**From:** Philip Barrett
**Sent:** 7 Jan 2020 08:04:58 +1300
**To:** Cameron Aplin
**Subject:** G & S Singleton- Section 92 reply Updated and final SW Mgt Plan
**Attachments:** L2 Stormwater Management Plan - 635 Whatwhata Road, Hamilton Full and Final.pdf

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We will be closed from Friday the 20th of December and re-opening on the 6th of January, we would like to thank you for your continued custom and wish you a safe festive season.

# G & S Singleton Heritage Ltd

635 Whatawhata Rd, DINSDALE

Stormwater Management Plan

*M13246AP2*
*20 December 2019*

cheal

# G & S Singleton Heritage Ltd

635 Whatawhata Rd, DINSDALE

Stormwater Management Plan

**Prepared by:**

Joe Hallam
Design Engineer

**Reviewed and Approved for Release by:**

Phil Rielly
Director
Chartered Professional Engineer

| | |
|---|---|
| **Date:** | 20 December 2019 |
| **Reference:** | M13246AP2 |
| **Status:** | Final |
| **Revision:** | NA |
| **Previous Revision Date:** | NA |

# TABLE OF CONTENTS

# 1. INTRODUCTION

G & S Singleton Heritage Ltd has applied to Waikato District Council (WDC) for subdivision consent. WDC have requested a Stormwater Management Plan be provided by the applicant. This plan describes the effects on stormwater quantity and quality arising from the residential development and proposes solutions for mitigating these effects.

The subdivision proposal allows for the creation of 10 new residential lots from an existing parcel that measures 45.6686ha. The underlying lot was previously a golf course and retains some features associated with that use. In particular, there are a number of ponds within the site and three of the lots have existing buildings. In general, the site is mainly grassed, with narrow belts of trees that formerly defined the bounds between holes.

The site is located at the head of a minor valley system that falls toward the North. The site itself occupies the eastern side of the valley, with a western aspect as the land rises to the east. On its north side, the site is bounded by State Highway 23, also known as Whatawhata Road. On all other sides, the abutting land is in mainly pastoral use with some low density residential.

Existing stormwater drainage is provided by open drains, with a main drain that runs north along the west boundary of the site to a 1.5m x 1.5m box culvert under SH23. Another open drain crosses the site from the eastern boundary approximately 70m north of Lot 1, discharging to the main northbound drain.

The site is exposed to external runoff from the abutting land. The combined catchments (both internal and external) amount to 256ha.

# 2. EFFECTS OF DEVELOPMENT

Typically, the main effect of introducing residential use within rural areas is increased runoff due to expansion of impervious areas. As well as the increased runoff, there is an increased risk of contaminants being introduced into the water cycle. In this development, however, the increase of the area of impervious surface is very small relative to the overall site, which will largely remain in a pastoral state on completion of the development.
Key effects are summarised below;

a) Roofs - Of the 10 new lots to be created, 3 already have substantial buildings located on them. It is proposed to install roof water tanks to provide for domestic water use, which can be designed to provide attenuation of excess runoff. However, other impervious areas around dwellings, such as driveways and patios, may not be easily captured by rainwater tanks.

b) Roads – existing roadways within the site are predominantly gravel, and it is anticipated that they will remain so as part of maintaining the rural character of the development.

Additional roading to provide access to most lots will be gravel formations. This amounts to approximately 3000m² of extra gravel formation. Gravel formations are relatively pervious (For Rational Method using NZBC:E1 Table 1, runoff coefficient c= 0.50). Using this method of assessment, the approximate net increase resulting from forming the gravel driveways is 3000 x 0.5 = 1250m², or 0. 66% of the total site area. An increase of this magnitude is considered insignificant in terms of runoff.

Road runoff will discharge on to the extensive grassed reserved areas on either side of the formation as is the current situation.

c) In the absence of any significant increase in runoff resulting from the development, the other effects to be considered are;
   i. The potential hazards to the proposed residential uses, specifically inundation (of dwellings, wastewater disposal fields and access formation). Effects and mitigation methods are discussed in Sections 3 & 4 below.
   ii. Erosion of earth worked slopes. Potential effects and methods of mitigation are discussed in Section 4 below
   iii. Introduction of contaminants into downstream waterways. This will most likely occur from road formations. Water quality measures are discussed in Section 4 below.

d) In summary, the effects of increased stormwater runoff are less than minor, while other issues relating to hazards or runoff water quality are addressed in Section 4 of this plan.

# 3. FLOOD RISKS

Given the extensive flat area and considerable external catchments, potential inundation risks arise which are discussed in this report. In particular, ensuring future dwellings and wastewater disposal fields are above any inundation by flood water in the valley bottom is critical to the success of the development.

Golovin have completed a flood analysis for the site and surrounding catchments. The analysis (attached at Appendix 2) determines flood levels for both 20year and 100year storm events, relative to proposed building sites and wastewater disposal fields. Note the report incorporates amendments resulting from a recent peer review.

Whilst the culvert performance has been analysed for the updated rainfall depths, there has been no assessment of the effects at the culvert outlet. That is because, in the context of this development comprising low impact stormwater management techniques, effectively any increase in predicted flow through the culvert is due only to the updated rainfall figures incorporating climate change factors, rather than as a result of the development effects.

a) Tables 4.1 and 4.2 of the Golovin report summarise the critical flood levels pertinent to individual dwellings and wastewater disposal fields respectively.

b) Figure 4.2 of the Golovin report shows the expected extent of flooding during a 100year storm which can be expected to inundate the existing main access road in two locations. Similarly, the proposed access corridor to Lot 7 will be affected.

Clause 3.3.14.1 k) of the Waikato RITS sets the maximum depth of "secondary flow" paths at 150mm. Clauses 3.3.14.10 and 4.2.3.4 further explain the definition of secondary flow. While it is not intended that the roadway be considered as a secondary flow path, the performance criteria are relevant to assessing the safety and functionality of the internal roading network during a severe rainstorm.

When considering the criteria as a whole, it is clearly envisaged that flows less than 150mm deep are considered acceptable. However, a road that floods frequently (e.g. annually or more frequent) would be somewhat of a nuisance to residents, and therefore it is recommended that primary flows (as defined in the RITS), be diverted in culverts under roads so as to keep the vehicle path free of water during the more frequent events up to a 10% AEP storm.

Additional analysis was done by Golovin to establish water flow depths and velocities for various Annual Exceedance Probability (AEP) rainfall events ranging from 100%AEP (1year Average Recurrence Interval or ARI) up to the 1%AEP (100year ARI) events which the report covers. The results for the critical areas are tabulated at Appendix 3.

The table shows minor flooding for Primary storm events of 10%AEP while for the most extreme of events, significant flood depths are predicted. Therefore, lifting of the road levels in the affected areas is necessary to meet the RITS criteria. Minor raising of road levels will have a less than minor effect on change to flow depths and velocities as modelled, especially in large storm events when the road levels will remain inundated as per the Golovin model.

At the time of detailed design, as well as considering depth and velocity individually, the product of the depth and velocity should also be assessed. This criterion provides a useful guide to safety for both humans and vehicles. This assessment is standard along much of the east coast of Australia, (refer to Ch 7.2 Book 6 Australian Rainfall and Runoff). Tables 6.7.3 and 6.7.4 of that publication provide respectively classifications of hazard levels and appropriate flow limits in terms of depth, velocity and depth times velocity. We conclude that H1 in Table 6.7.3 is appropriate for this development which requires a maximum depth x velocity of $0.30m^2/s$ for depths <0.3m.

In summary, it is recommended that where the existing road grade is to be lifted and a culvert installed, the design should ensure the overtopping flow (>10%AEP) shall comply with at least <u>one</u> of the above criteria. (either 150mm maximum depth or $0.30m^2/s$ depth x velocity

c) The peer review of the draft Golovin report sought clarification on potential surface flows from upstream catchment potentially affecting building floor levels. From examination of contour plans, Lots 1, 2, 4 -7 & 10 are all potentially exposed to runoff from higher land. Measures to prevent any adverse effects are discussed in Section 4.

# 4. STORMWATER MANAGEMENT APPROACH

This section outlines the proposed stormwater management approach to mitigate against the risks identified earlier in this report. The following points should be the basis for all earthworks and road grading designs.

Building immunity

i. Recommended building floor levels are set 500m higher than the highest water elevations (SH23 culvert 50% blocked). The recommended levels are incorporated in the Golovin report.
ii. The potential for higher land to flood a building site can be addressed when building platform earthworks are designed. Proposed measures include;
    1. Diversion drains (especially above cut batters).
    2. Ensuring platform levels are at least 500mm above any adjacent flow path.

b. Wastewater fields

i. These should be set above the relevant 20year flood levels as defined in Table 4.2 of the Golovin report.

c. Road runoff

<u>Water volumes</u>

i. As mentioned earlier, with gravel roads it is unlikely that stormwater runoff volumes will increase to the extent that specific management measures would be necessary.

<u>Water Quality</u>

ii. With roads to be gravelled allowing for rainfall losses to soakage through the pavement, the amount of TSS (Total suspended solids) and TPH (Total Petroleum Hydrocarbons) in residual surface runoff is not expected to be significant. Any road runoff will generally discharge to open space, which will be maintained as a combination of mown lawn and other vegetation, with a reasonably long travel time before entering the main outlet channel. The combined effect will provide for a significant amount of water quality improvement via overland flow filtration.

d. Access security

i. Where inundation is predicted during severe storms, road levels will be lifted sufficiently to ensure that, during a 1%AEP event, surface flows on the access are limited to either a maximum depth of 150mm or a maximum flow/depth product of $0.30m^2/s$ at a maximum depth of 0.30m

e. Erosion of Earthworks Slopes – to be addressed with detailed design

i. Batter slopes for building platforms will be constructed in accordance with the Geotech Report recommendations. On completion, topsoil will be spread, and grass sewn to stabilise the surface.
ii. Where analysis suggests earth worked slopes will be exposed to significant localised surface flows, diversion drains will be provided along the tops.

# 5. SUMMARY

The proposed development is rural in character, featuring very low density housing and extensive open space.

Existing infrastructure will be utilised extensively, with minimal new works mainly to create building platforms with attached wastewater effluent disposal fields. The increase of impervious area within the development will be insignificant in terms of increased runoff.

Some regrading of existing roads will be necessary to ensure reasonable and safe access during severe storms. The proposed access to Lot 7 will especially need to be raised relative the surrounding land where it crosses the main drain floodplain.

In summary, the effects of the development on surface water are less than minor while the risks of flooding to housing and infrastructure can be mitigated to ensure a less than minor effect.

# 6. BECA REVIEWS

Two Beca reviews received have informed this management plan. The second and final Beca review dated 8 November 2019 sought additional comment on nine (9) specific matters. The review prompted further reporting by Golovin author of the flood plain analysis report dated August 2019. The result of the additional analysis is contained in Appendix 5. This analysis replies to six (6) of the nine outstanding Beca queries. The remaining three (3) Beca queries were supplied by Cheal essentially requiring a planning reply rather than technical flood analysis. The additional Golovin flood plain analysis memo and planning replies were provided to Council on 5 December 2019. Council confirmed by email on 20 December 2019 that Beca has accepted the additional information provided thus satisfying all flood and stormwater matters.

# 7. DISCLAIMER

This Report has been prepared solely for the use of our client with respect to the particular brief given to Cheal Consultants Limited. No liability is accepted in respect of its use for any other purpose or by any other person or entity.

**PHILIP BARRETT**
**CHEAL CONSULTANTS LIMITED**
**20 December 2019**

# Appendix 1

M13246 Rev 1 - Scheme plan showing 100year flood extents


# M13246

## Proposed Easements

| Purpose | Shown | Burdened Land | Benefitted Land |
|---|---|---|---|
| Right of way & Right to convey Water, Electricity, Gas, Computer Media & Telecommunications & right to Drain Water & Sewage. | A | Lot 10 hereon | Lots 1 to 7 hereon |
| | B | Lot 10 hereon | Lots 3 to 7 hereon |
| | C | Lot 10 hereon | Lots 5 to 7 hereon |
| | D | Lot 10 hereon | Lot 6 hereon |
| | E | Lot 10 hereon | Lots 3 hereon |
| Right to convey Water | F | Lot 2 hereon | Lot 10 hereon |
| Right to covey Electricity | G | Lot 8 hereon | Lots 9 & 10 hereon |

Key
P - Pond

Area within which buildings/structure dwellings can be constructed.

100-year Flooding Level

50% Culvert Blockage

Contours - Waikato Regional LIDAR Service 2007 (WRLS 2007). LIDAR data sourced from Environment Waikato . COPYRIGHT RESERVED.

Contour Interval
Major Contour = 5m
Minor Contour = 0.5m

Aerial Photo is collected in February 2018.

Note: The Building Envelope within the land shown is all the land excluding the building setbacks specified in the Waikato District Plan.

Note: Areas & dimensions are subject to survey.

| | |
|---|---|
| Zone: | Rural Zone |
| Total Area: | 45.6686 Ha. |
| Comprised in: | SA10B/683 & SA10B/682 |
| Registered Owner(s): | G. & S. Singleton Heritage Ltd. |

I, David Vernon McCracken, Registered Professional Surveyor, do hereby certify that this plan has been prepared by me for a Resource Consent under the provisions of the Resource Management Act 1991 and should not be used for any other purpose.

Registered Professional Surveyor      Date

## Amendments

| No | Activity | Date |
|---|---|---|
| 1 | Amend 100-year Flooding Line & 50% Culvert Blockage Extent | 02/10/2019 |
| | | |
| | | |
| | | |



cheal

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land & engineering surveyors

# Proposed Subdivision of Lots 1 & 2 DPS 12627
# 635 Whatawhata Road, Dinsdale.

| | | | |
|---|---|---|---|
| Prepared for: G. & S. Singleton Heritage Ltd. | | | Sheet 1 |
| Drawn HC | Checked | Scales | Series of 8 |
| Traced | Date Sep. 2019 | 1:4000 A2 | File Ref M13246 |

# Appendix 2

Golovin Flood Report including Beca Peer Review and Golovin Response

# FLOODPLAIN ANALYSIS

## 635 Whatawhata Road, Hamilton

**October 2019**

**Graham and Sharon Singleton**

**Prepared by Dr Steven Joynes**

# FLOOD LEVEL ANALYSIS

## Contents

**Person assigned to manage the Project & Report**

Name Dr Steven Joynes

Organisation **GOLOVIN**

**Distribution List**

| Name | Project Designation | Organisation |
| --- | --- | --- |
| Dr Steven Joynes | Modeller | Golovin |
| Philip Barrett | Senior planner | Cheal Consultants Ltd |

**Revisions**

| Version | Date | Comment |
| --- | --- | --- |
| 1 | May 2017 | Original |
| 2 | October 2018 | Typographical amendments |
| 3 | August 2019 | Addendum added concerning culvert blockage |
| 4 | This report | Responding to Beca review and using the WRC Stormwater Run-off Guidelines |

Prepared by

Dr Steven Joynes

# 1 INTRODUCTION

## 1.1 Statement of Issues

The client wishes build a number of dwellings on the former golf course. The land is prone to flooding due to its location and has a history of low-level ponding. The land is part of the catchment of Ohote Stream that is the eventual tributary of the Waipa River. It legal description is LOTS 1 2 DPS 12627 BLK I HAMILTON SD and measures just over 45 ha.

The flood levels need to be understood because the property has a number of potential house sites available. This report will determine minimum floor levels and the minimum level for the wastewater fields.

Figure 1.1 shows the property boundary. It also shows the main drainage route on the western boundary and the outlet location underneath the State Highway. Figure 1.2 shows the Lot locations.

Figure 1.1 – Property location

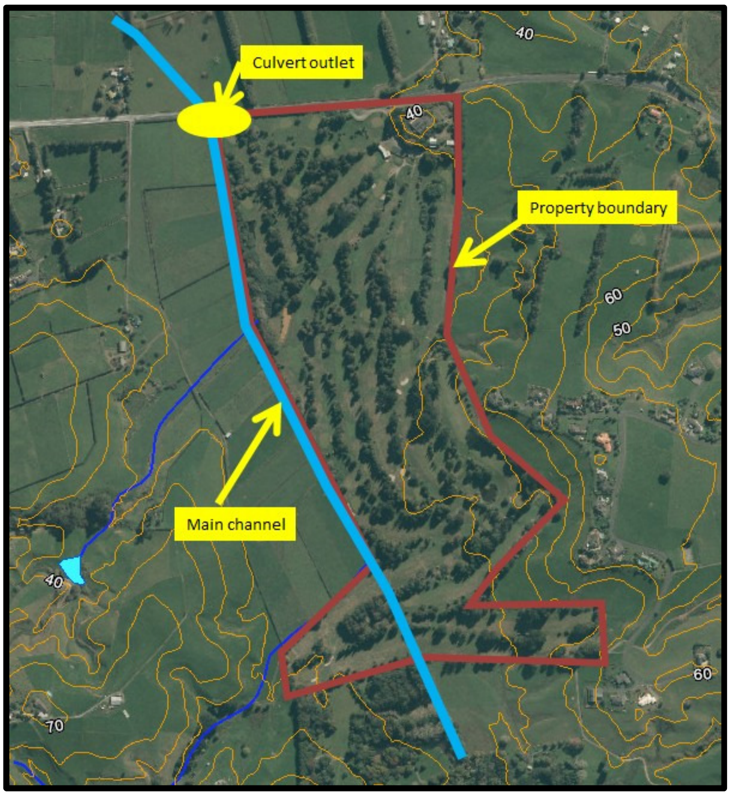


Figure 1.2 – Location of Lots


## 1.2 Proposed Strategy

The large catchment creates a reasonable sized floodplain. The hydrology will be calculated using the methodology required by the Waikato Regional Council and Waikato District Council. A hydraulic model will be used to calculate the floodplain levels based on LiDAR contours available and some site specific measurements at the proposed building Lots. The 100-year storm will be analysed to establish finished floor levels and the 20-year storm for the wastewater fields.

## 1.3 Target audience

The quality, quantity and tenure of the report should consider the following audience.

a) Waikato Regional Council engineering staff,

b) Waikato District Council engineering staff.



Document Set ID: 2509690
Version: 1, Version Date: 21/02/2020

## 1.4 Previous Study

There is no known flood study of the catchment prior to this work.

## 1.5 Previous flooding

The severe storm in April 2017 flooded the lower parts of the property at the culvert. Video evidence showed the peak flood level reached RL23m, about 1m above the invert of the culvert. The extent of flooding suggested no greater flood level than RL23.2m in the flooded area upstream of the culvert. The Waingaro rainfall gauge suggested a 20-year return period for a 12 hour storm. Therefore a 100-year flood level would be in the vicinity of RL24m and not overtop the road.

## 1.6 Sources of data

Table 1.1 – Source of Data

| **Attribute** | **Organisation** |
|---|---|
| Catchment plans & contours | Waikato Regional Council Maps |
| Cross-section extraction | LiDAR plots from McCracken Surveys Ltd |
| Flow & WL data | none |

## 1.7 Reference Technical Documents

- Waikato Regional Council – TR2018/02 – Waikato Stormwater Runoff Modelling Guidelines.
- WLASS - Regional Infrastructure Technical Specification (RITS).
- Open Channel Hydraulics, V T Chow (1959)
- Australian Rainfall & Runoff, Book 6 (2019)

# 2 HYDROLOGY

## 2.1 Methodology

The analysis is both conveyance and storage driven due to the impedance of the culvert at the outlet. Therefore it is important to do a dynamic analysis of the system, not a steady-state peak flow analysis. The analysis was done using the following steps:

1. Delineate the catchment.
2. Use HEC-HMS to generate flow hydrographs.
3. Input in the HEC-RAS model.

## 2.2 Rainfall Data

The rainfall depth is determined from HIRDS. The 24 hour storm needs to be analysed. Figure 2.1 shows the 100-year rain depth is 177mm. This is slightly higher than the previous Hamilton City Council IFS value of 169.9mm. The 20-year rain depth is 132mm. These are the climate change values.

Figure 2.1 – HIRDS output

**Rainfall depths (mm) :: RCP8.5 for the period 2081-2100**

| ARI | AEP | 10m | 20m | 30m | 1h | 2h | 6h | 12h | 24h |
|---|---|---|---|---|---|---|---|---|---|
| 1.58 | 0.633 | 12.0 | 16.3 | 19.3 | 25.5 | 32.8 | 46.5 | 56.4 | 67.8 |
| 2 | 0.500 | 13.2 | 17.9 | 21.2 | 28.1 | 36.2 | 51.2 | 62.2 | 74.3 |
| 5 | 0.200 | 17.4 | 23.6 | 28.0 | 37.0 | 47.6 | 67.2 | 81.6 | 97.1 |
| 10 | 0.100 | 20.7 | 28.0 | 33.1 | 43.7 | 56.2 | 79.3 | 96.0 | 114 |
| 20 | 0.050 | 24.1 | 32.5 | 38.5 | 50.8 | 65.2 | 92.0 | 111 | 132 |
| 30 | 0.033 | 26.2 | 35.4 | 41.8 | 55.1 | 70.7 | 99.7 | 120 | 143 |
| 40 | 0.025 | 27.7 | 37.4 | 44.2 | 58.2 | 74.6 | 105 | 127 | 151 |
| 50 | 0.020 | 28.9 | 39.0 | 46.2 | 60.8 | 77.9 | 110 | 132 | 157 |
| 60 | 0.017 | 29.9 | 40.4 | 47.7 | 62.8 | 80.5 | 114 | 137 | 162 |
| 80 | 0.012 | 31.6 | 42.6 | 50.4 | 66.2 | 84.8 | 119 | 144 | 170 |
| 100 | 0.010 | 32.8 | 44.3 | 52.3 | 68.8 | 88.1 | 124 | 150 | 177 |
| 250 | 0.004 | 38.2 | 51.5 | 60.8 | 79.8 | 102 | 143 | 173 | 204 |



Document Set ID: 2509690
Version: 1, Version Date: 21/02/2020

## 2.3 Future development

Examining the proposed Waikato District Plan sheet "Hamilton Environs 26" there appears to be no significant developments that will alter the run-off characteristic of the catchment.

## 2.4 Catchment Size

The catchment has been broken into four subcatchments which allows for the gradual input of flows. The areas are given in Figure 2.2.

Figure 2.2 – Catchment boundaries and areas

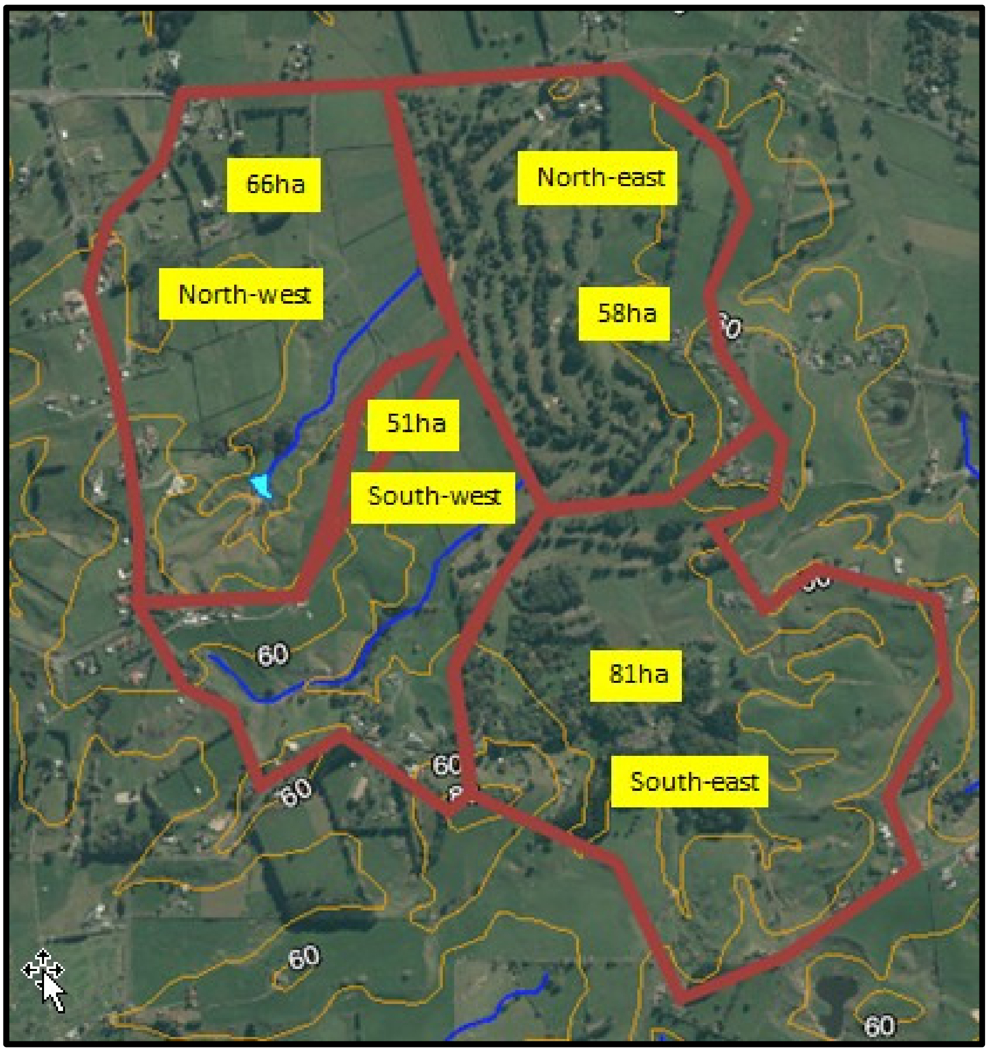



Table 2.1 gives data and calculation of the subcatchment time of concentrations using the Ramser-Kirpich method as per Section 7.3 of TR2018/02.

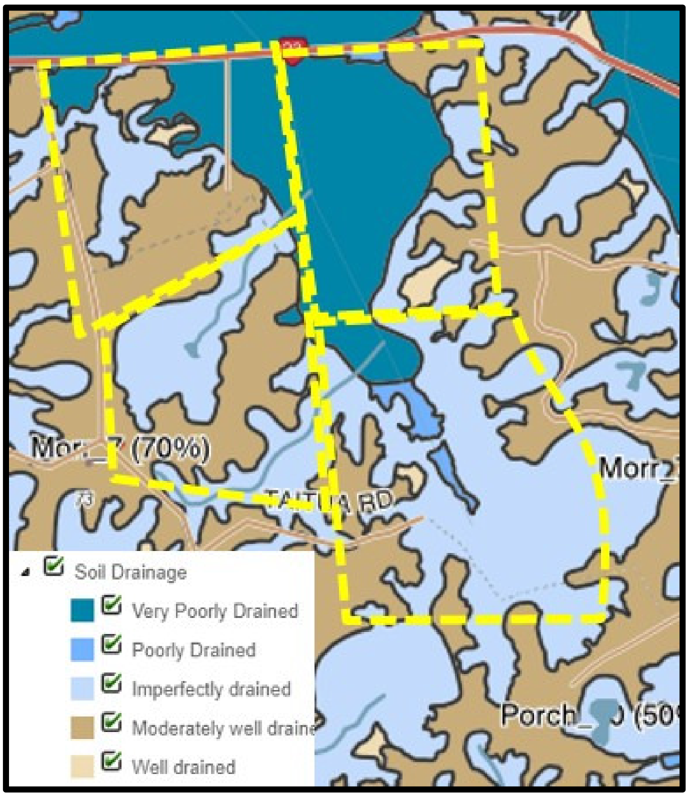
Table 2.1 – Time of concentrations

| | North-west | North-east | South-west | South-east |
|---|---|---|---|---|
| Length (m) | 1343 | 832 | 1225 | 1080 |
| H (m) | 47 | 37 | 57 | 57 |
| Slope % | 3.5 | 4.4 | 4.7 | 5.3 |
| **Tc** | **18** | **11** | **15** | **13** |

## 2.5 Curve Number

Curve numbers are based on S-Maponline provided by Manaaka Whenua (Landcare Research). Figure 2.3 shows the soil drainage characteristics within the four catchments. The lower floodplain area is poorly drained while the upper reaches are imperfect or well-drained.

Figure 2.3 – HEC-HMS Model






Document Set ID: 2509690
Version: 1, Version Date: 21/02/2020

Corresponding to Section 5.3 of TR2018/02, the soil types used in this analysis are:

Group B for well-drained soil,
Group C for imperfect,
Group D for poorly drained.

The percent area of each soil type was then calculated and a final curve number was calculated based on Table 5.2 of TR2018/02. Table 2.2 shows the details.

Table 2.2 – Curve number derivation

| | **Catchment** | | | |
|---|---|---|---|---|
| | **NW** | **NE** | **SW** | **SE** |
| **Soil make-up** | | | | |
| Group B | 40% | 20% | 50% | 30% |
| Group C | 20% | 0% | 50% | 65% |
| Group D | 40% | 80% | 0% | 5% |
| **Curve number category (Table 5.1, TR2018/02) using fair hydrological condition** | | | | |
| Group B | 69 | 69 | 69 | 69 |
| Group C | 79 | 79 | 79 | 79 |
| Group D | 84 | 84 | 84 | 84 |
| | | | | |
| **Curve number** | 77 | 81 | 74 | 76 |
| **Ia (Table 5.1, TR2018/02)** | 3.8 | 3.0 | 4.5 | 4.0 |

## 2.6 HEC-HMS modelling

A HEC-HMS model was built to generate hydrographs. Figure 2.4 shows the simple layout and the rainfall hyetograph required according to Section 4.1 TR2018/02. Figure 2.5 shows the run-off hydrograph for the north-west subcatchment. Finally Figure 2.6 shows the peak flow summaries from HEC-HMS for the two storm return periods.

Figure 2.4 – HEC-HMS Model

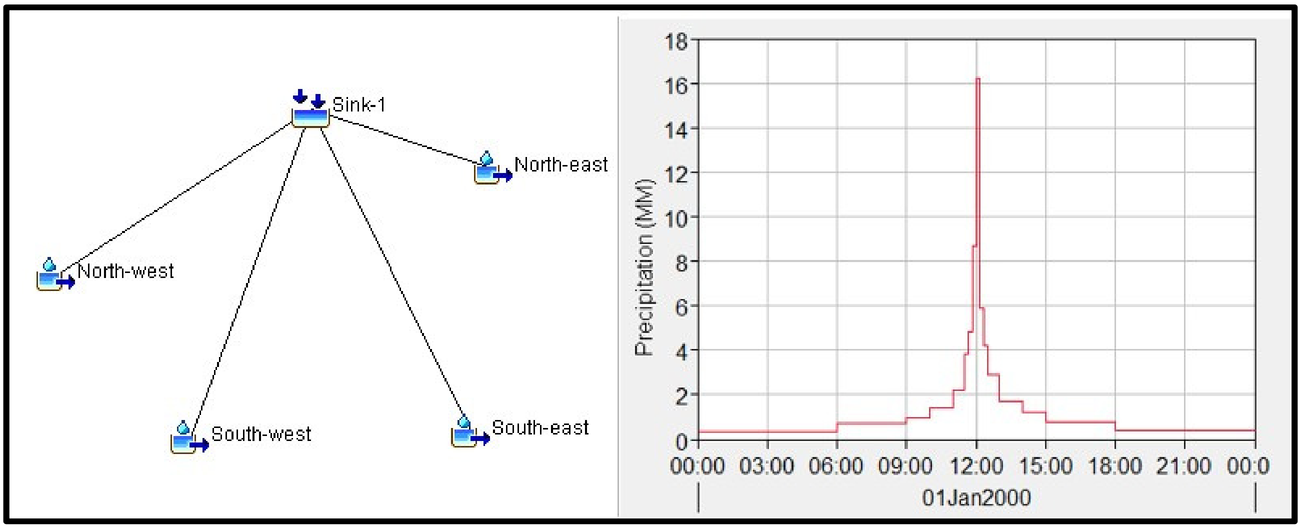
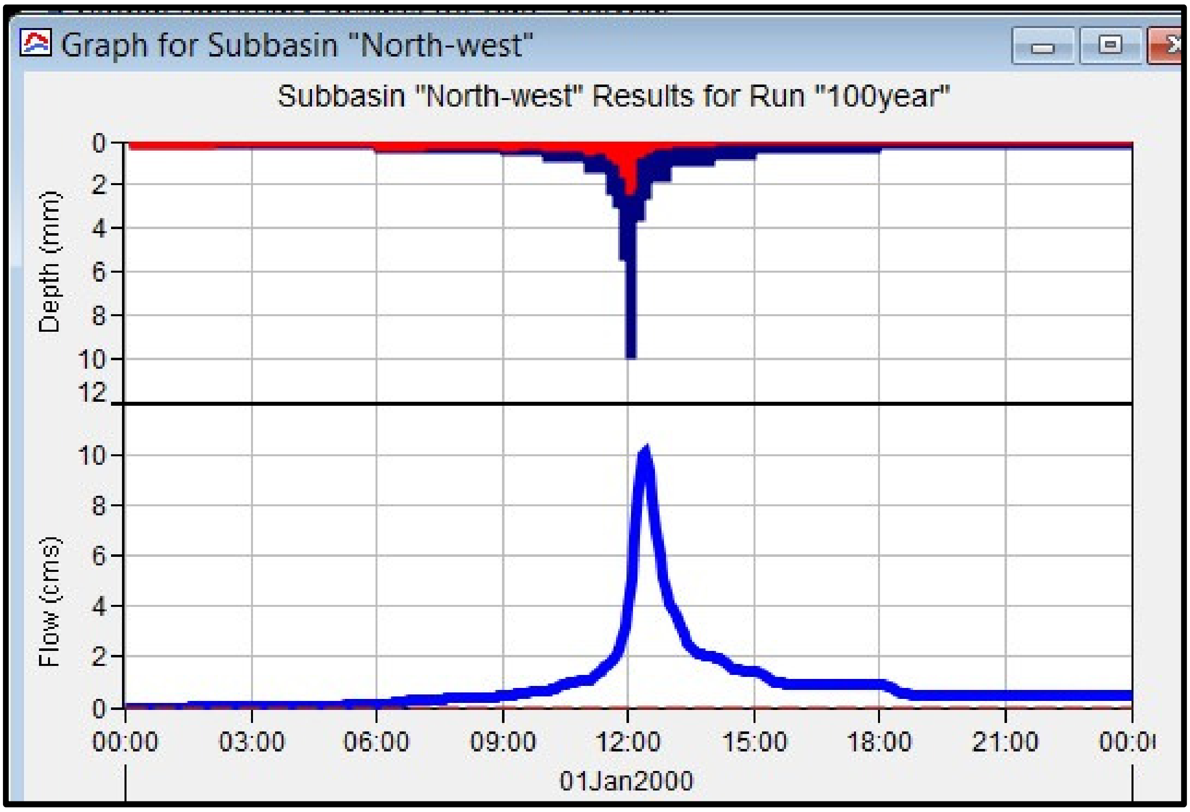


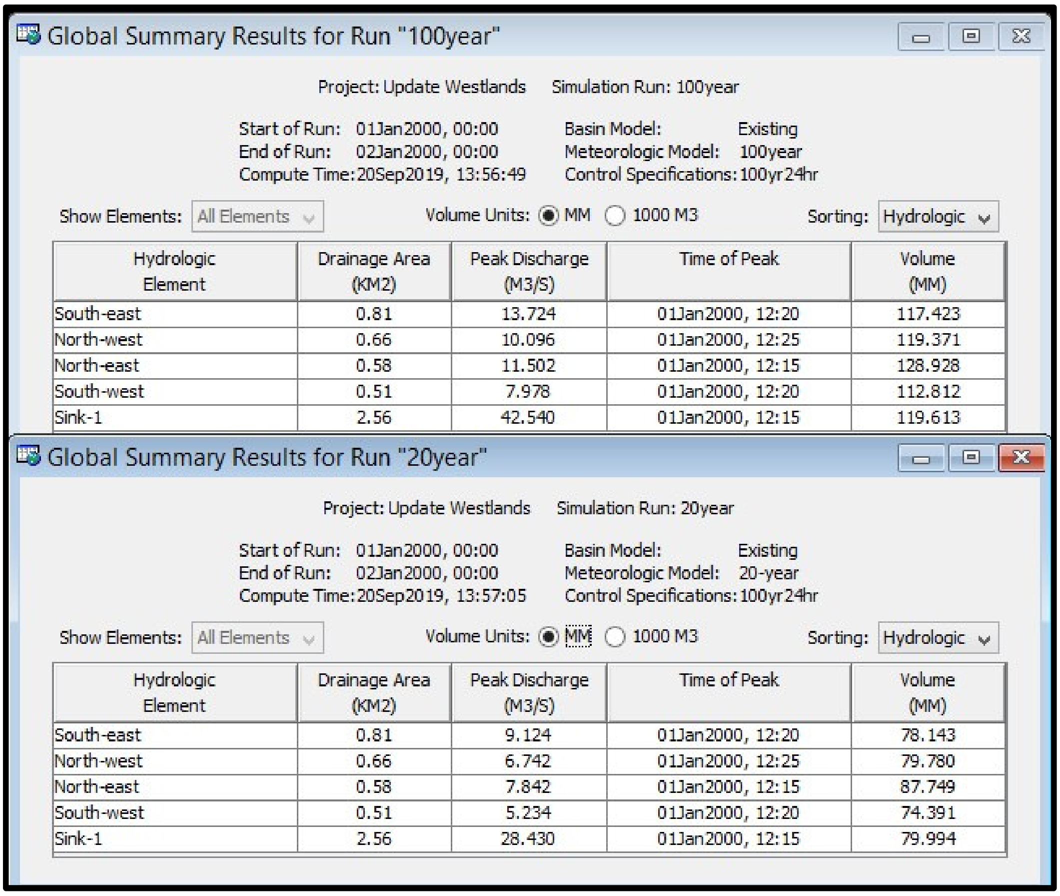

Figure 2.5 – Flow hydrograph, 100-year storm for north-west subcatchment






Document Set ID: 2509690
Version: 1, Version Date: 21/02/2020

Figure 2.6 – Peak flow summaries for 20- and 100-year storms



Global Summary Results for Run "100year"

Project: Update Westlands Simulation Run: 100year

Start of Run: 01Jan2000, 00:00 Basin Model: Existing
End of Run: 02Jan2000, 00:00 Meteorologic Model: 100year
Compute Time: 20Sep2019, 13:56:49 Control Specifications: 100yr24hr

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

| Hydrologic Element | Drainage Area (KM2) | Peak Discharge (M3/S) | Time of Peak | Volume (MM) |
|---|---|---|---|---|
| South-east | 0.81 | 13.724 | 01Jan2000, 12:20 | 117.423 |
| North-west | 0.66 | 10.096 | 01Jan2000, 12:25 | 119.371 |
| North-east | 0.58 | 11.502 | 01Jan2000, 12:15 | 128.928 |
| South-west | 0.51 | 7.978 | 01Jan2000, 12:20 | 112.812 |
| Sink-1 | 2.56 | 42.540 | 01Jan2000, 12:15 | 119.613 |

Global Summary Results for Run "20year"

Project: Update Westlands Simulation Run: 20year

Start of Run: 01Jan2000, 00:00 Basin Model: Existing
End of Run: 02Jan2000, 00:00 Meteorologic Model: 20-year
Compute Time: 20Sep2019, 13:57:05 Control Specifications: 100yr24hr

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

| Hydrologic Element | Drainage Area (KM2) | Peak Discharge (M3/S) | Time of Peak | Volume (MM) |
|---|---|---|---|---|
| South-east | 0.81 | 9.124 | 01Jan2000, 12:20 | 78.143 |
| North-west | 0.66 | 6.742 | 01Jan2000, 12:25 | 79.780 |
| North-east | 0.58 | 7.842 | 01Jan2000, 12:15 | 87.749 |
| South-west | 0.51 | 5.234 | 01Jan2000, 12:20 | 74.391 |
| Sink-1 | 2.56 | 28.430 | 01Jan2000, 12:15 | 79.994 |

# 3 HYDRAULIC ANALYSIS

## 3.1 Model Layout

HEC-RAS software was used to generate flood levels. The 1D model setup is shown in Figure 3.1. The cross-sections have been extrapolated from the LiDAR 0.5m contours. The cross-sections were specific chosen to reflect restrictions in flows between contours and the structures. However cross-sections were also interpolated at minimum of 25m. A 1m deep 1m wide drain was added for the whole length. The culvert under the State Highway is 1.5m square at an invert of RL22m. The floodplain bed roughness has been set to Manning's n = 0.05, a compromise between a good flowing main channel, shrubs on the edge of the stream and open grass paddocks. The reference is Open Channel Hydraulics, Ven Te Chow (1959).

Figure 3.1 – HEC-RAS model set up

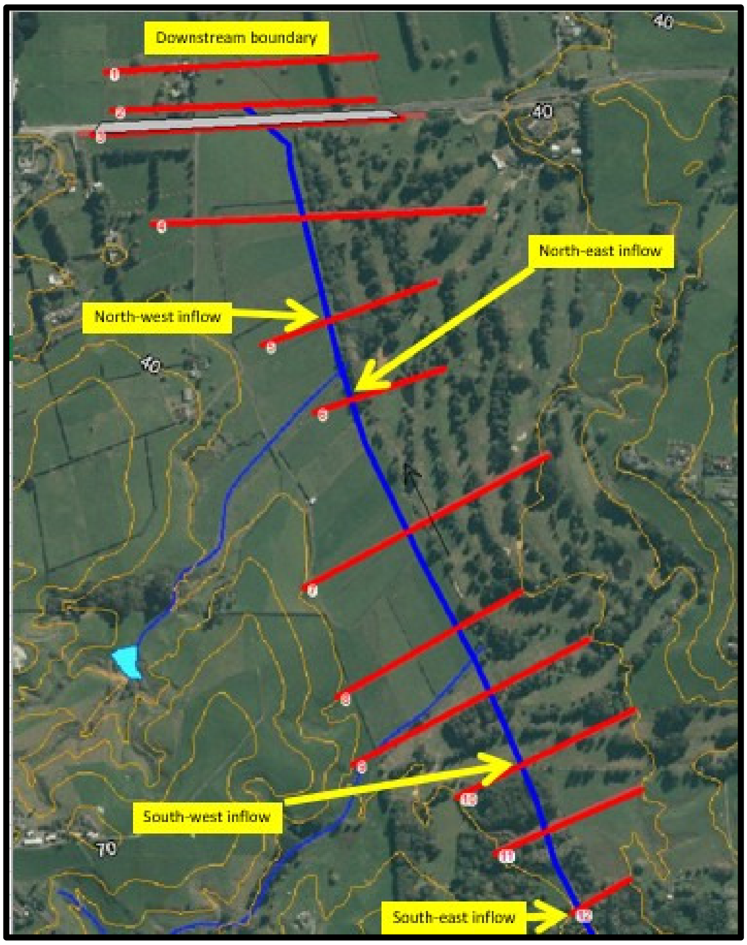
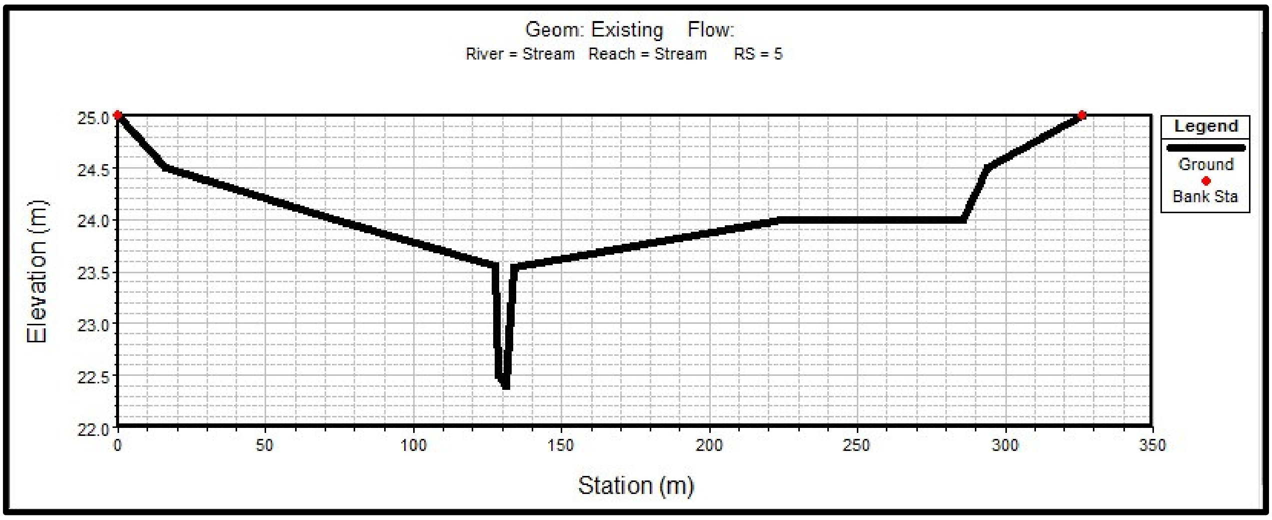


Figure 3.2 shows the cross-section at RS5 at the point of inflow for the north-west subcatchment.

Figure 3.2 – Cross-section RS5




## 3.2 Downstream boundary control

The downstream boundary (RS1) is a wide open floodplain with unrestricted flows. Instead of using a fixed boundary a normal flow boundary was used. This had a grade of 0.007 based on a bed drop of 0.5m over 72m. In fact the State Highway impedes the catchment flow and protects the downstream paddocks from flooding.

## 3.3 Floodplain hydraulic profile

Figure 3.3 shows the hydraulic grade-line for the whole reach. There is a uniform flow until RS6 where the effect of the culvert creates a flat hydraulic grade. The 100-year peak level at the culvert is RL24.6m.

Figure 3.4 shows the flow and water level hydrographs of RS5 and RS3. RS5 was chosen because it represents the highest flows where all subcatchments are contributing. RS3 is just upstream of the culvert. It is shown that the culvert reduces the floodplain flow (green-dashed line) from about 21$m^3$/s to 6$m^3$/s. The duration of the flows are affected as well with the culvert discharging over a good 12 hours compared to just 1-2 hours upstream. All this is expected due to the attenuation of the floodwaters.

Figure 3.3 – Hydraulic grade-line for the 100- and 20-year flows

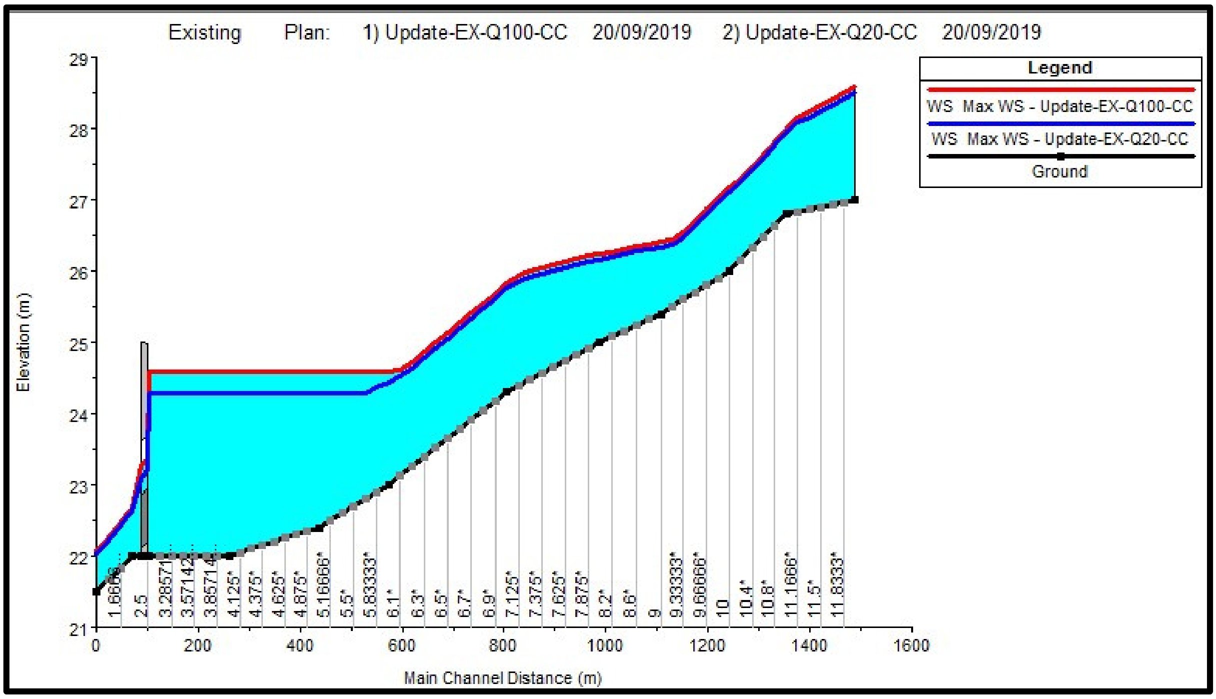
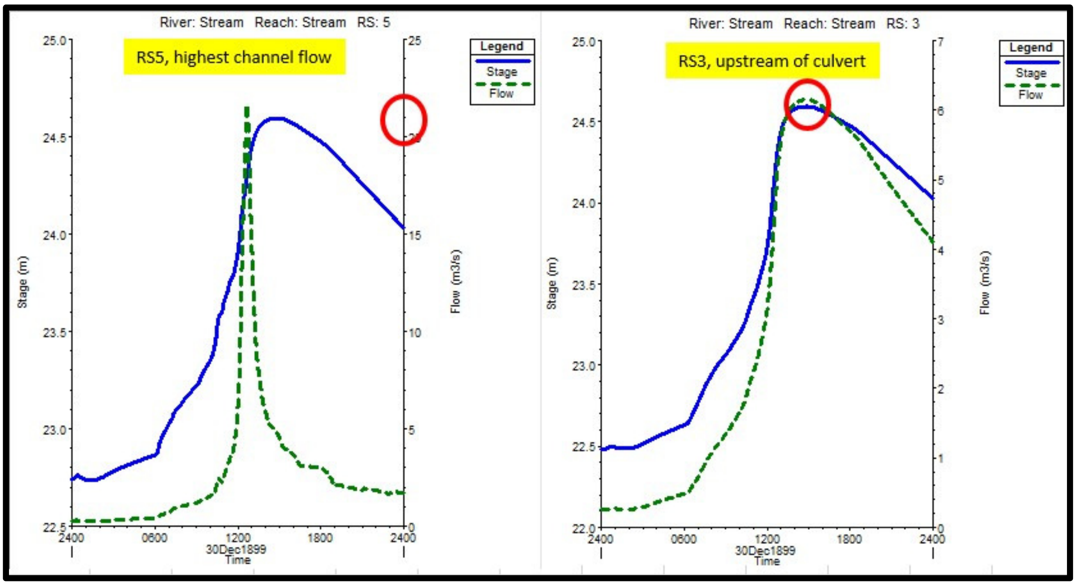



Figure 3.4 – Hydrographs to show attenuation of peak flows




## 3.4 Effect of a rougher floodplain

The bed roughness was increased from 0.05 to 0.1. The increase in flow depth for the 100-year storm was 100mm or less.down to RS6. Downstream of RS6 it made no difference to the water level.



Document Set ID: 2509690
Version: 1, Version Date: 21/02/2020

# 4 CULVERT BLOCKAGE

This section relates to an earlier Section 32 request from Waikato District Council. It reads

Steven to consider
3(b) above - Specifically we need to understand the flooding effect of the culvert under the road being blocked, however unlikely, on the proposed building platforms. What would the wastewater field levels look like now and any change should the culvert block.

There are 3 items within this statement

1. Effect of culvert blockage
2. New building platforms and/or locations
3. The wastewater fields locations based on flood levels

## 4.1 Effect of culvert blockage

The RITS have no criteria of blockage when examining flood risk. The two references to determine blockage are The Auckland Council's *COP for Land and Subdivision – Stormwater Chapter 4, Version 2.0*. It states

g) A secondary flow path shall be kept unobstructed at all times. The secondary flow path design shall assume the total blockage of the culvert in cases where it is less than 1500mm in diameter, and 50% blockage of the culvert where it is greater than or equal to 1500mm in diameter.

The Australian Rainfall and Run-off (ARR Project11, Book 6, Chapter 6 Blockage of hydraulic structures, 2019) has a more detailed analysis based on a number of risk factors. The risk is Low based on a low-low-low criteria for

Debris Availability

Well maintained rural lands and paddocks with minimal outbuildings or stored materials in the source area.

1. Streams with moderate to flat slopes and stable bed and banks.
2. Arid areas where vegetation is deep rooted and soils are resistant to scour.
3. Urban areas that are well maintained with limited debris present in the source area

Debris Mobility

1. Low rainfall intensities and large, flat source areas.
2. Receiving streams infrequently overtops their banks.
3. Main debris source areas well away from streams

Debris Transportability

1. Flat bed slopes (< 1%).and/or low stream velocity (V<1m/sec)
2. Shallow depth relative to vertical debris dimension (D < 0.5L10)
3. Narrow stream relative to horizontal debris dimension (W<L10)
4. Stream meanders with frequent constrictions/snag points.
5. Low temporal variability in maximum stream flows

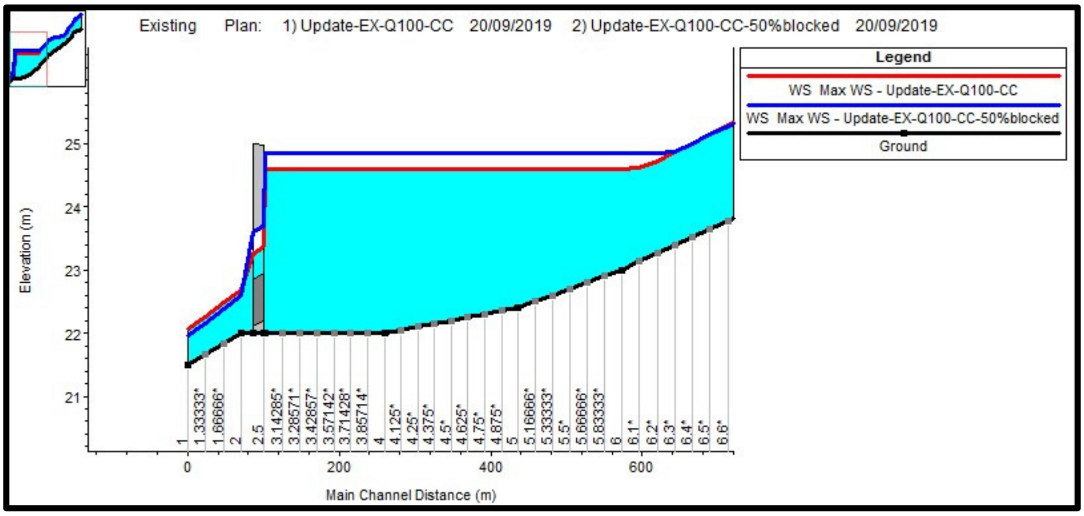
The analysis indicates that for a 100-year event the blockage for the inlet and sediment is 0%.

Therefore taking the worst-case of the two methods the 1.5m square culvert is an equivalent 1.7m barrel and the Auckland method might suggest 50% blockage.

The hydraulic model was re-run with the 100-year storm and the bottom 0.75m of the culvert blocked.

Figure 4.1 shows the hydraulic profiles along the reach comparing the non-blocked and 50% blocked. The 50% blockage effects cross-sections just upstream of RS6. The increase in water level at the culvert is 0.2m. The flow is decreased from 6.2$m^3$/s to 3.6$m^3$/s.

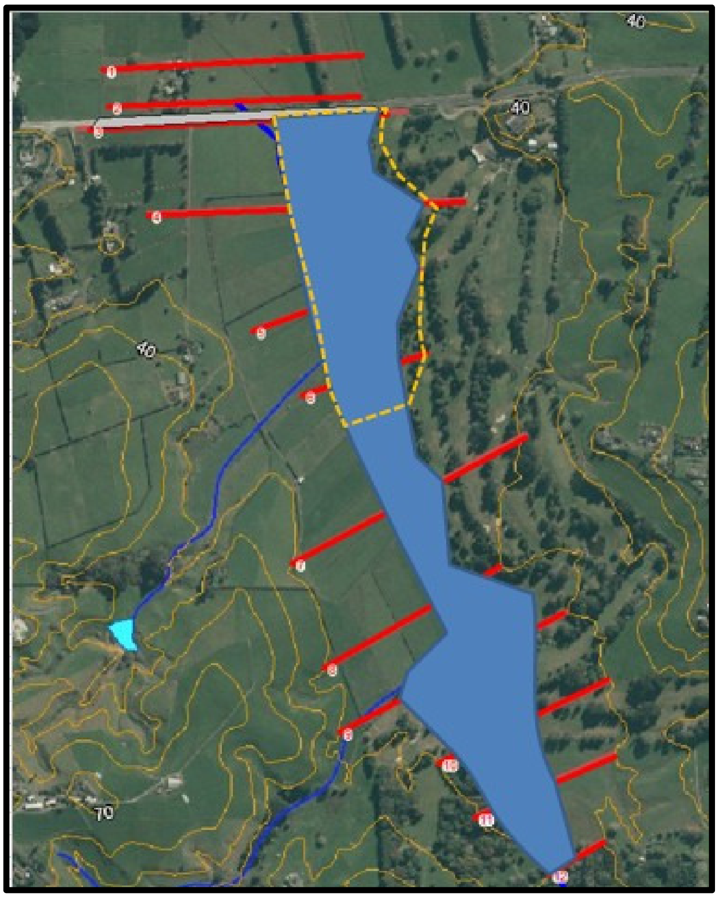
Figure 4.1 – Hydraulic grade-line comparing a 50% blockage




## 4.2 Floodplain

Figure 4.2 shows the floodplain for the 100-year event and the impact of the 50% blockage shown with a dashed line. The extra aerial extent is perhaps no greater than 10%.

Figure 4.2 – Change in floodplain width for 50% blockage near the culvert





Document Set ID: 2509690
Version: 1, Version Date: 21/02/2020

## 4.3 Minimum finished floor levels

Table 4.1 gives the minimum finished floor. Based on the estimated ground levels the new dwellings are above the freeboard requirement of 500mm even when the culvert is 50% blocked.

Table 4.1 – Minimum finished floor levels

| Lot number | Model RS | Estimated flood level RL(m) | | Minimum finished floor level RL(m) | Surveyed ground level RL(m) |
|---|---|---|---|---|---|
| | | No blockage | 50% blockage | | |
| 1 | 6 | 24.6 | 24.8 | 25.1 | 25.5 |
| 2 | 7 | 25.8 | 25.8 | 26.3 | 29.0 |
| 3 | 8 | 26.2 | 26.2 | 26.7 | 32.0 |
| 4 | 7 | 25.8 | 25.8 | 26.3 | 30.0 |
| 5 | 9 | 26.4 | 26.4 | 26.9 | 28.0 |
| 6 | 11 | 28.0 | 28.0 | 28.5 | 34.0 |
| 7 | 9 | 26.4 | 26.4 | 26.9 | 28.9 |
| 8 | 4 | 24.6 | 24.8 | 25.1 | 40.0 |
| 9 | 4 | 24.6 | 24.8 | 25.1 | 28.0 |
| 10 | 8 & 9 | 26.3 | 26.3 | 26.8 | 28.5 |

## 4.4 Wastewater field data

The wastewater field for each Lot must be above the 20-year flood-line. Assuming the wastewater fields are adjacent to the building within the Lot then Table 4.2 gives the minimum level required

Table 4.2 – 20-year flood levels for wastewater fields

| Lot number | Model RS | 20-year flood level RL(m) |
|---|---|---|
| | | |
| 1 | 6 | 24.4 |
| 2 | 7 | 25.8 |
| 3 | 8 | 26.2 |
| 4 | 7 | 25.8 |
| 5 | 9 | 26.3 |
| 6 | 11 | 28.0 |
| 7 | 9 | 26.3 |
| 8 | 4 | 24.3 |
| 9 | 4 | 24.3 |
| 10 | 8 & 9 | 26.3 |

# 5 SUMMARY

Flood modelling has been undertaken to calculate the 100-year flood levels for the whole property along the drainage channel to establish the minimum floor levels. The 20-year flood was analysed for the wastewater fields.

Utilising HEC-HMS, four hydrographs were generated and input into a 1D hydraulic model. The model included the state highway culvert which attenuated the flows from $21m^3/s$ to $6m^3/s$.

Table 4.1 provides details of finished floor levels for each of the proposed building sites and Table 4.2 shows the minimum level for the wastewater fields.

# Westlands Subdivision Response to Beca Review

| Item No. | Comment (WDC/Beca) | Response from Dr Steven Joynes |
|---|---|---|
| 1 | We note that Waikato Regional Council's Runoff Modelling Guide (2018) was not used for the hydrology. Please comment on the difference this could make to the flood results and if WRC are satisfied with the method used. We note WDC's preference is to remain consistent with WRC and their method is more recent than HCC's method. | I have updated the work for the new methodology |
| 2 | What consideration was made for post development impacts on flood levels? Including external future catchment development contributing to flooding (or document why this is not relevant), from the change in land-use (impervious surfaces, site compaction etc) of the site itself and allowance for climate change increases. We note this may impact on setting floor levels, or alternatively it would show the proposed developments insensitivity to these issues. Either way it needs to be documented. | See Sections 2.2 and 2.3 |
| 3 | The report notes that flood levels were compared to a video of historic flooding (referenced on page 2) and that this supports the model validation. Please include screen captures of the video in the report commentary to help support this statement. | I don't have video any more. Need to talk to owner. The report cover shows the flooding upstream of the culvert. |
| 4 | Section 1.7 references Hamilton City Infrastructure Specifications? Do you mean the RITS? HCC's ITS is no longer valid and HIRDS should be used for rainfall data. Please update for this. | This has been remedied |
| 5 | Later Figures in the report note 10yr ARI data. If the 10yr ARI is intended to be reported on (and we note this event is not relevant for setting of floor levels as is | This has been remedied |

| | | |
|---|---|---|
| | the stated as the purpose of the model), then please include 10yr ARI rainfall, flows, HGL information etc. If not, then delete. | |
| 6 | A map displaying roads/accessways would be helpful, as would a topographical map to give more context to the above levels, and subsequently the rest of the report. That is, we suggest the survey plans are included as an Appendix. | In Stormwater Management Plan by Cheals |
| 7 | The Tc's have been rounded up to 20mins. It would be more appropriate to take a more conservative Tc than what rounding up gives. Increasing the Tc will reduce the peak flow rates. Please clarify or show that this would not have a significant impact on flood levels. | This has been remedied. Actual Tc's used. |
| 8 | Please expand on the hydrology section to include parameters used (losses, % impervious, CN etc). | This has been remedied, see Section 2.5. |
| 9 | We assume this is 1D model only? Please clarify in the report. | Yes |
| 10 | Was any topographic survey used for the stream sections, culvert and to check consistency of the LiDAR? We assume so but this should be noted in the report (similar for confirmation of the downstream culvert size). | No survey as such as the flow is predominantly out of channel. The stream dimensions were measured on site. |
| 11 | The model does not contain many cross sections. Was the interpolation function in RAS used in the model but not stated in the report? | Yes |
| 12 | Floodplain bed –please clarify whether the Manning's roughness for the "floodplain" bed is applied to the whole section (i.e. the channel). It appears that the floodplains to the east have more trees than the west. Please comment on the implications on roughness of this. Also how were the channel roughness values selected (i.e what references were used etc)? How sensitive are flood levels to underestimating roughness? A sensitivity run would show this. | Used a Manning's n of 0.05 throughout the cross-section. If the stream was modelled differently it would, technically, be smoother so this method is conservative. Given the bottom end is flooded it would not make a difference given the scale.<br>Also see Section 3.4 |

| | | |
|---|---|---|
| 13 | Section 3.2 first paragraph –wording is unclear. Please revise | This has been remedied |
| 14 | The downstream boundary location is not show on map. Please show and clarify this is sufficiently far enough downstream i.e. there are no further controls downstream that could influence the culvert performance. | This has been remedied.<br>Site inspection shows that downstream controls will be irrelevant. A Normal slope is fine and is shown by the HGL to fine due to the upstream flood levels. |
| 15 | Downstream boundary slope is set at 0.1%. Please clarify how this was calculated and applied to the model. Figure 3.3 shows what appears to be a much steeper slope of 0.42. Downstream contours used to calculate a slope over 540m found it to be 0.007 (0.7%). | This has been remedied. See Section 3.2. |
| 16 | Figure 3.4/3.5 please update. The legend/labels to state 10yr and 100yr flows/HGL are shown but are not in the figure. Figure 3.4 are not HGL plots. | These have been remedied |
| 17 | Cross sections. Please confirm these all extend beyond the flood extents | Yes |
| 18 | Upstream overland flows need to be considered in setting floor levels. Alternatively, it needs to be shown that this does not dominate in setting flood levels. Presumably this would be addressed in the Stormwater Management Plan (i.e. not need modelling). | In Stormwater Management plan by Cheals |
| 19 | Freeboards noted are 500mm and will comply provided the above issues do not increase flood levels and freeboard is taken from flood level to underside of slab/floor joist. This will need to be shown on any plans submitted for approval. | FFLs have been adjusted accordingly in Table 4.1 |
| 20 | Addendum –wastewater fields locations based on flood levels has not been addressed, although this is not a flood issue so is just noted here for WDC to act on as required. Presumably this has been addressed by the applicant separately. | In Table 4.2. |
| 21 | Figure 5.2 –Show legend | Deleted |

| | | |
|---|---|---|
| 22 | Table 5.1 mentions new lots. Please include an image to show location of these new lots relative to floodplain and other proposed lots. | Deleted |
| 23 | Paragraph below Table 5.1 is a incomplete. | Deleted |
| 24 | Reference to AR&R Project 11 Stage 3 2015 was made. The most up to date AR&R guidelines are Book 6, Chapter 6, released in 2019. Please review and update reference. | This has been remedied |
| 25 | We expect the SMP will cover checking the impacts of development on neighbouring properties and compliance with the Waikato Regional Plan, amongst other issue. A comment only, no action/response required. | Okay, not in my report |

# Appendix 3

Road Flooding Assessment

| Section No | Scenario | Q Total | Min Ch El | W.S. Elev | Typical G L | Vel Chnl | Depth | | V x D | |
|---|---|---|---|---|---|---|---|---|---|---|
| Fig 4.2 Golovin Report | | | | | | | | | | |
| | | | | | | | *main* | *channel* | *main* | *channel* |
| | | *(m3/s)* | *(m)* | *(m)* | *(m)* | *(m/s)* | *(m)* | *(m)* | *(m²/s)* | *(m²/s)* |
| | | **Topo levels are generally around 26.8** | | | | | | | ideally less than 0.3m²/s at a deptl | |
| 10 | Update-EX-Q100-CC | 13.54 | 26 | 27.18 | 26.8 | 0.47 | 0.38 | 1.18 | 0.2 | 0.55 |
| 10 | Update-EX-Q20-CC | 8.96 | 26 | 27.1 | 26.8 | 0.44 | 0.30 | 1.10 | 0.1 | 0.48 |
| 10 | Update-EX-Q100-CC-50%blocked | 13.54 | 26 | 27.18 | 26.8 | 0.47 | 0.38 | 1.18 | 0.2 | 0.55 |
| 10 | Update-EX-Q100-CC-rougher | 13.33 | 26 | 27.3 | 26.8 | 0.29 | 0.50 | 1.30 | 0.1 | 0.38 |
| 10 | Update-EX-Q10-CC | 7.2 | 26 | 27.07 | 26.8 | 0.43 | 0.27 | 1.07 | 0.1 | 0.46 |
| 10 | Update-EX-Q1-CC | 3.02 | 26 | 26.96 | 26.8 | 0.4 | 0.16 | 0.96 | 0.1 | 0.38 |
| 10 | Update-EX-Q5-CC | 5.63 | 26 | 27.04 | 26.8 | 0.4 | 0.24 | 1.04 | 0.1 | 0.42 |
| | **Area of Lot 7 access , topo levels are generally under 26.0** | | | | | | | | | |
| 9 | Update-EX-Q100-CC | 20.77 | 25.4 | 26.41 | 26 | 0.32 | 0.41 | 1.01 | 0.1 | 0.32 |
| 9 | Update-EX-Q20-CC | 13.51 | 25.4 | 26.32 | 26 | 0.27 | 0.32 | 0.92 | 0.1 | 0.25 |
| 9 | Update-EX-Q100-CC-50%blocked | 20.77 | 25.4 | 26.41 | 26 | 0.32 | 0.41 | 1.01 | 0.1 | 0.32 |
| 9 | Update-EX-Q100-CC-rougher | 19.3 | 25.4 | 26.55 | 26 | 0.21 | 0.55 | 1.15 | 0.1 | 0.24 |
| 9 | Update-EX-Q10-CC | 10.65 | 25.4 | 26.28 | 26 | 0.21 | 0.28 | 0.88 | 0.1 | 0.18 |
| 9 | Update-EX-Q1-CC | 4.49 | 25.4 | 26.14 | 26 | 0.19 | 0.14 | 0.74 | 0.0 | 0.14 |
| 9 | Update-EX-Q5-CC | 8.98 | 25.4 | 26.25 | 26 | 0.24 | 0.25 | 0.85 | 0.1 | 0.20 |
| | | **Topo levels are generally around 26.0** | | | | | | | | |
| 8 | Update-EX-Q100-CC | 19.74 | 25 | 26.24 | 26 | 0.31 | 0.24 | 1.24 | 0.1 | 0.38 |
| 8 | Update-EX-Q20-CC | 13.08 | 25 | 26.16 | 26 | 0.29 | 0.16 | 1.16 | 0.0 | 0.34 |
| 8 | Update-EX-Q100-CC-50%blocked | 19.74 | 25 | 26.24 | 26 | 0.31 | 0.24 | 1.24 | 0.1 | 0.38 |
| 8 | Update-EX-Q100-CC-rougher | 18.14 | 25 | 26.37 | 26 | 0.2 | 0.37 | 1.37 | 0.1 | 0.27 |
| 8 | Update-EX-Q10-CC | 10.38 | 25 | 26.13 | 26 | 0.26 | 0.13 | 1.13 | 0.0 | 0.29 |
| 8 | Update-EX-Q1-CC | 3.91 | 25 | 25.99 | 26 | 0.32 | -0.01 | 0.99 | 0.0 | 0.32 |
| 8 | Update-EX-Q5-CC | 8.75 | 25 | 26.11 | 26 | 0.24 | 0.11 | 1.11 | 0.0 | 0.27 |
| | | **Topo levels are generally around 24.0** | | | | | | | | |
| 5 | Update-EX-Q100-CC | 4.73 | 22.4 | 24.59 | 24 | 0.02 | 0.59 | 2.19 | 0.0 | 0.04 |
| 5 | Update-EX-Q20-CC | 3.84 | 22.4 | 24.28 | 24 | 0.04 | 0.28 | 1.88 | 0.0 | 0.08 |
| 5 | Update-EX-Q100-CC-50%blocked | 2.71 | 22.4 | 24.84 | 24 | 0.01 | 0.84 | 2.44 | 0.0 | 0.02 |
| 5 | Update-EX-Q100-CC-rougher | 4.77 | 22.4 | 24.59 | 24 | 0.03 | 0.59 | 2.19 | 0.0 | 0.07 |
| 5 | Update-EX-Q10-CC | 3.55 | 22.4 | 24.15 | 24 | 0.05 | 0.15 | 1.75 | 0.0 | 0.09 |
| 5 | Update-EX-Q1-CC | 4.38 | 22.4 | 23.78 | 24 | 0.29 | -0.22 | 1.38 | -0.1 | 0.40 |
| 5 | Update-EX-Q5-CC | 3.39 | 22.4 | 24.05 | 24 | 0.07 | 0.05 | 1.65 | 0.0 | 0.12 |

**Topo levels are generally around 23.9**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 4 Update-EX-Q100-CC | 6.15 | 22 | 24.59 | 23.9 | 0.02 | 0.69 | 2.59 | 0.0 | 0.05 |
| 4 Update-EX-Q20-CC | 5 | 22 | 24.28 | 23.9 | 0.03 | 0.38 | 2.28 | 0.0 | 0.07 |
| 4 Update-EX-Q100-CC-50%blocked | 3.63 | 22 | 24.84 | 23.9 | 0.01 | 0.94 | 2.84 | 0.0 | 0.03 |
| 4 Update-EX-Q100-CC-rougher | 6.15 | 22 | 24.59 | 23.9 | 0.02 | 0.69 | 2.59 | 0.0 | 0.05 |
| 4 Update-EX-Q10-CC | 4.53 | 22 | 24.15 | 23.9 | 0.02 | 0.25 | 2.15 | 0.0 | 0.04 |
| 4 Update-EX-Q1-CC | 3.05 | 22 | 23.69 | 23.9 | 0.07 | -0.21 | 1.69 | 0.0 | 0.12 |
| 4 Update-EX-Q5-CC | 4.15 | 22 | 24.04 | 23.9 | 0.04 | 0.14 | 2.04 | 0.0 | 0.08 |

# Appendix 4

Extract from Australian Rainfall and Runoff

Table 6.7.3. Combined Hazard Curves - Vulnerability Thresholds (Smith et al., 2014)

| Hazard Vulnerability Classification | Description |
|---|---|
| H1 | Generally safe for vehicles, people and buildings. |
| H2 | Unsafe for small vehicles. |
| H3 | Unsafe for vehicles. children and the elderly. |
| H4 | Unsafe for vehicles and people. |
| H5 | Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure. |
| H6 | Unsafe for vehicles and people. All building types considered vulnerable to failure. |

Table 6.7.4. Combined Hazard Curves - Vulnerability Thresholds Classification Limits (Smith et al., 2014)

| Hazard Vulnerability Classification | Classification Limit (D and V in combination) | Limiting Still Water Depth (D) | Limiting Velocity (V) |
|---|---|---|---|
| H1 | $D*V \leq 0.3$ | 0.3 | 2.0 |
| H2 | $D*V \leq 0.6$ | 0.5 | 2.0 |
| H3 | $D*V \leq 0.6$ | 1.2 | 2.0 |
| H4 | $D*V \leq 1.0$ | 2.0 | 2.0 |
| H5 | $D*V \leq 4.0$ | 4.0 | 4.0 |
| H6 | $D*V > 4.0$ | - | - |

# Appendix 5

Reply to Beca Review 2

# Response to Stormwater Management Plane Issues

## Westlands Subdivision

A meeting was held on Monday 25th November 2019 to discuss the nine issues raised by the Beca Review. This is a summary of the extra work undertaken by Golovin.

### ITEM 1

• *Impact of the extra imperviousness of the development.*

The development is in the north-east subcatchment. The Cn value is 77 and Initial abstraction 3.8mm. However when the development imperviousness was included the Cn value is 77.3 and the initial abstraction 3.7mm. This is based on the following assumptions.

- Each house footprint is 300m$^2$ (total of 3,000m$^2$)
- Each driveway away is 100m$^2$ (total of 1,000m$^2$)
- The road-way is 1.3km long and 4m wide.

The total estimated area of imperviousness is 9,200m$^2$ and the total catchment is 0.66km$^2$.

HEC-HMS was re-run to generate a new hydrograph for north-east and input into HEC-RAS. The peak flow increased from 10.10 to 10.15m$^3$/s. The volume increase was from 78,790m$^3$ to 79,250m$^3$ (460m$^3$).

The new flood level at the downstream ponding area upstream of the culvert did not change compared to the un-developed scenario reported earlier. Figure 1 shows a screenshot from HEC-RAS for the lower ponding area. At RS5 the flood level is RL24.84m for both. The scenario is for a 50% blocked culvert with climate change rain.

Another scenario was run with the existing land-use and historical rain depth. The 24-hour rain depth is 145mm. For this scenario the flood level dropped by 0.46m at RS5.

In conclusion the impact of climate change will affect the flood levels by about 0.5m at the ponding area while the development will have no impact.

Figure 1 – Comparison of flood levels in lower area, existing and proposed land-use

| Reach | River Sta | Profile | Plan | Q Total | Min Ch El | W.S. Elev |
|---|---|---|---|---|---|---|
| | | | | (m3/s) | (m) | (m) |
| | | | | | | |
| Stream | 6 | Max WS | Update-EX-Q100-CC-50%blocked | 1.87 | 23.00 | 24.84 |
| Stream | 6 | Max WS | Update-Q100DEV-B | 1.90 | 23.00 | 24.84 |
| | | | | | | |
| Stream | 5 | Max WS | Update-EX-Q100-CC-50%blocked | 2.71 | 22.40 | 24.84 |
| Stream | 5 | Max WS | Update-Q100DEV-B | 2.71 | 22.40 | 24.84 |
| | | | | | | |
| Stream | 4 | Max WS | Update-EX-Q100-CC-50%blocked | 3.63 | 22.00 | 24.84 |
| Stream | 4 | Max WS | Update-Q100DEV-B | 3.63 | 22.00 | 24.84 |
| | | | | | | |
| Stream | 3 | Max WS | Update-EX-Q100-CC-50%blocked | 3.63 | 22.00 | 24.84 |
| Stream | 3 | Max WS | Update-Q100DEV-B | 3.63 | 22.00 | 24.84 |
| | | | | | | |
| Stream | 2.5 | | | Culvert | | |

## ITEM 2

*• Rainwater tank attenuation*

The volume generated due to the development for the 100-year storm is 460m$^3$. The house contribution is 150m$^3$, the driveway contribution is 50m$^3$ and the roadway is 260m$^3$. Itemised this is 15m$^3$ per house, 5m$^3$ per driveway and 0.2m$^3$/m run for the roadway.

Although the extra run-off generated will not affect flood levels in the WRC drain as shown in Item 1, there is a case for 15m$^3$ (above ground) and 5m$^3$ (below ground) detention tanks for each new house. If the 10-year storm is the design criteria is required the volumes will be generally 10% less. It is however understood that the owner wants to create a sustainable development and water tanks will be used for retention anyway.

## ITEM 3

*• Road run-off treatment*

The estimated extra run-off from the roadway is 0.2$m^3$ per m length over a 24-hour period. It is understood that plantings on the drain side of the roadway will be undertaken to absorb this extra volume and encourage soakage and improve water quality. Agreed that it can be finalised at Engineering Approval stage.

## ITEM 4

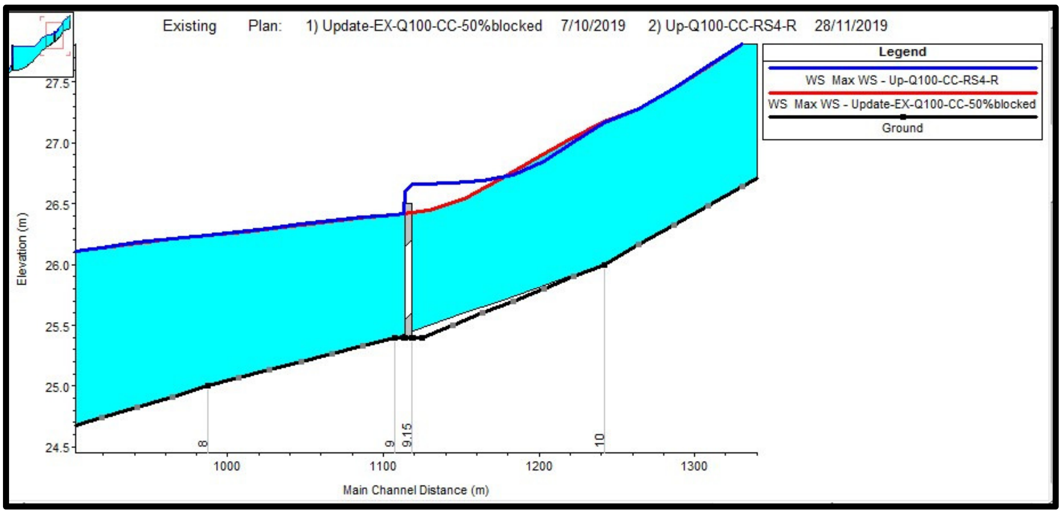
*• The effect of the ROW. Does it flood in the 100-year event? If it needs to be built up what impact does it have on the floodplain?*

There are two locations where the roadway is within the 100-year floodplain. It is Waikato District Council desire that the roadway be at or above this level.

At the northern end in Lot 10 the general cross-section is RS4. The 100-year level is RL25m. Based on LiDAR the typical ground level is RL24m. Therefore it would seem that the roadway needs to be built up to RL25m. This creates a 1m barrier for the flood to spread. To assess the effect of this barrier RS4 was amended. This was by reducing the width by 30m and creating a vertical wall in the HEC-RAS model. This caused the 100-year, climate change, 50% blocked culvert, water level to rise by 30mm. This suggests the finished floor level for Lot 1 should be raised by 30mm.

For Lot 7 the driveway cuts across overland flows. The ground level is about RL26m and the flood level is RL26.4m. This suggests a 400mm raising of the driveway. This may have an impact for the neighbours at Lot 39 DPS 76270 and Lot 1 12807. RS9 was adjusted by inserting a nominal 600mm culvert and driveway at RL26.5m. Figure 2 shows the change in HGL. Although the water level rises to get over the driveway the influence at RS10 diminishes to zero. This location is the neighbouring upstream boundary.

Figure 2 – Lot 7 raised driveway HGL




In conclusion, raising the roadway in Lot 10 requires the FFL of Lot 1 to be raised by 30mm. Within Lot 7 a culvert needs to be under the driveway to drain the area but its design and raised driveway does should not affect neighbouring properties.

## ITEM 5

- *Impact for each of the proposed house locations by the overland flowpath. Do the FFLs need to be raised above "normal" ground levels?*

The catchments for Lots 1 and 7 were analysed. The lot 1 catchment is the largest example for houses in Lots 2, 3, 4, 5 and 10. While Lot 7 has a catchment size based on the adjacent drain. These are shown in Figures 3 and 4.

Figure 3 – Lot 1 subcatchment

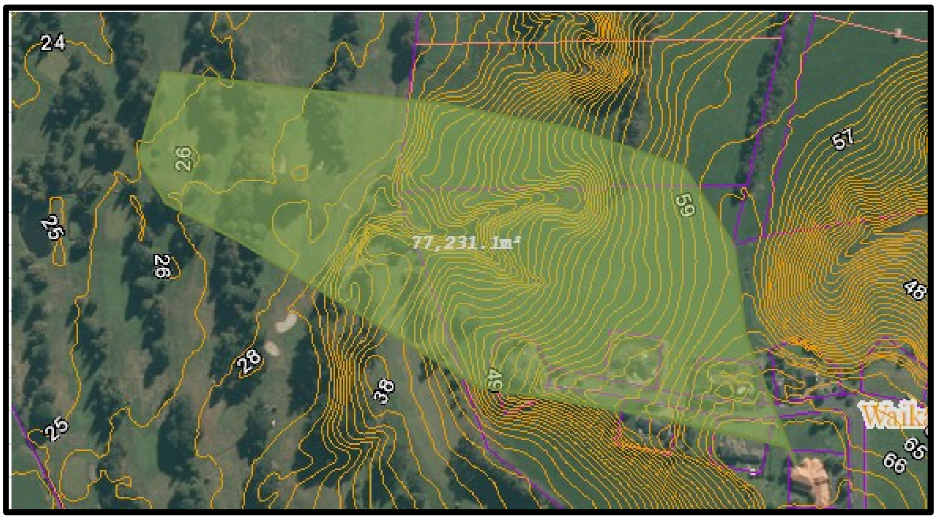
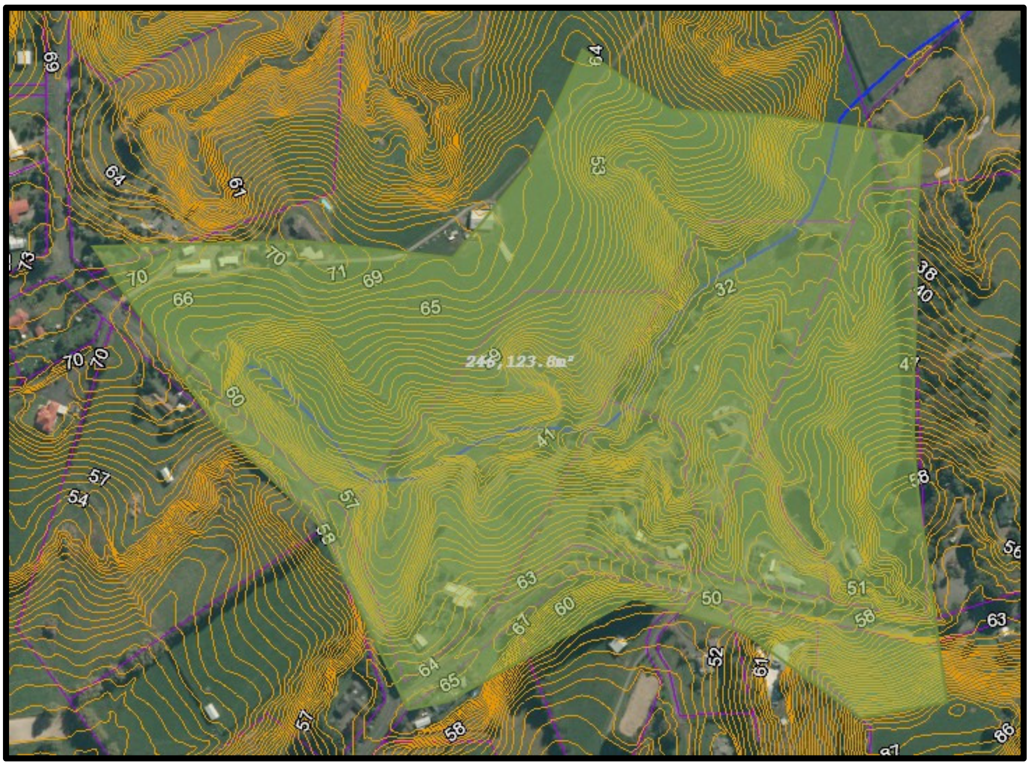


Figure 4 – Lot 7 subcatchment



Using the Rational Method on these small catchments within the whole project area, peak flows were generated based on the times of concentrations. Using Manning's equation and restricting flow depths to 100mm the widths of flow can be determined.

Figure 5 shows the calculations. For Lot 7 we have to account for the drain on the northern side. The estimated capacity is about 1m$^3$/s. This means the overland flow for Lot 7 is 0.421m$^3$/s. By adjusting the flow width the FOS for the 100mm depth can be adjusted.

At Lot 1 if the flow width is 24m or more the depth of flow is less than 100mm. For Lot 7 it is 23m. Close examination of the ground profiles there is no concentration of flows but general sheet flow. The widths of the Lots are about 40-50m and therefore the flow depths will be less than 100mm and the allowance for OLFP is within the normal building regulations for ground clearance.

Figure 5 – OLFP Check

| | | | |
|---|---|---|---|
| | | **Lot Number** | |
| | | **1** | **7** |
| Area | ha | 7.72 | 24.6 |
| Distance | m | 572 | 926 |
| Top | RL(m) | 70 | 70 |
| Bottom | RL(m) | 25 | 28 |
| Grade | | 0.08 | 0.05 |
| % | | 7.9 | 4.5 |
| n | | 0.045 | 0.045 |
| tc | minutes | 24 | 32 |
| C | | 0.2 | 0.2 |
| intensity | mm/hr | 104 | 104 |
| **Q** | m3/s | 0.446 | 0.421 |
| | | | |
| **Overland flow** | | | |
| | | **Lot Number** | |
| | | **5** | **18** |
| Garden slope | 1 in | 500 | 500 |
| Garden slope | | 0.002 | 0.002 |
| OLFP width | m | 24 | 23 |
| OLFP depth | m | 0.1 | 0.1 |
| Wetted perimeter | | 24.20 | 23.20 |
| Area | m2 | 2.4 | 2.3 |
| Velocity | m/s | 0.190 | 0.190 |
| Hyd Rad | | 0.099 | 0.099 |
| n | | 0.05 | 0.05 |
| Qmax | | 0.456 | 0.437 |
| | | | |
| Target | | 0.446 | 0.421 |
| | | | |
| **FOS** | | 1.0 | 1.0 |

**ITEM 6**

Done by Cheal.

**ITEM 7**

Summary of issues raised earlier.

To summarise:

There is no impact on upstream properties – see item 4

The roadway has to be raised and their hazards has been discussed in item 4.

## ITEM 8

Done by Cheal.

## ITEM 9

Done by Cheal.

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**Dr Steven Joynes**

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28th November 2019

## Philip Barrett

**From:** Philip Barrett
**Sent:** Thursday, 5 December 2019 2:52 pm
**To:** 'Cameron Aplin'; malcolm.brown@waidc.govt.nz
**Cc:** Sharon Singleton; 'Graham Singleton'
**Subject:** G & S Singleton -Extra Flood Hazard Analysis and Waikato Regional Council Consultation Reply
**Attachments:** IMG_0160.JPG; IMG_0162.JPG; IMG_0161.JPG; SWMP Issues Memo.pdf

Dear Cameron,

Following our meeting last week, Tuesday 26 November, we took away the following understanding in terms of replying to Beca second round of review comments dated 8 November 2019 items 1 – 9 inclusive.

Item 1
Undertake further flood modelling which includes climate change and impervious cover change. Check effect on flood levels.
number of scenarios are:
Existing rainfall vs. Existing land-use
Climate change rainfall vs. existing land-use
Existing rainfall vs. changed land-use
Climate change rainfall vs changed land-use
This will establish impact of land-use change relative to climate change. Depth increase in flooding is more critical than volumes generated.

Item 2
Will get clues from item 1 and expect to write a short narrative. No analysis of rain tanks sizes expected - just guidance for WDC engineers. Water tanks will be required irrespective of flood minor effect outcome because no Council water infrastructure is located at or near the development site.

Item 3
Short narrative about potential storm water attenuation methods for the ROWs.

Item 4
Check that the ROW / Access road is at or above 100-year level. Steven suggest it is the climate change option. Will draw profiles and check "blockage" of road on flood levels if necessary.
Suggest culvert sizes if necessary either 10-year size if road raising is minimal or 100-year if more pronounced.

Item 5
Potentially OLFP (over land flow paths) past each new house causing flooding. I can use my flood levels as downstream control if necessary.
Will calculate flows to each property and estimate flow depth and provide advice of OLFP channel if necessary.
Agreed.

With regard to items 1 -5 and 7 above please see Golovin report attached.

Item 6
Provide a narrative on the state of the drain with photos and cross-sections: On Wednesday 4 December a meeting was held onsite with Regional Council officers Russell Powell, Steve Edwards & Debra Hayer and WaiDC engineer Malcolm Brown. Steve Edwards noted the western Regional drain was cleaned about 3.5 to 4 years ago and is not due for clearance for another 10 years plus. The attached photos show a deep drain with well vegetated verges

with approximately 30mm of water at base. The average stream cross section is - Vertical 1.6m x Width 1.5m X Base 0.4m .

Item 7

Almost a summary of previous items. Just needs summarising (see Golovin report). I recall an agreement at the meeting that offsite upstream and downstream flood assessment is not required.

Item8

The Regional Council commented that the policy document Land Drainage Management Plan 29 August 2019 seeks to ensure that all lots less than 5ha has adequate connection to a Regional maintained drain with easements in place. This is regional policy only. The applicant prefers not to have any lateral drains over the site and in particular over Lot 10 that contains the Regional drain. Drains would be an anathema to the long term park vision of the site. These drains would severe the site and contain standing water for much of the year. It is highly debatable if drains from each lot to the western drain are indeed necessary since most small lots drain to residual Lot 10. The water then drains to: ground; pond system; or internal drain that eventually makes its way to the western drain via Lot 10. Lot 7 has direct access to the northern boundary Regional drain.

The flood and SW evidence to dates suggests there are no SW / flood effects on adjoining properties and where the ROW is raised above the 100 year flood level. Dwelling platforms are all above the 100 year flood (50% culvert blockage) level and dwellings will be subject to FFL's. Russell was concerned that long term owners of the small allotments may complain that drainage is poor. This can only result from their own earthworks or earthworks within Lot 10 that disrupts overland flows to cause nuisance. The most elegant solution discussed was that Lot 10 be subject to a consent notice. This CN will require Lot 10 to maintain overland flow paths to the regional drain. Should a small lot owner undertake their own on site works that causes themselves a nuisance that is a matter to be resolved by the land owner.

The other issue raised by Russell was the need for an easement over the western drain within Lot 10. However, according to the Regional Land Drainage Management Plan, easements are not required for lots in excess of 5ha. In any case an easement would be pointless given the historical golf course plantings along the boundary, digger access is constrained. Lot 7 northern boundary includes the regional drain. An easement is sought by Russell over Lot 7. Again, the easement is impracticable given the presence of golf course mature trees along the drain edge access, is constrained. Access is available on the adjoining land. No easement is proposed over Lot 7.

Item 9

Healthy Rivers narrative: WRC Plan Change 1 only applies to farming activity. Already addressed in the application where it is stated the site is not returning to a productive farm so that nitrogen loading is no longer an issue; The site will not therefore contain livestock (no requirement to exclude livestock from waterways). Moreover, onsite planting undertaken by the applicant exceeds 70,000 plus trees and shrubs and improved wetlands that will have positive effects on water quality.

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