Appendix H SW Drainage

WINDES Output

Greenfield Run of Calculations (IoH 124 Method)

Catchment Areas

Global Variables

Region	FSR - England & Wales
Return Period (yrs)	5
M5-60 (mm)	19.300
Ratio R	0.425
Volumetric Runoff Coef	0.750
Profile Type	Summer
PIMP (%)	100
Areal Reduction Factor	1.000
Storm Duration (mins)	15
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coefficient	0.500
MADD Factor * 10m³/ha Storage	2.000
Foul Sewage/Hectare (l/s)	0.00
Additional Flow - % of Total Flow	20
Inlet Coefficient	0.800
Number of Input Hydrographs	0
Number of Time/Area Diagrams	0
Number of Bifurcations	0
Number of Overflows	0
Number of Off-Line Controls	0
Number of On-Line Controls	0

Starting Storm file name

V:\DEVELOPMENTCAM2003\10589516 A509 ISHAM BYPASS\ANALYSIS\WINDES\POND1_CATCHQ2.SWS

Freely Discharging Outfalls

Outfall Pipe Number	Outfall MH/No	C.Level (m)	I.Level (m)	D,L (mm)	B (mm)
1.014	HW5	59.500	58.040	1500	0

Summary of Results

Return Period (years)	5	Analysis Time Step	Fine
Storm Duration (mins)	15	DTS Status	ON
Profile Type	Summer	DVD Status	OFF
Margin for Flood Risk warning (mm)	300	Inertia Status	OFF

PN	Water Lev. (m)	Surcharged Depth (m)	Flooded Vol (m³)	Flow/ Capacity	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	78.714	0.078	0.000	0.97	0.0	62.9	SURCH'ED
1.001	77.431	0.251	0.000	0.96	0.0	79.4	SURCH'ED
1.002	75.322	0.587	0.000	1.11	0.0	92.0	SURCH'ED
1.003	72.265	-0.106	0.000	0.73	0.0	109.2	O K
1.004	70.505	-0.142	0.000	0.68	0.0	126.5	O K
1.005	69.701	-0.074	0.000	0.98	0.0	142.7	O K
1.006	69.089	-0.155	0.000	0.75	0.0	160.7	O K
1.007	68.560	-0.234	0.000	0.46	0.0	180.7	O K
2.000	78.601	-0.069	0.000	0.76	0.0	54.7	O K
3.000	78.046	0.225	0.000	1.06	0.0	13.7	SURCH'ED
3.001	77.716	0.239	0.000	1.05	0.0	18.2	SURCH'ED
2.001	77.659	0.312	0.000	0.99	0.0	77.4	SURCH'ED
2.002	75.665	0.503	0.000	1.10	0.0	89.0	SURCH'ED
2.003	72.657	-0.110	0.000	0.71	0.0	106.3	O K
2.004	70.978	-0.108	0.000	0.84	0.0	122.7	O K
4.000	72.053	0.403	0.000	1.25	0.0	15.3	SURCH'ED
4.001	71.187	-0.067	0.000	0.79	0.0	25.1	O K
4.002	70.883	-0.153	0.000	0.22	0.0	25.1	O K
2.005	70.167	-0.151	0.000	0.74	0.0	159.8	O K
2.006	69.718	-0.135	0.000	0.81	0.0	168.4	O K
2.007	69.193	-0.232	0.000	0.47	0.0	178.1	O K
2.008	67.744	-0.260	0.000	0.37	0.0	178.4	O K
1.008	67.160	-0.121	0.000	0.88	0.0	368.3	O K
1.009	66.055	-0.119	0.000	0.88	0.0	377.4	O K
1.010	65.209	-0.116	0.000	0.89	0.0	385.2	O K
1.011	63.681	0.103	0.000	0.92	0.0	384.0	SURCH'ED
5.000	65.125	-0.045	0.000	0.82	0.0	18.2	O K
6.000	75.229	0.046	0.000	0.89	0.0	31.6	SURCH'ED
6.001	74.926	0.157	0.000	1.09	0.0	39.0	SURCH'ED
6.002	74.297	0.014	0.000	1.22	0.0	38.8	SURCH'ED
6.003	74.131	-0.101	0.000	0.58	0.0	49.9	O K
6.004	72.314	-0.118	0.000	0.65	0.0	60.8	O K
6.005	71.692	-0.191	0.000	0.29	0.0	60.7	O K
7.000	74.620	-0.002	0.000	0.84	0.0	29.8	O K
7.001	74.115	-0.103	0.000	0.67	0.0	51.2	O K
7.002	73.600	-0.142	0.000	0.53	0.0	66.3	O K
7.003	72.681	-0.149	0.000	0.49	0.0	80.8	O K
6.006	71.086	-0.078	0.000	0.89	0.0	152.0	O K
6.007	69.855	-0.079	0.000	0.88	0.0	174.0	O K
6.008	66.918	-0.058	0.000	0.99	0.0	193.9	O K
6.009	63.847	-0.127	0.000	0.86	0.0	213.0	O K
1.012	63.221	0.197	0.000	1.01	0.0	572.5	SURCH'ED
8.000	74.494	0.290	0.000	1.22	0.0	43.8	SURCH'ED
8.001	73.817	0.010	0.000	1.00	0.0	75.8	SURCH'ED
8.002	73.225	-0.110	0.000	0.72	0.0	92.1	O K
8.003	72.279	-0.119	0.000	0.67	0.0	98.3	O K
8.004	71.688	-0.122	0.000	0.65	0.0	114.4	O K
8.005	69.401	-0.122	0.000	0.65	0.0	130.4	O K
8.006	66.426	-0.105	0.000	0.74	0.0	147.5	O K
8.007	63.350	-0.103	0.000	0.87	0.0	164.7	O K
9.000	66.205	-0.032	0.000	0.79	0.0	18.2	O K
10.000	66.207	-0.064	0.000	0.61	0.0	18.0	O K
10.001	65.344	-0.076	0.000	0.48	0.0	18.1	O K
10.002	64.284	-0.079	0.000	0.74	0.0	40.0	O K
1.013	62.227	0.207	0.000	1.05	0.0	730.0	SURCH'ED
1.014	60.522	0.032	0.000	1.01	0.0	730.0	SURCH'ED

Rainfall Hyetograph

Region	FSR - England & Wales	Profile Type	Summer
Return Period (yrs)	5	Storm Duration (mins)	15
M5-60 (mm)	19.300		
Ratio R	0.425		

Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
1	17.08	4	25.68	7	115.55	10	58.39	13	21.39
2	18.78	5	34.08	8	179.34	11	34.08	14	18.78
3	21.39	6	58.39	9	115.55	12	25.68	15	17.08

Global Variables

Region	FSR - England & Wales
Return Period (yrs)	5
M5-60 (mm)	19.000
Ratio R	0.420
Volumetric Runoff Coef	0.750
Profile Type	Summer
PIMP (%)	100
Areal Reduction Factor	1.000
Storm Duration (mins)	30
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coefficient	0.500
MADD Factor * 10m³/ha Storage	2.000
Foul Sewage/Hectare (l/s)	0.00
Additional Flow - % of Total Flow	20
Inlet Coefficient	0.800
Number of Input Hydrographs	0
Number of Time/Area Diagrams	0
Number of Bifurcations	0
Number of Overflows	0
Number of Off-Line Controls	0
Number of On-Line Controls	0

Starting Storm file name

V:\DEVELOPMENTCAM2003\10589516 A509 ISHAM BYPASS\ANALYSIS\WINDES\POND1(B)_Q1.SWS

Freely Discharging Outfalls

Outfall Pipe Number	Outfall MH/No	C.Level (m)	I.Level (m)	D,L (mm)	B (mm)
1.013	HW4	59.793	55.839	1200	0

Summary of Results

Return Period (years)	5	Analysis Time Step	Fine
Storm Duration (mins)	30	DTS Status	ON
Profile Type	Summer	DVD Status	OFF
Margin for Flood Risk warning (mm)	300	Inertia Status	OFF

PN	Water Lev. (m)	Surcharged Depth (m)	Flooded Vol (m³)	Flow/ Capacity	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	74.533	-0.055	0.000	0.67	0.0	18.2	O K
1.001	72.895	-0.103	0.000	0.55	0.0	34.1	O K
1.002	71.542	-0.122	0.000	0.61	0.0	46.4	O K
1.003	71.134	-0.090	0.000	0.78	0.0	59.2	O K
1.004	70.638	-0.112	0.000	0.69	0.0	71.4	O K
1.005	69.755	-0.129	0.000	0.61	0.0	83.5	O K
1.006	68.187	-0.153	0.000	0.48	0.0	104.0	O K
1.007	65.737	-0.111	0.000	0.71	0.0	126.5	O K
1.008	64.006	-0.055	0.000	1.00	0.0	126.1	O K
1.009	63.447	-0.159	0.000	0.45	0.0	126.0	O K
2.000	64.458	0.022	0.000	0.99	0.0	25.5	SURCH'ED
2.001	62.946	-0.067	0.000	0.58	0.0	25.3	O K
1.010	61.441	0.092	0.000	1.05	0.0	149.9	SURCH'ED
1.011	60.236	-0.116	0.000	0.69	0.0	163.2	O K
3.000	60.178	-0.002	0.000	0.99	0.0	11.0	O K
3.001	59.177	0.037	0.000	0.98	0.0	32.8	SURCH'ED
1.012	56.742	0.153	0.000	1.58	0.0	195.0	SURCH'ED
1.013	56.490	0.001	0.000	1.05	0.0	193.6	SURCH'ED

Rainfall Hyetograph

Region	FSR - England & Wales	Profile Type	Summer
Return Period (yrs)	5	Storm Duration (mins)	30
M5-60 (mm)	19.000		
Ratio R	0.420		

Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
1	10.42	7	15.24	13	61.16	19	42.65	25	13.91
2	10.96	8	16.89	14	83.45	20	30.42	26	12.86
3	11.50	9	19.21	15	112.22	21	23.43	27	12.00
4	12.00	10	23.43	16	112.22	22	19.21	28	11.50
5	12.86	11	30.42	17	83.45	23	16.89	29	10.96
6	13.91	12	42.65	18	61.16	24	15.24	30	10.42

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
15 Summer	26.1	26.1	57.6153	1.3152	1031.5	O K
30 Summer	28.3	28.3	57.8612	1.5612	1426.9	O K
60 Summer	30.3	30.3	58.0832	1.7832	1850.3	O K
120 Summer	31.8	31.8	58.2617	1.9617	2241.0	O K
180 Summer	32.4	32.4	58.3462	2.0462	2441.1	O K
240 Summer	32.8	32.8	58.3927	2.0927	2556.8	O K
360 Summer	33.1	33.1	58.4357	2.1357	2665.2	O K
480 Summer	33.3	33.3	58.4527	2.1527	2709.9	O K
600 Summer	33.3	33.3	58.4537	2.1537	2711.7	O K
720 Summer	33.2	33.2	58.4467	2.1467	2693.9	O K
960 Summer	33.1	33.1	58.4287	2.1287	2647.5	O K
1440 Summer	32.7	32.7	58.3842	2.0842	2535.5	O K
2160 Summer	32.1	32.1	58.3067	2.0067	2345.9	O K
2880 Summer	31.4	31.4	58.2237	1.9237	2154.0	O K
4320 Summer	30.1	30.1	58.0677	1.7677	1818.9	O K
5760 Summer	28.9	28.9	57.9202	1.6202	1533.1	O K
7200 Summer	27.7	27.7	57.7852	1.4852	1296.1	O K
8640 Summer	26.5	26.5	57.6568	1.3567	1093.0	O K
10080 Summer	25.3	25.3	57.5368	1.2368	920.9	O K
15 Winter	26.9	26.9	57.7002	1.4002	1159.6	O K
30 Winter	29.3	29.3	57.9742	1.6742	1634.6	O K
60 Winter	31.4	31.4	58.2122	1.9122	2127.5	O K
120 Winter	32.8	32.8	58.3952	2.0952	2563.2	O K
180 Winter	33.5	33.5	58.4842	2.1842	2792.3	O K
240 Winter	33.9	33.9	58.5347	2.2347	2927.8	O K
360 Winter	34.3	34.3	58.5847	2.2847	3066.2	O K
480 Winter	34.5	34.5	58.6097	2.3097	3135.5	O K
600 Winter	34.5	34.5	58.6192	2.3191	3158.1	O K
720 Winter	34.5	34.5	58.6151	2.3151	3149.2	O K
960 Winter	34.3	34.3	58.5916	2.2916	3085.1	O K
1440 Winter	33.9	33.9	58.5387	2.2387	2938.3	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	124.17	30
30 Summer	80.89	45
60 Summer	50.21	74
120 Summer	30.16	132
180 Summer	22.11	190
240 Summer	17.65	248
360 Summer	12.75	366
480 Summer	10.14	484
600 Summer	8.48	600
720 Summer	7.32	674
960 Summer	5.81	782
1440 Summer	4.18	1034
2160 Summer	3.01	1444
2880 Summer	2.38	1852
4320 Summer	1.70	2648
5760 Summer	1.35	3456
7200 Summer	1.12	4184
8640 Summer	0.96	4936
10080 Summer	0.85	5656
15 Winter	124.17	30
30 Winter	80.89	44
60 Winter	50.21	72
120 Winter	30.16	130
180 Winter	22.11	188
240 Winter	17.65	244
360 Winter	12.75	360
480 Winter	10.14	474
600 Winter	8.48	584
720 Winter	7.32	694
960 Winter	5.81	894
1440 Winter	4.18	1108

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
2160 Winter	33.2	33.2	58.4407	2.1407	2678.1	O K
2880 Winter	32.3	32.3	58.3337	2.0337	2410.6	O K
4320 Winter	30.6	30.6	58.1167	1.8167	1920.2	O K
5760 Winter	28.8	28.8	57.9132	1.6132	1519.7	O K
7200 Winter	27.1	27.1	57.7222	1.4222	1194.4	O K
8640 Winter	25.4	25.4	57.5438	1.2438	930.5	O K
10080 Winter	23.8	23.8	57.3738	1.0738	714.0	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
2160 Winter	3.01	1564
2880 Winter	2.38	2004
4320 Winter	1.70	2856
5760 Winter	1.35	3640
7200 Winter	1.12	4408
8640 Winter	0.96	5184
10080 Winter	0.85	5944

Rainfall Details

Region	ENG+WAL	Cv (Summer)	0.750	Summer Storms	Yes
Return Period (years)	100	Cv (Winter)	0.840	Winter Storms	Yes
M5-60 (mm)	19.100	Shortest Storm (mins)	15	Climate Change %	+30
Ratio-R	0.421	Longest Storm (mins)	10080		

Pipe Network

Volume in Pipe Network (m^3)	367	Dia of Outfall Pipe (m)	0.200
Slope of Outfall Pipe (1:x)	500.0	Roughness of Outfall Pipe	0.600

Time / Area Diagram

Total Area (ha) = 6.090

Time from:	(mins) to:	Area (ha)	Time from:	(mins) to:	Area (ha)	Time from:	(mins) to:	Area (ha)	Time from:	(mins) to:	Area (ha)
0	4	1.500	4	8	1.500	8	12	1.500	12	16	1.590

Tank/Pond Details

Invert Level (m) 56.300 Ground Level (m) 58.900

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.00	250.9	0.40	524.9	0.80	887.9	1.20	1318.7	1.60	1812.0	2.00	2369.6
0.10	310.6	0.50	607.9	0.90	989.6	1.30	1436.4	1.70	1946.2	2.10	2518.4
0.20	376.1	0.60	696.6	1.00	1095.3	1.40	1557.9	1.80	2083.9	2.20	2670.5
0.30	447.7	0.70	790.2	1.10	1205.0	1.50	1683.5	1.90	2224.6	2.30	2825.0

Hydro-Brake Outflow Control

Design Head (m) 0.640 Hydro-Brake Type MD5 Invert Level (m) 56.300
Design Flow (l/s) 20.7 Diameter (mm) 194

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)
0.10	6.8	0.60	20.5	1.60	28.7	2.60	36.6	5.00	50.7	7.50	62.1
0.20	15.5	0.80	21.4	1.80	30.4	3.00	39.3	5.50	53.2	8.00	64.1
0.30	19.8	1.00	23.1	2.00	32.1	3.50	42.4	6.00	55.5	8.50	66.1
0.40	20.8	1.20	25.0	2.20	33.6	4.00	45.4	6.50	57.8	9.00	68.0
0.50	20.7	1.40	26.9	2.40	35.1	4.50	48.1	7.00	60.0	9.50	69.9

STORM SEWER DESIGN by the Modified Rational Method

Global Variables

Pipe Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.PIP
Manhole Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.MHS

Location - England & Wales

Return Period (years)	2	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	21.000	Min Cover Depth for Optimisation (m)	1.200
Ratio R	0.400	Min Vel for Auto Design Only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Min Slope for Optimisation (1:X)	500
Foul Sewage (l/s/ha)	0.00	Minimum Outfall Invert (m)	58.350
O'flow Setting (*Foul only)	0	Ground Level at Outfall (m)	59.500
Volumetric Runoff Coeff.	0.75	Outfall Manhole Name	HW5
Add Flow / Climate Change (%)	30	Outfall Manhole Dia/Length (mm)	1500
Minimum Backdrop Height (m)	0.200	Outfall Manhole Width (mm)	0

Designed with Level Soffits

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	90.00	1.456	61.8	0.220	3.00	0.0	0.600	o	225
1.001	93.00	2.445	38.0	0.140	0.00	0.0	0.600	o	225
1.002	90.00	2.364	38.1	0.110	0.00	0.0	0.600	o	225
1.003	90.00	1.724	52.2	0.110	0.00	0.0	0.600	o	300
1.004	93.00	0.872	106.7	0.110	0.00	0.0	0.600	o	375
1.005	91.00	0.531	171.4	0.120	0.00	0.0	0.600	o	375
1.006	90.00	0.450	200.0	0.150	0.00	0.0	0.600	o	450
1.007	92.00	1.513	60.8	0.170	0.00	0.0	0.600	o	450
2.000	65.00	1.323	49.1	0.173	3.00	0.0	0.600	o	225
3.000	62.00	0.344	180.2	0.056	3.00	0.0	0.600	o	150
3.001	11.00	0.130	84.6	0.000	0.00	0.0	0.600	o	150
2.001	93.00	2.185	42.6	0.150	0.00	0.0	0.600	o	225
2.002	95.00	2.395	39.7	0.100	0.00	0.0	0.600	o	300
2.003	87.00	1.681	51.8	0.110	0.00	0.0	0.600	o	300
2.004	95.00	0.550	172.7	0.090	0.00	0.0	0.600	o	375

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.000	50.0	3.9	78.411	0.220	0.0	0.0	8.9	1.67	66.3	38.7
1.001	50.0	4.6	76.955	0.360	0.0	0.0	14.6	2.13	84.6	63.4
1.002	50.0	5.3	74.510	0.470	0.0	0.0	19.1	2.13	84.6	82.7
1.003	50.0	6.0	72.071	0.580	0.0	0.0	23.6	2.18	154.2	102.1
1.004	50.0	6.9	70.272	0.690	0.0	0.0	28.0	1.75	193.7	121.5
1.005	50.0	8.0	69.400	0.810	0.0	0.0	32.9	1.38	152.5	142.6
1.006	50.0	9.0	68.794	0.960	0.0	0.0	39.0	1.43	228.1	169.0
1.007	50.0	9.6	68.344	1.130	0.0	0.0	45.9	2.61	415.2	198.9
2.000	50.0	3.6	78.445	0.173	0.0	0.0	7.0	1.87	74.4	30.5
3.000	50.0	4.4	77.671	0.056	0.0	0.0	2.3	0.75	13.2	9.9
3.001	50.0	4.6	77.327	0.056	0.0	0.0	2.3	1.09	19.3	9.9
2.001	50.0	5.3	77.122	0.379	0.0	0.0	15.4	2.01	80.0	66.7
2.002	50.0	6.0	74.862	0.479	0.0	0.0	19.5	2.50	177.0	84.3
2.003	50.0	6.6	72.467	0.589	0.0	0.0	23.9	2.19	154.8	103.7
2.004	50.0	7.8	70.711	0.679	0.0	0.0	27.6	1.38	151.9	119.5

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
4.000	79.00	0.396	199.5	0.062	2.00	0.0	0.600	o	150
4.001	53.50	0.218	245.4	0.052	0.00	0.0	0.600	o	225
4.002	11.00	0.718	15.3	0.000	0.00	0.0	0.600	o	225
2.005	93.00	0.465	200.0	0.110	0.00	0.0	0.600	o	450
2.006	92.00	0.428	215.0	0.100	0.00	0.0	0.600	o	450
2.007	92.00	1.421	64.7	0.100	0.00	0.0	0.600	o	450
2.008	11.00	0.723	15.2	0.000	0.00	0.0	0.600	o	450
1.008	55.00	1.107	49.7	0.120	0.00	0.0	0.600	o	450
1.009	38.00	0.849	44.8	0.100	0.00	0.0	0.600	o	450
1.010	88.00	1.747	50.4	0.100	0.00	0.0	0.600	o	450
1.011	12.00	0.554	21.7	0.000	0.00	0.0	0.600	o	450
5.000	69.00	1.114	61.9	0.050	2.00	0.0	0.600	o	150
6.000	83.00	0.414	200.5	0.120	3.00	0.0	0.600	o	225
6.001	97.00	0.486	199.6	0.090	0.00	0.0	0.600	o	300
6.002	6.00	0.051	117.6	0.000	0.00	0.0	0.600	o	300
6.003	61.80	1.800	34.3	0.080	0.00	0.0	0.600	o	300
6.004	70.70	0.549	128.8	0.080	0.00	0.0	0.600	o	300
6.005	11.00	0.719	15.3	0.000	0.00	0.0	0.600	o	300
7.000	81.00	0.404	200.5	0.100	2.00	0.0	0.600	o	225
7.001	95.00	0.476	199.6	0.130	0.00	0.0	0.600	o	300
7.002	65.00	0.912	71.3	0.080	0.00	0.0	0.600	o	300
7.003	70.00	1.666	42.0	0.080	0.00	0.0	0.600	o	300
6.006	46.00	1.230	37.4	0.070	0.00	0.0	0.600	o	300
6.007	88.00	2.958	29.7	0.130	0.00	0.0	0.600	o	300
6.008	91.00	3.002	30.3	0.130	0.00	0.0	0.600	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
4.000	50.0	3.9	71.500	0.062	0.0	0.0	2.5	0.71	12.5	10.9
4.001	50.0	4.9	71.029	0.114	0.0	0.0	4.6	0.83	33.0	20.1
4.002	50.0	5.0	70.811	0.114	0.0	0.0	4.6	3.36	133.6	20.1
2.005	50.0	8.9	69.868	0.903	0.0	0.0	36.7	1.43	228.1	159.0
2.006	50.0	10.0	69.403	1.003	0.0	0.0	40.7	1.38	219.9	176.6
2.007	50.0	10.6	68.975	1.103	0.0	0.0	44.8	2.53	402.4	194.2
2.008	50.0	10.6	67.554	1.103	0.0	0.0	44.8	5.23	832.2	194.2
1.008	50.0	10.9	66.831	2.353	0.0	0.0	95.6	2.89	459.6	414.2
1.009	49.9	11.1	65.724	2.453	0.0	0.0	99.5	3.05	484.3	431.0
1.010	48.7	11.6	64.875	2.553	0.0	0.0	101.0	2.87	456.4	437.7
1.011	48.6	11.7	63.128	2.553	0.0	0.0	101.0	4.38	697.1	437.7
5.000	50.0	2.9	65.020	0.050	0.0	0.0	2.0	1.28	22.6	8.8
6.000	50.0	4.5	74.958	0.120	0.0	0.0	4.9	0.92	36.6	21.1
6.001	50.0	6.0	74.469	0.210	0.0	0.0	8.5	1.11	78.4	37.0
6.002	50.0	6.0	73.983	0.210	0.0	0.0	8.5	1.45	102.4	37.0
6.003	50.0	6.4	73.932	0.290	0.0	0.0	11.8	2.69	190.3	51.1
6.004	50.0	7.3	72.132	0.370	0.0	0.0	15.0	1.38	97.8	65.1
6.005	50.0	7.3	71.583	0.370	0.0	0.0	15.0	4.04	285.6	65.1
7.000	50.0	3.5	74.397	0.100	0.0	0.0	4.1	0.92	36.6	17.6
7.001	50.0	4.9	73.918	0.230	0.0	0.0	9.3	1.11	78.4	40.5
7.002	50.0	5.5	73.442	0.310	0.0	0.0	12.6	1.86	131.8	54.6
7.003	50.0	6.0	72.530	0.390	0.0	0.0	15.8	2.43	171.9	68.7
6.006	50.0	7.6	70.864	0.830	0.0	0.0	33.7	2.58	182.3	146.1
6.007	50.0	8.1	69.634	0.960	0.0	0.0	39.0	2.89	204.5	169.0
6.008	50.0	8.6	66.676	1.090	0.0	0.0	44.3	2.87	202.6	191.9

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
6.009	94.00	0.620	151.6	0.130	0.00	0.0	0.600	o	450
1.012	12.00	1.004	12.0	0.000	0.00	0.0	0.600	o	450
8.000	79.00	0.397	199.0	0.200	5.00	0.0	0.600	o	225
8.001	94.00	0.472	199.2	0.200	0.00	0.0	0.600	o	300
8.002	64.50	0.937	68.8	0.110	0.00	0.0	0.600	o	300
8.003	28.00	0.588	47.6	0.040	0.00	0.0	0.600	o	300
8.004	86.00	2.287	37.6	0.100	0.00	0.0	0.600	o	300
8.005	87.00	2.992	29.1	0.100	0.00	0.0	0.600	o	300
8.006	90.00	3.078	29.2	0.110	0.00	0.0	0.600	o	300
8.007	92.00	0.903	101.9	0.110	0.00	0.0	0.600	o	375
9.000	28.00	4.217	6.6	0.070	5.00	0.0	0.600	o	100
10.000	28.00	0.851	32.9	0.070	5.00	0.0	0.600	o	150
10.001	21.50	1.057	20.3	0.000	0.00	0.0	0.600	o	150
10.002	83.00	0.954	87.0	0.100	0.00	0.0	0.600	o	225
1.013	23.00	1.530	15.0	0.000	0.00	0.0	0.600	o	525
1.014	30.00	2.000	15.0	0.000	0.00	0.0	0.600	o	525

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
6.009	50.0	9.6	63.524	1.220	0.0	0.0	49.6	1.65	262.2	214.8
1.012	48.5	11.7	62.574	3.823	0.0	0.0	150.7	5.91	939.2	652.9
8.000	50.0	6.4	73.979	0.200	0.0	0.0	8.1	0.92	36.7	35.2
8.001	50.0	7.8	73.507	0.400	0.0	0.0	16.2	1.11	78.5	70.4
8.002	50.0	8.4	73.035	0.510	0.0	0.0	20.7	1.90	134.1	89.8
8.003	50.0	8.6	72.098	0.550	0.0	0.0	22.3	2.28	161.5	96.8
8.004	50.0	9.2	71.510	0.650	0.0	0.0	26.4	2.57	181.8	114.4
8.005	50.0	9.7	69.223	0.750	0.0	0.0	30.5	2.93	206.9	132.0
8.006	50.0	10.2	66.231	0.860	0.0	0.0	34.9	2.92	206.3	151.4
8.007	50.0	11.0	63.078	0.970	0.0	0.0	39.4	1.79	198.2	170.8
9.000	50.0	5.2	66.137	0.070	0.0	0.0	2.8	3.02	23.7	12.3
10.000	50.0	5.3	66.121	0.070	0.0	0.0	2.8	1.76	31.1	12.3
10.001	50.0	5.4	65.270	0.070	0.0	0.0	2.8	2.24	39.6	12.3
10.002	50.0	6.4	64.138	0.170	0.0	0.0	6.9	1.40	55.8	29.9
1.013	48.4	11.8	61.495	5.033	0.0	0.0	197.7	5.80	1255.1	856.9
1.014	48.2	11.9	59.965	5.033	0.0	0.0	197.7	5.80	1256.5	856.9

Time Area Diagram

Time From (mins)	Time To (mins)	Area (ha)
0	4	1.225
4	8	2.498
8	12	1.309

Total Area Contributing (ha) = 5.033

Total Pipe Volume (m³) = 313.003

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	o	225	1	79.826	78.411	1.190	1050
1.001	o	225	2	78.237	76.955	1.057	1050
1.002	o	225	3	75.887	74.510	1.152	1050
1.003	o	300	4	73.475	72.071	1.104	1050
1.004	o	375	5	71.948	70.272	1.301	1350
1.005	o	375	6	71.399	69.400	1.624	1350
1.006	o	450	7	71.368	68.794	2.124	1350
1.007	o	450	8	70.555	68.344	1.761	1350
2.000	o	225	9	79.705	78.445	1.035	1050
3.000	o	150	10	79.500	77.671	1.679	1200
3.001	o	150	11	78.577	77.327	1.100	1050
2.001	o	225	12	78.695	77.122	1.348	1050
2.002	o	300	13	76.292	74.862	1.130	1050
2.003	o	300	14	73.889	72.467	1.122	1050
2.004	o	375	15	72.433	70.711	1.347	1350
4.000	o	150	16	72.700	71.500	1.050	1050
4.001	o	225	17	71.988	71.029	0.734	1050
4.002	o	225	18	72.588	70.811	1.552	1200
2.005	o	450	19	71.944	69.868	1.626	1350
2.006	o	450	20	71.840	69.403	1.987	1350
2.007	o	450	21	70.960	68.975	1.535	1350
2.008	o	450	22	69.422	67.554	1.418	1350
1.008	o	450	23	68.840	66.831	1.559	1350
1.009	o	450	24	67.945	65.724	1.771	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	90.00	61.8	2	78.237	76.955	1.057	1050
1.001	93.00	38.0	3	75.887	74.510	1.152	1050
1.002	90.00	38.1	4	73.475	72.146	1.104	1050
1.003	90.00	52.2	5	71.948	70.347	1.301	1350
1.004	93.00	106.7	6	71.399	69.400	1.624	1350
1.005	91.00	171.4	7	71.368	68.869	2.124	1350
1.006	90.00	200.0	8	70.555	68.344	1.761	1350
1.007	92.00	60.8	23	68.840	66.831	1.559	1350
2.000	65.00	49.1	12	78.695	77.122	1.348	1050
3.000	62.00	180.2	11	78.577	77.327	1.100	1050
3.001	11.00	84.6	12	78.695	77.197	1.348	1050
2.001	93.00	42.6	13	76.292	74.937	1.130	1050
2.002	95.00	39.7	14	73.889	72.467	1.122	1050
2.003	87.00	51.8	15	72.433	70.786	1.347	1350
2.004	95.00	172.7	19	71.944	70.161	1.408	1350
4.000	79.00	199.5	17	71.988	71.104	0.734	1050
4.001	53.50	245.4	18	72.588	70.811	1.552	1200
4.002	11.00	15.3	19	71.944	70.093	1.626	1350
2.005	93.00	200.0	20	71.840	69.403	1.987	1350
2.006	92.00	215.0	21	70.960	68.975	1.535	1350
2.007	92.00	64.7	22	69.422	67.554	1.418	1350
2.008	11.00	15.2	23	68.840	66.831	1.559	1350
1.008	55.00	49.7	24	67.945	65.724	1.771	1350
1.009	38.00	44.8	25	66.887	64.875	1.562	1350

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.010	o	450	25	66.887	64.875	1.562	1350
1.011	o	450	26	65.668	63.128	2.090	1350
5.000	o	150	27	66.270	65.020	1.100	1050
6.000	o	225	28	76.208	74.958	1.025	1050
6.001	o	300	29	76.113	74.469	1.344	1050
6.002	o	300	30	75.585	73.983	1.302	1050
6.003	o	300	31	75.367	73.932	1.135	1050
6.004	o	300	32	73.478	72.132	1.046	1050
6.005	o	300	33	72.947	71.583	1.064	1050
7.000	o	225	34	75.674	74.397	1.052	1050
7.001	o	300	35	75.490	73.918	1.272	1050
7.002	o	300	36	74.767	73.442	1.025	1050
7.003	o	300	37	73.800	72.530	0.970	1050
6.006	o	300	38	72.947	70.864	1.783	1200
6.007	o	300	39	71.044	69.634	1.110	1050
6.008	o	300	40	68.104	66.676	1.128	1050
6.009	o	450	41	65.766	63.524	1.792	1350
1.012	o	450	42	65.308	62.574	2.284	1350
8.000	o	225	43	75.229	73.979	1.025	1050
8.001	o	300	44	75.051	73.507	1.244	1050
8.002	o	300	45	74.338	73.035	1.003	1050
8.003	o	300	46	73.368	72.098	0.970	1050
8.004	o	300	47	72.800	71.510	0.990	1050
8.005	o	300	48	70.528	69.223	1.005	1050

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.010	88.00	50.4	26	65.668	63.128	2.090	1350
1.011	12.00	21.7	42	65.308	62.574	2.284	1350
5.000	69.00	61.9	42	65.308	63.906	1.252	1350
6.000	83.00	200.5	29	76.113	74.544	1.344	1050
6.001	97.00	199.6	30	75.585	73.983	1.302	1050
6.002	6.00	117.6	31	75.367	73.932	1.135	1050
6.003	61.80	34.3	32	73.478	72.132	1.046	1050
6.004	70.70	128.8	33	72.947	71.583	1.064	1050
6.005	11.00	15.3	38	72.947	70.864	1.783	1200
7.000	81.00	200.5	35	75.490	73.993	1.272	1050
7.001	95.00	199.6	36	74.767	73.442	1.025	1050
7.002	65.00	71.3	37	73.800	72.530	0.970	1050
7.003	70.00	42.0	38	72.947	70.864	1.783	1200
6.006	46.00	37.4	39	71.044	69.634	1.110	1050
6.007	88.00	29.7	40	68.104	66.676	1.128	1050
6.008	91.00	30.3	41	65.766	63.674	1.792	1350
6.009	94.00	151.6	42	65.308	62.904	1.954	1350
1.012	12.00	12.0	55	64.742	61.570	2.722	1500
8.000	79.00	199.0	44	75.051	73.582	1.244	1050
8.001	94.00	199.2	45	74.338	73.035	1.003	1050
8.002	64.50	68.8	46	73.368	72.098	0.970	1050
8.003	28.00	47.6	47	72.800	71.510	0.990	1050
8.004	86.00	37.6	48	70.528	69.223	1.005	1050
8.005	87.00	29.1	49	67.557	66.231	1.026	1050

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
8.006	o	300	49	67.557	66.231	1.026	1050
8.007	o	375	50	65.196	63.078	1.743	1350
9.000	o	100	51	66.731	66.137	0.494	1050
10.000	o	150	52	66.731	66.121	0.460	1050
10.001	o	150	53	66.731	65.270	1.311	1050
10.002	o	225	54	66.536	64.138	2.173	1200
1.013	o	525	55	64.742	61.495	2.722	1500
1.014	o	525	56	61.507	59.965	1.017	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
8.006	90.00	29.2	50	65.196	63.153	1.743	1350
8.007	92.00	101.9	55	64.742	62.175	2.192	1500
9.000	28.00	6.6	55	64.742	61.920	2.722	1500
10.000	28.00	32.9	53	66.731	65.270	1.311	1050
10.001	21.50	20.3	54	66.536	64.213	2.173	1200
10.002	83.00	87.0	55	64.742	63.184	1.333	1500
1.013	23.00	15.0	56	61.507	59.965	1.017	1500
1.014	30.00	15.0	HW5	59.500	57.965	1.010	1500

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
1	79.826	1.415	1050	1.000	78.411	225			
2	78.237	1.282	1050	1.001	76.955	225	1.000	76.955	225
3	75.887	1.377	1050	1.002	74.510	225	1.001	74.510	225
4	73.475	1.404	1050	1.003	72.071	300	1.002	72.146	225
5	71.948	1.676	1350	1.004	70.272	375	1.003	70.347	300
6	71.399	1.999	1350	1.005	69.400	375	1.004	69.400	375
7	71.368	2.574	1350	1.006	68.794	450	1.005	68.869	375
8	70.555	2.211	1350	1.007	68.344	450	1.006	68.344	450
9	79.705	1.260	1050	2.000	78.445	225			
10	79.500	1.829	1200	3.000	77.671	150			
11	78.577	1.250	1050	3.001	77.327	150	3.000	77.327	150
12	78.695	1.573	1050	2.001	77.122	225	2.000 3.001	77.122 77.197	225 150
13	76.292	1.430	1050	2.002	74.862	300	2.001	74.937	225
14	73.889	1.422	1050	2.003	72.467	300	2.002	72.467	300
15	72.433	1.722	1350	2.004	70.711	375	2.003	70.786	300
16	72.700	1.200	1050	4.000	71.500	150			
17	71.988	0.959	1050	4.001	71.029	225	4.000	71.104	150
18	72.588	1.777	1200	4.002	70.811	225	4.001	70.811	225
19	71.944	2.076	1350	2.005	69.868	450	2.004 4.002	70.161 70.093	375 225
20	71.840	2.437	1350	2.006	69.403	450	2.005	69.403	450
21	70.960	1.985	1350	2.007	68.975	450	2.006	68.975	450
22	69.422	1.868	1350	2.008	67.554	450	2.007	67.554	450
23	68.840	2.009	1350	1.008	66.831	450	1.007 2.008	66.831 66.831	450 450
24	67.945	2.221	1350	1.009	65.724	450	1.008	65.724	450
25	66.887	2.012	1350	1.010	64.875	450	1.009	64.875	450
26	65.668	2.540	1350	1.011	63.128	450	1.010	63.128	450
27	66.270	1.250	1050	5.000	65.020	150			
28	76.208	1.250	1050	6.000	74.958	225			
29	76.113	1.644	1050	6.001	74.469	300	6.000	74.544	225
30	75.585	1.602	1050	6.002	73.983	300	6.001	73.983	300
31	75.367	1.435	1050	6.003	73.932	300	6.002	73.932	300
32	73.478	1.346	1050	6.004	72.132	300	6.003	72.132	300
33	72.947	1.364	1050	6.005	71.583	300	6.004	71.583	300

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
34	75.674	1.277	1050	7.000	74.397	225			
35	75.490	1.572	1050	7.001	73.918	300	7.000	73.993	225
36	74.767	1.325	1050	7.002	73.442	300	7.001	73.442	300
37	73.800	1.270	1050	7.003	72.530	300	7.002	72.530	300
38	72.947	2.083	1200	6.006	70.864	300	6.005	70.864	300
							7.003	70.864	300
39	71.044	1.410	1050	6.007	69.634	300	6.006	69.634	300
40	68.104	1.428	1050	6.008	66.676	300	6.007	66.676	300
41	65.766	2.242	1350	6.009	63.524	450	6.008	63.674	300
42	65.308	2.734	1350	1.012	62.574	450	1.011	62.574	450
							5.000	63.906	150
							6.009	62.904	450
43	75.229	1.250	1050	8.000	73.979	225			
44	75.051	1.544	1050	8.001	73.507	300	8.000	73.582	225
45	74.338	1.303	1050	8.002	73.035	300	8.001	73.035	300
46	73.368	1.270	1050	8.003	72.098	300	8.002	72.098	300
47	72.800	1.290	1050	8.004	71.510	300	8.003	71.510	300
48	70.528	1.305	1050	8.005	69.223	300	8.004	69.223	300
49	67.557	1.326	1050	8.006	66.231	300	8.005	66.231	300
50	65.196	2.118	1350	8.007	63.078	375	8.006	63.153	300
51	66.731	0.594	1050	9.000	66.137	100			
52	66.731	0.610	1050	10.000	66.121	150			
53	66.731	1.461	1050	10.001	65.270	150	10.000	65.270	150
54	66.536	2.398	1200	10.002	64.138	225	10.001	64.213	150
55	64.742	3.247	1500	1.013	61.495	525	1.012	61.570	450
							8.007	62.175	375
							9.000	61.920	100
							10.002	63.184	225
56	61.507	1.542	1500	1.014	59.965	525	1.013	59.965	525
HW5	59.500	1.535	1500		OUTFALL		1.014	57.965	525

STORM SEWER DESIGN by the Modified Rational Method

Global Variables

Pipe Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.PIP
Manhole Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.MHS

Location - England & Wales

Return Period (years)	2	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	19.000	Min Cover Depth for Optimisation (m)	1.200
Ratio R	0.420	Min Vel for Auto Design Only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Min Slope for Optimisation (1:X)	500
Foul Sewage (l/s/ha)	0.00	Minimum Outfall Invert (m)	58.000
O'flow Setting (*Foul only)	0	Ground Level at Outfall (m)	59.793
Volumetric Runoff Coeff.	0.75	Outfall Manhole Name	HW4
Add Flow / Climate Change (%)	20	Outfall Manhole Dia/Length (mm)	0
Minimum Backdrop Height (m)	0.200	Outfall Manhole Width (mm)	0

Designed with Level Soffits

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	66.00	1.590	41.5	0.070	2.00	0.0	0.600	o	150
1.001	90.00	1.334	67.5	0.090	0.00	0.0	0.600	o	225
1.002	88.00	0.440	200.0	0.080	0.00	0.0	0.600	o	300
1.003	95.00	0.474	200.4	0.090	0.00	0.0	0.600	o	300
1.004	93.50	0.866	108.0	0.090	0.00	0.0	0.600	o	300
1.005	95.00	1.544	61.5	0.090	0.00	0.0	0.600	o	300
1.006	59.50	2.492	23.9	0.150	0.00	0.0	0.600	o	300
1.007	63.50	1.787	35.5	0.150	0.00	0.0	0.600	o	300
1.008	29.00	0.455	63.7	0.000	0.00	0.0	0.600	o	300
1.009	15.00	1.343	11.2	0.000	0.00	0.0	0.600	o	300
2.000	65.00	1.423	45.7	0.100	2.00	0.0	0.600	o	150
2.001	25.00	1.664	15.0	0.000	0.00	0.0	0.600	o	150
1.010	54.00	0.997	54.2	0.080	0.00	0.0	0.600	o	375
1.011	49.00	2.510	19.5	0.080	0.00	0.0	0.600	o	375
3.000	30.00	1.040	28.8	0.050	5.00	0.0	0.600	o	100
3.001	70.00	2.551	27.4	0.120	0.00	0.0	0.600	o	150

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.000	50.0	2.7	74.438	0.070	0.0	0.0	1.9	1.57	27.7	11.4
1.001	50.0	3.6	72.773	0.160	0.0	0.0	4.3	1.59	63.4	26.0
1.002	50.0	5.0	71.364	0.240	0.0	0.0	6.5	1.11	78.3	39.0
1.003	50.0	6.4	70.924	0.330	0.0	0.0	8.9	1.11	78.2	53.6
1.004	50.0	7.4	70.450	0.420	0.0	0.0	11.4	1.51	106.9	68.2
1.005	50.0	8.2	69.584	0.510	0.0	0.0	13.8	2.01	141.9	82.9
1.006	50.0	8.5	68.040	0.660	0.0	0.0	17.9	3.23	228.4	107.2
1.007	50.0	8.9	65.548	0.810	0.0	0.0	21.9	2.65	187.1	131.6
1.008	50.0	9.2	63.761	0.810	0.0	0.0	21.9	1.97	139.4	131.6
1.009	50.0	9.2	63.306	0.810	0.0	0.0	21.9	4.73	334.4	131.6
2.000	50.0	2.7	64.286	0.100	0.0	0.0	2.7	1.49	26.4	16.2
2.001	50.0	2.9	62.863	0.100	0.0	0.0	2.7	2.61	46.2	16.2
1.010	49.8	9.6	60.974	0.990	0.0	0.0	26.7	2.47	272.4	160.2
1.011	49.2	9.8	59.977	1.070	0.0	0.0	28.5	4.12	454.7	171.2
3.000	50.0	5.3	60.080	0.050	0.0	0.0	1.4	1.44	11.3	8.1
3.001	50.0	6.0	58.990	0.170	0.0	0.0	4.6	1.93	34.1	27.6

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.012	15.00	0.100	150.0	0.000	0.00	0.0	0.600	o	450
1.013	50.00	0.200	250.0	0.000	0.00	0.0	0.600	o	450

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.012	48.8	9.9	56.139	1.240	0.0	0.0	32.8	1.66	263.6	196.8
1.013	47.2	10.6	56.039	1.240	0.0	0.0	32.8	1.28	203.8	196.8

Time Area Diagram

Time From (mins)	Time To (mins)	Area (ha)
0	4	0.453
4	8	0.530
8	12	0.257

Total Area Contributing (ha) = 1.240

Total Pipe Volume (m^3) = 67.586

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	o	150	1	75.730	74.438	1.142	1050
1.001	o	225	2	74.103	72.773	1.105	1050
1.002	o	300	3	72.757	71.364	1.093	1050
1.003	o	300	4	72.489	70.924	1.265	1050
1.004	o	300	5	72.176	70.450	1.426	1050
1.005	o	300	6	71.297	69.584	1.413	1050
1.006	o	300	7	69.388	68.040	1.048	1050
1.007	o	300	8	67.081	65.548	1.233	1050
1.008	o	300	9	65.685	63.761	1.624	1200
1.009	o	300	10	64.694	63.306	1.088	1050
2.000	o	150	12	66.536	64.286	2.100	1200
2.001	o	150	12	65.226	62.863	2.213	1200
1.010	o	375	17	64.648	60.974	3.299	1350
1.011	o	375	17	62.587	59.977	2.235	1350
3.000	o	100	17	61.333	60.080	1.153	1050
3.001	o	150	17	60.497	58.990	1.357	1050
1.012	o	450	17	61.000	56.139	4.411	1350
1.013	o	450	18	59.793	56.039	3.304	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	66.00	41.5	2	74.103	72.848	1.105	1050
1.001	90.00	67.5	3	72.757	71.439	1.093	1050
1.002	88.00	200.0	4	72.489	70.924	1.265	1050
1.003	95.00	200.4	5	72.176	70.450	1.426	1050
1.004	93.50	108.0	6	71.297	69.584	1.413	1050
1.005	95.00	61.5	7	69.388	68.040	1.048	1050
1.006	59.50	23.9	8	67.081	65.548	1.233	1050
1.007	63.50	35.5	9	65.685	63.761	1.624	1200
1.008	29.00	63.7	10	64.694	63.306	1.088	1050
1.009	15.00	11.2	17	64.648	61.963	2.385	1350
2.000	65.00	45.7	12	65.226	62.863	2.213	1200
2.001	25.00	15.0	17	64.648	61.199	3.299	1350
1.010	54.00	54.2	17	62.587	59.977	2.235	1350
1.011	49.00	19.5	17	61.000	57.467	3.158	1350
3.000	30.00	28.8	17	60.497	59.040	1.357	1050
3.001	70.00	27.4	17	61.000	56.439	4.411	1350
1.012	15.00	150.0	18	59.793	56.039	3.304	1350
1.013	50.00	250.0	HW4	59.793	55.839	3.504	0

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
1	75.730	1.292	1050	1.000	74.438	150			
2	74.103	1.330	1050	1.001	72.773	225	1.000	72.848	150
3	72.757	1.393	1050	1.002	71.364	300	1.001	71.439	225
4	72.489	1.565	1050	1.003	70.924	300	1.002	70.924	300
5	72.176	1.726	1050	1.004	70.450	300	1.003	70.450	300
6	71.297	1.713	1050	1.005	69.584	300	1.004	69.584	300
7	69.388	1.348	1050	1.006	68.040	300	1.005	68.040	300
8	67.081	1.533	1050	1.007	65.548	300	1.006	65.548	300
9	65.685	1.924	1200	1.008	63.761	300	1.007	63.761	300
10	64.694	1.388	1050	1.009	63.306	300	1.008	63.306	300
12	66.536	2.250	1200	2.000	64.286	150			
12	65.226	2.363	1200	2.001	62.863	150	2.000	62.863	150
17	64.648	3.674	1350	1.010	60.974	375	1.009 2.001	61.963 61.199	300 150
17	62.587	2.610	1350	1.011	59.977	375	1.010	59.977	375
17	61.333	1.253	1050	3.000	60.080	100			
17	60.497	1.507	1050	3.001	58.990	150	3.000	59.040	100
17	61.000	4.861	1350	1.012	56.139	450	1.011 3.001	57.467 56.439	375 150
18	59.793	3.754	1350	1.013	56.039	450	1.012	56.039	450
HW4	59.793	3.954	0		OUTFALL		1.013	55.839	450

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
15 Summer	30.3	30.3	56.5348	0.5847	1552.4	O K
30 Summer	30.3	30.3	56.7168	0.7668	2155.1	O K
60 Summer	31.2	31.2	56.8828	0.9328	2759.9	O K
120 Summer	32.8	32.8	57.0433	1.0933	3391.4	O K
180 Summer	33.7	33.7	57.1248	1.1748	3731.5	O K
240 Summer	34.3	34.3	57.1733	1.2233	3940.1	O K
360 Summer	34.9	34.9	57.2278	1.2777	4180.8	O K
480 Summer	35.3	35.3	57.2603	1.3102	4325.3	O K
600 Summer	35.5	35.5	57.2773	1.3272	4402.4	O K
720 Summer	35.6	35.6	57.2858	1.3357	4442.6	O K
960 Summer	35.6	35.6	57.2853	1.3352	4440.9	O K
1440 Summer	35.4	35.4	57.2663	1.3162	4353.5	O K
2160 Summer	34.9	34.9	57.2278	1.2778	4180.5	O K
2880 Summer	34.3	34.3	57.1798	1.2298	3968.3	O K
4320 Summer	33.2	33.2	57.0798	1.1298	3542.4	O K
5760 Summer	32.1	32.1	56.9823	1.0323	3146.3	O K
7200 Summer	31.3	31.3	56.8893	0.9393	2784.0	O K
8640 Summer	30.6	30.6	56.8018	0.8518	2457.6	O K
10080 Summer	30.3	30.3	56.7153	0.7653	2149.8	O K
15 Winter	30.3	30.3	56.6063	0.6563	1781.5	O K
30 Winter	30.6	30.6	56.8033	0.8533	2463.1	O K
60 Winter	32.2	32.2	56.9863	1.0363	3162.0	O K
120 Winter	34.1	34.1	57.1578	1.2078	3872.4	O K
180 Winter	35.1	35.1	57.2463	1.2962	4262.4	O K
240 Winter	35.8	35.8	57.2992	1.3492	4504.4	O K
360 Winter	36.5	36.5	57.3592	1.4092	4783.8	O K
480 Winter	36.9	36.9	57.3952	1.4452	4954.6	O K
600 Winter	37.2	37.2	57.4167	1.4667	5057.4	O K
720 Winter	37.3	37.3	57.4272	1.4772	5109.1	O K
960 Winter	37.4	37.4	57.4337	1.4837	5141.0	O K
1440 Winter	37.1	37.1	57.4097	1.4597	5024.3	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	125.81	34
30 Summer	81.87	49
60 Summer	50.76	78
120 Summer	30.44	136
180 Summer	22.30	196
240 Summer	17.79	254
360 Summer	12.85	372
480 Summer	10.21	488
600 Summer	8.53	606
720 Summer	7.37	724
960 Summer	5.84	958
1440 Summer	4.20	1168
2160 Summer	3.02	1548
2880 Summer	2.39	1960
4320 Summer	1.71	2776
5760 Summer	1.35	3584
7200 Summer	1.12	4392
8640 Summer	0.97	5184
10080 Summer	0.85	5864
15 Winter	125.81	34
30 Winter	81.87	48
60 Winter	50.76	78
120 Winter	30.44	134
180 Winter	22.30	192
240 Winter	17.79	250
360 Winter	12.85	364
480 Winter	10.21	480
600 Winter	8.53	594
720 Winter	7.37	708
960 Winter	5.84	930
1440 Winter	4.20	1334

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
2160 Winter	36.5	36.5	57.3607	1.4107	4791.1	O K
2880 Winter	35.8	35.8	57.3013	1.3512	4512.5	O K
4320 Winter	34.2	34.2	57.1663	1.2163	3910.1	O K
5760 Winter	32.6	32.6	57.0298	1.0798	3336.7	O K
7200 Winter	31.3	31.3	56.8968	0.9468	2811.8	O K
8640 Winter	30.3	30.3	56.7663	0.8163	2330.8	O K
10080 Winter	30.3	30.3	56.6358	0.6858	1879.9	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
2160 Winter	3.02	1656
2880 Winter	2.39	2116
4320 Winter	1.71	3004
5760 Winter	1.35	3872
7200 Winter	1.12	4688
8640 Winter	0.97	5464
10080 Winter	0.85	6168

Rainfall Details

Region	ENG+WAL	Cv (Summer)	0.750	Summer Storms	Yes
Return Period (years)	100	Cv (Winter)	0.840	Winter Storms	Yes
M5-60 (mm)	19.300	Shortest Storm (mins)	15	Climate Change %	+30
Ratio-R	0.423	Longest Storm (mins)	10080		

Pipe Network

Volume in Pipe Network (m^3)	536	Dia of Outfall Pipe (m)	0.200
Slope of Outfall Pipe (1:x)	230.0	Roughness of Outfall Pipe	0.600

Time / Area Diagram

Total Area (ha) = 8.970

Time from:	(mins) to:	Area (ha)	Time from:	(mins) to:	Area (ha)	Time from:	(mins) to:	Area (ha)
0	4	1.790	8	12	1.790	16	20	1.810
4	8	1.790	12	16	1.790			

Tank/Pond Details

Invert Level (m) 55.950 Ground Level (m) 58.250

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.00	2170.0	0.40	2832.0	0.80	3543.0	1.20	4303.0	1.60	5113.0	2.00	5971.0
0.10	2331.0	0.50	3005.0	0.90	3728.0	1.30	4501.0	1.70	5323.0		
0.20	2495.0	0.60	3181.0	1.00	3917.0	1.40	4702.0	1.80	5536.0		
0.30	2662.0	0.70	3360.0	1.10	4108.0	1.50	4906.0	1.90	5752.0		

Hydro-Brake Outflow Control

Design Head (m) 0.600 Hydro-Brake Type MD5 Invert Level (m) 55.950
Design Flow (l/s) 30.0 Diameter (mm) 225

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)
0.10	8.1	0.60	30.0	1.60	38.8	2.60	49.3	5.00	68.4	7.50	83.8
0.20	19.5	0.80	30.2	1.80	41.1	3.00	53.0	5.50	71.8	8.00	86.6
0.30	27.0	1.00	31.8	2.00	43.3	3.50	57.3	6.00	75.0	8.50	89.2
0.40	29.8	1.20	34.0	2.20	45.4	4.00	61.2	6.50	78.0	9.00	91.8
0.50	30.3	1.40	36.4	2.40	47.4	4.50	64.9	7.00	81.0	9.50	94.3

STORM SEWER DESIGN by the Modified Rational Method

Global Variables

Pipe Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.PIP
Manhole Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.MHS

Location - England & Wales

Return Period (years)	2	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	19.300	Min Cover Depth for Optimisation (m)	1.200
Ratio R	0.424	Min Vel for Auto Design Only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Min Slope for Optimisation (1:X)	500
Foul Sewage (l/s/ha)	0.00	Minimum Outfall Invert (m)	57.000
O'flow Setting (*Foul only)	0	Ground Level at Outfall (m)	59.632
Volumetric Runoff Coeff.	0.75	Outfall Manhole Name	HW10
Add Flow / Climate Change (%)	30	Outfall Manhole Dia/Length (mm)	0
Minimum Backdrop Height (m)	0.200	Outfall Manhole Width (mm)	0

Designed with Level Soffits

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	80.00	0.706	113.3	0.100	5.00	0.0	0.600	o	225
1.001	80.00	0.527	151.8	0.100	0.00	0.0	0.600	o	225
1.002	80.00	0.804	99.5	0.100	0.00	0.0	0.600	o	300
1.003	85.00	0.907	93.7	0.100	0.00	0.0	0.600	o	300
1.004	11.50	0.060	191.7	0.000	0.00	0.0	0.600	o	300
2.000	80.00	0.400	200.0	0.130	2.00	0.0	0.600	o	225
2.001	80.00	0.400	200.0	0.120	0.00	0.0	0.600	o	300
2.002	80.00	0.873	91.6	0.120	0.00	0.0	0.600	o	300
2.003	85.00	1.870	45.5	0.150	0.00	0.0	0.600	o	300
1.005	80.00	1.665	48.0	0.270	0.00	0.0	0.600	o	375
1.006	90.00	1.920	46.9	0.250	0.00	0.0	0.600	o	375
1.007	90.00	1.455	61.9	0.190	0.00	0.0	0.600	o	450
1.008	75.00	0.895	83.8	0.180	0.00	0.0	0.600	o	450
1.009	75.00	0.580	129.3	0.090	0.00	0.0	0.600	o	525
1.010	50.00	0.300	166.7	0.060	0.00	0.0	0.600	o	525
1.011	55.00	0.633	86.9	0.060	0.00	0.0	0.600	o	525

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.000	50.0	6.1	74.419	0.100	0.0	0.0	4.1	1.23	48.8	17.6
1.001	50.0	7.3	73.713	0.200	0.0	0.0	8.1	1.06	42.1	35.2
1.002	50.0	8.2	73.111	0.300	0.0	0.0	12.2	1.58	111.4	52.8
1.003	50.0	9.1	72.307	0.400	0.0	0.0	16.2	1.62	114.8	70.4
1.004	50.0	9.2	71.400	0.400	0.0	0.0	16.2	1.13	80.0	70.4
2.000	50.0	3.4	74.958	0.130	0.0	0.0	5.3	0.92	36.6	22.9
2.001	50.0	4.7	74.483	0.250	0.0	0.0	10.2	1.11	78.3	44.0
2.002	50.0	5.5	74.083	0.370	0.0	0.0	15.0	1.64	116.1	65.1
2.003	50.0	6.1	73.210	0.520	0.0	0.0	21.1	2.34	165.3	91.5
1.005	50.0	9.7	71.265	1.190	0.0	0.0	48.3	2.62	289.3	209.5
1.006	48.8	10.3	69.600	1.440	0.0	0.0	57.1	2.65	292.9	247.6
1.007	47.4	10.9	67.605	1.630	0.0	0.0	62.7	2.59	411.7	271.9
1.008	46.1	11.4	66.150	1.810	0.0	0.0	67.7	2.22	353.4	293.5
1.009	44.7	12.1	65.180	1.900	0.0	0.0	69.0	1.97	426.1	298.9
1.010	43.7	12.6	64.600	1.960	0.0	0.0	69.6	1.73	375.0	301.5
1.011	42.9	12.9	64.300	2.020	0.0	0.0	70.5	2.40	520.4	305.4

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
3.000	80.00	0.534	149.8	0.220	5.00	0.0	0.600	o	225
3.001	80.00	0.458	174.7	0.230	0.00	0.0	0.600	o	300
3.002	80.00	0.446	179.4	0.240	0.00	0.0	0.600	o	375
3.003	80.00	1.106	72.3	0.280	0.00	0.0	0.600	o	375
3.004	80.00	1.499	53.4	0.300	0.00	0.0	0.600	o	375
3.005	90.00	2.106	42.7	0.290	0.00	0.0	0.600	o	375
3.006	90.00	1.312	68.6	0.250	0.00	0.0	0.600	o	450
3.007	90.00	1.218	73.9	0.280	0.00	0.0	0.600	o	450
3.008	86.00	0.522	164.8	0.190	0.00	0.0	0.600	o	525
3.009	80.00	0.811	98.6	0.090	0.00	0.0	0.600	o	525
4.000	85.00	0.498	170.7	0.220	5.00	0.0	0.600	o	225
4.001	85.00	0.964	88.2	0.220	0.00	0.0	0.600	o	300
4.002	90.00	2.026	44.4	0.170	0.00	0.0	0.600	o	300
4.003	75.00	2.331	32.2	0.090	0.00	0.0	0.600	o	300
4.004	75.00	2.796	26.8	0.090	0.00	0.0	0.600	o	300
4.005	75.00	2.797	26.8	0.090	0.00	0.0	0.600	o	300
4.006	90.00	2.557	35.2	0.190	0.00	0.0	0.600	o	375
4.007	80.00	2.319	34.5	0.220	0.00	0.0	0.600	o	375
4.008	80.00	1.713	46.7	0.210	0.00	0.0	0.600	o	375
4.009	80.00	1.737	46.1	0.140	0.00	0.0	0.600	o	375
4.010	70.00	1.206	58.0	0.080	0.00	0.0	0.600	o	450
4.011	80.00	0.713	112.2	0.090	0.00	0.0	0.600	o	450
4.012	80.00	0.594	134.7	0.090	0.00	0.0	0.600	o	525
4.013	78.00	0.396	197.0	0.090	0.00	0.0	0.600	o	525
4.014	11.50	0.254	45.3	0.000	0.00	0.0	0.600	o	525
5.000	80.00	0.415	192.8	0.280	5.00	0.0	0.600	o	300
5.001	90.00	1.040	86.5	0.290	0.00	0.0	0.600	o	300
5.002	80.00	1.698	47.1	0.230	0.00	0.0	0.600	o	300
5.003	70.00	2.037	34.4	0.150	0.00	0.0	0.600	o	300

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
3.000	50.0	6.3	73.979	0.220	0.0	0.0	8.9	1.07	42.4	38.7
3.001	50.0	7.4	73.370	0.450	0.0	0.0	18.3	1.19	83.9	79.2
3.002	50.0	8.4	72.837	0.690	0.0	0.0	28.0	1.35	149.1	121.5
3.003	50.0	9.0	72.391	0.970	0.0	0.0	39.4	2.13	235.5	170.8
3.004	50.0	9.5	71.285	1.270	0.0	0.0	51.6	2.48	274.5	223.6
3.005	49.5	10.1	69.786	1.560	0.0	0.0	62.7	2.78	306.9	271.7
3.006	47.9	10.7	67.605	1.810	0.0	0.0	70.4	2.46	390.8	305.3
3.007	46.4	11.3	66.293	2.090	0.0	0.0	78.8	2.37	376.5	341.3
3.008	44.6	12.1	65.000	2.280	0.0	0.0	82.6	1.74	377.2	357.8
3.009	43.4	12.7	64.478	2.370	0.0	0.0	83.5	2.26	488.3	361.9
4.000	50.0	6.4	86.868	0.220	0.0	0.0	8.9	1.00	39.7	38.7
4.001	50.0	7.3	86.295	0.440	0.0	0.0	17.9	1.68	118.4	77.5
4.002	50.0	7.9	85.331	0.610	0.0	0.0	24.8	2.37	167.2	107.4
4.003	50.0	8.3	83.305	0.700	0.0	0.0	28.4	2.78	196.6	123.2
4.004	50.0	8.8	80.974	0.790	0.0	0.0	32.1	3.05	215.4	139.1
4.005	50.0	9.2	78.178	0.880	0.0	0.0	35.7	3.05	215.5	154.9
4.006	50.0	9.7	75.306	1.070	0.0	0.0	43.5	3.06	338.3	188.4
4.007	49.4	10.1	72.749	1.290	0.0	0.0	51.8	3.09	341.7	224.4
4.008	48.1	10.6	70.430	1.500	0.0	0.0	58.6	2.66	293.5	254.1
4.009	46.9	11.1	68.717	1.640	0.0	0.0	62.5	2.68	295.6	270.8
4.010	45.9	11.5	66.905	1.720	0.0	0.0	64.1	2.67	425.1	277.9
4.011	44.4	12.2	65.699	1.810	0.0	0.0	65.3	1.92	305.2	282.9
4.012	43.0	12.9	64.911	1.900	0.0	0.0	66.4	1.93	417.5	287.7
4.013	41.5	13.7	64.317	1.990	0.0	0.0	67.1	1.59	344.7	290.7
4.014	41.4	13.8	63.921	1.990	0.0	0.0	67.1	3.34	722.0	290.7
5.000	50.0	6.2	86.865	0.280	0.0	0.0	11.4	1.13	79.8	49.3
5.001	50.0	7.1	86.450	0.570	0.0	0.0	23.2	1.69	119.5	100.3
5.002	50.0	7.6	85.410	0.800	0.0	0.0	32.5	2.30	162.3	140.8
5.003	50.0	8.1	83.712	0.950	0.0	0.0	38.6	2.69	190.2	167.2

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
5.004	65.00	2.323	28.0	0.150	0.00	0.0	0.600	o	300
5.005	80.00	3.187	25.1	0.090	0.00	0.0	0.600	o	300
5.006	85.00	2.698	31.5	0.230	0.00	0.0	0.600	o	375
5.007	90.00	2.689	33.5	0.320	0.00	0.0	0.600	o	375
5.008	90.00	1.973	45.6	0.300	0.00	0.0	0.600	o	450
5.009	90.00	1.903	47.3	0.200	0.00	0.0	0.600	o	450
5.010	60.00	0.779	77.0	0.070	0.00	0.0	0.600	o	525
5.011	80.00	1.013	79.0	0.090	0.00	0.0	0.600	o	525
5.012	80.00	0.402	199.0	0.090	0.00	0.0	0.600	o	600
5.013	80.00	0.816	98.0	0.100	0.00	0.0	0.600	o	600
1.012	23.50	5.812	4.0	0.000	0.00	0.0	0.600	o	600
1.013	22.50	0.216	104.2	0.000	0.00	0.0	0.600	o	825

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
5.004	50.0	8.4	81.675	1.100	0.0	0.0	44.7	2.98	210.9	193.6
5.005	50.0	8.9	79.352	1.190	0.0	0.0	48.3	3.15	222.7	209.5
5.006	50.0	9.3	76.090	1.420	0.0	0.0	57.7	3.24	357.6	250.0
5.007	50.0	9.8	73.392	1.740	0.0	0.0	70.7	3.14	346.9	306.3
5.008	48.9	10.3	70.628	2.040	0.0	0.0	81.1	3.02	479.7	351.2
5.009	47.6	10.8	68.655	2.240	0.0	0.0	86.7	2.96	471.1	375.6
5.010	46.7	11.2	66.677	2.310	0.0	0.0	87.6	2.55	552.9	379.7
5.011	45.5	11.7	65.898	2.400	0.0	0.0	88.7	2.52	546.0	384.4
5.012	43.9	12.5	64.810	2.490	0.0	0.0	88.7	1.72	487.1	384.5
5.013	42.8	13.0	64.408	2.590	0.0	0.0	90.0	2.46	695.5	390.2
1.012	41.3	13.8	63.592	8.970	0.0	0.0	301.2	12.16	3439.1	1305.2
1.013	41.1	13.9	57.555	8.970	0.0	0.0	301.2	2.91	1555.0	1305.2

Time Area Diagram

Time From (mins)	Time To (mins)	Area (ha)
0	4	1.304
4	8	5.230
8	12	2.223
12	16	0.213

Total Area Contributing (ha) = 8.970

Total Pipe Volume (m^3) = 536.859

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	o	225	1	75.674	74.419	1.030	1050
1.001	o	225	2	75.513	73.713	1.575	1200
1.002	o	300	3	74.986	73.111	1.575	1200
1.003	o	300	4	74.107	72.307	1.500	1200
1.004	o	300	5	72.740	71.400	1.040	1050
2.000	o	225	6	76.208	74.958	1.025	1050
2.001	o	300	7	76.033	74.483	1.250	1050
2.002	o	300	8	75.507	74.083	1.124	1050
2.003	o	300	9	74.557	73.210	1.047	1050
1.005	o	375	10	72.796	71.265	1.156	1350
1.006	o	375	11	70.961	69.600	0.986	1350
1.007	o	450	12	69.051	67.605	0.996	1350
1.008	o	450	13	67.575	66.150	0.975	1350
1.009	o	525	14	66.685	65.180	0.980	1500
1.010	o	525	15	66.104	64.600	0.979	1500
1.011	o	525	16	65.802	64.300	0.977	1500
3.000	o	225	17	75.229	73.979	1.025	1050
3.001	o	300	18	75.052	73.370	1.382	1050
3.002	o	375	19	74.529	72.837	1.317	1350
3.003	o	375	20	73.660	72.391	0.894	1350
3.004	o	375	21	72.560	71.285	0.900	1350
3.005	o	375	22	71.066	69.786	0.905	1350
3.006	o	450	23	69.142	67.605	1.087	1350
3.007	o	450	24	67.643	66.293	0.900	1350
3.008	o	525	25	66.589	65.000	1.064	1500
3.009	o	525	26	65.997	64.478	0.994	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	80.00	113.3	2	75.513	73.713	1.575	1200
1.001	80.00	151.8	3	74.986	73.186	1.575	1200
1.002	80.00	99.5	4	74.107	72.307	1.500	1200
1.003	85.00	93.7	5	72.740	71.400	1.040	1050
1.004	11.50	191.7	10	72.796	71.340	1.156	1350
2.000	80.00	200.0	7	76.033	74.558	1.250	1050
2.001	80.00	200.0	8	75.507	74.083	1.124	1050
2.002	80.00	91.6	9	74.557	73.210	1.047	1050
2.003	85.00	45.5	10	72.796	71.340	1.156	1350
1.005	80.00	48.0	11	70.961	69.600	0.986	1350
1.006	90.00	46.9	12	69.051	67.680	0.996	1350
1.007	90.00	61.9	13	67.575	66.150	0.975	1350
1.008	75.00	83.8	14	66.685	65.255	0.980	1500
1.009	75.00	129.3	15	66.104	64.600	0.979	1500
1.010	50.00	166.7	16	65.802	64.300	0.977	1500
1.011	55.00	86.9	56	65.724	63.667	1.532	1500
3.000	80.00	149.8	18	75.052	73.445	1.382	1050
3.001	80.00	174.7	19	74.529	72.912	1.317	1350
3.002	80.00	179.4	20	73.660	72.391	0.894	1350
3.003	80.00	72.3	21	72.560	71.285	0.900	1350
3.004	80.00	53.4	22	71.066	69.786	0.905	1350
3.005	90.00	42.7	23	69.142	67.680	1.087	1350
3.006	90.00	68.6	24	67.643	66.293	0.900	1350
3.007	90.00	73.9	25	66.589	65.075	1.064	1500
3.008	86.00	164.8	26	65.997	64.478	0.994	1500
3.009	80.00	98.6	56	65.724	63.667	1.532	1500

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
4.000	o	225	27	88.118	86.868	1.025	1050
4.001	o	300	28	87.759	86.295	1.164	1050
4.002	o	300	29	86.679	85.331	1.048	1050
4.003	o	300	30	84.755	83.305	1.150	1050
4.004	o	300	31	82.436	80.974	1.162	1050
4.005	o	300	32	79.659	78.178	1.181	1050
4.006	o	375	33	76.961	75.306	1.280	1350
4.007	o	375	34	74.085	72.749	0.961	1350
4.008	o	375	35	71.847	70.430	1.042	1350
4.009	o	375	36	69.962	68.717	0.870	1350
4.010	o	450	37	68.428	66.905	1.073	1350
4.011	o	450	38	67.289	65.699	1.140	1350
4.012	o	525	39	66.416	64.911	0.980	1500
4.013	o	525	40	65.895	64.317	1.053	1500
4.014	o	525	41	65.726	63.921	1.280	1500
5.000	o	300	42	88.115	86.865	0.950	1050
5.001	o	300	43	87.798	86.450	1.048	1050
5.002	o	300	44	86.678	85.410	0.968	1050
5.003	o	300	45	85.002	83.712	0.990	1050
5.004	o	300	46	83.013	81.675	1.038	1050
5.005	o	300	47	80.719	79.352	1.067	1050
5.006	o	375	48	77.626	76.090	1.161	1350
5.007	o	375	49	74.807	73.392	1.040	1350
5.008	o	450	50	72.196	70.628	1.118	1350
5.009	o	450	51	70.034	68.655	0.929	1350
5.010	o	525	52	68.317	66.677	1.115	1500
5.011	o	525	53	67.335	65.898	0.912	1500
5.012	o	600	54	66.444	64.810	1.034	1500
5.013	o	600	55	65.909	64.408	0.901	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
4.000	85.00	170.7	28	87.759	86.370	1.164	1050
4.001	85.00	88.2	29	86.679	85.331	1.048	1050
4.002	90.00	44.4	30	84.755	83.305	1.150	1050
4.003	75.00	32.2	31	82.436	80.974	1.162	1050
4.004	75.00	26.8	32	79.659	78.178	1.181	1050
4.005	75.00	26.8	33	76.961	75.381	1.280	1350
4.006	90.00	35.2	34	74.085	72.749	0.961	1350
4.007	80.00	34.5	35	71.847	70.430	1.042	1350
4.008	80.00	46.7	36	69.962	68.717	0.870	1350
4.009	80.00	46.1	37	68.428	66.980	1.073	1350
4.010	70.00	58.0	38	67.289	65.699	1.140	1350
4.011	80.00	112.2	39	66.416	64.986	0.980	1500
4.012	80.00	134.7	40	65.895	64.317	1.053	1500
4.013	78.00	197.0	41	65.726	63.921	1.280	1500
4.014	11.50	45.3	56	65.724	63.667	1.532	1500
5.000	80.00	192.8	43	87.798	86.450	1.048	1050
5.001	90.00	86.5	44	86.678	85.410	0.968	1050
5.002	80.00	47.1	45	85.002	83.712	0.990	1050
5.003	70.00	34.4	46	83.013	81.675	1.038	1050
5.004	65.00	28.0	47	80.719	79.352	1.067	1050
5.005	80.00	25.1	48	77.626	76.165	1.161	1350
5.006	85.00	31.5	49	74.807	73.392	1.040	1350
5.007	90.00	33.5	50	72.196	70.703	1.118	1350
5.008	90.00	45.6	51	70.034	68.655	0.929	1350
5.009	90.00	47.3	52	68.317	66.752	1.115	1500
5.010	60.00	77.0	53	67.335	65.898	0.912	1500
5.011	80.00	79.0	54	66.444	64.885	1.034	1500
5.012	80.00	199.0	55	65.909	64.408	0.901	1500
5.013	80.00	98.0	56	65.724	63.592	1.532	1500

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.012	o	600	56	65.724	63.592	1.532	1500
1.013	o	825	57	59.362	57.555	0.982	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.012	23.50	4.0	57	59.362	57.780	0.982	1800
1.013	22.50	104.2	HW10	59.632	57.339	1.468	0

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
1	75.674	1.255	1050	1.000	74.419	225			
2	75.513	1.800	1200	1.001	73.713	225	1.000	73.713	225
3	74.986	1.875	1200	1.002	73.111	300	1.001	73.186	225
4	74.107	1.800	1200	1.003	72.307	300	1.002	72.307	300
5	72.740	1.340	1050	1.004	71.400	300	1.003	71.400	300
6	76.208	1.250	1050	2.000	74.958	225			
7	76.033	1.550	1050	2.001	74.483	300	2.000	74.558	225
8	75.507	1.424	1050	2.002	74.083	300	2.001	74.083	300
9	74.557	1.347	1050	2.003	73.210	300	2.002	73.210	300
10	72.796	1.531	1350	1.005	71.265	375	1.004 2.003	71.340 71.340	300 300
11	70.961	1.361	1350	1.006	69.600	375	1.005	69.600	375
12	69.051	1.446	1350	1.007	67.605	450	1.006	67.680	375
13	67.575	1.425	1350	1.008	66.150	450	1.007	66.150	450
14	66.685	1.505	1500	1.009	65.180	525	1.008	65.255	450
15	66.104	1.504	1500	1.010	64.600	525	1.009	64.600	525
16	65.802	1.502	1500	1.011	64.300	525	1.010	64.300	525
17	75.229	1.250	1050	3.000	73.979	225			
18	75.052	1.682	1050	3.001	73.370	300	3.000	73.445	225
19	74.529	1.692	1350	3.002	72.837	375	3.001	72.912	300
20	73.660	1.269	1350	3.003	72.391	375	3.002	72.391	375
21	72.560	1.275	1350	3.004	71.285	375	3.003	71.285	375
22	71.066	1.280	1350	3.005	69.786	375	3.004	69.786	375
23	69.142	1.537	1350	3.006	67.605	450	3.005	67.680	375
24	67.643	1.350	1350	3.007	66.293	450	3.006	66.293	450
25	66.589	1.589	1500	3.008	65.000	525	3.007	65.075	450
26	65.997	1.519	1500	3.009	64.478	525	3.008	64.478	525
27	88.118	1.250	1050	4.000	86.868	225			
28	87.759	1.464	1050	4.001	86.295	300	4.000	86.370	225
29	86.679	1.348	1050	4.002	85.331	300	4.001	85.331	300
30	84.755	1.450	1050	4.003	83.305	300	4.002	83.305	300
31	82.436	1.462	1050	4.004	80.974	300	4.003	80.974	300
32	79.659	1.481	1050	4.005	78.178	300	4.004	78.178	300
33	76.961	1.655	1350	4.006	75.306	375	4.005	75.381	300
34	74.085	1.336	1350	4.007	72.749	375	4.006	72.749	375

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
35	71.847	1.417	1350	4.008	70.430	375	4.007	70.430	375
36	69.962	1.245	1350	4.009	68.717	375	4.008	68.717	375
37	68.428	1.523	1350	4.010	66.905	450	4.009	66.980	375
38	67.289	1.590	1350	4.011	65.699	450	4.010	65.699	450
39	66.416	1.505	1500	4.012	64.911	525	4.011	64.986	450
40	65.895	1.578	1500	4.013	64.317	525	4.012	64.317	525
41	65.726	1.805	1500	4.014	63.921	525	4.013	63.921	525
42	88.115	1.250	1050	5.000	86.865	300			
43	87.798	1.348	1050	5.001	86.450	300	5.000	86.450	300
44	86.678	1.268	1050	5.002	85.410	300	5.001	85.410	300
45	85.002	1.290	1050	5.003	83.712	300	5.002	83.712	300
46	83.013	1.338	1050	5.004	81.675	300	5.003	81.675	300
47	80.719	1.367	1050	5.005	79.352	300	5.004	79.352	300
48	77.626	1.536	1350	5.006	76.090	375	5.005	76.165	300
49	74.807	1.415	1350	5.007	73.392	375	5.006	73.392	375
50	72.196	1.568	1350	5.008	70.628	450	5.007	70.703	375
51	70.034	1.379	1350	5.009	68.655	450	5.008	68.655	450
52	68.317	1.640	1500	5.010	66.677	525	5.009	66.752	450
53	67.335	1.437	1500	5.011	65.898	525	5.010	65.898	525
54	66.444	1.634	1500	5.012	64.810	600	5.011	64.885	525
55	65.909	1.501	1500	5.013	64.408	600	5.012	64.408	600
56	65.724	2.132	1500	1.012	63.592	600	1.011 3.009 4.014 5.013	63.667 63.667 63.667 63.592	525 525 525 600
57	59.362	1.807	1800	1.013	57.555	825	1.012	57.780	600
HW10	59.632	2.293	0		OUTFALL		1.013	57.339	825

Global Variables

Region	FSR - England & Wales
Return Period (yrs)	5
M5-60 (mm)	19.300
Ratio R	0.424
Volumetric Runoff Coef	0.750
Profile Type	Summer
PIMP (%)	100
Areal Reduction Factor	1.000
Storm Duration (mins)	15
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coefficient	0.500
MADD Factor * 10m³/ha Storage	2.000
Foul Sewage/Hectare (l/s)	0.00
Additional Flow - % of Total Flow	30
Inlet Coefficient	0.800
Number of Input Hydrographs	0
Number of Time/Area Diagrams	0
Number of Bifurcations	0
Number of Overflows	0
Number of Off-Line Controls	0
Number of On-Line Controls	0

Starting Storm file name

C:\DOCUMENTS AND SETTINGS\UKSMT003\DESKTOP\WINDES_ISHAM\POND2_NETWORKQ2.SWS

Freely Discharging Outfalls

Outfall Pipe Number	Outfall MH/No	C.Level (m)	I.Level (m)	D,L (mm)	B (mm)
1.013	HW10	59.632	57.339	1200	0

Summary of Results

Return Period (years)	5	Analysis Time Step	Fine
Storm Duration (mins)	15	DTS Status	ON
Profile Type	Summer	DVD Status	OFF
Margin for Flood Risk warning (mm)	300	Inertia Status	OFF

PN	Water Lev. (m)	Surcharged Depth (m)	Flooded Vol (m³)	Flow/ Capacity	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	74.545	-0.099	0.000	0.56	0.0	26.7	O K
1.001	74.029	0.091	0.000	1.06	0.0	43.6	SURCH'ED
1.002	73.277	-0.134	0.000	0.57	0.0	61.2	O K
1.003	72.500	-0.107	0.000	0.71	0.0	79.0	O K
1.004	71.724	0.024	0.000	1.29	0.0	78.9	SURCH'ED
2.000	75.464	0.281	0.000	1.10	0.0	39.3	SURCH'ED
2.001	74.706	-0.077	0.000	0.82	0.0	61.6	O K
2.002	74.287	-0.096	0.000	0.77	0.0	85.7	O K
2.003	73.402	-0.108	0.000	0.71	0.0	113.3	O K
1.005	71.540	-0.100	0.000	0.87	0.0	240.0	O K
1.006	69.932	-0.043	0.000	1.00	0.0	279.7	O K
1.007	67.912	-0.143	0.000	0.80	0.0	310.1	O K
1.008	66.599	-0.001	0.000	1.00	0.0	330.7	O K
1.009	65.561	-0.144	0.000	0.87	0.0	342.8	O K
1.010	65.121	-0.004	0.000	1.00	0.0	334.4	O K
1.011	64.634	-0.191	0.000	0.73	0.0	340.7	O K
3.000	74.637	0.433	0.000	1.21	0.0	49.8	SURCH'ED
3.001	73.802	0.132	0.000	1.12	0.0	90.8	SURCH'ED
3.002	73.130	-0.082	0.000	0.94	0.0	132.7	O K
3.003	72.655	-0.111	0.000	0.82	0.0	183.7	O K
3.004	71.570	-0.090	0.000	0.91	0.0	238.5	O K
3.005	70.094	-0.067	0.000	0.99	0.0	291.9	O K
3.006	67.943	-0.112	0.000	0.91	0.0	335.0	O K
3.007	66.890	0.147	0.000	1.02	0.0	363.4	SURCH'ED
3.008	65.612	0.087	0.000	1.10	0.0	385.3	SURCH'ED
3.009	64.858	-0.145	0.000	0.87	0.0	393.5	O K
4.000	87.550	0.457	0.000	1.31	0.0	50.8	SURCH'ED
4.001	86.508	-0.087	0.000	0.82	0.0	93.6	O K
4.002	85.537	-0.094	0.000	0.79	0.0	127.3	O K
4.003	83.505	-0.100	0.000	0.76	0.0	144.3	O K
4.004	81.175	-0.099	0.000	0.78	0.0	160.4	O K
4.005	78.394	-0.084	0.000	0.85	0.0	176.8	O K
4.006	75.529	-0.152	0.000	0.65	0.0	210.9	O K
4.007	72.999	-0.125	0.000	0.77	0.0	249.8	O K
4.008	70.897	0.092	0.000	0.99	0.0	275.7	SURCH'ED
4.009	69.240	0.148	0.000	1.04	0.0	293.7	SURCH'ED
4.010	67.203	-0.152	0.000	0.77	0.0	304.0	O K
4.011	66.270	0.121	0.000	1.09	0.0	312.7	SURCH'ED
4.012	65.278	-0.158	0.000	0.82	0.0	319.7	O K
4.013	64.772	-0.070	0.000	1.00	0.0	319.2	O K
4.014	64.286	-0.160	0.000	0.83	0.0	319.2	O K
5.000	87.181	0.016	0.000	0.92	0.0	70.5	SURCH'ED
5.001	86.844	0.094	0.000	1.02	0.0	118.0	SURCH'ED
5.002	85.759	0.049	0.000	1.00	0.0	155.7	SURCH'ED
5.003	84.081	0.069	0.000	0.99	0.0	179.6	SURCH'ED
5.004	82.107	0.132	0.000	1.01	0.0	203.2	SURCH'ED
5.005	79.737	0.085	0.000	1.01	0.0	217.6	SURCH'ED
5.006	76.340	-0.125	0.000	0.76	0.0	260.2	O K
5.007	73.692	-0.075	0.000	0.97	0.0	322.2	O K
5.008	70.947	-0.131	0.000	0.83	0.0	375.7	O K
5.009	68.998	-0.107	0.000	0.92	0.0	411.9	O K
5.010	67.048	-0.154	0.000	0.84	0.0	420.9	O K
5.011	66.275	-0.148	0.000	0.86	0.0	433.8	O K
5.012	65.293	-0.117	0.000	0.99	0.0	440.2	O K
5.013	64.783	-0.225	0.000	0.70	0.0	448.3	O K
1.012	63.934	-0.258	0.000	0.62	0.0	1492.6	O K
1.013	58.747	0.367	0.000	1.69	0.0	1492.1	SURCH'ED

Rainfall Hyetograph

Region	FSR - England & Wales	Profile Type	Summer
Return Period (yrs)	5	Storm Duration (mins)	15
M5-60 (mm)	19.300		
Ratio R	0.424		

Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
1	17.06	4	25.66	7	115.47	10	58.34	13	21.37
2	18.76	5	34.05	8	179.21	11	34.05	14	18.76
3	21.37	6	58.34	9	115.47	12	25.66	15	17.06

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
15 Summer	17.0	17.0	64.3748	0.6748	871.5	O K
30 Summer	18.1	18.1	64.5563	0.8563	1194.9	O K
60 Summer	19.5	19.5	64.7238	1.0238	1529.8	O K
120 Summer	20.7	20.7	64.8753	1.1753	1863.7	O K
180 Summer	21.4	21.4	64.9518	1.2518	2043.7	O K
240 Summer	21.7	21.7	64.9923	1.2922	2142.9	O K
360 Summer	22.1	22.1	65.0383	1.3382	2257.8	O K
480 Summer	22.3	22.3	65.0622	1.3622	2319.0	O K
600 Summer	22.3	22.3	65.0722	1.3722	2344.3	O K
720 Summer	22.4	22.4	65.0742	1.3742	2349.2	O K
960 Summer	22.3	22.3	65.0643	1.3642	2324.3	O K
1440 Summer	22.1	22.1	65.0368	1.3367	2253.1	O K
2160 Summer	21.6	21.6	64.9863	1.2863	2127.6	O K
2880 Summer	21.2	21.2	64.9313	1.2313	1995.1	O K
4320 Summer	20.3	20.3	64.8243	1.1243	1747.5	O K
5760 Summer	19.5	19.5	64.7238	1.0238	1529.7	O K
7200 Summer	18.7	18.7	64.6293	0.9293	1336.2	O K
8640 Summer	18.0	18.0	64.5393	0.8393	1162.6	O K
10080 Summer	17.4	17.4	64.4533	0.7533	1006.1	O K
15 Winter	17.4	17.4	64.4543	0.7543	1007.9	O K
30 Winter	18.9	18.9	64.6543	0.9543	1385.6	O K
60 Winter	20.3	20.3	64.8258	1.1258	1750.5	O K
120 Winter	21.6	21.6	64.9858	1.2857	2126.5	O K
180 Winter	22.3	22.3	65.0643	1.3642	2323.1	O K
240 Winter	22.7	22.7	65.1132	1.4132	2451.2	O K
360 Winter	23.1	23.1	65.1622	1.4622	2581.6	O K
480 Winter	23.3	23.3	65.1917	1.4917	2662.3	O K
600 Winter	23.4	23.4	65.2057	1.5057	2701.3	O K
720 Winter	23.4	23.4	65.2107	1.5107	2715.4	O K
960 Winter	23.4	23.4	65.2062	1.5062	2703.0	O K
1440 Winter	23.1	23.1	65.1707	1.4707	2605.2	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
15 Summer	125.70	30
30 Summer	81.84	45
60 Summer	50.76	74
120 Summer	30.46	132
180 Summer	22.31	192
240 Summer	17.80	250
360 Summer	12.86	368
480 Summer	10.22	486
600 Summer	8.54	604
720 Summer	7.38	722
960 Summer	5.85	862
1440 Summer	4.21	1100
2160 Summer	3.03	1496
2880 Summer	2.39	1908
4320 Summer	1.72	2728
5760 Summer	1.35	3520
7200 Summer	1.13	4328
8640 Summer	0.97	5104
10080 Summer	0.85	5848
15 Winter	125.70	30
30 Winter	81.84	44
60 Winter	50.76	74
120 Winter	30.46	130
180 Winter	22.31	188
240 Winter	17.80	244
360 Winter	12.86	360
480 Winter	10.22	476
600 Winter	8.54	590
720 Winter	7.38	702
960 Winter	5.85	918
1440 Winter	4.21	1156

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

Storm Duration (mins)	Maximum Control (l/s)	Maximum Outflow (l/s)	Maximum Water Level (m OD)	Maximum Depth (m)	Maximum Volume (m³)	Status
2160 Winter	22.7	22.7	65.1117	1.4117	2446.9	O K
2880 Winter	22.1	22.1	65.0393	1.3392	2260.5	O K
4320 Winter	20.9	20.9	64.8933	1.1933	1904.9	O K
5760 Winter	19.7	19.7	64.7523	1.0523	1590.3	O K
7200 Winter	18.6	18.6	64.6188	0.9188	1315.8	O K
8640 Winter	17.6	17.6	64.4893	0.7893	1070.3	O K
10080 Winter	16.9	16.9	64.3598	0.6598	846.9	O K

Storm Duration (mins)	Rain (mm/hr)	Time-Peak (mins)
2160 Winter	3.03	1612
2880 Winter	2.39	2072
4320 Winter	1.72	2944
5760 Winter	1.35	3800
7200 Winter	1.13	4616
8640 Winter	0.97	5368
10080 Winter	0.85	6152

Rainfall Details

Region	ENG+WAL	Cv (Summer)	0.750	Summer Storms	Yes
Return Period (years)	100	Cv (Winter)	0.840	Winter Storms	Yes
M5-60 (mm)	19.300	Shortest Storm (mins)	15	Climate Change %	+30
Ratio-R	0.422	Longest Storm (mins)	10080		

Pipe Network

Volume in Pipe Network (m^3)	258	Dia of Outfall Pipe (m)	0.200
Slope of Outfall Pipe (1:x)	500.0	Roughness of Outfall Pipe	0.600

Time / Area Diagram

Total Area (ha) = 4.870

Time from:	(mins) to:	Area (ha)	Time from:	(mins) to:	Area (ha)	Time from:	(mins) to:	Area (ha)	Time from:	(mins) to:	Area (ha)
0	4	1.220	4	8	1.220	8	12	1.220	12	16	1.210

Tank/Pond Details

Invert Level (m) 63.700 Ground Level (m) 66.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.00	938.0	0.40	1354.0	0.80	1822.0	1.20	2340.0	1.60	2907.0	2.00	3523.0
0.10	1037.0	0.50	1466.0	0.90	1946.0	1.30	2477.0	1.70	3056.0	2.10	3523.0
0.20	1139.0	0.60	1581.0	1.00	2074.0	1.40	2617.0	1.80	3209.0	2.20	3523.0
0.30	1245.0	0.70	1700.0	1.10	2205.0	1.50	2760.0	1.90	3364.0		

Hydro-Brake Outflow Control

Design Head (m) 0.450 Hydro-Brake Type MD5 Invert Level (m) 63.700
Design Flow (l/s) 16.6 Diameter (mm) 178

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)
0.10	6.2	0.60	16.6	1.60	24.1	2.60	30.7	5.00	42.6	7.50	52.2
0.20	13.5	0.80	17.7	1.80	25.6	3.00	33.0	5.50	44.7	8.00	53.9
0.30	16.3	1.00	19.3	2.00	27.0	3.50	35.7	6.00	46.7	8.50	55.6
0.40	16.8	1.20	20.9	2.20	28.3	4.00	38.1	6.50	48.6	9.00	57.2
0.50	16.6	1.40	22.6	2.40	29.5	4.50	40.4	7.00	50.4	9.50	58.8

Global Variables

Region	FSR - England & Wales
Return Period (yrs)	5
M5-60 (mm)	19.100
Ratio R	0.420
Volumetric Runoff Coef	0.750
Profile Type	Summer
PIMP (%)	100
Areal Reduction Factor	1.000
Storm Duration (mins)	15
Hot Start (mins)	0
Hot Start Level (mm)	0
Manhole Headloss Coefficient	0.500
MADD Factor * 10m³/ha Storage	2.000
Foul Sewage/Hectare (l/s)	0.00
Additional Flow - % of Total Flow	30
Number of Input Hydrographs	0
Number of Time/Area Diagrams	0
Number of Bifurcations	0
Number of Overflows	0
Number of Off-Line Controls	0
Number of On-Line Controls	0

Starting Storm file name

C:\DOCUMENTS AND SETTINGS\UKSMT003\DESKTOP\WINDES_ISHAM\POND3_NETWORKQ2.SWS

Freely Discharging Outfalls

Outfall Pipe Number	Outfall MH/No	C.Level (m)	I.Level (m)	D,L (mm)	B (mm)
1.016	HW18	66.000	61.941	1200	0

Summary of Results

Return Period (years)	5	Analysis Time Step	Fine
Storm Duration (mins)	15	DTS Status	ON
Profile Type	Summer	DVD Status	OFF
Margin for Flood Risk warning (mm)	300	Inertia Status	OFF

PN	Water Lev. (m)	Surcharged Depth (m)	Flooded Vol (m³)	Flow/ Capacity	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	92.624	-0.042	0.000	0.79	0.0	12.8	O K
1.001	91.975	-0.043	0.000	0.82	0.0	27.9	O K
1.002	89.139	-0.087	0.000	0.67	0.0	61.0	O K
1.003	86.767	0.007	0.000	0.94	0.0	86.0	SURCH'ED
2.000	87.124	-0.044	0.000	0.83	0.0	62.8	O K
2.001	86.864	0.124	0.000	1.06	0.0	87.9	SURCH'ED
1.004	86.385	0.061	0.000	1.31	0.0	169.6	SURCH'ED
3.000	92.420	0.274	0.000	1.08	0.0	11.1	SURCH'ED
3.001	90.566	-0.042	0.000	0.85	0.0	29.1	O K
3.002	88.541	-0.079	0.000	0.74	0.0	54.4	O K
3.003	87.824	0.166	0.000	1.05	0.0	78.0	SURCH'ED
1.005	86.098	-0.117	0.000	0.90	0.0	259.3	O K
4.000	87.366	0.250	0.000	1.04	0.0	6.4	SURCH'ED
5.000	87.105	-0.011	0.000	0.92	0.0	9.4	O K
4.001	86.594	0.151	0.000	1.11	0.0	13.7	SURCH'ED
1.006	85.624	-0.121	0.000	0.94	0.0	289.6	O K
1.007	85.292	-0.293	0.000	0.40	0.0	312.0	O K
1.008	83.082	-0.264	0.000	0.49	0.0	339.0	O K
1.009	81.289	-0.279	0.000	0.44	0.0	382.6	O K
1.010	78.524	-0.282	0.000	0.44	0.0	413.9	O K
1.011	75.165	-0.288	0.000	0.42	0.0	437.4	O K
1.012	70.788	-0.317	0.000	0.33	0.0	437.1	O K
6.000	95.349	-0.059	0.000	0.58	0.0	7.3	O K
6.001	94.846	-0.101	0.000	0.57	0.0	20.3	O K
6.002	94.669	-0.103	0.000	0.55	0.0	34.6	O K
6.003	93.727	-0.082	0.000	0.71	0.0	53.4	O K
6.004	92.341	-0.069	0.000	0.80	0.0	80.6	O K
6.005	89.836	0.035	0.000	1.01	0.0	116.6	SURCH'ED
7.000	87.418	0.253	0.000	1.11	0.0	83.9	SURCH'ED
7.001	86.871	0.136	0.000	1.16	0.0	107.8	SURCH'ED
6.006	86.194	-0.138	0.000	0.57	0.0	223.8	O K
8.000	95.445	0.347	0.000	1.20	0.0	8.6	SURCH'ED
8.001	94.378	-0.011	0.000	1.00	0.0	25.7	O K
8.002	93.149	-0.118	0.000	0.46	0.0	34.7	O K
8.003	92.482	-0.120	0.000	0.44	0.0	62.1	O K
8.004	86.893	-0.069	0.000	0.80	0.0	96.5	O K
6.007	83.083	0.123	0.000	1.01	0.0	327.1	SURCH'ED
6.008	82.518	0.116	0.000	1.11	0.0	365.5	SURCH'ED
6.009	81.672	-0.154	0.000	0.76	0.0	396.4	O K
6.010	79.057	-0.169	0.000	0.71	0.0	421.7	O K
6.011	75.628	-0.180	0.000	0.67	0.0	437.8	O K
6.012	71.485	-0.191	0.000	0.63	0.0	444.4	O K
1.013	68.287	0.116	0.000	0.92	0.0	879.2	SURCH'ED
1.014	66.852	0.360	0.000	1.06	0.0	886.5	SURCH'ED
9.000	72.449	-0.070	0.000	0.54	0.0	19.2	O K
9.001	70.262	0.303	0.000	0.98	0.0	36.0	SURCH'ED
9.002	68.923	0.393	0.000	1.05	0.0	49.6	SURCH'ED
1.015	64.607	0.115	0.000	0.94	0.0	932.2	SURCH'ED
1.016	63.125	0.293	0.000	1.58	0.0	931.1	SURCH'ED

Rainfall Hyetograph

Region	FSR - England & Wales	Profile Type	Summer
Return Period (yrs)	5	Storm Duration (mins)	15
M5-60 (mm)	19.100		
Ratio R	0.420		

Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)	Time (mins)	Rain (mm/hr)
1	16.84	4	25.32	7	113.92	10	57.56	13	21.09
2	18.51	5	33.60	8	176.81	11	33.60	14	18.51
3	21.09	6	57.56	9	113.92	12	25.32	15	16.84

STORM SEWER DESIGN by the Modified Rational Method

Global Variables

Pipe Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.PIP
Manhole Size File C:\Program Files\Micro Drainage Ltd\WinDes\STANDARD.MHS

Location - England & Wales

Return Period (years)	2	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	19.100	Min Cover Depth for Optimisation (m)	1.200
Ratio R	0.420	Min Vel for Auto Design Only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Min Slope for Optimisation (1:X)	500
Foul Sewage (l/s/ha)	0.00	Minimum Outfall Invert (m)	65.250
O'flow Setting (*Foul only)	0	Ground Level at Outfall (m)	66.000
Volumetric Runoff Coeff.	0.75	Outfall Manhole Name	HW18
Add Flow / Climate Change (%)	30	Outfall Manhole Dia/Length (mm)	0
Minimum Backdrop Height (m)	0.200	Outfall Manhole Width (mm)	0

Designed with Level Soffits

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
1.000	75.00	0.648	115.7	0.050	5.00	0.0	0.600	o	150
1.001	75.00	2.792	26.9	0.070	0.00	0.0	0.600	o	150
1.002	77.00	2.466	31.2	0.150	0.00	0.0	0.600	o	225
1.003	58.00	0.436	133.0	0.130	0.00	0.0	0.600	o	300
2.000	85.50	0.428	199.8	0.250	5.00	0.0	0.600	o	300
2.001	68.50	0.416	164.7	0.190	0.00	0.0	0.600	o	300
1.004	8.00	0.109	73.4	0.000	0.00	0.0	0.600	o	375
3.000	52.00	1.538	33.8	0.050	5.00	0.0	0.600	o	100
3.001	51.00	1.988	25.7	0.080	0.00	0.0	0.600	o	150
3.002	43.50	0.962	45.2	0.110	0.00	0.0	0.600	o	225
3.003	67.00	1.443	46.4	0.130	0.00	0.0	0.600	o	225
1.005	48.00	0.470	102.1	0.080	0.00	0.0	0.600	o	450
4.000	62.00	0.673	92.1	0.028	3.00	0.0	0.600	o	100

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
1.000	50.0	6.3	92.516	0.050	0.0	0.0	2.0	0.93	16.5	8.8
1.001	50.0	7.0	91.868	0.120	0.0	0.0	4.9	1.95	34.5	21.1
1.002	50.0	7.5	89.001	0.270	0.0	0.0	11.0	2.35	93.4	47.5
1.003	50.0	8.2	86.460	0.400	0.0	0.0	16.2	1.36	96.2	70.4
2.000	50.0	6.3	86.868	0.250	0.0	0.0	10.2	1.11	78.4	44.0
2.001	50.0	7.2	86.440	0.440	0.0	0.0	17.9	1.22	86.4	77.5
1.004	50.0	8.3	85.949	0.840	0.0	0.0	34.1	2.12	233.8	147.9
3.000	50.0	5.7	92.046	0.050	0.0	0.0	2.0	1.33	10.5	8.8
3.001	50.0	6.1	90.458	0.130	0.0	0.0	5.3	2.00	35.3	22.9
3.002	50.0	6.4	88.395	0.240	0.0	0.0	9.7	1.95	77.6	42.2
3.003	50.0	7.0	87.433	0.370	0.0	0.0	15.0	1.92	76.5	65.1
1.005	50.0	8.7	85.765	1.290	0.0	0.0	52.4	2.01	319.9	227.1
4.000	50.0	4.3	87.016	0.028	0.0	0.0	1.1	0.80	6.3	4.9

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
5.000	22.00	0.673	32.7	0.028	3.00	0.0	0.600	o	100
4.001	15.50	0.698	22.2	0.000	0.00	0.0	0.600	o	100
1.006	27.00	0.160	168.8	0.120	0.00	0.0	0.600	o	525
1.007	75.00	2.239	33.5	0.140	0.00	0.0	0.600	o	525
1.008	75.00	1.778	42.2	0.170	0.00	0.0	0.600	o	525
1.009	75.00	2.762	27.2	0.280	0.00	0.0	0.600	o	525
1.010	75.00	3.353	22.4	0.200	0.00	0.0	0.600	o	525
1.011	82.00	4.348	18.9	0.140	0.00	0.0	0.600	o	525
1.012	8.00	2.934	2.7	0.000	0.00	0.0	0.600	o	525
6.000	90.00	0.461	195.2	0.030	5.00	0.0	0.600	o	150
6.001	33.00	0.175	188.6	0.060	0.00	0.0	0.600	o	225
6.002	62.50	0.963	64.9	0.068	0.00	0.0	0.600	o	225
6.003	62.50	1.399	44.7	0.090	0.00	0.0	0.600	o	225
6.004	66.00	2.609	25.3	0.130	0.00	0.0	0.600	o	225
6.005	66.00	3.469	19.0	0.180	0.00	0.0	0.600	o	225
7.000	86.00	0.430	200.0	0.300	3.00	0.0	0.600	o	300
7.001	51.00	0.403	126.6	0.180	0.00	0.0	0.600	o	300
6.006	20.50	3.372	6.1	0.000	0.00	0.0	0.600	o	300
8.000	50.00	0.709	70.5	0.040	5.00	0.0	0.600	o	100
8.001	51.00	1.122	45.5	0.080	0.00	0.0	0.600	o	150
8.002	27.00	0.665	40.6	0.040	0.00	0.0	0.600	o	225
8.003	71.50	5.640	12.7	0.120	0.00	0.0	0.600	o	225
8.004	71.50	4.002	17.9	0.150	0.00	0.0	0.600	o	225
6.007	45.00	0.558	80.6	0.080	0.00	0.0	0.600	o	450

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
5.000	50.0	3.3	87.016	0.028	0.0	0.0	1.1	1.35	10.6	4.9
4.001	50.0	4.4	86.343	0.056	0.0	0.0	2.3	1.65	12.9	9.9
1.006	50.0	9.0	85.220	1.466	0.0	0.0	59.6	1.72	372.7	258.1
1.007	50.0	9.3	85.060	1.606	0.0	0.0	65.2	3.88	839.9	282.7
1.008	49.9	9.6	82.821	1.776	0.0	0.0	72.0	3.46	748.1	312.0
1.009	49.1	9.9	81.043	2.056	0.0	0.0	82.0	4.31	933.1	355.5
1.010	48.4	10.2	78.281	2.256	0.0	0.0	88.7	4.75	1028.4	384.5
1.011	47.7	10.5	74.928	2.396	0.0	0.0	92.9	5.18	1120.3	402.7
1.012	47.7	10.5	70.580	2.396	0.0	0.0	92.9	13.63	2950.9	402.7
6.000	50.0	7.1	95.258	0.030	0.0	0.0	1.2	0.72	12.6	5.3
6.001	50.0	7.7	94.722	0.090	0.0	0.0	3.7	0.95	37.7	15.8
6.002	50.0	8.3	94.547	0.158	0.0	0.0	6.4	1.63	64.6	27.8
6.003	50.0	8.8	93.584	0.248	0.0	0.0	10.1	1.96	78.0	43.7
6.004	50.0	9.3	92.185	0.378	0.0	0.0	15.4	2.61	103.9	66.5
6.005	49.9	9.6	89.576	0.558	0.0	0.0	22.6	3.01	119.8	98.1
7.000	50.0	4.3	86.865	0.300	0.0	0.0	12.2	1.11	78.3	52.8
7.001	50.0	4.9	86.435	0.480	0.0	0.0	19.5	1.40	98.7	84.5
6.006	49.8	9.7	86.032	1.038	0.0	0.0	42.0	6.42	453.5	181.9
8.000	50.0	5.9	94.998	0.040	0.0	0.0	1.6	0.92	7.2	7.0
8.001	50.0	6.5	94.239	0.120	0.0	0.0	4.9	1.50	26.4	21.1
8.002	50.0	6.7	93.042	0.160	0.0	0.0	6.5	2.06	81.9	28.2
8.003	50.0	7.0	92.377	0.280	0.0	0.0	11.4	3.70	146.9	49.3
8.004	50.0	7.4	86.737	0.430	0.0	0.0	17.5	3.11	123.7	75.7
6.007	48.9	10.0	82.510	1.548	0.0	0.0	61.5	2.27	360.3	266.4

Network Design Table

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	T.E. (mins)	DWF (l/s)	k (mm)	HYD SECT	DIA (mm)
6.008	45.00	0.576	78.1	0.230	0.00	0.0	0.600	o	450
6.009	90.00	2.600	34.6	0.190	0.00	0.0	0.600	o	450
6.010	90.00	3.418	26.3	0.160	0.00	0.0	0.600	o	450
6.011	90.00	4.132	21.8	0.100	0.00	0.0	0.600	o	450
6.012	62.50	3.505	17.8	0.040	0.00	0.0	0.600	o	450
1.013	31.00	1.679	18.5	0.040	0.00	0.0	0.600	o	525
1.014	55.00	2.000	27.5	0.080	0.00	0.0	0.600	o	525
9.000	62.50	2.560	24.4	0.070	5.00	0.0	0.600	o	150
9.001	31.00	1.429	21.7	0.100	0.00	0.0	0.600	o	150
9.002	55.00	4.038	13.6	0.080	0.00	0.0	0.600	o	150
1.015	10.50	1.660	6.3	0.000	0.00	0.0	0.600	o	525
1.016	24.00	0.216	111.1	0.000	0.00	0.0	0.600	o	675

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	E.Area (ha)	E.DWF (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	CAP (l/s)	Flow (l/s)
6.008	48.0	10.3	81.952	1.778	0.0	0.0	69.4	2.30	366.1	300.7
6.009	47.0	10.8	81.376	1.968	0.0	0.0	75.1	3.46	551.0	325.4
6.010	46.1	11.2	78.776	2.128	0.0	0.0	79.7	3.97	632.1	345.2
6.011	45.3	11.5	75.358	2.228	0.0	0.0	82.0	4.37	695.2	355.4
6.012	44.8	11.7	71.226	2.268	0.0	0.0	82.6	4.83	768.6	358.0
1.013	44.6	11.8	67.646	4.704	0.0	0.0	170.5	5.23	1132.2	739.0
1.014	44.2	12.0	65.967	4.784	0.0	0.0	171.7	4.28	927.2	743.9
9.000	50.0	5.5	72.369	0.070	0.0	0.0	2.8	2.05	36.2	12.3
9.001	50.0	5.7	69.809	0.170	0.0	0.0	6.9	2.17	38.4	29.9
9.002	50.0	6.1	68.380	0.250	0.0	0.0	10.2	2.74	48.5	44.0
1.015	44.1	12.0	63.967	5.034	0.0	0.0	180.5	8.95	1936.5	782.1
1.016	43.8	12.2	62.157	5.034	0.0	0.0	180.5	2.49	889.6	782.1

Time Area Diagram

Time From (mins)	Time To (mins)	Area (ha)
0	4	1.701
4	8	3.111
8	12	0.221
12	16	0.001

Total Area Contributing (ha) = 5.034

Total Pipe Volume (m^3) = 257.576

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	o	150	1	93.766	92.516	1.100	1050
1.001	o	150	2	93.140	91.868	1.122	1050
1.002	o	225	3	90.823	89.001	1.597	1200
1.003	o	300	4	88.634	86.460	1.874	1200
2.000	o	300	5	88.118	86.868	0.950	1050
2.001	o	300	6	87.983	86.440	1.243	1050
1.004	o	375	7	88.134	85.949	1.810	1350
3.000	o	100	8	93.315	92.046	1.169	1050
3.001	o	150	9	91.847	90.458	1.239	1050
3.002	o	225	10	89.929	88.395	1.309	1050
3.003	o	225	11	88.940	87.433	1.282	1050
1.005	o	450	12	88.241	85.765	2.026	1350
4.000	o	100	13	87.786	87.016	0.670	1050
5.000	o	100	14	87.786	87.016	0.670	1050
4.001	o	100	15	87.786	86.343	1.343	1050
1.006	o	525	16	87.934	85.220	2.189	1500
1.007	o	525	17	87.121	85.060	1.536	1500
1.008	o	525	18	85.044	82.821	1.698	1500
1.009	o	525	19	82.886	81.043	1.318	1500
1.010	o	525	20	80.161	78.281	1.355	1500
1.011	o	525	21	76.846	74.928	1.393	1500
1.012	o	525	22	72.588	70.580	1.483	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
1.000	75.00	115.7	2	93.140	91.868	1.122	1050
1.001	75.00	26.9	3	90.823	89.076	1.597	1200
1.002	77.00	31.2	4	88.634	86.535	1.874	1200
1.003	58.00	133.0	7	88.134	86.024	1.810	1350
2.000	85.50	199.8	6	87.983	86.440	1.243	1050
2.001	68.50	164.7	7	88.134	86.024	1.810	1350
1.004	8.00	73.4	12	88.241	85.840	2.026	1350
3.000	52.00	33.8	9	91.847	90.508	1.239	1050
3.001	51.00	25.7	10	89.929	88.470	1.309	1050
3.002	43.50	45.2	11	88.940	87.433	1.282	1050
3.003	67.00	46.4	12	88.241	85.990	2.026	1350
1.005	48.00	102.1	16	87.934	85.295	2.189	1500
4.000	62.00	92.1	15	87.786	86.343	1.343	1050
5.000	22.00	32.7	15	87.786	86.343	1.343	1050
4.001	15.50	22.2	16	87.934	85.645	2.189	1500
1.006	27.00	168.8	17	87.121	85.060	1.536	1500
1.007	75.00	33.5	18	85.044	82.821	1.698	1500
1.008	75.00	42.2	19	82.886	81.043	1.318	1500
1.009	75.00	27.2	20	80.161	78.281	1.355	1500
1.010	75.00	22.4	21	76.846	74.928	1.393	1500
1.011	82.00	18.9	22	72.588	70.580	1.483	1500
1.012	8.00	2.7	43	72.589	67.646	4.418	1500

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
6.000	o	150	23	96.508	95.258	1.100	1050
6.001	o	225	24	96.134	94.722	1.187	1050
6.002	o	225	25	95.872	94.547	1.100	1050
6.003	o	225	26	94.909	93.584	1.100	1050
6.004	o	225	27	93.567	92.185	1.157	1050
6.005	o	225	28	91.233	89.576	1.432	1050
7.000	o	300	29	88.115	86.865	0.950	1050
7.001	o	300	30	88.074	86.435	1.339	1050
6.006	o	300	31	88.434	86.032	2.102	1200
8.000	o	100	32	96.248	94.998	1.150	1050
8.001	o	150	33	95.564	94.239	1.175	1050
8.002	o	225	34	94.445	93.042	1.178	1050
8.003	o	225	35	93.859	92.377	1.257	1050
8.004	o	225	36	91.257	86.737	4.295	1200
6.007	o	450	37	88.307	82.510	5.347	1350
6.008	o	450	38	86.947	81.952	4.545	1350
6.009	o	450	39	85.931	81.376	4.105	1350
6.010	o	450	40	83.377	78.776	4.151	1350
6.011	o	450	41	79.950	75.358	4.142	1350
6.012	o	450	42	75.900	71.226	4.224	1350
1.013	o	525	43	72.589	67.646	4.418	1500
1.014	o	525	44	71.007	65.967	4.515	1500
9.000	o	150	45	73.796	72.369	1.277	1050

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
6.000	90.00	195.2	24	96.134	94.797	1.187	1050
6.001	33.00	188.6	25	95.872	94.547	1.100	1050
6.002	62.50	64.9	26	94.909	93.584	1.100	1050
6.003	62.50	44.7	27	93.567	92.185	1.157	1050
6.004	66.00	25.3	28	91.233	89.576	1.432	1050
6.005	66.00	19.0	31	88.434	86.107	2.102	1200
7.000	86.00	200.0	30	88.074	86.435	1.339	1050
7.001	51.00	126.6	31	88.434	86.032	2.102	1200
6.006	20.50	6.1	37	88.307	82.660	5.347	1350
8.000	50.00	70.5	33	95.564	94.289	1.175	1050
8.001	51.00	45.5	34	94.445	93.117	1.178	1050
8.002	27.00	40.6	35	93.859	92.377	1.257	1050
8.003	71.50	12.7	36	91.257	86.737	4.295	1200
8.004	71.50	17.9	37	88.307	82.735	5.347	1350
6.007	45.00	80.6	38	86.947	81.952	4.545	1350
6.008	45.00	78.1	39	85.931	81.376	4.105	1350
6.009	90.00	34.6	40	83.377	78.776	4.151	1350
6.010	90.00	26.3	41	79.950	75.358	4.142	1350
6.011	90.00	21.8	42	75.900	71.226	4.224	1350
6.012	62.50	17.8	43	72.589	67.721	4.418	1500
1.013	31.00	18.5	44	71.007	65.967	4.515	1500
1.014	55.00	27.5	48	69.460	63.967	4.968	1500
9.000	62.50	24.4	46	71.326	69.809	1.367	1050

PIPELINE SCHEDULES

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
9.001	o	150	46	71.326	69.809	1.367	1050
9.002	o	150	47	69.747	68.380	1.217	1050
1.015	o	525	48	69.460	63.967	4.968	1500
1.016	o	675	49	69.000	62.157	6.168	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH No.	C.Level (m)	I.Level (m)	C.Depth (m)	MH DIAM., L*W (mm)
9.001	31.00	21.7	47	69.747	68.380	1.217	1050
9.002	55.00	13.6	48	69.460	64.342	4.968	1500
1.015	10.50	6.3	49	69.000	62.307	6.168	1500
1.016	24.00	111.1	HW18	66.000	61.941	3.384	0

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
1	93.766	1.250	1050	1.000	92.516	150			
2	93.140	1.272	1050	1.001	91.868	150	1.000	91.868	150
3	90.823	1.822	1200	1.002	89.001	225	1.001	89.076	150
4	88.634	2.174	1200	1.003	86.460	300	1.002	86.535	225
5	88.118	1.250	1050	2.000	86.868	300			
6	87.983	1.543	1050	2.001	86.440	300	2.000	86.440	300
7	88.134	2.185	1350	1.004	85.949	375	1.003	86.024	300
							2.001	86.024	300
8	93.315	1.269	1050	3.000	92.046	100			
9	91.847	1.389	1050	3.001	90.458	150	3.000	90.508	100
10	89.929	1.534	1050	3.002	88.395	225	3.001	88.470	150
11	88.940	1.507	1050	3.003	87.433	225	3.002	87.433	225
12	88.241	2.476	1350	1.005	85.765	450	1.004	85.840	375
							3.003	85.990	225
13	87.786	0.770	1050	4.000	87.016	100			
14	87.786	0.770	1050	5.000	87.016	100			
15	87.786	1.443	1050	4.001	86.343	100	4.000	86.343	100
							5.000	86.343	100
16	87.934	2.714	1500	1.006	85.220	525	1.005	85.295	450
							4.001	85.645	100
17	87.121	2.061	1500	1.007	85.060	525	1.006	85.060	525
18	85.044	2.223	1500	1.008	82.821	525	1.007	82.821	525
19	82.886	1.843	1500	1.009	81.043	525	1.008	81.043	525
20	80.161	1.880	1500	1.010	78.281	525	1.009	78.281	525
21	76.846	1.918	1500	1.011	74.928	525	1.010	74.928	525
22	72.588	2.008	1500	1.012	70.580	525	1.011	70.580	525
23	96.508	1.250	1050	6.000	95.258	150			
24	96.134	1.412	1050	6.001	94.722	225	6.000	94.797	150
25	95.872	1.325	1050	6.002	94.547	225	6.001	94.547	225
26	94.909	1.325	1050	6.003	93.584	225	6.002	93.584	225
27	93.567	1.382	1050	6.004	92.185	225	6.003	92.185	225
28	91.233	1.657	1050	6.005	89.576	225	6.004	89.576	225
29	88.115	1.250	1050	7.000	86.865	300			
30	88.074	1.639	1050	7.001	86.435	300	7.000	86.435	300
31	88.434	2.402	1200	6.006	86.032	300	6.005	86.107	225
							7.001	86.032	300
32	96.248	1.250	1050	8.000	94.998	100			

MANHOLE SCHEDULES

M/Hole Number	Cover Level (m)	M/Hole Depth (m)	M/Hole Diam.,L*W (mm)	Pipes Out PN	Pipes Out IL.(m)	Pipes Out D (mm)	Pipes In PN	Pipes In IL.(m)	Pipes In D (mm)
33	95.564	1.325	1050	8.001	94.239	150	8.000	94.289	100
34	94.445	1.403	1050	8.002	93.042	225	8.001	93.117	150
35	93.859	1.482	1050	8.003	92.377	225	8.002	92.377	225
36	91.257	4.520	1200	8.004	86.737	225	8.003	86.737	225
37	88.307	5.797	1350	6.007	82.510	450	6.006	82.660	300
							8.004	82.735	225
38	86.947	4.995	1350	6.008	81.952	450	6.007	81.952	450
39	85.931	4.555	1350	6.009	81.376	450	6.008	81.376	450
40	83.377	4.601	1350	6.010	78.776	450	6.009	78.776	450
41	79.950	4.592	1350	6.011	75.358	450	6.010	75.358	450
42	75.900	4.674	1350	6.012	71.226	450	6.011	71.226	450
43	72.589	4.943	1500	1.013	67.646	525	1.012	67.646	525
							6.012	67.721	450
44	71.007	5.040	1500	1.014	65.967	525	1.013	65.967	525
45	73.796	1.427	1050	9.000	72.369	150			
46	71.326	1.517	1050	9.001	69.809	150	9.000	69.809	150
47	69.747	1.367	1050	9.002	68.380	150	9.001	68.380	150
48	69.460	5.493	1500	1.015	63.967	525	1.014	63.967	525
							9.002	64.342	150
49	69.000	6.843	1500	1.016	62.157	675	1.015	62.307	525
HW18	66.000	4.059	0		OUTFALL		1.016	61.941	675

10589516 - A509 Isham Bypass
Catchment Plans

Pond 1	
Catchment Number	Area (Ha)
1	0.23
2	0.22
3	0.15
4	0.14
5	0.10
6	0.11
7	0.07
8	0.09
9	0.11
10	0.11
11	0.08
12	0.10
13	0.09
14	0.11
15	0.09
16	0.11
17	0.12
18	0.09
19	0.10
20	0.15
21	0.09
22	0.10
23	0.17
24	0.15
25	0.12
26	0.15
27	0.10
28	0.08
29	0.08
30	0.12
31	0.05
32	0.10
33	0.02
34	0.10
35	0.10
36	0.11
37	0.13
38	0.11
39	0.13
40	0.10
41	0.13
42	0.10
43	0.07
44	0.04
45	0.08
46	0.08
47	0.11
48	0.08
49	0.08
50	0.20
51	0.13
52	0.09
53	0.20
54	0.10
55	0.12
Total Area	**6.09**

Pond 2	
Catchment Number	Area (Ha)
1	0.22
2	0.10
3	0.13
4	0.23
5	0.10
6	0.12
7	0.24
8	0.10
9	0.12
10	0.28
11	0.10
12	0.15
13	0.30
14	0.27
15	0.29
16	0.25
17	0.25
18	0.19
19	0.28
20	0.18
21	0.19
22	0.09
23	0.06
24	0.09
25	0.06
26	0.09
27	0.10
28	0.09
29	0.09
30	0.09
31	0.09
32	0.08
33	0.07
34	0.14
35	0.20
36	Na
37	0.21
38	0.30
39	0.22
40	0.32
41	0.19
42	0.23
43	0.09
44	0.09
45	0.09
46	0.15
47	0.09
48	0.15
49	0.17
50	0.23
51	0.22
52	0.29
53	0.22
54	0.28
Total Area	**8.97**

Pond 3	
Catchment Number	Area (Ha)
1	0.25
2	0.30
3	0.19
4	0.18
5	0.18
6	0.15
7	0.13
8	0.12
9	0.09
10	0.08
11	0.04
12	0.06
13	0.03
14	0.08
15	0.13
16	0.13
17	0.15
18	0.11
19	0.08
20	0.07
21	0.05
22	0.05
23	0.12
24	0.08
25	0.14
26	0.23
27	0.17
28	0.19
29	0.28
30	0.16
31	0.20
32	0.10
33	0.14
34	0.04
35	0.04
36	0.08
37	0.08
38	0.10
39	0.07
Total Area	**4.87**

Project			Status	
ISHAM BY PASS			P	
Date 17-9-09 By ST Checked	Job no. 10589576.	Section DT	Sheet no. 1	Rev

Rev	Date	Details	Tel / Fax
		GREENFIELD RUN OFF. / IH 124.	

Part PRELIM. RAINFALL RUN OFF / WS-074.

REF

OUTPUT

TOTAL SITE = 38.80 ha = 0.388 km^2.

Q_a ((DEVELOPMENT MEAN ANNUAL PEAK FLOW) ($m^3 \rightarrow l/s$)

$$Q_a = \left(0.00108 \times \left(A^{*}/100\right)^{0.89} \times SAAR^{1.17} \times SPR^{2.17}\right) \times 1000$$

WHERE ∴ SAAR = 600 MM , SPR = 0.47

$$\therefore A^{*} = \left(\frac{38.80\ ha}{100}\right) = 0.388\ km^2 \text{ BUT } < 50\ ha \therefore \text{USE } 50\ ha.$$

$$\therefore \left(0.00108 \times (0.5)^{0.89} \times (600)^{1.17} \times (0.47)^{2.17}\right) \times 1000$$

$$\therefore (0.00108 \times (0.539) \times (1780) \times (0.194)) \times 10^3 = \underline{201}\ l/s.$$

∴ < 50 ha ∴ PRO RATA SITE:

$\frac{38.8}{50} \times 201 = Q\ 155.97\ l/s$. ∴ $\bar{Q}_p = \frac{156}{38.80} = 4.02\ l/s$.

$Q/A \times 0.85 = Q_1 = 3.4\ l/s$.

〃 $\times GC_{30} = Q_{30} = 9.45\ l/s$.

〃 $\times GC_{100} = Q_{100} = 14.07\ l/s$.

(SEE ATTACHED CALCS).

3.1 Initial sizing of Attenuation storage volume

ASV1

Greenfield estimation of peak flow rate of runoff

The aim of this first section is to determine the peak discharge rate of the greenfield site runoff for 1, 30 and 100 year return period events.

Site characteristics

1. Hydrological Region (1 – 10)(R) [5] — UK is divided up into 10 hydrological regions reflecting the different flood frequency growth curves. (Appendix 1, Figure 1.1)

2. (SOIL) type (1 – 5) (S) [4] — Refer to Wallingford Procedure WRAP map or FSR maps (Appendix 1, Figure 5)

3. Development size (A) [38.86] ha — The size of the gross development excluding large parkland areas being allocated as public open space which remain unmodified.

4. Method of Greenfield analysis

   If development area is 200+ ha a full FEH analysis is recommended to obtain a more accurate estimate of greenfield runoff characteristics.

5. Area (A) [38.86] ha — Excluding public open space not modified by the proposed development

6. Annual Rainfall (SAAR) [600] mm — SAAR – use either SAAR from FSR or AAR from FEH (Appendix 1, Figure 4)

7. Soil runoff coefficient (SPR) [0.47] — SPR value for SOIL – this is not the FSR index class value for SOIL (1 to 5) but its corresponding runoff coefficient (SPR) as follows:

SOIL	1	2	3	4	5
SPR	0.10	0.30	0.37	0.47	0.53

8. Development mean annual peak flow $(1.08(A/100)^{0.89}$. $SAAR^{1.17}$. $SPR^{2.17}) \times 1000$
($Q_{BAR} = Q_{BAR50\ hr} \times (A/50)$)
(Q_{BAR}) [156] l/s

For development sites of 50 ha or less, use 50 ha when applying the formula. Subsequently factor the resulting value by the ratio of the site area to 50 ha. (i.e. if the site is 10 ha divide the answer by 5)

9. Mean annual peak flow per unit area (Q_{BAR}/A) [4·02] l/s/ha

For SOIL type 1 and occasionally type 2 Q_{BAR}/A will generally have a value less than 1. If so use 1 l/s/ha (see note 2)

10. Minimum limit of discharge ($Q_{throttle}$) [ ] l/s

Minimum discharge (see note 3)

10.1 100 year flow rate per unit area ($Q_{throttle}/A$) [ ] l/s/ha

10.2 Equivalent mean annual peak flow per unit area ($Q_{throttle}/3.5A$) [ ] l/s/ha

N/A

Use this value as (Q_{BAR}/A) if it is greater than item 9.

11. 1yr, 30yr and 100yr peak discharge rate of runoff per unit area

Use the larger of the 2 values of item 9 and 10.2 for calculating 11.1 to 11.3

GC_{30} and GC_{100} are the growth curve ratios (Q/Q) for the 30 year and 100 year events for the relevant hydrological region.

The 30 and 100 year factors are found from Appendix 1, Figure 1.2 from FSSR 14. (Do NOT use the Growth Curve Factors from the embedded table in the figure).

11.1 $Q_{BAR}/A \times 0.85$ Q_{1yr} [3·4] l/s/ha

11.2 $Q_{BAR}/A \times GC_{30}$ Q_{30yr} [9·45] l/s/ha
4·02 × 2·35

11.3 $Q_{BAR}/A \times GC_{100}$ Q_{100yr} [14·07] l/s/ha
4·02 × 3·5

Note 1 *HOST classes for soil also have SPR values. Although derived a little differently, these values can also be used (IH Report 126 – Hydrology of Soil Types)*

Note 2 *Very low values of Q_{BAR}/A result in excessive storage volumes. As Long Term storage for SOIL type 1 is large, a minimum value of Q_{BAR}/A of 1 is to be used.*

Note 3 *Minimum sizes of an orifice may limit the minimum hydraulic control flow rate. This allows the derivation of an equivalent value of a Q_{BAR}/A.*

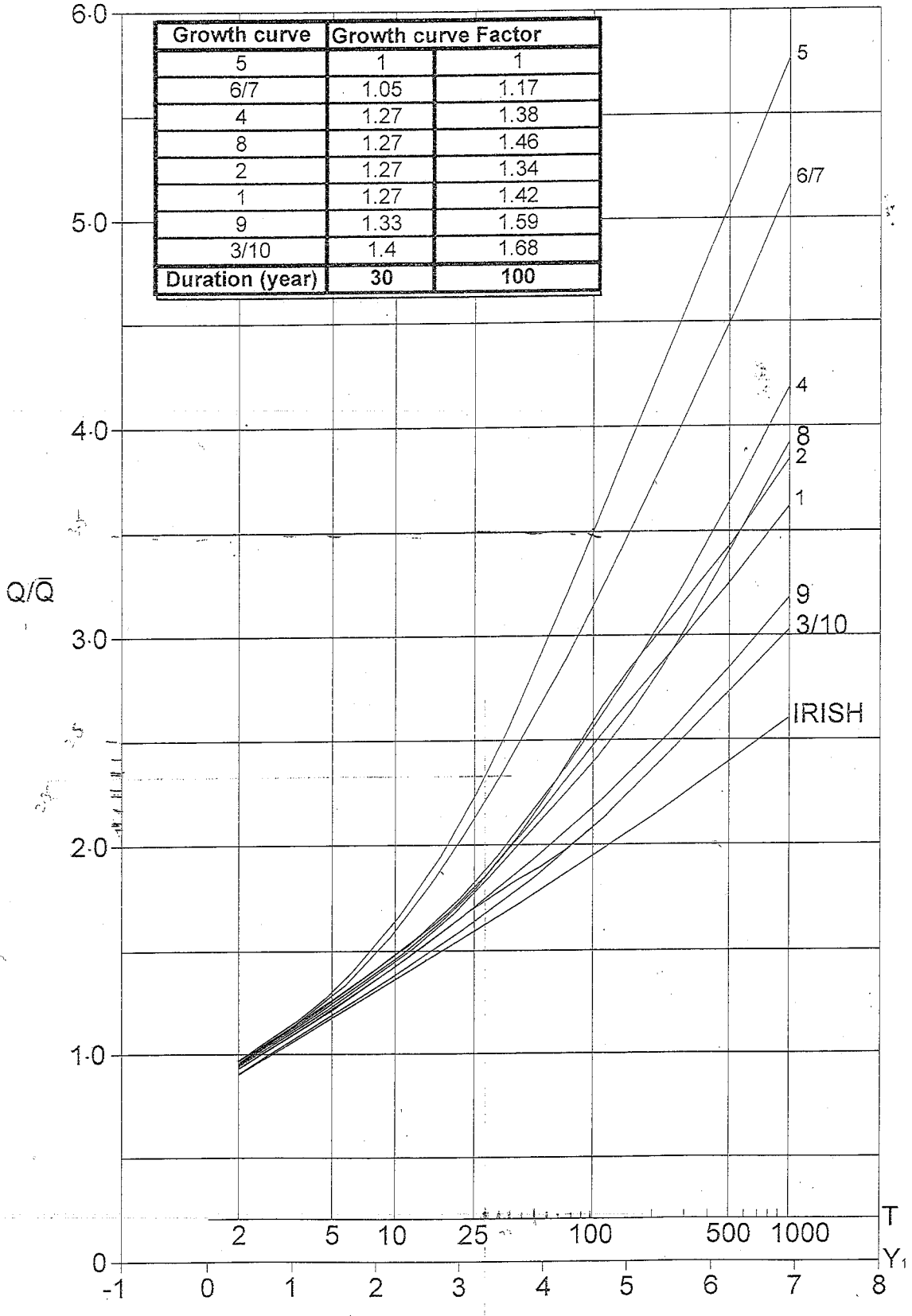

Figure 1.2 Peak flow growth curves of UK (from FSSR 14)

Appendix I Other Information Sources

Atkins Flood Risk Assessment
A509 Isham Bypass (January 2005)

NORTHAMPTONSHIRE COUNTY COUNCIL

A509 Isham Bypass

Flood Risk Assessment

Final Report
January 2005

Notice

Document History

JOB NUMBER: 5026518			DOCUMENT REF: 5026518/80/DG/FRA			
Revision	Purpose and Description	Originated	Checked	Reviewed	Authorised	Date
0	DRAFT – for comment	JET	GJD	MMH	MMH	27 May '04
1	FINAL	JET	GJD	MMH	MMH	04 Jun '04
2	FINAL – amended to reflect the Environment Agency's new Flood Map	GJD	JET	MMH	MMH	28 Jan '05

CONTENTS

1 Introduction

1.1 Background

Atkins Water was commissioned to carry out a Flood Risk Assessment (FRA) for the proposed A509 Isham Bypass. This report summarises the work undertaken and presents the findings. The approach taken and the content of this report were agreed with the Environment Agency (EA), through consultation with staff from the Kettering office.

The EA's particular requirements for this FRA report include:

- Culvert sizing where the new road crosses watercourses.
- Confirmation that any proposals are consistent with the EA's Culverting Policy.
- Confirmation that drainage design discharge from each outfall does not exceed 5 litres per second per hectare (typically, discharge should be between 3 and 5 l/s per ha).
- Details of balancing pond sizing.
- High level proposals for the use of vegetative systems, or SUDS (Sustainable Drainage Systems), to complement traditional hard engineering solutions.
- Proposed maintenance procedures for culverts and balancing ponds.

Much of this FRA builds on previous work undertaken by Atkins Water, which is documented in the April 2004 report entitled 'Isham Bypass – Flood Frequency Analysis Tributaries of the River Ise' (document reference: 4324001-DG-004-1). A copy of this report is included in Appendix C.

This version of the FRA updates the original document (version 1, 4 June 2004) with details of the EA's new Flood Map, which was published in October 2004 and replaces the Indicative Floodplain Map.

1.2 Scheme summary

The village of Isham lies on the A509, approximately 5km south of Kettering. A bypass has been proposed for a number of years, since the 22,000 vehicles currently passing through the village everyday is significantly above the 13,000 threshold for a bypass.

Route selection has been a sensitive issue, with Route 2 now selected as the preferred option. Route 2 heads south from the A14 Pytchley Roundabout and passes to the west of the village. The new bypass will rejoin the existing A509 south of the village, close to the B574 Orlingbury Road. The exact location where the bypass will rejoin the existing A509, south of Isham, has yet to be confirmed, due to uncertainty regarding other highway improvements in the vicinity. The new road to be constructed will be around 4km in length and will be a mixture dual-carriageway bypass and single-carriageway link roads.

1.3 Local environment

The local landscape is undulating and is drained by a number of small streams that flow to the River Ise. The River Ise, east of Isham village, is flanked by floodplain which varies in width between 150 and 700m. On the EA's new Flood Map (Figure 1), much of this floodplain is classified as having a significant chance of flooding, with the probability of flooding in one year greater than 1.3% (1 in 75 year). However, the proposed route lies to the west of the village and is outside the River Ise floodplain.

Key: dark blue = 1 in 100 year flood outline; light blue = 1 in 1000 year flood outline (both exclude the effect of defences)
Source: Environment Agency website

Figure 1 – Flood Map

The preferred route crosses three of these minor watercourses, namely:

- Pytchley Brook
- Hardwick Brook.
- An unnamed watercourse, commonly referred to as 'Little Harrowden Brook' on account of its proximity to the village of the same name (but not to be confused with Harrowden Brook).

Each of these watercourses also has an associated floodplain, although these are confined in width by the local topography. The EA's Flood Map indicates that in the downstream end of these watercourses (downstream of the existing A509), there is a significant chance of flooding. In the vicinity of the proposed new crossings, the chance of flooding has not yet been assessed in detail. However, the map provides a 1 in 100 year outline for Pytchley and Hardwick Books, which indicates that the 1 in 100 year flood would extend approximately 20 m either side of these watercourses. There is no 1 in 100 year outline mapped for the smaller, unnamed watercourse.

From discussion with EA Operational staff, the tributaries of the River Ise naturally come out of bank at least once a year. However, the EA is not aware of any problems of culverts backing-up on these tributaries.

Although none of the tributary watercourses are main river, the most problematic is likely to be Pytchley Brook. This stream enters the River Ise just downstream of the proposed crossings, close to the Weetabix factory. Weetabix has its own balancing pond and there is a relief channel for flood waters near to the factory. There may be issues with flow being constricted at the confluence, although the proposed bypass should have no impact on this.

As set out in Planning Policy Guidance Note 25 (PPG25), a FRA should consider the flood risk to the proposed development and also the potential effects of the development itself on the surrounding area. Mitigation measures should be proposed to deal with any risks.

2 Culverts

It has been agreed with the EA that culverts will be constructed where the new bypass crosses 3 minor watercourses:

- Pytchley Brook
- Hardwick Brook
- 'Little Harrowden Brook'.

The provision of culverts on the proposed Isham Bypass has been developed in accordance with the EA's policy on culverting. The EA is generally opposed to the culverting of watercourses because of the adverse ecological, flood defence and other effects that are likely to arise. Wherever possible, the EA aims to retain open watercourses.

Discussions with the EA during the design development phases indicate that approval will be given for the new culverts on Pytchley Brook, Hardwick Brook and 'Little Harrowden Brook'. This is largely to be expected since the EA recognises that culverts are often unavoidable where a road crosses a watercourse and that, in the case of the Isham Bypass, the impacts on the water environment are minor.

As agreed with the EA, culverts will be designed to accommodate the 1 in 100 year flood flow. Flood frequency analysis was undertaken to estimate the flows in these watercourses and the results are presented in Table 1 below. The analysis was carried out in accordance with the approach outlined in Volume III of Flood Estimation Handbook (FEH) (Institute of Hydrology, 1999) which is understood to the EA's preferred methodology. A full copy of the analysis is included in Appendix C.

Return Period (years)	Pytchley Brook 487852, 274735		Hardwick Brook 488250, 273250		'Little Harrowden Brook' 488250, 271750	
	Flood flow from FEH (m^3/s)	Flood flow with safety factor 50% (m^3/s)	Flood flow from FEH (m^3/s)	Flood flow with safety factor 50% (m^3s^{-1})	Flood flow from FEH (m^3/s)	Flood flow with safety factor 50% (m^3/s)
2	1.511	2.267	2.214	3.321	0.139	0.209
5	2.267	3.400	3.330	4.995	0.206	0.309
10	2.788	4.182	4.091	6.137	0.254	0.382
25	3.513	5.270	5.139	7.708	0.324	0.487
50	4.113	6.169	5.998	8.997	0.385	0.577
100	4.773	7.160	6.932	10.398	0.453	0.679
200	5.502	**8.252**	7.957	**11.936**	0.531	**0.796**

Table 1 – Flood frequency analysis

As shown in Table 1 above, a 50% factor of safety was applied to the estimated flows, allowing for inaccuracies and dilapidation (and hence changes to performance) during the lifetime of each culvert. Analysis of a range of culvert sizes revealed that the 1 in 200 year flow (plus 50% safety factor) could be accommodated by a slight increase in culvert dimensions. Therefore it is recommended that the culverts be designed to take the 1 in 200 year flows; in actual fact, due to the conservative safety factor used, the design will be able to accommodate an even greater flow.

Any culverting of a watercourse, or the alteration of an existing culvert, requires a Land Drainage Consent. The Agency's consent is required under Section 23 of the Land Drainage Act 1991. Highway authorities are required under Section 339 of the Highways Act 1980 to seek the consent of the drainage authority before carrying out any works affecting a watercourse. These are issues that will need to be progressed as the scheme develops.

A summary of the culverts proposed as part of the Isham Bypass are presented in Table 2 below. These culverts have been designed with a 25% freeboard. Detailed calculations are included in Appendix B, which also includes alternative designs.

The conservative approach that has been adopted when designing these culverts in general results in a more environmentally acceptable crossing. The large opening is less like a typical culvert and more akin to a bridge. This means that it will probably not be necessary to provide additional crossings at these locations for wildlife, such as badgers or water voles. However, it may be appropriate to create a ledge on the inside of the culverts to allow animals to pass beneath the new road during periods of high flow. Such issues would be confirmed at the detailed design stage. It should be noted that at this phase in the design, it is assumed that the culverts (as shown in Table 2 below) can be accommodated in the proposed road embankment.

Culvert location and OS grid reference	Proposed culvert	Design flow (m^3/s)	1 in100 yr flow from FEH (m^3/s)	1 in 200 yr flow from FEH (m^3/s)
Pytchley Brook (487852, 274735)	3.476 x 2.208m low profile corrugated metal pipe arch	8.252	4.773	5.502
Hardwick Brook (488250, 273250)	4.136 x 2.511m low profile corrugated metal pipe arch	11.936	6.932	7.957
'Little Harrowden Brook' (488250, 271750)	1.2m diameter* corrugated metal pipe (as existing)	0.796 (capacity ~1.7m^3/s)	0.453	0.531

Table 2 – Proposed culverts

**NB: A 1000mm diameter corrugated metal pipe would be adequate for Culvert 3, however a 1.2m diameter is proposed to match the existing culvert at this location.*

From inspection of the proposed route and local topography, it is noted that there are 2 dry valleys, at chainages 350m (close to Pytchley Lodge) and 3050m (close to Frisby Lodge). It is proposed that a 600mm diameter culvert (with concrete headwalls) is provided at each of these locations. It should be noted that the minimum size culvert permitted by the EA is 600mm diameter.

3 Drainage design

3.1 Drainage design philosophy

The underlying principle of the Isham Bypass drainage design is dictated by the undulating topography of the local area and, more specifically, the long section profile of the selected route – the existing ground level along the proposed route varies by 35m.

It is proposed that the carriageway at grade and on embankment will be drained via trapped gullies to a positive carrier drainage system in the verge. The trapped gullies will act as the first point of mitigation. In areas of cut it is proposed that the carriageway will be drained via combined surface water and ground water filter drain as per the Highways Construction Detail B1. All chambers on the surface water system will be catchpits as per Highways Construction Detail F11; these will act as the second point of mitigation.

A Class 1 Petrol/Oil Bypass separator will be provided at the two roundabouts on the scheme. These will include penstock valve chambers on the inlet and outlet to provide a bypass to the separator. This will provide an additional level of mitigation at the roundabouts which are considered to have a higher level of risk with respect to spillage.

A $25m^3$ emergency spillage containment facility will be provided at each of the 3 outfalls on the scheme. These will consist of a lined open ditch with an outfall structure which will enable the emergency services to isolate any spillage on the mainline of the scheme. This structure will also act as a containment facility for light liquids in its normal operating process. This facility will act as the third level of mitigation.

The balancing facilities will be designed to provide a wetland area habitat. The surface water system will outfall to a stilling basin. This will incorporate a filter wall – a rock gabion structure – to help reduce suspended and transported solids entering the pond area. The pond base will be contoured such that the depth of water shall vary, to enhance the environmental benefits. These ponds will provide the forth and final level of mitigation.

The proposed road crosses existing streams at approximate chainages of 1000m (Pytchley Brook), 2500m (Hardwick Brook) and 4100m (Little Harrowden Brook). Surface run-off will drain to one of 3 balancing ponds, to be located adjacent to each watercourse. The balancing ponds are to be sized in order to attenuate the flow in line with EA guidelines. A floating arm outfall from each pond will discharge into the neighbouring watercourse.

Where possible, the drainage design will incorporate vegetative systems, or SUDS, alongside more conventional engineering solutions, such as oil interceptors, penstocks and isolation valves.

A drainage plan is included in Appendix A, which illustrates the key features of the design.

3.2 Outfall design discharge

The EA has confirmed that the discharge from proposed outfalls should not exceed 5 litres per second per hectare. Typically, the EA would expect a value between 3 and 5 l/s/ha.

Microdrainage analysis software was used to design the outfall and balancing pond system. Details are provided in Appendix B. To ensure a conservative design at this stage of the project, the outfall discharge rate was set at 3 l/s/ha. The absolute discharge that this corresponds to is shown in Table 3 below.

Drainage area	Drained area (ha)	Discharge rate (l/s/ha)	Discharge (l/s)
Pond 1 - Pytchley Brook	3.183	3.0	9.6
Pond 2 - Hardwick Brook	4.920	3.0	14.8
Pond 3 - 'Little Harrowden Brook'	1.557	3.0	4.7
Total	**9.66**	-	**29.1**

Table 3 – Absolute discharge

3.3 Balancing ponds

The topography along the proposed route is undulating. The three minor water courses – Pytchley Brook, Hardwick Brook and 'Little Harrowden Brook' – are generally equally spaced (at chainages 1000m, 2500m and 4100m respectively) and are located at the low points on the route. The drainage design incorporates balancing ponds close to these watercourses. These balancing ponds will discharge via a floating arm outfall into the adjacent watercourse. The highway drainage is designed so that approximately equal surface areas of the new road drain to each balancing pond.

As agreed with the EA, the capacity of each balancing pond has been determined based on the following approach:

Balancing pond volume =

1 in 100 yr storm

+ 80% of run-off from a follow on 10 year event

+ 5 to 10% allowance for dilapidation

+ 20% allowance for climate change

Table 4 below presents the required storage volume of the 3 proposed balancing ponds, based on the requirements detailed in the above box.

The balancing ponds will be designed to provide a wetland habitat, with a filter wall preventing suspended and transported solids entering the pond area. Details of the calculations are included in Appendix B.

To enhance the environmental benefits, each pond base will be contoured, creating a range of water depths. This will encourage differing vegetation, for instance:

- 0m – meadow grasses
- 0.2m to 0.4m range – marshland and vegetated lagoons
- 1.5m – open water areas.

During operation, the water level in the ponds will fluctuate, possibly by up to 2m.

The outfall from these ponds will be controlled via a floating arm facility, giving a constant discharge rate of 3 l/s/ha. With the proposed bypass having a total surface area of 9.66 ha, this corresponds to an absolute discharge rate of 29.1 l/s.

	Pond 1 Pytchley Brook	Pond 2 Hardwick Brook	Pond 3 'Little Harrowden Brook'
1 in 100 yr	2038	3172	1003
80% of 1 in 10 year	926	1425	452
Sub-total	*2964*	*4597*	*1455*
10% factor for dilapidation	296	460	145
20% factor for climate change	593	919	291
Total volume (m^3)	**3853**	**5976**	**1891**
Additional storage above 1 in 100 yr	89%	88%	89%

Table 4 – Balancing pond storage requirements

It is considered that it may be inappropriate to provide ponds to accommodate the full capacity as shown in the above table, which are based on relatively stringent conditions. It is estimated that the full design volume shown above could accommodate a very extreme event, typically 89% higher volume that the 1 in 100 year event alone. This perhaps corresponds to a return period in the order of 1 in 1000 to 2000 years.

It is proposed that a more practical approach may be to provide a smaller capacity pond – to accommodate the 1 in 100 year storm. A secondary area around the pond would be available to be flooded during extreme events.

Alternatively, the proposed locations of the balancing ponds could be reviewed. Rather than constructing 3 large ponds, it may be more feasible to employ several smaller ponds. The practicalities of constructing smaller ponds may present fewer challenges, notably earthworks, landscaping and land purchase.

It may also be feasible to reduce the size of the proposed balancing ponds by incorporating SUDS techniques (see below) in the drainage system, which have the potential for reducing run-off rates. Such options will be investigated and, following consultation with the EA, confirmed during the detailed design phase. The location of the balancing ponds will have to be considered carefully during the detailed design phase, since it is possible that the size of the pond and the associated earthworks will have an impact on the floodplains of the brooks. The design and location of ponds will have to take account of local geology and groundwater levels.

3.4 Sustainable drainage systems (SUDS)

3.4.1 Introduction

In recent years vegetative treatment systems – more commonly known as Sustainable Drainage Systems or SUDS – have become increasingly important, as the effects of greater urbanisation become apparent. Whilst traditional drainage systems tend to increase the peak runoff from sites to watercourses, potentially leading to flooding problems downstream, SUDS use a number of techniques to mimic natural drainage systems. SUDS include tried-and-tested techniques that are already being implemented in a range of projects in England and Wales and elsewhere. Planning Policy Guidance Note 25 (PPG25) for England on Development and Flooding emphasises the role of SUDS and introduces a general presumption that they will be used.

The main SUDS techniques include:

- Source control of rainwater
- Infiltration of runoff where feasible
- The use of swales and filter drains to attenuate flow during conveyance
- Ponds and wetlands to balance peak runoff and improve water quality.

3.4.2 Benefits

SUDS offer a number of benefits compared to traditional drainage systems. These include:

- Improved water quality and enhanced biodiversity in watercourses
- Groundwater recharge leading to increased base flow to streams and rivers
- Reduced potential for flooding downstream of the development
- Improved identification of accidental pollution events prior to discharge to watercourses
- Development opportunities in areas where the existing surface water sewer system may already be at capacity
- Potential to improve amenity and biodiversity through the use of ponds and wetlands

SUDS also have the potential for providing amenity, water quality and ecological benefits over and above those provided by traditional drainage systems. To achieve these benefits, it is important that SUDS are considered at the earliest planning stages of a development to allow co-ordination and integration with other disciplines.

The opportunity to incorporate SUDS should ideally be considered as early as possible in the design and planning process. It is therefore appropriate now to carry out a high level review of the various options that could be incorporated into the A509 Isham Bypass design. The EA recognises the range of potential benefits offered by SUDS and is supportive to promote their use wherever possible.

3.4.3 Techniques

Permeable pavements

The need for surface water drains can be reduced where run-off is encouraged to permeate through a porous pavement, such as permeable concrete blocks, crushed stone or porous asphalt.

Depending on the ground conditions, water may infiltrate directly into the subsoil or be stored in an underground reservoir (for example, a crushed stone layer) before slowly soaking into the ground. If infiltration is not possible or appropriate (for example, because of ground contamination), an impermeable membrane can be used with an overflow to keep the pavement free from water in all conditions. Pollutant removal occurs either within the surfacing or sub-base material itself, or by the filtering action of the reservoir or subsoil.

Infiltration trenches

An infiltration trench is a shallow, excavated trench that has been filled with stone to create an underground reservoir.

Stormwater entering the trench is gradually infiltrated into the ground. Their longevity can be enhanced by providing pre-treatment of the stormwater using a filter strip, gully or sump pit to remove excessive solids.

Filter drains

Filter drains are already widely used by highway authorities for draining roads. They are similar structures to infiltration strips, through which a perforated pipe runs. This facilitates the storage, filtering and some infiltration of water passing from the source to the discharge point. Pollutants are removed by absorption, filtering and microbial decomposition in the surrounding soil. Systems can be designed to successfully incorporate both infiltration and filter systems.

Swales and basins

These can be created as features within the landscaping of a project. Swales and basins are often installed as part of a drainage network connecting to a pond or wetland, prior to discharge to a natural watercourse.

Swales are grassed depressions which lead surface water overland from the drained surface to a storage or discharge system. The green space of a roadside verge can be used for this purpose. If swales are used instead of conventional roadside kerbs, construction and maintenance cost savings can be made. Compared to a conventional ditch, a swale is shallow and relatively wide, providing temporary storage, conveyance, treatment and the possibility of infiltration under suitable conditions.

A basin is designed to hold back storm runoff for a few hours and to allow the settlement of solids. They are dry outside of storm periods. They provide temporary storage for storm water, reduce peak flows to receiving waters, facilitate the filtration of pollutants (deposited and incorporated into the substrate) and encourage microbial decomposition, as well as allowing water infiltration directly into the ground.

Figure 2 – Typical example of a highway drainage balancing pond

Ponds, wetlands and reed beds

Although these can be designed as wet or dry ponds, or wetlands, they are most likely to contribute to visual amenity and biodiversity where they include a permanent water body. Ponds or wetlands can be designed to accommodate considerable variations in water levels during storms, thereby enhancing flood-storage capacity.

By allowing adequate detention time, the level of solids removal can be significant. The algae and plants of wetlands provide a particularly good level of filtering and nutrient removal. Ponds and wetlands can be fed by swales, filter drains or piped systems, and the use of inlet and outlet sumps will enhance performance by trapping silt and preventing clogging of the outlet. Removal of collected sediment from the inlet sump may be needed, although typically this is unlikely to be more than once every seven years.

It should be noted that only specially constructed wetlands should be used to treat surface water – the use of existing, natural wetlands is unlikely to be acceptable.

3.4.4 Suitability for the Isham Bypass

As has already been noted, a combination of SUDS techniques is commonly used in highway design and construction. At this early stage of the design process, it is not possible to propose exact arrangements. What is important is that the opportunity to incorporate more sustainable alternatives is identified. These basic concepts can then be developed during detailed design stage.

Not all types of SUDS will be appropriate in this situation and a number of factors will determine the techniques that could be adopted at Isham. In brief, these include:

- Available space
- Local geology and soil type
- Local topography
- Design constraints, either due to client or regulatory requirements, legislation, design standards or future maintenance expectations.

Although a number of issues remain to be confirmed as the project progresses, it is likely that the type of SUDS to be incorporated in the Isham Bypass drainage design could include:

- Filter strips/drains
- Infiltration trenches
- Swales
- Balancing ponds, incorporating reed beds

4 Proposed maintenance

4.1 Introduction

Once the new bypass is in operation, Northamptonshire County Council will be responsible for the its maintenance, including the maintenance of associated culverts and balancing ponds. This maintenance will follow the highway authority's standard procedures, which are summarised below.

4.2 Culverts

A new bridge inspection system – the Bridge Condition Index – has been introduced by Northamptonshire County Council. This system will produce the nationally comparable bridge condition indices. A third of the bridge stock, over 200 bridges, will be included in the index by April 2005. Bridge inspection results are downloaded direct from data capture devices into the bridge condition software. All bridge record attributes will be updated to support the bridge condition index by the end of 2004. In addition the bridge element condition is computer analysed to produce a prioritised maintenance programme. These developments will lead to a robust bridge stock comparator and a soundly based maintenance programme.

The new structures forming part of the Isham Bypass will be covered by this inspection system.

4.3 Balancing ponds

Service inspections cover all visible drainage items, both on and off the carriageway. Such inspections, which include balancing ponds, are carried out annually.

Other inspections are carried out as needed, in particular after heavy rain or in response to reports. Maintenance is then undertaken as required based on the information gained from the inspections. All maintenance is carried out to the standards recommended in the IHT Code of Practice for Maintenance Management.

Well designed balancing ponds should be sustainable features of the drainage system in that they require little or no maintenance. They would, however, be subjected to the same routine inspections outlined above.

5 Risk of flooding

5.1 Flooding of the road

The preferred route (Route 2) of the proposed Isham Bypass lies outside the floodplain of the River Ise and is therefore unlikely to be at risk of flooding from the River Ise.

The new road will cross 3 minor watercourses, which are understood to come out of bank naturally at least once a year. However, they are expected to have a negligible impact on the new road due to their small size and the higher level of the finished road relative to the streams.

The road could potentially flood as a result of an intense rainstorm. However, the road has been designed to withstand a 1 in 100 year storm, in terms of the capacity of the road drainage, so it is assumed that this would only occur during an extreme weather event.

Overall, it can be concluded that the proposed Isham Bypass should not be at risk of flooding during design events.

5.2 Local flooding due to road drainage

As agreed with the EA, the drainage discharge from the new road has been designed so that run-off is restricted to the greenfield run-off rate. Run-off from the new road will be attenuated by the use of balancing ponds, located close to the culverted streams. The opportunity to incorporate SUDS techniques into the highway drainage design should also lessen the risk of local flooding due to the new road, since SUDS generally maximise infiltration and attenuation.

In conclusion, it is unlikely that the proposed Isham Bypass will contribute to local flooding.

5.3 Impact on nearby watercourses

The proposed bypass is outside the River Ise floodplain and is unlikely to impact on main river flows or flood storage capacity.

The new road crosses 3 minor watercourses – Pytchley Brook, Hardwick Brook and 'Little Harrowden Brook'. These streams will be culverted as they pass under the bypass. These culverts have been designed to accommodate the 1 in 200 year flood event plus a 50% safety factor and are therefore unlikely to impact on flows.

The location of proposed balancing ponds will be considered in more detail during the detailed design phase. If not considered carefully, the size of the ponds and the associated earthworks could potentially impact on the floodplains of these watercourses.

Overall, any impact on local watercourses should be negligible.

6 Conclusions

Following the work undertaken as part of this flood risk assessment, it is possible to reach the conclusions summarised below.

- The proposed Isham Bypass is not expected to increase the risk of local flooding, since flows from the highway drainage system will be attenuated to the greenfield run-off rate.
- The selected route lies outside the floodplain with the highest chance of flooding and the new road will typically be raised above the surrounding land; the risk of the road itself flooding is believed to be very low.
- Although 3 minor watercourses – Pytchley Brook, Hardwick Brook and 'Little Harrowden Brook' – will be culverted where the proposed bypass crosses, the culverts will be designed to accommodate the 1 in 200 year flow as agreed with the EA (plus a 50% safety factor) and therefore will have little impact on flows.
- Opportunities to incorporate vegetative treatment systems or SUDS – in particular, filter drains, infiltration trenches, swales and reed beds – will need to be considered further during the detailed design phase. Generally, it is hoped that there will be opportunities to combine conventional systems with more sustainable solutions.
- Once constructed and in operation, Northamptonshire County Council will be responsible for the maintenance of the culverts, balancing ponds and outfalls, which will be maintained in line with the Council's procedures.

Overall the additional risks of flooding to the local area due to the proposed A509 Isham Bypass are negligible. The risk of the road itself flooding is also negligible.