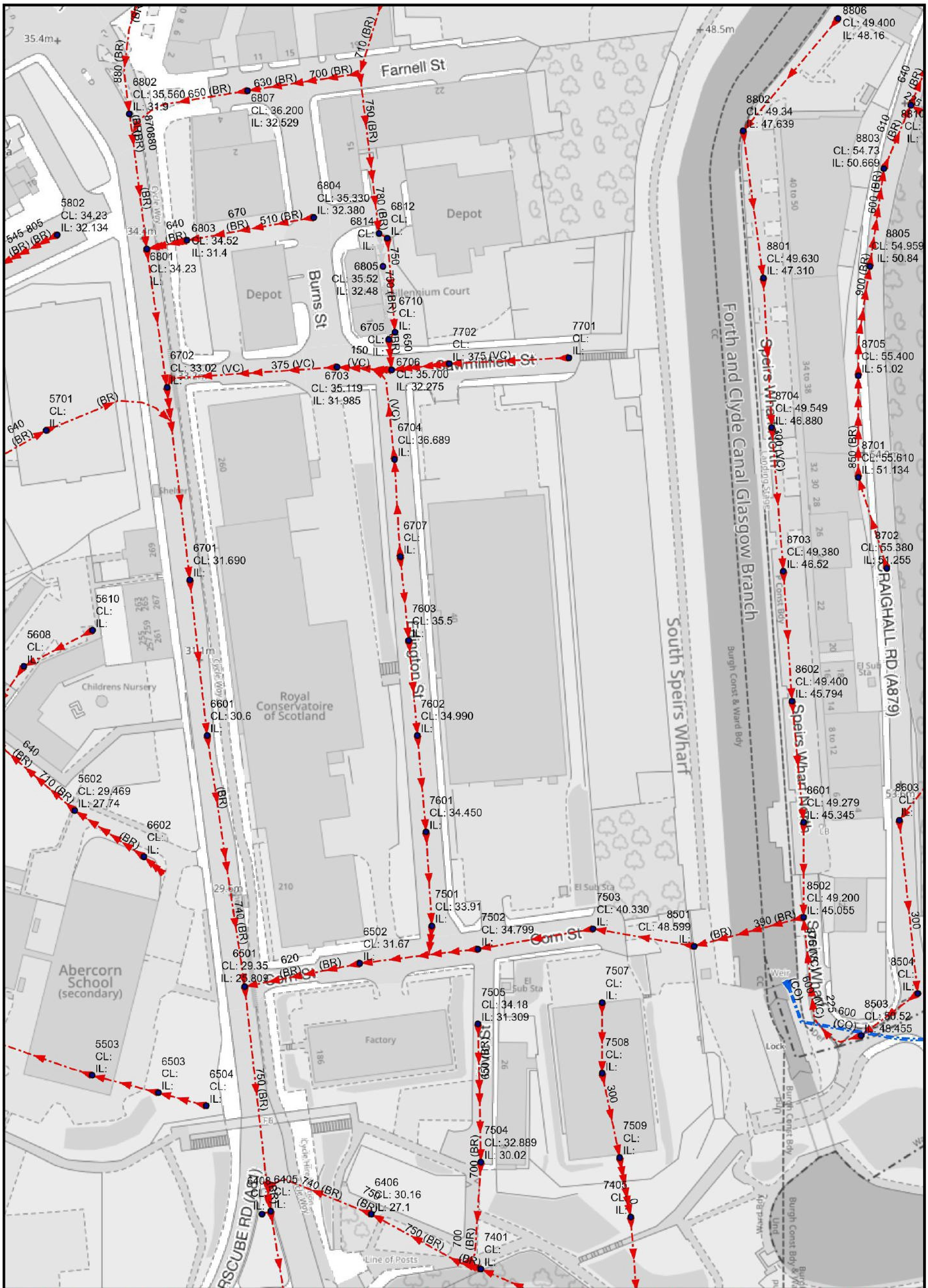
Appendix D

Scottish Water Record Plan



Warning! Damaging a large diameter trunk main (12"/300mm and above) can result in loss of life and major water supply and water quality problems. If you're planning any extension work in the vicinity of any large diameter mains shown on our maps, you must contact Scottish Water to arrange a site visit 08000 778 778 WELL IN ADVANCE OF THE WORKS.

N

Speirs Wharf

The representation of physical assets and the boundaries of areas in which Scottish Water and others have an interest does not necessarily imply their true positions. For further details contact the appropriate District office.

0 5 10 20 Meters

Scottish Water
Trusted to serve Scotland

The Bridge
6 Buchanan Gate
Stepps
Glasgow
G33 6FB

Tel No: 08000 778 778

Date Plotted: 11/12/2023

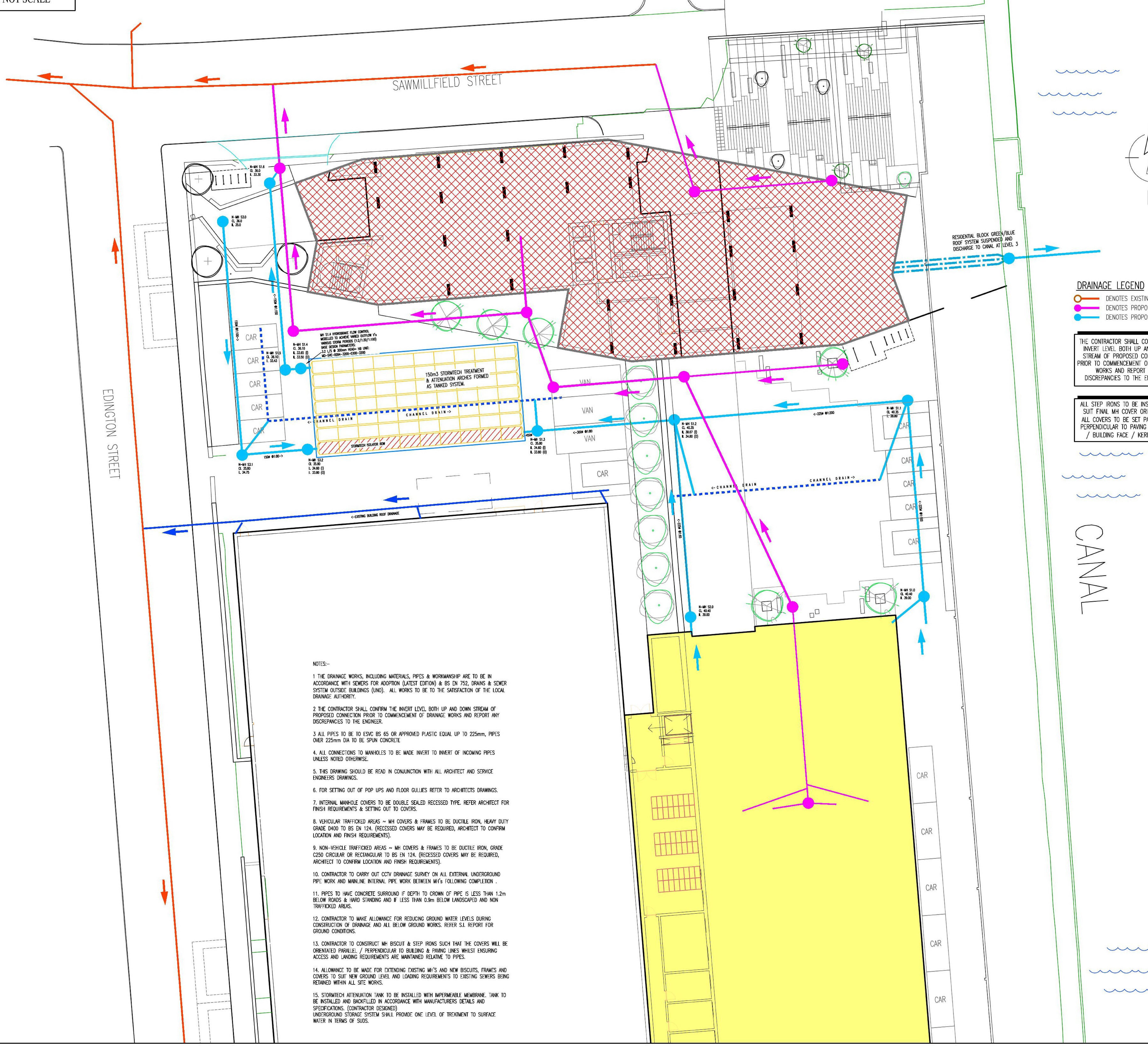
SCALE: 1:1,323

Plotted By: gordon.muir@struer.co.uk

Appendix E

Propose Drainage Layout

DO NOT SCALE

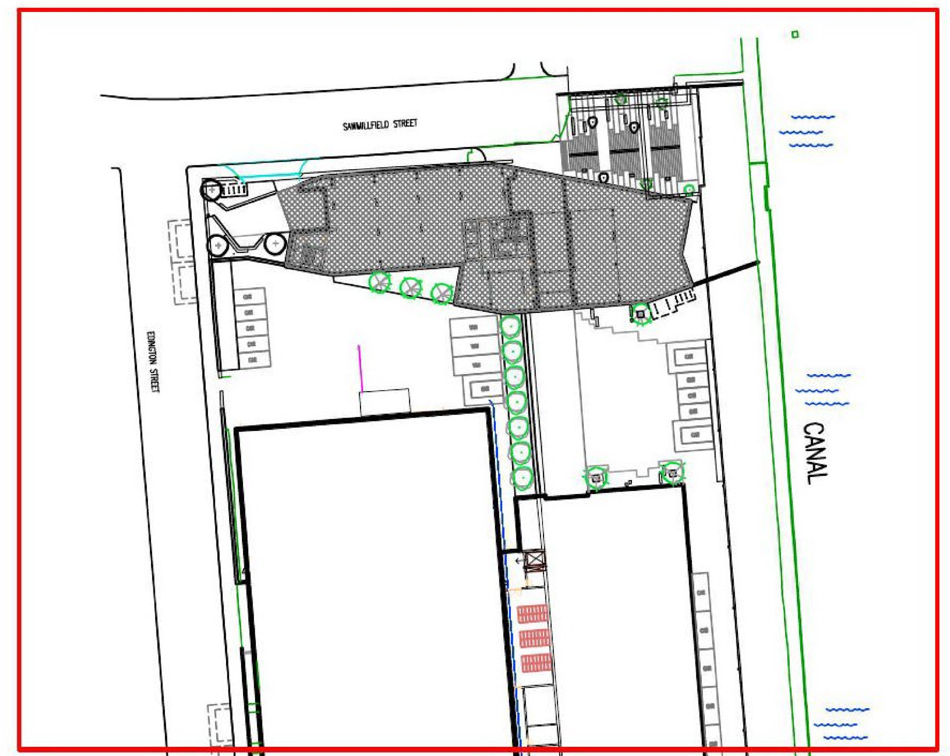


DRAINAGE LEGEND

- DENOTES EXISTING COMBINED DRAINAGE
- DENOTES PROPOSED FOUL DRAINAGE
- DENOTES PROPOSED SURFACE WATER DRAINAGE

THE CONTRACTOR SHALL CONFIRM THE INVERT LEVEL BOTH UP AND DOWN STREAM OF PROPOSED CONNECTION PRIOR TO COMMENCEMENT OF DRAINAGE WORKS AND REPORT ANY DISCREPANCIES TO THE ENGINEER.

ALL STEP IRONS TO BE INSTALLED TO SUIT FINAL MH COVER ORIENTATION. ALL COVERS TO BE SET PARALLEL / PERPENDICULAR TO PAVING DIRECTION / BUILDING FACE / KERB LINES.



KEY PLAN

NOTES:-

1 THE DRAINAGE WORKS, INCLUDING MATERIALS, PIPES & WORKMANSHIP ARE TO BE IN ACCORDANCE WITH SEWERS FOR ADOPTION (LATEST EDITION) & BS EN 752, DRAINS & SEWER SYSTEM OUTSIDE BUILDINGS (UNO). ALL WORKS TO BE TO THE SATISFACTION OF THE LOCAL DRAINAGE AUTHORITY.

2 THE CONTRACTOR SHALL CONFIRM THE INVERT LEVEL BOTH UP AND DOWN STREAM OF PROPOSED CONNECTION PRIOR TO COMMENCEMENT OF DRAINAGE WORKS AND REPORT ANY DISCREPANCIES TO THE ENGINEER.

3 ALL PIPES TO BE TO ESVC BS 65 OR APPROVED PLASTIC EQUAL UP TO 225mm, PIPES OVER 225mm DIA TO BE SPUN CONCRETE

4. ALL CONNECTIONS TO MANHOLES TO BE MADE INVERT TO INVERT OF INCOMING PIPES UNLESS NOTED OTHERWISE.

5. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH ALL ARCHITECT AND SERVICE ENGINEERS DRAWINGS.

6. FOR SETTING OUT OF POP UPS AND FLOOR GULLIES REFER TO ARCHITECTS DRAWINGS.

7. INTERNAL MANHOLE COVERS TO BE DOUBLE SEALED RECESSED TYPE. REFER ARCHITECT FOR FINISH REQUIREMENTS & SETTING OUT TO COVERS.

8. VEHICULAR TRAFFICKED AREAS ~ MH COVERS & FRAMES TO BE DUCTILE IRON, HEAVY DUTY GRADE D400 TO BS EN 124. (RECESSED COVERS MAY BE REQUIRED, ARCHITECT TO CONFIRM LOCATION AND FINISH REQUIREMENTS).

9. NON-VEHICLE TRAFFICKED AREAS ~ MH COVERS & FRAMES TO BE DUCTILE IRON, GRADE C250 CIRCULAR OR RECTANGULAR TO BS EN 124. (RECESSED COVERS MAY BE REQUIRED, ARCHITECT TO CONFIRM LOCATION AND FINISH REQUIREMENTS).

10. CONTRACTOR TO CARRY OUT CCTV DRAINAGE SURVEY ON ALL EXTERNAL UNDERGROUND PIPE WORK AND MAINLINE INTERNAL PIPE WORK BETWEEN MH's FOLLOWING COMPLETION .

11. PIPES TO HAVE CONCRETE SURROUND IF DEPTH TO CROWN OF PIPE IS LESS THAN 1.2m BELOW ROADS & HARD STANDING AND IF LESS THAN 0.9m BELOW LANDSCAPED AND NON TRAFFICKED AREAS.

12. CONTRACTOR TO MAKE ALLOWANCE FOR REDUCING GROUND WATER LEVELS DURING CONSTRUCTION OF DRAINAGE AND ALL BELOW GROUND WORKS. REFER S.I. REPORT FOR GROUND CONDITIONS.

13. CONTRACTOR TO CONSTRUCT MH BISCUIT & STEP IRONS SUCH THAT THE COVERS WILL BE ORIENTATED PARALLEL / PERPENDICULAR TO BUILDING & PAVING LINES WHILST ENSURING ACCESS AND LANDING REQUIREMENTS ARE MAINTAINED RELATIVE TO PIPES.

14. ALLOWANCE TO BE MADE FOR EXTENDING EXISTING MH'S AND NEW BISCUITS, FRAMES AND COVERS TO SUIT NEW GROUND LEVEL AND LOADING REQUIREMENTS TO EXISTING SEWERS BEING RETAINED WITHIN ALL SITE WORKS.

15. STORMTECH ATTENUATION TANK TO BE INSTALLED WITH IMPERMEABLE MEMBRANE. TANK TO BE INSTALLED AND BACKFILLED IN ACCORDANCE WITH MANUFACTURERS DETAILS AND SPECIFICATIONS. (CONTRACTOR DESIGNED)
UNDERGROUND STORAGE SYSTEM SHALL PROVIDE ONE LEVEL OF TREATMENT TO SURFACE WATER IN TERMS OF SUDS.

Rev	Description	Drawn	App	Date

Client

SCOTTISH OPERA

Project

NEW ROTTERDAM WHARF

Drawing Title

CONCEPT DRAINAGE ~ NORTH

STRUER
Struer Consulting Engineers Ltd
Moorpark House
Orton Place
Glasgow G51 2HF
Tel No. 0141 445 5621
Fax No. 0141 445 6011
Email: Struer@struer.co.uk

Drawn	Scale	Checked	Approved	Date
GM	1:200		KS	Feb24

ORIGINAL DRAWING A1

Status	Drg. No.	Rev
INFOMRATION	3072/ SKDR1	

DO NOT SCALE

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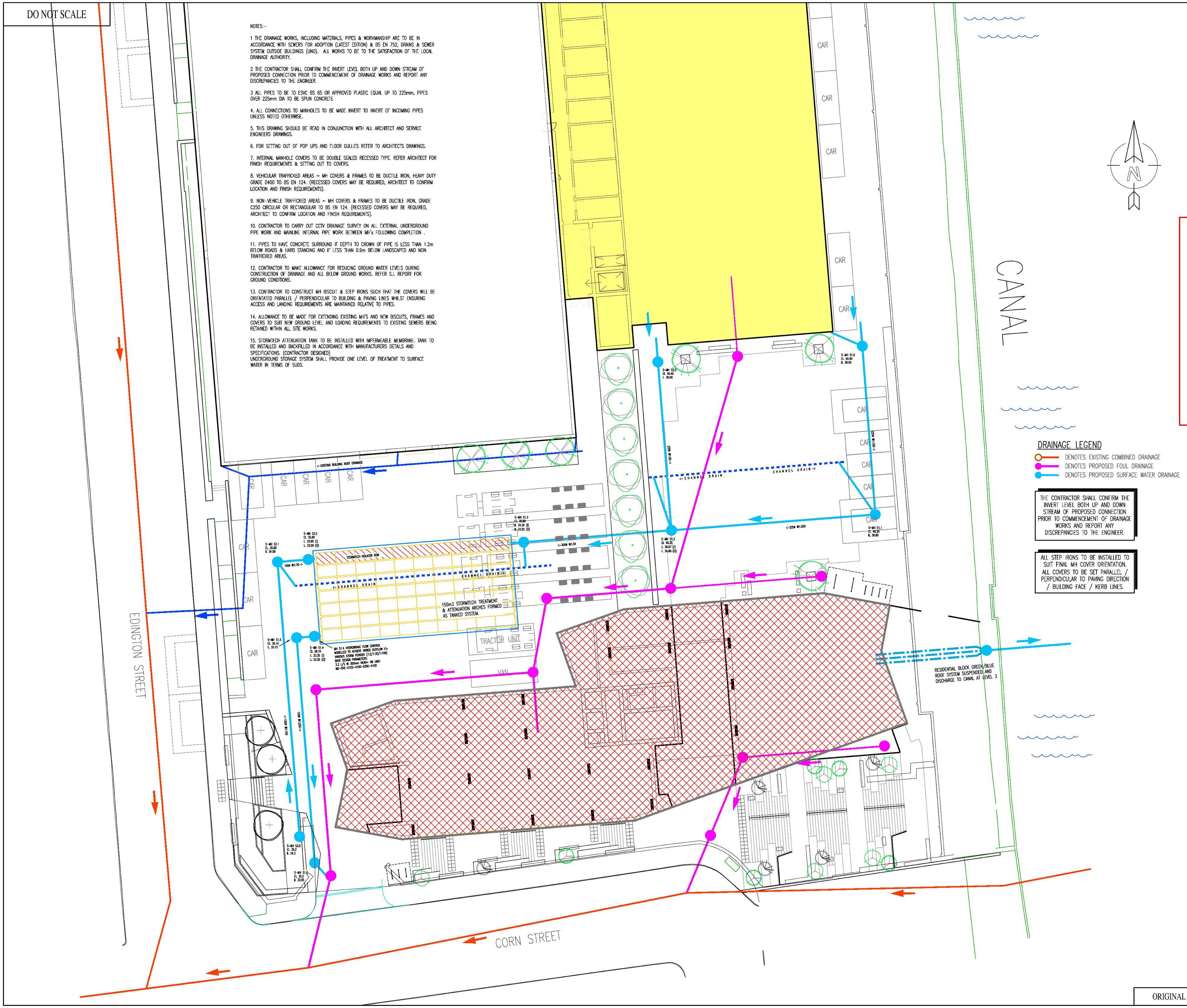

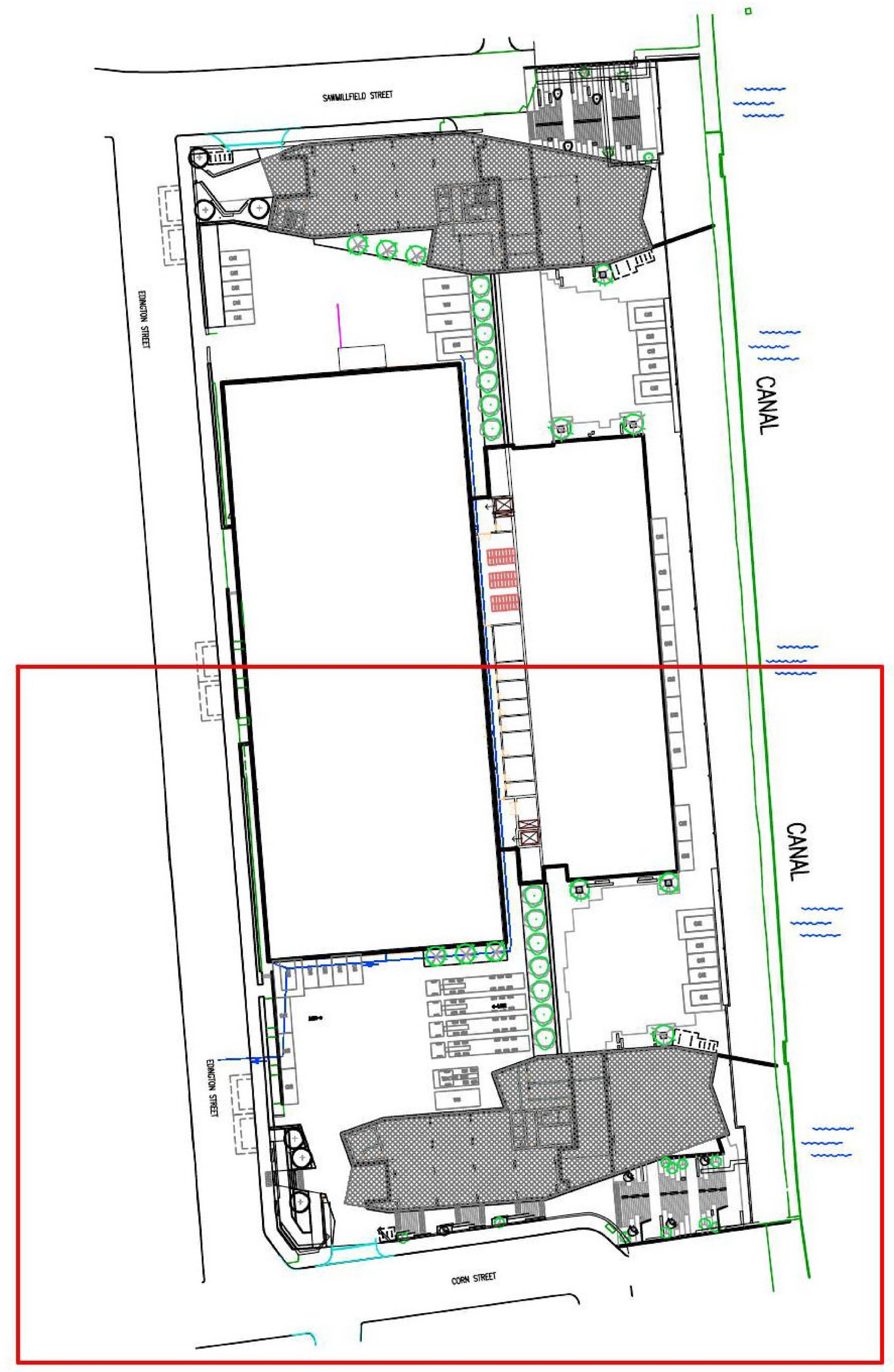

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Client

SCOTTISH OPERA

Project

NEW ROTTERDAM WHARF

Drawing Title

CONCEPT DRAINAGE ~ SOUTH

STRUER
Struer Consulting Engineers Ltd
Moorpark House
Orton Place
Glasgow G51 2HF
Tel No. 0141 445 5621
Fax No. 0141 445 6011
Email: Struer@struer.co.uk

Drawn	Scale	Checked	Approved	Date
GM	1:200		KS	Feb24

ORIGINAL DRAWING A1

Status	Drg. No.	Rev
INFOMRATION	3072/ SKDR2	

Appendix F

Pre Developed Sites' Results Summary

EXISTING NORTH PRE-DEVELOPED SITE FLOWS

1:2 Existing				
Storm Duration	Flow (l/s)	Flow (l/s)	Flow (l/s)	Discharge (m3)
	WHOLE SITE	EXIST ROOF	DIFF	ROOF (SITE)
360	9.5	6.3	3.2	54 (82)

1:30 Existing				
Storm Duration	Flow (l/s)	Flow (l/s)	Flow (l/s)	Discharge (m3)
	WHOLE SITE	EXIST ROOF	DIFF	ROOF (SITE)
360	16.4	10.8	5.6	93 (141)

1:100 Existing				
Storm Duration	Flow (l/s)	Flow (l/s)	Flow (l/s)	Discharge (m3)
	WHOLE SITE	EXIST ROOF	DIFF	ROOF (SITE)
360	20.8	13.8	7.0	118 (179)

EXISTING SOUTH PRE-DEVELOPED SITE FLOWS

1:2 Existing				
Storm Duration	Flow (l/s)	Flow (l/s)	Flow (l/s)	Discharge (m3)
	WHOLE SITE	EXIST ROOF	DIFF	ROOF (SITE)
360	10.3	6.2	4.1	53 (89)

1:30 Existing				
Storm Duration	Flow (l/s)	Flow (l/s)	Flow (l/s)	Discharge (m3)
	WHOLE SITE	EXIST ROOF	DIFF	ROOF (SITE)
360	17.7	10.6	7.1	92 (152)

1:100 Existing				
Storm Duration	Flow (l/s)	Flow (l/s)	Flow (l/s)	Discharge (m3)
	WHOLE SITE	EXIST ROOF	DIFF	ROOF (SITE)
360	22.5	13.5	9	117 (194)

Appendix G

Developed Sites' Results Summary

PORPOSED NORTH YARD AND UPPER AREAS

1:2 Proposed (Target peak 3.2 l/s)		
Storm Duration	Peak Flow (l/s)	TANK WL (m AOD)
15	3.2	33.628
60	3.2	33.704
120	3.2	33.728
240	3.2	33.733
360	3.2	33.724

1:30 Proposed (Target peak 5.6 l/s)		
Storm Duration	Peak Flow (l/s)	TANK WL (m AOD)
15	3.2	33.745
60	3.6	33.888
120	3.8	33.936
240	3.9	33.953
360	3.8	33.948

1:100 +40% CC Proposed (Target peak 7.0 l/s)		
Storm Duration	Peak Flow (l/s)	TANK WL (m AOD)
15	3.8	33.940
60	4.8	34.218
120	5.1	34.332
240	5.3	34.389
360	5.3	34.394

PROPOSED SOUTH YARD AND UPPER AREAS

1:2 Proposed (Target peak 4.1 l/s)		
Storm Duration	Peak Flow (l/s)	TANK WL (m AOD)
15	4.0	33.336
60	4.1	33.409
120	4.1	33.429
240	4.1	33.426
360	4.1	33.409

1:30 Proposed (Target peak 7.1 l/s)		
Storm Duration	Peak Flow (l/s)	TANK WL (m AOD)
15	4.1	33.459
60	4.6	33.603
120	4.8	33.643
240	4.9	33.653
360	4.8	33.640

1:100 +40% CC Proposed (Target peak 9.0 l/s)		
Storm Duration	Peak Flow (l/s)	TANK WL (m AOD)
15	4.9	33.665
60	6.1	33.951
120	6.5	34.057
240	6.7	34.096
360	6.7	34.092

Proposed North Model Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	16.000	Add Flow / Climate Change (%)	0
Ratio R	0.300	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	0	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 Inverts

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
1.000	21.000	0.200	105.0	0.069	5.00	0.0	0.600	o	225	Pipe/Conduit
1.001	25.000	0.130	192.3	0.053	0.00	0.0	0.600	o	225	Pipe/Conduit
2.000	21.110	0.330	64.0	0.067	5.00	0.0	0.600	o	225	Pipe/Conduit
1.002	16.170	0.200	80.9	0.032	0.00	0.0	0.600	o	300	Pipe/Conduit
1.003	20.110	0.150	134.1	0.048	0.00	0.0	0.600	o	450	Pipe/Conduit
3.000	25.000	0.250	100.0	0.006	5.00	0.0	0.600	o	150	Pipe/Conduit
3.001	12.000	0.150	80.0	0.050	0.00	0.0	0.600	o	150	Pipe/Conduit
3.002	9.342	0.150	62.3	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit
1.004	7.000	0.070	100.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	5.27	39.000	0.069	0.0	0.0	0.0	1.28	50.7	0.0
1.001	0.00	5.72	38.800	0.122	0.0	0.0	0.0	0.94	37.3	0.0
2.000	0.00	5.21	39.000	0.067	0.0	0.0	0.0	1.64	65.1	0.0
1.002	0.00	5.87	34.800	0.221	0.0	0.0	0.0	1.75	123.7	0.0
1.003	0.00	6.06	33.800	0.269	0.0	0.0	0.0	1.75	279.0	0.0
3.000	0.00	5.41	35.000	0.006	0.0	0.0	0.0	1.00	17.8	0.0
3.001	0.00	5.59	34.750	0.056	0.0	0.0	0.0	1.12	19.9	0.0
3.002	0.00	5.66	33.800	0.056	0.0	0.0	0.0	2.30	254.0	0.0
1.004	0.00	6.18	33.500	0.325	0.0	0.0	0.0	1.00	17.8	0.0

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
1.005	19.300	0.130	148.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.005	0.00	6.57	33.430	0.325	0.0	0.0	0.0	0.82	14.5	0.0

Online Controls for Storm

Complex Manhole: S1.4, DS/PN: 1.004, Volume (m³): 7.6

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0094-3200-0300-3200
Design Head (m)	0.300
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	94
Invert Level (m)	33.500
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.300	3.2
Flush-Flo™	0.136	3.2
Kick-Flo®	0.239	2.9
Mean Flow over Head Range	-	2.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	6.1	3.000	9.4	7.000	14.3
0.200	3.1	1.400	6.5	3.500	10.1	7.500	14.8
0.300	3.2	1.600	7.0	4.000	10.8	8.000	15.3
0.400	3.7	1.800	7.4	4.500	11.4	8.500	15.7
0.500	4.0	2.000	7.7	5.000	12.0	9.000	16.2
0.600	4.4	2.200	8.1	5.500	12.6	9.500	16.6
0.800	5.0	2.400	8.4	6.000	13.2		
1.000	5.6	2.600	8.8	6.500	13.7		

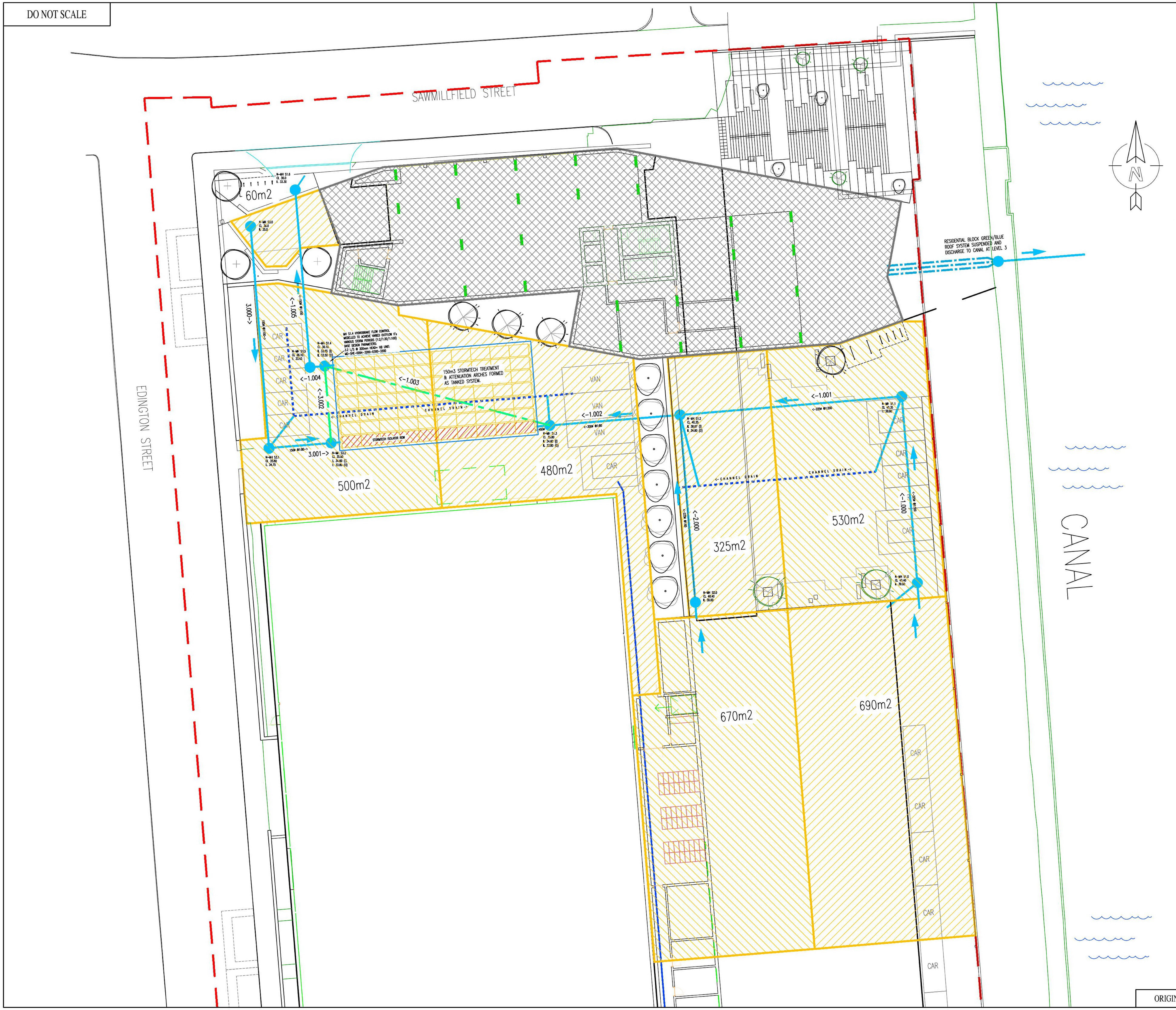
Storage Structures for Storm

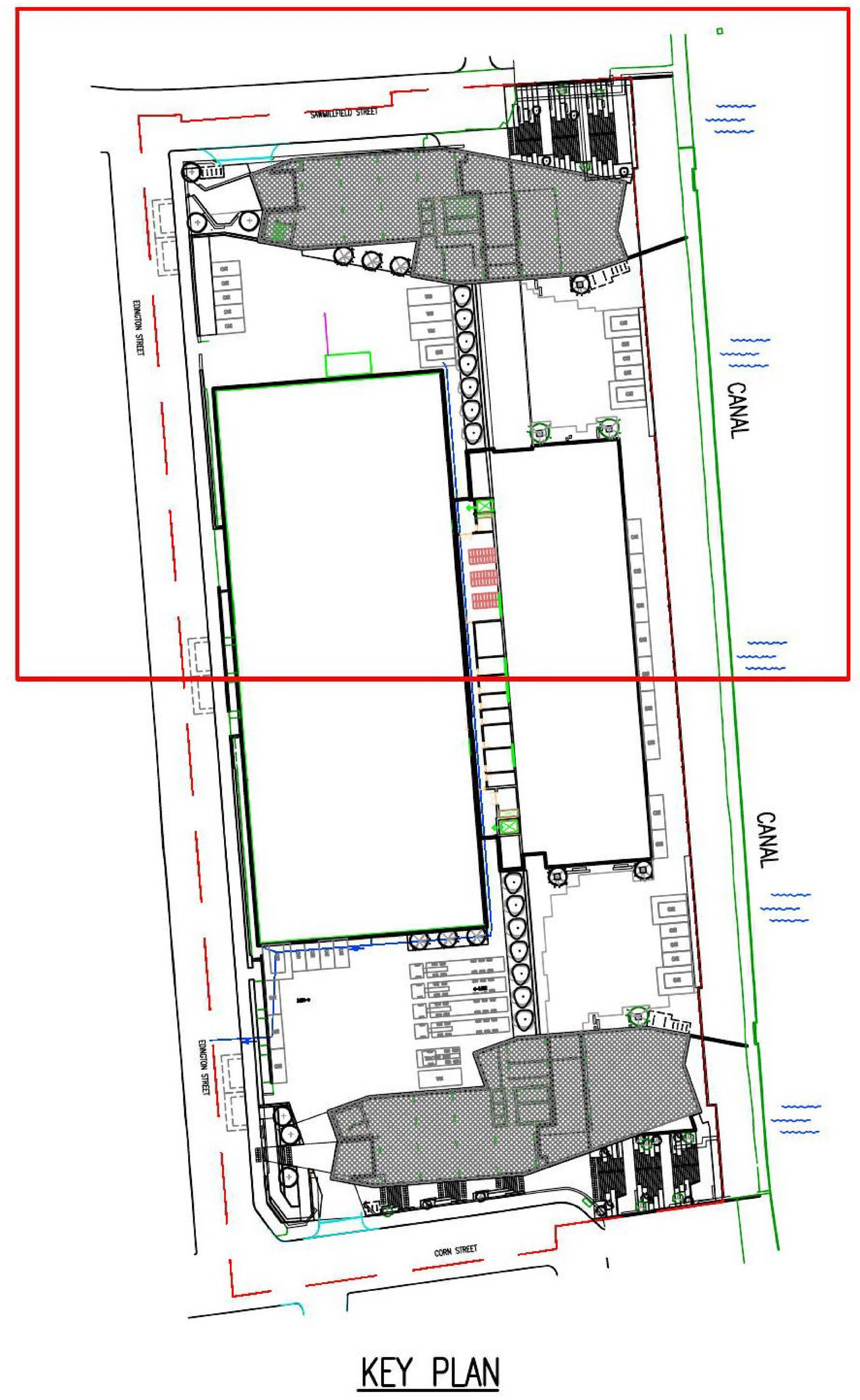
Cellular Storage Manhole: S1.4, DS/PN: 1.004

Invert Level (m) 33.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	150.0	0.0	1.001	1.2	0.0
1.000	150.0	0.0			

DO NOT SCALE





Rev	Description	Drawn	App	Date

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SCOTTISH OPERA

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NEW ROTTERDAM WHARF

Drawing Title

MICRODRAINAGE SCHEMATIC ~ NORTH

STRUER
Struer Consulting Engineers Ltd
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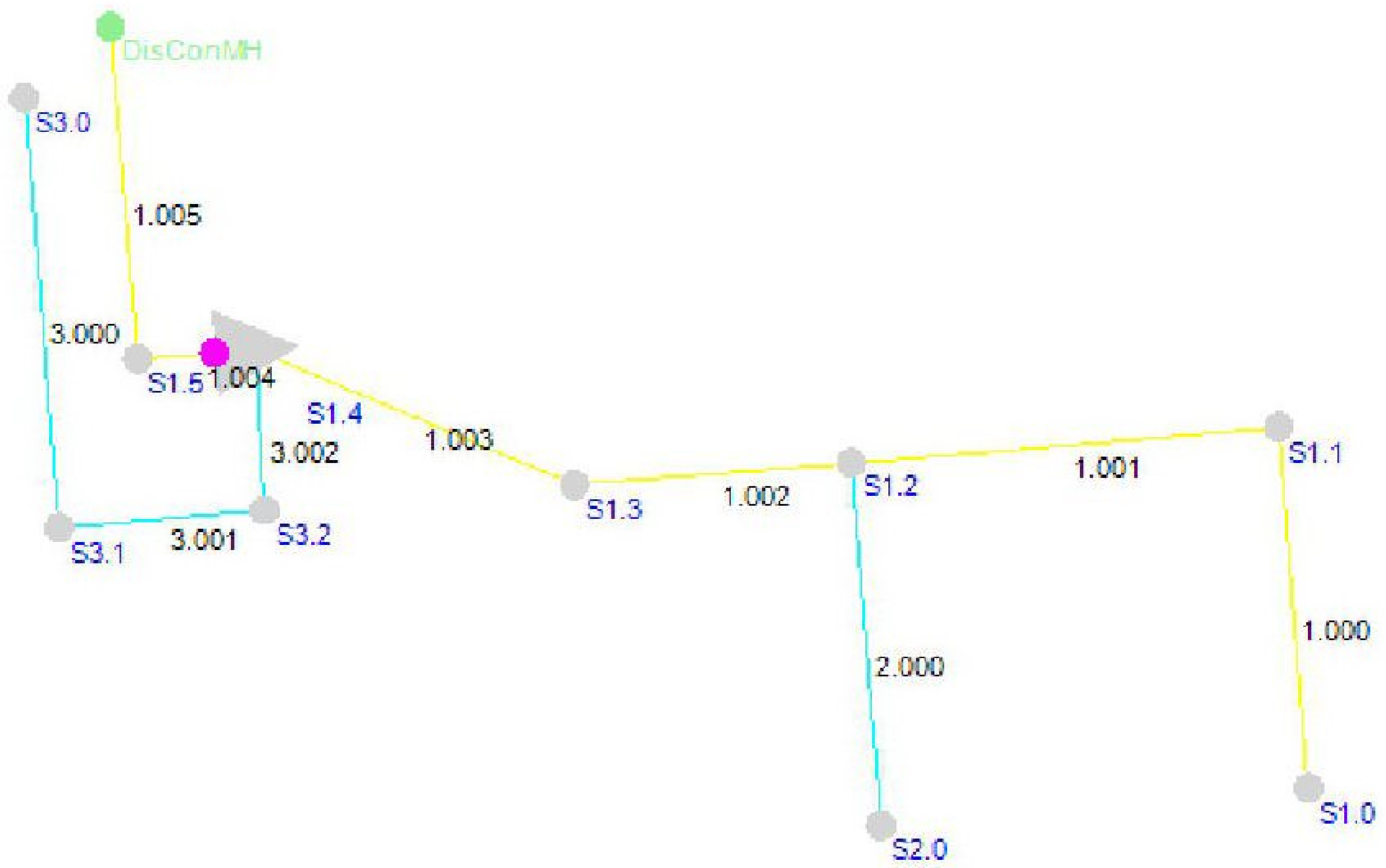

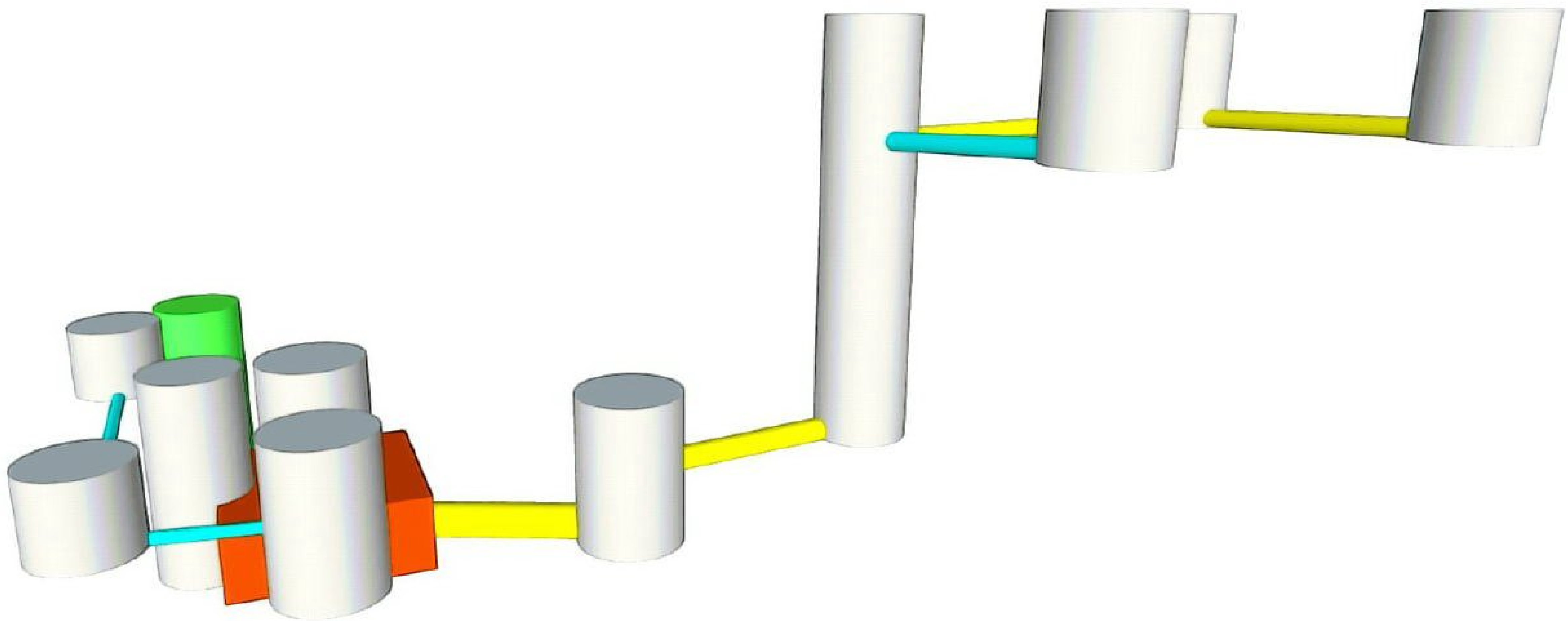

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
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	Run Time (mins)	1440
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	4

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	240
Ratio R	0.300		

Summary of Results for 240 minute 2 year Winter (Storm)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	S1.0	39.031	-0.194	0.000	0.05			2.2	OK
1.001	S1.1	38.850	-0.175	0.000	0.11			3.8	OK
2.000	S2.0	39.027	-0.198	0.000	0.04			2.1	OK
1.002	S1.2	34.850	-0.250	0.000	0.07			7.0	OK
1.003	S1.3	33.857	-0.393	0.000	0.04			8.5	OK
3.000	S3.0	35.008	-0.142	0.000	0.01			0.2	OK
3.001	S3.1	34.781	-0.119	0.000	0.10			1.8	OK
3.002	S3.2	33.821	-0.354	0.000	0.01			1.8	OK
1.004	S1.4	33.733	0.083	0.000	0.21		136	3.2	SURCHARGED
1.005	S1.5	33.479	-0.101	0.000	0.23			3.2	OK

Struer Consulting Engineers Ltd		Page 1
Moorpark House Orton Place Glasgow G51 2HF		
Date 14/02/2024 14:46 File 3072_PROPOSED NORTH.MDX	Designed by GordonM Checked by	
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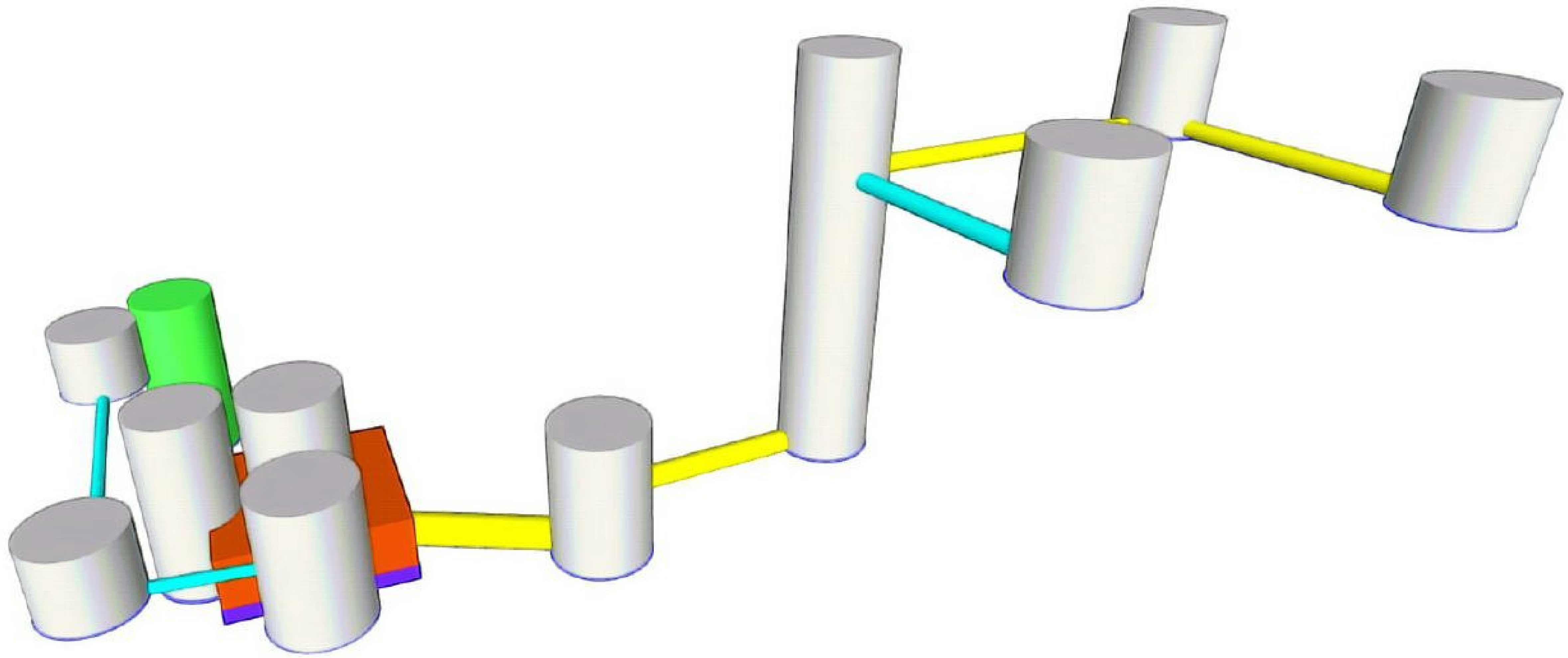


Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
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	Run Time (mins)	1440
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	4

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

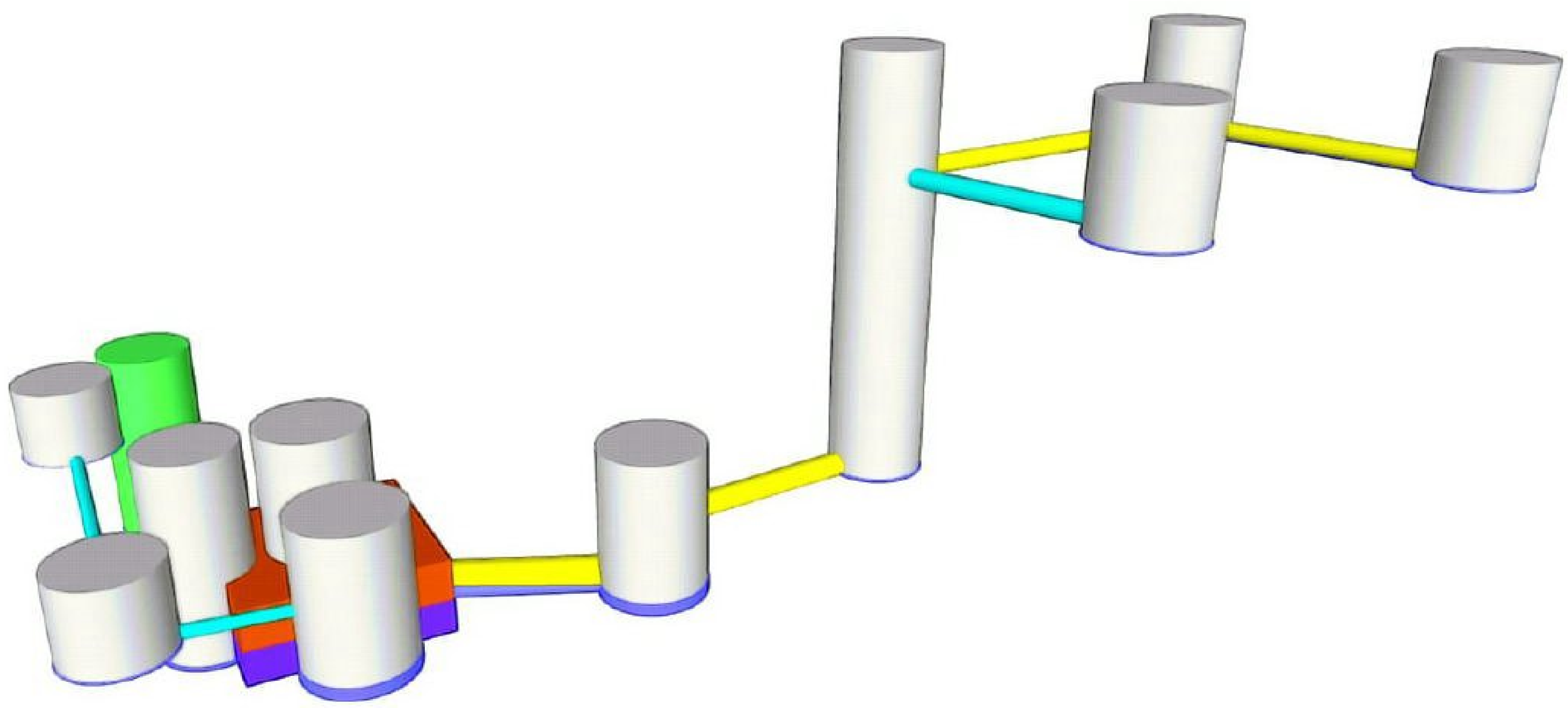
Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	240
Ratio R	0.300		

Summary of Results for 240 minute 30 year Winter (Storm)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	S1.0	39.043	-0.182	0.000	0.08			3.8	OK
1.001	S1.1	38.867	-0.158	0.000	0.20			6.7	OK
2.000	S2.0	39.036	-0.189	0.000	0.06			3.7	OK
1.002	S1.2	34.868	-0.232	0.000	0.12			12.2	OK
1.003	S1.3	33.954	-0.296	0.000	0.07			14.9	OK
3.000	S3.0	35.014	-0.136	0.000	0.02			0.3	OK
3.001	S3.1	34.792	-0.108	0.000	0.17			3.1	OK
3.002	S3.2	33.953	-0.222	0.000	0.02			3.1	OK
1.004	S1.4	33.953	0.303	0.000	0.26		212	3.9	SURCHARGED
1.005	S1.5	33.484	-0.096	0.000	0.28			3.9	OK



Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	40.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	1440
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	6

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

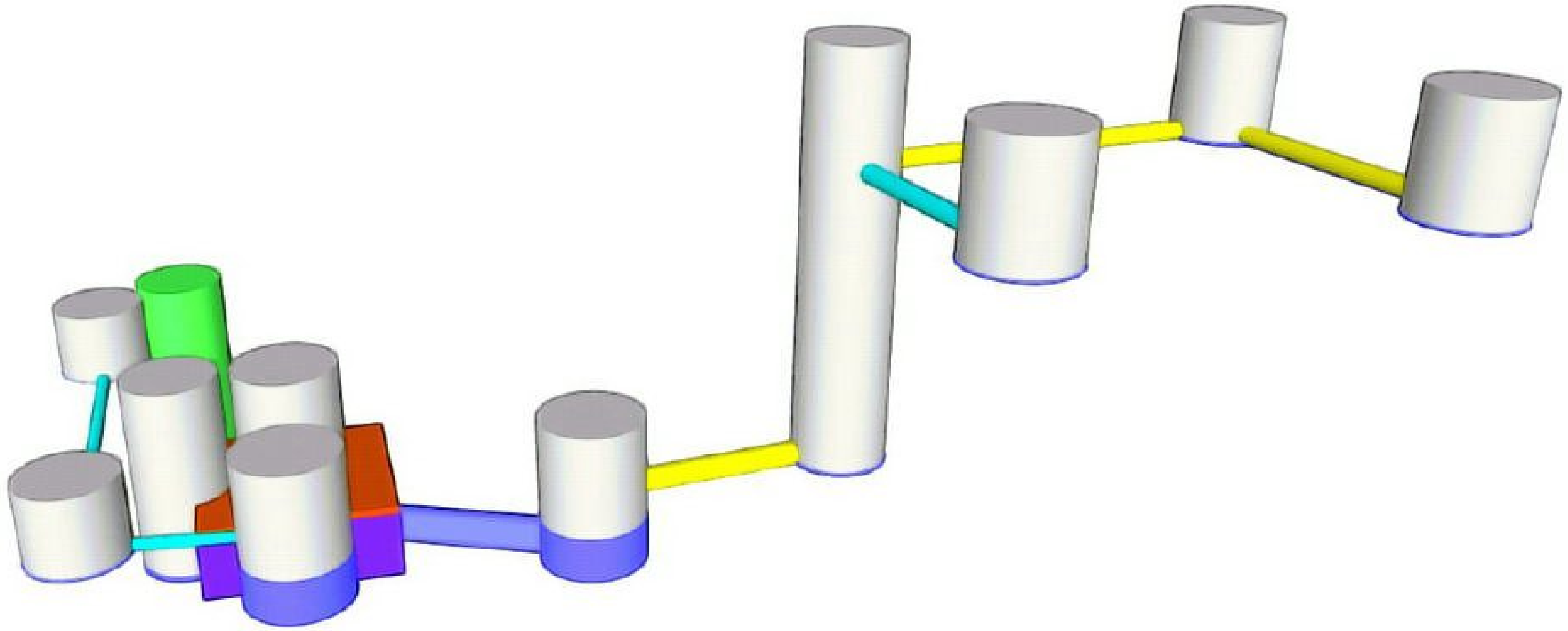
Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	360
Ratio R	0.300		

Summary of Results for 360 minute 100 year Winter (Storm)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	S1.0	39.050	-0.175	0.000	0.11			5.1	OK
1.001	S1.1	38.878	-0.147	0.000	0.26			9.0	OK
2.000	S2.0	39.043	-0.182	0.000	0.08			5.0	OK
1.002	S1.2	34.879	-0.221	0.000	0.16			16.4	OK
1.003	S1.3	34.396	0.146	0.000	0.09			19.7	SURCHARGED
3.000	S3.0	35.016	-0.134	0.000	0.03			0.4	OK
3.001	S3.1	34.799	-0.101	0.000	0.23			4.2	OK
3.002	S3.2	34.394	0.219	0.000	0.03			4.0	SURCHARGED
1.004	S1.4	34.394	0.744	0.000	0.35		318	5.3	SURCHARGED
1.005	S1.5	33.495	-0.085	0.000	0.39			5.3	OK



Proposed South Model Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	16.000	Add Flow / Climate Change (%)	0
Ratio R	0.300	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	0	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 Inverts

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
1.000	18.999	0.200	95.0	0.063	5.00	0.0	0.600	o	225	Pipe/Conduit
1.001	23.001	0.130	176.9	0.050	0.00	0.0	0.600	o	225	Pipe/Conduit
2.000	19.000	0.330	57.6	0.062	5.00	0.0	0.600	o	225	Pipe/Conduit
1.002	16.676	0.500	33.4	0.032	0.00	0.0	0.600	o	300	Pipe/Conduit
1.003	25.821	0.150	172.1	0.056	0.00	0.0	0.600	o	450	Pipe/Conduit
3.000	31.000	0.200	155.0	0.026	5.00	0.0	0.600	o	150	Pipe/Conduit
3.001	3.500	0.050	70.0	0.060	0.00	0.0	0.600	o	150	Pipe/Conduit
3.002	8.670	0.150	57.8	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit
1.004	2.000	0.050	40.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	0.00	5.24	39.000	0.063	0.0	0.0	0.0	1.34	53.3	0.0
1.001	0.00	5.63	38.800	0.113	0.0	0.0	0.0	0.98	39.0	0.0
2.000	0.00	5.18	39.000	0.062	0.0	0.0	0.0	1.73	68.7	0.0
1.002	0.00	5.73	34.800	0.207	0.0	0.0	0.0	2.73	193.1	0.0
1.003	0.00	6.01	33.500	0.263	0.0	0.0	0.0	1.55	246.0	0.0
3.000	0.00	5.64	34.200	0.026	0.0	0.0	0.0	0.80	14.2	0.0
3.001	0.00	5.69	34.000	0.086	0.0	0.0	0.0	1.20	21.3	0.0
3.002	0.00	5.75	33.500	0.086	0.0	0.0	0.0	2.39	263.7	0.0
1.004	0.00	6.03	33.200	0.349	0.0	0.0	0.0	1.60	28.2	0.0

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
1.005	25.400	0.100	254.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.005	0.00	6.70	33.150	0.349	0.0	0.0	0.0	0.63	11.1	0.0

Online Controls for Storm

Complex Manhole: S1.4, DS/PN: 1.004, Volume (m³): 8.9

Hydro-Brake® Optimum

Unit Reference	MD-SHE-0105-4100-0300-4100
Design Head (m)	0.300
Design Flow (l/s)	4.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	105
Invert Level (m)	33.200
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.300	4.1
Flush-Flo™	0.150	4.1
Kick-Flo®	0.247	3.7
Mean Flow over Head Range	-	3.1

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	3.6	1.200	7.8	3.000	12.1	7.000	18.4
0.200	4.0	1.400	8.4	3.500	12.9	7.500	19.0
0.300	4.1	1.600	9.0	4.000	13.9	8.000	19.7
0.400	4.7	1.800	9.5	4.500	14.7	8.500	20.3
0.500	5.2	2.000	10.0	5.000	15.5	9.000	20.9
0.600	5.6	2.200	10.4	5.500	16.3	9.500	21.4
0.800	6.5	2.400	10.9	6.000	17.0		
1.000	7.2	2.600	11.3	6.500	17.7		

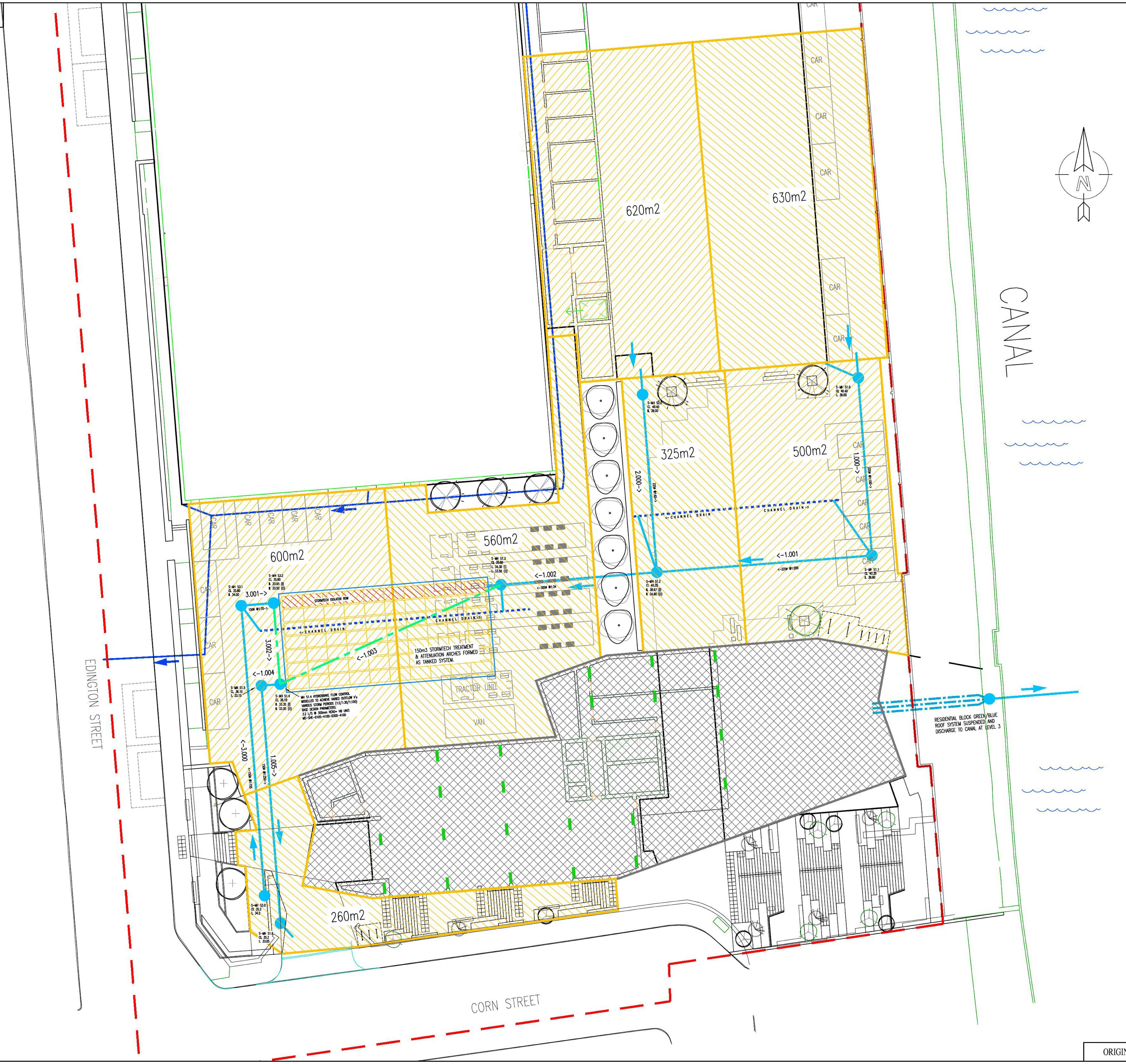
Storage Structures for Storm

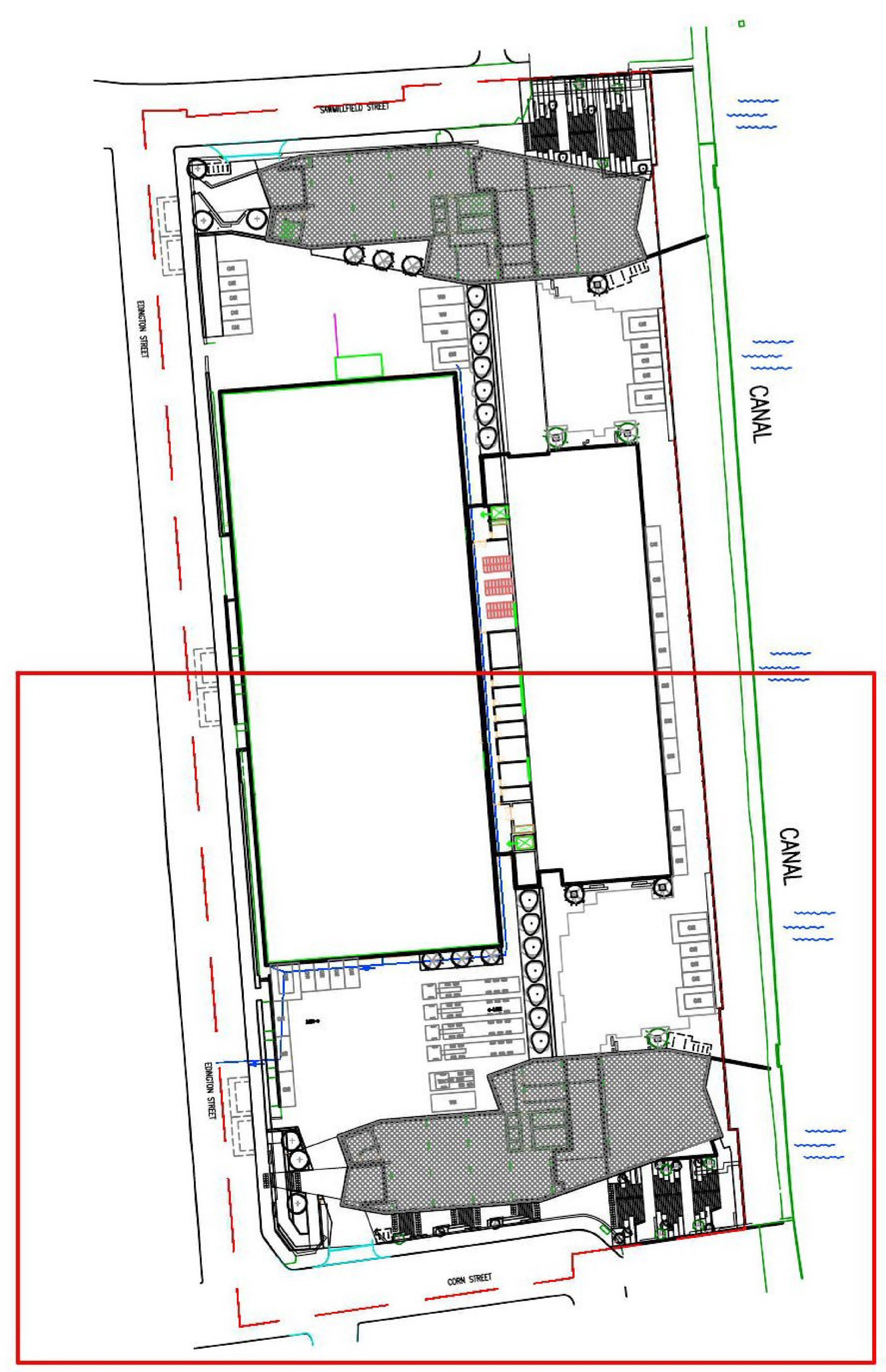
Cellular Storage Manhole: S1.4, DS/PN: 1.004

Invert Level (m) 33.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	150.0	0.0	1.001	1.2	0.0
1.000	150.0	0.0			

DO NOT SCALE





KEY PLAN

Rev	Description	Drawn	App	Date

Client

SCOTTISH OPERA

Project

NEW ROTTERDAM WHARF

Drawing Title

MICRODRAINAGE SCHEMATIC ~ SOUTH

STRUER
Struer Consulting Engineers Ltd
Moorpark House
Orton Place
Glasgow G51 2HF
Tel No. 0141 445 5621
Fax No. 0141 445 6011
Email: Struer@struer.co.uk

Drawn	Scale	Checked	Approved	Date
GM	1:200		KS	Feb24

	Status	Drg. No.	Rev
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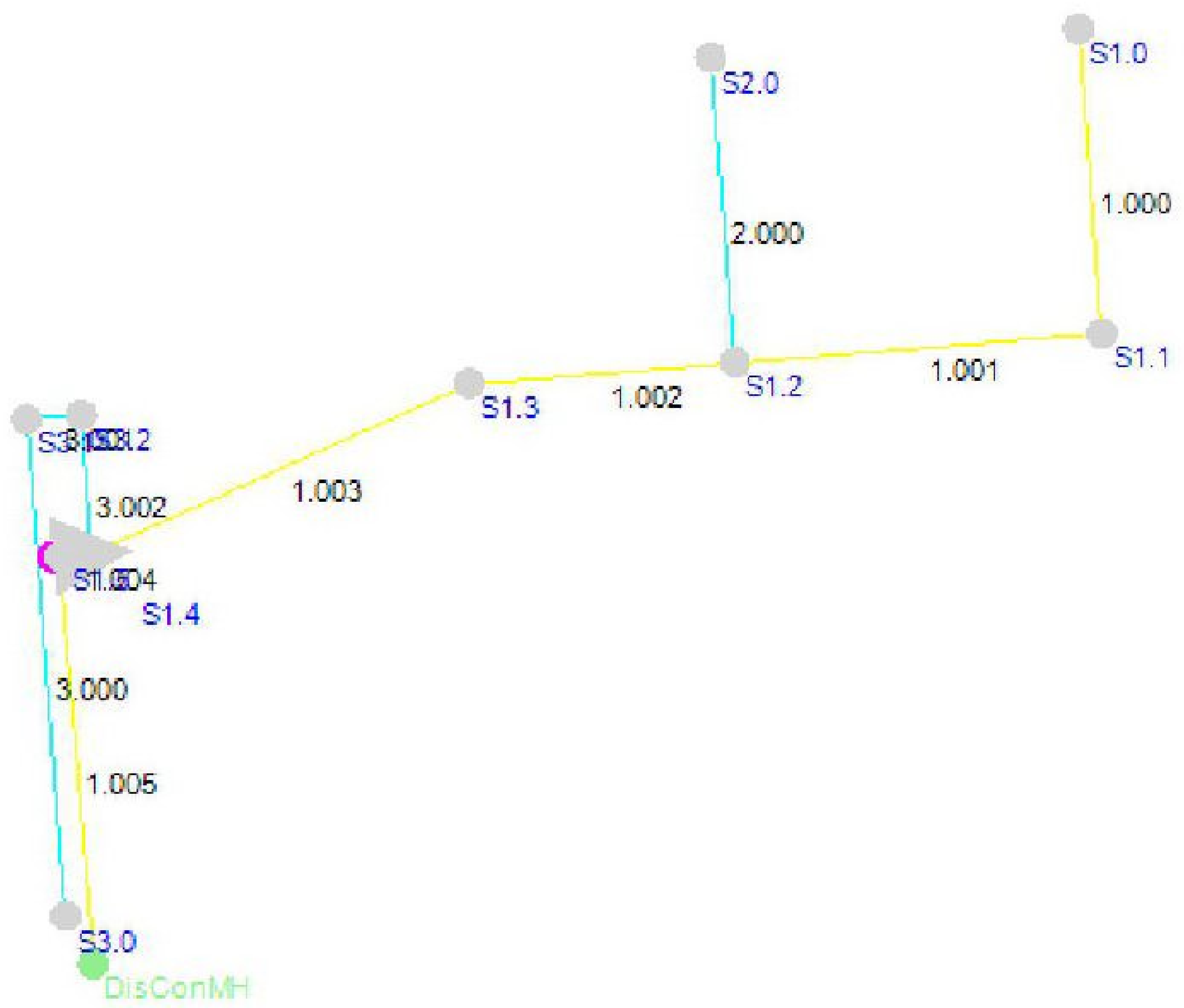

S1.0
S2.0
1.000
2.000
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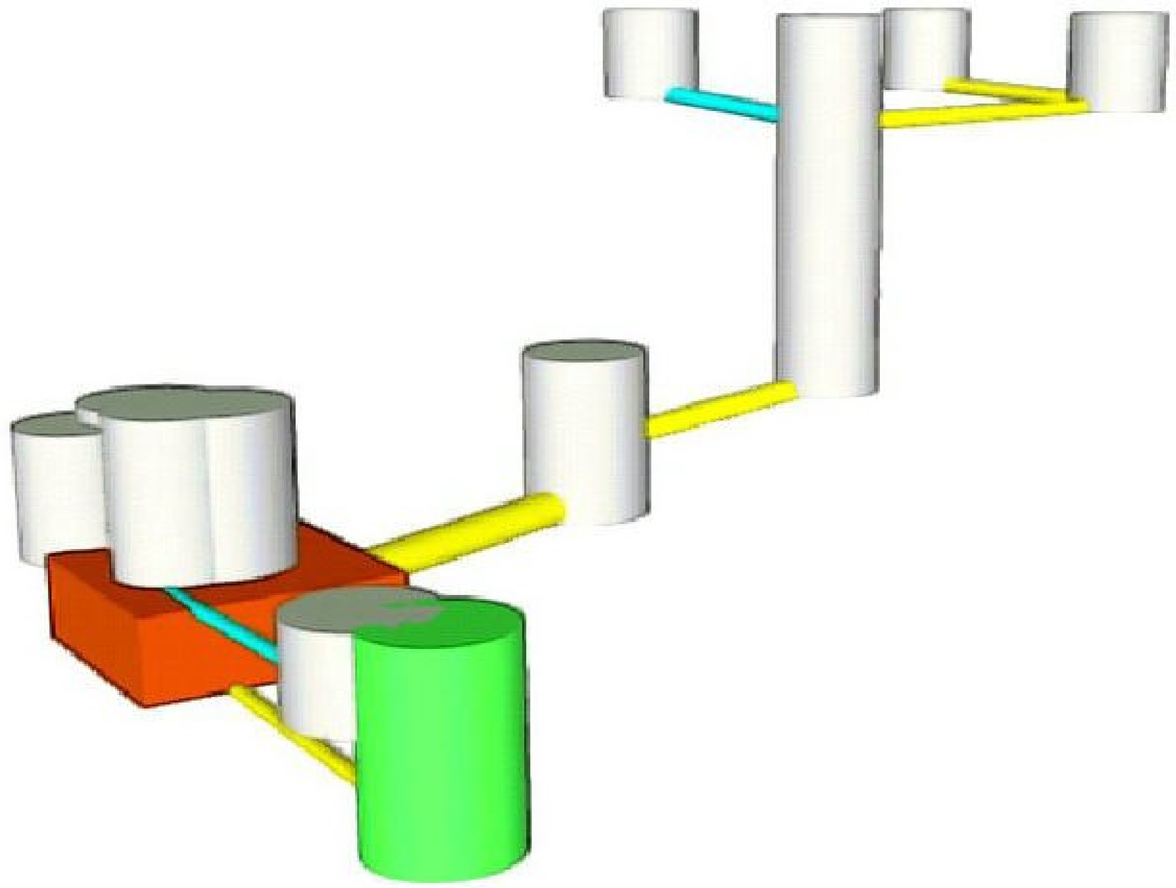


Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
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	Run Time (mins)	1440
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	4

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

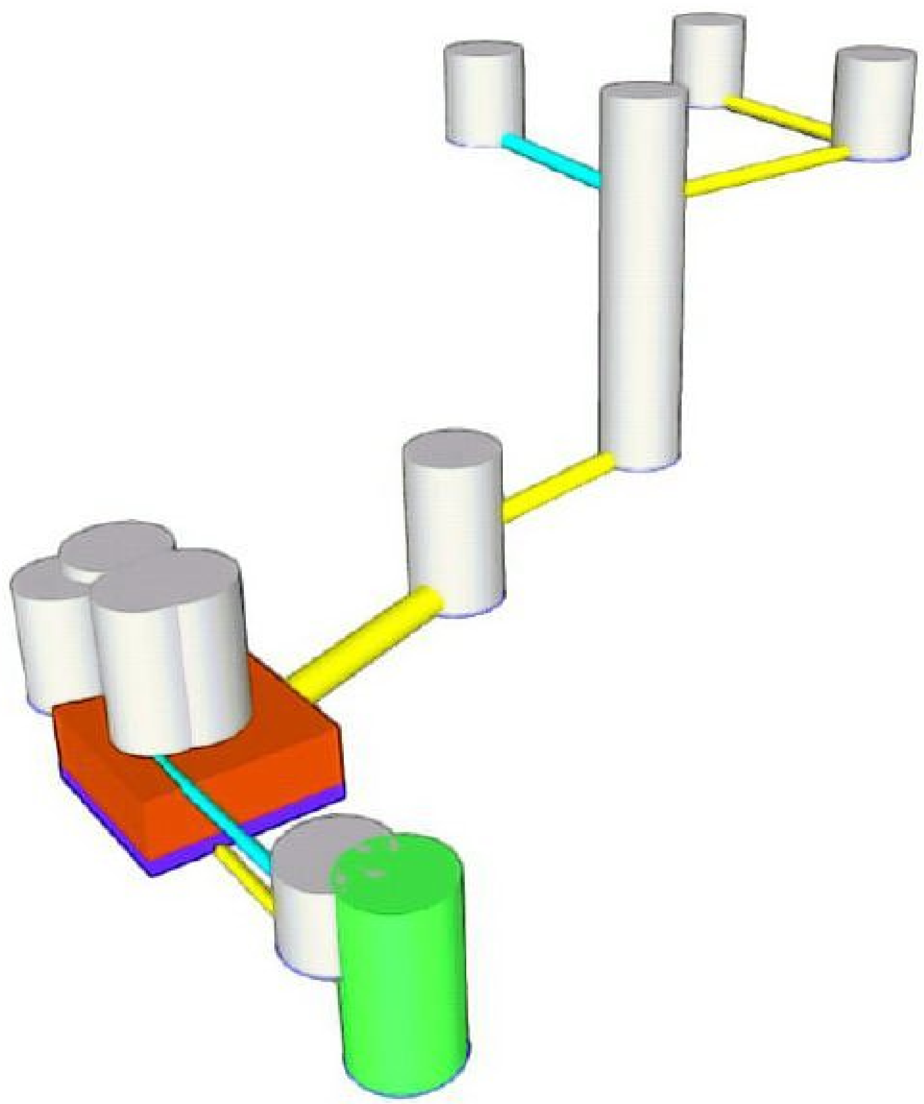
Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	120
Ratio R	0.300		

Summary of Results for 120 minute 2 year Winter (Storm)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	S1.0	39.037	-0.188	0.000	0.06			3.1	OK
1.001	S1.1	38.859	-0.166	0.000	0.16			5.6	OK
2.000	S2.0	39.032	-0.193	0.000	0.05			3.1	OK
1.002	S1.2	34.848	-0.252	0.000	0.06			10.2	OK
1.003	S1.3	33.573	-0.377	0.000	0.06			12.9	OK
3.000	S3.0	34.231	-0.119	0.000	0.09			1.3	OK
3.001	S3.1	34.056	-0.094	0.000	0.30			4.2	OK
3.002	S3.2	33.541	-0.334	0.000	0.03			4.2	OK
1.004	S1.4	33.429	0.079	0.000	0.29		92	4.1	SURCHARGED
1.005	S1.5	33.215	-0.085	0.000	0.39			4.1	OK



Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
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	Run Time (mins)	1440
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	4

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

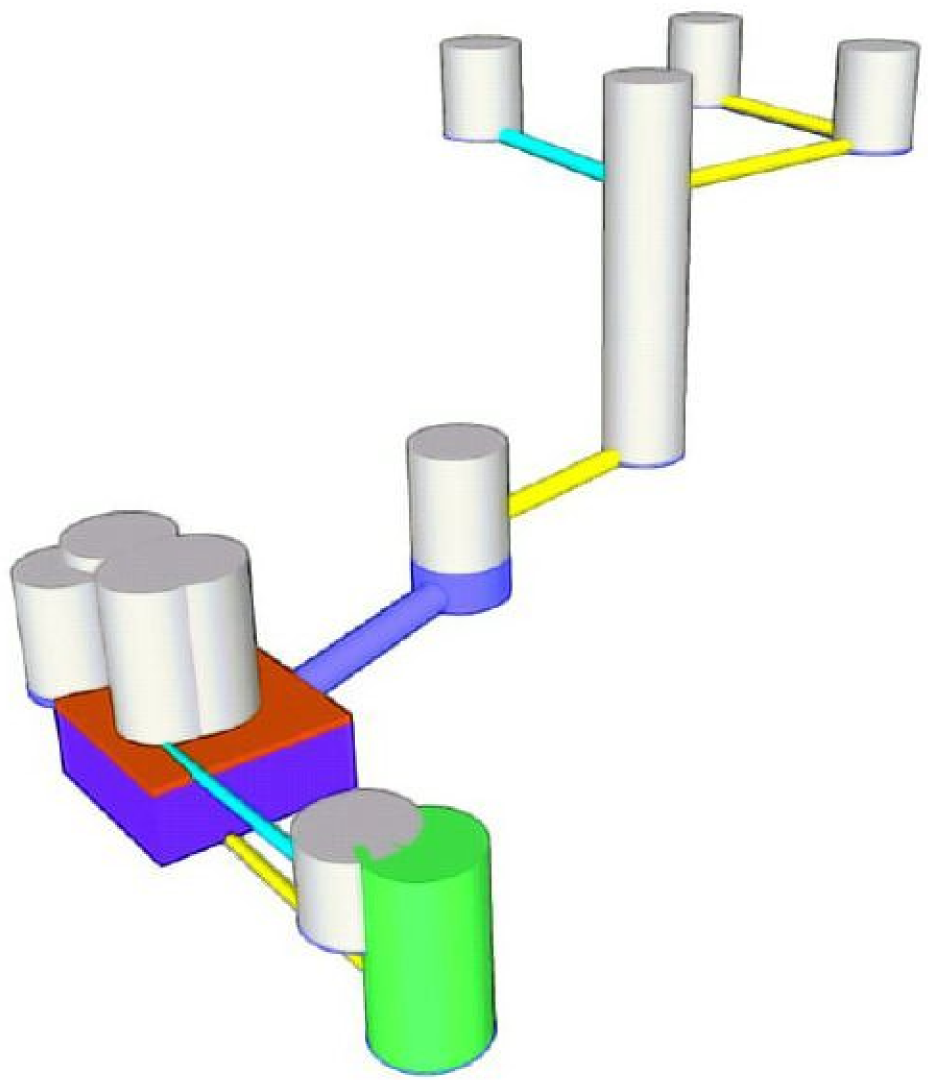
Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	240
Ratio R	0.300		

Summary of Results for 240 minute 30 year Winter (Storm)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	S1.0	39.040	-0.185	0.000	0.07			3.5	OK
1.001	S1.1	38.863	-0.162	0.000	0.18			6.2	OK
2.000	S2.0	39.034	-0.191	0.000	0.06			3.4	OK
1.002	S1.2	34.852	-0.248	0.000	0.07			11.4	OK
1.003	S1.3	33.655	-0.295	0.000	0.07			14.5	OK
3.000	S3.0	34.232	-0.118	0.000	0.11			1.4	OK
3.001	S3.1	34.060	-0.090	0.000	0.34			4.8	OK
3.002	S3.2	33.654	-0.221	0.000	0.03			4.8	OK
1.004	S1.4	33.653	0.303	0.000	0.35		180	4.9	SURCHARGED
1.005	S1.5	33.221	-0.079	0.000	0.46			4.9	OK



Simulation Criteria for Storm

Volumetric Runoff Coeff	0.840	Foul Sewage per hectare (l/s)	0.000
Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	40.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Run Time (mins)	1440
Manhole Headloss Coeff (Global)	0.500	Output Interval (mins)	4

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	240
Ratio R	0.300		

Summary of Results for 240 minute 100 year Winter (Storm)

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

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
1.000	S1.0	39.054	-0.171	0.000	0.13			6.2	OK
1.001	S1.1	38.886	-0.139	0.000	0.31			11.2	OK
2.000	S2.0	39.047	-0.178	0.000	0.10			6.1	OK
1.002	S1.2	34.870	-0.230	0.000	0.12			20.5	OK
1.003	S1.3	34.098	0.148	0.000	0.12			25.6	SURCHARGED
3.000	S3.0	34.244	-0.106	0.000	0.19			2.6	OK
3.001	S3.1	34.099	-0.051	0.000	0.61			8.5	OK
3.002	S3.2	34.096	0.221	0.000	0.05			8.3	SURCHARGED
1.004	S1.4	34.096	0.746	0.000	0.48		244	6.7	SURCHARGED
1.005	S1.5	33.237	-0.063	0.000	0.63			6.7	OK

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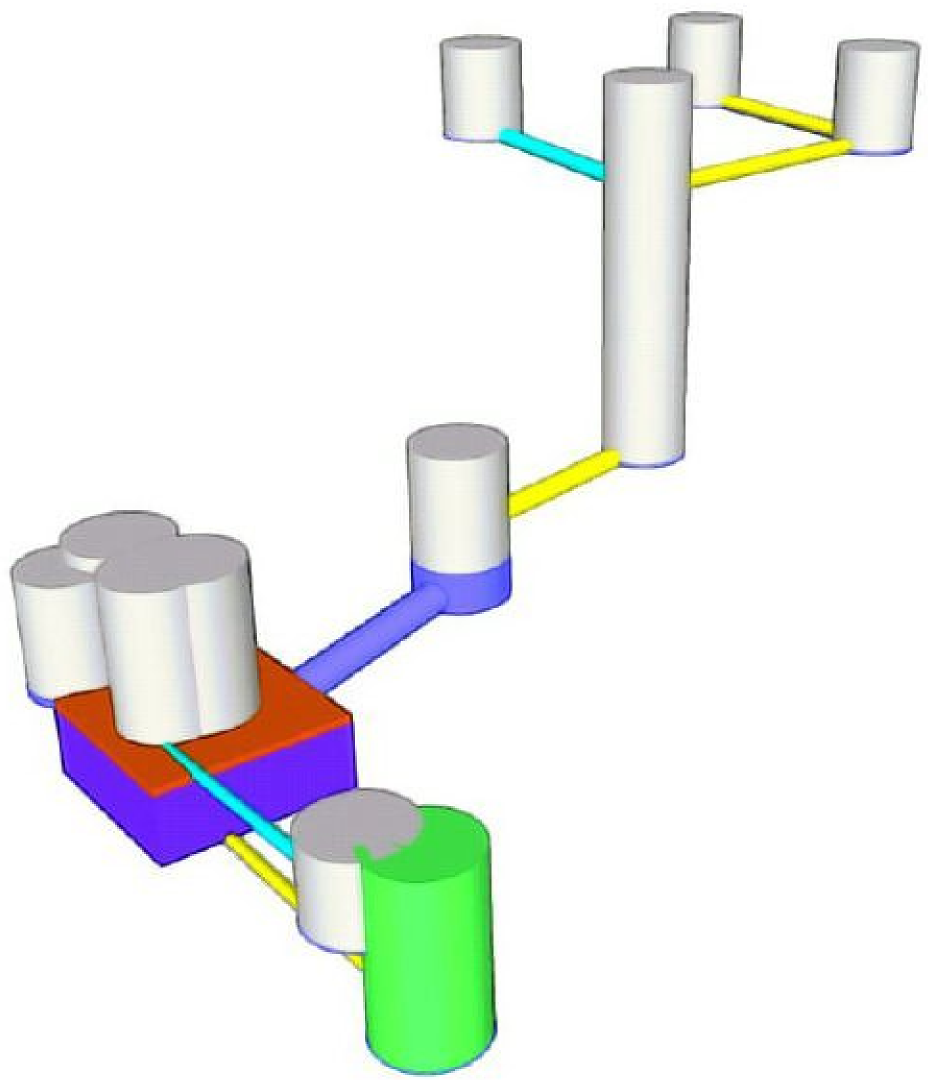


Appendix H

Inverted Blue Roof Detail

ACO Blue Roof Attenuation System

The ACO System (Patent Pending)

The ACO solution separates the competing drainage requirements by engineering an elevated structural attenuation system that operates independently of the flat roof drainage system, allowing both storm eventualities and systems to be engineered to known standards and best practice.

Separating the design issues ensures that compromise is not needed. The attenuation system can drain slowly in normal use and in an unforeseen eventuality the attenuation system can be bypassed if necessary and the flat roof drain quickly.

The system operates by creating a structural drainage void between the top of the roof waterproofing and the underside of the attenuation lining membrane that surrounds ACO RoofBloxx. As the blue roof tank sits inside the roof area a weir overflow is created at the perimeter of the tank and above the ACO roof outlets ensuring free flow of rainwater if the blue roof tank is full. The design of the system allows the blue roof tank to be controlled through as few ACO blue roof flow restrictors as needed and integrates with the ACO range of roof outlets.

The system can be incorporated under a wide range of roof finishes from soft landscaping to trafficked areas, and with a variety of roof construction types including inverted roofs and podium decks.

ACO Blue Roof Benefits

- The flat roof drainage including the roof outlets can be designed to BS12056:3 so the attenuation criteria are not compromised
- Drain down times are not affected as the blue roof attenuation system is independent of the flat roof drainage
- The roof membrane warranty is not compromised due to the addition of an attenuation liner which reduces the risk of leaks
- Design responsibility is clearly separated
- Inverted roof designs are not compromised – no reduction in U-value or potential buoyancy issues
- Risk is eliminated allowing use in a wider range of building categories/applications
- Normal roof falls – no backfall
- Level invert for blue roof tank
- Separate blue roof restrictor – no low flows

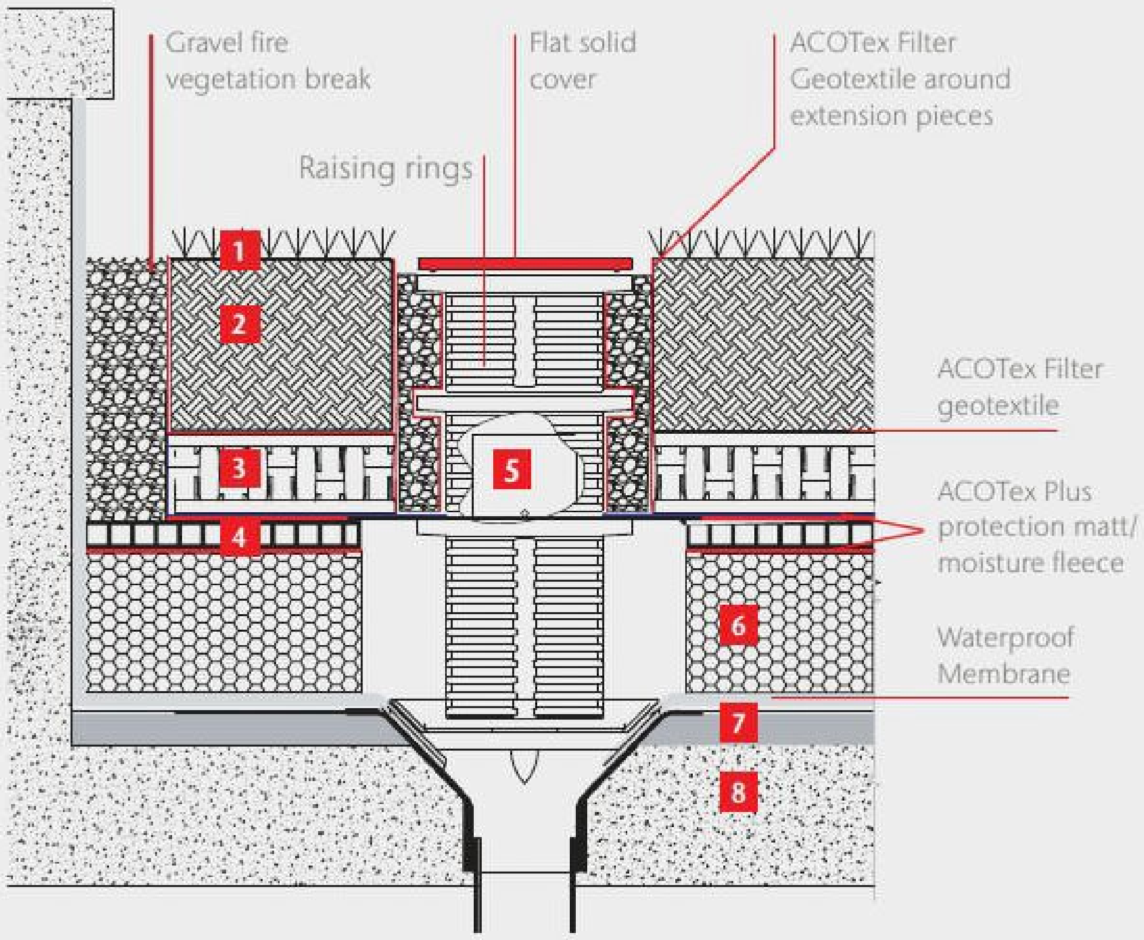
Design Service

ACO's in-house technical design team can assist with attenuation sizing and the design of blue roof drainage systems using bespoke software. They can also consider any other surface water drainage requirements by modelling the behaviour of the roof during various storm events.

ACO inverted blue roof design

Key

1 Planting
2 Planting substrate
3 RoofBloxx tank (depth to suit)
4 ACO RoofBloxx Cell 30mm
5 Blue Roof flow restrictor
6 Insulation
7 Levelling Screed
8 Roof slab



Request a FREE Blue Roofs Calculation

Our in-house software calculates the water storage volume, together with the discharge rate email **abdtechnical@aco.co.uk**

Appendix I

Pollution Hazard Indices

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4
Commercial yard and delivery areas, non-residential car parking with frequent change (eg hospitals, retail), all roads except low traffic roads and trunk roads/motorways[1]	Medium	0.7	0.6	0.7
Sites with heavy pollution (eg haulage yards, lorry parks, highly frequented lorry approaches to industrial estates, waste sites), sites where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured; industrial sites; trunk roads and motorways[1]	High	0.8[2]	0.8[2]	0.9[2]

Notes

1 Motorways and trunk roads should follow the guidance and risk assessment process set out in Highways Agency (2009).

2 These should only be used if considered appropriate as part of a detailed risk assessment – required for all these land use types (Table 4.3). When dealing with high hazard sites, the environmental regulator should first be consulted for pre-permitting advice. This will help determine the most appropriate approach to the development of a design solution.

Where a site land use falls outside the defined categories, the indices should be adapted (and agreed with the drainage approving body) or else the more detailed risk assessment method should be adopted.

Where nutrient or bacteria and pathogen removal is important for a particular receiving water, equivalent indices should be developed for these pollutants (if acceptable to the drainage approving body) or the risk assessment method adopted.

Where the mitigation index of an individual component is insufficient, two components (or more) in series will be required, where:

$$\textbf{Total SuDS mitigation index} = \textbf{mitigation index}_1 + 0.5\ (\textbf{mitigation index}_2)$$

Where:

mitigation index$_n$ = mitigation index for component n

A factor of 0.5 is used to account for the reduced performance of secondary or tertiary components associated with already reduced inflow concentrations.

TABLE 26.3 Indicative SuDS mitigation indices for discharges to surface waters

	Mitigation indices[1]		
Type of SuDS component	**TSS**	**Metals**	**Hydrocarbons**
Filter strip	0.4	0.4	0.5
Filter drain	0.4[2]	0.4	0.4
Swale	0.5	0.6	0.6
Bioretention system	0.8	0.8	0.8
Permeable pavement	0.7	0.6	0.7
Detention basin	0.5	0.5	0.6
Pond[4]	0.7[3]	0.7	0.5
Wetland	0.8[3]	0.8	0.8
Proprietary treatment systems[5,6]	These must demonstrate that they can address each of the contaminant types to acceptable levels for frequent events up to approximately the 1 in 1 year return period event, for inflow concentrations relevant to the contributing drainage area.		

Notes

1 SuDS components only deliver these indices if they follow design guidance with respect to hydraulics and treatment set out in the relevant technical component chapters.

2 Filter drains can remove coarse sediments, but their use for this purpose will have significant implications with respect to maintenance requirements, and this should be taken into account in the design and Maintenance Plan.

3 Ponds and wetlands can remove coarse sediments, but their use for this purpose will have significant implications with respect to the maintenance requirements and amenity value of the system. Sediment should normally be removed upstream, unless they are specifically designed to retain sediment in a separate part of the component, where it cannot easily migrate to the main body of water.

4 Where a wetland is not specifically designed to provide significantly enhanced treatment, it should be considered as having the same mitigation indices as a pond.

5 See Chapter 14 for approaches to demonstrate product performance. A British Water/Environment Agency assessment code of practice is currently under development that will allow manufacturers to complete an agreed test protocol for systems intended to treat contaminated surface water runoff. Full details can be found at **http://tinyurl.com/qf7yuj7**

6 SEPA only considers proprietary treatment systems as appropriate in exceptional circumstances where other types of SuDS component are not practicable. Proprietary treatment systems may also be considered appropriate for existing sites that are causing pollution where there is a requirement to retrofit treatment. SEPA (2014) also provides a flowchart with a summary of checks on suitability of a proprietary system.

Appendix J

Stormtech Technical Information

STORMTECH ISOLATOR ROW

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

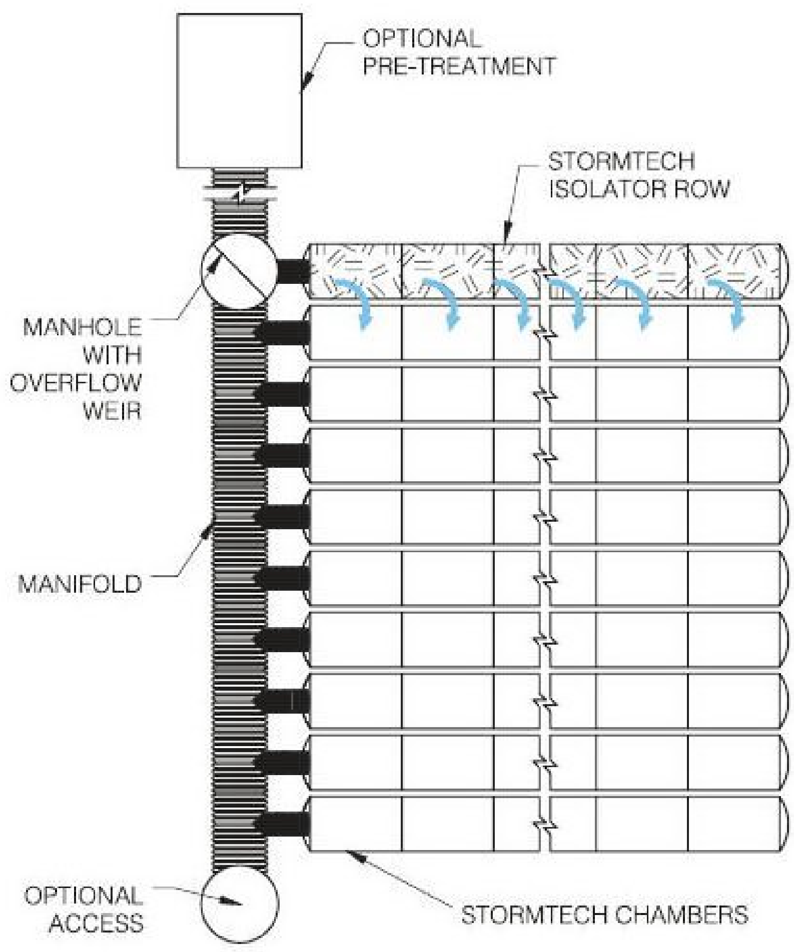
The Isolator Row is a row of StormTech chambers that is typically surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as stormwater rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3, and SC-740 models) allow stormwater to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row, protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for stormwater filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row, but typically includes a high flow weir such that stormwater flow rates or volumes that exceed the capacity of the Isolator Row crest the weir and discharge through a manifold to the other chambers. An alternative design using a "high/low" concept is an acceptable method. This creates a differential between the Isolator Row and the manifold thus allowing for settlement time in the Isolator Row.

The Isolator Row may also be part of a treatment train. By treating stormwater prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins and oil-water separators or can be innovative stormwater treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.



StormTech Isolator Row with Overflow Spillway (not to scale)

Note: Non-woven fabric is only required over the inlet pipe connection into the end cap for DC-780, MC-3500 and MC-4500 chamber models and is not required over the entire Isolator Row.

INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, public, residential) anticipated pollutant load, percent imperviousness, climate, rain fall data, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

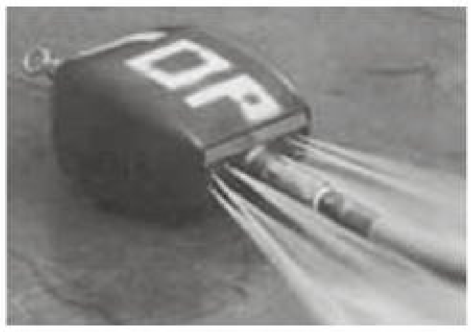
The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If, upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

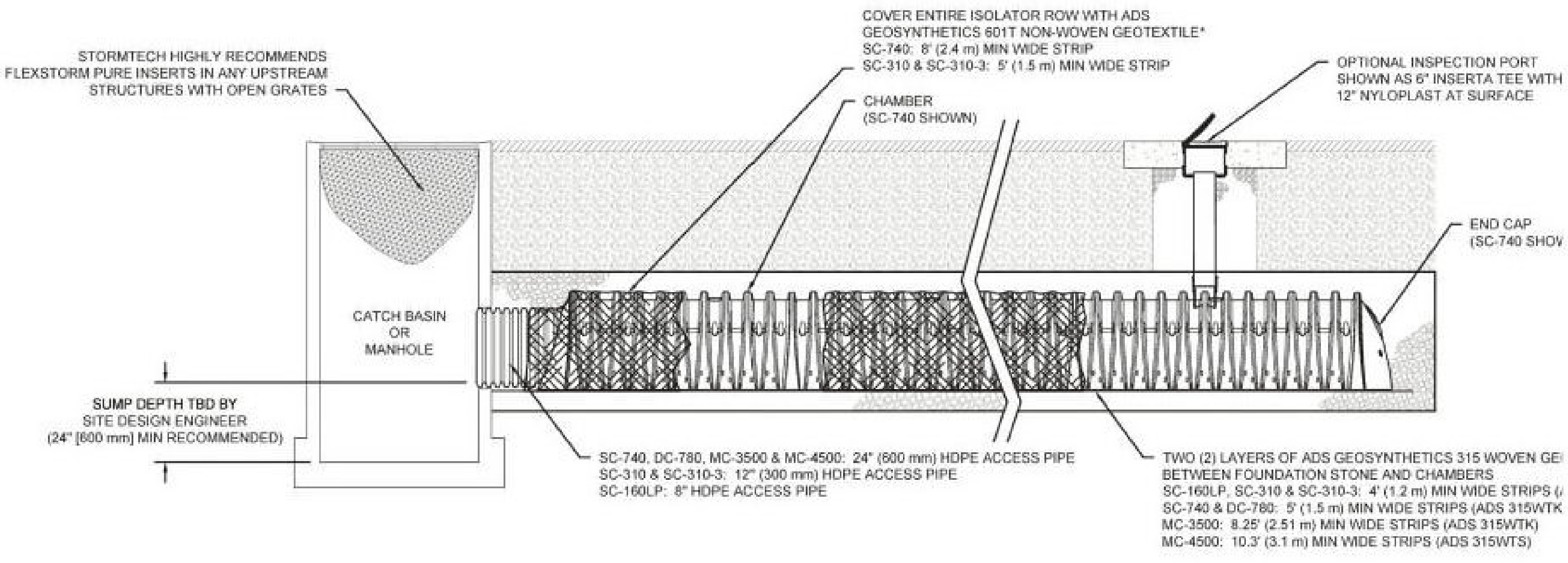
MAINTENANCE

The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.

Maintenance is accomplished with the jetvac process. The jetvac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/jetvac combination vehicles. Selection of an appropriate jetvac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most jetvac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. The jetvac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)



* NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR SC-160LP, DC-780, MC-3500 & MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

Kenny Stevenson

From:	Niall McDonald <Niall.McDonald@cubicm3.com>
Sent:	15 March 2018 09:23
To:	Kenny Stevenson
Subject:	RE: Stormtech Attenuation Mitigation Indices
Attachments:	Lorry Park, Orwell Crossing - Simple Index.xlsx

Morning Kenny,

Yes, in order to qualify as a 'proprietary treatment system' under the SUDS mitigation indices in CIRIA C753 the proposed treatment system must have undertaken independent testing in relation to its water quality capabilities. Independent testing must also preferably include UK based studies.

The Stormtech system has demonstrated that it can address Total Suspended solids, Metals and Hydrocarbons to acceptable levels for frequent storm events. The Stormtech system uses a combination of two treatment levels to mitigate pollution concerns, firstly through the systems isolator row and secondly through the aggregate filter surround. This has been demonstrated in three separate independent water quality testing studies;

Stormtech Testing Results and CIRIA C753 Mitigation Indices Comparison

1. UNHSC – University of New Hampshire Stormwater Centre.

The Stormtech Isolator row which is the first level of treatment was tested for TSS, hydrocarbons and metal removal from the receiving stormwater.

Testing was done on the stormwater runoff from non – residential car parking with frequent change. In CIRIA C753 this type of land use is given a pollution hazard indices of TSS 0.7, Metals 0.6 and Hydrocarbons 0.7.

Results found the Stormtech isolator row could remove up to 80% of TSS, up to 80% of hydrocarbon and up to 53% of metals. In comparison a filtration layer that provides treatment e.g. porous paving, has a pollution mitigation index of TSS 0.7, Metals 0.6 and Hydrocarbons 0.7 but is inferior in TSS reduction to the Stormtech isolator row, slightly better in metal reduction but there is no data for hydrocarbons.

Therefore, as a first level of treatment the Stormtech Isolator row would have a conservative pollution mitigation index of TSS 0.7, Metals 0.6 and Hydrocarbons 0.7.

2. SEPA – Scottish Environment Protection Agency.

The Stormtech system was tested for TSS and hydrocarbon removal from receiving stormwater which combined the second treatment component of the Stormtech system the aggregate surround and the isolator row.

The stormwater testing was done on a commercial haulage site with potential heavy pollution in Broxburn near Edinburgh. In CIRIA C753 this type of land use is given a pollution hazard indices of TSS 0.8 and Hydrocarbons 0.9.

Results found the system could remove up to 96% of TSS and up to 90% of hydrocarbons which far exceeds any traditional SUDS pollution control method. A pollution mitigation index of TSS 0.8 and Hydrocarbons 0.9 would be achieved by the Stormtech system based on the water quality results.

3. SEPA – Scottish Environment Protection Agency.

The Stormtech system was tested for TSS and hydrocarbon removal from receiving stormwater which combined the second treatment component of the Stormtech system the aggregate surround and the isolator row.

The stormwater testing was done on a residential carpark in Denny, Scotland. In CIRIA C753 this type of land use is given a pollution hazard indices of TSS 0.5 and Hydrocarbons 0.4. Only TSS results were achieved in this testing as hydrocarbon levels were limited.

Results found the system could remove up to 87.5% of TSS which again far exceeds any traditional SUDS pollution control method. Again a conservative pollution mitigation index of TSS 0.7 would be achieved by the Stormtech system based on other water quality results in CIRIA C753.

Stormtech Example CIRIA C753 Pollution Mitigation Indices Projects

We have done a number of projects based on the Stormtech System water quality capabilities based on CIRIA C753 mitigation indices.

A recent project is the Orwell Truck Stop near Ipswich, the projects pollution indices was high TSS 0.8, Metals 0.8 and Hydrocarbons 0.9. Attached is the Simple Index Spreadsheet use for the project, look under the tool tab. Note, the isolator row was the first line of pollution control and the second treatment phase was the 'polishing' of the stormwater through the stone surround.

Another project (to be installed in April) is the Westfield Retail Park in Cumbernauld which had a pollution mitigation indices of indices of TSS 0.8, Metals 0.8 and Hydrocarbons 0.9. Again the isolator row was the first line of pollution control and the second treatment phase was the 'polishing' of the stormwater through the stone surround.

I hope this helps. If you have any further queries or need any further information please do not hesitate to contact me.

Kind regards,

Niall McDonald

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CUBICM3 SUSTAINABLE ENGINEERING SOLUTIONS StormTech Subsurface Stormwater Management

[redacted]

Niall,

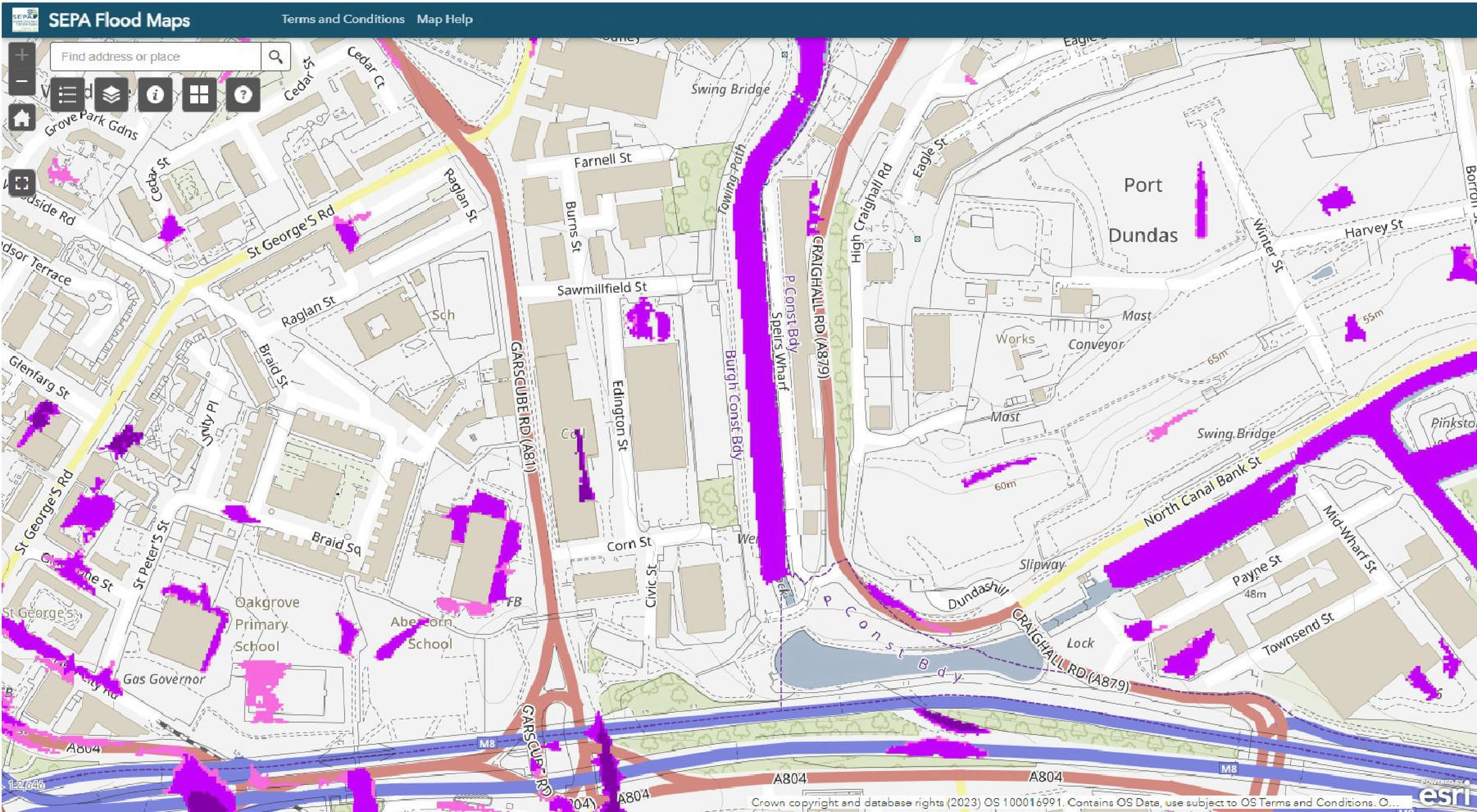
Does the Stormtech system have SUDS Mitigation Indices for TSS, Metals and Hydrocarbons?

I usually just use the filter strip scores but I'm falling short on this occasion. Table 26.3 of the Suds Manual states that proprietary treatment systems need to demonstrate levels.

Kenny

Appendix K

SEPA Flood Map


SEPA Flood Maps
Terms and Conditions
Map Help
Find address or place
Swing Bridge
Towing Path
Farnell St
Burns St
Sawmillfield St
Raglan St
St George'S Rd
Grove Park Gdns
Cedar St
Cedar Ct
Glenfarg St
Braid St
Unity Pl
Braid Sq
St Peter's St
Oakgrove Primary School
Abercorn School
Gas Governor
Sch
Coll
GARSCUBE RD (A81)
Edington St
Corn St
Civic St
Burgh Const Bdy
P Const Bdy
Speirs Wharf
CRAIGHALL RD (A879)
High Craighall Rd
Eagle St
Port Dundas
Harvey St
Winter St
Mast
Works
Conveyor
Swing Bridge
North Canal Bank St
Slipway
Dundashill
Lock
Payne St
Townsend St
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