Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Oct 2 2026

Culvert 4

Invert Elev Dn (m)	=	45.8000
Pipe Length (m)	=	24.0000
Slope (%)	=	0.8625
Invert Elev Up (m)	=	46.0070
Rise (mm)	=	750.0
Shape	=	Box
Span (mm)	=	3000.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

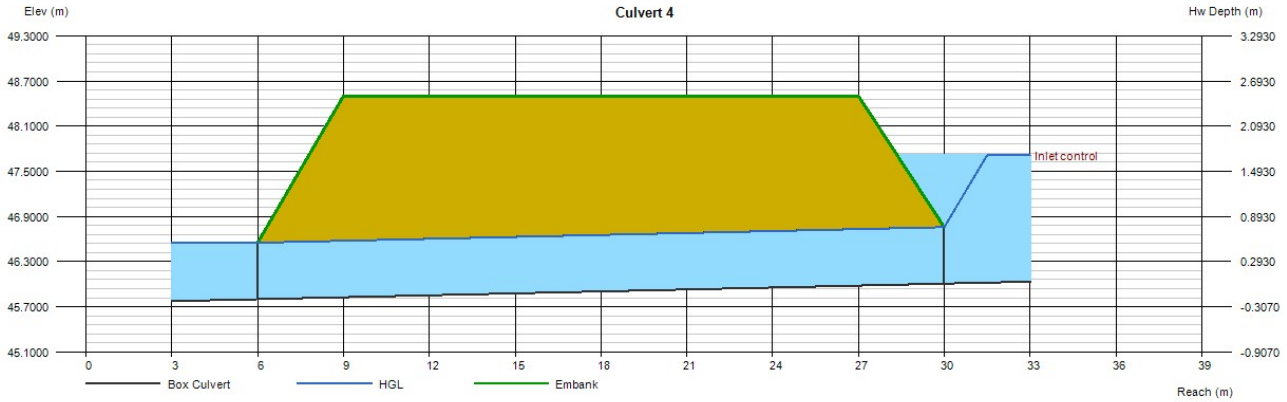
Top Elevation (m)	=	48.5000
Top Width (m)	=	18.0000
Crest Width (m)	=	20.0000

Calculations

Qmin (cms)	=	0.0000
Qmax (cms)	=	7.2800
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	7.0000
Qpipe (cms)	=	7.0000
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	3.1111
Veloc Up (m/s)	=	3.1111
HGL Dn (m)	=	46.5500
HGL Up (m)	=	46.7570
Hw Elev (m)	=	47.7132
Hw/D (m)	=	2.2749
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Oct 2 2026

Culvert 4

Invert Elev Dn (m)	=	51.2700
Pipe Length (m)	=	10.0000
Slope (%)	=	3.7000
Invert Elev Up (m)	=	51.6400
Rise (mm)	=	1345.0
Shape	=	Circular
Span (mm)	=	1345.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

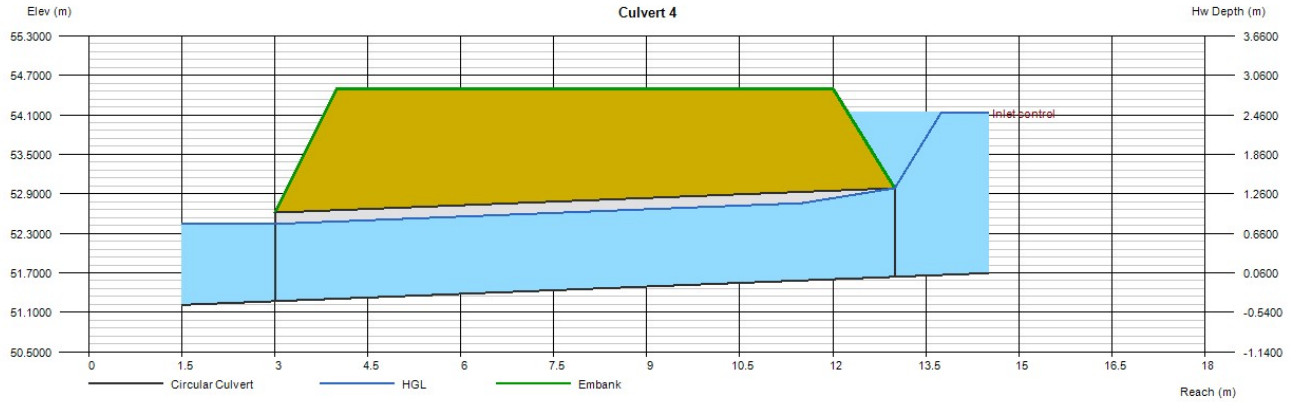
Top Elevation (m)	=	54.5000
Top Width (m)	=	8.0000
Crest Width (m)	=	10.0000

Calculations

Qmin (cms)	=	0.0000
Qmax (cms)	=	5.0800
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	5.0000
Qpipe (cms)	=	5.0000
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	3.8007
Veloc Up (m/s)	=	3.8007
HGL Dn (m)	=	52.4438
HGL Up (m)	=	52.8138
Hw Elev (m)	=	54.1334
Hw/D (m)	=	1.8538
Flow Regime	=	Inlet Control



Culvert Report

Culvert 4

Invert Elev Dn (m)	=	52.8100
Pipe Length (m)	=	15.0000
Slope (%)	=	0.8000
Invert Elev Up (m)	=	52.9300
Rise (mm)	=	1345.0
Shape	=	Circular
Span (mm)	=	1345.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

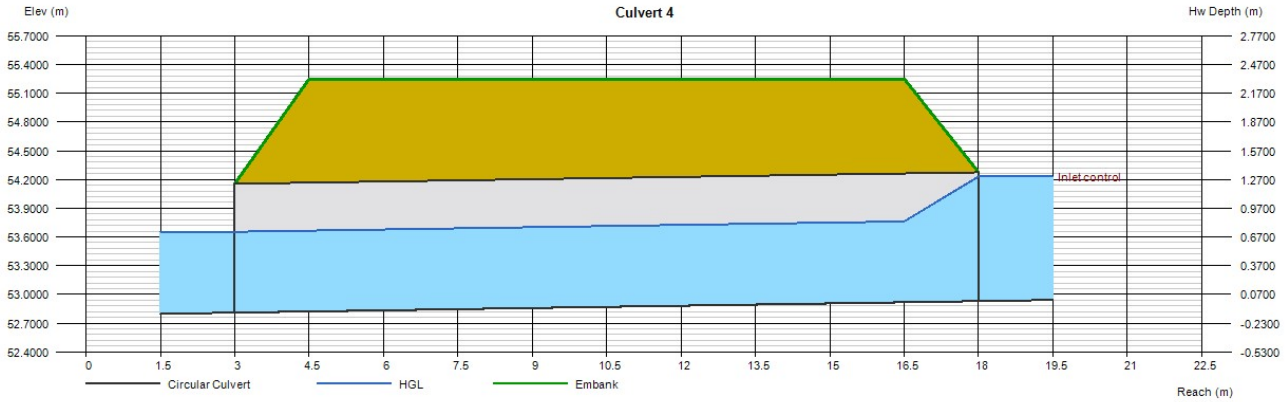
Top Elevation (m)	=	55.2500
Top Width (m)	=	12.0000
Crest Width (m)	=	10.0000

Calculations

Qmin (cms)	=	0.0000
Qmax (cms)	=	2.5700
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	2.5000
Qpipe (cms)	=	2.5000
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	2.6642
Veloc Up (m/s)	=	2.6642
HGL Dn (m)	=	53.6539
HGL Up (m)	=	53.7739
Hw Elev (m)	=	54.2301
Hw/D (m)	=	0.9666
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Oct 2 2026

Culvert 4

Invert Elev Dn (m)	=	58.3700
Pipe Length (m)	=	12.8100
Slope (%)	=	0.1561
Invert Elev Up (m)	=	58.3900
Rise (mm)	=	1076.0
Shape	=	Circular
Span (mm)	=	1076.0
No. Barrels	=	1
n-Value	=	0.012
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

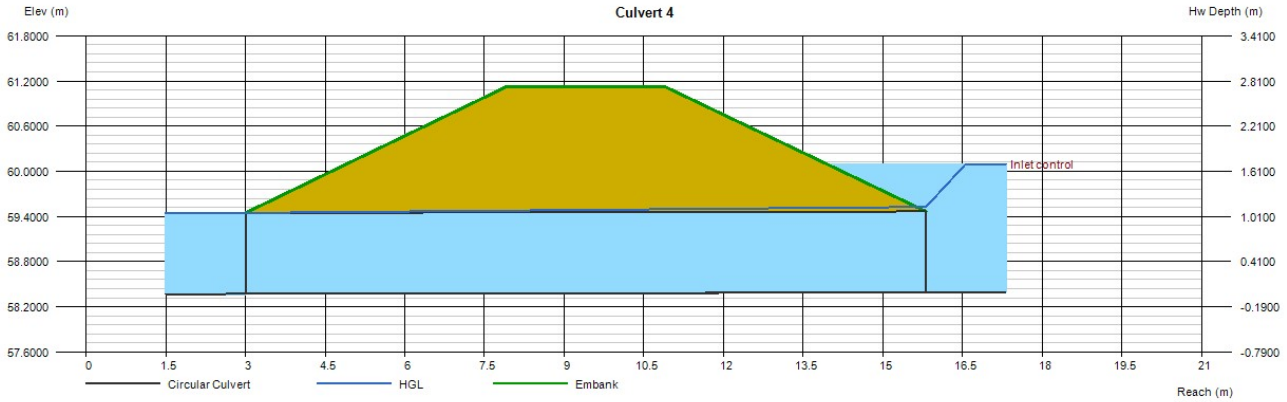
Top Elevation (m)	=	61.1200
Top Width (m)	=	3.0000
Crest Width (m)	=	10.0000

Calculations

Qmin (cms)	=	0.0000
Qmax (cms)	=	3.0000
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	2.5000
Qpipe (cms)	=	2.5000
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	2.7493
Veloc Up (m/s)	=	2.7493
HGL Dn (m)	=	59.4460
HGL Up (m)	=	59.5263
Hw Elev (m)	=	60.0971
Hw/D (m)	=	1.5865
Flow Regime	=	Inlet Control



RIPRAP DESIGN - OUTLET PROTECTION

Culvert 1

DATE: 2/10/2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Span =	3	m	
Pipe Dia. (D_o) =	1	m	From 12d
Slope =	0.8	%	From 12d
Flow (Q) =	6.880	m^3/s	From Hec Ras
Velocity (V) =	2.26	m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe(d_p) =	1	m	
Downstream channel material:	Kikuyu grass - low		
< veloctiy for erosion control (Vmax):	**1.9**	m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F_o) =	$V/(g \times d_p)^{0.5}$	= 0.7216	
Riprap Diameter (d_s) =	$0.25 \times D_o \times F_o$	= 0.18	m
Thickness of Riprap (D_A) =	$2 \times d_s$	= 0.36	m
Lengh of Riprap (L_s) =	$D_o \times (8 + 17 \times \text{Log}F_o)$	= 5.59	m
Head Width of Riprap (W_A) =	$3 \times D_o$	= 3.00	m
Tail Width of Riprap (W_T) =	L_s X 2/3 + W_A	= 6.73	m
Height of Riprap (H) =	crown of pipe + 300 mm	= 1.30	m

HEC14 V3, 2006

Tail Water Depth (TW) =	$0.4 \times D_o$	= 0.40	m
Riprap Size (D_{50}) =	$0.2 \times D \ (Q/g^{0.5}D^{2.5})^{4/3} \ (D/TW)$	= 1.428	m
Thickness of Riprap (D_A) =	$2.0 \times D50$	= 2.86	m
Length of Riprap (L) =	$8 \times D$	= 8.00	m
Head Width of Riprap (W_H) =	$3 \times D_o$	= 3.00	m
Tail Width of Riprap (W_T) =	L X 2/3 + W_H	= 8.33	m

Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.

Wingwall Dimensions

Tail Width of Wingwall (W_w) =		m
Height of Wingall (H_w) =		m

Riprap Dimensions

Design Method (TP10 or HEC14) =	TP10	
Riprap Diameter (d_s) =	0.18	m
Thickness of Riprap (D_A) =	0.36	m
Lengh of Riprap (L_s) =	5.59	m
Head Width of Riprap (W_H) =	3.00	m
Tail Width of Riprap (W_T) =	6.73	m
Height of Riprap (H) =	1.30	m

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 2

DATE: 2/10/2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Pipe Dia. (D_o) =	1.5	m	From 12d
Slope =	3.7	%	From 12d
Flow (Q) =	3.260	m^3/s	From Hec Ras
Velocity (V) =	1.62	m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe (d_p) =	1.5	m	
Downstream channel material:	Kikuyu grass - low		
< veloctiy for erosion control (Vmax):	**1.9**	m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F_o) =	$V/(g \times d_p)^{0.5}$	= 0.4223	
Riprap Diameter (d_s) =	$0.25 \times D_o \times F_o$	= 0.16	m
Thickness of Riprap (D_A) =	$2 \times d_s$	= 0.32	m
Lengh of Riprap (L_s) =	$D_o \times (8 + 17 \times \text{Log}F_o)$	= 2.45	m
Head Width of Riprap (W_A) =	$3 \times D_o$	= 4.50	m
Tail Width of Riprap (W_T) =	L_s X 2/3 + W_A	= 6.14	m
Height of Riprap (H) =	crown of pipe + 300 mm	= 1.80	m

HEC14 V3, 2006

Tail Water Depth (TW) =	$0.4 \times D_o$	= 0.60	m
Riprap Size (D_{50}) =	$0.2 \times D \ (Q/g^{0.5}D^{2.5})^{4/3} \ (D/TW)$	= 0.205	m
Thickness of Riprap (D_A) =	$3.3 \times D50$	= 0.68	m
Length of Riprap (L) =	$4 \times D$	= 6.00	m
Head Width of Riprap (W_H) =	$3 \times D_o$	= 4.50	m
Tail Width of Riprap (W_T) =	L X 2/3 + W_H	= 8.50	m

Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.

Wingwall Dimensions

Tail Width of Wingwall (W_w) =		m
Height of Wingall (H_w) =		m

Riprap Dimensions **V<Vmax, No Riprap required, use wingwall with apron**

Design Method (TP10 or HEC14) =	TP10	
Riprap Diameter (d_s) =	0.16	m
Thickness of Riprap (D_A) =	0.32	m
Lengh of Riprap (L_s) =	2.45	m
Head Width of Riprap (W_H) =	4.50	m
Tail Width of Riprap (W_T) =	6.14	m
Height of Riprap (H) =	1.80	m

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 3

DATE: 2/10/2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Pipe Dia. (D_o) =	1.5	m	From 12d
Slope =	0.8	%	From 12d
Flow (Q) =	3.720	m^3/s	From Hec Ras
Velocity (V) =	1.1	m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe (d_p) =	1.5	m	
Downstream channel material:	Kikuyu grass - low		
< velocity for erosion control (Vmax):	**1.9**	m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F_o) =	$V/(g \times d_p)^{0.5}$	= 0.2868	
Riprap Diameter (d_s) =	$0.25 \times D_o \times F_o$	= 0.11	m
Thickness of Riprap (D_A) =	$2 \times d_s$	= 0.22	m
Lengh of Riprap (L_a) =	$D_o \times (8 + 17 \times \text{Log}F_o)$	= -1.83	m
Head Width of Riprap (W_A) =	$3 \times D_o$	= 4.50	m
Tail Width of Riprap (W_T) =	L_a X 2/3 + W_A	= 3.28	m
Height of Riprap (H) =	crown of pipe + 300 mm	= 1.80	m

HEC14 V3, 2006

Tail Water Depth (TW) =	$0.4 \times D_o$	= 0.60	m
Riprap Size (D_{50}) =	$0.2 \times D \ (Q/g^{0.5}D^{2.5})^{4/3} \ (D/TW)$	= 0.244	m
Thickness of Riprap (D_A) =	$3.3 \times D50$	= 0.81	m
Length of Riprap (L) =	$4 \times D$	= 6.00	m
Head Width of Riprap (W_H) =	$3 \times D_o$	= 4.50	m
Tail Width of Riprap (W_T) =	L X 2/3 + W_H	= 8.50	m

Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.

Wingwall Dimensions

Tail Width of Wingwall (W_w) =		m
Height of Wingall (H_w) =		m

Riprap Dimensions **V<Vmax, No Riprap required, use wingwall with apron**

Design Method (TP10 or HEC14) =	TP10	
Riprap Diameter (d_s) =	0.11	m
Thickness of Riprap (D_A) =	0.22	m
Lengh of Riprap (L_a) =	1.83	m
Head Width of Riprap (W_H) =	4.50	m
Tail Width of Riprap (W_T) =	3.28	m
Height of Riprap (H) =	1.80	m

RIPRAP DESIGN - OUTLET PROTECTION

Culvert 4

DATE: 2/10/2026

CALCULATIONS TO DETERMINE THE RIPRAP REQUIRED FOR THE PIPE OUTLET PROTECTION

Location:

Pipe Dia. (D_o) =	1.2	m	From 12d
Slope =	8.5	%	From 12d
Flow (Q) =	2.810	m^3/s	From Hec Ras
Velocity (V) =	2.5	m/s	Peak velocity taken from HEC RAS
Depth of flow in pipe(d_p) =	1.2	m	
Downstream channel material:	Kikuyu grass - low		
< velocity for erosion control (Vmax):	**1.9**	m/s	(as per Table 1 TR2013/018)

TP10, 2003

Froude number (F_o) =	$V/(g \times d_p)^{0.5}$	= 0.7286	
Riprap Diameter (d_s) =	$0.25 \times D_o \times F_o$	= 0.22	m
Thickness of Riprap (D_A) =	$2 \times d_s$	= 0.44	m
Lengh of Riprap (L_a) =	$D_o \times (8 + 17 \times \text{Log}F_o)$	= 6.80	m
Head Width of Riprap (W_A) =	$3 \times D_o$	= 3.60	m
Tail Width of Riprap (W_T) =	L_a X 2/3 + W_A	= 8.13	m
Height of Riprap (H) =	crown of pipe + 300 mm	= 1.50	m

HEC14 V3, 2006

Tail Water Depth (TW) =	$0.4 \times D_o$	= 0.48	m
Riprap Size (D_{50}) =	$0.2 \times D \ (Q/g^{0.5}D^{2.5})^{4/3} \ (D/TW)$	= 0.283	m
Thickness of Riprap (D_A) =	$2.4 \times D50$	= 0.68	m
Length of Riprap (L) =	$5 \times D$	= 6.00	m
Head Width of Riprap (W_H) =	$3 \times D_o$	= 3.60	m
Tail Width of Riprap (W_T) =	L X 2/3 + W_H	= 7.60	m

Tailwater depth for Equation 10.4 should be limited to between 0.4D and 1.0D. If tailwater is unknown, use 0.4D.

Wingwall Dimensions

Tail Width of Wingwall (W_w) =		m
Height of Wingall (H_w) =		m

Riprap Dimensions

Design Method (TP10 or HEC14) =	TP10	
Riprap Diameter (d_s) =	0.22	m
Thickness of Riprap (D_A) =	0.44	m
Lengh of Riprap (L_a) =	6.80	m
Head Width of Riprap (W_H) =	3.60	m
Tail Width of Riprap (W_T) =	8.13	m
Height of Riprap (H) =	1.50	m

Maven Associates	Job Number 411001	Sheet 1	Rev A
Job Title: Harlow Village Calc Title: Orifice Size Calc Wetland A	Author: NK	Date: 29/09/2026	Checked:

Detention Volume

1305.00 m^3 *(See TR20 Summary)*

Flow Rate (Q_p) if released over 24 hours

0.01510 m^3/sec (Average Discharge Flow-Rate)

Wetland Details

Tank Height	2.000	m
Orifice Height	0.200	m (Above permanent water level)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P	0.01510	m^3/sec (Peak Discharge Flow-Rate)
G=	9.810	m^2/sec
H_T=	1.800	m (Height of water above Discharge Point)
$H_{2/3}$=	1.200	m (Average Head of Water in pond = Two-Thirds of H_T)

A= 0.005021 m^2 (Cross-Sectional of the Discharge Pipe)

Circular Area Formula

$A=(\pi*D^2)/4$

A=	0.005021	m^2 (Cross-Sectional of the Discharge Pipe)		
D=	0.079954	m (Diameter of Discharge Pipe)	=	79.95351 mm

Use 60mm Orifice

Maven Associates	Job Number 411001	Sheet 1	Rev A
Job Title: Harlow Village Calc Title: Orifice Size Calc Wetland B	Author NK	Date 29/09/2026	Checked

Detention Volume

641.20 m^3 *(See TR20 Summary)*

Flow Rate (Q_p) if released over 24 hours

0.00742 m^3/sec (Average Discharge Flow-Rate)

Wetland Details

Tank Height	1.100	m
Orifice Height	0.200	m (Above permanent water level)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P	0.00742	m^3/sec (Peak Discharge Flow-Rate)
G=	9.810	m^2/sec
H_T=	0.900	m (Height of water above Discharge Point)
$H_{2/3}$=	0.600	m (Average Head of Water in pond = Two-Thirds of H_T)

A= 0.003489 m^2 (Cross-Sectional of the Discharge Pipe)

Circular Area Formula

$A=(\pi*D^2)/4$

A=	0.003489	m^2 (Cross-Sectional of the Discharge Pipe)		
D=	0.066648	m (Diameter of Discharge Pipe)	=	66.64791 mm

Use 60mm Orifice

Maven Associates	Job Number	Sheet 1	Rev A
Job Title: Harlow Village Calc Title: Orifice Size Calc Wetland C	Author: NK	Date: 29/09/2026	Checked

Detention Volume

592.20 m^3 *(See TR20 Summary)*

Flow Rate (Q_p) if released over 24 hours

0.00685 m^3/sec (Average Discharge Flow-Rate)

Wetland Details

Tank Height	1.100	m
Orifice Height	0.200	m (Above permanent water level)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P	0.00685	m^3/sec (Peak Discharge Flow-Rate)
G=	9.810	m^2/sec
H_T=	0.900	m (Height of water above Discharge Point)
$H_{2/3}$=	0.600	m (Average Head of Water in pond = Two-Thirds of H_T)

A= 0.003222 m^2 (Cross-Sectional of the Discharge Pipe)

Circular Area Formula

$A=(\pi*D^2)/4$

A= 0.003222 m^2 (Cross-Sectional of the Discharge Pipe)

D= 0.064051 m (Diameter of Discharge Pipe) = 64.050715 mm

Use 60mm Orifice

Maven Associates		Job Number	Sheet 1	Rev A
Job Title Calc Title	Harlow Village Orifice Size Calc Wetland D	Author NK	Date 29/09/2026	Checked

Detention Volume

885.00 m^3 *(See TR20 Summary)*

Flow Rate (Q_p) if released over 24 hours

0.01024 m^3/sec (Average Discharge Flow-Rate)

Wetland Details

Tank Height	1.850	m
Orifice Height	0.200	m (Above permanent water level)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P	0.01024	m^3/sec (Peak Discharge Flow-Rate)
G=	9.810	m^2/sec
H_T=	1.650	m (Height of water above Discharge Point)
$H_{2/3}$=	1.100	m (Average Head of Water in pond = Two-Thirds of H_T)

A= 0.003556 m^2 (Cross-Sectional of the Discharge Pipe)

Circular Area Formula

$A=(\pi*D^2)/4$

A=	0.003556	m^2 (Cross-Sectional of the Discharge Pipe)		
D=	0.06729	m (Diameter of Discharge Pipe)	=	67.290082 mm

Use 60mm Orifice

Maven Associates	Job Number	Sheet 1	Rev A
Job Title: Harlow Village Calc Title: Orifice Size Calc Wetland E	Author: NK	Date: 29/09/2026	Checked

Detention Volume

707.00 m^3 *(See TR20 Summary)*

Flow Rate (Q_p) if released over 24 hours

0.00818 m^3/sec (Average Discharge Flow-Rate)

Wetland Details

Tank Height	1.150	m
Orifice Height	0.200	m (Above permanent water level)

Orifice Sizing (to atmo)

$Q_P=0.62*A*(2*G*H_{2/3})^{1/2}$

Q_P	0.00818	m^3/sec (Peak Discharge Flow-Rate)
G=	9.810	m^2/sec
H_T=	0.950	m (Height of water above Discharge Point)
$H_{2/3}$=	0.633	m (Average Head of Water in pond = Two-Thirds of H_T)

A= 0.003744 m^2 (Cross-Sectional of the Discharge Pipe)

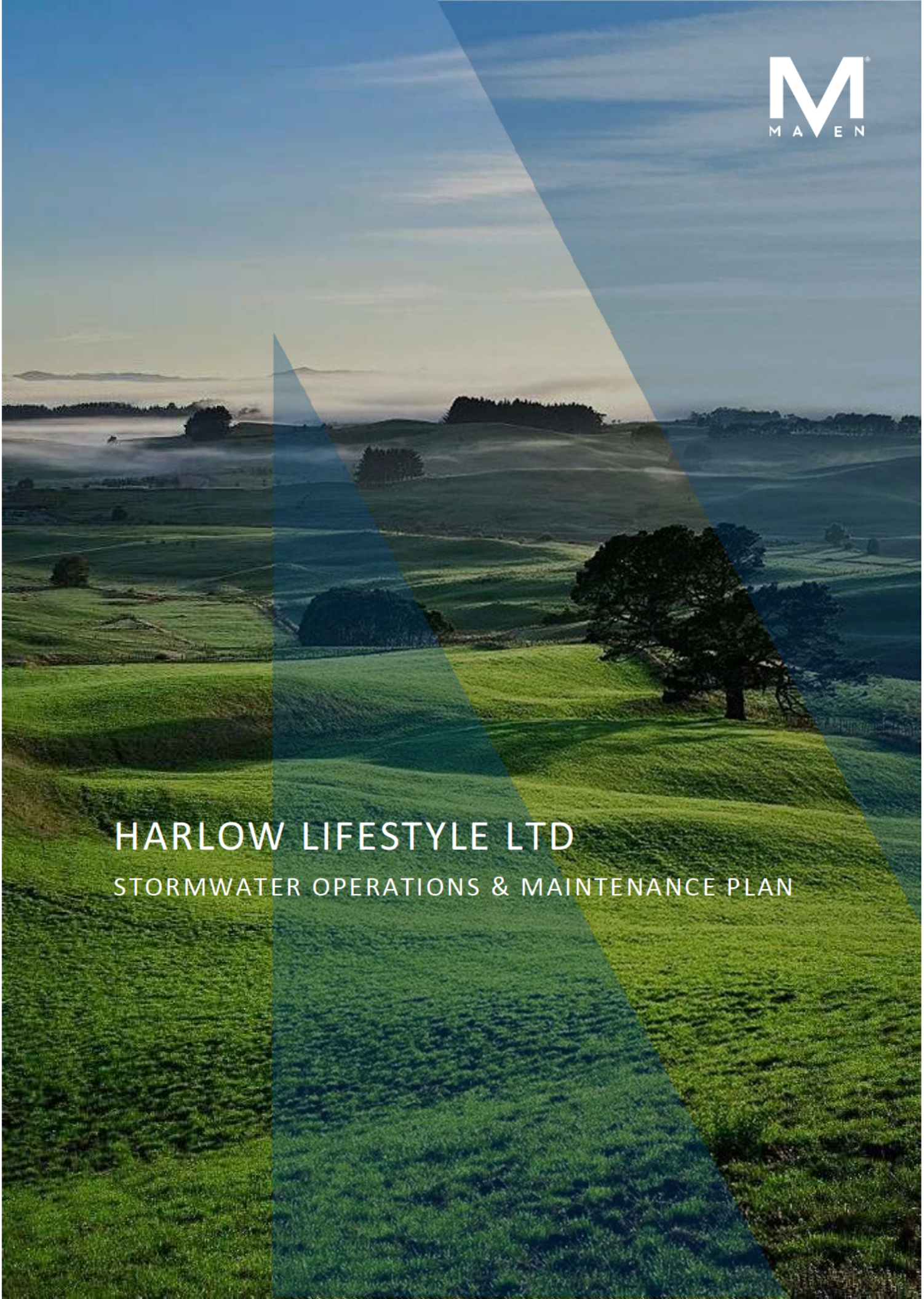
Circular Area Formula

$A=(\pi*D^2)/4$

A=	0.003744	m^2 (Cross-Sectional of the Discharge Pipe)		
D=	0.069045	m (Diameter of Discharge Pipe)	=	69.04452 mm

Use 60mm Orifice

Appendix B – Operation and Maintenance Plan



HARLOW LIFESTYLE LTD

STORMWATER OPERATIONS & MAINTENANCE PLAN

PROJECT INFORMATION

CLIENT	Harlow Lifestyle LTD
PROJECT	411001

DOCUMENT CONTROL

DATE OF ISSUE	08/10/2026
REVISION	A
AUTHOR	[redacted] Malik ur Rahman Civil Engineer
REVIEWED BY	[redacted] Navdeep Kaur Civil Engineering technician
APPROVED BY	[redacted] Sean McDonald Team Leader

© Maven Waikato Ltd
This document is and shall remain the property of Maven Ltd. The document may only be used for the purposes for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

19 Kaimiro Street, Pukete, Hamilton
New Zealand
Phone 07 242 0601
www.maven.co.nz

Contents

1. Introduction 4
   - 1.1. Background 4
   - 1.2. Purpose of this report 4
   - 1.3. Stormwater Assets 4
   - 1.4. Contact Information 5
2. Stormwater System Description 7
   - 2.1. Site Description 7
   - 2.2. Design Standards 7
   - 2.3. Stormwater Management Plan (SMP) 7
   - 2.4. Capacity and Quality 7
   - 2.5. Flooding 8
   - 2.6. Overland Flow 8
   - 2.7. DEPARTURES FROM STANDARD 9
3. Stormwater System Devices 10
   - 3.1. Raingardens 10
   - 3.2. Artificial Wetlands 13
   - 3.1. Temporary Swales and High Flow Bypass channel 16
4. Reporting and Scheduling 17

Appendix A – Auckland Council's Wetlands Operation and Maintenance Guide 18

Appendix B – Recommended Maintenance Event and Frequency Checklists 19

Appendix C – Troubleshooting Guide 20

1. Introduction

1.1. Background

Maven Waikato Limited have been engaged by Harlow Lifestyle Ltd to undertake the infrastructure design in support of the Harlow Lifestyle Village at 2025 Ohaupo Road (SH03), Te Awamutu.

1.2. Purpose of this report

The purpose of this operation and maintenance report is to ensure the correct ongoing operation of the stormwater quantity and quality management devices proposed for the Harlow Lifestyle Village. The information provided herein outlines the methodology associated with the stormwater infrastructure onsite. This report is to be read in conjunction with the stormwater engineering drawings, design calculations, proprietary device manuals and Stormwater management Plan (SMP and is to accompany the Substantive Application under the Fast-Track Approvals Act 2024.

It is the responsibility of the nominated maintenance contractor (pre-vesting: the developer's appointed contractor; post-vesting: Waipā District Council's contractor) to carry out maintenance of the stormwater system devices. Maintenance will be undertaken generally in accordance with this document, the Waikato Regional Council (WRC) Waikato Stormwater Management Guideline (TR2020/07).

1.3. Stormwater Assets

The Assets to be constructed which will require operation and maintenance are:

- Stormwater discharge from lot areas via piped network (perforated and non-perforated), and road corridors for OLFP conveyance to the designated Artificial Wetlands.
- Five artificial wetlands (Wetlands A, B, C, D, and E), each with an associated forebay, providing water quality treatment, extended detention.
- High flow bypass for the associated wetlands
- Temporary swales.
- Road corridor catchpits, sumps, kerb and channel providing primary conveyance to the piped network.

Public assets will be vested to Waipā District Council progressively as each stage is completed, subject to the Engineering Approval process.

Private assets will be managed by the lifestyle village body corporate where appropriate legal instruments will be set up by body corporate to manage the private infrastructure and pond and ensure ongoing operation and maintenance.

1.4. Contact Information

A summary of the contact information relating to the ownership, maintenance manager, and designer for the stormwater system is included below.

Table 1: Contact information summary

Asset ID:		**Resource Consent Number:**	
Location:	2025 Ohaupo Road (SH03), Te Awamutu	Development Name / Legal Description:	PT LOT 1 DP 35654 LOT 1 DPS 36696 BLK II PUNIU SD
Asset Owner Details:			
Name:		Postal Address:	
Telephone Number:			
Email:			
Maintenance Manager Emergency Contact Details			
Name:		Address:	
Telephone Number: (Daytime)			
Telephone Number: (Out-Of-Hours)			
Email:			

Designer Details:		
Name:	Dean Morris	19 Kaimiro Street, Pukete, Hamilton 3200
Telephone Number:	09 242 2724	
Email:	[redacted]	
Applicant Details		
Name:		Address:
Telephone Number		
Email:		
Landowner Details:		
Name:		
Telephone Number		
Email:		
Notes / Restrictions / Access		

2. Stormwater System Description

2.1. Site Description

The Harlow Lifestyle Village Development is a circa 25.78ha block of land within the Waipa District, located to the north of Te Awamutu Town. The site topography is split with low-lying terrain through the centre of the site and rolling hills to the north and south, with elevations ranging between 46m and 84m. A network of closely spaced open drains runs through the centre of the site from west to east, discharging to Mangapiko Stream down the flow path. The site is partially underlain by Walton Subgroup by the low hills and Hinuera Formation in the low-lying area of the site, which has a direct bearing on groundwater recharge and the ongoing maintenance of soakage-based devices.

2.2. Design Standards

Stormwater systems have been designed in accordance with the Regional Infrastructure Technical Specifications (RITS V2, 2025) and the Waikato Regional Council Waikato Stormwater Management Guideline (TR2020/07), which caters for the primary pipe system up to the 10-year cc ARI event, and the secondary system and overland flow paths for events up to and including the 100-year cc ARI event.

2.3. Stormwater Management Plan (SMP)

Discharge consent for the site has been sought from Waikato Regional Council. The overarching stormwater strategy is derived from the Harlow Lifestyle Village SMP (411001, Rev A), which sets out the high-level, best-practice approach to stormwater management for the site, in accordance with WRC's stormwater guidelines and RITS.

The key components of the Harlow Lifestyle Village stormwater management strategy are:

- Retention of the initial abstraction depth via Raingarden.
- Stormwater conveyance for up to the 10-year cc ARI rainfall event via the piped network to the designated artificial wetlands.
- Conveyance of flows up to the 100-year ARI storm event as overland flow within road corridors.
- Preservation of existing flow paths and discharge locations, and accounting for external/upstream inflows so downstream impacts are not worsened.

For further detail, refer to the SMP prepared by Maven Waikato Ltd (411001, Rev A).

2.4. Capacity and Quality

Stormwater Strategy for Road Carriageway and lots

Road runoff is collected by the proposed primary pipe network, sized for the 10-year cc ARI event. Flows exceeding the primary network capacity are conveyed via the road-designated overland flow path to the proposed artificial wetlands, together with the raingarden.

Stormwater Strategy for Catchment A to E (Wetlands A to E)

Catchment A to E discharge via the piped network and OLFP to Wetlands A to E respectively, providing water quality treatment.

Stormwater Strategy for Catchment F and G

Catchment F will be managed separately, with runoff directed to a proposed vegetated dry basin to provide stormwater treatment and support the overall water quality objectives.

Catchment G will remain untreated, with runoff continuing to discharge to the existing roadside drainage network. As the development does not increase the impervious area within this catchment, no additional treatment or attenuation measures are proposed.

2.5. Flooding

A 2D flood model (HEC-RAS) has been developed for the site and used to assess existing, design and sensitivity scenarios in which all primary stormwater devices are blocked. Even under this worst-case condition, the model demonstrates that the development maintains flood immunity, with only minor exceedances expected to be mitigated through detailed design refinements.

2.6. Overland Flow

Overland flow paths (OLFPs) are provided within road corridors to convey flows exceeding the primary piped network's capacity, up to the 10-year cc ARI event, to the designated wetlands.

- Identify and maintain natural overland flow/watercourse locations to convey concentrated stormwater from the site. Utilise existing culverts (where possible) to maintain the same discharge locations, post development.
- Identify and retain any upstream OLFPs and/or watercourses to avoid any upstream flooding.
- Ensure OLFPs are to be designed where possible within the roading network and discharge into watercourses.

The preliminary OLFP design is shown in Maven Associates drawings C460.

An assessment of the post development overland flow paths (OLFPs) has been carried out to evaluate the behaviour of surface runoff in the road carriageway under the proposed stormwater management system. The design scenario is based on the 2081-2100 RCP8.5 climate change scenario, incorporating all proposed devices and the assessment is done through Hydraflow software. The OLFPs represents the conveyance of surface runoff because of the proposed system during the 100-year storm event.

Flow depths and velocities were assessed at key locations throughout the development covering all the various road/accessway typologies ensuring and confirming conveyance of the OLFP is viable through proposed carriageway. See below table 2 showing results at the key locations.

Table 2: OLFP section details

CATCHMENT	SECTION	FLOW RATE FROM HEC-RAS MODEL (m^3/s)	MAX DEPTH (m)	VELOCITY (m/s)	DEPTH x VELOCITY (m^2/s)
A1	1	0.39	0.11	1.96	0.22
A1	2	0.71	0.10	2.30	0.23
B1	3	0.66	0.14	2.12	0.29
B1	4	0.96	0.17	1.00	0.17
C1	5	1.2	0.18	1.46	0.26
D1	6	0.2	0.09	1.06	0.09
E1	7	1.06	0.11	2.26	0.24

All modelled sections except Section 4 and Section 5 are within the 150mm design guideline. Depth x velocity values remain well below the critical safety thresholds defined in Austroads 2012 Part 5, which specify:

- < 0.4 m^2/s for pedestrian safety

- < 0.6 m^2/s for vehicle safety

The highest recorded value, 0.29 m^2/s is at Catchment B1 (Section 3), but confirms safe flow conveyance for both pedestrians and vehicles under design conditions. Flow is primarily routed along proposed roads and conveyed into roadside primary networks for the 10-year cc conveyance, with surcharge above this directed to the designated wetlands and/or existing channel via the OLFP.

2.7. DEPARTURES FROM STANDARD

A departure from standard stormwater design has been identified in Overland Flow Path (OLFP) sections 5 and 4 where the flow depth exceeds the recommended threshold of 150 mm according to RITS V2 2025 Clause 3.3.14.10. These two locations are proposed as departures and these exceedances are minor and occur in isolated sections of the residential OLFP network.

Sections exceeding the 150mm limit are:

- Catchment B1 – Section 4: Max Depth = 0.17m
- Catchment C1 – Section 5: Max Depth = 0.18m

These areas remain safely contained within their respective flow corridors and do not pose a risk to vehicles and pedestrians as Depth x Velocity (D x V) values remain well below the threshold. Further refinement of the earthworks model in conjunction with the Architectural and Landscape design will allow these maximum depths to be addressed and resolved at detailed design.

3. Stormwater System Devices

3.1. Raingardens

The proposed rain garden network is designed to absorb and retain initial stormwater runoff. Upon completion and consolidation, these assets will be amalgamated and vested with the Council for long-term ownership and maintenance.

Vegetation

Vegetation enhances raingarden performance for stormwater treatment and therefore requires close attention.

Maintenance includes fertilising plants, removing noxious plants or weeds, re-establishing plants that die and maintaining mulch cover.

Regular inspections by the responsible entity must be done to ensure that the desired vegetation remains and is not overtaken by invasive undesirable plants.

In some situations, the replacement of the planted vegetation by a volunteer species may be beneficial, but only if the invasive species provides equal or increased water quality benefits and is accepted by the owners of the site.

Plants

Use native plants as per the approved landscaping plans to replace plants if this is required.

Sediment

Sediments accumulate in raingardens. Removal should occur when surface ponding lasts significantly longer than the one day drain time, which indicates surface clogging. When sediments are to be removed, it is essential to restore the vegetation and soil conditions to the originally constructed condition.

Sediment removal will necessitate disturbance of the vegetation, so steps will have to be taken to re-establish the vegetation upon completion of sediment removal.

Erosion control in the contributing drainage area also will be necessary to prevent scour and excessive sedimentation in the rain garden until there is once again a dense stand of vegetation.

Sediment may also impede effective performance of a rain garden by clogging the soil surface and preventing design storms from being treated. If stormwater backs up into the upstream drainage area, overflow may occur and bypass the treatment area.

Debris

Similar to other types of practices, debris removal is an ongoing maintenance function at all rain garden systems.

Debris, if not removed, can block inlets or outlets, and can be unsightly if located in a visible location.

Soil

Only use approved raingarden soil (usually a sandy loam compost) which is readily available at some horticultural centres.

Drainage Testing

If water is not observed freely draining from the rain garden outlet it may be blocked. Back wash through the outlet and/or maintenance access port until the rain garden is freely draining. If this does not help then the soil may be blocked and need to be removed, pipes inspected/cleared.

Avoid

- The use of sprays to kill weeds or algae as this will contaminate the downstream waterways.
- Do not compact the rain garden soil mix.
- Do not add clay or silt in the rain garden soil mix as this will restrict infiltration.

Inspection requirements

- Debris cleanout
  - Removal of debris
  - No dumping of wastes into raingarden
  - Litter has been removed
- Vegetation
  - Plant height not less than design water depth
  - Fertilised per specifications
  - No evidence of erosion
  - Is planting composition still according to approved plans
  - No placement of inappropriate plants
- Dewatering and sedimentation
  - Raingarden dewaters between storms
  - No evidence of standing water
  - No evidence of surface clogging
  - Sediments should not be > than 20% raingarden design depth
- Outlets / Overflow Spillway
  - No evidence of erosion
  - No evidence of any blockages
- Integrity of Biofilter
  - Raingarden has not been blocked or filled inappropriately
  - Mulch layer still in place
  - Noxious plants or weeds removed

Maintenance procedures

Timing	Component	Action
Following storms	Grass filter strip, kerbing, and paved area	• Remove rubbish, leaves, and other debris from the grass filter strip and surrounding drainage area
	Ponding area	• Clear inflow points of sediments, rubbish, and leaves • Check for erosion or gouging and repair • Test drainage of ponding area
	Mulch	• Mulch may need to be redistributed or added around inflow points.
3 monthly	Grass filter strip, kerbing, and paved area	• Mow no shorter than 50mm. • Re-sow grass, as necessary. • Remove rubbish, leaves, and other debris. • Remove excess mulch/soil if required.

	Ponding area	• Clear inflow points of built-up sediment, rubbish, and leaves. • Check for erosion or gouging.
	Mulch layer	• Remove rubbish, leaves, and other debris. • After storm events, mulch may need to be redistributed or added around inflow points.
	Plants	• Water establishing plants monthly during extended dry periods. • Check plant health and replace dead plants. • Use native species to suit garden conditions. • Remove weeds – do not use herbicides, pesticides, and fertilisers.
Annually	Ponding area	• Clear inflow points of sediment, rubbish, and leaves. • Check for erosion or gouging and repair. • Check all water has drained 24 hours after heavy rain.
	Raingarden soil mix	• Check soil level is below surrounding hard surface level and overflow grate.
	Mulch layer	• Check surface of mulch for build-up of sediment, remove and replace.
	Underdrain system	• Use inspection well to check underdrain is working properly.

Troubleshooting

Symptom	Possible problems	Solutions
Stormwater runoff is bypassing the raingarden	Local earthworks increasing sediment load to raingarden, blocking raingarden outlets, or raising surface level of the raingarden	• Check surface of the raingarden is below the surrounding areas. • Remove any sediments and debris from inflow areas and from the surface of the raingarden. • Protect raingarden from future construction sediments.
	Rubbish and other debris blocking the inflow points to the raingarden	• Regularly remove rubbish leaves, and any other debris from inflow points.
Raingarden is ponding for longer than 24 hours	Incorrect blend of soil mix	• Replace soil mix with the correct raingarden soil mix.
Stormwater and/or mulch flowing off the raingarden	The soil within the garden compacted during construction or other activities	• Loosen the top 500mm of soil by tiling or forking.

	Raingarden filled with too much mulch or soil	• Remove excess mulch or soil so that surface of ponding area is approximately 200-300mm below the surrounding hard surfaces and overflow
Sulphur smell coming from the raingarden	Plants and soils lacking oxygen.	• Inspect raingarden after rain event to check garden drains within 12 to 24hours.
Erosion and gouging occurring within the raingarden	Kerbs and other hard structures channelling stormwater flow.	• Create openings in the kerb to increase number and width of run off points or replace kerbing with a different design.

3.2. Artificial Wetlands

Five artificial wetlands (A, B, C, D, and E) form the primary treatment and attenuation devices for the development, providing WQV treatment, EDV (Extended Detention Volume), discharging at up to 80% of pre-development peak flow.

Inspection requirements

- Embankment & Emergency Spillway
  - Level of spillway
  - Vegetation and ground cover
  - Freeboard
  - No evidence of embankment erosion
  - Removal of debris on emergency spillway

- Riser & Service Spillway
  - No low flow orifice obstructed
  - No excessive sediment accumulation inside the riser
  - Function of outfall channels
  - Slope protection
  - No rip-rap failures

- Wetland
  - No undesirable vegetation growth
  - Removal of floating debris
  - No visible pollution
  - No evidence of edge erosion

- Dry Pond
  - Vegetation cover
  - No presence of undesirable vegetation
  - No standing water of wet spots
  - Sediment and/or trash not accumulated
  - Low flow channels not observed

- Sediment Forebays
  - Sediment is not accumulated more than 50%
  - Provision of access of maintenance

Maintenance procedures

Timing	Component	Action
Following storms / Monthly	Inlet	• Inspect and remove rubbish and debris from inlets.
	Trash racks and debris screens	• Inspect and clear all litter, including leaves, rubbish, branches, and any other materials.
	Sediment forebay	• Check the forebay for accumulated sediment. • Test sediments for contaminants prior to dredging and dispose of sediment to landfill or similar, suitable for contaminant levels.
	Risers, control structures, grates, outlet pipes, skimmers, weirs, and orifices	• Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. • Clear and remove all blockages to avoid local flooding. • Inspect outflow pipes for leaky joints or soil piping erosion. • Check if anti-seep collars need repair or replacement. • Check outfall and water discharge areas for erosion and restore and stabilise erosion.
	Emergency overflow or spillway	• Check emergency overflow path remains clear of debris and blockages and remove any blockages. • Check flow paths for erosion and repair as necessary.
	Erosion and bank stability	• Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rolling.
	Water body	• Remove rubbish and other floating debris from wetland pond.
	Wildlife	• Remove dead animals to prevent disease spread.
	Soil	• Inspect for loss of soil on wetland banks from erosion.
Annually	Valves and pumps	• Check pumps and valves. • Check moving parts for corrosion and lubricate.
2+ years	Wetland liners	• Inspect liner for leaks and fix as per manufacturers or design specifications.
	Sediment forebay	• Check the forebay for accumulated sediment. • Test sediment for contaminants prior to dredging and dispose of sediment to

		landfill or similar suitable for contaminant levels.

Troubleshooting

Symptom	Possible problems	Solutions
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	• Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary,
	Outlets structures are clogged	• Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
Wetland is dry	Invasive plants	• Remove plants by hand. (No herbicide)
	A maintenance valve is open	• Check drains valves and shut if open
	Water leaking from cracks in outlet structure	• Inspect for cracks and repair, as necessary. • Inspect for leaky joints at outlet pipes and repair.
	Wetland in area of changing groundwater levels	• Pond will remain dry as long as groundwater levels are low. • Design for pond should have taken this into account, so this may be normal for this wetland.
Stormwater discharging from the wetland looks dirty, muddy, or dark	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area	• Check catchment for erosion areas, including construction works. • Check erosion controls are in place.
	Forebay full of sediment	• Forebay usually needs more frequent clearing of sediment than wetland pond.
	Local works disturbing soils, with rain washing these into wetland	• Check erosion and sediment controls in place on local construction sites.
Pond banks are eroding	Water flowing down pond banks is eroding soils	• Minor erosion can be repaired by replacing soil and stabilising with planting or other methods.
	Stormwater outlet pipes direct flow at banks	• Cause of erosion from direct discharge may be required, for example, by extending pipes down into pond. • Extensive erosion due to continuing discharge may require erosion protection.
Water is leaking form the wetland	Leak collars around pipes have failed or have not been fitted correctly.	• Qualified contractors should make immediate repairs. It usually requires

and through the banks along pipes		pond to be drained, banks excavated, leak collars repaired, and pond banks.

3.1. Temporary Swales and High Flow Bypass channel

Temporary swales will be constructed as part of interim stormwater management measures during construction to maintain existing drainage and direct flows through and around the site during earthworks. The swale provides water quality treatment by filtering runoff through vegetation ahead of discharge to the receiving environment.

Each wetland catchment includes a high-flow bypass (HFB) channel diverting flows above the 2-year event around the treatment train to the receiving drain, via a flow-splitter device and a discharge control device (2-10-year orifice/weir). As an open, generally grassed/vegetated conveyance channel, the High flow bypass is treated here consistently with TR2020/07's swale and filter strip guidance (Table 18-1).

Inspection requirements

- Debris cleanout
  - Removal of debris
  - No dumping of wastes into swales
  - Litter has been removed
- Vegetation
  - Plant height not less than design water depth
  - Fertilised per specifications
  - No evidence of erosion
  - Grass height not greater than 250mm
  - No placement of inappropriate plants
- Dewatering
  - Swales dewater between storms
  - No evidence of standing water

Maintenance procedures

Timing	Component	Action
Following storms	Inflow points	• Check for scouring, channelling, and erosion and repair as necessary.
	Side slopes	• Check for scouring, channelling, and erosion and repair by adding soil and replanting as necessary.
	Channel base	• Check for scouring, channelling, and erosion and repair by adding soil and replanting as necessary.
	Plants and soil	• Check stormwater is filtering through soil following stormwater runoff. • Remove weeds.
Monthly	Outlet	• Check for scouring or erosion and repair to suit.
	Inflow points	• Remove rubbish and debris.

	Channel base	• If grassed, mow channel no shorter than 150mm • Re-seed bare patches of grass.
	Plants and soil	• Replant gaps and water new plants in dry conditions until established.
Two yearly	Outlet	• Remove rubbish and debris from outlet grate or catchpit.
	Channel base	• Check for boggy patches and ponding water. • Check soil is not compacted and aerate surface or tip up dips to repair.
	Grass, plants, and soil	• Remove weeds, rubbish, and debris. • Re-plant gaps and re-seed bare patches, and water if required to establish. • Aerate soil to prevent natural compaction. • Check Stormwater is filtering through soil.

Troubleshooting

Symptom	Possible problems	Solutions
Water not draining	Soil compacted	• Aerate soil with rotating aerator or core.
	Soil clogged with fine sediments	• Remove top layer of soil and replace, turning soil.
	Underdrain, if present, may be blocked	• Re-build underdrain.
Water flowing straight to outlet	Soil not free draining	• Aerate soil, replace top layer of soil, replace soil with free draining mix.
	Swale slope is too steep	• If slope is over 5%, construct check dams to slow flows.
	Plants or grass is not dense enough	• Leave grass longer, and re-seed to increase density.
Scouring / Channels appearing	Inflow is concentrated at inlets	• Remove blockages including rubbish, debris, and sediment build up.

4. Reporting and Scheduling

Recording and Reporting of Operation and Maintenance activities to the Waipā District Council

Recording of information and device tracking are important components of the maintenance of stormwater system devices. It is important that site operator and/or owners track maintenance by use of database. This helps inspectors to understand what devices need to be inspected, when they need to be inspected, and when was the last maintenance. Contractors nominated by Waipā District Council will record operation and maintenance activities and report to Waipā District Council by use of a database. Established checklists will be used during the inspection and maintenance activities, and the activities will never rely on the memory of any one individual.

Appendix A – Auckland Council's Wetlands Operation and Maintenance Guide



WETLANDS

Operation & Maintanence Guide

STORMWATER DEVICE INFORMATION SERIES

Auckland Council

Te Kaunihera o Tāmaki Makaurau

What are constructed wetlands?

Constructed wetlands are large shallow planted ponds that filter stormwater runoff, slow flows and help control flooding downstream. Similar to natural wetlands, they look attractive and provide home and shelter to wildlife. Constructed wetlands help remove sediments, nutrients and contaminants from incoming stormwater before discharging to downstream stormwater system or waterways.

This guide offers a general description of constructed wetlands. Each constructed wetland is specifically designed to suit a particular site, so construction details will be on design and site construction plans. Correct construction levels are crucial for supplying suitable drainage for wetland plants.

How and when should maintenance be carried out?

Constructed wetlands need to be maintained in two main ways. Firstly, so they continue to work as designed (filtering stormwater, slowing flows and controlling downstream flooding) and secondly, to look attractive. A full inspection of constructed wetlands should take place a year after construction is completed.

This may be carried out by the construction contractor to coincide with the end of the defects liability period. The tables below give only typical timelines and actions for maintaining constructed wetlands. This is a general guide - each wetland should have its own detailed maintenance plan to suit the particular catchment size, pollutant loads and inflows.

WARNING - CONTAMINATED SOIL

Constructed wetlands treat stormwater run-off, so will collect contaminants in the sediments of the pond and forebay. All material removed from these sites should be tested for contaminants before being disposed of at a suitable secure landfill.



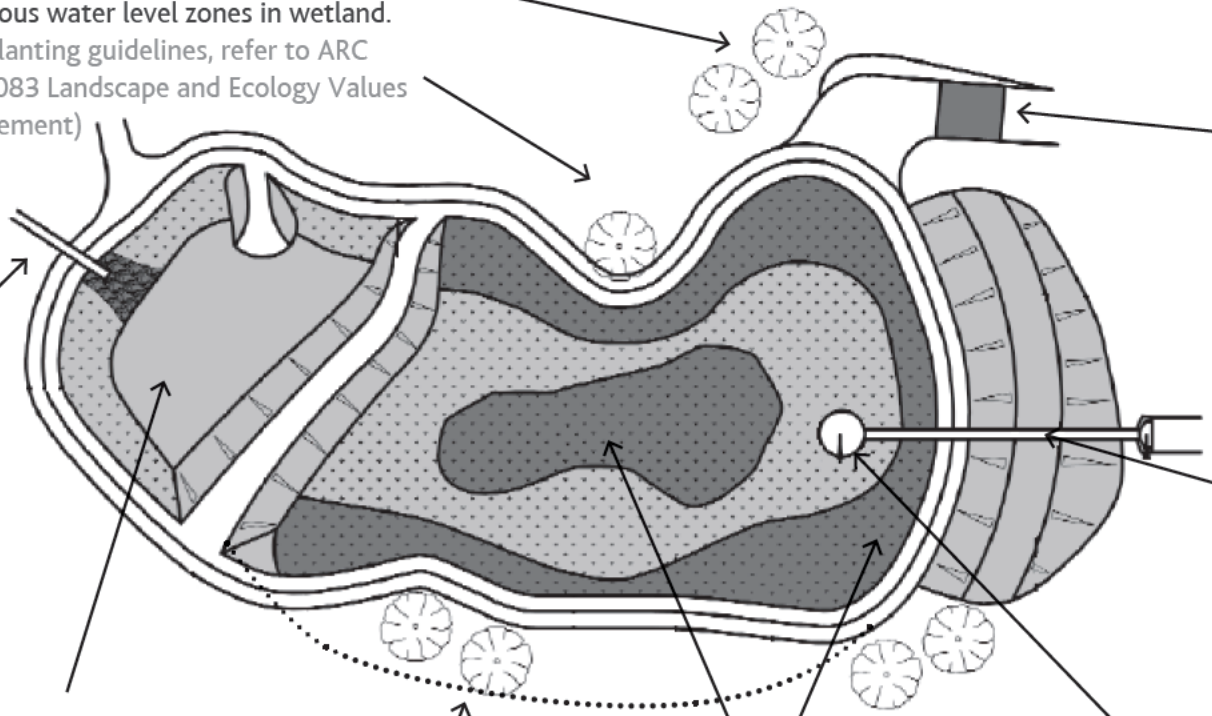




Eight key components of a constructed wetland

5. Plants

Usually native plants, in the pond and on littoral shelf.
Species chosen to suit various water level zones in wetland.
(For suitable species and planting guidelines, refer to ARC Technical Report TR2009/083 Landscape and Ecology Values within Stormwater Management)



7. Emergency overflow

Structure to allow extreme heavy rain flows to bypass wetland and drain downstream, to prevent overtopping of wetland banks. May be in outlet riser or separate.

8. Anti-seep collars

Collars are fitted to all pipework to prevent pond leakage and potential bank collapse from erosion.

1. Inlet

Inlet pipe, receiving runoff. Erosion controls at inlet (rip rap, energy dissipaters) slow flows. Debris screens or trash racks capture rubbish.

2. Sedimentation forebay (if included)

Forebay helps slow runoff and sediment drops to the bottom. Separated from main pond by a bund or low dam.

3. Main wetland

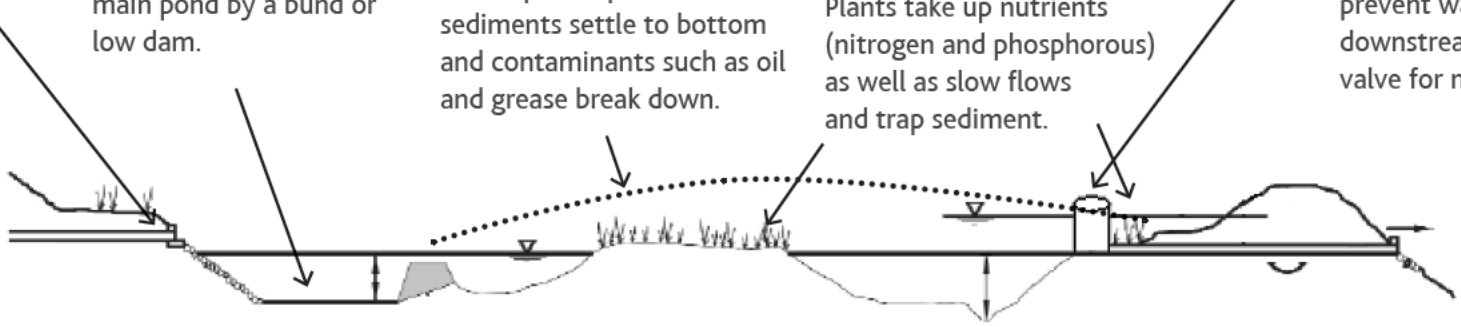
Shallow wide pond of variable depth to 1m, planted with aquatic species. Fine sediments settle to bottom and contaminants such as oil and grease break down.

4. Shallow wetland area

(Littoral shelf) Shoreline of the pond, planted with swamp species submerged at times. Plants take up nutrients (nitrogen and phosphorous) as well as slow flows and trap sediment.

6. Risers/outlets

Outlet riser pipe or weir for discharge of treated runoff. Risers may have scruffy dome to trap debris, or baffles/skimmer to prevent water life and debris from flowing downstream. Some risers have drain-down valve for maintenance.



MAINTENANCE SCHEDULE

Timing	Component	Action
Following storms	Inlet	• Inspect and remove rubbish and debris from inlets. • Check area around inlet, especially energy dissipation (rip rap) structures for erosion and cracking, and if present, repair.
	Trash racks and debris screens (if fitted)	• Inspect and clear all litter, including leaves, rubbish, branches and any other material that would block flows. Check racks for corrosion and replace if necessary.
	Sediment forebay	• Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. • Test sediments for contaminants (eg heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.
	Bund	• Check for erosion or instability and repair if required.
	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Blockage could be sediment build up, floating debris, rubbish. • Control structures could be overgrown with vegetation. • Clear and remove all blockages to avoid local flooding. Areas around control structure need to be clear of vegetation and rubbish to maintain stormwater flow. A boat may be required to access the outlet. • Inspect outflow pipes for leaky joints or soil piping erosion. • Check if anti-seep collars need repair or replacement. • Check outfall and water discharge areas for erosion and restore and stabilise erosion. • Check energy dissipaters are adequate.
	Emergency overflow or spillway	• Check emergency overflow path remains clear of debris and blockages, and remove any blockages. Check flow path for erosion and repair as necessary. Structural repairs must be repaired immediately to avoid catastrophic failure.

MAINTENANCE SCHEDULE cont...

TIMING	COMPONENT	ACTION
Following storms	Erosion and bank stability	• Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rilling. • Remove woody vegetation growth (unless species specifically included in pond planting plans) to avoid future root damage to banks. Removal will require bank material replacement and repair, compacted to design specification of maximum 90% dry soil density. • Inspect for pedestrian and cycle traffic or pathways on banks. • Either restrict traffic by closing paths off, or provide suitable resistant ground cover to avoid erosion from traffic.
	Water body	• Remove rubbish and other floating debris from wetland pond. • Inspect for algal blooms (usually dense water discolouration or surface scum) or fish kills – these could indicate water has extremely low levels of oxygen (eutrophication), or high nutrient loads or pollutants. • Test water quality if these problems suspected.
	Wildlife	• Control pest species so they do not threaten birds and aquatic life of the wetland. • Remove dead animals, especially water birds, to prevent disease spread. Wet areas where mosquito (mosquito larvae) could breed need careful maintenance.
	Soil	• Inspect for loss of soil on wetland banks from erosion. If plants are struggling to grow soil fertilizer may be required, but extra care must be taken to prevent fertilizer from entering wetland and local waterways.
Monthly	Inlet	• Inspect and remove rubbish and debris from inlets.
	Trash racks and debris screens (if fitted)	• Inspect and clear all litter, including leaves, rubbish, branches and any other material that would block flows. • Check racks for corrosion and replace if necessary.

MAINTENANCE SCHEDULE cont...

TIMING	COMPONENT	ACTION
Monthly	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect control structures, weirs, orifices, outfall pipes for leaks and blockages. Blockage could be sediment build up, floating debris, rubbish. Control structures could be overgrown with vegetation. • Clear and remove all blockages to avoid local flooding. Areas around control structure need to be clear of vegetation and rubbish to maintain stormwater flow. • Boat may be required to access outlet.
	Emergency overflow or spillway	• Check emergency overflow path remains clear of debris and blockages, and remove any blockages. • Check flow path for erosion and repair as necessary. Structural repairs must be repaired immediately to avoid catastrophic failure.
	Erosion and bank stability	• Inspect banks for settlement, erosion, scouring, cracking, sloughing, seepage and rilling. • Remove woody vegetation growth (unless species specifically included in pond planting plans) to avoid future root damage to banks. Removal will require bank material replacement and repair, compacted to design specification (of maximum 90% dry soil density). • Inspect for pedestrian and cycle traffic or pathways on banks. • Either restrict traffic by closing paths off, or provide suitable resistant ground cover to avoid erosion from traffic.
	Landscaping	• Clear wetland plants of weeds and prune and replace three-monthly. Mow split grass around pond monthly. Schedules may vary depending on seasonal growth.
	Water body	• Remove rubbish and other floating debris from wetland pond. Inspect for algal blooms (usually dense water discolouration or surface scum) or fish kills – these could indicate water has extremely low levels of oxygen (eutrophication), or high nutrient loads or pollutants. Test water quality if these problems suspected.

MAINTENANCE SCHEDULE cont...

TIMING	COMPONENT	ACTION
6 Monthly	Wildlife	• Control pest species so they do not threaten birds and aquatic life of the wetland. Remove dead animals, especially water birds, to prevent disease spread. • Wet areas where mosquito (mosquito larvae) could breed need careful maintenance.
	Soil	• Inspect for loss of soil on wetland banks from erosion. If plants are struggling to grow soil fertilizer may be required, but extra care must be taken to prevent fertilizer from entering wetland and local waterways.
	Inlet	• Check area around inlet, especially energy dissipation (rip rap) structures for erosion and cracking, and if present, repair.
	Bund	• Check for erosion or instability and repair if required.
	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect outflow pipes for leaky joints or soil piping erosion. • Check if anti-seep collars need repair or replacement. • Check outfall and water discharge areas for erosion and restore and stabilise erosion. Check energy dissipaters are adequate.
	Littoral zones	• Inspect wetland plants for exotic or invasive/nuisance water species and remove. • Control may be done manually, or with appropriate herbicide by properly licensed and registered professional. Follow up inspections may be needed during growing season.
Anually	Valves and pumps	• Check pumps and valves, if present, are functioning properly. • Check moving parts for corrosion and lubricate if required.
2+ Years	Wetland liner	• Inspect liner for leaks and fix as per manufacturer's or design specifications.
	Sediment forebay	• Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. • Test sediments for contaminants (eg heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.

TROUBLESHOOTING

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	• Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary. Refer decision to supervisor if necessary.
	Outlet structures are clogged	• Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
Wetland is dry	Invasive plants (such as raupo) clogging pond area	• Remove plants by hand – do not use herbicides.
	A maintenance valve is open.	• Check drain valves and shut if open.
	Water leaking from cracks in outlet structure.	• Inspect for cracks and repair as necessary. • Inspect for leaky joints at outlet pipes and repair.
	Wetland in area of changing groundwater levels.	• Pond will remain dry as long as groundwater levels are low. • Design for pond should have taken this into account, so this may be normal for this wetland.
	Ground water levels have dropped due to drought conditions	• Drought conditions cannot be solved, until wet season restores wetland pond levels. Use drought opportunity to clean sediments from forebay and repair stormwater infrastructure.
Stormwater discharging from the wetland looks dirty, muddy or dark	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area.	• Check catchment for erosion areas, including construction works. • Check erosion controls are in place. Add or repair erosion control as required.
	Forebay full of sediment.	• Forebay usually needs more frequent clearing of sediment than wetland pond. Dredging required when forebay water storage is around 50% of total volume.
	Local works disturbing soils, with rain washing these into wetland.	• Check erosion and sediment controls in place on local construction sites. • Repair if necessary and stabilise areas of exposed soil where erosion occurring.
	Wetland outlet constructed too close to inlet, preventing treatment of water before discharge.	• Should have been designed to suit. Well placed baffles or islands in wetland may redirect and slow flows to increase treatment between inlet and outlet points.

TROUBLESHOOTING cont...

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Wetland plants are growing over the edges and across surface of the pond	Wetland plants are growing in shallow edges of pond.	• Constructed wetlands are designed to have plants growing large fringes across pond. No action required unless plants are affecting pond function, for instance, clogging outlet structure.
Pond banks are eroding	Water flowing down pond banks is eroding soils.	• Minor erosion can be repaired by replacing soil and stabilising with planting or other methods.
	Stormwater outlet pipes direct flow at banks.	• Cause of erosion from direct discharge may be repaired, for instance, by extending pipes down into pond. • Extensive erosion due to continuing discharge may require erosion protection such as rip-rap, geotextile.
Water is leaking from the wetland and through the banks along pipes	Leak collars around pipes have failed or have not been fitted correctly (or at all). This can lead to failure of banks.	• Failure of pond banks can cause major damage at pond and downstream, so qualified construction contractors should make immediate repairs. This usually requires pond to be drained, banks excavated, leak collars repaired, and pond banks reconstructed to original design specifications.
Dead or dying birds	Botulism is a common killer of pond birds. Birds ingest toxins produced by the bacteria Clostridium botulinum, either from the water or by eating maggots or other infected food sources. Botulism can occur when water levels are low, often mid to late summer when pond water stagnates. It can also appear after algal blooms, when water oxygen levels are low.	• Remove all dead birds and animals from the area to reduce the spread of Botulism. Avoid algal blooms (see below). • Maintain flows through the ponds to avoid stagnant water. Improve shading over the water.

TROUBLESHOOTING cont...

SYMPTOM	POSSIBLE PROBLEMS	SOLUTION
Algal blooms (Yellow, green, red or blue-green coloured scum on the surface of the water.)	Algae is naturally present in waterways. Algal blooms occur in good growing conditions, including stagnant or slow moving water, high levels of nutrients, and warm and sunny weather.	• Avoid blooms by reducing nutrients entering the wetland, (for instance, controlling fertilizers from the surrounding area) and by maintaining water flows. • Although there are a number of suggested ways to deal with blooms, few are proven to work. The use of barley straw bales in the pond may work in some cases.
Animal pests present	Dense plant cover and abundant food supply in wetlands supports many animals, including pest species.	• Thin out vegetation where possible. • Set traps and poison in the area, using recommended procedures such as careful poison placement and providing warning signs.
Plants on edge of pond dying	Plants are suffering extreme wet and dry conditions.	• Choose plant varieties suitable to local conditions. • New plants need watering until established. • Replace unsuitable varieties.

Quick maintenance checks

- ✓ Check for leaks and erosion on and around banks, especially at leak collars.
- ✓ Regularly clear rubbish and dead vegetation around outlet structures, trash racks and forebay.
- ✓ Remove dead birds in case of botulism, especially in hot, humid conditions
- ✓ Keep new plants watered and control weed species.

Avoid

- ✗ Do not let erosion go unchecked. Repair, and replace erosion controls if necessary.
- ✗ Do not let forebay volume reach over half-full of sediment. Dredge and dispose of to suitable landfill.
- ✗ Prevent fertilizers, pesticides and herbicides entering the pond to avoid algal blooms and polluting downstream waterways.
- ✗ Do not ignore algal blooms and unusually dirty or dark pond water. These can affect the health of the wetland and downstream waterways.

Disclaimer

This publication is provided strictly subject to Auckland Council's (AC) copyright and other intellectual property rights (if any) in the publication. Users of the publication may only access, reproduce and use the publication, in a secure digital medium or hard copy, for responsible genuine non-commercial purposes relating to personal, public service or educational purposes, provided that the publication is only ever accurately reproduced and proper attribution of its source, publication date and authorship is attached to any use or reproduction. This publication must not be used in any way for any commercial purpose without the prior written consent of AC. AC does not give any warranty whatsoever, including without limitation, as to the availability, accuracy, completeness, currency or reliability of the information or data (including third party data) made available via the publication and expressly disclaim (to the maximum extent permitted in law) all liability for any damage or loss resulting from your use of, or reliance on the publication or the information and data provided via the publication. The publication and information and data contained within it are provided on an "as is" basis.

Appendix B – Recommended Maintenance Event and Frequency Checklists

Waikato REGIONAL COUNCIL Te Kaunihera ā Rohe o Waikato	**STORMWATER MAINTENANCE INSPECTION FORM**	Inspector: Date: Time: Weather: Rainfall over previous 2-3 days? Page 1 of 2 File No:

Site Name:		ID No:	
Location		Catchment:	
		Needs immediate attention Not Applicable	

SWALE AND FILTER STRIP PRACTICE MAINTENANCE INSPECTION CHECKLIST	×	Required Y / N	✓	Okay	?	Clarification Required

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Swale And Filter Strip Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
DEBRIS CLEANOUT	Y		Y	N	**M**	**CHECK DAMS / ENERGY DISSIPATORS / SUMPS**	Y	N	Y	N	**A**
1. Swales and filter strips and contributing areas clean of debris											
2. No dumping of wastes into swales or filter strips											
3. Litter (branches, etc) have been removed											
VEGETATION					**M**						
4. Plant height not less than design water depth											
5. Fertilised per specifications											
6. No evidence of erosion											
7. Grass height not greater than 250mm											
8. Is plant composition according to design plans											
9. No placement of inappropriate plants											
DEWATERING					**M**						
10. Swales and filter strips dewater between storms											
11. No evidence of standing water											

Inspection Frequency Key **A = Annual, M = Monthly**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Waikato REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

STORMWATER MAINTENANCE INSPECTION FORM

Inspector:
Date:
Time:
Weather: Rainfall over previous 2-3 days?

Site Name:		File No:	
Location:		Consent No:	
		Catchment:	

RAIN GARDEN MAINTENANCE INSPECTION CHECKLIST	× Needs immediate attention	✓ Okay	? Clarification Required
	– Not Applicable		

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Rain Garden Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
DEBRIS CLEANOUT	Y	N	Y	N	**M**	**OUTLETS/OVERFLOW SPILLWAY**	Y	N	Y	N	**A, AMS**
1. Rain gardens and contributing areas clean of debris						13. Good condition, no need for repair					
2. No dumping of yard wastes into rain garden						14. No evidence of erosion					
3. Litter (branches, etc) have been removed						15. No evidence of any blockages					
VEGETATION					**3M**	**INTEGRITY OF BIOFILTER**					**A**
4. Planting height not less than design water depth						16. Rain garden has not been blocked or filled inappropriately					
5. Fertilised per specifications						17. Mulch layer still in place					
6. No evidence of erosion						18. Noxious plants or weeds removed					
7. Is plant composition still according to approved plans											
8. No placement of inappropriate plants											
DEWATERING AND SEDIMENTATION											
9. Rain garden dewaters between storms					**3M**						
10. No evidence of standing water											
11. No evidence of surface clogging											
12. Sediments should not be > than 20% of rain garden design depth											

Inspection Frequency Key **A = Annual, M = Monthly, AMS = After Major Storm**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Waikato REGIONAL COUNCIL Te Kaunihera ā Rohe o Waikato	**STORMWATER MAINTENANCE INSPECTION FORM**	Inspector: Date: Time: Weather: Rainfall over previous 2-3 days?
		Page 1 of 2

Site Name:		File No:	
Location		Consent No:	
		Catchment:	

INFILTRATION TRENCH MAINTENANCE INSPECTION CHECKLIST	✕	Needs immediate attention	✓	Okay	?	Clarification Required	
	-	Not Applicable					

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Infiltration Trench Components:

Items Inspected	Checked		Maintenance Needed		Inspection Frequency		Checked		Maintenance Needed		Inspection Frequency
DEBRIS CLEANOUT	Y	N	Y	N	**M**	**INLETS**	Y	N	Y	N	**A**
1. Trench surface clear of debris						13. Good condition					
2. Inlet areas clear of debris						14. No evidence of erosion					
3. Inflow pipes clear of debris						**OUTLETS/OVERFLOW SPILLWAY**					**A**
4. Overflow spillway clear of debris						15. Good condition, no need for repair					
SEDIMENT TRAPS, FOREBAYS, OR PRETREATMENT SWALES					**A**	16. No evidence of erosion					
5. Obviously trapping sediment						**AGGREGATE REPAIRS**					**A**
6. Greater than 50% of storage volume remaining						17. Surface of aggregate clean					
VEGETATION					**M**	18. Top layer of stone does not need replacement					
7. Mowing done when needed						19. Trench does not need rehabilitation					
8. Fertilized per specifications						**VEGETATED SURFACE**					**M**
9. No evidence of erosion						20. No evidence of erosion					
DEWATERING					**3M**	21. Perforated inlet functioning adequately					
10. Trench dewaters between storms						22. Water does not stand on vegetative surface					
SEDIMENT CLEANOUT OF TRENCH					**A**	23. Good vegetative cover exists					
11. No evidence of sedimentation in trench											
12. Sediment accumulation does not yet require cleanout											

Inspection Frequency Key **A = Annual, M = Monthly**

INSPECTORS REMARKS:

OVERALL CONDITION OF DEVICE:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Waikato REGIONAL COUNCIL
Te Kaunihera ā Rohe o Waikato

STORMWATER MAINTENANCE INSPECTION FORM

Inspector:	
Date:	
Time:	
Weather: Rainfall over previous 2-3 days?	
Page 1 of 2	

Site Name:		File No:	
Location:		Consent No:	
		Catchment:	

STORMWATER POND/WETLAND MAINTENANCE INSPECTION CHECKLIST

× Needs immediate attention
– Not Applicable
✓ Okay
? Clarification Required

"As builts"	Required Y / N	Available Y / N	Adequate Y / N	Approx. check to verify vol(s). Y / N
"Operation & Maintenance Plan"	Required Y / N	Available Y / N	Adequate Y / N	
"Planting Plan"	Required Y / N	Available Y / N	Adequate Y / N	

Pond/Wetland Components:

Items Inspected	Checked Y	Checked N	Maintenance Needed Y	Maintenance Needed N	Inspection Frequency
EMBANKMENT & EMERGENCY SPILLWAY					**A,S**
1. Is the spillway level?					
2. Adequate vegetation & ground cover?					
3. Appropriate plants / weeds?					
4. Adequate freeboard?					
5. Embankment erosion evident?					
6. Cracking, bulging or sliding of dam					
a) Upstream embankment					
b) Downstream embankment					
c) At or beyond toe upstream					
d) At or beyond toe downstream					
e) Emergency spillway					
7. Pond & toe drains clear & functioning?					
8. Evidence of animal burrows?					
9. Seeps/leaks on downstream face?					
10. Vertical & horizontal alignment of top of dam as per As-Built plans?					
11. Emergency spillway clear of obstructions & debris					
12. Provision of access for maintenance?					
a) By hand?					
b) For machinery?					
13. Other?					
RISER & SERVICE SPILLWAY					**A**
Type: Reinforced concrete					
Metal pipe					
Masonry					
14. Low flow orifice obstructed?					
15. Low flow trash rack:					
a) Is debris removal necessary?					
b) Is corrosion evident?					
16. Weir trash rack maintenance					
a) Is debris removal required?					
b) Is corrosion evident?					
17. Is there excessive sediment accumulation inside the riser?					
18. Metal pipe condition	Good		Fair		Poor
19. Outfall channels functioning?					

Items Inspected	Checked Y	Checked N	Maintenance Needed Y	Maintenance Needed N	Inspection Frequency
20. Concrete/Masonry condition Riser and barrels:					
a) Cracks or displacement?					
b) Minor spalling (.0.25mm)?					
c) Major spalling (rebars exposed)?					
d) Joint failures?					
e) Water tightness adequate?					
21. Pond drain valve:					
a) Operational / exercised?					
b) Chained and locked?					
22. Slope protection or rip-rap failures?					
23. Other?					
PERMANENT POOL (WET POND)					**3M**
24. Undesirable vegetative growth?					
25. Removal of floating debris required?					
26. Visible pollution?					
27. Evidence of 'edge' erosion?					
28. Other?					
DRY POND					**3M**
29. Adequate vegetation cover?					
30. Presence of undesirable vegetation / woody growth?					
31. Standing water or wet spots?					
32. Sediment and/or trash accumulation?					
33. Low flow channels unobstructed?					
34. Other?					
SEDIMENT FOREBAYS					
35. Is sediment accumulation > 50% (maintenance req'd immed. If Yes)					
36. Provision of access for maintenance:					
a) By hand?					
b) For machinery?					
OUTFALLS INTO PONDS					**A,S**
37. Riprap failures?					
38. Condition of endwalls / headwalls	Good		Fair		Poor
39. Evidence of slope erosion?					
40. Condition of any inflow pipes.	Good		Fair		Poor
41. Other?					

Items Inspected	Checked Y	Checked N	Maintenance Needed Y	Maintenance Needed N	Inspection Frequency
OTHER					**6M**
CONSTRUCTED WETLAND AREAS					**A**

1

41. Encroachments on pond or easement area?						45. Vegetation healthy and growing?						
42. Complaints from residents?						46. Evidence of invasive species?						
43. Aesthetics						47. Excessive sedimentation in wetland area?						
a) grass mowing required?												
b) graffiti removal needed?												
c) other (specify)?												
44. Any public hazards (specify)?												

Inspection Frequency Key **A = Annual, M = Monthly, S = after monthly storm**

INSPECTOR REMARKS:

OVERALL CONDITION OF DEVICE:

In accordance with approved design plans? Y / N In accordance with As Built plans? Y / N

Maintenance required as detailed above? Y / N Compliance with other consent conditions? Y / N

Comments: _____

Dates by which maintenance must be completed: / /

Dates by which outstanding information as per consent conditions is required by: / /

Inspector's signature: _____

Appendix C – Troubleshooting Guide

Timing	Component	Action
		• Remove weeds – do not use herbicides, pesticides and fertilisers as these chemicals will pollute the stormwater runoff.
Annually	Ponding area	• Clear inflow points of sediment, rubbish and leaves. • Check for erosion or gouging and repair. • Check all water has drained 24 hours after heavy rain. • Alternatively test drainage of ponding area. Dig a hole 200mm wide x 200mm deep. Pour in 10 litres of water in hole. Check drainage rate over 1 hour period – minimum 25mm/hour. • If crust of fine sediment present on surface of soil mix, remove with spade and rework using rake. Top up soil and mulch as necessary (ensuring level is below surrounding hard surface and overflow). Dispose of contaminated crusted topsoil in a secure landfill (unless soil testing shows no contamination).
	Rain garden soil mix	• Check soil level is below surrounding hard surface level and overflow grate. Use drainage test described above to check soil is free draining. •
	Mulch layer (bark, pebbles, etc.)	• Check surface of mulch for build-up of sediment, remove and replace as required.
	Underdrain system	• Use inspection well (if present) to check underdrain is working properly. • Check rain garden draining freely using the drainage test described above. If rain garden is not free-draining, the underdrain may be blocked. Try back-washing under drain from the outlet. If still blocked, the rain garden may need plants and rain garden soil mix removed and replaced.

Table 18-5: Troubleshooting for bioretention devices[175]

Symptom	Possible problems	Solution
Stormwater runoff is bypassing the rain garden	Local earthworks increasing sediment load to rain garden, blocking rain garden outlets or raising surface level of the rain garden	• Check surface of the rain garden is below the surrounding areas. • Remove any sediments and debris from inflow areas and from the surface of the rain garden. • Protect rain garden from future construction sediments.
	Rubbish and other debris blocking the inflow points to the rain garden	• Regularly remove rubbish, leaves and any other debris from inflow points.
Rain garden is ponding for longer than 24 hours	Incorrect blend of soil mix	• Replace soil mix with the correct rain garden soil mix. Do Ribbon test or Percolation test to test soil mix is free-draining.

[175] Auckland Council Rain Garden Operation and Maintenance Guide

Symptom	Possible problems	Solution
Stormwater and/or mulch flowing off the rain garden	The soil within the garden compacted during construction or other activities.	• Loosen the top 500mm of soil by tilling or forking. Discourage vehicle, pedestrian and bicycle access to the rain garden.
	Layer of fine sediment settled on the garden surface	• Remove fine sediment layer and turn over the top layer of rain garden soil mix. Protect rain garden from surrounding sediment run off.
	Rain garden filled with too much mulch or soil	• Remove excess mulch or soil so that surface of ponding area is approximately 200-300mm below the surrounding hard surfaces and overflow.
	Overflows or discharge pipes clogged with sediments or debris	• Clear overflow and discharge pipes.
	Planting or rain garden soil mix clogged	• It may be necessary to remove some of the rain garden soil mix and replace with fresh rain garden soil mix.
Sulphur smell coming from the rain garden	Plants and soils lacking oxygen (anaerobic conditions). Organic material rotting within the garden The underdrain clogged and water is not properly draining out of the garden	• Inspect rain garden after rain event to check garden drains within 12 – 24 hours (see solutions above for rain garden ponding)
Erosion and gouging occurring within the rain garden	Kerbs and other hard structures channelling stormwater flow (rain gardens require an event sheet of flow of water to operate effectively)	• Create openings in the kerb to increase number and width of run off points, or replace kerbing with a different design (eg. kerbing slightly raised off the ground)
	Inflow points are too concentrated	• Increase kerb opening size by cutting kerbs or replacing with different design. If this is not possible install rip-rap (i.e. stones set into concrete) at the inflow point to spread flow and reduce erosion.
Plants are stressed or dying. Symptoms may include yellowing of leaves, unseasonal leaf fall, wilting.	Plant varieties selected for rain garden are unsuitable for the location and/or extreme wet/dry conditions.	• Select plants appropriate for the location (eg. full shade, partial shade, full sun, etc.) • Due to their hardy nature, native plants are recommended.
	Ponding or excessively long periods of flooding cause plants to become stressed or die.	• Inspect rain garden after rain event to check garden drains within 12 – 24 hour. If not, see above solutions for rain garden ponding.
	The plants poisoned by runoff from a hazards spill (fuel, paint, oil, etc).	• Check soil and mulch for evidence of heavily polluted runoff (eg. rainbow slick, coloured mulch, etc.)
	Pollutants accumulated in the rain garden reached a toxic level for plants.	• If contamination is extensive, clean out raingarden soil mix and replace fresh soil and new plants.
	The plants dehydrated from extended dry conditions	• Newly established plants need watering. • Check soil moisture content and water plants if dry.

Symptom	Possible problems	Solution
		• Establishing plants need watering in dry weather.
	Plants stressed due to attack by plant pests or diseases. Pests may include insects of animals.	• Check for leaf damage or pests and consult gardening manuals or a garden centre for the best treatment. • Stressed plants need replacing with healthy variety or pest-resistance species.
	Rain garden soil mix compacted	• Loosen the top 500mm of soil by tilling or forking. Do not allow vehicle, pedestrian and bicycle access to the rain garden.

18.2.1.4 Infiltration devices

Infiltration devices are very sensitive to impaired performance if excessive amounts of sediments or oils and greases are introduced into them. The greatest problem is clogging of soils in the sides and bottom or in the case of permeable paving surface clogging. This can occur fairly rapidly if inflow sediment loads are not reduced by pre-treatment devices.

Other contaminants, which are attached to sediments, are not considered a clogging concern.

Another problem is poor drainage as a result of high water table, groundwater mounding or a confining soil layer. Prolonged wetness encourages micro-organism growths that tend to clog soils.

18.2.1.5 Ponds and wetlands

Sediment forebay clogged with sediment and needing to be cleaned out



One of the greatest benefits of stormwater management ponds and wetlands is their resilient performance even when excessive contaminant loads enter them. However, performance will suffer if sediment is introduced in large amounts over a lengthy time frame. Sediments reduce the volume of storage and reduce extended detention times, which ultimately reduce the pond or wetland's contaminant reduction potential.

This impaired function is not something that tends to occur dramatically in a short time period but rather occurs cumulatively over a longer time period if the incoming sediment load is consistently elevated.

Another problem that ponds and wetlands have that other devices do not have to such an extent is maintenance problems associated with debris clogging inlets and outlet areas. While other devices can have visual issues related to debris, pond outlets can become blocked, especially the extended detention orifices. Clogging of these outfall orifices can cause significant adverse effects by elevating water in the pond or wetland and potentially killing the vegetation, increasing safety concerns and increasing the zone of saturation in the pond or wetland embankment.

A recommended maintenance schedule for wetlands is provided below:

Timing	Component	Action
	Bund	• Check for erosion or instability and repair if required.
	Risers, control structures, grates, outlet pipes, skimmers, weirs and orifices	• Inspect outflow pipes for leaky joints or soil piping erosion. • Check if anti-seep collars need repair or replacement. • Check outfall and water discharge areas for erosion and restore and stabilise erosion. Check energy dissipaters are adequate.
	Littoral zones	• Inspect wetland plants for exotic or invasive/nuisance water species and remove. • Control may be done manually, or with appropriate herbicide by properly licensed and registered professionals. Follow up inspections may be needed during growing season.
Annually	Valves and pumps	• Check pumps and valves, if present, are functioning properly. • Check moving parts for corrosion and lubricate if required.
2+ years	Wetland liners	• Inspect liner for leaks and fix as per manufacturer's or design specifications.
	Sediment forebay	• Check the forebay for accumulated sediment. In general the forebay should be dredged if sediment fills over 50% of design volume. • Test sediment for contaminants (eg. heavy metals, PAHs) prior to dredging and dispose of sediment to landfill or similar suitable for contaminant levels.

Table 18-7: Trouble shooting for wetland[177]

Symptom	Possible problems	Solution
Wetland water levels remain high	The outlet riser openings may be too narrow to allow fast draining after a storm	• Unless water levels remain high for more than two days or flooding is a threat, action may not be necessary. Refer decision to supervisor if necessary.
	Outlet structures are clogged	• Check outlet structures and openings for blockage by debris or sediment, and clean as necessary.
Wetland is dry	Invasive plants (such as raupo) clogging pond area	• Remove plants by hand, do not use herbicide.
	A maintenance valve is open	• Check drain valves and shut if open
	Water leaking from cracks in outlet structure	• Inspect for cracks and repair as necessary • Inspect for leaky joints at outlet pipes and repair

[177] Auckland Council Wetlands Operation and Maintenance Guide

Symptom	Possible problems	Solution
	Wetland in area of changing groundwater levels	• Pond will remain dry as long as groundwater levels are low. • Design for pond should have taken this into account, so this may be normal for this wetland.
	Groundwater levels have dropped due to drought conditions	• Drought conditions cannot be solved, until wet season restores wetland pond levels. Use drought opportunity to clean sediments from forebay and repair stormwater infrastructure.
Stormwater discharging from the wetland looks dirty, muddy or dark	High concentration of sediments washing into wetland, especially silts and clays, due to erosion or construction in the catchment area	• Check catchment for erosion areas, including construction works. • Check erosion controls are in place. Add or repair erosion control as required
	Forebay full of sediment	• Forebay usually needs more frequent clearing of sediment than wetland pond. Dredging required when forebay water storage is around 50% of total volume.
	Local works disturbing soils, with rain washing these into wetland	• Check erosion and sediment controls in place on local construction sites • Repair if necessary and stabilise areas of exposed soil where erosion occurring
	Wetland outlet constructed too close to inlet, preventing treatment of water before discharge	• Should have been designed to suit. Well placed baffles or islands in wetland may redirect and slow flows to increase treatment between inlet and outlet points.
Wetland plants are growing over the edges and across surface of the pond	Wetland plants are growing in shallow edges of pond	• Constructed wetlands are designed to have plants growing large fringes across pond. No action required unless plants are affecting pond function, for instance, clogging outlet structure.
Pond banks are eroding	Water flowing down pond banks is eroding soils	• Minor erosion can be repaired by replacing soil and stabilising with planting or other methods
	Stormwater outlet pipes direct flow at banks	• Cause of erosion from direct discharge may be repaired, for instance, by extending pipes down into pond. • Extensive erosion due to continuing discharge may require erosion protection such as rip-rap, geotextile.
Water is leaking from the wetland and through the banks along pipes	Leak collars around pipes have failed or have not been fitted correctly (or at all). This can lead to failure of banks.	• Failure of pond banks can cause major damage at pond and downstream, so qualified construction contractors should make immediate repairs. This usually requires pond to be drained, banks excavated, leak collars repaired, and pond banks

Symptom	Possible problems	Solution
		reconstructed to original design specifications.
Dead or dying birds	Botulism is a common killer of pond birds. Birds ingest toxins produced by the bacteria Clostridium botulinum, either from the water or by eating maggots or other infected food sources. Botulism can occur when water levels are low, often mid to late summer when pond water stagnates. It can also appear after algal blooms, when water oxygen levels are low.	• Remove all dead birds and animals from the area to reduce the spread of Botulism. Avoid algal blooms (see below). • Maintain flows through the ponds to avoid stagnant water. Improve shading over the water.
Algal blooms (yellow, green, red or blue-green coloured scum on the surface of the water)	Algae is naturally present in waterways. Algal blooms occur in good growing conditions, including stagnant or slow moving water, high levels of nutrients, and warm and sunny weather	• Avoid blooms by reducing nutrients entering the wetland, (for instance, controlling fertilizers from the surrounding area) and by maintaining water flows. • Although there are a number of suggested ways to deal with blooms, few are proven to work. The use of barley straw bales in the pond may work in some cases.
Animal pests present	Dense plant cover and abundant food supply in wetlands supports many animals, including pest species	• Thin out vegetation where possible. • Set traps and poison in the area, using recommended procedures such as careful poison placement and providing warning signs.
Plants on edge of pond dying	Plants are suffering extreme wet and dry conditions.	• Choose plant varieties suitable to local conditions. • New plants need watering until established. • Replace unsuitable varieties.

18.2.1.6 Green roofs

Principal reasons why this device performance can deteriorate are the following:

- Impermeable membrane failure due to leakage, puncture or UV deterioration
- Excessive weed growth outcompeting planted growth
- Ponding of water on flat roofs
- Concentration of flows across the green roof causing scour and discharge at locations not designed for
- Clogging of substrate, and
- Plugged outlets.

18.2.1.7 Water tanks

Water tank function can be compromised mainly due to two reasons:

1. Inadequate water supply where demand exceeds supply, and
2. The tank outlets or downspouts become clogged due to excessive vegetative entry into the tank from roof spouting.

Appendix C – Erosion Management Plan



HARLOW VILLAGE

STORMWATER EROSION PROTECTION PLAN

Contents

1. INTRODUCTION 3
2. GENERAL PRINCIPLES 3
3. WETLAND OUTLET PROTECTION 3
4. INLET PROTECTION 3
5. EXISTING CHANNEL PROTECTION 4
6. CULVERT INLET/ OUTLET PROTECTION 4
7. OVERLAND FLOW PATHS 4
8. CONCLUSION 5

1. INTRODUCTION

This Erosion Protection Plan supports the development Stormwater Management Plan (SMP) and sets out the measures adopted to manage flow velocities and erosion potential across the proposed stormwater Infrastructure. It covers the permanent (post-construction) stormwater devices.

Erosion protection has been applied at each point in the treatment train where concentrated flow or a change in flow velocity could otherwise cause scour: wetland/pond inlets and outlets, and high-flow bypass outlet, culvert crossings, overland flow paths, and the receiving environment (Mangapiko Stream and existing natural wetlands).

2. GENERAL PRINCIPLES

- Velocity appropriate protection: energy dissipation (riprap, level spreaders, splash pads) is provided wherever a device outlet or pipe discharge would otherwise generate a velocity capable of scouring the receiving surface.
- Avoid steep grades: culvert inverts have been kept to low longitudinal grades where practicable to limit velocity build-up; check dams are used where a steeper grade cannot be avoided.
- Stable batter slopes: vegetated embankments and pond/wetland side slopes are to be no steeper than 1V:2.5H (interior) and 1V:3H (exterior, where space allows), consistent with RITS and WRC guidelines. Slopes steeper than this increase both erosion risk and the difficulty in constructability, stabilizing and vegetation.
- Preserve natural flow paths: existing drainage corridors and discharge locations are retained rather than redirected, to avoid introducing new erosion risk at previously stable locations.
- Outlet protection generally comprises a riprap apron sized to the design discharge velocity, with the apron footprint set to dissipate flow to a non-erosive velocity before it reaches unprotected ground or vegetation. This is sized in accordance with GD08 guideline as specified Section 4.1.9.1 of RITS V2 2025.

3. WETLAND OUTLET PROTECTION

Each artificial wetland outlet comprises a low-flow orifice (extended detention), an overflow weir/spillway for events above the extended detention storage, and a backflow prevention device to prevent reverse flow from the receiving drain during elevated downstream water levels. Riprap protection and energy dissipation are provided at the wetland/HFB discharge point to the receiving drain or stream. Emergency spillways are designed to safely convey extreme events without structural erosion of the embankment.

4. INLET PROTECTION

Wetland and forebay inlets are protected with riprap pads or level spreaders to dissipate the energy of incoming piped flow before it enters the treatment device, preventing scour of the forebay base and short-circuiting of settled sediment. Where flow enters directly from a road corridor overland flow path,

the inlet is graded and protected to accept sheet flow without concentrating it into an erosive point discharge.

5. EXISTING CHANNEL PROTECTION

The treatment swale and the high-flow bypass (HFB) channels serving each wetland are vegetated conveyance features, designed for distributed (sheet) flow rather than concentrated flow. Protection measures include dense, uniform vegetation cover across the full channel width; longitudinal grades kept as low as practicable; and riprap or check-dam protection at any grade break, bend, or point where flow could concentrate. Channel base and side slopes are stabilised prior to flows being directed through the channel.

6. CULVERT INLET/ OUTLET PROTECTION

4 culvert crossings (1 box culverts, 3 circular culverts) convey the rerouted stream and wetland discharges beneath the collector road network. Culverts are concrete units, embedded approximately 25% into the streambed to support fish passage, with wingwalls to be confirmed at detailed design. Riprap protection has been sized for the inlet and outlet apron of each culvert based on the design discharge velocity, culvert geometry and outfall length, as set out in Table 1.

Table 1: Riprap sizing

Culvert	Type	Span x Height or dia. (m)	Riprap D50 (m)	Riprap thickness (m)	Outfall length (m)	Head width (m)	Tail width (m)	Apron area (m2)
1	Box	3.0 x 1.0	0.2	0.35	5.6	3	6.8	27.44
2	Circular	1.5 dia	0.15	0.35	2.5	4.5	6.2	13.375
3	Circular	1.5 dia	0.15	0.25	1.8	4.5	3.3	7.02
4	Circular	1.2 dia	0.25	0.45	6.8	3.6	8.2	40.12

Riprap median rock diameter (D50) and apron dimensions have been sized to the design discharge velocities and geometry of each culvert, the calculations have been based on TP10. Riprap thickness is generally set at approximately twice the D50 rock size, consistent with standard outlet protection practice. The D50 values are based on design velocities from HEC RAS modelling (Refer to Section 7-Flood Modelling of the SMP report). These dimensions are to be confirmed against final culvert sizing and discharge velocities at the detailed design.

7. OVERLAND FLOW PATHS

Road corridor overland flow paths (OLFPs) convey flows above the piped network's capacity, up to the 100-year cc ARI event. Erosion protection along OLFPs relies primarily on maintaining sealed road/kerb surfaces and directing flow to designated discharge points (wetlands or existing watercourses) rather than allowing it to leave the formed corridor. Modelled OLFP depths and velocities (refer to section 10-Overland Flowpaths of SMP report) have been checked against the Austroads 2012 Part 5 safety and scour thresholds (0.4 m^2/s pedestrian, 0.6 m^2/s vehicle), with all assessed sections remaining within these limits, indicating a low erosion risk within the road corridor itself.

8. CONCLUSION

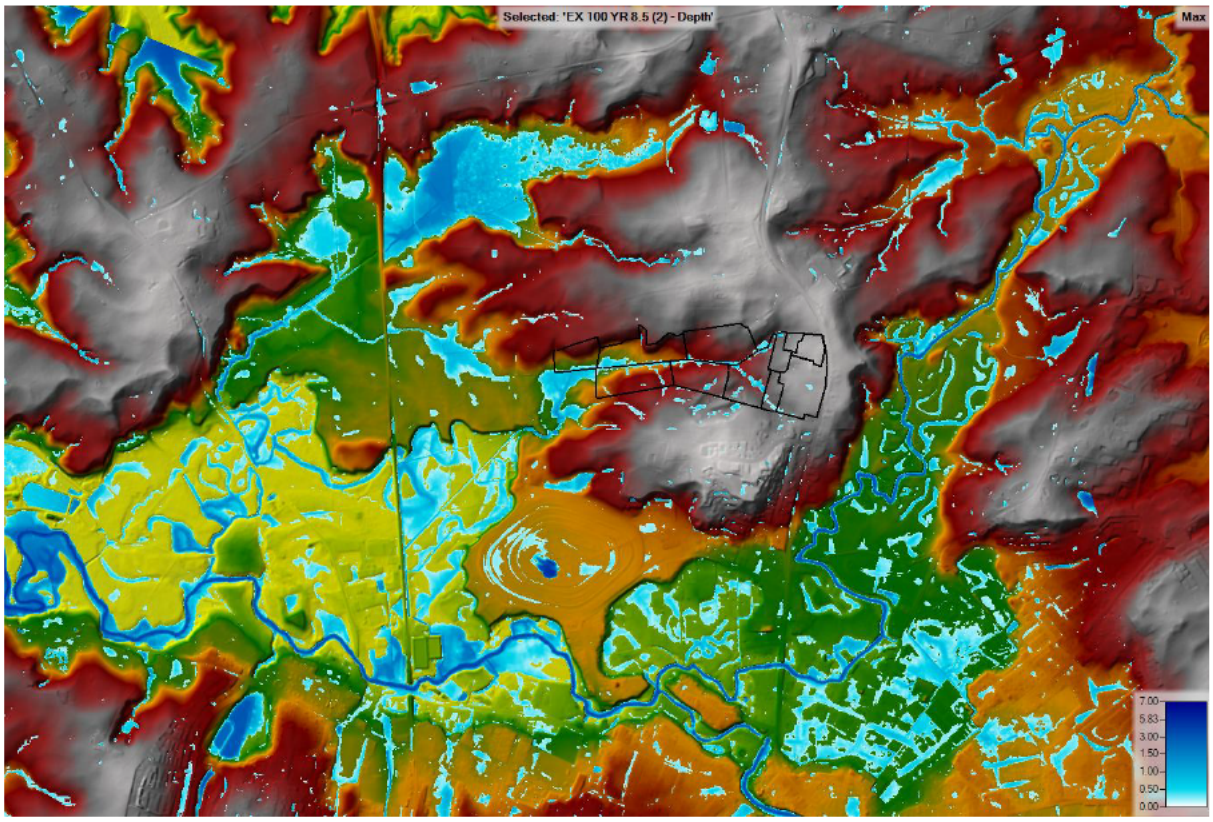
This Erosion Protection Plan sets out the measures adopted across the development stormwater network to manage flow velocities and protect against erosion, from the point of discharge at each lot and road corridor through to the receiving environment. Protection has been applied consistently at every point in the treatment train where a change in flow velocity or concentration of flow could otherwise cause scour, including wetland and forebay inlets and outlets, high-flow bypass and the culvert crossings beneath the collector road network.

Culvert protection has been designed on a structure-by-structure basis, with riprap median rock diameter, thickness and apron dimensions sized to the discharge velocity and geometry of each of the culverts (Table 1). Batter slopes, and vegetation establishment have been addressed through the general principles set out in Section 2 0f this report.

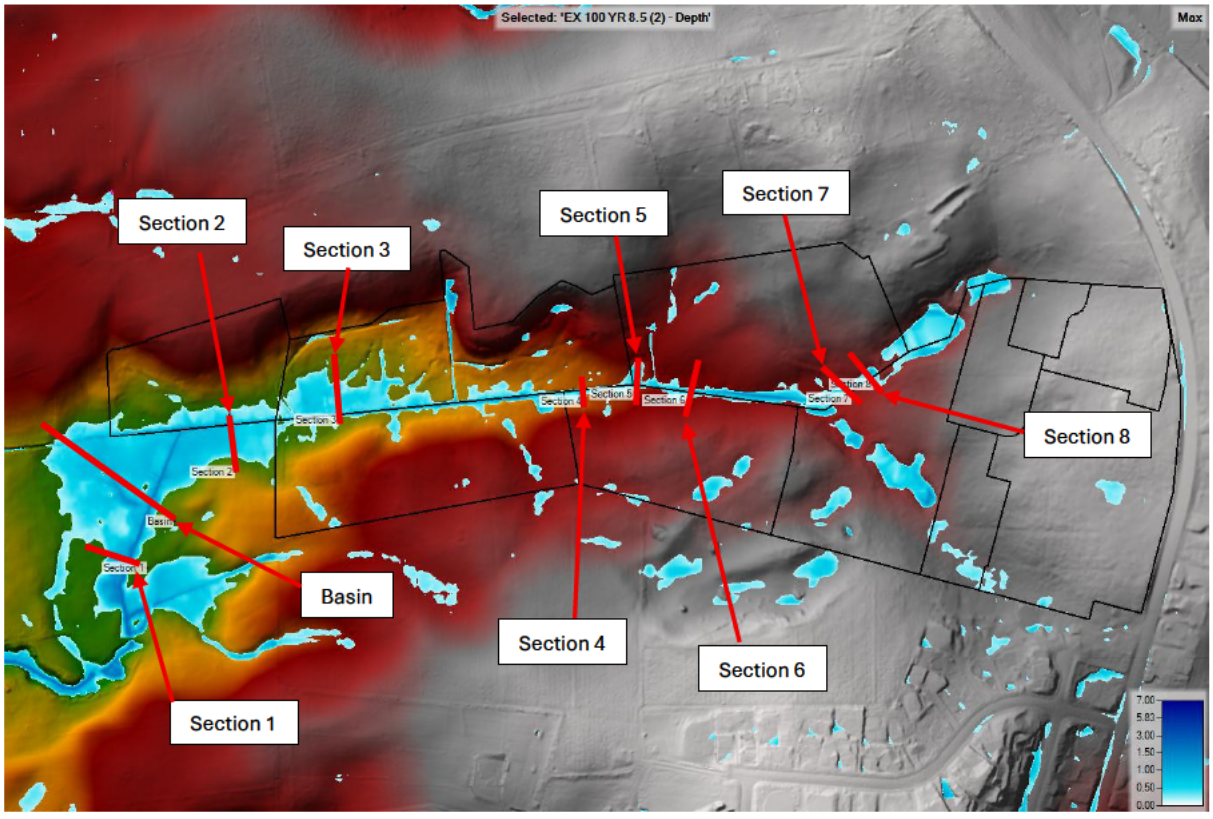
Together with the flow attenuation and hydraulic neutrality measures set out in the SMP, these erosion protection measures are considered sufficient to protect downstream channels, existing natural wetlands and the Mangapiko Stream from adverse erosion effects arising from the development. Final riprap sizing, wingwall details and planting specifications are to be confirmed at detailed design stage.

Appendix D – HEC-RAS Summary

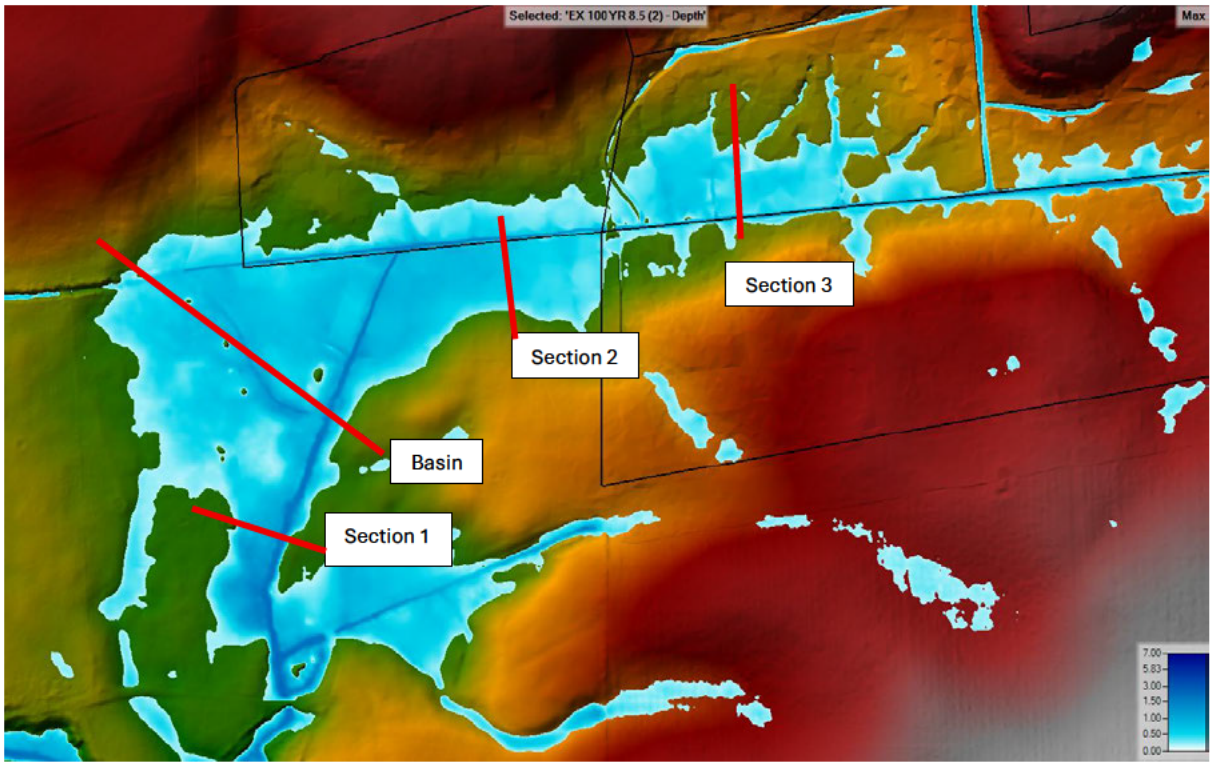
Pre-development



Pre-development- Overall site

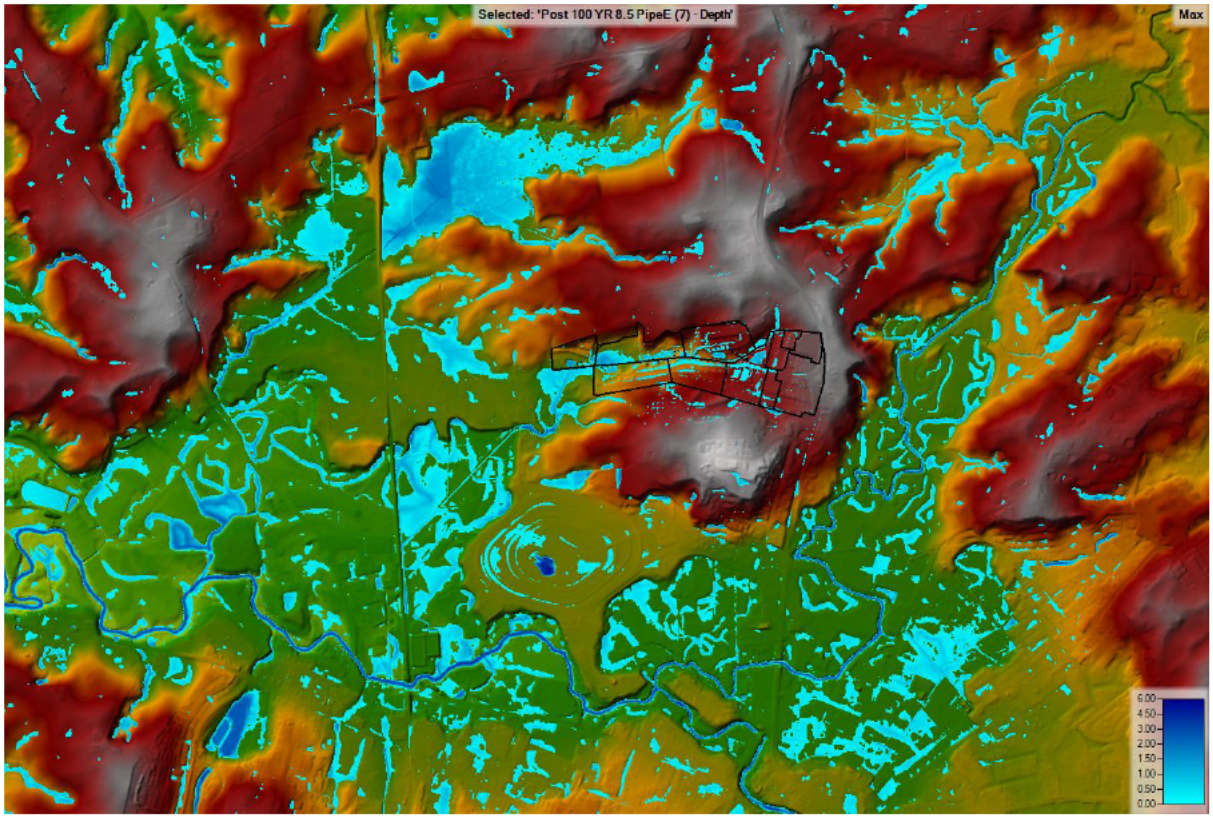


Pre-development- Zoomed to the site

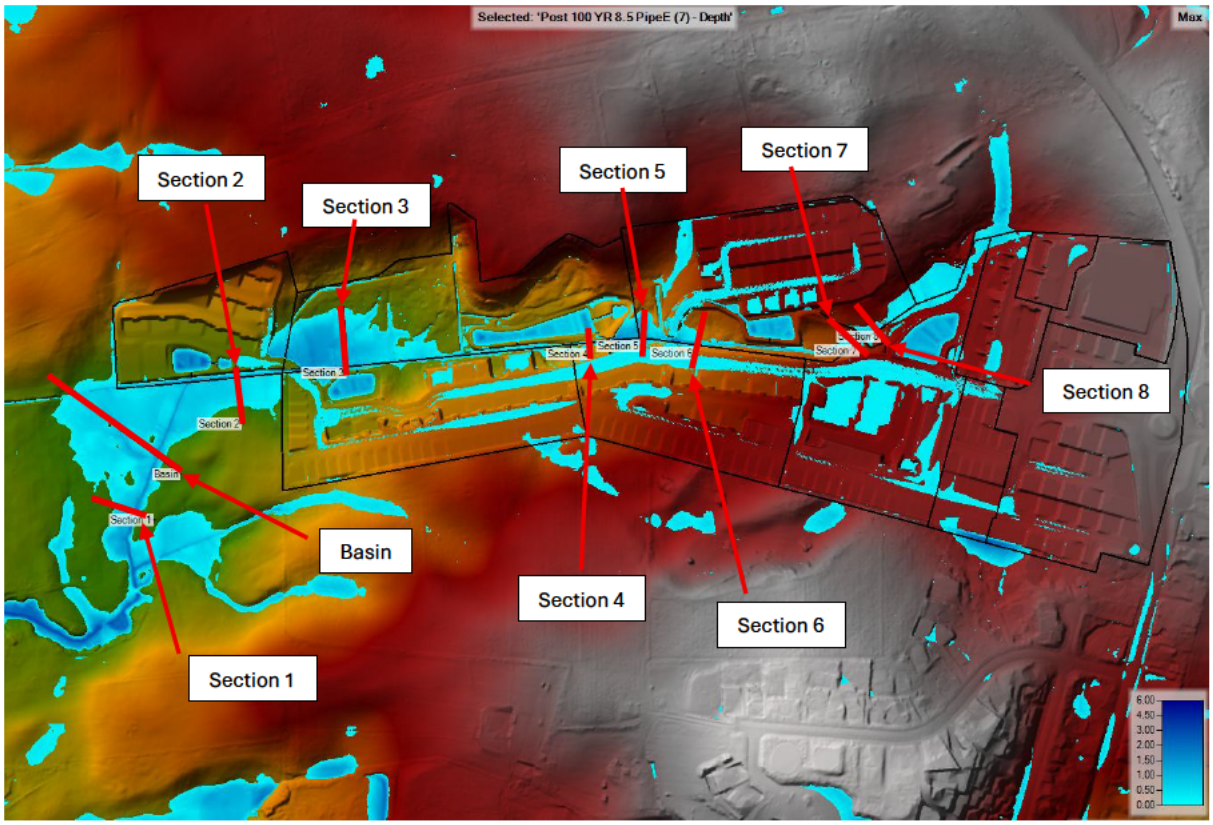


Pre-development- Downstream basin

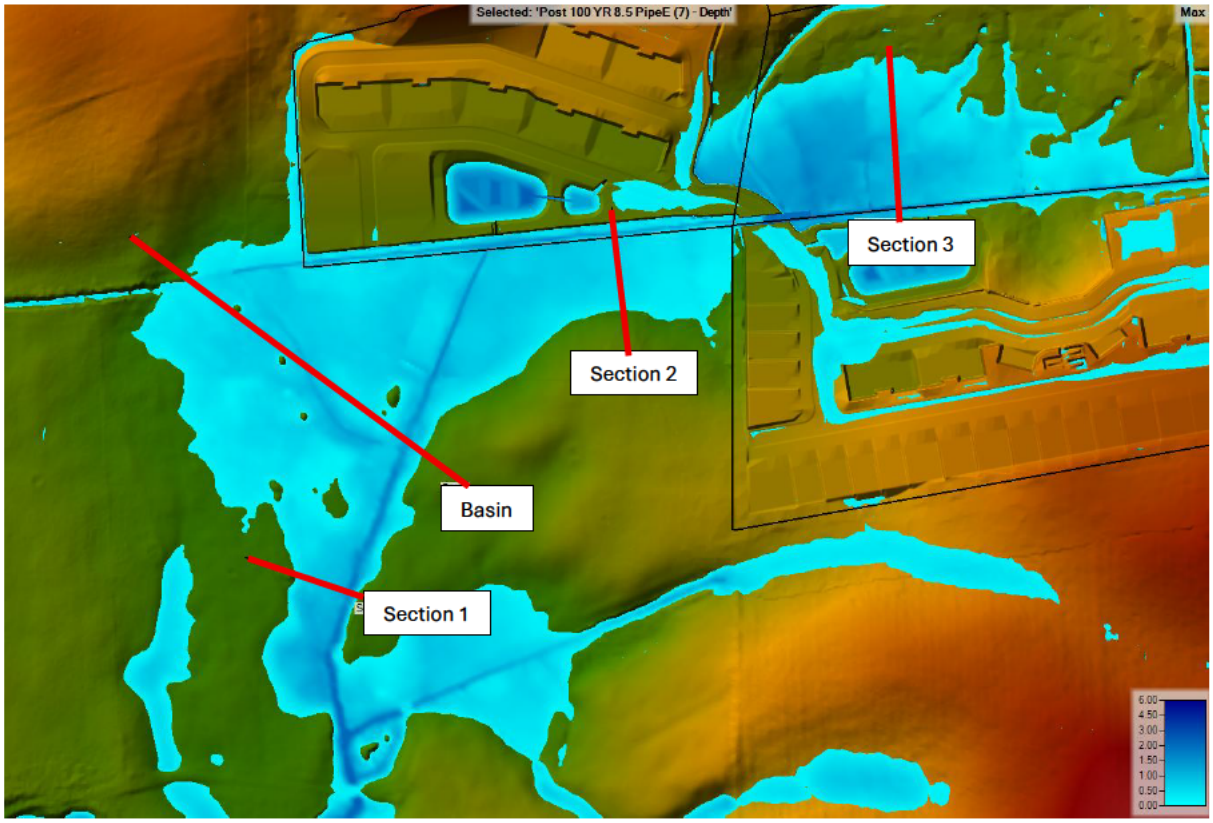
Post-development 100yr+cc



Post-development- Overall site

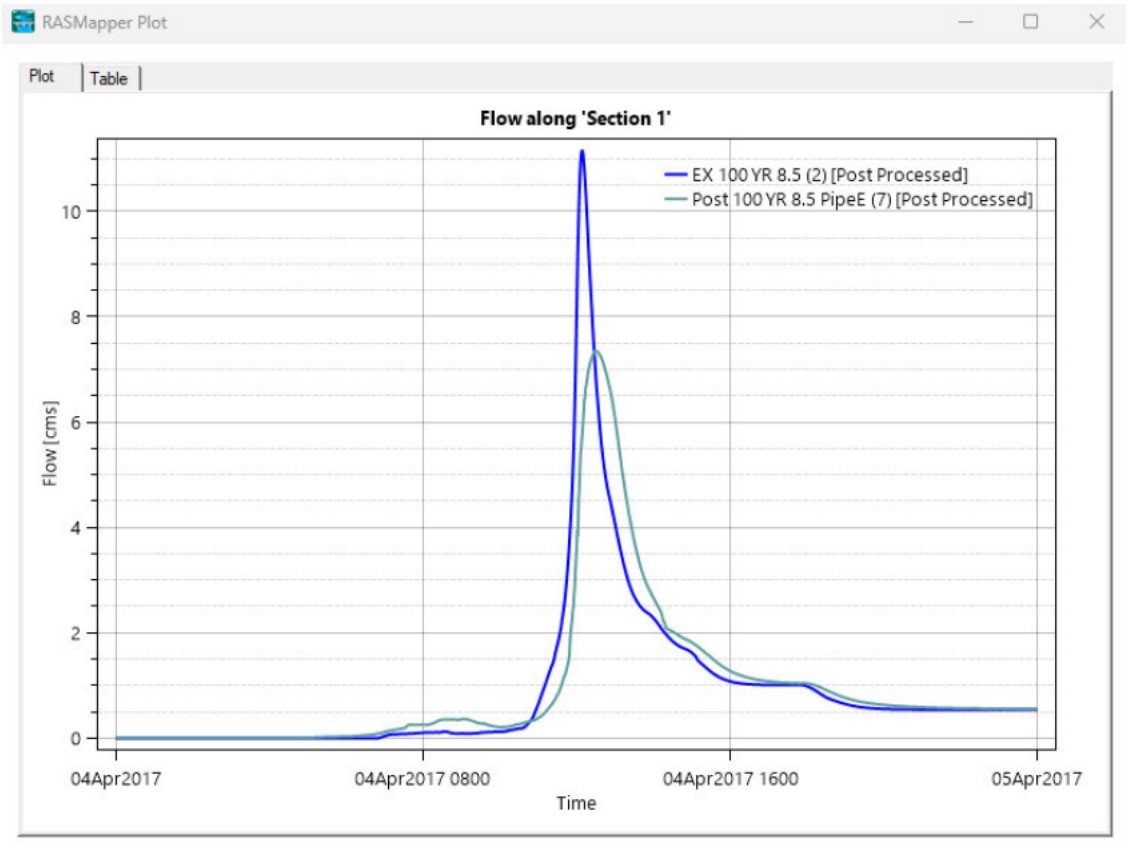


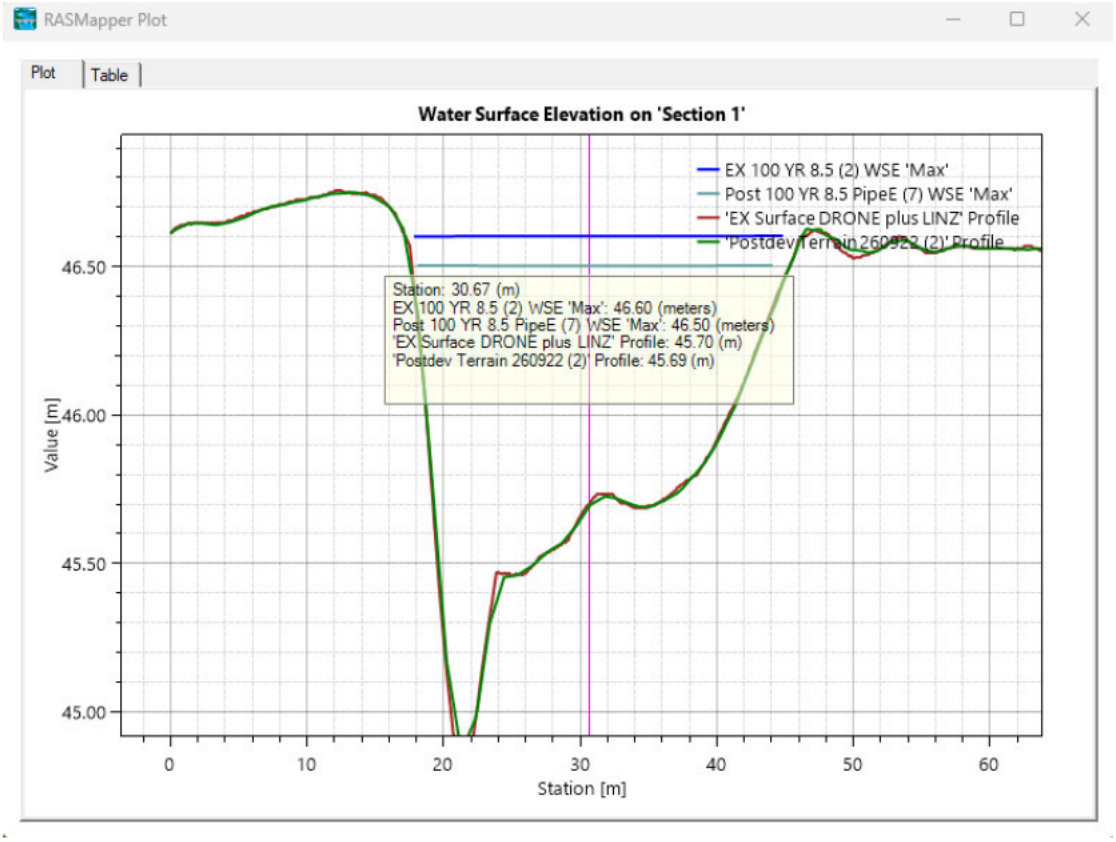
Post-development- Zoomed to the site

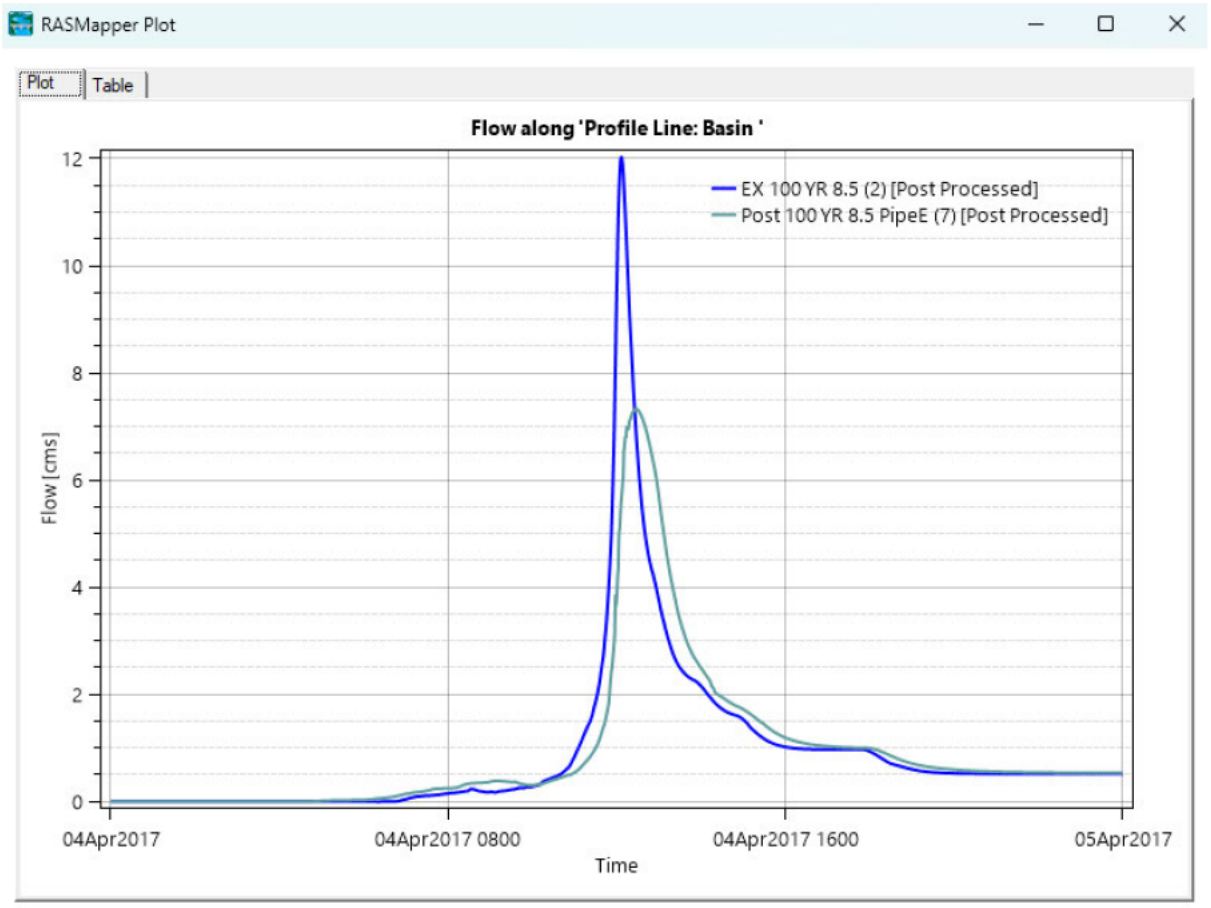


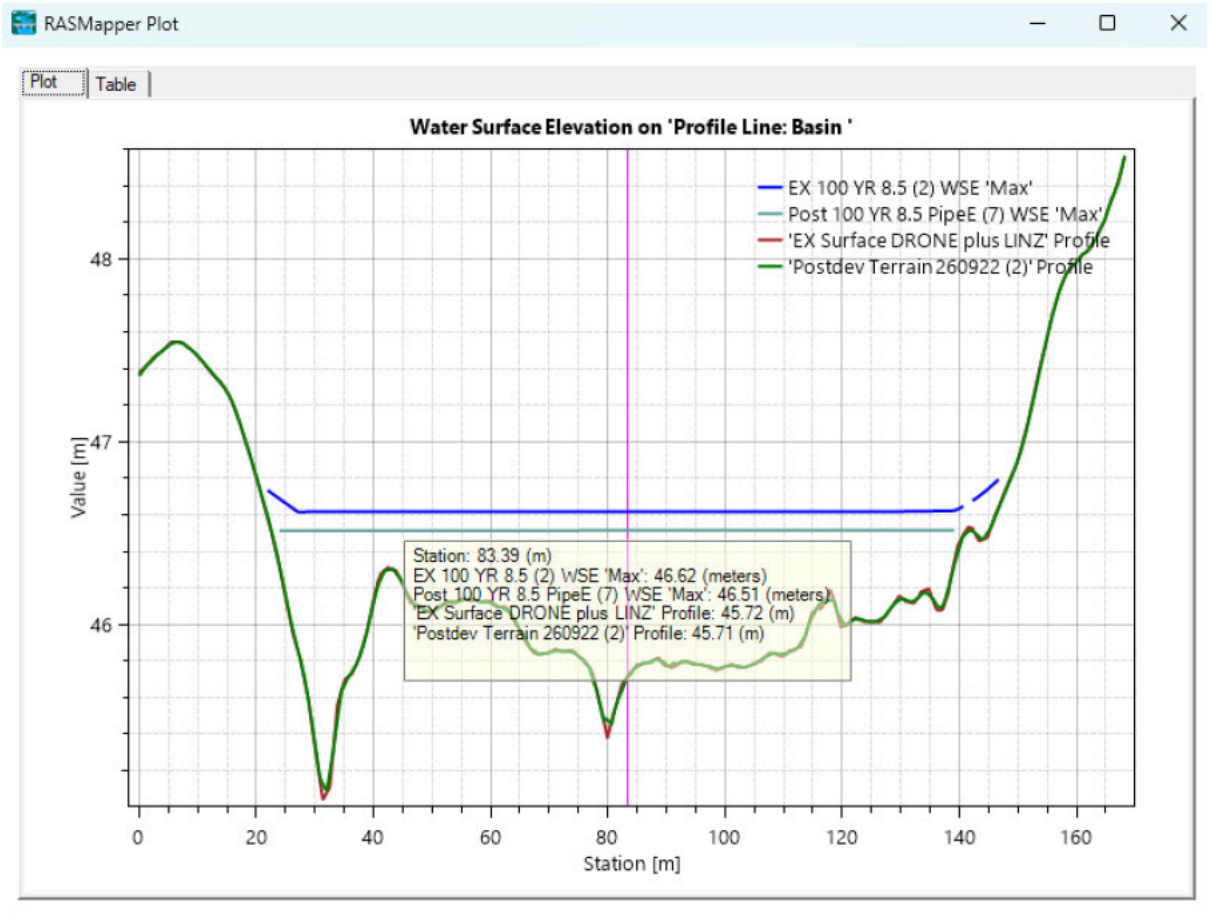
Post-development- Downstream basin

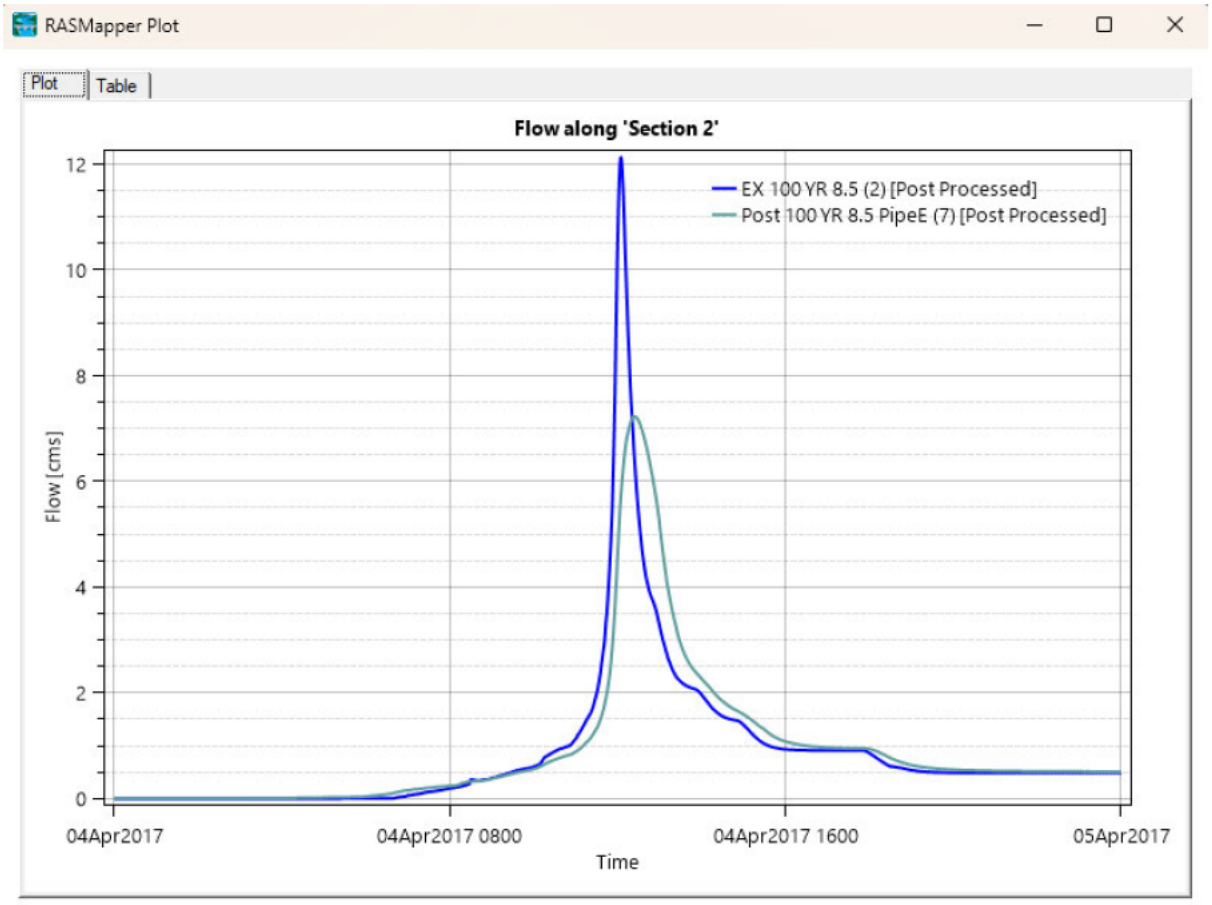
Flow and WSE of Sections

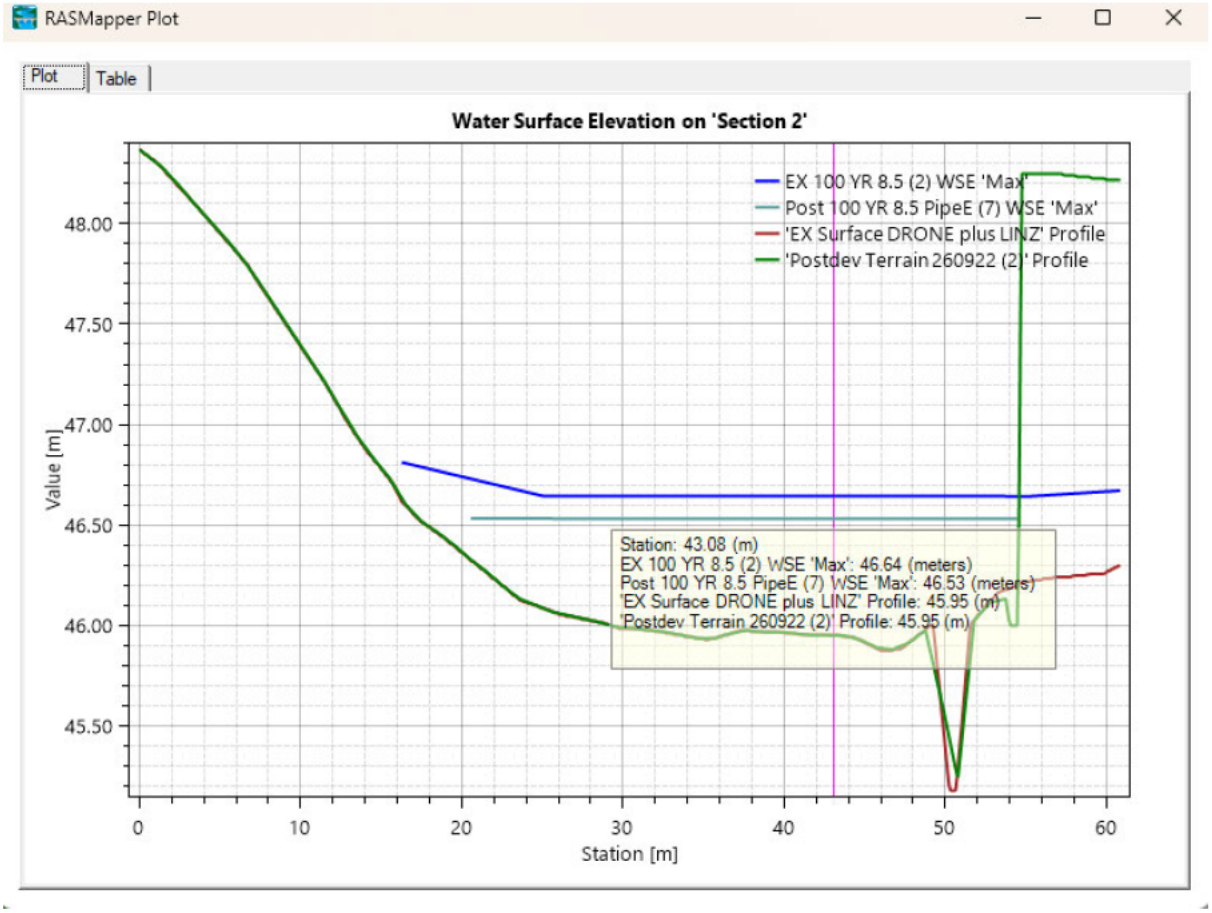


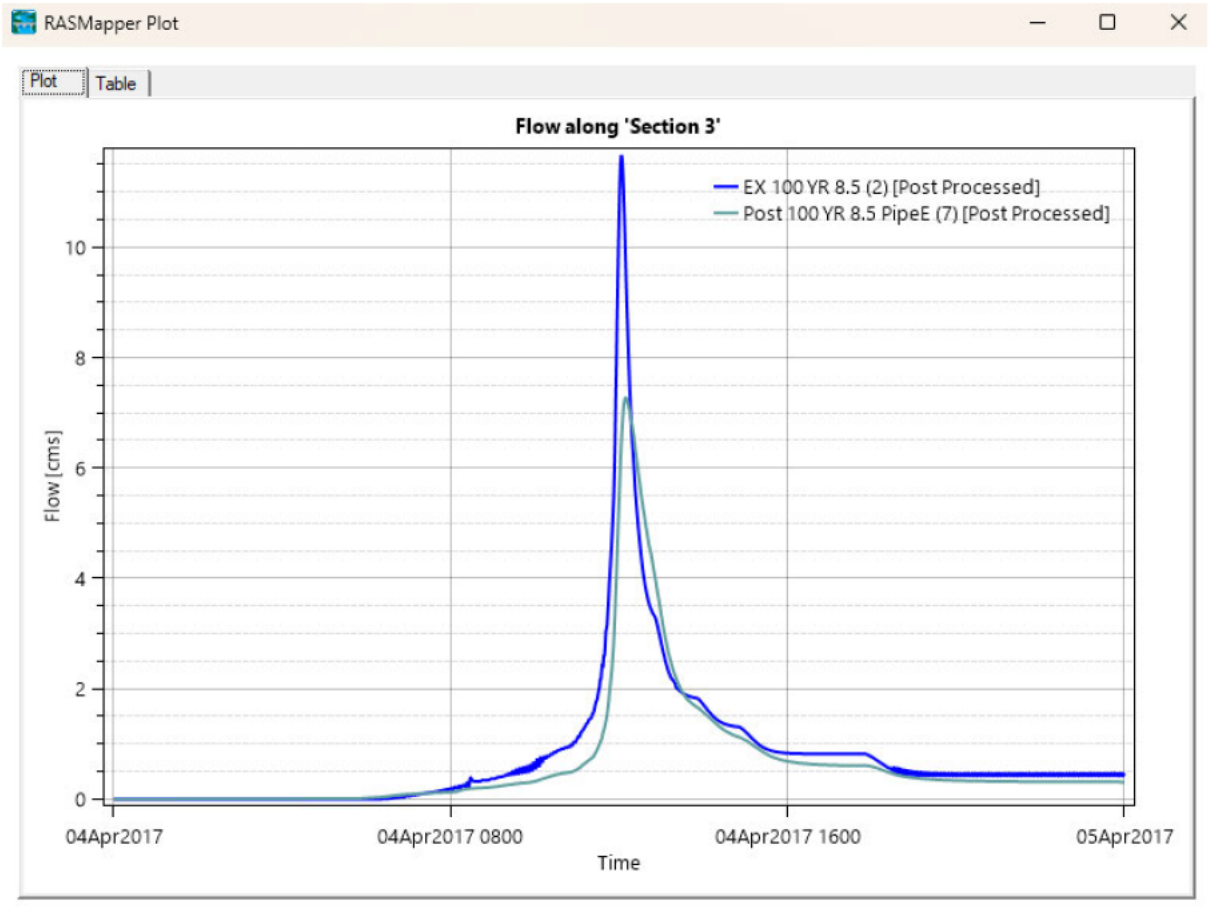


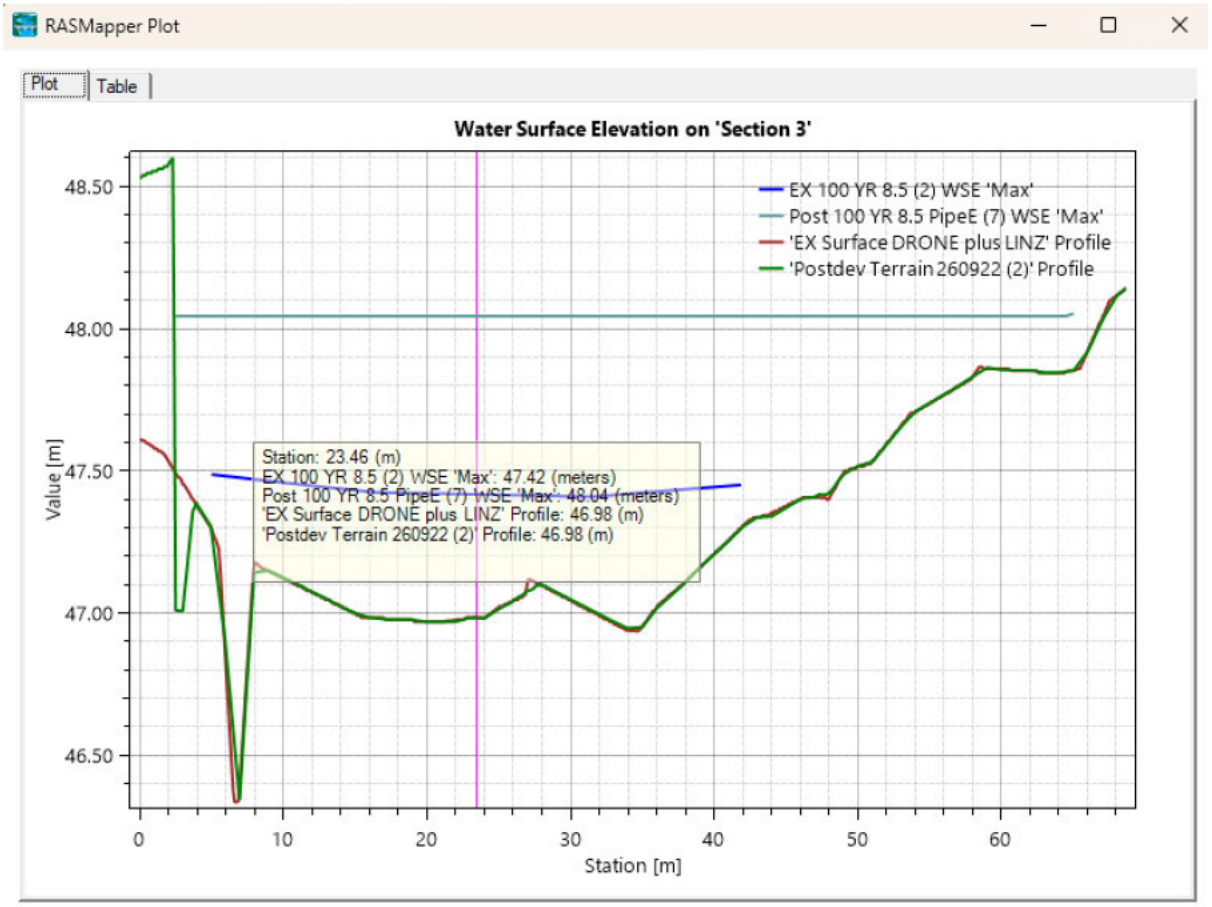

RASMapper Plot
Plot
Table
Flow along 'Profile Line: Basin '
EX 100 YR 8.5 (2) [Post Processed]
Post 100 YR 8.5 PipeE (7) [Post Processed]
Flow [cms]
0
2
4
6
8
10
12
04Apr2017
04Apr2017 0800
04Apr2017 1600
05Apr2017
Time

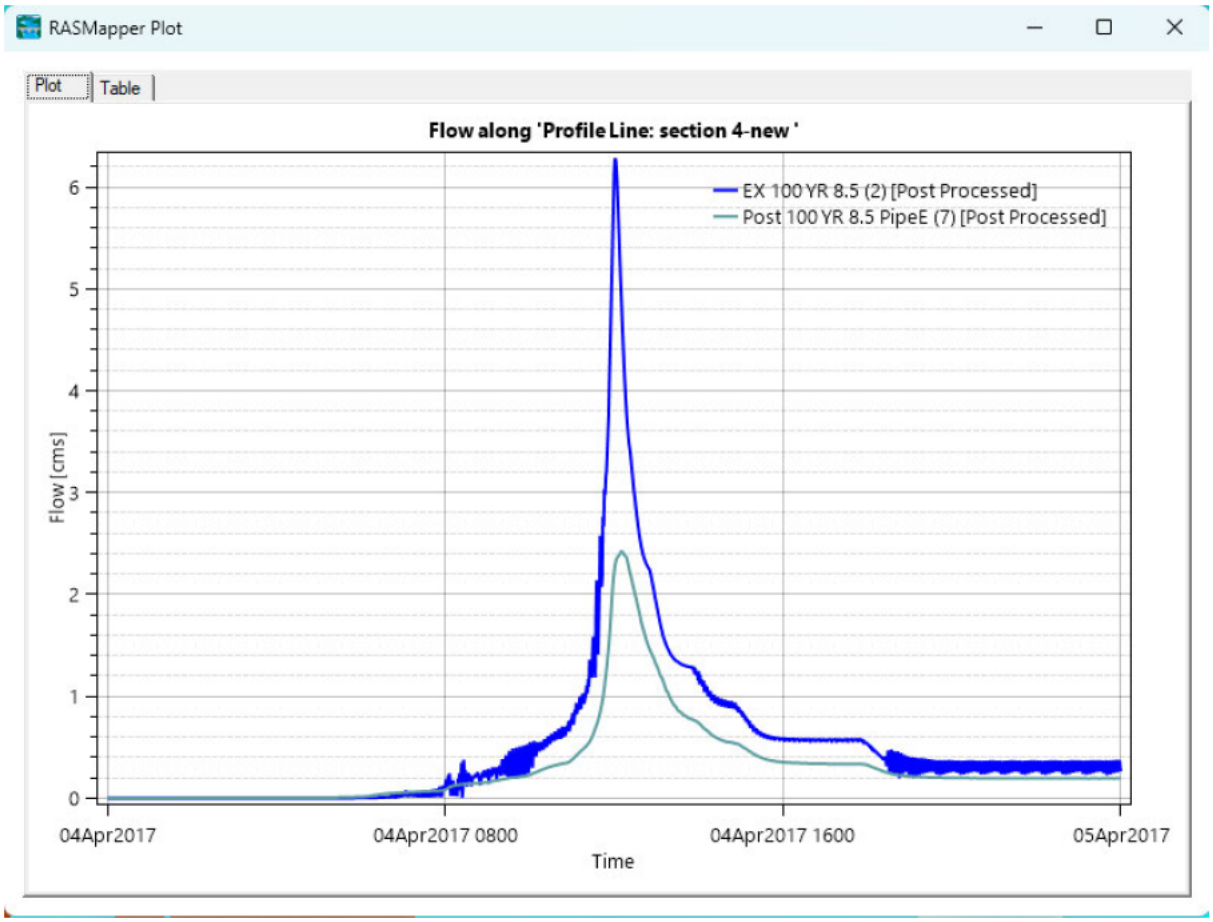

RASMapper Plot
Plot
Table
Water Surface Elevation on 'Profile Line: Basin '
EX 100 YR 8.5 (2) WSE 'Max'
Post 100 YR 8.5 PipeE (7) WSE 'Max'
'EX Surface DRONE plus LINZ' Profile
'Postdev Terrain 260922 (2)' Profile
Station: 83.39 (m)
EX 100 YR 8.5 (2) WSE 'Max': 46.62 (meters)
Post 100 YR 8.5 PipeE (7) WSE 'Max': 46.51 (meters)
'EX Surface DRONE plus LINZ' Profile: 45.72 (m)
'Postdev Terrain 260922 (2)' Profile: 45.71 (m)
Value [m]
46
47
48
0
20
40
60
80
100
120
140
160
Station [m]

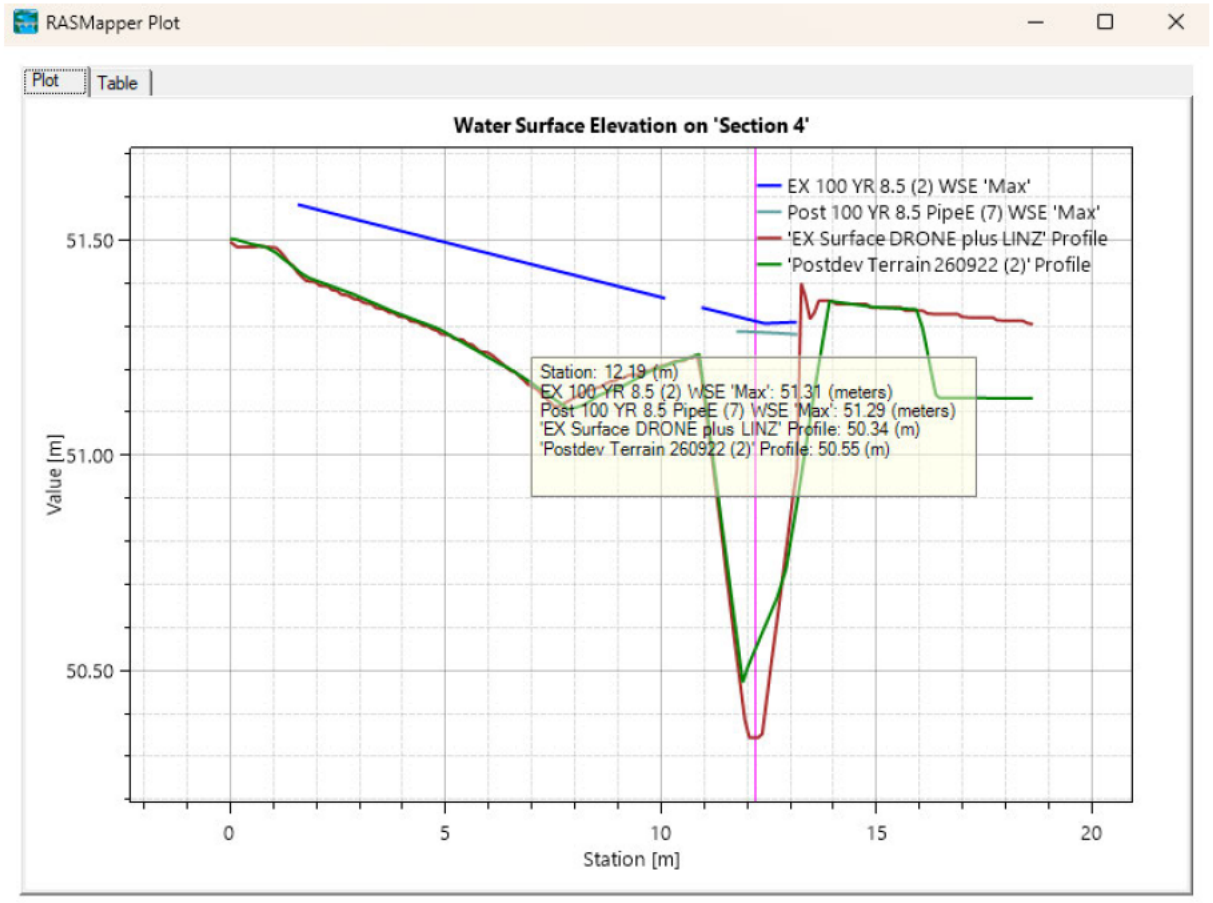

RASMapper Plot
Plot
Table
Flow along 'Section 2'
EX 100 YR 8.5 (2) [Post Processed]
Post 100 YR 8.5 PipeE (7) [Post Processed]
Flow [cms]
0
2
4
6
8
10
12
04Apr2017
04Apr2017 0800
04Apr2017 1600
05Apr2017
Time

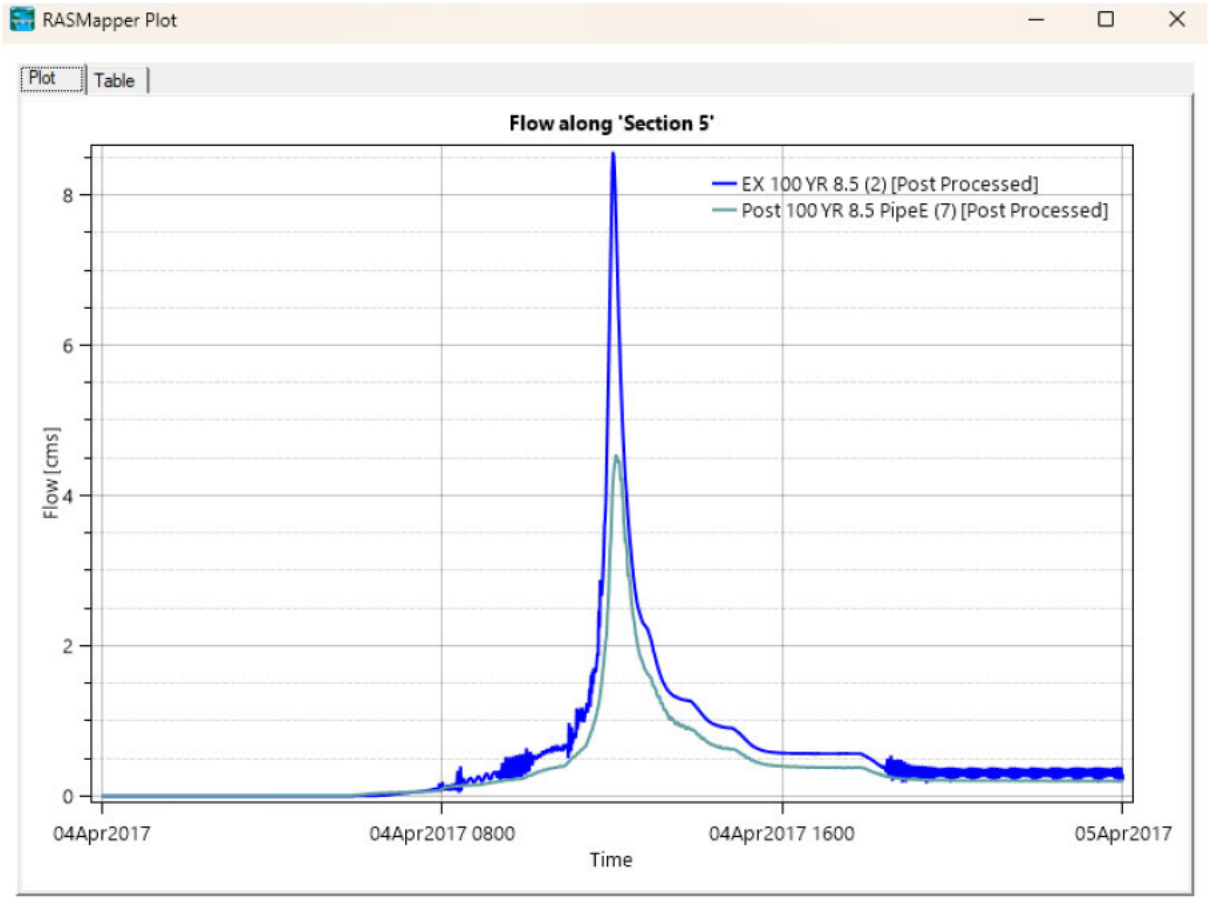

RASMapper Plot
Plot
Table
Water Surface Elevation on 'Section 2'
EX 100 YR 8.5 (2) WSE 'Max'
Post 100 YR 8.5 PipeE (7) WSE 'Max'
'EX Surface DRONE plus LINZ' Profile
'Postdev Terrain 260922 (2)' Profile
Station: 43.08 (m)
EX 100 YR 8.5 (2) WSE 'Max': 46.64 (meters)
Post 100 YR 8.5 PipeE (7) WSE 'Max': 46.53 (meters)
'EX Surface DRONE plus LINZ' Profile: 45.95 (m)
'Postdev Terrain 260922 (2)' Profile: 45.95 (m)
Value [m]
45.50
46.00
46.50
47.00
47.50
48.00
0
10
20
30
40
50
60
Station [m]

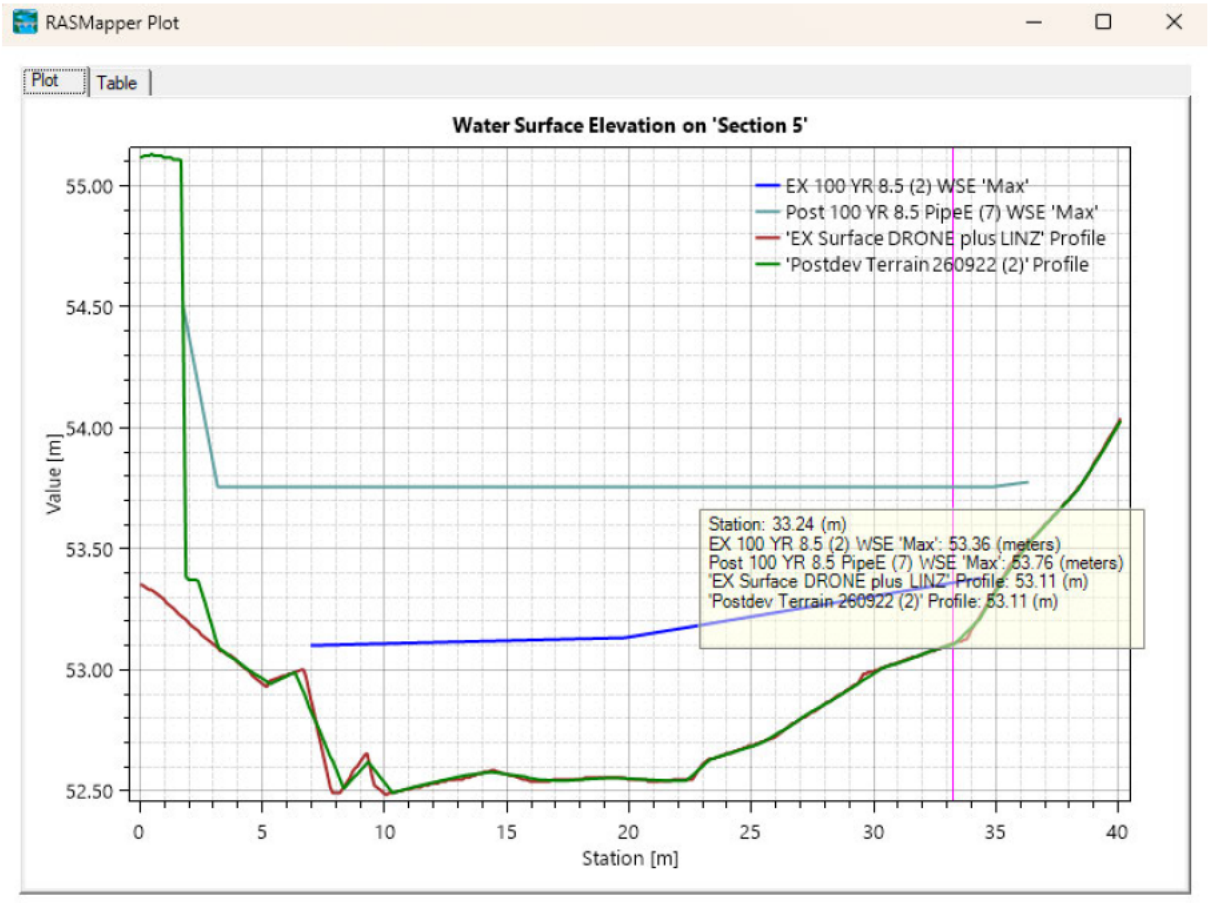

RASMapper Plot
Plot
Table
Flow along 'Section 3'
EX 100 YR 8.5 (2) [Post Processed]
Post 100 YR 8.5 PipeE (7) [Post Processed]
Flow [cms]
0
2
4
6
8
10
04Apr2017
04Apr2017 0800
04Apr2017 1600
05Apr2017
Time

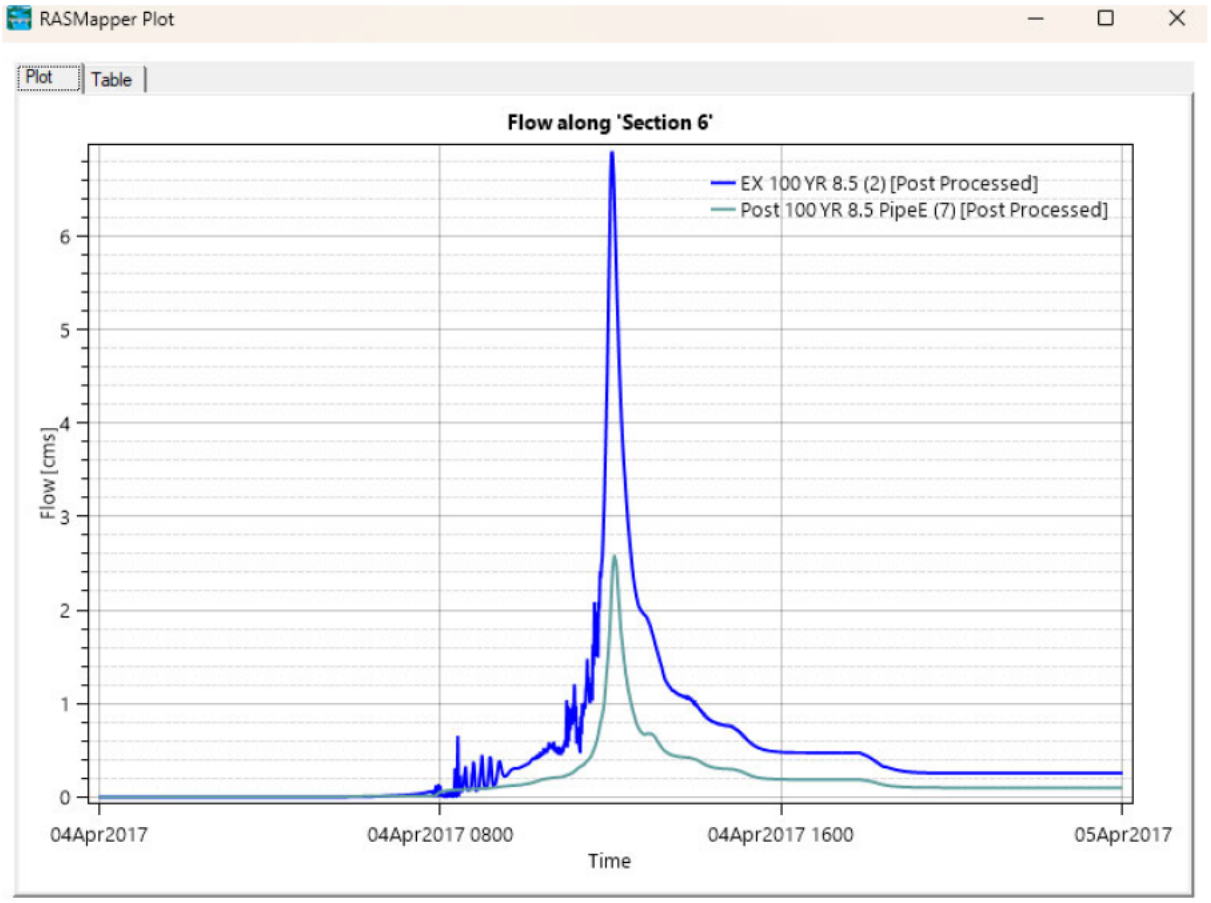

RASMapper Plot
Plot
Table
Water Surface Elevation on 'Section 3'
EX 100 YR 8.5 (2) WSE 'Max'
Post 100 YR 8.5 PipeE (7) WSE 'Max'
'EX Surface DRONE plus LINZ' Profile
'Postdev Terrain 260922 (2)' Profile
Station: 23.46 (m)
EX 100 YR 8.5 (2) WSE 'Max': 47.42 (meters)
Post 100 YR 8.5 PipeE (7) WSE 'Max': 48.04 (meters)
'EX Surface DRONE plus LINZ' Profile: 46.98 (m)
'Postdev Terrain 260922 (2)' Profile: 46.98 (m)
Value [m]
46.50
47.00
47.50
48.00
48.50
0
10
20
30
40
50
60
Station [m]

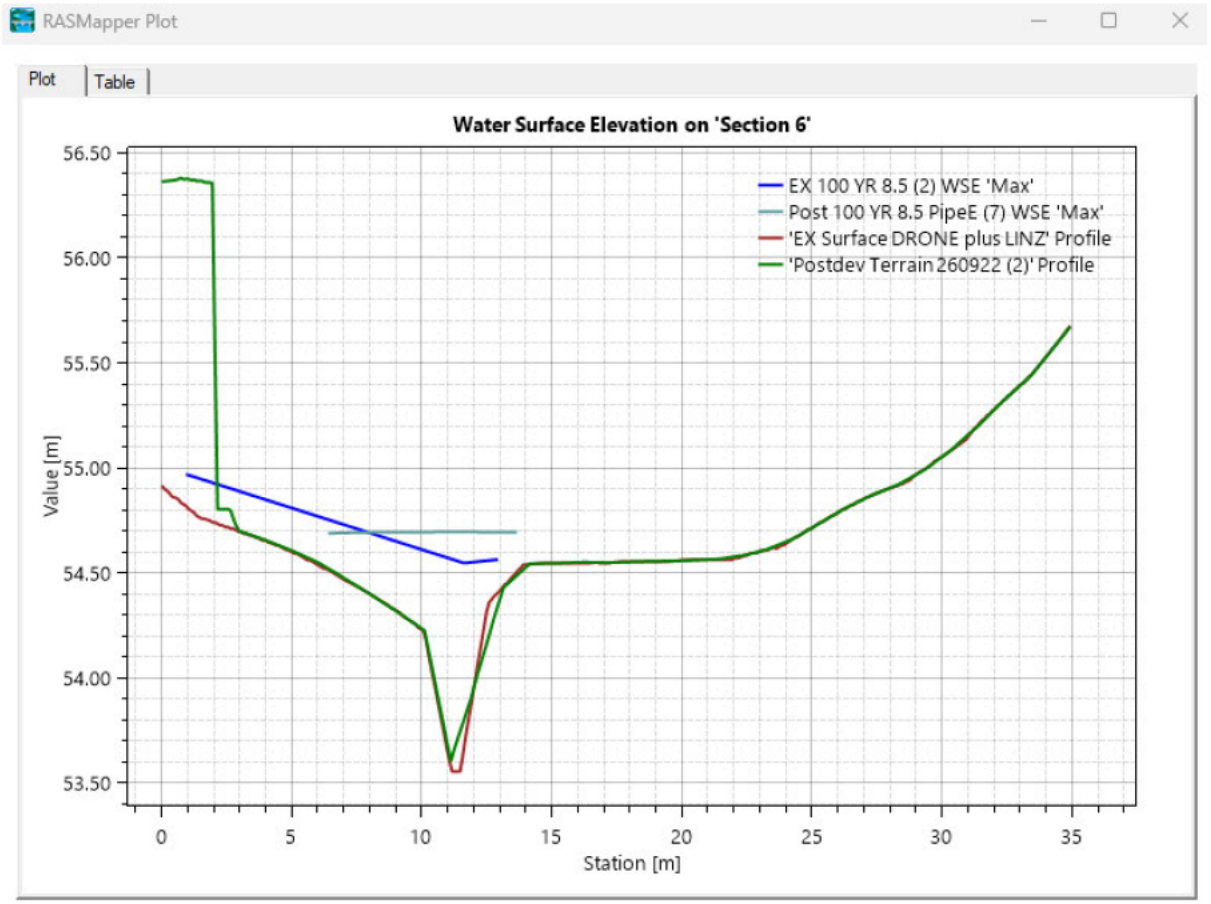

RASMapper Plot
Plot
Table
Flow along 'Profile Line: section 4-new '
EX 100 YR 8.5 (2) [Post Processed]
Post 100 YR 8.5 PipeE (7) [Post Processed]
Flow [cms]
0
1
2
3
4
5
6
04Apr2017
04Apr2017 0800
04Apr2017 1600
05Apr2017
Time

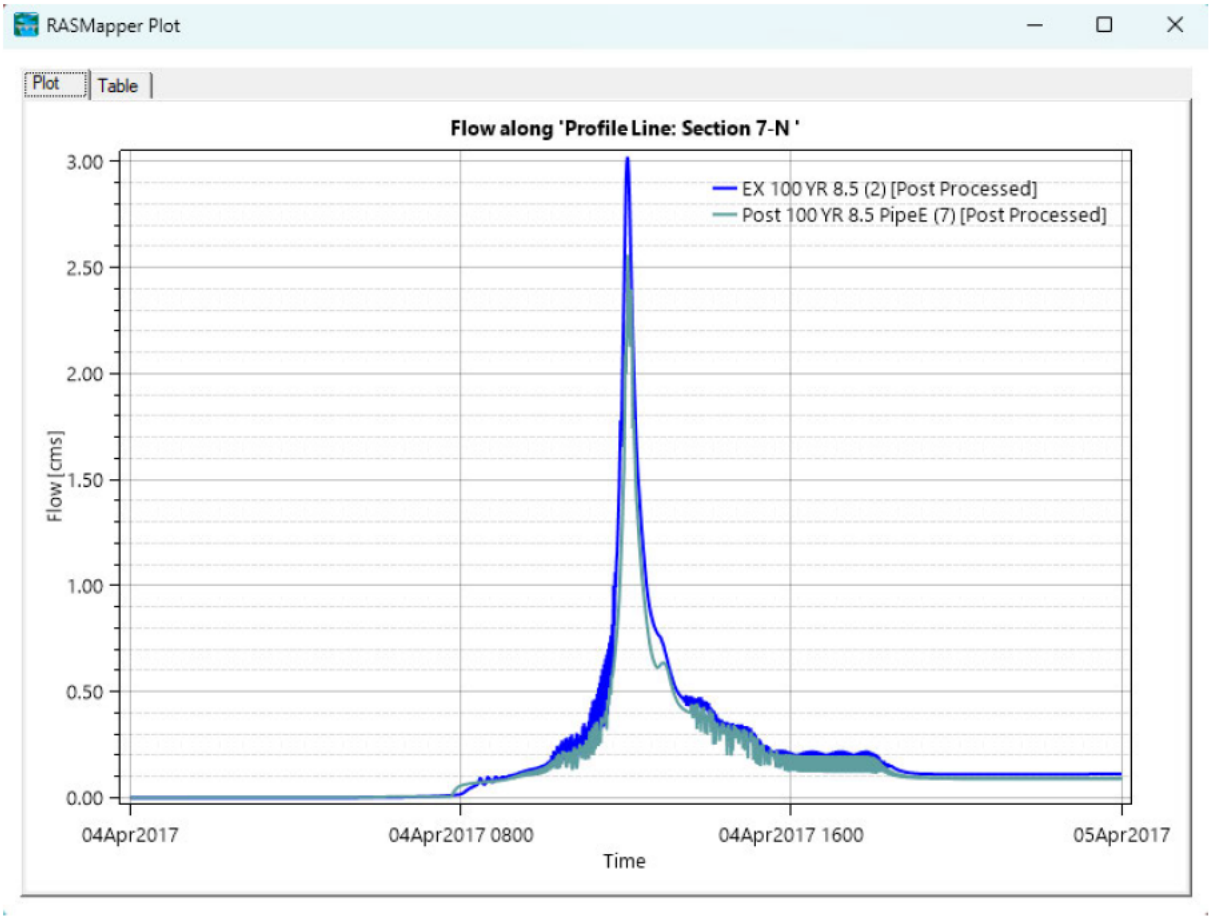

RASMapper Plot
Plot
Table
Water Surface Elevation on 'Section 4'
EX 100 YR 8.5 (2) WSE 'Max'
Post 100 YR 8.5 PipeE (7) WSE 'Max'
'EX Surface DRONE plus LINZ' Profile
'Postdev Terrain 260922 (2)' Profile
Station: 12.19 (m)
EX 100 YR 8.5 (2) WSE 'Max': 51.31 (meters)
Post 100 YR 8.5 PipeE (7) WSE 'Max': 51.29 (meters)
'EX Surface DRONE plus LINZ' Profile: 50.34 (m)
'Postdev Terrain 260922 (2)' Profile: 50.55 (m)
Value [m]
50.50
51.00
51.50
0
5
10
15
20
Station [m]

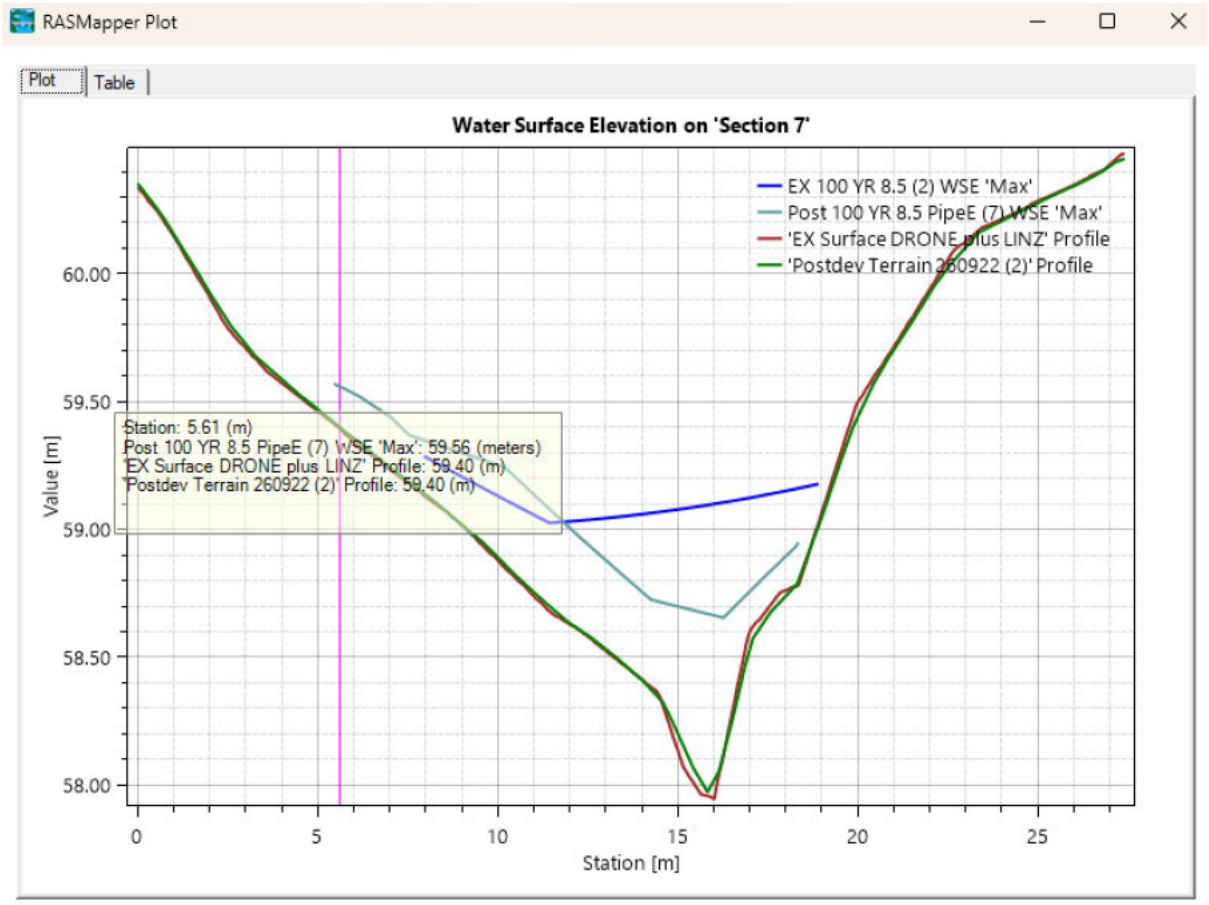

RASMapper Plot
Plot
Table
Flow along 'Section 5'
EX 100 YR 8.5 (2) [Post Processed]
Post 100 YR 8.5 PipeE (7) [Post Processed]
Flow [cms]
0
2
4
6
8
04Apr2017
04Apr2017 0800
04Apr2017 1600
05Apr2017
Time

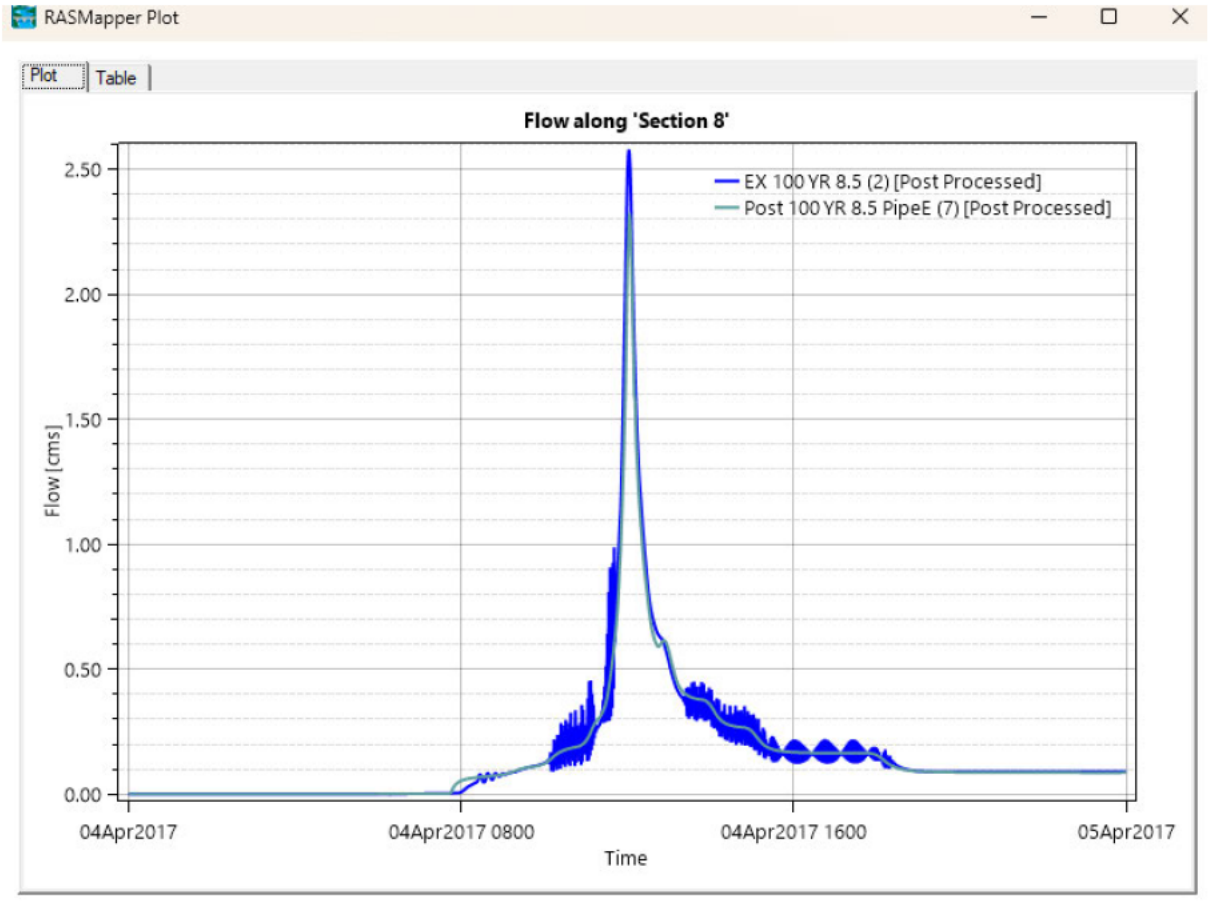

RASMapper Plot
Plot
Table
Water Surface Elevation on 'Section 5'
EX 100 YR 8.5 (2) WSE 'Max'
Post 100 YR 8.5 PipeE (7) WSE 'Max'
'EX Surface DRONE plus LINZ' Profile
'Postdev Terrain 260922 (2)' Profile
Station: 33.24 (m)
EX 100 YR 8.5 (2) WSE 'Max': 53.36 (meters)
Post 100 YR 8.5 PipeE (7) WSE 'Max': 53.76 (meters)
'EX Surface DRONE plus LINZ' Profile: 53.11 (m)
'Postdev Terrain 260922 (2)' Profile: 53.11 (m)
Value [m]
52.50
53.00
53.50
54.00
54.50
55.00
0
5
10
15
20
25
30
35
40
Station [m]

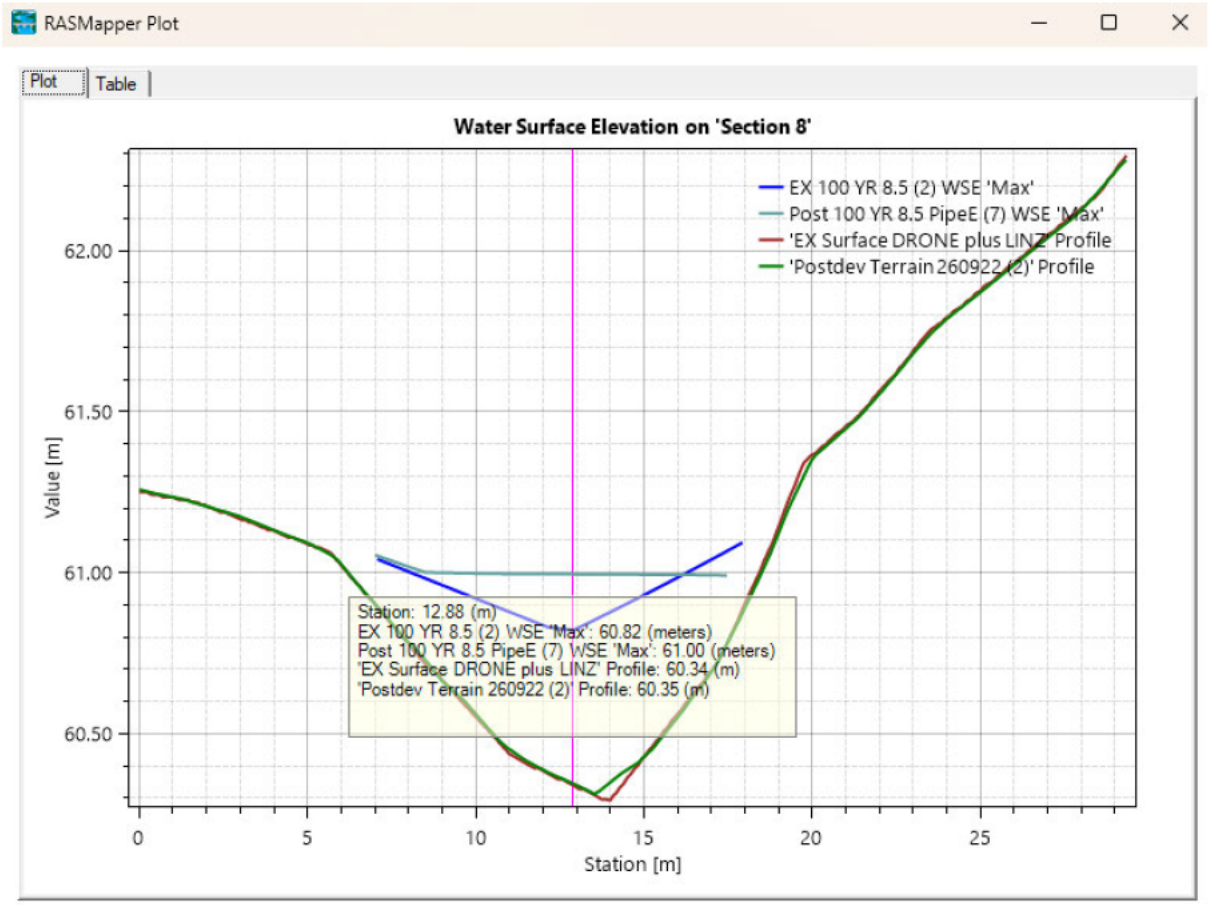

RASMapper Plot
Plot
Table
Flow along 'Section 6'
EX 100 YR 8.5 (2) [Post Processed]
Post 100 YR 8.5 PipeE (7) [Post Processed]
Flow [cms]
0
1
2
3
4
5
6
04Apr2017
04Apr2017 0800
04Apr2017 1600
05Apr2017
Time


RASMapper Plot
Plot
Table
Water Surface Elevation on 'Section 6'
EX 100 YR 8.5 (2) WSE 'Max'
Post 100 YR 8.5 PipeE (7) WSE 'Max'
'EX Surface DRONE plus LINZ' Profile
'Postdev Terrain 260922 (2)' Profile
Value [m]
53.50
54.00
54.50
55.00
55.50
56.00
56.50
0
5
10
15
20
25
30
35
Station [m]

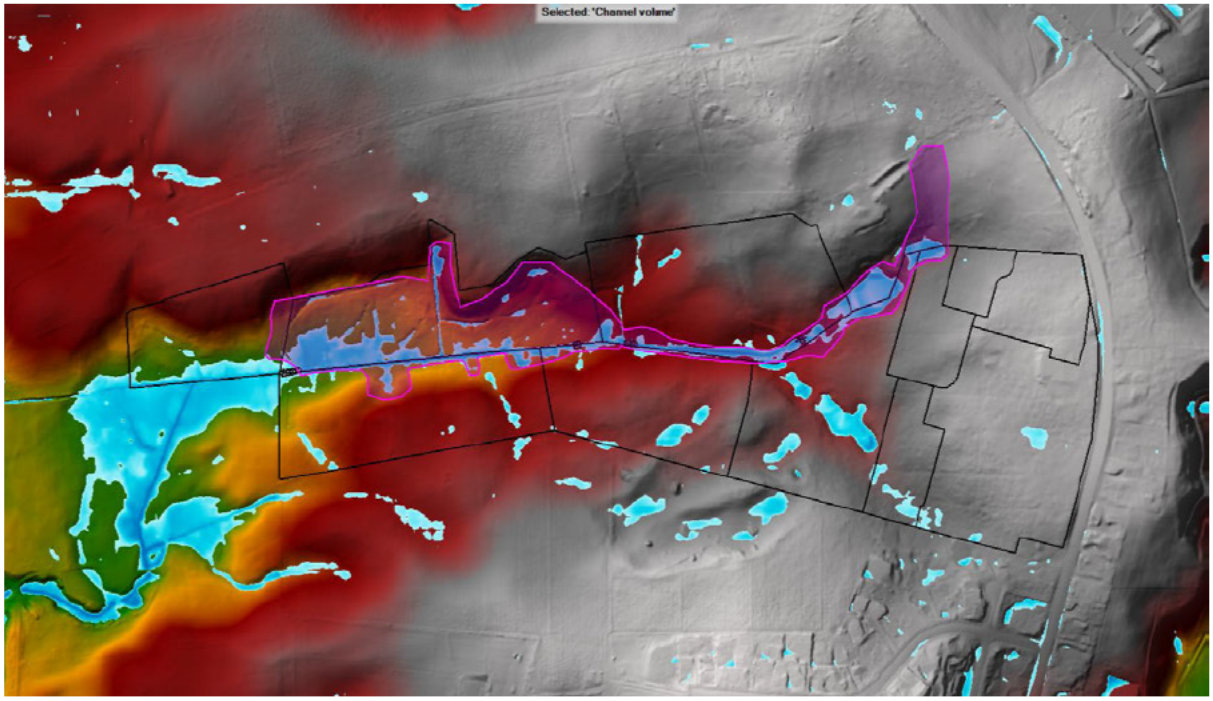

RASMapper Plot
Plot
Table
Flow along 'Profile Line: Section 7-N '
EX 100 YR 8.5 (2) [Post Processed]
Post 100 YR 8.5 PipeE (7) [Post Processed]
Flow [cms]
3.00
2.50
2.00
1.50
1.00
0.50
0.00
04Apr2017
04Apr2017 0800
04Apr2017 1600
05Apr2017
Time


RASMapper Plot
Plot
Table
Water Surface Elevation on 'Section 7'
EX 100 YR 8.5 (2) WSE 'Max'
Post 100 YR 8.5 PipeE (7) WSE 'Max'
'EX Surface DRONE plus LINZ' Profile
'Postdev Terrain 260922 (2)' Profile
Station: 5.61 (m)
Post 100 YR 8.5 PipeE (7) WSE 'Max': 59.56 (meters)
'EX Surface DRONE plus LINZ' Profile: 59.40 (m)
'Postdev Terrain 260922 (2)' Profile: 59.40 (m)
Value [m]
60.00
59.50
59.00
58.50
58.00
0
5
10
15
20
25
Station [m]

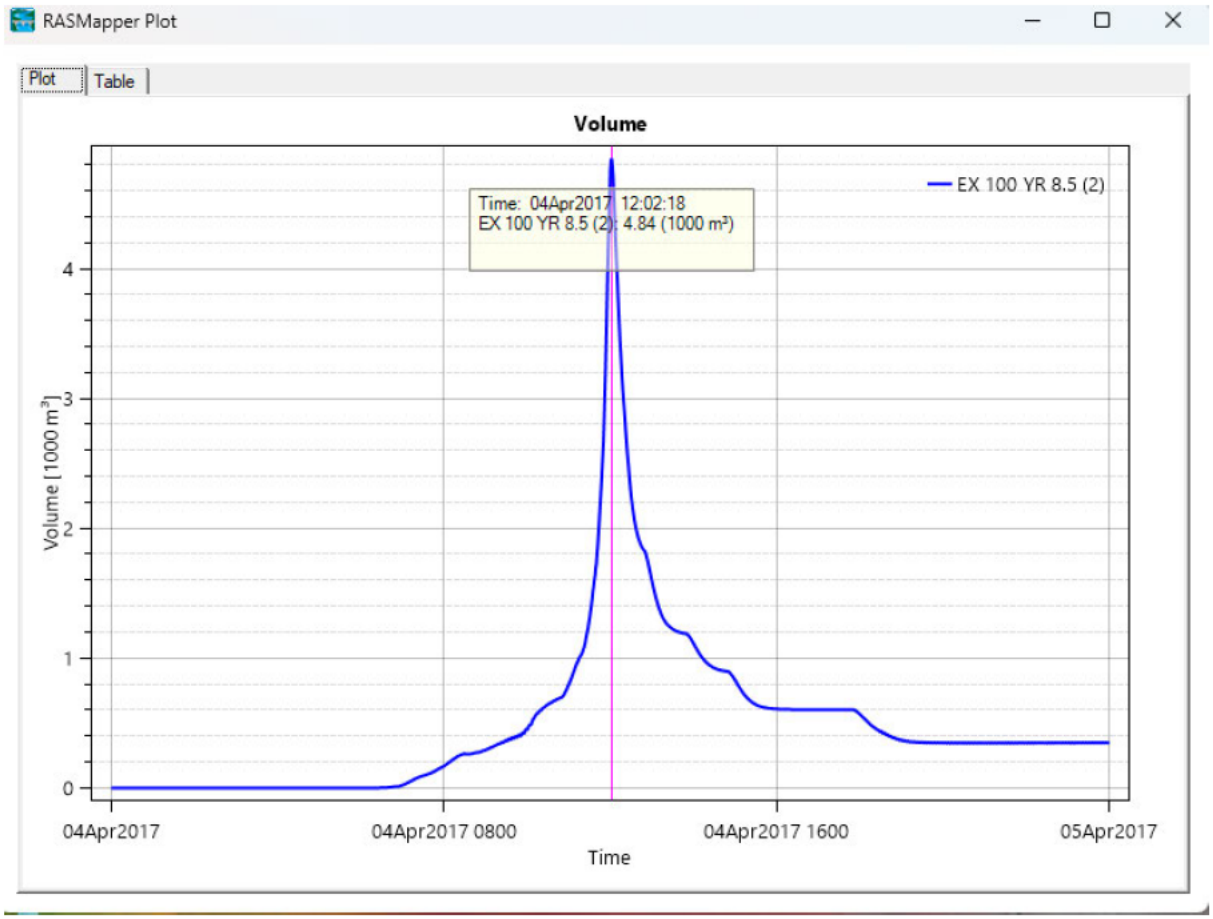

RASMapper Plot
Plot
Table
Flow along 'Section 8'
EX 100 YR 8.5 (2) [Post Processed]
Post 100 YR 8.5 PipeE (7) [Post Processed]
Flow [cms]
2.50
2.00
1.50
1.00
0.50
0.00
04Apr2017
04Apr2017 0800
04Apr2017 1600
05Apr2017
Time


RASMapper Plot
Plot
Table
Water Surface Elevation on 'Section 8'
EX 100 YR 8.5 (2) WSE 'Max'
Post 100 YR 8.5 PipeE (7) WSE 'Max'
'EX Surface DRONE plus LINZ' Profile
'Postdev Terrain 260922 (2)' Profile
Value [m]
62.00
61.50
61.00
60.50
Station: 12.88 (m)
EX 100 YR 8.5 (2) WSE 'Max': 60.82 (meters)
Post 100 YR 8.5 PipeE (7) WSE 'Max': 61.00 (meters)
'EX Surface DRONE plus LINZ' Profile: 60.34 (m)
'Postdev Terrain 260922 (2)' Profile: 60.35 (m)
0
5
10
15
20
25
Station [m]

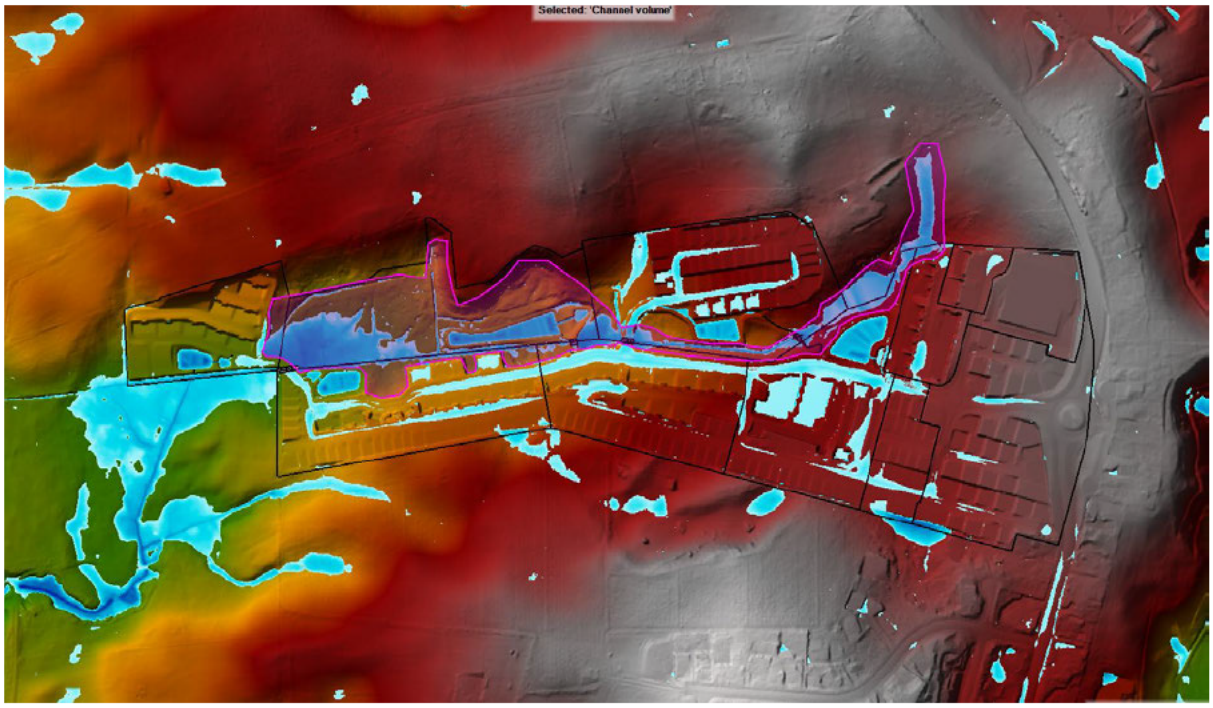
Volumes- 100yr RCP 8.5



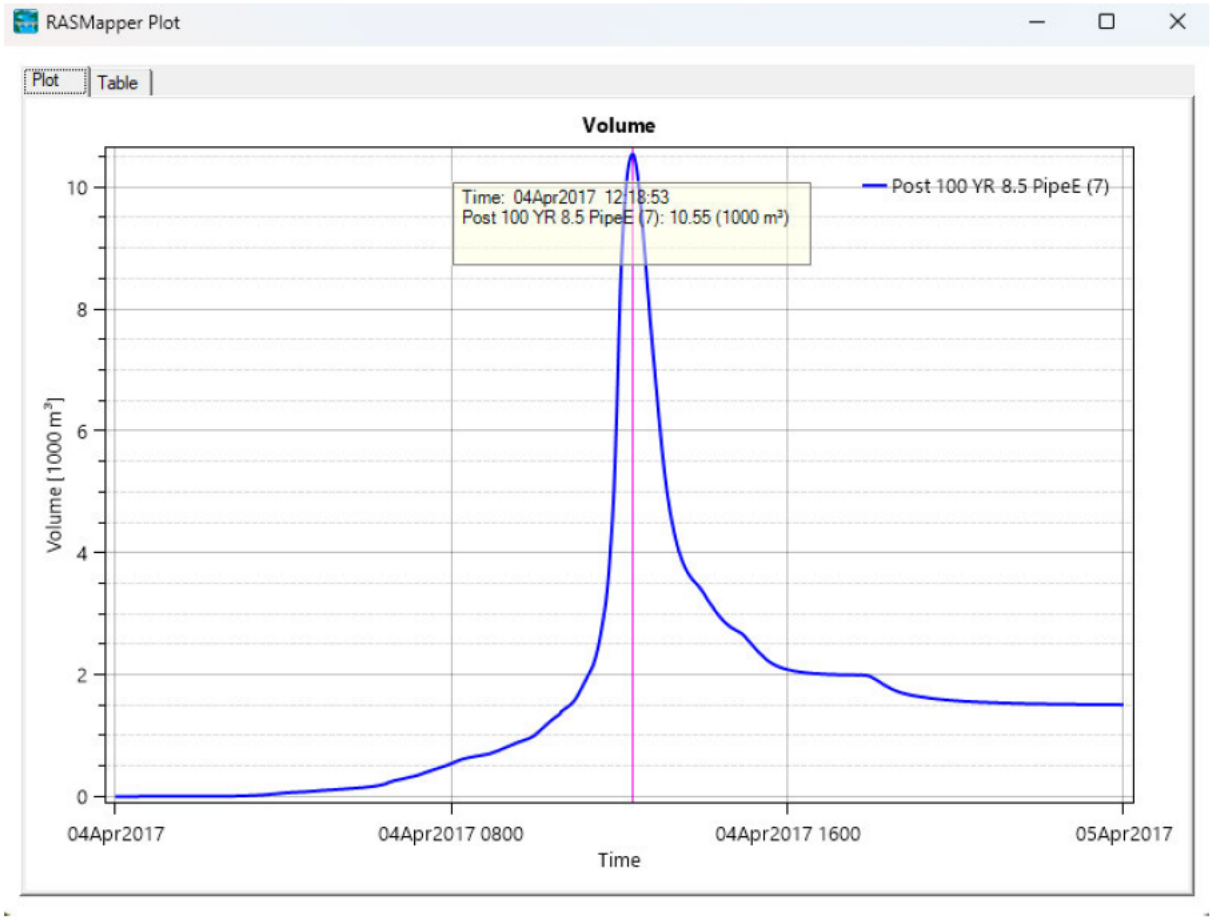
Pre-development – Channel volume extends



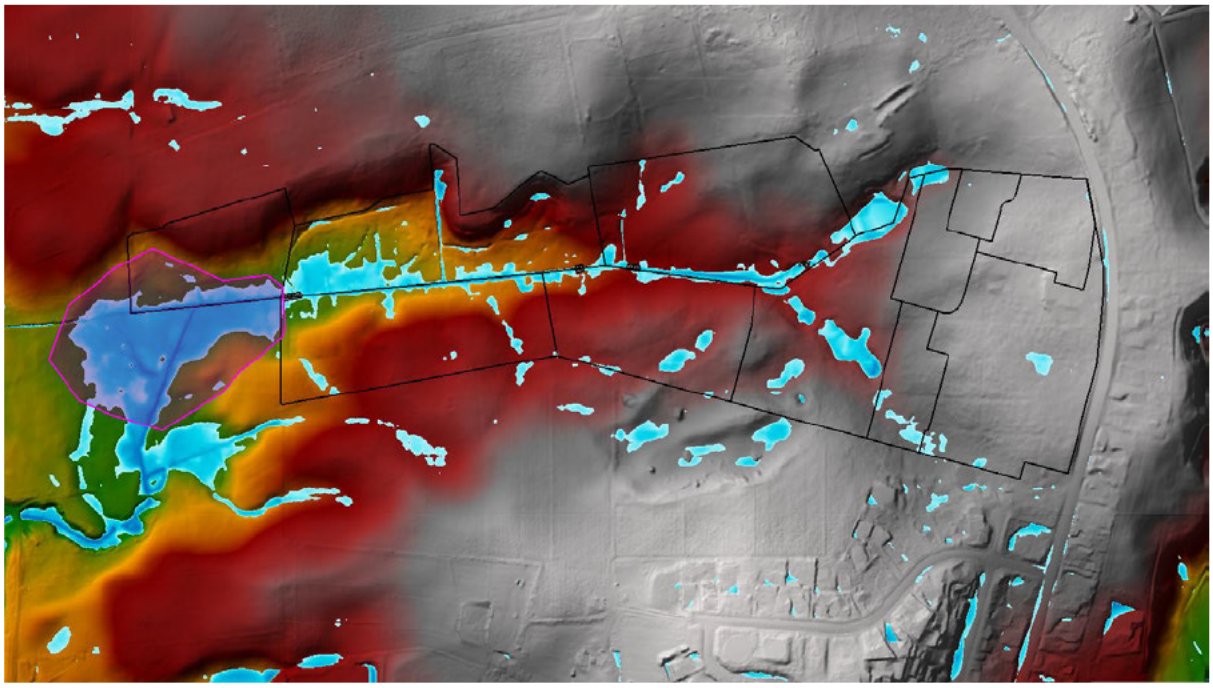
Pre-development channel volume



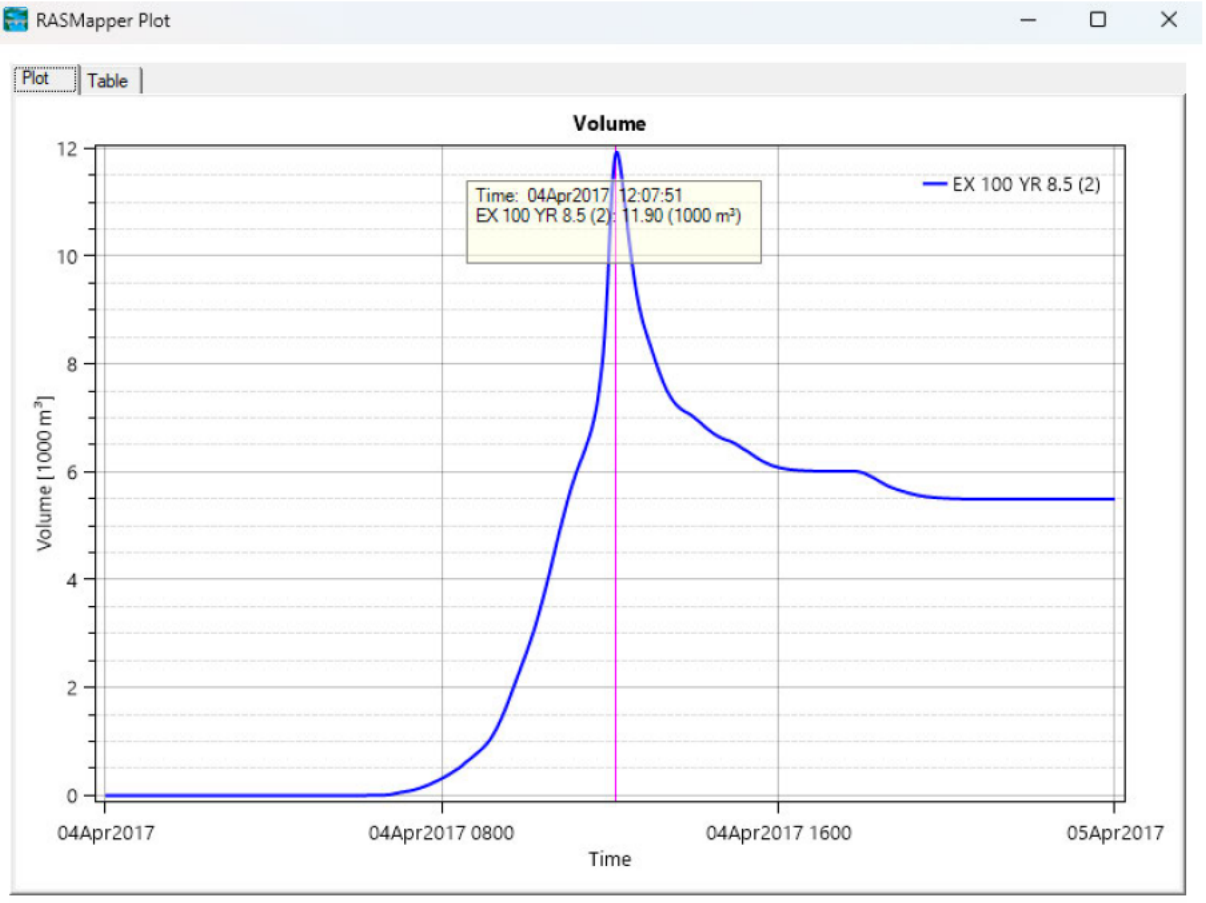
Post-development- Channel volume extends



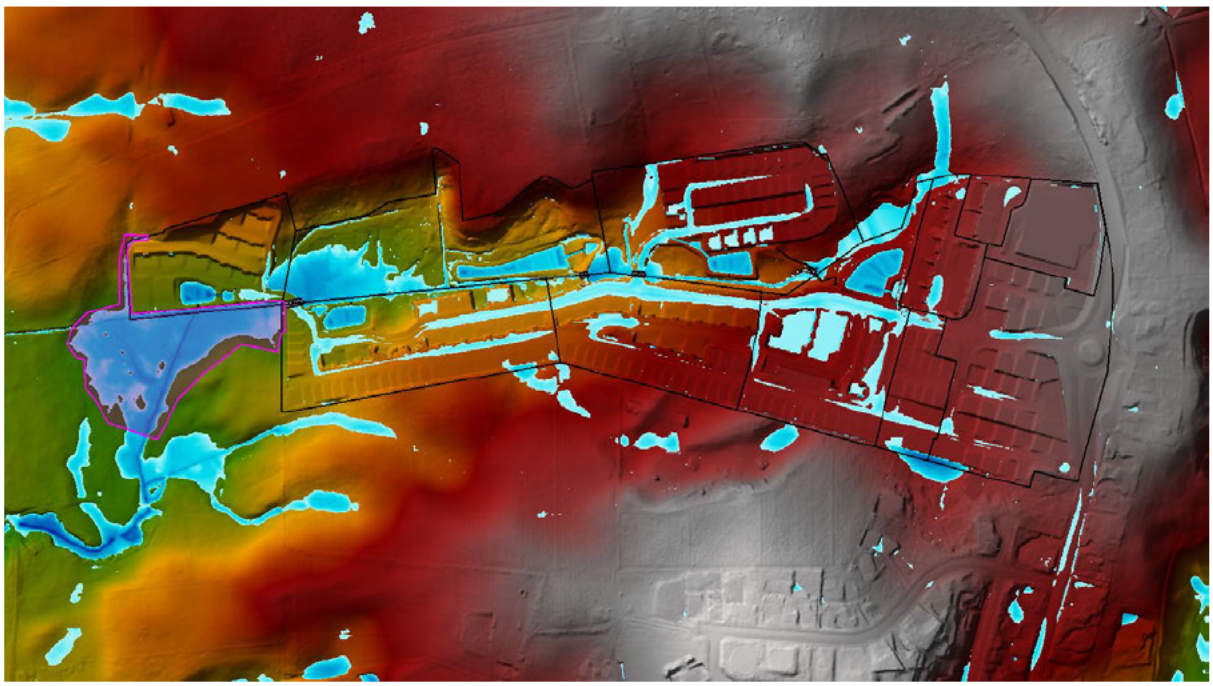
Post-development channel volume



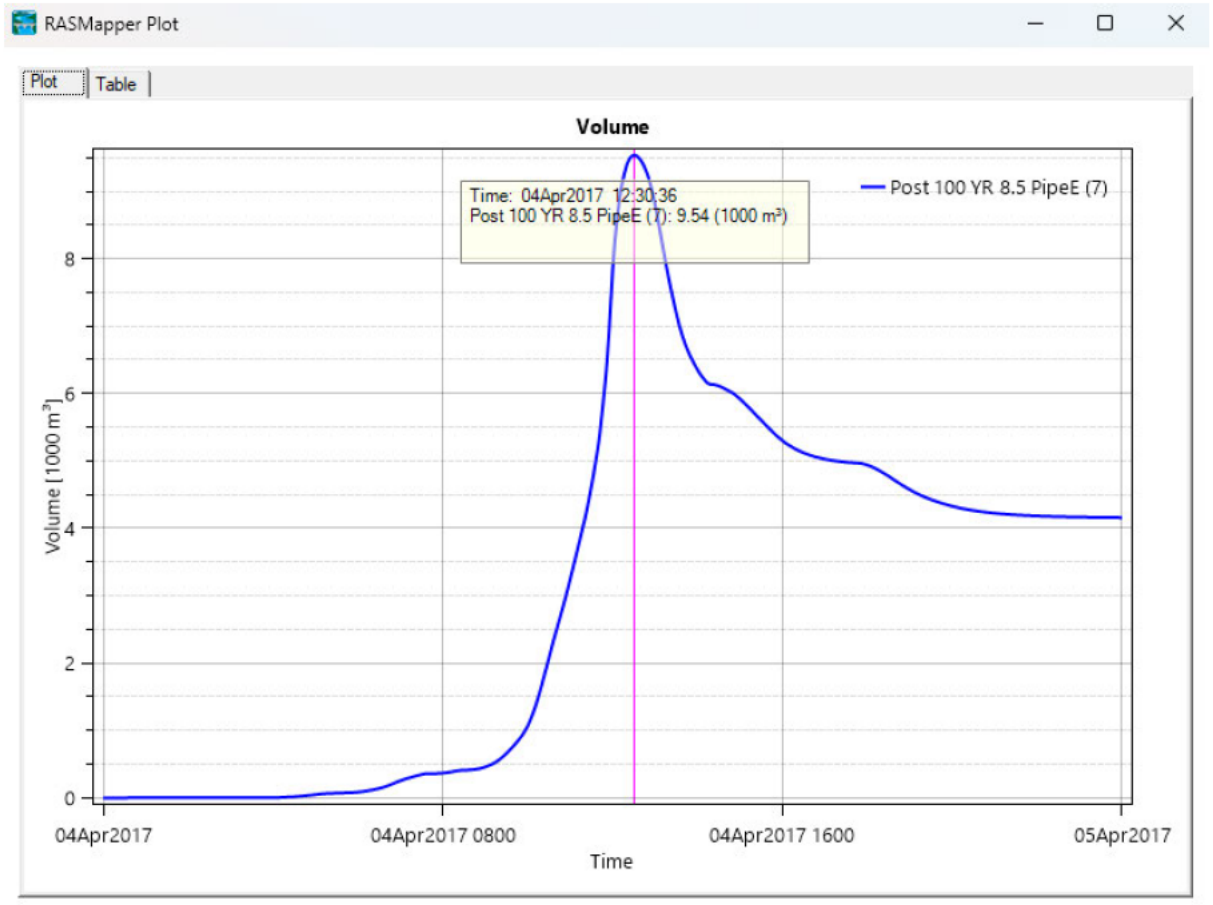
Pre-development- Basin Volume extends



Pre-development- Basin volume

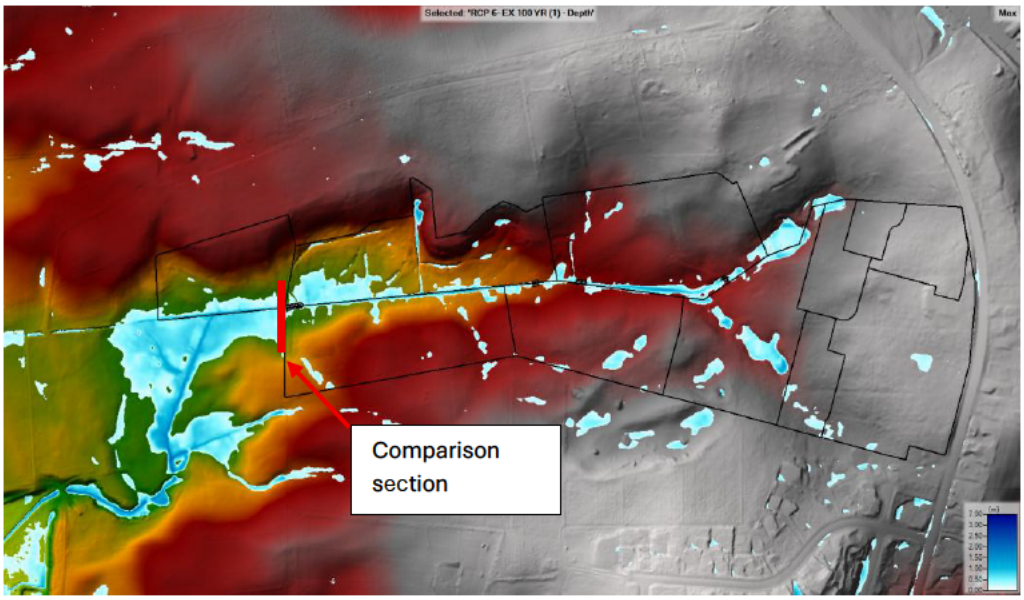


Post-development- Basin volume extends

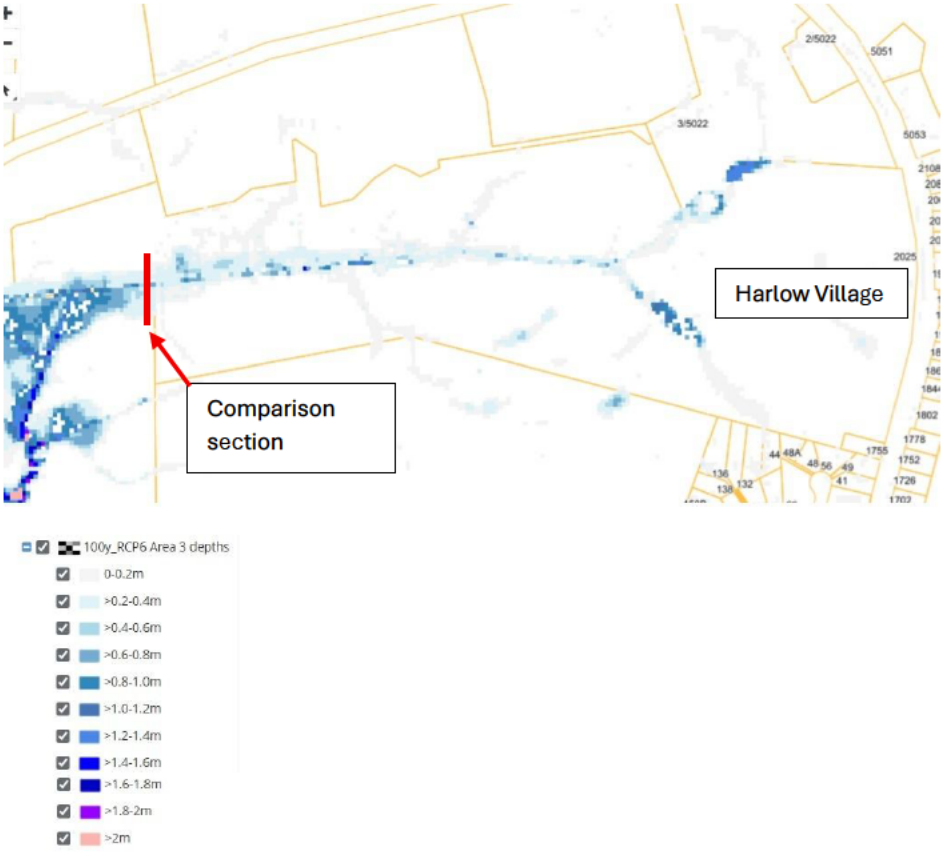


Post-development- Basin volume

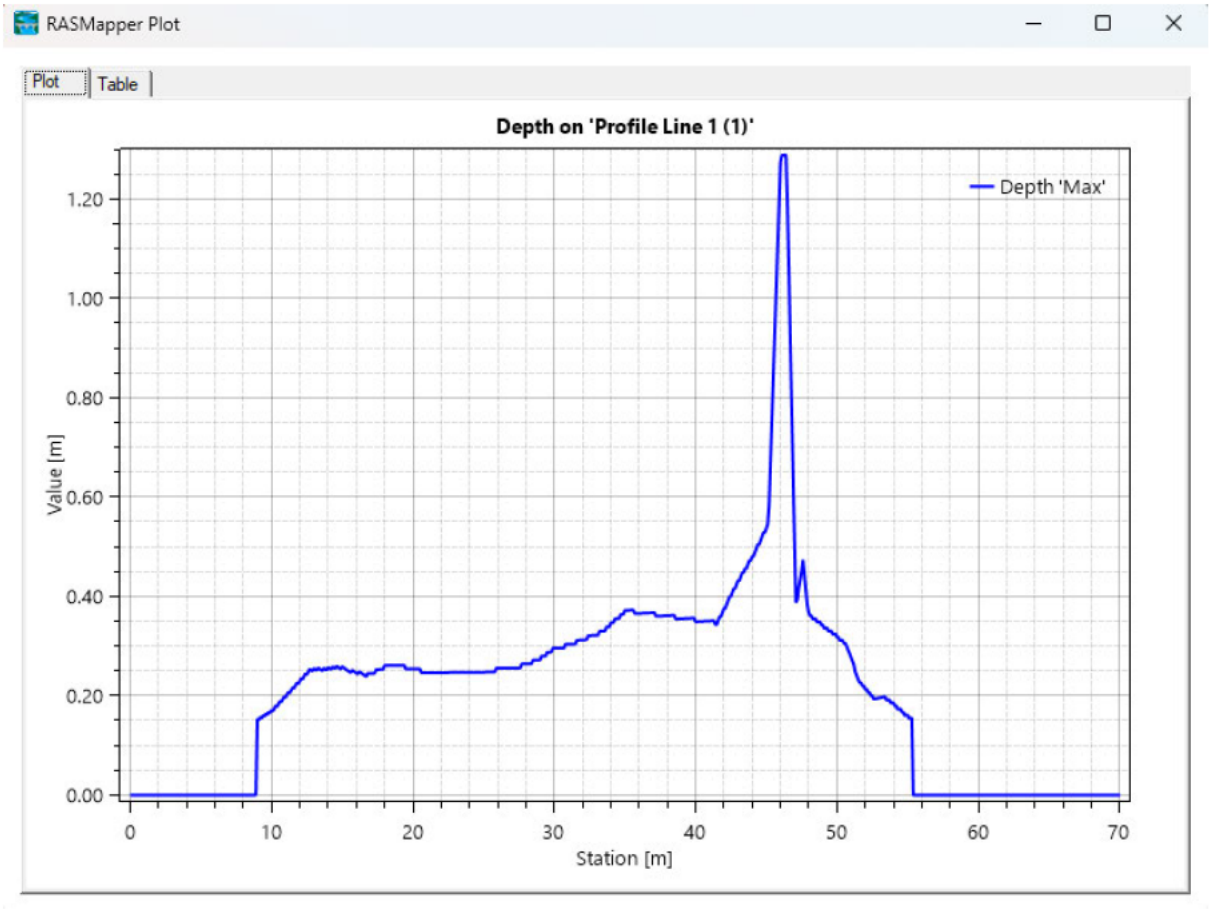
Pre-development 100yr RCP 6.0 flood extend



Pre-development RCP 6.0 flood extends



WRC flood 100yr RCP 6.0 flood extends



HEC RAS depth at the comparison section

Outlook

New Request ID: 71178 for Stormwater Enquiries

From Britta Jensen [redacted]
Date Wed 9/30/2026 12:59 PM
To Arjun Premnath [redacted]

2 attachments (551 KB)
100 yr RCP 6 climate change Flood Map.jpg; 100y RCP6 Rural Flood Map.jpg;

You don't often get email from [redacted]. Learn why this is important

Hello,

We can provide the modelled flood depths for the 1% AEP (100-year ARI) event under the RCP6 climate change scenario at this location.

Based on this, the 2025 Ohaupo Road does not appear to be directly affected by the river flooding. However, the modelled rural flood mapping indicates that the property is subject to localised flood depths in the order of approximately 100mm–1600 mm under the RCP6 Climate Change Scenario(excerpt attached).

The rural flood hazard mapping held by Waipā District Council, including that available via the public viewer, is a predictive screening tool intended to indicate potential flood extent and relative depths. It is not a design tool, and as such, we are unable to provide "exact" flood levels suitable for design purposes.

Please note the following important caveats:

It is important to note that the flood mapping is derived from regional-scale modelling and is therefore subject to inherent assumptions and limitations, including model resolution, input data quality, terrain representation, and the treatment of local drainage features.

We also note that any future development may be subject to the requirements of the National Policy Statement for Natural Hazard Decision-making (or relevant natural hazard assessments), which may require consideration of flood hazard metrics such as flood depth, velocity, and the depth × velocity product.

The information has been prepared and provided in good faith using the best available data at the time. While due care has been taken, Waipā District Council does not guarantee the accuracy, completeness, or reliability of this information. Independent professional advice should be sought before relying on it for decision-making.

Kind Regards,

Britta

Britta Jensen Stormwater Engineer **WAIPĀ DISTRICT COUNCIL**
[redacted] | www.waipadc.govt.nz

Flexible working: You may receive this email outside of ‘normal’ business hours, 8am-5pm. There is no expectation for you to read or reply outside of your working hours.

==========
This electronic message and any attached files may contain confidential information, and may be subject to legal professional privilege. If this message is not intended for you, do not use, read, distribute or copy it. Please contact the sender immediately and delete the original message and any attachments. Before opening or using attachments, check them for viruses and effects. Waipā District Council makes reasonable efforts to ensure that its electronic messages have been scanned and are free of viruses, however takes no responsibility for affected messages or attachments.
==========

Te Kaunihera ā Rohe o Waipa

Outlook

Re: Flood Model- for Ohaupo Road Te Awamutu

From Navdeep Kaur [redacted]
Date Mon 8/31/2026 8:41 AM
To Doug Stewart [redacted] Debbie Eastwood [redacted]
Cc Sean McDonald [redacted]

Hi Debbie and Doug,

Thanks for letting me know about the form and filling out one for us, appreciate it.

Our subject site catchment is draining to Mangapiko stream as marked below.



Looks like there is no information found on that stream.

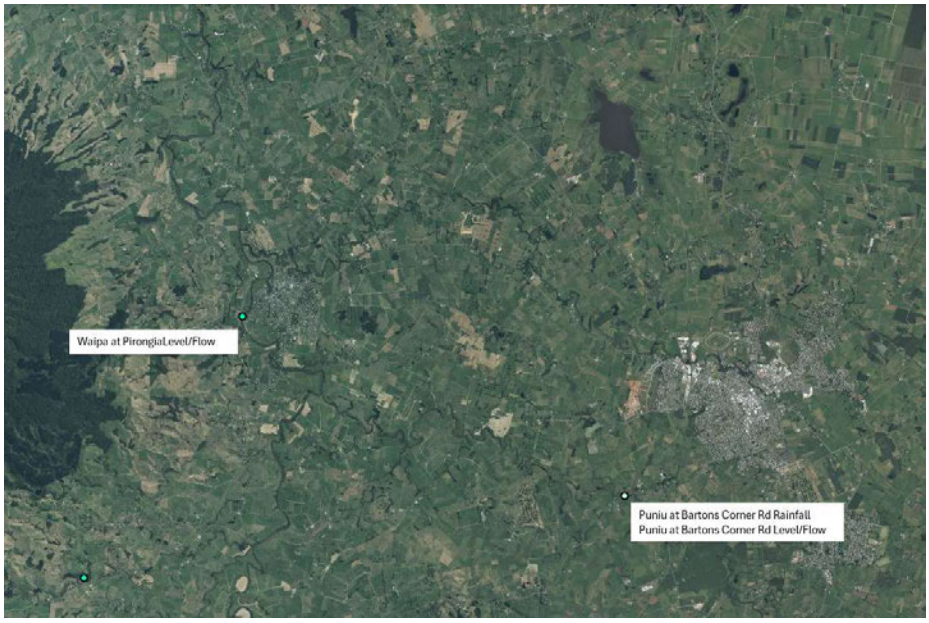
Thank you for helping out on this.

Thanks,

From: Doug Stewart [redacted]
Sent: Friday, August 28, 2026 4:45 PM
To: Navdeep Kaur [redacted]
Subject: Re: Flood Model- for Ohaupo Road Te Awamutu

Hi,
The closest site we have are rainfall, River level and River Flow on the Puniu River at Bartons Cnr Rd Bridge.
The nearest downstream site is on the Waipa at Pirongia. Both marked by small green dots in map below

Let me know if you would like data from either location
Cheers, Doug



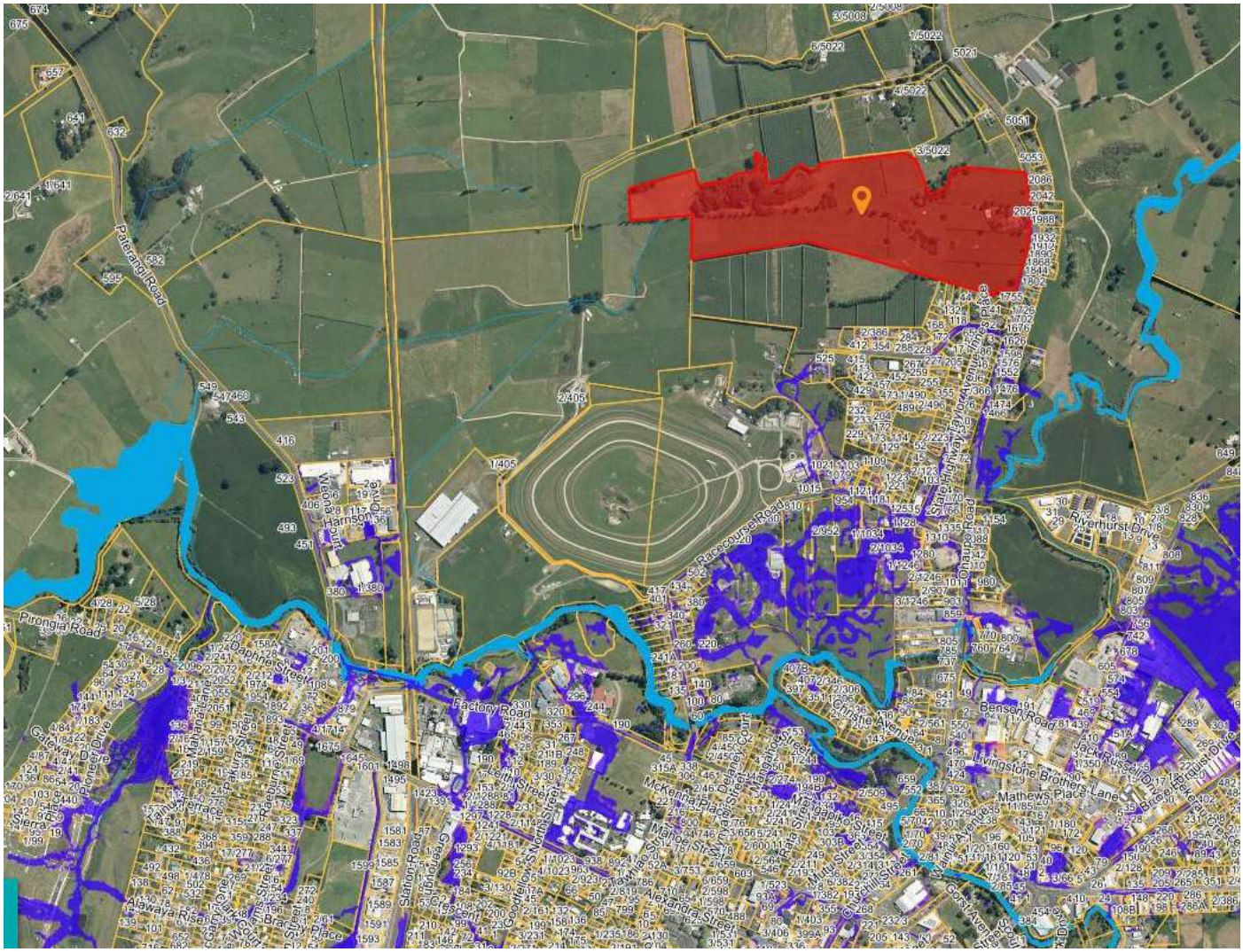
Doug Stewart | SENIOR ENVIRONMENTAL MONITORING SCIENTIST - HYDROLOGY | Hydrology and Air, Science, Policy and Information
WAIKATO REGIONAL COUNCIL | Te Kaunihera ā Rohe o Waikato
P: [redacted]
M: [redacted]
F: facebook.com/waikatoregion
Private Bag 3038, Waikato Mail Centre, Hamilton, 3240

From: Navdeep Kaur [redacted]
Sent: Friday, August 28, 2026 2:13 PM
To: Doug Stewart [redacted]
Subject: Flood Model- for Ohaupo Road Te Awamutu

CAUTION: This email originated from outside of Waikato Regional Council. Do not follow guidance, click links, or open attachments unless you recognise the sender and know the content is safe.

Hi Doug,

We are doing flood modelling in the Waikato Region, this time closer to Te Awamutu area with Mangapiko Stream running close to the subject site . The address location is 2025 Ohaupo road, Te Awamutu, North as per image below.



Do we have any rainfall data or stream levels around this region preferably downstream and close to highlighted region. Something we can use for calibration of our flood model.

Thanks and let me know if you have any further queries,

Regards

Navdeep Kaur
CIVIL ENGINEERING TECHNICIAN
MAVEN WAIKATO LIMITED
[redacted]
www.maven.co.nz
19 Kaimiro Street, Pukete, Hamilton 3200



This email is intended for the addressee(s) only and may contain privileged and/or confidential information. If you are not the intended recipient or have received this email in error, please notify the sender and delete all copies of this email.
****
This email message and any attached files may contain confidential information, and may be subject to legal professional privilege. If you have received this message in error, please notify us immediately and destroy the original message. Any views expressed in this message are those of the individual sender and may not necessarily reflect the views of Waikato Regional Council. Waikato Regional Council makes reasonable efforts to ensure that its email has been scanned and is free of viruses, however can make no warranty that this email or any attachments to it are free from viruses.
****