TECHNICAL NOTE

Job Name: Grundon Services Ltd. Merton Street, Banbury

Job No: 49730/4001

Note No: TN001

Date: July 2020

Prepared By: E Edney

Subject: **Surface Water Drainage Strategy & Pro-forma for planning reference 16/00472/OUT**

1. Introduction

1.1. An outline planning application was submitted to Cherwell District Council for the re-development of the Grundon site on Merton Street in Banbury to provide up to 200 residential units (planning reference 16/00472/OUT).

1.2. A Flood Risk Assessment (FRA) report was prepared by Stantec (formerly Peter Brett Associates (PBA)) in October 2017 to support the planning application (ref. *33390/4001 Rev A*) which provided outline details of surface water runoff rates and attenuation storage volumes for the site.

1.3. Oxfordshire County Council's (OxCC) Lead Local Flood Authority (LLFA) consultee response datesd December 2017 raised comments on the surface water drainage strategy, notably the location of the existing watercourse in relation to the site and the feasibility of infiltration drainage. Stantec provided a response to this in January 2018.

1.4. Further to the above, OxCC have requested completion of their LLFA surface water drainage pro-forma. The pro-forma has been completed as far as possible given the outline nature of the planning application (see **Appendix TN001-A**).

1.5. It should also be noted that the FRA report was written before the introduction of the surface water drainage guidance by OxCC in November 2018 and therefore was prepared based on the latest guidance at the time.

1.6. This Note sets out the surface water drainage principles for the proposed development below and re-iterates elements of the 2018 Stantec response.

2. Surface Water Drainage Strategy

2.1. The proposed surface water drainage strategy is shown in outline on the attached sketch in **Appendix TN001-B**. The sketch shows the proposed surface water drainage route through the site via lined permeable paving beneath the parking and access areas/access road, with an outfall proposed in the southern corner of the site to the existing drainage channel.

2.2. The impermeable area will be reduced post development so there will be a reduction in runoff rates and volumes before SuDS mitigation is considered.

2.3. The runoff rates were based on best practice at the time (i.e. minimum runoff rate limit of 5 l/s) however a complex control can be used to limit the runoff rate for each storm event to the equivalent greenfield runoff rate. This will be considered at the detailed application stage.

2.4. The pro-forma states that a runoff coefficient (Cv) of 1 should be used in the sizing of attenuation storage. MicroDrainage uses a default Cv of 0.75 for summer and 0.84 for winter storms. This is considered appropriate as permeable pavements are being utilised and therefore runoff is slowed as it is being filtered through the block paving and slowly filtrates through the sub-base rather than flowing across impermeable tarmac.

2.5. The MicroDrainage results in **Appendix TN001-B** show no flooding of the surface water drainage system up to and including the 1 in 100 annual probability +30% allowance for climate change rainfall event. It is noted within the pro-forma that the +40% allowance for climate change is requested and this can be reviewed at the detailed application stage.

2.6. Rainwater harvesting and open green features such as swales have not been considered that this outline stage due to space constraints along the side of the access road and the requirement of a sound bund between the site and the railway line to the south. However, as the masterplan is developed for the detailed planning stage, swales or other 'green' features may be considered within the landscaped areas. Rainwater harvesting may also be considered at this stage.

3. Conclusion

3.1. In conclusion, the surface water drainage has been assessed for the site based on discharging to watercourse and the sections above demonstrates that there is feasible solution.

3.2. Further intrusive testing will be undertaken to review the feasibility of infiltration drainage at the site so there is scope to reduce the runoff from the site further.

3.3. The suitability of different SuDS techniques, notably swales and open features within the site will be reviewed during the detailed application stage/masterplan development.

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Reviewed	Approved
49730/4001/TN001	-	30.07.20	E Edney	R Fisher	pp. R Fisher

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TECHNICAL NOTE

Appendix TN002-A

Oxfordshire County Council Surface Water Drainage Proforma

SuDS Flows and Volumes - LLFA Technical Assessment Pro-forma

This form identifies the information required by Oxfordshire County Council LLFA to enable technical assessment of flows and volumes determined as part of drainage I SuDS *calculations.*

Note : means delete as appropriate; Numbers in brackets refer to accompanying notes.*

TO BE READ IN CONJUNCTION WITH REPORTS 33390/4001 REV A & 49730/4001/TN001

SITE DETAILS

1.1	Planning application reference	16/00472/OUT
1.2	Site name	Grundon Services Ltd. Merton Street, Banbury
1.3	Total application site area (1	30,500 m² / 3.05 ha
1.4	Is the site located in a CDA or LFRZ	Y/N
1.5	Is the site located in a SPZ	Y/N

VOLUME AND FLOW DESIGN INPUTS

2.1	Site area which is positively drained by SuDS (2	16,000 m²
2.2	Impermeable area drained pre development (3	19,800 m²
2.3	Impermeable area drained post development (3)	16,000 m²
2.4	Additional impermeable area (2.3 minus 2.2)	-3,800 m²
2.5	Predevelopment use (4	Greenfield / Brownfield / Mixed*
2.6	Method of discharge (5	Infiltration / waterbody / storm sewer/ combined sewer*
2.7	Infiltration rate (where applicable)	N/A m/hr
2.8	Influencing factors on infiltration	
2.9	Depth to highest known ground water table	N/A mAOD
2.10	Coefficient of runoff (Cv) (6	0.74-0.84 - see 49730/TN001 for justification
2.11	Justification for Cv used	Permeable pavements to be used across majority of paved areas
2.12	FEH rainfall data used (Note that FSR is no longer the preferred rainfall calculation method)	Y/N
2.13	Will storage be subject to surcharge by elevated water levels in watercourse/ sewer	Y/N
2.14	Invert level at outlet (invert level of final flow control)	mAOD TBC
2.15	Design level used for surcharge water level at point of discharge (14)	mAOD TBC

SuDS Flows and Volumes - LLFA Technical Assessment Pro-forma

CALCULATION OUTPUTS

Sections 3 and 4 refer to site where storage is provided by attenuation and I or partial infiltration. Where all flows are infiltrated to ground omit Sections 3 -5 and complete Section 6.

3.0 Defining rate of runoff from the site (for 1.6ha imp area)

3.2 Max. discharge for 1 in 1 year rainfall .....l/s/ha, ...5.0.....l/s for the site

3.2 Max. discharge for Qmed rainfall .....l/s/ha, ...l/s for the site

3.3 Max. discharge for 1 in 30 year rainfall .....l/s/ha, ...l/s for the site

3.4 Max. discharge for 1 in 100 year rainfall .....l/s/ha, ...9.3.....l/s for the site

3.5 Max. discharge for 1 in 100 year plus 40%CC .....l/s/ha, ...9.3.....l/s for the site

4.0 Attenuation storage to manage peak runoff rates from the site

4.1 Storage - 1 in 1 year c.270-410 m^3 .....m^3/m^2 (of developed impermeable area)

4.2 Storage -1 in 30 year (7 c.520 m^3 .....m^3/m^2

4.3 Storage -1 in 100 year (8) c. 685 m^3 .....m^3/m^2

4.4 Storage - 1 in 100 year plus 40%CC (9) c.950 m^3 .....m^3/m^2

5.0 Controlling volume of runoff from the site (For 100yr 360min storm)

5.1 Pre development runoff volume(10) .....2,262..... m^3 for the site For 1.98ha

5.2 Post development runoff volume (unmitigated) (10) .....1,828..... m^3 for the site (for 1.6ha imp area)

5.3 Volume to be controlled/does not leave site (5.2-5.1).....c.800..... m^3 for the site (post-dev runoff 1.6ha)

5.4 Volume control provided by

Interception losses(11)	.....m3	
Rain harvesting(12)	.....m3	TBC at detailed planning stage
Infiltration (even at very low rates)	.....m3	
Separate area designated as long term storage(13)	.....m3	

5.5 Total volume control (sum of inputs for 5.4) m3 (15)

6.0 Site storage volumes (full infiltration only) Not Applicable

6.1 Storage - 1in 30 year (7 .....m^3 .....m^3/m^2 (of developed impermeable area)

6.2 Storage - 1 in 100 year plus CC (9 .....m3 .....m3/m2

TECHNICAL NOTE

Appendix TN002-B

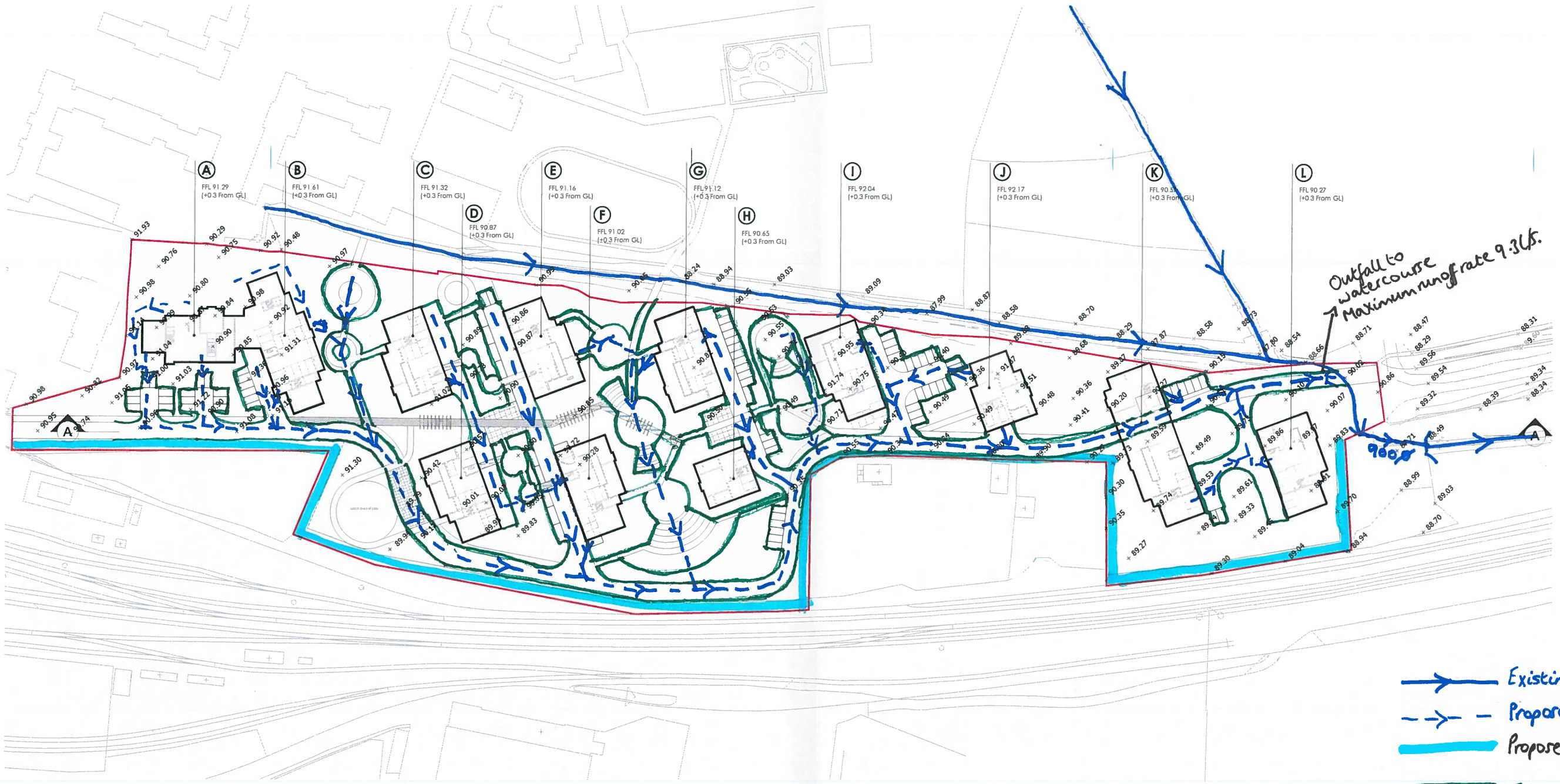
Surface Water Drainage Sketch dated 16th January 2018

Brownfield Runoff Rates and Volumes (existing and unmitigated)

MicroDrainage results

33390 Grundon Services Ltd. Banbury Proposed Surface Water Drainage_160118_EE

jsa
jsa architects



Existing Drainage Channel
Proposed Drainage Route
Proposed 3m high soundbund
Extent of Lined Permeable Paving/Surfacing.

Proposed Levels

Proposed Section A-A

0 5 10 20 30m
1:500

Subject to
Planning and Highways

Grundon
Grundon Depot, Market Street, Banbury
Proposed Levels

Project GMSB
Dwg No/rev PL-115
Scale 1:500@A0
Date JAN 2017
Checked by AC

Stantec	Grundon Waste Management Surface Water Drainage Strategy Existing Brownfield Runoff - 1 in 100yr	JOB No: 49730		SHEET: 1 of 1
		DATE: 29.07.20	BY: EE	CHECKED:

Calculation based on 'Modified Rational Method', HR Wallingford.

Assumes that water travels across the site at 1m/s from the furthest point to the connection with the existing network

Data

M5-60min 19.7 mm Q=2.78CiA
r 0.41

Calculation

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M100-Dmin mm	i mm/hr	Runoff Rate 1 in 100 yr l/s	
1	1.980	5	0.4	7.88	1.79	14.11	169.3	931.7	l/s
							Total	**931.7**	l/s

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	*Z1*
5	*0.40*
10	*0.52*
15	*0.62*

M5	*Z2 for 1 in 100yr*
5	*1.79*
10	*1.91*
15	*1.99*

Volume Calculation

Rainfall depth derived for the 1 in 100 year 360 minute storm from the FEH CD-Rom

Rainfall depth 142.7 mm

Rainfall Intensity 23.8 mm/hr

Volume = 2.78CiA x 3600 x 6 /1000

Volume **2262.2** **m^3**

Grnfld Volume **57.6** **m^3**

TOTAL **2319.8** **m^3**

Stantec	Grundon Waste Management Surface Water Drainage Strategy Brownfield Runoff (no mitigation) - 1 in 100yr	JOB No: 49730		SHEET: 1 of 1
		DATE: 30.07.20	BY: EE	CHECKED:

Calculation based on 'Modified Rational Method', HR Wallingford.

Assumes that water travels across the site at 1m/s from the furthest point to the connection with the existing network

Data

M5-60min 19.7 mm Q=2.78CiA
r 0.41

Calculation

Catchment Area	Impermeable Area ha	Duration (D) min	Z1	M5-Dmin mm	Z2	M100-Dmin mm	i mm/hr	Runoff Rate 1 in 100 yr l/s	
1	1.600	5	0.4	7.88	1.79	14.11	169.3	752.9	l/s
							Total	**752.9**	l/s

Note: Duration relates to time of concentration for the catchment including allowance for time of entry

D	*Z1*
5	*0.40*
10	*0.52*
15	*0.62*

M5	*Z2 for 1 in 100yr*
5	*1.79*
10	*1.91*
15	*1.99*

Volume Calculation

Rainfall depth derived for the 1 in 100 year 360 minute storm from the FEH CD-Rom

Rainfall depth 142.7 mm

Rainfall Intensity 23.8 mm/hr

Volume = 2.78CiA x 3600 x 6 /1000

Volume **1828.0** **m^3**

Grnfld Volume **46.55** **m^3**

TOTAL **1874.6** **m^3**

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.410	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+0

Time Area Diagram

Total Area (ha) 1.690

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.450	4	8	0.440	8	12	0.400	12	16	0.400

Model Details

Storage is Online Cover Level (m) 90.500

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	50.0
Membrane Percolation (mm/hr)	1000	Length (m)	204.0
Max Percolation (l/s)	2833.3	Slope (1:X)	500.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	89.800	Cap Volume Depth (m)	0.520

Hydro-Brake Optimum® Outflow Control

Unit Reference	MD-SHE-0147-9300-0520-9300
Design Head (m)	0.520
Design Flow (l/s)	9.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	147
Invert Level (m)	89.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.520	9.3
Flush-Flo™	0.223	9.3
Kick-Flo®	0.406	8.3
Mean Flow over Head Range	-	7.5

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake Optimum® as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.3	1.200	13.8	3.000	21.4	7.000	32.1
0.200	9.3	1.400	14.8	3.500	23.0	7.500	33.3
0.300	9.1	1.600	15.8	4.000	24.5	8.000	34.4
0.400	8.4	1.800	16.7	4.500	26.0	8.500	35.4
0.500	9.1	2.000	17.6	5.000	27.3	9.000	36.5
0.600	9.9	2.200	18.4	5.500	28.4	9.500	37.5
0.800	11.4	2.400	19.2	6.000	29.7		
1.000	12.7	2.600	19.9	6.500	31.0		

Summary of Results for 1 year Return Period

Half Drain Time : 145 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	89.908	0.108	0.0	5.9	5.9	43.7	O K
30 min Summer	89.935	0.135	0.0	8.0	8.0	68.4	O K
60 min Summer	89.957	0.157	0.0	9.1	9.1	92.5	O K
120 min Summer	89.973	0.173	0.0	9.2	9.2	112.5	O K
180 min Summer	89.980	0.180	0.0	9.2	9.2	121.2	O K
240 min Summer	89.984	0.184	0.0	9.2	9.2	126.9	O K
360 min Summer	89.987	0.187	0.0	9.2	9.2	131.8	O K
480 min Summer	89.988	0.188	0.0	9.2	9.2	132.2	O K
600 min Summer	89.986	0.186	0.0	9.2	9.2	130.4	O K
720 min Summer	89.984	0.184	0.0	9.2	9.2	127.3	O K
960 min Summer	89.978	0.178	0.0	9.2	9.2	119.2	O K
1440 min Summer	89.964	0.164	0.0	9.1	9.1	101.2	O K
2160 min Summer	89.946	0.146	0.0	8.7	8.7	80.3	O K
2880 min Summer	89.933	0.133	0.0	7.8	7.8	66.4	O K
4320 min Summer	89.914	0.114	0.0	6.5	6.5	49.2	O K
5760 min Summer	89.902	0.102	0.0	5.5	5.5	39.2	O K
7200 min Summer	89.893	0.093	0.0	4.7	4.7	32.8	O K
8640 min Summer	89.887	0.087	0.0	4.2	4.2	28.3	O K
10080 min Summer	89.881	0.081	0.0	3.8	3.8	24.8	O K
15 min Winter	89.921	0.121	0.0	7.0	7.0	54.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	31.246	0.0	47.4	28
30 min Summer	20.306	0.0	76.8	41
60 min Summer	12.800	0.0	109.7	66
120 min Summer	7.903	0.0	146.5	120
180 min Summer	5.931	0.0	170.5	152
240 min Summer	4.833	0.0	188.7	184
360 min Summer	3.601	0.0	215.0	252
480 min Summer	2.913	0.0	234.0	322
600 min Summer	2.471	0.0	249.3	390
720 min Summer	2.161	0.0	262.1	456
960 min Summer	1.748	0.0	282.8	588
1440 min Summer	1.296	0.0	312.6	836
2160 min Summer	0.962	0.0	342.1	1192
2880 min Summer	0.779	0.0	361.4	1556
4320 min Summer	0.577	0.0	383.8	2260
5760 min Summer	0.467	0.0	394.8	2992
7200 min Summer	0.396	0.0	398.9	3688
8640 min Summer	0.347	0.0	398.2	4416
10080 min Summer	0.310	0.0	394.3	5144
15 min Winter	31.246	0.0	59.3	28

Summary of Results for 1 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	89.949	0.149	0.0	8.8	8.8	82.7	O K
60 min Winter	89.972	0.172	0.0	9.2	9.2	111.0	O K
120 min Winter	89.990	0.190	0.0	9.2	9.2	135.1	O K
180 min Winter	89.996	0.196	0.0	9.3	9.3	144.4	O K
240 min Winter	89.999	0.199	0.0	9.3	9.3	149.0	O K
360 min Winter	90.001	0.201	0.0	9.3	9.3	151.5	O K
480 min Winter	89.999	0.199	0.0	9.3	9.3	148.3	O K
600 min Winter	89.995	0.195	0.0	9.3	9.3	142.7	O K
720 min Winter	89.990	0.190	0.0	9.2	9.2	135.8	O K
960 min Winter	89.979	0.179	0.0	9.2	9.2	120.5	O K
1440 min Winter	89.957	0.157	0.0	9.1	9.1	92.1	O K
2160 min Winter	89.934	0.134	0.0	7.9	7.9	67.2	O K
2880 min Winter	89.918	0.118	0.0	6.8	6.8	52.3	O K
4320 min Winter	89.899	0.099	0.0	5.2	5.2	36.4	O K
5760 min Winter	89.887	0.087	0.0	4.2	4.2	28.1	O K
7200 min Winter	89.878	0.078	0.0	3.5	3.5	23.0	O K
8640 min Winter	89.872	0.072	0.0	3.1	3.1	19.5	O K
10080 min Winter	89.867	0.067	0.0	2.7	2.7	16.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	20.306	0.0	92.2	41
60 min Winter	12.800	0.0	129.2	66
120 min Winter	7.903	0.0	170.6	120
180 min Winter	5.931	0.0	197.6	172
240 min Winter	4.833	0.0	218.2	198
360 min Winter	3.601	0.0	248.0	274
480 min Winter	2.913	0.0	269.6	350
600 min Winter	2.471	0.0	287.1	422
720 min Winter	2.161	0.0	301.7	492
960 min Winter	1.748	0.0	325.6	628
1440 min Winter	1.296	0.0	360.4	870
2160 min Winter	0.962	0.0	395.5	1224
2880 min Winter	0.779	0.0	419.2	1572
4320 min Winter	0.577	0.0	448.9	2292
5760 min Winter	0.467	0.0	465.9	3000
7200 min Winter	0.396	0.0	475.4	3744
8640 min Winter	0.347	0.0	479.9	4416
10080 min Winter	0.310	0.0	481.0	5144

Summary of Results for 30 year Return Period

Half Drain Time : 448 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	90.020	0.220	0.0	9.3	9.3	181.8	O K
30 min Summer	90.057	0.257	0.0	9.3	9.3	248.5	O K
60 min Summer	90.089	0.289	0.0	9.3	9.3	313.6	O K
120 min Summer	90.115	0.315	0.0	9.3	9.3	371.0	O K
180 min Summer	90.125	0.325	0.0	9.3	9.3	396.7	O K
240 min Summer	90.130	0.330	0.0	9.3	9.3	408.6	O K
360 min Summer	90.132	0.332	0.0	9.3	9.3	413.7	O K
480 min Summer	90.131	0.331	0.0	9.3	9.3	410.6	O K
600 min Summer	90.129	0.329	0.0	9.3	9.3	405.4	O K
720 min Summer	90.126	0.326	0.0	9.3	9.3	398.8	O K
960 min Summer	90.119	0.319	0.0	9.3	9.3	382.6	O K
1440 min Summer	90.103	0.303	0.0	9.3	9.3	344.6	O K
2160 min Summer	90.077	0.277	0.0	9.3	9.3	287.3	O K
2880 min Summer	90.051	0.251	0.0	9.3	9.3	235.8	O K
4320 min Summer	90.004	0.204	0.0	9.3	9.3	155.9	O K
5760 min Summer	89.968	0.168	0.0	9.1	9.1	105.2	O K
7200 min Summer	89.946	0.146	0.0	8.6	8.6	79.6	O K
8640 min Summer	89.932	0.132	0.0	7.7	7.7	64.9	O K
10080 min Summer	89.921	0.121	0.0	7.0	7.0	55.3	O K
15 min Winter	90.037	0.237	0.0	9.3	9.3	210.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	76.671	0.0	191.3	29
30 min Summer	49.712	0.0	263.1	43
60 min Summer	30.811	0.0	338.0	72
120 min Summer	18.537	0.0	416.1	128
180 min Summer	13.628	0.0	463.1	186
240 min Summer	10.910	0.0	496.8	244
360 min Summer	7.952	0.0	545.8	358
480 min Summer	6.352	0.0	582.6	410
600 min Summer	5.333	0.0	611.9	470
720 min Summer	4.621	0.0	636.4	532
960 min Summer	3.685	0.0	675.6	666
1440 min Summer	2.675	0.0	731.8	936
2160 min Summer	1.940	0.0	787.9	1328
2880 min Summer	1.543	0.0	826.4	1708
4320 min Summer	1.117	0.0	876.3	2424
5760 min Summer	0.887	0.0	906.5	3072
7200 min Summer	0.742	0.0	925.0	3752
8640 min Summer	0.641	0.0	935.9	4424
10080 min Summer	0.567	0.0	941.5	5152
15 min Winter	76.671	0.0	220.5	29

Summary of Results for 30 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	90.076	0.276	0.0	9.3	9.3	286.1	O K
60 min Winter	90.110	0.310	0.0	9.3	9.3	359.8	O K
120 min Winter	90.137	0.337	0.0	9.3	9.3	426.3	O K
180 min Winter	90.149	0.349	0.0	9.3	9.3	457.3	O K
240 min Winter	90.155	0.355	0.0	9.3	9.3	472.9	O K
360 min Winter	90.159	0.359	0.0	9.3	9.3	483.6	O K
480 min Winter	90.158	0.358	0.0	9.3	9.3	480.6	O K
600 min Winter	90.154	0.354	0.0	9.3	9.3	470.2	O K
720 min Winter	90.150	0.350	0.0	9.3	9.3	460.5	O K
960 min Winter	90.141	0.341	0.0	9.3	9.3	437.0	O K
1440 min Winter	90.118	0.318	0.0	9.3	9.3	379.8	O K
2160 min Winter	90.079	0.279	0.0	9.3	9.3	291.7	O K
2880 min Winter	90.039	0.239	0.0	9.3	9.3	214.2	O K
4320 min Winter	89.970	0.170	0.0	9.2	9.2	108.1	O K
5760 min Winter	89.937	0.137	0.0	8.1	8.1	70.2	O K
7200 min Winter	89.919	0.119	0.0	6.9	6.9	53.5	O K
8640 min Winter	89.908	0.108	0.0	5.9	5.9	43.7	O K
10080 min Winter	89.899	0.099	0.0	5.2	5.2	37.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	49.712	0.0	300.9	43
60 min Winter	30.811	0.0	384.9	72
120 min Winter	18.537	0.0	472.5	128
180 min Winter	13.628	0.0	525.3	184
240 min Winter	10.910	0.0	563.2	240
360 min Winter	7.952	0.0	618.5	354
480 min Winter	6.352	0.0	660.0	460
600 min Winter	5.333	0.0	693.2	552
720 min Winter	4.621	0.0	720.9	574
960 min Winter	3.685	0.0	765.5	724
1440 min Winter	2.675	0.0	829.8	1022
2160 min Winter	1.940	0.0	894.6	1432
2880 min Winter	1.543	0.0	939.7	1804
4320 min Winter	1.117	0.0	999.8	2436
5760 min Winter	0.887	0.0	1037.8	3064
7200 min Winter	0.742	0.0	1062.9	3752
8640 min Winter	0.641	0.0	1079.7	4496
10080 min Winter	0.567	0.0	1090.6	5152

Summary of Results for 100 year Return Period

Half Drain Time : 634 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	90.060	0.260	0.0	9.3	9.3	253.3	O K
30 min Summer	90.103	0.303	0.0	9.3	9.3	345.0	O K
60 min Summer	90.141	0.341	0.0	9.3	9.3	435.1	O K
120 min Summer	90.171	0.371	0.0	9.3	9.3	516.1	O K
180 min Summer	90.184	0.384	0.0	9.3	9.3	553.8	O K
240 min Summer	90.191	0.391	0.0	9.3	9.3	572.9	O K
360 min Summer	90.196	0.396	0.0	9.3	9.3	587.5	O K
480 min Summer	90.196	0.396	0.0	9.3	9.3	586.9	O K
600 min Summer	90.193	0.393	0.0	9.3	9.3	577.9	O K
720 min Summer	90.189	0.389	0.0	9.3	9.3	568.1	O K
960 min Summer	90.182	0.382	0.0	9.3	9.3	546.7	O K
1440 min Summer	90.166	0.366	0.0	9.3	9.3	501.0	O K
2160 min Summer	90.140	0.340	0.0	9.3	9.3	432.4	O K
2880 min Summer	90.114	0.314	0.0	9.3	9.3	369.0	O K
4320 min Summer	90.064	0.264	0.0	9.3	9.3	261.3	O K
5760 min Summer	90.020	0.220	0.0	9.3	9.3	180.7	O K
7200 min Summer	89.983	0.183	0.0	9.2	9.2	125.9	O K
8640 min Summer	89.957	0.157	0.0	9.1	9.1	92.4	O K
10080 min Summer	89.942	0.142	0.0	8.4	8.4	75.5	O K
15 min Winter	90.079	0.279	0.0	9.3	9.3	291.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	99.536	0.0	263.8	30
30 min Summer	65.075	0.0	360.5	44
60 min Summer	40.510	0.0	460.9	72
120 min Summer	24.362	0.0	563.8	130
180 min Summer	17.855	0.0	623.8	188
240 min Summer	14.239	0.0	665.5	248
360 min Summer	10.317	0.0	725.7	364
480 min Summer	8.210	0.0	771.0	482
600 min Summer	6.871	0.0	806.9	554
720 min Summer	5.939	0.0	836.7	606
960 min Summer	4.714	0.0	884.4	724
1440 min Summer	3.400	0.0	952.4	984
2160 min Summer	2.448	0.0	1020.0	1384
2880 min Summer	1.937	0.0	1066.3	1772
4320 min Summer	1.391	0.0	1126.7	2516
5760 min Summer	1.099	0.0	1163.8	3224
7200 min Summer	0.915	0.0	1187.3	3888
8640 min Summer	0.787	0.0	1202.0	4504
10080 min Summer	0.693	0.0	1210.6	5160
15 min Winter	99.536	0.0	301.6	30

Summary of Results for 100 year Return Period

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	90.124	0.324	0.0	9.3	9.3	394.3	O K
60 min Winter	90.164	0.364	0.0	9.3	9.3	496.3	O K
120 min Winter	90.197	0.397	0.0	9.3	9.3	589.7	O K
180 min Winter	90.211	0.411	0.0	9.3	9.3	634.8	O K
240 min Winter	90.219	0.419	0.0	9.3	9.3	658.7	O K
360 min Winter	90.226	0.426	0.0	9.3	9.3	679.9	O K
480 min Winter	90.228	0.428	0.0	9.3	9.3	684.3	O K
600 min Winter	90.226	0.426	0.0	9.3	9.3	678.7	O K
720 min Winter	90.222	0.422	0.0	9.3	9.3	667.1	O K
960 min Winter	90.212	0.412	0.0	9.3	9.3	636.7	O K
1440 min Winter	90.191	0.391	0.0	9.3	9.3	573.9	O K
2160 min Winter	90.154	0.354	0.0	9.3	9.3	471.1	O K
2880 min Winter	90.116	0.316	0.0	9.3	9.3	374.0	O K
4320 min Winter	90.039	0.239	0.0	9.3	9.3	215.0	O K
5760 min Winter	89.975	0.175	0.0	9.2	9.2	114.7	O K
7200 min Winter	89.942	0.142	0.0	8.4	8.4	75.8	O K
8640 min Winter	89.926	0.126	0.0	7.3	7.3	59.3	O K
10080 min Winter	89.914	0.114	0.0	6.5	6.5	49.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	65.075	0.0	410.0	44
60 min Winter	40.510	0.0	522.5	72
120 min Winter	24.362	0.0	637.9	128
180 min Winter	17.855	0.0	705.3	186
240 min Winter	14.239	0.0	752.2	244
360 min Winter	10.317	0.0	819.9	358
480 min Winter	8.210	0.0	871.0	470
600 min Winter	6.871	0.0	911.5	580
720 min Winter	5.939	0.0	945.2	684
960 min Winter	4.714	0.0	999.3	784
1440 min Winter	3.400	0.0	1076.6	1078
2160 min Winter	2.448	0.0	1154.3	1512
2880 min Winter	1.937	0.0	1208.2	1912
4320 min Winter	1.391	0.0	1280.1	2640
5760 min Winter	1.099	0.0	1325.8	3232
7200 min Winter	0.915	0.0	1356.4	3816
8640 min Winter	0.787	0.0	1377.2	4496
10080 min Winter	0.693	0.0	1391.1	5240

Summary of Results for 100 year Return Period (+30%)

Half Drain Time : 883 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	90.104	0.304	0.0	9.3	9.3	347.3	O K
30 min Summer	90.153	0.353	0.0	9.3	9.3	468.1	O K
60 min Summer	90.196	0.396	0.0	9.3	9.3	588.3	O K
120 min Summer	90.233	0.433	0.0	9.3	9.3	699.3	O K
180 min Summer	90.250	0.450	0.0	9.3	9.3	753.4	O K
240 min Summer	90.260	0.460	0.0	9.3	9.3	783.2	O K
360 min Summer	90.269	0.469	0.0	9.3	9.3	812.1	O K
480 min Summer	90.272	0.472	0.0	9.3	9.3	821.5	O K
600 min Summer	90.272	0.472	0.0	9.3	9.3	818.9	O K
720 min Summer	90.268	0.468	0.0	9.3	9.3	809.1	O K
960 min Summer	90.261	0.461	0.0	9.3	9.3	786.4	O K
1440 min Summer	90.246	0.446	0.0	9.3	9.3	739.1	O K
2160 min Summer	90.222	0.422	0.0	9.3	9.3	668.5	O K
2880 min Summer	90.199	0.399	0.0	9.3	9.3	597.9	O K
4320 min Summer	90.152	0.352	0.0	9.3	9.3	465.8	O K
5760 min Summer	90.107	0.307	0.0	9.3	9.3	353.9	O K
7200 min Summer	90.065	0.265	0.0	9.3	9.3	263.2	O K
8640 min Summer	90.027	0.227	0.0	9.3	9.3	193.8	O K
10080 min Summer	89.995	0.195	0.0	9.3	9.3	142.7	O K
15 min Winter	90.125	0.325	0.0	9.3	9.3	396.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	129.397	0.0	358.4	30
30 min Summer	84.598	0.0	484.1	44
60 min Summer	52.662	0.0	615.0	74
120 min Summer	31.670	0.0	749.0	132
180 min Summer	23.211	0.0	827.5	190
240 min Summer	18.510	0.0	882.1	248
360 min Summer	13.413	0.0	961.1	366
480 min Summer	10.672	0.0	1020.7	484
600 min Summer	8.932	0.0	1068.2	602
720 min Summer	7.720	0.0	1107.7	700
960 min Summer	6.129	0.0	1171.0	806
1440 min Summer	4.420	0.0	1257.8	1052
2160 min Summer	3.182	0.0	1355.1	1464
2880 min Summer	2.518	0.0	1419.9	1872
4320 min Summer	1.809	0.0	1507.5	2644
5760 min Summer	1.429	0.0	1564.9	3392
7200 min Summer	1.189	0.0	1604.7	4048
8640 min Summer	1.023	0.0	1633.0	4760
10080 min Summer	0.901	0.0	1653.3	5360
15 min Winter	129.397	0.0	407.6	30

Summary of Results for 100 year Return Period (+30%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	90.177	0.377	0.0	9.3	9.3	532.4	O K
60 min Winter	90.222	0.422	0.0	9.3	9.3	668.0	O K
120 min Winter	90.264	0.464	0.0	9.3	9.3	794.4	O K
180 min Winter	90.284	0.484	0.0	9.3	9.3	857.4	O K
240 min Winter	90.296	0.496	0.0	9.3	9.3	893.4	O K
360 min Winter	90.308	0.508	0.0	9.3	9.3	931.1	O K
480 min Winter	90.313	0.513	0.0	9.3	9.3	946.7	O K
600 min Winter	90.314	0.514	0.0	9.3	9.3	949.2	O K
720 min Winter	90.312	0.512	0.0	9.3	9.3	943.4	O K
960 min Winter	90.304	0.504	0.0	9.3	9.3	917.5	O K
1440 min Winter	90.284	0.484	0.0	9.3	9.3	855.8	O K
2160 min Winter	90.252	0.452	0.0	9.3	9.3	760.0	O K
2880 min Winter	90.220	0.420	0.0	9.3	9.3	660.4	O K
4320 min Winter	90.149	0.349	0.0	9.3	9.3	456.9	O K
5760 min Winter	90.079	0.279	0.0	9.3	9.3	291.4	O K
7200 min Winter	90.014	0.214	0.0	9.3	9.3	171.7	O K
8640 min Winter	89.964	0.164	0.0	9.1	9.1	100.8	O K
10080 min Winter	89.942	0.142	0.0	8.4	8.4	75.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	84.598	0.0	548.2	44
60 min Winter	52.662	0.0	695.1	72
120 min Winter	31.670	0.0	845.4	130
180 min Winter	23.211	0.0	933.4	188
240 min Winter	18.510	0.0	994.7	244
360 min Winter	13.413	0.0	1083.5	360
480 min Winter	10.672	0.0	1150.6	474
600 min Winter	8.932	0.0	1204.0	586
720 min Winter	7.720	0.0	1248.3	696
960 min Winter	6.129	0.0	1317.8	904
1440 min Winter	4.420	0.0	1374.5	1124
2160 min Winter	3.182	0.0	1529.5	1584
2880 min Winter	2.518	0.0	1604.1	2032
4320 min Winter	1.809	0.0	1706.4	2824
5760 min Winter	1.429	0.0	1774.7	3528
7200 min Winter	1.189	0.0	1823.5	4176
8640 min Winter	1.023	0.0	1859.5	4672
10080 min Winter	0.901	0.0	1886.5	5248