**United Utilities Water Ltd**
**Developer Services & Metering**
Second Floor, Grasmere House,
Lingley Mere Business Park,
Warrington
WA5 3LP

Telephone: 0345 072 6067
Wastewaterdeveloperservices@uuplc.co.uk

| | |
|---|---|
| Your Reference | EC5170 |
| Our Reference | 4200033424 |
| Date | 14th April 2021 |

Dear Aria,

| | |
|---|---|
| Location: | EC5170 Former Bauer Millett Site Albion Street Manchester M2 5QA 4200033424 |

**Section 106 Water Industry Act 1991**

I refer to your recent application to make a connection to the public sewerage system for the purpose of draining the above property. '**Application to connect to a public sewer'** (**Part 1**) has been approved and you may now appoint your contractor to carry out this work.

If it is your intention to make a connection direct to the public sewer then your contractor must complete the **Request for permission to work on the public sewer (Part 2)** of the application for approval prior to commencing the works. Please click on the link for further guidance and information.

***Please note:** It is important that your contractor/ground workers meet the requirements set out in the guidance on our website.

**http://www.unitedutilities.com/connecting-public-sewer.aspx**

**If the connection is to a lateral or drain only, you will need the approval of the Local Authority Building Inspector following which you may then proceed with this work.

If this connection connects a property to the public sewer for the first time, you need to tell us

**0345 672 2888** (for customers who don't have a water meter)

**0345 672 2999** (for customers with a water meter)

***Please Note: -** This approval is valid for 12 months from the date of this letter.

Should you require further information please call 0345 072 6067.

Yours sincerely,

Megan Wallis

For Developer Services and Metering

renaissance
STRUCTURAL • CIVIL ENGINEERING

# Viadux, Manchester

## Below Ground Surface Water Drainage Detailed Design

Project No: 1910-12
August 2020
Rev: 00

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| | |
|---|---|
| author | **Joe Bullough** |
| signature |  |
| date | **20.08.2020** |
| approved | **Patrick Clayton** |
| signature |  |
| date | **20.08.2020** |

Contact Details:-

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**MIStructE, CEng, Meng**

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**Manchester, M1 2HG**

e: patrickclayton@renaissance-ltd.com

| 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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| eng | JB |
| chk | PC |

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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*

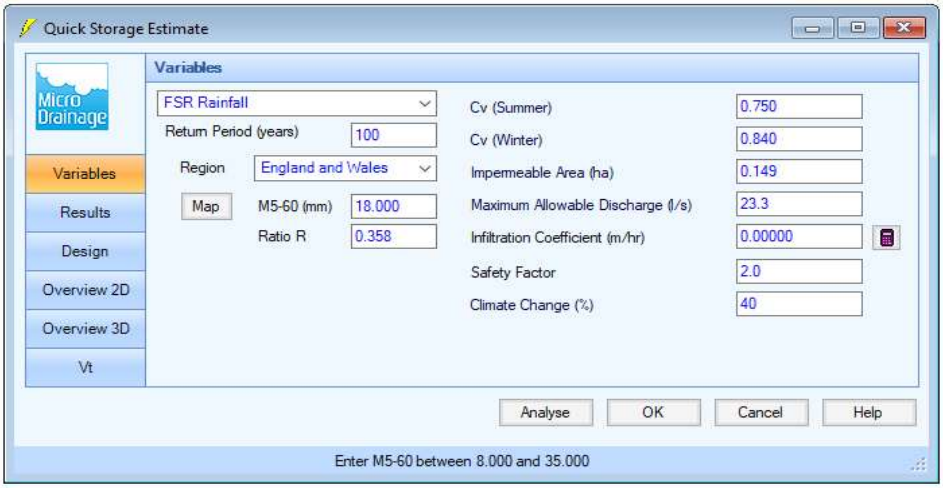
| RETURN PERIOD | TOWER ROOF (l/s) | PODIUM (l/s) | PUBLIC REALM (l/s) | TOTAL (l/s) |
|---|---|---|---|---|
| 1 IN 100 | 2.3 | 4.6 | 23.3 | 30.2 |

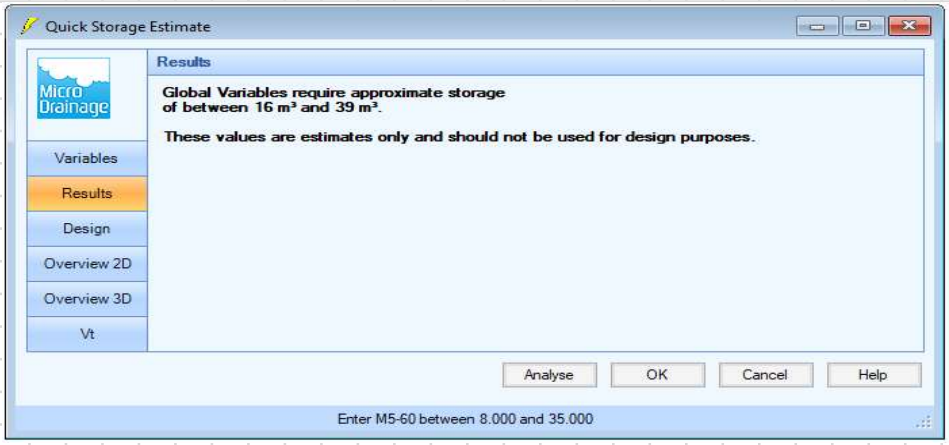
[1] REFER TO BLUE ROOF SPECIALIST'S CALCULATIONS FOR DETAILS OF THE TOWER ROOF AND PODIUM DISCHARGE RATES AND ATTENUATION

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| eng | JB |
| chk | PC |

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## *PUBLIC REALM QUICK STORAGE ESTIMATE*



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

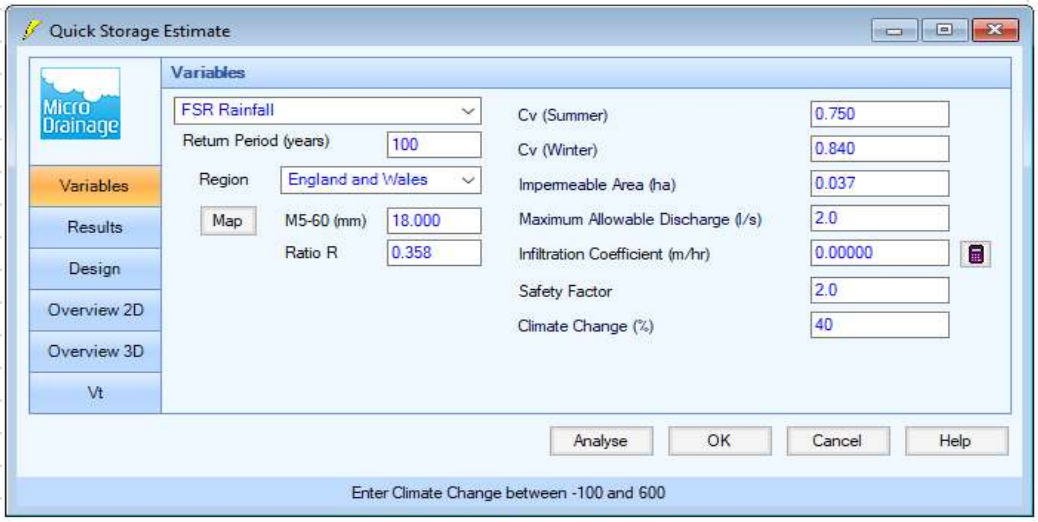
***GREENFIELD RUN-OFF RATES:***

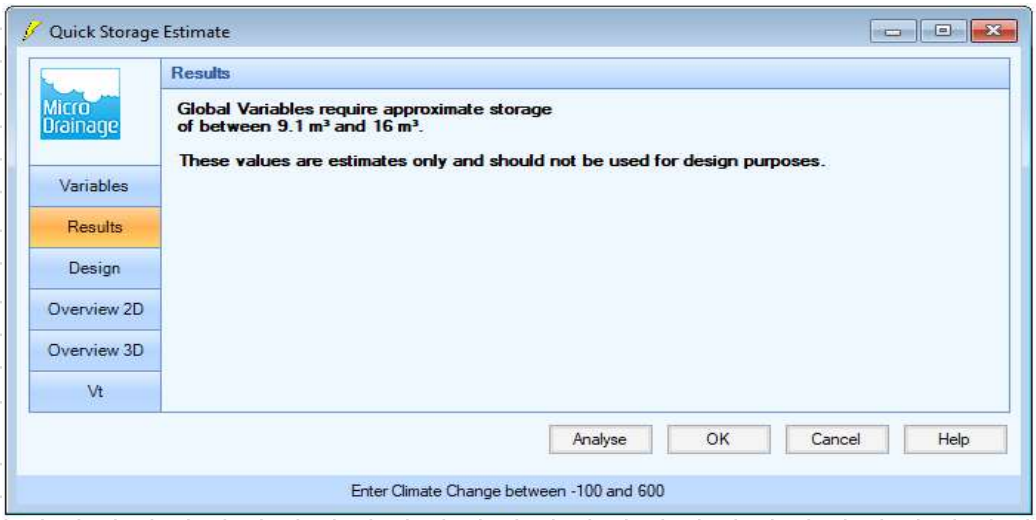
| RETURN PERIOD | Run-Off (l/s) |
|---|---|
| 1 IN 1 | 0.5 |
| 1 IN 2 | 0.5 |
| 1 IN 30 | 0.8 |
| 1 IN 100 | 0.8 |

***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

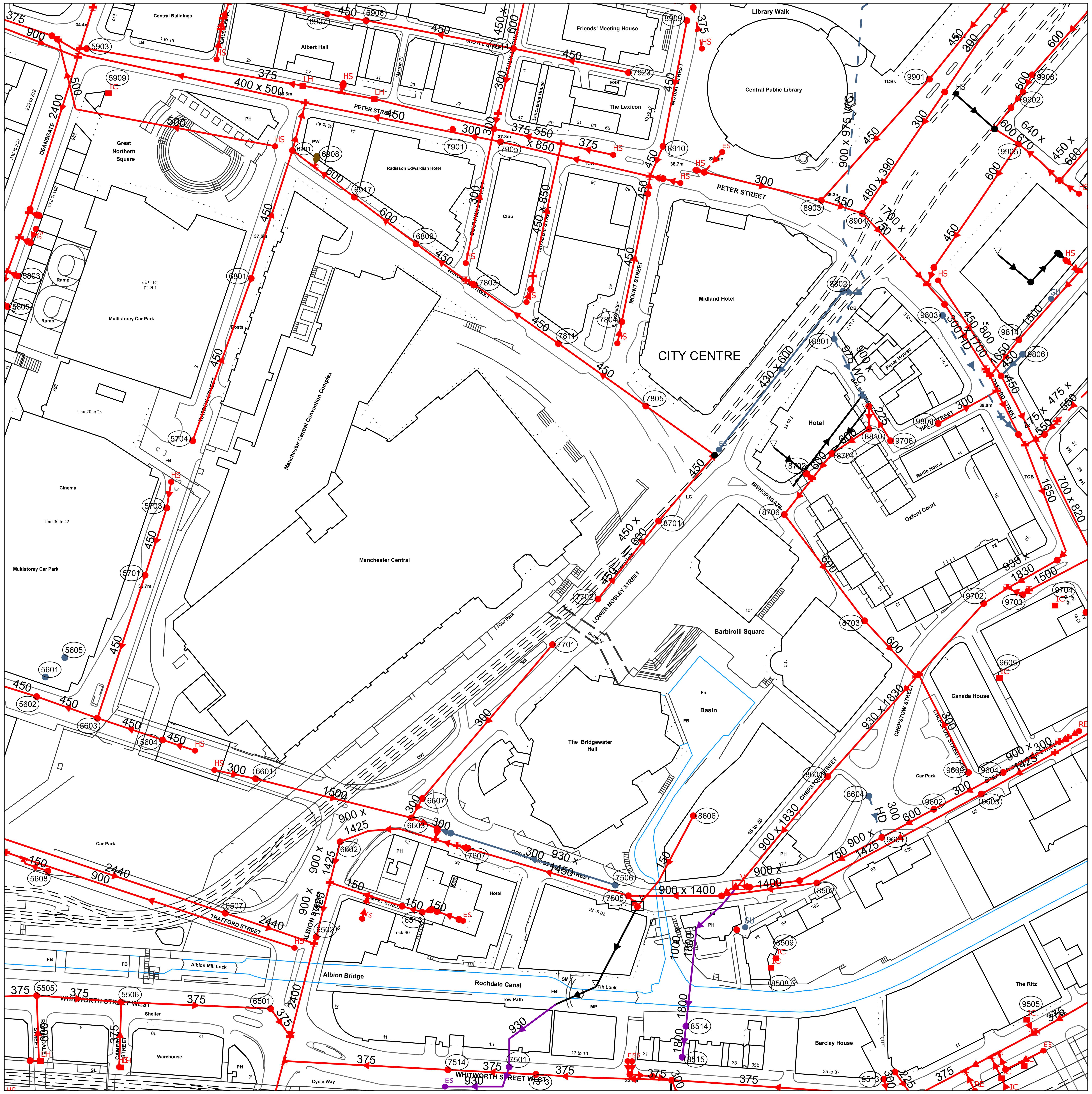
| PN | US/MH Name | Event | US/CL (m) | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) |
|---|---|---|---|---|---|---|---|---|
| S1.000 | S1 | 15 minute 100 year Summer I+40% | 35.440 | 33.528 | 0.863 | 0.000 | 0.11 | |
| S1.001 | S2 | 15 minute 100 year Winter 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

Foul / Surface / Combined / Overflow

- Manhole
- Manhole, Side Entry
- MainSewer, Public
- MainSewer, Private
- MainSewer, S104
- Rising Main, Public
- Rising Main, Private
- Rising Main, S104
- Highway Drain, Private

Foul / Surface / Combined

- WW Site Termination
- Air Valve
- Cascade
- Non Return Valve
- Extent of Survey
- Flow Meter
- Gulley
- Hatch Box
- Head of System
- Hydrobrake / Vortex
- Inlet
- Inspection Chamber
- Bifurcation
- Catchpit
- Contaminated Surface Water
- WW Pumping Station
- Sludge Pumping Station
- Sewer Overflow
- T Junction/Saddle
- LampHole
- OilInterceptor
- PenStock
- Pump
- RoddingEye
- Soakaway
- Summit
- Valve
- Valve Chamber
- Washout Chamber
- DropShaft
- WW Treatment Works
- Septic Tank
- Vent Column
- Network Storage Tank
- Orifice Plate
- Vortex Chamber
- Penstock Chamber
- Blind Manhole

Foul / Surface / Combined / Overflow

- Screen Chamber
- Discharge Point
- Outfall

- Sludge Main, Public
- Sludge Main, Private
- Sludge Main, S104

**ABANDONED PIPE**

- MainSewer
- Rising Main
- Highway Drain
- Sludge Main

- Control Kiosk
- Unspecified

## 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

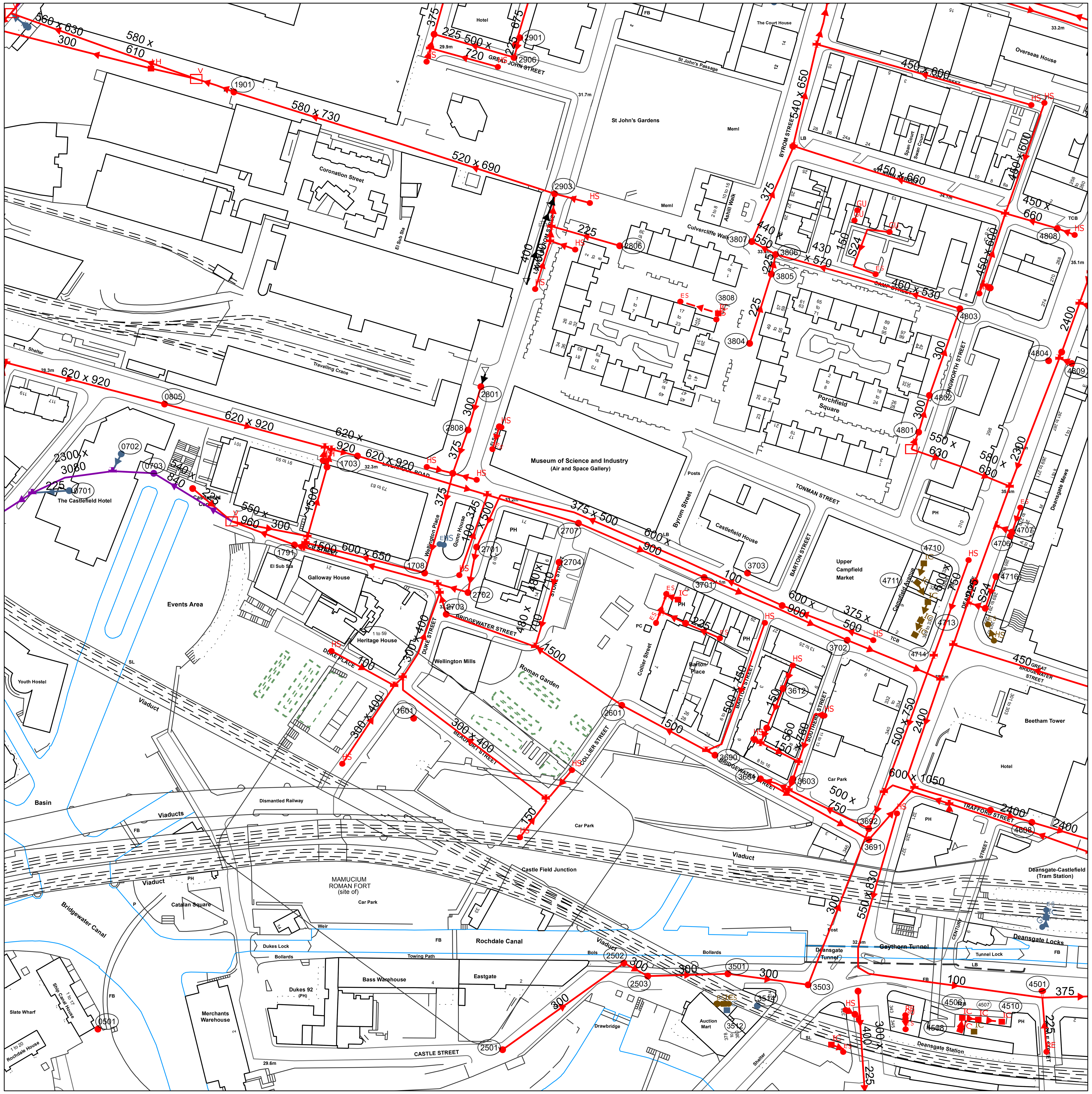
helping life flow smoothly

**SEWER RECORDS**

OS Sheet No: SJ8397NE

Printed By: Property Searches

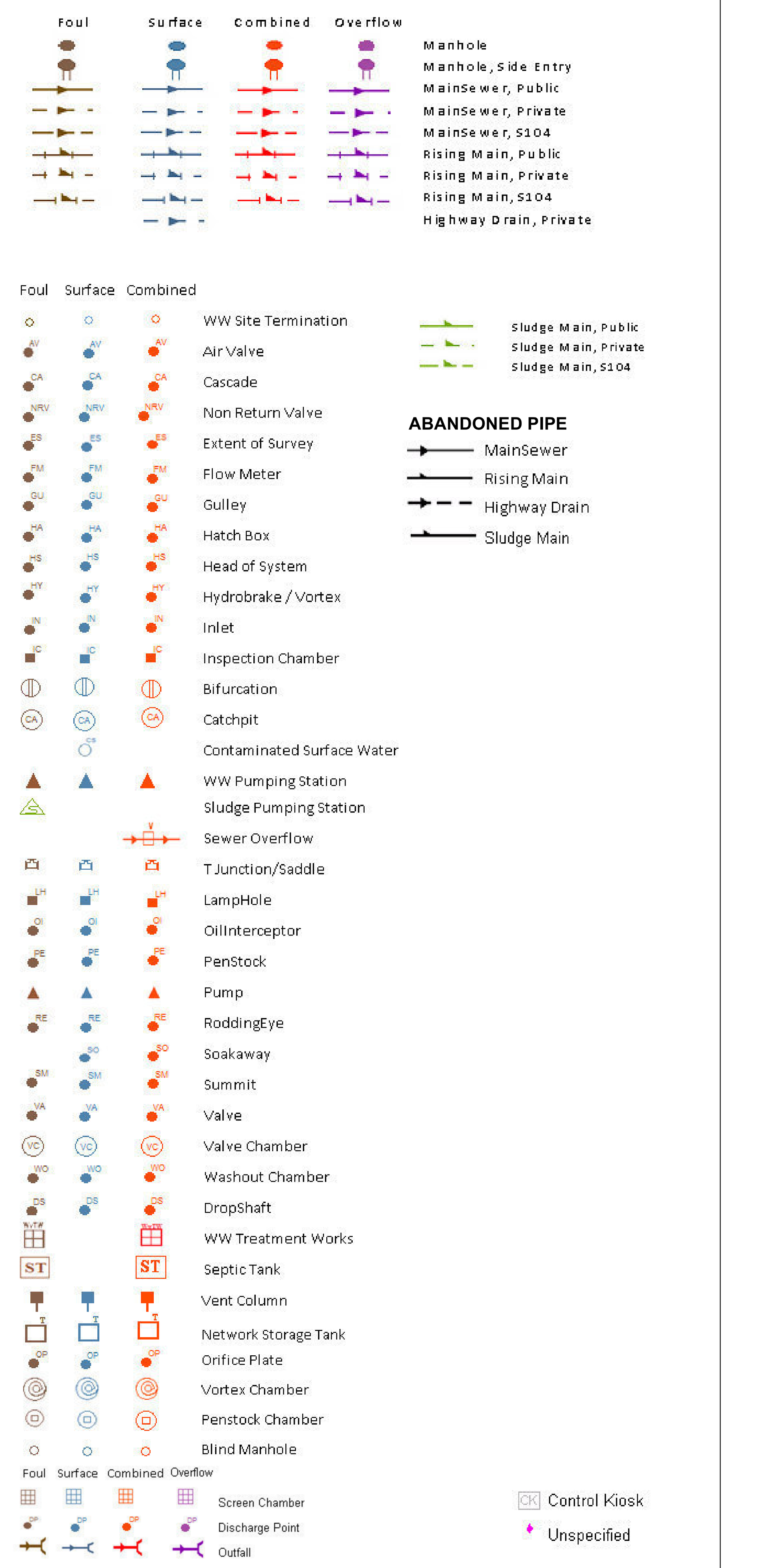
Scale: 1:1250 Date: 25/11/2016




| Refno | Cover | Func | Invert | Size.x | Size.y | Shape | Matl | Length | Grad |
|---|---|---|---|---|---|---|---|---|---|
| 0501 | | CO | | | | | | | |
| 0701 | 25.6 | SW | 24.47 | 225 | | CI | VC | 17.03 | |
| 0702 | 25.59 | SW | 24.74 | 225 | | CI | VC | 8.94 | |
| 0703 | 25.81 | OV | 22.78 | 2300 | 3080 | UN | BR | 128.36 | |
| 0704 | 26.25 | CO | 23.77 | 225 | | CI | VC | 23.54 | 81 |
| 0805 | 29.54 | CO | | | | | | | |
| 0901 | 26.68 | SW | 23.4 | 400 | | CI | VC | 5 | 26 |
| 1601 | 33.23 | CO | | | | | | | |
| 1703 | 31.99 | CO | 22.21 | 620 | 920 | EG | BR | 106.61 | |
| 1708 | 32.57 | CO | | | | | | | |
| 1709 | 31.39 | CO | | | | | | | |
| 1791 | 29.37 | CO | | | | | | | |
| 1901 | 28.95 | CO | | | | | | | |
| 1906 | | CO | | | | | | | |
| 2501 | 31.09 | CO | 24.95 | 300 | | CI | VC | 68.82 | 299 |
| 2502 | 29.53 | CO | | | | | | | |
| 2503 | 32.16 | CO | | | | | | | |
| 2601 | 33.75 | CO | 26.77 | 1500 | | CI | CO | 91.92 | 919 |
| 2701 | 33.05 | CO | 28.12 | 300 | | CI | BR | 10.2 | |
| 2702 | 33.12 | CO | 25.87 | 1500 | | CI | CO | 14.56 | |
| 2703 | 33.04 | CO | 25.9 | 1500 | | CI | CO | 14.56 | |
| 2704 | 33.44 | CO | 30.36 | 480 | 710 | FT | BR | 19.65 | |
| 2706 | 32.91 | CO | 29.87 | 375 | | CI | CO | 23.77 | |
| 2707 | 33.5 | CO | 22.19 | 600 | 900 | EG | BR | 63.16 | 1263 |
| 2801 | 33.17 | CO | 30.67 | 300 | | CI | BR | 20.88 | 54 |
| 2802 | | CO | | 150 | | CI | VC | 10.86 | |
| 2806 | 33.42 | CO | 31.38 | 225 | | CI | VC | 32.7 | |
| 2808 | | CO | 30.28 | 375 | | CI | CO | 21.19 | 54 |
| 2901 | | CO | | 225 | | CI | VC | 9.54 | |
| 2902 | | CO | 0 | 675 | | CI | VC | 66.76 | |
| 2903 | 32.21 | CO | | | | | | | |
| 2906 | | CO | | 225 | | CI | VC | 38.34 | |
| 3501 | 32.11 | CO | | | | | | | |
| 3502 | | CO | | | | | | | |
| 3503 | 32.24 | CO | | | | | | | |
| 3504 | 31.9 | CO | 30 | 300 | 400 | EG | VC | 30.07 | 15 |
| 3505 | | CO | | 100 | | CI | VC | 3.08 | |
| 3512 | | SW | | | | | | | |
| 3513 | 0 | FO | | | | | | | |
| 3514 | | SW | | | | | | | |
| 3601 | 34.38 | CO | 26.9 | 375 | | CI | VC | 28.65 | |
| 3603 | | CO | 0 | 560 | 760 | UN | BR | 5.39 | |
| 3605 | | CO | | | | | | | |
| 3612 | | CO | | | | | | | |
| 3690 | 34.2 | CO | 27.14 | 1500 | | CI | CO | 48.77 | 139 |
| 3691 | 33.4 | CO | | | | | | | |
| 3692 | 33.74 | CO | 0 | 500 | 750 | UN | BR | 41.15 | |
| 3701 | 34.12 | CO | | | | | | | |
| 3702 | 34.7 | CO | | | | | | | |
| 3703 | 34.32 | CO | | | | | | | |
| 3707 | 34.62 | CO | | | | | | | |
| 3710 | | CO | | 225 | | CI | VC | 12.82 | |
| 3711 | | CO | | | | | | | |
| 3804 | 34.07 | CO | 33.04 | 225 | | CI | VC | 33.53 | 17 |
| 3805 | 33.63 | CO | 31.01 | 225 | | CI | VC | 9.22 | 33 |
| 3806 | 33.49 | CO | | | | | | | |
| 3807 | 33.44 | CO | | | | | | | |
| 3808 | | CO | | | | | | | |
| 3901 | 33.28 | CO | 29.58 | 540 | 650 | FT | BR | 48.27 | |
| 4501 | 33.52 | CO | | | | | | | |
| 4506 | | CO | | | | | | | |
| 4507 | | CO | | | | | | | |
| 4508 | | CO | | | | | | | |
| 4509 | | FO | | | | | | | |
| 4510 | | CO | | | | | | | |
| 4512 | | SW | | | | | | | |
| 4608 | | CO | 0 | 2400 | | CI | BR | 27.9 | |
| 4609 | | CO | | 2400 | | CI | BR | 19.89 | |
| 4704 | 35.36 | CO | | | | | | | |
| 4706 | | CO | | 150 | | CI | VC | 2.11 | |
| 4707 | | CO | | | | | | | |
| 4710 | | FO | | | | | | | |
| 4711 | | FO | | | | | | | |
| 4712 | | FO | | | | | | | |
| 4713 | | FO | | | | | | | |
| 4714 | | FO | | | | | | | |
| 4715 | | CO | | | | | | | |
| 4716 | | CO | | 225 | | CI | VC | 15.41 | |
| 4801 | 34.39 | CO | | | | | | | |
| 4802 | 34.21 | CO | | | | | | | |
| 4803 | 34.44 | CO | 31.43 | 460 | 530 | UN | BR | 43.97 | 92 |
| 4804 | 35.23 | CO | | | | | | | |
| 4805 | 35.27 | CO | | | | | | | |
| 4808 | 35.15 | CO | 31.85 | 450 | 660 | UN | BR | 25 | |
| 4809 | | CO | | 0 | | CI | VC | 6.15 | |
| 4812 | | CO | | 225 | | CI | VC | 4.05 | |
| 9026 | | CO | 0 | 600 | 750 | UN | CO | 16.81 | |
| 3100 | | CO | | 150 | | CI | VC | 11.49 | |
| 0708 | | OV | 0 | 540 | 840 | UN | BR | 21.1 | |
| 0905 | | SW | 23.21 | 500 | 700 | UN | BR | 5.11 | 27 |
| 0906 | | CO | 23.89 | 560 | 630 | UN | BR | 45.54 | 52 |
| 0907 | | CO | 24.9 | 570 | 640 | FT | BR | 9.79 | 98 |
| 1602 | | CO | 0 | 300 | 400 | UN | CO | 48.92 | |
| 1702 | | CO | 0 | 450 | | CI | CO | 12.37 | |
| 1704 | | CO | 0 | 100 | | CI | CO | 33.12 | |
| 1902 | | CO | 0 | 500 | 750 | UN | VC | 6.42 | |
| 1904 | | CO | | | | | | | |
| 1905 | | CO | | | | | | | |
| 2602 | | CO | 0 | 150 | | CI | VC | 20 | |
| 2603 | | CO | 0 | 150 | | CI | VC | 15.62 | |
| 2605 | | CO | 0 | 400 | | CI | VC | 2.24 | |
| 2606 | | CO | | | | | | | |
| 2705 | | SW | | | | | | | |
| 2708 | | CO | | | | | | | |
| 2710 | | CO | 0 | 100 | | CI | VC | 39.22 | |
| 2711 | | CO | 0 | 450 | | CI | CO | 11.4 | |
| 2713 | | CO | 30.62 | 1500 | | CI | CO | 11.18 | |
| 2714 | | CO | | | | | | | |
| 2715 | | CO | 31.22 | 600 | 650 | UN | CO | 24.04 | |
| 2800 | | CO | 0 | 400 | 600 | UN | CO | 12.28 | |
| 2803 | | CO | | | | | | | |
| 2807 | | CO | 0 | 400 | 600 | UN | CO | 23.22 | |
| 2904 | | CO | 0 | 500 | 720 | UN | VC | 32.35 | |
| 3506 | | CO | 0 | 100 | | CI | VC | 80.75 | |
| 3507 | | CO | 27.93 | 225 | | CI | VC | 30.07 | 15 |
| 3509 | | CO | | 100 | | CI | VC | 4.71 | |
| 3511 | | CO | | | | | | | |
| 3600 | | CO | 0 | 150 | | CI | VC | 3.78 | |
| 3604 | | CO | 0 | 560 | 760 | UN | VC | 31.62 | |
| 3607 | | CO | | | | | | | |
| 3608 | | CO | | | | | | | |
| 3611 | | CO | | | | | | | |
| 3704 | | CO | 0 | 500 | 750 | UN | CO | 67.08 | |
| 3705 | | CO | 22.11 | 600 | 900 | EG | BR | 36.25 | 3625 |
| 3706 | | CO | | | | | | | |
| 3708 | | CO | 0 | 100 | | CI | VC | 22.47 | |
| 3715 | | CO | | | | | | | |
| 3801 | | CO | | | | | | | |
| 3802 | | CO | | | | | | | |
| 3904 | | CO | | | | | | | |
| 3905 | | CO | | | | | | | |
| 3906 | | CO | | | | | | | |
| 4505 | | CO | | | | | | | |
| 4511 | | SW | | | | | | | |
| 4514 | | SW | | | | | | | |
| 4603 | | CO | 0 | 550 | 830 | UN | VC | 79.39 | |
| 4604 | | CO | | | | | | | |
| 4605 | | CO | 0 | 600 | 1050 | UN | BR | 53.38 | |
| 4606 | | CO | | | | | | | |
| 4703 | | CO | 0 | 375 | 500 | UN | VC | 22.47 | |
| 4705 | | CO | 0 | 580 | 630 | UN | BR | 23.77 | |
| 4719 | | FO | | | | | | | |
| 4792 | | CO | 0 | 500 | 750 | UN | BR | 46.82 | |
| 4806 | | CO | 0 | 450 | 600 | UN | CO | 38.9 | |
| 4807 | | CO | 0 | 450 | 660 | UN | BR | 8.54 | |
| 4813 | | CO | | 150 | | CI | VC | 39.09 | |
| 4901 | | CO | 0 | 450 | 600 | UN | CO | 54.08 | |
| 4902 | | CO | 0 | 450 | 600 | UN | CO | 102.88 | |
| 6400 | | CO | | | | | | | |
| 0705 | | OV | | | | | | | |

| Refno | Cover | Func | Invert | Size.x | Size.y | Shape | Matl | Length | Grad |
|---|---|---|---|---|---|---|---|---|---|
| 0706 | | OV | | | | | | | |
| 0890 | | CO | | | | | | | |
| 0902 | | CO | | | | | | | |
| 1603 | | CO | | | | | | | |
| 1605 | | CO | | | | | | | |
| 1700 | | CO | | | | | | | |
| 1706 | | CO | | | | | | | |
| 1707 | | CO | | | | | | | |
| 1790 | | CO | | | | | | | |
| 1792 | | CO | | | | | | | |
| 1903 | | CO | | | | | | | |
| 2604 | | CO | 0 | 300 | 400 | UN | CO | 88.8 | |
| 2709 | | CO | | | | | | | |
| 2712 | | CO | | | | | | | |
| 2790 | | CO | | | | | | | |
| 2791 | | CO | | | | | | | |
| 2809 | | CO | | | | | | | |
| 2900 | | CO | | | | | | | |
| 3508 | | CO | | | | | | | |
| 3602 | | CO | 0 | 500 | 750 | UN | BR | 6.71 | |
| 3606 | | CO | | | | | | | |
| 3609 | | CO | | | | | | | |
| 3610 | | CO | | | | | | | |
| 3714 | | CO | | | | | | | |
| 3716 | | CO | | | | | | | |
| 3902 | | CO | 0 | 540 | 650 | FT | BR | 10.44 | |
| 3903 | | CO | | | | | | | |
| 4607 | | CO | | | | | | | |
| 4690 | | CO | | | | | | | |
| 4691 | | CO | | | | | | | |
| 4692 | | CO | | | | | | | |
| 4702 | | CO | | | | | | | |
| 4709 | | CO | | | | | | | |
| 4717 | | CO | | | | | | | |
| 4790 | | CO | | | | | | | |
| 4791 | | CO | 0 | 500 | 750 | UN | BR | 67.07 | |
| 4800 | | CO | | | | | | | |
| 4810 | | CO | | | | | | | |
| 4811 | | CO | | | | | | | |
| 4903 | | CO | | | | | | | |
| 2802 | | CO | | | | | | | |
| 2803 | | CO | | | | | | | |
| 2804 | | CO | | | | | | | |
| 2905 | | CO | | | | | | | |
| 0903 | | CO | 25.45 | 300 | | CI | VC | 95.49 | 48 |
| 0904 | | CO | | | | | | | |
| 1701 | | CO | | | | | | | |
| 4701 | | CO | 31.33 | 550 | 630 | UN | BR | 24.72 | |

## 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: SJ8397NW

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

198 Nodes

Sheet 1 of 1

United Utilities
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**SEWER RECORDS**

**OS Sheet No: SJ8397NW**

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

Printed By: Property Searches

**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
**Alumasc Roofing Systems**
an Alumasc Building Envelope Company

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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**

**Carvers Warehouse, 77 Dale Street**
**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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---

**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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**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
**Alumasc Roofing Systems** | New Build
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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

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

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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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**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
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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
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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
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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

**Patrick Clayton | Associate**
**MIStructE, CEng, MEng**

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