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56 The Ropewalk Nottingham NG1 5DW		
Date 26/11/2021 16:08 File SW network - planning.MDX	Designed by slawinska_a Checked by	
XP Solutions	Network 2018.1.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.353	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.994	4-8	1.589	8-12	0.118

Total Area Contributing (ha) = 2.701

Total Pipe Volume (m³) = 150.820

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	127.628	3.443	37.1	1.012	5.00	0.0	0.600	o	525	Pipe/Conduit	
1.001	97.970	1.873	52.3	0.076	0.00	0.0	0.600	o	525	Pipe/Conduit	
2.000	71.033	0.807	88.0	0.306	5.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.58	142.839	1.012	0.0	0.0	0.0	3.69	798.2	137.1
1.001	50.00	6.10	139.400	1.089	0.0	0.0	0.0	3.10	671.5	147.4
2.000	50.00	5.61	139.812	0.306	0.0	0.0	0.0	1.93	213.4	41.5

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<u>Network Design Table for Storm</u>											
PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.002	80.703	0.550	146.7	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
3.000	47.668	0.466	102.3	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	73.685	0.349	211.1	0.200	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.004	40.883	0.384	106.5	0.169	0.00	0.0	0.600	o	525	Pipe/Conduit	
4.000	72.111	0.618	116.7	0.153	5.00	0.0	0.600	o	300	Pipe/Conduit	
4.001	104.291	2.903	35.9	0.243	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.000	101.875	1.045	97.5	0.134	5.00	0.0	0.600	o	300	Pipe/Conduit	
6.000	106.725	1.468	72.7	0.090	5.00	0.0	0.600	o	300	Pipe/Conduit	
5.001	25.917	2.345	11.1	0.107	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.002	37.348	1.150	32.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.005	36.804	0.150	245.4	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
7.000	41.174	0.704	58.5	0.000	5.00	0.0	0.600	o	225	Pipe/Conduit	
7.001	27.964	0.478	58.5	0.166	0.00	0.0	0.600	o	225	Pipe/Conduit	
<u>Network Results Table</u>											
PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)	
1.002	50.00	6.83	137.500	1.395	0.0	0.0	0.0	1.85	399.8	188.9	
3.000	50.00	5.80	139.327	0.000	0.0	0.0	0.0	0.99	17.6	0.0	
1.003	50.00	7.63	136.914	1.595	0.0	0.0	0.0	1.54	332.9	216.0	
1.004	50.00	7.94	136.595	1.765	0.0	0.0	0.0	2.17	469.9	239.0	
4.000	50.00	5.83	139.631	0.153	0.0	0.0	0.0	1.45	102.8	20.7	
4.001	50.00	6.49	139.023	0.396	0.0	0.0	0.0	2.63	186.0	53.6	
5.000	50.00	6.07	139.711	0.134	0.0	0.0	0.0	1.59	112.6	18.1	
6.000	50.00	5.96	140.142	0.090	0.0	0.0	0.0	1.85	130.5	12.1	
5.001	50.00	6.16	138.643	0.331	0.0	0.0	0.0	4.76	336.1	44.8	
5.002	50.00	6.38	137.300	0.331	0.0	0.0	0.0	2.77	195.7	44.8	
1.005	50.00	8.37	136.150	2.491	0.0	0.0	0.0	1.43	308.6	337.3	
7.000	50.00	5.40	137.000	0.000	0.0	0.0	0.0	1.71	68.1	0.0	
7.001	50.00	5.67	136.296	0.166	0.0	0.0	0.0	1.71	68.1	22.5	
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Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.006	39.829	0.994	40.1	0.044	0.00	0.0	0.600	o	525	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.006	50.00	8.56	136.000	2.701	0.0	0.0	0.0	3.55	767.7	365.8

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Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	User	-	100	1.012	1.012	1.012
1.001	User	-	100	0.076	0.076	0.076
2.000	User	-	100	0.306	0.306	0.306
1.002	-	-	100	0.000	0.000	0.000
3.000	-	-	100	0.000	0.000	0.000
1.003	User	-	100	0.200	0.200	0.200
1.004	User	-	100	0.169	0.169	0.169
4.000	User	-	100	0.153	0.153	0.153
4.001	User	-	100	0.243	0.243	0.243
5.000	User	-	100	0.134	0.134	0.134
6.000	User	-	100	0.090	0.090	0.090
5.001	User	-	100	0.107	0.107	0.107
5.002	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.000	0.000	0.000
7.000	-	-	100	0.000	0.000	0.000
7.001	User	-	100	0.166	0.166	0.166
1.006	User	-	100	0.044	0.044	0.044
				Total	Total	Total
				2.701	2.701	2.701

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.006		136.000	135.006	130.620	525	0

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.353		

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Online Controls for Storm

Orifice Manhole: 5, DS/PN: 1.005, Volume (m³): 23.4

Diameter (m) 0.250 Discharge Coefficient 0.600 Invert Level (m) 136.150

Hydro-Brake® Optimum Manhole: 6, DS/PN: 1.006, Volume (m³): 10.3

Unit Reference	MD-SHE-0391-9700-0900-9700
Design Head (m)	0.900
Design Flow (l/s)	97.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	391
Invert Level (m)	136.000
Minimum Outlet Pipe Diameter (mm)	450
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	97.0
Flush-Flo™	0.535	96.9
Kick-Flo®	0.786	90.8
Mean Flow over Head Range	-	72.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	10.9	1.200	111.5	3.000	174.3	7.000	264.1
0.200	38.7	1.400	120.2	3.500	188.0	7.500	273.2
0.300	74.3	1.600	128.3	4.000	200.7	8.000	282.0
0.400	94.7	1.800	135.8	4.500	212.6	8.500	290.5
0.500	96.8	2.000	143.0	5.000	223.9	9.000	298.8
0.600	96.5	2.200	149.8	5.500	234.6	9.500	303.9
0.800	91.6	2.400	156.3	6.000	244.8		
1.000	102.1	2.600	162.5	6.500	254.7		

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XP Solutions	Network 2018.1.1																											
Storage Structures for Storm Cellular Storage Manhole: 5, DS/PN: 1.005 Invert Level (m) 136.150 Safety Factor 2.0 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95 Infiltration Coefficient Side (m/hr) 0.00000 <table><thead><tr><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th><th>Inf. Area (m²)</th></tr></thead><tbody><tr><td>0.000</td><td>970.0</td><td>0.0</td><td>1.201</td><td>0.0</td><td>0.0</td></tr><tr><td>1.200</td><td>970.0</td><td>0.0</td><td></td><td></td><td></td></tr></tbody></table> Tank or Pond Manhole: 6, DS/PN: 1.006 Invert Level (m) 136.000 <table><thead><tr><th>Depth (m)</th><th>Area (m²)</th><th>Depth (m)</th><th>Area (m²)</th></tr></thead><tbody><tr><td>0.000</td><td>140.0</td><td>0.900</td><td>331.7</td></tr></tbody></table>			Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	0.000	970.0	0.0	1.201	0.0	0.0	1.200	970.0	0.0				Depth (m)	Area (m²)	Depth (m)	Area (m²)	0.000	140.0	0.900	331.7
Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)																							
0.000	970.0	0.0	1.201	0.0	0.0																							
1.200	970.0	0.0																										
Depth (m)	Area (m²)	Depth (m)	Area (m²)																									
0.000	140.0	0.900	331.7																									
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for Storm

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Offline Controls 0 Number of Real Time Controls 0

Rainfall Model	FSR	Ratio R	0.352
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

DTS Status ON

Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600,
720, 960, 1440, 2160, 2880, 4320, 5760,
7200, 8640, 10080

PN	US/MH		Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
	Name	Storm						
1.000	1	15 Winter	1	+0%				
1.001	2	15 Winter	1	+0%	100/15 Summer	100/15 Summer		
2.000	3	15 Winter	1	+0%	100/15 Summer			
1.002	3	15 Winter	1	+0%	30/15 Summer	100/15 Summer		
3.000	5	360 Winter	1	+0%				
1.003	4	15 Winter	1	+0%	30/15 Summer			
1.004	7	15 Winter	1	+0%	100/15 Summer			
4.000	7	15 Winter	1	+0%	100/15 Summer			
4.001	8	15 Winter	1	+0%	100/15 Summer			
5.000	9	15 Winter	1	+0%				
6.000	10	15 Winter	1	+0%				
5.001	10	15 Winter	1	+0%				
5.002	11	15 Winter	1	+0%				
1.005	5	240 Winter	1	+0%	30/120 Winter			
7.000	15	360 Winter	1	+0%				
7.001	16	15 Winter	1	+0%	100/15 Summer			
1.006	6	240 Winter	1	+0%	100/120 Winter			

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

PN	US/MH Name	Water	Surcharged	Flooded			Pipe	Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m ³)	Flow / Cap.	Overflow (l/s)	Flow (l/s)		
1.000	1	142.984	-0.380	0.000	0.16		125.5	OK	
1.001	2	139.564	-0.361	0.000	0.21		131.8	OK	2
2.000	3	139.924	-0.263	0.000	0.19		38.8	OK	
1.002	3	137.749	-0.276	0.000	0.45		166.3	OK	2
3.000	5	139.327	-0.150	0.000	0.00		0.0	OK	
1.003	4	137.208	-0.231	0.000	0.58		179.6	OK	
1.004	7	136.848	-0.272	0.000	0.47		191.4	OK	
4.000	7	139.721	-0.210	0.000	0.19		18.7	OK	
4.001	8	139.124	-0.199	0.000	0.24		43.6	OK	
5.000	9	139.790	-0.221	0.000	0.15		16.1	OK	
6.000	10	140.203	-0.239	0.000	0.09		10.9	OK	
5.001	10	138.714	-0.229	0.000	0.13		38.3	OK	
5.002	11	137.393	-0.207	0.000	0.21		38.2	OK	
1.005	5	136.404	-0.271	0.000	0.11		30.2	OK	
7.000	15	137.000	-0.225	0.000	0.00		0.0	OK	
7.001	16	136.378	-0.143	0.000	0.28		17.7	OK	
1.006	6	136.181	-0.344	0.000	0.05		32.5	OK	

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

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

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.352
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

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

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Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

US/MH			Return	Climate	First (X)		First (Y)	First (Z)	Overflow
PN	Name	Storm	Period	Change	Surcharge		Flood	Overflow	Act.
1.000	1	15	Winter	30	+0%				
1.001	2	15	Winter	30	+0%		100/15	Summer	
2.000	3	15	Winter	30	+0%		100/15	Summer	
1.002	3	15	Winter	30	+0%		30/15	Summer	100/15 Summer
3.000	5	360	Winter	30	+0%				
1.003	4	15	Winter	30	+0%		30/15	Summer	
1.004	7	15	Winter	30	+0%		100/15	Summer	
4.000	7	15	Winter	30	+0%		100/15	Summer	
4.001	8	15	Winter	30	+0%		100/15	Summer	
5.000	9	15	Winter	30	+0%				
6.000	10	15	Winter	30	+0%				
5.001	10	15	Winter	30	+0%				
5.002	11	15	Winter	30	+0%				
1.005	5	180	Winter	30	+0%		30/120	Winter	
7.000	15	360	Winter	30	+0%				
7.001	16	15	Winter	30	+0%		100/15	Summer	
1.006	6	240	Winter	30	+0%		100/120	Winter	

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

PN	US/MH Name	Water	Surcharged	Flooded	Flow / Cap.	Overflow	Pipe	Status	Level Exceeded
		Level (m)	Depth (m)	Volume (m³)		(l/s)	Flow (l/s)		
1.000	1	143.075	-0.289	0.000	0.40		307.0	OK	
1.001	2	139.672	-0.253	0.000	0.52		327.1	OK	2
2.000	3	139.994	-0.193	0.000	0.47		94.9	OK	
1.002	3	138.267	0.242	0.000	1.04		385.2	SURCHARGED	2
3.000	5	139.327	-0.150	0.000	0.00		0.0	OK	
1.003	4	137.681	0.242	0.000	1.31		401.8	SURCHARGED	
1.004	7	137.038	-0.082	0.000	1.00		409.8	OK	
4.000	7	139.779	-0.152	0.000	0.47		45.8	OK	
4.001	8	139.208	-0.115	0.000	0.66		119.6	OK	
5.000	9	139.840	-0.171	0.000	0.36		39.4	OK	
6.000	10	140.237	-0.205	0.000	0.21		26.6	OK	
5.001	10	138.763	-0.180	0.000	0.32		97.4	OK	
5.002	11	137.460	-0.140	0.000	0.54		97.9	OK	
1.005	5	136.709	0.034	0.000	0.27		71.8	SURCHARGED	
7.000	15	137.000	-0.225	0.000	0.00		0.0	OK	
7.001	16	136.459	-0.062	0.000	0.87		54.9	OK	
1.006	6	136.302	-0.223	0.000	0.11		75.0	OK	

1) for Storm

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

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Number of Online Controls 2 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

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Rainfall Model	FSR	Ratio R	0.352
Region	England and Wales	Cv (Summer)	0.750
M5-60 (mm)	19.000	Cv (Winter)	0.840

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Analysis Timestep   Fine Inertia Status OFF
      DTS Status      ON
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Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Time Period(s) (years)	1, 30, 100
Climate Change (%)	0, 0, 40

US/MH			Return	Climate	First (X)		First (Y)	First (Z)	Overflow
PN	Name	Storm	Period	Change	Surcharge		Flood	Overflow	Act.
1.000	1	15	Winter	100	+40%				
1.001	2	15	Winter	100	+40%		100/15	Summer	
2.000	3	15	Winter	100	+40%		100/15	Summer	
1.002	3	15	Winter	100	+40%		30/15	Summer	100/15 Summer
3.000	5	360	Winter	100	+40%				
1.003	4	15	Winter	100	+40%		30/15	Summer	
1.004	7	15	Winter	100	+40%		100/15	Summer	
4.000	7	15	Winter	100	+40%		100/15	Summer	
4.001	8	15	Winter	100	+40%		100/15	Summer	
5.000	9	15	Winter	100	+40%				
6.000	10	15	Winter	100	+40%				
5.001	10	15	Winter	100	+40%				
5.002	11	15	Winter	100	+40%				
1.005	5	180	Winter	100	+40%		30/120	Winter	
7.000	15	360	Winter	100	+40%				
7.001	16	15	Winter	100	+40%		100/15	Summer	
1.006	6	180	Winter	100	+40%		100/120	Winter	

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XP Solutions	Network 2018.1.1	

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	1	143.182	-0.182	0.000	0.73		555.9	OK	
1.001	2	140.908	0.983	8.699	0.77		486.9	FLOOD	2
2.000	3	140.332	0.145	0.000	0.83		167.3	SURCHARGED	
1.002	3	140.005	1.980	4.899	1.48		550.7	FLOOD	2
3.000	5	139.327	-0.150	0.000	0.00		0.0	OK	
1.003	4	138.923	1.484	0.000	1.89		579.2	SURCHARGED	
1.004	7	137.628	0.508	0.000	1.52		624.0	SURCHARGED	
4.000	7	140.051	0.120	0.000	0.78		77.2	SURCHARGED	
4.001	8	139.664	0.341	0.000	1.05		189.8	SURCHARGED	
5.000	9	139.896	-0.115	0.000	0.65		71.4	OK	
6.000	10	140.274	-0.168	0.000	0.38		48.2	OK	
5.001	10	138.813	-0.131	0.000	0.59		176.3	OK	
5.002	11	137.543	-0.057	0.000	0.98		177.3	OK	
1.005	5	137.200	0.525	0.000	0.39		104.8	SURCHARGED	
7.000	15	137.000	-0.225	0.000	0.00		0.0	OK	
7.001	16	137.000	0.479	0.000	1.30		82.4	FLOOD RISK	
1.006	6	136.605	0.080	0.000	0.15		96.9	FLOOD RISK	