ROTORUA LAKES COUNCIL
Te kaunihera o ngā roto o Rotorua

SW Catchment 18

Model Development Memo and System Performance Report

Report – October 2018

Contents

1. Introduction

Jeff Booth Consulting Ltd (JBCL) has constructed a Catchment 18 stormwater model that includes manholes, pipes, and an open drain network. Catchment 18 (Figure 1) is on the west side of Lake Rotorua, with the Waiowhiro Stream to the north. A railway line, Koutu drain and Catchment 19 are to the west, with Catchment 17 to the east. The circled stormwater pipes and features were deleted from the Catchment 18 model because they drain to Catchment 19. This report outlines the model build process and the results of the modelling.

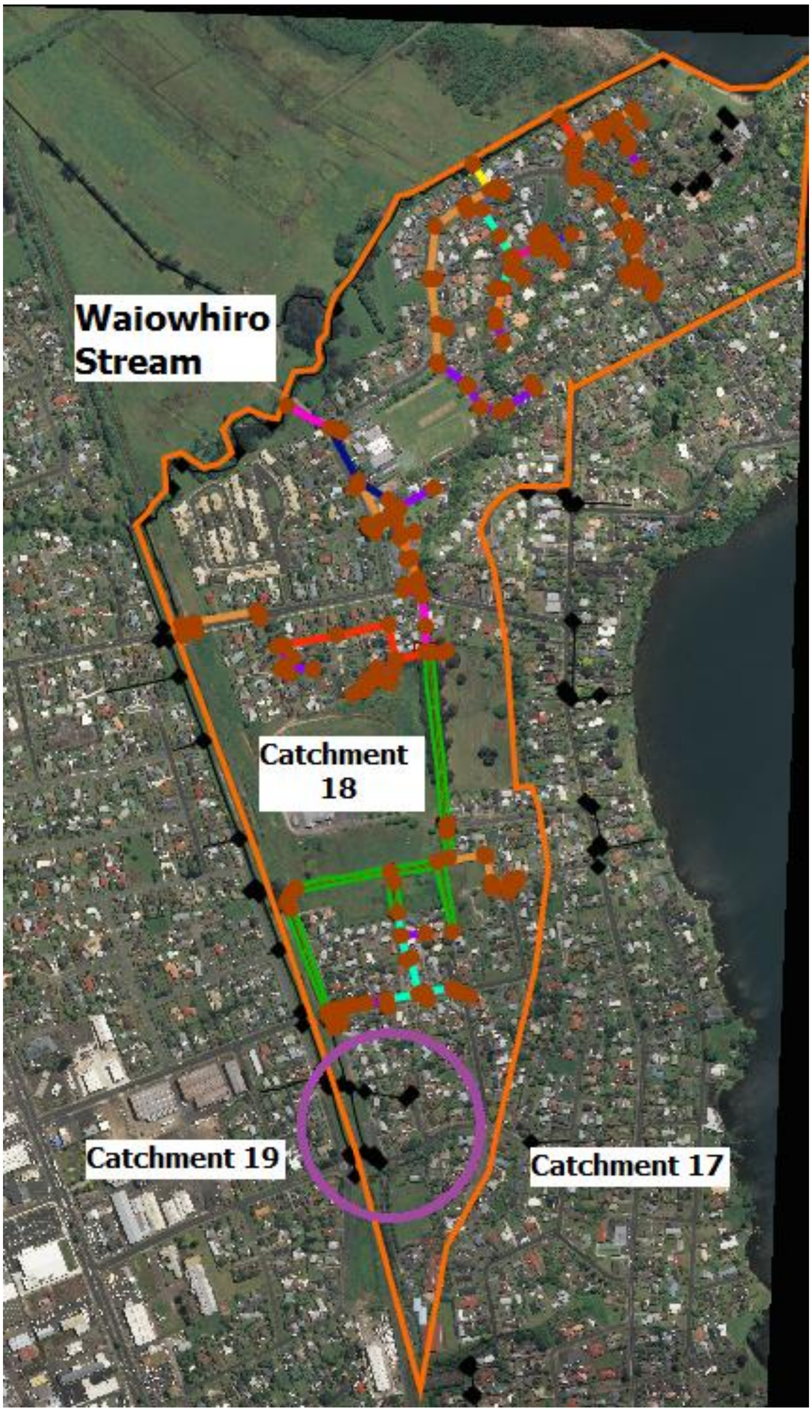


Figure 1: Stormwater Catchment 18 on the west side of Lake Rotorua

Rotorua Lakes Council (RLC) want to use the model to review options for reducing flooding from proposed future residential areas. Priorities for RLC are investigating the effects on the neighbouring properties of the Ian Street developments e.g. current development at 16 Ian Street (red) and future development (yellow) in Figure 2.

Figure 2: Proposed Ian Street developments in Stormwater Catchment 18

2. Catchment Description

Stormwater Catchment 18 is an approximately 80-hectare urban catchment that drains to the Waiowhiro Stream and then Lake Rotorua.

2.1 Stormwater Network Overview

The stormwater network flows from south to north and is a mixture of pipes and open drains that flow into the Waiowhiro Stream in four locations. Other than erosion and vegetation control for the Waiowhiro Stream, the only other noted maintenance area in the catchment is "The open drain system at the back of Bellvue Rd up to Frank St requires regular cleaning" (M Callingham, B Brown and R Rossouw, 2014).

2.2 Site Visits

Marnie Fornusek, Jeff Booth and/or Vicki Koopal undertook site visits on 11 July, 30 July and 31 August 2018. The site visits were regarding queries for specific areas of the stormwater network and to understand the topography of the catchment. Maintenance issues and missing assets were noted and this information was provided to RLC staff.

2.3 Wastewater

Figure 3 shows the location of the stormwater network and wastewater network from the Frank Street/Ian Street area towards the trash screen by Boielle Park. There are several locations where the sewer network is adjacent to stormwater open drains.

Figure 3: Stormwater network (green) and wastewater network (red) in the Frank Street/Ian Street area to trash screen

3. Model Build

Rotorua Lakes Council's GIS database provided the basis for the Stormwater Catchment 18 model. Additional information was obtained (where available) from: as-built drawings, cross section surveys, LiDAR (Light Detection and Ranging), site visits and RLC staff knowledge. When no data was available interpolation, inference rules and engineering judgement were applied.

In InfoWorks ICM, the origin of the model data is identified by a data flag. The Catchment 18 ICM model uses the following data flags:

- #A - Asset data from RLC's GIS system
- #D – System default
- AU – From AULOS model
- GLGM – Ground levels inferred from Ground Model
- CALC – Calculated
- STD – RLC Standards
- SUR – From Surveyed data
- INF – Inferred data
- ASB – From As-built plans
- JBCL – Changes made by Jeff Booth Consulting Ltd
- PRPA – Primary Parcels

Asset Data

3.1.1 Pipes

JBCL imported the piped network data from the Rotorua Lakes Council GIS system into InfoWorks ICM v8.5. All the mainline network was retained including the stormwater leads from inlets. Missing invert values were updated with information from either As-builts, or survey information. If no other information was available, missing inverts were inferred. Service leads were not imported. Figure 4 shows the pipes in the network with a pipe diameter theme. River reaches (green) represent the drains in the catchment.

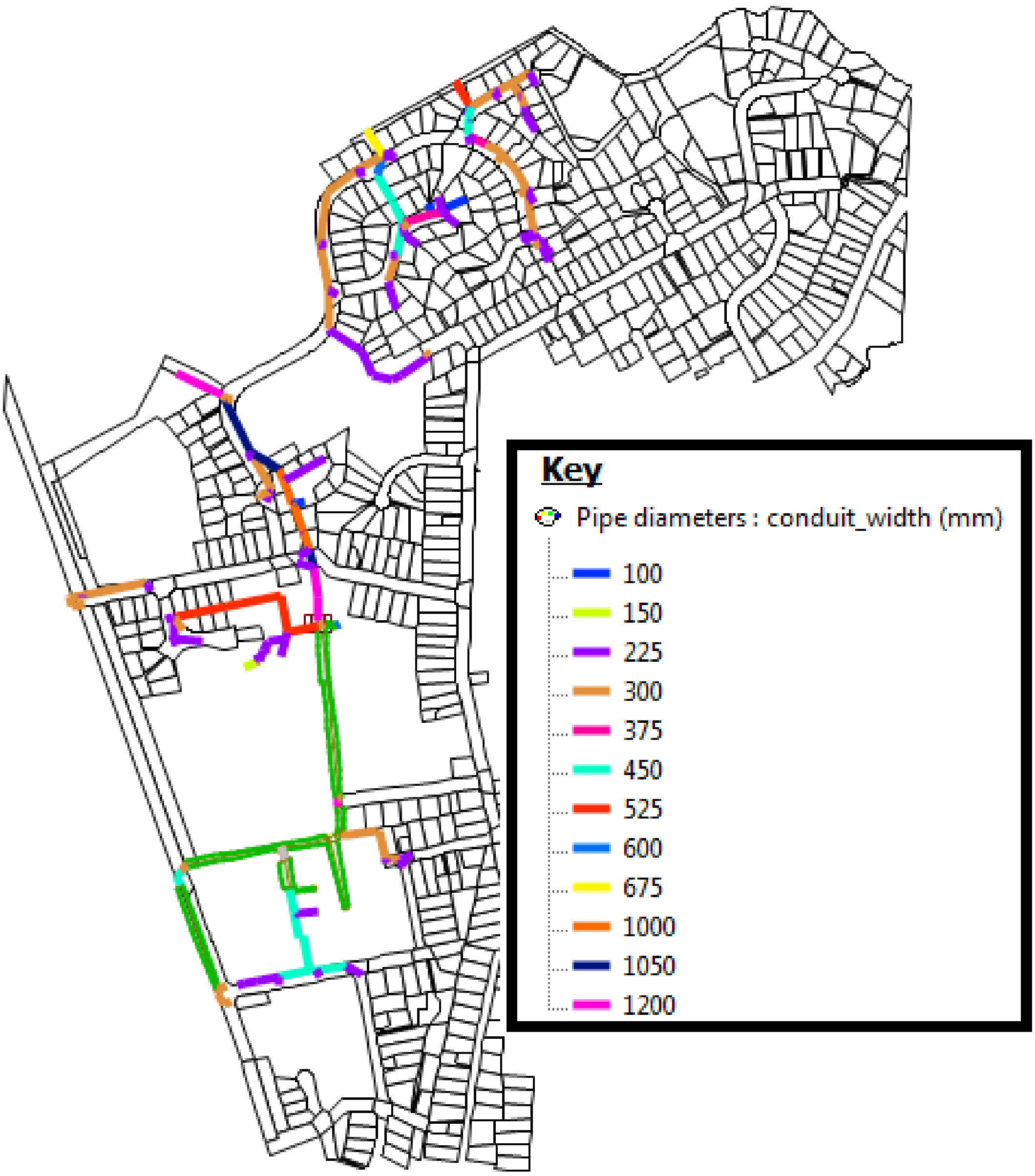


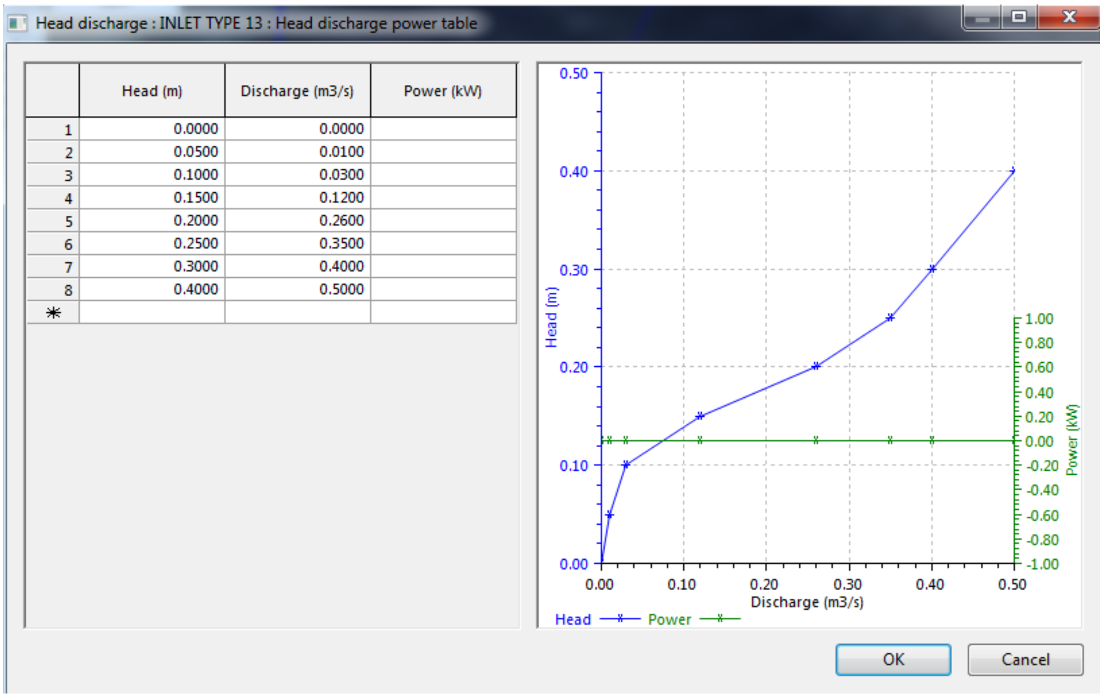
Figure 4: Pipe diameters for Catchment 18

3.1.2 Manholes

For the manholes, InfoWorks ICM imported lid level, depth to the bottom of manhole and location of manhole from the GIS. The default InfoWorks parameters were used to calculate the area of the manhole. The size was calculated based on the size of the pipes entering and exiting the manholes. The minimum manhole area is 1m^3 for a simulation. Any manholes with an area less than 1 m^3 are upsized for the simulation. This default setting was retained to improve the stability of the model.

Inlets were also imported as manholes with a flood type of Inlet 2D. Any missing values for ground levels were inferred from the ground model.

Inlets were set up as Inlet Type 13 (Guo, MacKenzie, & Mommandi, 2009) with a head/discharge as shown in Figure 5. Missing invert levels were inferred based on Rotorua Lakes Council Stormwater standards (Rotorua District Council, 2004).



	Head (m)	Discharge (m3/s)	Power (kW)
1	0.0000	0.0000	
2	0.0500	0.0100	
3	0.1000	0.0300	
4	0.1500	0.1200	
5	0.2000	0.2600	
6	0.2500	0.3500	
7	0.3000	0.4000	
8	0.4000	0.5000	
*			

Figure 5: Head/discharge graph for Inlet Type 13

3.1.3 Open Drains and Streams

The Waiowhiro Stream is not included in the ICM model as the stream is not in an area of interest for flooding. Instead there are three 2D outfalls and 1 outfall to represent the four outfalls into the Waiowhiro Stream. The one non-2D outfall has the boundary condition for the water level.

Catchment 18 has an open drain network that runs along Frank Street to Boielle Park, off Kawaha Point Road. The drains have been represented as 1D river reaches (in green) in Figure 6.

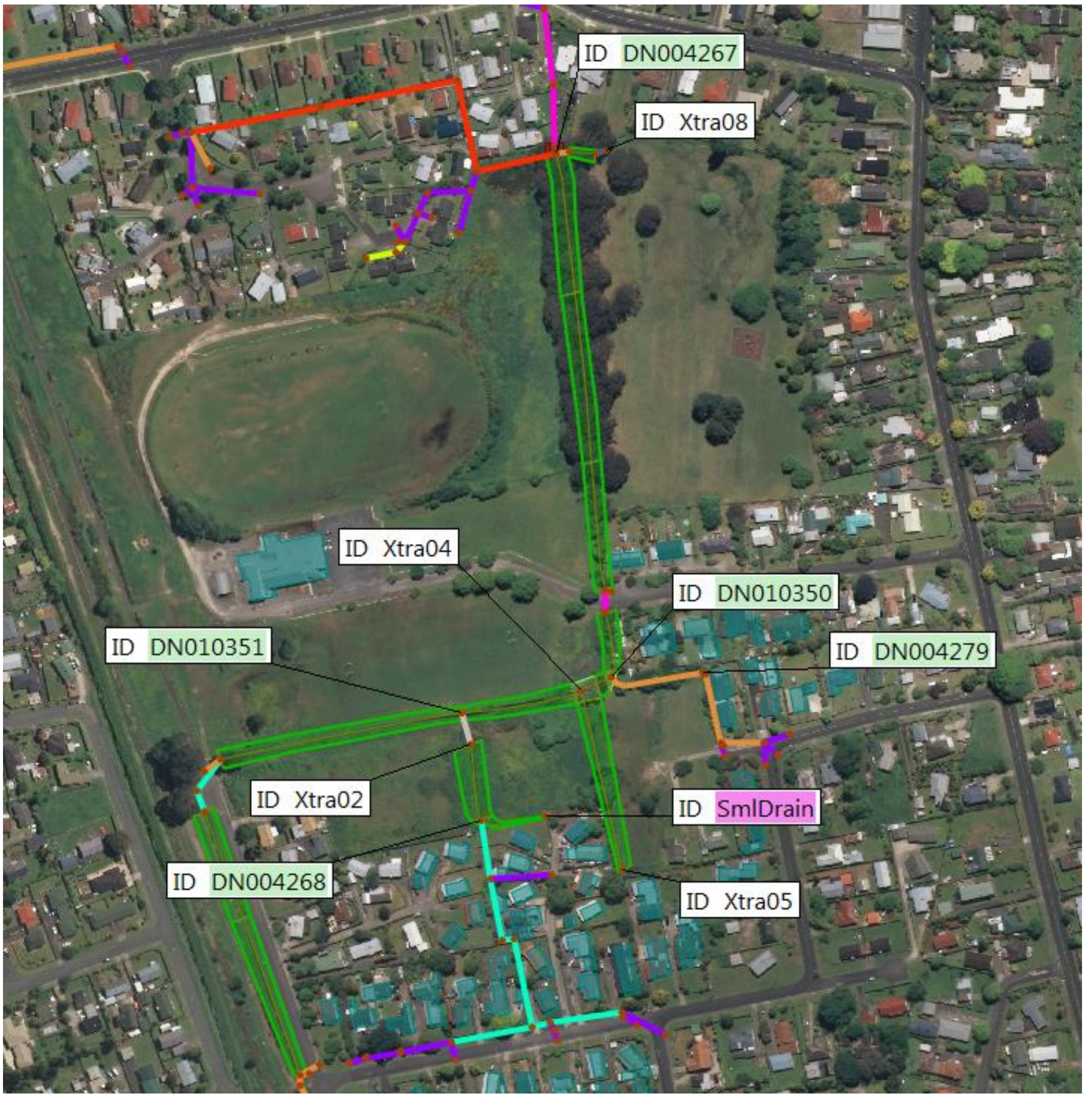


Figure 6: Drains from Frank St to Trash rack at Boielle Park

The locations of the drains were imported from the GIS system. Site visits revealed inconsistencies with the GIS data:

- Drain Xtra05/Xtra04 was added to the model as it was not in the GIS data.
- There are two pipes between Xtra02 and DN010351.
- Xtra02 to DN010351 has had part of the drain replaced as the culverts were not in GIS.
- Two culverts and a drain added between Xtra08 and DN004267.
- The small drain (SmlDrain/ DN004268) was also added using an estimated cross section.

RLC staff have advised that drain DN004279/DN010350 on the Ian Street property is to be replaced with a pipe; This drain has been replaced with a 300mm diameter pipe in the ICM model.

The drain cross sections were surveyed by Stamm Surveys Ltd. Figure 7 shows the drain DN004268/Xtra02 after clearing of blackberry. The survey of this drain is shown as an ICM cross section in Figure 8.

Figure 7: Drain DN004268/Xtra02 after clearing of blackberry

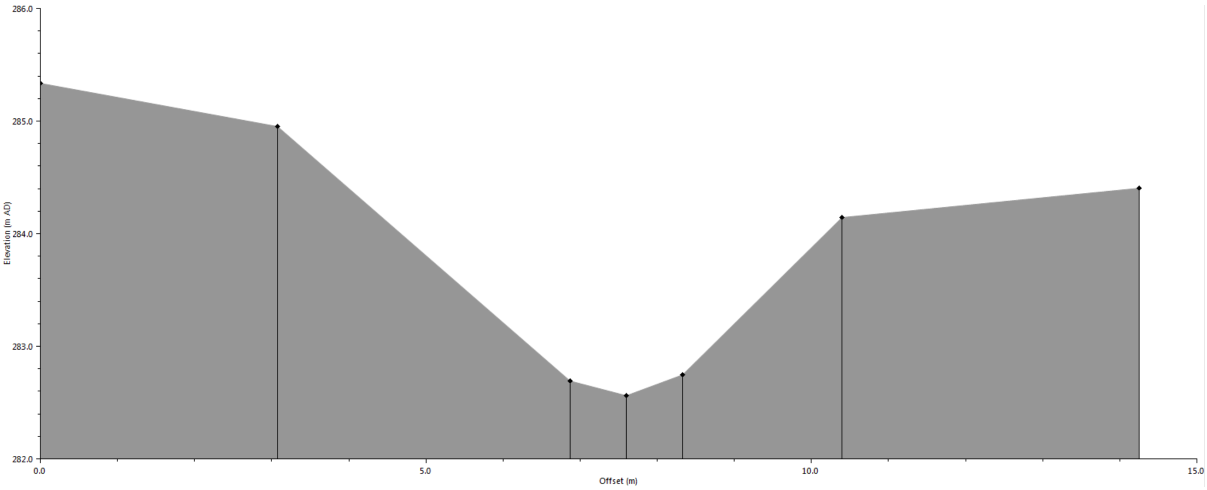


Figure 8: Cross section DN004268/Xtra02

At Boielle Park the drain enters the piped network at the trash screen and 1200mm diameter culvert (Figure 9).

Figure 9: Trash screen for 1200mm culvert from Boielle Park

3.2 Ground Level Data

Rotorua Lakes Council provided ground level data from a 2010 LiDAR survey. LiDAR ground levels were used for missing manhole ground levels, and the ground model for the 2D zones.

3.2.1 2D Zones

The catchment was represented using one 2D zone. The 2D surface in InfoWorks ICM is a triangular irregular mesh. This surface was generated from 2010 LiDAR data. The maximum triangle area is $100m^2$ and the minimum area is $25m^2$. The coordinate system is New Zealand Transverse Mercator and the vertical datum is Moturiki Datum 1953. All level data in the GIS system is recorded in terms of Moturiki Vertical Datum 1953.

Some of the roads that could act as overland flow paths were added to the model as roughness zones. A Manning's roughness value of 0.1 has been applied to the 2D zone and 0.02 to the road roughness zones (Auckland Council, 2015).

The 1D drains (shown in Figure 6 in green) represented inside the 2D surface are connected to the 2D mesh via bank lines. The bank lines allow water to move between the 2D surface and the 1D drain along the length of the river reach. Storage area polygons were created around two nodes (Xtra04 and DN010350) at two drain junctions. The storage areas are represented by voids in the 2D mesh. Voids stop double counting as flow cannot enter voids.

The 2D mesh is connected to the 1D pipe network via manholes or Outfall 2D nodes. For the manholes, the flood type is changed to '2D' or 'Inlet 2D'. The 2D connection uses a weir equation to transfer water between the 1D and 2D surfaces.

3.3 Hydrological Model

In InfoWorks ICM, the hydrological model is defined in the subcatchments.

3.3.1 Subcatchments

The primary parcel layer in the Catchment 18 area was imported to create the initial subcatchments. These subcatchments were then edited/deleted as required. Subcatchments were updated to drain to a node, lateral link (river reach or pipe) or another subcatchment.

3.3.2 Hydrological Model

The three factors that determine the rainfall runoff hydrograph are the:

- Volume model (quantity of runoff entering the system)
- Routing model (how quickly the rainfall enters the system)
- Initial losses (the first amount of rainfall which is lost to depression storage and interception during a rainfall event).

The values used for these three factors for Catchment 18 are shown in Table 1.

Table 1: Runoff surface and subcatchment set up in Catchment 18 model

	Surface 1
Surface type	Impervious
Runoff routing type	Abs
Runoff routing value	0.1
Runoff volume type	CN
Routing model	SCS Unit
Unit hydrograph definition	SCS-User-Tc
Initial loss type	SCS
Initial abstraction factor	0.00

For the Runoff volume type, each of the subcatchments was assigned a Curve Number of either 98 (roads), 61 (residential) or 39 (rural). These numbers have been used with the CN Runoff volume type in previous RLC Stormwater Models. The time of concentration for each subcatchment was calculated as shown in Table 2.

Table 2: Parameters for Time of Concentration calculation

T_c Parameter	**Base**
n (from Table 3.1, (USDA-SCS , 1986)	0.15 short grass prairie
2-year 24-hour rainfall (P_2)	110mm (From HIRD's V3 rainfall in Section 4.1)
Slope (S)	was taken for each subcatchment from the model, as the average gradient at which the subcatchment drains to the node. If slope = zero it was assigned a value = 0.001
Flow length (L)	was taken for each subcatchment from the model as the radius of a circle with area = Contributing Area
T_c	values calculated from the above parameters that were less than 10 mins were replaced by 10 mins. Road subcatchments were assigned Tc = 6 mins.

For the Routing model of SCS Unit, the time of concentration T_c for sheet flow was based on the TR-55. For each subcatchment, the minimum time chosen for road subcatchments was 6 minutes and for residential subcatchments was 10 minutes. Ministry of Business, Innovation and Employment (2016) states an assumption for time of entry as “10 minutes for low density residential areas where the impervious area is 36% to 50% of gross area”.

The Catchment 18 model has one boundary condition; the downstream water level of the Waiowhiro Stream recorded manually at the BOPRC staff gauge in the stream. The level is applied at the outfall using a level event. The BOPRC staff gauge is in the stream close to the culvert outlet. The staff gauge was removed by BOPRC in August 2018.

3.3.3 Calibration

The model has not been calibrated as there is no observed data available for the calibration. The model can be used as a tool to show the effects of changes on runoff and flooding.

3.3.4 Design Storms

JBCL generated the designs storms using Chicago Storm Profiles and HIRDS rainfall data at a point in Catchment 18. The location is in the Ian Street area at:

- Easting 1883672, Northing 5776455 (NZTM2000).

3.4 Summary of Modelled Objects

The objects included in the model are as follows:

- Nodes
  - Manholes 181 (95 with Flood Type = Inlet2D, 86 with Flood Type = 2D)
  - Break 15
  - Outfall 1 (Waiowhiro Stream)
  - Outfall 2D 3 (Waiowhiro Stream)
- Links
  - Pipes 4162 m
  - River reaches 926 m
- Subcatchments 464
- Polygons
  - 2D zones 1
  - Roughness zones 1
  - Storage areas (Voids) 2
- Lines
  - Bank lines 22

4 Design Runs

JBCL used Chicago Storm Profiles and local rainfall depths from HIRDS V3 to create the design storms. The rainfall includes an allowance for climate change to 2090.

4.1 Rainfall

Design rainfall events have been constructed for the 10% Annual Exceedence Probability (AEP), 2% AEP and 1% AEP storm events. 24-hour Chicago Storm Profiles were created from HIRDS V3 rainfall depths for a point in Catchment 18. The design storms include climate change to 2090 with a 2.1 degree temperature increase.

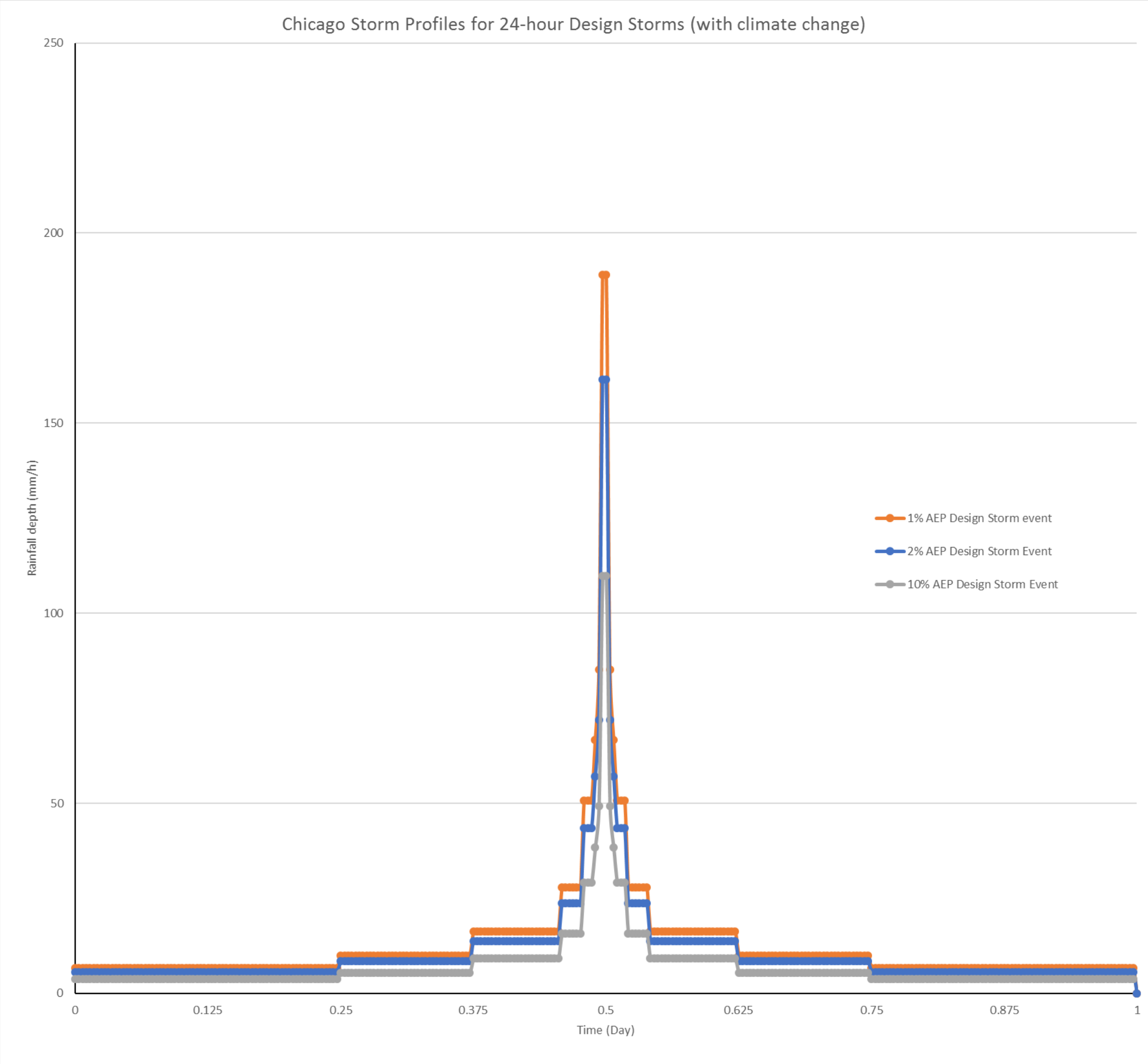


Figure 10: 24-hour Design Storms (with climate change) for Catchment 18

4.2 Level at culvert outfall

The value chosen for the level of the stream was 281.625m (MVD1953) which was the maximum recorded value in BOPRC's Waiowhiro Stream data. BOPRC's data is from spot manual gauge recordings and continuous flow and level data that was recorded between 1992-1995.

5 Results

5.1 Sensibility Checks

The flooding is occurring in low areas of the ground model such as the Frank Street area and Boielle Park. There are no measurements of flooding depths available for rainfall events in this catchment. The only report of flooding in the Catchment 18 is the flooding around the Waikite Rugby Club (Figure 11). This is shown on the flood maps as localised flooding (Figure 15 - Figure 17).

Figure 11: Rotorua Daily Post photo - Flooding at Waikite Rugby Club April 2018

5.2 Flood maps

Flood maps for the Frank Street/Ian Street area are shown in Figure 12 (10% AEP event), Figure 13 (2% AEP event) and Figure 14 (1% AEP event). There is an increase in extent and depth with the increase in rainfall.

Figure 12: Frank Street/Ian Street during 10% AEP event

Figure 13: Frank Street/Ian Street area during 2% AEP event

Figure 14: Frank Street/Ian Street area during 1% AEP event

Flood maps for Boielle Park are shown in Figure 15 (10% AEP event), Figure 16 (2% AEP event) and Figure 17 (1% AEP event). There is an increase in extent and depth with the increase in rainfall.

Figure 15: Boielle Park 10% AEP event

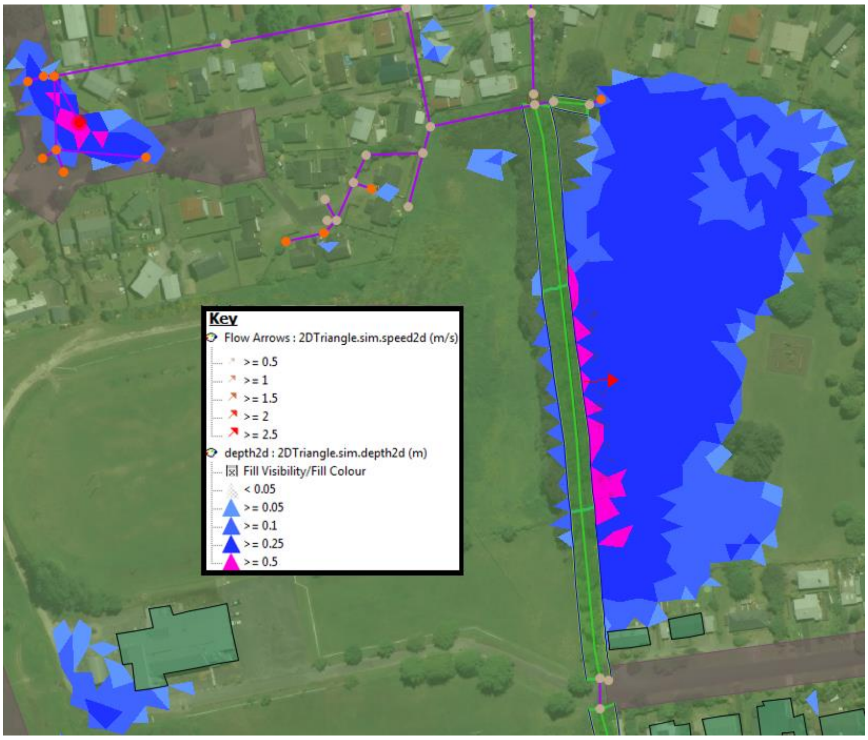


Figure 16: Boielle Park 2% AEP event

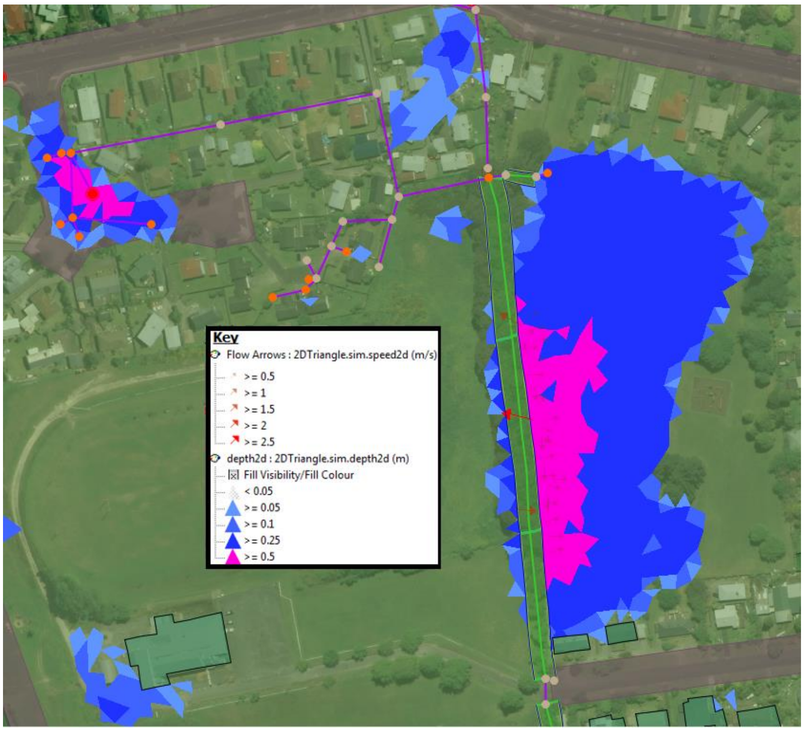


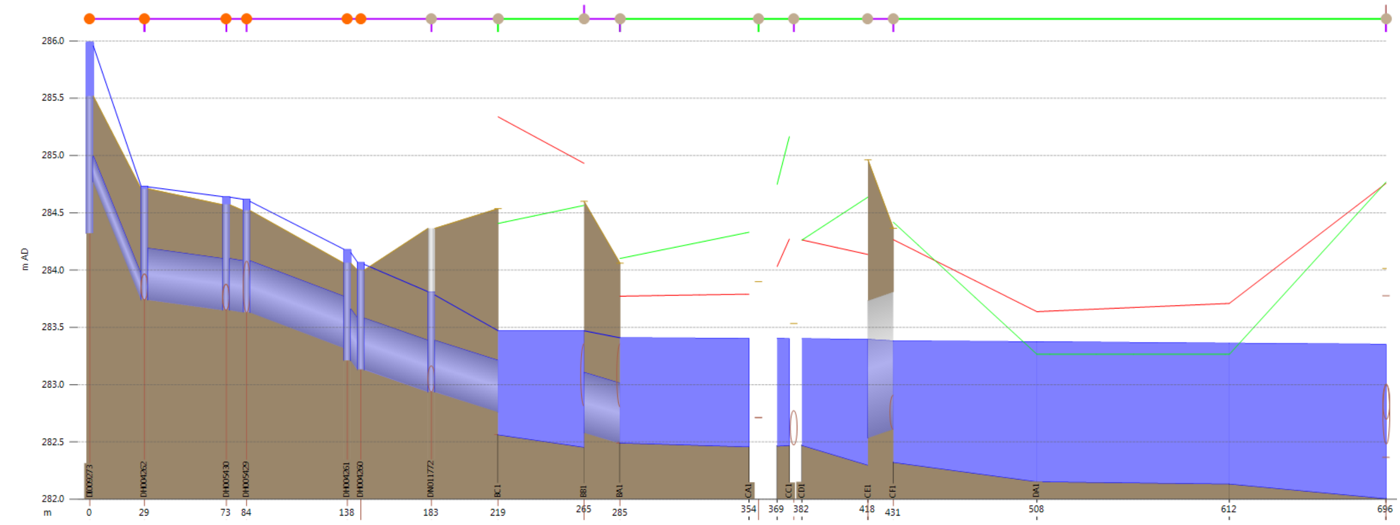
Figure 17: Boielle Park 1% AEP event

5.3 Flows and long sections

The plan view of the long section from Frank Street (DI009273) to the trash screen (DN004267) at the end of the drain is shown in Figure 18.

Figure 18: Plan view of long section DI009273 to DN004267

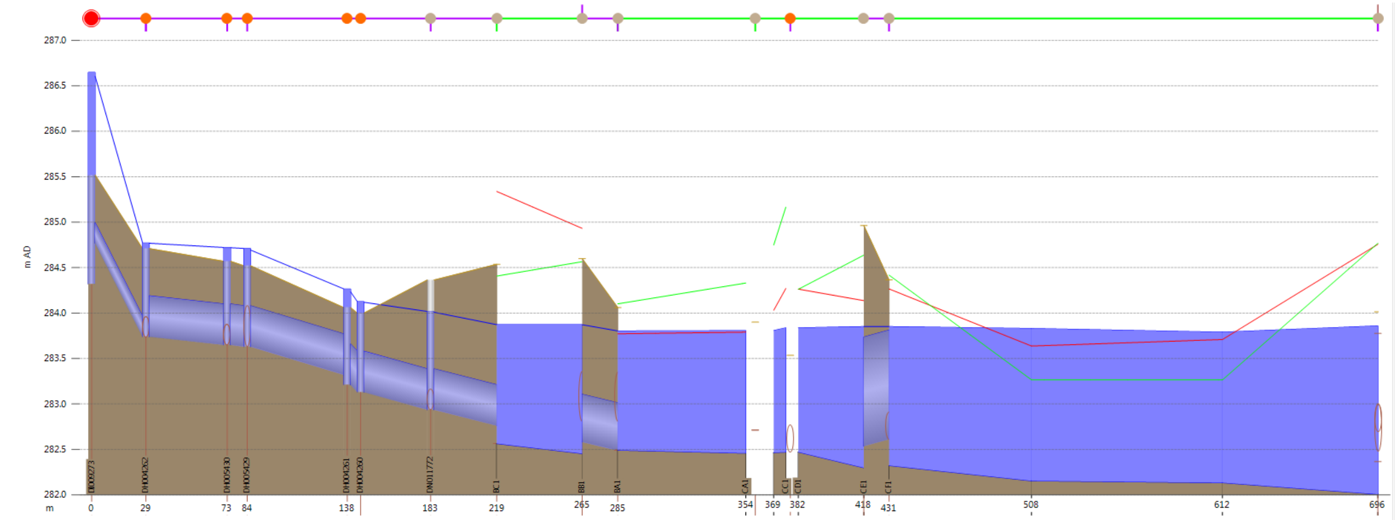
The peak flows and peak water levels for this long section during the three rainfall events are shown in Figure 19 (10% AEP event), Figure 20 (2% AEP event) and Figure 21 (1% AEP event). The red (left hand side) and green (right hand side) are the banks of the drain when looking downstream.



Link	DI009273.1	DH004262.1	-	DH005429.1	-	DH004260.1	DN011772.1	DN004268.1	-	DN010351.1	-	DN010350.1	-	DN004265.1
width (mm)	225	450	450	450	-	450	450		525				1200	
us inv (m AD)	284.769	283.740	-	283.630	-	283.130	282.936	282.564	282.581	282.492	-	282.471	-	282.323
ds inv (m AD)	283.740	283.650	-	283.320	-	282.936	282.761	282.455	282.487	282.459	-	282.298	-	282.007
US flow (m3/s)	0.09182	0.13418	-	0.26033	-	0.27188	0.31725	0.51830	0.24743	0.81517	-	1.02958	-	1.10059
DS flow (m3/s)	0.09182	0.13413	-	0.26038	-	0.27183	0.31714	0.52564	0.24743	0.81561	-	1.06604	-	1.27712

Node	-	DH004262	-	DH005429	DH004261	-	DN011772	DN004268	Xtra02	DN010351	Xtra04	-	-	DN004265	DN004267
ground (m AD)	-	284.710	284.570	284.520	284.060	-	284.364	284.537	284.600	284.060	283.900	283.534	284.962	284.365	284.014
level (m AD)	-	284.731	284.640	284.618	284.179	-	283.810	283.471	283.471	283.409	283.404	283.401	283.394	283.382	283.352

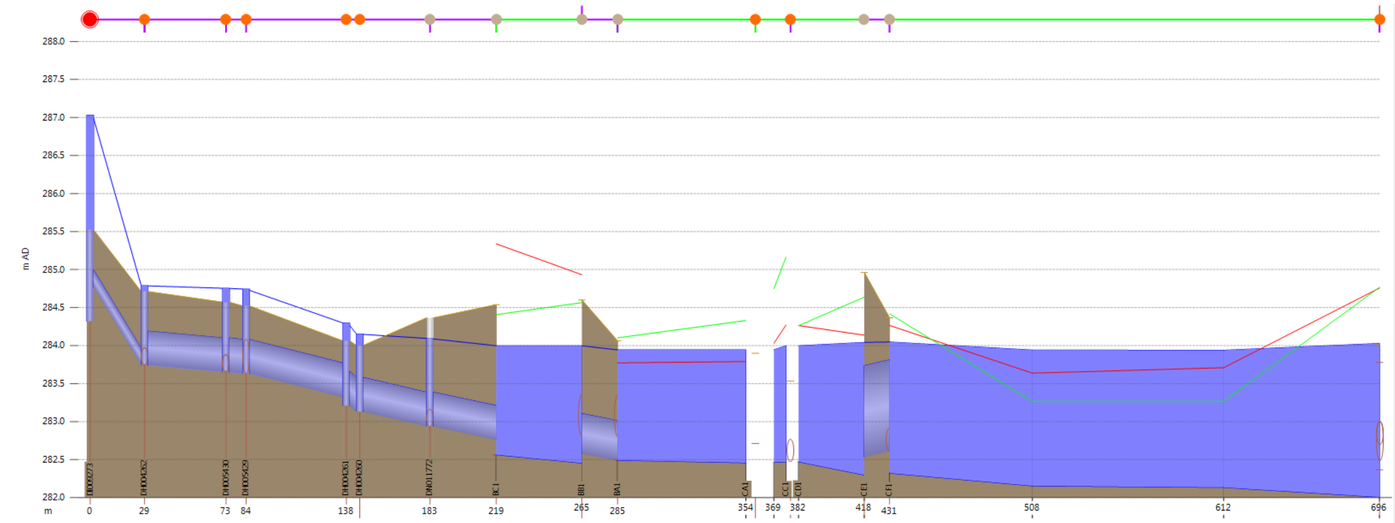
Figure 19: Long section from Frank Street to trash screen in 10% AEP rainfall event



Link	DI009273.1	DH004262.1	-	DH005429.1	-	DH004260.1	DN011772.1	DN004268.1	-	DN010351.1	-	DN010350.1	-	DN004265.1
width (mm)	225	450	450	450	-	450	450		525				1200	
us inv (m AD)	284.769	283.740	-	283.630	-	283.130	282.936	282.564	282.581	282.492	-	282.471	-	282.323
ds inv (m AD)	283.740	283.650	-	283.320	-	282.936	282.761	282.455	282.487	282.459	-	282.298	-	282.007
US flow (m3/s)	0.11274	0.13090	-	0.26284	-	0.26798	0.31062	0.84586	0.39878	1.36460	-	2.01603	-	2.88589
DS flow (m3/s)	0.11274	0.13087	-	0.26277	-	0.26741	0.31041	0.84747	0.39878	1.42464	-	2.13682	-	2.00226

Node	-	DH004262	-	DH005429	DH004261	-	DN011772	DN004268	Xtra02	DN010351	Xtra04	-	-	DN004265	DN004267
ground (m AD)	-	284.710	284.570	284.520	284.060	-	284.364	284.537	284.600	284.060	283.900	283.534	284.962	284.365	284.014
level (m AD)	-	284.771	284.721	284.710	284.263	-	284.018	283.872	283.872	283.803	283.808	283.838	283.852	283.851	283.859

Figure 20: Long section from Frank Street to trash screen in 2% AEP rainfall event

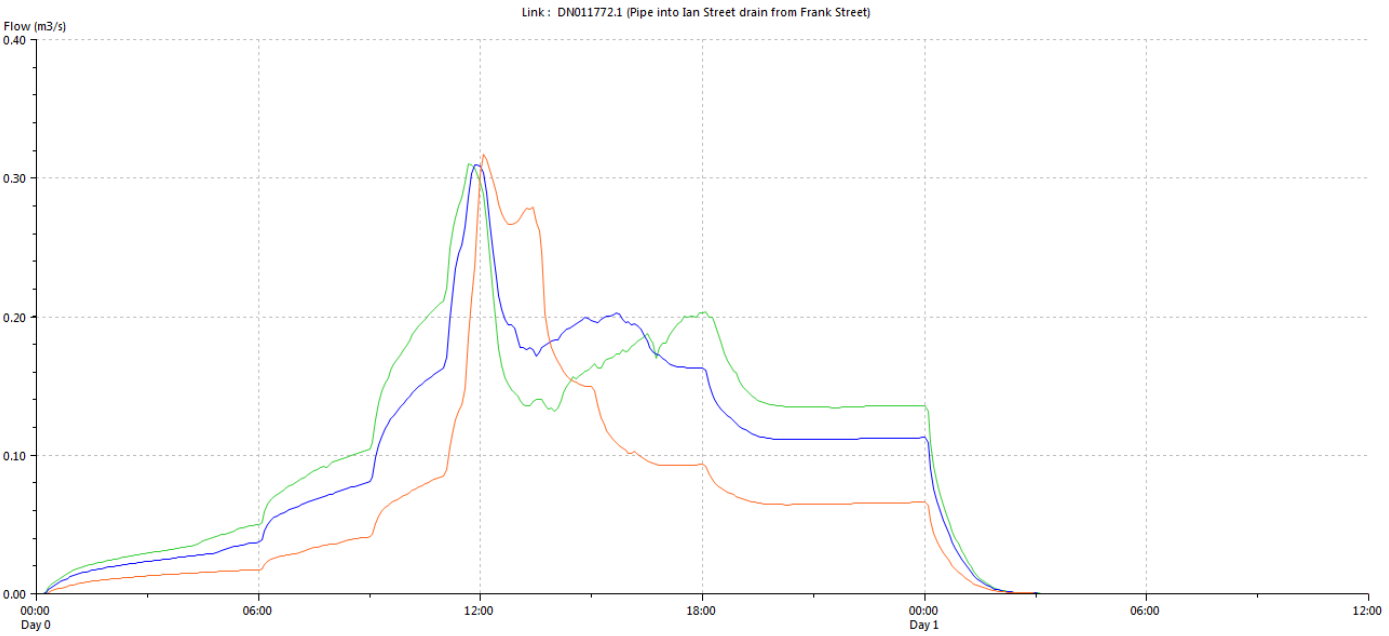


Link	DI009273.1	DH004262.1	-	DH005429.1	-	DH004260.1	DN011772.1	DN004268.1	-	DN010351.1	-	DN010350.1	-	DN004265.1
width (mm)	225	450	450	450	-	450	450		525				1200	
us inv (m AD)	284.769	283.740	-	283.630	-	283.130	282.936	282.564	282.581	282.492	-	282.471	-	282.323
ds inv (m AD)	283.740	283.650	-	283.320	-	282.936	282.761	282.455	282.487	282.459	-	282.298	-	282.007
US flow (m3/s)	0.12363	0.12957	-	0.26337	-	0.26705	0.31068	0.98240	0.46251	1.63584	-	2.63173	-	3.52129
DS flow (m3/s)	0.12363	0.12955	-	0.26331	-	0.26653	0.31043	0.98130	0.46250	2.03044	-	2.86831	-	2.14185

Node	-	DH004262	-	DH005429	DH004261	-	DN011772	DN004268	Xtra02	DN010351	Xtra04	-	-	DN004265	DN004267
ground (m AD)	-	284.710	284.570	284.520	284.060	-	284.364	284.537	284.600	284.060	283.900	283.534	284.962	284.365	284.014
level (m AD)	-	284.787	284.754	284.744	284.295	-	284.094	283.998	283.998	283.943	283.944	283.998	284.042	284.047	284.028

Figure 21: Long section from Frank Street to trash screen in 1% AEP rainfall event

The flows in the pipe into the Ian Street drain are shown for the three rainfall events.



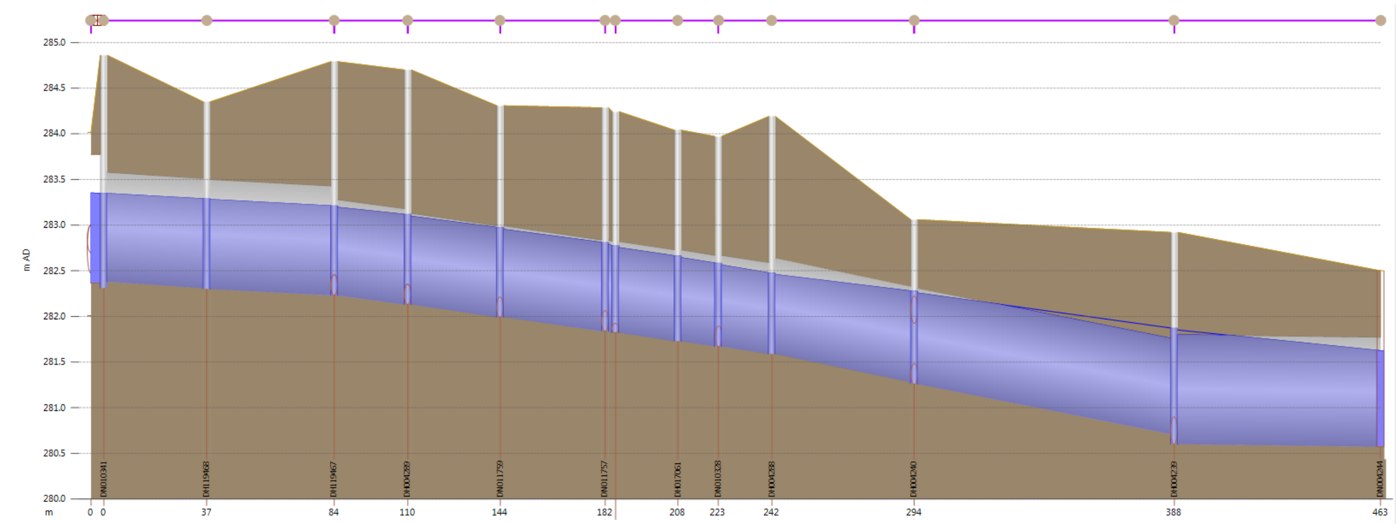
	Flow Min	Flow Max
1% AEP rainfall event	0.000	0.310
2% AEP rainfall event	0.000	0.310
10% AEP rainfall event	0.000	0.317

Figure 22: Flows in the pipe upstream of the Ian Street drain DN011772.1

The plan view of the long section from the trash screen (DN004267) to the outfall to the stream (DN004244) is shown in Figure 23.

Figure 23: Plan view of the long section from trash screen (DN004267) to the outfall to the stream (DN004244)

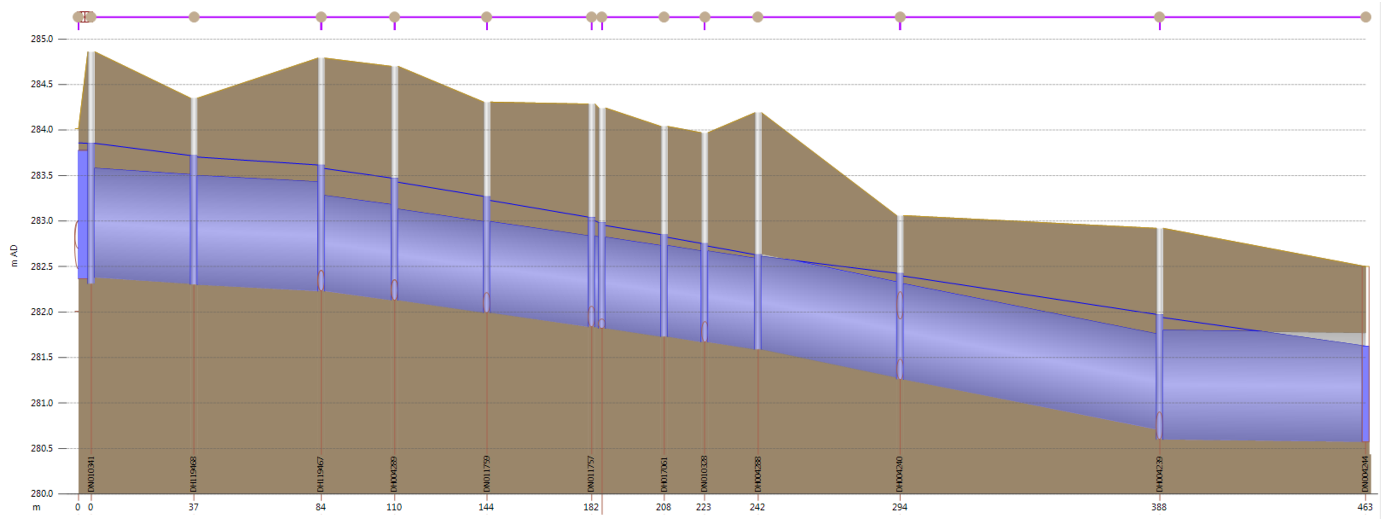
The peak flows and peak water levels for this long section during the three rainfall events are shown in Figure 24 (10% AEP event), Figure 25 (2% AEP event) and Figure 26 (1% AEP event). The flows for the outfall pipe are shown in Figure 27.



Link	-	DN010341.2	DH119468.1	DH119467.1	DH004289.1	DN011759.1	-	DN010337.1	-	-	DH004288.1	DH004240.1	DH004239.1
width (mm)		1200	1200	1050	1000	1000	-	1000	1000	1000	1050	1050	1200
us inv (m AD)		282.380	282.300	282.230	282.130	281.993	-	281.822	281.729	281.670	281.590	281.260	280.600
ds inv (m AD)		282.310	282.230	282.130	281.993	281.837	-	281.729	281.670	281.590	281.280	280.710	280.573
US flow (m3/s)	-	1.46772	1.46001	1.55056	1.55112	1.57450	-	1.59998	1.60226	1.63985	1.64042	1.76404	2.00924
DS flow (m3/s)	-	1.45994	1.46030	1.54943	1.55109	1.57426	-	1.59993	1.60229	1.64032	1.64809	1.76027	2.02021

Node	DN010341	DH119468	DH119467	DH004289	DN011759	DN011757	-	-	-	DH004288	DH004240	DH004239	DN004244
ground (m AD)	284.860	284.350	284.790	284.700	284.307	284.286	-	284.040	283.971	284.190	283.060	282.920	282.500
level (m AD)	283.347	283.289	283.211	283.117	282.973	282.809	-	282.663	282.584	282.476	282.277	281.871	281.625

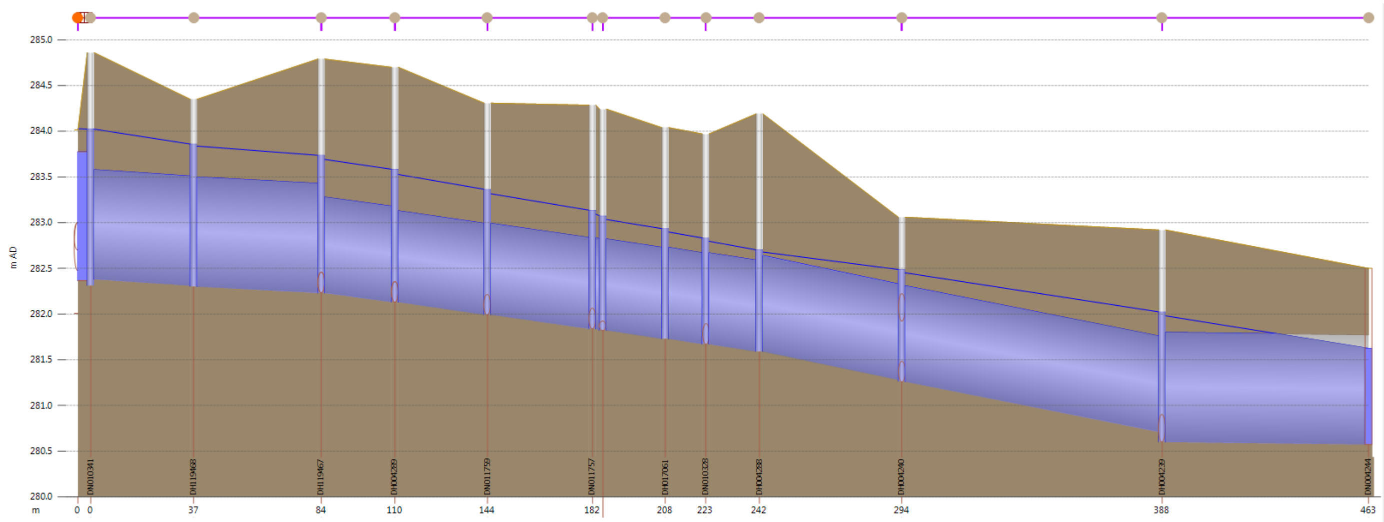
Figure 24: Long section from trash screen to outfall in 10% AEP rainfall event



Link	-	DN010341.2	DH119468.1	DH119467.1	DH004289.1	DN011759.1	-	DN010337.1	-	-	DH004288.1	DH004240.1	DH004239.1
width (mm)		1200	1200	1050	1000	1000	-	1000	1000	1000	1050	1050	1200
us inv (m AD)		282.380	282.300	282.230	282.130	281.993	-	281.822	281.729	281.670	281.590	281.260	280.600
ds inv (m AD)		282.310	282.230	282.130	281.993	281.837	-	281.729	281.670	281.590	281.280	280.710	280.573
US flow (m3/s)	-	1.72903	1.70361	1.71910	1.71605	1.72534	-	1.73279	1.73314	1.75725	1.75611	1.84927	2.32321
DS flow (m3/s)	-	1.70884	1.67800	1.71846	1.71513	1.72117	-	1.73132	1.73220	1.75618	1.76697	1.84451	2.33832

Node	DN010341	DH119468	DH119467	DH004289	DN011759	DN011757	-	-	-	DH004288	DH004240	DH004239	DN004244
ground (m AD)	284.860	284.350	284.790	284.700	284.307	284.286	-	284.040	283.971	284.190	283.060	282.920	282.500
level (m AD)	283.854	283.719	283.615	283.470	283.268	283.040	-	282.848	282.752	282.629	282.424	281.970	281.625

Figure 25 : Long section from trash screen to outfall in 2% AEP rainfall event



Link	-	DN010341.2	DH119468.1	DH119467.1	DH004289.1	DN011759.1	-	DN010337.1	-	-	DH004288.1	DH004240.1	DH004239.1
width (mm)		1200	1200	1050	1000	1000	-	1000	1000	1000	1050	1050	1200
us inv (m AD)		282.380	282.300	282.230	282.130	281.993	-	281.822	281.729	281.670	281.590	281.260	280.600
ds inv (m AD)		282.310	282.230	282.130	281.993	281.837	-	281.729	281.670	281.590	281.280	280.710	280.573
US flow (m3/s)	-	1.72812	1.69204	1.73417	1.73130	1.74274	-	1.75543	1.75548	1.77411	1.77346	1.86566	2.47639
DS flow (m3/s)	-	1.71468	1.68535	1.73340	1.73060	1.74231	-	1.75417	1.75466	1.77358	1.79119	1.86744	2.49519

Node	DN010341	DH119468	DH119467	DH004289	DN011759	DN011757	-	-	-	DH004288	DH004240	DH004239	DN004244
ground (m AD)	284.860	284.350	284.790	284.700	284.307	284.286	-	284.040	283.971	284.190	283.060	282.920	282.500
level (m AD)	284.024	283.858	283.735	283.581	283.361	283.132	-	282.931	282.830	282.700	282.485	282.020	281.625

Figure 26: Long section from trash screen to outfall in 1% AEP rainfall event

Flows for the outfall pipe are shown in Figure 27.

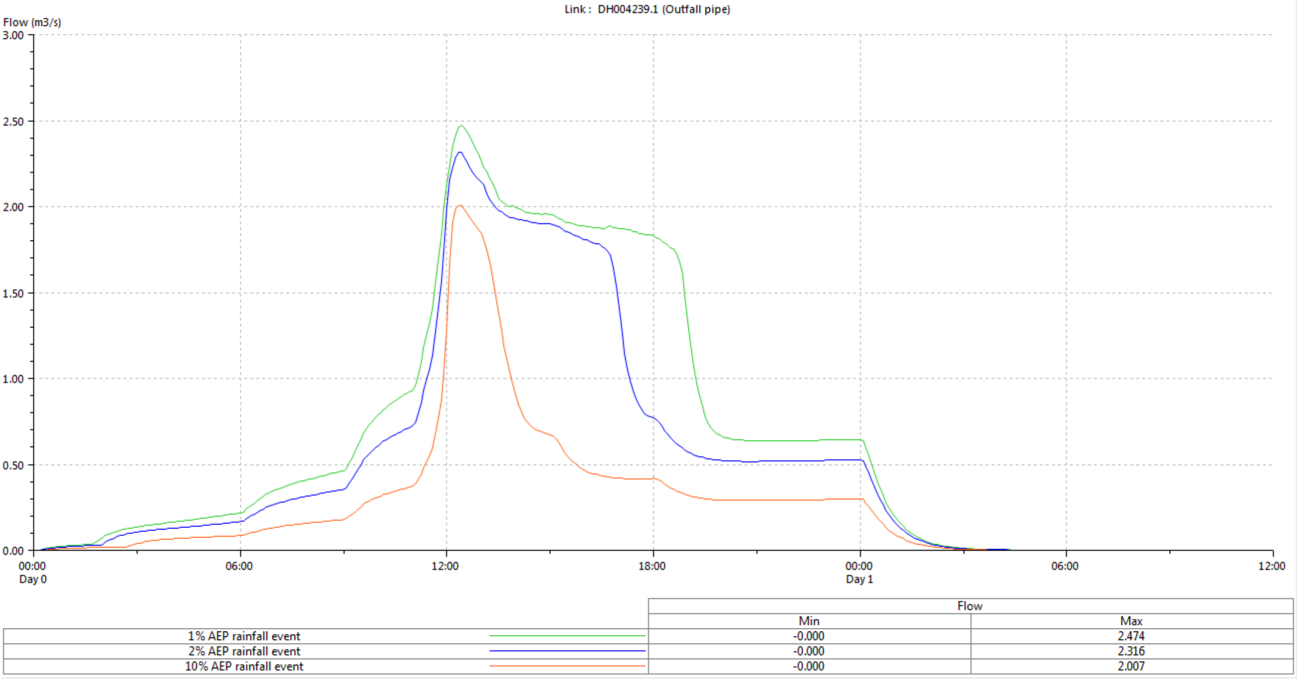


Figure 27: Flows in the outfall pipe DH004239.1

5.4 Mass Balance Checks

InfoWorks ICM has two built in checks for mass balance issues:

- A volume balance is carried out on all nodes in the model for each simulation. This can be checked in the results to ensure no calculation errors are occurring at the manholes.
  - The volume balance errors in the runs to date are negligible.
- Log results shows volume balance errors when water moves between the 1D and 2D network.
  - The volume balance errors in the runs to date are negligible.

5.5 Sensitivity Analysis

For sensitivity analysis purposes one scenario was run with a different n value for the time of concentration calculation. In this scenario, the time of concentration was calculated for each subcatchment using the parameters in Table 3.

Table 3: Parameters used for each subcatchment's Time of Concentration calculation

T_c Parameter	**Base n=0.15**	**Scenario n=0.24**
n (from Table 3.1, (USDA-SCS , 1986)	0.15 short grass prairie	n = 0.24 dense grass
2-year 24-hour rainfall (P_2)	110mm (From HIRD's V3 rainfall in Section 4.1)	
Slope (S)	was taken for each subcatchment from the model, as the average gradient at which the subcatchment drains to the node. If slope = zero it was assigned a value = 0.001	
Flow length (L)	was taken for each subcatchment from the model as the radius of a circle with area = Contributing Area	
T_c	Any values calculated from the above parameters for residential subcatchments that were less than 10 mins were replaced by 10 mins (Ministry of Business, Innovation and Employment, 2016). Road subcatchments were assigned Tc = 6 mins.	

The results of the sensitivity analysis for the Outfall pipe (DH004239.1) are shown in Figure 28 (10% AEP event), Figure 29 (2% AEP event) and Figure 30 (1% AEP event). The run with the time of concentration calculated using n= 0.15 has the greater peak value for all three AEP events.

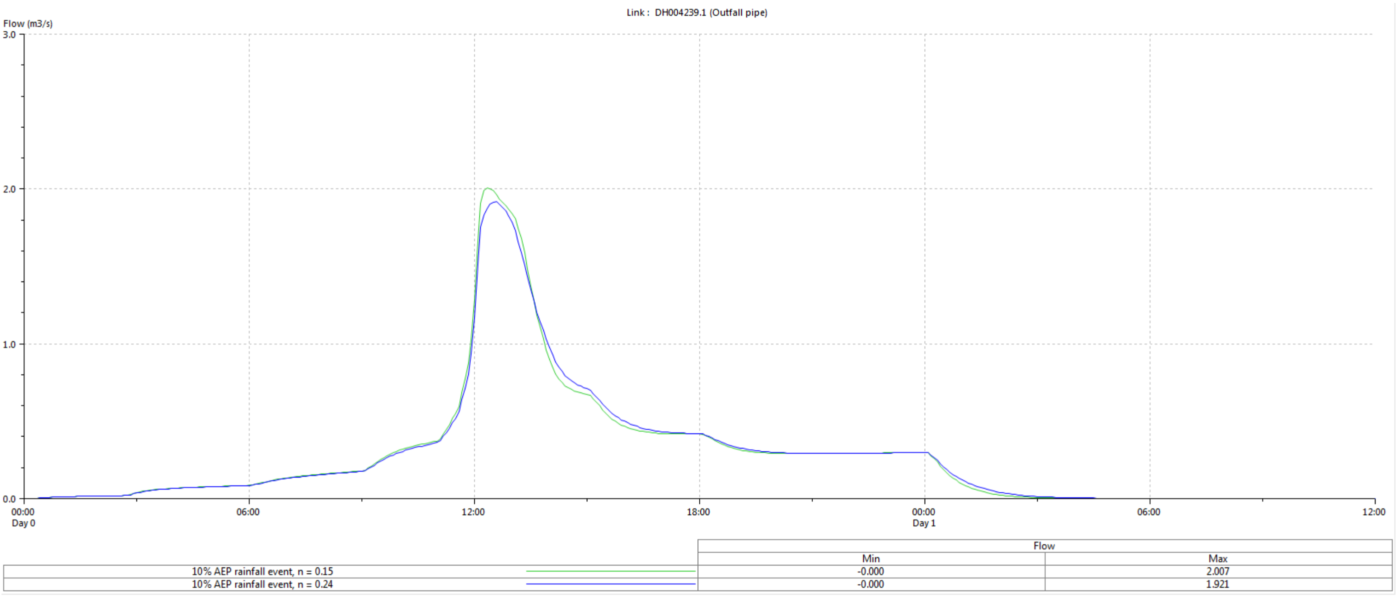


Figure 28: Sensitivity analysis for 10% AEP event

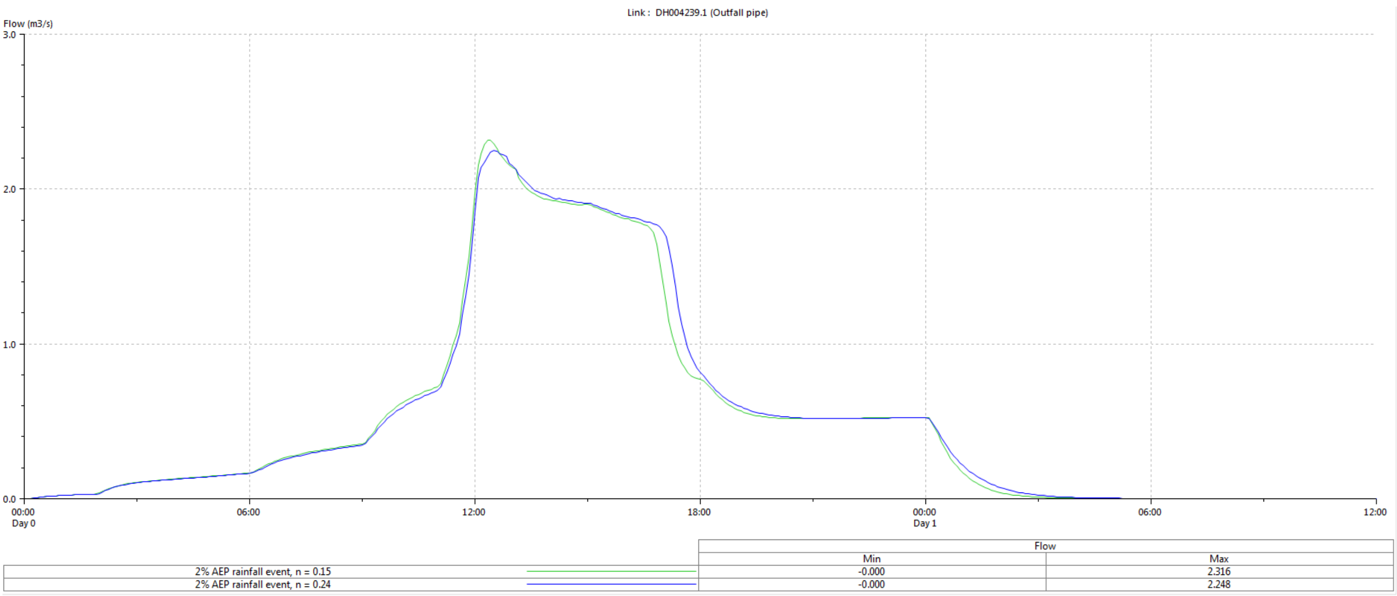


Figure 29: Sensitivity analysis for 2% AEP event

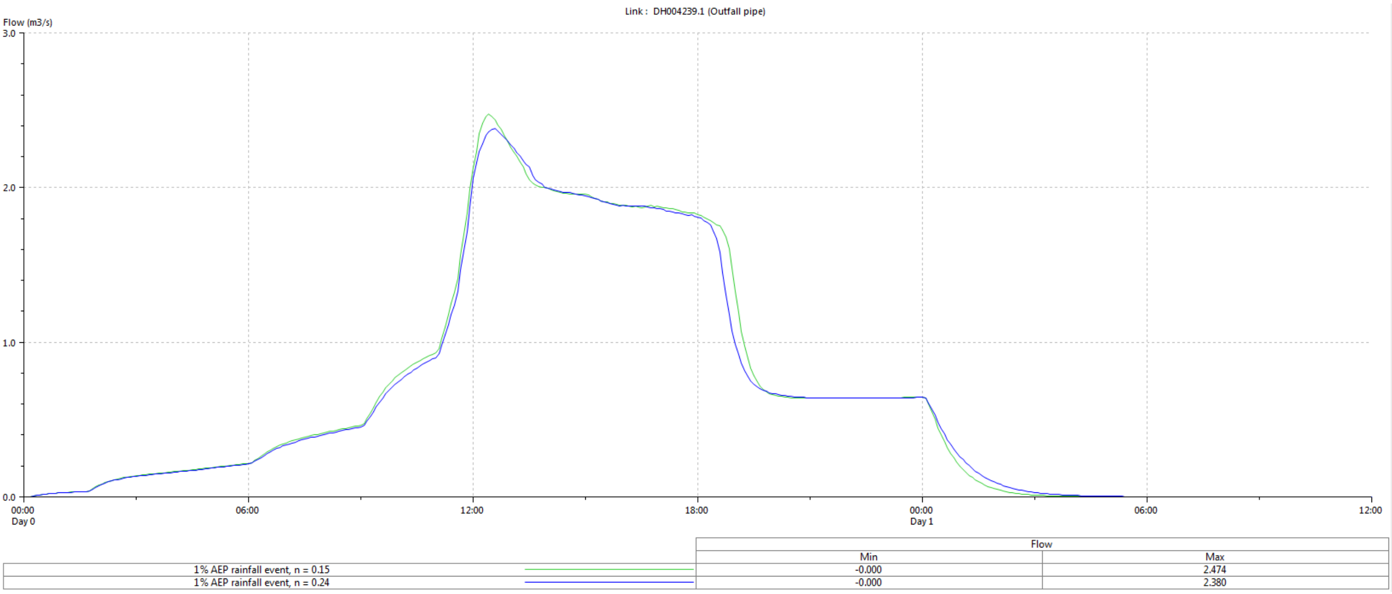


Figure 30: Sensitivity analysis for 1% AEP event

6 Conclusions

- The model is not calibrated due to the lack of observed data.
- The base manhole and pipe data used for the model is considered reasonably reliable. Missing assets were noted and provided to RLC staff.
- RLC staff were advised of any maintenance issues noted during site visits.

7 Recommendations

- The model is used as a tool to determine the effects of changes on runoff and flooding.
- The GIS system is updated with missing assets and all surveyed data provided to RLC staff.
- The stormwater drains are regularly maintained to ensure capacity is available in the drains.

References

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