Warehousing/Logistics, Office & Cafe/Restaurant Development at Calmount Road

Engineering Services Report

210175-DBFL-XX-XX-RP-C-0001

INFRASTRUCTURE

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DBFL CONSULTING ENGINEERS

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1 INTRODUCTION

DBFL are providing civil, structural and traffic engineering design services on behalf of Blackwin Limited for a proposed warehousing / logistical development comprising of 5 no. warehousing /logistic units, 3 no. 3 storey own-door office buildings, 1 no. café/restaurant unit, associated roads, car parking, services yards, landscaping and all associated development on a vacant infill site to the north of Calmount Road and west of Ballymount Avenue, Ballymount Industrial Estate, Dublin 12.

Industrial and commercial units border the site to the north and west respectively. The site is currently a vacant, infill site and consists of a grassed area, with an industrial, enterprise and employment development objective. The applicant's land has an area of approximately 7.1ha with a redline boundary extending to 7.45ha, the site falls in a north easterly direction at a gradient of 1:40.

Figure 1-1 Proposed Site Boundary

1.1 Proposed Development

The proposed development consists of the following:

- Construction of 5 no. warehouse / logistics units (Units 1, 2 3, 4 and 6), including ancillary office use and entrance / reception areas over two levels, with maximum heights of c. 17.09 metres and a combined total gross floor area (GFA) of 20,158 sq.m;
- Each warehouse / logistics unit includes car parking to the front, and service yards, including HGV loading bays, to the rear of each unit. Signage zones are proposed for each unit. A total of 200 no. car parking spaces and 110 no. cycle spaces are provided for the 5 no. warehouse / logistics units;
- Construction of 3 no. 3 storey own-door office buildings (Block 5A, 5B and 5C) with maximum heights of c. 13.45 metres and a combined GFA of 4,194 sq.m. Signage zones are proposed at the entrances to the buildings. A total of 77 no. car parking spaces and 50 no. cycle parking spaces are provided for the proposed office buildings;
- Construction of a café/restaurant unit with a maximum height of c. 6.09m and a GFA of 213 sq.m to be located in the south western section of the site. The proposal includes signage for the unit, associated outdoor seating and a bin store. 14 no. car parking spaces and 10 no. cycle spaces are provided for the café/restaurant unit;
- The proposal includes 5 no. ESB substation buildings;
- The development is to be accessed off Ballymount Avenue and Calmount Road and includes for alterations and upgrades to the public footpaths and road. The development provides for vehicular and service access points, associated internal access roads, circulation areas and footpaths; and
- The proposal includes landscaping and planting, entrance signage, boundary treatments, lighting, PV panels, green roofs, underground foul and storm water drainage network, including connections to the foul and surface water drainage network on the public roads, attenuation areas and all associated site works and development.

The proposed associated site infrastructure will include foul sewers, surface water sewers, water mains, drainage, internal roads and footpaths, car parking spaces and bicycle spaces, public open space, landscaping, street lighting, walls and fences.

The purpose of this report is to provide information on the existing services, initial calculations for the provision of proposed services, estimates and assumptions that will be used to design the following main infrastructure components:

- Foul drainage.
- Surface water drainage (including SuDS features)
- Potable water supply.
- Roads, cycle paths and footpaths.

A site-specific flood risk assessment (210175 – DBFL – XX – XX – RP – C - 0002) will also be referenced and reported on in this report and will be submitted under a separate cover.

2 FOUL SEWERS

2.1 Existing Services

There is an existing 300mm diameter foul sewer main located to the south east of the proposed development within Calmount Road. It is proposed to connect the foul sewer from the proposed development by means of a gravity network to the aforementioned foul sewer.

Figure 2-1 Existing Foul Water Sewer Infrastructure

Refer to attached Appendix A for existing Irish Water infrastructure maps showing the full extent of the existing public sewers in the area.

A pre-connection enquiry has been submitted to Irish Water to confirm the feasibility of the proposed connection to the existing foul sewer network, in line with SDCC development plan IE1 Objective 1 & 2.

2.2 Proposed Services

It is proposed to discharge foul water from the development to the existing 300mm diameter sewer to the south-east of the development. Individual units will be drained via internal foul drainage systems to deposit foul flows in the proposed foul sewer. A network of 150mm drains and 225mm diameter foul sewer gravity mains will service the development's units, collecting foul flows from each unit and draining from west to east to the proposed outfall in Calmount Road, east of the existing roundabout.

Foul sewers have been designed and will be constructed in accordance with the Irish Water's 'Standard Details for Wastewater Infrastructure' and 'Code of practice for Wastewater Infrastructure'. In addition, foul sewers have been designed to Building Regulations and specifically in accordance with the principles and methods set out in EN 752:2008 and DOE 'Recommendations for Site Development Works'. In addition, HR Wallingford 'Tables for the hydraulic design of pipes, sewers and channels' and Water UK/WRc 'Sewers for Adoption – 6th Edition' have been applied. Values for roughness of uPVC pipes were obtained from Wallingford "Tables for the Hydraulic Design of Pipes, Sewers and Channels" and Wavin sewer systems catalogue.

Foul sewers are sized using the EN752:2008 method in MICRODRAINAGE where:

$$Q = kDU\sqrt{\sum DU}$$

The following design criteria have been applied in the design of foul sewers:

(i) Discharge units (DU)

Discharge Units	DU
Toilets	1 7
Sinks	1 3
Washbasins	0 3
Showers	0 6
Baths	0 8
Urinals	0 8
Washing Machines	0 8
Floor Drains	2 0

(ii) EN 752 Frequency Factor (kDU) 0.5

(iii) Pipe Ks 1.5 mm (concrete)

0.6mm (uPVC for flow>0.5D)

0.15mm (uPVC for flow<0.5D)

(iv) Minimum velocity 0.75 m/s (self-cleansing vel.)

(v) Maximum velocity 3 m/s

Using Irish Water parameters, the peak flow leaving the site is calculated cumulatively as 26.68 l/s.

Sewers and drains shall be laid to comply with the requirements of the Building Regulations 1997 in accordance with the recommendations contained in the Technical Guidance Documents, Section H (revised 2005). Standard drainage details will be in accordance with the Greater Dublin Regional Code of Practice for Drainage Works and IW Standard Details for Wastewater infrastructure.

Please refer to Appendix B for Foul Sewerage calculations.

Please refer drawing no 210175-DBFL-FW-SP-DR-C-1302 for the foul water layout plan and details of existing foul water infrastructure.

3 SURFACE WATER

3.1 Existing Services

There is an existing 450mm sewer to the north of the proposed site located on the western side of Ballymount Avenue. It is proposed to discharge surface water from this development into the existing 450mm diameter public surface water located within Ballymount Avenue, in close proximity to the Ballymount Road Lower junction. This 450mm diameter surface water main will have to be extended, by approximately 200m, southward in order to service the proposed development.

Figure 3-1 Existing Surface Water Sewer Infrastructure

Refer to Appendix A for existing surface water sewer records showing the full extent of the public sewers in the area.

3.2 Proposed Services

The surface water from the proposed development will be collected by a proposed surface water sewer network. The network has been designed and modelled to include many sustainable drainage system (SuDS) features, in line with SDCC development plan IE2 Objective 4.

The proposed surface water drainage network will consist of 8 sub-catchments. The sub-catchments are based on the boundaries of the individual logistics and offices (units 1-6), the café unit at the entrance to the site and the roads drainage catchment (to be taken in charge). The sub-catchments cover the full proposed development footprint and provide discreet drainage, SuDS features and attenuation volume for each individual unit and for the proposed roads servicing the site.

The boundaries of each sub-catchment allow for the unit drainage to be maintained by the eventual unit purchaser through entering an agreement with a management company. The proposed roads drainage has also been designed to be standalone, collecting only roads and public open space area runoff so that it is suitable for taking in charge by the local authority. The 8 sub-catchments discharge at controlled rates to a collector sewer which in turn will exit the site at the northeast boundary and connect to the surface water sewer in Ballymount Avenue, in line with SDCC development plan IE1 Objective 7.

Surface water management for the proposed development is designed to comply with the 'Greater Dublin Strategic Drainage Study (GDSDS) Regional Drainage Policies Technical Document – Volume 2, New Developments, 2005' and the 'Greater Dublin Regional Code of Practice for Drainage Works, V6.0 2005'. CIRIA Design Manuals C753, C697 and C609 have also been used to design the surface water drainage system within the site.

The GDSDS guidelines require the following main 4 criteria to be provided by the development's surface water design;

- Criterion 1: River Water Quality Protection – satisfied by providing interception storage and treatment of run-off within the SuDS features e.g. green roofs, permeable paving, swales and on-line cellular storage attenuation systems.
- Criterion 2: River Regime Protection – satisfied by attenuating run-off with flow control device 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. Pluvial flood risk addressed by development designed to accommodate a 100-year storm as per GDSDS. Planned flood routing for storms greater than 100-year level considered in design and development run-off contained within site.

- Criterion 4: River flood protection – attenuation provided within the SuDS features e.g. permeable paving construction, swales and on-line cellular storage attenuation systems.

Effective runoff coefficients for the site catchment will be determined based on the runoff characteristics for each surface contributing to flows within the site. Pipe sizes have been determined for the site using MICRODRAINAGE software.

Rainwater downpipes from roofs will discharge to proposed private-side building drainage around the perimeter of the building footprint prior to discharging to the proposed soakaway and bioretention area (where implemented) for treatment and attenuation for smaller rainfall events. After treatment through the soakaway, the surface water runoff flows will discharge to a modular arch attenuation system which provides sufficient attenuation volume for a 1:100 year AEP event +20% climate change allowance.

Surface water flows are attenuated within the modular arch system through the use of a hydrobrake or similar approved flow control device. Each sub-catchment attenuation has been limited to discharge at a rate of 2 l/s/ha as per agreement with south Dublin County Council (SDCC). These restricted flows discharge to collector sewers which service the site and cumulative runoff for the site is consequently inhibited to the 2 l/s/ha rate. A total cumulative site runoff of 14.2 l/s has been allowed for. The discharge rate for each catchment is detailed as below:

Catchment	Permissible runoff rate for 1:100 AEP event +20%cc (l/s)	Required Hydrobrake or Similar approved orifice size (mm)
Café	0.5	32*
Unit 1	1.5	57
Unit 2	3.2	76
Unit 3	1.7	55
Unit 4	2.2	62

Unit 5	1.4	49*
Unit 6	2.0	59
Roads	1.6	53

Table 3-1: Individual catchment permissible runoff rates

*note that due to potential maintenance issues a minimum orifice size of 50mm will be implemented.

Please refer to drawing no 210175-DBFL-SW-SP-DR-C-1300 for the surface water layout plan.

Please refer to Appendix E for MICRODRAINAGE network modelling and simulations including attenuation sizing.

3.2.1 SuDS

It is proposed to use a sustainable urban drainage system (SuDS) approach to stormwater management throughout the site. The overall strategy aims to provide an effective system to mitigate the adverse effects of urban stormwater runoff on the environment by reducing runoff rates, volumes and frequency, reducing pollutant concentrations in stormwater, contributing to amenity, aesthetics and biodiversity enhancement and allow for the maximum collection of rainwater for re-use where possible. In addition, SuDS features aim to replicate the natural characteristics of rainfall runoff for any site by providing control of run-off at source and this has been achieved by the proposed SuDS features.

An initial site investigation was undertaken across the site to determine substrata depths and suitability for proposed development and SuDS features. 19 No. Trial pits were undertaken and results recorded for the depth and general composition of substrata. This has been included in full as Appendix H. The trialpits found that the site was well drained with no groundwater strikes across the 19 no. trial holes. The general composition of substrata was topsoil over sandy silty clay over brown sandy gravelly clay above weathered rock indicating that SuDS features would be able to infiltrate to ground.

SuDS are a requirement under the 'Regional Code of Practice for Drainage Works' and 'The Greater Dublin Strategic Drainage Study'. Additionally, these systems are recommended under the 2009 guidelines, 'The Planning System and Flood Risk Management'.

There are a number of SuDS features proposed which will be designed in accordance with CIRIA documents C753, C697 and C609 and in line with SDCC development plan GREEN INFRASTRUCTURE (G) Policy 5 (Sustainable Urban Drainage Systems*: It is the policy of the Council to promote and support the development of Sustainable Urban Drainage Systems (SUDS) in the County and to maximise the amenity and biodiversity value of these systems*), as follows:

<u>Swales (wet):</u> Broad, shallow drainage channels covered in grass which can treat, convey and attenuate runoff, at source, and can infiltrate to the ground where the subgrade is suitable. Swales also promote biodiversity. Swales have been proposed to cater for road surface water runoff for the north-south road servicing the site and also for a portion of the runoff from service yards for each logistics unit.

<u>Tree pits</u>: Tree pits attenuate surface water run-off underneath by utilising the void within the root zone of each tree. Tree pits will be provided with drain down pipes which will convey flows downstream. Runoff from the east-west road servicing the site will drain to tree pits via kerb gullies (locations of tree pits to be agreed in coordination with the appointed landscape architect.)

<u>Permeable Pavement</u>: Porous surfacing (paving block or open graded material) which can treat rainwater, at source, and allow infiltration through to an underlying porous sub-base where water can be stored within the voids of the sub-base before being slowly released to the drainage collection system through natural flow via the porous medium. These systems allow some storage for small rainfall events and will result in infiltration, water evaporation and adsorption in small quantities. Permeable paving is proposed for the parking areas of each unit, where HGV traffic will not be encountered.

<u>Green roofs</u>: Green roofs will be provided in line with SDCC Development plan - G5 Objective 2: *To promote the provision of Green Roofs and/or Living Walls in developments where expansive roofs are proposed such as industrial, retail and civic developments.*

Green roofs provide ecological, aesthetic and amenity benefits and intercept and retain rainfall, at source, reducing the volume of runoff and attenuating peak flows. Green roofs absorb most of the rainfall that they receive during ordinary events and they will only contribute to attenuation of flows for larger events. Additionally, green roofs treat surface water through removal of atmospherically deposited urban pollutants and green roofs may reduce heating (by adding mass and thermal resistance value) and cooling (by evaporative cooling) loads on a building.

The green roofs for the proposed site are located on the offices in unit 5 area. The green roof build up will be deeper than proposed for a standard sedum green roof to allow an enhanced variety of planting, providing greater biodiversity and amenity. Green roof areas will be designed to coordinate with proposed PV panels for these units. Approximately 50% of the roof area will be maintained as green roof. The logistics units are not suitable for green roofs and so alternative SuDS measures have been proposed below.

Soakaway and bioretention/raingarden areas: Roof drainage for the logistics units will be directed to a soakaway situated below a bioretention area. Soakaways are designated areas where an attenuated volume of runoff is allowed to infiltrate to ground using either a stone blanket or proprietary attenuation units. The proposed soakaway will provide attenuation for small rainfall events and allow infiltration to ground for these volumes as site conditions permit. In high levels of rainfall the soakaway will act as a SuDS treatment feature, settling out suspended solids prior to discharging to the modular arch system. Soakaways will be sited a minimum of 5 metres from buildings. Considering that the infiltration volume required for the site has been met via the use of other SuDS features we have only provided the storage volume for each soakaway area, considering a 1m deep stone blanket with 30% voids.

Above the soakway, separated by a permeable geotextile to prevent the migration of fines, a bioretention area will be situated. Bioretention areas improve amenity and biodiversity by using soil, plants and microbes to treat stormwater before it is infiltrated or discharged. Bioretention areas are typically shallow depressions filled with sandy soil, topped with a thick layer of mulch, and planted with dense vegetation. Surface water runoff from service yards and landscaping will be directed to the bioretention areas. A number of swales provided for the service yards will discharge to the neighbouring bioretention area, thereby increasing the volume of runoff intercepted and treated prior to discharging to the main network.

The effectiveness of the soakaway was measured by conducting a number of trial pit tests

Silt trap Manhole: Removes silts and grit from the from the water and thus protects downstream elements of the drainage system, namely the attenuation system.

Cellular Attenuation Storage System: Proprietary modular arch structure with a maintenance/inspection tunnel for providing underground surface water attenuation storage and can infiltrate runoff to ground where the subgrade is suitable. A modular arch system is proposed to provide attenuation volumes for each catchment. Stormtech is particularly suited for this site with the number of HGVs likely to be traversing the site as they have a high loading capacity. Stormtech units will be sited below the service yard for the logistics units and below the permeable carparking areas proposed for the office units in unit 5 and the café unit.

Petrol Interceptor: A proprietary oil/water separator which prevents hazardous chemical and petroleum products from entering watercourses and public sewers. This is proposed after the hydrobrake manhole prior to discharging to the greater surface water network outside of the site. Please refer to Appendix C for the SuDS summary.

Please refer to Appendix C for SuDS calculations

Please refer to Drawing No. 210175-DBFL-SW-SP-DR-C-1300 for surface water layout plan

3.2.2 SuDS Management Train

SuDS features have been proposed to act as part of a SuDS management train in line with SDCC Policy GI4 objective 2:

"To incorporate a SuDS management train during the design stage whereby surface water is managed locally in small sub-catchments rather than being conveyed to and managed in large systems further down the catchment"

For each catchment the management train has been designed to maximise the volume of runoff routing through SuDS features in series. As sub-catchments will be maintained individually by the eventual purchaser, the opportunity to use surface conveyance is limited as it may distort the maintenance responsibility where surface water flows from one catchment to another. Where possible, however, it is proposed to convey runoff at the surface within the sub-catchment boundary.

For example, following the route of rainfall falling in the service yard of Unit 2 as per Figure 3-2; The proposal is to have the service yard drain to a swale (1) on the perimeter of the catchment, this allows for conveyance at surface level of runoff to the proposed bioretention (2) and soakaway area (3) adjacent to the building. Any runoff not drained to ground through these features then enters the piped system where it discharges to the attenuation chamber via a silt trap manhole (4) and the isolator row of the proposed attenuation (5). After attenuation, the runoff is directed through a proprietary petrol interceptor (6) before exiting the catchment and site via the collector sewers.

In total we can see that rainfall runoff from the service yard of unit 2 will be routed through 6 SuDS features in series. In a scheme where no SuDS provision was made it would be usual for runoff from this area to be directed to a gully and enter directly to the piped network, losing 3 stages of treatment.

Whilst modelling the network to determine attenuation volumes a conservative approach was applied where runoff coefficients were not compounded along the treatment train. In the example of figure 3.2 the runoff for the areas draining to the swale was only reduced by a factor of 0.7 when we would expect a further reduction of 0.7 as the runoff will also be routed through the bioretention area. Consequently we can expect that runoff volumes, and as such attenuation volumes, would be reduced compared to those initially modelled herein. On receipt of detailed site investigation data a determination of the infiltration rate will be made to inform calculations as to the exact reduction in runoff and attenuation that can be achieved.

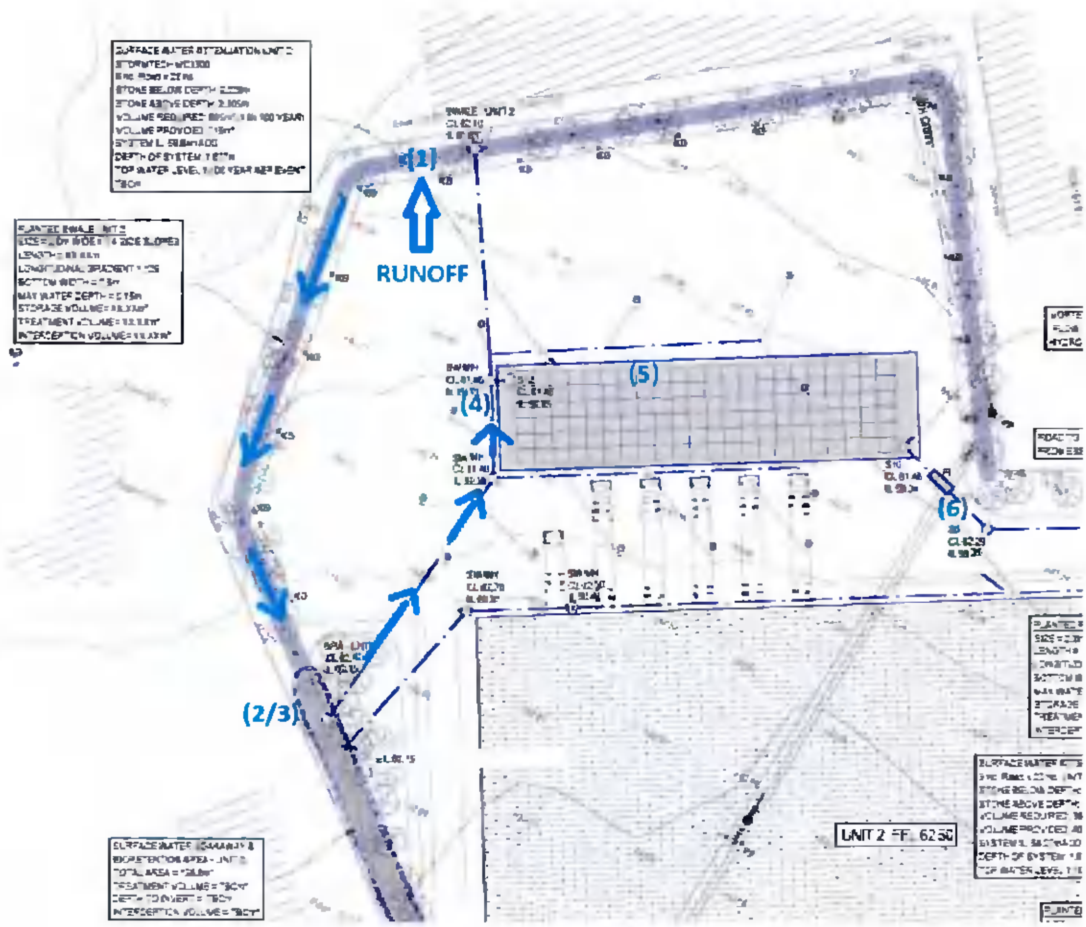


Figure 3-2: Proposed SuDS management train for portion of unit 2

3.2.3 Long Term Storage

In addition to limiting the runoff rate through attenuation (see below), the GDSDS requires that runoff volume from the site is limited in extreme events. The objective is to match the runoff volume discharged to the downstream receiving watercourse after development to that which occurred prior to development. This volume will be calculated by comparing the 100-year 6-hour event for 'pre' and 'post' development and is referred to as "Long-Term Storage".

Where long-term storage is provided, this has a direct effect on the permissible site discharge rate from the site, as explained further forward.

Due to the large extent of development within the site it is **not** proposed to provide long-term storage, this effects the permissible site discharge and resulting attenuation volumes required.

3.2.4 Permissible Site Discharge

According to the GDSDS, the method used for determining peak flow rates for small greenfield catchments is the UK 'Institute of Hydrology Report 124, Flood Estimation for Small Catchments'. This method calculates QBARrural which is the mean annual flood flow from a rural catchment.

Where long-term storage can be provided or is not necessary, surface water can be discharged at a higher value than QBARrural, this discharge rate (QBARgrowth) is dependent on the design return period and the corresponding growth factor from the GDSDS Table 6.6. However, if long-term storage cannot be provided on-site the discharge rate from the site should be kept to QBARrural **or 2 l/s/ha, which is the case for this development**.

The IH124 method calculates QBARrural which is the mean annual flood flow from a rural catchment. As the subject site area is less than 50 hectares, the calculated QBAR is to be linearly interpolated from the calculated value to produce a reduced allowable outflow based on the actual site area, as per GDSDS section 6.6.1.

QBAR rural = 0.00108 x (Area)0.89(SAAR)1.17(SOIL)2.17

where:

QBAR rural = Mean Annual Flood (m3/s)

Area = Catchment Area (km2)

SAAR = Standard Average Annual Rainfall (mm)

SOIL = SOIL index from Flood Studies Report

Using data received from Met Eireann for Irish Grid co-ordinates E310000 N230000 (Site Coordinates 309885/230375), the SAAR is determined as 700mm.

The soil value can be determined from the Flood Studies Report - Winter Rainfall Acceptance Maps (WRAP). A more accurate approach is to use the 'The Classification of Soils from Winter Rainfall Acceptance Rate, Flood Studies Report Table 4.5' to determine soil type and determine the soil value from Table 6.7 from the GDSDS. The latter method is adopted for this site.

Applicant's Total Site Area = 7.10 Ha

Surface Water Catchment Area: 7.10 Ha

SAAR = 700mm

SOIL = 0.37 (for soil type 4 from Table 6.7 from the GDSD)

Therefore, the greenfield runoff rate for the development (QBARrural) is 24.2 l/s.

The adopted runoff rate for the development will be 2 l/s/ha (as per discussions with SDCC Drainage Department) for the site area of 7.1 hectares, cumulatively 14.2 l/s will be permitted to discharge from the site.

Please refer to Appendix D for permissible discharge calculations.

3.2.5 Surface Water Runoff Coefficients

As a large proportion of runoff is routed through SuDS features these will have an attenuating effect which reduces the rate of stormwater runoff for every rainfall event. Also, SuDS features reduce the runoff volume through evaporation, transpiration, infiltration and depression storage of the water within each system.

The coefficients below have been used for the initial calculations:

Roofs - Type 1 (Draining to traditional gullies) = 1.0

Roofs – Type 2 (Draining to SuDS feature (Green roof/soakaway)) = 0.70

Roads and Footpaths - Type 1 (Draining to traditional gullies) = 0.80

Roads and Footpaths - Type 2 (Draining to SuDS features) = 0.70

Permeable paving = 0.50

Grassed Areas = 0.37 (soil type 4 SPR- Flood Studies Report)

3.2.6 Surface Water Attenuation

The development drainage infrastructure system, including Sustainable Drainage System features (SuDS) with underground attenuation, will be designed such that the runoff will drain to the SuDS features prior to passing through the attenuation proposed for each sub-catchment. The surface water runoff from the site will be restricted to a rate of 2l/s per hectare using hydro brake flow control devices or similar approved device for each sub-catchment.

As required by SDCC, a climate change allowance of 20% has been applied to the surface water drainage design.

This surface water system has been hydraulically modelled in MICRODRAINAGE to ensure that the overall discharge at the end of the hydraulic system is at, or below, a rate of 2l/s per hectare which discharges to the existing surface water pipeline.

A MICRODRAINAGE Simulation model has been created for the attenuation interaction please refer to Appendix E.

The MICRODRAINAGE Simulation uses the Wallingford Procedure, time/area full hydrograph methodology, including energy and momentum equations for dynamic analysis of surface water networks. The site drainage network is modelled as one system where all flows, capacities, water levels, surcharged manholes etc are determined throughout the network for each critical storm duration. Therefore, the final combined discharge rate to the stream from the outlet will be kept at (or below) the total permissible discharge rate defined above.

Maximum rainfall data from Extreme Rainfall Return Period values produced by Met Eireann was used to input into MICRODRAINAGE to determine maximum flood volumes. Rainfall data for the site was sourced from an Annual Average Rainfall (AAR) Grid (1981-2010) and a Depth Duration Frequency model produced by Met Éireann (Available from: http://www.met.ie/climate/products03.asp). This data was input into MICRODRAINAGE to determine the maximum flood volume for the 1 in 100-year rainfall event.

SAAR	=	700 mm
Ratio $M5_{60}/M5_{2d}$	=	0.276
$M5_{60}$	=	17.50 mm

While the use of SuDS features has significantly reduced the attenuation requirement it has not been possible to omit the below ground attenuation systems entirely, in line with SDCC development plan IE2 Objective 5. The results from MICRODRAINAGE modelling indicate a cumulative required attenuation volume of approximately 3062m^3 for the site with the current development proposal including proposed SuDS features. For means of comparison, the table below demonstrates the attenuation requirement for each catchment with and without SuDS features.

Catchment Area	Attenuation Requirement with proposed SuDS features (sized by full network modelling)	Attenuation Requirement with impermeable catchment surface (sized by simple source control modelling)
Café Unit	48 m^3	134 m^3
Unit 1	321 m^3	411m^3
Unit 2	695 m^3	868 m^3
Unit 3	501 m^3*	458m^3*
Unit 4	451m^3	626m^3
Unit 5	204 m^3	381 m^3
Unit 6	418 m^3	568 m^3
Roads	426 m^3	458 m^3
Total	3062 m^3	3904 m^3

Table 3-2: Comparison of attenuation volumes with and without SuDS features

*Note that attenuation requirement with no proposed SuDS does not factor into account network interaction or surcharging. In a detailed model with no SuDS features we would confidently expect a greater attenuation volume would be required.

Overall we can see that the proposed SuDS features reduce the attenuation requirement by approximately 843 m^3 compared to the same site with no proposed SuDS features. With a full scale model of the site with no SuDS features we would expect an even higher attenuation volume requirement than has been modelled in Microdrainage Source Control.

The attenuation provision as above is provided by a below ground arch attenuation system however it should be noted that there is further considerable storage volumes provided by the proposed SuDS features and within the pipe network proposed for the site.

MICRODRAINAGE Source Control calculations for each catchment with and without SuDS features can be referred to in Appendix E

It should be noted that attenuation volumes required are based on the results of the MICRODRAINAGE hydraulic simulation summary of Critical Results by Maximum Level. Hydro brake maximum head and discharges are based on results of MICRODRAINAGE hydraulic simulation summary of Critical Results by Maximum Outflow.

A minimum freeboard of 500mm above attenuation top water level for a 1 in 100-year flood event has been provided to all building floor levels.

The GDSDS requires flood waters for a 100-year return period to be managed on-site, therefore this return period is adopted for attenuation calculations.

The attenuation has been designed so that any storm water run-off from any storm event under 1 in 100 year will be contained in the underground modular arch attenuation system.

Site overland flow paths will be provided to direct run-off from high intensity, short duration storms which might fail to enter the drainage system.

Please refer to Appendix E for Microdrainage modelling and attenuation sizing calculations.

3.2.7 Interception Volume

The GDSDS requires that no run-off should directly pass to the receiving watercourse for rainfall depths of 5mm, therefore interception should be provided at source where practicable. The volume of interception required is based on 5mm of rainfall depth from 80% of the runoff from impermeable areas as defined in the GDSDS (Appendix D section E2.1.1).

The interception volume attributable to each SuDS feature (green roof etc.) consists of the volume of water that can infiltrate to the ground, the volume that will evaporate into the atmosphere and the volume that can transpire through plants and vegetation. Additionally, there will be some losses of water due to absorption and wetting of stone and soil media.

Not all SuDS features will be able to achieve infiltration, evaporation, transpiration and losses due to absorption/wetting, for example green roofs will have no infiltration capacity. The limits for each SuDS feature type are taken into account when calculating interception volumes.

Additional infiltration and evapotranspiration volume will be available in each of the SuDS features whereby a 50mm nominal depth storage reservoir will be provided below the invert of the outgoing pipe or control within each feature. This storage will be additional to the attenuation and interception storage required and will allow long-term infiltration and evapotranspiration (over minimum 24 hours) of run-off to ensure that a minimum of 5mm interception volume is achievable.

The interception storage attributable to the losses in stone and soil media, such as the stone media used in filter drains was not included in the calculations.

The total interception volume required (as calculated) for the site is 217.4m^3 the volume provided for the site is at least 344m^3, which far exceeds the required volume.

Please refer to Appendix F for Interception Volume Requirement.

3.2.8 Treatment Volume

The GDSDS requires that a "treatment volume" (Vt) be provided in order to prevent any pollutants or sediments discharging into existing public storm water systems, additionally a 'treatment train' stormwater runoff management system is required. According to CIRIA document C697 the following treatment train approach is necessary:

Roofs – 1 Treatment Stage

Road Areas – 2 Treatment Stages

Paved Areas excluding Roads - 1 Treatment Stage

The treatment volume is based on a treatment of 15mm of rainfall depth from 80% of the runoff from impermeable areas as defined in the GDSDS (Appendix D section E2.1.2).

All run-off areas will pass through the required number of treatment stages prior to discharging to the downstream outfall.

The total treatment volume required (as calculated) for the site is 652.3m^3, the volume provided for the site is at least 1403m^3 which far exceeds the required volume.

Please refer to Appendix F for Treatment Volumes.

3.2.9 Surface Water Sewers

Surface water from the proposed development will be discharged after attenuation to the existing 450mm surface water outfall located in Ballymount Avenue. Surface water sewers will be designed in MICRODRAINAGE using the Modified Rational Method. The return period for sizing pipes is based on the following: -

- Department of Environment – Recommendations for Site Development Works for Housing Areas (1998), Table 3.1;
- GDSDS – Regional Drainage Policies – Volume 2 – New Development (2005), Section 6.5;
- IS EN 752:2008 - Drain and Sewer Systems Outside Buildings, Table 2;
- Building Regulations (2005) – Section H - Drainage and Wastewater Disposal, Section 1.5.7.

The pipe system will be checked for the 5, 30 and 100-year return periods for flooding.

The following parameters will be applied:

Return period	5/30/100 year
Time of entry	4 minutes
Pipe Ks	0.6mm (concrete); 0.15mm (uPVC)
Minimum velocity	0.75 m/s
Maximum velocity	3.0 m/s

Effective runoff coefficients for the drainage catchment have been determined based on the runoff characteristics for each surface contributing to flows within the catchment.

The minimum pipe diameter for public surface water sewers is 225mm.

Proposed values for roughness of uPVC pipes were obtained from Wallingford "Tables for the Hydraulic Design of Pipes, Sewers and Channels" and Wavinsewer systems catalogue.

3.2.10 Amenity

SuDS features should be designed to replicate a natural environment with a visual appeal, promote both public and wildlife usage and promote biodiversity within urban environments. In addition, SuDS features should aim to use water as a resource where possible.

Substantial amenity, biodiversity and water usage provision has been included in the proposed site which includes; green roofs on office units and logistic unit atriums capable of supporting a greater diversity of plants than the commonly proposed sedum bed, bioretention areas suitable for a variety of plants at the landscape architect's direction as well as tree pits and swales to treat road runoff.

4 Water Mains

4.1 Existing Services

There is an existing 200mm diameter ductile iron watermain located in both Ballymount Avenue to the east of the site, and Calmount Road to the south.

Figure 4-1 Existing Watermain Infrastructure

4.2 Proposed Services

It is proposed to make a 150mm diameter connection to the existing watermain within Calmount Road for the proposed development. As noted above, a pre-application enquiry has been sent to Irish Water in order to confirm feasibility of connection to the Irish water network and the response will be forwarded once received.

A proposed nominal diameter 150mm watermain network will be constructed with fire hydrants provided throughout the site so that no unit is more than 23m from a hydrant. As indicated on the Irish Water Pre-connection Enquiry adequate fire storage capacity will be provided on the site. The estimated peak demand from the development will be 1.895 l/s with the average daily demand being 0.316 l/s.

The watermain will be designed and will be constructed in accordance with the Irish Water's 'Standard Details for Water Infrastructure' and 'Code of Practice for Water Infrastructure'

A bulk water meter will be provided at the connection to the site and a premises meter will be provided for each logistics unit, office and cafe. The supply arrangements will be carried out to the requirements of Irish Water's code of practice and standard details.

Please refer to Appendix G for Watermain calculations.

Please refer to drawing no 210175-DBFL-WM-SP-DR-C-1001 for the watermain layout plan

5 Roads

Vehicular access to the site will be from 2no. new entrances constructed for the site. One on the eastern side of the site from Ballymount Avenue and one from the south of the site from Calmount Road.

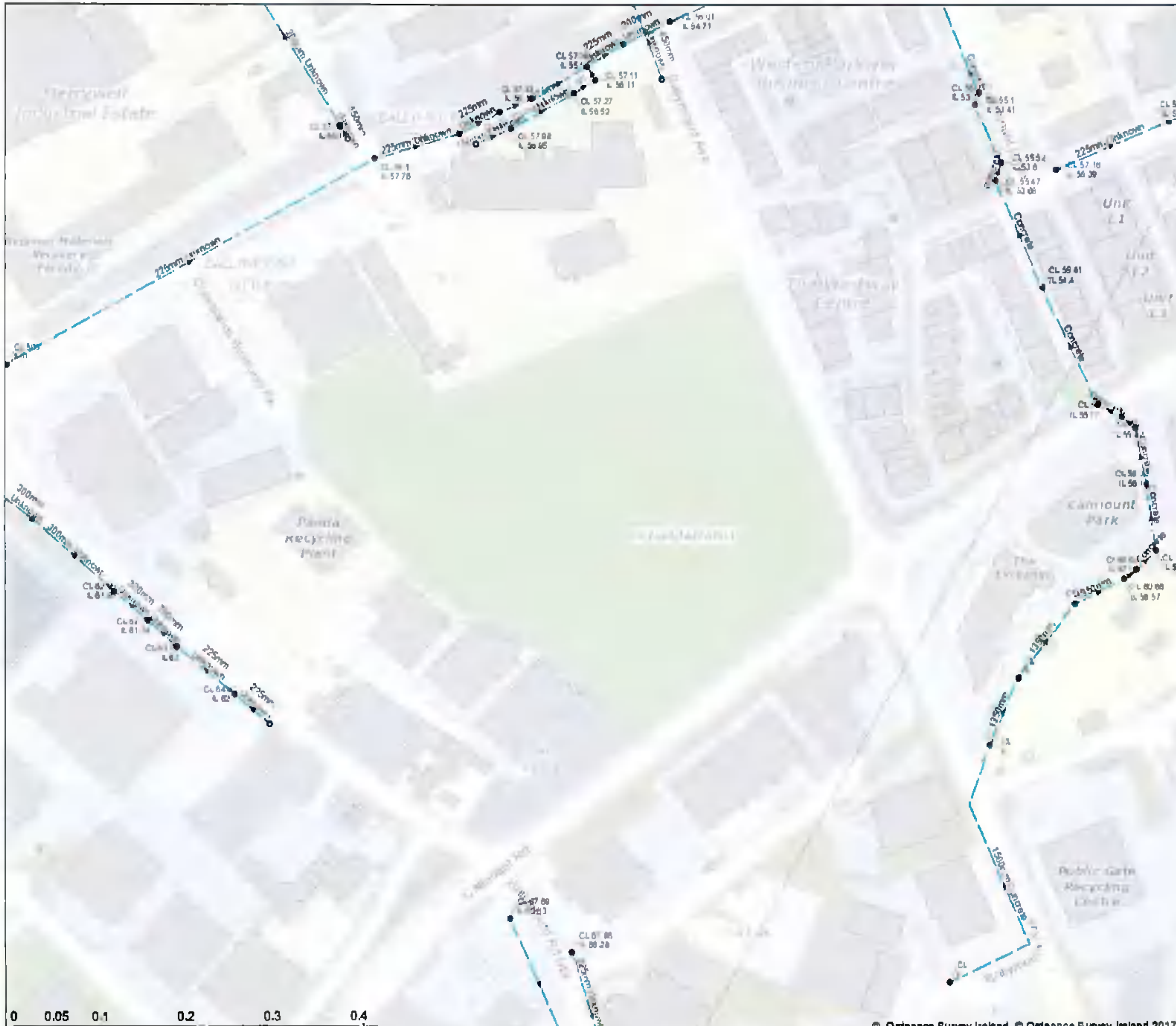
Refer to Traffic and Transport Assessment submitted under a separate cover for further detail on the proposed roads and access for the site.

DBFL CONSULTING ENGINEERS

MARCH 2022

Appendix A: Existing Service Records

Irish Water Web Map



UISCE ÉIREANN : IRISH WATER

Print Date: 07/11/2021

Printed by: Irish Water

Irish Water Web Map

UISCE ÉIREANN : IRISH WATER

Print Date: 07/11/2021

Printed by Irish Water

Appendix B: Foul Sewer Calculations

TITLE	Job Reference	
Calmount Road	210175	DBFL
SUBJECT	Calc. Sheet No.	
Irish Water Foul Loading - unit 1	1	

DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-FW-SP-DR-(	SSJ	RTM	28.03.2022

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	10
Sinks	2
Washbasins	10
Showers	2
Baths	0
Urinals	2
Washing Machines	0
Floor Drains	0
Total Discharge Units	25.4

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 2.52 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1.2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

			Result
Minimum Size Pipe:	150	mm	
1 in	85	Gradient	
Q =	***19.25***	***l/s full bore***	***OK***
V =	*1.09*	*m/s full bore*	
$V_{proportional}$ =	***0.75***	***m/s partial bore***	***OK***

TITLE		Job Reference	
Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Unit 2 GA & 1st Floor		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-	SSJ	RTM	28.03.2022

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	10
Sinks	2
Washbasins	10
Showers	2
Baths	0
Urinals	2
Washing Machines	0
Floor Drains	0
Total Discharge Units	25.4

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 2.52 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1.2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

Minimum Size Pipe: 225 mm
1 in 71 Gradient

			Result
Q =	***61.73***	***l/s full bore***	***OK***
V =	*1.55*	*m/s full bore*	
$V_{proportional}$ =	***0.75***	***m/s partial bore***	***OK***

TITLE		Job Reference	
Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Unit 3 GA & 1st Floor		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-	SSJ	RTM	28.03.2022

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	10
Sinks	2
Washbasins	10
Showers	2
Baths	0
Urinals	2
Washing Machines	0
Floor Drains	0
Total Discharge Units	25.4

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 2.52 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1.2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

			Result
Minimum Size Pipe:	100	mm	
1 in	90	Gradient	
***Q* =**	***6.36***	***l/s full bore***	***OK***
V =	*0.81*	*m/s full bore*	
***$V_{proportional}$* =**	***0.76***	***m/s partial bore***	***OK***

TITLE		Job Reference	
Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Unit 4 GA & 1st Floor		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-	SSJ	RTM	28.03.2022

OBFL

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	10
Sinks	2
Washbasins	10
Showers	2
Baths	0
Urinals	2
Washing Machines	0
Floor Drains	0
Total Discharge Units	25.4

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 2.52 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1.2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

Minimum Size Pipe: 150 mm

1 in 87 Gradient

			Result
Q =	***19.03***	***l/s full bore***	***OK***
V =	*1.08*	*m/s full bore*	
$V_{proportional}$ =	***0.75***	***m/s partial bore***	***OK***

TITLE		Job Reference	
Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Unit 5A GA, 1st & 2nd Floor		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-	SSJ	RTM	28.03.2022

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	24
Sinks	16
Washbasins	24
Showers	0
Baths	0
Urinals	0
Washing Machines	0
Floor Drains	0
Total Discharge Units	68.8

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 4.15 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1.2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

Minimum Size Pipe: 225 mm

1 in 218 Gradient

		Result
***Q* = 34.99**	***l/s full bore***	***OK***
V = *0.88*	*m/s full bore*	
V**$_{proportional}$* = ***0.59	***m/s partial bore***	***Fail*** **

** Note that discharge from unit 5A will be in addition to upstream discharge. Self cleansing achieved in Microdrainage model

TITLE		Job Reference	
Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Unit 5B GA, 1st & 2nd Floor		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-	SSJ	RTM	28.03.2022

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	24
Sinks	16
Washbasins	24
Showers	0
Baths	0
Urinals	0
Washing Machines	0
Floor Drains	0
Total Discharge Units	68.8

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 4.15 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1.2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

			Result
Minimum Size Pipe:	150	mm	
1 in	129	Gradient	
Q =	***15.58***	***l/s full bore***	***OK***
V =	*0.88*	*m/s full bore*	
$V_{proportional}$ =	***0.75***	***m/s partial bore***	***OK***

TITLE Calmount Road		Job Reference 210175	
SUBJECT Unit 5C GA. 1st & 2nd Floor		Calc. Sheet No. 1	
DRAWING NUMBER 210175-	Calculations by SSJ	Checked by RTM	Date 28.03.2022

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	24
Sinks	16
Washbasins	24
Showers	0
Baths	0
Urinals	0
Washing Machines	0
Floor Drains	0
Total Discharge Units	68.8

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 4.15 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1.2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

Minimum Size Pipe: 150 mm

1 in 129 Gradient

		Result
Q =	***15.58 l/s full bore***	***OK***
V =	*0.88 m/s full bore*	
$V_{proportional}$ =	***0.75 m/s partial bore***	***OK***

TITLE		Job Reference	
Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Unit 6A GA & 1st Floor		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-	SSJ	RTM	28.03.2022

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	10
Sinks	2
Washbasins	10
Showers	2
Baths	0
Urinals	2
Washing Machines	0
Floor Drains	0
Total Discharge Units	25.4

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 2.52 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1.2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

Minimum Size Pipe: 150 mm

1 in 87 Gradient

		Result
Q =	***19.03 l/s full bore***	***OK***
V =	*1.08 m/s full bore*	
$V_{proportional}$ =	***0.75 m/s partial bore***	***OK***

TITLE		Job Reference
Calmount Road		210175
SUBJECT		Calc. Sheet No.
Unit 7 Coffee Shop		1
DRAWING NUMBER	Calculations by	Checked by Date
210175-	SSJ	RTM 28.03.2022

FOUL DRAINAGE FOR A NON-RESIDENTIAL DEVELOPMENT

SITE COMPRISES

Toilets	4
Sinks	2
Washbasins	4
Showers	0
Baths	0
Urinals	0
Washing Machines	0
Floor Drains	0
Total Discharge Units	10.6

Discharge Units	DU
Toilets	1.7
Sinks	1.3
Washbasins	0.3
Showers	0.6
Baths	0.8
Urinals	0.8
Washing Machines	0.8
Floor Drains	2.0

RESULTING FOUL FLOW

Frequency Factor k_{DU} = 0.5

Therefore Peak Flow = 1.63 l/s

Frequency Factor	k_{DU}
Dwelling, Guesthouse, Office	0.5
Hospital, School, Restaurant, Hotel	0.7
Toilets and/or Showers open to Public	1.0
Laboratory Buildings	1 2

COLEBROOK - WHITE FORMULA

ks = 0.60 mm

Self cleansing velocity = 0.75 m/s

			Result
Minimum Size Pipe:	150	mm	
1 in	60	Gradient	
Q =	*22.96*	***l/s full bore***	***OK***
V =	*1.30*	*m/s full bore*	
$V_{proportional}$ =	*0.75*	***m/s partial bore***	***OK***

FOUL SEWERAGE DESIGN

Design Criteria for FOUL

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	10
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.000
Calculation Method	EN 752	Maximum Backdrop Height (m)	0.000
Frequency Factor	0.50	Min Design Depth for Optimisation (m)	0.750
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Inverts

Network Design Table for FOUL

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	69.543	0.800	86.9	0.000	25.4	0.0	0.600	o	225	Pipe/Conduit	
F1.001	44.341	0.540	82.1	0.000	0.0	0.0	0.600	o	225	Pipe/Conduit	
F2.000	27.249	0.410	66.5	0.000	10.6	0.0	0.600	o	150	Pipe/Conduit	
F3.000	18.334	0.200	91.7	0.000	25.4	0.0	0.600	o	150	Pipe/Conduit	
F2.001	31.341	0.290	108.1	0.000	0.0	0.0	0.600	o	150	Pipe/Conduit	
F4.000	25.561	0.270	94.7	0.000	25.4	0.0	0.600	o	150	Pipe/Conduit	
F2.002	41.564	0.310	134.1	0.000	0.0	0.0	0.600	o	150	Pipe/Conduit	
F1.002	49.141	0.360	136.5	0.000	0.0	0.0	0.600	o	225	Pipe/Conduit	
F5.000	30.532	0.310	98.5	0.000	25.4	0.0	0.600	o	150	Pipe/Conduit	
F5.001	17.037	0.170	100.2	0.000	0.0	0.0	0.600	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	61.550	0.000	0.0	25.4	0.3	34	0.73	1.40	55.8	2.8
F1.001	60.750	0.000	0.0	25.4	0.3	34	0.75	1.44	57.4	2.8
F2.000	64.200	0.000	0.0	10.6	0.2	29	0.75	1.24	21.8	1.8
F3.000	63.450	0.000	0.0	25.4	0.3	39	0.76	1.05	18.6	2.8
F2.001	63.250	0.000	0.0	36.0	0.3	45	0.75	0.97	17.1	3.3
F4.000	63.450	0.000	0.0	25.4	0.3	39	0.75	1.03	18.3	2.8
F2.002	62.960	0.000	0.0	61.4	0.4	54	0.75	0.87	15.3	4.3
F1.002	60.210	0.000	0.0	86.8	0.5	51	0.75	1.12	44.4	5.1
F5.000	60.130	0.000	0.0	25.4	0.3	40	0.74	1.01	17.9	2.8
F5.001	59.820	0.000	0.0	25.4	0.3	40	0.73	1.00	17.7	2.8

Network Design Table for FOUL

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
F1.003	81.729	0.520	157.2	0.000	0.0	0.0	0.600	o	225	Pipe/Conduit	
F6.000	45.981	0.350	131.4	0.000	68.8	0.0	0.600	o	100	Pipe/Conduit	
F6.001	11.559	0.090	128.4	0.000	0.0	0.0	0.600	o	100	Pipe/Conduit	
F1.004	37.268	0.200	186.3	0.000	0.0	0.0	0.600	o	225	Pipe/Conduit	
F7.000	28.462	0.300	94.9	0.000	25.4	0.0	0.600	o	150	Pipe/Conduit	
F1.005	76.253	0.350	217.9	0.000	68.8	0.0	0.600	o	225	Pipe/Conduit	
F8.000	34.756	0.250	139.0	0.000	68.8	0.0	0.600	o	150	Pipe/Conduit	
F8.001	25.789	0.190	135.7	0.000	0.0	0.0	0.600	o	150	Pipe/Conduit	
F1.006	17.539	0.080	219.2	0.000	0.0	0.0	0.600	o	225	Pipe/Conduit	
F1.007	30.182	0.120	251.5	0.000	0.0	0.0	0.600	o	225	Pipe/Conduit	
F1.008	52.863	0.220	240.3	0.000	0.0	0.0	0.600	o	225	Pipe/Conduit	
F1.009	24.563	0.100	245.6	0.000	0.0	0.0	0.600	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)
F1.003	59.650	0.000	0.0	112.2	0.5	57	0.74	1.04	41.4	5.8
F6.000	61.400	0.000	0.0	68.8	0.4	72	0.75	0.67	5.3	4.6
F6.001	61.050	0.000	0.0	68.8	0.4	71	0.76	0.68	5.3	4.6
F1.004	59.130	0.000	0.0	181.0	0.7	67	0.74	0.95	38.0	7.4
F7.000	60.000	0.000	0.0	25.4	0.3	39	0.75	1.03	18.2	2.8
F1.005	58.930	0.000	0.0	275.2	0.8	78	0.74	0.88	35.1	9.1
F8.000	62.000	0.000	0.0	68.8	0.4	57	0.75	0.85	15.0	4.6
F8.001	61.750	0.000	0.0	68.8	0.4	56	0.75	0.86	15.2	4.6
F1.006	58.580	0.000	0.0	344.0	0.9	83	0.76	0.88	35.0	10.2
F1.007	58.500	0.000	0.0	344.0	0.9	86	0.73	0.82	32.6	10.2
F1.008	58.380	0.000	0.0	344.0	0.9	85	0.74	0.84	33.4	10.2
F1.009	58.160	0.000	0.0	344.0	0.9	86	0.73	0.83	33.0	10.2

Free Flowing Outfall Details for FOUL

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
F1.009	F	0.000	58.060	0.000	0	0

Simulation Criteria for FOUL

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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	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)	17.500	Storm Duration (mins)	30
Ratio R	0.276		

Appendix C: SuDS Calculations

TITLE		Job Reference	
Development at Ballymount Ave		210175	
SUBJECT		Calc. Sheet No.	
Interception/Treatment Volume Summary		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	RTM	SVC	30.03.2022

INPUT DATA

Interception Volume Required	217.4	m^3
Treatment Volume Required	652.3	m^3

Catchment	Interception Volumes		Treatment Volumes	
Swales	6.1	m^3	296.2	m^3
Bio-Retention	98.9	m^3	43.2	m^3
Permeable Paving	231.6	m^3	865.7	m^3
Rain Gardens	3.0	m^3	12.0	m^3
Green Roofs	5.1	m^3	186.1	m^3
Tree Pits		m^3		m^3
Stormtech Isolator Row		m^3		m^3
Total Volumes Provided	344.7	m^3	1403.1	m^3
Check Provided Volumes are greater than Required Volumes	PASS		PASS	

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount road		210175	
SUBJECT		Calc. Sheet No.	
Bioretention Area (Café)		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Effective Impermeable Area for Treatment (A)	225.0	m^2
[1]Filter Bed Depth (L)	0.710	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.010	m
Time Required for Percolation (t)	48.0	hr

BIORETENTION AREA

Surface Area of Bioretention Area (A_f)	**49.3**	m^2

TREATMENT VOLUME

[3]Treatment Volume (V_T)	2.7	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	5.0	mm/hr	
Subgrade Infiltration Rate (*f*)	0.001	mm/s	
[4]Subgrade Infiltration Volume	7.461	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 1.2 and 1.5m

2 h = Half maximum height, where hmax <=2m

3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6.3.1.2.1)

4 Volume calculated using 6 hour storm event

Area of Bioretention Filter Bed = $\frac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source. SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0.000000028 - 0.000028
Loamy sand	0.0000000028 - 0.00000028
Sandy loam	0.000000014 - 0.00000014
Loam	0.00000000028 - 0.000000028
Silty Loam	0.00000000014 - 0.0000000014

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175		
SUBJECT Permeable Paving Design - Café		Calc. Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03.2022	

FLAT SITES

INPUT DATA

Pavement Area (A)	419.0	m^2	
Pavement Perimeter (P)	110.0	m	
Sub-base Depth (d)	0.400	m	
[1]Sub-base Voids Ratio (n)	0.30		
Sub-base Infiltration Rate per hour	1000	mm/hr	
Sub-base Infiltration Rate (k)	0.278	mm/s	
Subgrade Infiltration Rate per hour	5.0	mm/hr	
Subgrade Infiltration Rate (*f*)	0.001	mm/s	

VOLUME (STORAGE AND TREATMENT)

Permeable Paving Storage Volume per m^2	0.120	m^3/m^2	
Total Permeable Paving Storage Volume	50.3	m^3	

INFILTRATION / INTERCEPTION VOLUME

			5mm SURFACE INTERCEPTION
Approx. Permeable Paving Infiltration per m^2	0.002	$l/s/m^2$	5.03 m^3
[2]Total Permeable Paving Infiltration Rate	0.643	l/s	
[3]Total Permeable Paving Infiltration Volume	13.9	m^3	

FLOW

Average Distance between Outlet Drains	6.0	m	Assumed one outlet per house
Flow Velocity through Permeable Paving	0.000038	m/s	
Trench Retention Time	44.2	hr	

TITLE	Job Reference	
Warehousing and Logistics Development at Calmount Road	210175	

SUBJECT	Calc. Sheet No.
Permeable Paving Design - Café	1

DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29 03 2022

Notes:

1 Sub-base material has a void ratio of approximately 30%.
source 'BRE Digest 365'

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'.

3 Volume calculated using 6 hour storm event.

4 For Paving on slopes includes infiltration, provide 500mmx500mm trenches at 10m centres along slope with 1000mmx500mm at base of slope
source Formpave - Aquaflow Permeable Paving System'

Table: 1

Material	void Ratio, η
Clean stone	0 40 - 0.50
Uniform gravel	0 30 - 0 40
Graded sand or gravel	0 20 - 0 30
Source The SUDS manual Published by CIRIA	

Table: 2

Pavement Type	Effective Depth (m)
Car-Parking	0.40
Footpath	0 20
Effective Depths are provided from source 'Formpave - Aquaflow Permeable Paving System' and may subject to change as per site requirement	

Total Permeable Paving Outflow

= A . k . i

where

A = Cross Sectional Area of Subbase
k = Subbase Infiltration Rate
i = Hydraulic Gradient

Hydraulic gradient has been assumed as the pavement gradient with an additional 250mm fall per 100m length

Table: 3

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0 1 - 100
Loamy sand	0.01 - 1
Sandy loam	0 05 - 0 5
Loam	0 001 - 0.1
Silt loam	0.0005 - 0 005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0 01
Silty clay loam	0.00005 - 0.005
Clay	< 0 0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr Source Microdrainage	

Total Trench Infiltration:

= 1/2 D . L . *f*

where

L = Length
D = Depth to Invert
f = Subgrade infiltration rate

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175		DBFL
SUBJECT Swale Channel Café		Calc. Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29 03 2022	

INPUT DATA

Side Slopes	4.0	1 in ...
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	62.0	m
Slope (S)	50	1 in ...
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (*f*)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	107.7	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	21.538	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	7.5	m
Swale Storage Volume per 8m Length	**0.51**	m^3
Swale Storage Volume (V)	**4.05**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	0.01	l/s	
[3]Total Swale Infiltration Volume	0.244	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**161.9**	l/s
Maximum Swale Velocity at Outlet	**0.98**	m/s
[3]Typical Swale Retention Time	**0.018**	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . *f*

where:

P = Wetted Perimeter

L = Length

f = Subgrade infiltration rate

Total Swale Flow = 1/n.AR$^{2/3}$ *S*$^{1/2}$

where:

A = Area of flow

P = Wetted perimeter

R = A/P

n = Manning's Coefficient

s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr

Source: Microdrainage

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Bioretention Area (Unit 1)		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Effective Impermeable Area for Treatment (A)	300.0	m^2
[1]Filter Bed Depth (L)	1.500	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.010	m
Time Required for Percolation (t)	48.0	hr

BIORETENTION AREA

Surface Area of Bioretention Area (A_f)	**35.0**	m^2

TREATMENT VOLUME

[3]Treatment Volume (V_T)	3.6	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	5.0	mm/hr	
Subgrade Infiltration Rate (f)	0.001	mm/s	
[4]Subgrade Infiltration Volume	11.699	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 1.2 and 1.5m
2 h = Half maximum height, where hmax <=2m
3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6.3.1.2.1)
4 Volume calculated using 6 hour storm event

Area of Bioretention Filter Bed = $\frac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source: SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0.000000028 - 0.000028
Loamy sand	0.0000000028 - 0.0000028
Sandy loam	0.000000014 - 0.00000014
Loam	0.00000000028 - 0.000000028
Silty Loam	0.00000000014 - 0.0000000014

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc Sheet No.	
Permeable Paving Design - Unit 1		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	30.03.2022

DBFL

FLAT SITES

INPUT DATA

Pavement Area (A)	677 2	m^2
Pavement Perimeter (P)	123 0	m
Sub-base Depth (d)	0 400	m
[1]Sub-base Voids Ratio (n)	0 30	
Sub-base Infiltration Rate per hour	1000	mm/hr
Sub-base Infiltration Rate (k)	0 278	mm/s
Subgrade Infiltration Rate per hour	5 0	mm/hr
Subgrade Infiltration Rate (I)	0 001	mm/s

VOLUME (STORAGE AND TREATMENT)

Permeable Paving Storage Volume per m^2	0.120	m^3/m^2
Total Permeable Paving Storage Volume	81 3	m^3

INFILTRATION / INTERCEPTION VOLUME

5mm SURFACE INTERCEPTION

Approx Permeable Paving Infiltration per m^2	0 001	$l/s/m^2$	5 03 m^3
[2]Total Permeable Paving Infiltration Rate	1.009	l/s	
[3]Total Permeable Paving Infiltration Volume	21 8	m^3	

FLOW

Average Distance between Outlet Drains	6 0	m	Assumed one outlet per building
Flow Velocity through Permeable Paving	0.000038	m/s	
Trench Retention Time	44.2	hr	

TITLE			Job Reference
Warehousing and Logistics Development at Calmount Road			210175
SUBJECT			Calc. Sheet No.
Permeable Paving Design - Unit 1			1
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	30.03 2022

Notes:

1 Sub-base material has a void ratio of approximately 30%, source 'BRE Digest 365'

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'.

3 Volume calculated using 6 hour storm event.

4 For Paving on slopes includes infiltration, provide 500mmx500mm trenches at 10m centres along slope with 1000mmx500mm at base of slope source 'Formpave - Aquaflow Permeable Paving System'.

Table: 1

Material	void Ratio, η
Clean stone	0.40 - 0.50
Uniform gravel	0.30 - 0.40
Graded sand or gravel	0.20 - 0.30

Source. The SUDS manual, Published by CIRIA

Table: 2

Pavement Type	Effective Depth (m)
Car-Parking	0.40
Footpath	0.20

Effective Depths are provided from source 'Formpave - Aquaflow Permeable Paving System' and may subject to change as per site requirement

Total Permeable Paving Outflow

= A . k . i

where

A = Cross Sectional Area of Subbase
k = Subbase Infiltration Rate
i = Hydraulic Gradient

Hydraulic gradient has been assumed as the pavement gradient with an additional 250mm fall per 100m length.

Table: 3

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr
Source. Microdrainage

Total Trench Infiltration

= 1/2 D . L . *I*

where

L = Length
D = Depth to Invert
I = Subgrade infiltration rate

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Swale Channel 1 Unit 1		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in .....
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	140.0	m
Slope (S)	150	1 in .....
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (*f*)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	243.2	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	48.634	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	22.5	m
Swale Storage Volume per 23m Length	**1.52**	m^3
Swale Storage Volume (V)	**9.11**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.03**	l/s	
[2]Total Swale Infiltration Volume	0.747	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**93.5**	l/s
Maximum Swale Velocity at Outlet	**0.57**	m/s
[3]Typical Swale Retention Time	**0.069**	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . *f*

where:

P = Wetted Perimeter
L = Length
f = Subgrade infiltration rate

Total Swale Flow = 1/n AR$^{2/3}$ S$^{1/2}$

where:

A = Area of flow
P = Wetted perimeter
R = A/P
n = Manning's Coefficient
s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr
Source: Microdrainage

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175		DBFL
SUBJECT Swale Channel 2 Unit 1		Calc. Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03.2022	

INPUT DATA

Side Slopes	4.0	1 in ....
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	31.5	m
Slope (S)	50	1 in ....
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (f)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	54.7	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	10.943	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	7.5	m
Swale Storage Volume per 8m Length	**0.51**	m^3
Swale Storage Volume (V)	**2.03**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.01**	l/s	
[3]Total Swale Infiltration Volume	0.244	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**161.9**	l/s
Maximum Swale Velocity at Outlet	**0.98**	m/s
[3]Typical Swale Retention Time	**0.009**	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . f

where

P = Wetted Perimeter

L = Length

f = Subgrade infiltration rate

Total Swale Flow = 1/n $AR^{2/3}S^{1/2}$

where:

A = Area of flow

P = Wetted perimeter

R = A/P

n = Manning's Coefficient

s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr	
Source: Microdrainage	

TITLE		Job Reference		
Warehousing and Logistics Development at Calmount Road		210175		
SUBJECT		Calc. Sheet No.		
Swale Channel 3 Unit 1		1		
DRAWING NUMBER	Calculations by	Checked by	Date	
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022	

INPUT DATA

Side Slopes	4.0	1 in ...
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	21.0	m
Slope (S)	50	1 in ...
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (f)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	36.5	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	7.295	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	7.5	m
Swale Storage Volume per 8m Length	**0.51**	m^3
Swale Storage Volume (V)	**1.52**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.01**	l/s	
[3]Total Swale Infiltration Volume	0.244	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**161.9**	l/s
Maximum Swale Velocity at Outlet	**0.98**	m/s
[3]Typical Swale Retention Time	**0.006**	hr

Notes:

1 Assume 200mm of topsoil
2 Volume calculated using 6 hour storm event
3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . f

where:
P = Wetted Perimeter
L = Length
f = Subgrade infiltration rate

Total Swale Flow = $1/n.AR^{2/3}S^{1/2}$

where:
A = Area of flow
P = Wetted perimeter
R = A/P
n = Manning's Coefficient
s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr
Source: Microdrainage

TITLE	Job Reference	
Logistics and Warehousing Development at Calmount Road	210175	DBFL
SUBJECT	Calc. Sheet No.	
Bioretention Area (Unit 2)	1	

DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

INPUT DATA

Effective Impermeable Area for Treatment (A)	370.0	m^2
[1]Filter Bed Depth (L)	1.500	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.010	m
Time Required for Percolation (t)	48.0	hr

BIORETENTION AREA

Surface Area of Bioretention Area (A_f)	49.3	m^2

TREATMENT VOLUME

[3]Treatment Volume (V_T)	4.4	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	5.0	mm/hr	
Subgrade Infiltration Rate (*f*)	0.001	mm/s	
[4]Subgrade Infiltration Volume	14.118	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 1.2 and 1.5m

2 h = Half maximum height, where hmax <=2m

3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6.3.1.2.1).

4 Volume calculated using 6 hour storm event

Area of Bioretention Filter Bed = $\frac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source: SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0.000000028 - 0.000028
Loamy sand	0.0000000028 - 0.00000028
Sandy loam	0.000000014 - 0.0000001-4
Loam	0.00000000028 - 0.00[illegible]028
Silty Loam	0.00000000014 - 0.0000000014

TITLE		Job Reference		
Warehousing and Logistics Development at Calmount Road		210175		DBFL
SUBJECT		Calc. Sheet No.		
Permeable Paving Design - Unit 2		1		
DRAWING NUMBER	Calculations by	Checked by	Date	
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022	

FLAT SITES

INPUT DATA

Pavement Area (A)	1329.0	m^2
Pavement Perimeter (P)	208.0	m
Sub-base Depth (d)	0.400	m
[1]Sub-base Voids Ratio (η)	0.30	
Sub-base Infiltration Rate per hour	1000	mm/hr
Sub-base Infiltration Rate (k)	0.278	mm/s
Subgrade Infiltration Rate per hour	5.0	mm/hr
Subgrade Infiltration Rate (*f*)	0.001	mm/s

VOLUME (STORAGE AND TREATMENT)

Permeable Paving Storage Volume per m^2	0.120	m^3/m^2
Total Permeable Paving Storage Volume	159.5	m^3

INFILTRATION / INTERCEPTION VOLUME

			5mm SURFACE INTERCEPTION
Approx. Permeable Paving Infiltration per m^2	0.001	$l/s/m^2$	5.03 m^3
[2]Total Permeable Paving Infiltration Rate	1.961	l/s	
[3]Total Permeable Paving Infiltration Volume	42.4	m^3	

FLOW

Average Distance between Outlet Drains	6.0	m	Assumed one outlet per house
Flow Velocity through Permeable Paving	0.000038	m/s	
Trench Retention Time	44.2	hr	

TITLE		Job Reference		
Warehousing and Logistics Development at Calmount Road		210175		
SUBJECT		Calc. Sheet No.		
Permeable Paving Design - Unit 2		1		
DRAWING NUMBER	Calculations by	Checked by	Date	
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29 03 2022	

Notes:

1 Sub-base material has a void ratio of approximately 30%, source 'BRE Digest 365'.

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'.

3 Volume calculated using 6 hour storm event.

4 For Paving on slopes includes infiltration, provide 500mmx500mm trenches at 10m centres along slope with 1000mmx500mm at base of slope. source 'Formpave - Aquaflow Permeable Paving System'.

Table: 1

Material	void Ratio, η
Clean stone	0 40 - 0 50
Uniform gravel	0.30 - 0 40
Graded sand or gravel	0.20 - 0 30
Source The SUDS manual, Published by CIRIA	

Table: 2

Pavement Type	Effective Depth (m)
Car-Parking	0 40
Footpath	0 20
Effective Depths are provided from source 'Formpave - Aquaflow Permeable Paving System' and may subject to change as per site requirement	

Total Permeable Paving Outflow

= A . k . i

where

A = Cross Sectional Area of Subbase

k = Subbase Infiltration Rate

i = Hydraulic Gradient

Hydraulic gradient has been assumed as the pavement gradient with an additional 250mm fall per 100m length.

Table: 3

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0 1 - 100
Loamy sand	0 01 - 1
Sandy loam	0 05 - 0.5
Loam	0 001 - 0 1
Silt loam	0 0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0 001 - 0.01
Silty clay loam	0 00005 - 0 005
Clay	< 0 0001
Till	0.00001 - 0 01
Rock	0 00001 - 1
Cutoff point for most infiltration drainage systems = 0 001 mm/hr	
Source Microdrainage	

Total Trench Infiltration:

= 1/2 D . L . *f*

where

L = Length

D = Depth to Invert

f = Subgrade infiltration rate

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Swale Channel 1 Unit 2		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	188.0	m
Slope (S)	150	1 in
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (f)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	326.5	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	65.309	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	22.5	m
Swale Storage Volume per 23m Length	**1.52**	m^3
Swale Storage Volume (V)	**12.15**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.03**	l/s	
[3]Total Swale Infiltration Volume	0.747	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**93.5**	l/s
Maximum Swale Velocity at Outlet	**0.57**	m/s
[3]Typical Swale Retention Time	**0.092**	hr

Notes:

1 Assume 200mm of topsoil.

2 Volume calculated using 6 hour storm event.

3 Swale retention time depends on outlet control, refer to WINDES Model.

Total Swale Infiltration = P . L . f

where:

P = Wetted Perimeter

L = Length

f = Subgrade infiltration rate

Total Swale Flow = $1/n . AR^{2/3} S^{1/2}$

where:

A = Area of flow

P = Wetted perimeter

R = A/P

n = Manning's Coefficient

s = Slope

Table. 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr
Source: Microdrainage

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Swale Channel 2 Unit 2		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in ....
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	13.2	m
Slope (S)	100	1 in ....
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (*f*)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	22.9	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	4.585	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	13.2	m
Swale Storage Volume per 13m Length	**1.00**	m^3
Swale Storage Volume (V)	**1.00**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.02**	l/s	
[2]Total Swale Infiltration Volume	0.468	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**114.5**	l/s
Maximum Swale Velocity at Outlet	**0.69**	m/s
[3]Typical Swale Retention Time	**0.005**	hr

Notes.

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . *f*

where:

P = Wetted Perimeter
L = Length
f = Subgrade infiltration rate

Total Swale Flow = $1/n.AR^{2/3} S^{1/2}$

where

A = Area of flow
P = Wetted perimeter
R = A/P
n = Manning's Coefficient
s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr

Source: Microdrainage

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Swale Channel 3 Unit 2		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	35.9	m
Slope (S)	100	1 in
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (*f*)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	62.4	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	12.471	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	15.0	m
Swale Storage Volume per 15m Length	**1.01**	m^3
Swale Storage Volume (V)	**2.02**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.02**	l/s	
[2]Total Swale Infiltration Volume	0.487	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**114.5**	l/s
Maximum Swale Velocity at Outlet	**0.69**	m/s
[3]Typical Swale Retention Time	**0.014**	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . *f*

where:

P = Wetted Perimeter

L = Length

f = Subgrade infiltration rate

Total Swale Flow = 1/n $AR^{2/3}S^{1/2}$

where:

A = Area of flow

P = Wetted perimeter

R = A/P

n = Manning's Coefficient

s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr

Source: Microdrainage

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175		
SUBJECT Permeable Paving Design - Unit 3		Calc. Sheet No. 1		DBFL
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03 2022	

FLAT SITES

INPUT DATA

Pavement Area (A)	808.0	m^2
Pavement Perimeter (P)	162.0	m
Sub-base Depth (d)	0.400	m
[1]**Sub-base Voids Ratio (η)**	0.30	
Sub-base Infiltration Rate per hour	1000	mm/hr
Sub-base Infiltration Rate (k)	0.278	mm/s
Subgrade Infiltration Rate per hour	5.0	mm/hr
Subgrade Infiltration Rate (*f*)	0.001	mm/s

VOLUME (STORAGE AND TREATMENT)

Permeable Paving Storage Volume per m^2	0.120	m^3/m^2
Total Permeable Paving Storage Volume	97.0	m^3

INFILTRATION / INTERCEPTION VOLUME

5mm SURFACE INTERCEPTION

5.03 m^3

Approx. Permeable Paving Infiltration per m^2	0.002	$l/s/m^2$
[2]**Total Permeable Paving Infiltration Rate**	1.212	l/s
[3]**Total Permeable Paving Infiltration Volume**	26.2	m^3

FLOW

Average Distance between Outlet Drains	6.0	m	Assumed one outlet per house
Flow Velocity through Permeable Paving	0.000038	m/s	
Trench Retention Time	44.2	hr	

TITLE Warehousing and Logistics Development at Calmount Road		**Job Reference** 210175		
SUBJECT Permeable Paving Design - Unit 3		**Calc. Sheet No.** 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	**Calculations by** SSJ	**Checked by** RTM	**Date** 29.03 2022	DBFL

Notes:

1 Sub-base material has a void ratio of approximately 30%, source 'BRE Digest 365'.

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'.

3 Volume calculated using 6 hour storm event

4 For Paving on slopes includes infiltration, provide 500mmx500mm trenches at 10m centres along slope with 1000mmx500mm at base of slope source 'Formpave - Aquaflow Permeable Paving System'

Table: 1

Material	void Ratio, η
Clean stone	0.40 - 0.50
Uniform gravel	0.30 - 0.40
Graded sand or gravel	0.20 - 0.30
Source The SUDS manual, Published by CIRIA	

Table: 2

Pavement Type	Effective Depth (m)
Car-Parking	0.40
Footpath	0.20
Effective Depths are provided from source Formpave - Aquaflow Permeable Paving System' and may subject to change as per site requirement	

Total Permeable Paving Outflow

= A . k . i

where.

A = Cross Sectional Area of Subbase
k = Subbase Infiltration Rate
i = Hydraulic Gradient

Hydraulic gradient has been assumed as the pavement gradient with an additional 250mm fall per 100m length

Table: 3

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0 01 - 1
Sandy loam	0 05 - 0.5
Loam	0.001 - 0.1
Silt loam	0 0005 - 0.005
Chalk	0 001 - 100
Sandy clay loam	0 001 - 0.01
Silty clay loam	0.00005 - 0 005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0 00001 - 1
Cutoff point for most infiltration drainage systems = 0 001 mm/hr Source Microdrainage	

Total Trench Infiltration

= 1/2 D . L . *f*

where

L = Length
D = Depth to Invert
f = Subgrade infiltration rate

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175	
SUBJECT Swale Channel 1 UNIT 3		Calc. Sheet No. 1	
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in .....
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	58.2	m
Slope (S)	100	1 in .....
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (*f*)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	101.1	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	20.218	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	15.0	m
Swale Storage Volume per 15m Length	1.01	m^3
Swale Storage Volume (V)	4.04	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	0.02	l/s	
[3]Total Swale Infiltration Volume	0.487	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	114.5	l/s
Maximum Swale Velocity at Outlet	0.69	m/s
[3]Typical Swale Retention Time	0.023	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . *f*

where

P = Wetted Perimeter

L = Length

f = Subgrade infiltration rate

Total Swale Flow = 1/n.AR $^{2/3}$ *S* $^{1/2}$

where

A = Area of flow

P = Wetted perimeter

R = A/P

n = Manning's Coefficient

s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr

Source: Microdrainage

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Swale Channel 2 Unit 3		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in ....
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	75.3	m
Slope (S)	21	1 in ....
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (f)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	130.8	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	26.158	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	3.2	m
Swale Storage Volume per 3m Length	**0.22**	m^3
Swale Storage Volume (V)	**5.21**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.00**	l/s	
[2]Total Swale Infiltration Volume	0.103	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**249.9**	l/s
Maximum Swale Velocity at Outlet	**1.51**	m/s
[3]Typical Swale Retention Time	**0.014**	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model.

Total Swale Infiltration = P . L . f

where:

P = Wetted Perimeter

L = Length

f = Subgrade infiltration rate

Total Swale Flow = $1/n.AR^{2/3}S^{1/2}$

where:

A = Area of flow

P = Wetted perimeter

R = A/P

n = Manning's Coefficient

s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr

Source: Microdrainage

TITLE		Job Reference		
Logistics and Warehousing Development at Calmount road		210175		DBFL
SUBJECT		Calc. Sheet No.		
Bioretention Area (Unit 4)		1		
DRAWING NUMBER	Calculations by	Checked by	Date	
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022	

INPUT DATA

Effective Impermeable Area for Treatment (A)	460.0	m^2
[1]Filter Bed Depth (L)	1.350	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.010	m
Time Required for Percolation (t)	48.0	hr

BIORETENTION AREA

Surface Area of Bioretention Area (A_f)	**642.0**	m^2

TREATMENT VOLUME

[3]Treatment Volume (V_T)	5.5	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	5.0	mm/hr	
Subgrade Infiltration Rate (*f*)	0.001	mm/s	
[4]Subgrade Infiltration Volume	60.307	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 1 2 and 1 5m

2 h = Half maximum height, where hmax <=2m

3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6 3 1 2 1).

4 Volume calculated using 6 hour storm event

Area of Bioretention Filter Bed = $\frac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0 000000028 - [illegible]28
Loamy sand	0.0000000028 - 0 00000028
Sandy loam	0.000000014 - 0.00000014
Loam	0.00000000028 - 0 0[illegible]028
Silty Loam	0.00000000014 - 0 0000000014

TITLE Logistics and Warehousing Development at Calmount Road		Job Reference 210175		DBFL
SUBJECT GREEN ROOF DESIGN UNIT 4		Calc. Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03.2022	

INPUT DATA

Green Roof Area (A)	268.00	m^2	
[1]Filter Layer Depth (d)	0.500	m	
[1]**Filter Layer Voids Ratio (η)**	30.0	%	

TREATMENT VOLUME

[2]**Treatment Volume (V_T)**	40.2	m^3	Provided Treatment Volume

EVAPOTRANSPIRATION / INTERCEPTION VOLUME

[3]Evapotranspiration Rate per Day	4.00	mm/day	
Evapotranspiration Volume	1.1	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 0.15 and 0.35m. This consists of the substrate and drainage layer.

2 Treatment Volume Vt (m^3) = Green Roof Area (m^2) **x d x η**

3 Assumed 2mm evaporation and 3mm transpiration.

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175		
SUBJECT Permeable Paving Design - Unit 4		Calc. Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03.2022	

FLAT SITES

INPUT DATA

Pavement Area (A)	914.0	m^2
Pavement Perimeter (P)	181.0	m
Sub-base Depth (d)	0.400	m
[1]Sub-base Voids Ratio (η)	0.30	
Sub-base Infiltration Rate per hour	1000	mm/hr
Sub-base Infiltration Rate (k)	0.278	mm/s
Subgrade Infiltration Rate per hour	5.0	mm/hr
Subgrade Infiltration Rate (*f*)	0.001	mm/s

VOLUME (STORAGE AND TREATMENT)

Permeable Paving Storage Volume per m^2	0.120	m^3/m^2
Total Permeable Paving Storage Volume	109.7	m^3

INFILTRATION / INTERCEPTION VOLUME

			5mm SURFACE INTERCEPTION
Approx. Permeable Paving Infiltration per m^2	0.001	$l/s/m^2$	5.03 m^3
[2]Total Permeable Paving Infiltration Rate	1.370	l/s	
[3]Total Permeable Paving Infiltration Volume	29.6	m^3	

FLOW

Average Distance between Outlet Drains	6.0	m	Assumed one outlet per building
Flow Velocity through Permeable Paving	0.000038	m/s	
Trench Retention Time	44.2	hr	

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175		DBFL
SUBJECT Permeable Paving Design - Unit 4		Calc. Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03.2022	

Notes:

1 Sub-base material has a void ratio of approximately 30%, source 'BRE Digest 365'

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'.

3 Volume calculated using 6 hour storm event.

4 For Paving on slopes includes infiltration, provide 500mmx500mm trenches at 10m centres along slope with 1000mmx500mm at base of slope. source 'Formpave - Aquaflow Permeable Paving System'

Table: 1

Material	void Ratio, η
Clean stone	0.40 - 0.50
Uniform gravel	0.30 - 0.40
Graded sand or gravel	0.20 - 0.30
Source The SUDS manual Published by CIRIA	

Table: 2

Pavement Type	Effective Depth (m)
Car-Parking	0.40
Footpath	0.20
Effective Depths are provided from source 'Formpave - Aquaflow Permeable Paving System' and may subject to change as per site requirement	

Total Permeable Paving Outflow

= A . k . i

where:

A = Cross Sectional Area of Subbase
k = Subbase Infiltration Rate
i = Hydraulic Gradient

Hydraulic gradient has been assumed as the pavement gradient with an additional 250mm fall per 100m length

Table: 3

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr Source: Microdrainage	

Total Trench Infiltration

= 1/2 D . L . *f*

where

L = Length
D = Depth to Invert
f = Subgrade infiltration rate

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Swale Channel 1 Unit 4		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in ...
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	60.6	m
Slope (S)	100	1 in ...
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (f)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	105.3	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	21.052	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	15.0	m
Swale Storage Volume per 15m Length	**1.01**	m^3
Swale Storage Volume (V)	**4.04**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	0.02	l/s	
[2]Total Swale Infiltration Volume	0.487	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**114.5**	l/s
Maximum Swale Velocity at Outlet	**0.69**	m/s
[3]Typical Swale Retention Time	**0.024**	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . f

where

P = Wetted Perimeter

L = Length

f = Subgrade infiltration rate

Total Swale Flow = 1/n AR $^{2/3}$ *S* $^{1/2}$

where

A = Area of flow

P = Wetted perimeter

R = A/P

n = Manning's Coefficient

s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0.001 mm/hr

Source: Microdrainage

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Swale Channel 2 Unit 4		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in ....
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	34.8	m
Slope (S)	100	1 in ....
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (*f*)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	60.4	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	12.089	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	15.0	m
Swale Storage Volume per 15m Length	**1.01**	m^3
Swale Storage Volume (V)	**2.02**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.02**	l/s	
[3]Total Swale Infiltration Volume	0.487	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**114.5**	l/s
Maximum Swale Velocity at Outlet	**0.69**	m/s
[3]Typical Swale Retention Time	**0.014**	hr

Notes.

1 Assume 200mm of topsoil.

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . *f*

where:

P = Wetted Perimeter
L = Length
f = Subgrade infiltration rate

Total Swale Flow = 1/n AR$^{2/3}$ S$^{1/2}$

where:

A = Area of flow
P = Wetted perimeter
R = A/P
n = Manning's Coefficient
s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr	
Source: Microdrainage	

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No	
GREEN ROOF DESIGN UNIT 5A (OFFICES)		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Green Roof Area (A)	290.00	m^2
[1]Filter Layer Depth (d)	0.500	m
[1]Filter Layer Voids Ratio (η)	30.0	%

TREATMENT VOLUME

[2]Treatment Volume (V_T)	43.5	m^3	Provided Treatment Volume

EVAPOTRANSPIRATION / INTERCEPTION VOLUME

[3]Evapotranspiration Rate per Day	4.00	mm/day	
Evapotranspiration Volume	1.2	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 0.15 and 0.35m. This consists of the substrate and drainage layer.

2 Treatment Volume Vt (m^3) = Green Roof Area (m^2) **x d x η**

3 Assumed 2mm evaporation and 3mm transpiration

TITLE		Job Reference		
Logistics and Warehousing Development at Calmount Road		210175		DBFL
SUBJECT		Calc. Sheet No.		
GREEN ROOF DESIGN UNIT 5B (OFFICES)		1		
DRAWING NUMBER	Calculations by	Checked by	Date	
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022	

INPUT DATA

Green Roof Area (A)	264.25	m^2
[1]Filter Layer Depth (d)	0.500	m
[1]**Filter Layer Voids Ratio (η)**	30.0	%

TREATMENT VOLUME

[2]**Treatment Volume (V_T)**	39.6	m^3	Provided Treatment Volume

EVAPOTRANSPIRATION / INTERCEPTION VOLUME

[3]Evapotranspiration Rate per Day	4.00	mm/day	
Evapotranspiration Volume	1.1	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 0.15 and 0.35m. This consists of the substrate and drainage layer.

2 Treatment Volume Vt (m^3) = Green Roof Area (m^2) **x d x η**

3 Assumed 2mm evaporation and 3mm transpiration.

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
GREEN ROOF DESIGN UNIT 5C (OFFICES)		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Green Roof Area (A)	291.28	m^2
[1]Filter Layer Depth (d)	0.500	m
[1]Filter Layer Voids Ratio (η)	30.0	%

TREATMENT VOLUME

[2]Treatment Volume (V_T)	43.7	m^3	Provided Treatment Volume

EVAPOTRANSPIRATION / INTERCEPTION VOLUME

[3]Evapotranspiration Rate per Day	4.00	mm/day	
Evapotranspiration Volume	1.2	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 0.15 and 0.35m. This consists of the substrate and drainage layer

2 Treatment Volume Vt (m^3) = Green Roof Area (m^2) x d x η

3 Assumed 2mm evaporation and 3mm transpiration

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc Sheet No.	
Permeable Paving Design - Unit 5		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

FLAT SITES

INPUT DATA

Pavement Area (A)	1961 3	m^2
Pavement Perimeter (P)	243 0	m
Sub-base Depth (d)	0 400	m
[1]**Sub-base Voids Ratio (η)**	0 30	
Sub-base Infiltration Rate per hour	1000	mm/hr
Sub-base Infiltration Rate (k)	0.278	mm/s
Subgrade Infiltration Rate per hour	5 0	mm/hr
Subgrade Infiltration Rate (*f*)	0 001	mm/s

VOLUME (STORAGE AND TREATMENT)

Permeable Paving Storage Volume per m^2	0.120	m^3/m^2
Total Permeable Paving Storage Volume	235 4	m^3

INFILTRATION / INTERCEPTION VOLUME

			5mm SURFACE INTERCEPTION
Approx Permeable Paving Infiltration per m^2	0 001	$l/s/m^2$	5.03 m^3
[2]**Total Permeable Paving Infiltration Rate**	2.859	l/s	
[3]**Total Permeable Paving Infiltration Volume**	61 8	m^3	

FLOW

Average Distance between Outlet Drains	6 0	m	Assumed one outlet per building
Flow Velocity through Permeable Paving	0.000038	m/s	
Trench Retention Time	44.2	hr	

TITLE	Job Reference		
Warehousing and Logistics Development at Calmount Road	210175		
SUBJECT	**Calc Sheet No.**		
Permeable Paving Design - Unit 5	1		
DRAWING NUMBER	**Calculations by**	**Checked by**	**Date**
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29 03 2022

Notes

1 Sub-base material has a void ratio of approximately 30%
source 'BRE Digest 365'

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'

3 Volume calculated using 6 hour storm event.

4 For Paving on slopes includes infiltration, provide 500mmx500mm trenches at 10m centres along slope with 1000mmx500mm at base of slope.
source 'Formpave - Aquaflow Permeable Paving System'

Table: 1

Material	void Ratio, η
Clean stone	0 40 - 0 50
Uniform gravel	0 30 - 0 40
Graded sand or gravel	0 20 - 0 30

Source The SUDS manual Published by CIRIA

Table: 2

Pavement Type	Effective Depth (m)
Car-Parking	0.40
Footpath	0 20

Effective Depths are provided from source 'Formpave - Aquaflow Permeable Paving System' and may subject to change as per site requirement

Total Permeable Paving Outflow

= A . k . i

where.

A = Cross Sectional Area of Subbase
k = Subbase Infiltration Rate
i = Hydraulic Gradient

Hydraulic gradient has been assumed as the pavement gradient [illegible]

Table: 3

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0 1 - 100
Loamy sand	0.01 - 1
Sandy loam	0 05 - 0 5
Loam	0.001 - 0 1
Silt loam	0.0005 - 0.005
Chalk	0 001 - 100
Sandy clay loam	0 001 - 0 01
Silty clay loam	0.00005 - 0.005
Clay	< 0 0001
Till	0 00001 - 0 01
Rock	0.00001 - 1

Cutoff point for most infiltration drainage systems = 0 001 mm/hr
Source: Microdrainage

Total Trench Infiltration

= 1/2 D . L . *f*

where

L = Length
D = Depth to Invert
f = Subgrade infiltration rate

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Raingarden area No.1 Unit 5		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

INPUT DATA

Effective Impermeable Area for Treatment (A)	474.1	m^2
Filter Bed Depth (L)	0.650	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.020	m
Time Required for Percolation (t)	48.0	hr

AREA

Surface Area (A_f)	15.97	m^2
Provided Surface Area	153.91	m^2

TREATMENT VOLUME

[3]**Treatment Volume (V_T)**	5.7	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	0.108	mm/hr	
[5]Subgrade Infiltration Rate (f)	0.00003	mm/s	
[4]**Subgrade Infiltration Volume**	0.309	m^3	
Transpiration Rate per day	3.000	mm/day	
Transpiration	0.462	m^3	
Additional Storage Depth Below Outlet Invert	0.005	m	
Revoir Storage	0.308	m^3	
Total Infiltration/Interception Volume	1.078	m^3	Provided Interception Volume

Notes:

2 h = Half maximum height, where hmax <=2m
3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6.3.1.2.1).
4 Volume calculated using 6 hour storm event
5 Source ' The SuDS Manual Table 25.1'.

Area of Bioretention/Raingarden Filter Bed = $\frac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source: SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0.000000028 - 0.000028
Loamy sand	0.0000000028 - 0.00000028
Sandy loam	0.000000014 - 0.00000014
Loam	0.00000000028 - 0.000000028
Silty Loam	0.00000000014 - 0.0000000014

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Raingarden area No.2 Unit 5		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Effective Impermeable Area for Treatment (A)	106.0	m^2
Filter Bed Depth (L)	0.650	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.020	m
Time Required for Percolation (t)	48.0	hr

AREA

Surface Area (A_f)	3.57	m^2
Provided Surface Area	89.39	m^2

TREATMENT VOLUME

[3]Treatment Volume (V_T)	1.3	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	0.108	mm/hr	
[5]Subgrade Infiltration Rate (f)	0.00003	mm/s	
[4]Subgrade Infiltration Volume	0.217	m^3	
Transpiration Rate per day	3.000	mm/day	
Transpiration	0.268	m^3	
Additional Storage Depth Below Outlet Invert	0.005	m	
Revoir Storage	0.179	m^3	
Total Infiltration/Interception Volume	0.664	m^3	Provided Interception Volume

Notes:

2 h = Half maximum height, where hmax <=2m

3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6.3.1.2.1)

4 Volume calculated using 6 hour storm event

5 Source ' The SuDS Manual Table 25.1'.

Area of Bioretention/Raingarden Filter Bed = $\dfrac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source: SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0.000000028 - 0.000028
Loamy sand	0.0000000028 - 0.00000028
Sandy loam	0.000000014 - 0.00000014
Loam	0.00000000028 - 0.000000028
Silty Loam	0.00000000014 - 0.0000000014

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Raingarden area No.3		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Effective Impermeable Area for Treatment (A)	419.0	m^2
Filter Bed Depth (L)	0.650	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.020	m
Time Required for Percolation (t)	48.0	hr

AREA

Surface Area (A_f)	14.11	m^2
Provided Surface Area	182.52	m^2

TREATMENT VOLUME

[3]Treatment Volume (V_T)	5.0	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	0.108	mm/hr	
[5]Subgrade Infiltration Rate (f)	0.00003	mm/s	
[4]Subgrade Infiltration Volume	0.346	m^3	
Transpiration Rate per day	3.000	mm/day	
Transpiration	0.548	m^3	
Additional Storage Depth Below Outlet Invert	0.005	m	
Revoir Storage	0.365	m^3	
Total Infiltration/Interception Volume	1.258	m^3	Provided Interception Volume

Notes:

2 h = Half maximum height, where hmax <=2m
3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6.3.1.2.1).
4 Volume calculated using 6 hour storm event
5 Source ' The SuDS Manual Table 25.1'

Area of Bioretention/Raingarden Filter Bed = $\frac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0.000000028 - 0.000028
Loamy sand	0.0000000028 - 0.00000028
Sandy loam	0.000000014 - 0.00000014
Loam	0.00000000028 - 0.000000028
Silty Loam	0.00000000014 - 0.0000000014

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Bioretention Area 1 (Unit 6)		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Effective Impermeable Area for Treatment (A)	0.0	m^2
[1]Filter Bed Depth (L)	1.500	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.010	m
Time Required for Percolation (t)	48.0	hr

BIORETENTION AREA

Surface Area of Bioretention Area (A_f)	49.3	m^2

TREATMENT VOLUME

[3]Treatment Volume (V_T)	0.0	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	5.0	mm/hr	
Subgrade Infiltration Rate (f)	0.001	mm/s	
[4]Subgrade Infiltration Volume	14.118	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 1.2 and 1.5m

2 h = Half maximum height, where hmax <=2m

3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6.3.1.2.1)

4 Volume calculated using 6 hour storm event

Area of Bioretention Filter Bed = $\frac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source: SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0.000000028 - 0.000028
Loamy sand	0.0000000028 - 0.00000028
Sandy loam	0.000000014 - 0.00000014
Loam	0.00000000028 - 0.000000028
Silty Loam	0.00000000014 - 0.0000000014

TITLE		Job Reference	
Logistics and Warehousing Development at Calmount road		210175	
SUBJECT		Calc. Sheet No.	
Bioretention Area 2 (Unit 6)		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Effective Impermeable Area for Treatment (A)	440.0	m^2
[1]Filter Bed Depth (L)	1.350	m
Coefficient of Permeability of Filter Medium (k)	0.000002	m/s
[2]Average Height of Water above Filter Bed (h)	0.010	m
Time Required for Percolation (t)	48.0	hr

BIORETENTION AREA

Surface Area of Bioretention Area (A_f)	**49.3**	m^2

TREATMENT VOLUME

[3]Treatment Volume (V_T)	5.3	m^3	Provided Treatment Volume

INFILTRATION / INTERCEPTION VOLUME

Subgrade Infiltration Rate per hour	5.0	mm/hr	
Subgrade Infiltration Rate (*f*)	0.001	mm/s	
[4]Subgrade Infiltration Volume	12.854	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 1.2 and 1.5m

2 h = Half maximum height, where hmax <=2m

3 Treatment Volume Vt (m^3) = Impermeable Area (ha) x 15mm x 10 x 80% (GDSDS Section 6.3.1.2.1).

4 Volume calculated using 6 hour storm event

Area of Bioretention Filter Bed = $\frac{V_T \cdot L}{k(h+L)t}$

Table: 1

Material	Infiltration Rate (m/s)
Source: SUDS Manual Section 25-1	
Silty Loam	0.000002
Sand	0.000000028 - 0.000028
Loamy sand	0.0000000028 - 0.00000028
Sandy loam	0.000000014 - 0.00000014
Loam	0.00000000028 - 0.000000028
Silty Loam	0.00000000014 - 0.0000000014

TITLE Logistics and Warehousing Development at Calmount Road		Job Reference 210175		
SUBJECT GREEN ROOF DESIGN UNIT 6		Calc. Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03.2022	

INPUT DATA

Green Roof Area (A)	127.00	m^2	
[1]Filter Layer Depth (d)	0.500	m	SAME
[1]**Filter Layer Voids Ratio (η)**	30.0	%	SAME

TREATMENT VOLUME

[2]**Treatment Volume (V_T)**	19.1	m^3	Provided Treatment Volume

EVAPOTRANSPIRATION / INTERCEPTION VOLUME

[3]Evapotranspiration Rate per Day	4.00	mm/day	
Evapotranspiration Volume	0.5	m^3	Provided Interception Volume

Notes:

1 Filter Bed depth typically between 0.15 and 0.35m. This consists of the substrate and drainage layer

2 Treatment Volume Vt (m^3) = Green Roof Area (m^2) **x d x η**

3 Assumed 2mm evaporation and 3mm transpiration.

TITLE	Job Reference		
Warehousing and Logistics Development at Calmount Road	210175		
SUBJECT	Calc. Sheet No.		
Permeable Paving Design - Unit 6	1		
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

FLAT SITES

INPUT DATA

Pavement Area (A)	1104.0	m^2
Pavement Perimeter (P)	230.0	m
Sub-base Depth (d)	0.400	m
Sub-base Voids Ratio (η)	0.30	
Sub-base Infiltration Rate per hour	1000	mm/hr
Sub-base Infiltration Rate (k)	0.278	mm/s
Subgrade Infiltration Rate per hour	5.0	mm/hr
Subgrade Infiltration Rate (*f*)	0.001	mm/s

VOLUME (STORAGE AND TREATMENT)

Permeable Paving Storage Volume per m^2	0.120	m^3/m^2
Total Permeable Paving Storage Volume	132.5	m^3

INFILTRATION / INTERCEPTION VOLUME

			5mm SURFACE INTERCEPTION
Approx. Permeable Paving Infiltration per m^2	0.002	$l/s/m^2$	5.03 m^3
[2]**Total Permeable Paving Infiltration Rate**	1.661	l/s	
[3]**Total Permeable Paving Infiltration Volume**	35.9	m^3	

FLOW

Average Distance between Outlet Drains	6.0	m	Assumed one outlet per building
Flow Velocity through Permeable Paving	0.000038	m/s	
Trench Retention Time	44.2	hr	

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175		DBFL
SUBJECT Permeable Paving Design - Unit 6		Calc Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29 03.2022	

Notes

1 Sub-base material has a void ratio of approximately 30%, source 'BRE Digest 365'

2 Wetted perimeter assuming 50% of trench depth, source 'BRE Digest 365'

3 Volume calculated using 6 hour storm event

4 For Paving on slopes includes infiltration, provide 500mmx500mm trenches at 10m centres along slope with 1000mmx500mm at base of slope source 'Formpave - Aquaflow Permeable Paving System'

Table: 1

Material	void Ratio, η
Clean stone	0 40 - 0 50
Uniform gravel	0 30 - 0 40
Graded sand or gravel	0 20 - 0 30
Source The SUDS manual, Published by CIRIA	

Table: 2

Pavement Type	Effective Depth (m)
Car-Parking	0 40
Footpath	0 20
Effective Depths are provided from source 'Formpave - Aquaflow Permeable Paving System' and may subject to change as per site requirement	

Total Permeable Paving Outflow.

= A k i

where

A = Cross Sectional Area of Subbase
k = Subbase Infiltration Rate
i = Hydraulic Gradient

Hydraulic gradient has been assumed as the pavement gradient
Allow additional [illegible] mm fall per 100m length

Table: 3

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0 01 - 1
Sandy loam	0 05 - 0 5
Loam	0 001 - 0 1
Silt loam	0 0005 - 0 005
Chalk	0 001 - 100
Sandy clay loam	0 001 - 0 01
Silty clay loam	0 00005 - 0 005
Clay	< 0 0001
Till	0 00001 - 0 01
Rock	0 00001 - 1
Cutoff point for most infiltration drainage systems = 0 001 mm/hr	
Source Microdrainage	

Total Trench Infiltration.

= 1/2 D . L . *f*

where

L = Length
D = Depth to Invert
f = Subgrade infiltration rate

TITLE		Job Reference	
Warehousing and Logistics Development at Calmount Road		210175	
SUBJECT		Calc. Sheet No.	
Swale Channel 1 Unit 6		1	
DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

DBFL

INPUT DATA

Side Slopes	4.0	1 in	SAME
Bottom width (W)	1.00	m	
Depth to Invert (D)	0.15	m	SAME
Length (L)	26.0	m	
Slope (S)	100	1 in	SAME
Manning's Coefficient (n)	0.030		SAME
Subgrade Infiltration Rate per hour	5.000	mm/hr	SAME
Subgrade Infiltration Rate (*f*)	0.001388889	mm/s	

TREATMENT VOLUME

Total Plan Area of Swale	58.2	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	11.632	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	15.0	m
Swale Storage Volume per 15m Length	**1.57**	m^3
Swale Storage Volume (V)	**3.14**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.03**	l/s	
[3]Total Swale Infiltration Volume	0.697	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**180.6**	l/s
Maximum Swale Velocity at Outlet	**0.75**	m/s
[3]Typical Swale Retention Time	**0.010**	hr

Notes:

1 Assume 200mm of topsoil.

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . *f*

where:

P = Wetted Perimeter
L = Length
f = Subgrade infiltration rate

Total Swale Flow = 1/n.AR [illegible] *S* [illegible]

where:

A = Area of flow
P = Wetted perimeter
R = A/P
n = Manning's Coefficient
s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr	
Source: Microdrainage	

TITLE	Job Reference	
Warehousing and Logistics Development at Calmount Road	210175	DBFL
SUBJECT	Calc. Sheet No.	
Swale Channel 2 Unit 6	1	

DRAWING NUMBER	Calculations by	Checked by	Date
210175-DBFL-SW-SP-DR-C-1300	SSJ	RTM	29.03.2022

INPUT DATA

Side Slopes	4.0	1 in	SAME
Bottom width (W)	0.50	m	
Depth to Invert (D)	0.15	m	SAME
Length (L)	82.6	m	
Slope (S)	65	1 in	SAME
Manning's Coefficient (n)	0.030		SAME
Subgrade Infiltration Rate per hour	5.000	mm/hr	SAME
Subgrade Infiltration Rate (*f*)	0.001388889	mm/s	

TREATMENT VOLUME

Total Plan Area of Swale	143.5	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	28.694	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	9.8	m
Swale Storage Volume per 10m Length	0.66	m^3
Swale Storage Volume (V)	5.26	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	0.01	l/s	
[3]Total Swale Infiltration Volume	0.315	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	142.0	l/s
Maximum Swale Velocity at Outlet	0.86	m/s
[3]Typical Swale Retention Time	0.027	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model

Total Swale Infiltration = P . L . *f*

where:

P = Wetted Perimeter
L = Length
f = Subgrade infiltration rate

Total Swale Flow = $1/n.AR^{2/3}S^{1/2}$

where

A = Area of flow
P = Wetted perimeter
R = A/P
n = Manning's Coefficient
s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr	
Source: Microdrainage	

TITLE Warehousing and Logistics Development at Calmount Road		Job Reference 210175		DBFL
SUBJECT **Swale Channel 3 Unit 6**		Calc. Sheet No. 1		
DRAWING NUMBER 210175-DBFL-SW-SP-DR-C-1300	Calculations by SSJ	Checked by RTM	Date 29.03.2022	

INPUT DATA

Side Slopes	4.0	1 in ....
Bottom width (W)	0.50	m
Depth to Invert (D)	0.15	m
Length (L)	16.0	m
Slope (S)	65	1 in ....
Manning's Coefficient (n)	0.030	
Subgrade Infiltration Rate per hour	5.000	mm/hr
Subgrade Infiltration Rate (f)	0.001388889	mm/s

TREATMENT VOLUME

Total Plan Area of Swale	27.8	m^2	
[1]Depth of Subgrade Treatment	0.20	m	
Total Swale Treatment Volume (V_T)	5.558	m^3	Provided Treatment Volume

STORAGE VOLUME

Max. Length of Storage within Swale	9.8	m
Swale Storage Volume per 10m Length	**0.66**	m^3
Swale Storage Volume (V)	**1.31**	m^3

INFILTRATION/ INTERCEPTION VOLUME

Total Swale Infiltration Rate	**0.01**	l/s	
[2]Total Swale Infiltration Volume	0.315	m^3	Provided Interception Volume

FLOW

Maximum Swale Flow at Outlet	**142.0**	l/s
Maximum Swale Velocity at Outlet	**0.86**	m/s
[3]Typical Swale Retention Time	**0.005**	hr

Notes:

1 Assume 200mm of topsoil

2 Volume calculated using 6 hour storm event

3 Swale retention time depends on outlet control, refer to WINDES Model.

Total Swale Infiltration = P . L . f

where:

P = Wetted Perimeter

L = Length

f = Subgrade infiltration rate

Total Swale Flow = 1/n $AR^{2/3} S^{1/2}$

where:

A = Area of flow

P = Wetted perimeter

R = A/P

n = Manning's Coefficient

s = Slope

Table: 1

Material	Infiltration Rate (m/hr)
Gravel	10 - 1000
Sand	0.1 - 100
Loamy sand	0.01 - 1
Sandy loam	0.05 - 0.5
Loam	0.001 - 0.1
Silt loam	0.0005 - 0.005
Chalk	0.001 - 100
Sandy clay loam	0.001 - 0.01
Silty clay loam	0.00005 - 0.005
Clay	< 0.0001
Till	0.00001 - 0.01
Rock	0.00001 - 1
Cutoff point for most infiltration drainage systems = 0.001 mm/hr	
Source: Microdrainage	

Appendix D: Permissible Site Discharge Calculations

PROJECT		JOB REF.
Development at Ballymount Ave		210175
SUBJECT		Calc. Sheet No.
Surface Water Calculations - cafe Permissible Site Discharge		1
Drawing ref.	Calculations by Checked by	Date
210175 - info1	RTM SVC	24/02/2022

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the CATCHMENT area? **0.24** Hectares (ha)

What is the drained catchment area? **0.24** Hectares (ha) — Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? **No**

Catchment	1	
Area	0 24	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [1]	1	Class
SOIL Type	3	From FSR Table
SOIL Index	0 40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0 45	0.47
5	0 50	[illegible]

Site SOIL Index Value **0.40**

Site SPR Value **0.37**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? **No**

What is the overall site area for catchment? **0.24** Hectares (ha)

Catchment 1	Area (m²)	Runoff Coeff	Effective Area (m²)
Roofs - Type 1 (Traditional)	[illegible]	1 00	0 0
Roofs - Type 2 (Draining to SUDS features)	228	0 70	159 6
Green Roofs	0	0 70	0 0
Roads and Footpaths - Type 1 (Draining to gullies)	[illegible]	[illegible]	0 0
Roads and Footpaths - Type 2 (Draining to Suds features)	490	0 70	343 0
Paved Areas	[illegible]	[illegible]	0 0
Permeable Paving	494	[illegible]	247 0
Podium (extensive green roof)	0	0 50	0 0
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)	254	0.37	94.0
Public Open Space (Non Contributary Landscaping)	961	0 37	355 6

Include Public Open Space in Effective Catchment Area? **No**

Effective Catchment Area **843.6** m^2

Effective Catchment Runoff Coefficient **0.58**

Long-Term Storage

Is long-term Storage provided? **No**

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)? **700.0** mm

Is the overall site area less than 50 hectares? **Yes**

[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site **0.8** Litres/sec

[7]Site Discharge = **0.5** Litres/sec — SDCC require 2l/s/ha = 14.2l/s for the site

Notes and Formulae

1 SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5).

2 SPR value calculated from GDSDS - Table 6.7

3. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change.

4 Long-term storage Vol_{xs} (m^3) = Rainfall.Area 10 [(PIMP/100)(0.8.α)+(1-PIMP/100)(β SPR)-SPR] (GDSDS Section 6 7 3)

Where long-term storage cannot be provided on-site due to ground conditions. Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$

5 Total Permissible Outflow - $QBAR_{Rural}$ calculated in accordance with GDSDS - Regional Drainage Policies

(Volume 2 - Chapter 6). i.e $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area Flow rates are linearly interpolated for areas samller than 50hectares

6. Where Total Permissible Outflow is less than 2 0l/s and not achievable, use 2 0 l/s or closest value possible

7 QBAR multiplied by growth factors of 0 85 for 1 year 2 1 for 30 year and 2 6 for 100 year return period events, from GDSDS Figure C2

PROJECT		JOB REF.
Development at Ballymount Ave		210175
SUBJECT		Calc. Sheet No.
Surface Water Calculations - Roads Permissible Site Discharge		1
Drawing ref.	Calculations by Checked by	Date
210175 - info1	RTM SVC	24/02/2022

DBFL

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the CATCHMENT area?	0.81	Hectares (ha)	
What is the drained catchment area?	0.81	Hectares (ha)	Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? **No**

Catchment	1	
Area	0.81	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [6]	1	Class
SOIL Type	3	From FSR Table
SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value **0.40**

Site SPR Value **0.37**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? **No**

What is the overall site area for catchment? **0.81** Hectares (ha)

Catchment 1	Area (m²)	Runoff Coeff	Effective Area (m²)
Roofs - Type 1 (Traditional)	0	1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	0	0.70	0.0
Green Roofs	0	0.70	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	0	0.80	0.0
Roads and Footpaths - Type 2 (Draining to Suds features)	7524	0.70	5266.8
Paved Areas	0	0.80	0.0
Permeable Paving	0	0.50	0.0
Podium (extensive green roof)	0	0.50	0.0
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)	0	0.37	0.0
Public Open Space (Non Contributary Landscaping)	622	0.37	230.1

Include Public Open Space in Effective Catchment Area? **No**

Effective Catchment Area **5266.8** m²

Effective Catchment Runoff Coefficient **0.70**

Long-Term Storage

Is long-term Storage provided? **No**

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)?	700.0	mm	From Met Eireann Co-ordinates
Is the overall site area less than 50 hectares?	Yes		
5QBAR$_{Rural}$ calculated for 50 ha and linearly interpolated for area of site	2.8	Litres/sec	
7Site Discharge =	1.6	Litres/sec	SDCC require 2l/s/ha = 14.2l/s for the site

Notes and Formulae

1. SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5).
2. SPR value calculated from GDSDS - Table 6.7
3. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change
4. Long-term storage Vol_{xs} (m³) = Rainfall Area 10 [(PIMP/100)(0.8 α)+(1-PIMP/100)(β SPR)-SPR]. (GDSDS Section 6.7.3)

   Where long-term storage cannot be provided on-site due to ground conditions. Total Permissible Outflow is to be kept to QBAR$_{(Rural)}$
5. 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)$^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas smaller than 50hectares.
6. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible
7. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2.

PROJECT Development at Ballymount Ave		JOB REF. 210175
SUBJECT Surface Water Calculations - Unit 1 Permissible Site Discharge		Calc. Sheet No. 1
Drawing ref. 210175-INFO1	Calculations by Checked by RTM SVC	Date 29/06/2021

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the CATCHMENT area? **0.75** Hectares (ha)

What is the drained catchment area? **0.75** Hectares (ha) Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? No

Catchment	1	
Area	0.75	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [b]	1	Class
SOIL Type	3	From FSR Table
[1]SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value **0.40**

Site SPR Value **0.37**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? No

What is the overall site area for catchment? **0.75** Hectares (ha)

Catchment 1	Area (m^2)	Runoff Coeff	Effective Area (m^2)
Roofs - Type 1 (Traditional)	0	1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	2900	0.70	2030.0
Green Roofs	0	0.79	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	0	0.80	0.0
Roads and Footpaths - Type 2 (Draining to Suds features)	2511	0.79	1967.7
Paved Areas	0	0.80	0.0
Permeable Paving	777	0.50	388.5
Podium (extensive green roof)	0	0.50	0.0
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)	440	0.37	162.8
Public Open Space (Non Contributary Landscaping)	601	0.37	222.4

Include Public Open Space in Effective Catchment Area? No

Effective Catchment Area **4549.0** m^2

Effective Catchment Runoff Coefficient **0.66**

Long-Term Storage

Is long-term Storage provided? No

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)? 700.0 mm

Is the overall site area less than 50 hectares? Yes

[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site 2.6 Litres/sec

[7]Site Discharge = **1.5** Litres/sec **SDCC require 2l/s/ha = 14.2l/s for the site**

Notes and Formulae

1. SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5)
2. SPR value calculated from GDSDS - Table 6.7
3. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change
4. Long-term storage Vol_{xs} (m^3) = Rainfall Area 10.[(PIMP/100)(0.8 α)+(1-PIMP/100)(β.SPR)-SPR] (GDSDS Section 6.7.3).
   Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{Rural}$
5. 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}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas smaller than 50hectares.
6. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible
7. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2.

PROJECT Development at Ballymount Ave		JOB REF. 210175
SUBJECT Surface Water Calculations - Unit 2 Permissible Site Discharge		Calc. Sheet No 1
Drawing ref. 210175-INF01	Calculations by / Checked by RTM / SVC	Date 29/06/2021

DBFL

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the CATCHMENT area? **1.59** Hectares (ha)

What is the drained catchment area? **1.59** Hectares (ha) — Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? No

Catchment	1	
Area	1.59	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [6]	1	Class
SOIL Type	3	From FSR Table
[1]SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value **0.40**

Site SPR Value **0.37**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? No

What is the overall site area for catchment? **1.59** Hectares (ha)

Catchment 1	Area (m^2)	Runoff Coeff	Effective Area (m^2)
Roofs - Type 1 (Traditional)	0	1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	5851	0.70	4095.7
Green Roofs	0	0.70	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	3020	0.80	2416.0
Roads and Footpaths - Type 2 (Draining to Suds features)	3175	0.70	2222.5
Paved Areas	0	0.80	0.0
Permeable Paving	1516	0.50	758.0
Podium (extensive green roof)	0	0.50	0.0
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)	718	0.37	265.7
Public Open Space (Non Contributary Landscaping)	1620	0.37	599.4

Include Public Open Space in Effective Catchment Area? No

Effective Catchment Area **9757.9** m^2

Effective Catchment Runoff Coefficient **0.68**

Long-Term Storage

Is long-term Storage provided? No

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)? 700.0 mm

Is the overall site area less than 50 hectares? Yes

[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site: 5.4 Litres/sec

[7]Site Discharge = **3.2** Litres/sec — **SDCC require 2l/s/ha = 14.2l/s for the site**

Notes and Formulae

1 SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5)

2 SPR value calculated from GDSDS - Table 6.7

3 Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change

4 Long-term storage Vol_{xs} (m^3) = Rainfall Area 10.[(PIMP/100)(0.8.α)+(1-PIMP/100)(β.SPR)-SPR]. (GDSDS Section 6.7.3)

Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$

5 Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies

(Volume 2 - Chapter 6). i.e. $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas smaller than 50hectares.

6 Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible.

7 QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2

PROJECT		JOB REF.
Development at Ballymount Ave		180189
SUBJECT		Calc. Sheet No.
Surface Water Calculations - Unit 3 Permissible Site Discharge		1
Drawing ref.	Calculations by / Checked by	Date
210175-INFO1	RTM / SVC	29/09/2021

DBFL

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the CATCHMENT area?	0.84	Hectares (ha)	
What is the drained catchment area?	0.84	Hectares (ha)	Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? **No**

Catchment (This refers to the entire site area)	1	
Area	0.84	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [6]	1	Class
SOIL Type	3	From FSR Table
[1]SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value **0.40**

Site SPR Value **0.37**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? **No**

What is the overall site area for catchment? **0.84** Hectares (ha)

Catchment 1	Area (m^2)	Runoff Coeff	Effective Area (m^2)
Roofs - Type 1 (Traditional)	3393	1.00	3393.0
Roofs - Type 2 (Draining to SUDS features)	0	0.70	0.0
Green Roofs	0	0.70	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	1360	0.80	1088.0
Roads and Footpaths - Type 2 (Draining to Suds features)	0	0.70	0.0
Paved Areas	0	0.80	0.0
Permeable Paving	903	0.50	451.5
Podium (extensive green roof)	0	0.50	0.0
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)	119	0.37	44.0
Public Open Space (Non Contributary Landscaping)	844	0.37	312.3

Include Public Open Space in Effective Catchment Area?	No	
Effective Catchment Area	4976.5	m^2
Effective Catchment Runoff Coefficient	0.86	

Long-Term Storage

Is long-term Storage provided? **No**

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)?	700.0	mm	From Met Eireann, Co-ordinates 310000/230000
Is the overall site area less than 50 hectares?	Yes		
[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site	2.8	Litres/sec	
[7]Site Discharge =	1.7	Litres/sec	**SDCC require 2l/s/ha = 14.2l/s for the site**

Notes and Formulae

1. SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5)
2. SPR value calculated from GDSDS - Table 6.7
3. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change
4. Long-term storage Vol_{xs} (m^3) = Rainfall.Area.10.[(PIMP/100)(0.8.α)+(1-PIMP/100)(β.SPR)-SPR]. (GDSDS Section 6.7.3)
   Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$.
5. Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies
   (Volume 2 - Chapter 6), i.e. QBAR(m3/s)=0.00108x$(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas smaller than 50hectares.
6. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible
7. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2

PROJECT		JOB REF.
Development at Ballymount Ave		210175
SUBJECT		Calc. Sheet No.
Surface Water Calculations - Unit 4 Permissible Site Discharge		1
Drawing ref.	Calculations by / Checked by	Date
210175 - info1	RTM / SVC	24/02/2022

DBFL

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the CATCHMENT area?	1.14	Hectares (ha)	
What is the drained catchment area?	1.14	Hectares (ha)	Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? **No**

Catchment (This refers to the entire site area)	1	
Area	1.14	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [6]	1	Class
SOIL Type	3	From FSR Table
[1]SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value	0.40
Site SPR Value	0.37

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? **No**

What is the overall site area for catchment? **1.14** Hectares (ha)

Catchment 1	Area (m²)	Runoff Coeff	Effective Area (m²)
Roofs - Type 1 (Traditional)	0	1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	3386	0.70	2370.2
Green Roofs	268	0.70	187.6
Roads and Footpaths - Type 1 (Draining to gullies)	1415	0.80	1132.0
Roads and Footpaths - Type 2 (Draining to Suds features)	2010	0.70	1407.0
Paved Areas	0	0.80	0.0
Permeable Paving	900	0.50	450.0
Podium (extensive green roof)	0	0.80	0.0
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)	481	0.37	178.0
Public Open Space (Non Contributary Landscaping)	2948	0.37	1090.8

Include Public Open Space in Effective Catchment Area?	No	
Effective Catchment Area	5724.8	m²
Effective Catchment Runoff Coefficient	0.68	

Long-Term Storage

Is long-term Storage provided? **No**

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)?	700.0	mm	From Met Eireann, Co-ordinates [illegible]
Is the overall site area less than 50 hectares?	Yes		
[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site	3.9	Litres/sec	
[7]Site Discharge =	2.3	Litres/sec	SDCC require 2l/s/ha = 14.2l/s for the site

Notes and Formulae

1 SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5).

2 SPR value calculated from GDSDS - Table 6.7

3 Rainfall depth for 100 year return period 6 hour duration with additional 10% for climate change.

4 Long-term storage Vol_{xs} (m^3) = Rainfall.Area 10.[(PIMP/100)(0.8.α)+(1-PIMP/100)(β SPR)-SPR]. (GDSDS Section 6.7.3)

Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$

5 Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies

(Volume 2 - Chapter 6), i.e. $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas smaller than 50hectares.

6 Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible.

7 QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2

PROJECT			JOB REF.
Development at Ballymount Ave			210175
SUBJECT			Calc. Sheet No.
Surface Water Calculations - Unit 5 Permissible Site Discharge			1
Drawing ref.	Calculations by	Checked by	Date
210175 - info1	RTM	SVC	24/02/2022

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the CATCHMENT area?	0.70	Hectares (ha)	
What is the drained catchment area?	0.70	Hectares (ha)	Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? **No**

Catchment	1	
Area	0.70	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [6]	1	Class
SOIL Type	3	From FSR Table
[1]SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value	0.40
Site SPR Value	0.37

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? **No**

What is the overall site area for catchment? **0.70** Hectares (ha)

Catchment 1	Area (m²)	Runoff Coeff	Effective Area (m²)
Roofs - Type 1 (Traditional)	763	1.00	763.0
Roofs - Type 2 (Draining to SUDS features)	0	0.70	0.0
Green Roofs	845	0.70	591.5
Roads and Footpaths - Type 1 (Draining to gullies)	0	0.85	0.0
Roads and Footpaths - Type 2 (Draining to Suds features)	1046	0.70	732.2
Paved Areas	0	0.80	0.0
Permeable Paving	2001	0.50	1000.5
Podium (extensive green roof)	0	0.50	0.0
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)	605	0.37	223.9
Public Open Space (Non Contributary Landscaping)	1731	0.37	640.5

Include Public Open Space in Effective Catchment Area?	No	
Effective Catchment Area	3311.1	m²
Effective Catchment Runoff Coefficient	0.62	

Long-Term Storage

Is long-term Storage provided? **No**

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)?	700.0	mm	From Met Eireann Co-ordinates 310000, 230000
Is the overall site area less than 50 hectares?	Yes		
[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site	2.4	Litres/sec	
[7]Site Discharge =	1.4	Litres/sec	SDCC require 2l/s/ha = 14.2l/s for the site

Notes and Formulae

1 SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5)

2 SPR value calculated from GDSDS - Table 6.7

3 Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change

4 Long-term storage Vol_{xs} (m^3) = Rainfall.Area.10 [(PIMP/100)(0.8.α)+(1-PIMP/100)(β.SPR)-SPR]. (GDSDS Section 6.7.3).

Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$

5. Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies

(Volume 2 - Chapter 6). i.e. QBAR(m3/s)=0.00108x$(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas smaller than 50hectares

6. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible.

7 QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2.

PROJECT Development at Ballymount Ave		JOB REF. 210175
SUBJECT Surface Water Calculations - Unit 6 Permissible Site Discharge		Calc. Sheet No. 1
Drawing ref. 210175 - inf01	Calculations by / Checked by RTM / SVC	Date 24/02/2022

DBFL

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the CATCHMENT area? **1.01** Hectares (ha)

What is the drained catchment area? **1.01** Hectares (ha) — Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? No

Catchment	1	
Area	1.01	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [(a)]	1	Class
SOIL Type	3	From FSR Table
SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value **0.40**

Site SPR Value **0.37**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? No

What is the overall site area for catchment? 1.01 Hectares (ha)

Catchment 1	Area (m^2)	Runoff Coeff	Effective Area (m^2)
Roofs - Type 1 (Traditional)	0	1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	3462	0.70	2423.4
Green Roofs	127	0.70	88.9
Roads and Footpaths - Type 1 (Draining to gullies)	1939	0.80	1551.2
Roads and Footpaths - Type 2 (Draining to Suds features)	1689	0.70	1182.3
Paved Areas	0	0.80	0.0
Permeable Paving	1074	0.50	537.0
Podium (extensive green roof)	0	0.50	0.0
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)	115	0.37	42.6
Public Open Space (Non Contributary Landscaping)	1741	0.37	644.2

Include Public Open Space in Effective Catchment Area? No

Effective Catchment Area **5825.4** m^2

Effective Catchment Runoff Coefficient **0.69**

Long-Term Storage

Is long-term Storage provided? No

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)? 700.0 mm — From Met Eireann, co-ordinates 310000/230000

Is the overall site area less than 50 hectares? Yes

[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site 3.5 Litres/sec

[7]Site Discharge = **2.0** Litres/sec — **SDCC require 2l/s/ha = 14.2l/s for the site**

Notes and Formulae

1 SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5)

2 SPR value calculated from GDSDS - Table 6.7

3 Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change.

4 Long-term storage Vol_{xs} (m^3) = Rainfall Area 10 [(PIMP/100)(0.8.α)+(1-PIMP/100)(β SPR)-SPR] (GDSDS Section 6.7.3).

Where long-term storage cannot be provided on-site due to ground conditions Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$

5 Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies

(Volume 2 - Chapter 6), i.e. $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas samller than 50hectares.

6 Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible

7 QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2

PROJECT Commercial Development at Ballymount Avenue		JOB REF. 210175
SUBJECT Surface Water Calculations - Permissible Site Discharge		Calc. Sheet No. 1
Drawing ref. 210175 - info1	Calculations by RTM / Checked by SVC	Date 24/02/2022

DBFL

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the overall site area?	7.11	Hectares (ha)	
What is the drained catchment area?	7.11	Hectares (ha)	Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? **No**

Catchment	1	
Area	7.11	Hectares (ha)
Drainage Group	2	Class
Depth to Impermeable Layers	2	Class
Permeability Group above Impermeable Layers	2	Class
Slope [6]	1	Class
SOIL Type	3	From FSR Table
[1]SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value	0.40
Site SPR Value	0.37

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? **Yes**

What is the overall site area for Catchment 1? **7.11** Hectares (ha)

Catchment 1	Area (m²)	Runoff Coeff	Effective Area (m²)
Roofs - Type 1 (Traditional)			
Roofs - Type 2 (Draining to SUDS features)			
Green Roofs			
Roads and Footpaths - Type 1 (Draining to gullies)			
Roads and Footpaths - Type 2 (Draining to Suds features)			
Paved Areas			
Permeable Paving			
Podium (extensive green roof)			
Grassed Areas (inc. Filter drains, tree pits, bio-retention areas & pitches)			
Public Open Space (Non Contributary Landscaping)			

Include Public Open Space in Effective Catchment Area 1?	No	
Catchment 1 - Effective Catchment Area	0.0	m²
Catchment 1 - Effective Catchment Runoff Coefficient	#DIV/0!	

Long-Term Storage

Is long-term Storage provided? **No**

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)?	700.0	mm	From Met Eireann Geo-drainage
Is the overall site area less than 50 hectares?	Yes		(site coord 309678, 0383)
[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site	24.2	Litres/sec	
[7]Site Discharge =	14.2	Litres/sec	SDCC require 2l/s/ha = 14.2l/s for the site

Notes and Formulae

1 SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5)

2 SPR value calculated from GDSDS - Table 6.7

3 Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change

4 Long-term storage Vol_{xs} (m^3) = Rainfall Area.10.[(PIMP/100)(0.8 α)+(1-PIMP/100)(β SPR)-SPR]. (GDSDS Section 6.7.3)

Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$

5. Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies

(Volume 2 - Chapter 6) i.e. $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas samller than 50hectares

6. Where Total Permissible Outflow is less than 2.0l/s and not achevable, use 2.0 l/s or closest value possible

7 QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2

Appendix E: Microdrainage Calculations & Attenuation Sizing

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for CAFE

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	58
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	0
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.750
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 Inverts

Network Design Table for CAFE

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	16.534	0.180	91.9	0.003	4.00	0.0	0.600	o	150	Pipe/Conduit	
1.001	16.513	0.120	137.6	0.003	0.00	0.0	0.600	o	150	Pipe/Conduit	
2.000	15.528	0.110	141.2	0.003	4.00	0.0	0.600	o	150	Pipe/Conduit	
2.001	17.587	0.120	146.6	0.003	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.002	6.725	0.050	134.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.003	8.121	0.060	135.4	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.004	7.944	0.060	132.4	0.027	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.005	27.925	0.190	147.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.006	9.181	0.070	131.2	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
3.000	27.355	0.190	144.0	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
3.001	7.279	0.050	145.6	0.024	0.00	0.0	0.600	o	150	Pipe/Conduit	
4.000	24.447	0.160	152.8	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
4.001	3.507	0.030	116.9	0.022	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	55.78	4.26	64.8[illegible]0	0.003	0.0	0.0	0.0	1.05	18.5	0.5
1.001	54.39	4.58	64.670	0.007	0.0	0.0	0.0	0.85	15.1	1.0
2.000	55.59	4.31	64.850	0.003	0.0	0.0	0.0	0.84	14.9	0.4
2.001	54.07	4.66	64.740	0.006	0.0	0.0	0.0	0.83	14.6	0.8
1.002	53.54	4.79	64.550	0.013	0.0	0.0	0.0	0.86	15.3	1.9
1.003	52.91	4.95	64.500	0.013	0.0	0.0	0.0	0.86	15.2	1.9
1.004	52.33	5.10	64.440	0.040	0.0	0.0	0.0	0.87	15.4	5.7
1.005	50.28	5.66	64.380	0.040	0.0	0.0	0.0	0.83	14.6	5.7
1.006	49.69	5.84	64.190	0.040	0.0	0.0	0.0	0.88	15.5	5.7
3.000	54.55	4.55	64.320	0.000	0.0	0.0	0.0	0.84	14.8	0.0
3.001	53.94	4.69	64.130	0.024	0.0	0.0	0.0	0.83	14.7	3.6
4.000	54.73	4.50	64.170	0.000	0.0	0.0	0.0	0.81	14.3	0.0
4.001	54.47	4.57	64.010	0.022	0.0	0.0	0.0	0.93	16.4	3.3

Network Design Table for CAFE

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
3.002	2.612	0.020	130.6	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	🔒
1.007	12.535	0.050	250.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
1.008	12.535	0.010	1253.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
1.009	12.804	0.070	182.9	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)
3.002	53.74	4.74	63.980	0.046	0.0	0.0	0.0	0.88	15.5	6.8
1.007	48.85	6.09	63.790	0.086	0.0	0.0	0.0	0.82	32.7	11.4
1.008	47.08	6.67	63.740	0.086	0.0	0.0	0.0	0.36	14.4	11.4
1.009	55.97	4.22	63.730	0.000	0.5	0.0	0.0	0.96	38.3	0.5

Free Flowing Outfall Details for CAFE

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.009	CU -	64.800	63.660	0.000	0	0

Simulation Criteria for CAFE

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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	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)	17.500	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for CAFE

Hydro-Brake® Optimum Manhole: CU -2(ATTN), DS/PN: 1.008, Volume (m³): 2.0

Unit Reference	MD-SHE-0032-5000-1060-5000
Design Head (m)	1.060
Design Flow (l/s)	0.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	32
Invert Level (m)	63.740
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.060	0.5	Kick-Flo®	0.284	0.3
Flush-Flo™	0.141	0.3	Mean Flow over Head Range	-	0.4

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)	Depth (m)	Flow (l/s)
0.100	0.3	0.800	0.4	2.000	0.7	4.000	0.9	7.000	1.2
0.200	0.3	1.000	0.5	2.200	0.7	4.500	0.9	7.500	1.2
0.300	0.3	1.200	0.5	2.400	0.7	5.000	1.0	8.000	1.2
0.400	0.3	1.400	0.6	2.600	0.7	5.500	1.0	8.500	1.3
0.500	0.4	1.600	0.6	3.000	0.8	6.000	1.1	9.000	1.3
0.600	0.4	1.800	0.6	3.500	0.8	6.500	1.1	9.500	1.3

Storage Structures for CAFE

Tank or Pond Manhole: CU -2(ATTN), DS/PN: 1.008

Invert Level (m) 63.910

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	45.0	1.060	45.0	1.061	0.0

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 17.500 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.276 Cv (Winter) 0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
1.000	CU -10	15 Winter	100	+20%					64.880	-0.120
1.001	CU -9	960 Winter	100	+20%					64.745	-0.075
2.000	CU -8.2	15 Winter	100	+20%					64.881	-0.119
2.001	CU -8.1	15 Winter	100	+20%					64.784	-0.106
1.002	CU -8	960 Winter	100	+20%	100/480 Winter				64.745	0.045
1.003	CU -7	960 Winter	100	+20%	100/360 Winter				64.745	0.095
1.004	CU -6(BRA)	960 Winter	100	+20%	100/15 Summer				64.745	0.155
1.005	CU -5	960 Winter	100	+20%	100/15 Summer				64.744	0.214
1.006	CU -4	960 Winter	100	+20%	100/60 Summer				64.743	0.403
3.000	CU -3.1.02	960 Winter	100	+20%	100/120 Winter				64.743	0.273
3.001	CU -3.1.01	960 Winter	100	+20%	100/30 Winter				64.743	0.463
4.000	CU -3.1.2	960 Winter	100	+20%	100/60 Summer				64.742	0.422
4.001	CU -3.1.1	960 Winter	100	+20%	100/15 Summer				64.742	0.582
3.002	CU -3.1	960 Winter	100	+20%	100/15 Summer				64.742	0.612
1.007	CU -3	960 Winter	100	+20%	100/15 Summer				64.742	0.727
1.008	CU -2(ATTN)	960 Winter	100	+20%	100/15 Summer				64.741	0.776
1.009	CU -1(HB)	360 Winter	100	+20%					63.747	-0.208

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	CU -10	0.000	0.09			1.5	OK	
1.001	CU -9	0.000	0.02			0.2	OK	
2.000	CU -8.2	0.000	0.09			1.3	OK	
2.001	CU -8.1	0.000	0.18			2.5	OK	
1.002	CU -8	0.000	0.04			0.5	SURCHARGED	
1.003	CU -7	0.000	0.03			0.5	SURCHARGED	
1.004	CU -6(BRA)	0.000	0.11			1.4	SURCHARGED	

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

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
1.005	CU -5	0.000	0.10			1.4	SURCHARGED	
1.006	CU -4	0.000	0.09			1.3	SURCHARGED	
3.000	CU -3.1.02	0.000	0.00			0.0	SURCHARGED	
3.001	CU -3.1.01	0.000	0.06			0.7	SURCHARGED	
4.000	CU -3.1.2	0.000	0.00			0.0	SURCHARGED	
4.001	CU -3.1.1	0.000	0.06			0.7	SURCHARGED	
3.002	CU -3.1	0.000	0.12			1.3	SURCHARGED	
1.007	CU -3	0.000	0.09			2.5	SURCHARGED	
1.008	CU -2(ATTN)	0.000	0.04			0.5	SURCHARGED	
1.009	CU -1(HB)	0.000	0.02			0.5	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for CARRIER

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	20
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.750
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 Inverts

Network Design Table for CARRIER

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	64.454	0.430	149.9	0.000	4.00	0.5	0.600	o	225	Pipe/Conduit	
S2.000	30.698	0.210	146.2	0.000	4.00	1.5	0.600	o	225	Pipe/Conduit	
S1.001	81.963	0.550	149.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S3.000	57.161	0.390	146.6	0.000	4.00	1.4	0.600	o	225	Pipe/Conduit	
S1.002	60.591	0.410	147.8	0.000	0.00	2.0	0.600	o	225	Pipe/Conduit	
S1.003	59.750	0.400	149.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S4.000	6.583	0.050	131.7	0.000	4.00	3.2	0.600	o	225	Pipe/Conduit	
S4.001	79.711	0.530	150.4	0.000	0.00	1.6	0.600	o	225	Pipe/Conduit	
S4.002	4.185	0.030	139.5	0.000	0.00	1.7	0.600	o	225	Pipe/Conduit	
S1.004	65.754	0.440	149.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.005	34.291	0.230	149.1	0.000	0.00	2.3	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	52.68	5.01	63.660	0.000	0.5	0.0	0.1	1.07	42.4	0.6
S2.000	54.86	4.47	61.200	0.000	1.5	0.0	0.3	1.08	42.9	1.8
S1.001	48.24	6.29	60.990	0.000	2.0	0.0	0.4	1.07	42.5	2.4
S3.000	53.16	4.88	59.720	0.000	1.4	0.0	0.3	1.08	42.9	1.7
S1.002	45.52	7.23	59.330	0.000	5.4	0.0	1.1	1.07	42.7	6.5
S1.003	43.17	8.16	58.920	0.000	5.4	0.0	1.1	1.07	42.4	6.5
S4.000	56.54	4.10	58.070	0.000	3.2	0.0	0.6	1.14	45.2	3.8
S4.001	51.41	5.35	58.020	0.000	4.8	0.0	1.0	1.06	42.3	5.8
S4.002	51.18	5.41	57.490	0.000	6.5	0.0	1.3	1.11	43.9	7.8
S1.004	40.91	9.19	57.460	0.000	11.9	0.0	2.4	1.07	42.4	14.3
S1.005	39.85	9.72	56.410	0.000	14.2	0.0	2.8	1.07	42.5	17.0

Network Design Table for CARRIER

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
S1.006	79.800	0.540	147.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	✔
S1.007	81.107	0.540	150.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	✔
S1.008	21.505	0.150	143.4	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)
S1.006	37.63	10.96	56.180	0.000	14.2	0.0	2.8	1.07	42.7	17.0
S1.007	35.65	12.23	55.640	0.000	14.2	0.0	2.8	1.06	42.3	17.0
S1.008	35.18	12.56	55.100	0.000	14.2	0.0	2.8	1.09	43.3	17.0

Simulation Criteria for CARRIER

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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	0	Number of Storage Structures	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)	17.500	Storm Duration (mins)	30
Ratio R	0.276		

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

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

Synthetic Rainfall Details

Rainfall Model	FSR M5-60 (mm) 17.500	Cv (Summer)	0.750
Region Scotland and Ireland	Ratio R 0.276	Cv (Winter)	0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S1.000	CA - 9(C)	15 Summer	100	+20%					63.673	-0.212
S2.000	CA - 8.1(U1)	15 Summer	100	+20%					61.228	-0.197
S1.001	CA - 8	15 Summer	100	+20%					61.022	-0.193
S3.000	CA - 7.1(U5)	15 Summer	100	+20%					59.747	-0.198
S1.002	CA - 7(U6)	15 Summer	100	+20%					59.384	-0.171
S1.003	CA - 6	15 Summer	100	+20%					58.974	-0.171
S4.000	CA - 5.3(U2)	15 Summer	100	+20%					58.118	-0.177
S4.001	CA - 5.2(R)	15 Summer	100	+20%					58.071	-0.174
S4.002	CA - 5.1 (U3)	15 Summer	100	+20%					57.561	-0.154
S1.004	CA - 5	15 Summer	100	+20%					57.542	-0.143
S1.005	CA - 4(U4)	15 Summer	100	+20%					56.502	-0.133
S1.006	CA - 3	15 Summer	100	+20%					56.271	-0.134
S1.007	CA - 2	15 Summer	100	+20%					55.731	-0.134
S1.008	CA - 1	15 Summer	100	+20%					55.193	-0.132

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	CA - 9(C)	0.000	0.01			0.5	OK	
S2.000	CA - 8.1(U1)	0.000	0.04			1.5	OK	
S1.001	CA - 8	0.000	0.05			2.0	OK	
S3.000	CA - 7.1(U5)	0.000	0.03			1.4	OK	
S1.002	CA - 7(U6)	0.000	0.13			5.4	OK	
S1.003	CA - 6	0.000	0.13			5.4	OK	
S4.000	CA - 5.3(U2)	0.000	0.10			3.2	OK	
S4.001	CA - 5.2(R)	0.000	0.12			4.8	OK	
S4.002	CA - 5.1 (U3)	0.000	0.22			6.5	OK	
S1.004	CA - 5	0.000	0.29			11.9	OK	

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

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.005	CA - 4(U4)	0.000	0.35			14.2	OK	
S1.006	CA - 3	0.000	0.34			14.2	OK	
S1.007	CA - 2	0.000	0.34			14.2	OK	
S1.008	CA - 1	0.000	0.36			14.2	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for ROADS

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	70
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	0
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.000
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Inverts

Network Design Table for ROADS

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
P1.000	37.183	0.190	195.7	0.046	4.00	0.0	0.600	o	225	Pipe/Conduit	
P1.001	63.519	0.320	198.5	0.049	0.00	0.0	0.600	o	225	Pipe/Conduit	
P2.000	65.003	0.330	197.0	0.115	4.00	0.0	0.600	o	300	Pipe/Conduit	
P2.001	85.863	0.430	199.7	0.111	0.00	0.0	0.600	o	300	Pipe/Conduit	
P1.002	34.538	0.180	191.9	0.078	0.00	0.0	0.600	o	300	Pipe/Conduit	
P1.003	28.612	0.150	190.7	0.048	0.00	0.0	0.600	o	300	Pipe/Conduit	
P1.004	30.094	0.150	200.6	0.039	0.00	0.0	0.600	o	300	Pipe/Conduit	
P1.005	29.133	0.150	194.2	0.093	0.00	0.0	0.600	o	750	Pipe/Conduit	
P1.006	3.133	0.020	156.7	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)
P1.000	54.05	4.67	64.090	0.046	0.0	0.0	0.0	0.93	37.0	6.8
P1.001	49.78	5.81	63.900	0.095	0.0	0.0	0.0	0.92	36.8	12.8
P2.000	52.82	4.97	59.670	0.115	0.0	0.0	0.0	1.12	78.9	16.4
P2.001	48.32	6.26	59.340	0.226	0.0	0.0	0.0	1.11	78.4	29.6
P1.002	46.79	6.77	58.910	0.399	0.0	0.0	0.0	1.13	80.0	50.6
P1.003	45.62	7.19	58.730	0.447	0.0	0.0	0.0	1.13	80.2	55.2
P1.004	44.43	7.64	58.580	0.485	0.0	0.0	0.0	1.11	78.2	58.4
P1.005	43.83	7.89	58.430	0.578	0.0	0.0	0.0	2.00	885.6	68.6
P1.006	56.75	4.05	58.280	0.000	1.6	0.0	0.0	1.04	41.4	1.6

PIPELINE SCHEDULES for ROADS

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P1.000	o	225	S7	65.520	64.090	1.205	Open Manhole	1200
P1.001	o	225	S6	64.440	63.900	0.315	Open Manhole	1200
P2.000	o	300	S5.2	61.100	59.670	1.130	Open Manhole	1200
P2.001	o	300	S5.1	62.000	59.340	2.360	Open Manhole	1200
P1.002	o	300	S5	64.000	58.910	4.790	Open Manhole	1200
P1.003	o	300	S4	63.380	58.730	4.350	Open Manhole	1200
P1.004	o	300	S3	61.800	58.580	2.920	Open Manhole	1200
P1.005	o	750	S2(ATTN)	61.000	58.430	1.820	Open Manhole	1800
P1.006	o	225	S1(HB)	61.250	58.280	2.745	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P1.000	37.183	195.7	S6	64.440	63.900	0.315	Open Manhole	1200
P1.001	63.519	198.5	S5	64.000	63.580	0.195	Open Manhole	1200
P2.000	65.003	197.0	S5.1	62.000	59.340	2.360	Open Manhole	1200
P2.001	85.863	199.7	S5	64.000	58.910	4.790	Open Manhole	1200
P1.002	34.538	191.9	S4	63.380	58.730	4.350	Open Manhole	1200
P1.003	28.612	190.7	S3	61.800	58.580	2.920	Open Manhole	1200
P1.004	30.094	200.6	S2(ATTN)	61.000	58.430	2.270	Open Manhole	1800
P1.005	29.133	194.2	S1(HB)	61.250	58.280	2.220	Open Manhole	1800
P1.006	3.133	156.7	S	61.250	58.260	2.765	Open Manhole	0

Free Flowing Outfall Details for ROADS

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
P1.006	S	61.250	58.260	0.000	0	0

Simulation Criteria for ROADS

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

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	17.500
Return Period (years)	2	Ratio R	0.276
Region	Scotland and Ireland	Profile Type	Summer

Synthetic Rainfall Details

Cv (Summer) 0.750 Storm Duration (mins) 30
Cv (Winter) 0.840

Online Controls for ROADS

Hydro-Brake® Optimum Manhole: S2(ATTN), DS/PN: P1.005, Volume (m^3): 8.6

Unit Reference	MD-SHE-0053-1600-1670-1600
Design Head (m)	1.670
Design Flow (l/s)	1.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	53
Invert Level (m)	58.430
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	1.6	Kick-Flo®	0.471	0.9
Flush-Flo™	0.233	1.1	Mean Flow over Head Range	-	1.2

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)	Depth (m)	Flow (l/s)
0.100	1.0	0.800	1.1	2.000	1.7	4.000	2.4	7.000	3.1
0.200	1.1	1.000	1.3	2.200	1.8	4.500	2.5	7.500	3.2
0.300	1.1	1.200	1.4	2.400	1.9	5.000	2.6	8.000	3.3
0.400	1.0	1.400	1.5	2.600	2.0	5.500	2.8	8.500	3.4
0.500	0.9	1.600	1.6	3.000	2.1	6.000	2.9	9.000	3.5
0.600	1.0	1.800	1.7	3.500	2.2	6.500	3.0	9.500	3.6

Storage Structures for ROADS

Tank or Pond Manhole: S2(ATTN), DS/PN: P1.005

Invert Level (m) 58.430

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	255.0	1.670	255.0	1.671	0.0

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 17.500 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.276 Cv (Winter) 0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
P1.000	S7	15 Winter	100	+20%					64.214	-0.101
P1.001	S6	15 Winter	100	+20%	100/15 Summer				64.142	0.017
P2.000	S5.2	15 Winter	100	+20%	100/15 Summer				60.486	0.516
P2.001	S5.1	15 Winter	100	+20%	100/15 Summer				60.397	0.757
P1.002	S5	15 Winter	100	+20%	100/15 Summer				60.148	0.938
P1.003	S4	2880 Winter	100	+20%	100/15 Summer				60.065	1.035
P1.004	S3	2880 Winter	100	+20%	100/15 Summer				60.064	1.184
P1.005	S2(ATTN)	2880 Winter	100	+20%	100/120 Summer				60.062	0.882
P1.006	S1(HB)	2880 Winter	100	+20%					58.315	-0.190

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
P1.000	S7	0.000	0.57			19.9	OK	
P1.001	S6	0.000	1.04			36.9	FLOOD RISK	
P2.000	S5.2	0.000	0.62			46.5	SURCHARGED	
P2.001	S5.1	0.000	0.79			59.4	SURCHARGED	
P1.002	S5	0.000	1.54			113.4	SURCHARGED	
P1.003	S4	0.000	0.09			6.9	SURCHARGED	
P1.004	S3	0.000	0.10			7.4	SURCHARGED	
P1.005	S2(ATTN)	0.000	0.00			1.6	SURCHARGED	
P1.006	S1(HB)	0.000	0.06			1.6	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for UNIT 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	66
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	0
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.750
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 Inverts

Network Design Table for UNIT 1

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
P1.000	27.730	0.190	145.9	0.024	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
P1.001	49.968	0.330	151.4	0.048	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
P1.002	4.599	0.040	115.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
P2.000	42.876	0.290	147.8	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	🔒
P2.001	9.419	0.070	134.6	0.034	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
P3.000	41.858	0.280	149.5	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	🔒
P3.001	16.291	0.110	148.1	0.034	0.00	0.0	0.600	o	150	Pipe/Conduit	🔓
P1.003	15.997	0.080	200.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
P4.000	29.537	0.550	53.7	0.024	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
P4.001	52.495	0.350	150.0	0.048	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
P4.002	38.504	0.180	213.9	0.024	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
P4.003	18.011	0.080	225.1	0.024	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)
P1.000	55.05	4.43	63.520	0.024	0.0	0.0	0.0	1.08	42.9	3.6
P1.001	51.89	5.21	63.330	0.073	0.0	0.0	0.0	1.06	42.2	10.2
P1.002	51.66	5.28	63.000	0.073	0.0	0.0	0.0	1.22	48.4	10.2
P2.000	53.23	4.87	63.600	0.000	0.0	0.0	0.0	0.82	14.6	0.0
P2.001	52.52	5.05	63.310	0.034	0.0	0.0	0.0	0.86	15.3	4.9
P3.000	53.29	4.85	63.600	0.000	0.0	0.0	0.0	0.82	14.5	0.0
P3.001	52.02	5.18	63.320	0.034	0.0	0.0	0.0	0.82	14.6	4.8
P1.003	50.62	5.57	62.960	0.141	0.0	0.0	0.0	0.92	36.6	19.4
P4.000	55.73	4.28	62.920	0.024	0.0	0.0	0.0	1.79	71.1	3.7
P4.001	52.34	5.10	62.370	0.073	0.0	0.0	0.0	1.07	42.4	10.3
P4.002	49.75	5.82	62.020	0.097	0.0	0.0	0.0	0.89	35.4	13.1
P4.003	48.62	6.16	61.840	0.121	0.0	0.0	0.0	0.87	34.5	16.0

Network Design Table for UNIT 1

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
P1.004	11.647	0.060	194.1	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P5.000	10.427	0.070	149.0	0.143	6.00	0.0	0.600	o	225	Pipe/Conduit	
P1.005	5.123	0.020	256.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P1.006	40.814	0.140	291.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P6.000	7.890	0.060	131.5	0.057	6.00	0.0	0.600	o	225	Pipe/Conduit	
P6.001	8.835	0.060	147.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.007	3.520	0.010	352.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P1.008	73.668	0.330	223.2	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)
P1.004	47.98	6.37	61.760	0.263	0.0	0.0	0.0	0.93	37.2	34.1
P5.000	48.63	6.16	62.000	0.143	0.0	0.0	0.0	1.07	42.5	18.9
P1.005	47.71	6.46	61.700	0.406	0.0	0.0	0.0	0.98	69.1	52.4
P1.006	45.59	7.20	61.680	0.406	0.0	0.0	0.0	0.92	64.7	52.4
P6.000	48.78	6.12	61.920	0.057	0.0	0.0	0.0	1.14	45.3	7.5
P6.001	48.34	6.25	61.860	0.057	0.0	0.0	0.0	1.08	42.8	7.5
P1.007	45.40	7.27	61.540	0.463	0.0	0.0	0.0	0.83	58.8	56.9
P1.008	51.17	5.41	61.530	0.000	1.5	0.0	0.0	0.87	34.6	1.5

PIPELINE SCHEDULES for UNIT 1

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P6.001	o	225	U1 - 2.1	63.110	61.860	1.025	Open Manhole	1200
P1.007	o	300	U1 - 2(ATTN)	63.110	61.540	1.270	Open Manhole	1200
P1.008	o	225	U1 - 1(HB)	63.110	61.530	1.355	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P6.001	8.835	147.3	U1 - 2(ATTN)	63.110	61.800	1.085	Open Manhole	1200
P1.007	3.520	352.0	U1 - 1(HB)	63.110	61.530	1.280	Open Manhole	1200
P1.008	73.668	223.2	U1 -	63.180	61.200	1.755	Open Manhole	0

Free Flowing Outfall Details for UNIT 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
P1.008	U1 -	63.180	61.200	0.000	0	0

Simulation Criteria for UNIT 1

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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	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)	17.500	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for UNIT 1

Hydro-Brake® Optimum Manhole: U1 - 2(ATTN), DS/PN: P1.007, Volume (m³): 4.9

Unit Reference	MD-SHE-0057-1500-1060-1500
Design Head (m)	1.060
Design Flow (l/s)	1.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	57
Invert Level (m)	61.540
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.060	1.5	Kick-Flo®	0.508	1.1
Flush-Flo™	0.251	1.3	Mean Flow over Head Range	-	1.2

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)	Depth (m)	Flow (l/s)
0.100	1.2	0.800	1.3	2.000	2.0	4.000	2.7	7.000	3.6
0.200	1.3	1.000	1.5	2.200	2.1	4.500	2.9	7.500	3.7
0.300	1.3	1.200	1.6	2.400	2.2	5.000	3.0	8.000	3.8
0.400	1.3	1.400	1.7	2.600	2.3	5.500	3.2	8.500	3.9
0.500	1.1	1.600	1.8	3.000	2.4	6.000	3.3	9.000	4.0
0.600	1.2	1.800	1.9	3.500	2.6	6.500	3.4	9.500	4.1

Storage Structures for UNIT 1

Tank or Pond Manhole: U1 - 2(ATTN), DS/PN: P1.007

Invert Level (m) 61.650

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	303.0	1.060	303.0	1.061	0.0

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 17.500 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.276 Cv (Winter) 0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
P1.000	U1 - 9	15 Winter	100	+20%					63.599
P1.001	U1 - 8	15 Winter	100	+20%					63.515
P1.002	U1 - 7	15 Winter	100	+20%	100/15 Summer				63.375
P2.000	U1 - 6.02	15 Summer	100	+20%					63.600
P2.001	U1 - 6.01	15 Winter	100	+20%	100/15 Summer				63.468
P3.000	U1 - 6.2	15 Summer	100	+20%					63.600
P3.001	U1 - 6.1	15 Winter	100	+20%	100/15 Summer				63.478
P1.003	U1 - 6	15 Winter	100	+20%	100/15 Summer				63.305
P4.000	U1 - 5.4	15 Winter	100	+20%	100/15 Winter				63.182
P4.001	U1 - 5.3	15 Winter	100	+20%	100/15 Summer				63.167
P4.002	U1 - 5.2	15 Winter	100	+20%	100/15 Summer				63.114
P4.003	U1 - 5.1	15 Winter	100	+20%	100/15 Summer				63.046
P1.004	U1 - 5	15 Winter	100	+20%	100/15 Summer				62.978
P5.000	U1 - 4.1(SWA)	15 Winter	100	+20%	100/15 Summer				62.751
P1.005	U1 - 4	2160 Winter	100	+20%	100/15 Summer				62.633
P1.006	U1 - 3	2160 Winter	100	+20%	100/15 Summer				62.632
P6.000	U1 - 2.2(SWA)	2160 Winter	100	+20%	100/120 Summer				62.631
P6.001	U1 - 2.1	2160 Winter	100	+20%	100/60 Winter				62.631
P1.007	U1 - 2(ATTN)	2160 Winter	100	+20%	100/15 Summer				62.631
P1.008	U1 - 1(HB)	2160 Winter	100	+20%					61.560

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
P1.000	U1 - 9	-0.146	0.000	0.27			10.8	OK	
P1.001	U1 - 8	-0.040	0.000	0.71			28.9	OK	
P1.002	U1 - 7	0.150	0.000	0.94			28.0	SURCHARGED	
P2.000	U1 - 6.02	-0.150	0.000	0.00			0.0	OK	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
P2.001	U1 - 6.01	0.008	0.000	1.05			14.2	SURCHARGED	
P3.000	U1 - 6.2	-0.150	0.000	0.00			0.0	OK	
P3.001	U1 - 6.1	0.008	0.000	1.04			14.0	SURCHARGED	
P1.003	U1 - 6	0.120	0.000	1.63			52.8	SURCHARGED	
P4.000	U1 - 5.4	0.037	0.000	0.16			10.8	SURCHARGED	
P4.001	U1 - 5.3	0.572	0.000	0.59			24.0	SURCHARGED	
P4.002	U1 - 5.2	0.869	0.000	0.83			28.0	SURCHARGED	
P4.003	U1 - 5.1	0.981	0.000	1.02			31.6	SURCHARGED	
P1.004	U1 - 5	0.993	0.000	2.42			76.6	SURCHARGED	
P5.000	U1 - 4.1(SWA)	0.526	0.000	1.30			46.2	SURCHARGED	
P1.005	U1 - 4	0.633	0.000	0.17			7.8	SURCHARGED	
P1.006	U1 - 3	0.652	0.000	0.13			7.7	SURCHARGED	
P6.000	U1 - 2.2(SWA)	0.486	0.000	0.03			1.1	SURCHARGED	
P6.001	U1 - 2.1	0.546	0.000	0.03			1.1	SURCHARGED	
P1.007	U1 - 2(ATTN)	0.791	0.000	0.03			1.5	SURCHARGED	
P1.008	U1 - 1(HB)	-0.195	0.000	0.04			1.5	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for UNIT 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	68
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	0
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.750
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 Inverts

Network Design Table for UNIT 2

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
P1.000	27.084	0.180	150.5	0.050	4.00	0.0	0.600	o	225	Pipe/Conduit	
P1.001	90.606	0.600	151.0	0.050	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.002	16.641	0.110	151.3	0.100	0.00	0.0	0.600	o	225	Pipe/Conduit	
P2.000	78.833	0.530	148.7	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
P2.001	25.326	0.170	149.0	0.064	0.00	0.0	0.600	o	150	Pipe/Conduit	
P3.000	80.693	0.540	149.4	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
P3.001	19.371	0.130	149.0	0.067	0.00	0.0	0.600	o	150	Pipe/Conduit	
P1.003	19.054	0.070	272.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P1.004	24.734	0.090	274.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P4.000	29.405	0.280	105.0	0.050	4.00	0.0	0.600	o	225	Pipe/Conduit	
P4.001	55.971	0.520	107.6	0.050	0.00	0.0	0.600	o	225	Pipe/Conduit	
P4.002	48.339	0.320	151.1	0.088	0.00	0.0	0.600	o	375	Pipe/Conduit	
P4.003	24.497	0.160	153.1	0.050	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)
P1.000	55.07	4.42	61.670	0.050	0.0	0.0	0.0	1.06	42.3	7.5
P1.001	49.66	5.85	61.490	0.100	0.0	0.0	0.0	1.06	42.2	13.4
P1.002	48.80	6.11	60.890	0.200	0.0	0.0	0.0	1.06	42.2	26.4
P2.000	50.50	5.60	61.100	0.000	0.0	0.0	0.0	0.82	14.5	0.0
P2.001	48.79	6.11	60.570	0.064	0.0	0.0	0.0	0.82	14.5	8.4
P3.000	50.36	5.64	61.100	0.000	0.0	0.0	0.0	0.82	14.5	0.0
P3.001	49.04	6.03	60.560	0.067	0.0	0.0	0.0	0.82	14.5	8.9
P1.003	47.74	6.45	60.400	0.330	0.0	0.0	0.0	0.95	67.0	42.7
P1.004	46.46	6.88	60.330	0.330	0.0	0.0	0.0	0.94	66.7	42.7
P4.000	55.24	4.38	61.200	0.050	0.0	0.0	0.0	1.28	50.7	7.4
P4.001	52.23	5.12	60.920	0.100	0.0	0.0	0.0	1.26	50.1	14.1
P4.002	50.25	5.67	59.510	0.188	0.0	0.0	0.0	1.47	162.6	25.5
P4.003	49.31	5.95	59.190	0.238	0.0	0.0	0.0	1.46	161.5	31.8

Network Design Table for UNIT 2

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
P1.005	5.143	0.030	171.4	0.069	0.00	0.0	0.600	o	375	Pipe/Conduit	
P5.000	10.129	0.100	101.3	0.051	6.00	0.0	0.600	o	225	Pipe/Conduit	
P1.006	37.778	0.380	99.4	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
P6.000	37.892	0.190	199.4	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
P1.007	12.087	0.060	201.5	0.104	0.00	0.0	0.600	o	375	Pipe/Conduit	
P7.000	25.030	0.130	192.5	0.096	4.00	0.0	0.600	o	225	Pipe/Conduit	
P8.000	34.358	0.170	202.1	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
P7.001	3.919	0.020	196.0	0.074	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.008	2.741	0.010	274.1	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
P1.009	33.155	0.120	276.3	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
P1.010	17.672	0.100	176.7	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
P1.011	15.006	0.070	214.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.012	41.674	0.190	219.3	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)
P1.005	46.29	6.95	59.030	0.638	0.0	0.0	0.0	1.38	152.5	80.0
P5.000	48.73	6.13	61.750	0.051	0.0	0.0	0.0	1.30	51.6	6.7
P1.006	45.34	7.29	59.000	0.689	0.0	0.0	0.0	1.82	200.7	84.6
P6.000	53.97	4.68	59.920	0.000	0.0	0.0	0.0	0.92	36.7	0.0
P1.007	44.92	7.45	58.620	0.793	0.0	0.0	0.0	1.27	140.6	96.5
P7.000	54.98	4.44	59.500	0.096	0.0	0.0	0.0	0.94	37.3	14.3
P8.000	54.22	4.63	59.920	0.000	0.0	0.0	0.0	0.92	36.4	0.0
P7.001	53.93	4.70	59.370	0.170	0.0	0.0	0.0	0.93	37.0	24.8
P1.008	44.82	7.49	58.560	0.963	0.0	0.0	0.0	1.09	120.3	116.9
P1.009	43.55	8.00	58.550	0.963	0.0	0.0	0.0	1.09	119.8	116.9
P1.010	43.03	8.22	58.430	0.963	0.0	0.0	0.0	1.36	150.2	116.9
P1.011	55.70	4.28	58.330	0.000	3.2	0.0	0.0	0.89	35.3	3.2
P1.012	52.43	5.07	58.260	0.000	3.2	0.0	0.0	0.88	34.9	3.2

PIPELINE SCHEDULES for UNIT 2

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P1.007	o	375	S6	61.460	58.620	2.465	Open Manhole	1350
P7.000	o	225	S5.01(SWA)	61.000	59.500	1.275	Open Manhole	1200
P8.000	o	225	S5.2	61.450	59.920	1.305	Open Manhole	1200
P7.001	o	225	S5.1	61.450	59.370	1.855	Open Manhole	1200
P1.008	o	375	S5	61.460	58.560	2.525	Open Manhole	1350
P1.009	o	375	S4	61.460	58.550	2.535	Open Manhole	1350
P1.010	o	375	S3(ATTN)	61.460	58.430	2.655	Open Manhole	1350
P1.011	o	225	S2(HB)	61.460	58.330	2.905	Open Manhole	1350
P1.012	o	225	S1	62.290	58.260	3.805	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P1.007	12.087	201.5	S5	61.460	58.560	2.525	Open Manhole	1350
P7.000	25.030	192.5	S5.1	61.450	59.370	1.855	Open Manhole	1200
P8.000	34.358	202.1	S5.1	61.450	59.750	1.475	Open Manhole	1200
P7.001	3.919	196.0	S5	61.460	59.350	1.885	Open Manhole	1350
P1.008	2.741	274.1	S4	61.460	58.550	2.535	Open Manhole	1350
P1.009	33.155	276.3	S3(ATTN)	61.460	58.430	2.655	Open Manhole	1350
P1.010	17.672	176.7	S2(HB)	61.460	58.330	2.755	Open Manhole	1350
P1.011	15.006	214.4	S1	62.290	58.260	3.805	Open Manhole	1200
P1.012	41.674	219.3	S	61.250	58.070	2.955	Open Manhole	0

Free Flowing Outfall Details for UNIT 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
P1.012	S	61.250	58.070	0.000	0	0

Simulation Criteria for UNIT 2

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

Simulation Criteria for UNIT 2

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)	17.500	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for UNIT 2

Hydro-Brake® Optimum Manhole: S3(ATTN), DS/PN: P1.010, Volume (m³): 7.8

Unit Reference	MD-SHE-0076-3200-1670-3200
Design Head (m)	1.670
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	76
Invert Level (m)	58.430
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	3.2	Kick-Flo®	0.679	2.1
Flush-Flo™	0.332	2.6	Mean Flow over Head Range	-	2.5

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)	Depth (m)	Flow (l/s)
0.100	2.1	0.800	2.3	2.000	3.5	4.000	4.8	7.000	6.2
0.200	2.5	1.000	2.5	2.200	3.6	4.500	5.1	7.500	6.4
0.300	2.6	1.200	2.7	2.400	3.8	5.000	5.3	8.000	6.6
0.400	2.6	1.400	2.9	2.600	3.9	5.500	5.6	8.500	6.8
0.500	2.5	1.600	3.1	3.000	4.2	6.000	5.8	9.000	7.0
0.600	2.4	1.800	3.3	3.500	4.5	6.500	6.0	9.500	7.2

Storage Structures for UNIT 2

Tank or Pond Manhole: S3(ATTN), DS/PN: P1.010

Invert Level (m) 58.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	415.0	1.670	415.0	1.671	0.0

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 2

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 17.500 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.276 Cv (Winter) 0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
P1.000	S13	15 Winter	100	+20%					61.882
P1.001	S12	15 Winter	100	+20%	100/15 Summer				61.839
P1.002	S11	15 Winter	100	+20%	100/15 Summer				61.406
P2.000	S10.02	15 Winter	100	+20%	100/15 Summer				61.362
P2.001	S10.01	15 Winter	100	+20%	100/15 Summer				61.382
P3.000	S10.2	15 Winter	100	+20%	100/15 Winter				61.327
P3.001	S10.1	15 Winter	100	+20%	100/15 Summer				61.343
P1.003	S10	15 Winter	100	+20%	100/15 Summer				61.140
P1.004	S9	15 Winter	100	+20%	100/15 Summer				60.967
P4.000	S8.4	15 Winter	100	+20%					61.308
P4.001	S8.3	15 Winter	100	+20%					61.089
P4.002	S8.2	15 Winter	100	+20%	100/15 Summer				60.951
P4.003	S8.1	15 Winter	100	+20%	100/15 Summer				60.854
P1.005	S8	15 Winter	100	+20%	100/15 Summer				60.739
P5.000	S7.1(SWA)	15 Winter	100	+20%					61.856
P1.006	S7(BRA)	15 Winter	100	+20%	100/15 Summer				60.553
P6.000	S6.1	1440 Winter	100	+20%	100/1440 Winter				60.162
P1.007	S6	1440 Winter	100	+20%	100/15 Summer				60.162
P7.000	S5.01(SWA)	1440 Winter	100	+20%	100/15 Summer				60.161
P8.000	S5.2	1440 Winter	100	+20%	100/1440 Winter				60.161
P7.001	S5.1	1440 Winter	100	+20%	100/15 Summer				60.161
P1.008	S5	1440 Winter	100	+20%	100/15 Summer				60.160
P1.009	S4	1440 Winter	100	+20%	100/15 Summer				60.160
P1.010	S3(ATTN)	1440 Winter	100	+20%	100/15 Summer				60.157
P1.011	S2(HB)	1440 Winter	100	+20%					58.378
P1.012	S1	1440 Winter	100	+20%					58.307

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 2

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
P1.000	S13	-0.013	0.000	0.52			20.5	OK	
P1.001	S12	0.124	0.000	0.83			34.3	SURCHARGED	
P1.002	S11	0.291	0.000	1.84			69.1	SURCHARGED	
P2.000	S10.02	0.112	0.000	0.08			1.1	SURCHARGED	
P2.001	S10.01	0.662	0.000	1.35			18.7	SURCHARGED	
P3.000	S10.2	0.077	0.000	0.07			0.9	SURCHARGED	
P3.001	S10.1	0.633	0.000	1.48			20.2	SURCHARGED	
P1.003	S10	0.440	0.000	1.71			99.3	SURCHARGED	
P1.004	S9	0.337	0.000	1.64			97.4	SURCHARGED	
P4.000	S8.4	-0.117	0.000	0.46			21.9	OK	
P4.001	S8.3	-0.056	0.000	0.89			43.0	OK	
P4.002	S8.2	1.066	0.000	0.39			59.1	FLOOD RISK	
P4.003	S8.1	1.289	0.000	0.48			66.8	SURCHARGED	
P1.005	S8	1.334	0.000	1.80			168.4	SURCHARGED	
P5.000	S7.1(SWA)	-0.119	0.000	0.45			19.5	OK	
P1.006	S7(BRA)	1.178	0.000	1.01			184.1	SURCHARGED	
P6.000	S6.1	0.017	0.000	0.00			0.0	SURCHARGED	
P1.007	S6	1.167	0.000	0.19			20.7	SURCHARGED	
P7.000	S5.01(SWA)	0.436	0.000	0.07			2.6	SURCHARGED	
P8.000	S5.2	0.016	0.000	0.00			0.0	SURCHARGED	
P7.001	S5.1	0.566	0.000	0.17			4.4	SURCHARGED	
P1.008	S5	1.225	0.000	0.29			24.5	SURCHARGED	
P1.009	S4	1.235	0.000	0.23			24.4	SURCHARGED	
P1.010	S3(ATTN)	1.352	0.000	0.03			3.2	SURCHARGED	
P1.011	S2(HB)	-0.177	0.000	0.10			3.2	OK	
P1.012	S1	-0.178	0.000	0.10			3.2	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for UNIT 3

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	86
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	0
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.750
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 Inverts

Network Design Table for UNIT 3

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
P1.000	28.776	0.320	89.9	0.037	4.00	0.0	0.600	o	225	Pipe/Conduit	
P1.001	55.272	0.680	81.3	0.074	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.002	33.258	1.420	23.4	0.067	0.00	0.0	0.600	o	225	Pipe/Conduit	
P2.000	34.387	0.230	149.5	0.037	4.00	0.0	0.600	o	150	Pipe/Conduit	
P3.000	60.976	0.410	148.7	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
P3.001	10.648	0.080	133.1	0.041	0.00	0.0	0.600	o	150	Pipe/Conduit	
P4.000	62.537	0.420	148.9	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
P3.002	4.210	0.020	210.5	0.054	0.00	0.0	0.600	o	225	Pipe/Conduit	
P2.001	56.893	0.380	149.7	0.074	0.00	0.0	0.600	o	225	Pipe/Conduit	
P2.002	31.680	0.480	66.0	0.064	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.003	12.397	0.060	206.6	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)
P1.000	55.40	4.35	61.050	0.037	0.0	0.0	0.0	1.38	54.8	5.5
P1.001	52.78	4.98	60.730	0.111	0.0	0.0	0.0	1.45	57.7	15.9
P1.002	52.00	5.19	60.050	0.178	0.0	0.0	0.0	2.72	108.0	25.1
P2.000	53.91	4.70	61.770	0.037	0.0	0.0	0.0	0.82	14.5	5.4
P3.000	51.81	5.24	60.400	0.000	0.0	0.0	0.0	0.82	14.5	0.0
P3.001	50.86	5.50	59.990	0.041	0.0	0.0	0.0	0.80	14.2	5.7
P4.000	51.69	5.27	59.950	0.000	0.0	0.0	0.0	0.82	14.5	0.0
P3.002	50.59	5.58	59.530	0.095	0.0	0.0	0.0	0.90	35.7	13.1
P2.001	47.69	6.46	59.510	0.206	0.0	0.0	0.0	1.07	42.4	26.7
P2.002	46.73	6.79	59.130	0.270	0.0	0.0	0.0	1.61	64.1	34.2
P1.003	46.31	6.94	58.500	0.448	0.0	0.0	0.0	1.41	224.3	56.2

Network Design Table for UNIT 3

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
P5.000	24.444	0.100	244.4	0.037	4.00	0.0	0.600	o	225	Pipe/Conduit	
P6.000	13.738	0.170	80.8	0.035	4.00	0.0	0.600	o	225	Pipe/Conduit	
P1.004	5.168	0.060	86.1	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
P1.005	13.116	0.090	145.7	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
P7.000	12.907	0.410	31.5	0.114	6.00	0.0	0.600	o	225	Pipe/Conduit	
P7.001	12.866	0.050	257.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.006	13.116	0.100	131.2	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
P1.007	13.064	0.060	217.7	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)
P5.000	54.79	4.49	58.280	0.037	0.0	0.0	0.0	0.83	33.1	5.5
P6.000	56.26	4.16	58.280	0.035	0.0	0.0	0.0	1.46	57.9	5.4
P1.004	46.20	6.98	58.110	0.520	0.0	0.0	0.0	2.19	348.6	65.1
P1.005	45.84	7.11	57.890	0.520	0.0	0.0	0.0	1.68	267.5	65.1
P7.000	48.85	6.09	58.930	0.114	0.0	0.0	0.0	2.34	93.0	15.0
P7.001	48.02	6.36	58.520	0.114	0.0	0.0	0.0	0.81	32.2	15.0
P1.006	45.51	7.23	57.800	0.634	0.0	0.0	0.0	1.77	282.1	78.1
P1.007	56.25	4.16	57.700	0.000	1.7	0.0	0.0	1.37	218.5	1.7

PIPELINE SCHEDULES for UNIT 3

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P7.000	o	225	U3 -2.2(SWA)	60.360	58.930	1.205	Open Manhole	1200
P7.001	o	225	U3 -2.1	59.950	58.520	1.205	Open Manhole	1200
P1.006	o	450	U3 -2(ATTN)	59.950	57.800	1.700	Open Manhole	1350
P1.007	o	450	U3 -1	59.950	57.700	1.800	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P7.000	12.907	31.5	U3 -2.1	59.950	58.520	1.205	Open Manhole	1200
P7.001	12.866	257.3	U3 -2(ATTN)	59.950	58.470	1.255	Open Manhole	1350
P1.006	13.116	131.2	U3 -1	59.950	57.700	1.800	Open Manhole	1350
P1.007	13.064	217.7	U3 -	60.360	57.640	2.270	Open Manhole	0

Free Flowing Outfall Details for UNIT 3

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
P1.007	U3 -	60.360	57.640	0.000	0	0

Simulation Criteria for UNIT 3

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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	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)	17.500	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for UNIT 3

Hydro-Brake® Optimum Manhole: U3 -2(ATTN), DS/PN: P1.006, Volume (m³): 5.4

Unit Reference	MD-SHE-0055-1700-1670-1700
Design Head (m)	1.670
Design Flow (l/s)	1.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	55
Invert Level (m)	57.800
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	1.7	Kick-Flo®	0.488	1.0
Flush-Flo™	0.241	1.2	Mean Flow over Head Range	-	1.3

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)	Depth (m)	Flow (l/s)
0.100	1.1	0.800	1.2	2.000	1.8	4.000	2.5	7.000	3.3
0.200	1.2	1.000	1.3	2.200	1.9	4.500	2.7	7.500	3.4
0.300	1.2	1.200	1.5	2.400	2.0	5.000	2.8	8.000	3.5
0.400	1.1	1.400	1.6	2.600	2.1	5.500	2.9	8.500	3.6
0.500	1.0	1.600	1.7	3.000	2.2	6.000	3.1	9.000	3.7
0.600	1.1	1.800	1.8	3.500	2.4	6.500	3.2	9.500	3.8

Storage Structures for UNIT 3

Tank or Pond Manhole: U3 -2(ATTN), DS/PN: P1.006

Invert Level (m) 57.800

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	300.0	1.670	300.0	1.671	0.0

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 3

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

Synthetic Rainfall Details

Rainfall Model	FSR M5-60 (mm) 17.500	Cv (Summer)	0.750
Region Scotland and Ireland	Ratio R 0.276	Cv (Winter)	0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
P1.000	U3 -8	15 Winter	100	+20%					61.137
P1.001	U3 -7	15 Winter	100	+20%					60.895
P1.002	U3 -6	15 Winter	100	+20%					60.199
P2.000	U3 -5.2.01	15 Winter	100	+20%	100/15 Summer				61.967
P3.000	U3 -5.5	15 Winter	100	+20%	100/15 Winter				60.650
P3.001	U3 -5.4	15 Winter	100	+20%	100/15 Summer				60.669
P4.000	U3 -5.3.1	15 Winter	100	+20%	100/15 Summer				60.592
P3.002	U3 -5.3	15 Winter	100	+20%	100/15 Summer				60.637
P2.001	U3 -5.2	15 Winter	100	+20%	100/15 Summer				60.591
P2.002	U3 -5.1	15 Winter	100	+20%	100/15 Summer				59.713
P1.003	U3 -5	2880 Winter	100	+20%	100/360 Winter				59.384
P5.000	U3 -4.01	2880 Winter	100	+20%	100/15 Summer				59.383
P6.000	U3 -4.1	2880 Winter	100	+20%	100/15 Summer				59.383
P1.004	U3 -4	2880 Winter	100	+20%	100/15 Winter				59.383
P1.005	U3 -3	2880 Winter	100	+20%	100/30 Winter				59.383
P7.000	U3 -2.2(SWA)	2880 Winter	100	+20%	100/960 Winter				59.384
P7.001	U3 -2.1	2880 Winter	100	+20%	100/15 Summer				59.383
P1.006	U3 -2(ATTN)	2880 Winter	100	+20%	100/30 Summer				59.383
P1.007	U3 -1	2880 Winter	100	+20%					57.723

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
P1.000	U3 -8	-0.138	0.000	0.32			16.4	OK	
P1.001	U3 -7	-0.060	0.000	0.85			47.1	OK	
P1.002	U3 -6	-0.076	0.000	0.75			75.8	OK	
P2.000	U3 -5.2.01	0.047	0.000	1.10			15.3	SURCHARGED	
P3.000	U3 -5.5	0.100	0.000	0.10			1.4	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 3

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
P3.001	U3 -5.4	0.529	0.000	1.35			18.6	SURCHARGED	
P4.000	U3 -5.3.1	0.492	0.000	0.20			2.8	SURCHARGED	
P3.002	U3 -5.3	0.882	0.000	1.30			32.3	SURCHARGED	
P2.001	U3 -5.2	0.856	0.000	1.50			61.1	SURCHARGED	
P2.002	U3 -5.1	0.358	0.000	1.32			79.1	SURCHARGED	
P1.003	U3 -5	0.434	0.000	0.04			7.3	SURCHARGED	
P5.000	U3 -4.01	0.878	0.000	0.02			0.6	SURCHARGED	
P6.000	U3 -4.1	0.878	0.000	0.01			0.6	SURCHARGED	
P1.004	U3 -4	0.823	0.000	0.05			8.2	SURCHARGED	
P1.005	U3 -3	1.043	0.000	0.05			8.2	SURCHARGED	
P7.000	U3 -2.2(SWA)	0.229	0.000	0.02			1.9	SURCHARGED	
P7.001	U3 -2.1	0.638	0.000	0.06			1.8	SURCHARGED	
P1.006	U3 -2(ATTN)	1.133	0.000	0.01			1.7	SURCHARGED	
P1.007	U3 -1	-0.427	0.000	0.01			1.7	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for UNIT 4

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	68
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	0
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.750
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 Inverts

Network Design Table for UNIT 4

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
P1.000	27.057	0.180	150.3	0.029	4.00	0.0	0.600	o	225	Pipe/Conduit	
P1.001	53.928	0.250	215.7	0.029	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.002	5.795	0.030	193.2	0.029	0.00	0.0	0.600	o	225	Pipe/Conduit	
P2.000	49.984	0.340	147.0	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
P1.003	17.646	0.120	147.1	0.029	0.00	0.0	0.600	o	225	Pipe/Conduit	
P3.000	49.257	0.330	149.3	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
P3.001	8.874	0.070	126.8	0.036	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.004	35.558	0.160	222.2	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.005	10.562	0.170	62.1	0.014	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.006	14.580	0.110	132.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P4.000	19.185	0.130	147.6	0.029	4.00	0.0	0.600	o	225	Pipe/Conduit	
P4.001	13.904	0.090	154.5	0.029	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)
P1.000	55.07	4.42	60.120	0.029	0.0	0.0	0.0	1.06	42.3	4.4
P1.001	51.07	5.44	59.940	0.058	0.0	0.0	0.0	0.89	35.2	8.1
P1.002	50.71	5.54	59.690	0.088	0.0	0.0	0.0	0.94	37.3	12.0
P2.000	52.68	5.01	59.900	0.000	0.0	0.0	0.0	0.83	14.6	0.0
P1.003	49.77	5.81	59.560	0.116	0.0	0.0	0.0	1.08	42.8	15.7
P3.000	52.70	5.00	59.550	0.000	0.0	0.0	0.0	0.82	14.5	0.0
P3.001	52.21	5.13	59.220	0.036	0.0	0.0	0.0	1.16	46.1	5.1
P1.004	47.61	6.49	59.150	0.158	0.0	0.0	0.0	0.87	34.7	20.3
P1.005	47.29	6.60	58.990	0.171	0.0	0.0	0.0	1.66	66.1	21.9
P1.006	46.67	6.81	58.820	0.171	0.0	0.0	0.0	1.13	45.1	21.9
P4.000	55.63	4.30	58.700	0.029	0.0	0.0	0.0	1.07	42.7	4.4
P4.001	54.67	4.52	58.570	0.058	0.0	0.0	0.0	1.05	41.7	8.7

Network Design Table for UNIT 4

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
P1.007	7.290	0.060	121.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P5.000	25.042	0.170	147.3	0.029	4.00	0.0	0.600	o	225	Pipe/Conduit	
P5.001	65.143	1.020	63.9	0.029	0.00	0.0	0.600	o	225	Pipe/Conduit	
P5.002	5.989	0.030	199.6	0.029	0.00	0.0	0.600	o	225	Pipe/Conduit	
P5.003	8.888	0.050	177.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.008	7.290	0.060	121.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.009	13.311	0.110	121.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P6.000	21.598	0.150	144.0	0.050	6.00	0.0	0.600	o	225	Pipe/Conduit	
P7.000	19.405	0.130	149.3	0.033	6.00	0.0	0.600	o	225	Pipe/Conduit	
P1.010	47.817	0.190	251.7	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P8.000	64.400	1.610	40.0	0.007	4.00	0.0	0.600	o	225	Pipe/Conduit	
P8.001	12.861	0.430	29.9	0.039	0.00	0.0	0.600	o	225	Pipe/Conduit	
P8.002	12.694	0.130	97.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P1.011	5.915	0.040	147.9	0.078	0.00	0.0	0.600	o	300	Pipe/Conduit	
P9.000	23.763	0.170	139.8	0.092	6.00	0.0	0.600	o	225	Pipe/Conduit	
P1.012	33.234	0.220	151.1	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)
P1.007	46.38	6.92	58.480	0.230	0.0	0.0	0.0	1.18	47.1	28.9
P5.000	55.23	4.39	59.550	0.029	0.0	0.0	0.0	1.08	42.7	4.4
P5.001	52.51	5.05	58.270	0.058	0.0	0.0	0.0	1.64	65.2	8.3
P5.002	52.10	5.16	57.250	0.088	0.0	0.0	0.0	0.92	36.6	12.4
P5.003	51.54	5.31	57.220	0.088	0.0	0.0	0.0	0.98	38.9	12.4
P1.008	46.09	7.02	57.170	0.318	0.0	0.0	0.0	1.18	47.1	39.6
P1.009	45.58	7.21	57.110	0.318	0.0	0.0	0.0	1.19	47.2	39.6
P6.000	48.10	6.33	58.230	0.050	0.0	0.0	0.0	1.09	43.2	6.6
P7.000	48.19	6.30	58.230	0.033	0.0	0.0	0.0	1.07	42.5	4.3
P1.010	43.52	8.01	57.000	0.401	0.0	0.0	0.0	0.99	69.7	47.3
P8.000	54.67	4.52	60.140	0.007	0.0	0.0	0.0	2.07	82.5	1.0
P8.001	54.29	4.61	58.530	0.046	0.0	0.0	0.0	2.40	95.5	6.7
P8.002	53.63	4.77	58.100	0.046	0.0	0.0	0.0	1.32	52.6	6.7
P1.011	43.34	8.09	56.810	0.525	0.0	0.0	0.0	1.29	91.2	61.6
P9.000	48.01	6.36	57.410	0.092	0.0	0.0	0.0	1.10	43.9	12.0
P1.012	42.34	8.52	56.770	0.617	0.0	0.0	0.0	1.28	90.3	70.8

Network Design Table for UNIT 4

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
P1.013	10.309	0.100	103.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
P1.014	8.301	0.040	207.5	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)
P1.013	42.09	8.63	56.550	0.617	0.0	0.0	0.0	1.55	109.4	70.8
P1.014	56.28	4.15	56.450	0.000	2.3	0.0	0.0	0.90	35.9	2.3

Simulation Criteria for UNIT 4

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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	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)	17.500	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for UNIT 4

Hydro-Brake® Optimum Manhole: U4 -2(ATTN), DS/PN: P1.013, Volume (m^3): 5.3

Unit Reference	MD-SHE-0062-2200-1670-2200
Design Head (m)	1.670
Design Flow (l/s)	2.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	62
Invert Level (m)	56.550
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	2.2	Kick-Flo®	0.558	1.3
Flush-Flo™	0.275	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)	Depth (m)	Flow (l/s)
0.100	1.4	0.800	1.6	2.000	2.4	4.000	3.3	7.000	4.3
0.200	1.6	1.000	1.7	2.200	2.5	4.500	3.5	7.500	4.4
0.300	1.6	1.200	1.9	2.400	2.6	5.000	3.6	8.000	4.5
0.400	1.6	1.400	2.0	2.600	2.7	5.500	3.8	8.500	4.7
0.500	1.5	1.600	2.2	3.000	2.9	6.000	4.0	9.000	4.8
0.600	1.4	1.800	2.3	3.500	3.1	6.500	4.1	9.500	4.9

Storage Structures for UNIT 4

Tank or Pond Manhole: U4 -2(ATTN), DS/PN: P1.013

Invert Level (m) 57.020

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	270.0	1.670	270.0	1.671	0.0

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 4

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 17.500 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.276 Cv (Winter) 0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
P1.000	U4 -15	15 Winter	100	+20%					60.209
P1.001	U4 -14	15 Winter	100	+20%					60.088
P1.002	U4 -13	15 Winter	100	+20%	100/15 Summer				59.946
P2.000	U4 -12.1	15 Summer	100	+20%					59.900
P1.003	U4 -12	15 Winter	100	+20%	100/15 Summer				59.808
P3.000	U4 -11.2	15 Winter	100	+20%					59.657
P3.001	U4 -11.1	15 Winter	100	+20%	100/15 Summer				59.659
P1.004	U4 -11	15 Winter	100	+20%	100/15 Summer				59.651
P1.005	U4 -10	30 Winter	100	+20%	100/15 Summer				59.387
P1.006	U4 -9	15 Winter	100	+20%	100/15 Summer				59.255
P4.000	U4 -8.2	30 Winter	100	+20%	100/15 Summer				59.160
P4.001	U4 -8.1	30 Winter	100	+20%	100/15 Summer				59.149
P1.007	U4 -8	30 Winter	100	+20%	100/15 Summer				59.130
P5.000	U4 -7.4	15 Winter	100	+20%					59.639
P5.001	U4 -7.3	30 Winter	100	+20%	100/15 Summer				59.087
P5.002	U4 -7.2	30 Winter	100	+20%	100/15 Summer				59.044
P5.003	U4 -7.1	30 Winter	100	+20%	100/15 Summer				59.027
P1.008	U4 -7	30 Winter	100	+20%	100/15 Summer				58.992
P1.009	U4 -6	30 Winter	100	+20%	100/15 Summer				58.742
P6.000	U4 -5.02(BRA)	30 Winter	100	+20%					58.440
P7.000	U4 -5.01(SWA)	30 Winter	100	+20%					58.431
P1.010	U4 -5	1440 Winter	100	+20%	100/15 Summer				58.425
P8.000	U4 -4.3	15 Winter	100	+20%					60.168
P8.001	U4 -4.2	15 Winter	100	+20%					58.605
P8.002	U4 -4.1	1440 Winter	100	+20%	100/720 Winter				58.423
P1.011	U4 -4	1440 Winter	100	+20%	100/15 Summer				58.423
P9.000	U4 -3.1(SWA)	1440 Winter	100	+20%	100/15 Summer				58.423
P1.012	U4 -3	1440 Winter	100	+20%	100/15 Summer				58.422
P1.013	U4 -2(ATTN)	1440 Winter	100	+20%	100/15 Summer				58.419
P1.014	U4 -1(HB)	1440 Winter	100	+20%					56.492

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 4

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
P1.000	U4 -15	-0.136	0.000	0.33			12.9	OK	
P1.001	U4 -14	-0.077	0.000	0.71			24.2	OK	
P1.002	U4 -13	0.031	0.000	1.17			32.8	SURCHARGED	
P2.000	U4 -12.1	-0.150	0.000	0.00			0.0	OK	
P1.003	U4 -12	0.023	0.000	1.11			42.6	SURCHARGED	
P3.000	U4 -11.2	-0.043	0.000	0.05			0.7	OK	
P3.001	U4 -11.1	0.214	0.000	0.32			12.1	SURCHARGED	
P1.004	U4 -11	0.276	0.000	1.52			49.8	SURCHARGED	
P1.005	U4 -10	0.172	0.000	0.85			47.1	SURCHARGED	
P1.006	U4 -9	0.210	0.000	1.17			46.2	FLOOD RISK	
P4.000	U4 -8.2	0.235	0.000	0.24			9.4	SURCHARGED	
P4.001	U4 -8.1	0.354	0.000	0.48			17.4	FLOOD RISK	
P1.007	U4 -8	0.425	0.000	1.63			56.4	SURCHARGED	
P5.000	U4 -7.4	-0.136	0.000	0.33			13.0	OK	
P5.001	U4 -7.3	0.592	0.000	0.29			18.0	SURCHARGED	
P5.002	U4 -7.2	1.569	0.000	0.74			20.7	FLOOD RISK	
P5.003	U4 -7.1	1.582	0.000	0.72			22.6	SURCHARGED	
P1.008	U4 -7	1.597	0.000	2.04			70.3	SURCHARGED	
P1.009	U4 -6	1.407	0.000	1.73			70.7	SURCHARGED	
P6.000	U4 -5.02(BRA)	-0.015	0.000	0.42			16.6	OK	
P7.000	U4 -5.01(SWA)	-0.024	0.000	0.29			11.0	OK	
P1.010	U4 -5	1.125	0.000	0.16			10.3	SURCHARGED	
P8.000	U4 -4.3	-0.197	0.000	0.04			3.0	OK	
P8.001	U4 -4.2	-0.150	0.000	0.24			20.2	OK	
P8.002	U4 -4.1	0.098	0.000	0.03			1.2	SURCHARGED	
P1.011	U4 -4	1.313	0.000	0.22			13.5	SURCHARGED	
P9.000	U4 -3.1(SWA)	0.788	0.000	0.06			2.3	SURCHARGED	
P1.012	U4 -3	1.352	0.000	0.19			15.8	SURCHARGED	
P1.013	U4 -2(ATTN)	1.569	0.000	0.03			2.3	SURCHARGED	
P1.014	U4 -1(HB)	-0.183	0.000	0.08			2.3	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for UNIT 5

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	62
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	0
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.750
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 Inverts

Network Design Table for UNIT 5

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
P3.000	49.999	0.340	147.1	0.047	4.00	0.0	0.600	o	225	Pipe/Conduit	
P4.000	20.443	0.140	146.0	0.000	4.00	0.0	0.600	o	150	Pipe/Conduit	
P4.001	13.103	0.090	145.6	0.017	0.00	0.0	0.600	o	150	Pipe/Conduit	
P4.002	11.605	0.080	145.1	0.017	0.00	0.0	0.600	o	150	Pipe/Conduit	
P4.003	4.006	0.030	133.5	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
P4.004	4.531	0.030	151.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
P3.001	7.067	0.040	176.7	0.040	0.00	0.0	0.600	o	225	Pipe/Conduit	
P5.000	22.739	0.160	142.1	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
P5.001	9.765	0.070	139.5	0.016	0.00	0.0	0.600	o	225	Pipe/Conduit	
P6.000	33.444	0.230	145.4	0.027	4.00	0.0	0.600	o	225	Pipe/Conduit	
P7.000	12.009	0.240	50.0	0.009	4.00	0.0	0.600	o	150	Pipe/Conduit	
P7.001	13.297	0.270	49.2	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
P3.000	53.60	4.77	60.370	0.047	0.0	0.0	0.0	1.08	42.8	6.8
P4.000	55.13	4.41	60.600	0.000	0.0	0.0	0.0	0.83	14.7	0.0
P4.001	54.01	4.67	60.460	0.017	0.0	0.0	0.0	0.83	14.7	2.4
P4.002	53.08	4.91	60.370	0.033	0.0	0.0	0.0	0.83	14.7	4.8
P4.003	52.77	4.98	60.290	0.033	0.0	0.0	0.0	0.87	15.3	4.8
P4.004	52.42	5.08	60.260	0.033	0.0	0.0	0.0	0.82	14.4	4.8
P3.001	51.96	5.20	60.030	0.121	0.0	0.0	0.0	0.98	39.0	17.0
P5.000	55.41	4.35	61.270	0.000	0.0	0.0	0.0	1.09	43.5	0.0
P5.001	54.77	4.49	61.110	0.016	0.0	0.0	0.0	1.11	43.9	2.3
P6.000	54.68	4.52	61.520	0.027	0.0	0.0	0.0	1.08	43.0	4.0
P7.000	56.34	4.14	62.300	0.009	0.0	0.0	0.0	1.43	25.2	1.3
P7.001	55.64	4.29	62.060	0.017	0.0	0.0	0.0	1.44	25.4	2.5

Network Design Table for UNIT 5

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
P7.002	11.640	0.580	20.1	0.009	0.00	0.0	0.600	o	150	Pipe/Conduit	
P7.003	4.243	0.030	141.4	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
P6.001	8.907	0.050	178.1	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P3.002	9.222	0.050	184.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P8.000	45.613	0.230	198.3	0.047	4.00	0.0	0.600	o	225	Pipe/Conduit	
P9.000	11.528	0.080	144.1	0.008	4.00	0.0	0.600	o	150	Pipe/Conduit	
P9.001	12.320	0.090	136.9	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
P9.002	9.152	0.070	130.7	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
P9.003	8.200	0.060	136.7	0.008	0.00	0.0	0.600	o	150	Pipe/Conduit	
P8.001	6.455	0.030	215.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
P3.003	3.874	0.020	193.7	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P3.004	19.214	0.070	274.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P3.005	19.214	0.070	274.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
P3.006	12.190	0.060	203.2	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)
P7.002	55.26	4.38	61.790	0.025	0.0	0.0	0.0	2.26	39.9	3.8
P7.003	54.90	4.46	61.210	0.033	0.0	0.0	0.0	0.84	14.9	5.0
P6.001	54.04	4.67	61.180	0.061	0.0	0.0	0.0	0.98	38.8	8.9
P3.002	51.37	5.36	59.990	0.197	0.0	0.0	0.0	0.96	38.1	27.4
P8.000	53.41	4.82	60.620	0.047	0.0	0.0	0.0	0.92	36.8	6.8
P9.000	55.93	4.23	61.000	0.008	0.0	0.0	0.0	0.84	14.8	1.2
P9.001	54.87	4.47	60.920	0.016	0.0	0.0	0.0	0.86	15.1	2.4
P9.002	54.14	4.64	60.830	0.024	0.0	0.0	0.0	0.88	15.5	3.5
P9.003	53.49	4.80	60.760	0.032	0.0	0.0	0.0	0.86	15.2	4.7
P8.001	52.93	4.94	60.390	0.079	0.0	0.0	0.0	0.89	35.3	11.4
P3.003	51.16	5.41	59.940	0.277	0.0	0.0	0.0	1.13	79.6	38.3
P3.004	49.97	5.75	59.920	0.277	0.0	0.0	0.0	0.94	66.7	38.3
P3.005	48.85	6.09	59.850	0.277	0.0	0.0	0.0	0.94	66.7	38.3
P3.006	55.96	4.22	59.780	0.000	1.4	0.0	0.0	0.91	36.3	1.4

PIPELINE SCHEDULES for UNIT 5

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P9.000	o	150	U5 -4.1.4	61.900	61.000	0.750	Open Manhole	1200
P9.001	o	150	U5 -4.1.3	62.050	60.920	0.980	Open Manhole	1200
P9.002	o	150	U5 -4.1.2	62.200	60.830	1.220	Open Manhole	1200
P9.003	o	150	U5 -4.1.1	62.300	60.760	1.390	Open Manhole	1200
P8.001	o	225	U5 -4.1	61.850	60.390	1.235	Open Manhole	1200
P3.003	o	300	U5 -4	61.700	59.940	1.460	Open Manhole	1200
P3.004	o	300	U5 -3	61.700	59.920	1.480	Open Manhole	1200
P3.005	o	300	U5 -2(ATTN)	61.700	59.850	1.550	Open Manhole	1200
P3.006	o	225	U5 -1(HB)	61.700	59.780	1.695	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
P9.000	11.528	144.1	U5 -4.1.3	62.050	60.920	0.980	Open Manhole	1200
P9.001	12.320	136.9	U5 -4.1.2	62.200	60.830	1.220	Open Manhole	1200
P9.002	9.152	130.7	U5 -4.1.1	62.300	60.760	1.390	Open Manhole	1200
P9.003	8.200	136.7	U5 -4.1	61.850	60.700	1.000	Open Manhole	1200
P8.001	6.455	215.2	U5 -4	61.700	60.360	1.115	Open Manhole	1200
P3.003	3.874	193.7	U5 -3	61.700	59.920	1.480	Open Manhole	1200
P3.004	19.214	274.5	U5 -2(ATTN)	61.700	59.850	1.550	Open Manhole	1200
P3.005	19.214	274.5	U5 -1(HB)	61.700	59.780	1.620	Open Manhole	1200
P3.006	12.190	203.2	U5 -	61.640	59.720	1.695	Open Manhole	0

Free Flowing Outfall Details for UNIT 5

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
P3.006	U5 -	61.640	59.720	0.000	0	0

Simulation Criteria for UNIT 5

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

Synthetic Rainfall Details

Rainfall Model FSR Return Period (years) 2

Synthetic Rainfall Details

Region	Scotland and Ireland	Cv (Summer)	0.750
M5-60 (mm)	17.500	Cv (Winter)	0.840
Ratio R	0.276	Storm Duration (mins)	30
Profile Type	Summer		

Online Controls for UNIT 5

Hydro-Brake® Optimum Manhole: U5 -2(ATTN), DS/PN: P3.005, Volume (m^3): 3.4

Unit Reference	MD-SHE-0049-1400-1670-1400
Design Head (m)	1.670
Design Flow (l/s)	1.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	49
Invert Level (m)	59.850
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	1.4	Kick-Flo®	0.440	0.8
Flush-Flo™	0.216	0.9	Mean Flow over Head Range	-	1.0

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)	Depth (m)	Flow (l/s)
0.100	0.9	0.800	1.0	2.000	1.5	4.000	2.1	7.000	2.7
0.200	0.9	1.000	1.1	2.200	1.6	4.500	2.2	7.500	2.8
0.300	0.9	1.200	1.2	2.400	1.6	5.000	2.3	8.000	2.9
0.400	0.8	1.400	1.3	2.600	1.7	5.500	2.4	8.500	3.0
0.500	0.8	1.600	1.4	3.000	1.8	6.000	2.5	9.000	3.0
0.600	0.9	1.800	1.4	3.500	2.0	6.500	2.6	9.500	3.1

Storage Structures for UNIT 5

Tank or Pond Manhole: U5 -2(ATTN), DS/PN: P3.005

Invert Level (m) 59.850

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	192.0	1.060	192.0	1.061	0.0

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 5

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 17.500 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.276 Cv (Winter) 0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
P3.000	U5 -6.1	15 Winter	100	+20%	100/15 Summer				60.814	0.219
P4.000	U5 -11	15 Winter	100	+20%	100/15 Summer				60.824	0.074
P4.001	U5 -10	15 Winter	100	+20%	100/15 Summer				60.823	0.213
P4.002	U5 -9	15 Winter	100	+20%	100/15 Summer				60.810	0.290
P4.003	U5 -8	15 Winter	100	+20%	100/15 Summer				60.783	0.343
P4.004	U5 -7	15 Winter	100	+20%	100/15 Summer				60.772	0.362
P3.001	U5 -6	15 Winter	100	+20%	100/15 Summer				60.761	0.506
P5.000	U5 -5.1.03	15 Summer	100	+20%					61.270	-0.225
P5.001	U5 -5.1.02	15 Summer	100	+20%					61.176	-0.159
P6.000	U5 -5.1.01	15 Winter	100	+20%					61.604	-0.141
P7.000	U5 -5.1.4	15 Summer	100	+20%					62.341	-0.109
P7.001	U5 -5.1.3	15 Summer	100	+20%					62.118	-0.092
P7.002	U5 -5.1.2	15 Summer	100	+20%					61.848	-0.092
P7.003	U5 -5.1.1	15 Summer	100	+20%	100/15 Summer				61.397	0.037
P6.001	U5 -5.1	15 Winter	100	+20%					61.340	-0.065
P3.002	U5 -5	1440 Winter	100	+20%	100/15 Summer				60.734	0.519
P8.000	U5 -4.1.01	15 Winter	100	+20%					60.745	-0.100
P9.000	U5 -4.1.4	15 Summer	100	+20%					61.053	-0.097
P9.001	U5 -4.1.3	15 Summer	100	+20%					60.997	-0.073
P9.002	U5 -4.1.2	15 Winter	100	+20%					60.943	-0.037
P9.003	U5 -4.1.1	15 Winter	100	+20%					60.906	-0.004
P8.001	U5 -4.1	1440 Winter	100	+20%	100/15 Summer				60.733	0.118
P3.003	U5 -4	1440 Winter	100	+20%	100/15 Summer				60.733	0.493
P3.004	U5 -3	1440 Winter	100	+20%	100/15 Summer				60.733	0.513
P3.005	U5 -2(ATTN)	1440 Winter	100	+20%	100/30 Summer				60.732	0.582
P3.006	U5 -1(HB)	1440 Winter	100	+20%					59.807	-0.198

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 5

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
P3.000	U5 -6.1	0.000	0.39			16.0	SURCHARGED	
P4.000	U5 -11	0.000	0.11			1.5	SURCHARGED	
P4.001	U5 -10	0.000	0.52			6.9	SURCHARGED	
P4.002	U5 -9	0.000	0.80			10.7	SURCHARGED	
P4.003	U5 -8	0.000	1.12			12.2	SURCHARGED	
P4.004	U5 -7	0.000	1.25			13.6	SURCHARGED	
P3.001	U5 -6	0.000	1.17			35.0	SURCHARGED	
P5.000	U5 -5.1.03	0.000	0.00			0.0	OK	
P5.001	U5 -5.1.02	0.000	0.19			6.9	OK	
P6.000	U5 -5.1.01	0.000	0.30			12.0	OK	
P7.000	U5 -5.1.4	0.000	0.17			3.9	OK	
P7.001	U5 -5.1.3	0.000	0.32			7.4	OK	
P7.002	U5 -5.1.2	0.000	0.31			11.3	OK	
P7.003	U5 -5.1.1	0.000	1.34			14.5	SURCHARGED	
P6.001	U5 -5.1	0.000	0.84			26.3	OK	
P3.002	U5 -5	0.000	0.16			5.0	SURCHARGED	
P8.000	U5 -4.1.01	0.000	0.57			19.8	OK	
P9.000	U5 -4.1.4	0.000	0.27			3.6	OK	
P9.001	U5 -4.1.3	0.000	0.52			7.2	OK	
P9.002	U5 -4.1.2	0.000	0.75			10.3	OK	
P9.003	U5 -4.1.1	0.000	1.00			13.2	OK	
P8.001	U5 -4.1	0.000	0.08			2.1	SURCHARGED	
P3.003	U5 -4	0.000	0.14			7.0	SURCHARGED	
P3.004	U5 -3	0.000	0.12			7.0	SURCHARGED	
P3.005	U5 -2(ATTN)	0.000	0.02			1.0	SURCHARGED	
P3.006	U5 -1(HB)	0.000	0.03			1.0	OK	

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for UNIT 6

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	69
M5-60 (mm)	17.500	Add Flow / Climate Change (%)	0
Ratio R	0.276	Minimum Backdrop Height (m)	0.000
Maximum Rainfall (mm/hr)	150	Maximum Backdrop Height (m)	0.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.750
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 Inverts

Network Design Table for UNIT 6

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	36.227	0.280	129.4	0.010	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S1.001	4.117	0.040	102.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
S1.002	25.389	0.250	101.6	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
S1.003	5.884	0.040	147.1	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
S2.000	39.763	0.720	55.2	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S2.001	10.958	0.190	57.7	0.059	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
S1.004	12.260	0.060	204.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔓
S3.000	47.705	0.320	149.1	0.030	4.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S1.005	2.457	0.010	245.7	0.030	0.00	0.0	0.600	o	300	Pipe/Conduit	🔓
S4.000	59.418	0.410	144.9	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S4.001	20.498	0.100	205.0	0.032	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	54.63	4.53	63.800	0.010	0.0	0.0	0.0	1.15	45.6	1.5
S1.001	54.41	4.58	63.520	0.010	0.0	0.0	0.0	1.29	51.2	1.5
S1.002	53.08	4.91	63.480	0.041	0.0	0.0	0.0	1.30	51.6	5.9
S1.003	52.72	5.00	63.230	0.071	0.0	0.0	0.0	1.08	42.8	10.1
S2.000	55.28	4.38	63.630	0.000	0.0	0.0	0.0	1.76	70.1	0.0
S2.001	54.82	4.48	62.910	0.059	0.0	0.0	0.0	1.73	68.6	8.7
S1.004	51.87	5.22	62.720	0.130	0.0	0.0	0.0	0.91	36.2	18.2
S3.000	54.24	4.62	61.750	0.030	0.0	0.0	0.0	1.29	90.9	4.5
S1.005	51.71	5.26	61.430	0.190	0.0	0.0	0.0	1.00	70.6	26.7
S4.000	53.05	4.91	63.630	0.000	0.0	0.0	0.0	1.08	43.1	0.0
S4.001	51.61	5.29	63.220	0.032	0.0	0.0	0.0	0.91	36.2	4.5

Network Design Table for UNIT 6

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
S1.006	66.056	0.330	200.2	0.025	0.00	0.0	0.600	o	300	Pipe/Conduit	
S5.000	24.325	1.216	20.0	0.061	4.00	0.0	0.600	o	225	Pipe/Conduit	
S5.001	43.349	0.350	123.9	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.002	43.349	0.350	123.9	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	
S5.003	14.314	0.120	119.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.000	7.335	0.050	146.7	0.091	4.00	0.0	0.600	o	225	Pipe/Conduit	
S5.004	3.455	0.060	57.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.007	6.981	0.040	174.5	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.008	4.556	0.020	227.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.009	7.464	0.040	186.6	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S7.000	24.275	0.160	151.7	0.057	4.00	0.0	0.600	o	225	Pipe/Conduit	
S8.000	10.648	0.070	152.1	0.029	4.00	0.0	0.600	o	225	Pipe/Conduit	
S7.001	3.898	0.030	129.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S9.000	23.173	0.150	154.5	0.048	4.00	0.0	0.600	o	150	Pipe/Conduit	
S10.000	12.127	0.080	151.6	0.021	4.00	0.0	0.600	o	225	Pipe/Conduit	
S9.001	11.174	0.074	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.006	48.25	6.28	61.420	0.248	0.0	0.0	0.0	1.11	78.3	32.4
S5.000	56.35	4.14	63.620	0.061	0.0	0.0	0.0	2.94	116.9	9.3
S5.001	53.69	4.75	61.770	0.090	0.0	0.0	0.0	1.17	46.7	13.1
S5.002	51.32	5.37	61.420	0.120	0.0	0.0	0.0	1.17	46.7	16.7
S5.003	50.61	5.57	61.070	0.120	0.0	0.0	0.0	1.20	47.6	16.7
S6.000	56.46	4.11	61.520	0.091	0.0	0.0	0.0	1.08	42.8	13.9
S5.004	50.49	5.60	60.950	0.211	0.0	0.0	0.0	1.73	68.7	28.9
S1.007	47.95	6.38	60.890	0.459	0.0	0.0	0.0	1.19	83.9	59.6
S1.008	47.72	6.45	60.850	0.459	0.0	0.0	0.0	1.04	73.3	59.6
S1.009	47.40	6.56	60.830	0.459	0.0	0.0	0.0	1.15	81.1	59.6
S7.000	55.25	4.38	62.030	0.057	0.0	0.0	0.0	1.06	42.1	8.6
S8.000	56.21	4.17	61.770	0.029	0.0	0.0	0.0	1.06	42.1	4.4
S7.001	55.01	4.44	61.700	0.086	0.0	0.0	0.0	1.15	45.5	12.8
S9.000	54.83	4.48	62.030	0.048	0.0	0.0	0.0	0.81	14.2	7.1
S10.000	56.11	4.19	62.030	0.021	0.0	0.0	0.0	1.06	42.1	3.3
S9.001	54.10	4.65	61.880	0.069	0.0	0.0	0.0	1.07	42.4	10.1

Network Design Table for UNIT 6

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
S7.002	3.242	0.020	162.1	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	✔
S7.003	33.601	0.170	197.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	✔
S1.010	4.234	0.020	211.7	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	✔
S1.011	7.984	0.020	399.2	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	✔
S1.012	19.454	0.100	194.5	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)
S7.002	53.88	4.71	61.670	0.155	0.0	0.0	0.0	1.02	40.7	22.7
S7.003	51.53	5.31	61.650	0.155	0.0	0.0	0.0	0.93	36.8	22.7
S1.010	47.23	6.62	60.790	0.614	0.0	0.0	0.0	1.24	137.1	78.5
S1.011	46.80	6.77	60.770	0.614	0.0	0.0	0.0	0.90	99.5	78.5
S1.012	55.41	4.35	60.750	0.000	2.0	0.0	0.0	0.93	37.1	2.0

Free Flowing Outfall Details for UNIT 6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.012	U6 -	61.900	60.650	0.000	0	0

Simulation Criteria for UNIT 6

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 Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	1	Number of Storage Structures	1	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)	17.500	Storm Duration (mins)	30
Ratio R	0.276		

Online Controls for UNIT 6

Hydro-Brake® Optimum Manhole: U6 - 3(ATTN), DS/PN: S1.010, Volume (m^3): 5.5

Unit Reference	MD-SHE-0059-2000-1670-2000
Design Head (m)	1.670
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	60.790
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	2.0	Kick-Flo®	0.531	1.2
Flush-Flo™	0.264	1.5	Mean Flow over Head Range	-	1.5

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)	Depth (m)	Flow (l/s)
0.100	1.3	0.800	1.4	2.000	2.2	4.000	3.0	7.000	3.9
0.200	1.4	1.000	1.6	2.200	2.3	4.500	3.2	7.500	4.0
0.300	1.5	1.200	1.7	2.400	2.4	5.000	3.3	8.000	4.1
0.400	1.4	1.400	1.8	2.600	2.4	5.500	3.5	8.500	4.2
0.500	1.3	1.600	2.0	3.000	2.6	6.000	3.6	9.000	4.4
0.600	1.3	1.800	2.1	3.500	2.8	6.500	3.7	9.500	4.5

Storage Structures for UNIT 6

Tank or Pond Manhole: U6 - 3(ATTN), DS/PN: S1.010

Invert Level (m) 60.790

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	250.0	1.670	250.0	1.671	0.0

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 6

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 17.500 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.276 Cv (Winter) 0.840

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

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

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	U6 - 11	15 Winter	100	+20%					63.849
S1.001	U6 - 10	15 Winter	100	+20%					63.585
S1.002	U6 - 9	15 Winter	100	+20%					63.576
S1.003	U6 - 8	15 Winter	100	+20%					63.428
S2.000	U6 - 7.2	15 Summer	100	+20%					63.630
S2.001	U6 - 7.1	15 Winter	100	+20%					63.105
S1.004	U6 - 7	15 Winter	100	+20%	100/15 Summer				63.066
S3.000	U6 - 6.02	2160 Winter	100	+20%	100/15 Summer				62.418
S1.005	U6 - 6.01	2160 Winter	100	+20%	100/15 Summer				62.418
S4.000	U6 - 6.2	15 Summer	100	+20%					63.630
S4.001	U6 - 6.1	15 Winter	100	+20%					63.324
S1.006	U6 - 6	2160 Winter	100	+20%	100/15 Summer				62.418
S5.000	U6 - 5.5	15 Winter	100	+20%					63.696
S5.001	U6 - 5.4	15 Winter	100	+20%	100/15 Summer				62.486
S5.002	U6 - 5.3	2160 Winter	100	+20%	100/15 Summer				62.419
S5.003	U6 - 5.2(BRA)	2160 Winter	100	+20%	100/15 Summer				62.418
S6.000	U6 - 5.1(SWA us)	2160 Winter	100	+20%	100/15 Summer				62.417
S5.004	U6 - 5.1(SWA)	2160 Winter	100	+20%	100/15 Summer				62.417
S1.007	U6 - 5	2160 Winter	100	+20%	100/15 Summer				62.417
S1.008	U6 - 4	2160 Winter	100	+20%	100/15 Summer				62.416
S1.009	U6 - ATNN	2160 Winter	100	+20%	100/15 Summer				62.416
S7.000	U6 - 3.3	2160 Winter	100	+20%	100/15 Winter				62.417
S8.000	U6 - 3.2.1	2160 Winter	100	+20%	100/15 Summer				62.417
S7.001	U6 - 3.2	2160 Winter	100	+20%	100/15 Summer				62.417
S9.000	U6 - 3.1.01	15 Winter	100	+20%	100/15 Summer				62.472
S10.000	U6 - 3.1.2	2160 Winter	100	+20%	100/15 Winter				62.417
S9.001	U6 - 3.1.1	2160 Winter	100	+20%	100/15 Summer				62.417
S7.002	U6 - 3.1	2160 Winter	100	+20%	100/15 Summer				62.416
S7.003	U6 - ATTN	2160 Winter	100	+20%	100/15 Summer				62.416
S1.010	U6 - 3(ATTN)	2160 Winter	100	+20%	100/15 Summer				62.415

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 6

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	U6 - 11	-0.176	0.000	0.11			4.5	OK	
S1.001	U6 - 10	-0.160	0.000	0.15			4.5	OK	
S1.002	U6 - 9	-0.129	0.000	0.37			17.7	OK	
S1.003	U6 - 8	-0.027	0.000	1.00			29.9	OK	
S2.000	U6 - 7.2	-0.225	0.000	0.00			0.0	OK	
S2.001	U6 - 7.1	-0.030	0.000	0.42			24.6	OK	
S1.004	U6 - 7	0.121	0.000	1.76			54.8	SURCHARGED	
S3.000	U6 - 6.02	0.368	0.000	0.01			0.6	SURCHARGED	
S1.005	U6 - 6.01	0.688	0.000	0.07			3.8	SURCHARGED	
S4.000	U6 - 6.2	-0.225	0.000	0.00			0.0	OK	
S4.001	U6 - 6.1	-0.121	0.000	0.44			14.3	OK	
S1.006	U6 - 6	0.698	0.000	0.06			4.8	SURCHARGED	
S5.000	U6 - 5.5	-0.149	0.000	0.25			26.9	OK	
S5.001	U6 - 5.4	0.491	0.000	0.76			33.8	SURCHARGED	
S5.002	U6 - 5.3	0.774	0.000	0.05			2.2	SURCHARGED	
S5.003	U6 - 5.2(BRA)	1.123	0.000	0.05			2.1	FLOOD RISK	
S6.000	U6 - 5.1(SWA us)	0.672	0.000	0.06			1.7	FLOOD RISK	
S5.004	U6 - 5.1(SWA)	1.242	0.000	0.11			3.8	FLOOD RISK	
S1.007	U6 - 5	1.227	0.000	0.14			8.5	SURCHARGED	
S1.008	U6 - 4	1.266	0.000	0.18			8.4	SURCHARGED	
S1.009	U6 - ATNN	1.286	0.000	0.14			8.4	SURCHARGED	
S7.000	U6 - 3.3	0.162	0.000	0.03			1.1	SURCHARGED	
S8.000	U6 - 3.2.1	0.422	0.000	0.02			0.6	SURCHARGED	
S7.001	U6 - 3.2	0.492	0.000	0.06			1.7	SURCHARGED	
S9.000	U6 - 3.1.01	0.292	0.000	1.32			17.9	SURCHARGED	
S10.000	U6 - 3.1.2	0.162	0.000	0.01			0.4	SURCHARGED	
S9.001	U6 - 3.1.1	0.312	0.000	0.04			1.4	SURCHARGED	
S7.002	U6 - 3.1	0.521	0.000	0.12			3.1	SURCHARGED	
S7.003	U6 - ATTN	0.541	0.000	0.09			3.1	SURCHARGED	
S1.010	U6 - 3(ATTN)	1.250	0.000	0.02			2.0	SURCHARGED	

Summary of Critical Results by Maximum Level (Rank 1) for UNIT 6

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S1.011	U6 - 2(HB)	2160 Winter	100	+20%					60.814	-0.331
S1.012	U6 - 1	2160 Winter	100	+20%					60.785	-0.190

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.011	U6 - 2(HB)	0.000	0.03			2.0	OK	
S1.012	U6 - 1	0.000	0.06			2.0	OK	

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.209	0.209	0.3	41.8	O K
30 min Summer	0.287	0.287	0.3	57.5	O K
60 min Summer	0.370	0.370	0.3	73.9	O K
120 min Summer	0.462	0.462	0.3	92.4	O K
180 min Summer	0.521	0.521	0.4	104.1	O K
240 min Summer	0.564	0.564	0.4	112.8	O K
360 min Summer	0.628	0.628	0.4	125.6	O K
480 min Summer	0.675	0.675	0.4	135.0	O K
600 min Summer	0.711	0.711	0.4	142.2	O K
720 min Summer	0.741	0.741	0.4	148.2	O K
960 min Summer	0.786	0.786	0.4	157.2	O K
1440 min Summer	0.844	0.844	0.5	168.9	O K
2160 min Summer	0.888	0.888	0.5	177.6	O K
2880 min Summer	0.904	0.904	0.5	180.8	O K
4320 min Summer	0.913	0.913	0.5	182.5	O K
5760 min Summer	0.910	0.910	0.5	181.9	O K
7200 min Summer	0.901	0.901	0.5	180.2	O K
8640 min Summer	0.890	0.890	0.5	178.0	O K
10080 min Summer	0.877	0.877	0.5	175.5	O K
15 min Winter	0.234	0.234	0.3	46.8	O K
30 min Winter	0.322	0.322	0.3	64.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.226	0.0	28.2	23
30 min Summer	63.566	0.0	27.2	38
60 min Summer	41.084	0.0	54.1	68
120 min Summer	25.892	0.0	54.0	128
180 min Summer	19.608	0.0	55.3	188
240 min Summer	16.062	0.0	57.2	248
360 min Summer	12.096	0.0	60.3	368
480 min Summer	9.879	0.0	62.3	486
600 min Summer	8.439	0.0	63.7	606
720 min Summer	7.417	0.0	64.7	726
960 min Summer	6.050	0.0	65.9	966
1440 min Summer	4.539	0.0	66.5	1446
2160 min Summer	3.401	0.0	132.6	2164
2880 min Summer	2.768	0.0	133.7	2804
4320 min Summer	2.068	0.0	130.5	3504
5760 min Summer	1.681	0.0	248.5	4272
7200 min Summer	1.431	0.0	247.9	5048
8640 min Summer	1.254	0.0	244.7	5888
10080 min Summer	1.122	0.0	238.1	6760
15 min Winter	92.226	0.0	28.3	23
30 min Winter	63.566	0.0	26.3	38

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.414	0.414	0.3	82.9	O K
120 min Winter	0.518	0.518	0.4	103.7	O K
180 min Winter	0.584	0.584	0.4	116.9	O K
240 min Winter	0.634	0.634	0.4	126.8	O K
360 min Winter	0.707	0.707	0.4	141.4	O K
480 min Winter	0.760	0.760	0.4	152.1	O K
600 min Winter	0.802	0.802	0.4	160.5	O K
720 min Winter	0.837	0.837	0.4	167.4	O K
960 min Winter	0.890	0.890	0.5	178.1	O K
1440 min Winter	0.961	0.961	0.5	192.3	O K
2160 min Winter	1.019	1.019	0.5	203.9	O K
2880 min Winter	1.047	1.047	0.5	209.3	O K
4320 min Winter	1.057	1.057	0.5	211.4	O K
5760 min Winter	1.053	1.053	0.5	210.5	O K
7200 min Winter	1.040	1.040	0.5	208.1	O K
8640 min Winter	1.023	1.023	0.5	204.5	O K
10080 min Winter	1.002	1.002	0.5	200.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.084	0.0	53.9	68
120 min Winter	25.892	0.0	55.2	126
180 min Winter	19.608	0.0	58.2	186
240 min Winter	16.062	0.0	60.5	244
360 min Winter	12.096	0.0	63.7	364
480 min Winter	9.879	0.0	65.7	482
600 min Winter	8.439	0.0	67.1	600
720 min Winter	7.417	0.0	68.1	718
960 min Winter	6.050	0.0	69.3	950
1440 min Winter	4.539	0.0	69.6	1416
2160 min Winter	3.401	0.0	140.2	2100
2880 min Winter	2.768	0.0	141.0	2768
4320 min Winter	2.068	0.0	137.0	3980
5760 min Winter	1.681	0.0	264.9	4496
7200 min Winter	1.431	0.0	264.9	5408
8640 min Winter	1.254	0.0	261.1	6392
10080 min Winter	1.122	0.0	254.0	7264

Model Details

Storage is Online Cover Level (m) 2.060

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	1.060	200.0	1.061	0.0	1.560	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0032-5000-1060-5000
Design Head (m)	1.060
Design Flow (l/s)	0.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	32
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.060	0.5
Flush-Flo™	0.141	0.3
Kick-Flo®	0.284	0.3
Mean Flow over Head Range	-	0.4

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	0.3	1.200	0.5	3.000	0.8	7.000	1.2
0.200	0.3	1.400	0.6	3.500	0.8	7.500	1.2
0.300	0.3	1.600	0.6	4.000	0.9	8.000	1.2
0.400	0.3	1.800	0.6	4.500	0.9	8.500	1.3
0.500	0.4	2.000	0.7	5.000	1.0	9.000	1.3
0.600	0.4	2.200	0.7	5.500	1.0	9.500	1.3
0.800	0.4	2.400	0.7	6.000	1.1		
1.000	0.5	2.600	0.7	6.500	1.1		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.322	0.322	1.1	139.9	O K
30 min Summer	0.443	0.443	1.1	192.5	O K
60 min Summer	0.570	0.570	1.1	247.8	O K
120 min Summer	0.712	0.712	1.1	309.8	O K
180 min Summer	0.803	0.803	1.1	349.2	O K
240 min Summer	0.870	0.870	1.2	378.6	O K
360 min Summer	0.970	0.970	1.2	421.9	O K
480 min Summer	1.043	1.043	1.3	453.5	O K
600 min Summer	1.099	1.099	1.3	478.3	O K
720 min Summer	1.146	1.146	1.3	498.4	O K
960 min Summer	1.217	1.217	1.4	529.6	O K
1440 min Summer	1.311	1.311	1.4	570.2	O K
2160 min Summer	1.383	1.383	1.5	601.6	O K
2880 min Summer	1.412	1.412	1.5	614.3	O K
4320 min Summer	1.427	1.427	1.5	620.6	O K
5760 min Summer	1.424	1.424	1.5	619.3	O K
7200 min Summer	1.412	1.412	1.5	614.3	O K
8640 min Summer	1.396	1.396	1.5	607.4	O K
10080 min Summer	1.378	1.378	1.5	599.6	O K
15 min Winter	0.360	0.360	1.1	156.8	O K
30 min Winter	0.496	0.496	1.1	215.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.226	0.0	93.0	23
30 min Summer	63.566	0.0	90.9	38
60 min Summer	41.084	0.0	176.2	68
120 min Summer	25.892	0.0	172.0	128
180 min Summer	19.608	0.0	174.3	188
240 min Summer	16.062	0.0	180.2	248
360 min Summer	12.096	0.0	190.2	368
480 min Summer	9.879	0.0	196.8	488
600 min Summer	8.439	0.0	201.5	606
720 min Summer	7.417	0.0	204.9	726
960 min Summer	6.050	0.0	209.2	966
1440 min Summer	4.539	0.0	211.7	1446
2160 min Summer	3.401	0.0	423.4	2164
2880 min Summer	2.768	0.0	427.4	2884
4320 min Summer	2.068	0.0	418.4	3592
5760 min Summer	1.681	0.0	798.6	4376
7200 min Summer	1.431	0.0	799.5	5184
8640 min Summer	1.254	0.0	789.3	5968
10080 min Summer	1.122	0.0	768.7	6856
15 min Winter	92.226	0.0	93.5	23
30 min Winter	63.566	0.0	86.6	38

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.639	0.639	1.1	277.8	O K
120 min Winter	0.799	0.799	1.1	347.5	O K
180 min Winter	0.901	0.901	1.2	392.1	O K
240 min Winter	0.978	0.978	1.3	425.4	O K
360 min Winter	1.091	1.091	1.3	474.7	O K
480 min Winter	1.174	1.174	1.4	510.9	O K
600 min Winter	1.240	1.240	1.4	539.4	O K
720 min Winter	1.294	1.294	1.4	562.9	O K
960 min Winter	1.378	1.378	1.5	599.5	O K
1440 min Winter	1.491	1.491	1.5	648.6	O K
2160 min Winter	1.585	1.585	1.6	689.6	O K
2880 min Winter	1.632	1.632	1.6	709.9	O K
4320 min Winter	1.656	1.656	1.6	720.3	O K
5760 min Winter	1.649	1.649	1.6	717.3	O K
7200 min Winter	1.634	1.634	1.6	710.8	O K
8640 min Winter	1.609	1.609	1.6	700.0	O K
10080 min Winter	1.580	1.580	1.6	687.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.084	0.0	173.7	68
120 min Winter	25.892	0.0	174.4	126
180 min Winter	19.608	0.0	183.2	186
240 min Winter	16.062	0.0	190.8	246
360 min Winter	12.096	0.0	201.1	364
480 min Winter	9.879	0.0	207.9	482
600 min Winter	8.439	0.0	212.6	600
720 min Winter	7.417	0.0	216.0	718
960 min Winter	6.050	0.0	220.1	954
1440 min Winter	4.539	0.0	221.8	1416
2160 min Winter	3.401	0.0	447.9	2100
2880 min Winter	2.768	0.0	450.8	2772
4320 min Winter	2.068	0.0	439.0	4024
5760 min Winter	1.681	0.0	853.5	4560
7200 min Winter	1.431	0.0	853.7	5480
8640 min Winter	1.254	0.0	841.7	6400
10080 min Winter	1.122	0.0	819.4	7360

Model Details

Storage is Online Cover Level (m) 2.060

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	435.0	1.675	435.0	1.676	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0053-1600-1675-1600
Design Head (m)	1.675
Design Flow (l/s)	1.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	53
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	1.6
Flush-Flo™	0.233	1.1
Kick-Flo®	0.471	0.9
Mean Flow over Head Range	-	1.2

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	1.0	1.200	1.4	3.000	2.1	7.000	3.1
0.200	1.1	1.400	1.5	3.500	2.2	7.500	3.2
0.300	1.1	1.600	1.6	4.000	2.4	8.000	3.3
0.400	1.0	1.800	1.6	4.500	2.5	8.500	3.4
0.500	0.9	2.000	1.7	5.000	2.6	9.000	3.5
0.600	1.0	2.200	1.8	5.500	2.8	9.500	3.6
0.800	1.1	2.400	1.9	6.000	2.9		
1.000	1.3	2.600	1.9	6.500	3.0		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.210	0.210	1.3	129.3	O K
30 min Summer	0.289	0.289	1.3	177.7	O K
60 min Summer	0.372	0.372	1.3	228.5	O K
120 min Summer	0.464	0.464	1.3	285.5	O K
180 min Summer	0.524	0.524	1.3	322.0	O K
240 min Summer	0.568	0.568	1.3	349.2	O K
360 min Summer	0.632	0.632	1.3	388.9	O K
480 min Summer	0.679	0.679	1.3	417.7	O K
600 min Summer	0.716	0.716	1.3	440.2	O K
720 min Summer	0.745	0.745	1.3	458.3	O K
960 min Summer	0.791	0.791	1.3	486.2	O K
1440 min Summer	0.848	0.848	1.4	521.7	O K
2160 min Summer	0.891	0.891	1.4	548.0	O K
2880 min Summer	0.906	0.906	1.4	557.1	O K
4320 min Summer	0.910	0.910	1.4	559.6	O K
5760 min Summer	0.904	0.904	1.4	555.9	O K
7200 min Summer	0.893	0.893	1.4	549.2	O K
8640 min Summer	0.880	0.880	1.4	541.1	O K
10080 min Summer	0.865	0.865	1.4	532.1	O K
15 min Winter	0.236	0.236	1.3	144.9	O K
30 min Winter	0.324	0.324	1.3	199.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.226	0.0	98.8	23
30 min Summer	63.566	0.0	110.0	38
60 min Summer	41.084	0.0	205.5	68
120 min Summer	25.892	0.0	217.8	128
180 min Summer	19.608	0.0	211.8	188
240 min Summer	16.062	0.0	205.6	248
360 min Summer	12.096	0.0	198.5	368
480 min Summer	9.879	0.0	195.3	488
600 min Summer	8.439	0.0	194.7	606
720 min Summer	7.417	0.0	196.1	726
960 min Summer	6.050	0.0	200.6	966
1440 min Summer	4.539	0.0	204.1	1446
2160 min Summer	3.401	0.0	406.7	2164
2880 min Summer	2.768	0.0	410.2	2860
4320 min Summer	2.068	0.0	404.2	3552
5760 min Summer	1.681	0.0	812.2	4328
7200 min Summer	1.431	0.0	786.8	5120
8640 min Summer	1.254	0.0	759.1	5968
10080 min Summer	1.122	0.0	735.9	6848
15 min Winter	92.226	0.0	104.7	23
30 min Winter	63.566	0.0	111.4	38

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.417	0.417	1.3	256.3	O K
120 min Winter	0.521	0.521	1.3	320.7	O K
180 min Winter	0.588	0.588	1.3	361.8	O K
240 min Winter	0.638	0.638	1.3	392.3	O K
360 min Winter	0.711	0.711	1.3	437.4	O K
480 min Winter	0.765	0.765	1.3	470.4	O K
600 min Winter	0.807	0.807	1.3	496.3	O K
720 min Winter	0.841	0.841	1.3	517.4	O K
960 min Winter	0.895	0.895	1.4	550.1	O K
1440 min Winter	0.965	0.965	1.4	593.4	O K
2160 min Winter	1.021	1.021	1.5	628.2	O K
2880 min Winter	1.047	1.047	1.5	644.1	O K
4320 min Winter	1.055	1.055	1.5	648.6	O K
5760 min Winter	1.045	1.045	1.5	642.4	O K
7200 min Winter	1.029	1.029	1.5	633.1	O K
8640 min Winter	1.009	1.009	1.5	620.4	O K
10080 min Winter	0.985	0.985	1.4	605.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.084	0.0	216.4	68
120 min Winter	25.892	0.0	213.4	126
180 min Winter	19.608	0.0	205.2	186
240 min Winter	16.062	0.0	200.7	246
360 min Winter	12.096	0.0	197.5	364
480 min Winter	9.879	0.0	199.1	482
600 min Winter	8.439	0.0	203.5	600
720 min Winter	7.417	0.0	207.0	718
960 min Winter	6.050	0.0	211.5	950
1440 min Winter	4.539	0.0	214.5	1416
2160 min Winter	3.401	0.0	429.2	2100
2880 min Winter	2.768	0.0	433.7	2768
4320 min Winter	2.068	0.0	426.1	4020
5760 min Winter	1.681	0.0	839.0	4552
7200 min Winter	1.431	0.0	821.0	5472
8640 min Winter	1.254	0.0	807.5	6400
10080 min Winter	1.122	0.0	789.0	7360

Model Details

Storage is Online Cover Level (m) 2.060

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	615.0	1.060	615.0	1.061	0.0	1.560	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0057-1500-1060-1500
Design Head (m)	1.060
Design Flow (l/s)	1.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	57
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.060	1.5
Flush-Flo™	0.251	1.3
Kick-Flo®	0.508	1.1
Mean Flow over Head Range	-	1.2

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	1.2	1.200	1.6	3.000	2.4	7.000	3.6
0.200	1.3	1.400	1.7	3.500	2.6	7.500	3.7
0.300	1.3	1.600	1.8	4.000	2.7	8.000	3.8
0.400	1.3	1.800	1.9	4.500	2.9	8.500	3.9
0.500	1.1	2.000	2.0	5.000	3.0	9.000	4.0
0.600	1.2	2.200	2.1	5.500	3.2	9.500	4.1
0.800	1.3	2.400	2.2	6.000	3.3		
1.000	1.5	2.600	2.3	6.500	3.4		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.330	0.330	2.6	272.6	O K
30 min Summer	0.454	0.454	2.6	375.0	O K
60 min Summer	0.585	0.585	2.6	482.5	O K
120 min Summer	0.732	0.732	2.6	603.6	O K
180 min Summer	0.825	0.825	2.6	680.4	O K
240 min Summer	0.894	0.894	2.6	737.5	O K
360 min Summer	0.995	0.995	2.6	821.1	O K
480 min Summer	1.069	1.069	2.6	881.8	O K
600 min Summer	1.126	1.126	2.7	929.1	O K
720 min Summer	1.173	1.173	2.7	967.4	O K
960 min Summer	1.244	1.244	2.8	1026.1	O K
1440 min Summer	1.335	1.335	2.9	1101.1	O K
2160 min Summer	1.402	1.402	2.9	1156.3	O K
2880 min Summer	1.425	1.425	3.0	1175.6	O K
4320 min Summer	1.432	1.432	3.0	1181.6	O K
5760 min Summer	1.423	1.423	3.0	1174.1	O K
7200 min Summer	1.407	1.407	3.0	1160.7	O K
8640 min Summer	1.387	1.387	2.9	1144.4	O K
10080 min Summer	1.365	1.365	2.9	1126.4	O K
15 min Winter	0.370	0.370	2.6	305.5	O K
30 min Winter	0.510	0.510	2.6	420.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.226	0.0	207.8	27
30 min Summer	63.566	0.0	221.6	42
60 min Summer	41.084	0.0	425.5	72
120 min Summer	25.892	0.0	419.5	132
180 min Summer	19.608	0.0	405.2	190
240 min Summer	16.062	0.0	397.4	250
360 min Summer	12.096	0.0	392.9	370
480 min Summer	9.879	0.0	398.0	490
600 min Summer	8.439	0.0	407.7	608
720 min Summer	7.417	0.0	415.2	728
960 min Summer	6.050	0.0	425.2	968
1440 min Summer	4.539	0.0	432.7	1446
2160 min Summer	3.401	0.0	857.9	2164
2880 min Summer	2.768	0.0	869.3	2860
4320 min Summer	2.068	0.0	856.4	3552
5760 min Summer	1.681	0.0	1676.2	4328
7200 min Summer	1.431	0.0	1632.8	5120
8640 min Summer	1.254	0.0	1594.0	5968
10080 min Summer	1.122	0.0	1555.9	6768
15 min Winter	92.226	0.0	215.5	27
30 min Winter	63.566	0.0	221.9	41

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.656	0.656	2.6	541.3	O K
120 min Winter	0.821	0.821	2.6	677.4	O K
180 min Winter	0.926	0.926	2.6	764.0	O K
240 min Winter	1.004	1.004	2.6	828.6	O K
360 min Winter	1.120	1.120	2.7	923.8	O K
480 min Winter	1.204	1.204	2.7	993.4	O K
600 min Winter	1.270	1.270	2.8	1048.1	O K
720 min Winter	1.325	1.325	2.9	1092.7	O K
960 min Winter	1.408	1.408	3.0	1162.0	O K
1440 min Winter	1.519	1.519	3.1	1253.4	O K
2160 min Winter	1.609	1.609	3.1	1327.0	O K
2880 min Winter	1.649	1.649	3.2	1360.7	O K
4320 min Winter	1.661	1.661	3.2	1370.6	O K
5760 min Winter	1.648	1.648	3.2	1359.2	O K
7200 min Winter	1.625	1.625	3.2	1340.5	O K
8640 min Winter	1.594	1.594	3.1	1314.8	O K
10080 min Winter	1.558	1.558	3.1	1285.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.084	0.0	431.0	70
120 min Winter	25.892	0.0	408.2	130
180 min Winter	19.608	0.0	398.2	188
240 min Winter	16.062	0.0	396.2	248
360 min Winter	12.096	0.0	406.4	366
480 min Winter	9.879	0.0	420.9	484
600 min Winter	8.439	0.0	431.2	600
720 min Winter	7.417	0.0	438.7	718
960 min Winter	6.050	0.0	448.3	952
1440 min Winter	4.539	0.0	454.4	1418
2160 min Winter	3.401	0.0	909.5	2100
2880 min Winter	2.768	0.0	919.0	2772
4320 min Winter	2.068	0.0	901.4	3988
5760 min Winter	1.681	0.0	1742.8	4512
7200 min Winter	1.431	0.0	1726.4	5472
8640 min Winter	1.254	0.0	1707.2	6400
10080 min Winter	1.122	0.0	1666.5	7360

Model Details

Storage is Online Cover Level (m) 2.060

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	825.0	1.675	825.0	1.676	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0076-3200-1675-3200
Design Head (m)	1.675
Design Flow (l/s)	3.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	76
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	3.2
Flush-Flo™	0.335	2.6
Kick-Flo®	0.679	2.1
Mean Flow over Head Range	-	2.5

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	2.1	1.200	2.7	3.000	4.2	7.000	6.2
0.200	2.5	1.400	2.9	3.500	4.5	7.500	6.4
0.300	2.6	1.600	3.1	4.000	4.8	8.000	6.6
0.400	2.6	1.800	3.3	4.500	5.1	8.500	6.8
0.500	2.5	2.000	3.5	5.000	5.3	9.000	7.0
0.600	2.4	2.200	3.6	5.500	5.6	9.500	7.2
0.800	2.3	2.400	3.8	6.000	5.8		
1.000	2.5	2.600	3.9	6.500	6.0		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.330	0.330	1.2	143.7	O K
30 min Summer	0.454	0.454	1.2	197.6	O K
60 min Summer	0.585	0.585	1.2	254.4	O K
120 min Summer	0.731	0.731	1.2	317.9	O K
180 min Summer	0.823	0.823	1.2	358.2	O K
240 min Summer	0.892	0.892	1.3	388.2	O K
360 min Summer	0.994	0.994	1.3	432.3	O K
480 min Summer	1.068	1.068	1.4	464.4	O K
600 min Summer	1.125	1.125	1.4	489.4	O K
720 min Summer	1.172	1.172	1.4	509.7	O K
960 min Summer	1.244	1.244	1.5	541.0	O K
1440 min Summer	1.336	1.336	1.5	581.1	O K
2160 min Summer	1.405	1.405	1.6	611.1	O K
2880 min Summer	1.430	1.430	1.6	622.1	O K
4320 min Summer	1.442	1.442	1.6	627.3	O K
5760 min Summer	1.436	1.436	1.6	624.8	O K
7200 min Summer	1.423	1.423	1.6	618.8	O K
8640 min Summer	1.405	1.405	1.6	611.0	O K
10080 min Summer	1.385	1.385	1.6	602.4	O K
15 min Winter	0.370	0.370	1.2	161.0	O K
30 min Winter	0.509	0.509	1.2	221.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.226	0.0	100.1	23
30 min Summer	63.566	0.0	98.5	38
60 min Summer	41.084	0.0	190.7	68
120 min Summer	25.892	0.0	186.1	128
180 min Summer	19.608	0.0	187.5	188
240 min Summer	16.062	0.0	192.4	248
360 min Summer	12.096	0.0	203.2	368
480 min Summer	9.879	0.0	210.4	486
600 min Summer	8.439	0.0	215.4	606
720 min Summer	7.417	0.0	219.2	726
960 min Summer	6.050	0.0	223.9	966
1440 min Summer	4.539	0.0	226.8	1446
2160 min Summer	3.401	0.0	451.2	2164
2880 min Summer	2.768	0.0	455.9	2856
4320 min Summer	2.068	0.0	446.7	3544
5760 min Summer	1.681	0.0	849.0	4320
7200 min Summer	1.431	0.0	845.7	5112
8640 min Summer	1.254	0.0	835.7	5960
10080 min Summer	1.122	0.0	814.2	6760
15 min Winter	92.226	0.0	100.9	23
30 min Winter	63.566	0.0	94.1	38

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.656	0.656	1.2	285.1	O K
120 min Winter	0.820	0.820	1.2	356.6	O K
180 min Winter	0.925	0.925	1.3	402.2	O K
240 min Winter	1.003	1.003	1.3	436.2	O K
360 min Winter	1.118	1.118	1.4	486.4	O K
480 min Winter	1.203	1.203	1.5	523.3	O K
600 min Winter	1.269	1.269	1.5	552.2	O K
720 min Winter	1.324	1.324	1.5	575.9	O K
960 min Winter	1.408	1.408	1.6	612.7	O K
1440 min Winter	1.521	1.521	1.6	661.6	O K
2160 min Winter	1.613	1.613	1.7	701.5	O K
2880 min Winter	1.656	1.656	1.7	720.3	O K
4320 min Winter	1.672	1.672	1.7	727.5	O K
5760 min Winter	1.664	1.664	1.7	723.8	O K
7200 min Winter	1.645	1.645	1.7	715.4	O K
8640 min Winter	1.616	1.616	1.7	702.9	O K
10080 min Winter	1.583	1.583	1.7	688.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.084	0.0	188.2	68
120 min Winter	25.892	0.0	187.8	126
180 min Winter	19.608	0.0	195.6	186
240 min Winter	16.062	0.0	203.9	246
360 min Winter	12.096	0.0	215.0	364
480 min Winter	9.879	0.0	222.4	482
600 min Winter	8.439	0.0	227.5	600
720 min Winter	7.417	0.0	231.1	718
960 min Winter	6.050	0.0	235.6	950
1440 min Winter	4.539	0.0	237.7	1416
2160 min Winter	3.401	0.0	477.8	2100
2880 min Winter	2.768	0.0	481.3	2768
4320 min Winter	2.068	0.0	469.1	3980
5760 min Winter	1.681	0.0	903.2	4504
7200 min Winter	1.431	0.0	904.8	5472
8640 min Winter	1.254	0.0	892.9	6392
10080 min Winter	1.122	0.0	869.5	7272

Model Details

Storage is Online Cover Level (m) 2.060

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	435.0	1.675	435.0	1.676	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0054-1700-1675-1700
Design Head (m)	1.675
Design Flow (l/s)	1.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	54
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	1.7
Flush-Flo™	0.241	1.2
Kick-Flo®	0.488	1.0
Mean Flow over Head Range	-	1.3

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	1.1	1.200	1.5	3.000	2.2	7.000	3.3
0.200	1.2	1.400	1.6	3.500	2.4	7.500	3.4
0.300	1.2	1.600	1.7	4.000	2.5	8.000	3.5
0.400	1.1	1.800	1.8	4.500	2.7	8.500	3.6
0.500	1.0	2.000	1.8	5.000	2.8	9.000	3.7
0.600	1.1	2.200	1.9	5.500	2.9	9.500	3.8
0.800	1.2	2.400	2.0	6.000	3.1		
1.000	1.3	2.600	2.1	6.500	3.2		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.329	0.329	1.7	195.7	O K
30 min Summer	0.452	0.452	1.7	269.2	O K
60 min Summer	0.583	0.583	1.7	346.7	O K
120 min Summer	0.729	0.729	1.7	433.5	O K
180 min Summer	0.821	0.821	1.7	488.6	O K
240 min Summer	0.890	0.890	1.7	529.6	O K
360 min Summer	0.991	0.991	1.8	589.7	O K
480 min Summer	1.065	1.065	1.9	633.5	O K
600 min Summer	1.122	1.122	1.9	667.5	O K
720 min Summer	1.168	1.168	2.0	695.2	O K
960 min Summer	1.240	1.240	2.0	737.6	O K
1440 min Summer	1.331	1.331	2.1	792.1	O K
2160 min Summer	1.399	1.399	2.1	832.6	O K
2880 min Summer	1.424	1.424	2.1	847.2	O K
4320 min Summer	1.434	1.434	2.1	853.0	O K
5760 min Summer	1.426	1.426	2.1	848.7	O K
7200 min Summer	1.412	1.412	2.1	840.0	O K
8640 min Summer	1.393	1.393	2.1	828.9	O K
10080 min Summer	1.373	1.373	2.1	816.8	O K
15 min Winter	0.369	0.369	1.7	219.3	O K
30 min Winter	0.507	0.507	1.7	301.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.226	0.0	143.7	26
30 min Summer	63.566	0.0	147.2	41
60 min Summer	41.084	0.0	283.5	70
120 min Summer	25.892	0.0	271.4	130
180 min Summer	19.608	0.0	266.7	188
240 min Summer	16.062	0.0	266.7	248
360 min Summer	12.096	0.0	275.3	368
480 min Summer	9.879	0.0	285.2	488
600 min Summer	8.439	0.0	292.3	608
720 min Summer	7.417	0.0	297.5	726
960 min Summer	6.050	0.0	304.3	966
1440 min Summer	4.539	0.0	309.0	1446
2160 min Summer	3.401	0.0	613.8	2164
2880 min Summer	2.768	0.0	621.1	2860
4320 min Summer	2.068	0.0	610.3	3548
5760 min Summer	1.681	0.0	1171.7	4320
7200 min Summer	1.431	0.0	1153.5	5120
8640 min Summer	1.254	0.0	1139.3	5960
10080 min Summer	1.122	0.0	1110.9	6768
15 min Winter	92.226	0.0	146.7	26
30 min Winter	63.566	0.0	144.9	41

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.654	0.654	1.7	388.9	O K
120 min Winter	0.818	0.818	1.7	486.5	O K
180 min Winter	0.922	0.922	1.8	548.6	O K
240 min Winter	1.000	1.000	1.8	595.1	O K
360 min Winter	1.115	1.115	1.9	663.6	O K
480 min Winter	1.200	1.200	2.0	713.7	O K
600 min Winter	1.266	1.266	2.0	753.2	O K
720 min Winter	1.320	1.320	2.1	785.3	O K
960 min Winter	1.404	1.404	2.1	835.4	O K
1440 min Winter	1.516	1.516	2.2	901.8	O K
2160 min Winter	1.606	1.606	2.3	955.7	O K
2880 min Winter	1.649	1.649	2.3	980.9	O K
4320 min Winter	1.663	1.663	2.3	989.7	O K
5760 min Winter	1.652	1.652	2.3	983.2	O K
7200 min Winter	1.632	1.632	2.3	971.0	O K
8640 min Winter	1.603	1.603	2.3	953.6	O K
10080 min Winter	1.569	1.569	2.2	933.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.084	0.0	278.6	70
120 min Winter	25.892	0.0	268.1	128
180 min Winter	19.608	0.0	269.0	186
240 min Winter	16.062	0.0	276.1	246
360 min Winter	12.096	0.0	291.5	364
480 min Winter	9.879	0.0	301.6	482
600 min Winter	8.439	0.0	308.8	600
720 min Winter	7.417	0.0	314.0	718
960 min Winter	6.050	0.0	320.5	952
1440 min Winter	4.539	0.0	324.0	1416
2160 min Winter	3.401	0.0	650.2	2100
2880 min Winter	2.768	0.0	655.9	2768
4320 min Winter	2.068	0.0	641.3	3984
5760 min Winter	1.681	0.0	1231.7	4504
7200 min Winter	1.431	0.0	1233.4	5472
8640 min Winter	1.254	0.0	1218.3	6400
10080 min Winter	1.122	0.0	1187.7	7360

Model Details

Storage is Online Cover Level (m) 2.060

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	595.0	1.675	595.0	1.676	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0064-2300-1675-2300
Design Head (m)	1.675
Design Flow (l/s)	2.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	2.3
Flush-Flo™	0.278	1.7
Kick-Flo®	0.570	1.4
Mean Flow over Head Range	-	1.8

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	1.5	1.200	2.0	3.000	3.0	7.000	4.5
0.200	1.7	1.400	2.1	3.500	3.2	7.500	4.6
0.300	1.7	1.600	2.3	4.000	3.4	8.000	4.8
0.400	1.7	1.800	2.4	4.500	3.6	8.500	4.9
0.500	1.6	2.000	2.5	5.000	3.8	9.000	5.0
0.600	1.4	2.200	2.6	5.500	4.0	9.500	5.2
0.800	1.6	2.400	2.7	6.000	4.2		
1.000	1.8	2.600	2.8	6.500	4.3		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.211	0.211	1.2	120.0	O K
30 min Summer	0.289	0.289	1.2	165.0	O K
60 min Summer	0.372	0.372	1.2	212.2	O K
120 min Summer	0.465	0.465	1.2	265.1	O K
180 min Summer	0.525	0.525	1.2	299.0	O K
240 min Summer	0.569	0.569	1.2	324.2	O K
360 min Summer	0.633	0.633	1.2	361.0	O K
480 min Summer	0.680	0.680	1.2	387.7	O K
600 min Summer	0.717	0.717	1.2	408.5	O K
720 min Summer	0.746	0.746	1.2	425.3	O K
960 min Summer	0.791	0.791	1.2	451.0	O K
1440 min Summer	0.849	0.849	1.3	483.9	O K
2160 min Summer	0.891	0.891	1.3	508.1	O K
2880 min Summer	0.906	0.906	1.3	516.4	O K
4320 min Summer	0.910	0.910	1.3	518.7	O K
5760 min Summer	0.904	0.904	1.3	515.2	O K
7200 min Summer	0.893	0.893	1.3	509.1	O K
8640 min Summer	0.880	0.880	1.3	501.6	O K
10080 min Summer	0.865	0.865	1.3	493.3	O K
15 min Winter	0.236	0.236	1.2	134.5	O K
30 min Winter	0.324	0.324	1.2	184.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.226	0.0	91.9	23
30 min Summer	63.566	0.0	101.6	38
60 min Summer	41.084	0.0	190.6	68
120 min Summer	25.892	0.0	199.8	128
180 min Summer	19.608	0.0	193.2	188
240 min Summer	16.062	0.0	187.9	248
360 min Summer	12.096	0.0	182.3	368
480 min Summer	9.879	0.0	180.3	488
600 min Summer	8.439	0.0	180.7	606
720 min Summer	7.417	0.0	183.0	726
960 min Summer	6.050	0.0	187.3	966
1440 min Summer	4.539	0.0	190.5	1446
2160 min Summer	3.401	0.0	378.6	2164
2880 min Summer	2.768	0.0	382.7	2860
4320 min Summer	2.068	0.0	377.0	3548
5760 min Summer	1.681	0.0	753.4	4320
7200 min Summer	1.431	0.0	730.5	5120
8640 min Summer	1.254	0.0	705.8	5968
10080 min Summer	1.122	0.0	685.6	6768
15 min Winter	92.226	0.0	97.2	23
30 min Winter	63.566	0.0	102.7	38

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.417	0.417	1.2	237.9	O K
120 min Winter	0.522	0.522	1.2	297.7	O K
180 min Winter	0.589	0.589	1.2	335.8	O K
240 min Winter	0.639	0.639	1.2	364.2	O K
360 min Winter	0.712	0.712	1.2	406.0	O K
480 min Winter	0.766	0.766	1.2	436.6	O K
600 min Winter	0.808	0.808	1.2	460.6	O K
720 min Winter	0.842	0.842	1.3	480.1	O K
960 min Winter	0.896	0.896	1.3	510.5	O K
1440 min Winter	0.966	0.966	1.3	550.5	O K
2160 min Winter	1.022	1.022	1.4	582.7	O K
2880 min Winter	1.048	1.048	1.4	597.3	O K
4320 min Winter	1.055	1.055	1.4	601.2	O K
5760 min Winter	1.045	1.045	1.4	595.6	O K
7200 min Winter	1.030	1.030	1.4	587.0	O K
8640 min Winter	1.009	1.009	1.4	575.2	O K
10080 min Winter	0.986	0.986	1.4	561.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.084	0.0	199.8	68
120 min Winter	25.892	0.0	194.7	126
180 min Winter	19.608	0.0	187.8	186
240 min Winter	16.062	0.0	184.3	246
360 min Winter	12.096	0.0	182.6	364
480 min Winter	9.879	0.0	185.6	482
600 min Winter	8.439	0.0	190.1	600
720 min Winter	7.417	0.0	193.3	718
960 min Winter	6.050	0.0	197.5	950
1440 min Winter	4.539	0.0	200.2	1416
2160 min Winter	3.401	0.0	400.4	2100
2880 min Winter	2.768	0.0	404.6	2768
4320 min Winter	2.068	0.0	397.2	4020
5760 min Winter	1.681	0.0	779.2	4552
7200 min Winter	1.431	0.0	763.7	5472
8640 min Winter	1.254	0.0	752.4	6400
10080 min Winter	1.122	0.0	734.9	7360

Model Details

Storage is Online Cover Level (m) 2.060

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	570.0	1.060	570.0	1.061	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0055-1400-1060-1400
Design Head (m)	1.060
Design Flow (l/s)	1.4
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	55
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.060	1.4
Flush-Flo™	0.241	1.2
Kick-Flo®	0.490	1.0
Mean Flow over Head Range	-	1.1

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	1.1	1.200	1.5	3.000	2.2	7.000	3.3
0.200	1.2	1.400	1.6	3.500	2.4	7.500	3.4
0.300	1.2	1.600	1.7	4.000	2.6	8.000	3.5
0.400	1.1	1.800	1.8	4.500	2.7	8.500	3.6
0.500	1.0	2.000	1.9	5.000	2.8	9.000	3.7
0.600	1.1	2.200	1.9	5.500	3.0	9.500	3.8
0.800	1.2	2.400	2.0	6.000	3.1		
1.000	1.4	2.600	2.1	6.500	3.2		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	0.323	0.323	1.5	174.3	O K
30 min Summer	0.444	0.444	1.5	239.8	O K
60 min Summer	0.572	0.572	1.5	308.8	O K
120 min Summer	0.715	0.715	1.5	386.1	O K
180 min Summer	0.806	0.806	1.5	435.3	O K
240 min Summer	0.874	0.874	1.5	471.9	O K
360 min Summer	0.974	0.974	1.6	525.7	O K
480 min Summer	1.046	1.046	1.6	565.0	O K
600 min Summer	1.103	1.103	1.7	595.7	O K
720 min Summer	1.149	1.149	1.7	620.6	O K
960 min Summer	1.221	1.221	1.7	659.2	O K
1440 min Summer	1.313	1.313	1.8	709.1	O K
2160 min Summer	1.384	1.384	1.8	747.4	O K
2880 min Summer	1.412	1.412	1.8	762.4	O K
4320 min Summer	1.424	1.424	1.9	769.2	O K
5760 min Summer	1.420	1.420	1.9	766.7	O K
7200 min Summer	1.407	1.407	1.8	759.9	O K
8640 min Summer	1.390	1.390	1.8	750.9	O K
10080 min Summer	1.372	1.372	1.8	740.7	O K
15 min Winter	0.362	0.362	1.5	195.3	O K
30 min Winter	0.498	0.498	1.5	268.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	92.226	0.0	121.5	23
30 min Summer	63.566	0.0	122.7	38
60 min Summer	41.084	0.0	236.2	68
120 min Summer	25.892	0.0	226.7	128
180 min Summer	19.608	0.0	224.9	188
240 min Summer	16.062	0.0	227.3	248
360 min Summer	12.096	0.0	238.3	368
480 min Summer	9.879	0.0	246.7	488
600 min Summer	8.439	0.0	252.7	606
720 min Summer	7.417	0.0	257.1	726
960 min Summer	6.050	0.0	262.8	966
1440 min Summer	4.539	0.0	266.4	1446
2160 min Summer	3.401	0.0	531.7	2164
2880 min Summer	2.768	0.0	537.3	2884
4320 min Summer	2.068	0.0	527.0	3592
5760 min Summer	1.681	0.0	1009.0	4328
7200 min Summer	1.431	0.0	1003.1	5128
8640 min Summer	1.254	0.0	991.0	5968
10080 min Summer	1.122	0.0	965.7	6856
15 min Winter	92.226	0.0	123.4	23
30 min Winter	63.566	0.0	119.8	38

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	0.641	0.641	1.5	346.3	O K
120 min Winter	0.802	0.802	1.5	433.2	O K
180 min Winter	0.905	0.905	1.5	488.7	O K
240 min Winter	0.982	0.982	1.6	530.1	O K
360 min Winter	1.095	1.095	1.6	591.4	O K
480 min Winter	1.179	1.179	1.7	636.4	O K
600 min Winter	1.244	1.244	1.7	671.9	O K
720 min Winter	1.298	1.298	1.8	700.9	O K
960 min Winter	1.382	1.382	1.8	746.2	O K
1440 min Winter	1.494	1.494	1.9	806.8	O K
2160 min Winter	1.587	1.587	1.9	857.0	O K
2880 min Winter	1.632	1.632	2.0	881.5	O K
4320 min Winter	1.653	1.653	2.0	892.9	O K
5760 min Winter	1.645	1.645	2.0	888.1	O K
7200 min Winter	1.628	1.628	2.0	879.0	O K
8640 min Winter	1.602	1.602	2.0	864.9	O K
10080 min Winter	1.571	1.571	1.9	848.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	41.084	0.0	231.7	68
120 min Winter	25.892	0.0	225.8	126
180 min Winter	19.608	0.0	230.1	186
240 min Winter	16.062	0.0	239.1	246
360 min Winter	12.096	0.0	252.2	364
480 min Winter	9.879	0.0	260.8	482
600 min Winter	8.439	0.0	266.9	600
720 min Winter	7.417	0.0	271.2	718
960 min Winter	6.050	0.0	276.6	954
1440 min Winter	4.539	0.0	279.3	1416
2160 min Winter	3.401	0.0	562.7	2100
2880 min Winter	2.768	0.0	567.0	2772
4320 min Winter	2.068	0.0	553.4	4024
5760 min Winter	1.681	0.0	1070.8	4552
7200 min Winter	1.431	0.0	1072.0	5480
8640 min Winter	1.254	0.0	1057.8	6400
10080 min Winter	1.122	0.0	1030.6	7360

Model Details

Storage is Online Cover Level (m) 2.060

Tank or Pond Structure

Invert Level (m) 0.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	540.0	1.675	540.0	1.676	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0059-2000-1675-2000
Design Head (m)	1.675
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	59
Invert Level (m)	0.000
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	2.0
Flush-Flo™	0.264	1.5
Kick-Flo®	0.531	1.2
Mean Flow over Head Range	-	1.5

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	1.3	1.200	1.7	3.000	2.6	7.000	3.9
0.200	1.4	1.400	1.8	3.500	2.8	7.500	4.0
0.300	1.5	1.600	2.0	4.000	3.0	8.000	4.1
0.400	1.4	1.800	2.1	4.500	3.2	8.500	4.2
0.500	1.3	2.000	2.2	5.000	3.3	9.000	4.4
0.600	1.3	2.200	2.3	5.500	3.5	9.500	4.5
0.800	1.4	2.400	2.4	6.000	3.6		
1.000	1.6	2.600	2.4	6.500	3.7		

CAFE UNIT ATTENUATION SIZING

User Inputs

Chamber Model:	SC-740
Outlet Control Structure:	Yes
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	47.70 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	152 mm.
Stone Above Chambers:	152 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(6.00 m. x 25.50 m.)

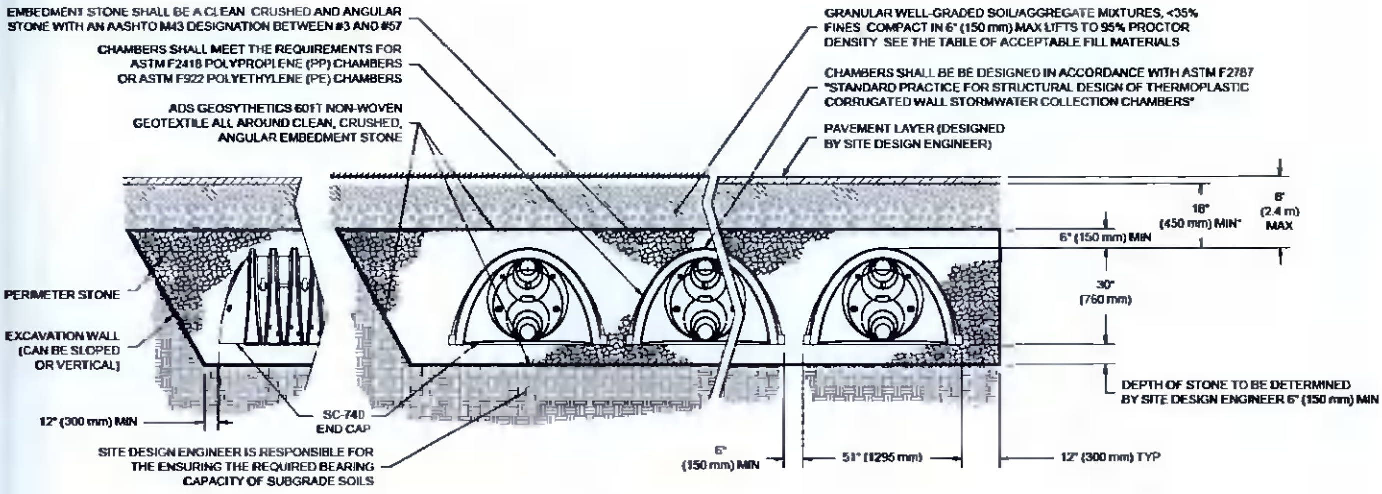
Results

System Volume and Bed Size

Installed Storage Volume:	51.79 cubic meters.
Storage Volume Per Chamber:	1.30 cubic meters.
Number of Chambers Required:	20
Number of End Caps Required:	4
Chamber Rows:	2
Maximum Length:	23.99 m.
Maximum Width:	3.54 m.
Approx. Bed Size Required:	84.81 square meters.

System Components

Amount Of Stone Required:	64.48 cubic meters
Volume of Excavation (Not Including Fill):	90.47 cubic meters
Non-woven Geotextile Required (excluding Isolator Row):	327.72 square meters
Non-woven Geotextile Required (Isolator Row):	77.62 square meters
Total Non-woven Geotextile Required:	405.33 square meters
Woven Geotextile Required (excluding Isolator Row):	7.92 square meters
Woven Geotextile Required (Isolator Row):	48.51 square meters
Total Woven Geotextile Required:	56.43 square meters



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

ROADS CATCHMENT
ATTENUATION SIZING

User Inputs

Chamber Model:	MC-3500
Outlet Control Structure:	No
Project Name:	210175 Calmount Rd,
Engineer:	Sai Janapareddy
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	426.00 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(9.00 m. x 52.00 m.)

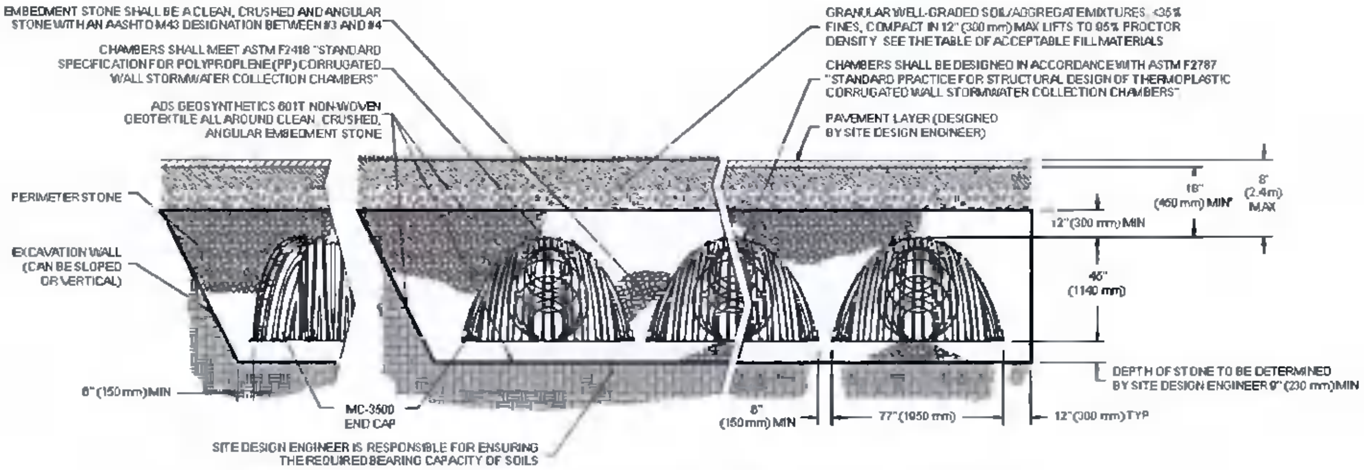
Results

System Volume and Bed Size

Installed Storage Volume:	435.42 cubic meters.
Storage Volume Per Chamber:	3.11 cubic meters.
Number of Chambers Required:	81
Number of End Caps Required:	8
Chamber Rows:	4
Maximum Length:	48.88 m.
Maximum Width:	8.89 m.
Approx. Bed Size Required:	420.77 square meters.

System Components

Amount Of Stone Required:	449.91 cubic meters
Volume of Excavation (Not Including Fill):	705.35 cubic meters
Total Non-woven Geotextile Required:	1485.77 square meters
Woven Geotextile Required (excluding Isolator Row):	50.19 square meters
Woven Geotextile Required (Isolator Row):	179.96 square meters
Total Woven Geotextile Required:	230.15 square meters



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

UNIT 1 ATTENUATION SIZING

ADS

User Inputs

Chamber Model:	SC-740
Outlet Control Structure:	Yes
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	321.18 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	152 mm.
Stone Above Chambers:	152 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(13.00 m. x 41.00 m.)

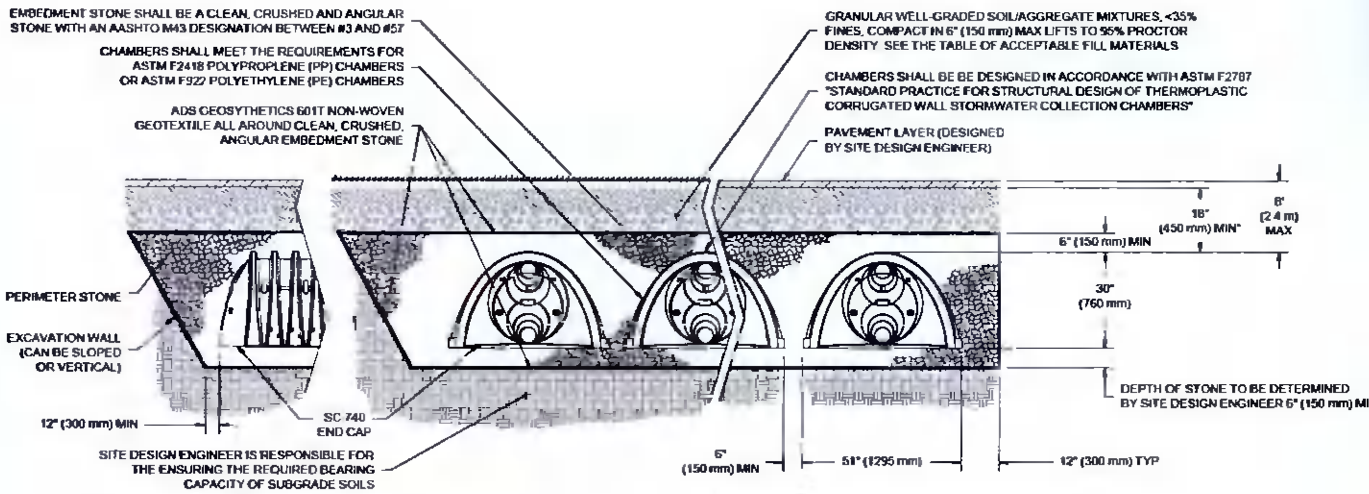
Results

System Volume and Bed Size

Installed Storage Volume:	327.32 cubic meters.
Storage Volume Per Chamber:	1.30 cubic meters.
Number of Chambers Required:	144
Number of End Caps Required:	16
Chamber Rows:	8
Maximum Length:	41.45 m.
Maximum Width:	12.22 m.
Approx. Bed Size Required:	503.90 square meters.

System Components

Amount Of Stone Required:	350.39 cubic meters
Volume of Excavation (Not Including Fill):	537.55 cubic meters
Non-woven Geotextile Required (excluding Isolator Row):	1610.76 square meters
Non-woven Geotextile Required (Isolator Row):	138.35 square meters
Total Non-woven Geotextile Required:	1749.1 square meters
Woven Geotextile Required (excluding Isolator Row):	47.5 square meters
Woven Geotextile Required (Isolator Row):	86.47 square meters
Total Woven Geotextile Required:	133.97 square meters



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

UNIT 2 ATTENUATION SIZING

//ADS

User Inputs

Chamber Model:	MC-3500
Outlet Control Structure:	Yes
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	695.13 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(33.00 m. x 57.00 m.)

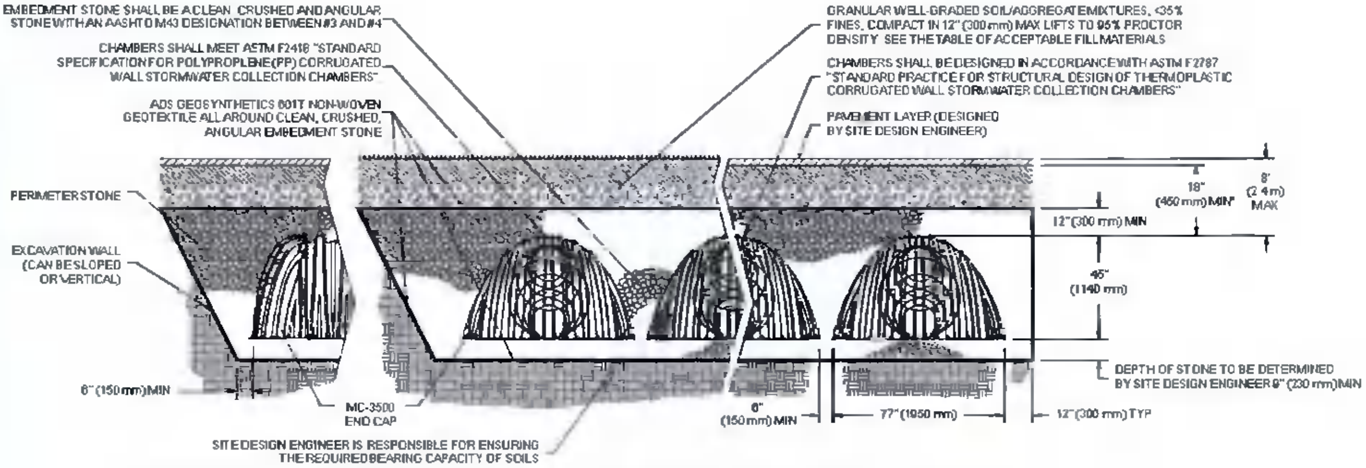
Results

System Volume and Bed Size

Installed Storage Volume:	714.62 cubic meters.
Storage Volume Per Chamber:	3.11 cubic meters.
Number of Chambers Required:	133
Number of End Caps Required:	12
Chamber Rows:	6
Maximum Length:	53.36 m.
Maximum Width:	13.29 m.
Approx. Bed Size Required:	690.83 square meters.

System Components

Amount Of Stone Required:	739.13 cubic meters
Volume of Excavation (Not Including Fill):	1158.08 cubic meters
Total Non-woven Geotextile Required:	2309.74 square meters
Woven Geotextile Required (excluding Isolator Row):	83.65 square meters
Woven Geotextile Required (Isolator Row):	196.68 square meters
Total Woven Geotextile Required:	280.33 square meters



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

UNIT 3 ATTENUATION SIZING

User Inputs

Chamber Model:	MC-3500
Outlet Control Structure:	No
Project Name:	210175 Calmount Rd,
Engineer:	Sai Janapareddy
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	501.00 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(9.00 m. x 60.00 m.)

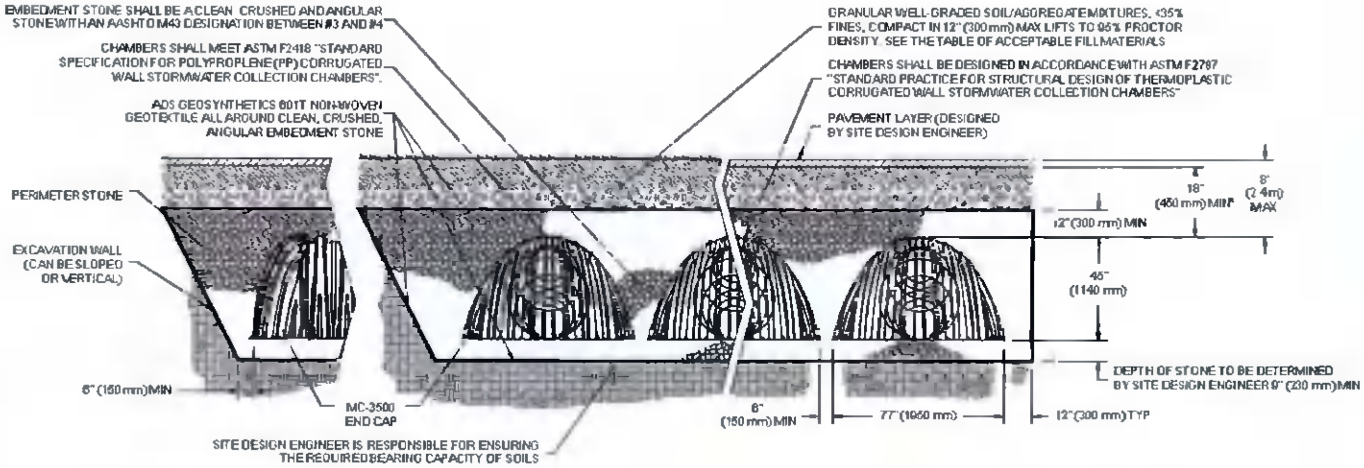
Results

System Volume and Bed Size

Installed Storage Volume:	511.75 cubic meters.
Storage Volume Per Chamber:	3.11 cubic meters.
Number of Chambers Required:	96
Number of End Caps Required:	8
Chamber Rows:	4
Maximum Length:	55.44 m.
Maximum Width:	8.89 m.
Approx. Bed Size Required:	492.84 square meters.

System Components

Amount Of Stone Required:	524.05 cubic meters
Volume of Excavation (Not Including Fill):	826.17 cubic meters
Total Non-woven Geotextile Required:	1724.18 square meters
Woven Geotextile Required (excluding Isolator Row):	50.19 square meters
Woven Geotextile Required (Isolator Row):	205.04 square meters
Total Woven Geotextile Required:	255.23 square meters



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

UNIT 4 ATTENUATION SIZING

ADS

User Inputs

Chamber Model:	MC-3500
Outlet Control Structure:	No
Project Name:	210175 Calmount Rd,
Engineer:	Sai Janapareddy
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	451.00 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(9.00 m. x 52.00 m.)

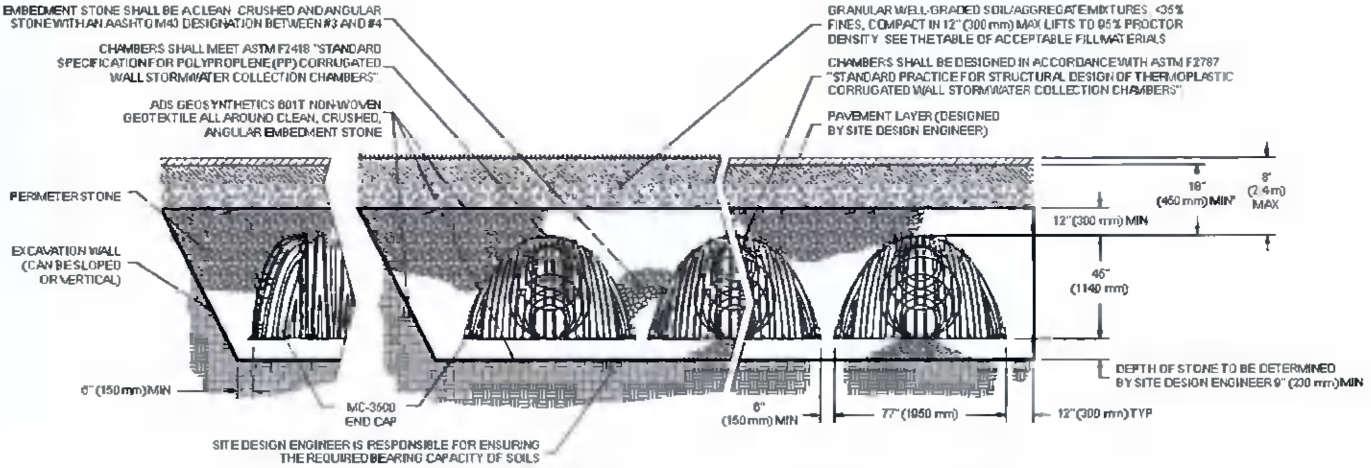
Results

System Volume and Bed Size

Installed Storage Volume:	460.86 cubic meters.
Storage Volume Per Chamber:	3.11 cubic meters.
Number of Chambers Required:	86
Number of End Caps Required:	8
Chamber Rows:	4
Maximum Length:	51.07 m.
Maximum Width:	8.89 m.
Approx. Bed Size Required:	444.79 square meters.

System Components

Amount Of Stone Required:	474.62 cubic meters
Volume of Excavation (Not Including Fill):	745.62 cubic meters
Total Non-woven Geotextile Required:	1565.24 square meters
Woven Geotextile Required (excluding Isolator Row):	50.19 square meters
Woven Geotextile Required (Isolator Row):	188.32 square meters
Total Woven Geotextile Required:	238.51 square meters



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

UNIT 5 ATTENUATION SIZING

ADS

User Inputs

Chamber Model:	SC-740
Outlet Control Structure:	No
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	203.52 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	152 mm.
Stone Above Chambers:	152 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(15.00 m. x 37.00 m.)

Results

System Volume and Bed Size

Installed Storage Volume:	209.08 cubic meters.
Storage Volume Per Chamber:	1.30 cubic meters.
Number of Chambers Required:	91
Number of End Caps Required:	12
Chamber Rows:	6
Maximum Length:	37.11 m.
Maximum Width:	9.14 m.
Approx. Bed Size Required:	323.66 square meters.

System Components

Amount Of Stone Required:	226.99 cubic meters
Volume of Excavation (Not Including Fill):	345.27 cubic meters
Non-woven Geotextile Required (excluding Isolator Row):	1070.67 square meters
Non-woven Geotextile Required (Isolator Row):	123.16 square meters
Total Non-woven Geotextile Required:	1193.83 square meters
Woven Geotextile Required (excluding Isolator Row):	39.58 square meters
Woven Geotextile Required (Isolator Row):	76.98 square meters
Total Woven Geotextile Required:	116.56 square meters