FLOOD DEPTHS TABLE			
NUMBER	MINIMUM DEPTH (m)	MAXIMUM DEPTH (m)	COLOUR
1	-0.50	0.00	
2	0.00	0.10	
3	0.10	0.50	
4	0.50	1.00	
5	1.00	1.50	
6	1.50	2.00	
7	2.00	3.00	
8	3.00	7.17	

REV	DATE	AMENDMENTS	CHECKED
#	#	#	#
#	#	#	#
#	#	#	#

Design: J CURTIS
Date: 15.03.2017
Check: N JULL
Job No: 11875

Subject: FLOOD RISK ASSESSMENT
Client: SF ESTATE LTD
Address: WARKWORTH NORTH
Drawing Title: 100 YEAR ED FLOOD EXTENTS PLAN

Drawing No: 901
Revision No: 0
Scale: 1:2500 @ A1
Issued for: RC

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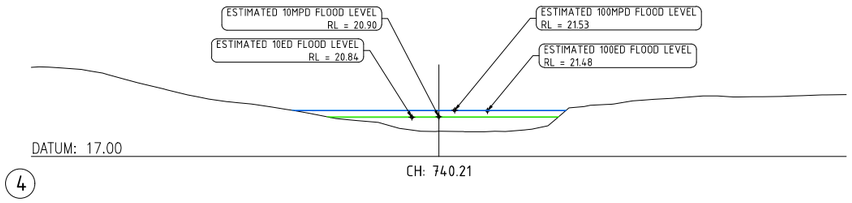

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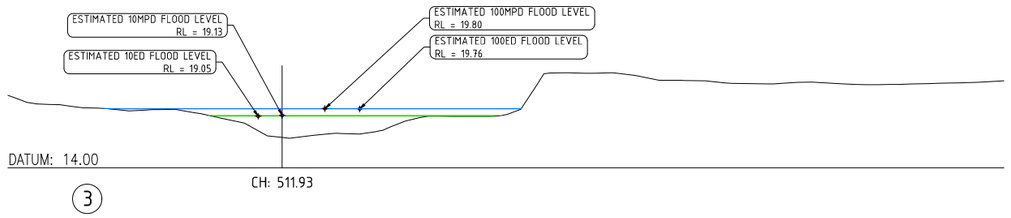

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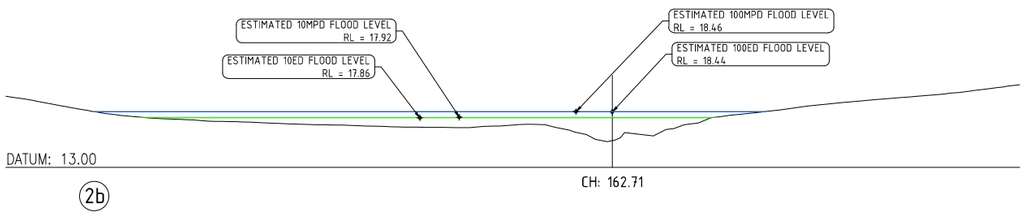

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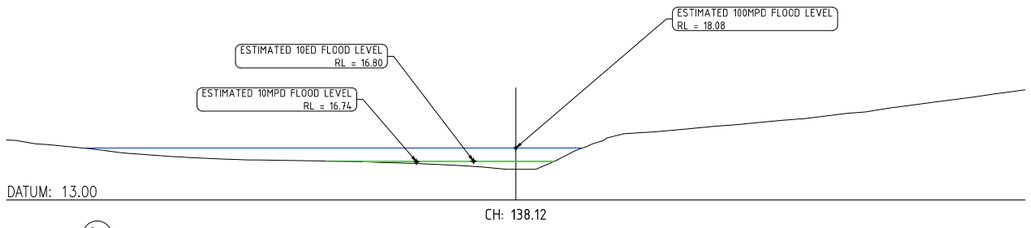

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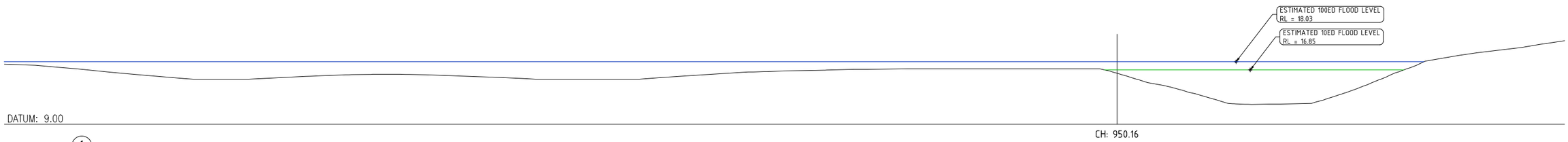

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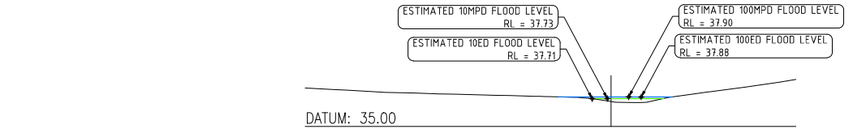

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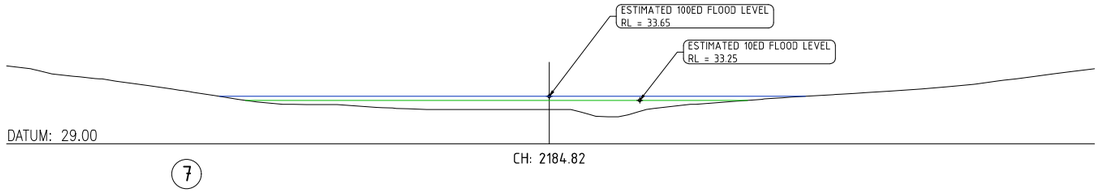

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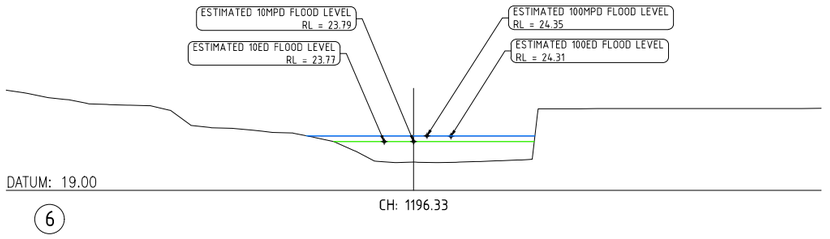

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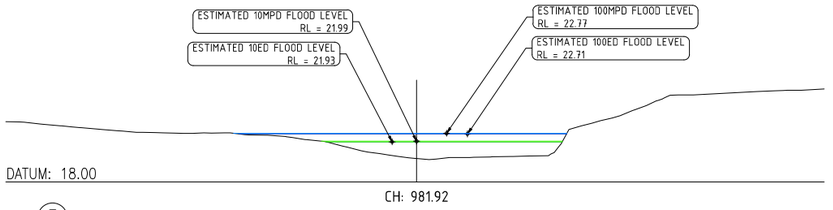

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#	#	#	#
#	#	#	#
#	#	#	#
REV	DATE	AMENDMENTS	CHECKED

Design: J CURTIS
Date: 15.03.2017
Check: N JULL
Job No: 11875

Subject: FLOOD RISK ASSESSMENT
Client: SF ESTATE LTD
Address: WARKWORTH NORTH
Drawing Title: FLOOD SECTIONS

Drawing No: 902
Revision No: 0
Scale: 1:300 @ A1
Issued for: RC

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Catchment Hydrological Summary

CATCH_ID	Area (ha)	Length (m)	Slope (m/m)	Imp Area (ha)	Perv Area (ha)	CN_Imp	CN_Perv	TC_IMP (min)	TC_PERV (min)	ED Peak Flow (m^3/s)	MPD Imp Area (ha)	MPD Perv Area (ha)	Increase IMP%	MPD Peak Flow (m^3/s)	Flow Increase %
MA01	1134.0	9600	0.005	56.7	1077.3	98	72.2	153.8	205.9	121.01				121.01	0%
MA02	218.1	3700	0.012	10.9	207.2	98	73.3	61.7	81.5	40.40				40.40	0%
MA03	2944.6	10800	0.010	147.2	2797.3	98	71.7	130.9	176.3	343.27				343.27	0%
MA04	41.3	900	0.044	4.1	37.1	98	74.0	16.4	21.5	14.78				14.78	0%
MA05	7.8	760	0.079	0.8	7.0	98	74.2	12.3	16.1	3.13				3.13	0%
MA06	106.6	1080	0.041	63.9	42.6	98	78.1	18.9	23.5	42.24				42.24	0%
MA07	2.8	340	0.148	0.1	2.7	98	73.3	10	10	1.27				1.27	0%
MA08	1.5	300	0.151	0.1	1.4	98	72.6	10	10	0.66				0.66	0%
MA09	1.4	220	0.134	0.1	1.4	98	72.2	10	10	0.64				0.64	0%
MA10	6.5	360	0.225	0.3	6.2	98	73.2	10	10	2.92				2.92	0%
MA11	23.8	480	0.161	3.6	20.3	98	72.6	10	10	10.84				10.84	0%
MA12	123.6	2000	0.033	61.8	61.8	98	77.0	30.3	38.3	38.83				38.83	0%
ST01	6.1	560	0.068	0.3	5.8	98	74.0	10.5	13.7	2.55	4.0	2.1	60.0	2.91	14%
ST02	3.0	220	0.159	0.3	2.7	98	74.0	10	10	1.38	2.0	1.1	55.0	1.52	10%
ST03	2.6	360	0.098	0.1	2.4	98	73.9	10	10	1.15	1.7	0.9	60.0	1.27	10%
ST04	2.1	200	0.063	0.1	2.0	98	73.8	10	10	0.97	1.4	0.7	60.0	1.04	8%
ST05	2.6	300	0.163	0.1	2.5	98	73.0	10	10	1.17	1.7	0.9	60.0	1.29	10%
ST06	2.0	280	0.146	0.1	1.9	98	73.6	10	10	0.92	1.3	0.7	60.0	1.00	10%
ST07	1.7	220	0.124	0.1	1.6	98	74.0	10	10	0.76	1.1	0.6	60.0	0.84	11%
ST08	1.8	260	0.126	0.1	1.7	98	74.0	10	10	0.83	1.2	0.6	60.0	0.89	8%
ST09	7.9	500	0.114	2.4	5.5	98	74.0	10	10.9	3.68	5.1	2.8	35.0	3.92	7%
ST10	1.3	220	0.137	0.1	1.2	98	74.0	10	10	0.60	0.9	0.5	60.0	0.67	12%
ST11	1.3	120	0.208	0.1	1.2	98	74.0	10	10	0.59	0.9	0.5	60.0	0.67	13%
ST12	5.0	480	0.085	3.0	2.0	98	74.0	10	11.6	2.46	3.3	1.8	5.0	2.50	2%
ST13	3.0	460	0.102	0.2	2.9	98	74.0	10	10.7	1.35	2.0	1.1	60.0	1.51	12%
ST14	0.6	100	0.117	0.0	0.5	98	74.0	10	10	0.26	0.4	0.2	60.0	0.28	10%
ST15	14.8	560	0.052	8.9	5.9	98	79.0	11.4	14.1	7.00	9.6	5.2	5.0	7.07	1%
ST16	5.9	480	0.078	0.3	5.6	98	73.2	10	12	2.53	3.8	2.1	60.0	2.89	14%
ST17	2.693	300	0.110	1.6	1.1	98	79.0	10	10	1.36	1.8	0.9	5.0	1.36	0%
ST18	4.9	480	0.101	0.2	4.7	98	74.0	10	11.1	2.19	3.2	1.7	60.0	2.43	11%
ST19	3.568	300	0.123	2.1	1.4	98	79.0	10	10	1.80	2.3	1.2	5.0	1.81	1%
ST20	4.6	500	0.090	0.2	4.4	98	74.0	10	11.7	2.02	3.0	1.6	60.0	2.26	12%
ST21	24.5	900	0.023	9.8	14.7	98	75.7	19.8	25.5	8.92	13.4	11.0	14.9	9.24	4%
ST22	43.9	1300	0.033	2.2	41.7	98	74.0	22.7	29.8	13.55	5.6	38.3	7.8	13.82	2%
ST23	92.4	1700	0.010	4.6	87.8	98	73.9	38.8	51	22.09	29.6	62.8	27.0	23.76	8%
ST24	6.0	280	0.087	0.3	5.7	98	74.0	10	10	2.71	3.9	2.1	60.0	2.98	10%
ST25	6.1	320	0.076	0.3	5.8	98	72.9	10	10	2.72				2.72	0%
TOTAL	4862.4									705.53				710.65	1%

Notes:

Forested areas digitised on GIS and areas calculated from an intersect with the subcatchments

Impervious Areas for urban areas assumed 60%. Where less an adjustment has been made based on a visual assessment of the aerial imagery.

Impervious areas for rural areas have been set at a minimum value of 5%. Where higher an adjustment has been made based on a visual assessment of the aerial imagery.

Lawn areas and Pasture areas make up the remaining portions of the subcatchments. The proportions have been assumed based on a visual assessment.

Hydraulic Model Results Summary

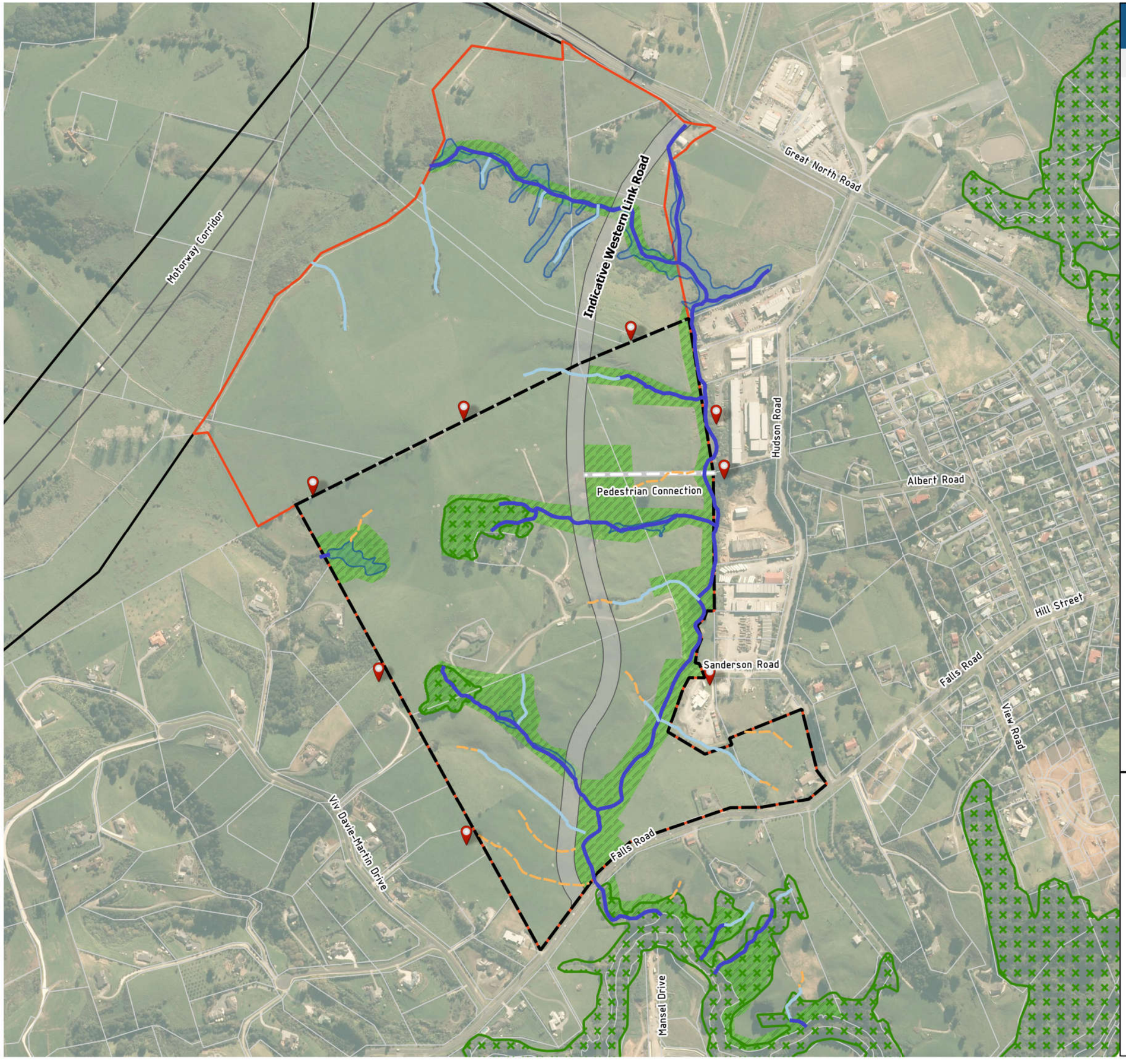
SECTION NO.	CHAINAGE	100ED Q m³/s	100MPD Q m³/s	100ED WL	100MPD WL	± 100 year	100ED Width	100MPD Width	± 100 year	10ED Q m³/s	10MPD Q m³/s	10ED WL	10MPD WL	± 10 year	10ED Width	10MPD Width	± 10 year
1	950.16	511.03	511.12	18.03	18.03	0	243.42	243.44	0.02	253.52	253.79	16.85	16.85	0	151.22	151.29	0.07
2a	138.12	71.64	74.88	18.08	18.08	0	48.87	48.85	-0.02	32.23	35.13	16.8	16.74	-0.06	22.10	18.66	-3.44
2b	162.71	71.64	74.88	18.44	18.46	0.02	65.54	65.86	0.32	32.23	35.13	17.86	17.92	0.06	55.46	56.55	1.09
3	511.93	70.64	73.83	19.76	19.8	0.04	40.37	40.81	0.44	32.02	34.55	19.05	19.13	0.08	26.11	28.72	2.61
4	740.21	70.64	73.83	21.48	21.53	0.05	26.60	26.94	0.34	32.02	34.55	20.84	20.9	0.06	22.43	22.79	0.36
5	981.92	69.34	72.39	22.71	22.77	0.06	32.17	32.72	0.55	31.8	33.71	21.93	21.99	0.06	23.19	23.65	0.46
6	1196.33	67	69.82	24.31	24.35	0.04	22.27	22.46	0.19	31.37	32.31	23.77	23.79	0.02	19.65	19.69	0.04
7	2184.82	60.89	60.87	33.65	33.65	0	57.52	57.52	0	20.72	28.8	33.25	33.25	0	49.17	49.20	0.03
8	2772.43	5.43	5.7	37.88	37.9	0.02	10.26	11.23	0.97	2.74	3.02	37.71	37.73	0.02	6.77	7.01	0.24

Culvert Data	Culvert Q m³/s	Weir Q m³/s	Velocity	US Elevation
100ED	22.1	49.54	2.21	18.41
100MPD	22.84	52.04	2.28	18.46
± 100 year	0.74	2.5	0.07	0.05
10ED	23.94	8.29	3.61	17.88
10MPD	24.8	10.33	3.65	17.94
± 10 year	0.86	2.04	0.04	0.06
100ED 90% Blocked	1.98	69.66	1.98	18.66
100MPD 90% Blocked	2.01	72.87	2.01	18.68
± 100 year	0.03	3.21	0.03	0.02

Proposed Warkworth North Plan Change

Date: 18/01/2019

Precinct Plan 1 - Warkworth North Precinct Plan



- Precinct - Warkworth North
- Sub-Precinct - Stubbs Farm Development Area
- Potential Future Road Connection
- Future Pedestrian Connection
- Significant Ecological Area (SEA)
- Indicative Open Space
- Land Parcels

Stream Classifications

- Permanent Stream
- Intermittent Stream
- Ephemeral Stream
- Wetlands

Proposed Zones

- Residential - Mixed Housing Urban Zone
- Business - Neighbourhood Centre Zone
- Residential - Single House Zone
- Residential - Mixed Housing Suburban Zone
- Business - Light Industry Zone
- Business - General Business Zone
- Future Urban Zone

N

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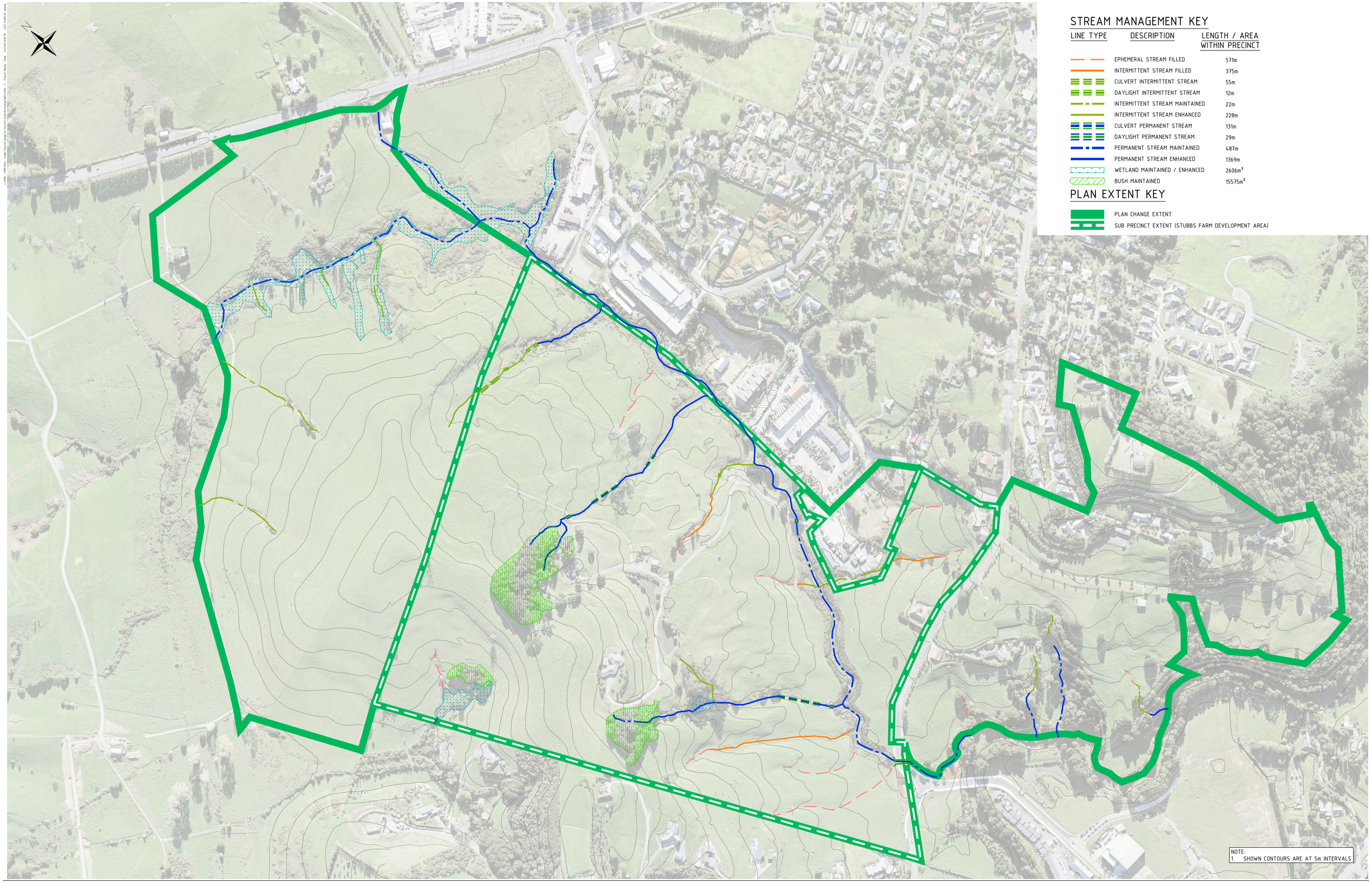
REVISION	DATE	COMMENT	CHECK
3	15/10/2018	SEA AREAS	NJ
4	15/11/2018	ZONE BOUNDARIES	NJ
5	20/12/2018	ZONE BOUNDARIES	NJ
6	11/01/2019	NEIGHBOURHOOD ZONE	NJ
7	18/01/2019	ZONE BOUNDARIES	NJ

100 0 100 200 300 400 m



STREAM MANAGEMENT KEY

LINE TYPE	DESCRIPTION	LENGTH / AREA WITHIN PRECINCT
	EPHEMERAL STREAM FILLED	571m
	INTERMITTENT STREAM FILLED	375m
	CULVERT INTERMITTENT STREAM	55m
	DAYLIGHT INTERMITTENT STREAM	12m
	INTERMITTENT STREAM MAINTAINED	22m
	INTERMITTENT STREAM ENHANCED	228m
	CULVERT PERMANENT STREAM	131m
	DAYLIGHT PERMANENT STREAM	29m
	PERMANENT STREAM MAINTAINED	487m
	PERMANENT STREAM ENHANCED	1369m
	WETLAND MAINTAINED / ENHANCED	2606m^2
	BUSH MAINTAINED	15575m^2

PLAN EXTENT KEY

- PLAN CHANGE EXTENT
- SUB PRECINCT EXTENT (STUBBS FARM DEVELOPMENT AREA)

NOTE:
1. SHOWN CONTOURS ARE AT 5m INTERVALS

REV	DATE	AMENDMENTS	CHECKED
3	03.05.2019	BDY CHANGE (MASON)	A. SCHUNKE
2	16.01.2019	SUB-PRECINCT EXTENT	N. JULL
1	16.10.2018	TITLES UPDATED	N. JULL

Design:	NJ
Date:	16.10.2018
Check:	SR
Job No:	11875

Subject:	PROPOSED WARKWORTH NORTH PLAN CHANGE
Client:	TURNSTONE CAPITAL LP - (WARKWORTH NORTH)
Address:	NORTH WARKWORTH
Drawing Title:	PRECINCT PLAN 2: WARKWORTH NORTH SWCMP - STREAMS

Drawing No:	402
Revision No:	2
Scale:	1:2500 @ A1
Issued for:	PLANNING

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CATCHMENT G
AREA: 0.6ha

CATCHMENT F
AREA: 4.4ha

CATCHMENT E
AREA: 3.8ha

CATCHMENT H
AREA: 2.8ha

CATCHMENT I
AREA: 2.6ha

CATCHMENT C
AREA: 4.4ha

CATCHMENT D
AREA: 2.7ha

CATCHMENT B
AREA: 3.1ha

CATCHMENT A
AREA: 7.8ha

CATCHMENT J
AREA: 5.4ha

DEVICE F
DEVICE E
DEVICE H
DEVICE C
DEVICE D
DEVICE A
DEVICE J

STREAM MANAGEMENT KEY

LINE TYPE	DESCRIPTION	LENGTH / AREA WITHIN PRECINCT
	EPHEMERAL STREAM FILLED	571m
	INTERMITTENT STREAM FILLED	375m
	CULVERT INTERMITTENT STREAM	55m
	DAYLIGHT INTERMITTENT STREAM	12m
	INTERMITTENT STREAM MAINTAINED	22m
	INTERMITTENT STREAM ENHANCED	228m
	CULVERT PERMANENT STREAM	131m
	DAYLIGHT PERMANENT STREAM	29m
	PERMANENT STREAM MAINTAINED	487m
	PERMANENT STREAM ENHANCED	1369m
	WETLAND MAINTAINED / ENHANCED	2606m^2
	BUSH MAINTAINED	15575m^2

PLAN EXTENT KEY

- PLAN CHANGE EXTENT
- SUB PRECINCT EXTENT (STUBBS FARM DEVELOPMENT AREA)

STORMWATER MANAGEMENT KEY

- STORMWATER SUB-CATCHMENT
- INDICATIVE ROAD WITH FULL QUALITY TREATMENT / SECONDARY FLOW CONVEYANCE
- INDICATIVE ROAD WITH PARTIAL QUALITY TREATMENT / SECONDARY FLOW CONVEYANCE
- INDICATIVE RETICULATED STORMWATER OUTFALL LOCATION
- INDICATIVE DRY BASIN LOCATION (DEVICE NAME CORRESPONDS WITH CATCHMENT)

NOTE:
CATCHMENTS B, G AND I WILL HAVE FULL AT SOURCE FLOW CONTROL AND DISCHARGE DIRECTLY TO THE STREAM WITH COMPLIANT EROSION CONTROL.

REV	DATE	AMENDMENTS	CHECKED
3	03.05.2019	BDY CHANGE (MASON)	A. SCHUNKE
2	16.01.2019	SUB-PRECINCT EXTENT	N. JULL
1	16.10.2018	TITLES UPDATED	N. JULL

Design: NJ
Date: 16.10.2018
Check: SR
Job No: 11875

Subject: PROPOSED WARKWORTH NORTH PLAN CHANGE
Client: TURNSTONE CAPITAL LP - (WARKWORTH NORTH)
Address: NORTH WARKWORTH
Drawing Title: PRECINCT PLAN 2 - WARKWORTH NORTH SWCMP - Sub-precinct A (1 OF 2)

Drawing No: 403
Revision No: 2
Scale: 1:1500 @ A1
Issued for: PLANNING

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CATCHMENT G
AREA: 0.6ha

CATCHMENT F
AREA: 4.4ha

CATCHMENT E
AREA: 3.8ha

CATCHMENT H
AREA: 2.8ha

CATCHMENT I
AREA: 2.6ha

CATCHMENT C
AREA: 4.4ha

CATCHMENT D
AREA: 2.7ha

CATCHMENT B
AREA: 3.1ha

CATCHMENT A
AREA: 7.8ha

CATCHMENT J
AREA: 5.4ha

DEVICE F
DEVICE E
DEVICE H
DEVICE C
DEVICE D
DEVICE A
DEVICE J

STREAM MANAGEMENT KEY

LINE TYPE	DESCRIPTION	LENGTH / AREA WITHIN PRECINCT
	EPHEMERAL STREAM FILLED	571m
	INTERMITTENT STREAM FILLED	375m
	CULVERT INTERMITTENT STREAM	55m
	DAYLIGHT INTERMITTENT STREAM	12m
	INTERMITTENT STREAM MAINTAINED	22m
	INTERMITTENT STREAM ENHANCED	228m
	CULVERT PERMANENT STREAM	131m
	DAYLIGHT PERMANENT STREAM	29m
	PERMANENT STREAM MAINTAINED	487m
	PERMANENT STREAM ENHANCED	1369m
	WETLAND MAINTAINED / ENHANCED	2606m²
	BUSH MAINTAINED	15575m²

PLAN EXTENT KEY

PLAN CHANGE EXTENT
SUB PRECINCT EXTENT (STUBBS FARM DEVELOPMENT AREA)

STORMWATER MANAGEMENT KEY

STORMWATER SUB-CATCHMENT
INDICATIVE ROAD WITH FULL QUALITY TREATMENT / SECONDARY FLOW CONVEYANCE
INDICATIVE ROAD WITH PARTIAL QUALITY TREATMENT / SECONDARY FLOW CONVEYANCE
INDICATIVE RETICULATED STORMWATER OUTFALL LOCATION
INDICATIVE DRY BASIN LOCATION (DEVICE NAME CORRESPONDS WITH CATCHMENT)

NOTE:
CATCHMENTS B, G AND I WILL HAVE FULL AT SOURCE FLOW CONTROL AND DISCHARGE DIRECTLY TO THE STREAM WITH COMPLIANT EROSION CONTROL.

NOTE:
1. SHOWN CONTOURS ARE AT 5m INTERVALS

REV	DATE	AMENDMENTS	CHECKED
3	03.05.2019	BDY CHANGE (MASON)	A. SCHUNKE
2	16.01.2019	SUB-PRECINCT EXTENT	N. JULL
1	16.10.2018	TITLES UPDATED	N. JULL

Design: NJ
Date: 16.10.2018
Check: SR
Job No: 11875

Subject: PROPOSED WARKWORTH NORTH PLAN CHANGE
Client: TURNSTONE CAPITAL LP - (WARKWORTH NORTH)
Address: NORTH WARKWORTH
Drawing Title: PRECINCT PLAN 2 - WARKWORTH NORTH SWCMP - Sub-precinct A (2 OF 2)

Drawing No: 404
Revision No: 2
Scale: 1:1500 @ A1
Issued for: PLANNING

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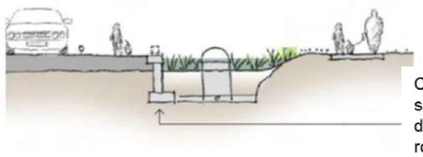
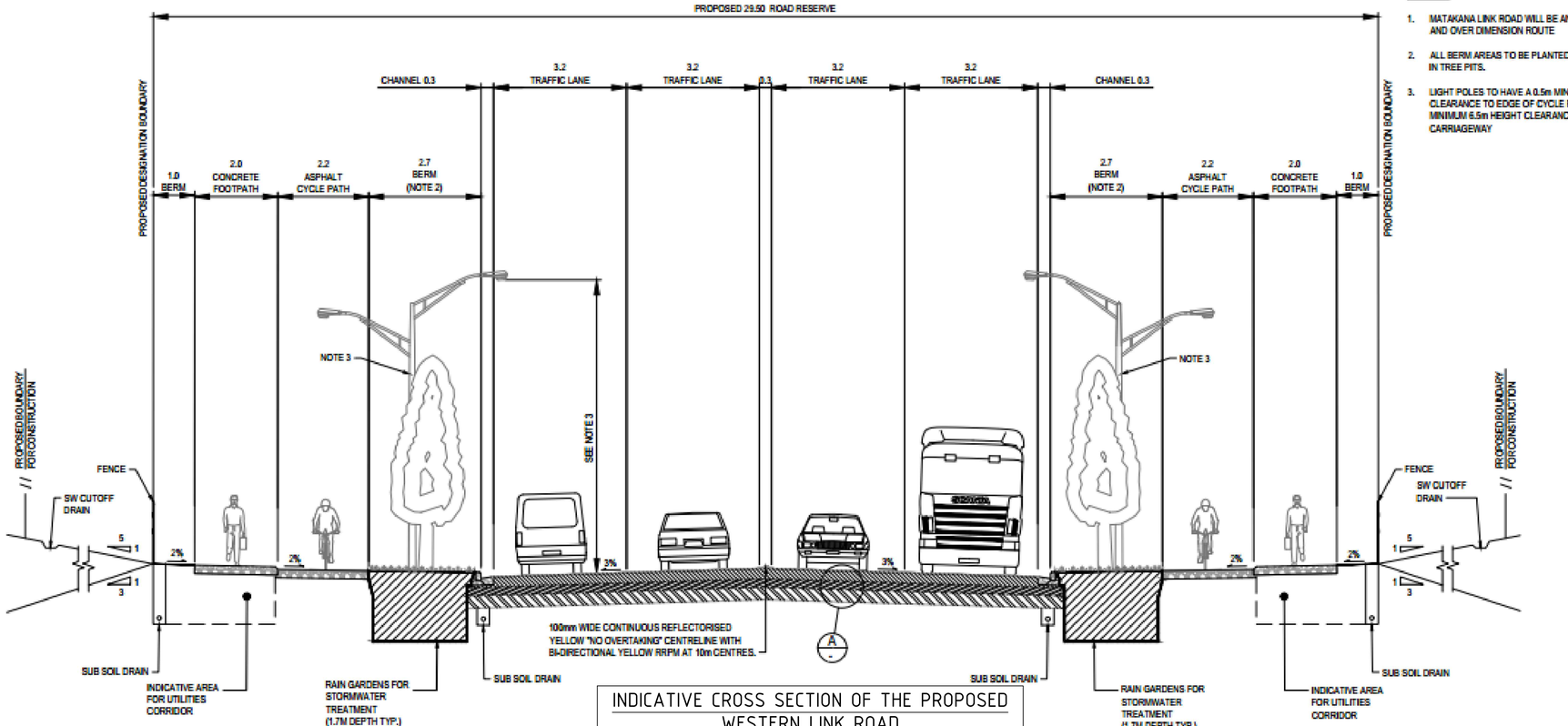


Concrete wall to support side of device if adjacent to road

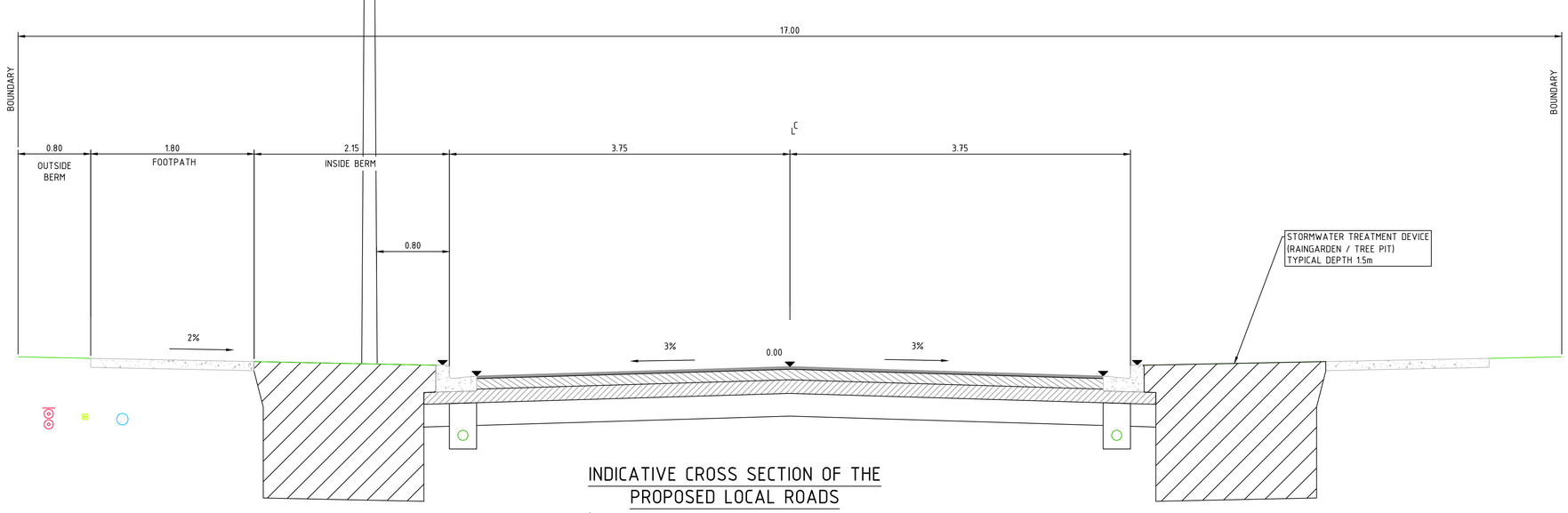
DEVICE ADJACENT TO ROAD
EXAMPLE FROM GD01



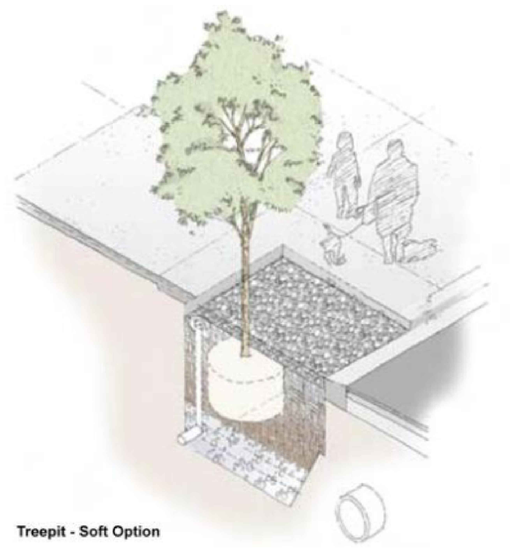
INDICATIVE CROSS SECTION OF THE PROPOSED WESTERN LINK ROAD
(ACTUAL CROSS SECTION OF MATAKANA LINK ROAD PREPARED BY JACOBS)

NOTES:

1. MATAKANA LINK ROAD WILL BE AN OVERWEIGHT AND OVER DIMENSION ROUTE
2. ALL BERM AREAS TO BE PLANTED WITH TREES IN TREE PITS.
3. LIGHT POLES TO HAVE A 0.5m MINIMUM CLEARANCE TO EDGE OF CYCLE PATH AND MINIMUM 6.5m HEIGHT CLEARANCE TO CARRIAGEWAY



INDICATIVE CROSS SECTION OF THE PROPOSED LOCAL ROADS
(PROVIDED AS AN EXAMPLE OF HOW STORMWATER CAN BE MANAGED WITHIN THE 17m WIDER ROAD CORRIDORS)



TREE PIT EXAMPLE FROM GD01

REV	DATE	AMENDMENTS	CHECKED
3	03.05.2019	BDY CHANGE (MASON)	A. SCHUNKE
2	16.01.2019	SUB-PRECINCT EXTENT	N. JULL
1	16.10.2018	TITLES UPDATED	N. JULL

Design:	NJ
Date:	16.10.2018
Check:	SR
Job No:	11875

Subject:	PROPOSED WARKWORTH NORTH PLAN CHANGE
Client:	TURNSTONE CAPITAL LP - (WARKWORTH NORTH)
Address:	NORTH WARKWORTH
Drawing Title:	PRECINCT PLAN 3 - ROAD SECTIONS AND ROAD STORMWATER MANAGMENT

Drawing No:	405
Revision No:	2
Scale:	NTS
Issued for:	PLANNING

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15 June 2017

Healthy Waters
Auckland Council
Private Bag 92300
Auckland 1142

Dear Sir or Madam,

Subject: Further information requested under clause 23 First Schedule of the Resource Management Act 1991

The following information is provided in response to the clause 23 request received on the 30 April 2018.

Appendix 2:

 # 14

Confirm the flood modelling undertaken by Chesters is consistent with the Mahurangi Catchment 2017 model outputs prepared by Council.

The flood modelling undertaken by Chester was prepared for the purposes of developing the structure plan in the absence of detailed model results from Auckland Council, which were not available when the project commenced. Chester's model results have been discussed with Ken Tomkins and Kevin Fan of Healthy Waters and it was accepted that the outputs were comparable with Council's Mahurangi Catchment model.

Chester confirms that the applicant is willing to adopt the results and outputs of the Mahurangi Catchment modelling completed by Auckland Council in 2017 (flood extents, modelled peak flows etc.) for subsequent design and consenting purposes.

Appendix 3: Advisory Notes

#36

There is an updated flood model available from council for the Mahurangi Catchment. (Mahurangi Catchment 2017). An offer was made to the applicant last year to access this model to inform their SMP.

As above, the project team will adopt the recent modelling data supplied by Healthy Waters for all subsequent design and consenting purposes.

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#47

Provide an assessment of the impact of post-development flood flows in Stubbs Stream on the frequency (if any) of stormwater overtopping of Falls Road for up to a 10 year storm event.

Following a meeting between Healthy Waters and Chester personnel it was agreed that Chester would update their existing hydrological model to assess the differences between the existing development (ED) and maximum probable development (MPD) scenario for the Stubbs Stream Catchment, including an assessment of the effects of peak flow mitigation measures applied to sub-catchments within the Structure Plan area. The 2 year, 5 year, 10 year and 20 year annual recurrence interval rainfall events were assessed.

Healthy Waters provided time series flow extracts from the wider Mahurangi Catchment model, to account for the spill from the Mahurangi River Catchment into the Stubbs Farm Stream catchment. The time series input was included in the Chester Hydrological model as a manual discharge gauge input.

The outputs from the hydrological model are summarised in Table 1.
In all cases the MPD peak flows are significantly larger than the corresponding peak flows from the ED scenario, due to the combined effect of increased rainfall due to climate change and increased impervious coverage in the catchment.

Table 1: Peak Flow Comparisons Upstream of Falls Road Bridge

Model Scenario	Peak Flow (m^3/s)	Time
2yr ARI ED	14.41	12:43
2yr ARI MPD	20.86	12:43
2yr ARI MPD with Mitigation	21.11	12:29
5yr ARI ED	21.63	12:53
5yr ARI MPD	31	12:37
5yr ARI MPD with Mitigation	30.06	12:30
10yr ARI ED	27.52	12:47
10yr ARI MPD	39.26	14:59
10yr ARI MPD with Mitigation	39.31	14:59
20yr ARI ED	35.37	15:06
20yr ARI MPD	53.47	14:48
20yr ARI MPD with Mitigation	53.47	14:48

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The peak flow hydrograph at the Falls Road Bridge displays a distinctive double peak in all the modelled scenarios, the peak flow hydrograph for the 10 year ARI event is depicted in Figure 1. The first peak arriving at the falls road bridge corresponds to flows from the Stubbs Farm Structure Plan area and from catchments to the north east of State Highway 1 which also contribute to Stubbs Farm Stream. The second peak occurs much later and corresponds to flows spilling from the much larger Mahurangi River Catchment. The peak from the Mahurangi River Catchment is delayed due to the size of the contributing catchments and extended time of concentration.

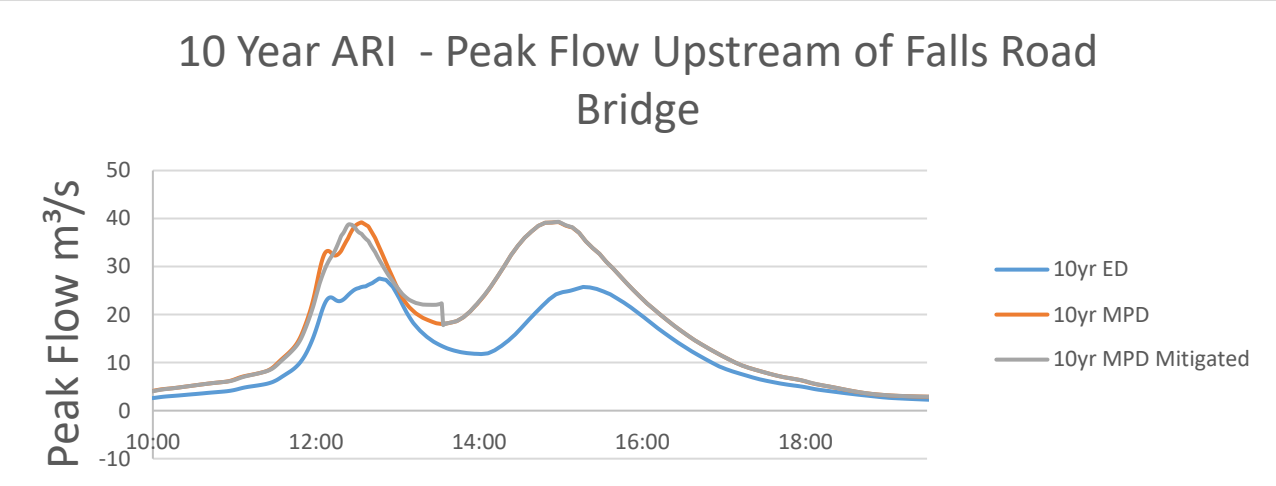

Figure 1: Peak Flow Hydrograph Upstream of Falls Road Bridge for 10 Year ARI

The maximum peak flow of the smaller rainfall events (2 year and 5 year ARI) is dictated by flows from the Stubbs Farm Stream Catchment, where the magnitude of flows spilling from the Mahurangi River Catchment is less. In the 10 and 20 year ARI events the maximum peak flow is dictated by the large volume of water spilling from the Mahurangi River Catchment.

Falls Road Bridge

A model of the Falls Road Bridge was built using the Federal Highway Administration's HY8 culvert analysis software in order to estimate the capacity of the bridge and the frequency of overtopping events.

A summary of the bridge/culvert analysis results are provided in Table 2.

The estimated capacity of the falls road bridge before overtopping is 23.13 m³/s. Utilising this capacity and the peak discharge rates from Chester's Hydrological model provided in Table 1 it is predicted that the falls road bridge has sufficient capacity to convey flows from the 2 year ED and MPD storms and the 5 year ED storm. For all other modelled storms exceeding the 5 year ED storm the Falls Road Bridge is expected to overtop.

Table 2: Summary of HY8 bridge/culvert analysis.

Model Scenario	Peak Flow (m^3/s)	Time	Headwater Elevation (m)	Culvert Discharge (m^3/s)	Roadway Discharge (m^3/s)
2yr ARI ED	14.41	12:43	16.54	14.41	0
2yr ARI MPD	20.86	12:43	16.97	20.86	0
2yr ARI MPD with Mitigation	21.11	12:29	16.99	21.11	0
5yr ARI ED	21.63	12:53	17.02	21.63	0
5yr ARI MPD	31	12:37	17.36	26.63	4.36
5yr ARI MPD with Mitigation	30.06	12:30	17.34	26.37	3.68
10yr ARI ED	27.52	12:47	17.28	25.54	1.97
10yr ARI MPD	39.26	14:59	17.49	28.46	10.79
10yr ARI MPD with Mitigation	39.31	14:59	17.49	28.46	10.82
20yr ARI ED	35.37	15:06	17.43	27.68	7.68
20yr ARI MPD	53.47	14:48	17.65	30.64	22.82
20yr ARI MPD with Mitigation	53.47	14:48	17.65	30.64	22.82

Hydrological Mitigation within the Stubbs Farm Development Area

Mitigation was assessed in the updated Chester Hydrological model by limiting the post development discharge from each sub-catchment in the model to never exceed pre-development levels using a storage-discharge restriction. The effect of hydrology on the peak flows upstream of Falls Road Bridge was variable across the 4 rainfall events modelled.

When applied to the 2 year rainfall event, mitigation measures resulted in an increased peak flow upstream of the Falls Road Bridge. Hydrological mitigation detains peak flows for an extended period, decreasing the magnitude but increasing the duration of the peak. The model results for the 2 year storm scenario suggest that despite the reduction in peak flows, the increased duration allows for the peaks from a larger number of sub-catchments to coincide resulting in a slight increase in flow upstream of the Stubbs Farm Bridge.

When applied to the 5 year rainfall event, mitigation measures resulted in a slight decrease in peak flow upstream of the Falls Road Bridge approximately 3%.

When applied to the 10 year and 20 year rainfall events, mitigation measures have a negligible effect as MPD flows through the Stubbs Farm Stream are dictated by flows from the Mahurangi River.

Runoff hydrographs from each of the modelled storm events are appended to this document.

Based on the results of the assessment undertaken it is our opinion that peak flow mitigation within the Stubbs Farm Development Area has limited potential to reduce peak flows upstream of the Falls Road Bridge and in some storm events may actually increase peak flows at the Falls Road Bridge by extending the duration of peak flows allowing for peak flows from a larger number of sub-catchments to coincide. We would not recommend that peak flow mitigation be a condition of development within the Stubbs Farm Development Area.

We trust that the information provided is sufficient to satisfy the request for information.

Warm regards,

Jordan Curtis
Civil Engineer

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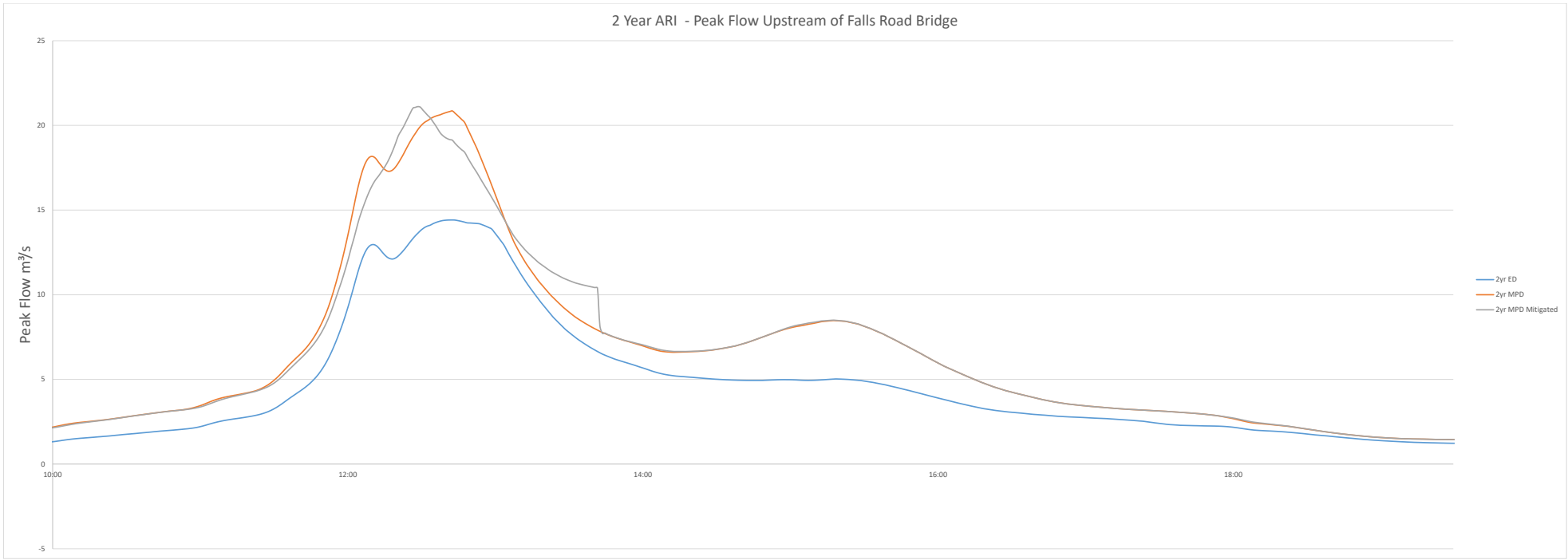
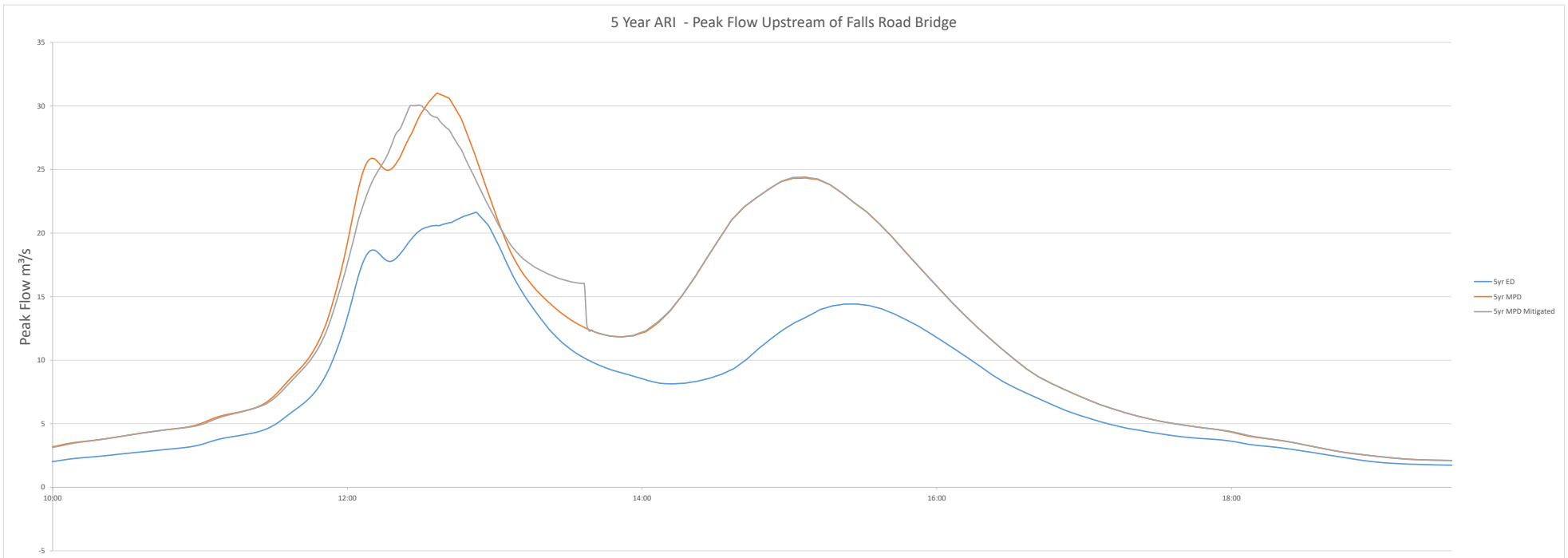
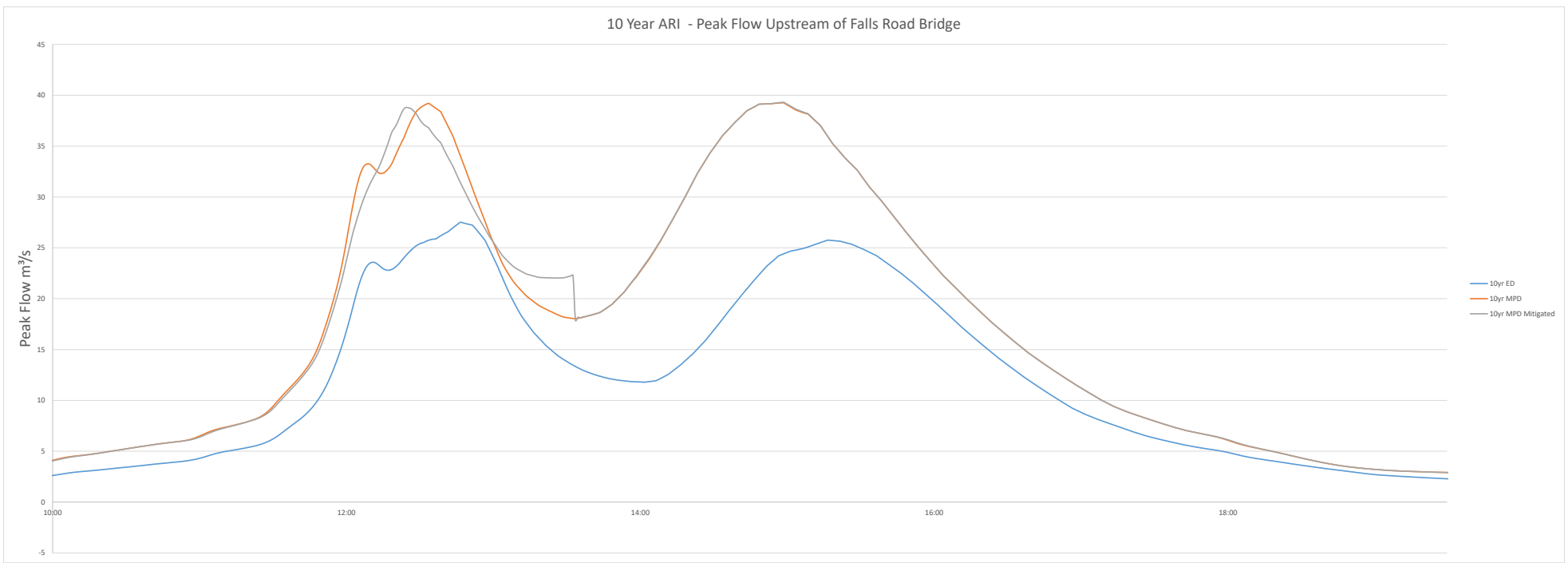
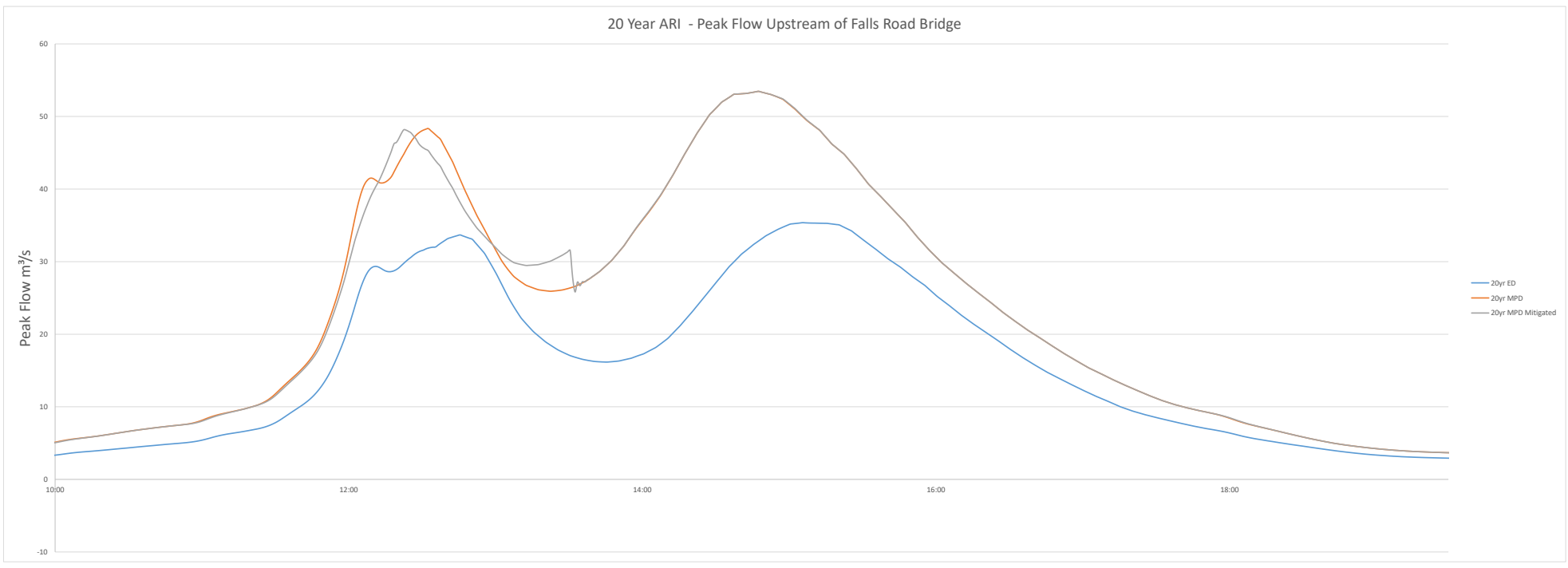

2 Year ARI - Peak Flow Upstream of Falls Road Bridge
Peak Flow m³/s
25
20
15
10
5
0
-5
10:00
12:00
14:00
16:00
18:00
2yr ED
2yr MPD
2yr MPD Mitigated


5 Year ARI - Peak Flow Upstream of Falls Road Bridge
Peak Flow m³/s
35
30
25
20
15
10
5
0
-5
10:00
12:00
14:00
16:00
18:00
5yr ED
5yr MPD
5yr MPD Mitigated


10 Year ARI - Peak Flow Upstream of Falls Road Bridge
Peak Flow m³/s
45
40
35
30
25
20
15
10
5
0
-5
10:00
12:00
14:00
16:00
18:00
10yr ED
10yr MPD
10yr MPD Mitigated


20 Year ARI - Peak Flow Upstream of Falls Road Bridge
Peak Flow m³/s
60
50
40
30
20
10
0
-10
10:00
12:00
14:00
16:00
18:00
20yr ED
20yr MPD
20yr MPD Mitigated

APPENDIX D: WATER SUPPLY SERVICING PLAN

PROPOSED DEVELOPMENT CUMULATIVE DAILY WATER DEMAND VOLUME OVER TIME				
STAGE	CUMULATIVE LOTS	AVERAGE DAILY WATER DEMAND (m^3)	PEAK DAILY WATER DEMAND (m^3)	224c TIMING
STAGE 1 (FALLS ROAD)	50	38	75	MARCH 2020
STAGE 2 TO 7	1060+	1188	1833	2022 ONWARDS

CALCULATIONS USE THE FOLLOWING AS PER WSL COP;

No. PEOPLE PER DWELLING:	3
AVERAGE DAILY WATER DEMAND:	250l/p/d
DAILY PEAKING FACTOR:	2
BUSINESS ZONE WATER DEMAND:	17,500l/ha/d
LAND TO LOT RATIO:	10.2/ha (PROPOSED LOTS/SITE AREA)

STRUCTURE PLAN EXTENT

SANDERSON ROAD BORE AND FUTURE TREATMENT SITE

EXISTING BULK WATER MAIN

WARKWORTH WATER TREATMENT PLANT

VIEW ROAD WATER RESERVOIR RL: 86.0m

Great North Road

Cemetery Road

Woodcocks Road

Falls

Auckland Road

REV	DATE	AMENDMENTS	CHECKED
4	18.01.2019	ZONING	NJ
3	07.03.2018	STAGE TIMING	NJ
2	14.02.2018	STAGE TIMING	NJ

Design:	NJ
Date:	18/01/2019
Check:	–
Job No:	11875

Subject:	CIVIL DESIGN – STRUCTURE PLAN
Client:	SF ESTATE LTD
Address:	WARKWORTH NORTH
Drawing Title:	WATER SUPPLY – EXISTING NETWORK OVERVIEW

Drawing No:	500
Revision No:	4
Scale:	1:5000 @ A1
Issued for:	COMMENT

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