ortega – Intermediate Engineer, Wood & Partners Consultants Limited

I am an Intermediate Three Waters Engineer within the Water Infrastructure & Planning team at Wood and Partners Consultants Ltd ("Woods"), a multi-disciplinary consultancy delivering planning, urban design, engineering, water infrastructure, and surveying services. I have been with Woods since 2024.

My qualifications include a Diploma in Civil Engineering Level 7 from the International College of Auckland (2023) and a Bachelor of Civil Engineering from the Philippines (2016). I hold affiliations with Engineering New Zealand and Water New Zealand, and have built solid practical experience in stormwater design, flood risk assessment, and hydraulic modelling across a number of residential and urban development projects, including flood recovery work, catchment-based planning, and the preparation of stormwater management plans.

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.

Danny Baucke – Senior Intermediate Geospatial Surveyor and Fluvial Geomorphologist, Wood & Partners Consultants Limited

I am a Senior Intermediate Geospatial Surveyor and Fluvial Geomorphologist 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 February 2025.

I hold a Master of Science (MSci) in Geography from the University of Auckland, which I completed in 2021, with a focus on coastal and fluvial geomorphology developed through my master's research and applied in river and catchment-focused projects, including collaborative work with local government and iwi. I have over five years of professional experience, including several years in the private sector as a survey technician and UAV specialist prior to joining Woods, where I built expertise in topographic and hydrological data collection, ground modelling, and spatial analysis. My work now bridges geospatial technologies- including UAV-derived imagery and LiDAR- with geomorphic understanding to deliver practical, data-informed solutions for water infrastructure, river systems, and natural hazard management.

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.

Boniface Kinnear – Principal 3 Waters Engineer, Wood & Partners Consultants Limited

I am a Principal 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 2020.

I hold a Bachelor of Science in Environmental Engineering from the University of Southern California, Los Angeles, California which I obtained 2004. I also hold Master of Engineering Studies and a Master of Engineering in Environmental Engineering both from the University of Auckland completed in 2007 and 2008 respectively. I am a Chartered Professional Engineer (CPEng), a chartered member of Engineering New Zealand (CMEngNZ) and an International Professional Engineer (IntPE)/APEC Engineer. Additionally, I am a member of the Environment Institute of Australia and New Zealand (EIANZ) as well as a member of the Rivers Group NZ.

I have over 18 years of experience in environmental management, contaminated land and water quality assessment/analyses, impact assessments, stormwater design and modelling, stream assessment and management, flood risk assessments, water infrastructure and stormwater management. I have authored and reviewed several stormwater management plans, flood modelling reports, infrastructure assessment/design reports, earthworks reports and detailed site investigation reports to support numerous projects.

1. Summary

This report presents an erosion assessment of a ~600m reach of the Herehere Stream, located adjacent to the proposed Middle Road Subdivision, Havelock North, approximately 270m upstream of the confluence with the Karamu River. The assessment combines desktop geomorphic review, an erosion screening tool (EST) methodology and a 2D hydraulic modelling to characterise erosion susceptibility of the reach as well as management considerations.

Key points:

- the reach is dominated by vertical bed incision rather than lateral bank retreat, attributed to its straightened culvert bound planform between two road crossings.
- an operative/adoptive critical shear stress (T_c) of approximately 2 Pa has been derived for the sandy bank toe material, with higher values (14-22 Pa) associated with the more cohesive upper bank horizons.
- 2D hydraulic modelling at the 2-year ARI event indicates shear stresses across the reach exceed critical shear stress (T_c)at the toe, indicating active erosion potential at the bed and bank under existing conditions
- The proposed reshaping of the true-left bank as part of the proposed development does not appear to exacerbate the erosion potential.

2. Introduction

This assessment evaluates erosion risk along the Herehere Stream (Figure 1) reach adjacent to the Middle Road Subdivision development (Figure 2), to identify any consequences of the proposed works to ease the slope on the southern stream bank.

Through consultation with the HBRC, the HDC and local Iwi it has been proposed that as part of the Middle Road development the developer will undertake works on the Herehere Stream bank adjacent to the development site. The bank is to be eased back to a 1 in 3 batter (33%) and stabilised through biodegradable matting and vegetation planting.

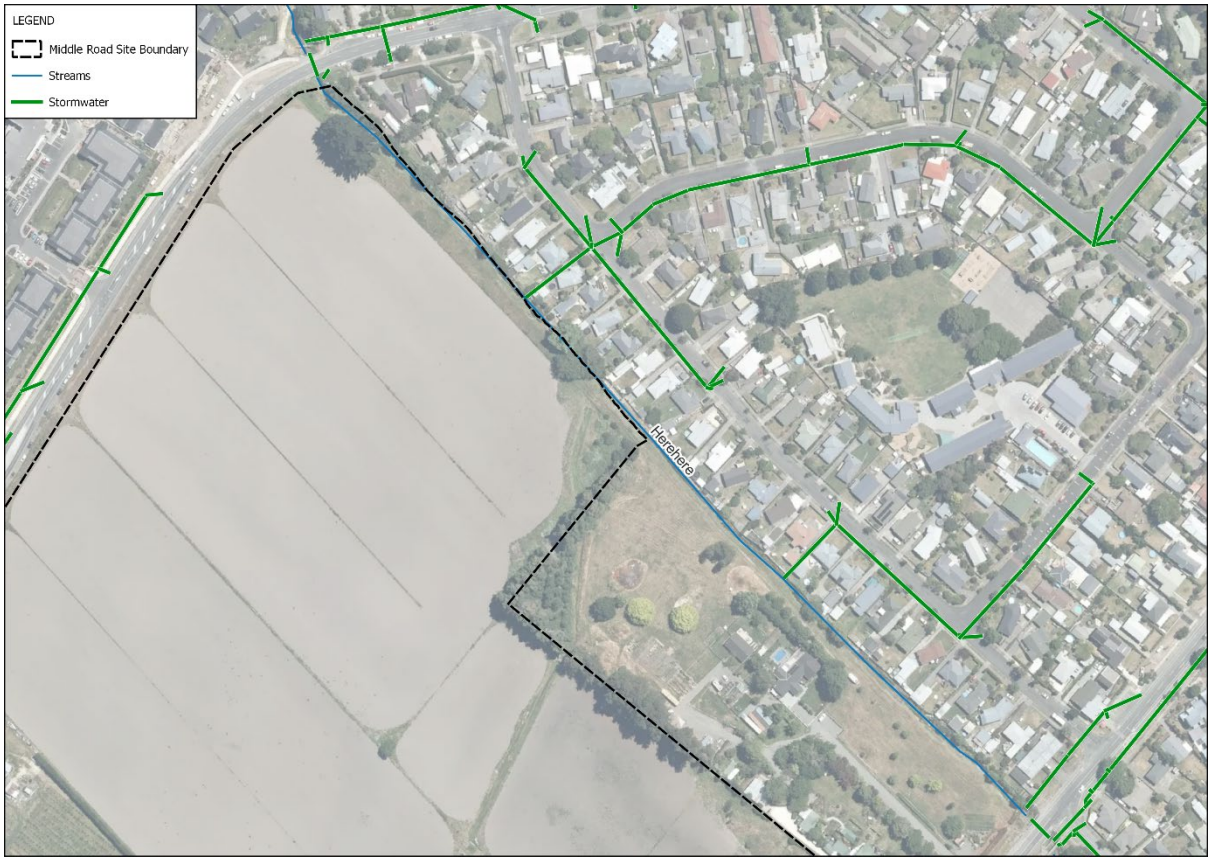


Figure 1: Project location - Herehere Stream



Figure 2: Proposed development subdivision

A cutdown hydrodynamic model focused on Herehere Stream has been developed to understand the hydraulic behaviour of the stream for different events. The cutdown model utilises flow inputs from the wider catchment model created for the development. The hydrodynamic model sets the basis for the Erosion Screen Tool (EST) as discussed below.

The EST as developed by Auckland Council Healthy Waters team, is a methodology that provides for the estimation of potential erosion risk in streams. The method uses bed shear stress results extracted from the hydraulic model which are converted into excess shear stress results and categorised based on the risk thresholds as stated in the EST. Table 1 summaries these thresholds used in the assessment.

Table 1: EST erosion risk profile

Threshold	Excess Shear	Description
Green	< 1.0	Indicates no erosion predicted to occur *(no erosion)*
Yellow	> 1.0 < 2.0	Indicates the potential for some erosion of the channel *(minimal erosion)*
Orange	> 2.0 < 10.0	Indicates the potential for channel to be mobile, *(active erosion)*
Red	> 10.0	Indicates potential rapid rates of erosion and incision of channel *(rapid erosion)*

Woods have adapted this tool for use in Herehere Stream as it is considered to be fit for purpose for this type of urban stream.

3. Site description

The following section summarises the site descriptors considered relevant to this assessment.

3.1. Site context

Stream: Herehere Stream

Reach length assessed: approximately 600m

Location: Middle Road, Havelock North, approximately 270 m upstream of the confluence with the Karamu River

Catchment: Karamu Catchment, Hastings District, Hawkes Bay (Figure 3)

Land use: Development site to the true left of the stream is existing farmland whereas adjacent to true right is urban built-up land. The immediate contributing catchment to the stream i.e., upstream of Middle Road, is also fully developed comprising mainly residential parcels. The middle part of the catchment has a combination of urban residential and larger lifestyle type parcels. Further upstream, i.e., headwaters of Herehere Stream is a sparsely vegetated hilly environment.

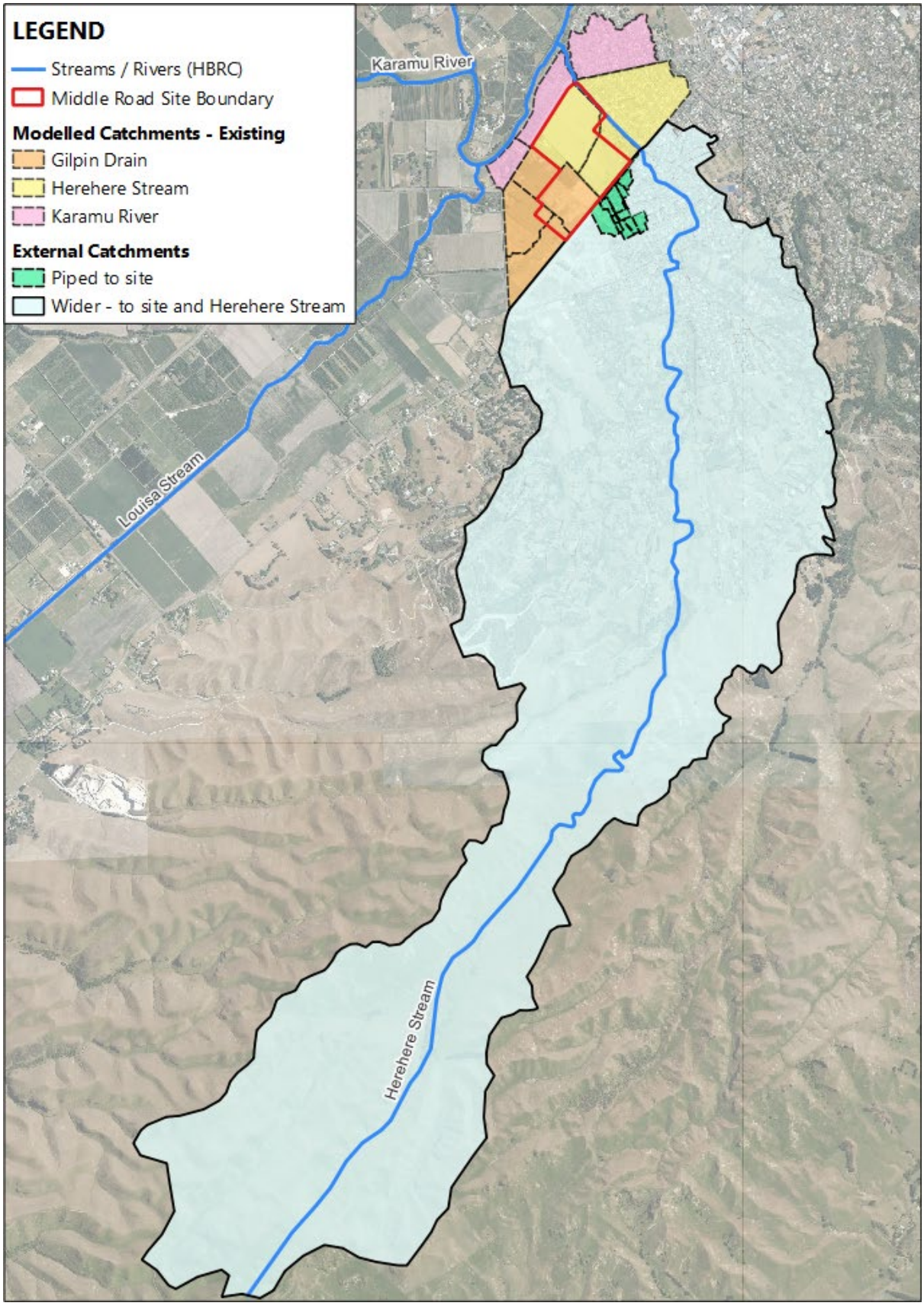


Figure 3: Contributing Catchment

3.2. Relevant features

Geology and soils

Alluvial deposits, three soil units identified via S-map (Figure 4) and cross referenced against site boreholes:

- Gley (S-map codes hp_TANK_9067, Hastings_29a.1) – upstream of stream
- Pallic (S-map codes hp_TANK_9026, Ruataniwha_7a.1) – downstream, dominates bank material at the assessed cross sections
- Recent (S-map codes hp_TANK_9001, Hinds_92a.1 / Patutahi_11b.2) – mid stream, limited extent

Confirmed by three Geotech boreholes (MH01- MH03, Middle Road subdivision, dated 25/05/2026), showing a consistent alluvial sequence:

- 0-1 m: Organic silt/topsoil, low plasticity
- ~ 1-2 m: Silt, low plasticity, moist to wet
- ~ 2-4.5 m: Alternating silty sand/fine sand, poorly graded, saturated below the water table (~1.95 m across all three boreholes)
- ~ 4.5-6.45 m: Sandy silt/silt, loose to firm/stiff

SPT N-values show a consistent pattern of high near-surface values (14-16) dropping sharply to very low values (0-4) in the saturated zone, indicating loose, poorly consolidated, highly erodible material below the water table.

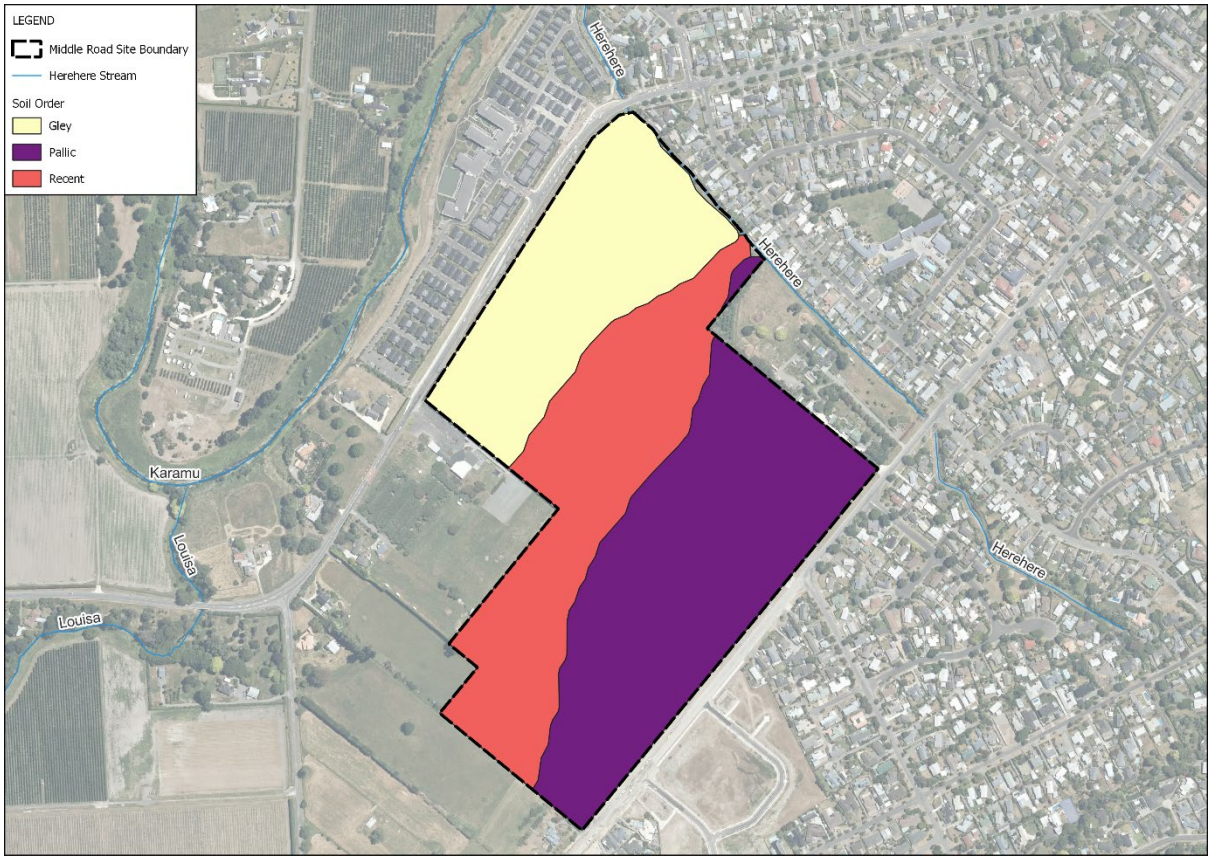


Figure 4: Soils order (from S-maps)

Stream shape

The portion of Herehere Stream from Middle Road bridge to Te Aute Road bridge has been noted to be relatively straight with steep banks on either side. The stream has a somewhat trapezoidal shape with a bed range from approximately 0.8m to 7m and an incised profile depth of approximately 3m. Several cross sections (Figure 5) were extracted from the surface which show this approximate shape (Figure 6).



Figure 5: Stream sections

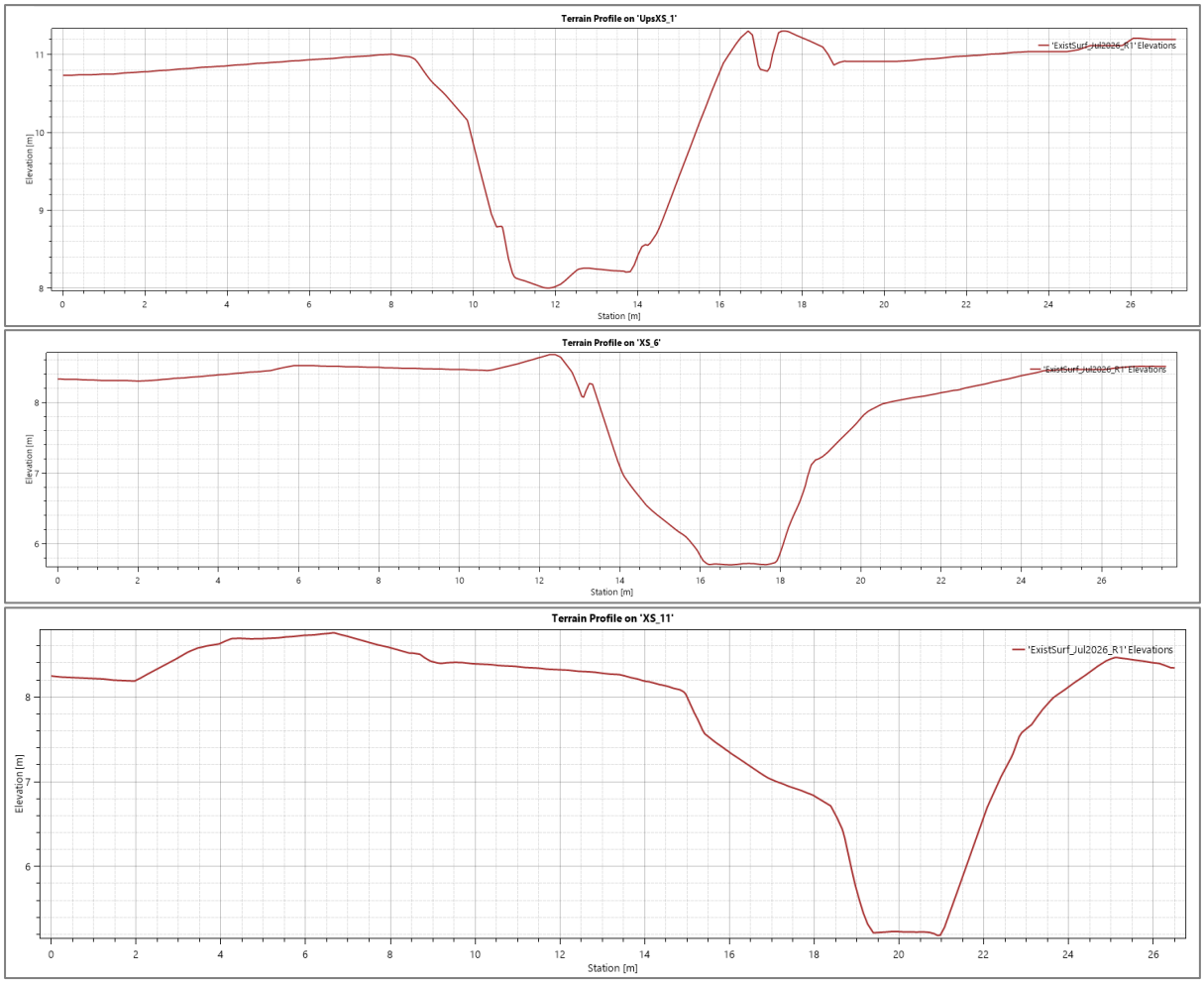


Figure 6: Select cross sections

Vegetation

Based on the work undertaken by Boffa Miskell, Herehere Stream banks are predominately covered in exotic rank grass and weeds. Towards Te Aute Road there is a small cluster of large pines (*Pinus radiata*). The northern bank (the true right bank – TRB) has only a narrow riparian margin adjoining the existing residential properties, containing rank grass, and some shrubs and trees. Figure 7 shows the existing vegetation as extract from the Boffa Miskell Ecological Assessment.



Herehere Stream at Middle Road. December 4, 2025.

Herehere Stream downstream of Middle Road. December 4, 2025.



Herehere Stream upstream of Te Aute Road. December 4, 2025.



Herehere Stream downstream of Te Aute Road. December 4, 2025.

Figure 7: Herehere Stream vegetation (extract from ecology report)

3.3. Climate and rainfall

HIRDs rainfall data has been converted to a 24-hour design storm event using the alternating block method. Rainfall data for RCP6.0 for a climate horizon to the year 2100 was converted to a 24-hour design storm.

The 24-hour rainfall depth used in the modelling, incorporating the climate uplift, is given in Table 2.

Table 2. 24-hour rainfall depths

Storm Event	24 Hour Rainfall Depth (mm) RCP6 (2081-2100)
2-Year	74.8
100-Year	182

4. Methodology

4.1. Desktop Review - S-map as a Proxy for Critical Shear Stress

In the absence of direct field or laboratory erosion testing at this site, the desktop assessment used S-map soil classification as a proxy for critical shear stress (Tc). S-map maps the landscape into discrete soil units, each of which is represented by one or more sibling soils, whereby a sibling being a specific fully classified soil profile (with defined horizons, textures and particle size class by depth) that is considered representative of the conditions found within that mapped unit. Rather than treating a soil unit as a single uniform material, the relevant sibling profile for each unit was used to obtain a representative textural/particle size breakdown by horizon, which was then used to estimate percent silt/clay content at the depths of interest.

Three S-map soil units were identified across the reach, each linked to its representative sibling profile:

- Gley (unit hp_TANK_9067, sibling Hastings_29a.1)
- Pallic (unit hp_TANK_9026, sibling Ruataniwha_7a.1)
- Recent (unit hp_TANK_9001, siblings Hinds_92a.1 / Patutahi_11b.2)

The percent silt/clay content taken from each sibling's horizon data was then applied to the Julian & Torres (2006) empirical relationship between silt/clay content and critical shear stress, giving a Tc value appropriate to each horizon depth rather than a single reach-wide figure. This is represented by the formula:

$$T_c = 0.1 + 0.1779 \cdot SC + 0.0028 \cdot SC2 - 0.0000234 \cdot SC3$$

Where SC is the silt-clay content (%) of the bank material. This produced an operative (bank toe) T_c of approximately 2 Pa, based on the sandy subsoil sibling horizon exposed at a cross-section showing a 3-3.5 m high bank, and a higher upper-profile T_c of 14-22 Pa for the more cohesive sibling horizons present at 0-55 cm (or 0-80 cm) depth. The clear difference between these two values reflects the vertical grading of the bank profile from a cohesive silt/topsoil cap into loose sandy alluvium, rather than any inconsistency in the method.

This S-map/Julian & Torres desktop T_c was then cross-checked against the CMW Geosciences borehole logs (MH01-MH03, Middle Road Subdivision) for the site, to confirm that the sibling derived stratigraphy was a reasonable match for actual ground conditions. The borehole logs showed a consistent alluvial sequence across all three holes, with a sharp drop in SPT N-values below approximately 2 m depth, coincident with the water table. This independently supports the sandy subsoil as the erosion-critical horizon at the bank toe.

4.2. Hydrological/hydraulic assessment

Overall flood modelling for the development was undertaken in XPSWMM (version 2024.2). However, to capture the finer hydraulic detail required along the Herehere Stream adjacent to the development area, a cut-down HEC-RAS model was developed specifically for the stream assessment. Inflow hydrographs for the 2-year and 100-year ARI storm events were extracted from the XPSWMM model at key flow regions and applied as boundary conditions within the HEC-RAS model.

Figure 8 illustrates the layout of the cut-down HEC-RAS model, including the location of the inflow boundary conditions and the extent of the 2D flow area. A variable mesh resolution was adopted which included a 0.5m cell size applied within the Herehere Stream corridor to more accurately represent flow conveyance, a 2m cell size was applied across the overland/basin low-flow channels, and a coarser 5m cell size was applied across the wider model extent. Manning's roughness coefficients were distributed as shown of Figure 9 and Figure 10 for pre and post development conditions respectively and summarised on Tx.

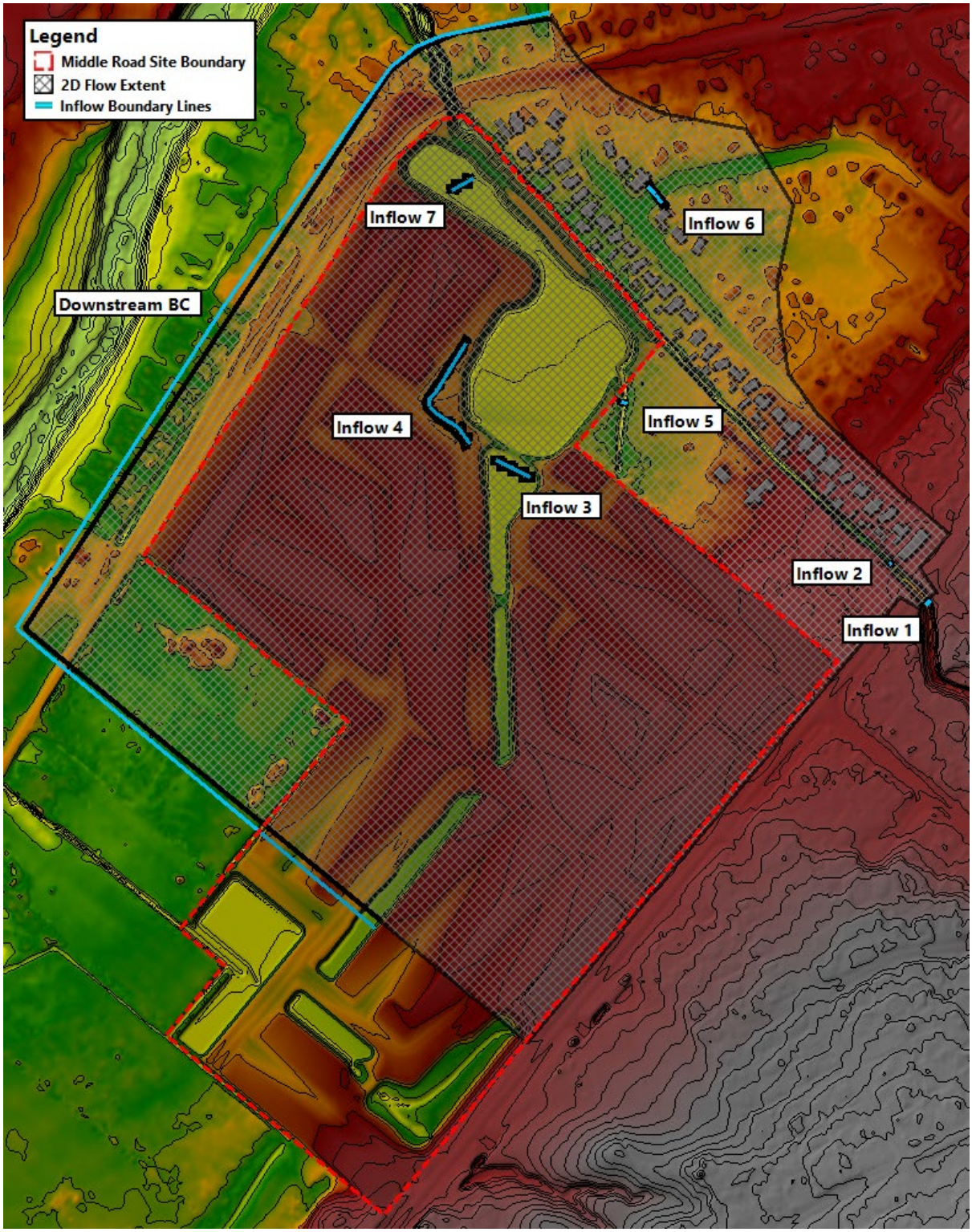


Figure 8. HEC-RAS Model Layout

Table 3: Manning's values

	Predevelopment	Post development
Stream bed	0.08	0.08
True right bank	0.07*	0.07
True left bank	0.035*	0.1*
Roads	0.02	0.02
Parcels and buildings	0.1	0.1
Basin	0.035	0.035

Notes: In the existing situation, the true left bank is mainly grassed while the true right bank has more mature foliage thus a higher Manning's the left. In the post development scenario, the true left bank Manning's coefficient has been adjusted to a slightly higher figure to represent potential mitigation works along the bank while the right remains the same.

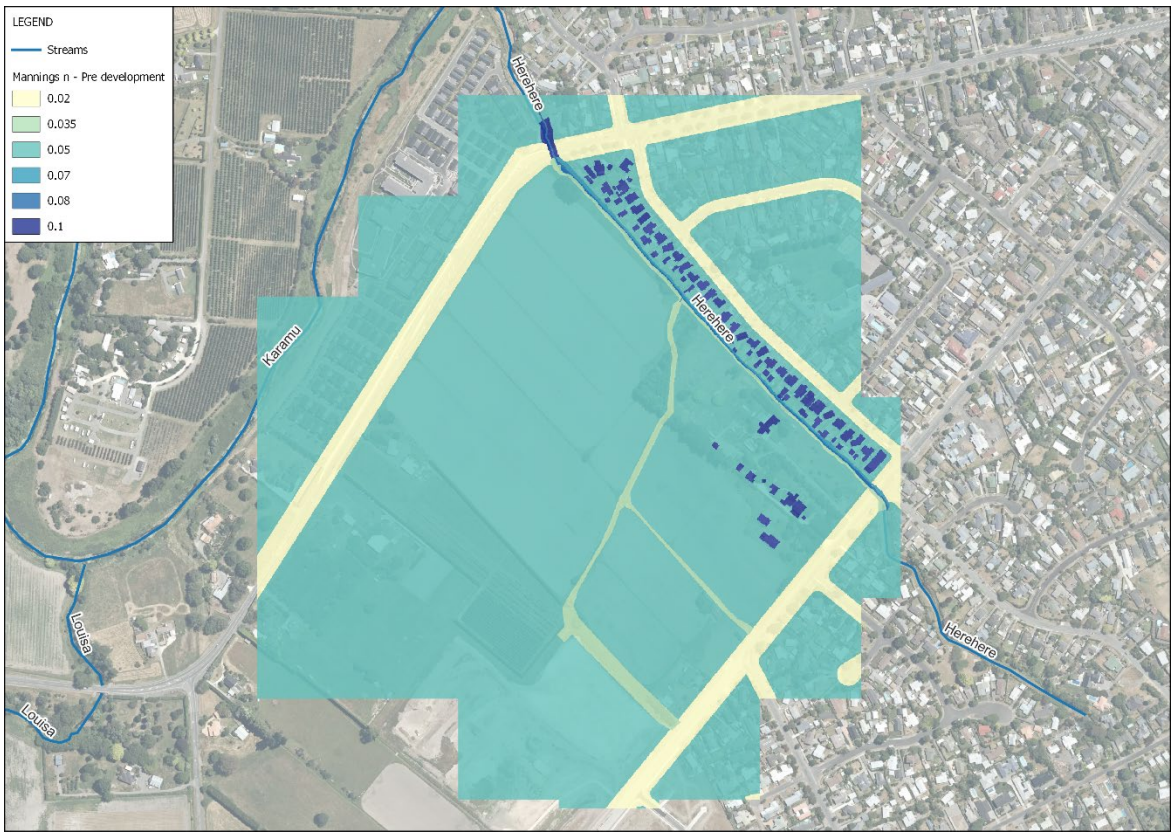


Figure 9: Manning's predevelopment

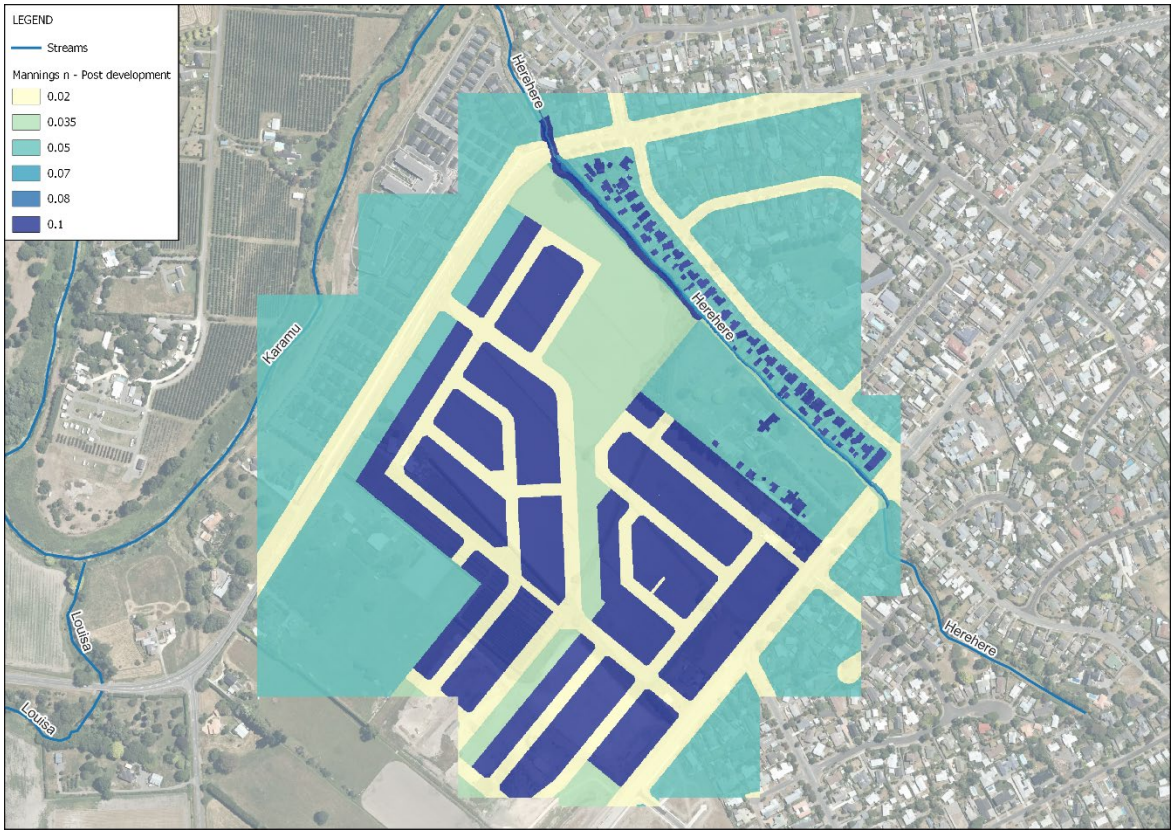


Figure 10: Manning's post development

5. Erosion hazard and risk assessment

Bed shear stress results were extracted from the hydraulic model and used to calculate the excess shear stress for each of the design events assessed. A critical shear stress (derived using the empirical formula of Julian and Torress, 2006) of 2N/m² was adopted for the Herehere Stream bed, while a critical shear stress of 22N/m² was adopted for the Herehere Stream banks and a portion of the development area as shown in Figure 11.

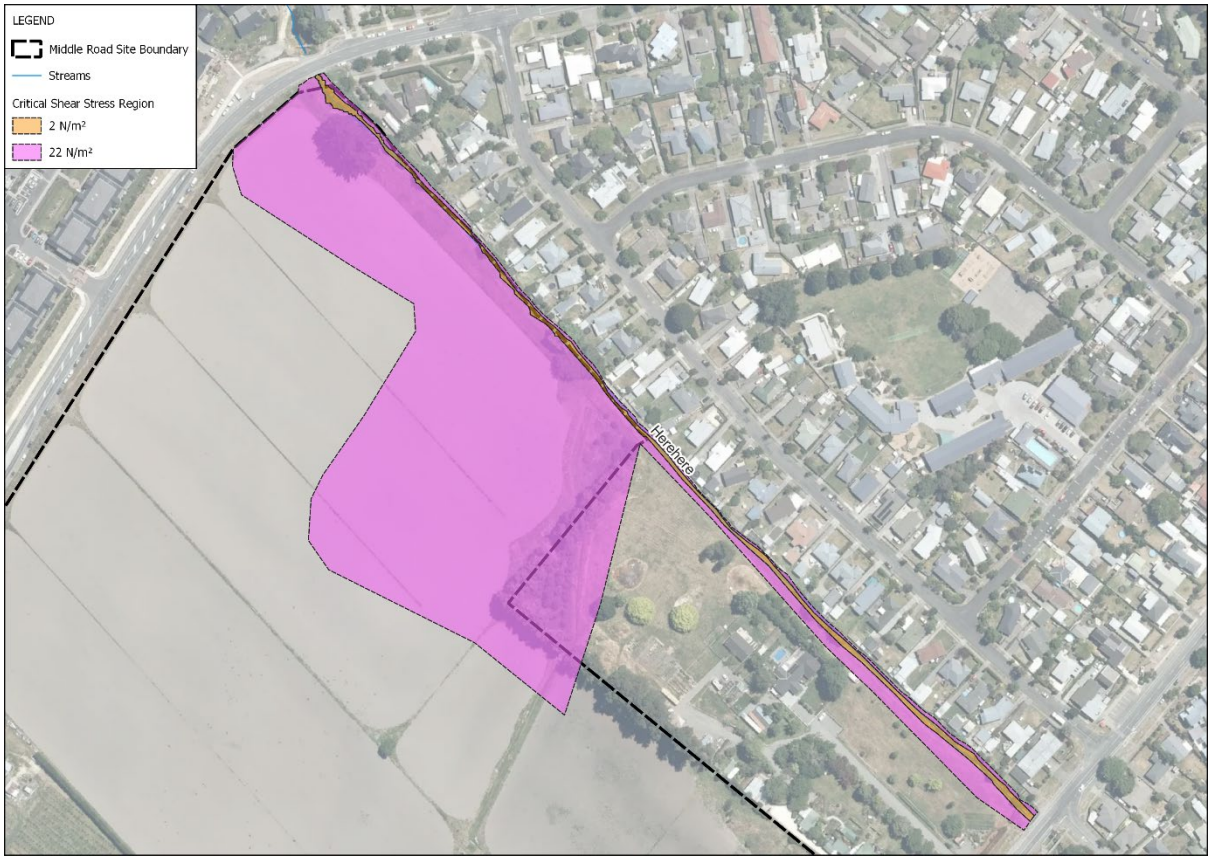


Figure 11. Critical Shear Stress Regions

Figure 12 to Figure 15 show the excess shear stresses for the modelled 2- and 100-year storm events. The results show that the stream bed is likely to be subjected to rapid erosion in both the pre and post development scenario for the modelled events. The banks indicate active erosion which is consistent with desktop assessments which show that material closer to the bottom of the stream is potentially highly erodible.

Velocities along the stream (Figure 16 to Figure 19) were also reviewed for both the 2-year and 100-year events in the pre and post development scenarios. In the predevelopment scenario for the 2-year and the 100-year, the velocities are greater than 1m/s which exceeds the permissible thresholds for eroding sandy type soils (Chang 1988) of which the stream bed comprises. Higher velocities are noted on the upper reach (i.e., immediately downstream of Middle Road bridge) than on the lower reach (adjacent to the development). As previously mentioned, the lower reach of the stream, adjacent to the development site, will be widened. With this widening/regrading of the stream along the true left bank (TLB), the post development models for both the 2-year, and 100-year show a reduction in the velocity (Figure 20 and Figure 21). By widening the banks and installing armouring (discussed in the next section) the velocities are reduced hence reducing the erosion potential. These works along the stream appear to have minimal impact to the upper reach (Figure 22 and Figure 23).

Additional cross sections were extracted further supporting this assessment (Appendix 1)

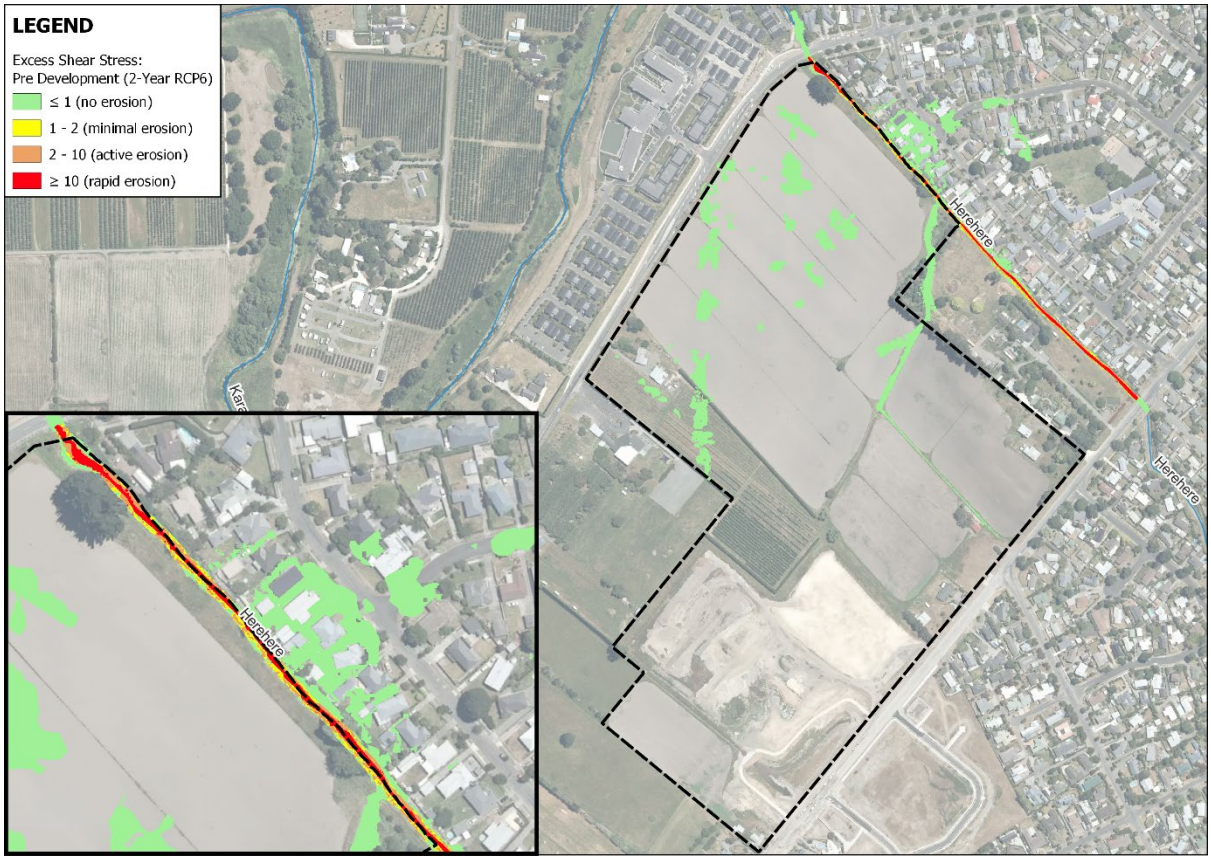


Figure 12. 2-Year Excess Shear Stress (Pre-development)

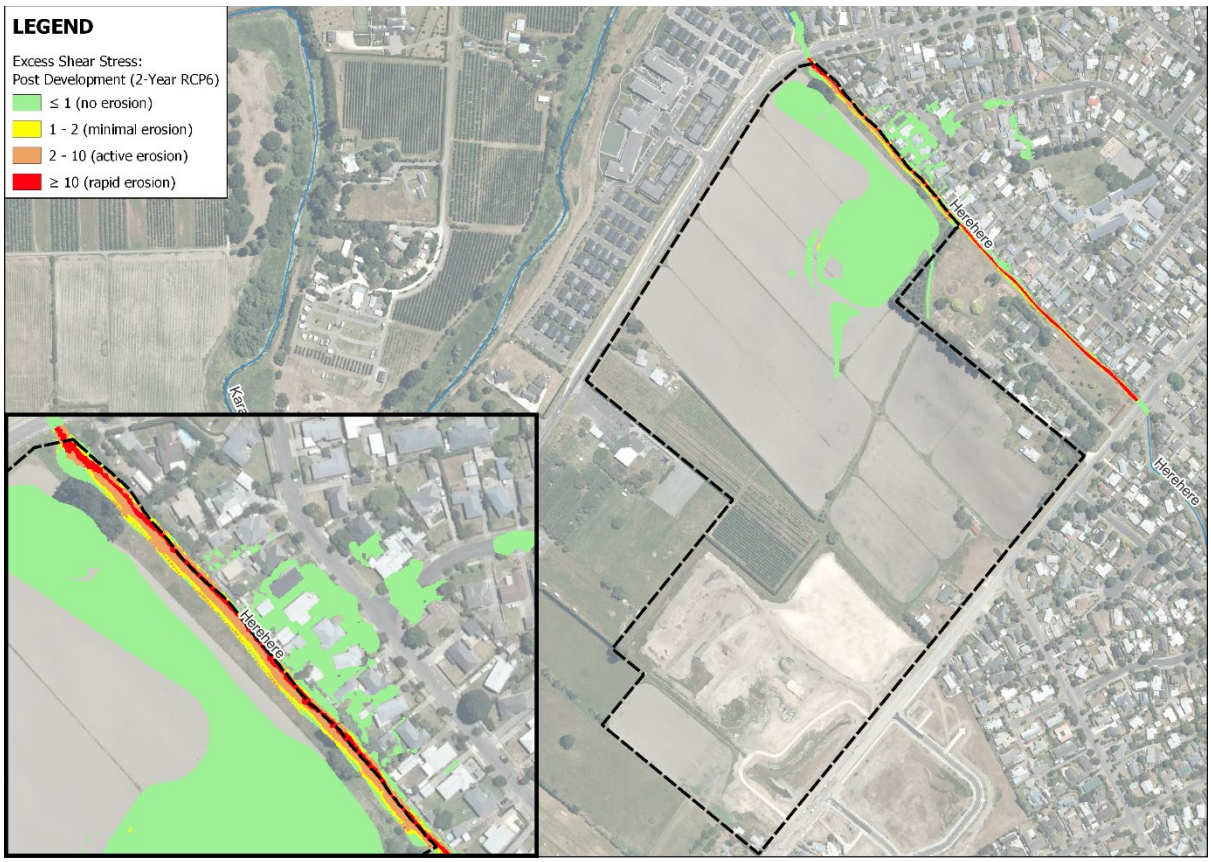


Figure 13. 2-Year Excess Shear Stress (Post-development)

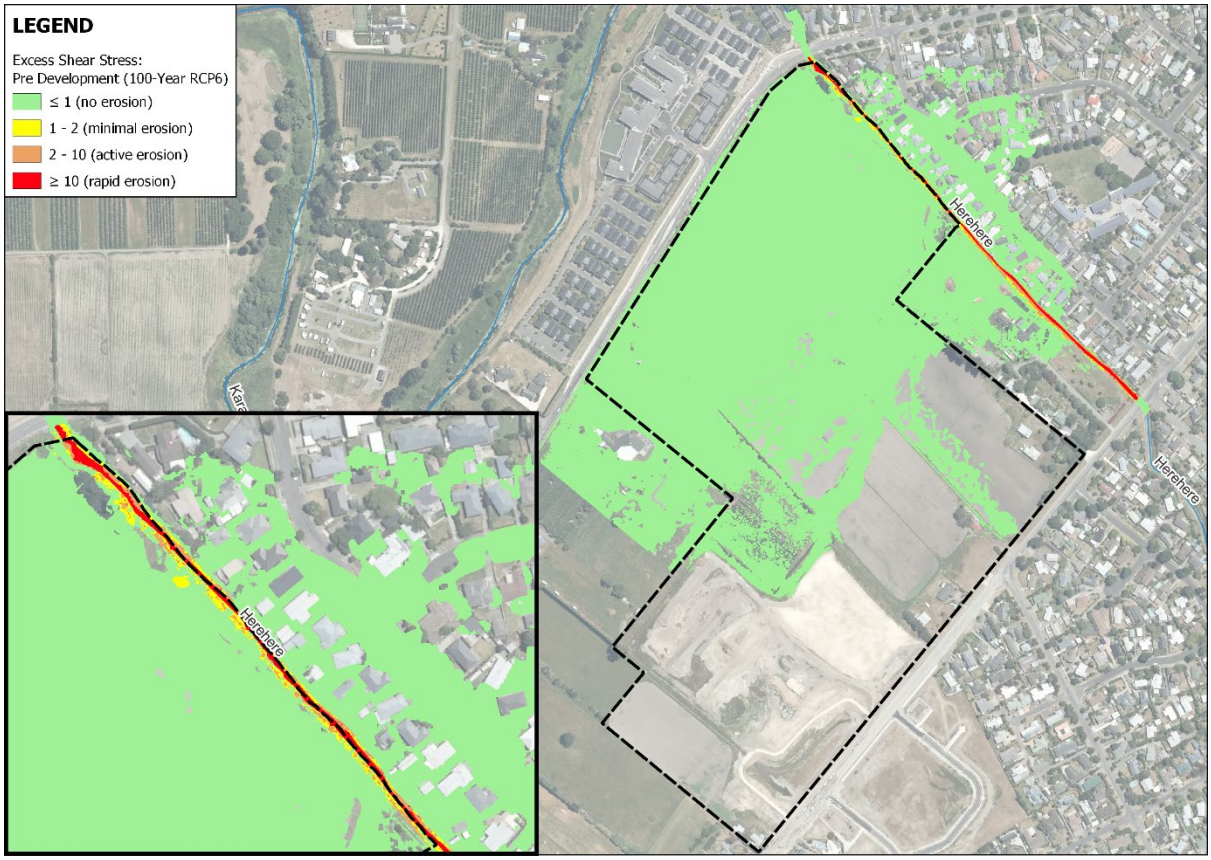


Figure 14. 100-Year Excess Shear Stress (Pre-development)

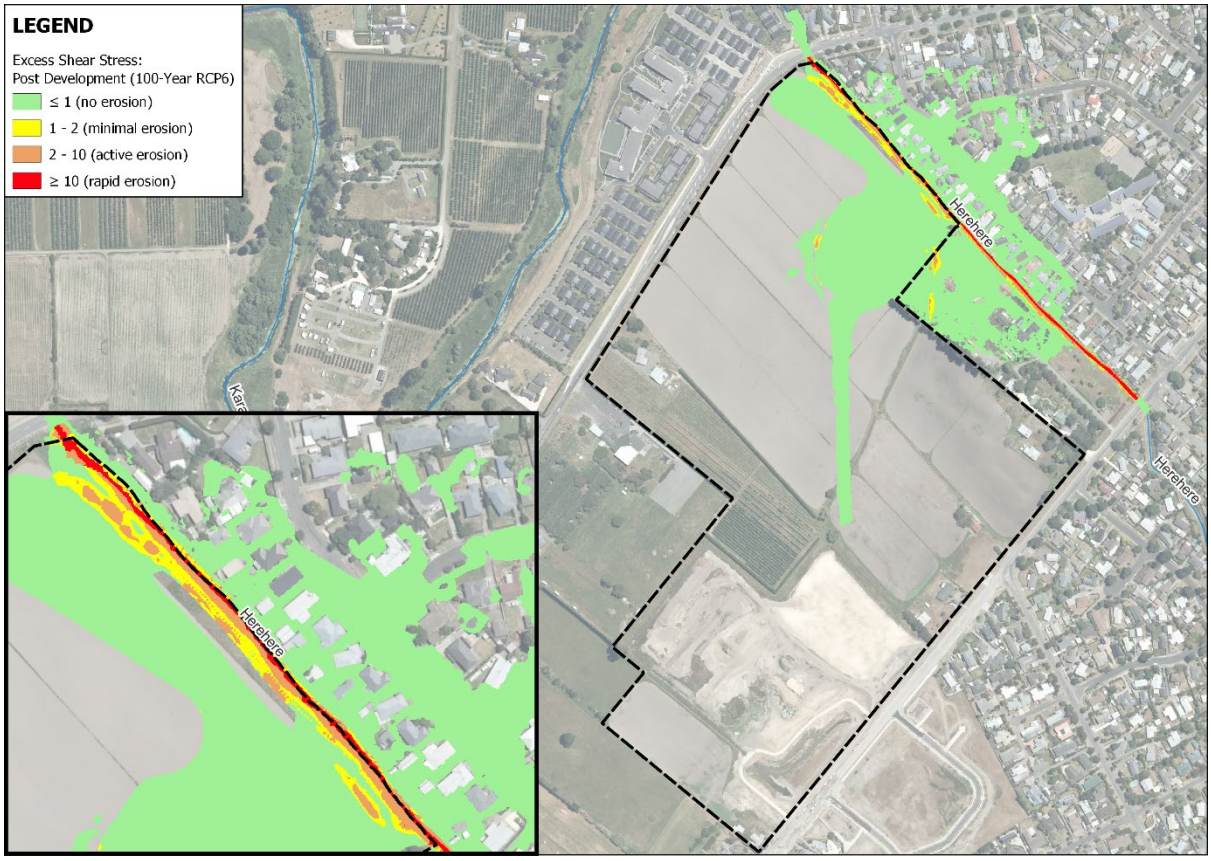


Figure 15. 100-Year Excess Shear Stress (Post-development)

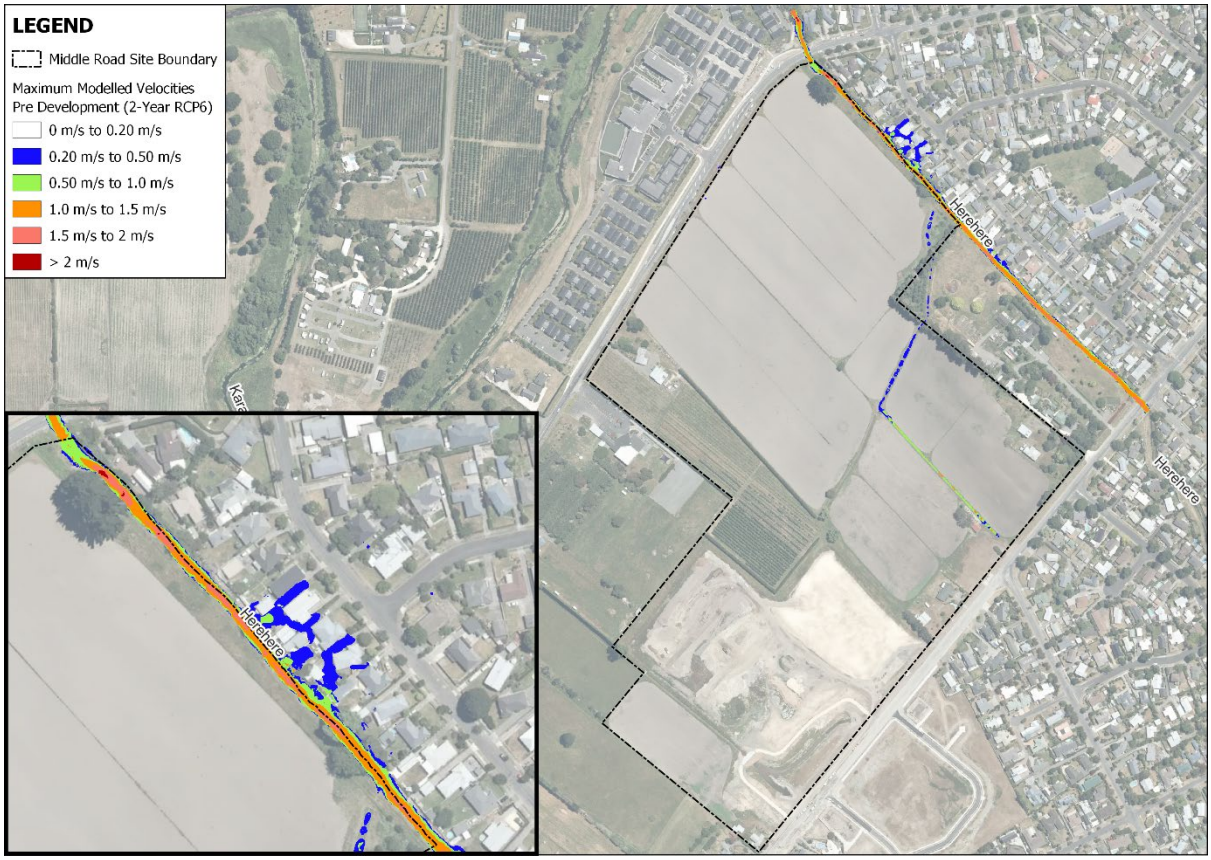


Figure 16: 2-Year Velocity (Pre-development)

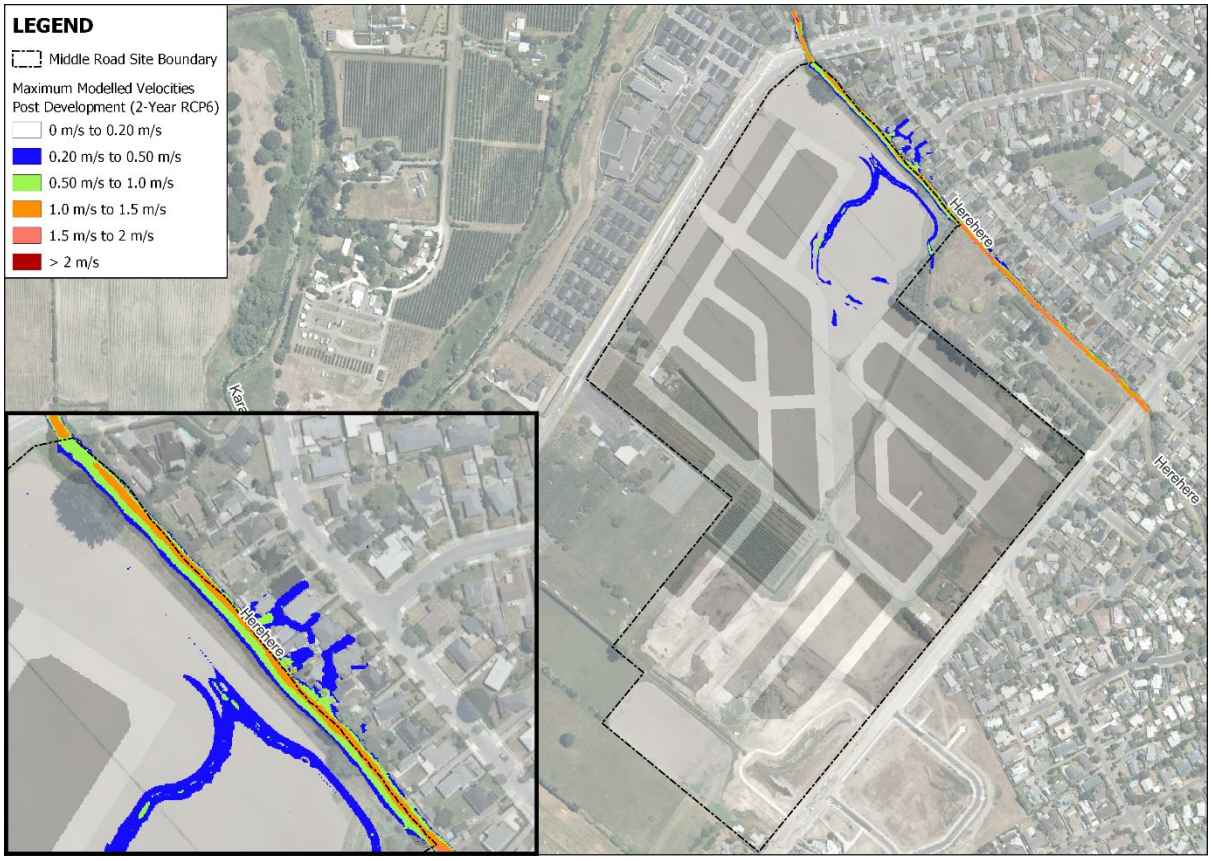


Figure 17: 2-Year Velocity (Post-development)

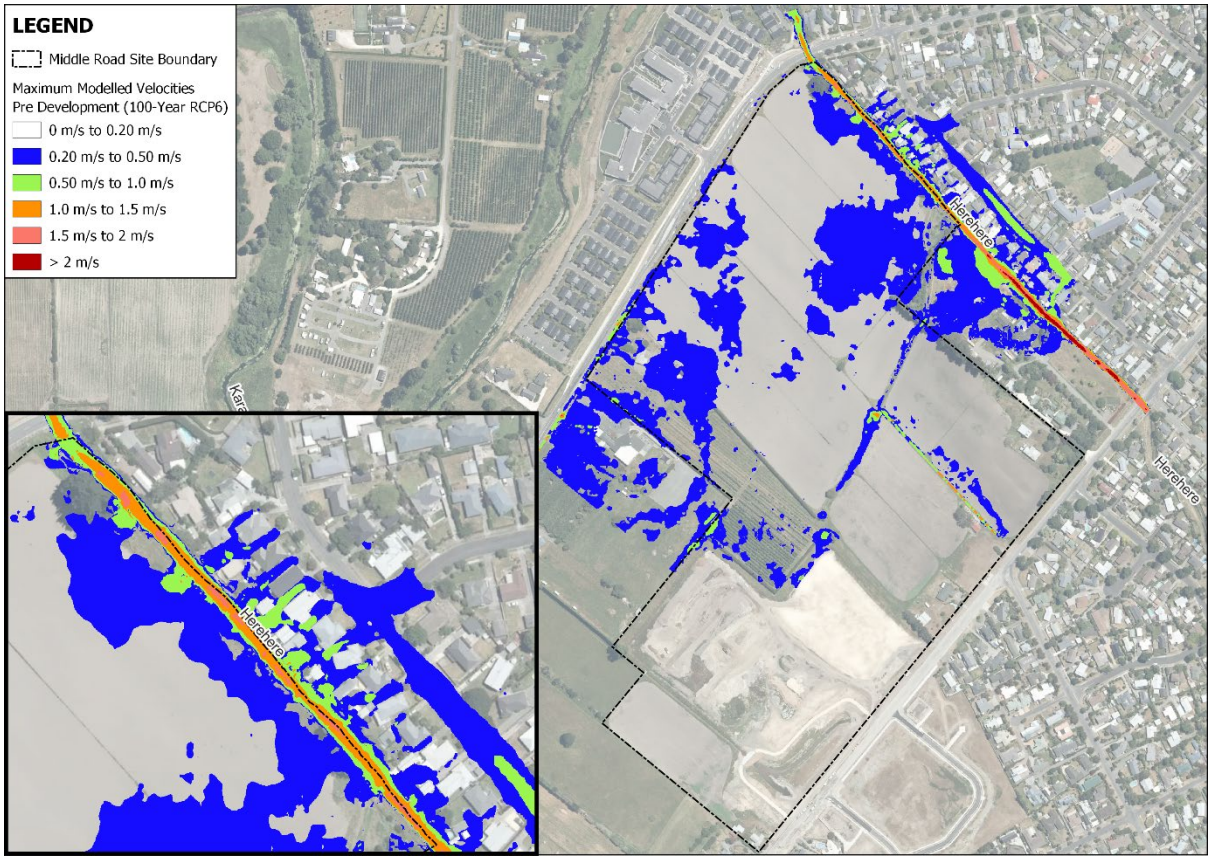


Figure 18: 100-Year Velocity (Pre-development)

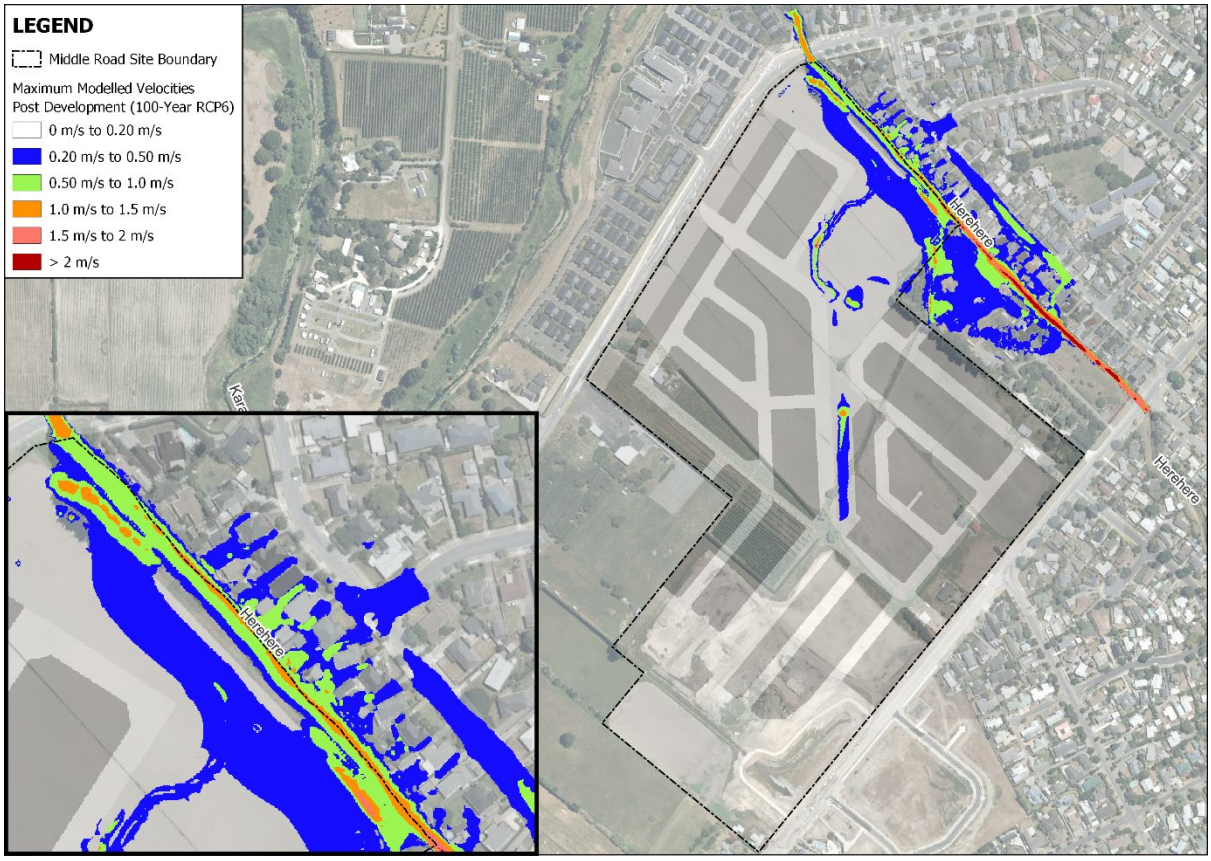


Figure 19: 100-Year Velocity (Post-development)

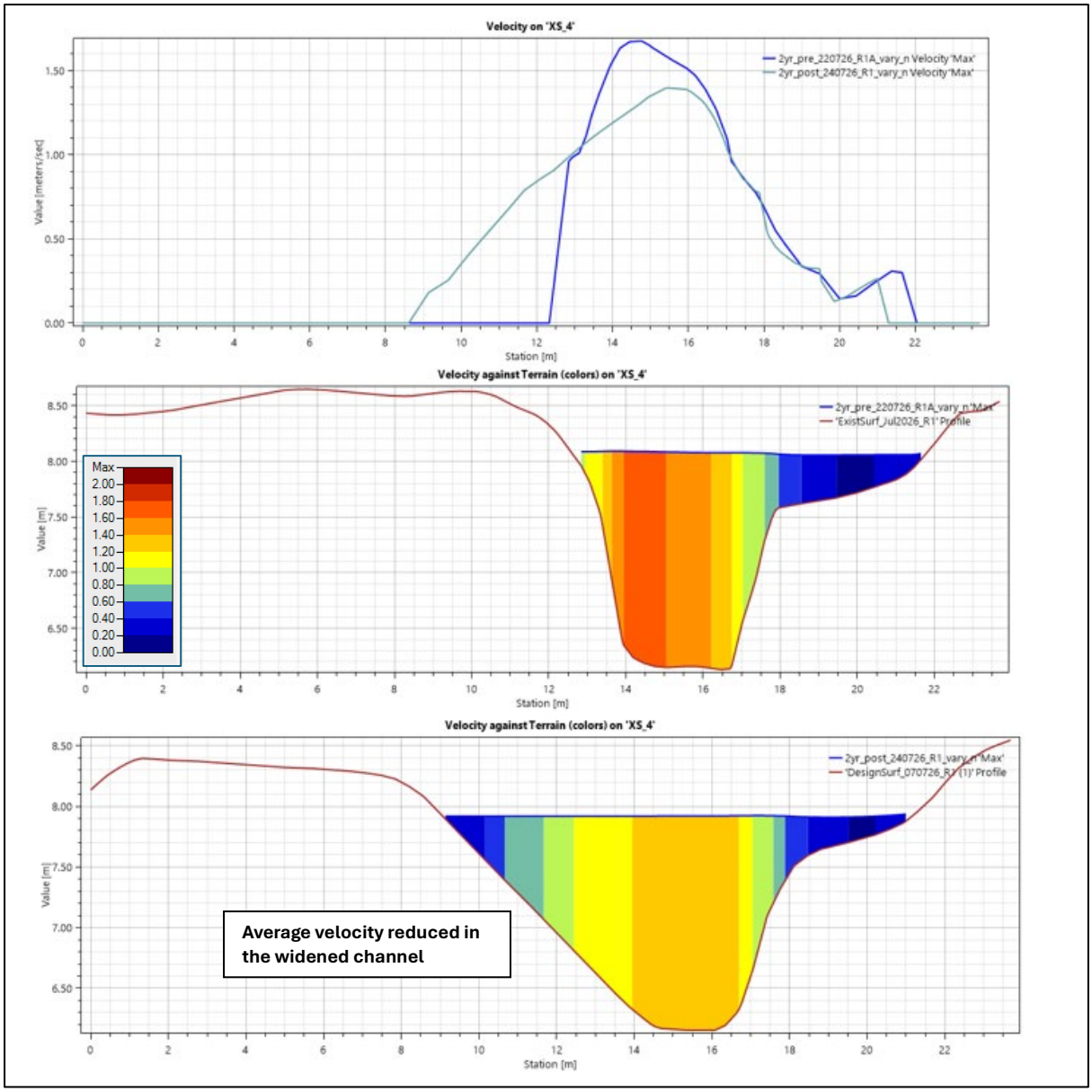


Figure 20: 2yr-velocity cross section analysis XS4

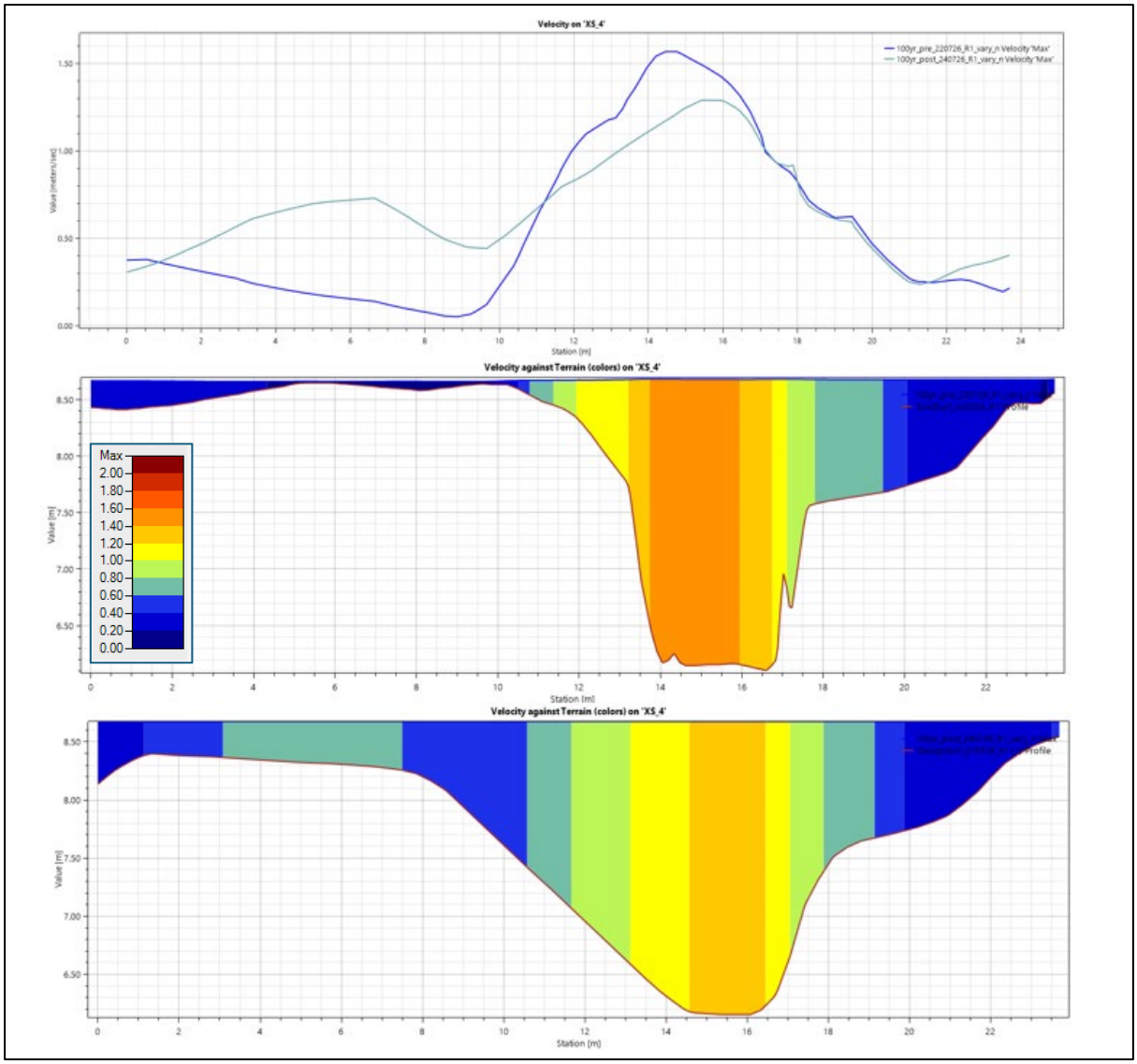


Figure 21: 100yr-velocity cross section analysis XS4

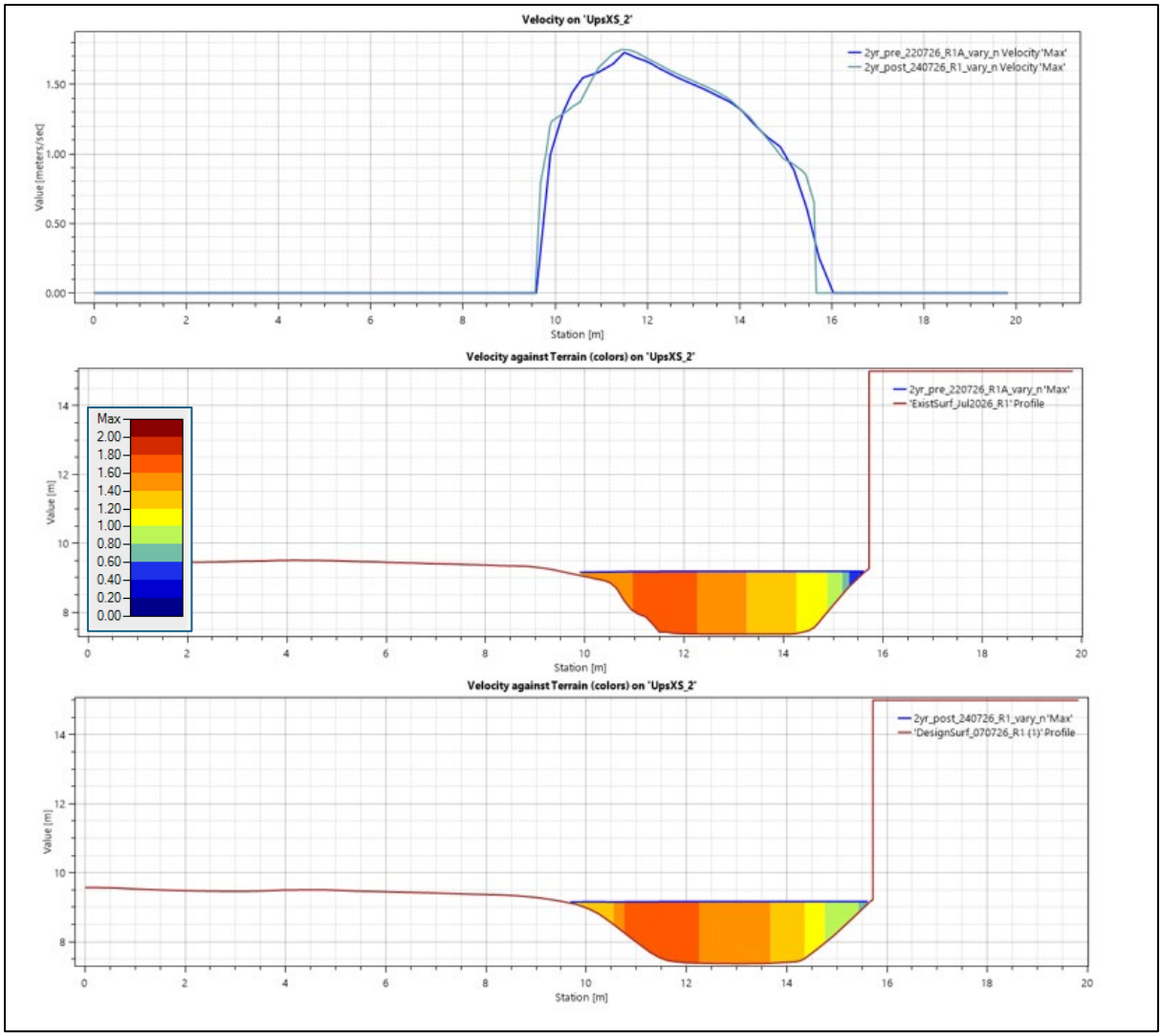


Figure 22: 2yr-velocity cross section analysis UpsXS2

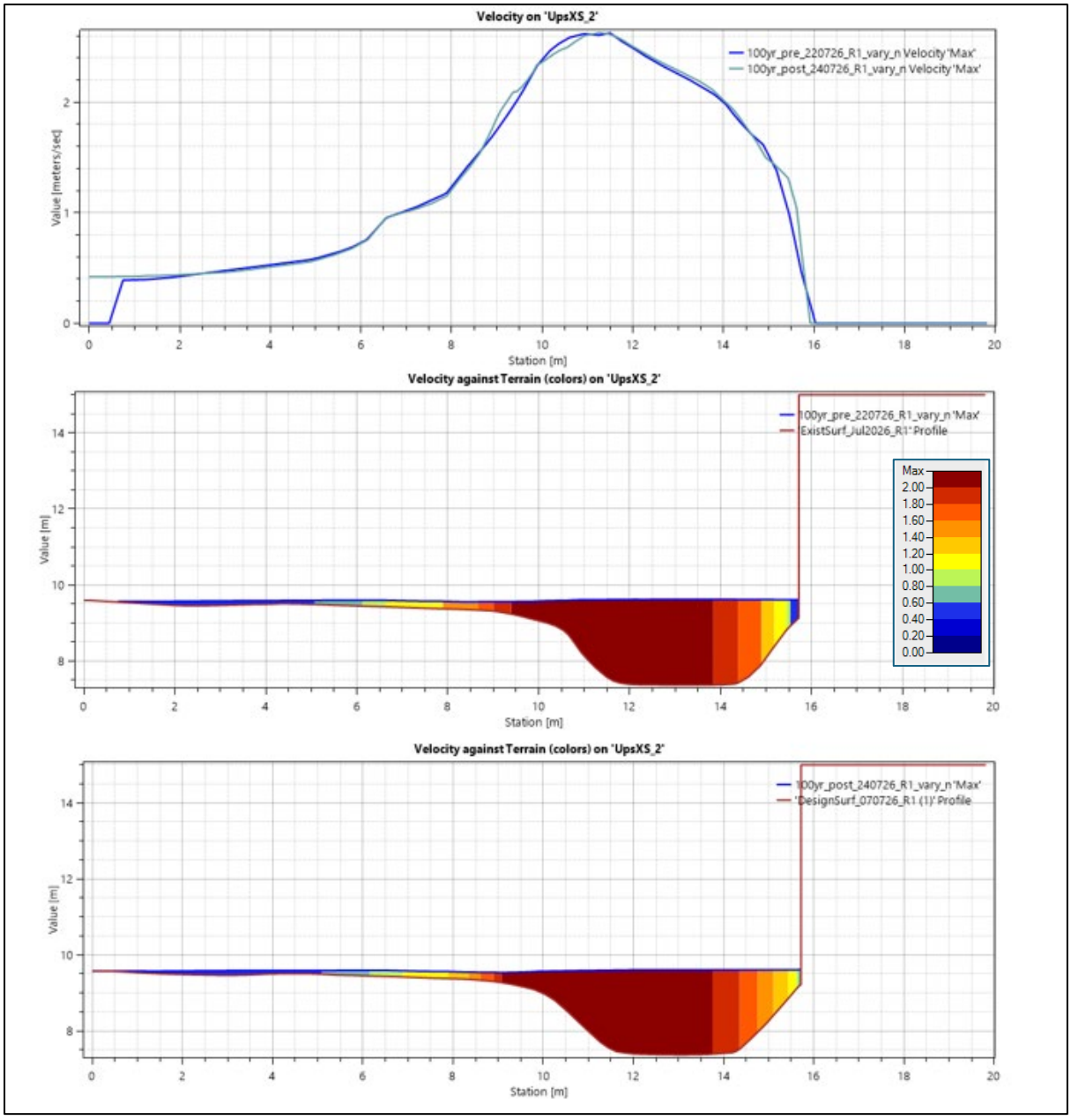


Figure 23: 100yr-velocity cross section analysis UpsXS2

6. Mitigation options and considerations

Current proposed works (True Left Bank)

The mitigation measures currently proposed through Hastings District Council and Woods addresses the true left bank (TLB) of the Herehere Strean, within the Local Purpose (Drainage) Reserve. The proposed works comprise bank regrading and surface stabilization as previously mentioned. In addition to that work Toe protection in the form of coir logs installed in a stacked arrangement at the bank toe and stacked in place. As part of the stabilisation sequence, the top two logs are relocated and restacked into new permanent positions within the riparian zone above the toe, while the bottom log remains at the stream bed level

This combines an earthwork based geometric correction with bioengineering surface protection appropriate to the streams diagnosed failure mode (i.e. incision and toe erosion) by reducing bank

steepness and height, reducing the risk of mass bank failure once a critical height or steepness threshold is reached (Simon, 1989)

7. Conclusion

This assessment has applied the Auckland Council Erosion Screening Tool (EST) framework, supported by S-map derived critical shear stress and 2D hydraulic modelling, to characterise erosion risk along the ~600m reach of the Herehere Stream adjacent to the Middle Road subdivision. The reach is diagnosed as incision dominant rather than laterally unstable, consistent with a straight, culvert bound channel alignment. An operative critical shear stress of 2 N/m^3 was adopted for the stream bed and toe, and 22 N/m^3 for the more cohesive upper banks and a portion of the development area, based on S-map silt-clay content and corroborated qualitatively by nearby CPT and borehole data.

2D modelling indicates that modelled shear stress exceeds the adopted critical shear stress at the stream bed under both pre and post development conditions, at all modelled ARIs, placing the bed in the EST rapid erosion (Red >10) category. The banks fall within the active erosion (Orange 2-10) range. This indicates the bed is already erosion prone under existing conditions, and the proposed development does not materially change this baseline behaviour.

Post development channel widening is predicted to reduce flow velocities overall, which is a net benefit for bed and bank stability. However, this benefit is not uniform across the channel where localised asymmetric flow risk is identified along the True Right Bank (TRB), where riparian vegetation is sparse and no engineering mitigation is proposed. Proposed mitigation on the True Left Bank (TLB), which includes regrading to a 1:3 slope over 10 m, combined with biodegradable matting, riparian planting and coir log installation, is expected to reduce erosion on that bank.

References

Chang, H. H. (1988). Fluvial processes in river engineering. *John Wiley & Sons*.

Simon, A. (1989). A model of channel response in disturbed alluvial channels. *Earth Surface Processes and Landforms*, 14(1), 11–26.

Julian, J. P., & Torres, R. (2006). Hydraulic erosion of cohesive riverbanks. *Geomorphology*, *76*(1-2), 193-206.

Appendix 1

Additional cross sections

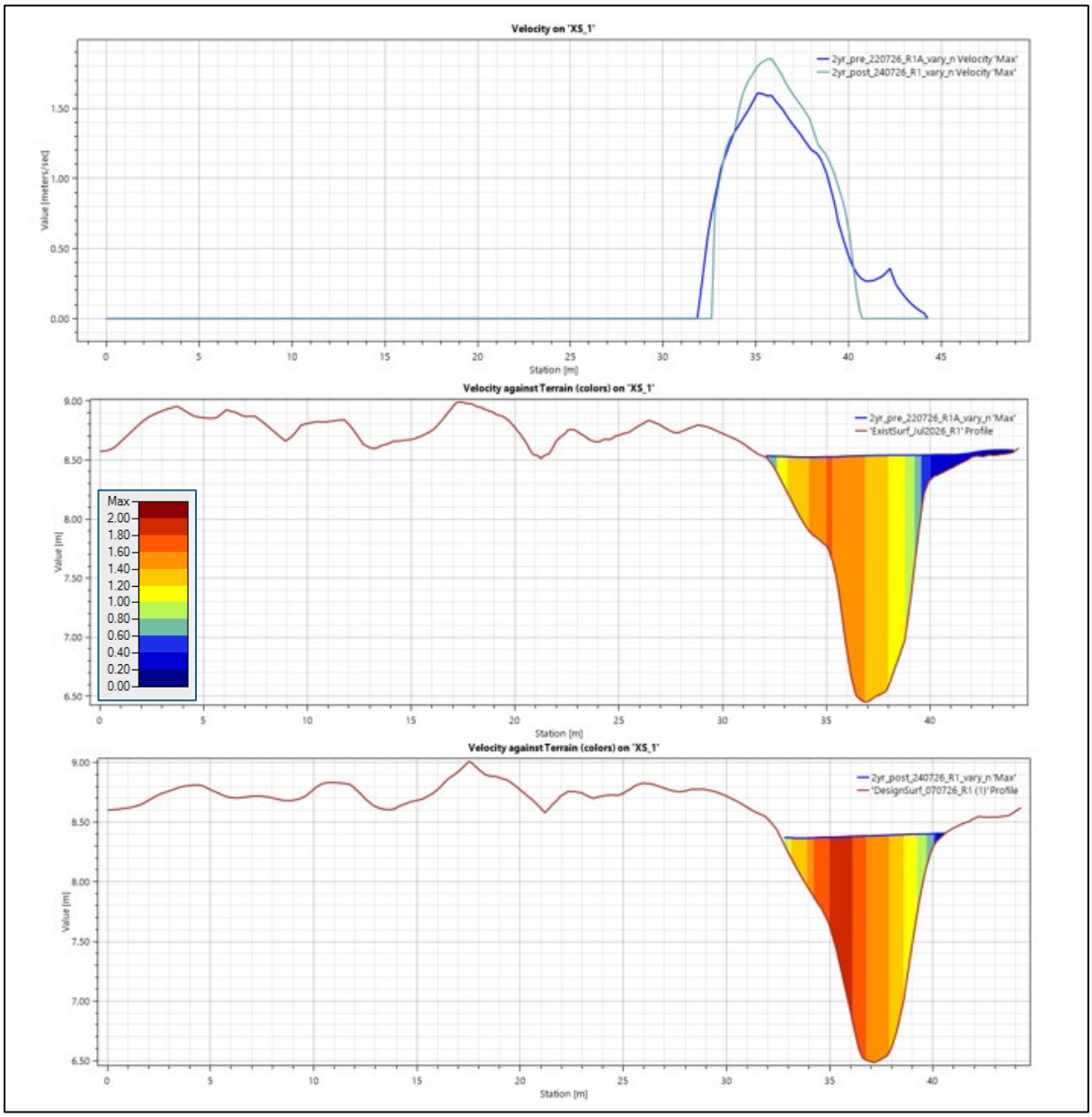


Figure A 1: 2yr-velocity cross section analysis XS1

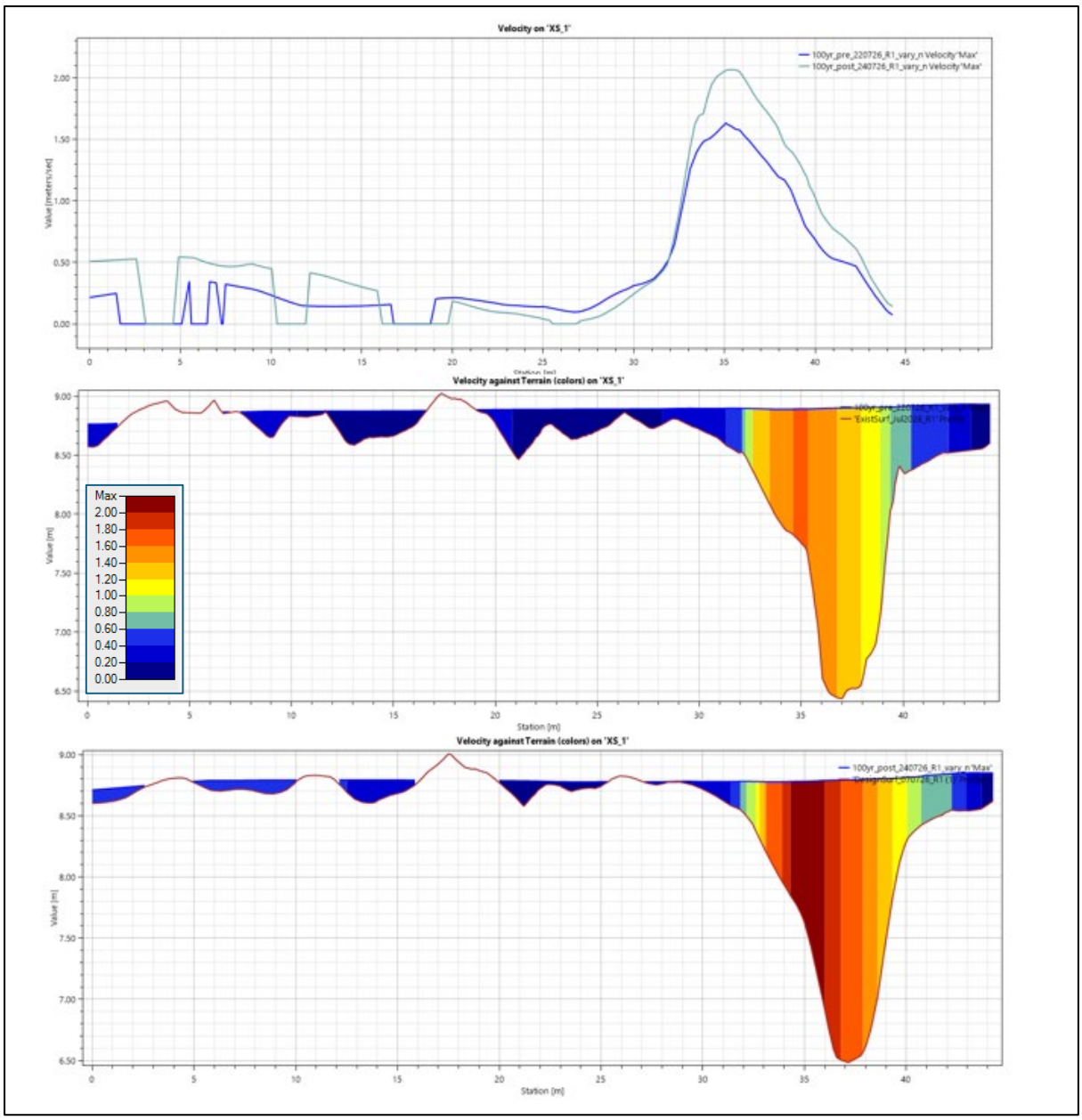


Figure A 2: 100yr-velocity cross section analysis XS1

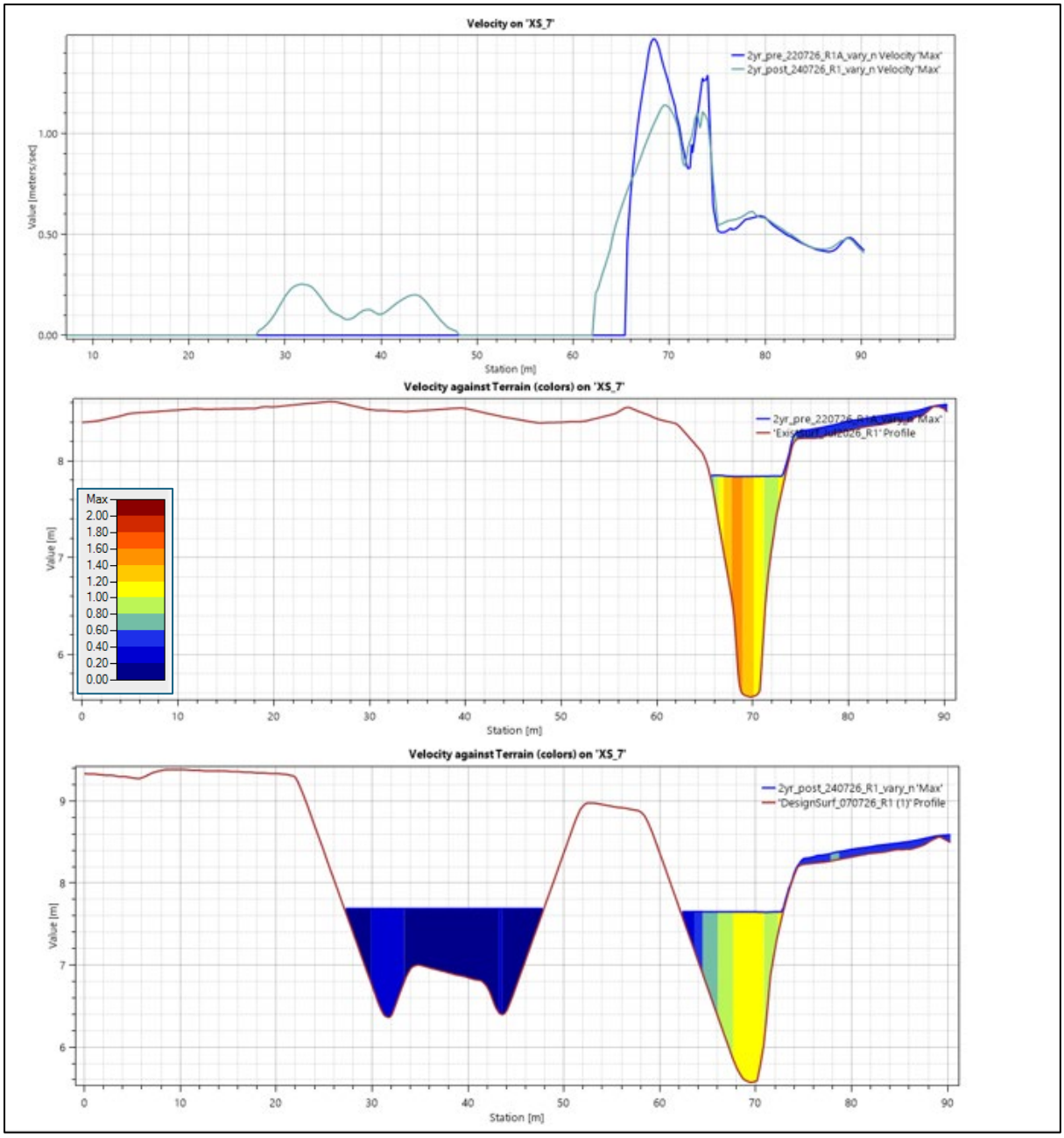


Figure A 3: 2yr-velocity cross section analysis XS7

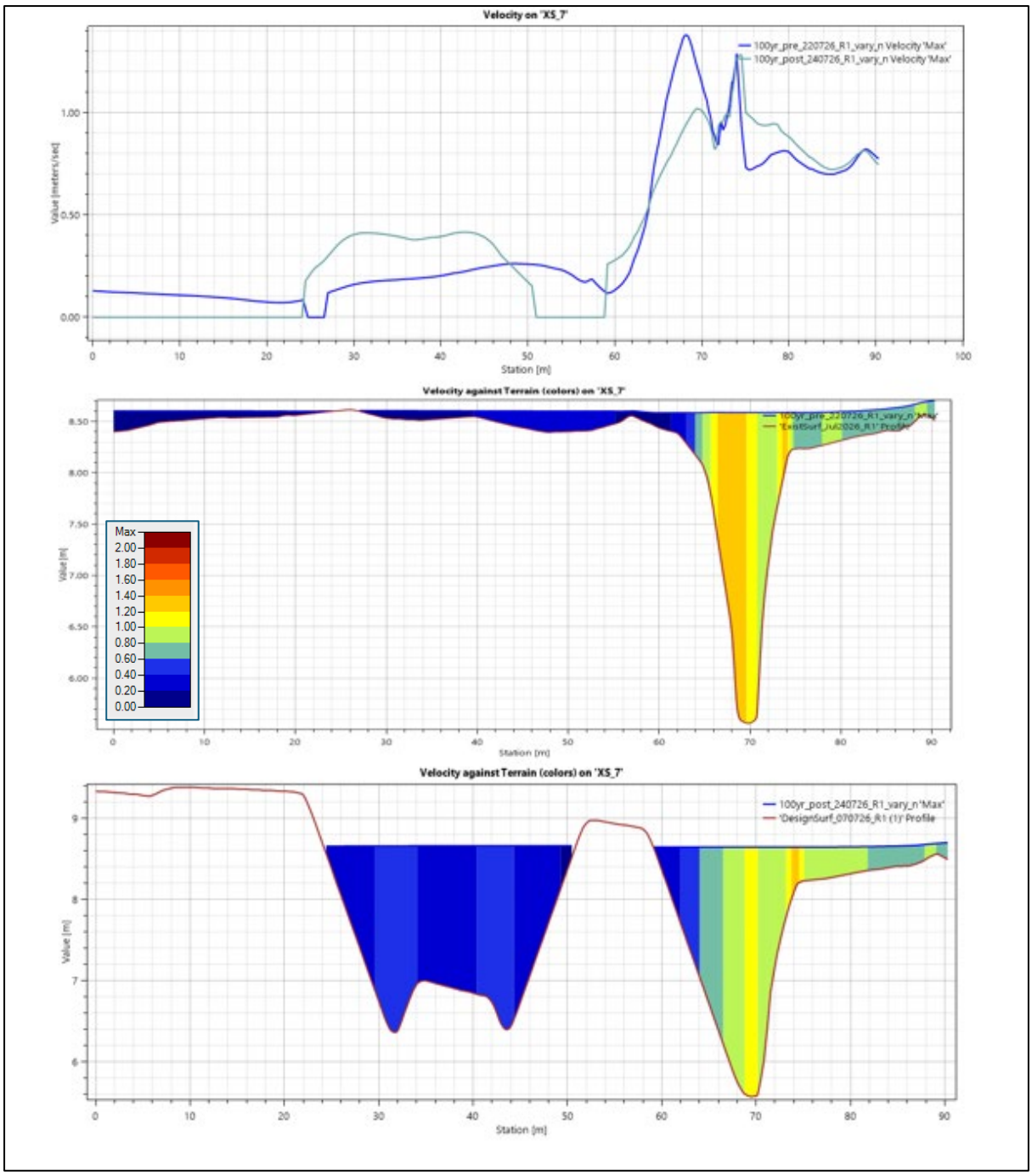


Figure A 4: 100yr-velocity cross section analysis XS7

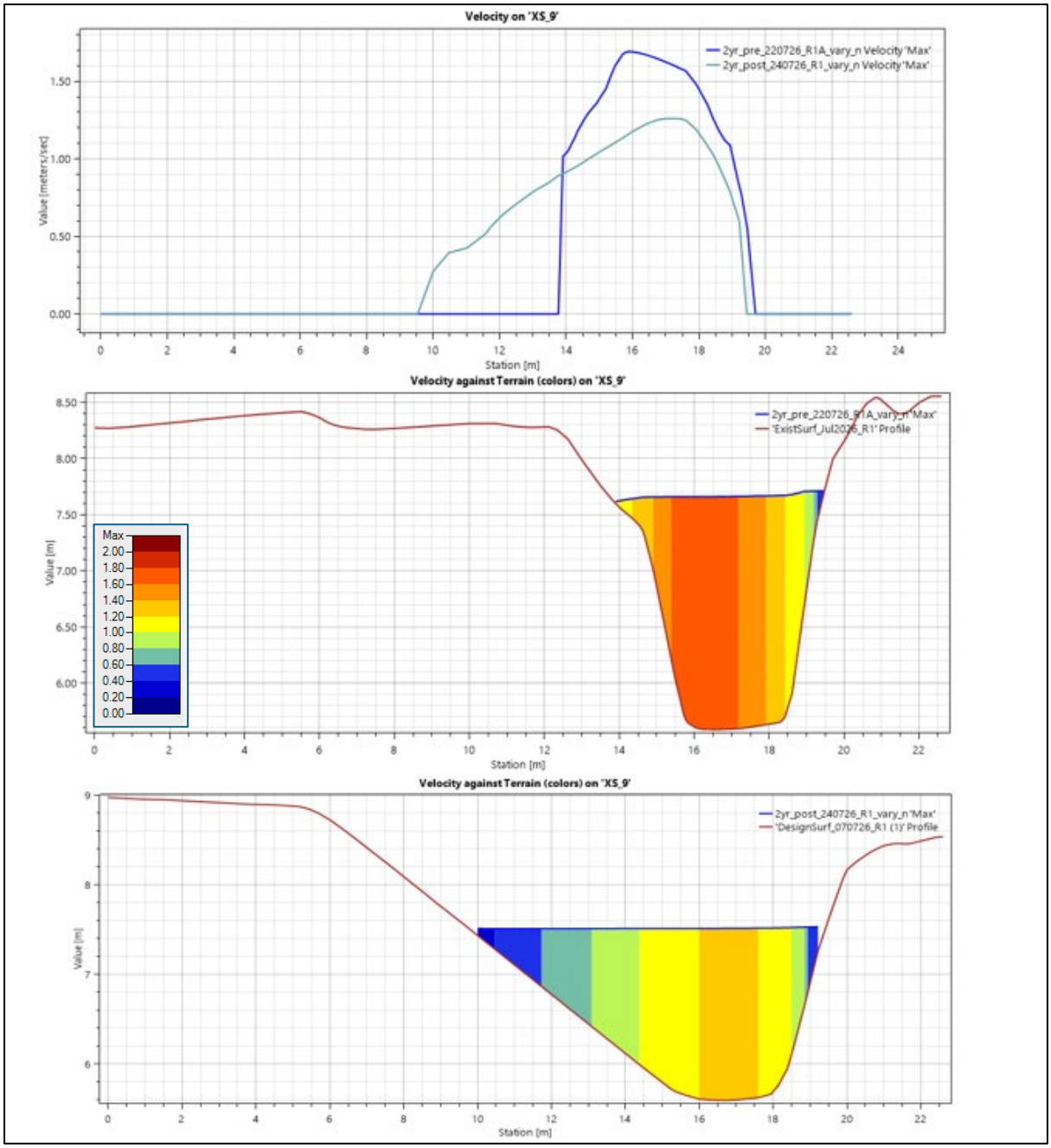


Figure A 5: 2yr-velocity cross section analysis XS9

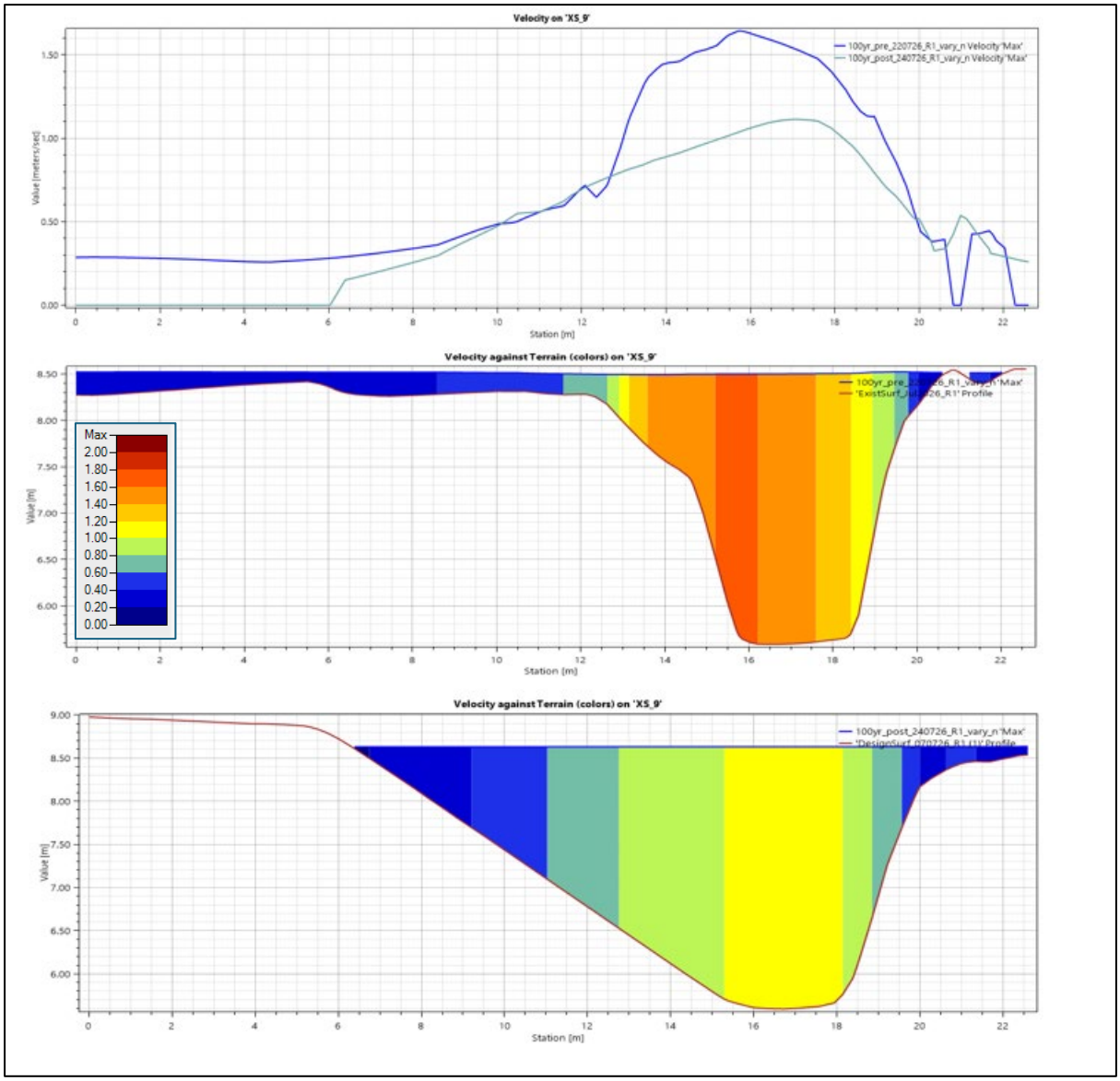


Figure A 6: 100yr-velocity cross section analysis XS9

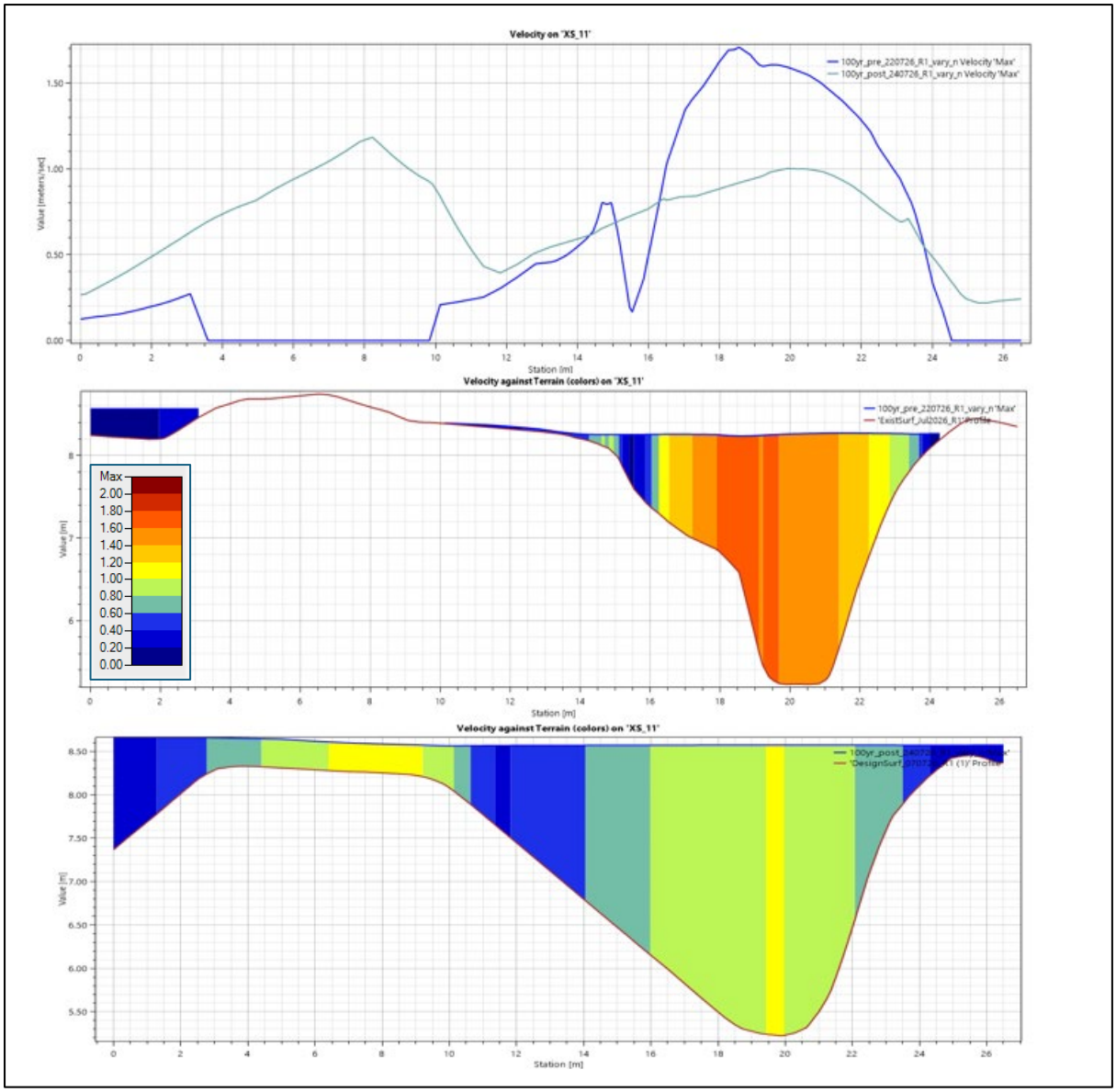


Figure A 7: 2yr-velocity cross section analysis XS11

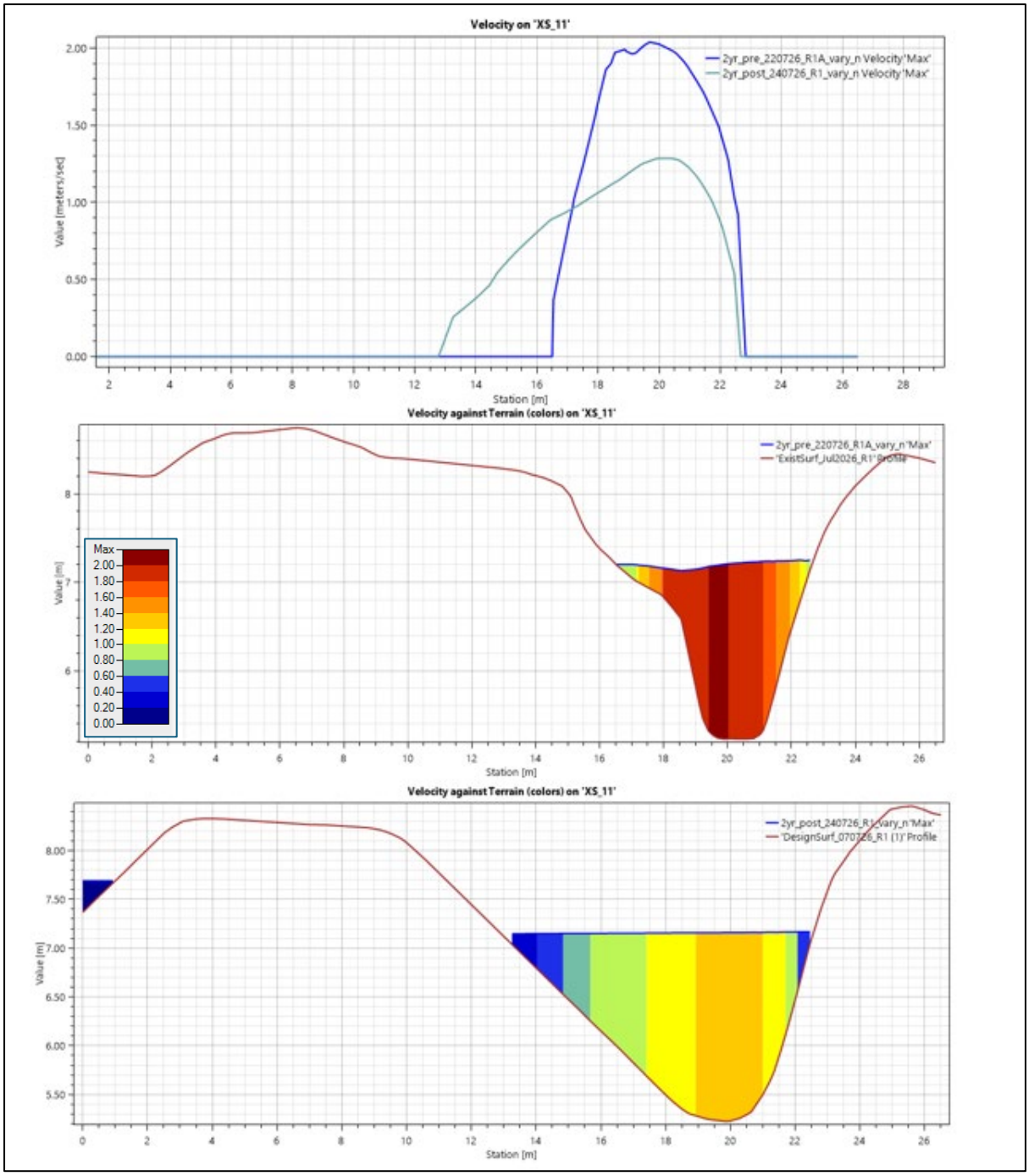


Figure A 8: 100yr-velocity cross section analysis XS11

APPENDIX 3: DRY BASINS OPERATIONS & MAINTENANCE MANUAL



WOODS
Est.1970
SIMPLY DONE WELL

Dry Basins
Operations & Maintenance Manual

Middle Road Substantive

Middle Road, Havelock North
CDL Land New Zealand Limited
30/09/2026
FINAL

Document Control

Project Number	P25-496
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1.0 Introduction

This operation and maintenance (O&M) manual details the proposed basin designs for the Middle Road development by CDL Land New Zealand Limited (CDL). The basin locations are shown in

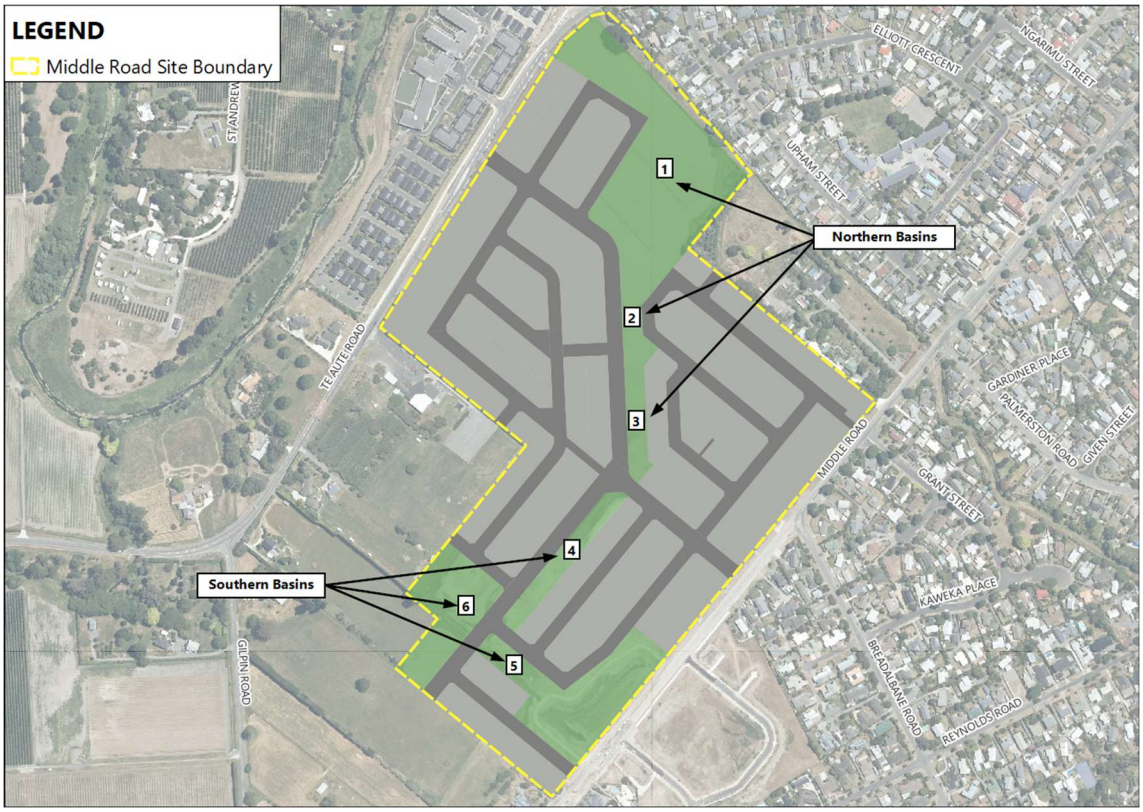


Figure 1.

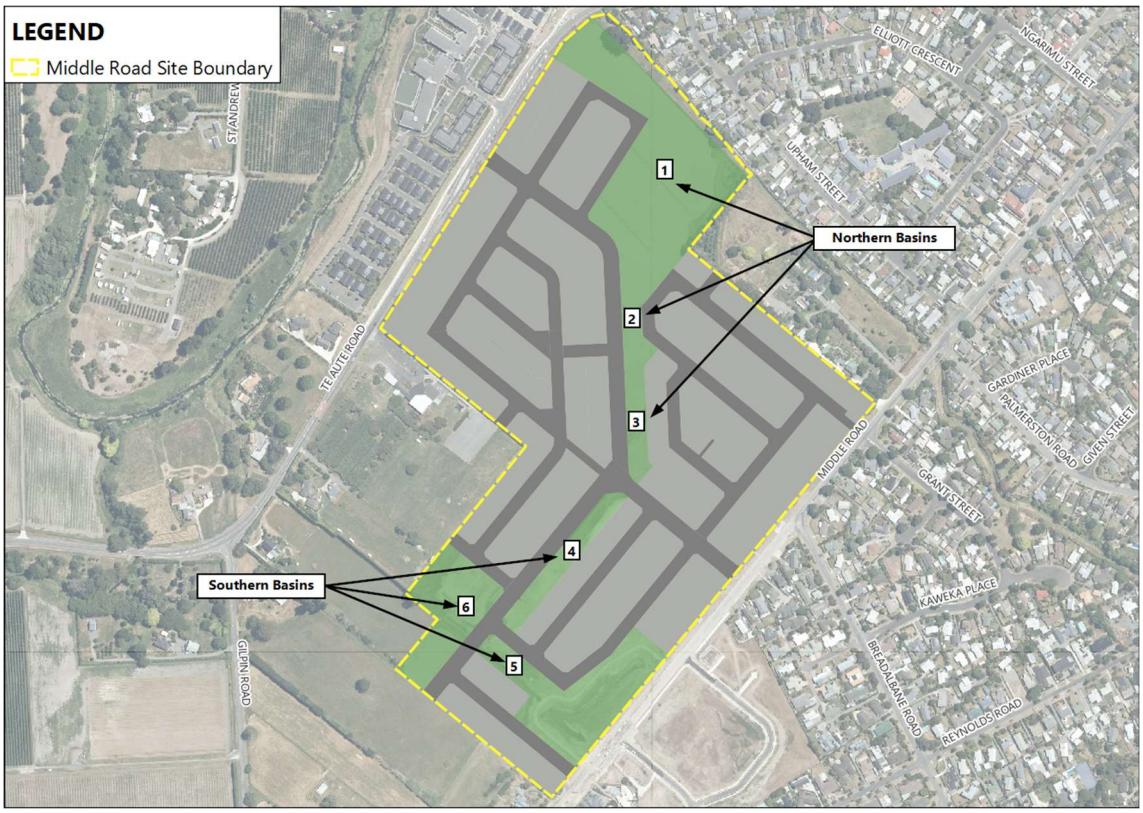


Figure 1: Proposed stormwater management.

It is intended that this O&M manual provides:

- Background information on the stormwater treatment and detention facilities at the basins;
- Basic background information on contributing stormwater catchment;
- Design details for the stormwater treatment and detention system; and
- O&M details.

This manual excludes information on the stormwater reticulation system within the contributing catchment area.

This manual is to be updated following consent and construction, with final O&M to be provided with CCC.

1.1. Contact Information

A summary of the contact information relating to the ownership, maintenance manager and designer for the basin is included in **Table 1**.

Table 1. Contact Information

Asset ID	**TBC**	**Resource Consent Number**	**TBC**
Location:	Location / address TBC Google Maps coordinates: TBC NZTM coordinates: TBC	Development Name / Legal Description:	Middle Road Project / TBC
Asset Owner Details:			
Name: Telephone Number:	Hastings District Council +64 6 871 5000	Address: 207 Lyndon Road East, Hastings 4122 Private Bag 9002, Hastings 4156	
Email:	customerservice@hdc.govt.nz		
Maintenance Manager Emergency Contact Details:			
Name:	TBC		

Telephone Number (Daytime): Telephone Number (Out of Hours): Email:	TBC TBC TBC	
Designer Details:		
Name: Telephone Number: Email:	Wood & Partners Consultants Ltd 0800 492 726 info@woods.co.nz	
Applicant Details:		
Name: Telephone Number Email:	CDL Land New Zealand Ltd +64 9 353 5077 admin@cdli.co.nz	
Landowner Details:		
Name: Telephone number: Email:	TBC (Hastings District Council) TBC (+64 6 871 5000) THC (customerservice@hdc.govt.nz)	
Notes / Restrictions / Access TBC – Description of access locations to be included with EA design details.		

2.0 System Description

2.1. Catchment Description

The basins provide stormwater treatment and detention for an approximate 30.3ha stormwater catchment, as detailed in **Table 2.**

Table 2. Catchments contributing to dry basins

Catchment	Total impervious area (ha)
Northern Catchment - discharging to Herehere Stream	17.9
Southern Catchment – discharging to Gilpin Drain	12.4

2.2. Design Philosophy

The purpose of the proposed basins is to provide stormwater treatment and detention for the contributing catchments. The basins have been designed to improve water quality through reducing contaminants such as Total Suspended Solids (TSS) before entering the receiving environments. Planting around the basin promotes biodiversity and improves public perception of the stormwater device.

2.2.1. Key Features

The basin was designed to meet the following design requirements.

Water Quality:

- Provide water quality treatment.

Hydrology Mitigation:

- Detention – Provide extended detention volume and a drain-down period of 24 hours.
- Attenuation – Provide attenuation of peak post development flows for 5-, 50-, and 100-year annual recurrence interval (ARI) events generated by the developed site to predevelopment flows.

2.2.2. Timeline

Construction is not yet completed. This section will be completed after the basins are constructed and vested.

2.2.3. Critical Levels as per approved Design and As-built Data

The design has not yet been approved. This section will be completed once the design of the Basin has been approved.

2.2.4. Dam Information

The basins are not classifiable dams according to the Building (Dam Safety) Regulations 2022. This is because it does not fulfil one of the criteria of:

- having a dam height greater than 4m and impounding a volume greater than 20,000m³. Or
- having a dam height greater than 1m and impounding a volume greater than 40,000m³. Therefore, the basin does not require a Potential Impact Classification (PIC) assessment.

2.3. As-Built Information

To be provided following consent and construction.

2.4. Design Standards and Assumptions

The proposed basins have been designed to provide management of the extended detention volume and attenuate peak post development flows for 5-, 50- and 100-year ARI generated on site to the predevelopment flows.

2.5. Ground Conditions

The basins shall be constructed as per the recommendations of the geotechnical report.

2.6. Consent Information

To be provided following consent approval.

3.0 System Components

3.1. Inlet Structure Details

Both basins have multiple inlet pipes. The inlet details can be summarised in **Table 3** below. Refer to drawing P24-496-00-3000-DR for further details.

Table 3. Dry Basin Inlets

Basin		Inlet Structures
Northern Basin	1	4 Circular Structures: DN450 DN600 DN825 DN900
	2	1 Circular Structure: DN525
	3	2 Circular Structures: DN600 DN1050 1 Twin Box Culvert Structure: 1m x 1m
Southern Basin	4	1 Circular Structure: DN375 1 Twin Box Culvert Structure: 1m x 1m
	5	1 Circular Structure: DN675 1 Twin Box Culvert Structure: 1m x 1m
	6	1 Circular Structure: DN675 1 Twin Box Culvert Structure: 1m x 1m

3.1.1. Routine Maintenance

Key routine maintenance actions identified for the basin inlets are summarised in **Table 4** below.

Table 4. Basin inlet maintenance actions

Component	Recommended Action
Basin Inlets and Energy Dissipation / Erosion Protection Structures	Inspect for clogging and buildup of debris and rubbish. Debris should not block or threaten to obstruct any stormwater inflow points.
	The area around the inlet and energy dissipation (e.g. rip rap) structures should also be inspected for erosion and cracks in the structure. Remove debris and litter and fix cracks and erosion as necessary.

3.1.2. Health and Safety Risks Associated with Dry Basin Inlet Structure Maintenance

There are several health and safety risks associated with working inlet structures. Some of these potential risks are highlighted in **Table 5** below.

Table 5. Health and safety risks associated with working around inlet structures

Risk	Mitigation
Steep and slippery banks	Take care and avoid wet soil conditions.
Flow through inlet making work unsafe (i.e. >0.5 m/s)	Ensure no rainfall has occurred in the last 24 hours and non in forecast
Confined space within inlet pipe	Do not enter the confined space.
Deep manholes	Do not enter the confined space. Take extra care when opening manholes.

3.2. Outlet Structure Details

The basin outlet structure details can be found in **Table 6**. To be updated following the as-built survey. Refer to drawings P24-496-00-3861/62-DR for further details.

Table 6. Outlet details

	Dry Basin – Zone 1 Herehere Stream	Dry Basin – Zone 2 Gilpin Drain
Orifice	120 mm	120 mm
Outflow control manhole	2100 mm	2100 mm
Slot	500x400 mm	400x300 mm
Outlet pipe	DN1500	DN1050

3.2.1. Routine Maintenance

Key routine maintenance actions identified for the basin outlet structures are summarised in **Table 7** below.

Table 7. Basin outlet maintenance actions

Component	Recommended Action
Basin outlets	Inspect basin outlets for blockages caused by heavy sedimentation, floating debris, and rubbish. The areas around the outlet control structure should be free of blockages and dense vegetation to maintain an unobstructed flow path for stormwater.
	Inspect for evidence of leaky joints or soil seeping around outflow pipe barrel.
	Inspect outfall and water discharge areas for erosion (presence and severity within 30 m of discharge point).
	Restore eroded areas and stabilise as necessary.
	Erosion (washout, scouring) around outflow pipes can be caused by water flowing from the basin and out along the outside of pipe, which can lead to embankment failure.
Erosion Protection	Inspect areas of erosion protection (rip rap, reno mattress, gabions) to identify any damage or loss of material. Identify any preferential flow paths forming through erosion protection that could be affecting function. Repairs should be carried out as required.
Debris Screens	The debris screens should be inspected for the build-up of pollutants, leaves, sticks, branches, litter, and other debris. Accumulated debris can hinder stormwater flows and cause localised flooding, and these should be removed and properly disposed of at an appropriate disposal facility. Visually inspect the debris screens for signs of corrosion, repair or replace if necessary. Check lock and chain for any rust or damage.

3.2.2. Stream Outfall Maintenance Access Requirements

The basin outlets are incorporated into scruffy dome structures. Plans P24-496-00-3861/62-DR highlight this. A maintenance vehicle could park on the access or maintenance tracks where wide enough for vehicles and personnel access the outfall by foot, by walking over the emergency spillways. Where access tracks are not wide enough, vehicle are expected to park next to the track and personnel can access the outfall structures on foot.

Where mechanical equipment such as excavators or vacuum trucks are required to remove larger debris and sediment buildup from the outfall, a sucker truck could park on the access track, maintenance track of the basin or at the base of the basin adjacent the outlet structure, and the suction hose carried manually to the riprap. For vehicular access in closer proximity to

the outfall for other maintenance activities, off-road vehicles such as 4WD or excavators, equipped with suitable traction and suspension systems to navigate the outfall access track is recommended. These can park on the access platform above the outfall structure, or at the base of the basin adjacent the structure.

Use of vehicles requires careful coordination to minimise environmental impacts.

3.2.3. Health and Safety Risks Associated with Dry Basin Outlet Structure Maintenance

There are a number of health and safety risks associated with working around waterbodies and outlet structures. Some of these potential risks are highlighted in **Table 8** below.

Table 8. Health and safety risks associated with working around Dry Basin outlet structures

Risk	Mitigation
Deep water (i.e. deeper than knee depth)	Do not enter the water, have rescue rope and second person available.
Removing blockage may generate high flow velocities	Lower water level before removing blockage.
Flow through basin making work unsafe (i.e. > 0.5 m/s)	Ensure no rainfall has occurred in the last 24 hours and none is forecast.
Confined space within outlet structure	Do not enter the outlet structure.
Fall Hazard	Avoid accessing close to steep drop offs, ensure safe site access

3.3. Emergency Spillway

Two basin emergency spillways are detailed in **Table 9** below. To be updated following the as-built survey.

Table 9. Spillway details

	Dry Basin – Zone 1 Herehere Stream	Dry Basin – Zone 2 Gilpin Drain
Invert of Emergency spillway	8.35 mRL	8.35 mRL

3.3.1. Routine Maintenance

Key routine maintenance actions identified for basin spillway structures are summarised in **Table 10** below.

Table 10. Maintenance actions

Component	Recommended Action
Emergency Spillway	Inspect and maintain grass cover at 100mm height. Ensure spillway is clear of trees and shrubs (only grass present). Inspect earth embankment for erosion, scour, slumping and any loss of soil. Cavities, erosion and scour should be repaired with engineered fill compacted to the earthwork's specifications (see glossary) Check embarkments for settlement, erosion, scouring, cracking, sloughing, separation, seepage, tomos, etc.

3.3.2. Health and Safety Risks Associated with Emergency Spillway Maintenance

There are several health and safety risks associated with working around the spillway. Some of these potential risks are highlighted in **Table 11** below.

Table 11. Health and safety risks associated with working around spillway

Risk	Mitigation
Deep water (i.e. deeper than knee depth)	Do not enter the water, have rescue rope and second person available.
Steep and slippery banks	Take care and avoid wet soil conditions.
Erosion, scouring of spillway	Do not access unstable spillway. Stay away from edge of erosion/failure.
Drop offs	Do not mow close to drop off at downstream shoulder of spillway.

3.4. Landscaping

The proposed basins have areas of vegetation proposed as per the planting plans outlined in the Fast Track application. Susceptibility and the loss of desirable native plant species to weed growth is a risk.

Pest plants can affect the basin's vegetation by outcompeting desirable native species. Due to the large number of pest plant species, refer to the Hawke's Bay Regional Council Pests and Weeds Hub Database (Hawke's Bay Regional Council, n.d.) and the Hawke's Bay Regional Pest Management Plan 2018-2038 (Hawke's Bay Regional Council, 2018).

3.4.1. Routine Maintenance

Key routine maintenance actions are summarised in **Table 12** below.

Table 12: Maintenance actions

Component	Recommended Action
Riparian Vegetation/Landscaping	Vegetation maintenance works including staking, trimming, lawn mowing, weed control, and replacement planting (only during planting season). Inspect riparian plant health and any build-up of dead plant material. Remove debris as necessary. Replace unhealthy or dead planting and undergo ongoing maintenance until established. When new planting is being carried out, exposed soil should be protected with mulch or organic matting such as coconut fibre to prevent soil erosion. Maintenance intervals will vary with growth rates and seasons. Identify weeds. Hawke's Bay Regional Council Pests and Weeds Hub Database (Hawke's Bay Regional Council, n.d.). Notify the Hawke's Bay Regional Council Biosecurity Team if pest species present 0800 108 838). Using appropriate control methods for the weed present, undertake weed control around the basin and in the wider property using a combination of mechanical control, manual removal and herbicide. Specialist to be contacted if further weed inspection and removal is required. Where soil erosion is observed, repair as necessary. Soil can be eroded from basin banks particularly after heavy rainfall and/or where vegetation cover is poor.

3.4.2. Health and Safety Risks Associated with Landscaping

There are several health and safety risks associated with working around riparian vegetation. Some of these risks are highlighted in the **Table 13** below.

Table 13. Health and safety risks associated with working around riparian vegetation

Risk	Mitigation
Steep and slippery banks	Take care and avoid wet soil conditions.
Unstable banks	Avoid standing on unstable banks
Stinging insects	Wear long sleeved clothing and take care during summer months.
Pollen/Dust	Wear respirator while mowing during summer.

3.5. Wildlife

The proposed dry basins will provide habitat for terrestrial and aquatic wildlife.

Mosquitos, pest animals such as rabbits, and stinging insects such as wasps can create health and safety hazards, which can negatively affect maintenance activities. For example, rabbit burrows can create a trip hazard for maintenance workers, or wasps can sting maintenance workers.

3.5.1. Routine Maintenance

Key routine maintenance actions identified for the basin wildlife are summarised in **Table 14** below.

Table 14. Maintenance actions

Component	Recommended Action
Wildlife	Regular inspection is required to ensure that desirable species are not threatened, and pest species are controlled. Areas for mosquito controlling organisms (e.g. minnows) should be maintained. Infestation of rabbits or rodents should be dealt with by a suitably qualified professional. Avoid contact with insects, such as wasps. If nests are on site, seek a suitably qualified professional to remove nests.

3.5.2. Health and Safety

There are several health and safety risks associated with working around ecology. These risks are highlighted in the **Table 15** below.

Table 15. Safety risks associated with working around ecology

Risk	Mitigation
Steep and slippery banks	Take care and avoid wet soil conditions.
Unstable banks	Avoid standing on unstable banks
Stinging insects	Wear long sleeved clothing and take care during summer months.
Pollen/Dust	Wear respirator while mowing during summer.

3.6. Access and Security

The basins are distributed throughout the development. Vehicular access to far Northern Basin is provided via a dedicated hoggin path access, while the remaining basins are accessed via the internal roading network. The access track can be referred to in drawing set P24-496-00-3850-DR.

Maintenance track around the dry basins

- The maintenance track along the northern boundary of the far Northern Basin adjacent the Herehere Stream is proposed to be 6m wide and constructed of durable and permeable materials such as gravel. This minimises soil compaction and erosion around the basins and allows for ease of maintenance of the track itself. A ute or excavator can comfortably track around the maintenance track. The access points to the maintenance track (off the access track) have been designed to allow for tracking of an 8.3m AT Truck design vehicle.
- The remaining basins (2-6) will be accessed via the internal road network.

Internal access

- Access to the internal parts of the basins can be made by foot. The battered slopes around the basins are typically 1V:3H with isolated sections at 1V:5H.

Basin outlet structure / scruff dome

- Access to the scruffy dome outlets can be made by vehicles using access tracks provided to the base of the basins, or by foot from the maintenance track walking over the shallow marsh, where the outlet has been placed at the edge of the outlet pool for ease of access.

  It is important that the access and maintenance track are regularly inspected and maintained for signs of erosion, damage, or excessive wear.

Emergency spillway

- Access to the northern basin spillway can be made by parking a vehicle on the maintenance track at the entry point of the emergency spillway, and inspections made by foot along the spillway.
- Access to the southern basin spillway can be made by parking a vehicle on the internal access road AR05, walking along the staff access track, and inspecting by foot along the spillway.

GPT/Proprietary Device

- All gross pollutant traps (GPTs) are accessible from the main internal road network. The drawing set P24-496-00-3000 indicates the location of each GPT. A vehicle could drive up to the GPT directly for maintenance activities. The GPTs are easily reachable by foot, and this method of access would be encouraged to minimise environmental impacts.

Land Drains

- There are two land drains located along the rear of the Southern Basin (Basin 6). Access to these drains can be made by parking a vehicle on the internal access road AR05, walking along the staff access track, and inspecting by foot.

Outfall structure

- This is discussed in Section 3.

3.6.1. Routine Maintenance

Key routine maintenance actions identified for the basin maintenance access are summarised in Table 16 below.

Table 16. Maintenance actions

Component	Recommended Action
Maintenance Accessway	Vehicular access to basin, structural integrity, width sufficient for plant and machinery access. Check presence of weeds. Remove if present.
Fences/Handrails	Check condition of perimeter/safety fences and handrails.
Signage	Check signage for graffiti or damage

3.6.2. Health and Safety Risks

There are several health and safety risks associated with working around a waterbody. Some of these potential risks are highlighted in the **Table 17** below

Table 17. Health and safety risks associated with working around access areas

Risk	Mitigation
Steep and slippery banks	Take care and avoid wet soil conditions.
Unstable banks	Avoid standing on unstable banks.
Public	Have a plan if an unwanted encounter occurs.

4.0 Dry Basin Operation & Maintenance Requirements

4.1. Inspection and Maintenance Activities

Inspection and maintenance checklists are designed to be used for all maintenance inspections. These checklists are included in **Appendix A**. It is recommended that all tables are printed/filled out during all inspections (although only the annual inspection requires every item).

Appendix A:

Maintenance Checklist

Effective long-term operation of the basins require dedicated and routine maintenance tasks performed to a consistent timetable:

Maintenance Activity	Monthly	6 Monthly	12 Monthly	5 Yearly
Remove weeds and replace dead plants. Eradicate noxious/pest weeds and undesirable growth. This shall be completed by competent workmen who have landscape experience. A hoe and weed knife will be required and other weed removal equipment.	✓			
Litter removal. Litter removal will require low skilled workman. Equipment includes a pickup tool claw, rubbish bags and other equipment suitable for the removal of litter.	✓			
Inflow, overflow/outlets – check overflow for clogging. Remove accumulated sediment. Check overflow spillway. This will require specialist materials and competent labour.	✓			
Summer-monitor and water vegetation in extended dry periods. Low skilled labour and watering tools will be required.	✓			
Visually check for damage or missing components of devices Replace/fix as required. Workmen who are competent at identifying broken equipment will be required as well as a site checklist, and other equipment deemed appropriate.	✓			
Pruning or thinning. Low skilled labour and pruning tools are required and other equipment deemed appropriate.		✓		
Inspect trees and shrubs and replace any dead or severely diseased vegetation. A shovel, weed knife, hoe and other equipment deemed appropriate may be required to carry out work.		✓		
Scour/erosion evident: check for erosion signs. Check dams/capping system areas and correct as required. Labourers who are competent in checking for erosion are required and other equipment that are deemed appropriate for job may be required.		✓		
Outlet manholes – check and remove silt from manhole sumps. Competent Labourers and a sucker truck. Equipment that is deemed appropriate maybe required.		✓		

Pre-treatment, inspection and silt removal as required. Low skilled labour is required and a sucker truck required. Equipment that is deemed appropriate maybe required.		✓		
Check for restrictions/clogging/failures in pipes. Competent workers and pipe work tools are required.			✓	

Appendix B:
As-Built Drawings

No as-built data available yet. This will be included once the construction is completed and the as-built drawings are made.