Revised Drainage Proposals

and

Standard Construction Details

for

Proposed Extension and Alterations

to

Existing Motor Showroom & Workshop

at

Ballymount, Dublin

for

Pilsen Auto Ltd

Rev P2

February 2023

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Proposed Extension and Alterations to Existing Motor Showroom and Workshop at Ballymount, Dublin

Proposed Extension and Alterations

The proposed works to the existing showroom and workshop building will consist of an extension and alterations to the existing building with internal layout changes and associated site works.

The proposed extension to the rear of the existing showroom and workshop building will be a two-storey building consisting of a new workshop area at ground level, with offices, sanitary services and canteen at first floor.

The existing external circulation roads including surface water drainage around the building will be altered and extended to accommodate the proposed layout. It is intended to extend the existing foul sewer to service the proposed building extension in accordance with this specification and with the attached drawings.

Foul Sewer Calculations

<u>Total discharge to Foul Sewer Pipe from Building Extension</u>

Using Table 2 of IS EN 12056-2 to find discharge units for appliances

Total no of sinks	= 1No @ 0.8 discharge units	= 0.8 units
Total no of Washbasins	= 5No @ 0.5 discharge units	= 2.5 units
Total no of WC's	= 5No @ 2.0 discharge units	= 10.0 units
Total no of Showers	= 1No @ 0.6 discharge units	= 0.6 units

Total number of discharge units entering drainage system = 13.9 units

<u>Total discharge to Foul Sewer Pipe from Existing Building</u>

Using Table 2 of IS EN 12056-2 to find discharge units for appliances

Total no of sinks	= 2No @ 0.8 discharge units	= 1.6 units
Total no of Washbasins	= 5No @ 0.5 discharge units	= 2.5 units
Total no of WC's	= 4No @ 2.0 discharge units	= 8.0 units
Total no of Urinals	= 2No @ 0.5 discharge units	= 1.0 units
Total no of Showers	= 1No @ 0.6 discharge units	= 0.6 units

Total number of discharge units entering drainage system = 13.7 units

From IS EN 12056-2-6.3, expected flow rate

$Q_{ww} = K\sqrt{(\sum DU)}$

Where K = 0.5 for intermittent use (from Table 3, IS EN 12506-2)

Q_{ww} = 2.63 l/s

Total flow rate to external drainage = 2.63 l/s

A 150mm dia uPVC pipe at min gradient 1:100; Capacity 22 l/sec => OK

The foul sewer network serving the proposed extension will be in accordance with Technical Guidance Document Part H, with pipe sizes and minimum gradients all in accordance with Table 6 of this document.

The existing piped foul sewer network within the site will be extended to serve the proposed extension.

The foul sewer network within the site currently connects to a public foul sewer in the Ballymount Avenue road.

Surface Water Drainage

The existing development (planning ref SD15A/0002) including all foul and storm sewers, circulation roads, permeable paving areas and attenuation system was completed circa February 2016. The original development was designed using a SuDs approach for the storm water management throughout the site, and utilises both permeable paving with a stone sub-base in the associated car parking areas and an attenuation system located to the south-east of the site.

The combined stone sub-base below the permeable paved areas and the attenuation system provide surface water storage for the existing site. A hydrobrake installed in the manhole at the downstream end of the attenuation system restricts the outflow from the site to 1.8 l/sec in accordance with the granted planning application reference SD15A/0002.

The proposed surface water drainage has been designed using the principles of sustainable drainage systems (SuDS). The objective of this approach is to safely deal with runoff from extreme storm events, without putting public or property at risk, avoid any increase in the pre-development flood risk associated with the receiving water course (hydraulic criteria), reduce urban runoff pollutants and improve storm water quality before discharge (water quality criteria).

There will be a slight increase in the runoff from the new roof area to the new drainage network in the existing yard. This is as a result of the replacement of existing impermeable yard and permeable paving surface with the new roof to the extension. The increase in discharge to the new storm network will be dealt with on site by means of attenuation.

Surface Water Runoff Coefficients

The following runoff coefficients have been applied as follows:

Roof	– 0.95
Roads	– 0.90
Permeable Paving	– 0.65
Landscaping	– 0.20 (Soil Type 3 / SPR Value – FSR)

Contributing Areas

Existing Roof	1127m^2 x 0.95	= 1071m^2
Proposed Roof	390m^2 x 0.95	= 371m^2
Roads	1638m^2 x 0.90	= 1474m^2
Permeable Paving	1114m^2 x 0.65	= 724m^2
Landscaping	406m^2 x 0.30	= 122m^2
Bio-Retention Tree Pits	114m^2 x 0.30	= 34m^2

Hydraulic Criteria

Hydraulic Criteria on the existing development has been met by controlling the rate of discharge of surface water from the roof and paved surfaces on the developed site to match pre-development runoff rates. The surface water runoff from the existing development discharges to the public surface water sewer in the public road to the east of the site and the flow rate is restricted to 1.8 l/sec by means of a flow restrictor.

The flow rate from the overall site is restricted to 1.8 l/sec in accordance with the granted planning application reference SD15A/0002 granted prior to the construction of the original development. There will be no increase in the rate of surface water discharge from the proposed extension.

Site control is incorporated in the existing system in the form of below ground attenuation storage located to the east of the site and through the use of a permeable aggregate sub-base below the permeable paving. Regional control would need to be managed for the local area as a whole on a co-ordinated basis.

The runoff from the new/extended roof area will be stored and discharged through additional attenuation as shown on the site layout plan. The additional attenuation will be achieved both in the new attenuation chambers to the rear of the new extension, the sub-base below the permeable paving, and in the tree pits provided as part of the landscaping around the new extension. This additional attenuation has been designed to contain the runoff for the 100 year storm ensuring that no flood water discharges from the site in the 1:100 year storm event, based on the most onerous rainfall profile from the full range of rainfall data. The rainfall figures (from Met Eireann) have been increased by 20% to allow for climate change.

The proposed permeable paving will allow for infiltration to the existing subsoils to occur. The design of the system however, has conservatively ignored the reduction in runoff which can be achieved through infiltration.

Calculate Attenuation Volume Required for the Proposed Extension

The existing and proposed storm drainage network for the overall site (existing and proposed areas) has been modelled and the required storage volumes for the 30 year and 100 year return periods have been calculated based on simulations of the 30 year and 100 year storm events using Met Eireann rainfall data, factored up for a 20% climate change, using the Causeway Flow design software.

The calculated storage volume for the overall site for the 30 year and 100 year return period are based on computer simulations combining the existing and proposed drainage network. The simulation indicates that an overall storage volume of 196.1m^3 is required for the 100 year storm event.

The results of the simulations are appended to this report and indicate that the storage volume provided within the site, using the existing stormtech attenuation chambers located to the east of the site, the storage volume available within the stone base below the existing permeable paving and the proposed permeable paving, the proposed stormtech chambers to the rear of the site and additionally, the bio-retention tree pits are adequate to contain these extreme storm events while limiting the outflow to 1.8 l/sec.

The calculated cumulative storage volume of each of the components provides 259.5m^3 of storm water storage. The various components are broken down as follows:

Existing Attenuation Chambers	= 85.3m^3
Existing Permeable Stone Sub-base	= 62.0m^3
Proposed Attenuation Chambers	= 42.1m^3
Proposed Permeable Stone Sub-base	= 53.0m^3
Bio-retention tree pits	= 17.1m^3
Total Storage Volume Provided	**= 259.5m^3**
Total Storage Volume Required	**= 196.1m^3**

The total storage volume provided for the 1 in 100 year rainfall event significantly exceeds the storage requirements for this rainfall event and provides circa 30% residual capacity.

The additional storage capacity to be provided as part of this development by construction of below ground attenuation will consist of 48No. StormTech SC-340 underground stormwater chambers (or similar approved) as shown on the site layout drawing. Technical details for these chamber types are appended to this report. This type of chamber has been selected due to their ease of maintenance and the capacity to incorporate an 'isolator row' which provides for the removal of suspended solids and improved water quality. The chambers are bedded, surrounded and covered with single sized stone and each have a storage capacity of 0.878m^3; 48No. chambers having a storage capacity of 42.1m^3.

The attenuation chambers are configured in an 'on-line' arrangement as indicated on the site layout drawing, which best suits the site and drainage layout. The chambers dissipate stored storm waters via a manhole and discharge to the existing surface water network within the site.

The above calculations conservatively ignore the infiltration rates to the base and sides of the attenuation system.
4No. Arborflow Rootspace bio-retention tree pits providing additional attenuation are being provided. 2No. 5m x 5m x 0.6m deep tree pits with an individual water storage capacity of 3.75m^3 are located each side of the proposed building extension in the parking areas. 4No. 4m x 4m x 0.6m deep trees pits are also located to the rear of the site. The total cumulative capacity of the additional tree pits provides 17.1m^3 surface water storage.

Surcharging of the manholes within the storm water network will occur during the extreme rainfall events, however, the system has been designed to ensure that the maximum surcharge level within the manholes for the 1 in 100 year rainfall event will be more than 500mm below the proposed building floor level, in accordance with the requirements of the GDSDS.

Appendix 1

Surface Water Sewer Design Calculations and Storm Simulation Results

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Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	2	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	0.75
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	17.600	Minimum Backdrop Height (m)	0.200
Ratio-R	0.270	Preferred Cover Depth (m)	1.200
CV	0.750	Include Intermediate Ground	✓
Time of Entry (mins)	5.00	Enforce best practice design rules	✓

Circular Default Sewer Type Link Type

Shape	Circular	Auto Increment (mm)	75
Barrels	1	Follow Ground	x

Available Diameters (mm)

100	150

Nodes

	Name	Area (ha)	T of E (mins)	Cover Level (m)	Node Type	Manhole Type	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
✓	1	0.019	5.00	67.700	Manhole	Adoptable	1200	980003.964	19133.672	0.825
✓	2	0.000		67.700	Manhole	Adoptable	1200	980003.964	19148.249	0.925
✓	19	0.019	5.00	67.700	Manhole	Adoptable	1200	979973.587	19133.563	1.020
✓	3	0.000		67.700	Manhole	Adoptable	1200	979973.587	19148.249	1.120
✓	4	0.063	5.00	67.600	Manhole	Adoptable	1200	979973.587	19158.796	1.080
✓	5	0.000		67.520	Manhole	Adoptable	1200	980003.217	19158.796	1.130
✓	18	0.021	5.00	67.400	Manhole	Adoptable	1200	980010.835	19168.456	0.930
✓	6	0.000		67.400	Manhole	Adoptable	1200	980010.829	19158.796	1.050
✓	7	0.052	5.00	67.440	Manhole	Adoptable	1200	980010.835	19141.146	1.200
✓	8	0.015	5.00	67.450	Manhole	Adoptable	1200	980010.835	19086.628	1.480
✓	15	0.006	5.00	67.425	Manhole	Adoptable	1200	979968.339	19168.456	1.035
✓	16	0.045	5.00	67.445	Manhole	Adoptable	1200	979968.339	19146.635	1.235
✓	17	0.015	5.00	67.600	Manhole	Adoptable	1200	979968.339	19086.628	1.690
✓	9	0.000		67.600	Manhole	Adoptable	1200	979982.288	19086.628	1.770
✓	20	0.025	5.00	67.550	Manhole	Adoptable	1200	980003.964	19131.002	1.080
✓	21	0.025	5.00	67.550	Manhole	Adoptable	1200	980003.964	19089.608	1.430
✓	24	0.025	5.00	67.550	Manhole	Adoptable	1200	979973.587	19128.799	1.350
✓	22	0.025	5.00	67.550	Manhole	Adoptable	1200	979973.587	19089.608	1.680
✓	23	0.000		67.600	Manhole	Adoptable	1200	979973.587	19084.106	1.850
✓	10	0.007	5.00	67.500	Manhole	Adoptable	1200	979982.288	19081.202	1.800
✓	11	0.000		67.500	Manhole	Adoptable	1200	979986.108	19081.202	1.880
✓	12	0.000		67.500	Manhole	Adoptable	1200	980005.321	19081.202	1.970
✓	13	0.000		67.450	Manhole	Adoptable	1200	980012.244	19077.664	1.950
✓	14	0.000		67.810	Manhole	Adoptable	1200	980010.716	19057.846	2.400

Links

	Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
?	1.000	1	2	14.577	0.600	66.875	66.775	0.100	145.8	225	5.22	50.0
?	1.001	2	3	30.377	0.600	66.775	66.580	0.195	155.8	225	5.71	49.9
?	4.000	19	3	14.686	0.600	66.680	66.580	0.100	146.9	225	5.23	50.0
?	1.002	3	4	10.547	0.600	66.580	66.520	0.060	175.8	225	5.89	49.3
?	1.003	4	5	29.630	0.600	66.520	66.390	0.130	227.9	225	6.46	47.5
?	1.004	5	6	7.612	0.600	66.390	66.350	0.040	190.3	225	6.60	47.1
?	3.000	18	6	9.660	0.600	66.470	66.350	0.120	80.5	225	5.11	50.0
?	1.005	6	7	17.650	0.600	66.350	66.240	0.110	160.5	225	6.88	46.3
?	1.006	7	8	54.518	0.600	66.240	65.970	0.270	201.9	225	7.87	43.7
✓	1.007	8	9	28.547	0.600	65.970	65.830	0.140	203.9	225	8.40	42.5
?	2.000	15	16	21.821	0.600	66.390	66.325	0.065	335.7	225	5.51	50.0
?	2.001	16	17	60.007	0.600	66.210	65.910	0.300	200.0	225	6.60	47.1
✓	2.002	17	9	13.949	0.600	65.910	65.830	0.080	174.4	225	6.84	46.4
✓	1.008	9	10	5.426	0.600	65.830	65.700	0.130	41.7	225	8.44	42.4
?	5.000	20	21	41.394	0.600	66.470	66.120	0.350	118.3	150	5.75	49.7
✓	5.001	21	22	30.377	0.600	66.120	65.870	0.250	121.5	150	6.30	48.0
✓	6.000	24	22	39.191	0.600	66.200	65.870	0.330	118.8	150	5.71	49.9
✓	5.002	22	23	5.502	0.600	65.870	65.750	0.120	45.9	150	6.37	47.8
✓	5.003	23	10	9.173	0.600	65.750	65.700	0.050	183.5	225	6.52	47.3
✓	1.009	10	11	3.820	0.600	65.700	65.620	0.080	47.8	225	8.47	42.3
✓	1.010	11	12	19.213	0.600	65.620	65.530	0.090	213.5	300	8.77	41.6
✓	1.011	12	13	7.775	0.600	65.530	65.500	0.030	259.2	300	8.91	41.4
✓	1.012	13	14	19.877	0.600	65.500	65.410	0.090	220.9	300	9.22	40.7

	Name	US Node	DS Node	Vel (m/s)	Cap (l/s)	Flow (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)	Pro Depth (mm)	Pro Velocity (m/s)
?	1.000	1	2	1.081	43.0	2.6	0.600	0.700	0.019	0.0	37	0.599
?	1.001	2	3	1.045	41.5	2.6	0.700	0.895	0.019	0.0	37	0.579
?	4.000	19	3	1.076	42.8	2.6	0.795	0.895	0.019	0.0	37	0.597
?	1.002	3	4	0.983	39.1	5.1	0.895	0.855	0.038	0.0	55	0.684
?	1.003	4	5	0.862	34.3	13.0	0.855	0.905	0.101	0.0	96	0.805
?	1.004	5	6	0.944	37.5	12.9	0.905	0.825	0.101	0.0	91	0.859
?	3.000	18	6	1.458	58.0	2.8	0.705	0.825	0.021	0.0	34	0.763
?	1.005	6	7	1.029	40.9	15.3	0.825	0.975	0.122	0.0	95	0.957
?	1.006	7	8	0.916	36.4	20.6	0.975	1.255	0.174	0.0	121	0.943
✓	1.007	8	9	0.912	36.2	21.8	1.255	1.545	0.189	0.0	126	0.953
?	2.000	15	16	0.708	28.1	0.8	0.810	0.895	0.006	0.0	26	0.310
?	2.001	16	17	0.921	36.6	6.5	1.010	1.465	0.051	0.0	64	0.696
✓	2.002	17	9	0.987	39.2	8.3	1.465	1.545	0.066	0.0	70	0.785
✓	1.008	9	10	2.030	80.7	29.3	1.545	1.575	0.255	0.0	94	1.873
?	5.000	20	21	0.923	16.3	3.4	0.930	1.280	0.025	0.0	46	0.727
✓	5.001	21	22	0.910	16.1	6.5	1.280	1.530	0.050	0.0	67	0.863
✓	6.000	24	22	0.921	16.3	3.4	1.200	1.530	0.025	0.0	47	0.730
✓	5.002	22	23	1.490	26.3	12.9	1.530	1.700	0.100	0.0	74	1.482
✓	5.003	23	10	0.962	38.2	12.8	1.625	1.575	0.100	0.0	89	0.866
✓	1.009	10	11	1.897	75.4	41.5	1.575	1.655	0.362	0.0	119	1.941
✓	1.010	11	12	1.072	75.8	40.9	1.580	1.670	0.362	0.0	157	1.091
✓	1.011	12	13	0.972	68.7	40.6	1.670	1.650	0.362	0.0	166	1.011
✓	1.012	13	14	1.054	74.5	39.9	1.650	2.100	0.362	0.0	156	1.071

Pipeline Schedule

Link	Length (m)	Slope (1:X)	Dia (mm)	Link Type	US CL (m)	US IL (m)	US Depth (m)	DS CL (m)	DS IL (m)	DS Depth (m)
1.000	14.577	145.8	225	Circular_Default Sewer Type	67.700	66.875	0.600	67.700	66.775	0.700
1.001	30.377	155.8	225	Circular_Default Sewer Type	67.700	66.775	0.700	67.700	66.580	0.895
4.000	14.686	146.9	225	Circular_Default Sewer Type	67.700	66.680	0.795	67.700	66.580	0.895
1.002	10.547	175.8	225	Circular_Default Sewer Type	67.700	66.580	0.895	67.600	66.520	0.855
1.003	29.630	227.9	225	Circular_Default Sewer Type	67.600	66.520	0.855	67.520	66.390	0.905
1.004	7.612	190.3	225	Circular_Default Sewer Type	67.520	66.390	0.905	67.400	66.350	0.825
3.000	9.660	80.5	225	Circular_Default Sewer Type	67.400	66.470	0.705	67.400	66.350	0.825
1.005	17.650	160.5	225	Circular_Default Sewer Type	67.400	66.350	0.825	67.440	66.240	0.975
1.006	54.518	201.9	225	Circular_Default Sewer Type	67.440	66.240	0.975	67.450	65.970	1.255
1.007	28.547	203.9	225	Circular_Default Sewer Type	67.450	65.970	1.255	67.600	65.830	1.545
2.000	21.821	335.7	225	Circular_Default Sewer Type	67.425	66.390	0.810	67.445	66.325	0.895
2.001	60.007	200.0	225	Circular_Default Sewer Type	67.445	66.210	1.010	67.600	65.910	1.465
2.002	13.949	174.4	225	Circular_Default Sewer Type	67.600	65.910	1.465	67.600	65.830	1.545
1.008	5.426	41.7	225	Circular_Default Sewer Type	67.600	65.830	1.545	67.500	65.700	1.575
5.000	41.394	118.3	150	Circular_Default Sewer Type	67.550	66.470	0.930	67.550	66.120	1.280
5.001	30.377	121.5	150	Circular_Default Sewer Type	67.550	66.120	1.280	67.550	65.870	1.530
6.000	39.191	118.8	150	Circular_Default Sewer Type	67.550	66.200	1.200	67.550	65.870	1.530
5.002	5.502	45.9	150	Circular_Default Sewer Type	67.550	65.870	1.530	67.600	65.750	1.700
5.003	9.173	183.5	225	Circular_Default Sewer Type	67.600	65.750	1.625	67.500	65.700	1.575
1.009	3.820	47.8	225	Circular_Default Sewer Type	67.500	65.700	1.575	67.500	65.620	1.655
1.010	19.213	213.5	300	Circular_Default Sewer Type	67.500	65.620	1.580	67.500	65.530	1.670
1.011	7.775	259.2	300	Circular_Default Sewer Type	67.500	65.530	1.670	67.450	65.500	1.650
1.012	19.877	220.9	300	Circular_Default Sewer Type	67.450	65.500	1.650	67.810	65.410	2.100

Link	US Node	Dia (mm)	Node Type	MH Type	DS Node	Dia (mm)	Node Type	MH Type
1.000	1	1200	Manhole	Adoptable	2	1200	Manhole	Adoptable
1.001	2	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
4.000	19	1200	Manhole	Adoptable	3	1200	Manhole	Adoptable
1.002	3	1200	Manhole	Adoptable	4	1200	Manhole	Adoptable
1.003	4	1200	Manhole	Adoptable	5	1200	Manhole	Adoptable
1.004	5	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
3.000	18	1200	Manhole	Adoptable	6	1200	Manhole	Adoptable
1.005	6	1200	Manhole	Adoptable	7	1200	Manhole	Adoptable
1.006	7	1200	Manhole	Adoptable	8	1200	Manhole	Adoptable
1.007	8	1200	Manhole	Adoptable	9	1200	Manhole	Adoptable
2.000	15	1200	Manhole	Adoptable	16	1200	Manhole	Adoptable
2.001	16	1200	Manhole	Adoptable	17	1200	Manhole	Adoptable
2.002	17	1200	Manhole	Adoptable	9	1200	Manhole	Adoptable
1.008	9	1200	Manhole	Adoptable	10	1200	Manhole	Adoptable
5.000	20	1200	Manhole	Adoptable	21	1200	Manhole	Adoptable
5.001	21	1200	Manhole	Adoptable	22	1200	Manhole	Adoptable
6.000	24	1200	Manhole	Adoptable	22	1200	Manhole	Adoptable
5.002	22	1200	Manhole	Adoptable	23	1200	Manhole	Adoptable
5.003	23	1200	Manhole	Adoptable	10	1200	Manhole	Adoptable
1.009	10	1200	Manhole	Adoptable	11	1200	Manhole	Adoptable
1.010	11	1200	Manhole	Adoptable	12	1200	Manhole	Adoptable
1.011	12	1200	Manhole	Adoptable	13	1200	Manhole	Adoptable
1.012	13	1200	Manhole	Adoptable	14	1200	Manhole	Adoptable

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Node Type	Connections	Link	IL (m)	Dia (mm)
1	67.700	0.825	1200	Manhole	0	1.000	66.875	225
2	67.700	0.925	1200	Manhole	1	1.000	66.775	225
					0	1.001	66.775	225
19	67.700	1.020	1200	Manhole	0	4.000	66.680	225
3	67.700	1.120	1200	Manhole	1	4.000	66.580	225
					2	1.001	66.580	225
					0	1.002	66.580	225
4	67.600	1.080	1200	Manhole	1	1.002	66.520	225
					0	1.003	66.520	225
5	67.520	1.130	1200	Manhole	1	1.003	66.390	225
					0	1.004	66.390	225
18	67.400	0.930	1200	Manhole	0	3.000	66.470	225
6	67.400	1.050	1200	Manhole	1	3.000	66.350	225
					2	1.004	66.350	225
					0	1.005	66.350	225
7	67.440	1.200	1200	Manhole	1	1.005	66.240	225
					0	1.006	66.240	225
8	67.450	1.480	1200	Manhole	1	1.006	65.970	225
					0	1.007	65.970	225
15	67.425	1.035	1200	Manhole	0	2.000	66.390	225
16	67.445	1.235	1200	Manhole	1	2.000	66.325	225
					0	2.001	66.210	225
17	67.600	1.690	1200	Manhole	1	2.001	65.910	225
					0	2.002	65.910	225

Manhole Schedule

Node	CL (m)	Depth (m)	Dia (mm)	Node Type	Connections	Link	IL (m)	Dia (mm)
9	67.600	1.770	1200	Manhole	1	2.002	65.830	225
					2	1.007	65.830	225
					0	1.008	65.830	225
20	67.550	1.080	1200	Manhole	0	5.000	66.470	150
21	67.550	1.430	1200	Manhole	1	5.000	66.120	150
					0	5.001	66.120	150
24	67.550	1.350	1200	Manhole	0	6.000	66.200	150
22	67.550	1.680	1200	Manhole	1	6.000	65.870	150
					2	5.001	65.870	150
					0	5.002	65.870	150
23	67.600	1.850	1200	Manhole	1	5.002	65.750	150
					0	5.003	65.750	225
10	67.500	1.800	1200	Manhole	1	5.003	65.700	225
					2	1.008	65.700	225
					0	1.009	65.700	225
11	67.500	1.880	1200	Manhole	1	1.009	65.620	225
					0	1.010	65.620	300
12	67.500	1.970	1200	Manhole	1	1.010	65.530	300
					0	1.011	65.530	300
13	67.450	1.950	1200	Manhole	1	1.011	65.500	300
					0	1.012	65.500	300
14	67.810	2.400	1200	Manhole	1	1.012	65.410	300

Simulation Settings

Rainfall Methodology	FSR	Analysis Speed	Normal
FSR Region	Scotland and Ireland	Skip Steady State	✓
M5-60 (mm)	17.600	Drain Down Time (mins)	240
Ratio-R	0.270	Additional Storage (m^3/ha)	20.0
Summer CV	1.000	Check Discharge Rate(s)	✓
Winter CV	1.000	1 year (l/s)	1.1

Simulation Settings

30 year (l/s)	2.7	Check Discharge Volume	✓
100 year (l/s)	3.3	100 year 360 minute (m^3)	

Storm Durations

15	30	60	120	180	240	360	480	600	720	960	1440

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
1	20	0	0
30	20	0	0
100	20	0	0

Pre-development Discharge Rate

Site Makeup	Greenfield	Growth Factor 30 year	1.95
Greenfield Method	IH124	Growth Factor 100 year	2.48
Positively Drained Area (ha)		Betterment (%)	0
SAAR (mm)		QBar	
Soil Index	1	Q 1 year (l/s)	
SPR	0.10	Q 30 year (l/s)	
Region	1	Q 100 year (l/s)	
Growth Factor 1 year	0.85		

Pre-development Discharge Volume

Site Makeup	Greenfield	Return Period (years)	100
Greenfield Method	FSR/FEH	Climate Change (%)	0
Positively Drained Area (ha)		Storm Duration (mins)	360
Soil Index	1	Betterment (%)	0
SPR	0.10	PR	
CWI		Runoff Volume (m^3)	

Node 12 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	65.530	Product Number	CTL-SHE-0065-1800-0900-1800
Design Depth (m)	0.900	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	1.8	Min Node Diameter (mm)	1200

Node 12 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	65.530
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	112.0	0.0	0.762	112.0	0.0	0.763	0.0	0.0

Node 8 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	65.970
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	144.5	0.0	0.300	144.5	0.0	0.301	0.0	0.0

Node 17 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	65.910
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	131.9	0.0	0.300	131.9	0.0	0.301	0.0	0.0

Node 11 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	65.620
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	33.3	0.0	0.300	33.3	0.0	0.301	0.0	0.0

Node 5 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	66.390
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	212.0	0.0	0.300	212.0	0.0	0.301	0.0	0.0

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
1 year +20% CC 15 minute summer	112.704	31.891	1 year +20% CC 960 minute winter	6.675	2.653
1 year +20% CC 15 minute winter	79.091	31.891	1 year +20% CC 1440 minute summer	7.654	2.051
1 year +20% CC 30 minute summer	77.681	21.981	1 year +20% CC 1440 minute winter	5.144	2.051
1 year +20% CC 30 minute winter	54.513	21.981	30 year +20% CC 15 minute summer	250.602	70.912
1 year +20% CC 60 minute summer	55.559	14.683	30 year +20% CC 15 minute winter	175.861	70.912
1 year +20% CC 60 minute winter	36.912	14.683	30 year +20% CC 30 minute summer	172.381	48.778
1 year +20% CC 120 minute summer	36.504	9.647	30 year +20% CC 30 minute winter	120.969	48.778
1 year +20% CC 120 minute winter	24.252	9.647	30 year +20% CC 60 minute summer	120.498	31.844
1 year +20% CC 180 minute summer	29.214	7.518	30 year +20% CC 60 minute winter	80.056	31.844
1 year +20% CC 180 minute winter	18.990	7.518	30 year +20% CC 120 minute summer	76.886	20.319
1 year +20% CC 240 minute summer	23.818	6.294	30 year +20% CC 120 minute winter	51.081	20.319
1 year +20% CC 240 minute winter	15.824	6.294	30 year +20% CC 180 minute summer	60.297	15.516
1 year +20% CC 360 minute summer	18.990	4.887	30 year +20% CC 180 minute winter	39.195	15.516
1 year +20% CC 360 minute winter	12.344	4.887	30 year +20% CC 240 minute summer	48.395	12.789
1 year +20% CC 480 minute summer	15.445	4.082	30 year +20% CC 240 minute winter	32.152	12.789
1 year +20% CC 480 minute winter	10.261	4.082	30 year +20% CC 360 minute summer	37.772	9.720
1 year +20% CC 600 minute summer	13.066	3.574	30 year +20% CC 360 minute winter	24.553	9.720
1 year +20% CC 600 minute winter	8.928	3.574	30 year +20% CC 480 minute summer	30.241	7.992
1 year +20% CC 720 minute summer	11.879	3.184	30 year +20% CC 480 minute winter	20.092	7.992
1 year +20% CC 720 minute winter	7.984	3.184	30 year +20% CC 600 minute summer	25.091	6.863
1 year +20% CC 960 minute summer	10.077	2.653	30 year +20% CC 600 minute winter	17.144	6.863

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year +20% CC 720 minute summer	22.606	6.059	100 year +20% CC 180 minute winter	50.047	19.813
30 year +20% CC 720 minute winter	15.193	6.059	100 year +20% CC 240 minute summer	61.493	16.251
30 year +20% CC 960 minute summer	18.897	4.976	100 year +20% CC 240 minute winter	40.855	16.251
30 year +20% CC 960 minute winter	12.518	4.976	100 year +20% CC 360 minute summer	47.649	12.262
30 year +20% CC 1440 minute summer	14.064	3.769	100 year +20% CC 360 minute winter	30.973	12.262
30 year +20% CC 1440 minute winter	9.452	3.769	100 year +20% CC 480 minute summer	37.945	10.028
100 year +20% CC 15 minute summer	325.470	92.097	100 year +20% CC 480 minute winter	25.210	10.028
100 year +20% CC 15 minute winter	228.400	92.097	100 year +20% CC 600 minute summer	31.350	8.575
100 year +20% CC 30 minute summer	225.078	63.689	100 year +20% CC 600 minute winter	21.420	8.575
100 year +20% CC 30 minute winter	157.949	63.689	100 year +20% CC 720 minute summer	28.148	7.544
100 year +20% CC 60 minute summer	156.285	41.301	100 year +20% CC 720 minute winter	18.917	7.544
100 year +20% CC 60 minute winter	103.832	41.301	100 year +20% CC 960 minute summer	23.400	6.162
100 year +20% CC 120 minute summer	98.810	26.113	100 year +20% CC 960 minute winter	15.501	6.162
100 year +20% CC 120 minute winter	65.647	26.113	100 year +20% CC 1440 minute summer	17.282	4.632
100 year +20% CC 180 minute summer	76.993	19.813	100 year +20% CC 1440 minute winter	11.615	4.632

Results for 1 year +20% CC Critical Storm Duration. Lowest mass balance: 99.21%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m^3)	Flood (m^3)	Status
15 minute summer	1	10	66.919	0.044	3.5	0.0704	0.0000	OK
15 minute summer	2	11	66.818	0.043	3.4	0.0489	0.0000	OK
15 minute summer	19	11	66.766	0.086	4.0	0.1288	0.0000	OK
15 minute summer	3	11	66.772	0.192	9.6	0.2168	0.0000	OK
15 minute summer	4	11	66.770	0.250	23.3	0.5747	0.0000	SURCHARGED
180 minute summer	5	112	66.442	0.052	7.6	11.0212	0.0000	OK
15 minute summer	18	10	66.510	0.040	3.9	0.0636	0.0000	OK
120 minute summer	6	72	66.402	0.052	4.9	0.0587	0.0000	OK
15 minute summer	7	10	66.353	0.113	13.3	0.2255	0.0000	OK
180 minute summer	8	112	66.039	0.069	9.1	10.0353	0.0000	OK
15 minute summer	15	11	66.421	0.031	1.1	0.0387	0.0000	OK
15 minute summer	16	10	66.302	0.092	9.3	0.1712	0.0000	OK
960 minute summer	17	765	66.005	0.095	2.4	12.7057	0.0000	OK
960 minute summer	9	735	66.005	0.175	6.3	0.1981	0.0000	OK
15 minute summer	20	11	66.523	0.053	4.6	0.0852	0.0000	OK
15 minute summer	21	11	66.199	0.079	9.1	0.1174	0.0000	OK
15 minute summer	24	10	66.254	0.054	4.6	0.0804	0.0000	OK
960 minute summer	22	720	66.005	0.135	2.8	0.1934	0.0000	OK
960 minute summer	23	735	66.005	0.255	2.8	0.2887	0.0000	SURCHARGED
1440 minute summer	10	1050	66.005	0.305	7.4	0.3693	0.0000	SURCHARGED
960 minute summer	11	720	66.005	0.385	14.2	10.4417	0.0000	SURCHARGED
960 minute summer	12	735	66.005	0.475	7.3	53.6906	0.0000	SURCHARGED
120 minute summer	13	110	65.533	0.033	1.8	0.0369	0.0000	OK
120 minute summer	14	110	65.441	0.031	1.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m^3)	Discharge Vol (m^3)
15 minute summer	1	1.000	2	3.4	0.649	0.080	0.0777	
15 minute summer	2	1.001	3	3.4	0.323	0.082	0.6283	
15 minute summer	19	4.000	3	6.5	0.478	0.151	0.3664	
15 minute summer	3	1.002	4	14.2	0.477	0.363	0.3998	
15 minute summer	4	1.003	5	26.3	1.560	0.768	0.5969	
180 minute summer	5	1.004	6	3.9	0.579	0.105	0.0521	
15 minute summer	18	3.000	6	3.9	0.735	0.067	0.0508	
120 minute summer	6	1.005	7	4.8	0.586	0.118	0.1718	
15 minute summer	7	1.006	8	13.6	1.375	0.373	0.5911	
180 minute summer	8	1.007	9	7.0	0.767	0.193	0.2623	
15 minute summer	15	2.000	16	1.1	0.368	0.038	0.0630	
15 minute summer	16	2.001	17	9.4	1.255	0.256	0.4995	
960 minute summer	17	2.002	9	1.8	0.403	0.046	0.3425	
960 minute summer	9	1.008	10	12.2	0.932	0.151	0.1979	
15 minute summer	20	5.000	21	4.5	0.604	0.274	0.3120	
15 minute summer	21	5.001	22	8.9	0.779	0.553	0.3468	
15 minute summer	24	6.000	22	4.5	0.506	0.275	0.3729	
960 minute summer	22	5.002	23	2.8	0.801	0.108	0.0944	
960 minute summer	23	5.003	10	4.5	0.478	0.119	0.3648	
1440 minute summer	10	1.009	11	15.5	0.763	0.206	0.1519	
960 minute summer	11	1.010	12	7.3	0.479	0.096	1.3530	
960 minute summer	12	Hydro-Brake®	13	1.8				
120 minute summer	13	1.012	14	1.8	0.454	0.024	0.0790	32.3

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.21%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	10	66.942	0.067	7.8	0.1060	0.0000	OK
15 minute summer	2	11	66.948	0.173	9.1	0.1953	0.0000	OK
15 minute summer	19	11	66.946	0.266	8.1	0.3997	0.0000	SURCHARGED
15 minute summer	3	11	66.941	0.361	19.2	0.4081	0.0000	SURCHARGED
15 minute summer	4	11	66.927	0.407	39.6	0.9349	0.0000	SURCHARGED
120 minute summer	5	74	66.481	0.091	20.6	19.4474	0.0000	OK
15 minute summer	18	10	66.531	0.061	8.6	0.0971	0.0000	OK
1440 minute summer	6	1080	66.442	0.092	4.5	0.1042	0.0000	OK
1440 minute summer	7	1080	66.442	0.202	6.5	0.4038	0.0000	OK
1440 minute summer	8	1110	66.441	0.471	7.1	44.0510	0.0000	SURCHARGED
1440 minute summer	15	1110	66.441	0.051	0.2	0.0641	0.0000	OK
1440 minute summer	16	1080	66.442	0.232	2.0	0.4306	0.0000	SURCHARGED
1440 minute summer	17	1110	66.442	0.532	6.2	40.3320	0.0000	SURCHARGED
1440 minute summer	9	1080	66.442	0.612	6.1	0.6917	0.0000	SURCHARGED
15 minute summer	20	12	66.581	0.111	10.2	0.1762	0.0000	OK
15 minute summer	21	12	66.512	0.392	20.2	0.5808	0.0000	SURCHARGED
1440 minute summer	24	1080	66.442	0.242	1.0	0.3636	0.0000	SURCHARGED
1440 minute summer	22	1140	66.442	0.572	4.0	0.8168	0.0000	SURCHARGED
1440 minute summer	23	1140	66.442	0.692	4.9	0.7821	0.0000	SURCHARGED
1440 minute summer	10	1110	66.442	0.742	10.5	0.8972	0.0000	SURCHARGED
1440 minute summer	11	1080	66.442	0.822	8.7	10.9360	0.0000	SURCHARGED
1440 minute summer	12	1080	66.442	0.912	7.5	86.4312	0.0000	SURCHARGED
1440 minute summer	13	1080	65.533	0.033	1.8	0.0370	0.0000	OK
1440 minute summer	14	1080	65.441	0.031	1.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	2	7.8	0.770	0.182	0.3084	
15 minute summer	2	1.001	3	11.9	0.371	0.286	1.1007	
15 minute summer	19	4.000	3	7.6	0.536	0.177	0.5841	
15 minute summer	3	1.002	4	23.3	0.641	0.597	0.4195	
15 minute summer	4	1.003	5	42.8	1.602	1.248	0.6880	
120 minute summer	5	1.004	6	10.9	0.737	0.291	0.1135	
15 minute summer	18	3.000	6	8.5	0.933	0.147	0.0884	
1440 minute summer	6	1.005	7	4.5	0.572	0.110	0.4668	
1440 minute summer	7	1.006	8	6.5	0.677	0.178	2.1094	
1440 minute summer	8	1.007	9	6.1	0.689	0.169	1.1353	
1440 minute summer	15	2.000	16	0.2	0.224	0.007	0.3000	
1440 minute summer	16	2.001	17	2.0	0.464	0.055	2.3865	
1440 minute summer	17	2.002	9	-3.6	0.388	-0.091	0.5548	
1440 minute summer	9	1.008	10	8.5	0.822	0.105	0.2158	
15 minute summer	20	5.000	21	10.0	0.693	0.614	0.6523	
15 minute summer	21	5.001	22	16.0	0.909	0.995	0.5348	
1440 minute summer	24	6.000	22	1.0	0.324	0.061	0.6900	
1440 minute summer	22	5.002	23	4.9	0.733	0.185	0.0969	
1440 minute summer	23	5.003	10	4.8	0.446	0.126	0.3648	
1440 minute summer	10	1.009	11	8.7	0.715	0.115	0.1519	
1440 minute summer	11	1.010	12	7.5	0.484	0.099	1.3530	
1440 minute summer	12	Hydro-Brake®	13	1.8				
1440 minute summer	13	1.012	14	1.8	0.455	0.024	0.0792	145.6

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.21%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	1	11	67.077	0.202	10.1	0.3215	0.0000	OK
15 minute summer	2	11	67.089	0.314	11.8	0.3547	0.0000	SURCHARGED
15 minute summer	19	11	67.063	0.383	10.1	0.5760	0.0000	SURCHARGED
15 minute summer	3	11	67.060	0.480	22.9	0.5431	0.0000	SURCHARGED
15 minute summer	4	11	67.037	0.517	48.9	1.1877	0.0000	SURCHARGED
1440 minute winter	5	1200	66.706	0.316	6.2	64.0634	0.0000	SURCHARGED
1440 minute winter	18	1200	66.706	0.236	0.7	0.3736	0.0000	SURCHARGED
1440 minute winter	6	1200	66.706	0.356	3.9	0.4026	0.0000	SURCHARGED
1440 minute winter	7	1200	66.706	0.466	5.6	0.9305	0.0000	SURCHARGED
1440 minute winter	8	1200	66.705	0.735	6.1	44.4033	0.0000	SURCHARGED
1440 minute winter	15	1200	66.705	0.315	0.9	0.3927	0.0000	SURCHARGED
1440 minute winter	16	1200	66.705	0.495	2.2	0.9208	0.0000	SURCHARGED
1440 minute winter	17	1200	66.705	0.795	4.2	40.6760	0.0000	SURCHARGED
1440 minute winter	9	1200	66.705	0.875	8.9	0.9899	0.0000	SURCHARGED
15 minute summer	20	12	66.954	0.484	13.3	0.7712	0.0000	SURCHARGED
15 minute summer	21	12	66.823	0.703	24.2	1.0404	0.0000	SURCHARGED
1440 minute winter	24	1200	66.705	0.505	0.8	0.7583	0.0000	SURCHARGED
1440 minute winter	22	1200	66.705	0.835	3.2	1.1928	0.0000	SURCHARGED
1440 minute winter	23	1200	66.705	0.955	4.9	1.0804	0.0000	SURCHARGED
1440 minute winter	10	1200	66.704	1.004	5.2	1.2141	0.0000	SURCHARGED
1440 minute winter	11	1200	66.705	1.085	12.4	11.2341	0.0000	SURCHARGED
1440 minute winter	12	1200	66.705	1.175	7.9	86.7291	0.0000	SURCHARGED
1440 minute winter	13	1200	65.535	0.035	2.0	0.0391	0.0000	OK
1440 minute winter	14	1200	65.443	0.033	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	1	1.000	2	10.6	0.803	0.247	0.5638	
15 minute summer	2	1.001	3	16.0	0.482	0.385	1.2081	
15 minute summer	19	4.000	3	9.5	0.581	0.223	0.5841	
15 minute summer	3	1.002	4	27.6	0.695	0.708	0.4195	
15 minute summer	4	1.003	5	51.2	1.834	1.494	0.7620	
1440 minute winter	5	1.004	6	-3.7	0.543	-0.098	0.3027	
1440 minute winter	18	3.000	6	0.7	0.246	0.012	0.3842	
1440 minute winter	6	1.005	7	3.9	0.553	0.095	0.7020	
1440 minute winter	7	1.006	8	5.6	0.629	0.153	2.1682	
1440 minute winter	8	1.007	9	4.6	0.661	0.127	1.1353	
1440 minute winter	15	2.000	16	-0.7	0.224	-0.026	0.8678	
1440 minute winter	16	2.001	17	1.7	0.410	0.046	2.3865	
1440 minute winter	17	2.002	9	-2.5	0.366	-0.062	0.5548	
1440 minute winter	9	1.008	10	4.7	0.833	0.059	0.2158	
15 minute summer	20	5.000	21	11.5	0.735	0.706	0.7287	
15 minute summer	21	5.001	22	19.1	1.083	1.185	0.5348	
1440 minute winter	24	6.000	22	0.8	0.293	0.049	0.6900	
1440 minute winter	22	5.002	23	4.9	0.697	0.184	0.0969	
1440 minute winter	23	5.003	10	3.0	0.415	0.079	0.3648	
1440 minute winter	10	1.009	11	12.4	0.742	0.165	0.1519	
1440 minute winter	11	1.010	12	7.9	0.484	0.104	1.3530	
1440 minute winter	12	Hydro-Brake®	13	2.0				
1440 minute winter	13	1.012	14	2.0	0.470	0.027	0.0860	159.5

Appendix 2

Site Rainfall Intensity Figures for Sliding Durations for
Various Return Periods for the site location
(Source: Met Eireann August 2022)

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 309770, Northing: 229990,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.4,	3.6,	4.3,	5.3,	6.0,	6.6,	8.4,	10.6,	12.1,	14.2,	16.2,	17.7,	20.1,	21.9,	23.5,	N/A ,
10 mins	3.4,	5.0,	6.0,	7.4,	8.4,	9.1,	11.7,	14.8,	16.9,	19.8,	22.5,	24.6,	28.0,	30.6,	32.8,	N/A ,
15 mins	4.0,	5.9,	7.0,	8.7,	9.8,	10.8,	13.8,	17.4,	19.8,	23.3,	26.5,	29.0,	32.9,	36.0,	38.6,	N/A ,
30 mins	5.3,	7.7,	9.1,	11.2,	12.6,	13.7,	17.5,	21.9,	24.9,	29.1,	32.9,	35.9,	40.5,	44.2,	47.2,	N/A ,
1 hours	6.9,	10.1,	11.8,	14.4,	16.2,	17.6,	22.2,	27.6,	31.1,	36.2,	40.8,	44.4,	49.9,	54.3,	57.9,	N/A ,
2 hours	9.2,	13.1,	15.3,	18.5,	20.7,	22.5,	28.2,	34.7,	39.0,	45.1,	50.6,	54.9,	61.5,	66.7,	70.9,	N/A ,
3 hours	10.8,	15.3,	17.8,	21.5,	24.0,	25.9,	32.4,	39.7,	44.5,	51.3,	57.4,	62.2,	69.5,	75.2,	79.9,	N/A ,
4 hours	12.1,	17.1,	19.8,	23.9,	26.6,	28.7,	35.7,	43.6,	48.9,	56.2,	62.8,	67.9,	75.8,	81.9,	86.9,	N/A ,
6 hours	14.3,	20.0,	23.1,	27.7,	30.8,	33.2,	41.0,	49.9,	55.7,	64.0,	71.2,	76.9,	85.6,	92.3,	97.9,	N/A ,
9 hours	16.8,	23.4,	26.9,	32.1,	35.6,	38.3,	47.1,	57.1,	63.6,	72.7,	80.8,	87.1,	96.7,	104.1,	110.3,	N/A ,
12 hours	18.9,	26.1,	29.9,	35.6,	39.5,	42.4,	52.0,	62.8,	69.8,	79.7,	88.4,	95.1,	105.4,	113.4,	120.0,	N/A ,
18 hours	22.2,	30.5,	34.8,	41.3,	45.6,	49.0,	59.8,	71.8,	79.7,	90.6,	100.3,	107.7,	119.1,	127.9,	135.1,	N/A ,
24 hours	24.9,	34.0,	38.8,	45.9,	50.6,	54.2,	66.0,	79.0,	87.5,	99.3,	109.7,	117.7,	129.9,	139.3,	147.0,	173.9,
2 days	31.2,	41.5,	46.9,	54.7,	59.8,	63.8,	76.4,	90.3,	99.2,	111.4,	122.2,	130.3,	142.8,	152.3,	160.1,	186.8,
3 days	36.2,	47.5,	53.3,	61.8,	67.3,	71.5,	84.9,	99.5,	108.8,	121.5,	132.6,	141.1,	153.8,	163.5,	171.5,	198.6,
4 days	40.6,	52.8,	59.0,	67.9,	73.8,	78.2,	92.3,	107.5,	117.1,	130.4,	141.8,	150.5,	163.5,	173.5,	181.6,	209.2,
6 days	48.3,	61.9,	68.7,	78.6,	85.0,	89.8,	105.0,	121.3,	131.6,	145.7,	157.7,	166.8,	180.5,	190.9,	199.3,	227.9,
8 days	55.1,	69.9,	77.3,	87.9,	94.8,	99.9,	116.1,	133.4,	144.2,	158.9,	171.5,	181.0,	195.3,	206.0,	214.7,	244.2,
10 days	61.3,	77.2,	85.1,	96.4,	103.6,	109.1,	126.2,	144.2,	155.6,	170.9,	184.0,	193.8,	208.5,	219.6,	228.6,	258.9,
12 days	67.1,	84.0,	92.4,	104.2,	111.8,	117.6,	135.4,	154.2,	166.0,	181.9,	195.4,	205.6,	220.8,	232.2,	241.4,	272.5,
16 days	77.9,	96.5,	105.7,	118.6,	126.9,	133.1,	152.3,	172.5,	185.0,	201.9,	216.2,	227.0,	242.9,	254.9,	264.6,	297.0,
20 days	87.9,	108.1,	117.9,	131.8,	140.6,	147.2,	167.7,	189.0,	202.3,	220.0,	235.1,	246.3,	263.0,	275.4,	285.5,	319.2,
25 days	99.6,	121.5,	132.1,	147.0,	156.5,	163.6,	185.4,	208.0,	222.1,	240.8,	256.6,	268.4,	285.8,	298.9,	309.4,	344.4,

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

Appendix 3

Technical Details for Proposed Stormtech Underground Attenuation Chambers

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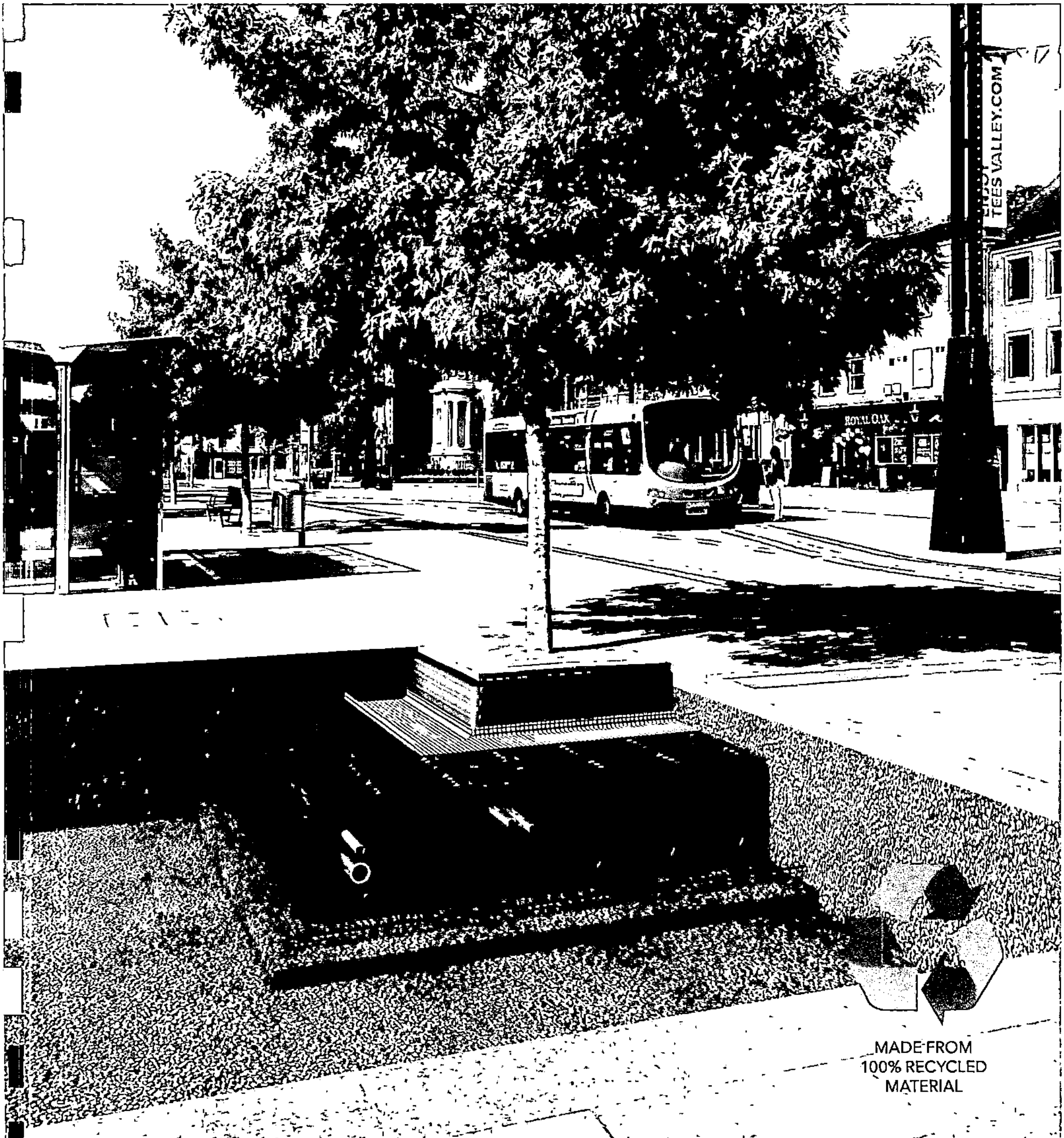
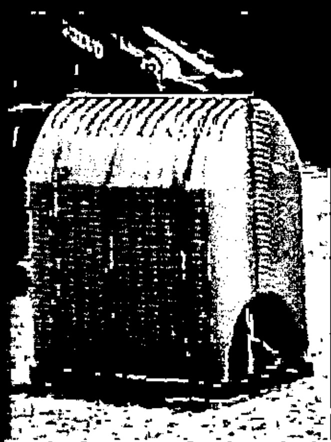
RootSpace® Pavement Support System

Product Overview

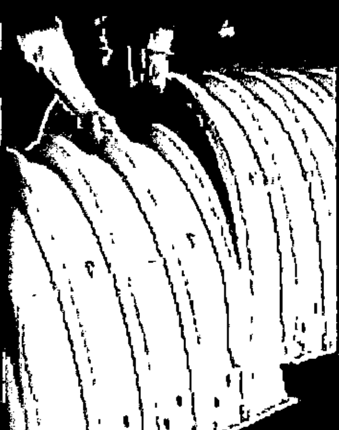
GreenBlue URBAN
Establishing the future urban landscape





Product Catalog

Underground Stormwater Chambers



Save Valuable Land and Protect Water Resources℠

StormTech®

Detention • Retention • Recharge

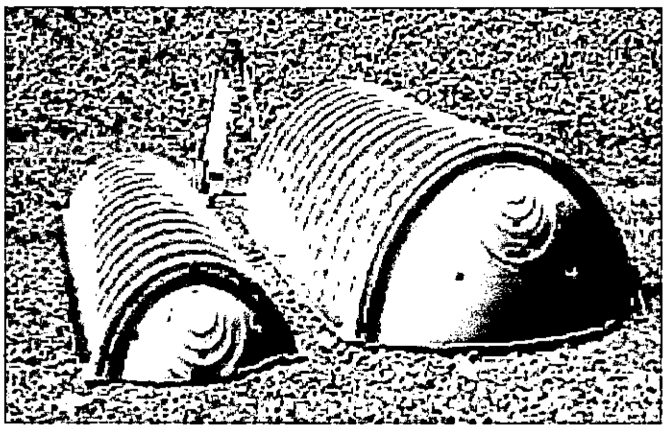
Subsurface Stormwater Management

StormTech® Subsurface Stormwater Management

The advanced design of StormTech's chambers allows stormwater professionals to create more profitable, environmentally sound installations. Compared with other subsurface systems, StormTech's innovative chambers offer lower overall installed costs, superior design flexibility and enhanced long-term performance.

Superior Design Flexibility for Optimal Land Use

StormTech chambers are ideal for commercial, municipal and residential applications. One of the key advantages of the StormTech chamber system is design flexibility. StormTech chambers can be configured into beds or trenches, in centralized or decentralized layouts to fit on nearly any site.



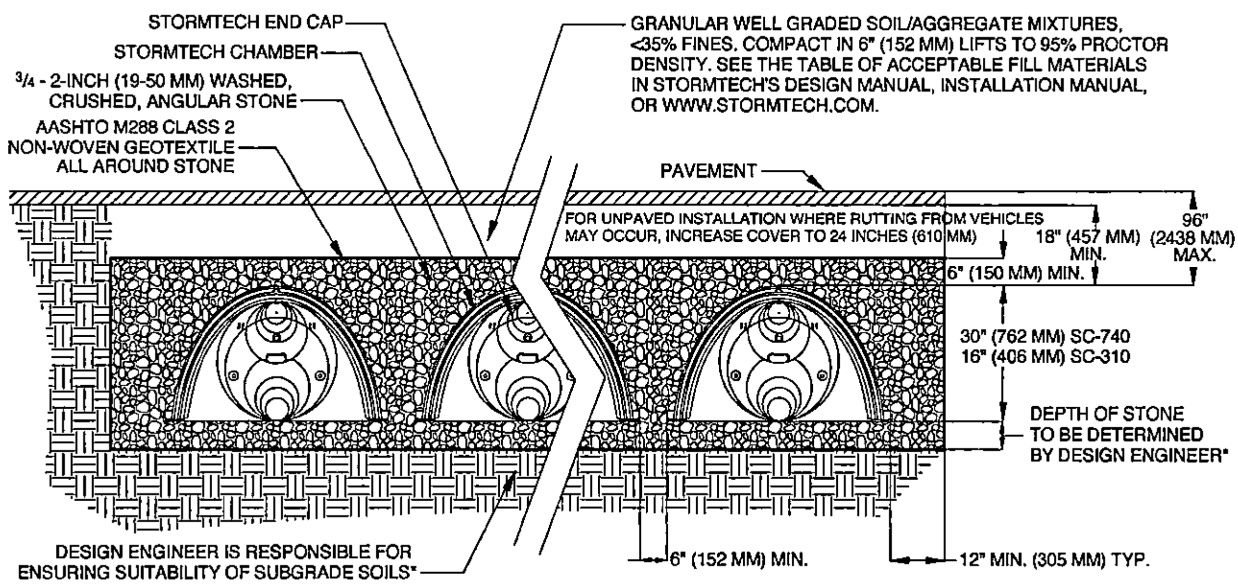
L to R: SC-310 chamber and SC-740 chamber

Product Features and Benefits

The advanced features and innovative technology of StormTech chambers streamline installations while lowering overall installed costs. StormTech chambers offer these unique advantages:

- Lightweight, two people can install chambers quickly and easily, saving time and money
- Extensive product research & development and rigorous testing ensure long term reliability and performance
- Versatile product design accommodates a wide range of site constraints with cost-effective system designs
- The chamber length can be cut in 6.5" (165 mm) increments – reducing waste and optimizing the use of available space
- Injection molded polypropylene ensures precise control of wall thickness and product consistency
- Isolator Row – a patent pending technique to inexpensively enhance total suspended solids (TSS) removal and provide easy access for inspection and maintenance
- Corrugated Arch Design – a proven geometry for structural integrity under H-20 live loads and deep burial loads, also provides high storage capacity

Typical Cross Section Detail (not to scale)



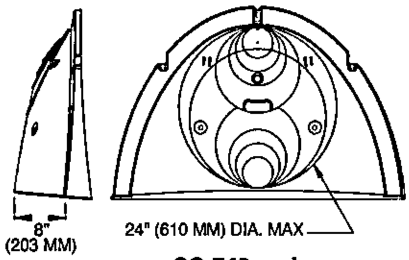
Detention-Retention-Recharge

The StormTech SC-740 chamber optimizes storage volumes in relatively small footprints by providing 2.2 ft^3/ft^2 (0.67 m^3/m^2) (minimum) of storage. This can decrease excavation, backfill and associated costs. The StormTech SC-310 chamber is ideal for systems requiring low-rise and wide-span solutions. The chamber allows the storage of large volumes, 1.3 ft^3/ft^2 (0.4 m^3/m^2) (minimum), at minimum depths.

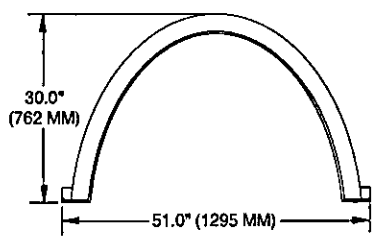
StormTech SC-740 Chamber
(not to scale)

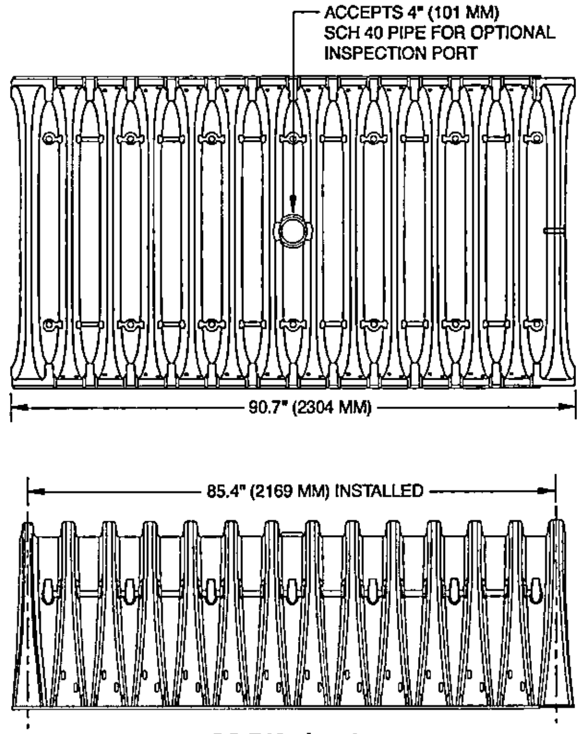
Nominal Chamber Specifications

Size (L x W x H)	85.4" x 51.0" x 30.0" (2169 x 1295 x 762 mm)
Chamber Storage	45.9 ft^3 (1.30 m^3)
Minimum Installed Storage*	74.9 ft^3 (2.12 m^3)
Weight	74.0 lbs (33.6 kg)
Shipping	30 chambers/pallet 60 end caps/pallet 12 pallets/truck



SC-740 end cap



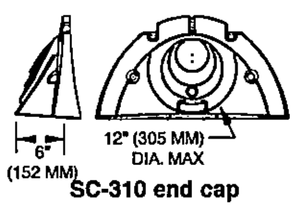


SC-740 chamber

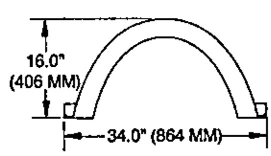
StormTech SC-310 Chamber
(not to scale)

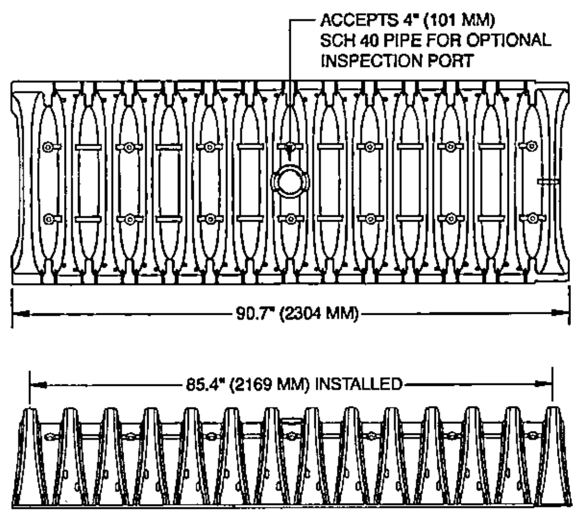
Nominal Chamber Specifications

Size (L x W x H)	85.4" x 34.0" x 16.0" (2169 x 864 x 406 mm)
Chamber Storage	14.7 ft^3 (0.42 m^3)
Minimum Installed Storage*	31.0 ft^3 (0.88 m^3)
Weight	37.0 lbs (16.8 kg)
Shipping	41 chambers/pallet 108 end caps/pallet 18 pallets/truck



SC-310 end cap

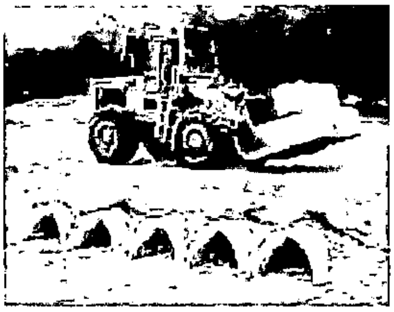




SC-310 chamber

*This assumes a minimum of 6 inches (152 mm) of stone below, above and between chamber rows.

Advanced Structural Performance for Greater Long-Term Reliability



StormTech developed a state of the art chamber design through:

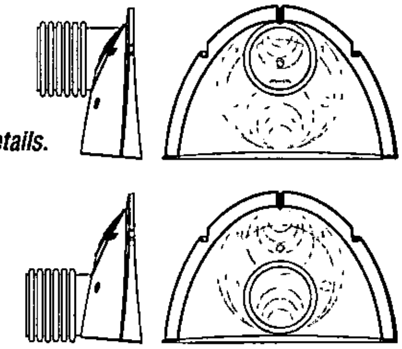
- Collaboration with world-renowned experts of buried drainage structures to develop and evaluate the structural testing program and product design
- Designing chambers to exceed AASHTO LRFD design specifications for HS-20 live loads and deep burial earth loads
- Subjecting the chambers to rigorous full scale testing, under severe loading conditions to verify the AASHTO safety factors for live load and deep burial applications

StormTech continues to conduct research and consult with outside experts to meet customer needs for alternative backfill materials, designs for special loadings and other technical solutions.

Technical Assistance

StormTech's technical support staff is available to provide assistance to engineers, contractors and developers. Please contact one of our engineers or product managers to discuss your particular application. A wide variety of technical support material is available in print, electronic media or from our website at www.stormtech.com. For any questions, please call StormTech at 888-892-2694.

Fabricated End Caps
Contact StormTech for details.



StormTech®
Detention • Retention • Recharge
Subsurface Stormwater Management℠

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Appendix 4

Details of Isolator Row incorporated into Stormtech Attenuation Chambers

6.0 Inlets for Chambers

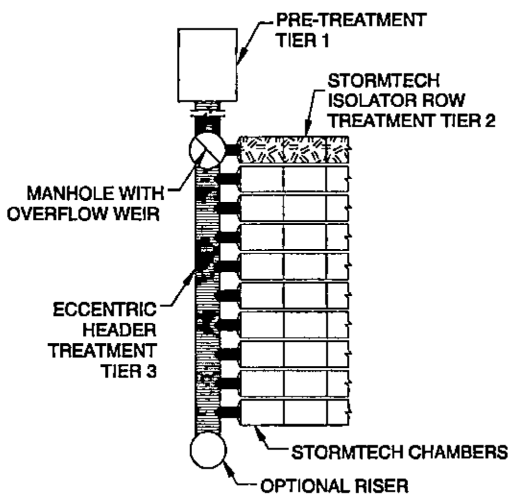
The design flexibility of a Stormtech chamber system includes many inletting possibilities. Contact StormTech's technical service department for guidance on designing an inlet system to meet specific site goals.

6.1 TREATMENT TRAIN

A properly designed inlet system can ensure good water quality, easy inspection and maintenance, and a long system service life. StormTech recommends a treatment train approach for inletting an underground stormwater management system under a typical commercial parking area. *Treatment train* is an industry term for a multi-tiered water quality network. As shown in **Figure 6**, a StormTech recommended inlet system can inexpensively have up to 3 tiers of treatment upstream of the StormTech chambers:

Tier 1 – Pre-treatment (BMP)
Tier 2 - StormTech Isolator Row
Tier 3 - Eccentric Pipe Header-Manifold

Figure 6 – Typical StormTech Treatment Train Inlet System



6.2 PRE-TREATMENT (BMP) – TREATMENT TIER 1

Typically, some level of pre-treatment of the stormwater is required prior to entry into a stormwater system. By treating the stormwater prior to entry into the system, the service life of the system can be extended, pollutants such as hydrocarbons may be captured, and local regulations met. Pre-treatment options are often described as a Best Management Practice or simply a BMP.

Pre-treatment devices differ greatly in complexity, design and effectiveness. Depending on a site's characteristics and treatment goals, the simple, least expensive pre-treatment solutions can sometimes be just as effective as the complex systems. Options include a simple deep sumped manhole with a 90° bend on its outlet, baffle boxes, swirl concentrators, sophisticated filtration devices, and devices that combine these processes. Some of the most effective pre-treatment options combine engineered site grading with vegetation such as bio-swales or grassy strips.

The type of pretreatment device specified as the first level of treatment up-stream of a StormTech chamber system can vary greatly throughout the country and from site-to-site. It is the responsibility of the design engineer to understand the water quality issues and design a stormwater treatment system that will satisfy local regulators and follow applicable laws. A design engineer should apply their understanding of local weather conditions, site topography, local maintenance requirements, expected service life, etc...to select an appropriate stormwater pre-treatment system.

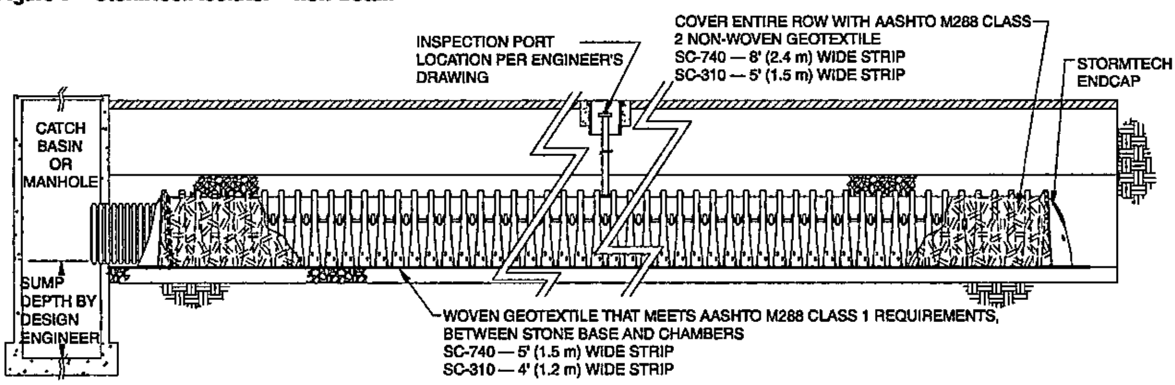
6.3 STORMTECH ISOLATOR™ ROW – TREATMENT TIER 2

StormTech has a patent pending technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance. The StormTech Isolator Row is a row of standard StormTech chambers surrounded with appropriate filter fabrics and connected to a manhole for easy access. This application basically creates a filter/detention basin that allows water to egress through the surrounding filter fabric while sediment is trapped within. It may be best to think of the Isolator Row as a first-flush treatment device. *First-Flush* is a term typically used to describe the first ½" to 1" (13-25 mm) of rainfall or runoff on a site. The majority of stormwater pollutants are carried in the sediments of the first-flush, therefore the Isolator Row can be an effective component of a treatment train.

The StormTech Isolator Row should be designed with a manhole with an overflow weir at its upstream end. The manhole is connected to the Isolator Row with a short length of 12" (305 mm) ID through 24" (610 mm) OD pipe set near the bottom of the StormTech SC-740 end cap. The diversion manhole is multi-purposed. It can provide access to the StormTech Isolator row for both inspection and maintenance. The overflow weir with its crest set even with the top of chambers allows stormwater in excess of the Isolator Row's storage/ conveyance capacity to bypass into the chamber system through the downstream Eccentric header/manifold system.

Specifying and installing proper geotextiles is essential for efficient operation and to prevent damage to the system during the JetVac maintenance process. A strip of woven geotextile that meets AASHTO M288 Class 1 requirements is required between the chambers and their stone foundation. This strong filter fabric traps sediments and protects the stone base during maintenance. A strip of non-woven AASHTO M288 Class 2 geotextile is draped over the Isolator chamber row. This 6-8 oz. (217-278 g/m²) non-woven filter fabric prevents sediments from migrating

Figure 7 – StormTech Isolator™ Row Detail



out of the chambers' perforations while allowing modest amounts of water to flow out of the Isolator Row. **Figure 7** is a detail of the Isolator Row that shows proper application of the geotextiles.

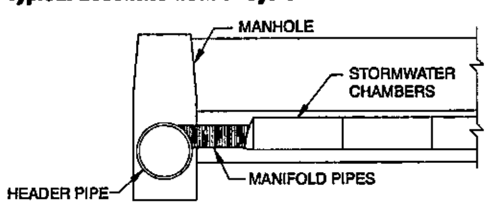
Inspection is easily accomplished through the upstream manhole or optional inspection ports. If specified, inspection ports should be located approximately every tenth chamber along the Isolator row or where practical to facilitate inspection. Maintenance of an Isolator Row is fast and easy using the JetVac process through the upstream manhole. Section 13.0 explains the Inspection and Maintenance process in more detail.

Each SC-740 chamber in an Isolator row will store 45.9 $ft.^3$ (1.3 m^3) of first-flush stormwater. During and between storm events an Isolator Row will allow stormwater to egress at a rate of 0.25 cfs (7.1 l/s) or less per chamber. A bed of StormTech chambers may have multiple Isolator rows to accommodate required first-flush volumes.

6.4 ECCENTRIC HEADER SYSTEM – TREATMENT TIER 3

The third tier of the treatment train is the eccentric header system. This is much like a typical header system except that the inlet pipes are smaller and located at a higher invert than the header pipe. This is accomplished by building the header system with reducer tees installed upside down so a sump is created within the large diameter header pipe as shown in **Figure 8.** A typical eccentric header system might have a 48" (1220 mm) header pipe with 18" (460 mm)manifolds creating a 30" (760 mm) header sump.

Figure 8 – Typical Eccentric Header System



The upstream end of the eccentric header system will typically be connected directly to the downstream side of the Isolator Row's weired manhole as shown in **Figure 6.** The downstream end of the header pipe may have a riser or manhole to facilitate inspection and maintenance. Pipe companies can provide more detailed information on designing a header system optimized for trapping TSS.

6.5 TREATMENT TRAIN CONCLUSION

The treatment train is a highly effective water-quality approach that does not add significant cost to a StormTech system being installed under commercial parking areas. Some type of pre-treatment device, perhaps as simple as a catchbasin or manhole, is usually required on all stormwater systems. The StormTech Isolator Row adds a significant level of treatment, easy inspection and maintenance, while maintaining storage volume credit for the cost of a modest amount geotextiles. Finally, a pipe header-manifold system is a well recognized component of a chamber inlet system. Inverting the reducer tees creates an eccentric header system that can be easily inspected and maintained. This treatment train concept provides three levels of treatment, inspection and maintenance upstream of the StormTech detention/retention bed with little additional expense.

6.6 OTHER INLET OPTIONS

While the three-tiered treatment train approach is the recommended method of inletting StormTech chambers for typical under-commercial parking application, there are other effective inlet methods that may be considered. For instance, Isolator Rows, while adding an inexpensive level of confidence, are not always necessary. A header system with fewer inlets can be designed to further minimize the cost of a StormTech system. There may be applications where stormwater pre-treatment may not be necessary at all and the system can be inlet directly from the source. In other cases it may make sense to design a system with a treatment device downstream of

Appendix 5

Details of Isolator Row Maintenance for Stormtech Attenuation Chambers

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13.0 Inspection & Maintenance

13.4 ISOLATOR™ ROW INSPECTION

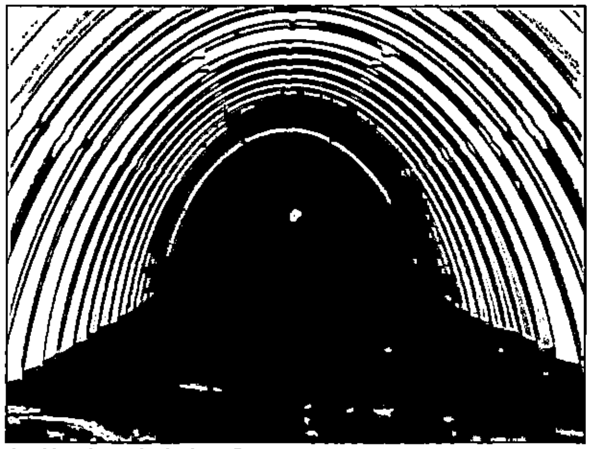
Regular inspection and maintenance are essential to assure a properly functioning stormwater system. Inspection is easily accomplished through the manhole or optional inspection ports of an Isolator Row. Please follow local and OSHA rules for a confined space entry.

Inspection ports can allow inspection to be accomplished completely from the surface without the need for a confined space entry. Inspection ports provide visual access to the system with the use of a flashlight. A stadia rod may be inserted to determine the depth of sediment. If upon visual inspection it is found that sediment has accumulated to an average depth exceeding 3" (76 mm), cleanout is required.

A StormTech Isolator Row should initially be inspected immediately after completion of the site's construction. While every effort should be made to prevent sediment from entering the system during construction, it is during this time that excess amounts of sediments are most likely to enter any stormwater system. Inspection and maintenance, if necessary, should be performed prior to passing responsibility over to the site's owner. Once in normal service, a StormTech Isolator Row should be inspected bi-annually until an understanding of the sites characteristics is developed. The site's maintenance manager can then revise the inspection schedule based on experience or local requirements.

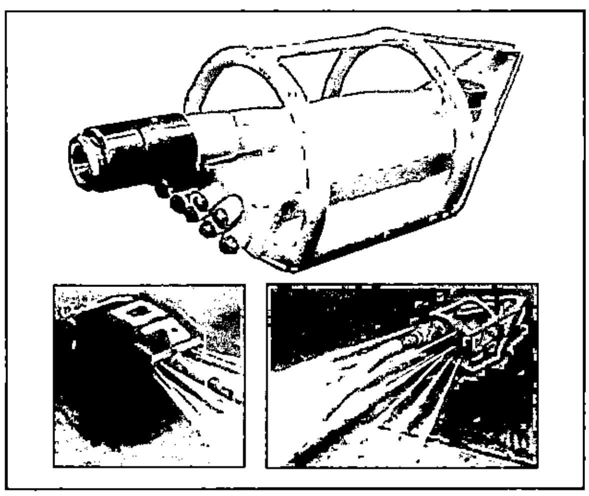
13.5 ISOLATOR ROW MAINTENANCE

JetVac maintenance is required if sediment has been collected to an average depth of 3" (76 mm) or more inside the Isolator Row. 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, a wave of suspended sediments is flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/ JetVac combination vehicles. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" (1140 mm) are best. Most JetVac reels have a minimum of 400 feet (122 m) of hose allowing maintenance of an Isolator Row up to 50 chambers long. The JetVac process shall only be performed on StormTech Rows that have AASHTO class 1 woven geotextile over their angular base stone.



Looking down the Isolator Row.

A typical JetVac truck. (This is not a StormTech product.)



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

STORMTECH 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

iv. If sediment is at, or above, 3" (76 mm) 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" (76 mm)] proceed to Step 2. If not proceed to Step 3.

Step 2) Clean out Isolator Row using the JetVac process

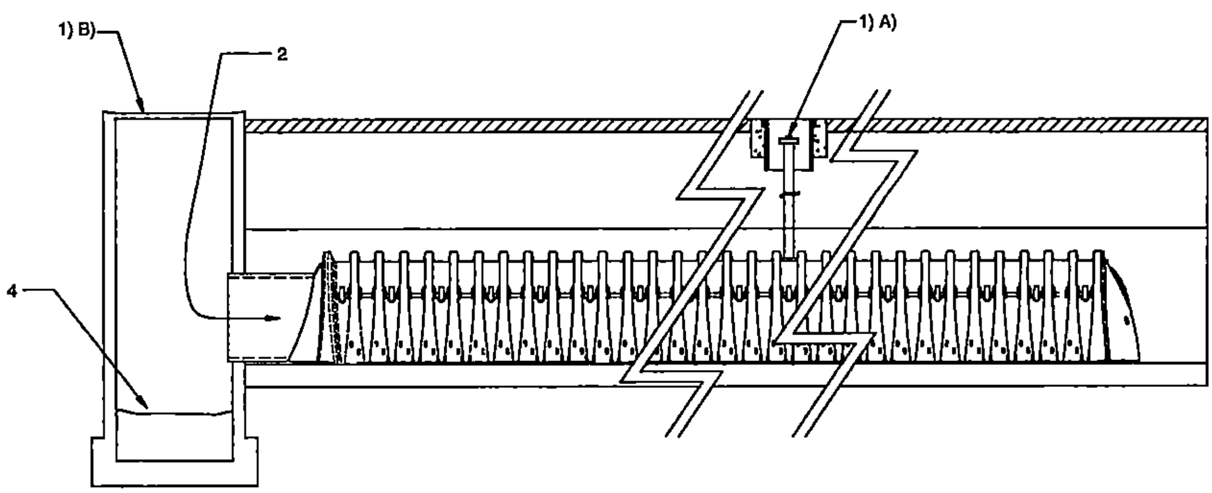
A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45" (1140 mm) or more is preferable
B) Apply multiple passes of JetVac until backflush water is clean
C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers

Step 4) Inspect and clean catch basins and manholes upstream of the StormTech system following the procedures for Classic Manifold Inlet System

Figure 19

StormTech Isolator Row (not to scale)



Appendix 6

ArborFlow Rootspace Tree Pits

The Key Benefits of Soil Cells

For over a quarter of a century, GreenBlue Urban has been working to ensure that every tree, wherever planted, has the chance to achieve species potential. Now, we are closer than ever to arriving at this objective, and it is very clear that the provision of uncompacted soil volume provided for the tree is probably the most critical single element in achieving long term establishment.

Urban trees are in an environment that is endemically hostile to where they would like to be, a forest floor, away from the demands and below ground competition of the urban environment. The RootSpace soil cell system replicates the forest floor scenario as closely as possible by providing the tree with the uncompacted, aerated soil that's crucial to it's long term health, whilst working around services and below ground constraints, marrying the needs of the built environment and the arboricultural needs of the tree.

Northumberland Avenue, London (2018) - Victorian era example of a suspended pavement support system.

The Benefits of Urban Trees

Particulate levels on tree-lined streets can be up to 60% lower than those without trees.

For every 5% of tree cover, stormwater runoff is reduced by 2%.

A series of international third-party studies have shown that trees increase property prices by between 5% to 18%.

A 10% increase in urban green space can postpone the onset of health problems by up to 5 years.

A single mature tree absorbs carbon at a rate of 47.5 lbs (21.6 kg) per year.

Few things can compare with the visual impact and seasonal interest that trees bring to an urban environment.

Research has indicated that a 10% increase in tree canopy was associated with roughly a 12% decrease in crime.

Students who have a green window view recover from mental fatigue faster and thus pay attention for longer.

Features & Benefits

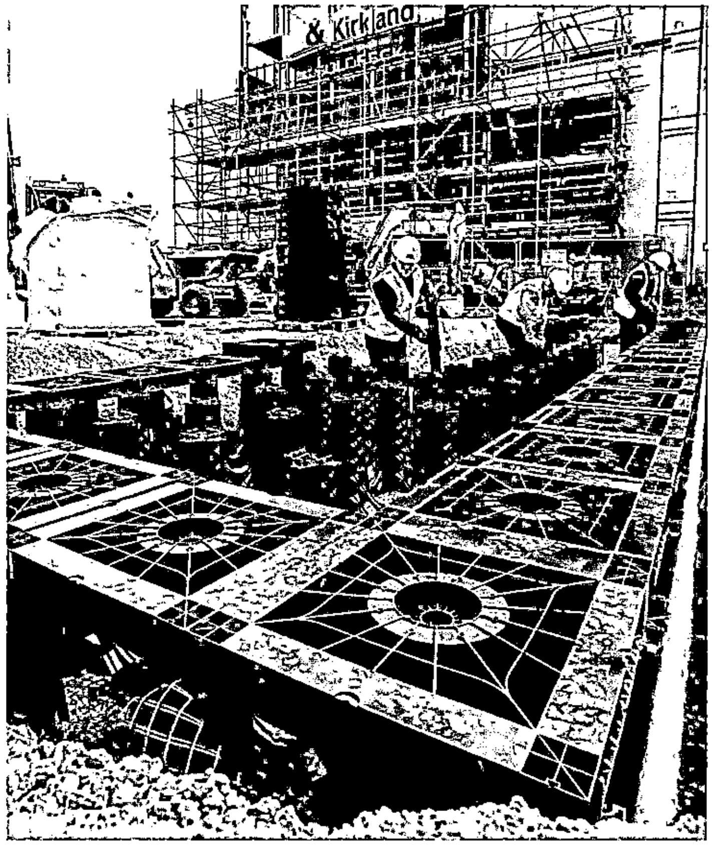
The GreenBlue Urban RootSpace Pavement Support System is an engineered load-bearing soil cell with over 95% open void space for maximum rooting volume as well as the ability to accommodate services.

RootSpace G2 is manufactured in the UK from 100% recycled material, designed to be economic freight and is the culmination of more than 27 years experience in helping establish trees in complex urban environments.

The new generation of RootSpace is launched with a 400mm high option to suit a greater spread of situations.

Key Benefits

- Optimum conditions for soil biology maximising root growth & tree health.
- Very fast, simple and easy to assemble reducing installation time & costs.
- Designed for easy integration, and re-excavation for maintenance, of utilities.
- Minimum carbon footprint with 100% UK manufacture
- Minimum excavation depths required.
- Can be used close to highways due to world leading lateral performance.

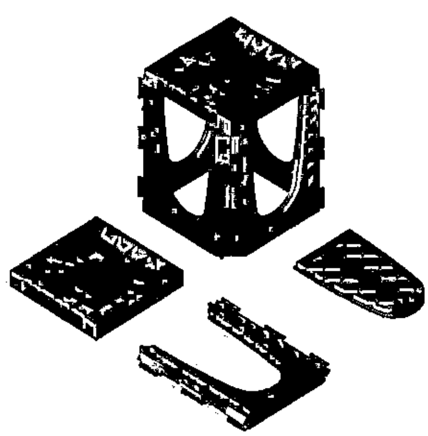


A typical RootSpace installation.

Product Specifications

Code	Description	Height	Width	Breadth
GBURAC600A	RootSpace 600 Upright	600mm	500mm	90mm
GBURAC500A	RootSpace Airflow Lid	75mm	500mm	500mm
GBURSP65A	RootSpace 600 Infill	527mm	334mm	40mm

Code	Description	Height	Width	Breadth
GBURAC400B	RootSpace 400 Upright	400mm	500mm	75mm
GBURAC500B	RootSpace Airflow Lid	75mm	500mm	500mm
GBURSP45PB	RootSpace 400 Infill	327mm	334mm	40mm



Material 100% recycled HDPE

Manufacture Location Injection moulded in the UK

Load Bearing Capacity

Load bearing capacity of structural soil cells is a complex science. It is common to interpret the actual breaking point of structural products as the ultimate allowable wheel load. Engineers employed by GreenBlue allow a factor of safety by basing calculations on loadings before undue displacement occurs.

Vertical Capacity

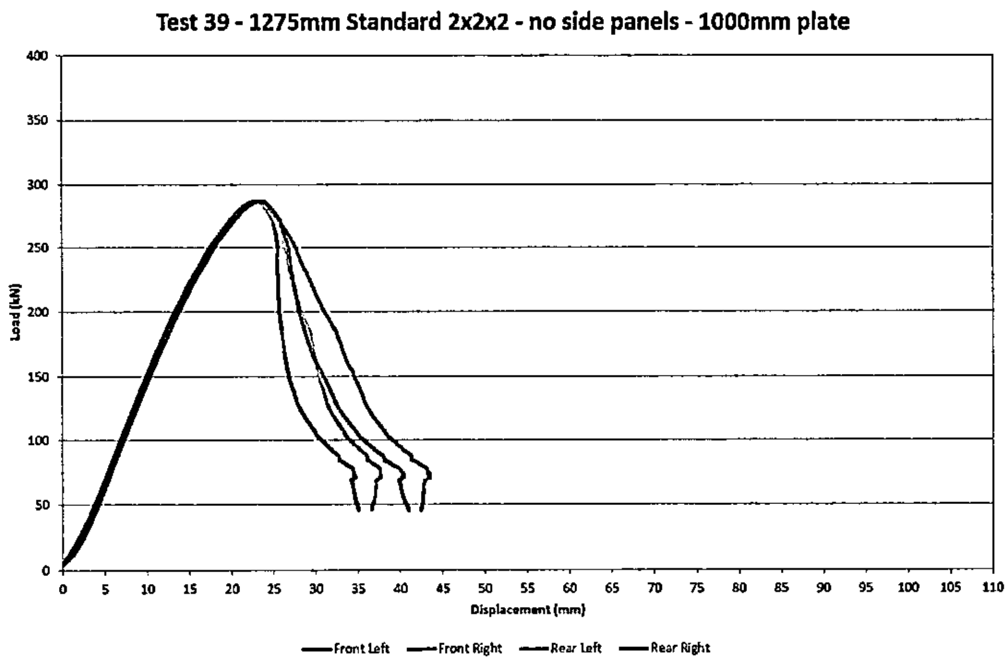
RootSpace Configuration	Vertical Crushing Load	
	kN/m2	tonne/m2
G2 400: 475mm units (single height)	434.0	44.3
G2 400: 875mm units (double height)	297.7	30.4
G2 600: 675mm units (single height)	308.0	31.4
G2 600: 1275mm units (double height)	285.7	29.1

Horizontal Capacity (with side panels)

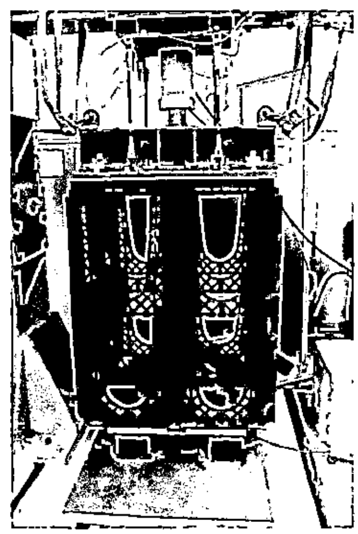
RootSpace Configuration	Horizontal Crushing Load	
	kN/m2	tonne/m2
G2 400: 875mm units (double height) Loaded on side - with side panels	139.4	14.2
G2 600: 1275mm units (double height) Loaded on side - with side panels	56.5	5.8

Load Testing

Extensive compression testing of RootSpace units has been carried out at highly reputable independent testing laboratories. The complete test of each size and configuration is repeated several times to ensure reliability of data and confirm consistency of the unit's structural performance.



Graph showing test results of test number 39


Photograph of RootSpace 600 (double height) being tested.

Road / Pavement Build-up Design

Guidelines given in the DMRB HD24 HD26: Pavement Design and Construction, require the design of road surfacing and layer works to be based principally on a traffic assessment figures. These are expressed in terms of million standard (80kN) axle loads (msa) to be carried during the design life of the construction. This traffic loading together with the quality of the subgrade dictates the selection of the surfacing and depth of a road pavement required.

The dispersal of wheel loads carried by buried structures depends on the type and depth of road layer works selected. Subbase layers are normally made up of compacted gravel. Surfacing layers are typically bituminous macadam, reinforced concrete or block pavers. The wheel load "footprint" on the road surface may be assumed to disperse further through the materials as shown in the table:

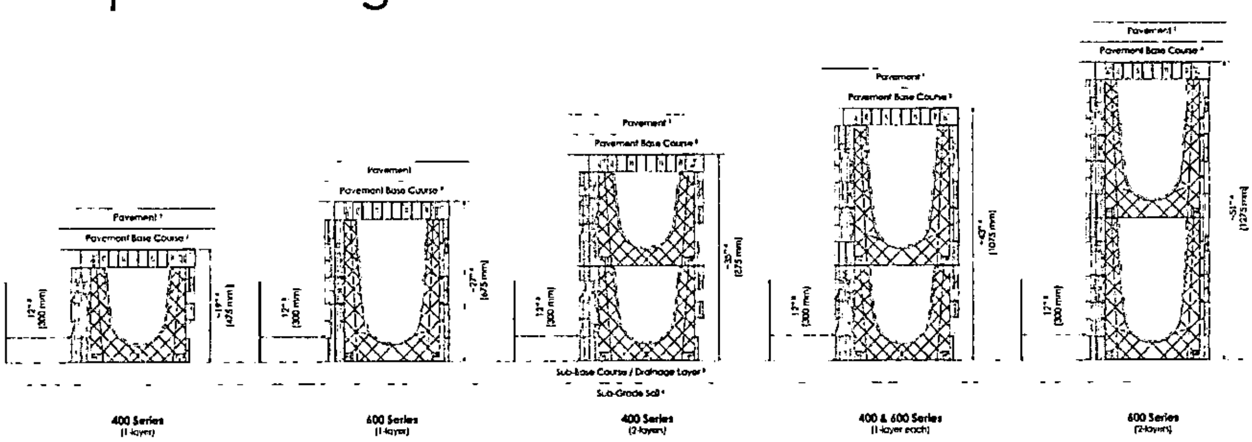
Material	Angle of load spread
Reinforced concrete	1.5 horz. to 1 vertical
Bituminous macadam	1.0 horz. to 1 vertical
Unreinforced concrete	1.0 horz. to 1 vertical
Compacted DTp Type 1 Gravel	0.5 horz. to 1 vertical
Interlocking block paving	1.0 horz. to 1 vertical

The following table gives the minimum allowable paving construction depths required to disperse a 4.5 tonne wheel load (as an example) on different RootSpace configurations (this is based on a typical macadam type road construction and the standard tree pit detail of GBU specification as shown overleaf):

RootSpace configuration	Height	Subbase DTp Type 1 depth	Macadam depth *	Total depth
400 single	475mm	150mm	150mm	300mm
600 single	675mm	300mm	150mm	450mm
400 + 400	875mm	300mm	150mm	450mm
400 + 600	1075mm	325mm	150mm	475mm
600 + 600	1275mm	325mm	150mm	475mm

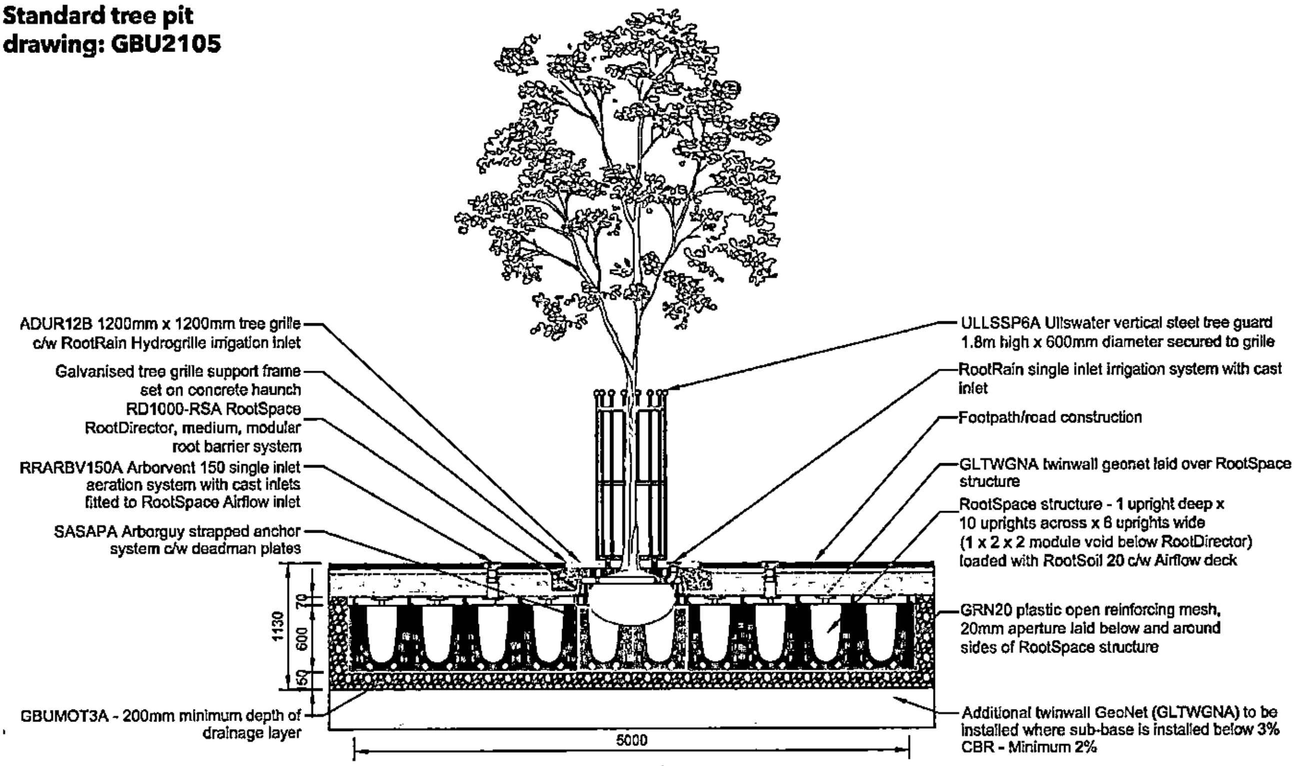
* Total depth of bound bituminous layers
(Minimum construction depths for a full range of wheel loads are available separately)

RootSpace Configurations



Typical Tree Pit & Ancillary Components

Standard tree pit drawing: GBU2105



SECTION A-A

Key RootSpace Tree Pit Products:

- GBURAC500A RootSpace Airflow deck - 56 No. 500mm x (") 500mm x 70mm
- GBURAC500A RootSpace Airflow deck - 56 No. 500mm x (") 500mm x 70mm
- Rootsoil 20 to fill RootSpace and RootDirector spaces (including root ball volume) - allow 9 cu. m per tree. Additional allowance needs to be made for settlement
- RootStart Mycorrhiza - apply to tree pit at time of planting in accordance with manufacturer's rzecommendations - allow 200g per tree
- RRARBV150A Arborvent 150 single inlet aeration system with cast inlets including 0.75m 100mm diameter pipe
- RD1000-RSA RootSpace RootDirector - medium
- GLTWGNA twinwall geonet - 15 sq. m
- GRN20 plastic open reinforcing mesh, 20mm aperture - 31 sq. m
- SASAPA Arborguy strapped anchor system - large
- GBUMOT3A - Drainage layer as per installation instructions

Optional RootSpace Tree Pit Products:

- ADUR12B Adur 1200mm x 1200mm tree grille, finished in black,with galvanised steel support frame
- ULLSSP6A Ullswater vertical steel tree guard with round angle-section rings, 16mm round bars topped with 50mm diameter ball finials, finished in black

Note:
20% additional for with the Geotextile and Reinforcing Mesh to allow for overlap and cutting requirements

For heavy load applications, install RootSpace side panels to installation as directed by engineer

Structural engineer's note:
For increased strength and stability in soft ground conditions, specify RootSpace modules to incorporate side panel inserts to tree pit perimeter

Additional geonet is required where sub-base is less than 3% CBR

Supporting Documents & Resources

Design

Tree Species Soil Volume Guide

Our tree species soil volume guide can be used as a refrence point when designing tree pits with adequate soil volume prevision.

Installation

RootSpace Installation Guide

A step by step guide to installing the RootSpace system including further information on excavation depths.

Tree Pits and Services Guide

A comprehensive guide to installing RootSpace in and around services and utilities with real world case studies.

Maintenance

ArborSystem Installation & Maintenance Manual

Comprehensive, detailed instructions on how to install and maintain the complete ArborSystem® tree pit package.

DOWNLOAD

Scan the QR codes to download each resource or head to: greenblue.com/resources

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Appendix 7

Standard Construction Details

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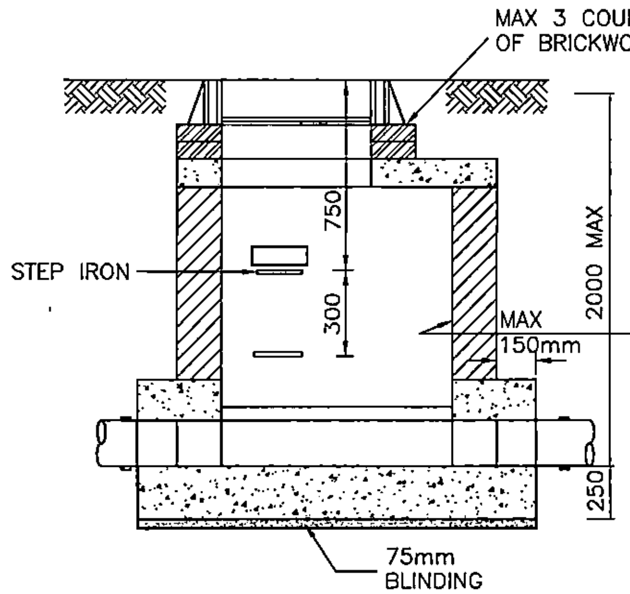
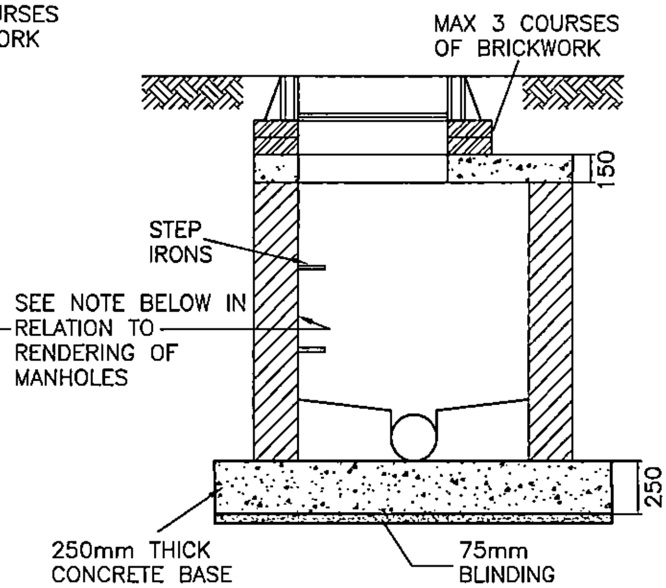
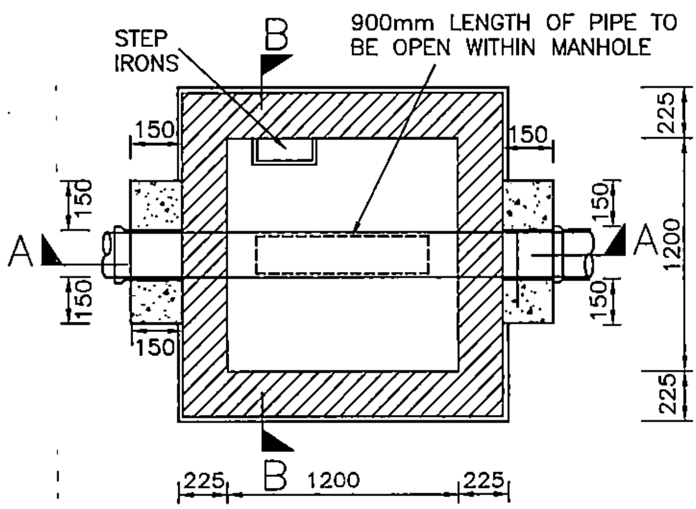
project	PILSEN SKODA		
title	BLOCKWORK MANHOLE		
scale	drawing no	rev	date
NTS	22164–SK01	–	OCT22



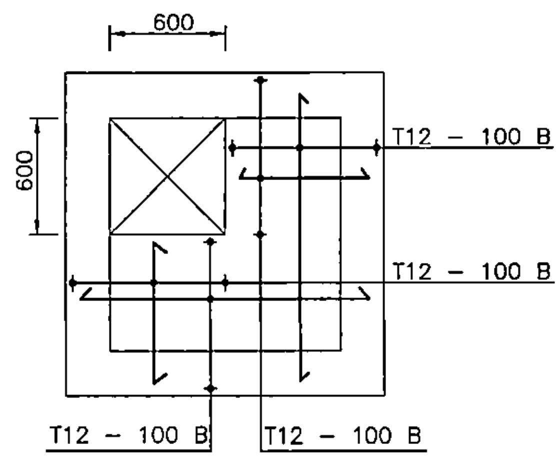
SECTION A–A



SECTION B–B



SECTION PLAN



ROOF PLAN

NOTES:
MANHOLE CONSTRUCTION
MANHOLES TO BE CONSTRUCTED IN SOLID CONCRETE BLOCKWORK TO I.S. 20 (TYPE A 10.5N/mm^2) AND CEMENT MORTAR BLOCKWORK TO BE MIN 225mm THICK FOR DEPTHS OF UP TO 2m. PIPES 225mm DIAMETER AND OVER SHALL HAVE AN R.C. LINTEL OVER THE PIPE TO THE FULL THICKNESS OF THE BLOCKWORK AND THE FULL LENGTH OF THE WALL.

COVERS
MANHOLE COVERS AND FRAMES TO BE DUCTILE IRON, NON–ROCK, GRADE C250 E.N. 24 WITH A 600mm SQUARE OR 600mm DIAMETER CLEAR OPENING – REXEL BY CAVANAGH FOUNDARIES OF NOROC BY PAM

BENCHING
BENCHING IS TO BE FORMED IN C28/35 CONCRETE AND SHOULD RISE UP UNIFORMLY FROM THE TOP EDGE OF THE CHANNEL TO A HEIGHT NOT LESS THAN THAT OF THE SOFFIT OF THE OUTLET AND SLOPE UPWARDS TO MEET THE WALL OF THE MANHOLE AT A GRADIENT OF 1:10 (MIN RISE 25mm). IT SHOULD BE FLOATED WITH A STEEL FLOAT TO A SMOOTH HARD SURFACE WITH A 25mm THICK COAT OF 1:1 CEMENT MORTAR LAID WHILE THE BENCHING CONCRETE IS STILL GREEN.

RENDERING
SURFACE WATER MANHOLES SHALL BE RENDERED INTERNALLY IN 1:3 CEMENT MORTAR 25mm THICK AND FINISHED WITH A STEEL TROWEL. FOUL MANHOLES SHALL BE RENDERED INTERNALLY AND EXTERNALLY IN 1:3 CEMENT MORTAR.

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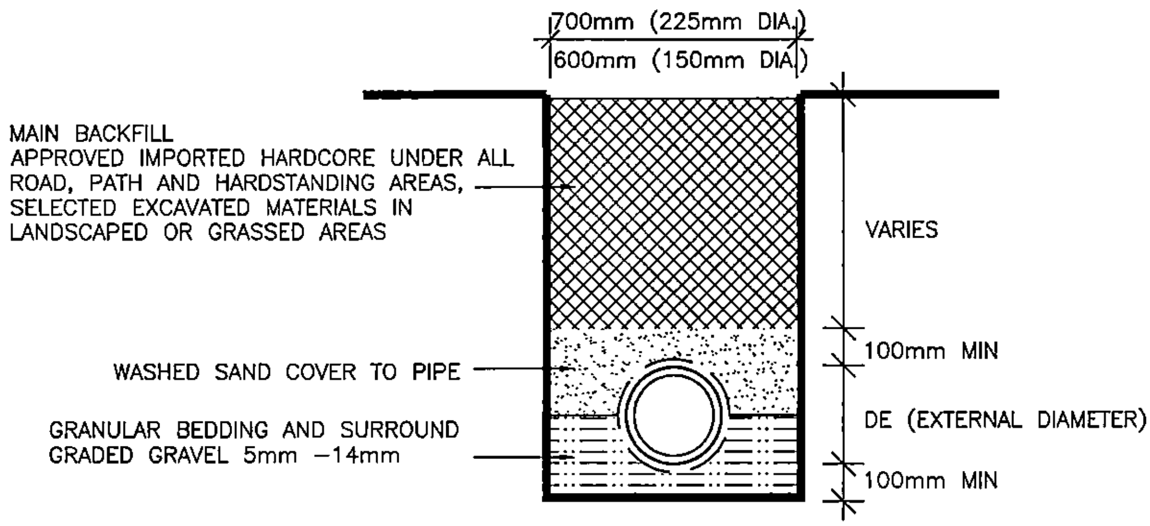
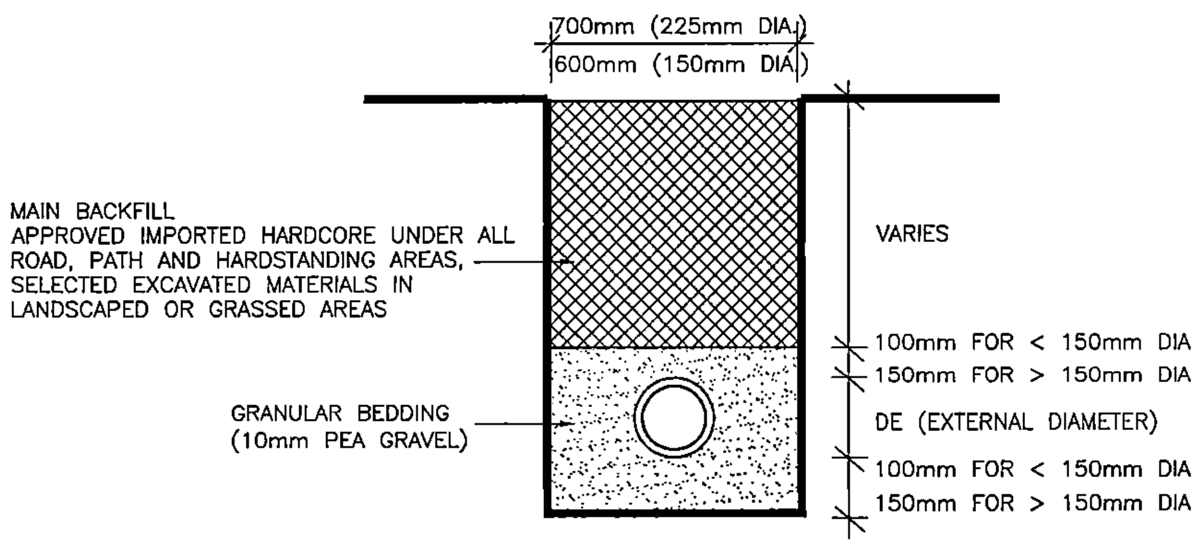
project: PILSEN SKODA

title: SEWER BEDDING DETAILS

scale	drawing no	rev	date
NTS	22164–SK02	–	OCT22



GRANULAR BEDDING FOR CONCRETE PIPES



GRANULAR BEDDING FOR uP.V.C. FLEXIBLE PIPES

NOTE:

(A) IN TRENCHES IN ROADS, MAIN BACKFILL SHALL BE GRANULAR MATERIAL TO CLAUSE 804 M.O.T. SPECIFICATION AND SHALL BE COMPACTED IN LAYERS NOT EXCEEDING 500mm LOOSE DEPTH.

(B) WHERE COVER IS LESS THAN ALLOWABLE, I.E. 1.20m IN ROADS AND 0.9m ELSEWHERE. A 150mm (20N MIX) CONCRETE SURROUND IS TO BE PLACED AROUND PIPE.
THE CONCRETE SURROUND SHALL HAVE 25mm BREAKS EVERY 6.0m (uPVC ONLY.
THE BREAKS ARE TO BE FILLED WITH A COMPRESSIBLE MATERIAL.

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title	WATERMAIN BEDDING DETAILS		
scale	drawing no	rev	date
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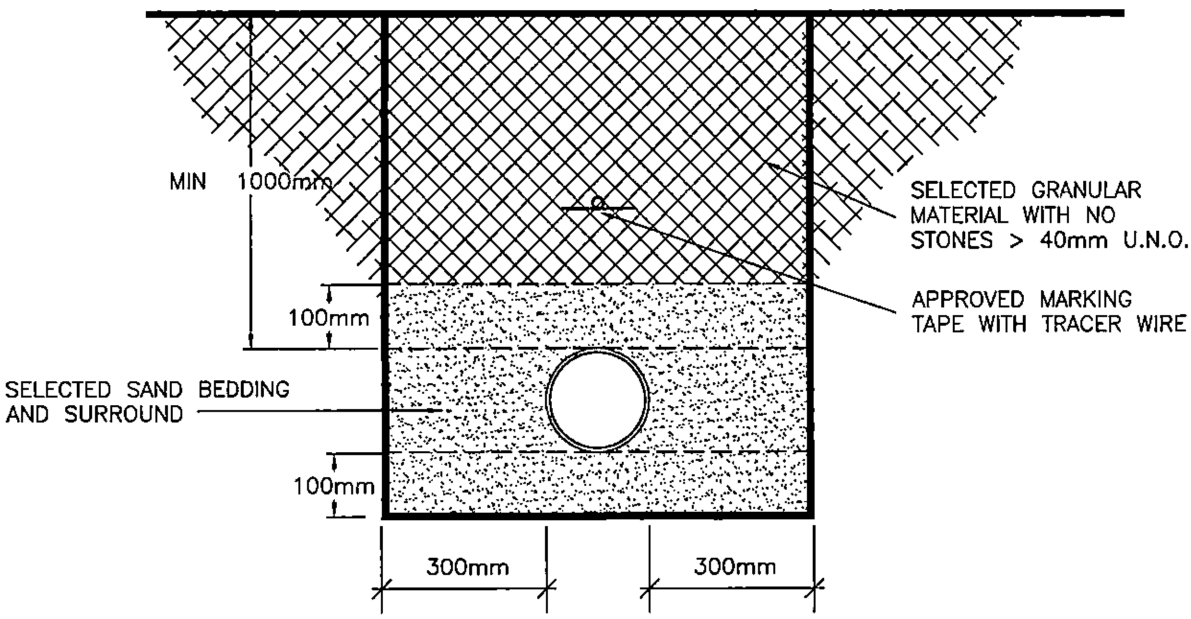
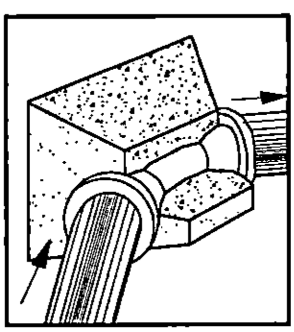


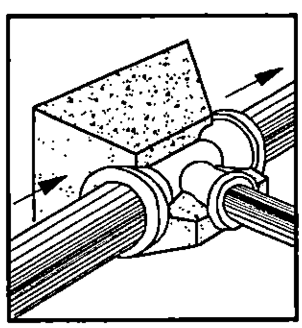
WATERMAIN BEDDING

PIPE ANCHORAGE

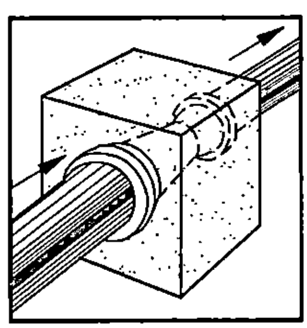
CONCRETE ANCHOR BLOCKS SHALL BE PROVIDED ON WATERMAINS AT, DEAD ENDS, TEES, BENDS OF CURVATURE GREATER THAN 22.5°, AND AT BOTH SIDES OF A SLUICE VALVE CHAMBER. ANCHOR BLOCKS SHALL ENCASE THE PIPE TO MINIMUM THICKNESS OF 150mm ALL AROUND AND SHALL BE A MINIMUM OF 600mm LONG.



90° BEND ANCHOR BLOCK



'T' JUNCTION ANCHOR BLOCK



REDUCER ANCHOR BLOCK