# Stormwater Report

On behalf of:

## Golding Meadow Developments Ltd

Golding & Yates Road
Pukekohe

3 November 2021
BSL Ref: 4294
Revision D

| Report prepared by | Report reviewed by | Report authorised by |
|---|---|---|
| Kelly Bosgra<br>Registered Professional Surveyor | Sir William Birch<br>Registered Professional Surveyor | Kelly Bosgra<br><br>Date: 18 May 2021 |

**Birch Surveyors Ltd**

Property House

2A Wesley Street, Pukekohe

PO Box 475, Pukekohe 2340, New Zealand

Telephone: 64 9 237 1111 Facsimile: 64 9 238 0033

Website: www.birchsurveyors.co.nz Email: Pukekohe@BSLnz.com

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## APPENDICES

# 1 INTRODUCTION

## 1.1 PROJECT

The report comprises a Stormwater and Flood Assessment to support the proposed Golding Road Plan Change comprising of the 17, 25, 27, 27$^{A}$ & 27$^{D}$ Royal Doulton Drive, 152-160 Golding Road, 240 & 242 Station Road and 27 & 49 Yates Road within the parameters of the Auckland Council's relevant objectives and policies for these properties. This report recommends the on-site treatment and disposal and also assesses flood plain and overland flow path requirements for the future development within the plan change area.

## 1.2 LEGAL DESCRIPTION

The legal descriptions of the Land parcels are as follows-

Appellation: Lots 8 & 9 DP 102609, Lots 1 & 2 DP 147908, Lots 1-6 DP 437089, Lot 1 DP 443991, Lot 1 DP 97787, Lot 1 DP 62593, & Lot 6 Deeds Plan 70

Records of Title: NA56C/755 & 766, NA88A/733 & 734, 538418-523, 562724, NA53B/664, NA18A/1372 & NA18D/367

Plan Change Area: ≈82.5Ha

## 1.3 SITE DESCRIPTION

The site is generally of flat contour, falling from Golding Road at the north down to Station Road / Yates Road to the south. It is bisected by an unnamed tributary of Tutaenui Stream, and bounded to the east by a sub-tributary. Most of the site drains to the tributary except a south-western portion of ≈18Ha fronting onto Station Road. This drains to the north, following existing open drains and culverts. Upon review of historic Photos dating back to 1942, the site appears to have been generally in grazing for the past 80 years, with a slow accumulation of equestrian features including training tracks, stables etc and associated housing and shedding.

The stream within the site appears to be in a fairly natural state in 1942, and later photos show progressive modification and it is now effectively a large straight ditch, having lost most of its ecology and environmental habitat.

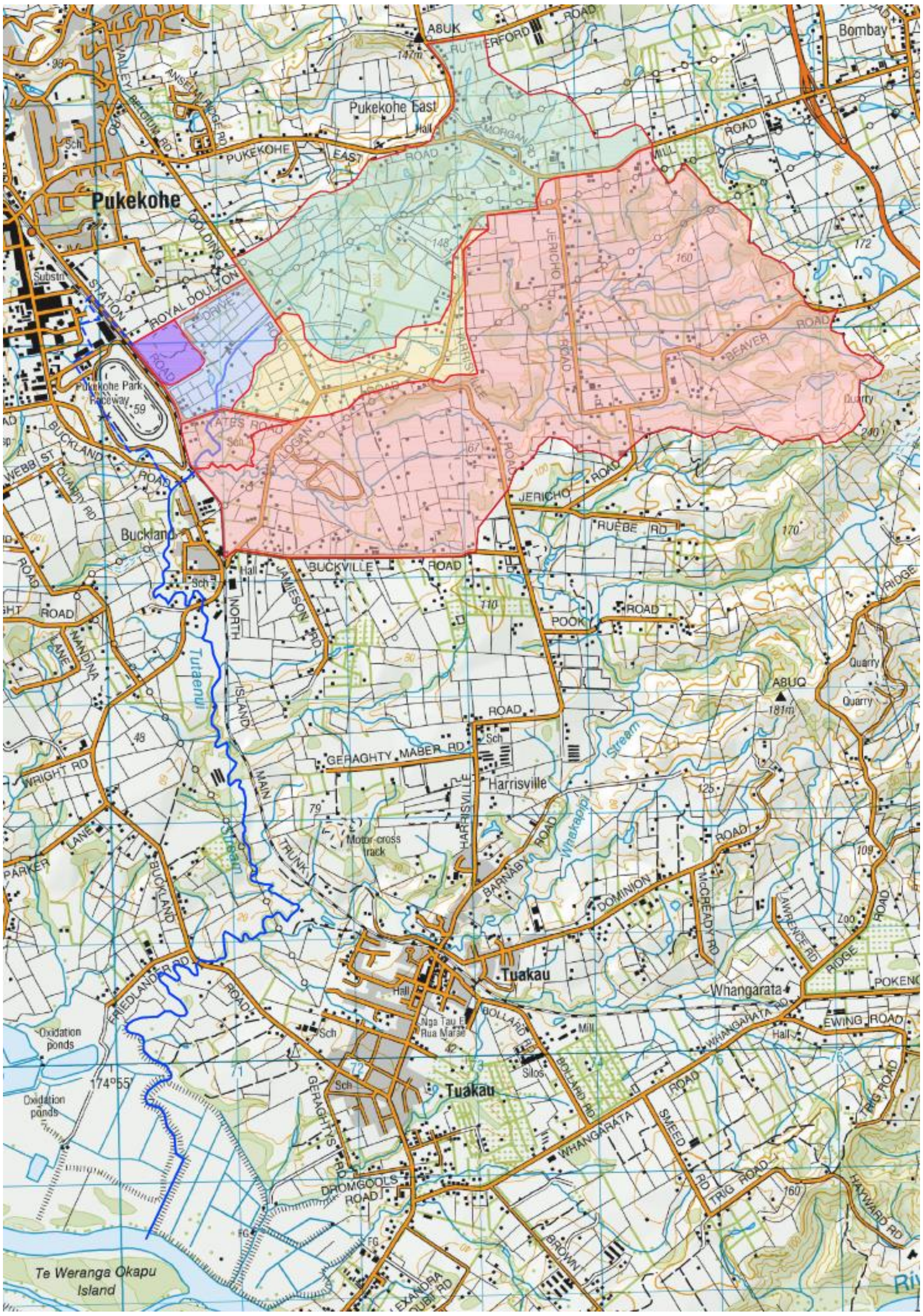
## 1.4 BACKGROUND

The site is situated near the bottom end of a side Tributary to Tutaenui Stream. Most of the catchment the site is located in drains about 1490Ha of Rural Zoned, east of Buckland, with 325Ha being upstream of the site (Green), 80Ha containing the site (Blue), 90Ha catchment skirting the site to join the catchment on the southern boundary (Yellow) and some 995Ha being the immediate downstream catchment (Red). These all join together join together to empty into the Tutaenui Stream west of Buckland.

A small portion of the site drains to the north-west, and is conveyed by existing open drains and culverts to the Tutaenui Stream near the southern end of Pukekohe

The Tutaenui Stream then flows south and joins the Whakapipi Stream before discharging into the Waikato River downstream of Tuakau.

The immediate Catchment is as shown; and is predominantly rural and contain rural activities. This catchment is currently serviced by open drains and culverts that direct surface flows from north-east to south-west. Some existing culverts appear undersized for major storms, and may cause localised flooding behind road embankments if they become blocked.




## 1.5 PROPOSED DEVELOPMENT

The Proposal is to complete a plan change to allow development within the proposed area in compliance with the Policies and Objectives of the Unitary Plan allowing for appropriate impervious Cover for the proposed zones and associated Stormwater Treatment and Flood Mitigation.

# 2 HYDROLOGICAL ASSESSMENT

## 2.1 HYDROLOGY

The hydrological assessment was undertaken to determine the impact of the development within the proposed zone change on both the site flows and the catchment flows, and to determine appropriate Stormwater Treatment & Attenuation and Stream Enhancement Opportunities.

## 2.2 FUTURE DEVELOPMENT

The Proposed zone change provides for a change in land use from the existing Rural (Future Urban) to a mix of Residential and business zones. The site Catchment Boundaries are based on the fully developed scenario and anticipates land uses as defined in the Auckland Unitary Plan within each catchment. The land uses, with corresponding impervious coverage including Improvements, Roading and Access are summarised in Table 2.2 below:

**Table 2-1 - Proposed Zone and Impervious Area Coverage**

| Proposed Zone | Maximum Impervious Cover |
|---|---|
| Residential – Mixed Housing Urban | 60% |
| Business – Light Industry | 100% |
| Open Space Zone | 5% |
| Recreation | 60% |

The Recreation Zone constitutes local parks and the impervious coverage anticipates carparking and courtyard/plaza pavements. The Open Space Zone constitutes riparian planting and any improvements are anticipated to consist of gravel or timber walking tracks and boardwalks.

## 2.3 AUCKLAND COUNCIL FLOOD MAPPING

Council has undertaken some flood modelling for this catchment, as reference to this is made in the WSP|OPUS “Paerata Pukekohe Future Urban Zone Structure Plan: Stormwater Management Plan”. We requested the Flood Data from Healthy Waters for this site and the data supplied did not appear to include any of the Structure Plan Flood Analysis. There appeared to be missing hydrological data and flow inconsistencies. Notwithstanding this, the Flood Map does identify low lying and flood prone areas, highlighting the on- and off-site stormwater and flooding issues and areas requiring mitigation.

Consequently, we have undertaken our own modelling in HEC-HMS to ascertain the site and catchment flows, and modelling the mitigation measures proposed to show compliance with the objectives and policies of the Auckland Unitary Plan and associated Guidance Documents and relevant Codes of Practice.

## 2.4 Model Build Summary

A Site and Catchment walkover was undertaken to ground truth the contour data obtained from Waikato Regional Council and the Auckland GIS. This was to assess the stream and overland flow paths and profiles within the catchment.

## 2.5 Software

The stormwater modelling was undertaken using TP108 (utilising HEC-HMS software) as per table 11 of GD2017/001, in combination with 12D Software, AutoCAD LT and HY-8 Culvert Simulation Software.

## 2.6 Topography Data

Topography data was collated from a number of Sources. The terrain model of the site derived from field survey and Waikato District Council Lidar Data. Contour Information for the upstream Catchment was derived from both Auckland Council and Waikato District Lidar Data, as the catchment is contained in both Councils.

## 2.7 Rainfall Data

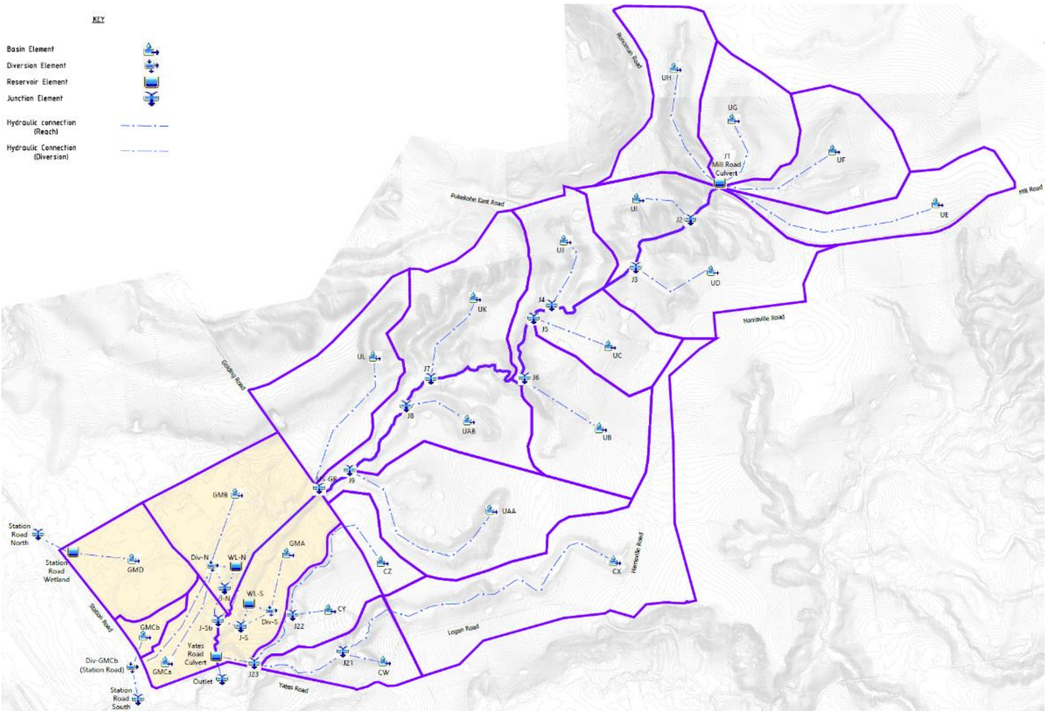
The design rainfall depths were obtained from Auckland Council rainfall maps from TP108 (Figures A.1 – A.6) and used for all pre-development calculations. Post Development calculations have had a 2.1° Climate Change Factor (CCF) allowance in accordance with the Ministry for Environment Guidelines 2008. The design rainfall depths used for the pre-development and post-development cases are summarised:

**Table 2-2 - Design Rainfall Depths**

| 24 Hour duration Storm Event | Pre-Development Rainfall Depth | Post-Development Rainfall Depth |
|---|---|---|
| SMAF 1 Equivalent / Water Quality Event (WQV)<br>90% Rainfall EventI | | 25mm |
| SMAF 2 Equivalent / Stream Protection<br>95% Rainfall Event<br>(Extended Detention Volume (EDV)) | | 34mm |
| 2 year ARI | 50mm | 54.5mm |
| 5 Year ARI | 89mm | 99.1mm |
| 10 Year ARI | 110mm | 124.6mm |
| 50 Year ARI | 165mm | 192.7mm |
| 100 Year ARI | 185mm | 216.1mm |

## 2.8 CATCHMENT DEFINITION

The contributing Stormwater Catchments have been carefully defined from both Lidar Data and site inspection and is defined by three distinct overland flowpaths/channels. The largest catchment discharges through the existing (highly) modified watercourse through the site and the smaller upstream catchments flow into watercourses that skirt the site further to the east, to enter the lower reach of the site via historic diversions prior to flowing under the existing culvert at Yates Road. It is these diversions that are not shown on the Council GIS, and will affect flood levels due to culvert backwater effects. The contributing catchments are further divided into sub-catchments, with the pervious and impervious areas modelled separately, even if they are not shown separately. Refer to Appendix B for the Full Catchment Plan. The Site catchments are divided into 2 Main Catchments being Catchment East and Catchment West.



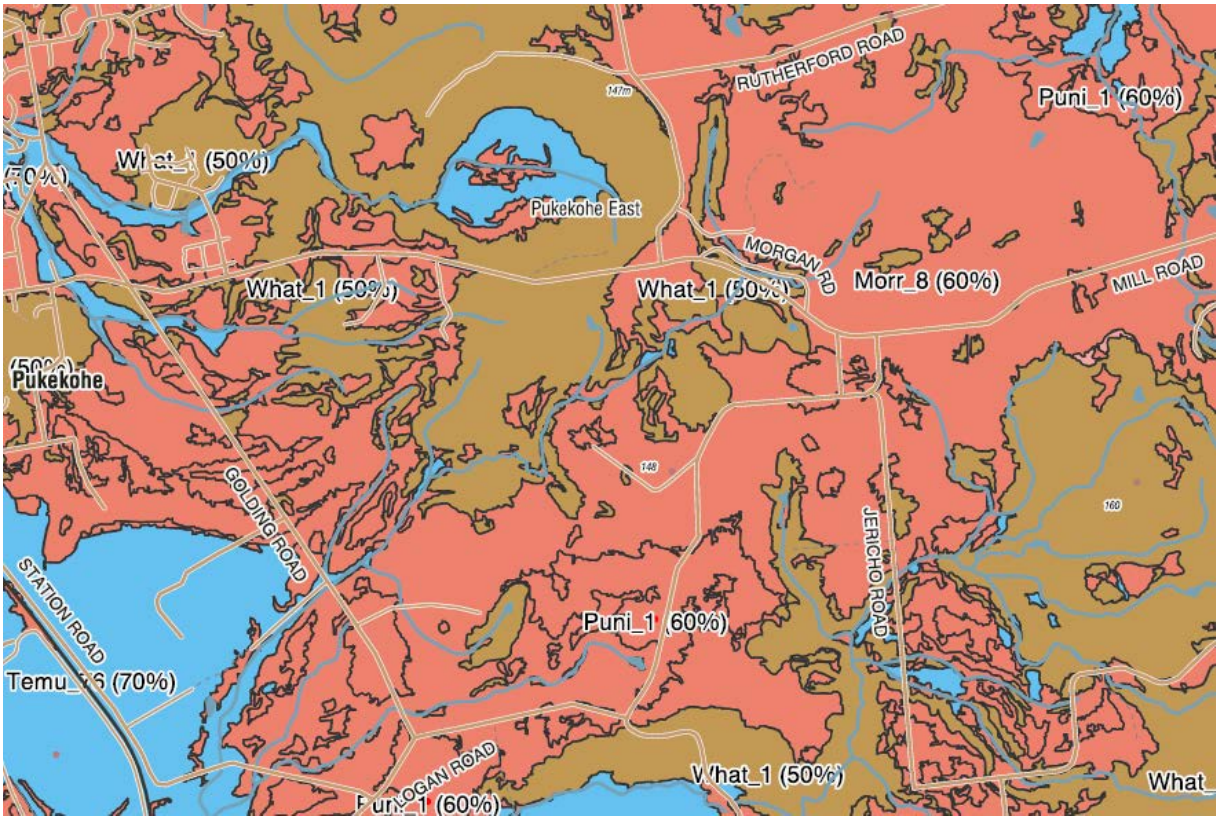

Catchment East contains 3 catchments, being GMA, for the eastern portion, GMB for the northern portion and GMC for the southern portion, which slopes gently to both Station Road and the Watercourse. This catchment can be further defined into sub-catchments GMCa & GMCb, and these end up discharging into the Watercourse.

An inspection of the drainage system within Station Road shows a very convoluted and complex system of open drains and small culverts, and runoff is conveyed up, down and across Station Road, with drains flowing in different directions on both sides of the road. We noted that the drains are all connected and the culverts are all measured as being 300mm, and are estimated to convey flows not exceeding 100l/s. Maintenance of this open drain network is not readily apparent, as a number of culverts appear blocked or partially blocked and the drains are likewise shallow & silted up, and contain dumped rubbish & standing water. These all affect the hydraulics of the drains, and we note that given that limited capacity of the culverts and drainage network, the majority of the runoff will travel as overland and be directed alongside the road. Sub-catchment GMCa fully drains to the Watercourse. Sub-catchment GMCb - has open drains than convey low flows across Station Road with overland flows being directed south along Station Road to discharge into the Stream via existing road drains and open drains through the adjacent Catchment GMCa

Catchment West contains one catchment, being GMD. This catchment drains north-west along Station Road and away from the stream. This catchment flows through existing drains, pipes and culverts and ends up in the Tutaenui Stream just north of the Pukekohe Park Raceway.

## 2.9 Catchment Runoff Parameters

The Underlying Site Soils vary somewhat, depending on the catchment geomorphology. The flat lower portion and the stream beds, comprising most of the proposed plan change area, have a S-Map classification of Temuka*f* Soils and has an historic DSIR Soil Classification of Ardmore Peat. These are poorly drained soils with a Hydrological Soil Classification as Class D. The elevated ground of gentle to undulating contour has a 50:50 ratio Morrinsville*f* (DSIR Soil Series Classification of Patumahoe Clay Loam - Air Fall Volcanic Ash) and Puni*f*. These are generally Granular Loams, from air fall volcanic ash and belong to Hydrological Soil Group A and Group B respectively. As these are considered comingled, a composite CN number being the average of Group A & B has been used for these soils. The Steep hillsides contain soils that have an S-Map classification of WhatitiriCL*f* and an historic DSIR soil classification as Kapu Hill and belongs to Hydrological Soil Group B. These Catchments also have a range of Ground Cover types and uses, including pasture, cropping and tracks. As these have different runoff and SCS Curve Numbers (CN), the Catchments have been divided into relevant subcatchments based on topography and the CN for each subcatchment has been calculated as a composite CN based on the relative proportion of Soil Types and Ground Cover present in that subcatchment.



## 2.10 Catchment Runoff Parameters

Auckland Council TP108 has been utilised to estimate the time of concentration and along with the SCS Curve Numbers (CN) the runoff and infiltration rates for each sub-catchment has also been calculated using TP108.

The contributing catchment has a variety of land uses including cropping, pasture, lawn and impervious surfaces. The following table outlines the curve numbers utilised in the assessment:

**Table 2-3 – SCS Curve Numbers**

| Land Use | Class A/B Soils | Class B Soil | Class D Soil |
|---|---|---|---|
| Cropping | 76.5 | 81 | 88 |
| Urban Lawn & Pasture | 50 | 61 | 74 |
| Impervious | 98 | 98 | 98 |

## 2.11 HEC-HMS Model Summary

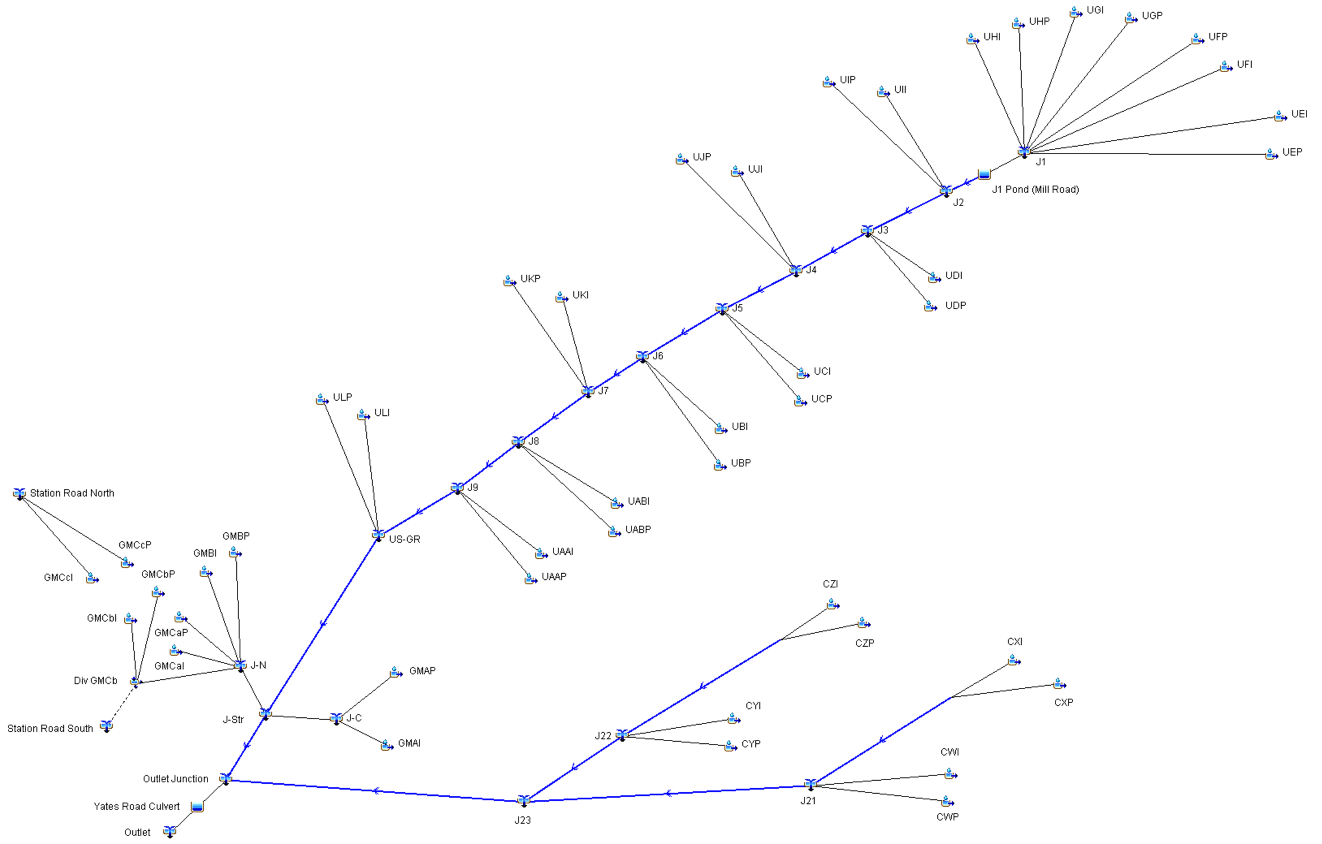
HEC-HMS was used in accordance with TP108 and GD2017/001 to estimate the peak flows of each sub-catchment to determine both the upstream catchment flows conveyed through the site and the peak flows exiting the site. A Summary of the modelling inputs are included in Table 2-4 below and the full HEC-HMS calculations are included in Appendix B

**Table 2-4 HEC-HMS Model Input Summary (Pre Development)**

| Catchment | Area Imp (Ha) | CN Imp | Tc Imp (min) | Lag Imp (min) | Area Per (Ha) | CN Per | Tc Per (min) | Lag Per (min) | Length (m) | Slope (m/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| GMA | 0.8609 | 98 | 15.6 | 10.406 | 17.5352 | 64.44 | 23.0 | 15.324 | 414 | 0.0196 |
| GMB | 2.9881 | 98 | 27.7 | 18.492 | 27.5910 | 80 | 33.9 | 22.609 | 891 | 0.0074 |
| GMCa | 1.4074 | 98 | 24.9 | 16.393 | 8.7317 | 80 | 30.1 | 20.042 | 580 | 0.0043 |
| GMCb | 0.9662 | 98 | 21.3 | 14.206 | 2.4911 | 80 | 26.1 | 17.368 | 500 | 0.0050 |
| GMD | 6.2479 | 98 | 18.2 | 12.138 | 13.1582 | 80 | 22.3 | 14.840 | 450 | 0.0067 |
| UAA | 1.122 | 98 | 23.7 | 15.819 | 43.7652 | 52.94 | 67.9 | 45.239 | 1821 | 0.0230 |
| UAB | 0.5724 | 98 | 10.5 | 6.988 | 22.3234 | 62.25 | 26.5 | 17.634 | 720 | 0.0455 |
| UB | 0.7624 | 98 | 13.4 | 8.921 | 29.7338 | 65.58 | 32.4 | 21.585 | 1226 | 0.0650 |
| UC | 0.4300 | 98 | 7.7 | 5.132 | 16.7700 | 64.21 | 18.9 | 12.632 | 630 | 0.0949 |
| UD | 0.9281 | 98 | 7.0 | 4.663 | 36.1948 | 60.31 | 18.1 | 12.066 | 543 | 0.0942 |
| UE | 0.5791 | 98 | 17.5 | 11.643 | 22.5837 | 68.65 | 40.7 | 27.123 | 1529 | 0.0435 |
| UF | 0.6619 | 98 | 9.1 | 6.034 | 25.8158 | 66.10 | 21.8 | 14.505 | 605 | 0.0506 |
| UG | 0.5250 | 98 | 10.3 | 6.845 | 20.4750 | 59.76 | 26.8 | 17.841 | 636 | 0.0371 |
| UH | 0.7230 | 98 | 16.0 | 10.650 | 28.1951 | 54.27 | 44.8 | 29.893 | 1199 | 0.0343 |
| UI | 0.3872 | 98 | 7.7 | 5.143 | 15.0998 | 57.55 | 20.7 | 13.804 | 597 | 0.0837 |
| UJ | 0.4860 | 98 | 9.2 | 6.109 | 18.9521 | 58.73 | 24.2 | 16.141 | 636 | 0.0542 |
| UK | 0.8997 | 98 | 12.7 | 8.475 | 35.0864 | 59.24 | 33.6 | 22.240 | 1023 | 0.0518 |
| UL | 0.7791 | 98 | 18.5 | 12.324 | 30.3867 | 57.88 | 49.4 | 32.933 | 1141 | 0.0190 |
| CW | 0.3730 | 98 | 6.1 | 4.076 | 14.5474 | 50 | 18.2 | 12.160 | 341 | 0.0530 |
| CX | 1.5301 | 98 | 20.9 | 13.948 | 59.6734 | 54.40 | 58.6 | 39.081 | 1957 | 0.0410 |
| CY | 0.3940 | 98 | 19.3 | 12.865 | 15.3676 | 50 | 57.6 | 38.382 | 800 | 0.0075 |
| CZ | 0.1958 | 98 | 8.0 | 5.349 | 7.6369 | 50 | 23.9 | 15.957 | 415 | 0.0330 |

## 2.12 HEC-HMS Model Schematic

The pervious and impervious components of the subcatchments were grouped at junctions and joined with reaches to simulate the stream flow, and better identify upstream peak flows from the differing catchment runoff characteristics. The pre-development HEC-HMS hydrologic basin model schematic is given below:




## 2.13 Pre-Development Assessment

The Pre-Development Assessment of Peak Flows and Total Volumes are summarised in Table 2-2 overleaf. The plan change area has two proposed zones, Commercial and Residential, and the Residential Zone is bisected by the Stream. The upstream Catchment consists of sub-catchments UAA – UL, with Junction **US-GR** being the Upstream Inflow onto the site. **J-Str** is the junction at the Attenuated Outfall, being the Site Exit. The adjacent catchments are CX-CZ. All the above have their confluence at the southern point of the site, at **Outlet Junction**, being the Outflow from the site. This then flows under Yates Road through the existing culvert, which has also been included in the hydrological model due to possible backwater and ponding effects.

The proposed Plan Change Area is divided into two main catchments, being Catchment East and Catchment West.

Catchment East is divided into three sub-catchments GMA (central sub-catchment), GMB (northern sub-catchment) and GMC (southern sub-catchment). Catchment GMC is further divided into 2 subcatchments GMCa, GMCb. Catchment GMCa drains fully to the Stream. Catchment GMCb has open drains that convey low flows (<100l/s) across the road with overland flows being directed south along Station Road to discharge into the Stream via existing road drains and/or open drains into and through the adjacent Catchment GMCa

Catchment West contains one catchment, being GMD. This catchment drains north-west along Station Road and away from the stream. This catchment flows through existing drains, pipes and culverts and ends up in the Tutaenui Stream just north of the Pukekohe Park Raceway.

Refer to Appendix A for full calculations and outputs.

**Table 2-5 Pre-Development Peak Flow Rates**

| Model Node | | 2 Year ARI | 10 Year ARI | 100 Year ARI | 100 Year ARI (cc) |
|---|---|---|---|---|---|
| USGR (Upstream Catchment) | Peak Flow ($m^3/s$) | 6.858 | 16.703 | 31.173 | 38.987 |
| | Time | 12:32 | 12:32 | 12:31 | 12:30 |
| J-N (Northern Catchment = GMB + GMCa + GMCb) | Peak Flow ($m^3/s$) | 1.967 | 4.572 | 7.723 | 9.333 |
| | Time | 12:22 | 12:22 | 12:22 | 12:22 |
| J-C (Central Catchment = GMA) | Peak Flow ($m^3/s$) | 0.603 | 1.575 | 2.916 | 3.641 |
| | Time | 12:16 | 12:16 | 12:16 | 12:16 |
| J-Str (Site Exit) | Peak Flow ($m^3/s$) | 8.526 | 20.349 | 37.689 | 47.211 |
| | Time | 12:36 | 12:38 | 12:37 | 12:35 |
| Outlet Junction (Catchment Exit) | Peak Flow ($m^3/s$) | 9.679 | 23.672 | 44.258 | 55.531 |
| | Time | 12:40 | 12:43 | 12:41 | 12:40 |
| Station Road North (Western Catchment = GMD) | Peak Flow ($m^3/s$) | 1.3034 | 2.716 | 4.380 | 5.238 |
| | Time | 12:15 | 12:15 | 12:42 | 12:15 |

## 2.14 Post-Development Assessment

The Post-Development Assessment of Peak Flows and Total Volumes have been calculated for a number of scenarios to determine the effects the differing scenarios have on the site, the upstream catchment and the downstream catchment. Post-Development rainfall depths have been adjusted for Climate Change in accordance with MfE Guidelines and the results are summarised in Table 2-2 below.

**Table 2-6 Post-Development Peak Flow Rates**

| Model Node | | 2 Year ARI | | | 10 Year ARI | | | 100 Year ARI | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No Att | Des Att | Full Att | No Att | Des Att | Full Att | No Att | Des Att | Full Att |
| USGR Upstream Catchment | Peak Flow ($m^3/s$) | 8.171 | 8.171 | 8.171 | 20.705 | 20.705 | 20.705 | 38.987 | 38.987 | 38.987 |
| | Time | 12:32 | 12:32 | 12:32 | 12:32 | 12.32 | 12:32 | 12:30 | 12:30 | 12:30 |
| J-N Northern Catchment: GMB + GMC | Peak Flow ($m^3/s$) | 4.155 | 3.597 | 1.969 | 7.938 | 7.890 | 4.577 | 12.294 | 12.290 | 7.720 |
| | Time | 12:14 | 12:15 | 12:34 | 12:15 | 12:15 | 12:30 | 12:15 | 12:15 | 12:29 |
| J-C Central Catchment: GMA | Peak Flow ($m^3/s$) | 1.512 | 1.295 | 0.602 | 2.903 | 2.889 | 1.573 | 4.583 | 4.582 | 2.916 |
| | Time | 12:14 | 12:15 | 12:41 | 12:15 | 12:15 | 12:34 | 12:15 | 12:15 | 12:30 |
| J-Str Site Exit | Peak Flow ($m^3/s$) | 10.532 | 10.178 | 10.632 | 24.878 | 24.855 | 26.177 | 46.278 | 46.275 | 48.333 |
| | Time | 12:35 | 12:36 | 12:32 | 12:38 | 12:38 | 12:40 | 12:35 | 12:35 | 12:37 |
| Outlet Junction Catchment Exit | Peak Flow ($m^3/s$) | 11.971 | 11.622 | 12.071 | 29.085 | 29.061 | 30.327 | 54.676 | 54.674 | 56.667 |
| | Time | 12.38 | 12:39 | 12:42 | 12:42 | 12:42 | 12:44 | 12:40 | 12:40 | 12:41 |
| Station Road North GMD Catchment Exit | Peak Flow ($m^3/s$) | 2.452 | 1.309 | 1.309 | 4.412 | 2.683 | 2.683 | 6.617 | 4.385 | 4.385 |
| | Time | 12.11 | 12:23 | 12:23 | 12:11 | 12:21 | 12:21 | 12:11 | 12:20 | 12:20 |

The above scenarios calculate the flowrates for No Site Attenuation, WQV and Limited Attenuation (Proposed Scenario) and Full Site Attenuation.

These illustrate some interesting catchment characteristics, and when taking into account the peak downstream catchment flow, the resulting Stormwater Management requires a radical solution to achieve all the objectives, policies and requirements required by the Unitary Plan and SWCop.

# 3 STORMWATER AND FLOOD MANAGEMENT

## 3.1 DESIGN CONSIDERATIONS

A review of the Unitary Plan Stormwater Policies and relevant Council Guidelines was undertaken to determine the appropriate stormwater treatment and flood mitigation requirements to be adopted. The relevant policies and guidelines are summarised as follows:

## 3.2 AUCKLAND UNITARY PLAN (OPERATIVE IN PART)

The AUP(OP) sets out objectives, policies and rules for development undertaken within the Auckland Region. There are both regional rules applicable to all developments, and also precinct rules, being more specific to certain areas.

### 3.2.1 AUCKLAND-WIDE PROVISIONS

The general AUP policies for management of stormwater and flooding are covered in Chapter E – Auckland Wide, namely:

- Section E1 – Water quality and integrated management.
- Section E10 – Stormwater management area – Flow 1 and Flow 2.
- Section E36 - Natural hazards and flooding.

Policy 8 in Section E1 (Policy E1.3.8) sets out the following requirements for the Management of Stormwater runoff from greenfield development:

> Avoid as far as practicable, or otherwise minimise or mitigate, adverse effects of stormwater runoff from greenfield development on freshwater systems, freshwater and coastal water by:
>
> (a) taking an integrated stormwater management approach (refer to Policy E1.3.10);
>
> (b) minimising the generation and discharge of contaminants, particularly from high contaminant generating car parks and high use roads and into sensitive receiving environments;
>
> (c) minimising or mitigating changes in hydrology, including loss of infiltration, to:
>
> (i) minimise erosion and associated effects on stream health and values;
>
> (ii) maintain stream baseflows; and
>
> (iii) support groundwater recharge;
>
> (d) where practicable, minimising or mitigating the effects on freshwater systems arising from changes in water temperature caused by stormwater discharges; and
>
> (e) providing for the management of gross stormwater pollutants, such as litter, in areas where the generation of these may be an issue.

The other relevant policies from Section E1 are summarised as follows:

- Enhance water quality, flows, stream channels and their margins (Policy E1.3.2b and Policy E1.3.3).
- Discharges are to avoid contamination that will have an adverse effect on the life supporting capacity of freshwater or freshwater ecosystem (Policy E1.3.4).
- Discharges are to avoid contamination that will have an adverse effect on health of people and communities (Policy E1.3.5).
- The integrated stormwater management approach (Policy E1.3.10) is to have regard to all of the following:
  - The nature and scale of the development and practical and cost considerations.
  - The location and design of site and infrastructure to protect significant site features and minimise effects on receiving environments.
  - The nature and sensitivity of receiving environments.
  - Reducing stormwater flows and contaminants at source.
  - The use and enhancement of natural hydrological features and green infrastructure where practicable.
- Avoid, minimise or mitigate adverse effects of stormwater diversions and discharges (Policy E1.3.11) having particular regard to:
  - The nature, quality, volume and peak flow of stormwater runoff
  - The potential for the diversion and discharge to create or exacerbate flood risks.
  - Options to manage stormwater on-site or using communal stormwater devices
  - Practical limitations in respect of the measures that can be applied.
  - The current state of the receiving environment.
- Manage contaminants in stormwater runoff from high contaminant generating carparks (> 30 cars) and high use roads (>5000 vehicles per day) to minimise adverse effects on water and sediment quality in freshwater systems (Policy E1.3.12).
- Require Stormwater quality or flow management to be achieved on-site unless there is a downstream communal device (Policy E1.3.13).
- Adopt the best practicable option to minimise the adverse effects of stormwater runoff and discharges (Policy E1.3.14).
- Utilise stormwater discharge to ground soakage where it is possible to do so safely and effectively (Policy E1.3.15 and Policy E1.3.16).

Section E10 sets out policies and additional controls for sites identified in the Stormwater Management Area control – Flow 1 and Flow 2 (SMAF1 and SMAF2). The policies are summarised as follows

- Manage stormwater runoff in SMAF areas to minimise the adverse effects of the runoff on streams to retain and where possible to enhance its naturalness, biodiversity, bank stability etc. (Policy E10.3.1).
- Require stormwater hydrology mitigation where there are new or redeveloped impervious areas. (Policy E10.3.2).
- Recognise there may be limitations to the hydrology mitigation that can be practicably achieved in some circumstances. (Policy E10.3.3).

These additional controls seek to lessen the impact of a change in runoff volumes and flow rate as a result of development. The SMAF Controls are designed to protect watercourses that are particularly susceptible to the effects of development or have relatively high values.

SMAF1 equivalent controls will be required to apply to the site as the discharge is to an existing (highly modified) stream and will ensure compliance with Policy E1.3.8 that requires "...minimising or mitigating changes in hydrology..."

The proposed hydrological mitigation requirements are as follows:

- Retention (volume reduction) of 5mm runoff depth from impervious areas.
- Detention (temporary storage) and a drain down period of 24 hours for the difference between the pre-development and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus the retention volume achieved, from the impervious areas.
- Exceptions for providing retention can be made in cases where soil infiltration rates preclude disposal to groundwater, soakage is not geotechnically feasable and rainwater reuse is not possible.

Section E36 sets out the policies and requirements relating to management of natural hazards and flooding. The relevant policies for this site are Policies 17-30 and are summarised as follows:

- Avoid locating buildings in the 1% AEP floodplain (Policy E36.3.17).
- Allow certain flood tolerant activities to occur within the 1% AEP floodplain if they do not exacerbate the flood hazard to either upstream or downstream properties (Policy E36.3.18 & Policy E36.3.19)

- Earthworks within the 1%AEP floodplain is required to remedy or mitigate flood hazards, not exacerbate flooding on upstream or downstream properties and not permanently reduce floodplain conveyance (Policy E36.3.20).
- Ensure all development in the 1% AEP floodplain does not increase adverse effects or increased flood depths or velocities to other properties upstream or downstream of the site (Policy E36.3.21).
- Enable retention and enhancement of vegetation within floodplains as long as is does not exacerbate flooding on upstream or downstream properties (Policy E36.3.24)
- Construct accessways so flood hazard risks are not increased (Policy E36.3.26)
- Maintain the function and capacity of overland flowpaths to convey stormwater runoff safely and without causing damage to property or the receiving environment (Policy E36.3.29 and Policy E36.3.30).

Sections E8 & E9 are relevant for determining activity standards, however these chapters do not contain any policies and objectives, referring to the Policies within Chapter E1.

The immediate Receiving Environment is a highly modified (unnamed) tributary of the Tutaenui Stream and the ultimate Receiving Environment is the Waikato River.

### 3.3 AUCKLAND UNITARY PLAN (OPERATIVE IN PART)

The required Stormwater objectives are to mitigate the effect of runoff from Development for both Flow and Water Quality; to not increase existing Flood Flows and Flood Levels, and to treat the runoff from new impervious surfaces. The following Council Publications and Guidelines form a key resource in both identifying appropriate stormwater devices and to calculate the appropriate sizing of devices to ensure the objectives and policies of the Unitary Plan are achieved:

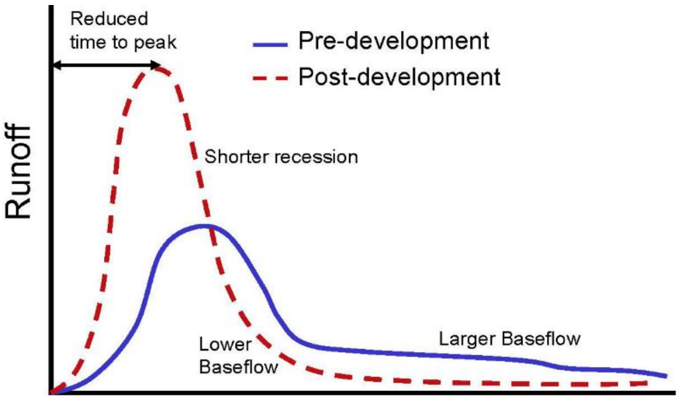
- Auckland Council GD01: Stormwater Management Devices Guide
- Auckland Council GD04: Water Sensitive Design Guide
- Auckland Council TP108: Guidelines for Stormwater Runoff Modelling in the Auckland Region
- Auckland Council TR2013/018: Hydraulic Energy Management
- Auckland Council TR2013/035: Unitary Plan Stormwater Management Provisions

There are a number of devices that can be used for stormwater management, and these can be used in conjunction with each other as part of an overall Stormwater Treatment Train. Table 10 in GD01 is useful as it identifies how different stormwater devices support the Unitary Plan mitigation measures and their effectiveness in achieving Quantity and/or Quality Controls:

**Table 10: Mitigation needed to support Auckland Unitary Plan requirements**

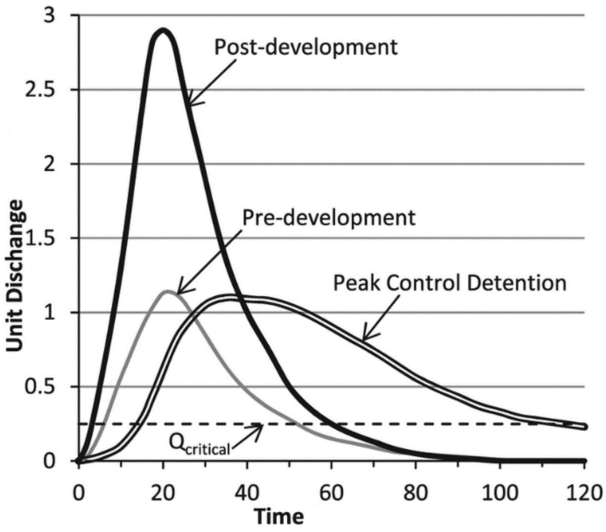
| Mitigation requirement (Auckland Unitary Plan) | Stormwater management requirement and aim | Devices providing this mitigation |
|---|---|---|
| Stormwater management - flow:<br>SMAF 1 and 2:<br>• Provide retention (volume reduction) of at least 5 mm runoff depth. | Retention:<br>• To protect streams and recharge groundwater. | • Rainwater tanks (with reuse)<br>• Bioretention devices (unlined)<br>• Living roofs<br>• Pervious paving (unlined)<br>• Infiltration devices. |
| Stormwater management - flow:<br>• SMAF 1: provide detention and a drain-down period of 24 hours for the difference between the pre- and post-development runoff volumes from the 95th percentile, 24-hour rainfall event minus the 5 mm retention<br>• SMAF 2: provide detention and a drain-down period of 24-hours for the difference between the pre- and post-development runoff volumes from the 90th percentile, 24-hour rainfall event minus the 5 mm retention. | Detention:<br>• To protect streams. | • Pervious pavements<br>• Bioretention devices<br>• Wetlands<br>• Ponds (dry and wet)<br>• Rainwater tanks. |
| Stormwater diversion and discharge:<br>• Provide detention of 10% AEP<br>• Provide detention of 1% AEP. | Detention:<br>• To manage and mitigate flood effects and flood risks, including effects on buildings and property. | • Rainwater tanks (no reuse)<br>• Ponds<br>• Wetlands. |
| Stormwater management – quality:<br>• Provide treatment of the water quality flow or volume. | Water quality mitigation:<br>• To protect water quality. | • Bioretention devices<br>• Swales<br>• Wetlands. |

## 3.4 Stormwater Mitigation



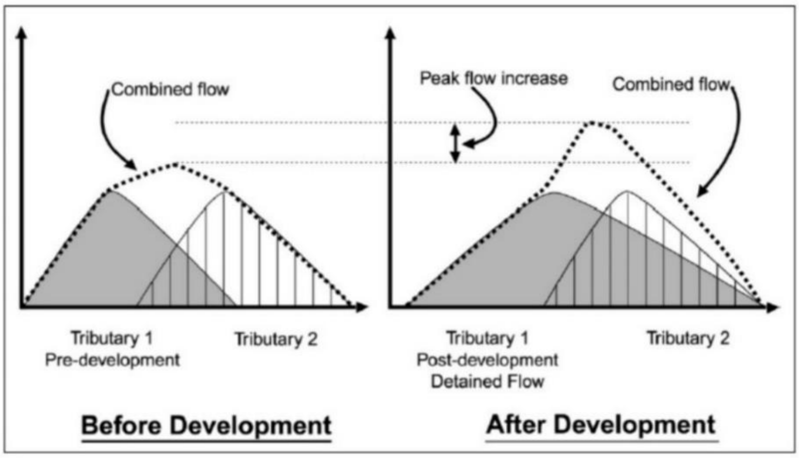

It is a well-known precept that development leads to increased stormwater runoff, in both peak flowrate & velocity and also in volume. Stormwater mitigation seeks to minimise as far as practical, the adverse effects of these increases, by constructing treatment devices to improve runoff quality & quantity and to aim to ensure post development peak flowrates & velocities to not exceed pre-development rates. The mitigation measures for flood control focus on detention and hydrological improvements to ensure flood flows and levels do not create a risk within the proposed development and are not increased on upstream or downstream properties.

Flooding is a 4-Dimension issue, with the timing of the peak flows and the location of the site within the catchment having the biggest influence on upstream and downstream flooding. Common Practice (and the Unitary Plan) require the peak flow at the outlet of a site such that post-development peak discharge equals pre-development peak discharge.




This type of Stormwater Management is commonly achieved using Wet or Dry Ponds and Wetlands. The peak flows are detained and released at a rate not exceeding the pre development rate. This does however extend the discharge rate for a longer period. While the mitigation requirements for the site are achieved, this does not always provide effective water quantity control downstream of the site, and may actually exacerbate flooding issues downstream.

If there is a sizeable upstream catchment, the detained flows from the downstream catchment may in fact cause an increase in the post development site runoff. Using figure 6 left as an example, Tributary 2 represents the upstream catchment and Tributary 1 represents the site catchment which is located further down the catchment.




**Effect of Increased Post-Development Runoff Volume with Detention on a Downstream Hydrograph**

The detention required by the Unitary Plan for a site cannot be considered in isolation of the entire catchment, especially if the site is located within the lower reaches of a catchment or the catchment is sensitive to flow and therefore flood changes.

Upon inspection of the catchment and location of the site within the catchment along with the results of the HEC-HMS catchment calculations of the pre-developed site, we recognised that this consideration is true for this catchment, and that detention and delayed flows of the larger storm events will increase downstream peak flows, even though site flowrates are mitigated to pre-development values.

There is an accepted solution to this detention issue, and is known as 'pass flows forward'. This is only appropriate in situations where detention will not achieve the desired outcome, where mitigation will only exacerbate existing flooding issues.

Pass Flows Forward is an approach where the peak flows from large events are not mitigated, *i.e.,* flows are passed on; ensuring there are no detained peak flows that could increase the catchment runoff. This will result in the site runoff peaking earlier, but the resulting peak catchment runoff is lower that the pre-development runoff. The summary results below show the pre- and post-development flows, and the graph shows where the change in flows occur, confirming that the hydrological goals are achieved ensuring the upstream and downstream peak flows are not increased.

Global Summary Results for Run "100yr w CC"

Project: Golding Road 2021 Simulation Run: 100yr w CC

Start of Run: 01Jan2018, 00:00 Basin Model: CATCHMENT 1 Pre-Development
End of Run: 02Jan2018, 18:00 Meteorologic Model: POST 100yr
Compute Time:07Jul2021, 17:05:30 Control Specifications:Pre-Development Assessment

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Hydrologic

| Hydrologic Element | Drainage Area (KM2) | Peak Dischar... (M3/S) | Time of Peak | Volume (MM) |
|---|---|---|---|---|
| R8 | 2.78190 | 32.4734 | 01Jan2018, 12:28 | 129.59 |
| UAAP | 0.43760 | 3.9274 | 01Jan2018, 12:51 | 108.09 |
| UAAI | 0.01120 | 0.3174 | 01Jan2018, 12:17 | 224.36 |
| J9 | 3.23070 | 35.6599 | 01Jan2018, 12:28 | 127.01 |
| R9 | 3.23070 | 35.4237 | 01Jan2018, 12:30 | 127.02 |
| ULP | 0.30390 | 3.5631 | 01Jan2018, 12:36 | 119.05 |
| ULI | 0.00780 | 0.2484 | 01Jan2018, 12:13 | 224.36 |
| US-GR | 3.54240 | 38.9866 | 01Jan2018, 12:30 | 126.55 |
| Stream | 3.54240 | 38.1256 | 01Jan2018, 12:37 | 126.55 |
| GMCbP | 0.02490 | 0.5779 | 01Jan2018, 12:19 | 170.11 |
| GMCbI | 0.00970 | 0.2886 | 01Jan2018, 12:15 | 219.29 |
| Div GMCb | 0.03460 | 0.7579 | 01Jan2018, 12:17 | 66.38 |
| GMBP | 0.27590 | 5.6394 | 01Jan2018, 12:24 | 170.11 |
| GMBI | 0.02990 | 0.7852 | 01Jan2018, 12:20 | 219.29 |
| GMCaP | 0.08730 | 1.8911 | 01Jan2018, 12:22 | 170.11 |
| GMCaI | 0.01410 | 0.3921 | 01Jan2018, 12:17 | 219.29 |
| J-N | 0.44180 | 9.3326 | 01Jan2018, 12:22 | 166.89 |
| GMAP | 0.17540 | 3.3911 | 01Jan2018, 12:17 | 133.84 |
| GMAI | 0.00861 | 0.2956 | 01Jan2018, 12:11 | 219.29 |
| J-C | 0.18401 | 3.6414 | 01Jan2018, 12:16 | 137.84 |
| J-Str | 4.16821 | 47.2107 | 01Jan2018, 12:35 | 131.32 |
| Reach-6 | 4.16821 | 46.4535 | 01Jan2018, 12:40 | 131.32 |
| CXP | 0.59670 | 5.9625 | 01Jan2018, 12:44 | 111.31 |
| CXI | 0.01530 | 0.4600 | 01Jan2018, 12:15 | 224.36 |
| Reach-3 | 0.61200 | 6.1312 | 01Jan2018, 12:45 | 114.14 |
| CWP | 0.14550 | 2.3294 | 01Jan2018, 12:14 | 101.65 |
| CWI | 0.00370 | 0.1850 | 01Jan2018, 12:05 | 224.36 |
| J21 | 0.76120 | 7.0131 | 01Jan2018, 12:41 | 112.29 |
| Reach-4 | 0.76120 | 6.9942 | 01Jan2018, 12:46 | 112.29 |
| CZP | 0.07640 | 1.0766 | 01Jan2018, 12:18 | 101.65 |
| CZI | 0.00200 | 0.0910 | 01Jan2018, 12:06 | 224.36 |
| Reach-1 | 0.07840 | 1.0981 | 01Jan2018, 12:23 | 104.76 |
| CYP | 0.15370 | 1.4052 | 01Jan2018, 12:43 | 101.65 |
| CYI | 0.00390 | 0.1217 | 01Jan2018, 12:14 | 224.36 |
| J22 | 0.23600 | 2.3041 | 01Jan2018, 12:28 | 104.71 |
| Reach-2 | 0.23600 | 2.2904 | 01Jan2018, 12:33 | 104.69 |
| J23 | 0.99720 | 9.1384 | 01Jan2018, 12:43 | 110.49 |
| Reach-5 | 0.99720 | 9.1309 | 01Jan2018, 12:44 | 110.48 |
| Outlet Junction | 5.16541 | 55.5308 | 01Jan2018, 12:40 | 127.30 |
| Yates Road Culvert | 5.16541 | 54.7186 | 01Jan2018, 12:44 | 125.93 |
| Outlet | 5.16541 | 54.7186 | 01Jan2018, 12:44 | 125.93 |
| GMDP | 0.13160 | 3.2922 | 01Jan2018, 12:16 | 170.11 |
| GMDI | 0.06250 | 2.0003 | 01Jan2018, 12:13 | 219.29 |
| Station Road North | 0.19410 | 5.2379 | 01Jan2018, 12:15 | 185.95 |
| Station Road South | 0.00000 | 0.1000 | 01Jan2018, 10:40 | n/a |

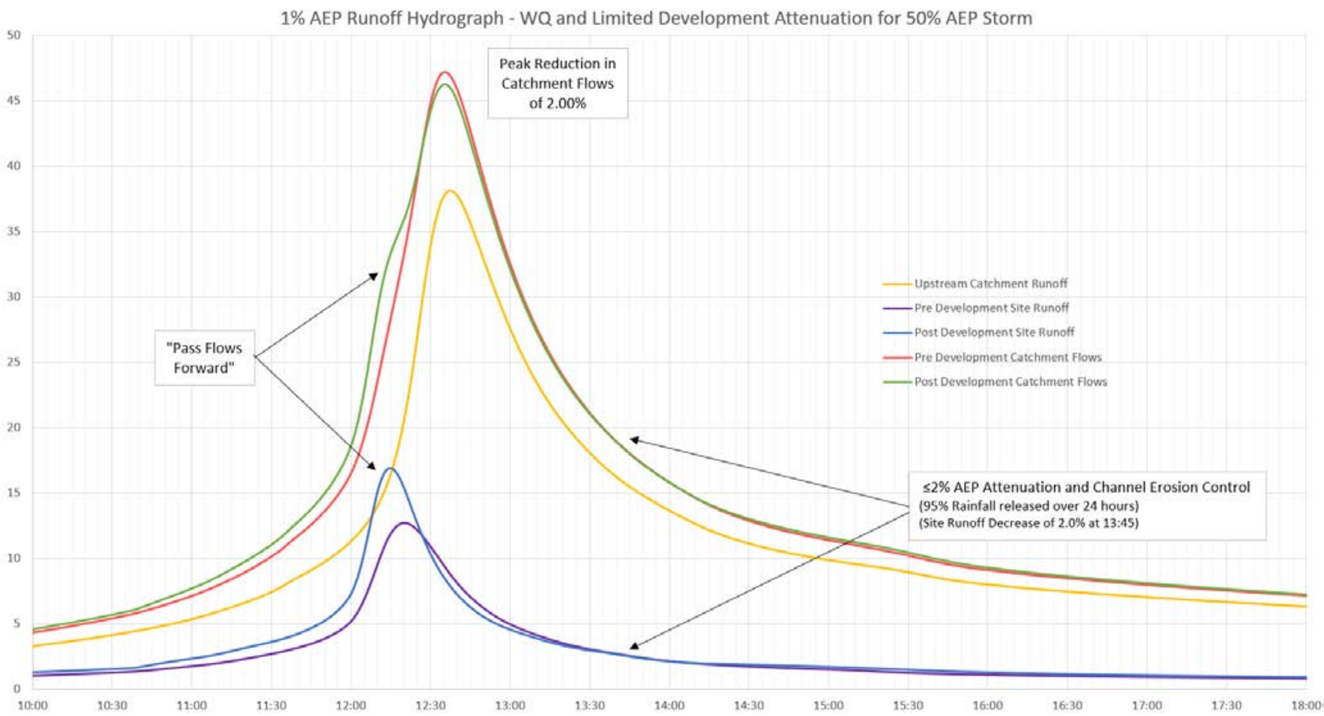
Global Summary Results for Run "POST 100yr"

Project: Golding Road 2021 Simulation Run: POST 100yr

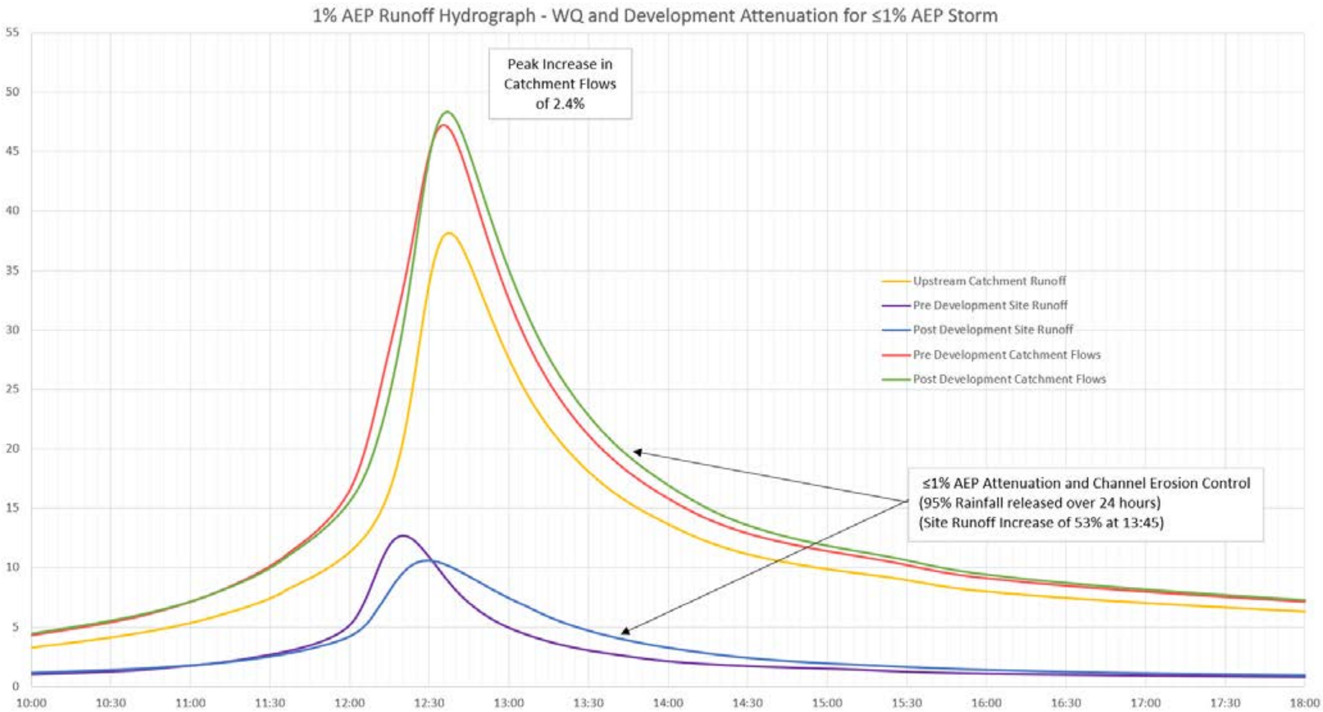
Start of Run: 01Jan2018, 00:00 Basin Model: CATCHMENT 2 Post-Development
End of Run: 02Jan2018, 18:00 Meteorologic Model: POST 100yr
Compute Time:07Jul2021, 16:48:17 Control Specifications:Post Development Assessment

Show Elements: All Elements Volume Units: MM 1000 M3 Sorting: Hydrologic

| Hydrologic Element | Drainage Area (KM2) | Peak Dischar... (M3/S) | Time of Peak | Volume (MM) |
|---|---|---|---|---|
| ULI | 0.0078 | 0.2484 | 01Jan2018, 12:13 | 224.36 |
| US-GR | 3.5424 | 38.9866 | 01Jan2018, 12:30 | 126.55 |
| Stream | 3.5424 | 38.1256 | 01Jan2018, 12:37 | 126.55 |
| GMCbP | 0.0013 | 0.0334 | 01Jan2018, 12:15 | 169.10 |
| GMCbI | 0.0333 | 1.1015 | 01Jan2018, 12:12 | 224.36 |
| Div GMCb | 0.0346 | 1.0335 | 01Jan2018, 12:12 | 80.06 |
| GMBP | 0.1148 | 2.6886 | 01Jan2018, 12:18 | 169.02 |
| GMBI | 0.1910 | 5.7854 | 01Jan2018, 12:15 | 224.36 |
| GMCaP | 0.0374 | 0.9135 | 01Jan2018, 12:16 | 166.45 |
| GMCaI | 0.0639 | 2.0584 | 01Jan2018, 12:13 | 224.36 |
| Div-N | 0.4417 | 10.9060 | 01Jan2018, 12:15 | 66.37 |
| WL-N | 0.0000 | 1.3884 | 01Jan2018, 13:59 | n/a |
| J-N | 0.4417 | 12.2912 | 01Jan2018, 12:15 | 193.77 |
| GMAP | 0.0770 | 1.3796 | 01Jan2018, 12:20 | 136.28 |
| GMAI | 0.1069 | 3.3355 | 01Jan2018, 12:14 | 224.36 |
| Div-C | 0.1839 | 4.0469 | 01Jan2018, 12:15 | 63.02 |
| WL-C | 0.0000 | 0.5363 | 01Jan2018, 14:11 | n/a |
| J-C | 0.1839 | 4.5818 | 01Jan2018, 12:15 | 187.48 |
| J-Str | 4.1680 | 46.2755 | 01Jan2018, 12:35 | 136.36 |
| Reach-6 | 4.1680 | 45.5969 | 01Jan2018, 12:40 | 136.36 |
| CXP | 0.5967 | 5.9625 | 01Jan2018, 12:44 | 111.31 |
| CXI | 0.0153 | 0.4600 | 01Jan2018, 12:15 | 224.36 |
| Reach-3 | 0.6120 | 6.1312 | 01Jan2018, 12:45 | 114.14 |
| CWP | 0.1455 | 2.3294 | 01Jan2018, 12:14 | 101.65 |
| CWI | 0.0037 | 0.1850 | 01Jan2018, 12:05 | 224.36 |
| J21 | 0.7612 | 7.0131 | 01Jan2018, 12:41 | 112.29 |
| Reach-4 | 0.7612 | 6.9942 | 01Jan2018, 12:46 | 112.29 |
| CZP | 0.0764 | 1.0766 | 01Jan2018, 12:18 | 101.65 |
| CZI | 0.0020 | 0.0910 | 01Jan2018, 12:06 | 224.36 |
| Reach-1 | 0.0784 | 1.0981 | 01Jan2018, 12:23 | 104.76 |
| CYP | 0.1537 | 1.4052 | 01Jan2018, 12:43 | 101.65 |
| CYI | 0.0039 | 0.1217 | 01Jan2018, 12:14 | 224.36 |
| J22 | 0.2360 | 2.3041 | 01Jan2018, 12:28 | 104.71 |
| Reach-2 | 0.2360 | 2.2904 | 01Jan2018, 12:33 | 104.69 |
| J23 | 0.9972 | 9.1384 | 01Jan2018, 12:43 | 110.49 |
| Reach-5 | 0.9972 | 9.1309 | 01Jan2018, 12:44 | 110.48 |
| Outlet Junction | 5.1652 | 54.6741 | 01Jan2018, 12:40 | 131.36 |
| Yates Road Culvert | 5.1652 | 53.9773 | 01Jan2018, 12:43 | 128.73 |
| Outlet | 5.1652 | 53.9773 | 01Jan2018, 12:43 | 128.73 |
| GMDP | 0.0289 | 0.7979 | 01Jan2018, 12:13 | 169.64 |
| GMDI | 0.1651 | 5.8385 | 01Jan2018, 12:11 | 224.36 |
| J-GMMc | 0.1940 | 6.6172 | 01Jan2018, 12:11 | 216.21 |
| Station Road Wetland | 0.1940 | 4.3848 | 01Jan2018, 12:20 | 216.21 |
| Station Road North | 0.1940 | 4.3848 | 01Jan2018, 12:20 | 216.21 |
| Station Road South | 0.0000 | 0.1000 | 01Jan2018, 09:47 | n/a |



We have also received flow routing data for the Tutaenui Stream at the Pukekohe Park Raceway, some 700m distant and upstream from where this catchment joins, and together with the flow data in the Pukekohe South Stormwater Catchment Management Plan, these indicate the Peak Flow rate at the Tutaenui Junction occurs between 13:00hrs and 14:00hrs (based on a 24hr Storm timing). This means that if the post development flows from the catchment exceed pre development flows prior to 14:00hrs, the peak flows and therefore flood levels on downstream properties are increased. This means that the mitigation measures are not in compliance with section E8 of the Unitary Plan - even if the required Stormwater Mitigation is achieved for the site, showing the importance of considering not only the peak flowrate, but also the timing of the peak flows. Compare the runoff hydrograph below for full attenuation of site development in accordance with GD01:




The two identified receiving environments have distinct and different stormwater runoff issues. Catchment East (Catchments GMA, GMB, GMCa & GMCb draining to Yates Road) has a major upstream catchment, and on-site detention will lead to super-position of peak flows as described above. Catchment West (Catchment GMD draining to Station Road North) has minimal upstream catchment and drains to and through a network of existing pipes and drains. Full attenuation for all storm events will be necessary to ensure there are no additional pressures on the existing infrastructure. The Stormwater mitigation options are identified separately for these two catchments.

### 3.5 Stormwater Mitigation Options – Stormwater Quantity

#### 3.5.1 Main Catchment (Catchments GMA, GMB, GMCa & GMCb)

A number of different scenario's were modelled, including full site mitigation, water quality and site mitigation up to and including the 10% AEP Storm, and water quality and catchment mitigation. The latter gave the best peak flow reduction and is the only scenario that ensured catchment flows were not increased prior to 14:00 hours, ensuring downstream flows and therefore downstream flood levels are not increased. Refer to Appendix A. The optimal scenario for this portion of the of the site and the wider catchment is to:

- Provide SMAF-1 equivalent treatment with 5mm Retention and the Detention and 24hr Release of the 95% Storm Event from Impervious Surfaces,
- Attenuate the 50% AEP post-development flows to be 86% of the unattenuated post-development flow rate
- Employing a pass flows forward approach for all other Storm Events

The above stormwater measures work together to ensure the existing peak catchment flowrates are not exceeded. This can be achieved by conveying flowrates up to the 95$^{th}$ percentile to the Wetland to provide treatment and controlled release, and all excess flows will be Passed Forward, either through the wetlands or bypassing the wetland via diversion manholes; or, in the case of overland flowpaths, being directed to the stream. This ensures all water is appropriately treated and the stream hydrology is adequately preserved and flood levels are not increased.

#### 3.5.2 Western Sub-Catchment (Catchments GMD)

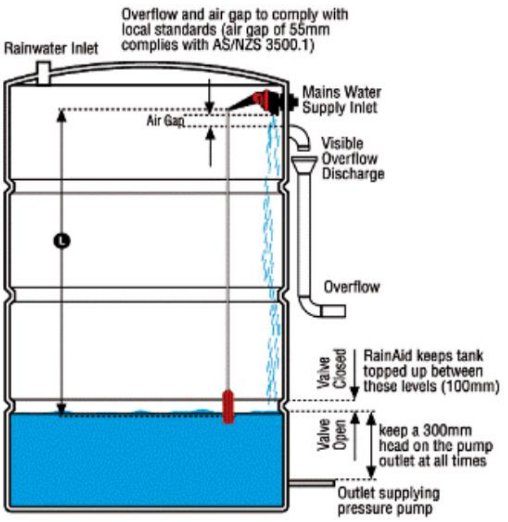
As this catchment is located at the upper reach of its larger drainage area, full detention is proposed to minimise downstream effects. The optimal scenario for this portion of the site is to:

- Provide SMAF-1 equivalent treatment with 5mm Retention and the Detention and 24hr Release of the 95% Storm Event from Impervious Surfaces,
- Attenuate flowrates for all storm events up to the 1% AEP, ensuring post-development flows to be equivalent or less that the pre-development flows.

This can be achieved by conveying all flows including overland flows to a centralised Pond or Wetland for treatment and flow mitigation.

### 3.5.3 RETENTION REQUIREMENTS FOR ALL CATCHMENTS

Retention via ground soakage is not suitable for a large proportion of the Plan Change Area (Refer to Geotechnical Assessment) and Rainwater Harvesting as currently promoted is not as efficient as it could be. There is (anecdotal) evidence that the rainwater reuse systems are being bypassed, and not




functioning as designed, especially when the dwelling is not in regular use. The requirement for regular testing of backflow preventers and frequent switching between pump and mains lead to system failures and additional expense. There are a number of minor changes that can be made to make Rainwater Harvesting more robust, efficient and cost effective. The system needs to be designed and constructed as a full-time system: with a maximum 3000L Tank and an automatic Water Mains top up system utilising an Air Gap Separation kit. The automatic top up can be either electronic and include alarms, or via float switch, with or without alarms. The Air Gap Separator will ensure efficiencies in ongoing maintenance and the 3000L tank will ensure sufficient storage for efficient reuse. This retention volume equates to a maximum 15mm runoff, although practically this will be less (6-12mm), due to maintaining a certain level of water in the tank to promote pump efficiencies.

Retention to a minimum 5mm runoff depth is proposed for all areas, to be achieved either through water reuse to the afore specifications or ground soakage if location permits. Further retention is afforded incidentally from Wetlands, tree pits and Raingardens via evaporation and transpiration.

Detention of runoff from impervious surfaces will be provided in the centralised Wetlands or Raingardens and these will provide detention and controlled release over 24 hours for the difference in the pre- and post-development runoff volumes for the 95th Percentile 24 Hour Rainfall event, less the achieved Retention Volume.

## 3.6 Stormwater Mitigation Options – Stormwater Quality

Stormwater quality for all catchments will be managed by a combination of at-source and centralised devices. The runoff from all roads and yielding carparks will be treated using bioretention (Swales, Tree Pits, Raingardens &tc). The Industrial Zone will require additional on-site treatment, that will be 'contaminant specific' and tailored to the proposed use. These could range from Gross Pollutant Traps & Oil/Grit Separators to other proprietary devices such as a Downstream Defender or Filtration. Treatment of the runoff from all other impervious areas is proposed will be in Centralised Wetlands or Raingardens, depending upon location and catchment area. Raingardens and swales need to be constructed above the winter water-table, to allow the required detention and drawdown, and ensure the plantings do not get waterlogged and die. However, constructing a Wetland where the Permanent Water Level intersects the Water Table has ecological and construction benefits, ensuring a continual supply of water for the Wetland vegetation. Raingardens, Wetlands and Swales can be integrated with the stream enhancement and green corridors, and being incorporated into public open space and flood plain management within areas that are best suited for stormwater management.

It has been noted that maintenance of privately owned and managed devices can prove more difficult than appropriately designed and located communal devices within public ownership, and ensuring ongoing compliance with the Unitary Plan and Precinct requirements.

## 3.7 Stormwater Mitigation Options – Centralised Treatment Device (Wetland Option)

Due to streams bisecting the site, it is expected that any centralised Stormwater Device will be located within the sub-catchment on each side of the stream, treating the runoff prior to discharge, as it is impractical to have a single Device to treat the entire site. Proposing a pass flows forward approach to flood flows means it is logical to conclude that Wetlands would be the best practice centralised Water Quality Device, as this can be located within the flood plain, maximising development efficiencies and stormwater design.

The Wetland were designed using the reservoir routing function within HEC-HMS Version 4.3, based on the minimum size required to hold the required WQV at an average depth of 650mm (depth ranging 300mm – 1000mm) for a Wetland size of 3600m$^2$. Flow runoff routing was then undertaken to determine the required Outlet Weirs sizes and positions to meet the following stormwater management objectives:

- Stormwater Quality Treatment to achieve reduction of 75% TSS
- Extended Detention (34mm rainfall depth to be released over 24hours (Retention was not allowed for to give a factor of safety) to preserve a pre-development stream hydrology and mitigate downstream erosion due to increased velocity and frequency of stormwater runoff from impervious surfaces.

- Attenuation of post-development peak catchment runoff flow rates to not exceed pre development catchment flow rates to ensure flood levels are not changed as a result of the development

### 3.7.1 Centralised Wetland Design – Wetland North

The Northern Catchment is formed A hypothetical centralised northern wetland has been designed for maximum development of that catchment and if used, the size of the device will be used to calculate the area to be reserved for a Stormwater Treatment Area, and full working drawings will be generated once a specific development layout is finalised. The flowrates include all modelled diversions is case diversion manholes are not employed.

| **Design Requirement** | **Value** | |
|---|---|---|
| Water Quality Volume (WQV – 25mm Rainfall Depth) | 7082$m^3$ | |
| Permanent Pool Volume – dead storage volume being ½ WQV | $3540^3$ | |
| Extended Detention Volume including ½ WQV (95$^{th}$ Percentile – 34mm Rainfall Depth) | 4200$m^3$ | |
| Fore Bay Volume | 531$m^3$ | |
| Total Storage Volume to top of Spillway | ≈6850$m^3$ | |
| 2 Year ARI peak flows – Pre-Development & Attenuated Post Development | 1.97$m^3$/s | 3.60$m^3$/s |
| 10 Year ARI peak flows – Pre-Development & Attenuated Post Development (PFF) | 4.57$m^3$/s | 7.89$m^3$/s |
| 100 Year ARI peak flows – Pre-Development & Attenuated Post Development (PFF) | 7.72$m^3$/s | 12.29$m^3$/s |

Refer to Appendix C for calculations

Surface flows will be directed to the Wetland via swales, surface channels or piped network, depending upon source, layout and site levels. The entry of flows will be into the fore bay which is to be suitably armoured with rip-rap to dissipate flows and to offer protection against scour and re-suspension of sediment within the wetland. The Diversion manholes will be installed to direct flowrates up to the 95$^{th}$ percentile storm event (or 1.39$m^3$/s for Catchments B, Ca & Cb ) to the wetland and excess flows will be directed to green outfalls within the receiving environment and include appropriate outlet scour protection.

The Wetland Outlet will direct all treated and attenuated flows to the stream using green outfalls and appropriate scour protection to prevent scour. The emergency Spillway will be designed to convey the 10 year ARI Flow and incorporate a permanent level spreader and be lined with Turf Reinforced Matting or similar reinforcement to prevent the embankment from scouring.

### 3.8 FURTHER DESIGN CONSIDERATIONS AND CONCLUSIONS

The Design of the Wetland is a preliminary design level to demonstrate that a Wetland is imminently suitable to manage the stormwater runoff from the site. The design is based on maximum development parameters and will be necessarily conservative and will be tweaked upon final development layout and contributing catchment. It is likely that a handful of communal devices are utilised in each catchment, rather than just one, and alternative devices can be used that achieve the required standard of treatment and attenuation. However, using the example design of the above Wetland, which treats and attenuates the runoff from Catchments GMB + GMCa + GMCb as a basis to determine an estimate of the raw land area required to set aside for a stormwater device, we calculate the following.

Catchments GMB, GMCa and GMCb have a total area of 59.63Ha and an impervious area of 28.83Ha. The Wetland footprint up to and including the bund, encompasses an area of just under 6500m². This means that at the planning stage for any development, ≈2.2% of the Gross Impervious Area to be treated should be reserved for Stormwater Devices, with the final detailed designs being completed once the type and extent of both the development and stormwater treatment devices have been finalised.

### 3.9 STORMWATER FLOW CONVEYANCE – PRIMARY

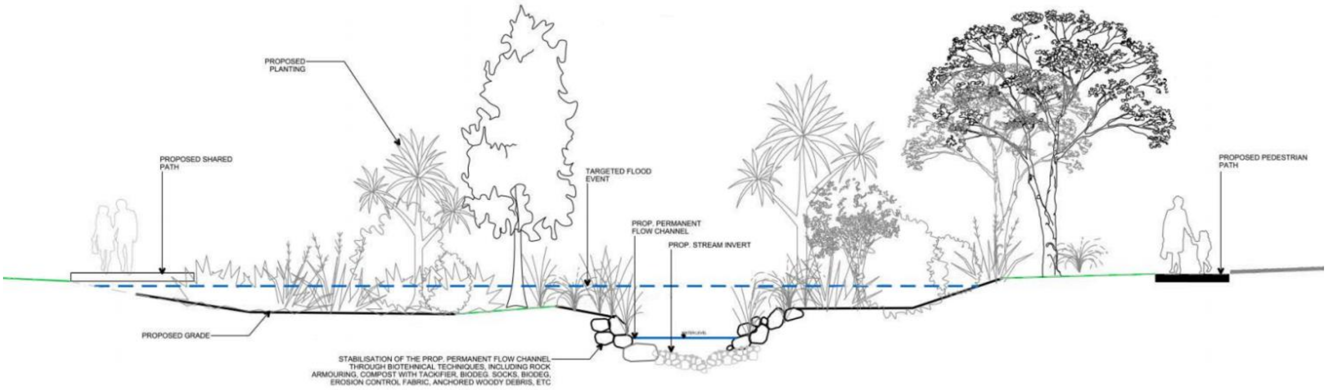
The Primary Stormwater flows (post -development flows of 10yr ARI Event or less) will be conveyed in a pipe network, connecting the lots, to the stormwater devices and outlets. Diversion manholes will direct the flows equivalent to the pre-developed 5yr ARI Event to the devices and all other flows up to the pipe capacity directly to the outlets. Any proposed swales will be designed to GD01 and will also have capacity to convey the primary flows. Secondary flows (greater than 10yr ARI and up to 100yr ARI) will be conveyed as overland flows, typically within the road reserve or overland flowpaths located within public ownership.

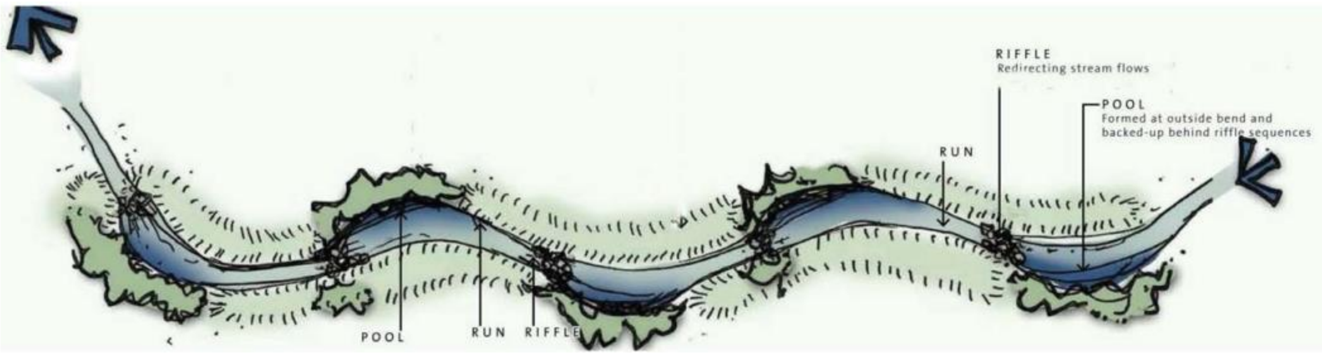
## 3.10 Stormwater Flow Conveyance – Secondary

Apart from the overland flows generated from excess site runoff, there is a 350Ha upstream catchment that flows through the plan change area, and further catchments totalling 88Ha that skirt the plan change area. These all confluence at the southern boundary, before flowing under Yates Road towards the Tutaenui Stream.

These catchments are drained by the existing, highly modified streams, and the current channels overflow their banks in storm events greater than the 5yr ARI Storm. The streams have been subject to a loss of fringe vegetation, and the channel straightening has led to a loss of habitat.

As part of the stormwater Management, the proposal is to rehabilitate the main stream running through the site, clearing existing restrictions and culverts, and recreating a more natural environment. This will incorporate Pools and riffles, meanders and terracing and planting associated with natural streams. These will be designed to both safely contain and convey the overland flows, minimising uncontrolled flooding as well as reconstruct the stream habitat:

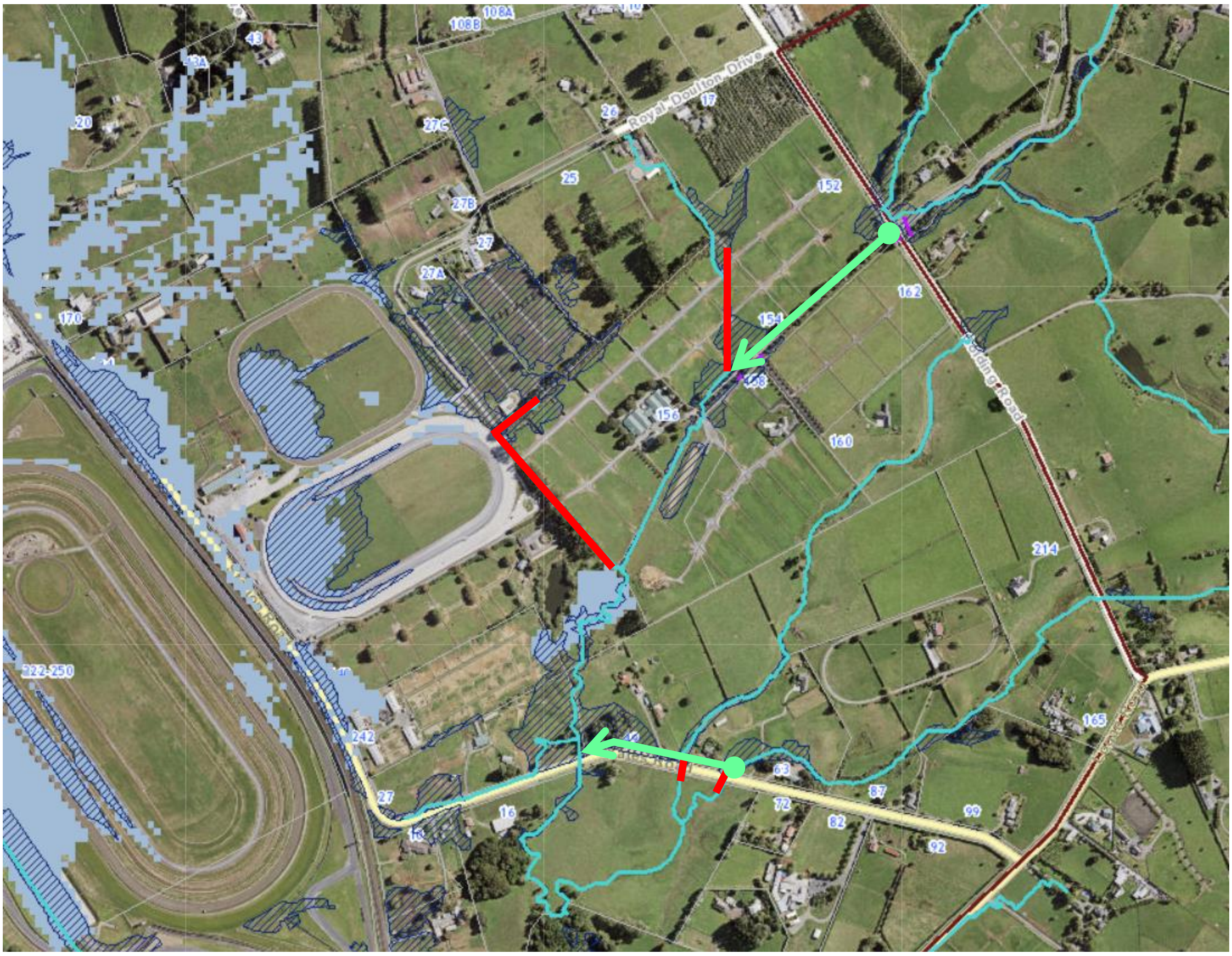



The expected width of the naturalised stream and reconstructed environs will range from 26-36m exclusive of additional site improvements and any future stream crossings will be designed to achieve the requirements of the National Environmental Standard for Freshwater Management, the Unitary Plan, the SWCoP and GD01-SMD with a preference for bridging rather than culverts.

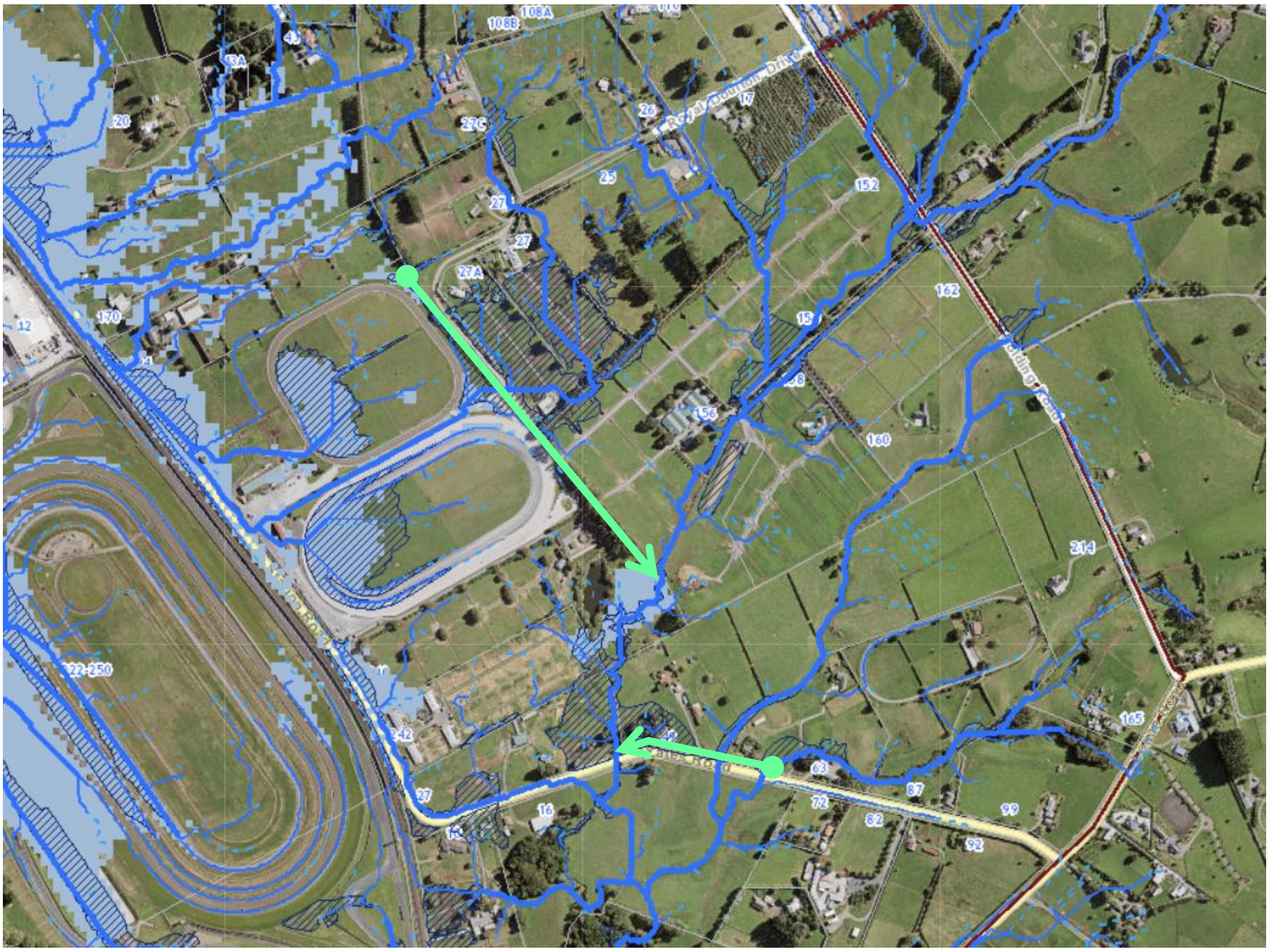
The site derived secondary flowpaths will be directed to the natural watercourses typically within the road reserve or overland flowpaths located within public ownership. These will be designed at the time of development and in compliance with SWCop Section 4.3.5.6, and specific to the contributing catchment.

The Council GIS identifies both Streams and Overland Flowpaths, and upon inspection, a number of omissions and commissions are apparent. Although these have been correctly modelled as part of our assessment, there are fairly large differences in hydrology for both primary and secondary flows comparing the actual situation with Council's GIS. the major issues for primary flows are highlighted in figure 12. The bright-red lines indicate Streams shown in the GIS that do not exist, and the lime-green lines indicate Streams (including diverted streams) omitted from the GIS.




The Ecological Report by Jenny Shanks identifies the natural stream pattern, matching the above amendments. There are also a number of minor artificial farm drains that have been excavated to improve the land. These are not watercourses, however they do direct overland flows, due to their modification of the topography.

These have also been overlooked or misidentified in the Council GIS, and there are similar discrepancies with the Overland Flowpath mapping in the GIS; where overland flowpaths have been omitted. The lime-green lines indicate overland flowpaths omitted from the GIS.




These will not make a large difference upon the proposed plan change, as the most significant change occurs along the southern boundary, and any impact will not be material, as the governing factor is the level of Yates Road, which is not being adjusted.

The presence of the flood ponding areas and overland flowpaths indicate a possible flood risk to future buildings. This flood risk is managed by the site works and any residual risk is anticipated by the Building Code and the Stormwater Code of Practice, and these statutory documents specify building clearances to both overland flows and flood plains. Furthermore, the Unitary Plan requires careful management of earthworks within the flood plain, to ensure all building site are safe and stable and fit for purpose. Adhering to these requirements will ensure any flood risks to the building sites created within the Plan Change are appropriately mitigated.

Figure 56 overleaf shows the anticipated major overland flows and floodplain (created by Yates Road), confirming these are contained within the proposed open space and stream restoration areas, confirming the proposed stormwater management proposal.

# 4 STORMWATER MANAGEMENT PLAN

This Stormwater Management Strategy is proposed for the Golding Road Plan change to allow a transition from the current rural use to a thriving commercial and urban neighbourhood.

The Strategy has been carefully prepared to ensure compliance with the objectives and policies of the Unitary Plan and the Stormwater Code of Practice:

- Stormwater Quality Treatment for the entire site.
- Contaminant Specific Treatment Devices for Industrial (and Commercial) sites.
- Provide Retention of a 5mm 24 hr rainfall event for new impervious roof areas. If it is not geotechnically feasible to utilise infiltration devices (including liquefaction, slope, offsets, poor soakage) and rainwater reuse is not reasonable due to the quality of the stormwater runoff or there are no activities occurring on site that can reuse the full 5mm retention volume, the retention volume will not need to be provided.
- Retention reuse to captured in a 3000L water tank (minimum), topped up from the water mains with a complying air gap separation.
- Provide Detention and drain down period of 24 hours for the volume of a 34mm 24hr rainfall event (minus any retention volume achieved) for all impervious areas.
- Centralised Stormwater Devices (Wetlands and/or bioretention) to be utilised for Stormwater Treatment and Attenuation.
- Stormwater Flow Mitigation required within Catchments GMA, GMB, GMCa & GMCb to ensure runoff is attenuated to be 86% of the unattenuated post-development flowrate for the 50% AEP Storm Event; and a Pass Flows Forward approach is adopted for all other storm events. This can be managed by using diversion manholes or detention overflows
- Stormwater Flow Mitigation required for Catchment GMD to ensure runoff is attenuated to pre-development flowrates for all storm events up to and including the 1% AEP Storm Event.
- The central stream shall be cleared of obstructions and a natural stream structure to be reinstated in accordance with the Ecology Report, to convey all flows up to the 100yr ARI storm event without overflowing. Preliminary calculations show the flood width will range up to 36m wide.

# 5 Conclusions

This Report has been prepared for the to assess the Stormwater requirements to support the proposed Golding Road Plan Change, and to promote stormwater management to conforming to the requirements of the Unitary Plan.

Any Development of the site will require Stormwater Treatment and Flood Attenuation which can be effectively managed via wetlands or bioretention in accordance with the measures proposed within this report. Naturalising the main stream will provide additional stream habitat values and manage flood flows through the property, and together with the stormwater treatment devices, creating a large open space and recreation feature.

In Summary, stormwater can be managed in the site and greater catchment whilst allowing for the development proposed by this plan change.