TERRY & O'FLANAGAN LTD
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Environmental Services Report

(SURFACE WATER DISPOSAL/ TREATMENT DESIGN ONLY)
REQUEST FOR ADDITIONAL INFORMATION
REG. REF. SD21A/0246 (POINT 7 & 9)

For Proposed Residential Development comprising 8 dwellings

at:

Grangebrook Avenue, Rathfarnham, Dublin 16.

APPLICANT

BECKETT DEVELOPMENTS LTD.

Date:

May 2022

Job ref no. D1194

PREPARED BY. B. English NCEA Dip. Eng. M.I.E.I ON BEHALF OF TERRY & O'FLANAGAN LTD.

(3) Tree pit incorporating SuDS features should include a deep cellular water storage/attenuation area below the surface which acts as a soak away allowing surface water to infiltrate into the ground"

Response

(a) This point is addressed in the cover letter accompanying the Additional Information response submission.

(b) This point is addressed in the cover letter accompanying the Additional Information response submission.

(c) The proposed development supports G5 Objective 1 and Objective 2 by the use of SUDS measures appropriate to this small infill site. An updated surface water design proposal is outlined in this report below.

(d) A comprehensive SUDS design is outlined below in this report, which demonstrates a reduced rate of run off into the existing surface water drainage network and includes maintenance of the proposed Stormtech underground attenuation system.

The applicant is providing permeable paving and underground attenuation which will ensure surface water interception and treatment while also allowing some infiltration into the existing ground, thereby aiding groundwater recharge. New trees are being proposed in the rear gardens of each respective property and same will be provided with tree pits to capture rainwater where appropriate. Rainwater harvesting systems will also be provided in each respective site thereby encouraging surface water re-use in accordance with South Dublin Co. Co. SUDS/ Green infrastructure objectives.

REG. REF. SD21A/0246 (Point 9)

"The SDCC Water Services Department requests that the applicant submit the following:
(a) A report showing site specific soil percolation test results and design calculations for the proposed soakaways in accordance with BRE Digest 365 – Soakaway Design.
(b) A revised surface water drainage layout drawing showing plan & cross-sectional views, dimensions, and location of proposed soakaways. Any proposed soakaway shall be located fully within the curtilage of the property and shall be:
i) At least 5m from any building, public sewer, road boundary or structure.
ii) Generally, not within 3m of the boundary of the adjoining property.
iii) Not in such a position that the ground below foundations is likely to be adversely affected.
iv) 10m from any sewage treatment percolation area and from any watercourse / floodplain.
v) Soakaways must include an overflow connection to the surface water drainage network"

REG. REF. SD21A/0246 (Point 7)

"The SDCC Public Realm Section has concerns in regard to the impact on existing trees and the lack of information in regard to landscape and SUDS. The applicant is requested to submit the following information:

(a) A fully detailed landscaping scheme for the proposed development. The applicant should provide a landscape rationale and a fully detailed landscape plan including Sections and Elevations and a full works specification that accords with the specifications and requirements of the Council's Public Realm Section.

(b) The impact of the proposed development on the existing trees contained within the development site is not acceptable to the Public Realm Section, and would contravene Council policy. The current proposal will have a negative impact on existing trees within the development site area. The proposed development will require the removal of 58 no. trees, three groups of trees and the part removal of two groups of trees. A response should be submitted including a revised layout to significantly reduce the impact of the proposed development on the existing mature trees, especially those trees located along the western boundary which are proposed to be removed.

(c) The Public Realm Section consider that the proposed development is contrary to Policy G5 - Sustainable Urban Drainage Systems and Objective G5 1 and G5 2 in the County Development Plan. The applicant should be requested to:

(1) Revisit the design and layout of the proposed development and demonstrate how the development will comply with these policies and objectives in a separate report.

(2) Submit revised plans and particulars addressing the above item and to include the following: i. Significantly reduce the impacts of the development on existing green infrastructure especially the mature boundary trees within the proposed development site.

ii. Demonstrate how natural SUDS features can be incorporated into the design of the proposed development.

(3) Submit green infrastructure proposals that will mitigate and compensate for the impact of the proposed development on this existing tree canopy. These proposals should include additional landscaping, SUDS measures (such as permeable paving, green roofs, filtration planting, above ground attenuation ponds, construction/bioretention tree pits etc.) and planting for carbon sequestration and pollination to support the local Bat population. Response should include revised layout and drawings.

(d) A comprehensive SUDS Management Plan should be submitted to demonstrate that the proposed SUDS features have reduced the rate of run off into the existing surface water drainage network. A maintenance plan should also be included as a demonstration of how the system will function following implementation. Additional natural SUDS features should be incorporated into the proposed drainage system for the development such as bio-retention/constructed tree pits. In addition, the applicant should provide the following:

(1) Demonstrate how the proposed natural SUDS features will be incorporated and work within the drainage design for the proposed development.

(2) Street Trees shall be planted in public open space with suitable tree pits that incorporates SUDS features in accordance with SDCC Adamstown Street Design Guide, Section 6.3 Side Street Design.

Response

(a) Prior to preparing this response, the applicant commissioned Ground Investigations Ireland (GII) to carry out a site investigation including soakaway testing as required. 6 copies of the GII report are enclosed as a separate document.

As confirmed in Section 5.2 of the enclosed GII report, the water level during testing dropped too slowly to allow calculation of the 'f' (soil infiltration rate) and therefore the subject is not suitable for soakaways in accordance with BRE Digest 365. An alternative surface water design in outlined below.

(b) Notwithstanding the limited infiltration available on site, the applicant is proposing to implement a number of SUDS features in order to address surface water discharge from the site.

It is proposed to provide a combination of permeable paving and underground attenuation via a Stormtech storage system within each respective site. The permeable paving will allow interception of the initial surface water runoff while the Stormtech will enable interception and storage. While a low infiltration rate has been confirmed by the site investigation, a permeable stone base on the Stomtech system will allow some infiltration, treatment and recharging of ground water.

Enclosed with this submission are 6 copies of an updated proposed surface water drainage layout plan (drawing no. D1194-25A) showing all details in relation to the surface water disposal.

Enclosed in Appendix 1 are Resolute Engineering Group Ltd. design details for the Stormtech attenuation system. Each site will have a similar Stormtech system installed with only a slight variation in size and configuration (appropriate to each respective site). Each individual site will have a flow control device limiting the outflow prior to connection to the existing surface water sewer located to the front of the subject site. The outflow will be restricted to 1l/s so as to ensure an appropriate minimum orifice size is used.

Enclosed is Appendix B are Resolute Engineering Group Ltd. Micro drainage design calculations for the Stormtech attenuation system which has been designed to cater for 1:100 year flood event with an additional 20% allowance for climate change.

Enclosed in Appendix C are typical longitudinal and cross sections of the Stormtech underground attenuation system. The Stormtech is supplied in modular units which can be configured in alternative layouts i.e. one single line, two/ three lines side by side etc. therefore each site will be subject to a final design confirmation

following a site inspection at construction stage and prior to the installation of the system.

Enclosed in Appendix D are maintenance details for the proposed Stormtech system as supplied by Resolute Engineering Group Ltd.

Enclosed in Appendix E are Roadstone Aquaform permeable paving details (or similar alternative approved system subject to availability) which will be provided in the front driveways of each respective site.

Rainfall design data for the subject area as received from Met Éireann is enclosed in Appendix F of this report.

We are satisfied that the updated surface water design outlined in this report incorporates a number of SUDS elements and supports the objectives of South Dublin Co. Co. in respect of green infrastructure insofar as reasonably possible on this small infill site.

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APPENDIX A

(Resolute Engineering Group Ltd. - Stormtech design calculations)

Resolute Group

INPUTS

Project Name	Rathfarnham Site 1.4.5.6.8
Project Reference	JN210004
Date	16-Feb-21
Designer	LP
Liner	Permeable
Chamber Model	SC740
Required Storage Volume	6.5 m^3
Stone Porosity	40%
Excavation Batter	60 °
Stone Above Chambers	0.15 m
Stone Foundation Depth	0.15 m
Chamber Seperation	0.15 m
Spacing at Sides	0.3 m
Spacing at Ends	0.3 m
No. of Rows	1
No. of Chambers per Row	1
Manholes - 1500mm dia.	1
Isolator Rows	1

RESULTS

System Volume and Bed Size

Installed Storage Volume	7.0 m^3
Height per Chamber	0.762
Width per Chamber	1.295
Length per Chamber	2.169
Depth of System	1.062 m
Tank Overall Installed Width at Base	1.9 m
Tank Overall Installed Length at Base	3.2 m
Area of Dig at Base of System	6 m^2
Area of Dig at Top of System	14 m^2

System Components

Chambers	1
Endcaps	2
Amount of Stone Required (m3)	9 m^3
Amount of Stone Required (tonne)	15 m^3
Volume of excavation (not including top-fill)	10 m^3

Resolute Group

INPUTS

Project Name	Rathfarnham Site 2.7
Project Reference	JN210004
Date	16-Feb-22
Designer	LP
Liner	Permeable
Chamber Model	SC740
Required Storage Volume	8.5 m^3
Stone Porosity	40%
Excavation Batter	60 °
Stone Above Chambers	0.15 m
Stone Foundation Depth	0.15 m
Chamber Seperation	0.15 m
Spacing at Sides	0.55 m
Spacing at Ends	0.55 m
No. of Rows	1
No. of Chambers per Row	1
Manholes - 1500mm dia.	1
Isolator Rows	1

RESULTS

System Volume and Bed Size

Installed Storage Volume	8.5 m^3
Height per Chamber	0.762
Width per Chamber	1.295
Length per Chamber	2.169
Depth of System	1.062 m
Tank Overall Installed Width at Base	2.4 m
Tank Overall Installed Length at Base	3.7 m
Area of Dig at Base of System	9 m^2
Area of Dig at Top of System	18 m^2

System Components

Chambers	1
Endcaps	2
Amount of Stone Required (m3)	13 m^3
Amount of Stone Required (tonne)	21 m^3
Volume of excavation (not including top-fill)	14 m^3

Resolute Group

INPUTS

Project Name	Rathfarnham Site 3
Project Reference	JN210004
Date	16-Feb-22
Designer	LP
Liner	Permeable
Chamber Model	SC740
Required Storage Volume	6.1 m^3
Stone Porosity	40%
Excavation Batter	60 °
Stone Above Chambers	0.15 m
Stone Foundation Depth	0.15 m
Chamber Seperation	0.15 m
Spacing at Sides	0.3 m
Spacing at Ends	0.3 m
No. of Rows	1
No. of Chambers per Row	1
Manholes - 1500mm dia.	1
Isolator Rows	1

RESULTS

System Volume and Bed Size

Installed Storage Volume	7.0 m^3
Height per Chamber	0.762
Width per Chamber	1.295
Length per Chamber	2.169
Depth of System	1.062 m
Tank Overall Installed Width at Base	1.9 m
Tank Overall Installed Length at Base	3.2 m
Area of Dig at Base of System	6 m^2
Area of Dig at Top of System	14 m^2

System Components

Chambers	1
Endcaps	2
Amount of Stone Required (m3)	9 m^3
Amount of Stone Required (tonne)	15 m^3
Volume of excavation (not including top-fill)	10 m^3

APPENDIX B

Resolute Engineering Group Ltd. Micro Drainage surface water attenuation calculations)

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 71 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	0.712	0.712	0.0	0.8	0.8	4.4	O K
30 min Winter	0.926	0.926	0.0	0.9	0.9	5.7	O K
60 min Winter	1.047	1.047	0.0	1.0	1.0	6.4	O K
120 min Winter	1.054	1.054	0.0	1.0	1.0	6.5	O K
180 min Winter	1.004	1.004	0.0	1.0	1.0	6.1	O K
240 min Winter	0.941	0.941	0.0	0.9	0.9	5.8	O K
360 min Winter	0.809	0.809	0.0	0.9	0.9	4.9	O K
480 min Winter	0.682	0.682	0.0	0.8	0.8	4.2	O K
600 min Winter	0.563	0.563	0.0	0.8	0.8	3.4	O K
720 min Winter	0.436	0.436	0.0	0.8	0.8	2.7	O K
960 min Winter	0.187	0.187	0.0	0.8	0.8	1.1	O K
1440 min Winter	0.070	0.070	0.0	0.7	0.7	0.4	O K
2160 min Winter	0.050	0.050	0.0	0.5	0.5	0.3	O K
2880 min Winter	0.041	0.041	0.0	0.4	0.4	0.2	O K
4320 min Winter	0.033	0.033	0.0	0.3	0.3	0.2	O K
5760 min Winter	0.029	0.029	0.0	0.2	0.2	0.2	O K
7200 min Winter	0.026	0.026	0.0	0.2	0.2	0.2	O K
8640 min Winter	0.024	0.024	0.0	0.2	0.2	0.1	O K
10080 min Winter	0.022	0.022	0.0	0.2	0.2	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	91.990	0.0	5.2	23
30 min Winter	62.658	0.0	7.1	35
60 min Winter	39.995	0.0	9.1	60
120 min Winter	24.901	0.0	11.1	90
180 min Winter	18.717	0.0	12.7	136
240 min Winter	15.262	0.0	13.8	172
360 min Winter	11.412	0.0	15.5	246
480 min Winter	9.274	0.0	16.8	316
600 min Winter	7.890	0.0	17.9	386
720 min Winter	6.913	0.0	18.8	460
960 min Winter	5.608	0.0	20.3	542
1440 min Winter	4.175	0.0	22.7	740
2160 min Winter	3.107	0.0	25.4	1104
2880 min Winter	2.518	0.0	27.4	1472
4320 min Winter	1.870	0.0	30.5	2176
5760 min Winter	1.512	0.0	32.9	2856
7200 min Winter	1.283	0.0	34.9	3568
8640 min Winter	1.121	0.0	36.6	4376
10080 min Winter	1.000	0.0	38.1	5136

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.027

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.009	4	8	0.009	8	12	0.009

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.60
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	10.2	10.2	1.200	0.0	25.8
1.100	10.2	25.8			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0046-1000-1100-1000
Design Head (m)	1.100
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	46
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.100	1.0
Flush-Flo™	0.200	0.8
Kick-Flo®	0.408	0.6
Mean Flow over Head Range	-	0.8

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	0.7	1.200	1.0	3.000	1.6	7.000	2.3
0.200	0.8	1.400	1.1	3.500	1.7	7.500	2.4
0.300	0.8	1.600	1.2	4.000	1.8	8.000	2.5
0.400	0.7	1.800	1.2	4.500	1.9	8.500	2.5
0.500	0.7	2.000	1.3	5.000	2.0	9.000	2.6
0.600	0.8	2.200	1.4	5.500	2.1	9.500	2.7
0.800	0.9	2.400	1.4	6.000	2.2		
1.000	1.0	2.600	1.5	6.500	2.2		

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 91 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	0.687	0.687	0.0	0.8	0.8	5.3	O K
30 min Winter	0.901	0.901	0.0	0.9	0.9	7.0	O K
60 min Winter	1.040	1.040	0.0	1.0	1.0	8.0	O K
120 min Winter	1.074	1.074	0.0	1.0	1.0	8.3	O K
180 min Winter	1.045	1.045	0.0	1.0	1.0	8.1	O K
240 min Winter	1.000	1.000	0.0	1.0	1.0	7.7	O K
360 min Winter	0.894	0.894	0.0	0.9	0.9	6.9	O K
480 min Winter	0.789	0.789	0.0	0.9	0.9	6.1	O K
600 min Winter	0.688	0.688	0.0	0.8	0.8	5.3	O K
720 min Winter	0.593	0.593	0.0	0.8	0.8	4.6	O K
960 min Winter	0.364	0.364	0.0	0.8	0.8	2.8	O K
1440 min Winter	0.117	0.117	0.0	0.7	0.7	0.9	O K
2160 min Winter	0.060	0.060	0.0	0.6	0.6	0.5	O K
2880 min Winter	0.048	0.048	0.0	0.5	0.5	0.4	O K
4320 min Winter	0.037	0.037	0.0	0.4	0.4	0.3	O K
5760 min Winter	0.032	0.032	0.0	0.3	0.3	0.2	O K
7200 min Winter	0.029	0.029	0.0	0.2	0.2	0.2	O K
8640 min Winter	0.026	0.026	0.0	0.2	0.2	0.2	O K
10080 min Winter	0.025	0.025	0.0	0.2	0.2	0.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	91.990	0.0	6.2	23
30 min Winter	62.658	0.0	8.4	36
60 min Winter	39.995	0.0	10.7	62
120 min Winter	24.934	0.0	13.4	104
180 min Winter	18.717	0.0	15.1	138
240 min Winter	15.262	0.0	16.4	176
360 min Winter	11.412	0.0	18.4	252
480 min Winter	9.274	0.0	19.9	322
600 min Winter	7.890	0.0	21.2	394
720 min Winter	6.913	0.0	22.3	464
960 min Winter	5.608	0.0	24.1	594
1440 min Winter	4.175	0.0	26.9	774
2160 min Winter	3.107	0.0	30.1	1104
2880 min Winter	2.518	0.0	32.5	1460
4320 min Winter	1.870	0.0	36.2	2152
5760 min Winter	1.512	0.0	39.0	2840
7200 min Winter	1.283	0.0	41.4	3704
8640 min Winter	1.121	0.0	43.4	4408
10080 min Winter	1.000	0.0	45.2	5128

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.032

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.011	4	8	0.011	8	12	0.011

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.60
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	12.9	12.9	1.200	0.0	29.0
1.100	12.9	29.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0046-1000-1100-1000
Design Head (m)	1.100
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	46
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.100	1.0
Flush-Flo™	0.200	0.8
Kick-Flo®	0.408	0.6
Mean Flow over Head Range	-	0.8

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	0.7	1.200	1.0	3.000	1.6	7.000	2.3
0.200	0.8	1.400	1.1	3.500	1.7	7.500	2.4
0.300	0.8	1.600	1.2	4.000	1.8	8.000	2.5
0.400	0.7	1.800	1.2	4.500	1.9	8.500	2.5
0.500	0.7	2.000	1.3	5.000	2.0	9.000	2.6
0.600	0.8	2.200	1.4	5.500	2.1	9.500	2.7
0.800	0.9	2.400	1.4	6.000	2.2		
1.000	1.0	2.600	1.5	6.500	2.2		

Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 67 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Winter	0.723	0.723	0.0	0.8	0.8	4.2	O K
30 min Winter	0.938	0.938	0.0	0.9	0.9	5.4	O K
60 min Winter	1.055	1.055	0.0	1.0	1.0	6.1	O K
120 min Winter	1.055	1.055	0.0	1.0	1.0	6.1	O K
180 min Winter	0.999	0.999	0.0	1.0	1.0	5.8	O K
240 min Winter	0.932	0.932	0.0	0.9	0.9	5.4	O K
360 min Winter	0.792	0.792	0.0	0.9	0.9	4.6	O K
480 min Winter	0.660	0.660	0.0	0.8	0.8	3.8	O K
600 min Winter	0.535	0.535	0.0	0.8	0.8	3.1	O K
720 min Winter	0.371	0.371	0.0	0.8	0.8	2.1	O K
960 min Winter	0.162	0.162	0.0	0.8	0.8	0.9	O K
1440 min Winter	0.067	0.067	0.0	0.6	0.6	0.4	O K
2160 min Winter	0.048	0.048	0.0	0.5	0.5	0.3	O K
2880 min Winter	0.039	0.039	0.0	0.4	0.4	0.2	O K
4320 min Winter	0.032	0.032	0.0	0.3	0.3	0.2	O K
5760 min Winter	0.028	0.028	0.0	0.2	0.2	0.2	O K
7200 min Winter	0.025	0.025	0.0	0.2	0.2	0.1	O K
8640 min Winter	0.023	0.023	0.0	0.2	0.2	0.1	O K
10080 min Winter	0.022	0.022	0.0	0.2	0.2	0.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Winter	91.990	0.0	5.0	23
30 min Winter	62.658	0.0	6.8	35
60 min Winter	39.995	0.0	8.7	60
120 min Winter	24.904	0.0	10.9	96
180 min Winter	18.717	0.0	12.3	134
240 min Winter	15.262	0.0	13.3	172
360 min Winter	11.412	0.0	15.0	244
480 min Winter	9.274	0.0	16.2	314
600 min Winter	7.890	0.0	17.2	384
720 min Winter	6.913	0.0	18.1	448
960 min Winter	5.608	0.0	19.6	534
1440 min Winter	4.175	0.0	21.9	738
2160 min Winter	3.107	0.0	24.4	1100
2880 min Winter	2.518	0.0	26.4	1468
4320 min Winter	1.870	0.0	29.4	2128
5760 min Winter	1.512	0.0	31.7	2936
7200 min Winter	1.283	0.0	33.6	3552
8640 min Winter	1.121	0.0	35.2	4400
10080 min Winter	1.000	0.0	36.7	5096

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.000	Shortest Storm (mins)	15
Ratio R	0.300	Longest Storm (mins)	10080
Summer Storms	No	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.026

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.009	4	8	0.009	8	12	0.009

Model Details

Storage is Online Cover Level (m) 2.000

Cellular Storage Structure

Invert Level (m) 0.000 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.60
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	9.6	9.6	1.200	0.0	23.2
1.100	9.6	23.2			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0046-1000-1100-1000
Design Head (m)	1.100
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	46
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.100	1.0
Flush-Flo™	0.200	0.8
Kick-Flo®	0.408	0.6
Mean Flow over Head Range	-	0.8

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	0.7	1.200	1.0	3.000	1.6	7.000	2.3
0.200	0.8	1.400	1.1	3.500	1.7	7.500	2.4
0.300	0.8	1.600	1.2	4.000	1.8	8.000	2.5
0.400	0.7	1.800	1.2	4.500	1.9	8.500	2.5
0.500	0.7	2.000	1.3	5.000	2.0	9.000	2.6
0.600	0.8	2.200	1.4	5.500	2.1	9.500	2.7
0.800	0.9	2.400	1.4	6.000	2.2		
1.000	1.0	2.600	1.5	6.500	2.2		

APPENDIX C

STORMTECH TYPICAL CROSS SECTIONS
(SUPPLIED BY RESOLUTE ENGINEERING GROUP LTD.)

THIS DRAWING IS FOR INFORMATION PURPOSES ONLY
NOT FOR CONSTRUCTION

NOTE:
DUE TO THE LIMITED SITE SIZE & SMALL STORAGE REQUIREMENTS OF EACH INDIVUDUAL SITE, A SINGLE LINE OF STORMTECH SC740 MAY BE UTILISED. FINAL DESIGN SUBJECT TO SITE INSPECTION PRIOR TO INSTALLATION OF THE STORAGE SYSTEM.

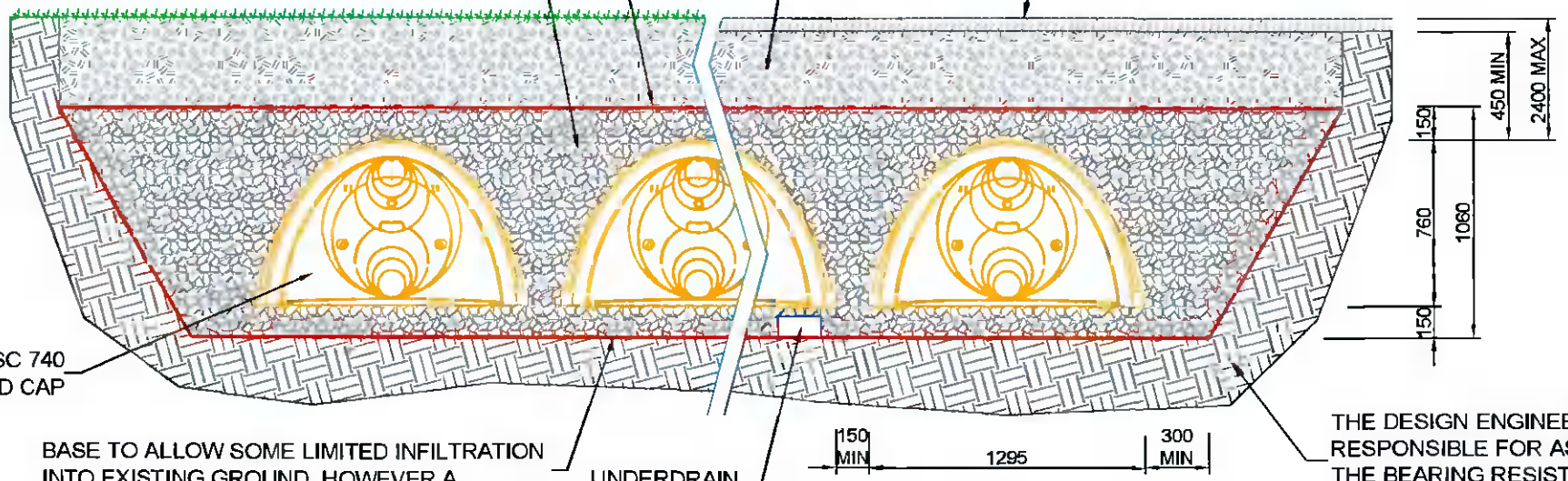
FOR ENGINEER APPROVAL

LAYER OF NEEDLE PUNCHED NON-WOVEN GEOTEXTILE BETWEEN COVER STONE AND LAYER ABOVE THAT MEETS MINIMUM TENSILE STRENGTH OF 8kn/m (EN ISO 1031). POLYFELT TS20, MULTITRACK NW8 OR THRACE S8NW

GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, < 35% FINES COMPACT IN 150mm LIFTS TO 95% PROCTOR DENSITY SEE TABLE OF ACCEPTABLE FILL MATERIALS IN STORMTECH DESIGN MANUAL

CLAUSE 505B, ANGULAR STONE

FINISHED SURFACE (PERMEABLE PAVING) BY OTHERS



SC 740 END CAP

BASE TO ALLOW SOME LIMITED INFILTRATION INTO EXISTING GROUND. HOWEVER A BENTOFIX NSP4000 IMPERMEABLE MEMBRANE CAN BE PROVIDED AROUND BASE AND SIDE OF EXCAVATION (IF REQUIRED)

UNDERDRAIN WRAPPED IN GEOTEXTILE

THE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE OF THE SUBGRADE SOILS*

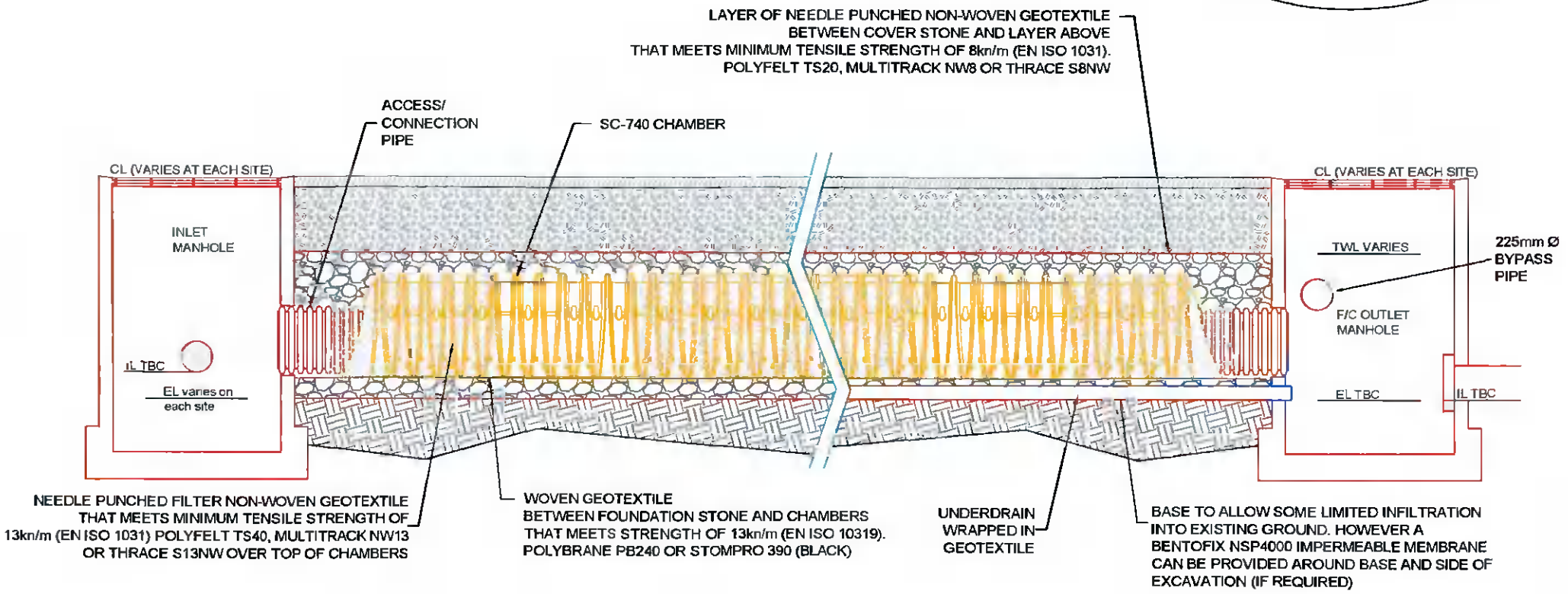
* REFER TO STORMTECH DESIGN MANUAL

SITE: 8 HOUSES AT GRANGEBROOK AVENUE	01 DRAWING NO.		01 PAGE NO.	MAY'22 DATE.
TITLE: CROSS SECTION TYPICAL	NTS SCALE	DRAWN.	CHECKED.	REVISION.

StormTech \Logos\400dpiLogoCropped.jpg

THIS DRAWING IS FOR INFORMATION PURPOSES ONLY
NOT FOR CONSTRUCTION

FOR ENGINEER APPROVAL



SITE: 8 HOUSES AT GRANGEBROOK AVENUE	02 DRAWING NO.		01 PAGE NO.	MAY'22 DATE
TITLE: LONGITUDINAL SECTION TYPICAL	NTS SCALE	DRAWN.	CHECKED.	REVISION.

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APPENDIX D

STORMTECH ISOLATOR ROW O&M MANUAL
(SUPPLIED BY RESOLUTE ENGINEERING GROUP LTD.)

THE ISOLATOR® ROW

INTRODUCTION

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

The Isolator Row is a row of StormTech chambers, either SC-160LP, SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is 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 storm water 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 storm water 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 storm water 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 SC-160LP, DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

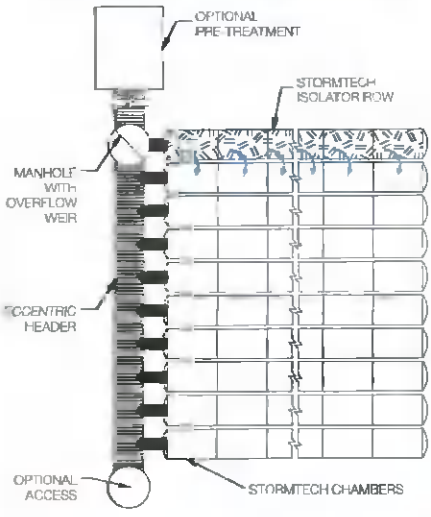
The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water 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, oil-water separators or can be innovative storm water 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.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

StormTech Isolator Row with Overflow Spillway (not to scale)



ISOLATOR ROW INSPECTION/MAINTENANCE

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, residential), anticipated pollutant load, percent imperviousness, climate, 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.

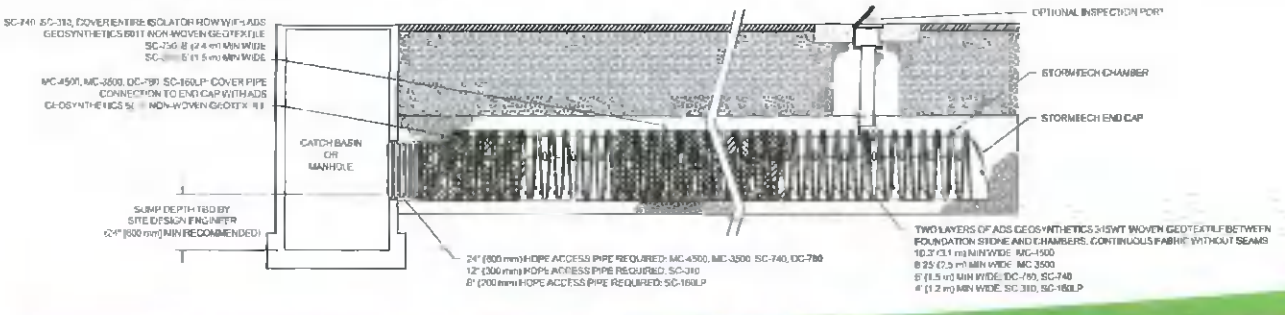
MAINTENANCE

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.**

StormTech Isolator Row (not to scale)

Note: Non-woven fabric is only required over the inlet pipe connection into the end cap for SC-160LP, DC-780, MC-3500 and MC-4500 chamber models and is not required over the entire Isolator Row.



ISOLATOR ROW STEP BY STEP MAINTENANCE PROCEDURES

STEP 1
Inspect Isolator Row for sediment.

A) Inspection ports (if present)
   i. Remove lid from floor box frame
   ii. Remove cap from inspection riser
   iii. Using a flashlight and stadia rod,measure depth of sediment and record results on maintenance log.
   iv. If sediment is at or above 3 inch depth, proceed to Step 2. If not, proceed to Step 3.

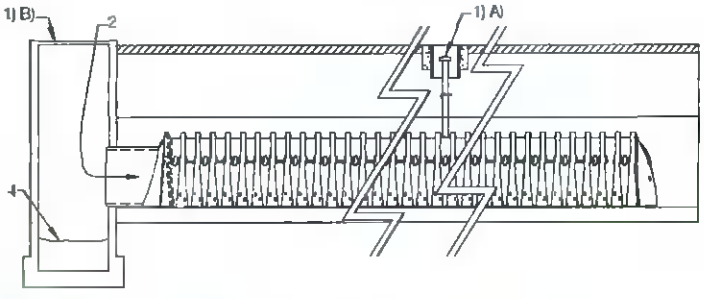
B) All Isolator Rows
   i. Remove cover from manhole at upstream end of Isolator Row
   ii. Using a flashlight, inspect down Isolator Row through outlet pipe
      1. Mirrors on poles or cameras may be used to avoid a confined space entry
      2. Follow OSHA regulations for confined space entry if entering manhole
   iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches), proceed to Step 2. If not, proceed to Step 3.

STEP 2
Clean out Isolator Row using the JetVac process.

A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
B) Apply multiple passes of JetVac until backflush water is clean
C) Vacuum manhole sump as required

STEP 3
Replace all caps, lids and covers, record observations and actions.

STEP 4
Inspect & clean catch basins and manholes upstream of the StormTech system.



SAMPLE MAINTENANCE LOG

Date	Stadia Rod Readings		Sediment Depth (1)–(2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/11	6.3 ft	none		New installation. Fixed point is CI frame at grade	DJM
9/24/11		6.2	0.1 ft	Some grit felt	SM
6/20/13		5.8	0.5 ft	Mucky feel, debris visible in manhole and in Isolator Row, maintenance due	NV
7/7/13	6.3 ft		0	System jetted and vacuumed	DJM

StormTech
A division of ADS

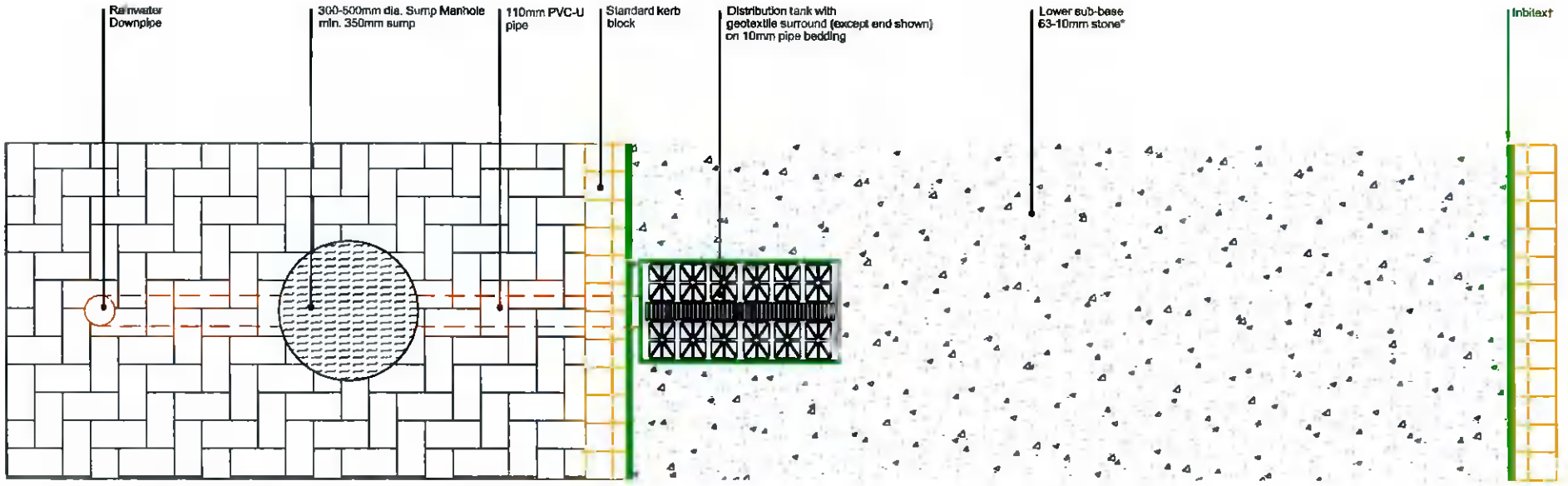
Advanced Drainage Systems, Inc.
4640 Trueman Blvd., Hilliard, OH 43026
1-800 821 6710 www.ads-pipe.com

APPENDIX E

Permeable paving details - Roadstone Aquaform/ or alternative approved system subject to availability

FORMPAVE STORMWATER SOURCE CONTROL SYSTEM

Downpipe drainage into Infiltration System - Plan



NOTES

† Supplied by WTB Geotextiles or UGS

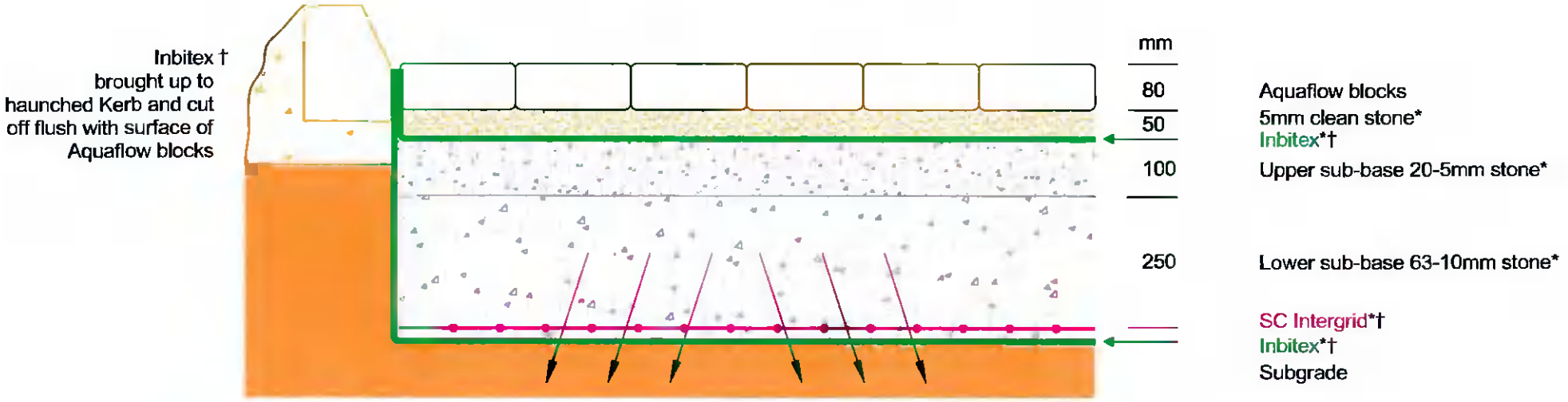
* Specification for sub-base and laying course:- the crushed stone must possess well defined edges and have a minimum 10% fines value of 150kN when tested in accordance with BS812 Part iii.

Grading of Lower sub-base stone

SIEVE SIZE	% PASSING
100mm	100
63mm	90-100
37.5mm	60-80
20mm	15-30
10mm	0-5

FORMPAVE STORMWATER SOURCE CONTROL SYSTEM

Typical Infiltration System with a CBR between 2 - 5%
Parking Areas subject to trafficking by Cars and Vans only



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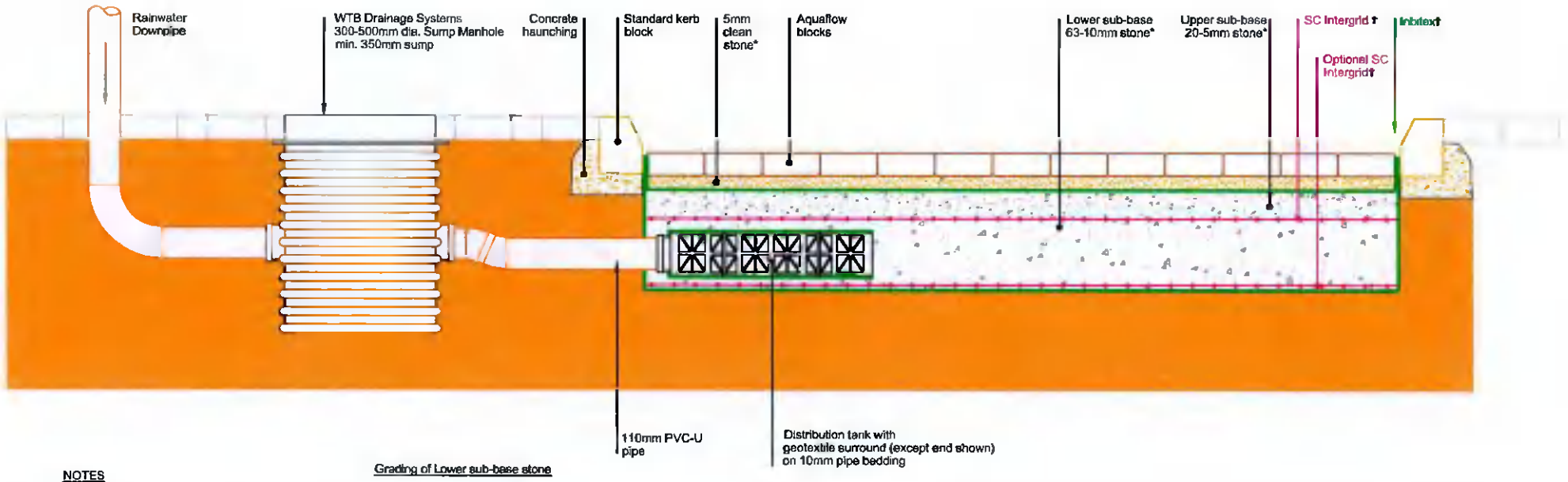
Grading of Lower sub-base stone

SIEVE SIZE	% PASSING
100mm	100
63mm	90-100
37.5mm	60-80
20mm	15-30
10mm	0-5

FORMPAVE STORMWATER SOURCE CONTROL SYSTEM

Downpipe drainage into Infiltration System - Section



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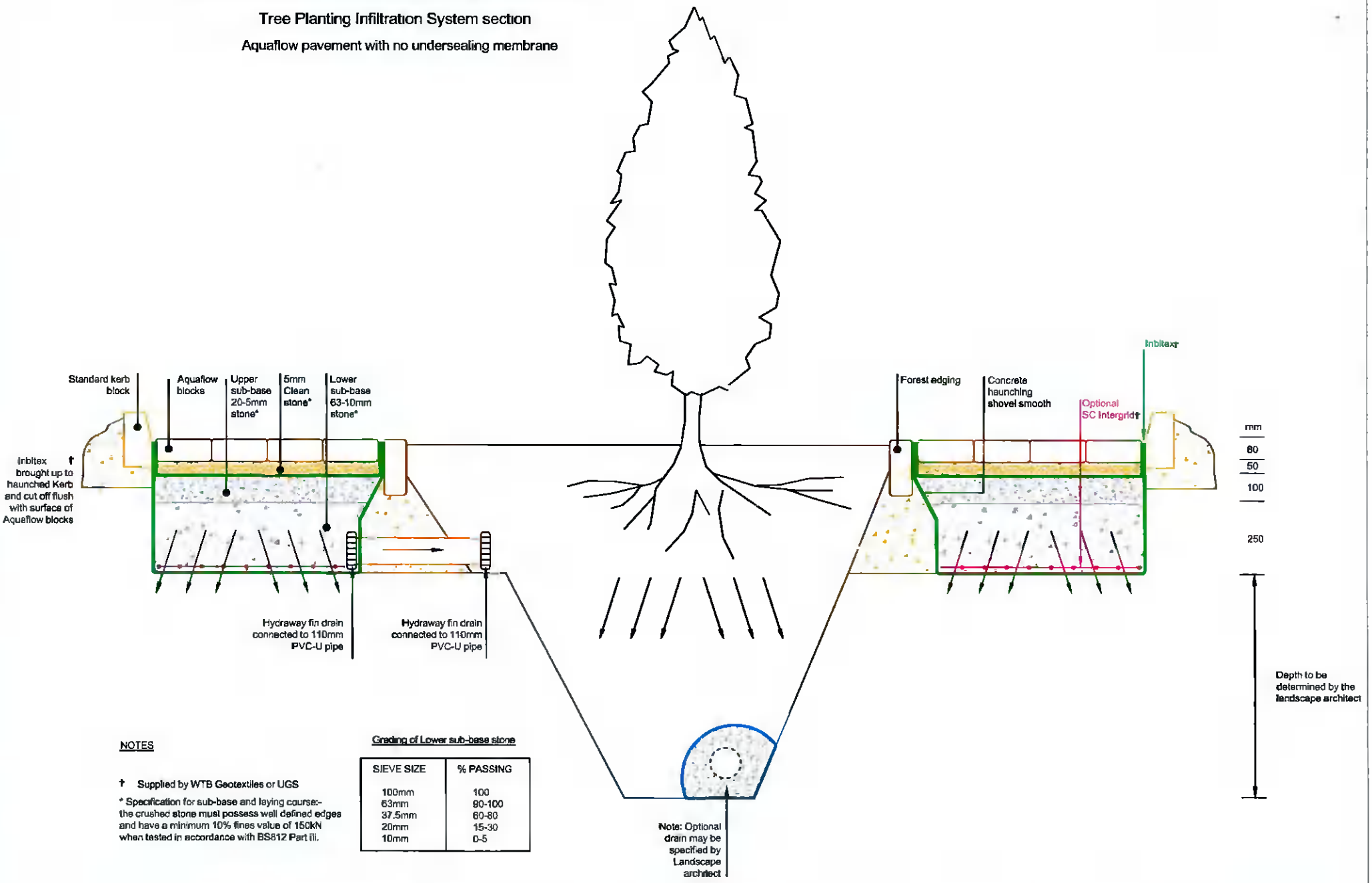
Grading of Lower sub-base stone

SIEVE SIZE	% PASSING
100mm	100
63mm	90-100
37.5mm	60-80
20mm	15-30
10mm	0-5

FORMPAVE STORMWATER SOURCE CONTROL SYSTEM

Tree Planting Infiltration System section

Aquaflow pavement with no undersealing membrane



NOTES

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* Specification for sub-base and laying course:- the crushed stone must possess well defined edges and have a minimum 10% fines value of 150kN when tested in accordance with BS812 Part iii.

Grading of Lower sub-base stone

SIEVE SIZE	% PASSING
100mm	100
63mm	90-100
37.5mm	60-80
20mm	15-30
10mm	0-5

APPENDIX F

Met Eireann Return Period rainfall data

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 314464, Northing: 226372,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.7,	4.0,	4.7,	5.8,	6.6,	7.2,	9.2,	11.5,	13.1,	15.3,	17.4,	19.0,	21.5,	23.4,	25.1,	N/A ,
10 mins	3.8,	5.6,	6.6,	8.1,	9.2,	10.0,	12.8,	16.1,	18.2,	21.4,	24.2,	26.4,	29.9,	32.6,	34.9,	N/A ,
15 mins	4.5,	6.6,	7.8,	9.6,	10.8,	11.8,	15.1,	18.9,	21.5,	25.1,	28.5,	31.1,	35.2,	38.4,	41.1,	N/A ,
30 mins	5.9,	8.6,	10.1,	12.3,	13.9,	15.1,	19.2,	24.0,	27.1,	31.7,	35.8,	39.0,	44.0,	47.9,	51.2,	N/A ,
1 hours	7.7,	11.2,	13.0,	15.9,	17.9,	19.4,	24.5,	30.4,	34.3,	39.9,	44.9,	48.9,	54.9,	59.7,	63.7,	N/A ,
2 hours	10.1,	14.5,	16.9,	20.5,	23.0,	24.9,	31.3,	38.6,	43.4,	50.3,	56.4,	61.2,	68.6,	74.4,	79.3,	N/A ,
3 hours	11.9,	17.0,	19.7,	23.8,	26.7,	28.9,	36.1,	44.3,	49.8,	57.6,	64.5,	69.9,	78.2,	84.7,	90.1,	N/A ,
4 hours	13.3,	18.9,	21.9,	26.5,	29.6,	32.0,	39.9,	48.9,	54.9,	63.4,	70.9,	76.7,	85.8,	92.8,	98.7,	N/A ,
6 hours	15.6,	22.1,	25.5,	30.8,	34.3,	37.0,	46.0,	56.3,	63.0,	72.5,	81.0,	87.6,	97.7,	105.6,	112.1,	N/A ,
9 hours	18.3,	25.8,	29.7,	35.7,	39.7,	42.9,	53.1,	64.7,	72.3,	83.0,	92.5,	99.9,	111.3,	120.1,	127.5,	N/A ,
12 hours	20.5,	28.7,	33.1,	39.7,	44.1,	47.5,	58.7,	71.4,	79.7,	91.4,	101.7,	109.7,	122.1,	131.7,	139.6,	N/A ,
18 hours	24.1,	33.5,	38.6,	46.1,	51.1,	55.0,	67.7,	82.0,	91.4,	104.6,	116.2,	125.2,	139.1,	149.8,	158.6,	N/A ,
24 hours	27.0,	37.4,	43.0,	51.2,	56.7,	61.0,	74.9,	90.5,	100.8,	115.1,	127.8,	137.5,	152.5,	164.1,	173.7,	207.2,
2 days	33.9,	45.9,	52.1,	61.3,	67.4,	72.1,	87.2,	103.9,	114.7,	129.8,	142.9,	153.0,	168.4,	180.2,	189.9,	223.5,
3 days	39.6,	52.7,	59.5,	69.5,	76.1,	81.1,	97.2,	114.9,	126.3,	141.9,	155.6,	166.1,	181.9,	194.1,	204.0,	238.3,
4 days	44.5,	58.7,	66.0,	76.6,	83.6,	89.0,	106.0,	124.4,	136.3,	152.6,	166.8,	177.6,	193.9,	206.4,	216.6,	251.5,
6 days	53.2,	69.2,	77.3,	89.0,	96.7,	102.6,	121.1,	141.0,	153.7,	171.1,	186.2,	197.6,	214.8,	227.8,	238.5,	274.9,
8 days	60.9,	78.4,	87.2,	99.9,	108.2,	114.5,	134.3,	155.5,	168.9,	187.3,	203.0,	215.0,	232.9,	246.6,	257.7,	295.3,
10 days	67.9,	86.8,	96.3,	109.8,	118.6,	125.3,	146.2,	168.5,	182.6,	201.8,	218.3,	230.7,	249.4,	263.5,	275.0,	313.8,
12 days	74.5,	94.6,	104.7,	119.0,	128.3,	135.3,	157.3,	180.6,	195.3,	215.2,	232.3,	245.2,	264.5,	279.1,	290.9,	330.9,
16 days	86.8,	109.1,	120.2,	135.9,	146.1,	153.7,	177.5,	202.6,	218.4,	239.7,	257.9,	271.6,	292.0,	307.4,	319.8,	361.8,
20 days	98.3,	122.5,	134.5,	151.4,	162.3,	170.5,	195.9,	222.7,	239.4,	261.9,	281.1,	295.4,	316.9,	333.0,	346.0,	389.7,
25 days	111.7,	138.1,	151.1,	169.5,	181.2,	190.0,	217.2,	245.8,	263.6,	287.4,	307.7,	322.8,	345.4,	362.3,	375.9,	421.7,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf