Drainage Proposals

and

Standard Construction Details

for

Proposed Extension and Alterations

to

Existing Motor Showroom & Workshop

at

Ballymount, Dublin

for

Pilsen Auto Ltd

October 2022

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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 in accordance 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 gravity foul sewer network serving the proposed building will connect and discharge to an existing foul sewer manhole adjacent to the proposed extension.

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

Surface Water Sewer

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 run-off 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 run-off pollutants and improve storm water quality before discharge (water quality criteria).

There will be a slight increase in the run-off 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.

Hydraulic Criteria

Hydraulic Criteria on the existing development is met by controlling the rate of discharge of surface water from the roof and paved surfaces on the developed site to match pre-development run-off rates. The surface water run-off 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 submitted as part 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 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 run-off from the existing and proposed roof area will be stored and discharged through the attenuation system as shown on the site layout plan. The additional attenuation system to cater for the proposed extension 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.

Calculate Attenuation Volume Required for the Proposed Extension

The existing and proposed storm network 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 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 additionally, the proposed stormtech chambers to the rear of the site are adequate to contain these extreme storm events while limiting the outflow to 1.8 l/sec.

The design calculations for the storm water system indicate that an additional attenuation storage of $8.7m^3$ is required for the 1 in 100 year rainfall event in addition to the existing storage provided on site.

The required additional storage capacity will be provided by construction of below ground attenuation which will consist of 24No. StormTech 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 $0.878m^3$; 24No. chambers having a storage capacity of $21.1m^3$.

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.

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

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)	1.00
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	0.048	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	0.020	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	0.046	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	0.018	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	11.1	0.855	0.905	0.086	0.0	87	0.769
?	1.004	5	6	0.944	37.5	11.0	0.905	0.825	0.086	0.0	83	0.821
?	3.000	18	6	1.458	58.0	2.7	0.705	0.825	0.020	0.0	33	0.750
?	1.005	6	7	1.029	40.9	13.3	0.825	0.975	0.106	0.0	88	0.923
?	1.006	7	8	0.916	36.4	18.0	0.975	1.255	0.152	0.0	112	0.915
?	1.007	8	9	0.912	36.2	19.2	1.255	1.545	0.167	0.0	116	0.925
?	2.000	15	16	0.708	28.1	2.4	0.810	0.895	0.018	0.0	44	0.434
?	2.001	16	17	0.921	36.6	8.0	1.010	1.465	0.063	0.0	72	0.742
?	2.002	17	9	0.987	39.2	9.8	1.465	1.545	0.078	0.0	77	0.826
✓	1.008	9	10	2.030	80.7	28.1	1.545	1.575	0.245	0.0	92	1.856
?	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	40.3	1.575	1.655	0.352	0.0	117	1.930
✓	1.010	11	12	1.072	75.8	39.7	1.580	1.670	0.352	0.0	154	1.084
?	1.011	12	13	0.972	68.7	39.5	1.670	1.650	0.352	0.0	163	1.004
✓	1.012	13	14	1.054	74.5	38.8	1.650	2.100	0.352	0.0	154	1.064

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 (m³/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)	1.7	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-0067-1800-0750-1800
Design Depth (m)	0.750	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 (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	139.8	0.0	0.300	139.8	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 (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	139.8	0.0	0.300	139.8	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 (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	62.1	0.0	0.300	62.1	0.0	0.301	0.0	0.0

Node 6 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	66.350
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	360

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	191.7	0.0	0.300	191.7	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)	0

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	50.0	0.0	0.406	50.0	0.0	0.407	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 360 minute summer	18.990	4.887
1 year +20% CC 15 minute winter	79.091	31.891	1 year +20% CC 360 minute winter	12.344	4.887
1 year +20% CC 30 minute summer	77.681	21.981	1 year +20% CC 480 minute summer	15.445	4.082
1 year +20% CC 30 minute winter	54.513	21.981	1 year +20% CC 480 minute winter	10.261	4.082
1 year +20% CC 60 minute summer	55.559	14.683	1 year +20% CC 600 minute summer	13.066	3.574
1 year +20% CC 60 minute winter	36.912	14.683	1 year +20% CC 600 minute winter	8.928	3.574
1 year +20% CC 120 minute summer	36.504	9.647	1 year +20% CC 720 minute summer	11.879	3.184
1 year +20% CC 120 minute winter	24.252	9.647	1 year +20% CC 720 minute winter	7.984	3.184
1 year +20% CC 180 minute summer	29.214	7.518	1 year +20% CC 960 minute summer	10.077	2.653
1 year +20% CC 180 minute winter	18.990	7.518	1 year +20% CC 960 minute winter	6.675	2.653
1 year +20% CC 240 minute summer	23.818	6.294	1 year +20% CC 1440 minute summer	7.654	2.051
1 year +20% CC 240 minute winter	15.824	6.294	1 year +20% CC 1440 minute winter	5.144	2.051

Rainfall

Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)	Event	Peak Intensity (mm/hr)	Average Intensity (mm/hr)
30 year +20% CC 15 minute summer	250.602	70.912	100 year +20% CC 15 minute summer	325.470	92.097
30 year +20% CC 15 minute winter	175.861	70.912	100 year +20% CC 15 minute winter	228.400	92.097
30 year +20% CC 30 minute summer	172.381	48.778	100 year +20% CC 30 minute summer	225.078	63.689
30 year +20% CC 30 minute winter	120.969	48.778	100 year +20% CC 30 minute winter	157.949	63.689
30 year +20% CC 60 minute summer	120.498	31.844	100 year +20% CC 60 minute summer	156.285	41.301
30 year +20% CC 60 minute winter	80.056	31.844	100 year +20% CC 60 minute winter	103.832	41.301
30 year +20% CC 120 minute summer	76.886	20.319	100 year +20% CC 120 minute summer	98.810	26.113
30 year +20% CC 120 minute winter	51.081	20.319	100 year +20% CC 120 minute winter	65.647	26.113
30 year +20% CC 180 minute summer	60.297	15.516	100 year +20% CC 180 minute summer	76.993	19.813
30 year +20% CC 180 minute winter	39.195	15.516	100 year +20% CC 180 minute winter	50.047	19.813
30 year +20% CC 240 minute summer	48.395	12.789	100 year +20% CC 240 minute summer	61.493	16.251
30 year +20% CC 240 minute winter	32.152	12.789	100 year +20% CC 240 minute winter	40.855	16.251
30 year +20% CC 360 minute summer	37.772	9.720	100 year +20% CC 360 minute summer	47.649	12.262
30 year +20% CC 360 minute winter	24.553	9.720	100 year +20% CC 360 minute winter	30.973	12.262
30 year +20% CC 480 minute summer	30.241	7.992	100 year +20% CC 480 minute summer	37.945	10.028
30 year +20% CC 480 minute winter	20.092	7.992	100 year +20% CC 480 minute winter	25.210	10.028
30 year +20% CC 600 minute summer	25.091	6.863	100 year +20% CC 600 minute summer	31.350	8.575
30 year +20% CC 600 minute winter	17.144	6.863	100 year +20% CC 600 minute winter	21.420	8.575
30 year +20% CC 720 minute summer	22.606	6.059	100 year +20% CC 720 minute summer	28.148	7.544
30 year +20% CC 720 minute winter	15.193	6.059	100 year +20% CC 720 minute winter	18.917	7.544
30 year +20% CC 960 minute summer	18.897	4.976	100 year +20% CC 960 minute summer	23.400	6.162
30 year +20% CC 960 minute winter	12.518	4.976	100 year +20% CC 960 minute winter	15.501	6.162
30 year +20% CC 1440 minute summer	14.064	3.769	100 year +20% CC 1440 minute summer	17.282	4.632
30 year +20% CC 1440 minute winter	9.452	3.769	100 year +20% CC 1440 minute winter	11.615	4.632

Results for 1 year +20% CC Critical Storm Duration. Lowest mass balance: 99.28%

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	10	66.723	0.043	3.5	0.0645	0.0000	OK
15 minute summer	3	11	66.643	0.063	6.8	0.0711	0.0000	OK
15 minute summer	4	10	66.631	0.111	15.1	0.2242	0.0000	OK
30 minute summer	5	22	66.475	0.085	14.6	4.3705	0.0000	OK
15 minute summer	18	9	66.548	0.078	3.7	0.1212	0.0000	OK
180 minute summer	6	112	66.400	0.050	7.3	9.6342	0.0000	OK
15 minute summer	7	10	66.328	0.088	8.5	0.1679	0.0000	OK
240 minute summer	8	152	66.033	0.063	6.9	8.8652	0.0000	OK
15 minute summer	15	11	66.443	0.053	3.3	0.0782	0.0000	OK
15 minute summer	16	10	66.313	0.103	11.4	0.1925	0.0000	OK
960 minute summer	17	795	65.967	0.057	2.2	8.0959	0.0000	OK
960 minute summer	9	840	65.968	0.138	6.0	0.1556	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
15 minute summer	22	11	65.977	0.107	17.8	0.1526	0.0000	OK
960 minute summer	23	825	65.968	0.218	3.4	0.2465	0.0000	OK
960 minute summer	10	795	65.970	0.270	8.7	0.3264	0.0000	SURCHARGED
960 minute summer	11	840	65.967	0.347	19.3	19.0540	0.0000	SURCHARGED
960 minute summer	12	810	65.967	0.437	6.2	49.4751	0.0000	SURCHARGED
120 minute summer	13	104	65.533	0.033	1.8	0.0369	0.0000	OK
120 minute summer	14	104	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	0.647	0.080	0.0777	
15 minute summer	2	1.001	3	3.4	0.480	0.082	0.2183	
15 minute summer	19	4.000	3	3.4	0.527	0.080	0.1044	
15 minute summer	3	1.002	4	6.7	0.487	0.171	0.1502	
15 minute summer	4	1.003	5	15.3	1.264	0.447	0.4082	
30 minute summer	5	1.004	6	9.5	1.340	0.253	0.0593	
15 minute summer	18	3.000	6	4.2	1.233	0.072	0.0589	
180 minute summer	6	1.005	7	4.5	0.589	0.110	0.1387	
15 minute summer	7	1.006	8	8.6	1.231	0.235	0.4262	
240 minute summer	8	1.007	9	5.9	0.726	0.163	0.2361	
15 minute summer	15	2.000	16	3.2	0.504	0.115	0.1398	
15 minute summer	16	2.001	17	11.6	1.322	0.317	0.5815	
960 minute summer	17	2.002	9	2.0	0.455	0.052	0.2329	
960 minute summer	9	1.008	10	6.2	0.946	0.076	0.1769	
15 minute summer	20	5.000	21	4.5	0.604	0.274	0.3119	
15 minute summer	21	5.001	22	8.9	0.778	0.553	0.3471	
15 minute summer	24	6.000	22	4.5	0.505	0.275	0.3732	
15 minute summer	22	5.002	23	17.6	1.278	0.670	0.0759	
960 minute summer	23	5.003	10	2.9	0.470	0.075	0.3630	
960 minute summer	10	1.009	11	19.3	0.853	0.256	0.1519	
960 minute summer	11	1.010	12	6.2	0.442	0.082	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	32.0

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.28%

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	0.1068	0.0000	OK
15 minute summer	2	11	66.840	0.065	7.7	0.0732	0.0000	OK
15 minute summer	19	10	66.744	0.064	7.8	0.0966	0.0000	OK
15 minute summer	3	11	66.709	0.129	15.2	0.1459	0.0000	OK
15 minute summer	4	11	66.698	0.178	33.8	0.3599	0.0000	OK
30 minute summer	5	21	66.530	0.140	31.6	7.1676	0.0000	OK
15 minute winter	18	8	66.577	0.107	7.7	0.1670	0.0000	OK
120 minute summer	6	76	66.436	0.086	19.8	16.6014	0.0000	OK
15 minute summer	7	10	66.368	0.128	18.8	0.2432	0.0000	OK
1440 minute summer	8	1110	66.270	0.300	6.3	42.2822	0.0000	SURCHARGED
15 minute summer	15	10	66.470	0.080	7.4	0.1179	0.0000	OK
15 minute summer	16	10	66.369	0.159	25.5	0.2962	0.0000	OK
1440 minute summer	17	1140	66.270	0.360	6.0	42.4812	0.0000	SURCHARGED
1440 minute summer	9	1110	66.270	0.440	6.5	0.4974	0.0000	SURCHARGED
15 minute summer	20	12	66.580	0.110	10.2	0.1752	0.0000	OK
15 minute summer	21	12	66.511	0.391	20.2	0.5785	0.0000	SURCHARGED
15 minute summer	24	12	66.301	0.101	10.2	0.1514	0.0000	OK
1440 minute summer	22	1080	66.270	0.400	4.0	0.5717	0.0000	SURCHARGED
1440 minute summer	23	1080	66.270	0.520	4.0	0.5881	0.0000	SURCHARGED
1440 minute summer	10	1140	66.270	0.570	9.4	0.6896	0.0000	SURCHARGED
1440 minute summer	11	1080	66.270	0.650	17.3	19.3961	0.0000	SURCHARGED
1440 minute summer	12	1110	66.269	0.739	6.8	83.6299	0.0000	SURCHARGED
15 minute summer	13	41	65.533	0.033	1.8	0.0369	0.0000	OK
15 minute summer	14	41	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	7.7	0.803	0.179	0.1400	
15 minute summer	2	1.001	3	7.6	0.498	0.183	0.5007	
15 minute summer	19	4.000	3	7.7	0.597	0.180	0.2398	
15 minute summer	3	1.002	4	15.1	0.572	0.387	0.3020	
15 minute summer	4	1.003	5	33.8	1.400	0.985	0.8273	
30 minute summer	5	1.004	6	26.8	1.702	0.714	0.1252	
15 minute winter	18	3.000	6	8.1	1.501	0.140	0.0905	
120 minute summer	6	1.005	7	12.1	0.763	0.296	0.2931	
15 minute summer	7	1.006	8	17.9	1.430	0.492	0.7401	
1440 minute summer	8	1.007	9	5.4	0.675	0.149	1.1353	
15 minute summer	15	2.000	16	7.2	0.630	0.255	0.2492	
15 minute summer	16	2.001	17	25.8	1.518	0.705	1.0645	
1440 minute summer	17	2.002	9	-2.9	0.473	-0.075	0.5548	
1440 minute summer	9	1.008	10	6.0	0.864	0.074	0.2158	
15 minute summer	20	5.000	21	10.0	0.694	0.614	0.6506	
15 minute summer	21	5.001	22	16.1	0.914	1.000	0.5348	
15 minute summer	24	6.000	22	10.0	0.636	0.613	0.5919	
1440 minute summer	22	5.002	23	4.0	0.769	0.150	0.0969	
1440 minute summer	23	5.003	10	3.9	0.467	0.103	0.3648	
1440 minute summer	10	1.009	11	17.3	0.762	0.230	0.1519	
1440 minute summer	11	1.010	12	6.8	0.469	0.089	1.3530	
1440 minute summer	12	Hydro-Brake®	13	1.8				
15 minute summer	13	1.012	14	1.8	0.454	0.024	0.0790	25.9

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.28%

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	66.952	0.077	10.1	0.1229	0.0000	OK
15 minute summer	2	11	66.849	0.074	10.0	0.0837	0.0000	OK
15 minute summer	19	12	66.774	0.094	10.1	0.1409	0.0000	OK
15 minute summer	3	12	66.773	0.193	19.7	0.2179	0.0000	OK
15 minute summer	4	11	66.758	0.238	42.4	0.4800	0.0000	SURCHARGED
1440 minute winter	5	1200	66.560	0.170	2.7	8.7150	0.0000	OK
15 minute winter	18	8	66.643	0.173	10.0	0.2705	0.0000	OK
1440 minute winter	6	1200	66.560	0.210	3.5	40.5804	0.0000	OK
1440 minute winter	7	1200	66.560	0.320	4.8	0.6082	0.0000	SURCHARGED
1440 minute winter	8	1170	66.560	0.590	5.3	42.7975	0.0000	SURCHARGED
1440 minute winter	15	1200	66.560	0.170	0.6	0.2519	0.0000	OK
1440 minute winter	16	1200	66.560	0.350	2.1	0.6515	0.0000	SURCHARGED
1440 minute winter	17	1170	66.560	0.650	4.5	42.8604	0.0000	SURCHARGED
1440 minute winter	9	1170	66.560	0.730	6.0	0.8260	0.0000	SURCHARGED
15 minute summer	20	12	66.951	0.481	13.3	0.7670	0.0000	SURCHARGED
15 minute summer	21	12	66.819	0.699	24.2	1.0345	0.0000	SURCHARGED
15 minute summer	24	12	66.569	0.369	13.3	0.5533	0.0000	SURCHARGED
1440 minute winter	22	1200	66.561	0.691	3.2	0.9872	0.0000	SURCHARGED
1440 minute winter	23	1170	66.560	0.810	3.3	0.9166	0.0000	SURCHARGED
1440 minute winter	10	1200	66.561	0.861	8.0	1.0404	0.0000	SURCHARGED
1440 minute winter	11	1170	66.560	0.940	5.8	19.7244	0.0000	SURCHARGED
1440 minute winter	12	1170	66.560	1.030	6.7	86.5646	0.0000	SURCHARGED
1440 minute winter	13	1170	65.535	0.035	2.1	0.0395	0.0000	OK
1440 minute winter	14	1170	65.443	0.033	2.1	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	10.0	0.858	0.233	0.1697	
15 minute summer	2	1.001	3	9.9	0.494	0.237	0.7100	
15 minute summer	19	4.000	3	10.0	0.591	0.234	0.3806	
15 minute summer	3	1.002	4	19.7	0.584	0.503	0.4007	
15 minute summer	4	1.003	5	40.2	1.415	1.173	1.0103	
1440 minute winter	5	1.004	6	2.7	0.523	0.072	0.2699	
15 minute winter	18	3.000	6	11.1	1.623	0.191	0.1595	
1440 minute winter	6	1.005	7	3.3	0.528	0.081	0.6920	
1440 minute winter	7	1.006	8	4.8	0.603	0.131	2.1682	
1440 minute winter	8	1.007	9	4.4	0.645	0.120	1.1353	
1440 minute winter	15	2.000	16	0.6	0.309	0.021	0.7858	
1440 minute winter	16	2.001	17	2.1	0.463	0.057	2.3865	
1440 minute winter	17	2.002	9	-2.3	0.439	-0.058	0.5548	
1440 minute winter	9	1.008	10	5.2	0.823	0.064	0.2158	
15 minute summer	20	5.000	21	11.5	0.736	0.706	0.7287	
15 minute summer	21	5.001	22	19.2	1.092	1.195	0.5348	
15 minute summer	24	6.000	22	10.7	0.638	0.656	0.6900	
1440 minute winter	22	5.002	23	3.3	0.740	0.126	0.0969	
1440 minute winter	23	5.003	10	3.1	0.413	0.081	0.3648	
1440 minute winter	10	1.009	11	5.8	0.760	0.077	0.1519	
1440 minute winter	11	1.010	12	6.7	0.462	0.089	1.3530	
1440 minute winter	12	Hydro-Brake®	13	2.1				
1440 minute winter	13	1.012	14	2.1	0.472	0.028	0.0875	161.9

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,

DURATION	Interval 6months,	1year,	Years 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:

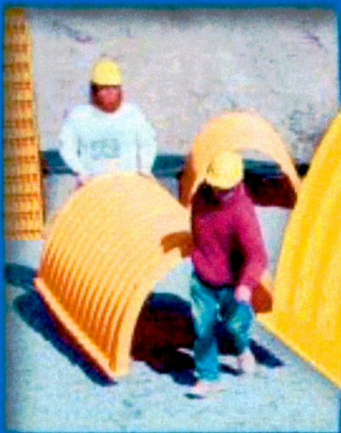
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

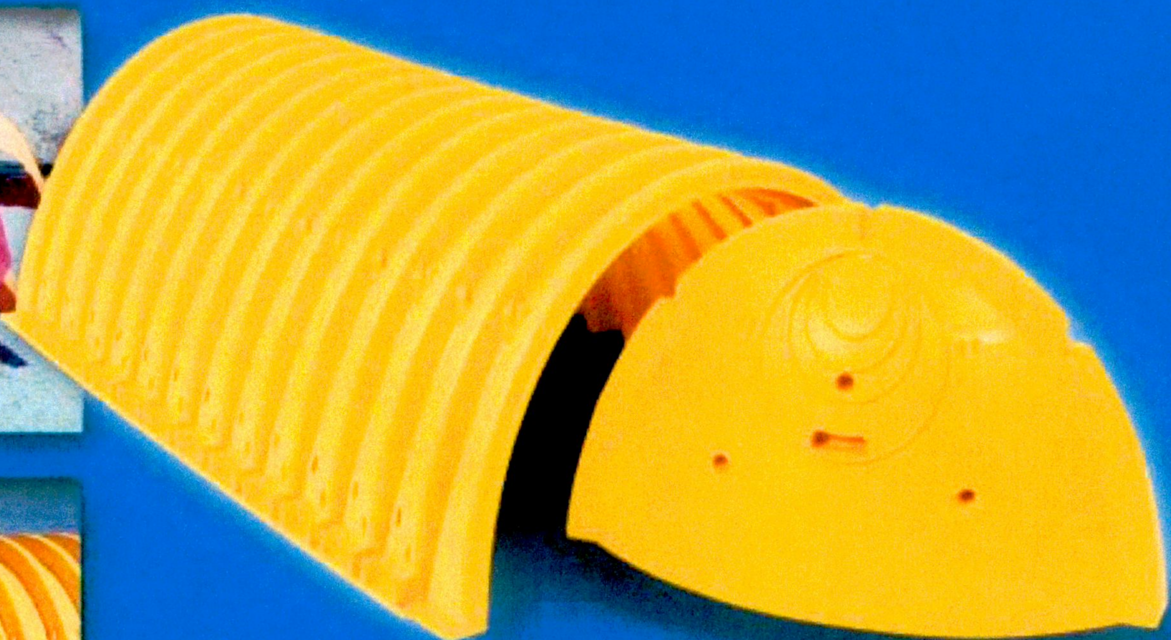
Appendix 3

Technical Details for Proposed Stormtech Underground Attenuation Chambers

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.

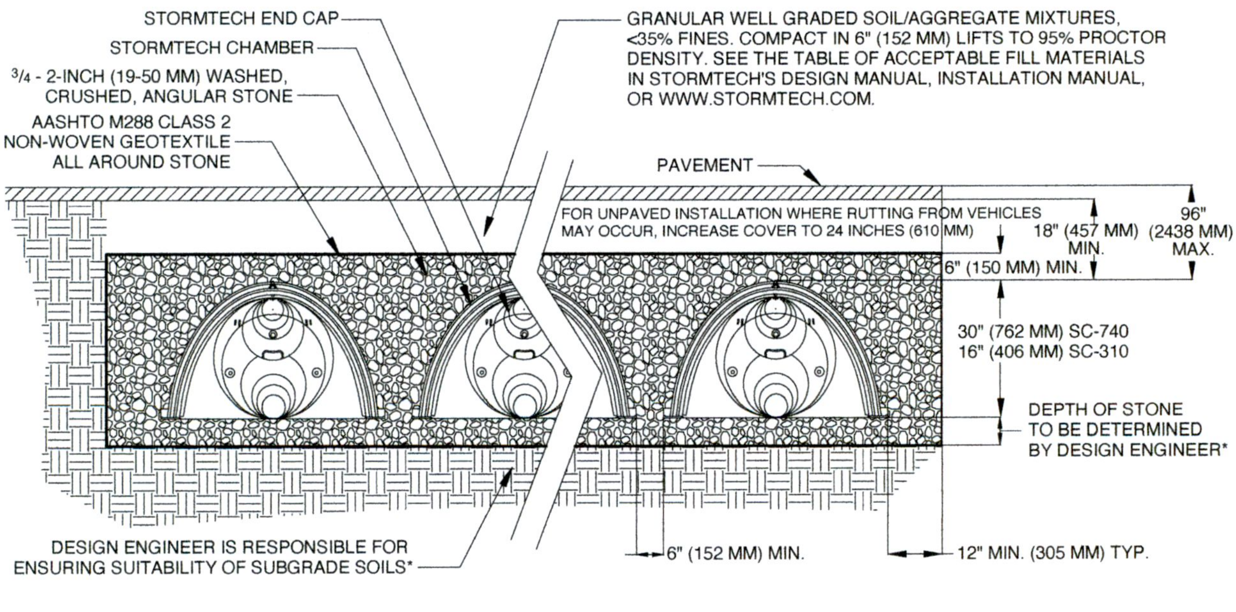
L to R: SC-310 chamber and SC-740 chamber

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

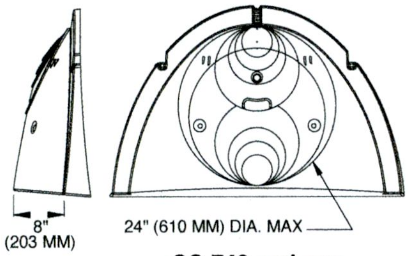
Size (L x W x H)
85.4" x 51.0" x 30.0"
(2169 x 1295 x 762 mm)

Chamber Storage
45.9 ft^3 (1.30 m^3)

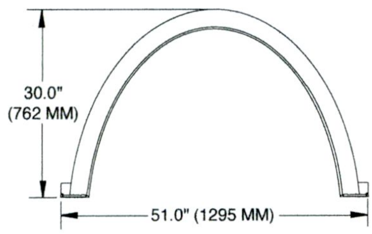
Minimum Installed Storage*
74.9 ft^3 (2.12 m^3)

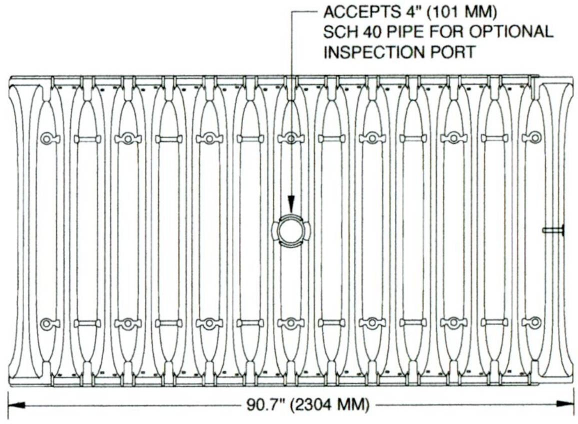
Weight
74.0 lbs (33.6 kg)

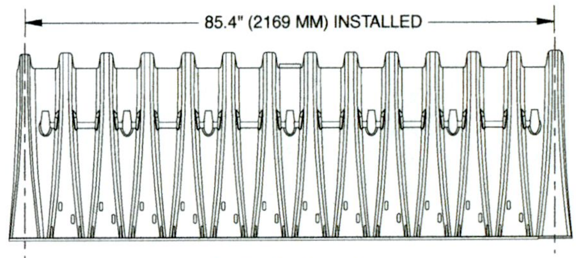
Shipping
30 chambers/pallet
60 end caps/pallet
12 pallets/truck



SC-740 end cap







SC-740 chamber

StormTech SC-310 Chamber
(not to scale)

Nominal Chamber Specifications

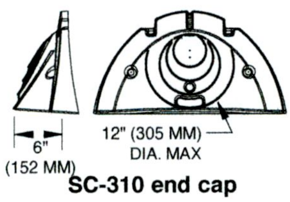
Size (L x W x H)
85.4" x 34.0" x 16.0"
(2169 x 864 x 406 mm)

Chamber Storage
14.7 ft^3 (0.42 m^3)

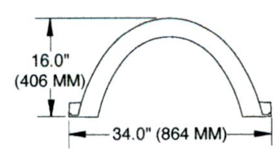
Minimum Installed Storage*
31.0 ft^3 (0.88 m^3)

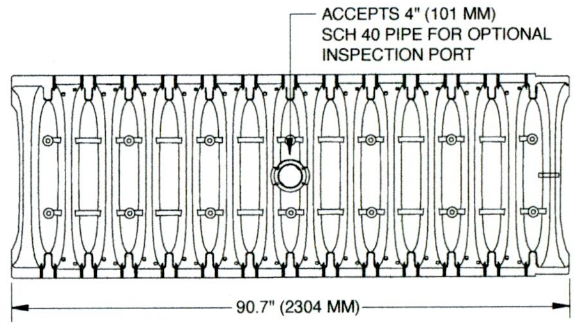
Weight
37.0 lbs (16.8 kg)

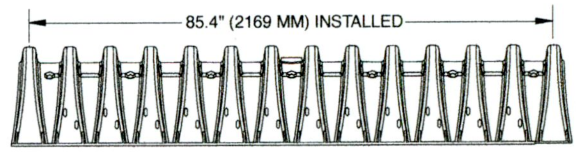
Shipping
41 chambers/pallet
108 end caps/pallet
18 pallets/truck



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:

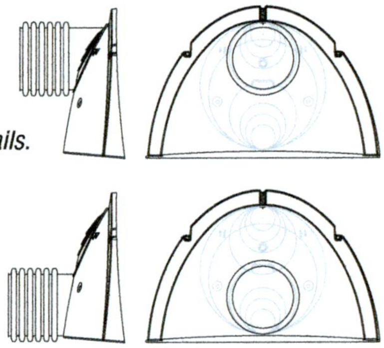
- Collaboration with world-renowned experts of buried drainage structures to develop and evaluate the structural testing program and product design
- Designing chambers to exceed AASHTO LRFD design specifications for HS-20 live loads and deep burial earth loads
- Subjecting the chambers to rigorous full 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.



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Appendix 4

Details of Isolator Row incorporated into Stormtech Attenuation Chambers

6.0 Inlets for Chambers

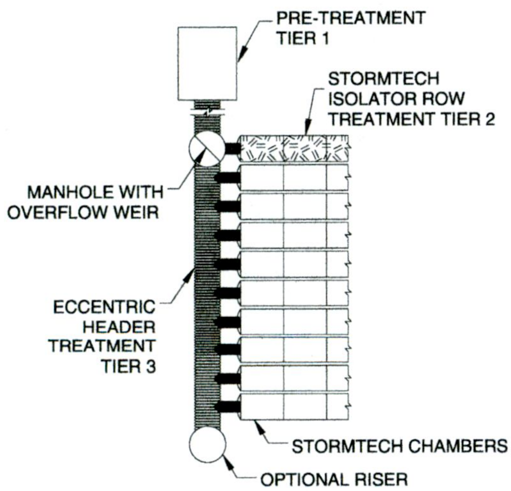
The design flexibility of a Stormtech chamber system includes many inletting possibilities. Contact StormTech's technical service department for guidance on designing an inlet system to meet specific site goals.

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

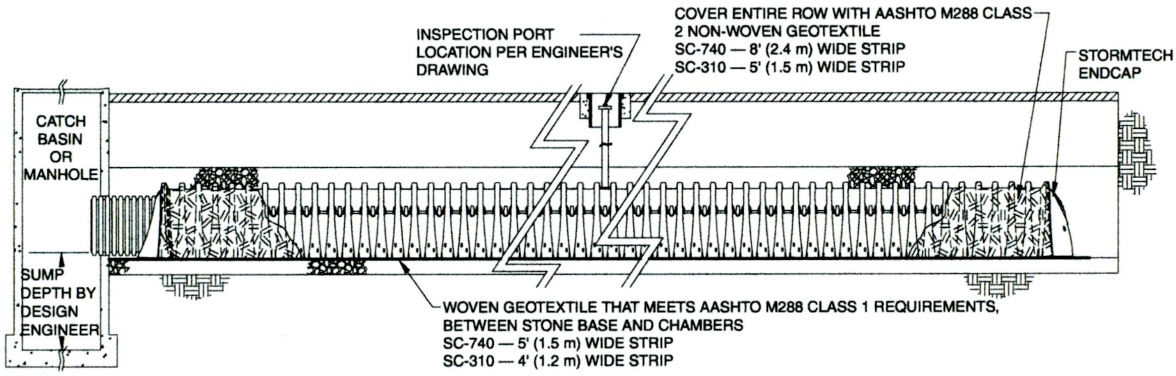
StormTech has a patent pending technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance. The StormTech Isolator Row is a row of standard StormTech chambers surrounded with appropriate filter fabrics and connected to a manhole for easy 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

StormTech

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.

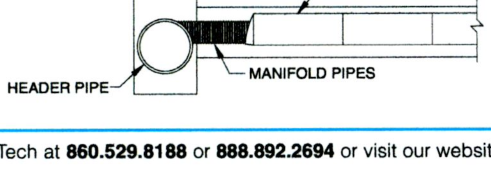
Inspection is easily accomplished through the upstream manhole or optional inspection ports. If specified, inspection ports should be located approximately every tenth chamber along the Isolator row or where practical to facilitate inspection. Maintenance of an Isolator Row is fast and easy using the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

13.0 Inspection & Maintenance

13.4 ISOLATOR™ ROW INSPECTION

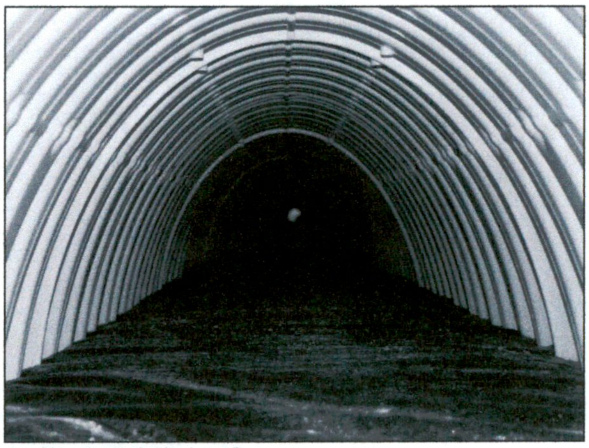
Regular inspection and maintenance are essential to assure a properly functioning stormwater system. Inspection is easily accomplished through the manhole or optional inspection ports of an Isolator Row. Please follow local and OSHA rules for a confined space entry.

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.

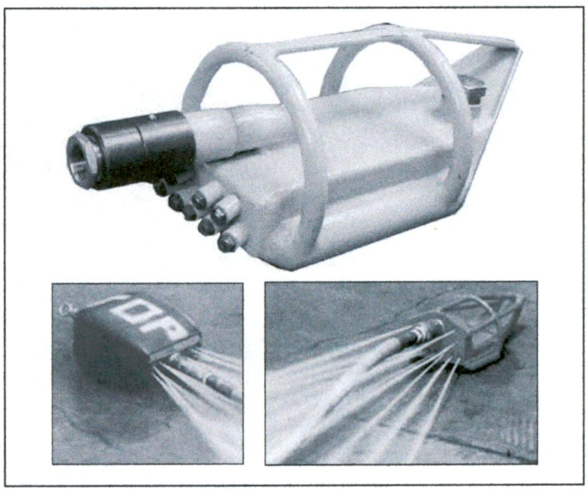
13.5 ISOLATOR ROW MAINTENANCE

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

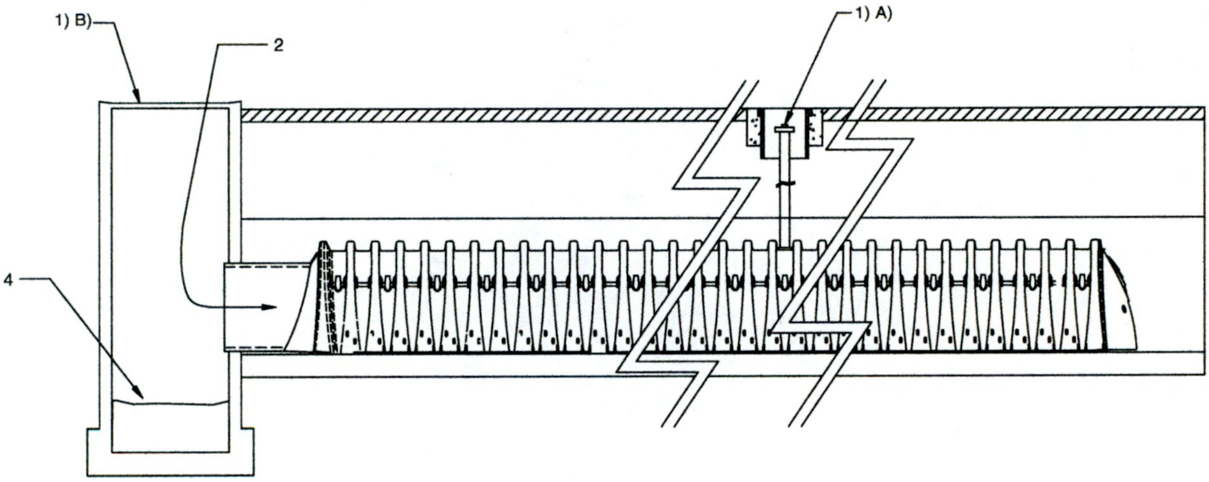
A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45" (1140 mm) or more is preferable
B) Apply multiple passes of JetVac until backflush water is clean
C) Vacuum manhole sump as required

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

Standard Construction Details

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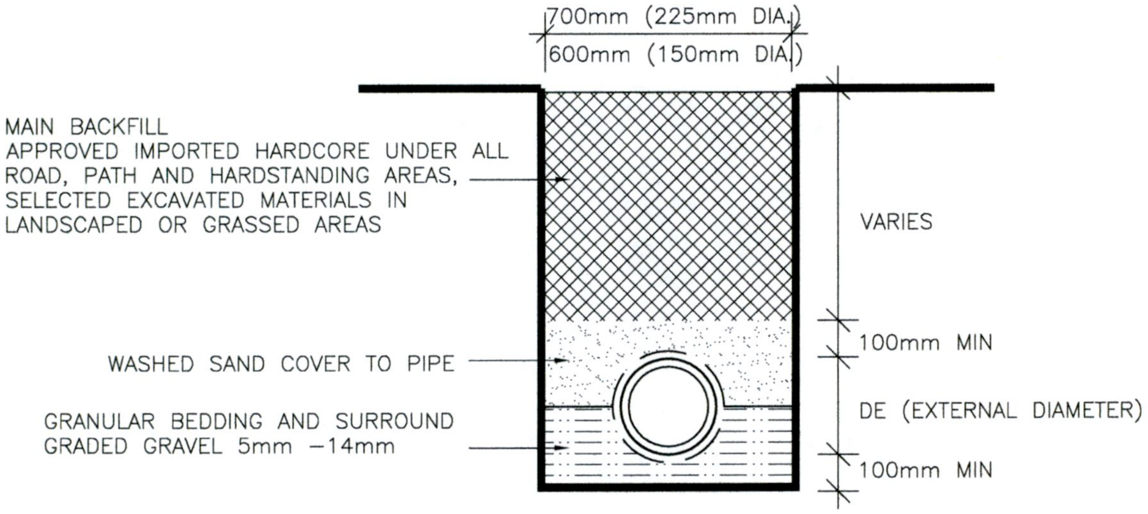
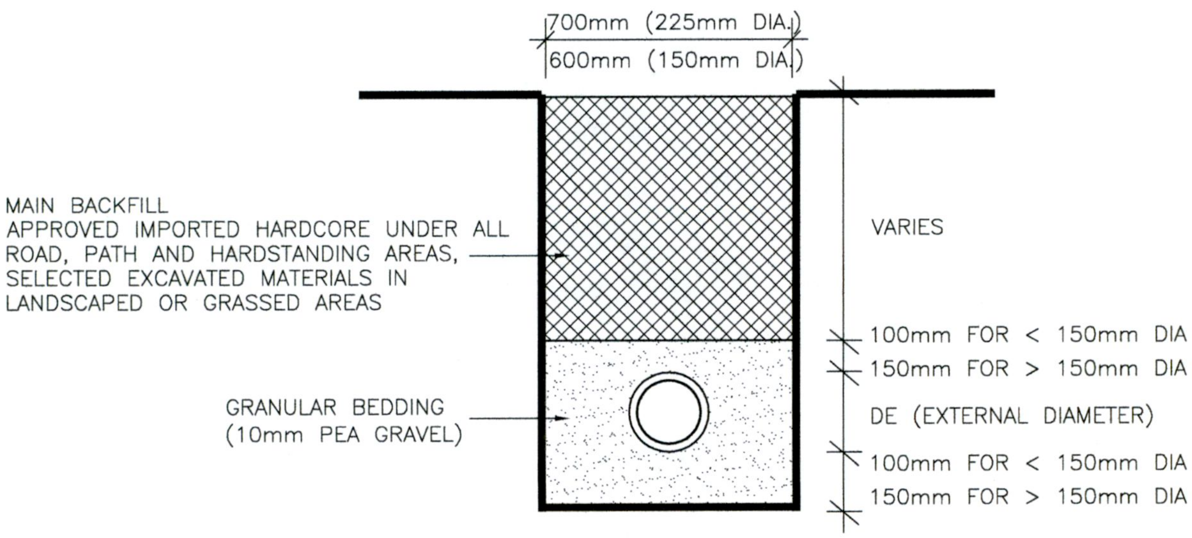
ALAN CLARKE & ASSOCIATES consulting civil & structural engineers PROJECT MANAGERS	project PILSEN SKODA			
	title SEWER BEDDING DETAILS			
ENTERPRISE CENTRE, DUBLIN ROAD, CASTLEBLAYNEY, CO MONAGHAN p: 042-9740071 f: 042-9746645 e: info@alanclarke.ie	scale NTS	drawing no 22164–SK02	rev –	date OCT22



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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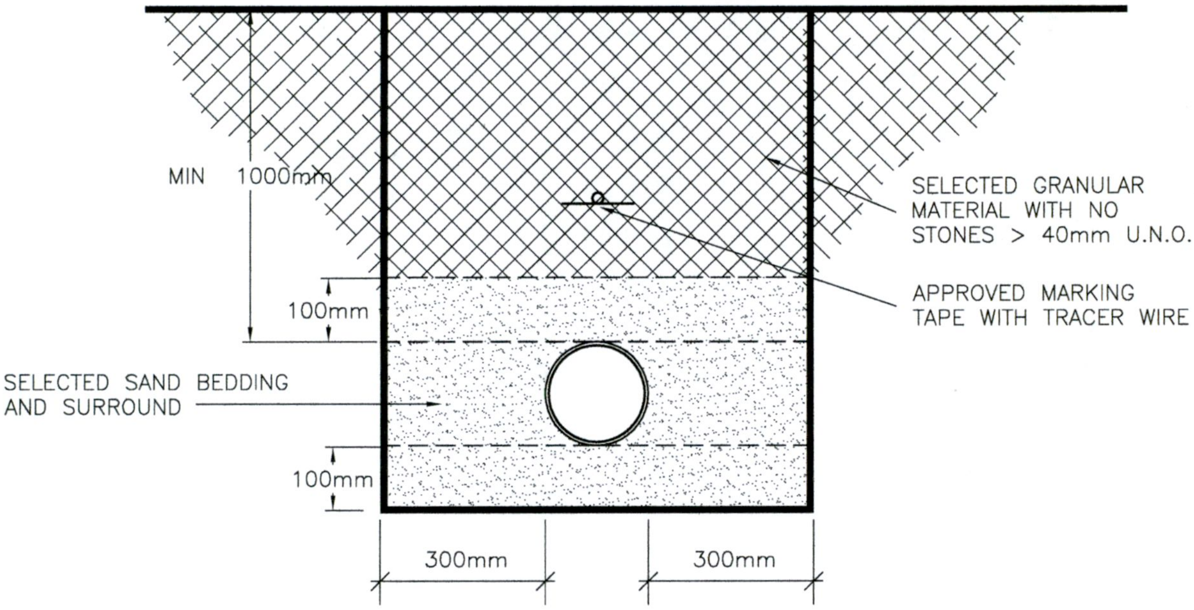
project	PILSEN SKODA
title	WATERMAIN BEDDING DETAILS

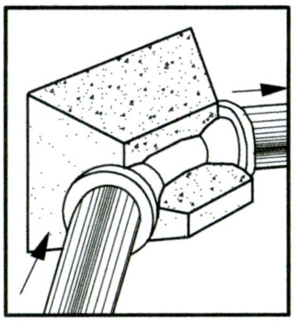
scale	drawing no	rev	date
NTS	22164–SK02	A	OCT22



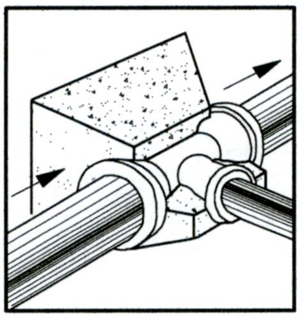
WATERMAIN BEDDING

PIPE ANCHORAGE

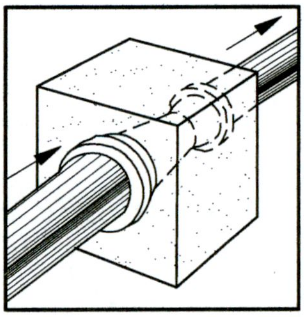
CONCRETE ANCHOR BLOCKS SHALL BE PROVIDED ON WATERMAINS AT, DEAD ENDS, TEES, BENDS OF CURVATURE GREATER THAN 22.5°, AND AT BOTH SIDES OF A SLUICE VALVE CHAMBER. ANCHOR BLOCKS SHALL ENCASE THE PIPE TO MINIMUM THICKNESS OF 150mm ALL AROUND AND SHALL BE A MINIMUM OF 600mm LONG.



90° BEND
ANCHOR BLOCK



'T' JUNCTION
ANCHOR BLOCK



REDUCER
ANCHOR BLOCK