ENGINEERING SERVICES REPORT

Spicer's Bakery, Ramparts Car Park and Andy Brennan Park Project

Athlumney Road, Co. Meath, Ireland

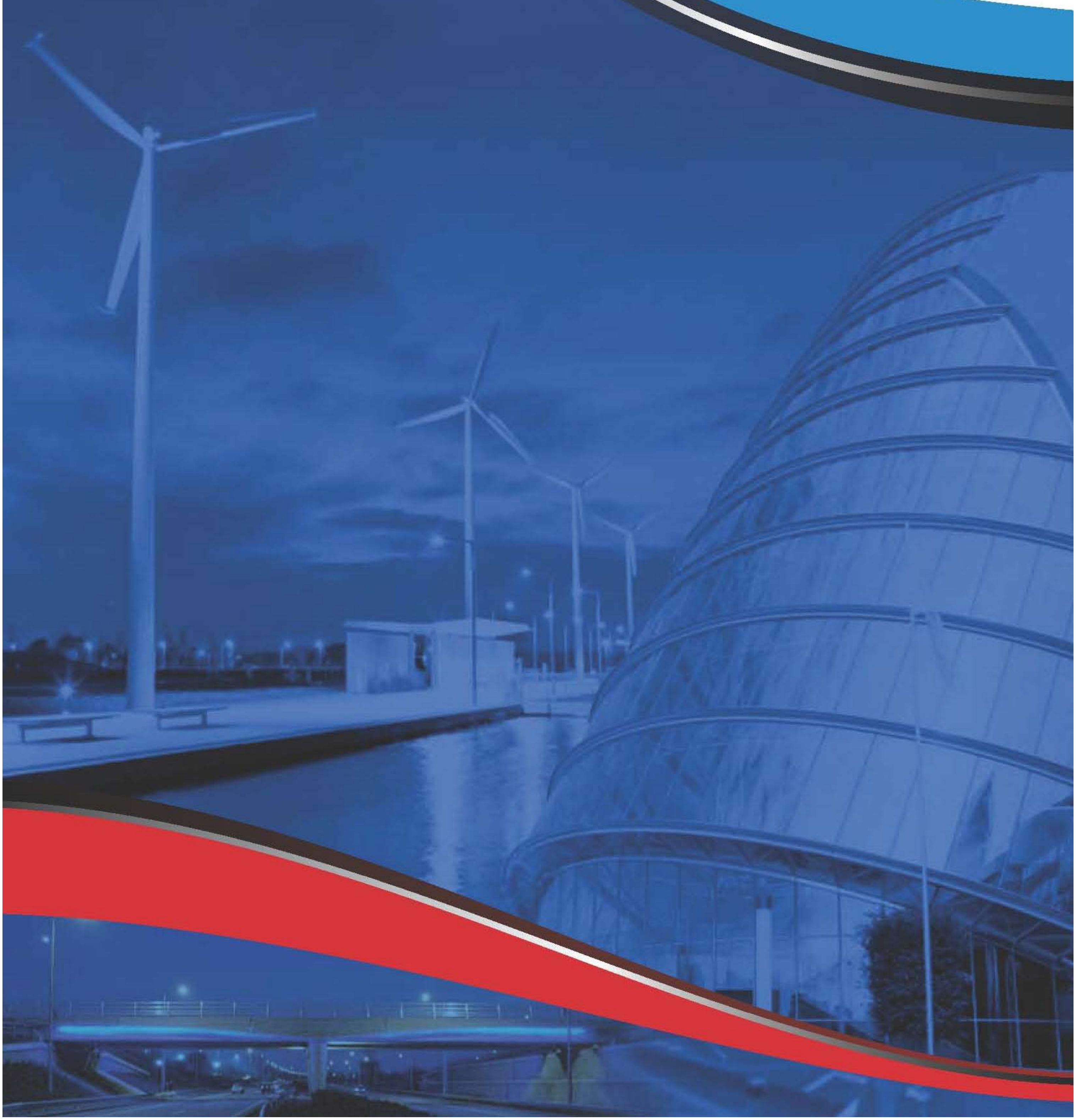
PROJECT NO. P340

20 December 2022

OCSC

O'CONNOR | SUTTON | CRONIN

Multidisciplinary Consulting Engineers



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ENGINEERING SERVICES REPORT

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1 INTRODUCTION

1.1 Appointment

O'Connor Sutton Cronin & Associates (OCSC) have been appointed by *Meath County Council* to carry out the design of the Civil Engineering services (surface water and wastewater drainage, watermain) associated with the site at Spicer's Bakery and Andy Brennan Park at Athlumney, Navan, Co. Meath, Ireland.

1.2 Administrative Jurisdiction

The proposed development is in the jurisdiction of Meath County Council (MCC), and therefore the engineering services design was carried out with reference to the following:

- Meath County Development Plan (2021 – 2027).
- Greater Dublin Strategic Drainage Study (GDSDS).
- The Planning System and Flood Risk Management Guidelines for Planning Authorities (Department of Environment, Heritage and Local Government and the Office of Public Works).
- Circular PL2/2014 (13th August 2014)

1.3 Site Location

The subject site is located near the Dillonsland, Navan Co. Meath with the R153 horizontally crossing through, dissecting the site.

The land within site boundaries to the North of the R153 currently comprises of a derelict mill and bakery. Within the mill and bakery site there are two National Inventory of Architectural Heritage (NIAH) protected structures: Spicers Basin (NIAH Reg. Number 14010082) and the Mill Building (NIAH Reg. Number 14010089). Within this area of land there is a plot which is owned by the Navan Silver Band and is therefore excluded from this assessment.

The land within the site boundaries to the South of the R153 currently encompasses Andy Brennan's Peoples Park.

The site is bounded by the River Boyne to the West, The River mill View Apartments to the Northwest. The Ramparts Walk Trail and historic canal to the North and Northeast and the grounds of Loreto Secondary School, Navan Education Centre, and the Sommerville Apartments to the South.

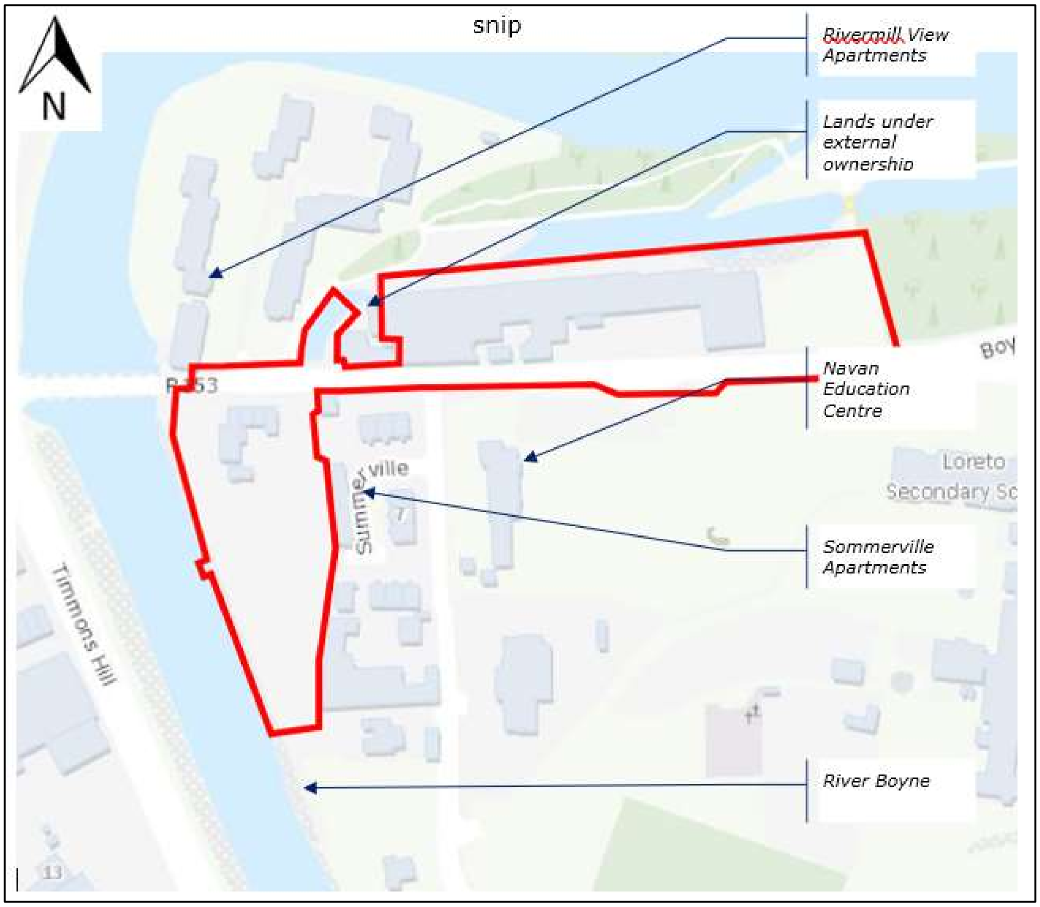

Figure:1-1: Site Location

1.4 Existing Site Overview

The subject site is approximately 1.6 hectares. It is a mix of landscape, brownfield, and hardstanding, see Figure 1 2

Figure 1-2: Existing site overview

The area of land within the site boundaries to the North of the R153 is sloping in a northerly direction towards the Ramparts Trail Walk and River Boyne. Levels at the northern boundary of the existing carpark are approximately 36.0m AOD falling to levels of 33.00m AOD at the site's Northern boundary.

The area of land to the South of the R153 is predominantly flat at a level of approximately 32m AOD however there are high points of 33.3m AOD at the park entrance and low points of 30.00m AOD at the tunnel underneath the R153.

1.5 Proposed Development Description

The proposed development comprises of the following

- The preservation and conservation of the former Spicer's Bakery (PS) and demolition of associated outbuildings and sheds.
- The renovation and extension of the former Spicers's Bakery 2 story office building as a café with associated public realm area inclusive of bandstand.
- The reconfiguration of the Ramparts Carpark with new access and egress points, cycle parking, public realm area and footpaths.
- The demolition of 4 no. terraced derelict properties along the Athlumney Road and replacement with a stepped public plaza area at the entrance to Andy Brennan Park.
- The redevelopment of the Andy Brennan Park for active recreational use including the refurbishment of the existing fishing platform.
- Associated landscaping, associated pedestrian linkages including 2 no. pedestrian crossings; site drainage works; and all associated site development works

Figure:1-3: Proposed Site Layout

2 SCOPE OF SERVICES REPORT

This Engineering Services Report was prepared by reviewing the available data from the Local Authority sources and national bodies *i.e.,* Meath County Council, Irish Water, the OPW, and the wider Design Team. The following services are addressed within this report, with respect to the proposed development:

- Surface Water Drainage;
- Wastewater Drainage;
- Potable Water Supply;

An assessment on potential flood risks associated with, and because of, the proposed development is provided under separate cover, as part of this application. Refer to document **P340-OCSC-XX-XX-RP-C-0003** for details of the Site-Specific Flood Risk Assessment.

This report should be read in conjunction with the set of OCSC Civil Engineering design drawings that also accompany this submission:

The proposed design, for the aforementioned services, have been carried out in accordance with the following technical guidelines and information:

- Meath County Council Development Plan (2021 – 2027).
- Greater Dublin Strategic Drainage Study (GDSDS).
- Greater Dublin Regional Code of Practice for Drainage Works (GDRCOP).
- Irish Water Code of Practice for Wastewater, IW-CDS-5030-03.
- Irish Water Code of Practice for Water Supply, IW-CDS-5020-03.
- The Building Regulations – Technical Guidance Document Part H.
- BE EN 752 – Drainage Outside Buildings.
- BS 7533-13 – Guide for Design of Permeable Pavements;
- The Office of Public Works, the Planning System and Flood Risk Management;
- Meath County Council and Irish Water's Drainage and Watermain Records.

Members of the wider design team cover all other elements of the application pertaining to traffic, sustainability, landscaping, planning, ecological, and architectural detail.

3 SURFACE WATER DRAINAGE

3.1 Design Guidelines Overview

Any planning permission sought on the subject lands are required to adhere to the Local Authority requirements *i.e.,* the Meath County Council Development Plan, and as such, the Greater Dublin Strategic Drainage Study (Dublin City Council, 2005).

New development must ensure that a comprehensive Sustainable Drainage System (SuDS) is incorporated into the development. SuDS requires that post development run-off rates be maintained at equivalent, or lower, levels than pre-development levels. Thus, the development must be able to retain, within its boundaries, surface water volumes from extreme rainfall events up to a 1 in 100-year rainfall event, more commonly expressed as a 1.0% AEP (Annual Exceedance Probability), *while also allowing for an additional climate change factor of 20% increase in rainfall intensity* in accordance with the current Meath County Development Plan.

Any new development must also have the physical capacity to retain surface water volumes as directed under the Greater Dublin Strategic Drainage Strategy (GDSDS) and, if necessary, release these attenuated surface water volumes to an outfall at a controlled flow rate, not greater than the greenfield runoff equivalent.

A further component of the SuDS protocol is to increase the overall water quality of surface water runoff before it enters a natural watercourse or a public sewer, which ultimately discharges to a water body. This is to ensure the highest possible standard of surface water quality.

All SuDS are designed in accordance with best practice Evaluation Guide, and the CIRIA C753 (The SuDS Manual) guidance material, with development discharge rates restricted to greenfield runoff equivalent, which is significantly less than existing scenario.

3.2 Existing Site Drainage

3.2.1 Existing Surface Water Drainage Infrastructure

There is no evidence that existing units, hardstanding areas and landscaping areas currently discharge surface water into either a local storm water network or a local combined network. There is no apparent treatment nor attenuation facilities in place.

Public records received indicate that there is no existing surface water network serving the site currently as seen in figure 3-1. However, there is an existing surfacewater network coming from the west of the Andy Brenan Park (Sommerville Apartments), there is no evidence of a storage tank or pond within in the park. The catchment served by the existing network is accounted in the proposed scheme for calculating the required attenuation volume. It is envisaged that a survey would be carried out at the next design stage for confirming the existing network details.

Figure 3-1: Existing surface water records

3.2.2 Existing Site Catchment Area

As detailed in *Section 1.4*, the existing 1.6 hectares is a mix of landscape, brownfield, and hardstanding.

In the absence of the surface water runoff infrastructure on the existing site, the runoff is believed to pond in the natural depression and is allowed to infiltrate naturally in the ground or find its way into the river Boyne located immediately adjacent, possibly by overland flow.

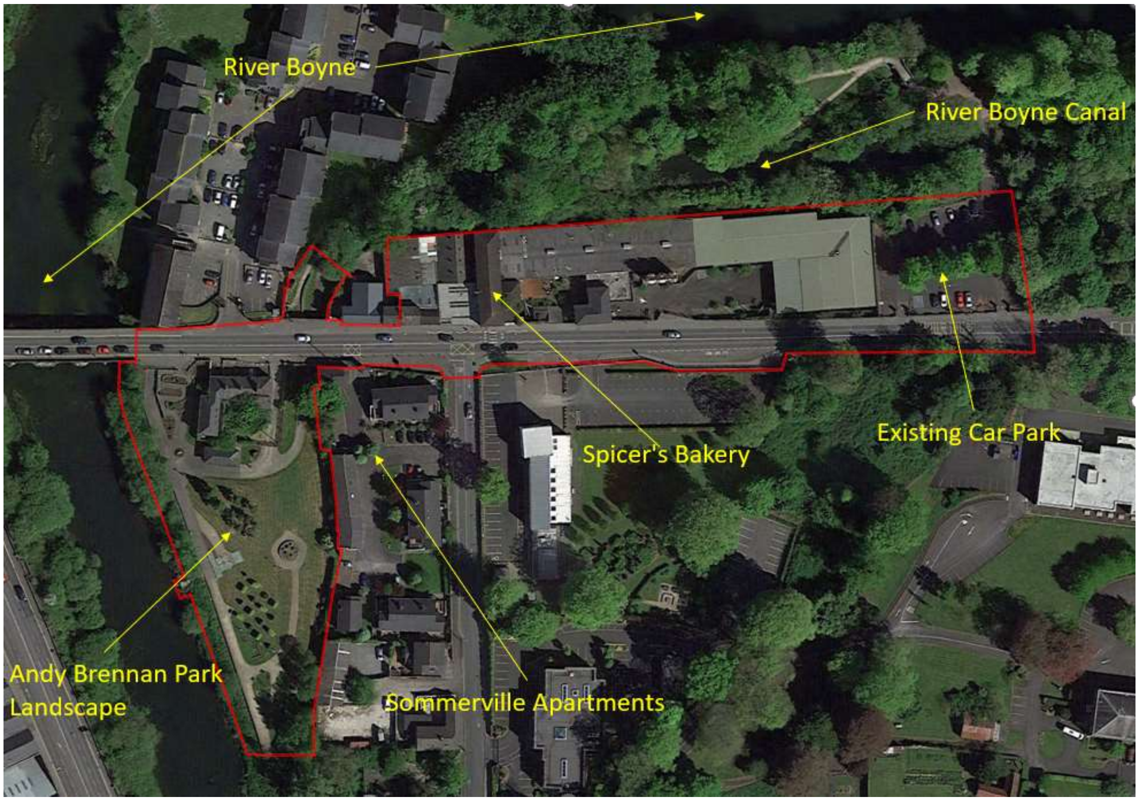

Figure 3.2 – Existing Site Catchment Area

3.2.3 Existing Site Rainfall Runoff

The soil value can be calculated from *Figure 1.4.18 (institute of Hydrology, 1978)* which shows the various soil types. The soil classifications are also available from the *Wallingford Procedure, Volume 3, Maps, "Winter rain acceptance potential"*. The equation was first published in FSSR 16, 1985. Refer to *Figure 3.2* for the "Soil" value in MicroDrainage that consider the SPR value and it can be obtained at *Greater Dublin Strategic Drainage Study – Regional Drainage Policies Volume 2 – New Development at section 6.7.2*.

SOIL	SPR value (% runoff)
1	0.1
2	0.3
3	0.37
4	0.47
5	0.53

Figure 3.3 – SPR Values for Soil (Excerpt from GDSDS: Table 6.7)

In the absence of the site-specific Geotechnical investigation, infiltration rates for the are partially adopted form a nearby project located south of the Andy Brenan Park at convent road, Athlumney

The hydraulic and hydrologic calculation and modelling for the Andy Brenan Park (Catchment-2) has adopted the infiltration rates from the adjacent project whereas the Parking area (Catchment-1) is modelled without considering any ground infiltration. Please refer to the Appendix F for the calculations for adopted soil infiltration values. A project specific Geotech investigation should be carried out prior to construction to confirm the groundwater depth and the soil infiltration rates.

For the purpose of hydrologic and hydraulic modelling, a Soil Type 3 is used in design calculations along with the local Standard Annual Average Rainfall (SAAR) equivalent of 863mm, as received from Met Éireann, was used to determine the rainfall runoff rate. Refer to the Appendix B for the Return Period Rainfall Depths for Sliding Durations from Met Éireann.

Using the ICPSuDS Input, {Flood Studies Report (FSR)} Method, the rainfall runoff discharging from the total brownfield site area that is to be developed (i.e., 1.6 ha), in its existing condition, has been estimated at $QBAR_{RURAL}$ = 3.7 l/s/ha. Refer to *Figure 3.3* for an excerpt of the results from the MicroDrainage Runoff Calculator, which also provides the calculated QBAR runoff rate along with the discharge rate for varying Annual Recurrence Intervals (ARI). Refer to the Appendix B for the QBAR runoff calculations.

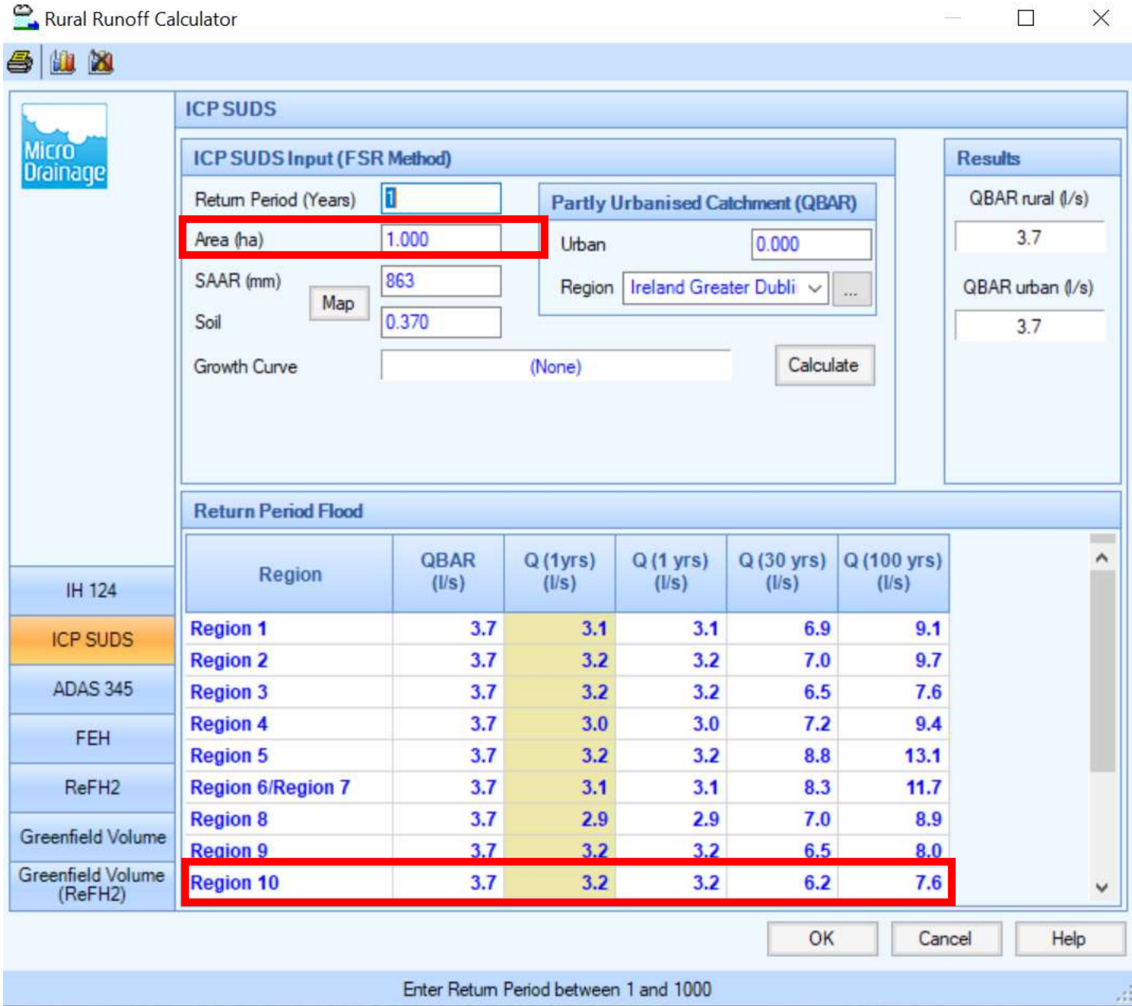

Figure 3.4 - Existing Site Runoff Calculator Results (MicroDrainage Excerpt)

3.3 Proposed Surface Water Drainage Design Strategy

3.3.1 Proposed Surface Water Strategy Overview

There is no existing surfacewater drainage network in the vicinity of the proposed development to receive the runoff generated from the site. Hence, it is proposed to dispose the surface water runoff by both local infiltration and discharging into the river Boyne at a controlled rate as per the section 3.2.2 included above.

Refer to drawings P340-OCSC-XX-XX-DR-C-0500 for the proposed surfacewater drainage layout proposed to serve the development.

The proposed development is to be served by a sustainable drainage system that is to be integrated with the developments landscaping features and is typically to comprise intensive landscaping, extensive pervious paving, filter drains, trapped road gullies, flow control devices and attenuation storages.

The overall development is divided into several surface water sub-catchments because of the natural topography, site layout, and other site constraints. All surface water runoff is attenuated and treated within the new development site boundary, before ultimately discharging to the river Boyne at a controlled rate as calculated in section 3.2.3 above.

Sustainable Drainage Systems are to be provided, wherever practicable, and these are discussed in more detail in Section 3.3.3, with discharge rates from site being restricted to the greenfield equivalent runoff rate for design rainfall events up to, and including, the 1% AEP, in accordance with the Meath County Development Plan and the GDSDS.

3.3.2 Climate Change Allowance

The proposed surface water network has been designed to allow for an additional 20% increase in rainfall intensity, to allow for Climate Change projections, in accordance with the Meath County Council Development Plan and the GDSDS.

All discussion within this report, with regards to surface water network design calculation and results, include for the allowance of an increase of 20% in rainfall intensity, as required.

3.3.3 Surface Water Management Strategy

The proposed surface water network is to be split into 2nr. main catchments, which are described further, in *Section 3.4.3*, replicating the natural site catchments.

1) Catchment 1 – Parking Area
2) Catchment 2 – Andy Brenan Park

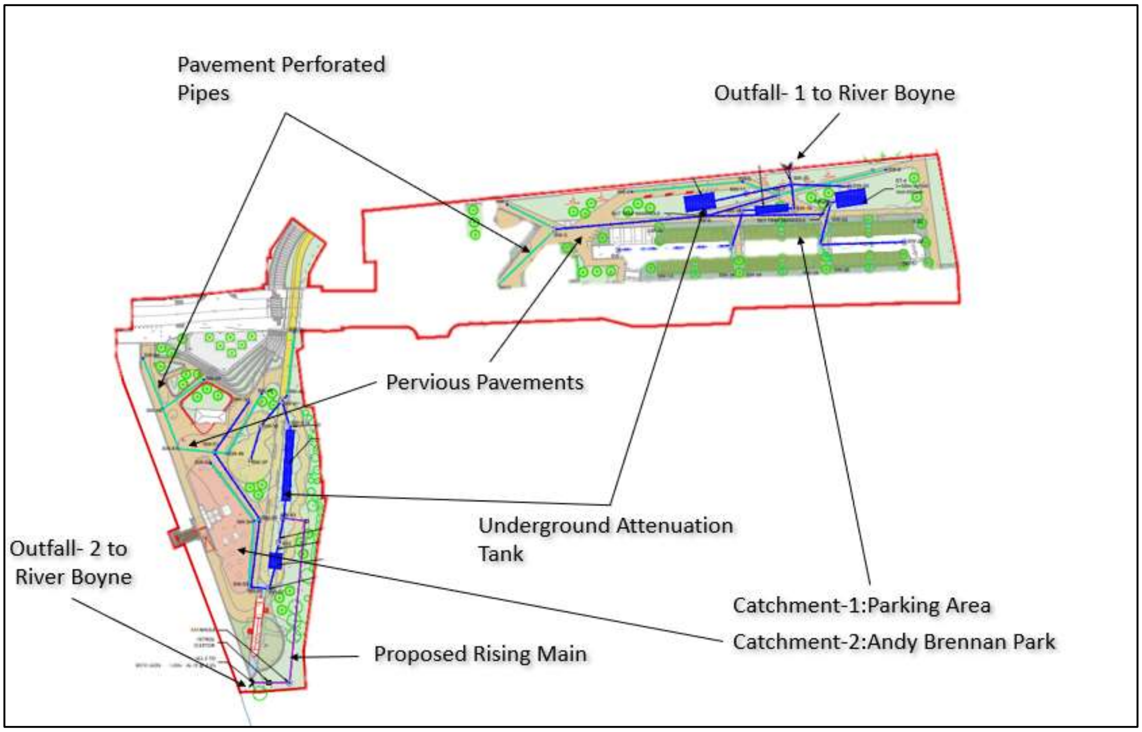

Figure 3.3 - Proposed Surface Water Drainage Strategy

As per the proposed site layout and landscaping features the 2 catchments are divided into several sub-catchments, in order to best integrate Sustainable Drainage Systems. Each sub-catchment area will look to provide interception and treatment to the rainfall runoff, either at source or through site design.

In the absence of the site-specific Geotechnical investigation, infiltration rates for the are partially adopted form a nearby project located south of the Andy Brenan Park at convent road, Athlumney

The hydraulic and hydrologic calculation and modelling for the Andy Brenan Park (Catchment-2) has adopted the infiltration rates from the adjacent project whereas the Parking area is modelled without considering any ground infiltration.

It is envisaged that a detailed that SI would be carried out for the project at the next stage of the development.

Each catchment is to discharge treated and attenuated flows (to Qbar equivalent) to the existing public surface water infrastructure.

Interim attenuation benefits are to be provided by the extensive landscaping features and pervious pavements .However, in order to reduce development flow rates to the Greenfield Equivalent Runoff Rate (QBAR), further attenuation within the underground Arch type attenuation tanks is to be provided; before discharging from the site to the River Boyne.

The typical traditional and Sustainable Drainage Systems (SuDS) provided, all of which have been designed in accordance with CIRIA C753, the SuDS Manual, and the design guidance material listed in *Section 2* of this report, are listed and detailed in order of general sequence within the drainage network, as follows:

3.3.3.1 Pervious Paving

Pervious pavements provide a pavement finish suitable for both pedestrian and vehicular traffic, while also allowing rainwater to infiltrate the surface layer and into the underlying pervious structural layers. Here, the rainwater is temporarily stored beneath the overlying finished surface before either infiltration to the ground or / and discharge to the proposed surface water drainage network

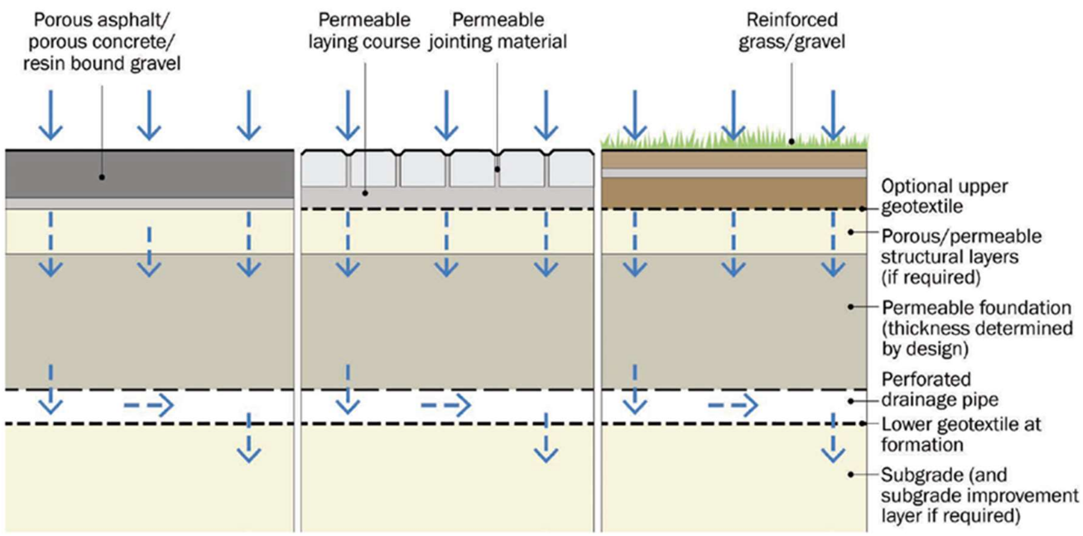

Figure 3.4 - Detail of Type B Pervious Paving (CIRIA C753)

Pervious paving systems are an efficient means of treating the rainwater at source by providing initial interception of the rainwater, reducing the volume and frequency of the runoff and improving the surface water quality by providing at source treatment of the rainfall runoff leaving the site. This is achieved by helping remove and retain pollutants prior to discharge to the drainage system and / or groundwater system.

A Type B pervious paving, with a 300mm (typical) depth of open graded crushed rock as base course, is to be provided in all car parking spaces, within the proposed development.

3.3.3.2 Filter Drains

Filter drains (perforated pipe with cl505 surround) to be provided along roads where possible to intercept and treat polluted water.

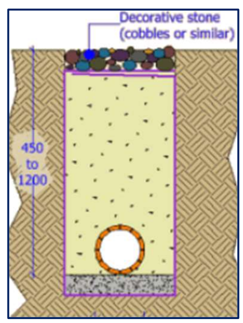

Figure 3.5 - Filter Drain under pavement (left)

Filter drains allow for interception of rainfall, while also acting as storage and conveying the excess rainfall runoff to the network outfall. Further benefits allow for filtration of surface water and infiltration to groundwater.

3.3.3.3 Trapped Road Gullies

All road gullies serving the proposed development are to be trapped, to help prevent sediment and gross pollutants from entering the surface water network, and thus improving the water quality discharging from site.

The grated covers are to have a minimum load classification of D400, for frequent vehicular traffic.

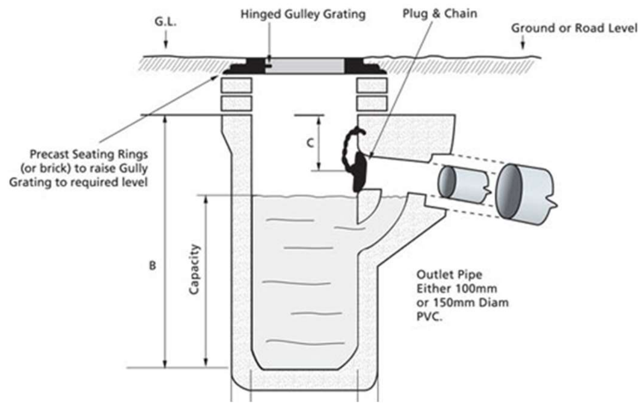

Figure 3.6 - Trapped Road Gully (Typical Detail)

3.3.3.4 Underground Pipe Network

A traditional gravity pipe and manhole network will be provided, to convey the collected rainfall runoff as far as the development’s proposed outfall. Manholes, compliant with the GDSDS and GDRCOP, are provided for maintenance access at branched connections, change in pipe size and gradient, and at intervals no greater than 90m distance.

3.3.3.5 Silt Traps

A manhole upstream of attenuation system is to contain a 600mm sump, below invert level of outlet pipe, in order to trap sediment and other gross pollutants, and prevent from entering the downstream watercourse; thus, improving the water quality discharging from site.

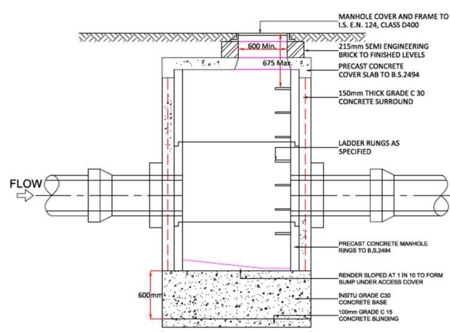

Figure 3.7 - Typical Detail of Silt Trap Manhole

3.3.3.6 Polytunnel/Arch Storage Systems

Unlined proprietary poly tunnel type stormtech storage units are to be provided for the attenuation of rainfall runoff for the catchment area.

These systems are to provide sufficient temporary storage volume for rainfall events up to, and including, the design 1% AEP rainfall event (including climate change). Typical Polytunnel storage systems comprise plastic curved tunnel units of good porosity (ranging from 60-70%), structurally arranged in rows.

These systems also allow for interception of initial rainfall to be provided at the base of the system, by elevating the outlet relative to the systems base.

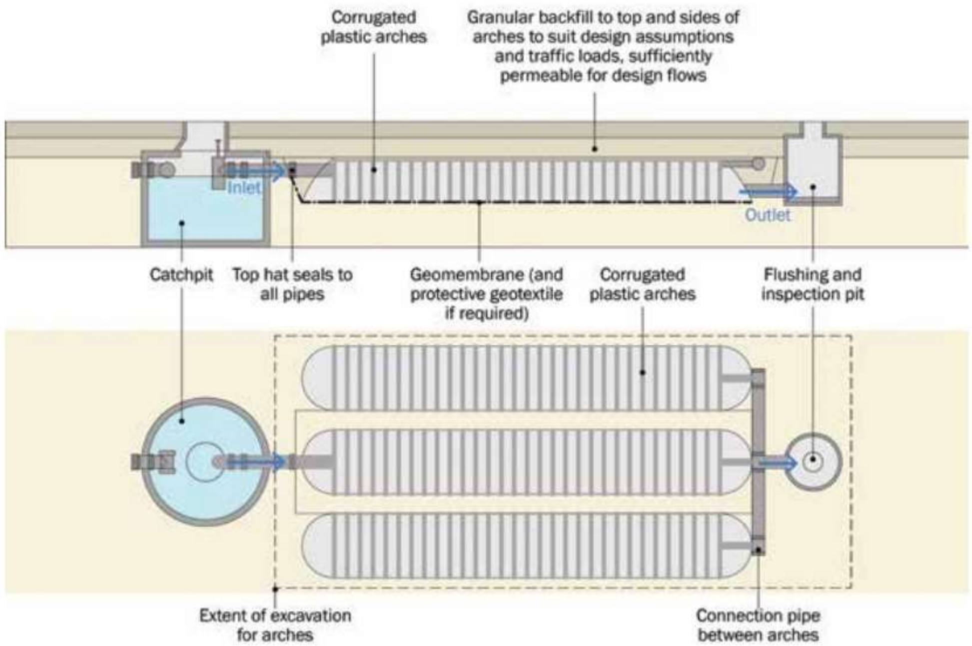

Figure 3.8 – Typical layout of an Arch type of storage system

Access chambers for inspection and maintenance are also to be provided.

Refer to **Appendix H** for the copy of the Attenuation System details.

3.3.3.7 *Flow Control Device*

Flow Control devices like hydrobrakes are to be provided at outlet of the attenuation tank with an aim to enable upstream storage.. These flow control devices shall be as per specialist design.

Figure 3.9 - Vortex Hydro-Brake Flow Control Unit (Hydro International)

The flow controls shall all be placed strategically across the development's sub-catchments so that the total development discharge rate is restricted to the greenfield equivalent runoff rate of 3.7 l/s/ha, as described in Section 0.

3.3.3.8 *Oil Separator*

Oil separators are designed to separate gross amounts of oil and large (>250μm) suspended solids from the surface water, mainly through sedimentation process.

A Class 1 bypass fuel separator is to be provided immediately upstream of the final manholes discharging from site, as an additional and final mitigation measure, prior to surface water discharge from each unit catchment to the river.

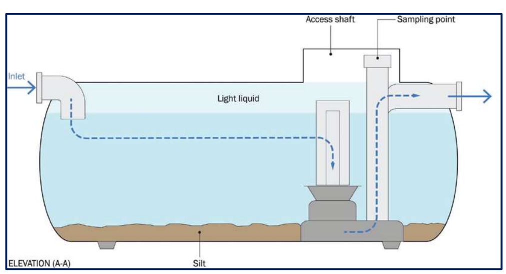

Figure 3.10 - Typical Section Detail of Fuel Separator (CIRIA C753)

3.4 Proposed Sustainable Drainage Network Detailed Design

3.4.1 Software Design Criteria

The proposed surface water network has been designed in accordance with the regulations and guidelines outlined in *Section 2*, using MicroDrainage Network Design package, by Innovyze Inc., which simulates the performance of the integrated drainage network for varying rainfall return periods and storm durations.

The MicroDrainage Network Design software applies the Flood Studies Report (FSR) methodology for analysis of the rainfall profiles. However, the input design parameters that were used, as part of this design, were based on the available Flood Studies Update (FSU) data, *i.e.,* the return period rainfall depths for sliding durations, which determine the $\mathbf{M_{5\text{-}60}}$ and **R** values, and the standard annual average rainfall (SAAR); as sourced from Met Éireann.

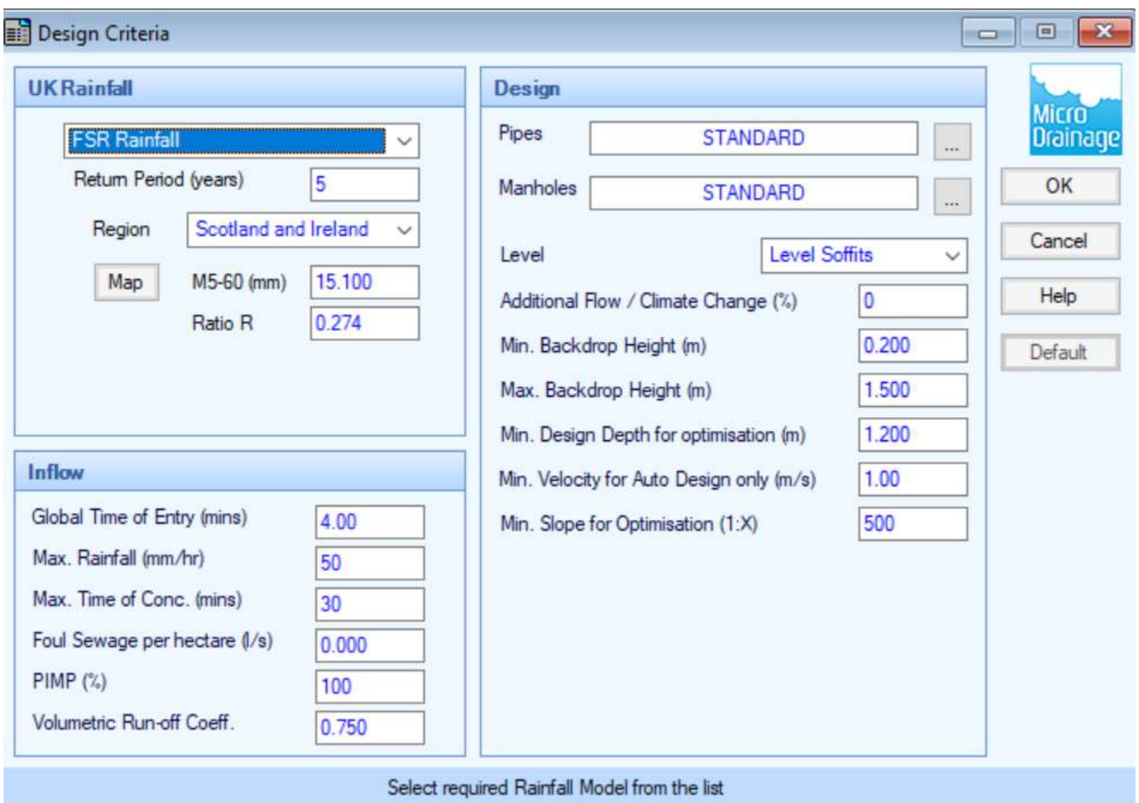

Figure 3.11 - Surface Water Network Design Criteria (MicroDrainage Excerpt)

3.4.2 Proposed Development Rainfall Runoff

It is proposed to reduce and restrict the rainfall runoff, discharging from the proposed development to the greenfield equivalent, $QBAR_{RURAL}$, runoff rate, as per the FSR ICP SuDS method, which is based on the IH124 method for catchments smaller than 25km^2 in area.

This is to be achieved with the provision of a flow restrictor/orifice (Hydro-Brake Optimum by Hydro-International, or similar approved) prior to discharging the attenuated runoff from the attenuation tank to the river. Sub-catchment flow-control devices and associated attenuation are also to be strategically provided, to maximise SuDS benefits and avail of the proposed SUDS feature for preliminary attenuation.

Refer to Figure 3.4, in *Section 3.2.3*, for an excerpt from the results MicroDrainage Runoff Calculator for the development catchment area, which indicates the greenfield equivalent, $QBAR_{RURAL}$, value of 3.7 l/s/ha**,** along with the calculated runoff for varying Average Recurrence Intervals (ARI).

This maximum flow rate (i.e., greenfield equivalent) was incorporated into the integrated drainage network design for each contributing catchment, on a pro-rata basis for each of the development's outfalls to the public sewer.

For the purpose of the surface water network design simulation, we have considered all paved areas as being 100% impermeable and taken a *summer* global runoff coefficient, C_v, of 0.75. The proposed car parking and Andy Brenan Park areas comprises of extensive pervious paving above a drainage layer base course.

3.4.3 Proposed Development Surface Water Catchment Areas

Due to the alignment of the proposed layout, the proposed surface water network is to be split into 2nr. main catchment areas. With catchment 1 being the parking area and catchment 2 being the Andy Brenan Park.

Each catchment is to be split into further sub-catchments, in order to maximise treatment and storage benefits of the SuDS structures described in *Section 3.3.3*

Each catchment is to discharge treated and attenuated flows (to Qbar equivalent of 3.7 l/s/ha) to the river Boyne.

3.4.4 Proposed Surface Water Pipe Network Design

The overall surface water drainage system, serving the proposed development, is to consist of a gravity sewer network that will convey runoff from the paved areas to the outfall manhole. The proposed surfacewater network will discharge a controlled attenuated flow rate to the river Boyne.

The proposed piped network shall be been designed in accordance with BS EN 752 and all new infrastructure is to be compliant with the requirements of the GDSDS and the GDRCOP for Drainage Works, with minimum full-bore velocities of 1.0 m/s achieved throughout.

Refer to drawing P340-OCSC-XX-XX-DR-C-0500 for the surfacewater drainage infrastructure layout.

3.5 Proposed Surface Water Attenuation Storage

An integrated attenuation strategy has been applied across the entire development, in order to best manage the rainfall runoff from hardstanding areas and reduce the runoff rates to less than the greenfield runoff equivalent rate.

This will be provided initially through integration with the landscape proposals around the development in which sufficient landscaped features are provided in addition to the permeable paved surfaces. Permeable pavers are a prominent feature of the proposed development and have been extensively used in the the pedestrian circulation areas, the parkour area and car parking areas.

The development is to combine a number of sustainable drainage features along with elements of a traditional drainage system. The developments main attenuation will be provided under the subsurface of the permeable pavements and also the modular polytunnel type storages like StormTech.

The Pervious paving to be provided within the development will provide at source treatment of runoff while also providing interim storage within the base course. A minimum of 300mm stone with a minimum porosity of 30% is to be provided below the previous paving. Runoff temporarily stored within the base course will be allowed to infiltrate naturally to ground and then also slowly routed downstream to the attenuation tank.

3.6 Surface Water Outfall Locations

Each catchment will have its own independent outfall into the river Boyne. The outfall location would be finalised based on the natural topography of the site, the new development layout, and the frozen design finish levels.

The discharge rates at both outfall locations are to be restricted to a maximum flow rate of 3.7 l/s/ha, which is equal to the greenfield runoff equivalent as discussed in *Section 3.2.3.*

The above is to ensure that there is no increase in flow rates and volumes, from the development site, being discharged to the receiving waterbody; thus, causing no adverse impact on adjoining and other downstream infrastructure.

3.7 Water Quality

The quality of the surface water discharging from site is to be improved through the following provisions, each of which is discussed in greater detail in *Section 3.3.3.*:

- Pervious Paving in all car parking areas;
- Intensive landscaping, where practical;
- Trapped road gullies on the road carriageway, to trap silt and gross pollutants.
- Silt trap to be provided on manhole immediately upstream of attenuation system, as a further preventative measure to trap silt and other gross pollutants.

- Class 1 bypass fuel separator to be provided prior to discharging from site.

3.8 Maintenance

The proposed surface water drainage network has been carefully designed, minimise risk of blockage throughout the network, mainly through the following provisions that limit and restrict the size of pollutants entering the network:

- Pervious paving;
- Trapped road gullies;
- Silt trap manhole;
- Flow control greater than 50mm diameter.

All devices, including road gullies, silt traps, flow control devices and attenuation systems, should be inspected regularly and maintained, as appropriate and in accordance with manufacturer's recommendations and guidelines.

Items such as the flow controls and fuel separators have been located so as to provide easy vehicular access for inspection and maintenance.

3.9 Taking in Charge

It is proposed that all new surface water infrastructure associated with the proposed distribution park development **is** to be offered to be taken in charge by Meath City Council.

3.10 Surface Water Impact Assessment

The design criteria for the drainage system are established in GDSDS-RDP Volume 2, Section 6.3.4 and explained further in GDSDS-RDP Volume 2, Appendix E. There are four design criteria, each of which has been considered for the subject site:

- River Water Quality Protection;
- River Regime Protection;
- Level of Service (flooding) for the site and;
- River Flood Protection.

3.11 Criterion 1 – River Water Quality Protection

It is proposed that the overall drainage system, serving this development, will contain a range of surface water treatment methods, as outlined previously in *Section 3.3.3,* which will improve the quality of surface water being discharged from the proposed development.

Gross pollutants, sediments, hydrocarbons, and other impurities, will be removed at source with the following provisions:

a) Pervious Paving along fire tender routes and shared surfaces;
b) Intensive landscaping, where practicable.
c) Silt-traps prior to attenuation storage area.
d) Class 1 fuel separator prior to discharge from the development.

3.12 Criterion 2 – River Regime Protection

Surface water discharge from the overall development will be restricted to an equivalent rural runoff rate of 3.7 l/s/ha, which is equal to the greenfield runoff equivalent. Refer to Section 3.2.3 for further details of the proposed development rainfall runoff calculations.

This will be achieved with the provision of a flow control devices/orifices (Hydro-Brake Optimum, by Hydro-International, or similar approved) upstream of the outfall manholes. Refer to *Section 3.3.3.* for further details.

3.13 Criterion 3 – Level of Service (Flooding) Site

There are four sub-criteria for the required level of service, for a new development; as set out in the *GDSDS Volume 2, Section 6.3.4 (Table 6.3).*

- No flooding on site except where planned (30-year high intensity rainfall event);
- No internal property flooding (100-year high intensity rainfall event);
- No internal property flooding (100-year river event and critical duration for site) and;

- No flood routing off site except where specifically planned. (100-year high intensity rainfall event).

3.13.1 Sub-Criterion 3.1

The surface water drainage systems, serving the proposed development, have been designed to accommodate the 30-year return period rainfall event (including an allowance of 20% increase in rainfall intensity for climate change) without flooding.

The performance of the proposed drainage system has been analysed for design rainfall events up to, and including, the 1% AEP event (incl. 20% climate change allowance) using the *MicroDrainage Network Design Software*, by Innovyze Inc. Refer to Appendix C for details of design criteria, calculations and results.

3.13.2 Sub-Criterion 3.2

The surface water drainage systems, serving the proposed development, have been designed to accommodate the 100-year return period rainfall event (including an allowance of 20% increase in rainfall intensity for climate change) without flooding of property.

The performance of the proposed drainage system in 100-year return period storm events (incl. 20% climate change allowance) has been analysed – Refer Appendix C for calculations. The analyses show that no flooding will occur in 100-year return period storm events

3.13.3 Sub-Criterion 3.3

Details of the flood risk assessment associated with the proposed development is outlined under separate cover, which is submitted as part of this application. The assessment indicates that there is no apparent risk of internal property flooding for a design 100-year return period pluvial rainfall event (including 20% climate change allowance).

3.13.4 Sub-Criterion 3.4

The surface water drainage systems, serving the proposed development, have been designed to accommodate the 100-year return period rainfall event (including an allowance of 20% increase in rainfall intensity for climate change) without flooding of property, so no flood routing off site will be experienced for such a rainfall event.

The performance of the proposed drainage system in 100-year return period storm events (incl. 20% climate change allowance) has been analysed – Refer Appendix C for calculations. The analyses show that no flooding will occur in 100-year return period storm events.

Details of the flood risk assessment associated with the proposed development is outlined in the Site-Specific Flood Risk Assessment (Document Nr. P340-OCSC-XX-XX-RP-C-0003), which has been submitted under separate cover, as part of this application. This assessment, along with the network design simulation results, from the MicroDrainage Network Analysis, indicates that no internal property flooding will occur in a 100-year return period fluvial flood event (including 20% climate change allowance).

3.14 Criterion 4 – River Flood Protection

As outlined in *Section 3.2.3* , the surface water runoff from the development's catchment will be limited to a maximum of 3.7 l/s/ha, which is equal to the greenfield runoff equivalent.

Refer to *Section 3.4.3* of this report for further details on the limiting discharge rates. The *GDSDS Volume 2, Appendix E* states that this practice ensures *"that sufficient stormwater runoff retention is achieved to protect the river during extreme events".*

Attenuation storage is to be provided for the 100-year return period rainfall event (including an increased 20% rainfall intensity; to allow for climate change). Discharge from site is to be achieved through the use of a vortex flow control device/orifices (e.g. Hydro-Brake Optimum, by Hydro-International, or similar approved), which will reduce the risk of blockage present with other flow devices.

Refer to Appendix C for details of hydraulic modelling calculations of attenuation and flow control facilities, as carried out using MicroDrainage software by Innovyze Inc.

4 WASTEWATER DRAINAGE

4.1 Overview

The proposed development works does not include any works to upgrade or expand the wastewater network within the project site. There are existing dilapidated buildings which are to be demolished and there is a proposal to renovate the former Spicers's Bakery double story office building as a café

Since the upcoming caffe building is already existing building it is believed to have a wastewater connection to the public sewer. A new Pre-Connection enquiry is being submitted simultaneously to the Irish water to secure/maintain the wastewater connection for the Café-Office Building.

4.2 Existing Wastewater Drainage

Irish water records a WWPS within the project boundary in the Andy Brenan Park. There is a rising main and gravity sewer that runs on the Athlumney road. Sewers lines leading from the Sommerville apartments to the WWPS are required to be realigned to accommodate the proposed works. It is envisaged that a detailed survey for the utilities would be carried out at the next stage of the project development.

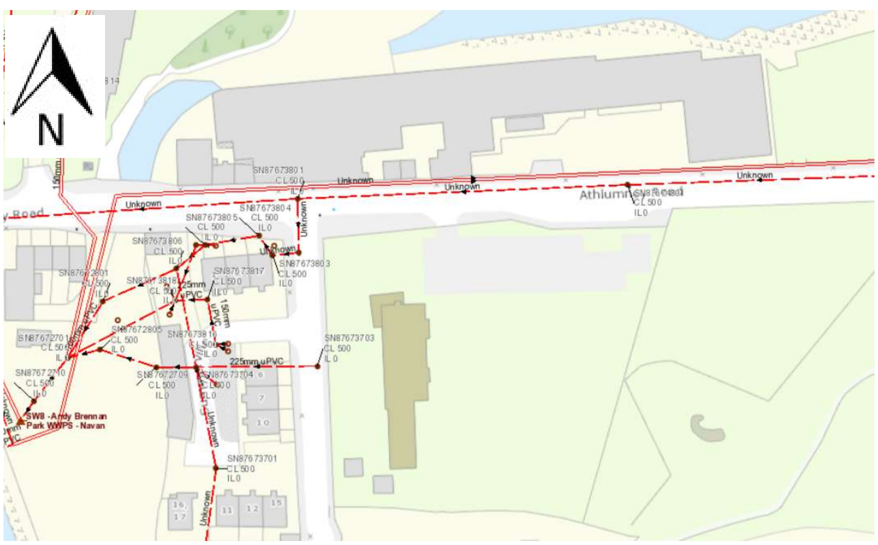

Figure 4.1 - Irish Water Public Records (Excerpt)

Refer to Appendix A for details of Irish Water existing wastewater infrastructure records.

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5 POTABLE WATER SUPPLY

5.1 Overview

The proposed development works does not include any works to upgrade or expand the watermain network within the project site. There are existing dilapidated buildings which are to be demolished and there is a proposal to renovate the former Spicers's Bakery double story office building as a café

Since the upcoming caffe building is already existing building it is believed to have a watermain connection from the Irish water. A new Pre-Connection enquiry is being submitted simultaneously to the Irish water to secure/maintain the watermain connection for the Café-Office Building.

5.2 Existing Watermain Infrastructure

The Irish Water records show 225 mm dia water main running across the Athlumney road.

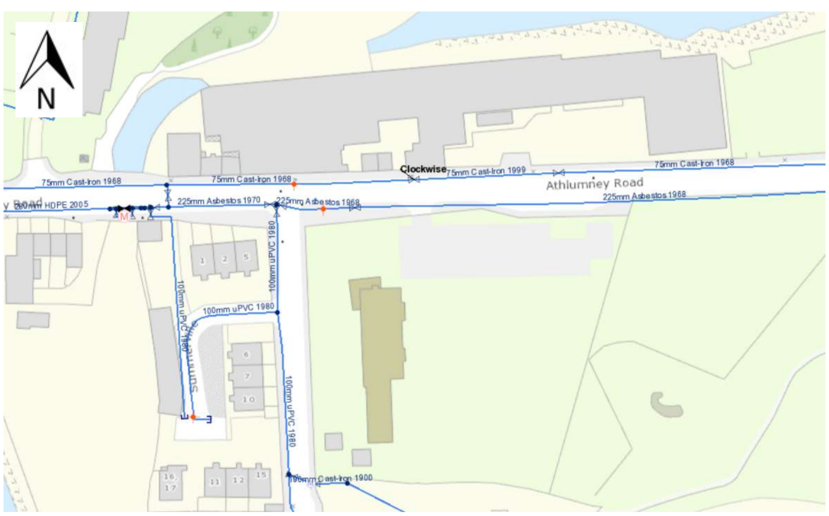
.

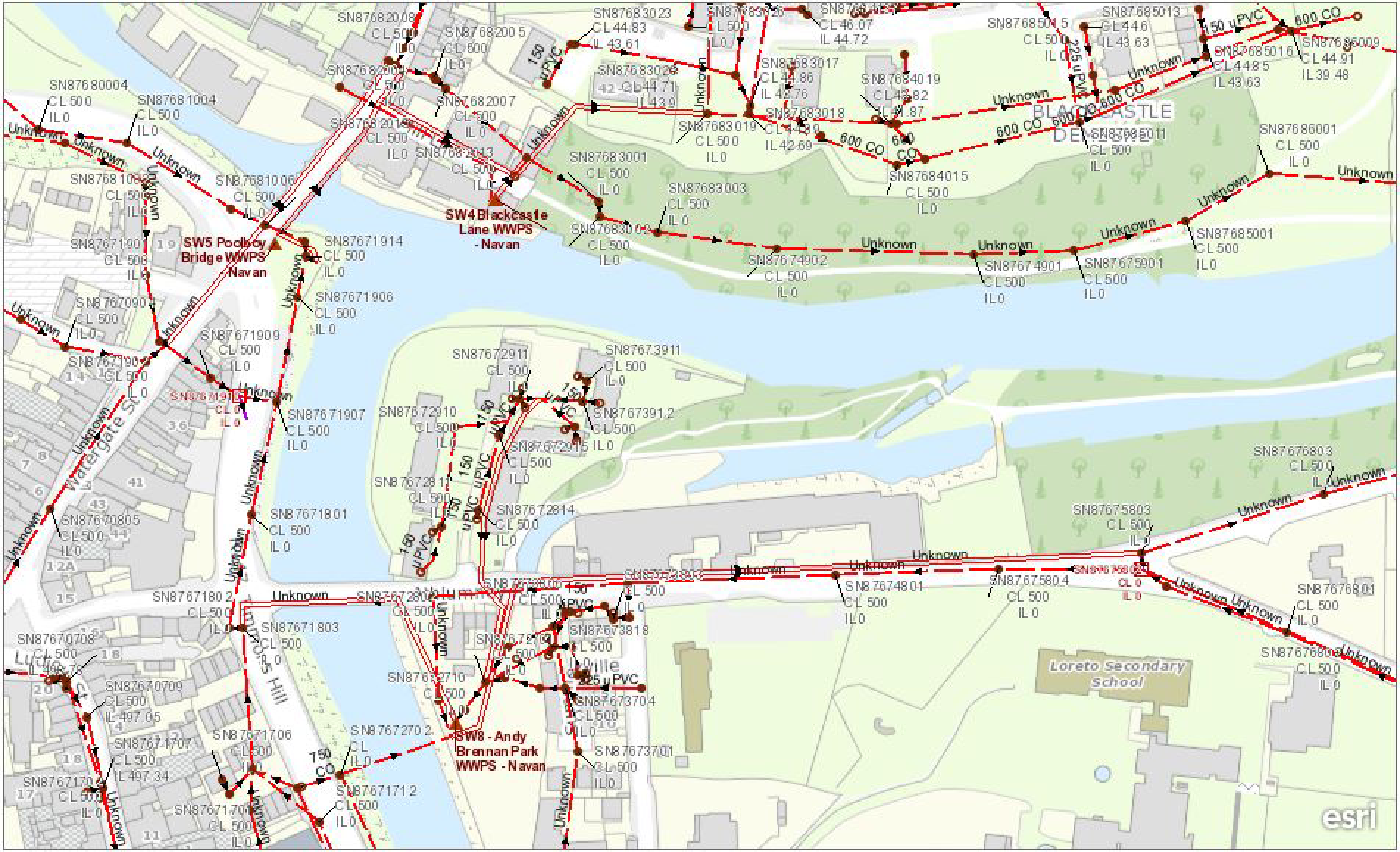
Figure 5-1: Existing watermain infrastructure

APPENDIX A. MEATH COUNTY COUNCIL & IRISH WATER PUBLIC RECORDS

Appendix A

Meath County Council & Irish Water Public Records

WNM Webmap SouthEast Prod online

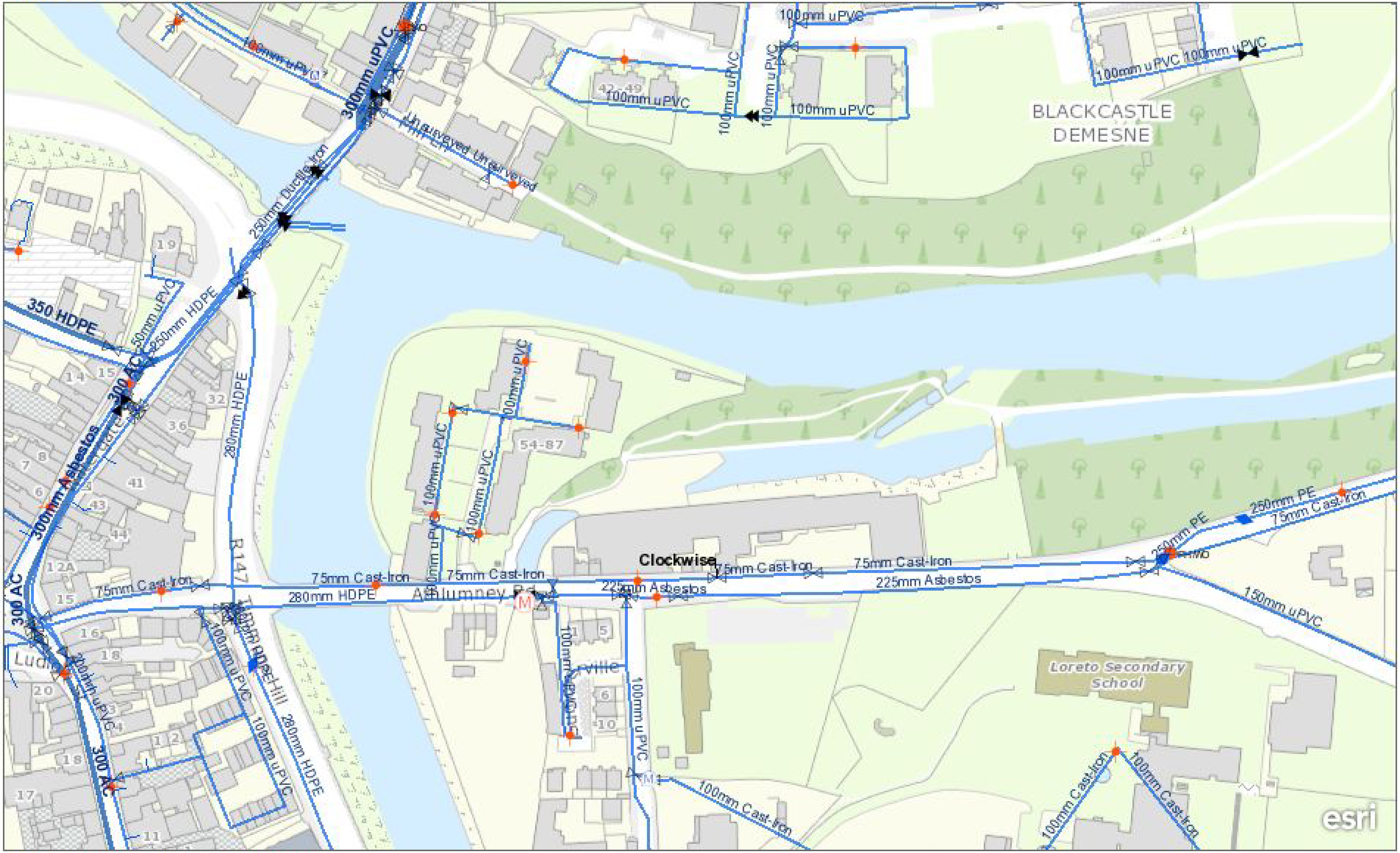


WNM Webmap SouthEast Prod online

60m

ESB | Ordnance Survey Ireland 2018

WNM Webmap SouthEast Prod online

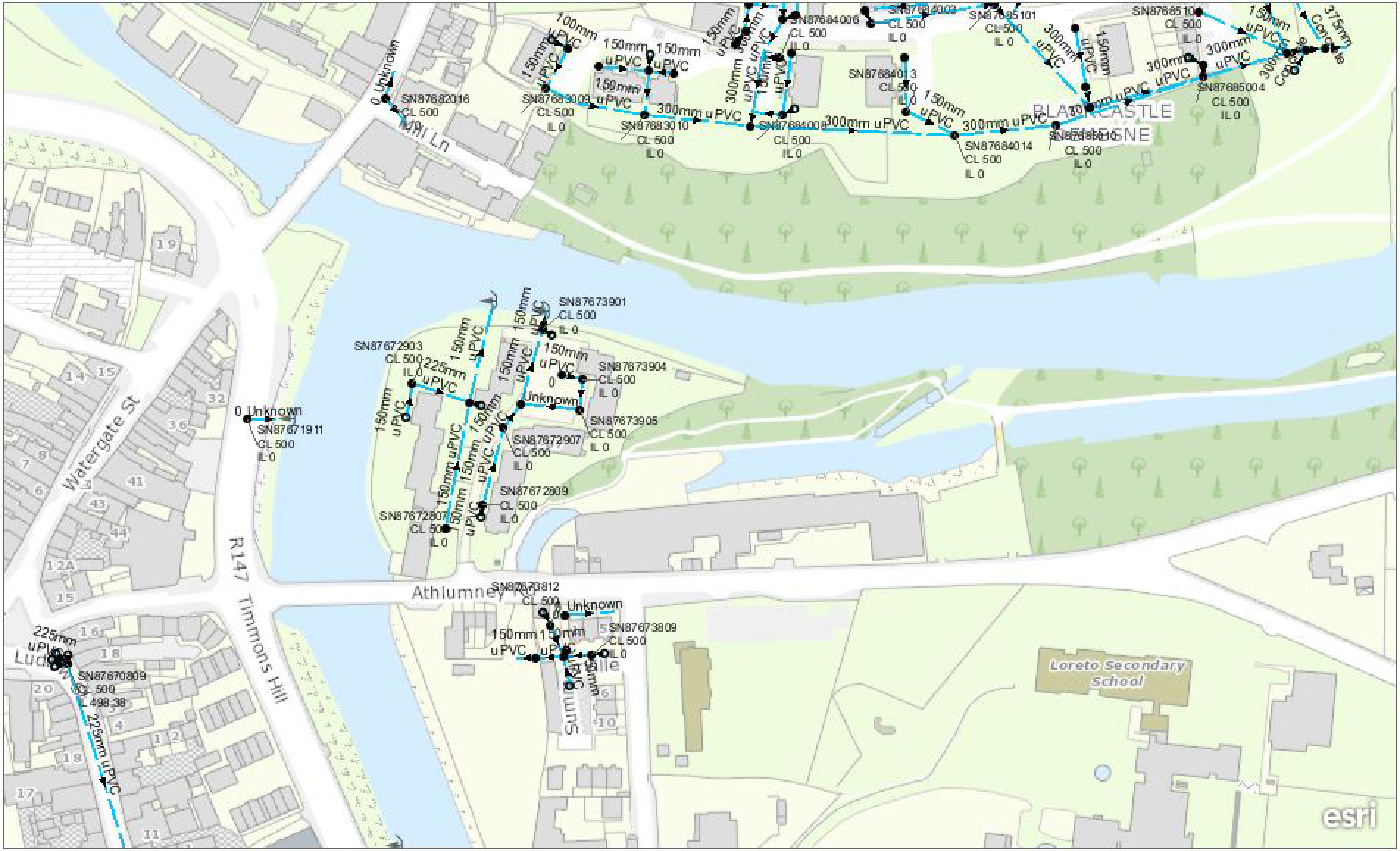


WNM Webmap SouthEast Prod online

60m

ESB | Ordnance Survey Ireland 2018

WNM Webmap SouthEast Prod online



WNM Webmap SouthEast Prod online

60m

ESB | Ordnance Survey Ireland 2018

APPENDIX B. Q_{BAR} RUNOFF CALCULATIONS & MET EIRAN

Appendix B

Q_{BAR} Runoff Calculations

ICP SUDS Mean Annual Flood

Input

Return Period (years)	1	Soil	0.370
Area (ha)	1.000	Urban	0.000
SAAR (mm)	863	Region Number	Ireland Greater Dublin

Results	l/s
QBAR Rural	3.7
QBAR Urban	3.7
Q1 year	3.1
Q1 year	3.1
Q30 years	7.8
Q100 years	9.6

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 287282, Northing: 267807,

	Interval		Years													
DURATION	6months	1year	2	3	4	5	10	20	30	50	75	100	150	200	250	500
5 mins	2.5	3.5	4.0	4.7	5.2	5.6	6.9	8.3	9.3	10.6	11.7	12.6	14.0	15.0	15.9	N/A
10 mins	3.5	4.8	5.5	6.6	7.3	7.8	9.6	11.6	12.9	14.7	16.3	17.6	19.5	20.9	22.2	N/A
15 mins	4.1	5.7	6.5	7.7	8.6	9.2	11.3	13.6	15.2	17.3	19.2	20.7	22.9	24.6	26.1	N/A
30 mins	5.4	7.4	8.4	10.0	11.0	11.8	14.3	17.2	19.0	21.6	23.8	25.6	28.2	30.2	31.9	N/A
1 hours	7.2	9.6	10.9	12.8	14.1	15.1	18.2	21.6	23.8	26.9	29.5	31.6	34.7	37.1	39.1	N/A
2 hours	9.5	12.6	14.2	16.5	18.1	19.3	23.0	27.1	29.8	33.5	36.6	39.1	42.7	45.6	47.9	N/A
3 hours	11.1	14.7	16.5	19.2	20.9	22.2	26.4	31.0	34.0	38.0	41.5	44.2	48.3	51.4	53.9	N/A
4 hours	12.5	16.4	18.4	21.3	23.2	24.6	29.2	34.1	37.3	41.7	45.4	48.3	52.6	55.9	58.6	N/A
6 hours	14.7	19.2	21.4	24.7	26.8	28.4	33.5	39.0	42.6	47.4	51.5	54.7	59.4	63.0	66.0	N/A
9 hours	17.3	22.4	24.9	28.6	31.0	32.8	38.5	44.6	48.5	53.9	58.4	61.9	67.1	71.1	74.3	N/A
12 hours	19.5	25.0	27.8	31.8	34.4	36.3	42.5	49.1	53.3	59.0	63.9	67.6	73.2	77.4	80.8	N/A
18 hours	22.9	29.2	32.3	36.8	39.7	41.9	48.8	56.2	60.8	67.1	72.5	76.5	82.6	87.2	91.0	N/A
24 hours	25.7	32.6	36.0	40.9	44.0	46.4	53.9	61.8	66.7	73.5	79.2	83.6	90.1	95.0	99.0	112.4
2 days	32.5	40.1	43.9	49.2	52.6	55.1	63.0	71.3	76.4	83.3	89.1	93.5	100.0	104.9	108.8	122.0
3 days	38.2	46.5	50.6	56.3	59.9	62.6	70.9	79.6	84.9	92.0	98.1	102.6	109.2	114.2	118.2	131.5
4 days	43.4	52.3	56.7	62.7	66.5	69.4	78.1	87.1	92.6	100.0	106.2	110.8	117.6	122.7	126.8	140.3
6 days	52.8	62.8	67.6	74.2	78.4	81.5	90.9	100.6	106.5	114.3	120.9	125.7	132.9	138.2	142.4	156.4
8 days	61.4	72.3	77.5	84.7	89.1	92.5	102.5	112.8	119.0	127.2	134.1	139.2	146.6	152.1	156.5	171.0
10 days	69.5	81.2	86.8	94.4	99.2	102.7	113.3	124.1	130.6	139.2	146.3	151.6	159.3	165.0	169.6	184.5
12 days	77.2	89.7	95.6	103.7	108.7	112.4	123.5	134.7	141.5	150.5	157.9	163.3	171.3	177.2	181.9	197.2
16 days	92.0	105.8	112.3	121.1	126.6	130.6	142.6	154.7	162.0	171.5	179.4	185.2	193.6	199.8	204.7	220.8
20 days	106.1	121.1	128.1	137.6	143.4	147.8	160.6	173.4	181.1	191.2	199.4	205.5	214.3	220.8	225.9	242.7
25 days	123.1	139.5	147.0	157.3	163.6	168.2	181.9	195.6	203.7	214.3	223.1	229.5	238.7	245.5	250.9	268.4

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 C. SURFACE WATER DESIGN & ATTENUATION CALCULATIONS

- Design Criteria;
- Network Design & Results Table;
- Simulation Criteria;
- Hydrobrake / Controls & Storage Design;
- Summary of Results.

Appendix C

Surface Water Design and Attenuation Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	15.100	Add Flow / Climate Change (%)	0
Ratio R	0.274	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S9.000	12.857	0.086	149.5	0.026	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S9.000	50.00	4.20	29.400	0.026	0.0	0.0	0.0	1.07	42.4	3.5

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S9.001	10.934	0.073	149.8	0.013	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.000	21.606	0.144	150.0	0.020	4.00	0.0	0.600	o	225	Pipe/Conduit	
S10.001	2.430	0.016	151.9	0.019	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.002	9.890	0.066	150.0	0.072	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.003	12.794	0.088	145.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.004	12.794	0.088	145.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.000	18.372	0.465	39.5	0.010	4.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S9.001	50.00	4.37	29.314	0.039	0.0	0.0	0.0	1.07	42.4	5.2
S10.000	50.00	4.34	29.500	0.020	0.0	0.0	0.0	1.07	42.3	2.7
S10.001	50.00	4.38	29.281	0.040	0.0	0.0	0.0	1.06	42.1	5.4
S9.002	50.00	4.53	29.241	0.150	0.0	0.0	0.0	1.07	42.4	20.4
S9.003	50.00	4.73	29.175	0.150	0.0	0.0	0.0	1.08	43.0	20.4
S9.004	50.00	4.93	29.087	0.150	0.0	0.0	0.0	1.08	43.0	20.4
S11.000	50.00	4.19	31.840	0.010	0.0	0.0	0.0	1.61	28.4	1.3

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S12.000	18.043	0.120	150.4	0.037	4.00	0.0	0.600	o	150	Pipe/Conduit	
S11.001	14.524	0.097	150.0	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
S11.002	12.573	0.084	149.7	0.026	0.00	0.0	0.600	o	150	Pipe/Conduit	
S13.000	23.927	0.160	149.5	0.020	4.00	0.0	0.600	o	150	Pipe/Conduit	
S13.001	4.082	0.027	151.2	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
S14.000	20.901	0.139	150.0	0.020	4.00	0.0	0.600	o	225	Pipe/Conduit	
S11.003	27.461	0.275	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S12.000	50.00	4.37	30.800	0.037	0.0	0.0	0.0	0.82	14.4	5.1
S11.001	50.00	4.66	30.680	0.055	0.0	0.0	0.0	0.82	14.5	7.4
S11.002	50.00	4.92	30.583	0.081	0.0	0.0	0.0	0.82	14.5	11.0
S13.000	50.00	4.49	30.600	0.020	0.0	0.0	0.0	0.82	14.5	2.6
S13.001	50.00	4.57	30.440	0.027	0.0	0.0	0.0	0.81	14.4	3.7
S14.000	50.00	4.33	30.720	0.020	0.0	0.0	0.0	1.07	42.4	2.7
S11.003	50.00	5.27	30.338	0.128	0.0	0.0	0.0	1.31	52.0	17.4

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S15.000	23.320	0.163	143.1	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
S16.000	21.854	0.163	134.1	0.022	4.00	0.0	0.600	o	150	Pipe/Conduit	
S15.001	4.666	0.031	150.0	0.065	0.00	0.0	0.600	o	150	Pipe/Conduit	
S11.004	25.314	0.169	149.5	0.010	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.005	5.480	0.038	146.1	0.010	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.006	17.796	0.129	137.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S11.007	14.236	0.020	695.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S15.000	50.00	4.46	31.100	0.000	0.0	0.0	0.0	0.84	14.8	0.0
S16.000	50.00	4.42	31.100	0.022	0.0	0.0	0.0	0.87	15.3	3.0
S15.001	50.00	4.56	30.937	0.087	0.0	0.0	0.0	0.82	14.5	11.8
S11.004	50.00	5.67	30.063	0.226	0.0	0.0	0.0	1.07	42.4	30.5
S11.005	50.00	5.75	29.894	0.235	0.0	0.0	0.0	1.08	42.9	31.9
S11.006	50.00	6.02	29.470	0.235	0.0	0.0	0.0	1.11	44.2	31.9
S11.007	50.00	6.42	29.266	0.235	0.0	0.0	0.0	0.59	41.6	31.9

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S9.005	8.544	0.059	144.9	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S9.005	50.00	6.53	28.924	0.386	0.0	0.0	0.0	1.30	92.2	52.2

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S9.005	S	31.560	28.865	0.000	0	0

Simulation Criteria for Storm

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	5	Number of Storage Structures	8	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	15.100	Cv (Summer)	0.750
Return Period (years)	5	Ratio R	0.274	Cv (Winter)	0.840
Region	Scotland and Ireland	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Storm

Orifice Manhole: S42, DS/PN: S9.003, Volume (m^3): 3.2

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 29.175

Orifice Manhole: S46, DS/PN: S11.001, Volume (m^3): 2.1

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 30.680

Orifice Manhole: S51, DS/PN: S11.003, Volume (m^3): 2.8

Diameter (m) 0.050 Discharge Coefficient 0.600 Invert Level (m) 30.413

Weir Manhole: S22, DS/PN: S11.007, Volume (m^3): 3.4

Discharge Coef 0.544 Width (m) 0.100 Invert Level (m) 31.200

Pump Manhole: S43, DS/PN: S9.005, Volume (m^3): 4.5

Invert Level (m) 28.999

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.500	2.0000	1.500	2.0000	2.500	2.0000	3.500	2.0000
1.000	2.0000	2.000	2.0000	3.000	2.0000		

Storage Structures for Storm

Cellular Storage Manhole: S42, DS/PN: S9.003

Invert Level (m)	28.373	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.65
Infiltration Coefficient Side (m/hr)	0.00526		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	60.0	0.0	0.400	60.0	10.6	0.800	60.0	21.2
0.100	60.0	2.7	0.500	60.0	13.3	0.900	60.0	23.8
0.200	60.0	5.3	0.600	60.0	15.9			
0.300	60.0	7.9	0.700	60.0	18.5			

Porous Car Park Manhole: S44, DS/PN: S11.000

Infiltration Coefficient Base (m/hr)	0.00526	Width (m)	20.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	111.1	Slope (1:X)	40.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	32.140	Membrane Depth (mm)	0

Porous Car Park Manhole: S45, DS/PN: S12.000

Infiltration Coefficient Base (m/hr)	0.00526	Porosity	0.30
Membrane Percolation (mm/hr)	1000	Invert Level (m)	30.800
Max Percolation (l/s)	30.6	Width (m)	11.0
Safety Factor	2.0	Length (m)	10.0

Porous Car Park Manhole: S45, DS/PN: S12.000

Slope (1:X)	150.0	Evaporation (mm/day)	3
Depression Storage (mm)	5	Membrane Depth (mm)	0

Porous Car Park Manhole: S47, DS/PN: S11.002

Infiltration Coefficient Base (m/hr)	0.00526	Width (m)	13.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	72.2	Slope (1:X)	149.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.745	Membrane Depth (mm)	0

Porous Car Park Manhole: S48, DS/PN: S13.000

Infiltration Coefficient Base (m/hr)	0.00526	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	55.6	Slope (1:X)	150.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.600	Membrane Depth (mm)	0

Porous Car Park Manhole: S49, DS/PN: S13.001

Infiltration Coefficient Base (m/hr)	0.00526	Width (m)	8.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	22.2	Slope (1:X)	151.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.570	Membrane Depth (mm)	0

Porous Car Park Manhole: S54, DS/PN: S15.001

Infiltration Coefficient Base (m/hr)	0.00526	Width (m)	21.0
Membrane Percolation (mm/hr)	1000	Length (m)	30.0
Max Percolation (l/s)	175.0	Slope (1:X)	317.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	30.976	Membrane Depth (mm)	0

Cellular Storage Manhole: S57, DS/PN: S11.006

Invert Level (m)	29.472	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.65
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	20.0	0.0	0.200	20.0	3.6	0.400	20.0	7.2
0.100	20.0	1.8	0.300	20.0	5.4	0.500	20.0	9.0

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

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	5	Number of Storage Structures	8	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	15.100	Cv (Summer)	0.750
Region	Scotland and Ireland	Ratio R	0.274	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	5, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S9.000	S37	15 minute 5 year Summer I+20%	15	30.000	29.456	-0.169	0.000	0.14		5.2	OK
S9.001	S38	1440 minute 5 year Winter I+20%	1440	30.500	29.402	-0.137	0.000	0.02		0.5	OK
S10.000	S39	15 minute 5 year Winter I+20%	15	30.400	29.548	-0.177	0.000	0.10		4.0	OK
S10.001	S40	1440 minute 5 year Winter I+20%	1440	31.670	29.402	-0.104	0.000	0.02		0.5	OK
S9.002	S41	1440 minute 5 year Winter I+20%	1440	31.500	29.402	-0.064	0.000	0.06		2.1	OK
S9.003	S42	1440 minute 5 year Winter I+20%	1440	31.700	29.400	0.000	0.000	0.04		1.4	SURCHARGED
S9.004	S7	1440 minute 5 year Winter I+20%	1440	31.700	29.307	-0.005	0.000	0.03		1.3	OK
S11.000	S44	360 minute 5 year Winter I+20%	360	33.040	31.847	-0.143	0.000	0.01		0.3	OK
S12.000	S45	4320 minute 5 year Winter I+20%	4320	31.700	31.009	0.059	0.000	0.02		0.2	SURCHARGED
S11.001	S46	4320 minute 5 year Winter I+20%	4320	32.000	31.009	0.179	0.000	0.07		1.0	SURCHARGED
S11.002	S47	4320 minute 5 year Winter I+20%	4320	31.880	31.008	0.275	0.000	0.05		0.6	SURCHARGED
S13.000	S48	4320 minute 5 year Winter I+20%	4320	31.500	31.007	0.257	0.000	0.00		0.1	SURCHARGED
S13.001	S49	4320 minute 5 year Winter I+20%	4320	32.000	31.008	0.418	0.000	0.01		0.1	SURCHARGED
S14.000	S50	4320 minute 5 year Winter I+20%	4320	31.920	31.008	0.063	0.000	0.00		0.1	SURCHARGED
S11.003	S51	4320 minute 5 year Winter I+20%	4320	31.900	31.008	0.445	0.000	0.01		0.4	SURCHARGED
S15.000	S52	15 minute 5 year Summer I+20%	15	32.000	31.100	-0.150	0.000	0.00		0.0	OK
S16.000	S53	15 minute 5 year Winter I+20%	15	32.000	31.156	-0.094	0.000	0.30		4.3	OK
S15.001	S54	30 minute 5 year Winter I+20%	30	32.000	31.020	-0.067	0.000	0.59		6.5	OK
S11.004	S55	4320 minute 5 year Winter I+20%	4320	32.000	31.018	0.730	0.000	0.01		0.5	SURCHARGED
S11.005	S56	4320 minute 5 year Winter I+20%	4320	32.000	31.018	0.899	0.000	0.02		0.5	SURCHARGED
S11.006	S57	4320 minute 5 year Winter I+20%	4320	31.800	31.018	1.323	0.000	0.01		0.5	SURCHARGED
S11.007	S22	4320 minute 5 year Winter I+20%	4320	31.700	31.022	1.457	0.000	0.00		0.0	SURCHARGED
S9.005	S43	1440 minute 5 year Winter I+20%	1440	31.700	29.305	0.081	0.000	0.02		1.2	SURCHARGED

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

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 5 Number of Storage Structures 8 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 15.100 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.274 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 5, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S9.000	S37	960 minute 30 year Winter I+20%	960	30.000	29.588	-0.037	0.000	0.02		0.7	OK
S9.001	S38	960 minute 30 year Winter I+20%	960	30.500	29.587	0.048	0.000	0.03		1.0	SURCHARGED
S10.000	S39	960 minute 30 year Winter I+20%	960	30.400	29.587	-0.138	0.000	0.01		0.5	OK
S10.001	S40	960 minute 30 year Winter I+20%	960	31.670	29.587	0.081	0.000	0.03		1.0	SURCHARGED
S9.002	S41	960 minute 30 year Winter I+20%	960	31.500	29.586	0.120	0.000	0.10		3.6	SURCHARGED
S9.003	S42	960 minute 30 year Winter I+20%	960	31.700	29.584	0.184	0.000	0.05		1.8	SURCHARGED
S9.004	S7	960 minute 30 year Winter I+20%	960	31.700	29.448	0.136	0.000	0.05		1.8	SURCHARGED
S11.000	S44	120 minute 30 year Winter I+20%	120	33.040	31.857	-0.133	0.000	0.03		0.8	OK
S12.000	S45	2880 minute 30 year Winter I+20%	2880	31.700	31.088	0.138	0.000	0.03		0.5	SURCHARGED
S11.001	S46	2880 minute 30 year Winter I+20%	2880	32.000	31.087	0.257	0.000	0.09		1.2	SURCHARGED
S11.002	S47	2880 minute 30 year Winter I+20%	2880	31.880	31.085	0.351	0.000	0.12		1.6	SURCHARGED
S13.000	S48	2880 minute 30 year Winter I+20%	2880	31.500	31.083	0.333	0.000	0.01		0.2	SURCHARGED
S13.001	S49	2880 minute 30 year Winter I+20%	2880	32.000	31.084	0.494	0.000	0.07		0.7	SURCHARGED
S14.000	S50	2880 minute 30 year Winter I+20%	2880	31.920	31.084	0.139	0.000	0.01		0.2	SURCHARGED
S11.003	S51	2880 minute 30 year Winter I+20%	2880	31.900	31.085	0.522	0.000	0.01		0.5	SURCHARGED
S15.000	S52	15 minute 30 year Summer I+20%	15	32.000	31.100	-0.150	0.000	0.00		0.0	OK
S16.000	S53	15 minute 30 year Winter I+20%	15	32.000	31.170	-0.080	0.000	0.44		6.4	OK
S15.001	S54	2880 minute 30 year Winter I+20%	2880	32.000	31.080	-0.007	0.000	0.09		1.0	OK
S11.004	S55	2880 minute 30 year Winter I+20%	2880	32.000	31.082	0.794	0.000	0.02		0.7	SURCHARGED
S11.005	S56	2880 minute 30 year Winter I+20%	2880	32.000	31.082	0.963	0.000	0.02		0.7	SURCHARGED
S11.006	S57	2880 minute 30 year Winter I+20%	2880	31.800	31.082	1.387	0.000	0.01		0.5	SURCHARGED
S11.007	S22	2880 minute 30 year Winter I+20%	2880	31.700	31.086	1.520	0.000	0.00		0.0	SURCHARGED
S9.005	S43	960 minute 30 year Winter I+20%	960	31.700	29.445	0.221	0.000	0.03		1.8	SURCHARGED

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

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 5 Number of Storage Structures 8 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 15.100 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.274 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 5, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S9.000	S37	720 minute 100 year Winter I+20%	720	30.000	29.811	0.186	0.000	0.03		1.0	FLOOD RISK
S9.001	S38	720 minute 100 year Winter I+20%	720	30.500	29.810	0.271	0.000	0.04		1.4	SURCHARGED
S10.000	S39	720 minute 100 year Winter I+20%	720	30.400	29.810	0.085	0.000	0.02		0.8	SURCHARGED
S10.001	S40	720 minute 100 year Winter I+20%	720	31.670	29.810	0.304	0.000	0.05		1.4	SURCHARGED
S9.002	S41	720 minute 100 year Winter I+20%	720	31.500	29.810	0.344	0.000	0.15		5.2	SURCHARGED
S9.003	S42	720 minute 100 year Winter I+20%	720	31.700	29.807	0.407	0.000	0.06		2.2	SURCHARGED
S9.004	S7	720 minute 100 year Winter I+20%	720	31.700	29.646	0.333	0.000	0.06		2.2	SURCHARGED
S11.000	S44	60 minute 100 year Winter I+20%	60	33.040	31.864	-0.126	0.000	0.06		1.6	OK
S12.000	S45	2880 minute 100 year Winter I+20%	2880	31.700	31.162	0.212	0.000	0.03		0.5	SURCHARGED
S11.001	S46	2880 minute 100 year Winter I+20%	2880	32.000	31.161	0.331	0.000	0.14		1.9	SURCHARGED
S11.002	S47	2880 minute 100 year Winter I+20%	2880	31.880	31.158	0.425	0.000	0.09		1.2	SURCHARGED
S13.000	S48	2880 minute 100 year Winter I+20%	2880	31.500	31.157	0.407	0.000	0.01		0.1	SURCHARGED
S13.001	S49	2880 minute 100 year Winter I+20%	2880	32.000	31.158	0.568	0.000	0.01		0.1	SURCHARGED
S14.000	S50	2880 minute 100 year Winter I+20%	2880	31.920	31.158	0.213	0.000	0.01		0.3	SURCHARGED
S11.003	S51	2880 minute 100 year Winter I+20%	2880	31.900	31.158	0.595	0.000	0.01		0.5	SURCHARGED
S15.000	S52	2880 minute 100 year Winter I+20%	2880	32.000	31.153	-0.097	0.000	0.00		0.0	OK
S16.000	S53	15 minute 100 year Winter I+20%	15	32.000	31.182	-0.068	0.000	0.57		8.2	OK
S15.001	S54	2880 minute 100 year Winter I+20%	2880	32.000	31.153	0.066	0.000	0.09		1.0	SURCHARGED
S11.004	S55	2880 minute 100 year Winter I+20%	2880	32.000	31.154	0.866	0.000	0.02		0.7	SURCHARGED
S11.005	S56	2880 minute 100 year Winter I+20%	2880	32.000	31.154	1.035	0.000	0.02		0.7	SURCHARGED
S11.006	S57	2880 minute 100 year Winter I+20%	2880	31.800	31.154	1.459	0.000	0.02		0.7	SURCHARGED
S11.007	S22	2880 minute 100 year Winter I+20%	2880	31.700	31.158	1.593	0.000	0.00		0.0	SURCHARGED
S9.005	S43	720 minute 100 year Winter I+20%	720	31.700	29.642	0.418	0.000	0.03		2.0	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	15.100	Add Flow / Climate Change (%)	0
Ratio R	0.274	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S2.000	21.704	0.145	149.7	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
S3.000	24.959	0.166	150.0	0.020	4.00	0.0	0.600	o	150	Pipe/Conduit	
S2.001	51.911	0.347	149.7	0.108	0.00	0.0	0.600	o	150	Pipe/Conduit	
S4.000	33.952	0.226	150.0	0.006	4.00	0.0	0.600	o	150	Pipe/Conduit	
S4.001	13.566	0.090	150.0	0.012	0.00	0.0	0.600	o	150	Pipe/Conduit	
S5.000	35.197	0.235	150.0	0.051	4.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S2.000	50.00	4.44	31.175	0.000	0.0	0.0	0.0	0.82	14.5	0.0
S3.000	50.00	4.51	31.900	0.020	0.0	0.0	0.0	0.82	14.5	2.7
S2.001	50.00	5.56	31.030	0.128	0.0	0.0	0.0	0.82	14.5«	17.3
S4.000	50.00	4.69	31.780	0.006	0.0	0.0	0.0	0.82	14.5	0.8
S4.001	50.00	4.97	31.554	0.018	0.0	0.0	0.0	0.82	14.5	2.4
S5.000	50.00	4.72	32.710	0.051	0.0	0.0	0.0	0.82	14.5	6.9

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S4.002	25.795	0.172	150.0	0.025	0.00	0.0	0.600	o	150	Pipe/Conduit	
S6.000	40.025	0.266	150.4	0.008	4.00	0.0	0.600	o	150	Pipe/Conduit	
S2.002	5.319	0.035	150.0	0.031	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.003	14.013	0.093	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.004	15.650	0.104	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S7.000	38.776	0.259	150.0	0.025	4.00	0.0	0.600	o	150	Pipe/Conduit	
S8.000	23.083	0.330	70.0	0.021	4.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S4.002	50.00	5.49	31.463	0.094	0.0	0.0	0.0	0.82	14.5	12.8
S6.000	50.00	4.82	32.870	0.008	0.0	0.0	0.0	0.82	14.4	1.1
S2.002	50.00	5.65	30.608	0.261	0.0	0.0	0.0	1.07	42.4	35.3
S2.003	50.00	5.87	30.573	0.261	0.0	0.0	0.0	1.07	42.4	35.3
S2.004	50.00	6.11	30.151	0.261	0.0	0.0	0.0	1.07	42.4	35.3
S7.000	50.00	4.79	32.385	0.025	0.0	0.0	0.0	0.82	14.5	3.4
S8.000	50.00	4.32	32.690	0.021	0.0	0.0	0.0	1.20	21.3	2.8

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S8.001	8.105	0.054	150.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
S9.000	20.752	0.138	150.0	0.010	4.00	0.0	0.600	o	150	Pipe/Conduit	
S9.001	6.696	0.223	30.0	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
S7.001	13.109	0.045	294.3	0.022	0.00	0.0	0.600	o	225	Pipe/Conduit	
S7.002	16.797	0.112	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S7.003	9.905	0.066	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.000	22.290	0.149	149.9	0.007	4.00	0.0	0.600	o	150	Pipe/Conduit	
S10.001	7.319	0.050	147.5	0.006	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S8.001	50.00	4.48	31.921	0.021	0.0	0.0	0.0	0.82	14.5	2.8
S9.000	50.00	4.42	32.550	0.010	0.0	0.0	0.0	0.82	14.5	1.3
S9.001	50.00	4.48	32.000	0.018	0.0	0.0	0.0	1.84	32.6	2.4
S7.001	50.00	5.08	30.578	0.086	0.0	0.0	0.0	0.76	30.1	11.7
S7.002	50.00	5.34	30.533	0.086	0.0	0.0	0.0	1.07	42.4	11.7
S7.003	50.00	5.50	30.421	0.086	0.0	0.0	0.0	1.07	42.4	11.7
S10.000	50.00	4.45	32.730	0.007	0.0	0.0	0.0	0.82	14.5	0.9
S10.001	50.00	4.60	32.581	0.012	0.0	0.0	0.0	0.83	14.6	1.7

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S11.000	25.892	0.141	183.5	0.014	4.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S11.001	2.945	0.020	150.0	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S12.000	22.779	0.152	150.0	0.016	4.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S12.001	9.121	0.061	150.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S11.002	3.876	0.020	197.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S10.002	15.243	0.046	332.6	0.023	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
S10.003	8.844	0.059	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S11.000	50.00	4.58	33.545	0.014	0.0	0.0	0.0	0.74	13.1	1.9
S11.001	50.00	4.64	33.404	0.024	0.0	0.0	0.0	0.82	14.5	3.2
S12.000	50.00	4.46	33.100	0.016	0.0	0.0	0.0	0.82	14.5	2.1
S12.001	50.00	4.65	32.948	0.016	0.0	0.0	0.0	0.82	14.5	2.1
S11.002	50.00	4.74	32.887	0.040	0.0	0.0	0.0	0.71	12.6	5.4
S10.002	50.00	5.10	32.456	0.075	0.0	0.0	0.0	0.71	28.3	10.2
S10.003	50.00	5.24	32.411	0.075	0.0	0.0	0.0	1.07	42.4	10.2

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S10.004	4.278	0.029	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
S10.005	20.746	0.138	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S2.005	6.188	0.003	1793.6	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	🔓
S13.000	25.108	0.386	65.0	0.011	4.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S13.001	6.564	0.044	150.0	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
S14.000	20.409	0.261	78.3	0.013	4.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S14.001	6.734	0.048	140.3	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S10.004	50.00	5.30	32.352	0.075	0.0	0.0	0.0	1.07	42.4	10.2
S10.005	50.00	5.63	31.700	0.075	0.0	0.0	0.0	1.07	42.4	10.2
S2.005	50.00	6.33	29.822	0.422	0.0	0.0	0.0	0.47	74.9	57.1
S13.000	50.00	4.33	33.750	0.011	0.0	0.0	0.0	1.25	22.1	1.5
S13.001	50.00	4.47	33.364	0.021	0.0	0.0	0.0	0.82	14.5	2.8
S14.000	50.00	4.30	34.015	0.013	0.0	0.0	0.0	1.14	20.1	1.7
S14.001	50.00	4.43	33.754	0.013	0.0	0.0	0.0	0.85	15.0	1.7

Simulation Criteria for Storm

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	4	Number of Storage Structures	12	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	15.100	Cv (Summer)	0.750
Return Period (years)	5	Ratio R	0.274	Cv (Winter)	0.840
Region	Scotland and Ireland	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Storm

Orifice Manhole: S9, DS/PN: S2.002, Volume (m^3): 5.2

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 30.608

Orifice Manhole: S17, DS/PN: S7.001, Volume (m^3): 3.0

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 31.702

Orifice Manhole: S27, DS/PN: S10.002, Volume (m^3): 2.7

Diameter (m) 0.100 Discharge Coefficient 0.600 Invert Level (m) 32.456

Pump Manhole: S31, DS/PN: S2.005, Volume (m^3): 4.4

Invert Level (m) 29.822

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.500	1.5000	1.500	1.5000	2.500	1.5000	3.500	1.5000	4.500	1.5000
1.000	1.5000	2.000	1.5000	3.000	1.5000	4.000	1.5000		

Storage Structures for Storm

Porous Car Park Manhole: S2, DS/PN: S3.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	23.0
Max Percolation (l/s)	63.9	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.900	Membrane Depth (mm)	0

Porous Car Park Manhole: S4, DS/PN: S4.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	14.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	77.8	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.780	Membrane Depth (mm)	0

Porous Car Park Manhole: S5, DS/PN: S4.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.0
Max Percolation (l/s)	33.3	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.554	Membrane Depth (mm)	0

Porous Car Park Manhole: S7, DS/PN: S4.002

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	18.0
Membrane Percolation (mm/hr)	1000	Length (m)	20.0
Max Percolation (l/s)	100.0	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.463	Membrane Depth (mm)	0

Cellular Storage Manhole: S9, DS/PN: S2.002

Invert Level (m)	30.183	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.65
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	50.0	0.0	0.200	50.0	6.0	0.400	50.0	12.0
0.100	50.0	3.0	0.300	50.0	9.0	0.500	50.0	15.0

Porous Car Park Manhole: S14, DS/PN: S8.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.4
Max Percolation (l/s)	34.4	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	31.921	Membrane Depth (mm)	0

Cellular Storage Manhole: S17, DS/PN: S7.001

Invert Level (m)	30.578	Safety Factor	2.0
Infiltration Coefficient Base (m/hr)	0.00000	Porosity	0.65
Infiltration Coefficient Side (m/hr)	0.00000		

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	25.0	0.0	0.200	25.0	4.0	0.400	25.0	8.0
0.100	25.0	2.0	0.300	25.0	6.0	0.500	25.0	10.0

Porous Car Park Manhole: S21, DS/PN: S10.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.5
Max Percolation (l/s)	34.7	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	32.581	Membrane Depth (mm)	0

Porous Car Park Manhole: S25, DS/PN: S12.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.5
Max Percolation (l/s)	34.7	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	32.948	Membrane Depth (mm)	0

Cellular Storage Manhole: S27, DS/PN: S10.002

Invert Level (m) 32.031 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.65
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	50.0	0.0	0.200	50.0	6.0	0.400	50.0	12.0
0.100	50.0	3.0	0.300	50.0	9.0	0.500	50.0	15.0

Porous Car Park Manhole: S33, DS/PN: S13.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	14.0
Max Percolation (l/s)	38.9	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	33.364	Membrane Depth (mm)	0

Porous Car Park Manhole: S35, DS/PN: S14.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	12.0
Max Percolation (l/s)	33.3	Slope (1:X)	50.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	33.754	Membrane Depth (mm)	0

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

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	4	Number of Storage Structures	12	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	15.100	Cv (Summer)	0.750
Region	Scotland and Ireland	Ratio R	0.274	Cv (Winter)	0.840

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	5, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S2.000	S1	1440 minute 5 year Winter I+20%	1440	32.600	31.757	0.432	0.000	0.00		0.1	SURCHARGED
S3.000	S2	30 minute 5 year Winter I+20%	30	32.800	31.943	-0.107	0.000	0.18		2.5	OK
S2.001	S3	1440 minute 5 year Winter I+20%	1440	33.600	31.757	0.577	0.000	0.13		1.8	SURCHARGED
S4.000	S4	600 minute 5 year Winter I+20%	600	32.680	31.785	-0.145	0.000	0.01		0.1	OK
S4.001	S5	1440 minute 5 year Winter I+20%	1440	32.600	31.754	0.051	0.000	0.02		0.2	SURCHARGED
S5.000	S6	15 minute 5 year Winter I+20%	15	33.610	32.805	-0.055	0.000	0.72		10.0	OK
S4.002	S7	1440 minute 5 year Winter I+20%	1440	33.050	31.754	0.141	0.000	0.09		1.3	SURCHARGED
S6.000	S8	15 minute 5 year Winter I+20%	15	33.770	32.904	-0.116	0.000	0.11		1.6	OK
S2.002	S9	1440 minute 5 year Winter I+20%	1440	33.400	31.753	0.920	0.000	0.11		3.3	SURCHARGED
S2.003	S10	1440 minute 5 year Winter I+20%	1440	33.150	31.740	0.942	0.000	0.08		3.0	SURCHARGED
S2.004	S11	1440 minute 5 year Winter I+20%	1440	32.500	31.738	1.362	0.000	0.07		2.5	SURCHARGED
S7.000	S12	15 minute 5 year Winter I+20%	15	33.810	32.447	-0.088	0.000	0.36		5.0	OK
S8.000	S13	15 minute 5 year Winter I+20%	15	33.570	32.736	-0.104	0.000	0.21		4.2	OK
S8.001	S14	15 minute 5 year Winter I+20%	15	32.620	31.977	-0.094	0.000	0.30		3.8	OK
S9.000	S15	15 minute 5 year Winter I+20%	15	33.450	32.587	-0.113	0.000	0.14		1.9	OK
S9.001	S16	15 minute 5 year Winter I+20%	15	33.630	32.034	-0.116	0.000	0.12		3.2	OK
S7.001	S17	600 minute 5 year Winter I+20%	600	32.460	31.758	0.955	0.000	0.06		1.5	SURCHARGED
S7.002	S18	1440 minute 5 year Winter I+20%	1440	32.730	31.738	0.979	0.000	0.03		1.1	SURCHARGED
S7.003	S19	1440 minute 5 year Winter I+20%	1440	32.865	31.737	1.091	0.000	0.04		1.3	SURCHARGED
S10.000	S20	15 minute 5 year Winter I+20%	15	33.630	32.761	-0.119	0.000	0.10		1.3	OK
S10.001	S21	15 minute 5 year Winter I+20%	15	34.300	32.612	-0.119	0.000	0.10		1.2	OK
S11.000	S22	15 minute 5 year Winter I+20%	15	34.970	33.593	-0.102	0.000	0.22		2.7	OK
S11.001	S23	15 minute 5 year Winter I+20%	15	34.470	33.470	-0.084	0.000	0.40		4.2	OK
S12.000	S24	15 minute 5 year Winter I+20%	15	34.000	33.149	-0.101	0.000	0.23		3.1	OK
S12.001	S25	15 minute 5 year Winter I+20%	15	34.000	33.000	-0.098	0.000	0.21		2.7	OK
S11.002	S26	15 minute 5 year Winter I+20%	15	34.580	32.980	-0.057	0.000	0.69		6.8	OK

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S10.002	S27	480 minute 5 year Winter I+20%	480	34.690	32.511	-0.171	0.000	0.06		1.4	OK
S10.003	S28	480 minute 5 year Winter I+20%	480	34.040	32.440	-0.196	0.000	0.04		1.4	OK
S10.004	S29	480 minute 5 year Winter I+20%	480	33.878	32.383	-0.194	0.000	0.05		1.4	OK
S10.005	S30	1440 minute 5 year Winter I+20%	1440	33.715	31.738	-0.187	0.000	0.03		1.0	OK
S2.005	S31	1440 minute 5 year Winter I+20%	1440	32.220	31.737	1.465	0.000	0.01		1.5	SURCHARGED
S13.000	S32	15 minute 5 year Winter I+20%	15	34.650	33.782	-0.118	0.000	0.10		2.2	OK
S13.001	S33	30 minute 5 year Winter I+20%	30	34.300	33.406	-0.108	0.000	0.18		2.2	OK
S14.000	S34	15 minute 5 year Winter I+20%	15	35.460	34.051	-0.114	0.000	0.13		2.5	OK
S14.001	S35	15 minute 5 year Winter I+20%	15	35.200	33.797	-0.107	0.000	0.18		2.3	OK

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

Simulation Criteria

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

Number of Input Hydrographs 0 | Number of Offline Controls 0 | Number of Time/Area Diagrams 0
Number of Online Controls 4 | Number of Storage Structures 12 | Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR | M5-60 (mm) 15.100 | Cv (Summer) 0.750
Region Scotland and Ireland | Ratio R 0.274 | Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 5, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S2.000	S1	1440 minute 30 year Winter I+20%	1440	32.600	32.021	0.696	0.000	0.00		0.1	SURCHARGED
S3.000	S2	1440 minute 30 year Winter I+20%	1440	32.800	32.022	-0.028	0.000	0.03		0.4	OK
S2.001	S3	2160 minute 30 year Winter I+20%	2160	33.600	32.022	0.842	0.000	0.12		1.7	SURCHARGED
S4.000	S4	1440 minute 30 year Winter I+20%	1440	32.680	32.019	0.089	0.000	0.02		0.2	SURCHARGED
S4.001	S5	1440 minute 30 year Winter I+20%	1440	32.600	32.019	0.315	0.000	0.03		0.5	SURCHARGED
S5.000	S6	15 minute 30 year Winter I+20%	15	33.610	32.866	0.006	0.000	1.01		14.1	SURCHARGED
S4.002	S7	1440 minute 30 year Winter I+20%	1440	33.050	32.019	0.406	0.000	0.13		1.7	SURCHARGED
S6.000	S8	15 minute 30 year Winter I+20%	15	33.770	32.911	-0.109	0.000	0.17		2.4	OK
S2.002	S9	1440 minute 30 year Winter I+20%	1440	33.400	32.017	1.184	0.000	0.12		3.5	SURCHARGED
S2.003	S10	1440 minute 30 year Winter I+20%	1440	33.150	32.007	1.209	0.000	0.09		3.2	SURCHARGED
S2.004	S11	1440 minute 30 year Winter I+20%	1440	32.500	32.005	1.629	0.000	0.07		2.7	SURCHARGED
S7.000	S12	15 minute 30 year Winter I+20%	15	33.810	32.462	-0.073	0.000	0.52		7.3	OK
S8.000	S13	15 minute 30 year Winter I+20%	15	33.570	32.746	-0.094	0.000	0.30		6.1	OK
S8.001	S14	1440 minute 30 year Winter I+20%	1440	32.620	32.010	-0.061	0.000	0.03		0.4	OK
S9.000	S15	15 minute 30 year Winter I+20%	15	33.450	32.596	-0.104	0.000	0.21		2.8	OK
S9.001	S16	15 minute 30 year Winter I+20%	15	33.630	32.044	-0.106	0.000	0.19		5.3	OK
S7.001	S17	1440 minute 30 year Winter I+20%	1440	32.460	32.009	1.206	0.000	0.06		1.6	SURCHARGED
S7.002	S18	1440 minute 30 year Winter I+20%	1440	32.730	32.005	1.247	0.000	0.04		1.6	SURCHARGED
S7.003	S19	1440 minute 30 year Winter I+20%	1440	32.865	32.005	1.358	0.000	0.04		1.5	SURCHARGED
S10.000	S20	15 minute 30 year Winter I+20%	15	33.630	32.768	-0.112	0.000	0.14		2.0	OK
S10.001	S21	30 minute 30 year Winter I+20%	30	34.300	32.623	-0.108	0.000	0.17		2.1	OK
S11.000	S22	15 minute 30 year Winter I+20%	15	34.970	33.604	-0.091	0.000	0.32		4.0	OK
S11.001	S23	15 minute 30 year Winter I+20%	15	34.470	33.492	-0.062	0.000	0.63		6.7	OK
S12.000	S24	15 minute 30 year Winter I+20%	15	34.000	33.160	-0.090	0.000	0.33		4.6	OK
S12.001	S25	15 minute 30 year Winter I+20%	15	34.000	33.021	-0.077	0.000	0.33		4.2	OK
S11.002	S26	15 minute 30 year Winter I+20%	15	34.580	33.009	-0.028	0.000	1.00		9.8	OK

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S10.002	S27	240 minute 30 year Winter I+20%	240	34.690	32.549	-0.133	0.000	0.13		3.1	OK
S10.003	S28	240 minute 30 year Winter I+20%	240	34.040	32.456	-0.179	0.000	0.09		3.1	OK
S10.004	S29	180 minute 30 year Winter I+20%	180	33.878	32.400	-0.176	0.000	0.11		3.1	OK
S10.005	S30	1440 minute 30 year Winter I+20%	1440	33.715	32.006	0.081	0.000	0.04		1.4	SURCHARGED
S2.005	S31	1440 minute 30 year Winter I+20%	1440	32.220	32.004	1.733	0.000	0.01		1.5	FLOOD RISK
S13.000	S32	15 minute 30 year Winter I+20%	15	34.650	33.789	-0.111	0.000	0.15		3.2	OK
S13.001	S33	15 minute 30 year Winter I+20%	15	34.300	33.428	-0.086	0.000	0.37		4.5	OK
S14.000	S34	15 minute 30 year Winter I+20%	15	35.460	34.060	-0.105	0.000	0.20		3.7	OK
S14.001	S35	15 minute 30 year Winter I+20%	15	35.200	33.807	-0.097	0.000	0.27		3.4	OK

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

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 4 Number of Storage Structures 12 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 15.100 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.274 Cv (Winter) 0.840

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 5, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S2.000	S1	1440 minute 100 year Winter I+20%	1440	32.600	32.197	0.872	0.000	0.00		0.0	SURCHARGED
S3.000	S2	1440 minute 100 year Winter I+20%	1440	32.800	32.197	0.147	0.000	0.03		0.5	SURCHARGED
S2.001	S3	1440 minute 100 year Winter I+20%	1440	33.600	32.197	1.017	0.000	0.20		2.8	SURCHARGED
S4.000	S4	1440 minute 100 year Winter I+20%	1440	32.680	32.194	0.264	0.000	0.03		0.4	SURCHARGED
S4.001	S5	1440 minute 100 year Winter I+20%	1440	32.600	32.194	0.490	0.000	0.04		0.6	SURCHARGED
S5.000	S6	15 minute 100 year Winter I+20%	15	33.610	33.002	0.142	0.000	1.26		17.6	SURCHARGED
S4.002	S7	1440 minute 100 year Winter I+20%	1440	33.050	32.194	0.580	0.000	0.14		2.0	SURCHARGED
S6.000	S8	15 minute 100 year Winter I+20%	15	33.770	32.917	-0.103	0.000	0.22		3.0	OK
S2.002	S9	1440 minute 100 year Winter I+20%	1440	33.400	32.193	1.359	0.000	0.12		3.7	SURCHARGED
S2.003	S10	1440 minute 100 year Winter I+20%	1440	33.150	32.187	1.390	0.000	0.09		3.3	SURCHARGED
S2.004	S11	1440 minute 100 year Winter I+20%	1440	32.500	32.190	1.814	0.000	0.07		2.8	SURCHARGED
S7.000	S12	15 minute 100 year Winter I+20%	15	33.810	32.476	-0.059	0.000	0.68		9.5	OK
S8.000	S13	15 minute 100 year Winter I+20%	15	33.570	32.755	-0.085	0.000	0.39		7.9	OK
S8.001	S14	2160 minute 100 year Winter I+20%	2160	32.620	32.183	0.112	0.000	0.05		0.6	SURCHARGED
S9.000	S15	15 minute 100 year Winter I+20%	15	33.450	32.603	-0.097	0.000	0.27		3.7	OK
S9.001	S16	1440 minute 100 year Winter I+20%	1440	33.630	32.184	0.034	0.000	0.02		0.4	SURCHARGED
S7.001	S17	1440 minute 100 year Winter I+20%	1440	32.460	32.183	1.380	0.000	0.07		1.9	FLOOD RISK
S7.002	S18	1440 minute 100 year Winter I+20%	1440	32.730	32.184	1.426	0.000	0.05		1.8	SURCHARGED
S7.003	S19	1440 minute 100 year Winter I+20%	1440	32.865	32.188	1.542	0.000	0.05		1.7	SURCHARGED
S10.000	S20	15 minute 100 year Winter I+20%	15	33.630	32.774	-0.106	0.000	0.19		2.5	OK
S10.001	S21	180 minute 100 year Winter I+20%	180	34.300	32.636	-0.095	0.000	0.10		1.3	OK
S11.000	S22	15 minute 100 year Winter I+20%	15	34.970	33.613	-0.082	0.000	0.42		5.2	OK
S11.001	S23	15 minute 100 year Winter I+20%	15	34.470	33.509	-0.045	0.000	0.82		8.7	OK
S12.000	S24	15 minute 100 year Winter I+20%	15	34.000	33.169	-0.081	0.000	0.43		5.9	OK
S12.001	S25	15 minute 100 year Winter I+20%	15	34.000	33.054	-0.044	0.000	0.48		6.1	OK
S11.002	S26	15 minute 100 year Winter I+20%	15	34.580	33.041	0.003	0.000	1.11		10.9	SURCHARGED

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

PN	US/MH Name	Event	Duration (mins)	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
S10.002	S27	180 minute 100 year Winter I+20%	180	34.690	32.635	-0.046	0.000	0.15		3.8	OK
S10.003	S28	480 minute 100 year Summer I+20%	480	34.040	32.462	-0.174	0.000	0.10		3.4	OK
S10.004	S29	360 minute 100 year Winter I+20%	360	33.878	32.404	-0.172	0.000	0.12		3.5	OK
S10.005	S30	1440 minute 100 year Winter I+20%	1440	33.715	32.190	0.265	0.000	0.05		1.7	SURCHARGED
S2.005	S31	2160 minute 100 year Winter I+20%	2160	32.220	32.193	1.921	0.000	0.01		1.5	FLOOD RISK
S13.000	S32	15 minute 100 year Winter I+20%	15	34.650	33.795	-0.105	0.000	0.20		4.1	OK
S13.001	S33	15 minute 100 year Winter I+20%	15	34.300	33.442	-0.072	0.000	0.52		6.3	OK
S14.000	S34	15 minute 100 year Winter I+20%	15	35.460	34.066	-0.099	0.000	0.25		4.8	OK
S14.001	S35	15 minute 100 year Winter I+20%	15	35.200	33.815	-0.089	0.000	0.35		4.4	OK

APPENDIX D. POLYTUNNEL/ARCH TYPE STORAGE

Appendix D

APPENDIX D. POLYTUNNEL/ARCH TYPE STORAGE

MC-3500 & MC-7200
Design Manual

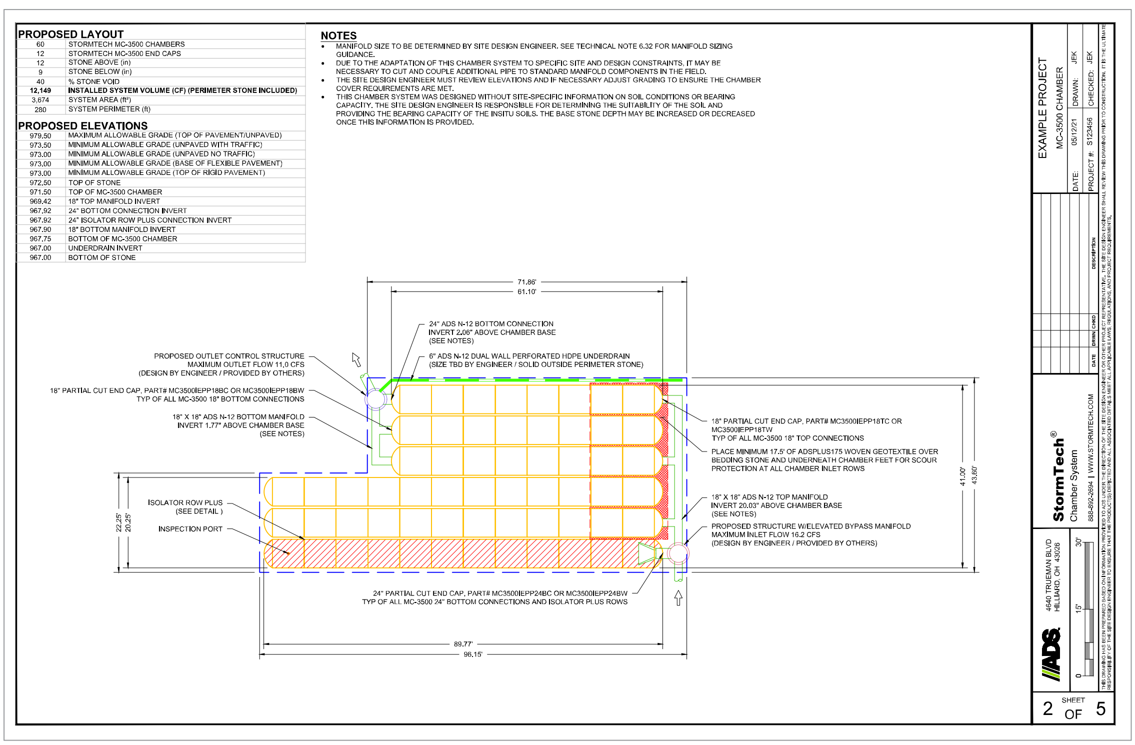
StormTech® Chamber Systems for Stormwater Management

ADS StormTech™

Table of Contents

*For SC-160LP, SC-310, SC-740 & DC-780 designs, please refer to the SC-160LP/SC-310/SC-740/DC-780 Design Manual.

StormTech Engineering Services assists design professionals in specifying StormTech stormwater systems. This assistance includes the layout of chambers to meet the engineer's volume requirements and the connections to and from the chambers. They can also assist converting and cost engineering projects currently specified with ponds, pipe, concrete vaults and other manufactured stormwater detention/retention products. Please note that it is the responsibility of the site design engineer to ensure that the chamber bed layout meets all design requirements and is in compliance with applicable laws and regulations governing a project.



This manual is exclusively intended to assist engineers in the design of subsurface stormwater systems using StormTech chambers.

StormTech MC-3500 Chamber

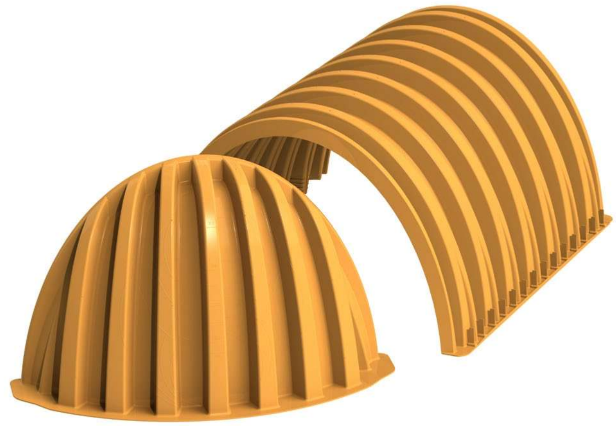
Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.

MC-3500 Chamber (not to scale)

Nominal Specifications

Size (LxWxH)	90” x 77” x 45” (2286 x 1956 x 1143 mm)
Chamber Storage	109.9 ft^3 (3.11 m^3)
Min. Installed Storage*	175.0 ft^3 (4.96 m^3)
Weight	134 lbs (60.8 kg)

*Assumes a minimum of 12” (300 mm) of stone above, 9” (230 mm) of stone below chambers, 6” (150 mm) of stone between chambers/end caps and 40% stone porosity.

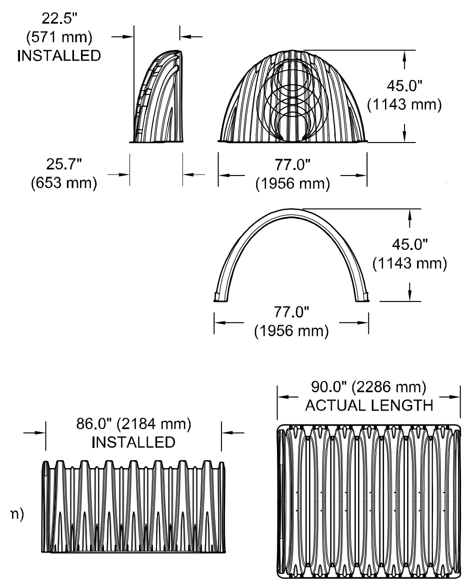


MC-3500 Chamber (not to scale)

Nominal Specifications

Size (LxWxH)	26.5” x 71” x 45.1” (673 x 1803 x 1145 mm)
End Cap Storage	14.9 ft^3 (0.42 m^3)
Min. Installed Storage*	45.1 ft^3 (1.28 m^3)
Weight	49 lbs (22.2 kg)

*Assumes a minimum of 12” (300 mm) of stone above, 9” (230 mm) of stone below, 6” (150 mm) of stone perimeter, 6” (150 mm) of stone between chambers/end caps and 40% stone porosity.

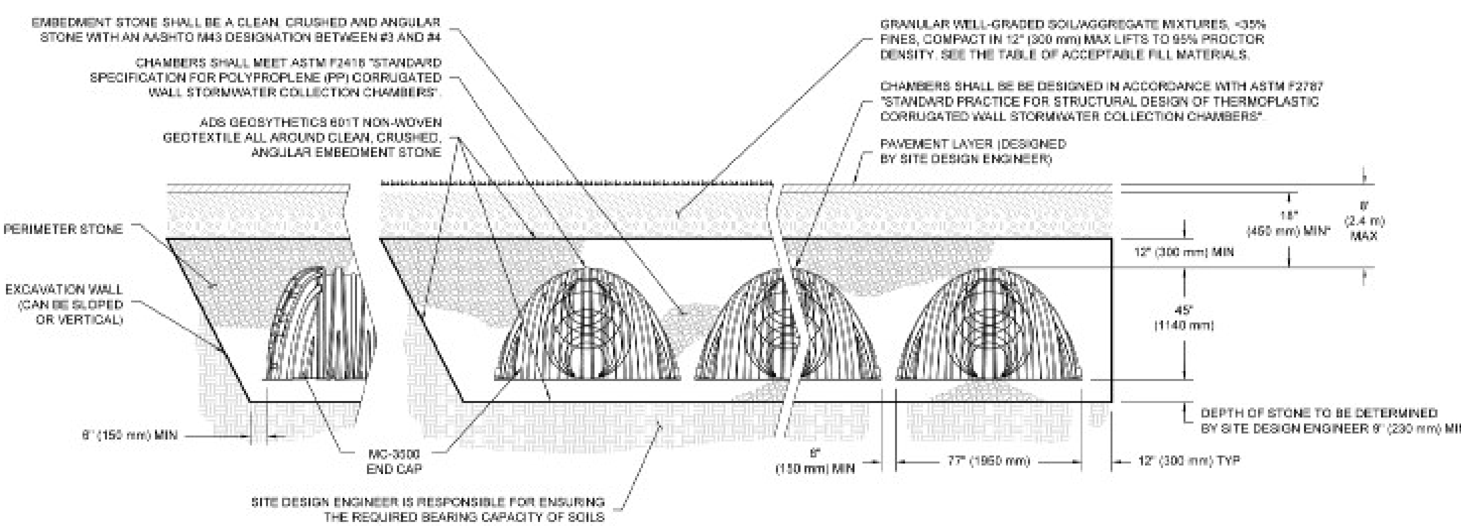


Shipping

15 chambers/pallet

7 end caps/pallet

7 pallets/truck



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 24" (600 mm).

Storage Volume Per Chamber/End Cap ft^3 (m^3)

	Bare Unit Storage ft^3 (m^3)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
Chamber	109.9 (3.11)	175.0 (4.96)	179.9 (5.09)	184.9 (5.24)	189.9 (5.38)
End Cap	14.9 (0.42)	45.1 (1.28)	46.6 (1.32)	48.3 (1.37)	49.9 (1.41)

Note: Assumes 6" (150 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume.

Amount of Stone Per Chamber

ENGLISH tons (yd^3)	Stone Foundation Depth			
	9"	12"	15"	18"
Chamber	8.5 (6.0)	9.1 (6.5)	9.7 (6.9)	10.4 (7.4)
End Cap	3.9 (2.8)	4.1 (2.9)	4.3 (3.1)	4.5 (3.2)
METRIC kg (m^3)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
Chamber	7711 (4.6)	8255 (5.0)	8800 (5.3)	9435 (5.7)
End Cap	3538 (2.1)	3719 (2.2)	3901 (2.4)	4082 (2.5)

Note: Assumes 12" (300 mm) of stone above and 6" (150 mm) row spacing and 6" (150 mm) of perimeter stone in front of end caps.

Volume of Excavation Per Chamber/End Cap yd^3 (m^3)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15" (375 mm)	18" (450 mm)
Chamber	11.9 (9.1)	12.4 (9.5)	12.8 (9.8)	13.3 (10.2)
End Cap	4.0 (3.1)	4.1 (3.2)	4.3 (3.3)	4.4 (3.4)

Note: Assumes 6" (150 mm) of separation between chamber rows and 24" (600 mm) of cover. The volume of excavation will vary as depth of cover increases.

Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

StormTech MC-7200 Chamber

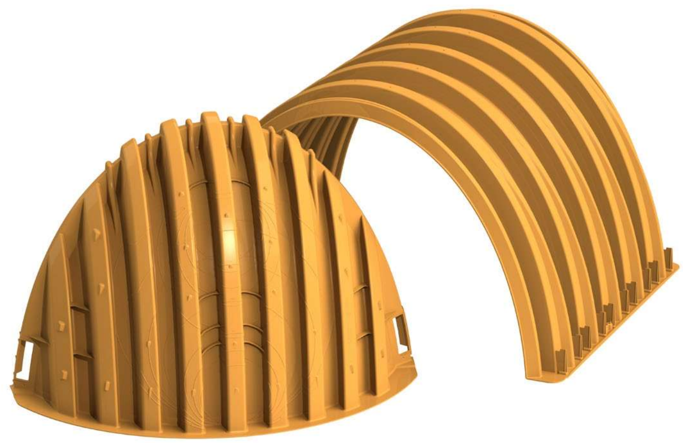
Designed to meet the most stringent industry performance standards for superior structural integrity while providing designers with a cost-effective method to save valuable land and protect water resources. The StormTech system is designed primarily to be used under parking lots, thus maximizing land usage for private (commercial) and public applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.

MC-7200 Chamber (not to scale)

Nominal Specifications

Size (LxWxH)	83.4" x 100" x 60" (2120 x 2540 x 1524 mm)
Chamber Storage	175.9 ft³ (4.98 m³)
Min. Installed Storage*	267.3 ft³ (7.56 m³)
Weight	205 lbs (92.9 kg)

*Assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below chambers, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.



MC-7200 Chamber (not to scale)

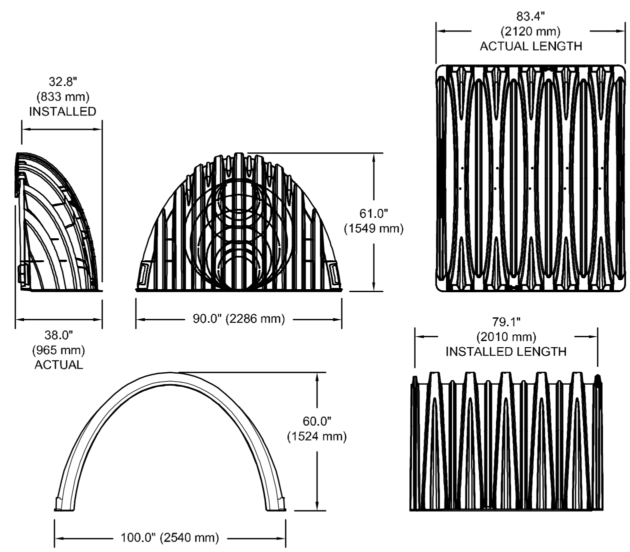
Nominal Specifications

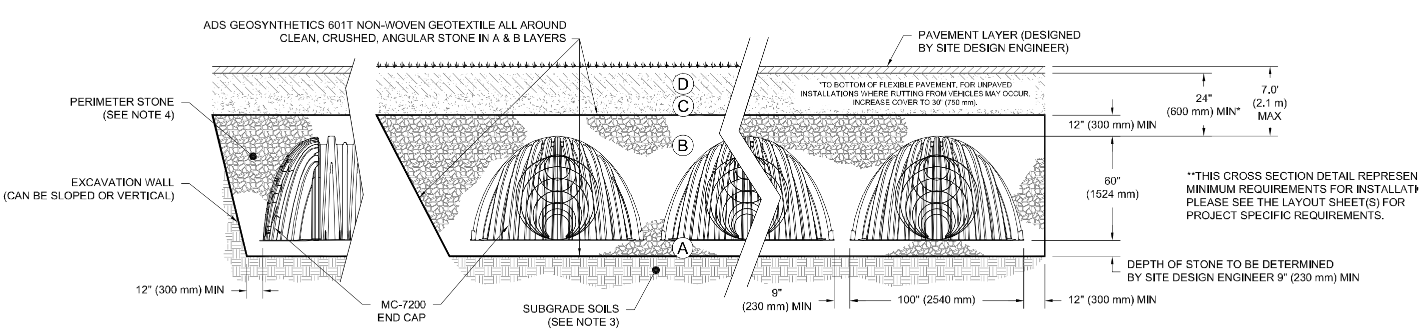
Size (LxWxH)	38" x 90" x 61" (965 x 2286 x 1549 mm)
End Cap Storage	39.5 ft³ (1.12 m³)
Min. Installed Storage*	115.3 ft³ (3.26 m³)
Weight	90.0 lbs (40.8 kg)

*Assumes a minimum of 12" (300 mm) of stone above, 9" (230 mm) of stone below, 12" (300 mm) of stone perimeter, 9" (230 mm) of stone between chambers/end caps and 40% stone porosity.

Shipping

7 chambers/pallet
5 end caps/pallet
6 pallets/truck





Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
Chamber	175.9 (4.98)	267.3 (7.57)	273.3 (7.74)	279.3 (7.91)	285.2 (8.08)
End Cap	39.5 (1.12)	115.3 (3.26)	111.9 (3.17)	121.9 (3.45)	125.2 (3.54)

Note: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 12" (300 mm) stone perimeter in front of end cap.

Amount of Stone Per Chamber

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
Chamber	11.9 (8.5)	12.6 (9.0)	13.4 (9.6)	14.6 (10.1)
End Cap	9.8 (7.0)	10.2 (7.3)	10.6 (7.6)	11.1 (7.9)
METRIC kg (m³)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
Chamber	10796 (6.5)	11431 (6.9)	12156 (7.3)	13245 (7.7)
End Cap	8890 (5.3)	9253 (5.5)	9616 (5.8)	10069 (6.0)

Note: Assumes 12" (300 mm) of stone above and 9" (230 mm) row spacing and 12" (300 mm) of perimeter stone in front of end caps.

Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15" (375 mm)	18" (450 mm)
Chamber	17.2 (13.2)	17.7 (13.5)	18.3 (14.0)	18.8 (14.4)
End Cap	9.7 (7.4)	10.0 (7.6)	10.3 (7.9)	10.6 (8.1)

Note: Assumes 9" (230 mm) of separation between chamber rows, 12" (300 mm) of perimeter in front of the end caps, and 24" (600 mm) of cover. The volume of excavation will vary as depth of cover increases.

Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

1.0 Product Information

1.1 Product Design

StormTech's commitment to thorough product testing programs, materials evaluation and adherence to national standards has resulted in two more superior products. Like other StormTech chambers, the MC-3500 and MC-7200 are designed to meet the full scope of design requirements of the American Society of Testing Materials (ASTM) International specification F2787 "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers" and produced to the requirements of the ASTM F 2418 "Standard Specification for Polypropylene (PP) Corrugated Stormwater Collection Chambers".

The StormTech MC-3500 and MC-7200 chambers provide the full AASHTO safety factors for live loads and permanent earth loads. The ASTM F 2787 standard provides specific guidance on how to design thermoplastic chambers in accordance with AASHTO Section 12.12. of the AASHTO LRFD Bridge Design Specifications. ASTM F 2787 requires that the safety factors included in the AASHTO guidance are achieved as a prerequisite to meeting ASTM F 2418. The three standards provide both the assurance of product quality and safe structural design.

The design of larger chambers in the same tradition of our other chambers required the collaboration of experts in soil-structure interaction, plastics and manufacturing. Years of extensive research, including laboratory testing and field verification, were required to produce chambers that are ready to meet both the rigors of installation and the longevity expected by engineers and owners.

This Design Manual provides the details and specifications necessary for consulting engineers to design stormwater management systems using the MC-3500 and MC-7200 chambers. It provides specifications for storage capacities, layout dimensions as well as requirements for design to ensure a long service life. The basic design concepts for foundation and backfill materials, subgrade bearing capacities and row spacing remain equally as pertinent for the MC-3500 and MC-7200 as the SC-740, SC-310 and DC-780 chamber systems. However, since many design values and dimensional requirements are different for these larger chambers than the SC-740, SC-310 and DC-780 chambers, design manuals and installation instructions are not interchangeable.

This manual includes only those details, dimensions, cover limits, etc for the MC-3500 and MC-7200 and is intended to be a stand-alone design guide for the MC-3500 and MC-7200 chambers. A Construction Guide specifically for these two chamber models has also been published.

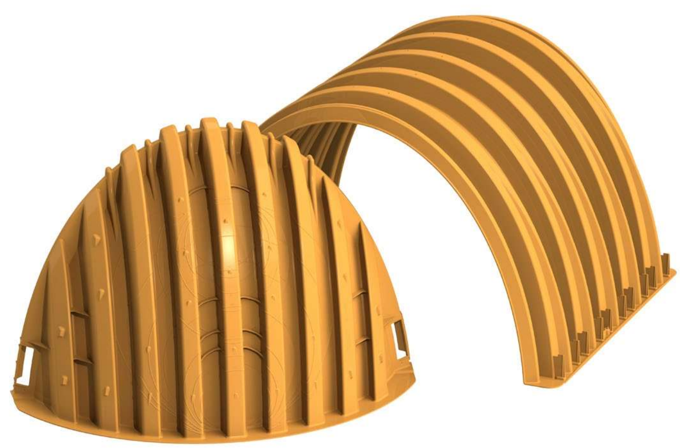
1.2 Technical Support

The StormTech Technical Services Department is available to assist the engineer with the layout of MC-3500 and MC-7200 chamber systems and answer questions regarding all the StormTech chamber models. Call the Technical Services Department, email us at info@stormtech.com or contact your local StormTech representative.

1.3 MC-3500 and MC-7200 Chambers

All StormTech chambers are designed to the full scope of AASHTO requirements without repeating end walls or other structural reinforcing. StormTech's continuously curved, elliptical arch and the surrounding angular backfill are the key components of the structural system. With the addition of patent pending integral stiffening ribs (Figure 5), the MC-3500 and MC-7200 are assured to provide a long, safe service life. Like other StormTech chambers, the MC-3500 and MC-7200 are produced from high quality, impact modified resins which are tested for short-term and long-term mechanical properties.

With all StormTech chambers, one chamber type is used for the start, middle and end of rows. Rows are formed by overlapping the upper joint corrugation of the next chamber over the lower joint corrugation of the previous chamber (Figure 6).



1.4 Chamber Joints

All StormTech chambers are designed with an optimized joining system. The height and width of the end corrugations have been designed to provide the required structural safety factors while providing an unobstructed flow path down each row.

1.0 Product Information

To assist the contractor, StormTech chambers are molded with simple assembly instructions and arrows that indicate the direction in which to build rows. The corrugation valley immediately adjacent to the lower joint corrugation is marked "Overlap Here - Lower Joint." The corrugation valley immediately adjacent to the upper joint corrugation is marked "Build This Direction - Upper Joint."

Two people can safely and efficiently carry and place chambers without cumbersome connectors, special tools or heavy equipment. Each row of chambers must begin and end with a joint corrugation. Since joint corrugations are of a different size than the corrugations along the body of the chamber, chambers cannot be field cut and installed. Only whole MC-3500 and MC-7200 chambers can be used. For system layout assistance contact StormTech.

1.5 MC-3500 and MC-7200 End Caps

The MC-3500 and MC-7200 end caps are easy to install. These end caps are designed with a corrugation joint that fits over the top of either end of the chamber. The end cap joint is simply set over the top of either of the upper or lower chamber joint corrugations (Figure 7).

The MC-3500 end cap has pipe cutting guides for 12"–24" (300 mm–600 mm) top inverts (Figure 9).

The MC-7200 end cap has pipe cutting guides for 12"–42" (300 mm–1050 mm) bottom inverts and 12"–24" (300 mm–600 mm) top inverts (Figure 8).

Standard and custom pre-cored end caps are available. MC-3500 pre-cored end caps, 18" in diameter and larger include a welded crown plate.

Figure 5 - Chamber and End Cap Components

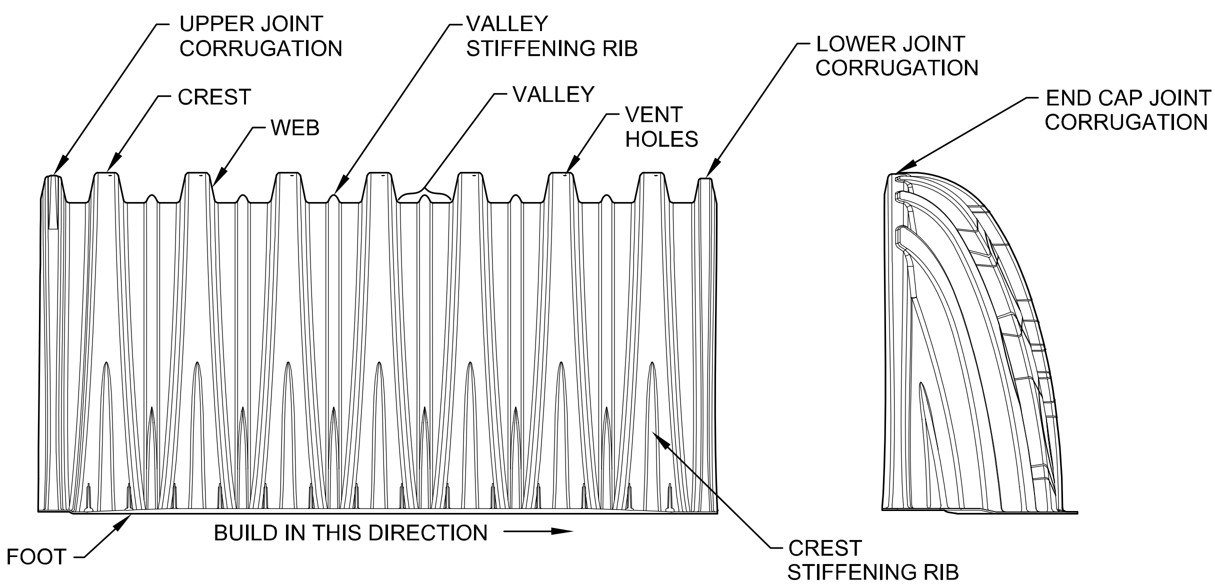


Figure 6 - Chamber Joint Overlap

Figure 7 - End Cap Joint Overlap

1.0 Product Information

Figure 8 - MC-7200 End Cap Inverts

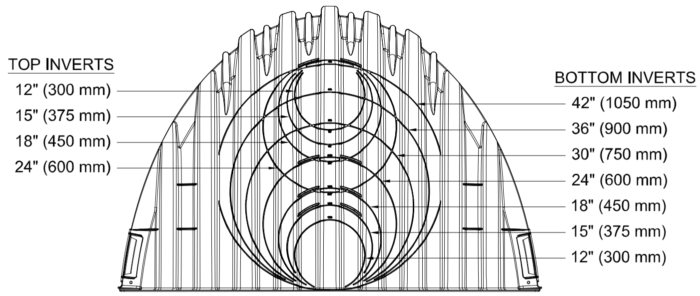
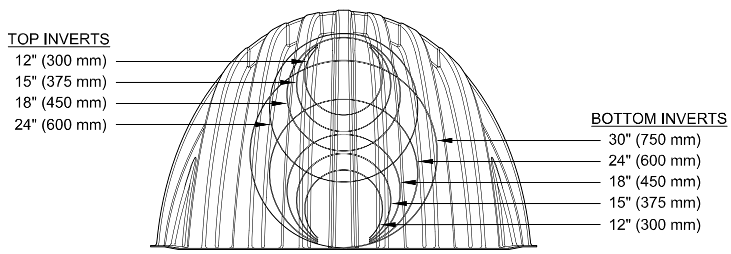


Figure 9 - MC-3500 End Cap Inverts

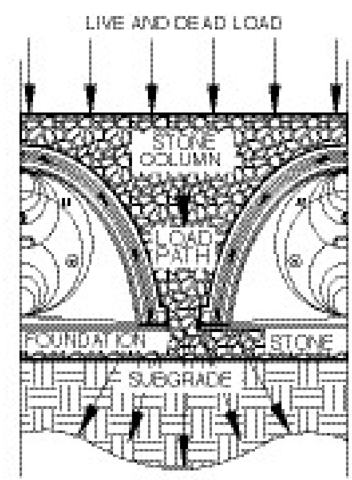


2.0 Foundations for Chambers

2.1 Foundation Requirements

StormTech chamber systems can be installed in various soil types. The subgrade bearing capacity and the cover height over the chambers determine the required depth of clean, crushed, angular foundation stone below the chambers. Foundation stone, also called bedding, is the stone between the subgrade soils and the feet of the chamber. Flexible structures are designed to transfer a significant portion of both live and dead loads through the surrounding soils. Chamber systems accomplish this by creating load paths through the columns of embedment stone between and around the rows of chambers. This creates load concentrations at the base of the columns between the rows. The foundation stone spreads out the concentrated loads to distributed loads that can be supported by the subgrade soils.

Since increasing the cover height (top of chamber to finished grade) causes increasing soil load, a greater depth of foundation stone is necessary to distribute the load to the subgrade soils. **Table 1** and **2** specify the minimum required foundation depths for varying cover heights and allowable subgrade bearing capacities. These tables are based on StormTech service loads. The minimum required foundation depth is 9” (230 mm) for both chambers.



For additional guidance on foundation stone design please see our Technical Note 6.22 - StormTech Subgrade Performance

2.2 Weaker Soils

StormTech has not provided guidance for subgrade bearing capacities less than 2000 pounds per square foot [(2.0 ksf) (96 kPa)]. These soils are often highly vari- able, may contain organic materials and could be more sensitive to moisture. A geotechnical engineer must be consulted if soils with bearing capacities less than 2000 psf (96 kPa) are present.

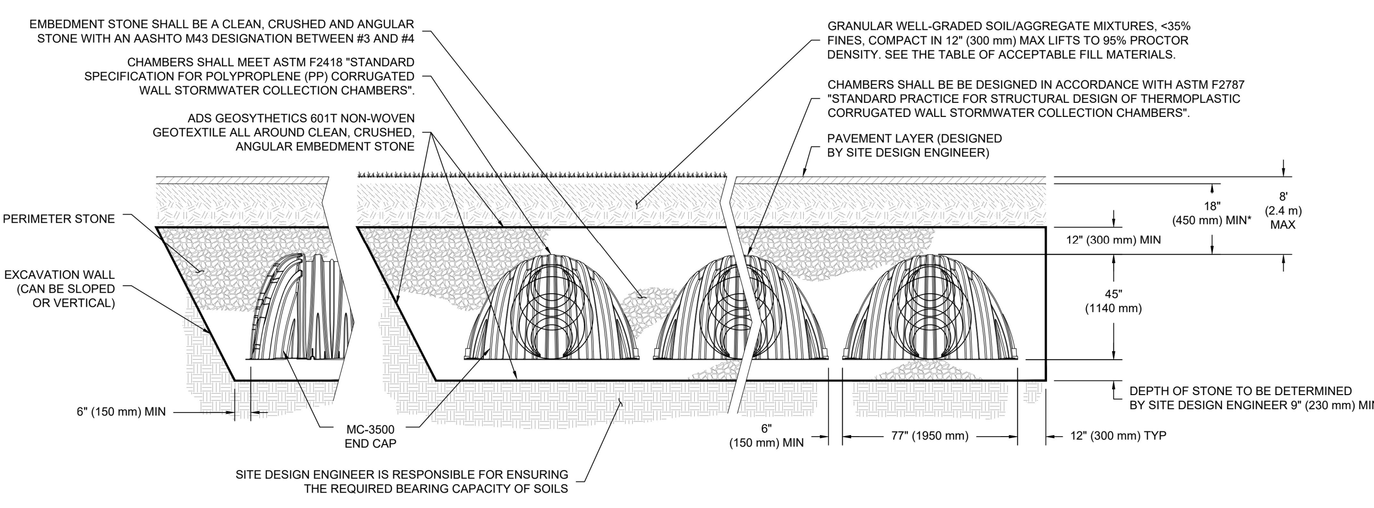
2.0 Foundations for Chambers

Table 1 - MC-3500 Minimum Required Foundation Depth in inches (millimeters)
Assumes 6” (150 mm) row spacing.

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																								
	4.4 (211)	4.3 (206)	4.2 (201)	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
1.5 (0.46)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)
2.0 (0.61)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)
2.5 (0.76)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	21 (525)
3.0 (0.91)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)
3.5 (1.07)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)
4.0 (1.22)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)
4.5 (1.37)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)
5.0 (1.52)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	30 (750)
5.5 (1.68)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)
6.0 (1.83)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)
6.5 (1.98)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	30 (750)
7.0 (2.13)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	30 (750)	30 (750)
7.5 (2.30)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	27 (675)	30 (750)	30 (750)	30 (750)	30 (750)
8.0 (2.44)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	30 (750)	30 (750)	30 (750)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

Figure 10A - MC-3500 Structural Cross Section Detail (Not to Scale)



Special applications will be considered on a project by project basis. Please contact our applications department should you have a unique application for our team to evaluate.

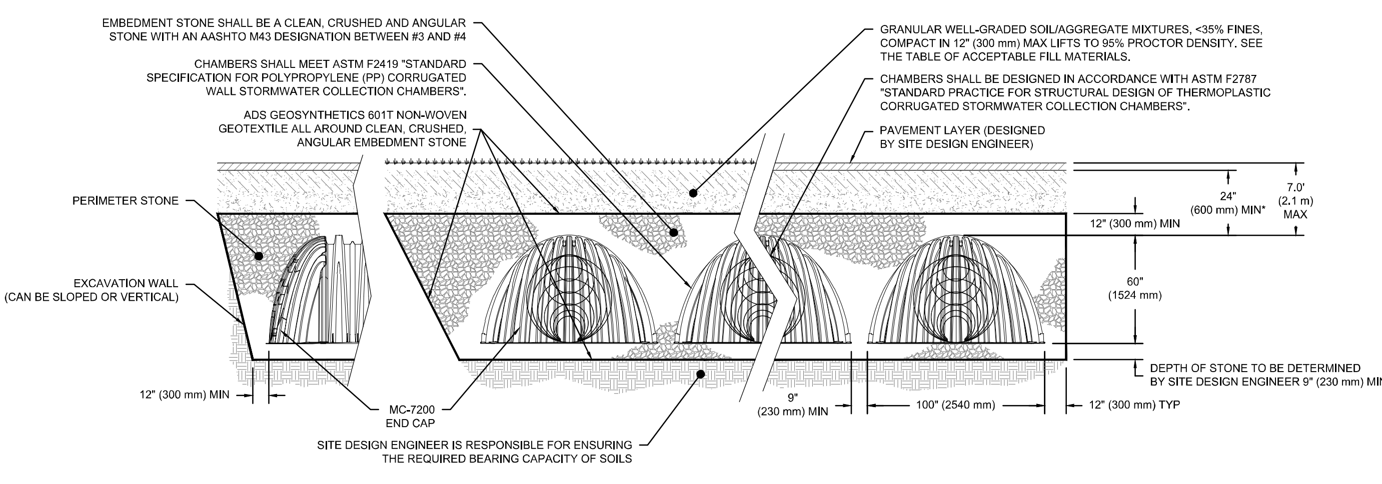
2.0 Foundations for Chambers

Table 2 - MC-7200 Minimum Required Foundation Depth in inches (millimeters)
Assumes 9” (230 mm) row spacing.

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																								
	4.4 (211)	4.3 (206)	4.2 (201)	4.1 (196)	4.0 (192)	3.9 (187)	3.8 (182)	3.7 (177)	3.6 (172)	3.5 (168)	3.4 (163)	3.3 (158)	3.2 (153)	3.1 (148)	3.0 (144)	2.9 (139)	2.8 (134)	2.7 (129)	2.6 (124)	2.5 (120)	2.4 (115)	2.3 (110)	2.2 (105)	2.1 (101)	2.0 (96)
2.0 (0.61)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	21 (525)	21 (525)
2.5 (0.76)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)
3.0 (0.91)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)
3.5 (1.07)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	30 (750)
4.0 (1.22)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)
4.5 (1.37)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	33 (825)	33 (825)
5.0 (1.52)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	33 (825)	33 (825)	36 (900)
5.5 (1.68)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	33 (825)	33 (825)	36 (900)	36 (900)
6.0 (1.83)	12 (300)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	33 (825)	33 (825)	36 (900)	36 (900)	36 (900)
6.5 (1.98)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	33 (825)	33 (825)	36 (900)	36 (900)	36 (900)	36 (900)
7.0 (2.13)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	18 (450)	21 (525)	21 (525)	21 (525)	24 (600)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	30 (750)	33 (825)	36 (900)	36 (900)	36 (900)	36 (900)	36 (900)	36 (900)

NOTE: The design engineer is solely responsible for assessing the bearing resistance (allowable bearing capacity) of the subgrade soils and determining the depth of foundation stone. Subgrade bearing resistance should be assessed with consideration for the range of soil moisture conditions expected under a stormwater system.

Figure 10B - MC-7200 Structural Cross Section Detail (Not to Scale)



Special applications will be considered on a project by project basis. Please contact our applications department should you have a unique application for our team to evaluate.

3.0 Required Materials/Row Separation

3.1 Foundation and Embedment Stone

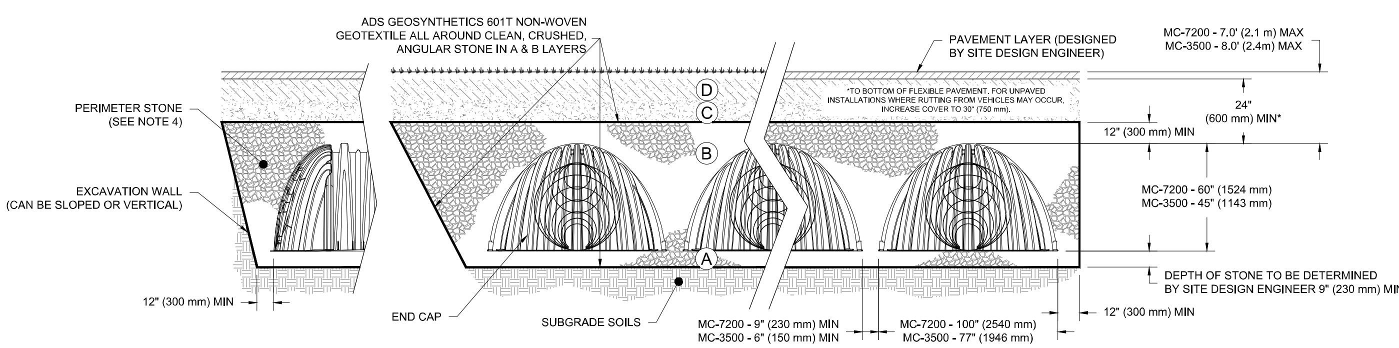
The stone surrounding the chambers consists of the foundation stone below the chambers and embedment stone surrounding the chambers. The foundation stone and embedment stone are important components of the structural system and also provide open void space for stormwater storage. Table 3 provides the stone specifications that achieve both structural requirements and a porosity of 40% for stormwater storage. Figure 11 specifies the extents of each backfill stone location.

Table 3 - Acceptable Fill Materials

	Material Location	Description	AASHTO Material Classifications	Compaction / Density Requirement
D	**Final Fill:** Fill Material for layer 'D' starts from the top of the 'C' layer to the bottom of flexible pavement or unpaved finished grade above. Note that pavement subbase may be part of the 'D' layer.	Any soil/rock materials, native soils, or per engineer's plans. check plans for pavement subgrade requirements.	N/A	Prepare per site design engineer's plans. Paved installations may have stringent material and preparation requirements.
C	**Initial Fill:** Fill material for layer 'C' starts from the top of the embedment stone ('B' layer) to 24" (600 mm) above the top of the chamber. note that pavement subbase may be a part of the 'C' layer.	Granular well-graded soil/aggregate mixtures, <35% fines or processed aggregate. most pavement subbase materials can be used in lieu of this layer.	AASHTO M145[1] a-1,a-2-4,a-3 or AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	Begin compactoins after 24" (600 mm) of material over the chambers is reached. compact addtional layers in 12" (300 mm) max lifts to a min. 95% proctor density for well-graded material and 95% relative density for processed aggregate materials.
B	**Embedment Stone:** Fill surrounding the chambers form the foudation stone ('A' layer) to the 'C' layer above.	Clean, crushed, angular stone	AASHTO M43[1] 3, 4	No compaction required
A	**Foundation Stone:** Fill below chambers from the subgrade up to the foot (bottom) of the chamber.	Clean, crushed, angular stone	AASHTO M43[1] 3, 4	Plate compact or roll to achieve a flat surface. [2 3]

Please Note:
1. The listed AASHTO designations are for gradations only. The stone must also be clean, crushed, angular. For example, a specification for #4 stone would state: "clean, crushed, angular NO. 4 (AASHTO m43) stone".
2. Stormtech compaction requirements are met for 'A' location materials when placed and compacted in 9" (230 mm) (max) lifts using two full coverages with a vibratory compactor.
3. Where infiltration surfaces may be compromised by compaction, for standard design load conditions, a flat surface may be achieved by raking or dragging without compaction equipment. For special load designs, contact stormtech for compaction requirements.

Figure 11 - Fill Material Locations



Once layer 'C' is placed, any soil/material can be placed in layer 'D' up to the finished grade. Most pavement subbase soils can be used to replace the materials of layer 'C' or 'D' at the design engineer's discretion.

3.0 Required Materials/Row Separation

3.2 Fill Above Chambers

Refer to Table 3 and Figure 11 for acceptable fill material above the clean, crushed, angular stone. StormTech requires a minimum of 24" (600 mm) from the top of the chamber to the bottom of flexible pavement. For non-paved installations where rutting from vehicles may occur StormTech requires a minimum of 30" (750 mm) from top of chamber to finished grade.

3.3 Geotextile Separation

A non-woven geotextile meeting AASHTO M288 Class 2 separation requirements must be installed to completely envelope the system and prevent soil intrusion into the crushed, angular stone. Overlap adjacent geotextile rolls per AASHTO M288 separation guidelines. Contact StormTech for a list of acceptable geotextiles.

3.4 Parallel Row Separation/ Perpendicular Bed Separation

Parallel Row Separation

The minimum installed spacing between parallel rows after backfilling is 9" (230 mm) for the MC-7200 chambers and 6" (150mm) for the MC-3500 (measurement taken between the outside edges of the feet). Spacers may be used for layout convenience. Row spacing wider than the minimum spacing above may be specified.

Perpendicular Bed Separation

When beds are laid perpendicular to each other, a minimum installed spacing of 36" (900 mm) between beds is required.

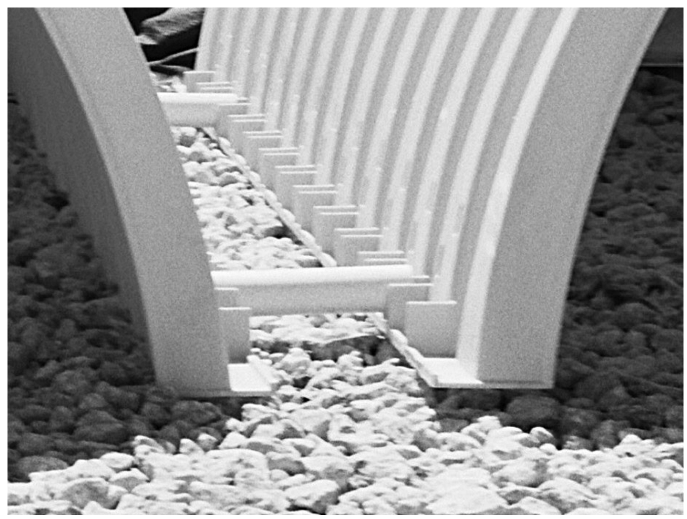
3.5 Special Structural Designs

StormTech engineers may provide special structural designs to enable deeper cover depths or increase the capacity to carry higher live loads. Special designs may utilize the additional strength that can be achieved by compaction of embedment stone or by increasing the spacing between rows.

Increasing the spacing between chamber rows may also facilitate the application of StormTech chambers with either less foundation stone or with weaker subgrade soils. This may be a good option where vertical restrictions on site prevent the use of a deeper foundation.

Contact ADS Engineering Services for more information on special structural designs.

System Cross Section



Minimum Row Spacing

4.0 Hydraulics

4.1 General

StormTech subsurface chamber systems offer the flexibility for a variety of inlet and outlet configurations. Contact the StormTech Technical Services Department or your local StormTech representative for assistance configuring inlet and outlet connections.

The open graded stone around and under the chambers provides a significant conveyance capacity ranging from approximately 0.8 cfs (23 l/s) to 13 cfs (368 l/s) per MC-3500 chamber and for the MC-7200 chamber. The actual conveyance capacity is dependent upon stone size, depth of foundation stone and head of water. Although the high conveyance capacity of the open graded stone is an important component of the flow network, StormTech recommends that a system of inlet and outlet manifolds be designed to distribute and convey the peak flow through the chamber system.

It is the responsibility of the design engineer to provide the design flow rates and storage volumes for the stormwater system and to ensure that the final design meets all conveyance and storage requirements. However, StormTech will work with the design engineer to assist with manifold and chamber layouts that meet the design objectives.

4.2 The Isolator® Row Plus

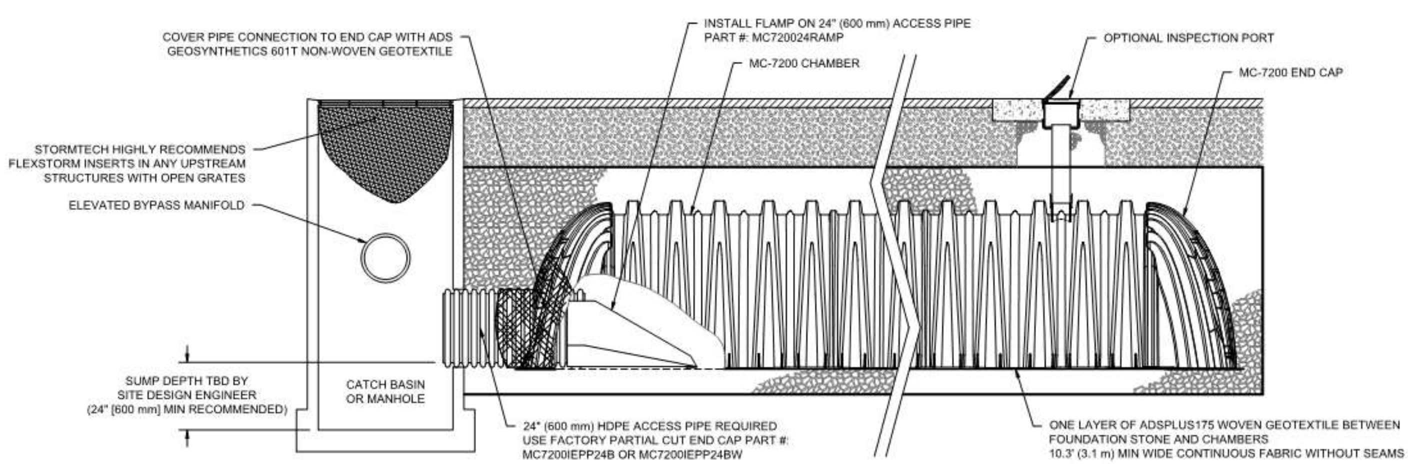
The Isolator Row Plus is a system that inexpensively captures total suspended solids (TSS) and debris and provides easy access for inspection and maintenance. In a typical configuration, a single layer of ADS Plus fabric is placed between the chambers and the stone foundations. This fabric traps and filters sediments as well as protects the stone base during cleaning and maintenance. Each installed MC-3500 chamber and MC-3500 end cap provides 42.9 ft2 (4.0 m^2) and 7.5 ft^2 (0.7 m^2) of bottom filter area respectively. Each installed MC-7200 chamber and MC-7200 end cap provides 57.9 ft^2 (5.4 m^2) and 12.8 ft^2 (1.19 m^2) of bottom filter area respectively.

The Isolator Row Plus can be configured for maintenance objectives or, in some regulatory jurisdictions, for water quality objectives. For water quality applications, the Isolator Row Plus can be sized based on water quality volume or flow rate.

All Isolator Plus Rows require: 1) a manhole for maintenance access, 2) a means of diversion of flows to the Isolator Row Plus 3) a high flow bypass and 4)FLAMP (Flared End Ramp). When used on an Isolator Row Plus, a 24" FLAMP (flared end ramp) is attached to the inside of the inlet pipe with a provided threaded rod and bolt. The FLAMP then lays on top of the ADS Plus fabric.. Flow diversion can be accomplished by either a weir in the upstream access manhole or simply by feeding the Isolator Row Plus at a lower elevation than the high flow bypass. Contact StormTech for assistance sizing Isolator Plus Rows.

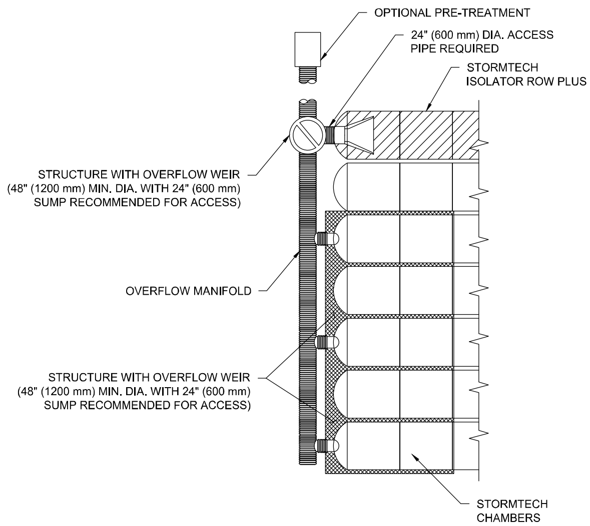
When additional stormwater treatment is required, StormTech systems can be configured using a treatment train approach where other stormwater BMPs are located in series.

Figure 12 - StormTech Isolator Row Plus Detail



4.0 Hydraulics

Figure 13 - Typical Inlet Configuration With Isolator Row Plus and Scour Protection



4.3 Inlet Manifolds

The primary function of the inlet manifold is to convey and distribute flows to a sufficient number of rows in the chamber bed such that there is ample conveyance capacity to pass the peak flows without creating an unacceptable backwater condition in upstream piping or scour the foundation stone under the chambers.

Manifolds are connected to the end caps either at the top or bottom of the end cap. Standard distances from the base of chamber to the invert of inlet and outlet manifolds connecting to StormTech end caps can be found in table 6. High inlet flow rates from either connection location produce a shear scour potential of the foundation stone. Inlet flows from top inlets also produce impingement scour potential. Scour potential is reduced when standing water is present over the foundation stone. However, for safe design across the wide range of applications, StormTech assumes minimal standing water at the time the design flow occurs.

To minimize scour potential, StormTech recommends the installation of woven scour protection fabric at each inlet row. This enables a protected transition zone from the concentrated flow coming out of the inlet pipe to a uniform flow across the entire width of the chamber for both top and bottom connections.

Allowable flow rates for design are dependent upon: the elevation of inlet pipe, foundation stone size and scour protection. With an appropriate scour protection geotextile installed from the end cap to at least 14.5 ft (4.42 m) in front of the inlet pipe for the MC-3500 and for the MC-7200, for both top and bottom feeds, the flow rates listed in Table 4 can be used for all StormTech specified foundation stone gradations.

*See StormTech's Tech Note 6.32 for manifold sizing guidance.

Table 4 - Allowable Inlet Flows*

Inlet Pipe Diameter Inches (mm)	Allowable Maximum Flow Rate cfs (l/s)
12 (300)	2.48 (70)
15 (375)	3.5 (99)
18 (450)	5.5 (156)
24 (600)	8.5 (241) [MC-3500]
24 (600)	9.5 (269) [MC-7200]

*Assumes appropriate length of scour fabric per section 4.3

Table 5 - Maximum Outlet Flow Rate Capacities From StormTech Oulet Manifolds

Pipe Diameter	Flow (CFS)	Flow (L/S)
6" (150 mm)	0.4	11.3
8" (200 mm)	0.7	19.8
10" (250 mm)	1.0	28.3
12" (300 mm)	2.0	56.6
15" (375 mm)	2.7	76.5
18" (450 mm)	4.0	113.3
24" (600 mm)	7.0	198.2
30" (750 mm)	11.0	311.5
36" (900 mm)	16.0	453.1
42" (1050 mm)	22.0	623.0
48" (1200 mm)	28.0	792.9

Table 6 - Standard Distances From Base of Chamber to Invert of Inlet and Outlet Manifolds on StormTech End Caps

MC-3500 ENDCAPS			
	Pipe Diameter	Inv. (in)	Inv. (mm)
Top	6" (150 mm)	33.21	841
	8" (200 mm)	31.16	789
	10" (250 mm)	29.04	738
	12" (300 mm)	26.36	671
	15" (375 mm)	23.39	594
	18" (450 mm)	20.03	509
	24" (600 mm)	14.48	369
Bottom	12" (750 mm)	1.35	34
	15" (900 mm)	1.5	40
	18" (1050 mm)	1.77	46
	24" (1200 mm)	2.06	52

MC-7200 ENDCAPS			
	Pipe Diameter	Inv. (in)	Inv. (mm)
Top	12" (300 mm)	35.69	907
	15" (375 mm)	32.72	831
	18" (450 mm)	29.36	746
	24" (600 mm)	23.05	585
Bottom	12" (750 mm)	1.55	34
	15" (900 mm)	1.7	43
	18" (1050 mm)	1.97	50
	24" (1200 mm)	2.26	57

4.4 Outlet Manifolds

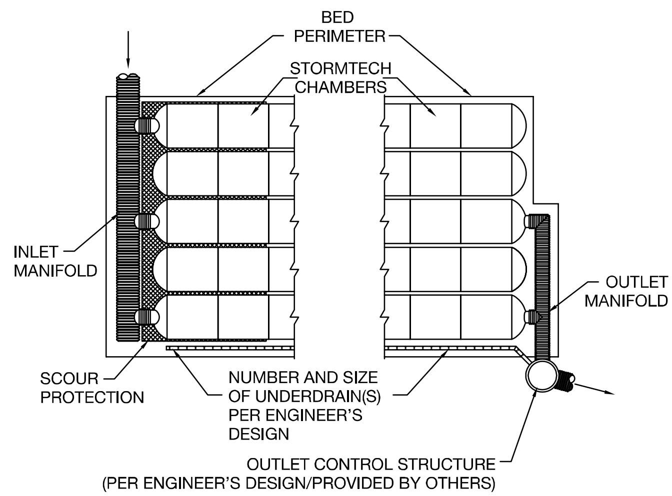
The primary function of the outlet manifold is to convey peak flows from the chamber system to the outlet control structure. Outlet manifolds are often sized for attenuated flows. They may be smaller in diameter and have fewer row connections than inlet manifolds. In some applications however, the intent of the outlet piping is to convey an unattenuated bypass flow rate and manifolds may be sized similar to inlet manifolds.

Since chambers are generally flowing at or near full at the time of the peak outlet flow rate, scour is generally not governing and outlet manifold sizing is based on pipe flow equations. In most cases, StormTech recommends that outlet manifolds connect the same rows that are connected to an inlet manifold. This provides a continuous flow path through open conduits to pass the peak flow without dependence on passing peak flows through stone.

The primary function of the underdrains is to draw down water stored in the stone below the invert of the manifold. Underdrains are generally not sized for conveyance of the peak flow.

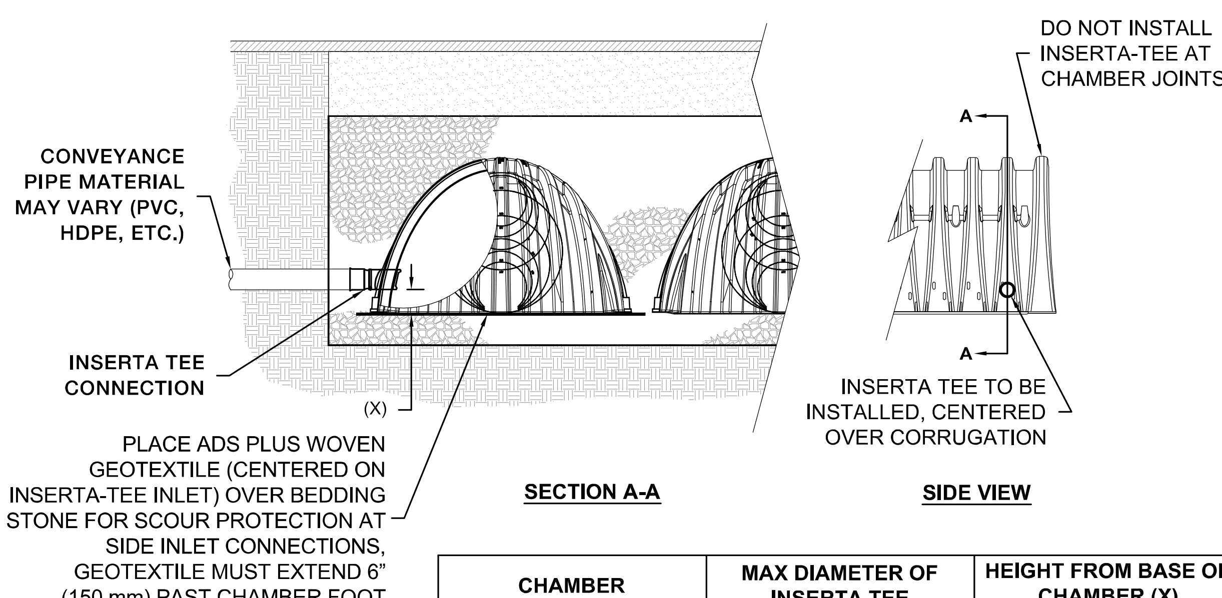
The maximum outlet flow rate capacities from StormTech outlet manifolds can be found in Table 5.

Figure 14 - Typical Inlet, Outlet and Underdrain Configuration



4.5 Inserta Tee® Inlet Connections

Figure 15 - Inserta Tee Detail



CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
MC-3500	12" (250 mm)	6" (150 mm)
MC-7200	12" (250 mm)	8" (200 mm)
INSERTA TEE FITTINGS AVAILABLE FOR SDR 26, SDR 35, SCH 40 IPS GASKETED & SOLVENT WELD, N-12, HP STORM, C-900 OR DUCTILE IRON		

NOTE:
PART NUMBERS WILL VARY BASED ON INLET PIPE MATERIALS. CONTACT STORMTECH FOR MORE INFORMATION.

5.0 Cumulative Storage Volumes

Tables 7 and 8 provide cumulative storage volumes for the MC-3500 chamber and end cap. These tables can be used to calculate the stage-storage relationship for the retention or detention system. Digital spreadsheets in which the number of chambers and end caps can be input for quick cumulative storage calculations are available at www.stormtech.com. For assistance with site-specific calculations or input into routing software, contact the StormTech Technical Services Department.

Table 7 – MC-3500 Incremental Storage Volume Per Chamber
Assumes 40% stone porosity. Calculations are based upon a 9” (230 mm) stone base under the chambers, 12” (300 mm) of stone above chambers, and 6” (150 mm) of spacing between chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
66 (1676)	0.00	175.02 (4.956)
65 (1651)	0.00	173.36 (4.909)
64 (1626)	0.00	171.71 (4.862)
63 (1600)	0.00	170.06 (4.816)
62 (1575)	0.00	168.41 (4.7.69)
61 (1549)	Stone Cover 0.00	166.76 (4.722)
60 (1524)	0.00	165.10 (4.675)
59 (1499)	0.00	163.45 (4.628)
58 (1473)	0.00	161.80 (4.582)
57 (1448)	0.00	160.15 (4.535)
56 (1422)	0.00	158.49 (4.488)
55 (1397)	0.00	156.84 (4.441)
54 (1372)	109.95 (3.113)	155.19 (4.394)
53 (1346)	109.89 (3.112)	153.50 (4.347)
52 (1321)	109.69 (3.106)	151.73 (4.297)
51 (1295)	109.40 (3.098)	149.91 (4.245)
50 (1270)	109.00 (3.086)	148.01 (4.191)
49 (1245)	108.31 (3.067)	145.95 (4.133)
48 (1219)	107.28 (3.038)	143.68 (4.068)
47 (1194)	106.03 (3.003)	141.28 (4.000)
46 (1168)	104.61 (2.962)	138.77 (3.930)
45 (1143)	103.04 (2.918)	136.17 (3.856)
44 (1118)	101.33 (2.869)	133.50 (3.780)
43 (1092)	99.50 (2.818)	130.75 (3.702)
42 (1067)	97.56 (2.763)	127.93 (3.623)
41 (1041)	95.52 (2.705)	125.06 (3.541)
40 (1016)	93.39 (2.644)	122.12 (3.458)
39 (991)	91.16 (2.581)	119.14 (3.374)
38 (965)	88.86 (2.516)	116.10 (3.288)
37 (948)	86.47 (2.449)	113.02 (3.200)
36 (914)	84.01 (2.379)	109.89 (3.112)
35 (889)	81.49 (2.307)	106.72 (3.022)
34 (864)	78.89 (2.234)	103.51 (2.931)
33 (838)	76.24 (2.159)	100.27 (2.839)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
32 (813)	73.52 (2.082)	96.98 (2.746)
31 (787)	70.75 (2.003)	93.67 (2.652)
30 (762)	67.92 (1.923)	90.32 (2.558)
29 (737)	65.05 (1.842)	86.94 (2.462)
28 (711)	62.12 (1.759)	83.54 (2.366)
27 (686)	59.15 (1.675)	80.10 (2.268)
26 (680)	56.14 (1.590)	76.64 (2.170)
25 (635)	53.09 (1.503)	73.16 (2.072)
24 (610)	49.99 (1.416)	69.65 (1.972)
23 (584)	46.86 (1.327)	66.12 (1.872)
22 (559)	43.70 (1.237)	62.57 (1.772)
21 (533)	40.50 (1.147)	59.00 (1.671)
20 (508)	37.27 (1.055)	55.41 (1.569)
19 (483)	34.01 (0.963)	51.80 (1.467)
18 (457)	30.72 (0.870)	48.17 (1.364)
17 (432)	27.40 (0.776)	44.53 (1.261)
16 (406)	24.05 (0.681)	40.87 (1.157)
15 (381)	20.69 (0.586)	37.20 (1.053)
14 (356)	17.29 (0.490)	33.51 (0.949)
13 (330)	13.88 (0.393)	29.81 (0.844)
12 (305)	10.44 (0.296)	26.09 (0.739)
11 (279)	6.98 (0.198)	22.37 (0.633)
10 (254)	3.51 (0.099)	18.63 (0.527)
9 (229)	0.00	14.87 (0.421)
8 (203)	0.00	13.22 (0.374)
7 (178)	0.00	11.57 (0.328)
6 (152)	0.00	9.91 (0.281)
5 (127)	Stone Cover 0.00	8.26 (0.234)
4 (102)	0.00	6.61 (0.187)
3 (76)	0.00	4.96 (0.140)
2 (51)	0.00	3.30 (0.094)
1 (25)	0.00	1.65 (0.047)

NOTE: Add 1.65 ft^3 (0.047 m^3) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volume

Table 8 – MC-3500 Incremental Storage Volume Per End Cap
Assumes 40% stone porosity. Calculations are based upon a 9” (230 mm) stone base under the chambers, 12” (300 mm) of stone above end caps, and 6” (150 mm) of spacing between end caps and 6” (150 mm) of stone perimeter.

Depth of Water in System Inches (mm)	Cumulative End Cap Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
66 (1676)	0.00	45.10 (1.277)
65 (1651)	0.00	44.55 (1.262)
64 (1626)	0.00	44.00 (1.246)
63 (1600)	0.00	43.46 (1.231)
62 (1575)	0.00	42.91 (1.2.15)
61 (1549)	Stone Cover 0.00	42.36 (1.200)
60 (1524)	0.00	41.81 (1.184)
59 (1499)	0.00	41.27 (1.169)
58 (1473)	0.00	40.72 (1.153)
57 (1448)	0.00	40.17 (1.138)
56 (1422)	0.00	39.62 (1.122)
55 (1397)	0.00	39.08 (1.107)
54 (1372)	15.64 (0.443)	38.53 (1.091)
53 (1346)	15.64 (0.443)	37.98 (1.076)
52 (1321)	15.63 (0.443)	37.42 (1.060)
51 (1295)	15.62 (0.442)	36.85 (1.043)
50 (1270)	15.60 (0.442)	36.27 (1.027)
49 (1245)	15.56 (0.441)	35.68 (1.010)
48 (1219)	15.51 (0.439)	35.08 (0.993)
47 (1194)	15.44 (0.437)	34.47 (0.976)
46 (1168)	15.35 (0.435)	33.85 (0.959)
45 (1143)	15.25 (0.432)	33.22 (0.941)
44 (1118)	15.13 (0.428)	32.57 (0.922)
43 (1092)	14.99 (0.424)	31.91 (0.904)
42 (1067)	14.83 (0.420)	31.25 (0.885)
41 (1041)	14.65 (0.415)	30.57 (0.866)
40 (1016)	14.45 (0.409)	29.88 (0.846)
39 (991)	14.24 (0.403)	29.18 (0.826)
38 (965)	14.00 (0.396)	28.48 (0.806)
37 (948)	13.74 (0.389)	27.76 (0.786)
36 (914)	13.47 (0.381)	27.04 (0.766)
35 (889)	13.18 (0.373)	26.30 (0.745)
34 (864)	12.86 (0.364)	25.56 (0.724)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
33 (838)	12.53 (0.355)	24.82 (0.703)
32 (813)	12.18 (0.345)	24.06 (0.681)
31 (787)	11.81 (0.335)	23.30 (0.660)
30 (762)	11.42 (0.323)	22.53 (0.638)
29 (737)	11.01 (0.312)	21.75 (0.616)
28 (711)	10.58 (0.300)	20.96 (0.594)
27 (686)	10.13 (0.287)	20.17 (0.571)
26 (680)	9.67 (0.274)	19.37 (0.549)
25 (635)	9.19 (0.260)	18.57 (0.526)
24 (610)	8.70 (0.246)	17.76 (0.503)
23 (584)	8.19 (0.232)	16.94 (0.480)
22 (559)	7.67 (0.217)	16.12 (0.456)
21 (533)	7.13 (0.202)	15.29 (0.433)
20 (508)	6.59 (0.187)	14.45 (0.409)
19 (483)	6.03 (0.171)	13.61 (0.385)
18 (457)	5.46 (0.155)	12.76 (0.361)
17 (432)	4.88 (0.138)	11.91 (0.337)
16 (406)	4.30 (0.122)	11.06 (0.313)
15 (381)	3.70 (0.105)	10.20 (0.289)
14 (356)	3.10 (0.088)	9.33 (0.264)
13 (330)	2.49 (0.071)	8.46 (0.240)
12 (305)	1.88 (0.053)	7.59 (0.215)
11 (279)	1.26 (0.036)	6.71 (0.190)
10 (254)	0.63 (0.018)	5.83 (0.165)
9 (229)	0.00	4.93 (0.139)
8 (203)	0.00	4.38 (0.124)
7 (178)	0.00	3.83 (0.108)
6 (152)	0.00	3.28 (0.093)
5 (127)	Stone Cover 0.00	2.74 (0.077)
4 (102)	0.00	2.19 (0.062)
3 (76)	0.00	1.64 (0.046)
2 (51)	0.00	1.09 (0.031)
1 (25)	0.00	0.55 (0.015)

NOTE: Add 0.56 ft^3 (0.016 m^3) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volumes

Tables 9 and **10** provide cumulative storage volumes for the MC-7200 chamber and end cap. These tables can be used to calculate the stage-storage relationship for the retention or detention system. Digital spreadsheets in which the number of chambers and end caps can be input for quick cumulative storage calculations are available at www.stormtech.com. For assistance with site-specific calculations or input into routing software, contact the StormTech Technical Services Department.

Table 9 – MC-7200 Incremental Storage Volume Per Chamber

Assumes 40% stone porosity. Calculations are based upon a 9" (230 mm) stone base under the chambers, 12" (300 mm) of stone above chambers, and 9" (230 mm) of spacing between chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
81 (2057)	0.00	267.30 (7.569)
80 (2032)	0.00	265.30 (7.512)
79 (2007)	0.00	263.30 (7.456)
78 (1981)	0.00	261.31 (7.399)
77 (1956)	0.00	259.31 (7.343)
76 (1930)	Stone Cover 0.00	257.31 (7.286)
75 (1905)	0.00	255.32 (7.230)
74 (1880)	0.00	253.32 (7.173)
73 (1854)	0.00	251.32 (7.117)
72 (1829)	0.00	249.33 (7.060)
71 (1803)	0.00	247.33 (7.004)
70 (1778)	0.00	245.33 (6.947)
69 (1753)	175.90 (4.981)	243.33 (6.890)
68 (1727)	175.84 (4.979)	241.30 (6.833)
67 (1702)	175.65 (4.974)	239.19 (6.773)
66 (1676)	175.38 (4.966)	237.03 (6.712)
65 (1651)	175.02 (4.956)	234.82 (6.649)
64 (1626)	174.56 (4.943)	232.54 (6.585)
63 (1600)	173.82 (4.922)	230.10 (6.516)
62 (1575)	172.72 (4.891)	227.45 (6.441)
61 (1549)	171.41 (4.854)	224.66 (6.362)
60 (1524)	169.91 (4.811)	221.76 (6.280)
59 (1499)	168.25 (4.764)	218.77 (6.195)
58 (1473)	166.46 (4.714)	215.70 (6.108)
57 (1448)	164.53 (4.659)	212.55 (6.019)
56 (1422)	162.50 (4.602)	209.33 (5.928)
55 (1397)	160.36 (4.541)	206.05 (5.835)
54 (1372)	158.11 (4.477)	202.70 (5.740)
53 (1346)	155.77 (4.411)	199.30 (5.644)
52 (1321)	153.33 (4.342)	195.84 (5.546)
51 (1295)	150.81 (4.271)	192.33 (5.446)
50 (1270)	148.21 (4.197)	188.78 (5.346)
49 (1245)	145.53 (4.121)	185.17 (5.244)
48 (1219)	142.78 (4.043)	181.52 (5.140)
47 (1194)	139.96 (3.963)	177.83 (5.036)
46 (1168)	137.07 (3.881)	174.10 (4.930)
45 (1143)	134.11 (3.798)	170.33 (4.823)
44 (1118)	131.09 (3.712)	166.52 (4.715)
43 (1092)	128.01 (3.625)	162.68 (4.607)
42 (1067)	124.88 (3.536)	158.80 (4.497)
41 (1041)	121.68 (3.446)	154.89 (4.386)

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
40 (1016)	118.44 (3.354)	150.94 (4.274)
39 (991)	115.14 (3.260)	146.97 (4.162)
38 (965)	111.80 (3.166)	142.96 (4.048)
37 (948)	108.40 (3.070)	138.93 (3.934)
36 (914)	104.97 (2.972)	134.87 (3.819)
35 (889)	101.48 (2.874)	130.78 (3.703)
34 (864)	97.96 (2.774)	126.67 (3.587)
33 (838)	94.39 (2.673)	122.54 (3.470)
32 (813)	90.79 (2.571)	118.38 (3.352)
31 (787)	87.14 (2.468)	114.19 (3.234)
30 (762)	83.46 (2.363)	109.99 (3.114)
29 (737)	79.75 (2.258)	105.76 (2.995)
28 (711)	76.00 (2.152)	101.52 (2.875)
27 (686)	72.22 (2.045)	97.25 (2.754)
26 (680)	68.41 (1.937)	92.97 (2.632)
25 (610)	64.56 (1.828)	88.66 (2.511)
24 (609)	60.69 (1.719)	84.34 (2.388)
23 (584)	56.80 (1.608)	80.01 (2.266)
22 (559)	52.87 (1.497)	75.66 (2.142)
21 (533)	48.92 (1.385)	71.29 (2.019)
20 (508)	44.95 (1.273)	66.91 (1.895)
19 (483)	40.96 (1.160)	62.52 (1.770)
18 (457)	36.94 (1.046)	58.11 (1.646)
17 (432)	32.91 (0.932)	53.69 (1.520)
16 (406)	28.85 (0.817)	49.26 (1.395)
15 (381)	24.78 (0.702)	44.82 (1.269)
14 (356)	20.69 (0.586)	40.37 (1.143)
13 (330)	16.58 (0.469)	35.91 (1.017)
12 (305)	12.46 (0.353)	31.44 (0.890)
11 (279)	8.32 (0.236)	26.96 (0.763)
10 (254)	4.17 (0.118)	22.47 (0.636)
9 (229)	0.00	17.97 (0.509)
8 (203)	0.00	15.98 (0.452)
7 (178)	0.00	13.98 (0.396)
6 (152)	0.00	11.98 (0.339)
5 (127)	Stone Cover 0.00	9.99 (0.283)
4 (102)	0.00	7.99 (0.226)
3 (76)	0.00	5.99 (0.170)
2 (51)	0.00	3.99 (0.113)
1 (25)	0.00	2.00 (0.057)

NOTE: Add 2.00 ft^3 (0.057 m^3) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

5.0 Cumulative Storage Volumes

Table 10 – MC-7200 Incremental Storage Volume Per End Cap
Assumes 40% stone porosity. Calculations are based upon a 9” (230 mm) stone base under the chambers, 12” (300 mm) of stone above end caps, and 9” (230 mm) of spacing between end caps and 6” (150 mm) of stone perimeter.

Depth of Water in System Inches (mm)	Cumulative End Cap Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
81 (2057)	0.00	115.28 (3.264)
80 (2032)	0.00	114.15 (3.232)
79 (2007)	0.00	113.02 (3.200)
78 (1981)	0.00	111.89 (3.168)
77 (1956)	0.00	110.76 (3.136)
76 (1930)	Stone 0.00	109.63 (3.104)
75 (1905)	Cover 0.00	108.50 (3.072)
74 (1880)	0.00	107.37 (3.040)
73 (1854)	0.00	106.24 (3.008)
72 (1829)	0.00	105.11 (2.976)
71 (1803)	0.00	103.98 (2.944)
70 (1778)	0.00	102.85 (2.912)
69 (1753)	39.54 (1.120)	101.72 (2.880)
68 (1727)	39.53 (1.119)	100.58 (2.848)
67 (1702)	39.50 (1.118)	99.43 (2.816)
66 (1676)	39.45 (1.117)	98.27 (2.783)
65 (1651)	39.38 (1.115)	97.10 (2.750)
64 (1626)	39.30 (1.113)	95.92 (2.716)
63 (1600)	39.19 (1.110)	94.73 (2.682)
62 (1575)	39.06 (1.106)	93.52 (2.648)
61 (1549)	38.90 (1.101)	92.29 (2.613)
60 (1524)	38.71 (1.096)	91.04 (2.578)
59 (1499)	38.49 (1.090)	89.78 (2.542)
58 (1473)	38.24 (1.083)	88.50 (2.506)
57 (1448)	37.97 (1.075)	87.21 (2.469)
56 (1422)	37.67 (1.067)	85.90 (2.432)
55 (1397)	37.34 (1.057)	84.57 (2.395)
54 (1372)	36.98 (1.047)	83.23 (2.357)
53 (1346)	36.60 (1.036)	81.87 (2.318)
52 (1321)	36.19 (1.025)	80.49 (2.279)
51 (1295)	35.75 (1.012)	79.10 (2.240)
50 (1270)	35.28 (0.999)	77.69 (2.200)
49 (1245)	34.79 (0.985)	76.26 (2.159)
48 (1219)	34.27 (0.970)	74.82 (2.119)
47 (1194)	33.72 (0.955)	73.36 (2.077)
46 (1168)	33.15 (0.939)	71.89 (2.036)
45 (1143)	32.57 (0.922)	70.40 (1.994)
44 (1118)	31.96 (0.905)	68.91 (1.951)
43 (1092)	31.32 (0.887)	67.40 (1.909)
42 (1067)	30.68 (0.869)	65.88 (1.866)
41 (1041)	30.00 (0.850)	64.35 (1.822)
40 (1016)	29.30 (0.830)	62.80 (1.778)
39 (991)	28.58 (0.809)	61.23 (1.734)
38 (965)	27.84 (0.788)	59.65 (1.689)
37 (948)	27.07 (0.767)	58.07 (1.644)
36 (914)	26.29 (0.744)	56.46 (1.599)
35 (889)	25.48 (0.722)	54.85 (1.553)
34 (864)	24.66 (0.698)	53.23 (1.507)
33 (838)	23.83 (0.675)	51.60 (1.461)
32 (813)	22.98 (0.651)	49.96 (1.415)
31 (787)	22.12 (0.626)	48.31 (1.368)
30 (762)	21.23 (0.601)	46.65 (1.321)
29 (737)	20.32 (0.575)	44.97 (1.273)
28 (711)	19.40 (0.549)	43.29 (1.226)
27 (686)	18.48 (0.523)	41.61 (1.178)
26 (680)	17.54 (0.497)	39.91 (1.130)
25 (610)	16.59 (0.470)	38.21 (1.082)
24 (609)	15.62 (0.442)	36.50 (1.033)
23 (584)	14.64 (0.414)	34.78 (0.985)
22 (559)	13.66 (0.387)	33.07 (0.936)
21 (533)	12.66 (0.359)	31.33 (0.887)
20 (508)	11.65 (0.330)	29.60 (0.838)
19 (483)	10.63 (0.301)	27.85 (0.3789)
18 (457)	9.60 (0.272)	26.11 (0.739)
17 (432)	8.56 (0.242)	24.35 (0.690)
16 (406)	7.51 (0.213)	22.59 (0.640)
15 (381)	6.46 (0.183)	20.83 (0.590)
14 (356)	5.41 (0.153)	19.07 (0.540)
13 (330)	4.35 (0.123)	17.31 (0.490)
12 (305)	3.28 (0.093)	15.53 (0.440)
11 (279)	2.19 (0.062)	13.75 (0.389)
10 (254)	1.11 (0.031)	11.97 (0.339)
9 (229)	0.00	10.17 (0.288)
8 (203)	0.00	9.04 (0.256)
7 (178)	0.00	7.91 (0.224)
6 (152)	0.00	6.78 (0.192)
5 (127)	Stone Cover 0.00	5.65 (0.160)
4 (102)	0.00	4.52 (0.128)
3 (76)	0.00	3.39 (0.096)
2 (51)	0.00	2.26 (0.064)
1 (25)	0.00	1.13 (0.032)

NOTE: Add 1.08 ft^3 (0.031 m^3) of storage for each additional inch (25 mm) of stone foundation. Contact StormTech for cumulative volume spreadsheets in digital format.

6.0 MC-3500 Chamber System Sizing

The following steps provide the calculations necessary for preliminary sizing of an MC-3500 chamber system. For custom bed configurations to fit specific sites, contact the StormTech Technical Services Department or your local StormTech representative.

1) Determine the amount of storage volume (VS) required. It is the design engineer's sole responsibility to determine the storage volume required.

Table 11 - Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-3500 Chamber	109.9 (3.11)	175.0 (4.96)	179.9 (5.09)	184.9 (5.24)	189.9 (5.38)
MC-3500 End Cap	14.9 (0.42)	45.1 (1.28)	46.6 (1.32)	48.3 (1.37)	49.9 (1.41)

NOTE: Assumes 6" (150 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 6" (150 mm) stone perimeter.

2) Determine the number of chambers (C) required. To calculate the number of chambers required for adequate storage, divide the storage volume (Vs) by the storage volume of the chamber (from **Table 11**), as follows: **C = Vs / Storage Volume per Chamber**

3) Determine the number of end caps required. The number of end caps (EC) required depends on the number of rows required by the project. Once the num- ber of chamber rows is determined, multiply the number of chamber rows by 2 to determine the number of end caps required. **EC = No. of Chamber Rows x 2**

NOTE: Additional end caps may be required for systems having inlet locations within the chamber bed.

4) Determine additional storage provided by end caps.
End Caps will provide additional storage to the project. Multiply the number of end caps (EC) by the storage volume per end cap (ECS) to determine the additional storage (As) provided by the end caps. **As = EC x ECs**

5) Adjust number of chambers (C) to account for additional end cap storage (As). The original number of chambers (C) can now be reduced due to the additional storage in the end caps. Divide the additional storage (As) by the storage volume per chamber to determine the number of chambers that can be removed. **Number of chambers to remove = As/ volume per chamber**

NOTE: Additional storage exists in the stone perimeter as well as in the inlet and outlet manifold systems. Contact StormTech's Technical Services Department for assistance with determining the number of chambers and end caps required for your project.

6) Determine the required bed size (S).
The size of the bed will depend on the number of chambers and end caps required:

MC-3500 area per chamber = 49.6 ft² (4.6 m²)
MC-3500 area per end cap = 16.4 ft² (1.5 m²)

S = (C x area per chamber) + (EC x area per end cap)

NOTE: It is necessary to add 12" (300 mm) of stone perimeter parallel to the chamber rows and 6" (150 mm) of stone perimeter from the base of all end caps. The additional area due to perimeter stone is not included in the area numbers above.

7) Determine the amount of stone (Vst) required. To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) and the number of end caps (EC) by the selected weight of stone from **Table 12.**

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

Table 12 - Amount of Stone Per Chamber/End Cap

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
Chamber	8.5 (6.0)	9.1 (6.5)	9.7 (6.9)	10.4 (7.4)
End Cap	3.9 (2.8)	4.1 (2.9)	4.3 (3.1)	4.5 (3.2)
METRIC kg (m³)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
Chamber	7711 (4.6)	8255 (5.0)	8800 (5.3)	9435 (5.7)
End Cap	3538 (2.1)	3719 (2.2)	3901 (2.4)	4082 (2.5)

NOTE: Assumes 12" (300 mm) of stone above, and 6" (150 mm) row spacing, and 6" (150 mm) of perimeter stone in front of end caps.

8) Determine the volume of excavation (Ex) required. Each additional foot of cover will add a volume of excavation of 1.9 yd³ (1.5 m³) per MC-3500 chamber and 0.6 yd³ (0.5 m³) per MC-3500 end cap.

Table 13—Volume of Excavation Per Chamber/End Cap yd³ (m³)

	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15" (375 mm)	18" (450 mm)
Chamber	11.9 (9.1)	12.4 (9.5)	12.8 (9.8)	13.3 (10.2)
End Cap	4.0 (3.1)	4.1 (3.2)	4.3 (3.3)	4.4 (3.4)

NOTE: Assumes 6" (150 mm) separation between chamber rows, 6" (150 mm) of perimeter in front of end caps, and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

9) Determine the area of geotextile (F) required. The bottom, top and sides of the bed must be covered with a non-woven geotextile (filter fabric) that meets AASHTO M288 Class 2 requirements. The area of the sidewalls must be calculated and a 24" (600 mm) overlap must be included for all seams. Geotextiles typically come in 15 foot (4.57 m) wide rolls.

6.0 MC-7200 Chamber System Sizing

The following steps provide the calculations necessary for preliminary sizing of an MC-7200 chamber system. For custom bed configurations to fit specific sites, contact the StormTech Technical Services Department or your local StormTech representative.

1) Determine the amount of storage volume (VS) required. It is the design engineer's sole responsibility to determine the storage volume required.

Table 14 - Storage Volume Per Chamber/End Cap ft³ (m³)

	Bare Unit Storage ft³ (m³)	Chamber/End Cap and Stone Volume — Stone Foundation Depth in. (mm)			
		9 (230)	12 (300)	15 (375)	18 (450)
MC-7200 Chamber	175.9 (4.98)	267.3 (7.57)	273.3 (7.74)	279.3 (7.91)	285.2 (8.08)
MC-7200 End Cap	39.5 (1.12)	115.3 (3.26)	118.6 (3.36)	121.9 (3.45)	125.29 (3.54)

NOTE: Assumes 9" (230 mm) row spacing, 40% stone porosity, 12" (300 mm) stone above and includes the bare chamber/end cap volume. End cap volume assumes 12" (300 mm) stone perimeter.

2) Determine the number of chambers (C) required.
To calculate the number of chambers required for adequate storage, divide the storage volume (Vs) by the storage volume of the chamber (from **Table 14**), as follows: **C = Vs / Storage Volume per Chamber**

3) Determine the number of end caps required.
The number of end caps (EC) required depends on the number of rows required by the project. Once the number of chamber rows is determined, multiply the number of chamber rows by 2 to determine the number of end caps required. **EC = No. of Chamber Rows x 2**

NOTE: Additional end caps may be required for systems having inlet locations within the chamber bed.

4) Determine additional storage provided by end caps.
End Caps will provide additional storage to the project. Multiply the number of end caps (EC) by the storage volume per end cap (ECS) to determine the additional storage (As) provided by the end caps. **As = EC x ECs**

5) Adjust number of chambers (C) to account for additional end cap storage (As). The original number of chambers (C) can now be reduced due to the additional storage in the end caps. Divide the additional storage (As) by the storage volume per chamber to determine the number of chambers that can be removed. **Number of chambers to remove = As/ volume per chamber**

NOTE: Additional storage exists in the stone perimeter as well as in the inlet and outlet manifold systems. Contact StormTech's Technical Services Department for assistance with determining the number of chambers and end caps required for your project.

6) Determine the required bed size (S).
The size of the bed will depend on the number of chambers and end caps required:

MC-7200 area per chamber = 59.9 ft² (5.6 m²)
MC-7200 area per end cap = 33.9 ft² (3.1 m²)

S = (C x area per chamber) + (EC x area per end cap)

NOTE: It is necessary to add 12" (300 mm) of stone perimeter parallel to the chamber rows and 6" (150 mm) of stone perimeter from the base of all end caps. The additional area due to perimeter stone is not included in the area numbers above.

7) Determine the amount of stone (Vst) required.
To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) and the number of end caps (EC) by the selected weight of stone from **Table 15.**

NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

Table 15 - Amount of Stone Per Chamber/End Cap

ENGLISH tons (yd³)	Stone Foundation Depth			
	9"	12"	15"	18"
Chamber	11.9 (8.5)	12.6 (9.0)	13.4 (9.6)	14.6 (10.1)
End Cap	9.8 (7.0)	10.2 (7.3)	10.6 (7.6)	11.1 (7.9)
METRIC kg (m³)	**230 mm**	**300 mm**	**375 mm**	**450 mm**
Chamber	10796 (6.5)	11431 (6.9)	12156 (7.3)	13245 (7.7)
End Cap	8890 (5.3)	9253 (5.5)	9616 (5.8)	10069 (6.0)

NOTE: Assumes 12" (300 mm) of stone above, and 9" (230 mm) row spacing, and 12" (300 mm) of perimeter stone in front of end caps.

8) Determine the volume of excavation (Ex) required.
Each additional foot of cover will add a volume of excavation of 2.2 yd³ (1.7 m³) per MC-7200 chamber and 1.4 yd³ (0.8 m³) per MC-7200 end cap.

Table 13- Volume of Excavation Per Chamber/End Cap yd³ (m³)

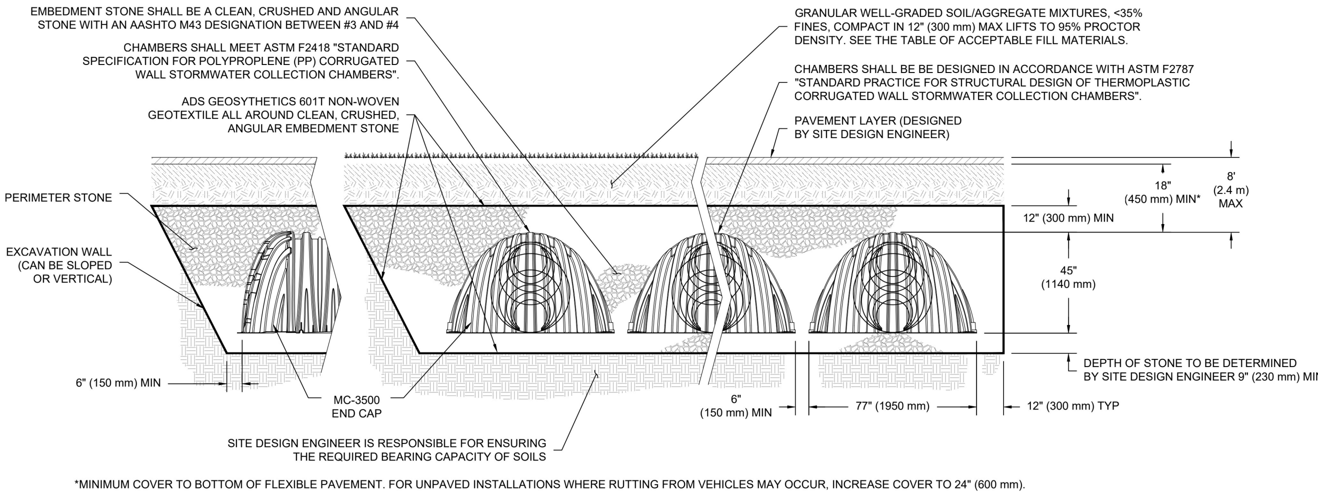
	Stone Foundation Depth			
	9" (230 mm)	12" (300 mm)	15" (375 mm)	18" (450 mm)
Chamber	17.2 (13.2)	17.7 (13.5)	18.3 (14.0)	18.8 (14.4)
End Cap	9.7 (7.4)	10.0 (7.6)	10.3 (7.9)	10.6 (8.1)

NOTE: Assumes 9" (230 mm) separation between chamber rows, 12" (300 mm) of perimeter in front of end caps, and 24" (600 mm) of cover. The volume of excavation will vary as the depth of cover increases.

9) Determine the area of geotextile (F) required.
The bottom, top and sides of the bed must be covered with a non-woven geotextile (filter fabric) that meets AASHTO M288 Class 2 requirements. The area of the sidewalls must be calculated and a 24" (600 mm) overlap must be included for all seams. Geotextiles typically come in 15 foot (4.57 m) wide rolls.

7.0 Structural Cross Sections and Specifications

Figure 16A - MC-3500 Structural Cross Section Detail (Not to Scale)



Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

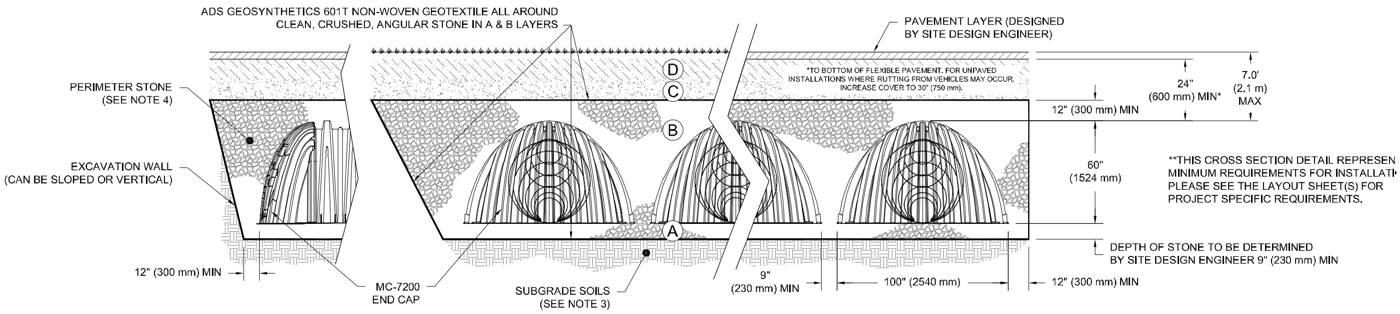
MC-3500 Stormwater Chamber Specifications

1. Chambers shall be StormTech MC-3500 or approved equal.
2. Chambers shall be made from virgin, impact-modified polypropylene copolymers.
3. Chamber rows shall provide continuous, unobstructed internal space with no internal panels that would impede flow.
4. The structural design of the chambers, the structural backfill and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met for: 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO Design Truck with consideration for impact and multiple vehicle presences.
5. Chambers shall meet the requirements of ASTM F 2418, “Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers.”
6. Chambers shall conform to the requirements of ASTM F 2787, “Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers.”
7. Only chambers that are approved by the engineer will be allowed. The contractor shall submit (3 sets) of the following to the engineer for approval before delivering chambers to the project site:
   - A structural evaluation by a registered structural engineer that demonstrates that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met. The 50-year creep modulus data specified in ASTM F 2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.
   - Structural cross section detail on which the structural cross section is based.
8. The installation of chambers shall be in accordance with the manufacturer’s latest Construction Guide.

Detail drawings available in Cad Rev. 2000 format at www.stormtech.com

7.0 Structural Cross Sections and Specifications

Figure 16B - MC-7200 Structural Cross Section Detail (Not to Scale)



Special applications will be considered on a project by project basis. Please contact our application department should you have a unique application for our team to evaluate.

MC-7200 Stormwater Chamber Specifications

1. Chambers shall be StormTech MC-7200 or approved equal.
2. Chambers shall be made from virgin, impact-modified polypropylene copolymers.
3. Chamber rows shall provide continuous, unobstructed internal space with no internal panels that would impede flow.
4. The structural design of the chambers, the structural backfill and the installation requirements shall ensure that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met for: 1) long-duration dead loads and 2) short-duration live loads, based on the AASHTO Design Truck with consideration for impact and multiple vehicle presences.
5. Chambers shall meet the requirements of ASTM F 2418, “Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers.”
6. Chambers shall conform to the requirements of ASTM F 2787, “Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers.”
7. Only chambers that are approved by the engineer will be allowed. The contractor shall submit (3 sets) of the following to the engineer for approval before delivering chambers to the project site:
   - A structural evaluation by a registered structural engineer that demonstrates that the load factors specified in the AASHTO LRFD Bridge Design Specifications, Section 12.12 are met. The 50-year creep modulus data specified in ASTM F 2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.
   - Structural cross section detail on which the structural cross section is based.
8. The installation of chambers shall be in accordance with the manufacturer’s latest Construction Guide.

Detail drawings available in Cad Rev. 2000 format at www.stormtech.com

8.0 General Notes

1. StormTech requires installing contractors to use and understand the latest StormTech **MC-3500 and MC-7200 Construction Guides** prior to beginning system installation.
2. StormTech offers installation consultations to installing contractors. Contact our Technical Service Department or local StormTech representative at least 30 days prior to system installation to arrange a pre-installation consultation. Our representatives can then answer questions or address comments on the StormTech chamber system and inform the installing contractor of the minimum installation requirements before beginning the system's construction. Call 860-529-8188 to speak to a Technical Service Representative or visit www.stormtech.com to receive a copy of our Construction Guide.
3. StormTech requirements for systems with pavement design (asphalt, concrete pavers, etc.): Minimum cover is 18" (450mm) for the MC-3500 and 24"(600mm) for the MC-7200 not including pavement; MC-3500 maximum cover is 8.0' (1.98 m) and MC-7200 maximum cover is 7.0' (2.43 m) both including pavement. For designs with cover depths deeper than these maximums, please contact Stormtech. For installations that do not include pavement, where rutting from vehicles may occur, minimum required cover is increased to 30" (762 mm).
4. The contractor must report any discrepancies with the bearing capacity of the subgrade materials to the design engineer.
5. AASHTO M288 Class 2 non-woven geotextile (ADS601 or equal) (filter fabric) must be used as indicated in the project plans.
6. Stone placement between chamber rows and around perimeter must follow instructions as indicated in the most current version of StormTech MC-3500 / MC-7200 Construction Guides.
7. Backfilling over the chambers must follow requirements as indicated in the most current version of StormTech MC-3500 / MC-7200 Construction Guides.
8. The contractor must refer to StormTech MC-3500 / MC-7200 Construction Guides for a Table of Acceptable Vehicle Loads at various depths of cover. This information is also available at the StormTech website: www.stormtech.com. The contractor is responsible for preventing vehicles that exceed StormTech requirements from traveling across or parking over the stormwater system. Temporary fencing, warning tape and appropriately located signs are commonly used to prevent unauthorized vehicles from entering sensitive construction areas.
9. The contractor must apply erosion and sediment control measures to protect the stormwater system during all phases of site construction per local codes and design engineer's specifications.
10. STORMTECH PRODUCT WARRANTY IS LIMITED. Contact StormTech for warranty information.

9.0 Inspection and Maintenance

9.1 Isolator Row Plus 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 Plus. Please follow local and OSHA rules for a confined space entry.

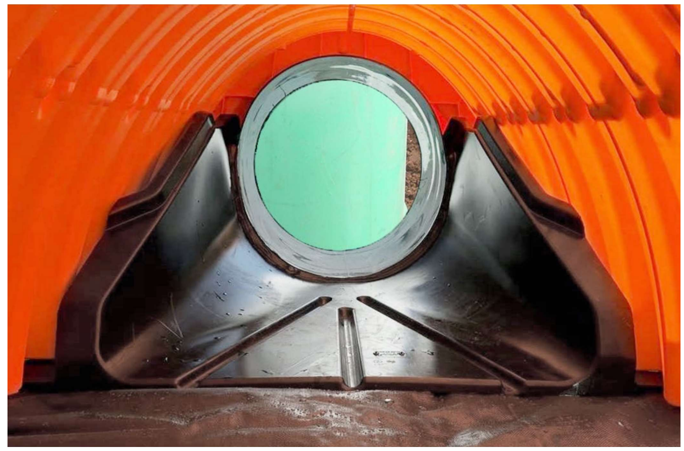
Inspection ports can allow inspection to be accomplished completely from the surface without the need for a con- fined space entry. Inspection ports provide visual access to the system with the use of a flashlight. A stadia rod may be inserted to determine the depth of sediment. If upon visual inspection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

A StormTech Isolator Row Plus 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 Plus 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.

9.2 Isolator Row Plus Maintenance

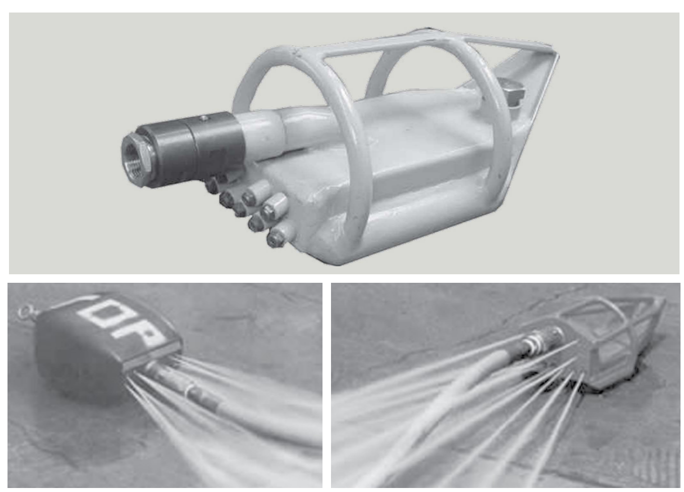
JetVac maintenance is recommended if sediment has been collected to an average depth of 3" (76 mm) inside the Isolator Row Plus. More frequent maintenance may be required to maintain minimum flow rates through the Isolator Row Plus. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row Plus 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 combi- nation vehicles. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" (1143 mm) are best. StormTech recommends a maximum nozzle pressure of 2000 psi be utilized during cleaning. The JetVac process shall only be performed on StormTech Rows that have ADS Plus fabric over the foundation stone.

A Flamp (flared end ramp) is attached to the inlet pipe on the inside of the chamber end cap to provide a smooth transition from pipe invert to fabric bottom. It is configured to improve chamber function performance over time by distributing sediment and debris that would otherwise collect at the inlet. It also serves to improve the fluid and solid flow back into the inlet pipe during maintenance and cleaning, and to guide cleaning and inspection equipment back into the inlet pipe when complete.



Flamp (Flared End Ramp)

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



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

A Family of Products and Services for the Stormwater Industry:

MC-3500 and MC-7200 Chambers and End Caps

SC-160LP, SC-310 and SC-740 Chambers & End Caps

DC-780 Chambers and End Caps

Fabricated End Caps

Fabricated Manifold Fittings

Patented Isolator Row PLUS for Maintenance and Water Quality

Chamber Separation Spacers

In-House System Layout Assistance

On-Site Educational Seminars

Worldwide Technical Sales Group

Centralized Product Applications Department

Research and Development Team

Technical Literature, O&M Manuals and Detailed CAD drawings all downloadable via our Website

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APPENDIX E. PROPOSED SUDS FEATURES

Appendix E

APPENDIX E. PROPOSED SUDS FEATURES

PLANNING DRAWING.
NOT FOR CONSTRUCTION.
ALL LEVELS GIVEN ARE
RELATIVE TO ORDNANCE DATUM.
THIS DRAWING HAS BEEN ISSUED FOR INFORMATION PURPOSES ONLY AND MUST NOT BE USED FOR CONSTRUCTION UNDER ANY CIRCUMSTANCES

- FOR SETTING OUT REFER TO ARCHITECT'S DRAWINGS.
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Rev No.	Date	Revision Note	Drn by	Chkd by
P01	01.12.22	SUITABLE FOR INFORMATION	COR	DP

Rev No.	Date	Revision Note	Drn by	Chkd by

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Head Office,
9 Prussia Street,
Dublin 7.
D07 KT57

TEL +353 (0)1 8682000

e: contactus@ocsc.ie
w: www.ocsc.ie

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Client: MEATH COUNTY COUNCIL
Project: SPICER'S BAKERY, RAMPARTS CAR PARK AND ANDY BRENNAN PARK
Title: PROPOSED SUDS FEATURES

Code	Originator	Zone	Level	Type	Role	Number	Status	Revision
P340	OCSC	XX	XX	SK	C	0526	S4	P01

Date: 01.12.22 Scale: 1:400 @ A1 Drn by: COR Chkd by: EH Aprvd by: DP

APPENDIX F. SI INVESTIGATION FROM ADJACENT SITE

Appendix F

SI INVESTIGATION FROM ADJACENT SITE

EurGeol **Robert Meehan,** B.A., Ph.D., PGeo.
Soil, subsoil and landscape geologist

86 Athlumney Castle,
Navan,
County Meath.

Tel: +353-(0)46-9070070
Mob: +353-(0)87-6875558
email: antalamhireland@gmail.com

6th July 2022

Mr. Thomas Salmon,
Convent Road,
Athlumney,
Navan,
County Meath,
C15 D7Y8.

Re: Infiltration tests as per BRE 365 for impermeable area serving proposed new roof area, meaning a total additional impermeable area of 263 m², at Convent Road, Athlumney, Navan, County Meath, C15 D7Y8, for Thomas and Joanne Salmon

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Dear Thomas,

Here follows infiltration test results serving proposed new roof area, meaning a total additional impermeable area of 263 m2, at Convent Road, Athlumney, Navna, County Meath, as supplied by O'Halloran Rooney Architects, 3 The Beehives, Ballinderry, Mullingar, County Westmeath, and Met Eireann's Extreme Rainfall Return Periods for central Meath.

Impermeable area

A = **263** m²

Rainfall data from met Eireann for central Meath

100 year return period
Duration = 60 minutes
Rainfall depth = 31.6 mm+ 20% Climate Change Factor = 37.92 mm

The void ratio for the trench fill was set at 30% (0.3) to accommodate the use of granular fill material *i.e.* rounded gravel. The safety factor was taken as 1.

Soil infiltration rate

Test carried out between 8th and 10th April 2022, base of tests at 550mm below ground level.

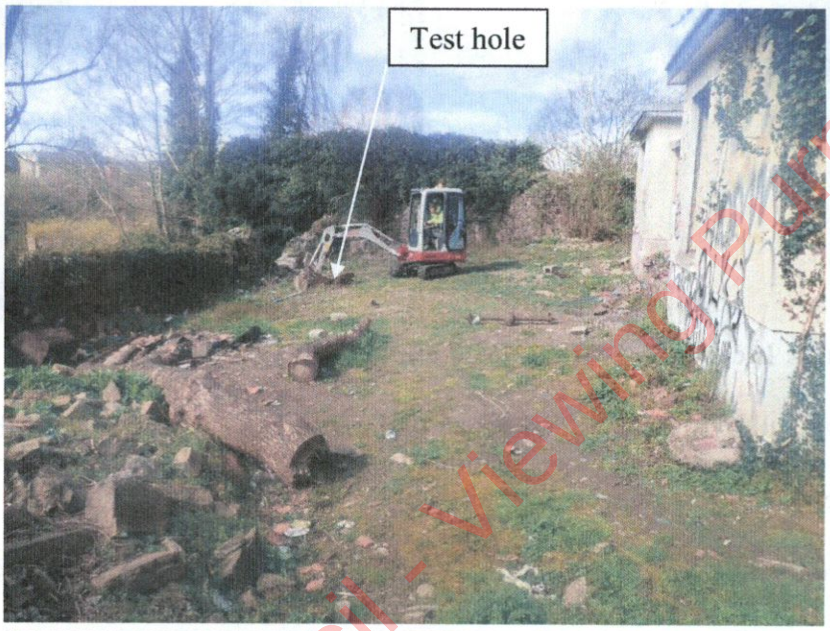
Calculated as per BRE365.

APPENDIX

Infiltration test details

Dimensions of test hole

0.8 m length x 0.55 m breadth x 0.5 m depth (depth below existing ground level, see Plate 2).



Plates 1 and 2: Location of and dimensions of test hole for BRE Digest 365 soakaway test on site for Thomas and Joanne Salmon, Convent Road, Athlumney, Navan, County Meath.

Plate 5: Water seeping from hole towards the end of the second fill, on 9th April at 07.27.

Calculations

Storage volume from 75% depth to 25% depth of filled area

$$V_{p75\_25} = (L_{trial} \times B_{trial} \times (D75 - D25)) = \mathbf{0.066}\ m^3$$

Internal surface area to 50% depth

$$As50 = ((L_{trial} \times B_{trial}) + ((L_{trial} + B_{trial}) \times 2 \times D50) = \mathbf{0.405}\ m^2$$

Soil infiltration rate $f = V_{p75\_25} / (Ap50 \times T_{lg} \times 60) = \mathbf{8.76144962 \times 10^{-5}}\ m/s$

Time for emptying soakaway to half volume

$$t_s50 = S_{req} \times 0.5 / (As50 \times f) = \textbf{12 hours 8 minutes 31 seconds}$$