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DFH JOINT VENTURE

Stormwater Management Report for Proposed Residential Subdivision at Graham Block, Pokeno

DOCUMENT CONTROL RECORD

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1. Executive Summary

This report details the stormwater management for a proposed development at Graham Block and for further intensification of the proposed development on the Pokeno Village Holdings land to the north and east.

The catchment drains to the east via two streams which discharge to the existing stormwater pipe network.

Extended detention for the development will be provided on-lot and in a proposed reserve on the development site.

Treatment will be provided by the existing Pond J downstream of the catchment as well as forebays to provide pre-treatment of runoff to the streams on the site.

Flooding and overland flow in the 100 year storm event will be confined to the site, within roads and the gully reserve.

Minimum floor levels are proposed to protect houses on low-lying lots in extreme storm events.

Climate change has been allowed for in all analyses.

2. Introduction

2.1 Purpose of the Report

This report details the stormwater management for a proposed development at Graham Block, in Pokeno, which is located at the end of Hitchen Road, and for further intensification of the proposed development on the Pokeno Village Holdings land to the north and east.

There is an existing structure plan covering residential development on Graham Block to the west of Hitchen Road, and large lot residential subdivision on the Pokeno Village Holdings land to the north and east of Graham Block. This report is to support a proposed structure plan to allow intensification of the area currently designated as large lot residential (from approximately 70 proposed lots to 110), and to provide approximately 85 additional residential lots on Graham Block to the east of Hitchen Road, with the remainder of the block remaining as large lot rural or reserve.

2.2 Limitations

This report has been prepared for DFH Joint Venture to support the proposed structure plan covering development of this site.

3. Documents Referenced

The following documents and standards have been referenced to complete the stormwater design:

- Pokeno Stormwater Catchment Management Plan (CMP) – Report and Drawings – Franklin District Council, September 2010.
- Hamilton City Council Infrastructure Technical Specifications . Section 4 – Drainage (ITS).
- Auckland Regional Council TP108 – Guidelines for Storm Water Runoff Modelling in the Auckland Region.
- Auckland Regional Council TP10 – Stormwater Management Devices: Design Guidelines Manual.
- Proposed Stormwater Discharge at Pokeno – Resource Consent Application and Assessment of Effects on the Environment – Harrison Grierson, February 2010.

4. Existing Catchment

4.1 Location

The site is located to the east of Pokeno Road and the North Island Main Trunk Line, being approximately 37ha in size. The site is within the Tanitewhiora Stream catchment, which has a total catchment area of 1,270 ha. Refer to Figures 1 and 2.

Figure 1 – Proposed Development Site.

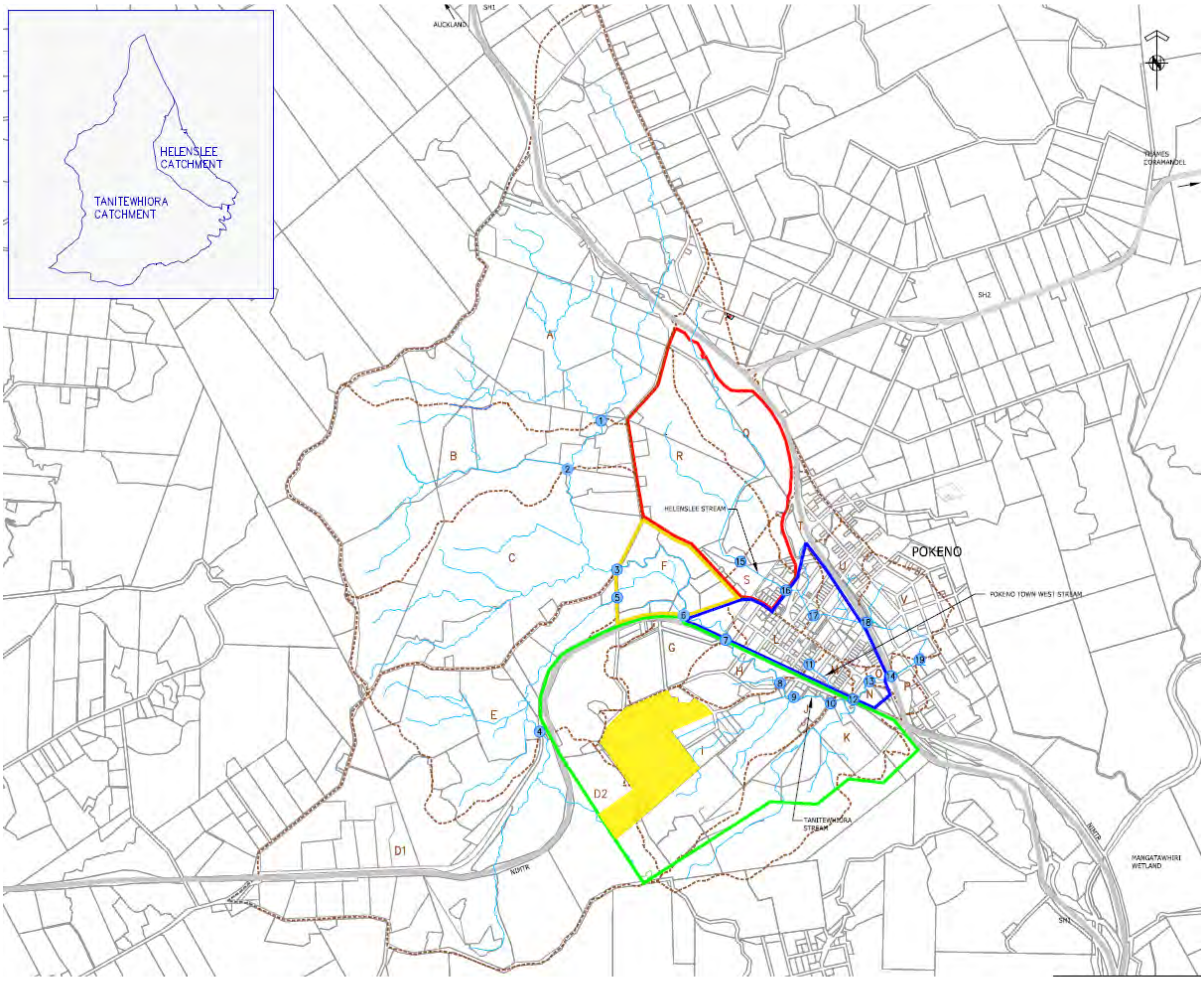

Figure 2 – Existing catchment from the CMP drawing 121412-SW100. Site is highlighted yellow.

4.2 Existing Land Use

The majority of the land is currently used for farming, with minimal impervious areas.

4.3 Topography

Hitchen Road follows a ridgeline along the north side of the site and then runs north-south through Graham Block. The site falls away from Hitchen Road to the east and west.

The proposed residential development drains to a stream running to the east through a reserve formed as part of the adjacent "Lot 30" Gateway Industrial subdivision, and collected by the existing pipe network at Yashili Drive. The pipe network discharges to the Tanitewhiora Stream via a stormwater treatment pond identified as "Pond J" in the Catchment Management Plan.

There is a second stream draining the proposed rural residential land on the southeast part of the site, which is also collected at the edge of the "Lot 30" industrial site by the existing pipe network. The catchment for this stream also includes approximately 21 Ha of rural land upstream of the site.

The proposed rural residential land on the southern corner of the site drains to a stream to the west of the site.

5. Design Objectives

The following sections summarise the design objectives targeted for the stormwater design.

5.1 Treatment targets

The Infrastructure Technical Specification (ITS) requires a centralised TP10 based treatment device for a Water Quality Volume (WQV) equal to the runoff from a 24 hour storm event that is 1/3 of the 50% AEP (1 in 2 year) event, including climate change. The site is upstream of existing treatment Pond J which is designed with excess capacity. As detailed in section 9.1 below, the increased water quality volume from the proposed development is less than the excess capacity of the pond, therefore the existing pond size is adequate. The contaminant yield of the site will be low due to the nature of the development (i.e. generally comprising low level local roads and roof runoff), however to protect the streams on the site, which are upstream of Pond J, it is proposed to discharge via treatment forebays which will constructed in the reserve at the head of the gulleys. The forebays will be sized with a permanent pool volume of 15% of the water quality volume.

5.2 Detention (flow mitigation) targets

Pond J was designed for treatment only, therefore extended detention must be provided on the development site to mitigate the increase in stream flows. In accordance with the ITS Extended Detention (temporary storage with a drain down period of 24 hours) will be provided for runoff from the roads and access lots for a 32.9mm rainfall event, being 1.2 x the Water Quality Volume storm event, including climate change. The detention volume will be provided in the proposed treatment forebays.

In addition to the chambers in the reserve, all lots will require on-lot detention which is to be sized based on the lot area and allowing for impervious areas as per District Plan Rule 26.6.12. A typical detail and sizing calculations are included in Appendix 3.

Note that District Plan Rule 26.6.12 requires detention of a 20% AEP 10 minute storm event. Extended detention volumes calculated based on the ITS are significantly larger and are thus conservative in relation to the District Plan.

5.3 Peak flow mitigation targets

The catchment management plan identified the adjoining sites as being near the bottom of the catchment, and attenuation of the 50% AEP, 10% AEP, and 1% AEP storm events was not deemed necessary, as it would delay peak flows from the site, which would coincide with peaks from upper catchment areas, exacerbating peak flows for the catchment. Therefore Pond J was designed for treatment only. Hence, no peak flow mitigation is proposed for this development.

5.4 Pipe network sizing

In accordance with the Infrastructure Technical Specification (ITS), it is proposed to use the 10 minute, 50% AEP + climate change event (1 in 2 yr + cc) rainfall intensity to size the pipe network within the residential subdivision, which equates to 70.8 mm/hr.

The downstream pipe network is in an industrial area so the downstream pipe capacities have been checked for the 20% AEP+ cc event (1 in 5 yr + cc) as per the ITS. The 15 minute rainfall intensity has been used as the length of the catchment increases the time of concentration for runoff from the proposed development.

5.5 Flooding and Overland Flows

In the residential area overland flow through the development will be via roads which discharge to the stream reserve. In the rural area flow will be via existing streams and overland flow paths.

Both streams on the east side of the site are collected by the existing pipe network and will flood in the event of a blockage or a storm event that exceeds the pipe capacity.

TP108 calculations show that the storage volumes available in each stream exceed the total runoff volumes for the 100 year storm event, therefore even with 100% blockage of the downstream pipe network there would be no overland flow in the 100 year event from the site into Yashili Drive or the "Lot 30" industrial site.

It is proposed to set minimum floor levels on the site to 500mm above the downstream ground level, based on the potential in an extreme storm event for ponding up to that level before overland flow can leave the streams on the site.

6. Catchment Rainfall Data

In accordance with Council requirements, rainfall for the site was taken from NIWA HIRDS v3 data, with rainfall for all storms increased by 16.8% to allow for 2°C climate change:

It is noted that the CMP uses the Auckland TP108 rainfall charts. These show higher rainfall depths than the HIRDS v3 data for the site. However the CMP did not consider climate change for the majority of storm events. Waikato Regional Council has confirmed that the TP108 rainfall depths are generated for Auckland and are not to be used in the Waikato region.

The design rainfall depths are shown in Table 1.

TABLE 1: Design Rainfall Depths (mm)

Rainfall Event	24hr Rainfall Depth from HIRDS v3	24hr Rainfall Depth including 16.8% Climate Change
Water Quality Volume (WQV)	23.5	27.4
Extended Detention Volume (EDV)	28.2	32.9
50% AEP	70.4	82.2
20% AEP	91.7	107.1
10% AEP	109.2	127.5
1% AEP	188.7	220.4

7. Catchment Curve Numbers

The existing soil type is classified as South Auckland Volcanic Field, which is identified in the CMP to correspond to a soil classification of A-B, with a pervious CN of 50 for pasture, and 43 for bush. In the post-development condition it is assumed that pervious soils have a CN value of 74 to represent compacted, earth-worked soils.

8. Catchment Impervious Areas

The runoff calculations are based on the following impervious areas:

- Estimates of existing impervious areas based on aerial photos.
- 0% for pasture, bush, and the proposed reserve.
- 35% roof area and an additional 20% impervious area for proposed residential lots up to 1000m². 350m² roof area and 200m² impervious area for each lot larger than 1000m². This is based on the District Plan rule 26.6.12 requirement for stormwater management design.
- Roof areas and residential areas for each rural lot as per those for residential lots larger than 1000m², outlined above.
- 75% for proposed road corridors, as per the Catchment Management Plan.
- 75% for access lots.
- 90% for the downstream industrial area, as per the Catchment Management Plan.

To calculate how much the proposed development will increase the water quality volume compared to development according to the existing Structure Plan, the "large lot" residential area in the existing Structure Plan was divided into 1200m² lots with 550m² of impervious area per lot.

9. Proposed Development Stormwater

9.1 Quality Treatment

9.1.1 Downstream Treatment Pond J

The water quality volume calculated for the site is summarised in Table 2 below. Refer to Appendix 2 for TP108 calculations.

TABLE 2: Proposed Development Water Quality Volume (m^3)

	WQV for development as per existing plan change	WQV for proposed development	Increase in WQV
Northern stream	1,874	3,206	1,332
Southern stream	490	538	48
Total	2364	3744	1380

Runoff from the site discharges to the downstream treatment Pond J via the existing streams on the site and downstream pipe networks. Pond J is identified in the Stormwater Discharge Report as exceeding the required design volumes, as summarised in Table 3 below. Based on the ITS requirements for pond sizing, the excess capacity of Pond J could treat an additional 4037m^3 WQV. This exceeds the 1380m^3 increase in WQV from the proposed development, therefore Pond J is adequately sized for the increased flows from the development.

Note also that this assessment is conservative due to the proposal for extended detention on the site (i.e. upstream of the pond), and the EDV storm being 20% larger than the WQV storm.

TABLE 3: Pond J Volumes (m^3)

	Volume Required for 75% TSS removal	Volume Provided	Excess Volume	Additional WQV that could be treated (based on ITS requirements for pond design)
Main Pond	12,809	15,500	2691	Excess Volume x 0.75 x 2 = 4,037
Forebay	765	1,500	735	Excess Volume x 0.75 x 2 x 10 = 11,025

For comparison, water quality volume calculations for the entire Pond J catchment are included in Appendix 4, based on the original Pond J sizing calculations, and the proposed development changing roughly 9.6ha of rural land to residential. These calculations are based on Curve Numbers that are higher than those taken from the Catchment Management Plan, and higher impervious areas (10% impervious area for rural residential and 65% impervious area for residential). The higher numbers are considered to be excessively conservative, but even using these numbers together with the current (larger) design storm, and ignoring the effect of extended detention on the development site, the pond would still achieve 75% sediment removal efficiency.

9.1.2 Treatment Forebays

Road runoff will be discharged to the stream via treatment forebays located at the pipe outlets, and shown indicatively on the stormwater layout plan SK102. The forebays will be sized based on their contributing subcatchments, with a permanent wetland equal to 15% of the WQV, and detention storage equal to the EDV. Refer to Table 4 below for the design volumes and Appendix 2 for TP108 calculations. The forebays will be formed with a weir and low flow pipe which will be detailed at Consent stage.

9.1.3 On-Lot Treatment Devices

The ITS and Three Waters Management Practice Notes require on-lot bioretention. Peak flows in the extended detention storm are calculated to reduce from existing (refer to section 9.2.1 below), therefore it is proposed that these are sized for treatment only i.e. sized according to Practice Note HCC04 as a "reduced at-source measure", at 2% of the trafficked impermeable area. This will be prescribed by consent notices on each title.

9.2 Extended Detention

9.2.1 Runoff Volumes

The proposed development will increase the runoff volume in the EDV storm from the site from 3,193m^3 to 4,883m^3, and will increase the peak flow rate from 0.08m^3/s to 0.10m^3/s in the southern stream subcatchment and from 0.37m^3/s to 0.66m^3/s in the northern stream subcatchment. However, due to the provision of extended detention as outlined below, peak flows in the streams are estimated to be attenuated to 0.34m^3/s and 0.09m^3/s, a net reduction of 4% from existing. Refer to the calculations in Appendix 2.

9.2.2 Treatment Forebays

Detention for the road reserves and access lots will be provided in the treatment forebays located in the proposed reserve and sized based on their contributing subcatchments. No attenuation will be provided for the most eastern subcatchment adjacent to Hitchen Road (lots 1 to 18), as it discharges at the downstream end of the stream, so extended detention will have negligible benefit.

The proposed devices are shown indicatively on the stormwater layout plan on drawing SK102, and indicative volumes shown in Table 4 below. Refer to Appendix 2 for TP108 calculations.

TABLE 4: Proposed Treatment Forebay Volumes

	Catchment (roads and access lots) (m^2)	EDV (m^3)	WQV (m^3)	Treatment Forebay Permanent Pool (m^3) = 0.15 WQV	Total Forebay volume (m^3) = 0.15WQV+ EDV
Forebay 1	6,634	191	147	22	213
Forebay 2	9,238	266	204	31	296
Forebay 3	8,140	234	180	27	261
Forebay 4	2,836	82	63	9	91
Forebay 5	2,608	75	58	9	84
Forebay 6	1,254	NA	28	4	4
Total	30,710	847	679	102	949

9.2.3 On-lot detention

All lots require tanks for roof areas to provide on-lot detention and reuse. The detention volume is to be sized based on capture of runoff from 35% of the lot, up to a maximum of 350m^2 for lots 1000m^2 or larger, which corresponds to a maximum required detention volume of 10.9m^3. The reuse volume is to be 5m^3 based on practice note HCC05. A tank typical detail and sizing calculations are included in Appendix 3. Specific design for onsite tanks will need to be considered at the time of construction of each dwelling, and will be prescribed by consent notices on each title.

The tanks on the majority of the residential lots are proposed to connect to the reticulated network, which will discharge in the reserve at the locations of the treatment forebays. The remainder of the residential lots and rural lots 198-213 are proposed to discharge on-lot via T-bar level-spreaders, shown indicatively on the plan.

9.3 Downstream Pipe Network Capacity Checks

9.3.1 Existing pipe network

The northern stream discharges via a pipe (Stormwater Line 2) running from Yashili Drive eastwards along Hitchen Road. The calculations which were used to size this pipe allowed for 2.46m^3/s inflow from the stream, however parts of the pipe were installed at flatter grades and therefore the as-built capacity without surcharge is lower than the design capacity.

The southern stream discharges via a pipe running across the "Lot 30" industrial site and eastwards along Yashili Drive.

There is also an 825mm pipe (Stormwater Line 6) from the northern stream southwards along Yashili Drive and connecting to the pipe from the southern stream (Stormwater Line 5), which was installed primarily as a temporary diversion while the pipe running along Hitchen Road was built. The inlet of Line 6 is lower than the inlet of Line 2.

9.3.2 Peak flow

The two streams provide a significant storage volume which will attenuate peak flows. The post development peak runoff rates in the 5 year storm event without considering this attenuation are calculated as 2.89m^3/s for the northern stream and 1.13m^3/s for the southern stream.

9.3.3 Pipe Capacity

Peak flows in the downstream pipe network have been modelled using XPStorm software both with and without considering attenuation due to storage in the streams. The model shows the pipe network has sufficient capacity in both cases. Peak flow outputs for the model without storage (the conservative case) are included in Appendix 2.

The pipe capacity has also been verified by hand calculations.

9.4 Flooding and Overland Flows

Table 6 below shows that the available storage in the two streams on the site exceeds the total runoff volumes for the 100 year storm event, therefore even with 100% blockage of the downstream pipe network there would be no overland flow in the 100 year event from the site into Yashili Drive or the "Lot 30" industrial site. Refer to Appendix 2 for TP108 calculations.

TABLE 6: Runoff Volumes from 1% AEP 24 Hour Storm Including Climate Change (m^3)

Catchment	Runoff Volume (m^3)	Downstream RL (m)	Storage in Stream (m^3)
Northern stream	16,940	30	42,927
Southern stream	6,157	32	6,522

The northern stream has storage of 17,219m^3 below RL 28.0, therefore flooding from the 100 year storm will not exceed this level. The proposed lots are all above RL28.0 except approximately 70m^2 (9% of site area) at the rear corner of Lot 3.

Due to the topography, lot owners are unlikely to build on the low-lying parts of lots, but minimum floor levels are proposed which will provide 500mm freeboard in the case of an extreme storm event causing ponding in the streams up to the downstream ground level – refer to table 7 below.

TABLE 7: Proposed Minimum Floor Levels

Lots	Minimum Floor Level
1,2,3,8,9,16, 30,31,32	RL 30.5
212 (rural lot)	RL 32.5

10. Conclusion

- The downstream Pond J has sufficient excess treatment capacity to cater for runoff from the proposed development.
- Road runoff in the development will discharging to the streams in the proposed reserve via treatment forebays constructed at the pipe outlets.
- Each lot will require a rain tank to provide extended detention and reuse and sized as detailed.
- Each lot will require bioretention to treat runoff from impervious areas, sized in accordance with HCC04 as a "reduced-at-source" measure.
- Extended detention will be provided on the site by on-lot detention tanks and the treatment forebays.
- Peak flows in the stream and therefore velocities will be attenuated in the EDV storm to approximately equal pre-development flows.
- The downstream pipe network has sufficient capacity to convey runoff from the development.
- There is sufficient storage in the streams on the site that there will be no overland flow into Yashili Drive and the "Lot 30" industrial site in the 100 year storm.
- All residential lots are high enough to avoid flooding in the 100 year storm, however some lots should have a minimum floor level set as detailed in section 9.4 above, to avoid flooding in extreme storm events.

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APPENDIX 1

Drawings

LEGEND

EXISTING STRUCTURE PLAN BOUNDARY

PROPOSED RESIDENTIAL 2 ZONE

PROPOSED RURAL OR COUNTRYSIDE LIVING

INDICATIVE RESERVES

INDICATIVE STORMWATER WETLANDS

PROPOSED RESIDENTIAL 2 (MAX 2000m2) - 197 LOTS

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REV	REVISION DETAILS	BY	DATE
D1	STORMWATER REPORT	AJH	21.03.17

DRAWN: AJH	DATE: 02.2017
CHECKED: AJH	DATE: 03.2017
APPROVED: MSS	DATE: 21.03.17

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PROJECT TITLE:
DFH JOINT VENTURE
POKENO VILLAGE
GRAHAM BLOCK

SHEET TITLE:
GRAHAM BLOCK
POSTDEVELOPMENT
CATCHMENT PLAN

ISSUE STATUS: FOR CONSENT

SCALE: (A1/A3) 1:2500 / 1:5000

SCALE BAR 1:5000@A3 0 50 100 150 200 250m

DRAWING NUMBER: 1950-00-SK101 REV: D1

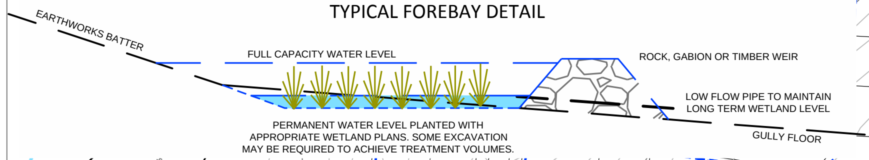
Rev: (NO REV.=DRAFT) (D=DESIGN) (C=CONSENT) (B=BUILD) (A=AS-BUILT / FINAL ISSUE)

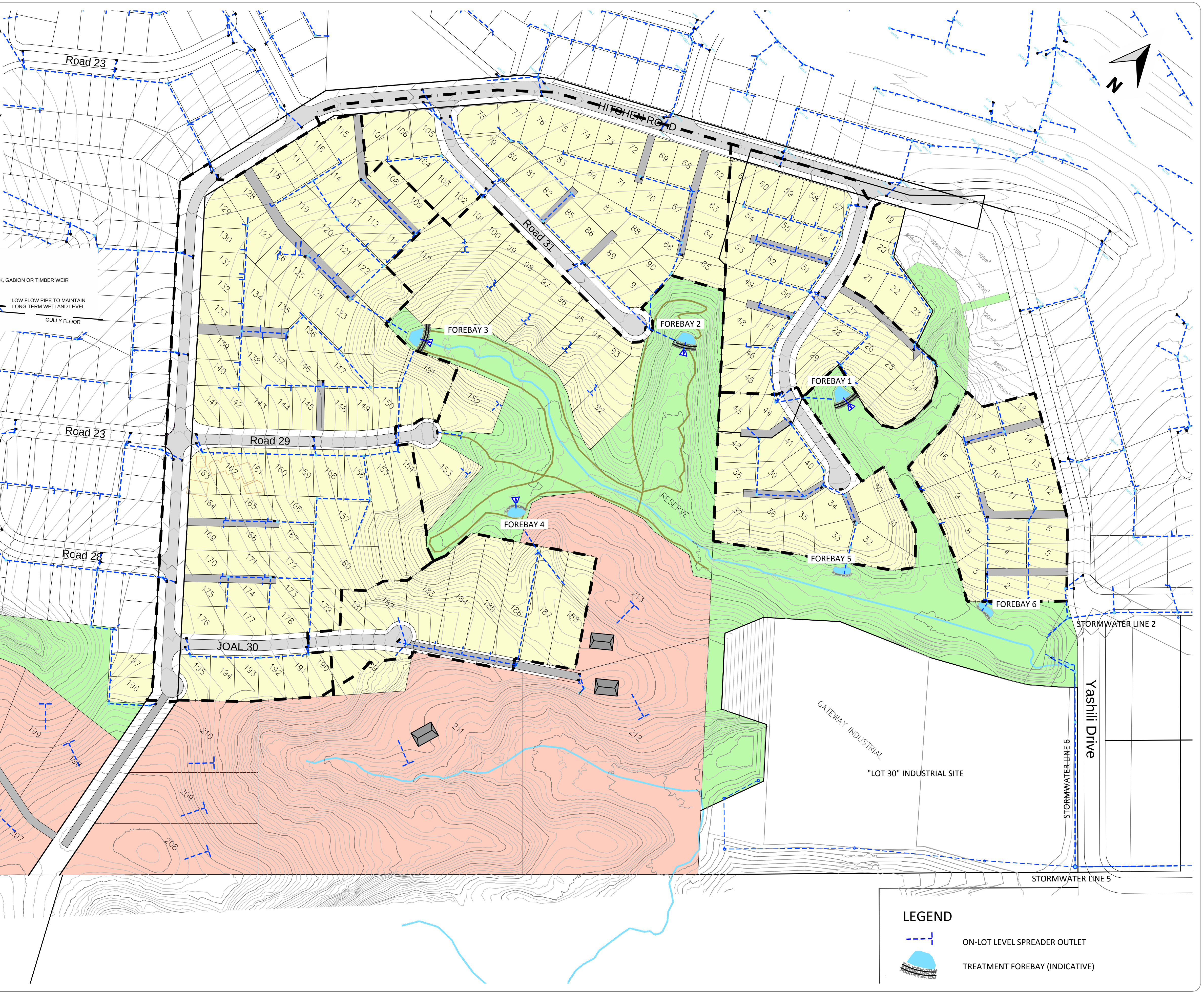
NOTES:

1. ALL LOTS TO HAVE ON-LOT BIORETENTION SIZED AT 2% OF IMPERVIOUS AREA EXCLUDING ROOF AREAS. REFER TO PRACTICE NOTE HC004.
2. ALL LOTS TO HAVE ON-LOT REUSE AND DETENTION TANKS SIZED ACCORDING TO:
   REUSE VOLUME = 5m³
   DETENTION VOLUME (m³) = LOT AREA (m²) ÷ 91.7
   USE 1000m² FOR LARGE LOTS
   REFER TO CALCULATION SHEET FOR DETAILS
3. ROAD RUNOFF TO DISCHARGE TO RESERVE VIA TREATMENT FOREBAYS INDICATIVELY SIZED AS FOLLOWS:

	Catchment (roads and access lots) (m²)	EDV (m³)	WQV (m³)	Treatment Forebay Permanent Pool (m³) = 0.15 WQV	Total Forebay volume (m³) = 0.15WQV+ EDV
Forebay 1	6,634	191	147	22	213
Forebay 2	9,238	266	204	31	296
Forebay 3	8,140	234	180	27	261
Forebay 4	2,836	82	63	9	91
Forebay 5	2,608	75	58	9	84
Forebay 6	1,254	NA	28	4	4
Total	30,710	847	679	102	949

TYPICAL FOREBAY DETAIL





REV	REVISION DETAILS	BY	DATE
D1	STORMWATER REPORT	AJH	20.04.17

DRAWN: AJH DATE: 03.2017
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PROJECT TITLE:
DFH JOINT VENTURE
POKENO VILLAGE
GRAHAM BLOCK

SHEET TITLE:
GRAHAM BLOCK
POSTDEVELOPMENT
STORMWATER LAYOUT

ISSUE STATUS: FOR CONSENT
SCALE: (A1/A3) 1:1500 / 1:3000
SCALE BAR 1:3000@A3: 0 30 60 90 120 150m
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APPENDIX 2

Catchment Design Calculations

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

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STORMWATER PEAK FLOW RATE, RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

SUMMARY OF RESULTS FOR: **Catchment draining via northern stream (WQV check)**

		WQV	**EDV**	**50% AEP+ 16.8%CC**	**20% AEP+ 16.8%CC**	**10% AEP+16.8%CC**	**1% AEP+16.8% CC**
Pre Development	Peak flow rate (m^3/s):	0.28	0.37	1.30	1.90	2.43	5.16
	Runoff volume (m^3):	1874	2448	9338	13673	17538	37413
Post Development	Peak flow rate (m^3/s):	0.52	0.66	2.09	2.89	3.60	7.09
	Runoff volume (m^3):	3206	4082	14056	18903	23576	46338
Difference	**Peak flow rate (m^3/s):**	**0.24**	**0.30**	**0.78**	**0.99**	**1.17**	**1.93**
	Runoff volume (m^3):	**1332**	**1634**	**4718**	**5230**	**6038**	**8925**

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Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: **Catchment draining via northern stream (WQV check)**

TOTAL CATCHMENT AREA: **28.113** **Ha**

SCENARIO: **"PRE DEVELOPMENT" = DEVELOPMENT OF EXISTING STRUCTURE PLAN AREA AS 1200m² lots with 550m² IA**

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**A-B**	**Pasture**	**50**	**13.977**	698.870
South Auckland Volcanic Field	**A-B**	**Urban lawns**	**74**	**5.417**	400.892
South Auckland Volcanic Field	**A-B**	**Replanted bush along stream**	**43**	**1.120**	48.160
South Auckland Volcanic Field	**A-B**	**Reserve**	**50**	**1.601**	80.060
			Total Pervious=	22.116	1227.982

CN (weighted) = Total product / Total Area = **55.5**

Ia (weighted) = 5.0 mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*
Catchment Length (measured along drainage path)		L=	**0.77**	km
Catchment Slope (calculated by equal area method)		Sc=	**0.031**	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.38	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.45	hrs min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.30	hrs

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 203.5 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From HIRDS)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(+16.8%)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.04	0.05	0.15	0.19	0.22	0.34
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.009	0.012	0.032	0.041	0.047	0.066
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.05	0.09	0.59	0.97	1.31	3.22
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	2.2	3.4	21.2	34.1	46.1	110.8
Runoff Volume (m³)	1000*Q24*A/100	V24=	492	744	4699	7546	10188	24498

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**A-B**	**Residential lots**	**98**	**4.029**	394.822
South Auckland Volcanic Field	**A-B**	**Roading at 75% IA**	**98**	**1.968**	192.908
			Total Impervious=	5.997	587.730

86169

11863

CN (weighted) = Total product / Total Area = **98.0**

Ia (weighted) = 0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*
Catchment Length (measured along drainage path)		L=	**0.77**	km
Catchment Slope (calculated by equal area method)		Sc=	**0.031**	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.96	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.27	hrs min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.18	hrs

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.73	0.76	0.89	0.91	0.92	0.96
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.136	0.139	0.145	0.145	0.146	0.147
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.22	0.27	0.71	0.93	1.11	1.94
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	23.0	28.4	77.4	102.2	122.6	215.3
Runoff Volume (m³)	1000*Q24*A/100	V24=	1382	1704	4639	6127	7350	12914

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Peak flow rate (m³/s):	**0.28**	**0.37**	**1.30**	**1.90**	**2.43**	**5.16**
Runoff volume (m³):	**1874**	**2448**	**9338**	**13673**	**17538**	**37413**

AVERAGE SLOPE BY END AREA METHOD					
Elevation (m)	**h (m)**	**x (m)**	**delta x (m)**	**average h (m)**	**delta A (m²)**
23.0	0.0	**0.0**			
25.0	2.0	**105.0**	105.0	1.0	105.0
30.0	7.0	**286.0**	181.0	4.5	814.5
35.0	12.0	**450.0**	164.0	9.5	1558.0
40.0	17.0	**577.0**	127.0	14.5	1841.5
45.0	22.0	**651.0**	74.0	19.5	1443.0
50.0	27.0	**700.0**	49.0	24.5	1200.5
55.0	32.0	**747.0**	47.0	29.5	1386.5
60.0	37.0	**757.0**	10.0	34.5	345.0
64.0	41.0	**767.0**	10.0	39.0	390.0
			767.0		9084.0
Sc =	0.031				

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: **Catchment draining via northern stream (WQV check)**

TOTAL CATCHMENT AREA: **28.113 Ha**

SCENARIO: **POST DEVELOPMENT**

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**A-B**	**Pasture**	**50**	**1.308**	65.380
South Auckland Volcanic Field	**A-B**	**Urban lawns**	**74**	**9.472**	700.913
South Auckland Volcanic Field	**A-B**	**Replanted bush along stream**	**43**	**1.120**	48.160
South Auckland Volcanic Field	**A-B**	**Reserve**	**50**	**4.413**	220.640
			Total Pervious=	16.312	1035.093

CN (weighted) =	Total product / Total Area =		**63.5**	
Ia (weighted) =			5.0	mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.6**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.12**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.042**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.46		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.36	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs	

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 146.3 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.06	0.07	0.20	0.25	0.29	0.42
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.015	0.018	0.047	0.056	0.063	0.087
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.06	0.10	0.63	0.98	1.32	3.13
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	3.0	4.5	26.7	42.0	55.9	128.3
Runoff Volume (m³)	1000*Q24*A/100	V24=	486	729	4353	6847	9112	20926

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**A-B**	**Residential lots at 55% IA with maximum 550m²**	**98**	**8.888**	871.017
South Auckland Volcanic Field	**A-B**	**Roading at 75% IA**	**98**	**2.858**	280.101
South Auckland Volcanic Field	**A-B**	**Rural lots IA at 550m² each**	**98**	**0.055**	5.390
			Total Impervious=	11.801	1156.508

CN (weighted) =	Total product / Total Area =		**98.0**
Ia (weighted) =			0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.6**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.12**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.042**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.96		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.24	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.16	hrs	

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.73	0.76	0.89	0.91	0.92	0.96
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.142	0.145	0.150	0.151	0.151	0.152
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.46	0.56	1.46	1.91	2.28	3.96
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	23.0	28.4	82.2	102.2	122.6	215.3
Runoff Volume (m³)	1000*Q24*A/100	V24=	2720	3353	9704	12056	14464	25412

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Peak flow rate (m³/s):	**0.52**	**0.66**	**2.09**	**2.89**	**3.60**	**7.09**
Runoff volume (m³):	**3206**	**4082**	**14056**	**18903**	**23576**	**46338**

AVERAGE SLOPE BY END AREA METHOD					
Elevation (m)	**h (m)**	**x (m)**	**delta x (m)**	**average h (m)**	**delta A (m²)**
23.0	0.0	**0.0**			
25.0	2.0	**105.0**	105.0	1.0	105.0
30.0	7.0	**286.0**	181.0	4.5	814.5
35.0	12.0	**450.0**	164.0	9.5	1558.0
40.0	17.0	**577.0**	127.0	14.5	1841.5
45.0	22.0	**651.0**	74.0	19.5	1443.0
50.0	27.0	**700.0**	49.0	24.5	1200.5
55.0	32.0	**747.0**	47.0	29.5	1386.5
60.0	37.0	**757.0**	10.0	34.5	345.0
64.0	41.0	**767.0**	10.0	39.0	390.0
79.0	56.0	**1117.0**	350.0	48.5	16975.0
			1117.0		26059.0
Sc =	0.042				

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

STORMWATER PEAK FLOW RATE, RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

SUMMARY OF RESULTS FOR: **Graham Block and Upstream Catchment draining via southern stream (WQV check)**

		WQV	**EDV**	**50% AEP+ 16.8%CC**	**20% AEP+ 16.8%CC**	**10% AEP+16.8%CC**	**1% AEP+16.8% CC**
Pre Development	Peak flow rate (m^3/s):	0.05	0.08	0.59	0.97	1.35	3.45
	Runoff volume (m^3):	490	745	4898	7988	10905	27232
Post Development	Peak flow rate (m^3/s):	0.07	0.10	0.69	1.13	1.55	3.90
	Runoff volume (m^3):	538	801	4979	8035	10926	27058
Difference	**Peak flow rate (m^3/s):**	**0.02**	**0.02**	**0.10**	**0.15**	**0.20**	**0.45**
	Runoff volume (m^3):	**48**	**56**	**82**	**48**	**22**	**-174**

Client:	DFH Joint Venture
Project:	Graham Block Pokeno
Job No:	1950
Designer:	AJH
Date:	03.03.17
Revision:	1

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STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: Graham Block and Upstream Catchment draining via southern stream (WQV check)

TOTAL CATCHMENT AREA: 28.4271 Ha

SCENARIO: PRE DEVELOPMENT

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	A-B	Pasture	50	22.627	1131.350
South Auckland Volcanic Field	A-B	Bush	43	5.800	249.400
			Total Pervious=	28.427	1380.750

CN (weighted) =	Total product / Total Area =	48.6	
Ia (weighted) =		5.0	mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	0.8	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	0.92	km	
Catchment Slope (calculated by equal area method)		Sc=	0.054	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.32		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.47	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.32	hrs	

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 268.9 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	1/3 2yr	EDV	2yr+CC	5yr+CC	10yr+CC	100yr+CC
24hr rainfall depth (mm)	(From HIRDS)	P24=	23.5	28.2	70.4	91.7	109.2	188.7
24hr rainfall depth+CC (mm)	(+16.8%)	P24+CC=	27.4	32.9	82.2	107.1	127.5	220.4
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.03	0.04	0.12	0.15	0.18	0.28
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.007	0.009	0.025	0.032	0.037	0.055
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.05	0.08	0.59	0.97	1.35	3.45
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	1.7	2.6	17.2	28.1	38.4	95.8
Runoff Volume (m³)	1000*Q24*A/100	V24=	490	745	4898	7987	10905	27232

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
Pokeno	B	Existing Roofs and Access Tracks	98	0.000	0.010
			Total Impervious=	0.000	0.010

CN (weighted) =	Total product / Total Area =	98.0	
Ia (weighted) =		0.0	

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	0.8	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	0.92	km	
Catchment Slope (calculated by equal area method)		Sc=	0.054	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.96		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.26	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.17	hrs	

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	1/3 2yr	EDV	2yr+CC	5yr+CC	10yr+CC	100yr+CC
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	23.5	28.2	70.4	91.7	109.2	188.7
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	27.4	32.9	82.2	107.1	127.5	220.4
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.73	0.76	0.89	0.91	0.92	0.96
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.139	0.142	0.147	0.148	0.148	0.149
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.00	0.00	0.00	0.00	0.00	0.00
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	23.0	28.4	77.4	102.2	122.6	215.3
Runoff Volume (m³)	1000*Q24*A/100	V24=	0	0	0	0	0	0

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Peak flow rate (m³/s):	0.05	0.08	0.59	0.97	1.35	3.45
Runoff volume (m³):	490	745	4898	7988	10905	27232

AVERAGE SLOPE BY END AREA METHOD

Elevation (m)	h (m)	x (m)	delta x (m)	average h (m)	delta A (m²)
30.0	0.0				
31.5	1.5		50.0	0.8	37.5
34.5	4.5		106.6	3.0	319.9
36.0	6.0		54.6	5.3	286.6
37.5	7.5		52.8	6.8	356.5
38.5	8.5		47.3	8.0	378.6
39.0	9.0		26.8	8.8	234.5
39.5	9.5		22.3	9.3	205.8
40.5	10.5		31.7	10.0	317.1
41.5	11.5		22.3	11.0	245.1
42.5	12.5		33.7	12.0	404.5
44.0	14.0		30.2	13.3	400.4
44.5	14.5		18.8	14.3	268.2
45.0	15.0		15.9	14.8	234.2
47.0	17.0		29.0	16.0	464.0
47.5	17.5		7.0	17.3	120.1
49.5	19.5		17.9	18.5	330.4
51.0	21.0		16.9	20.3	342.3
52.5	22.5		8.1	21.8	176.0
54.5	24.5		12.4	23.5	290.7
60.0	30.0		14.4	27.3	393.2
65.0	35.0		19.2	32.5	624.1
75.0	45.0		43.2	40.0	1729.5
77.5	47.5		15.0	46.3	691.6
79.0	49.0		14.1	48.3	681.6
80.5	50.5		11.0	49.8	546.2
84.5	54.5		17.2	52.5	904.9
87.0	57.0		10.2	55.8	567.5
90.0	60.0		14.2	58.5	831.5
95.0	65.0		12.9	62.5	804.3
99.5	69.5		13.9	67.3	935.6
107.5	77.5		20.0	73.5	1468.1
112.5	82.5		33.4	80.0	2673.7
115.0	85.0		14.7	83.8	1231.9
130.0	100.0		58.0	55.8	3234.4
			915.7		22730.6
Sc =	0.054				

CIVILPLAN CONSULTANTS

Client:	DFH Joint Venture
Project:	Graham Block Pokeno
Job No:	1950
Designer:	AJH
Date:	03.03.17
Revision:	1

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: Graham Block and Upstream Catchment draining via southern stream (WQV check)

TOTAL CATCHMENT AREA: 27.999 Ha

SCENARIO: POST DEVELOPMENT

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	A-B	Pasture	50	21.147	1057.345
South Auckland Volcanic Field	A-B	Existing bush	43	5.800	249.400
South Auckland Volcanic Field	A-B	Urban lawns	61	0.117	7.137
South Auckland Volcanic Field	A-B	20m wide planting strip along stream	43	0.660	28.380
			Total Pervious=	27.724	1342.262

CN (weighted) = Total product / Total Area = **48.4**

Ia (weighted) = 5.0 mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.6**	*(Averaged)*
Catchment Length (measured along drainage path)		L=	**0.92**	km
Catchment Slope (calculated by equal area method)		Sc=	**0.054**	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.32	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.36	hrs — min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 270.6 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.03	0.04	0.12	0.15	0.18	0.28
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.008	0.010	0.028	0.036	0.042	0.062
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.06	0.09	0.65	1.08	1.50	3.80
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	1.7	2.6	17.1	28.0	38.2	95.5
Runoff Volume (m³)	1000*Q24*A/100	V24=	475	722	4753	7755	10589	26466

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	A-B	Rural lots IA at 550m² each	98	0.275	26.950
			Total Impervious=	0.275	26.950

CN (weighted) = Total product / Total Area = **98.0**

Ia (weighted) = 0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.6**	*(Averaged)*
Catchment Length (measured along drainage path)		L=	**0.23**	km
Catchment Slope (calculated by equal area method)		Sc=	**0.020**	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.96	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.17	hrs — min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.11	hrs

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.73	0.76	0.89	0.91	0.92	0.96
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.155	0.158	0.164	0.164	0.165	0.166
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.01	0.01	0.04	0.05	0.06	0.10
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	23.0	28.4	82.2	102.2	122.6	215.3
Runoff Volume (m³)	1000*Q24*A/100	V24=	63	78	226	281	337	592

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Peak flow rate (m³/s):	**0.07**	**0.10**	**0.69**	**1.13**	**1.55**	**3.90**
Runoff volume (m³):	**538**	**801**	**4979**	**8035**	**10926**	**27058**

AVERAGE SLOPE BY END AREA METHOD

Elevation (m)	h (m)	x (m)	delta x (m)	average h (m)	delta A (m²)
30.0	0.0				
31.5	1.5		**50.0**	0.8	37.5
34.5	4.5		**106.6**	3.0	319.9
36.0	6.0		**54.6**	5.3	286.6
37.5	7.5		**52.8**	6.8	356.5
38.5	8.5		**47.3**	8.0	378.6
39.0	9.0		**26.8**	8.8	234.5
39.5	9.5		**22.3**	9.3	205.8
40.5	10.5		**31.7**	10.0	317.1
41.5	11.5		**22.3**	11.0	245.1
42.5	12.5		**33.7**	12.0	404.5
44.0	14.0		**30.2**	13.3	400.4
44.5	14.5		**18.8**	14.3	268.2
45.0	15.0		**15.9**	14.8	234.2
47.0	17.0		**29.0**	16.0	464.0
47.5	17.5		**7.0**	17.3	120.1
49.5	19.5		**17.9**	18.5	330.4
51.0	21.0		**16.9**	20.3	342.3
52.5	22.5		**8.1**	21.8	176.0
54.5	24.5		**12.4**	23.5	290.7
60.0	30.0		**14.4**	27.3	393.2
65.0	35.0		**19.2**	32.5	624.1
75.0	45.0		**43.2**	40.0	1729.5
77.5	47.5		**15.0**	46.3	691.6
79.0	49.0		**14.1**	48.3	681.6
80.5	50.5		**11.0**	49.8	546.2
84.5	54.5		**17.2**	52.5	904.9
87.0	57.0		**10.2**	55.8	567.5
90.0	60.0		**14.2**	58.5	831.5
95.0	65.0		**12.9**	62.5	804.3
99.5	69.5		**13.9**	67.3	935.6
107.5	77.5		**20.0**	73.5	1468.1
112.5	82.5		**33.4**	80.0	2673.7
115.0	85.0		**14.7**	83.8	1231.9
130.0	100.0		**58.0**	55.8	3234.4
			915.7		22730.6
Sc =	0.054				

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

CIVILPLAN CONSULTANTS

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: **Catchment draining via northern stream**

TOTAL CATCHMENT AREA: **3.686 Ha**

SCENARIO: **EDV calculation**

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**A-B**	**Urban lawns (road reserve and accessways only)**	**74**	**0.921**	68.182
			Total Pervious=	0.921	68.182

CN (weighted) =	Total product / Total Area =	**74.0**	
Ia (weighted) =		5.0	mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.6**	*(Averaged)*
Catchment Length (measured along drainage path)		L=	**1.12**	km
Catchment Slope (calculated by equal area method)		Sc=	**0.042**	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.59	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.31	hrs
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.21	hrs

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 89.2 mm

			WQV	EDV	50% AEP+ 16.8%CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=		0.11	
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=		0.029	
Peak Flow Rate (m^3/s)	A*P24*q*/100	qp=		0.01	
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=		6.6	
Runoff Volume (m^3)	1000*Q24*A/100	V24=		61	

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**A-B**	**Roading at 75% IA**	**98**	**2.764**	270.884
			Total Impervious=	2.764	270.884

CN (weighted) =	Total product / Total Area =	**98.0**
Ia (weighted) =		0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.6**	*(Averaged)*
Catchment Length (measured along drainage path)		L=	**1.12**	km
Catchment Slope (calculated by equal area method)		Sc=	**0.042**	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.96	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.24	hrs
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.16	hrs

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=		0.76	
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=		0.145	
Peak Flow Rate (m^3/s)	A*P24*q*/100	qp=		0.13	
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=		28.4	
Runoff Volume (m^3)	1000*Q24*A/100	V24=		785	

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC
Peak flow rate (m^3/s):		**0.14**	
Runoff volume (m^3):		**847**	

AVERAGE SLOPE BY END AREA METHOD					
Elevation (m)	**h (m)**	**x (m)**	**delta x (m)**	**average h (m)**	**delta A (m^2)**
23.0	0.0	**0.0**			
25.0	2.0	**105.0**	105.0	1.0	105.0
30.0	7.0	**286.0**	181.0	4.5	814.5
35.0	12.0	**450.0**	164.0	9.5	1558.0
40.0	17.0	**577.0**	127.0	14.5	1841.5
45.0	22.0	**651.0**	74.0	19.5	1443.0
50.0	27.0	**700.0**	49.0	24.5	1200.5
55.0	32.0	**747.0**	47.0	29.5	1386.5
60.0	37.0	**757.0**	10.0	34.5	345.0
64.0	41.0	**767.0**	10.0	39.0	390.0
79.0	56.0	**1117.0**	350.0	48.5	16975.0
			1117.0		26059.0
Sc =	0.042				

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**21.03.17**
Revision:	**1**

CIVILPLAN CONSULTANTS

Post-Development mitigated peak flow estimate - EDV storm

Subcatchment	Flow (m^3/s)
Northern Stream	
Pervious areas (from TP108 calculation)	0.10
Detention tanks 205 dwelling × $0.0002m^3/s$	0.04
Treatment forebays $847m^3$ ÷ 24hrs ÷ 3600s × assumed peaking factor 2	0.02
Bioretention Runoff calculations are based on 20% paved and 35% roof area. Total IA for residential lots = 8.888Ha. So total paved area = 20 ÷ 55 × 8.888 = 3.232 Ha Flow from total impervious area of 11.801Ha from TP108 calculation = $0.66m^3/s$ So peak flow = 3.232 ÷ 11.801 × 0.66 = $0.18m^3/s$ Assume bioretention at 2% of catchment area provides no attenuation of peak flow (conservative)	0.18
Northern Stream Total	**0.34**
Southern Stream	
Pervious areas (from TP108 calculation)	0.09
Detention tanks 5 dwelling x $0.0002m^3/s$	0.00
Bioretention 20% ÷ 55% × 0.275 Ha = 0.1 Ha impervious area 0.1Ha ÷ 0.275Ha × $0.01m^3/s$ = $0.00m^3/s$ peak flow	0.00
Southern Stream Total	**0.09**

CIVILPLAN CONSULTANTS

Client:	DFH Joint Venture
Project:	Graham Block Pokeno
Job No:	1950
Designer:	AJH
Date:	03.03.17
Revision:	1

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: Catchment draining via southern stream including "Lot 30" industrial for pipe capacity check

TOTAL CATCHMENT AREA: 33.659 Ha

SCENARIO: POST DEVELOPMENT TOTAL RUNOFF

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	A-B	Pasture	50	21.672	1083.620
South Auckland Volcanic Field	A-B	Bush	43	6.460	277.780
South Auckland Volcanic Field	A-B	Urban lawns	74	0.597	44.178
South Auckland Volcanic Field	A-B	Reserve	50	0.335	16.725
			Total Pervious=	29.064	1422.303

CN (weighted) = Total product / Total Area = 48.9

Ia (weighted) = 5.0 mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	0.6	*(Averaged)*
Catchment Length (measured along drainage path)		L=	0.92	km
Catchment Slope (calculated by equal area method)		Sc=	0.054	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.32	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.35	hrs — min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 265.0 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	1/3 2yr	EDV	2yr+CC	5yr+CC	10yr+CC	100yr+CC
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	23.5	28.2	70.4	91.7	109.2	188.7
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	27.4	32.9	82.2	107.1	127.5	220.4
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.03	0.04	0.12	0.15	0.18	0.28
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.008	0.010	0.029	0.037	0.043	0.063
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.06	0.10	0.69	1.15	1.60	4.05
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	1.7	2.7	17.4	28.4	38.7	96.6
Runoff Volume (m³)	1000*Q24*A/100	V24=	508	772	5065	8253	11261	28068

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	A-B	Lot 30 Industrial development at 90% IA	98	4.320	423.360
					0.000
South Auckland Volcanic Field	A-B	Rural lots IA at 550m² each	98	0.275	26.950
					0.000
			Total Impervious=	4.595	450.310

CN (weighted) = Total product / Total Area = 98.0

Ia (weighted) = 0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	0.6	*(Averaged)*
Catchment Length (measured along drainage path)		L=	0.23	km
Catchment Slope (calculated by equal area method)		Sc=	0.020	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.96	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.17	hrs — min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.11	hrs

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	1/3 2yr	EDV	2yr+CC	5yr+CC	10yr+CC	100yr+CC
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	23.5	28.2	70.4	91.7	109.2	188.7
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	27.4	32.9	82.2	107.1	127.5	220.4
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.73	0.76	0.89	0.91	0.92	0.96
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.155	0.158	0.164	0.164	0.165	0.166
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.19	0.24	0.62	0.81	0.97	1.68
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	23.0	28.4	82.2	102.2	122.6	215.3
Runoff Volume (m³)	1000*Q24*A/100	V24=	1059	1306	3778	4694	5632	9895

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Peak flow rate (m³/s):	0.26	0.34	1.31	1.96	2.56	5.73
Runoff volume (m³):	1567	2077	8843	12948	16893	37963

AVERAGE SLOPE BY END AREA METHOD					
Elevation (m)	h (m)	x (m)	delta x (m)	average h (m)	delta A (m²)
30.0	0.0				
31.5	1.5		50.0	0.8	37.5
34.5	4.5		106.6	3.0	319.9
36.0	6.0		54.6	5.3	286.6
37.5	7.5		52.8	6.8	356.5
38.5	8.5		47.3	8.0	378.6
39.0	9.0		26.8	8.8	234.5
39.5	9.5		22.3	9.3	205.8
40.5	10.5		31.7	10.0	317.1
41.5	11.5		22.3	11.0	245.1
42.5	12.5		33.7	12.0	404.5
44.0	14.0		30.2	13.3	400.4
44.5	14.5		18.8	14.3	268.2
45.0	15.0		15.9	14.8	234.2
47.0	17.0		29.0	16.0	464.0
47.5	17.5		7.0	17.3	120.1
49.5	19.5		17.9	18.5	330.4
51.0	21.0		16.9	20.3	342.3
52.5	22.5		8.1	21.8	176.0
54.5	24.5		12.4	23.5	290.7
60.0	30.0		14.4	27.3	393.2
65.0	35.0		19.2	32.5	624.1
75.0	45.0		43.2	40.0	1729.5
77.5	47.5		15.0	46.3	691.6
79.0	49.0		14.1	48.3	681.6
80.5	50.5		11.0	49.8	546.2
84.5	54.5		17.2	52.5	904.9
87.0	57.0		10.2	55.8	567.5
90.0	60.0		14.2	58.5	831.5
95.0	65.0		12.9	62.5	804.3
99.5	69.5		13.9	67.3	935.6
107.5	77.5		20.0	73.5	1468.1
112.5	82.5		33.4	80.0	2673.7
115.0	85.0		14.7	83.8	1231.9
130.0	100.0		58.0	55.8	3234.4
			915.7		22730.6
Sc =	0.054				

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

CIVILPLAN CONSULTANTS

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: **Catchment draining via northern stream**

TOTAL CATCHMENT AREA: **28.113 Ha**

SCENARIO: **POST DEVELOPMENT TOTAL RUNOFF**

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**A-B**	**Pasture**	**50**	**1.308**	65.380
South Auckland Volcanic Field	**A-B**	**Urban lawns**	**74**	**9.472**	700.913
South Auckland Volcanic Field	**A-B**	**Replanted bush along stream**	**43**	**1.120**	48.160
South Auckland Volcanic Field	**A-B**	**Reserve**	**50**	**4.413**	220.640
			Total Pervious=	16.312	1035.093

CN (weighted) =	Total product / Total Area =		**63.5**	
Ia (weighted) =			5.0	mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.6**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.12**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.042**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.46		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.36	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs	

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 146.3 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.06	0.07	0.20	0.25	0.29	0.42
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.015	0.018	0.047	0.056	0.063	0.087
Peak Flow Rate (m^3/s)	A*P24*q*/100	qp=	0.06	0.10	0.63	0.98	1.32	3.13
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	3.0	4.5	26.7	42.0	55.9	128.3
Runoff Volume (m^3)	1000*Q24*A/100	V24=	486	729	4353	6847	9112	20926

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**A-B**	**Residential lots at 55% IA**	**98**	**8.888**	871.017
South Auckland Volcanic Field	**A-B**	**Roading at 75% IA**	**98**	**2.858**	280.101
South Auckland Volcanic Field	**A-B**	**Rural lots IA at $550m^2$ each**	**98**	**0.055**	5.390
			Total Impervious=	11.801	1156.508

CN (weighted) =	Total product / Total Area =		**98.0**
Ia (weighted) =			0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.6**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.12**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.042**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.96		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.24	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.16	hrs	

Graphical Peak Flow Rate:

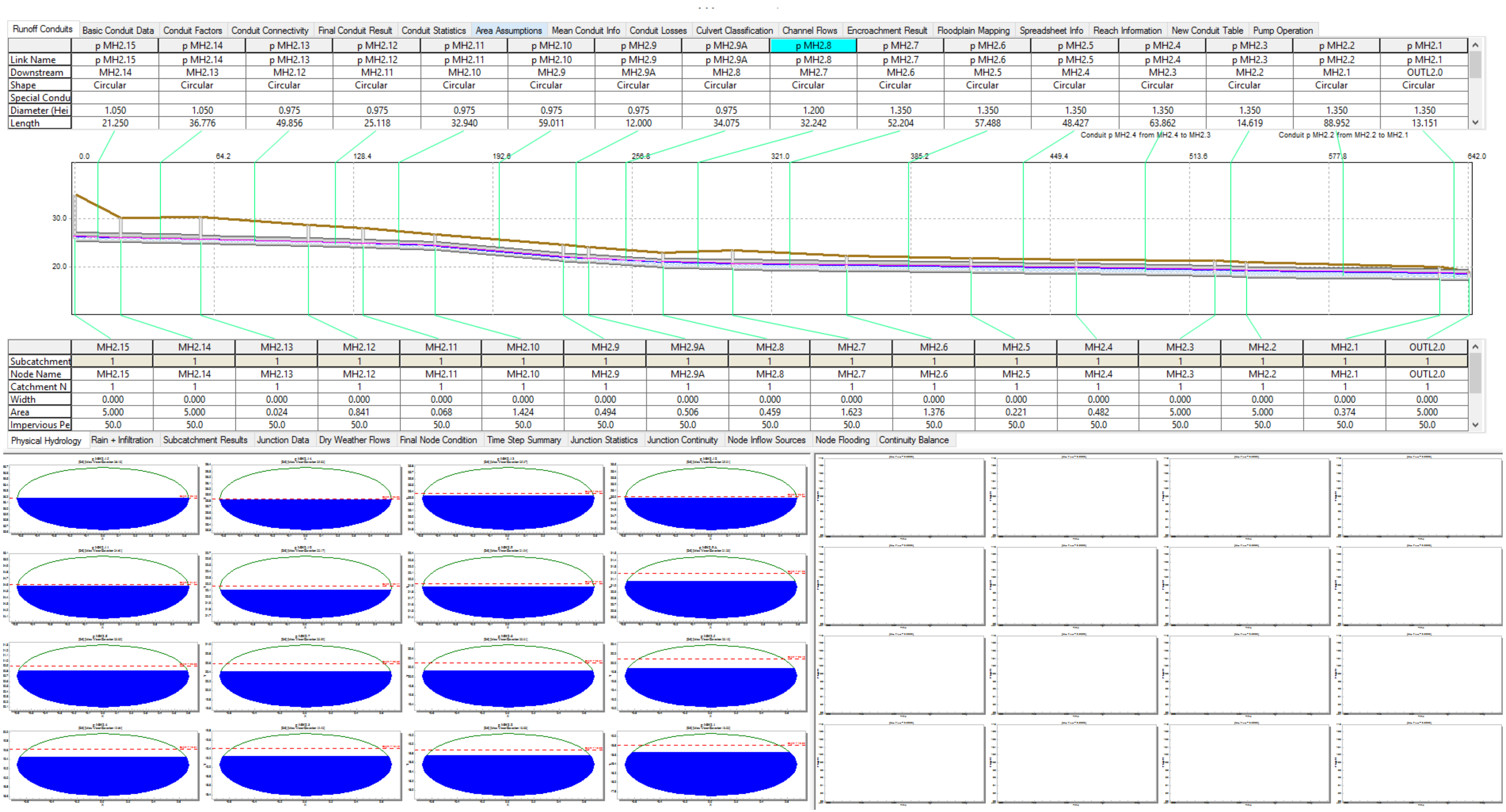
Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.73	0.76	0.89	0.91	0.92	0.96
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.142	0.145	0.150	0.151	0.151	0.152
Peak Flow Rate (m^3/s)	A*P24*q*/100	qp=	0.46	0.56	1.46	1.91	2.28	3.96
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	23.0	28.4	82.2	102.2	122.6	215.3
Runoff Volume (m^3)	1000*Q24*A/100	V24=	2720	3353	9704	12056	14464	25412

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Peak flow rate (m^3/s):	**0.52**	**0.66**	**2.09**	**2.89**	**3.60**	**7.09**
Runoff volume (m^3):	**3206**	**4082**	**14056**	**18903**	**23576**	**46338**

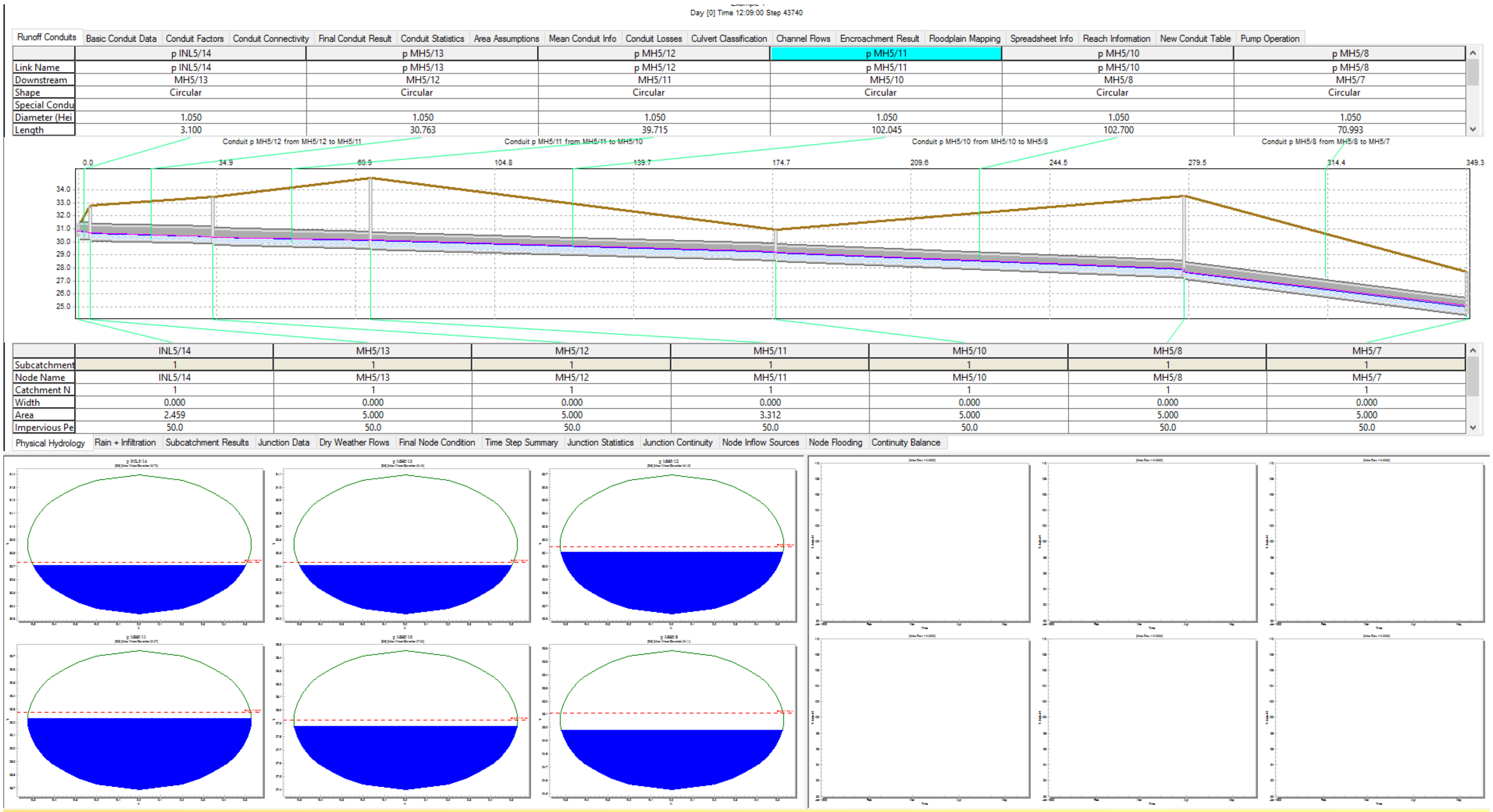
AVERAGE SLOPE BY END AREA METHOD					
Elevation (m)	**h (m)**	**x (m)**	**delta x (m)**	**average h (m)**	**delta A (m^2)**
23.0	0.0	**0.0**			
25.0	2.0	**105.0**	105.0	1.0	105.0
30.0	7.0	**286.0**	181.0	4.5	814.5
35.0	12.0	**450.0**	164.0	9.5	1558.0
40.0	17.0	**577.0**	127.0	14.5	1841.5
45.0	22.0	**651.0**	74.0	19.5	1443.0
50.0	27.0	**700.0**	49.0	24.5	1200.5
55.0	32.0	**747.0**	47.0	29.5	1386.5
60.0	37.0	**757.0**	10.0	34.5	345.0
64.0	41.0	**767.0**	10.0	39.0	390.0
79.0	56.0	**1117.0**	350.0	48.5	16975.0
			1117.0		26059.0
Sc =	0.042				



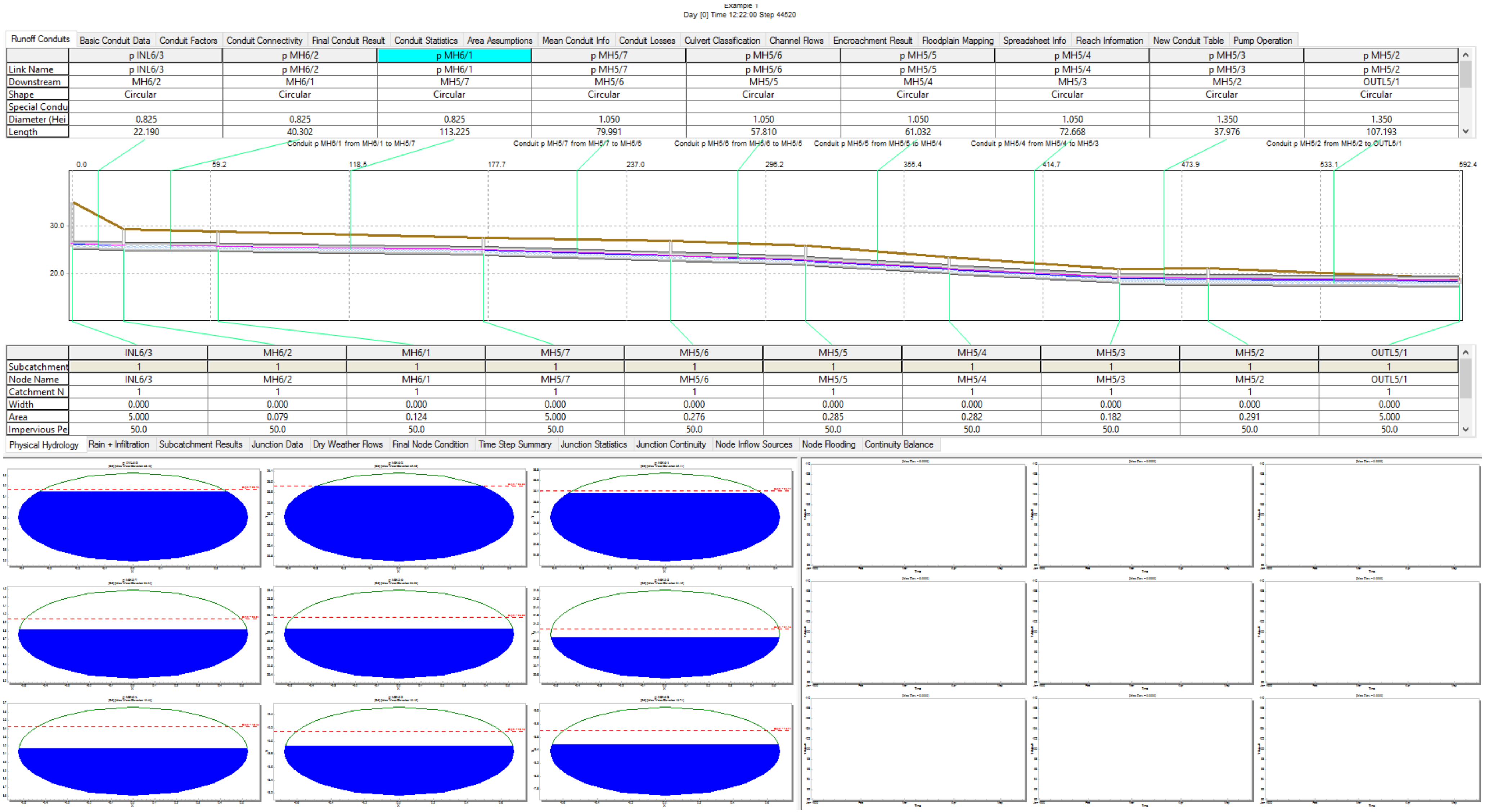
	p MH2.15	p MH2.14	p MH2.13	p MH2.12	p MH2.11	p MH2.10	p MH2.9	p MH2.9A	p MH2.8	p MH2.7	p MH2.6	p MH2.5	p MH2.4	p MH2.3	p MH2.2	p MH2.1
Link Name	p MH2.15	p MH2.14	p MH2.13	p MH2.12	p MH2.11	p MH2.10	p MH2.9	p MH2.9A	p MH2.8	p MH2.7	p MH2.6	p MH2.5	p MH2.4	p MH2.3	p MH2.2	p MH2.1
Downstream	MH2.14	MH2.13	MH2.12	MH2.11	MH2.10	MH2.9	MH2.9A	MH2.8	MH2.7	MH2.6	MH2.5	MH2.4	MH2.3	MH2.2	MH2.1	OUTL2.0
Shape	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular	Circular
Special Condu																
Diameter (Hei	1.050	1.050	0.975	0.975	0.975	0.975	0.975	0.975	1.200	1.350	1.350	1.350	1.350	1.350	1.350	1.350
Length	21.250	36.776	49.856	25.118	32.940	59.011	12.000	34.075	32.242	52.204	57.488	48.427	63.862	14.619	88.952	13.151

	MH2.15	MH2.14	MH2.13	MH2.12	MH2.11	MH2.10	MH2.9	MH2.9A	MH2.8	MH2.7	MH2.6	MH2.5	MH2.4	MH2.3	MH2.2	MH2.1	OUTL2.0
Subcatchment	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Node Name	MH2.15	MH2.14	MH2.13	MH2.12	MH2.11	MH2.10	MH2.9	MH2.9A	MH2.8	MH2.7	MH2.6	MH2.5	MH2.4	MH2.3	MH2.2	MH2.1	OUTL2.0
Catchment N	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Width	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Area	5.000	5.000	0.024	0.841	0.068	1.424	0.494	0.506	0.459	1.623	1.376	0.221	0.482	5.000	5.000	0.374	5.000
Impervious Pe	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0	50.0

XPSTORM 5 yr peak flows - SW Line 2 without in-stream storage.png



XPSTORM 5 yr peak flows - SW Line 5-14 to 5-7 without in-stream storage.png



XPSTORM 5 yr peak flows - SW Line 6-3 to 5-1 without in-stream storage.png

APPENDIX 3

On-Lot Detention Tank Sizing

Practice Note HCC04 for On-Lot Bioretention

CIVILPLAN CONSULTANTS

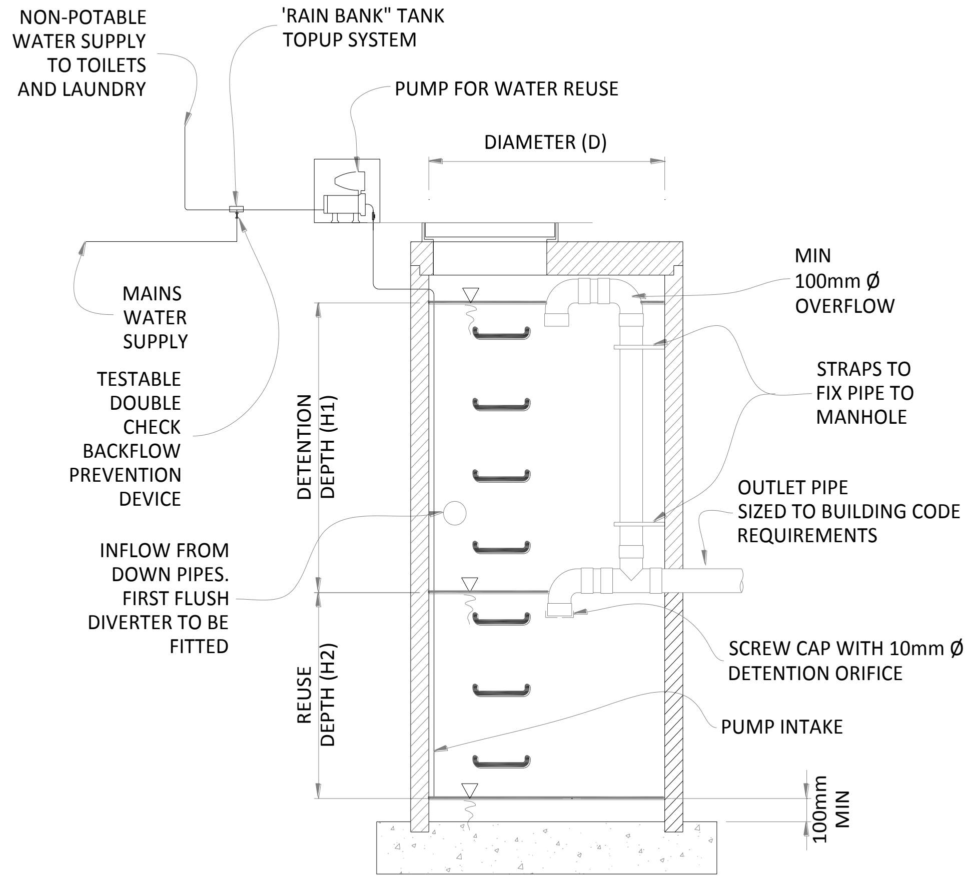
GRAHAM BLOCK, POKENO

ON-LOT DETENTION TANK CALCULATOR

INPUT Lot area (use 1000m² if lot is larger than 1000m²*)	L =		m²
Roof area to allow for	A = 0.35 × L		m²
*** Based on District Plan Rule 26.6.12**			
*** Other impervious areas to be treated by bioretention sized at 2% of catchment area. Refer to Practice Note HCC04.**			
Required Reuse Volume	U =	**5.0**	m³
Extended Detention Volume storm depth based on Infrastructure Technical Specification			
HIRDS 50% AEP 24 hr rainfall		70.4	mm
+16.8% for climate change		82.2	mm
EDV storm (= WQV × 1.2, where WQV = 50% AEP/3 × 0.4	i =	**32.9**	mm
Runoff Coefficient based on Infrastructure Technical Specification	C =	**0.95**	
CALCULATE Required Detention volume = Runoff volume	1000 = L ÷ 91.7		m³
CHOOSE tank diameter	D =		m
CALCULATE Tank Detention Depth	H = 1.27 × V ÷ D²		m
CALCULATE Tank Reuse Depth	H2 = 1.27 × U ÷ D²		m

ALLOW FOR ADDITIONAL HEIGHT FOR THE SUMP AND TO FIT IN THE OVERFLOW PIPE - REFER TO THE TYPICAL DETAIL BELOW

Target time to drain is 24 hours, however this requires small orifices prone to blockage. Use 10mm diameter orifice instead.



Client:	**DFH Joint Venture**
Project:	**raham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**21.03.17**
Revision:	**2**

GRAHAM BLOCK, POKENO

ON-LOT DETENTION TANK CALCULATOR - LARGE LOT EXAMPLE

INPUT Lot area (use 1000m² if lot is larger than 1000m²*)	$L =$	**1000**	m^2
Roof area to allow for	$A = 0.35 \times L$	**350**	m^2

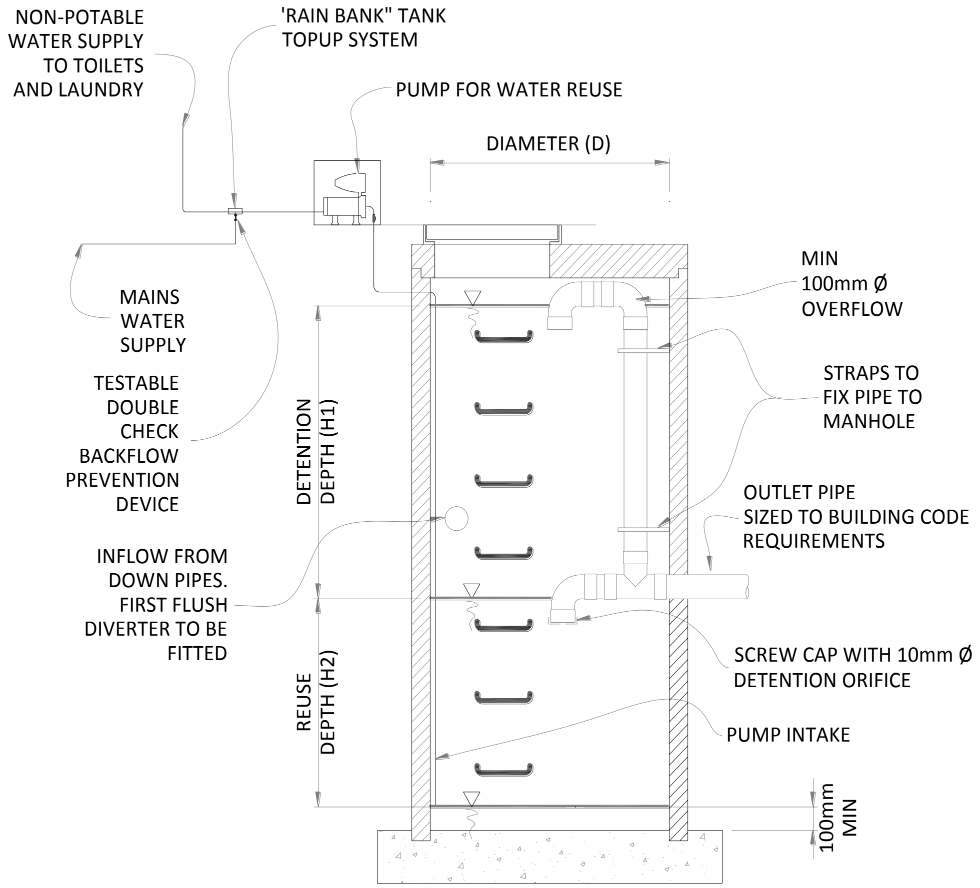
*** Based on District Plan Rule 26.6.12**

*** Other impervious areas to be treated by bioretention sized at 2% of catchment area. Refer to Practice Note HCC04.**

Required Reuse Volume	$U =$	**5.0**	m^3
Extended Detention Volume storm depth based on Infrastructure Technical Specification			
HIRDS 50% AEP 24 hr rainfall		70.4	mm
+16.8% for climate change		82.2	mm
EDV storm (= WQV × 1.2, where WQV = 50% AEP/3 × 0.4	$i =$	**32.9**	mm
Runoff Coefficient based on Infrastructure Technical Specification	$C =$	**0.95**	
	1000		
CALCULATE Required Detention volume = Runoff volume	$= L \div 91.7$	**10.9**	m^3
CHOOSE tank diameter	$D =$	**3.6**	m
CALCULATE Tank Detention Depth	$H1 = 1.27 \times V \div D^2$	**1.1**	m
CALCULATE Tank Reuse Depth	$H2 = 1.27 \times U \div D^2$	**0.5**	m

ALLOW FOR ADDITIONAL HEIGHT FOR THE SUMP AND TO FIT IN THE OVERFLOW PIPE - REFER TO THE TYPICAL DETAIL BELOW

Target time to drain is 24 hours, however this requires small orifices prone to blockage. Use 10mm diameter orifice instead.



Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
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CIVILPLAN CONSULTANTS

ON-LOT DETENTION TANKS - CHECK OF ACTUAL DRAIN TIME

ORIFICE DIAMETER INCREASES WITH LOT SIZE AND DECREASES WITH DETENTION DEPTH

CHECK ACTUAL DRAIN TIME FOR MAXIMUM IA (1000m² LOT) AND RELATIVELY SHALLOW TANK

SIZE DETENTION TANKS

INPUT Lot area (use 1000m² if lot is larger than 1000m²*)					
L =	**600**	**1000**	**1000**	**1000**	m²
CALCULATE Required Detention volume = Runoff volume					
V = C × i × A ÷ 1000 = L ÷ 91.7	6.5	10.9	10.9	10.9	m³
CHOOSE tank diameter					
D =	**3.6**	**3.6**	**4.2**	**4.2**	m
CALCULATE Tank Detention Depth					
H1 = 1.27 × V ÷ D²	0.6	1.1	0.8	0.8	m

CHECK ACTUAL DRAIN TIME

Orifice diameter					
Check if 10mm is always suitable:	**10.0**	**10.0**	**10.0**	**11.0**	mm
Coefficient of discharge					
Cd	0.6	0.6	0.6	0.6	
Orifice area					
= π(diameter÷1000)²÷4	7.85398E-05	7.85398E-05	7.85398E-05	9.50332E-05	m²
Average head					
= H ÷ 2	0.32	0.54	0.39	0.39	m
Average flow rate					
=Cd ×orifice area × SQRT(2×9.81×average hea	0.00012	0.00015	0.00013	0.00016	m³/s
Actual time to discharge detention volume					
= V ÷ average flow rate ÷ 3600	15.4	19.8	23.1	19.1	hrs
Maximum flow rate					
=Cd ×orifice area × SQRT(2×9.81×H)	0.00017	0.00022	0.00019	0.00022	m³/s

CONCLUSION:

Typical lot size is 600m² - to avoid draining in less than 24 hrs these lots require an orifice smaller than 10mm, which is prone to blockage
To need a larger orifice diameter the tanks would need to be shallower and therefore impractically large
The largest orifices would be required by the largest lots, but even for these, drain time does not exceed 24 hours for a 10mm orifice unless tanks are very large and very shallow.
So use a standard 10mm orifice diameter in all cases.

HCC 04: Bioretention systems (Raingardens)

1. INTRODUCTION

This practice note[1] has been developed to provide general information on the minimum design and sizing requirements for bioretention systems which are used in residential and non-residential applications for on-site stormwater management. Design information is provided for a bioretention device designed to provide full water quality treatment and extended detention, and also for a bioretention reduced at-source measure sized for a smaller contributing catchment, refer to Sections 2 and 3 below.

1.1 Bioretention systems

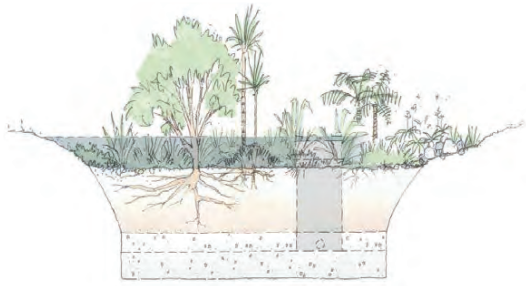
Bioretention systems are specially designed garden beds which filter stormwater runoff from surrounding areas or from stormwater pipes. Bioretention is widely accepted as one of the best stormwater management practices. It makes uses of the chemical, biological and physical properties of plants, microbes and soils and is an effort to mimic nature. Plants in a bioretention system transpire some of the water that is directed into it back into the atmosphere. Unlined bioretention systems allow infiltration of stormwater into the underlying soils, hence volume reduction. Bioretention devices also provide water quality treatment through the filtering that occurs through the soil media layer.

In this practice note, bioretention encompasses a number of different devices, including:

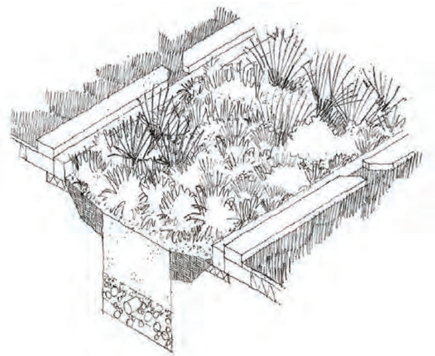
- Raingardens
- Bio-retention swales
- Stormwater planters, and
- Tree pits.

[1] Three Waters Management Practice Notes are Hamilton City Council controlled documents and will be subject to ongoing review. The latest version can be downloaded from the Hamilton City Council website: http://www.hamilton.govt.nz/our-council/council-publications/manuals/Pages/Three-Waters-Management-Practice-Notes.aspx

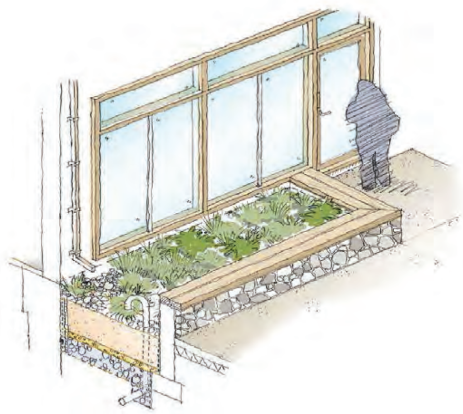
A **raingarden** is essentially a sunken garden with good well drained soil and an underdrain to which stormwater is directed.



A **bioretention swale** is a long narrow sloping swale with a bioretention system along the base of the swale. It can be used to convey as well as treat stormwater.



A **stormwater planter** is an above ground garden in a large container with bioretention soil media and an underdrain to which stormwater is directed.



Tree pits which are used for planting trees along streets can also be used for bioretention as long as they are designed with an appropriate underdrainage system.

1.2 Advantages of a bioretention system

Bioretention offers a number of benefits which is why it is one of the preferred methods for on-site stormwater management. The benefits include:

- ***Improved water quality by treating and filtering out contaminants.***
- ***Improved hydrological response of stormwater peak flow and volume, especially for smaller rainfall events.***
- ***Providing amenity and increased vegetative cover.***
- ***Utilises the same space as is normally used for gardens.***
- ***Providing better growing conditions (free draining soils) for plants and thus improves the garden, and***
- ***Mimics nature and uses natural processes.***

Hamilton City Council
Te kaunihera o Kirikiriroa

2. BIORETENTION – FULL TREATMENT

2.1 Minimum design requirements

The following information is intended as a guide only. All bioretention systems within Hamilton City require specific design by a suitably qualified person and approval from Hamilton City Council's Building Control Unit.

General design requirements are presented below. Figure 1 presents the typical layers within a bioretention system:

1. **Size and shape:** Bioretention systems can be any shape. Shapes that blend in with the site can improve site amenity and look more natural. Bioretention systems are to be designed to cater to stormwater runoff from impermeable areas at your property. The bioretention system size refers to the AREA that is filled with planting soil mix and should be sized so that it has an area equivalent to 2% of the impermeable area draining it to provide water quality treatment, or 5% if providing extended detention and water quality treatment. The minimum size for a bioretention system is $2m^2$.

2. **Location:** Devices should be located so that stormwater can flow to the device under gravity. **The bulk and location of the bioretention system shall be in accordance with the requirements for onsite soakage systems, including being above the winter high water table**[2].

3. **Inlet design**: Good inlet design is essential for a bioretention systems to work. The most important thing to consider is that the water must be able to flow into the device. Flow should be directed into the device in a sheet flow over a vegetated filter strip if possible, and should always flow into the device in a manner which avoids concentrated flows and scour. If possible high flows should bypass the device.

   For household raingardens the inlet can be provided with a factory made PVC flow spreader, a cost effective option.

4. **Planting soil mix:** The main component of the bioretention system is the planting soil mix (refer to Section 4 for more details). The minimum soil depth is 600mm (500mm of planting soil mix and 100mm transition layer) which should be increased to at least 1m when trees are planted.

   For rain gardens, stormwater planters and tree pits the surface of the planting soil should be flat and level to avoid localised ponding and blinding, while for bio-retention swales the surface should be gently sloping. Soil compaction should be avoided, allowing natural compaction only. Install materials in 300mm layers and soak with water to aid natural compaction. Depending on the soil material, up to 20% natural compaction may occur over time.

5. **Plants:** Native plants are preferable but not essential. Any plants which suit your garden may be used. The plants should be able to tolerate short periods of inundation and longer dry periods, be perennial rather than annual, have deep fibrous root systems and have spreading rather than clumped growth forms. Note that the use of wetland plants is not recommended as these plants are not well suited to free draining soils.

6. **Mulch:** 50-100mm surface mulch layer. Note that the depth of mulch should be taken into account when setting the overflow level. Ensuring stormwater runoff doesn't wash mulch into drains and cause blockages can be addressed by good device design and selection of a mulch material that doesn't float.

7. **Under drain:** Bioretention systems typically require under drains. The under drain should be a perforated PVC pipe with a minimum diameter of 100mm and should have a minimum slope of 0.5% (5cm over 10m). For bioretention areas up to $10m^2$ a single 100mm diameter pipe will suffice, for areas between $10m^2$ and $20m^2$ a single 150mm or two 100mm diameter pipes will suffice. For areas larger than $20m^2$ a site specific design is required. Under drain spacing - there should be one under drain per 3m width of bioretention system.

   Under drains should be evenly spaced along the length of the device. They should be placed 75 to 300mm above the bottom of the drainage layer where no liner is present to allow for infiltration into the in-situ soils, or on top of the liner if one is used. There should be at least 25mm of drainage layer above the top of the under drain. The underdrain shall be connected an approved stormwater outfall in accordance with Council's drainage hierarchy.

8. **Liner:** An impervious liner is required when bioretention is used in geotechnically unstable or steep sites greater than 1V:5H. The use of stormwater planters should be considered in these situations.

9. **Geofabric:** The use of geofabric in the construction of bioretention systems is generally not recommended.

10. **Root barrier**: Consider using a root barrier when there are susceptible services such (as sewers), or foundations nearby. These are likely to be at risk from root penetration. The root barrier should only be placed adjacent to the services which require protection and not around the whole device.

11. **Filter layer:** A filter layer is required between the planting soil and the drainage layer. A geofabric is not recommended for this purpose. The filter zone should consist of 50mm of pea-gravel (US #8 (1.18mm - 9.5mm) with 50mm of washed sand (0.5mm – 1mm) on top.

12. **Ponding depth:** Ponding should normally be designed for a depth of 200-300mm above the bed of the device.

13. **Overflow:** Ideally, when the capacity of the rain garden is exceeded, flows should be by-passed to an overflow located outside the rain garden. If an overflow is located within the rain garden then the overflow can be by means of a pipe/manhole which connects into the underdrain system, or it could be a gravel curtain which connects into the drainage layer.

    For household raingardens the overflow can be provided as a 100mm vertical pipe connecting to the underdrain with an elbow bend. When the raingarden is finished the overflow pipe should sit 100mm below the top edge of the raingarden and 100mm above the mulch level. Apply a cap or tape the top of the overflow pipe during construction to prevent debris entering the underdrain.

14. **Access:** Suitable access needs to be provided for routine maintenance. Small residential gardens may require access for a wheel barrow, while larger commercial gardens will require more substantial access, suitable for a small excavator.

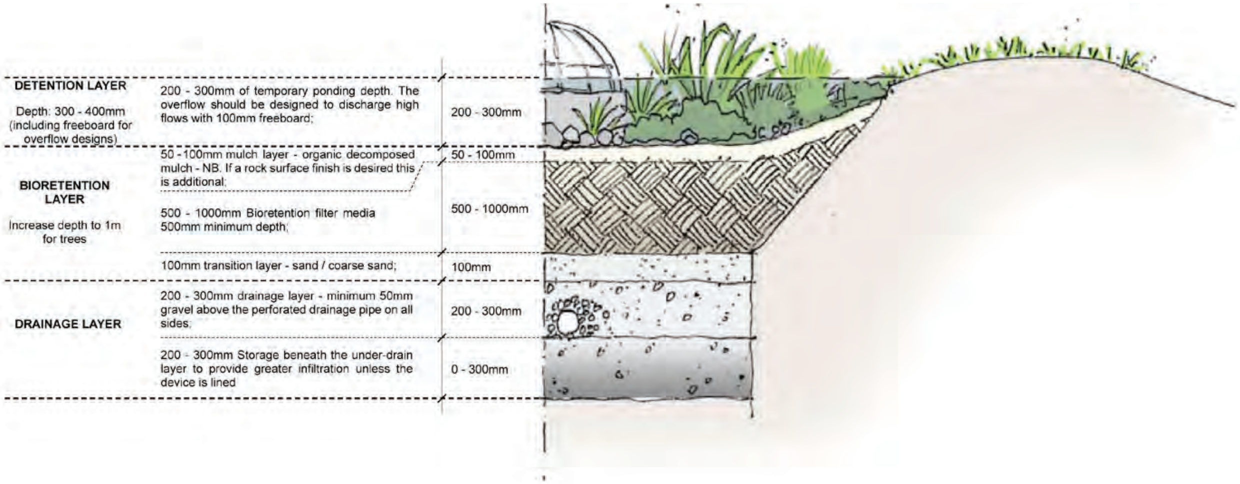


Figure 1: Typical bioretention layers (images here and above from NSCC Bioretention Guidelines July 2008)

[2] Refer to Practice Note HCC 03: Soakage

3. BIORETENTION – REDUCED AT-SOURCE MEASURE

If there is an approved downstream stormwater management device providing stormwater flow attenuation and stormwater quality treatment for your site, you can provide bioretention on-lot designed as a reduced at-source measure only, referred to bioretention reduced (refer to HCC01 Overview for further discussion about this topic).

3.1 Minimum design requirements

The following information is intended as a guide only. All bioretention systems within Hamilton City require specific design by a suitably qualified person and approval from Hamilton City Council's Building Control Unit.

A bioretention reduced device should be designed in accordance with the minimum design requirements described above for the bioretention full treatment device, except the size of the reduced device is assessed differently, as outlined below:

a) The bioretention reduced device is designed to cater to stormwater runoff from impermeable areas where cars drive and park at your property. The bioretention reduced device should be sized so that it has an AREA equivalent to 2% of the impermeable trafficked areas draining to it (i.e. roof area does not need to drain to a bioretention reduced device). The device should be located in such a way to maximise the collection of site runoff from trafficked areas. Refer to Figure 2 below for an indicative schematic of the typical arrangement for a bioretention reduced device. Ensure overflow from the device drains to approved overland flowpath.

b) Refer to Section 2.1 Minimum design requirements for all other details.

c) It is important to ensure the bioretention device is above the winter high water table as per 2 in Section 2.1 above.

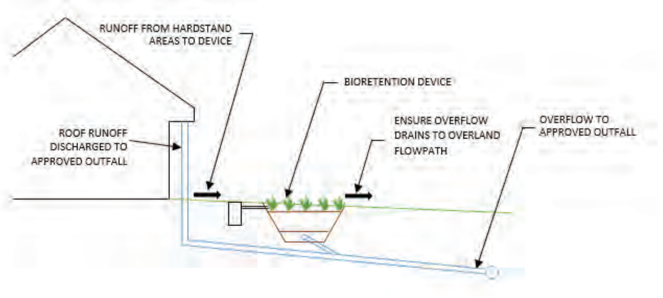


Figure 2: Schematic showing typical arrangement for bioretention reduced

3.2 Example

The following example clarifies how to size a bioretention reduced device for a 500m^2 lot with:

- 250m^2 house and garage
- 125m^2 driveway and associated hardstand area (all trafficked)

The bioretention reduced device is designed to cater to stormwater runoff from impervious areas where cars drive and park. For this site this equates to 125m^2. The bioretention reduced device is sized to have an area equivalent to 2% of the contributing catchment.

Area of bioretention device = 125m^2 x 2% = 2.5m^2

The remaining design parameters for the bioretention reduced device are determined in accordance with Section 2.1 of this practice note - Minimum design requirements.

3.3 Indicative bioretention reduced device sizings

The following table outlines indicative bioretention reduced device sizings for a range of connected impervious areas:

Lot area (m^2)	Bioretention reduced area (m^2)
50	1
100	2
150	3
200	4
250	5
300	6
350	7
400	8

4. BIORETENTION FILTER MEDIA

The bioretention filter media is required to support a range of plants (groundcovers to trees) that are adapted to freely draining soils with occasional flooding. The filter media should generally be a **loamy sand** with high permeability under compaction and should be free of rubbish and weeds. The filter media should contain some organic matter for increased water holding capacity but be low in nutrient content.

General specifications for bioretention filter media are listed below:

- A mix of **mature** compost (approximately 15-25%), soil (approximately 15-25%) and sand (approximately 60%) is recommended. Allophanic (Ash) or Pumice Soils are preferred. Poorly structured clay or silty clay soils should not be used. Pumice sand is preferred.
- A uniform mix, free of stones, stumps, roots or other similar objects and free of brush or seeds from noxious plants.
- Hydraulic conductivity of 50 – 150 mm/hr
- Organic matter content at least 2% (w/w)
- Seed germination score of 6 (out of 7)
- pH range 6 – 7.5

5. CONSTRUCTION

Ideally bioretention systems should not be built until the rest of the site has been constructed and the site stabilised. They must be protected from stormwater flows carrying high sediment loads during construction activities from your site or neighbouring sites. If they are not protected during construction then the planting soil mix will need to be replaced. If work on the bioretention system needs to commence before the rest of the site is stabilised then the device should be constructed, but not planted, and covered with a geofabric and topsoil. This will later be removed and the device planted once the rest of the site has been stabilised.

6. MAINTENANCE

One of the important considerations with bioretention systems is long-term maintenance. Remember that a bioretention system is a garden and not just a drainage system – they are generally low maintenance, not NO maintenance.

They need water when it doesn't rain until the plants are established. During dry periods the under drain in the bioretention systems may cause the planting soil to dry out. Watering the vegetation on an as needed basis helps ensure a healthy condition and appearance.

- Mulch annually with hardwood mulch as this suppresses weeds and retains moisture.
- Every few years' excess mulch may need to be removed.
- Weed regularly as you would with any garden.
- Don't park or drive on the device as this causes compaction and leaves ruts.
- Don't let (fine) sediment build up – if a crust forms remove it & rework the top layer of soil.
- Keep an eye on the plants – if they are unhappy they may need moving. Plants may need pruning, thinning or replacing from time to time.
- Strong water flows may cause erosion, this will need to be repaired and measures put in place to prevent recurrence.
- Check the overflow for clogging and remove any build-up of rubbish or debris regularly.

7. SUMMARY OF PLANNING REQUIREMENTS

Your bioretention system must be consented either as part of the whole site's building consent or as a separate building consent.

For details on building consents please contact Hamilton City Council's Building Control Unit phone (07) 838 6699.

Bioretention systems are required to be designed by a suitably qualified person based on this practice note, council's Infrastructure Technical Guideline and other best practice guidance. As-laid plans, authorised by a registered installer, are required for the drainage components of the bioretention system and shall be provided to council.

APPENDIX 4

Pond J Sizing Comparison

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

CIVILPLAN CONSULTANTS

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: **Total Pond J catchment as per original design**

TOTAL CATCHMENT AREA: **106.000 Ha**

SCENARIO: **Original Pond J design storms**

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**B**	**Rural Residential**	**69**	**43.400**	2994.600
South Auckland Volcanic Field	**B**	**Residential**	**69**	**6.200**	427.800
South Auckland Volcanic Field	**B**	**Industrial**	**69**	**4.000**	276.000
South Auckland Volcanic Field	**B**	**Bush**	**55**	**0.000**	0.000
			Total Pervious=	53.600	3698.400

CN (weighted) = Total product / Total Area = **69.0**

Ia (weighted) = 5.0 mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.40**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.044**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.53		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.51	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.34	hrs	

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 114.1 mm

			WQV	2 yr	10yr	100yr	30mm	
Av. recurrence interval		ARI=	**1/3 2yr**	**2 yr**	**10yr**	**100yr**	**30mm**	
24hr rainfall depth (mm)	(+16.8%)	P24+CC=	**26.0**	**80.0**	**152.0**	**245.0**	**30.0**	
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.07	0.23	0.38	0.51	0.08	
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.014	0.046	0.069	0.084	0.017	
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.20	1.95	5.63	11.08	0.27	
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	3.3	29.7	82.8	162.7	4.5	
Runoff Volume (m³)	1000*Q24*A/100	V24=	1749	15943	44357	87185	2408	

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area	
South Auckland Volcanic Field	**B**	**Rural Residential**	**98**	**4.800**	470.400	
South Auckland Volcanic Field	**B**	**Residential**	**98**	**11.500**	1127.000	86169
South Auckland Volcanic Field	**B**	**Industrial**	**98**	**36.100**	3537.800	11863
			Total Impervious=	52.400	5135.200	

CN (weighted) = Total product / Total Area = **98.0**

Ia (weighted) = 0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.4**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.044**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.96		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.36	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs	

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	2 yr	10yr	100yr	30mm	
Av. recurrence interval		ARI=	**1/3 2yr**	**2 yr**	**10yr**	**100yr**	**30mm**	
24hr rainfall depth (mm)	(From graphs in TP 108)	P24+CC=	**26.0**	**80.0**	**152.0**	**245.0**	**30.0**	
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.71	0.89	0.94	0.96	0.74	0.00
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.121	0.130	0.131	0.132	0.123	0.000
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	1.65	5.45	10.47	16.96	1.94	0.00
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	21.7	75.1	147.0	239.9	25.6	0.0
Runoff Volume (m³)	1000*Q24*A/100	V24=	11359	39369	77021	125720	13404	0

TOTALS:

	WQV	2 yr	10yr	100yr	30mm	0
Peak flow rate (m³/s):	**1.85**	**7.41**	**16.10**	**28.04**	**2.21**	**0.00**
Runoff volume (m³):	**13109**	**55312**	**121379**	**212905**	**15812**	**0**

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

CIVILPLAN CONSULTANTS

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: **Total Pond J catchment as per original design**

TOTAL CATCHMENT AREA: **106.000** **Ha**

SCENARIO: **Current ITS design storms**

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**B**	**Rural Residential**	**69**	**43.400**	2994.600
South Auckland Volcanic Field	**B**	**Residential**	**69**	**6.200**	427.800
South Auckland Volcanic Field	**B**	**Industrial**	**69**	**4.000**	276.000
South Auckland Volcanic Field	**B**	**Bush**	**55**	**0.000**	0.000
			Total Pervious=	53.600	3698.400

CN (weighted) = Total product / Total Area = **69.0**

Ia (weighted) = 5.0 mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.40**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.044**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.53		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.51	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.34	hrs	

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 114.1 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.07	0.09	0.24	0.30	0.34	0.48
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.015	0.019	0.047	0.056	0.063	0.081
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.22	0.34	2.05	3.23	4.28	9.57
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	3.7	5.5	31.2	48.2	63.5	140.8
Runoff Volume (m³)	1000*Q24*A/100	V24=	1972	2936	16707	25844	34012	75472

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**B**	**Rural Residential**	**98**	**4.800**	470.400
South Auckland Volcanic Field	**B**	**Residential**	**98**	**11.500**	1127.000
South Auckland Volcanic Field	**B**	**Industrial**	**98**	**36.100**	3537.800
			Total Impervious=	52.400	5135.200

CN (weighted) = Total product / Total Area = **98.0**

Ia (weighted) = 0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.40**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.044**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.96		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.36	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs	

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.73	0.76	0.89	0.91	0.92	0.96
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.122	0.125	0.130	0.131	0.131	0.132
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	1.75	2.15	5.61	7.34	8.76	15.24
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	23.0	28.4	82.2	102.2	122.6	215.3
Runoff Volume (m³)	1000*Q24*A/100	V24=	12078	14888	43087	53532	64224	112837

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Peak flow rate (m³/s):	**1.98**	**2.49**	**7.66**	**10.57**	**13.04**	**24.82**
Runoff volume (m³):	**14050**	**17825**	**59794**	**79377**	**98236**	**188308**

AVERAGE SLOPE BY END AREA METHOD					
Elevation (m)	**h (m)**	**x (m)**	**delta x (m)**	**average h (m)**	**delta A (m²)**
23.0	0.0	**0.0**			
25.0	2.0	**105.0**	105.0	1.0	105.0
30.0	7.0	**286.0**	181.0	4.5	814.5
35.0	12.0	**450.0**	164.0	9.5	1558.0
40.0	17.0	**577.0**	127.0	14.5	1841.5
45.0	22.0	**651.0**	74.0	19.5	1443.0
50.0	27.0	**700.0**	49.0	24.5	1200.5
55.0	32.0	**747.0**	47.0	29.5	1386.5
60.0	37.0	**757.0**	10.0	34.5	345.0
64.0	41.0	**767.0**	10.0	39.0	390.0
79.0	56.0	**1117.0**	350.0	48.5	16975.0
			1117.0		26059.0
Sc =	0.042				

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

CIVILPLAN CONSULTANTS

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: **Total Pond J catchment post development**

TOTAL CATCHMENT AREA: **106.000** **Ha**

SCENARIO: **Current ITS design storms**

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**B**	**Rural Residential**	**69**	**34.760**	2398.440
South Auckland Volcanic Field	**B**	**Residential**	**69**	**9.560**	659.640
South Auckland Volcanic Field	**B**	**Industrial**	**69**	**4.000**	276.000
South Auckland Volcanic Field	**B**	**Bush**	**55**	**0.000**	0.000
			Total Pervious=	48.320	3334.080

CN (weighted) =	Total product / Total Area =		**69.0**	
Ia (weighted) =			5.0	mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.40**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.044**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.53		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.51	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.34	hrs	

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 114.1 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.07	0.09	0.24	0.30	0.34	0.48
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.015	0.019	0.047	0.056	0.063	0.081
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.20	0.30	1.85	2.92	3.86	8.63
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	3.7	5.5	31.2	48.2	63.5	140.8
Runoff Volume (m³)	1000*Q24*A/100	V24=	1777	2647	15061	23298	30662	68037

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**B**	**Rural Residential**	**98**	**3.840**	376.320
South Auckland Volcanic Field	**B**	**Residential**	**98**	**17.740**	1738.520
South Auckland Volcanic Field	**B**	**Industrial**	**98**	**36.100**	3537.800
			Total Impervious=	57.680	5652.640

CN (weighted) =	Total product / Total Area =		**98.0**
Ia (weighted) =			0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.40**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.044**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.96		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.36	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs	

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Av. recurrence interval		ARI=	**1/3 2yr**	**EDV**	**2yr+CC**	**5yr+CC**	**10yr+CC**	**100yr+CC**
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	**23.5**	**28.2**	**70.4**	**91.7**	**109.2**	**188.7**
24hr rainfall depth+CC (mm)	(From graphs in TP 108)	P24+CC=	**27.4**	**32.9**	**82.2**	**107.1**	**127.5**	**220.4**
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.73	0.76	0.89	0.91	0.92	0.96
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.122	0.125	0.130	0.131	0.131	0.132
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	1.93	2.37	6.17	8.08	9.65	16.78
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	23.0	28.4	82.2	102.2	122.6	215.3
Runoff Volume (m³)	1000*Q24*A/100	V24=	13295	16389	47429	58927	70695	124206

TOTALS:

	WQV	EDV	50% AEP+ 16.8%CC	20% AEP+ 16.8%CC	10% AEP+16.8%CC	1% AEP+16.8% CC
Peak flow rate (m³/s):	**2.13**	**2.67**	**8.02**	**11.00**	**13.50**	**25.41**
Runoff volume (m³):	**15072**	**19036**	**62490**	**82225**	**101357**	**192244**

AVERAGE SLOPE BY END AREA METHOD					
Elevation (m)	**h (m)**	**x (m)**	**delta x (m)**	**average h (m)**	**delta A (m²)**
23.0	0.0	**0.0**			
25.0	2.0	**105.0**	105.0	1.0	105.0
30.0	7.0	**286.0**	181.0	4.5	814.5
35.0	12.0	**450.0**	164.0	9.5	1558.0
40.0	17.0	**577.0**	127.0	14.5	1841.5
45.0	22.0	**651.0**	74.0	19.5	1443.0
50.0	27.0	**700.0**	49.0	24.5	1200.5
55.0	32.0	**747.0**	47.0	29.5	1386.5
60.0	37.0	**757.0**	10.0	34.5	345.0
64.0	41.0	**767.0**	10.0	39.0	390.0
79.0	56.0	**1117.0**	350.0	48.5	16975.0
			1117.0		26059.0
Sc =	0.042				

CIVILPLAN CONSULTANTS

Client:	**DFH Joint Venture**
Project:	**Graham Block Pokeno**
Job No:	**1950**
Designer:	**AJH**
Date:	**03.03.17**
Revision:	**1**

STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CATCHMENT: **Total Pond J catchment post development**

TOTAL CATCHMENT AREA: **106.000 Ha**

SCENARIO: **Original Pond J design storms**

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**B**	**Rural Residential**	**69**	**34.760**	2398.440
South Auckland Volcanic Field	**B**	**Residential**	**69**	**9.560**	659.640
South Auckland Volcanic Field	**B**	**Industrial**	**69**	**4.000**	276.000
South Auckland Volcanic Field	**B**	**Bush**	**55**	**0.000**	0.000
			Total Pervious=	48.320	3334.080

CN (weighted) = Total product / Total Area = **69.0**

Ia (weighted) = 5.0 mm

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.40**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.044**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.53		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.51	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.34	hrs	

Graphical Peak Flow Rate:

Soil Storage Parameter S = ((1000/CN)-10)*25.4= 114.1 mm

			WQV	2 yr	10yr	100yr	30mm	
Av. recurrence interval		ARI=	**1/3 2yr**	**2 yr**	**10yr**	**100yr**	**30mm**	
24hr rainfall depth (mm)	(From graphs in TP 108)	P24+CC=	**26.0**	**80.0**	**152.0**	**245.0**	**30.0**	
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.07	0.23	0.38	0.51	0.08	
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.014	0.046	0.069	0.084	0.017	
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	0.18	1.76	5.07	9.99	0.25	
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	3.3	29.7	82.8	162.7	4.5	
Runoff Volume (m³)	1000*Q24*A/100	V24=	1577	14372	39988	78597	2171	

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
South Auckland Volcanic Field	**B**	**Rural Residential**	**98**	**3.840**	376.320
South Auckland Volcanic Field	**B**	**Residential**	**98**	**17.740**	1738.520
South Auckland Volcanic Field	**B**	**Industrial**	**98**	**36.100**	3537.800
			Total Impervious=	57.680	5652.640

CN (weighted) = Total product / Total Area = **98.0**

Ia (weighted) = 0.0

Time of Concentration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	**0.8**	*(Averaged)*	
Catchment Length (measured along drainage path)		L=	**1.40**	km	
Catchment Slope (calculated by equal area method)		Sc=	**0.044**	m/m	
Runoff Factor =	CN/(200-CN)=	RF=	0.96		
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.36	hrs	min. of 0.17hrs to be used
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs	

Graphical Peak Flow Rate:

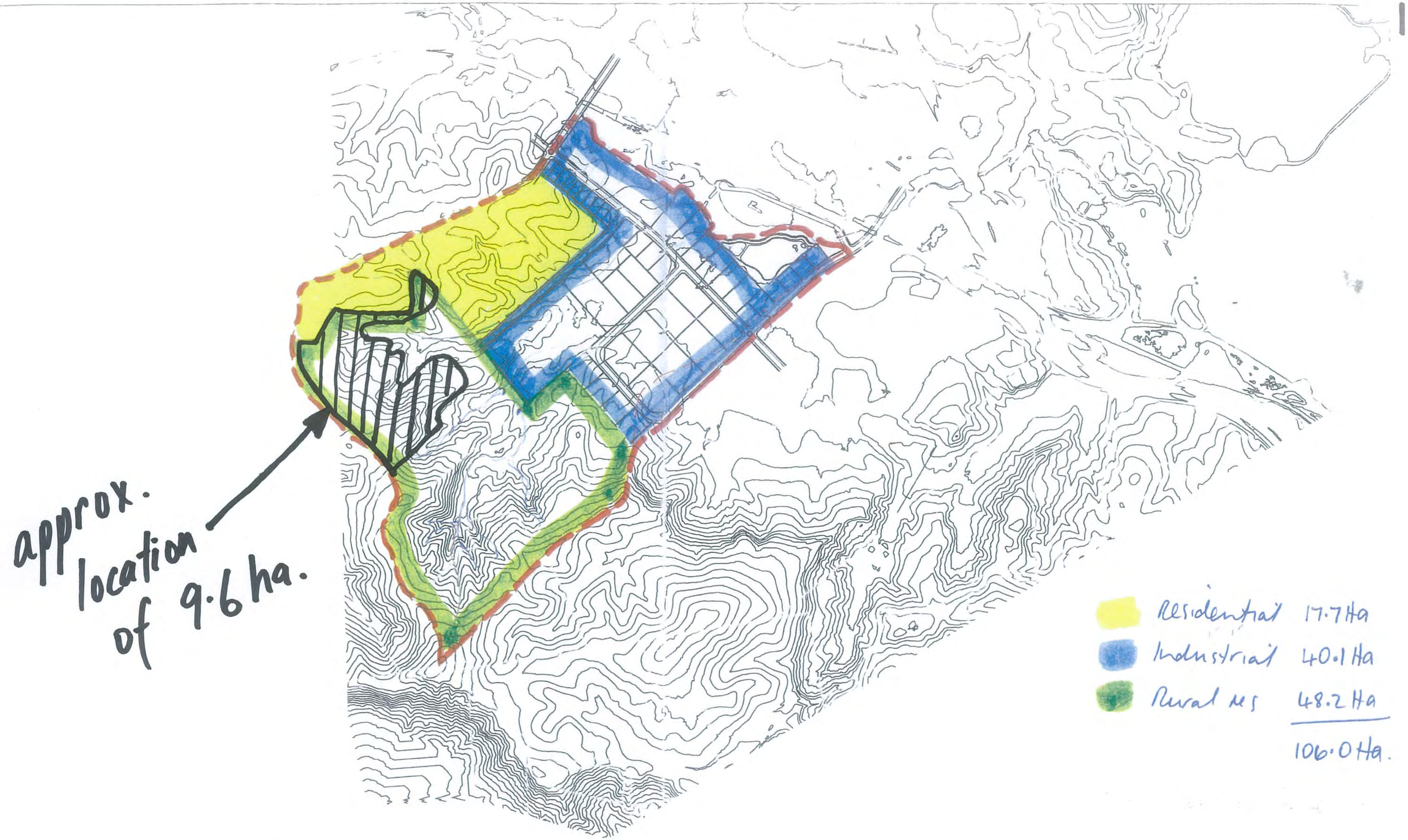
Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	2 yr	10yr	100yr	30mm	
Av. recurrence interval		ARI=	**1/3 2yr**	**2 yr**	**10yr**	**100yr**	**30mm**	
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=						
24hr rainfall depth (mm)	(From graphs in TP 108)	P24+CC=	**26.0**	**80.0**	**152.0**	**245.0**	**30.0**	
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.71	0.89	0.94	0.96	0.74	
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.121	0.130	0.131	0.132	0.123	
Peak Flow Rate (m³/s)	A*P24*q*/100	qp=	1.82	6.00	11.53	18.67	2.14	
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia+S)	Q24=	21.7	75.1	152.0	239.9	25.6	
Runoff Volume (m³)	1000*Q24*A/100	V24=	12504	43336	87674	138388	14755	

TOTALS:

	WQV	2 yr	10yr	100yr	30mm	
Peak flow rate (m³/s):	**2.00**	**7.76**	**16.60**	**28.66**	**2.38**	
Runoff volume (m³):	**14081**	**57708**	**127661**	**216985**	**16925**	

AVERAGE SLOPE BY END AREA METHOD					
Elevation (m)	**h (m)**	**x (m)**	**delta x (m)**	**average h (m)**	**delta A (m²)**
23.0	0.0	**0.0**			
25.0	2.0	**105.0**	105.0	1.0	105.0
30.0	7.0	**286.0**	181.0	4.5	814.5
35.0	12.0	**450.0**	164.0	9.5	1558.0
40.0	17.0	**577.0**	127.0	14.5	1841.5
45.0	22.0	**651.0**	74.0	19.5	1443.0
50.0	27.0	**700.0**	49.0	24.5	1200.5
55.0	32.0	**747.0**	47.0	29.5	1386.5
60.0	37.0	**757.0**	10.0	34.5	345.0
64.0	41.0	**767.0**	10.0	39.0	390.0
79.0	56.0	**1117.0**	350.0	48.5	16975.0
			1117.0		26059.0
Sc =	0.042				



1:10,000 A3

REF	AMENDMENT	BY	DATE

DESIGNED: DATE: SIGNATURE:
DRAWN: DATE: SIGNATURE.
CHECKED: DATE: SIGNATURE:
APPROVED: DATE: SIGNATURE:
CAD REF: C:\pokeno\CAD\industrial Area\pork5.dwg

PLOT DATE: 23Aug06 12:34p.m.
PLOT BY: MIKE SMITH
SURVEY BY:
SURVEY DATE:
SURVEY REF:

ASSOCIATION OF CONSULTING ENGINEERS NEW ZEALAND
ACENZ
ISO 9001 QUALITY ASSURED

HARRISON GRIERSON
CONSULTING ENGINEERS SURVEYORS PLANNERS
Level 5 Cogita House. 20 Amersham Way Manukau City Ph 09 966 3380 Fax 09 966 3390

PROJECT:
POKENO LANDOWNER CONSORTIUM

TITLE:
PROPOSED FINISHED CONTOUR PLAN

PLOT STATUS:
DRAFT

PROJECT No: 1150.121412.
SCALES: 1:2500 A1; 1:5000 A3
DRAWING No: 121412-8-200
REV

HARRISON GRIERSON CONSULTANTS LTD
STORMWATER PEAK FLOW RATE,RUNOFF DEPTH, AND RUNOFF VOLUME (ARC TP 108)

CLIENT:	DFH JOINT VENTURE	DESIGNER:	MSS
PROJECT:	POKENO INDUSTRIAL BLOCK	JOB NO.:	128287
OUTFALL:	Pond J	DATE:	12.06.09

NOTE: This spreadsheet calculates stormwater peak flow rates using ARC TP 108, Graphical Method.

PERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
	B	Rural residential	69	43.4	2993
	B	Residential	69	6.2	428
	B	Industrial	69	4.0	277
	B	Bush	55	0.0	0
					0
			Total Pervious=	53.6	3698

CN (weighted) = Total product / Total Area = **69.0**

Ia (weighted) = 5.0 mm

Time of Concerntration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	0.8	*(Averaged)*
Catchment Length (measured along drainage path)		L=	1.40	km
Catchment Slope (calculated by equal area method)		Sc=	0.044	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.53	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.51	hrs
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.34	hrs

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 114.1 mm

			WQV	Storm B	Storm C	Storm D	Storm E
Av. recurrence interval		ARI=	1/3 2yr	2yr	10yr	100yr	
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	26	80	152	245	
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.07	0.23	0.38	0.51	-0.05
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.020	0.045	0.070	0.085	
Peak Flow Rate (m3/s)	A*P24*q*/100	qp=	0.28	1.93	5.70	11.16	0.00
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia)+S	Q24=	3.4	29.7	82.8	162.7	0.2
Runoff Volume (m3)	1000*Q24*A/100	V24=	1811	15940	44349	87169	123

2

IMPERVIOUS CATCHMENT

Runoff Curve Number (CN) and Initial Abstraction (Ia):

Soil Type	Soil Classification	Cover Description (cover type, treatment, hydrological cond.)	Curve No. CN	Area Ha	CN * Area
	B	Rural residential	98	4.8	472
	B	Residential	98	11.5	1127
	B	Industrial	98	36.1	3537
	B				0
			Total Impervious=	52.4	5136

CN (weighted) =	Total product / Total Area =		98.0
Ia (weighted) =			0.0

Time of Concerntration:

Channelisation Factor (choose C=0.6 piped or C=0.8 engineered grass channels)		C=	0.8	*(Averaged)*
Catchment Length (measured along drainage path)		L=	1.40	km
Catchment Slope (calculated by equal area method)		Sc=	0.044	m/m
Runoff Factor =	CN/(200-CN)=	RF=	0.96	
tc =	0.14*C*L^0.66*((CN/(200-CN))^-0.55*Sc^-0.30 =	tc=	0.36	hrs
SCS lag for HEC-HMS =	tp = 2/3*tc=	tp=	0.24	hrs

Graphical Peak Flow Rate:

Storage S = ((1000/CN)-10)*25.4= 5.2 mm

			WQV	Storm B	Storm C	Storm D	Storm E
Av. recurrence interval		ARI=	1/3 2yr	2yr	10yr	100yr	
24hr rainfall depth (mm)	(From graphs in TP 108)	P24=	26	80	152	245	
c* =	(P24-2Ia)/(P24-2Ia+2S)	c*=	0.72	0.89	0.94	0.96	0.00
Specific Peak Flow Rate	(from fig 5.1 in TP 108)	q*=	0.122	0.082	0.135	0.135	
Peak Flow Rate (m3/s)	A*P24*q*/100	qp=	1.69	3.44	10.75	17.33	0.00
Runoff Depth (mm)	(P24-Ia)^2/(P24-Ia)+S	Q24=	22.1	75.1	147.0	239.9	0.0
Runoff Volume (m3)	1000*Q24*A/100	V24=	11565	39377	77036	125744	0

TOTALS:

	WQV	Storm B	Storm C	Storm D	Storm E
Peak flow rate:	**1.97**	**5.37**	**16.46**	**28.49**	**0.00**
Runoff volume:	**13376**	**55316**	**121385**	**212913**	**123**

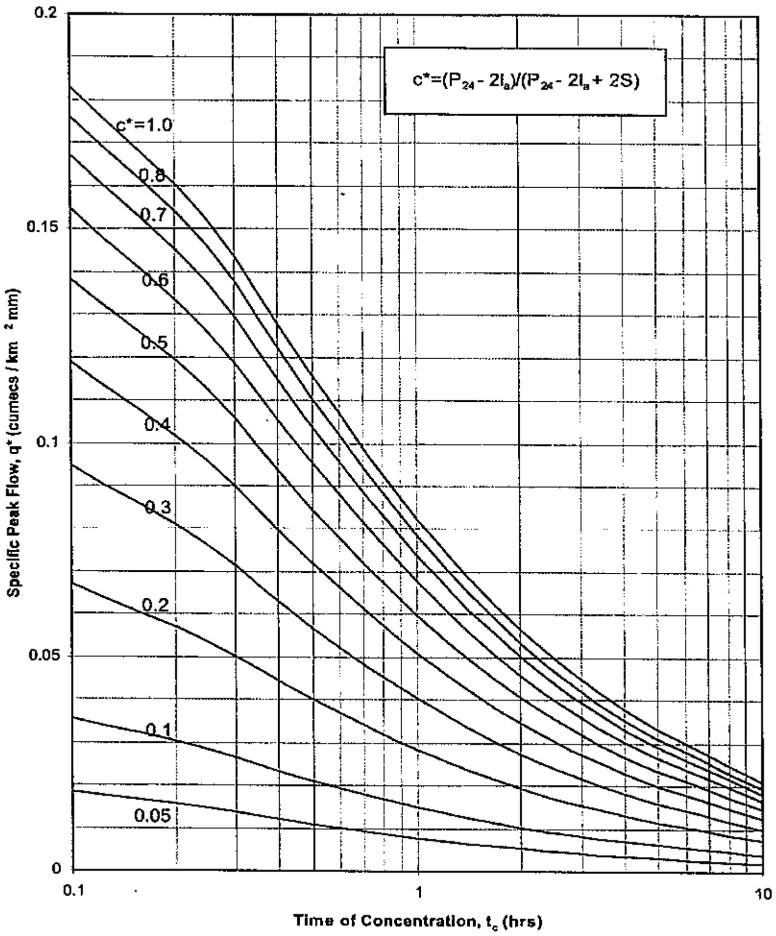


Figure 5.1 - Specific Peak Flow Rate

STORMWATER TREATMENT PONDS
POND SIZING AND EFFICIENCY RATING

CLIENT: DFH Joint Venture
PROJECT: Pokeno Industrial - Pond J
(with rural going into pond)

DATE: 15.06.09
DESIGNER: MSS

Total catchment area to pond:	m2	1060000
Total impervious catchment area:	m2	524000
Total pervious area:	m2	536000
Overall average impervious percentage:	%	**49.4**

Soil type:	Soil	clay
Select trial depth:	da (m)	2.0
Design storm depth (from figure 4.2):	Sd (mm)	30.0
Runoff volume from impervious areas:	Vimp (m3)	11716
Runoff volumes from pervious areas:	Vperv (m3)	1858
Total water quality volume for 75% TSS removal efficiency:	Vd (m3)	**13574**

Fraction of Target Pond Volume	Pond Volume (m3)	Pond area (m2)	Sediment Removal Efficiency (%)
2	27148	13574	85
1.75	23755	11877	84
1.5	20361	10181	82
1.25	16968	8484	79
1	13574	6787	75
0.75	10181	5090	70
0.5	6787	3394	60
0.25	3394	1697	50

Permanent water surface level RL:	RL (m)	19.5
Chosen stormwater treatment pond volume:	m3	17000
Removal efficiency rate:	%	80

Clean out frequency:

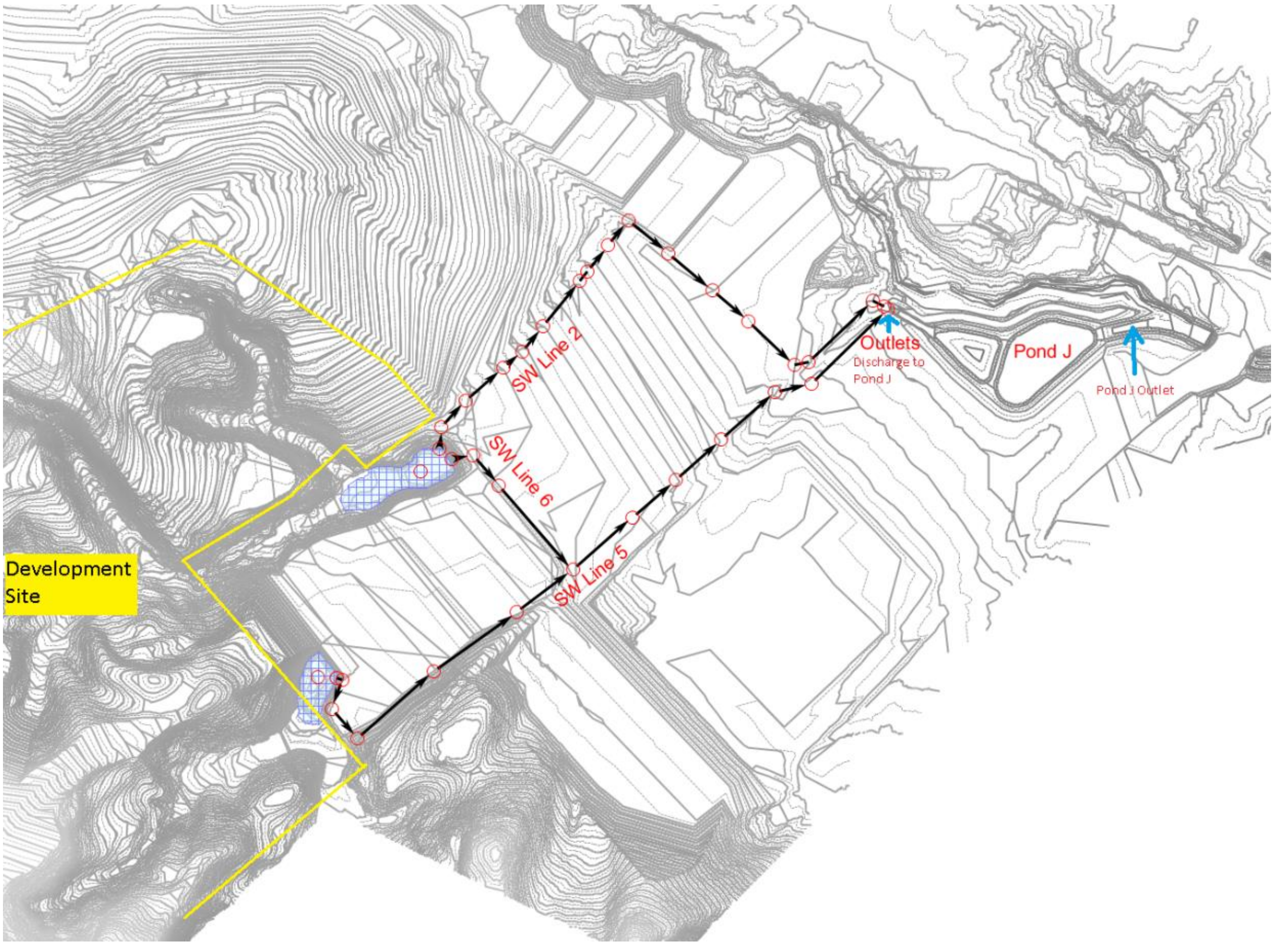
Annual volumetric surface runoff coefficient:	(figure 2.4)		0.8
Annual rainfall:		m	1.3
Long term mean concentration of sediment:	(table2.4)	g/m3	50
Annual sediment load:		Tonnes	**55**
Sediment dry density:		kg/m3	750
Accretion rate:		m3	**73**
% accretion collected by forebay:		%	30
% accretion collected by main pond:		%	70
Minimum forebay volume:		m3	**765**
Chosen forebay volume:		m3	1500
Maximum allowable accretion in forebay:		m3	**150**
Minimum cleanout frequency for sediment forebay:		years	**6.8**
Main pond volume:		m3	15500
Maximum allowable accretion in main pond:		m3	**1085**
Minimum cleanout frequency for main pond:		years	**21.1**

MEMO

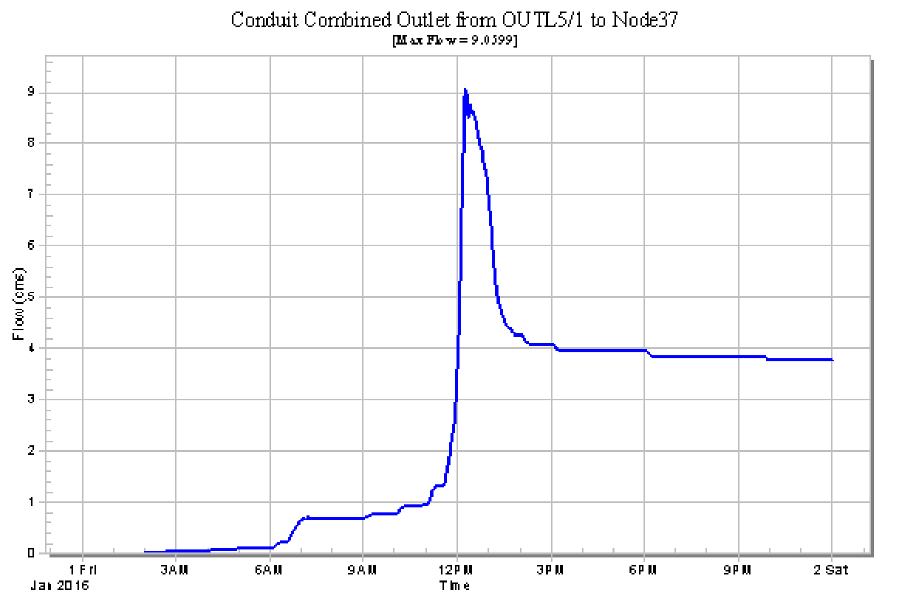
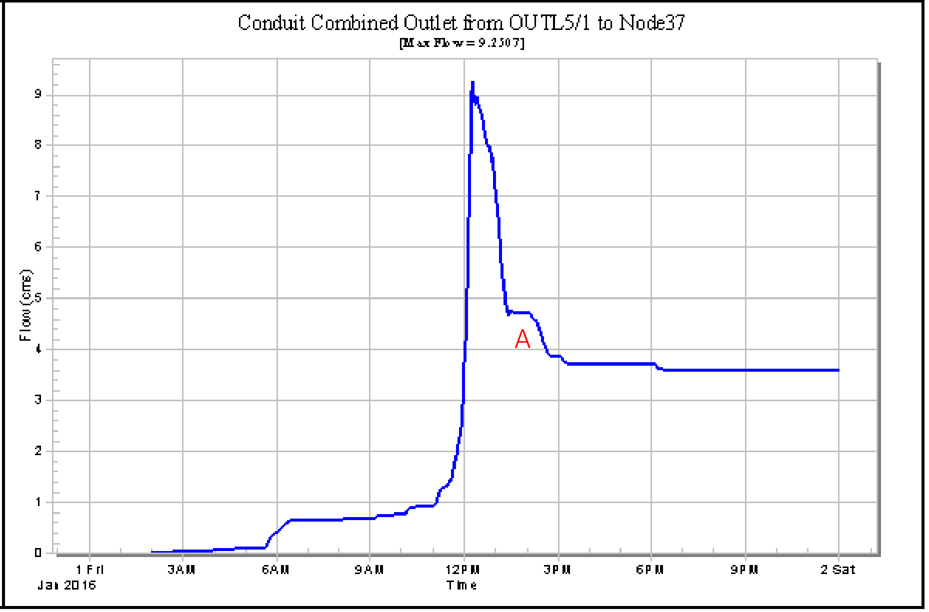
To:	Chris Scrafton	Date:	12 July 2017
From:	Alister Hood	CivilPlan Project No:	1950
Subject:	Graham Block Development Plan Change RFI – Response to Stormwater Matters		

With regard to the Council request for information dated 23 June, 2017, item 3:

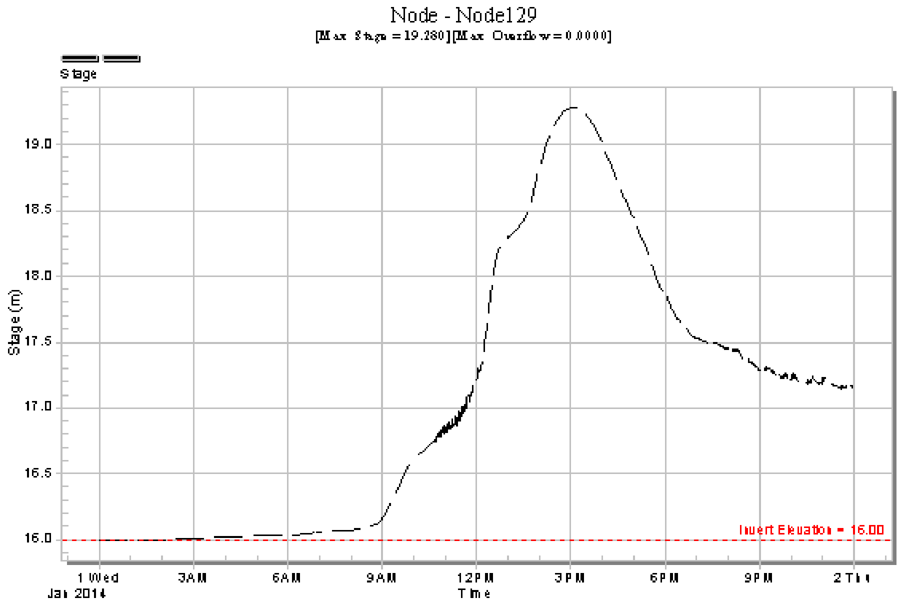
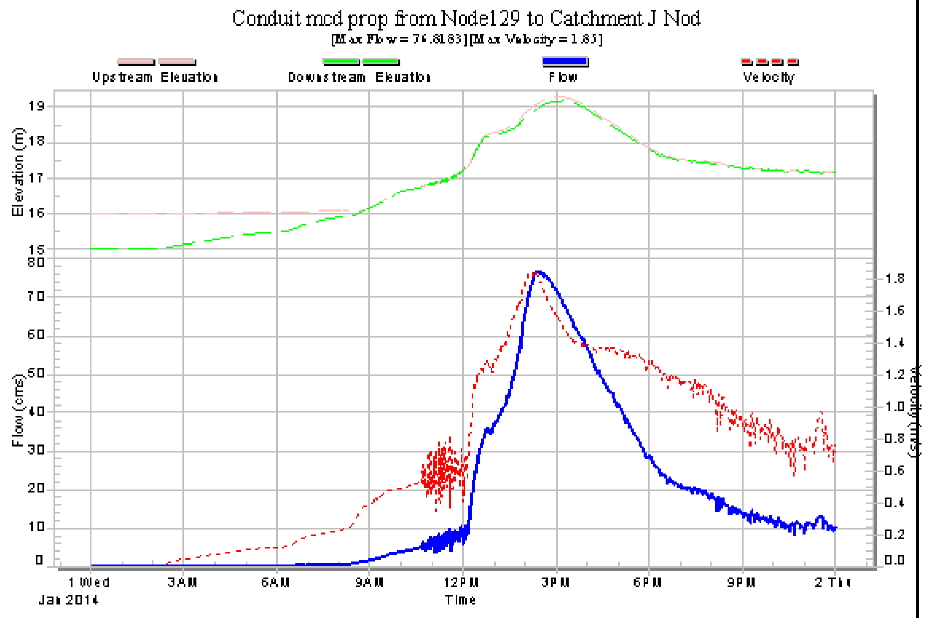
a) All stormwater drainage from the site connects to the Tanitewhiora Stream via pond J. Refer to the plan of the drainage below:



b) The pre- and post-development outlet hydrographs are below. These show that there will be minimal increase in peak flow compared to predevelopment, and after the peak there is about an hour (from 1pm, indicated by A) where the flow is increased from pre-development by approximately 0.5m³/s, after which it drops below predevelopment.

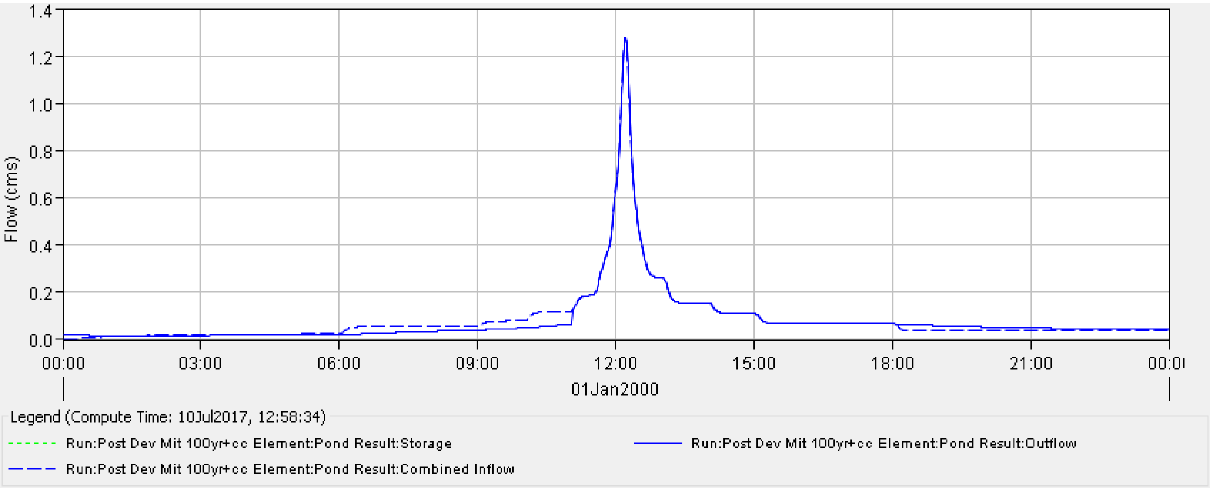
Pre-development Hydrograph – Discharge from SW Lines 2 and 5	Post-development Hydrograph – Discharge from SW Lines 2 and 5
	

This can be compared with the outputs from the overall model for the stream (produced for the Catchment G2 report), shown below, where stage peaks at about 3pm, and flow peaks about 2:30pm. Based on this, the increased flows from the development will be less than 1% of the total flow in the stream at the Pond J outlet, and will pass before the peak at the Pond J outlet. The effects can thus be considered less than minor.

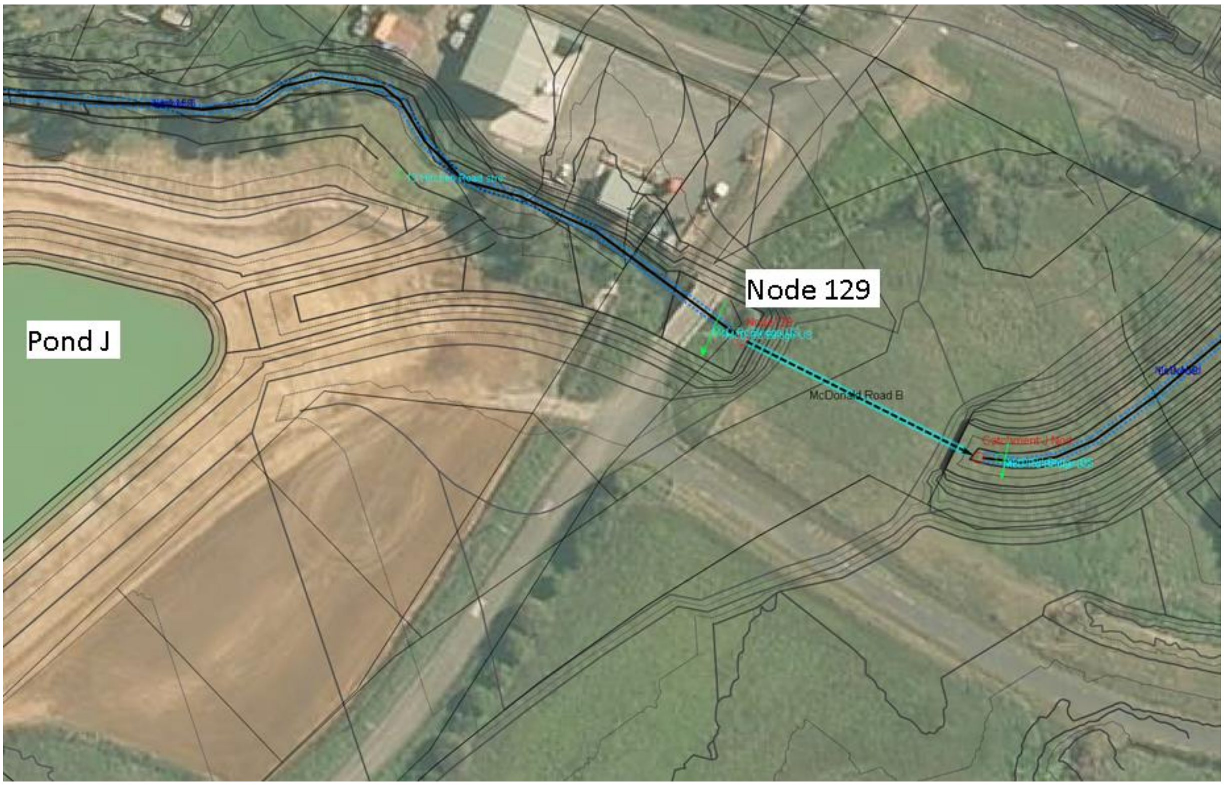
Downstream Stage – Node 129 (refer to location diagram below)	Downstream Hydrograph - McDonald Road Culvert
	

The period of increased flow discussed above is due to detention in the natural stream gulleys. We have assessed the effect of the treatment forebays and the proposed on-lot detention by modelling in HEC-HMS. The model output for the treatment forebays is shown below and shows that there is only a flow reduction between 6am and 11am, and a slightly increased flow (<20l/s) between 6pm and 9pm. The output for the on-lot detention is similar, which indicates that the extended detention will not affect peak catchment flows.

Treatment Forebays Combined Hydrograph



Pond J outlet Location:



c) The conditions of the stormwater discharge consent generally seem to be appropriate without amendment due to generalised wording such as “and any other stormwater treatment devices approved under this consent”. We suggest:

- Condition 1 be amended to add a reference to this application and the stormwater management report 1950 TR001 as supporting documentation.

- Condition 10 be amended to include a reference to drawing 1950-00-SK101 revision D1.

\\c2k12\Data\Jobs\1950 - DFH Joint Venture Hitchen Block Stage 3\correspondence\letters\Graham Block Plan Change RFI - response to stormwater matters.docx