Project

Strategic Housing Development at Colpe West, Drogheda, Co. Meath

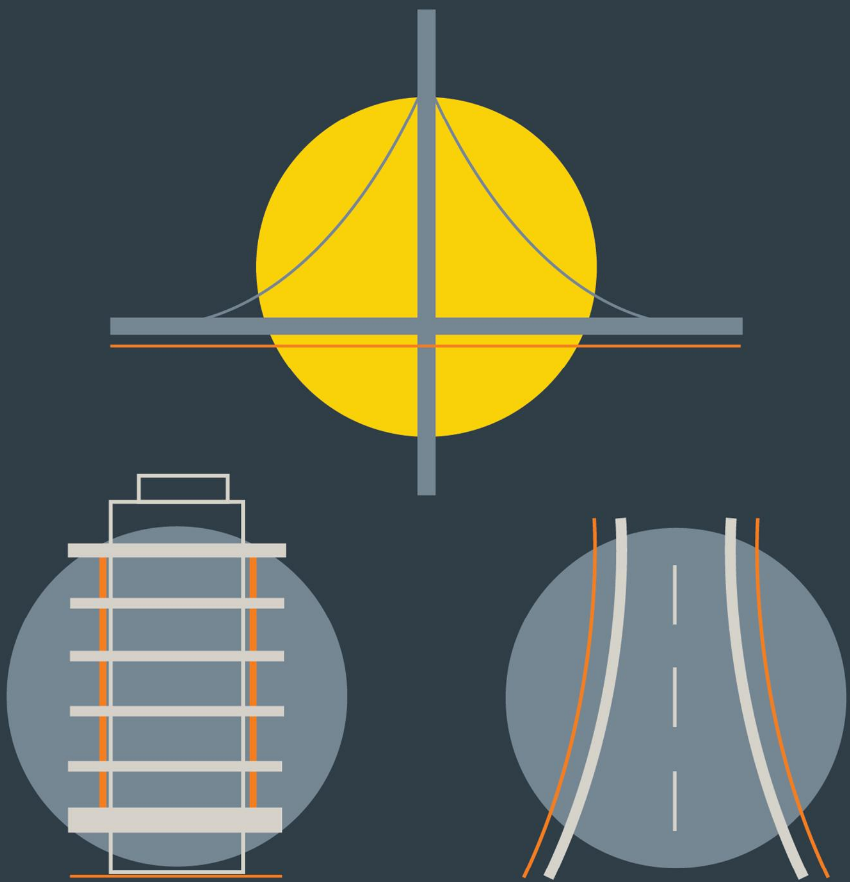
Report Title

Infrastructure Design Report

Client

Shannon Homes Drogheda

INFRASTRUCTURE



DBFL CONSULTING ENGINEERS

October 2019

Job Title: **Strategic Housing Development at Colpe West, Drogheda, Co. Meath**

Job Number: **170092**

Report Title: **Infrastructure Design Report**

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Final	14.10.2010	SHD Stage 3 Planning	AOS	DMW	DMW

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APPENDICES

1.0 INTRODUCTION

1.1 General

DBFL were commissioned to undertake an infrastructure design report to accompany a planning submission for a proposed residential development in the townland of Colpe West, Drogheda, County Meath. The subject site is within the "Mill Road / Marsh Road Urban Design Framework Plan 2017" extents and is included in lands that have been identified for development in the "Local Area Plan for the Southern Environs of Drogheda 2009-2015".

The proposed development comprises 357 residential units (169 no. houses, 52 no. duplex units, and 136 no. apartments), a childcare facility and associated infrastructure including a link street and a surface water outfall pipe on a site area of circa 13ha. The application is under consideration through the SHD (Strategic Housing Development) planning process, with An Bord Pleanala. This application also seeks to amend a link street approved under Meath County Council Planning Reference LB180620 (commercial development and link street through the "Mill Road / Marsh Road Framework Plan lands").

This report addresses the engineering items relevant to DBFL Consulting Engineers included in the An Bord Pleanala "Opinion" following the tripartite meeting and also addresses foul and surface water drainage strategy and design, water supply and road design.

1.2 Location and Topography and Site Characteristics

The subject site is situated to the southwest of Drogheda Town, to the east of the Dublin-Belfast railway line. It is bounded to the north by greenfield agricultural lands (also within the *"Mill Road / Marsh Road Framework Plan Lands"*) and to the east by an existing primary school, Gaelscoil, "An Bhradain Feasa" and Mill Road. Refer to *Figure 1* below.

The lands are currently predominately greenfield agricultural lands and largely slope from south-west to north-west and north-east. There is an existing ditch system which forms the north eastern boundary of the site and continues in an easterly direction towards Mill Road. There is also a ditch system in lands immediately west of Colpe Road and continuing in an easterly direction where it crosses under the route of the link street and is culverted under Mill Road before continuing eastwards in an open channel arrangement.

Figure 1: Site Location Map

2.0 ACCESS AND ROADS

2.1 General

Vehicular access to the residential development would be from a link street through the "Framework Plan" lands linking the residential lands with Colpe Road to the south east. The link street under consideration comprises modifications to the street granted planning permission by Meath County Council under Planning Reference LB180620. The modifications ensure that the design is in accordance with the "Design Manual for Urban Roads and Streets", (DMURS) and include replacing the most western roundabout with a 4-arm signalised junction and replacing the middle roundabout with priority junction arrangements to adjoining lands. The link street includes a vehicular link to Gaelscoil "An Bhradain Feasa", which is currently accessed from Mill Road and also provides access to the temporary post primary school approved under planning reference LB190739.

The street layout for the proposed development is designed in accordance the Design Manual for Urban Roads and Streets (DMURS) and we refer to the *DMURS Compliance Statement*, which is included under separate cover.

Refer also to DBFL drawing no. 170092-1053 for the "Road Hierarchy Plan" in support of the *DMURS Compliance Statement*.

2.2 Traffic & Transportation

A *'Traffic & Transport Assessment'* by DBFL Consulting Engineers is included, as a separate report, with this planning submission.

3.0 GROUND CONDITIONS

Surface water soakaway tests have been carried out in accordance with BRE Digest 365 to determine the permeability of the soil. The results of the soakaway testing are included in the Ground Investigations Ireland report, *"Mill Road Marsh Road, Co. Meath, Ground Investigation Report"*, which is included with the planning application under separate cover.

The results of the soakaway testing indicate that the ground is not suitable for the disposal of surface water to the ground. At soakaway pits SA01; 02; 04; 05 & 06, while the water level dropped, it was too slow to calculate a soil infiltration rate "f", in accordance with BRE Digest 365. At soakaway pit location SA03, groundwater filled the test pit to 500mm below ground level.

Excavation of the soakaway pits confirmed that ground conditions in the area generally comprise firm gravelly sandy clay, overlying firm to stiff gravelly sandy clay. Rock was encountered at circa 0.8m and 1.8m below ground level, in soakaway pits SA01 & SA02, which were carried out in the site of the approved commercial development (LB180620). Rock in the area comprises limestone.

Rock was generally found between 2m and 4m throughout the site.

4.0 SURFACE WATER DRAINAGE

4.1 General

The jurisdiction of Meath County Council forms part of the Greater Dublin Area (GDA) as identified in the *Greater Dublin Strategic Drainage Study* (GDSDS). The GDSDS outlines regional drainage policies to address the drainage needs of the GDA. These policies address surface water management from development sites, from the point of view of water quality, quantity, risk of flooding and compliance with relevant environmental legislation. As outlined in the GDSDS, proposed developments must be drained on separate foul and surface water drainage systems and must incorporate Sustainable Urban Drainage Systems (SuDS) for the management of surface water runoff.

Surface water runoff from the proposed development would therefore be designed in accordance with the principles of the GDSDS and Meath County Council's requirements, and all current guidelines, including CIRIA SuDS Guidelines.

4.2 Compliance with Surface Water Policy

Surface water management for the proposed development is designed to comply with the Greater Dublin Strategic Drainage Study (GDSDS) policies and guidelines and the requirements of South Dublin County Council. The guidelines require the following main 4 main criteria to be provided by the development's surface water design;

- Criterion 1: River Water Quality Protection – satisfied by providing interception storage, treatment of run-off within the SUDS features. This is satisfied using green roofs, permeable paving, swales, petrol interceptors and on-line cellular storage attenuation systems.
- Criterion 2: River Regime Protection – satisfied by attenuating run-off with flow control devices prior to discharge to the outfall.
- Criterion 3: Level of Service (flooding) for the site – satisfied by the Site being outside the 1000 year coastal and fluvial flood levels and extents. Pluvial flood risk addressed by development designed to accommodate surface water runoff from a 100-year period storm (1& AEP) plus climate change (10%) as per the recommendations of the GDSDS. Planned flood routing for storms greater than 100-year return period level considered in design and development run-off contained within site.

- Criterion 4: River flood protection – attenuation provided within the SUDS features i.e. permeable paving, green roofs and on-line attenuation basins.

4.3 Surface Water Management

4.3.1 General

Surface water runoff from the proposed residential development would be attenuated to Qbar in accordance with the recommendations of the GDSDS, with surface water runoff exceeding the allowable outflow rate stored for up to a 1% AEP (Annual Event Probability) rainfall event. Surface water storage would be provided in an underground storage system, such as ‘Stormtech’ or similar approved systems and in an overground system in the form of shallow detention basins above the ‘Stormtech’ units.

SuDS features are incorporated into the surface water drainage network, as required in the GDSDS.

There are three surface water outfall points identified for receiving attenuated surface water runoff from the subject site, as follows:

(i) Outfall “A”: The existing 1050mm diameter surface water pipe (existing MH S4) adjacent to the railway line (*Figure 2* below) via the surface water outfall pipe approved under *LB180620*.

(ii) Outfall “B”: The existing ditch system adjacent to the most western section of the link street, which forms the northern boundary of *Gaelscoil An Bhradáin Feasa* before crossing Mill Road and continuing in an easterly direction towards the Stameen River (*Figure 3* below).

This ditch is currently piped under Mill Road and continues in a westerly direction towards the Stameen River, via a surface water pipe through private front gardens. Preliminary investigations indicate that this piped section is sub-standard. It is therefore proposed to construct a new surface water outfall in a westerly direction to the Stameen River via Mill Road. Refer to DBFL drawing no.170092-3058 for details of this surface water outfall.

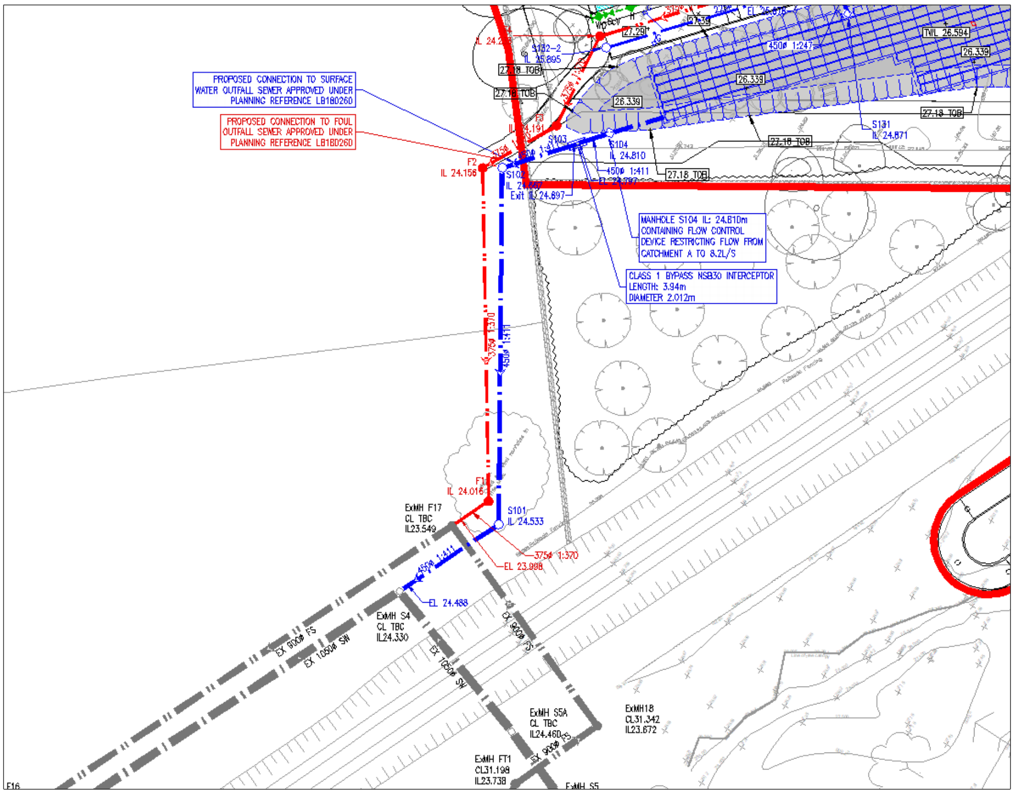

Figure 2: Outfall A; Extract of Site Services Plan indicating the surface water connection point to the existing 1050mm diameter surface water sewer north of railway line

(iii) Outfall "C": The existing ditch along the south-eastern boundary of the commercial development approved under *LB180620* and adjacent to Colpe Road, which crosses Mill Road in a culvert and continues in an easterly direction (*Figure 4* below). This ditch originally drained lands to the south west of the railway line, however following development of these lands the catchment area reduced significantly and runoff to this ditch also reduced, with runoff from the section of Colpe Road between the bridge and Mill Road now being the primary source of runoff.

The proposed works include a new surface water drainage network for this section of road which would discharge attenuated runoff to the ditch between the realigned section of Mill Road and the existing Mill Road, (Outfall "C"). This ditch is currently culverted under Mill Road in a culvert of 0.46m wide x 0.9m high, which has settled resulting in the upstream end of the culvert being lower than the downstream end. It is therefore proposed to remove this culvert and to replace it with a new 900mm diameter surface water pipe. Refer to DBFL drawing no. 170092-3057 for further details.

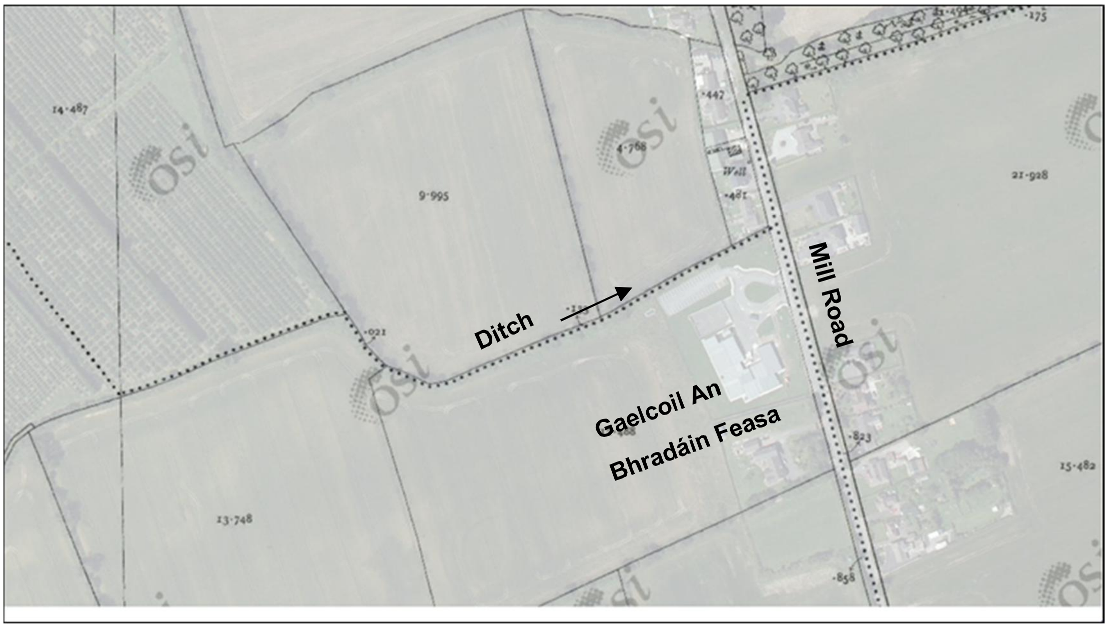

Figure 3: Outfall B; Extract of OSI historic 25-inch map (1888-1913) showing the ditch system which forms the western boundary of “Gaelscoil an Bhradáin Feasa”

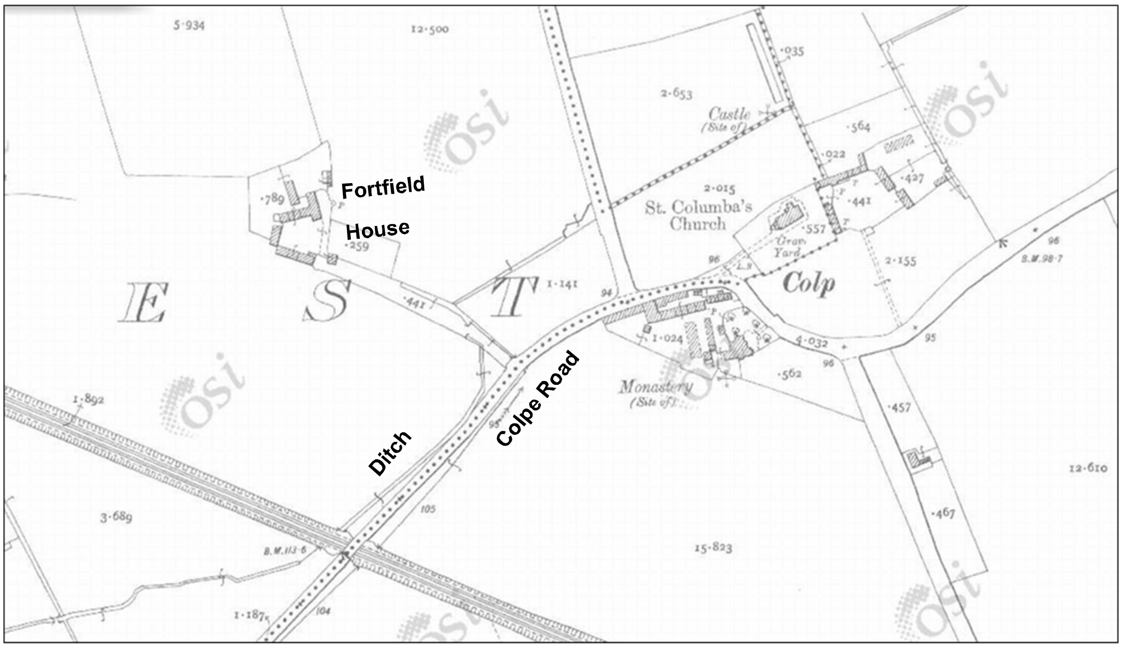

Figure 4: Outfall C; Extract of OSI historic 25 inch map (1888-1913) showing the ditch system crossing the railway and continuing in a north easterly direction

4.3.2 Surface Water Catchments

To manage surface water runoff from the development, it is proposed to separate the development into three surface water catchments ("A", "B", and "C") corresponding to each surface water outfall. Each catchment is divided into smaller sub-catchments with surface water storage for a 1% AEP (Annual Event Probability), or 1 in 100-year return period event storm provided within each catchment and sub-catchment. Refer to *Figure 5* below for the surface water catchments for the subject site.

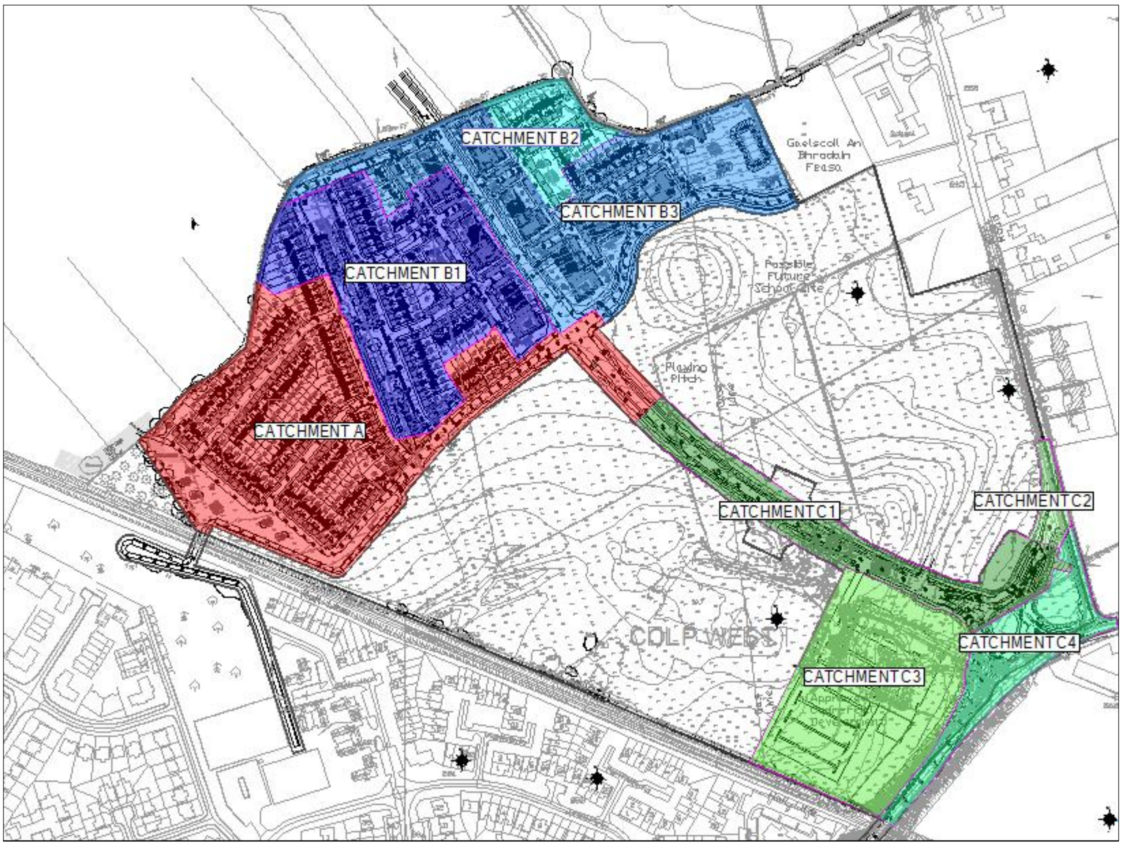

Figure 5: Surface Water Catchment Plan

Catchment "A": Comprises the western portion of the lands and a section of the link street, with attenuated runoff from this catchment discharging to the existing 1050mm diameter surface water sewer, adjacent to the railway line (

2 above). Surface water storage for this catchment is provided in the public open space area.

Catchment "B": Comprises the balance of the residential development and is subdivided in catchments "B1", "B2" and "B3". Attenuated runoff from catchment "B" outfalls to the ditch system to the west of Gaelscoil An Bhradain Feasa (Outfall "B"; *Figure 3* above). Surface water storage for this catchment is provided in open space areas and primarily in the public open space at the eastern end of the site.

Catchment “C”: Comprises the balance of the link street and is subdivided into catchments “C1”, “C2”, “C3” & “C4". Attenuated runoff from catchment “C” outfalls to the existing ditch system adjacent to Colpe Road (Outfall “C”; Figure 4 above). Sub-catchment C3 is not included in the application site but refers to attenuated runoff rate from committed development (commercial development approved under LB180620).

4.3.3 Surface Water Attenuation

The GDSDS recommends limiting outflow to the maximum discharge rate of QBAR or 2l/s/ha, whichever is the greater, for all attenuation storage, where QBAR is estimated using the Flood Studies Report Method (FSR).

Qbar is calculated using the *Institute of Hydrology* Q_{bar} equation is as follows:

$$Q_{bar\,[rural]} = 0.00108\ x\ AREA^{0.89} x\ SAAR^{1.17} x\ Soil^{2.17}$$

Where:

- $Q_{bar[rural]}$ is the mean catchment annual flow from a rural catchment in m^3/s;
- AREA is the area of the catchment in km^2. For a catchment area less than 50ha, calculate Q_{bar} for 50 ha and pro rata it.
- Area = 50ha or $0.5km^2$;
- SAAR is the standard average annual rainfall = 760mm;
- SOIL is the soil index, with 5 soil types used and SPR values (standard percentage runoff) applied to each soil type.
- SAAR = 760mm for Colpe Road, Drogheda.
- The SPR values for the 5 soil types are as follows:
    - Soil 1 = 0.1; (well drained; very low ruoff potential)
    - Soil 2 = 0.3; (very permeable soil, sand and gravel, low water table; low runoff potential)
    - Soil 3 = 0.37; (very fine sands, silts, clays ; permeable soils; moderate runoff potential)
    - Soil 4 = 0.47; (clay or loamy soils; high runoff potential)
    - Soil 5 = 0.53; (peat, rocky soils; very high runoff potential)

The site investigations included as a standalone report indicate that the soil throughout the site are predominantly clay with no permeability, corresponding to soil type 4. Also, rock was found generally throughout the site between 2m and 4m below ground level. However, while on site testing and conditions indicate the most appropriate soil type as being soil type 4 throughout the site, Qbar is calculated based on a more conservative SPR value of 0.37 (Soil Type 3). Qbar calculation is outlined below.

$Q_{(bar\ rural)} = 0.00108 \times 0.50^{.89} \times 760^{1.17} \times 0.37^{2.17} = 0.158m3/s$ = 158l/s for 50ha

Q_{bar} = 3.1 l/s/ha

(A copy of the allowable outflow spreadsheet is included in Appendix A.)

While Qbar has been calculated for soil type 3, a more conservative value of 2l/s/ha has been applied for the residential element of the development. This is equivalent to soil type 2. The allowable outflow rate applied for the link street is 3l/s/ha (soil type 3) as approved under LB180620. Therefore, the overall allowable outflow rate for the entire site including the modifications to the link street approved under LB180620 is 2.23l/s/ha. Refer to *Table 1* for details of the allowable outflow rate applied for each catchment.

'Hydrobrake' flow controls will be located on the outfall from each sub-catchment and set at a rate to optimise storage within each upstream catchment. The allowable outflow from each catchment and sub-catchment is included in *Table 1* below.

4.3.4 Surface Water Storage

The surface water storage method proposed for each catchment is determined by the site layout and available space within each catchment and sub-catchment. They all comprise underground 'Stormtech' systems (or similar approved), with some over ground storage in the form of detention basins. The total surface water storage volume required for the subject site comprises circa 2,600m^3. Refer to *Table 1* below for a breakdown of the surface water storage requirement for each catchment and sub-catchment.

The volume of surface water storage required for each catchment has been calculated using the *"Source Control"* module of *"Microdrainage"* software taking account of design invert levels, ground levels, and depth and type of storage system and allowable outflow rate.

The surface water drainage network and the surface water storage system have also been simulated using the *"Network*" module of *"Microdrainage"* for a range of storm events including 1 in 2, 1 in 10, 1 in 30 and 1 in 100-year storm events.

Details of surface water attenuation and storage for each sub-catchment and catchment is included in *Table 1* below.

Refer to Appendix B for Microdrainage surface water storage calculations.

Surface Water Catchment	Area of Catchment (ha)	Allowable Outflow Rate (Qbar) (l/s)	Allowable Outflow Rate/ha (Qbar) (l/s)	Underground Storage 'Stormtech' Volume (m^3)	Type of Stormtech Unit	Aboveground Storage "Detention Basin" Volume (m^3)	Total Storage Volume (m^3) (100-year Return Period / 1% AEP)
A	4.472	8.9	1.99	560	SC-740	215	775
B	6.29	12.7	2.0	1,107	-	278	1,385
B1	2.620	5.3		398	SC-740	60	458
B2	0.620	N/A[1]		88	SC-310	-	88
B3	3.050	7.4		627	SC-740	218	845
C	4.83	14.2	2.9	583.5	-	274	857.5
C1	1.370	4.1		-	-	274	274
C2	0.180	2.0		12.5	SC-310	-	12.5
C3[2]	2.320	6.1		406	SC-740	-	406
C4	0.960	2.0		165	SC-740	-	165
Total	15.590	35.8		2,250.5	-	767	3,065.5
Total for application site, excluding catchment C3	13.27	29.7	2.23				2,659

Table 1: Details of Surface Water Storage and Attenuation for Each Catchment

[1] Allowable outflow from Catchment B2 = 2l/s; This catchment runs in series to Catchment B3, where Q_{bar} = 7.4l/s (for Catchment B2 + B3 combined);

[2] Catchment C3 is not included in this application, however the allowable outflow from it is included in the drainage calcs and has been approved for the commercial application under LB180620.

4.4 Surface Water Drainage Design

Surface water drainage for the development is designed using the Modified Rational Method as recommended in the GDSDS, EN752 and BS8301:1985, with the following parameters applied;

- Return period for pipe network 2 years,
  - check 30-year 15 minute, no flooding;
  - check 100-year flooding in designated areas;
- Time of entry 4 minutes
- Pipe Friction (Ks) 0.6 mm
- Minimum Velocity 1.0 m/s
- Standard Average Annual Rainfall 760mm
- M5-60 14.9mm
- Ratio r (M5-60/M5-2D) 0.279
- Storage System Storm Return Event GDSDS Volume 2, p61, Criterion 3
  - 30-year no flooding on site;
  - 100-year check no internal property flooding. Flood routing plan. FFL + 500mm freeboard above 100-year flood level. No flooding to adjacent areas.
- Climate Change 10% for rainfall intensities.
- Factor of Safety for infiltration 2.0

A breakdown of the impermeable areas contributing to the surface water drainage network with runoff coefficients agreed with Meath County Council included in *Table 2* below. Figure 6 includes these surface types colour coded in accordance with the surface types in Table 2.

Surface Type	Runoff Co-Efficient	Catchment "A" Imp Area (ha)	Catchment "B1" Imp Area (ha)	Catchment "B2" Imp Area (ha)	Catchment "B3" Imp Area (ha)	Total Impermeable Area (ha)
Roof to SuDS features	0.6	0.486	0.180	0.046	0.094	0.806
Roofs to traditional collection system	0.9	-	0.220	-	0.267	0.487
Roads to traditional collection system	1.0	0.753	0.270	0.094	0.473	1.590
Roads to SuDs features	0.5	0.025	0.020	0.005	0.007	0.057
Paths to Traditional Drainage	1.0	0.278	0.200	0.039	0.525	1.042
Cycle Track to Traditional Drainage	1.0	0.038	-	-	0.080	0.118
Car Parking (Permeable Paving)	0.5	0.128	0.110	0.038	0.096	0.372
Public Open Space	0.1	0.089	0.060	0.019	0.121	0.289
Total (ha)		1.797	1.060	0.241	1.663	4.761
Impermeability factor (%)		36%				

Table 2: Breakdown of Impermeable Areas for Proposed Development – refer to Figure 6

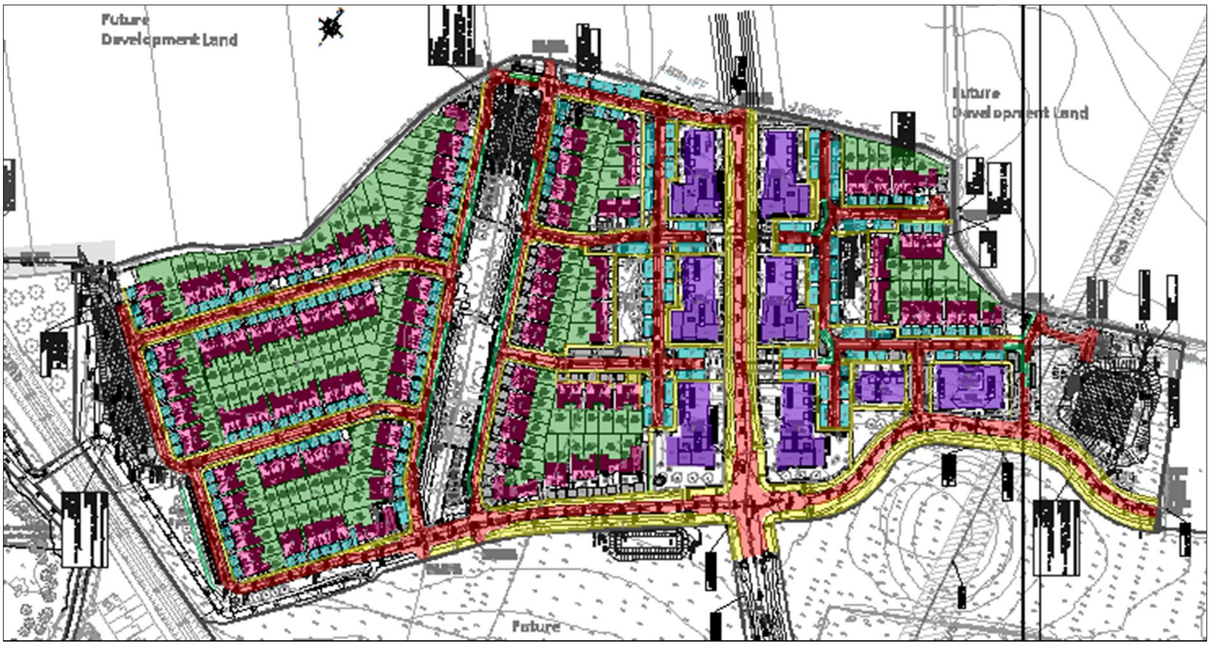

Figure 6: Surface Types – Refer to Table 2

Standard drainage details are in accordance with the Greater Dublin Regional "Code of Practice for Drainage Works". The minimum pipe diameter for public surface water sewers is 225mm. Private drains within the proposed development will be 100mm diameter and collector drains will be 150mm diameter. Refer to DBFL drawing numbers 170092-3051 to 170092-3057, for the proposed surface water layout plan.

Surface water sewers have been designed using the "Network" module of "Microdrainage", using the Modified Rational Method. The network is designed in accordance with IS EN 752 and the recommendations of the 'Greater Dublin Strategic Drainage Study', (GDSDS).

Surface water sewer calculations are included in Appendix C.

4.5 'Sustainable Urban Drainage Systems' (SuDS)

The document 'Sustainable Urban Drainage Systems' (SuDS) published by CIRIA, document No. C521, was utilised for the surface water design strategy for the proposed development. The document encourages the use of a variety of alternative measures in the design of sustainable drainage systems, which take account of quality, quantity and amenity. These measures protect or enhance water quality, are sympathetic to the environment, provide a habitat for wildlife and encourage natural ground water recharge. The following SuDS features are incorporated into the drainage design for the scheme:

Primary SuDS features

Swales, bio-retention areas, permeable paving and 'green roofs' which operate under normal rainfall events. They provide storage that not only attenuates the flow but also permits settlement of coarse silts, with plants in the water to promote settlement. Runoff would also be treated by adsorption of particles by aquatic vegetation or by soil, and by biological activity.

Secondary SuDS features

'Detention Basins' to store runoff between a 1 in 30-year and 1 in 100-year return period event. Therefore, the detention basins are only utilised during extreme rainfall events. Features of the proposed detention basins include retardation of surface water flows, balancing of surface water flows and an increased loss of surface water to natural ground through infiltration. Access would be required to the basin for inspection and to allow for regular cutting of grass, the annual clearance of aquatic vegetation and silt removal if required. The basins should be inspected approximately twice a year, with eroded and damaged areas repaired. Sediment accumulations would be removed when necessary and appropriate measures would be taken to ensure that the extracted material is disposed of properly and safely.

Refer to Appendix D for Operation and Maintenance Manual.

4.6 Interception Storage

To prevent pollutants or sediments discharging into water courses the GDSDS requires "interception storage" to be incorporated into the drainage design for the development. The volume of interception required is based on 5-10mm of rainfall depth from 80% of the runoff from impermeable areas as defined in GDSDS. The interception volume attributable to each SuDs feature consists of the volume of water that can infiltrate to the ground, what will evaporate into the atmosphere and what can transpirate through plants and vegetation. Additionally, there will be some loses of water due to absorption and wetting of stone and soil media.

Required Interception Storage

The total interception storage required is circa 190.4m^3,

Interception Storage Provided

The interception volume provided for the overall site is circa 299m^3 in the permeable paving stone layer. This is calculated as follows:

Car Parking (Permeable) = 3,720m^2

Stone layer 300mm deep;

Void Ratio = 30%

Storage = 334.8m^3

4.7 Treatment Volume

The GDSDS requires that a “treatment volume” (Vt) be provided to prevent any pollutants or sediments entering river systems. Additionally, a ‘treatment train’ stormwater runoff management system is required. According to CIRIA document C697 the following treatment train approach is necessary:

- Surface Water Runoff from Roofs – 1 Treatment Stage
- Surface Water Runoff from Roads – 2 Treatment Stages
- Surface Water Runoff from other Paved Areas excluding Roads – 1 Treatment Stage

The treatment volume is based on treatment 15mm of rainfall depth from 80% of the runoff from impermeable areas as defined in the GDSDS.

The total treatment volume required for the site is 571.2m^3, and the volume provided for the site is 845.31m^3.

- Storage in Permeable Paving: Volume = 334.8m^3 (refer to Section 4.6);
- Storage in Stormtech: Area of Stormtech = 2932.9m^2

  Stone layer 150mm deep;

  Void Ratio = 30%

  Storage = 440.2m^3
- Storage in Bio Retention Areas: Effective Impermeable Area = 159.2 m^2

  Filter Bed Depth = 0.9 m

  Volume = 5.70m^3
- Storage in Swales: Total plan area of swales = 323.1 m^2

  Depth of subgrade treatment = 0.2m

  Volume = 64.61 m^3

4.8 Treatment of Ditches & Watercourses

Ditch systems traversing the development site would be accommodated in suitable road crossings where necessary, in the form of culverts or pipes. The existing ditch systems within the subject site comprise surface water outfalls "B" and "C". The proposed treatment of these ditches within the development site is described below and on DBFL drawing no. 170092-3059.

Outfall "B":

The existing ditch system which forms the western boundary of "*Gaelscoil An Bhradain Feasa*" will remain as an open channel. This channel is piped under Mill Road and through private front gardens. It is proposed to intercept this outfall on Mill Road and to re-route it through Mill Road to the Stameen River. This will ensure a suitably sized and accessible outfall.

Refer to Appendix E for further details and 'Microdrainage' calculations for proposed surface water outfall.

Outfall "C":

It is proposed to divert the existing ditch (as approved under LB180620) adjacent to Colpe Road to facilitate the construction of the footpath and cycle path along the western side of Colpe Road. This ditch would be diverted into an open channel with dimensions matching the existing ditch. The ditch will be piped under the link street in a 900mm diameter pipe as indicated on drawing no. 170092-3057. This ditch is currently culverted under Mill Road in a culvert of 0.46m wide x 9m high, which has settled resulting in the upstream end of the culvert being lower than the downstream end. It is therefore proposed to remove this culvert and to replace it with a new surface water culvert / pipe.

Refer to Appendix E for further details and 'Microdrainage' calculations of the proposed 900mm diameter surface water pipe under the link street.

4.9 Flood Risk

A 'Site Specific flood Risk Assessment' (SSFRA) by DBFL Consulting Engineers, is included under separate cover.

5.0 Foul Drainage

5.1 General

Foul flows from the development will outfall to the foul outfall sewer approved under LB180620 at the north east corner of the site, before continuing to the existing 900mm diameter foul outfall sewer which crosses the railway and continues in a northerly direction to Drogheda Wastewater Treatment Works adjacent to Marsh Road.

The proposed development is separated into two foul drainage Catchments, “1A” & “1B” as per *Figure 7* below. Catchment “1A” comprises the western section of the site (87 no. houses), with foul flows from this *catchment* discharging by gravity to the existing 900mm diameter foul sewer, at manhole F17, adjacent to the railway line. The balance of the development site is included in Catchment “1B” and comprises 270 residential units and a childcare facility and commercial development approved under *LB180620*. Foul flows from Catchment “1B” will discharge to a new temporary foul pumping station located to the east of the lands. The foul drainage for this catchment is designed to enable the foul pumping station to be decommissioned in the future and the foul sewer to continue along the link street to the strategic foul pumping station at Marsh Road which will be designed to drain the *“Mill Road / Marsh Road Urban Design Framework Plan Lands”*. The interim foul drainage arrangement for this catchment will be to pump foul flows from the temporary pumping station to the foul sewer on the link street.

Figure 7: Foul Drainage Catchment Plan

5.2 Design Calculations

The gravity foul sewer network is designed using the *"Network"* Module of *"Microdrainage".* Foul sewer network calculations are included in Appendix F.

Foul sewers have been designed in accordance with the Building Regulations and specifically in accordance with the principles and methods set out in the DOE "Recommendations for Site Development Works for Housing Areas", BS8301: 1985, IS EN752 (2008), IS EN12056: Part 2 (2000) and the recommendations of the 'Greater Dublin Strategic Drainage Study', (GDSDS).

The following design parameters have been applied:

Hydraulic Loading	:	446l/house/day
Discharge units	:	14 units per house (as EN752 7 BS8301:1985) (for the commercial development, the equivalent number of houses is calculated based on the daily foul loading, refer to Table 4).
Pipe Friction (Ks)	:	1.5 mm
Minimum Velocity	:	0.7 m/s (self-cleansing velocity)
Maximum Velocity	:	3.0 m/s (1:20 maximum pipe gradient used)
Frequency Factor	:	0.5 for domestic use

5.3 Temporary Foul Pumping Station

It is proposed to discharge foul flows from Catchment "2" to a temporary foul pumping station located to the east of the lands. The pumping station is designed to pump foul flows from catchment "2" via a 100mm diameter foul rising main to the proposed gravity foul sewer in the link street.

The pumping station is designed in accordance with Irish Waters Code of Practice and includes 12-hour emergency storage in the event of pump breakdown. Duty and standby pumps are proposed. It is proposed to provide an overflow facility from the pumping station to a storage tank capable of holding effluent for 12 hours in the event of pump failure. Therefore, the wet well and storage facility will be capable of storing approximately 60m^3.

The foul pumping station would include a kiosk to accommodate the control panel, telemetry equipment, a flow recorder, hose reel and washing facilities.

Pumping station and rising main calculations and details of the proposed pumps are included in Appendix G.

5.4 Irish Water

A copy of the Irish Water "Statement of Design Acceptance" and "Confirmation of Feasibility" for the development is included in Appendix H.

6.0 WATER SUPPLY AND DISTRIBUTION

The development's water-main distribution system is indicated on drawings 170092-3051 to 170092-3057. It is proposed to connect to the existing 200mm diameter watermain on Colpe Road, west of the railway line, with the 200mm diameter main extended along the link street and the residential development supplied from 150mm and 100mm diameter watermains.

Connections to the public water main will include a bulk meter and sluice valves in accordance with the Irish Water requirements.

Individual houses will have their own connections to the distribution main via service connections and boundary boxes. Individual service boundary boxes will be of the type to suit Irish Water.

6.1 Watermain Standards and Details

The water main layout and details are in accordance with Irish Water Connection and Developer Services, 'Code of Practice for Water Infrastructure' and 'Water Infrastructure Standard Details'.

6.2 Water Demand & Conservation

The average daily peak demand is approximately 145m^3 (assuming an occupancy rate of 2.7 persons per house and a water usage rate of 150l/head/day).

6.3 Irish Water

Irish Water have been provided with a pre-connection enquiry form for the application site.

A copy of the Irish Water Confirmation of Feasibility and Statement of Design Acceptance are included in Appendix H.

7.0 RESPONSE TO AN BORD PLEANALA OPINION

An Bord Pleanala raised a number of issues following the pre-application planning process for case reference ABP-303309-18, which must be addressed to facilitate an application for strategic housing development. These items are outlined in their opinion document dated 20th February 2019.

The water services are outlined below using the same numbering system as follows:

5. Surface Water Management and Risk of Flooding

Further consideration of documents as they relate to surface and storm water management for the site. This further consideration should have regard to the requirements of the Council in respect of surface water treatment and disposal as set out in section 7.6.2 of the Planning Authority's opinion. Any surface water management proposals should be considered in tandem with any Flood Risk Assessment, which should in turn accord with the requirements of "The Planning system and Flood Risk Management Guidelines" (including the associated 'Technical Appendices'). In this regard, consideration should be given to objective Flood Risk FR POL 3 in the Drogheda Southern Environs Local Area Plan. Further consideration of these issues may require an amendment to the documents and/or design proposals submitted.

We refer you to DBFL "Site Specific Flood Risk Assessment", Rev "A", included under separate cover and to the DBFL "Infrastructure Design Report".

Meath County Council Opinion dated 21st January 2019

7.6.2 Surface Water Treatment & Disposal

The development as proposed does not meet the requirements of Meath County Council Water Services Section with respect to the orderly collection, treatment and disposal of surface water. Meath County Council Water Services Section requires that the following matters be addressed prior to submission of an SHD application;

1. Meath County Council Water services consider the proposed attenuation volume to be undersized for the scale of development. The applicant shall provide justification for the use of the runoff factors applied to each of the "Surface Types" detailed in Table 2 of the "Infrastructure Design Report December 2018" which forms part of the applicants submission. The applicant shall also satisfy by means of additional

drawings the areas where each of the "Surface Types" referenced in Table 2 apply within each of the catchments.

Dermot Grogan (DBFL) agreed the runoff coefficients with David O'Reilly (MCC) and Paul Aspell (MCC). Refer to Table 2, Section 4 above for updated runoff coefficients. Refer also to Table 1 for updated attenuation volumes based on these runoff coefficients. Refer to Figure 6 for 'Surface Types' Drawing in Section 4.0

2. The applicant shall provide justification for the use of a soil Type 2 in their runoff calculations. MCC Water Services believe the soil type at the subject site is a Soil Type 1.

The soil survey maps accompanying the Flood Studies Report indicate soil type 1 for the subject site. The GDSDS states that "it is important to carry out soil tests on soil characteristics to choose an appropriate SOIL category". Site investigations and surface water soakaway testing was carried out by Ground Investigations Ireland and are included under separate cover. The results indicate the predominant soil type in the subject site as being clay with poor permeability. Further site investigations confirm rock at relatively shallow depths of 2 to 4m below ground level. The site conditions indicate the most appropriate soil type as soil type 4. However, a conservative soil type of soil type 2 (2l/s/ha) is used for calculating Qbar for the residential element of the development. Qbar for the link street is based on soil type 3 (3l/s/la) as approved under LB180620. Refer to Table 1, Section 4 for further details.

3. The applicant shall provide greater detail in relation to the configuration of attenuation systems, in particular where the discharge of one catchment discharges to another. Associated drainage long section should be provided for clarity.

Only surface water Catchments B2 and B3 are in series with the Hydrobrake for Catchment B3 set to accommodate the allowable outflow from Catchment B2 and Catchment B3. i.e. the Hydrobrake set at 7.4l/s from Catchment B3 includes 2l/s from Catchment B2. Refer to Table 1 in Section 4.

The storage requirement for Catchment B3 is calculated using an input (additional hydrograph) of 2l/s to account for the inflow in series from Catchment B2. Refer to Appendix B. Refer to DBFL drawing nos. 170092-3051 and 170092-3052.

4. The applicant shall reconfigure the proposed attenuation systems, the attenuation systems should be configured to achieve partial treatment; the isolator row shall connect the attenuation systems inlet and outlet chambers. The isolator row shall also be linked to adjacent rows by means of a high level 225mm overflow pipe.

We confirm that the surface water drainage has been redesigned, with all surface water storage provided via on-line storage.

The underground "Stormtech" units will be installed and constructed in accordance with the manufacturers instructions. Refer to Appendix D and to DBFL drawing no. 170092-3066.

5. The applicant shall provide details of the winter ground water level for the sites of each of the proposed attenuation systems. Where infiltration systems are to be used, they shall be a minimum depth of 1 metre above the winter water table level. The applicant shall design the attenuation system suitable for the ground conditions and acceptable to MCC Water Services Engineer.

We confirm that the standpipe installed in June 2019 at RC05 indicated a ground water level of circa 3.5m BGL. We confirm that the groundwater level at each surface water storage system will be confirmed prior to construction.

6. In order to isolate and carry out maintenance of the flow control devices a penstock valve or similar approved) shall be installed within the flow control chamber, on the upstream end of the manhole.

We confirm that a penstock will be provided on the upstream end of the flow control manhole. The details to be agreed with Meath County Council prior to construction.

7. Further clarification in relation to Catchment C, in particular how the proposal within this application changes the drainage system for the proposed link street granted permission under Planning Application LB180620.

We confirm that the link street is now included in the application boundary and the surface water drainage design has been updated accordingly. We refer you to DBFL drawing nos. 170092-3050 to 3057.

8. It is the applicant's intention to discharge Catchments B, C, D & E to the existing ditch system. The applicant shall undertake a detailed assessment of the existing ditch system into which it is proposed to discharge surface water. The assessment

shall prove the existence and capacity of the proposed discharge route. The detailed assessment shall be furnished to MCC Water Services and if required, a remedial works plan agreed with MCC Water Services prior to submission of an SHD application to An Bord Pleanala.

We refer you to Section 4.8 regarding treatment of ditches and specifically relating to surface water outfalls “B” and “C”.

It is proposed to construct a new surface water outfall pipe on Mill Road to accommodate the existing drain from catchment B.

It is proposed to remove the existing culvert under Mill Road, which has settled and replace it with a new culvert / pipe at the correct gradient. The culvert accommodates runoff from Catchment “C”.

9. Where the provision of permeable paving is welcomed by Meath County Council, it should be limited to privately owned car parking spaces. The provision of storage volume within private property including within sub-surface permeable paving detail is not acceptable. The functionality of such a proposal is unproved and has potential to cause future maintenance issues for the Local Authority. MCC Water Services require that the proposed inlet and outlet distributor boxes within the private driveways be linked by means of a perforated rigid pipe which can be jetted for maintenance purposes.

We refer you to DBFL drawing no. 170092-3067 for details of roof drainage discharging to the stone under the permeable paving, before being piped to the main surface water drainage network.

We confirm that permeable paving is proposed for all driveways in curtilage and for car parking spaces under the control of a management company. The storage within the voids between the stone is not included in the surface water storage calculations but is used to apply an appropriate runoff factor for this surface type as agreed with Meath County Council. Refer to Table 2 Section 4.

....furthermore the following specific information should be submitted with any application for permission.

An Bord Pleanala Specific Further Information:

6. All existing watercourses that traverse the site including any proposal to culvert / re-route existing drains should be clearly identified on a site layout plan.

Refer to DBFL drawing no. 170092-3059.

10. A phasing plan for the proposed development which includes the phasing arrangements for the delivery of the public open spaces, surface water management proposals having regard to sub-catchments within the scheme and Part V provision.

Refer to Figure 8 below.

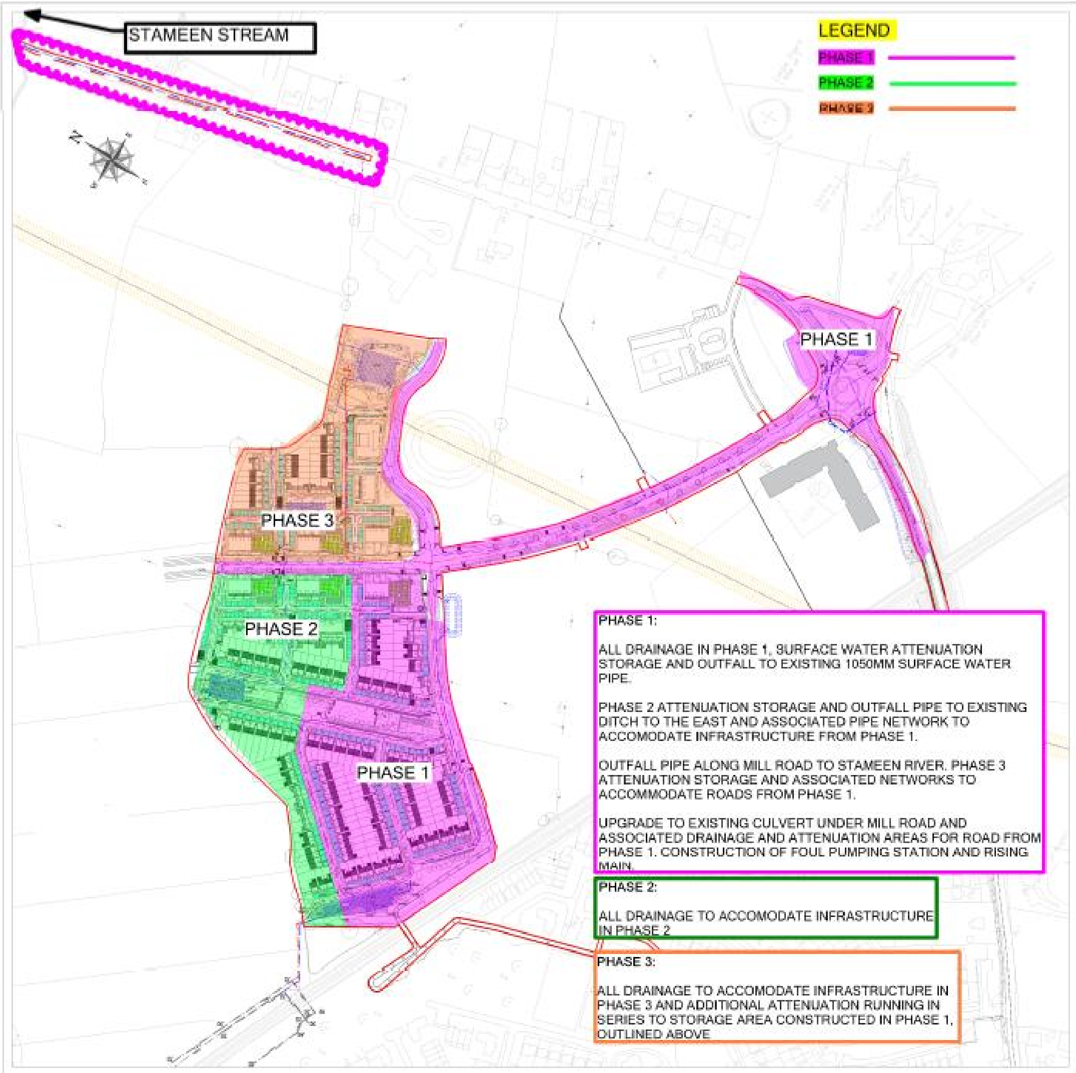

Figure 8 Catchment Phasing

Appendix A

ALLOWABLE OUTFLOW Q_{bar} CALCULATIONS

TITLE	Job Reference
Proposed Residential Development at Colpe Road, Drogheda	170092
SUBJECT	Calc. Sheet No.
QBAR Calculation using IOH Report 124 for Sites < 25 km²	1

DRAWING NUMBER	Calculations by	Checked by	Date
170092-3050	AOS	DMW	03-Jul-19

Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation

[1]$Q_{bar} = 0.00108 * (AREA)^{0.89} (SAAR)^{1.17} (SOIL)^{2.17}$

[2]Site Area = 13.27 Ha

Site area is less than 50 Ha, calculate Qbar for a 50 Ha Site then pro-rata

AREA = 0.133 km²

SAAR = 760 mm

[3]SOIL = 0.37

Q_{bar} = 0.00006 cumecs/Ha

Q_{bar} = 3.2 l/s/Ha

$Q_{bar\,(total)}$ = 42.0 l/s

Note to Institute of Hydrology Report No. 124 Eqn

Q_{bar}	The Mean Annual Flood (cumecs)
AREA	Area of the Catchment (km²)
SAAR	Standard Annual Average Rainfall (mm)
	NERC Flood Studies Report, 1975
SOIL	Soil Index Values of Catchment
	Winter Rain Acceptance Potential
	(Supplementary Report No. 7)

Soil Classification for Runoff Potential FSR Maps

Soil 1	0	%
Soil 2	0	%
Soil 3	100	%
Soil 4	0	%
Soil 5	0	%

[4]Qbar from Site with factorial Error Allowance

r^2 =	0.647
n =	71
fse =	1.651
Q_{bar} =	69.30 l/s

(With Allowance for the standard factorial error)

Permissible Outflow from Site using Growth Factor

Qbar growth for permitted outflows from site for given return period (assuming long term storage). (No allowance for standard factorial error)

Flood Return Event	[5]Growth Factor	Permitted Flow (l/s)
1	0.85	35.7
QBAR	1	42.0
10	1.67	70.1
30	2.1	88.1
50	2.33	97.8
100	2.6	109.1
200	2.85	119.6
1000	3.5	146.9

Is longterm storage provided?	No

Storm Return Period to be provided for =	30	Years *
QBAR (Growth) =	88.1	Litres/sec
[6]Permissible Outflow from site =	42.0	Litres/sec
[7]Maximum Allowable Outflow from site =	42.0	Litres/sec

(* 30, 50 or 100)

1hectare = 10,000m² 1km² = 100 hectares

Notes

1. Based on the Institute of Hydrology Report 124 for small catchments less than 25km².
2. For catchments smaller than 50 hectares in area, flow rates are linearly interpolated for smaller areas.
3. Soil Index value (SPR) calculated from Flood Studies Report Vol V Fig I.4.18(1) - The Classification of Soils from Winter Rainfall Acceptance Rate.
4. Fse is the standard factorial error
5. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year, 2.3 for 50 and 2.6 for 100 year return period events, from GDSDS Figure C2.
6. Total Permissible Outflow - $QBAR_{rural}$ calculated in accordance with GDSDS - Regional Drainage Policies (Volume 2 - Chapter 6), i.e. QBAR(m3/s)=0.00108x(area)^0.89(SAAR)^1.17(SOIL)^2.17
7. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0l/s.
8. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change. (Value from Dublin Airport)
9. Interception Volume Vi (m3) = Impermeable Area (ha) x 10mm x 10 (GDSDS, Vol 2, Section 6.3.1.2.1)

Appendix B

SURFACE WATER STORAGE CALCULATIONS & MET EIREANN RAINFALL DATA

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 311881, Northing: 274674,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.5,	3.4,	4.0,	4.7,	5.3,	5.7,	7.0,	8.5,	9.4,	10.8,	12.0,	12.9,	14.4,	15.5,	16.4,	N/A ,
10 mins	3.4,	4.8,	5.5,	6.6,	7.3,	7.9,	9.7,	11.8,	13.1,	15.0,	16.7,	18.0,	20.0,	21.6,	22.9,	N/A ,
15 mins	4.0,	5.6,	6.5,	7.8,	8.6,	9.3,	11.4,	13.9,	15.5,	17.7,	19.7,	21.2,	23.6,	25.4,	26.9,	N/A ,
30 mins	5.4,	7.4,	8.4,	10.0,	11.0,	11.8,	14.3,	17.2,	19.0,	21.6,	23.9,	25.6,	28.3,	30.3,	32.0,	N/A ,
1 hours	7.2,	9.6,	10.9,	12.8,	14.0,	14.9,	18.0,	21.3,	23.4,	26.4,	29.0,	30.9,	33.9,	36.2,	38.1,	N/A ,
2 hours	9.6,	12.6,	14.2,	16.4,	17.9,	19.0,	22.5,	26.4,	28.8,	32.2,	35.1,	37.4,	40.7,	43.3,	45.4,	N/A ,
3 hours	11.4,	14.8,	16.5,	19.0,	20.6,	21.8,	25.7,	29.9,	32.6,	36.2,	39.3,	41.7,	45.3,	48.0,	50.3,	N/A ,
4 hours	12.8,	16.5,	18.4,	21.0,	22.8,	24.1,	28.2,	32.7,	35.5,	39.3,	42.6,	45.1,	48.9,	51.7,	54.0,	N/A ,
6 hours	15.2,	19.3,	21.4,	24.3,	26.2,	27.7,	32.2,	37.0,	40.1,	44.2,	47.7,	50.4,	54.4,	57.4,	59.8,	N/A ,
9 hours	18.0,	22.6,	24.9,	28.1,	30.2,	31.8,	36.8,	42.0,	45.2,	49.7,	53.4,	56.3,	60.5,	63.7,	66.3,	N/A ,
12 hours	20.3,	25.3,	27.7,	31.2,	33.5,	35.1,	40.4,	45.9,	49.3,	53.9,	57.9,	60.8,	65.3,	68.6,	71.2,	N/A ,
18 hours	24.0,	29.5,	32.3,	36.1,	38.6,	40.4,	46.1,	52.0,	55.7,	60.6,	64.8,	67.9,	72.6,	76.1,	78.9,	N/A ,
24 hours	27.0,	33.0,	36.0,	40.0,	42.7,	44.6,	50.6,	56.8,	60.7,	65.9,	70.2,	73.5,	78.3,	81.9,	84.8,	94.5,
2 days	32.8,	39.9,	43.3,	48.0,	51.1,	53.4,	60.3,	67.5,	72.0,	77.9,	82.9,	86.6,	92.1,	96.3,	99.6,	110.6,
3 days	37.6,	45.5,	49.3,	54.6,	58.0,	60.6,	68.3,	76.3,	81.3,	87.8,	93.4,	97.5,	103.6,	108.1,	111.8,	123.9,
4 days	41.7,	50.4,	54.6,	60.4,	64.1,	66.9,	75.3,	84.1,	89.4,	96.6,	102.6,	107.1,	113.7,	118.6,	122.5,	135.7,
6 days	49.1,	59.1,	63.9,	70.6,	74.9,	78.0,	87.7,	97.7,	103.8,	111.9,	118.8,	123.8,	131.3,	136.9,	141.4,	156.3,
8 days	55.7,	66.8,	72.2,	79.7,	84.4,	87.9,	98.6,	109.7,	116.5,	125.5,	133.1,	138.7,	147.0,	153.1,	158.1,	174.5,
10 days	61.7,	73.9,	79.8,	88.0,	93.1,	97.0,	108.7,	120.7,	128.1,	137.9,	146.1,	152.2,	161.2,	167.9,	173.3,	191.1,
12 days	67.3,	80.6,	86.9,	95.7,	101.3,	105.4,	118.0,	131.0,	139.0,	149.5,	158.3,	164.9,	174.6,	181.7,	187.5,	206.6,
16 days	77.8,	92.9,	100.1,	110.1,	116.4,	121.1,	135.4,	150.1,	159.0,	170.9,	180.9,	188.3,	199.2,	207.3,	213.7,	235.2,
20 days	87.5,	104.3,	112.3,	123.4,	130.4,	135.6,	151.4,	167.6,	177.6,	190.7,	201.7,	209.9,	221.9,	230.8,	237.9,	261.5,
25 days	99.0,	117.7,	126.6,	139.0,	146.8,	152.6,	170.2,	188.2,	199.2,	213.8,	226.0,	235.1,	248.3,	258.2,	266.1,	292.2,

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

DBFL Consulting Engineers		Page 1
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT A - 30 YR	Micro Drainage
Date 07/10/2019 16:19 File CATCH A 30 YR- 07.10.20...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	25.318	0.339	8.9	179.9	O K
30 min Summer	25.440	0.461	8.9	244.5	O K
60 min Summer	25.569	0.590	8.9	313.0	O K
120 min Summer	25.703	0.724	8.9	383.8	O K
180 min Summer	25.776	0.797	8.9	422.6	O K
240 min Summer	25.821	0.842	8.9	446.3	O K
360 min Summer	25.869	0.890	8.9	471.8	O K
480 min Summer	25.888	0.909	8.9	481.7	O K
600 min Summer	25.898	0.919	8.9	486.9	O K
720 min Summer	25.902	0.923	8.9	489.4	O K
960 min Summer	25.902	0.923	8.9	489.1	O K
1440 min Summer	25.881	0.902	8.9	478.3	O K
2160 min Summer	25.831	0.852	8.9	451.5	O K
2880 min Summer	25.771	0.792	8.9	419.9	O K
4320 min Summer	25.620	0.641	8.9	339.8	O K
5760 min Summer	25.479	0.500	8.9	265.0	O K
7200 min Summer	25.369	0.390	8.9	206.7	O K
8640 min Summer	25.287	0.308	8.9	163.0	O K
10080 min Summer	25.227	0.248	8.8	131.2	O K
15 min Winter	25.360	0.381	8.9	202.1	O K
30 min Winter	25.498	0.519	8.9	274.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	55.192	0.0	180.3	22
30 min Summer	37.956	0.0	249.5	37
60 min Summer	24.882	0.0	332.4	66
120 min Summer	15.840	0.0	423.8	126
180 min Summer	12.078	0.0	484.9	186
240 min Summer	9.939	0.0	532.2	246
360 min Summer	7.539	0.0	605.7	364
480 min Summer	6.189	0.0	662.9	452
600 min Summer	5.307	0.0	710.6	508
720 min Summer	4.680	0.0	751.8	574
960 min Summer	3.835	0.0	821.1	700
1440 min Summer	2.896	0.0	928.3	984
2160 min Summer	2.186	0.0	1058.5	1408
2880 min Summer	1.790	0.0	1155.5	1820
4320 min Summer	1.349	0.0	1305.3	2600
5760 min Summer	1.104	0.0	1426.8	3296
7200 min Summer	0.944	0.0	1525.3	4032
8640 min Summer	0.831	0.0	1610.2	4672
10080 min Summer	0.746	0.0	1684.4	5344
15 min Winter	55.192	0.0	202.5	22
30 min Winter	37.956	0.0	279.8	37

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DBFL Consulting Engineers		Page 2
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT A - 30 YR	Micro Drainage
Date 07/10/2019 16:19 File CATCH A 30 YR- 07.10.20...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	25.645	0.666	8.9	353.2	O K
120 min Winter	25.798	0.819	8.9	433.8	O K
180 min Winter	25.882	0.903	8.9	478.6	O K
240 min Winter	25.936	0.957	8.9	507.1	O K
360 min Winter	25.998	1.019	8.9	540.1	O K
480 min Winter	26.026	1.047	8.9	555.1	O K
600 min Winter	26.036	1.057	8.9	560.4	O K
720 min Winter	26.037	1.058	8.9	560.6	O K
960 min Winter	26.034	1.055	8.9	559.3	O K
1440 min Winter	25.997	1.018	8.9	539.3	O K
2160 min Winter	25.909	0.930	8.9	492.9	O K
2880 min Winter	25.808	0.829	8.9	439.6	O K
4320 min Winter	25.552	0.573	8.9	303.5	O K
5760 min Winter	25.350	0.371	8.9	196.5	O K
7200 min Winter	25.222	0.243	8.8	128.9	O K
8640 min Winter	25.152	0.173	8.4	91.9	O K
10080 min Winter	25.125	0.146	7.8	77.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	24.882	0.0	372.6	66
120 min Winter	15.840	0.0	474.8	124
180 min Winter	12.078	0.0	543.3	182
240 min Winter	9.939	0.0	596.2	240
360 min Winter	7.539	0.0	678.5	352
480 min Winter	6.189	0.0	742.6	462
600 min Winter	5.307	0.0	795.9	564
720 min Winter	4.680	0.0	842.0	598
960 min Winter	3.835	0.0	919.5	746
1440 min Winter	2.896	0.0	1038.9	1058
2160 min Winter	2.186	0.0	1185.6	1520
2880 min Winter	1.790	0.0	1294.3	1964
4320 min Winter	1.349	0.0	1462.5	2768
5760 min Winter	1.104	0.0	1598.2	3408
7200 min Winter	0.944	0.0	1708.6	4032
8640 min Winter	0.831	0.0	1803.8	4584
10080 min Winter	0.746	0.0	1887.3	5152

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT A - 30 YR	Micro Drainage
Date 07/10/2019 16:19 File CATCH A 30 YR- 07.10.20...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.797

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	1.797

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT A - 30 YR	Micro Drainage
Date 07/10/2019 16:19 File CATCH A 30 YR- 07.10.20...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 26.500

Tank or Pond Structure

Invert Level (m) 24.979

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	530.0	0.700	530.0	1.400	0.0	2.100	0.0
0.100	530.0	0.800	530.0	1.500	0.0	2.200	0.0
0.200	530.0	0.900	530.0	1.600	0.0	2.300	0.0
0.300	530.0	1.000	530.0	1.700	0.0	2.400	0.0
0.400	530.0	1.100	530.0	1.800	0.0	2.500	0.0
0.500	530.0	1.200	0.0	1.900	0.0		
0.600	530.0	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0137-8900-1060-8900
Design Head (m)	1.060
Design Flow (l/s)	8.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	137
Invert Level (m)	24.979
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.060	8.9
Flush-Flo™	0.316	8.9
Kick-Flo®	0.697	7.3
Mean Flow over Head Range	-	7.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.9	1.200	9.4	3.000	14.5	7.000	21.8
0.200	8.6	1.400	10.1	3.500	15.7	7.500	22.6
0.300	8.9	1.600	10.8	4.000	16.7	8.000	23.3
0.400	8.8	1.800	11.4	4.500	17.7	8.500	24.0
0.500	8.6	2.000	12.0	5.000	18.6	9.000	24.6
0.600	8.2	2.200	12.6	5.500	19.4	9.500	25.3
0.800	7.8	2.400	13.1	6.000	20.3		
1.000	8.7	2.600	13.6	6.500	21.1		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT A - 100 YR	Micro Drainage
Date 07/10/2019 16:19 File CATCH A 100 YR - 07.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	25.363	0.384	8.8	234.4	O K
30 min Summer	25.507	0.528	8.9	321.8	O K
60 min Summer	25.657	0.678	8.9	413.6	O K
120 min Summer	25.809	0.830	8.9	506.1	O K
180 min Summer	25.896	0.917	8.9	559.6	O K
240 min Summer	25.956	0.977	8.9	595.9	O K
360 min Summer	26.032	1.053	8.9	642.1	O K
480 min Summer	26.070	1.091	8.9	665.6	O K
600 min Summer	26.090	1.111	8.9	676.9	O K
720 min Summer	26.098	1.119	8.9	680.6	O K
960 min Summer	26.101	1.122	8.9	681.7	O K
1440 min Summer	26.080	1.101	8.9	671.7	O K
2160 min Summer	26.034	1.055	8.9	643.6	O K
2880 min Summer	25.972	0.993	8.9	605.8	O K
4320 min Summer	25.823	0.844	8.9	514.9	O K
5760 min Summer	25.688	0.709	8.9	432.6	O K
7200 min Summer	25.570	0.591	8.9	360.7	O K
8640 min Summer	25.472	0.493	8.9	301.0	O K
10080 min Summer	25.393	0.414	8.9	252.3	O K
15 min Winter	25.410	0.431	8.9	263.0	O K
30 min Winter	25.572	0.593	8.9	361.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	71.340	0.0	232.0	23
30 min Summer	49.472	0.0	323.4	37
60 min Summer	32.411	0.0	432.5	68
120 min Summer	20.489	0.0	547.4	126
180 min Summer	15.541	0.0	623.0	186
240 min Summer	12.733	0.0	680.6	246
360 min Summer	9.598	0.0	769.4	366
480 min Summer	7.840	0.0	837.7	484
600 min Summer	6.698	0.0	894.0	604
720 min Summer	5.886	0.0	942.2	702
960 min Summer	4.799	0.0	1022.2	812
1440 min Summer	3.596	0.0	1138.7	1072
2160 min Summer	2.695	0.0	1304.0	1480
2880 min Summer	2.195	0.0	1415.8	1908
4320 min Summer	1.641	0.0	1586.6	2684
5760 min Summer	1.334	0.0	1724.8	3408
7200 min Summer	1.136	0.0	1834.8	4176
8640 min Summer	0.995	0.0	1929.0	4840
10080 min Summer	0.890	0.0	2010.6	5544
15 min Winter	71.340	0.0	260.4	23
30 min Winter	49.472	0.0	362.6	37

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT A - 100 YR	Micro Drainage
Date 07/10/2019 16:19 File CATCH A 100 YR - 07.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	25.743	0.764	8.9	465.8	O K
120 min Winter	25.918	0.939	8.9	572.6	O K
180 min Winter	26.022	1.043	8.9	636.4	O K
240 min Winter	26.093	1.114	8.9	678.5	O K
360 min Winter	26.502	1.523	8.9	727.8	O K
480 min Winter	26.546	1.567	8.9	754.5	O K
600 min Winter	26.570	1.591	8.9	768.8	O K
720 min Winter	26.580	1.601	8.9	775.0	O K
960 min Winter	26.577	1.598	8.9	773.2	O K
1440 min Winter	26.555	1.576	8.9	760.2	O K
2160 min Winter	26.488	1.509	8.9	719.2	O K
2880 min Winter	26.081	1.102	8.9	672.4	O K
4320 min Winter	25.834	0.855	8.9	521.7	O K
5760 min Winter	25.618	0.639	8.9	389.6	O K
7200 min Winter	25.450	0.471	8.9	287.4	O K
8640 min Winter	25.330	0.351	8.7	213.8	O K
10080 min Winter	25.247	0.268	8.4	163.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	32.411	0.0	484.7	66
120 min Winter	20.489	0.0	613.3	124
180 min Winter	15.541	0.0	697.9	184
240 min Winter	12.733	0.0	762.2	242
360 min Winter	9.598	0.0	861.6	356
480 min Winter	7.840	0.0	937.9	470
600 min Winter	6.698	0.0	1000.7	580
720 min Winter	5.886	0.0	1054.4	688
960 min Winter	4.799	0.0	1142.8	872
1440 min Winter	3.596	0.0	1263.0	1100
2160 min Winter	2.695	0.0	1460.6	1564
2880 min Winter	2.195	0.0	1585.7	2076
4320 min Winter	1.641	0.0	1777.1	2900
5760 min Winter	1.334	0.0	1932.0	3624
7200 min Winter	1.136	0.0	2055.3	4320
8640 min Winter	0.995	0.0	2160.9	4928
10080 min Winter	0.890	0.0	2252.9	5552

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT A - 100 YR	Micro Drainage
Date 07/10/2019 16:19 File CATCH A 100 YR - 07.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.797

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	1.797

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT A - 100 YR	Micro Drainage
Date 07/10/2019 16:19 File CATCH A 100 YR - 07.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 27.840

Tank or Pond Structure

Invert Level (m) 24.979

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	610.0	0.700	610.0	1.400	1.0	2.100	0.0
0.100	610.0	0.800	610.0	1.500	610.0	2.200	0.0
0.200	610.0	0.900	610.0	1.600	610.0	2.300	0.0
0.300	610.0	1.000	610.0	1.700	0.0	2.400	0.0
0.400	610.0	1.100	610.0	1.800	0.0	2.500	0.0
0.500	610.0	1.200	1.0	1.900	0.0		
0.600	610.0	1.300	1.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0129-8900-1615-8900
Design Head (m)	1.615
Design Flow (l/s)	8.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	129
Invert Level (m)	24.979
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.615	8.9
Flush-Flo™	0.477	8.9
Kick-Flo®	0.994	7.1
Mean Flow over Head Range	-	7.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.6	1.200	7.7	3.000	11.9	7.000	17.8
0.200	7.9	1.400	8.3	3.500	12.8	7.500	18.4
0.300	8.6	1.600	8.9	4.000	13.7	8.000	19.0
0.400	8.8	1.800	9.4	4.500	14.4	8.500	19.6
0.500	8.9	2.000	9.8	5.000	15.2	9.000	20.1
0.600	8.8	2.200	10.3	5.500	15.9	9.500	20.7
0.800	8.4	2.400	10.7	6.000	16.6		
1.000	7.1	2.600	11.1	6.500	17.2		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF:170092 CATCHMENT B1 - 60 YR	Micro Drainage
Date 04/10/2019 08:05 File CATCH B1 60 YR - 04.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 60 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	23.277	0.317	5.3	123.5	O K
30 min Summer	23.393	0.433	5.3	168.9	O K
60 min Summer	23.515	0.555	5.3	216.6	O K
120 min Summer	23.641	0.681	5.3	265.7	O K
180 min Summer	23.712	0.752	5.3	293.4	O K
240 min Summer	23.757	0.797	5.3	310.8	O K
360 min Summer	23.808	0.848	5.3	330.7	O K
480 min Summer	23.830	0.870	5.3	339.4	O K
600 min Summer	23.839	0.879	5.3	342.7	O K
720 min Summer	23.843	0.883	5.3	344.5	O K
960 min Summer	23.844	0.884	5.3	344.6	O K
1440 min Summer	23.828	0.868	5.3	338.4	O K
2160 min Summer	23.787	0.827	5.3	322.5	O K
2880 min Summer	23.738	0.778	5.3	303.3	O K
4320 min Summer	23.616	0.656	5.3	255.9	O K
5760 min Summer	23.485	0.525	5.3	204.9	O K
7200 min Summer	23.382	0.422	5.3	164.5	O K
8640 min Summer	23.299	0.339	5.3	132.3	O K
10080 min Summer	23.236	0.276	5.3	107.5	O K
15 min Winter	23.316	0.356	5.3	138.7	O K
30 min Winter	23.447	0.487	5.3	189.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	63.980	0.0	123.5	23
30 min Summer	44.211	0.0	171.5	37
60 min Summer	28.972	0.0	228.5	68
120 min Summer	18.370	0.0	290.0	126
180 min Summer	13.965	0.0	330.8	186
240 min Summer	11.463	0.0	362.1	246
360 min Summer	8.664	0.0	410.5	364
480 min Summer	7.092	0.0	448.0	484
600 min Summer	6.068	0.0	479.1	554
720 min Summer	5.340	0.0	505.8	612
960 min Summer	4.364	0.0	550.6	744
1440 min Summer	3.280	0.0	618.9	1014
2160 min Summer	2.466	0.0	704.3	1432
2880 min Summer	2.013	0.0	766.5	1852
4320 min Summer	1.510	0.0	861.9	2684
5760 min Summer	1.231	0.0	938.8	3400
7200 min Summer	1.050	0.0	1000.8	4104
8640 min Summer	0.922	0.0	1054.1	4760
10080 min Summer	0.826	0.0	1100.5	5448
15 min Winter	63.980	0.0	138.6	22
30 min Winter	44.211	0.0	192.3	37

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF:170092 CATCHMENT B1 - 60 YR	Micro Drainage
Date 04/10/2019 08:05 File CATCH B1 60 YR - 04.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 60 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	23.586	0.626	5.3	244.3	O K
120 min Winter	23.730	0.770	5.3	300.4	O K
180 min Winter	23.811	0.851	5.3	332.0	O K
240 min Winter	23.864	0.904	5.3	352.6	O K
360 min Winter	23.928	0.968	5.3	377.5	O K
480 min Winter	23.960	1.000	5.3	390.1	O K
600 min Winter	23.975	1.015	5.3	395.9	O K
720 min Winter	23.979	1.019	5.3	397.5	O K
960 min Winter	23.975	1.015	5.3	395.7	O K
1440 min Winter	23.949	0.989	5.3	385.7	O K
2160 min Winter	23.880	0.920	5.3	358.9	O K
2880 min Winter	23.798	0.838	5.3	326.9	O K
4320 min Winter	23.593	0.633	5.3	246.9	O K
5760 min Winter	23.394	0.434	5.3	169.3	O K
7200 min Winter	23.257	0.297	5.3	115.8	O K
8640 min Winter	23.169	0.209	5.1	81.6	O K
10080 min Winter	23.116	0.156	4.9	60.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	28.972	0.0	256.0	66
120 min Winter	18.370	0.0	324.9	124
180 min Winter	13.965	0.0	370.6	184
240 min Winter	11.463	0.0	405.6	240
360 min Winter	8.664	0.0	459.8	356
480 min Winter	7.092	0.0	501.7	468
600 min Winter	6.068	0.0	536.4	576
720 min Winter	5.340	0.0	566.3	678
960 min Winter	4.364	0.0	616.2	774
1440 min Winter	3.280	0.0	691.1	1086
2160 min Winter	2.466	0.0	788.9	1556
2880 min Winter	2.013	0.0	858.5	1996
4320 min Winter	1.510	0.0	965.7	2860
5760 min Winter	1.231	0.0	1051.6	3520
7200 min Winter	1.050	0.0	1121.1	4176
8640 min Winter	0.922	0.0	1180.8	4760
10080 min Winter	0.826	0.0	1233.1	5440

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF:170092 CATCHMENT B1 - 60 YR	Micro Drainage
Date 04/10/2019 08:05 File CATCH B1 60 YR - 04.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	60	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.060

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	1.060

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF:170092 CATCHMENT B1 - 60 YR	Micro Drainage
Date 04/10/2019 08:05 File CATCH B1 60 YR - 04.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 24.500

Tank or Pond Structure

Invert Level (m) 22.960

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	390.0	0.700	390.0	1.400	0.0	2.100	0.0
0.100	390.0	0.800	390.0	1.500	0.0	2.200	0.0
0.200	390.0	0.900	390.0	1.600	0.0	2.300	0.0
0.300	390.0	1.000	390.0	1.700	0.0	2.400	0.0
0.400	390.0	1.100	390.0	1.800	0.0	2.500	0.0
0.500	390.0	1.200	0.0	1.900	0.0		
0.600	390.0	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0108-5300-1060-5300
Design Head (m)	1.060
Design Flow (l/s)	5.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	22.960
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.060	5.3
Flush-Flo™	0.315	5.3
Kick-Flo®	0.673	4.3
Mean Flow over Head Range	-	4.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	5.6	3.000	8.6	7.000	12.9
0.200	5.1	1.400	6.0	3.500	9.3	7.500	13.3
0.300	5.3	1.600	6.4	4.000	9.9	8.000	13.7
0.400	5.2	1.800	6.8	4.500	10.4	8.500	14.2
0.500	5.1	2.000	7.1	5.000	11.0	9.000	14.5
0.600	4.8	2.200	7.5	5.500	11.5	9.500	14.9
0.800	4.6	2.400	7.8	6.000	12.0		
1.000	5.2	2.600	8.1	6.500	12.4		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B1 -100 YR	Micro Drainage
Date 04/10/2019 08:03 File CATCH B1 - 100YR - 04.1...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	23.355	0.395	4.9	138.3	O K
30 min Summer	23.503	0.543	5.0	189.9	O K
60 min Summer	23.658	0.698	5.0	244.3	O K
120 min Summer	23.817	0.857	5.0	299.9	O K
180 min Summer	23.910	0.950	5.0	332.5	O K
240 min Summer	23.970	1.010	5.0	353.6	O K
360 min Summer	24.044	1.084	5.0	379.4	O K
480 min Summer	24.089	1.129	5.0	392.7	O K
600 min Summer	24.383	1.423	5.0	397.8	O K
720 min Summer	24.404	1.444	5.0	398.8	O K
960 min Summer	24.413	1.453	5.0	399.6	O K
1440 min Summer	24.131	1.171	5.0	396.9	O K
2160 min Summer	24.055	1.095	5.0	383.1	O K
2880 min Summer	24.004	1.044	5.0	365.5	O K
4320 min Summer	23.886	0.926	5.0	324.2	O K
5760 min Summer	23.734	0.774	5.0	270.8	O K
7200 min Summer	23.604	0.644	5.0	225.3	O K
8640 min Summer	23.496	0.536	5.0	187.6	O K
10080 min Summer	23.407	0.447	5.0	156.5	O K
15 min Winter	23.403	0.443	5.0	155.2	O K
30 min Winter	23.570	0.610	5.0	213.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	71.340	0.0	138.4	23
30 min Summer	49.472	0.0	192.6	37
60 min Summer	32.411	0.0	256.0	68
120 min Summer	20.489	0.0	323.8	126
180 min Summer	15.541	0.0	368.5	186
240 min Summer	12.733	0.0	402.5	246
360 min Summer	9.598	0.0	455.0	366
480 min Summer	7.840	0.0	495.4	484
600 min Summer	6.698	0.0	528.7	588
720 min Summer	5.886	0.0	557.3	634
960 min Summer	4.799	0.0	604.7	764
1440 min Summer	3.596	0.0	672.1	1058
2160 min Summer	2.695	0.0	769.9	1476
2880 min Summer	2.195	0.0	835.9	1908
4320 min Summer	1.641	0.0	936.8	2732
5760 min Summer	1.334	0.0	1017.7	3464
7200 min Summer	1.136	0.0	1082.7	4184
8640 min Summer	0.995	0.0	1138.5	4928
10080 min Summer	0.890	0.0	1187.0	5552
15 min Winter	71.340	0.0	155.2	23
30 min Winter	49.472	0.0	215.7	37

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B1 -100 YR	Micro Drainage
Date 04/10/2019 08:03 File CATCH B1 - 100YR - 04.1...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	23.746	0.786	5.0	275.3	O K
120 min Winter	23.929	0.969	5.0	339.2	O K
180 min Winter	24.035	1.075	5.0	376.2	O K
240 min Winter	24.419	1.459	5.0	400.4	O K
360 min Winter	24.515	1.555	5.1	429.1	O K
480 min Winter	24.561	1.601	5.2	445.1	O K
600 min Winter	24.585	1.625	5.2	453.7	O K
720 min Winter	24.596	1.636	5.3	457.4	O K
960 min Winter	24.594	1.634	5.3	456.6	O K
1440 min Winter	24.575	1.615	5.2	450.1	O K
2160 min Winter	24.511	1.551	5.1	427.8	O K
2880 min Winter	24.430	1.470	5.0	402.1	O K
4320 min Winter	23.929	0.969	5.0	339.3	O K
5760 min Winter	23.678	0.718	5.0	251.4	O K
7200 min Winter	23.488	0.528	5.0	184.8	O K
8640 min Winter	23.349	0.389	4.9	136.0	O K
10080 min Winter	23.252	0.292	4.8	102.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	32.411	0.0	286.8	66
120 min Winter	20.489	0.0	362.7	126
180 min Winter	15.541	0.0	412.7	184
240 min Winter	12.733	0.0	450.8	242
360 min Winter	9.598	0.0	509.5	356
480 min Winter	7.840	0.0	554.6	470
600 min Winter	6.698	0.0	591.8	580
720 min Winter	5.886	0.0	623.6	688
960 min Winter	4.799	0.0	675.8	868
1440 min Winter	3.596	0.0	739.1	1100
2160 min Winter	2.695	0.0	862.3	1564
2880 min Winter	2.195	0.0	936.2	2020
4320 min Winter	1.641	0.0	1048.9	2984
5760 min Winter	1.334	0.0	1139.9	3696
7200 min Winter	1.136	0.0	1212.8	4392
8640 min Winter	0.995	0.0	1275.3	5016
10080 min Winter	0.890	0.0	1329.9	5648

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B1 -100 YR	Micro Drainage
Date 04/10/2019 08:03 File CATCH B1 - 100YR - 04.1...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.060

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	1.060

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B1 -100 YR	Micro Drainage
Date 04/10/2019 08:03 File CATCH B1 - 100YR - 04.1...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 25.700

Tank or Pond Structure

Invert Level (m) 22.960

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	350.0	0.700	350.0	1.400	1.0	2.100	0.0
0.100	350.0	0.800	350.0	1.500	350.0	2.200	0.0
0.200	350.0	0.900	350.0	1.600	350.0	2.300	0.0
0.300	350.0	1.000	350.0	1.700	350.0	2.400	0.0
0.400	350.0	1.100	350.0	1.800	0.0	2.500	0.0
0.500	350.0	1.200	1.0	1.900	0.0		
0.600	350.0	1.300	1.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0099-5300-1660-5300
Design Head (m)	1.660
Design Flow (l/s)	5.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	99
Invert Level (m)	22.960
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.660	5.3
Flush-Flo™	0.432	5.0
Kick-Flo®	0.882	4.0
Mean Flow over Head Range	-	4.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.2	1.200	4.6	3.000	7.0	7.000	10.4
0.200	4.5	1.400	4.9	3.500	7.5	7.500	10.8
0.300	4.8	1.600	5.2	4.000	8.0	8.000	11.1
0.400	4.9	1.800	5.5	4.500	8.5	8.500	11.5
0.500	4.9	2.000	5.8	5.000	8.9	9.000	11.8
0.600	4.8	2.200	6.0	5.500	9.3	9.500	12.1
0.800	4.4	2.400	6.3	6.000	9.7		
1.000	4.2	2.600	6.5	6.500	10.1		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B2 - 100 YR	
Date 04/10/2019 08:26 File CATCH B2 100 YR -04.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	21.774	0.260	2.0	30.7	O K
30 min Summer	21.869	0.355	2.0	41.8	O K
60 min Summer	21.965	0.451	2.0	53.2	O K
120 min Summer	22.051	0.537	2.0	63.4	O K
180 min Summer	22.090	0.576	2.0	68.0	O K
240 min Summer	22.109	0.595	2.0	70.2	O K
360 min Summer	22.121	0.607	2.0	71.6	O K
480 min Summer	22.122	0.608	2.0	71.8	O K
600 min Summer	22.119	0.605	2.0	71.4	O K
720 min Summer	22.114	0.600	2.0	70.7	O K
960 min Summer	22.097	0.583	2.0	68.8	O K
1440 min Summer	22.057	0.543	2.0	64.1	O K
2160 min Summer	21.988	0.474	2.0	55.9	O K
2880 min Summer	21.902	0.388	2.0	45.7	O K
4320 min Summer	21.771	0.257	2.0	30.3	O K
5760 min Summer	21.687	0.173	2.0	20.4	O K
7200 min Summer	21.638	0.124	1.9	14.6	O K
8640 min Summer	21.610	0.096	1.8	11.3	O K
10080 min Summer	21.597	0.083	1.7	9.8	O K
15 min Winter	21.806	0.292	2.0	34.5	O K
30 min Winter	21.914	0.400	2.0	47.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	71.340	0.0	32.0	22
30 min Summer	49.472	0.0	44.5	37
60 min Summer	32.411	0.0	58.3	66
120 min Summer	20.489	0.0	73.7	126
180 min Summer	15.541	0.0	83.9	186
240 min Summer	12.733	0.0	91.6	244
360 min Summer	9.598	0.0	103.6	318
480 min Summer	7.840	0.0	112.8	382
600 min Summer	6.698	0.0	120.5	448
720 min Summer	5.886	0.0	127.1	516
960 min Summer	4.799	0.0	138.2	658
1440 min Summer	3.596	0.0	155.3	930
2160 min Summer	2.695	0.0	174.6	1348
2880 min Summer	2.195	0.0	189.6	1732
4320 min Summer	1.641	0.0	212.7	2424
5760 min Summer	1.334	0.0	230.5	3112
7200 min Summer	1.136	0.0	245.3	3752
8640 min Summer	0.995	0.0	258.0	4416
10080 min Summer	0.890	0.0	269.2	5144
15 min Winter	71.340	0.0	35.9	22
30 min Winter	49.472	0.0	49.8	37

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B2 - 100 YR	Micro Drainage
Date 04/10/2019 08:26 File CATCH B2 100 YR -04.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	22.024	0.510	2.0	60.2	O K
120 min Winter	22.123	0.609	2.0	71.9	O K
180 min Winter	22.172	0.658	2.0	77.6	O K
240 min Winter	22.197	0.683	2.0	80.6	O K
360 min Winter	22.215	0.701	2.0	82.8	O K
480 min Winter	22.213	0.699	2.0	82.5	O K
600 min Winter	22.209	0.695	2.0	82.0	O K
720 min Winter	22.200	0.686	2.0	80.9	O K
960 min Winter	22.173	0.659	2.0	77.8	O K
1440 min Winter	22.106	0.592	2.0	69.9	O K
2160 min Winter	21.992	0.478	2.0	56.5	O K
2880 min Winter	21.852	0.338	2.0	39.9	O K
4320 min Winter	21.680	0.166	2.0	19.6	O K
5760 min Winter	21.609	0.095	1.8	11.2	O K
7200 min Winter	21.591	0.077	1.6	9.1	O K
8640 min Winter	21.581	0.067	1.4	7.9	O K
10080 min Winter	21.574	0.060	1.3	7.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	32.411	0.0	65.3	66
120 min Winter	20.489	0.0	82.6	124
180 min Winter	15.541	0.0	93.9	180
240 min Winter	12.733	0.0	102.6	238
360 min Winter	9.598	0.0	116.0	346
480 min Winter	7.840	0.0	126.4	400
600 min Winter	6.698	0.0	135.0	472
720 min Winter	5.886	0.0	142.3	552
960 min Winter	4.799	0.0	154.7	706
1440 min Winter	3.596	0.0	174.0	1014
2160 min Winter	2.695	0.0	195.5	1456
2880 min Winter	2.195	0.0	212.4	1820
4320 min Winter	1.641	0.0	238.2	2464
5760 min Winter	1.334	0.0	258.2	3048
7200 min Winter	1.136	0.0	274.7	3680
8640 min Winter	0.995	0.0	288.9	4408
10080 min Winter	0.890	0.0	301.5	5144

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B2 - 100 YR	Micro Drainage
Date 04/10/2019 08:26 File CATCH B2 100 YR -04.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.240

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	0.240

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B2 - 100 YR	Micro Drainage
Date 04/10/2019 08:26 File CATCH B2 100 YR -04.10....	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 23.500

Tank or Pond Structure

Invert Level (m) 21.514

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	118.0	0.700	118.0	1.400	0.0	2.100	0.0
0.100	118.0	0.800	118.0	1.500	0.0	2.200	0.0
0.200	118.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	118.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	118.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	118.0	1.200	0.0	1.900	0.0		
0.600	118.0	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0071-2000-0705-2000
Design Head (m)	0.705
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	21.510
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.705	2.0
Flush-Flo™	0.208	2.0
Kick-Flo®	0.451	1.6
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.5	3.000	3.9	7.000	5.8
0.200	2.0	1.400	2.7	3.500	4.2	7.500	6.0
0.300	2.0	1.600	2.9	4.000	4.4	8.000	6.2
0.400	1.8	1.800	3.1	4.500	4.7	8.500	6.4
0.500	1.7	2.000	3.2	5.000	4.9	9.000	6.6
0.600	1.9	2.200	3.4	5.500	5.2	9.500	6.7
0.800	2.1	2.400	3.5	6.000	5.4		
1.000	2.3	2.600	3.6	6.500	5.6		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 30 YR	Micro Drainage
Date 04/10/2019 08:51 File CATCH B3 30YR - 04.10.2...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	20.885	0.281	7.4	167.3	O K
30 min Summer	20.987	0.383	7.4	227.6	O K
60 min Summer	21.096	0.492	7.4	293.0	O K
120 min Summer	21.217	0.613	7.4	364.8	O K
180 min Summer	21.295	0.691	7.4	411.1	O K
240 min Summer	21.349	0.745	7.4	443.6	O K
360 min Summer	21.422	0.818	7.4	486.7	O K
480 min Summer	21.465	0.861	7.4	512.4	O K
600 min Summer	21.490	0.886	7.4	527.3	O K
720 min Summer	21.505	0.901	7.4	535.8	O K
960 min Summer	21.521	0.917	7.4	545.3	O K
1440 min Summer	21.526	0.922	7.4	548.5	O K
2160 min Summer	21.453	0.849	7.4	505.4	O K
2880 min Summer	21.356	0.752	7.4	447.5	O K
4320 min Summer	21.215	0.611	7.4	363.5	O K
5760 min Summer	21.107	0.503	7.4	299.4	O K
7200 min Summer	21.016	0.412	7.4	245.4	O K
8640 min Summer	20.942	0.338	7.4	201.3	O K
10080 min Summer	20.884	0.280	7.4	166.6	O K
15 min Winter	20.920	0.316	7.4	187.7	O K
30 min Winter	21.034	0.430	7.4	255.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	55.192	0.0	270.6	23
30 min Summer	37.956	0.0	335.0	37
60 min Summer	24.882	0.0	421.3	68
120 min Summer	15.840	0.0	505.8	126
180 min Summer	12.078	0.0	562.2	186
240 min Summer	9.939	0.0	605.6	246
360 min Summer	7.539	0.0	673.1	366
480 min Summer	6.189	0.0	725.6	486
600 min Summer	5.307	0.0	769.1	604
720 min Summer	4.680	0.0	806.7	724
960 min Summer	3.835	0.0	869.5	862
1440 min Summer	2.896	0.0	963.5	1048
2160 min Summer	2.186	0.0	1094.2	1432
2880 min Summer	1.790	0.0	1183.9	1852
4320 min Summer	1.349	0.0	1322.2	2640
5760 min Summer	1.104	0.0	1435.9	3392
7200 min Summer	0.944	0.0	1526.9	4104
8640 min Summer	0.831	0.0	1605.2	4760
10080 min Summer	0.746	0.0	1673.3	5448
15 min Winter	55.192	0.0	291.2	22
30 min Winter	37.956	0.0	363.3	37

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 30 YR	Micro Drainage
Date 04/10/2019 08:51 File CATCH B3 30YR - 04.10.2...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	21.159	0.555	7.4	329.9	O K
120 min Winter	21.297	0.693	7.4	412.3	O K
180 min Winter	21.385	0.781	7.4	464.4	O K
240 min Winter	21.445	0.841	7.4	500.2	O K
360 min Winter	21.528	0.924	7.4	549.7	O K
480 min Winter	21.580	0.976	7.4	580.7	O K
600 min Winter	21.613	1.009	7.4	600.2	O K
720 min Winter	21.633	1.029	7.4	612.3	O K
960 min Winter	21.657	1.053	7.4	626.4	O K
1440 min Winter	21.652	1.048	7.4	623.5	O K
2160 min Winter	21.558	0.954	7.4	567.7	O K
2880 min Winter	21.438	0.834	7.4	496.3	O K
4320 min Winter	21.195	0.591	7.4	351.8	O K
5760 min Winter	21.026	0.422	7.4	251.2	O K
7200 min Winter	20.902	0.298	7.4	177.4	O K
8640 min Winter	20.820	0.216	7.2	128.6	O K
10080 min Winter	20.769	0.165	6.9	98.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	24.882	0.0	458.4	66
120 min Winter	15.840	0.0	552.9	126
180 min Winter	12.078	0.0	615.9	184
240 min Winter	9.939	0.0	664.5	242
360 min Winter	7.539	0.0	740.0	358
480 min Winter	6.189	0.0	798.5	474
600 min Winter	5.307	0.0	847.1	586
720 min Winter	4.680	0.0	888.8	696
960 min Winter	3.835	0.0	958.1	916
1440 min Winter	2.896	0.0	1056.4	1098
2160 min Winter	2.186	0.0	1211.7	1544
2880 min Winter	1.790	0.0	1312.1	2020
4320 min Winter	1.349	0.0	1467.6	2816
5760 min Winter	1.104	0.0	1594.5	3520
7200 min Winter	0.944	0.0	1696.5	4184
8640 min Winter	0.831	0.0	1784.4	4832
10080 min Winter	0.746	0.0	1861.2	5440

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Date 04/10/2019 08:51 File CATCH B3 30YR - 04.10.2...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.663

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	1.663

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Model Details

Storage is Online Cover Level (m) 22.500

Tank or Pond Structure

Invert Level (m) 20.604

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	595.0	0.700	595.0	1.400	0.0	2.100	0.0
0.100	595.0	0.800	595.0	1.500	0.0	2.200	0.0
0.200	595.0	0.900	595.0	1.600	0.0	2.300	0.0
0.300	595.0	1.000	595.0	1.700	0.0	2.400	0.0
0.400	595.0	1.100	595.0	1.800	0.0	2.500	0.0
0.500	595.0	1.200	0.0	1.900	0.0		
0.600	595.0	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0126-7400-1060-7400
Design Head (m)	1.060
Design Flow (l/s)	7.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	126
Invert Level (m)	20.604
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.060	7.4
Flush-Flo™	0.315	7.4
Kick-Flo®	0.689	6.1
Mean Flow over Head Range	-	6.4

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.5	1.200	7.8	3.000	12.1	7.000	18.1
0.200	7.1	1.400	8.4	3.500	13.0	7.500	18.7
0.300	7.4	1.600	9.0	4.000	13.9	8.000	19.3
0.400	7.3	1.800	9.5	4.500	14.7	8.500	19.9
0.500	7.1	2.000	10.0	5.000	15.4	9.000	20.4
0.600	6.8	2.200	10.4	5.500	16.1	9.500	21.0
0.800	6.5	2.400	10.9	6.000	16.8		
1.000	7.2	2.600	11.3	6.500	17.5		

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Innovyze	Source Control 2018.1	

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	102	1.6	202	1.7	302	2.0	402	1.9	502	1.8
4	0.0	104	1.6	204	1.7	304	2.0	404	1.9	504	1.8
6	0.0	106	1.7	206	1.7	306	2.0	406	1.9	506	1.8
8	0.0	108	1.7	208	1.7	308	2.0	408	1.9	508	1.8
10	0.0	110	1.7	210	1.7	310	2.0	410	1.9	510	1.8
12	0.0	112	1.8	212	1.7	312	2.0	412	1.9	512	1.8
14	0.0	114	1.8	214	1.8	314	2.0	414	1.9	514	1.8
16	0.0	116	1.8	216	1.8	316	2.0	416	1.9	516	1.8
18	0.0	118	1.8	218	1.8	318	2.0	418	1.9	518	1.8
20	0.0	120	1.9	220	1.8	320	2.0	420	1.9	520	1.8
22	0.0	122	1.9	222	1.8	322	2.0	422	1.9	522	1.8
24	0.0	124	1.9	224	1.8	324	2.0	424	1.9	524	1.8
26	0.1	126	1.9	226	1.8	326	2.0	426	1.9	526	1.8
28	0.1	128	1.9	228	1.8	328	2.0	428	1.9	528	1.8
30	0.1	130	1.9	230	1.9	330	2.0	430	1.9	530	1.8
32	0.1	132	1.9	232	1.9	332	2.0	432	1.9	532	1.8
34	0.2	134	1.9	234	1.9	334	2.0	434	1.9	534	1.8
36	0.2	136	1.9	236	1.9	336	2.0	436	1.9	536	1.8
38	0.2	138	2.0	238	1.9	338	2.0	438	1.9	538	1.8
40	0.3	140	2.0	240	1.9	340	2.0	440	1.9	540	1.8
42	0.3	142	2.0	242	1.9	342	2.0	442	1.9	542	1.8
44	0.4	144	2.0	244	1.9	344	2.0	444	1.9	544	1.8
46	0.4	146	2.0	246	1.9	346	2.0	446	1.9	546	1.7
48	0.5	148	2.0	248	1.9	348	2.0	448	1.9	548	1.7
50	0.5	150	2.0	250	1.9	350	2.0	450	1.9	550	1.7
52	0.6	152	2.0	252	1.9	352	2.0	452	1.9	552	1.7
54	0.6	154	2.0	254	1.9	354	2.0	454	1.9	554	1.7
56	0.7	156	2.0	256	1.9	356	2.0	456	1.9	556	1.7
58	0.7	158	2.0	258	1.9	358	2.0	458	1.9	558	1.7
60	0.8	160	2.0	260	2.0	360	2.0	460	1.9	560	1.7
62	0.8	162	2.0	262	2.0	362	2.0	462	1.9	562	1.7
64	0.9	164	2.0	264	2.0	364	2.0	464	1.9	564	1.7
66	0.9	166	2.0	266	2.0	366	2.0	466	1.9	566	1.7
68	0.9	168	2.0	268	2.0	368	2.0	468	1.9	568	1.7
70	1.0	170	2.0	270	2.0	370	2.0	470	1.9	570	1.7
72	1.0	172	2.0	272	2.0	372	2.0	472	1.8	572	1.7
74	1.1	174	1.9	274	2.0	374	2.0	474	1.8	574	1.7
76	1.1	176	1.9	276	2.0	376	2.0	476	1.8	576	1.7
78	1.1	178	1.9	278	2.0	378	2.0	478	1.8	578	1.7
80	1.2	180	1.9	280	2.0	380	2.0	480	1.8	580	1.7
82	1.2	182	1.9	282	2.0	382	2.0	482	1.8	582	1.7
84	1.2	184	1.9	284	2.0	384	2.0	484	1.8	584	1.7
86	1.3	186	1.9	286	2.0	386	2.0	486	1.8	586	1.7
88	1.3	188	1.8	288	2.0	388	2.0	488	1.8	588	1.7
90	1.3	190	1.8	290	2.0	390	2.0	490	1.8	590	1.7
92	1.4	192	1.8	292	2.0	392	2.0	492	1.8	592	1.7
94	1.4	194	1.7	294	2.0	394	2.0	494	1.8	594	1.7
96	1.5	196	1.7	296	2.0	396	1.9	496	1.8	596	1.7
98	1.5	198	1.6	298	2.0	398	1.9	498	1.8	598	1.7
100	1.5	200	1.7	300	2.0	400	1.9	500	1.8	600	1.7

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Innovyze	Source Control 2018.1	

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
602	1.7	702	1.8	802	2.0	902	2.0	1002	1.8	1102	0.5
604	1.7	704	1.8	804	2.0	904	2.0	1004	1.8	1104	0.5
606	1.7	706	1.9	806	2.0	906	2.0	1006	1.7	1106	0.5
608	1.7	708	1.9	808	2.0	908	2.0	1008	1.7	1108	0.5
610	1.7	710	1.9	810	2.0	910	2.0	1010	1.7	1110	0.5
612	1.7	712	1.9	812	2.0	912	2.0	1012	1.6	1112	0.5
614	1.7	714	1.9	814	2.0	914	2.0	1014	1.6	1114	0.5
616	1.7	716	1.9	816	2.0	916	2.0	1016	1.6	1116	0.4
618	1.7	718	1.9	818	2.0	918	2.0	1018	1.5	1118	0.4
620	1.7	720	1.9	820	2.0	920	2.0	1020	1.5	1120	0.4
622	1.6	722	1.9	822	2.0	922	2.0	1022	1.5	1122	0.4
624	1.6	724	1.9	824	2.0	924	2.0	1024	1.5	1124	0.4
626	1.6	726	1.9	826	2.0	926	2.0	1026	1.4	1126	0.4
628	1.6	728	1.9	828	2.0	928	2.0	1028	1.4	1128	0.4
630	1.6	730	1.9	830	2.0	930	2.0	1030	1.4	1130	0.4
632	1.6	732	1.9	832	2.0	932	2.0	1032	1.3	1132	0.4
634	1.7	734	1.9	834	2.0	934	2.0	1034	1.3	1134	0.4
636	1.7	736	1.9	836	2.0	936	2.0	1036	1.3	1136	0.4
638	1.7	738	1.9	838	2.0	938	2.0	1038	1.3	1138	0.4
640	1.7	740	1.9	840	2.0	940	2.0	1040	1.2	1140	0.3
642	1.7	742	1.9	842	2.0	942	2.0	1042	1.2	1142	0.3
644	1.7	744	1.9	844	2.0	944	2.0	1044	1.2	1144	0.3
646	1.7	746	1.9	846	2.0	946	2.0	1046	1.1	1146	0.3
648	1.7	748	1.9	848	2.0	948	1.9	1048	1.1	1148	0.3
650	1.7	750	1.9	850	2.0	950	1.9	1050	1.1	1150	0.3
652	1.7	752	1.9	852	2.0	952	1.9	1052	1.1	1152	0.3
654	1.7	754	1.9	854	2.0	954	1.9	1054	1.0	1154	0.3
656	1.7	756	1.9	856	2.0	956	1.9	1056	1.0	1156	0.3
658	1.7	758	1.9	858	2.0	958	1.9	1058	1.0	1158	0.3
660	1.7	760	1.9	860	2.0	960	1.9	1060	0.9	1160	0.3
662	1.7	762	1.9	862	2.0	962	1.9	1062	0.9	1162	0.3
664	1.8	764	1.9	864	2.0	964	1.9	1064	0.9	1164	0.3
666	1.8	766	1.9	866	2.0	966	1.9	1066	0.9	1166	0.3
668	1.8	768	1.9	868	2.0	968	1.9	1068	0.9	1168	0.3
670	1.8	770	1.9	870	2.0	970	1.9	1070	0.8	1170	0.2
672	1.8	772	1.9	872	2.0	972	1.9	1072	0.8	1172	0.2
674	1.8	774	1.9	874	2.0	974	1.9	1074	0.8	1174	0.2
676	1.8	776	1.9	876	2.0	976	1.9	1076	0.8	1176	0.2
678	1.8	778	1.9	878	2.0	978	1.9	1078	0.7	1178	0.2
680	1.8	780	1.9	880	2.0	980	1.9	1080	0.7	1180	0.2
682	1.8	782	1.9	882	2.0	982	1.9	1082	0.7	1182	0.2
684	1.8	784	1.9	884	2.0	984	1.9	1084	0.7	1184	0.2
686	1.8	786	1.9	886	2.0	986	1.9	1086	0.7	1186	0.2
688	1.8	788	1.9	888	2.0	988	1.8	1088	0.6	1188	0.2
690	1.8	790	1.9	890	2.0	990	1.8	1090	0.6	1190	0.2
692	1.8	792	2.0	892	2.0	992	1.8	1092	0.6	1192	0.2
694	1.8	794	2.0	894	2.0	994	1.8	1094	0.6	1194	0.2
696	1.8	796	2.0	896	2.0	996	1.8	1096	0.6	1196	0.2
698	1.8	798	2.0	898	2.0	998	1.8	1098	0.6	1198	0.2
700	1.8	800	2.0	900	2.0	1000	1.8	1100	0.6	1200	0.2

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Date 04/10/2019 08:51 File CATCH B3 30YR - 04.10.2...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1202	0.2	1302	0.1	1402	0.0	1502	0.0	1602	0.0	1702	0.0
1204	0.2	1304	0.1	1404	0.0	1504	0.0	1604	0.0	1704	0.0
1206	0.2	1306	0.1	1406	0.0	1506	0.0	1606	0.0	1706	0.0
1208	0.2	1308	0.1	1408	0.0	1508	0.0	1608	0.0	1708	0.0
1210	0.2	1310	0.1	1410	0.0	1510	0.0	1610	0.0	1710	0.0
1212	0.2	1312	0.1	1412	0.0	1512	0.0	1612	0.0	1712	0.0
1214	0.2	1314	0.1	1414	0.0	1514	0.0	1614	0.0	1714	0.0
1216	0.2	1316	0.1	1416	0.0	1516	0.0	1616	0.0	1716	0.0
1218	0.2	1318	0.1	1418	0.0	1518	0.0	1618	0.0	1718	0.0
1220	0.2	1320	0.1	1420	0.0	1520	0.0	1620	0.0	1720	0.0
1222	0.2	1322	0.1	1422	0.0	1522	0.0	1622	0.0	1722	0.0
1224	0.2	1324	0.1	1424	0.0	1524	0.0	1624	0.0	1724	0.0
1226	0.2	1326	0.1	1426	0.0	1526	0.0	1626	0.0	1726	0.0
1228	0.2	1328	0.1	1428	0.0	1528	0.0	1628	0.0	1728	0.0
1230	0.1	1330	0.1	1430	0.0	1530	0.0	1630	0.0	1730	0.0
1232	0.1	1332	0.1	1432	0.0	1532	0.0	1632	0.0	1732	0.0
1234	0.1	1334	0.1	1434	0.0	1534	0.0	1634	0.0	1734	0.0
1236	0.1	1336	0.1	1436	0.0	1536	0.0	1636	0.0	1736	0.0
1238	0.1	1338	0.1	1438	0.0	1538	0.0	1638	0.0	1738	0.0
1240	0.1	1340	0.1	1440	0.0	1540	0.0	1640	0.0	1740	0.0
1242	0.1	1342	0.1	1442	0.0	1542	0.0	1642	0.0	1742	0.0
1244	0.1	1344	0.1	1444	0.0	1544	0.0	1644	0.0	1744	0.0
1246	0.1	1346	0.1	1446	0.0	1546	0.0	1646	0.0	1746	0.0
1248	0.1	1348	0.1	1448	0.0	1548	0.0	1648	0.0	1748	0.0
1250	0.1	1350	0.1	1450	0.0	1550	0.0	1650	0.0	1750	0.0
1252	0.1	1352	0.1	1452	0.0	1552	0.0	1652	0.0	1752	0.0
1254	0.1	1354	0.1	1454	0.0	1554	0.0	1654	0.0	1754	0.0
1256	0.1	1356	0.1	1456	0.0	1556	0.0	1656	0.0	1756	0.0
1258	0.1	1358	0.1	1458	0.0	1558	0.0	1658	0.0	1758	0.0
1260	0.1	1360	0.1	1460	0.0	1560	0.0	1660	0.0	1760	0.0
1262	0.1	1362	0.1	1462	0.0	1562	0.0	1662	0.0	1762	0.0
1264	0.1	1364	0.1	1464	0.0	1564	0.0	1664	0.0	1764	0.0
1266	0.1	1366	0.1	1466	0.0	1566	0.0	1666	0.0	1766	0.0
1268	0.1	1368	0.1	1468	0.0	1568	0.0	1668	0.0	1768	0.0
1270	0.1	1370	0.1	1470	0.0	1570	0.0	1670	0.0	1770	0.0
1272	0.1	1372	0.1	1472	0.0	1572	0.0	1672	0.0	1772	0.0
1274	0.1	1374	0.1	1474	0.0	1574	0.0	1674	0.0	1774	0.0
1276	0.1	1376	0.1	1476	0.0	1576	0.0	1676	0.0	1776	0.0
1278	0.1	1378	0.1	1478	0.0	1578	0.0	1678	0.0	1778	0.0
1280	0.1	1380	0.1	1480	0.0	1580	0.0	1680	0.0	1780	0.0
1282	0.1	1382	0.1	1482	0.0	1582	0.0	1682	0.0	1782	0.0
1284	0.1	1384	0.1	1484	0.0	1584	0.0	1684	0.0	1784	0.0
1286	0.1	1386	0.1	1486	0.0	1586	0.0	1686	0.0	1786	0.0
1288	0.1	1388	0.1	1488	0.0	1588	0.0	1688	0.0	1788	0.0
1290	0.1	1390	0.1	1490	0.0	1590	0.0	1690	0.0	1790	0.0
1292	0.1	1392	0.1	1492	0.0	1592	0.0	1692	0.0	1792	0.0
1294	0.1	1394	0.1	1494	0.0	1594	0.0	1694	0.0	1794	0.0
1296	0.1	1396	0.1	1496	0.0	1596	0.0	1696	0.0	1796	0.0
1298	0.1	1398	0.1	1498	0.0	1598	0.0	1698	0.0	1798	0.0
1300	0.1	1400	0.0	1500	0.0	1600	0.0	1700	0.0	1800	0.0

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Ormond House
Upper Ormond Quay
Dublin 7

LANDS AT MILL/MARSH ROAD
DBFL REF: 170092
CATCHMENT B3 - 30 YR

Date 04/10/2019 08:51
File CATCH B3 30YR - 04.10.2...

Designed by AOS
Checked by DMW

Innovyze | Source Control 2018.1

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1802	0.0	1902	0.0	2002	0.0	2102	0.0	2202	0.0	2302	0.0
1804	0.0	1904	0.0	2004	0.0	2104	0.0	2204	0.0	2304	0.0
1806	0.0	1906	0.0	2006	0.0	2106	0.0	2206	0.0	2306	0.0
1808	0.0	1908	0.0	2008	0.0	2108	0.0	2208	0.0	2308	0.0
1810	0.0	1910	0.0	2010	0.0	2110	0.0	2210	0.0	2310	0.0
1812	0.0	1912	0.0	2012	0.0	2112	0.0	2212	0.0	2312	0.0
1814	0.0	1914	0.0	2014	0.0	2114	0.0	2214	0.0	2314	0.0
1816	0.0	1916	0.0	2016	0.0	2116	0.0	2216	0.0	2316	0.0
1818	0.0	1918	0.0	2018	0.0	2118	0.0	2218	0.0	2318	0.0
1820	0.0	1920	0.0	2020	0.0	2120	0.0	2220	0.0	2320	0.0
1822	0.0	1922	0.0	2022	0.0	2122	0.0	2222	0.0	2322	0.0
1824	0.0	1924	0.0	2024	0.0	2124	0.0	2224	0.0	2324	0.0
1826	0.0	1926	0.0	2026	0.0	2126	0.0	2226	0.0	2326	0.0
1828	0.0	1928	0.0	2028	0.0	2128	0.0	2228	0.0	2328	0.0
1830	0.0	1930	0.0	2030	0.0	2130	0.0	2230	0.0	2330	0.0
1832	0.0	1932	0.0	2032	0.0	2132	0.0	2232	0.0	2332	0.0
1834	0.0	1934	0.0	2034	0.0	2134	0.0	2234	0.0	2334	0.0
1836	0.0	1936	0.0	2036	0.0	2136	0.0	2236	0.0	2336	0.0
1838	0.0	1938	0.0	2038	0.0	2138	0.0	2238	0.0	2338	0.0
1840	0.0	1940	0.0	2040	0.0	2140	0.0	2240	0.0	2340	0.0
1842	0.0	1942	0.0	2042	0.0	2142	0.0	2242	0.0	2342	0.0
1844	0.0	1944	0.0	2044	0.0	2144	0.0	2244	0.0	2344	0.0
1846	0.0	1946	0.0	2046	0.0	2146	0.0	2246	0.0	2346	0.0
1848	0.0	1948	0.0	2048	0.0	2148	0.0	2248	0.0	2348	0.0
1850	0.0	1950	0.0	2050	0.0	2150	0.0	2250	0.0	2350	0.0
1852	0.0	1952	0.0	2052	0.0	2152	0.0	2252	0.0	2352	0.0
1854	0.0	1954	0.0	2054	0.0	2154	0.0	2254	0.0	2354	0.0
1856	0.0	1956	0.0	2056	0.0	2156	0.0	2256	0.0	2356	0.0
1858	0.0	1958	0.0	2058	0.0	2158	0.0	2258	0.0	2358	0.0
1860	0.0	1960	0.0	2060	0.0	2160	0.0	2260	0.0	2360	0.0
1862	0.0	1962	0.0	2062	0.0	2162	0.0	2262	0.0	2362	0.0
1864	0.0	1964	0.0	2064	0.0	2164	0.0	2264	0.0	2364	0.0
1866	0.0	1966	0.0	2066	0.0	2166	0.0	2266	0.0	2366	0.0
1868	0.0	1968	0.0	2068	0.0	2168	0.0	2268	0.0	2368	0.0
1870	0.0	1970	0.0	2070	0.0	2170	0.0	2270	0.0	2370	0.0
1872	0.0	1972	0.0	2072	0.0	2172	0.0	2272	0.0	2372	0.0
1874	0.0	1974	0.0	2074	0.0	2174	0.0	2274	0.0	2374	0.0
1876	0.0	1976	0.0	2076	0.0	2176	0.0	2276	0.0	2376	0.0
1878	0.0	1978	0.0	2078	0.0	2178	0.0	2278	0.0	2378	0.0
1880	0.0	1980	0.0	2080	0.0	2180	0.0	2280	0.0	2380	0.0
1882	0.0	1982	0.0	2082	0.0	2182	0.0	2282	0.0	2382	0.0
1884	0.0	1984	0.0	2084	0.0	2184	0.0	2284	0.0	2384	0.0
1886	0.0	1986	0.0	2086	0.0	2186	0.0	2286	0.0	2386	0.0
1888	0.0	1988	0.0	2088	0.0	2188	0.0	2288	0.0	2388	0.0
1890	0.0	1990	0.0	2090	0.0	2190	0.0	2290	0.0	2390	0.0
1892	0.0	1992	0.0	2092	0.0	2192	0.0	2292	0.0	2392	0.0
1894	0.0	1994	0.0	2094	0.0	2194	0.0	2294	0.0	2394	0.0
1896	0.0	1996	0.0	2096	0.0	2196	0.0	2296	0.0	2396	0.0
1898	0.0	1998	0.0	2098	0.0	2198	0.0	2298	0.0	2398	0.0
1900	0.0	2000	0.0	2100	0.0	2200	0.0	2300	0.0	2400	0.0

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 30 YR	Micro Drainage
Date 04/10/2019 08:51 File CATCH B3 30YR - 04.10.2...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2402	0.0	2482	0.0	2562	0.0	2642	0.0	2722	0.0	2802	0.0
2404	0.0	2484	0.0	2564	0.0	2644	0.0	2724	0.0	2804	0.0
2406	0.0	2486	0.0	2566	0.0	2646	0.0	2726	0.0	2806	0.0
2408	0.0	2488	0.0	2568	0.0	2648	0.0	2728	0.0	2808	0.0
2410	0.0	2490	0.0	2570	0.0	2650	0.0	2730	0.0	2810	0.0
2412	0.0	2492	0.0	2572	0.0	2652	0.0	2732	0.0	2812	0.0
2414	0.0	2494	0.0	2574	0.0	2654	0.0	2734	0.0	2814	0.0
2416	0.0	2496	0.0	2576	0.0	2656	0.0	2736	0.0	2816	0.0
2418	0.0	2498	0.0	2578	0.0	2658	0.0	2738	0.0	2818	0.0
2420	0.0	2500	0.0	2580	0.0	2660	0.0	2740	0.0	2820	0.0
2422	0.0	2502	0.0	2582	0.0	2662	0.0	2742	0.0	2822	0.0
2424	0.0	2504	0.0	2584	0.0	2664	0.0	2744	0.0	2824	0.0
2426	0.0	2506	0.0	2586	0.0	2666	0.0	2746	0.0	2826	0.0
2428	0.0	2508	0.0	2588	0.0	2668	0.0	2748	0.0	2828	0.0
2430	0.0	2510	0.0	2590	0.0	2670	0.0	2750	0.0	2830	0.0
2432	0.0	2512	0.0	2592	0.0	2672	0.0	2752	0.0	2832	0.0
2434	0.0	2514	0.0	2594	0.0	2674	0.0	2754	0.0	2834	0.0
2436	0.0	2516	0.0	2596	0.0	2676	0.0	2756	0.0	2836	0.0
2438	0.0	2518	0.0	2598	0.0	2678	0.0	2758	0.0	2838	0.0
2440	0.0	2520	0.0	2600	0.0	2680	0.0	2760	0.0	2840	0.0
2442	0.0	2522	0.0	2602	0.0	2682	0.0	2762	0.0	2842	0.0
2444	0.0	2524	0.0	2604	0.0	2684	0.0	2764	0.0	2844	0.0
2446	0.0	2526	0.0	2606	0.0	2686	0.0	2766	0.0	2846	0.0
2448	0.0	2528	0.0	2608	0.0	2688	0.0	2768	0.0	2848	0.0
2450	0.0	2530	0.0	2610	0.0	2690	0.0	2770	0.0	2850	0.0
2452	0.0	2532	0.0	2612	0.0	2692	0.0	2772	0.0	2852	0.0
2454	0.0	2534	0.0	2614	0.0	2694	0.0	2774	0.0	2854	0.0
2456	0.0	2536	0.0	2616	0.0	2696	0.0	2776	0.0	2856	0.0
2458	0.0	2538	0.0	2618	0.0	2698	0.0	2778	0.0	2858	0.0
2460	0.0	2540	0.0	2620	0.0	2700	0.0	2780	0.0	2860	0.0
2462	0.0	2542	0.0	2622	0.0	2702	0.0	2782	0.0	2862	0.0
2464	0.0	2544	0.0	2624	0.0	2704	0.0	2784	0.0	2864	0.0
2466	0.0	2546	0.0	2626	0.0	2706	0.0	2786	0.0	2866	0.0
2468	0.0	2548	0.0	2628	0.0	2708	0.0	2788	0.0	2868	0.0
2470	0.0	2550	0.0	2630	0.0	2710	0.0	2790	0.0	2870	0.0
2472	0.0	2552	0.0	2632	0.0	2712	0.0	2792	0.0	2872	0.0
2474	0.0	2554	0.0	2634	0.0	2714	0.0	2794	0.0	2874	0.0
2476	0.0	2556	0.0	2636	0.0	2716	0.0	2796	0.0	2876	0.0
2478	0.0	2558	0.0	2638	0.0	2718	0.0	2798	0.0	2878	0.0
2480	0.0	2560	0.0	2640	0.0	2720	0.0	2800	0.0	2880	0.0

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	Micro Drainage
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	20.919	0.315	7.2	217.7	O K
30 min Summer	21.038	0.434	7.4	299.3	O K
60 min Summer	21.164	0.560	7.4	386.6	O K
120 min Summer	21.299	0.695	7.4	479.4	O K
180 min Summer	21.383	0.779	7.4	537.5	O K
240 min Summer	21.442	0.838	7.4	578.5	O K
360 min Summer	21.529	0.925	7.4	638.3	O K
480 min Summer	21.589	0.985	7.4	679.8	O K
600 min Summer	21.629	1.025	7.4	707.5	O K
720 min Summer	21.657	1.053	7.4	726.5	O K
960 min Summer	21.692	1.088	7.4	751.0	O K
1440 min Summer	21.686	1.082	7.4	746.9	O K
2160 min Summer	21.622	1.018	7.4	702.5	O K
2880 min Summer	21.526	0.922	7.4	636.0	O K
4320 min Summer	21.381	0.777	7.4	535.8	O K
5760 min Summer	21.280	0.676	7.4	466.5	O K
7200 min Summer	21.189	0.585	7.4	403.6	O K
8640 min Summer	21.109	0.505	7.4	348.3	O K
10080 min Summer	21.040	0.436	7.4	300.9	O K
15 min Winter	20.958	0.354	7.3	244.2	O K
30 min Winter	21.091	0.487	7.4	336.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	71.340	0.0	315.7	23
30 min Summer	49.472	0.0	400.3	37
60 min Summer	32.411	0.0	513.0	68
120 min Summer	20.489	0.0	618.9	128
180 min Summer	15.541	0.0	688.3	186
240 min Summer	12.733	0.0	741.0	246
360 min Summer	9.598	0.0	821.8	366
480 min Summer	7.840	0.0	882.8	486
600 min Summer	6.698	0.0	932.0	606
720 min Summer	5.886	0.0	973.0	726
960 min Summer	4.799	0.0	1034.9	964
1440 min Summer	3.596	0.0	1062.3	1144
2160 min Summer	2.695	0.0	1320.4	1520
2880 min Summer	2.195	0.0	1423.6	1936
4320 min Summer	1.641	0.0	1580.3	2724
5760 min Summer	1.334	0.0	1711.4	3464
7200 min Summer	1.136	0.0	1813.0	4248
8640 min Summer	0.995	0.0	1899.8	4928
10080 min Summer	0.890	0.0	1974.5	5648
15 min Winter	71.340	0.0	342.1	23
30 min Winter	49.472	0.0	436.0	37

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DBFL Consulting Engineers		Page 2
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	Micro Drainage
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	21.234	0.630	7.4	434.6	O K
120 min Winter	21.387	0.783	7.4	540.2	O K
180 min Winter	21.484	0.880	7.4	607.1	O K
240 min Winter	21.554	0.950	7.4	655.4	O K
360 min Winter	21.655	1.051	7.4	725.4	O K
480 min Winter	21.726	1.122	7.4	771.3	O K
600 min Winter	22.092	1.488	7.4	799.9	O K
720 min Winter	22.121	1.517	7.4	818.8	O K
960 min Winter	22.159	1.555	7.4	844.9	O K
1440 min Winter	22.155	1.551	7.4	842.2	O K
2160 min Winter	22.088	1.484	7.4	797.7	O K
2880 min Winter	21.668	1.064	7.4	734.2	O K
4320 min Winter	21.427	0.823	7.4	567.9	O K
5760 min Winter	21.257	0.653	7.4	450.3	O K
7200 min Winter	21.118	0.514	7.4	354.4	O K
8640 min Winter	21.007	0.403	7.4	278.0	O K
10080 min Winter	20.923	0.319	7.2	219.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	32.411	0.0	561.1	66
120 min Winter	20.489	0.0	679.5	126
180 min Winter	15.541	0.0	756.9	184
240 min Winter	12.733	0.0	815.4	244
360 min Winter	9.598	0.0	904.1	362
480 min Winter	7.840	0.0	970.3	478
600 min Winter	6.698	0.0	1023.0	590
720 min Winter	5.886	0.0	1064.9	704
960 min Winter	4.799	0.0	1113.3	928
1440 min Winter	3.596	0.0	1101.2	1142
2160 min Winter	2.695	0.0	1464.8	1604
2880 min Winter	2.195	0.0	1579.7	2108
4320 min Winter	1.641	0.0	1755.0	2944
5760 min Winter	1.334	0.0	1903.1	3696
7200 min Winter	1.136	0.0	2017.0	4464
8640 min Winter	0.995	0.0	2114.5	5104
10080 min Winter	0.890	0.0	2198.9	5752

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Shortest Storm (mins)	15
Ratio R	0.279	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.663

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.000	4	8	1.663

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DBFL Consulting Engineers		Page 4
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	Micro Drainage
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 23.500

Tank or Pond Structure

Invert Level (m) 20.604

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	690.0	0.700	690.0	1.400	1.0	2.100	0.0
0.100	690.0	0.800	690.0	1.500	690.0	2.200	0.0
0.200	690.0	0.900	690.0	1.600	690.0	2.300	0.0
0.300	690.0	1.000	690.0	1.700	0.0	2.400	0.0
0.400	690.0	1.100	690.0	1.800	0.0	2.500	0.0
0.500	690.0	1.200	1.0	1.900	0.0		
0.600	690.0	1.300	1.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0118-7400-1570-7400
Design Head (m)	1.570
Design Flow (l/s)	7.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	118
Invert Level (m)	20.604
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.570	7.4
Flush-Flo™	0.468	7.4
Kick-Flo®	0.964	5.9
Mean Flow over Head Range	-	6.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.2	1.200	6.5	3.000	10.0	7.000	15.0
0.200	6.6	1.400	7.0	3.500	10.8	7.500	15.5
0.300	7.1	1.600	7.5	4.000	11.5	8.000	16.0
0.400	7.4	1.800	7.9	4.500	12.2	8.500	16.5
0.500	7.4	2.000	8.3	5.000	12.8	9.000	16.9
0.600	7.3	2.200	8.7	5.500	13.4	9.500	17.4
0.800	6.9	2.400	9.0	6.000	13.9		
1.000	6.0	2.600	9.4	6.500	14.5		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	Micro Drainage
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2	0.0	102	1.6	202	1.7	302	2.0	402	1.9	502	1.8
4	0.0	104	1.6	204	1.7	304	2.0	404	1.9	504	1.8
6	0.0	106	1.7	206	1.7	306	2.0	406	1.9	506	1.8
8	0.0	108	1.7	208	1.7	308	2.0	408	1.9	508	1.8
10	0.0	110	1.7	210	1.7	310	2.0	410	1.9	510	1.8
12	0.0	112	1.8	212	1.7	312	2.0	412	1.9	512	1.8
14	0.0	114	1.8	214	1.8	314	2.0	414	1.9	514	1.8
16	0.0	116	1.8	216	1.8	316	2.0	416	1.9	516	1.8
18	0.0	118	1.8	218	1.8	318	2.0	418	1.9	518	1.8
20	0.0	120	1.9	220	1.8	320	2.0	420	1.9	520	1.8
22	0.0	122	1.9	222	1.8	322	2.0	422	1.9	522	1.8
24	0.0	124	1.9	224	1.8	324	2.0	424	1.9	524	1.8
26	0.1	126	1.9	226	1.8	326	2.0	426	1.9	526	1.8
28	0.1	128	1.9	228	1.8	328	2.0	428	1.9	528	1.8
30	0.1	130	1.9	230	1.9	330	2.0	430	1.9	530	1.8
32	0.1	132	1.9	232	1.9	332	2.0	432	1.9	532	1.8
34	0.2	134	1.9	234	1.9	334	2.0	434	1.9	534	1.8
36	0.2	136	1.9	236	1.9	336	2.0	436	1.9	536	1.8
38	0.2	138	2.0	238	1.9	338	2.0	438	1.9	538	1.8
40	0.3	140	2.0	240	1.9	340	2.0	440	1.9	540	1.8
42	0.3	142	2.0	242	1.9	342	2.0	442	1.9	542	1.8
44	0.4	144	2.0	244	1.9	344	2.0	444	1.9	544	1.8
46	0.4	146	2.0	246	1.9	346	2.0	446	1.9	546	1.7
48	0.5	148	2.0	248	1.9	348	2.0	448	1.9	548	1.7
50	0.5	150	2.0	250	1.9	350	2.0	450	1.9	550	1.7
52	0.6	152	2.0	252	1.9	352	2.0	452	1.9	552	1.7
54	0.6	154	2.0	254	1.9	354	2.0	454	1.9	554	1.7
56	0.7	156	2.0	256	1.9	356	2.0	456	1.9	556	1.7
58	0.7	158	2.0	258	1.9	358	2.0	458	1.9	558	1.7
60	0.8	160	2.0	260	2.0	360	2.0	460	1.9	560	1.7
62	0.8	162	2.0	262	2.0	362	2.0	462	1.9	562	1.7
64	0.9	164	2.0	264	2.0	364	2.0	464	1.9	564	1.7
66	0.9	166	2.0	266	2.0	366	2.0	466	1.9	566	1.7
68	0.9	168	2.0	268	2.0	368	2.0	468	1.9	568	1.7
70	1.0	170	2.0	270	2.0	370	2.0	470	1.9	570	1.7
72	1.0	172	2.0	272	2.0	372	2.0	472	1.8	572	1.7
74	1.1	174	1.9	274	2.0	374	2.0	474	1.8	574	1.7
76	1.1	176	1.9	276	2.0	376	2.0	476	1.8	576	1.7
78	1.1	178	1.9	278	2.0	378	2.0	478	1.8	578	1.7
80	1.2	180	1.9	280	2.0	380	2.0	480	1.8	580	1.7
82	1.2	182	1.9	282	2.0	382	2.0	482	1.8	582	1.7
84	1.2	184	1.9	284	2.0	384	2.0	484	1.8	584	1.7
86	1.3	186	1.9	286	2.0	386	2.0	486	1.8	586	1.7
88	1.3	188	1.8	288	2.0	388	2.0	488	1.8	588	1.7
90	1.3	190	1.8	290	2.0	390	2.0	490	1.8	590	1.7
92	1.4	192	1.8	292	2.0	392	2.0	492	1.8	592	1.7
94	1.4	194	1.7	294	2.0	394	2.0	494	1.8	594	1.7
96	1.5	196	1.7	296	2.0	396	1.9	496	1.8	596	1.7
98	1.5	198	1.6	298	2.0	398	1.9	498	1.8	598	1.7
100	1.5	200	1.7	300	2.0	400	1.9	500	1.8	600	1.7

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	Micro Drainage
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

<u>Additional Hydrograph #1</u>

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
602	1.7	702	1.8	802	2.0	902	2.0	1002	1.8	1102	0.5
604	1.7	704	1.8	804	2.0	904	2.0	1004	1.8	1104	0.5
606	1.7	706	1.9	806	2.0	906	2.0	1006	1.7	1106	0.5
608	1.7	708	1.9	808	2.0	908	2.0	1008	1.7	1108	0.5
610	1.7	710	1.9	810	2.0	910	2.0	1010	1.7	1110	0.5
612	1.7	712	1.9	812	2.0	912	2.0	1012	1.6	1112	0.5
614	1.7	714	1.9	814	2.0	914	2.0	1014	1.6	1114	0.5
616	1.7	716	1.9	816	2.0	916	2.0	1016	1.6	1116	0.4
618	1.7	718	1.9	818	2.0	918	2.0	1018	1.5	1118	0.4
620	1.7	720	1.9	820	2.0	920	2.0	1020	1.5	1120	0.4
622	1.6	722	1.9	822	2.0	922	2.0	1022	1.5	1122	0.4
624	1.6	724	1.9	824	2.0	924	2.0	1024	1.5	1124	0.4
626	1.6	726	1.9	826	2.0	926	2.0	1026	1.4	1126	0.4
628	1.6	728	1.9	828	2.0	928	2.0	1028	1.4	1128	0.4
630	1.6	730	1.9	830	2.0	930	2.0	1030	1.4	1130	0.4
632	1.6	732	1.9	832	2.0	932	2.0	1032	1.3	1132	0.4
634	1.7	734	1.9	834	2.0	934	2.0	1034	1.3	1134	0.4
636	1.7	736	1.9	836	2.0	936	2.0	1036	1.3	1136	0.4
638	1.7	738	1.9	838	2.0	938	2.0	1038	1.3	1138	0.4
640	1.7	740	1.9	840	2.0	940	2.0	1040	1.2	1140	0.3
642	1.7	742	1.9	842	2.0	942	2.0	1042	1.2	1142	0.3
644	1.7	744	1.9	844	2.0	944	2.0	1044	1.2	1144	0.3
646	1.7	746	1.9	846	2.0	946	2.0	1046	1.1	1146	0.3
648	1.7	748	1.9	848	2.0	948	1.9	1048	1.1	1148	0.3
650	1.7	750	1.9	850	2.0	950	1.9	1050	1.1	1150	0.3
652	1.7	752	1.9	852	2.0	952	1.9	1052	1.1	1152	0.3
654	1.7	754	1.9	854	2.0	954	1.9	1054	1.0	1154	0.3
656	1.7	756	1.9	856	2.0	956	1.9	1056	1.0	1156	0.3
658	1.7	758	1.9	858	2.0	958	1.9	1058	1.0	1158	0.3
660	1.7	760	1.9	860	2.0	960	1.9	1060	0.9	1160	0.3
662	1.7	762	1.9	862	2.0	962	1.9	1062	0.9	1162	0.3
664	1.8	764	1.9	864	2.0	964	1.9	1064	0.9	1164	0.3
666	1.8	766	1.9	866	2.0	966	1.9	1066	0.9	1166	0.3
668	1.8	768	1.9	868	2.0	968	1.9	1068	0.9	1168	0.3
670	1.8	770	1.9	870	2.0	970	1.9	1070	0.8	1170	0.2
672	1.8	772	1.9	872	2.0	972	1.9	1072	0.8	1172	0.2
674	1.8	774	1.9	874	2.0	974	1.9	1074	0.8	1174	0.2
676	1.8	776	1.9	876	2.0	976	1.9	1076	0.8	1176	0.2
678	1.8	778	1.9	878	2.0	978	1.9	1078	0.7	1178	0.2
680	1.8	780	1.9	880	2.0	980	1.9	1080	0.7	1180	0.2
682	1.8	782	1.9	882	2.0	982	1.9	1082	0.7	1182	0.2
684	1.8	784	1.9	884	2.0	984	1.9	1084	0.7	1184	0.2
686	1.8	786	1.9	886	2.0	986	1.9	1086	0.7	1186	0.2
688	1.8	788	1.9	888	2.0	988	1.8	1088	0.6	1188	0.2
690	1.8	790	1.9	890	2.0	990	1.8	1090	0.6	1190	0.2
692	1.8	792	2.0	892	2.0	992	1.8	1092	0.6	1192	0.2
694	1.8	794	2.0	894	2.0	994	1.8	1094	0.6	1194	0.2
696	1.8	796	2.0	896	2.0	996	1.8	1096	0.6	1196	0.2
698	1.8	798	2.0	898	2.0	998	1.8	1098	0.6	1198	0.2
700	1.8	800	2.0	900	2.0	1000	1.8	1100	0.6	1200	0.2

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1202	0.2	1302	0.1	1402	0.0	1502	0.0	1602	0.0	1702	0.0
1204	0.2	1304	0.1	1404	0.0	1504	0.0	1604	0.0	1704	0.0
1206	0.2	1306	0.1	1406	0.0	1506	0.0	1606	0.0	1706	0.0
1208	0.2	1308	0.1	1408	0.0	1508	0.0	1608	0.0	1708	0.0
1210	0.2	1310	0.1	1410	0.0	1510	0.0	1610	0.0	1710	0.0
1212	0.2	1312	0.1	1412	0.0	1512	0.0	1612	0.0	1712	0.0
1214	0.2	1314	0.1	1414	0.0	1514	0.0	1614	0.0	1714	0.0
1216	0.2	1316	0.1	1416	0.0	1516	0.0	1616	0.0	1716	0.0
1218	0.2	1318	0.1	1418	0.0	1518	0.0	1618	0.0	1718	0.0
1220	0.2	1320	0.1	1420	0.0	1520	0.0	1620	0.0	1720	0.0
1222	0.2	1322	0.1	1422	0.0	1522	0.0	1622	0.0	1722	0.0
1224	0.2	1324	0.1	1424	0.0	1524	0.0	1624	0.0	1724	0.0
1226	0.2	1326	0.1	1426	0.0	1526	0.0	1626	0.0	1726	0.0
1228	0.2	1328	0.1	1428	0.0	1528	0.0	1628	0.0	1728	0.0
1230	0.1	1330	0.1	1430	0.0	1530	0.0	1630	0.0	1730	0.0
1232	0.1	1332	0.1	1432	0.0	1532	0.0	1632	0.0	1732	0.0
1234	0.1	1334	0.1	1434	0.0	1534	0.0	1634	0.0	1734	0.0
1236	0.1	1336	0.1	1436	0.0	1536	0.0	1636	0.0	1736	0.0
1238	0.1	1338	0.1	1438	0.0	1538	0.0	1638	0.0	1738	0.0
1240	0.1	1340	0.1	1440	0.0	1540	0.0	1640	0.0	1740	0.0
1242	0.1	1342	0.1	1442	0.0	1542	0.0	1642	0.0	1742	0.0
1244	0.1	1344	0.1	1444	0.0	1544	0.0	1644	0.0	1744	0.0
1246	0.1	1346	0.1	1446	0.0	1546	0.0	1646	0.0	1746	0.0
1248	0.1	1348	0.1	1448	0.0	1548	0.0	1648	0.0	1748	0.0
1250	0.1	1350	0.1	1450	0.0	1550	0.0	1650	0.0	1750	0.0
1252	0.1	1352	0.1	1452	0.0	1552	0.0	1652	0.0	1752	0.0
1254	0.1	1354	0.1	1454	0.0	1554	0.0	1654	0.0	1754	0.0
1256	0.1	1356	0.1	1456	0.0	1556	0.0	1656	0.0	1756	0.0
1258	0.1	1358	0.1	1458	0.0	1558	0.0	1658	0.0	1758	0.0
1260	0.1	1360	0.1	1460	0.0	1560	0.0	1660	0.0	1760	0.0
1262	0.1	1362	0.1	1462	0.0	1562	0.0	1662	0.0	1762	0.0
1264	0.1	1364	0.1	1464	0.0	1564	0.0	1664	0.0	1764	0.0
1266	0.1	1366	0.1	1466	0.0	1566	0.0	1666	0.0	1766	0.0
1268	0.1	1368	0.1	1468	0.0	1568	0.0	1668	0.0	1768	0.0
1270	0.1	1370	0.1	1470	0.0	1570	0.0	1670	0.0	1770	0.0
1272	0.1	1372	0.1	1472	0.0	1572	0.0	1672	0.0	1772	0.0
1274	0.1	1374	0.1	1474	0.0	1574	0.0	1674	0.0	1774	0.0
1276	0.1	1376	0.1	1476	0.0	1576	0.0	1676	0.0	1776	0.0
1278	0.1	1378	0.1	1478	0.0	1578	0.0	1678	0.0	1778	0.0
1280	0.1	1380	0.1	1480	0.0	1580	0.0	1680	0.0	1780	0.0
1282	0.1	1382	0.1	1482	0.0	1582	0.0	1682	0.0	1782	0.0
1284	0.1	1384	0.1	1484	0.0	1584	0.0	1684	0.0	1784	0.0
1286	0.1	1386	0.1	1486	0.0	1586	0.0	1686	0.0	1786	0.0
1288	0.1	1388	0.1	1488	0.0	1588	0.0	1688	0.0	1788	0.0
1290	0.1	1390	0.1	1490	0.0	1590	0.0	1690	0.0	1790	0.0
1292	0.1	1392	0.1	1492	0.0	1592	0.0	1692	0.0	1792	0.0
1294	0.1	1394	0.1	1494	0.0	1594	0.0	1694	0.0	1794	0.0
1296	0.1	1396	0.1	1496	0.0	1596	0.0	1696	0.0	1796	0.0
1298	0.1	1398	0.1	1498	0.0	1598	0.0	1698	0.0	1798	0.0
1300	0.1	1400	0.0	1500	0.0	1600	0.0	1700	0.0	1800	0.0

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	Micro Drainage
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
1802	0.0	1902	0.0	2002	0.0	2102	0.0	2202	0.0	2302	0.0
1804	0.0	1904	0.0	2004	0.0	2104	0.0	2204	0.0	2304	0.0
1806	0.0	1906	0.0	2006	0.0	2106	0.0	2206	0.0	2306	0.0
1808	0.0	1908	0.0	2008	0.0	2108	0.0	2208	0.0	2308	0.0
1810	0.0	1910	0.0	2010	0.0	2110	0.0	2210	0.0	2310	0.0
1812	0.0	1912	0.0	2012	0.0	2112	0.0	2212	0.0	2312	0.0
1814	0.0	1914	0.0	2014	0.0	2114	0.0	2214	0.0	2314	0.0
1816	0.0	1916	0.0	2016	0.0	2116	0.0	2216	0.0	2316	0.0
1818	0.0	1918	0.0	2018	0.0	2118	0.0	2218	0.0	2318	0.0
1820	0.0	1920	0.0	2020	0.0	2120	0.0	2220	0.0	2320	0.0
1822	0.0	1922	0.0	2022	0.0	2122	0.0	2222	0.0	2322	0.0
1824	0.0	1924	0.0	2024	0.0	2124	0.0	2224	0.0	2324	0.0
1826	0.0	1926	0.0	2026	0.0	2126	0.0	2226	0.0	2326	0.0
1828	0.0	1928	0.0	2028	0.0	2128	0.0	2228	0.0	2328	0.0
1830	0.0	1930	0.0	2030	0.0	2130	0.0	2230	0.0	2330	0.0
1832	0.0	1932	0.0	2032	0.0	2132	0.0	2232	0.0	2332	0.0
1834	0.0	1934	0.0	2034	0.0	2134	0.0	2234	0.0	2334	0.0
1836	0.0	1936	0.0	2036	0.0	2136	0.0	2236	0.0	2336	0.0
1838	0.0	1938	0.0	2038	0.0	2138	0.0	2238	0.0	2338	0.0
1840	0.0	1940	0.0	2040	0.0	2140	0.0	2240	0.0	2340	0.0
1842	0.0	1942	0.0	2042	0.0	2142	0.0	2242	0.0	2342	0.0
1844	0.0	1944	0.0	2044	0.0	2144	0.0	2244	0.0	2344	0.0
1846	0.0	1946	0.0	2046	0.0	2146	0.0	2246	0.0	2346	0.0
1848	0.0	1948	0.0	2048	0.0	2148	0.0	2248	0.0	2348	0.0
1850	0.0	1950	0.0	2050	0.0	2150	0.0	2250	0.0	2350	0.0
1852	0.0	1952	0.0	2052	0.0	2152	0.0	2252	0.0	2352	0.0
1854	0.0	1954	0.0	2054	0.0	2154	0.0	2254	0.0	2354	0.0
1856	0.0	1956	0.0	2056	0.0	2156	0.0	2256	0.0	2356	0.0
1858	0.0	1958	0.0	2058	0.0	2158	0.0	2258	0.0	2358	0.0
1860	0.0	1960	0.0	2060	0.0	2160	0.0	2260	0.0	2360	0.0
1862	0.0	1962	0.0	2062	0.0	2162	0.0	2262	0.0	2362	0.0
1864	0.0	1964	0.0	2064	0.0	2164	0.0	2264	0.0	2364	0.0
1866	0.0	1966	0.0	2066	0.0	2166	0.0	2266	0.0	2366	0.0
1868	0.0	1968	0.0	2068	0.0	2168	0.0	2268	0.0	2368	0.0
1870	0.0	1970	0.0	2070	0.0	2170	0.0	2270	0.0	2370	0.0
1872	0.0	1972	0.0	2072	0.0	2172	0.0	2272	0.0	2372	0.0
1874	0.0	1974	0.0	2074	0.0	2174	0.0	2274	0.0	2374	0.0
1876	0.0	1976	0.0	2076	0.0	2176	0.0	2276	0.0	2376	0.0
1878	0.0	1978	0.0	2078	0.0	2178	0.0	2278	0.0	2378	0.0
1880	0.0	1980	0.0	2080	0.0	2180	0.0	2280	0.0	2380	0.0
1882	0.0	1982	0.0	2082	0.0	2182	0.0	2282	0.0	2382	0.0
1884	0.0	1984	0.0	2084	0.0	2184	0.0	2284	0.0	2384	0.0
1886	0.0	1986	0.0	2086	0.0	2186	0.0	2286	0.0	2386	0.0
1888	0.0	1988	0.0	2088	0.0	2188	0.0	2288	0.0	2388	0.0
1890	0.0	1990	0.0	2090	0.0	2190	0.0	2290	0.0	2390	0.0
1892	0.0	1992	0.0	2092	0.0	2192	0.0	2292	0.0	2392	0.0
1894	0.0	1994	0.0	2094	0.0	2194	0.0	2294	0.0	2394	0.0
1896	0.0	1996	0.0	2096	0.0	2196	0.0	2296	0.0	2396	0.0
1898	0.0	1998	0.0	2098	0.0	2198	0.0	2298	0.0	2398	0.0
1900	0.0	2000	0.0	2100	0.0	2200	0.0	2300	0.0	2400	0.0

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B3 - 100 YR	Micro Drainage
Date 04/10/2019 09:30 File CATCH B3 100 YR - 04.10...	Designed by AOS Checked by DMW	
Innovyze	Source Control 2018.1	

Additional Hydrograph #1

Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)	Time (mins)	Flow (l/s)
2402	0.0	2482	0.0	2562	0.0	2642	0.0	2722	0.0	2802	0.0
2404	0.0	2484	0.0	2564	0.0	2644	0.0	2724	0.0	2804	0.0
2406	0.0	2486	0.0	2566	0.0	2646	0.0	2726	0.0	2806	0.0
2408	0.0	2488	0.0	2568	0.0	2648	0.0	2728	0.0	2808	0.0
2410	0.0	2490	0.0	2570	0.0	2650	0.0	2730	0.0	2810	0.0
2412	0.0	2492	0.0	2572	0.0	2652	0.0	2732	0.0	2812	0.0
2414	0.0	2494	0.0	2574	0.0	2654	0.0	2734	0.0	2814	0.0
2416	0.0	2496	0.0	2576	0.0	2656	0.0	2736	0.0	2816	0.0
2418	0.0	2498	0.0	2578	0.0	2658	0.0	2738	0.0	2818	0.0
2420	0.0	2500	0.0	2580	0.0	2660	0.0	2740	0.0	2820	0.0
2422	0.0	2502	0.0	2582	0.0	2662	0.0	2742	0.0	2822	0.0
2424	0.0	2504	0.0	2584	0.0	2664	0.0	2744	0.0	2824	0.0
2426	0.0	2506	0.0	2586	0.0	2666	0.0	2746	0.0	2826	0.0
2428	0.0	2508	0.0	2588	0.0	2668	0.0	2748	0.0	2828	0.0
2430	0.0	2510	0.0	2590	0.0	2670	0.0	2750	0.0	2830	0.0
2432	0.0	2512	0.0	2592	0.0	2672	0.0	2752	0.0	2832	0.0
2434	0.0	2514	0.0	2594	0.0	2674	0.0	2754	0.0	2834	0.0
2436	0.0	2516	0.0	2596	0.0	2676	0.0	2756	0.0	2836	0.0
2438	0.0	2518	0.0	2598	0.0	2678	0.0	2758	0.0	2838	0.0
2440	0.0	2520	0.0	2600	0.0	2680	0.0	2760	0.0	2840	0.0
2442	0.0	2522	0.0	2602	0.0	2682	0.0	2762	0.0	2842	0.0
2444	0.0	2524	0.0	2604	0.0	2684	0.0	2764	0.0	2844	0.0
2446	0.0	2526	0.0	2606	0.0	2686	0.0	2766	0.0	2846	0.0
2448	0.0	2528	0.0	2608	0.0	2688	0.0	2768	0.0	2848	0.0
2450	0.0	2530	0.0	2610	0.0	2690	0.0	2770	0.0	2850	0.0
2452	0.0	2532	0.0	2612	0.0	2692	0.0	2772	0.0	2852	0.0
2454	0.0	2534	0.0	2614	0.0	2694	0.0	2774	0.0	2854	0.0
2456	0.0	2536	0.0	2616	0.0	2696	0.0	2776	0.0	2856	0.0
2458	0.0	2538	0.0	2618	0.0	2698	0.0	2778	0.0	2858	0.0
2460	0.0	2540	0.0	2620	0.0	2700	0.0	2780	0.0	2860	0.0
2462	0.0	2542	0.0	2622	0.0	2702	0.0	2782	0.0	2862	0.0
2464	0.0	2544	0.0	2624	0.0	2704	0.0	2784	0.0	2864	0.0
2466	0.0	2546	0.0	2626	0.0	2706	0.0	2786	0.0	2866	0.0
2468	0.0	2548	0.0	2628	0.0	2708	0.0	2788	0.0	2868	0.0
2470	0.0	2550	0.0	2630	0.0	2710	0.0	2790	0.0	2870	0.0
2472	0.0	2552	0.0	2632	0.0	2712	0.0	2792	0.0	2872	0.0
2474	0.0	2554	0.0	2634	0.0	2714	0.0	2794	0.0	2874	0.0
2476	0.0	2556	0.0	2636	0.0	2716	0.0	2796	0.0	2876	0.0
2478	0.0	2558	0.0	2638	0.0	2718	0.0	2798	0.0	2878	0.0
2480	0.0	2560	0.0	2640	0.0	2720	0.0	2800	0.0	2880	0.0

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C1- 100 YR	Micro Drainage
Date 08/10/2019 10:43 File C1 BASIN T 08.10.2019.SRCX	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	24.717	0.213	4.1	91.1	O K
30 min Summer	24.795	0.291	4.1	124.6	O K
60 min Summer	24.875	0.371	4.1	158.9	O K
120 min Summer	24.954	0.450	4.1	192.6	O K
180 min Summer	24.996	0.492	4.1	210.4	O K
240 min Summer	25.020	0.516	4.1	220.9	O K
360 min Summer	25.045	0.541	4.1	231.6	O K
480 min Summer	25.052	0.548	4.1	234.8	O K
600 min Summer	25.054	0.550	4.1	235.3	O K
720 min Summer	25.053	0.549	4.1	235.0	O K
960 min Summer	25.048	0.544	4.1	232.7	O K
1440 min Summer	25.029	0.525	4.1	224.9	O K
2160 min Summer	24.994	0.490	4.1	209.9	O K
2880 min Summer	24.954	0.450	4.1	192.8	O K
4320 min Summer	24.859	0.355	4.1	151.9	O K
5760 min Summer	24.777	0.273	4.1	116.9	O K
7200 min Summer	24.711	0.207	4.1	88.6	O K
8640 min Summer	24.661	0.157	4.1	67.0	O K
10080 min Summer	24.624	0.120	4.1	51.4	O K
15 min Winter	24.743	0.239	4.1	102.4	O K
30 min Winter	24.832	0.328	4.1	140.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	72.036	0.0	94.3	19
30 min Summer	49.883	0.0	130.8	33
60 min Summer	32.616	0.0	171.0	64
120 min Summer	20.592	0.0	216.0	122
180 min Summer	15.607	0.0	245.6	182
240 min Summer	12.780	0.0	268.2	242
360 min Summer	9.627	0.0	303.0	360
480 min Summer	7.860	0.0	329.9	468
600 min Summer	6.712	0.0	352.2	522
720 min Summer	5.897	0.0	371.3	586
960 min Summer	4.806	0.0	403.5	714
1440 min Summer	3.599	0.0	453.3	994
2160 min Summer	2.695	0.0	509.1	1408
2880 min Summer	2.194	0.0	552.8	1840
4320 min Summer	1.640	0.0	619.6	2596
5760 min Summer	1.332	0.0	671.4	3336
7200 min Summer	1.134	0.0	714.0	4032
8640 min Summer	0.993	0.0	750.8	4672
10080 min Summer	0.888	0.0	783.3	5344
15 min Winter	72.036	0.0	105.7	18
30 min Winter	49.883	0.0	146.4	33

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C1- 100 YR	Micro Drainage
Date 08/10/2019 10:43 File C1 BASIN T 08.10.2019.SRCX	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	24.924	0.420	4.1	179.7	O K
120 min Winter	25.014	0.510	4.1	218.3	O K
180 min Winter	25.063	0.559	4.1	239.3	O K
240 min Winter	25.093	0.589	4.1	252.2	O K
360 min Winter	25.127	0.623	4.1	266.7	O K
480 min Winter	25.141	0.637	4.1	272.6	O K
600 min Winter	25.144	0.640	4.1	274.0	O K
720 min Winter	25.141	0.637	4.1	272.7	O K
960 min Winter	25.133	0.629	4.1	269.1	O K
1440 min Winter	25.104	0.600	4.1	257.0	O K
2160 min Winter	25.047	0.543	4.1	232.5	O K
2880 min Winter	24.983	0.479	4.1	205.0	O K
4320 min Winter	24.827	0.323	4.1	138.4	O K
5760 min Winter	24.706	0.202	4.1	86.5	O K
7200 min Winter	24.626	0.122	4.1	52.2	O K
8640 min Winter	24.582	0.078	3.9	33.3	O K
10080 min Winter	24.567	0.063	3.6	26.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	32.616	0.0	191.6	62
120 min Winter	20.592	0.0	242.0	120
180 min Winter	15.607	0.0	275.0	178
240 min Winter	12.780	0.0	300.4	236
360 min Winter	9.627	0.0	339.4	350
480 min Winter	7.860	0.0	369.6	460
600 min Winter	6.712	0.0	394.5	566
720 min Winter	5.897	0.0	415.9	664
960 min Winter	4.806	0.0	451.9	752
1440 min Winter	3.599	0.0	507.7	1068
2160 min Winter	2.695	0.0	570.4	1532
2880 min Winter	2.194	0.0	618.9	1988
4320 min Winter	1.640	0.0	694.1	2764
5760 min Winter	1.332	0.0	751.8	3456
7200 min Winter	1.134	0.0	799.7	4040
8640 min Winter	0.993	0.0	840.9	4584
10080 min Winter	0.888	0.0	877.3	5240

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C1- 100 YR	Micro Drainage
Date 08/10/2019 10:43 File C1 BASIN T 08.10.2019.SRCX	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.000	Shortest Storm (mins)	15
Ratio R	0.281	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.700

Time (mins) From:	To:	Area (ha)
0	4	0.700

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C1- 100 YR	Micro Drainage
Date 08/10/2019 10:43 File C1 BASIN T 08.10.2019.SRCX	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 27.070

Tank or Pond Structure

Invert Level (m) 24.504

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	428.0	0.400	428.0	0.800	0.0	1.200	0.0
0.100	428.0	0.500	428.0	0.900	0.0	1.300	0.0
0.200	428.0	0.600	428.0	1.000	0.0	1.400	0.0
0.300	428.0	0.700	428.0	1.100	0.0	1.500	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0100-4100-0696-4100
Design Head (m)	0.696
Design Flow (l/s)	4.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	100
Invert Level (m)	24.458
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.696	4.1
Flush-Flo™	0.209	4.1
Kick-Flo®	0.472	3.4
Mean Flow over Head Range	-	3.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.3	1.200	5.3	3.000	8.1	7.000	12.1
0.200	4.1	1.400	5.7	3.500	8.7	7.500	12.5
0.300	4.0	1.600	6.0	4.000	9.3	8.000	12.9
0.400	3.8	1.800	6.4	4.500	9.8	8.500	13.3
0.500	3.5	2.000	6.7	5.000	10.3	9.000	13.7
0.600	3.8	2.200	7.0	5.500	10.8	9.500	14.1
0.800	4.4	2.400	7.3	6.000	11.3		
1.000	4.8	2.600	7.6	6.500	11.7		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C2 - 100 YR	Micro Drainage
Date 08/10/2019 09:46 File CATCHMENT C2 100 YEAR 0...	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	24.473	0.303	2.0	7.6	O K
30 min Summer	24.557	0.387	2.0	9.7	O K
60 min Summer	24.595	0.425	2.0	10.6	O K
120 min Summer	24.598	0.428	2.0	10.7	O K
180 min Summer	24.584	0.414	2.0	10.4	O K
240 min Summer	24.563	0.393	2.0	9.8	O K
360 min Summer	24.511	0.341	2.0	8.5	O K
480 min Summer	24.445	0.275	2.0	6.9	O K
600 min Summer	24.386	0.216	2.0	5.4	O K
720 min Summer	24.336	0.166	2.0	4.1	O K
960 min Summer	24.261	0.091	2.0	2.3	O K
1440 min Summer	24.188	0.018	1.9	0.4	O K
2160 min Summer	24.170	0.000	1.5	0.0	O K
2880 min Summer	24.170	0.000	1.3	0.0	O K
4320 min Summer	24.170	0.000	0.9	0.0	O K
5760 min Summer	24.170	0.000	0.8	0.0	O K
7200 min Summer	24.170	0.000	0.6	0.0	O K
8640 min Summer	24.170	0.000	0.6	0.0	O K
10080 min Summer	24.170	0.000	0.5	0.0	O K
15 min Winter	24.520	0.350	2.0	8.7	O K
30 min Winter	24.621	0.451	2.0	11.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	72.036	0.0	9.4	17
30 min Summer	49.883	0.0	13.1	31
60 min Summer	32.616	0.0	17.2	54
120 min Summer	20.592	0.0	21.6	88
180 min Summer	15.607	0.0	24.5	122
240 min Summer	12.780	0.0	26.9	158
360 min Summer	9.627	0.0	30.3	228
480 min Summer	7.860	0.0	33.0	290
600 min Summer	6.712	0.0	35.3	350
720 min Summer	5.897	0.0	37.1	410
960 min Summer	4.806	0.0	40.4	520
1440 min Summer	3.599	0.0	45.3	738
2160 min Summer	2.695	0.0	50.9	0
2880 min Summer	2.194	0.0	55.3	0
4320 min Summer	1.640	0.0	62.0	0
5760 min Summer	1.332	0.0	67.1	0
7200 min Summer	1.134	0.0	71.4	0
8640 min Summer	0.993	0.0	75.1	0
10080 min Summer	0.888	0.0	78.3	0
15 min Winter	72.036	0.0	10.6	17
30 min Winter	49.883	0.0	14.6	31

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C2 - 100 YR	Micro Drainage
Date 08/10/2019 09:46 File CATCHMENT C2 100 YEAR 0...	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	24.675	0.505	2.0	12.6	O K
120 min Winter	24.670	0.500	2.0	12.5	O K
180 min Winter	24.643	0.473	2.0	11.8	O K
240 min Winter	24.606	0.436	2.0	10.9	O K
360 min Winter	24.519	0.349	2.0	8.7	O K
480 min Winter	24.409	0.239	2.0	6.0	O K
600 min Winter	24.322	0.152	2.0	3.8	O K
720 min Winter	24.257	0.087	2.0	2.2	O K
960 min Winter	24.187	0.017	1.9	0.4	O K
1440 min Winter	24.170	0.000	1.5	0.0	O K
2160 min Winter	24.170	0.000	1.1	0.0	O K
2880 min Winter	24.170	0.000	0.9	0.0	O K
4320 min Winter	24.170	0.000	0.7	0.0	O K
5760 min Winter	24.170	0.000	0.6	0.0	O K
7200 min Winter	24.170	0.000	0.5	0.0	O K
8640 min Winter	24.170	0.000	0.4	0.0	O K
10080 min Winter	24.170	0.000	0.4	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	32.616	0.0	19.2	58
120 min Winter	20.592	0.0	24.3	94
180 min Winter	15.607	0.0	27.5	132
240 min Winter	12.780	0.0	30.1	170
360 min Winter	9.627	0.0	34.0	246
480 min Winter	7.860	0.0	37.0	308
600 min Winter	6.712	0.0	39.5	364
720 min Winter	5.897	0.0	41.6	416
960 min Winter	4.806	0.0	45.2	512
1440 min Winter	3.599	0.0	50.8	0
2160 min Winter	2.695	0.0	57.0	0
2880 min Winter	2.194	0.0	61.9	0
4320 min Winter	1.640	0.0	69.4	0
5760 min Winter	1.332	0.0	75.2	0
7200 min Winter	1.134	0.0	80.0	0
8640 min Winter	0.993	0.0	84.1	0
10080 min Winter	0.888	0.0	87.7	0

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C2 - 100 YR	Micro Drainage
Date 08/10/2019 09:46 File CATCHMENT C2 100 YEAR 0...	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.000	Shortest Storm (mins)	15
Ratio R	0.281	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.070

Time From:	(mins) To:	Area (ha)
0	4	0.070

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C2 - 100 YR	Micro Drainage
Date 08/10/2019 09:46 File CATCHMENT C2 100 YEAR 0...	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 25.705

Tank or Pond Structure

Invert Level (m) 24.170

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	25.0	0.700	0.0	1.400	0.0	2.100	0.0
0.100	25.0	0.800	0.0	1.500	0.0	2.200	0.0
0.200	25.0	0.900	0.0	1.600	0.0	2.300	0.0
0.300	25.0	1.000	0.0	1.700	0.0	2.400	0.0
0.400	25.0	1.100	0.0	1.800	0.0	2.500	0.0
0.500	25.0	1.200	0.0	1.900	0.0		
0.600	0.0	1.300	0.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0073-2000-0600-2000
Design Head (m)	0.600
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	73
Invert Level (m)	24.086
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	2.0
Flush-Flo™	0.177	2.0
Kick-Flo®	0.397	1.7
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.7	3.000	4.2	7.000	6.3
0.200	2.0	1.400	2.9	3.500	4.5	7.500	6.5
0.300	1.9	1.600	3.1	4.000	4.8	8.000	6.7
0.400	1.7	1.800	3.3	4.500	5.1	8.500	6.9
0.500	1.8	2.000	3.5	5.000	5.3	9.000	7.1
0.600	2.0	2.200	3.6	5.500	5.6	9.500	7.3
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

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DBFL Consulting Engineers		Page 1
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C4 - 100 YR	Micro Drainage
Date 07/10/2019 12:17 File CATCH C4 100 YR - 07.10...	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	24.388	0.218	2.0	51.3	O K
30 min Summer	24.469	0.299	2.0	70.3	O K
60 min Summer	24.554	0.384	2.0	90.2	O K
120 min Summer	24.640	0.470	2.0	110.5	O K
180 min Summer	24.689	0.519	2.0	121.9	O K
240 min Summer	24.719	0.549	2.0	129.1	O K
360 min Summer	24.755	0.585	2.0	137.5	O K
480 min Summer	24.772	0.602	2.0	141.4	O K
600 min Summer	24.778	0.608	2.0	142.9	O K
720 min Summer	24.781	0.611	2.0	143.5	O K
960 min Summer	24.781	0.611	2.0	143.6	O K
1440 min Summer	24.770	0.600	2.0	141.1	O K
2160 min Summer	24.744	0.574	2.0	134.8	O K
2880 min Summer	24.712	0.542	2.0	127.3	O K
4320 min Summer	24.639	0.469	2.0	110.2	O K
5760 min Summer	24.550	0.380	2.0	89.3	O K
7200 min Summer	24.478	0.308	2.0	72.5	O K
8640 min Summer	24.420	0.250	2.0	58.8	O K
10080 min Summer	24.374	0.204	2.0	47.9	O K
15 min Winter	24.415	0.245	2.0	57.6	O K
30 min Winter	24.506	0.336	2.0	79.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	72.036	0.0	51.0	19
30 min Summer	49.883	0.0	71.0	33
60 min Summer	32.616	0.0	94.5	64
120 min Summer	20.592	0.0	119.5	122
180 min Summer	15.607	0.0	135.9	182
240 min Summer	12.780	0.0	148.4	242
360 min Summer	9.627	0.0	167.6	362
480 min Summer	7.860	0.0	182.5	480
600 min Summer	6.712	0.0	194.7	572
720 min Summer	5.897	0.0	205.2	624
960 min Summer	4.806	0.0	222.6	754
1440 min Summer	3.599	0.0	248.8	1022
2160 min Summer	2.695	0.0	283.1	1448
2880 min Summer	2.194	0.0	307.2	1848
4320 min Summer	1.640	0.0	344.1	2684
5760 min Summer	1.332	0.0	373.8	3408
7200 min Summer	1.134	0.0	397.5	4112
8640 min Summer	0.993	0.0	417.8	4840
10080 min Summer	0.888	0.0	435.4	5456
15 min Winter	72.036	0.0	57.2	18
30 min Winter	49.883	0.0	79.6	33

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C4 - 100 YR	Micro Drainage
Date 07/10/2019 12:17 File CATCH C4 100 YR - 07.10...	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	24.603	0.433	2.0	101.7	O K
120 min Winter	24.701	0.531	2.0	124.8	O K
180 min Winter	24.756	0.586	2.0	137.8	O K
240 min Winter	24.793	0.623	2.0	146.3	O K
360 min Winter	24.837	0.667	2.0	156.8	O K
480 min Winter	24.860	0.690	2.0	162.2	O K
600 min Winter	24.871	0.701	2.0	164.8	O K
720 min Winter	24.875	0.705	2.0	165.8	O K
960 min Winter	24.872	0.702	2.0	164.9	O K
1440 min Winter	24.856	0.686	2.0	161.2	O K
2160 min Winter	24.812	0.642	2.0	150.9	O K
2880 min Winter	24.760	0.590	2.0	138.6	O K
4320 min Winter	24.641	0.471	2.0	110.7	O K
5760 min Winter	24.499	0.329	2.0	77.3	O K
7200 min Winter	24.399	0.229	2.0	53.8	O K
8640 min Winter	24.331	0.161	2.0	37.9	O K
10080 min Winter	24.290	0.120	1.9	28.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	32.616	0.0	105.9	62
120 min Winter	20.592	0.0	133.9	120
180 min Winter	15.607	0.0	152.2	180
240 min Winter	12.780	0.0	166.2	238
360 min Winter	9.627	0.0	187.7	352
480 min Winter	7.860	0.0	204.3	464
600 min Winter	6.712	0.0	218.0	574
720 min Winter	5.897	0.0	229.6	680
960 min Winter	4.806	0.0	249.0	788
1440 min Winter	3.599	0.0	276.9	1094
2160 min Winter	2.695	0.0	317.1	1556
2880 min Winter	2.194	0.0	344.1	2016
4320 min Winter	1.640	0.0	385.4	2900
5760 min Winter	1.332	0.0	418.7	3584
7200 min Winter	1.134	0.0	445.3	4248
8640 min Winter	0.993	0.0	468.0	4848
10080 min Winter	0.888	0.0	487.9	5448

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C4 - 100 YR	Micro Drainage
Date 07/10/2019 12:17 File CATCH C4 100 YR - 07.10...	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.000	Shortest Storm (mins)	15
Ratio R	0.281	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 0.390

Time From:	(mins) To:	Area (ha)
0	4	0.390

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT C4 - 100 YR	Micro Drainage
Date 07/10/2019 12:17 File CATCH C4 100 YR - 07.10...	Designed by DCG Checked by DMW	
Innovyze	Source Control 2018.1	

Model Details

Storage is Online Cover Level (m) 25.250

Tank or Pond Structure

Invert Level (m) 24.170

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	235.0	0.400	235.0	0.800	235.0	1.200	0.0
0.100	235.0	0.500	235.0	0.900	0.0	1.300	0.0
0.200	235.0	0.600	235.0	1.000	0.0	1.400	0.0
0.300	235.0	0.700	235.0	1.100	0.0	1.500	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0071-2000-0705-2000
Design Head (m)	0.705
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	24.170
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.705	2.0
Flush-Flo™	0.208	2.0
Kick-Flo®	0.451	1.6
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.5	3.000	3.9	7.000	5.8
0.200	2.0	1.400	2.7	3.500	4.2	7.500	6.0
0.300	2.0	1.600	2.9	4.000	4.4	8.000	6.2
0.400	1.8	1.800	3.1	4.500	4.7	8.500	6.4
0.500	1.7	2.000	3.2	5.000	4.9	9.000	6.6
0.600	1.9	2.200	3.4	5.500	5.2	9.500	6.7
0.800	2.1	2.400	3.5	6.000	5.4		
1.000	2.3	2.600	3.6	6.500	5.6		

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Appendix C

SURFACE WATER SEWER NETWORK CALCULATIONS-MICRODRAINAGE

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/ MARSH ROAD DBFL REF: 170092 NETWORK A	
Date 09/10/2019 10:50 File CATCHMENT A 09.10.2019.mdx	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	14.900	Add Flow / Climate Change (%)	10
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	3.000
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
S1.000	40.400	0.238	170.0	0.067	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	60.130	0.354	170.0	0.060	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	14.800	0.302	49.0	0.007	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	37.280	0.174	214.0	0.106	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.003	46.500	0.188	247.0	0.044	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	34.000	0.083	411.0	0.052	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.005	34.040	0.083	410.1	0.046	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.006	25.990	0.063	411.0	0.023	0.00	0.0	0.600	o	450	Pipe/Conduit	
S3.000	19.200	0.147	130.6	0.039	5.00	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)
S1.000	43.01	5.67	26.915	0.067	0.0	0.0	0.8	1.00	39.8	8.6
S1.001	40.28	6.68	26.677	0.127	0.0	0.0	1.4	1.00	39.8	15.2
S2.000	44.69	5.13	26.530	0.007	0.0	0.0	0.1	1.87	74.5	0.9
S1.002	38.88	7.26	26.088	0.240	0.0	0.0	2.5	1.07	75.7	27.8
S1.003	37.19	8.03	25.914	0.284	0.0	0.0	2.9	1.00	70.4	31.5
S1.004	36.06	8.60	25.724	0.336	0.0	0.0	3.3	1.00	158.5	36.1
S1.005	35.02	9.17	25.641	0.382	0.0	0.0	3.6	1.00	158.7	39.8
S1.006	34.27	9.61	25.558	0.405	0.0	0.0	3.8	1.00	158.5	41.3
S3.000	44.22	5.28	26.220	0.039	0.0	0.0	0.5	1.14	45.4	5.1

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/ MARSH ROAD DBFL REF: 170092 NETWORK A	Micro Drainage
Date 09/10/2019 10:50 File CATCHMENT A 09.10.2019.mdx	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

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
S4.000	15.500	0.091	170.3	0.039	5.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	32.900	0.194	170.0	0.079	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.002	34.300	0.210	163.0	0.065	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.007	60.400	0.147	411.0	0.035	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.008	39.700	0.097	411.0	0.103	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.009	6.800	0.017	411.0	0.039	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.010	67.400	0.164	411.0	0.098	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.000	23.700	0.139	170.5	0.068	5.00	0.0	0.600	o	225	Pipe/Conduit	
S5.001	65.100	0.383	170.0	0.068	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.011	25.700	0.063	411.0	0.062	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.012	8.600	0.021	411.0	0.062	0.00	0.0	0.600	o	450	Pipe/Conduit	
S6.000	30.000	0.176	170.5	0.091	5.00	0.0	0.600	o	225	Pipe/Conduit	
S7.000	26.300	0.155	169.7	0.026	5.00	0.0	0.600	o	225	Pipe/Conduit	
S6.001	28.200	0.166	169.9	0.048	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.002	55.700	0.328	169.8	0.099	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)
S4.000	44.28	5.26	26.155	0.039	0.0	0.0	0.5	1.00	39.7	5.1
S3.001	42.56	5.83	26.064	0.157	0.0	0.0	1.8	1.00	39.8	19.9
S3.002	41.02	6.39	25.870	0.222	0.0	0.0	2.5	1.02	40.6	27.1
S1.007	32.67	10.62	25.495	0.662	0.0	0.0	5.9	1.00	158.5	64.4
S1.008	31.72	11.28	25.348	0.765	0.0	0.0	6.6	1.00	158.5	72.3
S1.009	31.56	11.39	25.251	0.804	0.0	0.0	6.9	1.00	158.5	75.6
S1.010	30.11	12.52	25.235	0.902	0.0	0.0	7.4	1.00	158.5	80.9
S5.000	43.85	5.40	26.025	0.068	0.0	0.0	0.8	1.00	39.7	8.9
S5.001	40.77	6.48	25.886	0.136	0.0	0.0	1.5	1.00	39.8	16.5
S1.011	29.60	12.95	25.071	1.100	0.0	0.0	8.8	1.00	158.5	97.0
S1.012	29.43	13.09	25.008	1.162	0.0	0.0	9.3	1.00	158.5	101.9
S6.000	43.53	5.50	26.025	0.091	0.0	0.0	1.1	1.00	39.7	11.8
S7.000	43.72	5.44	26.325	0.026	0.0	0.0	0.3	1.00	39.8	3.4
S6.001	42.15	5.97	25.849	0.165	0.0	0.0	1.9	1.00	39.8	20.7
S6.002	39.73	6.90	25.683	0.264	0.0	0.0	2.8	1.00	39.8	31.2

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/ MARSH ROAD DBFL REF: 170092 NETWORK A	Micro Drainage
Date 09/10/2019 10:50 File CATCHMENT A 09.10.2019.mdx	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

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
S6.003	37.600	0.152	247.4	0.076	0.00	0.0	0.600	o	300	Pipe/Conduit	
S6.004	53.300	0.216	246.8	0.099	0.00	0.0	0.600	o	300	Pipe/Conduit	
S6.005	10.300	0.042	245.2	0.014	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.000	35.900	0.211	170.1	0.060	5.00	0.0	0.600	o	225	Pipe/Conduit	
S9.000	54.000	0.318	169.8	0.099	5.00	0.0	0.600	o	225	Pipe/Conduit	
S6.006	6.200	0.025	247.0	0.023	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.013	1.000	0.004	250.0	0.000	0.00	0.0	0.600	o	450	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)
S6.003	38.27	7.53	25.280	0.340	0.0	0.0	3.5	1.00	70.3	38.8
S6.004	36.41	8.42	25.128	0.439	0.0	0.0	4.3	1.00	70.4	47.6
S6.005	36.08	8.59	24.912	0.453	0.0	0.0	4.4	1.00	70.7	48.7
S8.000	43.23	5.60	25.896	0.060	0.0	0.0	0.7	1.00	39.7	7.7
S9.000	42.35	5.90	26.095	0.099	0.0	0.0	1.1	1.00	39.8	12.5
S6.006	35.89	8.70	24.870	0.635	0.0	0.0	6.2	1.00	70.4	67.9
S1.013	29.42	13.11	24.979	1.797	0.0	0.0	14.3	1.28	203.8	157.5

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdr (mm)
S124	28.340	1.425	Open Manhole	1200	S1.000	26.915	225				
S123	28.000	1.323	Open Manhole	1200	S1.001	26.677	225	S1.000	26.677	225	
S122-1	27.470	0.940	Open Manhole	1200	S2.000	26.530	225				
S122	27.970	1.882	Open Manhole	1200	S1.002	26.088	300	S1.001	26.324	225	1
								S2.000	26.228	225	
S121	27.360	1.446	Open Manhole	1200	S1.003	25.914	300	S1.002	25.914	300	
S115	27.970	2.246	Open Manhole	1350	S1.004	25.724	450	S1.003	25.726	300	
S114	27.900	2.259	Open Manhole	1350	S1.005	25.641	450	S1.004	25.641	450	
S113	27.030	1.472	Open Manhole	1350	S1.006	25.558	450	S1.005	25.558	450	
S112-3	27.000	0.780	Open Manhole	1200	S3.000	26.220	225				
S112-2-1	27.130	0.975	Open Manhole	1200	S4.000	26.155	225				
S112-2	27.160	1.096	Open Manhole	1200	S3.001	26.064	225	S3.000	26.073	225	
								S4.000	26.064	225	
S112-1	27.300	1.430	Open Manhole	1200	S3.002	25.870	225	S3.001	25.870	225	
S112	27.290	1.795	Open Manhole	1350	S1.007	25.495	450	S1.006	25.495	450	
								S3.002	25.660	225	
S111	27.060	1.712	Open Manhole	1350	S1.008	25.348	450	S1.007	25.348	450	
S110	28.460	3.209	Open Manhole	1350	S1.009	25.251	450	S1.008	25.251	450	
S109	28.300	3.065	Open Manhole	1350	S1.010	25.235	450	S1.009	25.235	450	
S108-2	27.000	0.975	Open Manhole	1200	S5.000	26.025	225				
S108-1	27.180	1.294	Open Manhole	1200	S5.001	25.886	225	S5.000	25.886	225	
S108	27.610	2.539	Open Manhole	1350	S1.011	25.071	450	S1.010	25.071	450	
								S5.001	25.503	225	2
S107	27.520	2.512	Open Manhole	1350	S1.012	25.008	450	S1.011	25.008	450	
S137-1	27.100	1.075	Open Manhole	1200	S6.000	26.025	225				
S138	27.300	0.975	Open Manhole	1200	S7.000	26.325	225				
S137	27.160	1.311	Open Manhole	1200	S6.001	25.849	225	S6.000	25.849	225	
								S7.000	26.170	225	3
S136	27.170	1.487	Open Manhole	1200	S6.002	25.683	225	S6.001	25.683	225	
S135	26.970	1.690	Open Manhole	1200	S6.003	25.280	300	S6.002	25.355	225	
S134	27.100	1.972	Open Manhole	1200	S6.004	25.128	300	S6.003	25.128	300	
S133	27.100	2.188	Open Manhole	1200	S6.005	24.912	300	S6.004	24.912	300	
S132-1	27.320	1.425	Open Manhole	1200	S8.000	25.895	225				
S132-2	27.520	1.425	Open Manhole	1200	S9.000	26.095	225				
S132	27.200	2.330	Open Manhole	1200	S6.006	24.870	300	S6.005	24.870	300	
								S8.000	25.684	225	7
								S9.000	25.777	225	8
S24	27.500	2.655	Open Manhole	1350	S1.013	24.979	450	S1.012	24.987	450	

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Ba
								S6.006	24.845	300	
S	26.000	1.025	Open Manhole	0		OUTFALL		S1.013	24.975	450	

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Storm Duration (mins)	30
Ratio R	0.279		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S24, DS/PN: S1.013, Volume (m³): 5.1

Unit Reference	MD-SHE-0129-8900-1615-8900
Design Head (m)	1.615
Design Flow (l/s)	8.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	129
Invert Level (m)	24.979
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.615	8.9
Flush-Flo™	0.477	8.9
Kick-Flo®	0.994	7.1
Mean Flow over Head Range	-	7.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.6	1.200	7.7	3.000	11.9	7.000	17.8
0.200	7.9	1.400	8.3	3.500	12.8	7.500	18.4
0.300	8.6	1.600	8.9	4.000	13.7	8.000	19.0
0.400	8.8	1.800	9.4	4.500	14.4	8.500	19.6
0.500	8.9	2.000	9.8	5.000	15.2	9.000	20.1
0.600	8.8	2.200	10.3	5.500	15.9	9.500	20.7
0.800	8.4	2.400	10.7	6.000	16.6		
1.000	7.1	2.600	11.1	6.500	17.2		

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.279
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 14.900 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 10, 10, 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S124	15 Winter	100	+10%				
S1.001	S123	15 Winter	100	+10%				
S2.000	S122-1	15 Winter	100	+10%				
S1.002	S122	15 Winter	100	+10%	100/15 Summer			
S1.003	S121	960 Winter	100	+10%	100/15 Summer			
S1.004	S115	960 Winter	100	+10%	100/15 Winter			
S1.005	S114	960 Winter	100	+10%	100/15 Winter			
S1.006	S113	960 Winter	100	+10%	100/15 Winter			
S3.000	S112-3	15 Winter	100	+10%	100/15 Summer			
S4.000	S112-2-1	15 Winter	100	+10%	100/15 Summer			
S3.001	S112-2	15 Winter	100	+10%	30/15 Summer			
S3.002	S112-1	960 Winter	100	+10%	30/15 Summer			
S1.007	S112	960 Winter	100	+10%	100/15 Winter			
S1.008	S111	960 Winter	100	+10%	30/30 Winter			
S1.009	S110	960 Winter	100	+10%	30/15 Summer			
S1.010	S109	960 Winter	100	+10%	30/30 Winter			
S5.000	S108-2	960 Winter	100	+10%	100/720 Winter			
S5.001	S108-1	960 Winter	100	+10%	100/15 Summer			
S1.011	S108	960 Winter	100	+10%	30/15 Winter			
S1.012	S107	960 Winter	100	+10%	30/30 Winter			
S6.000	S137-1	15 Winter	100	+10%	30/15 Summer			

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S124	27.044	-0.096	0.000	0.56		21.3	OK	
S1.001	S123	26.893	-0.009	0.000	1.00		38.4	OK	
S2.000	S122-1	26.557	-0.198	0.000	0.03		2.2	OK	
S1.002	S122	26.473	0.085	0.000	0.94		65.9	SURCHARGED	
S1.003	S121	26.414	0.200	0.000	0.12		8.0	SURCHARGED	
S1.004	S115	26.416	0.242	0.000	0.07		9.4	SURCHARGED	
S1.005	S114	26.416	0.325	0.000	0.08		10.6	SURCHARGED	
S1.006	S113	26.414	0.405	0.000	0.08		11.0	SURCHARGED	
S3.000	S112-3	26.592	0.147	0.000	0.24		9.9	SURCHARGED	
S4.000	S112-2-1	26.587	0.207	0.000	0.29		10.0	SURCHARGED	
S3.001	S112-2	26.577	0.288	0.000	1.04		38.7	SURCHARGED	
S3.002	S112-1	26.416	0.320	0.000	0.16		6.3	SURCHARGED	
S1.007	S112	26.414	0.469	0.000	0.12		17.8	SURCHARGED	
S1.008	S111	26.411	0.613	0.000	0.14		19.0	SURCHARGED	
S1.009	S110	26.407	0.705	0.000	0.19		19.1	SURCHARGED	
S1.010	S109	26.406	0.721	0.000	0.15		21.6	SURCHARGED	
S5.000	S108-2	26.395	0.145	0.000	0.05		1.9	SURCHARGED	
S5.001	S108-1	26.391	0.280	0.000	0.10		3.8	SURCHARGED	
S1.011	S108	26.404	0.883	0.000	0.20		26.5	SURCHARGED	
S1.012	S107	26.403	0.945	0.000	0.31		28.2	SURCHARGED	
S6.000	S137-1	26.869	0.619	0.000	0.55		20.2	FLOOD RISK	

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S7.000	S138	15 Winter	100	+10%	100/15 Summer			
S6.001	S137	15 Winter	100	+10%	30/15 Summer			
S6.002	S136	15 Winter	100	+10%	30/15 Summer			
S6.003	S135	960 Winter	100	+10%	30/15 Summer			
S6.004	S134	960 Winter	100	+10%	30/15 Summer			
S6.005	S133	960 Winter	100	+10%	1/120 Summer			
S8.000	S132-1	960 Winter	100	+10%	100/480 Winter			
S9.000	S132-2	960 Winter	100	+10%	100/960 Winter			
S6.006	S132	960 Winter	100	+10%	1/30 Winter			
S1.013	S24	960 Winter	100	+10%	30/60 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S7.000	S138	26.800	0.250	0.000	0.20		7.3	SURCHARGED	
S6.001	S137	26.784	0.710	0.000	0.95		35.3	SURCHARGED	
S6.002	S136	26.632	0.724	0.000	1.31		50.1	SURCHARGED	
S6.003	S135	26.406	0.826	0.000	0.14		9.1	SURCHARGED	
S6.004	S134	26.401	0.973	0.000	0.18		11.7	SURCHARGED	
S6.005	S133	26.397	1.165	0.000	0.22		12.0	SURCHARGED	
S8.000	S132-1	26.398	0.278	0.000	0.05		1.7	SURCHARGED	
S9.000	S132-2	26.400	0.080	0.000	0.07		2.6	SURCHARGED	
S6.006	S132	26.396	1.226	0.000	0.34		17.1	SURCHARGED	
S1.013	S24	26.401	0.972	0.000	0.07		8.9	SURCHARGED	

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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	14.900	Add Flow / Climate Change (%)	10
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	3.000
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
S1.000	10.900	0.064	170.3	0.035	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	29.200	0.209	139.7	0.034	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	43.700	0.546	80.0	0.090	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	26.800	0.394	68.0	0.075	5.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	17.500	0.106	165.1	0.070	5.00	0.0	0.600	o	225	Pipe/Conduit	
S2.001	51.300	0.446	115.0	0.070	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.002	34.500	0.209	165.1	0.040	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	64.100	0.588	109.0	0.050	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)
S1.000	44.53	5.18	25.940	0.035	0.0	0.0	0.4	1.00	39.7	4.6
S1.001	43.16	5.62	25.876	0.069	0.0	0.0	0.8	1.10	43.9	8.9
S1.002	41.73	6.12	25.185	0.159	0.0	0.0	1.8	1.46	58.2	19.8
S2.000	44.21	5.28	25.265	0.075	0.0	0.0	0.9	1.59	63.1	9.9
S3.000	44.19	5.29	25.155	0.070	0.0	0.0	0.8	1.01	40.3	9.2
S2.001	42.10	5.99	24.871	0.215	0.0	0.0	2.5	1.22	48.4	27.0
S2.002	40.58	6.56	24.425	0.255	0.0	0.0	2.8	1.01	40.4	30.8
S1.003	38.86	7.27	24.141	0.464	0.0	0.0	4.9	1.51	106.4	53.7

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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
S4.000	18.600	0.113	164.6	0.052	5.00	0.0	0.600	o	225	Pipe/Conduit	
S5.000	47.700	0.289	165.1	0.053	5.00	0.0	0.600	o	225	Pipe/Conduit	
S6.000	31.800	0.193	164.8	0.046	5.00	0.0	0.600	o	225	Pipe/Conduit	
S4.001	19.400	0.118	164.4	0.062	0.00	0.0	0.600	o	225	Pipe/Conduit	
S4.002	19.500	0.118	165.3	0.050	0.00	0.0	0.600	o	225	Pipe/Conduit	
S4.003	34.300	0.288	119.1	0.060	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	39.400	0.358	110.1	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
S7.000	29.100	0.176	165.3	0.081	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.005	4.700	0.235	20.0	0.010	0.00	0.0	0.600	o	300	Pipe/Conduit	
S8.000	62.400	1.522	41.0	0.081	5.00	0.0	0.600	o	225	Pipe/Conduit	
S8.001	5.900	0.257	23.0	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.006	10.000	0.217	46.1	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)
S4.000	44.14	5.31	24.280	0.052	0.0	0.0	0.6	1.02	40.4	6.8
S5.000	42.69	5.78	24.535	0.053	0.0	0.0	0.6	1.01	40.4	6.7
S6.000	43.47	5.52	24.345	0.046	0.0	0.0	0.5	1.02	40.4	6.0
S4.001	41.79	6.10	24.152	0.213	0.0	0.0	2.4	1.02	40.4	26.5
S4.002	40.93	6.42	24.034	0.263	0.0	0.0	2.9	1.01	40.3	32.1
S4.003	39.72	6.90	23.916	0.323	0.0	0.0	3.5	1.20	47.6	38.2
S1.004	37.88	7.70	23.553	0.858	0.0	0.0	8.8	1.50	105.9	96.8
S7.000	43.60	5.48	24.025	0.081	0.0	0.0	1.0	1.01	40.3	10.5
S1.005	37.84	7.73	23.195	0.949	0.0	0.0	9.7	3.53	249.6	107.0
S8.000	43.51	5.51	25.925	0.081	0.0	0.0	1.0	2.05	81.5	10.5
S8.001	43.40	5.54	24.403	0.111	0.0	0.0	1.3	2.74	109.0	14.4
S1.006	37.68	7.80	22.960	1.060	0.0	0.0	10.8	2.32	164.1	119.0

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK B1	Micro Drainage
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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdr (mm)
S218	26.980	1.040	Open Manhole	1200	S1.000	25.940	225				
S217	27.040	1.164	Open Manhole	1200	S1.001	25.876	225	S1.000	25.876	225	
S216	26.610	1.425	Open Manhole	1200	S1.002	25.185	225	S1.001	25.667	225	4
S215-3	26.690	1.425	Open Manhole	1200	S2.000	25.265	225				
S215-2-1	26.380	1.225	Open Manhole	1200	S3.000	25.155	225				
S215-2	26.290	1.419	Open Manhole	1200	S2.001	24.871	225	S2.000	24.871	225	
								S3.000	25.049	225	1
S215-1	25.600	1.175	Open Manhole	1200	S2.002	24.425	225	S2.001	24.425	225	
S215	25.990	1.849	Open Manhole	1200	S1.003	24.141	300	S1.002	24.639	225	4
								S2.002	24.216	225	
S214-3A	25.600	1.320	Open Manhole	1200	S4.000	24.280	225				
S214-4	25.510	0.975	Open Manhole	1200	S5.000	24.535	225				
S214-3B	25.310	0.965	Open Manhole	1200	S6.000	24.345	225				
S214-3	26.170	2.018	Open Manhole	1200	S4.001	24.152	225	S4.000	24.167	225	[illegible]
								S5.000	24.246	225	[illegible]
								S6.000	24.152	225	
S214-2	26.430	2.396	Open Manhole	1200	S4.002	24.034	225	S4.001	24.034	225	
S214-1	26.500	2.584	Open Manhole	1200	S4.003	23.916	225	S4.002	23.916	225	
S214	26.610	3.057	Open Manhole	1200	S1.004	23.553	300	S1.003	23.553	300	
								S4.003	23.628	225	
S213	25.450	1.425	Open Manhole	1200	S7.000	24.025	225				
S15	26.200	3.005	Open Manhole	1200	S1.005	23.195	300	S1.004	23.195	300	
								S7.000	23.849	225	5
S209-5	27.350	1.425	Open Manhole	1200	S8.000	25.925	225				
S209-4	25.400	0.997	Open Manhole	1200	S8.001	24.403	225	S8.000	24.403	225	
S209-3	26.000	3.040	Open Manhole	1200	S1.006	22.960	300	S1.005	22.960	300	
								S8.001	24.146	225	11
S19	26.000	3.257	Open Manhole	0		OUTFALL		S1.006	22.743	300	

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Innovyze	Network 2018.1	

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Storm Duration (mins)	30
Ratio R	0.279		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK B1	Micro Drainage
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Innovyze	Network 2018.1	

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S209-3, DS/PN: S1.006, Volume (m^3): 3.9

Unit Reference	MD-SHE-0099-5300-1660-5300
Design Head (m)	1.660
Design Flow (l/s)	5.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	99
Invert Level (m)	22.960
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.660	5.3
Flush-Flo™	0.432	5.0
Kick-Flo®	0.882	4.0
Mean Flow over Head Range	-	4.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.2	1.200	4.6	3.000	7.0	7.000	10.4
0.200	4.5	1.400	4.9	3.500	7.5	7.500	10.8
0.300	4.8	1.600	5.2	4.000	8.0	8.000	11.1
0.400	4.9	1.800	5.5	4.500	8.5	8.500	11.5
0.500	4.9	2.000	5.8	5.000	8.9	9.000	11.8
0.600	4.8	2.200	6.0	5.500	9.3	9.500	12.1
0.800	4.4	2.400	6.3	6.000	9.7		
1.000	4.2	2.600	6.5	6.500	10.1		

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Innovyze	Network 2018.1	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.279
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 14.900 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 10, 10, 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S218	15 Winter	100	+10%				
S1.001	S217	15 Winter	100	+10%				
S1.002	S216	15 Winter	100	+10%				
S2.000	S215-3	15 Winter	100	+10%	100/15 Summer			
S3.000	S215-2-1	15 Winter	100	+10%	100/15 Summer			
S2.001	S215-2	15 Winter	100	+10%	30/15 Summer			
S2.002	S215-1	15 Winter	100	+10%	30/15 Summer			
S1.003	S215	15 Winter	100	+10%	30/15 Summer			
S4.000	S214-3A	15 Winter	100	+10%	30/15 Summer			
S5.000	S214-4	15 Winter	100	+10%	30/15 Winter			
S6.000	S214-3B	15 Winter	100	+10%	30/15 Summer			
S4.001	S214-3	15 Winter	100	+10%	30/15 Summer			
S4.002	S214-2	15 Winter	100	+10%	30/15 Summer			
S4.003	S214-1	15 Winter	100	+10%	30/15 Summer			
S1.004	S214	15 Winter	100	+10%	30/15 Summer			
S7.000	S213	720 Winter	100	+10%	100/360 Winter			
S1.005	S15	720 Winter	100	+10%	30/15 Summer			
S8.000	S209-5	15 Winter	100	+10%				
S8.001	S209-4	720 Winter	100	+10%				
S1.006	S209-3	720 Winter	100	+10%	1/120 Winter			

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Innovyze	Network 2018.1	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S218	26.042	-0.123	0.000	0.33		11.2	OK	
S1.001	S217	25.997	-0.104	0.000	0.54		22.3	OK	
S1.002	S216	25.394	-0.016	0.000	0.92		51.3	OK	
S2.000	S215-3	25.812	0.322	0.000	0.37		21.4	SURCHARGED	
S3.000	S215-2-1	25.803	0.423	0.000	0.52		18.8	SURCHARGED	
S2.001	S215-2	25.774	0.678	0.000	0.99		45.9	SURCHARGED	
S2.002	S215-1	25.444	0.794	0.000	1.33		50.4	FLOOD RISK	
S1.003	S215	25.142	0.701	0.000	0.92		93.3	SURCHARGED	
S4.000	S214-3A	25.292	0.787	0.000	0.27		9.9	SURCHARGED	
S5.000	S214-4	25.317	0.557	0.000	0.36		13.8	FLOOD RISK	
S6.000	S214-3B	25.305	0.735	0.000	0.26		9.7	FLOOD RISK	
S4.001	S214-3	25.282	0.905	0.000	1.01		36.9	SURCHARGED	
S4.002	S214-2	25.149	0.890	0.000	1.19		43.3	SURCHARGED	
S4.003	S214-1	24.987	0.846	0.000	1.12		50.4	SURCHARGED	
S1.004	S214	24.641	0.788	0.000	1.56		153.7	SURCHARGED	
S7.000	S213	24.533	0.283	0.000	0.07		2.8	SURCHARGED	
S1.005	S15	24.532	1.037	0.000	0.26		31.7	SURCHARGED	
S8.000	S209-5	26.013	-0.137	0.000	0.33		25.6	OK	
S8.001	S209-4	24.530	-0.098	0.000	0.05		3.8	OK	
S1.006	S209-3	24.530	1.270	0.000	0.04		5.2	SURCHARGED	

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Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	14.900	Add Flow / Climate Change (%)	10
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	3.000
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
S1.000	59.500	0.580	102.6	0.068	5.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	31.600	0.186	169.9	0.042	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	12.400	0.124	100.0	0.040	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	48.500	0.285	170.2	0.058	5.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	13.800	0.081	170.4	0.032	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	1.000	0.006	166.7	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)
S1.000	42.73	5.77	22.455	0.068	0.0	0.0	0.8	1.29	51.3	8.7
S2.000	43.45	5.53	23.305	0.042	0.0	0.0	0.5	1.00	39.8	5.4
S1.001	42.28	5.93	21.875	0.150	0.0	0.0	1.7	1.31	52.0	18.9
S3.000	42.61	5.81	21.880	0.058	0.0	0.0	0.7	1.00	39.7	7.4
S3.001	41.96	6.04	21.595	0.090	0.0	0.0	1.0	1.00	39.7	11.3
S1.002	41.91	6.06	21.514	0.240	0.0	0.0	2.7	1.01	40.2	30.0

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Innovyze	Network 2018.1	

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Storm Duration (mins)	30
Ratio R	0.279		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B2	Micro Drainage
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Innovyze	Network 2018.1	

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S306, DS/PN: S1.002, Volume (m^3): 2.6

Unit Reference	MD-SHE-0071-2000-0705-2000
Design Head (m)	0.705
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	21.514
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.705	2.0
Flush-Flo™	0.208	2.0
Kick-Flo®	0.451	1.6
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.5	3.000	3.9	7.000	5.8
0.200	2.0	1.400	2.7	3.500	4.2	7.500	6.0
0.300	2.0	1.600	2.9	4.000	4.4	8.000	6.2
0.400	1.8	1.800	3.1	4.500	4.7	8.500	6.4
0.500	1.7	2.000	3.2	5.000	4.9	9.000	6.6
0.600	1.9	2.200	3.4	5.500	5.2	9.500	6.7
0.800	2.1	2.400	3.5	6.000	5.4		
1.000	2.3	2.600	3.6	6.500	5.6		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CATCHMENT B2	Micro Drainage
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Innovyze	Network 2018.1	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.279
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 14.900 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 10, 10, 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S308	15 Winter	100	+10%				
S2.000	S307-1	15 Winter	100	+10%				
S1.001	S307	480 Winter	100	+10%	100/180 Winter			
S3.000	S304-2	480 Winter	100	+10%	100/180 Winter			
S3.001	S304-1	480 Winter	100	+10%	30/60 Summer			
S1.002	S306	480 Winter	100	+10%	30/30 Summer			

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S308	22.560	-0.120	0.000	0.43		21.2	OK	
S2.000	S307-1	23.399	-0.131	0.000	0.36		13.3	OK	
S1.001	S307	22.182	0.082	0.000	0.15		6.9	SURCHARGED	
S3.000	S304-2	22.183	0.078	0.000	0.07		2.6	SURCHARGED	
S3.001	S304-1	22.181	0.361	0.000	0.10		3.6	SURCHARGED	
S1.002	S306	22.180	0.441	0.000	0.07		2.0	SURCHARGED	

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Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	14.900	Add Flow / Climate Change (%)	10
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	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
S1.000	44.800	0.264	169.7	0.085	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	37.900	0.292	129.8	0.063	0.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	28.400	0.171	166.1	0.071	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	28.800	0.169	170.4	0.041	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	16.900	0.099	170.7	0.010	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	63.600	0.374	170.1	0.022	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	20.200	0.119	169.7	0.035	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.005	65.200	0.384	169.8	0.100	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)
S1.000	42.80	5.75	23.752	0.085	0.0	0.0	1.0	1.00	39.8	10.8
S1.001	41.26	6.30	23.488	0.148	0.0	0.0	1.7	1.15	45.6	18.2
S2.000	43.63	5.47	24.095	0.071	0.0	0.0	0.8	1.01	40.2	9.2
S1.002	40.02	6.78	23.196	0.260	0.0	0.0	2.8	1.00	39.7	31.0
S1.003	39.34	7.06	23.027	0.270	0.0	0.0	2.9	1.00	39.7	31.6
S1.004	37.01	8.12	22.928	0.292	0.0	0.0	2.9	1.00	39.7	32.2
S3.000	44.04	5.34	22.742	0.035	0.0	0.0	0.4	1.00	39.8	4.6
S1.005	35.28	9.02	22.479	0.427	0.0	0.0	4.1	1.20	85.1	44.9

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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
S4.000	52.300	1.162	45.0	0.065	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.006	48.500	0.196	247.0	0.058	0.00	0.0	0.600	o	300	Pipe/Conduit	
S5.000	27.000	0.871	31.0	0.070	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.007	7.700	0.043	180.0	0.012	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.008	11.000	0.059	186.0	0.019	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.009	33.100	0.203	163.1	0.010	0.00	2.0	0.600	o	375	Pipe/Conduit	
S6.000	29.100	0.728	40.0	0.062	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.010	58.600	0.237	247.3	0.045	0.00	0.0	0.600	o	375	Pipe/Conduit	
S7.000	34.800	0.205	169.8	0.062	5.00	0.0	0.600	o	225	Pipe/Conduit	
S1.011	10.900	0.044	247.7	0.090	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.012	27.900	0.113	246.9	0.100	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.013	12.900	0.052	247.0	0.055	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.014	3.800	0.020	192.2	0.015	0.00	0.0	0.600	o	375	Pipe/Conduit	
S8.000	18.000	0.450	40.0	0.069	5.00	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)
S4.000	43.70	5.45	26.015	0.065	0.0	0.0	0.8	1.96	77.7	8.5
S1.006	33.89	9.83	22.095	0.550	0.0	0.0	5.0	1.00	70.4	55.5
S5.000	44.50	5.19	24.825	0.070	0.0	0.0	0.8	2.36	93.8	9.3
S1.007	33.71	9.94	21.899	0.632	0.0	0.0	5.8	1.17	82.6	63.5
S1.008	33.46	10.10	21.856	0.651	0.0	0.0	5.9	1.15	81.3	64.9
S1.009	32.86	10.49	21.273	0.661	2.0	0.0	6.1	1.42	156.4	66.9
S6.000	44.36	5.23	23.695	0.062	0.0	0.0	0.7	2.08	82.5	8.2
S1.010	31.63	11.34	21.070	0.768	2.0	0.0	6.8	1.15	126.8	74.6
S7.000	43.29	5.58	22.275	0.062	0.0	0.0	0.7	1.00	39.8	8.0
S1.011	31.41	11.50	20.833	0.920	2.0	0.0	8.0	1.15	126.6	88.3
S1.012	30.88	11.91	20.789	1.020	2.0	0.0	8.7	1.15	126.9	96.0
S1.013	30.64	12.10	20.676	1.075	2.0	0.0	9.1	1.15	126.8	100.3
S1.014	30.58	12.14	20.624	1.090	2.0	0.0	9.2	1.30	144.0	101.5
S8.000	44.65	5.14	25.551	0.069	0.0	0.0	0.8	2.07	82.5	9.2

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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	37.500	1.500	25.0	0.070	0.00	0.0	0.600	o	225	Pipe/Conduit	✓
S8.002	23.500	0.168	139.9	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit	✓
S8.003	57.700	0.409	141.1	0.055	0.00	0.0	0.600	o	225	Pipe/Conduit	✓
S8.004	19.700	0.272	72.4	0.060	0.00	0.0	0.600	o	225	Pipe/Conduit	✓
S8.005	21.600	0.127	170.1	0.070	0.00	0.0	0.600	o	225	Pipe/Conduit	✓
S9.000	12.700	0.075	169.3	0.065	5.00	0.0	0.600	o	225	Pipe/Conduit	✓
S9.001	20.200	0.119	169.7	0.072	0.00	0.0	0.600	o	225	Pipe/Conduit	✓
S8.006	12.800	0.320	40.0	0.045	0.00	0.0	0.600	o	225	Pipe/Conduit	✓
S8.007	11.900	0.595	20.0	0.062	0.00	0.0	0.600	o	225	Pipe/Conduit	✓
S1.015	1.000	0.010	100.0	0.000	0.00	0.0	0.600	o	375	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	43.89	5.38	25.101	0.139	0.0	0.0	1.7	2.63	104.5	18.2
S8.002	42.82	5.74	23.601	0.144	0.0	0.0	1.7	1.10	43.9	18.4
S8.003	40.44	6.61	23.433	0.199	0.0	0.0	2.2	1.10	43.7	24.0
S8.004	39.90	6.83	23.024	0.259	0.0	0.0	2.8	1.54	61.2	30.8
S8.005	39.04	7.19	22.752	0.329	0.0	0.0	3.5	1.00	39.7	38.3
S9.000	44.44	5.21	24.105	0.065	0.0	0.0	0.8	1.00	39.8	8.6
S9.001	43.39	5.55	24.030	0.137	0.0	0.0	1.6	1.00	39.8	17.7
S8.006	38.81	7.29	22.625	0.511	0.0	0.0	5.4	2.07	82.5	59.1
S8.007	38.65	7.36	22.305	0.573	0.0	0.0	6.0	2.94	116.9	66.0
S1.015	30.57	12.15	20.604	1.663	2.0	0.0	14.0	1.81	200.1	153.6

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S418	25.450	1.698	Open Manhole	1200	S1.000	23.752	225				
S417	25.490	2.002	Open Manhole	1200	S1.001	23.488	225	S1.000	23.488	225	
S416-1	25.520	1.425	Open Manhole	1200	S2.000	24.095	225				
S416	25.000	1.804	Open Manhole	1200	S1.002	23.196	225	S1.001	23.196	225	
								S2.000	23.924	225	728
S415	24.297	1.270	Open Manhole	1200	S1.003	23.027	225	S1.002	23.027	225	
S414	24.180	1.252	Open Manhole	1200	S1.004	22.928	225	S1.003	22.928	225	
S413-1	24.530	1.788	Open Manhole	1200	S3.000	22.742	225				
S413	24.780	2.301	Open Manhole	1200	S1.005	22.479	300	S1.004	22.554	225	
								S3.000	22.623	225	69
S412-1	27.440	1.425	Open Manhole	1200	S4.000	26.015	225				
S412	25.850	3.755	Open Manhole	1200	S1.006	22.095	300	S1.005	22.095	300	
								S4.000	24.853	225	2683
S410-1	26.250	1.425	Open Manhole	1200	S5.000	24.825	225				
S411	25.190	3.291	Open Manhole	1200	S1.007	21.899	300	S1.006	21.899	300	
								S5.000	23.954	225	1980
S410	24.870	3.014	Open Manhole	1200	S1.008	21.856	300	S1.007	21.856	300	
S300	24.800	3.527	Open Manhole	1350	S1.009	21.273	375	S1.008	21.797	300	449
S406-1	24.770	1.075	Open Manhole	1200	S6.000	23.695	225				
S409	23.860	2.790	Open Manhole	1350	S1.010	21.070	375	S1.009	21.070	375	
								S6.000	22.967	225	1747
S405-1	25.720	3.445	Open Manhole	1200	S7.000	22.275	225				
S408	24.010	3.177	Open Manhole	1350	S1.011	20.833	375	S1.010	20.833	375	
								S7.000	22.070	225	1087
S407	23.460	2.671	Open Manhole	1350	S1.012	20.789	375	S1.011	20.789	375	
S406	23.210	2.534	Open Manhole	1350	S1.013	20.676	375	S1.012	20.676	375	
S405	22.970	2.346	Open Manhole	1350	S1.014	20.624	375	S1.013	20.624	375	
S58	27.170	1.619	Open Manhole	1200	S8.000	25.551	225				
S57	26.560	1.459	Open Manhole	1200	S8.001	25.101	225	S8.000	25.101	225	
S56	25.060	1.459	Open Manhole	1200	S8.002	23.601	225	S8.001	23.601	225	
S55	24.940	1.507	Open Manhole	1200	S8.003	23.433	225	S8.002	23.433	225	
S54	25.880	2.856	Open Manhole	1200	S8.004	23.024	225	S8.003	23.024	225	
S53	26.000	3.248	Open Manhole	1200	S8.005	22.752	225	S8.004	22.752	225	
S52-2	25.530	1.425	Open Manhole	1200	S9.000	24.105	225				
S52-1	25.780	1.750	Open Manhole	1200	S9.001	24.030	225	S9.000	24.030	225	
S52	26.130	3.505	Open Manhole	1200	S8.006	22.625	225	S8.005	22.625	225	
								S9.001	23.911	225	1286
S51	25.180	2.875	Open Manhole	1200	S8.007	22.305	225	S8.006	22.305	225	

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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN (Pipe Out)	Invert Level (m) (Pipe Out)	Diameter (mm) (Pipe Out)	PN (Pipes In)	Invert Level (m) (Pipes In)	Diameter (mm) (Pipes In)	Backdrop (mm)
S0	26.000	5.396	Open Manhole	1350	S1.015	20.604	375	S1.014	20.604	375	
								S8.007	21.710	225	956
S	25.000	4.406	Open Manhole	0		OUTFALL		S1.015	20.594	375	

Simulation Criteria for Storm

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.900	Storm Duration (mins)	30
Ratio R	0.279		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: S0, DS/PN: S1.015, Volume (m³): 8.4

Unit Reference	MD-SHE-0118-7400-1570-7400
Design Head (m)	1.570
Design Flow (l/s)	7.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	118
Invert Level (m)	20.604
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.570	7.4
Flush-Flo™	0.468	7.4
Kick-Flo®	0.964	5.9
Mean Flow over Head Range	-	6.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.2	1.200	6.5	3.000	10.0	7.000	15.0
0.200	6.6	1.400	7.0	3.500	10.8	7.500	15.5
0.300	7.1	1.600	7.5	4.000	11.5	8.000	16.0
0.400	7.4	1.800	7.9	4.500	12.2	8.500	16.5
0.500	7.4	2.000	8.3	5.000	12.8	9.000	16.9
0.600	7.3	2.200	8.7	5.500	13.4	9.500	17.4
0.800	6.9	2.400	9.0	6.000	13.9		
1.000	6.0	2.600	9.4	6.500	14.5		

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.279
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 14.900 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 10, 10, 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
S1.000	S418	15 Winter	100	+10%	30/15 Winter			
S1.001	S417	15 Winter	100	+10%	30/15 Summer			
S2.000	S416-1	15 Winter	100	+10%	100/15 Winter			
S1.002	S416	15 Winter	100	+10%	30/15 Summer			
S1.003	S415	30 Winter	100	+10%	30/15 Summer			
S1.004	S414	30 Winter	100	+10%	30/15 Summer			
S3.000	S413-1	30 Winter	100	+10%	100/15 Summer			
S1.005	S413	30 Winter	100	+10%	30/15 Summer			
S4.000	S412-1	15 Winter	100	+10%				
S1.006	S412	30 Winter	100	+10%	30/15 Summer			
S5.000	S410-1	15 Winter	100	+10%				
S1.007	S411	30 Winter	100	+10%	30/15 Summer			
S1.008	S410	30 Winter	100	+10%	30/15 Summer			
S1.009	S300	30 Winter	100	+10%	30/15 Summer			
S6.000	S406-1	15 Winter	100	+10%				
S1.010	S409	1440 Winter	100	+10%	30/15 Summer			
S7.000	S405-1	15 Winter	100	+10%				
S1.011	S408	1440 Winter	100	+10%	30/15 Summer			
S1.012	S407	1440 Winter	100	+10%	30/15 Summer			
S1.013	S406	1440 Winter	100	+10%	30/15 Summer			
S1.014	S405	1440 Winter	100	+10%	1/480 Winter			

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Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S418	24.511	0.534	0.000	0.58		22.0	SURCHARGED	
S1.001	S417	24.446	0.733	0.000	0.68		29.2	SURCHARGED	
S2.000	S416-1	24.361	0.041	0.000	0.60		22.3	SURCHARGED	
S1.002	S416	24.320	0.899	0.000	1.37		50.7	SURCHARGED	
S1.003	S415	24.071	0.819	0.000	1.30		46.0	FLOOD RISK	
S1.004	S414	23.897	0.744	0.000	1.30		49.9	FLOOD RISK	
S3.000	S413-1	23.371	0.404	0.000	0.24		8.5	SURCHARGED	
S1.005	S413	23.367	0.588	0.000	0.87		70.6	SURCHARGED	
S4.000	S412-1	26.096	-0.144	0.000	0.28		20.5	OK	
S1.006	S412	23.088	0.693	0.000	1.35		89.5	SURCHARGED	
S5.000	S410-1	24.902	-0.148	0.000	0.26		22.4	OK	
S1.007	S411	22.720	0.521	0.000	1.72		104.9	SURCHARGED	
S1.008	S410	22.532	0.376	0.000	1.78		109.1	SURCHARGED	
S1.009	S300	22.334	0.686	0.000	0.81		112.5	SURCHARGED	
S6.000	S406-1	23.772	-0.148	0.000	0.26		19.8	OK	
S1.010	S409	22.180	0.735	0.000	0.15		17.6	SURCHARGED	
S7.000	S405-1	22.393	-0.107	0.000	0.52		19.6	OK	
S1.011	S408	22.176	0.968	0.000	0.22		20.5	SURCHARGED	
S1.012	S407	22.174	1.010	0.000	0.20		22.4	SURCHARGED	
S1.013	S406	22.170	1.119	0.000	0.24		23.5	SURCHARGED	
S1.014	S405	22.168	1.169	0.000	0.30		23.7	SURCHARGED	

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL.MARSH ROAD DBFL REF: 170092 CATCHMENT B3	Micro Drainage
Date 04/10/2019 14:57 File CATCHMENT B3-04.10.2019...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S8.000	S58	15 Winter	100	+10%					25.635
S8.001	S57	15 Winter	100	+10%					25.209
S8.002	S56	15 Winter	100	+10%	30/15 Summer				24.894
S8.003	S55	15 Winter	100	+10%	30/15 Summer				24.764
S8.004	S54	15 Winter	100	+10%	30/15 Summer				24.332
S8.005	S53	15 Winter	100	+10%	30/15 Summer				24.091
S9.000	S52-2	15 Winter	100	+10%	100/15 Summer				24.362
S9.001	S52-1	15 Winter	100	+10%	100/15 Summer				24.308
S8.006	S52	15 Winter	100	+10%	30/15 Summer				23.675
S8.007	S51	15 Winter	100	+10%	30/15 Summer				22.880
S1.015	S0	1440 Winter	100	+10%	1/480 Winter				22.167

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S8.000	S58	-0.141	0.000	0.30		22.0	OK	
S8.001	S57	-0.117	0.000	0.46		45.6	OK	
S8.002	S56	1.068	0.000	0.85		34.4	FLOOD RISK	
S8.003	S55	1.106	0.000	1.04		43.7	FLOOD RISK	
S8.004	S54	1.083	0.000	1.01		55.8	SURCHARGED	
S8.005	S53	1.114	0.000	1.89		68.4	SURCHARGED	
S9.000	S52-2	0.032	0.000	0.60		20.4	SURCHARGED	
S9.001	S52-1	0.053	0.000	1.19		43.0	SURCHARGED	
S8.006	S52	0.825	0.000	1.58		112.5	SURCHARGED	
S8.007	S51	0.350	0.000	1.26		126.2	SURCHARGED	
S1.015	S0	1.188	0.000	0.08		7.4	SURCHARGED	

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C1	Micro Drainage
Date 08/10/2019 14:53 File CATCHMENT C1- 08.10.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for C1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	15.000	Add Flow / Climate Change (%)	10
Ratio R	0.281	Minimum Backdrop Height (m)	1.500
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 C1

- Indicates pipe length does not match coordinates

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
1.000	28.600	0.168	170.2	0.064	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	89.600	0.543	165.0	0.154	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	86.013	0.430	200.0	0.109	0.00	4.5	0.600	o	300	Pipe/Conduit	
1.003	80.718	0.673	119.9	0.109	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	43.516	0.240	181.3	0.109	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.005	30.132	0.267	112.9	0.155	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.006	15.400#	0.286	53.8	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.007	14.423	0.100	144.2	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	44.05	5.48	26.830	0.064	0.0	0.0	0.8	1.00	39.7	8.4
1.001	40.62	6.70	26.587	0.218	0.0	0.0	2.4	1.22	86.3	26.4
1.002	37.64	7.99	26.044	0.327	4.5	0.0	3.8	1.11	78.3	41.6
1.003	35.79	8.93	25.614	0.436	4.5	0.0	4.7	1.43	101.4	51.4
1.004	34.83	9.47	24.866	0.545	4.5	0.0	5.6	1.34	148.3	61.5
1.005	34.33	9.77	24.626	0.700	4.5	0.0	7.0	1.70	188.3	76.5
1.006	34.16	9.87	24.359	0.700	4.5	0.0	7.0	2.47	273.2	76.5
1.007	33.90	10.03	24.073	0.700	4.5	0.0	7.0	1.51	166.4	76.5

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C1	Micro Drainage
Date 08/10/2019 14:53 File CATCHMENT C1- 08.10.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

Manhole Schedules for C1

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
30	28.260	1.430	Open Manhole	1200	1.000	26.830	225				
29	28.490	1.903	Open Manhole	1200	1.001	26.587	300	1.000	26.662	225	
28	29.266	3.222	Open Manhole	1200	1.002	26.044	300	1.001	26.044	300	
27	28.160	2.546	Open Manhole	1200	1.003	25.614	300	1.002	25.614	300	
26	26.120	1.254	Open Manhole	1350	1.004	24.866	375	1.003	24.941	300	
25	26.040	1.414	Open Manhole	1350	1.005	24.626	375	1.004	24.626	375	
24	25.700	1.341	Open Manhole	1350	1.006	24.359	375	1.005	24.359	375	
8	26.500	2.427	Open Manhole	1350	1.007	24.073	375	1.006	24.073	375	
BASIN	26.500	2.527	Open Manhole	0		OUTFALL		1.007	23.973	375	

Simulation Criteria for C1

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.000	Storm Duration (mins)	30
Ratio R	0.281		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C1	Micro Drainage
Date 08/10/2019 14:53 File CATCHMENT C1- 08.10.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

Online Controls for C1

Hydro-Brake® Optimum Manhole: 24, DS/PN: 1.006, Volume (m³): 5.1

Unit Reference	MD-SHE-0094-4100-1160-4100
Design Head (m)	1.160
Design Flow (l/s)	4.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	94
Invert Level (m)	24.359
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.160	4.1
Flush-Flo™	0.343	4.1
Kick-Flo®	0.719	3.3
Mean Flow over Head Range	-	3.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.0	1.200	4.2	3.000	6.4	7.000	9.5
0.200	3.9	1.400	4.5	3.500	6.9	7.500	9.8
0.300	4.1	1.600	4.8	4.000	7.3	8.000	10.2
0.400	4.1	1.800	5.0	4.500	7.7	8.500	10.4
0.500	4.0	2.000	5.3	5.000	8.1	9.000	10.7
0.600	3.8	2.200	5.5	5.500	8.5	9.500	11.0
0.800	3.5	2.400	5.7	6.000	8.9		
1.000	3.8	2.600	6.0	6.500	9.2		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C1	Micro Drainage
Date 08/10/2019 14:53 File CATCHMENT C1- 08.10.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

Summary of Critical Results by Maximum Level (Rank 1) for C1

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.281
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 15.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 10, 10, 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.
1.000	30	15 Winter	100	+10%				
1.001	29	15 Winter	100	+10%				
1.002	28	15 Winter	100	+10%	30/15 Summer			
1.003	27	15 Winter	100	+10%	100/15 Summer			
1.004	26	15 Winter	100	+10%				
1.005	25	1440 Winter	100	+10%	100/1440 Winter			
1.006	24	1440 Winter	100	+10%	30/480 Winter			
1.007	8	960 Winter	1	+10%				

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	30	26.968	-0.087	0.000	0.54		20.1	OK	
1.001	29	26.856	-0.031	0.000	0.79		66.2	OK	
1.002	28	26.580	0.236	0.000	1.15		86.8	SURCHARGED	
1.003	27	25.995	0.081	0.000	1.06		103.3	SURCHARGED	
1.004	26	25.198	-0.043	0.000	0.92		125.5	OK	
1.005	25	25.044	0.043	0.000	0.12		19.2	SURCHARGED	
1.006	24	25.041	0.307	0.000	0.02		4.1	SURCHARGED	

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C1	Micro Drainage
Date 08/10/2019 14:53 File CATCHMENT C1- 08.10.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

Summary of Critical Results by Maximum Level (Rank 1) for C1

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.007	8	24.117	-0.331	0.000	0.03		4.1	OK	

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Ormond House	LANDS AT MILL/MARSH ROAD	
Upper Ormond Quay	DBFL REF: 170092	
Dublin 7	NETWORK C2	
Date 08/10/2019 11:17	Designed by DCG	
File CATCHMENT C2- 08.10.201...	Checked by DMW	
Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for C2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	15.000	Add Flow / Climate Change (%)	10
Ratio R	0.281	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 C2

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
1.000	28.600	0.168	170.2	0.030	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	11.500	0.131	87.8	0.040	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	5.000	0.030	166.7	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)
1.000	44.05	5.48	24.385	0.030	0.0	0.0	0.4	1.00	39.7	3.9
1.001	43.63	5.61	24.217	0.070	0.0	0.0	0.8	1.40	55.5	9.1
1.002	43.38	5.70	24.086	0.070	0.0	0.0	0.8	1.01	40.2	9.1

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C2	Micro Drainage
Date 08/10/2019 11:17 File CATCHMENT C2- 08.10.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

Manhole Schedules for C2

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
22-6	25.360	0.975	Open Manhole	1200	1.000	24.385	225				
22-5	25.609	1.392	Open Manhole	1200	1.001	24.217	225	1.000	24.217	225	
3	25.500	1.414	Open Manhole	1200	1.002	24.086	225	1.001	24.086	225	
STORMTECH	25.500	1.444	Open Manhole	0		OUTFALL		1.002	24.056	225	

Simulation Criteria for C2

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.000	Storm Duration (mins)	30
Ratio R	0.281		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C2	
Date 08/10/2019 11:17 File CATCHMENT C2- 08.10.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

Online Controls for C2

Hydro-Brake® Optimum Manhole: 3, DS/PN: 1.002, Volume (m³): 2.0

Unit Reference	MD-SHE-0073-2000-0600-2000
Design Head (m)	0.600
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	73
Invert Level (m)	24.086
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.600	2.0
Flush-Flo™	0.177	2.0
Kick-Flo®	0.397	1.7
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.9	1.200	2.7	3.000	4.2	7.000	6.3
0.200	2.0	1.400	2.9	3.500	4.5	7.500	6.5
0.300	1.9	1.600	3.1	4.000	4.8	8.000	6.7
0.400	1.7	1.800	3.3	4.500	5.1	8.500	6.9
0.500	1.8	2.000	3.5	5.000	5.3	9.000	7.1
0.600	2.0	2.200	3.6	5.500	5.6	9.500	7.3
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

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Ormond House	LANDS AT MILL/MARSH ROAD	Micro Drainage
Upper Ormond Quay	DBFL REF: 170092	
Dublin 7	NETWORK C2	
Date 08/10/2019 11:17	Designed by DCG	
File CATCHMENT C2- 08.10.201...	Checked by DMW	
Innovyze	Network 2018.1	

Summary of Critical Results by Maximum Level (Rank 1) for C2

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.281
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 15.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 10, 10, 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	22-6	120 Winter	100	+10%					24.566
1.001	22-5	120 Winter	100	+10%	30/60 Winter				24.585
1.002	3	120 Winter	100	+10%	30/15 Summer				24.598

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	22-6	-0.044	0.000	0.09		3.4	OK	
1.001	22-5	0.143	0.000	0.16		7.3	SURCHARGED	
1.002	3	0.287	0.000	0.06		1.8	SURCHARGED	

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C4	Micro Drainage
Date 07/10/2019 12:17 File CATCHMENT C4 04.010.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for C4

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	15.000	Add Flow / Climate Change (%)	10
Ratio R	0.281	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 C4

- Indicates pipe length does not match coordinates

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
1.000	42.800#	1.430	29.9	0.078	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	51.200#	2.327	22.0	0.078	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	25.200#	1.200	21.0	0.039	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	55.100#	1.137	48.5	0.039	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	29.000	0.170	170.6	0.078	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	19.294	0.240	80.4	0.078	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	11.400	0.240	47.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.006	1.000	0.050	20.0	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)
1.000	44.62	5.30	30.744	0.078	0.0	0.0	0.9	2.40	95.4	10.4
1.001	43.67	5.60	29.314	0.156	0.0	0.0	1.8	2.80	111.4	20.3
1.002	43.23	5.75	26.987	0.195	0.0	0.0	2.3	2.87	114.0	25.1
1.003	41.84	6.24	25.787	0.234	0.0	0.0	2.7	1.88	74.9	29.2
2.000	44.03	5.48	24.820	0.078	0.0	0.0	0.9	1.00	39.7	10.2
1.004	41.25	6.46	24.650	0.390	0.0	0.0	4.4	1.46	58.0	47.9
1.005	40.99	6.56	24.410	0.390	0.0	0.0	4.4	1.90	75.7	47.9
1.006	40.98	6.56	24.170	0.390	0.0	0.0	4.4	2.94	116.9	47.9

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C4	Micro Drainage
Date 07/10/2019 12:17 File CATCHMENT C4 04.010.201...	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

Manhole Schedules for C4

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
40	32.169	1.425	Open Manhole	1200	1.000	30.744	225				
39	30.810	1.496	Open Manhole	1200	1.001	29.314	225	1.000	29.314	225	
38	28.500	1.513	Open Manhole	1200	1.002	26.987	225	1.001	26.987	225	
37	27.180	1.393	Open Manhole	1200	1.003	25.787	225	1.002	25.787	225	
36-1	26.140	1.320	Open Manhole	1200	2.000	24.820	225				
36	26.300	1.650	Open Manhole	1200	1.004	24.650	225	1.003	24.650	225	
								2.000	24.650	225	
35	25.800	1.390	Open Manhole	1200	1.005	24.410	225	1.004	24.410	225	
0	25.300	1.130	Open Manhole	1200	1.006	24.170	225	1.005	24.170	225	
0	26.500	2.380	Open Manhole	0		OUTFALL		1.006	24.120	225	

Simulation Criteria for C4

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.000	Storm Duration (mins)	30
Ratio R	0.281		

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Online Controls for C4

Hydro-Brake® Optimum Manhole: 0, DS/PN: 1.006, Volume (m³): 1.7

Unit Reference	MD-SHE-0071-2000-0705-2000
Design Head (m)	0.705
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	71
Invert Level (m)	24.170
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.705	2.0
Flush-Flo™	0.208	2.0
Kick-Flo®	0.451	1.6
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.5	3.000	3.9	7.000	5.8
0.200	2.0	1.400	2.7	3.500	4.2	7.500	6.0
0.300	2.0	1.600	2.9	4.000	4.4	8.000	6.2
0.400	1.8	1.800	3.1	4.500	4.7	8.500	6.4
0.500	1.7	2.000	3.2	5.000	4.9	9.000	6.6
0.600	1.9	2.200	3.4	5.500	5.2	9.500	6.7
0.800	2.1	2.400	3.5	6.000	5.4		
1.000	2.3	2.600	3.6	6.500	5.6		

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C4	Micro Drainage
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Summary of Critical Results by Maximum Level (Rank 1) for C4

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.281
Region Scotland and Ireland Cv (Summer) 0.750
M5-60 (mm) 15.000 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0 DVD Status OFF
Analysis Timestep Coarse Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years) 1, 30, 100
Climate Change (%) 10, 10, 10

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	40	15 Winter	100	+10%					30.824
1.001	39	15 Winter	100	+10%					29.426
1.002	38	15 Winter	100	+10%					27.120
1.003	37	15 Winter	100	+10%	30/15 Winter				26.687
2.000	36-1	15 Winter	100	+10%	30/15 Summer				25.833
1.004	36	15 Winter	100	+10%	30/15 Summer				25.766
1.005	35	15 Winter	100	+10%	30/15 Summer				24.934
1.006	0	720 Winter	100	+10%	30/30 Summer				24.862

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	40	-0.145	0.000	0.28		25.2	OK	
1.001	39	-0.113	0.000	0.48		51.3	OK	
1.002	38	-0.092	0.000	0.61		64.6	OK	
1.003	37	0.675	0.000	0.92		66.3	SURCHARGED	
2.000	36-1	0.788	0.000	0.52		19.2	SURCHARGED	
1.004	36	0.891	0.000	1.84		96.4	SURCHARGED	
1.005	35	0.299	0.000	1.51		96.8	SURCHARGED	

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 NETWORK C4	Micro Drainage
Date 07/10/2019 12:17 File CATCHMENT C4 04.010.201...	Designed by DCG Checked by DMW	
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Summary of Critical Results by Maximum Level (Rank 1) for C4

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.006	0	0.467	0.000	0.06		2.0	SURCHARGED	

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD OUTFALL DBFL REF: 170092	
Date 09/10/2019 14:14 File Outfall pipe-22.08.2019...	Designed by AOS Checked by DMW	
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	14.900	Add Flow / Climate Change (%)	20
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	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
1.000	57.400	0.230	249.6	0.000	4.00	12.7	0.600	o	600	Pipe/Conduit	
1.001	68.200	0.850	80.2	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.002	49.200	0.154	319.5	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.003	69.500	0.217	320.3	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.004	29.700	0.424	70.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.005	29.800	0.452	65.9	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.006	43.100	0.653	66.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.007	4.400	0.067	66.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	46.43	4.62	16.957	0.000	12.7	0.0	2.5	1.54	434.6	15.2
1.001	44.99	5.04	16.727	0.000	12.7	0.0	2.5	2.72	769.2	15.2
1.002	43.10	5.64	15.877	0.000	12.7	0.0	2.5	1.36	383.7	15.2
1.003	40.73	6.50	15.723	0.000	12.7	0.0	2.5	1.36	383.2	15.2
1.004	40.29	6.67	15.506	0.000	12.7	0.0	2.5	2.91	823.7	15.2
1.005	39.88	6.83	15.082	0.000	12.7	0.0	2.5	3.00	848.9	15.2
1.006	39.31	7.07	14.000	0.000	12.7	0.0	2.5	3.00	848.4	15.2
1.007	39.25	7.10	13.347	0.000	12.7	0.0	2.5	3.00	848.4	15.2

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD OUTFALL DBFL REF: 170092	Micro Drainage
Date 09/10/2019 14:14 File Outfall pipe-22.08.2019...	Designed by AOS Checked by DMW	
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Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
508	19.880	2.923	Open Manhole	1500	1.000	16.957	600				
507	18.540	1.813	Open Manhole	1500	1.001	16.727	600	1.000	16.727	600	
506	17.870	1.993	Open Manhole	1500	1.002	15.877	600	1.001	15.877	600	
505	19.640	3.917	Open Manhole	1500	1.003	15.723	600	1.002	15.723	600	
504	18.250	2.744	Open Manhole	1500	1.004	15.506	600	1.003	15.506	600	
503	17.200	2.118	Open Manhole	1500	1.005	15.082	600	1.004	15.082	600	
502	16.170	2.170	Open Manhole	1500	1.006	14.000	600	1.005	14.630	600	630
501	15.100	1.753	Open Manhole	1500	1.007	13.347	600	1.006	13.347	600	
500	15.000	1.720	Open Manhole	0		OUTFALL		1.007	13.280	600	

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Appendix D

OPERATION AND MAINTENANCE OF SUDS FEATURES

HYDRO-BRAKE® FLOW CONTROL
MAINTENANCE AND SAFETY DATA SHEET

MAINTENANCE

Normally, little maintenance is required as there are no moving parts within the Hydro-Brake® Flow Control. Experience has shown that if blockages occur they do so at the intake, and the cause on such occasions has been due to a lack of attention to engineering detail such as approach velocities being too low, inadequate benching, or the use of units below the minimum recommended size. Hydro-Brake® Flow Controls are fitted with a pivoting by-pass door, which allows the manhole chamber to be drained down should blockages occur. The smaller type conical units, below the minimum recommended size, are also supplied with roding facilities or vortex suppressor pipes as standard.

Following installation of the Hydro-Brake® Flow Control it is vitally important that any extraneous material i.e. Building materials are removed from the unit and the chamber. After the system is made live, and assuming that the chamber design is satisfactory, it is recommended that each unit be inspected monthly for three months and thereafter at six monthly intervals with hose down if required. If problems are experienced please do not hesitate to contact the company so that an investigation may be made.

Hydro-Brake® Flow Controls are typically manufactured from grade 304 Stainless Steel which has an estimated life span in excess of the design life of drainage systems.

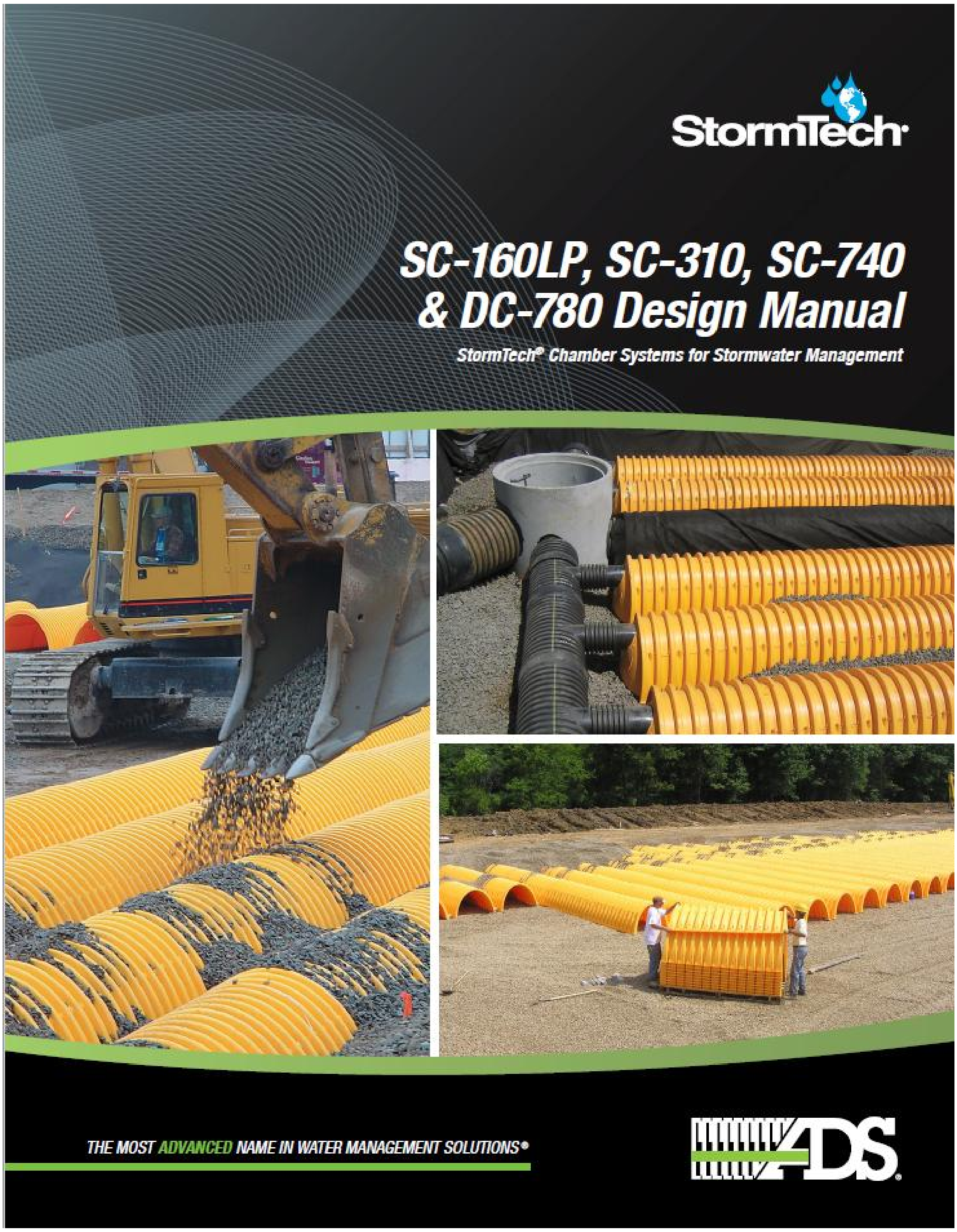
StormTech
SC-160LP, SC-310, SC-740
& DC-780 Design Manual
StormTech® Chamber Systems for Stormwater Management
THE MOST ADVANCED NAME IN WATER MANAGEMENT SOLUTIONS®
ADS


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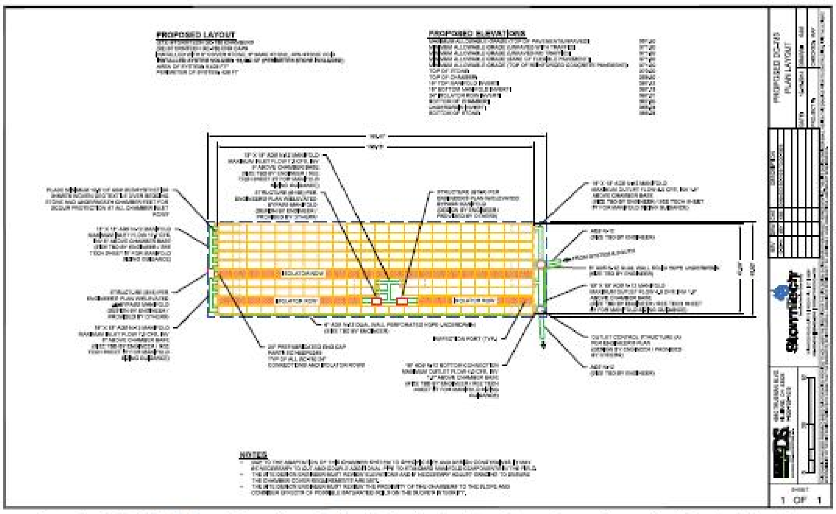
Table of Contents

StormTech

* For MC-3500 and MC-4500 designs, please refer to the MC-3500/MC-4500 Design Manual.

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



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

1.0 Introduction

1.1 INTRODUCTION

StormTech stormwater management systems allow storm water professionals to create more profitable, environmentally sound developments. Compared with other subsurface systems, StormTech systems offer lower overall installed cost, superior design flexibility and enhanced performance. Applications include commercial, residential, agricultural and highway drainage.

StormTech has invested over $10 million and many years in the development of StormTech chambers. These innovative products exceed the rigorous requirements of the standards governing the design of thermoplastic structures.

1.2 THE GOLD STANDARD IN STORMWATER MANAGEMENT

The advanced designs of StormTech chambers were created by implementing an aggressive research, development, design and manufacturing protocol. StormTech chamber products establish the new gold standard in stormwater management through:

- Collaborations with experts in the field of buried plastic structures and polyolefin materials
- The development and utilization of new testing methods and proprietary test methods
- The use of thermoformed prototypes to verify engineering models, perform in-ground testing and install observation sites
- The investment in custom-designed, injection molding equipment
- The utilization of polypropylene and polyethylene as manufacturing materials
- The design of molded-in features not possible with traditional thermoformed chambers

Section 3.0 of this design manual, Structural Capabilities, provides a detailed description of the research, development and design process.

Many of StormTech's unique chamber features can benefit a site developer, stormwater system designer, and installer. Where applicable, StormTech Product Specifications are referenced throughout this design manual. If StormTech's unique product benefits are important to a stormwater system design, consider including the applicable StormTech Product Specifications on the site plans. This can prevent substitutions with inferior products. Refer to Section 14.0, *StormTech Product Specifications*.

1.3 PRODUCT QUALITY AND DESIGN TO INTERNATIONAL STANDARDS

StormTech chambers are designed to meet the full scope of design requirements of Section 12.12 of the AASHTO LRFD Bridge Design Specifications and produced to the requirements of the American Society of Testing Materials (ASTM) International specifications F2418 (polypropylene chambers) and F2922 (polyethylene chambers).

StormTech chambers provide the full AASHTO safety factors for live loads and permanent earth loads. The two ASTM standards mentioned previously are linked to the AASHTO LRFD Bridge Design Specifications Section 12.12 design standard. Both ASTM standards require that the safety factors included in the AASHTO guidance are achieved as a prerequisite to meeting either ASTM F2418 or ASTM F2922. StormTech chambers are also designed in accordance with ASTM F2787, "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers" which provides specific guidance on how to design thermoplastic chambers in accordance with AASHTO Section 12.12. These standards provide both the assurance of product quality and safe structural design.

For non-proprietary specifications for public bids that ensure high product quality and safe design, consider including the specification in Section 15.0 Chamber Specifications for Contract Documents.

1.4 TECHNICAL SUPPORT FOR PLAN REVIEWS

StormTech's in-house technical support staff is available to review proposed plans that incorporate StormTech chamber systems. They are also available to assist with plan conversions from existing products to StormTech. Not all plan sheets are necessary for StormTech's review. Required sheets include plan view sheet(s) with design contours, cross sections of the stormwater system including catch basins and drainage details.

When specifying StormTech chambers it is recommended that the following items are included in project plans: StormTech chamber system General Notes, applicable StormTech chamber illustrations and StormTech chamber system Product Specifications. These items are available in various formats and can be obtained by contacting StormTech at **1-860-529-8188** or may be downloaded at **www.stormtech.com**.

StormTech's plan review is limited to the sole purpose of determining whether plans meet StormTech chamber systems' minimum requirements. **It is the ultimate responsibility of the design engineer to assure that the stormwater system's design is in full compliance with all applicable laws and regulations.** StormTech products must be designed and installed in accordance with StormTech's minimum requirements.

SEND PLANS TO:
E-mail: info@stormtech.com.

2.0 Product Information

StormTech

2.1 PRODUCT APPLICATIONS

StormTech chamber systems may function as stormwater detention, retention, first-flush storage, or some combination of these. The StormTech chambers can be used for commercial, municipal, industrial, recreational, and residential applications especially for installations under parking lots and commercial roadways.

One of the key advantages of the StormTech chamber system is its design flexibility. Chambers may be configured into beds or trenches of various sizes or shapes. They can be centralized or decentralized, and fit on nearly all sites. Chamber lengths enhance the ability to develop on both existing and pre-developed projects. The systems can be designed easily and efficiently around utilities, natural or man-made structures and any other limiting boundaries.

2.2 CHAMBERS FOR STORMWATER DETENTION

Chamber systems have been used effectively for storm water detention for over 15 years. A detention system temporarily holds water while it is released at a defined rate through an outlet. While some infiltration may occur in a detention system, it is often considered an environmental benefit and a storage safety factor. Over 70% of StormTech's installations are non-watertight detention systems. There are only a few uncommon situations where a detention system might need to limit infiltration: the subgrade soil's bearing capacity is significantly affected by saturation such as with expansive clays or karst soils, and; in sensitive aquifer areas where the depth to groundwater does not meet local guidelines. Adequate pretreatment could eliminate concerns for the latter case. A thermoplastic liner may be considered for both situations to limit infiltration.

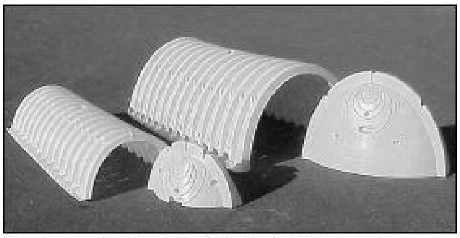
2.3 STONE POROSITY ASSUMPTION

A StormTech chamber system requires the application of clean, crushed, angular stone below, between and above the chambers. This stone serves as a structural component while allowing conveyance and storage of stormwater. Storage volume examples throughout this Design Manual are calculated with an assumption that the stone has an industry standard porosity of 40%. Actual stone porosity may vary. Contact StormTech for information on calculating storm water volumes with varying stone porosity assumptions.

2.4 CHAMBER SELECTION

Primary considerations when selecting between the SC-160LP, SC-310, SC-740 and DC-780 chambers are the depth to restrictive layer, available area for subsurface storage, cover height and outfall restrictions.

The StormTech SC-160LP chamber shown on page 4 is the smallest of the chamber family and has been optimized to fit in the shallowest of applications. This extra low profile chamber allows for storage of 1.01 ft^3/ft^2 ($0.3 m^3/m^2$) [minimum] of storage.



The SC-310 and SC-740 chambers and end plates.

StormTech systems can be integrated into retrofit and new construction projects.

The StormTech SC-310 chamber shown on page 6 is ideal for systems requiring low-rise and wide-span solutions. This low profile chamber allows the storage of large volumes, 1.3 ft^3/ft^2 ($0.40 m^3/m^2$) [minimum], at minimum depths.

Like the Stormtech SC-310, the StormTech SC-310-3 found on page 8 allows for a design option for sites with both limited cover and limited space. With only 3" of spacing between the chambers, the SC-310-3 still provides 1.3 ft^3/ft^2 ($0.40 m^3/m^2$) [minimum] of storage.

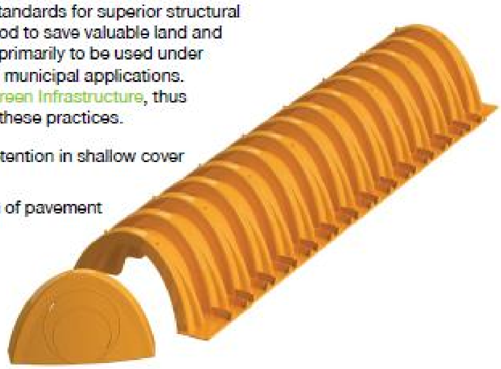
The StormTech SC-740 chamber shown on page 10 optimizes storage volumes in relatively small footprints. By providing 2.2 ft^3/ft^2 ($0.67 m^3/m^2$) [minimum] of storage, the SC-740 chambers can minimize excavation, backfill and associated costs.

The DC-780 chamber shown on page 12 has been developed for those applications which exceed the maximum 8 ft (2.44 m) burial depth of the SC-740 and SC-310 chambers. The DC-780 is a modified version of the SC-740 allowing it to reach a maximum burial depth of 12 ft (3.66 m). The design of the DC-780 chamber, like other StormTech chambers, is designed and manufactured in accordance with the AASHTO LRFD Bridge Design Specifications as well as ASTM F 2418 and ASTM F 2787 ensuring structural adequacy for deeper systems.

The end corrugations of the DC-780 chamber have not been modified in order to allow connections to the SC-740 chamber. This will allow hybrid systems utilizing both chambers in one system design.

StormTech SC-160LP 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 commercial and municipal applications. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.



The SC-160LP chamber was developed for infiltration and detention in shallow cover applications

- Only 14" (350 mm) required from top of chamber to bottom of pavement
- Only 12" (300 mm) tall
- Installs toe to toe—no additional spacing between rows

StormTech SC-160LP (not to scale)

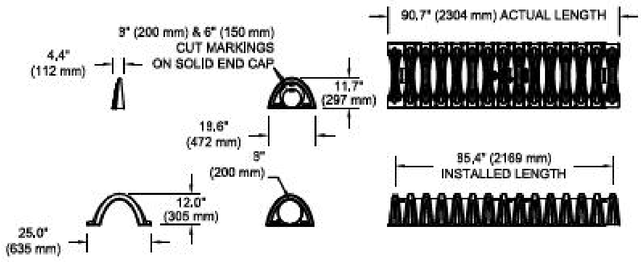
Nominal Chamber Specifications

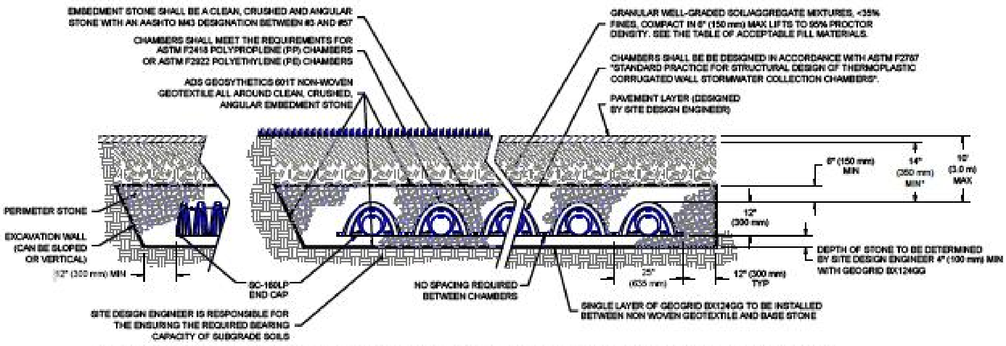
Size (LxWxH)	85.4" x 25.0" x 12.0" (2170 x 635 x 305 mm)
Chamber Storage	6.85 ft³ (0.19 m³)
Min. Installed Storage*	15.0 ft³ (0.42 m³)
Weight	24.0 lbs. (10.9 kg)

*Assumes 6" (150 mm) stone above, 4" (100 mm) below and stone between chambers with 40% stone porosity

Shipping

132 chambers/pallet
144 end caps/pallet
12 pallets/truck





*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 20" (510 mm).

THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

StormTech

SC-160LP Cumlative Storage Volumes per chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 4" (100 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
22 (559)	↑ 6.85 (0.194)	14.98 (0.424)
21 (533)	6.85 (0.194)	14.49 (0.410)
20 (508)	Stone 6.85 (0.194)	14.00 (0.396)
19 (483)	Cover 6.85 (0.194)	13.50 (0.382)
18 (457)	6.85 (0.194)	13.01 (0.368)
17 (432)	↓ 6.85 (0.194)	12.51 (0.354)
16 (406)	6.85 (0.194)	12.02 (0.340)
15 (381)	6.80 (0.193)	11.49 (0.325)
14 (356)	6.67 (0.189)	10.92 (0.309)
13 (330)	6.38 (0.181)	10.25 (0.290)
12 (305)	5.94 (0.168)	9.49 (0.269)
11 (279)	5.40 (0.153)	8.67 (0.246)
10 (254)	4.78 (0.135)	7.81 (0.221)
9 (229)	4.10 (0.116)	6.91 (0.196)
8 (203)	3.36 (0.095)	5.97 (0.169)
7 (178)	2.58 (0.073)	5.01 (0.142)
6 (152)	1.76 (0.050)	4.02 (0.114)
5 (127)	0.89 (0.025)	3.01 (0.085)
4 (102)	↑ 0 (0)	1.98 (0.056)
3 (76)	Stone 0 (0)	1.48 (0.042)
2 (51)	Foundation 0 (0)	0.99 (0.028)
1 (25)	↓ 0 (0)	0.49 (0.014)

Note: Add 0.49 ft^3 (0.014 m^3) of storage for each additional inch (25 mm) of stone foundation.

Amount of Stone Per Chamber

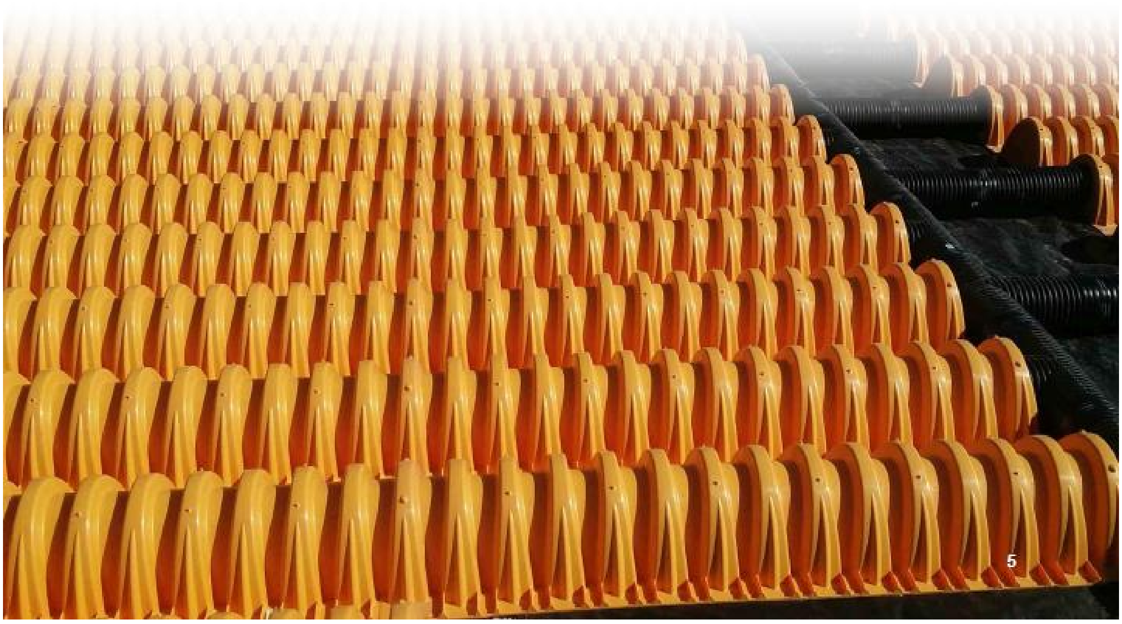
ENGLISH TONS (yds^3)	Stone Foundation Depth		
	4"	6"	8"
StormTech SC-160LP	1.1 (0.8)	1.2 (0.9)	1.3 (0.9)
METRIC KILOGRAMS (m^3)	100 mm	150 mm	200 mm
StormTech SC-160LP	952 (0.7)	1,074 (0.8)	1,197 (0.8)

Note: Assumes 6" (150 mm) of stone above and only embedment stone between chambers.

Volume Excavation Per Chamber yd^3 (m^3)

	Stone Foundation Depth		
	4" (100)	8" (200)	12" (300)
StormTech SC-160LP	1.4 (1.1)	1.6 (1.2)	1.8 (1.3)

Note: Assumes no row separation and 14" (350 mm) of cover. The volume of excavation will vary as depth of cover increases.



StormTech SC-310 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.

StormTech SC-310 Chamber (not to scale)

Nominal Chamber Specifications

Size (L x W x H)	85.4" x 34.0" x 16.0" (2170 x 864 x 406 mm)
Chamber Storage	14.7 ft³ (0.42 m³)
Min. Installed Storage*	31.0 ft³ (0.88 m³)
Weight	37.0 lbs (16.8 kg)

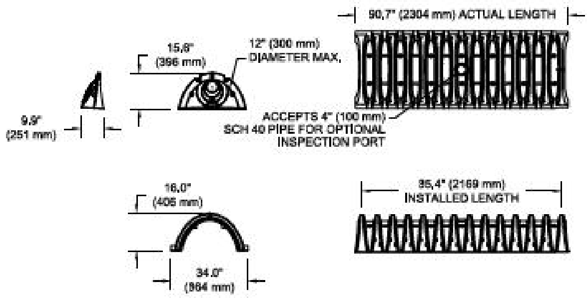
*Assumes 6" (150 mm) stone above, below and between chambers and 40% stone porosity.

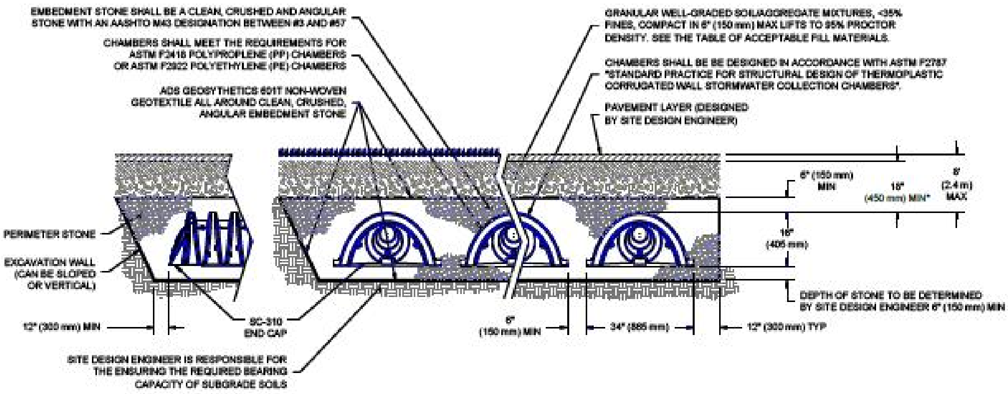
Shipping

41 chambers/pallet

108 end caps/pallet

18 pallets/truck





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

THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

6 Call StormTech at **860.529.8188** or **888.892.2694** or visit our website at **www.stormtech.com** for technical and product information.

StormTech

SC-310 CUMLATIVE STORAGE VOLUMES PER CHAMBER

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft^3 (m^3)	Total System Cumulative Storage ft^3 (m^3)
28 (711)	14.70 (0.416)	31.00 (0.878)
27 (686)	14.70 (0.416)	30.21 (0.855)
26 (660)	Stone 14.70 (0.416)	29.42 (0.833)
25 (610)	Cover 14.70 (0.416)	28.63 (0.811)
24 (609)	14.70 (0.416)	27.84 (0.788)
23 (584)	14.70 (0.416)	27.05 (0.766)
22 (559)	14.70 (0.416)	26.26 (0.748)
21 (533)	14.64 (0.415)	25.43 (0.720)
20 (508)	14.49 (0.410)	24.54 (0.695)
19 (483)	14.22 (0.403)	23.58 (0.668)
18 (457)	13.68 (0.387)	22.47 (0.636)
17 (432)	12.99 (0.368)	21.25 (0.602)
16 (406)	12.17 (0.345)	19.97 (0.566)
15 (381)	11.25 (0.319)	18.62 (0.528)
14 (356)	10.23 (0.290)	17.22 (0.488)
13 (330)	9.15 (0.260)	15.78 (0.447)
12 (305)	7.99 (0.227)	14.29 (0.425)
11 (279)	6.78 (0.192)	12.77 (0.362)
10 (254)	5.51 (0.156)	11.22 (0.318)
9 (229)	4.19 (0.119)	9.64 (0.278)
8 (203)	2.83 (0.081)	8.03 (0.227)
7 (178)	1.43 (0.041)	6.40 (0.181)
6 (152)	0	4.74 (0.134)
5 (127)	0	3.95 (0.112)
4(102)	Stone Foundation 0	3.16 (0.090)
3 (76)	0	2.37 (0.067)
2 (51)	0	1.58 (0.046)
1 (25)	0	0.79 (0.022)

Note: Add 0.79 ft^3 (0.022 m^3) of storage for each additional inch. (25 mm) of stone foundation.

Storage Volume Per Chamber ft^3 (m^3)

	Bare Chamber Storage ft^3 (m^3)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
StormTech SC-310	14.7 (0.4)	31.0 (0.9)	35.7 (1.0)	40.4 (1.1)

Note: Assumes 6" (150 mm) of stone above chambers, 6" (150 mm) row spacing and 40% stone porosity.

Amount of Stone Per Chamber

ENGLISH TONS (yds^3)	Stone Foundation Depth		
	6"	12"	18"
StormTech SC-310	2.1 (1.5 yd^3)	2.7 (1.9 yd^3)	3.4 (2.4 yd^3)
METRIC KILOGRAMS (m^3)	150 mm	300 mm	450 mm
StormTech SC-310	1,830 (1.1 m^3)	2,490 (1.5 m^3)	2,990 (1.8 m^3)

Note: Assumes 6" (150 mm) of stone above, and between chambers.

Volume Excavation Per Chamber yd^3 (m^3)

	Stone Foundation Depth		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
StormTech SC-310	2.9 (2.2)	3.4 (2.6)	3.8 (2.9)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.

StormTech SC-310-3 Chamber

The proven strength and durability of the SC-310-3 Chamber allows for a design option for sites where limited cover, limited space, high water table and escalated aggregate cost are a factor. The SC-310-3 has a minimum cover requirement of 16" (400 mm) to bottom of flexible pavement and reduces the spacing requirement between chambers by 50% to 3" (76 mm). This provides a reduced footprint overall, reduces aggregate needed, and allows the designer to offer a traffic bearing application yet comply with water table separation regulations. StormTech chambers can also be used in conjunction with Green Infrastructure, thus enhancing the performance and extending the service life of these practices.

StormTech SC-310-3 Chamber (not to scale)

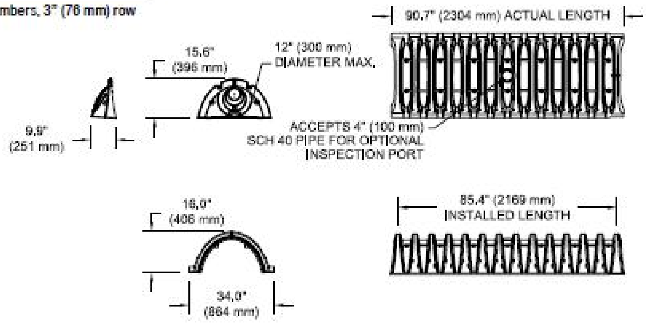
Nominal Chamber Specifications

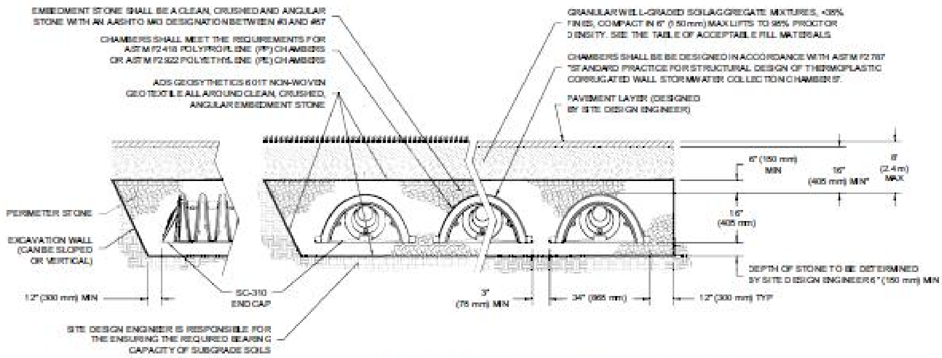
Size (L x W x H)	85.4" x 34.0" x 16.0" (2,170 x 864 x 406 mm)
Chamber Storage	14.7ft³ (0.42 m³)
Min. Installed Storage*	29.3 ft³ (0.83 m³)
Weight	37.0 lbs (16.8 kg)

*Assumes 6" (150 mm) stone above and below chambers, 3" (76 mm) row spacing and 40% stone porosity.

Shipping

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





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StormTech

SC-310-3 CUMLATIVE STORAGE VOLUMES PER CHAMBER

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
28 (711)	14.70 (0.416)	29.34 (0.831)
27 (686)	14.70 (0.416)	28.60 (0.810)
26 (660)	Stone 14.70 (0.416)	27.87 (0.789)
25 (635)	Cover 14.70 (0.416)	27.14 (0.769)
24 (610)	14.70 (0.416)	26.41 (0.748)
23 (584)	14.70 (0.416)	25.68 (0.727)
22 (559)	14.70 (0.416)	24.95 (0.707)
21 (533)	14.64 (0.415)	24.18 (0.685)
20 (508)	14.49 (0.410)	23.36 (0.661)
19 (483)	14.22 (0.403)	22.47 (0.636)
18 (457)	13.68 (0.387)	21.41 (0.606)
17 (432)	12.99 (0.368)	20.25 (0.573)
16 (406)	12.17 (0.345)	19.03 (0.539)
15 (381)	11.25 (0.319)	17.74 (0.502)
14 (356)	10.23 (0.290)	16.40 (0.464)
13 (330)	9.15 (0.260)	15.01 (0.425)
12 (305)	7.99 (0.226)	13.59 (0.385)
11 (279)	6.78 (0.192)	12.13 (0.343)
10 (254)	5.51 (0.156)	10.63 (0.301)
9 (229)	4.19 (0.119)	9.11 (0.258)
8 (203)	2.83 (0.080)	7.56 (0.214)
7 (178)	1.43 (0.041)	5.98 (0.169)
6 (152)	0 (0)	4.39 (0.124)
5 (127)	0 (0)	3.66 (0.104)
4 (102)	Stone 0 (0)	2.93 (0.083)
3 (76)	Foundation 0 (0)	2.19 (0.062)
2 (51)	0 (0)	1.46 (0.041)
1 (25)	0 (0)	0.73 (0.021)

Note: Add 0.73 ft³ (0.021 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
SC-310-3 Chamber	14.7 (0.42)	29.3 (0.83)	33.7 (0.95)	38.1 (1.08)

Note: Assumes 6" (150 mm) of stone above chambers, 3" (76 mm) row spacing and 40% stone porosity.

Amount of Stone Per Chamber

ENGLISH TONS (yds³)	Stone Foundation Depth		
	6"	12"	16"
SC-310-3	1.9 (1.4)	2.5 (1.8)	3.1 (2.2)
METRIC KILOGRAMS (m³)	150 mm	300 mm	450 mm
SC-310-3	1,724 (1.0)	2,268 (1.3)	2,812 (1.7)

Note: Assumes 6" (150 mm) of stone above and and 3" (76 mm) row spacing.

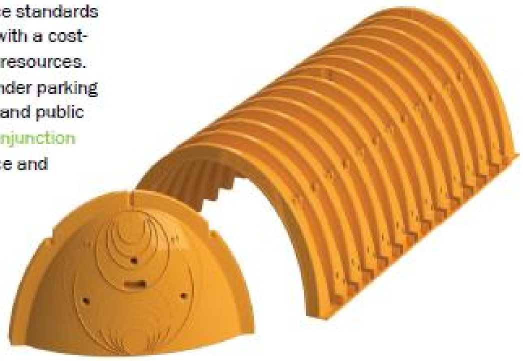
Volume Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6 (150)	12 (300)	18 (450)
SC-310-3	2.6 (2.0)	3.0 (2.0)	3.4 (2.6)

Note: Assumes 3" (76 mm) of row separation and 6" (150 mm) of stone above the chambers and 16" (400 mm) of cover. The volume of excavation will vary as depth of cover increases

StormTech SC-740 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.



StormTech SC-740 Chamber (not to scale)
Nominal Chamber Specifications

Size (L x W x H)	85.4" x 51.0" x 30.0" (2,170 x 1,295 x 762 mm)
Chamber Storage	45.9 ft³ (1.30 m³)
Min. Installed Storage*	74.9 ft³ (2.12 m³)
Weight	74.0 lbs (33.6 kg)

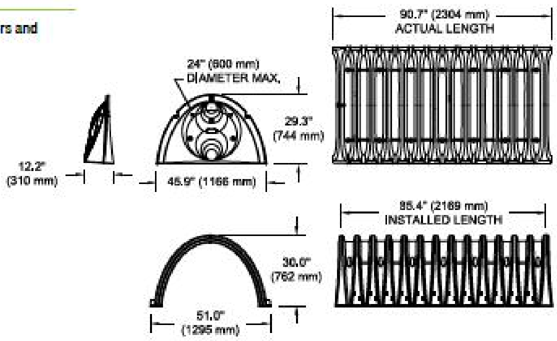
*Assumes 6" (150 mm) stone above, below and between chambers and 40% stone porosity.

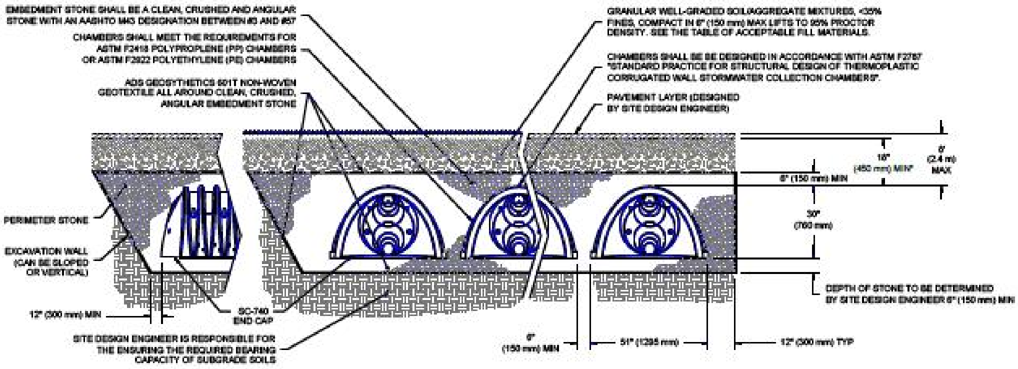
Shipping

30 chambers/pallet

60 end caps/pallet

12 pallets/truck





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StormTech

SC-740 CUMLATIVE STORAGE VOLUMES PER CHAMBER

Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
42 (1067)	↑ 45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (940)	↓ 45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.14 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	1.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.96 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	↑ 0 (0)	6.76 (0.191)
5 (127)	0 (0)	5.63 (0.160)
4 (102)	Stone 0 (0)	4.51 (0.128)
3 (76)	Foundation 0 (0)	3.38 (0.096)
2 (51)	0 (0)	2.25 (0.064)
1 (25)	↓ 0 (0)	1.13 (0.032)

Note: Add 1.13 ft³ (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Foundation Depth in. (mm)		
		6 (150)	12 (300)	18 (450)
SC-740 Chamber	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)

Note: Assumes 6" (150 mm) stone above chambers, 6" (150 mm) row spacing and 40% stone porosity.

Amount of Stone Per Chamber

ENGLISH TONS (yds³)	Stone Foundation Depth		
	6"	12"	18"
SC-740	3.8 (2.8)	4.6 (3.3)	5.5 (3.9)
METRIC KILOGRAMS (m³)	150 mm	300 mm	450 mm
SC-740	3,450 (2.1)	4,170 (2.5)	4,490 (3.0)

Note: Assumes 6" (150 mm) of stone above and between chambers.

Volume Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	6 (150)	12 (300)	18 (450)
SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)

Note: Assumes 6" (150 mm) of row separation and 18" (450 mm) of cover. The volume of excavation will vary as depth of cover increases.

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StormTech DC-780 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.

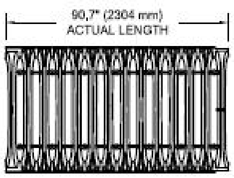
- 12' (3.6 m) Deep Cover Applications
- Designed in accordance with ASTM F2787 and produced to meet the ASTM 2418 product standard.
- AASHTO safety factors provided for AASHTO Design Truck (H20 and deep cover conditions.)

StormTech DC-780 Chamber (not to scale)

Nominal Chamber Specifications

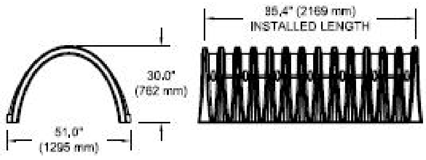
Size (L x W x H)	85.4" x 51.0" x 30.0" (2169 x 1295 x 762 mm)
Chamber Storage	46.2 ft^3 (1.30 m^3)
Min. Installed Storage*	78.4 ft^3 (2.2 m^3)

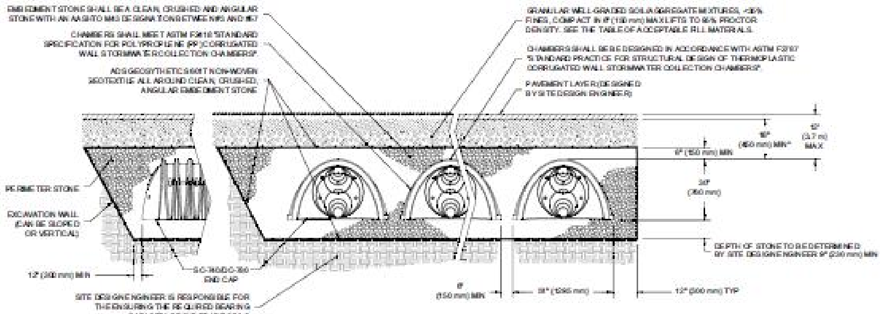
*Assumes 9" (230 mm) stone below, 6" (150 mm) stone above, 6" (150 mm) row spacing and 40% stone porosity.



Shipping

24 chambers/pallet	
60 end caps/pallet	
12 pallets/truck	





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

THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE THE LOAD FACTORS SPECIFIED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12 FOR EARTH AND LIVE LOADS, WITH CONSIDERATION FOR IMPACT AND MULTIPLE VEHICLE PRESENCES.

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StormTech

DC-780 Cumulative Storage Volumes Per Chamber

Assumes 40% Stone Porosity. Calculations are Based Upon a 9" (230 mm) Stone Base Under Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
45 (1,143)	46.27 (1.310)	78.47 (2.222)
44 (1,118)	46.27 (1.310)	77.34 (2.190)
43 (1,092)	Stone 46.27 (1.310)	76.21 (2.158)
42 (1,067)	Cover 46.27 (1.310)	75.09 (2.126)
41 (1,041)	46.27 (1.310)	73.96 (2.094)
40 (1,016)	46.27 (1.310)	72.83 (2.062)
39 (991)	46.27 (1.310)	71.71 (2.030)
38 (965)	46.21 (1.309)	70.54 (1.998)
37 (940)	46.04 (1.304)	69.32 (1.963)
36 (914)	45.76 (1.296)	68.02 (1.926)
35 (889)	45.15 (1.278)	66.53 (1.884)
34 (864)	44.34 (1.255)	64.91 (1.838)
33 (838)	43.38 (1.228)	63.21 (1.790)
32 (813)	42.29 (1.198)	61.43 (1.740)
31 (787)	41.11 (1.164)	59.59 (1.688)
30 (762)	39.83 (1.128)	57.70 (1.634)
29 (737)	38.47 (1.089)	55.76 (1.579)
28 (711)	37.01 (1.048)	53.76 (1.522)
27 (686)	35.49 (1.005)	51.72 (1.464)
26 (660)	33.90 (0.960)	49.63 (1.405)
25 (635)	32.24 (0.913)	47.52 (1.346)
24 (610)	30.54 (0.865)	45.36 (1.285)
23 (584)	28.77 (0.815)	43.18 (1.223)
22 (559)	26.96 (0.763)	40.97 (1.160)
21 (533)	25.10 (0.711)	38.72 (1.096)
20 (508)	23.19 (0.657)	36.45 (1.032)
19 (483)	21.25 (0.602)	34.16 (0.967)
18 (457)	19.26 (0.545)	31.84 (0.902)
17 (432)	17.24 (0.488)	29.50 (0.835)
16 (406)	15.19 (0.430)	27.14 (0.769)
15 (381)	13.10 (0.371)	24.76 (0.701)
14 (356)	10.98 (0.311)	22.36 (0.633)
13 (330)	8.83 (0.250)	19.95 (0.565)
12 (305)	6.66 (0.189)	17.52 (0.496)
11 (279)	4.46 (0.126)	15.07 (0.427)
10 (254)	2.24 (0.064)	12.61 (0.357)
9 (229)	0 (0)	10.14 (0.287)
8 (203)	0 (0)	9.01 (0.255)
7 (178)	0 (0)	7.89 (0.223)
6 (152)	0 (0)	6.76 (0.191)
5 (127)	Stone Foundation 0 (0)	5.63 (0.160)
4 (102)	0 (0)	4.51 (0.128)
3 (76)	0 (0)	3.38 (0.096)
2 (51)	0 (0)	2.25 (0.064)
1 (25)	0 (0)	1.13 (0.032)

Note: Add 1.13 ft³ (0.032 m³) of Storage for Each Additional Inch (25 mm) of Stone Foundation.

Storage Volume Per Chamber ft³ (m³)

	Bare Chamber Storage ft³ (m³)	Chamber and Stone Foundation Depth in. (mm)		
		9" (230 mm)	12" (300 mm)	18" (450 mm)
DC-780 Chamber	78.4 (2.2)	78.4 (2.2)	81.8 (2.3)	88.6 (2.5)

Note: Assumes 40% porosity for the stone, the bare chamber volume, 6" (150 mm) of stone above, and 6" (150 mm) row spacing.

Amount of Stone Per Chamber

ENGLISH TONS (yds³)	Stone Foundation Depth		
	9"	12"	18"
DC-780 Chamber	4.2 (3.0)	4.7 (3.3)	5.6 (3.9)
METRIC KILOGRAMS (m³)	230 mm	300 mm	450 mm
DC-780 Chamber	3,810 (2.3)	4,264 (2.5)	5,080 (3.0)

Note: Assumes 9" (150 mm) of stone above, and between chambers.

Volume Excavation Per Chamber yd³ (m³)

	Stone Foundation Depth		
	9" (230 mm)	12" (300 mm)	18" (450 mm)
DC-780 Chamber	5.9 (4.5)	6.3 (4.8)	6.9 (5.3)

Note: Assumes 6" (150 mm) separation between chamber rows and 18" (450 mm) of cover. The volume of excavation will vary as depth of cover increases.

2.0 Product Information

2.5 STORMTECH CHAMBERS

StormTech chamber systems have unique features to improve site optimization and reduce product waste. The SC-160LP, SC-310, SC-740, and DC-780 chambers can be cut at the job site in approximately 6.5" (165 mm) increments to shorten a chamber's length. Designing and constructing chamber rows around site obstacles is easily accomplished by including specific cutting instructions or a well placed "cut to fit" note on the design plans. The last chamber of a row can be cut in any of its corrugation's valleys. An end cap placed into the trimmed corrugation's crest completes the row. The trimmed-off piece of a StormTech chamber may then be used to start the next row. See **Figure 4**.

To assist the contractor, StormTech chambers are molded with simple assembly instructions and arrows that indicate the direction in which to build rows. Rows are formed by overlapping the next chamber's "Start End" corrugation with the previously laid chamber's end corrugation. Two people can safely and efficiently form rows of chambers without complicated connectors, special tools or heavy equipment.
Product Specifications: 2.2, 2.4, 2.5, 2.9 and 3.2.

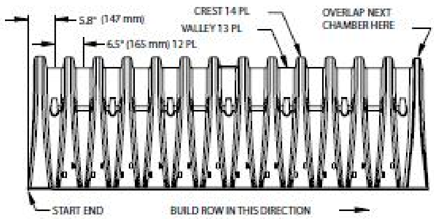
2.6 STORMTECH END CAPS

The StormTech end cap has features which make the chamber system simple to design, easy to build and more versatile than other products. StormTech end caps can be easily secured within any corrugation's crest. A molded-in handle makes attaching the end cap a oneperson operation. Tools or fasteners are not required.

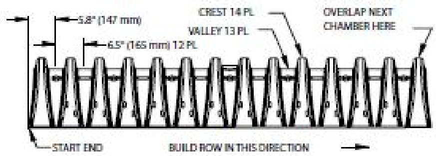
StormTech end caps are required at each end of a chamber row to prevent stone intrusion (two per row). The SC-740 and DC-780 end caps will accept up to a 24" (600 mm) HDPE inlet pipe. The SC-310 end cap will accept up to a 12" (300 mm) HDPE inlet pipe. The SC-160LP will accept either a 6" or 8" (150 mm or 200 mm) HDPE inlet Pipe. See **Figure 5**.
Product Specifications: 3.1, 3.2, 3.3 and 3.4

FIGURE 4 - Distance Between Corrugations (not to scale)

SC-740 Chamber



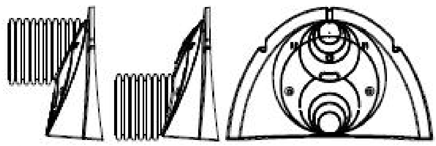
SC-310 Chamber



SC-160LP Chamber

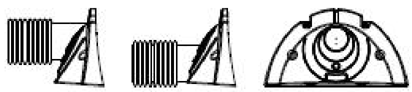
FIGURE 5 - Chamber End Caps (not to scale)

SC-740 / DC-780 End Cap



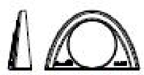
SC-740/DC-780 CHAMBER FABRICATED END CAP (TOP AND BOTTOM FEED)
PIPES SIZES RANGE FROM 6" (150 mm) TO 24" (600 mm)
(INVERTS VARY WITH PIPE SIZE)

SC-310 End Cap



SC-310 CHAMBER FABRICATED END CAP (TOP AND BOTTOM FEED)
PIPES SIZES RANGE FROM 6" (150 mm) TO 12" (300 mm)
(INVERTS VARY WITH PIPE SIZE)

SC-160LP End Cap



SC-160LP CHAMBER END CAP

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3.0 Structural Capabilities

3.1 STRUCTURAL DESIGN APPROACH

When installed per StormTech's minimum requirements, StormTech products are designed to exceed American Association of State Highway and Transportation Officials (AASHTO) LRFD recommended design factors for Earth loads and Vehicular live loads. AASHTO Vehicular live loads (previously HS-20) consist of two heavy axle configurations, that of a single 32 (142 kN) kip axle and that of tandem 25 (111 kN) kip axles. Factors for impact and multiple presences of vehicles ensure a conservative design where structural adequacy is assumed for a wide range of street legal vehicle weights and axle configurations.

Computer models of the chambers under shallow and deep conditions were developed. Utilizing design forces from computer models, chamber sections were evaluated using AASHTO procedures that consider thrust and moment, and check for local buckling capacity. The procedures also considered the time-dependent strength and stiffness properties of polypropylene and polyethylene. These procedures were developed in a research study conducted by the National Cooperative Highway Research Program (NCHRP) for AASHTO, and published as NCHRP Report 438 Recommended LRFD Specifications for Plastic Pipe and Culverts. *Product Specifications: 2.12.*

StormTech does not recommend installing StormTech products underneath buildings or parking garages. When specifying the StormTech products in close proximity to buildings, it is important to ensure that the StormTech products are not receiving any loads from these structures that may jeopardize the long term performance of the chambers.

3.2 FULL SCALE TESTING

After developing the StormTech chamber designs, the chambers were subjected to rigorous full-scale testing. The test programs verified the predicted safety factors of the designs by subjecting the chambers to more severe load conditions than anticipated during service life. Capacity under live loads and deep fill was investigated by conducting tests with a range of cover depths. Monitoring of long term deep fill installations has been done to validate the long term performance of the StormTech products.

3.3 INDEPENDENT EXPERT ANALYSIS

StormTech worked closely with the consulting firm Simpson Gumpertz & Heger Inc. (SGH) to develop and evaluate the SC-160LP, SC-310, SC-740 and DC-780 chamber designs. SGH has world-renowned expertise in the design of buried drain age structures. The firm was the principal investigator for the NCHRP research program that developed the structural analysis and design methods adopted by AASHTO for thermoplastic culverts. SGH conducted design calculations and computer simulations of chamber performance under various installation and live load conditions. They worked with StormTech to design the full-scale test programs to verify the structural capacity of the chambers. SGH also observed all full-scale tests and inspected the chambers after completion of the tests. SGH continues to be StormTech's structural consultant.

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3.0 Structural Capabilities

3.4 INJECTION MOLDING

To comply with both the structural and design requirements of AASHTO's LRFD specifications and ASTM F2787 as well as the product requirements of ASTM F2418 or ASTM F2922, StormTech uses proprietary injection molding equipment to manufacture the chambers and end caps.

In addition to meeting structural goals, injection molding allows StormTech to design added features and advantages into StormTech's parts including:

- Precise control of wall thickness throughout parts
- Precise fit of joints and end caps
- Molded-in inspection port fitting
- Molded-in handles on end caps
- Molded-in pipe guides with blade starter slots
- Repeatability for Quality Control (See Section 3.6)

Product Specifications: 2.1, 3.1 and 3.3

3.5 POLYPROPYLENE AND POLYETHYLENE RESIN

StormTech chambers are injection molded from polypropylene and polyethylene. Polypropylene and polyethylene chambers are inherently resistant to chemicals typically found in stormwater run-off. StormTech chambers maintain a greater portion of their structural stiffness through higher installation and service temperatures.

StormTech polypropylene and polyethylene are virgin materials specially designed to achieve a high 75-year creep modulus that is necessary to provide a sound long-term structural design. Since the modulus remains high well beyond the 75-year value, StormTech chambers can exhibit a service life in excess of 75 years.

3.6 QUALITY CONTROL

StormTech chambers are manufactured under tight quality control programs. Materials are routinely tested in an environmentally controlled lab that is verified every six months via the external ASTM Proficiency Testing Program. The chamber material properties are measured and controlled with procedures following ISO 9001:2000 requirements.

Statistical Process Control (SPC) techniques are applied during manufacturing. Established upper and lower control limits are maintained on key manufacturing para - meters to maintain consistent product.
Product Specifications: 2.13 and 3.6

4.0 Foundation for Chambers

StormTech

4.1 FOUNDATION REQUIREMENTS

StormTech chamber systems and embedment stone may be installed in various native soil types. The subgrade bearing capacity and chamber cover height determine the required depth of clean, crushed, angular stone for the chamber foundation. The chamber foundation is the clean, crushed, angular stone placed between the subgrade soils and the feet of the chamber.

As cover height increases (top of chamber to top of finished grade) the chambers foundation requirements increase. Foundation strength is the product of the subgrade soils bearing capacity and the depth of clean, crushed, angular stone below the chamber foot. **Table 1** for the SC-160LP, **Table 2** for the SC-740 and SC-310, **Table 3** for the SC-310-3, and **Table 4** for the DC-780 specify the required minimum foundation depth for varying cover heights and subgrade bearing capacities.

4.2 WEAKER SOILS

For sub-grade soils with allowable bearing capacity less than 2000 pounds per square foot [(2.0 ksf) (96 kPa)], a geotechnical engineer should evaluate the specific conditions. These soils are often highly variable, may contain organic materials and could be more sensitive to moisture. A geotechnical engineer's recommendations may include increasing the stone foundation, improving the bearing capacity of the sub-grade soils through compaction, replacement, or other remedial measures including the use of geogrids. The use of a thermoplastic liner may also be considered for systems installed in subgrade soils that are highly affected by moisture. The project engineer is responsible for ensuring overall site settlement is within acceptable limits. A geotechnical engineer should always review installation of StormTech chambers on organic soils.

4.3 CHAMBER SPACING OPTION

No spacing is required between the SC-160LP chambers. StormTech requires a minimum of 6" (150 mm) clear spacing between the feet of chambers rows for the SC-310, SC-740 and DC-780 chambers. However, increasing the spacing between chamber rows may allow the application of StormTech chambers with either less foundation stone or with weaker subgrade soils. This may be a good option where a vertical restriction on site prevents the use of a deeper foundation. Contact StormTech's Technical Service Department for more information on this option. In all cases, StormTech recommends consulting a geotechnical engineer for subgrade soils with a bearing capacity less than 2.0 ksf (96 kPa).

TABLE 1 - SC-160LP Bearing Capacity Table
(Assumes no spacing)
Minimum Required Foundation Depth in Inches (mm)

Cover Hgt. ft. (m)	Minimum Bearing Resistance for Service Loads ksf (kPa)																		
	4.4-3.8 (211 to 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 (95)
1.0 (0.31)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)
1.2 (0.46)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)
1.5 (0.46)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)
2.0 (0.61)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)	6 (150)
2.5 to 9 (0.76 to 2.74)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)
9.5 (2.89)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)
10.0 (3.05)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	3 (75)	6 (150)	6 (150)

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.

4.0 Foundations for Chambers

TABLE 2 - SC-310 and SC-740 Minimum Required Foundation Depth in inches (millimeters)

Cover Hgt. ft. (m)	Minimum Required Bearing Resistance for Service Loads ksf (kPa) 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)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)
2.0 (0.61)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)
2.5 (0.76)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	18 (450)
3.0 (0.91)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	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)
3.5 (1.07)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	18 (450)	18 (450)	21 (550)
4.0 (1.22)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	18 (450)	18 (450)	21 (550)
4.5 (1.37)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	18 (450)	18 (450)	21 (550)
5.0 (1.52)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	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 (550)
5.5 (1.68)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	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 (550)
6.0 (1.83)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	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 (550)	21 (550)
6.5 (1.98)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	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 (550)	24 (600)
7.0 (2.13)	6 (150)	6 (150)	6 (150)	6 (150)	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 (550)	21 (550)	24 (600)
7.5 (2.30)	6 (150)	6 (150)	6 (150)	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 (550)	21 (550)	24 (600)	27 (675)
8.0 (2.44)	6 (150)	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 (550)	21 (550)	24 (600)	24 (600)	27 (675)

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.

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4.0 Foundations for Chambers

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TABLE 3 - SC-310-3 Minimum Required Foundation Depth in inches (millimeters)

Cover Hgt. ft. (m)	Minimum Required Bearing Resistance for Service Loads ksf (kPa)										
	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)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)
2.0 (0.61)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)
2.5 (0.76)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)
3.0 (0.91)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)
3.5 (1.07)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	12 (300)
4.0 (1.22)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)
4.5 (1.37)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)
5.0 (1.52)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)
5.5 (1.68)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	12 (300)
6.0 (1.83)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)
6.5 (1.98)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
7.0 (2.13)	6 (150)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)
7.5 (2.30)	6 (150)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)
8.0 (2.44)	6 (150)	6 (150)	6 (150)	9 (230)	9 (230)	9 (230)	9 (230)	12 (300)	12 (300)	12 (300)	15 (375)

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.

Table 4 – DC-780 Minimum Required Foundation Depth in inches (millimeters)

Cover Hgt. ft. (m)	Minimum Required Bearing Resistance for Service Loads ksf (kPa)																					
	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)
8.5 (2.59)	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)	18 (450)	21 (550)	24 (600)	24 (600)	27 (675)	30 (750)
9.0 (2.74)	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)	18 (450)	21 (550)	21 (550)	24 (600)	24 (600)	27 (675)	30 (750)
9.5 (2.90)	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)	18 (450)	21 (550)	21 (550)	24 (600)	24 (600)	27 (675)	30 (750)	33 (825)
10.0 (3.05)	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 (550)	21 (550)	24 (600)	24 (600)	27 (675)	30 (750)	33 (825)	36 (900)
10.5 (3.20)	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 (550)	21 (550)	24 (600)	24 (600)	27 (675)	30 (750)	30 (750)	33 (825)	36 (900)
11.0 (3.35)	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 (550)	21 (550)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	33 (825)	36 (900)	39 (975)
11.5 (3.50)	12 (300)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (550)	21 (550)	24 (600)	24 (600)	27 (675)	27 (675)	30 (750)	33 (825)	36 (900)	39 (975)	42 (1050)
12.0 (3.66)	12 (300)	12 (300)	12 (300)	15 (375)	15 (375)	15 (375)	15 (375)	18 (450)	18 (450)	18 (450)	21 (550)	21 (550)	21 (550)	24 (600)	24 (600)	27 (675)	30 (750)	30 (750)	33 (825)	36 (900)	39 (975)	42 (1050)

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.

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5.0 Cumulative Storage Volumes

Tables 4, 5, 6 and 7 provide cumulative storage volumes for the SC-160LP, SC-310, SC-740 and DC-780 chamber systems. This information may be used to calculate a detention/retention system's stage storage volume. A spreadsheet is available at www.stormtech.com in which the number of chambers can be input for quick cumulative storage calculations.
Product Specifications: 1.1, 2.2, 2.3, 2.4, and 2.6

Table 4 - SC-160LP Cumulative Storage Volumes Per Chamber
Assumes 40% Stone Porosity. Calculations are Based Upon a 4" (100 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)		Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
22 (559)	Stone Cover	6.85 (0.194)	14.98 (0.424)
21 (533)	Stone Cover	6.85 (0.194)	14.49 (0.410)
20 (508)	Stone Cover	6.85 (0.194)	14.00 (0.396)
19 (483)	Stone Cover	6.85 (0.194)	13.50 (0.382)
18 (457)	Stone Cover	6.85 (0.194)	13.01 (0.368)
17 (432)	Stone Cover	6.85 (0.194)	12.51 (0.354)
16 (406)		6.85 (0.194)	12.02 (0.340)
15 (381)		6.80 (0.193)	11.49 (0.325)
14 (356)		6.67 (0.189)	10.92 (0.309)
13 (330)		6.38 (0.181)	10.25 (0.290)
12 (305)		5.94 (0.168)	9.49 (0.269)
11 (279)		5.40 (0.153)	8.67 (0.246)
10 (254)		4.78 (0.135)	7.81 (0.221)
9 (229)		4.10 (0.116)	6.91 (0.196)
8 (203)		3.36 (0.095)	5.97 (0.169)
7 (178)		2.58 (0.073)	5.01 (0.142)
6 (152)		1.76 (0.050)	4.02 (0.114)
5 (127)		0.89 (0.025)	3.01 (0.085)
4 (102)	Stone Foundation	0 (0)	1.98 (0.056)
3 (76)	Stone Foundation	0 (0)	1.48 (0.042)
2 (51)	Stone Foundation	0 (0)	0.99 (0.028)
1 (25)	Stone Foundation	0 (0)	0.49 (0.014)

Note: Add 0.49 ft³ (0.014 m³) of storage for each additional inch (25 mm) of stone foundation.

Table 5 - SC-310 Cumulative Storage Volumes Per Chamber
Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)		Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
28 (711)	Stone Cover	14.70 (0.416)	31.00 (0.878)
27 (686)	Stone Cover	14.70 (0.416)	30.21 (0.855)
26 (680)	Stone Cover	14.70 (0.416)	29.42 (0.833)
25 (635)	Stone Cover	14.70 (0.416)	28.63 (0.811)
24 (610)	Stone Cover	14.70 (0.416)	27.84 (0.788)
23 (584)	Stone Cover	14.70 (0.416)	27.05 (0.766)
22 (559)		14.70 (0.416)	26.26 (0.748)
21 (533)		14.64 (0.415)	25.43 (0.720)
20 (508)		14.49 (0.410)	24.54 (0.695)
19 (483)		14.22 (0.403)	23.58 (0.668)
18 (457)		13.68 (0.387)	22.47 (0.636)
17 (432)		12.99 (0.368)	21.25 (0.602)
16 (406)		12.17 (0.345)	19.97 (0.566)
15 (381)		11.25 (0.319)	18.62 (0.528)
14 (356)		10.23 (0.290)	17.22 (0.488)
13 (330)		9.15 (0.260)	15.78 (0.447)
12 (305)		7.99 (0.227)	14.29 (0.425)
11 (279)		6.78 (0.192)	12.77 (0.362)
10 (254)		5.51 (0.156)	11.22 (0.318)
9 (229)		4.19 (0.119)	9.64 (0.278)
8 (203)		2.83 (0.081)	8.03 (0.227)
7 (178)		1.43 (0.041)	6.40 (0.181)
6 (152)	Stone Foundation	0	4.74 (0.134)
5 (127)	Stone Foundation	0	3.95 (0.112)
4 (102)	Stone Foundation	0	3.16 (0.090)
3 (76)	Stone Foundation	0	2.37 (0.067)
2 (51)	Stone Foundation	0	1.58 (0.046)
1 (25)	Stone Foundation	0	0.79 (0.022)

Note: Add 0.79 ft³ (0.022 m³) of storage for each additional inch (25 mm) of stone foundation.

5.0 Cumulative Storage Volumes

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Table 6 - SC-740 Cumulative Storage Volumes Per Chamber
Assumes 40% Stone Porosity. Calculations are Based Upon a 6" (150 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
42 (1067)	45.90 (1.300)	74.90 (2.121)
41 (1041)	45.90 (1.300)	73.77 (2.089)
40 (1016)	Stone 45.90 (1.300)	72.64 (2.057)
39 (991)	Cover 45.90 (1.300)	71.52 (2.025)
38 (965)	45.90 (1.300)	70.39 (1.993)
37 (948)	45.90 (1.300)	69.26 (1.961)
36 (914)	45.90 (1.300)	68.17 (1.929)
35 (889)	45.85 (1.298)	66.98 (1.897)
34 (864)	45.69 (1.294)	65.75 (1.862)
33 (838)	45.41 (1.286)	64.46 (1.825)
32 (813)	44.81 (1.269)	62.97 (1.783)
31 (787)	44.01 (1.246)	61.36 (1.737)
30 (762)	43.06 (1.219)	59.66 (1.689)
29 (737)	41.98 (1.189)	57.89 (1.639)
28 (711)	40.80 (1.155)	56.05 (1.587)
27 (686)	39.54 (1.120)	54.17 (1.534)
26 (660)	38.18 (1.081)	52.23 (1.479)
25 (635)	36.74 (1.040)	50.23 (1.422)
24 (610)	35.22 (0.977)	48.19 (1.365)
23 (584)	33.64 (0.953)	46.11 (1.306)
22 (559)	31.99 (0.906)	44.00 (1.246)
21 (533)	30.29 (0.858)	41.85 (1.185)
20 (508)	28.54 (0.808)	39.67 (1.123)
19 (483)	26.74 (0.757)	37.47 (1.061)
18 (457)	24.89 (0.705)	35.23 (0.997)
17 (432)	23.00 (0.651)	32.69 (0.939)
16 (406)	21.06 (0.596)	30.68 (0.869)
15 (381)	19.09 (0.541)	28.36 (0.803)
14 (356)	17.08 (0.484)	26.03 (0.737)
13 (330)	15.04 (0.426)	23.68 (0.670)
12 (305)	12.97 (0.367)	21.31 (0.608)
11 (279)	10.87 (0.309)	18.92 (0.535)
10 (254)	8.74 (0.247)	16.51 (0.468)
9 (229)	6.58 (0.186)	14.09 (0.399)
8 (203)	4.41 (0.125)	11.66 (0.330)
7 (178)	2.21 (0.063)	9.21 (0.264)
6 (152)	0	6.76 (0.191)
5 (127)	0	5.63 (0.160)
4 (102)	Stone 0	4.51 (0.125)
3 (76)	Foundation 0	3.38 (0.095)
2 (51)	0	2.25 (0.064)
1 (25)	0	1.13 (0.032)

Note: Add 1.13 ft³ (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

Table 7 - DC-780 Cumulative Storage Volumes Per Chamber
Assumes 40% Stone Porosity. Calculations are Based Upon a 9" (230 mm) Stone Base Under the Chambers.

Depth of Water in System Inches (mm)	Cumulative Chamber Storage ft³ (m³)	Total System Cumulative Storage ft³ (m³)
45 (1143)	46.27 (1.310)	78.47 (2.222)
44 (1118)	46.27 (1.310)	77.34 (2.190)
43 (1092)	Stone 46.27 (1.310)	76.21 (2.158)
42 (1067)	Cover 46.27 (1.310)	75.09 (2.126)
41 (1041)	46.27 (1.310)	73.96 (2.094)
40 (1016)	46.27 (1.310)	72.83 (2.062)
39 (991)	46.27 (1.310)	71.71 (2.030)
38 (965)	46.21 (1.309)	70.54 (1.998)
37 (948)	46.04 (1.304)	69.32 (1.963)
36 (914)	45.76 (1.296)	68.02 (1.926)
35 (889)	45.15 (1.278)	66.53 (1.884)
34 (864)	44.34 (1.255)	64.91 (1.838)
33 (838)	43.38 (1.228)	63.21 (1.790)
32 (813)	42.29 (1.198)	61.43 (1.740)
31 (787)	41.11 (1.164)	59.59 (1.688)
30 (762)	39.83 (1.128)	57.70 (1.634)
29 (737)	38.47 (1.089)	55.76 (1.579)
28 (711)	37.01 (1.048)	53.76 (1.522)
27 (686)	35.49 (1.005)	51.72 (1.464)
26 (660)	33.90 (0.960)	49.63 (1.405)
25 (635)	32.24 (0.913)	47.52 (1.346)
24 (610)	30.54 (0.865)	45.36 (1.285)
23 (584)	28.77 (0.815)	43.18 (1.223)
22 (559)	26.96 (0.763)	40.97 (1.160)
21 (533)	25.10 (0.711)	38.72 (1.096)
20 (508)	23.19 (0.657)	36.45 (1.032)
19 (483)	21.25 (0.602)	34.16 (0.967)
18 (457)	19.26 (0.545)	31.84 (0.902)
17 (432)	17.24 (0.488)	29.50 (0.835)
16 (406)	15.19 (0.430)	27.14 (0.769)
15 (381)	13.10 (0.371)	24.76 (0.701)
14 (356)	10.98 (0.311)	22.36 (0.633)
13 (330)	8.83 (0.250)	19.95 (0.565)
12 (305)	6.66 (0.189)	17.52 (0.496)
11 (279)	4.46 (0.126)	15.07 (0.427)
10 (254)	2.24 (0.064)	12.61 (0.357)
9 (229)	0	10.14 (0.287)
8 (203)	0	9.01 (0.255)
7 (178)	0	7.89 (0.223)
6 (152)	0	6.76 (0.191)
5 (127)	Stone 0	5.63 (0.160)
4 (102)	Foundation 0	4.51 (0.128)
3 (76)	0	3.38 (0.096)
2 (51)	0	2.25 (0.064)
1 (25)	0	1.13 (0.032)

Note: Add 1.13 ft³ (0.032 m³) of storage for each additional inch (25 mm) of stone foundation.

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6.0 Required Materials/Row Separation

6.1 CHAMBER ROW SEPARATION

StormTech SC-740, SC-310 and DC-780 chambers must be specified with a minimum 6" (150 mm) space between the feet of adjacent parallel chamber rows. No spacing is required between the SC-160LP chambers. Increasing the space between rows is acceptable. This will increase the storage volume due to additional stone voids.

6.2 STONE SURROUNDING CHAMBERS

Refer to **Table 8** for acceptable stone materials. StormTech requires clean, crushed, angular stone below, between and above chambers as shown in **Figure 6**. Acceptable gradations are listed in Table 8. Subrounded and rounded stone are not acceptable.

6.3 GEOTEXTILE SEPARATION REQUIREMENT

A non-woven geotextile that meets AASHTO M288 Class 2 Separation requirements must be applied as a separation layer to prevent soil intrusion into the clean, crushed, angular stone as shown in **Figure 6**. The geotextile is required between the clean, crushed, angular stone and the subgrade soils, the excavation's sidewalls and the fill materials. The geotextile should completely envelope the clean, crushed, angular stone. Overlap adjacent geotextile rolls per AASHTO M288 separation guidelines. Contact StormTech for a list of acceptable geotextiles.

6.4 FILL ABOVE CHAMBERS

Refer to **Table 8** and **Figure 6** for acceptable fill material above the 6" (150 mm) of clean, crushed, angular stone. Minimum and maximum fill requirements for the SC-160LP, SC-740, SC-310 and DC-780 chambers are shown in **Figure 6** below. StormTech requires a minimum of 24" (600 mm) of fill in non-paved installations where rutting from vehicles may occur. **Table 8** provides details on soil class and compaction requirements for suitable fill materials.

Table 8 – Acceptable Fill Materials

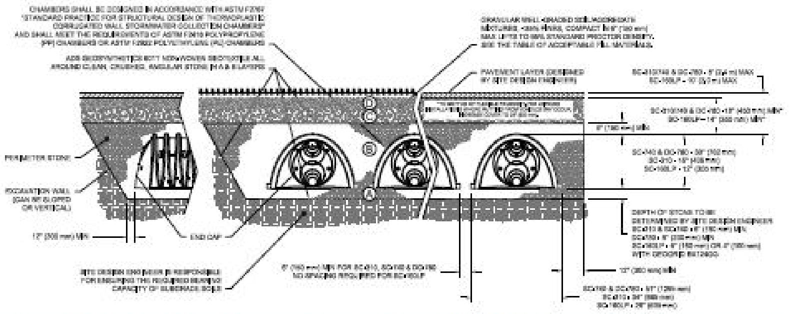
	Material Location	Description	AASHTO Material Classifications	Compaction / Density Requirement
D	**Final Fill:** Fill material for layer 'D' starts from the top of the 'C' layer to the bottom of the flexible pavement to unpaved finished grade above. Note that pavement subbase may be part of the 'D' layer.	Any soil/rock material, 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 form the top of the embedment stone ('B' Layer) to 18" (450 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 M145¹ A-1, A-2-4, A-3 OR AASHTO M43¹ 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	Begin Compactions after 12" (300 mm) of material over the chambers is reached. Compact additional layers in 6" (150 mm) max lifts to a min. 95% proctor density for well graded material and 95% relative Density for processed aggregate materials. Roller gross vehicle weight not to exceed 12,000 lbs (53 kN). Dynamic force not to exceed 20,000 lbs (89 kN)
B	**Embedment stone:** Fill surrounding the chambers from the foundation stone ('A' layer) to the 'C' layer above	Clean, crushed, angular stone, nominal size distribution between ¾-2 inch (20-50 mm)	AASHTO M145¹ 3, 357, 4, 467, 5, 56, 57	No compaction required.
A	**Foundation stone:** Fill below chambers from the subgrade up to the foot (bottom) of the chamber.	Clean, crushed, angular stone, nominal size distribution between ¾-2 inch (20-50 mm)	AASHTO M145¹ 3, 357, 4, 467, 5, 56, 57	Plate compact or roll to achieve a flat surface. ²³

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 6" (150 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 of dragging without compaction equipment. For special load designs, contact StormTech for compaction requirements.

Figure 6 – 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 requirements of layer 'C' or 'D' at the design engineer's discretion.



7.0 Inletting the Chambers

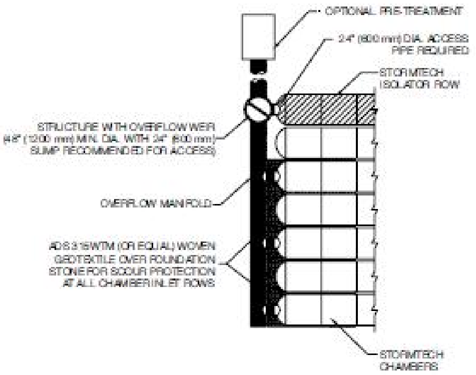
The design flexibility of a StormTech chamber system includes many inletting possibilities. Contact StormTech's Technical Service Department for guidance on designing an inlet system to meet specific site goals.

7.1 TREATMENT TRAIN

A properly designed inlet system can ensure good water quality, easy inspection and maintenance, and a long system service life. StormTech recommends a treatment train approach for inletting an underground stormwater management system under a typical commercial parking area. Treatment train is an industry term for a multi-tiered water quality network. As shown in **Figure 7**, a StormTech recommended inlet system can inexpensively have tiers of treatment upstream of the StormTech chambers:

Tier 1 – Pre-treatment (BMP)
Tier 2 - StormTech Isolator® Row
Tier 3 - Enhanced Treatment (BMP)

Figure 7 - Typical StormTech Treatment Train Inlet System



7.2 PRE-TREATMENT (BMP) – TREATMENT TIER 1

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

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

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

7.3 STORMTECH ISOLATOR ROW – TREATMENT TIER 2

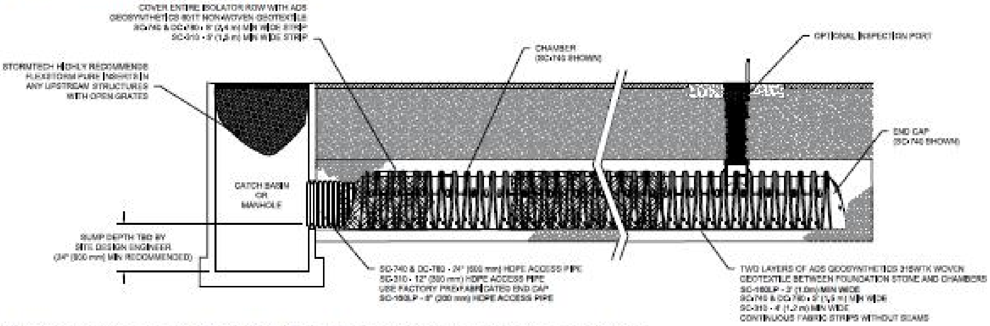
StormTech has a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance. The StormTech Isolator Row is a row of standard StormTech chambers surrounded with appropriate filter fabrics and connected to a manhole for easy access. This application basically creates a filter/detention basin that allows water to egress through the surrounding filter fabric while sediment is trapped within. It may be best to think of the Isolator Row as a first-flush treatment device. First-Flush is a term typically used to describe the first 1/2" to 1" (13-25 mm) of rainfall or runoff on a site. The majority of stormwater pollutants are carried in the sediments of the firstflush, therefore the Isolator Row is an effective component of a treatment train.

The StormTech Isolator Row should be designed with a manhole with an overflow weir at its upstream end. The diversion manhole is multi-purposed. It can provide access to the Isolator Row for both inspection and maintenance and acts as a diversion structure. The manhole is connected to the Isolator Row with a short length of 8" (200mm) pipe for the SC-160LP chambers, 12" (300 mm) pipe for the SC-310 chamber and 24" (600 mm) pipe for the SC-740 and DC-780 chambers. These pipes are connected to the Isolator Row with an 8" (200mm) precored end cap for the SC-160LP, a 12" (300 mm) fabricated end cap for the SC-310 chamber and a 24" (600 mm) fabricated end cap for the SC-740 and DC-780 chambers. The overflow weir typically has its crest set between the top of the chamber and its midpoint. This allows storm water in excess of the Isolator Row's storage/conveyance capacity to bypass into the chamber system through the downstream manifold system.

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

7.0 Inletting the Chambers

Figure 8 – StormTech Isolator Row Detail



Note: Non-woven geotextile over DC-780 Isolator Row chambers is not required.

filter fabric prevents sediments from migrating out of the chamber perforations while allowing modest amounts of water to flow out of the Isolator Row. **Figure 8** is a detail of the Isolator Row that shows proper application of the geotextiles. Contact StormTech for a table of acceptable geotextiles.

Inspection is easily accomplished through the upstream manhole or optional inspection ports. Maintenance of an Isolator Row is fast and easy using the JetVac process through the upstream manhole. Section 12.0 explains the inspection and maintenance process in more detail.

Isolator Rows can be sized to accommodate either a water quality volume or a water quality flow rate requirement. The use of filter fabric around the Isolator Row chambers allows stormwater to egress out of the row during and between storm events. The rate of egression for design is dependent upon the chamber model and sediment accumulation on the geotextile. Contact StormTech's Technical Services Department for more information on Isolator Row sizing.

7.4 ENHANCED TREATMENT (BMP) – TREATMENT TIER 3

As regulations have become more stringent, requiring higher levels of containment removal, water quality systems may be required to treat higher flow rates, greater volumes or to provide a higher level of filtration or other more sophisticated treatment process. StormTech systems can easily be configured with enhanced treatment techniques located either upstream or downstream of the retention or detention chamber system. Located upstream of an infiltration bed, between the pretreatment device and the Isolator Row, enhanced treatment provides a high level of contaminant removal which protects groundwater or better preserves the infiltration surface. Located downstream of detention, enhanced treatment provides a higher level of contaminant removal prior to discharge to a receiving body.

Enhanced treatment BMPs are normally applied where specific regulations and specific water quality product approvals are in place. StormTech works closely with providers of enhanced treatment technologies to meet local requirements.

7.5 TREATMENT TRAIN CONCLUSION

The treatment train is a highly effective water-quality approach that may not add significant cost to a StormTech system being installed under commercial parking areas. The StormTech Isolator Row adds a significant level of treatment, easy inspection and maintenance, while maintaining storage volume credit for the cost of a modest amount of geotextile. Finally where higher levels of treatment are required, StormTech can integrate other technologies into the treatment train to provide the most cost effective treatment approach. This treatment train concept provides three levels of treatment, inspection and maintenance upstream and downstream of the StormTech detention/retention bed.

7.0 Inletting the Chambers

StormTech

7.6 OTHER INLET OPTIONS

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

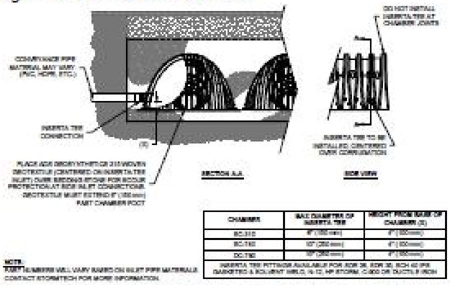
7.7 LATERAL FLOW RATES

The embedment stone surrounding the StormTech chambers allows the rapid conveyance of stormwater between chamber rows. Stormwater will rise and fall evenly within a bed of chambers. A single StormTech SC-740 chamber is able to release or accept stormwater at a rate of at least 0.5 cfs (14.2 l/s) through the surrounding stone.

7.8 INLETTING PERPENDICULAR TO A ROW OF CHAMBERS WITH INSERTA TEE

There is an easy, inexpensive method to perpendicularly inlet a row of chambers. Simply connect the inlet directly to the chamber with an Inserta Tee. Figure 9 shows a typical detail along with the standard sizes offered for each chamber model.

Figure 9 – Inserta Tee Side Detail



NOTE: SIDE INSERTA TEES CANNOT BE USED ON SC-160LP CHAMBERS.

7.9 MAXIMUM INLET PIPE VELOCITIES TO PREVENT SCOURING OF THE STONE FOUNDATION

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. 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. An appropriate scour protection geotextile is installed from the end cap to at least 10.5' (3.2 m) for the SC-310, SC- 740 and DC 780 chambers for both top and bottom feeding inlet pipes.

See StormTech's Tech Sheet #7 for guidance on manifold sizing. ADS's Technical Services department can also assist with sizing inlet manifolds for the StormTech chamber systems.

Table 9A – Standard Distances from Base of Chamber to Invert of Inlet and Outlet Manifolds on StormTech End Caps

SC-160LP END CAPS			
PIPE DIA.	**INV. (IN)**	**INV. (FT)**	**INV. (MM)**
6" (150mm)	0.66	0.05	16
8" (200mm)	0.80	0.07	20
8" (200mm) Cored	0.96	0.08	24

SC-310 END CAPS				
	PIPE DIA.	**INV. (IN)**	**INV. (FT)**	**INV. (MM)**
TOP	6" (150 mm)	5.8	0.48	146
	8" (200 mm)	3.5	0.29	88
	10" (250 mm)	1.4	0.12	37
BOTTOM	6" (150 mm)	0.5	0.04	12
	8" (200 mm)	0.6	0.05	15
	10" (250 mm)	0.7	0.06	18
	12" (750 mm)	0.9	0.08	24

SC-740 / DC-780 ENDCAPS				
	PIPE DIA.	**INV. (IN)**	**INV. (FT)**	**INV. (MM)**
TOP	6" (150 mm)	18.5	1.54	469
	8" (200 mm)	16.5	1.38	421
	10" (250 mm)	14.5	1.21	369
	12" (300 mm)	12.5	1.04	317
	15" (375 mm)	9	0.75	229
	18" (450 mm)	5	0.42	128
BOTTOM	6" (150 mm)	0.5	0.04	12
	8" (200 mm)	0.6	0.05	15
	10" (250 mm)	0.7	0.06	18
	12" (750 mm)	1.2	0.10	30
	15" (900 mm)	1.3	0.11	34
	18" (1050 mm)	1.6	0.13	40
	24" (1200 mm)	0.1	0.01	3

See StormTech's Tech Sheet #7 for manifold sizing guidance

8.0 Outlets for Chambers

8.0 OUTLETS FOR STORMTECH CHAMBER SYSTEMS

The majority of StormTech installations are detention systems and have some type of outlet structure. An outlet manifold is generally designed to ensure that peak flows can be conveyed to the outlet structure.

To drain the system completely, an underdrain system is located at or below the bottom of the foundation stone. Some beds may be designed with a pitched base to ensure complete drainage of the system. A grade of ½% is usually satisfactory.

An outlet pipe may be located at a higher invert within a bed. This allows a designed volume of water to infiltrate while excess volumes are outlet as necessary. This is an excellent method of recharging groundwater, replicating a site's pre-construction hydraulics.

Depending on the bed layout and inverts, outlet pipes should be placed in the embedment stone along the bed's perimeter as shown in **Figures 10** and **11**. Solid outlet pipes should also be used to penetrate the StormTech end caps at the designed outlet invert as shown in **Figure 12**. An Isolator Row should not be directly penetrated with an outlet pipe. For systems requiring higher outlet flow rates, a combination of connections may be utilized as shown in **Figure 13**.

In detention and retention applications the discharge of water from the stormwater management system is determined based on the hydrology of the area and the hydraulic design of the system. It is the design engineer's responsibility to design an outlet system that meets their hydraulic objectives while following local laws and regulations.

Table 9B – Maximum Outlet Flow Rate Capacities from StormTech Manifolds

OUTLET FLOW		
PIPE DIA.	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

Figure 10 – Underdrain Parallel

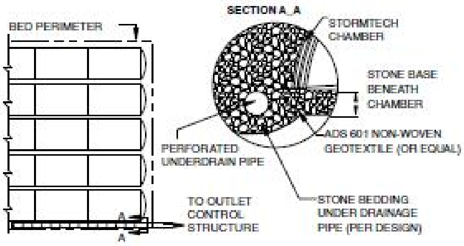


Figure 11 – Underdrain Perpendicular

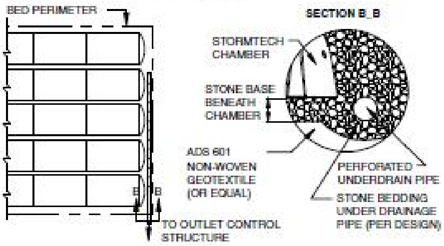


Figure 12 – Outlet Manifold

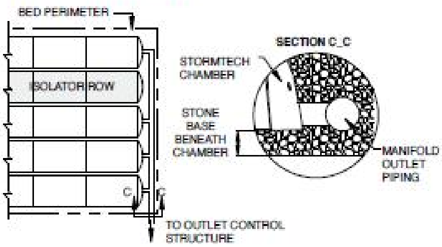
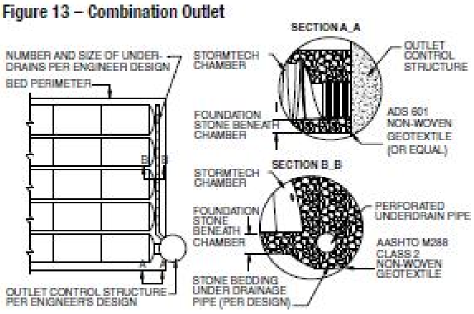


Figure 13 – Combination Outlet



26 Call StormTech at **860.529.8188** or **888.892.2694** or visit our website at **www.stormtech.com** for technical and product information.

9.0 Other Considerations

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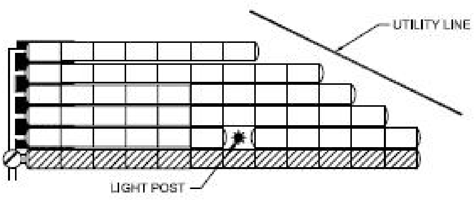
9.1 EROSION CONTROL
Erosion and sediment control measures must be integrated into the plan to protect the stormwater system both during and after construction. These practices may have a direct impact on the system's infiltration performance and longevity. Vegetation, temporary sediment barriers (silt fences, hay bales, fabric-wrapped catch basin grates), and strategic stormwater runoff management may be used to control erosion and sedimentation. StormTech recommends the use of pipe plugs on the inlet pipe until the system is in service.

9.2 SITE IMPROVEMENT TECHNIQUES
When site conditions are less than optimal, StormTech recognizes many methods for improving a site for construction. Some techniques include the removal and replacement of poor materials, the use of engineered subgrade materials, aggregates, chemical treatment, and mechanical treatments including the use of geosynthetics. StormTech recommends referring to AASHTO M 288 guidelines for the appropriate use of geotextiles.

StormTech also recognizes geogrid as a potential component of an engineered solution to improve site conditions or as a construction tool for the experienced contractor. StormTech chamber systems are compatible with the use of geosynthetics. The use of geosynthetics or any other site improvement method does not eliminate or modify any of StormTech's requirements. **It is the ultimate responsibility of the design engineer to ensure that site conditions are suitable for a StormTech chamber system.**

9.3 CONFORMING TO SITE CONSTRAINTS
StormTech chambers have the unique ability to conform to site constraints such as utility lines, light posts, large trees, etc. Rows of chambers can be ended short or interrupted by placing an end cap at the desired location, leaving the required number of chambers out of the row to get by the obstruction, then starting the row of chambers again with another end cap. See **Figure 14** for an example.

Figure 14 – Ability to Conform to Site Constraints



9.4 LINERS
StormTech chambers offer the distinct advantage and versatility that allow them to be designed as an open bottom detention or retention system. In fact, the vast majority of StormTech installations and designs are open bottom detention systems. Using an open bottom system enables treatment of the storm water through the underlying soils and provides a volume safety factor based on the infiltrative capacity of the underlying soils.

In some applications, however, open bottom detention systems may not be allowed. StormTech's Tech Sheet #2 provides guidance for the design and installation of thermoplastic liners for detention systems using StormTech chambers. The major points of the memo are:

- Infiltration of stormwater is generally a desirable stormwater management practice, often required by regulations. Lined systems should only be specified where unique site conditions preclude significant infiltration.
- Thermoplastic liners provide cost effective and viable means to contain stormwater in StormTech subsurface systems where infiltration is undesirable.
- PVC and LLDPE are the most cost effective, installed membrane materials.
- Enhanced puncture resistance from angular aggregate on the water side and from protrusions on the soil side can be achieved by placing a non-woven geotextile reinforcement on each side of the geomembrane. A sand underlayment in lieu of the geotextile reinforcement on the soil side may be considered when cost effective.
- StormTech does not design, fabricate, sell or install thermoplastic liners. StormTech recommends consulting with liner professionals for final design and installation advice.

Figure 15 – Chamber bed placed around light post.

10.0 System Sizing

For quick calculations, refer to the Site Calculator on StormTech's website at www.stormtech.com.

10.1 SYSTEM SIZING

The following steps provide the calculations necessary to size a system. If you need assistance determining the number of chambers per row or customizing the bed configuration to fit a specific site, call StormTech's Technical Services Department at 1-888-892-2694.

1) Determine the amount of storage volume (V_S) required.

It is the design engineer's sole responsibility to determine the storage volume required by local codes.

TABLE 10 - Storage Volume Per Chamber

	Bare Chamber Storage	Chamber and Stone Foundation Depth in. (mm)		
	ft³ (m³)	6 (150)	12 (300)	18 (450)
SC-160LP	6.85 (0.19)	15.0 (0.42)	17.9 (0.51)	20.9 (0.59)
SC-310	14.7 (0.4)	31.0 (0.9)	35.7 (1.0)	40.4 (1.1)
SC-740	45.9 (1.3)	74.9 (2.1)	81.7 (2.3)	88.4 (2.5)
	ft³ (m³)	9 (230)	12 (300)	18 (450)
DC-780	46.2 (1.3)	78.4 (2.2)	81.8 (2.3)	88.6 (2.5)

Note: Assumes 40% porosity for the stone plus the chamber volume.

2) Determine the number of chambers (C) required.

To calculate the number of chambers needed for adequate storage, divide the storage volume (V_S) by the volume of the selected chamber, as follows:
$C = V_S$ / Volume per Chamber

3) Determine the required bed size (S).

To find the size of the bed, multiply the number of chambers needed (C) by either:

StormTech SC-160LP
bed area per chamber = 14.8 ft² (1.3 m²)

StormTech SC-310
bed area per chamber = 23.7 ft² (2.2 m²)

StormTech SC-740 / DC-780
bed area per chamber = 33.8 ft² (3.1 m²)

S = (C x bed area per chamber) +
[1 foot (0.3 m) x bed perimeter in feet (meters)]
NOTE: It is necessary to add one foot (0.3 m) around the perimeter of the bed for end caps and working space.

4) Determine the amount of clean, crushed, angular stone (Vst) required.

TABLE 11 – Amount of Stone Per Chamber

	Stone Foundation Depth		
ENGLISH tons (yd³)	6"	12"	18"
SC-160LP	1.2 (0.9)	1.6 (1.2)	1.9 (1.4)
SC-310	2.1 (1.5)	2.7 (1.9)	3.4 (2.4)
SC-740	3.8 (2.8)	4.6 (3.3)	5.5 (3.9)
METRIC kg (m³)	150 mm	300 mm	450 mm
SC-160LP	1088 (0.7)	1452 (0.9)	1724 (1.0)
SC-310	1830 (1.1)	2490 (1.5)	2990 (1.8)
SC-740	3450 (2.1)	4170 (2.5)	4490 (3.0)
ENGLISH tons (yd³)	9"	12"	18"
DC-780	4.2 (3.0)	4.7 (3.3)	5.6 (3.9)
METRIC kg (m³)	230 mm	300 mm	450 mm
DC-780	3810 (2.3)	4264 (2.5)	5080 (3.0)

Note: Assumes 6" (150 mm) of stone above, and between chambers. For SC-310, SC-740 and DC-780 Chambers only.

To calculate the total amount of clean, crushed, angular stone required, multiply the number of chambers (C) by the selected weight of stone from **Table 11**.
NOTE: Clean, crushed, angular stone is also required around the perimeter of the system.

5) Determine the volume of excavation (Ex) required.
6) Determine the area of filter fabric (F) required.

TABLE 12 – Volume of Excavation Per Chamber

	Stone Foundation Depth yd³ (m³)		
	6" (150 mm)	12" (300 mm)	18" (450 mm)
SC-160LP	1.5 (1.1)	1.8 (1.3)	2.1 (1.5)
SC-310	2.9 (2.2)	3.4 (2.6)	3.8 (2.9)
SC-740	5.5 (4.2)	6.2 (4.7)	6.8 (5.2)
	9" (230 mm)	12" (300 mm)	18" (450 mm)
DC-780	5.9 (4.5)	6.3 (4.8)	6.9 (5.3)

Note: Assumes 6" (150 mm) of separation between chamber rows (no spacing for the SC-160LP) and 18" (450 mm) of cover. The volume of excavation will vary as the depth of the cover increases.

Each additional foot of cover will add a volume of excavation of 1.3 yds³ (1.0 m³) per SC-740 / DC-780, 0.9 yds3 (0.7 m3) per SC-310 chamber and 0.55 yds³ (0.4m³) per SC-160LP chamber.

The bottom and sides of the bed and the top of the embedment stone must be covered with ADS 601 (or equal) a non-woven geotextile (filter fabric). The area of the sidewalls must be calculated and a 2 foot (0.6 m) overlap must be included where two pieces of filter fabric are placed side-by-side or end-to-end. Geotextiles typically come in 15 foot (4.6 m) wide rolls.

7) Determine the number of end caps (E_C) required.

Each row of chambers requires two end caps.
E_C = number of rows x 2

11.0 Detail Drawings

StormTech

Figure 16 – 4" Inspection Port Detail

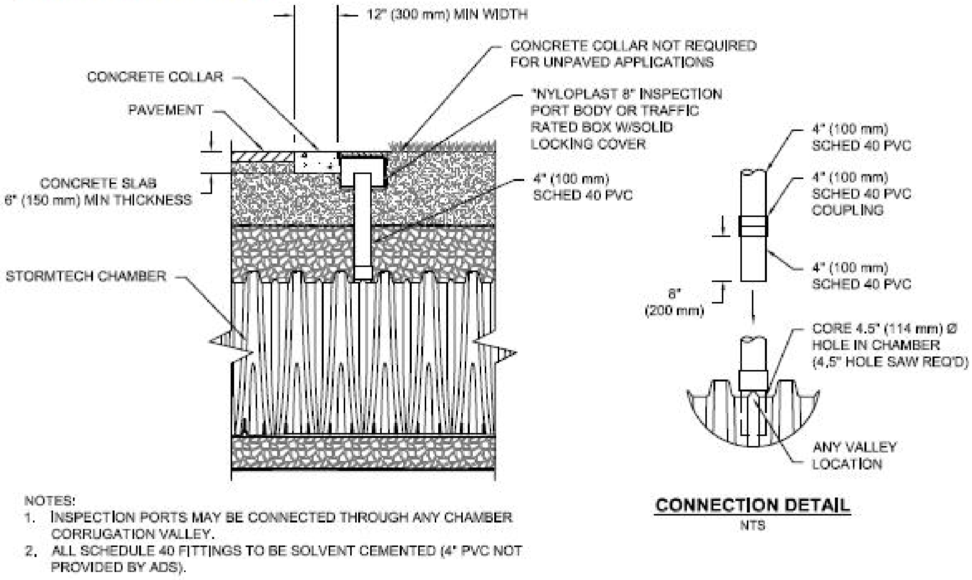
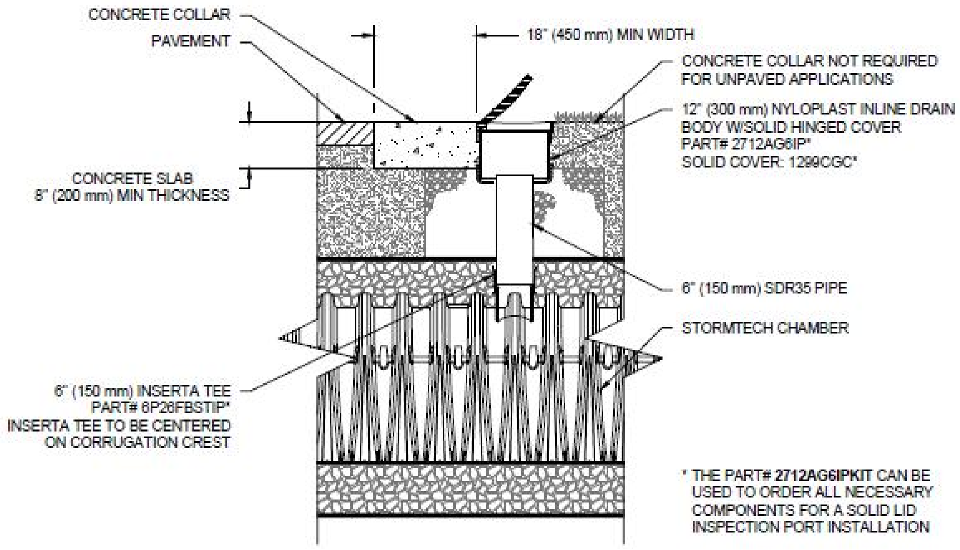


Figure 17 – 6" Inspection Port Detail



11.0 Detail Drawings

Figure 18 – Under Drain Detail

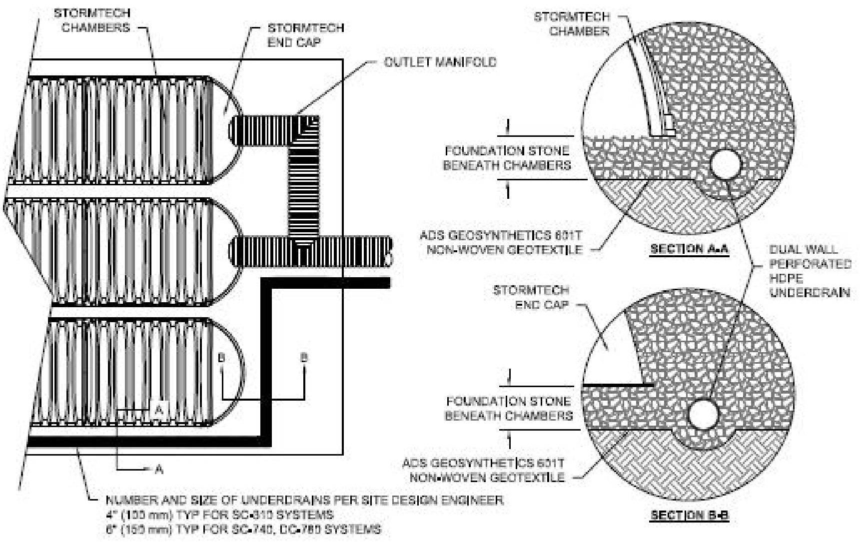
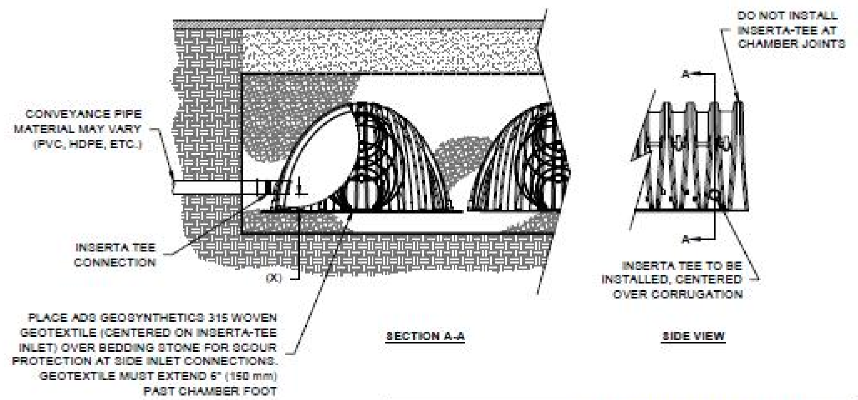


Figure 19 – INSERTA TEE Side Detail



CHAMBER	MAX DIAMETER OF INSERTA TEE	HEIGHT FROM BASE OF CHAMBER (X)
SC-310	6" (150 mm)	4" (100 mm)
SC-740	10" (250 mm)	4" (100 mm)
DC-780	10" (250 mm)	4" (100 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.

NOTE: SIDE INSERTA TEES CANNOT BE USED ON SC-160LP CHAMBERS.

30 Call StormTech at **860.529.8188** or **888.892.2694** or visit our website at **www.stormtech.com** for technical and product information.

12.0 Inspection and Maintenance

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12.1 ISOLATOR ROW INSPECTION

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

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

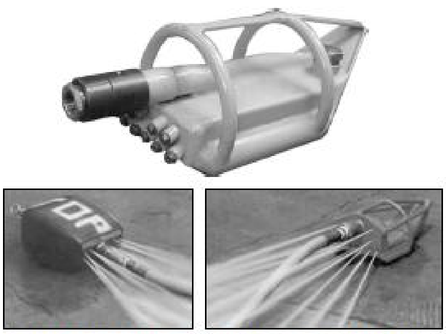
A StormTech Isolator Row should initially be inspected immediately after completion of the site's construction. While every effort should be made to prevent sediment from entering the system during construction, it is during this time that excess amounts of sediments are most likely to enter any stormwater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

12.2 ISOLATOR ROW MAINTENANCE

JetVac maintenance is recommended if sediment has been collected to an average depth of 3" (76 mm) inside the Isolator Row. More frequent maintenance may be required to maintain minimum flow rates through the Isolator Row. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, a wave of suspended sediments is flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/ JetVac combination vehicles. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" (1143 mm) are best. The JetVac process shall only be performed on StormTech Rows that have AASHTO class 1 woven geotextile over the foundation stone (ADS 315ST or equal).

Looking down the Isolator Row

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



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

12.0 Inspection & Maintenance

STORMTECH ISOLATOR™ ROW - STEP-BY-STEP MAINTENANCE PROCEDURES

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment

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

B) All Isolator Rows

i. Remove cover from manhole at upstream end of Isolator Row

ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Follow OSHA regulations for confined space entry if entering manhole
2. Mirrors on poles or cameras may be used to avoid a confined space entry

iii. If sediment is at or above the lower row of sidewall holes [approximately 3" (76 mm)] proceed to Step 2. If not proceed to Step 3.

Step 2) Clean out Isolator Row using the JetVac process

A) A fixed floor cleaning nozzle with rear facing nozzle spread of 45" (1143 mm) or more is preferable

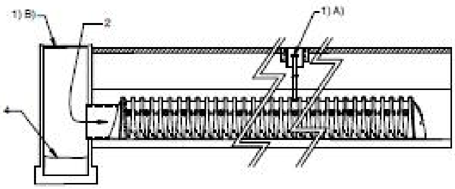
B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required during jetting

Step 3) Replace all caps, lids and covers

Step 4) Inspect and clean catch basins and manholes upstream of the StormTech system following local guidelines.

Figure 20 – StormTech Isolator Row (not to scale)



12.3 ECCENTRIC PIPE HEADER INSPECTION

Theses guidelines do not supercede a pipe manufacturer's recommended I&M procedures. Consult with the manufacturer of the pipe header system for specific I&M procedures. Inspection of the header system should be carried out quarterly. On sites which generate higher levels of sediment more frequent inspections may be necessary. Headers may be accessed through risers, access ports or manholes. Measurement of sediment may be taken with a stadia rod or similar device. Cleanout of sediment should occur when the sediment volume has reduced the storage area by 25% or the depth of sediment has reached approximately 25% of the diameter of the structure.

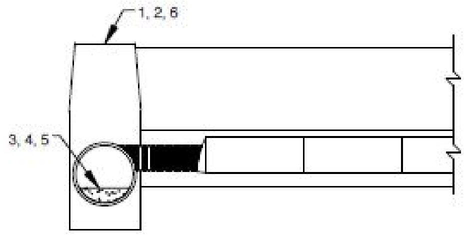
12.4 ECCENTRIC PIPE MANIFOLD MAINTENANCE

Cleanout of accumulated material should be accomplished by vacuum pumping the material from the header. Cleanout should be accomplished during dry weather. Care should be taken to avoid flushing sediments out through the outlet pipes and into the chamber rows.

Eccentric Header Step-by-Step Maintenance Procedures

1. Locate manholes connected to the manifold system
2. Remove grates or covers
3. Using a stadia rod, measure the depth of sediment
4. If sediment is at a depth of about 25% pipe volume or 25% pipe diameter proceed to step 5. If not proceed to step 6.
5. Vacuum pump the sediment. Do not flush sediment out inlet pipes.
6. Replace grates and covers
7. Record depth and date and schedule next inspection

Figure 21 – Eccentric Manifold Maintenance



Please contact StormTech's Technical Services Department at 888-892-2694 for a spreadsheet to estimate cleaning intervals.

32 Call StormTech at **860.529.8188** or **888.892.2694** or visit our website at **www.stormtech.com** for technical and product information.

13.0 General Notes

StormTech

1. StormTech ("StormTech") requires installing contractors to use and understand StormTech's latest Installation Instructions prior to beginning system installation.

2. Our Technical Services Department offers installation consultations to installing contractors. Contact our Technical Service Representatives at least 30 days prior to system installation to arrange a preinstallation 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 Installation Instructions.

3. StormTech's requirements for systems with pavement design (asphalt, concrete pavers, etc.): Minimum cover for the SC-740, DC-780 and SC-310 chambers is 18" (457 mm) not including pavement; Minimum cover for the SC-160LP chamber is 14" (350 mm); Maximum cover for the SC-740 and SC-310 chambers is 96" (2.4 m) including pavement design; Maximum cover for the SC-160LP chamber is 10' (3.0 m); Maximum cover for the DC-780 chamber is 12' (3.6 m) including pavement design. For installations that do not include pavement, where rutting from vehicles may occur, minimum required cover is 24" (610 mm), maximum cover is as stated above.

4. The contractor must report any discrepancies with the bearing capacity of the chamber foundation materials to the design engineer.

5. AASHTO M288 Class 2 non-woven geotextile (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's Installation Instructions.

7. Backfilling over the chambers must follow requirements as indicated in the most current version of StormTech's Installation Instructions.

8. The contractor must refer to StormTech's Installation Instructions for a Table of Acceptable Vehicle Loads at various depths of cover. This information is also available at StormTech's website: **www.stormtech.com**. The contractor is responsible for preventing vehicles that exceed StormTech's 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.

14.0 StormTech Product Specifications

1.0 GENERAL

1.1 StormTech chambers are designed to control storm water runoff. As a subsurface retention system, StormTech chambers retain and allow effective infiltration of water into the soil. As a subsurface detention system, StormTech chambers detain and allow for the metered flow of water to an outfall.

2.0 CHAMBER PARAMETERS

2.1 The Chamber shall be injection molded of an impact modified polypropylene or polyethylene copolymer to maintain adequate stiffness through higher temperatures experienced during installation and service.

2.2 The nominal chamber dimensions of the StormTech SC-740 and DC-780 shall be 30.0" (762 mm) tall, 51.0" (1295 mm) wide and 90.7" (2304 mm) long. The nominal chamber dimensions of the StormTech SC-310 shall be 16.0" (406 mm) tall, 34.0" (864 mm) wide and 90.7" (2304 mm) long. SC-160LP shall be 12"(305mm) tall, 25" (635 mm) wide and 90.7" (2304mm) long. The installed length of a joined chamber shall be 85.4" (2169 mm).

2.3 The chamber shall have a continuously curved section profile.

2.4 The chamber shall be open-bottomed.

2.5 The chamber shall incorporate an overlapping corrugation joint system to allow chamber rows of almost any length to be created. The overlapping corrugation joint system shall be effective while allowing a chamber to be trimmed to shorten its overall length.

2.6 The nominal storage volume of all StormTech chambers includes the volume of the clean, crushed, angular stone with an assumed 40% porosity. The nominal storage volume of a joined StormTech SC-740 chamber shall be 74.9 ft^3 (2.1 m^3) per chamber when installed per StormTech's typical details. This equates to a storage volume per unit area of bed of 2.2 ft^3/ft^2 (0.67 m^3/m^2). The nominal storage volume of a joined StormTech DC-780 chamber shall be 78.4 ft^3 (2.2 m^3) per chamber when installed per StormTech's typical details. This equates to a storage volume per unit area of bed of 2.3 ft^3/ft^2 (0.70 m3/m2). The nominal storage volume of a joined StormTech SC-310 chamber shall be 31.0 ft^3 (0.88 m^3) per chamber when installed per StormTech's typical details. This equates to a storage volume per unit area of bed of 1.3 ft^3/ft2 (0.40 m^3/m^2). The nominal storage volume of a joined StormTech SC-160LP chamber shall be 15 ft^3 (0.42 m^3) per chamber when installed per StormTech's typical details. This equates to a storage volume per unit area of bed of 1.0 ft^3/ft^3 (0.30 m^3/m^3).

2.7 The SC-740 and SC-310 chambers shall have forty eight orifices penetrating the sidewalls to allow for lateral conveyance of water.

2.8 The chamber shall have two orifices near its top to allow for equalization of air pressure between its interior and exterior.

2.9 The chamber shall have both of its ends open to allow for unimpeded hydraulic flows and visual inspections down a row's entire length.

2.10 The chamber shall have 14 corrugations.

2.11 The chamber shall be analyzed and designed using AASHTO methods for thermoplastic culverts contained in the LRFD Bridge Design Specifications, 2nd Edition, including Interim Specifications through 2001. Design live load shall be the AASHTO design truck. Design shall consider earth and live loads as appropriate for the minimum to maximum specified depth of fill.

2.12 The chamber shall be manufactured in an ISO 9001:2000 certified facility.

3.0 END CAP PARAMETERS

3.1 The end cap shall be designed to fit into any corrugation of a chamber, which allows: capping a chamber that has its length trimmed; segmenting rows into storage basins of various lengths.

3.2 The end cap shall have saw guides to allow easy cutting for various diameters of pipe that may be used to inlet the system.

3.3 The end cap shall have excess structural adequacies to allow cutting an orifice of any size at any invert elevation.

3.4 The primary face of an end cap shall be curved outward to resist horizontal loads generated near the edges of beds.

3.5 The end cap shall be manufactured in an ISO 9001:2000 certified facility.

15.0 Chamber Specifications for Contract Documents

SC-160LP STORMTECH CHAMBER SPECIFICATIONS

1. Chambers shall be Stormtech SC-160LP.
2. Chambers shall be arch-shaped and shall be manufactured from virgin, impact-modified polypropylene copolymers.
3. Chambers shall meet the requirements of ASTM F2418-16A, "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers"
4. Chamber rows shall provide continuous, unobstructed internal space with no internal supports that would impede flow or limit access for inspection.
5. 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.
6. Chambers shall be designed, tested and allowable load configurations determined in accordance with ASTM F2787, "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers". Load configurations shall include: 1) instantaneous (<1 min) AASHTO design truck live load on minimum cover 2) maximum permanent (75-yr) cover load and 3) allowable cover with parked (1-week) aashto design truck.
7. Requirements for handling and installation:
   - To maintain the width of chambers during shipping and handling, chambers shall have integral, interlocking stacking lugs.
   - To ensure a secure joint during installation and backfill, the height of the chamber joint shall not be less than 1.5".
   - To ensure the integrity of the arch shape during installation, a) the arch stiffness constant as defined in section 6.2.8 of ASTM F2418 shall be greater than or equal to 400 lbs/in/in. And b) to resist softening during hot, sunny installation conditions, chambers shall be produced from light, reflective gold or yellow colors.
8. Only chambers that are approved by the site design engineer will be allowed. The chamber manufacturer shall submit the following upon request to the site design engineer for approval before delivering chambers to the project site:
   - A structural evaluation sealed by a registered professional engineer that demonstrates that the safety factors are greater than or equal to 1.95 for dead load and 1.75 for live load, the minimum required by ASTM F2787 and by AASHTO for thermoplastic pipe.
   - A structural evaluation sealed by a registered professional engineer that demonstrates that the load factors specified in the AASHTO IRFD bridge design specifications, Section 12.12, are met. The 50 year creep modulus data specified in ASTM F2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.

Chambers and end caps shall be produced at an ISO 9001 certified manufacturing facility.

SC-310 STORMTECH CHAMBER SPECIFICATIONS

1. Chambers shall be Stormtech SC-310.
2. Chambers shall be arch-shaped and shall be manufactured from virgin, impact-modified polypropylene or polyethylene copolymers.
3. Chambers shall meet the requirements of ASTM F2922 (polethylene) or ASTM F2418-16A (polypropylene), "Standard Specification for Corrugated Wall Stormwater Collection Chambers"
4. Chamber rows shall provide continuous, unobstructed internal space with no internal supports that would impede flow or limit access for inspection.
5. The structural design of the chambers, the structural backfill, and the installation requirements shall ensure that the load factors specified in the AASHTO IRFD 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.
6. Chambers shall be designed, tested and allowable load configurations determined in accordance with ASTM F2787, "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers". Load configurations shall include: 1) instantaneous (<1 min) AASHTO design truck live load on minimum cover 2) maximum permanent (75-yr) cover load and 3) allowable cover with parked (1-week) AASHTO to design truck.
7. Requirements for handling and installation:
   - To maintain the width of chambers during shipping and handling, chambers shall have integral, interlocking stacking lugs.
   - To ensure a secure joint during installation and backfill, the height of the chamber joint shall not be less than 2".
   - To ensure the integrity of the arch shape during installation, a) the arch stiffness constant as defined in Section 6.2.8 of ASTM F2418 shall be greater than or equal to 400 lbs/in/in. And b) to resist softening during hot, sunny installation conditions, chambers shall be produced from light, reflective gold or yellow colors.
8. Only chambers that are approved by the site design engineer will be allowed. The chamber manufacturer shall submit the following upon request to the site design engineer for approval before delivering chambers to the project site:
   - A structural evaluation sealed by a registered professional engineer that demonstrates that the safety factors are greater than or equal to 1.95 for dead load and 1.75 for live load, the minimum required by ASTM F2787 and by AASHTO for thermoplastic pipe.
   - A structural evaluation sealed by a registered professional 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 F2418 must be used as part of the aashto structural evaluation to verify long-term performance.

Chambers and end caps shall be produced at an ISO 9001 certified manufacturing facility.

15.0 Chamber Specifications for Contract Documents

SC-740 STORMTECH CHAMBER SPECIFICATIONS

1. Chambers shall be Stormtech SC-740.
2. Chambers shall be arch-shaped and shall be manufactured from virgin, impact-modified polypropylene copolymers.
3. Chambers shall meet the requirements of ASTM F2418-16A, "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers"
4. Chamber rows shall provide continuous, unobstructed internal space with no internal supports that would impede flow or limit access for inspection.
5. 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.
6. Chambers shall be designed, tested and allowable load configurations determined in accordance with ASTM F2787, "Standard practice for structural design of Thermoplastic Corrugated Wall Stormwater Collection Chambers". Load configurations shall include: 1) instantaneous (<1 min) AASHTO design truck live load on minimum cover 2) maximum permanent (75-yr) cover load and 3) allowable cover with parked (1-week) AASHTO design truck.
7. Requirements for handling and installation:
   - To maintain the width of chambers during shipping and handling, chambers shall have integral, interlocking stacking lugs.
   - To ensure a secure joint during installation and backfill, the height of the chamber joint shall not be less than 2".
   - To ensure the integrity of the arch shape during installation, a) the arch stiffness constant as defined in Section 6.2.8 of ASTM F2418 shall be greater than or equal to 550 lbs/in/in. And b) to resist softening during hot, sunny installation conditions, chambers shall be produced from light, reflective gold or yellow colors.
8. Only chambers that are approved by the site design engineer will be allowed. The chamber manufacturer shall submit the following upon request to the site design engineer for approval before delivering chambers to the project site:
   - A structural evaluation sealed by a registered professional engineer that demonstrates that the safety factors are greater than or equal to 1.95 for dead load and 1.75 for live load, the minimum required by ASTM F2787 and by AASHTO for thermoplastic pipe.
   - A structural evaluation sealed by a registered professional engineer that demonstrates that the load factors specified in the AASHTO LRDF bridge design specifications, Section 12.12, are met. The 50 year creep modulus data specified in ASTM F2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.

Chambers and end caps shall be produced at an ISO 9001 certified manufacturing facility.

DC-780 STORMTECH CHAMBER SPECIFICATIONS

1. Chambers shall be Stormtech DC-780.
2. Chambers shall be arch-shaped and shall be manufactured from virgin, impact-modified polypropylene copolymers.
3. Chambers shall meet the requirements of ASTM F2418-16A, "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers"
4. Chamber rows shall provide continuous, unobstructed internal space with no internal supports that would impede flow or limit access for inspection.
5. 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.
6. Chambers shall be designed, tested and allowable load configurations determined in accordance with ASTM F2787, "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers". Load configurations shall include: 1) instantaneous (<1 min) AASHTO design truck live load on minimum cover 2) maximum permanent (75-yr) cover load and 3) allowable cover with parked (1-week) AASHTO design truck.
7. Requirements for handling and installation:
   - To maintain the width of chambers during shipping and handling, chambers shall have integral, interlocking stacking lugs.
   - To ensure a secure joint during installation and backfill, the height of the chamber joint shall not be less than 2".
   - To ensure the integrity of the arch shape during installation, a) the arch stiffness constant as defined in Section 6.2.8 of ASTM F2418 shall be greater than or equal to 550 lbs/in/in. And b) to resist softening during hot, sunny installation conditions, chambers shall be produced from light, reflective gold or yellow colors.
8. Only chambers that are approved by the site design engineer will be allowed. The chamber manufacturer shall submit the following upon request to the site design engineer for approval before delivering chambers to the project site:
   - A structural evaluation sealed by a registered professional engineer that demonstrates that the safety factors are greater than or equal to 1.95 for dead load and 1.75 for live load, the minimum required by ASTM F2787 and by AASHTO for thermoplastic pipe.
   - A structural evaluation sealed by a registered professional 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 F2418 must be used as part of the AASHTO structural evaluation to verify long-term performance.

Chambers and end caps shall be produced at an ISO 9001 certified manufacturing facility.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- 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 for Maintenance and Water Quality
- Chamber Separation Spacers
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Detention basins will require ongoing regular maintenance to ensure continuing operation to design performance standards, and all designers should provide detailed specifications and frequencies for the required maintenance activities along with likely machinery requirements and typical annual costs – within the Maintenance Plan. The treatment performance of bioretention systems is dependent on maintenance, and robust management plans will be required to ensure maintenance is carried out in the long term. Different designs will have different operation and maintenance requirements, but this section gives some generic guidance.

Maintenance of detention basins is relatively straightforward for landscape contractors, and typically there should only be a small amount of extra work (if any) required for a SuDS detention basin over and above what is necessary for standard public open space.

Maintenance responsibility for a basin should always be placed with an appropriate organisation. Adequate access should be provided to all detention basin areas for inspection and maintenance, including for appropriate equipment and vehicles. Litter and debris removal should be undertaken as part of general landscape maintenance for the site and before any other SuDS management task. All litter should be removed from site.

The major maintenance requirement for detention basins is usually mowing. Regular mowing in and around detention basins is only required along maintenance access routes, amenity areas (eg footpaths), across any embankment and across the main storage area. The remaining areas can be managed as 'meadow', unless additional management is required for landscape/amenity/recreational or aesthetic reasons.

Mowing should ideally retain grass lengths of 75-150 mm across the main "treatment" surface to assisting filtering pollutants and retaining sediments and to reduce the risk of flattening during runoff events. Longer lengths of vegetation may be appropriate, depending on the functionality of the component, and its associated design criteria and are not considered to pose a significant risk to functionality.

Shorter lengths may be required when recreational facilities form part of the basin, but in this case the basin will be dealing with exceedance flows only and not treatment.

Grass clippings should be disposed of off-site or outside the detention basin area to remove nutrients and pollutants. Where a detention basin has a small permanent pool at the outlet, its submerged and emergent aquatic vegetation should be managed as for ponds or wetlands. Plant management, to achieve the desired habitat effect, should be clearly specified in a maintenance schedule. All vegetation management activities should take account of the need to maximise biosecurity and prevent the spread of invasive species.

Occasionally sediment will need to be removed (eg once deposits exceed 25 mm in depth). Sediments excavated from a detention basin that receives runoff from residential or standard road and roof areas are generally not toxic or hazardous and can therefore be safely disposed of by either land application or landfilling. However, consultation should take place with the environmental regulator to confirm appropriate protocols. Sediment testing may be required before sediment excavation to determine its classification and appropriate disposal methods. For runoff from busy streets with high vehicle traffic, sediment testing will be essential. In the majority of cases, it will be acceptable to distribute the sediment on-site if there is an appropriate safe and acceptable location to do so. Any damage due to sediment removal or erosion and scour resulting from major events should be repaired and immediately reseeded or planted.

Table 1 provides guidance on the type of operational and maintenance requirements that may be appropriate. The list of actions is not exhaustive, and some actions may not always be required. Maintenance Plans and schedules should be developed during the design phase. Specific maintenance needs of the detention basins should be monitored, and maintenance schedules adjusted to suit requirements.

Many of the specific maintenance activities for detention basins can be undertaken as part of a general landscape management contract and therefore, if landscape management is already required at site, should have marginal cost implications. If basins are implemented within private property, owners should be educated on their routine maintenance needs, and should understand the long-term Maintenance Plan and any legally binding maintenance agreement.

Table 1 Operation and Maintenance requirements for Detention Basins

Maintenance Schedule	Required Action	Typical Frequency
Regular Maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season), or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn)
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)
	Manage wetland plants in outlet pool – where provided	Annually
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial Actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Appendix E

Capacity Check of Proposed Piped Drains (Outfalls “B” & “C”)

DBFL Consulting Engineers
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PHONE: +353 51 309 500 FAX: +353 51 844 913
DUBLIN OFFICE: Ormond House, Upper Ormond Quay, Dublin 7.
PONE: +353 1 400 4000
CORK OFFICE: Phoenix House, Monahan Road, Cork. Tel: +353 (0) 21 2024538
EMAIL: info@dbfl.ie SITE: www.dbfl.ie

Technical Note 170092-TN-003

Project:	SHD Colpe West	**Prepared by:**	Deirdre Walsh
Title:	Capacity Check of Piped Drains	**Date:**	11th October 2019
Client:	Shannon Homes Drogheda	**Job No:**	170092

1.0 INTRODUCTION

This technical note is prepared to confirm that the proposed 900mm diameter pipe under the link street (immediately west of Colpe Road) has been appropriately sized. This pipe intercepts the existing open drain to the west of Colpe Road and through the commercial development approved under LB180820 before connecting to the culvert (to be upgraded) under Mill Road. This drain originally drained lands to the south west of the railway line, however following development of these lands the catchment area greatly reduced and runoff to this ditch greatly reduced also;

The estimated catchment discharging to the culvert under Mill Road is outlined in Figure 1 below:

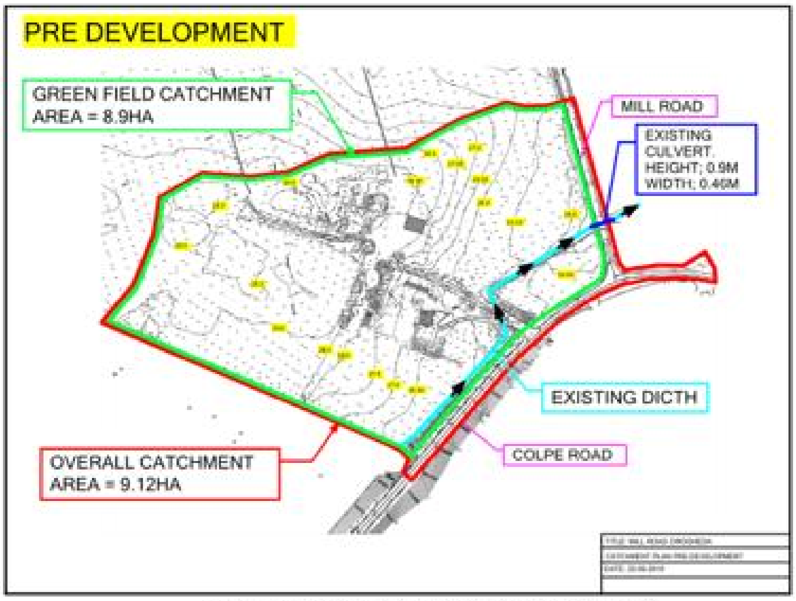

Figure 1: Catchment Plan for Mill Road Culvert – South East

2.0 Estimation of Surface Water Runoff

- **Estimation of Surface Water Runoff Pre-Development**

The quantity of surface water runoff from the catchment to the culvert is estimated as follows:

(i) Greenfield Runoff from Catchment using the FSR Method as follows:

Qbar from the undeveloped catchment is calculated using the Institute of Hydrology equation as follows:

- $Qbar\ (rural) = 0.00108 \times AREA^{0.89} \times SAAR^{1.17} \times Soil^{2.17}$

  Where:

  - Qbar (rural) is the mean catchment annual flow from a rural catchment in m^3/s;
  - AREA is the area of the catchment in km^2. For a catchment area less than 50ha, calculate Qbar for 50 ha and pro rata it;
  - SAAR is the standard average annual rainfall;
  - SOIL is the soil index, with 5 soil types used and SPR values (standard percentage runoff) applied to each soil type;

- Area = 50ha or $0.5km^2$;
- SAAR = 756mm
- The SPR values for the 5 soil types are as follows:

  Soil 1 = 0.1; Soil 2 = 0.3; Soil 3 = 0.37; Soil 4 = 0.47; Soil 5 = 0.53;

  A SPR value of 0.47 (Soil Type 4) is applied for the subject site. This is based on site specific soakaway testing, by GII, included as a standalone report, which indicated that the soil throughout the site are predominantly clay with generally no permeability. It should be noted that at planning stage Qbar was based on a conservative soil type of 3, however, soil type 4 is more representative of the existing runoff scenario;

- $Qbar\ (rural)\ 50\ ha = 0.00108 \times (0.5)^{0.89} \times (756)^{1.17} \times (0.47)^{2.17}$

= $0.2641\ m^3/s$ or 264.1l/s for 50ha;

= 47.0l/s for 8.9ha site = Q_{bar} or 5.2l/s/ha

(ii) Runoff from Colpe Road and Mill Road

estimated using the modified rational method as follows:

Q (runoff, l/s) = 2.71 x Rainfall Intensity (mm/hr) x Impermeable Area (ha)

- Rainfall Intensity for 1% AEP (Annual event Probability)
- Impermeable Area
  - Western side of Colpe Road; 335m x 3.8m = $1273m^2$
  - Mill Road – 181m x 5.6m = $1013.6m^2$
  - Total Impermeable Area = $2286.6m^2$ = 0.22866ha

(iii) Total Pre-Development Runoff for a 1 in 2-Year Return Period Event AEP Event

= (Greenfield Runoff from Qbar) + Runoff from Colpe Road & Mill Road
= 81.2l/s
(refer to Microdrainage calculation in *Appendix A* - calculated by inputting Qbar as a baseflow and by inputting the impermeable areas of Colpe Road and Mill Road discharging to the culvert.
Climate change = 10%)

- **Estimation of Surface Water Runoff Post-Development**

Post development, surface water runoff to this culvert from Catchment C (C1, C2, C3 & C4) is attenuated to Qbar, 14.64l/s for 4.649ha = 3.14l/s/ha including Colpe Road for up to a 1%AEP (Annual Event Probability). (Refer to Figure 2 below). This is significantly less than the existing scenario.

Taking the entire catchment area of 9.13ha, Qbar = 9.13ha x 3.14l/s/ha = 28.668l/s, which is significantly less than the capacity of the culvert which is estimated as 177.8l/s.

Post development, the runoff to this pipe will be significantly reduced as the allowable outflow from the developed site for a 1% AEP event, is capped at Qbar (i.e runoff from a 1 in 2.4 year return period).

3.0 CAPACITY OF 900MM DIAMETER PIPE UNDER LINK STREET

The capacity of the 900mm diameter pipe at a gradient of 1:500 = 887.1l/s – Figure 1.

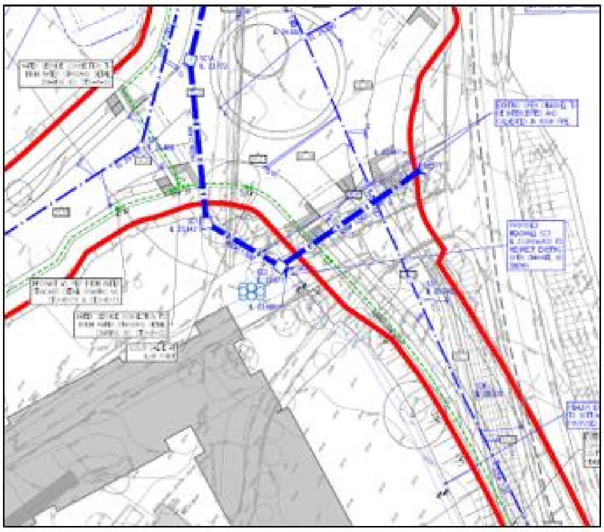

Figure 1: Extract of Site Services Plan (sheet 7) showing proposed piped drain

The capacity of the 900mm diameter pipe at a gradient of 1:105 under Mill Road = 1945.3l/s - replacing the existing culvert with a backdrop. Refer to Figure 2.

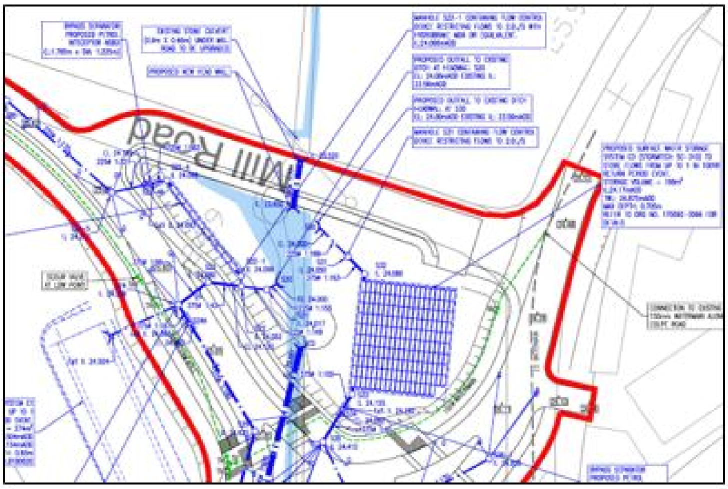

Figure 2: Extract of Site Services Plan (sheet 7) showing proposed upgrading of culvert under Mill Road

Refer to Appendix 'A' for calculations.

4.0 Capacity of 600mm diameter new surface outfall pipe on Mill Road - Outfall 'B'

Capacity of the 600mm outfall pipe = 848.5l/s. Refer to Appendix B for calculations.

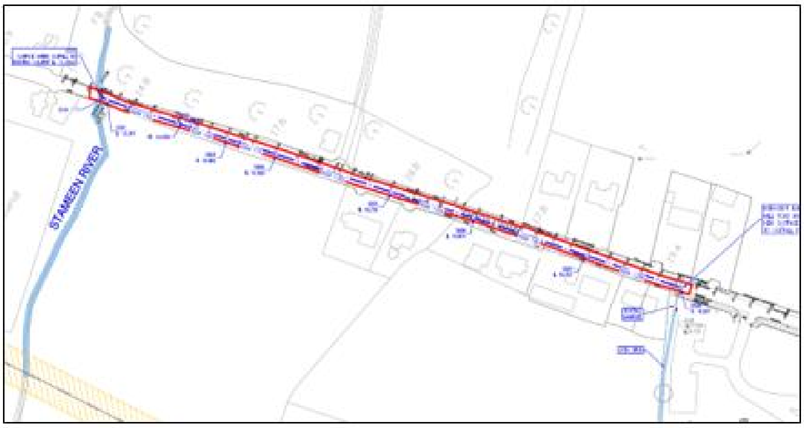

Figure 2: Extract of Surface Water Outfall Plan showing proposed surface water outfall pipe on Mill Road

Appendix A – Surface Water Calculations

For Pipe/ Culverted Drain - west of Colpe Road

DBFL Consulting Engineers		Page 1
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CAPACITY CULVERT/PIPED DRAIN	Micro Drainage
Date 11/10/2019 16:44 File 900 Culvert MARSH ROAD.mdx	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	14.900	Add Flow / Climate Change (%)	10
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	90	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
S1.000	15.000	0.143	105.0	0.228	5.00	47.0	0.600	o	900	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)
S1.000	44.86	5.08	23.650	0.228	47.0	0.0	7.5	3.06	1945.3	82.2

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DBFL Consulting Engineers		Page 1
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 CAPACITY CULVERT/PIPED DRAIN	Micro Drainage
Date 11/10/2019 16:43 File 900 Culvert.mdx	Designed by DCG Checked by DMW	
Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	14.900	Add Flow / Climate Change (%)	10
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	90	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
S1.000	15.000	0.030	500.0	0.228	5.00	47.0	0.600	o	900	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)
S1.000	44.54	5.18	100.000	0.228	47.0	0.0	7.5	1.39	887.1	82.0

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Appendix B – Surface Water Calculations

For Proposed Surface Water Outfall Pipe on Mill Road

DBFL Consulting Engineers		Page 1
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD OUTFALL DBFL REF: 170092	Micro Drainage
Date 09/10/2019 14:14 File Outfall pipe-22.08.2019...	Designed by AOS Checked by DMW	
Innovyze	Network 2018.1	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	14.900	Add Flow / Climate Change (%)	20
Ratio R	0.279	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	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
1.000	57.400	0.230	249.6	0.000	4.00	12.7	0.600	o	600	Pipe/Conduit	
1.001	68.200	0.850	80.2	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.002	49.200	0.154	319.5	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.003	69.500	0.217	320.3	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.004	29.700	0.424	70.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.005	29.800	0.452	65.9	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.006	43.100	0.653	66.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.007	4.400	0.067	66.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	46.43	4.62	16.957	0.000	12.7	0.0	2.5	1.54	434.6	15.2
1.001	44.99	5.04	16.727	0.000	12.7	0.0	2.5	2.72	769.2	15.2
1.002	43.10	5.64	15.877	0.000	12.7	0.0	2.5	1.36	383.7	15.2
1.003	40.73	6.50	15.723	0.000	12.7	0.0	2.5	1.36	383.2	15.2
1.004	40.29	6.67	15.506	0.000	12.7	0.0	2.5	2.91	823.7	15.2
1.005	39.88	6.83	15.082	0.000	12.7	0.0	2.5	3.00	848.9	15.2
1.006	39.31	7.07	14.000	0.000	12.7	0.0	2.5	3.00	848.4	15.2
1.007	39.25	7.10	13.347	0.000	12.7	0.0	2.5	3.00	848.4	15.2

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Appendix F

FOUL SEWER NETWORK CALCULATIONS

DBFL Consulting Engineers		Page 1
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 FOUL- CATCHMENT 1A	Micro Drainage
Date 04/10/2019 15:04 File 170092_FOUL 1A - 04.10....	Designed by AOS Checked by DMW	
Innovyze	Network 2018.1	

FOUL SEWERAGE DESIGN

Design Criteria for Foul - Unit

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00
Industrial Peak Flow Factor	0.00
Calculation Method	BS 8301
Frequency Factor	0.00
Domestic (l/s/ha)	0.00
Domestic Peak Flow Factor	6.00
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F1.000	58.840	0.210	280.2	0.000	10948.0	0.0	1.500	o	300	Pipe/Conduit	
F1.001	23.000	0.082	280.5	0.000	56.0	0.0	1.500	o	375	Pipe/Conduit	
F1.002	28.120	0.100	280.0	0.000	56.0	0.0	1.500	o	375	Pipe/Conduit	
F1.003	37.970	0.212	179.5	0.000	14.0	0.0	1.500	o	375	Pipe/Conduit	
F1.004	30.550	0.359	85.0	0.000	98.0	0.0	1.500	o	375	Pipe/Conduit	
F1.005	54.320	0.147	370.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
F1.006	40.400	0.109	370.0	0.000	28.0	0.0	1.500	o	375	Pipe/Conduit	
F1.007	6.120	0.017	370.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
F1.008	66.000	0.178	370.0	0.000	112.0	0.0	1.500	o	375	Pipe/Conduit	
F2.000	49.400	0.520	95.0	0.000	182.0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.000	26.037	0.000	0.0	10948.0	0.0	164	0.86	0.83	58.4	33.7
F1.001	25.827	0.000	0.0	11004.0	0.0	146	0.85	0.96	105.5	33.8
F1.002	25.745	0.000	0.0	11060.0	0.0	146	0.85	0.96	105.6	33.9
F1.003	25.645	0.000	0.0	11074.0	0.0	129	1.00	1.20	132.1	33.9
F1.004	25.433	0.000	0.0	11172.0	0.0	107	1.32	1.74	192.2	34.1
F1.005	25.074	0.000	0.0	11172.0	0.0	158	0.77	0.83	91.8	34.1
F1.006	24.927	0.000	0.0	11200.0	0.0	158	0.77	0.83	91.8	34.2
F1.007	24.818	0.000	0.0	11200.0	0.0	158	0.77	0.83	91.8	34.2
F1.008	24.801	0.000	0.0	11312.0	0.0	159	0.77	0.83	91.8	34.4
F2.000	25.990	0.000	0.0	182.0	0.0	55	0.77	0.90	15.9	4.5

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 FOUL- CATCHMENT 1A	Micro Drainage
Date 04/10/2019 15:04 File 170092_FOUL 1A - 04.10....	Designed by AOS Checked by DMW	
Innovyze	Network 2018.1	

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F2.001	48.500	0.722	67.2	0.000	98.0	0.0	1.500	o	225	Pipe/Conduit	
F1.009	5.350	0.014	370.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
F1.010	7.900	0.021	370.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
F1.011	65.900	0.178	370.0	0.000	112.0	0.0	1.500	o	375	Pipe/Conduit	
F3.000	35.000	0.368	95.1	0.000	112.0	0.0	1.500	o	150	Pipe/Conduit	
F3.001	52.700	0.527	100.0	0.000	182.0	0.0	1.500	o	225	Pipe/Conduit	
F3.002	58.000	0.682	85.0	0.000	126.0	0.0	1.500	o	225	Pipe/Conduit	
F1.012	28.700	0.078	370.0	0.000	42.0	0.0	1.500	o	375	Pipe/Conduit	
F1.013	15.100	0.041	370.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
F1.014	13.400	0.036	370.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
F1.015	51.400	0.139	370.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
F1.016	6.800	0.018	370.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F2.001	25.395	0.000	0.0	280.0	0.0	46	0.87	1.40	55.7	5.1
F1.009	24.523	0.000	0.0	11592.0	0.0	160	0.78	0.83	91.8	34.9
F1.010	24.509	0.000	0.0	11592.0	0.0	160	0.78	0.83	91.8	34.9
F1.011	24.487	0.000	0.0	11704.0	0.0	160	0.78	0.83	91.8	35.1
F3.000	26.120	0.000	0.0	112.0	0.0	52	0.75	0.90	15.9	4.0
F3.001	25.677	0.000	0.0	294.0	0.0	51	0.76	1.15	45.6	5.2
F3.002	25.150	0.000	0.0	420.0	0.0	52	0.83	1.25	49.5	5.8
F1.012	24.309	0.000	0.0	12166.0	0.0	163	0.78	0.83	91.8	35.9
F1.013	24.232	0.000	0.0	12166.0	0.0	163	0.78	0.83	91.8	35.9
F1.014	24.191	0.000	0.0	12166.0	0.0	163	0.78	0.83	91.8	35.9
F1.015	24.154	0.000	0.0	12166.0	0.0	163	0.78	0.83	91.8	35.9
F1.016	24.016	0.000	0.0	12166.0	0.0	163	0.78	0.83	91.8	35.9

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF: 170092 FOUL- CATCHMENT 1A	Micro Drainage
Date 04/10/2019 15:04 File 170092_FOUL 1A - 04.10....	Designed by AOS Checked by DMW	
Innovyze	Network 2018.1	

Manhole Schedules for Foul - Unit

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
F16	27.600	1.563	Open Manhole	1200	F1.000	26.037	300				
F15	27.820	1.993	Open Manhole	1350	F1.001	25.827	375	F1.000	25.827	300	
F14	27.880	2.135	Open Manhole	1350	F1.002	25.745	375	F1.001	25.745	375	
F13	27.600	1.955	Open Manhole	1350	F1.003	25.645	375	F1.002	25.645	375	
F12	27.070	1.637	Open Manhole	1350	F1.004	25.433	375	F1.003	25.433	375	
F6	27.500	2.426	Open Manhole	1350	F1.005	25.074	375	F1.004	25.074	375	
F11	27.990	3.063	Open Manhole	1350	F1.006	24.927	375	F1.005	24.927	375	
F10	28.460	3.642	Open Manhole	1350	F1.007	24.818	375	F1.006	24.818	375	
F9	28.250	3.449	Open Manhole	1350	F1.008	24.801	375	F1.007	24.801	375	
F8-2	27.110	1.120	Open Manhole	1200	F2.000	25.990	150				
F8-1	27.280	1.885	Open Manhole	1200	F2.001	25.395	225	F2.000	25.470	150	
F8	27.590	3.067	Open Manhole	1350	F1.009	24.523	375	F1.008	24.623	375	100
								F2.001	24.673	225	
F7	27.650	3.141	Open Manhole	1350	F1.010	24.509	375	F1.009	24.509	375	
F6	27.590	3.103	Open Manhole	1350	F1.011	24.487	375	F1.010	24.487	375	
F5-3	27.080	0.960	Open Manhole	1200	F3.000	26.120	150				
F5-2	26.950	1.273	Open Manhole	1200	F3.001	25.677	225	F3.000	25.752	150	
F5-1	27.170	2.020	Open Manhole	1200	F3.002	25.150	225	F3.001	25.150	225	
F5	27.200	2.891	Open Manhole	1350	F1.012	24.309	375	F1.011	24.309	375	
								F3.002	24.468	225	9
F4	27.000	2.768	Open Manhole	1350	F1.013	24.232	375	F1.012	24.232	375	
F3	26.680	2.489	Open Manhole	1350	F1.014	24.191	375	F1.013	24.191	375	
F2	26.790	2.636	Open Manhole	1350	F1.015	24.154	375	F1.014	24.154	375	
F1	26.700	2.684	Open Manhole	1350	F1.016	24.016	375	F1.015	24.016	375	
F0	0.000		Open Manhole	0		OUTFALL		F1.016	23.997	375	

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DBFL Consulting Engineers		Page 1
Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF:170092 FOUL- CATCHMENT 1B	Micro Drainage
Date 04/10/2019 15:32 File 170092_FOUL 1B. i.mdx	Designed by AOS Checked by DMW	
Innovyze	Network 2018.1	

FOUL SEWERAGE DESIGN

Design Criteria for Foul - Unit

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00
Industrial Peak Flow Factor	0.00
Calculation Method	BS 8301
Frequency Factor	0.00
Domestic (l/s/ha)	0.00
Domestic Peak Flow Factor	6.00
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F1.000	7.300	0.104	70.2	0.000	28.0	0.0	1.500	o	150	Pipe/Conduit	
F1.001	80.600	0.971	83.0	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
F1.002	77.700	0.863	90.0	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
F1.003	61.200	0.680	90.0	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
F1.004	34.100	0.379	90.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F2.000	89.800	1.056	85.0	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
F2.001	81.000	0.810	100.0	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
F2.002	44.800	0.427	104.9	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
F1.005	57.400	0.442	129.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.000	26.250	0.000	0.0	28.0	0.0	41	0.77	1.05	18.5	3.0
F1.001	26.071	0.000	0.0	168.0	0.0	45	0.78	1.26	50.1	4.4
F1.002	25.100	0.000	0.0	308.0	0.0	50	0.79	1.21	48.1	5.3
F1.003	24.237	0.000	0.0	392.0	0.0	52	0.81	1.21	48.1	5.7
F1.004	23.557	0.000	0.0	392.0	0.0	52	0.81	1.21	48.1	5.7
F2.000	25.843	0.000	0.0	140.0	0.0	45	0.76	1.25	49.5	4.3
F2.001	24.787	0.000	0.0	280.0	0.0	51	0.76	1.15	45.6	5.1
F2.002	23.977	0.000	0.0	364.0	0.0	54	0.76	1.12	44.6	5.5
F1.005	23.177	0.000	0.0	756.0	0.0	64	0.76	1.01	40.0	7.2

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Ormond House Upper Ormond Quay Dublin 7	LANDS AT MILL/MARSH ROAD DBFL REF:170092 FOUL- CATCHMENT 1B	Micro Drainage
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Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F3.000	32.600	0.313	104.0	0.000	420.0	0.0	1.500	o	225	Pipe/Conduit	
F4.000	53.600	0.631	84.9	0.000	84.0	0.0	1.500	o	150	Pipe/Conduit	
F3.001	67.700	0.542	125.0	0.000	378.0	0.0	1.500	o	225	Pipe/Conduit	
F5.000	6.000	0.100	60.0	0.000	14.0	0.0	1.500	o	150	Pipe/Conduit	
F6.000	56.000	0.747	75.0	0.000	56.0	0.0	1.500	o	150	Pipe/Conduit	
F5.001	23.400	0.418	56.0	0.000	14.0	0.0	1.500	o	150	Pipe/Conduit	
F3.002	64.700	0.404	160.1	0.000	420.0	0.0	1.500	o	225	Pipe/Conduit	
F1.006	25.280	0.149	170.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F1.007	20.300	0.119	170.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F3.000	25.750	0.000	0.0	420.0	0.0	55	0.77	1.13	44.8	5.8
F4.000	24.258	0.000	0.0	84.0	0.0	49	0.77	0.95	16.8	3.8
F3.001	23.552	0.000	0.0	882.0	0.0	66	0.79	1.03	40.8	7.6
F5.000	25.550	0.000	0.0	14.0	0.0	36	0.77	1.13	20.0	2.6
F6.000	24.250	0.000	0.0	56.0	0.0	45	0.78	1.01	17.9	3.5
F5.001	23.503	0.000	0.0	84.0	0.0	44	0.89	1.17	20.7	3.8
F3.002	23.010	0.000	0.0	1386.0	0.0	78	0.76	0.91	36.0	9.4
F1.006	22.606	0.000	0.0	2142.0	0.0	90	0.79	0.88	35.0	11.8
F1.007	22.457	0.000	0.0	2142.0	0.0	90	0.79	0.88	34.9	11.8

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Manhole Schedules for Foul - Unit

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backd (mm)
F822	27.390	1.140	Open Manhole	1200	F1.000	26.250	150				
F821	27.300	1.229	Open Manhole	1200	F1.001	26.071	225	F1.000	26.146	150	
F820	26.970	1.870	Open Manhole	1200	F1.002	25.100	225	F1.001	25.100	225	
F819	27.200	2.963	Open Manhole	1200	F1.003	24.237	225	F1.002	24.237	225	
F818	25.380	1.823	Open Manhole	1200	F1.004	23.557	225	F1.003	23.557	225	
F817-3	27.220	1.377	Open Manhole	1200	F2.000	25.843	225				
F817-2	26.400	1.613	Open Manhole	1200	F2.001	24.787	225	F2.000	24.787	225	
F817-1	26.390	2.413	Open Manhole	1200	F2.002	23.977	225	F2.001	23.977	225	
F817	25.320	2.143	Open Manhole	1200	F1.005	23.177	225	F1.004	23.178	225	
								F2.002	23.550	225	[illegible]
F816-2-1	26.690	0.940	Open Manhole	1200	F3.000	25.750	225				
F816-3	25.450	1.192	Open Manhole	1200	F4.000	24.258	150				
F12	26.290	2.738	Open Manhole	1200	F3.001	23.552	225	F3.000	25.437	225	1
								F4.000	23.627	150	
F816-1-1A	26.750	1.200	Open Manhole	1200	F5.000	25.550	150				
F816-1-2	25.600	1.350	Open Manhole	1200	F6.000	24.250	150				
F816-1-1	26.800	3.297	Open Manhole	1200	F5.001	23.503	150	F5.000	25.450	150	1
								F6.000	23.503	150	
F816-1	26.170	3.160	Open Manhole	1200	F3.002	23.010	225	F3.001	23.010	225	
								F5.001	23.085	150	
F816	25.140	2.534	Open Manhole	1200	F1.006	22.606	225	F1.005	22.735	225	[illegible]
								F3.002	22.606	225	
F815	24.000	1.543	Open Manhole	1200	F1.007	22.457	225	F1.006	22.457	225	
F20	0.000		Open Manhole	0		OUTFALL		F1.007	22.338	225	

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FOUL SEWERAGE DESIGN

Design Criteria for Foul - Unit

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00
Industrial Peak Flow Factor	0.00
Calculation Method	BS 8301
Frequency Factor	0.00
Domestic (l/s/ha)	0.00
Domestic Peak Flow Factor	6.00
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.200
Maximum Backdrop Height (m)	1.500
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F1.000	44.000	0.489	90.0	0.000	252.0	0.0	1.500	o	225	Pipe/Conduit	
F1.001	28.600	0.272	105.1	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
F2.000	53.200	0.665	80.0	0.000	56.0	0.0	1.500	o	150	Pipe/Conduit	
F1.002	17.000	0.155	109.7	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
F3.000	43.830	0.404	108.6	0.000	420.0	0.0	1.500	o	225	Pipe/Conduit	
F1.003	6.900	0.049	141.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F1.004	50.900	0.328	155.2	0.000	378.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.000	21.489	0.000	0.0	252.0	0.0	49	0.78	1.21	48.1	5.0
F1.001	21.000	0.000	0.0	336.0	0.0	53	0.76	1.12	44.5	5.4
F2.000	21.650	0.000	0.0	56.0	0.0	46	0.76	0.98	17.3	3.5
F1.002	20.728	0.000	0.0	420.0	0.0	56	0.76	1.10	43.6	5.8
F3.000	22.900	0.000	0.0	420.0	0.0	55	0.76	1.10	43.8	5.8
F1.003	20.573	0.000	0.0	840.0	0.0	67	0.75	0.97	38.4	7.5
F1.004	20.524	0.000	0.0	1218.0	0.0	75	0.76	0.92	36.6	8.8

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Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F4.000	42.500	0.404	105.1	0.000	378.0	0.0	1.500	o	225	Pipe/Conduit	
F5.000	59.550	0.602	99.0	0.000	154.0	0.0	1.500	o	150	Pipe/Conduit	
F4.001	11.400	0.380	30.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F1.005	43.600	0.242	180.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F1.006	58.000	0.322	180.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F4.000	22.900	0.000	0.0	378.0	0.0	54	0.77	1.12	44.5	5.6
F5.000	21.500	0.000	0.0	154.0	0.0	54	0.75	0.88	15.6	4.4
F4.001	20.823	0.000	0.0	532.0	0.0	42	1.23	2.10	83.5	6.3
F1.005	20.196	0.000	0.0	1750.0	0.0	86	0.75	0.85	34.0	10.5
F1.006	19.954	0.000	0.0	1750.0	0.0	86	0.75	0.85	34.0	10.5

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Manhole Schedules for Foul - Unit

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdr (mm)
F814-7	22.810	1.321	Open Manhole	1200	F1.000	21.489	225				
F814-6	23.850	2.850	Open Manhole	1200	F1.001	21.000	225	F1.000	21.000	225	
F814-5-1	23.000	1.350	Open Manhole	1200	F2.000	21.650	150				
F814-5	24.730	4.002	Open Manhole	1200	F1.002	20.728	225	F1.001	20.728	225	
								F2.000	20.985	150	[illegible]
F814-4-1	26.250	3.350	Open Manhole	1200	F3.000	22.900	225				
F814-4	24.887	4.314	Open Manhole	1200	F1.003	20.573	225	F1.002	20.573	225	
								F3.000	22.496	225	1[illegible]
F814-3	24.730	4.206	Open Manhole	1200	F1.004	20.524	225	F1.003	20.524	225	
F814-2-1A	23.960	1.060	Open Manhole	1200	F4.000	22.900	225				
F814-2-2	22.400	0.900	Open Manhole	1200	F5.000	21.500	150				
F814-2-1	23.490	2.667	Open Manhole	1200	F4.001	20.823	225	F4.000	22.496	225	1[illegible]
								F5.000	20.898	150	
F814-2	23.950	3.754	Open Manhole	1200	F1.005	20.196	225	F1.004	20.196	225	
								F4.001	20.443	225	[illegible]
F814-1	24.760	4.806	Open Manhole	1200	F1.006	19.954	225	F1.005	19.954	225	
F	0.000		Open Manhole	0		OUTFALL		F1.006	19.632	225	

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Appendix G

FOUL PUMPING STATION CALCULATIONS

(A) CALCULATION OF DESIGN FLOWS

IW Loading Standards	=	446 l/dwelling/day
Dwelling + Creche Equilvalent	=	275 Units
Development Loading	=	122,650.00 l/day

			Total
Dry Weather Flow (DWF)		=	122,650 l/day
		=	1.420 l/s
		=	0.00142 m^3/s
		=	122.65 m^3/day
	3 x DWF	=	4.25868 l/s
	6 x DWF	=	8.51736 l/s
Size of Existing Rising Main		=	100 mm dia
Hydraulic gradient		=	1 in 85
Capacity		=	7 l/s
Velocity		=	0.833 m/s
Note: Capacity of existing pumps		=	7 l/s

(B) DELIVERY HEAD

Static Lift	=	3.2 m
Hydraulic gradient	=	1 in 85
Friction Loss in 280m long Rising Main	=	3.3 m
Station Losses	=	3 m
Total Delivery Head Required	=	9.5 m

(C) SEPTICITY IN RISING MAIN

Length of Rising Main	=	280 m
Volume of Rising Main	=	2.20 m^3
Turnover per day	=	55.8 times/day
Time Interval between clearing of Main	=	0.43 hours
	=	26 mins

(D) STORAGE REQUIREMENTS

Provide 12 hour storage	=	61 m^3

Appendix H

IRISH WATER STATEMENT OF DESIGN ACCEPTANCE & CONFIRMATION OF FEASIBILITY

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na Cathrach Theas
Cathair Chorcaí

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

Dermot Grogan
DBFL
Ormond House Upper
Ormond Quay
Dublin 7

8 October 2019

Re: Design Submission for Strategic Housing Development at Colpe West, Drogheda, Co. Meath (the "Design Submission") / Connection Reference No: 4211898364

Dear Dermot,

Many thanks for your recent Design Submission.

We have reviewed your proposal for the connection(s) at the Development. Based on the information provided, which included the documents outlined in Appendix A to this letter, Irish Water has no objection to your proposals.

This letter does not constitute an offer, in whole or in part, to provide a connection to any Irish Water infrastructure. Before you can connect to our network you must sign a connection agreement with Irish Water. This can be applied for by completing the connection application form at www.water.ie/connections. Irish Water's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation of Utilities (CRU)(https://www.cru.ie/document_group/irish-waters-water-charges-plan-2018/).

You the Customer (including any designers/contractors or other related parties appointed by you) is entirely responsible for the design and construction of all water and/or wastewater infrastructure within the Development which is necessary to facilitate connection(s) from the boundary of the Development to Irish Water's network(s) (the "**Self-Lay Works**"), as reflected in your Design Submission. Acceptance of the Design Submission by Irish Water does not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.

If you have any further questions, please contact your Irish Water representative:
Name: Fionán Ginty
Phone: 01 8925734
Email: fginty@water.ie

Yours sincerely,

M O'Dwyer

Maria O'Dwyer
Connections and Developer Services

Stiúrthóirí / Directors: Cathal Marley (Chairman), Niall Gleeson, Eamon Gallen, Brendan Murphy, Michael G. O'Sullivan
Oifig Chláraithe / Registered Office: Teach Colvill, 24-26 Sráid Thalbóid, Baile Átha Cliath 1, D01 NP86 / Colvill House, 24-26 Talbot Street, Dublin 1, D01 NP86
Is cuideachta ghníomhaíochta ainmnithe atá faoi theorainn scaireanna é Uisce Éireann / Irish Water is a designated activity company, limited by shares.
Uimhir Chláraithe in Éirinn / Registered in Ireland No.: 530363

REV008

Appendix A

Document Title & Revision

- 170092-3050 Rev.A
- 170092-3051 Rev.C
- 170092-3052 Rev.B
- 170092-3053 Rev.C
- 170092-3054
- 170092-3055
- 170092-3056
- 170092-3057
- 170092-3091
- 170092-3092
- 170092-3093
- 170092-3094
- 170092-3095

Standard Details/Code of Practice Exemption: N/A

For further information, visit www.water.ie/connections

Notwithstanding any matters listed above, the Customer (including any appointed designers/contractors, etc.) is entirely responsible for the design and construction of the Self-Lay Works. Acceptance of the Design Submission by Irish Water will not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.

Letter Ref: CUST17874

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Dublin 1
Ireland

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www.water.ie

Dermot Grogan
DBFL
Ormond House Upper
Ormond Quay
Dublin 7

29-Dec-17

Dear Sir/Madam,

Re: 4211898364 pre-connection enquiry - Subject to contract | Contract denied
Connection for 380 unit residential at Mill/Marsh Road, Drogheda, Co. Louth

Irish Water has reviewed your pre-connection enquiry in relation to
water and wastewater connections at Mill/Marsh Road, Drogheda, Co. Louth
Based upon the details you have provided with your pre-connection enquiry and on the capacity currently available as assessed by Irish Water, we wish to advise you that, subject to a valid connection agreement being put in place, your proposed connection to the Irish Water network can be facilitated.

Strategic Housing Development
Irish Water notes that the scale of this development dictates that it is subject to the Strategic Housing Development planning process. Therefore:

A. In advance of submitting your full application to An Bord Pleanala for assessment, you must have reviewed this development with Irish Water and received a Statement of Design Acceptance in relation to the layout of water and wastewater services. B. You are advised that this correspondence does not constitute an offer in whole or in part to provide a connection to any Irish Water infrastructure and is provided subject to a connection agreement being signed at a later date.

In order to accomodate the proposed water connection at the development, upgrade works are required to increase the capacity of the Irish Water network. Works to include upgrading approx 950m of 150mm pipework. Irish Water does not currently have any plans to carry out the works required to provide the necessary upgrade and capacity. Should you wish to have such upgrade works progressed, Irish Water will require you to provide a contribution of a relevant portion of the costs for the required upgrades, please contact Irish Water to discuss this further.

A connection agreement can be applied for by completing the connection application form available at **www.water.ie/connections**. Irish Water's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation for Utilities.

If you have any further questions, please contact Fionán Ginty from the design team on 018925734 or email fginty@water.ie. For further information, visit **www.water.ie/connections**

Yours sincerely,

Maria O'Dwyer
Connections and Developer Services