STORMWATER GUIDANCE - BUILDERS

THE LANDING @ MARSDEN

The Landing, One Tree Point has been designed with specific requirements in relation to stormwater runoff for the residential sections. This memo will provide guidance to any purchaser/designer of a residential sections on what they must consider as part of their design process.

Overall Stormwater Design Strategy

The overall design strategy is to mitigate the effects of the development by providing temporary detention ponds to store and slowly release the additional runoff created. This is explained in our consented stormwater management plan included and limits site coverage to a maximum of 45% for all residential sections. For a typical section of 600m^2 it is limited to 270m^2 of site coverage (being the total metres square of buildings, driveways, patios, etc) unless mitigation methods are used as described below.

Design considerations

As part of any residential section the following documents should be referred to

- Title/Consent Notice
  All sections have a consent notice where impervious coverage is limited to 45% or mitigation is required.
- The Landing Stage 3 Asbuilts Plans
  Construction plans showing where your connection is available.
- Stormwater Memorandum by Cooke Costello
  This provides a guideline on methods of mitigation if you plan on exceeding the site coverage.
- Stormwater Management Plan by Woods
  This report provides the underpinning design strategy and is provided for reference. All the necessary information for design is available in the documents above.

Mitigation methods

The majority of sites are 600m^2 and the 45% coverage threshold provides enough space to construct a 200m^2 home and a 70m^2 driveway. This should be plenty for most, but there are options for grander designs as detailed in the memo by Cooke Costello.

In short the options are:

- Detention
  The additional coverage can be managed by storing the extra runoff created and slowly releasing it into the network. The most popular method is a detention tank but equally rain gardens, infiltration trenches and other variations can achieve the same outcome. As a rule of thumb, every 50m^2 of impervious surface over the 45% threshold will result in 4,000 litres of detention required.
  The following options are available:
    - Above ground detention tanks
      These will need to be screened from the road to meet our covenant rules and are not our preferred solution.
    - Below ground detention tanks
      These are a great solution that can be cost effective, hidden from sight and require minimal maintenance. Care should be taken to avoid loading from driveways and buildings or a structural design maybe necessary.
    - Infiltration trenches
      These are a cost effective way to manage stormwater runoff. Again care should be taken to keep clear of structures but more details are provided in Cooke Costello's memo.
    - Rain gardens
      These can address mitigation requirements and provide some landscaping at the same time. They will require ongoing maintenance but have the added benefit of improving the quality of your runoff.
- Permeable surfaces
  This method avoids the need for detention because the material allows water to penetrate, technically known as a permeable surface. There are a variety of options here and common examples are timber decks, permeable pavers and gravel.
- Passive runoff management
  This is a method limited to certain situations where runoff from one impermeable surface is directed to an equal or greater area of permeable surface. Typically this is used for small areas such as: footpaths under 1m wide, concrete patios and small portions of driveways.

Final Note

The information is intended as a guide and we recommend using it to quickly understand your options before seeking either professional advice or talking to council.

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14333-003
September 30, 2020

Attention: Grant Fahey - WFH Properties Ltd

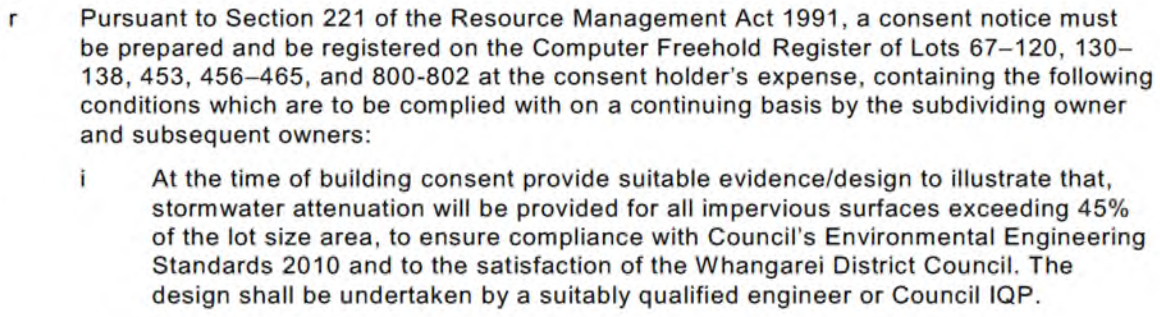
Email: Grant.Fahey@fultonhogan.com

Stormwater Memorandum
The Landing – Stage 3, One Tree Point – Attenuation for Residential Lots

Introduction

Cook Costello Ltd have been requested to assess the attenuation requirements Stage 3 of The Landing subdivision at One Tree Point. Being Lots 67-120, 130-138 and 453-465 DP 548998. This reports provides examples of a suitable solution that could be used to meet the attenuation requirements of the subdivision as stated in the consent notice registered on the Titles - see consent notice wording below.

Consent Notice:



r Pursuant to Section 221 of the Resource Management Act 1991, a consent notice must be prepared and be registered on the Computer Freehold Register of Lots 67–120, 130–138, 453, 456–465, and 800-802 at the consent holder's expense, containing the following conditions which are to be complied with on a continuing basis by the subdividing owner and subsequent owners:

- i At the time of building consent provide suitable evidence/design to illustrate that, stormwater attenuation will be provided for all impervious surfaces exceeding 45% of the lot size area, to ensure compliance with Council's Environmental Engineering Standards 2010 and to the satisfaction of the Whangarei District Council. The design shall be undertaken by a suitably qualified engineer or Council IQP.

Stormwater Attenuation

Stage 3 stormwater system discharges into a large pond that was designed to attenuate runoff from the residential lots with up to 45% impervious surfaces without additional attenuation. If the proposed development of each lot exceed 45% then attenuation will be required.

The stormwater attenuation assessment needs to be in accordance with Whangarei District Council 2010 Environmental Engineering Standards. Of particular relevance is the requirement to reduce stormwater runoff from the increase in impervious area for the design events (5yr & 100yr ARI) plus climate change (+20% rainfall depth) to 80% of the predevelopment discharge without climate change. The stormwater analysis has been conducted with desktop study and a hydrological model built using the modified SCS method, in accordance with NRCS TR-55 Type 1A rainfall distribution, as per WDC 2010 EES. Rainfall data sourced from NIWA HIRDS. Model parameters are detailed below.

Hydrological Model Parameters

100yr ARI 24hr Depth (mm) = 241 (HIRDS – One Tree Point)

5yr ARI 24hr Depth (mm) = 135 (HIRDS – One tree Point)

	Predevelopment	Post Development
Area m^2 (Pervious / Impervious)	45% of lot area	>45% of lot area
Soil Type	Ruakaka Sands	Ruakaka Sands
Soil Category	B	B
SCS Curve Number	61	98
Initial Abstraction (mm)	5	0
Time of Concentration (min)	10	10
Infiltration Rate	45mm/hr	or 0.75l/m^2/min.
There are no existing impervious areas to be replaced by the development of any lot		
Void ratio of drainage metal assumed to be 0.33		
Soakage infiltration to side of trench only		

Design

The design should follow the following steps:

1. Calculated the area of imperious surfaces proposed (ie. Roof, driveway, paths, patio, pools etc.)
2. Calculate 45% of the lot area.
3. Calculate difference.

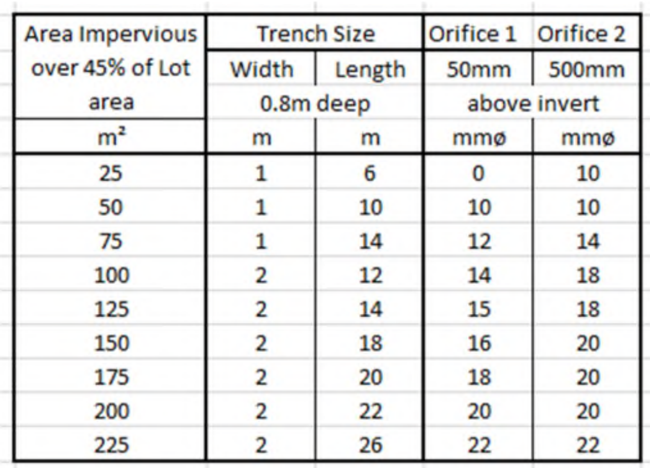
If the proposed impervious area is less than 45% of the lot area, then no attenuation is required.

As shown in example one on the attached plans.

If the proposed impervious area is greater than 45% of the lot area, then attenuation is required and a solution could be as follows:

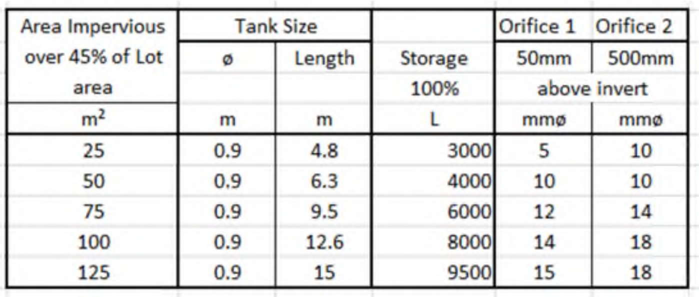
4. Determine the area to be attenuated from above. Design the site drainage to direct runoff from the proposed roof to a soakage trench or in-ground tank to match the area that requires attenuation. All other runoff can discharge directly to the stormwater lot connection or flow onto the road.
5. Size the trench, low level orifice (1) and high-level orifice (2) from the tables below (Note: round area up to nearest 25m^2):

SOAKAGE TRENCH OPTION



Area Impervious over 45% of Lot area	Trench Size		Orifice 1	Orifice 2
	Width	Length	50mm	500mm
	0.8m deep		above invert	
m^2	m	m	mmø	mmø
25	1	6	0	10
50	1	10	10	10
75	1	14	12	14
100	2	12	14	18
125	2	14	15	18
150	2	18	16	20
175	2	20	18	20
200	2	22	20	20
225	2	26	22	22

IN_GROUND TANK OPTION



Area Impervious over 45% of Lot area	Tank Size			Orifice 1	Orifice 2
	ø	Length	Storage	50mm	500mm
			100%	above invert	
m²	m	m	L	mmø	mmø
25	0.9	4.8	3000	5	10
50	0.9	6.3	4000	10	10
75	0.9	9.5	6000	12	14
100	0.9	12.6	8000	14	18
125	0.9	15	9500	15	18

6. Design the site drainage as per examples two-four on the attached plans.

Full calculations are provided in the HydroCAD outputs attached, along with a full summary of calculation table.

Tank Options

There are many options in the market currently for both above and below ground solutions. It is fair to say, the above ground tanks are not that visually appealing and therefore are not recommended in a residential environment. In general, below ground plastic tanks are the cheapest and most commonly used. Some common suppliers of in-ground tanks are; Promax, APD detention tanks, Solo Plastics detention tanks and Aquacomb detention solutions.

Ways to reduce impermeable surfaces and improve water quality.

Driveway run-off that discharges directly into the stormwater system untreated. Traditional sumps that discharge directly into the stormwater network do not treat the water quality and is not considered best practice.

Below is a list of options to consider for stormwater treatment systems that remove contaminants from the runoff of driveways and paths and will help protect the subdivisions wetland/pond and therefore protect the local beach discharge point.

Passive treatment

Runoff from an impermeable surface to permeable surface of equal or greater area (e.g. 40m2 of driveway discharging to 40m2 of grass or garden)

Active treatment

Rain gardens, soakage trenches or filtration systems.

Permeable surfaces

Permeable pavers or Timber decks are great ways to reduce the total area of impermeable surfaces. The following pervious pavement technologies are available:

- Interlocking concrete block paving with permeable gaps between pavers

- Interlocking permeable concrete block paving
- Concrete grid pavers e.g. Gobi Blocks
- Reinforced gravel or turf (plastic grid pavers or roll out Sureflex grass protection)
- Grasscrete or Grasspaver products

A schematic showing a typical application of permeable pavers is shown on Figure 1.

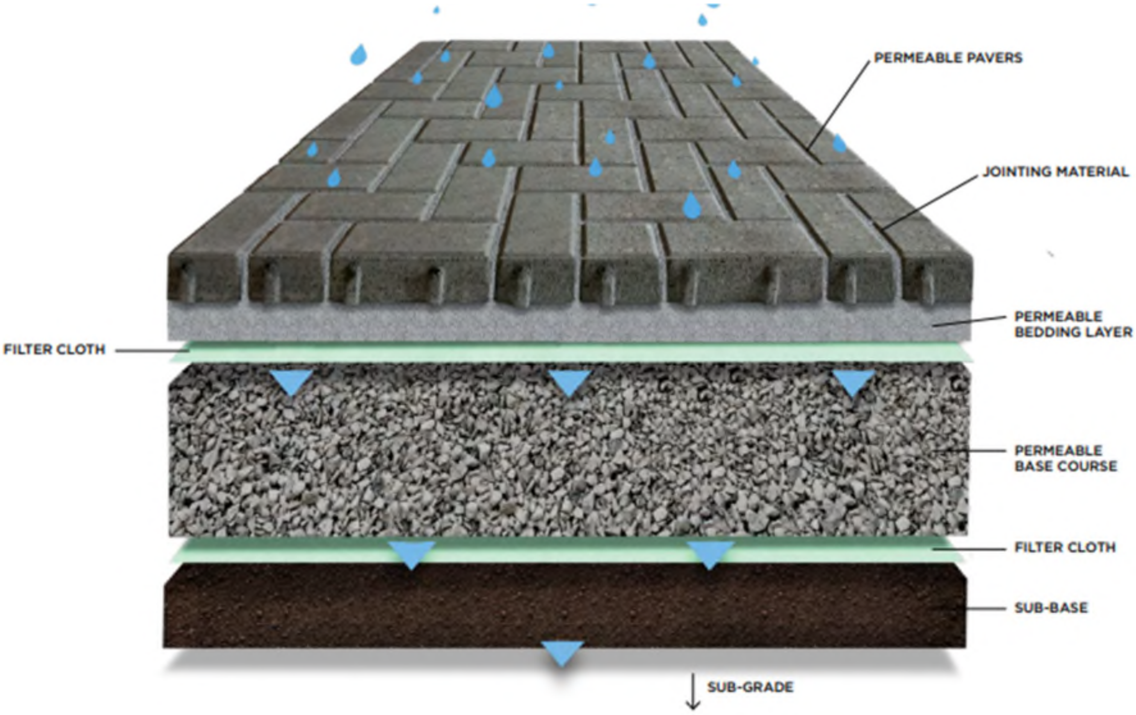


Figure 1: Permeable/ Porous Pavers.

It is important to note that design constraints as noted in Auckland Councils Guidance Document 01 (GD01) should be considered when adopting permeable paving.

Recommendations

If roof runoff from the new dwelling is reticulated to the attenuation trench or tank it is recommended leaf guard and/or first flush system be installed with the spouting to minimize long term maintenance requirements. There are a range of proprietary products available and widely used with rain harvesting systems for this purpose.

To keep soakage trench clean it is not recommended to collect surface water directly into the trench (ie. driveway flow). A forebay or maintainable filter system is recommended to protect the life of the soakage trench.

If the table provided does not cover the area required or if an active permeable pavers solution is proposed, then a specific design will be required. An active permeable paver solution is one that takes more runoff than what falls directly onto the surface.

Note that the design is based on the trench dimensions given in this report and if these change, then some modification design will be required.

The use of permeable surfaces should be considered if practical for the site as this reduces the total site runoff and improves water quality.

Conclusions

It is the conclusion of Cook Costello that this design could be used to size and install an acceptable solution that will meet the attenuation requirements of the consent notice attached to these titles.

Limitations

This report has been prepared solely for the benefit of our client and the Whangarei District Council. The purpose is to determine the stormwater attenuation requirements for the proposed residential dwelling. The reliance by other parties on the information or opinions contained therein shall, without our prior review and agreement in writing, do so at their own risk.

Encl:

Soakage Trench Example and Detail plans

In-Ground Tanks Example and Detail plans

HIRDS Rainfall Depths

Calculation Summary Table

HydroCAD Calculations Reports

Yours faithfully	Reviewed By:
Guy McGregor Registered Professional Surveyor BSurv, MNZIS, WDC IQP 002	Adrian Tonks Engineer BE (ESci), GIPENZ, WDC IQP 024

Soakage Trench Example and Details Plans

14333-003 SW001 Sheets 1&3

LEGEND

━ Ø375 ━	STORMWATER PIPES
✕──	STORMWATER CONNECTION 100mmØ
◉	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
🟩	PROPOSED ROOF
▨	PROPOSED DRIVEWAY
🟧	PROPOSED PATHS AND PATIOS
▭	PROPOSED SOAKAGE TRENCH
▭	600mmø OUTLET CHAMBER WITH UP-STAND
⫽	LAMP-HOLE FOR CLEANING UPSTREAM END OF SOAKAGE PIT
──●	PAVED SURFACE INLET SUMP (DON'T CONNECT TO SOAKAGE TRENCH)
──	PROPOSED SITE DRAINAGE
▩	ROOF AREA CONNECTED TO SOAKAGE TRENCH

NOTE:

1. ALL PIPES 100Ø ARE uPVC SN8.
2. ALL CONCRETE CHAMBERS 600Ø ARE TO BE HYDRUA.
3. ASSUMED VOID RATIO OF 0.33 (DRAINAGE METAL).
4. ASSUMED SOAKAGE RATE 45mm/hr TO SIDE OF TRENCH.
5. SIZED FOR 100 YEAR ARI PLUS 20% CLIMATE CHANGE.
6. IF PERMEABLE PAVERS ARE USED SPECIFIC DESIGN IS REQUIRED.
7. ASSUMED TYPE B SOILS FOR RUAKAKA SANDS. PRE-DEVELOPMENTAL PERVIOUS CN OF 61 (GOOD GRASS COVER) & POST DEVELOPMENT IMPERVIOUS CN OF 98 (ROOFS & DRIVES, ETC).
8. DESIGNED TO ACHIEVE 80% OF THE PRE-DEVELOPMENT FLOWS FOR ANY IMPERVIOUS COVERAGE OF THE PERMITTED 45% OF THE LOT AREA.
9. BASED ON A NRCS TR55 TYPE 1A STORM PROFILE.

INSTRUCTIONS:

1. DETERMINE PROPOSED IMPERMEABLE SURFACE AREA TOTAL BY ADDING THE AREA OF THE ROOFS, DRIVES, PATIO AND PATHS.
2. CALCULATE THE PERMITTED IMPERVIOUS COVERAGE ALLOWED UNDER THE RESOURCE CONSENT CONDITIONS - 45% OF THE LOT AREA.
3. CALCULATE THE DIFFERENCE.
4. IF THE PROPOSED IMPERVIOUS COVERAGE AREA IS LESS THAN 45% OF THE TOTAL AREA THEN NO ADDITIONAL ATTENUATION IS REQUIRED - SEE EXAMPLE ONE.
5. IF THE PROPOSED IMPERVIOUS COVERAGE AREA IS GREATER THAN 45% THEN ATTENUATION IS REQUIRED.
6. THREE EXAMPLES OF HOW THIS COULD BE ACHIEVED BY A SOAKAGE TRENCH ARE BELOW:
7. FROM THE TABLE ON SHEET 2 DETERMINE THE SOAKAGE TRENCH SIZE REQUIRED BY ROUNDING UP TO THE NEAREST 25m² - SEE EXAMPLES TWO, THREE AND FOUR, THESE HAVE DIFFERENCE CONFIGURATION IN SIZE OF TRENCH REQUIRED AND OUTLET CHAMBER LOCATION.
8. THE ROOF AREA CAN BE CONNECTED FROM A DOWNPIPES TO THE SOAKAGE TRENCH WITH A STANDARD PIPE TEE OR AT THE BACK OF THE RODDING EYE. TRY TO MATCH THE ROOF AREA TO (OR CLOSELY OVER) WHAT IS REQUIRED TO BE ATTENUATED.
9. INSTALL UPSTAND AND ORIFICES AS PER THE TABLE ON SHEET 2.

EXAMPLE ONE
ROOF AREA = 202m²
DRIVE AREA = 23m²
PATIO AREA = 34m²
TOTAL IMPERMEABLE AREA = 259m²
LOT AREA = 615m²
PERMITTED IMPERMEABLE AREA (45% 0F LOT AREA) = 276m²
DIFFERENCE TO ATTENUATE = -17m²
ATTENUATION PIT SIZE FROM TABLE = N/A

CONNECT AT LEAST AND CLOSE TO 48m² TO SOAKAGE TRENCH

EXAMPLE TWO
ROOF AREA = 177m²
DRIVE AREA = 81m²
PATIO AREA = 23m²
TOTAL IMPERMEABLE AREA = 281m²
LOT AREA = 517m²
PERMITTED IMPERMEABLE AREA (45% 0F LOT AREA) = 233m²
DIFFERENCE TO ATTENUATE = 48m²
ATTENUATION PIT SIZE FROM TABLE = 1 X 10m

EXAMPLE FOUR
ROOF AREA = 244m²
DRIVE AREA = 34m²
PATIO AREA = 55m²
TOTAL IMPERMEABLE AREA = 328m²
LOT AREA = 601m²
PERMITTED IMPERMEABLE AREA (45% 0F LOT AREA) = 270m²
DIFFERENCE TO ATTENUATE = 58m²
ATTENUATION PIT SIZE FROM TABLE = 1 X 14m

CONNECT AT LEAST AND CLOSE TO 58m² TO SOAKAGE TRENCH

G. M.
MCGREGOR
WDC IQP#002

CONNECT AT LEAST AND CLOSE TO 89m² TO SOAKAGE TRENCH

EXAMPLE THREE
ROOF AREA 228m²
DRIVE AREA 96m²
PATIO AREA 100m²
TOTAL IMPERMEABLE AREA = 424m²
LOT AREA = 745m²
PERMITTED IMPERMEABLE AREA (45% 0F LOT AREA) = 335m²
DIFFERENCE TO ATTENUATE = 89m²
ATTENUATION PIT SIZE FROM TABLE = 2 X 12m

SCALE 1:500

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C			
B			
A	1ST ISSUE 31-07-20	KH	GMcG

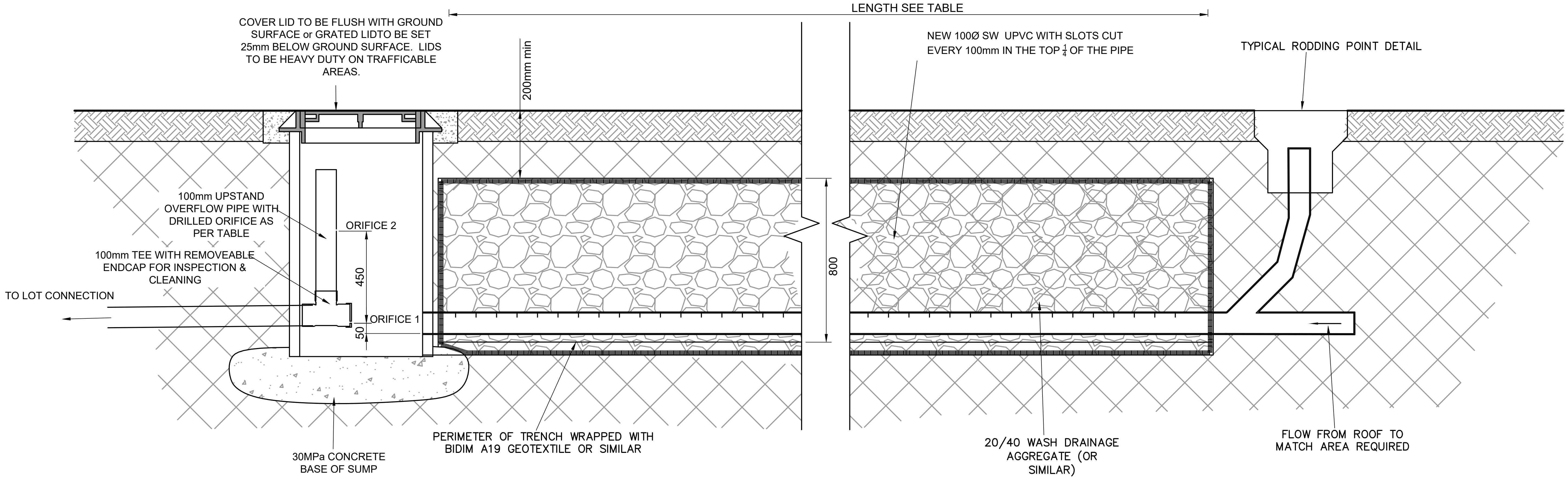
PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER ATTENUATION - SHEET 1
SOAKAGE TRENCH OPTION

DATE CREATED: 31-07-2020
DRAWN: K HANSARD
DESIGNED: -
APPROVED: G McGREGOR
CCL REF NO: 14333-003
SCALE: 1:500 @ A3
STATUS: CONCEPT
DWG NUMBER: SW001
REVISION: A

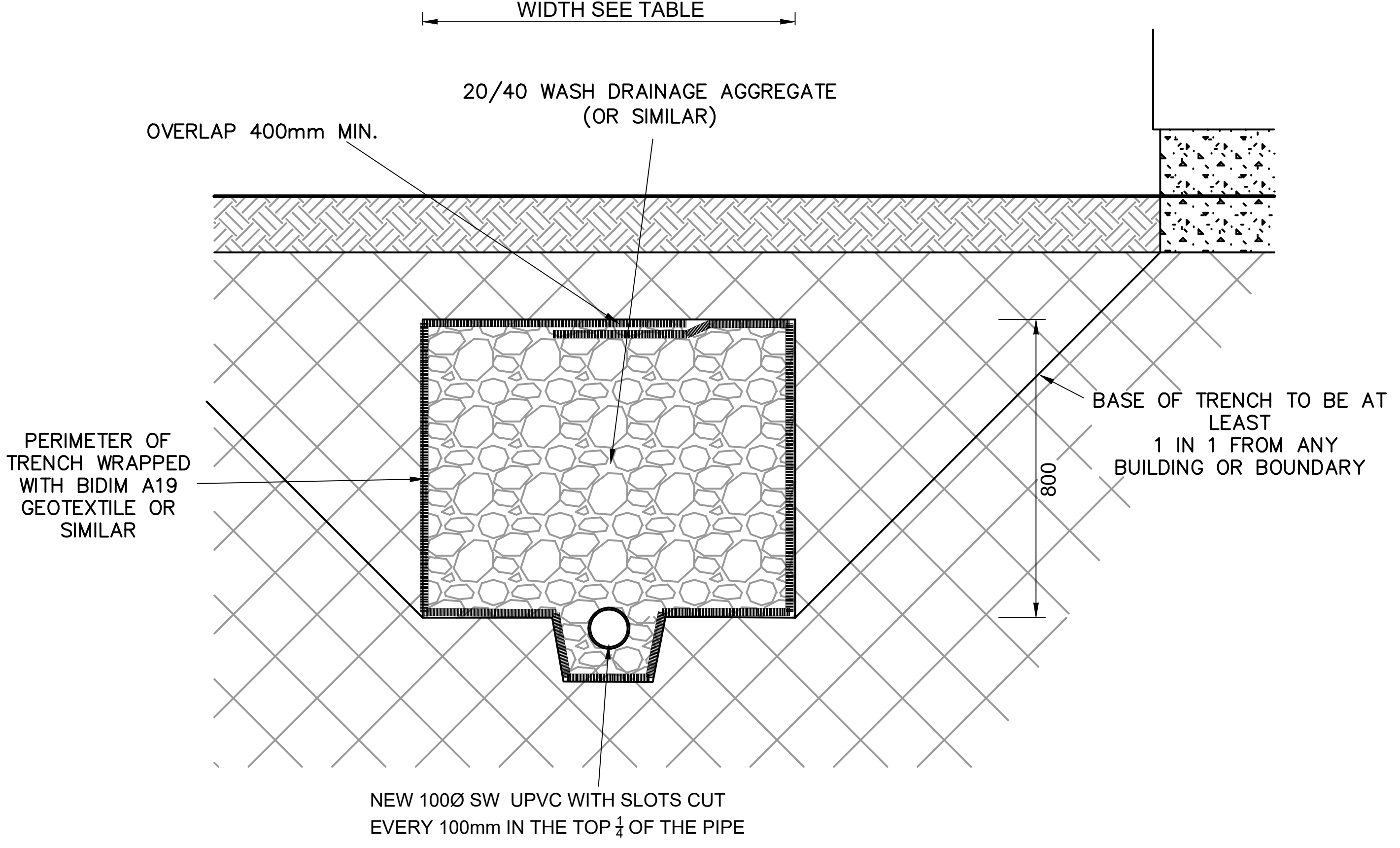
SCALE 1:500

DATE PLOTTED: Wednesday, 7 October 2020 2:19:07 PM FILE PATH: Z:\14000-14499\14333 - WFH Properties OTP\CAD\Stage 3\As Builts - Stage 3\14333-003-Attenuation Examples Plan.dwg



SOAKAGE TRENCH LONG SECTION DETAIL

NOT TO SCALE

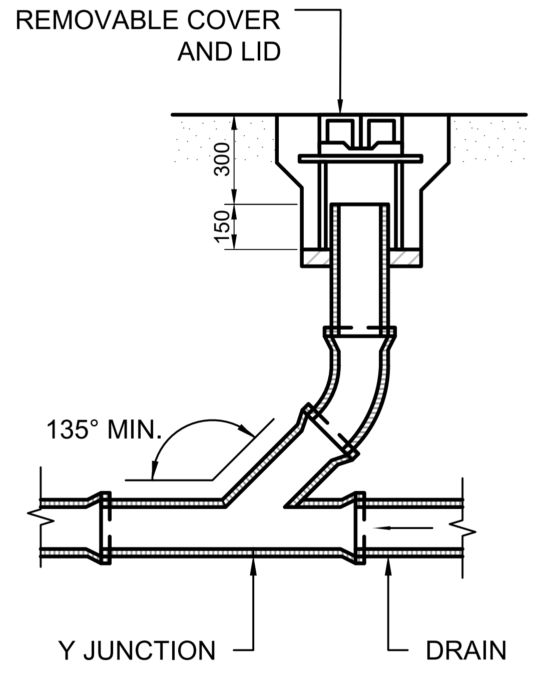


SOAKAGE TRENCH CROSS SECTION DETAIL

NOT TO SCALE

TABLE OF TRENCH DIMENSIONS

Area Impervious over 45% of Lot area	Trench Size		Orifice 1	Orifice 2
	Width	Length	50mm	500mm
	0.8m deep		above invert	
m²	m	m	mmø	mmø
25	1	6	0	10
50	1	10	10	10
75	1	14	12	14
100	2	12	14	18
125	2	14	15	18
150	2	18	16	20
175	2	20	18	20
200	2	22	20	20
225	2	26	22	22



TYPICAL RODDING POINT DETAIL

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PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER ATTENUATION - SHEET 2
TYPICAL SOAKAGE TRENCH DETAIL

DATE CREATED: 31-07-2020
DRAWN: K HANSARD
DESIGNED:
APPROVED: G McGREGOR
CCL REF NO: 14333-003
SCALE: NTS @ A3
STATUS: CONCEPT
DWG NUMBER: SW001
REVISION: A

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In-Ground Tank Examples and Details Plans

14333-003 SW001 Sheets 2&4

LEGEND

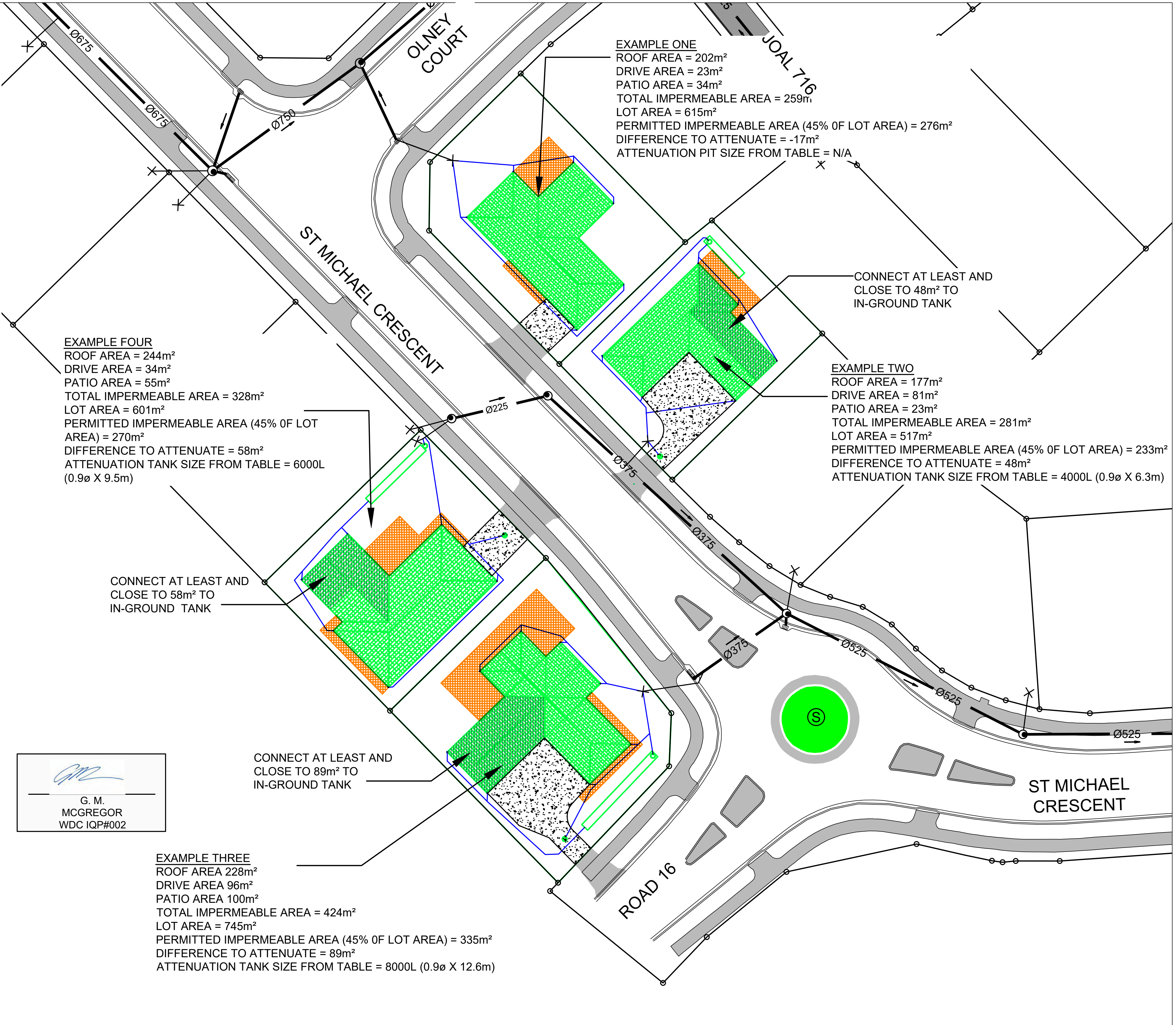
—— Ø375 ——	STORMWATER PIPES
×——	STORMWATER CONNECTION 100mmØ
◉	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
🟩	PROPOSED ROOF
▨	PROPOSED DRIVEWAY
🟧	PROPOSED PATHS AND PATIOS
▭	PROPOSED INGROUND TANK
▭	OUTLET CHAMBER WITH UP-STAND
—●	PAVED SURFACE INLET SUMP (DON'T CONNECT TO SOAKAGE TRENCH)
——	PROPOSED SITE DRAINAGE
▩	ROOF AREA CONNECTED TO SOAKAGE TRENCH

NOTE:

1. ALL PIPES 100Ø ARE uPVC SN8.
2. ALL CONCRETE CHAMBERS 600Ø ARE TO BE HYDRUA.
3. SIZED FOR 100 YEAR ARI PLUS 20% CLIMATE CHANGE.
4. IF PERMEABLE PAVERS ARE USED SPECIFIC DESIGN IS REQUIRED.
5. ASSUMED TYPE B SOILS FOR RUAKAKA SANDS. PRE-DEVELOPMENTAL PERVIOUS CN OF 61 (GOOD GRASS COVER) & POST DEVELOPMENT IMPERVIOUS CN OF 98 (ROOFS & DRIVES, ETC).
6. DESIGNED TO ACHIEVE 80% OF THE PRE-DEVELOPMENT FLOWS FOR ANY IMPERVIOUS COVERAGE OF THE PERMITTED 45% OF THE LOT AREA.
7. BASED ON A NRCS TR55 TYPE 1A STORM PROFILE.

INSTRUCTIONS:

1. DETERMINE PROPOSED IMPERMEABLE SURFACE AREA TOTAL BY ADDING THE AREA OF THE ROOFS, DRIVES, PATIO AND PATHS.
2. CALCULATE THE PERMITTED IMPERVIOUS COVERAGE ALLOWED UNDER THE RESOURCE CONSENT CONDITIONS - 45% OF THE LOT AREA.
3. CALCULATE THE DIFFERENCE.
4. IF THE PROPOSED IMPERVIOUS COVERAGE AREA IS LESS THAN 45% OF THE TOTAL AREA THEN NO ADDITIONAL ATTENUATION IS REQUIRED - SEE EXAMPLE ONE.
5. IF THE PROPOSED IMPERVIOUS COVERAGE AREA IS GREATER THAN 45% THEN ATTENUATION IS REQUIRED.
6. THREE EXAMPLES OF HOW THIS COULD BE ACHIEVED BY A IN-GROUND TANK ARE BELOW:
7. FROM THE TABLE ON SHEET 4 DETERMINE THE TANK SIZE REQUIRED BY ROUNDING UP TO THE NEAREST 25m² - SEE EXAMPLES TWO, THREE AND FOUR, THESE HAVE DIFFERENCE CONFIGURATION IN SIZE OF TANK REQUIRED AND OUTLET CHAMBER LOCATION.
8. THE ROOF AREA CAN BE CONNECTED FROM A DOWNPIPES TO THE TANK AS PER THE TANK SUPPLIERS DETAILS. TRY TO MATCH THE ROOF AREA TO (OR CLOSELY OVER) WHAT IS REQUIRED TO BE ATTENUATED.
9. INSTALL UPSTAND AND ORIFICES AS PER THE TABLE ON SHEET 4.



EXAMPLE ONE
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LOT AREA = 615m²
PERMITTED IMPERMEABLE AREA (45% 0F LOT AREA) = 276m²
DIFFERENCE TO ATTENUATE = -17m²
ATTENUATION PIT SIZE FROM TABLE = N/A

CONNECT AT LEAST AND CLOSE TO 48m² TO IN-GROUND TANK

EXAMPLE TWO
ROOF AREA = 177m²
DRIVE AREA = 81m²
PATIO AREA = 23m²
TOTAL IMPERMEABLE AREA = 281m²
LOT AREA = 517m²
PERMITTED IMPERMEABLE AREA (45% 0F LOT AREA) = 233m²
DIFFERENCE TO ATTENUATE = 48m²
ATTENUATION TANK SIZE FROM TABLE = 4000L (0.9ø X 6.3m)

EXAMPLE FOUR
ROOF AREA = 244m²
DRIVE AREA = 34m²
PATIO AREA = 55m²
TOTAL IMPERMEABLE AREA = 328m²
LOT AREA = 601m²
PERMITTED IMPERMEABLE AREA (45% 0F LOT AREA) = 270m²
DIFFERENCE TO ATTENUATE = 58m²
ATTENUATION TANK SIZE FROM TABLE = 6000L (0.9ø X 9.5m)

CONNECT AT LEAST AND CLOSE TO 58m² TO IN-GROUND TANK

CONNECT AT LEAST AND CLOSE TO 89m² TO IN-GROUND TANK

EXAMPLE THREE
ROOF AREA 228m²
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PATIO AREA 100m²
TOTAL IMPERMEABLE AREA = 424m²
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DIFFERENCE TO ATTENUATE = 89m²
ATTENUATION TANK SIZE FROM TABLE = 8000L (0.9ø X 12.6m)

G. M.
MCGREGOR
WDC IQP#002

SCALE 1:500
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IN-GROUND TANK OPTION

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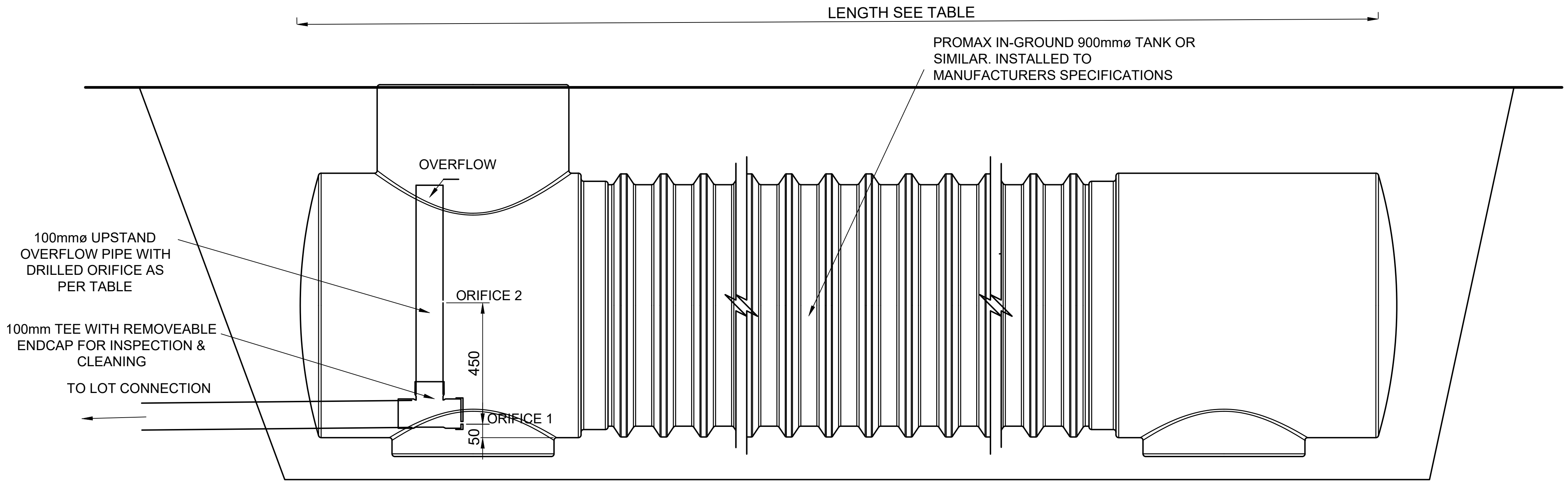
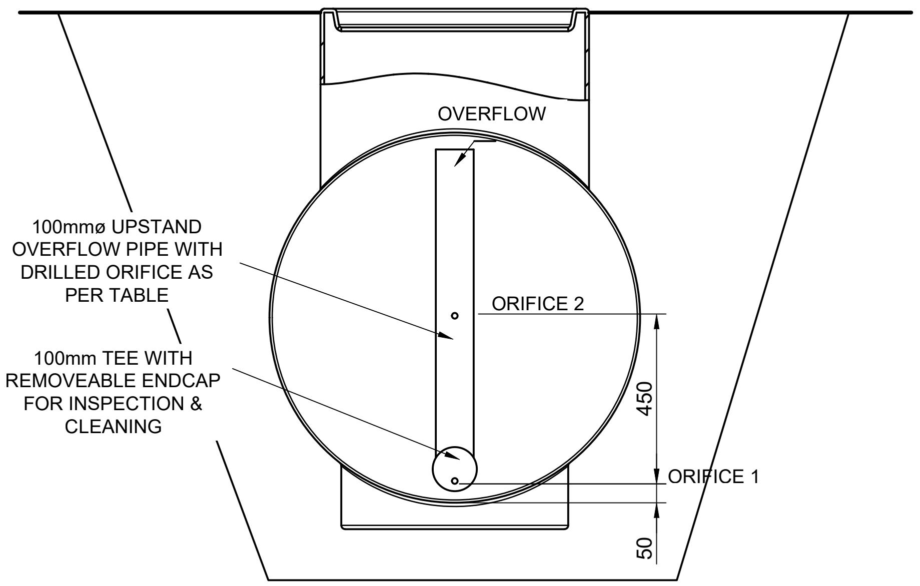


TANK LONG SECTION DETAIL

NOT TO SCALE

TABLE OF TANK DIMENSIONS

Area Impervious over 45% of Lot area	Tank Size			Orifice 1	Orifice 2
	ø	Length	Storage 100%	50mm above invert	500mm
m²	m	m	L	mmø	mmø
25	0.9	4.8	3000	5	10
50	0.9	6.3	4000.0	10	10
75	0.9	9.5	6000.0	12	14
100	0.9	12.6	8000.0	14	16
125	0.9	15	9500.0	15	18



TANK CROSS SECTION DETAIL

NOT TO SCALE

cook | costello
www.coco.co.nz
Whangarei | Auckland | Wellington | Christchurch

REV.	REVISION DETAILS	DATE	DRAWN	APP.
C				
B				
A	1ST ISSUE	31-07-20	KH	GMcG

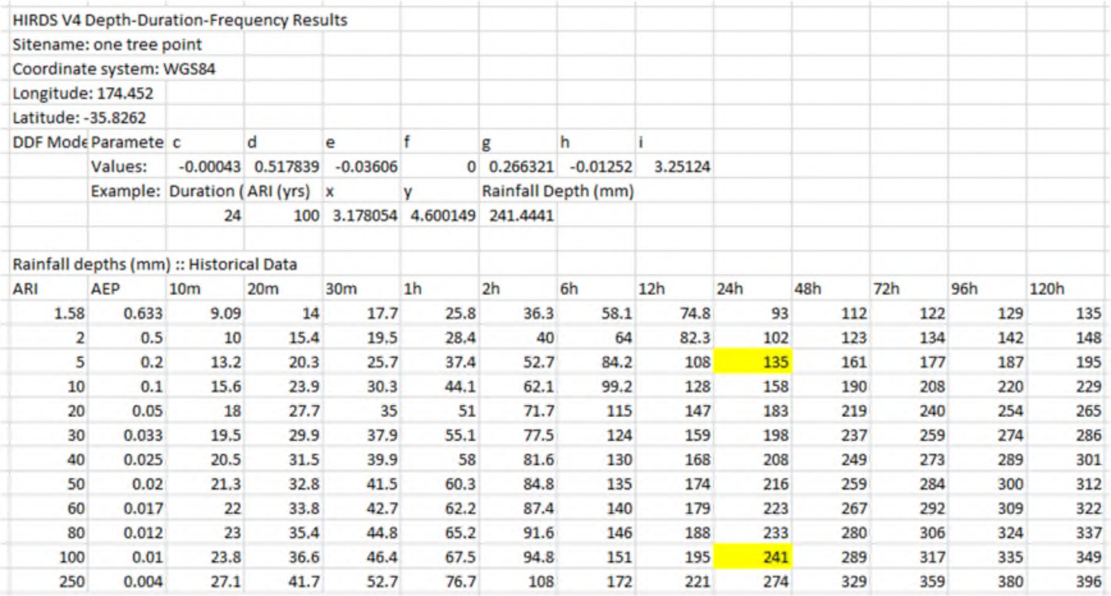
PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER ATTENUATION - SHEET 4
TYPICAL INGROUND TANK DETAIL

DATE CREATED 31-07-2020
DRAWN K HANSARD
DESIGNED
APPROVED G McGREGOR
CCL REF NO 14333-003
SCALE NTS @ A3
STATUS CONCEPT
DWG NUMBER SW001
REVISION A

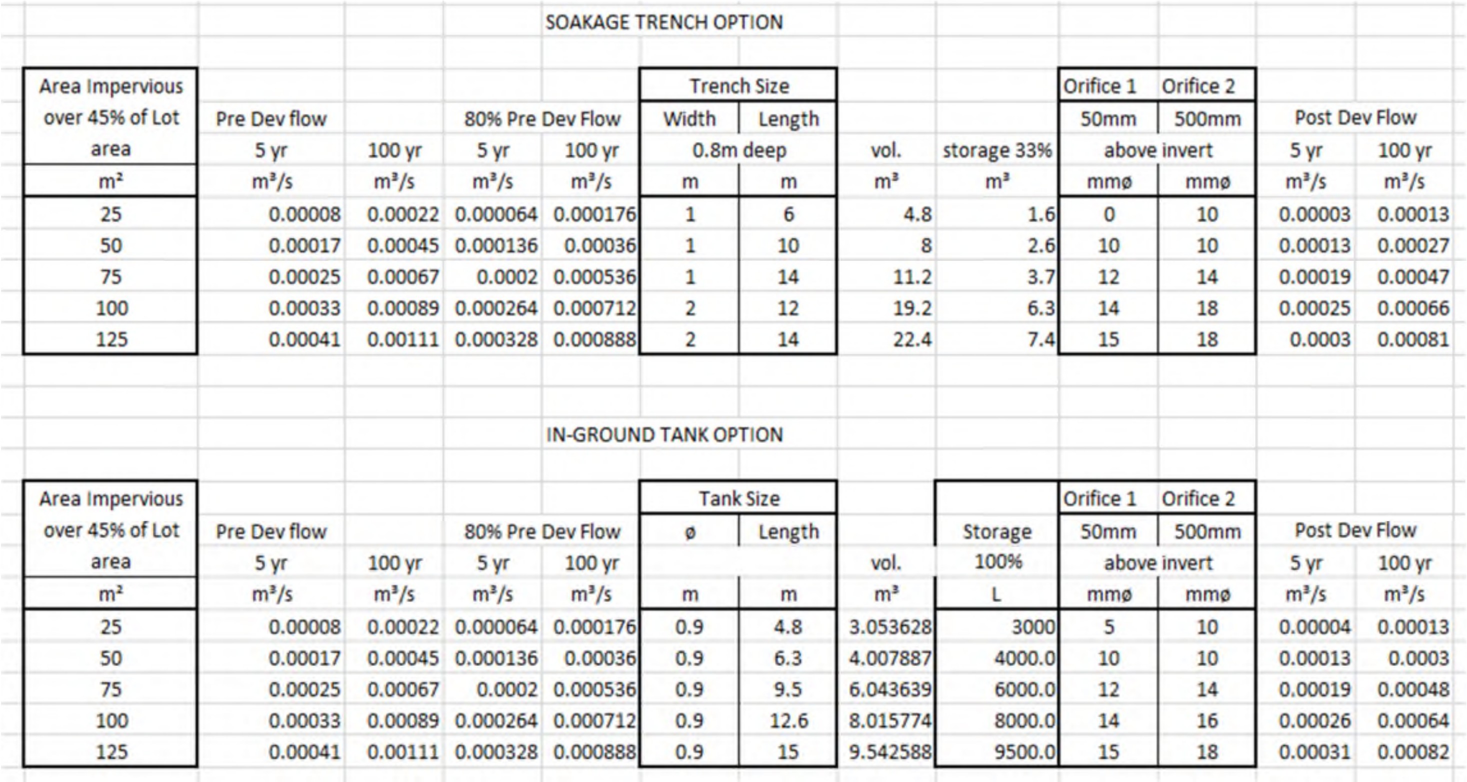
DATE PLOTTED: Wednesday, 7 October 2020 2:18:14 PM FILE PATH: Z:\14000-14499\14333 - WFH Properties OTP\CAD\Stage 3\As Builts - Stage 3\14333-003-Attenuation Trench Detail.dwg

HIRDS Rainfall Depths



HIRDS V4 Depth-Duration-Frequency Results													
Sitename: one tree point													
Coordinate system: WGS84													
Longitude: 174.452													
Latitude: -35.8262													
DDF Mode	Paramete	c	d	e	f	g	h	i					
	Values:	-0.00043	0.517839	-0.03606	0	0.266321	-0.01252	3.25124					
	Example:	Duration (	ARI (yrs)	x	y	Rainfall Depth (mm)							
		24	100	3.178054	4.600149	241.4441							
Rainfall depths (mm) :: Historical Data													
ARI	AEP	10m	20m	30m	1h	2h	6h	12h	24h	48h	72h	96h	120h
1.58	0.633	9.09	14	17.7	25.8	36.3	58.1	74.8	93	112	122	129	135
2	0.5	10	15.4	19.5	28.4	40	64	82.3	102	123	134	142	148
5	0.2	13.2	20.3	25.7	37.4	52.7	84.2	108	135	161	177	187	195
10	0.1	15.6	23.9	30.3	44.1	62.1	99.2	128	158	190	208	220	229
20	0.05	18	27.7	35	51	71.7	115	147	183	219	240	254	265
30	0.033	19.5	29.9	37.9	55.1	77.5	124	159	198	237	259	274	286
40	0.025	20.5	31.5	39.9	58	81.6	130	168	208	249	273	289	301
50	0.02	21.3	32.8	41.5	60.3	84.8	135	174	216	259	284	300	312
60	0.017	22	33.8	42.7	62.2	87.4	140	179	223	267	292	309	322
80	0.012	23	35.4	44.8	65.2	91.6	146	188	233	280	306	324	337
100	0.01	23.8	36.6	46.4	67.5	94.8	151	195	241	289	317	335	349
250	0.004	27.1	41.7	52.7	76.7	108	172	221	274	329	359	380	396

Calculation Summary Table



SOAKAGE TRENCH OPTION

Area Impervious over 45% of Lot area	Pre Dev flow		80% Pre Dev Flow		Trench Size				Orifice 1	Orifice 2	Post Dev Flow	
					Width	Length			50mm	500mm		
	5 yr	100 yr	5 yr	100 yr	0.8m deep		vol.	storage 33%	above invert		5 yr	100 yr
m²	m³/s	m³/s	m³/s	m³/s	m	m	m³	m³	mmø	mmø	m³/s	m³/s
25	0.00008	0.00022	0.000064	0.000176	1	6	4.8	1.6	0	10	0.00003	0.00013
50	0.00017	0.00045	0.000136	0.00036	1	10	8	2.6	10	10	0.00013	0.00027
75	0.00025	0.00067	0.0002	0.000536	1	14	11.2	3.7	12	14	0.00019	0.00047
100	0.00033	0.00089	0.000264	0.000712	2	12	19.2	6.3	14	18	0.00025	0.00066
125	0.00041	0.00111	0.000328	0.000888	2	14	22.4	7.4	15	18	0.0003	0.00081

IN-GROUND TANK OPTION

Area Impervious over 45% of Lot area	Pre Dev flow		80% Pre Dev Flow		Tank Size				Orifice 1	Orifice 2	Post Dev Flow	
					ø	Length		Storage	50mm	500mm		
	5 yr	100 yr	5 yr	100 yr			vol.	100%	above invert		5 yr	100 yr
m²	m³/s	m³/s	m³/s	m³/s	m	m	m³	L	mmø	mmø	m³/s	m³/s
25	0.00008	0.00022	0.000064	0.000176	0.9	4.8	3.053628	3000	5	10	0.00004	0.00013
50	0.00017	0.00045	0.000136	0.00036	0.9	6.3	4.007887	4000.0	10	10	0.00013	0.0003
75	0.00025	0.00067	0.0002	0.000536	0.9	9.5	6.043639	6000.0	12	14	0.00019	0.00048
100	0.00033	0.00089	0.000264	0.000712	0.9	12.6	8.015774	8000.0	14	16	0.00026	0.00064
125	0.00041	0.00111	0.000328	0.000888	0.9	15	9.542588	9500.0	15	18	0.00031	0.00082

HydroCAD Calculations Reports

Soakage Trench Option

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (mm)	AMC
1	5yr	Type IA 24-hr		Default	24.00	1	135	2
2	100yr	Type IA 24-hr		Default	24.00	1	241	2

Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 25msq: Catchment 25m^2 Runoff Area=25.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00008 m^3/s 1.4 m^3

Subcatchment 50msq: Catchment 50m^2 Runoff Area=50.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00017 m^3/s 2.7 m^3

Subcatchment 75msq: Catchment 75m^2 Runoff Area=75.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00025 m^3/s 4.1 m^3

Subcatchment 100msq: Catchment Runoff Area=100.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00033 m^3/s 5.5 m^3

Subcatchment 125msq: Catchment Runoff Area=125.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00041 m^3/s 6.8 m^3

Subcatchment 150msq: Catchment Runoff Area=150.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00050 m^3/s 8.2 m^3

Subcatchment 175msq: Catchment Runoff Area=175.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00058 m^3/s 9.5 m^3

Subcatchment 200msq: Catchment Runoff Area=200.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00066 m^3/s 10.9 m^3

Subcatchment 225msq: Catchment Runoff Area=225.0 m^2 0.00% Impervious Runoff Depth=55 mm
Tc=10.0 min CN=61 Runoff=0.00074 m^3/s 12.3 m^3

Summary for Subcatchment 25msq: Catchment 25m²

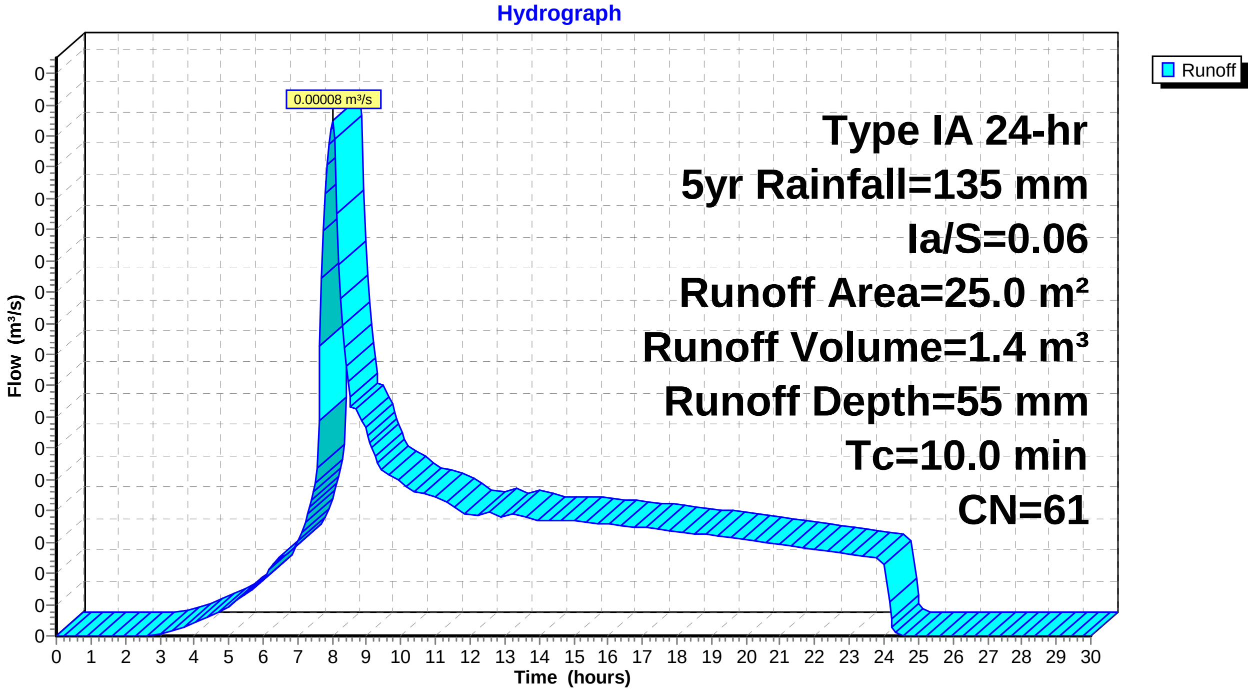
Runoff = 0.00008 m³/s @ 8.01 hrs, Volume= 1.4 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
25.0	61	>75% Grass cover, Good, HSG B
25.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 25msq: Catchment 25m²



Summary for Subcatchment 50msq: Catchment 50m²

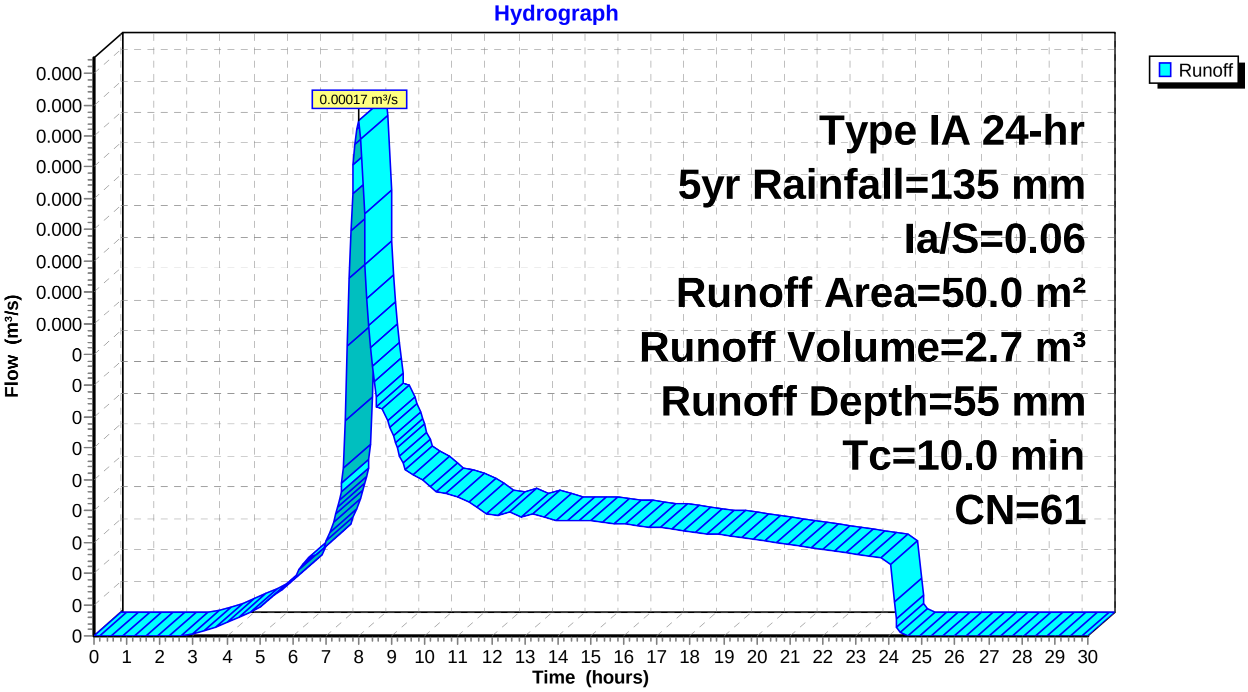
Runoff = 0.00017 m³/s @ 8.01 hrs, Volume= 2.7 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
50.0	61	>75% Grass cover, Good, HSG B
50.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 50msq: Catchment 50m²



Summary for Subcatchment 75msq: Catchment 75m²

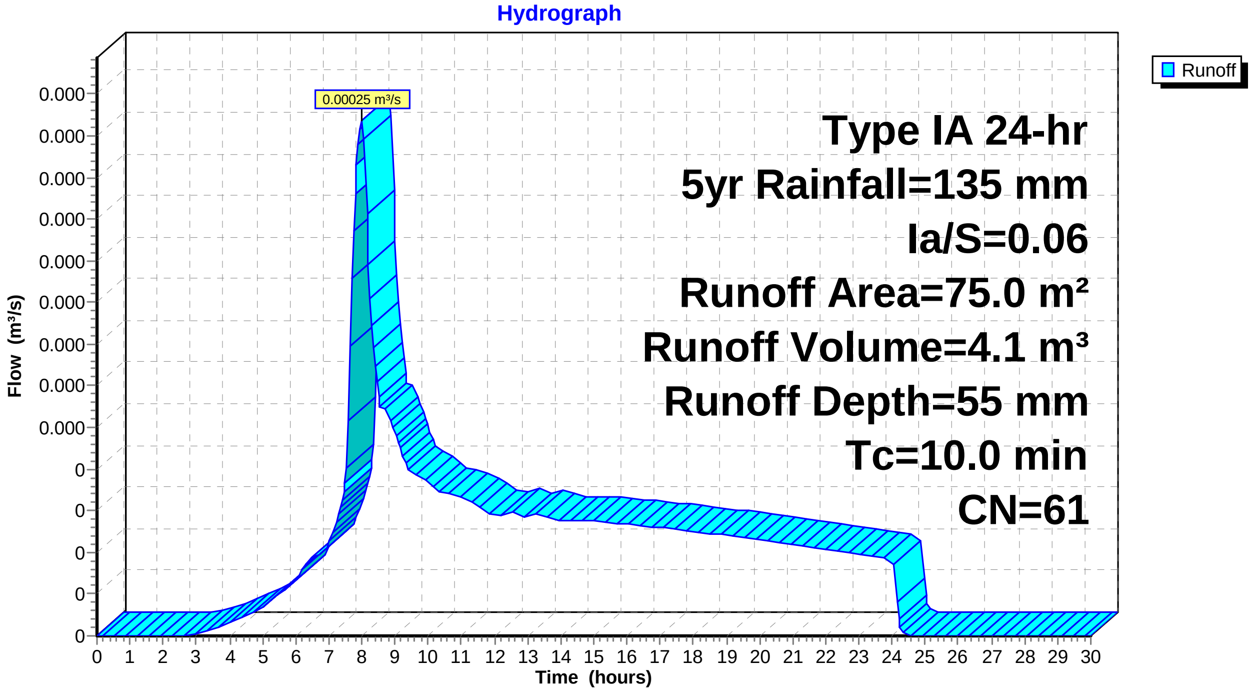
Runoff = 0.00025 m³/s @ 8.01 hrs, Volume= 4.1 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
75.0	61	>75% Grass cover, Good, HSG B
75.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 75msq: Catchment 75m²



Summary for Subcatchment 100msq: Catchment 100m²

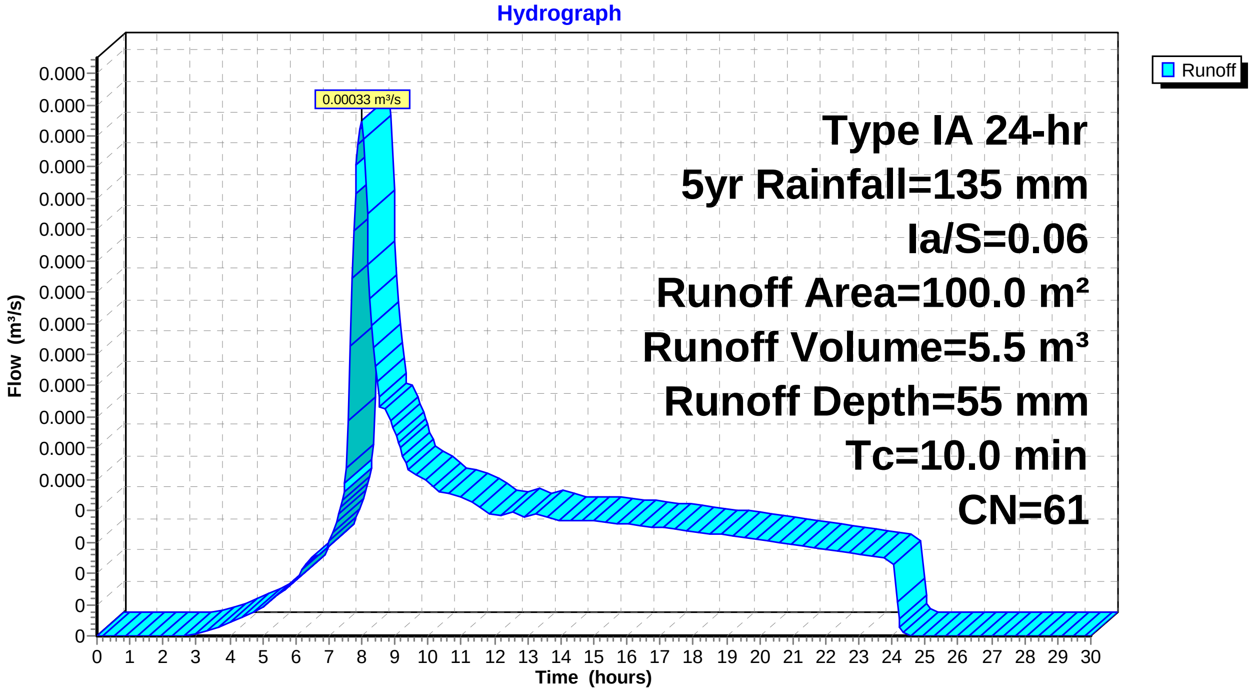
Runoff = 0.00033 m³/s @ 8.01 hrs, Volume= 5.5 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
100.0	61	>75% Grass cover, Good, HSG B
100.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 100msq: Catchment 100m²



Summary for Subcatchment 125msq: Catchment 125m²

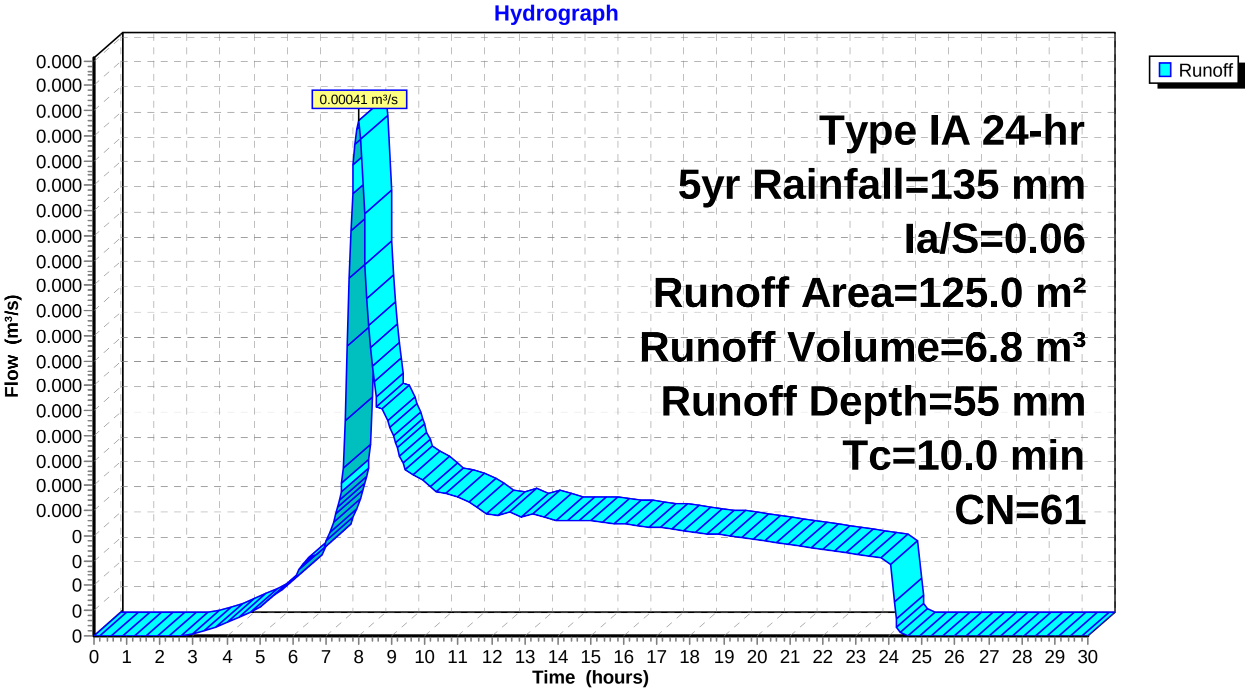
Runoff = 0.00041 m³/s @ 8.01 hrs, Volume= 6.8 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
125.0	61	>75% Grass cover, Good, HSG B
125.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 125msq: Catchment 125m²



Summary for Subcatchment 150msq: Catchment 150m²

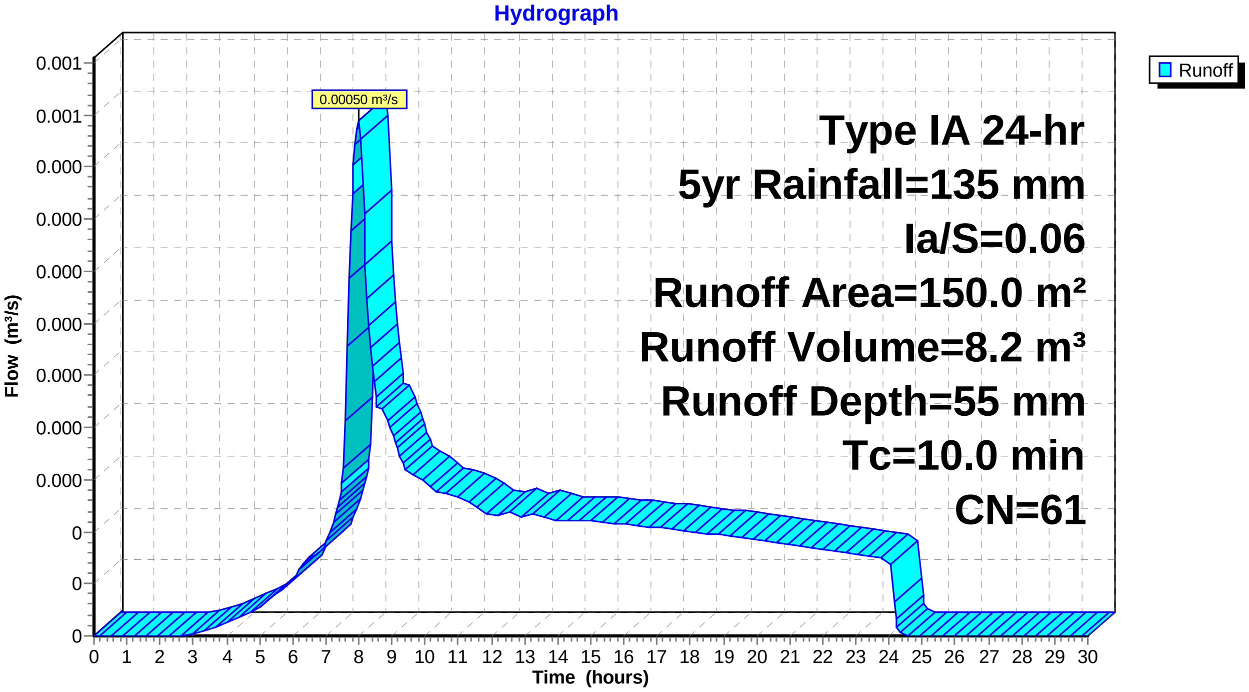
Runoff = 0.00050 m³/s @ 8.01 hrs, Volume= 8.2 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
150.0	61	>75% Grass cover, Good, HSG B
150.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 150msq: Catchment 150m²



Summary for Subcatchment 175msq: Catchment 175m²

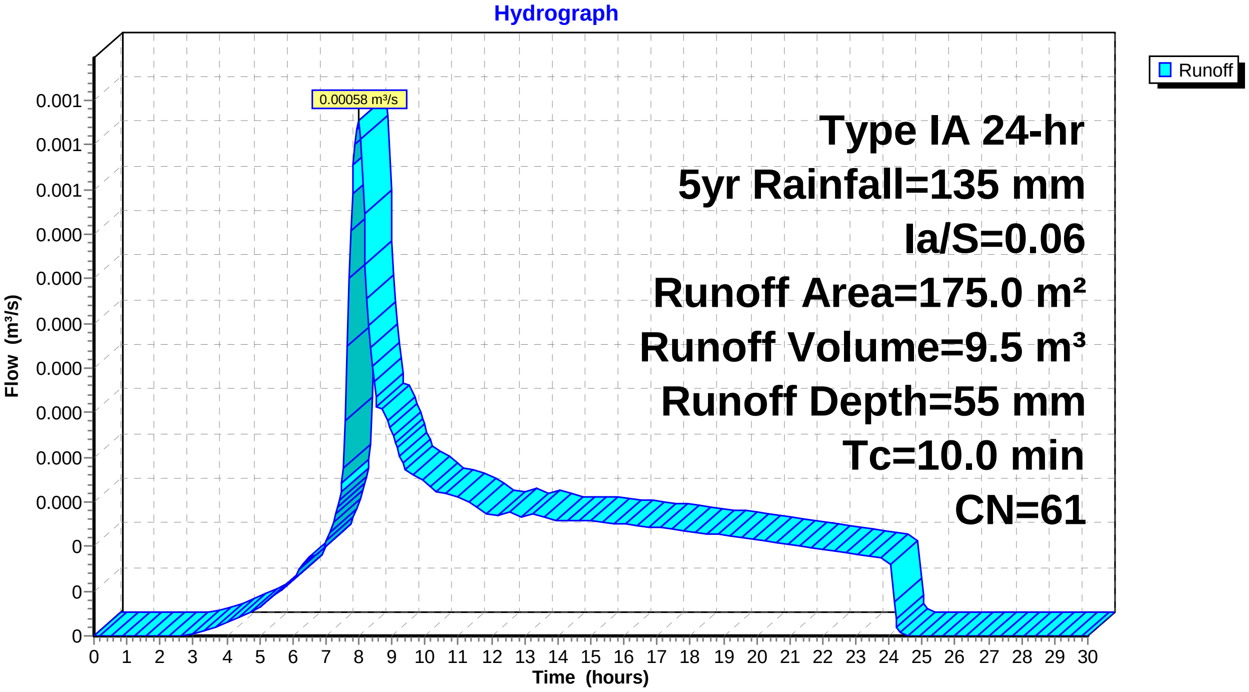
Runoff = 0.00058 m³/s @ 8.01 hrs, Volume= 9.5 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
175.0	61	>75% Grass cover, Good, HSG B
175.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 175msq: Catchment 175m²



Summary for Subcatchment 200msq: Catchment 200m²

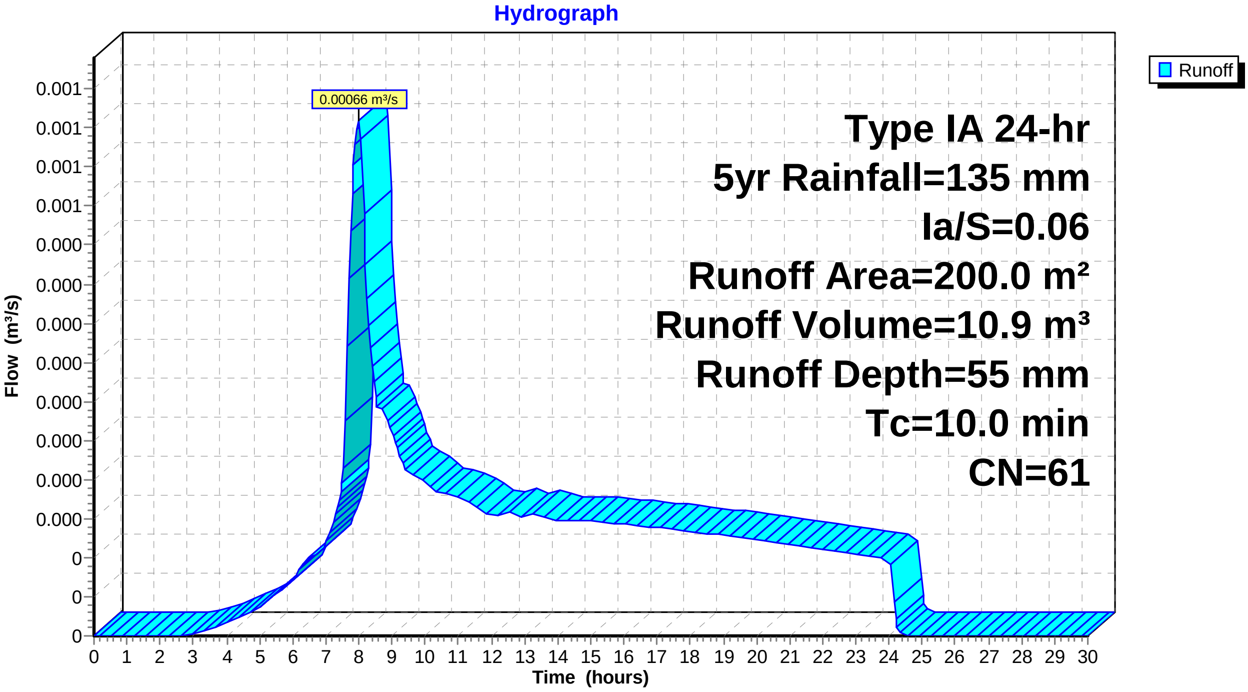
Runoff = 0.00066 m³/s @ 8.01 hrs, Volume= 10.9 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
200.0	61	>75% Grass cover, Good, HSG B
200.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 200msq: Catchment 200m²



Summary for Subcatchment 225msq: Catchment 225m²

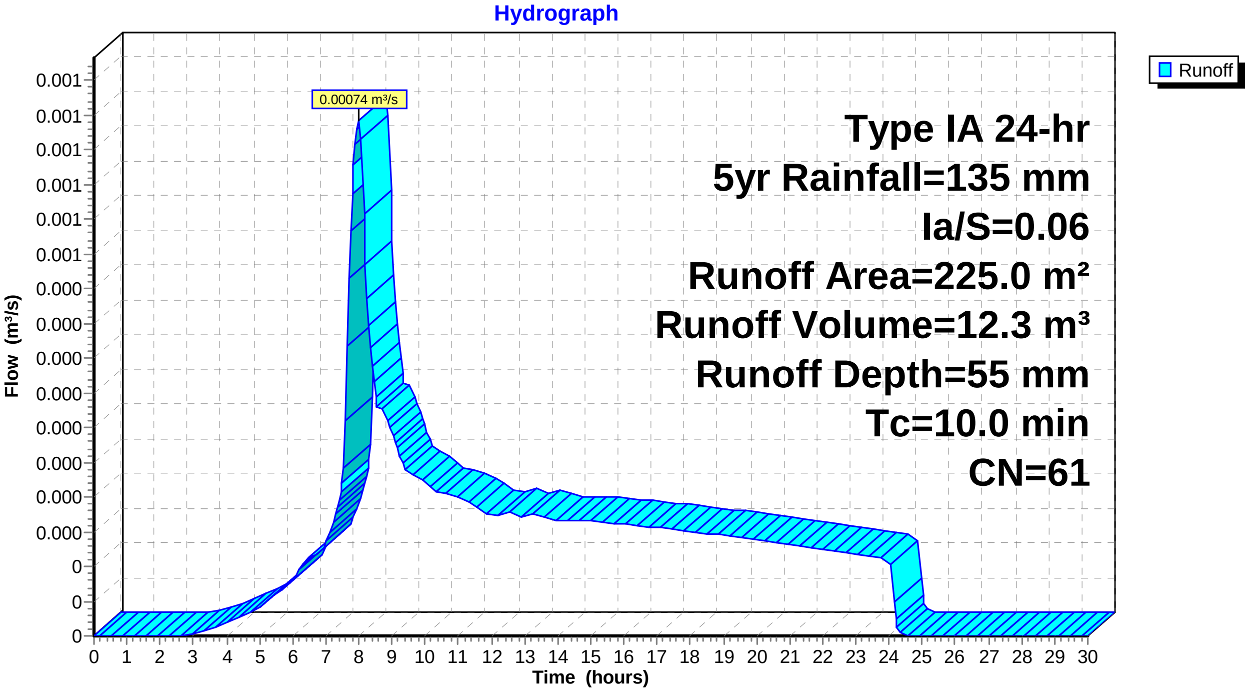
Runoff = 0.00074 m³/s @ 8.01 hrs, Volume= 12.3 m³, Depth= 55 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=135 mm, Ia/S=0.06

Area (m²)	CN	Description
225.0	61	>75% Grass cover, Good, HSG B
225.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 225msq: Catchment 225m²



Time span=0.00-30.00 hrs, dt=0.05 hrs, 601 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 25msq: Catchment 25m² Runoff Area=25.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00022 m³/s 3.4 m³

Subcatchment 50msq: Catchment 50m² Runoff Area=50.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00045 m³/s 6.8 m³

Subcatchment 75msq: Catchment 75m² Runoff Area=75.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00067 m³/s 10.2 m³

Subcatchment 100msq: Catchment Runoff Area=100.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00089 m³/s 13.6 m³

Subcatchment 125msq: Catchment Runoff Area=125.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00111 m³/s 17.0 m³

Subcatchment 150msq: Catchment Runoff Area=150.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00134 m³/s 20.4 m³

Subcatchment 175msq: Catchment Runoff Area=175.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00156 m³/s 23.8 m³

Subcatchment 200msq: Catchment Runoff Area=200.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00178 m³/s 27.2 m³

Subcatchment 225msq: Catchment Runoff Area=225.0 m² 0.00% Impervious Runoff Depth=136 mm
Tc=10.0 min CN=61 Runoff=0.00201 m³/s 30.6 m³

Summary for Subcatchment 25msq: Catchment 25m²

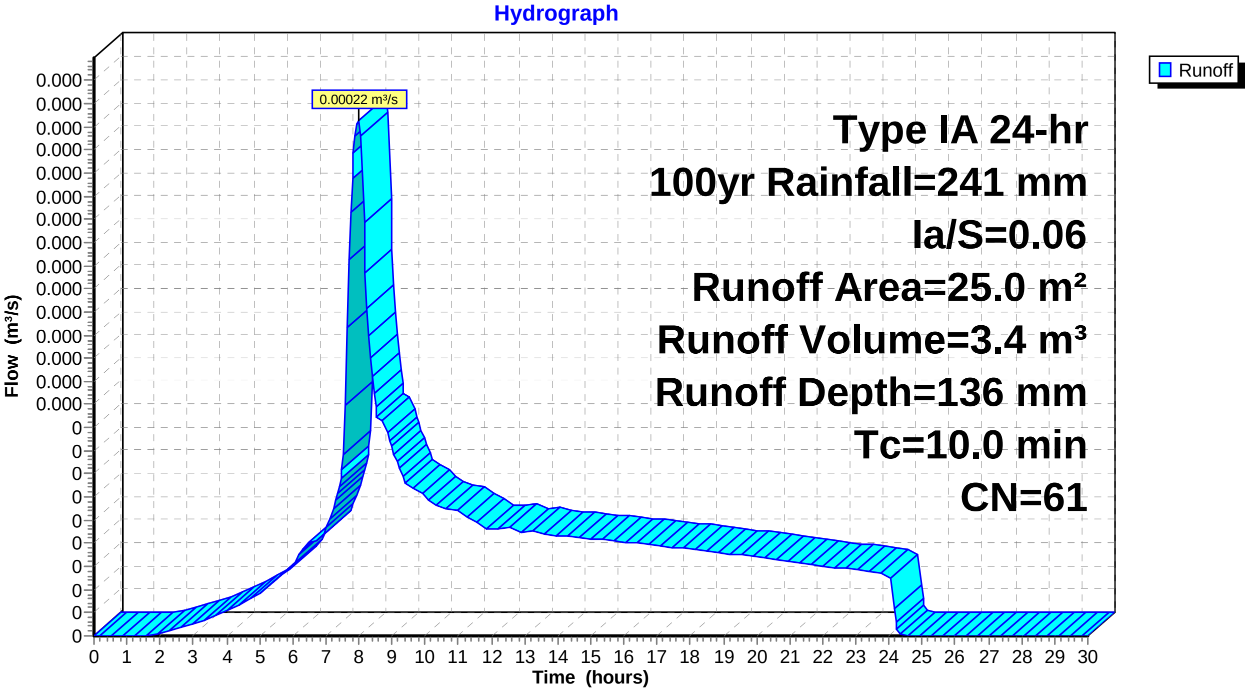
Runoff = 0.00022 m³/s @ 7.99 hrs, Volume= 3.4 m³, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m²)	CN	Description
25.0	61	>75% Grass cover, Good, HSG B
25.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 25msq: Catchment 25m²



Summary for Subcatchment 50msq: Catchment 50m²

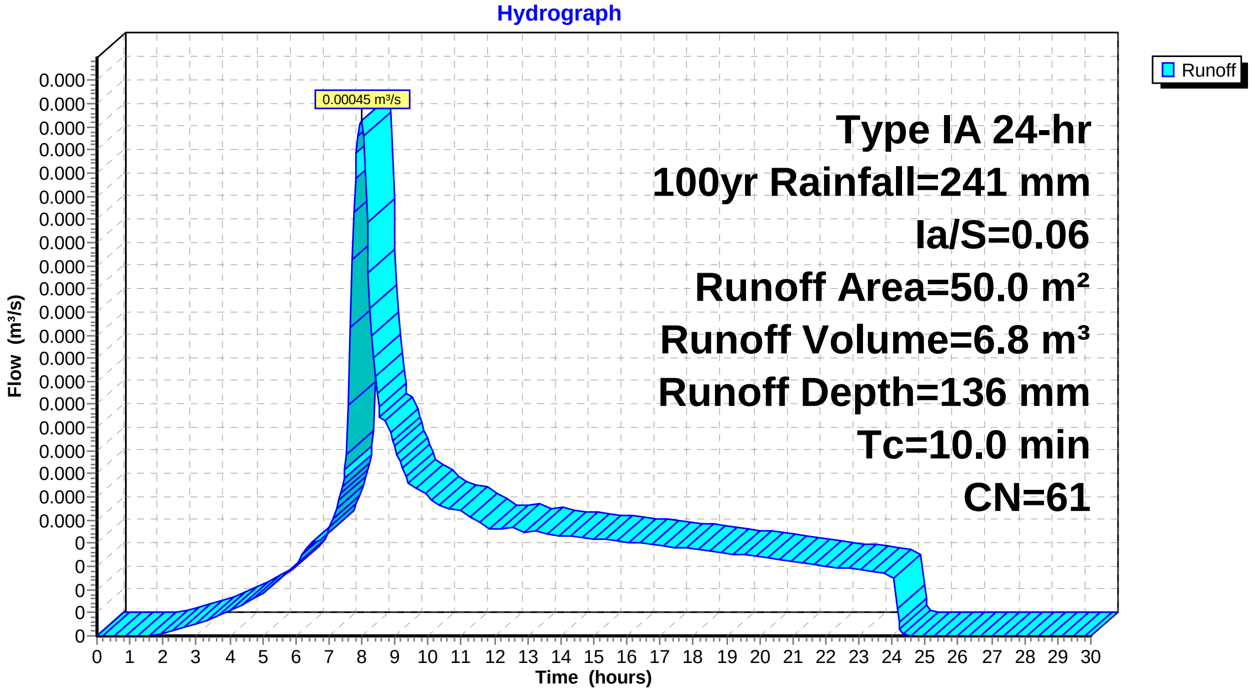
Runoff = 0.00045 m³/s @ 7.99 hrs, Volume= 6.8 m³, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m²)	CN	Description
50.0	61	>75% Grass cover, Good, HSG B
50.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 50msq: Catchment 50m²



Summary for Subcatchment 75msq: Catchment 75m²

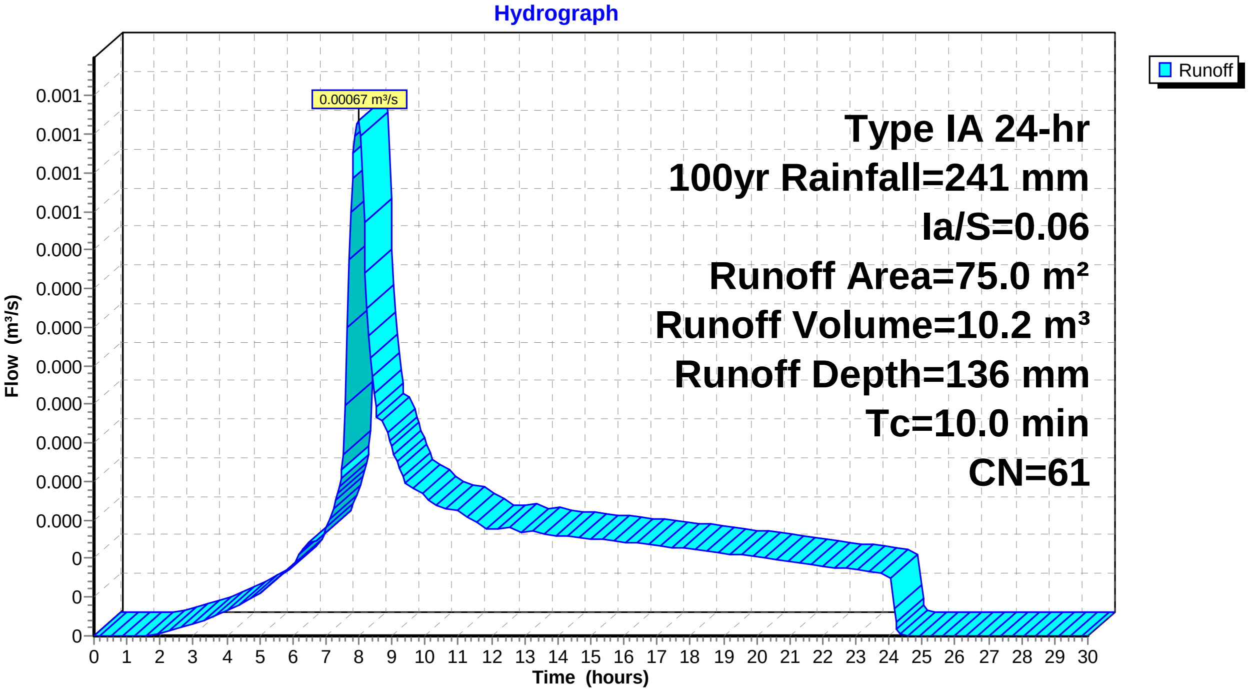
Runoff = 0.00067 m³/s @ 7.99 hrs, Volume= 10.2 m³, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m²)	CN	Description
75.0	61	>75% Grass cover, Good, HSG B
75.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 75msq: Catchment 75m²



Summary for Subcatchment 100msq: Catchment 100m²

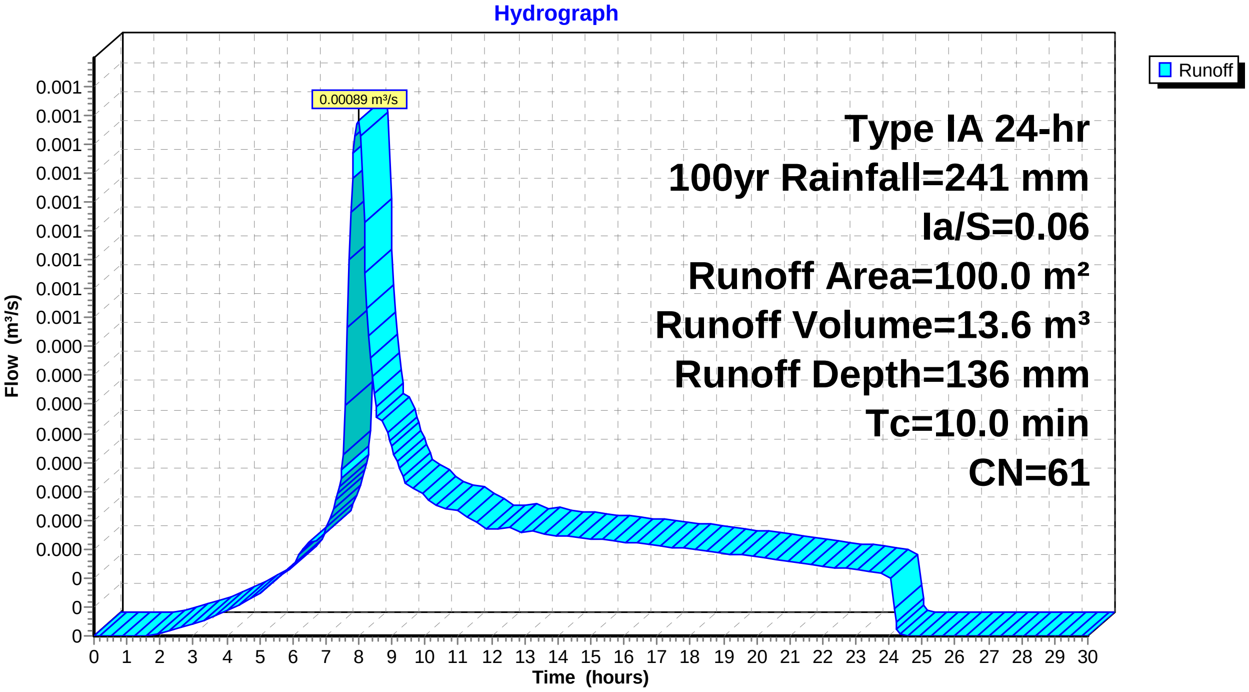
Runoff = 0.00089 m^3/s @ 7.99 hrs, Volume= 13.6 m^3, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m^2)	CN	Description
100.0	61	>75% Grass cover, Good, HSG B
100.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m^3/s)	Description
10.0					**Direct Entry,**

Subcatchment 100msq: Catchment 100m²



Summary for Subcatchment 125msq: Catchment 125m²

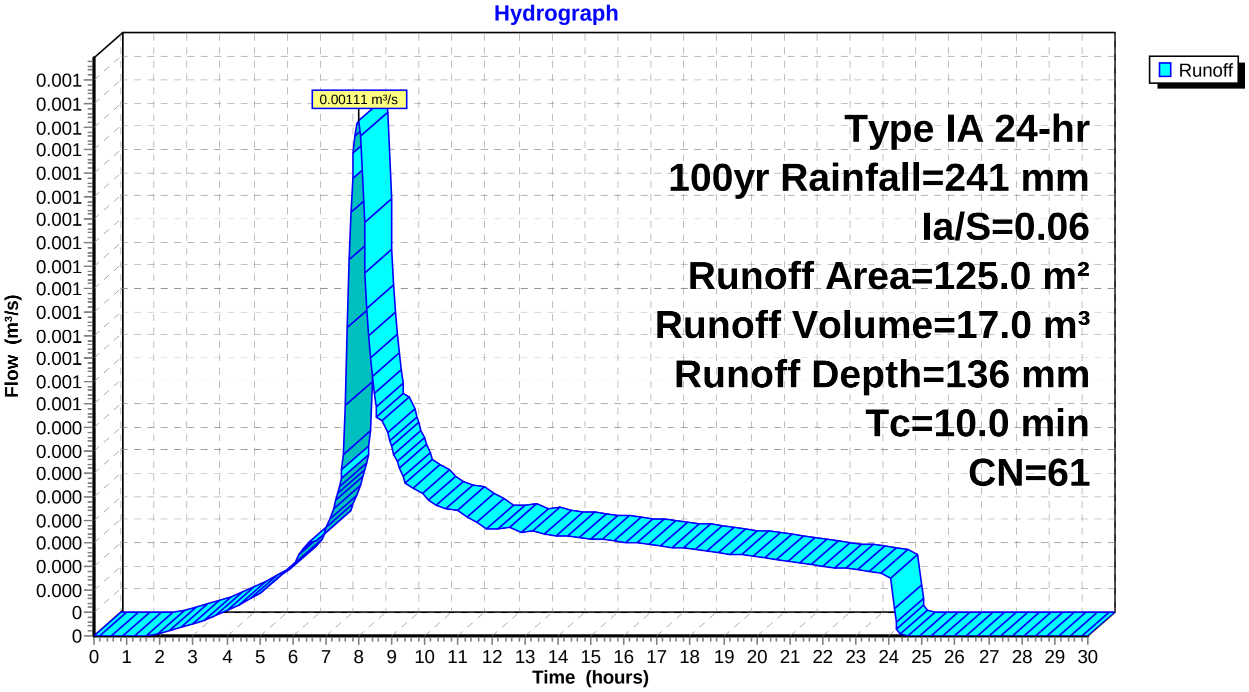
Runoff = 0.00111 m³/s @ 7.99 hrs, Volume= 17.0 m³, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m²)	CN	Description
125.0	61	>75% Grass cover, Good, HSG B
125.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 125msq: Catchment 125m²



Summary for Subcatchment 150msq: Catchment 150m²

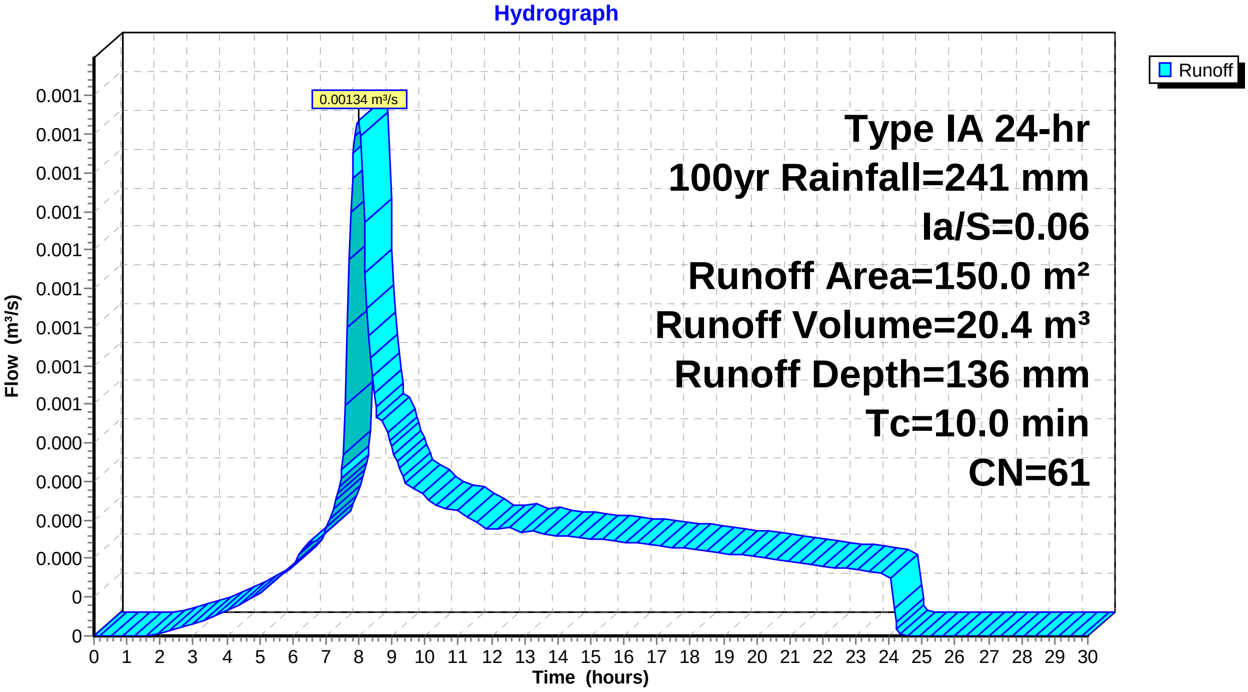
Runoff = 0.00134 m³/s @ 7.99 hrs, Volume= 20.4 m³, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m²)	CN	Description
150.0	61	>75% Grass cover, Good, HSG B
150.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 150msq: Catchment 150m²



Summary for Subcatchment 175msq: Catchment 175m^2

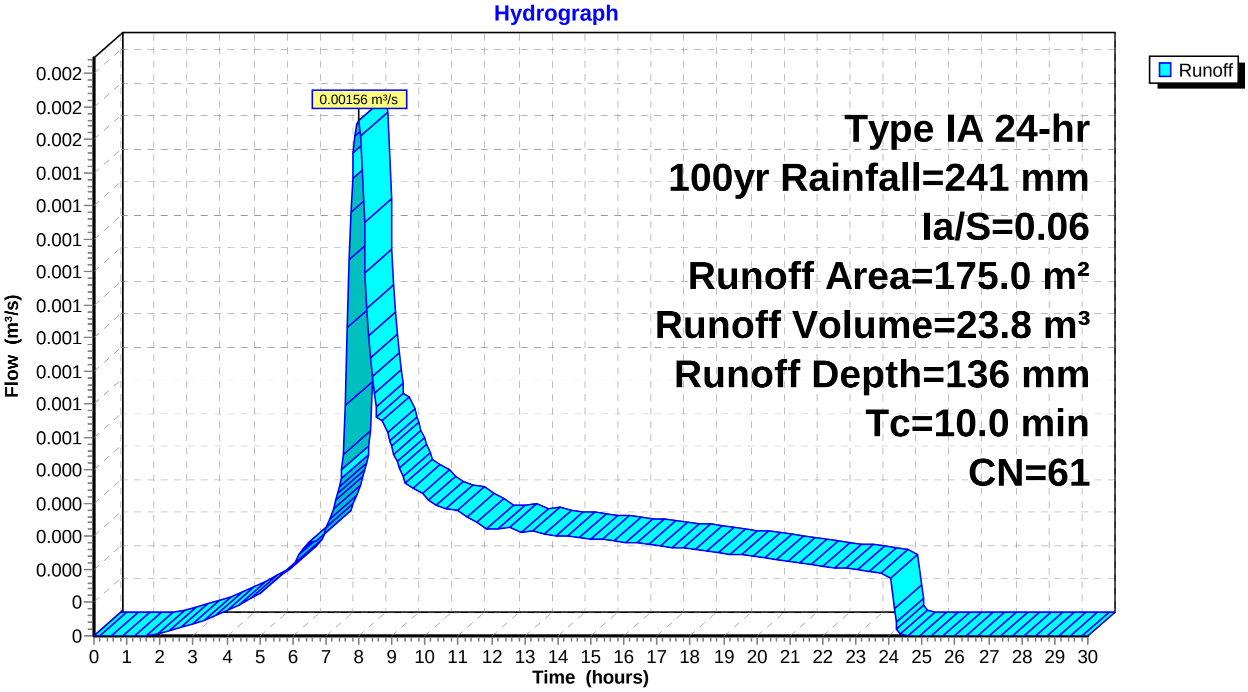
Runoff = 0.00156 m^3/s @ 7.99 hrs, Volume= 23.8 m^3, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m²)	CN	Description
175.0	61	>75% Grass cover, Good, HSG B
175.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 175msq: Catchment 175m^2



Summary for Subcatchment 200msq: Catchment 200m²

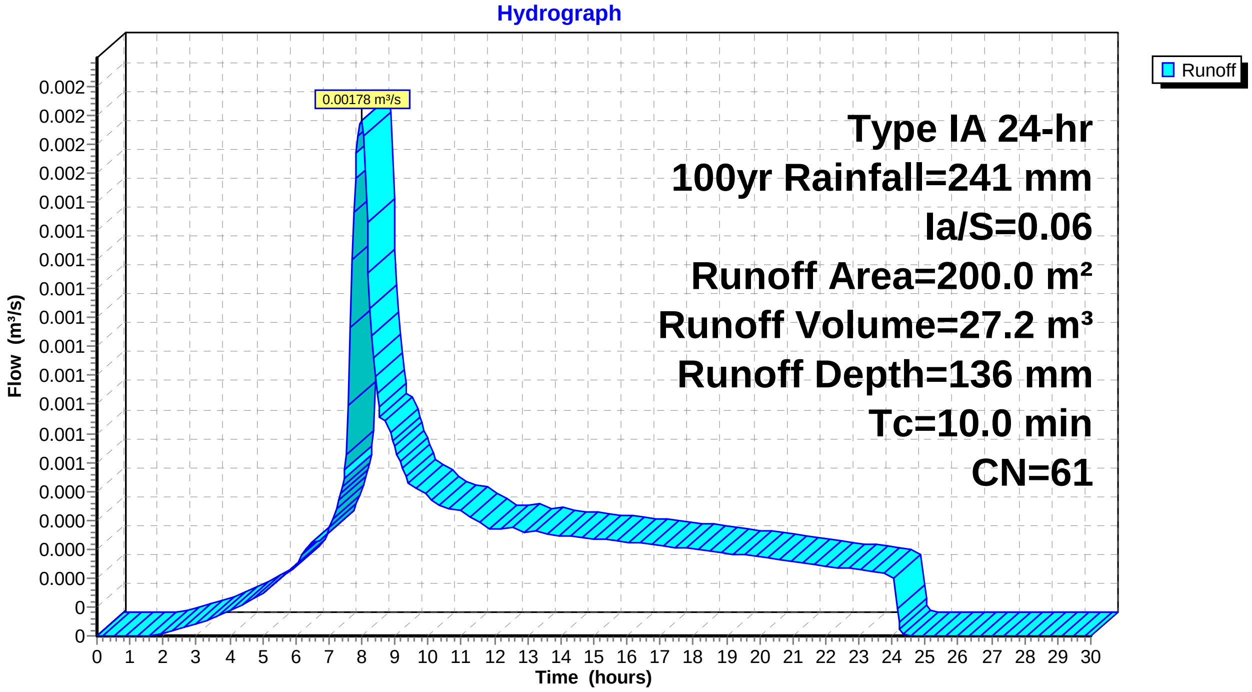
Runoff = 0.00178 m³/s @ 7.99 hrs, Volume= 27.2 m³, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m²)	CN	Description
200.0	61	>75% Grass cover, Good, HSG B
200.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 200msq: Catchment 200m²



Summary for Subcatchment 225msq: Catchment 225m²

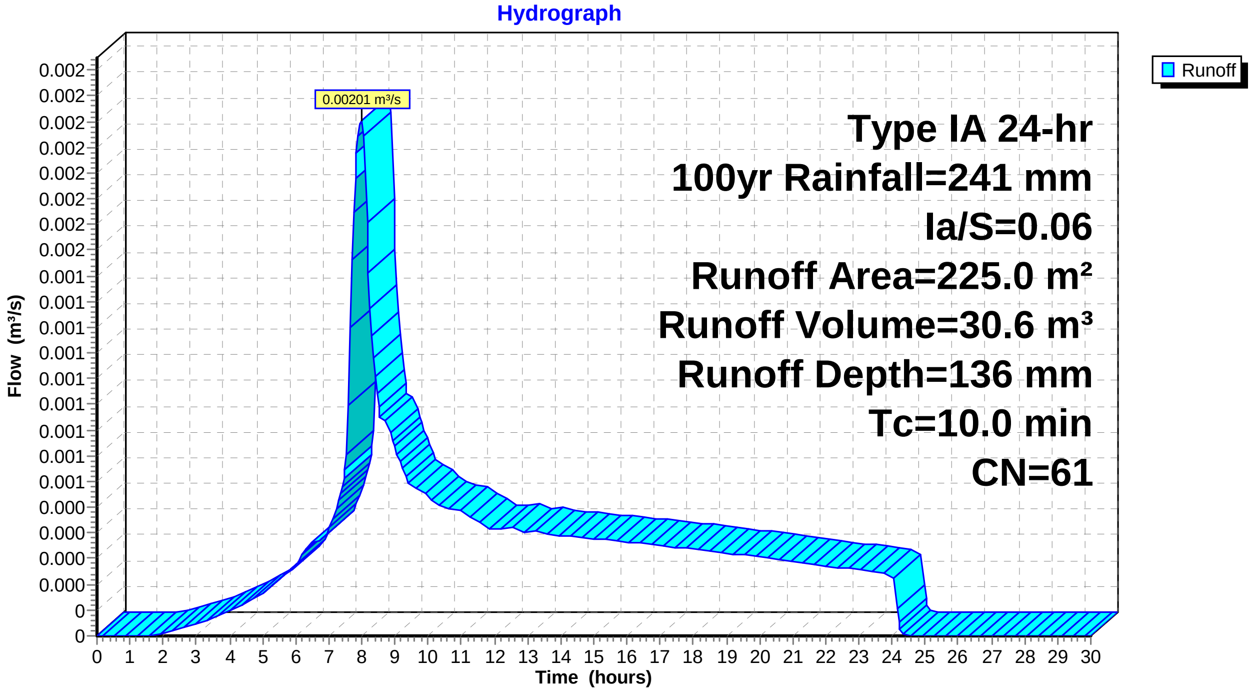
Runoff = 0.00201 m³/s @ 7.99 hrs, Volume= 30.6 m³, Depth= 136 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=241 mm, Ia/S=0.06

Area (m²)	CN	Description
225.0	61	>75% Grass cover, Good, HSG B
225.0	61	100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 225msq: Catchment 225m²



Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (mm)	AMC
1	5yr	Type IA 24-hr		Default	24.00	1	162	2
2	100yr	Type IA 24-hr		Default	24.00	1	289	2

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 25: 25m^2 Impervious Runoff Area=25.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00027 m^3/s 3.9 m^3

Subcatchment 50: 50m^2 Impervious Runoff Area=50.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00053 m^3/s 7.8 m^3

Subcatchment 75: 75m^2 Impervious Runoff Area=75.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00080 m^3/s 11.7 m^3

Subcatchment 100: 100m^2 Runoff Area=100.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00106 m^3/s 15.6 m^3

Subcatchment 125: 125m^2 Runoff Area=125.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00133 m^3/s 19.5 m^3

Pond 25P: 1m x 6m Soakpit Peak Elev=10.524 m Storage=1.0 m^3 Inflow=0.00027 m^3/s 3.9 m^3
Discarded=0.00009 m^3/s 3.4 m^3 Primary=0.00003 m^3/s 0.1 m^3 Outflow=0.00011 m^3/s 3.5 m^3

Pond 50P: 1m x 10m Soakpit Peak Elev=10.420 m Storage=1.4 m^3 Inflow=0.00053 m^3/s 7.8 m^3
Discarded=0.00010 m^3/s 2.5 m^3 Primary=0.00013 m^3/s 5.0 m^3 Outflow=0.00023 m^3/s 7.5 m^3

Pond 75P: 1m x 14m Soakpit Peak Elev=10.451 m Storage=2.1 m^3 Inflow=0.00080 m^3/s 11.7 m^3
Discarded=0.00015 m^3/s 3.7 m^3 Primary=0.00019 m^3/s 7.6 m^3 Outflow=0.00034 m^3/s 11.3 m^3

Pond 100P: 2m x 12m Soakpit Peak Elev=10.425 m Storage=3.4 m^3 Inflow=0.00106 m^3/s 15.6 m^3
Discarded=0.00013 m^3/s 3.9 m^3 Primary=0.00025 m^3/s 11.0 m^3 Outflow=0.00038 m^3/s 14.9 m^3

Pond 125P: 2m x 14m Soakpit Peak Elev=10.464 m Storage=4.3 m^3 Inflow=0.00133 m^3/s 19.5 m^3
Discarded=0.00017 m^3/s 5.1 m^3 Primary=0.00030 m^3/s 13.5 m^3 Outflow=0.00047 m^3/s 18.6 m^3

Summary for Subcatchment 25: 25m² Impervious

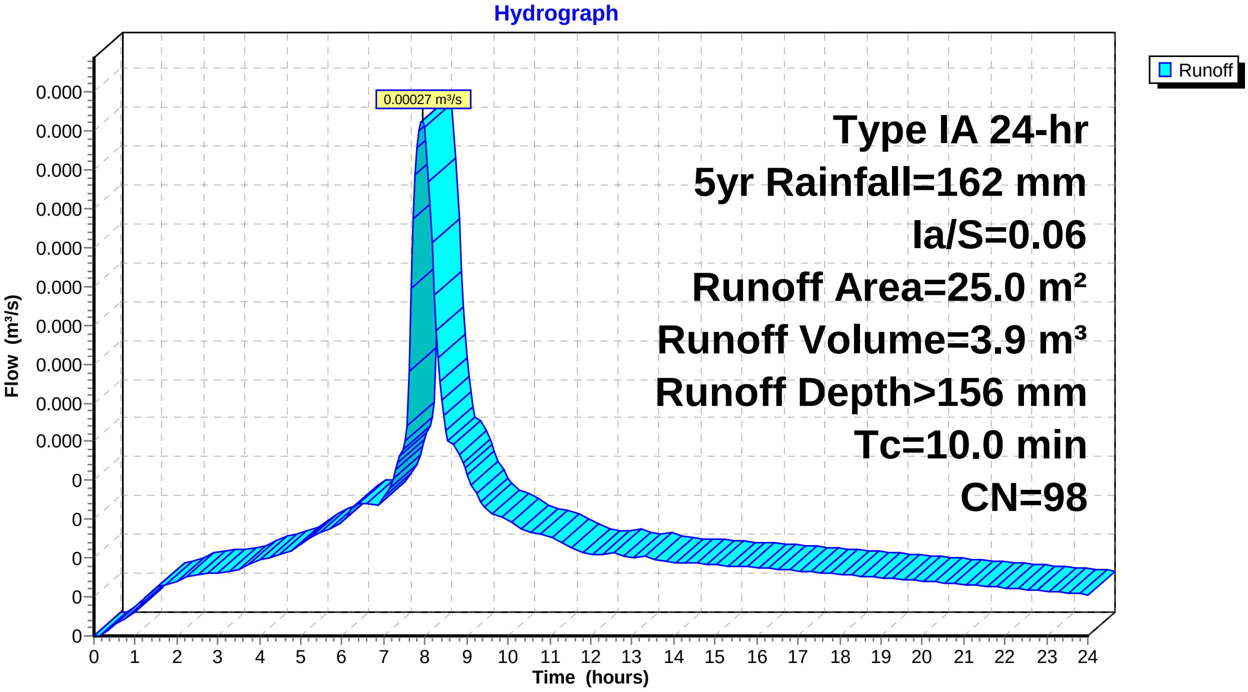
Runoff = 0.00027 m³/s @ 7.94 hrs, Volume= 3.9 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
25.0	98	Paved parking, HSG D
25.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 25: 25m² Impervious



Summary for Subcatchment 50: 50m² Impervious

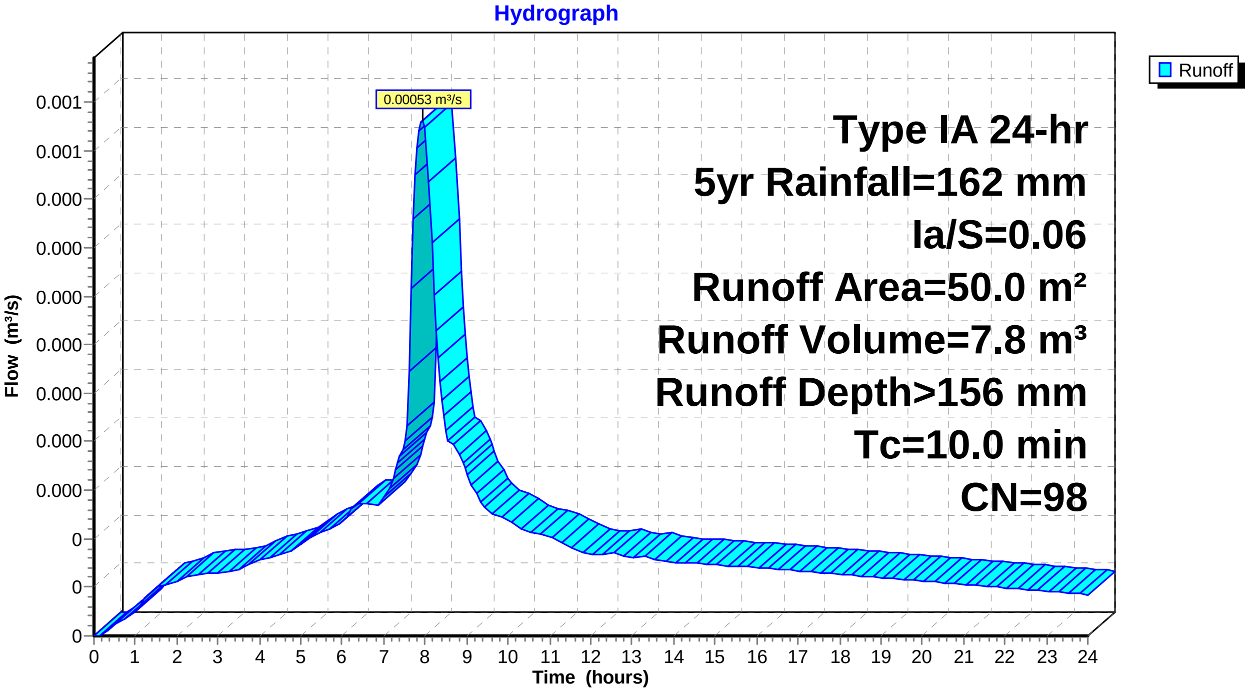
Runoff = 0.00053 m³/s @ 7.94 hrs, Volume= 7.8 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
50.0	98	Paved parking, HSG D
50.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 50: 50m² Impervious



Summary for Subcatchment 75: 75m² Impervious

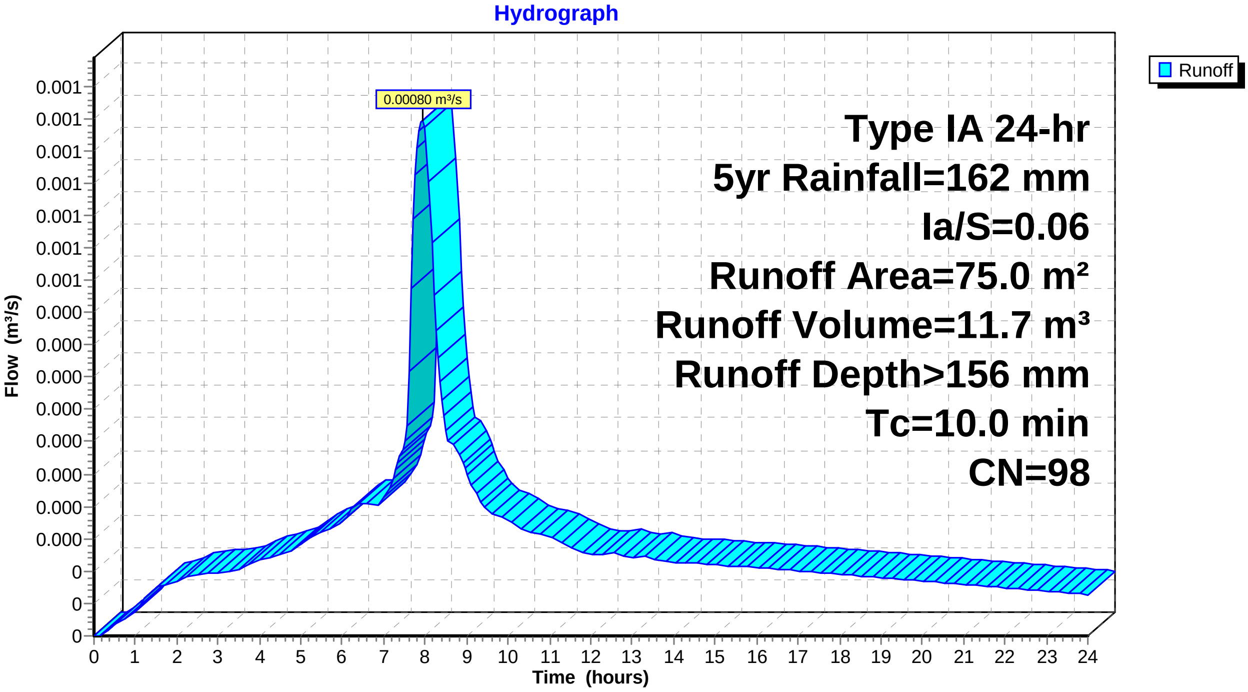
Runoff = 0.00080 m³/s @ 7.94 hrs, Volume= 11.7 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
75.0	98	Paved parking, HSG D
75.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 75: 75m² Impervious



Summary for Subcatchment 100: 100m² Impervious

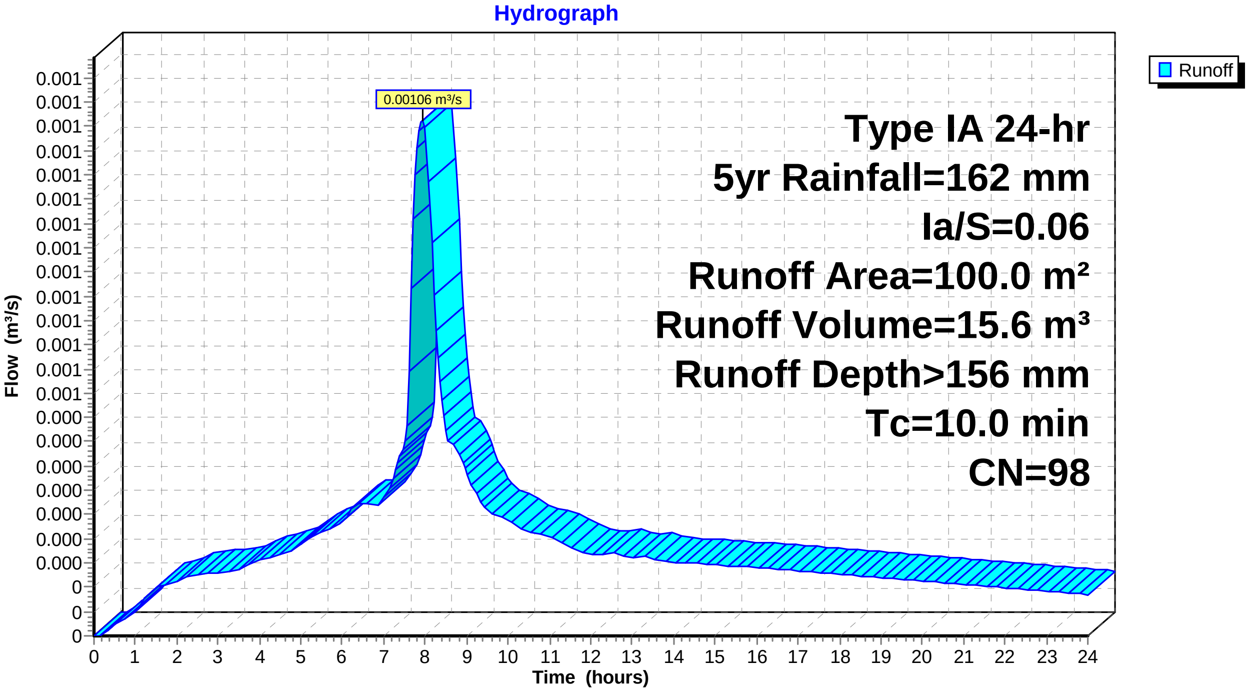
Runoff = 0.00106 m³/s @ 7.94 hrs, Volume= 15.6 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
100.0	98	Paved parking, HSG D
100.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 100: 100m² Impervious



Summary for Subcatchment 125: 125m² Impervious

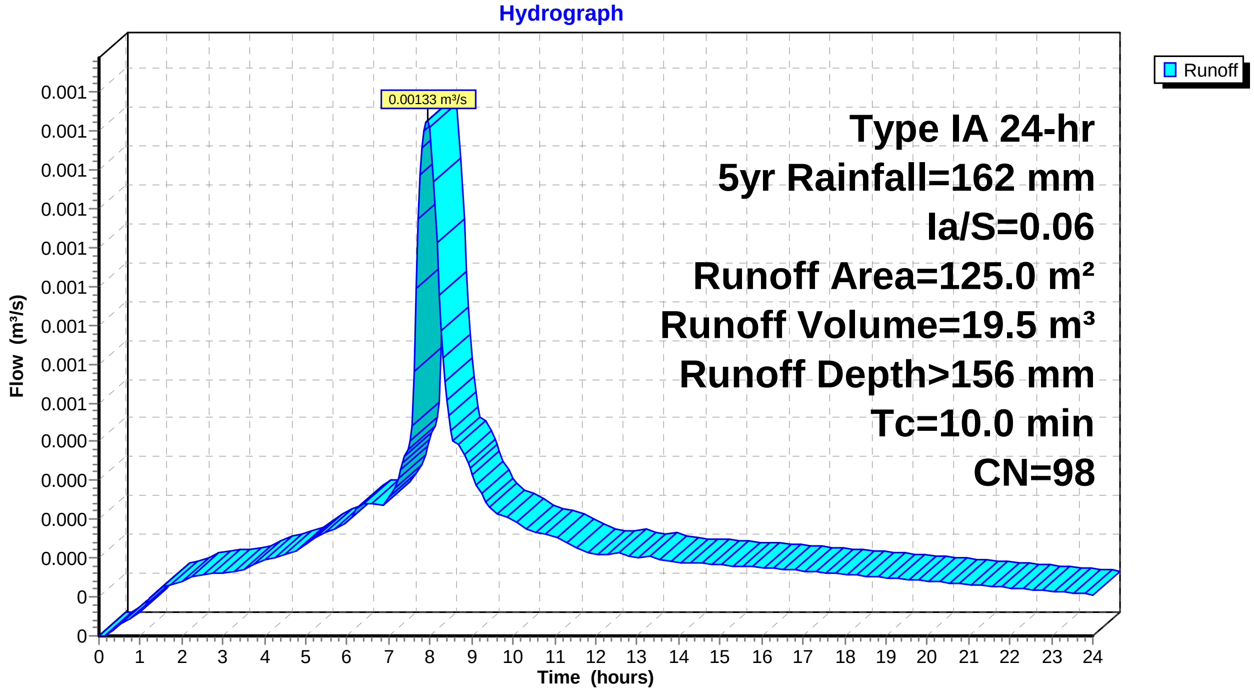
Runoff = 0.00133 m³/s @ 7.94 hrs, Volume= 19.5 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
125.0	98	Paved parking, HSG D
125.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 125: 125m² Impervious



Summary for Pond 25P: 1m x 6m Soakpit

Inflow Area = 25.0 m^2,100.00% Impervious, Inflow Depth > 156 mm for 5yr event
Inflow = 0.00027 m^3/s @ 7.94 hrs, Volume= 3.9 m^3
Outflow = 0.00011 m^3/s @ 8.45 hrs, Volume= 3.5 m^3, Atten= 57%, Lag= 30.5 min
Discarded = 0.00009 m^3/s @ 8.45 hrs, Volume= 3.4 m^3
Primary = 0.00003 m^3/s @ 8.45 hrs, Volume= 0.1 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.524 m @ 8.45 hrs Surf.Area= 6.0 m^2 Storage= 1.0 m^3

Plug-Flow detention time= 202.8 min calculated for 3.5 m^3 (90% of inflow)
Center-of-Mass det. time= 128.4 min (778.0 - 649.6)

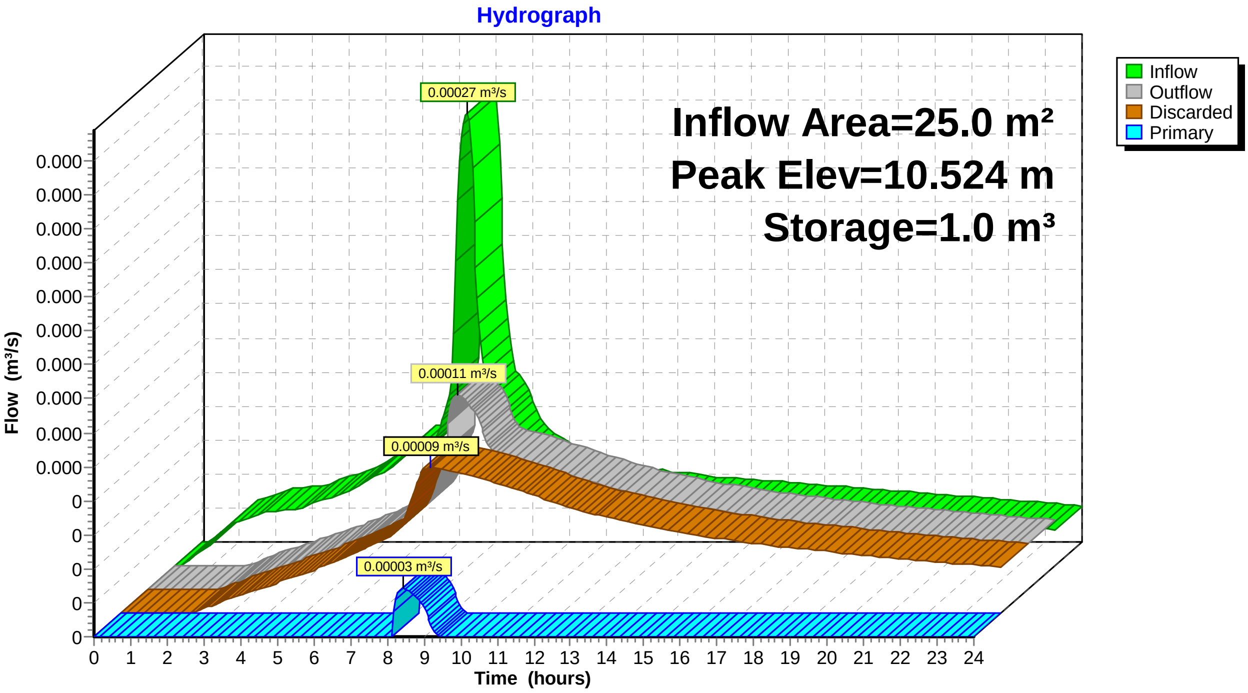
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	1.6 m^3	**1.00 mW x 6.00 mL x 0.80 mH Prismatoid** 4.8 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Device 1	10.500 m	**10 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 6.7 m^2
#4	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00009 m^3/s @ 8.45 hrs HW=10.524 m (Free Discharge)
└─**3=Exfiltration** (Controls 0.00009 m^3/s)

Primary OutFlow Max=0.00003 m^3/s @ 8.45 hrs HW=10.524 m (Free Discharge)
└─**1=Culvert** (Passes 0.00003 m^3/s of 0.01017 m^3/s potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.00003 m^3/s @ 0.36 m/s)
  └─**4=Orifice/Grate** (Controls 0.00000 m^3/s)

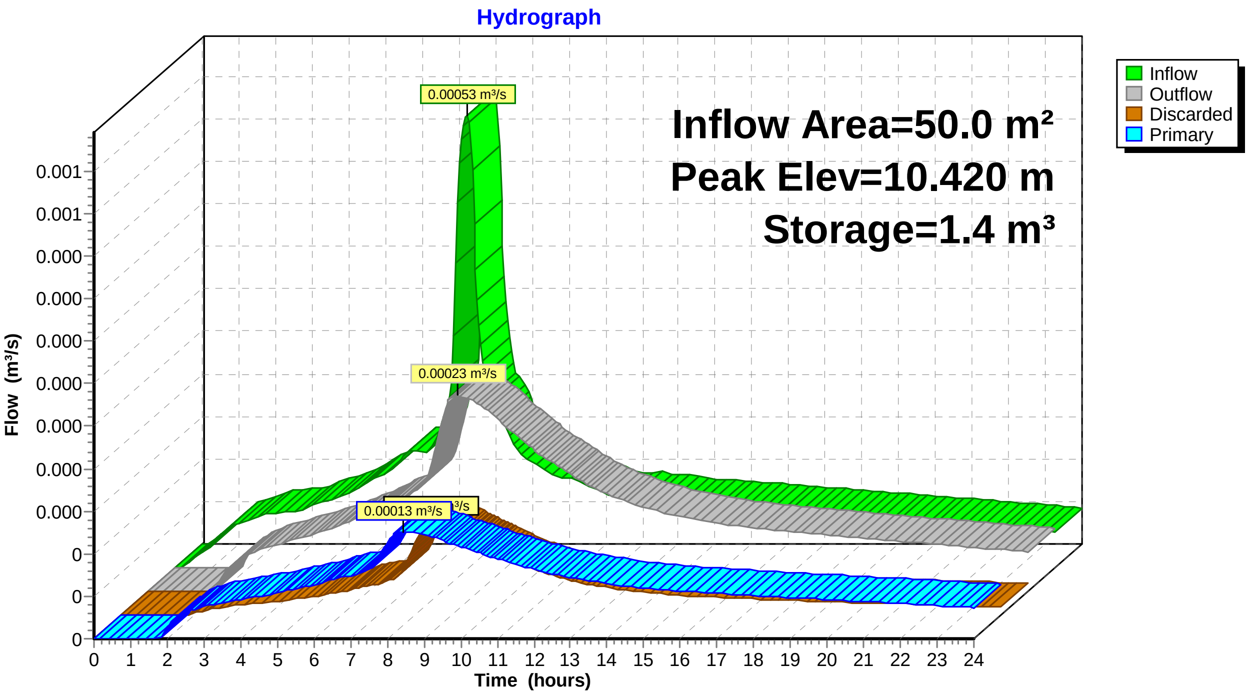
Pond 25P: 1m x 6m Soakpit



Summary for Pond 50P: 1m x 10m Soakpit

```
Inflow Area =            50.0 m²,100.00% Impervious,  Inflow Depth >    156 mm    for  5yr event
Inflow      =     0.00053 m³/s @     7.94 hrs,  Volume=              7.8 m³
Outflow     =     0.00023 m³/s @     8.44 hrs,  Volume=              7.5 m³,  Atten= 57%,  Lag= 30.0 min
Discarded   =     0.00010 m³/s @     8.44 hrs,  Volume=              2.5 m³
Primary     =     0.00013 m³/s @     8.44 hrs,  Volume=              5.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.420 m @ 8.44 hrs   Surf.Area= 10.0 m²   Storage= 1.4 m³

Plug-Flow detention time= 93.0 min calculated for 7.5 m³ (96% of inflow)
Center-of-Mass det. time= 65.3 min ( 714.9 - 649.6 )

Volume       Invert    Avail.Storage   Storage Description
   #1      10.000 m           2.6 m³   1.00 mW x 10.00 mL x 0.80 mH Prismatoid
                                       8.0 m³ Overall  x 33.0% Voids

Device   Routing          Invert   Outlet Devices
   #1    Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Primary        10.050 m   10 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #3    Device 1       10.500 m   10 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #4    Discarded      10.050 m   45.00 mm/hr Exfiltration over Wetted area above 10.050 m
                                   Conductivity to Groundwater Elevation = 3.000 m
                                   Excluded Wetted area = 11.1 m²
   #5    Device 1       10.790 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Discarded OutFlow  Max=0.00010 m³/s @ 8.44 hrs  HW=10.420 m   (Free Discharge)
└─4=Exfiltration  ( Controls 0.00010 m³/s)

Primary OutFlow  Max=0.00013 m³/s @ 8.44 hrs  HW=10.420 m   (Free Discharge)
├─1=Culvert  (Passes 0.00000 m³/s of 0.00987 m³/s potential flow)
│ ├─3=Orifice/Grate  ( Controls 0.00000 m³/s)
│ └─5=Orifice/Grate  ( Controls 0.00000 m³/s)
└─2=Orifice/Grate  (Orifice Controls 0.00013 m³/s @ 1.61 m/s)
```

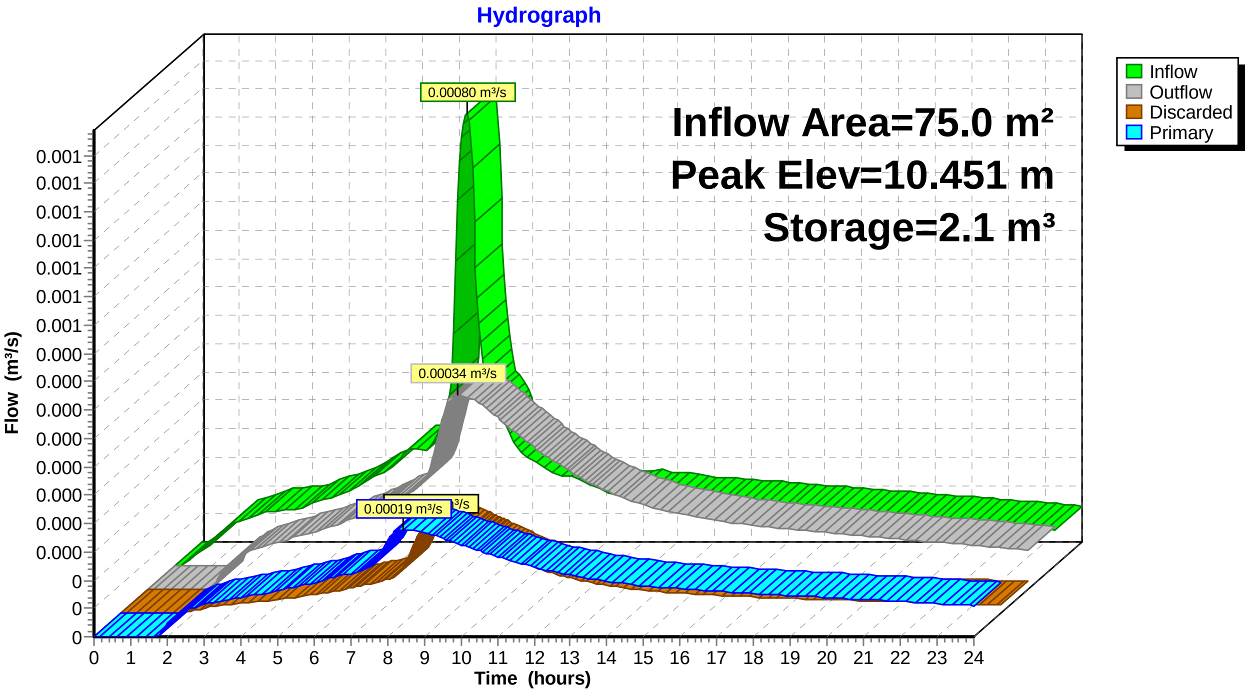
Pond 50P: 1m x 10m Soakpit



Summary for Pond 75P: 1m x 14m Soakpit

```
Inflow Area =           75.0 m²,100.00% Impervious,  Inflow Depth >    156 mm    for  5yr event
Inflow      =     0.00080 m³/s @    7.94 hrs,  Volume=            11.7 m³
Outflow     =     0.00034 m³/s @    8.44 hrs,  Volume=            11.3 m³,  Atten= 57%,  Lag= 30.4 min
Discarded   =     0.00015 m³/s @    8.44 hrs,  Volume=             3.7 m³
Primary     =     0.00019 m³/s @    8.44 hrs,  Volume=             7.6 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.451 m @ 8.44 hrs   Surf.Area= 14.0 m²   Storage= 2.1 m³

Plug-Flow detention time= 92.5 min calculated for 11.3 m³ (96% of inflow)
Center-of-Mass det. time= 65.5 min ( 715.1 - 649.6 )

Volume      Invert    Avail.Storage   Storage Description
  #1      10.000 m           3.7 m³   1.00 mW x 14.00 mL x 0.80 mH Prismatoid
                                      11.2 m³ Overall  x 33.0% Voids

Device   Routing          Invert   Outlet Devices
  #1     Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
  #2     Primary        10.050 m   12 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
  #3     Device 1       10.500 m   14 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
  #4     Discarded      10.050 m   45.00 mm/hr Exfiltration over Wetted area above 10.050 m
                                   Conductivity to Groundwater Elevation = 3.000 m
                                   Excluded Wetted area = 15.5 m²
  #5     Device 1       10.790 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Discarded OutFlow  Max=0.00015 m³/s @ 8.44 hrs  HW=10.451 m   (Free Discharge)
└─4=Exfiltration  ( Controls 0.00015 m³/s)

Primary OutFlow  Max=0.00019 m³/s @ 8.44 hrs  HW=10.451 m   (Free Discharge)
├─1=Culvert  (Passes 0.00000 m³/s of 0.00996 m³/s potential flow)
│ ├─3=Orifice/Grate  ( Controls 0.00000 m³/s)
│ └─5=Orifice/Grate  ( Controls 0.00000 m³/s)
└─2=Orifice/Grate  (Orifice Controls 0.00019 m³/s @ 1.67 m/s)
```

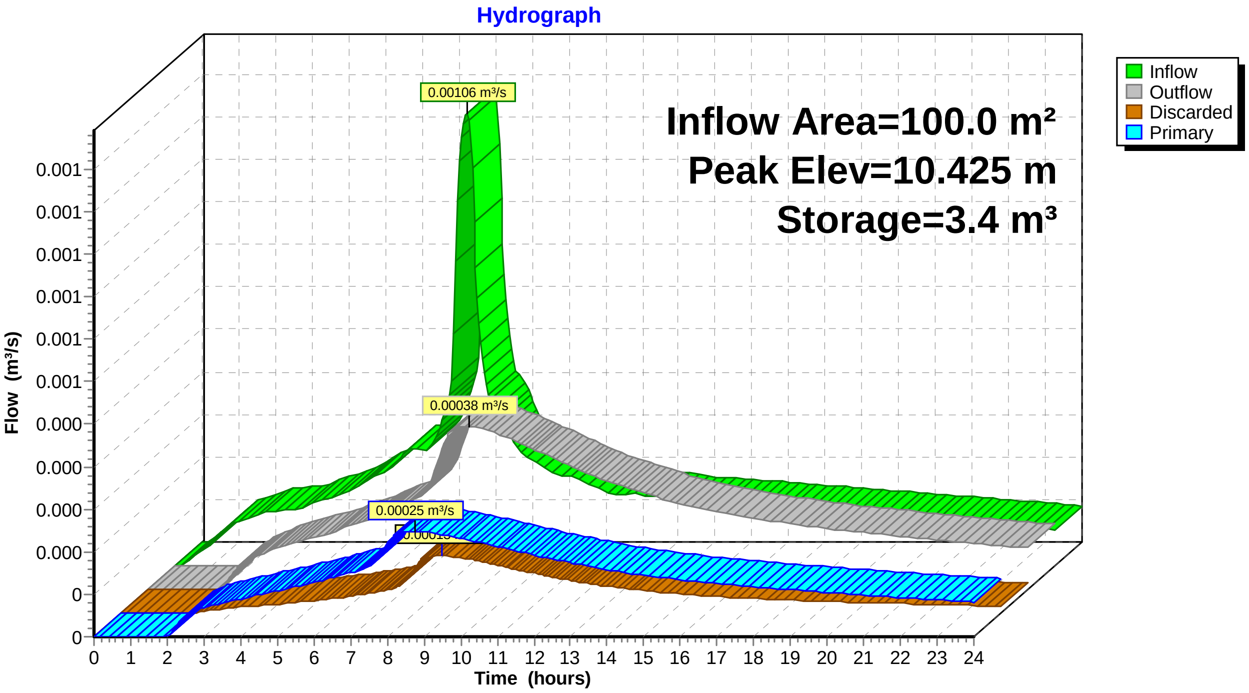
Pond 75P: 1m x 14m Soakpit



Summary for Pond 100P: 2m x 12m Soakpit

```
Inflow Area =          100.0 m²,100.00% Impervious,  Inflow Depth >    156 mm    for  5yr event
Inflow      =     0.00106 m³/s @    7.94 hrs,  Volume=            15.6 m³
Outflow     =     0.00038 m³/s @    8.78 hrs,  Volume=            14.9 m³,  Atten= 64%,  Lag= 50.4 min
Discarded  =      0.00013 m³/s @    8.78 hrs,  Volume=             3.9 m³
Primary     =     0.00025 m³/s @    8.78 hrs,  Volume=            11.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.425 m @ 8.78 hrs   Surf.Area= 24.0 m²   Storage= 3.4 m³

Plug-Flow detention time= 130.0 min calculated for 14.9 m³ (95% of inflow)
Center-of-Mass det. time= 93.0 min ( 742.6 - 649.6 )

Volume        Invert     Avail.Storage   Storage Description
   #1        10.000 m           6.3 m³   2.00 mW x 12.00 mL x 0.80 mH Prismatoid
                                         19.2 m³ Overall  x 33.0% Voids

Device   Routing           Invert   Outlet Devices
   #1    Primary          9.000 m   100 mm  Round Culvert
                                    L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                    Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                    0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Primary         10.050 m   14 mm Vert. Orifice/Grate    C= 0.600
                                    Limited to weir flow at low heads
   #3    Device 1        10.500 m   18 mm Horiz. Orifice/Grate    C= 0.600
                                    Limited to weir flow at low heads
   #4    Discarded       10.050 m   45.00 mm/hr Exfiltration over Wetted area above 10.050 m
                                    Conductivity to Groundwater Elevation = 3.000 m
                                    Excluded Wetted area = 25.4 m²
   #5    Device 1        10.790 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                    Limited to weir flow at low heads

Discarded OutFlow  Max=0.00013 m³/s @ 8.78 hrs  HW=10.425 m   (Free Discharge)
└─4=Exfiltration  ( Controls 0.00013 m³/s)

Primary OutFlow  Max=0.00025 m³/s @ 8.78 hrs  HW=10.425 m   (Free Discharge)
├─1=Culvert  (Passes 0.00000 m³/s of 0.00989 m³/s potential flow)
│  ├─3=Orifice/Grate  ( Controls 0.00000 m³/s)
│  └─5=Orifice/Grate  ( Controls 0.00000 m³/s)
└─2=Orifice/Grate  (Orifice Controls 0.00025 m³/s @ 1.61 m/s)
```

Pond 100P: 2m x 12m Soakpit



Summary for Pond 125P: 2m x 14m Soakpit

Inflow Area = 125.0 m^2,100.00% Impervious, Inflow Depth > 156 mm for 5yr event
Inflow = 0.00133 m^3/s @ 7.94 hrs, Volume= 19.5 m^3
Outflow = 0.00047 m^3/s @ 8.82 hrs, Volume= 18.6 m^3, Atten= 65%, Lag= 52.6 min
Discarded = 0.00017 m^3/s @ 8.82 hrs, Volume= 5.1 m^3
Primary = 0.00030 m^3/s @ 8.82 hrs, Volume= 13.5 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.464 m @ 8.82 hrs Surf.Area= 28.0 m^2 Storage= 4.3 m^3

Plug-Flow detention time= 133.6 min calculated for 18.6 m^3 (95% of inflow)
Center-of-Mass det. time= 96.3 min (745.9 - 649.6)

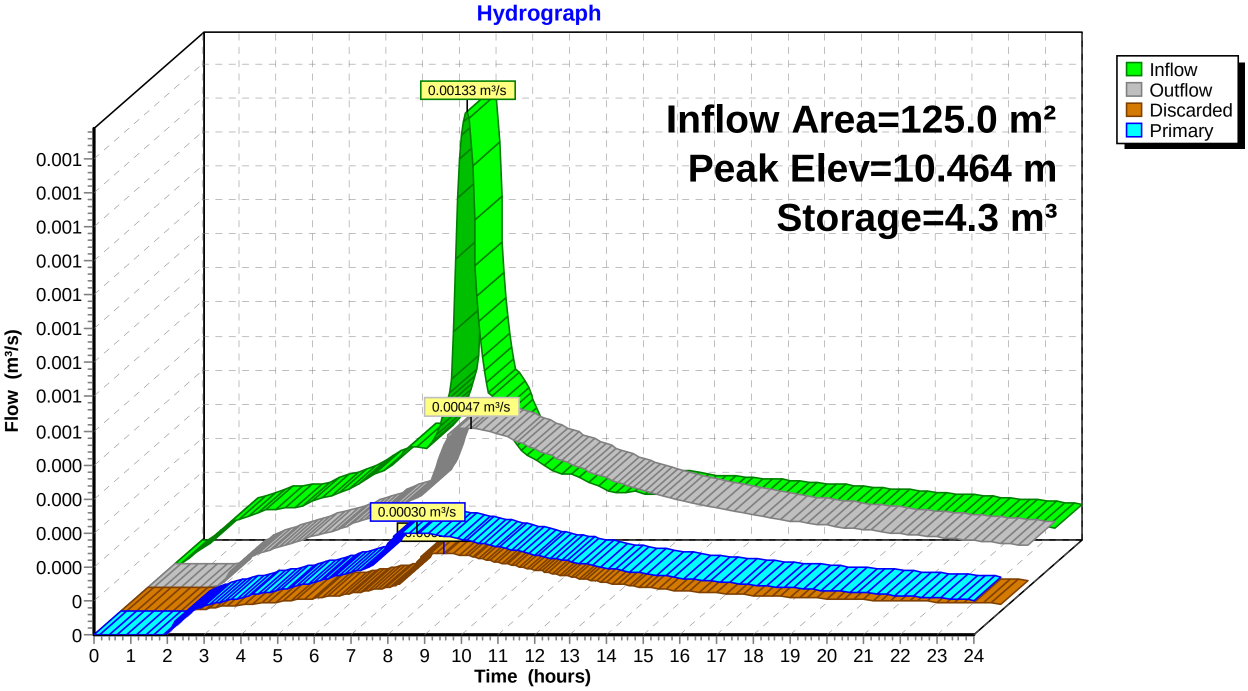
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	7.4 m^3	**2.00 mW x 14.00 mL x 0.80 mH Prismatoid** 22.4 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Primary	10.050 m	**15 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**18 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 29.6 m^2
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00017 m^3/s @ 8.82 hrs HW=10.464 m (Free Discharge)
└─**4=Exfiltration** (Controls 0.00017 m^3/s)

Primary OutFlow Max=0.00030 m^3/s @ 8.82 hrs HW=10.464 m (Free Discharge)
├─**1=Culvert** (Passes 0.00000 m^3/s of 0.01000 m^3/s potential flow)
│ ├─**3=Orifice/Grate** (Controls 0.00000 m^3/s)
│ └─**5=Orifice/Grate** (Controls 0.00000 m^3/s)
└─**2=Orifice/Grate** (Orifice Controls 0.00030 m^3/s @ 1.69 m/s)

Pond 125P: 2m x 14m Soakpit



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 25: 25m^2 Impervious Runoff Area=25.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00048 m^3/s 7.1 m^3

Subcatchment 50: 50m^2 Impervious Runoff Area=50.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00095 m^3/s 14.1 m^3

Subcatchment 75: 75m^2 Impervious Runoff Area=75.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00143 m^3/s 21.2 m^3

Subcatchment 100: 100m^2 Runoff Area=100.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00191 m^3/s 28.3 m^3

Subcatchment 125: 125m^2 Runoff Area=125.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00238 m^3/s 35.4 m^3

Pond 25P: 1m x 6m Soakpit Peak Elev=10.791 m Storage=1.6 m^3 Inflow=0.00048 m^3/s 7.1 m^3
Discarded=0.00014 m^3/s 5.4 m^3 Primary=0.00013 m^3/s 1.0 m^3 Outflow=0.00027 m^3/s 6.4 m^3

Pond 50P: 1m x 10m Soakpit Peak Elev=10.740 m Storage=2.4 m^3 Inflow=0.00095 m^3/s 14.1 m^3
Discarded=0.00020 m^3/s 5.3 m^3 Primary=0.00027 m^3/s 8.3 m^3 Outflow=0.00047 m^3/s 13.7 m^3

Pond 75P: 1m x 14m Soakpit Peak Elev=10.773 m Storage=3.6 m^3 Inflow=0.00143 m^3/s 21.2 m^3
Discarded=0.00028 m^3/s 7.7 m^3 Primary=0.00047 m^3/s 12.8 m^3 Outflow=0.00075 m^3/s 20.5 m^3

Pond 100P: 2m x 12m Soakpit Peak Elev=10.726 m Storage=5.7 m^3 Inflow=0.00191 m^3/s 28.3 m^3
Discarded=0.00025 m^3/s 8.0 m^3 Primary=0.00066 m^3/s 18.9 m^3 Outflow=0.00090 m^3/s 26.9 m^3

Pond 125P: 2m x 14m Soakpit Peak Elev=10.792 m Storage=7.3 m^3 Inflow=0.00238 m^3/s 35.4 m^3
Discarded=0.00031 m^3/s 10.2 m^3 Primary=0.00081 m^3/s 23.3 m^3 Outflow=0.00112 m^3/s 33.6 m^3

Summary for Subcatchment 25: 25m² Impervious

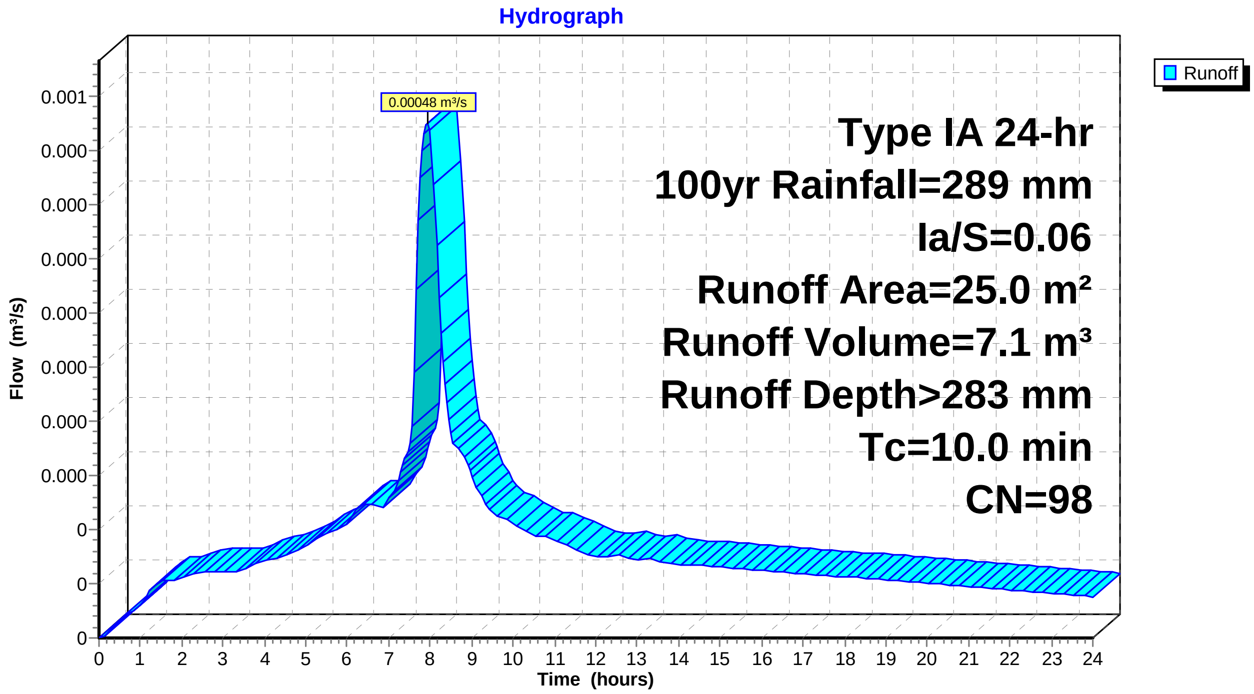
Runoff = 0.00048 m³/s @ 7.94 hrs, Volume= 7.1 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
25.0	98	Paved parking, HSG D
25.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 25: 25m² Impervious



Summary for Subcatchment 50: 50m² Impervious

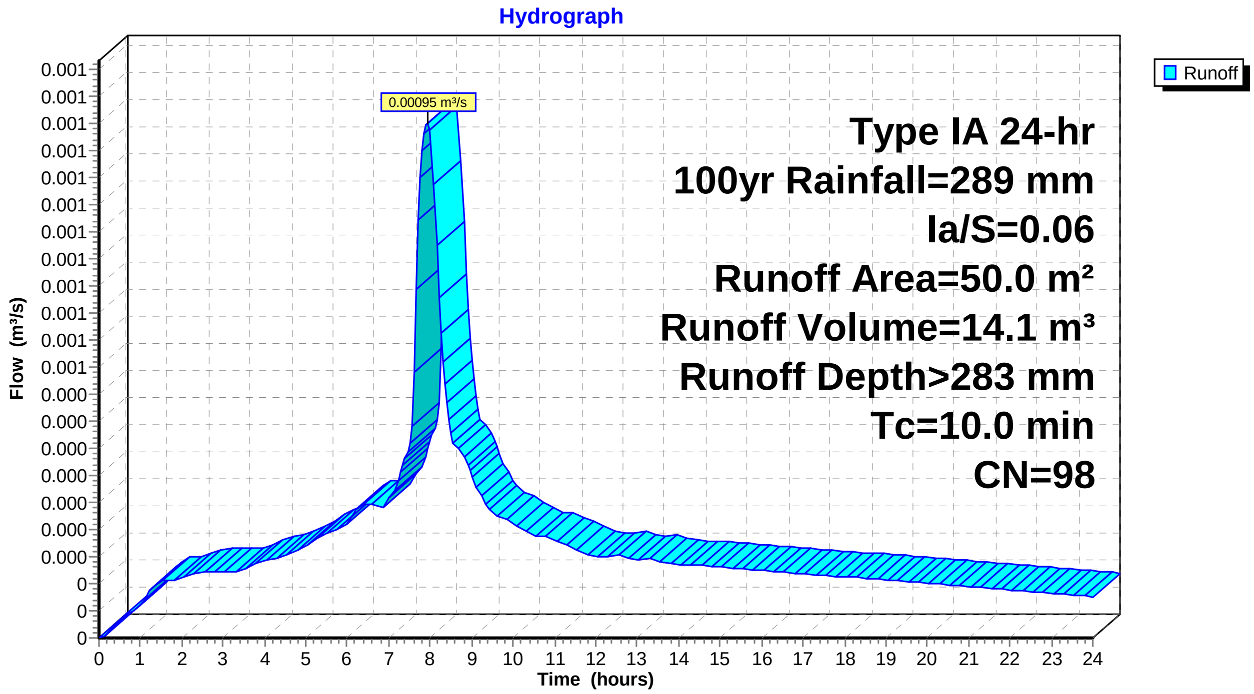
Runoff = 0.00095 m³/s @ 7.94 hrs, Volume= 14.1 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
50.0	98	Paved parking, HSG D
50.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 50: 50m² Impervious



Summary for Subcatchment 75: 75m² Impervious

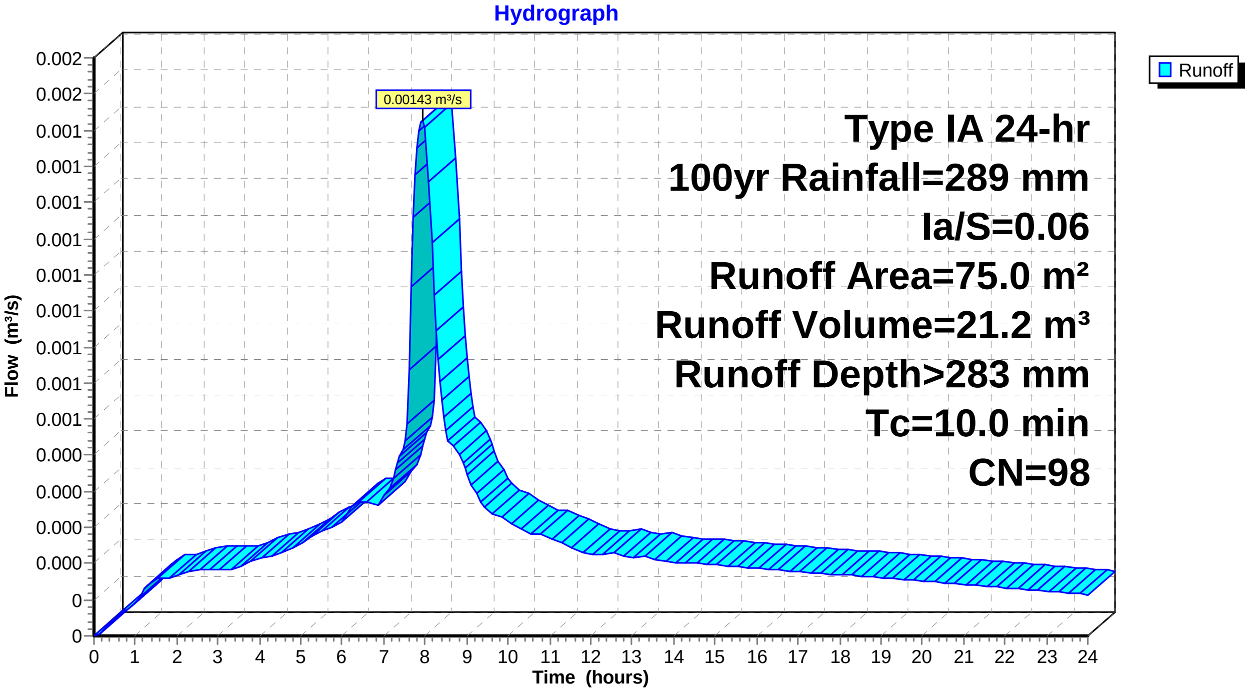
Runoff = 0.00143 m³/s @ 7.94 hrs, Volume= 21.2 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
75.0	98	Paved parking, HSG D
75.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 75: 75m² Impervious



Summary for Subcatchment 100: 100m² Impervious

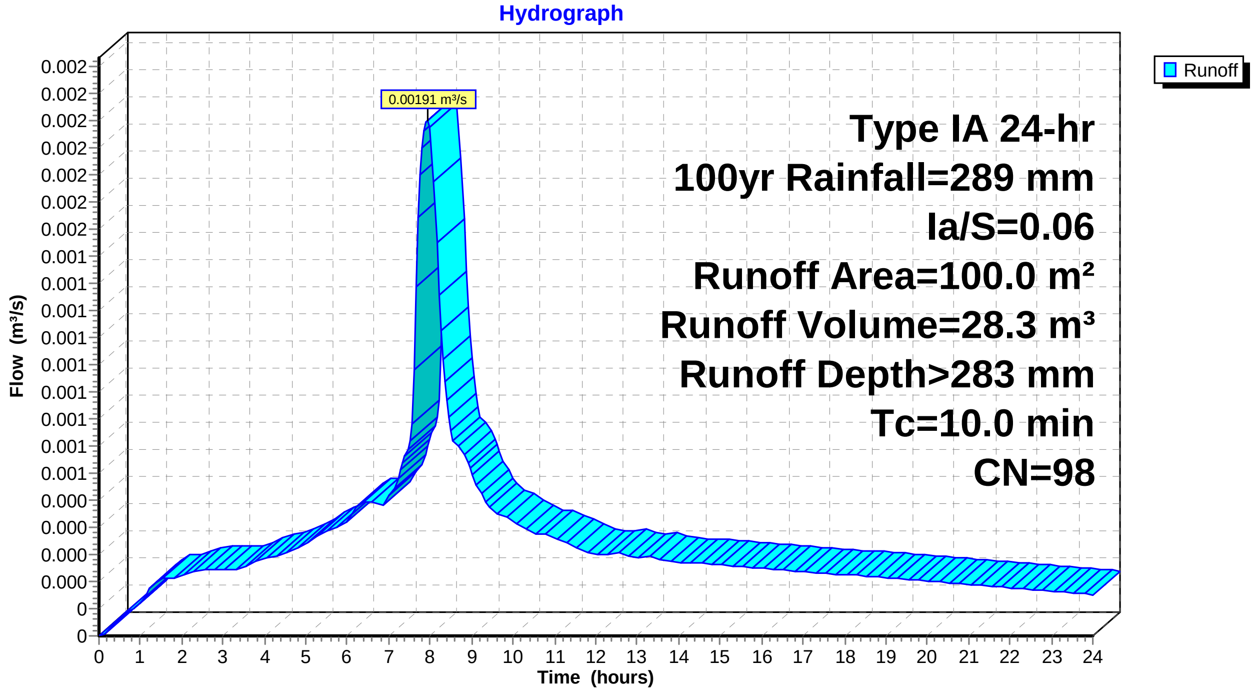
Runoff = 0.00191 m³/s @ 7.94 hrs, Volume= 28.3 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
100.0	98	Paved parking, HSG D
100.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 100: 100m² Impervious



Summary for Subcatchment 125: 125m² Impervious

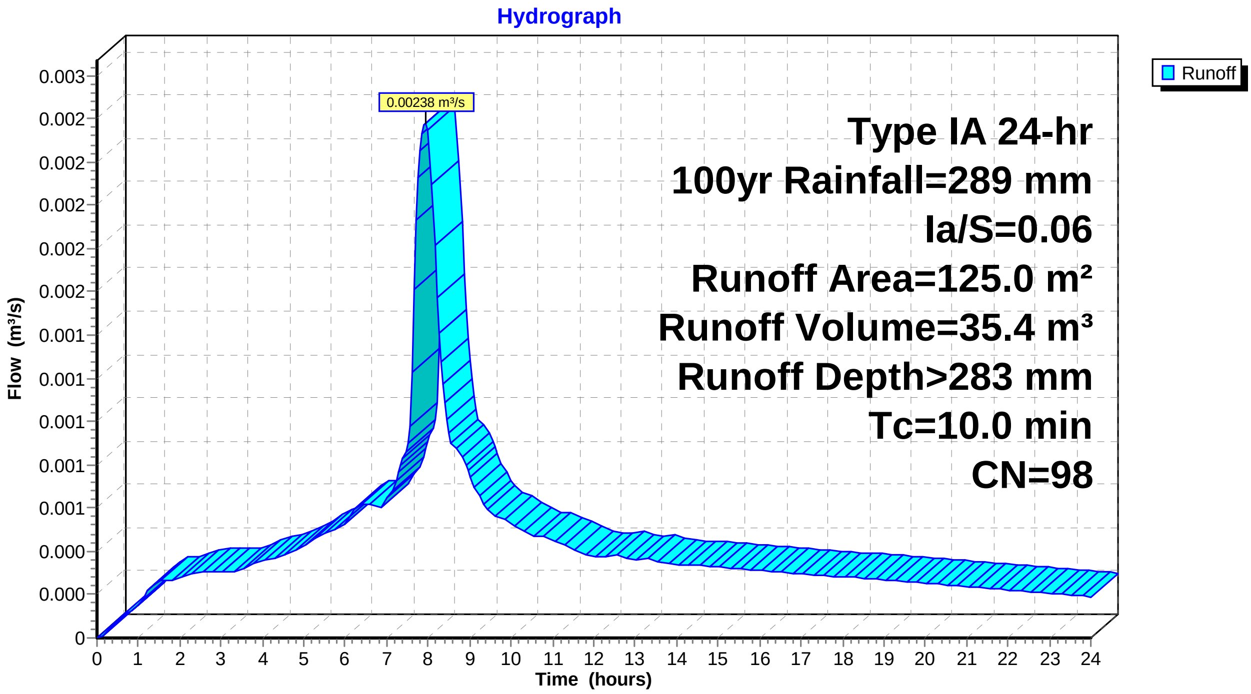
Runoff = 0.00238 m³/s @ 7.94 hrs, Volume= 35.4 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
125.0	98	Paved parking, HSG D
125.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 125: 125m² Impervious



Summary for Pond 25P: 1m x 6m Soakpit

Inflow Area = 25.0 m^2,100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00048 m^3/s @ 7.94 hrs, Volume= 7.1 m^3
Outflow = 0.00027 m^3/s @ 8.27 hrs, Volume= 6.4 m^3, Atten= 44%, Lag= 20.2 min
Discarded = 0.00014 m^3/s @ 8.27 hrs, Volume= 5.4 m^3
Primary = 0.00013 m^3/s @ 8.27 hrs, Volume= 1.0 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.791 m @ 8.27 hrs Surf.Area= 6.0 m^2 Storage= 1.6 m^3

Plug-Flow detention time= 163.4 min calculated for 6.4 m^3 (91% of inflow)
Center-of-Mass det. time= 98.1 min (741.2 - 643.1)

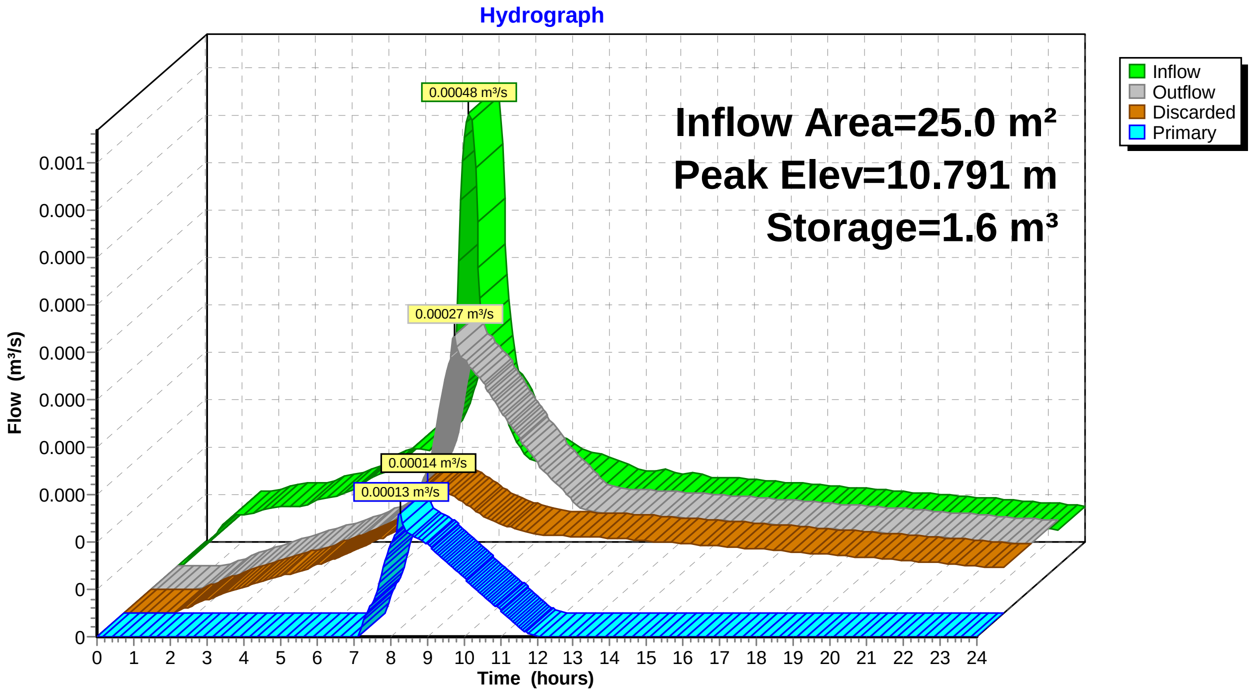
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	1.6 m^3	**1.00 mW x 6.00 mL x 0.80 mH Prismatoid** 4.8 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Device 1	10.500 m	**10 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 6.7 m^2
#4	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00014 m^3/s @ 8.27 hrs HW=10.791 m (Free Discharge)
└─**3=Exfiltration** (Controls 0.00014 m^3/s)

Primary OutFlow Max=0.00012 m^3/s @ 8.27 hrs HW=10.791 m (Free Discharge)
└─**1=Culvert** (Passes 0.00012 m^3/s of 0.01088 m^3/s potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.00011 m^3/s @ 1.42 m/s)
  └─**4=Orifice/Grate** (Weir Controls 0.00001 m^3/s @ 0.05 m/s)

Pond 25P: 1m x 6m Soakpit



Summary for Pond 50P: 1m x 10m Soakpit

Inflow Area = 50.0 m^2,100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00095 m^3/s @ 7.94 hrs, Volume= 14.1 m^3
Outflow = 0.00047 m^3/s @ 8.35 hrs, Volume= 13.7 m^3, Atten= 50%, Lag= 24.7 min
Discarded = 0.00020 m^3/s @ 8.35 hrs, Volume= 5.3 m^3
Primary = 0.00027 m^3/s @ 8.35 hrs, Volume= 8.3 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.740 m @ 8.35 hrs Surf.Area= 10.0 m^2 Storage= 2.4 m^3

Plug-Flow detention time= 91.3 min calculated for 13.7 m^3 (97% of inflow)
Center-of-Mass det. time= 66.2 min (709.3 - 643.1)

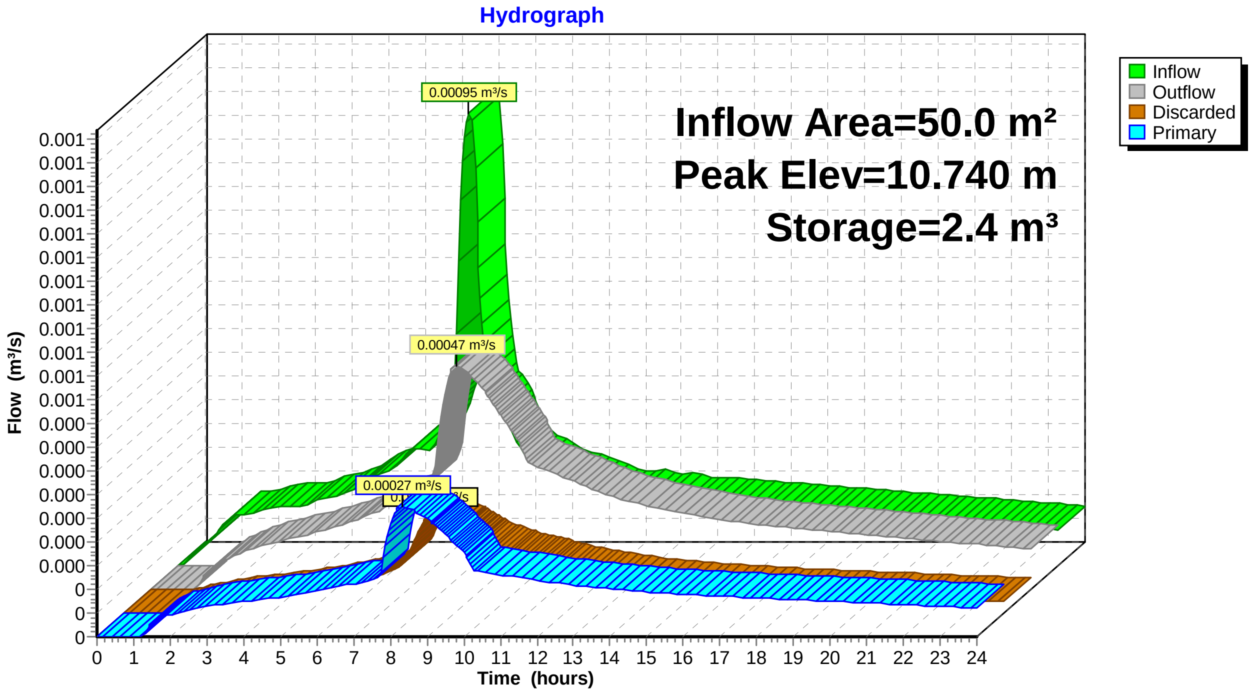
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	2.6 m^3	**1.00 mW x 10.00 mL x 0.80 mH Prismatoid** 8.0 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Primary	10.050 m	**10 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**10 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 11.1 m^2
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00020 m^3/s @ 8.35 hrs HW=10.740 m (Free Discharge)
└─**4=Exfiltration** (Controls 0.00020 m^3/s)

Primary OutFlow Max=0.00027 m^3/s @ 8.35 hrs HW=10.740 m (Free Discharge)
├─**1=Culvert** (Passes 0.00010 m^3/s of 0.01075 m^3/s potential flow)
│ ├─**3=Orifice/Grate** (Orifice Controls 0.00010 m^3/s @ 1.29 m/s)
│ └─**5=Orifice/Grate** (Controls 0.00000 m^3/s)
└─**2=Orifice/Grate** (Orifice Controls 0.00017 m^3/s @ 2.20 m/s)

Pond 50P: 1m x 10m Soakpit



Summary for Pond 75P: 1m x 14m Soakpit

Inflow Area = 75.0 m^2,100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00143 m^3/s @ 7.94 hrs, Volume= 21.2 m^3
Outflow = 0.00075 m^3/s @ 8.32 hrs, Volume= 20.5 m^3, Atten= 48%, Lag= 22.6 min
Discarded = 0.00028 m^3/s @ 8.32 hrs, Volume= 7.7 m^3
Primary = 0.00047 m^3/s @ 8.32 hrs, Volume= 12.8 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.773 m @ 8.32 hrs Surf.Area= 14.0 m^2 Storage= 3.6 m^3

Plug-Flow detention time= 89.6 min calculated for 20.5 m^3 (97% of inflow)
Center-of-Mass det. time= 64.7 min (707.7 - 643.1)

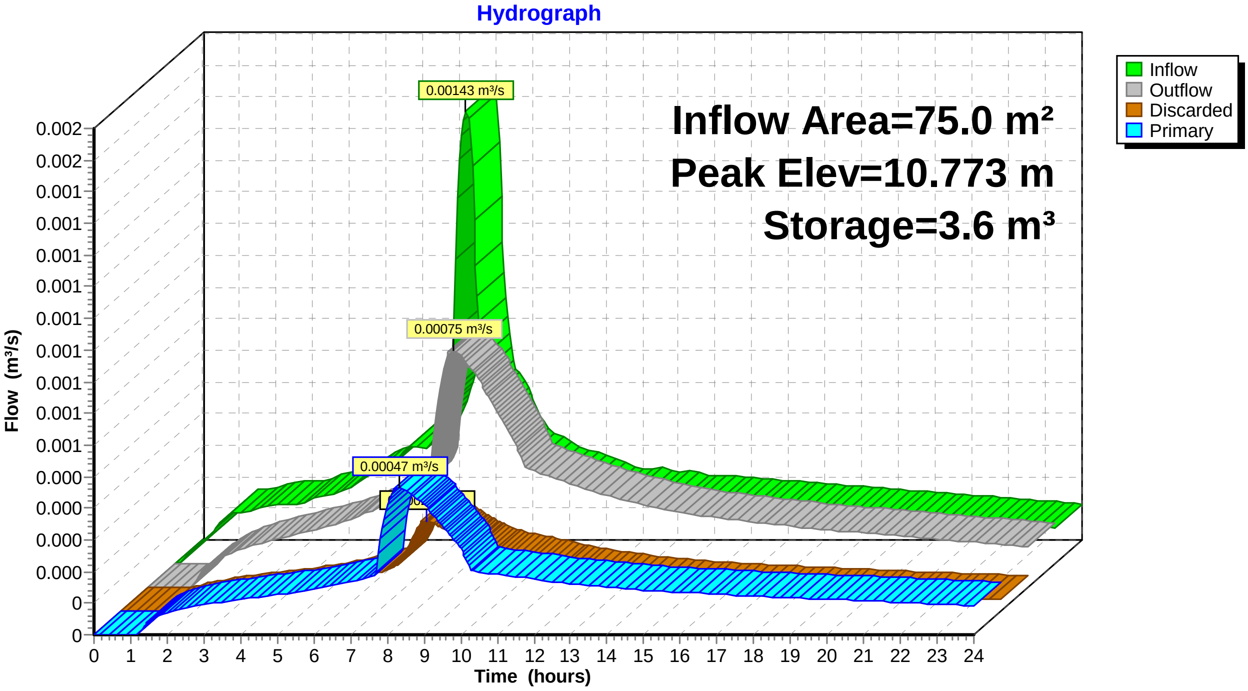
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	3.7 m^3	**1.00 mW x 14.00 mL x 0.80 mH Prismatoid** 11.2 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Primary	10.050 m	**12 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**14 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 15.5 m^2
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00028 m^3/s @ 8.32 hrs HW=10.773 m (Free Discharge)
└─**4=Exfiltration** (Controls 0.00028 m^3/s)

Primary OutFlow Max=0.00047 m^3/s @ 8.32 hrs HW=10.773 m (Free Discharge)
├─**1=Culvert** (Passes 0.00021 m^3/s of 0.01084 m^3/s potential flow)
│ ├─**3=Orifice/Grate** (Orifice Controls 0.00021 m^3/s @ 1.37 m/s)
│ └─**5=Orifice/Grate** (Controls 0.00000 m^3/s)
└─**2=Orifice/Grate** (Orifice Controls 0.00025 m^3/s @ 2.25 m/s)

Pond 75P: 1m x 14m Soakpit



Summary for Pond 100P: 2m x 12m Soakpit

Inflow Area = 100.0 m^2,100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00191 m^3/s @ 7.94 hrs, Volume= 28.3 m^3
Outflow = 0.00090 m^3/s @ 8.38 hrs, Volume= 26.9 m^3, Atten= 53%, Lag= 26.3 min
Discarded = 0.00025 m^3/s @ 8.38 hrs, Volume= 8.0 m^3
Primary = 0.00066 m^3/s @ 8.38 hrs, Volume= 18.9 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.726 m @ 8.38 hrs Surf.Area= 24.0 m^2 Storage= 5.7 m^3

Plug-Flow detention time= 126.5 min calculated for 26.9 m^3 (95% of inflow)
Center-of-Mass det. time= 89.3 min (732.4 - 643.1)

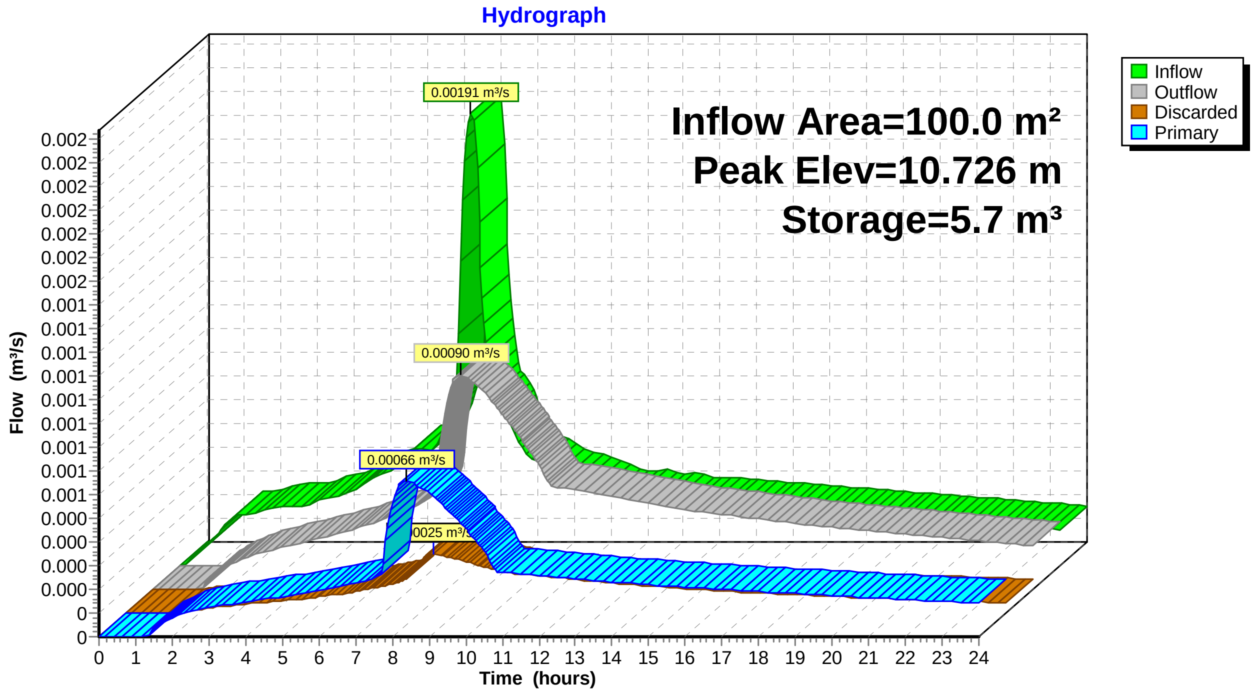
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	6.3 m^3	**2.00 mW x 12.00 mL x 0.80 mH Prismatoid** 19.2 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Primary	10.050 m	**14 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**18 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 25.4 m^2
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00025 m^3/s @ 8.38 hrs HW=10.726 m (Free Discharge)
4=Exfiltration (Controls 0.00025 m^3/s)

Primary OutFlow Max=0.00066 m^3/s @ 8.38 hrs HW=10.726 m (Free Discharge)
1=Culvert (Passes 0.00032 m^3/s of 0.01071 m^3/s potential flow)
  3=Orifice/Grate (Orifice Controls 0.00032 m^3/s @ 1.26 m/s)
  5=Orifice/Grate (Controls 0.00000 m^3/s)
2=Orifice/Grate (Orifice Controls 0.00033 m^3/s @ 2.17 m/s)

Pond 100P: 2m x 12m Soakpit



Summary for Pond 125P: 2m x 14m Soakpit

Inflow Area = 125.0 m^2,100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00238 m^3/s @ 7.94 hrs, Volume= 35.4 m^3
Outflow = 0.00112 m^3/s @ 8.38 hrs, Volume= 33.6 m^3, Atten= 53%, Lag= 26.8 min
Discarded = 0.00031 m^3/s @ 8.38 hrs, Volume= 10.2 m^3
Primary = 0.00081 m^3/s @ 8.38 hrs, Volume= 23.3 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.792 m @ 8.38 hrs Surf.Area= 28.0 m^2 Storage= 7.3 m^3

Plug-Flow detention time= 129.2 min calculated for 33.6 m^3 (95% of inflow)
Center-of-Mass det. time= 90.5 min (733.6 - 643.1)

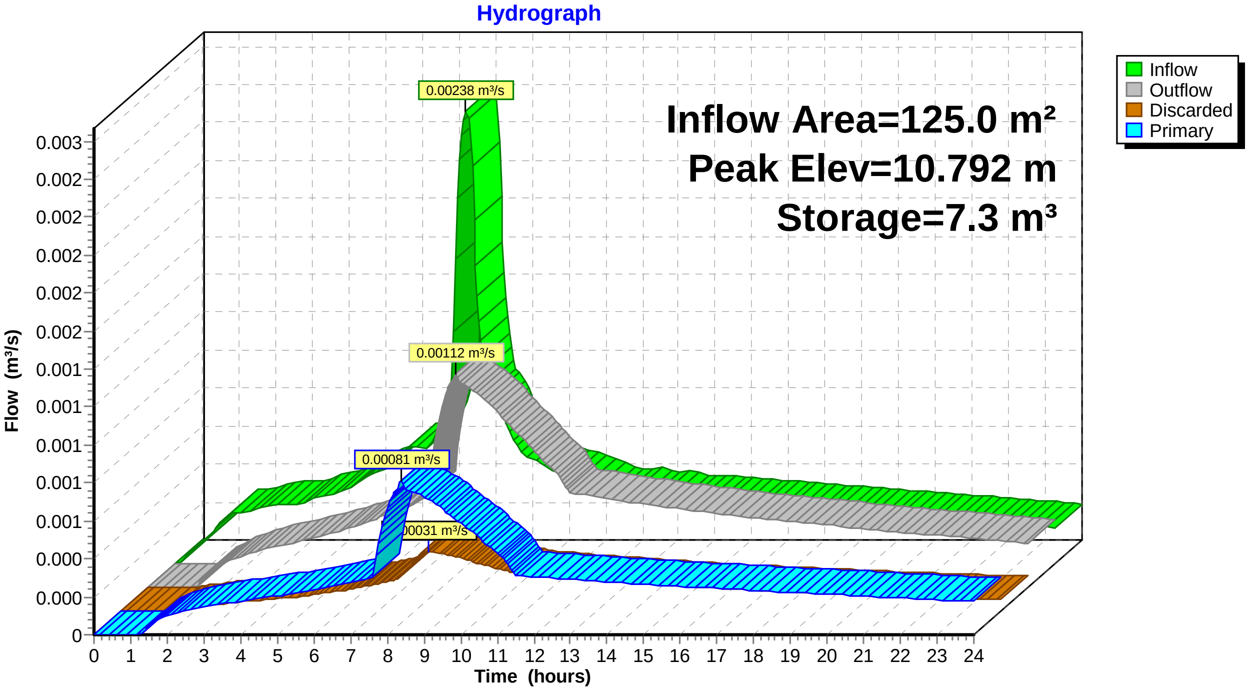
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	7.4 m^3	**2.00 mW x 14.00 mL x 0.80 mH Prismatoid** 22.4 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Primary	10.050 m	**15 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**18 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 29.6 m^2
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00031 m^3/s @ 8.38 hrs HW=10.792 m (Free Discharge)
└—**4=Exfiltration** (Controls 0.00031 m^3/s)

Primary OutFlow Max=0.00080 m^3/s @ 8.38 hrs HW=10.792 m (Free Discharge)
├—**1=Culvert** (Passes 0.00040 m^3/s of 0.01089 m^3/s potential flow)
│ ├—**3=Orifice/Grate** (Orifice Controls 0.00037 m^3/s @ 1.43 m/s)
│ └—**5=Orifice/Grate** (Weir Controls 0.00003 m^3/s @ 0.07 m/s)
└—**2=Orifice/Grate** (Orifice Controls 0.00040 m^3/s @ 2.28 m/s)

Pond 125P: 2m x 14m Soakpit



Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (mm)	AMC
1	5yr	Type IA 24-hr		Default	24.00	1	162	2
2	100yr	Type IA 24-hr		Default	24.00	1	289	2

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 150: 150m^2 Runoff Area=150.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00160 m^3/s 23.4 m^3

Subcatchment 175: 175m^2 Runoff Area=175.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00186 m^3/s 27.3 m^3

Subcatchment 200: 200m^2 Runoff Area=200.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00213 m^3/s 31.3 m^3

Subcatchment 225: 225m^2 Runoff Area=225.0 m^2 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00239 m^3/s 35.2 m^3

Pond 150P: 2m x 18m Soakpit Peak Elev=10.455 m Storage=5.4 m^3 Inflow=0.00160 m^3/s 23.4 m^3
Discarded=0.00021 m^3/s 6.5 m^3 Primary=0.00034 m^3/s 15.6 m^3 Outflow=0.00054 m^3/s 22.1 m^3

Pond 175P: 2m x 20m Soakpit Peak Elev=10.456 m Storage=6.0 m^3 Inflow=0.00186 m^3/s 27.3 m^3
Discarded=0.00023 m^3/s 6.9 m^3 Primary=0.00043 m^3/s 19.1 m^3 Outflow=0.00066 m^3/s 26.0 m^3

Pond 200P: 2m x 22m Soakpit Peak Elev=10.453 m Storage=6.6 m^3 Inflow=0.00213 m^3/s 31.3 m^3
Discarded=0.00025 m^3/s 7.1 m^3 Primary=0.00052 m^3/s 22.7 m^3 Outflow=0.00077 m^3/s 29.8 m^3

Pond 225P: 2m x 26m Soakpit Peak Elev=10.463 m Storage=7.9 m^3 Inflow=0.00239 m^3/s 35.2 m^3
Discarded=0.00030 m^3/s 9.1 m^3 Primary=0.00053 m^3/s 24.2 m^3 Outflow=0.00083 m^3/s 33.3 m^3

Summary for Subcatchment 150: 150m² Impervious

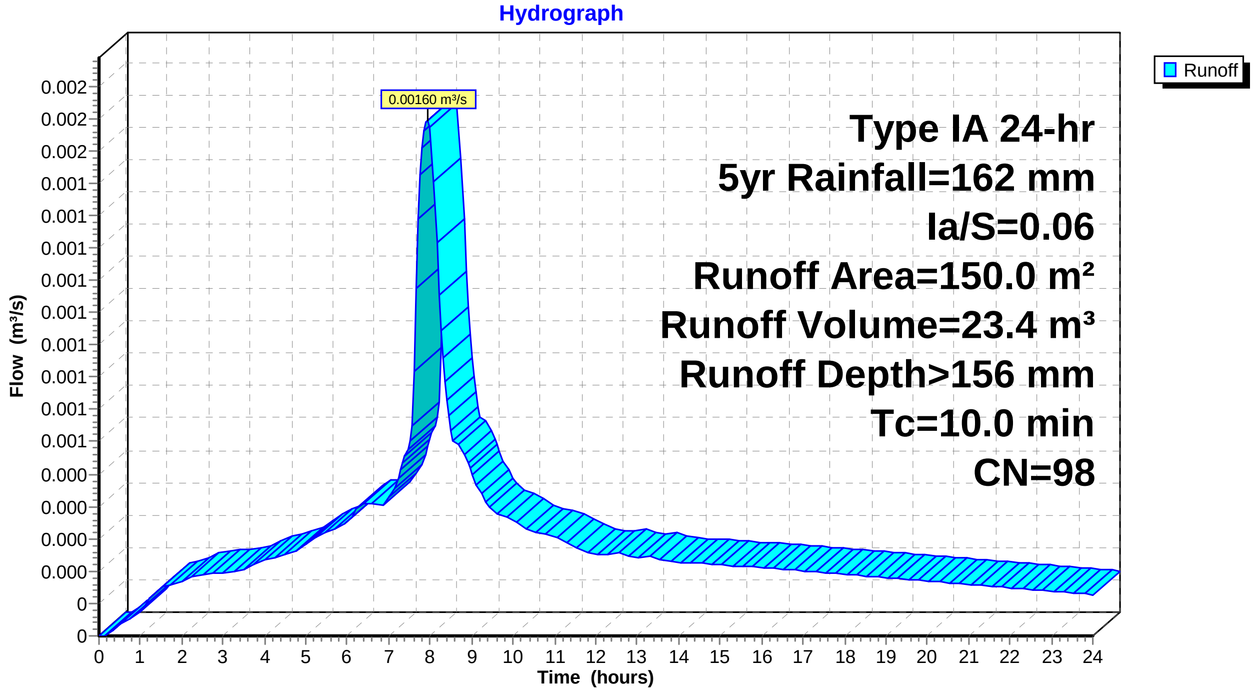
Runoff = 0.00160 m³/s @ 7.94 hrs, Volume= 23.4 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
150.0	98	Paved parking, HSG D
150.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 150: 150m² Impervious



Summary for Subcatchment 175: 175m² Impervious

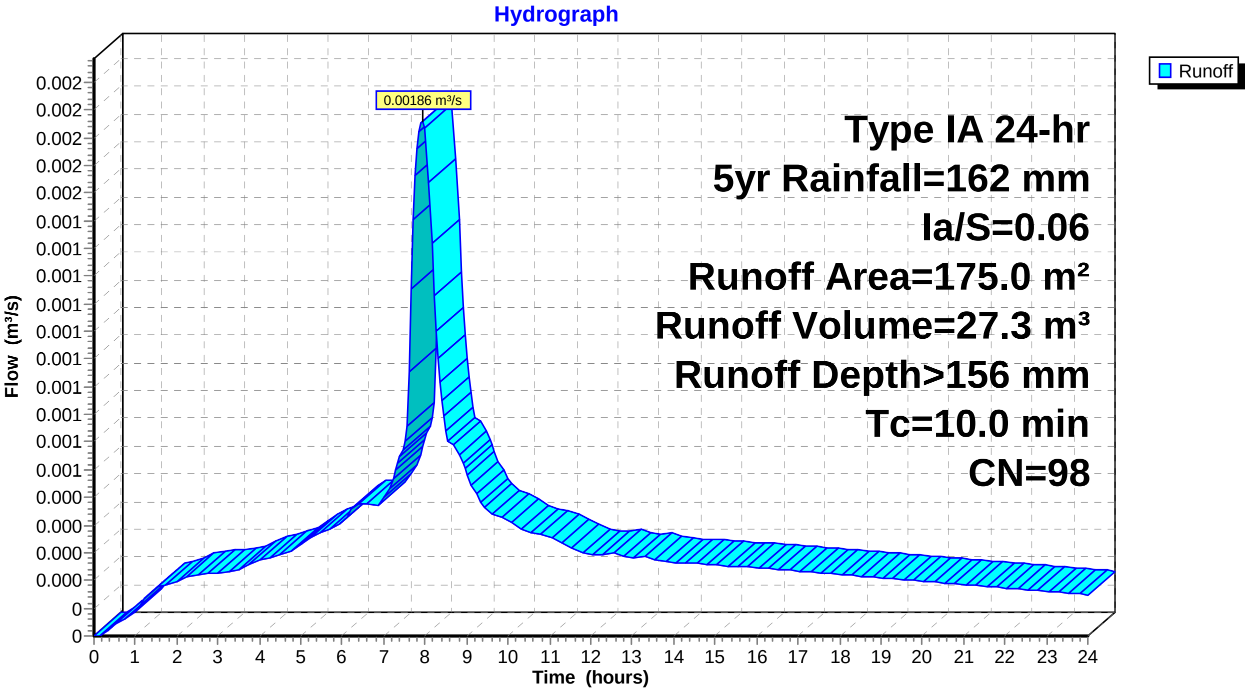
Runoff = 0.00186 m³/s @ 7.94 hrs, Volume= 27.3 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
175.0	98	Paved parking, HSG D
175.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 175: 175m² Impervious



Summary for Subcatchment 200: 200m² Impervious

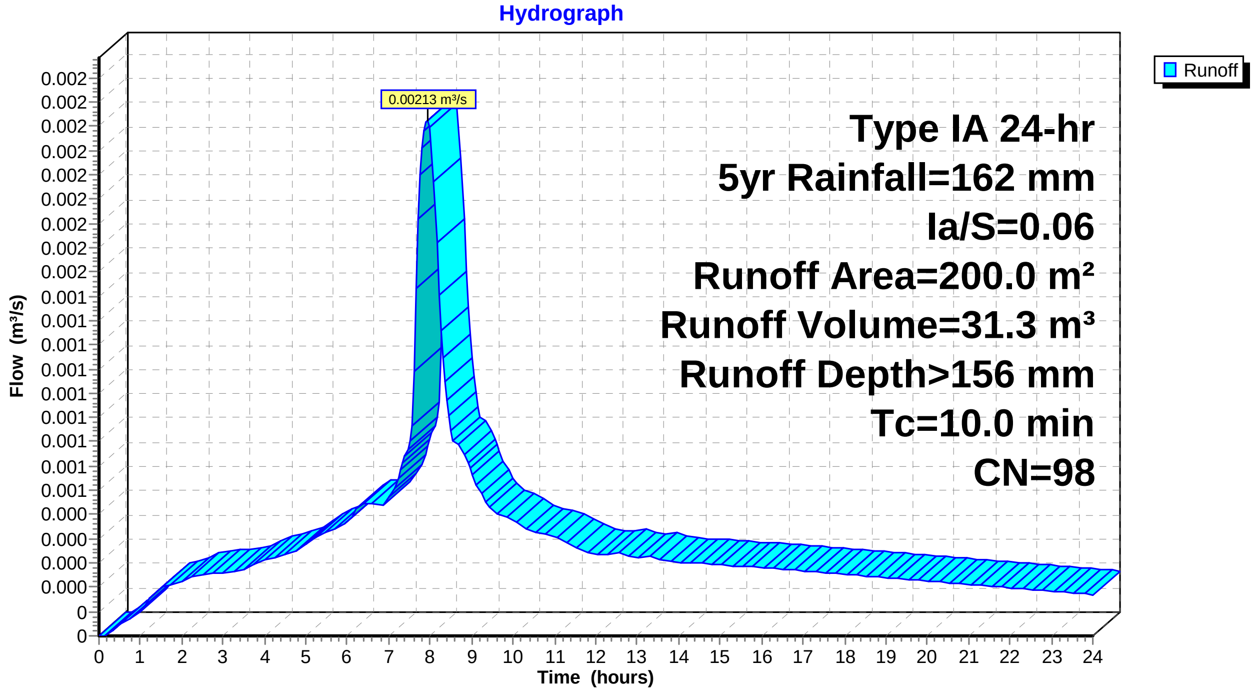
Runoff = 0.00213 m³/s @ 7.94 hrs, Volume= 31.3 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
200.0	98	Paved parking, HSG D
200.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 200: 200m² Impervious



Summary for Subcatchment 225: 225m² Impervious

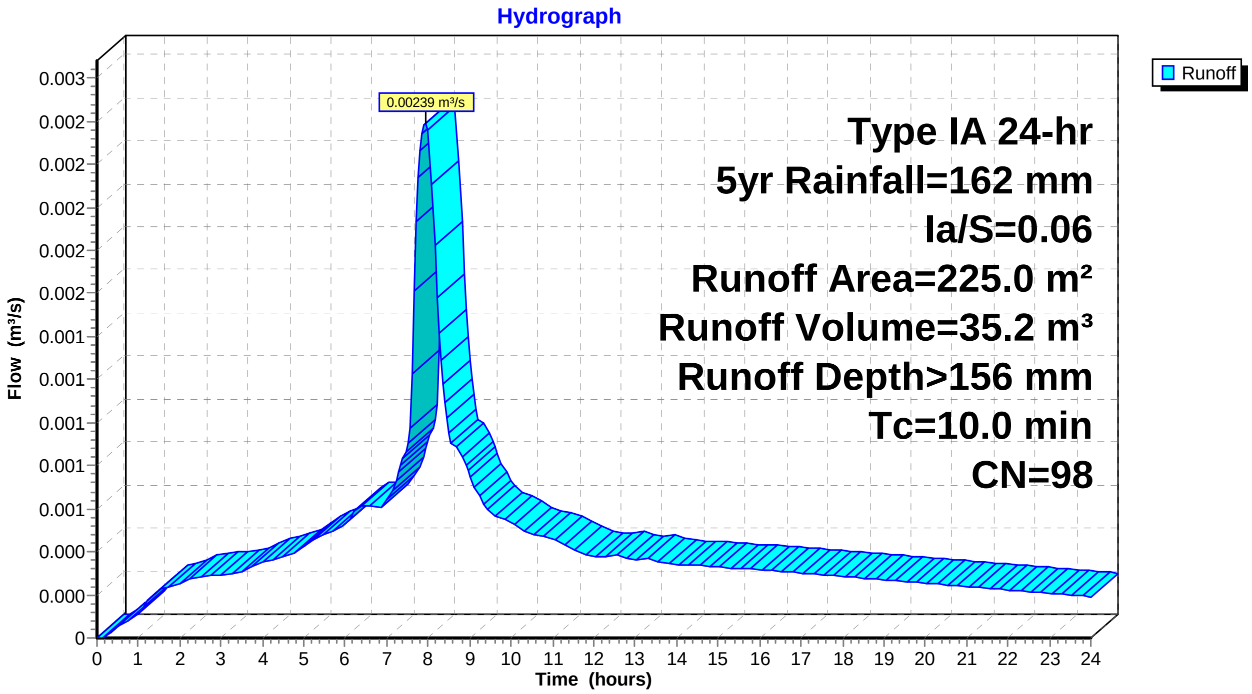
Runoff = 0.00239 m³/s @ 7.94 hrs, Volume= 35.2 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
225.0	98	Paved parking, HSG D
225.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

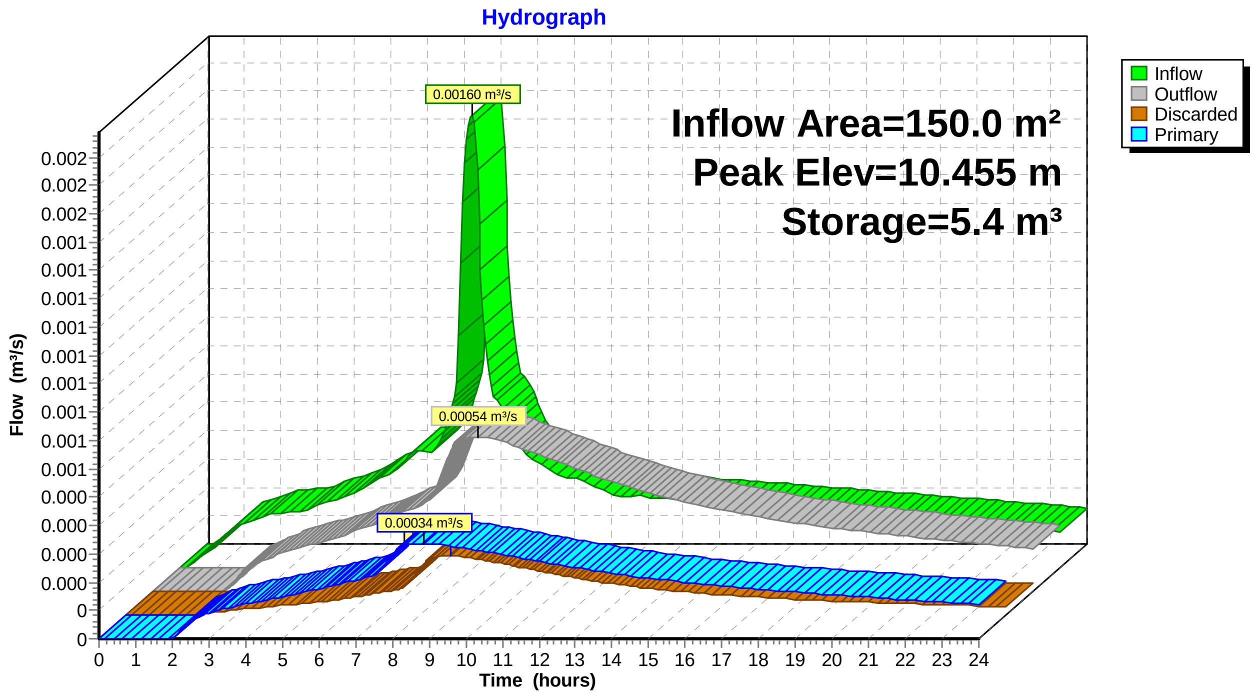
Subcatchment 225: 225m² Impervious



Summary for Pond 150P: 2m x 18m Soakpit

```
Inflow Area =            150.0 m²,100.00% Impervious,  Inflow Depth >    156 mm    for  5yr event
Inflow      =     0.00160 m³/s @    7.94 hrs,  Volume=            23.4 m³
Outflow     =     0.00054 m³/s @    8.87 hrs,  Volume=            22.1 m³,  Atten= 66%,  Lag= 56.2 min
Discarded  =      0.00021 m³/s @    8.87 hrs,  Volume=             6.5 m³
Primary     =     0.00034 m³/s @    8.87 hrs,  Volume=            15.6 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.455 m @ 8.87 hrs   Surf.Area= 36.0 m²   Storage= 5.4 m³

Plug-Flow detention time= 146.6 min calculated for 22.1 m³ (94% of inflow)
Center-of-Mass det. time= 104.9 min ( 754.5 - 649.6 )

Volume       Invert     Avail.Storage   Storage Description
  #1       10.000 m            9.5 m³   2.00 mW x 18.00 mL x 0.80 mH Prismatoid
                                        28.8 m³ Overall  x 33.0% Voids

Device   Routing          Invert   Outlet Devices
   #1    Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Primary        10.050 m   16 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #3    Device 1       10.500 m   20 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #4    Discarded      10.050 m   45.00 mm/hr Exfiltration over Wetted area above 10.050 m
                                   Conductivity to Groundwater Elevation = 3.000 m
                                   Excluded Wetted area = 38.0 m²
   #5    Device 1       10.790 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Discarded OutFlow  Max=0.00021 m³/s @ 8.87 hrs  HW=10.455 m   (Free Discharge)
└─4=Exfiltration  ( Controls 0.00021 m³/s)

Primary OutFlow  Max=0.00034 m³/s @ 8.87 hrs  HW=10.455 m   (Free Discharge)
├─1=Culvert  (Passes 0.00000 m³/s of 0.00997 m³/s potential flow)
│ ├─3=Orifice/Grate  ( Controls 0.00000 m³/s)
│ └─5=Orifice/Grate  ( Controls 0.00000 m³/s)
└─2=Orifice/Grate  (Orifice Controls 0.00034 m³/s @ 1.67 m/s)
```

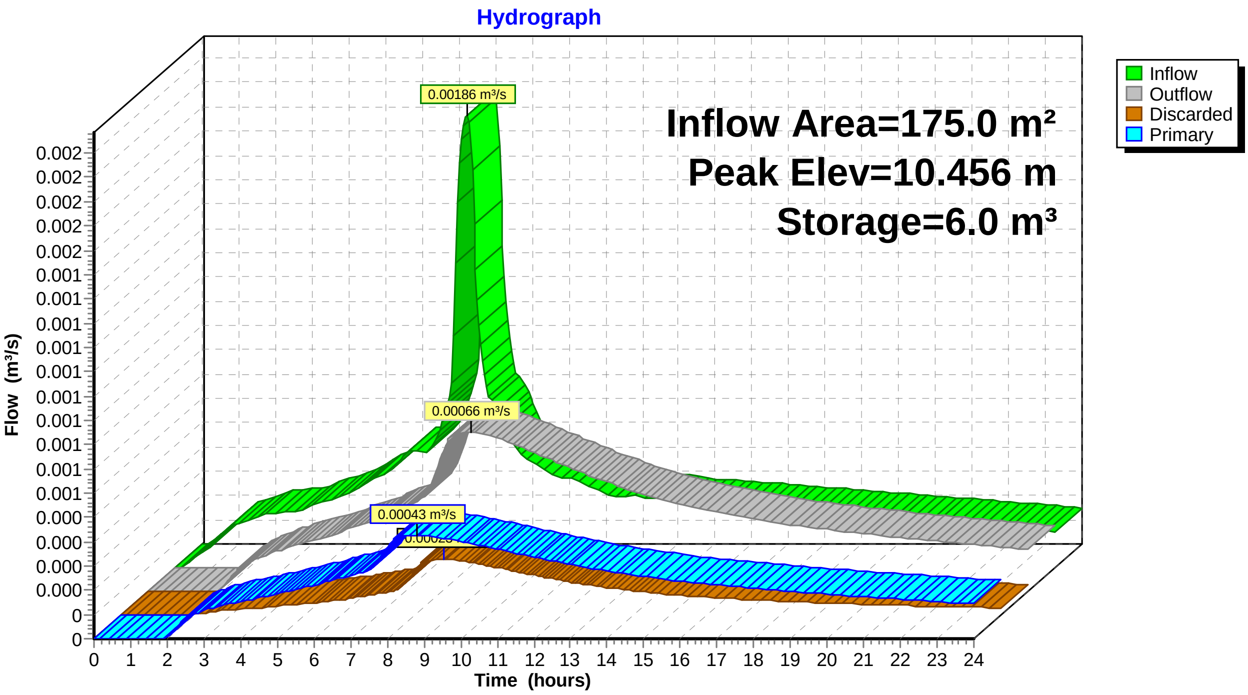
Pond 150P: 2m x 18m Soakpit



Summary for Pond 175P: 2m x 20m Soakpit

```
Inflow Area =            175.0 m²,100.00% Impervious,  Inflow Depth >    156 mm    for  5yr event
Inflow      =      0.00186 m³/s @     7.94 hrs,  Volume=              27.3 m³
Outflow     =      0.00066 m³/s @     8.82 hrs,  Volume=              26.0 m³,  Atten= 65%,  Lag= 52.9 min
Discarded   =      0.00023 m³/s @     8.82 hrs,  Volume=               6.9 m³
Primary     =      0.00043 m³/s @     8.82 hrs,  Volume=              19.1 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.456 m @ 8.82 hrs   Surf.Area= 40.0 m²   Storage= 6.0 m³

Plug-Flow detention time= 134.6 min calculated for 25.9 m³ (95% of inflow)
Center-of-Mass det. time= 96.8 min ( 746.4 - 649.6 )

Volume      Invert     Avail.Storage  Storage Description
   #1     10.000 m          10.6 m³   2.00 mW x 20.00 mL x 0.80 mH Prismatoid
                                      32.0 m³ Overall  x 33.0% Voids

Device   Routing         Invert   Outlet Devices
    #1   Primary        9.000 m   100 mm  Round Culvert
                                  L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                  Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                  0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
    #2   Primary       10.050 m   18 mm Vert. Orifice/Grate    C= 0.600
                                  Limited to weir flow at low heads
    #3   Device 1      10.500 m   20 mm Horiz. Orifice/Grate    C= 0.600
                                  Limited to weir flow at low heads
    #4   Discarded     10.050 m   45.00 mm/hr Exfiltration over Wetted area above 10.050 m
                                  Conductivity to Groundwater Elevation = 3.000 m
                                  Excluded Wetted area = 42.2 m²
    #5   Device 1      10.790 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                  Limited to weir flow at low heads

Discarded OutFlow  Max=0.00023 m³/s @ 8.82 hrs  HW=10.456 m   (Free Discharge)
↑─4=Exfiltration  ( Controls 0.00023 m³/s)

Primary OutFlow  Max=0.00043 m³/s @ 8.82 hrs  HW=10.456 m   (Free Discharge)
↑─1=Culvert  (Passes 0.00000 m³/s of 0.00997 m³/s potential flow)
│  ↑─3=Orifice/Grate  ( Controls 0.00000 m³/s)
│  └─5=Orifice/Grate  ( Controls 0.00000 m³/s)
└─2=Orifice/Grate  (Orifice Controls 0.00043 m³/s @ 1.67 m/s)
```

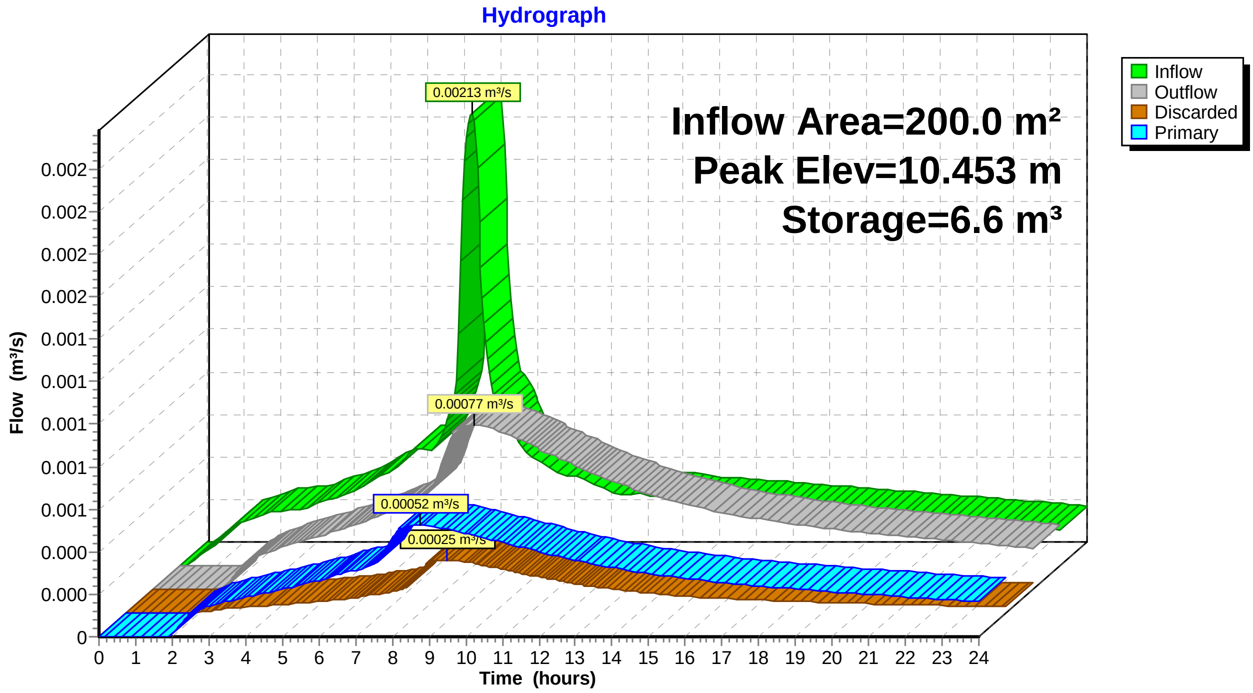
Pond 175P: 2m x 20m Soakpit



Summary for Pond 200P: 2m x 22m Soakpit

```
Inflow Area =          200.0 m²,100.00% Impervious,  Inflow Depth >   156 mm    for  5yr event
Inflow      =     0.00213 m³/s @    7.94 hrs,  Volume=            31.3 m³
Outflow     =     0.00077 m³/s @    8.76 hrs,  Volume=            29.8 m³,  Atten= 64%,  Lag= 49.2 min
Discarded  =      0.00025 m³/s @    8.76 hrs,  Volume=             7.1 m³
Primary     =     0.00052 m³/s @    8.76 hrs,  Volume=            22.7 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.453 m @ 8.76 hrs   Surf.Area= 44.0 m²   Storage= 6.6 m³

Plug-Flow detention time= 124.1 min calculated for 29.8 m³ (95% of inflow)
Center-of-Mass det. time= 89.4 min ( 739.0 - 649.6 )

Volume        Invert    Avail.Storage   Storage Description
   #1     10.000 m          11.6 m³     2.00 mW x 22.00 mL x 0.80 mH Prismatoid
                                        35.2 m³ Overall  x 33.0% Voids

Device   Routing          Invert   Outlet Devices
   #1    Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Primary        10.050 m   20 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #3    Device 1       10.500 m   20 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #4    Discarded      10.050 m   45.00 mm/hr Exfiltration over Wetted area above 10.050 m
                                   Conductivity to Groundwater Elevation = 3.000 m
                                   Excluded Wetted area = 46.4 m²
   #5    Device 1       10.790 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Discarded OutFlow  Max=0.00025 m³/s @ 8.76 hrs  HW=10.453 m   (Free Discharge)
└─4=Exfiltration  ( Controls 0.00025 m³/s)

Primary OutFlow  Max=0.00052 m³/s @ 8.76 hrs  HW=10.453 m   (Free Discharge)
├─1=Culvert  (Passes 0.00000 m³/s of 0.00997 m³/s potential flow)
│  ├─3=Orifice/Grate  ( Controls 0.00000 m³/s)
│  └─5=Orifice/Grate  ( Controls 0.00000 m³/s)
└─2=Orifice/Grate  (Orifice Controls 0.00052 m³/s @ 1.67 m/s)
```

Pond 200P: 2m x 22m Soakpit



Summary for Pond 225P: 2m x 26m Soakpit

Inflow Area = 225.0 m^2,100.00% Impervious, Inflow Depth > 156 mm for 5yr event
Inflow = 0.00239 m^3/s @ 7.94 hrs, Volume= 35.2 m^3
Outflow = 0.00083 m^3/s @ 8.85 hrs, Volume= 33.3 m^3, Atten= 65%, Lag= 54.9 min
Discarded = 0.00030 m^3/s @ 8.85 hrs, Volume= 9.1 m^3
Primary = 0.00053 m^3/s @ 8.85 hrs, Volume= 24.2 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.463 m @ 8.85 hrs Surf.Area= 52.0 m^2 Storage= 7.9 m^3

Plug-Flow detention time= 141.1 min calculated for 33.2 m^3 (95% of inflow)
Center-of-Mass det. time= 101.2 min (750.9 - 649.6)

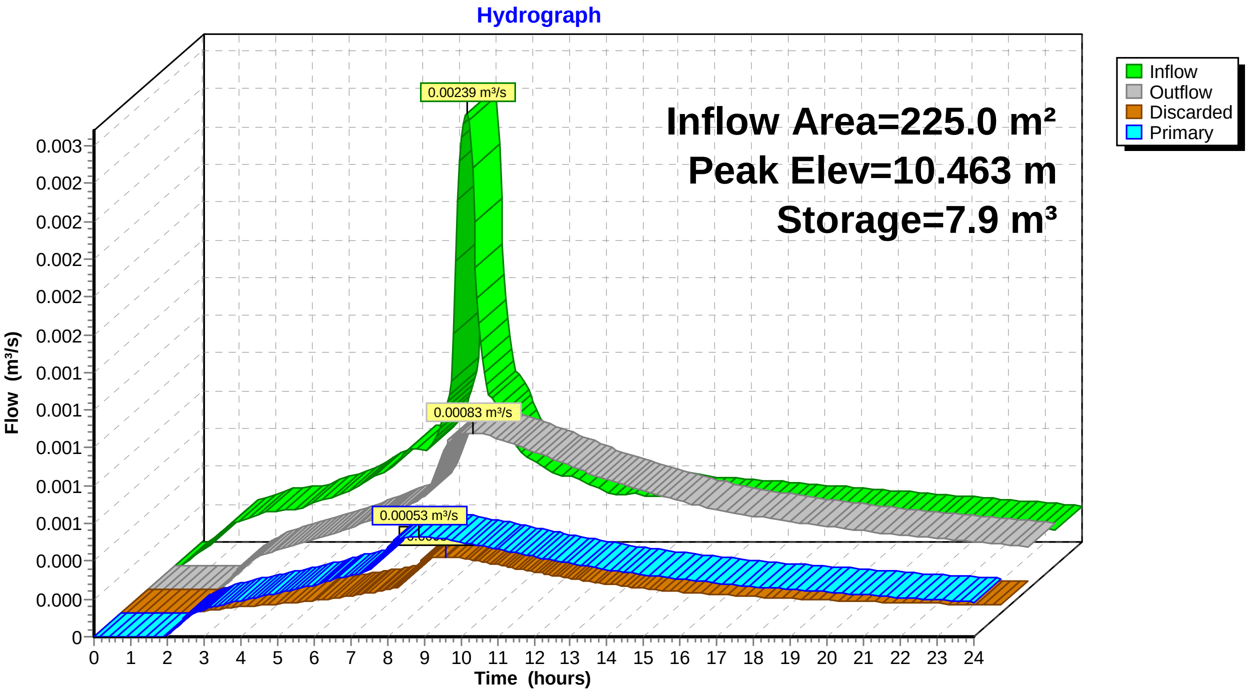
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	13.7 m^3	**2.00 mW x 26.00 mL x 0.80 mH Prismatoid** 41.6 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Primary	10.050 m	**20 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**22 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 54.8 m^2
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00030 m^3/s @ 8.85 hrs HW=10.463 m (Free Discharge)
└─**4=Exfiltration** (Controls 0.00030 m^3/s)

Primary OutFlow Max=0.00053 m^3/s @ 8.85 hrs HW=10.463 m (Free Discharge)
├─**1=Culvert** (Passes 0.00000 m^3/s of 0.00999 m^3/s potential flow)
│ ├─**3=Orifice/Grate** (Controls 0.00000 m^3/s)
│ └─**5=Orifice/Grate** (Controls 0.00000 m^3/s)
└─**2=Orifice/Grate** (Orifice Controls 0.00053 m^3/s @ 1.69 m/s)

Pond 225P: 2m x 26m Soakpit



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 150: 150m^2 Runoff Area=150.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00286 m^3/s 42.4 m^3

Subcatchment 175: 175m^2 Runoff Area=175.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00333 m^3/s 49.5 m^3

Subcatchment 200: 200m^2 Runoff Area=200.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00381 m^3/s 56.6 m^3

Subcatchment 225: 225m^2 Runoff Area=225.0 m^2 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00429 m^3/s 63.6 m^3

Pond 150P: 2m x 18m Soakpit Peak Elev=10.773 m Storage=9.2 m^3 Inflow=0.00286 m^3/s 42.4 m^3
Discarded=0.00038 m^3/s 13.0 m^3 Primary=0.00089 m^3/s 27.0 m^3 Outflow=0.00127 m^3/s 40.0 m^3

Pond 175P: 2m x 20m Soakpit Peak Elev=10.790 m Storage=10.4 m^3 Inflow=0.00333 m^3/s 49.5 m^3
Discarded=0.00043 m^3/s 14.0 m^3 Primary=0.00103 m^3/s 32.9 m^3 Outflow=0.00146 m^3/s 47.0 m^3

Pond 200P: 2m x 22m Soakpit Peak Elev=10.795 m Storage=11.5 m^3 Inflow=0.00381 m^3/s 56.6 m^3
Discarded=0.00047 m^3/s 14.9 m^3 Primary=0.00141 m^3/s 39.1 m^3 Outflow=0.00188 m^3/s 54.0 m^3

Pond 225P: 2m x 26m Soakpit Peak Elev=10.796 m Storage=13.7 m^3 Inflow=0.00429 m^3/s 63.6 m^3
Discarded=0.00055 m^3/s 18.6 m^3 Primary=0.00156 m^3/s 41.6 m^3 Outflow=0.00211 m^3/s 60.2 m^3

Summary for Subcatchment 150: 150m² Impervious

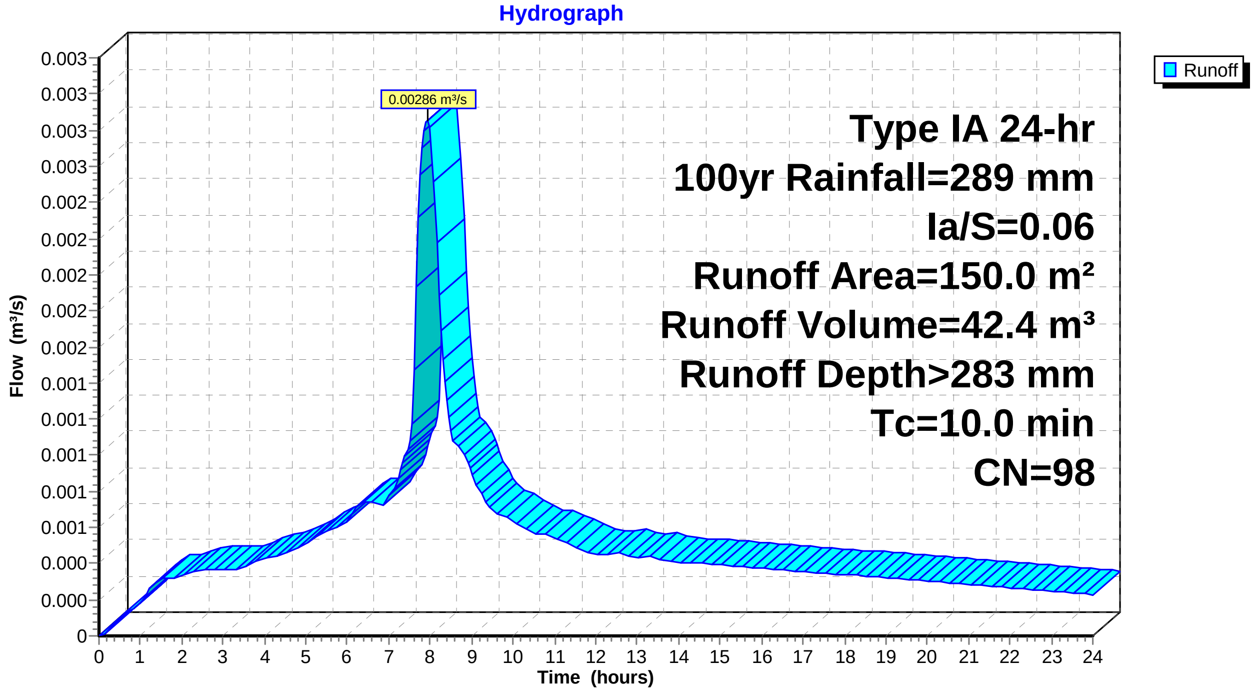
Runoff = 0.00286 m³/s @ 7.94 hrs, Volume= 42.4 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
150.0	98	Paved parking, HSG D
150.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 150: 150m² Impervious



Summary for Subcatchment 175: 175m² Impervious

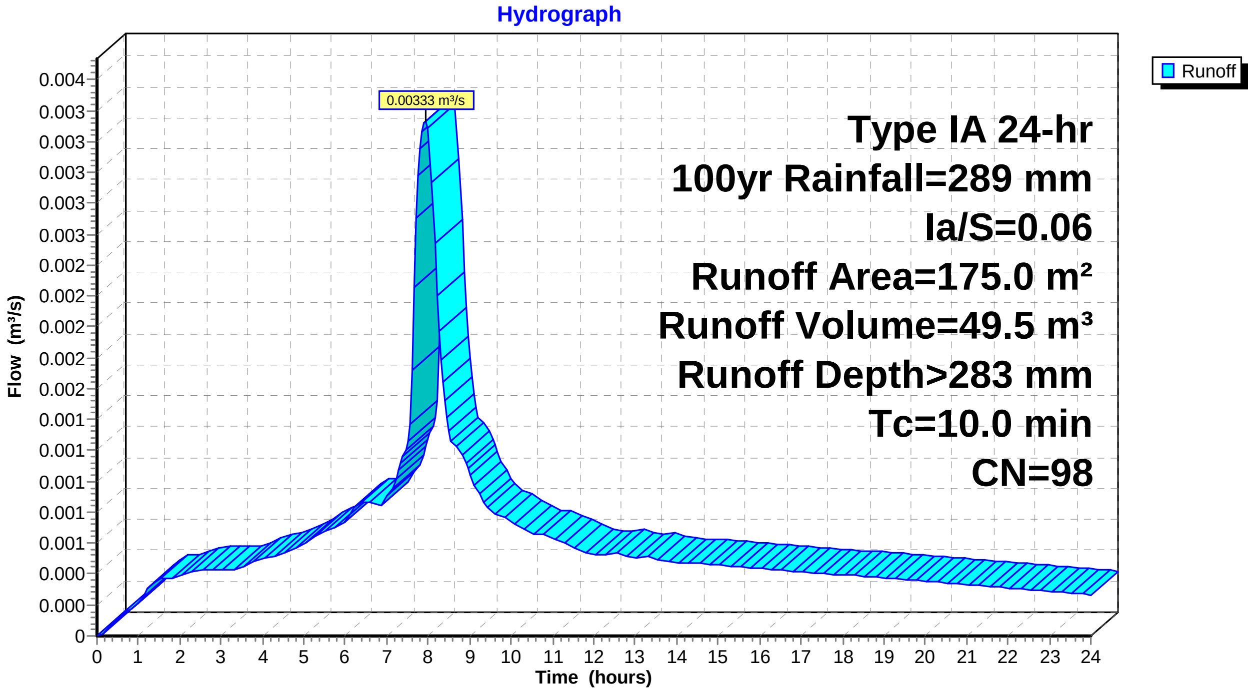
Runoff = 0.00333 m³/s @ 7.94 hrs, Volume= 49.5 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
175.0	98	Paved parking, HSG D
175.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 175: 175m² Impervious



Summary for Subcatchment 200: 200m² Impervious

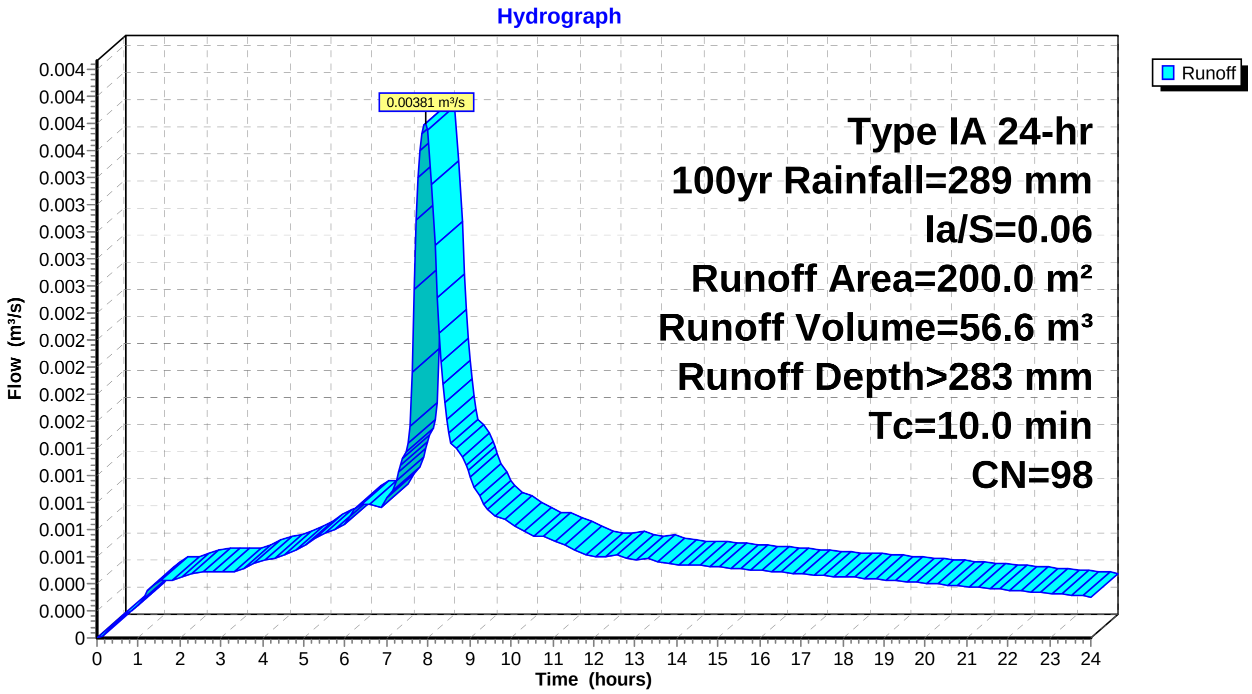
Runoff = 0.00381 m³/s @ 7.94 hrs, Volume= 56.6 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
200.0	98	Paved parking, HSG D
200.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 200: 200m² Impervious



Summary for Subcatchment 225: 225m² Impervious

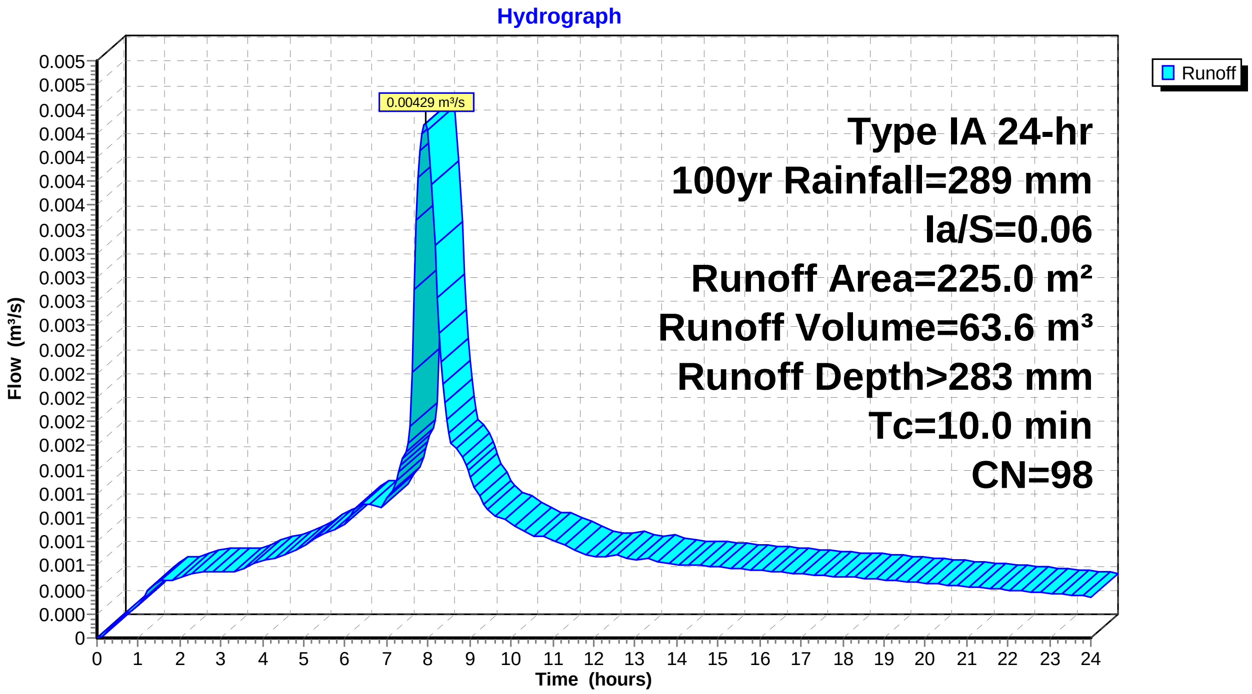
Runoff = 0.00429 m³/s @ 7.94 hrs, Volume= 63.6 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
225.0	98	Paved parking, HSG D
225.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 225: 225m² Impervious



Summary for Pond 150P: 2m x 18m Soakpit

Inflow Area = 150.0 m^{2},100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00286 m^{3}/s @ 7.94 hrs, Volume= 42.4 m^{3}
Outflow = 0.00127 m^{3}/s @ 8.42 hrs, Volume= 40.0 m^{3}, Atten= 56%, Lag= 29.0 min
Discarded = 0.00038 m^{3}/s @ 8.42 hrs, Volume= 13.0 m^{3}
Primary = 0.00089 m^{3}/s @ 8.42 hrs, Volume= 27.0 m^{3}

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.773 m @ 8.42 hrs Surf.Area= 36.0 m^{2} Storage= 9.2 m^{3}

Plug-Flow detention time= 140.4 min calculated for 39.9 m^{3} (94% of inflow)
Center-of-Mass det. time= 96.8 min (739.9 - 643.1)

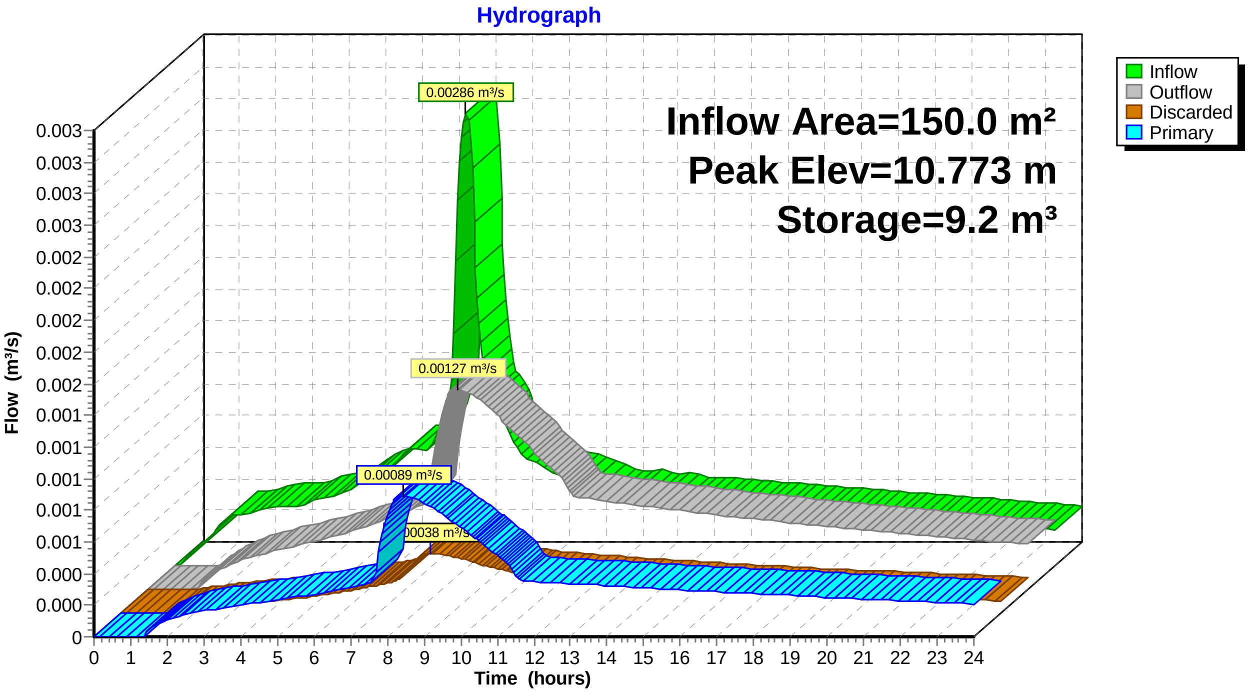
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	9.5 m^{3}	**2.00 mW x 18.00 mL x 0.80 mH Prismatoid** 28.8 m^{3} Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^{2}
#2	Primary	10.050 m	**16 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**20 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 38.0 m^{2}
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00038 m^{3}/s @ 8.42 hrs HW=10.773 m (Free Discharge)
- **4=Exfiltration** (Controls 0.00038 m^{3}/s)

Primary OutFlow Max=0.00089 m^{3}/s @ 8.42 hrs HW=10.773 m (Free Discharge)
- **1=Culvert** (Passes 0.00044 m^{3}/s of 0.01084 m^{3}/s potential flow)
  - **3=Orifice/Grate** (Orifice Controls 0.00044 m^{3}/s @ 1.39 m/s)
  - **5=Orifice/Grate** (Controls 0.00000 m^{3}/s)
- **2=Orifice/Grate** (Orifice Controls 0.00045 m^{3}/s @ 2.25 m/s)

Pond 150P: 2m x 18m Soakpit



Summary for Pond 175P: 2m x 20m Soakpit

Inflow Area = 175.0 m^2,100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00333 m^3/s @ 7.94 hrs, Volume= 49.5 m^3
Outflow = 0.00146 m^3/s @ 8.43 hrs, Volume= 47.0 m^3, Atten= 56%, Lag= 29.7 min
Discarded = 0.00043 m^3/s @ 8.43 hrs, Volume= 14.0 m^3
Primary = 0.00103 m^3/s @ 8.43 hrs, Volume= 32.9 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.790 m @ 8.43 hrs Surf.Area= 40.0 m^2 Storage= 10.4 m^3

Plug-Flow detention time= 131.7 min calculated for 47.0 m^3 (95% of inflow)
Center-of-Mass det. time= 92.7 min (735.8 - 643.1)

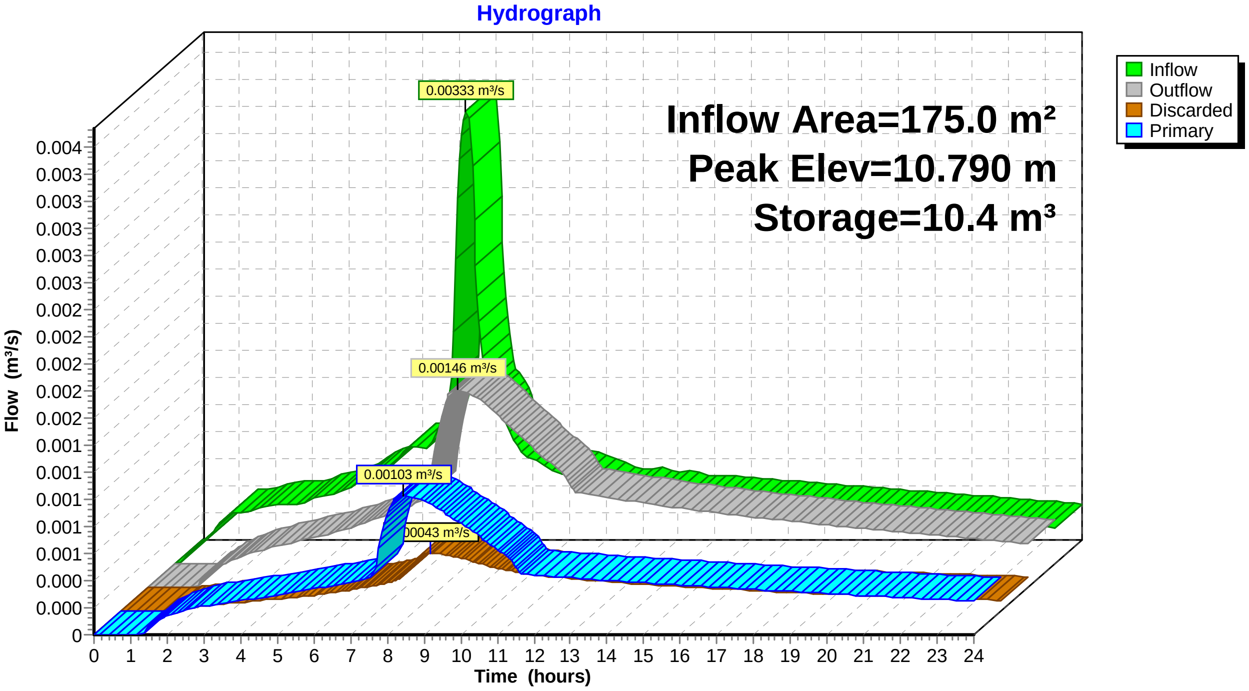
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	10.6 m^3	**2.00 mW x 20.00 mL x 0.80 mH Prismatoid** 32.0 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Primary	10.050 m	**18 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**20 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 42.2 m^2
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00043 m^3/s @ 8.43 hrs HW=10.790 m (Free Discharge)
└─**4=Exfiltration** (Controls 0.00043 m^3/s)

Primary OutFlow Max=0.00103 m^3/s @ 8.43 hrs HW=10.790 m (Free Discharge)
├─**1=Culvert** (Passes 0.00045 m^3/s of 0.01088 m^3/s potential flow)
│ ├─**3=Orifice/Grate** (Orifice Controls 0.00045 m^3/s @ 1.43 m/s)
│ └─**5=Orifice/Grate** (Controls 0.00000 m^3/s)
└─**2=Orifice/Grate** (Orifice Controls 0.00058 m^3/s @ 2.27 m/s)

Pond 175P: 2m x 20m Soakpit



Summary for Pond 200P: 2m x 22m Soakpit

Inflow Area = 200.0 m^2,100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00381 m^3/s @ 7.94 hrs, Volume= 56.6 m^3
Outflow = 0.00188 m^3/s @ 8.36 hrs, Volume= 54.0 m^3, Atten= 51%, Lag= 25.3 min
Discarded = 0.00047 m^3/s @ 8.36 hrs, Volume= 14.9 m^3
Primary = 0.00141 m^3/s @ 8.36 hrs, Volume= 39.1 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.795 m @ 8.36 hrs Surf.Area= 44.0 m^2 Storage= 11.5 m^3

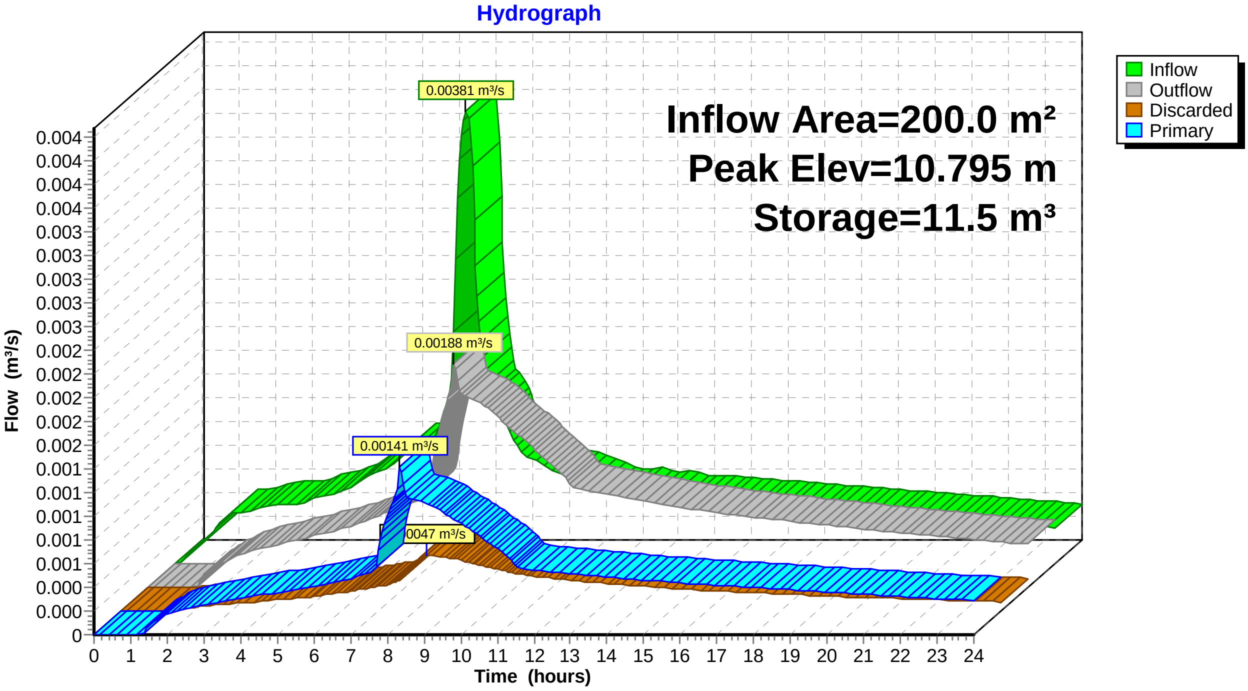
Plug-Flow detention time= 123.9 min calculated for 53.9 m^3 (95% of inflow)
Center-of-Mass det. time= 88.9 min (732.0 - 643.1)

Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	11.6 m^3	**2.00 mW x 22.00 mL x 0.80 mH Prismatoid** 35.2 m^3 Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Primary	10.050 m	**20 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**20 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 46.4 m^2
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

```
Discarded OutFlow  Max=0.00047 m³/s @ 8.36 hrs  HW=10.795 m   (Free Discharge)
└─4=Exfiltration  ( Controls 0.00047 m³/s)

Primary OutFlow  Max=0.00136 m³/s @ 8.36 hrs  HW=10.795 m   (Free Discharge)
├─1=Culvert  (Passes 0.00064 m³/s of 0.01089 m³/s potential flow)
│ ├─3=Orifice/Grate  (Orifice Controls 0.00045 m³/s @ 1.42 m/s)
│ └─5=Orifice/Grate  (Weir Controls 0.00020 m³/s @ 0.13 m/s)
└─2=Orifice/Grate  (Orifice Controls 0.00072 m³/s @ 2.28 m/s)
```

Pond 200P: 2m x 22m Soakpit



Summary for Pond 225P: 2m x 26m Soakpit

```
Inflow Area =          225.0 m²,100.00% Impervious,  Inflow Depth >   283 mm   for  100yr event
Inflow      =     0.00429 m³/s @    7.94 hrs,  Volume=            63.6 m³
Outflow     =     0.00211 m³/s @    8.36 hrs,  Volume=            60.2 m³,  Atten= 51%,  Lag= 25.4 min
Discarded  =     0.00055 m³/s @    8.36 hrs,  Volume=            18.6 m³
Primary     =     0.00156 m³/s @    8.36 hrs,  Volume=            41.6 m³
```

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.796 m @ 8.36 hrs Surf.Area= 52.0 m² Storage= 13.7 m³

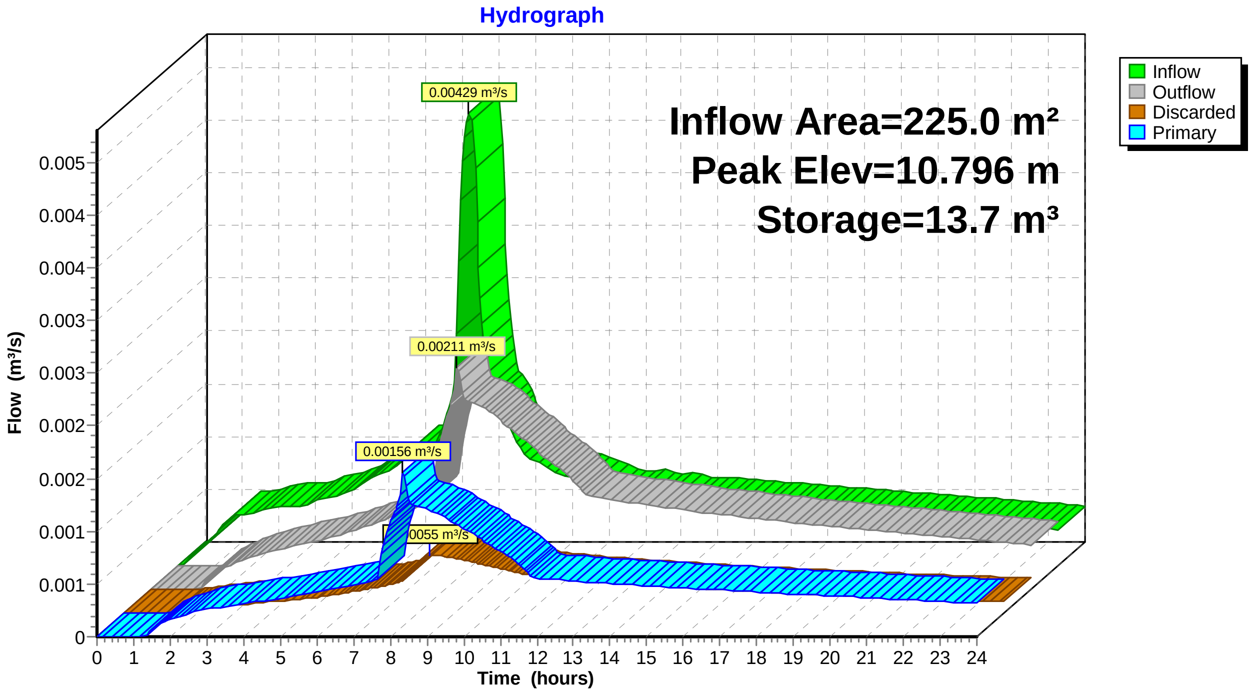
Plug-Flow detention time= 137.7 min calculated for 60.2 m³ (95% of inflow)
Center-of-Mass det. time= 96.2 min (739.3 - 643.1)

Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	13.7 m³	**2.00 mW x 26.00 mL x 0.80 mH Prismatoid** 41.6 m³ Overall x 33.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m²
#2	Primary	10.050 m	**20 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**22 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Discarded	10.050 m	**45.00 mm/hr Exfiltration over Wetted area above 10.050 m** Conductivity to Groundwater Elevation = 3.000 m Excluded Wetted area = 54.8 m²
#5	Device 1	10.790 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

```
Discarded OutFlow  Max=0.00055 m³/s @ 8.36 hrs  HW=10.796 m   (Free Discharge)
└─4=Exfiltration  ( Controls 0.00055 m³/s)

Primary OutFlow  Max=0.00151 m³/s @ 8.36 hrs  HW=10.796 m   (Free Discharge)
├─1=Culvert  (Passes 0.00079 m³/s of 0.01090 m³/s potential flow)
│  ├─3=Orifice/Grate  (Orifice Controls 0.00054 m³/s @ 1.42 m/s)
│  └─5=Orifice/Grate  (Weir Controls 0.00025 m³/s @ 0.14 m/s)
└─2=Orifice/Grate  (Orifice Controls 0.00072 m³/s @ 2.28 m/s)
```

Pond 225P: 2m x 26m Soakpit



HydroCAD Calculations Reports

In-Ground Tank Option

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (mm)	AMC
1	5yr	Type IA 24-hr		Default	24.00	1	162	2
2	100yr	Type IA 24-hr		Default	24.00	1	289	2

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 25: 25m² Impervious Runoff Area=25.0 m² 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00027 m³/s 3.9 m³

Subcatchment 50: 50m² Impervious Runoff Area=50.0 m² 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00053 m³/s 7.8 m³

Subcatchment 75: 75m² Impervious Runoff Area=75.0 m² 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00080 m³/s 11.7 m³

Subcatchment 100: 100m² Runoff Area=100.0 m² 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00106 m³/s 15.6 m³

Subcatchment 125: 125m² Runoff Area=125.0 m² 100.00% Impervious Runoff Depth>156 mm
Tc=10.0 min CN=98 Runoff=0.00133 m³/s 19.5 m³

Pond 25P: 3000L - 0.9mø Peak Elev=10.501 m Storage=1.7 m³ Inflow=0.00027 m³/s 3.9 m³
Primary=0.00004 m³/s 2.3 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00004 m³/s 2.3 m³

Pond 50P: 4000L 0.9mø underground Peak Elev=10.450 m Storage=2.0 m³ Inflow=0.00053 m³/s 7.8 m³
Primary=0.00013 m³/s 7.4 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00013 m³/s 7.4 m³

Pond 75P: 6000L 0.9mø Peak Elev=10.459 m Storage=3.1 m³ Inflow=0.00080 m³/s 11.7 m³
Primary=0.00019 m³/s 11.0 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00019 m³/s 11.0 m³

Pond 100P: 8000L 0.9mø Peak Elev=10.456 m Storage=4.1 m³ Inflow=0.00106 m³/s 15.6 m³
Primary=0.00026 m³/s 14.7 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00026 m³/s 14.7 m³

Pond 125P: 9500L 0.9mø Peak Elev=10.491 m Storage=5.3 m³ Inflow=0.00133 m³/s 19.5 m³
Primary=0.00031 m³/s 18.1 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00031 m³/s 18.1 m³

Summary for Subcatchment 25: 25m² Impervious

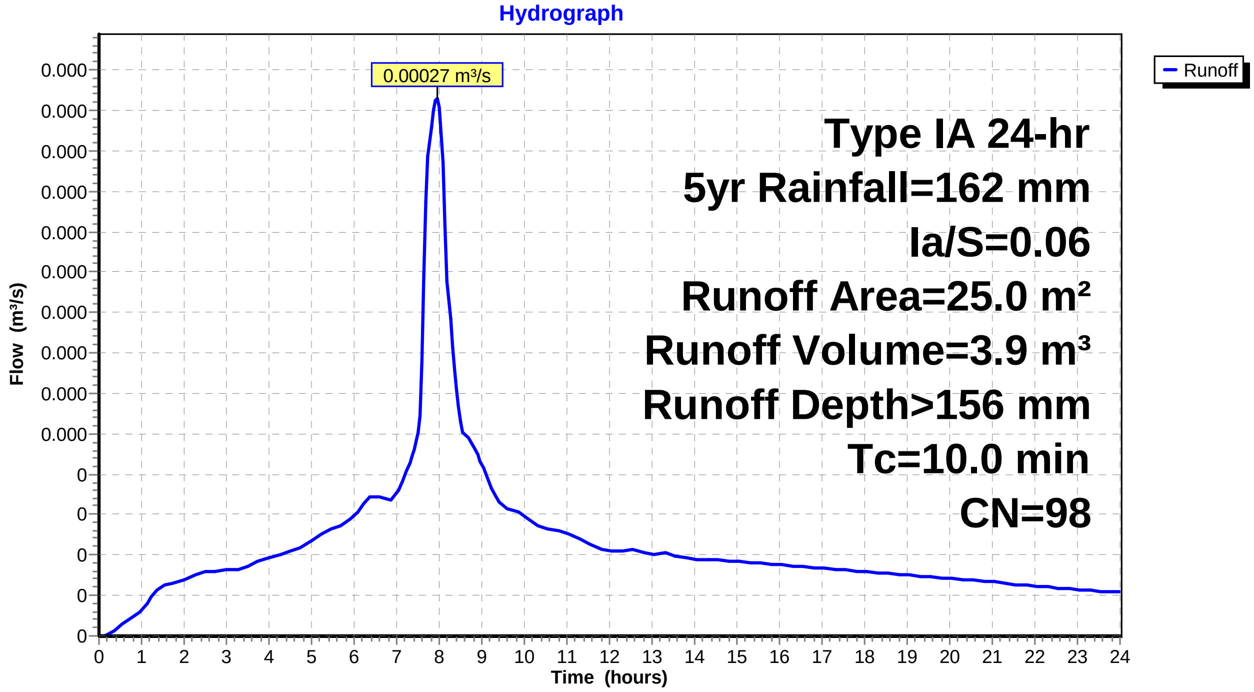
Runoff = 0.00027 m³/s @ 7.94 hrs, Volume= 3.9 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
25.0	98	Paved parking, HSG D
25.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 25: 25m² Impervious



Summary for Subcatchment 50: 50m² Impervious

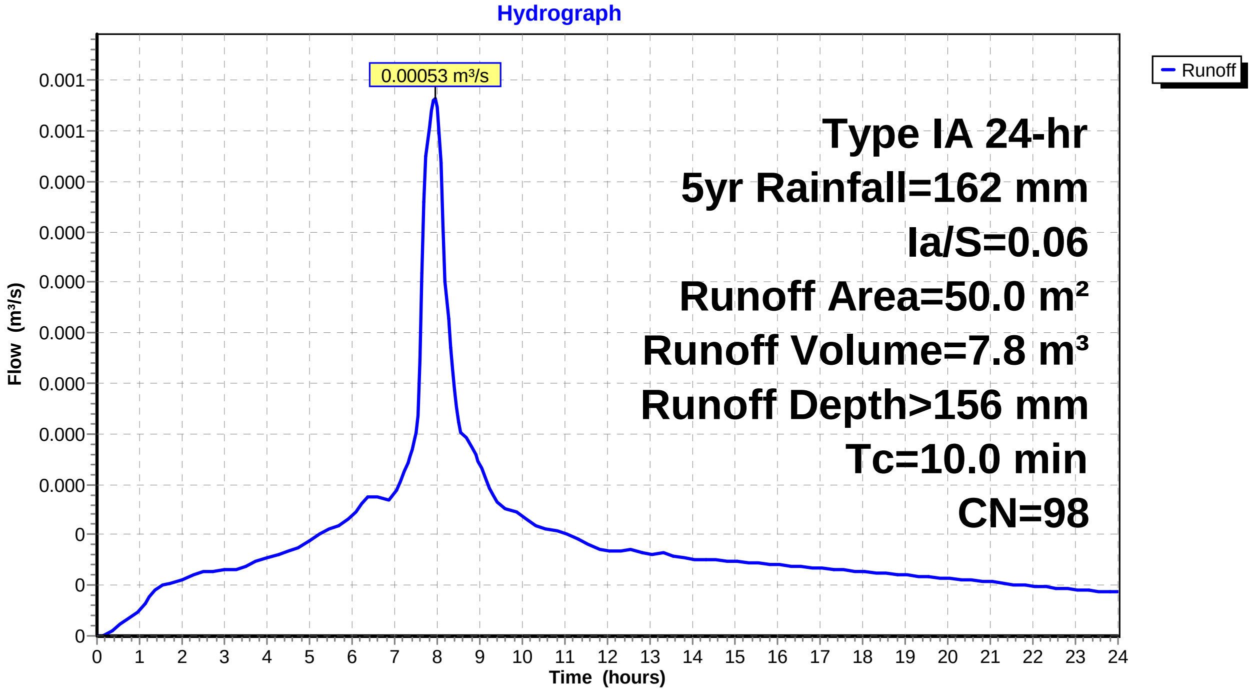
Runoff = 0.00053 m³/s @ 7.94 hrs, Volume= 7.8 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
50.0	98	Paved parking, HSG D
50.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 50: 50m² Impervious



Summary for Subcatchment 75: 75m² Impervious

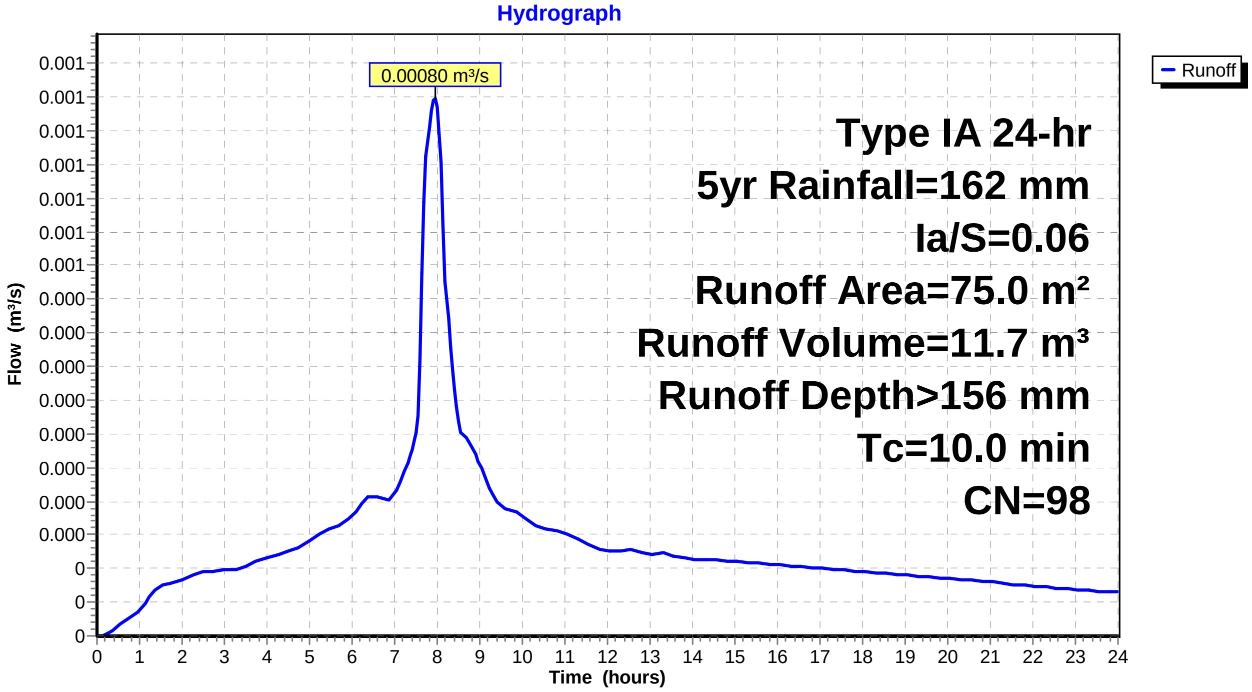
Runoff = 0.00080 m³/s @ 7.94 hrs, Volume= 11.7 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
75.0	98	Paved parking, HSG D
75.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 75: 75m² Impervious



Summary for Subcatchment 100: 100m² Impervious

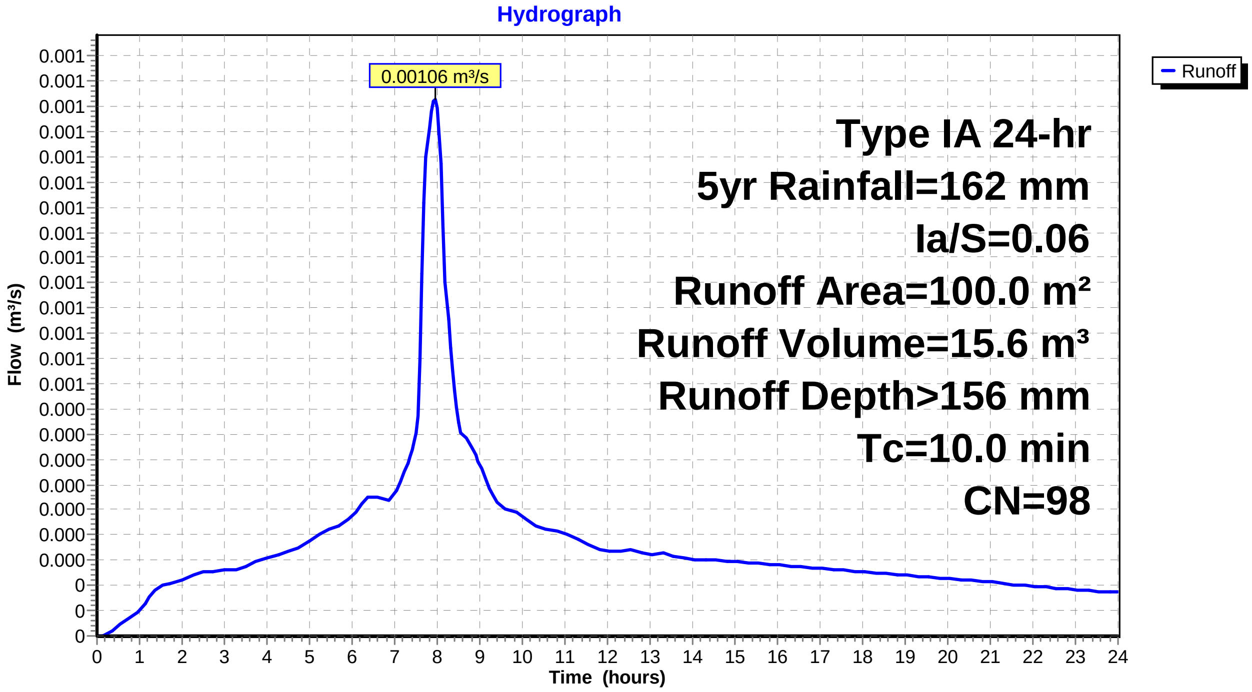
Runoff = 0.00106 m³/s @ 7.94 hrs, Volume= 15.6 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
100.0	98	Paved parking, HSG D
100.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 100: 100m² Impervious



Summary for Subcatchment 125: 125m² Impervious

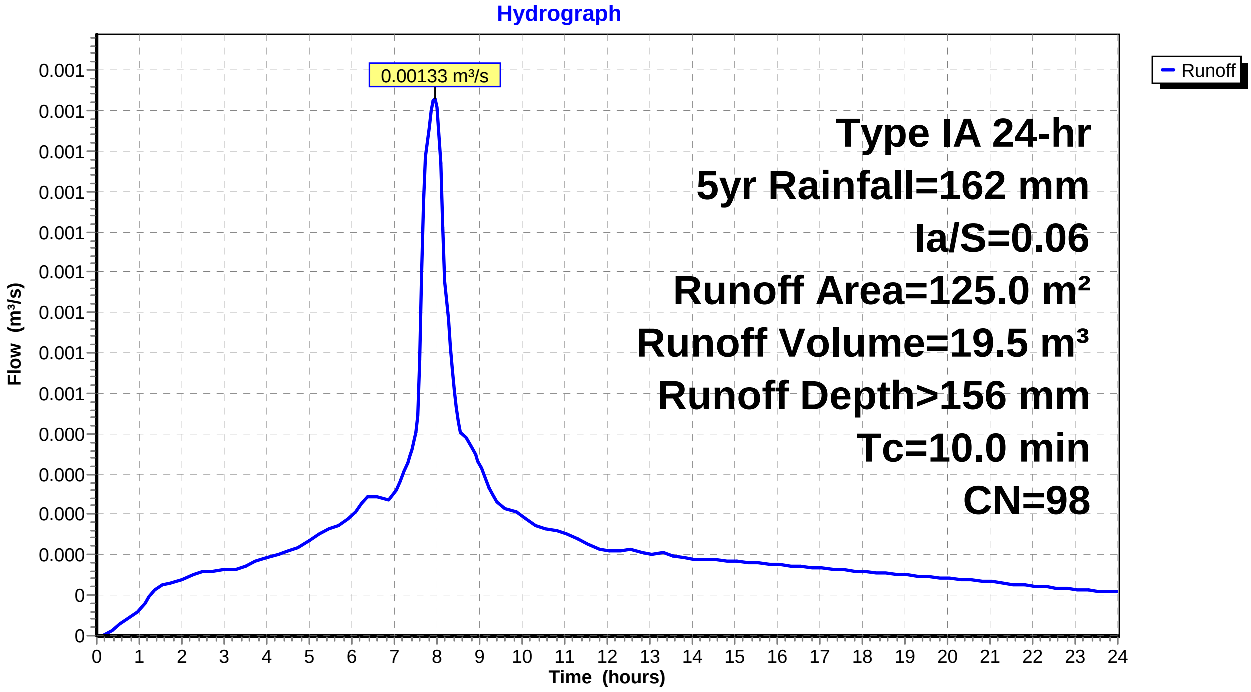
Runoff = 0.00133 m³/s @ 7.94 hrs, Volume= 19.5 m³, Depth> 156 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 5yr Rainfall=162 mm, Ia/S=0.06

Area (m²)	CN	Description
125.0	98	Paved parking, HSG D
125.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

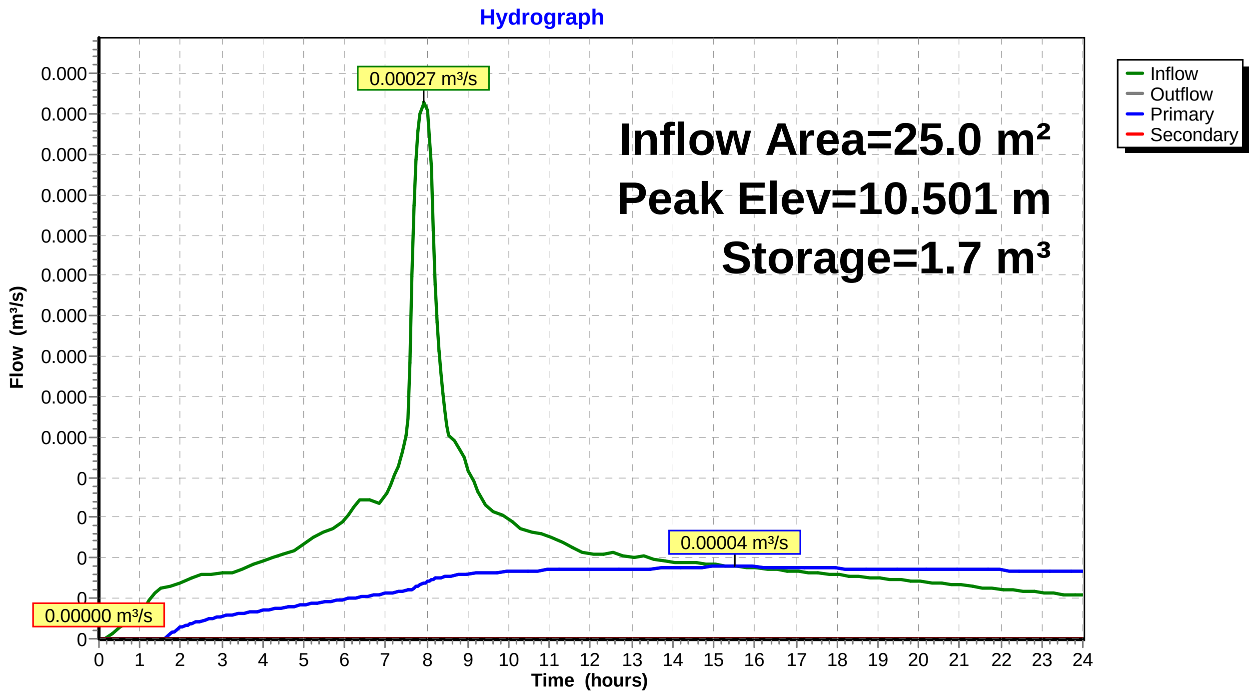
Subcatchment 125: 125m² Impervious



Summary for Pond 25P: 3000L - 0.9mø Underground tank

```
Inflow Area =          25.0 m²,100.00% Impervious,  Inflow Depth >   156 mm   for  5yr event
Inflow      =     0.00027 m³/s @    7.94 hrs,  Volume=              3.9 m³
Outflow     =     0.00004 m³/s @   15.49 hrs,  Volume=              2.3 m³,  Atten= 86%,  Lag= 453.2 min
Primary     =     0.00004 m³/s @   15.49 hrs,  Volume=              2.3 m³
Secondary =       0.00000 m³/s @    0.00 hrs,  Volume=              0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.501 m @ 15.49 hrs   Surf.Area= 4.3 m²   Storage= 1.7 m³

Plug-Flow detention time= 447.5 min calculated for 2.3 m³ (60% of inflow)
Center-of-Mass det. time= 215.2 min ( 864.8 - 649.6 )

Volume        Invert     Avail.Storage   Storage Description
   #1       10.000 m            3.1 m³   900 mm  Round Pipe Storage
                                         L= 4.80 m

Device   Routing          Invert   Outlet Devices
   #1    Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Device 1       10.050 m   5 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #3    Device 1       10.500 m   10 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #4    Secondary      10.890 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Primary OutFlow  Max=0.00004 m³/s @ 15.49 hrs  HW=10.501 m   (Free Discharge)
└─1=Culvert  (Passes 0.00004 m³/s of 0.01010 m³/s potential flow)
   ├─2=Orifice/Grate  (Orifice Controls 0.00003 m³/s @ 1.78 m/s)
   └─3=Orifice/Grate  (Orifice Controls 0.00000 m³/s @ 0.06 m/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└─4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

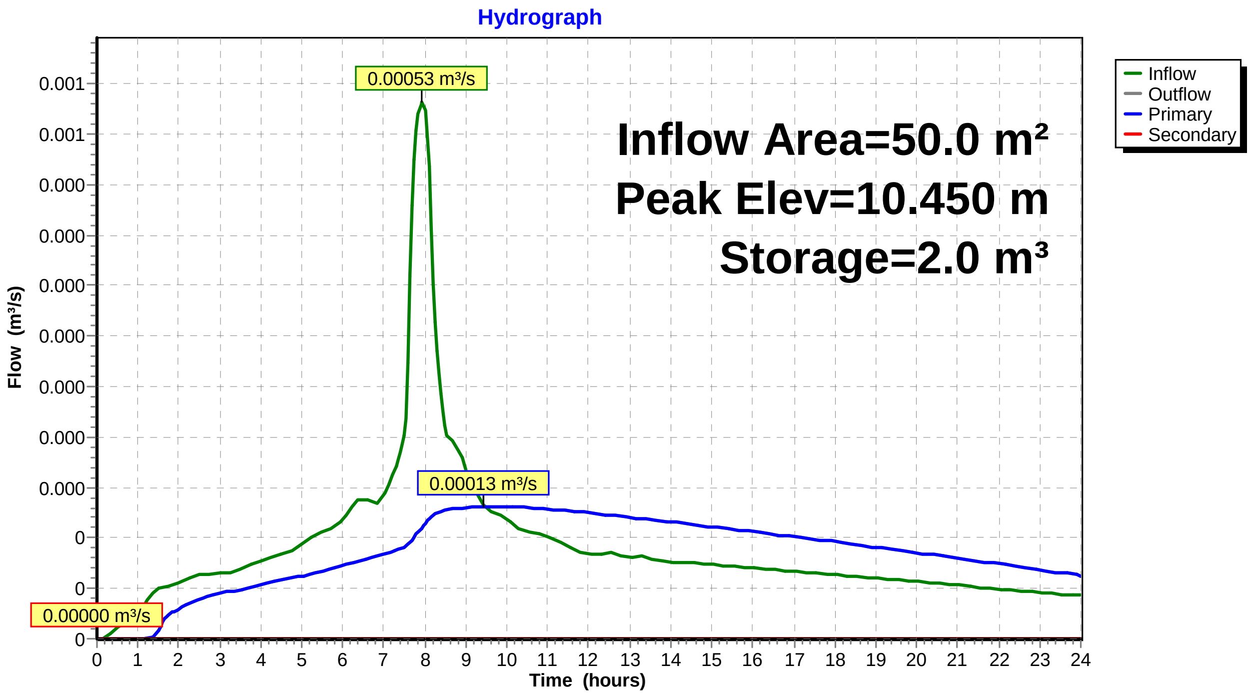
Pond 25P: 3000L - 0.9mø Underground tank



Summary for Pond 50P: 4000L 0.9mø underground tank

```
Inflow Area =          50.0 m²,100.00% Impervious,  Inflow Depth >    156 mm    for  5yr event
Inflow      =     0.00053 m³/s @    7.94 hrs,  Volume=              7.8 m³
Outflow     =     0.00013 m³/s @    9.45 hrs,  Volume=              7.4 m³,  Atten= 75%,  Lag= 90.7 min
Primary     =     0.00013 m³/s @    9.45 hrs,  Volume=              7.4 m³
Secondary =       0.00000 m³/s @    0.00 hrs,  Volume=              0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.450 m @ 9.45 hrs   Surf.Area= 5.7 m²   Storage= 2.0 m³

Plug-Flow detention time= 182.9 min calculated for 7.4 m³ (95% of inflow)
Center-of-Mass det. time= 142.8 min ( 792.4 - 649.6 )

Volume        Invert     Avail.Storage   Storage Description
   #1       10.000 m            4.0 m³   900 mm  Round Pipe Storage
                                         L= 6.30 m

Device   Routing           Invert   Outlet Devices
   #1    Primary          9.000 m   100 mm  Round Culvert
                                    L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                    Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                    0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Device 1        10.050 m   10 mm Vert. Orifice/Grate    C= 0.600
                                    Limited to weir flow at low heads
   #3    Device 1        10.500 m   10 mm Vert. Orifice/Grate    C= 0.600
                                    Limited to weir flow at low heads
   #4    Secondary       10.890 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                    Limited to weir flow at low heads

Primary OutFlow  Max=0.00013 m³/s @ 9.45 hrs  HW=10.450 m   (Free Discharge)
└─1=Culvert  (Passes 0.00013 m³/s of 0.00996 m³/s potential flow)
   ├─2=Orifice/Grate  (Orifice Controls 0.00013 m³/s @ 1.67 m/s)
   └─3=Orifice/Grate  ( Controls 0.00000 m³/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└─4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

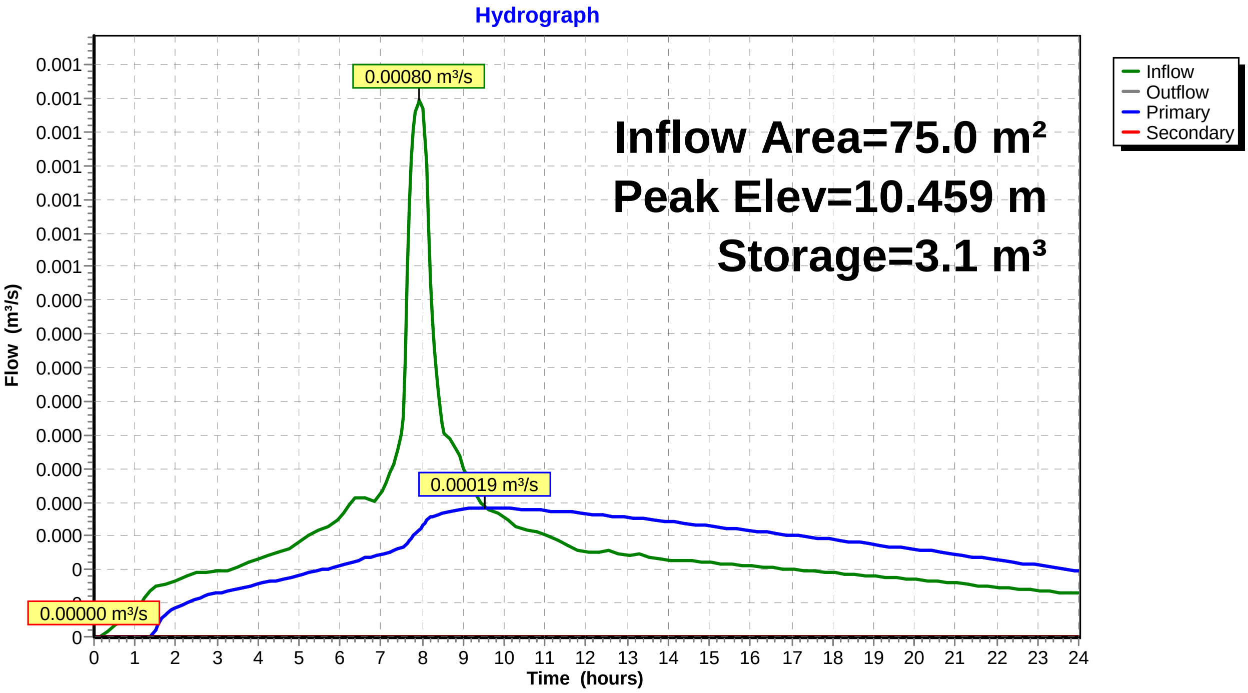
Pond 50P: 4000L 0.9mø underground tank



Summary for Pond 75P: 6000L 0.9mø underground tank

```
Inflow Area =           75.0 m²,100.00% Impervious,  Inflow Depth >   156 mm   for  5yr event
Inflow      =    0.00080 m³/s @    7.94 hrs,  Volume=            11.7 m³
Outflow     =    0.00019 m³/s @    9.54 hrs,  Volume=            11.0 m³,  Atten= 76%,  Lag= 96.0 min
Primary     =    0.00019 m³/s @    9.54 hrs,  Volume=            11.0 m³
Secondary =      0.00000 m³/s @    0.00 hrs,  Volume=             0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.459 m @ 9.54 hrs   Surf.Area= 8.5 m²   Storage= 3.1 m³

Plug-Flow detention time= 196.9 min calculated for 11.0 m³ (94% of inflow)
Center-of-Mass det. time= 149.5 min ( 799.2 - 649.6 )

Volume       Invert    Avail.Storage  Storage Description
   #1      10.000 m           6.0 m³  900 mm  Round Pipe Storage
                                      L= 9.50 m

Device   Routing        Invert   Outlet Devices
    #1   Primary       9.000 m   100 mm  Round Culvert
                                 L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                 Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                 0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
    #2   Device 1     10.050 m   12 mm Vert. Orifice/Grate    C= 0.600
                                 Limited to weir flow at low heads
    #3   Device 1     10.500 m   14 mm Vert. Orifice/Grate    C= 0.600
                                 Limited to weir flow at low heads
    #4   Secondary    10.890 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                 Limited to weir flow at low heads

Primary OutFlow  Max=0.00019 m³/s @ 9.54 hrs  HW=10.459 m   (Free Discharge)
└─1=Culvert  (Passes 0.00019 m³/s of 0.00998 m³/s potential flow)
   ├─2=Orifice/Grate  (Orifice Controls 0.00019 m³/s @ 1.69 m/s)
   └─3=Orifice/Grate  ( Controls 0.00000 m³/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└─4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

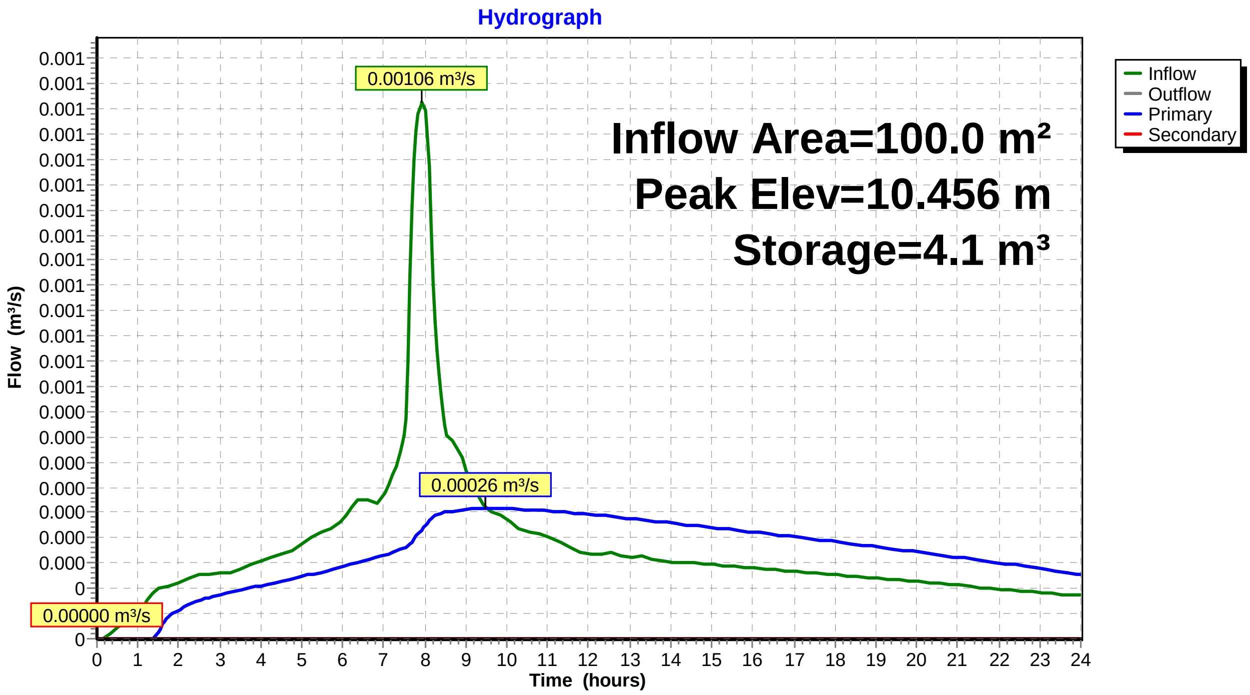
Pond 75P: 6000L 0.9mø underground tank



Summary for Pond 100P: 8000L 0.9mø underground tank

```
Inflow Area =          100.0 m²,100.00% Impervious,  Inflow Depth >   156 mm    for  5yr event
Inflow      =     0.00106 m³/s @    7.94 hrs,  Volume=              15.6 m³
Outflow     =     0.00026 m³/s @    9.49 hrs,  Volume=              14.7 m³,  Atten= 76%,  Lag= 93.0 min
Primary     =     0.00026 m³/s @    9.49 hrs,  Volume=              14.7 m³
Secondary =       0.00000 m³/s @    0.00 hrs,  Volume=               0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.456 m @ 9.49 hrs   Surf.Area= 11.3 m²   Storage= 4.1 m³

Plug-Flow detention time= 190.6 min calculated for 14.7 m³ (94% of inflow)
Center-of-Mass det. time= 146.5 min ( 796.1 - 649.6 )

Volume        Invert    Avail.Storage   Storage Description
   #1      10.000 m           8.0 m³    900 mm  Round Pipe Storage
                                        L= 12.60 m

Device   Routing            Invert   Outlet Devices
   #1    Primary           9.000 m   100 mm  Round Culvert
                                     L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                     Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                     0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Device 1         10.050 m   14 mm Vert. Orifice/Grate    C= 0.600
                                     Limited to weir flow at low heads
   #3    Device 1         10.500 m   16 mm Horiz. Orifice/Grate    C= 0.600
                                     Limited to weir flow at low heads
   #4    Secondary        10.890 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                     Limited to weir flow at low heads

Primary OutFlow  Max=0.00026 m³/s @ 9.49 hrs  HW=10.456 m   (Free Discharge)
└──1=Culvert  (Passes 0.00026 m³/s of 0.00998 m³/s potential flow)
    ├──2=Orifice/Grate  (Orifice Controls 0.00026 m³/s @ 1.68 m/s)
    └──3=Orifice/Grate  ( Controls 0.00000 m³/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└──4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

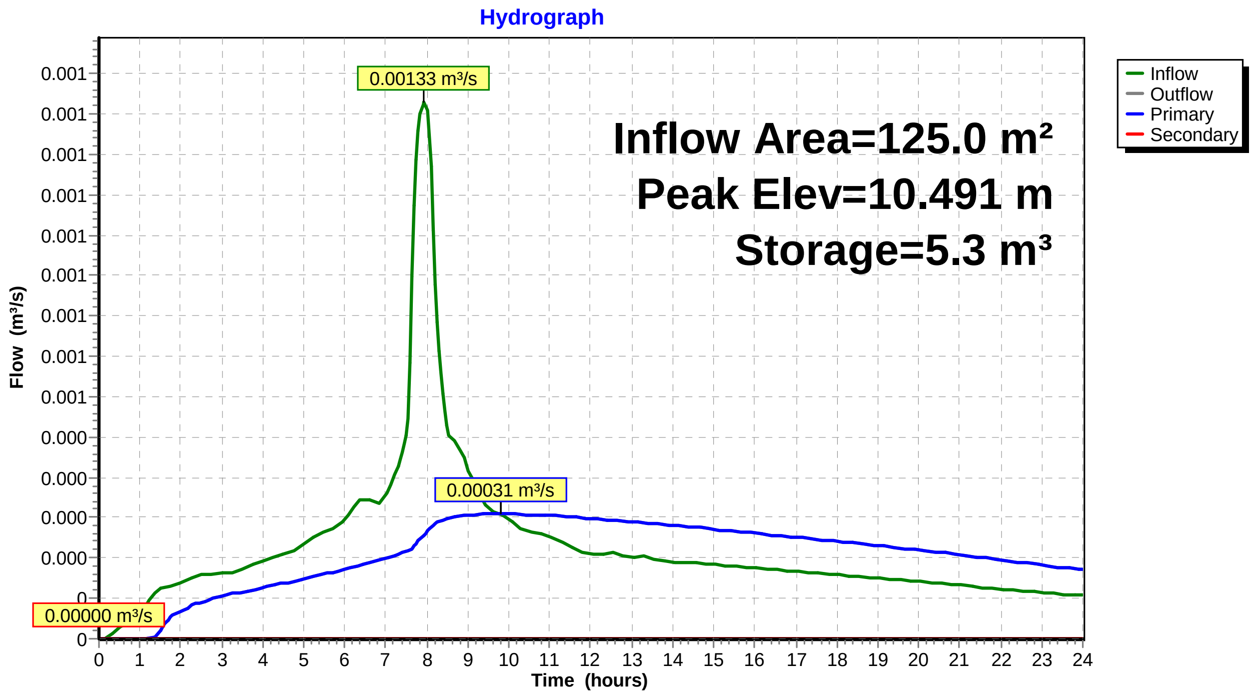
Pond 100P: 8000L 0.9mø underground tank



Summary for Pond 125P: 9500L 0.9mø underground tank

```
Inflow Area =            125.0 m²,100.00% Impervious,  Inflow Depth >    156 mm    for  5yr event
Inflow      =     0.00133 m³/s @    7.94 hrs,  Volume=              19.5 m³
Outflow     =     0.00031 m³/s @    9.80 hrs,  Volume=              18.1 m³,  Atten= 77%,  Lag= 111.8 min
Primary     =     0.00031 m³/s @    9.80 hrs,  Volume=              18.1 m³
Secondary =       0.00000 m³/s @    0.00 hrs,  Volume=               0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.491 m @ 9.80 hrs   Surf.Area= 13.4 m²   Storage= 5.3 m³

Plug-Flow detention time= 210.2 min calculated for 18.1 m³ (93% of inflow)
Center-of-Mass det. time= 155.3 min ( 804.9 - 649.6 )

Volume        Invert     Avail.Storage   Storage Description
   #1      10.000 m             9.5 m³   900 mm  Round Pipe Storage
                                         L= 15.00 m

Device   Routing           Invert    Outlet Devices
   #1    Primary          9.000 m    100 mm  Round Culvert
                                     L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                     Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                     0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Device 1        10.050 m    15 mm Vert. Orifice/Grate    C= 0.600
                                     Limited to weir flow at low heads
   #3    Device 1        10.500 m    18 mm Horiz. Orifice/Grate    C= 0.600
                                     Limited to weir flow at low heads
   #4    Secondary       10.890 m    100 mm Horiz. Orifice/Grate    C= 0.600
                                     Limited to weir flow at low heads

Primary OutFlow  Max=0.00031 m³/s @ 9.80 hrs  HW=10.491 m   (Free Discharge)
└─1=Culvert  (Passes 0.00031 m³/s of 0.01007 m³/s potential flow)
    ├─2=Orifice/Grate  (Orifice Controls 0.00031 m³/s @ 1.75 m/s)
    └─3=Orifice/Grate  ( Controls 0.00000 m³/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└─4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

Pond 125P: 9500L 0.9mø underground tank



Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 25: 25m² Impervious Runoff Area=25.0 m² 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00048 m³/s 7.1 m³

Subcatchment 50: 50m² Impervious Runoff Area=50.0 m² 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00095 m³/s 14.1 m³

Subcatchment 75: 75m² Impervious Runoff Area=75.0 m² 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00143 m³/s 21.2 m³

Subcatchment 100: 100m² Runoff Area=100.0 m² 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00191 m³/s 28.3 m³

Subcatchment 125: 125m² Runoff Area=125.0 m² 100.00% Impervious Runoff Depth>283 mm
Tc=10.0 min CN=98 Runoff=0.00238 m³/s 35.4 m³

Pond 25P: 3000L - 0.9mø Peak Elev=10.694 m Storage=2.5 m³ Inflow=0.00048 m³/s 7.1 m³
Primary=0.00013 m³/s 5.3 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00013 m³/s 5.3 m³

Pond 50P: 4000L 0.9mø Peak Elev=10.807 m Storage=3.8 m³ Inflow=0.00095 m³/s 14.1 m³
Primary=0.00030 m³/s 12.7 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00030 m³/s 12.7 m³

Pond 75P: 6000L 0.9mø Peak Elev=10.792 m Storage=5.6 m³ Inflow=0.00143 m³/s 21.2 m³
Primary=0.00048 m³/s 18.8 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00048 m³/s 18.8 m³

Pond 100P: 8000L 0.9mø Peak Elev=10.788 m Storage=7.4 m³ Inflow=0.00191 m³/s 28.3 m³
Primary=0.00064 m³/s 25.3 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00064 m³/s 25.3 m³

Pond 125P: 9500L 0.9mø Peak Elev=10.855 m Storage=9.4 m³ Inflow=0.00238 m³/s 35.4 m³
Primary=0.00082 m³/s 31.3 m³ Secondary=0.00000 m³/s 0.0 m³ Outflow=0.00082 m³/s 31.3 m³

Summary for Subcatchment 25: 25m² Impervious

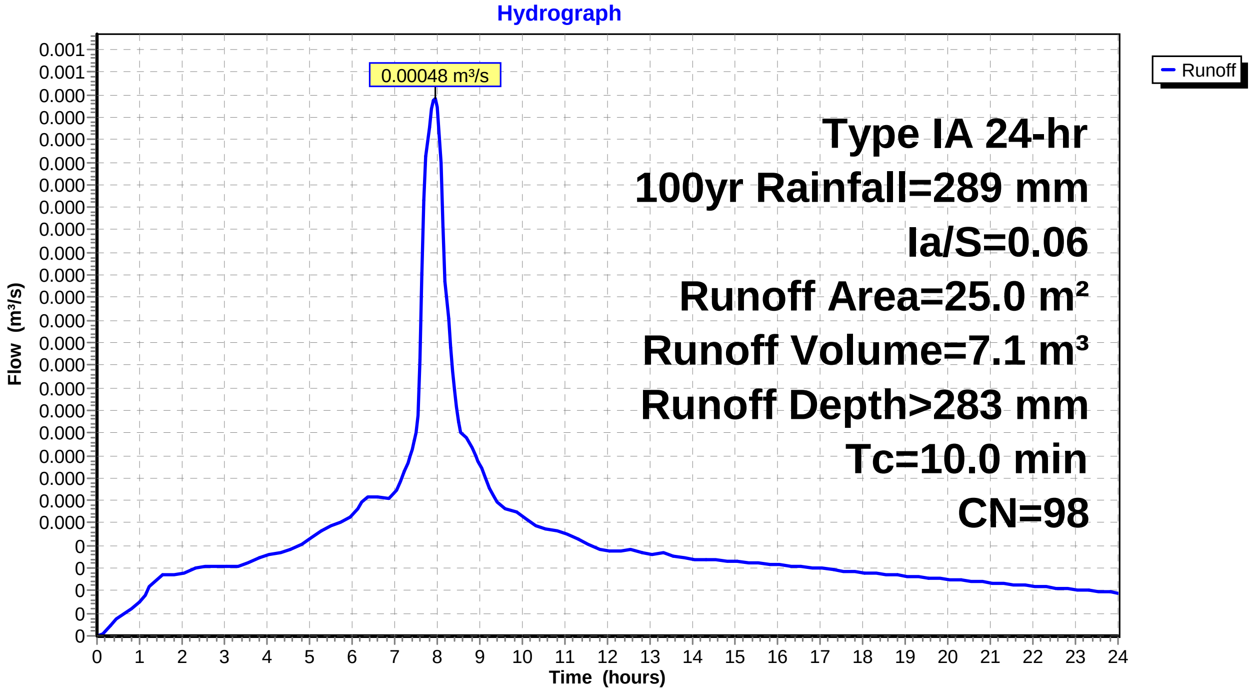
Runoff = 0.00048 m³/s @ 7.94 hrs, Volume= 7.1 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
25.0	98	Paved parking, HSG D
25.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 25: 25m² Impervious



Summary for Subcatchment 50: 50m² Impervious

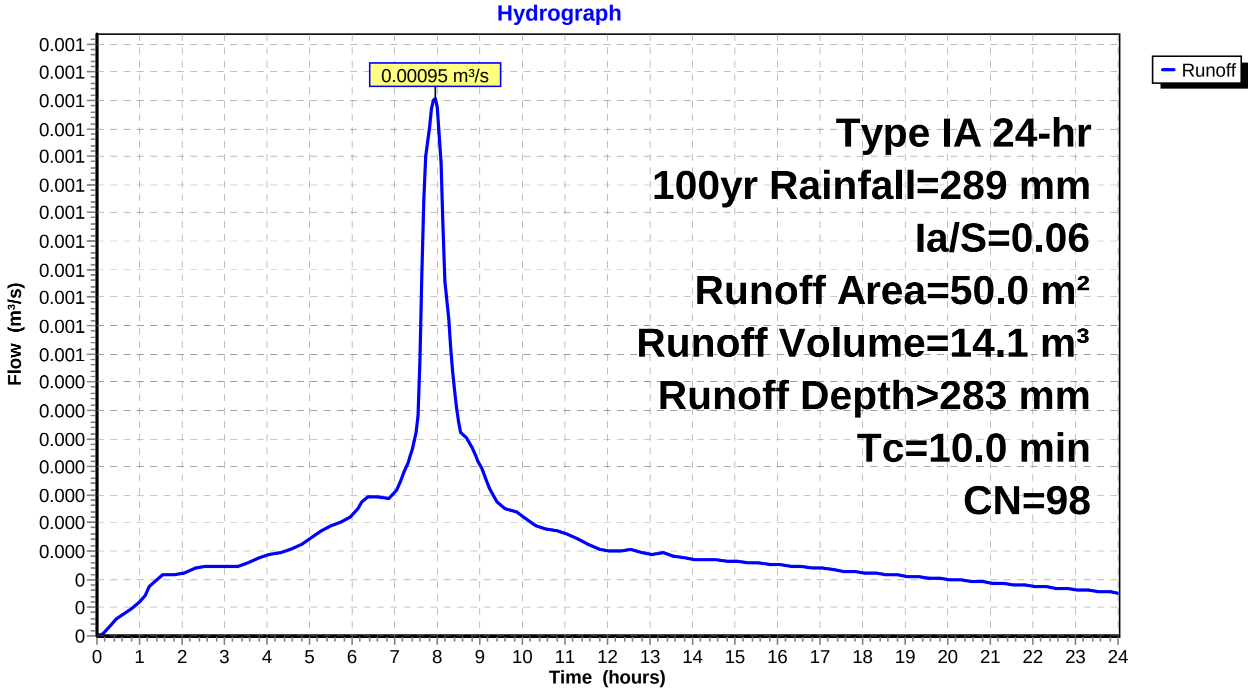
Runoff = 0.00095 m³/s @ 7.94 hrs, Volume= 14.1 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
50.0	98	Paved parking, HSG D
50.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 50: 50m² Impervious



Summary for Subcatchment 75: 75m² Impervious

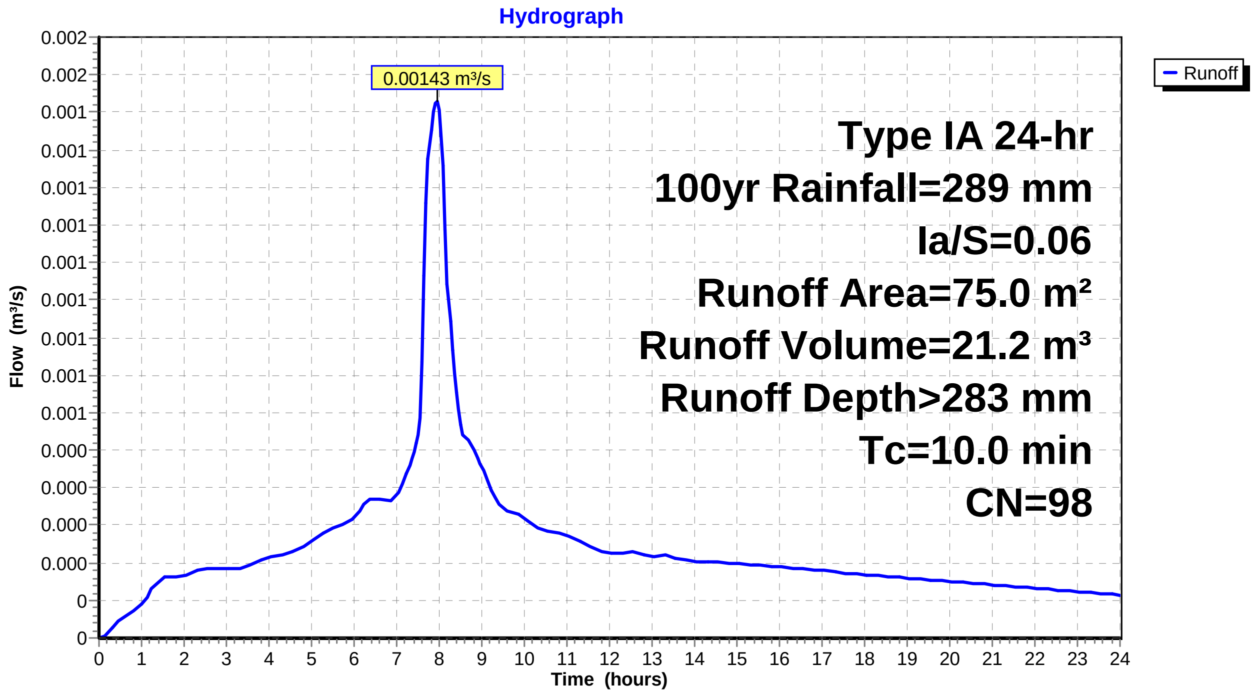
Runoff = 0.00143 m³/s @ 7.94 hrs, Volume= 21.2 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
75.0	98	Paved parking, HSG D
75.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 75: 75m² Impervious



Summary for Subcatchment 100: 100m² Impervious

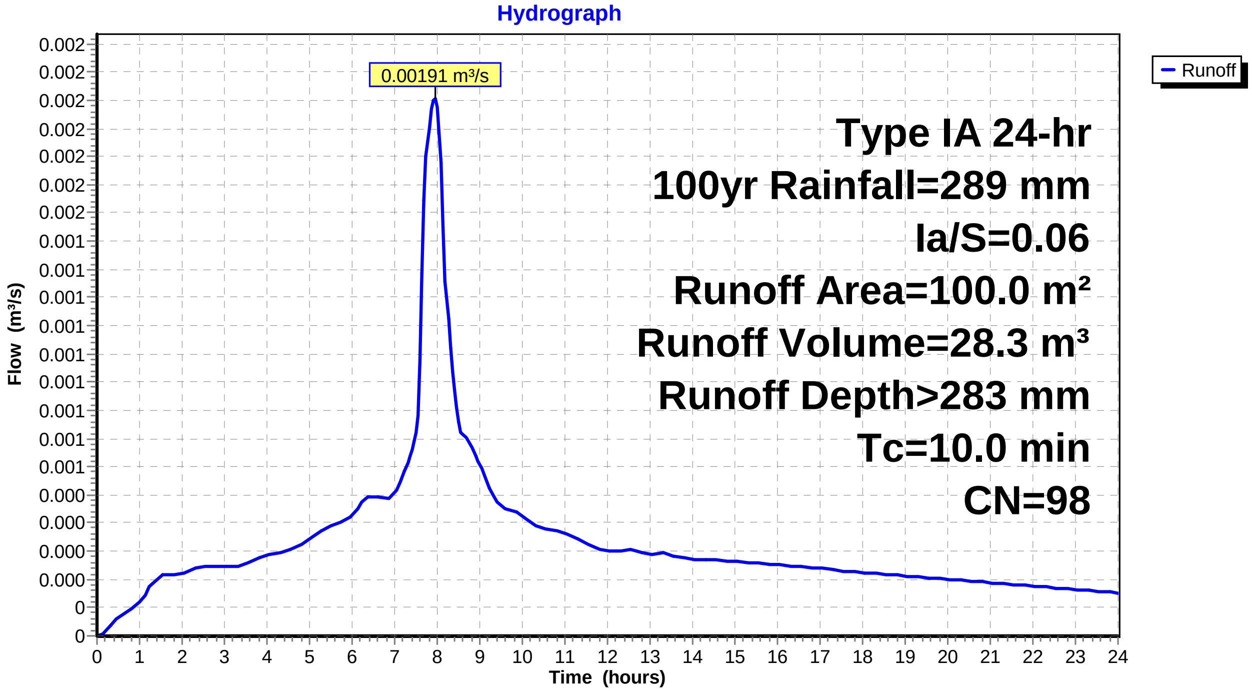
Runoff = 0.00191 m³/s @ 7.94 hrs, Volume= 28.3 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
100.0	98	Paved parking, HSG D
100.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 100: 100m² Impervious



Summary for Subcatchment 125: 125m² Impervious

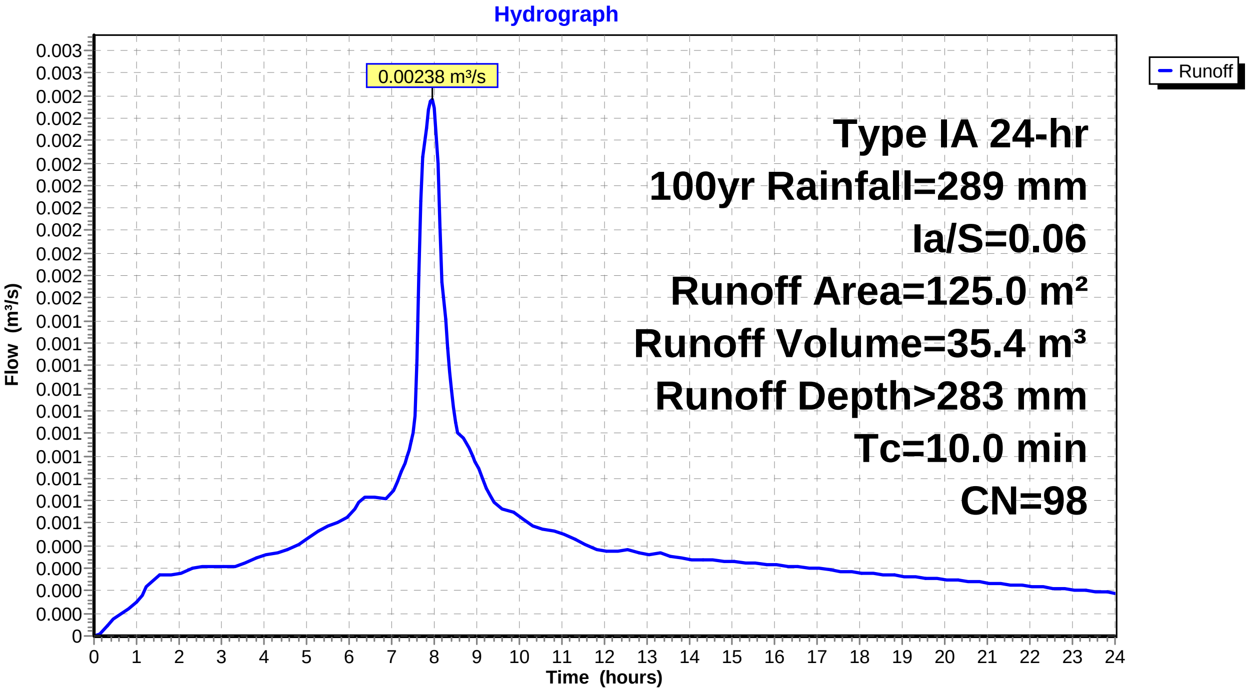
Runoff = 0.00238 m³/s @ 7.94 hrs, Volume= 35.4 m³, Depth> 283 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100yr Rainfall=289 mm, Ia/S=0.06

Area (m²)	CN	Description
125.0	98	Paved parking, HSG D
125.0	98	100.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

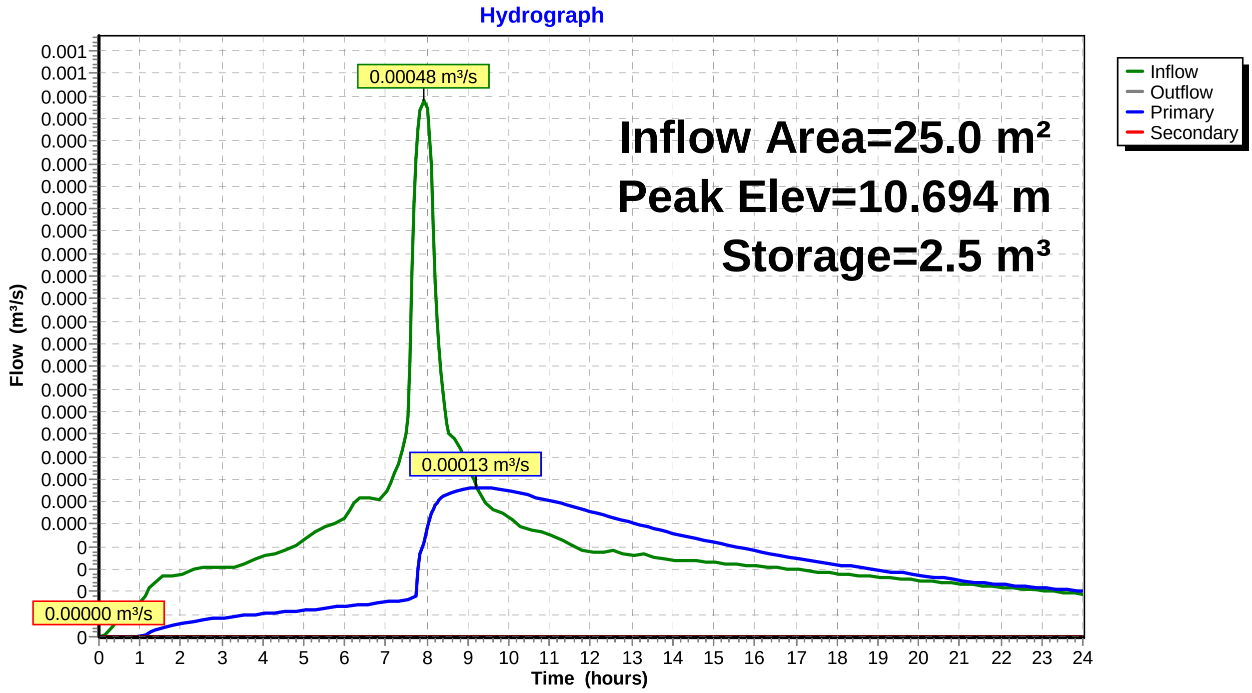
Subcatchment 125: 125m² Impervious



Summary for Pond 25P: 3000L - 0.9mø Underground tank

```
Inflow Area =            25.0 m²,100.00% Impervious,  Inflow Depth >    283 mm    for  100yr event
Inflow      =      0.00048 m³/s @    7.94 hrs,  Volume=              7.1 m³
Outflow     =      0.00013 m³/s @    9.20 hrs,  Volume=              5.3 m³,  Atten= 72%,  Lag= 75.8 min
Primary     =      0.00013 m³/s @    9.20 hrs,  Volume=              5.3 m³
Secondary =        0.00000 m³/s @    0.00 hrs,  Volume=              0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.694 m @ 9.20 hrs   Surf.Area= 3.6 m²   Storage= 2.5 m³

Plug-Flow detention time= 322.6 min calculated for 5.3 m³ (75% of inflow)
Center-of-Mass det. time= 159.5 min ( 802.6 - 643.1 )

Volume        Invert     Avail.Storage   Storage Description
  #1        10.000 m            3.1 m³   900 mm  Round Pipe Storage
                                         L= 4.80 m

Device   Routing          Invert   Outlet Devices
   #1    Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Device 1       10.050 m   5 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #3    Device 1       10.500 m   10 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #4    Secondary      10.890 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Primary OutFlow  Max=0.00013 m³/s @ 9.20 hrs  HW=10.694 m   (Free Discharge)
└—1=Culvert  (Passes 0.00013 m³/s of 0.01063 m³/s potential flow)
    ├—2=Orifice/Grate  (Orifice Controls 0.00004 m³/s @ 2.13 m/s)
    └—3=Orifice/Grate  (Orifice Controls 0.00009 m³/s @ 1.16 m/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└—4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

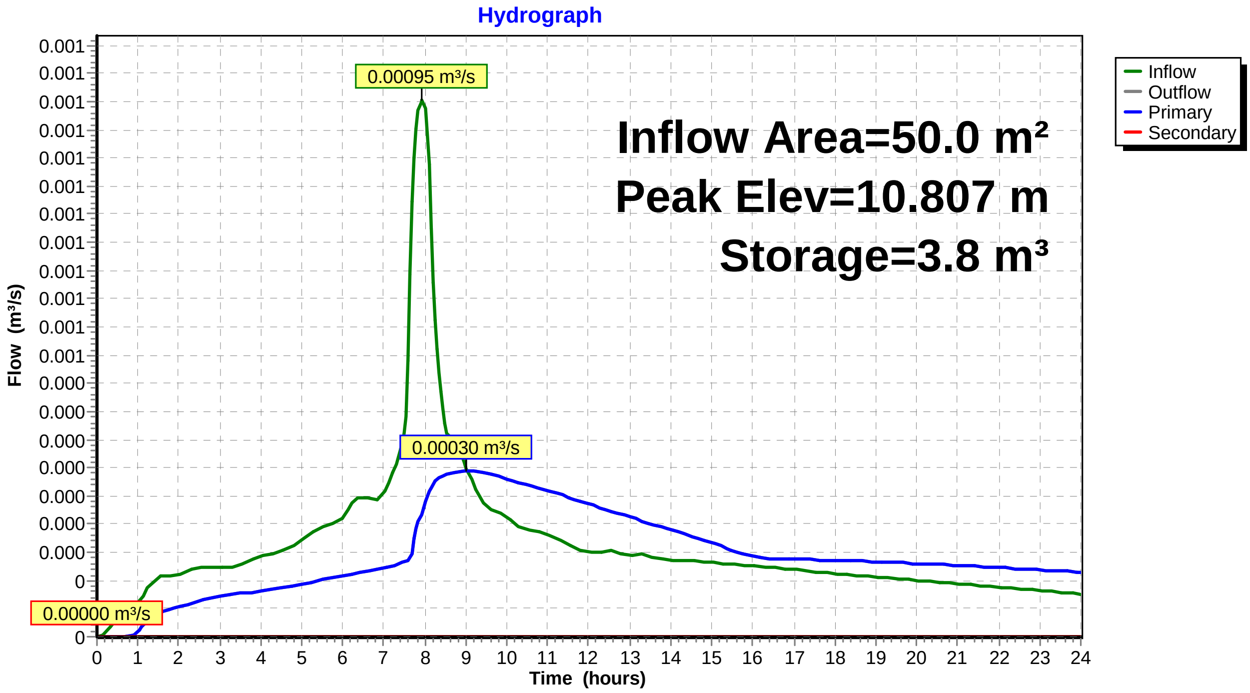
Pond 25P: 3000L - 0.9mø Underground tank



Summary for Pond 50P: 4000L 0.9mø underground tank

```
Inflow Area =            50.0 m²,100.00% Impervious,  Inflow Depth >    283 mm    for  100yr event
Inflow      =     0.00095 m³/s @    7.94 hrs,  Volume=             14.1 m³
Outflow     =     0.00030 m³/s @    9.03 hrs,  Volume=             12.7 m³,  Atten= 69%,  Lag= 65.5 min
Primary     =     0.00030 m³/s @    9.03 hrs,  Volume=             12.7 m³
Secondary =       0.00000 m³/s @    0.00 hrs,  Volume=              0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.807 m @ 9.03 hrs   Surf.Area= 3.4 m²   Storage= 3.8 m³

Plug-Flow detention time= 205.4 min calculated for 12.6 m³ (89% of inflow)
Center-of-Mass det. time= 129.2 min ( 772.3 - 643.1 )

Volume       Invert     Avail.Storage   Storage Description
  #1       10.000 m            4.0 m³   900 mm  Round Pipe Storage
                                        L= 6.30 m

Device   Routing          Invert   Outlet Devices
   #1    Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Device 1       10.050 m   10 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #3    Device 1       10.500 m   10 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #4    Secondary      10.890 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Primary OutFlow  Max=0.00030 m³/s @ 9.03 hrs  HW=10.807 m   (Free Discharge)
└─1=Culvert  (Passes 0.00030 m³/s of 0.01093 m³/s potential flow)
   ├─2=Orifice/Grate  (Orifice Controls 0.00018 m³/s @ 2.31 m/s)
   └─3=Orifice/Grate  (Orifice Controls 0.00011 m³/s @ 1.46 m/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└─4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

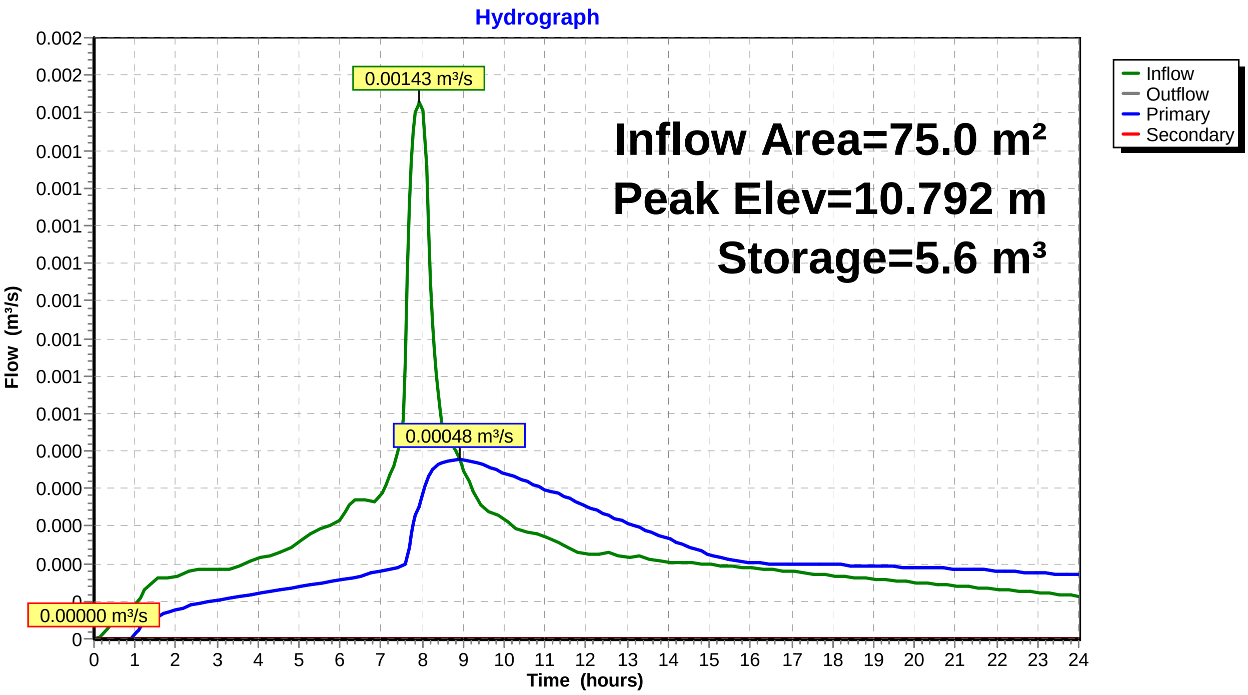
Pond 50P: 4000L 0.9mø underground tank



Summary for Pond 75P: 6000L 0.9mø underground tank

```
Inflow Area =             75.0 m²,100.00% Impervious,  Inflow Depth >    283 mm    for  100yr event
Inflow      =     0.00143 m³/s @     7.94 hrs,  Volume=              21.2 m³
Outflow     =     0.00048 m³/s @     8.91 hrs,  Volume=              18.8 m³,  Atten= 67%,  Lag= 58.5 min
Primary     =     0.00048 m³/s @     8.91 hrs,  Volume=              18.8 m³
Secondary =       0.00000 m³/s @     0.00 hrs,  Volume=               0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.792 m @ 8.91 hrs   Surf.Area= 5.5 m²   Storage= 5.6 m³

Plug-Flow detention time= 205.3 min calculated for 18.8 m³ (89% of inflow)
Center-of-Mass det. time= 123.8 min ( 766.8 - 643.1 )

Volume       Invert     Avail.Storage   Storage Description
   #1      10.000 m            6.0 m³   900 mm  Round Pipe Storage
                                        L= 9.50 m

Device   Routing          Invert   Outlet Devices
   #1    Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Device 1       10.050 m   12 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #3    Device 1       10.500 m   14 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #4    Secondary      10.890 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Primary OutFlow  Max=0.00048 m³/s @ 8.91 hrs  HW=10.792 m   (Free Discharge)
└─1=Culvert  (Passes 0.00048 m³/s of 0.01089 m³/s potential flow)
    ├─2=Orifice/Grate  (Orifice Controls 0.00026 m³/s @ 2.28 m/s)
    └─3=Orifice/Grate  (Orifice Controls 0.00022 m³/s @ 1.42 m/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└─4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

Pond 75P: 6000L 0.9mø underground tank



Summary for Pond 100P: 8000L 0.9mø underground tank

Inflow Area = 100.0 m^2,100.00% Impervious, Inflow Depth > 283 mm for 100yr event
Inflow = 0.00191 m^3/s @ 7.94 hrs, Volume= 28.3 m^3
Outflow = 0.00064 m^3/s @ 8.91 hrs, Volume= 25.3 m^3, Atten= 67%, Lag= 58.3 min
Primary = 0.00064 m^3/s @ 8.91 hrs, Volume= 25.3 m^3
Secondary = 0.00000 m^3/s @ 0.00 hrs, Volume= 0.0 m^3

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.788 m @ 8.91 hrs Surf.Area= 7.5 m^2 Storage= 7.4 m^3

Plug-Flow detention time= 201.4 min calculated for 25.3 m^3 (89% of inflow)
Center-of-Mass det. time= 123.2 min (766.3 - 643.1)

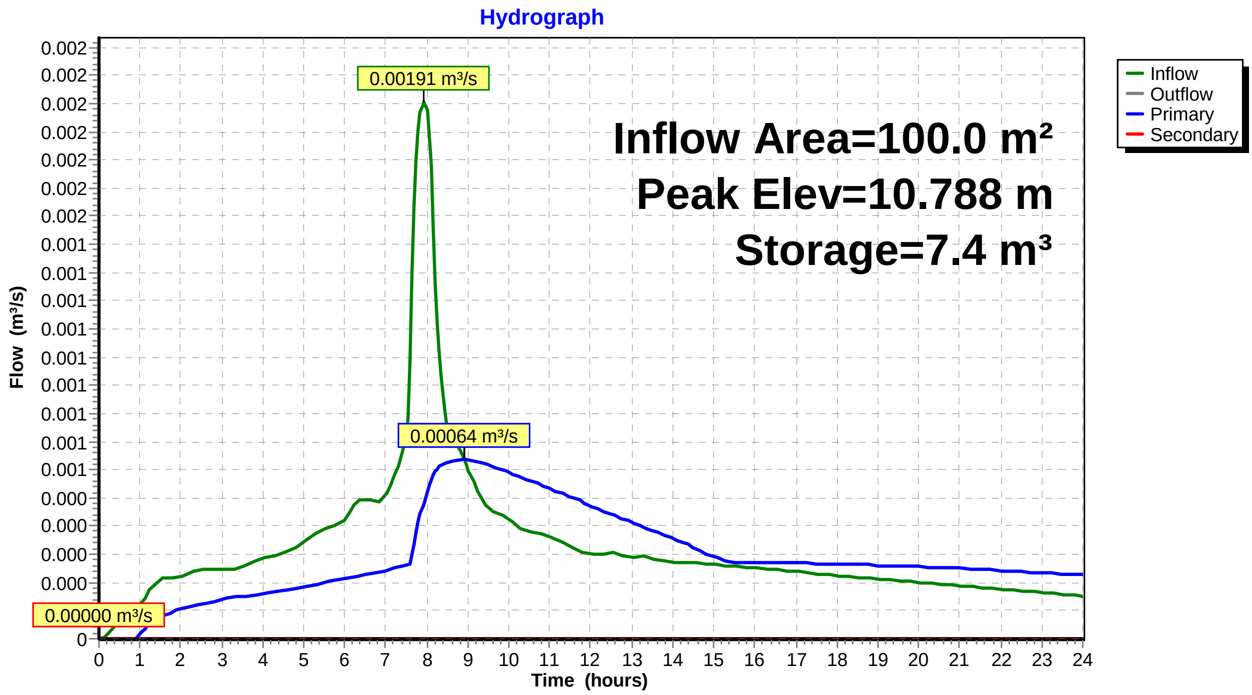
Volume	Invert	Avail.Storage	Storage Description
#1	10.000 m	8.0 m^3	**900 mm Round Pipe Storage** L= 12.60 m

Device	Routing	Invert	Outlet Devices
#1	Primary	9.000 m	**100 mm Round Culvert** L= 60.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 9.000 m / 8.600 m S= 0.0067 m/m Cc= 0.900 n= 0.011 PVC, smooth interior, Flow Area= 0.008 m^2
#2	Device 1	10.050 m	**14 mm Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	10.500 m	**16 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Secondary	10.890 m	**100 mm Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00064 m^3/s @ 8.91 hrs HW=10.788 m (Free Discharge)
└─**1=Culvert** (Passes 0.00064 m^3/s of 0.01088 m^3/s potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.00035 m^3/s @ 2.27 m/s)
  └─**3=Orifice/Grate** (Orifice Controls 0.00029 m^3/s @ 1.43 m/s)

Secondary OutFlow Max=0.00000 m^3/s @ 0.00 hrs HW=10.000 m (Free Discharge)
└─**4=Orifice/Grate** (Controls 0.00000 m^3/s)

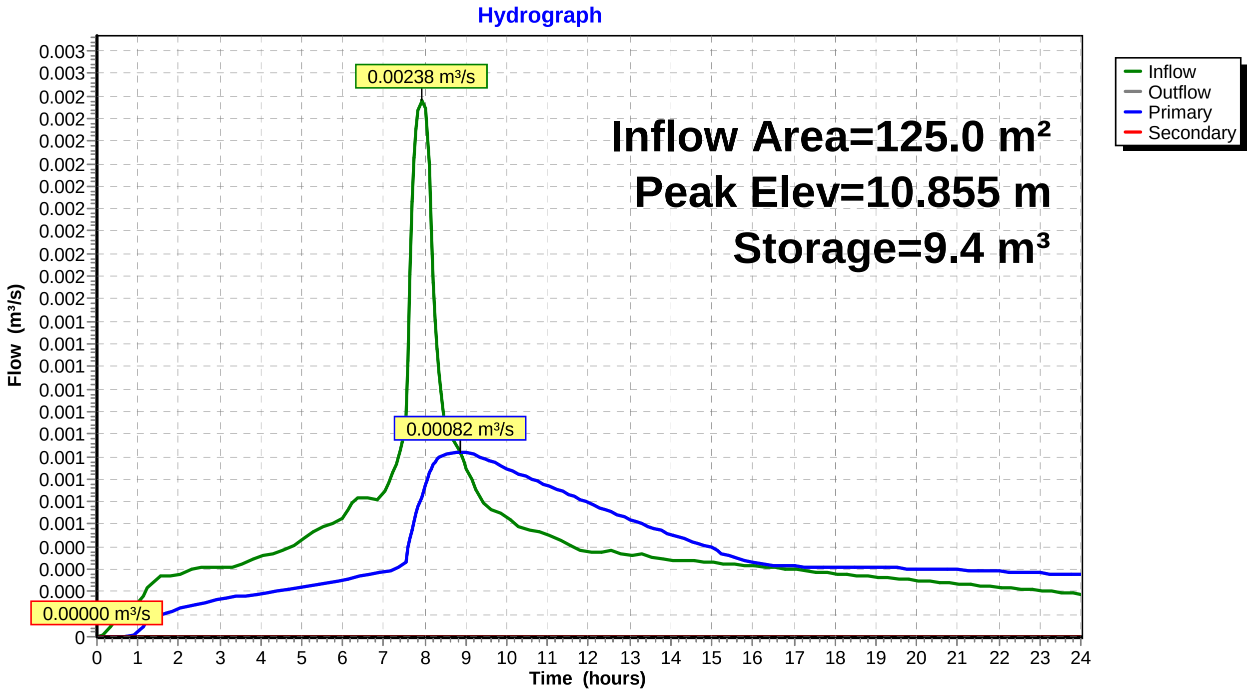
Pond 100P: 8000L 0.9mø underground tank



Summary for Pond 125P: 9500L 0.9mø underground tank

```
Inflow Area =          125.0 m²,100.00% Impervious,  Inflow Depth >    283 mm    for  100yr event
Inflow      =     0.00238 m³/s @    7.94 hrs,  Volume=              35.4 m³
Outflow     =     0.00082 m³/s @    8.85 hrs,  Volume=              31.3 m³,  Atten= 65%,  Lag= 54.9 min
Primary     =     0.00082 m³/s @    8.85 hrs,  Volume=              31.3 m³
Secondary =       0.00000 m³/s @    0.00 hrs,  Volume=               0.0 m³

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 10.855 m @ 8.85 hrs   Surf.Area= 5.9 m²   Storage= 9.4 m³

Plug-Flow detention time= 202.3 min calculated for 31.2 m³ (88% of inflow)
Center-of-Mass det. time= 118.9 min ( 761.9 - 643.1 )

Volume       Invert     Avail.Storage   Storage Description
   #1      10.000 m            9.5 m³   900 mm  Round Pipe Storage
                                        L= 15.00 m

Device   Routing          Invert   Outlet Devices
   #1    Primary         9.000 m   100 mm  Round Culvert
                                   L= 60.00 m   CMP, projecting, no headwall,  Ke= 0.900
                                   Inlet / Outlet Invert= 9.000 m / 8.600 m   S= 0.0067 m/m   Cc=
                                   0.900   n= 0.011  PVC, smooth interior,  Flow Area= 0.008 m²
   #2    Device 1       10.050 m   15 mm Vert. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #3    Device 1       10.500 m   18 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads
   #4    Secondary      10.890 m   100 mm Horiz. Orifice/Grate    C= 0.600
                                   Limited to weir flow at low heads

Primary OutFlow  Max=0.00082 m³/s @ 8.85 hrs  HW=10.855 m   (Free Discharge)
└─1=Culvert  (Passes 0.00082 m³/s of 0.01105 m³/s potential flow)
    ├─2=Orifice/Grate  (Orifice Controls 0.00042 m³/s @ 2.37 m/s)
    └─3=Orifice/Grate  (Orifice Controls 0.00040 m³/s @ 1.58 m/s)

Secondary OutFlow  Max=0.00000 m³/s @ 0.00 hrs  HW=10.000 m   (Free Discharge)
└─4=Orifice/Grate  ( Controls 0.00000 m³/s)
```

Pond 125P: 9500L 0.9mø underground tank



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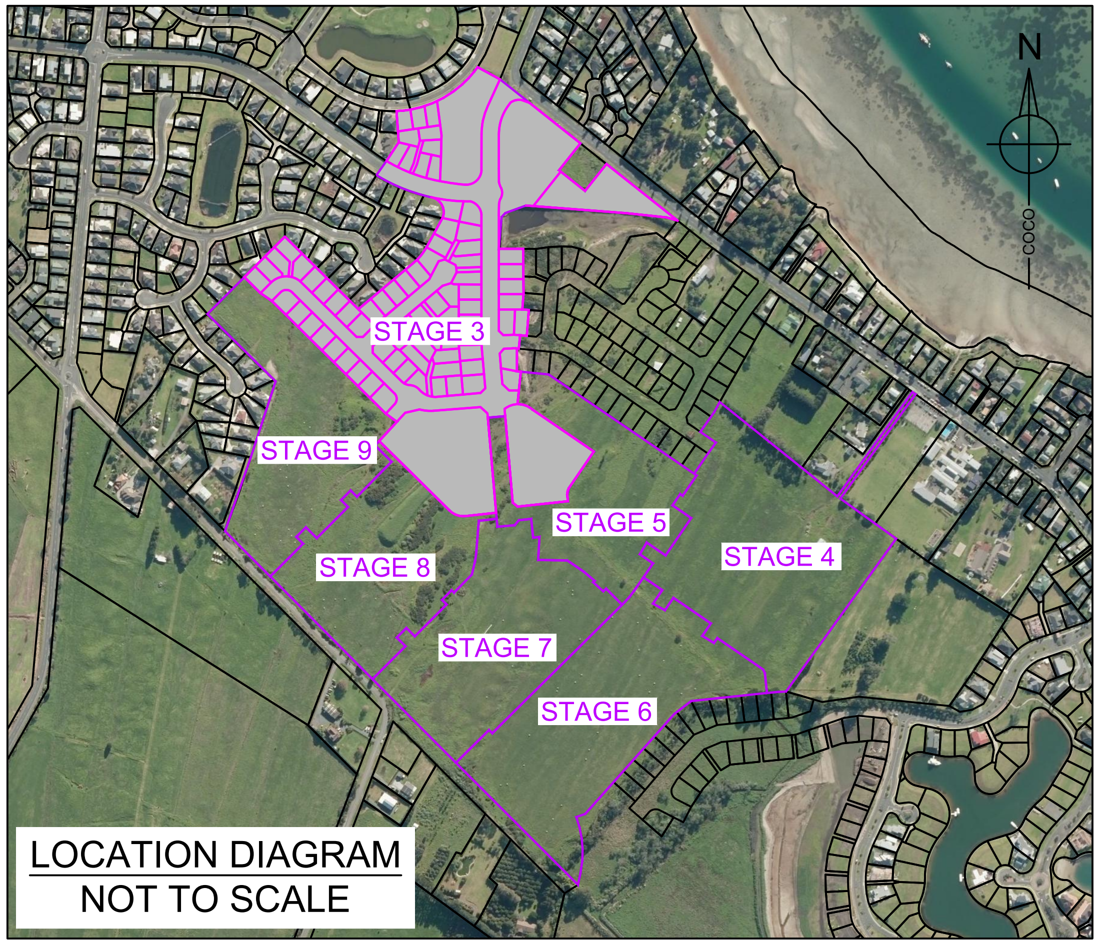
AS BUILT PLANS

FOR WFH PROPERTIES LTD, THE LANDING, STAGE 3, ONE TREE POINT

WDC REF: SD1800110

JOB NO:14333-003
DATE: 26 JUNE 2020



LOCATION DIAGRAM
NOT TO SCALE

DWG NUMBER	REV.
AB000	A

SCHEDULE OF DRAWINGS

SHEET #	TITLE	REV
AB000 - GENERAL		
AB000	COVER SHEET	A
AB001	DRAWING INDEX	A
AB500 - ROADING		
AB500	ROADING LAYOUT OVERVIEW PLAN	B
AB501	ROADING LAYOUT - SHEET 1	B
AB502	ROADING LAYOUT - SHEET 2	B
AB503	ROADING LAYOUT - SHEET 3	B
AB504	ROADING LAYOUT - SHEET 4	B
AB505	ROADING LAYOUT - SHEET 5	B
AB506	ROADING LAYOUT - SHEET 6	B
AB507	ROADING LAYOUT - SHEET 7	B
AB508	ROADING LAYOUT - SHEET 8	B
AB509	ROADING LAYOUT - SHEET 9	A
AB510	ROADING TYPICAL SECTIONS - SHEET 1	A
AB511	ROADING TYPICAL SECTIONS - SHEET 2	A
AB512	ROADING TYPICAL SECTIONS - SHEET 3	A
AB513	COMBINED SERVICE TRENCH DETAILS	A
AB514	TYPICAL ROUNDABOUT & PAVEMENT DETAILS	A
AB515	TYPICAL PAVEMENT DETAILS	A
AB516	TYPICAL KEYSTONE RETAINING WALL DETAILS	A
AB550	LINEMARKING & SIGNPOSTING PLAN - ROUNDABOUT 2	A
AB551	LINEMARKING & SIGNPOSTING PLAN - ROUNDABOUT 1	A
AB552	LINEMARKING & SIGNPOSTING PLAN - ROUNDABOUT 3	A
AB553	LINEMARKING & SIGNPOSTING PLAN - ROUNDABOUT 11	A
AB554	LINEMARKING & SIGNPOSTING PLAN - RDS 4 & 18 INTER	A
AB560	VEHICLE CROSSING - JOAL 711 & 701	A
AB561	VEHICLE CROSSING - JOAL 702, 703 & 716 AND LOT 117	A
AB600 - DRAINAGE		
AB600	STORMWATER LAYOUT OVERVIEW PLAN	B
AB601	STORMWATER LAYOUT - SHEET 1	B
AB602	STORMWATER LAYOUT - SHEET 2	B
AB603	STORMWATER LAYOUT - SHEET 3	B
AB604	STORMWATER LAYOUT - SHEET 4	B
AB605	STORMWATER LAYOUT - SHEET 5	B
AB606	STORMWATER LAYOUT - SHEET 6	B
AB607	STORMWATER LAYOUT - SHEET 7	B
AB610	SANITARY SEWER - OVERVIEW PLAN	B
AB611	SANITARY SEWER - SHEET 1	B
AB612	SANITARY SEWER - SHEET 2	B
AB613	SANITARY SEWER - SHEET 3	B
AB614	SANITARY SEWER - SHEET 4	B
AB615	SANITARY SEWER - SHEET 5	B
AB616	SANITARY SEWER - SHEET 6	B
AB617	SANITARY SEWER - SHEET 7	B
AB618	SANITARY SEWER - SHEET 8	B
AB630	STORMWATER LONGSECTIONS - SHEET 1	A
AB631	STORMWATER LONGSECTIONS - SHEET 2	A
AB632	STORMWATER LONGSECTIONS - SHEET 3	A
AB633	STORMWATER LONGSECTIONS - SHEET 4	A
AB634	STORMWATER LONGSECTIONS - SHEET 5	A
AB635	STORMWATER LONGSECTIONS - SHEET 6	A
AB636	STORMWATER LONGSECTIONS - SHEET 7	A
AB637	STORMWATER LONGSECTIONS - SHEET 8	A
AB638	STORMWATER LONGSECTIONS - SHEET 9	A
AB639	STORMWATER LONGSECTIONS - SHEET 10	A
AB640	STORMWATER LONGSECTIONS - SHEET 11	A
AB641	STORMWATER LONGSECTIONS - SHEET 12	A
AB642	STORMWATER LONGSECTIONS - SHEET 13	A
AB643	STORMWATER LONGSECTIONS - SHEET 14	A
AB644	STORMWATER LONGSECTIONS - SHEET 15	A
AB645	STORMWATER LONGSECTIONS - SHEET 16	A
AB646	STORMWATER LONGSECTIONS - SHEET 17	A
AB647	STORMWATER LONGSECTIONS - SHEET 18	A
AB648	STORMWATER LONGSECTIONS - SHEET 19	A
AB650	SEWER LONGSECTIONS - LINE 1	A
AB651	SEWER LONGSECTIONS - LINE 1	A
AB652	SEWER LONGSECTIONS - LINE 1	A
AB653	SEWER LONGSECTIONS - LINES 2 & 2B	A
AB654	SEWER LONGSECTIONS - LINES 3, 5 & 6	A
AB655	SEWER LONGSECTION - LINES 8 & 9	A
AB670	TYPICAL MANHOLE DETAIL & TYPICAL SUMP DETAIL	A
AB671	TYPICAL INLET AND OUTLET DETAILS	A
AB672	TYPICAL STORMWATER & SEWER CONNECTION DETAIL	A
AB673	TYPICAL TRENCH & HEADWALL DETAILS	A
AB674	TYPICAL HYDRANT & VALVE DETAILS	A
AB675	SANITARY SEWER CONNECTION INTO MANHOLE DETAIL	A
AB676	BOUNDARY KIT WITH EXTENDED STUBS	A
AB677	FLUSHING POINT DETAIL	A
AB678	2010IP SIMPLEX 800 X 2100IP	A
AB679	TYPICAL BRANCH ARRANGEMENT	A
AB700 - POTABLE WATER		
AB700	POTABLE WATER OVERVIEW PLAN	B
AB701	POTABLE WATER - SHEET 1	B
AB702	POTABLE WATER - SHEET 2	B
AB703	POTABLE WATER - SHEET 3	B
AB704	POTABLE WATER - SHEET 4	B
AB705	POTABLE WATER - SHEET 5	B
AB706	POTABLE WATER - SHEET 6	B
AB707	POTABLE WATER - SHEET 7	B
AB708	POTABLE WATER - SHEET 8	B
AB709	POTABLE WATER - SHEET 9	B
AB710	POTABLE WATER - SHEET 10	B
AB711	POTABLE WATER - SHEET 11	B
AB712	POTABLE WATER - SHEET 12	B
AB713	POTABLE WATER - SHEET 13	B
AB720	POTABLE WATER LONGSECTIONS W1 & W2	A
AB721	POTABLE WATER LONGSECTIONS W6	A
AB722	POTABLE WATER LONGSECTIONS W7, W9, W10 & W12	A
AB730 - AB731	POTABLE WATER TYPICAL DETAILS	A
AB800 - ASSET REGISTER		
AB800	STORMWATER ASSET REGISTER - SHEET 1	A
AB801	STORMWATER ASSET REGISTER - SHEET 2	A
AB802	STORMWATER ASSET REGISTER - SHEET 3	A
AB803	STORMWATER ASSET REGISTER - SHEET 4	A
AB804	STORMWATER ASSET REGISTER - SHEET 5	A
AB805	STORMWATER ASSET REGISTER - SHEET 6	A
AB806	STORMWATER ASSET REGISTER - SHEET 7	A
AB807	STORMWATER ASSET REGISTER - SHEET 8	A
AB808	STORMWATER ASSET REGISTER - SHEET 9	A
AB809	STORMWATER ASSET REGISTER - SHEET 10	A
AB810	STORMWATER ASSET REGISTER - SHEET 11	A
AB811	SEWER ASSET REGISTER - SHEET 1	A
AB812	SEWER ASSET REGISTER - SHEET 2	A
AB813	SEWER ASSET REGISTER - SHEET 3	A
AB814	WATER ASSET REGISTER - SHEET 1	A
AB815	WATER ASSET REGISTER - SHEET 2	A
AB816	WATER ASSET REGISTER - SHEET 3	A
AB817	WATER ASSET REGISTER - SHEET 4	A

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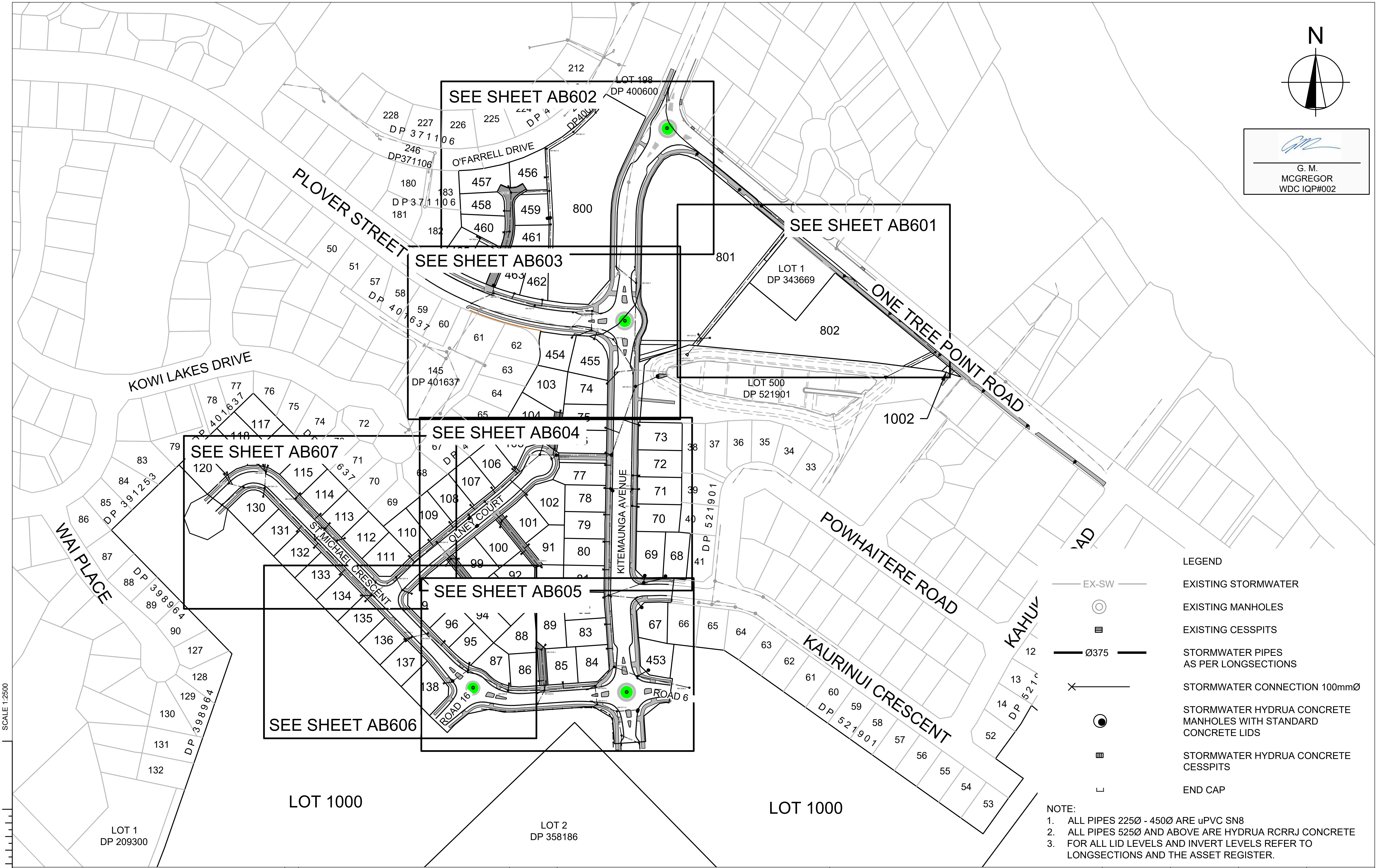
REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE 26-06-20	KH	GM

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
DRAWING INDEX

DATE CREATED: 26-06-2020
DRAWN: K HANSARD
DESIGNED: -
APPROVED: G McGREGOR
CCL REF NO: 14333-003
SCALE: NTS @ A3
STATUS: AS BUILTS
DWG NUMBER: AB001
REVISION: A

DO NOT REPRODUCE WITHOUT WRITTEN AUTHORITY



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SCALE 1:2500
100
50
0

LEGEND

EX-SW	EXISTING STORMWATER
◎	EXISTING MANHOLES
▤	EXISTING CESSPITS
Ø375	STORMWATER PIPES AS PER LONGSECTIONS
×	STORMWATER CONNECTION 100mmØ
◉	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
⌴	END CAP

NOTE:
1. ALL PIPES 225Ø - 450Ø ARE uPVC SN8
2. ALL PIPES 525Ø AND ABOVE ARE HYDRUA RCRRJ CONCRETE
3. FOR ALL LID LEVELS AND INVERT LEVELS REFER TO LONGSECTIONS AND THE ASSET REGISTER.

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B	AS BUILT REVISED FOR WDC	26-06-20 KH	GMcG
A	1ST ISSUE	19-06-20 KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER PLAN - OVERVIEW

DATE CREATED 19-06-2020
DRAWN K HANSARD
DESIGNED -
APPROVED G McGREGOR
CCL REF NO 14333-003
SCALE 1:2500 @ A3
STATUS AS BUILTS
DWG NUMBER AB600
REVISION B

0 50 100 SCALE 1:2500

DATE PLOTTED: Thursday, 25 June 2020 11:26:17 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB600-SW Plan.dwg

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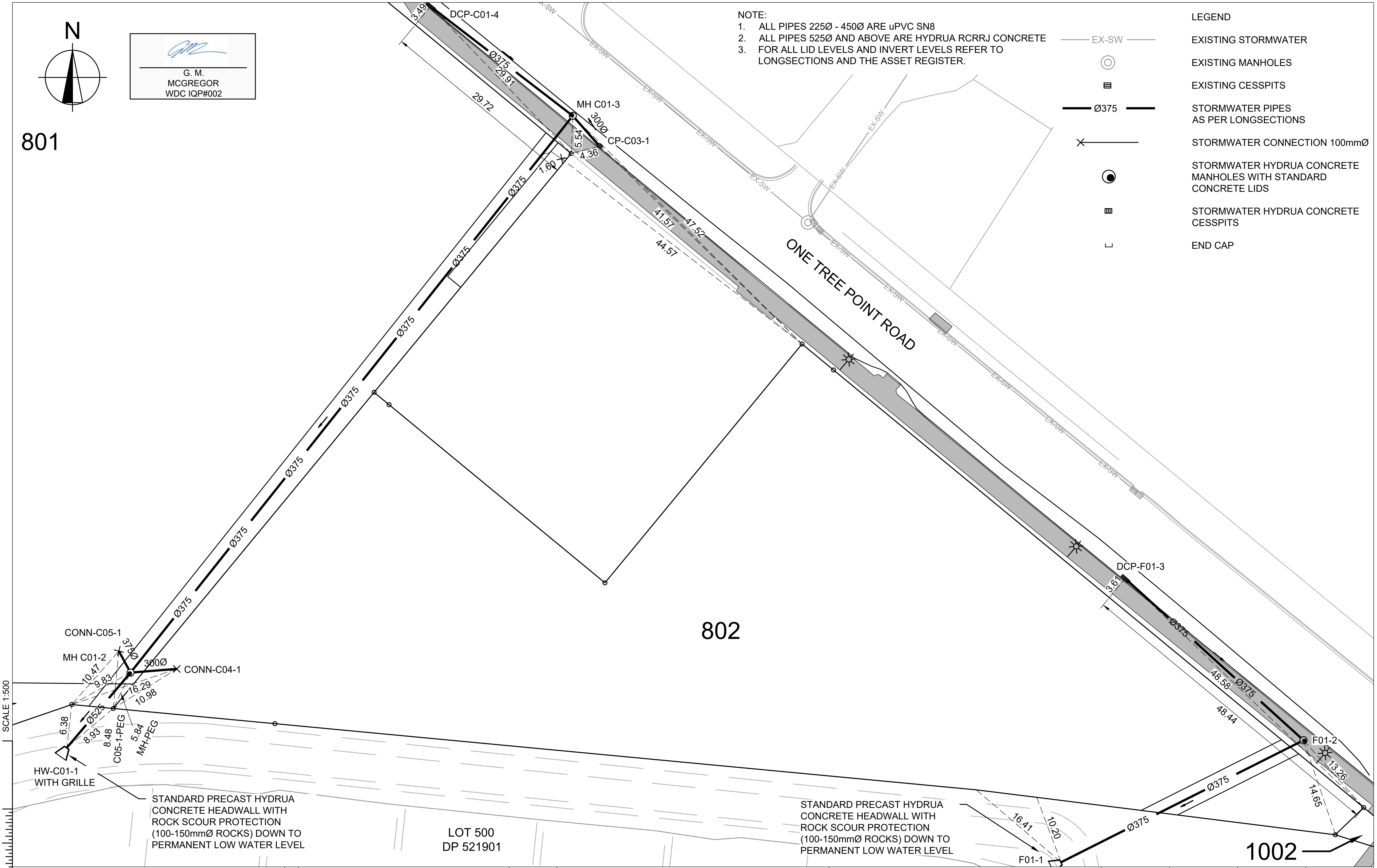

STANDARD PRECAST HYDRUA CONCRETE HEADWALL WITH ROCK SCOUR PROTECTION (100-150mmØ ROCKS) DOWN TO PERMANENT LOW WATER LEVEL

STANDARD PRECAST HYDRUA CONCRETE HEADWALL WITH ROCK SCOUR PROTECTION (100-150mmØ ROCKS) DOWN TO PERMANENT LOW WATER LEVEL

NOTE:
1. ALL PIPES 225Ø - 450Ø ARE uPVC SN8
2. ALL PIPES 525Ø AND ABOVE ARE HYDRUA RCRRJ CONCRETE
3. FOR ALL LID LEVELS AND INVERT LEVELS REFER TO LONGSECTIONS AND THE ASSET REGISTER.

LEGEND

EX-SW	EXISTING STORMWATER
◎	EXISTING MANHOLES
▤	EXISTING CESSPITS
Ø375	STORMWATER PIPES AS PER LONGSECTIONS
✕	STORMWATER CONNECTION 100mmØ
◉	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
⊔	END CAP

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C			
B	AS BUILT REVISED FOR WDC	26-06-20 KH	GMcG
A	1ST ISSUE	19-06-20 KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LAYOUT - SHEET 1

DATE CREATED	DRAWN	DESIGNED	APPROVED
19-06-2020	K HANSARD	-	G McGREGOR

CCL REF NO	SCALE	STATUS
14333-003	1:500 @ A3	AS BUILTS

DWG NUMBER	REVISION
AB601	B

SCALE 1:500
0 10 20

DATE PLOTTED: Thursday, 25 June 2020 11:25:38 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB600-SW Plan.dwg

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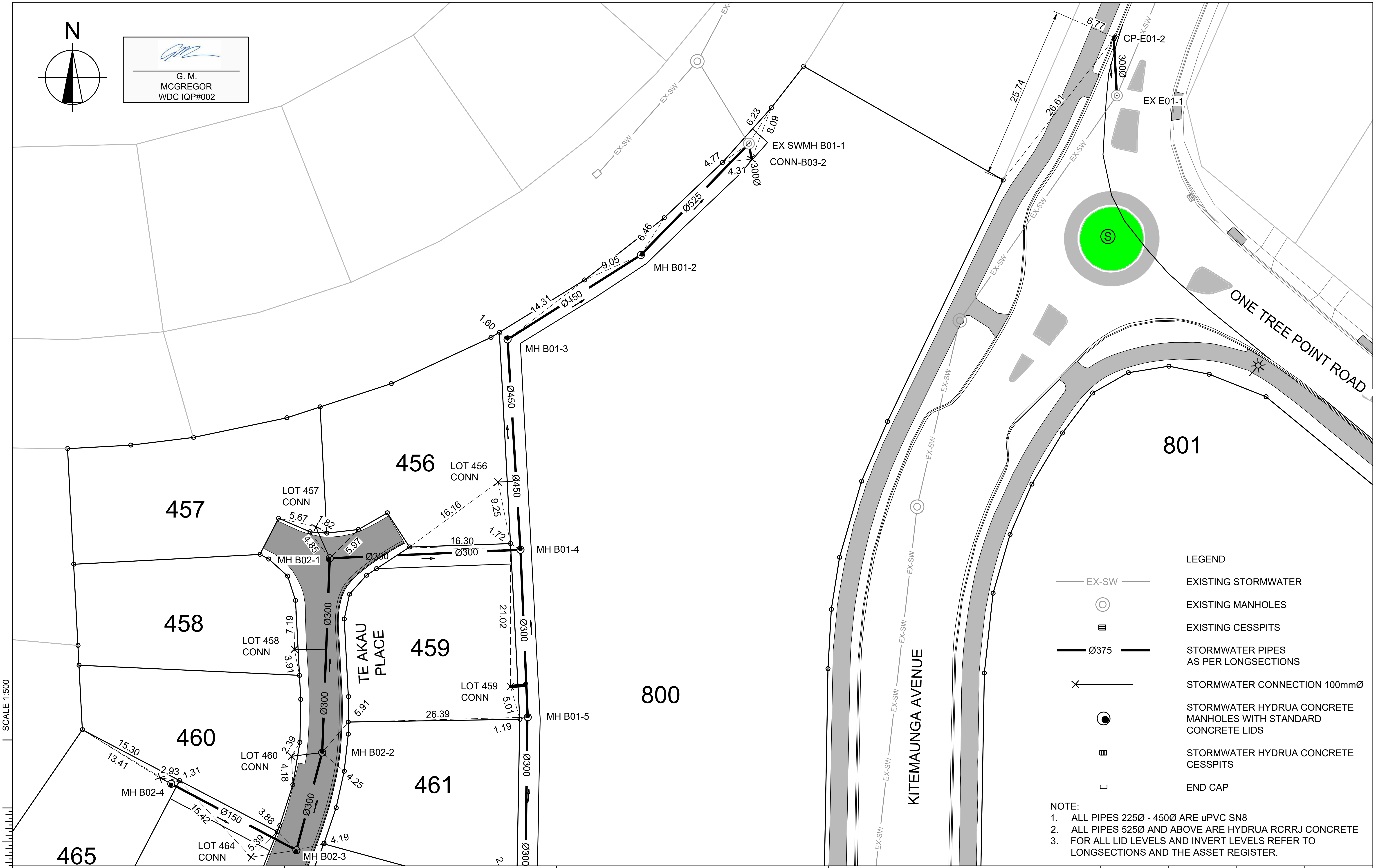

LEGEND

EX-SW	EXISTING STORMWATER
◎	EXISTING MANHOLES
▤	EXISTING CESSPITS
Ø375	STORMWATER PIPES AS PER LONGSECTIONS
×	STORMWATER CONNECTION 100mmØ
◉	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
⊔	END CAP

NOTE:
1. ALL PIPES 225Ø - 450Ø ARE uPVC SN8
2. ALL PIPES 525Ø AND ABOVE ARE HYDRUA RCRRJ CONCRETE
3. FOR ALL LID LEVELS AND INVERT LEVELS REFER TO LONGSECTIONS AND THE ASSET REGISTER.

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B	AS BUILT REVISED FOR WDC 26-06-20	KH	GMcG
A	1ST ISSUE 19-06-20	KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LAYOUT - SHEET 2

DATE CREATED	DRAWN	DESIGNED	APPROVED
19-06-2020	K HANSARD	-	G McGREGOR
CCL REF NO	SCALE	STATUS	
14333-003	1:500 @ A3	AS BUILTS	
DWG NUMBER		REVISION	
AB602		B	

SCALE 1:500
0 10 20

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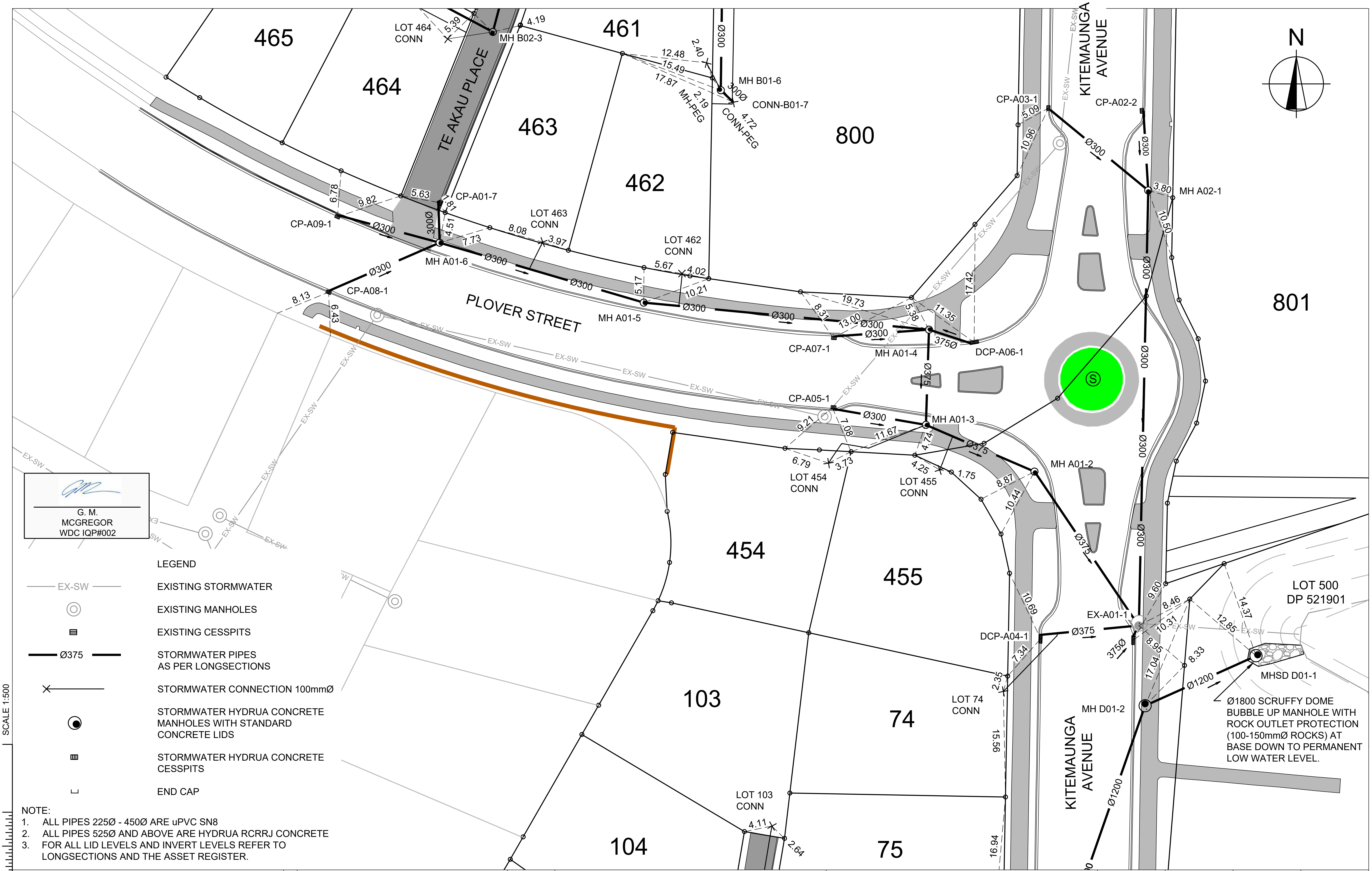

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WDC IQP#002

LEGEND

— EX-SW —	EXISTING STORMWATER
◎	EXISTING MANHOLES
▤	EXISTING CESSPITS
━ Ø375 ━	STORMWATER PIPES AS PER LONGSECTIONS
×—	STORMWATER CONNECTION 100mmØ
◉	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
⊔	END CAP

NOTE:
1. ALL PIPES 225Ø - 450Ø ARE uPVC SN8
2. ALL PIPES 525Ø AND ABOVE ARE HYDRUA RCRRJ CONCRETE
3. FOR ALL LID LEVELS AND INVERT LEVELS REFER TO LONGSECTIONS AND THE ASSET REGISTER.

SCALE 1:500
0 10 20

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B	AS BUILT REVISED FOR WDC	26-06-20 KH	GMcG
A	1ST ISSUE	19-06-20 KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LAYOUT - SHEET 3

DATE CREATED	DRAWN	DESIGNED	APPROVED
19-06-2020	K HANSARD	-	G McGREGOR

CCL REF NO	SCALE	STATUS
14333-003	1:500 @ A3	AS BUILTS

DWG NUMBER	REVISION
AB603	B

SCALE 1:500
0 10 20

DATE PLOTTED: Thursday, 25 June 2020 11:25:39 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB600-SW Plan.dwg

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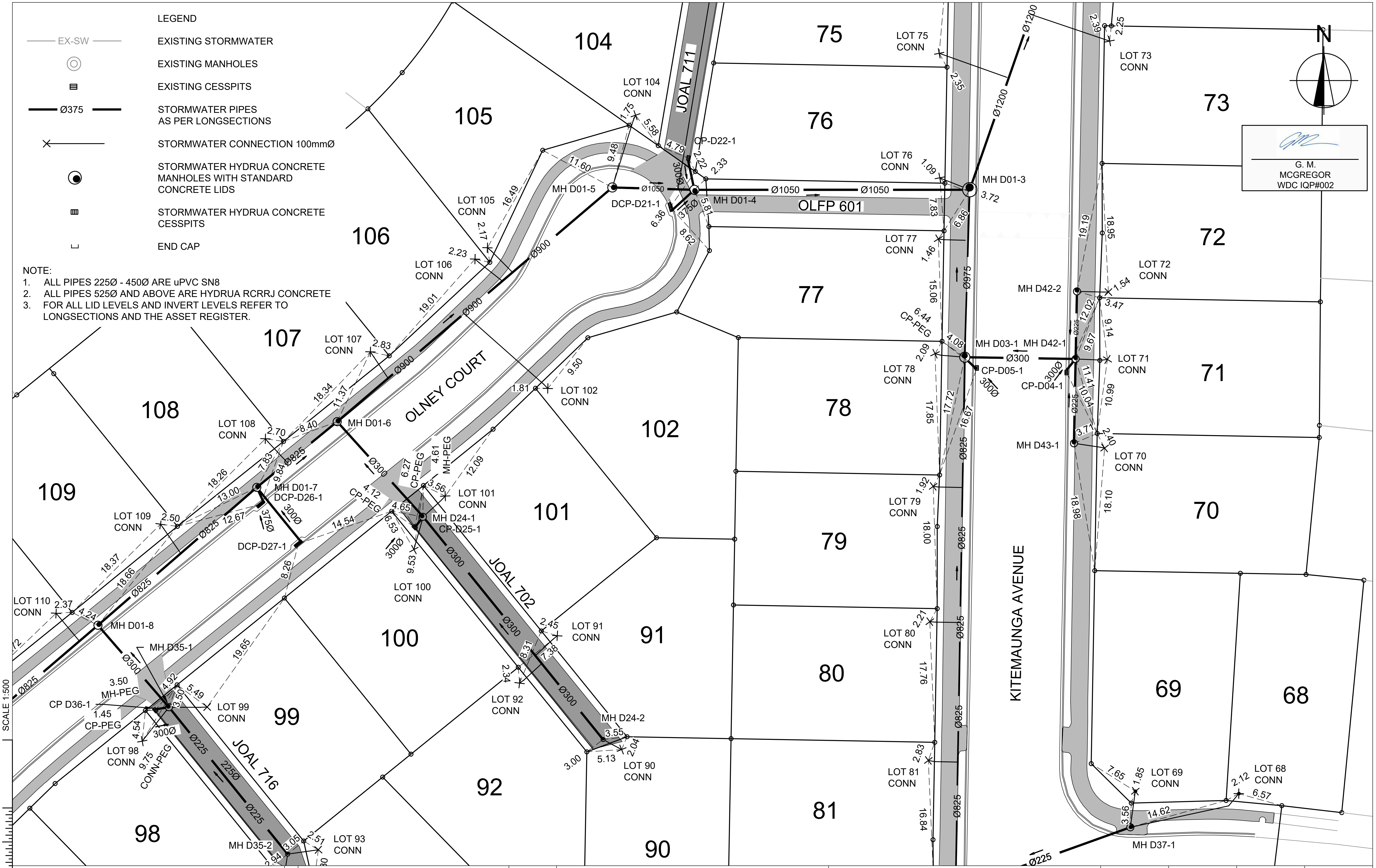
LEGEND

— EX-SW —	EXISTING STORMWATER
◎	EXISTING MANHOLES
▤	EXISTING CESSPITS
—Ø375—	STORMWATER PIPES AS PER LONGSECTIONS
×——	STORMWATER CONNECTION 100mmØ
◉	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
⊔	END CAP

NOTE:

1. ALL PIPES 225Ø - 450Ø ARE uPVC SN8
2. ALL PIPES 525Ø AND ABOVE ARE HYDRUA RCRRJ CONCRETE
3. FOR ALL LID LEVELS AND INVERT LEVELS REFER TO LONGSECTIONS AND THE ASSET REGISTER.



C			
B	AS BUILT REVISED FOR WDC	26-06-20	KH GMcG
A	1ST ISSUE	19-06-20	KH GMcG
REV.	REVISION DETAILS	DRAWN	APP.

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WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LAYOUT - SHEET 4

DATE CREATED 19-06-2020	DRAWN K HANSARD	DESIGNED -	APPROVED G McGREGOR
CCL REF NO 14333-003	SCALE 1:500 @ A3		STATUS AS BUILTS
DWG NUMBER AB604			REVISION B

SCALE 1:500 0 10 20

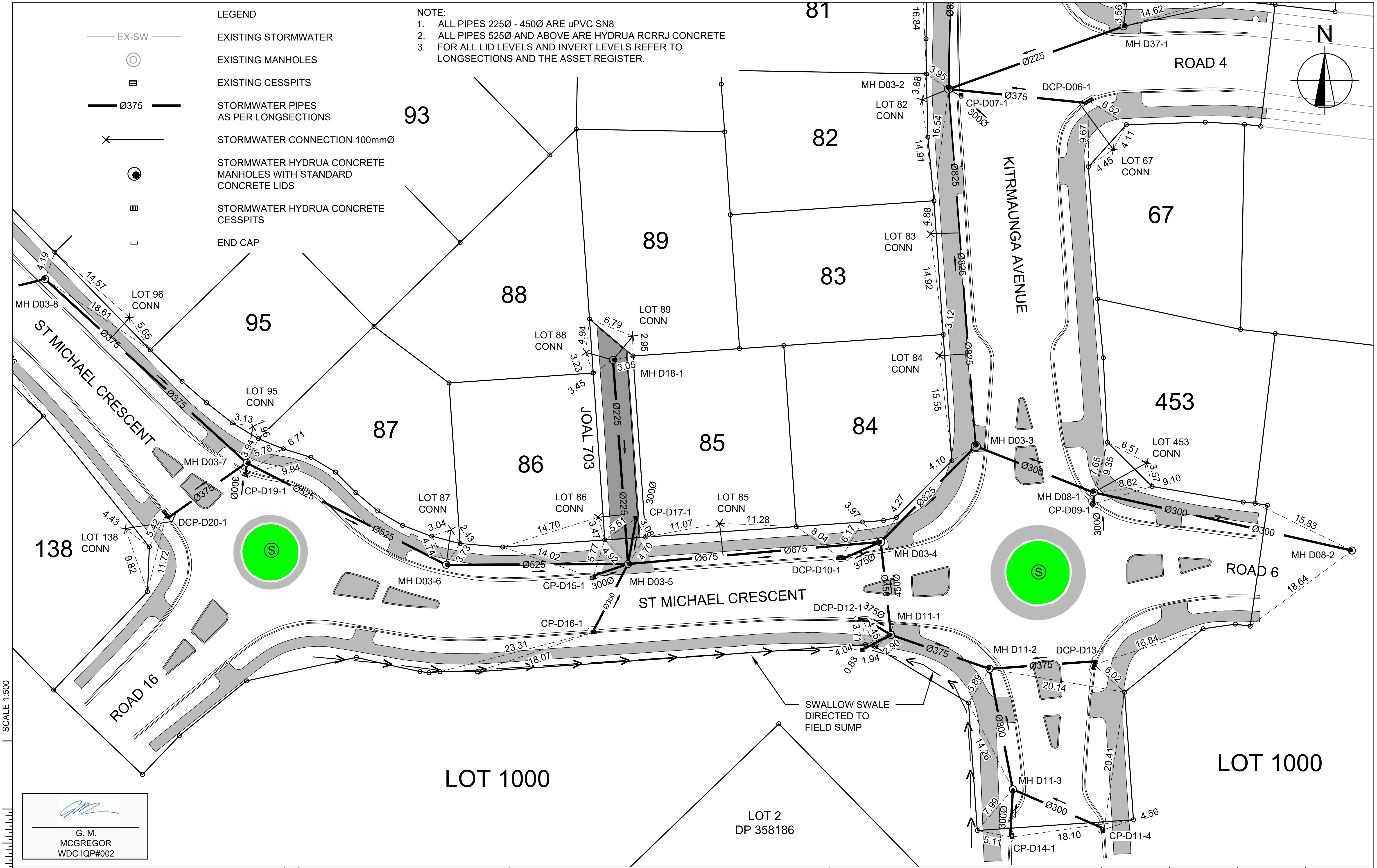
DATE PLOTTED: Thursday, 25 June 2020 11:25:40 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB600-SW Plan.dwg

DO NOT REPRODUCE WITHOUT WRITTEN AUTHORITY

LEGEND

— EX-SW —	EXISTING STORMWATER
◎	EXISTING MANHOLES
▤	EXISTING CESSPITS
— Ø375 —	STORMWATER PIPES AS PER LONGSECTIONS
×—	STORMWATER CONNECTION 100mmØ
◉	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
⊔	END CAP

NOTE:
1. ALL PIPES 225Ø - 450Ø ARE uPVC SN8
2. ALL PIPES 525Ø AND ABOVE ARE HYDRUA RCRRJ CONCRETE
3. FOR ALL LID LEVELS AND INVERT LEVELS REFER TO LONGSECTIONS AND THE ASSET REGISTER.



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WDC IQP#002

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B	AS BUILT REVISED FOR WDC	26-06-20 KH	GMcG
A	1ST ISSUE	19-06-20 KH	GMcG

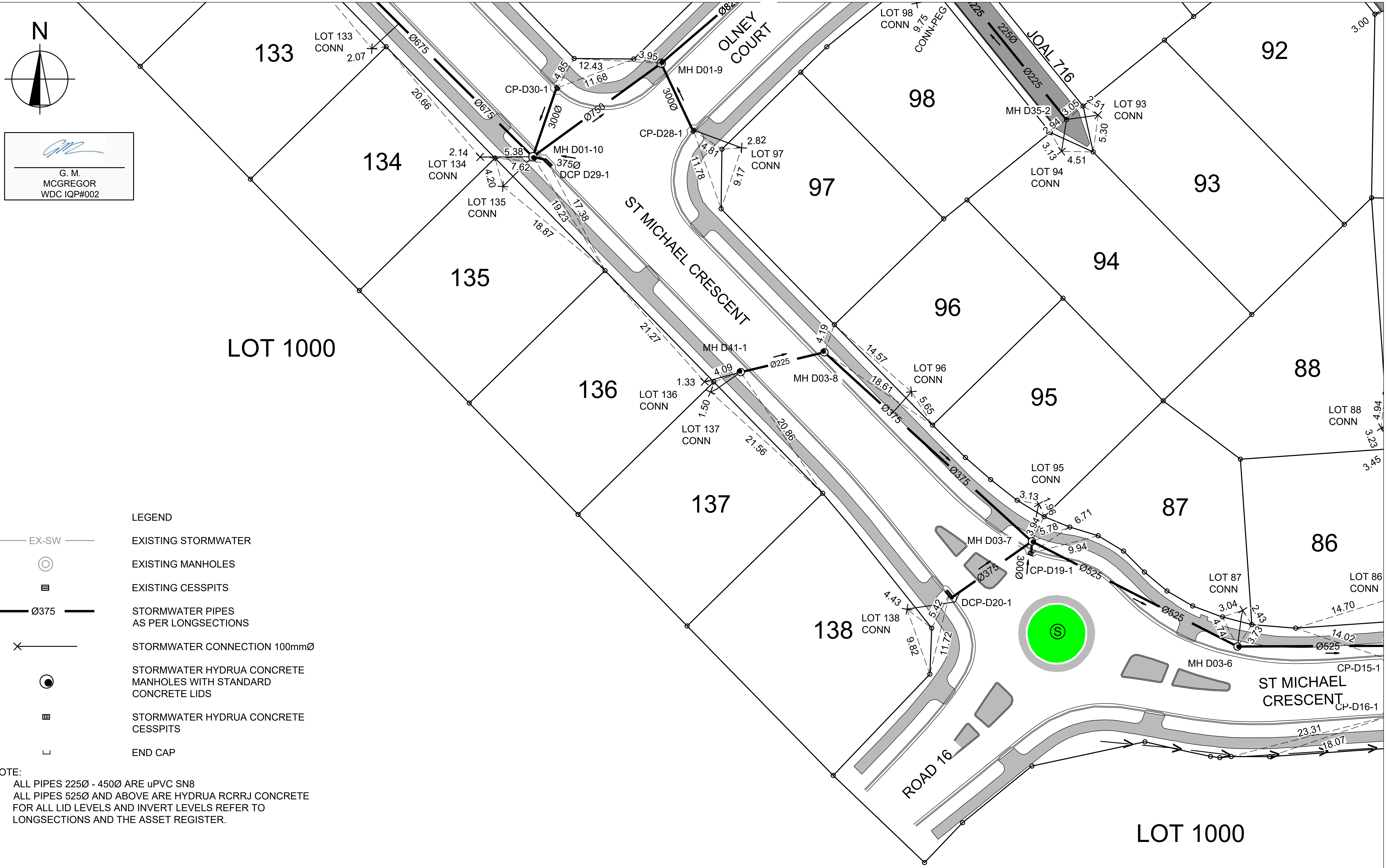
PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LAYOUT - SHEET 5

DATE CREATED	DRAWN	DESIGNED	APPROVED
19-06-2020	K HANSARD	-	G McGREGOR
CCL REF NO	SCALE		STATUS
14333-003	1:500 @ A3		AS BUILTS
DWG NUMBER			REVISION
AB605			B

0 10 20 SCALE 1:500

DATE PLOTTED: Thursday, 25 June 2020 11:25:40 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB600-SW Plan.dwg



G. M. MCGREGOR
WDC IQP#002

LEGEND

—— EX-SW ——	EXISTING STORMWATER
◎	EXISTING MANHOLES
▤	EXISTING CESSPITS
▬ Ø375 ▬	STORMWATER PIPES AS PER LONGSECTIONS
×——	STORMWATER CONNECTION 100mmØ
⊙	STORMWATER HYDRUA CONCRETE MANHOLES WITH STANDARD CONCRETE LIDS
▥	STORMWATER HYDRUA CONCRETE CESSPITS
⊔	END CAP

NOTE:
1. ALL PIPES 225Ø - 450Ø ARE uPVC SN8
2. ALL PIPES 525Ø AND ABOVE ARE HYDRUA RCRRJ CONCRETE
3. FOR ALL LID LEVELS AND INVERT LEVELS REFER TO LONGSECTIONS AND THE ASSET REGISTER.

SCALE 1:500
0 10 20

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B	AS BUILT REVISED FOR WDC 26-06-20	KH	GMcG
A	1ST ISSUE 19-06-20	KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LAYOUT - SHEET 6

DATE CREATED	DRAWN	DESIGNED	APPROVED
19-06-2020	K HANSARD	-	G McGREGOR

CCL REF NO: 14333-003
SCALE: 1:500 @ A3
STATUS: AS BUILTS
DWG NUMBER: AB606
REVISION: B

SCALE 1:500
0 10 20

DATE PLOTTED: Thursday, 25 June 2020 11:25:41 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB600-SW Plan.dwg

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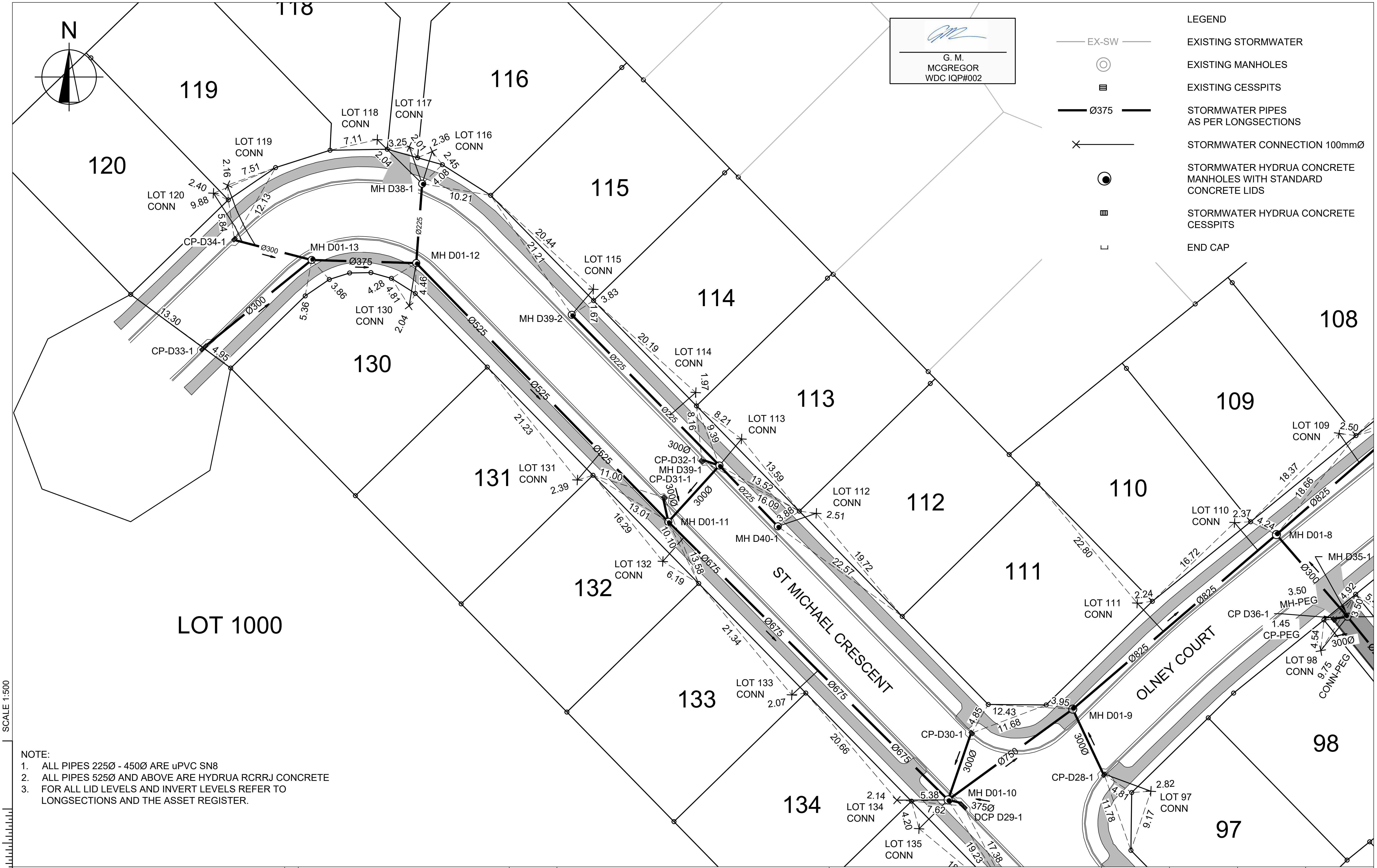

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WDC IQP#002

NOTE:
1. ALL PIPES 225Ø - 450Ø ARE uPVC SN8
2. ALL PIPES 525Ø AND ABOVE ARE HYDRUA RCRRJ CONCRETE
3. FOR ALL LID LEVELS AND INVERT LEVELS REFER TO LONGSECTIONS AND THE ASSET REGISTER.

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B	AS BUILT REVISED FOR WDC	26-06-20 KH	GMcG
A	1ST ISSUE	19-06-20 KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LAYOUT - SHEET 6

DATE CREATED: 19-06-2020
DRAWN: K HANSARD
DESIGNED: -
APPROVED: G McGREGOR
CCL REF NO: 14333-003
SCALE: 1:500 @ A3
STATUS: AS BUILTS
DWG NUMBER: AB607
REVISION: B

SCALE 1:500
0 10 20

DATE PLOTTED: Thursday, 25 June 2020 11:25:41 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB600-SW Plan.dwg

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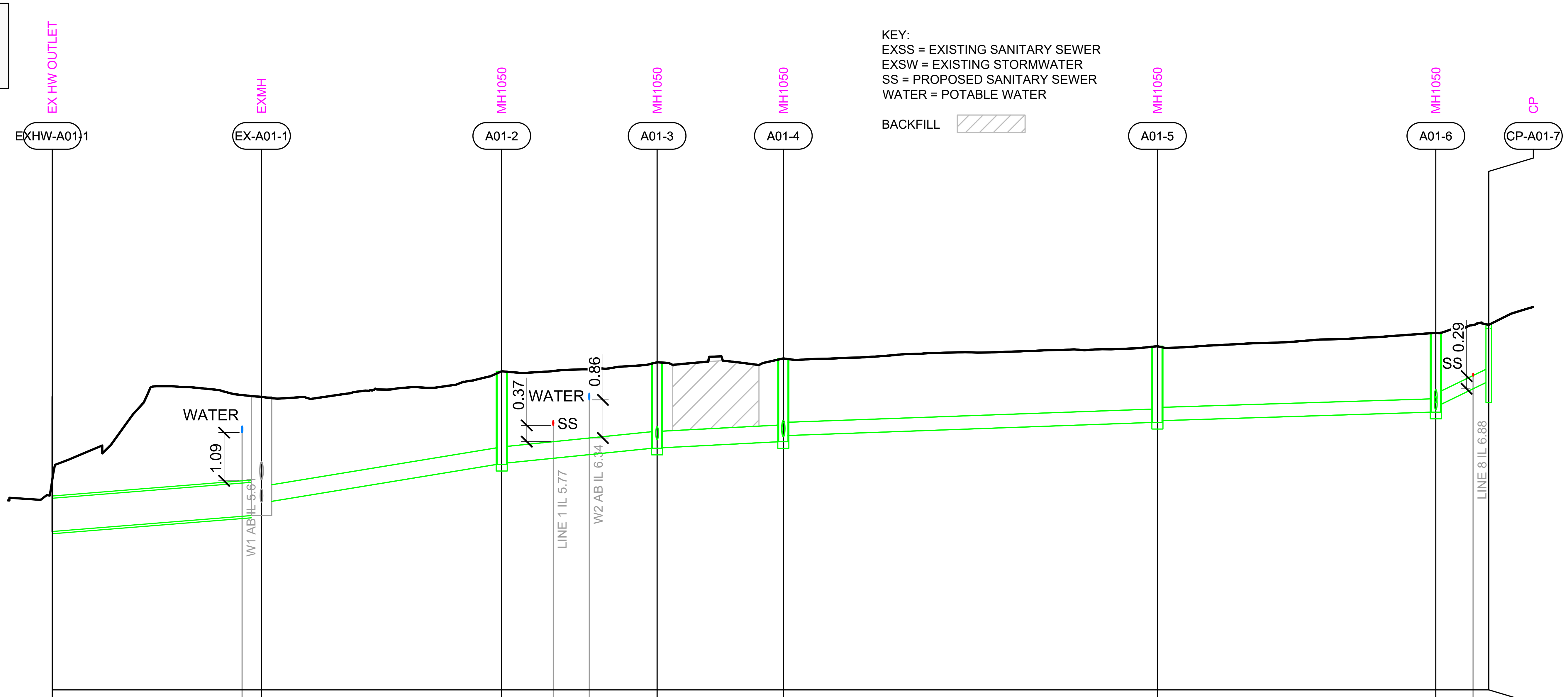
WDC IQP#002



Pipe Size/Type	Ø750 RCRRJ Class 4	Ø375 uPVC SN8	Ø375 uPVC SN8	Ø375 uPVC SN8	Ø300 uPVC SN8	Ø300 uPVC SN8	Ø300 uPVC SN8
Grade (%)	1.52%	3.08%	1.91%	0.96%	0.7%	0.61%	8.34%
Datum	-4.000						

Depth To Invert	3.038 3.038		2.679 2.359	2.100 2.070			1.940 1.930	1.880 1.740	1.720 1.680	1.790 1.620		1.303 1.753
Invert Levels	3.374 3.374		3.733 4.053	4.888 4.918	5.03	5.11	5.252 5.262	5.399 5.539	5.835 5.875	6.066 6.236	6.59	6.734 6.284
Finished Surface	6.412		6.412	6.988			7.192	7.279	7.555	7.856		8.037
Chainage	0.000	21.42 21.42	23.605	50.699	5.82 56.52	9.88 60.58	68.224	82.459	124.648	156.048	4.21 160.25	162.021

LINE A01

SCALE 1:100
4
2
0

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE	??-??-?? KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINE A01

DATE CREATED	DRAWN	DESIGNED	APPROVED
???	K HANSARD	???	G McGREGOR

CCL REF NO	SCALE	STATUS
14333-003	1:500H 1:100V @ A3	AS BUILTS

DWG NUMBER	REVISION
AB630	A

0 10 20 SCALE 1:500

DATE PLOTTED: Thursday, 25 June 2020 11:25:48 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB630-SW LS.dwg

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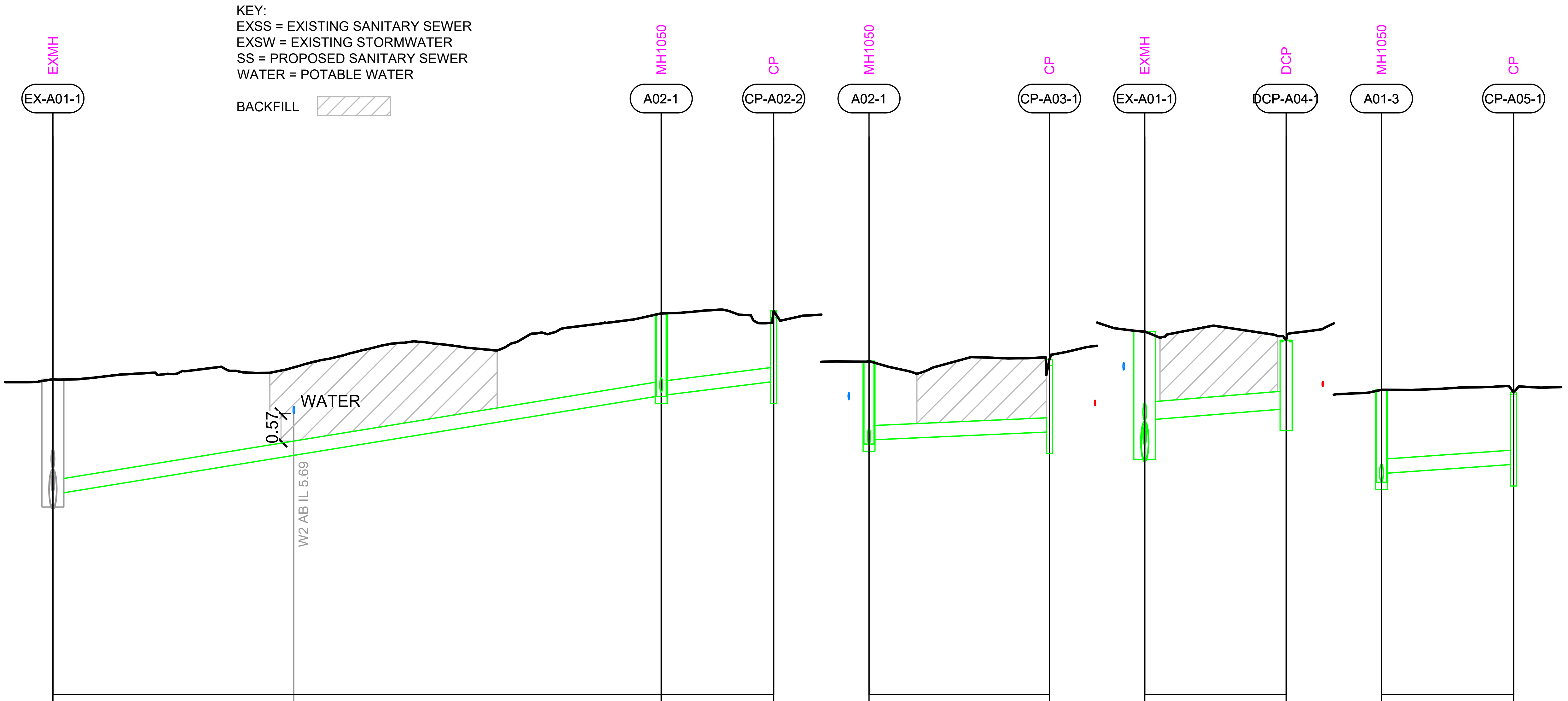

LINE A02

Pipe Size/Type		Ø300 uPVC SN8				Ø300 uPVC SN8		
Grade (%)		3.17%				2.32%		
Datum		-4.000						
Depth To Invert	2.679	2.380			1.740	1.710	1.490	1.940
Invert Levels	3.733	4.032		4.82	6.053	6.083	6.357	5.907
Finished Surface		6.412				7.793		7.847
Chainage		0.000	25.27	25.27		63.822		75.622

LINE A03

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		0.85%		
Datum		-3.000		
Depth To Invert	1.740	1.650	1.525	1.975
Invert Levels	6.053	6.143	6.304	5.854
Finished Surface		7.793		7.829
Chainage		0.000		18.932

LINE A04

Pipe Size/Type		Ø375 uPVC SN8		
Grade (%)		1.42%		
Datum		-5.000		
Depth To Invert	2.679	1.840	1.450	1.900
Invert Levels	3.733	4.572	4.783	4.333
Finished Surface		6.412		6.233
Chainage		0.000		14.833

LINE A05

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		1.31%		
Datum		-3.000		
Depth To Invert	1.940	1.750	1.510	1.960
Invert Levels	5.252	5.442	5.623	5.173
Finished Surface		7.192		7.133
Chainage		0.000		13.865

SCALE 1:100
0 2 4

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0 10 20 SCALE 1:500

REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE	??-??-?? KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINES A02, A03, A04 & A05

DATE CREATED	DRAWN	DESIGNED	APPROVED
???	K HANSARD	???	G McGREGOR
CCL REF NO	SCALE		STATUS
14333-003	1:500H 1:100V @ A3		AS BUILTS
DWG NUMBER			REVISION
AB631			A

DATE PLOTTED: Thursday, 25 June 2020 11:25:49 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB630-SW LS.dwg

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KEY:
EXSS = EXISTING SANITARY SEWER
EXSW = EXISTING STORMWATER
SS = PROPOSED SANITARY SEWER
WATER = POTABLE WATER

BACKFILL ▨

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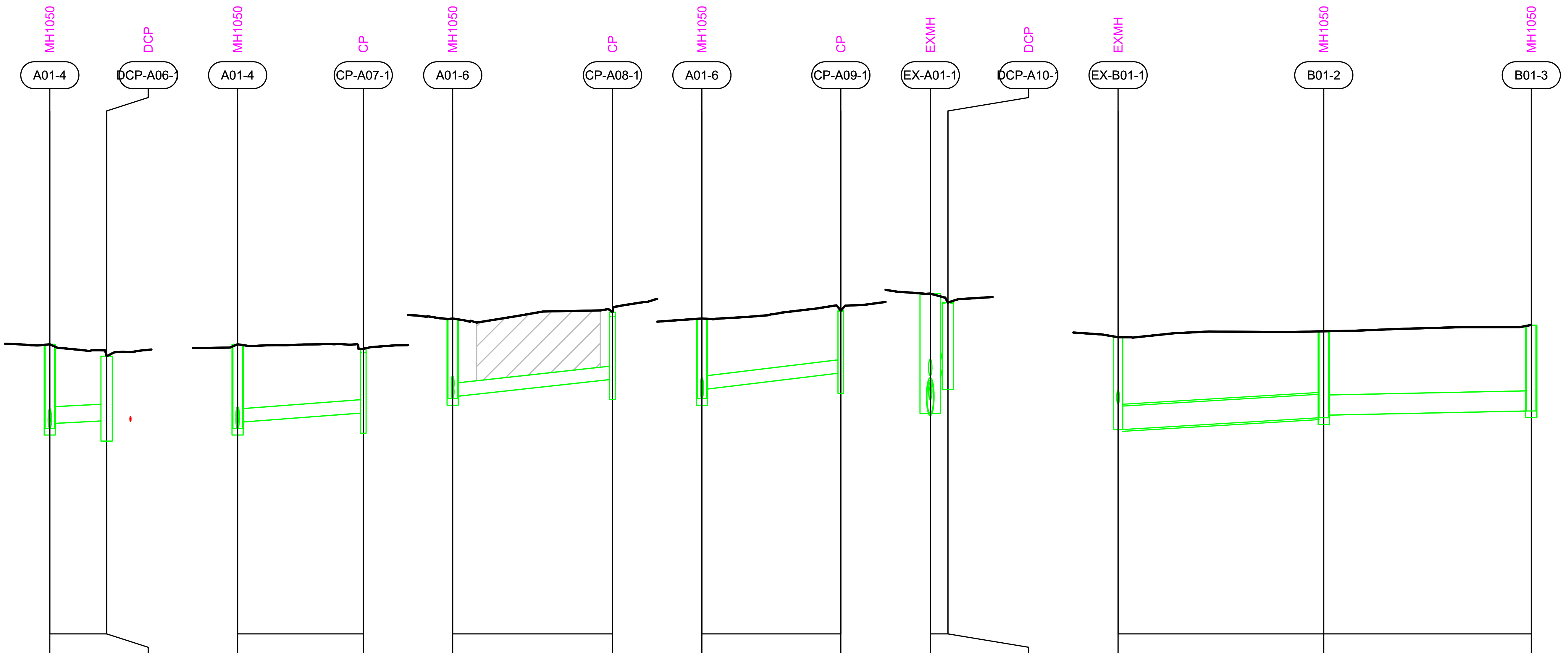
WDC IQP#002



	LINE A06	LINE A07	LINE A08	LINE A09	LINE A10	LINE B01
Pipe Size/Type	Ø375 uPVC SN8	Ø300 uPVC SN8	Ø300 uPVC SN8	Ø300 uPVC SN8	Ø375 uPVC SN8	Ø525 RCRRJ Class 4 Ø450 uPVC SN8
Grade (%)	0.85%	1.42%	2.09%	2.29%	9.11%	1.14% 0.4%
Datum	-3.000	-3.000	-3.000	-3.000	-5.000	-2.000
Depth To Invert	1.880 1.770 1.450 1.900	1.880 1.740 1.440 1.890	1.790 1.740 1.510 1.960	1.790 1.580 1.400 1.850	2.679 1.870 1.490 1.940	2.060 2.060 1.930 1.870 1.920
Invert Levels	5.399 5.509 5.563 5.113	5.399 5.539 5.739 5.289	6.066 6.116 6.489 6.039	6.066 6.276 6.631 6.181	3.733 4.542 4.722 4.272	6.372 6.372 6.635 6.695 6.787
Finished Surface	7.279 7.013	7.279 7.179	7.856 7.999	7.856 8.031	6.412 6.212	8.432 8.565 8.707
Chainage	0.000 6.356	0.000 14.046	0.000 17.867	0.000 15.535	0.000 1.975	0.000 22.998 46.199

LINE A06 LINE A07 LINE A08 LINE A09 LINE A10 LINE B01

SCALE 1:100

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE ??-??-??	KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINES A06,A07,A08, A09, A10 & B01

DATE CREATED	DRAWN	DESIGNED	APPROVED
???	K HANSARD	???	G McGREGOR

CCL REF NO: 14333-003
SCALE: 1:500H 1:100V @ A3
STATUS: AS BUILTS
DWG NUMBER: AB632
REVISION: A

SCALE 1:500

DATE PLOTTED: Thursday, 25 June 2020 11:25:49 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB630-SW LS.dwg

DO NOT REPRODUCE WITHOUT WRITTEN AUTHORITY

KEY:
EXSS = EXISTING SANITARY SEWER
EXSW = EXISTING STORMWATER
SS = PROPOSED SANITARY SEWER
WATER = POTABLE WATER

BACKFILL ▨

G. M.
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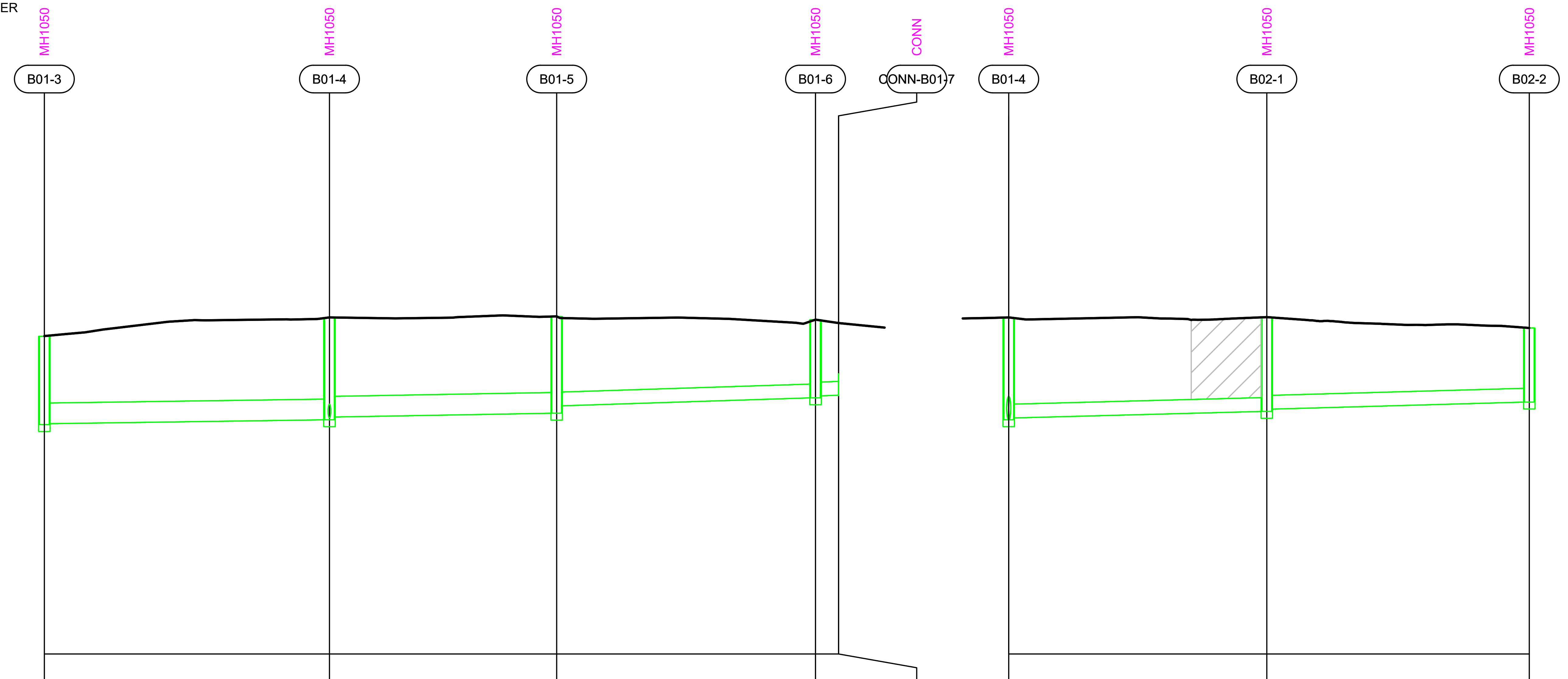
WDC IQP#002



LINE B01

	B01-3		B01-4		B01-5		B01-6		CONN-B01-7
Pipe Size/Type		Ø450 uPVC SN8		Ø450 uPVC SN8		Ø300 uPVC SN8		Ø300 uPVC SN8	
Grade (%)		0.27%		0.34%		0.62%		0.57%	
Datum	-2.000								
Depth To Invert	1.920 1.900		2.220 2.160		2.100 1.940		1.700 1.657		0.465
Invert Levels	6.787 6.807		6.892 6.952		7.035 7.195		7.369 7.412		7.427
Finished Surface	8.707		9.112		9.135		9.069		7.892
Chainage	46.199		77.190		101.885		130.020		132.526

LINE B02

	B01-4		B02-1		B02-2
Pipe Size/Type		Ø300 uPVC SN8		Ø300 uPVC SN8	
Grade (%)		0.51%		0.54%	
Datum	-2.000				
Depth To Invert	2.220 2.180		2.050 2.000		1.610
Invert Levels	6.892 6.932		7.074 7.124		7.277
Finished Surface	9.112		9.124		8.887
Chainage	0.000		28.051		56.582

SCALE 1:100
0
2
4

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE ??-??-??	KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINE B01 & B02

DATE CREATED	DRAWN	DESIGNED	APPROVED
???	K HANSARD	???	G McGREGOR

CCL REF NO: 14333-003
SCALE: 1:500H 1:100V @ A3
STATUS: AS BUILTS
DWG NUMBER: AB633
REVISION: A

0 10 20 SCALE 1:500

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EXSW = EXISTING STORMWATER
SS = PROPOSED SANITARY SEWER
WATER = POTABLE WATER

BACKFILL ▨

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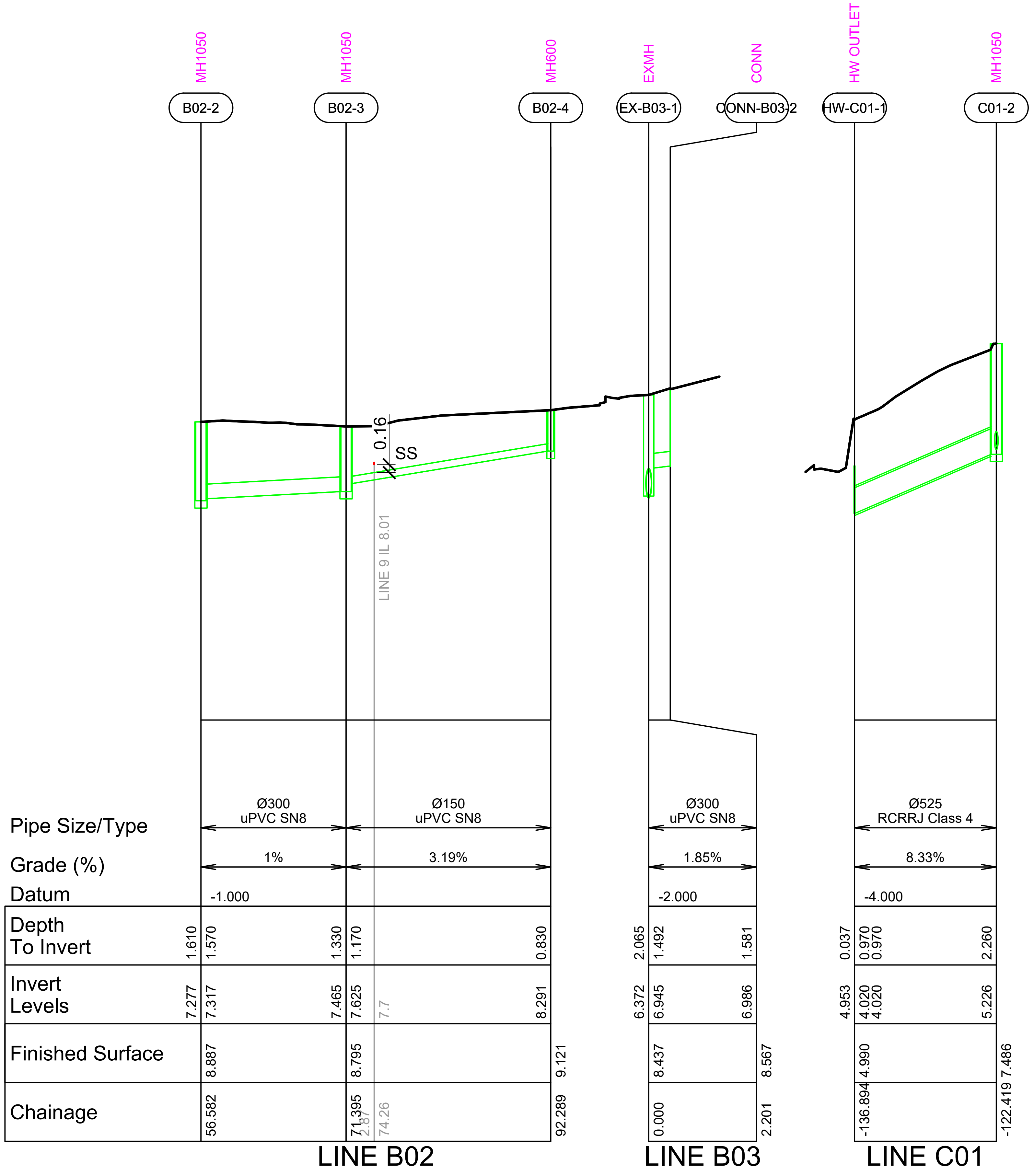
WDC IQP#002



SCALE 1:100

SCALE 1:500

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE	??-??-?? KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINES B02, B03 & C01

DATE CREATED	DRAWN	DESIGNED	APPROVED
???	K HANSARD	???	G McGREGOR

CCL REF NO: 14333-003
SCALE: 1:500H 1:100V @ A3
STATUS: AS BUILTS
DWG NUMBER: AB634
REVISION: A

DATE PLOTTED: Thursday, 25 June 2020 11:25:50 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB630-SW LS.dwg

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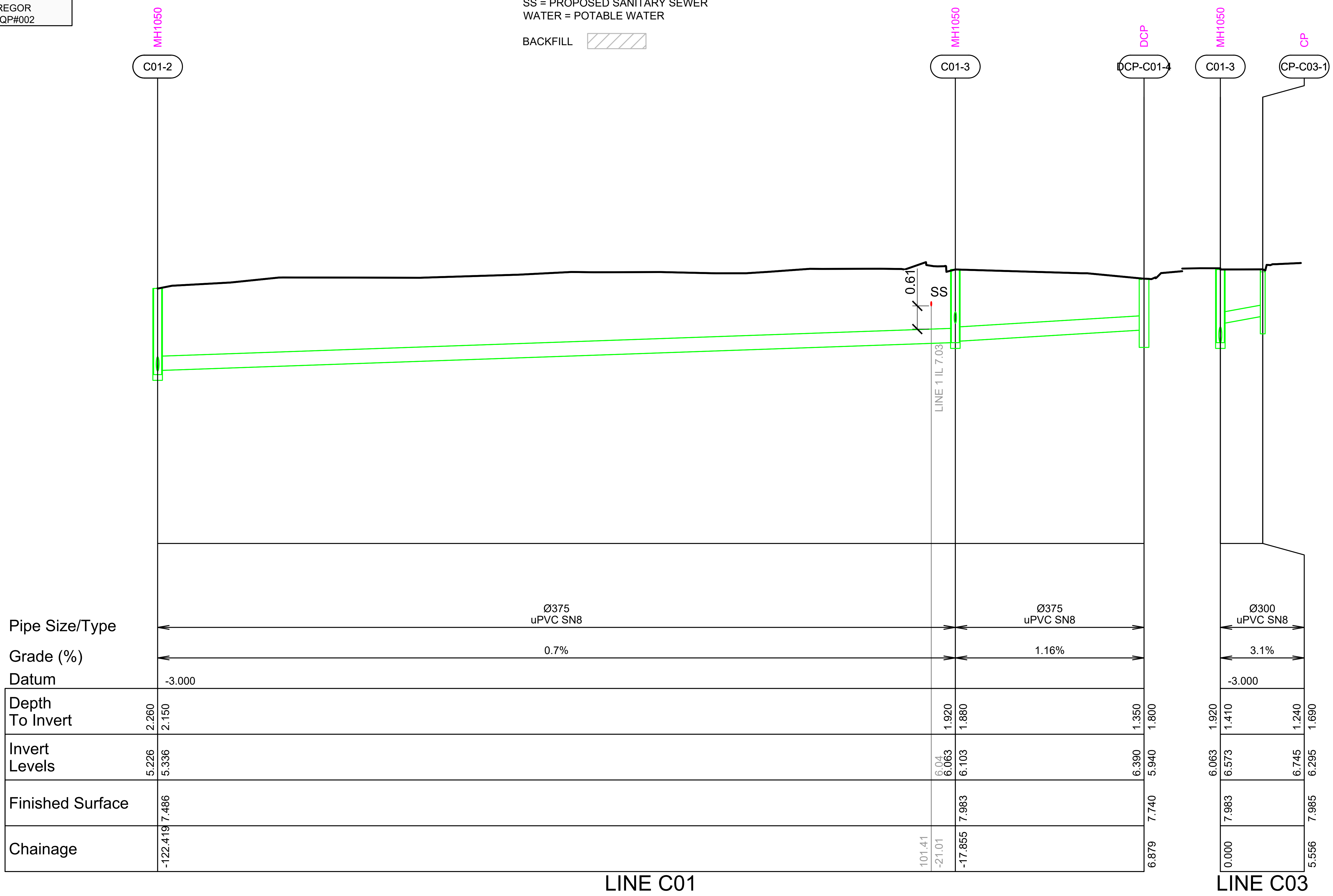
WDC IQP#002

KEY:
EXSS = EXISTING SANITARY SEWER
EXSW = EXISTING STORMWATER
SS = PROPOSED SANITARY SEWER
WATER = POTABLE WATER

BACKFILL ▨



SCALE 1:100

SCALE 1:500

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE	??-??-?? KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINES C01 & C03

DATE CREATED	DRAWN	DESIGNED	APPROVED
???	K HANSARD	???	G McGREGOR

CCL REF NO: 14333-003
SCALE: 1:500H 1:100V @ A3
STATUS: AS BUILTS
DWG NUMBER: AB635
REVISION: A

DATE PLOTTED: Thursday, 25 June 2020 11:25:50 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB630-SW LS.dwg

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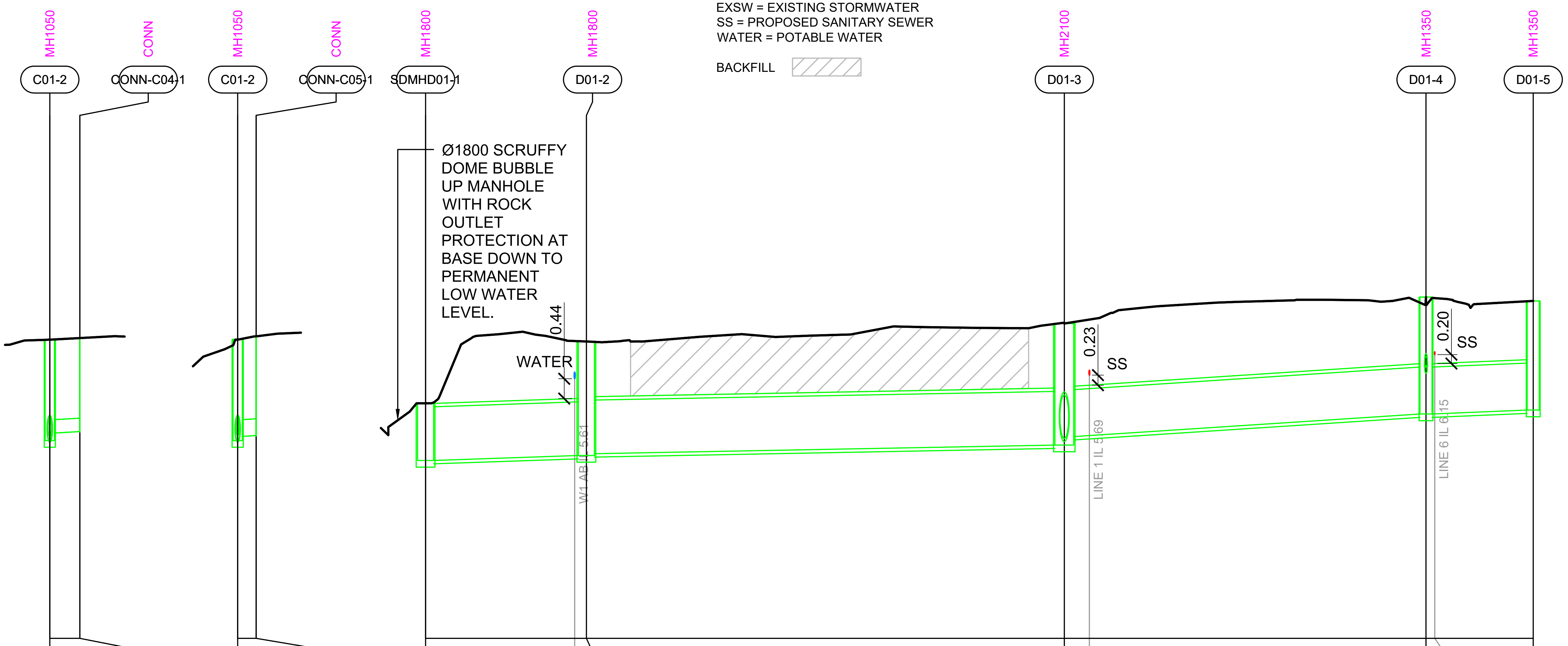
MCGREGOR
WDC IQP#002

KEY:
EXSS = EXISTING SANITARY SEWER
EXSW = EXISTING STORMWATER
SS = PROPOSED SANITARY SEWER
WATER = POTABLE WATER

BACKFILL ▨



LINE C04

Pipe Size/Type		Ø300 uPVC SN8	
Grade (%)		1%	
Datum		-3.000	
Depth To Invert	2.260	2.093	2.091
Invert Levels	5.226	5.393	5.426
Finished Surface		7.486	7.518
Chainage		0.000	3.355

LINE C05

Pipe Size/Type		Ø375 uPVC SN8	
Grade (%)		0.96%	
Datum		-3.000	
Depth To Invert	2.260	2.168	2.219
Invert Levels	5.226	5.318	5.338
Finished Surface		7.486	7.557
Chainage		0.000	2.064

LINE D01

Pipe Size/Type		Ø1200 RCRRJ Class 4			Ø1200 RCRRJ Class 4			Ø1050 RCRRJ Class 4			Ø1050 RCRRJ Class 4	
Grade (%)		0.62%			0.36%			1.25%			0.74%	
Datum		-4.000										
Depth To Invert	1.222	1.273 1.273		2.550	2.510	2.720	2.530		2.616	2.616		2.440
Invert Levels	3.831	3.780 3.780		3.891	3.931	4.124	4.314	4.34	4.819	4.819	4.82	4.908
Finished Surface		5.053			6.441		6.844			7.435		7.348
Chainage		0.000	16.66	16.66	17.977		71.391 2.8	74.19		113.819	112.8	123.800

SCALE 1:100
0
2
4

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE ??-??-??	KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINES C04, C05 & D01

DATE CREATED	DRAWN	DESIGNED	APPROVED
???	K HANSARD	???	G McGREGOR
CCL REF NO	SCALE	STATUS	
14333-003	1:500H 1:100V @ A3	AS BUILTS	
DWG NUMBER		REVISION	
AB636		A	

0 10 20 SCALE 1:500

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KEY:
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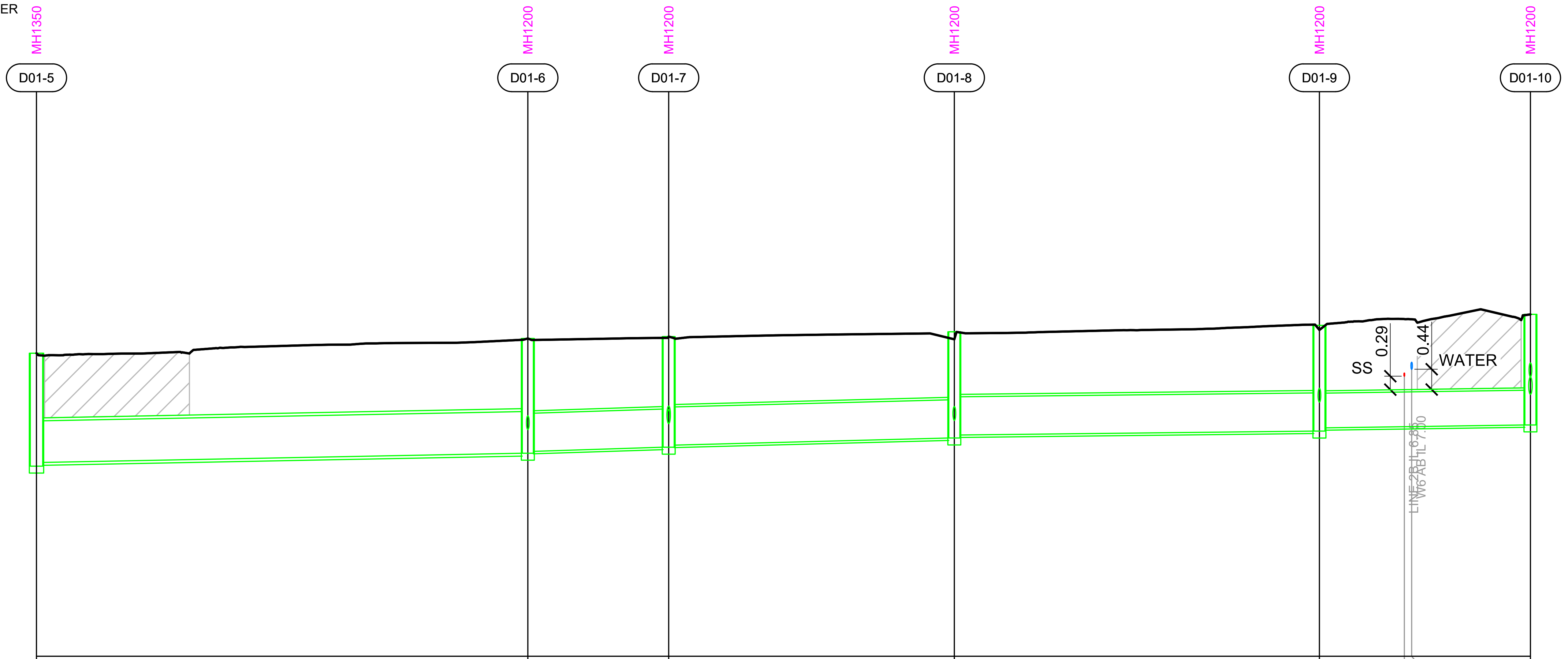
EXSW = EXISTING STORMWATER
SS = PROPOSED SANITARY SEWER
WATER = POTABLE WATER

BACKFILL ▨

G. M.
MCGREGOR
WDC IQP#002



	D01-5		D01-6		D01-7		D01-8		D01-9		D01-10
Pipe Size/Type		Ø900 RCRRJ Class 4		Ø825 RCRRJ Class 4		Ø825 RCRRJ Class 4		Ø825 RCRRJ Class 4		Ø750 RCRRJ Class 4	
Grade (%)		0.37%		0.59%		0.5%		0.21%		0.28%	
Datum	-3.000										
Depth To Invert	2.440 2.360		2.480 2.440		2.390 2.345		2.295 2.230		2.285 2.215		2.390
Invert Levels	4.908 4.988		5.187 5.227		5.317 5.362		5.516 5.581		5.665 5.735	5.76 5.76	5.798
Finished Surface	7.348		7.667		7.707		7.811		7.950		8.188
Chainage	123.800		176.916		192.141		223.020		262.488	9.18 271.767 272.46	285.298

LINE D01

SCALE 1:100
0
2
4

SCALE 1:500
0
10
20

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REV.	REVISION DETAILS	DRAWN	APP.
C			
B			
A	1ST ISSUE	??-??-?? KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINE D01

DATE CREATED	DRAWN	DESIGNED	APPROVED
???	K HANSARD	???	G McGREGOR

CCL REF NO: 14333-003
SCALE: 1:500H 1:100V @ A3
STATUS: AS BUILTS
DWG NUMBER: AB637
REVISION: A

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EXSW = EXISTING STORMWATER
SS = PROPOSED SANITARY SEWER
WATER = POTABLE WATER

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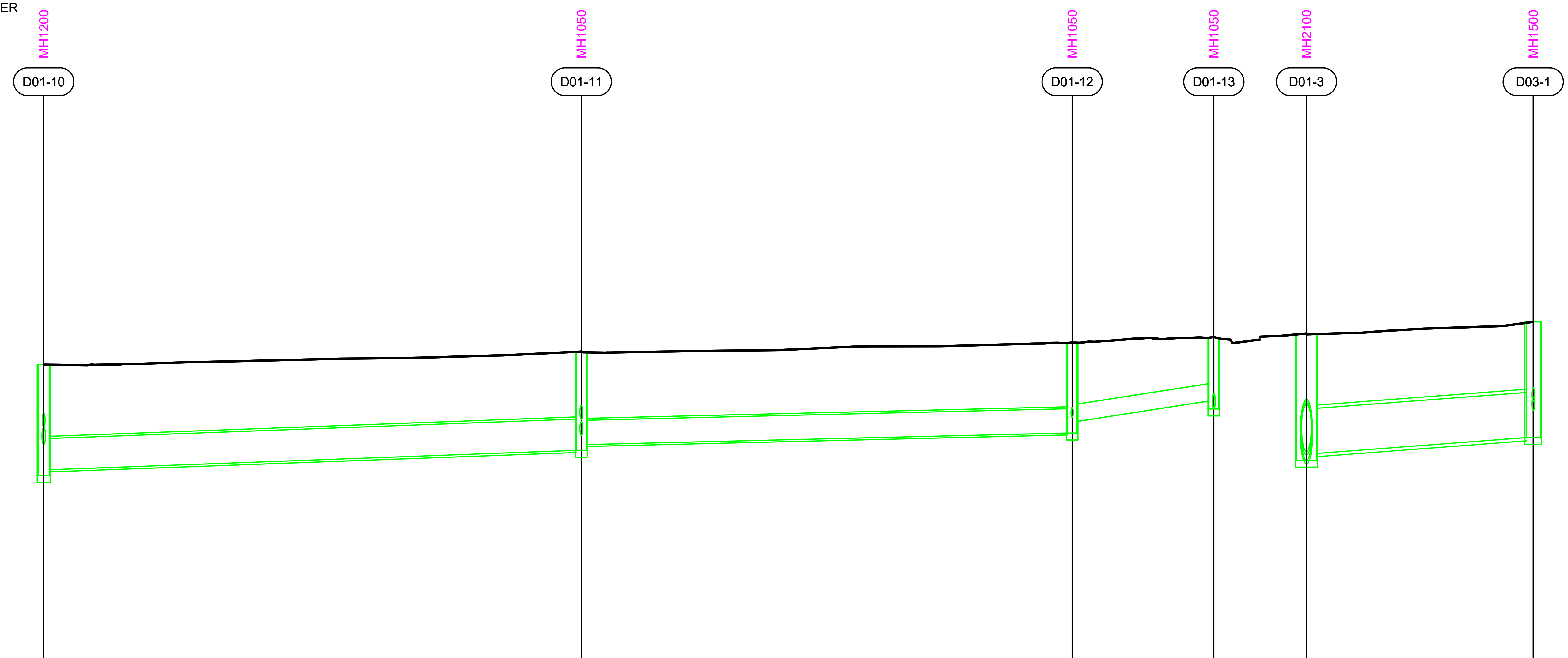

	D01-10		D01-11		D01-12		D01-13	D01-3		D03-1
Pipe Size/Type		Ø675 RCRRJ Class 4		Ø525 RCRRJ Class 4		Ø375 uPVC SN8			Ø975 RCRRJ Class 4	
Grade (%)		0.72%		0.47%		2.89%			1.4%	
Datum	-2.000							-4.000		
Depth To Invert	2.390 2.270		2.140 2.015		1.950 1.700		1.377 1.550	2.720 2.575		2.500
Invert Levels	5.798 5.918		6.337 6.462		6.711 6.961		7.403 7.230	4.124 4.269		4.612
Finished Surface	8.188		8.477		8.661		8.780	6.844		7.112
Chainage	285.298		343.325		396.298		411.590	0.000		24.476

LINE D01

LINE D03

SCALE 1:100
0 2 4

SCALE 1:500
0 10 20

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PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINES D01 & D03

DATE CREATED ???
DRAWN K HANSARD
DESIGNED ???
APPROVED G McGREGOR
CCL REF NO 14333-003
SCALE 1:500H 1:100V @ A3
STATUS AS BUILTS
DWG NUMBER AB638
REVISION A

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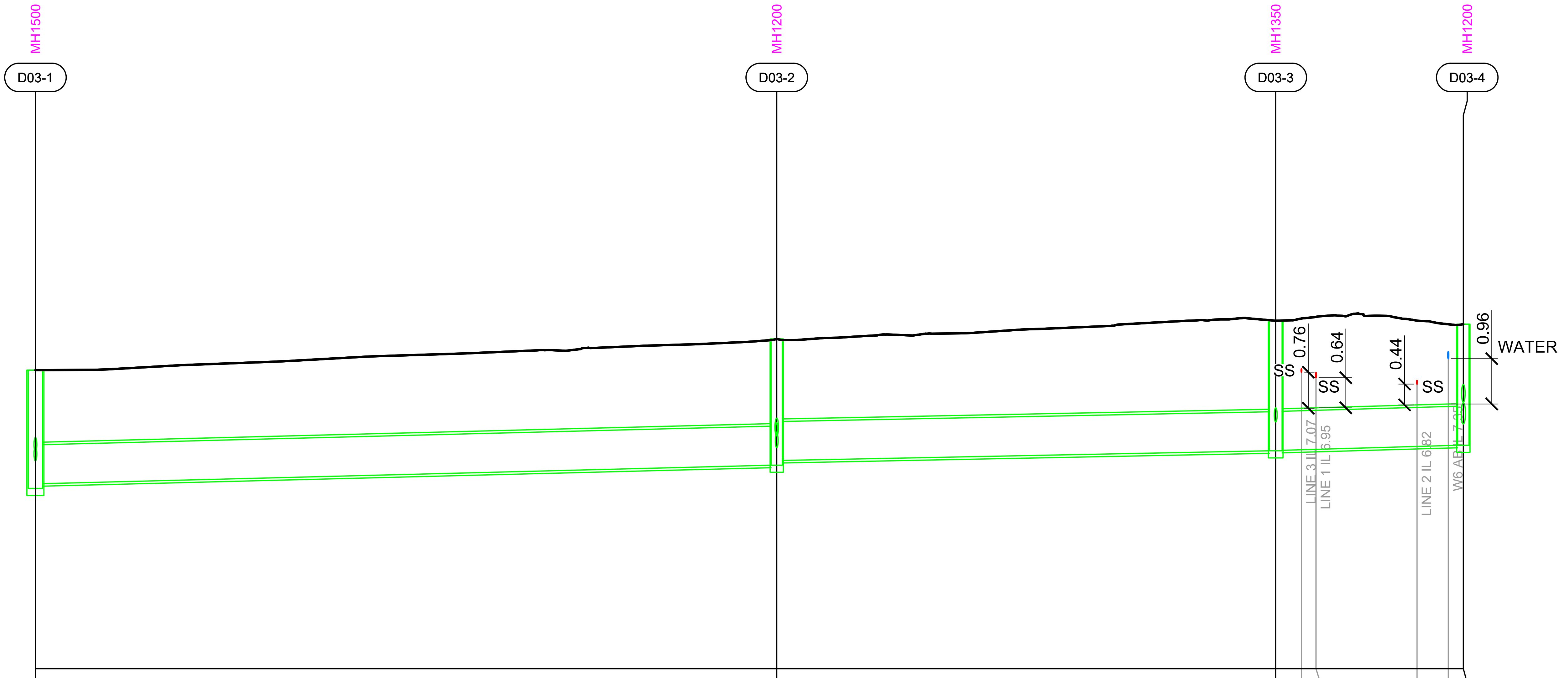

	D03-1		D03-2		D03-3						D03-4
Pipe Size/Type	Ø825 RCRRJ Class 4		Ø825 RCRRJ Class 4		Ø825 RCRRJ Class 4						
Grade (%)	0.5%		0.39%		0.54%						
Datum	-3.000										
Depth To Invert	2.500	2.400	2.670	2.570	2.750	2.740					2.560
Invert Levels	4.612	4.712	5.103	5.203	5.407	5.417	5.43	5.44		5.5	5.524
Finished Surface		7.112		7.773		8.157					8.084
Chainage		24.476		102.829		155.573 2.72	4.56 158.29	159.83	14.93	170.51 18.24	173.81 175.403

LINE D03

SCALE 1:100

SCALE 1:500

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THE LANDING - STAGE 3 AS BUILTS
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TITLE
STORMWATER LONGSECTIONS
LINE D03

DATE CREATED	DRAWN	DESIGNED	APPROVED
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CCL REF NO	SCALE	STATUS
14333-003	1:500H 1:100V @ A3	AS BUILTS

DWG NUMBER	REVISION
AB639	A

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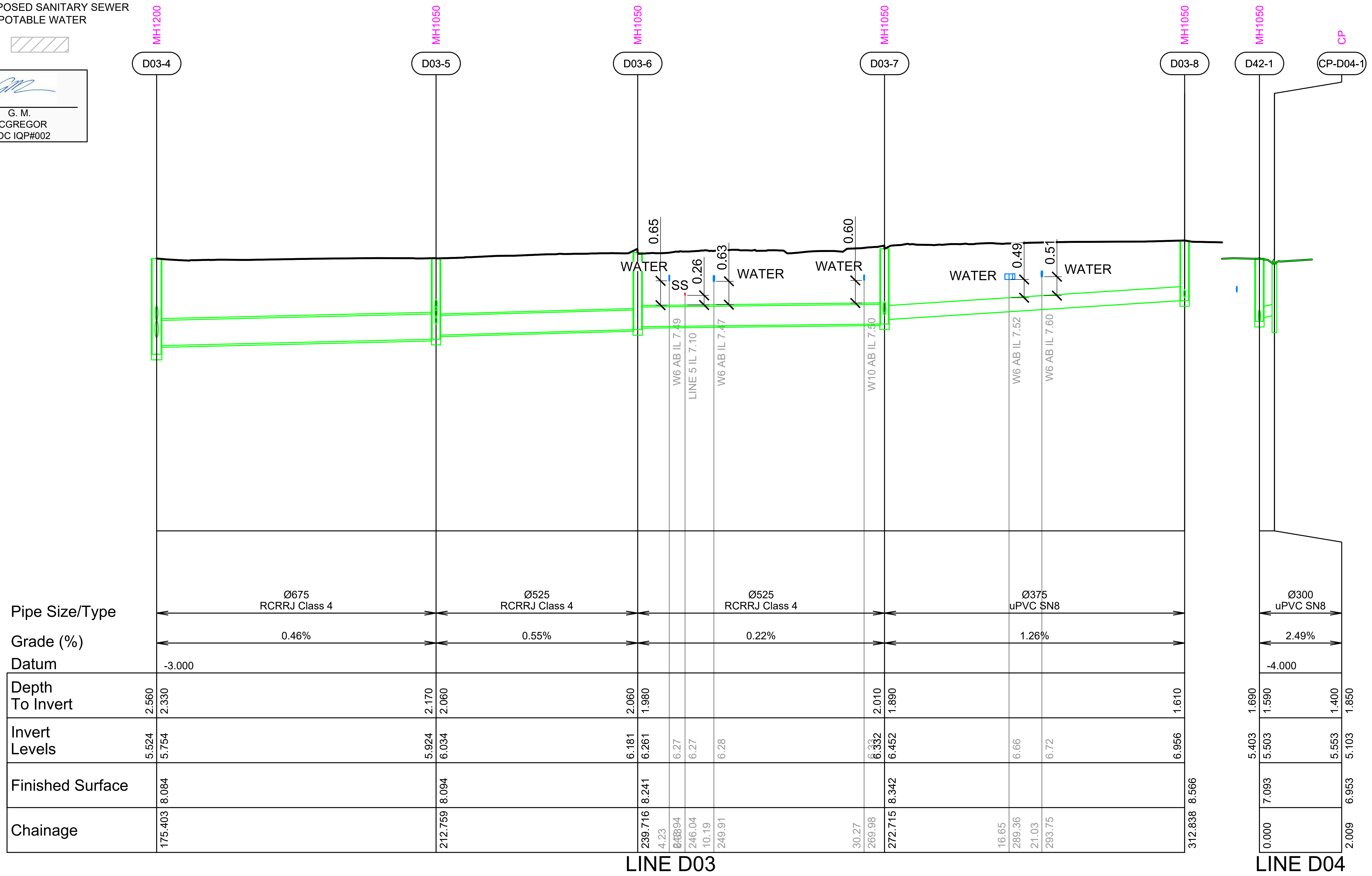

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PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
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TITLE
STORMWATER LONGSECTIONS
LINES D03 & D04

DATE CREATED	DRAWN	DESIGNED	APPROVED
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CCL REF NO: 14333-003
SCALE: 1:500H 1:100V @ A3
STATUS: AS BUILTS
DWG NUMBER: AB640
REVISION: A

0 10 20 SCALE 1:500

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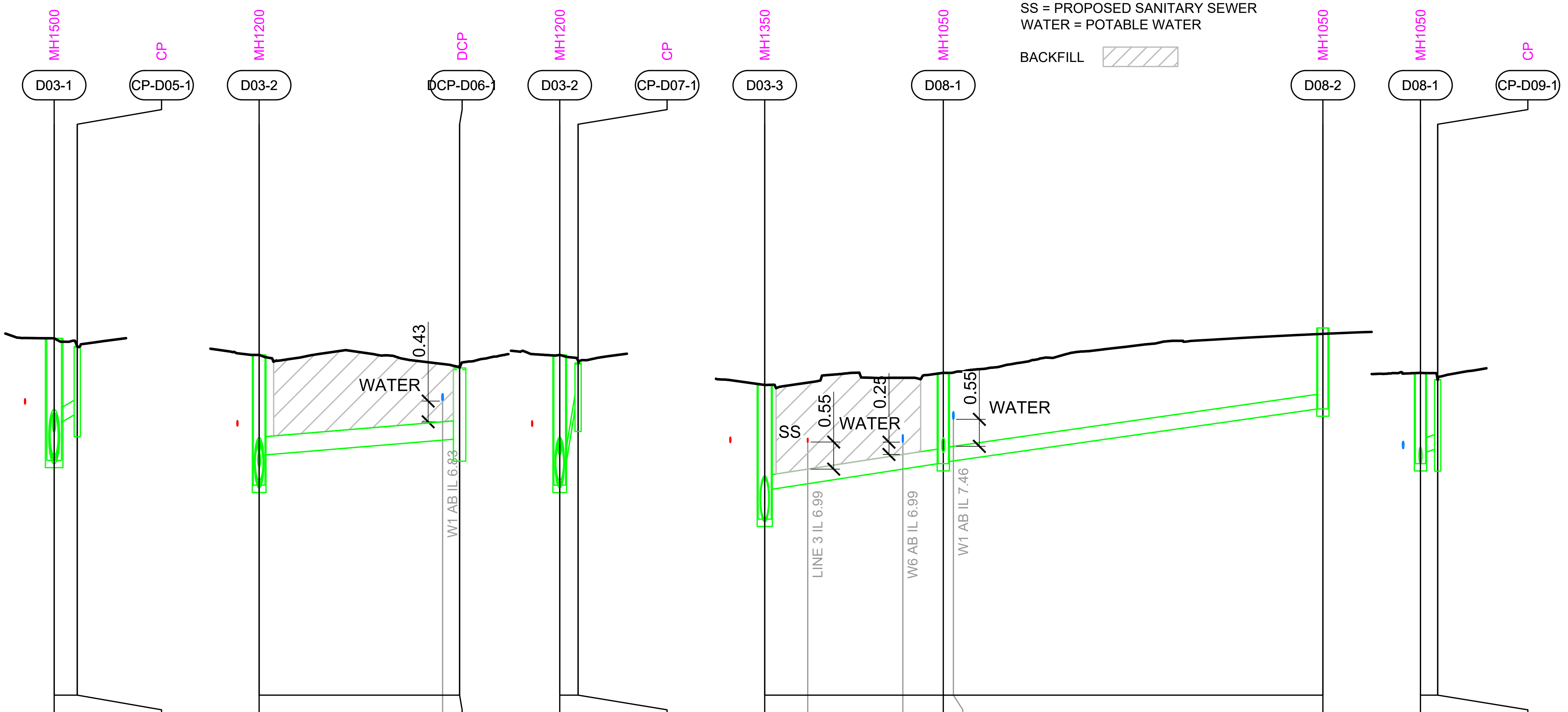

LINE D05

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		6.46%		
Datum		-4.000		
Depth To Invert	2.500	1.720	1.400	1.850
Invert Levels	4.612	5.392	5.545	5.095
Finished Surface		7.112		6.945
Chainage		0.000		2.368

LINE D06

Pipe Size/Type		Ø375 uPVC SN8				
Grade (%)		1.57%				
Datum		-3.000				
Depth To Invert	2.670	2.050			1.460	1.910
Invert Levels	5.103	5.723			6.045	5.595
Finished Surface		7.773				7.505
Chainage		0.000	18.79	18.79		20.534

LINE D07

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		62.73%		
Datum		-3.000		
Depth To Invert	2.670	2.300	0.955	1.405
Invert Levels	5.103	5.473	6.653	6.203
Finished Surface		7.773		7.608
Chainage		0.000		1.881

LINE D08

Pipe Size/Type		Ø300 uPVC SN8						Ø300 uPVC SN8			
Grade (%)		2.89%						2.78%			
Datum		-2.000									
Depth To Invert	2.750	2.140					1.860	1.820		1.658	
Invert Levels	5.407	6.017		6.13		6.43	6.545	6.585	6.6	7.666	
Finished Surface		8.157						8.405			9.324
Chainage		0.000	4.41	4.41	14.15	14.15		18.296	19.33		57.181

LINE D09

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		3.69%		
Datum		-2.000		
Depth To Invert	1.860	1.630	1.420	1.870
Invert Levels	6.545	6.775	6.840	6.390
Finished Surface		8.405		8.260
Chainage		0.000		1.763

SCALE 1:100
0 2 4

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PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
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TITLE
STORMWATER LONGSECTIONS
LINES D05, D06, D07, D08 & D09

DATE CREATED: ???
DRAWN: K HANSARD
DESIGNED: ???
APPROVED: G McGREGOR
CCL REF NO: 14333-003
SCALE: 1:500H 1:100V @ A3
STATUS: AS BUILTS
DWG NUMBER: AB641
REVISION: A

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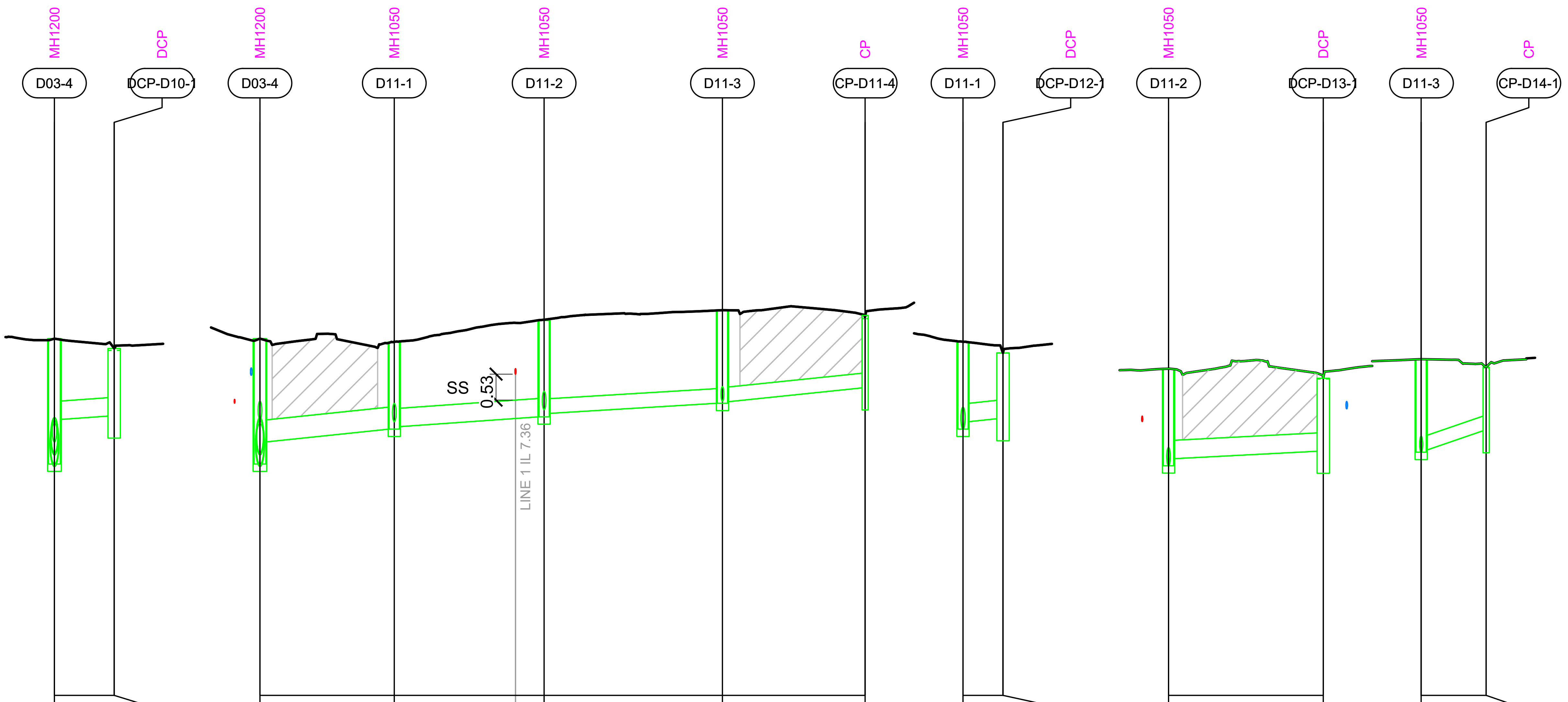

LINE D10

Pipe Size/Type		Ø375 uPVC SN8		
Grade (%)		1.13%		
Datum		-3.000		
Depth To Invert	2.560	1.650	1.380	1.830
Invert Levels	5.524	6.434	6.503	6.053
Finished Surface		8.084		7.883
Chainage		0.000		6.104

LINE D11

Pipe Size/Type		Ø450 uPVC SN8		Ø375 uPVC SN8				Ø300 uPVC SN8		Ø300 uPVC SN8		
Grade (%)		1.92%		1.31%				1.14%		1.94%		
Datum		-3.000										
Depth To Invert	2.560	2.110	1.780	1.730			1.970	1.900	1.900	1.870	1.480	1.930
Invert Levels	5.524	5.974	6.237	6.287		6.45	6.488	6.558	6.765	6.795	7.078	6.628
Finished Surface		8.084		8.017				8.458		8.665		8.558
Chainage		0.000		13.724	12.39	26.11		29.033		47.253		61.832

LINE D12

Pipe Size/Type		Ø375 uPVC SN8		
Grade (%)		1.52%		
Datum		-3.000		
Depth To Invert	1.780	1.630	1.340	1.790
Invert Levels	6.237	6.387	6.449	5.999
Finished Surface		8.017		7.789
Chainage		0.000		4.083

LINE D13

Pipe Size/Type		Ø375 uPVC SN8		
Grade (%)		0.96%		
Datum		-2.000		
Depth To Invert	1.970	1.825	1.490	1.940
Invert Levels	6.488	6.633	6.785	6.335
Finished Surface		8.458		8.275
Chainage		0.000		15.811

LINE D14

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		5.99%		
Datum		-2.000		
Depth To Invert	1.900	1.860	1.300	1.750
Invert Levels	6.765	6.805	7.203	6.753
Finished Surface		8.665		8.503
Chainage		0.000		6.642

SCALE 1:100
0 2 4

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WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
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TITLE
STORMWATER LONGSECTIONS
LINES D10, D11, D12, D13, & D14,

DATE CREATED	DRAWN	DESIGNED	APPROVED
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14333-003	1:500H 1:100V @ A3	AS BUILTS

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AB642	A

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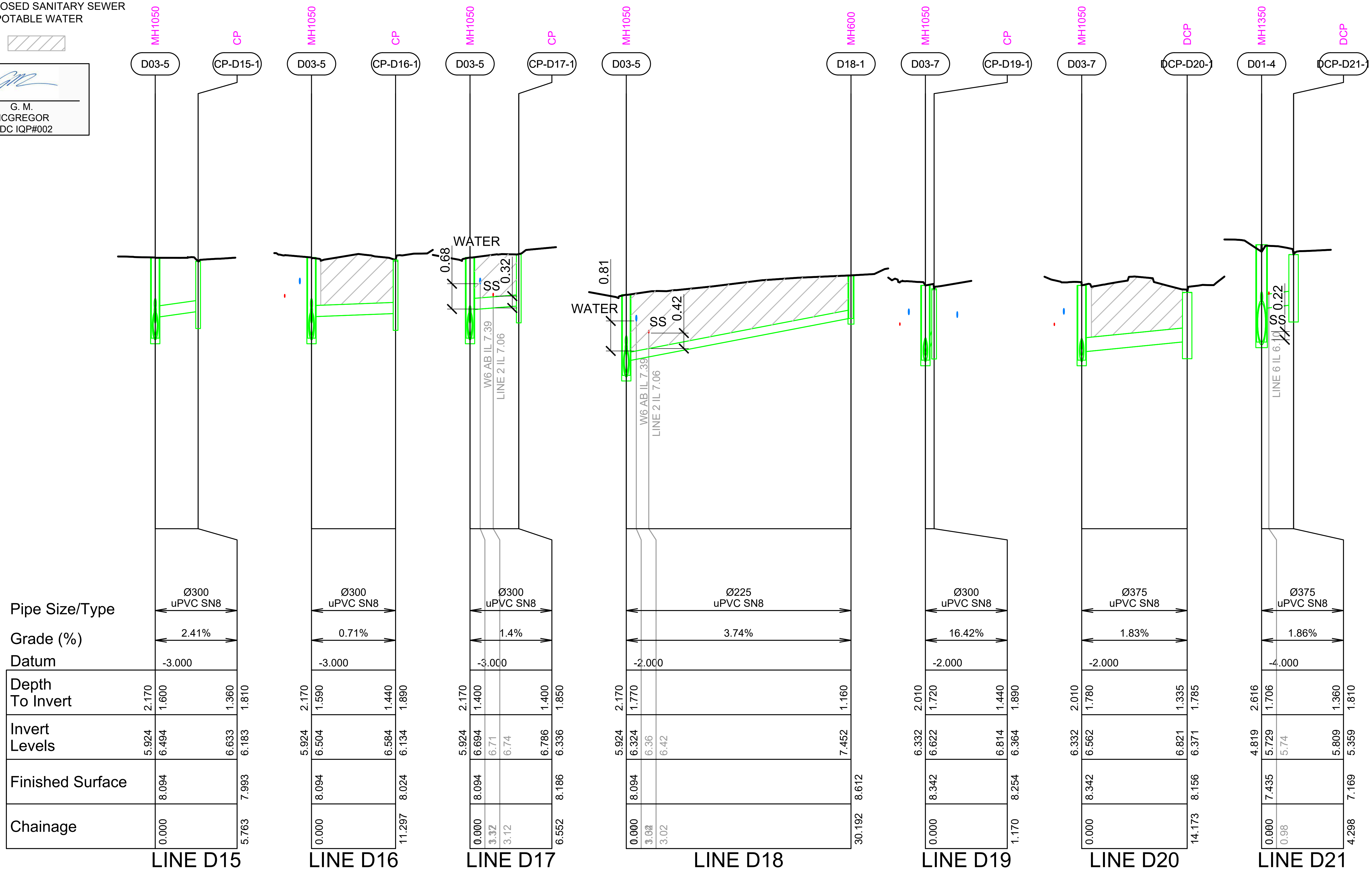

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PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINES D15, D16, D17, D18, D19, D20 & D21

DATE CREATED ???
DRAWN K HANSARD
DESIGNED ???
APPROVED G McGREGOR
CCL REF NO 14333-003
SCALE 1:500H 1:100V @ A3
STATUS AS BUILTS
DWG NUMBER AB643
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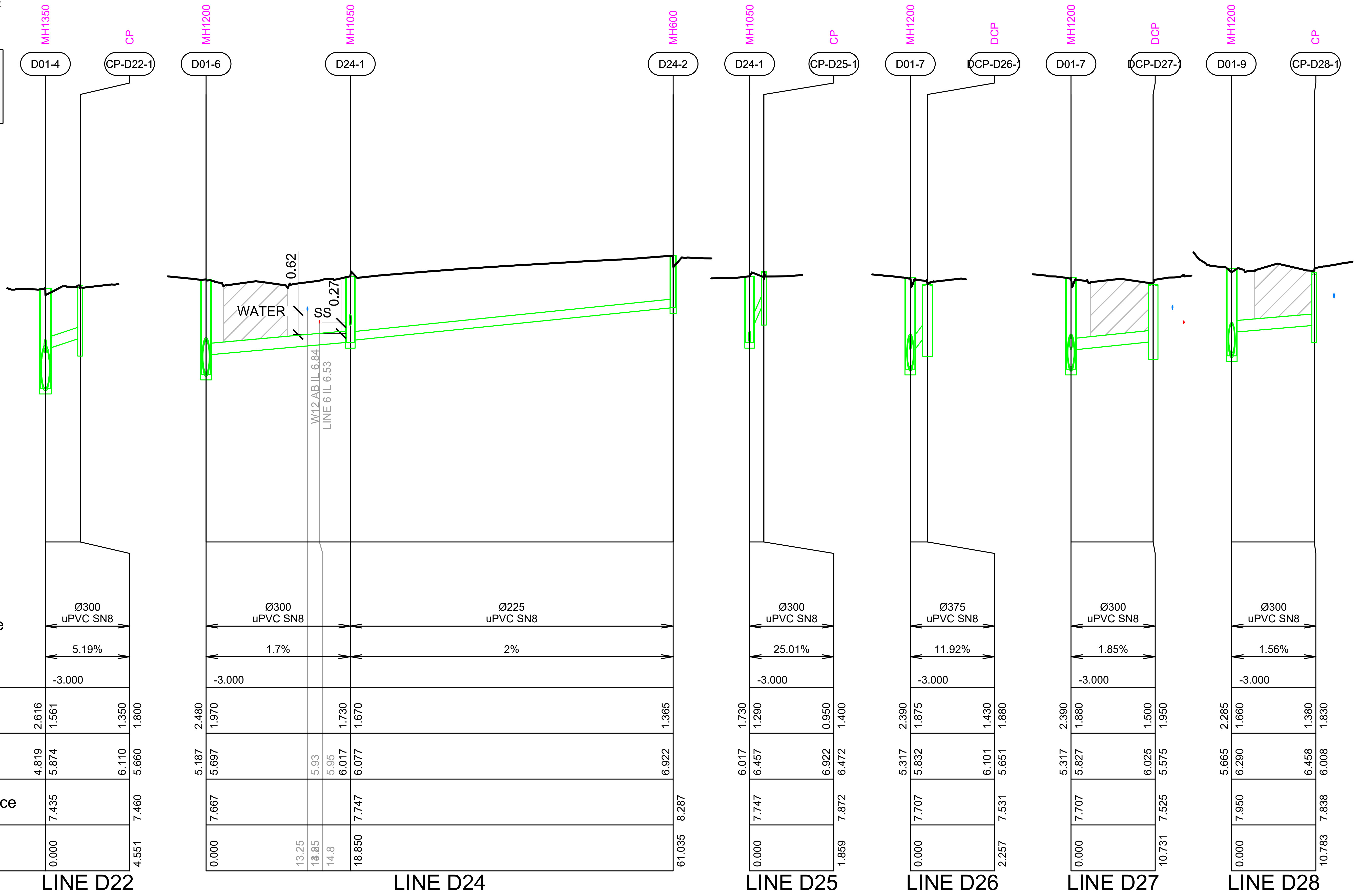

SCALE 1:100

SCALE 1:500

LINE D22

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		5.19%		
Datum		-3.000		
Depth To Invert	2.616	1.561	1.350	1.800
Invert Levels	4.819	5.874	6.110	5.660
Finished Surface		7.435		7.460
Chainage		0.000		4.551

LINE D24

Pipe Size/Type		Ø300 uPVC SN8					Ø225 uPVC SN8		
Grade (%)		1.7%					2%		
Datum		-3.000							
Depth To Invert	2.480	1.970				1.730	1.670	1.365	
Invert Levels	5.187	5.697		5.93	5.95	6.017	6.077	6.922	
Finished Surface		7.667					7.747		8.287
Chainage		0.000	13.25	13.85	14.8		18.850		61.035

LINE D25

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		25.01%		
Datum		-3.000		
Depth To Invert	1.730	1.290	0.950	1.400
Invert Levels	6.017	6.457	6.922	6.472
Finished Surface		7.747		7.872
Chainage		0.000		1.859

LINE D26

Pipe Size/Type		Ø375 uPVC SN8		
Grade (%)		11.92%		
Datum		-3.000		
Depth To Invert	2.390	1.875	1.430	1.880
Invert Levels	5.317	5.832	6.101	5.651
Finished Surface		7.707		7.531
Chainage		0.000		2.257

LINE D27

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		1.85%		
Datum		-3.000		
Depth To Invert	2.390	1.880	1.500	1.950
Invert Levels	5.317	5.827	6.025	5.575
Finished Surface		7.707		7.525
Chainage		0.000		10.731

LINE D28

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		1.56%		
Datum		-3.000		
Depth To Invert	2.285	1.660	1.380	1.830
Invert Levels	5.665	6.290	6.458	6.008
Finished Surface		7.950		7.838
Chainage		0.000		10.783

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WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
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TITLE
STORMWATER LONGSECTIONS
LINES D22, D24, D25, D26, D27 & D28

DATE CREATED	DRAWN	DESIGNED	APPROVED
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14333-003	1:500H 1:100V @ A3	AS BUILTS	
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AB644		A	

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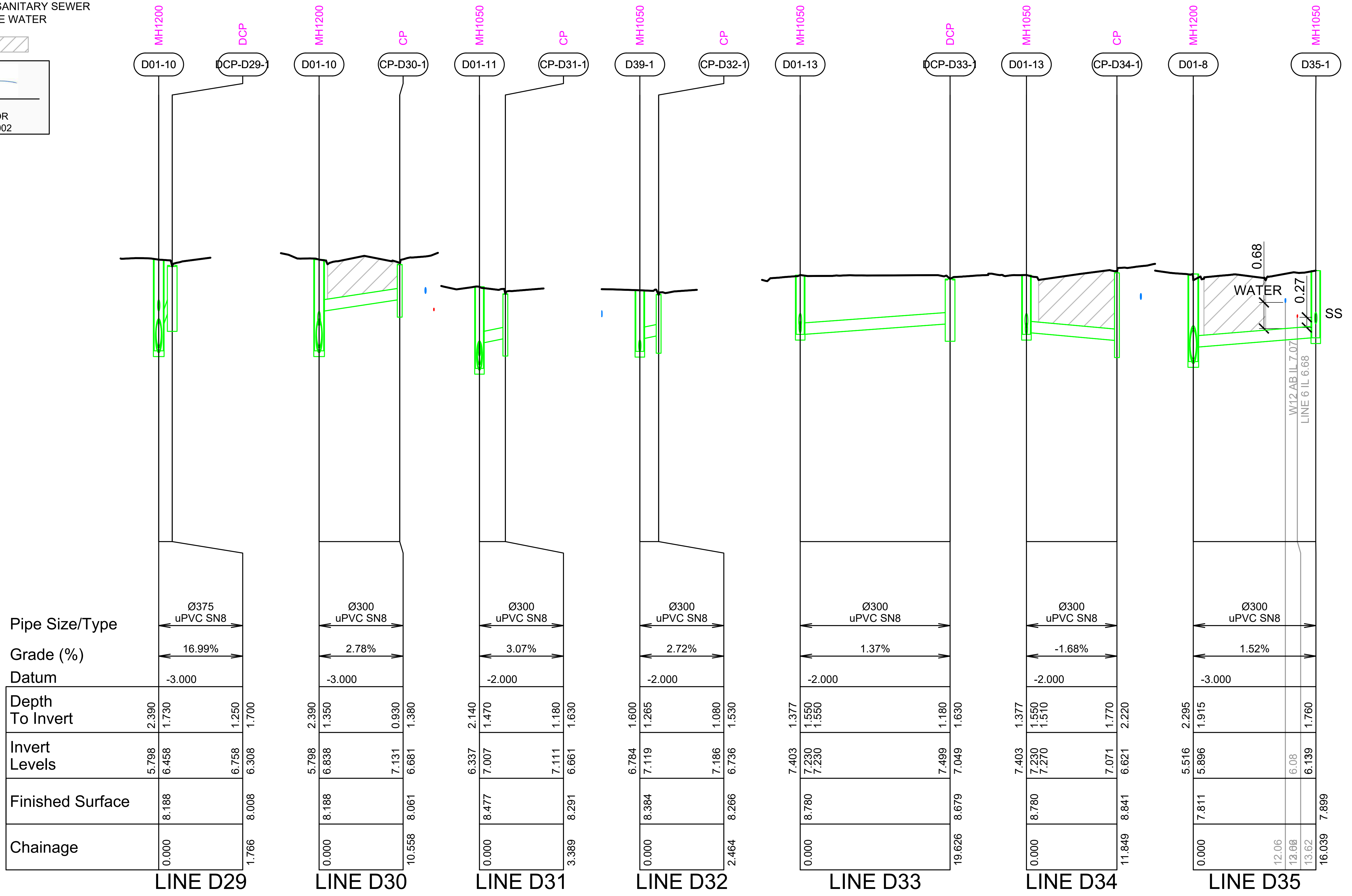

SCALE 1:100
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PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
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TITLE
STORMWATER LONGSECTIONS
LINES D29, D30, D31, D32, D33, D34 & D35

DATE CREATED	DRAWN	DESIGNED	APPROVED
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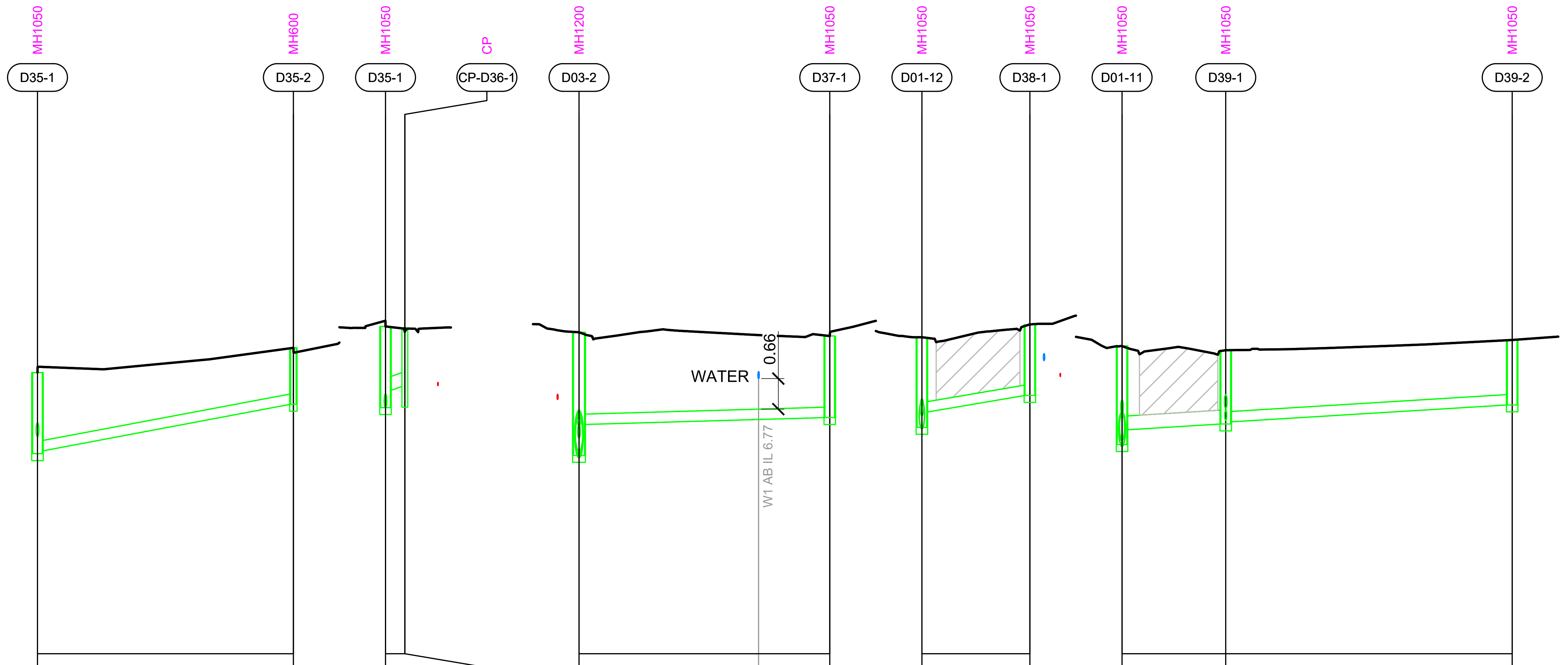

LINE D35

Pipe Size/Type		Ø225 uPVC SN8	
Grade (%)		3.64%	
Datum		-2.000	
Depth To Invert	1.760	1.700	1.225
Invert Levels	6.139	6.199	7.211
Finished Surface		7.899	8.436
Chainage		16.039	43.808

LINE D36

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		4.24%		
Datum		-3.000		
Depth To Invert	1.760	1.390	1.270	1.720
Invert Levels	6.139	6.509	6.598	6.148
Finished Surface		7.899		7.868
Chainage		0.000		2.099

LINE D37

Pipe Size/Type		Ø225 uPVC SN8		
Grade (%)		0.55%		
Datum		-3.000		
Depth To Invert	2.670	2.000		1.770
Invert Levels	5.103	5.773	5.88	5.922
Finished Surface		7.773		7.692
Chainage		0.000	19.49 19.49	27.211

LINE D38

Pipe Size/Type		Ø225 uPVC SN8	
Grade (%)		3.09%	
Datum		-2.000	
Depth To Invert	1.950	1.620	1.535
Invert Levels	6.711	7.041	7.403
Finished Surface		8.661	8.938
Chainage		0.000	11.720

LINE D39

Pipe Size/Type		Ø300 uPVC SN8		Ø225 uPVC SN8	
Grade (%)		1.13%		1.18%	
Datum		-2.000			
Depth To Invert	2.140	1.820	1.600	1.555	1.410
Invert Levels	6.337	6.657	6.784	6.829	7.197
Finished Surface		8.477		8.384	8.607
Chainage		0.000		11.252	42.339

SCALE 1:100
0 2 4

0 10 20 SCALE 1:500

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TITLE
STORMWATER LONGSECTIONS
LINES D35, D36, D37, D38 & D39

DATE CREATED	DRAWN	DESIGNED	APPROVED
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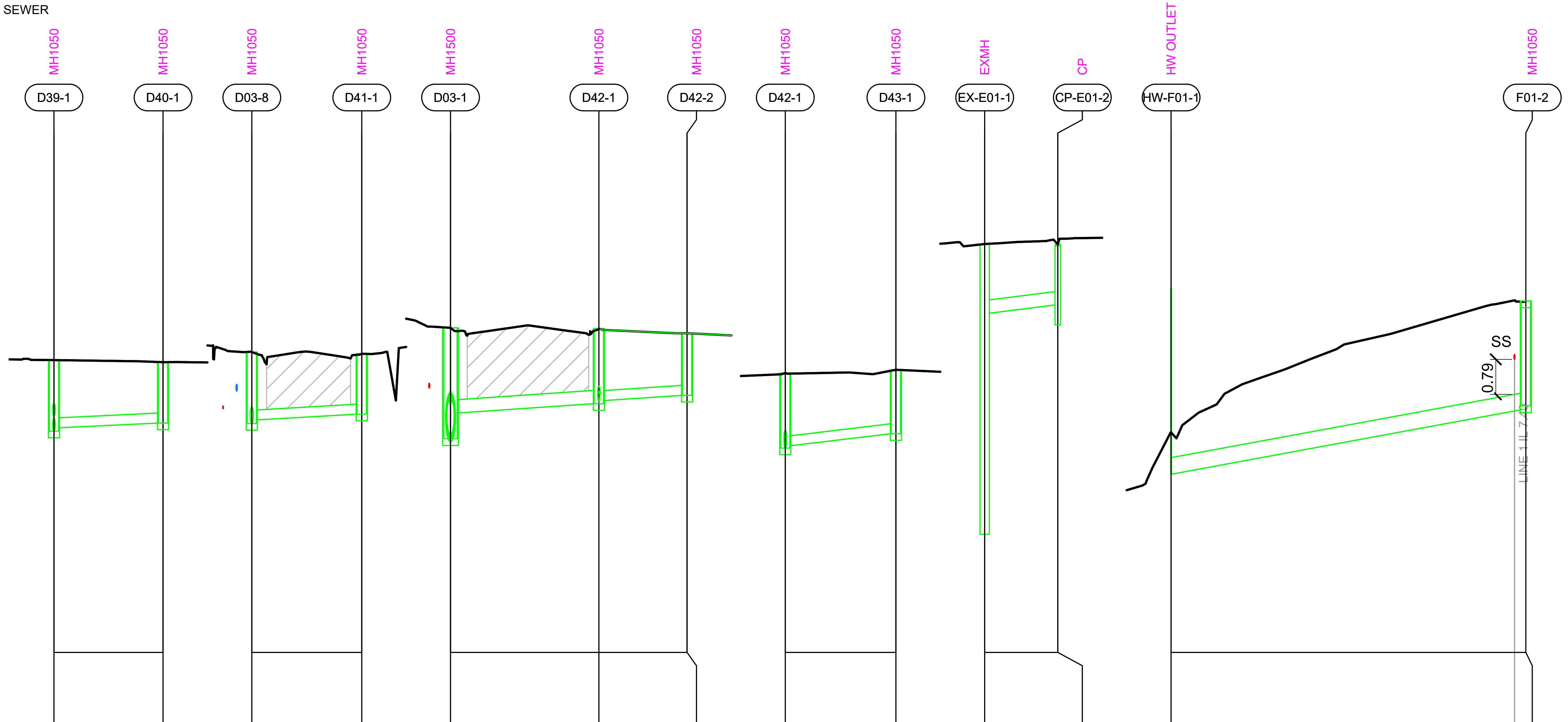

LINE D40

Pipe Size/Type		Ø225 uPVC SN8		
Grade (%)		0.88%		
Datum		-2.000		
Depth To Invert	1.600	1.525	1.370	
Invert Levels	6.784	6.859	6.967	
Finished Surface		8.384		8.337
Chainage		0.000		12.290

LINE D41

Pipe Size/Type		Ø225 uPVC SN8		
Grade (%)		1.06%		
Datum		-2.000		
Depth To Invert	1.610	1.530	1.360	
Invert Levels	6.956	7.036	7.167	
Finished Surface		8.566		8.527
Chainage		0.000		12.386

LINE D42

Pipe Size/Type		Ø300 uPVC SN8		Ø225 uPVC SN8		
Grade (%)		1.26%		1.18%		
Datum		-4.000				
Depth To Invert	2.500	1.920	1.690	1.620	1.400	
Invert Levels	4.612	5.192	5.403	5.473	5.590	
Finished Surface		7.112		7.093		6.990
Chainage		0.000		16.714		26.647

LINE D43

Pipe Size/Type		Ø225 uPVC SN8		
Grade (%)		2.2%		
Datum		-3.000		
Depth To Invert	1.690	1.640	1.440	
Invert Levels	5.403	5.453	5.727	
Finished Surface		7.093		7.167
Chainage		0.000		12.463

LINE E01

Pipe Size/Type		Ø300 uPVC SN8		
Grade (%)		2.27%		
Datum		-4.000		
Depth To Invert	6.539	1.560	1.360	1.810
Invert Levels	2.461	7.440	7.627	7.177
Finished Surface		9.000		8.987
Chainage		0.000		8.240

LINE F01

Pipe Size/Type		Ø375 uPVC SN8		
Grade (%)		3.63%		
Datum		-3.000		
Depth To Invert	4.150	4.186 4.186	2.450	0.000
Invert Levels	4.850	4.814 4.814	6.266	8.716
Finished Surface		9.000		8.716
Chainage		0.000	38.69 38.69	39.965

SCALE 1:100
0 2 4

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A	1ST ISSUE	??-??-?? KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
ONE TREE POINT
RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINES D40. D41, D42, D43, E01 & F01

DATE CREATED: ???
DRAWN: K HANSARD
DESIGNED: ???
APPROVED: G McGREGOR
CCL REF NO: 14333-003
SCALE: 1:500H 1:100V @ A3
STATUS: AS BUILTS
DWG NUMBER: AB647
REVISION: A

0 10 20 SCALE 1:500

DATE PLOTTED: Thursday, 25 June 2020 11:25:53 a.m. FILE PATH: C:\Users\Karren\AppData\Local\Temp\BricsCAD\bp_1\14333-003-AB630-SW LS.dwg

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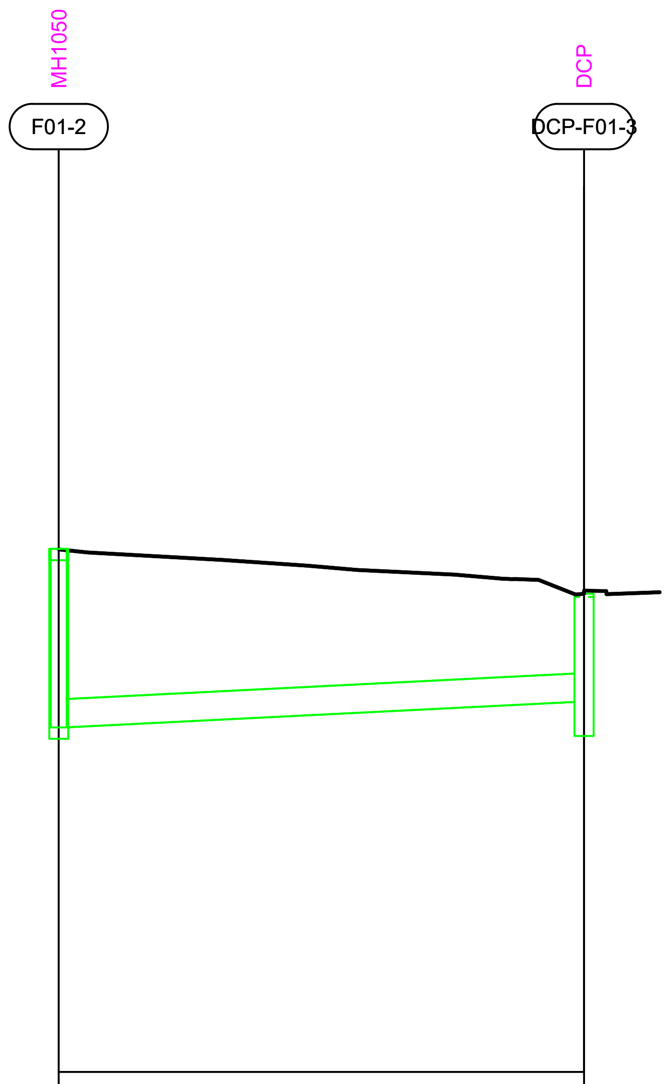
KEY:
EXSS = EXISTING SANITARY SEWER
EXSW = EXISTING STORMWATER
SS = PROPOSED SANITARY SEWER
WATER = POTABLE WATER

BACKFILL ▨

G. M.
MCGREGOR
WDC IQP#002



Pipe Size/Type	Ø375 uPVC SN8	
Grade (%)	0.97%	
Datum	-2.000	
Depth To Invert	2.450 0.000 2.360	1.430 1.880
Invert Levels	6.266 8.716 6.356	6.692 6.242
Finished Surface	8.716	8.122
Chainage	39.965	74.713

LINE F01

SCALE 1:100
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A	1ST ISSUE	??-??-?? KH	GMcG

PROJECT DETAILS
WFH PROPERTIES LIMITED
THE LANDING - STAGE 3 AS BUILTS
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RUAKAKA

TITLE
STORMWATER LONGSECTIONS
LINE F01

DATE CREATED ???
DRAWN K HANSARD
DESIGNED ???
APPROVED G McGREGOR
CCL REF NO 14333-003
SCALE 1:500H 1:100V @ A3
STATUS AS BUILTS
DWG NUMBER AB648
REVISION A

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STORMWATER MANAGEMENT PLAN

THE LANDING @ MARSDEN

WFH PROPERTIES LTD
ONE TREE POINT
PROJECT NO. 31013

DOCUMENT CONTROL

Job Number:

31013

Project:

Stormwater Management Plan

Client:

WFH Properties Ltd

Date:

20-12-2017

Version

V4

Issue Status

Final

File Path

12D Synergy

Originator

Pranil Wadan – Senior Engineer [CPEng, Int(PE), MIPENZ]

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Reviewer

Todd Fraser – Principal Engineer [CPEng, Int(PE), MIPENZ]

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Final Review & Authorisation for Issue

Tim James - Director

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CONTENTS

APPENDICES

REVISION HISTORY

Revision Nº	Prepared By	Description	Date
1	Pranil Wadan	For Information	November 2016
2	Pranil Wadan	For Peer Review	April 2017
3	Pranil Wadan	Incorporates peer review comments	June 2017
4	Pranil Wadan	Updated to include revised Stormwater Trunk Alignment. Includes detail design of Ponds 2, 3 & 4.	December 2017

1 BACKGROUND INFORMATION

1.1 INTRODUCTION

WFH Properties Ltd proposes to develop a 50ha block of land in the One Tree Point/Marsden Point area. The development is known as The Landing @ Marsden and will result in the creation of an urban residential living area and an isolated business/commercial precinct.

This report outlines the proposed stormwater management plan for the entire development. The stormwater management for the development deals with treatment (quality) of runoff prior to final discharge and the management of secondary flows (quantity).

1.2 BACKGROUND

The subject site has a relatively flat topography with minor undulations. The land use in the area is predominantly rural with pastoral farming/ grazing.

Minor earthworks were undertaken in 2008, over an approximate area of 7ha adjacent to One Tree Point Road. The earthworks undertaken associated with recontouring to facilitate the development of the proposed residential and commerical development.

Given the site topography, stormwater runoff for the existing site is difficult to determine due to a lack of defined flow paths, however, a series of historical coastal dunes on the site indicate that discharge from the site will flow partly to the north along One Tree Point Road, and partly to the low-lying land further south.

2 PROPOSED DEVELOPMENT

The proposed development will change the existing land use from pastoral/grazing to predominantly residential. The change in land use to a more urban environment will contribute to an increase in stormwater runoff as well as an increase in runoff contaminants.

The stormwater management plan comprises of communal stormwater wetlands for treatment and attenuation. These wetlands have been designed in keeping with the requirements of Auckland Council’s TP10.

A preliminary scheme plan for the development is shown in Figure 1. This plan illustrates what the development could deliver.

Figure 1: Preliminary Scheme Plan

2.1 PROPOSED LANDUSE & IMPERVIOUS COVERAGES

The proposed land use change will increase impervious coverage and consequently stormwater runoff. The percentage of impervious area within the development is expected to increase from 1% to approximately 51% (weighted average).

The existing impervious coverage of 1% was derived from an assessment of the aerial photography available on the Whangarei District Council GIS.

The weighted impervious coverage for the development is based on the proposed scheme plan. The impervious coverages used for each of the areas is summarised in Table 1.

Table 1 – Impervious Coverages

	Impervious Coverage (%)
COMMERCIAL LOTS	100%
RESIDENTIAL LOTS	45%
ROADS	80%
GREEN RESERVES	10%
AVERAGE IMPERVIOUS COVERAGE	***52%**

**Average impervious coverage of 52% was calculated based on the land areas as per the proposed scheme plan.*

3 DESIGN CRITERIA

3.1 GUIDANCE

The development approach for the management of stormwater for The Landing @ Marsden is to align with the One Tree Point (OTP) & Marsden Point (MP) Catchment Management Plans (CMP) (2006).

3.1.1 Catchment Management Plans

The subject site is located at the boundary of the One Tree Point and Marsden Point Stormwater Catchment Management Plans (CMPs) and extends from One Tree Point Road to the north of Pyle Road East in the South. The site is approximately 50ha in size, a plan outlining the catchment extents in relation to the CMPs can be found in Appendix A.

Both CMPs outline the stormwater requirements and strongly guide the overall stormwater management for the site.

The key difference between the two CMPs is the requirement for attenuation. The One Tree Point CMP does not require attenuation of flows due to the nature and proximity of the receiving environment.

The Marsden Point CMP requires all post-development stormwater flows discharging within the catchment boundary to be reduced to pre-development levels. This applies to all stormwater flows up to the 10 year ARI event.

There are no other secondary flow paths discharging directly to the coastal environment. The proposed wetlands are to be designed to impound runoff in the 100 year (+ climate change) storm event.

3.1.2 Guidance Documents

A summary of the technical guidance documents used in the preparation of the SMP is outlined in Table 2 – Guidance Summary.

Table 2 – Guidance Summary

Guidance Document	What it says	Relevant for SMP
Design Guideline Manual for Stormwater Treatment Devices – Technical Publication 10 (2003). Auckland Regional Council. Chapter 5.	Benchmark document for technical guidance on the design criteria for stormwater management devices	Yes - Provides technical guidance on design of stormwater devices
Water Sensitive Design for Stormwater – Guidance Document 2015/004 (March 2015). Auckland Council.	Guidance document for the application of Water Sensitive Design (WSD)	Yes - outlines the WSD approach for the site. WSD works alongside the urban design solution.
NZS4404 – Land development and Subdivision infrastructure.	Provides detail on stormwater management including WSD, flood risk management, freeboard allowance etc.	Yes - Guidance to be followed
One Tree Point – Stormwater Management Plan (2000/2006)	Outlines the stormwater management plan for catchments located within the One Tree Point Area	Yes – Guidance to be followed
Marsden Point – Stormwater Catchment Management Plan. (2007), Pattle Delamore Partners Ltd	Outlines the stormwater management plan for catchments located within the Marsden Point.	Yes - however the majority of the site is located within the OTP catchment
Environmental Engineering Standards. (July 2010), Whangarei District Council.	Engineering standards for the Whangarei Region	Yes - Guidance to be followed

3.2 DESIGN CRITERIA

The stormwater management design criteria for the site is provided in Table 3.

Table 3 – Design Criteria

Item	Criteria	
(1)Rainfall Depths (Climate Change)	WQV	1/3rd 2 Year ARI (38.7mm)
	2 Year ARI (20% AEP)	20% Increase on rainfall depth (139mm)
	5 Year ARI (20% AEP)	20% Increase on rainfall depth (178mm)
	10 Year ARI (10% AEP)	20% Increase on rainfall depth (209mm)
	50 Year ARI (2% AEP)	20% Increase on rainfall depth (297mm)
	100 Year ARI (1% AEP)	20% Increase on rainfall depth (346mm)
Upstream Development	Allow for 0.62m^3/s from Northlakes (Saint Just Development)) (2)	
Quality	Buildings	No high contaminant yielding roofing or cladding e.g. Zn or Cu
Flood Attenuation	Floor levels	0.5m freeboard to 1% AEP event flood levels (Residential Buildings) 0.3m freeboard to 1% AEP event flood levels (Commercial & Industrial Buildings)
	Offsite properties: (downstream catchments)	No Increase to peak flows to downstream catchments for events up to the 1% AEP event.
Conveyance	Primary Network	(3)20% AEP event (5yr ARI event)
	Secondary Network	1% AEP event (100yr ARI event) (include allowance for climate change)

Notes:

(1) Rainfall depths adopted from HIRDS V3, 20% increase as per WDC EES.

(2) Northlakes, Saint-Just development flow of 0.62m^3/s, which has been agreed through earlier resource consent and private developer agreements.

(3) Exception being a small 0.54ha section located in Stage 1 in which the conveyance for the primary network has been designed for up to the 100yr storm event, this is a result of the secondary flows being unable to be conveyed overland into Wetland 1.

4 STORMWATER MANAGEMENT

4.1 SUB-CATCHMENTS

The development spans an area of approximately 50 hectares. This has been divided into 4 sub-catchments comprising of a primary stormwater network and an engineered wetland device.

A plan highlighting the proposed sub-catchments is shown in Appendix A.

4.2 BEST PRACTICABLE OPTION

The nature of discharge from urban development is such that potential contaminants are typically attached to suspended solids contained in the runoff. The objective of the proposed stormwater management wetlands is to allow these suspended solids to settle out.

The proposal to use stormwater management wetlands is considered the best practicable approach. The proposed stormwater management wetlands have been designed in accordance with the former Auckland Regional Council's "Stormwater Management Devices" Design Guidelines Manual – Technical Publication No.10 (TP10). Devices designed as per TP10 achieve 75% Total Suspended Solids (TSS) removal. The stormwater management wetlands also provide attenuation for up to the 100 year + climate change event.

4.3 STORMWATER NETWORK

4.3.1 Primary Network

The primary stormwater network (pipe) will be capable of conveying the 5 year ARI peak flow . This is in line with the WDC Environmental Engineering Standards (EES) (2010) that requires primary reticulation to be designed to accommodate the 5 year ARI event for residential areas.

The primary network within the development will consist of pipelines with sumps for collection. Stormwater will be conveyed through this network to one of the four proposed stormwater management wetlands.

4.3.2 Secondary Network (Overland Flow Paths)

The secondary network consists of overland flows, i.e. flows that exceed the primary network capacity. As secondary flows cannot be directly conveyed to the receiving environment due to site topography, flows in the 100 year (+ climate change) storm event are to be directed to the stormwater management wetlands.

Overland flow paths are proposed to be contained within the road reserves so as not to create a nuisance to the adjacent built environment contained within the residential lots. As per the WDC EES (2010), a 500mm (minimum) freeboard above the top water levels within the OLFP during the 100 year storm event will be provided to habitable finished floor levels.

It is important to note that for a small section of Stage 1 the primary network will be sized to convey secondary flows (100yr ARI event) directly to the trunk stormwater network. These secondary flows are conveyed through the trunk pipe network due to topographical constraints in this area. The Road 1 catchment is discussed further in section 9.3.1 of this report.

4.3.3 Trunk Stormwater Network

A reticulated “trunk” stormwater network is proposed to be provided in addition to the primary stormwater network. This trunk line consists of a network that collects stormwater from each of the proposed stormwater wetlands for conveyance to the outlet. The sizing of this network is based on the flows being discharged from each of the stormwater management wetlands. This line has also been designed to account for flows from the upstream proposed North Lakes development located south of Pyle Road East. The stormwater modelling of this line has been undertaken in XP Storm and is discussed further in section 5.5 of this report.

The proposed trunk main is to discharge via an upgraded stormwater coastal outlet located adjacent to 110 One Tree Point Road.

The existing stormwater outlet is approximately 375mm dia in size and is included within a small boat ramp.

4.4 WETLANDS

Stormwater management wetlands are to be adopted for the treatment and attenuation of stormwater runoff from the proposed development. A total of four stormwater management wetlands are proposed. The wetlands have been designed to contain up to the 100 year (+ climate change) storm event.

The 5 year ARI storm event is to be reticulated via the primary (pipe) stormwater network to the stormwater management wetlands. Runoff in storm events up to the 100 year (+ climate change) storm event will be conveyed to the wetlands via overland flow paths, with the exception being a small section of Stage 1 (0.54ha) in which the stormwater network will be sized to convey secondary flows (100yr ARI event) directly to the trunk stormwater network.

Stormwater runoff from the stormwater management wetlands is to be conveyed and discharged to the Whangarei Harbour/Paradise Point through a "trunk" stormwater network and an upgraded coastal outlet.

It is important to note that as the development is located in the One Tree Point CMP, attenuation is not required. Attenuation is being provided due to site topography, a lack of conveyance system through One Tree Point Road and to minimise the size of the "trunk" stormwater network discharging to the Whangarei Harbour/Paradise Point outlet.

The design of these wetlands is discussed in section 5.0.

5 STORMWATER MANAGEMENT WETLANDS

A total of four stormwater management wetlands are proposed within the development. This section will provide an overview for each of the proposed stormwater management wetlands.

5.1 WETLAND DESIGN

A plan showing the location of these wetlands can be found in **Appendix A**.

The wetlands are to be designed in general accordance with the recommendations of TP10. An assessment of the size of the wetlands was done by calculating the surface area required to achieve water quality volume for a deeper conventional stormwater pond. The wetland uses this surface footprint as the basis of design.

The emphasis of the wetlands is to provide both primary treatment and a level of attenuation. Primary flows for the 5 year ARI event (20% AEP) to the wetlands are to be conveyed via a piped network, with secondary flows being received via overland flow paths (with the exception to a small section of stage 1 in which secondary flows will be piped directly to the trunk stormwater network).

Water Quality objectives targeted:

- Capturing and retaining 1/3rd of the 2 year ARI storm event for water quality treatment.
- **Sediments (TSS):** Designed in accordance with TP10 and therefore provides 75% TSS removal from the incoming stormwater runoff.
- **Metals (Cu/Zn):** Given the stormwater device proposed is a wetland, it is expected that biological uptake of metals through the planted species will occur. This will help to reduce adverse effects on the downstream environment.
- **Temperature:** Given the dense planting within the wetland, it is expected that there will be sufficient shading to ensure the flow being discharged is within the temperature threshold proposed in the Regional Plan.

Water Quantity objectives targeted:

- Given the site's close proximity to Whangarei Harbour/ Paradise Point, stormwater flows can be passed forward, however attenuation is provided to reduce the size of the pipes for the "trunk" stormwater network.

5.2 STORMWATER MODELLING (HEC HMS)

Version 4.1 of HEC-HMS software was used to model each of the catchments discharging to the contributing wetland catchments. A schematic of the HEC HMS model is shown in Figure 2. A catchment plan outlining these catchments is provided in Appendix A.

It is important to note that this report only outlines an overview of the Stormwater Management Wetlands, a detailed report for each wetland will be provided at engineering approval stage.

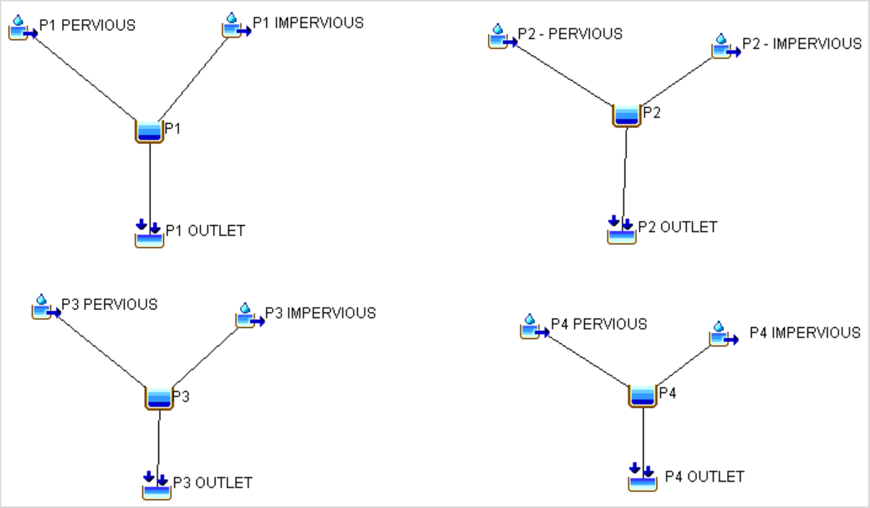


Figure 2: Model Layout for Wetlands in HEC HMS

5.2.1 Design & Modelling Parameters

Stormwater runoff flows and volumes were calculated using the SCS methodology in the HEC-HMS software. An NRCS TR55 Type 1a storm profile has been adopted. The modelling parameters are summarised in the following sections.

5.2.1.1 Rainfall

The 24-hour rainfall depths used in the model are based on NIWA's High-Intensity Rainfall System (HIRDS) V3. Climate change has been adopted as per section 4.6.3 of the WDC EES (20% increase applied). A summary of the rainfall data is summarised in Table 4.

Table 4: Rainfall Data

Rainfall Events	24 hr Rainfall Depths (Without Climate Change) mm	24 hr Rainfall Depths (With Climate Change) mm
WQV (1/3rd 2 Year ARI)	38.7	NA
2 Year ARI (50% AEP)	116	139
5 Year ARI (20% AEP)	148	178
10 Year ARI (10% AEP)	174	209
50 Year ARI (2% AEP)	248	297
100 Year ARI (1% AEP)	288	346

5.2.1.2 Catchment Parameters

The catchment areas for each of the proposed stormwater management wetlands are summarised in Table 5. A schematic of the wetland locations and catchments is provided in Appendix A.

Table 5: Catchment Parameters

	Area Types	**Wetland 1**	**Wetland 2**	**Wetland 3**	**Wetland 4**
5 Year ARI	Total Pervious Area (ha)	7.05	6.66	5.1	5.11
	Total Impervious Area (ha)	8.99	5.45	5.53	4.18
	Total Catchment Area [5 Yr] (ha)	16.04	12.11	11.61*	9.29
100 Year ARI	Total Pervious Area (ha)	7.05	6.66	5.1	5.11
	Total Impervious Area (ha)	8.99	5.45	5.53	4.18
	Total Catchment Area [100 Yr] (ha)	16.04	12.11	10.63*	9.29

***Note**: *For Wetland 3, 0.97ha of residential lots at the southern edge of the site is discharged directly to Pyle Road East in the 100 Year event, but it will be serviced by the wetlands in the 5 Year event.*

5.2.1.3 SCS Parameters

The runoff has been modelled using the SCS hydrology method. Curve Numbers (CN) for this development are based on the soils being classified conservatively as Group B. A summary of the modelling parameters is summarised in tables 6, 7 and 8.

Table 6: Catchment Data

	Wetland 1	Wetland 2	Wetland 3	Wetland 4
Catchment Area [100 Year] (ha)	16.04	12.11	10.63	9.29
Pervious Area – Group B (ha)	7.05	6.66	5.1	5.11
Impervious Area (ha)	8.99	5.45	5.53	4.18
Channelisation factor (C)	0.6	0.6	0.6	0.6
Catchment Length (km)	0.65	0.52	0.34	0.40
Catchment Slope Sc (%)	0.6	1.0	0.7	0.6

Note: *The catchment areas for Wetland 3 and 4 are different for the primary and secondary events. For Wetland 3, a portion of the southern edge of the site is discharged directly to Pyle Road East in 100 Year event, but not in 5 Year event.*

Table 7: Curve Numbers (CN) & Initial Abstraction

Cover Description	**CN**
Impervious Cover	98
Pervious cover – Group B	61
Initial Abstraction	Ia (mm)
Impervious	0
Pervious	5

Table 8: Time of Concentration

	Wetland 1	Wetland 2	Wetland 3	Wetland 4
Runoff Factor = CN/(200-CN)	0.69	0.65	0.67	0.67
tc =0.14 C x L0.66 x [CN/(200-CN)]–0.55xSc–0.30 (hrs)	0.36	0.28	0.23	0.27
SCS Lag for HEC-HMS “tp” =2/3 tc (hrs)	0.24	0.19	0.15	0.18

5.3 ENGINEERING STRUCTURES

It is proposed that stormwater runoff for events up to the 5 year ARI event will be conveyed through the primary stormwater network to the wetland. For events greater than the 5 year ARI event, runoff will be conveyed to the wetlands via designated overland flow paths.

5.3.1 Inlet & Outlet Structures:

Details regarding the inlet and outlet structures for Stormwater Management Wetlands are summarised below:

Wetland 1

Inlet Structures

- 1.050m diameter scruffy dome at 7.50m RL
- 525mm circular orifice at 6.40m RL
- Rip rap and rocks at the inlet structure to reduce inflow velocities

Outlet Structures

- 900mm diameter outlet pipe

Wetland 2

Inlet Structures

- 1.050m diameter scruffy dome at 6.30m RL
- 600mm circular orifice at 5.20m RL
- Rip rap and rocks at the inlet structure to reduce inflow velocities

Outlet Structures

- 900mm diameter outlet pipe

Wetland 3

Inlet Structures

- 1.050m diameter scruffy dome at 5.90m RL
- 600mm circular orifice at 4.70m RL
- Rip rap and rocks at the inlet structure to reduce inflow velocities

Outlet Structures

- 900mm diameter outlet pipe

<u>Wetland 4</u>

<u>Inlet Structures</u>

- 1.050m diameter scruffy dome at 7.50m RL
- 525mm circular orifice at 4.70m RL
- Rip rap and rocks at the inlet structure to reduce inflow velocities

<u>Outlet Structures</u>

- 900mm diameter outlet pipe

Calculations for each of the Wetlands are provided in Appendix D of the Report.

5.3.2 Emergency Outlets

An emergency scruffy dome structure is proposed to be included for each of the stormwater management wetlands. These scruffy dome outlets are proposed to be set at the 100 year ARI level and have been included as an emergency outlet that will be triggered in the instance that the primary outlet structure fails or when the storm exceeds the designed 100 year ARI event.

It is important to note that given the site topography, these emergency outlet structures have been provided in lieu of a traditional spillway structure and as a contingency for blockages of the primary outlet.

5.3.3 Freeboard

A minimum freeboard of 500mm to the 100 year top water level in the wetland is to be provided for all lots adjacent to the stormwater management wetlands.

5.4 WETLAND CONSTRUCTION, MAINTENANCE AND SAFETY

The wetlands will be constructed mostly by excavation between approximately 2-3m below natural ground level. This work will be undertaken during land development earthworks construction.

Section 4.10.2 of the EES (2010) outlines ponds shall comply with the following:

- Maximum permanent water depth is 1.5m
- Internal slopes shall be 1:4 (V:H)
- Reverse benches around the full perimeter with a slope 1:10 min 2.0m wide at 300mm above the permanent water level where ponds are not fenced.

The wetlands have been designed based on a bathymetry design with varying depths that range from 1m deep in the forebay, 0.5m in the deeper areas and 0.15 in the shallow areas. The maximum permanent water depths will not exceed 1.5m in depth.

Internal slopes for wetlands have been designed for a maximum slope of 1:3 (V:H) where there is proposed vegetation or planting. Vegetating internal slopes reduces the requirement of maintenance and mowing, therefore enabling steeper batter slopes.

It is important to note that the wetlands have been designed with internal slopes below the Permanent Water Level (PWL) of 1:4 (V:H) or shallower.

3m wide safety benches are provided above the PWL, these are formed as reverse benches 300mm above PWL that double as a maintenance track.

The requirement for a clay or impermeable liner will be assessed based on field investigations prior to the wetland construction. Due to the highly organic nature of the underlying ground immediately beneath the various wetland locations and associated potential settlement.

A typical section of how these impermeable liners could be constructed is provided in Appendix C. The section shows a minimum 200mm topsoil thickness (or thicker for maintenance track materials) above the liner. The liner is extended up the batter slopes of the wetlands at least 100mm above the 10 year flood level and trenched in accordance with the manufacturer’s recommendations.

The thickness of the topsoil proposed across the liner should be sufficient to ensure that the liner is not compromised during periodic maintenance such as silt removal etc.

The wetlands are expected to be well landscaped with a bathymetric profile. Landscaping plans for the Wetlands are provided in Appendix C

The gradients across the wetlands are no steeper than 1 in 3 (V:H), and as such, stability of this thickness of topsoil is expected to be satisfactory, particularly once vegetation has established.

5.5 STORMWATER MODELLING – TRUNK STORMWATER NETWORK (XP STORM)

The proposed trunk stormwater network has been modelled using XP Storm 2016. The XP Storm model has been created to perform the hydraulics analysis of the trunk stormwater network.

Sizing of the stormwater management wetlands has been undertaken using HEC-HMS. This package sufficiently simulates routing through the wetlands and provides peak flows and water levels within the wetland for various storm events.

The XP Storm model uses the HEC-HMS wetland outputs as a user inflow hydrograph to load flows to the trunk line. Flows from the neighbouring Northlakes development along with flows for the primary event (5 year ARI event as per WDC EES) for existing areas discharge to this line. A plan showing these catchments can be found in Appendix A, these areas consist of:

- Residential lots (70% impervious)
- One Tree Point Road (80% impervious)
- One Tree Point School (50% impervious)
- Catchment H - Residential lots/ One Tree Point Road (70% & 80% impervious)

The impervious coverages for the existing areas noted above have been calculated via an assessment of the aerial photography in this area.

An elevation shape file is formed in XP Storm over the proposed wetlands to represent the max water level as per the results in the HEC HMS model. The XP storm model is simulated and any ponding above the elevation shape file represents the additional volume that is required and stored within the wetlands.

It is important to note that the XP Storm model is simulated to incorporate tail water effects at the outlet into the Whangarei Harbour/ Paradise Point. A mean high water surface (MHWS) of RL 1.044m + 0.35m (1.394m RL) for storm surge has been adopted for the Whangarei Harbour/ Paradise Point discharge location.

The MHWS of 1.044m RL is based on:

- MHWS (LINZ defined) at Marsden Point - 2.72 Chart Datum
- Chart Datum defined as 4.816 below RNZN BM DJM9
- DJM9 RL=3.14m IN OTP1964
- 3.14 – 4.816 + 2.72 = 1.044

A screenshot of the trunk network modelled in XP storm is shown in Figure 3.

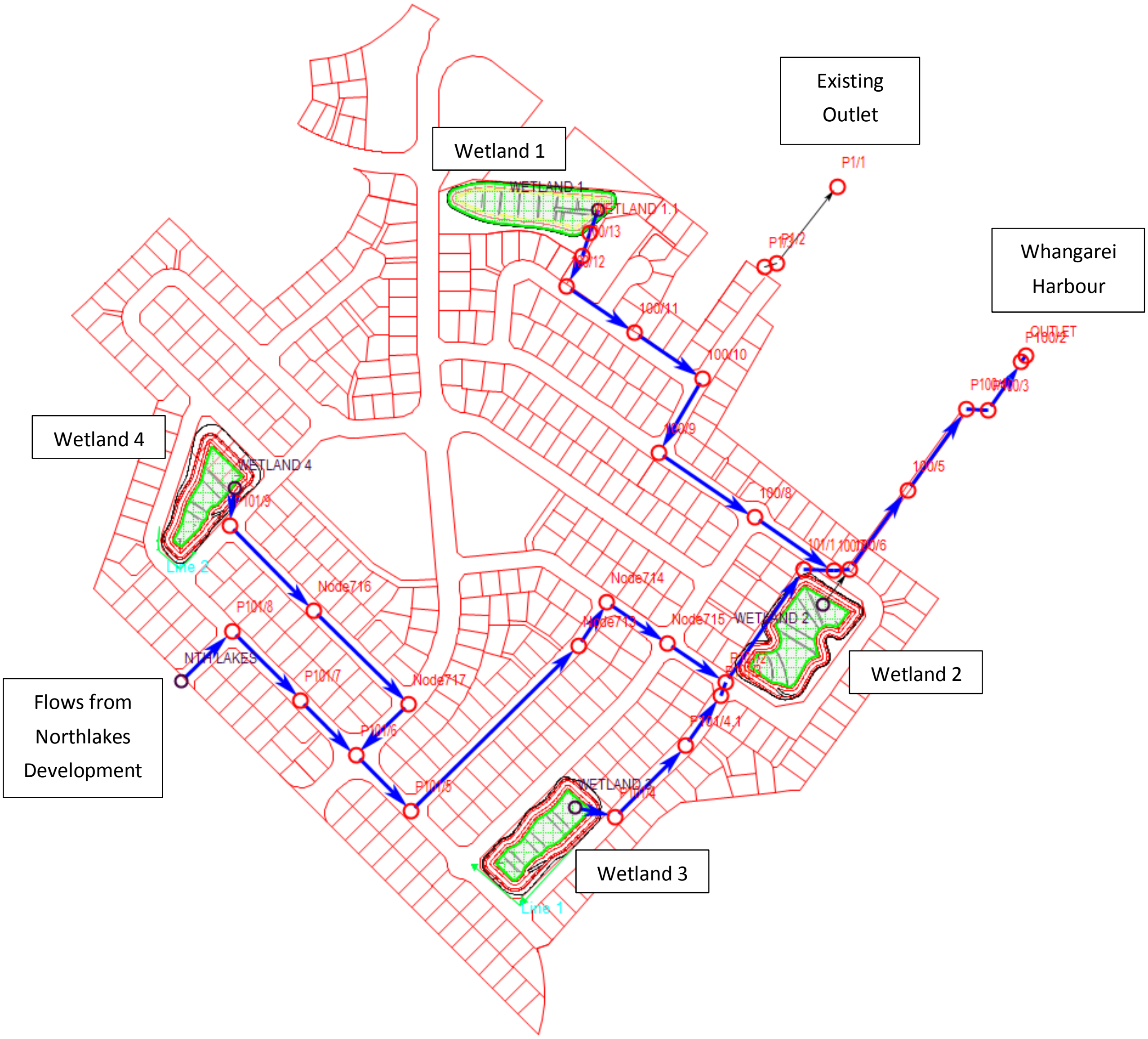


Figure 3: XP Storm – Trunk Stormwater Network

5.6 MODELLING RESULTS

5.6.1 HEC HMS

Iterations of the HEC-HMS model were run for various storm events and the results from the iterations are summarised in the sections below.

The results outlined in Table 9 highlight the results for the proposed Stormwater Management Wetlands.

Table 9: HEC HMS Results

		Peak Inflow (m^3/s)	**Peak Outflow (m^3/s)**	**Peak Elevation (m RL)**
Wetland 1	5 Year	1.33	0.32	5.62
	100 Year	2.89	1.95	6.13
Wetland 2	5 Year	0.94	0.41	5.78
	100 Year	2.12	0.75	6.33
Wetland 3	5 Year	0.87	0.43	5.31
	100 Year	1.91	0.73	5.89
Wetland 4	5 Year	0.75	0.33	6.97
	100 Year	1.68	0.67	7.56

The peak outflows are based on the outlet structures as discussed in section 5.3 of this report. Flow through the orifice was modelled using the orifice equation:

$$Q = 0.62A\ (2gh)^{0.5}$$

Detailed stormwater attenuation calculations and HEC HMS outputs are provided in Appendix D.

5.6.2 XP Storm

The results from the XP Storm model demonstrate that the trunk stormwater network in conjunction with the stormwater wetlands are able to efficiently discharge to the Whangarei Harbour outlet with the tidal boundary conditions applied.

The screenshot from the XP Storm model scheme is shown in Figure 4 with a summary of the flood levels in each of the wetlands for the 100yr event.

Detailed outputs from the XP storm model for the 100 year ARI storm events are provided in Appendix E – XP Storm Outputs.

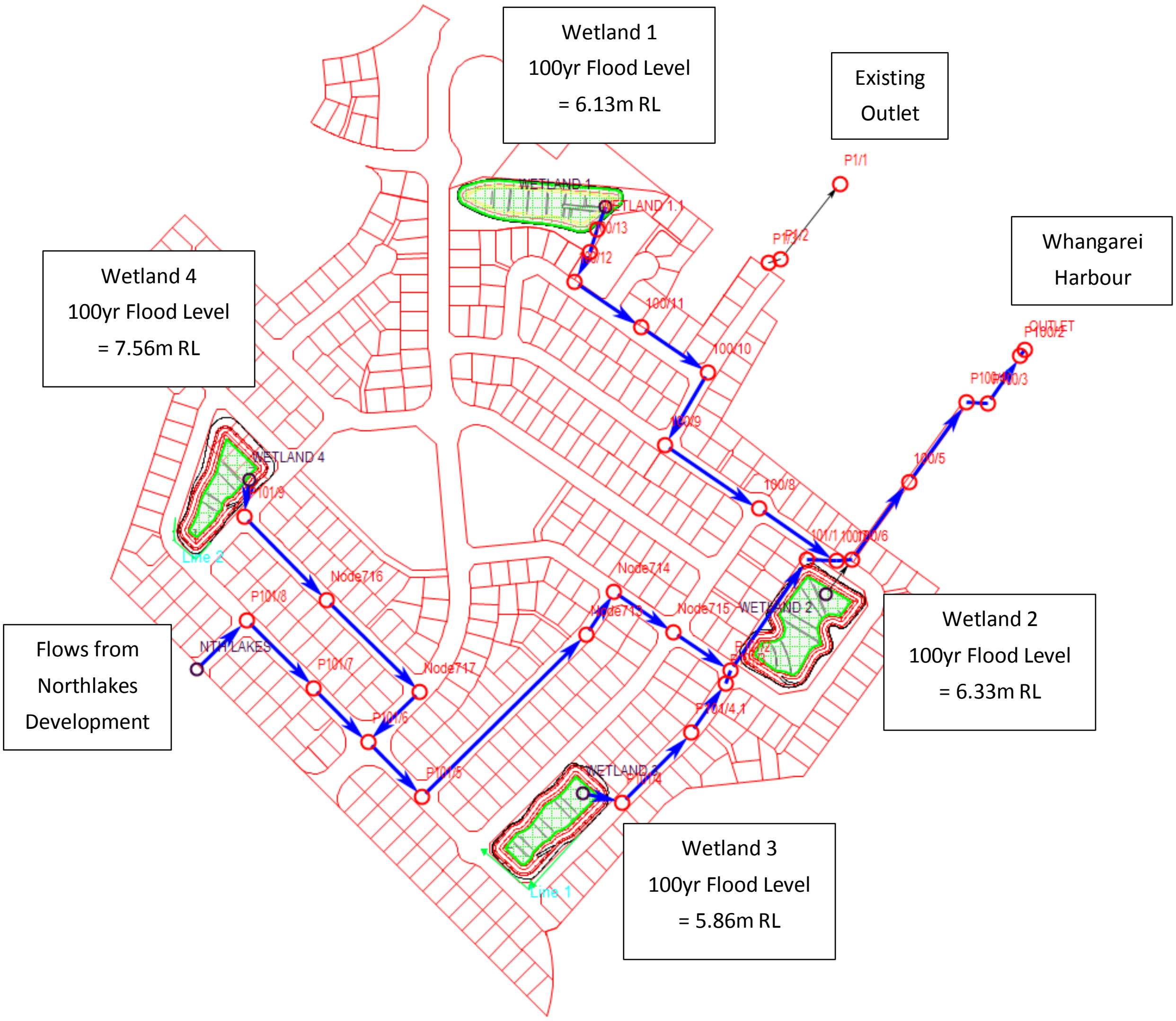


Figure 4: XP Storm – Results – 100 Year Storm Event

6 STORMWATER OUTFALL STRUCTURE

Stormwater will be discharged from the development to Whangarei Harbour/ Paradise Point via the proposed trunk stormwater network. The outlet for the network will be upgraded and will remain at approximately the same location. The outlet is located at the existing boat ramp just west of Paradise Point, adjacent to 110 One Tree Point Road.

Work on the physical setting, coastal processes and environmental impact of the discharges to this location has already been undertaken by a coastal geomorphologist.

A design of the proposed upgrade to the boat ramp outlet was undertaken in 2006. It is considered that the original design parameters and assumptions are still applicable.

The trunk stormwater network has an outlet that consists of a 900mm x 600mm rectangular outlet with a high flow surcharge overland bypass. The design purpose of the outlet structure is to create laminar flows, discharging into the coastal marine environment. The outlet and its effects on discharge are discussed further in section 7.4.1.

As the outlet requires a resource consent, it is anticipated this element of the proposal will have suitable consultative continuity with NRC and WDC.

7 STORMWATER EFFECTS & MITIGATION MEASURES

7.1 GENERAL

The stormwater runoff from the site currently is discharged untreated via a system of shallow dune systems extending across the site. Development of the site will result in an increase in stormwater runoff. Stormwater runoff from the site is proposed to be reticulated to the stormwater management wetlands for treatment and attenuation prior to final discharge into Whangarei Harbour/Paradise Point.

The effects of the proposed development upon the receiving environment in terms of stormwater quality and quantity are discussed in the sections below.

7.2 STORMWATER QUALITY

The proposed stormwater management wetlands are designed with a bathymetric profile and in accordance with the design approach outlined in TP10. The wetlands are designed for treatment and fill up during large storm events. A summary of the wetland design features are outlined in Table 10.

Table 10: Wetland Characteristics

Wetland	Contributing Catchment Area (ha)*	Wetland Area at Crest Level (m^2)	**Wetland Volume (m^3)	Wetland Full Depth (m^3)	Permanent Water Level (m RL)
Wetland 1	16.04	7071	11889	3.1	4.3
Wetland 2	12.14	8879	7904	2.3	5.10
Wetland 3	10.63	6715	8876	3.1	4.70
Wetland 4	9.28	6137	7527	2.9	6.40

***Notes**:*

**Contributing catchment area based on primary network catchment – Refer drawings attached in Appendix A.*

***Wetland volume above PWL (flood storage volume)*

The wetlands are proposed to have a permanent water level depth that varies between 0.15m to 0.50m with appropriate plant species selected for planting. Outflows from the wetland are regulated by the orifices placed on the side of the main outlet manhole riser. A sediment forebay will remain at least 1m deep as recommended in TP10.

As the wetlands are designed as per TP10, the overall efficiency of the wetlands are expected to meet the target level of 75% TSS removal, based on a long term average.

7.3 STORMWATER QUANTITY

The proposed development manages stormwater quantity through the internal primary stormwater network and secondary flow paths that convey flows to the 4 proposed wetlands, the system is designed to convey stormwater to wetlands for storm events up to, and including the 100 year ARI (+ climate change) storm event.

The proposed wetlands are designed with dual purpose quality treatment and attenuation, that have the capacity to attenuate up to the 100 year ARI (+ climate change) storm event.

The rate of stormwater discharge at the fully developed stage have also been assessed. The results are summarised in Table 11 and are based on the HEC-HMS and XP Storm model. The XP Storm assessment takes account of the trunk stormwater network and the effects of tail water at the outlet.

Table 11: Result Summary

Wetland	Storm Event	Peak Inflow (m^3/s)	Peak Outflow (m^3/s)	Max Elevation (m RL)	Flow Reduction (%)
Wetland 1 **(Crest Level = 6.13 m RL)**	2 Year	0.99	0.24	5.27	76%
	5 Year	1.33	0.32	5.62	76%
	10 Year	1.61	0.54	5.72	66%
	100 Year	2.89	1.95	6.13	33%
Wetland 2 **(Crest Level = 6.33 m RL)**	2 Year	0.69	0.33	5.68	52%
	5 Year	0.94	0.41	5.78	56%
	10 Year	1.15	0.47	5.87	59%
	100 Year	2.12	0.75	6.33	65%
Wetland 3 **(Crest Level = 5.89 m RL)**	2 Year	0.64	0.35	5.21	45%
	5 Year	0.87	0.43	5.31	51%
	10 Year	1.05	0.49	5.40	53%
	100 Year	1.91	0.73	5.89	62%
Wetland 4 **(Crest Level = 7.56 m RL)**	2 Year	0.55	0.26	6.86	53%
	5 Year	0.75	0.33	6.97	56%
	10 Year	0.91	0.38	7.07	58%
	100 Year	1.68	0.67	7.56	60%

The wetlands are able to store large volumes and consequently provide attenuation of peak flows. This is illustrated in Table 11, which shows that post-development peak flows are reduced by up to 76%. It is important to note that this attenuation is above the requirements of the One Tree Point Catchment Management Plan which does not require attenuation of flows for discharge into the Whangarei Harbour rather than to a perennial watercourse.

Wetlands are able to accommodate and pass the 100 year flows without causing inundation of neighbouring properties. For example, Wetland 1 has a max water elevation of 6.16m RL in the 100 year event. The neighbouring lots have a ground elevation of 7.29m RL, this would provide a freeboard of greater than 1m above the predicted flood level.

7.4 DISCHARGE NETWORK & OUTLET STRUCTURE

The development proposes the construction of a trunk stormwater network that the four proposed wetlands will discharge to. The trunk stormwater network will discharge to the upgraded coastal outlet at Whangarei Harbour / Paradise Point.

The trunk stormwater network operates separately to the primary stormwater reticulation system. The trunk stormwater network is designed to convey flows from the following areas:

- Controlled flows from Wetlands 1,2,3 & 4
- Stormwater flows from catchment C (Primary only)
- Controlled flows from the Northlakes, Saint-Just development.
- Existing WDC stormwater reticulation within catchment B

A plan of these areas can be found in Appendix A. The total contributing catchment to the trunk stormwater network is approximately 60.11ha (primary catchment).

It is proposed that each of the four wetlands located within the development will discharge into the trunk stormwater network through a wing wall inlet and a single pipe outlet control system. These have been designed to attenuate flows to allow for the 100 year ARI (+ climate change) storm event to be routed through the trunk stormwater network.

7.4.1 Effects of Discharge

The effects of the discharge to Whangarei Harbour/ Paradise Point was assessed by DTec Consulting in March 2006. The assessment refers to flows and velocities for the 20% AEP (5 Year ARI event). The results reported at the time along with the updated results are summarised in Table 12.

Table 12: Discharge from Outfall

Storm Event	Previously Reported (2006)		Current XP Storm Outputs (2016)	
	Peak Outflow (m^3/s)	Peak Velocity (m/s)	Peak Outflow (m^3/s)	Peak Velocity (m/s)
5 Year (20% AEP)	$3.16m^3/s$	1.75m/s	$2.00m^3/s$	3.69m/s

The peak outflow and velocities from the current XP Storm model are based on the proposed 900mmx600mm box culvert. Overall the peak outflow has reduced as the wetlands are now designed for a greater level of attenuation (100 year event where previously they were designed for the 50 year event).

The peak velocity has increased however it is important to note that this velocity does not factor in scour protection at the toe of the outfall or the proposed energy dissipation, the design of the energy dissipation structure will be undertaken at engineering approval stage. Overall the effect is deemed of a similar nature to that previously assessed.

A copy of this assessment has been included in Appendix F.

7.4.2 Overland Flows – Boat Ramp

An assessment for overland flows over the proposed boat ramp has been undertaken, the assessment is based on the total flow being discharged from the bubble up chamber in conjunction with the secondary flows from Catchment B (contributing catchment to the boat ramp).

The XP storm model predicts that the peak flow being discharged via the bubble-up chamber equates to approximately 0.5941m^3/s, this equates to approximately 60mm of depth over a 3m width (12.5% grade).

The peak flow from Catchment B contributing to the boat ramp equate to 1.18m^3/s for the 100yr + CC ARI event. A HEC-HMS model was used to determine the peak flow and is based on a total area of approximately 5.494ha (1.59ha pervious and 3.904ha impervious). A peak flow of 1.18m^3/s equates to approximately 97mm of depth over a 3m width (12.5% grade).

Given the attenuation being undertaken in the OTP model and the proximity of Catchment B to the outlet, the peak flows from catchment B would pass before the peak of the OTP development flows.

However, in the instance that the peak flows did combine a manning's assessment for an open channel was used to determine the depth of flow over the proposed boat ramp, the peak flow from catchment B (1.18m^3/s) was combined with the peak flow from the bubble-up chamber (0.5941m^3/s), the assessment showed that depth of flow over the boat ramp equates to approximately 115mm based on a slope of 12.5%.

A summary of this assessment is shown in Table 13 with calculations provided in Appendix G.

Table 13: Discharge from Outfall

Scenario (1% AEP)	Peak Flow (m^3/s)	Flow Depth (mm)	Peak Velocity (m/s)
Existing Flows (Catchment B)	1.18m^3/s	97mm	4.02m/s
Bubbleup Flows (Development)	0.59m^3/s	60mm	3.31m/s
Combined	1.77m^3/s	125mm	5.00m/s

8 CONCLUSION

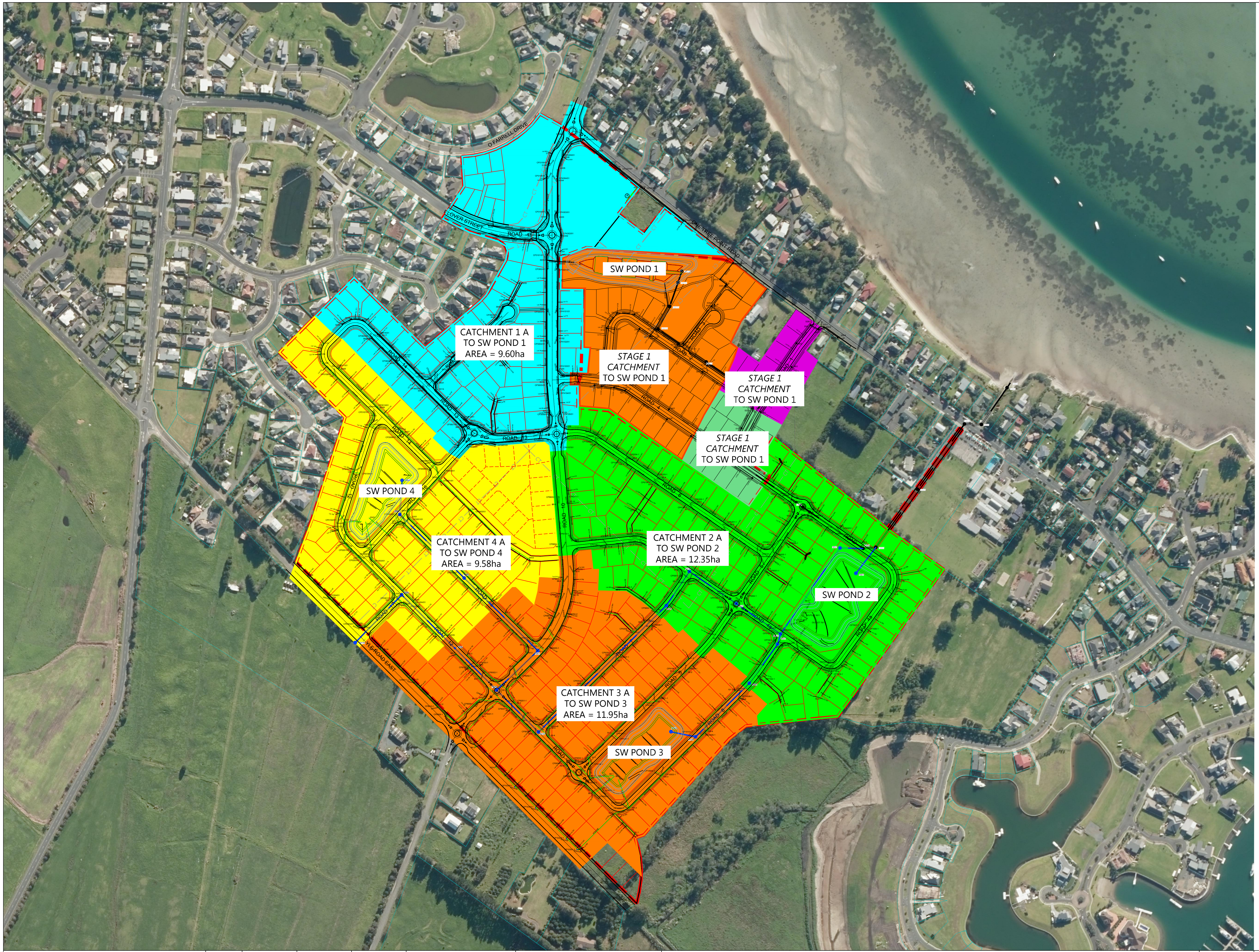
The information summarised and results provided show that the effects of development with respect to stormwater runoff are adequately managed through the proposed stormwater management plan outlined in this report.

The stormwater management plan includes the use of a reticulated primary stormwater network, overland flow paths, wetlands and a trunk stormwater network for the management of stormwater runoff.

The primary stormwater network (pipe reticulated) has been designed for the 5 year ARI event (20% AEP) as per the criteria set in the current WDC Engineering standards. The wetlands have been designed in accordance with the TP10 design approach and modelled in HEC-HMS for volume/peak flow design and in XP Storm for the sizing and validation of the trunk stormwater network.

It is concluded that the stormwater management for this development is in line with the One Tree Point & Marsden Point CMP's and meets the requirements set out in the WDC EES.

APPENDIX A



WOODS
EST.1970

LEGEND

PROPOSED STORMWATER	20/1
PROPOSED STORMWATER TRUNK MAIN	101/1
EXISTING STORMWATER	01/1
EXISTING STORMWATER TRUNK MAIN	101/1
CESSPIT SUMP	CP1101-1
PROPOSED BOUNDARY	
EXISTING BOUNDARY	
DESIGN MINOR CONTOUR	
DESIGN MAJOR CONTOUR	6.0

REVISION DETAILS		INT	DATE		
1.	ISSUED FOR CONSENT	JL	19/01/18	SURVEYED	
				DESIGNED	
				DRAWN	JL
				CHECKED	
				APPROVED	

ONE TREE POINT ROAD
ONE TREE POINT
NORTHLAND

WOODS.CO.NZ

WFH PROPERTIES

THE LANDING @ MARSDEN, ONE TREE POINT
STAGES 3-9
STORMWATER MAIN CATCHMENT PLAN

N

STATUS	ISSUED FOR CONSENT	REV
SCALE	1:5000 @ A3	1
COUNCIL	WHANGAREI DISTRICT COUNCIL	
DWG NO	31014-00-310-DR	

WOODS
EST.1970

LEGEND

WETLAND 1 CATCHMENT	🟥
WETLAND 2 CATCHMENT	🟪
WETLAND 3 CATCHMENT	🟨
WETLAND 4 CATCHMENT	🟦
NORTH LAKES CATCHMENT	🟧
CATCHMENT A	🟩
CATCHMENT B	🟪
CATCHMENT C	🟩
LA POINTE ESTATES CATCHMENT	🟩
WFH PROPERTIES LTD PROPERTY EXTENT	▪▪▪▪▪▪
PRELIMINARY STORMWATER TRUNK LINES	—●—
INDICATIVE WETLAND RESERVES	▨
INDICATIVE PROPOSED ROADS	≈

NOTES

(1) CATCHMENT A DISCHARGES TO THE EXISTING OUTLET 1
(2) LA POINTE ESTATES CATCHMENT DISCHARGES TO LA POINTE ESTATES WETLAND

REVISION DETAILS		BY	DATE
4	FINAL	PW	1–2018

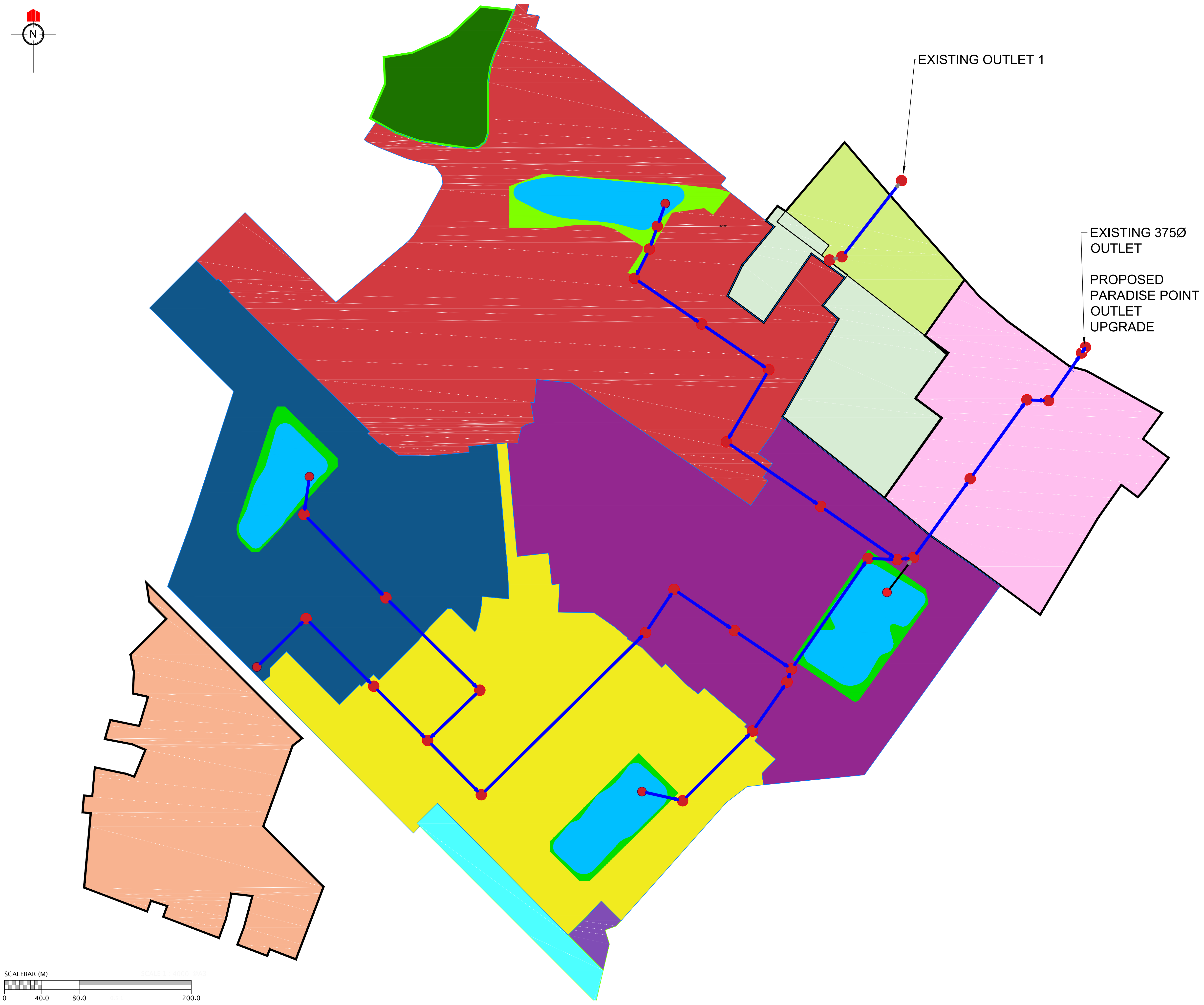
SURVEYED	XXX	ONE TREE POINT ROAD ONE TREE POINT NORTHLAND
DESIGNED	ZY/PW	
DRAWN	ZY	
CHECKED	PW	
APPROVED	TF	WOODS.CO.NZ

WFH
PROPERTIES

ONE TREE POINT

STORMWATER CATCHMENT PLAN
(PRIMARY)

STATUS	ENGINEERING APPROVAL	REV
SCALE	1:4000@ A3	
COUNCIL	WDC	
DWG NO	31013–01–320 DR	



WOODS
Est.1970

LEGEND

WETLAND 1 CATCHMENT	🟥
WETLAND 2 CATCHMENT	🟪
WETLAND 3 CATCHMENT	🟨
WETLAND 4 CATCHMENT	🟦
NORTH LAKES CATCHMENT	🟧
CATCHMENT A	🟩
CATCHMENT B	🟪
CATCHMENT C	🟩
CATCHMENT D	🟦
CATCHMENT E	🟪
LA POINTE ESTATES CATCHMENT	🟩
WFH PROPERTIES LTD PROPERTY EXTENT	▬ ▬ ▬
PRELIMINARY STORMWATER TRUNK LINES	—●—
INDICATIVE WETLAND RESERVES	🟦
INDICATIVE PROPOSED ROADS	⌒

NOTES

(1) DISCHARGE LOCATIONS FOR CATCHMENT A, B, C & NORTH LAKES ARE YET TO BE CONFIRMED
(2) CATCHMENT D DISCHARGES TO PYLE ROAD EAST
(2) CATCHMENT E DISCHARGES TO NEIGHBOURING SITE

REVISION DETAILS		BY	DATE
4	FINAL	PW	01–18

SURVEYED		ONE TREE POINT ROAD ONE TREE POINT NORTHLAND
DESIGNED	ZY/PW	
DRAWN	ZY	
CHECKED	PW	
APPROVED	TF	WOODS.CO.NZ

WFH PROPERTIES

ONE TREE POINT

STORMWATER CATCHEMENT PLAN (SECONDARY)

STATUS	ENGINEERING APPROVAL	REV
SCALE	1:4000@ A3	
COUNCIL	WDC	
DWG NO	31013–01–321–DR	

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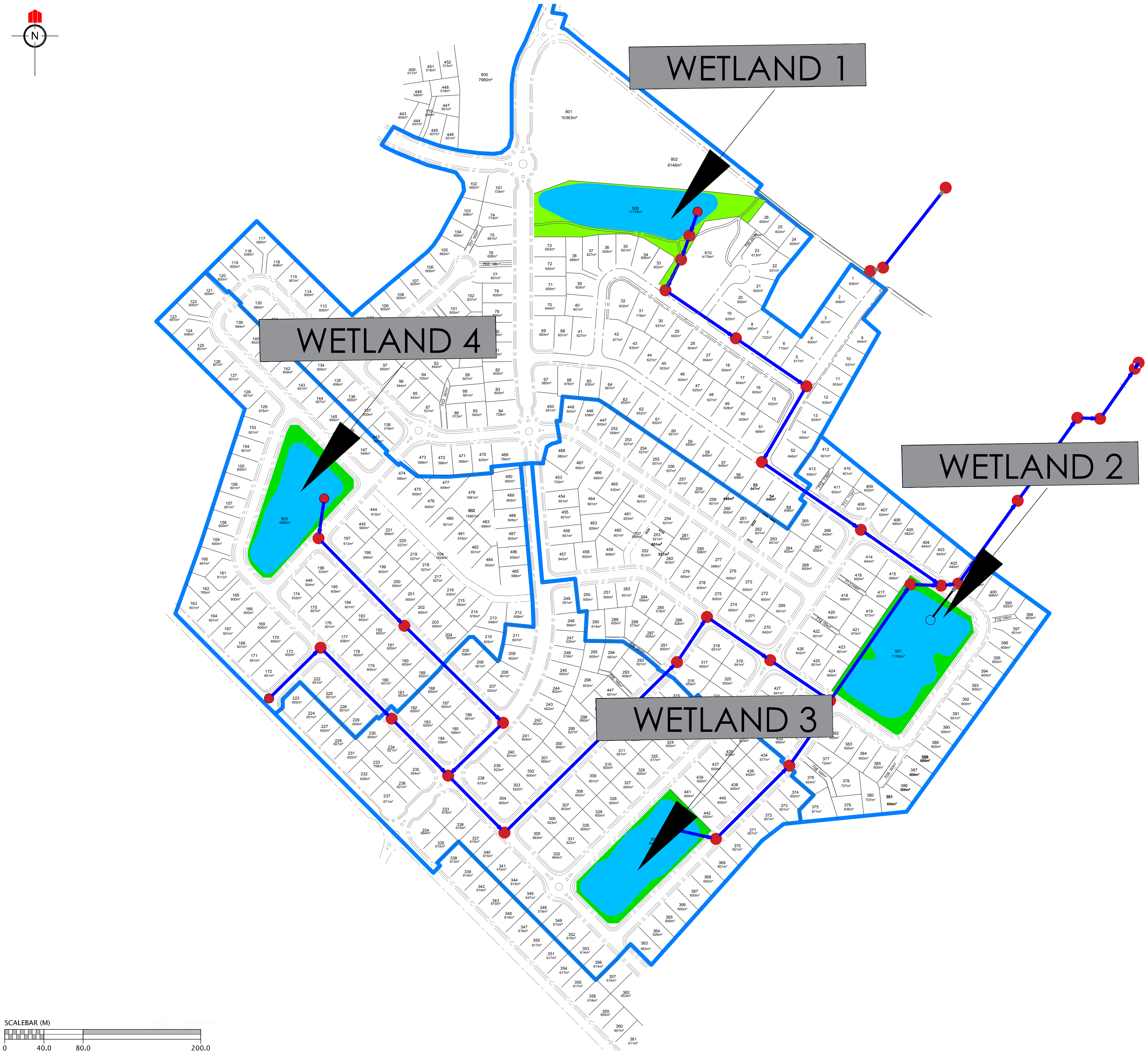
APPENDIX B

WOODS
EST.1970



LEGEND

INDICATIVE WETLAND RESERVES	🟦
INDICATIVE PROPOSED ROADS	═
WFH PROPERTIES LTD PROPERTY EXTENT	🟥
GREEN RESERVES	🟩

REVISION DETAILS		BY	DATE
4	FINAL	PW	01–18

SURVEYED		ONE TREE POINT ROAD ONE TREE POINT NORTHLAND
DESIGNED	ZY/PW	
DRAWN	ZY	
CHECKED	PW	
APPROVED	TF	WOODS.CO.NZ

WFH PROPERTIES

ONE TREE POINT

WETLAND LOCATION PLAN

STATUS	ENGINEERING APPROVAL	REV
SCALE	1:4000@ A3	
COUNCIL	WDC	
DWG NO	31013–01–323–DR	

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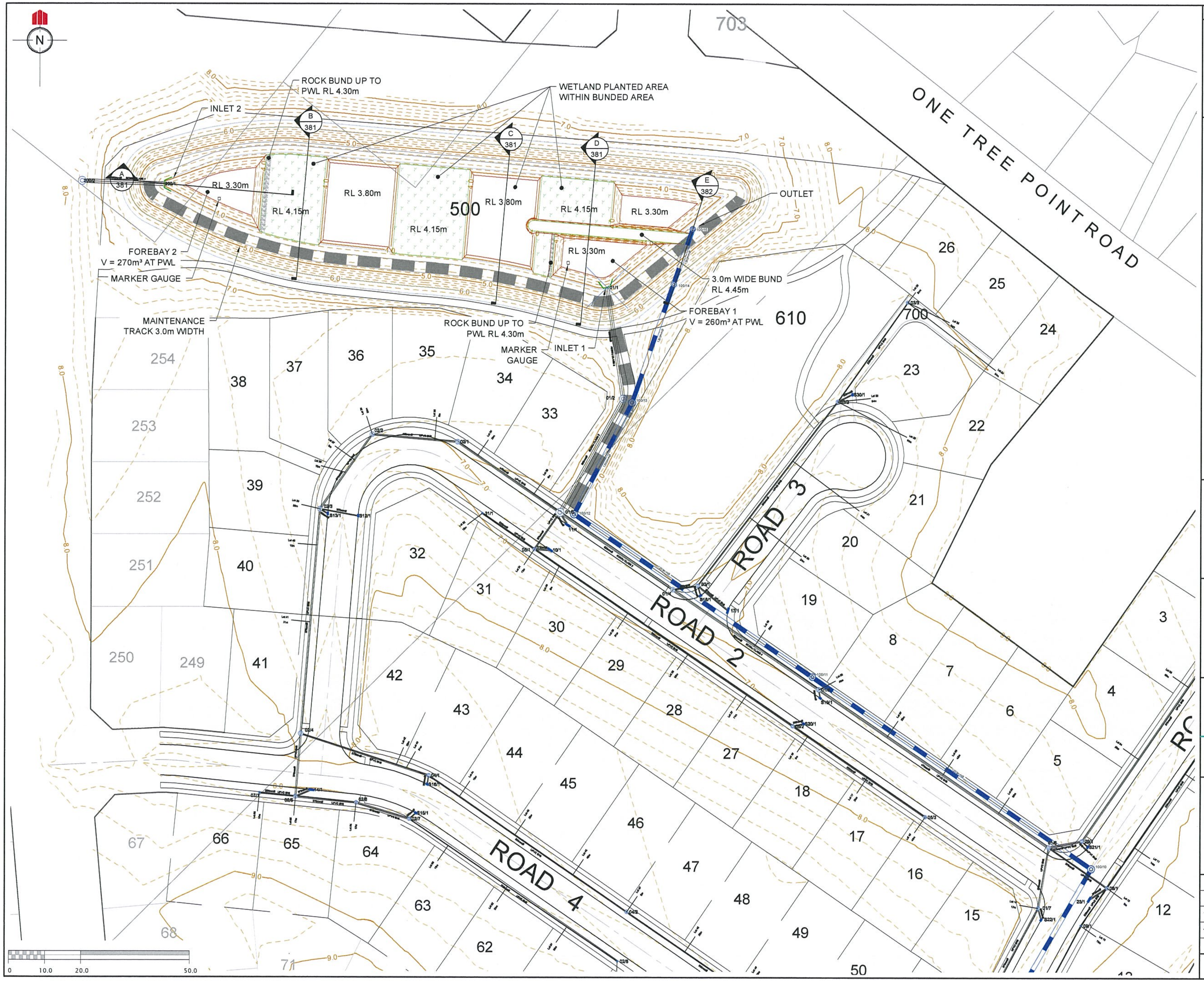
APPENDIX C



REVISION DETAILS	NAME	DATE
1 ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

NOTES

1. REFER TO LASF LTD LANDSCAPE PLAN FOR OVERALL PLANTING PLAN FOR WETLAND

LEGEND

PROPOSED STORMWATER	01/1
PROPOSED STORMWATER TRUNK MAIN	100/1
SINGLE / DOUBLE SUMP	S1/1 DS2/1
LATERAL CONNECTION	
DESIGN CONTOUR MAJOR (1.0m INCREMENTS)	
DESIGN CONTOUR MINOR (0.2m INCREMENTS)	
PROPOSED BOUNDARY	
PLANTED AREA - BATHYMETRIC BUNDS	▨
ACCESS / MAINTENANCE TRACK	▬ ▬ ▬

CLIENT:

WFH PROPERTIES

WOODS
Engineers. Surveyors. Planners.

THE LANDING @ MARSDEN
STAGE 1 & 2

WETLAND 01 OVERALL PLAN

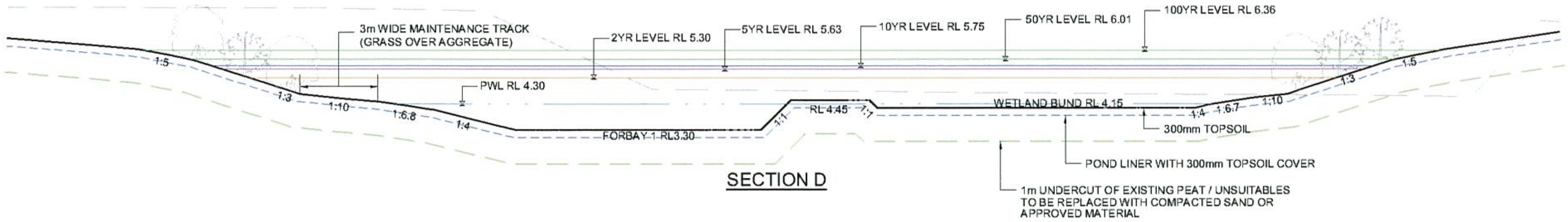
WHANGAREI DISTRICT COUNCIL

DESIGNED: MRM	ISSUED FOR ENG. APPROVAL
CHECKED: TF	DRAWN: AX
APPROVED: TF	SURVEYED:
JOB NUMBER: 31013	SCALE: 1:1000 @ A3
ISSUED: APRIL	
DWG. NO. 31013-01-380-DR	REV. 1

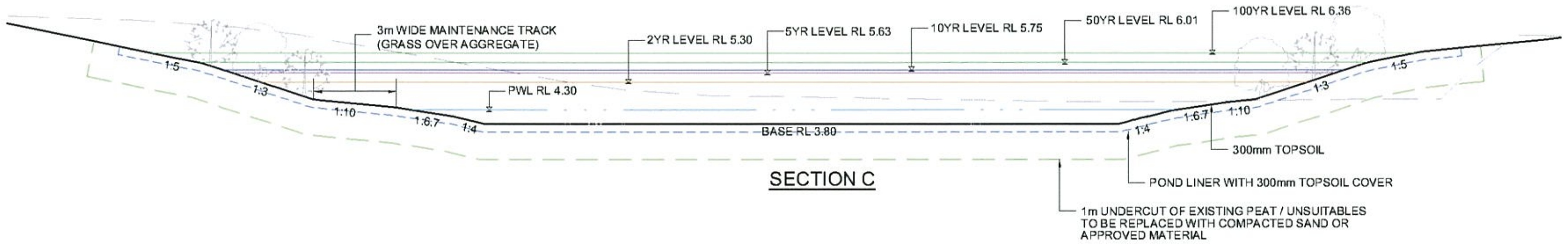
J:\31013 One Tree Point 2013\Project Data\Acad Drawings\Stage 1 & 2 Working Drawings\31013-01-380-DR Wetland.dwg, 18/04/2017 1:45:37 p.m.

TO BE REPLACED WITH COMPACTED SAND OR
APPROVED MATERIAL

PROPOSED WETLAND WATER LEVELS	
PERMANENT WATER LEVEL	4.30 m
2 YR	5.30 m
5 YR	5.63 m
10 YR	5.75 m
50 YR	6.01 m
100 YR	6.36 m



SECTION D



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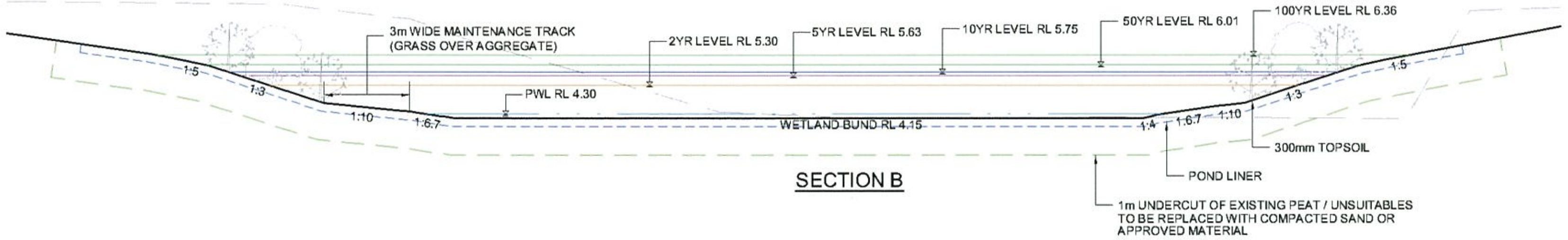
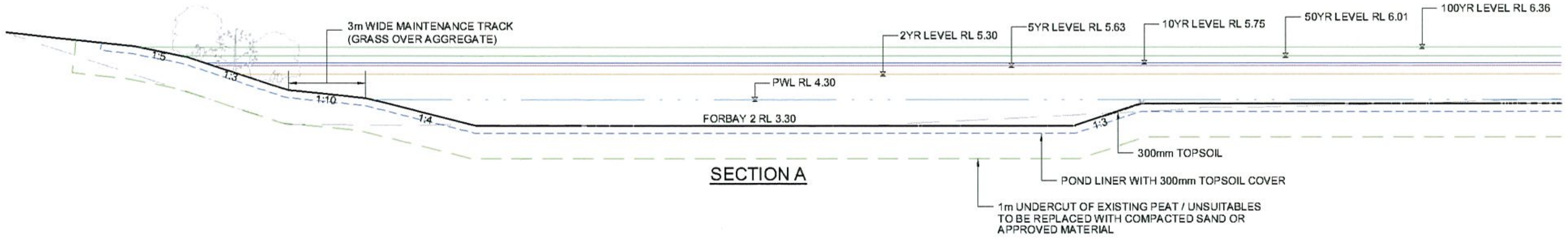


SECTION B



SECTION A

REVISION DETAILS		NAME	DATE
1	ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

LEGEND

EXISTING SURFACE
FINAL SURFACE
PERMANENT WATER LEVEL

CLIENT:

WFH PROPERTIES

WOODS
Engineers. Surveyors. Planners.

THE LANDING @ MARSDEN
STAGE 1 & 2

WETLAND 01 CROSS SECTIONS

WHANGAREI DISTRICT COUNCIL

DESIGNED: MRM	ISSUED FOR ENG. APPROVAL
CHECKED:	DRAWN: JLS
APPROVED:	SURVEYED:
JOB NUMBER: 31013	SCALE: 1:250 @ A3
ISSUED: APRIL	
DWG. NO. 31013-01-381-DR	REV. 1

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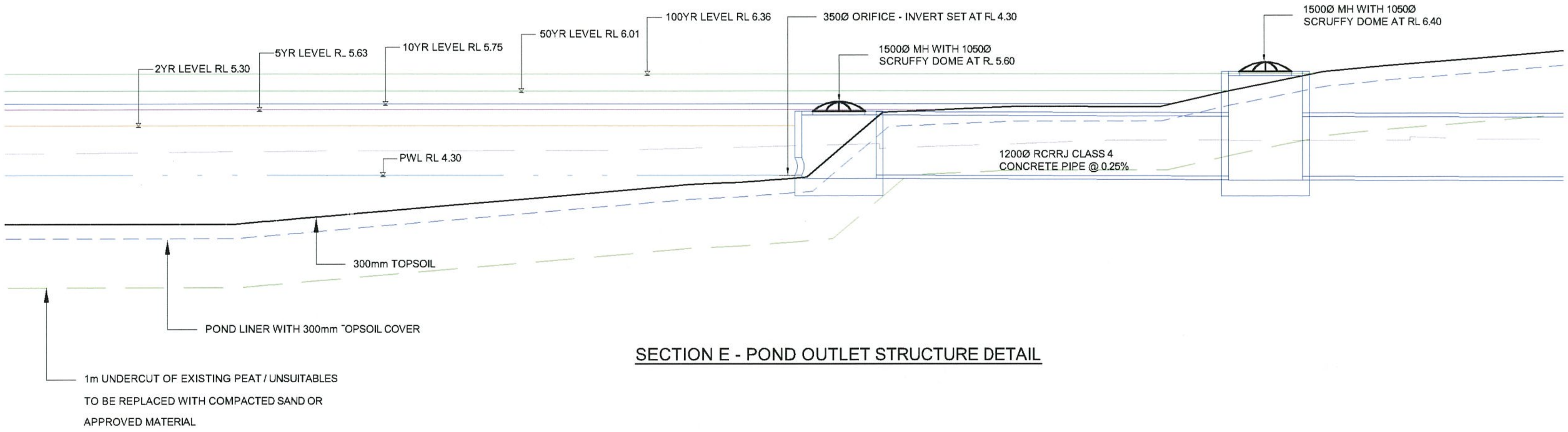


SECTION E - POND OUTLET STRUCTURE DETAIL

REVISION DETAILS		NAME	DATE
1	ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

NOTES

1. ALL WORK AND MATERIALS TO COMPLY WITH WHANGAREI DISTRICT COUNCIL STANDARDS. ANY AMBIGUITY BETWEEN DRAWINGS AND WHANGAREI DISTRICT COUNCIL STANDARDS TO BE REPORTED TO THE ENGINEER FOR CLARIFICATION.
2. ALL CONCRETE PIPES, MANHOLES AND INSITU CONCRETE TO BE ACID SULPHATE SOIL RESISTANT (100 YEAR DESIGN LIFE) (TYPE SR CEMENT AS 3972).
3. BEDDING OF PIPES AS PER WHANGAREI DISTRICT COUNCIL ENGINEERING STANDARDS.
4. CONTRACTOR TO INSPECT ALL PIPES FOR CRACKING PRIOR TO PLACEMENT. IF A PIPE IS FOUND TO BE CRACKED IT SHALL BE REPLACED.
5. INSTALLATION OF RUBBER RING JOINTED PIPES TO BE UNDERTAKEN WITH CARE.
6. TRENCH SHIELD TO BE USED ON ALL DRAINAGE INSTALLED. OR ELEVATIONS BENCHED BACK TO THE GEOTECHNICAL ENGINEERS APPROVAL.

LEGEND

EXISTING SURFACE	– – –
FINAL SURFACE	———
PERMANENT WATER LEVEL	– – –

CLIENT:

WFH
PROPERTIES

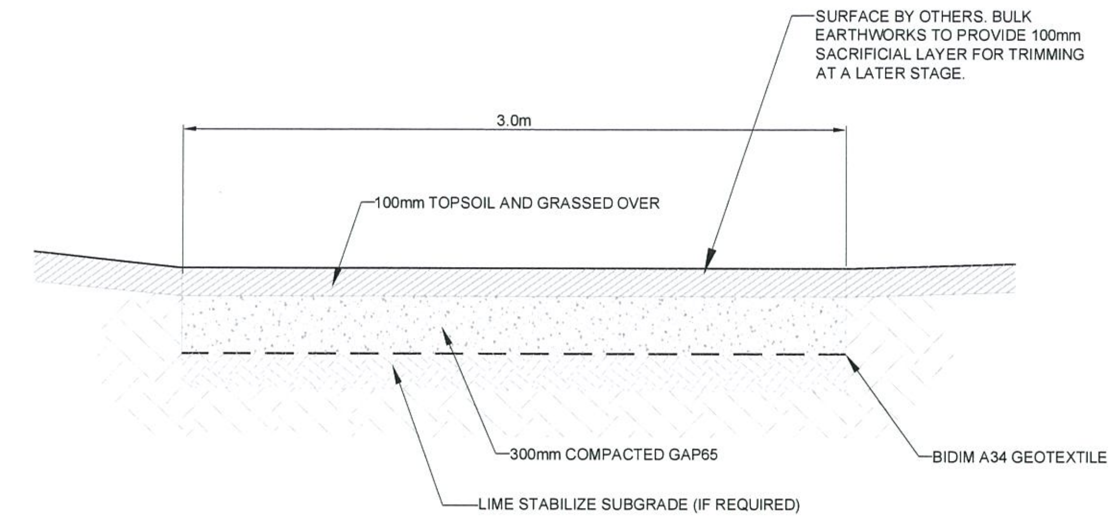
WOODS
Engineers. Surveyors. Planners.

THE LANDING @ MARSDEN
STAGE 1 & 2

WETLAND 01 CROSS SECTIONS

WHANGAREI DISTRICT COUNCIL

DESIGNED: MRM	ISSUED FOR ENG. APPROVAL
CHECKED:	DRAWN: JLS
APPROVED:	SURVEYED:
JOB NUMBER: 31013	SCALE: 1:100 @ A3
ISSUED: APRIL	
DWG. NO. 31013-01-382-DR	REV. 1



MAINTENANCE TRACK - REINFORCED GRASS SECTIONAL DETAIL

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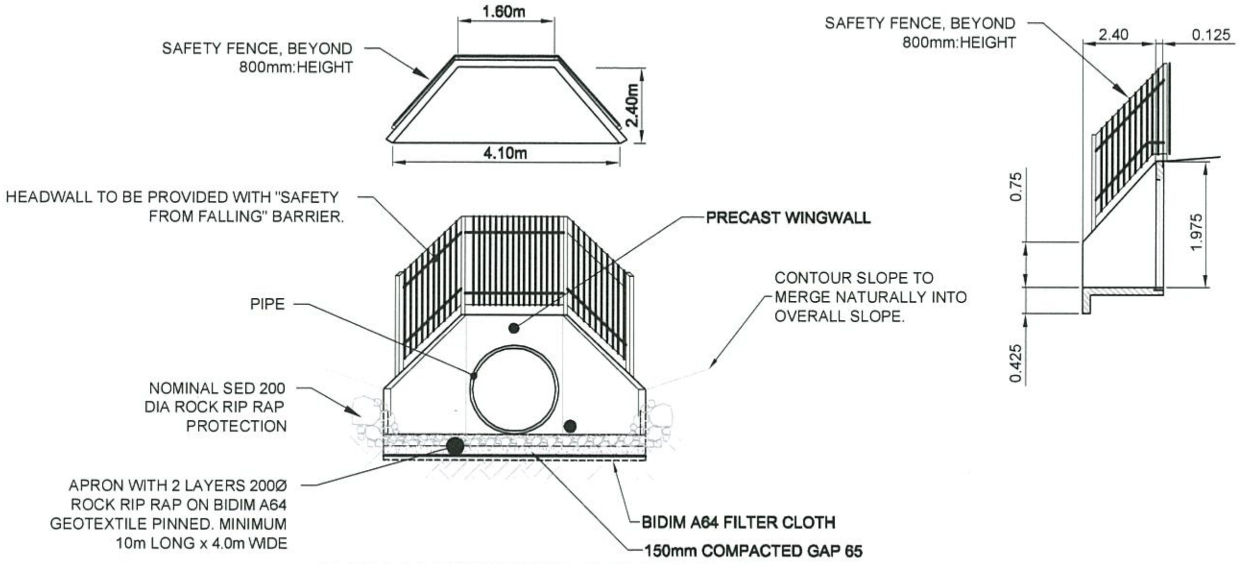
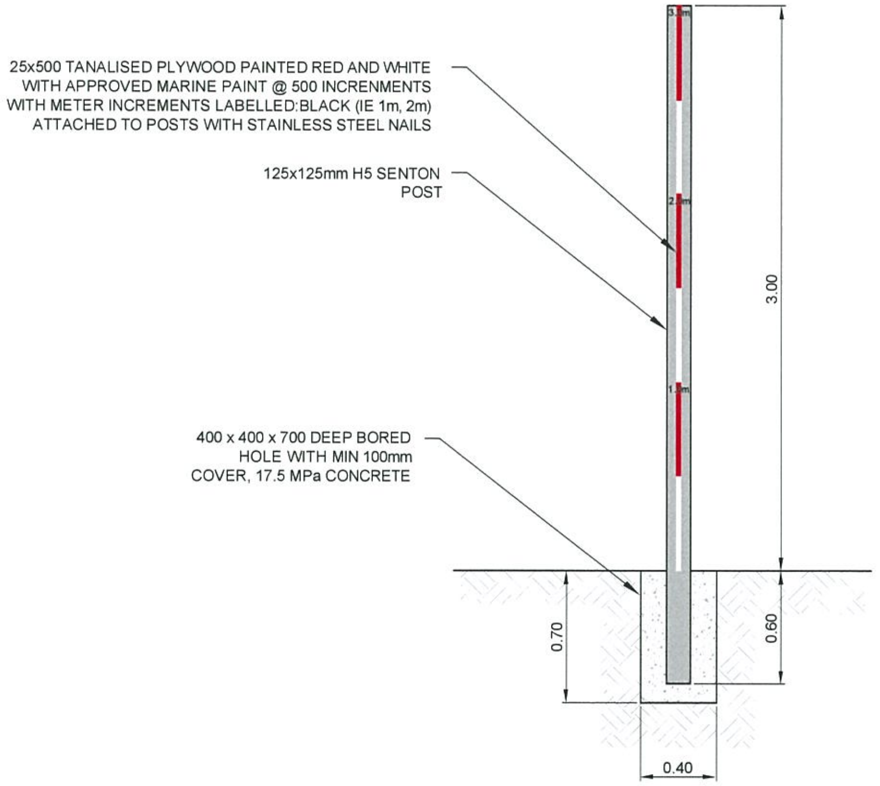


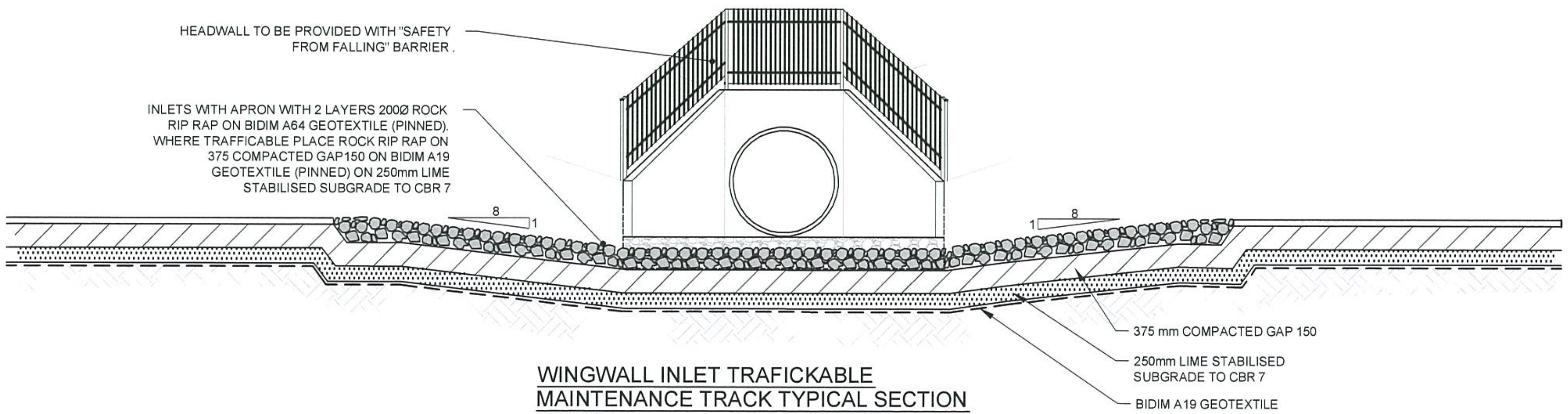
TYPICAL WINGWALL INLET DETAIL

SCALE NTS



MARKER GAUGE DETAIL,

SCALE 1:40 A3



WINGWALL INLET TRAFICABLE MAINTENANCE TRACK TYPICAL SECTION

SCALE 1:100 A3

REVISION DETAILS	NAME	DATE
1 ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

NOTES

1. ALL WORK AND MATERIALS TO COMPLY WITH WHANGAREI DISTRICT COUNCIL STANDARDS. ANY AMBIGUITY BETWEEN DRAWINGS AND WHANGAREI DISTRICT COUNCIL STANDARDS TO BE REPORTED TO THE ENGINEER FOR CLARIFICATION.
2. ALL CONCRETE PIPES, MANHOLES AND INSITU CONCRETE TO BE ACID SULPHATE SOIL RESISTANT (100 YEAR DESIGN LIFE) (TYPE SR CEMENT AS 3972).
3. BEDDING OF PIPES AS PER WHANGAREI DISTRICT COUNCIL ENGINEERING STANDARDS.
4. CONTRACTOR TO INSPECT ALL PIPES FOR CRACKING PRIOR TO PLACEMENT. IF A PIPE IS FOUND TO BE CRACKED IT SHALL BE REPLACED.
5. INSTALLATION OF RUBBER RING JOINTED PIPES TO BE UNDERTAKEN WITH CARE.
6. TRENCH SHIELD TO BE USED ON ALL DRAINAGE INSTALLED. OR ELEVATIONS BENCHED BACK TO THE GEOTECHNICAL ENGINEERS APPROVAL.

CLIENT:

WFH
PROPERTIES

WOODS
Engineers. Surveyors. Planners.

THE LANDING @ MARSDEN
STAGE 1 & 2

WETLAND 01 DETAILS

WHANGAREI DISTRICT COUNCIL

DESIGNED: MRM	ISSUED FOR ENG. APPROVAL
CHECKED: T.T	DRAWN: AX
APPROVED: T.T	SURVEYED:
JOB NUMBER: 31013	SCALE:
ISSUED: APRIL	
DWG. NO. 31013-01-383-DR	REV. 1

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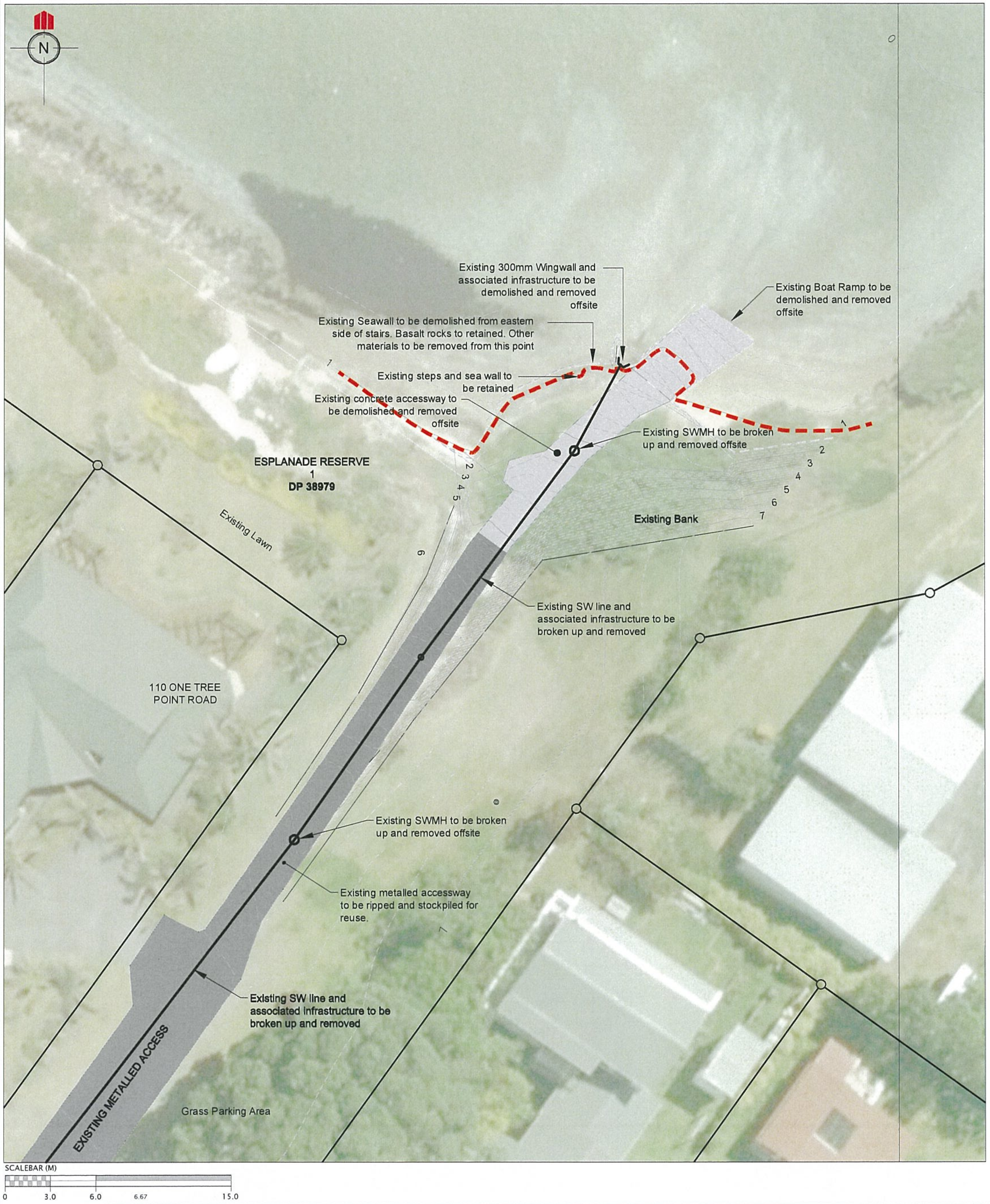
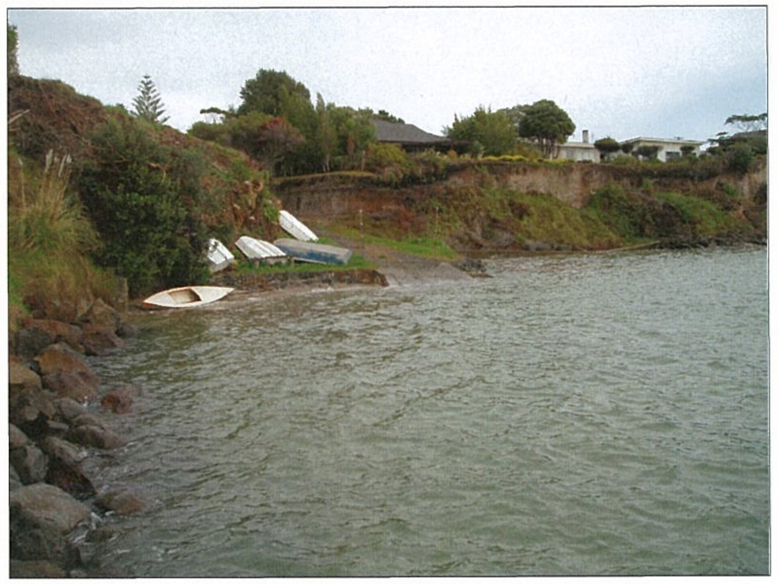


Low Tide View

Existing Approach to Boat Ramp



High Tide View

REVISION DETAILS		NAME	DATE
1	ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

CLIENT:

WFH PROPERTIES

WOODS
Engineers. Surveyors. Planners.

THE LANDING @ MARSDEN
STAGE 1 & 2

EXISTING COASTAL OUTFALL

WHANGAREI DISTRICT COUNCIL

DESIGNED: TBF	ISSUED FOR ENG. APPROVAL
CHECKED: T.F	DRAWN: JLS
APPROVED: T.F	SURVEYED:
JOB NUMBER: 31013	SCALE: 1:300 @ A3
ISSUED: APRIL	
DWG. NO. 31013-01-390-DR	REV. 1

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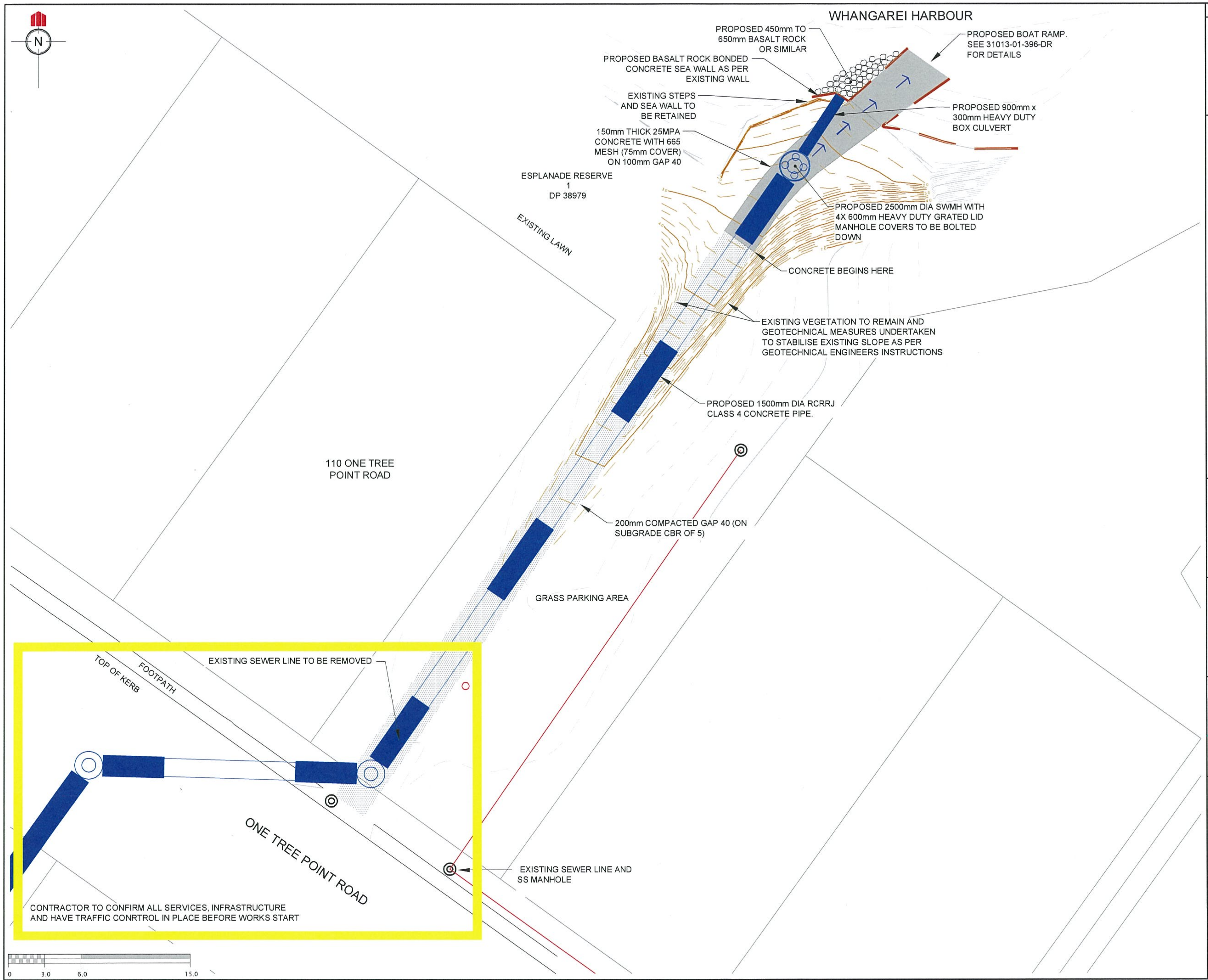

REVISION DETAILS	NAME	DATE
1 ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

NOTES

1. ALL WORK AND MATERIALS TO COMPLY WITH WHANGAREI DISTRICT COUNCIL STANDARDS. ANY AMBIGUITY BETWEEN DRAWINGS AND WHANGAREI DISTRICT COUNCIL STANDARDS TO BE REPORTED TO THE ENGINEER FOR CLARIFICATION.
2. ALL CONCRETE PIPES, MANHOLES AND INSITU CONCRETE TO BE ACID SULPHATE SOIL RESISTANT (100 YEAR DESIGN LIFE) (TYPE SR CEMENT AS 3972).
3. BEDDING OF PIPES AS PER WHANGAREI DISTRICT COUNCIL ENGINEERING STANDARDS.
4. CONTRACTOR TO INSPECT ALL PIPES FOR CRACKING PRIOR TO PLACEMENT. IF A PIPE IS FOUND TO BE CRACKED IT SHALL BE REPLACED.
5. INSTALLATION OF RUBBER RING JOINTED PIPES TO BE UNDERTAKEN WITH CARE.
6. TRENCH SHIELD TO BE USED ON ALL DRAINAGE INSTALLED. OR ELEVATIONS BENCHED BACK TO THE GEOTECHNICAL ENGINEERS APPROVAL.
7. ALL PIPE CROSSINGS UNDER ROADS TO BE HARDFILL BACKFILLED.

LEGEND

PROPOSED STORMWATER
PROPOSED BOX CULVERT
DESIGN CONTOUR MAJOR (1.0m INCREMENTS)
DESIGN CONTOUR MINOR (0.2m INCREMENTS)
EXISTING CONTOUR MAJOR (1.0m INCREMENTS)
EXISTING CONTOUR MINOR (0.2m INCREMENTS)
EXISTING BOUNDARY
MEAN HIGH WATER SPRINGS (RL: 1.044m)
OVERLAND FLOW PATH

CLIENT:

THE LANDING @ MARSDEN
STAGE 1 & 2

PROPOSED COASTAL OUTFALL UPGRADE

WHANGAREI DISTRICT COUNCIL

DESIGNED: TBF	ISSUED FOR ENG. APPROVAL
CHECKED: T.F	DRAWN: JLS
APPROVED: T.F	SURVEYED:
JOB NUMBER: 31013	SCALE: 1:300 @ A3
ISSUED: APRIL	
DWG. NO. 31013-01-391-DR	REV. 1

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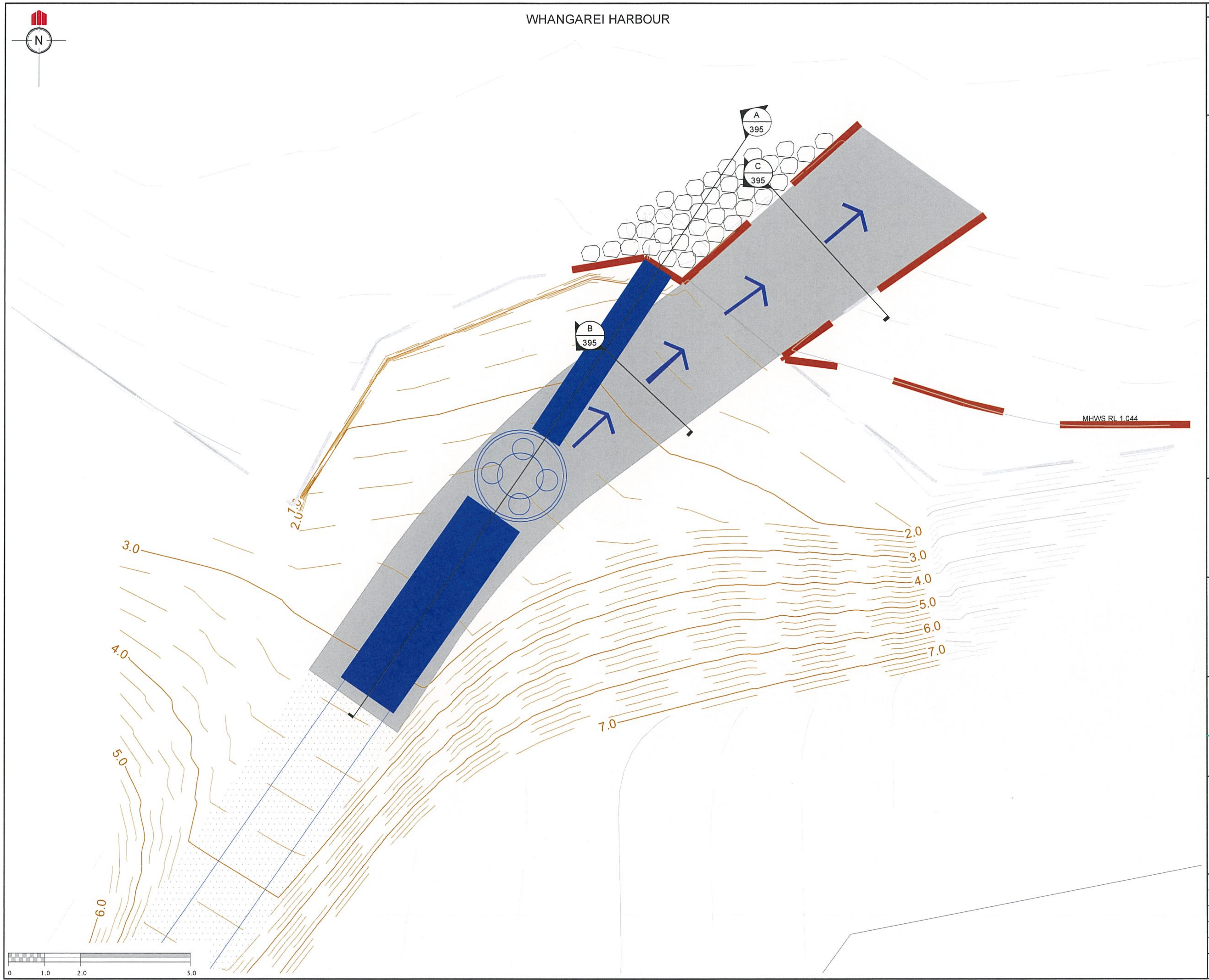

REVISION DETAILS	NAME	DATE
1 ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

LEGEND

PROPOSED STORMWATER	
PROPOSED BOX CULVERT	▭
DESIGN CONTOUR MAJOR (1.0m INCREMENTS)	
DESIGN CONTOUR MINOR (0.2m INCREMENTS)	
EXISTING CONTOUR MAJOR (1.0m INCREMENTS)	
EXISTING CONTOUR MINOR (0.2m INCREMENTS)	
EXISTING BOUNDARY	
MEAN HIGH WATER SPRINGS (RL: 1.044m)	
OVERLAND FLOW PATH	→ → → →

CLIENT:

WFH PROPERTIES

WOODS
Engineers. Surveyors. Planners.

THE LANDING @ MARSDEN

STAGE 1 & 2

PROPOSED COASTAL OUTFALL UPGRADE

WHANGAREI DISTRICT COUNCIL

DESIGNED: TBF	ISSUED FOR ENG. APPROVAL
CHECKED: T.F	DRAWN: JLS
APPROVED: T.F	SURVEYED:
JOB NUMBER: 31013	SCALE: 1:100 @ A3
ISSUED: APRIL	
DWG. NO. 31013-01-392-DR	REV. 1

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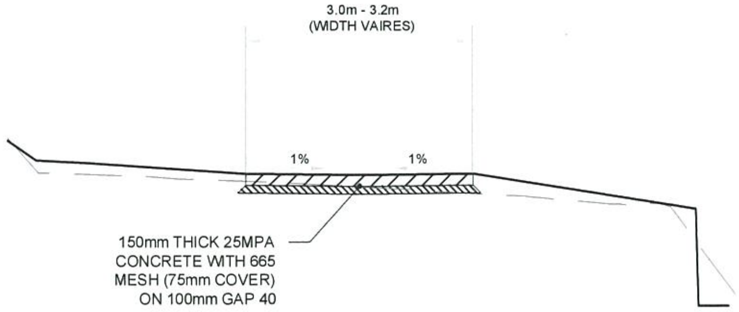
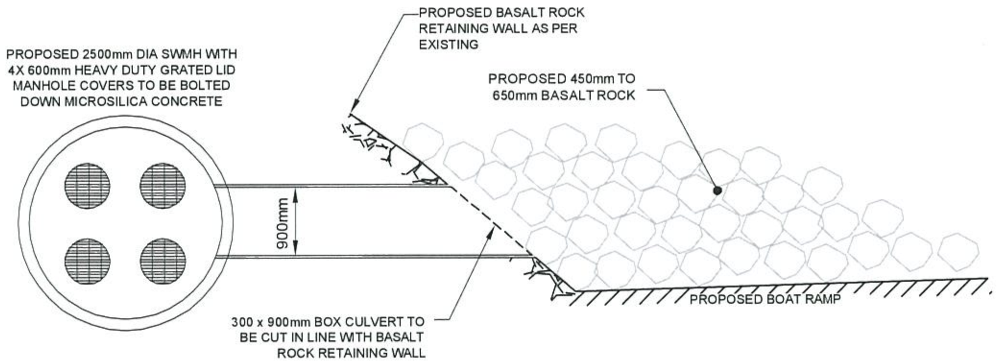
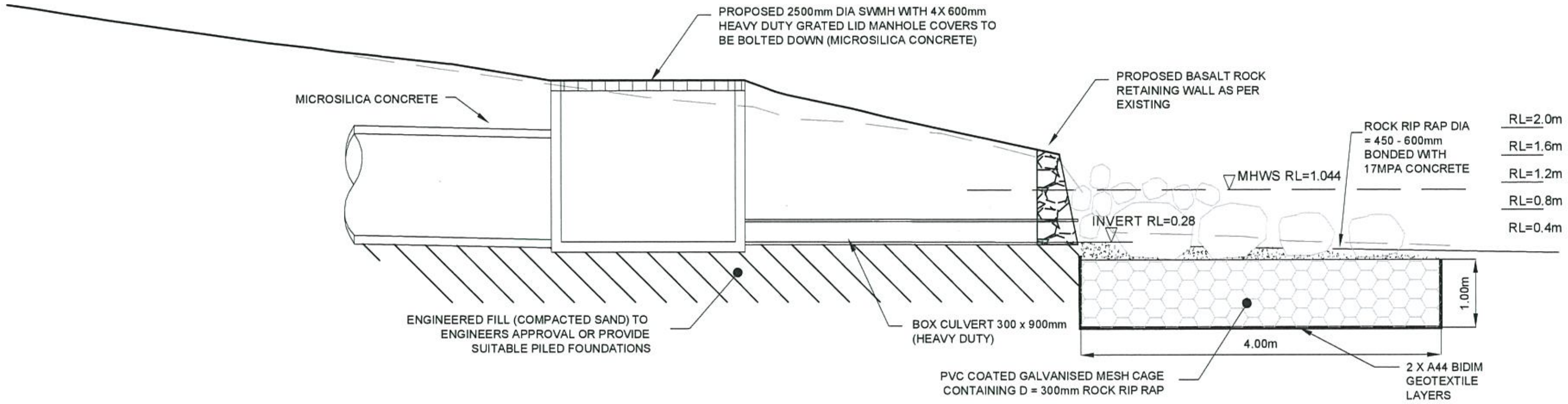


ACCESSWAY/ OVERLAND FLOW PATH CROSS SECTION



OUTLET PLAN VEIW



OUTLET STRUCTURE DETAIL

0 1.0 2.0 5.0

REVISION DETAILS	NAME	DATE
1 ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

CLIENT:

WFH PROPERTIES

WOODS
Engineers. Surveyors. Planners.

THE LANDING @ MARSDEN
STAGE 1 & 2

PROPOSED COASTAL OUTFALL DETAILS

WHANGAREI DISTRICT COUNCIL

DESIGNED: TBF
ISSUED FOR ENG. APPROVAL
CHECKED: T.F
DRAWN: JLS
APPROVED: T.F
SURVEYED:
JOB NUMBER: 31013
SCALE: 1:100 @ A3
ISSUED: APRIL
DWG. NO. 31013-01-395-DR
REV. 1

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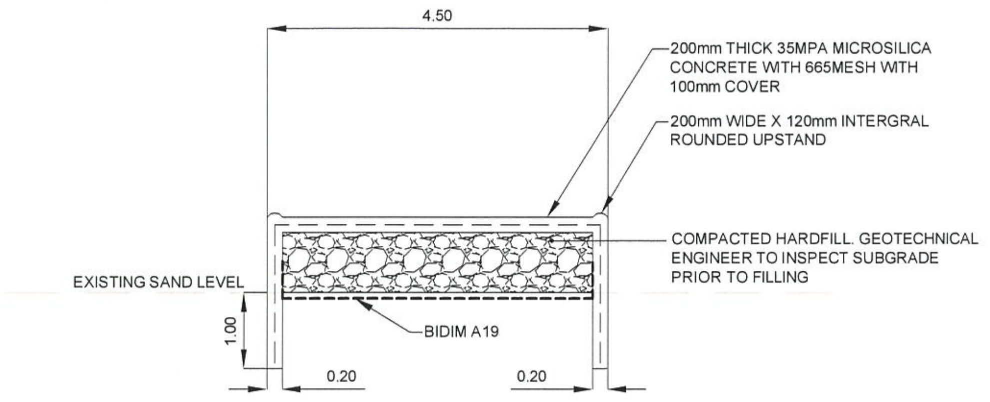
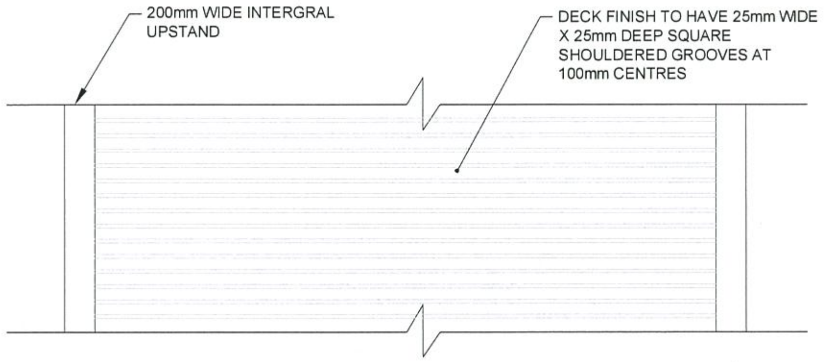
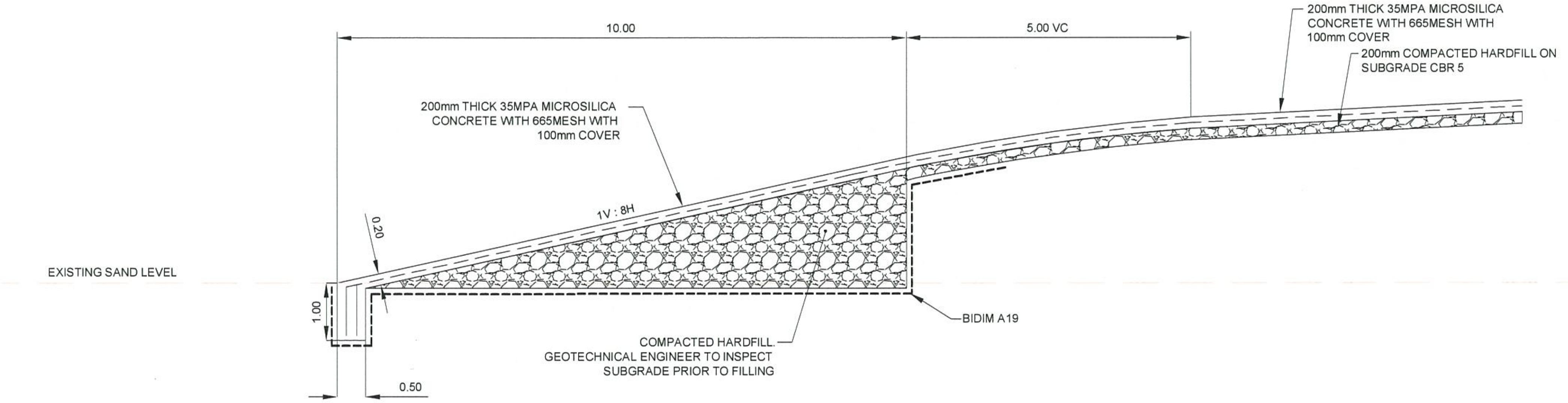


BOAT RAMP TYPICAL CROSS SECTION



DECK - PLAN VEIW

NOT TO SCALE



BOAT RAMP TYPICAL LONG SECTION

0 1.0 2.0 5.0

REVISION DETAILS	NAME	DATE
1 ISSUED FOR ENG. APPROVAL	TBF	18/04/2017

CLIENT:

WFH PROPERTIES

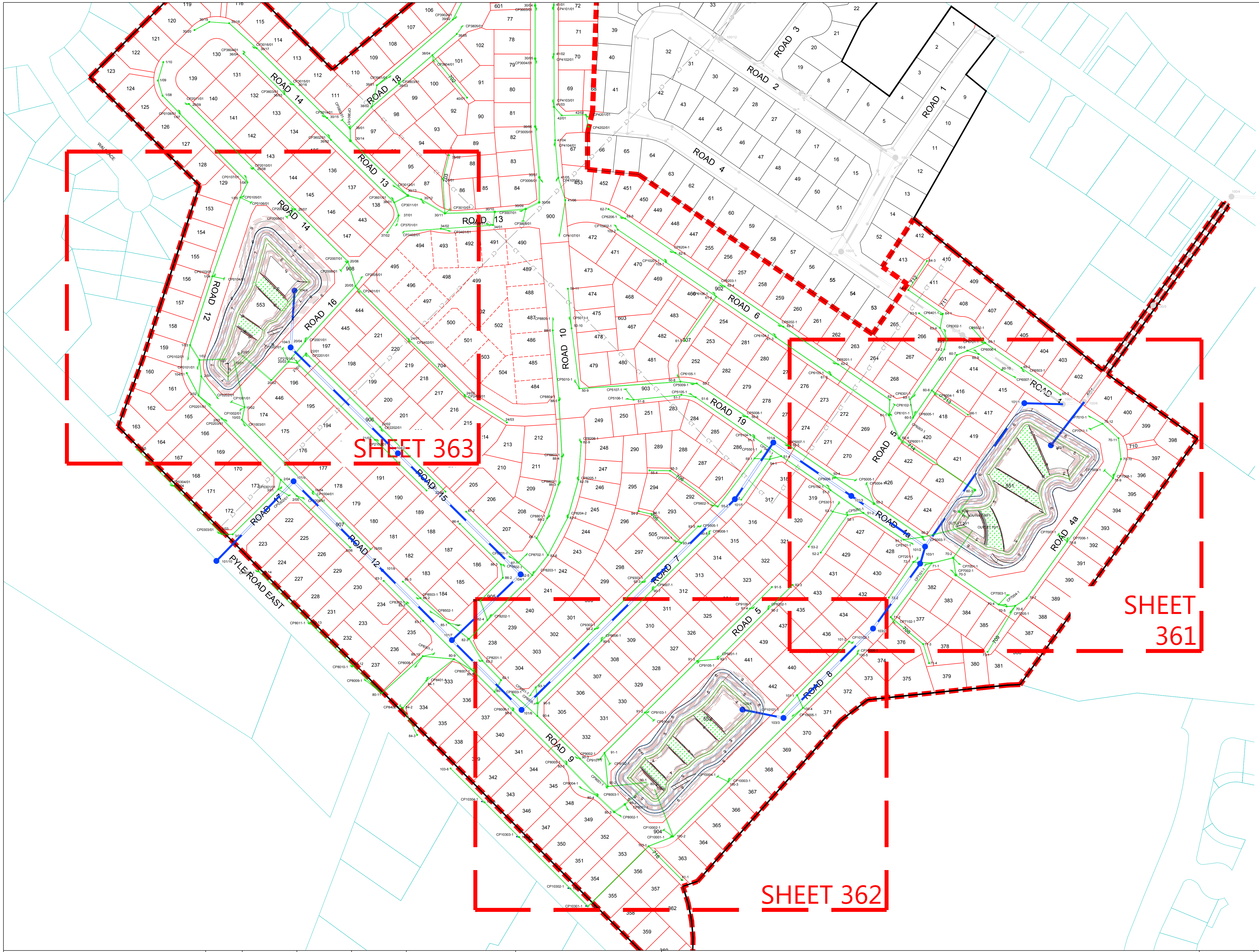
WOODS
Engineers. Surveyors. Planners.

THE LANDING @ MARSDEN
STAGE 1 & 2

PROPOSED COASTAL OUTFALL DETAILS

WHANGAREI DISTRICT COUNCIL

DESIGNED: TBF	ISSUED FOR ENG. APPROVAL
CHECKED: T.F	DRAWN: JLS
APPROVED: T.F	SURVEYED:
JOB NUMBER: 31013	SCALE: 1:100 @ A3
ISSUED: APRIL	
DWG. NO. 31013-01-396-DR	REV. 1



WOODS
EST.1970

LEGEND

PROPOSED STORMWATER	01/1
PROPOSED STORMWATER TRUNK MAIN	100/1
SINGLE / DOUBLE SUMP	S1/1 DS2/1
LATERAL CONNECTION	
DESIGN CONTOUR MAJOR	
DESIGN CONTOUR MINOR	
PROPOSED BOUNDARY	
PLANTED AREA - BATHYMETRIC BUNDS	▨

SCALEBAR (m)
0 30 60 150

REVISION DETAILS		INT	DATE	SURVEYED	
1	ISSUED FOR CONSENT	DB	22/11/17	DESIGNED	DB
				DRAWN	DB
				CHECKED	
				APPROVED	

ONE TREE POINT ROAD
ONE TREE POINT
NORTHLAND

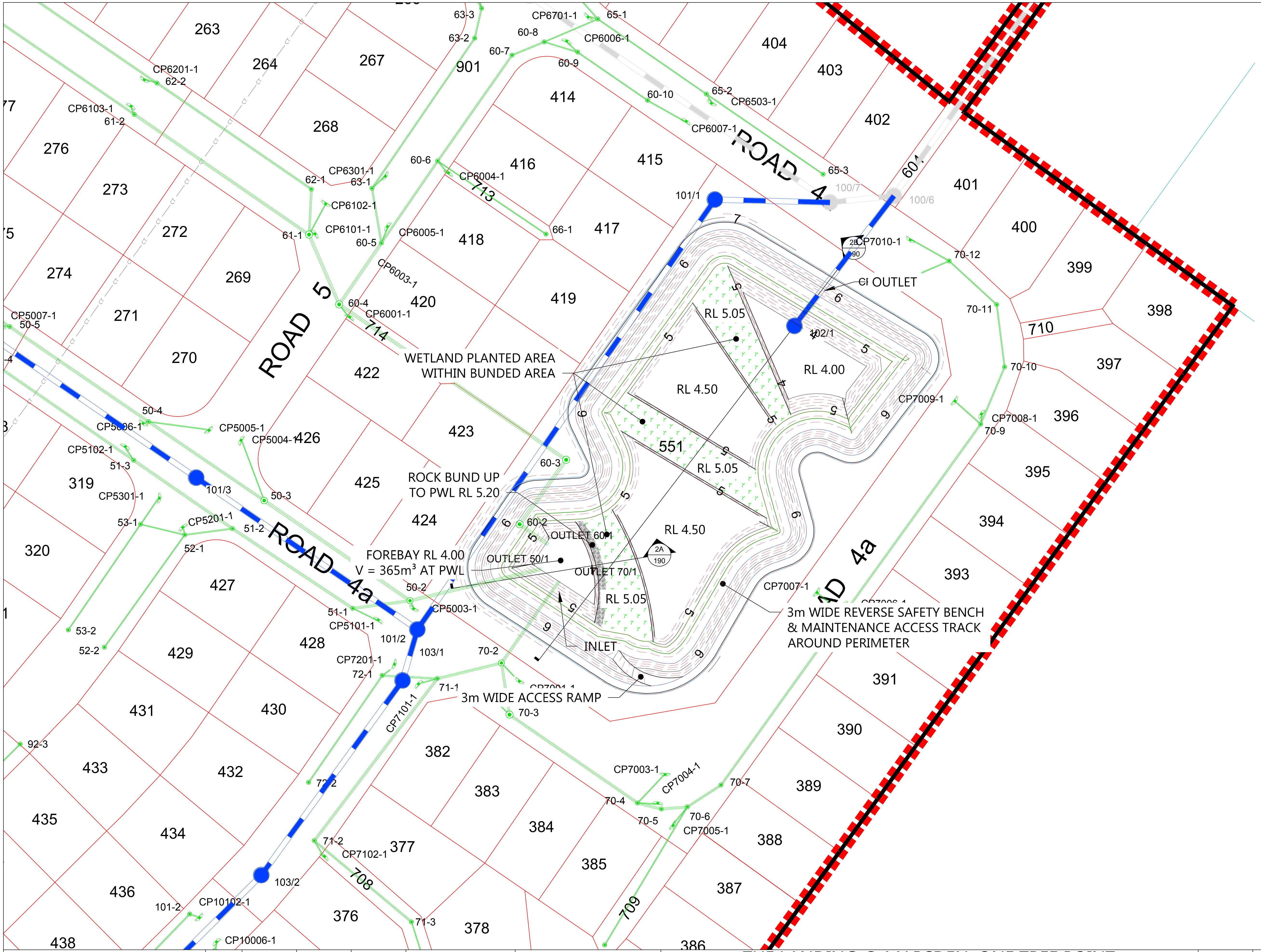
WOODS.CO.NZ

WFH
PROPERTIES

THE LANDING @ MARSDEN, ONE TREE POINT
STAGES 3-9
STORMWATER QUALITY POND KEY PLAN

N

STATUS	ISSUED FOR CONSENT	REV
SCALE	1:3000 @ A3	1
COUNCIL	WHANGAREI DISTRICT COUNCIL	
DWG NO	31014-00-360-EW	



LEGEND

PROPOSED STORMWATER	01/1
PROPOSED STORMWATER TRUNK MAIN	100/1
SINGLE / DOUBLE SUMP	S1/1 DS2/1
LATERAL CONNECTION	
DESIGN CONTOUR MAJOR (1.0m INCREMENTS)	6.0
DESIGN CONTOUR MINOR (0.2m INCREMENTS)	
PROPOSED BOUNDARY	
PLANTED AREA - BATHYMETRIC BUNDS	

SCALEBAR (m)
0 10 20 50

REVISION DETAILS		INT	DATE
1	ISSUED FOR CONSENT	DB	22/11/17

SURVEYED	
DESIGNED	DB
DRAWN	DB
CHECKED	
APPROVED	

ONE TREE POINT ROAD
ONE TREE POINT
NORTHLAND

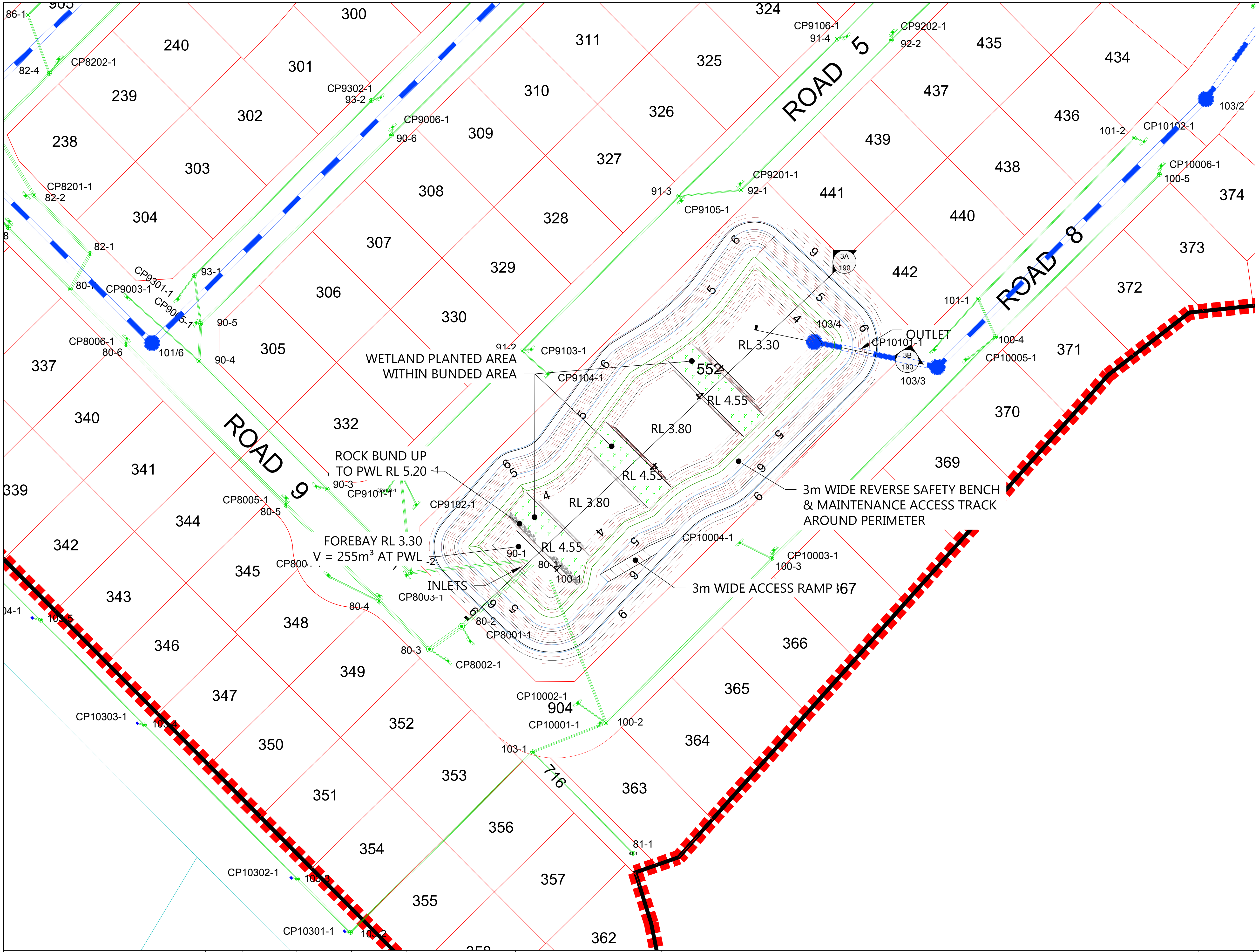
WOODS.CO.NZ

WFH PROPERTIES

THE LANDING @ MARSDEN, ONE TREE POINT
STAGES 3-9
STORMWATER QUALITY POND WETLAND 2

N

STATUS	ISSUED FOR CONSENT	REV
SCALE	1:1000 @ A3	1
COUNCIL	WHANGAREI DISTRICT COUNCIL	
DWG NO	31014-00-361-EW	



LEGEND

PROPOSED STORMWATER	01/1
PROPOSED STORMWATER TRUNK MAIN	100/1
SINGLE / DOUBLE SUMP	S1/1 DS2/1
LATERAL CONNECTION	
DESIGN CONTOUR MAJOR (1.0m INCREMENTS)	8.0
DESIGN CONTOUR MINOR (0.2m INCREMENTS)	
PROPOSED BOUNDARY	
PLANTED AREA - BATHYMETRIC BUNDS	

SCALEBAR (m)
0 10 20 50

REVISION DETAILS		INT	DATE
1	ISSUED FOR CONSENT	DB	22/11/17

SURVEYED	
DESIGNED	DB
DRAWN	DB
CHECKED	
APPROVED	

ONE TREE POINT ROAD
ONE TREE POINT
NORTHLAND

WOODS.CO.NZ

THE LANDING @ MARSDEN, ONE TREE POINT
STAGES 3-9
STORMWATER QUALITY POND WETLAND 3

N

STATUS	ISSUED FOR CONSENT	REV
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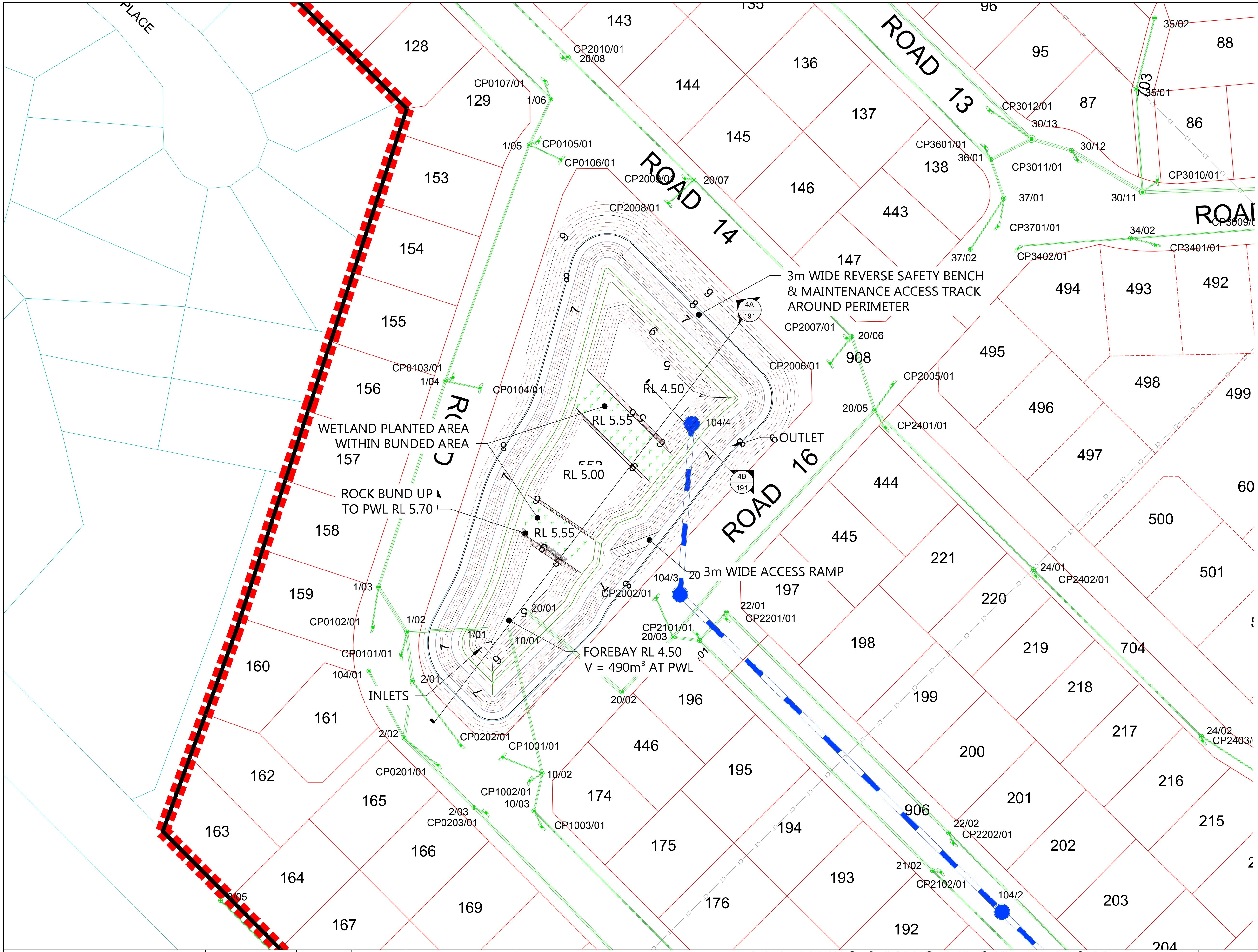
COUNCIL	WHANGAREI DISTRICT COUNCIL	
DWG NO	31014-00-362-EW	



LEGEND

PROPOSED STORMWATER	01/1
PROPOSED STORMWATER TRUNK MAIN	100/1
SINGLE / DOUBLE SUMP	S1/1 DS2/1
LATERAL CONNECTION	
DESIGN CONTOUR MAJOR (1.0m INCREMENTS)	6.0
DESIGN CONTOUR MINOR (0.2m INCREMENTS)	
PROPOSED BOUNDARY	
PLANTED AREA - BATHYMETRIC BUNDS	

WOODS
EST.1970

REVISION DETAILS		INT	DATE
1	ISSUED FOR CONSENT	DB	22/11/17

SURVEYED	
DESIGNED	DB
DRAWN	DB
CHECKED	
APPROVED	

ONE TREE POINT ROAD
ONE TREE POINT
NORTHLAND

WOODS.CO.NZ

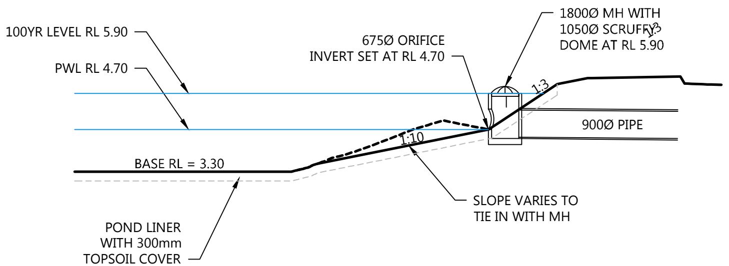
WFH PROPERTIES

THE LANDING @ MARSDEN, ONE TREE POINT
STAGES 3-9
STORMWATER QUALITY POND WETLAND 4

N

STATUS	ISSUED FOR CONSENT	REV
SCALE	1:1000 @ A3	1
COUNCIL	WHANGAREI DISTRICT COUNCIL	
DWG NO	31014-00-363-EW	

WOODS
EST.1970



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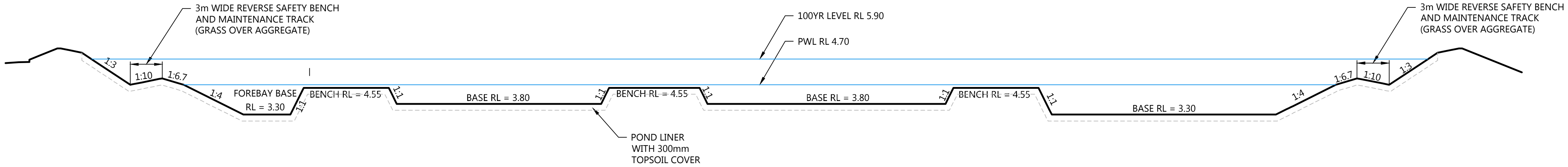

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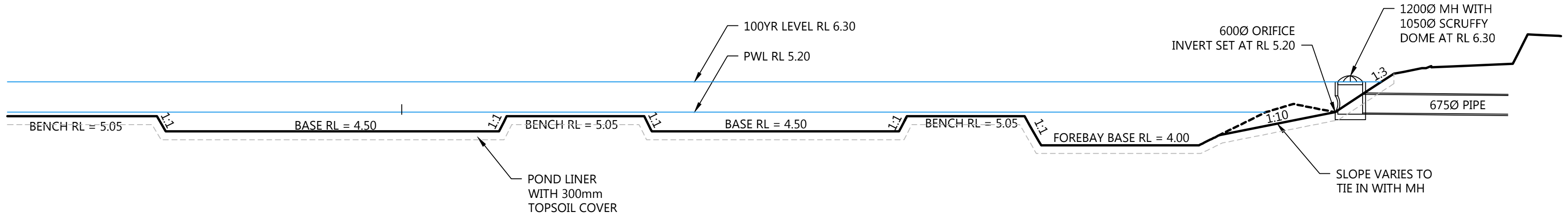

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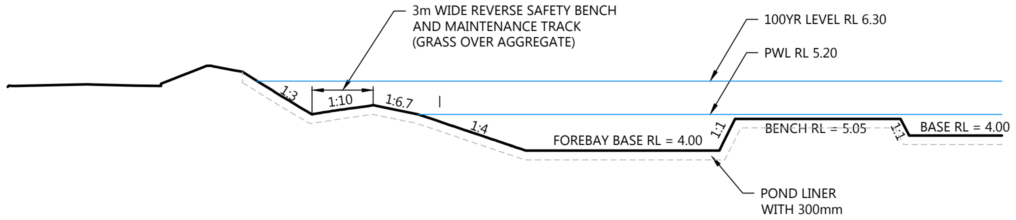


SECTION 2A

REVISION DETAILS		INT	DATE	SURVEYED	
1	ISSUED FOR CONSENT	DB	22/11/17	DESIGNED	DB
				DRAWN	DB
				CHECKED	
				APPROVED	

ONE TREE POINT ROAD
ONE TREE POINT
NORTHLAND

WOODS.CO.NZ

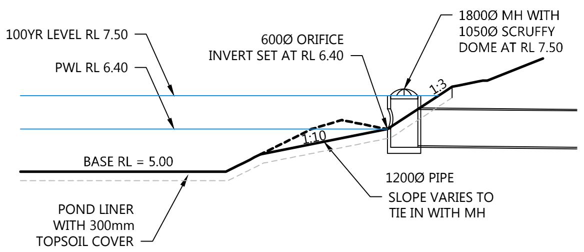
WFH PROPERTIES

THE LANDING @ MARSDEN, ONE TREE POINT
STAGES 3-9
STORMWATER QUALITY POND CROSS SECTIONS

N

STATUS: ISSUED FOR CONSENT
SCALE: H 1:500 V 1:250 @ A3
COUNCIL: WHANGAREI DISTRICT COUNCIL
DWG NO: 31014-00-370-DR
REV: 1

WOODS
EST.1970



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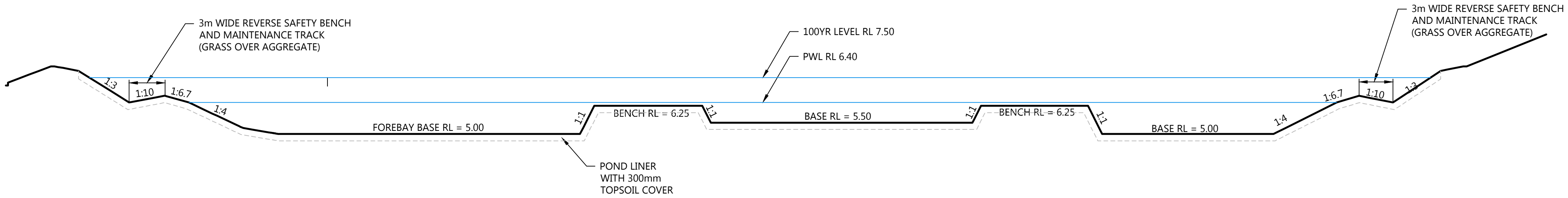


SECTION 4A

REVISION DETAILS		INT	DATE	SURVEYED	
1	ISSUED FOR CONSENT	DB	22/11/17	DESIGNED	DB
				DRAWN	DB
				CHECKED	
				APPROVED	

ONE TREE POINT ROAD
ONE TREE POINT
NORTHLAND

WOODS.CO.NZ

WFH PROPERTIES

THE LANDING @ MARSDEN, ONE TREE POINT
STAGES 3-9
STORMWATER QUALITY POND CROSS SECTIONS

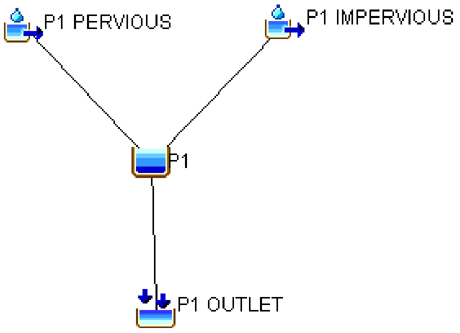
N

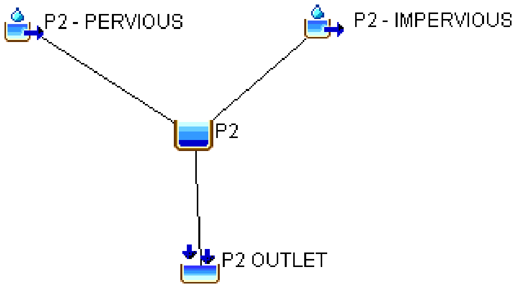
STATUS	ISSUED FOR CONSENT	REV
SCALE	H 1:500 V 1:250 @ A3	1
COUNCIL	WHANGAREI DISTRICT COUNCIL	
DWG NO	31014-00-371-DR	

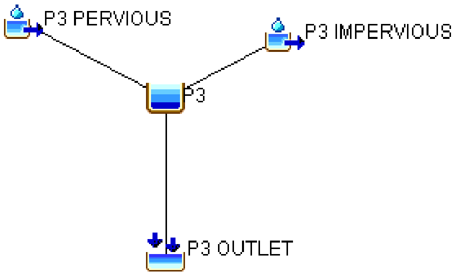
APPENDIX D

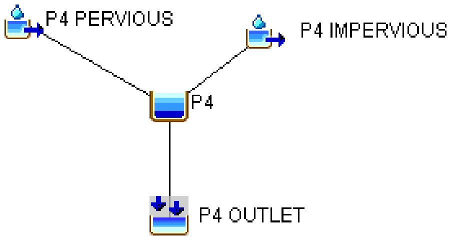
HEC HMS RESULTS

MODEL

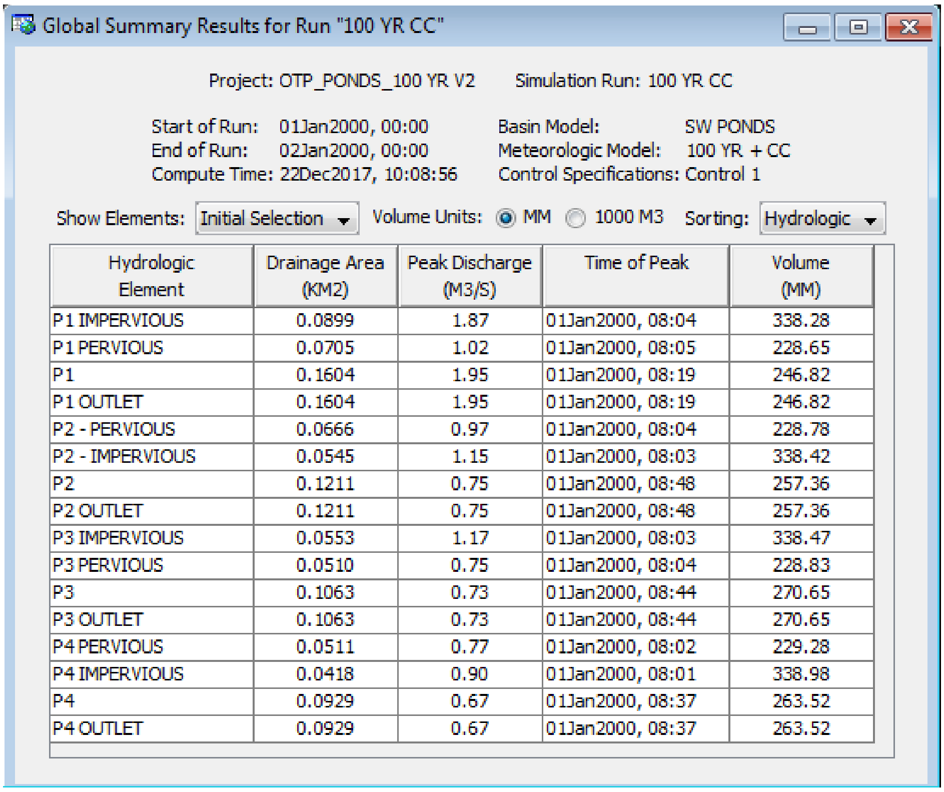








GLOBAL SUMMARY – 100 YR



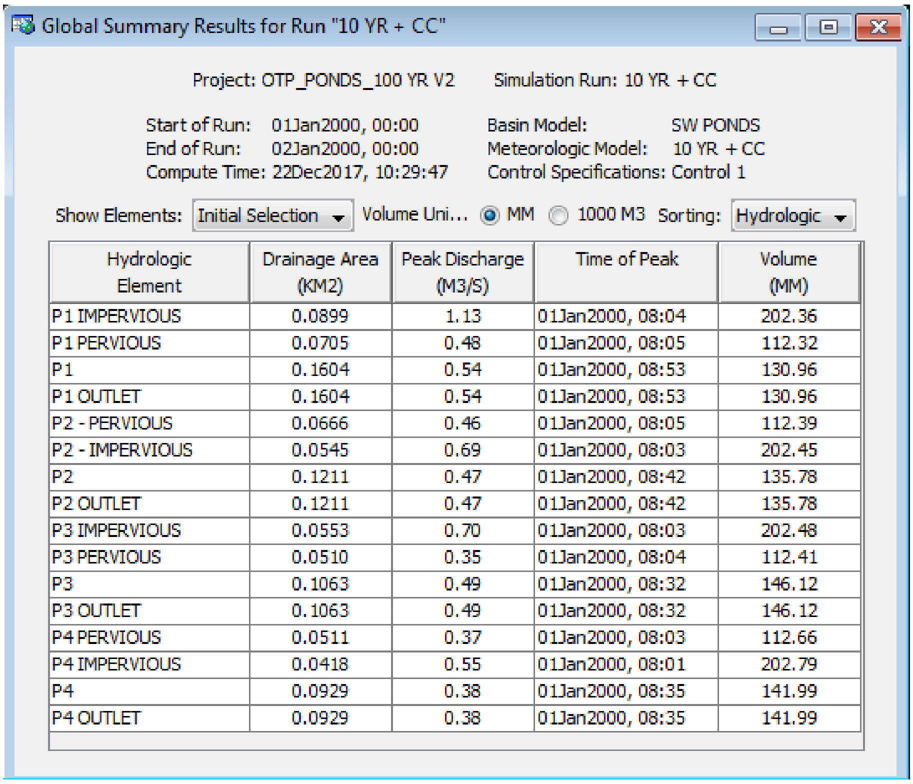
Project: OTP_PONDS_100 YR V2 Simulation Run: 100 YR CC

Start of Run: 01Jan2000, 00:00 Basin Model: SW PONDS
End of Run: 02Jan2000, 00:00 Meteorologic Model: 100 YR + CC
Compute Time: 22Dec2017, 10:08:56 Control Specifications: Control 1

Show Elements: Initial Selection Volume Units: ● MM ○ 1000 M3 Sorting: Hydrologic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
P1 IMPERVIOUS	0.0899	1.87	01Jan2000, 08:04	338.28
P1 PERVIOUS	0.0705	1.02	01Jan2000, 08:05	228.65
P1	0.1604	1.95	01Jan2000, 08:19	246.82
P1 OUTLET	0.1604	1.95	01Jan2000, 08:19	246.82
P2 - PERVIOUS	0.0666	0.97	01Jan2000, 08:04	228.78
P2 - IMPERVIOUS	0.0545	1.15	01Jan2000, 08:03	338.42
P2	0.1211	0.75	01Jan2000, 08:48	257.36
P2 OUTLET	0.1211	0.75	01Jan2000, 08:48	257.36
P3 IMPERVIOUS	0.0553	1.17	01Jan2000, 08:03	338.47
P3 PERVIOUS	0.0510	0.75	01Jan2000, 08:04	228.83
P3	0.1063	0.73	01Jan2000, 08:44	270.65
P3 OUTLET	0.1063	0.73	01Jan2000, 08:44	270.65
P4 PERVIOUS	0.0511	0.77	01Jan2000, 08:02	229.28
P4 IMPERVIOUS	0.0418	0.90	01Jan2000, 08:01	338.98
P4	0.0929	0.67	01Jan2000, 08:37	263.52
P4 OUTLET	0.0929	0.67	01Jan2000, 08:37	263.52

GLOBAL SUMMARY - 10 YR



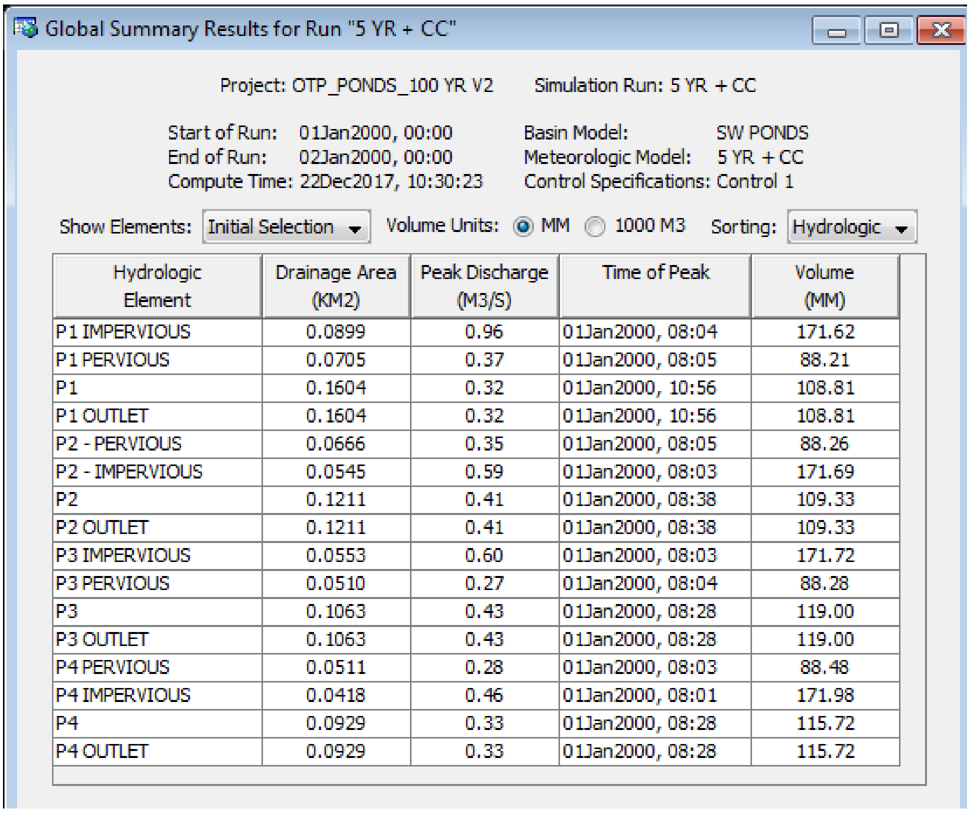
Project: OTP_PONDS_100 YR V2 Simulation Run: 10 YR + CC

Start of Run: 01Jan2000, 00:00 Basin Model: SW PONDS
End of Run: 02Jan2000, 00:00 Meteorologic Model: 10 YR + CC
Compute Time: 22Dec2017, 10:29:47 Control Specifications: Control 1

Show Elements: Initial Selection Volume Uni... ● MM ○ 1000 M3 Sorting: Hydrologic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
P1 IMPERVIOUS	0.0899	1.13	01Jan2000, 08:04	202.36
P1 PERVIOUS	0.0705	0.48	01Jan2000, 08:05	112.32
P1	0.1604	0.54	01Jan2000, 08:53	130.96
P1 OUTLET	0.1604	0.54	01Jan2000, 08:53	130.96
P2 - PERVIOUS	0.0666	0.46	01Jan2000, 08:05	112.39
P2 - IMPERVIOUS	0.0545	0.69	01Jan2000, 08:03	202.45
P2	0.1211	0.47	01Jan2000, 08:42	135.78
P2 OUTLET	0.1211	0.47	01Jan2000, 08:42	135.78
P3 IMPERVIOUS	0.0553	0.70	01Jan2000, 08:03	202.48
P3 PERVIOUS	0.0510	0.35	01Jan2000, 08:04	112.41
P3	0.1063	0.49	01Jan2000, 08:32	146.12
P3 OUTLET	0.1063	0.49	01Jan2000, 08:32	146.12
P4 PERVIOUS	0.0511	0.37	01Jan2000, 08:03	112.66
P4 IMPERVIOUS	0.0418	0.55	01Jan2000, 08:01	202.79
P4	0.0929	0.38	01Jan2000, 08:35	141.99
P4 OUTLET	0.0929	0.38	01Jan2000, 08:35	141.99

GLOBAL SUMMARY - 5YR



Global Summary Results for Run "5 YR + CC"

Project: OTP_PONDS_100 YR V2 Simulation Run: 5 YR + CC

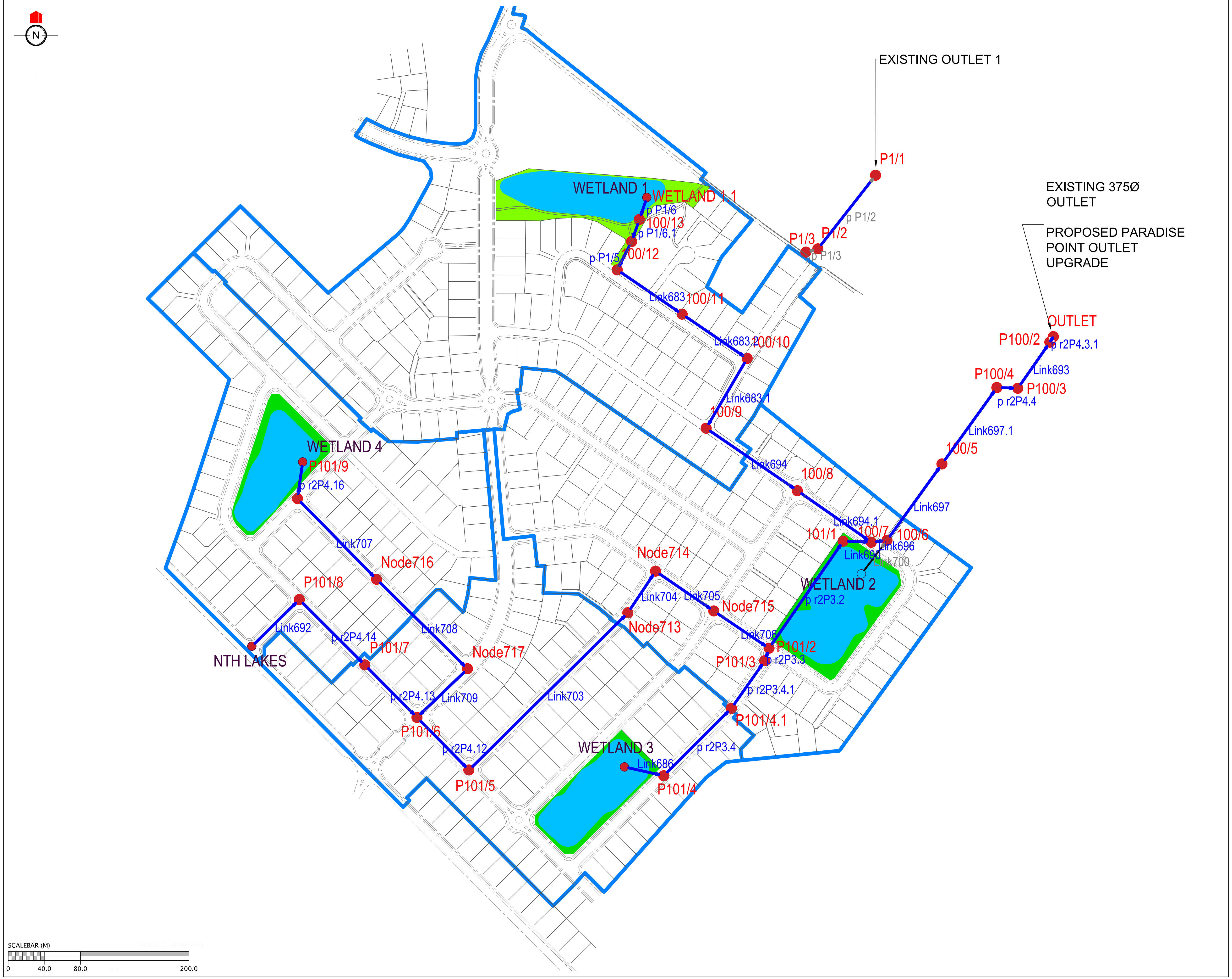
Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 22Dec2017, 10:30:23

Basin Model: SW PONDS
Meteorologic Model: 5 YR + CC
Control Specifications: Control 1

Show Elements: Initial Selection Volume Units: ● MM ○ 1000 M3 Sorting: Hydrologic

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
P1 IMPERVIOUS	0.0899	0.96	01Jan2000, 08:04	171.62
P1 PERVIOUS	0.0705	0.37	01Jan2000, 08:05	88.21
P1	0.1604	0.32	01Jan2000, 10:56	108.81
P1 OUTLET	0.1604	0.32	01Jan2000, 10:56	108.81
P2 - PERVIOUS	0.0666	0.35	01Jan2000, 08:05	88.26
P2 - IMPERVIOUS	0.0545	0.59	01Jan2000, 08:03	171.69
P2	0.1211	0.41	01Jan2000, 08:38	109.33
P2 OUTLET	0.1211	0.41	01Jan2000, 08:38	109.33
P3 IMPERVIOUS	0.0553	0.60	01Jan2000, 08:03	171.72
P3 PERVIOUS	0.0510	0.27	01Jan2000, 08:04	88.28
P3	0.1063	0.43	01Jan2000, 08:28	119.00
P3 OUTLET	0.1063	0.43	01Jan2000, 08:28	119.00
P4 PERVIOUS	0.0511	0.28	01Jan2000, 08:03	88.48
P4 IMPERVIOUS	0.0418	0.46	01Jan2000, 08:01	171.98
P4	0.0929	0.33	01Jan2000, 08:28	115.72
P4 OUTLET	0.0929	0.33	01Jan2000, 08:28	115.72

APPENDIX E



LEGEND

XP STORM MODELLED NODES	●
XP STORM MODELLED LINKS	—
INDICATIVE WETLAND RESERVES	🟩
INDICATIVE PROPOSED ROADS	
WFH PROPERTIES LTD PROPERTY EXTENT	▬▬▬

REVISION DETAILS		BY	DATE
4	FINAL	PW	01–18

SURVEYED		ONE TREE POINT ROAD ONE TREE POINT NORTHLAND
DESIGNED	ZY/PW	
DRAWN	ZY	
CHECKED	PW	
APPROVED	TF	WOODS.CO.NZ

ONE TREE POINT

XP STORM MODELLED LINKS & NODES PLAN

STATUS	ISSUED FOR INFORMATION	REV
SCALE	1:4000@ A3	
COUNCIL	WDC	
DWG NO	31013–01–322–DR	

C:\12dSynergy\1\31014 - One Tree Point Overall Consent_1\Model\Eng\Stormwater\Stormwater Reporting\2016-11-04 Stormwater Management Plan\V4\Appendix A\CAD\31013-01-320-DR Overall Catchments v4.dwg, 11/01/2018 9:34:10 a.m.

WOODS
Engineers. Surveyors. Planners.

MODEL OUTPUTS

Project One Tree Point **By** ZY

Location One Tree Point **Date** 8/05/2017

Hydrologic Data

Node Name	Subcatchment	Area (ha)	Impervious Percentage (%)	Routing Method	Time of Concentration (or Parameter 2) min	Initial Abstraction Method	Initial Abstraction Depth (mm)	CN Number
100/10	1	0.419	100	SCS Hydrology	10	Depth	1	98
100/10	2	0.180	0	SCS Hydrology	10	Depth	5	61
100/10	3	1.594	100	SCS Hydrology	10	Depth	1	98
100/10	4	0.683	0	SCS Hydrology	10	Depth	5	61
100/3	1	0.991	100	SCS Hydrology	10	Depth	1	98
100/3	2	0.425	0	SCS Hydrology	10	Depth	5	61
100/4	1	2.914	100	SCS Hydrology	10	Depth	1	98
100/4	2	1.166	0	SCS Hydrology	10	Depth	5	61
WETLAND 1	User Inflow Data							
WETLAND 2	User Inflow Data							
WETLAND 3	User Inflow Data							
WETLAND 4	User Inflow Data							
NTH LAKES	User Inflow Data							

Manhole Data

Name	Ground Elevat	Invert Elevatio	User Inflow Fl	Ponding Type
NTH LAKES	8.981	4.537	☑	Link Spill Cr
WETLAND 2	6.000	3.500	☑	Link Spill Cr
WETLAND 3	6.700	4.400	☑	Link Spill Cr
WETLAND 4	8.500	6.200	☑	Link Spill Cr
WETLAND 1	6.290	4.300	☑	Link Spill Cr
101/1	7.200	2.440	☐	Link Spill Cr
P101/2	5.989	2.750	☐	Link Spill Cr
P101/3	5.717	2.888	☐	Link Spill Cr
P101/4	6.181	4.200	☐	Link Spill Cr
OUTLET	2.370	0.270	☐	Link Invert to
P100/3	6.850	1.786	☐	Link Spill Cr
P100/4	7.000	1.853	☐	Link Spill Cr
100/7	7.800	2.364	☐	Link Spill Cr
P101/5	7.218	3.743	☐	Link Spill Cr
P101/6	8.539	3.827	☐	Link Spill Cr
P101/7	8.895	4.108	☐	Link Spill Cr
P101/8	8.050	4.330	☐	Link Spill Cr
P101/9	8.079	5.931	☐	Link Spill Cr
P1/1	7.002	0.828	☐	Link Spill Cr
P1/2	6.903	2.899	☐	Link Spill Cr
P1/3	7.135	3.251	☐	Link Spill Cr
100/12	6.830	3.851	☐	Link Spill Cr
100/13	7.730	4.147	☐	Link Spill Cr
P100/2	3.100	0.340	☐	Link Spill Cr
100/10	7.790	3.500	☐	Link Spill Cr
100/9	7.030	3.323	☐	Link Spill Cr
100/6	7.800	2.309	☐	Link Spill Cr
100/11	7.310	3.690	☐	Link Spill Cr
100/8	8.200	3.080	☐	Link Spill Cr
100/5	7.020	2.090	☐	Link Spill Cr
P101/4.1	6.610	3.403	☐	Link Spill Cr
Node713	7.944	3.230	☐	Link Spill Cr
Node714	7.758	3.097	☐	Link Spill Cr
Node715	7.140	2.921	☐	Link Spill Cr
Node716	8.516	5.166	☐	Link Spill Cr
Node717	8.744	4.296	☐	Link Spill Cr
WETLAND 1.1	7.010	4.267	☐	Link Spill Cr

Link Data

Name	Link Name	Upstream Nod	Downstream	Length	Roughness
Link692	Link692	NTH LAKES	P101/8	73.610	0.0130
Link700	Link700	WETLAND 2	100/6	46.580	0.0130
Link686	Link686	WETLAND 3	P101/4	44.600	0.0140
p r2P4.16	p r2P4.16	WETLAND 4	P101/9	40.760	0.0140
p P1/6	p P1/6	WETLAND 1	WETLAND 1.1	25.790	0.0140
Link690	Link690	101/1	100/7	31.210	0.0140
p r2P3.2	p r2P3.2	P101/2	101/1	144.090	0.0140
p r2P3.3	p r2P3.3	P101/3	P101/2	14.650	0.0140
p r2P3.4	p r2P3.4	P101/4	P101/4.1	105.560	0.0140
Link693	Link693	P100/3	P100/2	62.050	0.0140
p r2P4.4	p r2P4.4	P100/4	P100/3	23.260	0.0140
Link696	Link696	100/7	100/6	17.420	0.0140
Link703	Link703	P101/5	Node713	247.330	0.0130
p r2P4.12	p r2P4.12	P101/6	P101/5	81.680	0.0140
p r2P4.13	p r2P4.13	P101/7	P101/6	81.920	0.0140
p r2P4.14	p r2P4.14	P101/8	P101/7	102.330	0.0140
Link707	Link707	P101/9	Node716	125.170	0.0130
p P1/2	p P1/2	P1/2	P1/1	103.530	0.0140
p P1/3	p P1/3	P1/3	P1/2	13.670	0.0140
Link683	Link683	100/12	100/11	86.940	0.0140
p P1/5	p P1/5	100/13	100/12	35.170	0.0140
900mmx600mm	p r2P4.3.1	P100/2	OUTLET	7.260	0.0140
Spill_Restrict	p r2P4.3.1	P100/2	OUTLET	7.260	0.0140
Link683.1	Link683.1	100/10	100/9	89.440	0.0140
Link694	Link694	100/9	100/8	122.300	0.0140
Link697	Link697	100/6	100/5	104.060	0.0140
Link683.2	Link683.2	100/11	100/10	86.940	0.0140
Link694.1	Link694.1	100/8	100/7	99.700	0.0140
Link697.1	Link697.1	100/5	P100/4	104.060	0.0130
p r2P3.4.1	p r2P3.4.1	P101/4.1	P101/3	64.220	0.0140
Link704	Link704	Node713	Node714	55.140	0.0130
Link705	Link705	Node714	Node715	78.180	0.0130
Link706	Link706	Node715	P101/2	73.620	0.0130
Link708	Link708	Node716	Node717	141.060	0.0130
Link709	Link709	Node717	P101/6	77.530	0.0130
p P1/6.1	p P1/6.1	WETLAND 1.1	100/13	25.790	0.0140

Link Data

Name	Upstream Inve	Downstream I	Shape	Diameter (Hei
Link692	4.573000	4.354000	Circular	0.900
Link700	3.500000	3.020000	Circular	0.900
Link686	4.400000	4.220000	Circular	0.900
p r2P4.16	6.600000	6.180000	Circular	1.200
p P1/6	4.300000	4.290000	Circular	1.200
Link690	2.440000	2.384000	Circular	1.200
p r2P3.2	2.750000	2.440000	Circular	1.200
p r2P3.3	2.888000	2.770000	Circular	0.900
p r2P3.4	4.200000	3.423000	Circular	0.900
Link693	1.786000	0.470000	Circular	1.500
p r2P4.4	1.853000	1.806000	Circular	1.500
Link696	2.364000	2.329000	Circular	1.500
Link703	3.743000	3.250000	Circular	1.200
p r2P4.12	3.827000	3.763000	Circular	1.200
p r2P4.13	4.108000	3.945000	Circular	0.900
p r2P4.14	4.330000	4.128000	Circular	0.900
Link707	5.931000	5.186000	Circular	1.200
p P1/2	2.899000	0.828000	Circular	0.450
p P1/3	3.251000	2.924000	Circular	0.675
Link683	3.851000	3.690000	Circular	1.200
p P1/5	4.147000	4.078000	Circular	1.200
900mmx600mm	0.340000	0.300000	Rectangular	0.600
Spill_Restrict	2.050000	0.630000	Circular	1.050
Link683.1	3.500000	3.323000	Circular	1.200
Link694	3.323000	3.080000	Circular	1.200
Link697	2.309000	2.113000	Circular	1.500
Link683.2	3.690000	3.500000	Circular	1.200
Link694.1	3.080000	2.880000	Circular	1.200
Link697.1	2.090000	1.873000	Circular	1.500
p r2P3.4.1	3.403000	2.908000	Circular	0.900
Link704	3.230000	3.117000	Circular	1.200
Link705	3.097000	2.940000	Circular	1.200
Link706	2.921000	2.770000	Circular	1.200
Link708	5.166000	4.316000	Circular	1.200
Link709	4.296000	3.827000	Circular	1.200
p P1/6.1	4.267000	4.172000	Circular	1.200

APPENDIX F

Consulting Ltd

ASSESSMENT OF EFFECTS ON COASTAL PROCESSES OF STORMWATER OUTFALL AND DISCHARGE, ONE TREE POINT, WHANGAREI HARBOUR.

REPORT FOR
Dannemora Holdings Limited and Fulton Hogan Limited

DATE
March 2006

CLIENT REFERENCE
1124.164WP

AUTHOR
Derek Todd

COPIES SUPPLIED TO
Wood and Partners Consultants Limited

CONTENTS

1.0 Introduction

DTec Consulting Ltd (DTec) have been asked by Wood and Partners (W&P), representing Dannemora Holdings Limited and Fulton Hogan Limited (Dannemora) to provide an assessment of potential effects on coastal processes of a proposed stormwater outfall and discharge on the west side of Paradise Point, within Whangarei Harbour (Figure 1). The discharge is from a contributing catchment of approximately 59 hectares, consisting of a combination of existing and proposed residential development. The proposed Dannemora residential sub division is approximately 50ha in size, within the area generally referred to as One Tree Point. It is understood that this assessment will form part of the information provided with resource consent applications to the Northland Regional Council (NRC) for Coastal Permits and Stormwater Discharge for the stormwater discharge and upgraded outlet structure.

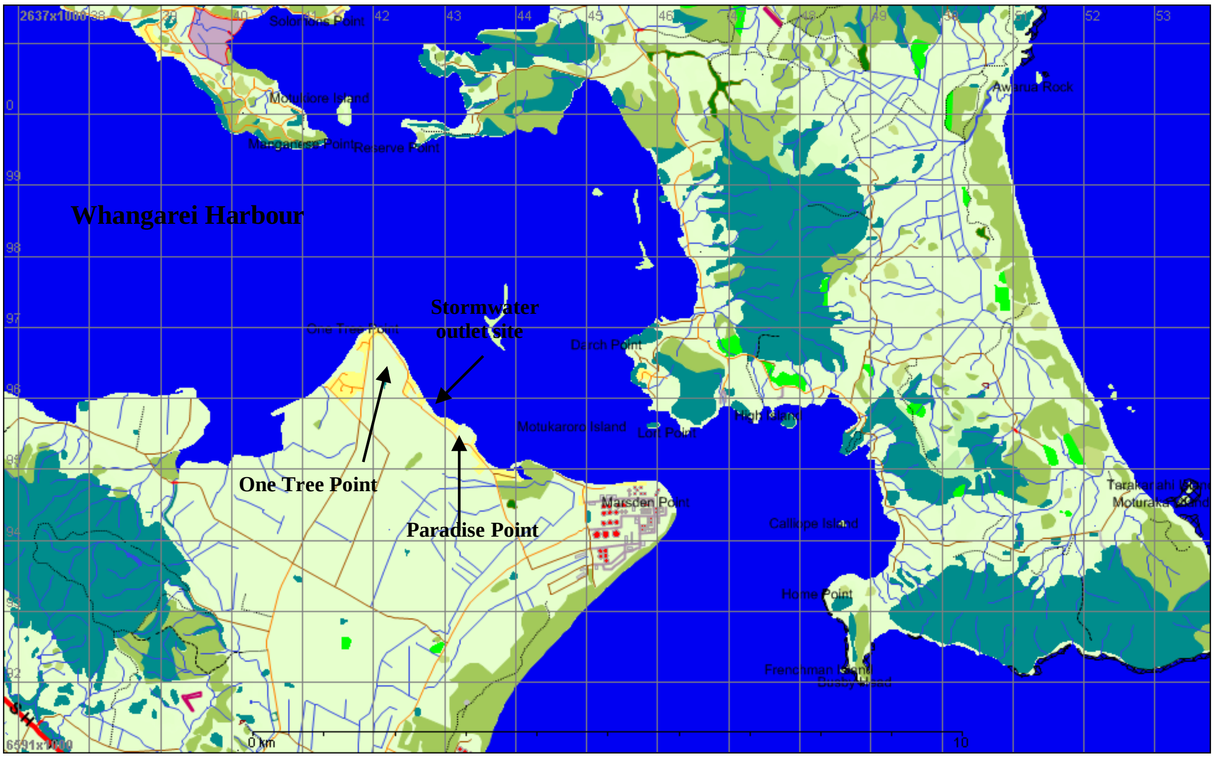


Figure 1: Location of One Tree Point In Whangarei Harbour

At the location of the proposed discharge is an existing stormwater outfall adjacent to an existing concrete boat ramp as shown in Figure 2. It is understood that consent is required for these activities as the discharge volume and size of the outfall structure will differ from the existing situation to accommodate the proposed sub-division development. It is also understood that the existing boat ramp is not covered under any existing Northland Regional Council consents, and since the stormwater discharge proposal includes works on this ramp, a retrospective Coastal Permit is also required for this structure.

Figure 2: Existing boat ramp and stormwater outlet at Paradise Point

1.1 The Proposed Works

The Engineering design plans for the proposed works are presented in Appendix A. These works and the discharge activity can be divided into the following four parts:

- The Discharge
    - Discharge up to the 20% AEP to be discharge to the beach via a new box culvert outlet located in a similar position to the current outfall. This discharge has been calculated by W&P at approximately 3.16 m^3/s.
    - Discharges greater that the 20% AEP and up to the 2% AEP storm event to be discharged via bubble up chambers onto the boat ramp, and from there as overland flow onto the beach. The 2% AEP discharge has been calculated by W&P at approximately 5.2 m3/s.
    - Discharges greater than 2% AEP not to be discharged at this site, instead traveling overland to discharge into the Marsden Cove Marina, located to the south.

- The Outfall
    - A new outfall consisting of a box culvert structure with outlet dimensions of approximately 6m wide and 0.3m high.

  - The outfall includes secondary energy dissipation comprising of rock rip rap (450-600 mm Diameter) and erosion protection of a 1m deep gabion basket covering an area in the order of 60m^2, which extends seaward to the end of the boat ramp (approximately 5 m), and alongshore extends approximately 12 m.
- The Boat Ramp:
  - Resurface the existing ramp (concrete) to provide discharge pathways for the over land flow across the sides as well as the end of the ramp
  - Include kerb (or equivalent) downstream of the first bubble up chamber to the start of the ramp to ensure that the overland flow does not undermine the batter of the ramp access.

- Associated Works
  - The existing sloping rock revetment around the outfall be replaced by a stepped keystone seawall to a minimum height of 2 m RL, with step dimensions in the order of 0.4 m x 0.4 m.
  - Removal of the existing low concrete seawall located seaward of Lot 4 DP 38979 and west of the boat ramp and replace with a revetment of suitable sized rock rip rap overlaying a geotextile mat.
  - Replacement of the existing rock wall at the back of the beach to the east of the boat ramp.

The engineering plans in Appendix A show that the overall design has a similar footprint as the original structure. It is also noted that it is not the intention to provide parking or increase/improve the functionality of the boat ramp. Bollards are proposed to be provided to prevent vehicles parking on the area above the outfall structure.

2.0 Coastal Processes

2.1 Physical Setting

Whangarei Harbour has a tidal compartment at Spring tide of 164 x10^6 m^3, and at a neap tide of 11 x 10^6 m^3, covering a surface area of 95 km^2 at high tide, of which 56 km^2 are exposed mudflats at low tide (Heath, 1976).

One Tree Point is a small promontory on the south side of the harbour, located approximately 5 km from Marsden Point at the mouth of the Harbour. Geologically the Point is the northwest corner of the inner Bream Bay coastal barrier, which is comprised of the remnants of a extensive Pleistocene dune ridge system. These raised ridges are evident in the continuous 6-8 m high cliff outcrop around One Tree Point (Figure 3). The ridges have been dated by Nichol (2002) as being in the order 115,000 to 85,000 years, with the ridges decreasing in age in a eastward direction to Paradise Point. Hence, Nichol concluded that the ridges were laid down in the last interglacial period when sea level was in the order 4-5 m higher than present. Nichol (2002) identified three sand Facies in the cliff deposits, representing the nearshore, foreshore, and dune environments at the time of deposition.

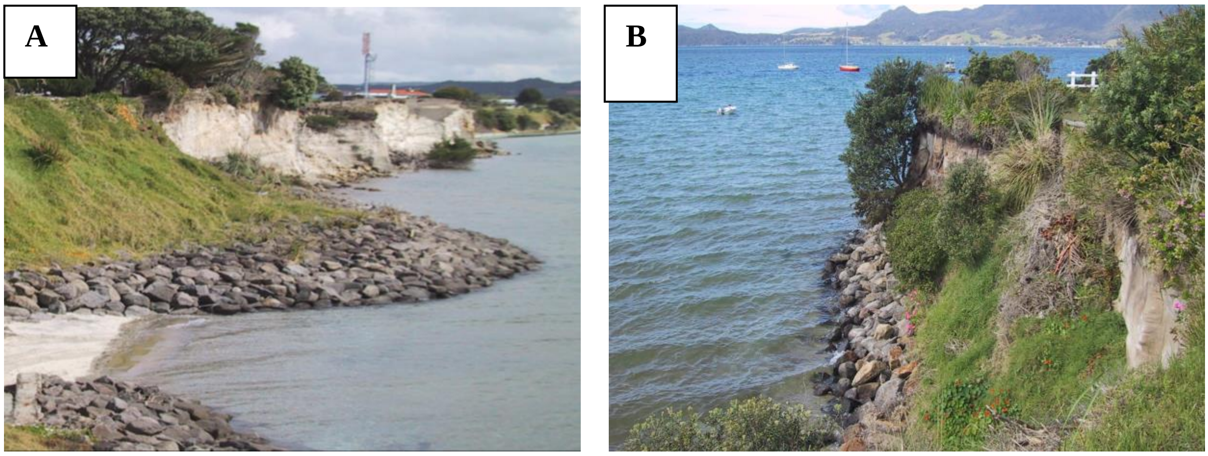


Figure 3: Exposed Sandstone Sea cliffs at One Tree Point. A) West of Kararo Rd, B) West end of Paradise Point

To the east of Paradise Point the Pleistocene Plain is bounded by the former estuary of Blacksmiths Creek, which has been infilled by Holocene sediments over the last 6,500 years (Gibb 1998). Further east is outer Bream Bay coastal barrier comprising of a relatively narrow plain of Holocene sand dunes, which Nichol (2002) has dated as being in the order of 5,750 years old.

Gibb (1998) considers that since sea level reached its present level about 6,500 years ago, the shoreline around One Tree Point has retreated to leave a wide inter-tidal shore platform, which is overlain by mobile sheets of sand. NZ Navy Bathymetric chart SN5213 (Figure 4), shows this platform to be around 600 m wide from Paradise Point to One Tree Point. A “blind” channel” that branches off the Shipping Channel on the east side of Paradise Point bisects the platform in the vicinity of Paradise Point before petering out close to the apex of One Tree Point. Tonkin & Taylor (2002) noted that meanders in this channel move slowly down the harbour, repeating the cycle over periods of 50 years or more. This channel is used for the mooring of recreational craft. On the harbour side of the platform is the main shipping channel, then the two flood tide deltas of the harbour; Snake Bank, and McDonald Bank.

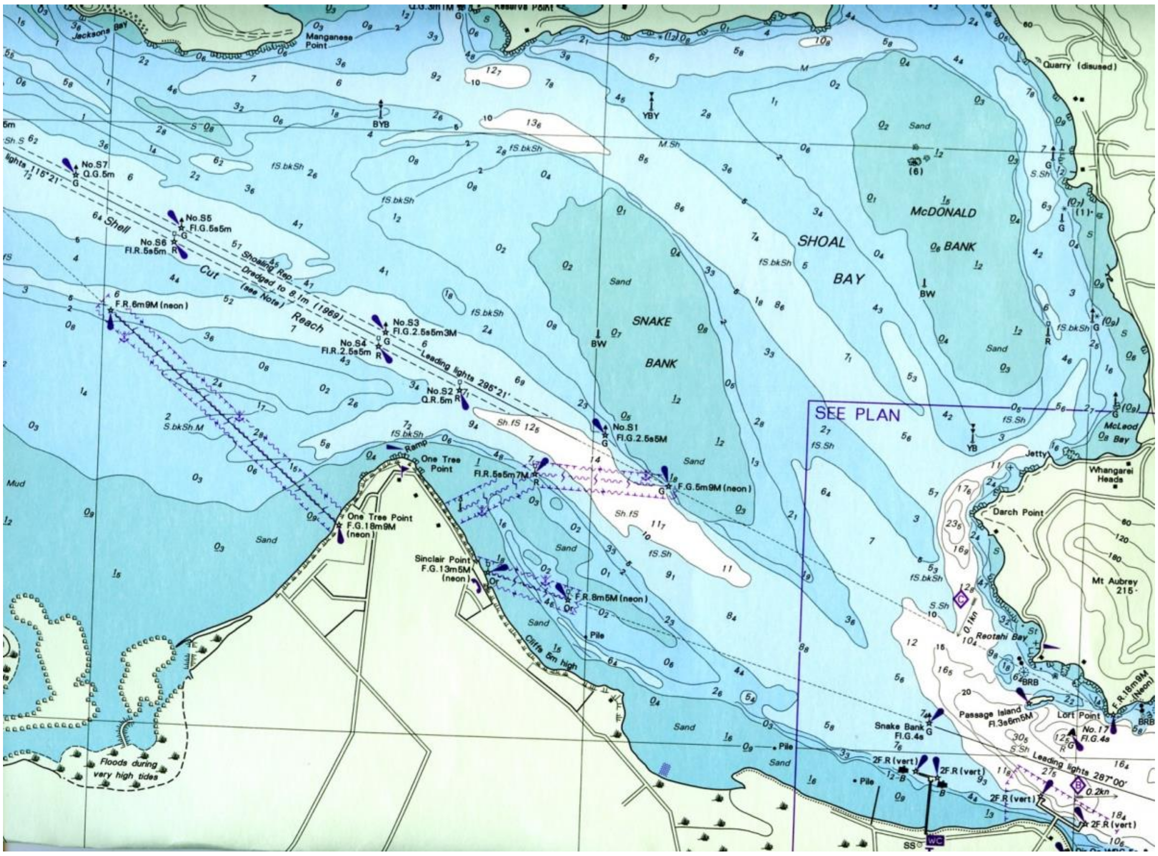


Figure 4: Bathymetry of Lower Whangarei Harbour around One Tree Point

2.2 Sediments

Tonkin & Taylor (2002) summaries the previous information on sediment characters of the area around One Tree Point and Marsden Bay. This is reproduced here:

- Beach sands along the eastern side of One Tree Point are predominantly fine to medium sands (i.e. 0.5 to 0.125 mm diameter).
- Similar size sands are found on the beach and foreshore in Marsden Bay, with median gain size coursing and shell content increasing in an offshore direction.
- The sands in the inter-tidal area of Marsden Bay were slightly gravely than the beach sands, having a median gain size of 0.325 mm.
- Towards the blind channel the sediments becomes more sandy with less evidence of shell.
- Very little silt and clay was found on the inter-tidal shelf (<0.5%), with higher concentrations in the main channel (up to 3.5%).

2.3 Hydrodynamics

Tidal conditions are semi-diurnal, with a mean spring range of 2.1 m and mean neap range of 1.5 m at Marsden Bay (Tonkin & Taylor, 2002). The NZ Nautical Almanac gives MHWS at Marsden Point an elevation of 1.03 m RL. Tonkin & Taylor suggested that water levels up to 0.4 m higher were reasonably common due to the influence of storm surge. Maximum storm surge of 0.82 m was recorded during a significant storm in July 1978, but this did not coincide with extreme tidal levels. The highest recorded water level occurred during Cyclone Gavin (11/3/97), when a predicted tide of 1.33 m combined with a 0.5 m storm surge to produce of levels of 1.85 m RL (Tonkin & Taylor, 2002). During this event, high tide water levels exceeded 1.4 m RL for three consecutive days, resulting in inundation depths of up to 0.6 m along Marsden Bay (Gibb, 1998).

Black (1983) undertook his post-doctoral research on sediment transport through the mouth of Whangarei Harbour, involving the use of one and two dimensional numerical hydrodynamic models. His conclusions included that within the harbour the ebb tide currents dominates over the flood tide currents, with a strong ebb tide flow along the shipping channel past One Tree Point. The modelling showed the ebb tide dominance was primarily due to the harbour morphology and the expansion of surface area with rising tide. As the inter-tidal zones evolve, the harbour became progressively more ebb dominated, which reduced the potential for harbour deposition. The models correctly predicted a stable ebb shield on the flood-tide delta, which is the shore platform along the east side of One Tree Point. The models estimated that the net sediment flux on the inter-tidal areas around the (at the time) proposed Marsden

Point harbour development were in the order of 1m^3/m/yr, with the up and down harbour components being in the range of 2-10 m^3/m/year.

Gibb (1998) measured tidal current velocities at high tide conditions at 15 sites close to the shore along the eastern side of One Tree Point and in Marsden Bay. Measurements were taken in water depths of 0.5 to 1 m, with the assumption that sub-surface current measured at each site was similar to that on the seabed. The results showed that there was an easterly current along the eastern One Tree Point shoreline on both the flood and ebb tide. During the flood tide these currents were very weak, only up to 0.03 m/s, and stronger on the ebb tide being in the range of 0.05 to 0.33 m/s, with the strongest at the apex of the headland. Gibb concluded that since wind and wave action was negligible during the measurements, the velocities were mostly tide generated, and were too weak to initiate sand transport on their own in the medium to fine graded sands except at the apex of One Tree Point. Therefore the assistance of breaking waves is required to entrain the sand, with the direction of transport being the direction of the current. Gibb used a series of geomorphic evidence to support his conclusion of net NE transport along the east coast of One Tree Point; sighting the trapping of sand on the NW side boat ramps and small promontories on Paradise Point, and the SE decrease in beach width, which he considered was also indicative of little supply of sand from west of One Tree Point.

Due the sheltered nature of the entrance to Whangarei Harbour, only waves generated within the harbour are likely to affect the shoreline of the harbour. Along the eastern shore of One Tree Point, wave heights are further limited by the narrow fetch, shallow water depths, and generally low wind speeds. Tonkin & Taylor (2002) present wind data from 22 years of record at Marsden Point (1969-1991), which showed that winds greater than 20.1 m/s occurred for only 0.1% of the time per year, with the highest recorded wind speed being 29 m/s from the NE direction. Tonkin & Taylor also present a hind cast of wave heights and periods calculated by the Bretschneider method for the Marsden Bay area based on wind speeds and fetch lengths for relevant direction sectors. Similar wave conditions could be expected at the proposed outfall and ramp site on the west side of Paradise Point, except for easterly and north-easterly waves, which are largely sheltered from the location by Paradise Point. For wind speeds of 22.5 m/s (81 km/hr; Windforce 9 strong gale on the Beaufort scale), the hindcast showed maximum wave less than 0.8 m and peak wave periods less than 4 seconds for winds from NW and north directions. Waves from easterly and NE winds refracted around Paradise Point are likely to be smaller.

2.4 Shoreline Stability

Gibb (1998) states "*the seacliffs cut into the Pleistocene marine sandstone deposits around One Tree Point are retreating by a combination of backcutting and downcutting*."

Downcutting, is the erosion of the sandstone platform by abrasion from sand moving back and fore across the surface under wave action. This process was measured by Gibb (1998) to be around 20-30 mm/yr on the high tide platform around Paradise Point.

Backcutting, or horizontal retreat, at One Tree Point is considered by Gibb (1998) to be due to a combination of sub-aerial (landsliding) and marine (wave attack). Gibb summarised the changes in cliff top position between 1942 and 1997 from 121 sites at 20 m intervals along the eastern shore of One Tree Point to Marsden Bay as being:

- Most widespread retreat is in the northern area up to 600 m from the apex of One Tree Point, which is exposed to deeper water waters closer to the cliffs. Average rate of cliff top retreat of 0.04 m/yr, with retreat distances ranging from zero to 7 m over the 55 year period. Erosion tends to be by instantaneous failure of a block, followed by stability over several decades.
- A stable 800 m long section centred on where One Tree Point Road runs perpendicular to the coast. This section is characterised by a relatively wide sand beach and well vegetated cliff face (Figure 5). Most of the sites showed no change in cliff top position, with erosion confined to small exposed promontories, which act as groynes. Average rate of cliff top retreat of less than 0.01 m/yr, with maximum retreat distance of 5 m over the 55 year period.
- Along the 600 m of the southern part of One Tree Point Road to Paradise Point, the coast is characterised by a narrowing transient beach which allows the waves at high tide to break against the sea cliff, promoting moderately widespread cliff top erosion. Two-thirds of the measurement sites experienced retreat over the 55 year period, with a maximum retreat distance of 5.5 m. however, the average cliff top erosion rate for this section of cliff was 0.03 mm/yr over this period. Since the 1970's, a number of piecemeal vertical timber and concrete seawalls have been built in an attempt to protect the cliff face from erosion (Figure 6).
- Paradise Point has also been exposed to moderately widespread cliff top retreat (61% of sites), with maximum retreat of 7 m in 55 years, and an average rate similar to the previous section. Areas of zero change were typified by iron stained and partially

cemented sandstone, which is relatively erosion resistant, while the areas of highest retreat were in softer lighter coloured sandstone located on the east side of Paradise Point (i.e. Marsden Bay side).

Gibb (1998) noted the following two very important points about the rates of retreat around One Tree Point compared with those experienced elsewhere in New Zealand:

1) On a nation wide scale, all the rates at One Tree Point were "*very slow*", and
2) This is the most common rate of retreat of the New Zealand coast.

Figure 5: Stable Vegetated cliff face in Central section of One Tree Point

Figure 6: Seawalls along southern section of One Tree Point

Given the very slow rates of retreat and low longshore transport environment, it is some what surprising that Dr. Gibb recommended that Whangarei District Council (WDC) should undertake a beach replenishment from One Tree Point to Paradise Point involving the placement of 25,000 to 30,000 m^3 of sand together with the construction of three small groynes along the 1670 m length of this coast (Gibb, 1998). A resource consent for this work was granted by the NRC in August 1999. However, this work was not implemented and a new consent has been applied (July 2005, NRC Ref: CON20050859610) involving the placement of 50,000 m^3 of sand along the same length of coast, and including the construction of 29 semi-permeable timber groynes and the extension of 7 stormwater outlets. This application is subject to a hearing, scheduled for early April.

3.0 Potential Effects

The potential coastal process effects of relevance to the proposed ramp upgrade and stormwater outfall can be divided into the following five categories:

1) Effect of the coastal processes on the integrity of the proposed works.
2) Effect of the proposed works on the shoreline stability in the immediate area, which includes scour of the inter-tidal platform and horizontal retreat of the adjacent cliff face.
3) Effect of the proposed increased discharge on scour of the inter-tidal platform
4) Effects of the proposed works on sediment transport, hence the potential effects on shoreline stability at more remote areas.
5) Effects on the proposed WDC beach renourishment scheme.

3.1 Effect of the Coastal Processes on the Structures

These potential effects relate to water levels, run-up elevations and wave energies.

The height of the seawall around the outfall and the revetment to the west is shown in the design plans (Appendix A) to be 2 m RL. This elevation is 0.5 m higher than existing revetment and seawall elevation, hence there is less overtopping potential than with the present structures. However, consideration still needs to be given as to whether this elevation is sufficient to prevent significant or frequent overtopping by extreme water levels and wave events which may result in progressive failure of the structures .

As outlined in section 2.3, the highest recorded water level in the harbour was 1.85 m RL during Cyclone Gavin (11/3/97). While the return period for this water level within Whangarei Harbour are not given in any previous reports, it is considered to be very extreme, being the combination of tides 0.3 above the MHWS elevation and storm surge in the order of 0.5 m. Hence, the height of the protection works are sufficient to prevent overtopping in the highest recorded water level with a 0.15 m freeboard.

At the most extreme tidal conditions (HAT estimated to 1.5 m RL), it would require a 0.5 m surge to overtop the design wall height, therefore it is considered that the design wall height is sufficient to withstand all but the most serve water levels possible within the harbour.

The effect of waves on top of water levels also needs to be considered. Clearly during very extreme water levels similar to those experienced in Cyclone Gavin, some wave overtopping could be expected at high tide. However, due to the very low frequency of these extreme water levels, there is little change in the probability or risk of overtopping from these size events. An alternative approach is to determine the wave height required to result in overtopping for a water level of know probability, such as MHWS (exceeded approximately 12% of high tides within a year). From the methodology given in the Shore Protection Manual (SPM) (CERC, 1984), the wave height required to produce the necessary 1 m run-up elevation on a stepped seawall is in the order of 0.5 m. From the wave hindcast in Tonkin & Taylor (2002), this would require a wind speed of 10-12 m/s, which occurs around 1% of the time from the NW and north directions. The resulting expected frequency of two conditions occurring together is 0.5 days per year.

Based on the above calculations of low frequency of overtopping occurrence, together with the fact that overtopping duration would be limited to a short period on either side of high tide, and the design of the seawall (0.4 m wide step at the top) and revetment (use of a geotextile layer behind the revetment), it is considered that the risk of failure of these structures from wave overtopping is negligible.

It is considered that predicted sea level rise will have little effect of the risk from overtopping. Based on the most recent IPCC (2001) predictions of sea level rise, the 0.15 m freeboard for the highest recorded water level can be accommodated for another 40-50 years, and changes to the possible run-up elevations will be small.

3.2 Effects of the Structures on Shoreline Stability

3.2.1 Scour of the Inter-tidal Platform

Scour at structures located on the shoreline can occur in both non-breaking wave situations due to wave reflection, and in situations where waves break on or just before the structure due to the high levels of turbulence at the toe of the structure. Scour caused by breaking waves is generally greater than for non breaking waves. The US Army Coastal Engineering Manual (CEM) (US Army, 2002) gives a rule of thumb that the maximum scour at a vertical wall is approximately equal to the non breaking wave height that can be supported by the water depth. For sloping or stepped walls, should as proposed works, the CEM notes that there are no generally accepted techniques for estimating maximum scour depths or plan form extent of scour, but suggests the following relevant rules of thumb:

1) *Maximum scour at the toe of a sloping structure is expected to be somewhat less than scour calculated for a vertical wall at the same location and under the same wave conditions. Therefore a conservative estimate is provided by the vertical wall scour prediction equations (i.e.* $S_m < H_{max}$*).*
2) *Depth of scour decreases with structure reflection coefficient. Therefore structures with milder slopes and greater porosity will experience less wave-induced scour.*

From this discussion, it can be established that maximum scour at the toe of the proposed stepped seawall will be somewhat less than 0.8 m. Therefore the proposed 1 m deep gabion basket (see plans in Appendix A) that extends along the total length of the stepped wall from the side of the boat ramp to the new western revetment will be totally adequate to deal with any scour generated from the seawall.

At the new western revetment, toe scour will be even less due to dissipation of the reflected wave energy on the rock surface of the revetment. It is therefore considered that the 0.5 m burial depth proposed for this revetment (see Appendix A) will be sufficient to accommodate any toe scour from the structure.

There does not appear to be a current toe scour problems at the boat ramp. Since the proposed works do not change the slope or nature of this structure, it can be assumed that this will continue to be the situation in the future. The effect of the discharge across this ramp is treated separately in section 3.3.

3.2.2 Local Shoreline Retreat

Local shoreline retreat associated with coastal structures are generally termed “end effects” and are caused by the increase in energy from wave reflection, refraction and diffraction attacking soft unprotected sediments at the ends of the structures.

An important consideration here is that the footprint of the proposed ramp and outfall structure is the same as the current structures, therefore the area of potential influence of the works on the adjoining shoreline will be the same.

To the west of the outfall structure, any possible “end effects” will be totally mitigated by the new western revetment. This proposed design of this revetment (Appendix A) will provide an enhanced protection function over the existing low concrete wall, which have failed due to poor design and construction. It is assumed that the new revetment will tie into the existing revetment further west, therefore eliminating any potential “end effects” from the new revetment it shelf.

To the east of the ramp, any current potential “end effects” on the small pocket beach appear to be adequately mitigated by the existing rock wall at the back of the beach, which is proposed to be replaced. There does not appear to be any affect of the current structures on the sandstone cliffs at the western end of Paradise Point.

3.3 Effects of Increased Discharge on Scour of the Inter-tidal Platform

3.3.1 Discharge from the Outfall

Entrainment of fine and medium sized sand occurs at flows of less than 1 m/s, hence discharge velocities at flows greater than this result in scour of the inter-tidal platform. The current outfall is a 375 mm diameter pipe with a maximum discharge capacity of approximately 0.637 m^3/s, discharging at a velocity of 5.58 m/s (GHD 2000). Energy dissipation of the discharge is provided by a triangular concrete block splitting the flow on exiting the outfall (Figure 2), however no scour protection is provided on the inter-tidal platform in front of the outfall. As would be expected with the high discharge velocity, a scour channel does develop during discharge from this outlet. However, it does not appear to be a permanent feature, being short lived with sand rapidly re-filling the scour channel once discharge has finished. Site investigations did not show any evidence of either downcutting of the platform, or instability of the boat ramp foundation as a result of the discharge. Probing of the inter-tidal platform in a transverse out from the outfall revealed sand depths to be 1.2 m or deeper up to 60 m out from the outfall, hence confirming there is plenty of sand available on the adjacent platform to be redistributed in the scour channel following discharge.

The new outfall will have an increased capacity of approximately 3.16 m^3/s (20% AEP), but a reduced discharge velocity of 1.75 m/s due to a substantially increased discharge area provided by the 6 m x 0.3 m outlet opening. Hence discharge will occur as a sheet flow, rather than a concentrated channel flow. In addition, scour protection at the toe of the outfall is proposed via a 1 m deep gabion apron extending 5 m in front of the outfall, and secondary energy dissipation is provided for by nominal 450 mm diameter rock rip placed on top of the gabion apron over the total 6 m length of the outfall (see design plans in Appendix A). While the discharge velocity is still sufficient to entrain any fine and medium sized sand present at mouth of the outlet, it is considered that the gabion apron and rock rip rap will totally mitigate the formation of a scour channel on the inter-tidal platform. It is therefore concluded that the increased discharge from the proposed outfall will not result in any scour effects on the inter-tidal platform.

3.3.2 Overland Flow down the Boat Ramp.

The second consideration is the effect of overland flow down boat ramp in events with discharge above the 20%AEP. Clearly in discharges up to the 20% AEP level, there will be no difference from the current situation, hence consideration is only required for events which have a return period of greater than 5 years.

From Section 1.1, the maximum overland flow down the ramp will be in the order of 2 m^3/s, which could be expected to occur once every 50 years. It is anticipated that the velocity of this discharge would be above the threshold for entrainment of fine and medium sized sand, (approximately 1 m/s), hence there is the potential for scour at the toe and sides of the boat ramp from this discharge. However, this could be mitigated by the surface of the ramp being contoured such that the discharge is across the ramp towards the western side, so that it is discharged on to the gabion apron, rather than directly on to the inter-tidal platform.

3.4 Effects on Longshore Sediment Transport

The existing structures are located at the eastern end of the One Tree Point coastal cell, for which there appears to be limited supply and longshore transport of sand (Gibb, 1998). Indeed there is little build up of sand on the up drift side of the outfall and boat ramp structures, and Gibb found no evidence of littoral drift sand bypassing Paradise Point. Therefore it is concluded that the existing structures have no effect on the longshore transport of sediment in the area.

Since the proposed structures will occupy a similar footprint as the existing structures, it is considered that they also will not have any effect on longshore sediment transport.

3.5 Effects on Proposed WDC Beach Renourishment

Although the sketch plans supplied with the consent application for the renourishment are not particularly detailed, it would appear that the eastern limit of the renourishment is about the boat ramp covered in this assessment. The sketch plans show that a 24 m extension is required on the existing the outfall pipe to clear the renourished beach. The beach itself is shown as being built up to 2 m RL at the back, having a 8 m wide berm at this elevation, then sloping at 1:12 to meet the existing inter-tidal platform around the position of the outfall extension (i.e. 24 m from current position).

Should the WDC application be approved by NRC (subject to NRC Hearing and Commissioners Decision), the proposed renourishment as shown in the sketch plans will cover the proposed outfall structure being considered under this assessment. Clearly, this would create issues for blockage of the outfall, and hence for the efficiency of discharge. Any successful discharge from the outfall would remove the beach sand in front of the outfall down to the existing platform level as a result of flow at this elevation. This would allow tides and waves to run into this area, and hence further move and re-distribute the renourishment sands in this vicinity. Due to ongoing discharge keeping this area saturated, it is unlikely that sand will build up. The aerial extent of this sand removal is difficult to predict, but could easily extend across the area to the proposed new western revetment.

The renourishment as proposed would also fill to the top of the proposed new western revetment, and cover the boat ramp. Under this scenario, any work on the revetment or the boat ramp would not be warranted.

From this assessment it is clear that the renourishment and the outfall works can not co-exist as currently proposed. Either the outfall and boat ramp need to be extended to accommodate the renourishment, or the renourishment needs to be terminated at some point to the west of the outfall. This could be achieved by progressively reducing the width of the renourishment as Paradise Point is approached, such that it is zero at the outfall. Given that there are low rates of longshore transport in this area, it is considered that there will not be large volumes of sand moving into this area as a result of the renourishment.

It is considered appropriate that the WDC amend the extent of the proposed beach renourishment, to compliment the proposed boat ramp upgrade and prevent the need for extending the boat ramp in a seaward direction. It is understood that Dannemora will be pursuing this at the NRC Hearing.

4.0 Conclusions

The coastal process environment at the location of the proposed works on the western side of Paradise Point can be summarised as being one of low energy with little sand inputs.

The assessment of effects on coastal processes shows that the proposed new structure, replacing the existing boat ramp will be better designed to withstand the effects of coastal processes than the existing structure.

Any potential effects of the proposed structures or discharge of treated stormwater on coastal processes such as shoreline stability and scour of the inter-tidal platform are considered to be negligible or non-existence.

5.0 References

Black K.P. 1983 Sediment Transport and Tidal Inlet Hydraulics. Unpublished PhD (Earth Sciences), University of Waikato.

CERC 1984 Shore Protection Manual. US Army Corp of Engineers, Coastal Engineering Research Centre. Washington, USA.

GHC 2000 One Tree Point Catchment Management Plan. Report for WDC. 34 pps.

Gibb J.G. 1998 Coastal Hazards and Solutions for Eastern One Tree Point, Whangarei Harbour, Whangarei District. Report prepared for Whangarei District Council. 57pps.

Heath R.A. 1976 Stability of Some New Zealand Coastal Inlets. *NZ Journal of Marine & Freshwater Research 9(4):* 449-457.

IPCC. (2001). Climate change 2001: The scientific basis. Summary for policy makers and technical summary of the Working Group I report. Part of Working Group I contribution to the assessment report of the Inter-Governmental Panel on Climate Change (IPCC), Cambridge, England.

Nichol S.L. 2002 Morphology, Stratigraphy, and Origin of Last Interglacial Beach Ridges at Bream Bay, New Zealand. *Journal of Coastal Research 18*(1): 149-159.

Tonkin & Taylor 2002 Marsden Cove Coastal Process Assessment. Report for Marsden Cove Ltd. 33pps

U.S. Army Corps of Engineers. 2002. *Coastal Engineering Manual*. Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers, Washington, D.C. (in 6 volumes).

Disclaimer

This report has been prepared for the benefit of Wood & Partners Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

DTec Consulting Ltd
Environmental & Coastal Consulting

Report written by: Report Reviewed by:

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Derek Todd

24 November, 2016
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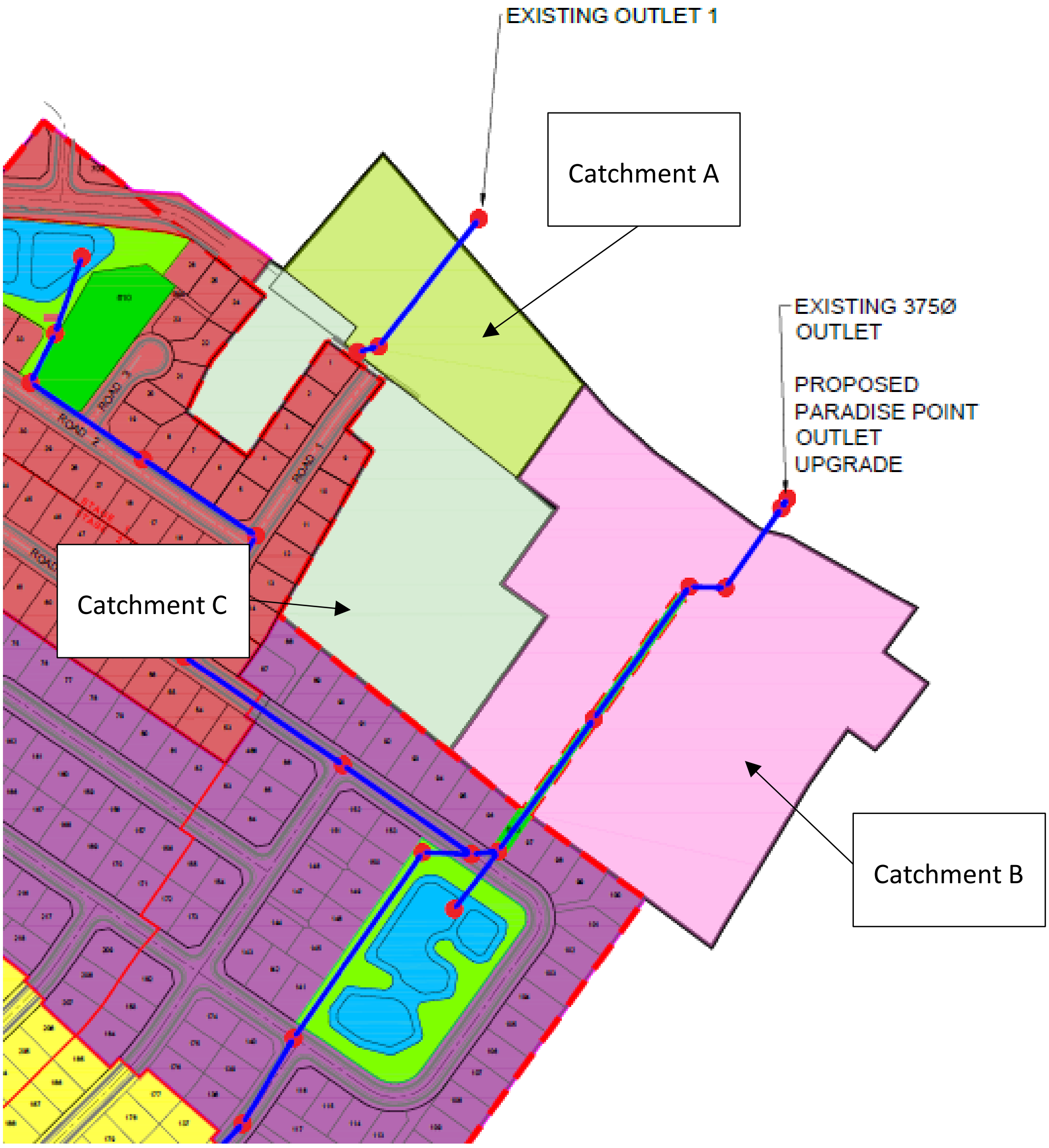
Appendix A

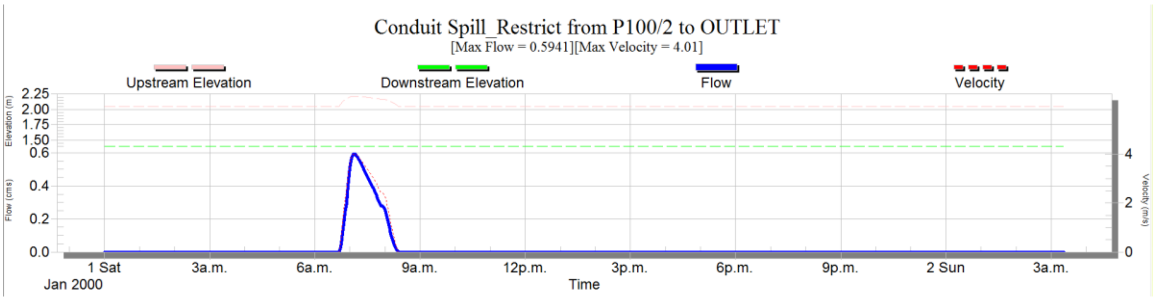
DESIGN PLANS FOR PROPOSED WORKS

APPENDIX G

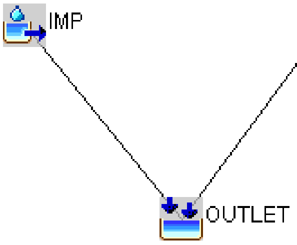
Catchment C – Contributing Catchment to Boat Ramp

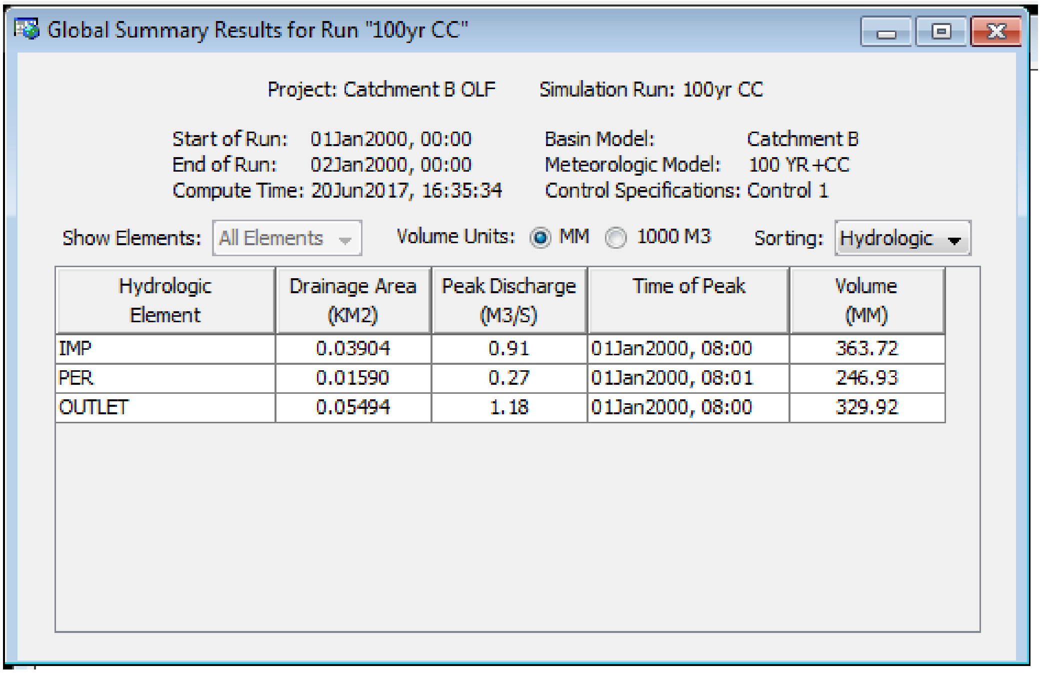


Peak flow XP Storm Model – Bubble Chamber (100yr)



Catchment B - HEC – HMS Outputs and Results





Project: Catchment B OLF Simulation Run: 100yr CC

Start of Run: 01Jan2000, 00:00
End of Run: 02Jan2000, 00:00
Compute Time: 20Jun2017, 16:35:34

Basin Model: Catchment B
Meteorologic Model: 100 YR +CC
Control Specifications: Control 1

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

Hydrologic Element	Drainage Area (KM2)	Peak Discharge (M3/S)	Time of Peak	Volume (MM)
IMP	0.03904	0.91	01Jan2000, 08:00	363.72
PER	0.01590	0.27	01Jan2000, 08:01	246.93
OUTLET	0.05494	1.18	01Jan2000, 08:00	329.92

Manning's Overland Flow Depth Assessment

Scenario 1: Existing Flows – 100yr (Catchment B only)

Manning Calculation for Trapezoidal channels

PROJECT DETAILS

Project Number:	31013
Location:	One Tree Point
Date:	
By:	P.Wadan
	Existing Flows

REQUIRED DESIGN FLOW (m^3/s)

Design Flow	Q =	1.18

CHANNEL PARAMETERS

Manning's Coefficient	n =	0.016
Channel Slope (m/m)	S =	0.1
Channel depth (m)	D =	0.097
Bottom Width of Channel	W =	3
Right Side Slope (V:H)	Z_L =	1
Left Side Slope (V:H)	Z_R =	1

MANNINGS EQUATION

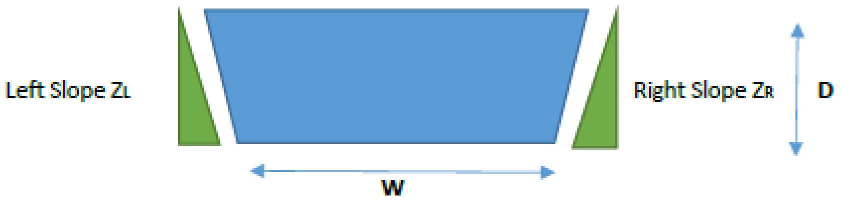
V =	1/n x S^0.5x R^2/3
Q =	VxA

RESULTS

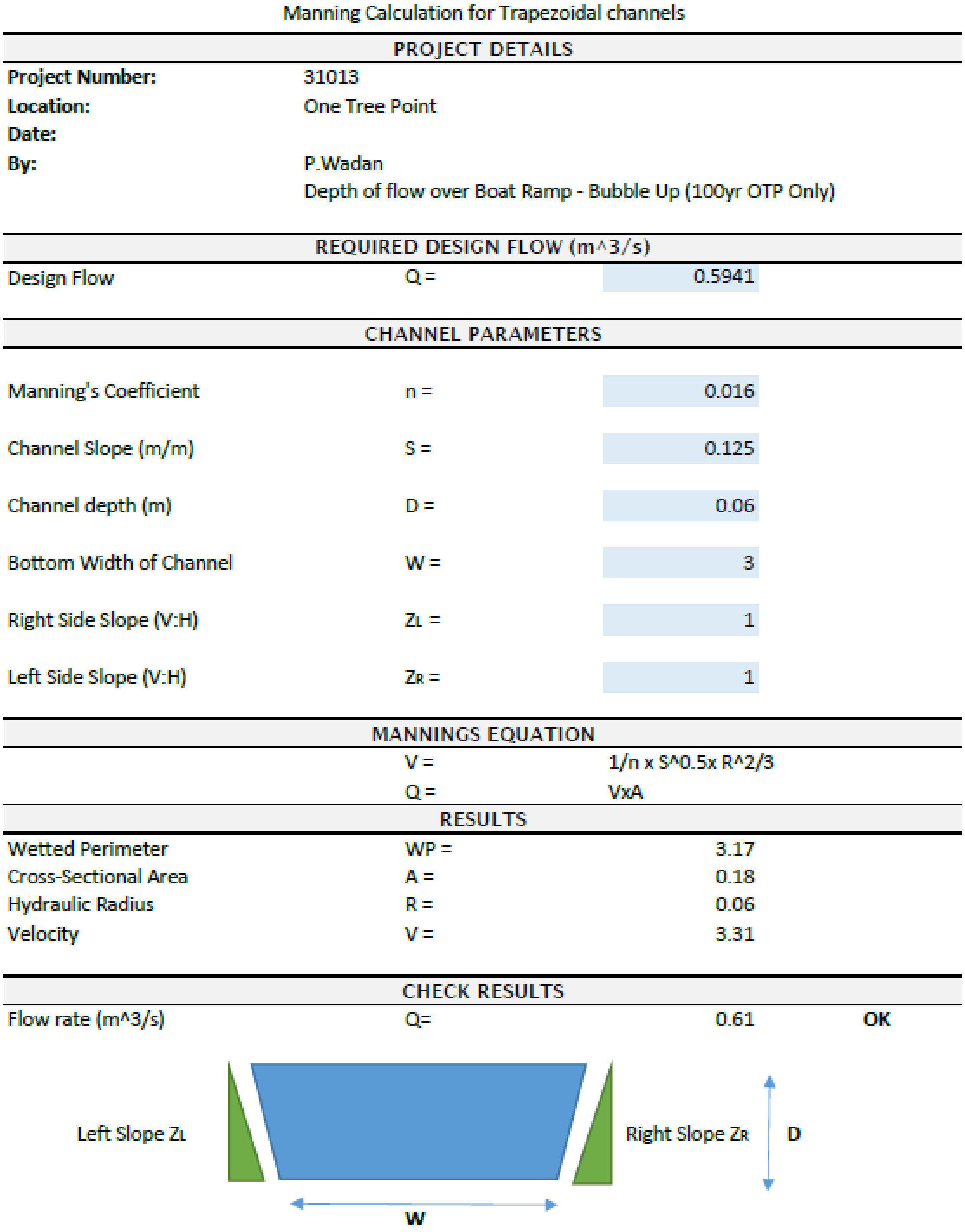
Wetted Perimeter	WP =	3.27
Cross-Sectional Area	A =	0.30
Hydraulic Radius	R =	0.09
Velocity	V =	4.02

CHECK RESULTS

Flow rate (m^3/s)	Q=	1.21	**OK**



Scenario 2: Flows from Bubbleup – The Landing @ Marsden Development 100yr flows



Manning Calculation for Trapezoidal channels

PROJECT DETAILS

Project Number: 31013
Location: One Tree Point
Date:
By: P.Wadan
Depth of flow over Boat Ramp - Bubble Up (100yr OTP Only)

REQUIRED DESIGN FLOW (m^3/s)

Design Flow	Q =	0.5941

CHANNEL PARAMETERS

Manning's Coefficient	n =	0.016
Channel Slope (m/m)	S =	0.125
Channel depth (m)	D =	0.06
Bottom Width of Channel	W =	3
Right Side Slope (V:H)	Z_L =	1
Left Side Slope (V:H)	Z_R =	1

MANNINGS EQUATION

V = 1/n x S^0.5x R^2/3
Q = VxA

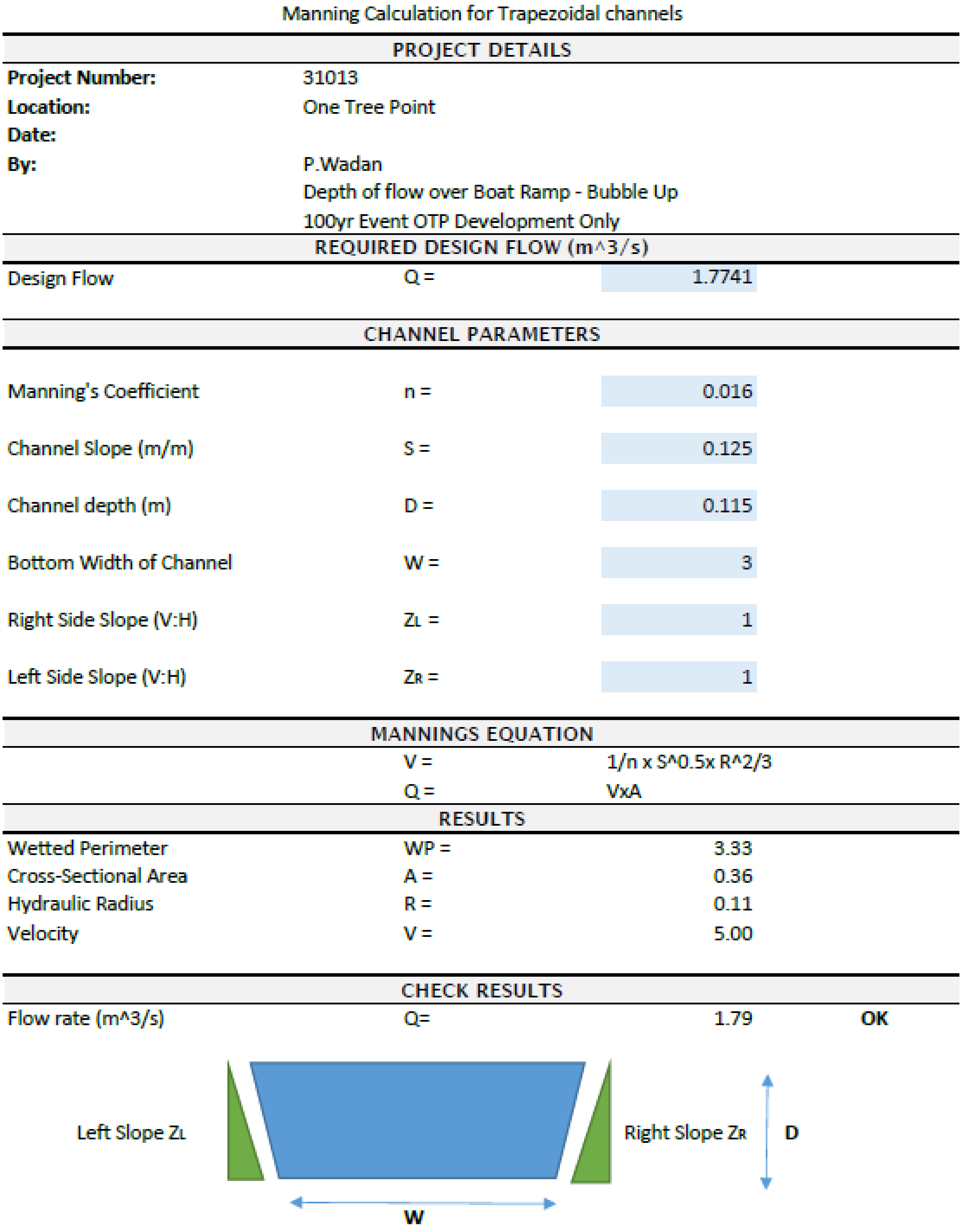
RESULTS

Wetted Perimeter	WP =	3.17
Cross-Sectional Area	A =	0.18
Hydraulic Radius	R =	0.06
Velocity	V =	3.31

CHECK RESULTS

Flow rate (m^3/s)	Q=	0.61	**OK**

Scenario 3: Flows from Bubbleup + Existing (Scenarios 1+2)



Manning Calculation for Trapezoidal channels

PROJECT DETAILS

Project Number:	31013
Location:	One Tree Point
Date:	
By:	P.Wadan
	Depth of flow over Boat Ramp - Bubble Up
	100yr Event OTP Development Only

REQUIRED DESIGN FLOW (m^3/s)

Design Flow	Q =	1.7741

CHANNEL PARAMETERS

Manning's Coefficient	n =	0.016
Channel Slope (m/m)	S =	0.125
Channel depth (m)	D =	0.115
Bottom Width of Channel	W =	3
Right Side Slope (V:H)	Z_L =	1
Left Side Slope (V:H)	Z_R =	1

MANNINGS EQUATION

V = 1/n x S^0.5x R^2/3

Q = VxA

RESULTS

Wetted Perimeter	WP =	3.33
Cross-Sectional Area	A =	0.36
Hydraulic Radius	R =	0.11
Velocity	V =	5.00

CHECK RESULTS

Flow rate (m^3/s)	Q=	1.79	**OK**