Site Evolution Ltd

Proposed Housing Development,

Kirkland Road,

Ennerdale Bridge.

Drainage Strategy and Calculations

asher
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Document No: AA6874/9/1/1

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	Name	Signature	Date
Prepared by	Ryan Johnston	[redacted]	28/10/20
Purpose of Issue	**Planning Application**		

27 October 2020

Surface Water Drainage Design

The proposed surface water from the development will discharge into new swales to provide storage and clean the water before discharging into existing culverts. The flow is restricted to greenfield runoff rate for each area discharging. A filter trench along the north boundary of the site catches the runoff from north of the site and will pick up any intercepted field drainage. Catchment for the filter drain is 2.1ha.

Greenfield runoff rates: Greenfield runoff rates were calculated using HR Wallingford's Greenfield runoff rate estimation for sites and the following values were obtained for an area of 0.99ha.

1 year – 13.6L/s

100 years – 28.4L/s

This area was the divided up between the impermeable areas on each Network and the following run off for each Network was calculated

Network 1

1 year – 4.2L/s

100 years – 7.9L/s

Network 2

1 year – 5.8L/s

100 years – 13.5L/s

Network 3

1 year – 2.8L/s

100 years – 6.5L/s

The additional runoff from the are to the north of the site is added to Network 1. The outfall from the suds area is to be attenuated to 38L/s at a 100 year storm.

Calculations : All calculations are as prescribed by the Wallingford Procedure – 'Modified Rational Method' and use the parameters set out in Sewers for Adoption 8th edition as the design criteria. Rainfall was generated using the Flood Estimation Handbook CD-ROM. The CASDeF application within the Microdrainage suite was used to generate various rainfall events with return periods of 1, 30 & 100 years.

The design criteria for the network was:

Design Storm, pipes full	1 year
Design Storm, no flooding	30 year
Flood Risk Assessment	100 year
Minimum velocity, pipe full	1m/sec
Ks roughness value	0.6mm
Time of Entry	5 mins
Contributing Area Impermeability	100%

For all storm simulations the model was set to record a flood risk when manhole surcharge reached a level of 300mm below the cover level.

A 40% increase for climate change was added to the design storms.

A further 10% was added to the impervious areas contributing to the proposed networks to allow for urban creep.

Where possible, a minimum cover of 1500mm has been applied to pipework under roads and 900mm in open ground. Where cover is less then 1200mm below the road, concrete protection will be applied to pipework.

Critical Storms

The network was then modelled in Microdrainage to ensure that it will not flood for storms with a return period of up to 30 years and also to establish the critical storms with return periods of 1, 30 and 100 years for use in the network simulation. The critical storms for the network were established during this process and are presented in the Micro Drainage calculations.

Network Simulation

The entire network including all manholes, pipes and the detention basin were then simulated for the critical storm events shown in the Microdrainage calculations.

During the 1 year return period critical storms all flows are contained within the system. No surcharging is experienced at any point in the system during the1 year return period critical storms.

During the 30 year return period critical storms all flows are contained within the system, there is some surcharging into manholes. No flooding is experienced at any point in the system during the 30 year return period critical storms.

During the 100 year return period critical storms there is $0.084m^3$ of flooding at manhole S5 on network 2. No flooding is experienced at any other point in the system during the 100 year return period critical storms.

HR Wallingford Green Field Runoff Calculator

Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

HR Wallingford
Working with water

Calculated by:	William Milne
Site name:	Ennerdale bridge
Site location:	Ennerdale

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

Site Details

Latitude:	54.53207° N
Longitude:	3.43791° W
Reference:	119470346
Date:	Aug 27 2020 17:19

Runoff estimation approach IH124

Site characteristics

Total site area (ha): .99

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	1714	1714
Hydrological region:	10	10
Growth curve factor 1 year:	0.87	0.87
Growth curve factor 30 years:	1.7	1.7
Growth curve factor 100 years:	2.08	2.08
Growth curve factor 200 years:	2.37	2.37

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	13.63	13.63
1 in 1 year (l/s):	11.86	11.86
1 in 30 years (l/s):	23.17	23.17
1 in 100 year (l/s):	28.35	28.35
1 in 200 years (l/s):	32.3	32.3

Simple Index Approach Tool (SIA)

SIMPLE INDEX APPROACH: TOOL

1. The steps set out in the tool should be applied for each inflow or 'runoff area' (ie each impermeable surface area separately discharging to a SuDS component).

2. The supporting 'Design Conditions' stated by the tool must be fully considered and implemented in all cases.

3. The process that is automated in this tool is described in the SuDS Manual, Chapter 26 (Section 26.7)

3. Relevant design examples are included in the SuDS Manual Appendix C.

4. Each of the steps below are part of the process set out in the flowchart on Sheet 3.

5. Sheet 4 summarises the selections made below and indicates the acceptability of the proposed SuDS components.

6. Interception should be delivered for all upstream impermeable areas as part of the strategy for water quantity and quality control for the site. This is required in order to deliver both of the water quality criteria set out in Chapter 4 of the SuDS Manual

(blue cell)	DROP DOWN LIST	RELEVANT INPUTS NEED TO BE SELECTED FROM THESE LISTS, FOR EACH STEP
(green cell)	USER ENTRY	USER ENTRY CELLS ARE ONLY REQUIRED WHERE INDICATED BY THE TOOL

STEP 1: Determine the Pollution Hazard Index for the runoff area discharging to the proposed SuDS scheme

This step requires the user to select the appropriate land use type for the area from which the runoff is occurring

If the land use varies across the 'runoff area', either:

- use the land use type with the highest Pollution Hazard Index
- apply the approach for each of the land use types to determine whether the proposed SuDS design is sufficient for all. If it is not, consider collecting more hazardous runoff separately and providing additional treatment.

If the generic land use types suggested are not applicable, select 'Other' and enter a description of the land use of the runoff area and agreed user defined indices in the row below the drop down lists.

	Runoff Area Land Use Description	*Pollution Hazard*	Total Suspended Solids (*Pollution Hazard Indices*)	Metals (*Pollution Hazard Indices*)	Hydrocarbons (*Pollution Hazard Indices*)	*DESIGN CONDITIONS* 1	*DESIGN CONDITIONS* 2
Select land use type from the drop down list (or 'Other' if none applicable): →	Low traffic roads (e.g. residential roads and general access roads, < 300 traffic movements/day)	Low	0.5	0.4	0.4		
If the generic land use types in the drop down list above are not applicable, select 'Other' and enter a description of the land use of the runoff area and agreed user defined indices in this row:							
	Landuse Pollution Hazard Index	**Low**	**0.5**	**0.4**	**0.4**		

STEP 2A: Determine the Pollution Mitigation Index for the proposed SuDS components

This step requires the user to select the proposed SuDS components that will be used to treat runoff - before it is discharged to a receiving surface waterbody or downstream infiltration component

If the runoff is discharged directly to an infiltration component, without upstream treatment, select 'None' for each of the 3 SuDS components and move to Step 2B

This step should be applied to evaluate the water quality protection provided by proposed SuDS components for discharges to receiving surface waters or downstream infiltration components (note: in England and Wales this will include components that allow any amount of infiltration, however small, even where infiltration is not specifically accounted for in the design).

If you have fewer than 3 components, select 'None' for the components that are not required

If the proposed component is bespoke and/or a proprietary treatment product and not generically described by the suggested components, then 'Proprietary treatment system' or 'User defined indices' should be selected and a description of the component and agreed user defined indices should be entered in the rows below the drop down lists

	SuDS Component Description	Total Suspended Solids (*Pollution Mitigation Indices*)	Metals (*Pollution Mitigation Indices*)	Hydrocarbons (*Pollution Mitigation Indices*)	*DESIGN CONDITIONS* 1	*DESIGN CONDITIONS* 2	*DESIGN CONDITIONS* 3
Select SuDS Component 1 (i.e. the upstream SuDS component) from the drop down list: →	Swale	0.5	0.6	0.6	SuDS components can only be assumed to deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters of the SuDS Manual. See also checklists in Appendix B		
Select SuDS Component 2 (i.e. the second SuDS component in a series) from the drop down list: →	Filter drain (where the trench is not designed as an infiltration component)	0.4	0.4	0.4	SuDS components can only be assumed to deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters of the SuDS Manual. See also checklists in Appendix B	Filter drains should be preceded by upstream component(s) that trap(s) silt, or designed specifically to retain sediment in a separate zone, easily accessible for maintenance, such that the sediment will not be re-suspended in subsequent events	
Select SuDS Component 3 (i.e. the third SuDS component in a series) from the drop down list: →	None	0	0	0			
If the proposed SuDS components are bespoke/proprietary and/or the generic indices above are not considered appropriate, select 'Proprietary treatment system' or 'User defined indices' and enter component descriptions and agreed user defined indices in these rows:							
	Aggregated Surface Water Pollution Mitigation Index	**0.7**	**0.8**	**0.8**			

Note: If the total aggregated mitigation index is > 1 (which is not a realistic outcome), then the outcome is fixed at ">0.95". In this scenario, the proposed components are likely to have a very high mitigation potential for reducing pollutant levels in the runoff and should be sufficient for any proposed land use (note: where risk assessment is required, this outcome would need more detailed verification).

Is the runoff now discharged to an infiltration component?

Yes ? Go to Step 2B
No ? Go to Step 2C

STEP 2B: Determine the Pollution Mitigation Index for the proposed Groundwater Protection

This step requires the user to select the type of groundwater protection that is either part of the SuDS component or that lies between the component and the groundwater

This step should be applied where a SuDS component is specifically designed to infiltrate runoff (note: in England and Wales this will include components that allow any amount of infiltration, however small, even where infiltration is not specifically accounted for in the design).

'Groundwater protection' describes the proposed depth of soil or other material through which runoff will flow between the runoff surface and the underlying groundwater.

Where the discharge is to surface waters and risks to groundwater need not be considered, select 'None'

If the proposed groundwater protection is bespoke and/or a proprietary product and not generically described by the suggested measures, then a description of the protection and agreed user defined indices should be entered in the row below the drop down list

		Total Suspended Solids (*Pollution Mitigation Indices*)	Metals (*Pollution Mitigation Indices*)	Hydrocarbons (*Pollution Mitigation Indices*)	*DESIGN CONDITIONS* 1	*DESIGN CONDITIONS* 2	*DESIGN CONDITIONS* 3	*DESIGN CONDITIONS* 4
Select type of groundwater protection from the drop down list: →	300 mm minimum depth of soils with good contamination attenuation potential	0.4	0.3	0.3	All designs must include a minimum of 1 m unsaturated depth of subsoil or aquifer material between the infiltration surface and the maximum likely groundwater level. Infiltration components should always be preceded by upstream component(s) that trap(s) silt, or designed specifically to retain sediment in a separate lined zone, easily accessible for maintenance, such that the sediment will not be re-suspended in subsequent events	The underlying soils must provide good contaminant attenuation potential (eg as recommended in Sniffer 2008 (a) and (b) / Scott Wilson (2010) or other appropriate guidance). Alternative depth and soil combinations must provide equivalent protection to the underlying groundwater		
If the proposed groundwater protection is bespoke/proprietary and/or the generic indices above are not considered appropriate, select 'Proprietary product' or 'User defined indices' and enter a description of the protection and agreed user defined indices in this row:								
	Groundwater Protection Pollution Mitigation Index	**0.4**	**0.3**	**0.3**				

STEP 2C: Determine the Combined Pollution Mitigation Indices for the Runoff Area

This is an automatic step which combines the proposed SuDS Pollution Mitigation Indices with any Groundwater Protection Pollution Mitigation Indices

	Total Suspended Solids (*Combined Pollution Mitigation Indices*)	Metals (*Combined Pollution Mitigation Indices*)	Hydrocarbons (*Combined Pollution Mitigation Indices*)
Combined Pollution Mitigation Indices for the Runoff Area	**0.9**	**0.95**	**0.95**

Note: If the total aggregated mitigation index is > 1 (which is not a realistic outcome), then the outcome is fixed at ">0.95". In this scenario, the proposed components are likely to have a very high mitigation potential for reducing pollutant levels in the runoff and should be sufficient for any proposed land use (note: where risk assessment is required, this outcome would need more detailed verification).

STEP 2D: Determine Sufficiency of Pollution Mitigation Indices for Selected SuDS Components

This is an automatic step which compares the Combined Pollution Mitigation Indices with the Land Use Hazard Indices, to determine whether the proposed components are sufficient to manage each pollutant category type

When the combined mitigation index exceeds the land use pollution hazard index, then the proposed components are considered sufficient in providing pollution risk mitigation.

In England and Wales, where the discharge is to protected surface waters or groundwater, an additional treatment component (ie over and above that required for standard discharges), or other equivalent protection, is required that provides environmental protection in the event of an unexpected pollution event or poor system performance. Protected surface waters are those designated for drinking water abstraction. In England and Wales, protected groundwater resources are defined as Source Protection Zone 1. In Northern Ireland, a more precautionary approach may be required and this should be checked with the environmental regulator on a site by site basis.

Total Suspended Solids (*Sufficiency of Pollution Mitigation Indices*)	Metals (*Sufficiency of Pollution Mitigation Indices*)	Hydrocarbons (*Sufficiency of Pollution Mitigation Indices*)	*DESIGN CONDITIONS* 1
Sufficient	Sufficient	Sufficient	Reference to local planning documents should also be made to identify any additional protection required for sites due to habitat conservation (see *Chapter 7 The SuDS design process*). The implications of developments on or within close proximity to an area with an environmental designation, such as a Site of Special Scientific Interest (SSSI), should be considered via consultation with relevant conservation bodies such as Natural England

Note: In order to meet both Water Quality criteria set out in the SuDS Manual (Chapter 4), Interception should be delivered for all impermeable areas wherever possible. Interception delivery and treatment may be met by the same components, but Interception requires separate evaluation.

Microdrainage calculations – Surface Water

Network 1

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for STORM 1.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.500	Add Flow / Climate Change (%)	40
Ratio R	0.210	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for STORM 1.SWS

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	70.048	2.802	25.0	0.000	5.00	38.0	0.600	o	300	Pipe/Conduit	
S1.001	26.612	1.064	25.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	41.116	0.206	199.6	0.073	5.00	0.0	0.600	o	300	Pipe/Conduit	
S2.001	1.558	0.031	50.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	11.432	0.457	25.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	42.577	0.213	199.9	0.035	5.00	0.0	0.600	o	300	Pipe/Conduit	
S3.001	1.193	0.039	30.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.003	30.526	1.221	25.0	0.000	0.00	0.0	0.600	o	300	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	48.00	5.37	113.090	0.000	38.0	0.0	15.2	3.16	223.2	53.2
S1.001	47.57	5.51	110.340	0.000	38.0	0.0	15.2	3.16	223.1	53.2
S2.000	47.26	5.62	109.770	0.073	0.0	0.0	3.7	1.11	78.4	13.1
S2.001	47.23	5.63	109.564	0.073	0.0	0.0	3.7	2.22	157.2	13.1
S1.002	47.05	5.69	109.276	0.073	38.0	0.0	18.9	3.16	223.1	66.2
S3.000	47.19	5.64	109.830	0.035	0.0	0.0	1.8	1.11	78.3	6.3
S3.001	47.17	5.65	109.617	0.035	0.0	0.0	1.8	2.85	201.7	6.3
S1.003	46.59	5.85	108.819	0.108	38.0	0.0	20.7	3.16	223.2	72.3

Manhole Schedules for STORM 1.SWS

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	114.000	0.910	Open Manhole	1200	S1.000	113.090	300				
S2	114.000	3.712	Open Manhole	1200	S1.001	110.340	300	S1.000	110.288	300	
S6	111.370	1.600	Open Manhole	1200	S2.000	109.770	300				
S7	111.900	2.336	Open Manhole	1200	S2.001	109.564	300	S2.000	109.564	300	
S3	111.950	2.674	Junction		S1.002	109.276	300	S1.001	109.276	300	
								S2.001	109.533	300	257
S8	111.500	1.670	Open Manhole	1200	S3.000	109.830	300				
S9	112.000	2.383	Open Manhole	1200	S3.001	109.617	300	S3.000	109.617	300	
S4	112.000	3.181	Open Manhole	1200	S1.003	108.819	300	S1.002	108.819	300	
								S3.001	109.578	300	759
S5	109.450	1.852	Open Manhole	0		OUTFALL		S1.003	107.598	300	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	307045.141	516218.752	307045.141	516218.752	Required	
S2	306988.435	516177.628	306988.435	516177.628	Required	
S6	307044.618	516167.068	307044.618	516167.068	Required	
S7	307004.852	516156.619	307004.852	516156.619	Required	
S3	307003.568	516155.737			No Entry	
S8	307052.148	516158.008	307052.148	516158.008	Required	
S9	307011.022	516146.987	307011.022	516146.987	Required	
S4	307010.038	516146.312	307010.038	516146.312	Required	
S5	307027.312	516121.144			No Entry	

Area Summary for STORM 1.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.000	0.000	0.000
1.001	-	-	100	0.000	0.000	0.000
2.000	-	-	100	0.073	0.073	0.073
2.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.035	0.035	0.035
3.001	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.108	0.108	0.108

Free Flowing Outfall Details for STORM 1.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.003	S5	109.450	107.598	107.700	0	0

Online Controls for STORM 1.SWS

Hydro-Brake® Optimum Manhole: S7, DS/PN: S2.001, Volume (m³): 5.5

Unit Reference	MD-SHE-0078-2200-0500-2200	Sump Available	Yes
Design Head (m)	0.500	Diameter (mm)	78
Design Flow (l/s)	2.2	Invert Level (m)	109.564
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	100
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	2.2	Kick-Flo®	0.345	1.9
Flush-Flo™	0.150	2.2	Mean Flow over Head Range	-	1.9

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)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.1	0.600	2.4	1.600	3.7	2.600	4.7	5.000	6.4	7.500	7.8
0.200	2.2	0.800	2.7	1.800	4.0	3.000	5.0	5.500	6.7	8.000	8.1
0.300	2.0	1.000	3.0	2.000	4.2	3.500	5.4	6.000	7.0	8.500	8.3
0.400	2.0	1.200	3.3	2.200	4.3	4.000	5.8	6.500	7.3	9.000	8.6
0.500	2.2	1.400	3.5	2.400	4.5	4.500	6.1	7.000	7.5	9.500	8.8

Hydro-Brake® Optimum Manhole: S9, DS/PN: S3.001, Volume (m³): 5.6

Unit Reference	MD-SHE-0058-1200-0500-1200	Sump Available	Yes
Design Head (m)	0.500	Diameter (mm)	58
Design Flow (l/s)	1.2	Invert Level (m)	109.617
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.500	1.2	Kick-Flo®	0.331	1.0
Flush-Flo™	0.148	1.2	Mean Flow over Head Range	-	1.0

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)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.2	0.600	1.3	1.600	2.0	2.600	2.5	5.000	3.4	7.500	4.2
0.200	1.2	0.800	1.5	1.800	2.1	3.000	2.7	5.500	3.6	8.000	4.3
0.300	1.1	1.000	1.6	2.000	2.2	3.500	2.9	6.000	3.8	8.500	4.5
0.400	1.1	1.200	1.8	2.200	2.3	4.000	3.1	6.500	3.9	9.000	4.6
0.500	1.2	1.400	1.9	2.400	2.4	4.500	3.3	7.000	4.1	9.500	4.7

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 1.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 40.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 2 Number of Storage Structures 3 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.900 Cv (Summer) 0.750
Region England and Wales Ratio R 0.201 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years) 1, 30, 100
Climate Change (%) 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)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	15 Summer	1	+0%					113.191	-0.199	0.000	0.25	
S1.001	S2	15 Summer	1	+0%					110.445	-0.195	0.000	0.27	
S2.000	S6	120 Winter	1	+0%	30/15 Summer				110.021	-0.049	0.000	0.06	
S2.001	S7	120 Winter	1	+0%	1/15 Summer				110.018	0.154	0.000	0.04	
S1.002	S3	15 Summer	1	+0%					109.404	-0.172	0.000	0.33	
S3.000	S8	120 Winter	1	+0%	100/60 Winter				109.908	-0.222	0.000	0.03	
S3.001	S9	120 Winter	1	+0%	30/15 Summer				109.906	-0.011	0.000	0.02	
S1.003	S4	15 Summer	1	+0%					108.928	-0.191	0.000	0.28	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1		53.2	OK	
S1.001	S2		53.3	OK	
S2.000	S6	32	4.5	OK	
S2.001	S7		2.2	SURCHARGED	
S1.002	S3		55.4	OK*	
S3.000	S8	19	2.5	OK	
S3.001	S9		1.2	OK	
S1.003	S4		56.5	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 1.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 40.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 2 Number of Storage Structures 3 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.900 Cv (Summer) 0.750
Region England and Wales Ratio R 0.201 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years) 1, 30, 100
Climate Change (%) 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)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	2880 Summer	30	+0%					113.191	-0.199	0.000	0.25	
S1.001	S2	15 Summer	30	+0%					110.445	-0.195	0.000	0.27	
S2.000	S6	120 Winter	30	+0%	30/15 Summer				110.845	0.775	0.000	0.07	
S2.001	S7	180 Winter	30	+0%	1/15 Summer				110.870	1.006	0.000	0.06	
S1.002	S3	15 Summer	30	+0%					109.404	-0.172	0.000	0.33	
S3.000	S8	180 Winter	30	+0%	100/60 Winter				110.105	-0.025	0.000	0.04	
S3.001	S9	180 Winter	30	+0%	30/15 Summer				110.103	0.186	0.000	0.02	
S1.003	S4	15 Summer	30	+0%					108.928	-0.191	0.000	0.28	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1		53.2	OK	
S1.001	S2		53.3	OK	
S2.000	S6	65	5.1	SURCHARGED	
S2.001	S7		3.4	SURCHARGED	
S1.002	S3		55.7	OK*	
S3.000	S8	81	3.0	OK	
S3.001	S9		1.2	SURCHARGED	
S1.003	S4		56.8	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 1.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Manhole Headloss Coeff (Global)	0.500	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Foul Sewage per hectare (l/s)	0.000	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Additional Flow - % of Total Flow	40.000	Flow per Person per Day (l/per/day)	0.000

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	2	Number of Storage Structures	3	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.900	Cv (Summer)	0.750
Region	England and Wales	Ratio R	0.201	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	2.5 Second Increment (Extended)	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years)	1, 30, 100
Climate Change (%)	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)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	2880 Summer	100	+0%					113.191	-0.199	0.000	0.25	
S1.001	S2	15 Summer	100	+0%					110.445	-0.195	0.000	0.27	
S2.000	S6	180 Winter	100	+0%	30/15 Summer				111.006	0.936	0.000	0.08	
S2.001	S7	180 Winter	100	+0%	1/15 Summer				111.182	1.318	0.000	0.06	
S1.002	S3	15 Summer	100	+0%					109.404	-0.172	0.000	0.33	
S3.000	S8	240 Winter	100	+0%	100/60 Winter				110.168	0.038	0.000	0.04	
S3.001	S9	180 Winter	100	+0%	30/15 Summer				110.272	0.355	0.000	0.02	
S1.003	S4	180 Winter	100	+0%					108.928	-0.191	0.000	0.29	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1		53.2	OK	
S1.001	S2		53.3	OK	
S2.000	S6	88	6.0	SURCHARGED	
S2.001	S7		3.6	SURCHARGED	
S1.002	S3		56.0	OK*	
S3.000	S8	112	2.7	SURCHARGED	
S3.001	S9		1.3	SURCHARGED	
S1.003	S4		58.0	OK	

Microdrainage calculations – Surface Water

Network 2

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for STORM 2.SWS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.700	Add Flow / Climate Change (%)	40
Ratio R	0.215	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for STORM 2.SWS

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	28.135	0.141	199.5	0.066	5.00	0.0	0.600	o	300	Pipe/Conduit	
S1.001	23.604	0.118	200.0	0.016	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	18.028	0.090	200.3	0.088	5.00	0.0	0.600	o	300	Pipe/Conduit	
S2.001	16.185	0.081	199.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.002	16.800	0.084	200.0	0.017	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	12.027	0.200	60.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	12.245	0.061	200.7	0.028	5.00	0.0	0.600	o	300	Pipe/Conduit	
S3.001	18.840	0.094	200.4	0.028	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.003	23.683	0.947	25.0	0.027	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	8.651	0.043	201.2	0.000	0.00	0.0	0.600	o	300	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	48.90	5.42	109.980	0.066	0.0	0.0	3.5	1.11	78.4	12.2
S1.001	47.83	5.78	109.839	0.082	0.0	0.0	4.2	1.11	78.3	14.9
S2.000	49.38	5.27	109.976	0.088	0.0	0.0	4.7	1.11	78.3	16.5
S2.001	48.62	5.51	109.886	0.088	0.0	0.0	4.7	1.11	78.4	16.5
S2.002	47.86	5.77	109.805	0.105	0.0	0.0	5.4	1.11	78.3	19.1
S1.002	47.55	5.88	109.721	0.187	0.0	0.0	9.6	2.03	143.6	33.7
S3.000	49.66	5.18	109.830	0.028	0.0	0.0	1.5	1.11	78.2	5.3
S3.001	48.76	5.47	109.769	0.056	0.0	0.0	3.0	1.11	78.2	10.4
S1.003	47.19	6.00	109.521	0.270	0.0	0.0	13.8	3.16	223.1	48.3
S1.004	46.83	6.13	108.024	0.270	0.0	0.0	13.8	1.10	78.1	48.3

Manhole Schedules for STORM 2.SWS

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	111.650	1.670	Open Manhole	675 x 1350	S1.000	109.980	300				
S2	111.650	1.811	Open Manhole	1200	S1.001	109.839	300	S1.000	109.839	300	
S9	113.500	3.524	Open Manhole	1200	S2.000	109.976	300				
S10	113.300	3.414	Open Manhole	1200	S2.001	109.886	300	S2.000	109.886	300	
S6	112.000	2.195	Open Manhole	1200	S2.002	109.805	300	S2.001	109.805	300	
S3	111.450	1.729	Open Manhole	675 x 1350	S1.002	109.721	300	S1.001	109.721	300	
								S2.002	109.721	300	
S7	111.400	1.570	Open Manhole	675 x 1350	S3.000	109.830	300				
S8	111.550	1.781	Open Manhole	675 x 1350	S3.001	109.769	300	S3.000	109.769	300	
S4	111.000	1.479	Open Manhole	675 x 1350	S1.003	109.521	300	S1.002	109.521	300	
								S3.001	109.675	300	154
S5	110.000	1.976	Open Manhole	675 x 1350	S1.004	108.024	300	S1.003	108.574	300	550
S5	109.500	1.519	Open Manhole	0		OUTFALL		S1.004	107.981	300	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	307059.511	516174.801	307059.511	516174.801	Required	
S2	307082.515	516190.999	307082.515	516190.999	Required	
S9	307094.984	516219.446	307094.984	516219.446	Required	
S10	307112.738	516216.315	307112.738	516216.315	Required	
S6	307109.928	516200.376	307109.928	516200.376	Required	
S3	307105.140	516184.273	307105.140	516184.273	Required	
S7	307073.109	516171.290	307073.109	516171.290	Required	
S8	307083.120	516178.339	307083.120	516178.339	Required	
S4	307101.165	516172.921	307101.165	516172.921	Required	
S5	307094.416	516150.220	307094.416	516150.220	Required	
S5	307102.466	516147.054			No Entry	

Area Summary for STORM 2.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.066	0.066	0.066
1.001	-	-	100	0.016	0.016	0.016
2.000	-	-	100	0.088	0.088	0.088
2.001	-	-	100	0.000	0.000	0.000
2.002	-	-	100	0.017	0.017	0.017
1.002	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.028	0.028	0.028
3.001	-	-	100	0.028	0.028	0.028
1.003	-	-	100	0.027	0.027	0.027
1.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.270	0.270	0.270

Free Flowing Outfall Details for STORM 2.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.004	S5	109.500	107.981	0.000	0	0

Online Controls for STORM 2.SWS

Orifice Manhole: S10, DS/PN: S2.001, Volume (m^3): 5.1

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 109.886

Orifice Manhole: S3, DS/PN: S1.002, Volume (m^3): 4.3

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 109.721

Orifice Manhole: S4, DS/PN: S1.003, Volume (m^3): 3.4

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 109.521

Complex Manhole: S5, DS/PN: S1.004, Volume (m^3): 3.4

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0095-5400-2000-5400	Sump Available	Yes
Design Head (m)	2.000	Diameter (mm)	95
Design Flow (l/s)	5.4	Invert Level (m)	108.024
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.000	5.4	Kick-Flo®	0.851	3.6
Flush-Flo™	0.418	4.5	Mean Flow over Head Range	-	4.3

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)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.1	0.600	4.4	1.600	4.9	2.600	6.1	5.000	8.3	7.500	10.1
0.200	4.1	0.800	3.9	1.800	5.1	3.000	6.5	5.500	8.7	8.000	10.4
0.300	4.4	1.000	3.9	2.000	5.4	3.500	7.0	6.000	9.0	8.500	10.7
0.400	4.5	1.200	4.3	2.200	5.6	4.000	7.5	6.500	9.4	9.000	11.0
0.500	4.5	1.400	4.6	2.400	5.9	4.500	7.9	7.000	9.7	9.500	11.3

Weir

Discharge Coef 0.544 Width (m) 1.200 Invert Level (m) 109.975

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 2.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 40.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 4 Number of Storage Structures 6 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.600 Cv (Summer) 0.750
Region England and Wales Ratio R 0.209 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 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)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	180 Winter	1	+0%	30/30 Winter				110.120	-0.160	0.000	0.05	
S1.001	S2	180 Winter	1	+0%	30/15 Summer				110.120	-0.019	0.000	0.05	
S2.000	S9	60 Winter	1	+0%	30/15 Summer				110.193	-0.083	0.000	0.10	
S2.001	S10	360 Summer	1	+0%	30/15 Summer				110.186	0.000	0.000	0.05	
S2.002	S6	180 Winter	1	+0%	1/120 Winter				110.120	0.015	0.000	0.05	
S1.002	S3	180 Winter	1	+0%	1/30 Winter				110.124	0.103	0.000	0.05	
S3.000	S7	180 Winter	1	+0%	30/15 Winter				110.062	-0.068	0.000	0.02	
S3.001	S8	180 Winter	1	+0%	30/15 Summer				110.062	-0.007	0.000	0.04	
S1.003	S4	180 Winter	1	+0%	1/15 Summer				110.060	0.239	0.000	0.04	
S1.004	S5	180 Winter	1	+0%	1/15 Summer	100/15 Winter			109.976	1.652	0.000	0.09	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1		3.7	OK	
S1.001	S2	66	3.8	OK	
S2.000	S9	43	6.4	OK	
S2.001	S10		3.3	OK	
S2.002	S6	99	3.7	SURCHARGED	
S1.002	S3		5.6	SURCHARGED	
S3.000	S7	62	1.4	OK	
S3.001	S8		2.5	OK	
S1.003	S4	99	8.5	SURCHARGED	
S1.004	S5		5.4	FLOOD RISK	2

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 2.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 40.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 4 Number of Storage Structures 6 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.600 Cv (Summer) 0.750
Region England and Wales Ratio R 0.209 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 0

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	240 Winter	30	+0%	30/30 Winter				110.484	0.204	0.000	0.07	
S1.001	S2	240 Winter	30	+0%	30/15 Summer				110.562	0.423	0.000	0.10	
S2.000	S9	60 Winter	30	+0%	30/15 Summer				110.707	0.431	0.000	0.20	
S2.001	S10	60 Winter	30	+0%	30/15 Summer				110.692	0.506	0.000	0.19	
S2.002	S6	240 Winter	30	+0%	1/120 Winter				110.497	0.392	0.000	0.14	
S1.002	S3	240 Winter	30	+0%	1/30 Winter				110.711	0.690	0.000	0.07	
S3.000	S7	60 Winter	30	+0%	30/15 Winter				110.309	0.179	0.000	0.08	
S3.001	S8	60 Winter	30	+0%	30/15 Summer				110.305	0.236	0.000	0.14	
S1.003	S4	60 Winter	30	+0%	1/15 Summer				110.296	0.475	0.000	0.06	
S1.004	S5	60 Winter	30	+0%	1/15 Summer	100/15 Winter			109.996	1.672	0.000	0.19	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	122	4.9	SURCHARGED	
S1.001	S2	173	7.3	SURCHARGED	
S2.000	S9	49	13.5	SURCHARGED	
S2.001	S10		12.5	SURCHARGED	
S2.002	S6	153	9.1	SURCHARGED	
S1.002	S3		7.5	SURCHARGED	
S3.000	S7	43	5.1	SURCHARGED	
S3.001	S8		9.8	SURCHARGED	
S1.003	S4		11.4	SURCHARGED	
S1.004	S5		11.4	FLOOD RISK	2

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 2.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 40.000 Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 4 Number of Storage Structures 6 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.600 Cv (Summer) 0.750
Region England and Wales Ratio R 0.209 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status ON
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status ON
DTS Status OFF

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 0, 0, 0

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	240 Winter	100	+0%	30/30 Winter				110.636	0.356	0.000	0.07	
S1.001	S2	240 Winter	100	+0%	30/15 Summer				110.710	0.571	0.000	0.11	
S2.000	S9	60 Winter	100	+0%	30/15 Summer				111.028	0.752	0.000	0.24	
S2.001	S10	60 Winter	100	+0%	30/15 Summer				110.996	0.810	0.000	0.24	
S2.002	S6	240 Winter	100	+0%	1/120 Winter				110.652	0.547	0.000	0.15	
S1.002	S3	240 Winter	100	+0%	1/30 Winter				110.900	0.879	0.000	0.08	
S3.000	S7	60 Winter	100	+0%	30/15 Winter				110.456	0.326	0.000	0.10	
S3.001	S8	60 Winter	100	+0%	30/15 Summer				110.454	0.385	0.000	0.20	
S1.003	S4	60 Winter	100	+0%	1/15 Summer				110.442	0.621	0.000	0.07	
S1.004	S5	60 Winter	100	+0%	1/15 Summer	100/15 Winter			110.000	1.676	0.084	0.23	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	150	5.1	SURCHARGED	
S1.001	S2	232	8.0	SURCHARGED	
S2.000	S9	40	16.3	SURCHARGED	
S2.001	S10		15.7	SURCHARGED	
S2.002	S6	172	10.1	SURCHARGED	
S1.002	S3		9.2	SURCHARGED	
S3.000	S7	31	6.3	SURCHARGED	
S3.001	S8		13.3	SURCHARGED	
S1.003	S4		13.8	SURCHARGED	
S1.004	S5		13.5	FLOOD	2

Microdrainage calculations – Surface Water

Network 3

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for STORM 3.SWS

Pipe Sizes STORM 2 Manhole Sizes STORM 2

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.700	Add Flow / Climate Change (%)	40
Ratio R	0.215	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	0.000
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)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for STORM 3.SWS

« - Indicates pipe capacity < flow

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	17.330	0.087	199.2	0.058	5.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S2.000	12.668	0.063	201.1	0.029	5.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S1.001	6.195	0.031	199.8	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒

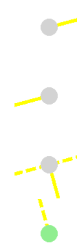
Network Results Table

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)
S1.000	48.95	5.41	106.354	0.058	0.0	0.0	3.1	0.71	12.5	10.8
S2.000	49.29	5.30	106.330	0.029	0.0	0.0	1.5	0.71	12.5	5.4
S1.001	48.50	5.55	106.267	0.087	0.0	0.0	4.6	0.71	12.5«	16.0

Manhole Schedules for STORM 3.SWS

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	109.250	2.896	Open Manhole	1200	S1.000	106.354	150				
S4	108.000	1.670	Open Manhole	1200	S2.000	106.330	150				
S2	108.500	2.233	Open Manhole	1200	S1.001	106.267	150	S1.000	106.267	150	
								S2.000	106.267	150	
S3	108.000	1.764	Open Manhole	0		OUTFALL		S1.001	106.236	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	307034.846	516123.076	307034.846	516123.076	Required	
S4	307063.833	516130.798	307063.833	516130.798	Required	
S2	307051.596	516127.525	307051.596	516127.525	Required	
S3	307053.259	516121.557			No Entry	



Area Summary for STORM 3.SWS

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.058	0.058	0.058
2.000	-	-	100	0.029	0.029	0.029
1.001	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.087	0.087	0.087

Free Flowing Outfall Details for STORM 3.SWS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.001	S3	108.000	106.236	0.000	0	0

Online Controls for STORM 3.SWS

Hydro-Brake® Optimum Manhole: S2, DS/PN: S1.001, Volume (m³): 3.0

Unit Reference	MD-SHE-0070-2800-1700-2800	Sump Available	Yes
Design Head (m)	1.700	Diameter (mm)	70
Design Flow (l/s)	2.8	Invert Level (m)	106.267
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	100
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.700	2.8	Kick-Flo®	0.631	1.8
Flush-Flo™	0.311	2.2	Mean Flow over Head Range	-	2.2

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)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	0.600	1.9	1.600	2.7	2.600	3.4	5.000	4.6	7.500	5.6
0.200	2.1	0.800	2.0	1.800	2.9	3.000	3.6	5.500	4.8	8.000	5.8
0.300	2.2	1.000	2.2	2.000	3.0	3.500	3.9	6.000	5.0	8.500	5.9
0.400	2.2	1.200	2.4	2.200	3.1	4.000	4.2	6.500	5.2	9.000	6.1
0.500	2.1	1.400	2.6	2.400	3.3	4.500	4.4	7.000	5.4	9.500	6.2

1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 3.SWS

Simulation Criteria

Areal Reduction Factor	1.000	Manhole Headloss Coeff (Global)	0.500	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Foul Sewage per hectare (l/s)	0.000	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Additional Flow - % of Total Flow	40.000	Flow per Person per Day (l/per/day)	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	2	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	19.900	Cv (Summer)	0.750
Region	England and Wales	Ratio R	0.208	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0	DVD Status	OFF
Analysis Timestep	2.5 Second Increment (Extended)	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years)	1, 30, 100
Climate Change (%)	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)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	120 Winter	1	+0%	1/15 Summer				106.958	0.454	0.000	0.18	
S2.000	S4	120 Winter	1	+0%	1/15 Summer				106.955	0.475	0.000	0.08	
S1.001	S2	120 Winter	1	+0%	1/15 Summer				106.956	0.539	0.000	0.21	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	47	2.1	SURCHARGED	
S2.000	S4	49	0.9	SURCHARGED	
S1.001	S2		2.2	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 3.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 40.000 Flow per Person per Day (l/per/day) 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 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.900 Cv (Summer) 0.750
Region England and Wales Ratio R 0.208 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years) 1, 30, 100
Climate Change (%) 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)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	240 Winter	30	+0%	1/15 Summer				107.759	1.255	0.000	0.42	
S2.000	S4	240 Winter	30	+0%	1/15 Summer				107.751	1.271	0.000	0.20	
S1.001	S2	240 Winter	30	+0%	1/15 Summer				107.757	1.340	0.000	0.25	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	178	4.9	SURCHARGED	
S2.000	S4	105	2.2	FLOOD RISK	
S1.001	S2		2.6	SURCHARGED	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for STORM 3.SWS

Simulation Criteria

Areal Reduction Factor 1.000 Manhole Headloss Coeff (Global) 0.500 MADD Factor * 10m³/ha Storage 2.000
Hot Start (mins) 0 Foul Sewage per hectare (l/s) 0.000 Inlet Coeffiecient 0.800
Hot Start Level (mm) 0 Additional Flow - % of Total Flow 40.000 Flow per Person per Day (l/per/day) 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 2 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.900 Cv (Summer) 0.750
Region England and Wales Ratio R 0.208 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep 2.5 Second Increment (Extended) Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880
Return Period(s) (years) 1, 30, 100
Climate Change (%) 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)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)
S1.000	S1	240 Winter	100	+0%	1/15 Summer				107.973	1.469	0.000	0.58	
S2.000	S4	240 Winter	100	+0%	1/15 Summer				107.964	1.484	0.000	0.22	
S1.001	S2	240 Winter	100	+0%	1/15 Summer				107.968	1.551	0.000	0.27	

PN	US/MH Name	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	245	6.8	SURCHARGED	
S2.000	S4	139	2.5	FLOOD RISK	
S1.001	S2		2.8	SURCHARGED	