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Viadux, Manchester

Below Ground Surface Water Drainage Detailed Design

Project No: 1910-12
August 2020
Rev: 00

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Revision	Description	Issued by	Date	Checked
00	Issued for Information	J Bullough	20.08.2020	P Clayton

1.0 INTRODUCTION

1.1 Purpose of this report

This report has been prepared to support the planning application for the Viadux, Manchester Site. The assessment includes a summary of the site and an estimate of the existing discharge rates. It also includes full detailed calculations of the proposed surface water network along with the relevant drawings.

This report should be read in conjunction with the Flood Risk Assessment, renaissance, March 2020.

1.2 Site Location

The site is located in Manchester City Centre, adjacent to Albion Street. The site location is described below:

- Post Code M1 5LH
- OS X (Easting) 383550
- OS Y (Northing) 397630
- Nat. Grid SJ835976

1.2 Site Description

The site comprises of Grade II listed masonry viaduct. There is an Upper Deck on the top of a Grade II listed masonry viaduct with the Lower Deck underlying it. Both levels are generally flat. The lower deck is currently used as a carpark beneath the viaduct with two empty car showrooms on the east of the site and a substation in the west of the site. There is a ramp off Trafford Street that leads to the Upper Deck, which is also used for car parking. The site is bounded by the Metrolink and Trafford Street towards the south and east. The west of the site is bound by the Hilton Hotel and to the north is the Great Bridgewater Street and Manchester Central building (former GMex). Rochdale canal is located within close proximity to the south, and the surrounding area comprises of predominantly commercial and residential buildings.

The proposed development is split into 2 phases. The first phase will include the construction of a residential tower building and provision of public realm that links Great Bridgewater Street with Castlefield Metrolink Station. The latter phase comprises of an office building that will link to first phase.

1.3 Reference Drawings

Reference should be made to following drawings whilst reviewing this document:

- VIA-REN-00-00-DR-C-01121 - Existing Impermeable Areas Plan Ground
- VIA-REN-00-01-DR-C-01122 - Existing Impermeable Areas Plan Level 01
- VIA-REN-00-ZZ-DR-C-01120 - Phase 1 Proposed Impermeable Areas Plan
- VIA-REN-00-00-DR-C-01100 - Below Ground Drainage Ground Level Plan
- VIA-REN-00-01-DR-C-01101 - Below Ground Drainage Level 01 Plan (1)
- VIA-REN-00-01-DR-C-01102 - Below Ground Drainage Level 01 Plan (2)
- VIA-REN-00-00-DR-C-01105 - Slot Site Below Ground Drainage Plan
- VIA-REN-00-00-SK-C-00010 - Ground Floor Overland Flow Routes

- VIA-REN-00-01-SK-C-00015 - Level 01 Overland Flow Routes (1)
- VIA-REN-00-01-SK-C-00020 - Level 01 Overland Flow Routes (2)
- VIA-REN-00-ZZ-DR-C-03113 -Below Ground Drainage Detail - Attenuation Tank

2.0 SURFACE WATER DRAINAGE

2.1 Existing Site Drainage and Discharge Rates

The overall site area is circa 0.7 hectares and is split across two levels. The service yard level forms the main area of the site and comprises hard standing across its full extent. This upper level is drained by a shallow surface water system that appears to flow from east to west and discharges via 2 downpipes into the low level within the arches.

At ground level the existing surface water drainage discharges to an existing United Utilities sewer in Trafford Street

The eastern corner of the site is hard paved and a tram bridges crosses part of the site. The tram bridge discharges via multiple downpipes to a separate system at low level that ultimately discharges into a public sewer in Trafford Street.

The two existing networks have been modelled using MicroDrainage to obtain an existing discharge for the whole site, shown in the tables and calculations attached.

In addition to the main site the adjacent slot site has also been assessed. As this site is currently un-developed and is not actively drained it is considered as Greenfield and the existing discharge has been assessed accordingly, shown in the attached tables and calculations

2.2 Proposed Drainage and Discharge Rates

The Strategic Flood Risk Assessment (SFRA) for Manchester indicates that the site is within a critical drainage area. It is therefore necessary to restrict the surface water discharge from the site to a maximum of 50% of brownfield run-off and as close as practicable to the Greenfield run-off rates.

As the majority of the site is developed with the Grade II listed masonry viaduct structure, tram viaduct and associated bridge abutments, the opportunity to reduce the discharge rates to Greenfield is not practicable. Therefore a 50% betterment has been provided on the existing site discharge. This rate has then been divided between Phase 1 and Phase 2, based on area, to obtain a proposed allowable discharge rate for each phase.

The proposals are to provide a new shallow drainage system at service yard level that collects the water from the residential tower, podium, and landscaped area to the top deck of the viaduct. This is to then drop into the below ground drainage system toward the rear entrance on Trafford Street. This will then combine with the diverted service yard drainage and discharge into the United Utilities sewer via the existing connection in Trafford Street subject to UU agreement.

Due to the constraints of the Grade II listed arches it is not possible to provide attenuation at the service yard level. However it is proposed to use blue roofs to the residential tower and podium level to attenuate flows. Attenuation to the public realm at service yard level will be provided at ground level via an offline attenuation tank.

The adjacent slot site will drain via a separate surface water network that will discharge into an existing United Utilities sewer in Great Bridgewater Street, subject to UU agreement. Attenuation to this network will be provided by a series of oversized manholes.

The tables below provide a summary of the drainage calculations and should be reviewed along with the detail calculation outputs and relevant drawings.

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EXISTING SITE IMPERMEABLE AREAS

ZONE	AREA (ha)
AREA 1	0.223
AREA 2	0.201
AREA 3	0.033
AREA 4	0.037
AREA 5	0.033
AREA 6	0.059
AREA 7	0.096
TOTAL	**0.682**

REFER TO DRAWINGS VIA-REN-00-01-DR-C-01122 & VIA-REN-00-00-DR-C-01121

RETURN PERIOD	VIADUCT (LEVEL01) (l/s)		EAST AREA (LEVEL00)	TOTAL (l/s)
1 IN 1	17	20.7	11.6	49.3
1 IN 2	21.6	26.4	14.8	62.8
1 IN 30	39.4	47.3	28.2	114.9
1 IN 100	51	57.9	34.2	143.1
1 IN 100 40CC	70.3	78.8	43.3	192.4

REFER TO EXISTING DRAINAGE CALCULATIONS

RETURN PERIOD	TOTAL (l/s)	50% BROWNFIELD (l/s)
1 IN 1	49.3	24.7
1 IN 2	62.8	31.4
1 IN 30	114.9	57.5
1 IN 100	143.1	71.6
1 IN 100 40CC	192.4	96.2

ZONE	AREA (m)	AREA (ha)
PHASE 1	2975.4	0.298
PHASE 2	4085.3	0.409
TOTAL	**7060.7**	**0.707**

RETURN PERIOD	PHASE 1 50% BROWNFIELD (l/s)	PHASE 2 50% BROWNFIELD (l/s)
1 IN 1	10.4	14.3
1 IN 2	13.2	18.2
1 IN 30	24.2	33.2
1 IN 100	30.2	41.4
1 IN 100 40CC	40.5	55.7

PHASE 1 PROPOSED IMPERMEABLE AREAS

ZONE	AREA (m2)	AREA (ha)
TOWER ROOF	915	0.092
PODIUM[1]	878	0.088
PUBLIC REALM[1]	1491	0.149

REFER TO DRAWING VIA-REN-00-00-DR-C-01120

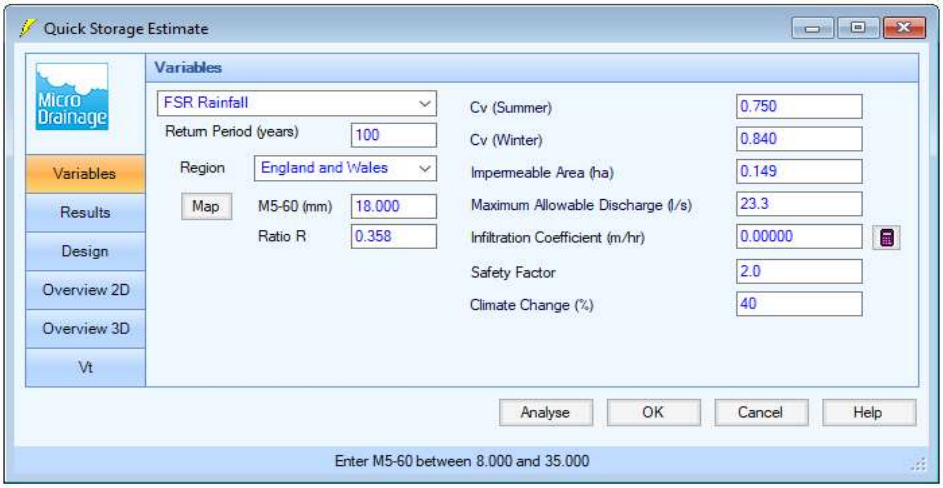
[1] AREA INCREASED TO ACCOUNT FOR WASH DOWN FROM BUILDING FAÇADE IN ACCORDANCE WITH BS EN 12056:2000. ' THE EFFECTIVE CATCHMENT AREA OF A SINGLE WALL SHOULD BE TAKEN AS 50% OF ITS AREAS, UPTO A MAXIMUM OF 10m' - 48.5 x 10 x 50% = 242.5m2

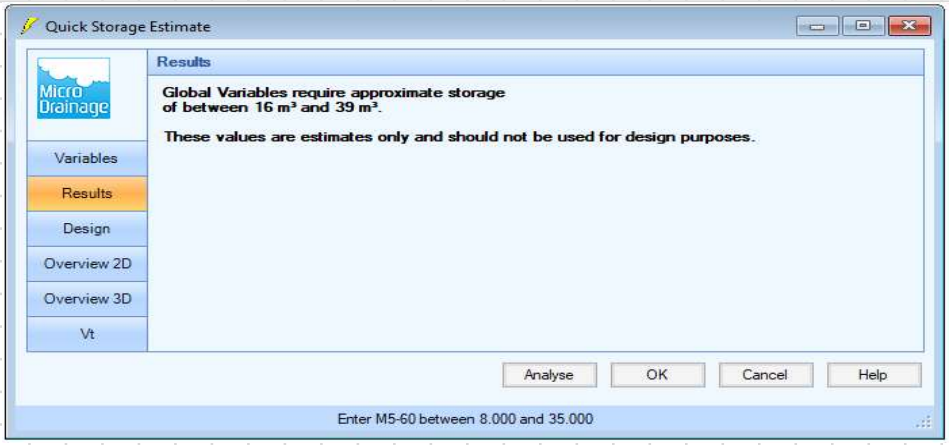
PHASE 1 ACHIEVABLE RATES

RETURN PERIOD	TOWER ROOF (l/s)	PODIUM (l/s)	PUBLIC REALM (l/s)	TOTAL (l/s)
1 IN 100	2.3	4.6	23.3	30.2

[1] REFER TO BLUE ROOF SPECIALIST'S CALCULATIONS FOR DETAILS OF THE TOWER ROOF AND PODIUM DISCHARGE RATES AND ATTENUATION

PUBLIC REALM QUICK STORAGE ESTIMATE





ZONE	AREA (m)	AREA (ha)
SLOT SITE	370	0.037

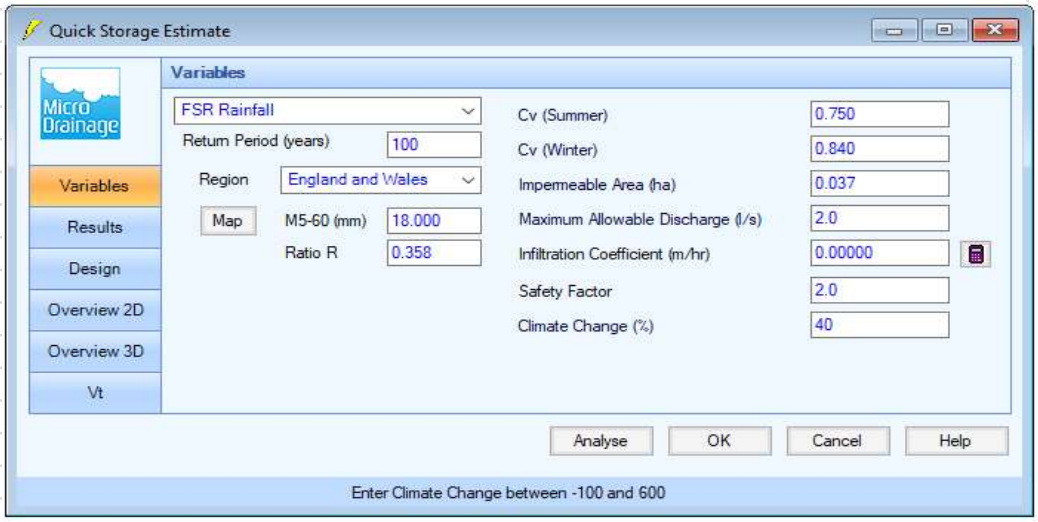
GREENFIELD RUN-OFF RATES:

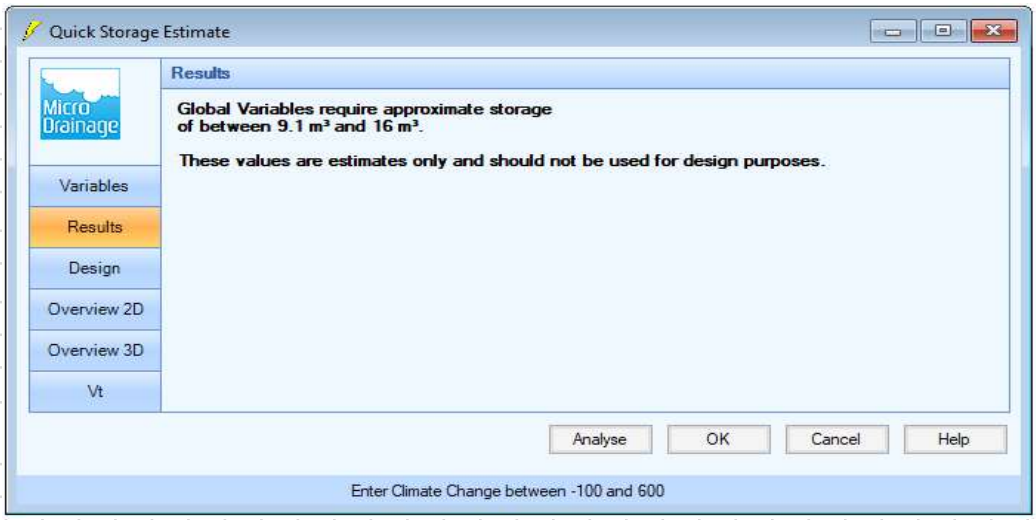
RETURN PERIOD	Run-Off (l/s)
1 IN 1	0.5
1 IN 2	0.5
1 IN 30	0.8
1 IN 100	0.8

ACHIEVABLE DISCHARGE RATES

TO MITIGATE THE RISK OF A FLOW CONTROL BLOCKAGE THE MINIMUM DISHCARGE SHOULD BE LIMITED TO: 2 l/s

QUICK STORAGE ESTIMATE





APPENDIX A

Existing Surface Water Discharge Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.358	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm at outfall S (pipe S1.003)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.157	4-8	0.066

Total Area Contributing (ha) = 0.223

Total Pipe Volume (m³) = 3.863

Time Area Diagram at outfall S (pipe S3.003)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.173	4-8	0.098

Total Area Contributing (ha) = 0.271

Total Pipe Volume (m³) = 3.785

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	51.772	0.431	120.0	0.121	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	20.885	0.174	120.0	0.077	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.72	41.805	0.121	0.0	0.0	0.0	1.19	47.4	16.4
S1.001	50.00	6.02	41.374	0.198	0.0	0.0	0.0	1.19	47.4	26.8

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S2.000	15.908	0.133	120.0	0.025	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	5.128	0.043	120.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	3.455	0.029	120.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	48.245	0.402	120.0	0.201	5.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	15.652	0.130	120.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.002	29.402	0.245	120.0	0.033	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.003	1.896	0.016	120.0	0.037	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.000	50.00	5.22	41.333	0.025	0.0	0.0	0.0	1.19	47.4	3.4
S1.002	50.00	6.09	41.200	0.223	0.0	0.0	0.0	1.19	47.4	30.2
S1.003	50.00	6.14	41.157	0.223	0.0	0.0	0.0	1.19	47.4	30.2
S3.000	50.00	5.67	41.825	0.201	0.0	0.0	0.0	1.19	47.4	27.2
S3.001	50.00	5.89	41.423	0.201	0.0	0.0	0.0	1.19	47.4	27.2
S3.002	50.00	6.30	41.293	0.234	0.0	0.0	0.0	1.19	47.4	31.7
S3.003	50.00	6.33	41.048	0.271	0.0	0.0	0.0	1.19	47.4	36.7

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.121	0.121	0.121
1.001	-	-	100	0.077	0.077	0.077
2.000	-	-	100	0.025	0.025	0.025
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.201	0.201	0.201
3.001	-	-	100	0.000	0.000	0.000
3.002	-	-	100	0.033	0.033	0.033
3.003	-	-	100	0.037	0.037	0.037
				Total	Total	Total
				0.494	0.494	0.494

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.003	S	43.310	41.128	0.000	225	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S3.003	S	42.560	41.032	0.000	225	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model		FSR	Profile Type Summer
Return Period (years)		100	Cv (Summer) 0.750
Region	England and Wales		Cv (Winter) 0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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1 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.358
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	60 Summer	1	+0%					41.875
S1.001	S2	60 Summer	1	+0%	30/60 Summer				41.466
S2.000	S5	60 Summer	1	+0%	100/60 Summer				41.365
S1.002	S3	60 Summer	1	+0%	30/60 Summer				41.321
S1.003	S4	60 Summer	1	+0%	30/60 Summer				41.278
S3.000	S6	60 Summer	1	+0%	100/60 Summer				41.917
S3.001	S7	60 Summer	1	+0%	30/60 Summer				41.519
S3.002	S8	60 Summer	1	+0%	30/60 Summer				41.393
S3.003	S9	60 Summer	1	+0%	30/60 Summer				41.188

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.155	0.000	0.21			9.3	OK	
S1.001	S2	-0.133	0.000	0.35			15.1	OK	
S2.000	S5	-0.193	0.000	0.05			2.0	OK	
S1.002	S3	-0.104	0.000	0.57			17.0	OK	
S1.003	S4	-0.104	0.000	0.57			17.0	OK	
S3.000	S6	-0.133	0.000	0.34			15.5	OK	
S3.001	S7	-0.129	0.000	0.37			15.6	OK	
S3.002	S8	-0.125	0.000	0.41			18.1	OK	
S3.003	S9	-0.085	0.000	0.71			20.7	OK	

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2 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.358
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.100 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	60 Summer	2	+0%					41.884
S1.001	S2	60 Summer	2	+0%	30/60 Summer				41.479
S2.000	S5	60 Summer	2	+0%	100/60 Summer				41.373
S1.002	S3	60 Summer	2	+0%	30/60 Summer				41.341
S1.003	S4	60 Summer	2	+0%	30/60 Summer				41.299
S3.000	S6	60 Summer	2	+0%	100/60 Summer				41.931
S3.001	S7	60 Summer	2	+0%	30/60 Summer				41.533
S3.002	S8	60 Summer	2	+0%	30/60 Summer				41.408
S3.003	S9	60 Summer	2	+0%	30/60 Summer				41.215

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.146	0.000	0.26			11.9	OK	
S1.001	S2	-0.119	0.000	0.45			19.2	OK	
S2.000	S5	-0.185	0.000	0.06			2.5	OK	
S1.002	S3	-0.083	0.000	0.72			21.7	OK	
S1.003	S4	-0.083	0.000	0.72			21.6	OK	
S3.000	S6	-0.119	0.000	0.44			19.8	OK	
S3.001	S7	-0.115	0.000	0.48			19.9	OK	
S3.002	S8	-0.109	0.000	0.52			23.1	OK	
S3.003	S9	-0.058	0.000	0.90			26.4	OK	

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30 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.100	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	60 Summer	30	+0%					41.920
S1.001	S2	60 Summer	30	+0%	30/60 Summer				41.626
S2.000	S5	60 Summer	30	+0%	100/60 Summer				41.514
S1.002	S3	60 Summer	30	+0%	30/60 Summer				41.505
S1.003	S4	60 Summer	30	+0%	30/60 Summer				41.423
S3.000	S6	60 Summer	30	+0%	100/60 Summer				41.986
S3.001	S7	60 Summer	30	+0%	30/60 Summer				41.687
S3.002	S8	60 Summer	30	+0%	30/60 Summer				41.588
S3.003	S9	60 Summer	30	+0%	30/60 Summer				41.364

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.110	0.000	0.50			22.7	OK	
S1.001	S2	0.027	0.000	0.83			35.8	SURCHARGED	
S2.000	S5	-0.044	0.000	0.11			4.5	OK	
S1.002	S3	0.081	0.000	1.33			39.7	SURCHARGED	
S1.003	S4	0.042	0.000	1.32			39.4	SURCHARGED	
S3.000	S6	-0.064	0.000	0.83			37.7	OK	
S3.001	S7	0.039	0.000	0.87			36.4	SURCHARGED	
S3.002	S8	0.070	0.000	0.94			41.6	SURCHARGED	
S3.003	S9	0.092	0.000	1.62			47.3	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.100	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	60 Summer	100	+0%					41.989
S1.001	S2	60 Summer	100	+0%	30/60 Summer				41.815
S2.000	S5	60 Summer	100	+0%	100/60 Summer				41.626
S1.002	S3	60 Summer	100	+0%	30/60 Summer				41.615
S1.003	S4	60 Summer	100	+0%	30/60 Summer				41.478
S3.000	S6	60 Summer	100	+0%	100/60 Summer				42.315
S3.001	S7	60 Summer	100	+0%	30/60 Summer				41.898
S3.002	S8	60 Summer	100	+0%	30/60 Summer				41.753
S3.003	S9	60 Summer	100	+0%	30/60 Summer				41.422

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	-0.041	0.000	0.64			29.0	OK	
S1.001	S2	0.217	0.000	1.06			45.7	SURCHARGED	
S2.000	S5	0.068	0.000	0.14			5.9	SURCHARGED	
S1.002	S3	0.190	0.000	1.72			51.3	SURCHARGED	
S1.003	S4	0.096	0.000	1.71			51.0	SURCHARGED	
S3.000	S6	0.265	0.000	1.01			45.8	SURCHARGED	
S3.001	S7	0.250	0.000	1.08			45.1	SURCHARGED	
S3.002	S8	0.236	0.000	1.16			51.1	SURCHARGED	
S3.003	S9	0.149	0.000	1.99			57.9	SURCHARGED	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.358	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm at outfall S (pipe S1.003)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.157	4-8	0.066

Total Area Contributing (ha) = 0.223

Total Pipe Volume (m³) = 3.863

Time Area Diagram at outfall S (pipe S3.003)

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.173	4-8	0.098

Total Area Contributing (ha) = 0.271

Total Pipe Volume (m³) = 3.785

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	51.772	0.431	120.0	0.121	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	20.885	0.174	120.0	0.077	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.72	41.805	0.121	0.0	0.0	0.0	1.19	47.4	16.4
S1.001	50.00	6.02	41.374	0.198	0.0	0.0	0.0	1.19	47.4	26.8

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S2.000	15.908	0.133	120.0	0.025	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	5.128	0.043	120.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	3.455	0.029	120.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	48.245	0.402	120.0	0.201	5.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	15.652	0.130	120.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.002	29.402	0.245	120.0	0.033	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.003	1.896	0.016	120.0	0.037	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.000	50.00	5.22	41.333	0.025	0.0	0.0	0.0	1.19	47.4	3.4
S1.002	50.00	6.09	41.200	0.223	0.0	0.0	0.0	1.19	47.4	30.2
S1.003	50.00	6.14	41.157	0.223	0.0	0.0	0.0	1.19	47.4	30.2
S3.000	50.00	5.67	41.825	0.201	0.0	0.0	0.0	1.19	47.4	27.2
S3.001	50.00	5.89	41.423	0.201	0.0	0.0	0.0	1.19	47.4	27.2
S3.002	50.00	6.30	41.293	0.234	0.0	0.0	0.0	1.19	47.4	31.7
S3.003	50.00	6.33	41.048	0.271	0.0	0.0	0.0	1.19	47.4	36.7

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.121	0.121	0.121
1.001	-	-	100	0.077	0.077	0.077
2.000	-	-	100	0.025	0.025	0.025
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.201	0.201	0.201
3.001	-	-	100	0.000	0.000	0.000
3.002	-	-	100	0.033	0.033	0.033
3.003	-	-	100	0.037	0.037	0.037
				Total	Total	Total
				0.494	0.494	0.494

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.003	S	43.310	41.128	0.000	225	0

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S3.003	S	42.560	41.032	0.000	225	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.100	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 100
Climate Change (%) 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S1	60 Summer	100	+40%	100/60 Summer				42.575
S1.001	S2	60 Summer	100	+40%	100/60 Summer				42.248
S2.000	S5	60 Summer	100	+40%	100/60 Summer				41.879
S1.002	S3	60 Summer	100	+40%	100/60 Summer				41.863
S1.003	S4	60 Summer	100	+40%	100/60 Summer				41.602
S3.000	S6	60 Summer	100	+40%	100/60 Summer				43.208
S3.001	S7	60 Summer	100	+40%	100/60 Summer				42.468
S3.002	S8	60 Summer	100	+40%	100/60 Summer				42.197
S3.003	S9	60 Summer	100	+40%	100/60 Summer				41.578

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.545	0.000	0.85			38.6	SURCHARGED	
S1.001	S2	0.650	0.000	1.45			62.7	SURCHARGED	
S2.000	S5	0.321	0.000	0.20			8.3	SURCHARGED	
S1.002	S3	0.439	0.000	2.36			70.7	SURCHARGED	
S1.003	S4	0.220	0.000	2.35			70.3	SURCHARGED	
S3.000	S6	1.158	0.000	1.33			60.2	FLOOD RISK	
S3.001	S7	0.820	0.000	1.45			60.5	SURCHARGED	
S3.002	S8	0.679	0.000	1.57			69.3	SURCHARGED	
S3.003	S9	0.306	0.000	2.70			78.8	SURCHARGED	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.358	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.128	4-8	0.026

Total Area Contributing (ha) = 0.154

Total Pipe Volume (m³) = 1.443

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	2.271	0.023	100.0	0.009	5.00	0.0	0.600	o	100	Pipe/Conduit	
2.000	6.790	0.068	100.0	0.009	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.001	21.335	1.067	20.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.002	1.532	0.077	20.0	0.021	0.00	0.0	0.600	o	100	Pipe/Conduit	
3.000	17.770	0.383	46.4	0.025	5.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.05	35.623	0.009	0.0	0.0	0.0	0.77	6.0	1.2
2.000	50.00	5.15	35.668	0.009	0.0	0.0	0.0	0.77	6.0	1.2
1.001	50.00	5.35	35.600	0.018	0.0	0.0	0.0	1.73	13.6	2.4
1.002	50.00	5.37	34.533	0.039	0.0	0.0	0.0	1.73	13.6	5.3
3.000	50.00	5.20	34.790	0.025	0.0	0.0	0.0	1.48	26.2	3.4

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.003	9.132	0.203	45.0	0.023	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.000	20.730	0.456	45.5	0.024	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	11.511	0.256	45.0	0.023	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	8.303	0.185	45.0	0.020	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.003	50.00	5.47	34.407	0.087	0.0	0.0	0.0	1.50	26.6	11.8
4.000	50.00	5.23	34.660	0.024	0.0	0.0	0.0	1.50	26.4	3.2
1.004	50.00	5.60	34.204	0.134	0.0	0.0	0.0	1.50	26.6	18.1
1.005	50.00	5.69	33.948	0.154	0.0	0.0	0.0	1.50	26.6	20.9

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.009	0.009	0.009
2.000	-	-	100	0.009	0.009	0.009
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.021	0.021	0.021
3.000	-	-	100	0.025	0.025	0.025
1.003	-	-	100	0.023	0.023	0.023
4.000	-	-	100	0.024	0.024	0.024
1.004	-	-	100	0.023	0.023	0.023
1.005	-	-	100	0.020	0.020	0.020
				Total	Total	Total
				0.154	0.154	0.154

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.005		35.500	33.764	0.000	225	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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1 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.358
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	60 Summer	1	+0%					35.651
2.000	7	60 Summer	1	+0%					35.692
1.001	2	60 Summer	1	+0%					35.622
1.002	3	60 Summer	1	+0%	100/60 Summer				34.576
3.000	8	60 Summer	1	+0%					34.818
1.003	4	60 Summer	1	+0%	100/60 Summer				34.461
4.000	9	60 Summer	1	+0%					34.687
1.004	5	60 Summer	1	+0%	30/60 Summer				34.272
1.005	6	60 Summer	1	+0%	30/60 Summer				34.023

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.072	0.000	0.17			0.7	OK	
2.000	7	-0.076	0.000	0.13			0.7	OK	
1.001	2	-0.078	0.000	0.10			1.4	OK	
1.002	3	-0.057	0.000	0.38			2.9	OK	
3.000	8	-0.122	0.000	0.08			2.0	OK	
1.003	4	-0.096	0.000	0.28			6.5	OK	
4.000	9	-0.123	0.000	0.08			1.9	OK	
1.004	5	-0.082	0.000	0.42			10.1	OK	
1.005	6	-0.075	0.000	0.50			11.6	OK	

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2 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
Hot Start Level (mm) 0 Inlet Coeffiecient 0.800
Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.358
Region England and Wales Cv (Summer) 0.750
M5-60 (mm) 18.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	60 Summer	2	+0%					35.654
2.000	7	60 Summer	2	+0%					35.695
1.001	2	60 Summer	2	+0%					35.625
1.002	3	60 Summer	2	+0%	100/60 Summer				34.583
3.000	8	60 Summer	2	+0%					34.822
1.003	4	60 Summer	2	+0%	100/60 Summer				34.469
4.000	9	60 Summer	2	+0%					34.691
1.004	5	60 Summer	2	+0%	30/60 Summer				34.282
1.005	6	60 Summer	2	+0%	30/60 Summer				34.035

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.069	0.000	0.21			0.9	OK	
2.000	7	-0.073	0.000	0.16			0.9	OK	
1.001	2	-0.075	0.000	0.13			1.8	OK	
1.002	3	-0.050	0.000	0.48			3.7	OK	
3.000	8	-0.118	0.000	0.10			2.5	OK	
1.003	4	-0.088	0.000	0.36			8.3	OK	
4.000	9	-0.119	0.000	0.10			2.4	OK	
1.004	5	-0.072	0.000	0.54			12.9	OK	
1.005	6	-0.063	0.000	0.64			14.8	OK	

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30 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	60 Summer	30	+0%					35.668
2.000	7	60 Summer	30	+0%					35.707
1.001	2	60 Summer	30	+0%					35.635
1.002	3	60 Summer	30	+0%	100/60 Summer				34.618
3.000	8	60 Summer	30	+0%					34.835
1.003	4	60 Summer	30	+0%	100/60 Summer				34.542
4.000	9	60 Summer	30	+0%					34.703
1.004	5	60 Summer	30	+0%	30/60 Summer				34.446
1.005	6	60 Summer	30	+0%	30/60 Summer				34.178

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.055	0.000	0.40			1.7	OK	
2.000	7	-0.061	0.000	0.31			1.7	OK	
1.001	2	-0.065	0.000	0.25			3.3	OK	
1.002	3	-0.015	0.000	0.96			7.4	OK	
3.000	8	-0.105	0.000	0.19			4.7	OK	
1.003	4	-0.015	0.000	0.69			16.1	OK	
4.000	9	-0.107	0.000	0.18			4.5	OK	
1.004	5	0.092	0.000	1.03			24.6	SURCHARGED	
1.005	6	0.080	0.000	1.22			28.2	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	60 Summer	100	+0%					35.676
2.000	7	60 Summer	100	+0%					35.713
1.001	2	60 Summer	100	+0%					35.641
1.002	3	60 Summer	100	+0%	100/60 Summer				34.969
3.000	8	60 Summer	100	+0%					34.890
1.003	4	60 Summer	100	+0%	100/60 Summer				34.865
4.000	9	60 Summer	100	+0%					34.749
1.004	5	60 Summer	100	+0%	30/60 Summer				34.723
1.005	6	60 Summer	100	+0%	30/60 Summer				34.319

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	-0.047	0.000	0.53			2.2	OK	
2.000	7	-0.055	0.000	0.41			2.2	OK	
1.001	2	-0.059	0.000	0.33			4.4	OK	
1.002	3	0.335	0.000	1.16			8.9	SURCHARGED	
3.000	8	-0.050	0.000	0.25			6.2	OK	
1.003	4	0.308	0.000	0.83			19.4	SURCHARGED	
4.000	9	-0.061	0.000	0.24			6.0	OK	
1.004	5	0.369	0.000	1.24			29.7	SURCHARGED	
1.005	6	0.221	0.000	1.48			34.2	SURCHARGED	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.358	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.128	4-8	0.026

Total Area Contributing (ha) = 0.154

Total Pipe Volume (m³) = 1.443

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	2.271	0.023	100.0	0.009	5.00	0.0	0.600	o	100	Pipe/Conduit	
2.000	6.790	0.068	100.0	0.009	5.00	0.0	0.600	o	100	Pipe/Conduit	
1.001	21.335	1.067	20.0	0.000	0.00	0.0	0.600	o	100	Pipe/Conduit	
1.002	1.532	0.077	20.0	0.021	0.00	0.0	0.600	o	100	Pipe/Conduit	
3.000	17.770	0.383	46.4	0.025	5.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.05	35.623	0.009	0.0	0.0	0.0	0.77	6.0	1.2
2.000	50.00	5.15	35.668	0.009	0.0	0.0	0.0	0.77	6.0	1.2
1.001	50.00	5.35	35.600	0.018	0.0	0.0	0.0	1.73	13.6	2.4
1.002	50.00	5.37	34.533	0.039	0.0	0.0	0.0	1.73	13.6	5.3
3.000	50.00	5.20	34.790	0.025	0.0	0.0	0.0	1.48	26.2	3.4

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.003	9.132	0.203	45.0	0.023	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.000	20.730	0.456	45.5	0.024	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	11.511	0.256	45.0	0.023	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	8.303	0.185	45.0	0.020	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.003	50.00	5.47	34.407	0.087	0.0	0.0	0.0	1.50	26.6	11.8
4.000	50.00	5.23	34.660	0.024	0.0	0.0	0.0	1.50	26.4	3.2
1.004	50.00	5.60	34.204	0.134	0.0	0.0	0.0	1.50	26.6	18.1
1.005	50.00	5.69	33.948	0.154	0.0	0.0	0.0	1.50	26.6	20.9

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.009	0.009	0.009
2.000	-	-	100	0.009	0.009	0.009
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.021	0.021	0.021
3.000	-	-	100	0.025	0.025	0.025
1.003	-	-	100	0.023	0.023	0.023
4.000	-	-	100	0.024	0.024	0.024
1.004	-	-	100	0.023	0.023	0.023
1.005	-	-	100	0.020	0.020	0.020
				Total	Total	Total
				0.154	0.154	0.154

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.005		35.500	33.764	0.000	225	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 0 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 60
Return Period(s) (years) 100
Climate Change (%) 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	1	60 Summer	100	+40%	100/60 Summer				35.751
2.000	7	60 Summer	100	+40%					35.761
1.001	2	60 Summer	100	+40%	100/60 Summer				35.743
1.002	3	60 Summer	100	+40%	100/60 Summer				35.566
3.000	8	60 Summer	100	+40%	100/60 Summer	100/60 Summer			35.390
1.003	4	60 Summer	100	+40%	100/60 Summer				35.379
4.000	9	60 Summer	100	+40%	100/60 Summer				35.242
1.004	5	60 Summer	100	+40%	100/60 Summer				35.196
1.005	6	60 Summer	100	+40%	100/60 Summer				34.571

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	0.028	0.000	0.74			3.1	SURCHARGED	
2.000	7	-0.007	0.000	0.57			3.1	OK	
1.001	2	0.042	0.000	0.46			6.0	SURCHARGED	
1.002	3	0.933	0.000	1.51			11.7	FLOOD RISK	
3.000	8	0.450	0.501	0.42			10.3	FLOOD	1
1.003	4	0.822	0.000	1.08			25.2	SURCHARGED	
4.000	9	0.432	0.000	0.30			7.5	FLOOD RISK	
1.004	5	0.842	0.000	1.55			37.3	SURCHARGED	
1.005	6	0.473	0.000	1.87			43.3	SURCHARGED	

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APPENDIX B

Slot Site Greenfield Run-Off Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	2	SAAR (mm)	860	Urban	0.750
Area (ha)	0.037	Soil	0.450	Region Number	Region 10

Results l/s

QBAR Rural	0.2
QBAR Urban	0.5
Q2 years	0.5
Q1 year	0.5
Q30 years	0.8
Q100 years	0.8

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APPENDIX C

Proposed Surface Water Network Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.358	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.117	4-8	0.032

Total Area Contributing (ha) = 0.149

Total Pipe Volume (m³) = 3.367

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	2.211	0.015	150.0	0.149	5.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	0.957	0.006	150.0	0.000	5.00	0.0	0.600	o	225	Pipe/Conduit	
S2.001	23.549	0.157	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.002	3.126	0.021	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	2.616	0.491	5.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	1.769	0.012	147.4	0.000	5.00	6.9	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.03	32.846	0.149	0.0	0.0	0.0	1.07	42.4	20.2
S2.000	50.00	5.01	33.015	0.000	0.0	0.0	0.0	1.07	42.4	0.0
S2.001	50.00	5.38	33.009	0.000	0.0	0.0	0.0	1.07	42.4	0.0
S2.002	50.00	5.43	32.852	0.000	0.0	0.0	0.0	1.07	42.4	0.0
S1.001	50.00	5.44	32.831	0.149	0.0	0.0	0.0	5.71	226.9	20.2
S3.000	50.00	5.03	32.859	0.000	6.9	0.0	0.0	1.07	42.7	6.9

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S3.001	3.738	0.507	7.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	11.681	0.957	12.2	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S3.001	50.00	5.04	32.847	0.000	6.9	0.0	0.0	4.85	192.8	6.9
S1.002	50.00	5.47	32.115	0.149	6.9	0.0	0.0	5.85	929.6	27.1

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.149	0.149	0.149
2.000	-	-	100	0.000	0.000	0.000
2.001	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.000	0.000	0.000
3.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.149	0.149	0.149

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.002	S	34.900	31.158	31.010	600	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0	Number of Offline Controls 0	Number of Time/Area Diagrams 0
Number of Online Controls 1	Number of Storage Structures 1	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S2, DS/PN: S1.001, Volume (m³): 2.5

Unit Reference	MD-SCL-0195-2330-1000-2330
Design Head (m)	1.000
Design Flow (l/s)	23.3
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	195
Invert Level (m)	32.831
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	23.3	Kick-Flo®	0.634	18.8
Flush-Flo™	0.267	23.3	Mean Flow over Head Range	-	18.9

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	7.5	1.200	25.4	3.000	39.4	7.000	59.3
0.200	20.1	1.400	27.3	3.500	42.4	7.500	61.3
0.300	23.2	1.600	29.1	4.000	45.2	8.000	63.3
0.400	22.5	1.800	30.8	4.500	47.9	8.500	65.2
0.500	21.5	2.000	32.4	5.000	50.4	9.000	67.0
0.600	19.8	2.200	33.9	5.500	52.8	9.500	68.8
0.800	21.0	2.400	35.4	6.000	55.0		
1.000	23.3	2.600	36.8	6.500	57.2		

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Storage Structures for Storm

Cellular Storage Manhole: SAttenuation Tank, DS/PN: S2.000

Invert Level (m) 33.015 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	45.0	0.0	0.900	0.0	0.0
0.800	45.0	0.0			

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1 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.
S1.000	S1	15 minute 1 year Winter I+0%	35.110	33.007	-0.064	0.000	0.62
S2.000	SAttenuation Tank	15 minute 1 year Summer I+0%	35.110	33.015	-0.225	0.000	0.00
S2.001	S3	15 minute 1 year Summer I+0%	35.110	33.009	-0.225	0.000	0.00
S2.002	S4	15 minute 1 year Summer I+0%	35.077	32.993	-0.084	0.000	0.08
S1.001	S2	15 minute 1 year Winter I+0%	34.965	32.999	-0.057	0.000	0.17
S3.000	S5	180 minute 1 year Summer I+0%	35.110	32.932	-0.152	0.000	0.23
S3.001	S6	15 minute 1 year Summer I+0%	34.965	32.885	-0.187	0.000	0.07
S1.002	SCW1	15 minute 1 year Winter I+0%	34.902	32.174	-0.391	0.000	0.04

PN	US/MH Name	Overflow (l/s)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1		8.376	17.7	OK
S2.000	SAttenuation Tank		0.000	0.0	OK
S2.001	S3		0.000	0.0	OK
S2.002	S4		0.000	2.1	OK
S1.001	S2		8.370	16.5	OK
S3.000	S5		148.884	6.9	OK
S3.001	S6		24.672	6.9	OK
S1.002	SCW1		32.948	23.3	OK

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.358	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.117	4-8	0.032

Total Area Contributing (ha) = 0.149

Total Pipe Volume (m³) = 3.367

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	2.211	0.015	150.0	0.149	5.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	0.957	0.006	150.0	0.000	5.00	0.0	0.600	o	225	Pipe/Conduit	
S2.001	23.549	0.157	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.002	3.126	0.021	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	2.616	0.491	5.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	1.769	0.012	147.4	0.000	5.00	6.9	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.03	32.846	0.149	0.0	0.0	0.0	1.07	42.4	20.2
S2.000	50.00	5.01	33.015	0.000	0.0	0.0	0.0	1.07	42.4	0.0
S2.001	50.00	5.38	33.009	0.000	0.0	0.0	0.0	1.07	42.4	0.0
S2.002	50.00	5.43	32.852	0.000	0.0	0.0	0.0	1.07	42.4	0.0
S1.001	50.00	5.44	32.831	0.149	0.0	0.0	0.0	5.71	226.9	20.2
S3.000	50.00	5.03	32.859	0.000	6.9	0.0	0.0	1.07	42.7	6.9

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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S3.001	3.738	0.507	7.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	11.681	0.957	12.2	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S3.001	50.00	5.04	32.847	0.000	6.9	0.0	0.0	4.85	192.8	6.9
S1.002	50.00	5.47	32.115	0.149	6.9	0.0	0.0	5.85	929.6	27.1

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.149	0.149	0.149
2.000	-	-	100	0.000	0.000	0.000
2.001	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.000	0.000	0.000
3.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.149	0.149	0.149

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.002	S	34.900	31.158	31.010	600	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0	Number of Offline Controls 0	Number of Time/Area Diagrams 0
Number of Online Controls 1	Number of Storage Structures 1	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S2, DS/PN: S1.001, Volume (m³): 2.5

Unit Reference	MD-SCL-0195-2330-1000-2330
Design Head (m)	1.000
Design Flow (l/s)	23.3
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	195
Invert Level (m)	32.831
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	23.3	Kick-Flo®	0.634	18.8
Flush-Flo™	0.267	23.3	Mean Flow over Head Range	-	18.9

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	7.5	1.200	25.4	3.000	39.4	7.000	59.3
0.200	20.1	1.400	27.3	3.500	42.4	7.500	61.3
0.300	23.2	1.600	29.1	4.000	45.2	8.000	63.3
0.400	22.5	1.800	30.8	4.500	47.9	8.500	65.2
0.500	21.5	2.000	32.4	5.000	50.4	9.000	67.0
0.600	19.8	2.200	33.9	5.500	52.8	9.500	68.8
0.800	21.0	2.400	35.4	6.000	55.0		
1.000	23.3	2.600	36.8	6.500	57.2		

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Storage Structures for Storm

Cellular Storage Manhole: SAttenuation Tank, DS/PN: S2.000

Invert Level (m) 33.015 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	45.0	0.0	0.900	0.0	0.0
0.800	45.0	0.0			

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100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 100
Climate Change (%) 40

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 minute 100 year Winter I+40%	35.110	34.149	1.078	0.000
S2.000	SAttenuation Tank	30 minute 100 year Winter I+40%	35.110	33.433	0.193	0.000
S2.001	S3	15 minute 100 year Winter I+40%	35.110	33.419	0.186	0.000
S2.002	S4	15 minute 100 year Winter I+40%	35.077	33.691	0.614	0.000
S1.001	S2	15 minute 100 year Winter I+40%	34.965	33.839	0.783	0.000
S3.000	S5	180 minute 100 year Summer I+40%	35.110	32.932	-0.152	0.000
S3.001	S6	15 minute 100 year Summer I+40%	34.965	32.885	-0.187	0.000
S1.002	SCW1	15 minute 100 year Winter I+40%	34.902	32.182	-0.383	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Discharge Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	2.70		37.034	76.8	SURCHARGED
S2.000	SAttenuation Tank	0.68		-0.936	20.4	SURCHARGED
S2.001	S3	0.53		-0.540	20.6	SURCHARGED
S2.002	S4	0.78		-0.563	21.3	SURCHARGED
S1.001	S2	0.24		36.450	23.3	SURCHARGED
S3.000	S5	0.23		148.884	6.9	OK
S3.001	S6	0.07		24.672	6.9	OK
S1.002	SCW1	0.05		61.035	30.2	OK

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APPENDIX D

Slot Site Proposed Surface Water Network Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.358	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.032	4-8	0.005

Total Area Contributing (ha) = 0.037

Total Pipe Volume (m³) = 2.792

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	4.648	0.031	150.0	0.018	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	4.198	0.028	150.0	0.019	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	15.344	0.236	65.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.07	32.440	0.018	0.0	0.0	0.0	1.07	42.4	2.4
S1.001	50.00	5.14	32.409	0.037	0.0	0.0	0.0	1.07	42.4	5.0
S1.002	50.00	5.24	32.156	0.037	0.0	0.0	0.0	2.52	401.5	5.0

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.018	0.018	0.018
1.001	-	-	100	0.019	0.019	0.019
1.002	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.037	0.037	0.037

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.002	S	35.480	31.920	31.920	1350	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0	Number of Offline Controls 0	Number of Time/Area Diagrams 0
Number of Online Controls 1	Number of Storage Structures 0	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S3, DS/PN: S1.002, Volume (m³): 6.2

Unit Reference	MD-SCL-0055-2000-1900-2000
Design Head (m)	1.900
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	55
Invert Level (m)	32.156
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.900	2.0	Kick-Flo®	0.490	1.1
Flush-Flo™	0.224	1.4	Mean Flow over Head Range	-	1.5

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	1.2	1.200	1.6	3.000	2.5	7.000	3.6
0.200	1.4	1.400	1.7	3.500	2.6	7.500	3.8
0.300	1.4	1.600	1.8	4.000	2.8	8.000	3.9
0.400	1.3	1.800	1.9	4.500	3.0	8.500	4.0
0.500	1.1	2.000	2.0	5.000	3.1	9.000	4.1
0.600	1.2	2.200	2.1	5.500	3.2	9.500	4.2
0.800	1.4	2.400	2.2	6.000	3.4		
1.000	1.5	2.600	2.3	6.500	3.5		

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1 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	15 minute 1 year Winter I+0%	35.440	32.536	-0.129	0.000	0.07	
S1.001	S2	15 minute 1 year Winter I+0%	35.440	32.536	-0.098	0.000	0.13	
S1.002	S3	15 minute 1 year Summer I+0%	35.590	32.511	-0.095	0.000	0.01	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	1.010	2.1	OK
S1.001	S2	2.077	4.0	OK
S1.002	S3	1.853	1.4	OK

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2 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	1, 2, 30, 100
Climate Change (%)	0, 0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	15 minute 2 year Summer I+0%	35.440	32.580	-0.085	0.000	0.09	
S1.001	S2	15 minute 2 year Summer I+0%	35.440	32.579	-0.055	0.000	0.15	
S1.002	S3	240 minute 2 year Summer I+0%	35.590	32.341	-0.265	0.000	0.01	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	1.168	2.6	OK
S1.001	S2	2.402	4.6	OK
S1.002	S3	6.175	1.4	OK

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30 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	15 minute 30 year Summer I+0%	35.440	32.925	0.260	0.000	0.10	
S1.001	S2	15 minute 30 year Summer I+0%	35.440	32.924	0.290	0.000	0.21	
S1.002	S3	60 minute 30 year Winter I+0%	35.590	33.137	0.531	0.000	0.01	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	2.209	3.0	SURCHARGED
S1.001	S2	4.531	6.1	SURCHARGED
S1.002	S3	8.568	1.5	SURCHARGED

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100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 1, 2, 30, 100
Climate Change (%) 0, 0, 0, 0

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	15 minute 100 year Winter I+0%	35.440	33.260	0.595	0.000	0.09	
S1.001	S2	15 minute 100 year Winter I+0%	35.440	33.259	0.625	0.000	0.19	
S1.002	S3	60 minute 100 year Winter I+0%	35.590	33.507	0.901	0.000	0.01	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	2.786	2.6	SURCHARGED
S1.001	S2	5.571	5.5	SURCHARGED
S1.002	S3	9.684	1.7	SURCHARGED

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	18.000	Add Flow / Climate Change (%)	0
Ratio R	0.358	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.032	4-8	0.005

Total Area Contributing (ha) = 0.037

Total Pipe Volume (m³) = 2.792

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	4.648	0.031	150.0	0.018	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	4.198	0.028	150.0	0.019	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	15.344	0.236	65.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.07	32.440	0.018	0.0	0.0	0.0	1.07	42.4	2.4
S1.001	50.00	5.14	32.409	0.037	0.0	0.0	0.0	1.07	42.4	5.0
S1.002	50.00	5.24	32.156	0.037	0.0	0.0	0.0	2.52	401.5	5.0

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.018	0.018	0.018
1.001	-	-	100	0.019	0.019	0.019
1.002	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.037	0.037	0.037

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.002	S	35.480	31.920	31.920	1350	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0	Number of Offline Controls 0	Number of Time/Area Diagrams 0
Number of Online Controls 1	Number of Storage Structures 0	Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	18.000	Storm Duration (mins)	30
Ratio R	0.358		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S3, DS/PN: S1.002, Volume (m³): 6.2

Unit Reference	MD-SCL-0055-2000-1900-2000
Design Head (m)	1.900
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	55
Invert Level (m)	32.156
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.900	2.0	Kick-Flo®	0.490	1.1
Flush-Flo™	0.224	1.4	Mean Flow over Head Range	-	1.5

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	1.2	1.200	1.6	3.000	2.5	7.000	3.6
0.200	1.4	1.400	1.7	3.500	2.6	7.500	3.8
0.300	1.4	1.600	1.8	4.000	2.8	8.000	3.9
0.400	1.3	1.800	1.9	4.500	3.0	8.500	4.0
0.500	1.1	2.000	2.0	5.000	3.1	9.000	4.1
0.600	1.2	2.200	2.1	5.500	3.2	9.500	4.2
0.800	1.4	2.400	2.2	6.000	3.4		
1.000	1.5	2.600	2.3	6.500	3.5		

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100 year Return Period Summary of Critical Results by Maximum Outflow (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 1 Number of Storage Structures 0 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.358
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	18.000	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360
Return Period(s) (years) 100
Climate Change (%) 40

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	15 minute 100 year Summer I+40%	35.440	33.528	0.863	0.000	0.11	
S1.001	S2	15 minute 100 year Winter I+40%	35.440	33.697	1.063	0.000	0.25	
S1.002	S3	60 minute 100 year Winter I+40%	35.590	34.164	1.558	0.000	0.01	

PN	US/MH Name	Discharge Vol (m³)	Pipe Flow (l/s)	Status
S1.000	S1	3.211	3.4	SURCHARGED
S1.001	S2	6.956	7.4	SURCHARGED
S1.002	S3	11.650	2.0	SURCHARGED

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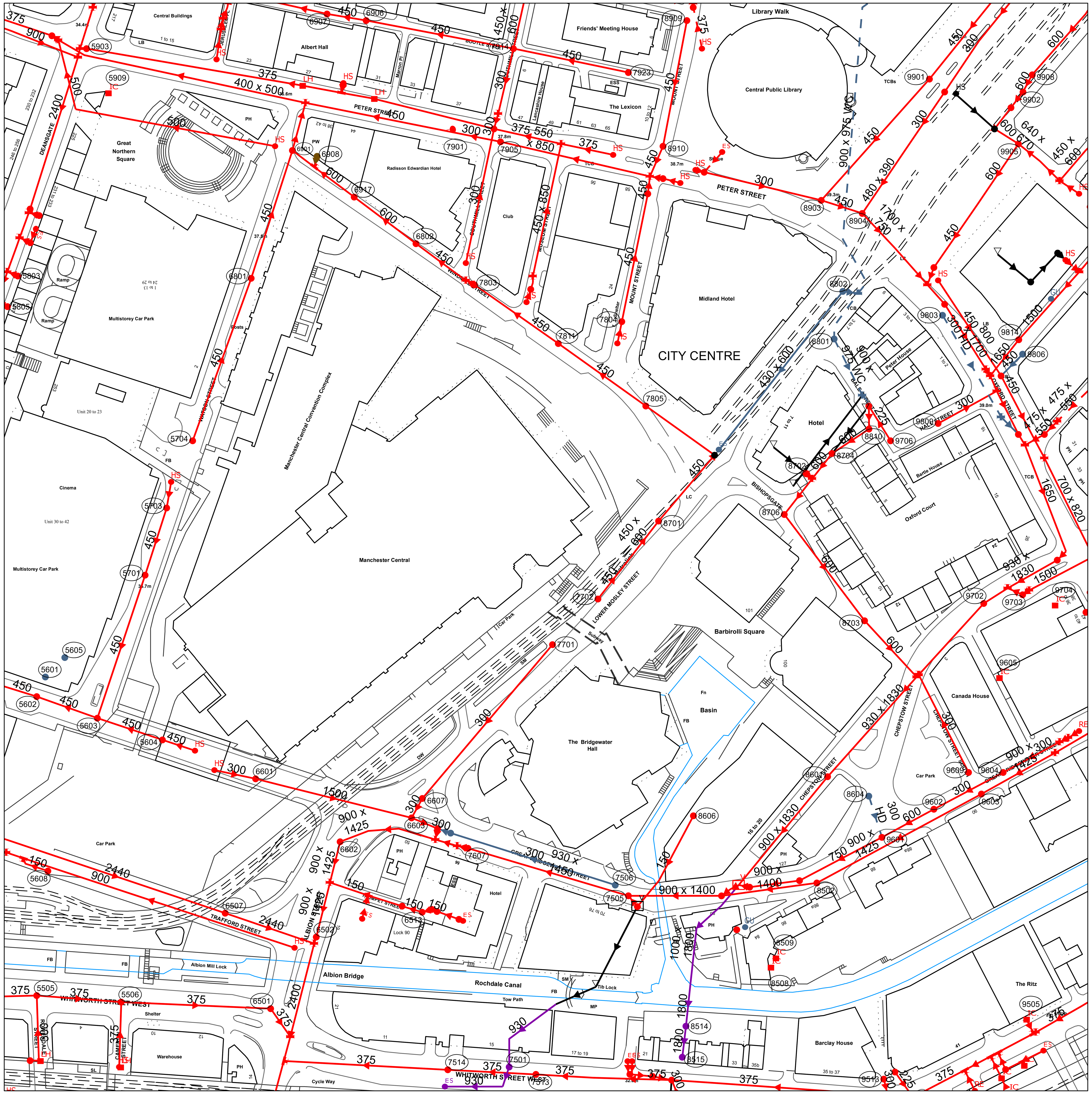
APPENDIX E

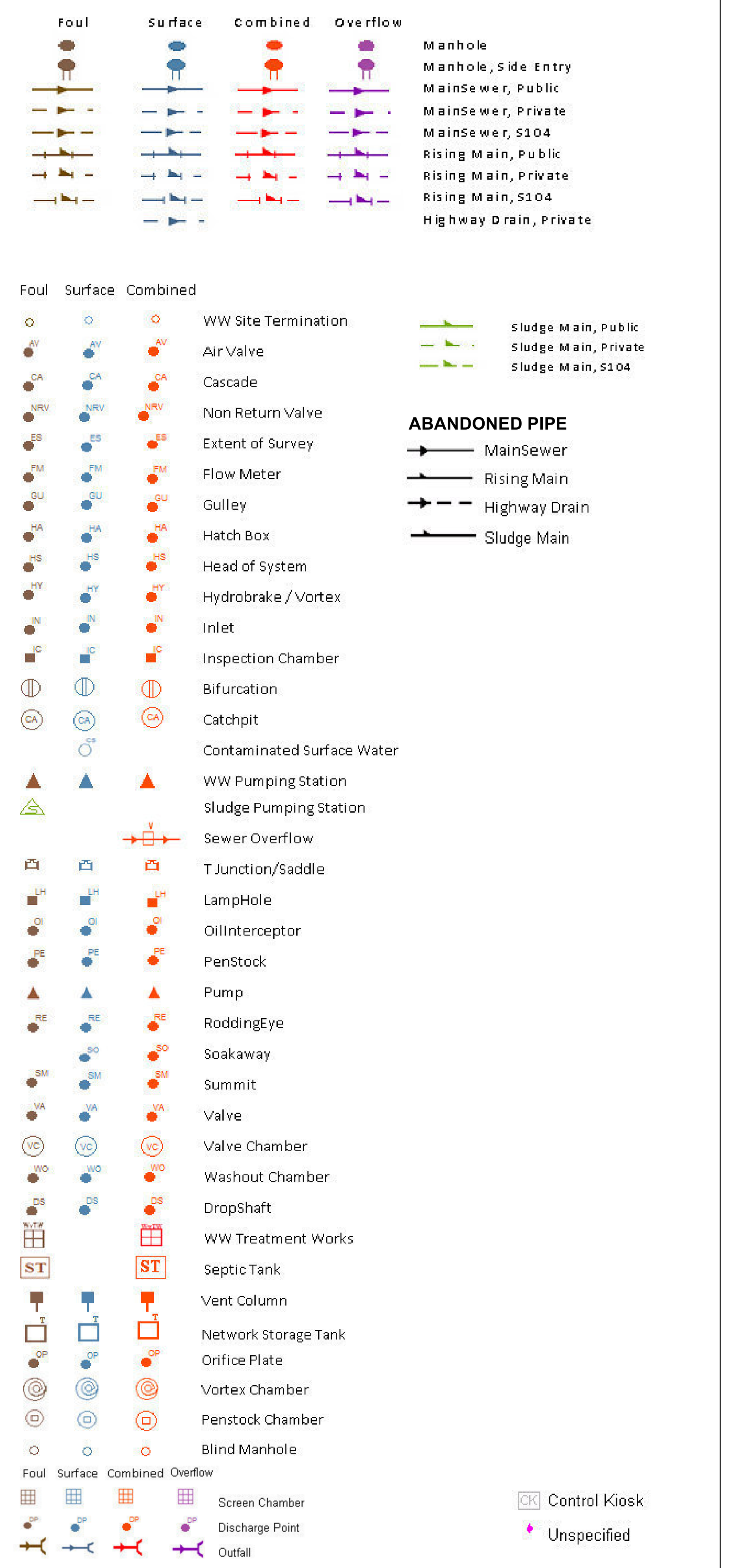
United Utilities Asset Maps



Refno	Cover	Func	Invert	Size.x	Size.y	Shape	Matl	Length	Grad
5503	33.4	CO	30.67	300		CI	VC	34.02	8
5505	33.83	CO							
5506	34.08	CO							
5601	36.03	SW							
5602	35.48	CO	31.92	450		CI	CO	80.65	
5603	35.59	CO	0	450		CI	CO	29.73	
5604	35.71	CO	32.67	450		CI	CO	31.62	
5605	35.76	SW							
5608		CO		150		CI	VC	13.54	
5701	35.76	CO							
5703	17.87	CO	0	450		CI	CO	32.57	
5704		CO	0	450		CI	CO	79.71	
5801		CO		0		CI	VC	5.41	
5803		CO		0		CI	VC	5.16	
5805		CO		0		CI	VC	5.45	
5901	34.79	CO	21.81	2400		CI	BR	70.23	780
5902	34.19	CO							
5903	34.5	CO							
5909		CO							
5912		CO		0		CI	VC	4.98	
6501	34.91	CO	0	375		CI	VC	15.81	
6502	36.02	CO	22.59	2400		CI	BR	3.16	
6505	35.94	CO		150		CI	VC	35.13	
6507	9.01	CO	0	2440		CI	CO	43.32	
6513		CO		150		CI	VC	9.62	
6514		CO		150		CI	VC	4.65	
6515		CO		150		CI	VC	2.51	
6601	35.88	CO							
6602	36.37	CO	22.74	900	1425	EG	BR	19.4	129
6603	37.02	CO							
6607	38.01	CO	0	300		CI	CO	10.3	
6801		CO	0	450		CI	CO	61.98	
6802	18.46	CO	14.43	600		CI	CO	35.73	
6901	36.94	CO							
6906	18.09	CO	0	450		CI	VC	18.25	
6907	27.13	CO	0	450		CI	VC	22.56	
6908		FO		150		CI	VC	5.12	
6910		CO							
6917		CO							
7501	33.14	OV	27.68	900	1330	EG	BR	9.49	
7505	37.28	CO							
7506	37.31	SW	34.55	300		CI	CO	79.7	347
7507	32.51	CO		225		CI	UN	10.5	
7508		CO		150		CI	VC	10.77	
7512	32.37	CO		225		CI	UN	8.97	
7513		CO		375		CI	VC	40.74	
7514		CO		375		CI	VC	75.83	
7516		CO							
7607	37.09	CO	23.12	900	1425	EG	BR	5.1	
7608	37.09	SW	34.32	300		CI	CO	6.32	1
7609	37.12	CO							
7701	39	CO	35.54	300		CI	CO	92.96	
7702		CO	0	450		CI	CO	22.8	
7801	39.53	CO							
7803	39.37	CO	34.88	450		CI	CO	4.47	
7804	39.52	CO							
7805	40.87	CO							
7811		CO							
7901		CO	34.09	450		CI	VC	66.29	
7905	37.89	CO							
7907	37.82	CO	30.14	375		CI	VC	191.71	342
7911		CO							
7914	38.51	CO							
7923		CO	0	450		CI	VC	54.13	
8502	36.36	CO							
8503	36.47	CO	31.55	750		CI	CO	23.19	63
8504	36.93	CO	28.16	525		CI	CO	5.2	
8505	32.34	CO							
8506	36.98	CO	23.44	900	1400	EG	BR	42.95	226
8508		CO							
8509		CO							
8510		CO							
8514		OV	0	1800		CI	BR	14.41	
8515		OV							
8601	36.5	CO	27.8	900	1830	EG	BR	64.73	141
8604	35.93	SW	33.35	300		CI	VC	19.92	25
8606		CO	0	150		CI	VC	49.49	
8701	39.37	CO							
8702	37.28	CO	34.68	600		CI	CO	3.8	
8703	36.76	CO	28.96	600		CI	CO	35.38	
8704	37.6	CO							
8706	37.42	CO	32.92	600		CI	CO	61.4	16
8801	39.34	SW							
8802	39.51	SW	35.59	600		CI	VC	7.07	
8803	37.76	CO							
8810	37.6	CO	34	600		CI	CO	20.52	47
8901	38.88	CO	35.32	550	850	EG	BR	6.08	
8902	39.04	CO	33.7	300		CI	VC	55.54	40
8903	39.45	CO							
8904	39.55	CO	30.92	1700	750	EG	CO	21.93	
8905	39.82	CO							
8909		CO	0	450		CI	VC	59.03	
8910		CO	0	450		CI	VC	15.23	
9502		CO	0	225		CI	VC	8.67	
9505		CO							
9512		CO		225		CI	UN	14.29	
9513		CO		300		CI	VC	7.63	
9514		CO							
9514		CO							
9601	36.54	CO							
9602	36.14	CO	32.73	600		CI	CO	27.29	161
9603	36.26	CO							
9604	36.45	CO							
9605	0	CO							
9609	36.22	CO	29.73	300		CI	VC	50.54	
9701		CO		150		CI	VC	6.17	
9702	38.08	CO							
9703	38.33	CO	29.42	1500		CI	CO	7.62	
9704		CO							
9705	38.49	CO	28.14	930	1830	EG	BR	39.46	
9706	37.71	CO	36.36	225		CI	VC	18.87	70
9801	39.33	CO	31	450		CI	CI	8.54	
9802	39.35	CO							
9803	39.23	SW	35.83	300		CI	VC	54.2	
9806	39.32	SW	36.1	450		CI	VC	14.14	28
9808	39.09	CO							
9809	38.17	CO	30.88	300		CI	VC	30.89	
9814		CO	0	1650		CI	CO	21.31	
9820	39.27	CO	37.25	550		CI	BR	10.3	
9822	38.93	CO							
9901	39.86	CO	33.36	450		CI	VC	75.07	70
9902	40.37	CO	36.65	600		CI	CO	9.04	452
9903	40.42	CO	36.63	600		CI	VC	25.39	77
9905	40.25	CO							
9906	39.99	CO							
9908		CO		600		CI	CO	9.08	
5606		CO	0	450		CI	CO	15.81	
5607		CO	0	300		CI	PVC	19.42	
5610		CO	0	2440		CI	CO	106.57	
5702		CO	0	450		CI	CO	12.17	
5904		CO	0	939		CI	CO	14.14	
5908		CO	0	500		CI	BR	32.98	
5911		CO	0	900		CI	BR	35.47	
6503		CO	0	900		CI	BR	140.09	
6512		CO							
6904		CO							
6905		CO							
6914		CO							
6915		CO	0	500		CI	CO	93.56	
7502		OV	0	930		CI	BR	39.9	
7503		CO							
7515		OV							
7703		CO							
7802		CO	0	450	850	EG	BR	3	
7808		CO	0	300		CI	VC	63.35	
7812		CO	0	470	800	FT	BR	6.32	
7815		CO	0	450		CI	VC	10.2	
7920		CO	0	375		CI	VC	24.52	
8501		CO	25.57	300		CI	CO	5	3
8511		OV	0	1800		CI	BR	20.32	

Refno	Cover	Func	Invert	Size.x	Size.y	Shape	Matl	Length	Grad
8512		SW							
8809		SW							
8906		CO	0	850		CI	VC	8.25	
8907		CO	0	300		CI	VC	4.12	
8908		CO		375		CI	VC	19.42	
8911		CO							
9501		CO	0	375		CI	VC	24.19	
9507		CO		150		CI	UN	8.96	
9510		CO							
9515		CO							
9710		CO							
9804		CO	0	800	1700	EG	CO	34.71	
9805		SW							
9813		CO							
9815		CO							
9818		CO	0	450		CI	VC	52.7	
9909		CO							
9912		CO	0	450	600	EG	BR	10.82	
9914		CO	33.64	450		CI	CI	35.23	13
9915		CO	0	640	670	RE	BR	12.81	
5502		CO							
5508		CO							
5609		CO							
5611		CO							
5802		CO							
5804		CO							
5905		CO							
5906		CO	0	2400		CI	BR	97.42	
5907		CO							
5910		CO							
5913		CO							
6504		CO							
6506		CO							
6508		CO	22.74	900	1425	EG	BR	25.96	173
6509		CO							
6510		CO							
6606		CO	0	900	1425	EG	BR	45.68	
6902		CO							
6903		CO							
6909		CO							
6911		CO							
6912		CO							
6913		CO							
6916		CO							
7611		CO	0	900	1425	EG	BR	10.44	
7809		CO	0	450		CI	CO	28.6	
7813		CO							
7921		CO							
7922		CO	0	300		CI	VC	7.28	
7930		CO	0	550	850	EG	BR	70.83	
8705		CO	0	600		CI	CO	20.96	
8804		SW		900	975	EG	BR	2.83	
8807		SW							
9503		CO							
9504		CO							
9506		CO							
9508		CO							
9509		CO							
9516		CO							
9612		CO							
9613		CO							
9615		CO	0	300		CI	CO	29.53	
9616		CO	0	900	1425	EG	BR	38.95	
9617		CO	0	300		CI	CO	4.47	
9708		CO							
9709		CO	0	1500		CI	CO	3.61	
9711		CO							
9712		CO							
9807		CO							
9811		SW	0	300		CI	VC	11.31	
9812		CO							
9817		CO							
9823		CO							
9825		CO							
9827		CO	0	475	550	EG	BR	8.49	
9910		CO							
7504		CO							
7508		OV							
8707		SW							
8709		CO							
8710	39.43	CO							
8811		CO							
9805		CO							
9810		CO							
9819		CO							
9904	40.27	CO							
9907		CO							
8507		CO							

WASTE WATER SYMBOLOGY



LEGEND

MANHOLE FUNCTION

- FO Foul
- SW Surface Water
- CO Combined
- OV Overflow

SEWER SHAPE

CI	Circular	TR	Trapezoidal
EG	Egg	AR	Arch
OV	Oval	BA	Barrel
FT	Flat Top	HO	HorseShoe
RE	Rectangular	UN	Unspecified
SQ	Square		

SEWER MATERIAL

AC	Asbestos Cement	DI	Ductile Iron
BR	Brick	PVC	Polyvinyl Chloride
PE	Polyethylene	CI	Cast Iron
RP	Reinforced Plastic Matrix	SI	Spun Iron
CO	Concrete	ST	Steel
CSB	Concrete Segment Bolted	VC	Vitrified Clay
CSU	Concrete Segment Unbolted	PP	Polypropylene
CC	Concrete Box Culverted	PF	Pitch Fibre
PSC	Plastic/Steel Composite	MAC	Masonry, Coursed
GRC	Glass Reinforced Concrete	MAR	Masonry, Random
GRP	Glass Reinforced Plastic	U	Unspecified

The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown.
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OS Sheet No: SJ8397NE

Scale: 1:1250 Date: 25/11/2016

238 Nodes

Sheet 1 of 1

United Utilities helping life flow smoothly

SEWER RECORDS

OS Sheet No: SJ8397NE

Scale: 1:1250 Date: 25/11/2016

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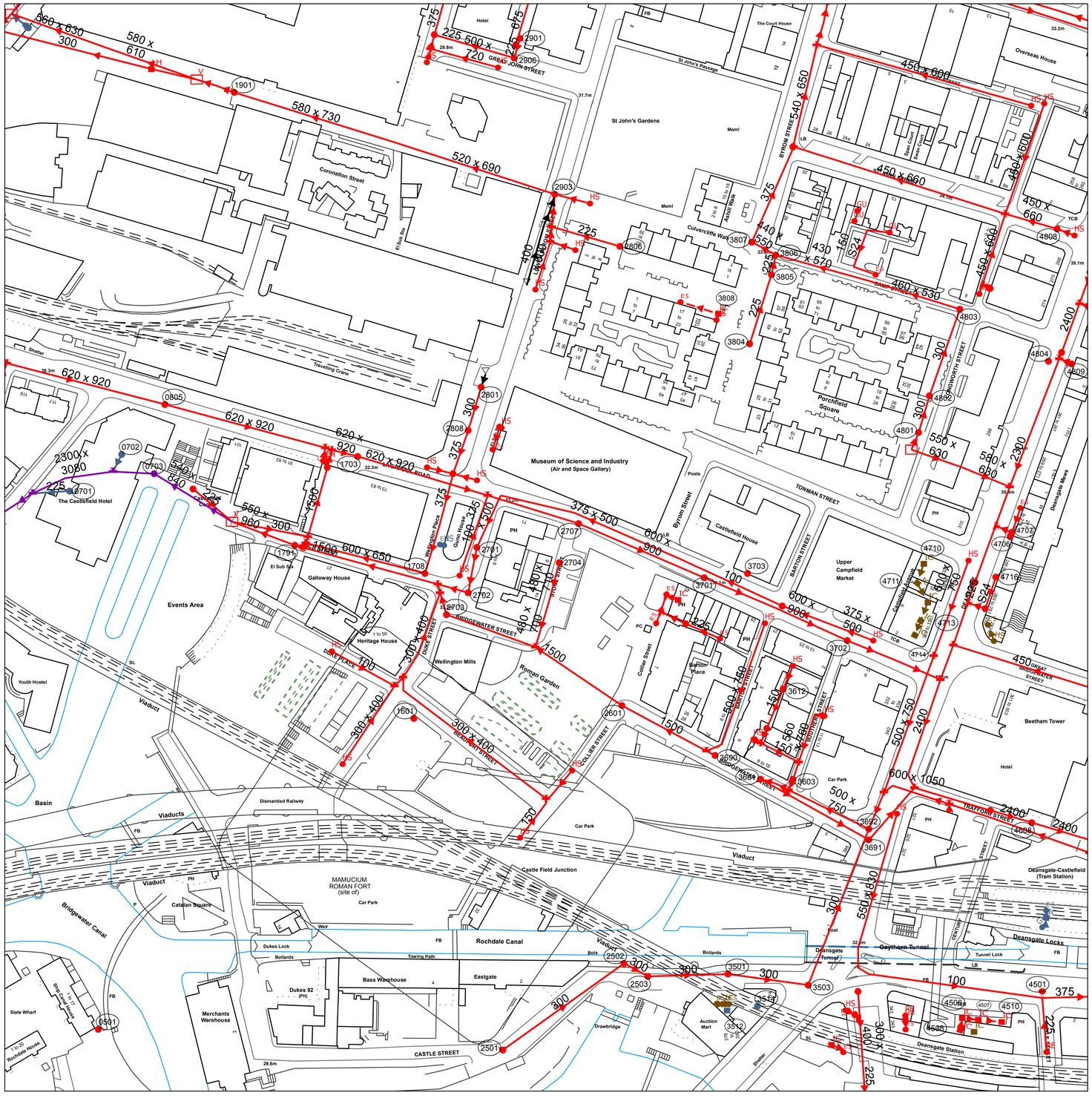
St John's Gardens
Museum of Science and Industry (Air and Space Gallery)
Coronation Street
Great John Street
St John's Passage
Byrom Street
Castlefield House
Overseas House
The Court House
Hotel
Memi
Culvercliffe Walk
Ashton Walk
Porchfield Square
Tonman Street
Barton Street
Upper Campfield Market
Campfield Arcade
Deansgate
Deansgate Station
Deansgate Locks
Gaythorn Tunnel
Tunnel Lock
Beetham Tower
Trafford Street
Southern Street
Bridgewater Street
Duke Street
Duke Place
Wellington Mills
Heritage House
Roman Garden
Collier Street
Barton Place
Wellington Place
Galloway House
Events Area
Youth Hostel
Viaduct
Basin
Dismantled Railway
Viaducts
Castle Field Junction
MAMUCIUM ROMAN FORT (site of)
Car Park
Catalan Square
Bridgewater Canal
Rochdale Canal
Towing Path
Dukes Lock
Dukes 92 (PH)
Bass Warehouse
Eastgate
Merchants Warehouse
Slate Wharf
Castle Street
Drawbridge
Auction Mart
Shelter
Travelling Crane
The Castlefield Hotel
Castlefield Canal Basin
Galleon Court
Swan Court
Swan Place
Quay Street
Dantzic Street
Hilton Street
Oxford Street
Chapel Street
Peter Street
Whitworth Street
Granby Row
Dunlop House
Dunlop Mews
Grum House
Rochdale House
Ship Canal House
Posts
Bollards
Weir
Tcb
Tca
Lb
Pc
Ph
Fb
Sl
Es
Gu
Ic
Rsj
Ep
Ts
Hs
Cv
Tunnel
Lost
Car Park
Drawbridge
Bridge
Viaduct
Shelter
Auction Mart
Deansgate Locks
Deansgate-Castlefield (Tram Station)
Deansgate Tunnel
Gaythorn Tunnel
Castlefield Hotel
Castlefield Canal Basin
Ship Canal House
Rochdale House
Slate Wharf
Merchants Warehouse
Bass Warehouse
Dukes 92 (PH)
Dukes Lock
Towing Path
Bridgewater Canal
Catalan Square
Viaduct
Viaducts
Basin
Dismantled Railway
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Trafford Street
Deansgate Station
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Hotel
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Campfield Arcade
Castlefield House
Byrom Street
Tonman Street
Barton Street
Whitworth Street
Great John Street
St John's Passage
Overseas House
The Court House
Hotel
Memi
Culvercliffe Walk
Ashton Walk
Porchfield Square
Coronation Street
Swan Court
Swan Place
Quay Street
Dantzic Street
Hilton Street
Oxford Street
Chapel Street
Peter

APPENDIX F

Blue Roof Designer Correspondence

JoeBullough

From: ABP Roofing <technical@alumascroofing.com>
Sent: 30 July 2020 10:14
To: JoeBullough
Cc: Mark Fulton; Patrick Clayton
Subject: RE: Blue & Green Roof Proposal - Manchester Central - SP109948

Hi Joe,

In response to your e-mail, I've been reviewing the blue roof calculations and information supplied to date from my colleague Andy.

Drainage calculations for conventional gravity drainage systems are carried out in accordance with BS EN 12056:2000. It is within this standard that vertical surfaces are to be factored into the calculation. The standard quotes 'The effective catchment area of a single wall should be taken as 50% of its area, up to a maximum of 10m'. The previous advice from my colleague therefore does requires a little adjustment. Assuming that the width is 48.4m and including a maximum of 10m height, the additional catchment to be compliant with this standard is 242m^2 thus totalling a total catchment of 878m^2 and not the 1198.89m^2 previously advised.

There are no standards directly governing Blue Roof design, whilst reference is made within CIRIA C753 ("The SuDS Manual") to the principles of BS EN 12056-3:2000, it down to the client if vertical catchment is to be factored into the overall design. This appears to be in the case on this occasion.

For the podium deck the blue roof response is summarised below by applying the catchment areas noted and limiting the VF depth to 100mm.
- Total Gross footprint of building = 636m^2 + 242m^2 of vertical catchment = 878m^2
- Roof area available for blue roof attenuation system = 530m^2 approx.
- Design flow = 4.59 l/s
- Detention volume = 44.7m^3
- Max. stage depth = 89mm
- Outlets = 3 No

By reducing the design flow will increase the stage depth and subsequently the VF to accommodate it. You will need a VF of circa. 150mm to get below 2 l/s.

Hope this helps.

Regards

Chris Buckley | Technical Design Manager
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From: JoeBullough <JoeBullough@renaissance-ltd.com>
Sent: 20 July 2020 17:04
To: Andrew Beeney <beeneya@alumasc-exteriors.co.uk>; Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Cc: ABP Roofing Customer Support <customersupport@alumascroofing.com>; Patrick Clayton <patrickclayton@renaissance-ltd.com>
Subject: RE: Blue & Green Roof Proposal - Manchester Central - SP109948

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Hi Both,

Upon further discussions with the Architect and the rest of the design team would it be possible to run the podium roof calculation again but limit the void former to 100mm and let us know the discharge rate.

Also I would just like enquiry further about the calculation to account for the façade wash down. Would it be possible to explain a little more of where the 10% comes from or point us in the right direction so we could do some further research? Also is this calculation only applicable for blue/green roof systems or is it appropriate for estimating the wash down for any façade of the building.

Many Thanks,

Joe Bullough | Graduate Engineer
MEng

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Manchester, M1 2HG

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We will continue to carry out meetings via teleconference and attendance on site will be undertaken only when a risk assessment and site protocol has been issued and signed-off by our management team.

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From: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Sent: 15 July 2020 18:12
To: Andrew Beeney <beeneya@alumasc-exteriors.co.uk>; Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Cc: ABP Roofing Customer Support <customersupport@alumascroofing.com>; JoeBullough <JoeBullough@renaissance-ltd.com>
Subject: RE: Blue & Green Roof Proposal - Manchester Central - SP109948

Thanks Andrew, Mark,

Much appreciated

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f: renaissance associates ltd
w: www.renaissance-ltd.com

From: Andrew Beeney <beeneya@alumasc-exteriors.co.uk>
Sent: 15 July 2020 13:16
To: Mark Fulton <fultonm@alumasc-exteriors.co.uk>; Patrick Clayton <patrickclayton@renaissance-ltd.com>
Cc: ABP Roofing Customer Support <customersupport@alumascroofing.com>
Subject: RE: Blue & Green Roof Proposal - Manchester Central - SP109948

Patrick,

I've gone through the information below & have updated our calculations. These will obviously still be of subject to change, dependant upon any design changes of the building. I've commented below on the information sent over.

Tower Roof:

- Total Gross footprint of building = 913m^2
- Roof area available for blue roof attenuation system = 670m^2 approx – Taken as 670

Phase 1 Level 02 Landscaped roof 'podium' deck
- Total Gross footprint of building = 636m^2
- Roof area available for blue roof attenuation system = 530m^2 approx – Taken as 530, plus additional will be added due to façade – See below.

Allowable discharge rates (greenfield equivalent) for each return period (RP) provided below:

RP	TOWER ROOF (l/s)	PODIUM (l/s)
1	1.12	0.78
2	1.32	0.92
30	1.87	1.30
100	2.02	1.41
100+40CC	2.83	1.97

- Closest I can get calculations are 2.31 L/S & 1.392 L/S

Tower Roof – 6 No. BR15 restricted outlets, with 100mm Void Former, discharge of 2.31 L/S, attenuates for 6.15 hours
Terrace Roof – 3 No. BR15 Outlets, with 225mm Void Former, discharge of 1.392 L/S, attenuating for 21.6 hours.

Would it be possible to update the blue roof proposals to achieve these figures? Also, would there be any opportunity to further reduce the flow rates at all? We are trying hard to avoid putting in additional attenuation in the form of buried tanks, so we are trying to maximise the performance of the blue roof system to try and compensate for free discharge of areas of public realm (if agreeable with UU / MCC).

In addition to the above, Manchester City Council have asked for the drainage design to consider additional volumes of rainwater due to the wash down on the tall building façade. This will come into play for the Level 02 podium deck. Can you provide commentary/calcs on how you are accounting for this so we can include in our response to the planners? Additional square meterage will need to be added to the Roof area – this is taken at 10% of the width of the proposed façade x the height of the façade in question (width is 48.4m – 10% = 4.84m x 116.3m height = 562.89m2) so total area of roof drainage is 562.89+636m2 = 1198.89m2.

Hopefully the above information will help, if however, you do require any additional information, please do not hesitate to contact me.

Kind regards

Andy Beeney
Southern Technical Manager

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Project drone footage, training videos, latest case studies and news can all be found on our social media channels:

Head Office: Alumasc Roofing Systems, White House Works, Bold Road, St Helens, Merseyside WA9 4JG

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From: Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Sent: 09 July 2020 07:25
To: ABP Roofing <technical@alumascroofing.com>
Subject: FW: Blue & Green Roof Proposal - Manchester Central - SP109948
Importance: High

Hi All,

Please see email below regarding updates to the Blu Roof Calcs that were recently done on SP109948.

Can these be updated in line with the info below and Patrick proposals looked at please?

Many Thanks

Mark Fulton | Senior Area Technical Manager
Alumasc Roofing Systems | New Build
an Alumasc Building Envelope Company

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From: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Sent: 08 July 2020 15:27
To: Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Cc: Robyn Wight <RobynWight@renaissance-ltd.com>; Gary Robinson <garyrobinson@renaissance-ltd.com>; Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Leon Ferguson <l.ferguson@alumasc-exteriors.co.uk>; Matt Hakes <MattHakes@ridge.co.uk>; Kate Newman <k.newman@simpsonhaugh.com>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

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Hi Mark,

Many thanks for putting the information together and having a look into this proposal. Agree that something went slightly wrong with my initial email on the limited rate of discharge, thanks for picking this up and providing the attenuated scheme.

Further to this we just wanted to clarify the drainage strategy and what we need the blue roof/roofs to achieve in terms of peak outfall rates. We have recently concluded the Stage 3 (developed) design drawings so there are some small updates from the info discussed previously to bring in line with the current design.

I have attached more detailed mark-ups to show the relevant areas of each roof, summarised here below;

Tower Roof:

- Total Gross footprint of building = 913m^2
- Roof area available for blue roof attenuation system = 670m^2 approx

Phase 1 Level 02 Landscaped roof 'podium' deck

- Total Gross footprint of building = 636m^2
- Roof area available for blue roof attenuation system = 530m^2 approx

Allowable discharge rates (greenfield equivalent) for each return period (RP) provided below:

RP	TOWER ROOF (l/s)	PODIUM (l/s)
1	1.12	0.78
2	1.32	0.92
30	1.87	1.30
100	2.02	1.41
100+40CC	2.83	1.97

Would it be possible to update the blue roof proposals to achieve these figures? Also, would there be any opportunity to further reduce the flow rates at all? We are trying hard to avoid putting in additional attenuation in the form of buried tanks, so we are trying to maximise the performance of the blue roof system to try and compensate for free discharge of areas of public realm (if agreeable with UU / MCC).

In addition to the above, Manchester City Council have asked for the drainage design to consider additional volumes of rainwater due to the wash down on the tall building façade. This will come into play for the Level 02 podium deck. Can you provide commentary/calcs on how you are accounting for this so we can include in our response to the planners?

Hope that is all clear, please give me a call if you wished to discuss further.

Many Thanks
Patrick

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From: Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Sent: 19 June 2020 13:48
To: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Cc: Robyn Wight <RobynWight@renaissance-ltd.com>; Gary Robinson <garyrobinson@renaissance-ltd.com>; Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Leon Ferguson <l.ferguson@alumasc-exteriors.co.uk>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

Hi Patrick,

Please find attached Blu Roof Calculations as requested.

We have looked over the roof plans & the information sent over regarding discharge rates. The discharge rates that have been proposed are very excessive, especially with the Terrace Roof – you quote 9.53l/s – an unrestricted outlet comes in at 10.7l/s, so not much rainwater would be attenuated on the roof.

Therefore we have produced 2 outline calculations for each roof.

One shows as close as possible to your required discharge rate, however little water is attenuated here and for a small amount of time.

The other one which will attenuate the water, but allow to drain completely within 24 hours which is what we are looking for in a BluRoof, otherwise it could just be considered an expensive 'normal' roof.

I hope this is helpful and any feedback is much appreciated.

I am also available to put together the supporting NBS specifications if required.

Kind Regards

Mark Fulton | Senior Area Technical Manager
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From: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Sent: 16 June 2020 15:14
To: Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Cc: Robyn Wight <RobynWight@renaissance-ltd.com>; Gary Robinson <garyrobinson@renaissance-ltd.com>; Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

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Hi Mark,

Apologies this wasn't included.

This area is complicated by the fact it will be delivered in two phases - I have indicated on the attached pdf drawing the area of the roof delivered in Phase 1 which is what we are currently looking at.

Let me know if you needed anything else for your initial assessment.

Regards
Patrick

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From: Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Sent: 15 June 2020 11:53
To: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

Hi Patrick,

Technical are looking at this now for you. However, in the original email, you mentioned a BluRoof to the main roof (which we have info on), but also mention about a BluRoof on the terrace area. We cannot find any information in all the drawings sent over that show any areas of terrace or anything which is dimensioned up. Could you please send this information over so we can produce an additional calculation.

Many Thanks

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From: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Sent: 05 June 2020 17:41
To: Mark Fulton <fultonm@alumasc-exteriors.co.uk>; Leon Ferguson <l.ferguson@alumasc-exteriors.co.uk>; Neil Delve <delven@alumasc-exteriors.co.uk>; gregfletcher@domisconstruction.co.uk
Cc: Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Kate Newman <k.newman@simpsonhaugh.com>; Matt Hakes <MattHakes@ridge.co.uk>; Adrian Culling <Adrian.Culling@blackdown.co.uk>; Gary Robinson <garyrobinson@renaissance-ltd.com>; Robyn Wight <RobynWight@renaissance-ltd.com>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

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Hi Mark,

Thanks for looking into this.

See attached rough drawings with set out of the two areas of roof in question. These are just original check prints of our drawings so please excuse the presentation. The residential tower roof might get a bit smaller as the lift overrun is shown too small on the attached (maybe allow for it to roughly double) but trust this gets you what you need to get going in the first instance.

Regards
Patrick

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From: Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Sent: 05 June 2020 16:08
To: Leon Ferguson <l.ferguson@alumasc-exteriors.co.uk>; Patrick Clayton <patrickclayton@renaissance-ltd.com>; Neil Delve <delven@alumasc-exteriors.co.uk>; gregfletcher@domisconstruction.co.uk
Cc: Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Kate Newman <k.newman@simpsonhaugh.com>; Matt Hakes <MattHakes@ridge.co.uk>; Adrian Culling <Adrian.Culling@blackdown.co.uk>
Subject: RE: Blue & Green Roof Proposal - Manchester Central
Importance: High

Hi Patrick,

Looking through the information, the only thing we can see missing at the moment for us to conduct a blu roof calculation is a dimensioned roof plan. If this roof plan could be clearly marked with which area(s) are blu roof this will also help us in our calculations. We will also have to produce wind calcs so if you have a postcode for the project that would be helpful.

Many Thanks

Mark Fulton | Senior Area Technical Manager
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an Alumasc Building Envelope Company

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From: Mark Fulton
Sent: 05 June 2020 14:53
To: Leon Ferguson <l.ferguson@alumasc-exteriors.co.uk>; Patrick Clayton <patrickclayton@renaissance-ltd.com>; Neil Delve <delven@alumasc-exteriors.co.uk>; gregfletcher@domisconstruction.co.uk
Cc: Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Kate Newman <k.newman@simpsonhaugh.com>; Matt Hakes <MattHakes@ridge.co.uk>; Adrian Culling <Adrian.Culling@blackdown.co.uk>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

Hi Patrick,

We are reviewing the information for you now, we will be back in touch with you soon.

Regards

Mark Fulton | Senior Area Technical Manager
Alumasc Roofing Systems | New Build
an Alumasc Building Envelope Company

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From: Leon Ferguson <l.ferguson@alumasc-exteriors.co.uk>
Sent: 05 June 2020 14:27
To: Patrick Clayton <patrickclayton@renaissance-ltd.com>; Neil Delve <delven@alumasc-exteriors.co.uk>; gregfletcher@domisconstruction.co.uk
Cc: Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Kate Newman <k.newman@simpsonhaugh.com>; Matt Hakes <MattHakes@ridge.co.uk>; Adrian Culling <Adrian.Culling@blackdown.co.uk>; Mark Fulton <fultonm@alumasc-exteriors.co.uk>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

Hello Patrick,

With this email you now have my contact details. I will be happy to help on this project in any way I can.

I will be discussing your requirements with my colleague Mark Fulton (copied in) as he is also going to assist from a Technical point of view and will contribute to providing what you need.

We'll be in contact once we've gathered the info requested by you.

Many thanks,

Leon

Leon Ferguson | Area Technical Manager
Alumasc Roofing Systems | Refurbishment
an Alumasc Building Envelope Company

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From: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Sent: 05 June 2020 13:07
To: Neil Delve <delven@alumasc-exteriors.co.uk>; gregfletcher@domisconstruction.co.uk
Cc: Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Kate Newman <k.newman@simpsonhaugh.com>; Matt Hakes <MattHakes@ridge.co.uk>; Leon Ferguson <l.ferguson@alumasc-exteriors.co.uk>; Adrian Culling <Adrian.Culling@blackdown.co.uk>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

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Thanks Neil,

Further to the below I've included Greg Fletcher from Domis who has been working on the costings, and may be interested in the budgets you mention below.

Many thanks
Patrick

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From: Neil Delve <delven@alumasc-exteriors.co.uk>
Sent: 05 June 2020 12:40
To: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Cc: Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Kate Newman <k.newman@simpsonhaugh.com>; Matt Hakes <MattHakes@ridge.co.uk>; Leon Ferguson <l.ferguson@alumasc-exteriors.co.uk>; Adrian Culling <Adrian.Culling@blackdown.co.uk>
Subject: RE: Blue & Green Roof Proposal - Manchester Central

Patrick

Thanks for your email.

Yes we will look at this for you, I have copied my colleague Leon Ferguson, who is the Area Technical Manager for our Roofing Division who will look into the BluRoof requirements and depth implications with our internal technical team. We can also look at the overall build ups for you via our green roofing and landscaping company, Blackdown. If/when required, Blackdown will be able to provide installation budget costs for the BluRoof void former and landscaping elements, as well as assisting with any design queries on the landscaping. Blackdown have extensive installation experience with BluRoof and as such, means the tendering waterproofing contractors can focus on their speciality.

Regards
Neil Delve | Director Roofpro & Blackdown
Alumasc Roofing Systems
an Alumasc Building Envelope Company

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From: Patrick Clayton <patrickclayton@renaissance-ltd.com>
Sent: 05 June 2020 11:04
To: Neil Delve <delven@alumasc-exteriors.co.uk>
Cc: Kevin Gilsenan <kevingilsenan@renaissance-ltd.com>; Kate Newman <k.newman@simpsonhaugh.com>; Matt Hakes <MattHakes@ridge.co.uk>
Subject: Blue & Green Roof Proposal - Manchester Central

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Good Morning Neil,

Further to our work together on the Burlington Square job for Domis in Manchester, we are looking at a new project which has opportunities for a mix of blue/green roof systems to provide stormwater storage requirements. The job is commencing piling in August. I have attached some project drawings showing the general massing of the scheme – residential 40 storey tower and shared residents roof garden at Level 02. Note a phase 2 large commercial office scheme is also likely to be progressed in future.

From our surface water management and drainage point of view, we would be interested in;

- A blue roof type system to the residential tower. Roof slab structure is proposed as 275mm insitu flat slab, with RC upstand edge beam
- A similar blue / (green?) roof system with restricted outflow from the shared roof garden at level 02 , note there are also areas of grassed/soft landscaped areas too here. Structure is long span steelwork beams supporting precast plank and structural topping floor system. We can provide upstands to the edge.
- Restricted outlets and sufficient attenuation void space within the roofing build up to provide the 1 in 100 year + 40% climate change storage allowance within the roof systems. Initial numbers suggest the following max discharge rates (pro-rata'd based on total site areas and allowable site discharge)
    - Resi tower roof max discharge 1 in 100 + 40% = 6.81l/s
    - Level 02 Terrace roof max discharge 1 in 100 + 40% = 9.53l/s (note increased flow to be considered here to suit tower façade run down)

Please can you advise on;

1. Initial feasibility of roof storage systems esp. relating to the level 02 long span structure
2. Anticipated build ups such that this can be incorporated by the wider project team – Kate, Matt; please shout if you have any other specific questions from an architectural or above ground drainage design point of view

Any questions please let us know.

Regards,
Patrick

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