# DEVELOPMENT OF LAND AT DALGUISE HOUSE MONKSTOWN ROAD, DUBLIN

## Engineering Services Report

GEDV Monkstown Owner Limited

**Report No. W3683-BLP-XX-XX-RP-Z-02**

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# Contents

# 1 Introduction

Byrne Looby Partners have been commissioned by GEDV Monkstown Owner Limited to prepare an Engineering Services Report (ESR) for the proposed development of land at Dalguise House, Monkstown, Co. Dublin as part of the pre-planning application to Dun Laoghaire Rathdown County Council.

# 2 Site Location

The site is located some 11km Southeast of Dublin City Centre and approx. 2 km from Dun Laoghaire. The Dalguise House proposed residential development consists of an overall site area of c.3.58 hectares within a mature landscape setting adjoining, with Monkstown Valley to the West, Richmond Park to the East, Brock Court to the South with Monkstown Road to the Northern boundary of the site.

The site comprises of Dalguise House, 2 gate lodges and a dwelling house, walled garden and associated buildings and garden lands. There is significant tree coverage and vegetative screening from the surrounding area, which is predominantly residential.

Pedestrian & vehicle access is proposed through the existing Dalguise access and Purbeck Road off Monkstown Road. Current access to the site is provided via the current existing entrance opposite Albany Avenue, off the Monkstown Road. The access via a bridge from Purbeck Road is to be developed as part of the site development. See figures 1 and 2 below.

Figure 1 – Location of proposed development site (*source osi.ie*)


Figure 2 – Photo location of proposed development site (*source Google Maps*)

# 3 Development Description

GEDV Monkstown Owner Limited intends to apply for a seven year permission for development on a site of c. 3.58 hectares at Dalguise House (Protected Structure RPS No. 870), Monkstown Road, Monkstown, County Dublin, A94 D7D1 (the lands include the following structures identified as Garage (A94 N3A1); Gate Lodge (aka Brick Lodge) (A94 R9T1); Dalguise Lodge (aka Entrance Lodge) (No. 71 Monkstown Rd, A94 TP46); White Lodge (A94 V6V9)); and on-street car parking in front of Nos. 6 and 7 Purbeck (A94 C586 and A94 HT99, respectively), with the provision of vehicular and pedestrian access and egress at two points on Monkstown Road: the existing entrance to Dalguise; and at Purbeck.

Alterations will be made at Purbeck including the relocation of 4 No. existing car parking spaces to facilitate the construction of a new vehicular and pedestrian bridge over the Stradbrook Stream.

The development, with a total gross floor area of approximately 47,382 sq m (including a basement of 5,396 sq m and undercroft parking of 1,403 sq m) (of which some 46,154 sq m is new build, and 1,228 sq m retained existing buildings), will consist of the construction of 493 No. residential units, consisting of 486 No. new build and 7 No. residential units (the latter within existing structures (repurposed from Dalguise House, Gate Lodge (Brick Lodge) and Coach House)).

The residential provision will comprise: 3 No. three storey 3-bed terraced houses (GFA 569 sq m), and 490 No. Build-to-Rent units (consisting of 2 No. studio units; 289 No. 1-beds; 20 No. 2-beds/3 persons; 166 No. 2-beds/4-persons; and 13 No. 3-beds) (with an option for the use of 4 No. of the BTR Units to cater for short-term stays of up to 14 days at any one time to cater inter alia for visitors and short-term visits to residents of the overall scheme) residential amenities and residential support facilities; a childcare facility; and restaurant/café.

The development will consist of: the demolition and partial demolition of existing structures (total demolition area 967 sq m, comprising: two residential properties (White Lodge (A94 V6V9), a 2 storey house (192 sq m); and a residential garage (A94 N3A1) and shed to the southwest of Dalguise House (285 sq m)); swimming pool extension to the southeast of Dalguise House (250 sq m); lean-to structures to the south of the walled garden (142 sq m); part-demolition of Lower Ground Floor at Dalguise House (9 sq m); single storey extension to the south of the Coach House (29 sq m) and three ancillary single-storey structures (8 sq m, 8 sq m, and 31 sq m) within the yard; potting shed (13 sq m); removal of 2 No. glasshouses; and alterations to, including the creation of 3 No. opes and the removal of a 12.4 m section of the walled garden wall to the east); the construction of: 11 No. residential blocks (identified as: Block A (total GFA 2,015 sq m) 7 storey, comprising 19 No. apartment units (15 No. 1-beds, 4 No. 2-beds/4-persons) and a childcare facility (540 sq m over Ground and First Floor Levels); Block B (total GFA 3,695 sq m) 7 storey over undercroft car parking, comprising 48 No. apartment units (33 No. 1-beds, 1 No. 2-beds/3 persons, 14 No. 2-beds/4-persons); Block C (total GFA 3,695 sq m) 7 storey over undercroft car parking, comprising 48 No. apartment units (33 No. 1-beds, 1 No. 2-beds/3 persons, 14 No. 2-beds/4-persons); Block D (total GFA 4,325 sq m) 7 storey over basement level car park, comprising 52 No. apartment units (25 No. 1-beds, 26 No. 2-beds/4-persons, 1 No. 3-bed); Block E (total GFA 5,946 sq m) 9 storey over basement level car park, comprising 66 No. apartment units (40 No. 1-beds, 26 No. 2-beds/4-persons), with residents' support facilities (75 sq m) and residents' amenities (gym, yoga studio, residents' lounge/co-working space; lobby 485 sq m) at Ground Floor Level, residents' amenities (bookable rooms 42 sq m) at First Floor, and residents' amenities (residents' lounge; games room; screen room; private lounge; kitchen 350 sq m) with roof terrace (106 sq m) at Eighth Floor Level;

Block F (total GFA 5,469 sq m) 7 storey over basement level car park, comprising 76 No. apartment units (46 No. 1-beds, 5 No. 2-beds/3-persons, 23 No. 2-beds/4-persons, 2 No. 3-beds); Block G (total GFA 5,469 sq m) 7 storey over basement level car park, comprising 76 No. apartment units (46 No. 1-beds, 5 No. 2-beds/3-persons, 23 No. 2-beds/4-persons, 2 No. 3-beds); Block H (total GFA 4,252 sq m) 5 storey over Lower Ground Floor, comprising 54 No. apartment units (30 No. 1-beds, 1 No. 2-beds/3-persons, 21 No. 2-beds/4-persons, 2 No. 3-beds); Block I1 (total GFA 1,038 sq m) 3 storey, comprising 12 No. apartment units (3 No. 1-beds, 3 No. 2-beds/3-persons, 6 No. 2-beds/4-persons); Block I2 (total GFA 1,038 sq m) 3 storey, comprising 12 No. apartment units (3 No. 1-beds, 3 No. 2-beds/3-persons, 6 No. 2-beds/4-persons); and Block J (total GFA 1,844 sq m) 4 storey, comprising 20 No. apartment units (13 No. 1-beds; 1 No. 2-bed/4-persons, 6 No. 3-beds));the refurbishment, adaptation and reuse of: two storey Dalguise Lodge (Entrance Lodge) (GFA 55 sq m) comprising residential support facilities; a single storey Gate Lodge (GFA 55 sq m) comprising 1 No. 1-bed unit; and two storey Coach House and single storey Stableman's House (GFA 319 sq m) to provide 3 No. apartment units (1 No. 1-bed, 2 No. 2-bed/4 persons); the refurbishment, adaptation and change of use of Dalguise House (GFA 799 sq m) from a single residential dwelling to provide: 3 No. apartment units (2 No. studios and 1 No. 2-bed/3 person) at First Floor Level; a restaurant/cafe at Lower Ground Floor Level (GFA 273 sq m); and residents' amenities at Ground Floor Level (library, residents' lounge, events space, bar/bookable room, 157 sq m); works to the existing structures include: removal of existing internal partitions and doors, alterations to internal layout including provision of new partitions and doors to Dalguise Lodge (Entrance Lodge); the removal of existing internal partitions and doors, and alterations to internal layout including provision of new partitions and doors to Gate Lodge (Brick Lodge); replacement of existing roof, windows and doors, non-original mezzanine floor and stairs of Coach House, creation of new internal and external opes, reconstruction of chimney, construction of new stairs, provision of new internal partitions and doors, replacement of the demolished single storey structure to south of Coach House with a 42 sq m single storey extension, including construction of a link between Coach House and Stableman's House; replacement of existing roofs, windows, doors, creation of new external opes and provision of new internal partitions and doors to Stableman's House; restoration of Coach House yard walls; removal of security bars from windows, internal partitions, doors, two secondary staircases, non-original fireplaces; and the reconfiguration of internal layout including introduction of new partitions, doors and fireplaces, in-fill of former secondary staircases; removal of an existing window at rear facade of Lower Ground Level, alterations to ope and replacement with a new external door; reinstatement of external wall fabric in place of demolished lean-to at the rear facade; removal of external door to swimming pool on eastern facade and closure of ope; and creation of new external ope at Lower Ground Floor rear façade, provision of external plant (connected to the new ope by ducting), waste storage area, water tank at surface level adjoining the western façade, enclosed within a screen at Dalguise House).

The development will also consist of: the construction of a garden pavilion; the provision of balconies and terraces, communal open space including roof gardens, public open spaces, hard and soft landscaping, landscaping works including the removal of trees, alterations to boundaries; the provision of: 228 No. car parking spaces (148 No. at basement level; 19 No. at undercroft; and 61 No. at surface level); motorbike spaces; level changes; ESB Substations (at Block D and Block H); plant areas; waste storage areas; provision of cycle parking (including cargo bike spaces) at basement and surface level; signage/wayfinding; and all ancillary site development works above and below ground.

Provision is made in the landscaping proposals for potential future pedestrian and cycle connections that would facilitate permeability through the site boundaries with the residential estates of Arundel and

Richmond Park, respectively, and the former Cheshire Home site, subject to agreement with those parties and/or Dún Laoghaire-Rathdown County Council, as appropriate.

# 4 Statutory Guidance

Note, the site wide pipe work on site will adhere to the requirements of the following statutory guidance documents where applicable: -

- Building Regulation 2010 TGD Part H 2016

- Building Regulation 2017 TGD Part B 2021

- IS EN 752: 2008 “Drain & Sewer Systems Outside Buildings”

- Dublin City Council “Drainage requirement for Planning Application”

- IS EN 12056-1/2/5: 2000 “Gravity Drainage Systems Inside Building”

- Greater Dublin Regional Code of Practice for Drainage Works Version 6.0 & Addendums

- Irish Water Code of Practice for Wastewater Infrastructure IW-CDS-5030-03

- Irish Water Code of Practice for Water Infrastructure IW-CDS-5020-03

- Greater Dublin Strategic Drainage Study Regional Drainage Policies Technical Documents

Volume 2 – New Developments

Volume 5 – Climate Change

- Ciria C753 “The SuDs Manual”

- Ciria C768 “Guidance on the construction of SuDs”

- C644-Building Greener (Guidance on the use of Green Roofs)

- Green Roofs over Dublin – Guidance Policy

- FLL’s Guidelines for the Planning, Construction and Maintenance of Green Roofs

- DLRCC Development Plan 2022-2028

# 5 Scope of Works

The associated site and infrastructural works include provision for, water services; foul and surface water drainage and connections to attenuation proposals, permeable paving etc including all green/blue roofs across the site.

This report describes the proposed drainage and watermain infrastructure associated with the development and how it interfaces with public watermain on Monkstown Road and on the Irish Water/ DLRCC main foul main running along the line of the Stradbrook/Monkstown Stream as per information provided by both Irish Water and Dun Laoghaire Rathdown County Council.

The project has been provided with Connection Of Feasibility (COF) approval from IW on 14 September 2022 following the pre connection enquiry submitted on 15 December 2021 for the connection to the existing infrastructure.  The project has a Statement of Design Acceptance on 06 October 2022 from IW following review of the proposed site utilities application. Both documents have been appended to this report.

# 6 Pre-Planning Drainage discussions

- For the new LRD application, a pre-application consultation was held on 25 February 2022, with the Dalguise Design Team Representatives and DLRCC Officers, Planners and Engineers to present the project proposal following the pre-planning consultation brochure issued 10 December 2021.
- ByrneLooby and the Executive Engineers Drainage Department had a discussion on March 1st, 2022, for the site SUDs and drainage proposal, to ensure any requirements that had changed from the 2019 application were highlighted and captured in the new proposal.
- ByrneLooby liaised with Beton and held an informative meeting on the Blue Roof system proposed for the scheme on the 24th, March 2022.
- Following the pre-planning submission on the 24th May 2022, a meeting was held on the 16th of June 2022 with the Dalguise Design Team Representatives and DLRCC Officers, Planners and Engineers to discuss the LRD proposal submitted allowing initial comments to be made.
- On the 23rd June ByrneLooby met with Executive Engineers of DRLCC Drainage Department to allow for deeper discussion regarding SUDs, drainage and flooding risk proposed for the development.

# 7 Foul Infrastructure

## 7.1 Existing Foul Sewer Infrastructure

The background information identifies that a main combined sewer exists running under on the line of the Stradbrook/Monkstown Stream was obtained. The main is a 450mm dia. vitrified clay (VC) line flowing towards Carrickbrennan Road with an existing manhole for connection 1 at the Western end of the Purbeck Lodge and Dalguise House site intersection while proposed connection 2 is adjacent western boundary to the Drayton Close estate. See figure 3 below.

A further 450mm dia. Irish Water/ DLRCC Vitrified Clay (VC) combined line, exists, which runs from the Monkstown Valley development onto the application site, current entrance/exit roadway, and onto Monkstown Road, down Albany Avenue before connecting onto a main combined line on Seapoint Avenue was noted.

It is not proposed as part of this submission to utilize this connection for maintaining the existing connection to the Gate Lodge/ New Management Office, adjacent to the site entrance.

Dalguise House is served by a separate septic tank and percolation area located in the lands outside to the Walled Garden on the western boundary. (See figure 3).

It is proposed that Remediation Plan will be developed during the design development of the site for the de-commissioning of the septic tank and removal of contaminated soils. Chemical samples have been retrieved from the area and are currently undergoing testing in accordance with Waste Classification legislation. It is expected that the plan will include, but not limited, the following steps;

*Septic Tank Removal*

• De-sludge septic tank.

• Break base of tank and fill with inert material i.e. Sand, Gravel.

• Alternatively demolish the tank structure and dispose of material to licensed waste facility.

• Grout existing inlet and outlet pipelines or alternatively remove pipelines and dispose of to licensed waste facility.

*Contaminated soil removal*

• Review results of chemical samples taken from the area.

• Locate extents of percolation system- Note that the contaminated soil around the percolation stone will be almost black in colour.

• Excavate and dispose of all contaminated soil and gravel material to licensed waste facility.


Figure 3 – Dalguise House Site Showing Foul Connection Points

## 7.2 Proposed Foul Infrastructure

The Foul Drainage System for the site will be separated from the surface water network throughout the development. The required connection points will be as indicated in figure 3 above and have been approved by Irish Water on 08 March 2022 through a Confirmation of Feasibility letter following a Pre-Connection Enquiry application submitted on 15 December 2021, see Appendix A for the Confirmation of Feasibility response letter.  Irish water has requested that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the assets during and after the works.

Specific details on the above are contained within Appendix B of this report and on ByrneLooby Partners Ltd Drg. No. W3683-DR-1007, included with this submission.  See Appendix B for foul calculations.

The proposed development is to consist of 493 units total, inclusive of childcare facility and cafe/restaurant. Based on Irish Water guidelines, the foul effluent generated will be based on:

⇒ flow l/day/apt x total units = DF l/day. ⇒ Average Domestic flow l/day per apartment (based on 2.7 persons per apartment x 150l/person/day

⇒ Average Non-Domestic flow l/day per apartment (based on 2.7 persons per apartment x 60l/person/day

⇒ flow l/sec Peak Flow (3 Domestic Flow and 4.5 Non-Domestic Flow)

An updated COF has been obtained from IW and is submitted with this Planning Application.

The proposed basement car park, located under Blocks D, E, F G, and the central space, will have a series of gullies cast into the floor slab which will cater for limited amounts of run-off that enters the proposed car park through ramps, service ventilation opes etc. and vehicles entry point.

All basement drainage shall be collected in a separate collection chamber prior to passing through a suitable petrol interceptor. This collection chamber will pump to the foul sewer system via duty and standby pumps.

The proposed gullies will be connected to a buried gravity pipe network that will be collected in a separate collection chamber prior to passing through the pumps into a suitable petrol interceptor then onto the foul sewer system.

# 8 Watermain Infrastructure

## 8.1 Existing Waterman Infrastructure

Irish Water Local infrastructure details relating to the site are contained with the mapping in Appendix A. From the mapping there is an existing 160 dia. HPPE or equivalent, Irish Water, watermain on Monkstown Road. This has been confirmed by Irish water in the pre-connection enquiry approval.

To provide future proofing for development of the subject site at Dalguise House, as part of the Purbeck Lodge, 77 Monkstown Road, site development and with the agreement of Irish Water, an additional 150mm dia MDPE watermain was laid thru the site and terminated adjacent to the Stradbrook / Monkstown Stream. Details of this, un-connected additional line are shown on ByrneLooby Partners Ltd Drg. No W3683-DR-1015 “Proposed Utilities Plan - Water Main Layout”, submitted with this application.

## 8.2 Proposed Watermain Infrastructure

Aside from the connection to the existing 160mm dia HPPE watermain, Irish Water have also requested in the pre-connection enquiry a secondary connection to the southeast of the site outside of the site boundaries to an existing 100mm dia uPVC water main, including the installation of a control valve and bulk meter. This connection is to remain closed during normal operations. GEDV Monkstown Owner Limited will take this pipe to the site boundary for the connection to be made by others.

Detailed calculations are provided in Appendix C of this report and the estimated waters usage for the existing 7no. units and proposed 486 No. Residential units with ancillary services of 299498 litres/ day, with a provision for 24-hour storage provided for by way of a Format 30 tanks housed within a designated water services room within the development with boaster pump sets to provide adequate pressured flows to the upper-level apartments. A 20% additional allowance was included for in the water tank sizing to cater for possible ballcock positioning.

The proposed development is to consist of 493 units, inclusive of childcare facility and cafe/restaurant based on Irish Water guidelines, the water demand will be:

⇒ Average Domestic Demand l/day/apt x total units = Demand l/day.

⇒ Average Domestic Demand l/day per apartment (based on 2.7 persons per apartment x 150l/person/day

⇒ Average Non-Domestic demand l/day per apartment (based on 2.7 persons per apartment x 60l/person/day

⇒ Demand l/sec Peak water demand (5 times average water demand).

For firefighting purposes, the watermain will be installed in accordance with the requirements of TGD B of the Building Regulations. The new proposed hydrant layout for the site is shown on ByrneLooby Partners Ltd Drg. No W3683-DR-1015, which will be utilized as part of the firefighting strategy.

Watermain works shall be strictly in accordance with the requirements of Irish Water Code of Practice for Infrastructure & Water Infrastructure Standard Details and any Dun Laoghaire Rathdown County Council requirements on specifications and standard details Pressure control, will be to the requirements of Irish

Water & Dun Laoghaire Rathdown County Council, details of which will be agreed prior to commencement of the development on site.

Water conservation measures are encouraged as part of the design development, including the use of dual flush water cisterns, low flow taps, etc. These should be utilised within the residential development and may be subject to the approval of Irish Water & Dun Laoghaire Rathdown County Council.

# 9 Storm Water Infrastructure

The development will be designed in accordance with the principles of Sustainable Urban Drainage Systems (SuDs) as embodied in the recommendations of the Greater Dublin Strategic Drainage Study (GDSDS) and Chapter 10 to the DLRCoCo Development plan 2022-2028.

• Criterion 1: River Water Quality Protection – satisfied by providing interception storage and treatment of run-off within 'SUDS' features e.g., landscaping, and green roof areas.

• Criterion 2: River Regime Protection - satisfied by attenuating run-off from the site.

• 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 extreme storm as noted in 'GDSDS'. Planned flood routing for storms greater that 100-year level considered in design and development run-off contained on site.

• Criterion 4: River Flood Protection – attenuation and/or long-term storage provided within the 'SuDs' features. In accordance with the requirements of DCC all new developments are to incorporate the principles of 'SuDs'. The 'SuDs' principles require a two-fold approach to address storm water management on new developments.

## 9.1 Existing Storm Water Infrastructure

Based on the Irish Water drainage infrastructure maps, the surrounding areas of Dalguise House site, indicate that there is no specific separate surface water main in proximity to the development.

It is noted that the existing developed sites adjacent to the subject site have discharged surface water to the Stradbrook Stream located on the Northern boundary, using agreed controlled flows, set by the Local Authority, equivalent to, or less than undeveloped greenfield discharge Qbar as defined in the section 6.3.1.2.2 "River Regime Protection" of the Greater Dublin Strategic Drainage Study Volume 2 – New development and within Report 124 "Flood estimation for small catchments",1994 produced by the Institute of Hydrology.

The existing development site is generally greenfield but there are some small areas of brownfield located within the overall site area of 3.58 hectare section of site (excluding roadway section in Purbeck lodge, 77 Monkstown Road of Area = 0.156 ha), at Dalguise House, the White Lodge (3 No existing houses subject to demolition and re-development), Gate Lodges (2 No) and the Coach House located on the South-West boundary.

The current site surface water from the above existing areas is combined with the foul discharges and connected to an existing site septic tank or onto the existing 450 dia. vitrified clay Irish Water combined main from Monkstown Valley flowing down the existing site entrance roadway (beside Drayton Close) onto Albany Avenue - see Irish Water map in Appendix D.

It should be noted that a small area of land north of the Stradbroke Stream at Purbeck is included in the Planning Application boundary (with the consent of a third party) to allow for the relocation of 4 no. existing car parking spaces and in order to facilitate the construction of the new bridge, the levels and surface water system on the north side of the new bridge at Purbeck will tie into the existing and there will be no SW runoff to surrounding lands.

## 9.2 Proposed Storm Water Infrastructure

In accordance with Dun Laoghaire Rathdown County Council requirements, storm water shall be managed in two phases. The first is to restrict storm water run-off from the proposed development to greenfield run-off rates. The second aspect to be included in new applications is to incorporate sustainable urban drainage systems (‘SuDs’) proposals into the scheme. The ‘SuDs’ concept requires that storm water quality is improved before disposal and, where applicable, storm water is discharged into the ground on site. The proposed surface water system within the site will be separated from the foul system as required.

The development will be served by a simple gravity drainage system (as far as reasonably possible) including Suds features (swales, permeable paving etc) and will follow the natural topography of the site, falling towards the Stradbrook Stream on the Northern end of the site.

The proposed basement car park, located under Blocks D, E, F G and the Central Plaza, will have a series of gullies and drainage channels cast into the floor slab which will cater for limited amounts of run-off that enters the proposed car park through ramps, service ventilation opes etc. and vehicles entry point.

The proposed channels and gullies will be connected to a buried gravity pipe network that will fall to the attenuation tanks shown in Drg. No. W3683-DR-1014. The outflow from the tank, will flow to the outfall points via a gravity system and through oil interceptors prior to discharge into Stradbrook Stream.

The site has been split into two catchment areas, the upper catchment area (south and east of the site) and the lower catchment area (northwest of the site). The upper catchment flows into two tanks within the network. It captures runoff from Block I (No. 1 & 2), Block H, Block J, existing buildings, and central space to the north and south of Block J and all hardstanding areas/roads upstream of the first attenuation tank and then continues to the second tank prior to discharge into Stradbrook Stream. The second tank captures runoff from Block F, Block E, Block B, Block C and associated road and hardstanding areas. The lower catchment includes runoff from Block A, Block D, existing buildings and proposed 3no. buildings to the west of Block A and proposed roads and hardstanding area.

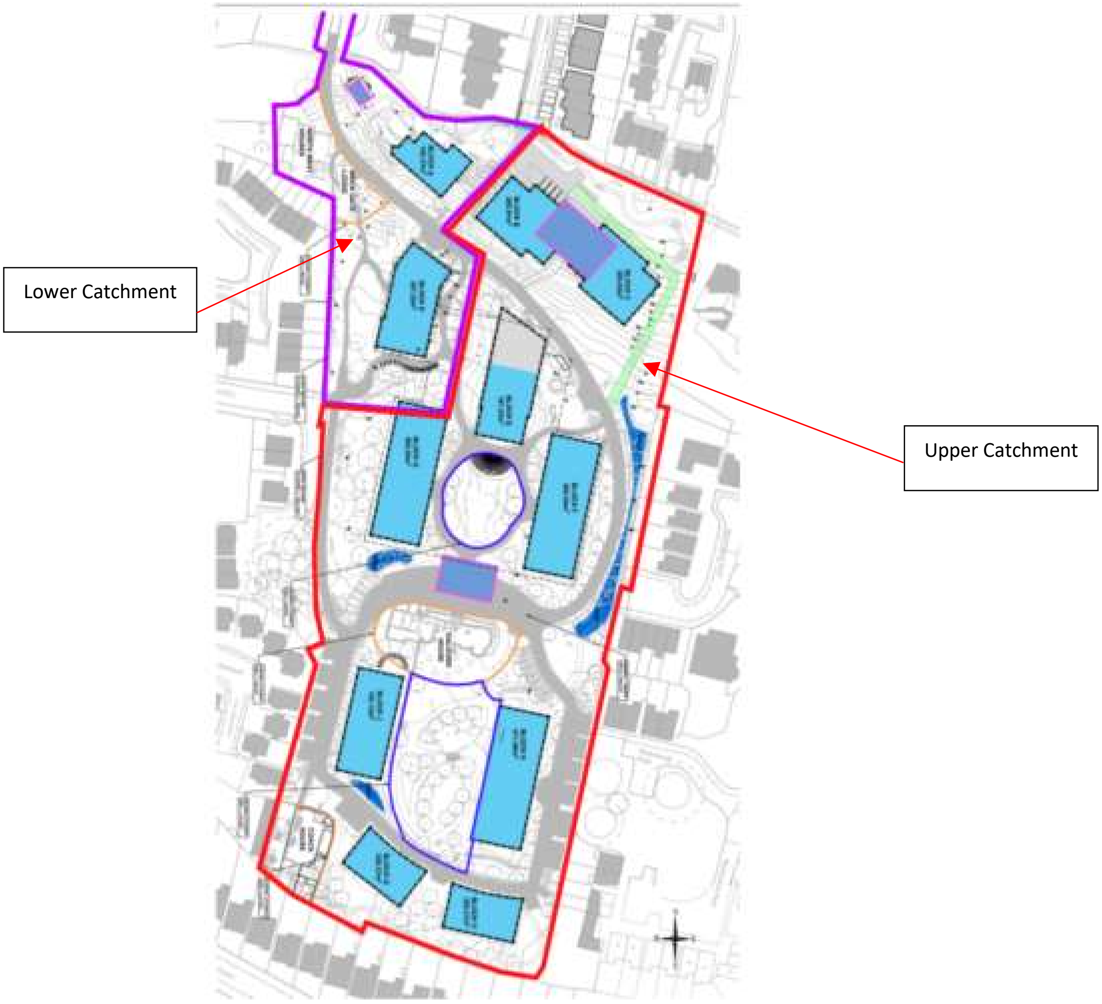


Figure 4: Outline Site Catchment Areas

On the 24th May 2022 the pre-planning package was submitted, this included the initial Storm Water Audit Report. This report identified several measures and clarifications required to be incorporated into the storm water design for the final planning submission to DLR. BLP has since liaised with the Auditor (JBA) to ensure each point was encapsulated in the design. BLP has now received acceptance of the proposed storm water and SUDs design aligning with the DLR requirements and associated guidance documents referenced within this report. On 25th November 2022 the planning submission was delivered to DLR for review, DLR have returned a request for further information on 27th January 2023 This report and the design drawings have been amended to reflect the changes made to address these queries.

# 10 Description of SUDS Measures

As per Criterion 4, in accordance with the recommendations of CIRIA 753 (SUDs Manual) and requirements of DCC all new developments are to incorporate the principles of 'SuDs'. The aim of 'SuDs', inclusion across the development is to provide an effective system separate from the foul network to mitigate the adverse effects of storm water run-off on the environment, through enhanced quality systems and on local infrastructure to aid in preventing downstream flooding. The features proposed shall reduce runoff volumes, pollution concentrations and enhance groundwater recharge and biodiversity.

The proposed development 'SuDs' features shall consist of:

a) Blue Green Roof – The proposed system is a ACO Roofbloxx Blue roof system, this allows the roof areas of the proposed apartments to use a filter layer to direct rainfall events into a storage layer below. An 85mm space will be provided for rainfall to be retained in the storage layer. As more intense rain falls on the blue roof can overflow from the roof through down pipes and into the schemes main drainage runs. The storage area will be covered with a sedum topsoil to increase the water retention on each roof. This technology also controls the amount of water that will be released into the storm network.

b) Permeable Paving – this system allows rainwater to be directed into carparking bays whereby the rainwater can filter through gaps in the paving blocks and percolate into the subsoil or to swales. The area which can be drained is subject to the infiltration characteristics of the subsoil, (Ref IGSL Report) which is established following ground investigation testing on site.

c) Tree Pits – Tree pits will be located along the existing avenue to capture runoff for the existing hard standing area. It is proposed that the tree pits will be connected and act like an attenuation basin where the water can then be released slowly into the storm network.

d) Swales and pond – it's proposed to allow storm water to be directed locally into swales when the permeable paving is overflowing to delay storm water from entering the main drainage network. As the swales overall can only accommodate relatively small surface areas across this site, the proposal cannot be used to drain the site as a whole, but will be installed to contribute to the overall 'SuDs' strategy.

e) Filter Strip – An area of the existing road will have a filter strip located to the North to capture rod run-off for small rain fall events. This allows run-off from localised hardstanding areas to be filtered and trap silt prior to entering the storm network.

f) Attenuation Tanks – As noted above, for extreme storm events, a dedicated system to contain the storm water flows generated during a 1-in-100-year storm, increased by 20% for climate change are required by DLR. It is proposed to use underground storage tanks in three locations for this purpose see Drg. No. W3683-DR-1018. Two of these tanks are proposed to be constructed of a stormcell block system where no buildings are proposed above.

g) Low Water Usage Appliances – It is also worth highlighting that low water usage appliances should also be utilised to aid in the reduction of water usage on the development.

With the above SUDs provisions it meant that oil separators are not required prior to final disposal of storm water from the development drainage network into the Stradbrook Stream (at two locations).

The combination of the above noted elements will allow the proposed development to adhere to the principles of sustainable drainage practices while enhancing overall storm water quality.

## 10.1 QBAR and Impervious area calculations

To ensure an accurate calculation of the required attenuation for the site Met Eireann was contacted to provide:

a) The SAAR (Standard Annual Average Rainfall) for the area: 900mm/year.

b) The sliding duration table for the site indicating the 1:100-year rainwater intensities to be used.

c) Soil type value obtained from the Flood Studies Report, has been established as soil type 4.

These parameters allow the Q-Bar, greenfield run-off rate, to be calculated. The Q-Bar value for the site is 22.14 l/sec. The calculations for the attenuation on site takes account of the positively drained areas only which is identified below.

| **Area** | **Upper Catchment (m2)** | **Lower Catchment (m2)** |
|---|---|---|
| Roofs and Green/Blue Roofs | 6084.12 | 991.91 |
| Road/Permeable Paving | 4882.05 | 1104.20 |
| Existing Properties | 970.00 | 170.00 |
| **Total** | 13,824.74 (1.384 ha) | 1,850.31 (0.185 ha) |

The allowable discharge rate off site is as follows:

Upper Catchment (downstream outfall) – 8.9 l/s (flow rate of 6.48l/s/ha)

From Tank 1 – 5.2l/s

From Tank 2 – 8.9l/s

Lower Catchment (upstream outfall) – 1.2l/s (flow rate of 10.81 l/s/ha)

## 10.2 Interception Storage

In accordance with the requirement of the SuDs Manual C752 Section 4.3 “Water Quality Design Standards” and Section 24.8 “Designing for interception”, interception needs to be provided for any contributing impermeable area, so a check is required to confirm that adequate provision is made for all such areas throughout the site.

There is an amount of storage provided for interception across the site in accordance with Ciria 753. This is to capture and retain the first 5mm of the rainfall to result in no runoff to the stream. Interception and evaporation can account for 15-50% of yearly precipitation. Several approaches below have been taken to include interception storage across the site.

- Permeable paving

- Green/blue roofs

- Swales and pond

- Tree pits and bio – retention areas

- Filter strip

Additional approaches were looked at but were not found to be effective for this development. For example, soakaways, the existing ground conditions to do not support this system.

Interception Storage Requirement = 15675 x 0.005 = 78.38m$^3$ which is the total volume of the first 5mm to be intercepted across the positively drained area site.

| **SUDs Element** | **Volume of Interception (m$^3$)** |
|---|---|
| Permeable Paving | 23.06 |
| Green/Blue Roof Area | 324.72 |
| Swale/Pond | 10.50 |
| Tree Pits and Bio-retention Areas | 639 |
| Filter Strip | 1.28 |
| **Total Volume of Interception (m$^3$)** | 998.56 |

The Calculations below show that the total interception storage equates to 998.56m$^3$ for the site providing adequate interception is provided to meet the requirements within the SuDs Manual and GDSDS.

### 10.2.1 Permeable Paving

In areas across the site where the development will require new hard standing for road access and car parking, permeable paving will be installed to a total area of c.2429.10m$^2$. This is proposed to prevent surface ponding without the need for an additional channel drainage system. The overflow connection from the permeable paving is connected to swales located close by where possible. Otherwise the flow will connect directly into the storm network.

Total hard standing area = 5986.25m$^2$

Permeable Paving = 2429.102 m$^2$ x 0.005 x 2 =24.29m$^3$

The emergancy access road is made off a grasscrete structure which will allow it to drain 90% like a grassed area and therefore has not been considered for the permeable paving or hardstanding areas across the site.

### 10.2.2 Green/Blue Roofs

All of the proposed buildings on site are to have a blue roof system to comply with the requirements of Appendix 7 of DLRCC Development Plan 2022-2028 70% of a new roof areas to be constructed as Green/Blue Roofs, this is summarised in Appendix F. The blue roof has is to be installed as a first stage storage system and its volume is separate from the overall site attenuation requirement to aid storage during and exceedance event. The proposed Green/ Blue Roof will be an Extensive type, build up comprising of durable, slow growing, low maintenance planting generally sedum type, with a substrate depth of typically 100mm of free-draining growing medium. The substrate will be agreed between the blue/green roof supplier and the landscape architect. The provision of PV panels on the roofs has meant that some of the roof area is unable to be utilised for the blue/green roof storage, however the PV area used is minimal overall.

Access will be provided to the blue/green roof spaces via stairs and/or openable hatches, AOVs. Alternative means of access will also be considered such as external mobile access. This will be developed further at detailed design stage in conjunction with the Development Facilities Company and Project Supervisor Design Stage.

The retention from the roofs alone has been set to an 125mm depth which gives an overall maximum retention of 324.72m$^3$ for all the blue roofs across the development and a maximum outflow of 0.37l/s. As the design develops across the site the depth can be increased to higher levels to give more capacity. We have engaged with a specialist Green/Blue roof supplier for identify the available capacities of the system for the site.

See Appendix F for the proposed blue roof arrangement and calculations summarised below.

Lower catchment green/blue roof 350.62m$^2$ contribution = 39.44m$^3$

Upper catchment green/blue roof 2755.10m$^2$ contribution = 285.28 m$^3$

Interception volume over the green/blue roofs = 324.72m$^3$

Total Roof Area (proposed) = 3105.72m$^2$

### 10.2.3 Tree Pits and Bio-retention Areas

To allow for the capture of surface run-off along the existing road, tree pits and bio-retention basin will be located intermittently to intercept run-off along this route. The aim is to use medium in the bio-retention and tree-pit system that meets the criteria of the Facility for Advanced Water Biofiltration (FAWB) or similar for interception of run-off and to allow evaporation of leaves and provide biodiversity benefits. Guidance on the construction and maintenance of the tree pit should align with BS 8545.

Following the SDCC SUDs Explanatory, Design and Evaluation Guide by McCloys Consulting notes that on average the available storge in a bio-retention basin:

Total retention basin area of c.1065m$^2$

Total basin volume = c.1065m$^2$ x 0.6 = 639m$^3$

### 10.2.4 Pond and Swales

It is proposed that the swales will be lined as per Table 24.6 of the CIRIA 753 Suds Manual. Based on the recent SI carried out in 2022 confirming no appropriate soil infiltration capability and therefore the swales can only provide interception of up to 5 times the swale area. The swale is utilized as a connection from the permeable paving for overflow scenarios. The swales are proposed to be terraced and or flat with a raised outlet to create a temporary storage zone. This is proposed to be developed further at detailed design stage with the landscape architect.

There is a total swale/pond area of c.419.82m$^2$.

Swale/Pond Volume = c. 419.82$m^2$ x 0.005m x 5= 10.50$m^3$

### 10.2.5 Filter Strips

Filter strips are an open stone trench of 0.4-1m wide proposed to be located at the side of the existing site entrance to the entrance of Block D, for capturing run off and removing silt before entering the storm network. The filter strip is utilised areas where existing trees are to be retained and utilisation of tree pits is not possible. The road length the filter strip is draining is 170m long, with 1m sections of filter strip every 6m along this section of road, connecting into the stormwater network at the end of the strip. Based on Table 24.6 of the CIRIA 753 Suds Manual the filter strip provides the following interception volume.

Total length of filter strip = 256m    Proposed width of 500mm

Filter strip = 128$m^2$ x 0.005m x 5= 1.28$m^3$

## 10.3 Long-term Attenuation Storage and Volume

Using the microdrainage software, the volumes of the required attenuation for the site as shown in Appendix D result in the following tank volumes:

Upper Catchment stormcell tank 1 is 640$m^3$. Modelled with a 5.2 l/s discharge @ 1.98m head.

Upper Catchment tank 2 is 360$m^3$ modelled with 8.9 l/s discharge @ 1.45m head.

Lower catchment stormcell tank is 85.12$m^3$ modelled with 1.2 l/s discharge @ 1.5m head.

These tanks have been designed for a 1:100 year storm event accommodating a 20% climate change and runoff rates for summer and winter (Cv) at a value of 1.0 to ensure accurate simulation results as per Appendix 7 the DLRCC Development Plan 2022-2028 requirements for sizing the attenuation tanks.

The filtration test results across the site indicates that infiltration of water through the soil is not possible, however at the request of DLR, stormcell tanks have been provided in areas free of buildings to allow some nature recharge, if ever possible. The above volume of water is critical, the change from concrete material to stormcell tanks where suitable is possible ensuring the above volumes are accommodated.

As part of the storm network review, the effect of blockages occurring at critical points in the system were examined in order to ensure that any flood flows will be away from buildings. The locations chosen and consequential flows are listed below. The effect of blockages occurring at critical points in the system were examined in order to ensure that any flood flows will be away from buildings. The locations chosen and consequential flows are listed below.

The effect of blockages occurring at critical points in the system were examined in order to ensure that any flood flows will be away from buildings or captured by suds measures. The scenarios modelled and the consequential flows are listed below. Refer to drawing W3683-DR-C-1041 for the flood location during scenarios 1 and 2.

Scenario 1 - 30 year storm + 50% blockage on upper catchment stormcell tank no. 1 inlet: flooding at SWMH S7 opposite block J and the coach house will flow away from the buildings and be captured by tree pits and permeable paving.

Scenario 2 - 30 year storm + 99% blockage on upper catchment stormcell tank no. 1 outlet flooding at SWMH S7 opposite block J and the coach house will flow away from the buildings and be captured by tree pits and permeable paving.

Scenario 3 - 30 year storm + 50% blockage on upper catchment tank no. 2 inlet: no flooding

Scenario 4 - 30 year storm + 99% blockage on upper catchment tank no. 2 outlet: no flooding

Scenario 5 - 30 year storm + 50% blockage on lower catchment stormcell tank inlet: no flooding

Scenario 6 - 30 year storm + 99% blockage on lower catchment tank outlet: no flooding

Note that SWMH S7 is located at the lowest point of the site, any flooding that occurs due to blockages will be captured by the surrounding SUDs systems.

## 10.4 Summary

The below table summarises the total volume of interception and attenuation storage provided across the site.

| | **Volume Required ($m^3$)** | **Volume Provided ($m^3$)** |
|---|---|---|
| Attenuation | 796.80 | 1092 |
| Interception | 78.38 | 998.56 |

# Appendix A – Irish Water Confirmation of Feasibility Response

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

Aoibhin Gormley
Byrne Looby
H5 Centrepoint Business Park
Oak Road
Dublin
D12 VW27

14 September 2022

**Re: CDS21008876 pre-connection enquiry - Subject to contract | Contract denied**

**Connection for Multi/Mixed Use Development of 491 unit(s) at Dalguise House, 71 Monkstown Road, Dublin**

Dear Sir/Madam,

Irish Water has reviewed your pre-connection enquiry in relation to a Water & Wastewater connection at Dalguise House, 71 Monkstown Road, Dublin (the **Premises**). Based upon the details you have provided with your pre-connection enquiry and on our desk top analysis of the capacity currently available in the Irish Water network(s) as assessed by Irish Water, we wish to advise you that your proposed connection to the Irish Water network(s) can be facilitated at this moment in time.

| SERVICE | OUTCOME OF PRE-CONNECTION ENQUIRY<br>THIS IS NOT A CONNECTION OFFER. YOU MUST APPLY FOR A CONNECTION(S) TO THE IRISH WATER NETWORK(S) IF YOU WISH TO PROCEED. |
|---|---|
| Water Connection | Feasible without infrastructure upgrade by Irish Water |
| Wastewater Connection | Feasible without infrastructure upgrade by Irish Water |
| **SITE SPECIFIC COMMENTS** | |
| Water Connection | The primary connection is feasible to the watermain on Purbeck Road subject to the following:<br>The proposed water connection for this development connects to the Irish Water network via infrastructure that has not been taken in charge by Irish Water (Third Party Infrastructure). Please be advised that at connection application stage and prior to the commencement of any Self-Lay Works, you have to:<br>• Identify and procure transfer to Irish Water of the arterial infrastructure within the Third-Party Infrastructure, |

<table>
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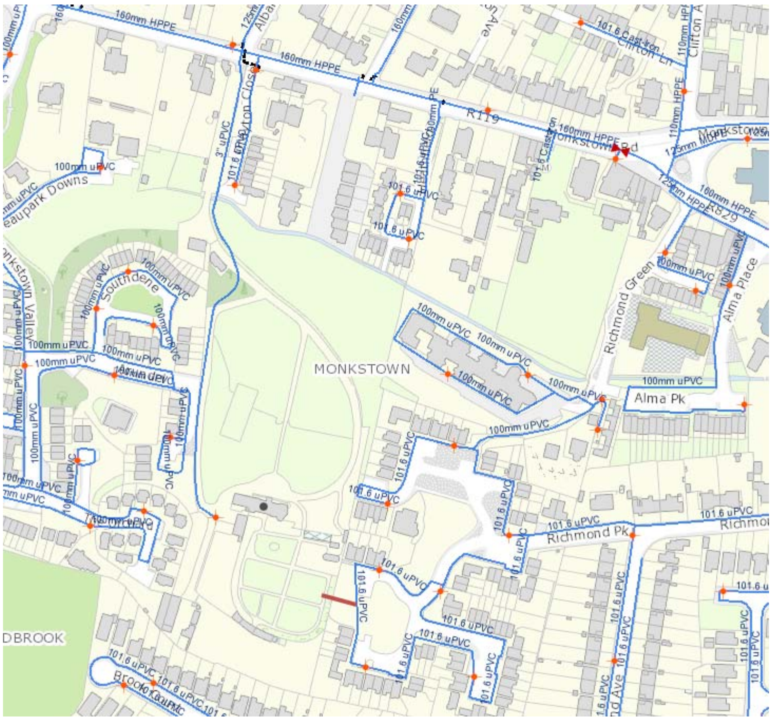
- Demonstrate that the arterial infrastructure is in compliance with requirements of Irish Water Code of Practice and Standard Details and in adequate condition and capacity to cater for the additional load from the Development.

A secondary connection is required to the existing 4” /100mm UPVC watermain to the East of the site (Red line in map below). A control valve is required on this main and set to closed during normal operations.

A booster pump may be required on the connection main.

A bulk meter is required on the connection main.

The proposed Development indicates that Irish Water assets are present on the site. The Developer has to demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the assets during and after the works. Drawings (showing clearance distances, changing to ground levels) and Method Statements should be included in the Detailed Design of the Development. A wayleave in favour of Irish Water will be required over the assets that are not located within the Public Space. For design submissions and queries related to diversion/build near or over, please contact IW Diversion Team via email address [diversions@water.ie](mailto:diversions@water.ie)

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<tr>
<td>Wastewater Connection</td>
<td>The proposed Development indicates that Irish Water assets are present on the site. The Developer has to demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the assets during and after the works. Drawings (showing clearance distances, changing to ground levels) and Method</td>
</tr>
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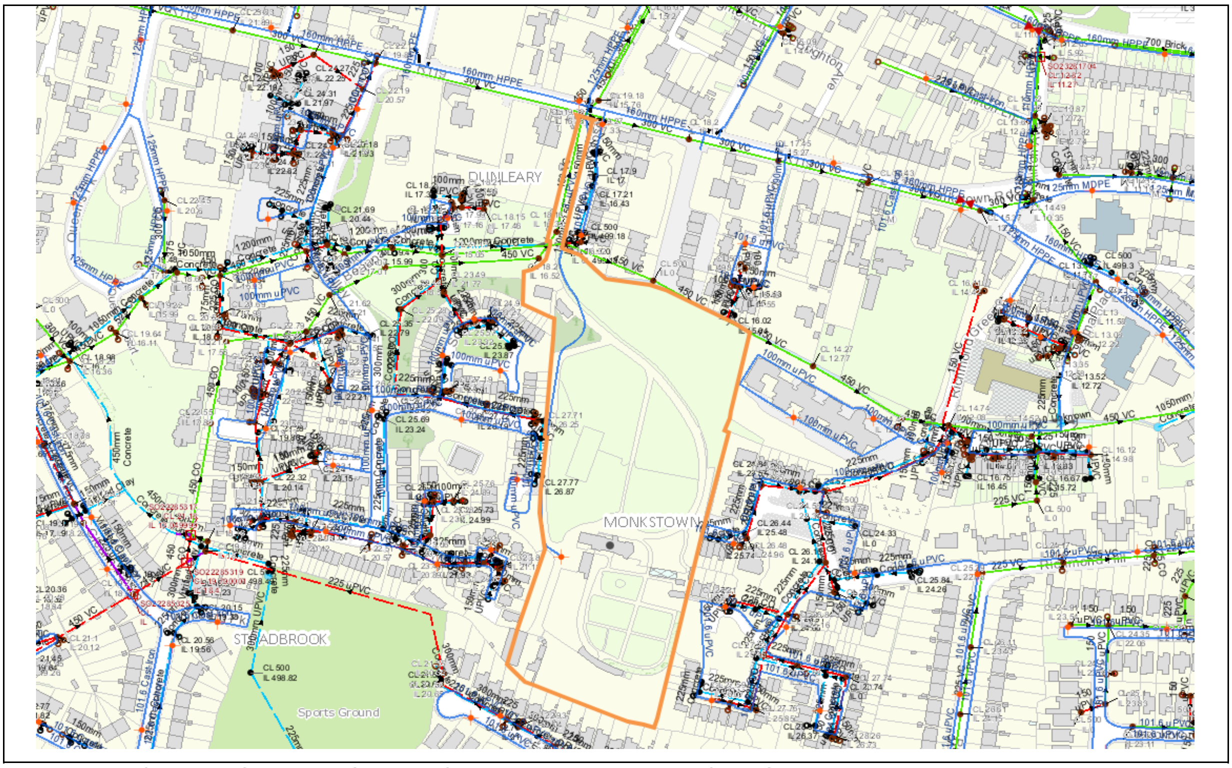
| | |
|---|---|
| | Statements should be included in the Detailed Design of the Development. A wayleave in favour of Irish Water will be required over the assets that are not located within the Public Space. For design submissions and queries related to diversion/build near or over, please contact IW Diversion Team via email address diversions@water.ie |
| The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this development shall comply with the Irish Water Connections and Developer Services Standard Details and Codes of Practice that are available on the Irish Water website. Irish Water reserves the right to supplement these requirements with Codes of Practice and these will be issued with the connection agreement. | |

**The map included below outlines the current Irish Water infrastructure adjacent to your site:**





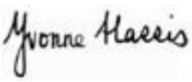

Whilst every care has been taken in its compilation Irish Water gives this information as to the position of its underground network as a general guide only on the strict understanding that it is based on the best available information provided by each Local Authority in Ireland to Irish Water. Irish Water can assume no responsibility for and give no guarantees, undertakings or warranties concerning the accuracy, completeness or up to date nature of the information provided and does not accept any liability whatsoever arising from any errors or omissions. This information should not be relied upon in the event of excavations or any other works being carried out in the vicinity of the Irish Water underground network. The onus is on the parties carrying out excavations or any other works to ensure the exact location of the Irish Water underground network is identified prior to excavations or any other works being carried out. Service connection pipes are not generally shown but their presence should be anticipated.

**General Notes:**

1) The initial assessment referred to above is carried out taking into account water demand and wastewater discharge volumes and infrastructure details on the date of the assessment. **The availability of capacity may change at any date after this assessment.**
2) This feedback does not constitute a contract in whole or in part to provide a connection to any Irish Water infrastructure. All feasibility assessments are subject to the constraints of the Irish Water Capital Investment Plan.
3) The feedback provided is subject to a Connection Agreement/contract being signed at a later date.
4) A Connection Agreement will be required to commencing the connection works associated with the enquiry this can be applied for at https://www.water.ie/connections/get-connected/
5) A Connection Agreement cannot be issued until all statutory approvals are successfully in place.
6) Irish Water Connection Policy/ Charges can be found at https://www.water.ie/connections/information/connection-charges/
7) Please note the Confirmation of Feasibility does not extend to your fire flow requirements.
8) Irish Water is not responsible for the management or disposal of storm water or ground waters. You are advised to contact the relevant Local Authority to discuss the management or disposal of proposed storm water or ground water discharges
9) To access Irish Water Maps email datarequests@water.ie
10) All works to the Irish Water infrastructure, including works in the Public Space, shall have to be carried out by Irish Water.

If you have any further questions, please contact Kevin McManmon from the design team at kmcmanmon@water.ie For further information, visit **www.water.ie/connections.**

Yours sincerely,



**Yvonne Harris**

**Head of Customer Operations**

UISCE ÉIREANN : IRISH WATER

Uisce Éireann
Bosca OP 448
Oifig Sheachadta na Cathrach Theas
Cathair Chorcaí

Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

Aoibhin Gormley
H5 Centrepoint Business Park
Oak Road
Dublin D12 VW27

6 October 2022

**Re: Design Submission for Dalguise House, 71 Monkstown Road, Dublin (the "Development")**
**(the "Design Submission") / Connection Reference No: CDS21008876**

Dear Aoibhin Gormley,

Many thanks for your recent Design Submission.

We have reviewed your proposal for the connection(s) at the Development. Based on the information provided, which included the documents outlined in Appendix A to this letter, Irish Water has no objection to your proposals.

This letter does not constitute an offer, in whole or in part, to provide a connection to any Irish Water infrastructure. Before you can connect to our network you must sign a connection agreement with Irish Water. This can be applied for by completing the connection application form at www.water.ie/connections. Irish Water's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation of Utilities (CRU)(https://www.cru.ie/document_group/irish-waters-water-charges-plan-2018/).

You the Customer (including any designers/contractors or other related parties appointed by you) is entirely responsible for the design and construction of all water and/or wastewater infrastructure within the Development which is necessary to facilitate connection(s) from the boundary of the Development to Irish Water's network(s) (the "**Self-Lay Works**"), as reflected in your Design Submission. Acceptance of the Design Submission by Irish Water does not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.

If you have any further questions, please contact your Irish Water representative:
Name: Antonio Garzón
Email: Antonio.garzon@water.ie

Yours sincerely,

Yvonne Harris

**Yvonne Harris**
**Head of Customer Operations**

**Appendix A**

**Document Title & Revision**

- W3683-DR-1007-05
- W3683-DR-1014-07*
- W3683-DR-1015-04
- W3683-DR-1024-02
- W3683-DR-1025-01

**Additional Comments**

The design submission will be subject to further technical review at connection application stage.

06/10/22

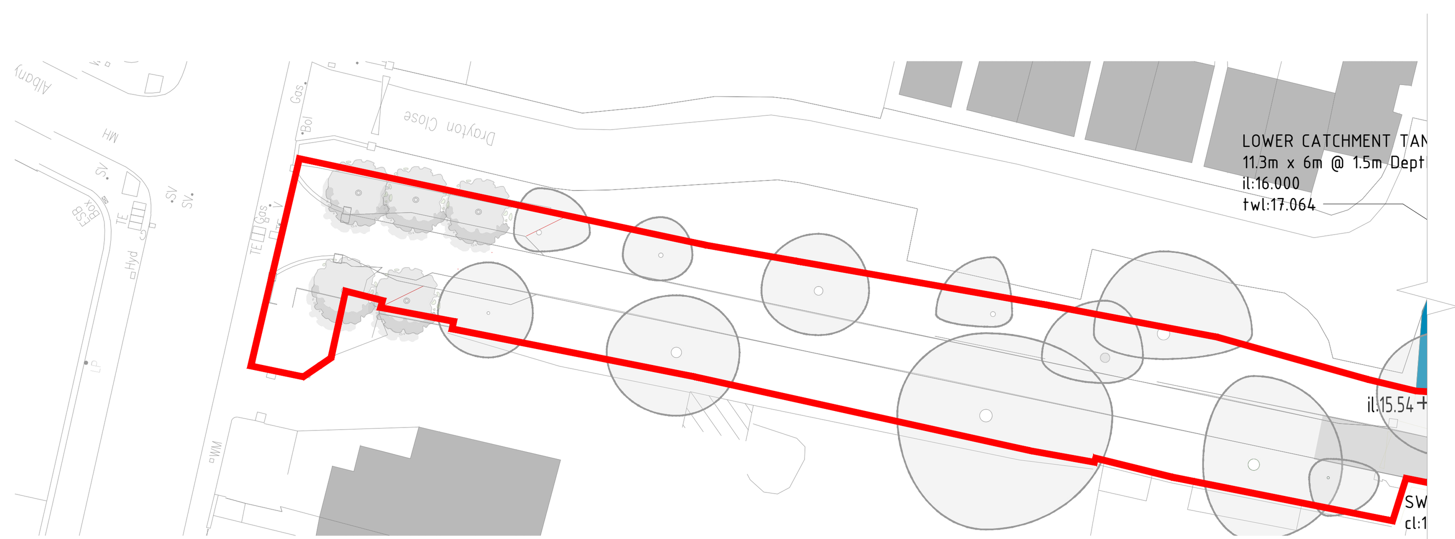
Updated Statement to reflect additional changes to the stormwater network. Changes include the increase in the size of a pipe and the revision of a connection, however these modifications have no affection upon the foul or potable water services for the site.

*For further information, visit* ***www.water.ie/connections***

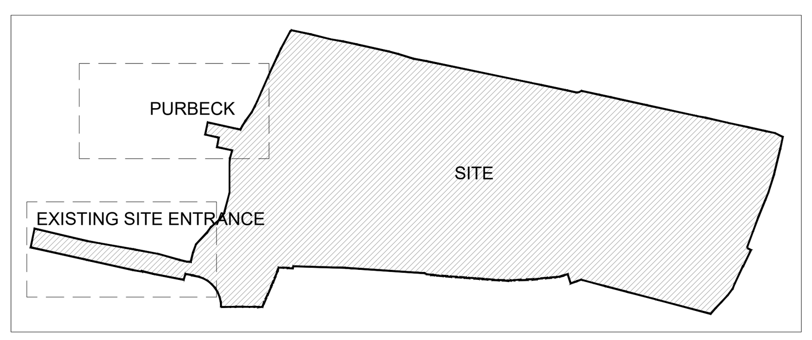
*Notwithstanding any matters listed above, the Customer (including any appointed designers/contractors, etc.) is entirely responsible for the design and construction of the Self-Lay Works. Acceptance of the Design Submission by Irish Water will not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.*


# PROPOSED UTILITIES PLAN

SCALE: 1:500




EXISTING SITE ENTRANCE




KEYPLAN

## PROPOSED UTILITIES LEGEND

- EXISTING SURFACE WATER MANHOLE — Ex. SW MH
- EXISTING SURFACE WATER PIPE — PIPE DESCRIPTION
- NEW SURFACE WATER MANHOLE — SW MH
- NEW SURFACE WATER PIPE — PIPE DESCRIPTION
- SURFACE ACCESS JUNCTION — AJ
- RAINWATER PIPE — RWP
- ROAD GULLY — RG
- HYDRO-BRAKE MANHOLE
- ACO DRAIN
- NEW PERMEABLE PAVING PIPE

### PROPOSED STORM MANHOLE

| IDENTITY | COVER LEVEL | DIA. (mm) | EASTING | NORTHING | DEPTH (m) |
|---|---|---|---|---|---|
| SWMH–S1 | 27.000 | 1200 | – | – | 1.090 |
| SWMH–S2 | 26.300 | 1200 | – | – | 0.978 |
| SWMH–S3 | 25.000 | 1200 | – | – | 0.759 |
| SWMH–S4 | 24.500 | 1200 | – | – | 1.094 |
| SWMH–S5 | 24.000 | 1200 | – | – | 1.173 |
| SWMH–S6 | 23.650 | 1200 | – | – | 1.176 |
| SWMH–S7 | 23.450 | 1200 | – | – | 1.262 |
| SWMH–S8 | 26.075 | 1200/1800 | – | – | 3.953 |
| SWMH–S9 | 26.000 | 1200/1800 | – | – | 4.131 |
| SWMH–10 | 27.500 | 1200/1800 | – | – | 5.689 |
| SWMH–S11 | 27.500 | 1200/1800 | – | – | 6.140 |
| SWMH–S12 | 26.900 | 1200/1800 | – | – | 5.616 |
| SWMH–S13 | 26.100 | 1200/1800 | – | – | 4.924 |
| SWMH–S14 | 25.150 | 1200/1800 | – | – | 4.144 |
| SWMH–S15 | 24.450 | 1200/1800 | – | – | 3.555 |
| SWMH–S17 | 23.000 | 1200 | – | – | 2.584 |
| SWMH–S18 | 22.500 | 1200/1800 | – | – | 6.617 |
| SWMH–S3A | 26.000 | 1200 | – | – | 0.600 |
| SWMH–S4B | 26.750 | 1200 | – | – | 0.900 |
| SWMH–S4A | 25.250 | 1200 | – | – | 0.910 |
| SWMH–S9B | 26.500 | 1200 | – | – | 1.500 |
| SWMH–S9A | 24.500 | 1200 | – | – | 0.992 |
| SWMH–S20C | 21.700 | 1200 | – | – | 1.225 |
| SWMH–S20B | 20.700 | 1200 | – | – | 0.349 |
| SWMH–S20A | 20.150 | 1200 | – | – | 0.600 |
| SWMH–S20 | 19.200 | 1200 | – | – | 1.815 |
| SWMH–S21 | 19.000 | 1200 | – | – | 1.650 |
| SWMH–S18 | 18.400 | 1200 | – | – | 0.800 |
| SWMH–S19 | 19.000 | 1200 | – | – | 1.490 |
| SWMH–S24 | 16.500 | 1200 | – | – | 0.900 |
| SWMH–S16 | 24.000 | 1200/1800 | – | – | 3.364 |

### PROPOSED STORM PIPES

| IDENTITY | US NODE | DS NODE | LENGTH (m) | US IL (m) | DS IL (m) | FALL (m) | DROP IL (m) | SLOPE (1/X) | DIA. (mm) | US DEPTH (m) | DS DEPTH (m) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.000 | SWMH–S1 | SWMH–S2 | 51.311 | 25.910 | 25.397 | 0.5130 | 0.0750 | 1:100 | 225 | 0.8650 | 0.6780 |
| 4.001 | SWMH–S2 | SWMH–S3 | 27.017 | 25.322 | 24.241 | 1.0810 | | 1:25 | 300 | 0.6780 | 0.4590 |
| 4.002 | SWMH–S3 | SWMH–S4 | 10.750 | 24.399 | 23.572 | 0.8270 | 0.1660 | 1:13 | 300 | 0.3010 | 0.6280 |
| 4.003 | SWMH–S4 | SWMH–S5 | 20.650 | 23.406 | 22.902 | 0.5040 | 0.0750 | 1:41 | 300 | 0.7940 | 0.7980 |
| 4.004 | SWMH–S5 | SWMH–S6 | 13.777 | 22.827 | 22.474 | 0.3530 | | 1:39 | 375 | 0.7980 | 0.8010 |
| 4.005 | SWMH–S6 | SWMH–S7 | 28.562 | 22.474 | 22.188 | 0.2860 | | 1:100 | 375 | 0.8010 | 0.8870 |
| 4.006 | SWMH–S7 | SWMH–S8 | 45.000 | 22.188 | 22.112 | 0.0760 | | 1:235.6 | 450 | 0.8120 | 3.5130 |
| 4.007 | SWMH–S8 | SWMH–S9 | 12.454 | 22.112 | 21.921 | 0.1910 | 0.0520 | 1:65 | 450 | 3.5130 | 3.6290 |
| 4.008 | SWMH–S9 | SWMH–10 | 13.734 | 21.869 | 21.811 | 0.0580 | | 1:125 | 450 | 3.6810 | 5.2390 |
| 4.009 | SWMH–10 | UC TANK 1 | 24.101 | 21.811 | 21.711 | 0.1000 | 0.1470 | 1:212.5 | 450 | 5.2390 | 5.8390 |
| 2.000 | UC TANK 1 | SWMH–S11 | 34.138 | 21.564 | 21.360 | 0.2040 | | 1:167 | 225 | 6.2110 | 5.9150 |
| 2.001 | SWMH–S11 | SWMH–S12 | 12.679 | 21.360 | 21.284 | 0.0760 | | 1:167 | 225 | 5.9150 | 5.3910 |
| 2.002 | SWMH–S12 | SWMH–S13 | 18.030 | 21.284 | 21.176 | 0.1080 | | 1:167 | 225 | 5.3910 | 4.6990 |
| 2.003 | SWMH–S13 | SWMH–S14 | 24.266 | 21.176 | 21.031 | 0.1450 | 0.0250 | 1:167.4 | 225 | 4.6990 | 3.8940 |
| 2.004 | SWMH–S14 | SWMH–S15 | 18.556 | 21.006 | 20.895 | 0.1110 | | 1:167.2 | 250 | 3.8940 | 3.3050 |
| 2.005 | SWMH–S15 | SWMH–S25 | 19.000 | 20.895 | 20.686 | 0.2090 | 0.0500 | 1:91 | 250 | 3.3050 | 3.0640 |
| 2.006 | SWMH–S25 | SWMH–S16 | 19.975 | 20.636 | 20.416 | 0.2200 | | 1:90.8 | 300 | 3.0640 | 2.2840 |
| 2.007 | SWMH–S16 | SWMH–S17 | 14.000 | 20.416 | 20.157 | 0.2590 | 4.2740 | 1:54 | 300 | 2.2840 | 2.0430 |
| 2.008 | SWMH–S17 | UC TANK 2 | 23.480 | 15.883 | 15.100 | 0.7830 | 0.4000 | 1:30 | 300 | 6.3170 | 0.6000 |
| 2.009 | UC TANK 2 | OUTFALL 1 | 20.375 | 14.700 | 14.466 | 0.2340 | | 1:87 | 375 | 0.9250 | 0.4090 |
| 3.000 | SWALE | SWMH–S15 | 9.448 | 23.000 | 22.906 | 0.0940 | | 1:100 | 225 | 1.0250 | –1.6310 |
| 5.000 | SWMH–S3A | SWMH–S3 | 39.434 | 25.400 | 24.409 | 0.9910 | | 1:28 | 225 | 0.3750 | 0.3660 |
| 6.000 | SWMH–S4B | SWMH–S4A | 14.820 | 25.850 | 24.368 | 1.4820 | | 1:10 | 225 | 0.6750 | 0.6570 |
| 6.001 | SWMH–S4A | SWMH–S4 | 11.537 | 24.368 | 23.481 | 0.8870 | | 1:13 | 225 | 0.6570 | 0.7940 |
| 7.000 | SWMH–S9B | SWMH–S9A | 20.500 | 25.000 | 23.633 | 1.3670 | | 1:15 | 225 | 1.2750 | 0.6420 |
| 7.001 | SWMH–S9A | SWMH–S9 | 11.742 | 23.633 | 23.584 | 0.0490 | | 1:240 | 225 | 0.6420 | 2.1910 |
| 8.000 | SWMH–S24 | UC TANK 2 | 14.927 | 15.600 | 15.407 | 0.1930 | | 1:77 | 225 | 0.6750 | 0.3680 |
| 1.000 | SWMH–S20C | SWMH–S20B | 21.000 | 20.475 | 20.351 | 0.1240 | | 1:170 | 225 | 1.0000 | 0.1240 |
| 1.001 | SWMH–S20B | SWMH–S20A | 11.500 | 20.351 | 20.294 | 0.0570 | 0.7440 | 1:200 | 225 | 0.1240 | –0.3690 |
| 1.002 | SWMH–S20A | SWMH–S20 | 27.000 | 19.550 | 18.650 | 0.9000 | 1.2650 | 1:30 | 225 | 0.3750 | 0.3250 |
| 1.003 | SWMH–S20 | SWMH–S21 | 7.000 | 17.385 | 17.350 | 0.0350 | | 1:200 | 300 | 1.5150 | 1.3500 |
| 1.004 | SWMH–S21 | LC TANK | 7.597 | 17.350 | 17.262 | 0.0880 | 0.9250 | 1:86.5 | 300 | 1.3500 | 1.0680 |
| 1.005 | LC TANK | OUTFALL 2 | 12.279 | 16.337 | 15.674 | 0.6630 | | 1:40.7 | 300 | 1.9930 | 0.0260 |
| 2.000 | SWMH–S18 | SWMH–S19 | 18.000 | 17.600 | 17.510 | 0.0900 | | 1:200 | 225 | 0.5750 | 1.2650 |
| 2.001 | SWMH–S19 | SWMH–S20 | 10.000 | 17.510 | 17.460 | 0.0500 | | 1:200 | 225 | 1.2650 | 1.5150 |

### GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES (mm) UNLESS OTHER NOTED
2. ALL LEVELS ARE IN METERS AND RELATE TO THE ORDANCE SURVEY DATUM.
3. FOR LONGSECTION CHAINAGE & LEVELS, REFER TO DWG NO. W3683–DR–1025.
4. FULL DETAIL OF TUNNEL AND SERVICES CO–ORDINATION TO BE PROVIDED WITH FULL PLANNING PERMISSION.
5. ALL PIPE DETAILS SHALL BE IN ACCORDANCE WITH IRISH WATER CODE OF PRACTICE FOR WASTEWATER INFRASTRUCTURE AND IRISH WATER STANDARD DETAILS.
6. PIPE BEDDING SHALL COMPLY WITH WIS 4–08–02 AND IGN 4–08–01.
7. PIPES SHALL NOT BE SUPPORTED ON STONES OR ROCKS, OR ANY HARD OBJECT AT ANY POINT ALONG THE TRENCH. ROCK SHALL BE EXCAVATED TO A DEPTH OF 150mm BELOW THE ACTUAL DEPTH OF THE TRENCH WITH THE VOID FILLED WITH CLAUSE 804 MATERIAL IN ACCORDANCE WITH THE NATIONAL ROADS AUTHORITY SPECIFICATION FOR ROAD WORKS. THE GRANULAR MATERIAL SHALL BE LAID ABOVE THIS VOID BACKFILL MATERIAL.
8. SHOULD PIPES HAVE MINIMUM COVER OF LESS THAN 800mm, CONCRETE GRADE C8/10 SHALL BE USED AS BACKFILL MATERIAL.
9. ALL WORKS OUTSIDE OF THE BOUNDARY ARE TO BE CARRIED OUT BY IRISH WATER.
10. WHERE SEPARATION DISTANCE BETWEEN PIPE CROSSINGS ARE LESS THAN 300mm CONCRETE SURROUND IS TO BE PROVIDED IN ACCORDANCE WITH STD–WW–08 OF IRISH WATER CODE OF PRACTICE.
11. GIVEN THE PROXIMITY OF TREES, FOR TREE ROOT PROTECTION, TRENCHLESS ACTIVITIES TO BE CONSIDERED BY CONTRACTOR.
12. THE DESIGN HAS ACCOUNTED FOR SITE SPECIFIC GROUND CONDITIONS, IDENTIFIED FROM THE IGSL GROUND INVESTIGATION REPORT, MAY 2022.
13. ROAD GULLIES WILL CONNECT INTO THE PROPOSED TREE PITS AND FILTER DRAINS AS SHOWN ON DWG W3683–DR–1018. FOR TREE PIT DETAILS SEE DWG W3683–DR–1030.

LEGEND:

- SITE BOUNDARY
- ADJACENT SITE IN OWNERSHIP OF APPLICANT
- OUTLINE OF PROPOSED BUILDINGS
- OUTLINE OF U/G EXCAVATION
- ATTENUATION TANK
- GREEN/BLUE ROOF
- PAVING
- ATS–NETLON OR SIMILAR APPROVED EMERGENCY ACCESS

| Rev | Date | Description | By | Chk | App |
|---|---|---|---|---|---|
| 07 | 04/10/22 | ISSUE FOR INFORMATION | LT | RT | AG |
| 06 | 21/09/22 | ISSUE FOR INFORMATION | LT | RT | AG |
| 05 | 05/09/22 | ISSUE FOR INFORMATION | LT | RT | AG |
| 04 | 01/09/22 | ISSUE FOR INFORMATION | LT | RT | AG |
| 03 | 16/08/22 | ISSUE FOR INFORMATION | LT | RT | AG |
| 02 | 11/05/22 | ISSUE FOR INFORMATION | LT | RT | AG |
| 01 | 27/04/22 | ISSUE FOR INFORMATION | LT | RT | AG |
| 00 | 29/03/22 | ISSUE FOR INFORMATION | LT | RT | AG |

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CLIENT
GEDV MONKSTOWN OWNER LIMITED

PROJECT
RESIDENTIAL DEVELOPMENT ON LANDS OF DALGUISE HOUSE

DRAWING TITLE
PROPOSED UTILITIES PLAN
SURFACE WATER DRAINAGE LAYOUT

STATUS
FOR INFORMATION

| Date 29/03/22 | Scale AS SHOWN | Drawn: LT | Chk: RT | App: AG |
|---|---|---|---|---|
| Project No: W3683 | Drg. No: W3683–DR–1014 | | | Rev: 07 |

# Appendix B – Foul Drainage Calculations

| BYRNELOOBY | Project | Dalguise Monkstown | Job No. | W3683 | | |
|---|---|---|---|---|---|---|
| | | | Made By | AG | Date | 30/08/2022 |
| | Calc. Title | Site Foul Drainage | Chkd By | | Date | |
| | | | Sheet No. | 1 | Rev | 2 |

| Reference | Calculations | Output |
|---|---|---|

**Existing Site Foul Drainage**

Total Site Area = 3.58 hectares

Existing Units = 7 (Dalguise house, gate lodges, Coach House, and White Lodge)

Average daily demand per unit = 2.70 plp/unit

Total = 18.9 persons

@ 150l/plp/day = 2835 l/day

= 0.03281 l/s

Existing Average daily discharge = 0.03 l/s

Peak Domestic Discharge = 0.03 x 3 = 0.10 l/s

**Proposed Devlopment**

based on Irish Water guidelines

Proposed new no. units = 493 (11 apartment blocks and 3 terraced houses)

Average daily demand per unit = 2.70 plp/unit

Total = 1331 persons

@ 150l/plp/day = 199665 l/day

= 2.31094 l/s

Proposed Average daily discharge = 2.31 l/s

Creche = 121 persons

@ 60 l/plp/day = 7260 l/day

Average Non-Domestic Discharge = 0.084 l/s

Peaking Factor (as per IW COP) => Domestic = 3, Non-Domestic = 4.5

Peak Domestic Discharge = 2.28 x 3 = 6.93 l/s

Peak Non-Domestic Discharge = 0.084 x 4.5 = 0.38 l/s

TOTAL PEAK DESIGN FLOW = 7.409 l/s

Dalguise House taken as 3no. Units. Allowance of 4no. Units taken for the Coach House and gate lodge = 7 units total.

# Appendix C – Water Demand Calculations

| | | | | | |
|---|---|---|---|---|---|
| BYRNELOOBY | Project | Dalguise Monkstown | Job No. | W3683 | |
| | | | Made By | AG | Date 05/06/2023 |
| | Calc. Title | Site Water Demand | Chkd By | | Date |
| | | | Sheet No. | 1 | Rev |

| Reference | Calculations | Output |
|---|---|---|
| | Using IW-CDS-5020-03 | |
| | **Existing Site Foul Drainage** | Dalguise House taken as 3no. Units. Allowance of 4no. Units taken for the Coach House and gate lodge = 7 units total. |
| | Total Site Area = 3.58 hectares | |
| | Existing Units = 7 (Dalguise house, 2 gate lodges, Coach House, and White Lodge) | |
| | Average daily demand per unit = 2.70 plp/unit | |
| | Total = 18.9 plp | |
| | @ 150l/plp/day = 2835 l/day | |
| | = 0.03281 l/s | |
| | Average Daily demand (1.25 domestic demand) = 0.04 l/s | |
| | Peak Daily Demand (5 times average demand) = 0.205 l/s | |
| | **Proposed Devlopment** | |
| | Proposed new no. units = 486 (11 apartment blocks and 3 houses) | |
| | Total no. of units on site = 493 | |
| | Average daily demand per unit = 2.70 plp/unit | |
| | Total = 1331 plp | |
| | @ 150l/plp/day = 199665 l/day | |
| | = 2.31094 l/s | |
| | Average Daily demand (1.25 domestic demand) = 2.89 l/s | |
| | Peak Daily Deman (5 times average demand) = 14.443 l/s | |
| | Mixed Use: | |
| | Creche - 36 children + 10 staff = 46 plp | |
| | @ 60 l/plp/day = 2760 l/day | |
| | = 0.03194 l/s | |
| | Average Daily demand (1.25 domestic demand) = 0.04 l/s | |
| | Peak Daily Demand (5 times average demand) = 0.200 l/s | |
| | Management Office - 5 No. Staff = 5 plp | |
| | @ 50 l/plp/day = 250 l/day | |
| | = 0.00289 l/s | |
| | Average Daily demand (1.25 domestic demand) = 0.004 l/s | |
| | Peak Daily Demand (5 times average demand) = 0.018 l/s | |
| | Leisure Suite - 65 no. people = 65 plp | |
| | @ 60 l/plp/day = 3900 l/day | |
| | = 0.04514 l/s | |
| | Average Daily demand (1.25 domestic demand) = 3.02 l/s | |
| | Peak Daily Demand (5 times average demand) = 15.092 l/s | |

BYRNELOOBY

| Project | | Job No. | | | |
|---|---|---|---|---|---|
| | | Made By | | Date | |
| Calc. Title | | Chkd By | | Date | |
| | | Sheet No. | | Rev | |

| Reference | Calculations | Output |
|---|---|---|

**Water tank Sizing**

All units shall have facilities for a minimum water storage capacity of 24- hour water demand. The tank volume should meet the daily demand

Average daily demand (+20% for ballcock location) = 299498 l/day

| Blocks | Units (each) | Average Daily Demand | | Tank Format 30 sizing | Volume (L) |
|---|---|---|---|---|---|
| A | 19 | 11542.5 | l/day | 3 x 3 x 1.5m high | 13500 |
| B | 48 | 29160 | l/day | 4.5 x 4.5 x 1.5m high | 30375 |
| C | 48 | 29160 | l/day | 4.5 x 4.5 x 1.5m high | 30375 |
| D | 52 | 31590 | l/day | 5 x 4.5 x 1.5m high | 33750 |
| E | 66 | 40095 | l/day | 5.5 x 5.5 x 1.5m high | 45375 |
| F | 76 | 46170 | l/day | 6 x 5.5 x 1.5m high | 49500 |
| G | 76 | 46170 | l/day | 6 x 5.5 x 1.5m high | 49500 |
| H | 54 | 32805 | l/day | 5 x 5 x 1.5m high | 37500 |
| $I_1$ | 12 | 7290 | l/day | 3 x 2.5 x 1.5m high | 11250 |
| $I_2$ | 12 | 7290 | l/day | 3 x 2.5 x 1.5m high | 11250 |
| J | 22 | 13365 | l/day | 3 x3 x 1.5m high | 13500 |
| Existing | 7 | 4252.5 | l/day | 2.5 x 2 x 1m high | 5000 |
| Creche | 1 | 607.5 | l/day | 1.67 x 0.939 x 0.812m | 1273 |
| 3 Houses | 1 | 607.5 | l/day | 1.67 x 0.939 x 0.812m | 1273 |
| | Size/house | | | | |

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# Appendix D – MicroDrainage Results

# Appendix D1 – Upper Catchment

Print | Close Report

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| Calculated by: | Gearoid O Sullivan |
| Site name: | Upper Catchment |
| Site location: | Monkstown |

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

### Site Details

| | |
|---|---|
| Latitude: | 53.29243° N |
| Longitude: | 6.15759° W |
| Reference: | 3608911440 |
| Date: | Jun 16 2022 11:32 |

**Runoff estimation approach** IH124

### Site characteristics

Total site area (ha): 1.384

### Methodology

$Q_{BAR}$ estimation method: Calculate from SPR and SAAR

SPR estimation method: Calculate from SOIL type

### Soil characteristics

| | Default | Edited |
|---|---|---|
| SOIL type: | 4 | 4 |
| HOST class: | N/A | N/A |
| SPR/SPRHOST: | 0.47 | 0.47 |

### Hydrological characteristics

| | Default | Edited |
|---|---|---|
| SAAR (mm): | 881 | 900 |
| Hydrological region: | 12 | 12 |
| Growth curve factor 1 year: | 0.85 | 0.85 |
| Growth curve factor 30 years: | 2.13 | 2.13 |
| Growth curve factor 100 years: | 2.61 | 2.61 |
| Growth curve factor 200 years: | 2.86 | 2.86 |

### Notes

**(1) Is $Q_{BAR}$ < 2.0 l/s/ha?**

When $Q_{BAR}$ is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

**(2) Are flow rates < 5.0 l/s?**

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

**(3) Is SPR/SPRHOST ≤ 0.3?**

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

### Greenfield runoff rates

| | Default | Edited |
|---|---|---|
| $Q_{BAR}$ (l/s): | 8.74 | 8.97 |
| 1 in 1 year (l/s): | 7.43 | 7.62 |
| 1 in 30 years (l/s): | 18.63 | 19.1 |
| 1 in 100 year (l/s): | 22.82 | 23.4 |
| 1 in 200 years (l/s): | 25.01 | 25.64 |

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | PIMP (%) | 100 |
| M5-60 (mm) | 16.200 | Add Flow / Climate Change (%) | 20 |
| Ratio R | 0.277 | Minimum Backdrop Height (m) | 0.100 |
| Maximum Rainfall (mm/hr) | 50 | Maximum Backdrop Height (m) | 20.000 |
| Maximum Time of Concentration (mins) | 30 | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha) | 0.000 | Min Vel for Auto Design only (m/s) | 1.00 |
| Volumetric Runoff Coeff. | 1.000 | Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

### Time Area Diagram for Storm at outfall (pipe 2.009)

| **Time (mins)** | **Area (ha)** | **Time (mins)** | **Area (ha)** |
|---|---|---|---|
| 0-4 | 0.424 | 4-8 | 0.149 |

Total Area Contributing (ha) = 0.574

Total Pipe Volume (m³) = 12.074

### Time Area Diagram at outfall 11 (pipe 4.011)

| **Time (mins)** | **Area (ha)** | **Time (mins)** | **Area (ha)** |
|---|---|---|---|
| 0-4 | 0.448 | 4-8 | 0.362 |

Total Area Contributing (ha) = 0.810

Total Pipe Volume (m³) = 34.638

### Network Design Table for Storm

# - Indicates pipe length does not match coordinates

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

### Network Results Table

Network Design Table for Storm

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

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 34.138 | 0.204 | 167.0 | 0.100 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.001 | 12.679 | 0.076 | 167.0 | 0.020 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.002 | 18.030 | 0.108 | 167.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.003 | 24.266 | 0.145 | 167.4 | 0.060 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.004 | 18.556 | 0.111 | 167.2 | 0.008 | 0.00 | 0.0 | 0.600 | o | 250 | Pipe/Conduit | |
| 3.000 | 9.448 | 0.094 | 100.0 | 0.000 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.005 | 19.000 | 0.209 | 91.0 | 0.100 | 0.00 | 0.0 | 0.600 | o | 250 | Pipe/Conduit | |
| 2.006 | 19.975 | 0.220 | 90.8 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.007 | 14.000 | 0.259 | 54.0 | 0.080 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.008 | 23.480 | 0.783 | 30.0 | 0.196 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.009 | 20.375# | 0.234 | 87.1 | 0.000 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 4.000 | 51.311 | 0.513 | 100.0 | 0.120 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 4.001 | 27.017 | 1.081 | 25.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 5.000 | 27.750 | 0.991 | 28.0 | 0.100 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 4.002 | 10.750 | 0.827 | 13.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 6.000 | 14.820 | 1.482 | 10.0 | 0.035 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 50.00 | 4.56 | 21.564 | 0.100 | 0.0 | 0.0 | 3.6 | 1.01 | 40.1 | 21.7 |
| 2.001 | 49.72 | 4.77 | 21.360 | 0.120 | 0.0 | 0.0 | 4.3 | 1.01 | 40.1 | 25.9 |
| 2.002 | 48.63 | 5.07 | 21.284 | 0.130 | 0.0 | 0.0 | 4.6 | 1.01 | 40.1 | 27.4 |
| 2.003 | 47.25 | 5.47 | 21.176 | 0.190 | 0.0 | 0.0 | 6.5 | 1.01 | 40.1 | 38.9 |
| 2.004 | 46.32 | 5.76 | 21.006 | 0.198 | 0.0 | 0.0 | 6.6 | 1.08 | 53.0 | 39.6 |
| 3.000 | 50.00 | 4.12 | 23.000 | 0.000 | 0.0 | 0.0 | 0.0 | 1.31 | 52.0 | 0.0 |
| 2.005 | 45.66 | 5.97 | 20.895 | 0.298 | 0.0 | 0.0 | 9.8 | 1.47 | 72.0 | 58.9 |
| 2.006 | 45.05 | 6.18 | 20.636 | 0.298 | 0.0 | 0.0 | 9.8 | 1.65 | 116.7 | 58.9 |
| 2.007 | 44.74 | 6.29 | 20.416 | 0.378 | 0.0 | 0.0 | 12.2 | 2.14 | 151.6 | 73.2 |
| 2.008 | 44.35 | 6.42 | 15.883 | 0.574 | 0.0 | 0.0 | 18.4 | 2.88 | 203.7 | 110.2 |
| 2.009 | 43.86 | 6.60 | 14.700 | 0.574 | 0.0 | 0.0 | 18.4 | 1.94 | 214.6 | 110.2 |
| 4.000 | 50.00 | 4.65 | 25.910 | 0.120 | 0.0 | 0.0 | 4.3 | 1.31 | 52.0 | 26.0 |
| 4.001 | 49.63 | 4.80 | 25.322 | 0.120 | 0.0 | 0.0 | 4.3 | 3.16 | 223.2 | 26.0 |
| 5.000 | 50.00 | 4.19 | 25.400 | 0.100 | 0.0 | 0.0 | 3.6 | 2.48 | 98.7 | 21.7 |
| 4.002 | 49.48 | 4.84 | 24.399 | 0.220 | 0.0 | 0.0 | 7.9 | 4.38 | 309.9 | 47.2 |
| 6.000 | 50.00 | 4.06 | 25.850 | 0.035 | 0.0 | 0.0 | 1.3 | 4.16 | 165.5 | 7.6 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.001 | 11.537 | 0.887 | 13.0 | 0.030 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 4.003 | 20.650 | 0.504 | 41.0 | 0.060 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 4.004 | 13.777 | 0.353 | 39.0 | 0.045 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 4.005 | 28.562# | 0.095 | 300.0 | 0.024 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 4.006 | 45.000# | 0.191 | 235.6 | 0.000 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 4.007 | 45.000 | 0.191 | 235.6 | 0.143 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |
| 4.008 | 12.454 | 0.052 | 239.5 | 0.020 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |
| 7.000 | 20.500 | 1.367 | 15.0 | 0.041 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 7.001 | 11.742 | 0.049 | 240.0 | 0.062 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 4.009 | 13.734 | 0.057 | 240.0 | 0.030 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |
| 4.010 | 21.254 | 0.100 | 212.5 | 0.100 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |
| 4.011 | 4.317 | 0.100 | 43.2 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 6.001 | 50.00 | 4.11 | 24.368 | 0.065 | 0.0 | 0.0 | 2.3 | 3.65 | 145.1 | 14.1 |
| 4.003 | 48.97 | 4.98 | 23.406 | 0.345 | 0.0 | 0.0 | 12.2 | 2.46 | 174.1 | 73.2 |
| 4.004 | 48.68 | 5.06 | 22.827 | 0.390 | 0.0 | 0.0 | 13.7 | 2.91 | 321.2 | 82.3 |
| 4.005 | 47.11 | 5.51 | 22.474 | 0.414 | 0.0 | 0.0 | 14.1 | 1.04 | 115.0 | 84.5 |
| 4.006 | 45.13 | 6.15 | 22.378 | 0.414 | 0.0 | 0.0 | 14.1 | 1.18 | 129.9 | 84.5 |
| 4.007 | 43.52 | 6.72 | 22.112 | 0.557 | 0.0 | 0.0 | 17.5 | 1.32 | 210.0 | 105.1 |
| 4.008 | 43.10 | 6.88 | 21.921 | 0.577 | 0.0 | 0.0 | 18.0 | 1.31 | 208.2 | 107.8 |
| 7.000 | 50.00 | 4.10 | 25.000 | 0.041 | 0.0 | 0.0 | 1.5 | 3.40 | 135.0 | 8.9 |
| 7.001 | 50.00 | 4.33 | 23.633 | 0.103 | 0.0 | 0.0 | 3.7 | 0.84 | 33.4 | 22.3 |
| 4.009 | 42.65 | 7.05 | 21.869 | 0.710 | 0.0 | 0.0 | 21.9 | 1.31 | 208.0 | 131.2 |
| 4.010 | 42.01 | 7.31 | 21.812 | 0.810 | 0.0 | 0.0 | 24.6 | 1.39 | 221.2 | 147.5 |
| 4.011 | 41.95 | 7.33 | 21.712 | 0.810 | 0.0 | 0.0 | 24.6 | 3.10 | 493.2 | 147.5 |

## Surcharged Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 2.009 | | 16.500 | 14.466 | 0.000 | 0 | 0 |

Datum (m) 15.490 Offset (mins) 0

## Surcharged Outfall Details for Storm

| Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| 288 | 15.400 | 864 | 15.400 | 1440 | 15.400 | 2016 | 15.400 | 2592 | 15.400 |
| 576 | 15.400 | 1152 | 15.400 | 1728 | 15.400 | 2304 | 15.400 | 2880 | 15.400 |

## Free Flowing Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 4.011 | 11 | 27.500 | 21.612 | 0.000 | 1350 | 0 |

## Simulation Criteria for Storm

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

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 2 |
| Number of Online Controls | 2 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Profile Type | Summer |
| Return Period (years) | 2 | Cv (Summer) | 1.000 |
| Region | Scotland and Ireland | Cv (Winter) | 1.000 |
| M5-60 (mm) | 16.200 | Storm Duration (mins) | 30 |
| Ratio R | 0.277 | | |

## Online Controls for Storm

### Hydro-Brake® Optimum Manhole: 20, DS/PN: 2.009, Volume (m³): 10.4

| | |
|---|---|
| Unit Reference | MD-SHE-0131-8900-1500-8900 |
| Design Head (m) | 1.500 |
| Design Flow (l/s) | 8.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 131 |
| Invert Level (m) | 14.700 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.500 | 8.9 |
| Flush-Flo™ | 0.441 | 8.8 |
| Kick-Flo® | 0.926 | 7.1 |
| Mean Flow over Head Range | - | 7.7 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 4.7 | 1.200 | 8.0 | 3.000 | 12.3 | 7.000 | 18.5 |
| 0.200 | 8.0 | 1.400 | 8.6 | 3.500 | 13.3 | 7.500 | 19.1 |
| 0.300 | 8.6 | 1.600 | 9.2 | 4.000 | 14.1 | 8.000 | 19.7 |
| 0.400 | 8.8 | 1.800 | 9.7 | 4.500 | 14.9 | 8.500 | 20.3 |
| 0.500 | 8.8 | 2.000 | 10.2 | 5.000 | 15.7 | 9.000 | 20.8 |
| 0.600 | 8.7 | 2.200 | 10.6 | 5.500 | 16.4 | 9.500 | 21.4 |
| 0.800 | 8.1 | 2.400 | 11.1 | 6.000 | 17.1 | | |
| 1.000 | 7.3 | 2.600 | 11.5 | 6.500 | 17.8 | | |

### Hydro-Brake® Optimum Manhole: 28, DS/PN: 4.011, Volume (m³): 11.5

| | |
|---|---|
| Unit Reference | MD-SHE-0100-5200-1500-5200 |
| Design Head (m) | 1.500 |
| Design Flow (l/s) | 5.2 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 100 |
| Invert Level (m) | 21.712 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

## Hydro-Brake® Optimum Manhole: 28, DS/PN: 4.011, Volume ($m^3$): 11.5

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.500 | 5.2 |
| Flush-Flo™ | 0.439 | 5.1 |
| Kick-Flo® | 0.894 | 4.1 |
| Mean Flow over Head Range | - | 4.5 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 3.3 | 1.200 | 4.7 | 3.000 | 7.2 | 7.000 | 10.7 |
| 0.200 | 4.6 | 1.400 | 5.0 | 3.500 | 7.7 | 7.500 | 11.1 |
| 0.300 | 5.0 | 1.600 | 5.4 | 4.000 | 8.2 | 8.000 | 11.4 |
| 0.400 | 5.1 | 1.800 | 5.7 | 4.500 | 8.7 | 8.500 | 11.8 |
| 0.500 | 5.1 | 2.000 | 5.9 | 5.000 | 9.1 | 9.000 | 12.1 |
| 0.600 | 5.0 | 2.200 | 6.2 | 5.500 | 9.6 | 9.500 | 12.4 |
| 0.800 | 4.6 | 2.400 | 6.5 | 6.000 | 10.0 | | |
| 1.000 | 4.3 | 2.600 | 6.7 | 6.500 | 10.4 | | |

## Storage Structures for Storm

### Tank or Pond Manhole: 20, DS/PN: 2.009

Invert Level (m) 14.700

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|---|---|
| 0.000 | 400.0 | 1.000 | 400.0 | 1.200 | 400.0 | 1.500 | 400.0 |

### Tank or Pond Manhole: 28, DS/PN: 4.011

Invert Level (m) 21.761

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|
| 0.000 | 260.0 | 1.000 | 260.0 | 1.500 | 260.0 |

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

### Simulation Criteria

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

Number of Input Hydrographs 0 Number of Storage Structures 2
Number of Online Controls 2 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.277
Region Scotland and Ireland Cv (Summer) 1.000
M5-60 (mm) 16.200 Cv (Winter) 1.000

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 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) |
|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 12 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 22.988 |
| 2.001 | 13 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 22.751 |
| 2.002 | 14 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 22.614 |
| 2.003 | 15 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 22.421 |
| 2.004 | 15 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 21.887 |
| 3.000 | 6 | 15 Summer | 100 | +20% | | | | | 23.000 |
| 2.005 | 16 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 21.641 |
| 2.006 | 7 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 21.014 |
| 2.007 | 17 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 20.769 |
| 2.008 | 19 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 16.719 |
| 2.009 | 20 | 2880 Winter | 100 | +20% | 100/30 Summer | | | | 16.448 |
| 4.000 | 1 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 26.389 |
| 4.001 | 2 | 15 Summer | 100 | +20% | | | | | 25.433 |
| 5.000 | 3A | 15 Summer | 100 | +20% | | | | | 25.525 |
| 4.002 | 3 | 15 Summer | 100 | +20% | | | | | 24.548 |
| 6.000 | 4B | 15 Summer | 100 | +20% | | | | | 25.904 |
| 6.001 | 4A | 15 Summer | 100 | +20% | | | | | 24.450 |
| 4.003 | 4 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 24.280 |
| 4.004 | 5 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 23.802 |

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

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 12 | 1.199 | 0.000 | 1.11 | | | 42.1 | SURCHARGED | |
| 2.001 | 13 | 1.167 | 0.000 | 1.36 | | | 46.9 | SURCHARGED | |
| 2.002 | 14 | 1.105 | 0.000 | 1.41 | | | 50.5 | SURCHARGED | |
| 2.003 | 15 | 1.020 | 0.000 | 1.89 | | | 69.8 | SURCHARGED | |
| 2.004 | 15 | 0.631 | 0.000 | 1.58 | | | 74.1 | SURCHARGED | |
| 3.000 | 6 | -0.225 | 0.000 | 0.00 | | | 0.0 | OK | |
| 2.005 | 16 | 0.497 | 0.000 | 1.69 | | | 108.1 | SURCHARGED | |
| 2.006 | 7 | 0.078 | 0.000 | 1.07 | | | 109.1 | SURCHARGED | |
| 2.007 | 17 | 0.053 | 0.000 | 1.09 | | | 136.7 | SURCHARGED | |
| 2.008 | 19 | 0.536 | 0.000 | 1.27 | | | 229.4 | SURCHARGED | |
| 2.009 | 20 | 1.373 | 0.000 | 0.05 | | | 8.8 | FLOOD RISK | |
| 4.000 | 1 | 0.254 | 0.000 | 1.20 | | | 59.6 | SURCHARGED | |
| 4.001 | 2 | -0.189 | 0.000 | 0.30 | | | 59.5 | OK | |
| 5.000 | 3A | -0.100 | 0.000 | 0.60 | | | 54.6 | OK | |
| 4.002 | 3 | -0.151 | 0.000 | 0.48 | | | 109.5 | OK | |
| 6.000 | 4B | -0.171 | 0.000 | 0.13 | | | 19.1 | OK | |
| 6.001 | 4A | -0.143 | 0.000 | 0.29 | | | 35.4 | OK | |
| 4.003 | 4 | 0.575 | 0.000 | 1.07 | | | 162.2 | FLOOD RISK | |
| 4.004 | 5 | 0.600 | 0.000 | 0.71 | | | 165.1 | FLOOD RISK | |

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

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. | Water Level (m) |
|---|---|---|---|---|---|---|---|---|---|
| 4.005 | 6 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 23.630 |
| 4.006 | 7 | 720 Winter | 100 | +20% | 100/15 Summer | | | | 23.446 |
| 4.007 | 7 | 720 Winter | 100 | +20% | 100/15 Summer | | | | 23.443 |
| 4.008 | 8 | 720 Winter | 100 | +20% | 100/15 Summer | | | | 23.441 |
| 7.000 | 9A | 15 Summer | 100 | +20% | | | | | 25.065 |
| 7.001 | 9B | 15 Summer | 100 | +20% | 100/15 Summer | | | | 23.988 |
| 4.009 | 9 | 720 Winter | 100 | +20% | 100/15 Summer | | | | 23.440 |
| 4.010 | 10 | 720 Winter | 100 | +20% | 100/15 Summer | | | | 23.438 |
| 4.011 | 28 | 720 Winter | 100 | +20% | 100/15 Summer | | | | 23.436 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 4.005 | 6 | 0.781 | 0.000 | 1.66 | | | 168.1 | FLOOD RISK | |
| 4.006 | 7 | 0.692 | 0.000 | 0.15 | | | 18.3 | FLOOD RISK | |
| 4.007 | 7 | 0.881 | 0.000 | 0.13 | | | 24.6 | SURCHARGED | |
| 4.008 | 8 | 1.070 | 0.000 | 0.17 | | | 25.4 | SURCHARGED | |
| 7.000 | 9A | -0.160 | 0.000 | 0.18 | | | 22.4 | OK | |
| 7.001 | 9B | 0.130 | 0.000 | 1.97 | | | 56.0 | SURCHARGED | |
| 4.009 | 9 | 1.121 | 0.000 | 0.20 | | | 31.5 | SURCHARGED | |
| 4.010 | 10 | 1.176 | 0.000 | 0.20 | | | 36.0 | SURCHARGED | |
| 4.011 | 28 | 1.274 | 0.000 | 0.03 | | | 5.5 | SURCHARGED | |

## Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 765 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 22.200 | 0.411 | 0.0 | 5.0 | 5.0 | 125.0 | O K |
| 30 min Summer | 22.357 | 0.568 | 0.0 | 5.0 | 5.0 | 172.7 | O K |
| 60 min Summer | 22.545 | 0.756 | 0.0 | 5.0 | 5.0 | 229.7 | O K |
| 120 min Summer | 22.711 | 0.922 | 0.0 | 5.0 | 5.0 | 280.3 | O K |
| 180 min Summer | 22.807 | 1.018 | 0.0 | 5.0 | 5.0 | 309.4 | O K |
| 240 min Summer | 22.870 | 1.081 | 0.0 | 5.0 | 5.0 | 328.7 | O K |
| 360 min Summer | 22.877 | 1.088 | 0.0 | 5.0 | 5.0 | 330.7 | O K |
| 480 min Summer | 22.956 | 1.167 | 0.0 | 5.0 | 5.0 | 354.6 | O K |
| 600 min Summer | 22.961 | 1.172 | 0.0 | 5.0 | 5.0 | 356.3 | O K |
| 720 min Summer | 22.956 | 1.167 | 0.0 | 5.0 | 5.0 | 354.9 | O K |
| 960 min Summer | 22.944 | 1.155 | 0.0 | 5.0 | 5.0 | 351.0 | O K |
| 1440 min Summer | 22.920 | 1.131 | 0.0 | 5.0 | 5.0 | 343.8 | O K |
| 2160 min Summer | 22.872 | 1.083 | 0.0 | 5.0 | 5.0 | 329.3 | O K |
| 2880 min Summer | 22.814 | 1.025 | 0.0 | 5.0 | 5.0 | 311.5 | O K |
| 4320 min Summer | 22.683 | 0.894 | 0.0 | 5.0 | 5.0 | 271.9 | O K |
| 5760 min Summer | 22.545 | 0.756 | 0.0 | 5.0 | 5.0 | 229.7 | O K |
| 7200 min Summer | 22.369 | 0.580 | 0.0 | 5.0 | 5.0 | 176.3 | O K |
| 8640 min Summer | 22.220 | 0.431 | 0.0 | 5.0 | 5.0 | 131.1 | O K |
| 10080 min Summer | 22.107 | 0.318 | 0.0 | 5.0 | 5.0 | 96.6 | O K |
| 15 min Winter | 22.200 | 0.411 | 0.0 | 5.0 | 5.0 | 124.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 84.984 | 0.0 | 141.1 | 42 |
| 30 min Summer | 58.807 | 0.0 | 192.0 | 58 |
| 60 min Summer | 38.241 | 0.0 | 255.2 | 86 |
| 120 min Summer | 24.146 | 0.0 | 320.6 | 138 |
| 180 min Summer | 18.293 | 0.0 | 366.0 | 196 |
| 240 min Summer | 14.994 | 0.0 | 401.1 | 252 |
| 360 min Summer | 11.296 | 0.0 | 429.2 | 362 |
| 480 min Summer | 9.227 | 0.0 | 493.1 | 486 |
| 600 min Summer | 7.882 | 0.0 | 527.5 | 598 |
| 720 min Summer | 6.928 | 0.0 | 556.6 | 650 |
| 960 min Summer | 5.650 | 0.0 | 604.9 | 782 |
| 1440 min Summer | 4.237 | 0.0 | 681.0 | 1046 |
| 2160 min Summer | 3.176 | 0.0 | 766.0 | 1464 |
| 2880 min Summer | 2.586 | 0.0 | 831.3 | 1884 |
| 4320 min Summer | 1.933 | 0.0 | 932.0 | 2720 |
| 5760 min Summer | 1.571 | 0.0 | 1009.8 | 3528 |
| 7200 min Summer | 1.338 | 0.0 | 1075.4 | 4264 |
| 8640 min Summer | 1.173 | 0.0 | 1130.1 | 4936 |
| 10080 min Summer | 1.049 | 0.0 | 1180.2 | 5592 |
| 15 min Winter | 84.984 | 0.0 | 130.3 | 22 |

## Summary of Results for 100 year Return Period (+20%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 30 min Winter | 22.452 | 0.663 | 0.0 | 5.0 | 5.0 | 201.5 | O K |
| 60 min Winter | 22.635 | 0.846 | 0.0 | 5.0 | 5.0 | 257.2 | O K |
| 120 min Winter | 22.846 | 1.057 | 0.0 | 5.0 | 5.0 | 321.3 | O K |
| 180 min Winter | 22.956 | 1.167 | 0.0 | 5.0 | 5.0 | 354.7 | O K |
| 240 min Winter | 23.027 | 1.238 | 0.0 | 5.0 | 5.0 | 376.4 | O K |
| 360 min Winter | 23.115 | 1.326 | 0.0 | 5.1 | 5.1 | 403.1 | O K |
| 480 min Winter | 23.157 | 1.368 | 0.0 | 5.2 | 5.2 | 416.0 | O K |
| 600 min Winter | 23.174 | 1.385 | 0.0 | 5.2 | 5.2 | 421.0 | O K |
| 720 min Winter | 23.176 | 1.387 | 0.0 | 5.2 | 5.2 | 421.6 | O K |
| 960 min Winter | 23.153 | 1.364 | 0.0 | 5.2 | 5.2 | 414.7 | O K |
| 1440 min Winter | 23.111 | 1.322 | 0.0 | 5.1 | 5.1 | 401.8 | O K |
| 2160 min Winter | 23.030 | 1.241 | 0.0 | 5.0 | 5.0 | 377.4 | O K |
| 2880 min Winter | 22.932 | 1.143 | 0.0 | 5.0 | 5.0 | 347.3 | O K |
| 4320 min Winter | 22.717 | 0.928 | 0.0 | 5.0 | 5.0 | 282.3 | O K |
| 5760 min Winter | 22.481 | 0.692 | 0.0 | 5.0 | 5.0 | 210.2 | O K |
| 7200 min Winter | 22.196 | 0.407 | 0.0 | 5.0 | 5.0 | 123.7 | O K |
| 8640 min Winter | 22.017 | 0.228 | 0.0 | 5.0 | 5.0 | 69.4 | O K |
| 10080 min Winter | 21.898 | 0.109 | 0.0 | 4.9 | 4.9 | 33.3 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 30 min Winter | 58.807 | 0.0 | 219.9 | 59 |
| 60 min Winter | 38.241 | 0.0 | 283.0 | 86 |
| 120 min Winter | 24.146 | 0.0 | 361.9 | 138 |
| 180 min Winter | 18.293 | 0.0 | 411.1 | 194 |
| 240 min Winter | 14.994 | 0.0 | 448.4 | 250 |
| 360 min Winter | 11.296 | 0.0 | 507.7 | 364 |
| 480 min Winter | 9.227 | 0.0 | 553.2 | 476 |
| 600 min Winter | 7.882 | 0.0 | 591.0 | 588 |
| 720 min Winter | 6.928 | 0.0 | 623.5 | 694 |
| 960 min Winter | 5.650 | 0.0 | 678.3 | 866 |
| 1440 min Winter | 4.237 | 0.0 | 763.0 | 1114 |
| 2160 min Winter | 3.176 | 0.0 | 858.1 | 1584 |
| 2880 min Winter | 2.586 | 0.0 | 930.9 | 2036 |
| 4320 min Winter | 1.933 | 0.0 | 1043.6 | 2944 |
| 5760 min Winter | 1.571 | 0.0 | 1132.4 | 3824 |
| 7200 min Winter | 1.338 | 0.0 | 1204.3 | 4408 |
| 8640 min Winter | 1.173 | 0.0 | 1266.0 | 5024 |
| 10080 min Winter | 1.049 | 0.0 | 1321.5 | 5608 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | Scotland and Ireland | Cv (Winter) | 0.840 |
| M5-60 (mm) | 16.200 | Shortest Storm (mins) | 15 |
| Ratio R | 0.277 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +20 |

## Pipe Network

| | | | |
|---|---|---|---|
| Volume in Pipe Network ($m^3$) | 24 | Dia of Outfall Pipe (m) | 0.2 |
| Slope of Outfall Pipe (1:X) | 150 | Roughness of Outfall Pipe (mm) | 0.600 |

## Time Area Diagram

Total Area (ha) 0.893

| Time From: | (mins) To: | Area (ha) | Time From: | (mins) To: | Area (ha) |
|---|---|---|---|---|---|
| 0 | 4 | 0.444 | 4 | 8 | 0.449 |

## Time Area Diagram

Total Area (ha) 0.000

| Time From: | (mins) To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.000 |

## Model Details

Storage is Online Cover Level (m) 26.750

## Cellular Storage Structure

Invert Level (m) 21.789 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 320.0 | 0.0 | 1.500 | 320.0 | 0.0 |
| 0.500 | 320.0 | 0.0 | 2.000 | 320.0 | 0.0 |
| 1.000 | 320.0 | 0.0 | | | |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0099-5200-1582-5200 |
| Design Head (m) | 1.582 |
| Design Flow (l/s) | 5.2 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 99 |
| Invert Level (m) | 21.564 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.582 | 5.2 |
| Flush-Flo™ | 0.433 | 5.0 |
| Kick-Flo® | 0.882 | 4.0 |
| Mean Flow over Head Range | - | 4.4 |

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 | 3.2 | 1.200 | 4.6 | 3.000 | 7.0 | 7.000 | 10.5 |
| 0.200 | 4.5 | 1.400 | 4.9 | 3.500 | 7.5 | 7.500 | 10.8 |
| 0.300 | 4.8 | 1.600 | 5.2 | 4.000 | 8.0 | 8.000 | 11.1 |
| 0.400 | 5.0 | 1.800 | 5.5 | 4.500 | 8.5 | 8.500 | 11.5 |
| 0.500 | 4.9 | 2.000 | 5.8 | 5.000 | 8.9 | 9.000 | 11.8 |
| 0.600 | 4.9 | 2.200 | 6.1 | 5.500 | 9.3 | 9.500 | 12.1 |
| 0.800 | 4.4 | 2.400 | 6.3 | 6.000 | 9.7 | | |
| 1.000 | 4.2 | 2.600 | 6.5 | 6.500 | 10.1 | | |

## 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 | 14.899 | 0.199 | 8.1 | 71.7 | O K |
| 30 min Summer | 14.960 | 0.260 | 8.5 | 93.5 | O K |
| 60 min Summer | 15.070 | 0.370 | 8.8 | 133.2 | O K |
| 120 min Summer | 15.155 | 0.455 | 8.8 | 163.7 | O K |
| 180 min Summer | 15.176 | 0.476 | 8.8 | 171.5 | O K |
| 240 min Summer | 15.195 | 0.495 | 8.8 | 178.3 | O K |
| 360 min Summer | 15.203 | 0.503 | 8.8 | 181.2 | O K |
| 480 min Summer | 15.202 | 0.502 | 8.8 | 180.5 | O K |
| 600 min Summer | 15.192 | 0.492 | 8.8 | 177.1 | O K |
| 720 min Summer | 15.180 | 0.480 | 8.8 | 172.7 | O K |
| 960 min Summer | 15.150 | 0.450 | 8.8 | 162.0 | O K |
| 1440 min Summer | 15.088 | 0.388 | 8.8 | 139.7 | O K |
| 2160 min Summer | 15.008 | 0.308 | 8.7 | 110.8 | O K |
| 2880 min Summer | 14.947 | 0.247 | 8.4 | 89.0 | O K |
| 4320 min Summer | 14.872 | 0.172 | 7.8 | 62.0 | O K |
| 5760 min Summer | 14.840 | 0.140 | 7.0 | 50.2 | O K |
| 7200 min Summer | 14.823 | 0.123 | 6.1 | 44.2 | O K |
| 8640 min Summer | 14.811 | 0.111 | 5.5 | 40.1 | O K |
| 10080 min Summer | 14.803 | 0.103 | 4.9 | 37.1 | O K |
| 15 min Winter | 14.919 | 0.219 | 8.2 | 78.9 | O K |
| 30 min Winter | 15.028 | 0.328 | 8.7 | 118.2 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 84.984 | 0.0 | 87.3 | 35 |
| 30 min Summer | 58.807 | 0.0 | 100.2 | 34 |
| 60 min Summer | 38.241 | 0.0 | 162.4 | 74 |
| 120 min Summer | 24.146 | 0.0 | 210.0 | 126 |
| 180 min Summer | 18.293 | 0.0 | 236.4 | 172 |
| 240 min Summer | 14.994 | 0.0 | 260.8 | 204 |
| 360 min Summer | 11.296 | 0.0 | 294.7 | 272 |
| 480 min Summer | 9.227 | 0.0 | 321.6 | 340 |
| 600 min Summer | 7.882 | 0.0 | 343.4 | 408 |
| 720 min Summer | 6.928 | 0.0 | 362.6 | 476 |
| 960 min Summer | 5.650 | 0.0 | 394.2 | 610 |
| 1440 min Summer | 4.237 | 0.0 | 443.2 | 870 |
| 2160 min Summer | 3.176 | 0.0 | 499.9 | 1240 |
| 2880 min Summer | 2.586 | 0.0 | 542.6 | 1592 |
| 4320 min Summer | 1.933 | 0.0 | 607.7 | 2276 |
| 5760 min Summer | 1.571 | 0.0 | 660.2 | 2960 |
| 7200 min Summer | 1.338 | 0.0 | 702.4 | 3688 |
| 8640 min Summer | 1.173 | 0.0 | 738.5 | 4416 |
| 10080 min Summer | 1.049 | 0.0 | 769.9 | 5144 |
| 15 min Winter | 84.984 | 0.0 | 95.1 | 35 |
| 30 min Winter | 58.807 | 0.0 | 139.2 | 48 |

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 | 15.118 | 0.418 | 8.8 | 150.6 | O K |
| 120 min Winter | 15.217 | 0.517 | 8.8 | 186.0 | O K |
| 180 min Winter | 15.252 | 0.552 | 8.8 | 198.7 | O K |
| 240 min Winter | 15.270 | 0.570 | 8.8 | 205.1 | O K |
| 360 min Winter | 15.274 | 0.574 | 8.8 | 206.5 | O K |
| 480 min Winter | 15.264 | 0.564 | 8.8 | 203.1 | O K |
| 600 min Winter | 15.246 | 0.546 | 8.8 | 196.5 | O K |
| 720 min Winter | 15.223 | 0.523 | 8.8 | 188.3 | O K |
| 960 min Winter | 15.172 | 0.472 | 8.8 | 169.9 | O K |
| 1440 min Winter | 15.072 | 0.372 | 8.8 | 133.9 | O K |
| 2160 min Winter | 14.957 | 0.257 | 8.5 | 92.4 | O K |
| 2880 min Winter | 14.884 | 0.184 | 7.9 | 66.3 | O K |
| 4320 min Winter | 14.830 | 0.130 | 6.5 | 46.8 | O K |
| 5760 min Winter | 14.810 | 0.110 | 5.4 | 39.4 | O K |
| 7200 min Winter | 14.798 | 0.098 | 4.6 | 35.2 | O K |
| 8640 min Winter | 14.790 | 0.090 | 4.0 | 32.3 | O K |
| 10080 min Winter | 14.784 | 0.084 | 3.6 | 30.1 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 60 min Winter | 38.241 | 0.0 | 180.8 | 74 |
| 120 min Winter | 24.146 | 0.0 | 233.8 | 126 |
| 180 min Winter | 18.293 | 0.0 | 266.1 | 180 |
| 240 min Winter | 14.994 | 0.0 | 292.8 | 230 |
| 360 min Winter | 11.296 | 0.0 | 330.9 | 292 |
| 480 min Winter | 9.227 | 0.0 | 360.6 | 368 |
| 600 min Winter | 7.882 | 0.0 | 385.1 | 444 |
| 720 min Winter | 6.928 | 0.0 | 406.2 | 518 |
| 960 min Winter | 5.650 | 0.0 | 441.7 | 660 |
| 1440 min Winter | 4.237 | 0.0 | 496.7 | 922 |
| 2160 min Winter | 3.176 | 0.0 | 560.0 | 1284 |
| 2880 min Winter | 2.586 | 0.0 | 607.9 | 1616 |
| 4320 min Winter | 1.933 | 0.0 | 680.9 | 2264 |
| 5760 min Winter | 1.571 | 0.0 | 739.5 | 2968 |
| 7200 min Winter | 1.338 | 0.0 | 786.8 | 3728 |
| 8640 min Winter | 1.173 | 0.0 | 827.3 | 4416 |
| 10080 min Winter | 1.049 | 0.0 | 862.7 | 5144 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | Scotland and Ireland | Cv (Winter) | 0.840 |
| M5-60 (mm) | 16.200 | Shortest Storm (mins) | 15 |
| Ratio R | 0.277 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +20 |

## Pipe Network

| | | | |
|---|---|---|---|
| Volume in Pipe Network (m³) | 24 | Dia of Outfall Pipe (m) | 0.2 |
| Slope of Outfall Pipe (1:X) | 150 | Roughness of Outfall Pipe (mm) | 0.600 |

## Time Area Diagram

Total Area (ha) 0.584

| **Time From:** | **(mins) To:** | **Area (ha)** | **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|---|---|---|
| 0 | 4 | 0.362 | 4 | 8 | 0.222 |

## Time Area Diagram

Total Area (ha) 0.000

| **Time From:** | **(mins) To:** | **Area (ha)** |
|---|---|---|
| 0 | 4 | 0.000 |

## Model Details

Storage is Online Cover Level (m) 16.000

## Tank or Pond Structure

Invert Level (m) 14.700

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|
| 0.000 | 360.0 | 1.000 | 360.0 |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0131-8900-1450-8900 |
| Design Head (m) | 1.450 |
| Design Flow (l/s) | 8.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 131 |
| Invert Level (m) | 14.700 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| **Control Points** | **Head (m)** | **Flow (l/s)** |
|---|---|---|
| Design Point (Calculated) | 1.450 | 8.9 |
| Flush-Flo™ | 0.424 | 8.8 |
| Kick-Flo® | 0.896 | 7.1 |
| Mean Flow over Head Range | - | 7.7 |

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

| **Depth (m)** | **Flow (l/s)** | **Depth (m)** | **Flow (l/s)** | **Depth (m)** | **Flow (l/s)** | **Depth (m)** | **Flow (l/s)** |
|---|---|---|---|---|---|---|---|
| 0.100 | 4.7 | 1.200 | 8.1 | 3.000 | 12.5 | 7.000 | 18.8 |
| 0.200 | 8.1 | 1.400 | 8.7 | 3.500 | 13.5 | 7.500 | 19.4 |
| 0.300 | 8.7 | 1.600 | 9.3 | 4.000 | 14.4 | 8.000 | 20.0 |
| 0.400 | 8.8 | 1.800 | 9.8 | 4.500 | 15.2 | 8.500 | 20.6 |
| 0.500 | 8.8 | 2.000 | 10.3 | 5.000 | 16.0 | 9.000 | 21.2 |
| 0.600 | 8.7 | 2.200 | 10.8 | 5.500 | 16.7 | 9.500 | 21.8 |
| 0.800 | 7.9 | 2.400 | 11.3 | 6.000 | 17.5 | | |
| 1.000 | 7.5 | 2.600 | 11.7 | 6.500 | 18.1 | | |

# Appendix D2 – Lower Catchment

# Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

| | |
|---|---|
| Calculated by: | Gearoid O Sullivan |
| Site name: | Lower Catchment |
| Site location: | Monkstown |

**Site Details**

| | |
|---|---|
| Latitude: | 53.29243° N |
| Longitude: | 6.15759° W |
| Reference: | 1911502431 |
| Date: | Jun 16 2022 11:34 |

This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013) , the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). This information on greenfield runoff rates may be the basis for setting consents for the drainage of surface water runoff from sites.

**Runoff estimation approach** IH124

**Site characteristics**

Total site area (ha): 0.185

**Methodology**

| | |
|---|---|
| $Q_{BAR}$ estimation method: | Calculate from SPR and SAAR |
| SPR estimation method: | Calculate from SOIL type |

| Soil characteristics | Default | Edited |
|---|---|---|
| SOIL type: | 4 | 4 |
| HOST class: | N/A | N/A |
| SPR/SPRHOST: | 0.47 | 0.47 |

| Hydrological characteristics | Default | Edited |
|---|---|---|
| SAAR (mm): | 881 | 900 |
| Hydrological region: | 12 | 12 |
| Growth curve factor 1 year: | 0.85 | 0.85 |
| Growth curve factor 30 years: | 2.13 | 2.13 |
| Growth curve factor 100 years: | 2.61 | 2.61 |
| Growth curve factor 200 years: | 2.86 | 2.86 |

**Notes**

**(1) Is $Q_{BAR}$ < 2.0 l/s/ha?**

When $Q_{BAR}$ is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

**(2) Are flow rates < 5.0 l/s?**

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

**(3) Is SPR/SPRHOST ≤ 0.3?**

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

| Greenfield runoff rates | Default | Edited |
|---|---|---|
| $Q_{BAR}$ (l/s): | 1.17 | 1.2 |
| 1 in 1 year (l/s): | 0.99 | 1.02 |
| 1 in 30 years (l/s): | 2.49 | 2.55 |
| 1 in 100 year (l/s): | 3.05 | 3.13 |
| 1 in 200 years (l/s): | 3.34 | 3.43 |

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | PIMP (%) | 100 |
| M5-60 (mm) | 16.200 | Add Flow / Climate Change (%) | 0 |
| Ratio R | 0.277 | Minimum Backdrop Height (m) | 0.100 |
| Maximum Rainfall (mm/hr) | 50 | Maximum Backdrop Height (m) | 20.000 |
| Maximum Time of Concentration (mins) | 30 | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha) | 0.000 | Min Vel for Auto Design only (m/s) | 1.00 |
| Volumetric Runoff Coeff. | 0.750 | Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

### Time Area Diagram for Storm

| Time (mins) | Area (ha) | Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|---|---|
| 0-4 | 0.370 | 4-8 | 0.774 | 8-12 | 0.081 |

Total Area Contributing (ha) = 1.225

Total Pipe Volume (m³) = 41.013

### Network Design Table for Storm

# - Indicates pipe length does not match coordinates
« - Indicates pipe capacity < flow

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 51.311 | 0.588 | 87.3 | 0.116 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.001 | 27.008 | 1.149 | 23.5 | 0.020 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 3.000 | 39.434 | 0.802 | 49.2 | 0.061 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 50.00 | 4.61 | 25.910 | 0.116 | 0.0 | 0.0 | 0.0 | 1.40 | 55.7 | 15.8 |
| 2.001 | 49.71 | 4.78 | 25.322 | 0.136 | 0.0 | 0.0 | 0.0 | 2.71 | 107.8 | 18.4 |
| 3.000 | 50.00 | 4.46 | 25.100 | 0.061 | 0.0 | 0.0 | 0.0 | 1.44 | 25.4 | 8.3 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.002 | 7.882 | 0.606 | 13.0 | 0.025 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 4.000 | 14.682 | 0.593 | 24.8 | 0.018 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 4.001 | 11.499 | 0.466 | 24.7 | 0.030 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.003 | 20.646 | 0.394 | 52.4 | 0.058 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.004 | 13.782 | 0.331 | 41.6 | 0.058 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.005 | 28.777 | 0.211 | 136.4 | 0.020 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.006 | 45.000 | 0.191 | 235.6 | 0.131 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.007 | 12.454 | 0.051 | 244.2 | 0.059 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.008 | 23.804 | 0.068 | 350.0 | 0.040 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.009 | 16.521 | 0.100 | 165.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.010 | 10.186# | 0.103 | 99.2 | 0.112 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 5.000 | 13.201# | 0.066 | 200.0 | 0.020 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 5.001 | 31.926# | 0.160 | 200.0 | 0.020 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.011 | 15.612# | 0.136 | 115.0 | 0.025 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.012 | 12.679 | 0.076 | 166.8 | 0.025 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.013 | 17.997 | 0.102 | 176.4 | 0.025 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.014 | 24.270 | 0.145 | 167.4 | 0.027 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.002 | 49.57 | 4.81 | 24.173 | 0.222 | 0.0 | 0.0 | 0.0 | 3.65 | 145.0 | 29.8 |
| 4.000 | 50.00 | 4.09 | 25.750 | 0.018 | 0.0 | 0.0 | 0.0 | 2.64 | 105.0 | 2.4 |
| 4.001 | 50.00 | 4.17 | 24.000 | 0.048 | 0.0 | 0.0 | 0.0 | 2.64 | 105.2 | 6.5 |
| 2.003 | 48.99 | 4.97 | 23.500 | 0.328 | 0.0 | 0.0 | 0.0 | 2.18 | 153.9 | 43.6 |
| 2.004 | 48.65 | 5.06 | 23.106 | 0.386 | 0.0 | 0.0 | 0.0 | 2.44 | 172.7 | 50.9 |
| 2.005 | 47.58 | 5.37 | 22.570 | 0.406 | 0.0 | 0.0 | 0.0 | 1.55 | 171.2 | 52.4 |
| 2.006 | 45.54 | 6.01 | 22.284 | 0.537 | 0.0 | 0.0 | 0.0 | 1.18 | 129.9 | 66.3 |
| 2.007 | 45.01 | 6.19 | 22.093 | 0.596 | 0.0 | 0.0 | 0.0 | 1.15 | 127.6 | 72.7 |
| 2.008 | 43.84 | 6.60 | 22.042 | 0.636 | 0.0 | 0.0 | 0.0 | 0.96 | 106.3 | 75.5 |
| 2.009 | 43.31 | 6.80 | 21.974 | 0.636 | 0.0 | 0.0 | 0.0 | 1.41 | 155.4 | 75.5 |
| 2.010 | 43.06 | 6.89 | 21.874 | 0.748 | 0.0 | 0.0 | 0.0 | 1.82 | 200.9 | 87.3 |
| 5.000 | 50.00 | 4.24 | 25.350 | 0.020 | 0.0 | 0.0 | 0.0 | 0.92 | 36.6 | 2.7 |
| 5.001 | 49.56 | 4.82 | 25.284 | 0.040 | 0.0 | 0.0 | 0.0 | 0.92 | 36.6 | 5.4 |
| 2.011 | 42.51 | 7.11 | 21.700 | 0.813 | 0.0 | 0.0 | 0.0 | 1.22 | 48.4« | 93.6 |
| 2.012 | 41.99 | 7.32 | 21.565 | 0.838 | 0.0 | 0.0 | 0.0 | 1.01 | 40.1« | 95.3 |
| 2.013 | 41.25 | 7.62 | 21.453 | 0.863 | 0.0 | 0.0 | 0.0 | 0.98 | 39.0« | 96.4 |
| 2.014 | 40.33 | 8.02 | 21.347 | 0.890 | 0.0 | 0.0 | 0.0 | 1.01 | 40.1« | 97.2 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.015 | 17.975 | 0.114 | 157.7 | 0.170 | 0.00 | 0.0 | 0.600 | o | 250 | Pipe/Conduit | |
| 2.016 | 19.205 | 1.567 | 12.3 | 0.016 | 0.00 | 0.0 | 0.600 | o | 250 | Pipe/Conduit | |
| 2.017 | 18.897 | 0.420 | 45.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.018 | 13.940 | 0.128 | 108.9 | 0.010 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.019 | 13.075# | 0.154 | 84.9 | 0.050 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.020 | 8.537# | 0.327 | 26.1 | 0.000 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 6.000 | 14.927 | 0.194 | 76.9 | 0.079 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.021 | 15.716 | 0.052 | 302.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |
| 2.022 | 21.206# | 0.080 | 265.1 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |
| 2.023 | 1.000# | 0.004 | 250.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.015 | 39.74 | 8.29 | 21.006 | 1.060 | 0.0 | 0.0 | 0.0 | 1.11 | 54.6« | 114.1 |
| 2.016 | 39.57 | 8.37 | 20.892 | 1.076 | 0.0 | 0.0 | 0.0 | 4.02 | 197.3 | 115.3 |
| 2.017 | 39.29 | 8.51 | 19.275 | 1.086 | 0.0 | 0.0 | 0.0 | 2.35 | 166.1 | 115.6 |
| 2.018 | 39.01 | 8.64 | 18.780 | 1.096 | 0.0 | 0.0 | 0.0 | 1.74 | 191.7 | 115.8 |
| 2.019 | 38.79 | 8.75 | 18.652 | 1.146 | 0.0 | 0.0 | 0.0 | 1.97 | 217.3 | 120.4 |
| 2.020 | 38.71 | 8.79 | 15.700 | 1.146 | 0.0 | 0.0 | 0.0 | 3.56 | 393.0 | 120.4 |
| 6.000 | 50.00 | 4.17 | 15.300 | 0.079 | 0.0 | 0.0 | 0.0 | 1.49 | 59.3 | 10.7 |
| 2.021 | 38.26 | 9.02 | 14.700 | 1.225 | 0.0 | 0.0 | 0.0 | 1.16 | 185.2 | 127.0 |
| 2.022 | 37.72 | 9.30 | 14.648 | 1.225 | 0.0 | 0.0 | 0.0 | 1.24 | 197.8 | 127.0 |
| 2.023 | 37.69 | 9.31 | 14.568 | 1.225 | 0.0 | 0.0 | 0.0 | 1.28 | 203.8 | 127.0 |

## Surcharged Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 2.023 | | 16.000 | 14.564 | 0.000 | 0 | 0 |

Datum (m) 0.000 Offset (mins) 0

| Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| 288 | 15.400 | 864 | 15.400 | 1440 | 15.400 | 2016 | 15.400 | 2592 | 15.400 |
| 576 | 15.400 | 1152 | 15.400 | 1728 | 15.400 | 2304 | 15.400 | 2880 | 15.400 |

## Simulation Criteria for Storm

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

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 2 |
| Number of Online Controls | 2 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Profile Type | Summer |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | Scotland and Ireland | Cv (Winter) | 0.840 |
| M5-60 (mm) | 16.200 | Storm Duration (mins) | 30 |
| Ratio R | 0.277 | | |

## Online Controls for Storm

### Hydro-Brake® Optimum Manhole: 6, DS/PN: 2.011, Volume (m³): 10.5

| | |
|---|---|
| Unit Reference | MD-SHE-0094-5200-1980-5200 |
| Design Head (m) | 1.980 |
| Design Flow (l/s) | 5.2 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 94 |
| Invert Level (m) | 21.771 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.980 | 5.2 |
| Flush-Flo™ | 0.410 | 4.4 |
| Kick-Flo® | 0.836 | 3.5 |
| Mean Flow over Head Range | - | 4.1 |

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 | 3.0 | 1.200 | 4.1 | 3.000 | 6.3 | 7.000 | 9.4 |
| 0.200 | 4.0 | 1.400 | 4.4 | 3.500 | 6.8 | 7.500 | 9.7 |
| 0.300 | 4.3 | 1.600 | 4.7 | 4.000 | 7.2 | 8.000 | 10.0 |
| 0.400 | 4.4 | 1.800 | 5.0 | 4.500 | 7.6 | 8.500 | 10.3 |
| 0.500 | 4.3 | 2.000 | 5.2 | 5.000 | 8.0 | 9.000 | 10.6 |
| 0.600 | 4.2 | 2.200 | 5.5 | 5.500 | 8.4 | 9.500 | 10.9 |
| 0.800 | 3.7 | 2.400 | 5.7 | 6.000 | 8.7 | | |
| 1.000 | 3.8 | 2.600 | 5.9 | 6.500 | 9.1 | | |

### Hydro-Brake® Optimum Manhole: 18, DS/PN: 2.021, Volume (m³): 3.2

| | |
|---|---|
| Unit Reference | MD-SHE-0131-8900-1450-8900 |
| Design Head (m) | 1.450 |
| Design Flow (l/s) | 8.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 131 |
| Invert Level (m) | 14.700 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

## Hydro-Brake® Optimum Manhole: 18, DS/PN: 2.021, Volume (m³): 3.2

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.450 | 8.9 |
| Flush-Flo™ | 0.424 | 8.8 |
| Kick-Flo® | 0.896 | 7.1 |
| Mean Flow over Head Range | - | 7.7 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 4.7 | 1.200 | 8.1 | 3.000 | 12.5 | 7.000 | 18.8 |
| 0.200 | 8.1 | 1.400 | 8.7 | 3.500 | 13.5 | 7.500 | 19.4 |
| 0.300 | 8.7 | 1.600 | 9.3 | 4.000 | 14.4 | 8.000 | 20.0 |
| 0.400 | 8.8 | 1.800 | 9.8 | 4.500 | 15.2 | 8.500 | 20.6 |
| 0.500 | 8.8 | 2.000 | 10.3 | 5.000 | 16.0 | 9.000 | 21.2 |
| 0.600 | 8.7 | 2.200 | 10.8 | 5.500 | 16.7 | 9.500 | 21.8 |
| 0.800 | 7.9 | 2.400 | 11.3 | 6.000 | 17.5 | | |
| 1.000 | 7.5 | 2.600 | 11.7 | 6.500 | 18.1 | | |

## Storage Structures for Storm

### Cellular Storage Manhole: 6, DS/PN: 2.011

Invert Level (m) 21.789 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 320.0 | 0.0 | 1.500 | 320.0 | 0.0 |
| 0.500 | 320.0 | 0.0 | 2.000 | 320.0 | 0.0 |
| 1.000 | 320.0 | 0.0 | | | |

### Tank or Pond Manhole: 18, DS/PN: 2.021

Invert Level (m) 14.700

| Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|
| 0.000 | 360.0 | 1.000 | 360.0 |

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

### Simulation Criteria

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

Number of Input Hydrographs 0 Number of Storage Structures 2
Number of Online Controls 2 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.277
Region Scotland and Ireland Cv (Summer) 1.000
M5-60 (mm) 16.200 Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 200.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2
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) |
|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 1 | 15 Summer | 2 | +20% | | | | | 26.022 |
| 2.001 | 2 | 15 Summer | 2 | +20% | | | | | 25.406 |
| 3.000 | 3A | 15 Summer | 2 | +20% | | | | | 25.181 |
| 2.002 | 3 | 15 Summer | 2 | +20% | | | | | 24.277 |
| 4.000 | 4B | 15 Summer | 2 | +20% | | | | | 25.780 |
| 4.001 | 4A | 15 Summer | 2 | +20% | | | | | 24.048 |
| 2.003 | 4 | 15 Summer | 2 | +20% | | | | | 23.650 |
| 2.004 | 5 | 15 Summer | 2 | +20% | | | | | 23.263 |
| 2.005 | 6 | 15 Summer | 2 | +20% | | | | | 22.765 |
| 2.006 | 7 | 15 Summer | 2 | +20% | | | | | 22.564 |
| 2.007 | 8 | 30 Summer | 2 | +20% | | | | | 22.466 |
| 2.008 | 9 | 30 Summer | 2 | +20% | | | | | 22.417 |
| 2.009 | 10 | 960 Summer | 2 | +20% | 2/360 Summer | | | | 22.403 |
| 2.010 | 10 | 960 Summer | 2 | +20% | 2/120 Summer | | | | 22.401 |
| 5.000 | 15 | 15 Summer | 2 | +20% | | | | | 25.407 |
| 5.001 | 15 | 15 Summer | 2 | +20% | | | | | 25.358 |
| 2.011 | 6 | 960 Summer | 2 | +20% | 2/15 Summer | | | | 22.400 |
| 2.012 | 11 | 30 Summer | 2 | +20% | | | | | 21.636 |
| 2.013 | 12 | 30 Summer | 2 | +20% | | | | | 21.541 |

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

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 1 | -0.113 | 0.000 | 0.48 | | | 25.9 | OK | |
| 2.001 | 2 | -0.141 | 0.000 | 0.29 | | | 29.0 | OK | |
| 3.000 | 3A | -0.069 | 0.000 | 0.57 | | | 14.0 | OK | |
| 2.002 | 3 | -0.121 | 0.000 | 0.43 | | | 46.8 | OK | |
| 4.000 | 4B | -0.195 | 0.000 | 0.04 | | | 4.1 | OK | |
| 4.001 | 4A | -0.177 | 0.000 | 0.10 | | | 9.3 | OK | |
| 2.003 | 4 | -0.150 | 0.000 | 0.49 | | | 66.1 | OK | |
| 2.004 | 5 | -0.143 | 0.000 | 0.53 | | | 76.4 | OK | |
| 2.005 | 6 | -0.180 | 0.000 | 0.53 | | | 79.5 | OK | |
| 2.006 | 7 | -0.095 | 0.000 | 0.80 | | | 95.5 | OK | |
| 2.007 | 8 | -0.002 | 0.000 | 0.96 | | | 94.3 | OK | |
| 2.008 | 9 | 0.000 | 0.000 | 1.08 | | | 98.7 | OK | |
| 2.009 | 10 | 0.054 | 0.000 | 0.14 | | | 17.6 | SURCHARGED | |
| 2.010 | 10 | 0.152 | 0.000 | 0.16 | | | 20.4 | SURCHARGED | |
| 5.000 | 15 | -0.168 | 0.000 | 0.14 | | | 4.6 | OK | |
| 5.001 | 15 | -0.151 | 0.000 | 0.23 | | | 8.0 | OK | |
| 2.011 | 6 | 0.475 | 0.000 | 0.10 | | 624 | 4.4 | SURCHARGED | |
| 2.012 | 11 | -0.154 | 0.000 | 0.21 | | | 7.4 | OK | |
| 2.013 | 12 | -0.137 | 0.000 | 0.32 | | | 11.3 | OK | |

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

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| 2.014 | 13 | 30 Summer | 2 | +20% | | | | |
| 2.015 | 14 | 30 Summer | 2 | +20% | | | | |
| 2.016 | 15 | 30 Summer | 2 | +20% | | | | |
| 2.017 | 16 | 30 Summer | 2 | +20% | | | | |
| 2.018 | 21 | 30 Summer | 2 | +20% | | | | |
| 2.019 | 17 | 30 Summer | 2 | +20% | | | | |
| 2.020 | 26 | 30 Summer | 2 | +20% | | | | |
| 6.000 | 26 | 4320 Summer | 2 | +20% | 2/1440 Summer | | | |
| 2.021 | 18 | 4320 Summer | 2 | +20% | 2/360 Summer | | | |
| 2.022 | 27 | 4320 Summer | 2 | +20% | 2/360 Summer | 2/5760 Summer | | |
| 2.023 | 28 | 5760 Summer | 2 | +20% | 2/240 Summer | 2/8640 Winter | | |

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Half Drain Time (mins) | Pipe Flow (l/s) | Status |
|---|---|---|---|---|---|---|---|---|---|
| 2.014 | 13 | 21.449 | -0.123 | 0.000 | 0.42 | | | 15.6 | OK |
| 2.015 | 14 | 21.193 | -0.063 | 0.000 | 0.89 | | | 43.2 | OK |
| 2.016 | 15 | 20.979 | -0.163 | 0.000 | 0.26 | | | 45.9 | OK |
| 2.017 | 16 | 19.394 | -0.181 | 0.000 | 0.33 | | | 47.6 | OK |
| 2.018 | 21 | 18.933 | -0.222 | 0.000 | 0.35 | | | 49.3 | OK |
| 2.019 | 17 | 18.810 | -0.217 | 0.000 | 0.37 | | | 57.2 | OK |
| 2.020 | 26 | 15.828 | -0.247 | 0.000 | 0.26 | | | 57.1 | OK |
| 6.000 | 26 | 15.592 | 0.067 | 0.000 | 0.02 | | | 0.9 | SURCHARGED |
| 2.021 | 18 | 15.591 | 0.441 | 0.000 | 0.06 | | | 8.8 | SURCHARGED |
| 2.022 | 27 | 15.403 | 0.305 | 0.000 | 0.07 | | | 10.9 | SURCHARGED |
| 2.023 | 28 | 15.403 | 0.385 | 0.000 | 0.10 | | | 13.8 | SURCHARGED |

| PN | US/MH Name | Level Exceeded |
|---|---|---|
| 2.014 | 13 | |
| 2.015 | 14 | |
| 2.016 | 15 | |
| 2.017 | 16 | |
| 2.018 | 21 | |
| 2.019 | 17 | |
| 2.020 | 26 | |
| 6.000 | 26 | |
| 2.021 | 18 | |
| 2.022 | 27 | |
| 2.023 | 28 | |

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | PIMP (%) | 100 |
| M5-60 (mm) | 16.200 | Add Flow / Climate Change (%) | 0 |
| Ratio R | 0.277 | Minimum Backdrop Height (m) | 0.100 |
| Maximum Rainfall (mm/hr) | 50 | Maximum Backdrop Height (m) | 20.000 |
| Maximum Time of Concentration (mins) | 30 | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha) | 0.000 | Min Vel for Auto Design only (m/s) | 1.00 |
| Volumetric Runoff Coeff. | 0.750 | Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

### Time Area Diagram for Storm

| **Time (mins)** | **Area (ha)** | **Time (mins)** | **Area (ha)** | **Time (mins)** | **Area (ha)** |
|---|---|---|---|---|---|
| 0-4 | 0.370 | 4-8 | 0.774 | 8-12 | 0.081 |

Total Area Contributing (ha) = 1.225

Total Pipe Volume (m³) = 41.013

### Network Design Table for Storm

\# - Indicates pipe length does not match coordinates
« - Indicates pipe capacity < flow

| **PN** | **Length (m)** | **Fall (m)** | **Slope (1:X)** | **I.Area (ha)** | **T.E. (mins)** | **Base Flow (l/s)** | **k (mm)** | **HYD SECT** | **DIA (mm)** | **Section Type** | **Auto Design** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 51.311 | 0.588 | 87.3 | 0.116 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.001 | 27.008 | 1.149 | 23.5 | 0.020 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 3.000 | 39.434 | 0.802 | 49.2 | 0.061 | 4.00 | 0.0 | 0.600 | o | 150 | Pipe/Conduit | |

### Network Results Table

| **PN** | **Rain (mm/hr)** | **T.C. (mins)** | **US/IL (m)** | **Σ I.Area (ha)** | **Σ Base Flow (l/s)** | **Foul (l/s)** | **Add Flow (l/s)** | **Vel (m/s)** | **Cap (l/s)** | **Flow (l/s)** |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 50.00 | 4.61 | 25.910 | 0.116 | 0.0 | 0.0 | 0.0 | 1.40 | 55.7 | 15.8 |
| 2.001 | 49.71 | 4.78 | 25.322 | 0.136 | 0.0 | 0.0 | 0.0 | 2.71 | 107.8 | 18.4 |
| 3.000 | 50.00 | 4.46 | 25.100 | 0.061 | 0.0 | 0.0 | 0.0 | 1.44 | 25.4 | 8.3 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.002 | 7.882 | 0.606 | 13.0 | 0.025 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 4.000 | 14.682 | 0.593 | 24.8 | 0.018 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 4.001 | 11.499 | 0.466 | 24.7 | 0.030 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.003 | 20.646 | 0.394 | 52.4 | 0.058 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.004 | 13.782 | 0.331 | 41.6 | 0.058 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.005 | 28.777 | 0.211 | 136.4 | 0.020 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.006 | 45.000 | 0.191 | 235.6 | 0.131 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.007 | 12.454 | 0.051 | 244.2 | 0.059 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.008 | 23.804 | 0.068 | 350.0 | 0.040 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.009 | 16.521 | 0.100 | 165.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.010 | 10.186# | 0.103 | 99.2 | 0.112 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 5.000 | 13.201# | 0.066 | 200.0 | 0.020 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 5.001 | 31.926# | 0.160 | 200.0 | 0.020 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.011 | 15.612# | 0.136 | 115.0 | 0.025 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.012 | 12.679 | 0.076 | 166.8 | 0.025 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.013 | 17.997 | 0.102 | 176.4 | 0.025 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.014 | 24.270 | 0.145 | 167.4 | 0.027 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.002 | 49.57 | 4.81 | 24.173 | 0.222 | 0.0 | 0.0 | 0.0 | 3.65 | 145.0 | 29.8 |
| 4.000 | 50.00 | 4.09 | 25.750 | 0.018 | 0.0 | 0.0 | 0.0 | 2.64 | 105.0 | 2.4 |
| 4.001 | 50.00 | 4.17 | 24.000 | 0.048 | 0.0 | 0.0 | 0.0 | 2.64 | 105.2 | 6.5 |
| 2.003 | 48.99 | 4.97 | 23.500 | 0.328 | 0.0 | 0.0 | 0.0 | 2.18 | 153.9 | 43.6 |
| 2.004 | 48.65 | 5.06 | 23.106 | 0.386 | 0.0 | 0.0 | 0.0 | 2.44 | 172.7 | 50.9 |
| 2.005 | 47.58 | 5.37 | 22.570 | 0.406 | 0.0 | 0.0 | 0.0 | 1.55 | 171.2 | 52.4 |
| 2.006 | 45.54 | 6.01 | 22.284 | 0.537 | 0.0 | 0.0 | 0.0 | 1.18 | 129.9 | 66.3 |
| 2.007 | 45.01 | 6.19 | 22.093 | 0.596 | 0.0 | 0.0 | 0.0 | 1.15 | 127.6 | 72.7 |
| 2.008 | 43.84 | 6.60 | 22.042 | 0.636 | 0.0 | 0.0 | 0.0 | 0.96 | 106.3 | 75.5 |
| 2.009 | 43.31 | 6.80 | 21.974 | 0.636 | 0.0 | 0.0 | 0.0 | 1.41 | 155.4 | 75.5 |
| 2.010 | 43.06 | 6.89 | 21.874 | 0.748 | 0.0 | 0.0 | 0.0 | 1.82 | 200.9 | 87.3 |
| 5.000 | 50.00 | 4.24 | 25.350 | 0.020 | 0.0 | 0.0 | 0.0 | 0.92 | 36.6 | 2.7 |
| 5.001 | 49.56 | 4.82 | 25.284 | 0.040 | 0.0 | 0.0 | 0.0 | 0.92 | 36.6 | 5.4 |
| 2.011 | 42.51 | 7.11 | 21.700 | 0.813 | 0.0 | 0.0 | 0.0 | 1.22 | 48.4« | 93.6 |
| 2.012 | 41.99 | 7.32 | 21.565 | 0.838 | 0.0 | 0.0 | 0.0 | 1.01 | 40.1« | 95.3 |
| 2.013 | 41.25 | 7.62 | 21.453 | 0.863 | 0.0 | 0.0 | 0.0 | 0.98 | 39.0« | 96.4 |
| 2.014 | 40.33 | 8.02 | 21.347 | 0.890 | 0.0 | 0.0 | 0.0 | 1.01 | 40.1« | 97.2 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2.015 | 17.975 | 0.114 | 157.7 | 0.170 | 0.00 | 0.0 | 0.600 | o | 250 | Pipe/Conduit | |
| 2.016 | 19.205 | 1.567 | 12.3 | 0.016 | 0.00 | 0.0 | 0.600 | o | 250 | Pipe/Conduit | |
| 2.017 | 18.897 | 0.420 | 45.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 2.018 | 13.940 | 0.128 | 108.9 | 0.010 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.019 | 13.075# | 0.154 | 84.9 | 0.050 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 2.020 | 8.537# | 0.327 | 26.1 | 0.000 | 0.00 | 0.0 | 0.600 | o | 375 | Pipe/Conduit | |
| 6.000 | 14.927 | 0.194 | 76.9 | 0.079 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.021 | 15.716 | 0.052 | 302.2 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |
| 2.022 | 21.206# | 0.080 | 265.1 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |
| 2.023 | 1.000# | 0.004 | 250.0 | 0.000 | 0.00 | 0.0 | 0.600 | o | 450 | Pipe/Conduit | |

## Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.015 | 39.74 | 8.29 | 21.006 | 1.060 | 0.0 | 0.0 | 0.0 | 1.11 | 54.6« | 114.1 |
| 2.016 | 39.57 | 8.37 | 20.892 | 1.076 | 0.0 | 0.0 | 0.0 | 4.02 | 197.3 | 115.3 |
| 2.017 | 39.29 | 8.51 | 19.275 | 1.086 | 0.0 | 0.0 | 0.0 | 2.35 | 166.1 | 115.6 |
| 2.018 | 39.01 | 8.64 | 18.780 | 1.096 | 0.0 | 0.0 | 0.0 | 1.74 | 191.7 | 115.8 |
| 2.019 | 38.79 | 8.75 | 18.652 | 1.146 | 0.0 | 0.0 | 0.0 | 1.97 | 217.3 | 120.4 |
| 2.020 | 38.71 | 8.79 | 15.700 | 1.146 | 0.0 | 0.0 | 0.0 | 3.56 | 393.0 | 120.4 |
| 6.000 | 50.00 | 4.17 | 15.300 | 0.079 | 0.0 | 0.0 | 0.0 | 1.49 | 59.3 | 10.7 |
| 2.021 | 38.26 | 9.02 | 14.700 | 1.225 | 0.0 | 0.0 | 0.0 | 1.16 | 185.2 | 127.0 |
| 2.022 | 37.72 | 9.30 | 14.648 | 1.225 | 0.0 | 0.0 | 0.0 | 1.24 | 197.8 | 127.0 |
| 2.023 | 37.69 | 9.31 | 14.568 | 1.225 | 0.0 | 0.0 | 0.0 | 1.28 | 203.8 | 127.0 |

## Surcharged Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 2.023 | | 16.000 | 14.564 | 0.000 | 0 | 0 |

Datum (m) 0.000 Offset (mins) 0

| Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| 288 | 15.400 | 864 | 15.400 | 1440 | 15.400 | 2016 | 15.400 | 2592 | 15.400 |
| 576 | 15.400 | 1152 | 15.400 | 1728 | 15.400 | 2304 | 15.400 | 2880 | 15.400 |

## Simulation Criteria for Storm

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

| | | | |
|---|---|---|---|
| Number of Input Hydrographs | 0 | Number of Storage Structures | 2 |
| Number of Online Controls | 2 | Number of Time/Area Diagrams | 0 |
| Number of Offline Controls | 0 | Number of Real Time Controls | 0 |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Profile Type | Summer |
| Return Period (years) | 2 | Cv (Summer) | 0.750 |
| Region | Scotland and Ireland | Cv (Winter) | 0.840 |
| M5-60 (mm) | 16.200 | Storm Duration (mins) | 30 |
| Ratio R | 0.277 | | |

## Online Controls for Storm

### Hydro-Brake® Optimum Manhole: 6, DS/PN: 2.011, Volume (m³): 10.5

| | |
|---|---|
| Unit Reference | MD-SHE-0094-5200-1980-5200 |
| Design Head (m) | 1.980 |
| Design Flow (l/s) | 5.2 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 94 |
| Invert Level (m) | 21.771 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.980 | 5.2 |
| Flush-Flo™ | 0.410 | 4.4 |
| Kick-Flo® | 0.836 | 3.5 |
| Mean Flow over Head Range | - | 4.1 |

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 | 3.0 | 1.200 | 4.1 | 3.000 | 6.3 | 7.000 | 9.4 |
| 0.200 | 4.0 | 1.400 | 4.4 | 3.500 | 6.8 | 7.500 | 9.7 |
| 0.300 | 4.3 | 1.600 | 4.7 | 4.000 | 7.2 | 8.000 | 10.0 |
| 0.400 | 4.4 | 1.800 | 5.0 | 4.500 | 7.6 | 8.500 | 10.3 |
| 0.500 | 4.3 | 2.000 | 5.2 | 5.000 | 8.0 | 9.000 | 10.6 |
| 0.600 | 4.2 | 2.200 | 5.5 | 5.500 | 8.4 | 9.500 | 10.9 |
| 0.800 | 3.7 | 2.400 | 5.7 | 6.000 | 8.7 | | |
| 1.000 | 3.8 | 2.600 | 5.9 | 6.500 | 9.1 | | |

### Hydro-Brake® Optimum Manhole: 18, DS/PN: 2.021, Volume (m³): 3.2

| | |
|---|---|
| Unit Reference | MD-SHE-0131-8900-1450-8900 |
| Design Head (m) | 1.450 |
| Design Flow (l/s) | 8.9 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 131 |
| Invert Level (m) | 14.700 |
| Minimum Outlet Pipe Diameter (mm) | 150 |
| Suggested Manhole Diameter (mm) | 1200 |

## Hydro-Brake® Optimum Manhole: 18, DS/PN: 2.021, Volume (m³): 3.2

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.450 | 8.9 |
| Flush-Flo™ | 0.424 | 8.8 |
| Kick-Flo® | 0.896 | 7.1 |
| Mean Flow over Head Range | - | 7.7 |

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

| Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) | Depth (m) | Flow (l/s) |
|---|---|---|---|---|---|---|---|
| 0.100 | 4.7 | 1.200 | 8.1 | 3.000 | 12.5 | 7.000 | 18.8 |
| 0.200 | 8.1 | 1.400 | 8.7 | 3.500 | 13.5 | 7.500 | 19.4 |
| 0.300 | 8.7 | 1.600 | 9.3 | 4.000 | 14.4 | 8.000 | 20.0 |
| 0.400 | 8.8 | 1.800 | 9.8 | 4.500 | 15.2 | 8.500 | 20.6 |
| 0.500 | 8.8 | 2.000 | 10.3 | 5.000 | 16.0 | 9.000 | 21.2 |
| 0.600 | 8.7 | 2.200 | 10.8 | 5.500 | 16.7 | 9.500 | 21.8 |
| 0.800 | 7.9 | 2.400 | 11.3 | 6.000 | 17.5 | | |
| 1.000 | 7.5 | 2.600 | 11.7 | 6.500 | 18.1 | | |

## Storage Structures for Storm

### Cellular Storage Manhole: 6, DS/PN: 2.011

Invert Level (m) 21.789 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area ($m^2$) | Inf. Area ($m^2$) | Depth (m) | Area ($m^2$) | Inf. Area ($m^2$) |
|---|---|---|---|---|---|
| 0.000 | 320.0 | 0.0 | 1.500 | 320.0 | 0.0 |
| 0.500 | 320.0 | 0.0 | 2.000 | 320.0 | 0.0 |
| 1.000 | 320.0 | 0.0 | | | |

### Tank or Pond Manhole: 18, DS/PN: 2.021

Invert Level (m) 14.700

| Depth (m) | Area ($m^2$) | Depth (m) | Area ($m^2$) |
|---|---|---|---|
| 0.000 | 360.0 | 1.000 | 360.0 |

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

### Simulation Criteria

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

Number of Input Hydrographs 0 Number of Storage Structures 2
Number of Online Controls 2 Number of Time/Area Diagrams 0
Number of Offline Controls 0 Number of Real Time Controls 0

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.277
Region Scotland and Ireland Cv (Summer) 1.000
M5-60 (mm) 16.200 Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 200.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 30
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) |
|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 1 | 15 Summer | 30 | +20% | | | | | 26.079 |
| 2.001 | 2 | 15 Summer | 30 | +20% | | | | | 25.444 |
| 3.000 | 3A | 15 Summer | 30 | +20% | 30/15 Summer | | | | 25.258 |
| 2.002 | 3 | 15 Summer | 30 | +20% | | | | | 24.348 |
| 4.000 | 4B | 15 Summer | 30 | +20% | | | | | 25.793 |
| 4.001 | 4A | 15 Summer | 30 | +20% | | | | | 24.072 |
| 2.003 | 4 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 24.035 |
| 2.004 | 5 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 23.775 |
| 2.005 | 6 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 23.530 |
| 2.006 | 7 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 23.389 |
| 2.007 | 8 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 23.059 |
| 2.008 | 9 | 960 Winter | 30 | +20% | 30/15 Summer | | | | 23.006 |
| 2.009 | 10 | 960 Winter | 30 | +20% | 30/15 Summer | | | | 23.004 |
| 2.010 | 10 | 960 Winter | 30 | +20% | 30/15 Summer | | | | 23.002 |
| 5.000 | 15 | 15 Summer | 30 | +20% | | | | | 25.432 |
| 5.001 | 15 | 15 Summer | 30 | +20% | | | | | 25.395 |
| 2.011 | 6 | 960 Winter | 30 | +20% | 30/15 Summer | | | | 23.000 |
| 2.012 | 11 | 15 Summer | 30 | +20% | | | | | 21.711 |
| 2.013 | 12 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 21.693 |

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

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 2.000 | 1 | -0.056 | 0.000 | 0.89 | | | 47.6 | OK | |
| 2.001 | 2 | -0.103 | 0.000 | 0.55 | | | 55.3 | OK | |
| 3.000 | 3A | 0.008 | 0.000 | 1.00 | | | 24.5 | SURCHARGED | |
| 2.002 | 3 | -0.050 | 0.000 | 0.81 | | | 89.4 | OK | |
| 4.000 | 4B | -0.182 | 0.000 | 0.08 | | | 7.6 | OK | |
| 4.001 | 4A | -0.153 | 0.000 | 0.23 | | | 20.2 | OK | |
| 2.003 | 4 | 0.235 | 0.000 | 0.94 | | | 126.0 | SURCHARGED | |
| 2.004 | 5 | 0.369 | 0.000 | 0.94 | | | 133.5 | SURCHARGED | |
| 2.005 | 6 | 0.585 | 0.000 | 0.84 | | | 126.4 | FLOOD RISK | |
| 2.006 | 7 | 0.730 | 0.000 | 1.29 | | | 154.2 | SURCHARGED | |
| 2.007 | 8 | 0.591 | 0.000 | 1.70 | | | 167.7 | SURCHARGED | |
| 2.008 | 9 | 0.589 | 0.000 | 0.20 | | | 18.6 | SURCHARGED | |
| 2.009 | 10 | 0.655 | 0.000 | 0.15 | | | 18.5 | SURCHARGED | |
| 2.010 | 10 | 0.753 | 0.000 | 0.17 | | | 21.9 | SURCHARGED | |
| 5.000 | 15 | -0.143 | 0.000 | 0.26 | | | 8.4 | OK | |
| 5.001 | 15 | -0.114 | 0.000 | 0.48 | | | 16.4 | OK | |
| 2.011 | 6 | 1.075 | 0.000 | 0.10 | | 928 | 4.4 | SURCHARGED | |
| 2.012 | 11 | -0.079 | 0.000 | 0.37 | | | 12.9 | OK | |
| 2.013 | 12 | 0.015 | 0.000 | 0.67 | | | 23.5 | SURCHARGED | |

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

| PN | US/MH Name | Storm | Return Period | Climate Change | First (X) Surcharge | First (Y) Flood | First (Z) Overflow | Overflow Act. |
|---|---|---|---|---|---|---|---|---|
| 2.014 | 13 | 15 Summer | 30 | +20% | 30/15 Summer | | | |
| 2.015 | 14 | 15 Summer | 30 | +20% | 30/15 Summer | | | |
| 2.016 | 15 | 15 Summer | 30 | +20% | | | | |
| 2.017 | 16 | 15 Summer | 30 | +20% | | | | |
| 2.018 | 21 | 15 Summer | 30 | +20% | | | | |
| 2.019 | 17 | 15 Summer | 30 | +20% | | | | |
| 2.020 | 26 | 15 Summer | 30 | +20% | | | | |
| 6.000 | 26 | 2880 Summer | 30 | +20% | 30/720 Summer | | | |
| 2.021 | 18 | 2880 Summer | 30 | +20% | 30/240 Summer | | | |
| 2.022 | 27 | 2880 Summer | 30 | +20% | 30/240 Summer | 30/5760 Summer | | |
| 2.023 | 28 | 10080 Winter | 30 | +20% | 30/180 Summer | 30/8640 Summer | | |

| PN | US/MH Name | Water Level (m) | Surcharged Depth (m) | Flooded Volume (m³) | Flow / Cap. | Overflow (l/s) | Half Drain Time (mins) | Pipe Flow (l/s) | Status |
|---|---|---|---|---|---|---|---|---|---|
| 2.014 | 13 | 21.659 | 0.087 | 0.000 | 0.92 | | | 34.0 | SURCHARGED |
| 2.015 | 14 | 21.580 | 0.324 | 0.000 | 1.91 | | | 92.2 | SURCHARGED |
| 2.016 | 15 | 21.029 | -0.113 | 0.000 | 0.56 | | | 98.9 | OK |
| 2.017 | 16 | 19.466 | -0.109 | 0.000 | 0.72 | | | 103.1 | OK |
| 2.018 | 21 | 19.028 | -0.127 | 0.000 | 0.76 | | | 107.0 | OK |
| 2.019 | 17 | 18.912 | -0.115 | 0.000 | 0.81 | | | 124.7 | OK |
| 2.020 | 26 | 15.900 | -0.175 | 0.000 | 0.55 | | | 124.2 | OK |
| 6.000 | 26 | 15.720 | 0.195 | 0.000 | 0.03 | | | 1.8 | SURCHARGED |
| 2.021 | 18 | 15.718 | 0.568 | 0.000 | 0.06 | | | 8.8 | SURCHARGED |
| 2.022 | 27 | 15.404 | 0.306 | 0.000 | 0.07 | | | 11.1 | SURCHARGED |
| 2.023 | 28 | 15.403 | 0.385 | 0.000 | 0.12 | | | 16.0 | SURCHARGED |

| PN | US/MH Name | Level Exceeded |
|---|---|---|
| 2.014 | 13 | |
| 2.015 | 14 | |
| 2.016 | 15 | |
| 2.017 | 16 | |
| 2.018 | 21 | |
| 2.019 | 17 | |
| 2.020 | 26 | |
| 6.000 | 26 | |
| 2.021 | 18 | |
| 2.022 | 27 | |
| 2.023 | 28 | |

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | PIMP (%) | 100 |
| M5-60 (mm) | 16.200 | Add Flow / Climate Change (%) | 20 |
| Ratio R | 0.277 | Minimum Backdrop Height (m) | 0.200 |
| Maximum Rainfall (mm/hr) | 50 | Maximum Backdrop Height (m) | 8.000 |
| Maximum Time of Concentration (mins) | 30 | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha) | 0.000 | Min Vel for Auto Design only (m/s) | 1.00 |
| Volumetric Runoff Coeff. | 1.000 | Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

### Time Area Diagram for Storm

| **Time (mins)** | **Area (ha)** | **Time (mins)** | **Area (ha)** |
|---|---|---|---|
| 0-4 | 0.147 | 4-8 | 0.038 |

Total Area Contributing (ha) = 0.185

Total Pipe Volume (m³) = 5.449

### Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 21.000 | 0.124 | 169.4 | 0.075 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 1.001 | 11.500 | 0.058 | 200.0 | 0.005 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 1.002 | 27.000 | 0.900 | 30.0 | 0.005 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.000 | 18.000 | 0.090 | 200.0 | 0.080 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.001 | 10.000 | 0.050 | 200.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 50.00 | 4.35 | 20.475 | 0.075 | 0.0 | 0.0 | 2.7 | 1.00 | 39.8 | 16.2 |
| 1.001 | 50.00 | 4.56 | 20.351 | 0.080 | 0.0 | 0.0 | 2.9 | 0.92 | 36.6 | 17.3 |
| 1.002 | 49.82 | 4.75 | 19.550 | 0.085 | 0.0 | 0.0 | 3.1 | 2.40 | 95.3 | 18.4 |
| 2.000 | 50.00 | 4.33 | 17.600 | 0.080 | 0.0 | 0.0 | 2.9 | 0.92 | 36.6 | 17.3 |
| 2.001 | 50.00 | 4.51 | 17.510 | 0.090 | 0.0 | 0.0 | 3.2 | 0.92 | 36.6 | 19.5 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 7.000 | 0.035 | 200.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 1.004 | 7.611 | 0.088 | 86.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 1.005 | 13.265 | 0.326 | 40.7 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 49.43 | 4.85 | 17.385 | 0.185 | 0.0 | 0.0 | 6.6 | 1.11 | 78.3 | 39.6 |
| 1.004 | 49.15 | 4.93 | 17.350 | 0.185 | 0.0 | 0.0 | 6.6 | 1.69 | 119.6 | 39.6 |
| 1.005 | 48.83 | 5.01 | 16.000 | 0.185 | 0.0 | 0.0 | 6.6 | 2.47 | 174.7 | 39.6 |

## Surcharged Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 1.005 | | 16.000 | 15.674 | 0.000 | 0 | 0 |

Datum (m) 15.870 Offset (mins) 0

| Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| 288 | 0.000 | 864 | 0.000 | 1440 | 0.000 | 2016 | 0.000 | 2592 | 0.000 |
| 576 | 0.000 | 1152 | 0.000 | 1728 | 0.000 | 2304 | 0.000 | 2880 | 0.000 |

## Simulation Criteria for Storm

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

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

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | M5-60 (mm) | 16.200 |
| Return Period (years) | 2 | Ratio R | 0.277 |
| Region | Scotland and Ireland | Profile Type | Winter |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Cv (Summer) | 1.000 | Storm Duration (mins) | 30 |
| Cv (Winter) | 1.000 | | |

## Online Controls for Storm

### Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.005, Volume ($m^3$): 3.4

| | |
|---|---|
| Unit Reference | MD-SHE-0047-1200-1500-1200 |
| Design Head (m) | 1.500 |
| Design Flow (l/s) | 1.2 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 47 |
| Invert Level (m) | 16.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| **Control Points** | **Head (m)** | **Flow (l/s)** |
|---|---|---|
| Design Point (Calculated) | 1.500 | 1.2 |
| Flush-Flo™ | 0.207 | 0.8 |
| Kick-Flo® | 0.417 | 0.7 |
| Mean Flow over Head Range | - | 0.9 |

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 | 0.8 | 1.200 | 1.1 | 3.000 | 1.6 | 7.000 | 2.4 |
| 0.200 | 0.8 | 1.400 | 1.2 | 3.500 | 1.8 | 7.500 | 2.5 |
| 0.300 | 0.8 | 1.600 | 1.2 | 4.000 | 1.9 | 8.000 | 2.6 |
| 0.400 | 0.7 | 1.800 | 1.3 | 4.500 | 2.0 | 8.500 | 2.7 |
| 0.500 | 0.7 | 2.000 | 1.4 | 5.000 | 2.1 | 9.000 | 2.7 |
| 0.600 | 0.8 | 2.200 | 1.4 | 5.500 | 2.2 | 9.500 | 2.8 |
| 0.800 | 0.9 | 2.400 | 1.5 | 6.000 | 2.3 | | |
| 1.000 | 1.0 | 2.600 | 1.5 | 6.500 | 2.3 | | |

## Storage Structures for Storm

### Tank or Pond Manhole: 10, DS/PN: 1.005

Invert Level (m) 16.000

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 68.0 | 1.000 | 68.0 | 1.200 | 68.0 | 1.500 | 68.0 |

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

### Simulation Criteria

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

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

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.277
Region Scotland and Ireland Cv (Summer) 1.000
M5-60 (mm) 16.200 Cv (Winter) 1.000

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2
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) |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 15 Summer | 2 | +20% | | | | | 20.584 |
| 1.001 | 2 | 15 Summer | 2 | +20% | | | | | 20.474 |
| 1.002 | 3 | 15 Summer | 2 | +20% | | | | | 19.620 |
| 2.000 | 5 | 15 Summer | 2 | +20% | | | | | 17.720 |
| 2.001 | 6 | 15 Summer | 2 | +20% | | | | | 17.643 |
| 1.003 | 7 | 15 Summer | 2 | +20% | | | | | 17.573 |
| 1.004 | 8 | 15 Summer | 2 | +20% | | | | | 17.507 |
| 1.005 | 10 | 1440 Summer | 2 | +20% | 2/30 Summer | | | | 16.685 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | -0.116 | 0.000 | 0.47 | | | 17.1 | OK | |
| 1.001 | 2 | -0.102 | 0.000 | 0.56 | | | 17.5 | OK | |
| 1.002 | 3 | -0.155 | 0.000 | 0.21 | | | 18.6 | OK | |
| 2.000 | 5 | -0.105 | 0.000 | 0.55 | | | 18.2 | OK | |
| 2.001 | 6 | -0.092 | 0.000 | 0.64 | | | 19.6 | OK | |

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

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 7 | -0.112 | 0.000 | 0.71 | | | 40.2 | OK | |
| 1.004 | 8 | -0.143 | 0.000 | 0.54 | | | 40.1 | OK | |
| 1.005 | 10 | 0.385 | 0.000 | 0.01 | | | 0.8 | SURCHARGED | |

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | PIMP (%) | 100 |
| M5-60 (mm) | 16.200 | Add Flow / Climate Change (%) | 20 |
| Ratio R | 0.277 | Minimum Backdrop Height (m) | 0.200 |
| Maximum Rainfall (mm/hr) | 50 | Maximum Backdrop Height (m) | 8.000 |
| Maximum Time of Concentration (mins) | 30 | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha) | 0.000 | Min Vel for Auto Design only (m/s) | 1.00 |
| Volumetric Runoff Coeff. | 1.000 | Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

### Time Area Diagram for Storm

| Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|
| 0-4 | 0.147 | 4-8 | 0.038 |

Total Area Contributing (ha) = 0.185

Total Pipe Volume (m³) = 5.449

### Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 21.000 | 0.124 | 169.4 | 0.075 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 1.001 | 11.500 | 0.058 | 200.0 | 0.005 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 1.002 | 27.000 | 0.900 | 30.0 | 0.005 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.000 | 18.000 | 0.090 | 200.0 | 0.080 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.001 | 10.000 | 0.050 | 200.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 50.00 | 4.35 | 20.475 | 0.075 | 0.0 | 0.0 | 2.7 | 1.00 | 39.8 | 16.2 |
| 1.001 | 50.00 | 4.56 | 20.351 | 0.080 | 0.0 | 0.0 | 2.9 | 0.92 | 36.6 | 17.3 |
| 1.002 | 49.82 | 4.75 | 19.550 | 0.085 | 0.0 | 0.0 | 3.1 | 2.40 | 95.3 | 18.4 |
| 2.000 | 50.00 | 4.33 | 17.600 | 0.080 | 0.0 | 0.0 | 2.9 | 0.92 | 36.6 | 17.3 |
| 2.001 | 50.00 | 4.51 | 17.510 | 0.090 | 0.0 | 0.0 | 3.2 | 0.92 | 36.6 | 19.5 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 7.000 | 0.035 | 200.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 1.004 | 7.611 | 0.088 | 86.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 1.005 | 13.265 | 0.326 | 40.7 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 49.43 | 4.85 | 17.385 | 0.185 | 0.0 | 0.0 | 6.6 | 1.11 | 78.3 | 39.6 |
| 1.004 | 49.15 | 4.93 | 17.350 | 0.185 | 0.0 | 0.0 | 6.6 | 1.69 | 119.6 | 39.6 |
| 1.005 | 48.83 | 5.01 | 16.000 | 0.185 | 0.0 | 0.0 | 6.6 | 2.47 | 174.7 | 39.6 |

## Surcharged Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 1.005 | | 16.000 | 15.674 | 0.000 | 0 | 0 |

Datum (m) 15.870 Offset (mins) 0

| Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| 288 | 0.000 | 864 | 0.000 | 1440 | 0.000 | 2016 | 0.000 | 2592 | 0.000 |
| 576 | 0.000 | 1152 | 0.000 | 1728 | 0.000 | 2304 | 0.000 | 2880 | 0.000 |

## Simulation Criteria for Storm

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

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

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | M5-60 (mm) | 16.200 |
| Return Period (years) | 2 | Ratio R | 0.277 |
| Region | Scotland and Ireland | Profile Type | Winter |

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Cv (Summer) | 1.000 | Storm Duration (mins) | 30 |
| Cv (Winter) | 1.000 | | |

## Online Controls for Storm

### Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.005, Volume ($m^3$): 3.4

| | |
|---|---|
| Unit Reference | MD-SHE-0047-1200-1500-1200 |
| Design Head (m) | 1.500 |
| Design Flow (l/s) | 1.2 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 47 |
| Invert Level (m) | 16.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| **Control Points** | **Head (m)** | **Flow (l/s)** |
|---|---|---|
| Design Point (Calculated) | 1.500 | 1.2 |
| Flush-Flo™ | 0.207 | 0.8 |
| Kick-Flo® | 0.417 | 0.7 |
| Mean Flow over Head Range | - | 0.9 |

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 | 0.8 | 1.200 | 1.1 | 3.000 | 1.6 | 7.000 | 2.4 |
| 0.200 | 0.8 | 1.400 | 1.2 | 3.500 | 1.8 | 7.500 | 2.5 |
| 0.300 | 0.8 | 1.600 | 1.2 | 4.000 | 1.9 | 8.000 | 2.6 |
| 0.400 | 0.7 | 1.800 | 1.3 | 4.500 | 2.0 | 8.500 | 2.7 |
| 0.500 | 0.7 | 2.000 | 1.4 | 5.000 | 2.1 | 9.000 | 2.7 |
| 0.600 | 0.8 | 2.200 | 1.4 | 5.500 | 2.2 | 9.500 | 2.8 |
| 0.800 | 0.9 | 2.400 | 1.5 | 6.000 | 2.3 | | |
| 1.000 | 1.0 | 2.600 | 1.5 | 6.500 | 2.3 | | |

## Storage Structures for Storm

### Tank or Pond Manhole: 10, DS/PN: 1.005

Invert Level (m) 16.000

| Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) | Depth (m) | Area (m²) |
|---|---|---|---|---|---|---|---|
| 0.000 | 68.0 | 1.000 | 68.0 | 1.200 | 68.0 | 1.500 | 68.0 |

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

### Simulation Criteria

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

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

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.277
Region Scotland and Ireland Cv (Summer) 1.000
M5-60 (mm) 16.200 Cv (Winter) 1.000

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 30
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) |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 15 Summer | 30 | +20% | | | | | 20.651 |
| 1.001 | 2 | 15 Summer | 30 | +20% | | | | | 20.563 |
| 1.002 | 3 | 15 Summer | 30 | +20% | | | | | 19.645 |
| 2.000 | 5 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 17.867 |
| 2.001 | 6 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 17.781 |
| 1.003 | 7 | 15 Summer | 30 | +20% | 30/15 Summer | | | | 17.716 |
| 1.004 | 8 | 15 Summer | 30 | +20% | | | | | 17.581 |
| 1.005 | 10 | 960 Winter | 30 | +20% | 30/15 Summer | | | | 17.275 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | -0.049 | 0.000 | 0.86 | | | 31.1 | OK | |
| 1.001 | 2 | -0.013 | 0.000 | 1.00 | | | 31.1 | OK | |
| 1.002 | 3 | -0.130 | 0.000 | 0.37 | | | 32.9 | OK | |
| 2.000 | 5 | 0.042 | 0.000 | 0.92 | | | 30.2 | SURCHARGED | |
| 2.001 | 6 | 0.046 | 0.000 | 1.12 | | | 34.3 | SURCHARGED | |

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

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 7 | 0.031 | 0.000 | 1.25 | | | 70.9 | SURCHARGED | |
| 1.004 | 8 | -0.069 | 0.000 | 0.95 | | | 70.7 | OK | |
| 1.005 | 10 | 0.975 | 0.000 | 0.01 | | | 1.1 | SURCHARGED | |

## STORM SEWER DESIGN by the Modified Rational Method

### Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

| | | | |
|---|---|---|---|
| Return Period (years) | 2 | PIMP (%) | 100 |
| M5-60 (mm) | 16.200 | Add Flow / Climate Change (%) | 20 |
| Ratio R | 0.277 | Minimum Backdrop Height (m) | 0.200 |
| Maximum Rainfall (mm/hr) | 50 | Maximum Backdrop Height (m) | 8.000 |
| Maximum Time of Concentration (mins) | 30 | Min Design Depth for Optimisation (m) | 1.200 |
| Foul Sewage (l/s/ha) | 0.000 | Min Vel for Auto Design only (m/s) | 1.00 |
| Volumetric Runoff Coeff. | 1.000 | Min Slope for Optimisation (1:X) | 500 |

Designed with Level Soffits

### Time Area Diagram for Storm

| Time (mins) | Area (ha) | Time (mins) | Area (ha) |
|---|---|---|---|
| 0-4 | 0.147 | 4-8 | 0.038 |

Total Area Contributing (ha) = 0.185

Total Pipe Volume (m³) = 5.449

### Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 21.000 | 0.124 | 169.4 | 0.075 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 1.001 | 11.500 | 0.058 | 200.0 | 0.005 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 1.002 | 27.000 | 0.900 | 30.0 | 0.005 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.000 | 18.000 | 0.090 | 200.0 | 0.080 | 4.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |
| 2.001 | 10.000 | 0.050 | 200.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 225 | Pipe/Conduit | |

### Network Results Table

| PN | Rain (mm/hr) | T.C. (mins) | US/IL (m) | Σ I.Area (ha) | Σ Base Flow (l/s) | Foul (l/s) | Add Flow (l/s) | Vel (m/s) | Cap (l/s) | Flow (l/s) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 50.00 | 4.35 | 20.475 | 0.075 | 0.0 | 0.0 | 2.7 | 1.00 | 39.8 | 16.2 |
| 1.001 | 50.00 | 4.56 | 20.351 | 0.080 | 0.0 | 0.0 | 2.9 | 0.92 | 36.6 | 17.3 |
| 1.002 | 49.82 | 4.75 | 19.550 | 0.085 | 0.0 | 0.0 | 3.1 | 2.40 | 95.3 | 18.4 |
| 2.000 | 50.00 | 4.33 | 17.600 | 0.080 | 0.0 | 0.0 | 2.9 | 0.92 | 36.6 | 17.3 |
| 2.001 | 50.00 | 4.51 | 17.510 | 0.090 | 0.0 | 0.0 | 3.2 | 0.92 | 36.6 | 19.5 |

## Network Design Table for Storm

| PN | Length (m) | Fall (m) | Slope (1:X) | I.Area (ha) | T.E. (mins) | Base Flow (l/s) | k (mm) | HYD SECT | DIA (mm) | Section Type | Auto Design |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 7.000 | 0.035 | 200.0 | 0.010 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 1.004 | 7.611 | 0.088 | 86.5 | 0.000 | 0.00 | 0.0 | 0.600 | o | 300 | Pipe/Conduit | |
| 1.005 | 13.265 | 0.326 | 40.7 | 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) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 49.43 | 4.85 | 17.385 | 0.185 | 0.0 | 0.0 | 6.6 | 1.11 | 78.3 | 39.6 |
| 1.004 | 49.15 | 4.93 | 17.350 | 0.185 | 0.0 | 0.0 | 6.6 | 1.69 | 119.6 | 39.6 |
| 1.005 | 48.83 | 5.01 | 16.000 | 0.185 | 0.0 | 0.0 | 6.6 | 2.47 | 174.7 | 39.6 |

## Surcharged Outfall Details for Storm

| Outfall Pipe Number | Outfall Name | C. Level (m) | I. Level (m) | Min I. Level (m) | D,L (mm) | W (mm) |
|---|---|---|---|---|---|---|
| 1.005 | | 16.000 | 15.674 | 0.000 | 0 | 0 |

Datum (m) 15.870 Offset (mins) 0

| Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) | Time (mins) | Depth (m) |
|---|---|---|---|---|---|---|---|---|---|
| 288 | 0.000 | 864 | 0.000 | 1440 | 0.000 | 2016 | 0.000 | 2592 | 0.000 |
| 576 | 0.000 | 1152 | 0.000 | 1728 | 0.000 | 2304 | 0.000 | 2880 | 0.000 |

## Simulation Criteria for Storm

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

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

## Synthetic Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | M5-60 (mm) | 16.200 |
| Return Period (years) | 2 | Ratio R | 0.277 |
| Region | Scotland and Ireland | Profile Type | Winter |

## Synthetic Rainfall Details

Cv (Summer) 1.000 Storm Duration (mins) 30
Cv (Winter) 1.000

## Online Controls for Storm

### Hydro-Brake® Optimum Manhole: 10, DS/PN: 1.005, Volume ($m^3$): 3.4

| | |
|---|---|
| Unit Reference | MD-SHE-0047-1200-1500-1200 |
| Design Head (m) | 1.500 |
| Design Flow (l/s) | 1.2 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 47 |
| Invert Level (m) | 16.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.500 | 1.2 |
| Flush-Flo™ | 0.207 | 0.8 |
| Kick-Flo® | 0.417 | 0.7 |
| Mean Flow over Head Range | - | 0.9 |

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 | 0.8 | 1.200 | 1.1 | 3.000 | 1.6 | 7.000 | 2.4 |
| 0.200 | 0.8 | 1.400 | 1.2 | 3.500 | 1.8 | 7.500 | 2.5 |
| 0.300 | 0.8 | 1.600 | 1.2 | 4.000 | 1.9 | 8.000 | 2.6 |
| 0.400 | 0.7 | 1.800 | 1.3 | 4.500 | 2.0 | 8.500 | 2.7 |
| 0.500 | 0.7 | 2.000 | 1.4 | 5.000 | 2.1 | 9.000 | 2.7 |
| 0.600 | 0.8 | 2.200 | 1.4 | 5.500 | 2.2 | 9.500 | 2.8 |
| 0.800 | 0.9 | 2.400 | 1.5 | 6.000 | 2.3 | | |
| 1.000 | 1.0 | 2.600 | 1.5 | 6.500 | 2.3 | | |

## Storage Structures for Storm

### Tank or Pond Manhole: 10, DS/PN: 1.005

Invert Level (m) 16.000

| **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** | **Depth (m)** | **Area (m²)** |
|---|---|---|---|---|---|---|---|
| 0.000 | 68.0 | 1.000 | 68.0 | 1.200 | 68.0 | 1.500 | 68.0 |

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

### Simulation Criteria

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

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

### Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.277
Region Scotland and Ireland Cv (Summer) 1.000
M5-60 (mm) 16.200 Cv (Winter) 1.000

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

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 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) |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 20.767 |
| 1.001 | 2 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 20.613 |
| 1.002 | 3 | 15 Summer | 100 | +20% | | | | | 19.663 |
| 2.000 | 5 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 18.037 |
| 2.001 | 6 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 17.909 |
| 1.003 | 7 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 17.811 |
| 1.004 | 8 | 15 Summer | 100 | +20% | 100/15 Summer | | | | 17.679 |
| 1.005 | 10 | 960 Winter | 100 | +20% | 100/15 Summer | | | | 17.642 |

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 1.000 | 1 | 0.067 | 0.000 | 1.07 | | | 38.9 | SURCHARGED | |
| 1.001 | 2 | 0.037 | 0.000 | 1.33 | | | 41.5 | SURCHARGED | |
| 1.002 | 3 | -0.112 | 0.000 | 0.50 | | | 44.1 | OK | |
| 2.000 | 5 | 0.212 | 0.000 | 1.15 | | | 37.7 | SURCHARGED | |
| 2.001 | 6 | 0.174 | 0.000 | 1.39 | | | 42.4 | SURCHARGED | |

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

| 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 |
|---|---|---|---|---|---|---|---|---|---|
| 1.003 | 7 | 0.126 | 0.000 | 1.61 | | | 91.0 | SURCHARGED | |
| 1.004 | 8 | 0.029 | 0.000 | 1.22 | | | 90.6 | SURCHARGED | |
| 1.005 | 10 | 1.342 | 0.000 | 0.01 | | | 1.2 | SURCHARGED | |

## Summary of Results for 100 year Return Period (+20%)

Half Drain Time : 762 minutes.

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 15 min Summer | 16.478 | 0.314 | 0.0 | 0.8 | 0.8 | 25.4 | O K |
| 30 min Summer | 16.609 | 0.445 | 0.0 | 0.8 | 0.8 | 36.0 | O K |
| 60 min Summer | 16.745 | 0.581 | 0.0 | 0.9 | 0.9 | 47.0 | O K |
| 120 min Summer | 16.885 | 0.721 | 0.0 | 0.9 | 0.9 | 58.3 | O K |
| 180 min Summer | 16.963 | 0.799 | 0.0 | 1.0 | 1.0 | 64.6 | O K |
| 240 min Summer | 17.013 | 0.849 | 0.0 | 1.0 | 1.0 | 68.7 | O K |
| 360 min Summer | 17.071 | 0.907 | 0.0 | 1.0 | 1.0 | 73.3 | O K |
| 480 min Summer | 17.098 | 0.934 | 0.0 | 1.0 | 1.0 | 75.5 | O K |
| 600 min Summer | 17.106 | 0.942 | 0.0 | 1.0 | 1.0 | 76.2 | O K |
| 720 min Summer | 17.107 | 0.943 | 0.0 | 1.0 | 1.0 | 76.3 | O K |
| 960 min Summer | 17.102 | 0.938 | 0.0 | 1.0 | 1.0 | 75.8 | O K |
| 1440 min Summer | 17.086 | 0.922 | 0.0 | 1.0 | 1.0 | 74.6 | O K |
| 2160 min Summer | 17.057 | 0.893 | 0.0 | 1.0 | 1.0 | 72.2 | O K |
| 2880 min Summer | 17.020 | 0.856 | 0.0 | 1.0 | 1.0 | 69.2 | O K |
| 4320 min Summer | 16.937 | 0.773 | 0.0 | 1.0 | 1.0 | 62.5 | O K |
| 5760 min Summer | 16.854 | 0.690 | 0.0 | 0.9 | 0.9 | 55.7 | O K |
| 7200 min Summer | 16.774 | 0.610 | 0.0 | 0.9 | 0.9 | 49.3 | O K |
| 8640 min Summer | 16.700 | 0.536 | 0.0 | 0.9 | 0.9 | 43.3 | O K |
| 10080 min Summer | 16.632 | 0.468 | 0.0 | 0.8 | 0.8 | 37.9 | O K |
| 15 min Winter | 16.520 | 0.356 | 0.0 | 0.8 | 0.8 | 28.8 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 15 min Summer | 84.984 | 0.0 | 29.4 | 66 |
| 30 min Summer | 58.807 | 0.0 | 40.7 | 76 |
| 60 min Summer | 38.241 | 0.0 | 53.1 | 98 |
| 120 min Summer | 24.146 | 0.0 | 66.9 | 146 |
| 180 min Summer | 18.293 | 0.0 | 76.1 | 200 |
| 240 min Summer | 14.994 | 0.0 | 83.1 | 256 |
| 360 min Summer | 11.296 | 0.0 | 94.0 | 370 |
| 480 min Summer | 9.227 | 0.0 | 102.4 | 486 |
| 600 min Summer | 7.882 | 0.0 | 109.3 | 596 |
| 720 min Summer | 6.928 | 0.0 | 115.3 | 650 |
| 960 min Summer | 5.650 | 0.0 | 125.4 | 776 |
| 1440 min Summer | 4.237 | 0.0 | 141.0 | 1042 |
| 2160 min Summer | 3.176 | 0.0 | 158.5 | 1460 |
| 2880 min Summer | 2.586 | 0.0 | 172.2 | 1880 |
| 4320 min Summer | 1.933 | 0.0 | 193.1 | 2704 |
| 5760 min Summer | 1.571 | 0.0 | 209.1 | 3496 |
| 7200 min Summer | 1.338 | 0.0 | 222.7 | 4280 |
| 8640 min Summer | 1.173 | 0.0 | 234.2 | 5080 |
| 10080 min Summer | 1.049 | 0.0 | 244.4 | 5856 |
| 15 min Winter | 84.984 | 0.0 | 33.0 | 67 |

## Summary of Results for 100 year Return Period (+20%)

| Storm Event | Max Level (m) | Max Depth (m) | Max Infiltration (l/s) | Max Control (l/s) | Max Σ Outflow (l/s) | Max Volume (m³) | Status |
|---|---|---|---|---|---|---|---|
| 30 min Winter | 16.668 | 0.504 | 0.0 | 0.8 | 0.8 | 40.7 | O K |
| 60 min Winter | 16.822 | 0.658 | 0.0 | 0.9 | 0.9 | 53.2 | O K |
| 120 min Winter | 16.983 | 0.819 | 0.0 | 1.0 | 1.0 | 66.2 | O K |
| 180 min Winter | 17.075 | 0.911 | 0.0 | 1.0 | 1.0 | 73.6 | O K |
| 240 min Winter | 17.137 | 0.973 | 0.0 | 1.1 | 1.1 | 78.6 | O K |
| 360 min Winter | 17.211 | 1.047 | 0.0 | 1.1 | 1.1 | 84.7 | O K |
| 480 min Winter | 17.251 | 1.087 | 0.0 | 1.1 | 1.1 | 87.9 | O K |
| 600 min Winter | 17.270 | 1.106 | 0.0 | 1.1 | 1.1 | 89.4 | O K |
| 720 min Winter | 17.277 | 1.113 | 0.0 | 1.1 | 1.1 | 90.0 | O K |
| 960 min Winter | 17.270 | 1.106 | 0.0 | 1.1 | 1.1 | 89.4 | O K |
| 1440 min Winter | 17.242 | 1.078 | 0.0 | 1.1 | 1.1 | 87.1 | O K |
| 2160 min Winter | 17.191 | 1.027 | 0.0 | 1.1 | 1.1 | 83.0 | O K |
| 2880 min Winter | 17.127 | 0.963 | 0.0 | 1.1 | 1.1 | 77.9 | O K |
| 4320 min Winter | 16.992 | 0.828 | 0.0 | 1.0 | 1.0 | 66.9 | O K |
| 5760 min Winter | 16.863 | 0.699 | 0.0 | 0.9 | 0.9 | 56.5 | O K |
| 7200 min Winter | 16.745 | 0.581 | 0.0 | 0.9 | 0.9 | 47.0 | O K |
| 8640 min Winter | 16.637 | 0.473 | 0.0 | 0.8 | 0.8 | 38.3 | O K |
| 10080 min Winter | 16.534 | 0.370 | 0.0 | 0.8 | 0.8 | 29.9 | O K |

| Storm Event | Rain (mm/hr) | Flooded Volume (m³) | Discharge Volume (m³) | Time-Peak (mins) |
|---|---|---|---|---|
| 30 min Winter | 58.807 | 0.0 | 45.6 | 76 |
| 60 min Winter | 38.241 | 0.0 | 59.3 | 98 |
| 120 min Winter | 24.146 | 0.0 | 75.0 | 146 |
| 180 min Winter | 18.293 | 0.0 | 85.3 | 198 |
| 240 min Winter | 14.994 | 0.0 | 93.2 | 254 |
| 360 min Winter | 11.296 | 0.0 | 105.3 | 366 |
| 480 min Winter | 9.227 | 0.0 | 114.7 | 478 |
| 600 min Winter | 7.882 | 0.0 | 122.4 | 588 |
| 720 min Winter | 6.928 | 0.0 | 129.1 | 694 |
| 960 min Winter | 5.650 | 0.0 | 140.5 | 812 |
| 1440 min Winter | 4.237 | 0.0 | 150.3 | 1114 |
| 2160 min Winter | 3.176 | 0.0 | 177.7 | 1576 |
| 2880 min Winter | 2.586 | 0.0 | 192.9 | 2032 |
| 4320 min Winter | 1.933 | 0.0 | 216.3 | 2904 |
| 5760 min Winter | 1.571 | 0.0 | 234.4 | 3752 |
| 7200 min Winter | 1.338 | 0.0 | 249.5 | 4560 |
| 8640 min Winter | 1.173 | 0.0 | 262.2 | 5384 |
| 10080 min Winter | 1.049 | 0.0 | 273.9 | 6232 |

## Rainfall Details

| | | | |
|---|---|---|---|
| Rainfall Model | FSR | Winter Storms | Yes |
| Return Period (years) | 100 | Cv (Summer) | 0.750 |
| Region | Scotland and Ireland | Cv (Winter) | 0.840 |
| M5-60 (mm) | 16.200 | Shortest Storm (mins) | 15 |
| Ratio R | 0.277 | Longest Storm (mins) | 10080 |
| Summer Storms | Yes | Climate Change % | +20 |

## Pipe Network

| | | | |
|---|---|---|---|
| Volume in Pipe Network ($m^3$) | 24 | Dia of Outfall Pipe (m) | 0.2 |
| Slope of Outfall Pipe (1:X) | 150 | Roughness of Outfall Pipe (mm) | 0.600 |

## Time Area Diagram

Total Area (ha) 0.185

| Time From: | (mins) To: | Area (ha) | Time From: | (mins) To: | Area (ha) |
|---|---|---|---|---|---|
| 0 | 4 | 0.147 | 4 | 8 | 0.038 |

## Time Area Diagram

Total Area (ha) 0.000

| Time From: | (mins) To: | Area (ha) |
|---|---|---|
| 0 | 4 | 0.000 |

## Model Details

Storage is Online Cover Level (m) 18.630

## Cellular Storage Structure

Invert Level (m) 16.164 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

| Depth (m) | Area (m²) | Inf. Area (m²) | Depth (m) | Area (m²) | Inf. Area (m²) |
|---|---|---|---|---|---|
| 0.000 | 85.1 | 0.0 | 1.000 | 85.1 | 0.0 |
| 0.500 | 85.1 | 0.0 | 1.320 | 85.1 | 0.0 |

## Hydro-Brake® Optimum Outflow Control

| | |
|---|---|
| Unit Reference | MD-SHE-0047-1200-1500-1200 |
| Design Head (m) | 1.500 |
| Design Flow (l/s) | 1.2 |
| Flush-Flo™ | Calculated |
| Objective | Minimise upstream storage |
| Application | Surface |
| Sump Available | Yes |
| Diameter (mm) | 47 |
| Invert Level (m) | 16.000 |
| Minimum Outlet Pipe Diameter (mm) | 75 |
| Suggested Manhole Diameter (mm) | 1200 |

| Control Points | Head (m) | Flow (l/s) |
|---|---|---|
| Design Point (Calculated) | 1.500 | 1.2 |
| Flush-Flo™ | 0.207 | 0.8 |
| Kick-Flo® | 0.417 | 0.7 |
| Mean Flow over Head Range | - | 0.9 |

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 | 0.8 | 1.200 | 1.1 | 3.000 | 1.6 | 7.000 | 2.4 |
| 0.200 | 0.8 | 1.400 | 1.2 | 3.500 | 1.8 | 7.500 | 2.5 |
| 0.300 | 0.8 | 1.600 | 1.2 | 4.000 | 1.9 | 8.000 | 2.6 |
| 0.400 | 0.7 | 1.800 | 1.3 | 4.500 | 2.0 | 8.500 | 2.7 |
| 0.500 | 0.7 | 2.000 | 1.4 | 5.000 | 2.1 | 9.000 | 2.7 |
| 0.600 | 0.8 | 2.200 | 1.4 | 5.500 | 2.2 | 9.500 | 2.8 |
| 0.800 | 0.9 | 2.400 | 1.5 | 6.000 | 2.3 | | |
| 1.000 | 1.0 | 2.600 | 1.5 | 6.500 | 2.3 | | |

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# Appendix E – Project Acceptance Form

# PROJECT ACCEPTANCE FORM

JBA consulting

| | |
|---|---|
| JBA Project Code: | Q22-0597 |
| Contract | **Stage 1 SWA – Monkstown Road** |
| Date | 07/04/2022 |
| Quotation Manager | Michael O'Donoghue |

Project Contact:

Aoibhin Gormley
Byrne Looby
1 College House,
Citylink Business Park
Belfast,
BT12 4HQ,
United Kingdom

Tel:
Email: AGormley@ByrneLooby.com

To proceed with this quotation, please complete and return this form.

Provide details of the ultimate Client. The Contract will be formed between the Client and JBA Consulting, and it is the Client who is responsible for payment of invoices. If the box below is not completed it will be assumed that the Project Contact is the Client, and all liabilities will lie with that Contact.

Client Name & Address:
GEDU Monkstown Owner Limited
3rd Floor,
Kilmore House,
Park Lane,
Spencer Dock,
Dublin 1

Tel: 086 8542754
Email: ward.friday@greystar.com

I/We, (Client)…ward friday…… have received your quotation dated 07/04/2022 for providing a Stage 1 Stormwater Audit for the above development.

I/We (Client) …ward friday…… wish to accept the services described above for the sum of € 3,500 (excluding VAT)

I/We accept the terms and conditions of contract, as laid out below.

**Payment Terms**

We will invoice for the full fee on delivery of the draft report. Payment of same will be 28 days as per the attached Terms and Conditions or prior to release of the final report, whichever is the earlier.

# PROJECT ACCEPTANCE FORM

JBA consulting

| | |
|---|---|
| JBA Project Code: | Q22-0597 |
| Contract | **Stage 1 SWA – Monkstown Road** |
| Date | 07/04/2022 |
| Quotation Manager | Michael O'Donoghue |

**Conditions of Contract**

Our standard terms of business will apply to this contract, a copy of which is attached to this document. The Professional Indemnity Insurance cover offered is €13,000 and our liability is set at the same amount.

Signed (Client): ..........................................................................................

On behalf of: Greystar Ireland..........................................................................................

Dated: 14/4/2022..........................................................................................

Payment to be made to:

JBA Consulting Engineers and Scientists Ltd

Allied Irish Bank

106 O'Connell Street

Limerick

IBAN: IE80 AIBK 9355 1413 0440 82

BIC: AIBKIE2D

This form, and any remittance advice can be returned to accounts@jbaconsulting.ie

JBA consulting

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JBA Consulting Engineers and Scientists Limited
Registerd no: 444752

JBA Group Ltd is certified to:
ISO 9001:2015
ISO 14001:2015
ISO27001:2013
ISO 45001:2018

Byrne Looby
1 College House,
Citylink Business Park
Belfast,
BT12 4HQ,
United Kingdom

***For the attention of Aoibhin Gormley***

Our Ref: LL\Q22-0597-I-L001

7th April 2022

Dear Aoibhin,

**Stage 1 SW Audit, Dalguise Site, Monkstown Road**

Further to correspondence from David Rehill of David Rehill Consulting Engineers on 9th March 2022 requesting a Stage 1 Stormwater Audit for the above development, please find our fee proposal detailed below.

We have based our scope of work on Dún Laoghaire-Rathdown County Council's Stormwater Audit Procedure.

**Stormwater Audit**

**Stage 1 – Pre-Planning Stage** – A Stage 1 audit shall be carried out on the Stormwater Impact Assessment (SIA) prepared by the consultant of the applicant. The audit will focus on the SUDS management train and whether there has been careful consideration of all known SUDS techniques. The techniques used to ensure improved water quality, biodiversity and volume control will be assessed. The audit shall be forwarded to DLRCC prior to lodging the planning application. All recommendations shall be complied with, unless agreed in writing otherwise with DLRCC.

**Deliverables**

JBA will undertake a desk-top exercise where the proposed drainage design will be reviewed in the context of relevant reports (e.g. the Greater Dublin Strategic Drainage Study); pre and post development flow characteristics, and the SUDS management train. Storage capacities, pipe sizing and discharge rates will be reviewed, as will any phasing and maintenance considerations of the proposed SUDS design. We will liaise with you directly on any issues arising with the design and will submit our Stage 1 audit report to you for forwarding to DLRCC as part of the planning application submission.

As part of the review, some changes to your drainage proposals may be required prior to issue of the said audit report.

**Cost of Study**

Our fee for the Stage 1 work is as follows:

- €3,500 (excluding VAT).

We will invoice for the full fee on delivery of the draft report. Payment of same will be 28 days as per the attached Terms and Conditions or prior to release of the final report, whichever is the earlier.

**Data Requirements**

The quality of information provided will have a direct bearing on our ability to provide a quick and effective audit. Additional costs may be incurred if additional information is required or delays occur due to insufficient information requiring a number of iterations to close out the audit. To this end we will require the following information to be provided for completion of Stage 1;

1. Drawings of the proposed development, as well as any survey information;

2. The proposed surface water drainage layout, proposed details, longitudinal sections and available sections including attenuation details and all proposed SuDS details;

3. Pre-development run-off calculations;

4. Estimated post development run-off calculations (if relevant);

5. Proposed flow control details;

6. Drainage Design calculations (Micro-drainage Windes or similar);

7. Proposed SuDS, treatment volume (if relevant), attenuation calculations and design;

8. Any geotechnical data, including infiltration tests and ground water monitoring;

9. Details of SuDS measures considered but not included and reasoning for same.

10. An engineering report summarising the above and Stormwater Impact Assessment (similar to drainage report generally submitted with planning).

**Terms & Conditions**

The Professional Indemnity Insurance cover offered would be limited to €13,000, and the limit of our liability is set at the same amount.

We trust we have interpreted your requirements correctly and that you will find our proposal to be of interest. We await your further instructions, but if you have any queries in the meantime, please do not hesitate to contact either Michael O'Donoghue (michael.odonoghue@jbaconsulting.ie), or the undersigned.

Yours faithfully,
For **JBA Consulting Engineers and Scientists Limited**

Jonathan Cooper
**Managing Director**
**jonathan.cooper@jbaconsulting.ie**

Encs. T&C
Project Acceptance Form

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# Appendix F – Green/Blue Roof Specification

# Info Sheet
# Green Roof Maintenance



Extensive landscapes with wind, frost and drought resistant plants require little maintenance. The better adapted the plants are to their roof conditions, the less maintenance required. Maintenance objectives vary with each case and will depend on the plant types used, their stage of development, the local climate and the specific position and conditions on the roof.

## Maintenance objectives depending on vegetation type

**ZinCo Plant Community "Sedum Carpet"**
The goal is a dense, long-lasting and bio-diverse carpet of sedum plants. Broad-leaved sedum species should constitute the majority. Weeds should be regularly removed.

Strategic use of slow-release fertilizer will strengthen sedum vegetation while limiting moss growth. At least once, safer twice yearly there should be a maintenance and weeding.

**ZinCo Plant Communities "Rockery Type Plants" and "Pitched Green Roofs"**
Again, the goal is a stable, diverse community of species. Weaker species such as hybrid Sempervivum must be protected from more aggressive species through maintenance.

Self-seeding species such as some grasses must be pruned regularly to avoid overpopulation. Weeds and unwanted pioneers should also be regularly controlled.

Maintenance should occur 2-3 times annually. On flat roofs, additional watering may be necessary during drought. Pitched and steep roofs may sometimes need more frequent watering, especially on south exposed surfaces. Proper fertilization on pitched roofs is important for establishing good cover and thus erosion control.

**Wildflowers, herbs, grasses**
*Wildflowers and herbs:*
The highest possible biodiversity should be sought. Aggressive species may need to be isolated and regularly cut back. Sprouting trees and other unwanted plants should be removed regularly.

*Grass roofs or grass - wildflower Mixtures:*
The aim here is a low-maintenance dry meadow.
Mowing can be conducted every 1-3 years, or more depending on desired appearance. Cuttings should be removed.

## Maintenance objectives depending on the stage of development

**Completion Care as integral part of the**

**installation**



**ZinCo Green Roof Systems Ltd.**
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office@zinco-greenroof.co.uk · www.zinco-greenroof.co.uk

Life on Roofs

# Info Sheet
# Green Roof Maintenance



Successful installation - seeding, Sedum cuttings, plug planting.

Requirements: 60% surface coverage (with Sedum cuttings it must be at least 4 species, each 15%); at least 80% of the advertised species must be present and growing; max. 20% of total covered by foreign species; must have experienced one full growing and rest cycle (lasting dry or frost).

Successful installation – pre-cultivated vegetation mats or elements.

Vegetation mats must have established and secure root systems. There must be 90% cover by the advertised vegetation for acceptance. A maximum of 10% of the joints may be visible. Vegetation mats with wild flowers, herbs and grasses may contain a maximum 20% suitable species;. Sedum vegetation mats should not contain any foreign vegetation.

**Development Care**

Directly after handing over the project, a 2 year maintenance period will begin. The goal is a permanently functioning green roof with a surface cover of at least 90% and a species composition in accordance with the plant lists. There are usually required 2 to 3 maintenance rounds per year. For this purpose, a maintenance contract should be struck with a specialist company.

**Maintenance Care**

Here it is important to preserve a functional state, the area coverage and possibly regulatory action.

Maintenance care belongs in the hands of skilled personnel.

2 to 3 maintenance rounds per year are recommended. The client may agree to a single annual maintenance in the case of sedum roofs and simple grass roofs.

*"Starving" Sedum vegetation*

*The same surface after appropriate fertilization*

## Description of steps

**Fertilization**

For initial and subsequent fertilization, the FLL Guideline recommends a coated NPK slow-release fertilizer at a rate of 5 g N/m² FLL-Guidelines for the Planning, Construction and Maintenance of Green Roofing, 2008. For example a coated NPK long-term fertilizer 23-5-10 with a residual effect of about 4 months can be used.  The ideal time for fertilization is March to mid-June. If necessary, fertilizing later in the vegetation period can be conducted with a slow-release lawn fertilizer. Fertilizing should not occur in the rest period.

**Recommendations for initial fertilization**

When planting in mid-March to mid-June: coated NPK long-term fertilizer 23-5-10, 25 g/m².
When planting in late June to mid-September:
slow release lawn fertilizer NPK 20-5-8, 10 g/m²
Greening mid-September to February: start fertilization in early spring.

**Recommendations for subsequent fertilization**

Every 2-3 years – coated NPK long-term fertilizer 23-5-10, 25 g/m².



**ZinCo Green Roof Systems Ltd.**
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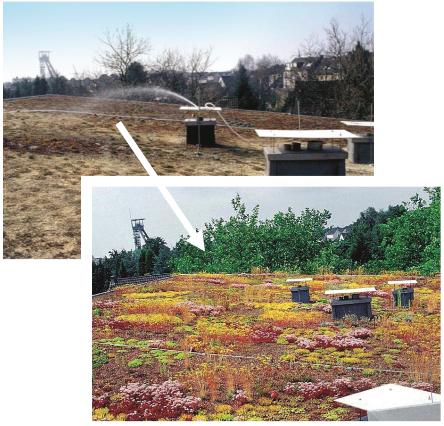
Life on Roofs

# Info Sheet
# Green Roof Maintenance



### Irrigation
For temporary overhead irrigation and for emergency irrigation a water connection with a sufficient water pressure should be provided for any extensive green roof project.



### Initial irrigation
A thorough irrigation after planting is always necessary. Other early irrigations are required depending on the weather. We recommend the use of an automated irrigation for the initial period.

### Duration
Planting – 3 to 4 weeks
Vegetation mats – 4 to 5 weeks
Seeding – 6 to 8 weeks (avoid any drying out after germination)

### Irrigation in intervals
As long as the vegetation is not yet closed, evaporation losses from the substrate will occur. It is possible that rooting is not yet complete. Watering in intervals can be necessary until handover, especially in areas with low amounts of precipitation or during periods of draught.

### Emergency irrigation
A green roof should also be watered long-term (except sedum plantings in climatically favourable regions)
Permanent irrigation installation can be useful, especially for pitched roofs > 20 ° and for roofs in hot, dry climates.

### Removal of undesired vegetation
Weeds do not only disturb with the desired appearance of the roof. They also compete with the intended vegetation for nutrients and water and therefore interfere with the development of a healthy green roof. The first step towards preventing weeds is the use of a sterile growing medium. However, weeds can also be introduced by birds or wind. Due to the exposed state of the substrate during the establishment phase, weeding is especially important at that time. If undesired species are removed by their roots regularly and on time before they produce seeds or cover large areas, the total effort can be kept low. Usually 2-3 maintenance rounds per year until handover, and once annually thereafter is required for extensive green roofs. More frequent weeding may be necessary depending on the project, for example in extremely windy locations or near a forest.

*Clover*

*Tree seedlings*

### Mowing
*Grass roof:*
A shallow trimming after the emergence of grasses can be beneficial to their development, while upsetting potential weeds.

*All seeding varieties:*
A clean cut every 2-3 years promotes biodiversity. More frequent mowing can be agreed for optical reasons. Cut grass must be removed.

### Levelling after frost-heave
Plantings in autumn or early winter sometimes have insufficient time to root.

Therefore, conduct a temper rolling in the spring or in accordance with frost-free weather to level the vegetation and avoid desiccation.

### Rework joints in vegetation mats
Joints in vegetation mats always occur to some degree. A reworking is necessary for a good appearance. On pitched roofs erosion must be avoided. As remedy, additional substrate and vegetation can be introduced to match the vegetation mats.



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Life on Roofs

# Info Sheet
# Green Roof Maintenance

### Maintenance of security and fire protection strips

These areas should be cleaned regularly and kept free of vegetation.

### Erosion Control

Erosion control during installation and maintenance is particularly important, especially in pitched roofs. Wind uplift must also be controlled. For example, an adhesive may be used again after hydro seeding. Stones can be used to secure mats until roots have formed. Long term, full vegetative coverage is key to avoiding erosion. This may require reseeding or replanting.

### Control of irrigation and drainage facilities

Drains and drainage systems must be kept clean, clear of obstructions and free-flowing. Optionally installed irrigation systems must also be kept in good working order.

## Example of typical steps

Typical tasks for the different stages include, but are not limited to, the following:

| Maintenance measure | CC | DC | MC |
|---|---|---|---|
| Initial fertilization | | | |
| Development and maintenance fertilizing | | | |
| Initial watering | | | |
| Interval watering | | | |
| Emergency watering | | | |
| Removing unwanted foreign growth | | | |
| Mowing | | | |
| Pruning | | | |
| Levelling after frost-heave | | | |
| Rework joints | | | |
| Reseeding/replanting | | | |
| Maintenance of security and fire protection strips | | | |
| Erosion prevention | | | |
| Control of irrigation and drainage facilities | | | |

CC = Completion Care DC = Development Care MC = Maintenance Care



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Life on Roofs

**Dalguise Roof Areas**

| Block | Roof Area ($m^2$) | Blue/Green Roof Area ($m^2$) |
|---|---|---|
| A | 250.25 | 142.27 |
| B | 367.65 | 295.81 |
| C | 378.39 | 305.93 |
| D | 367.92 | 270.22 |
| E | 404.71 | 187.23 |
| F | 688.33 | 562.24 |
| G | 688.33 | 562.24 |
| H | 639.47 | 611.68 |
| $I_1$ | 301.80 | 250.37 |
| $I_2$ | 301.90 | 250.37 |
| J | 246.50 | 183.12 |
| **Totals** | 4635.25 | 3621.48 |
| | 78.13% | Of Green/Blue Roof Area |

**ACO Blue Roof Calculator** Version 1.0.0.46

| Project Title | Design Number |
|---|---|
| Dalguise, Monkstown | |

**Notes / Reference**

Roof A

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 142.3 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **142.3** |
| Net Roof Area (m²) | 120.9 |
| Permitted Outflow (l/s) | 0.090 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 12.59 |
| Actual Depth (mm) | 116 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 13.60 |
| Utilisation | 92.5 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 2.43 |
| 10 mins | 144.72 | 3.38 |
| 15 mins | 113.76 | 3.97 |
| 30 mins | 70.32 | 4.84 |
| 1 hour | 53.64 | 7.31 |
| 2 hours | 26.82 | 6.98 |
| 4 hours | 16.60 | 8.15 |
| 6 hours | 12.52 | 8.74 |
| 10 hours | 11.12 | 12.59 |
| 24 hours | 4.79 | 8.57 |
| 48 hours | 2.92 | 4.36 |

Required aperture / outlet plate size: 10 mm

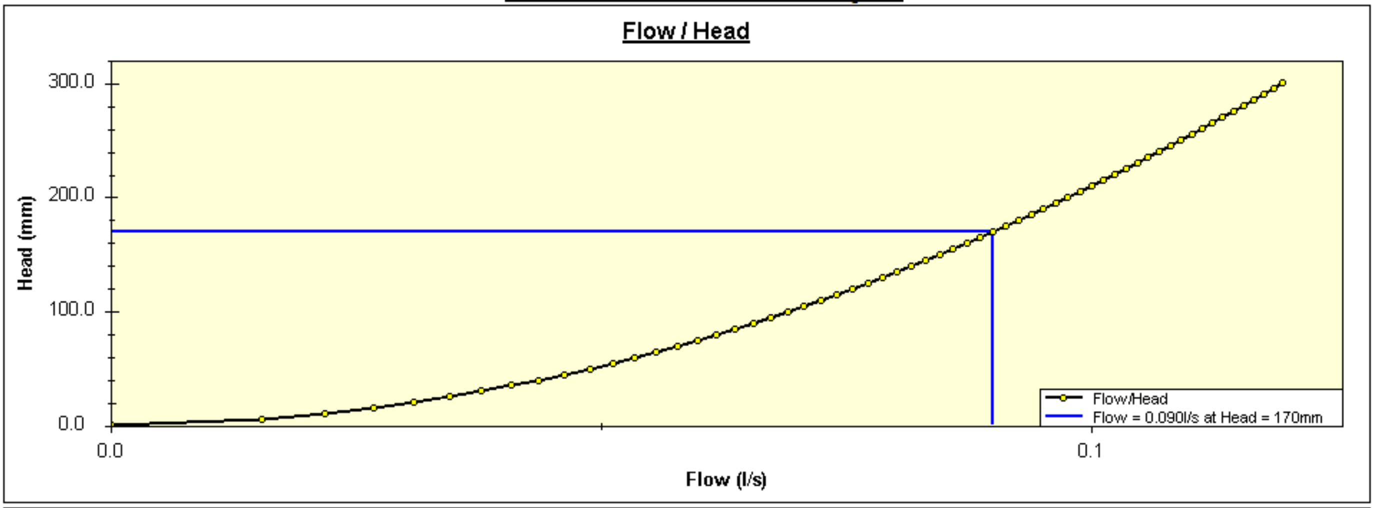
Half Empty Time: 1345 mins

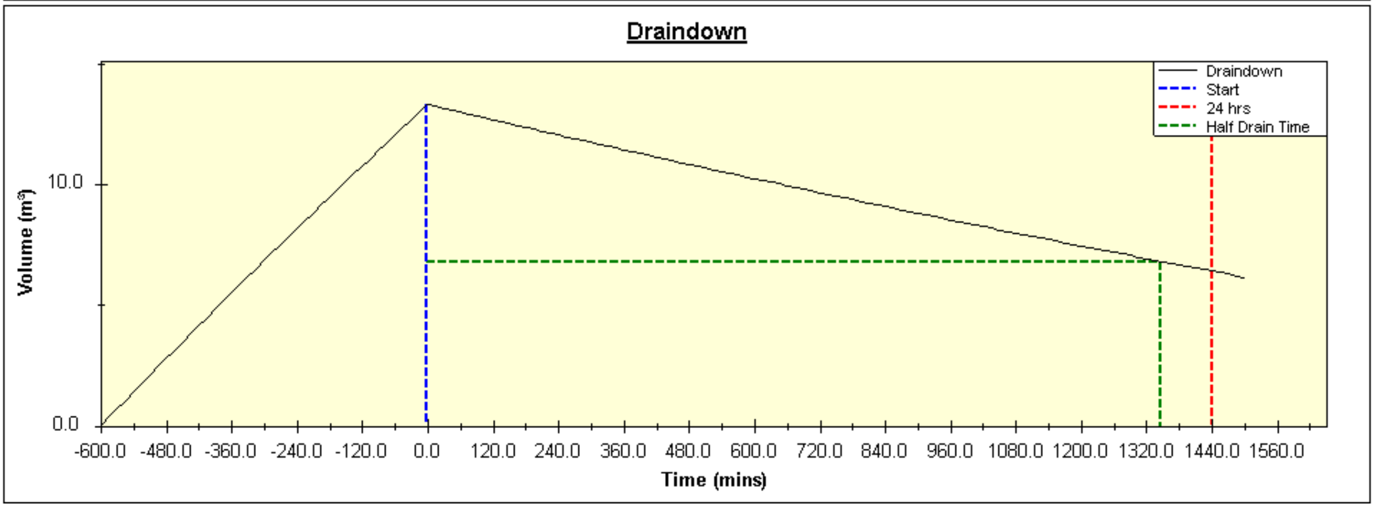
**Project Status:** **PASS**

**Structural Load Calculations**

| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs



# ACO Blue Roof Calculator Version 1.0.0.46

**Project Title**

Dalguise, Monkstown

**Design Number**

**Notes / Reference**

Roof B

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 295.8 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **295.8** |
| Net Roof Area (m²) | 251.4 |
| Permitted Outflow (l/s) | 0.200 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 25.71 |
| Actual Depth (mm) | 114 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 28.29 |
| Utilisation | 90.9 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 5.05 |
| 10 mins | 144.72 | 7.01 |
| 15 mins | 113.76 | 8.23 |
| 30 mins | 70.32 | 10.04 |
| 1 hour | 53.64 | 15.15 |
| 2 hours | 26.82 | 14.43 |
| 4 hours | 16.60 | 16.76 |
| 6 hours | 12.52 | 17.89 |
| 10 hours | 11.12 | 25.71 |
| 24 hours | 4.79 | 16.71 |
| 48 hours | 2.92 | 6.84 |

Required aperture / outlet plate size: 16 mm

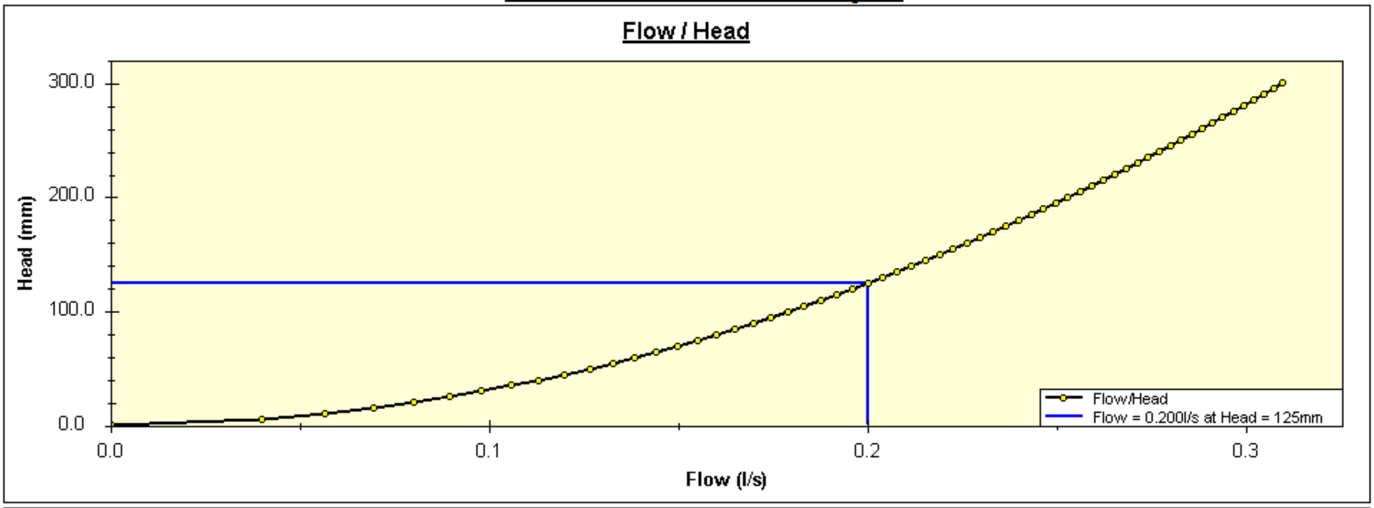
Half Empty Time: 1360 mins

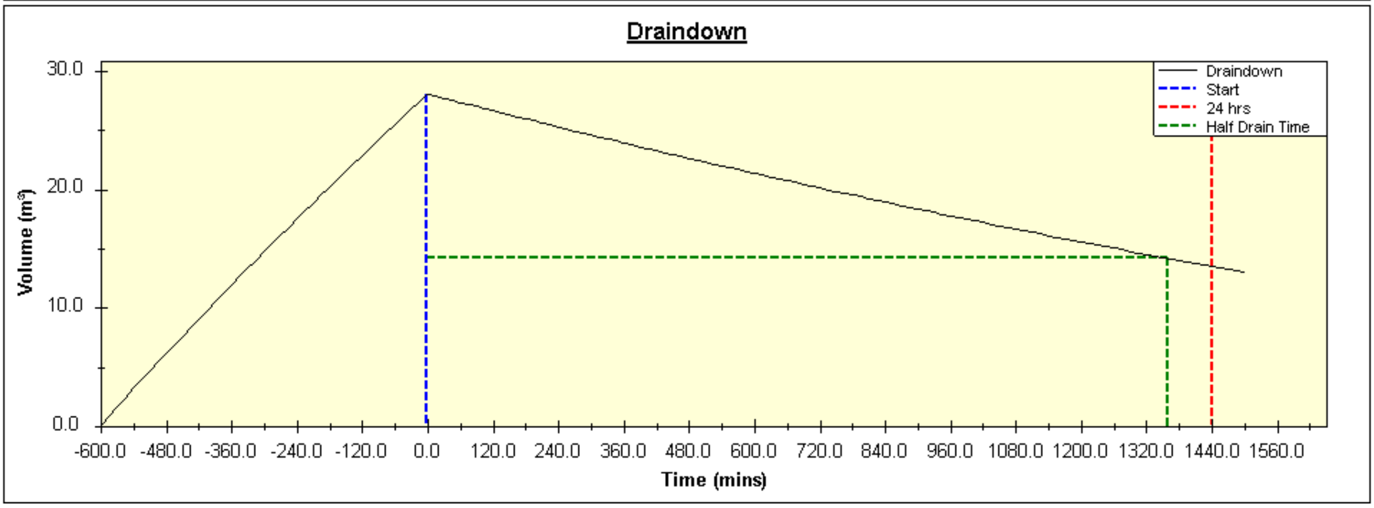
**Project Status:** PASS

**Structural Load Calculations**

| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs



**ACO Blue Roof Calculator** Version 1.0.0.46

**Project Title**

Dalguise, Monkstown

**Design Number**

**Notes / Reference**

Roof C

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 305.9 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **305.9** |
| Net Roof Area (m²) | 260.0 |
| Permitted Outflow (l/s) | 0.200 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 26.83 |
| Actual Depth (mm) | 115 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 29.25 |
| Utilisation | 91.7 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 5.23 |
| 10 mins | 144.72 | 7.26 |
| 15 mins | 113.76 | 8.52 |
| 30 mins | 70.32 | 10.40 |
| 1 hour | 53.64 | 15.69 |
| 2 hours | 26.82 | 14.97 |
| 4 hours | 16.60 | 17.43 |
| 6 hours | 12.52 | 18.65 |
| 10 hours | 11.12 | 26.83 |
| 24 hours | 4.79 | 17.88 |
| 48 hours | 2.92 | 8.26 |

Required aperture / outlet plate size: 16 mm

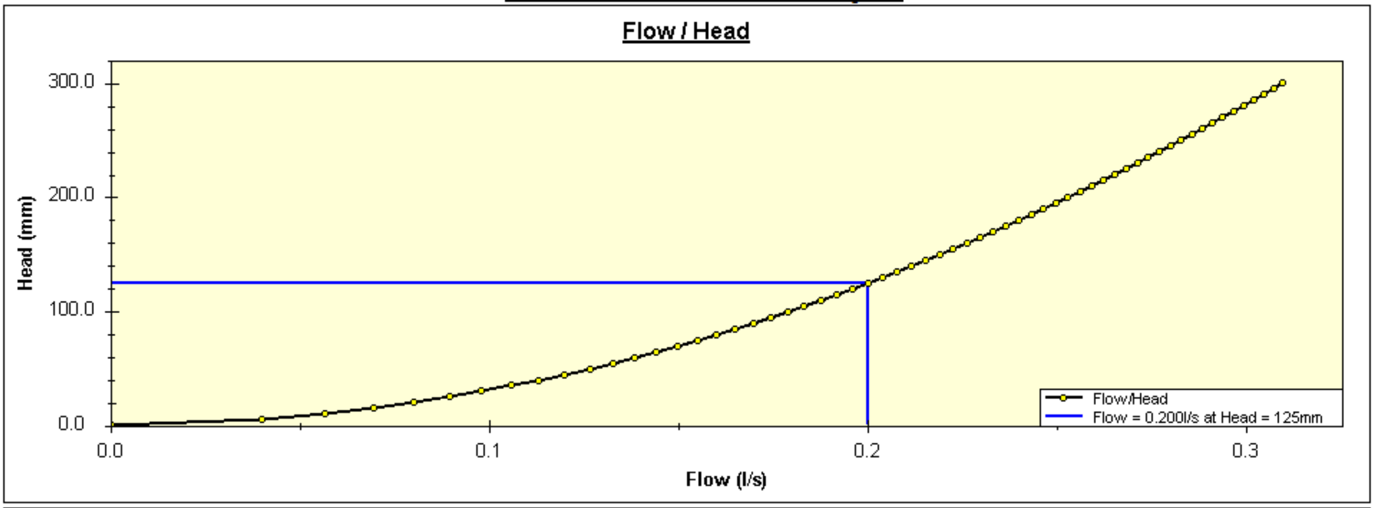
Half Empty Time: 1419 mins

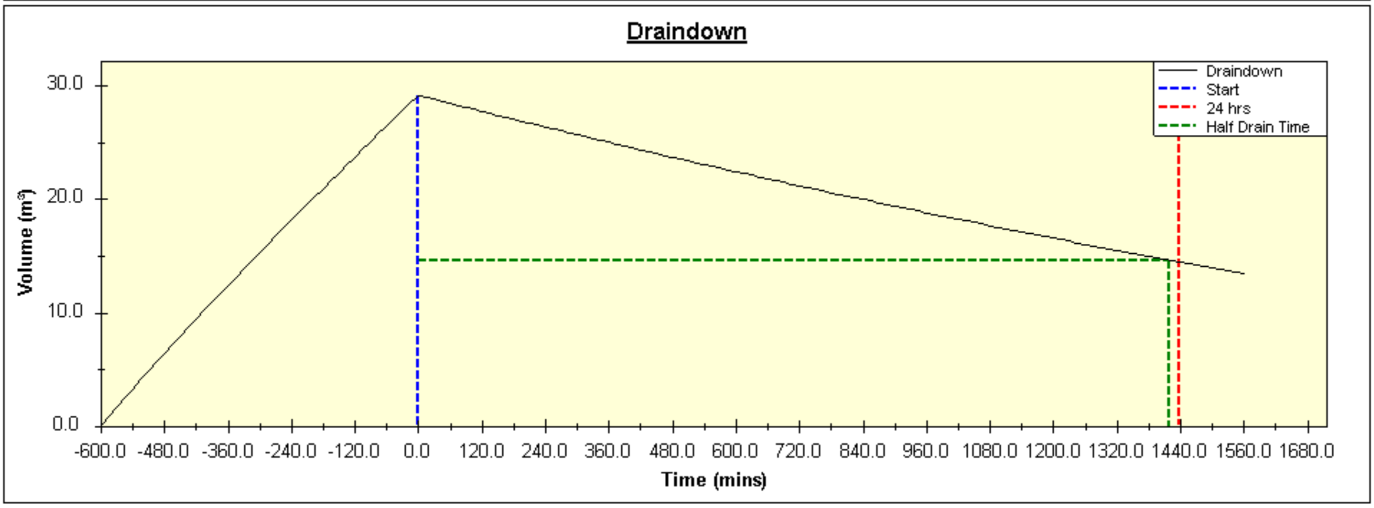
**Project Status:** **PASS**

**Structural Load Calculations**

| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs



# ACO Blue Roof Calculator Version 1.0.0.46

**Project Title**: Dalguise, Monkstown

**Design Number**:

**Notes / Reference**: Roof D

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 270.2 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **270.2** |
| Net Roof Area (m²) | 229.7 |
| Permitted Outflow (l/s) | 0.170 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 23.94 |
| Actual Depth (mm) | 116 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 25.84 |
| Utilisation | 92.6 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 4.62 |
| 10 mins | 144.72 | 6.42 |
| 15 mins | 113.76 | 7.53 |
| 30 mins | 70.32 | 9.19 |
| 1 hour | 53.64 | 13.88 |
| 2 hours | 26.82 | 13.27 |
| 4 hours | 16.60 | 15.49 |
| 6 hours | 12.52 | 16.62 |
| 10 hours | 11.12 | 23.94 |
| 24 hours | 4.79 | 16.36 |
| 48 hours | 2.92 | 8.45 |

Required aperture / outlet plate size: 14 mm

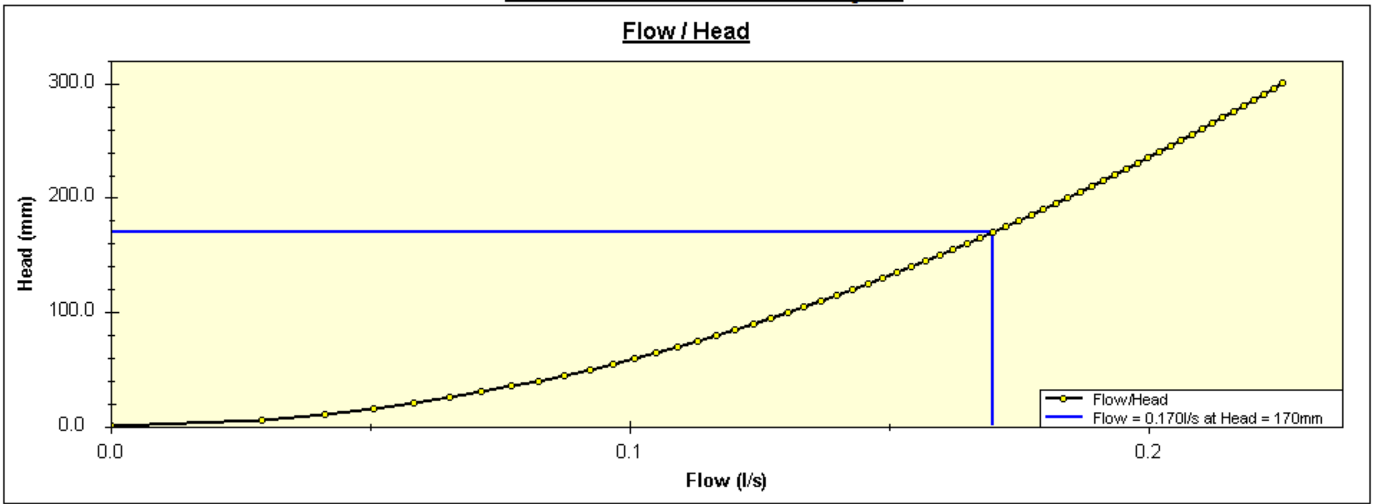
Half Empty Time: 1355 mins

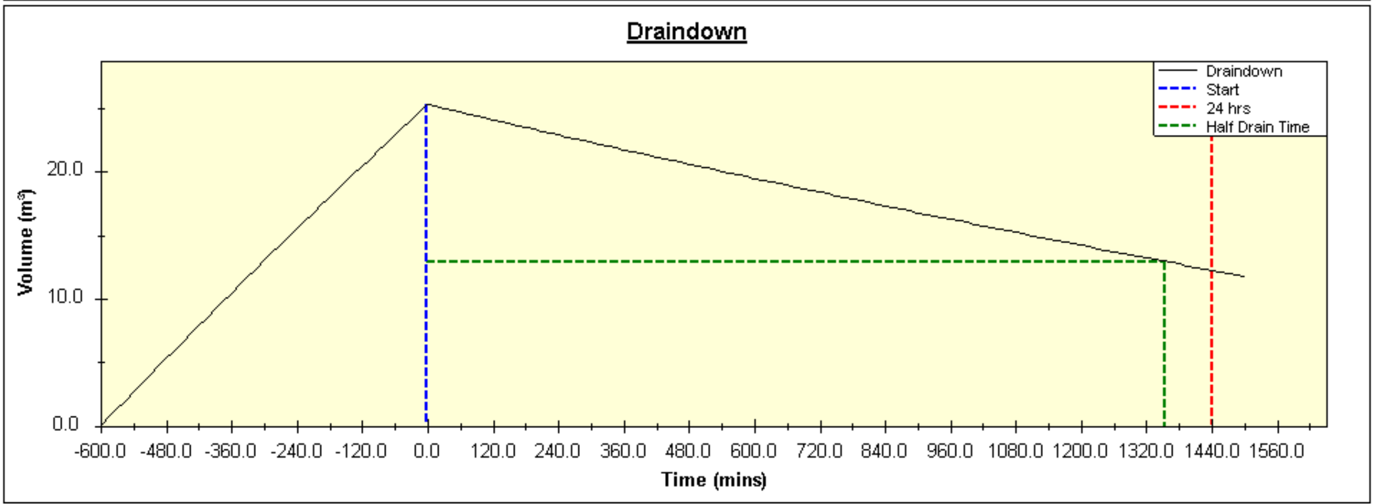
**Project Status:** **PASS**

### Structural Load Calculations

| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs



## ACO Blue Roof Calculator Version 1.0.0.46

**Project Title**: Dalguise, Monkstown

**Design Number**:

**Notes / Reference**

Roof E

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 187.2 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **187.2** |
| Net Roof Area (m²) | 159.2 |
| Permitted Outflow (l/s) | 0.120 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 16.51 |
| Actual Depth (mm) | 115 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 17.90 |
| Utilisation | 92.2 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 3.20 |
| 10 mins | 144.72 | 4.44 |
| 15 mins | 113.76 | 5.22 |
| 30 mins | 70.32 | 6.37 |
| 1 hour | 53.64 | 9.61 |
| 2 hours | 26.82 | 9.18 |
| 4 hours | 16.60 | 10.70 |
| 6 hours | 12.52 | 11.47 |
| 10 hours | 11.12 | 16.51 |
| 24 hours | 4.79 | 11.15 |
| 48 hours | 2.92 | 5.47 |

Required aperture / outlet plate size: 12 mm

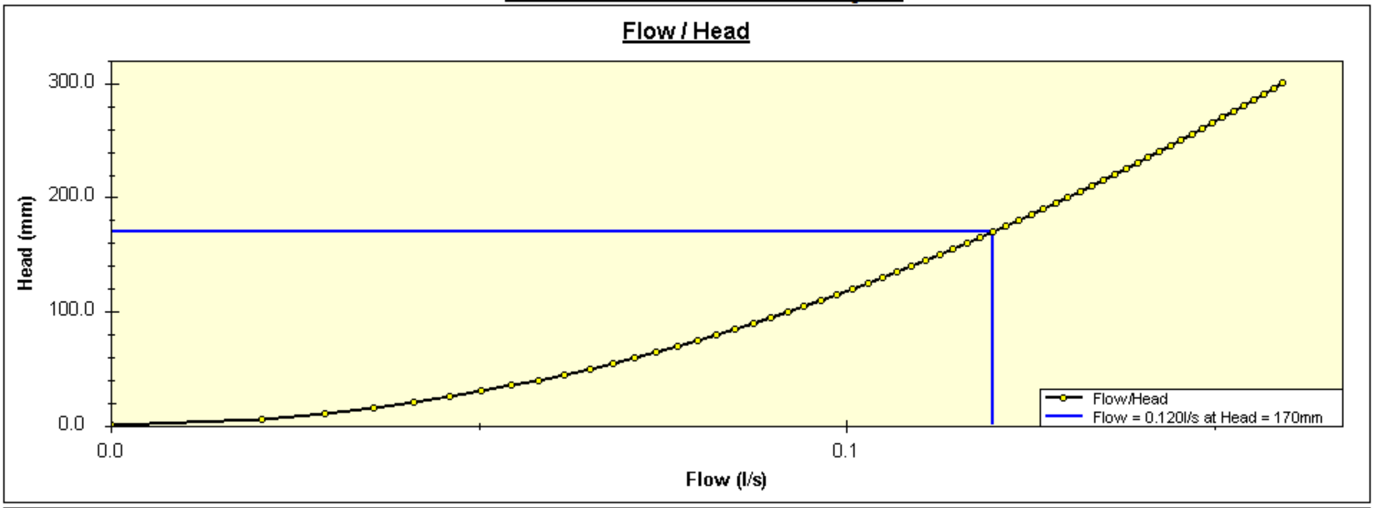
Half Empty Time: 1322 mins

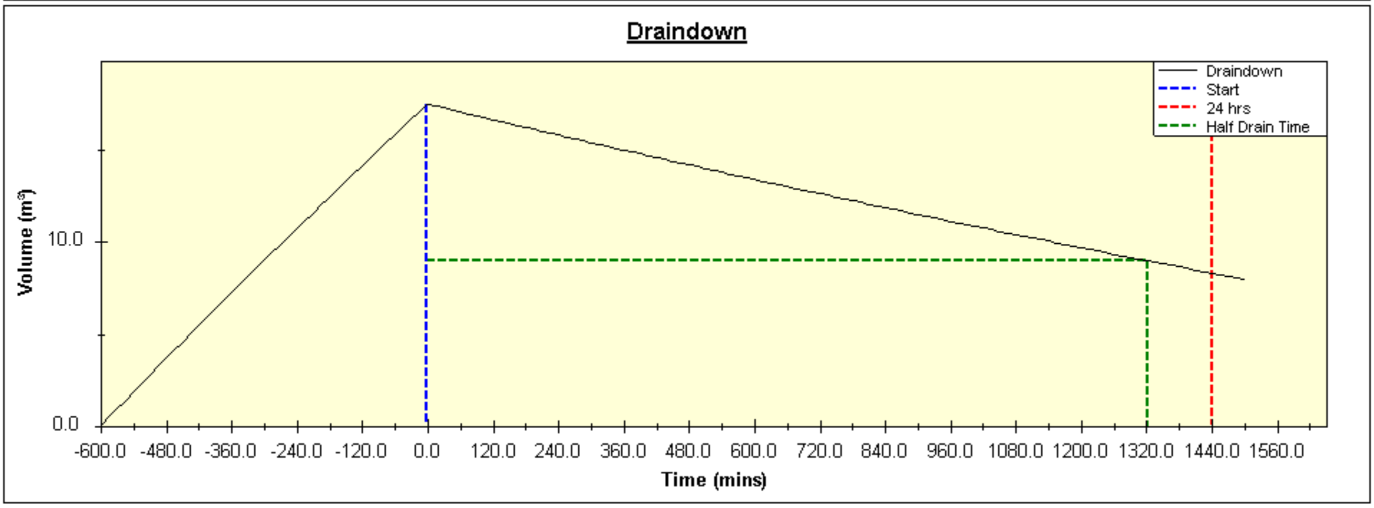
**Project Status:** **PASS**

### Structural Load Calculations

| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs



# ACO Blue Roof Calculator Version 1.0.0.46

| Project Title | Design Number |
|---|---|
| Dalguise, Monkstown | |

**Notes / Reference**

Roof F

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 562.2 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **562.2** |
| Net Roof Area (m²) | 477.9 |
| Permitted Outflow (l/s) | 0.340 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 50.30 |
| Actual Depth (mm) | 117 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 53.76 |
| Utilisation | 93.6 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 9.61 |
| 10 mins | 144.72 | 13.36 |
| 15 mins | 113.76 | 15.68 |
| 30 mins | 70.32 | 19.16 |
| 1 hour | 53.64 | 28.93 |
| 2 hours | 26.82 | 27.71 |
| 4 hours | 16.60 | 32.43 |
| 6 hours | 12.52 | 34.88 |
| 10 hours | 11.12 | 50.30 |
| 24 hours | 4.79 | 35.23 |
| 48 hours | 2.92 | 19.94 |

Required aperture / outlet plate size: 20 mm

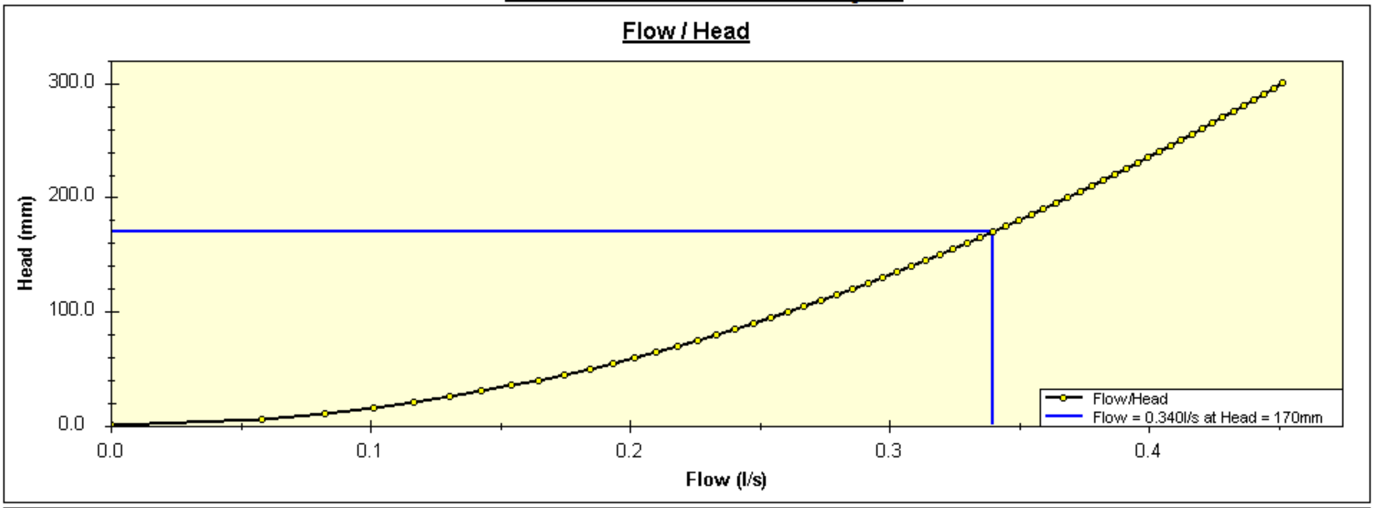
Half Empty Time: 1428 mins

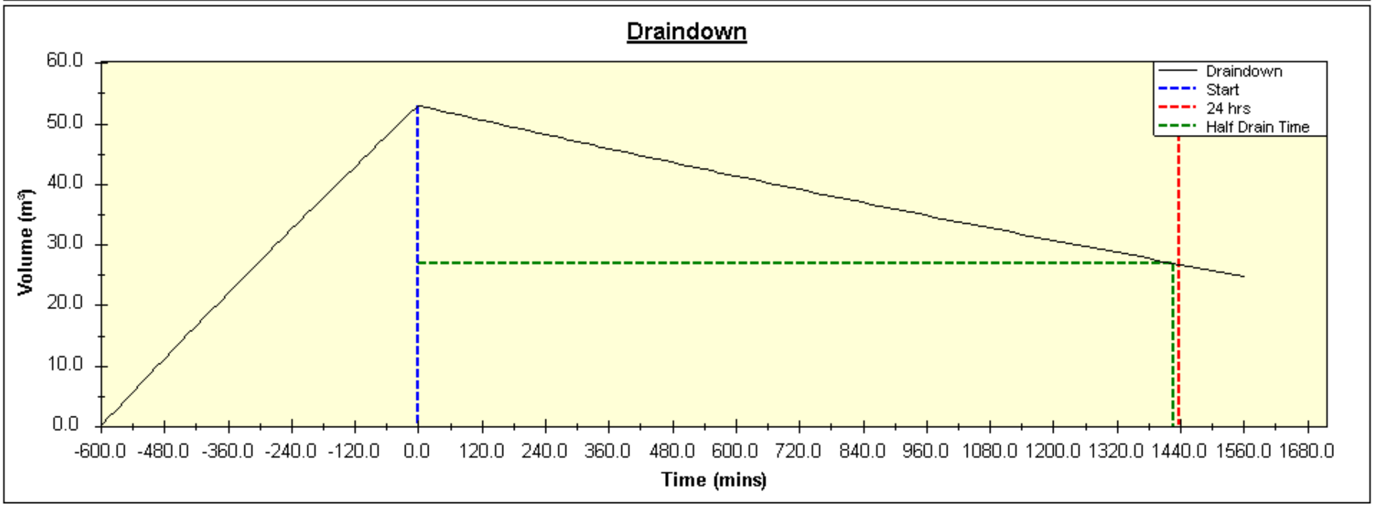
**Project Status:** **PASS**

### Structural Load Calculations

| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs



## ACO Blue Roof Calculator Version 1.0.0.46

**Project Title**: Dalguise, Monkstown

**Design Number**:

**Notes / Reference**: Roof G

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 562.2 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **562.2** |
| Net Roof Area (m²) | 477.9 |
| Permitted Outflow (l/s) | 0.340 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 50.30 |
| Actual Depth (mm) | 117 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 53.76 |
| Utilisation | 93.6 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 9.61 |
| 10 mins | 144.72 | 13.36 |
| 15 mins | 113.76 | 15.68 |
| 30 mins | 70.32 | 19.16 |
| 1 hour | 53.64 | 28.93 |
| 2 hours | 26.82 | 27.71 |
| 4 hours | 16.60 | 32.43 |
| 6 hours | 12.52 | 34.88 |
| 10 hours | 11.12 | 50.30 |
| 24 hours | 4.79 | 35.23 |
| 48 hours | 2.92 | 19.94 |

Required aperture / outlet plate size: 20 mm

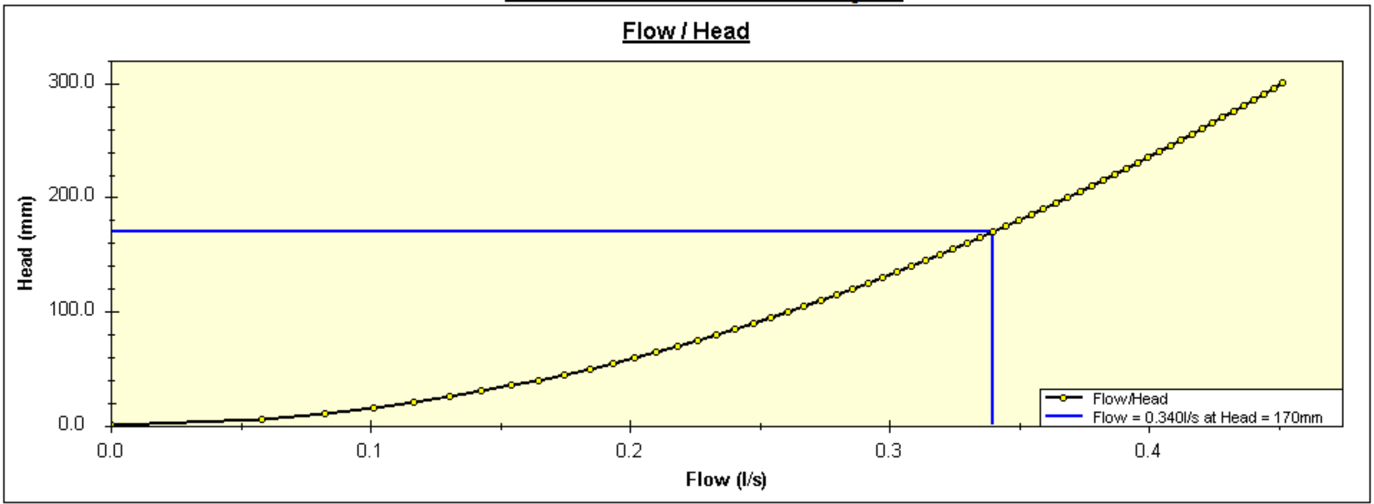
Half Empty Time: 1428 mins

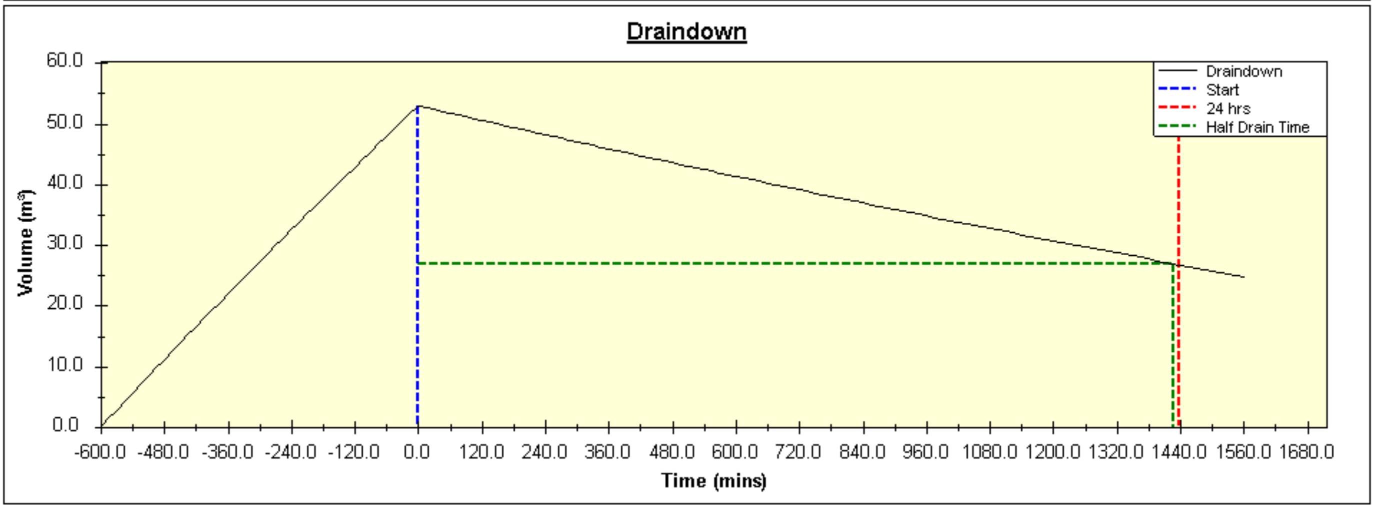
**Project Status:** **PASS**

### Structural Load Calculations

| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs



## ACO Blue Roof Calculator Version 1.0.0.46

**Project Title**: Dalguise, Monkstown

**Design Number**:

**Notes / Reference**: Roof H

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 611.7 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **611.7** |
| Net Roof Area (m²) | 519.9 |
| Permitted Outflow (l/s) | 0.370 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 54.72 |
| Actual Depth (mm) | 117 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 58.49 |
| Utilisation | 93.6 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 10.46 |
| 10 mins | 144.72 | 14.53 |
| 15 mins | 113.76 | 17.06 |
| 30 mins | 70.32 | 20.84 |
| 1 hour | 53.64 | 31.48 |
| 2 hours | 26.82 | 30.15 |
| 4 hours | 16.60 | 35.28 |
| 6 hours | 12.52 | 37.94 |
| 10 hours | 11.12 | 54.72 |
| 24 hours | 4.79 | 38.32 |
| 48 hours | 2.92 | 21.68 |

Required aperture / outlet plate size: 21 mm

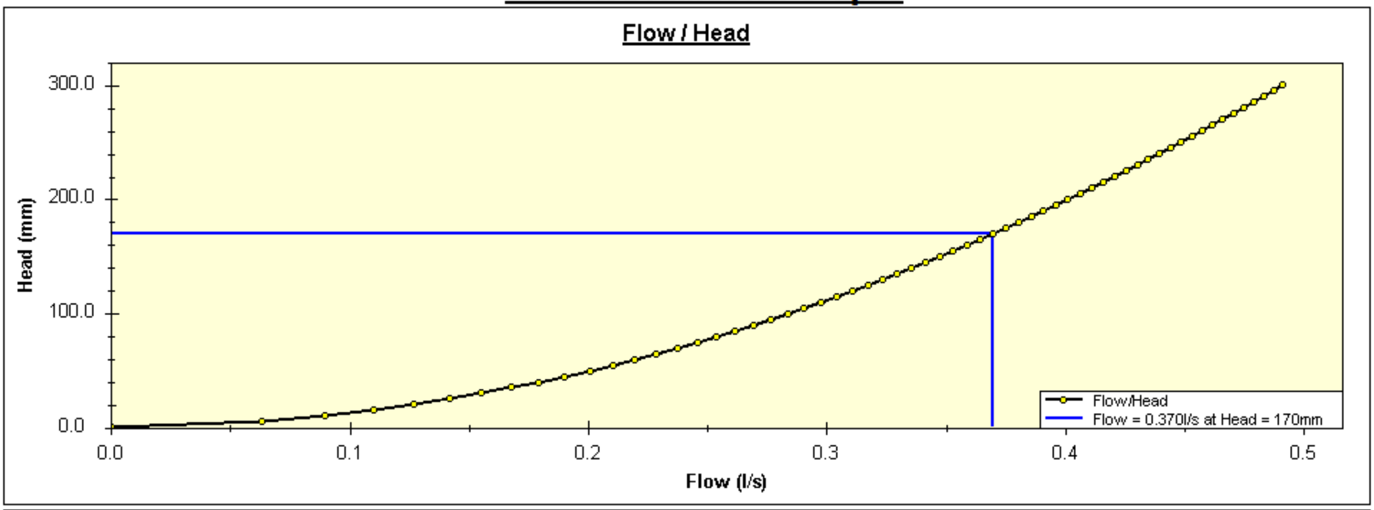
Half Empty Time: 1428 mins

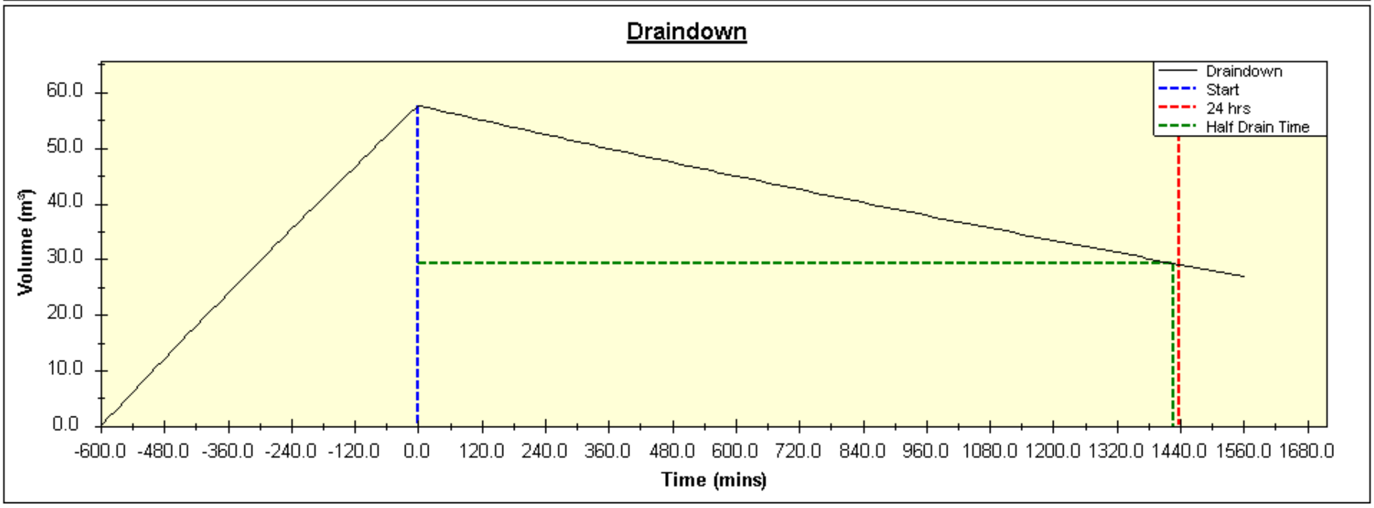
**Project Status: PASS**

### Structural Load Calculations

| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs



## ACO Blue Roof Calculator Version 1.0.0.46

**Project Title**

Dalguise, Monkstown

**Design Number**

**Notes / Reference**

Roof I1

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 250.4 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **250.4** |
| Net Roof Area (m²) | 212.8 |
| Permitted Outflow (l/s) | 0.160 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 22.09 |
| Actual Depth (mm) | 115 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 23.94 |
| Utilisation | 92.3 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 4.28 |
| 10 mins | 144.72 | 5.94 |
| 15 mins | 113.76 | 6.98 |
| 30 mins | 70.32 | 8.52 |
| 1 hour | 53.64 | 12.85 |
| 2 hours | 26.82 | 12.28 |
| 4 hours | 16.60 | 14.32 |
| 6 hours | 12.52 | 15.35 |
| 10 hours | 11.12 | 22.09 |
| 24 hours | 4.79 | 14.95 |
| 48 hours | 2.92 | 7.40 |

Required aperture / outlet plate size: 14 mm

Half Empty Time: 1327 mins

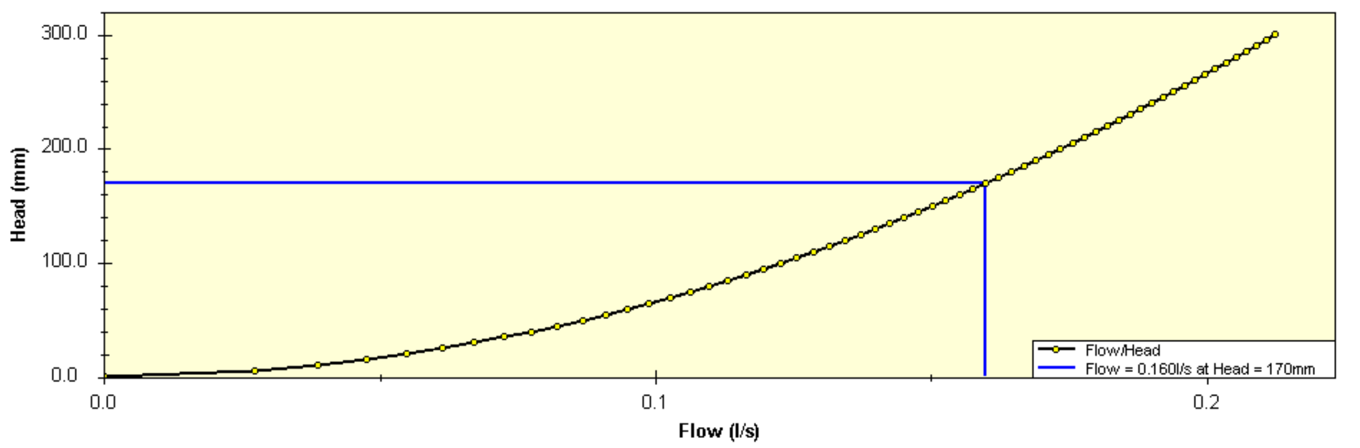
**Project Status:** **PASS**

### Structural Load Calculations

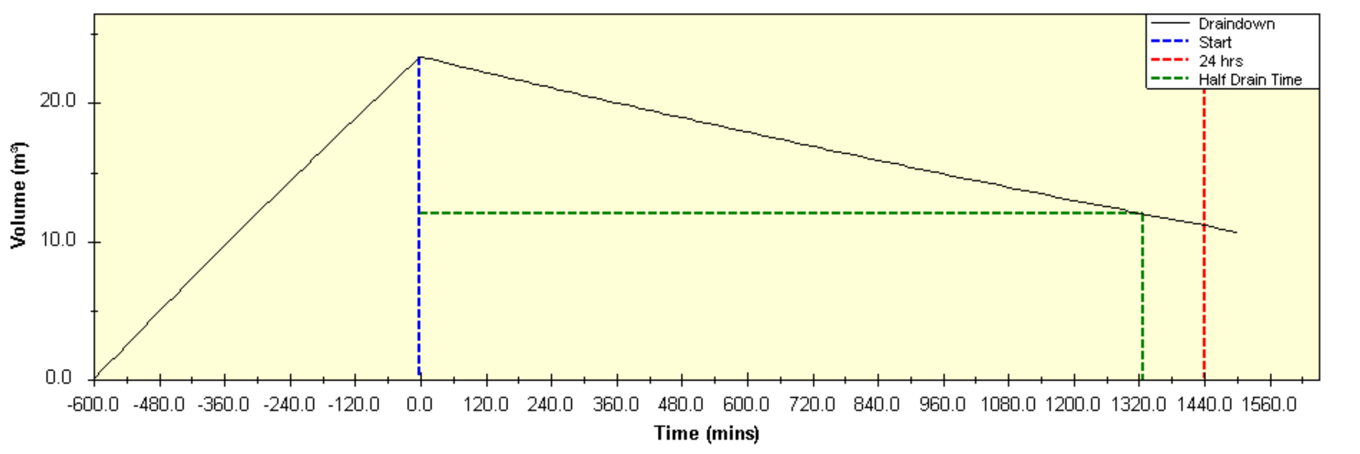
| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs

### Flow / Head




### Draindown



## ACO Blue Roof Calculator Version 1.0.0.46

**Project Title**

Dalguise, Monkstown

**Design Number**

**Notes / Reference**

Roof I2

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 250.4 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **250.4** |
| Net Roof Area (m²) | 212.8 |
| Permitted Outflow (l/s) | 0.160 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 22.09 |
| Actual Depth (mm) | 115 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 23.94 |
| Utilisation | 92.3 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 4.28 |
| 10 mins | 144.72 | 5.94 |
| 15 mins | 113.76 | 6.98 |
| 30 mins | 70.32 | 8.52 |
| 1 hour | 53.64 | 12.85 |
| 2 hours | 26.82 | 12.28 |
| 4 hours | 16.60 | 14.32 |
| 6 hours | 12.52 | 15.35 |
| 10 hours | 11.12 | 22.09 |
| 24 hours | 4.79 | 14.95 |
| 48 hours | 2.92 | 7.40 |

Required aperture / outlet plate size: 14 mm

Half Empty Time: 1327 mins

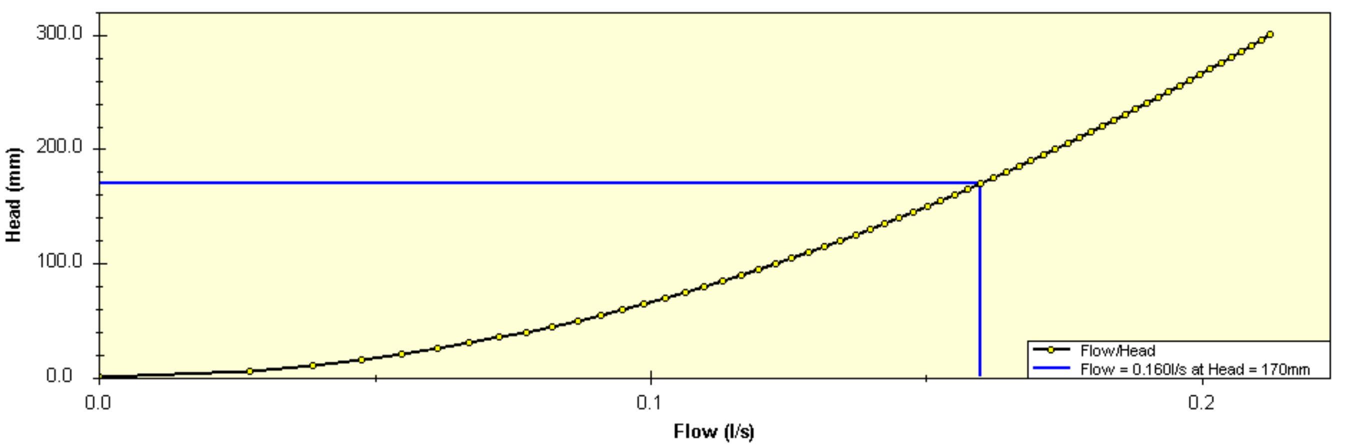
**Project Status:** **PASS**

### Structural Load Calculations

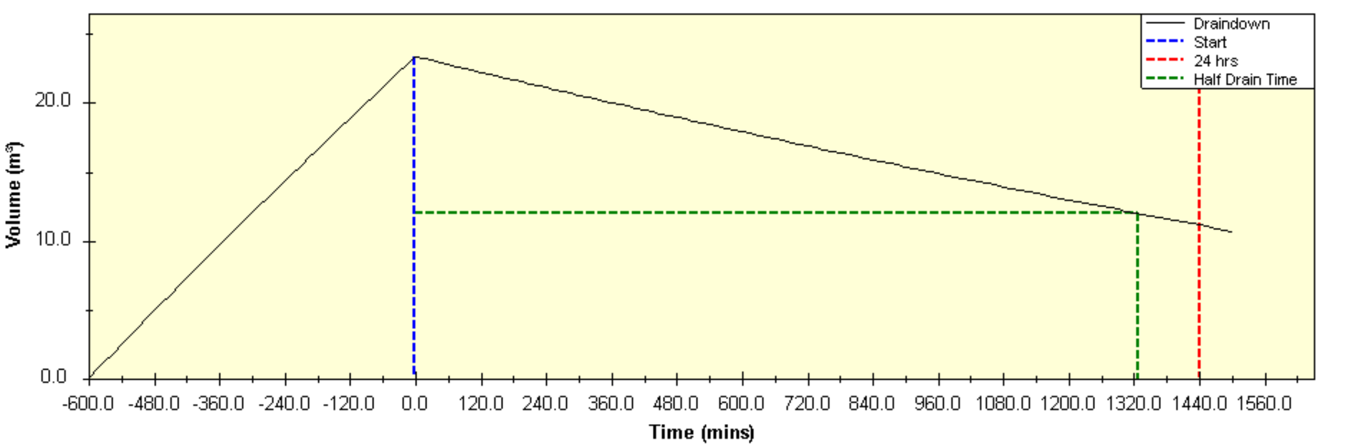
| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs

### Flow / Head




### Draindown



# ACO Blue Roof Calculator Version 1.0.0.46

| Project Title | Design Number |
|---|---|
| Dalguise, Monkstown | |

**Notes / Reference**

Roof J

| | |
|---|---|
| Design Storm Event | 1:100 |
| Climate Change | 20 % |
| Runoff Coefficient | 1.00 |
| Location | Monkstown |
| Roof Area m² | 183.1 |
| Additional Contributing Areas (m²) | |
| **Total Catchment Area (m²)** | **183.1** |
| Net Roof Area (m²) | 155.7 |
| Permitted Outflow (l/s) | 0.120 |
| Blue or Blue/Green Roof | Unknown |
| If B/G, Green Roof Type | Extensive |
| a. Permanent reservoir above or in storage void | None |
| b. Required Reservoir Depth (mm) | |

| | |
|---|---|
| Required Net Storm Storage Volume (m³) | 16.05 |
| Actual Depth (mm) | 115 |
| Porosity | 90 % |
| Selected depth of storage tank (mm) | 125 |
| Provided Storage Volume (m³) | 17.51 |
| Utilisation | 91.7 % |

R: l/s

M5-60: mm/h

| DURATION (mins) | INTENSITY (mm/h) | REQUIRED STORAGE VOLUME (m³) |
|---|---|---|
| 5 mins | 207.36 | 3.13 |
| 10 mins | 144.72 | 4.34 |
| 15 mins | 113.76 | 5.10 |
| 30 mins | 70.32 | 6.22 |
| 1 hour | 53.64 | 9.39 |
| 2 hours | 26.82 | 8.96 |
| 4 hours | 16.60 | 10.43 |
| 6 hours | 12.52 | 11.16 |
| 10 hours | 11.12 | 16.05 |
| 24 hours | 4.79 | 10.67 |
| 48 hours | 2.92 | 4.89 |

Required aperture / outlet plate size: 13 mm

Half Empty Time: 1415 mins

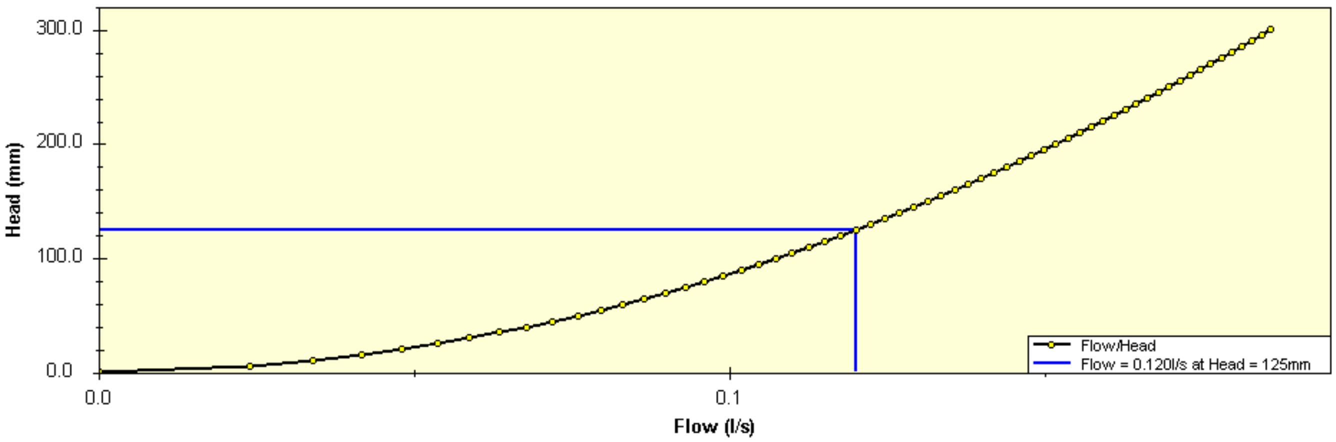
**Project Status:** **PASS**

### Structural Load Calculations

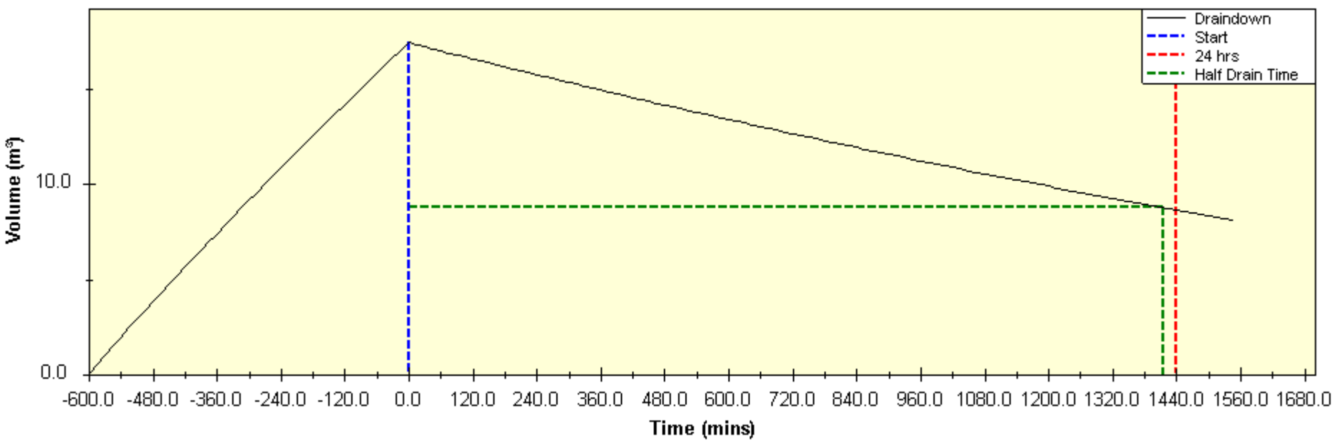
| Item | kN/m² |
|---|---|
| Weight of Product (Tank / Cell) | 0.162 |
| Weight of Product (Tray) | 0.000 |
| Geotextile | 0.005 |
| Weight of Permanent Storage | 0.000 |
| Weight of Stormwater Storage | 1.158 |

## Level & Draindown Graphs

### Flow / Head




### Draindown



**BETON EXTENSIVE GREEN ROOF WATERPROOFING INVERTED SYSTEM WITH ATTENUATION (blue roof) SPECIFICATION – Dalguise House, Monkstown, Co Dublin**

Spec no 300322 rev b Dalguise House

**Components:**
**Beton MasterSeal 2103 (Coniroof 2103) – Certification ETA 04/0035**
**Beton ACO Roofbloxx Blue roof system – to drainage standards**
**Beton Zinco Green Roof build up – Certification ETA 13/0668**

**Note:** This specification can only include materials which:

1. Bear a CE Marking in accordance with the provisions of the Construction Products Regulation.
2. Comply with an appropriate harmonised standard or European Technical Assessment in accordance with the provisions of the Construction Products Regulation.
3. Can be used without restriction in accordance with Irish Building Regulations.

**System Supplier**
Beton Construction Services Ltd.
**System Applicator**
Beton Construction Services Ltd.

**Suitability of concrete base**
Before starting work make sure the concrete base is such to permit the overlaying with the specified system. The concrete surface must be free of dirt, debris, materials and other such items and obstructions so as to allow the seamless installation of the system. The substrate must be to zero falls with no back falls from outlets.

**Preparation**
Prior to the application of the system. The entire substrate must be cleaned using jet washing techniques and/or captive shot blasting and/or mechanical, rolling or hand held grinding equipment.

**Coating System MasterSeal Roof 2103 (Coniroof 2103)**
Substrate to be primed with one of the following as per data sheet. Mastertop P622, BC375N, MasterSeal P660, P684 and for overlapping and missed priming window reasons MasterSeal P691. While wet the primer coat is broadcasted with silica sand to provide a mechanical key. When cured remove all excess sand.
Membrane must be applied by specialised computer controlled spray plant. Membrane must be Masterseal M803.

**Insulation**

1. Guideline thickness 220mm giving a U value of 0.15W/m2/k for insulation only.

**Separation Membrane**

1. Water Flow Reduction layer as per insulation supplier.

**Attenuation - ACO Roofbloxx Blue roof system**

1. 30mm drainage layer with filter.
2. ACO Roofbloxx (125mm) wrapped in Linear Low Density Polyethylene secondary membrane (LLDPE) and welded in place to form tank.
3. ACO Blue Roof Flow Restrictor one for each outlet.

**ZinCo Green Roof System**

1. Zinco Fixodrain ZD20.
2. Zinco substrate Sedum Carpet type 80mm.
3. Sedum Carpet.

**Option for Ballast Roof System (to replace ZinCo Green Roof System above)**

1. Ballast of 20mm stone 50mm in depth.

Note:
There will be a requirement for a ballast area 500mm around the perimeter held in place with a gravel retainer, this needs to be shown on working drawings.

**Build up height**

| | | |
|---|---|---|
| Dalguise House | | |
| Build up for green Roof | | |
| | Layer description | Max thicknes/mm |
| 1 | Sedum Carpet | 25 |
| 2 | Sedum Substrate | 80 |
| 3 | Fixodrain XD20 | 20 |
| 4 | ACO RoofBloxx 3 stacked | 125 |
| 6 | LLDPE | 1 |
| 7 | Drainage layer 30mm with filter attached | 30 |
| 8 | WFRL | 1 |
| 9 | Insulation | 220 |
| 10 | MasterSeal Roof 2103 | 2 |
| | | |
| | Total* | 504 |

*Stone ballast areas will have an approximately 55mm lower build up.

BYRNELOOBY

# Appendix G – SI Filtration Test Results

# Soakaway Design f -value from field tests (F2C) IGSL

Contract: Dalguise house — Contract No. 23927
Test No. SA1
Client Greystar Ltd
Date: 03/03/2022

Summary of ground conditions

| from | to | Description | Ground water |
|---|---|---|---|
| 0.00 | 0.30 | TOPSOIL | Mod flow at 2 m. |
| 0.30 | 1.20 | Firm light brown slightly gravelly sandy CLAY. | |
| 1.20 | 1.60 | Medium dense grey very sandy very clayey GRAVEL. | |
| 1.60 | 2.00 | Firm to stiff brownish grey slightly sandy gravelly CLAY with medium cobble content. | |

Notes:

Field Data

| Depth to Water (m) | Elapsed Time (min) |
|---|---|
| 1.40 | 0.00 |
| 1.40 | 1.00 |
| 1.40 | 2.00 |
| 1.40 | 3.00 |
| 1.40 | 4.00 |
| 1.40 | 5.00 |
| 1.40 | 10.00 |
| 1.40 | 15.00 |
| 1.40 | 20.00 |
| 1.40 | 30.00 |
| 1.40 | 40.00 |
| 1.40 | 60.00 |
| 1.40 | 90.00 |
| 1.40 | 120.00 |

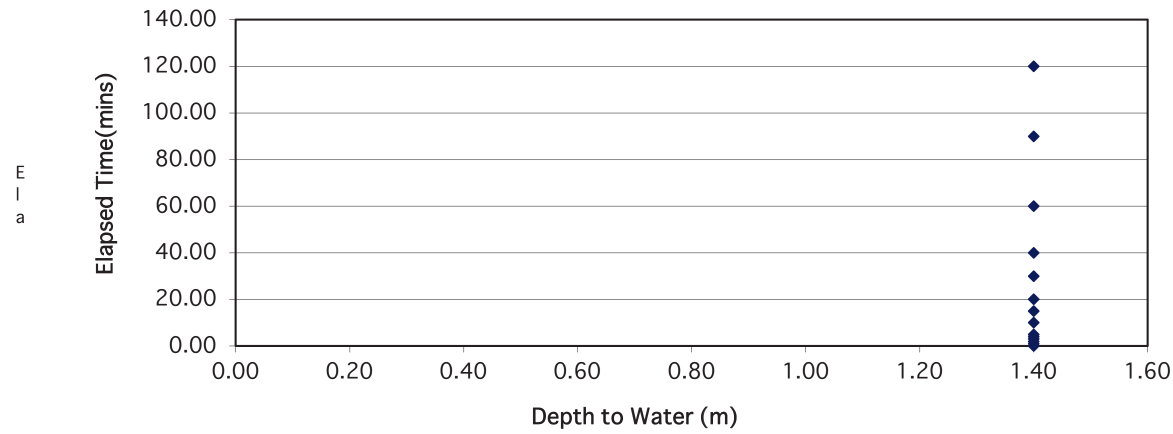
Field Test

| | | |
|---|---|---|
| Depth of Pit (D) | 2.00 | m |
| Width of Pit (B) | 0.70 | m |
| Length of Pit (L) | 2.00 | m |
| Initial depth to Water = | 1.40 | m |
| Final depth to water = | 1.40 | m |
| Elapsed time (mins)= | 120.00 | |
| Top of permeable soil | | m |
| Base of permeable soil | | m |
| Base area= | 1.4 | m2 |
| *Av. side area of permeable stratum over test period= | 3.24 | m2 |
| Total Exposed area = | 4.64 | m2 |

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec

Depth of water vs Elapsed Time (mins)



# Soakaway Design f -value from field tests (F2C) IGSL

Contract: Dalguise house development Contract No. 23927
Test No. SA2
Client Greystar Ltd.
Date: 03/03/2022

Summary of ground conditions

| from | to | Description | Ground water |
|---|---|---|---|
| 0.00 | 0.30 | TOPSOIL | Dry |
| 0.30 | 0.90 | Firm brown slightly sandy slightly gravelly CLAY. | |
| 0.90 | 2.00 | Stiff brownish grey slightly sandy very gravelly CLAY with high cobble content and medium boulder content. | |

Notes:

Field Data

| Depth to Water (m) | Elapsed Time (min) |
|---|---|
| 1.23 | 0.00 |
| 1.23 | 1.00 |
| 1.23 | 2.00 |
| 1.23 | 3.00 |
| 1.23 | 4.00 |
| 1.23 | 5.00 |
| 1.23 | 10.00 |
| 1.23 | 15.00 |
| 1.23 | 20.00 |
| 1.23 | 30.00 |
| 1.23 | 40.00 |
| 1.23 | 60.00 |
| 1.23 | 90.00 |
| 1.23 | 120.00 |

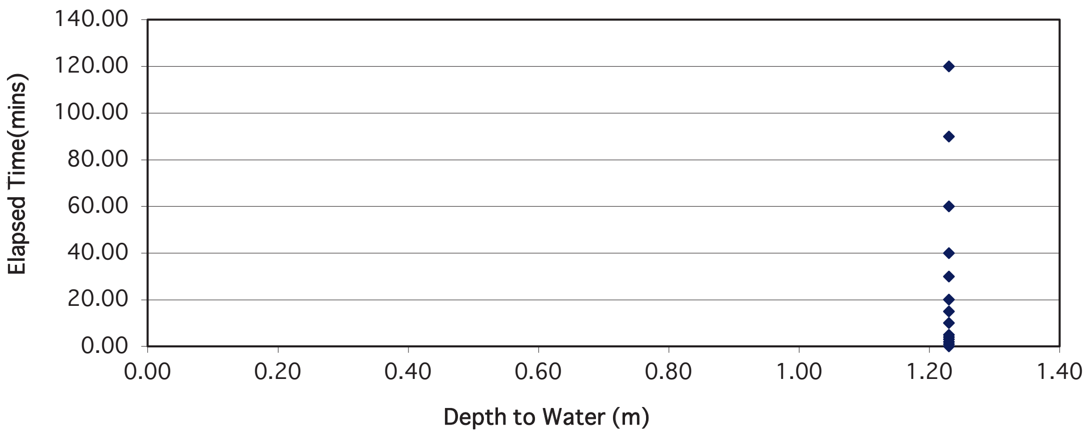
Field Test

| | | |
|---|---|---|
| Depth of Pit (D) | 2.00 | m |
| Width of Pit (B) | 0.70 | m |
| Length of Pit (L) | 2.00 | m |
| Initial depth to Water = | 1.23 | m |
| Final depth to water = | 1.23 | m |
| Elapsed time (mins)= | 120.00 | |
| Top of permeable soil | | m |
| Base of permeable soil | | m |
| Base area= | 1.4 | m2 |
| *Av. side area of permeable stratum over test period= | 4.158 | m2 |
| Total Exposed area = | 5.558 | m2 |

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec

Depth of water vs Elapsed Time (mins)



# Soakaway Design f -value from field tests (F2C) IGSL

Contract: Dalguise house — Contract No. 23927
Test No. SA3
Client Greystar Ltd.
Date: 03/03/2022

Summary of ground conditions

| from | to | Description | Ground water |
|---|---|---|---|
| 0.00 | 0.20 | TOPSOIL | Dry |
| 0.20 | 0.60 | Firm light brown slightly sandy gravelly CLAY. | |
| 0.60 | 2.00 | Stiff brownish grey slightly sandy very gravelly CLAY with medium cobble content. | |
| | | | |

Notes:

Field Data

| Depth to Water (m) | Elapsed Time (min) |
|---|---|
| 1.12 | 0.00 |
| 1.12 | 1.00 |
| 1.12 | 2.00 |
| 1.12 | 3.00 |
| 1.12 | 4.00 |
| 1.12 | 5.00 |
| 1.12 | 10.00 |
| 1.12 | 15.00 |
| 1.12 | 20.00 |
| 1.12 | 30.00 |
| 1.12 | 40.00 |
| 1.12 | 60.00 |
| 1.11 | 90.00 |
| 1.10 | 120.00 |
| | |
| | |
| | |
| | |
| | |

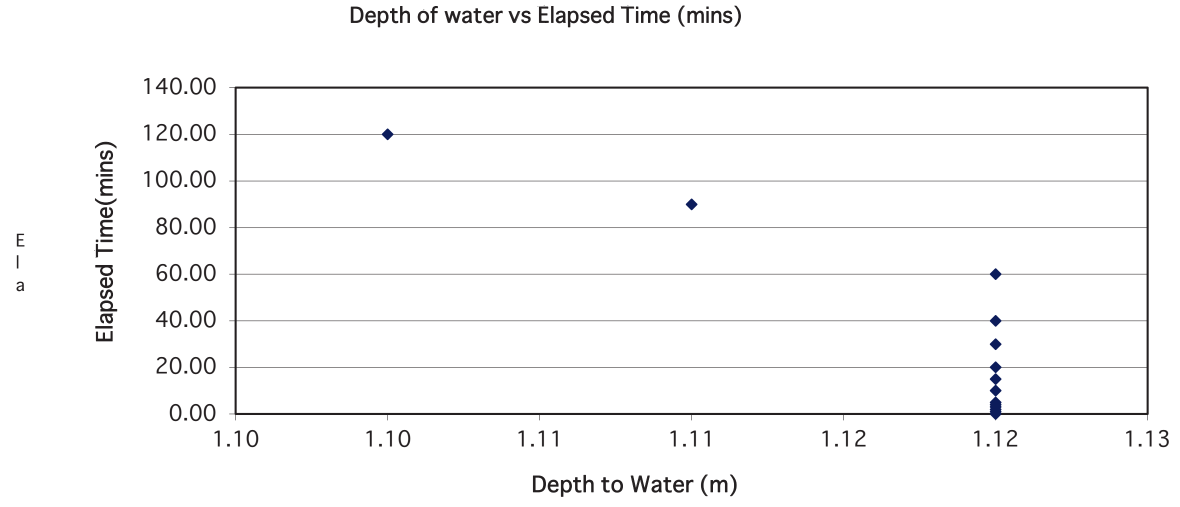
Field Test

| | | |
|---|---|---|
| Depth of Pit (D) | 2.00 | m |
| Width of Pit (B) | 0.70 | m |
| Length of Pit (L) | 2.00 | m |
| Initial depth to Water = | 1.12 | m |
| Final depth to water = | 1.10 | m |
| Elapsed time (mins)= | 120.00 | |
| Top of permeable soil | | m |
| Base of permeable soil | | m |
| Base area= | 1.4 | m2 |
| *Av. side area of permeable stratum over test period= | 4.806 | m2 |
| Total Exposed area = | 6.206 | m2 |

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec

Water rose during test



# Soakaway Design f -value from field tests (F2C) IGSL

Contract: Dalguise house development Contract No. 23927
Test No. SA4
Client Greystar Ltd
Date: 03/03/2022

Summary of ground conditions

| from | to | Description | Ground water |
|---|---|---|---|
| 0.00 | 0.20 | TOPSOIL | |
| 0.20 | 0.90 | Firm light brown slightly sandy gravelly CLAY. | Dry |
| 0.90 | 2.00 | Stiff brownish grey slightly sandy very gravelly CLAY with medium cobble content. | |

Notes:

**Field Data**

| Depth to Water (m) | Elapsed Time (min) |
|---|---|
| 1.45 | 0.00 |
| 1.45 | 1.00 |
| 1.45 | 2.00 |
| 1.45 | 3.00 |
| 1.45 | 4.00 |
| 1.45 | 5.00 |
| 1.45 | 10.00 |
| 1.45 | 15.00 |
| 1.45 | 20.00 |
| 1.45 | 30.00 |
| 1.45 | 40.00 |
| 1.45 | 60.00 |
| 1.45 | 90.00 |
| 1.45 | 120.00 |

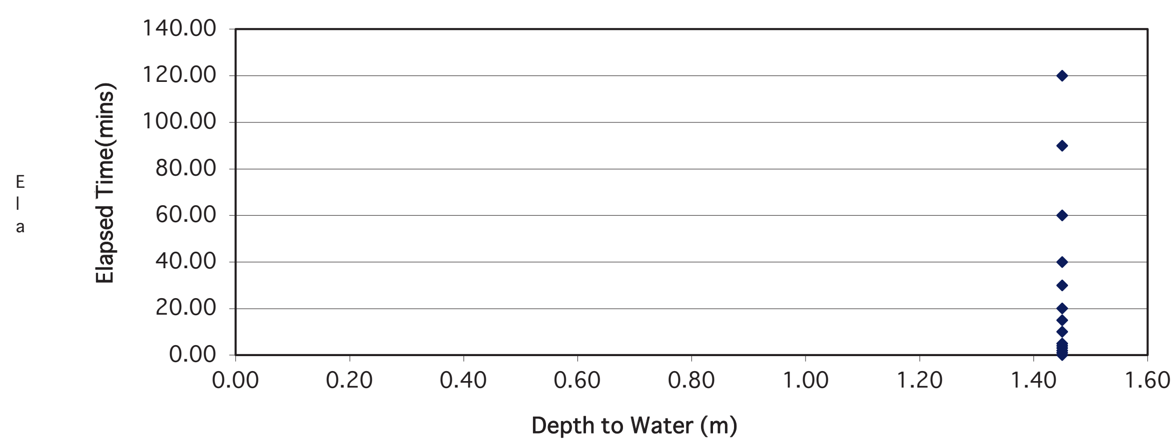
**Field Test**

| | | |
|---|---|---|
| Depth of Pit (D) | 2.00 | m |
| Width of Pit (B) | 0.70 | m |
| Length of Pit (L) | 2.00 | m |
| Initial depth to Water = | 1.45 | m |
| Final depth to water = | 1.45 | m |
| Elapsed time (mins)= | 120.00 | |
| Top of permeable soil | | m |
| Base of permeable soil | | m |
| Base area= | 1.4 | m2 |
| *Av. side area of permeable stratum over test period= | 2.97 | m2 |
| Total Exposed area = | 4.37 | m2 |

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec

Depth of water vs Elapsed Time (mins)



# Soakaway Design f -value from field tests (F2C) IGSL

Contract: Dalguise house development Contract No. 23927
Test No. SA5
Client Greystar Ltd.
Date: 03/03/2022

Summary of ground conditions

| from | to | Description | Ground water |
|---|---|---|---|
| 0.00 | 0.20 | TOPSOIL | |
| 0.20 | 0.90 | Firm light brown slightly sandy gravelly CLAY. | Dry |
| 0.90 | 2.00 | Stiff brownish grey slightly sandy very gravelly CLAY with medium cobble content. | |
| | | | |

Notes:

Field Data

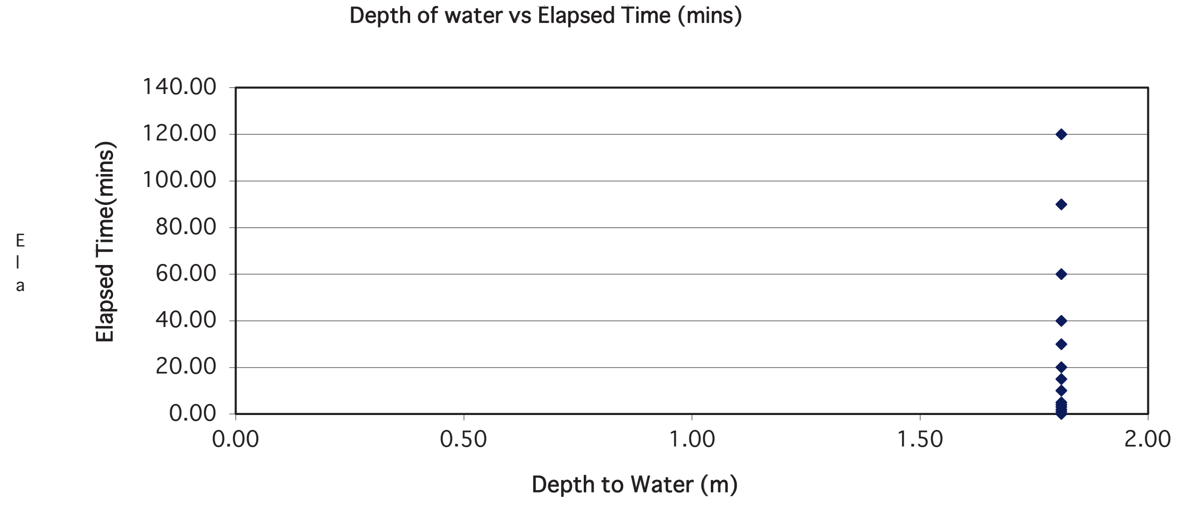
| Depth to Water (m) | Elapsed Time (min) |
|---|---|
| 1.81 | 0.00 |
| 1.81 | 1.00 |
| 1.81 | 2.00 |
| 1.81 | 3.00 |
| 1.81 | 4.00 |
| 1.81 | 5.00 |
| 1.81 | 10.00 |
| 1.81 | 15.00 |
| 1.81 | 20.00 |
| 1.81 | 30.00 |
| 1.81 | 40.00 |
| 1.81 | 60.00 |
| 1.81 | 90.00 |
| 1.81 | 120.00 |
| | |
| | |
| | |
| | |
| | |

Field Test

| | | |
|---|---|---|
| Depth of Pit (D) | 2.00 | m |
| Width of Pit (B) | 0.70 | m |
| Length of Pit (L) | 2.00 | m |
| Initial depth to Water = | 1.81 | m |
| Final depth to water = | 1.81 | m |
| Elapsed time (mins)= | 120.00 | |
| Top of permeable soil | | m |
| Base of permeable soil | | m |
| Base area= | 1.4 | m2 |
| *Av. side area of permeable stratum over test period= | 1.026 | m2 |
| Total Exposed area = | 2.426 | m2 |

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 0 m/min or 0 m/sec



# Soakaway Design f -value from field tests

(F2C) IGSL

Contract: Dalguise house development

Contract No. 23927

Test No. SA6

Client Greystar Ltd

Date: 03/03/2022

Summary of ground conditions

| from | to | Description | Ground water |
|---|---|---|---|
| 0.00 | 0.25 | TOPSOIL | |
| 0.25 | 0.80 | Firm yellowish brown slightly sandy gravelly CLAY. | Dry |
| 0.80 | 2.00 | Firm to stiff pinkish brown mottled grey slightly sandy slightly gravelly CLAY. | |
| | | | |

Notes:

Field Data

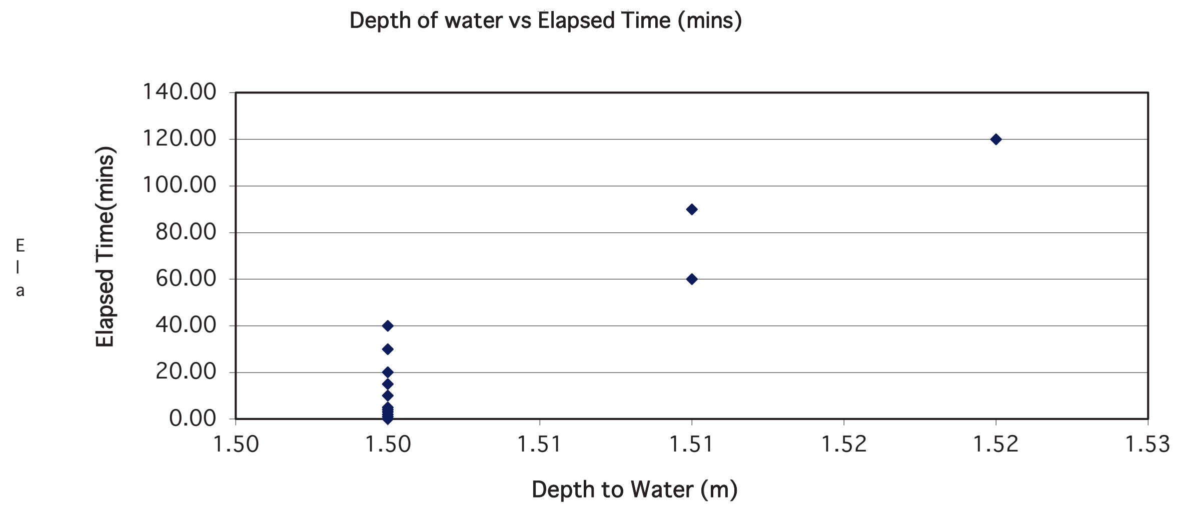
| Depth to Water (m) | Elapsed Time (min) |
|---|---|
| 1.50 | 0.00 |
| 1.50 | 1.00 |
| 1.50 | 2.00 |
| 1.50 | 3.00 |
| 1.50 | 4.00 |
| 1.50 | 5.00 |
| 1.50 | 10.00 |
| 1.50 | 15.00 |
| 1.50 | 20.00 |
| 1.50 | 30.00 |
| 1.50 | 40.00 |
| 1.51 | 60.00 |
| 1.51 | 90.00 |
| 1.52 | 120.00 |
| | |
| | |
| | |
| | |
| | |

Field Test

| | | |
|---|---|---|
| Depth of Pit (D) | 2.00 | m |
| Width of Pit (B) | 0.70 | m |
| Length of Pit (L) | 2.00 | m |
| Initial depth to Water = | 1.50 | m |
| Final depth to water = | 1.52 | m |
| Elapsed time (mins)= | 120.00 | |
| Top of permeable soil | | m |
| Base of permeable soil | | m |
| Base area= | 1.4 | m2 |
| *Av. side area of permeable stratum over test period= | 2.646 | m2 |
| Total Exposed area = | 4.046 | m2 |

Infiltration rate (f) = Volume of water used/unit exposed area / unit time

f= 5.8E-05 m/min or 9.61169E-07 m/sec



BYRNELOOBY

# Appendix H – Storm Water Audit

# STORMWATER AUDIT (STAGE 1)

| | |
|---|---|
| JBA Project Code | 2022s0433 |
| Contract | Residential Development, Monkstown, Co. Dublin |
| Client | Byrne Looby Partners |
| Prepared by | David Micks |
| Subject | Stormwater Audit Stage 1 Report |

**Revision History**

| Issue | Date | Status | Issued to |
|---|---|---|---|
| S3-P01 | 06/04/2022 | First Issue | Byrne Looby Partners |
| S3-P03 | 07.10.2022 | Final Issue | Byrne Looby Partners |
| S3-P04 | 27.10.2022 | Updated for planning | Byrne Looby Partners |
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| | | | |

## 1 Introduction

JBA Consulting have been contracted to undertake a Stage 1 SW Audit of the surface water drainage design prepared by Byrne Looby Partners for the proposed residential development at Monkstown Road, Monkstown, Dublin 18. The audit has been completed in accordance with Dún Laoghaire Rathdown County Council's (DLRCC) Stormwater Audit Procedure (Rev 0, Jan 2012) as set out below.

The subject of this Stage 1 stormwater audit is to review the proposed surface water drainage design and sustainable urban drainage system (SuDS) proposals for the proposed development. This audit was undertaken in advance of a Strategic Housing Development (SHD) planning submission to An Bord Pleanála.

***Stage 1 – Pre-Planning Stage:*** *A Stage 1 audit shall be carried out of the Stormwater Impact Assessment (SIA) prepared by the applicant. The audit will focus on the SUDS management train and whether the applicant has carefully considered all known SUDS techniques and applied the most appropriate type(s) for the site that will ensure improved water quality, biodiversity and volume control.*

### 1.1 Report Structure

The Feedback Form in Appendix A identifies queries raised in this report which are to be answered by the Design Engineers. Once an 'Acceptable' status is achieved for each query the audit is deemed to be closed out. The report contents are not updated for the updated information received except for a log of incoming information and the responses on the feedback form and new data provided allow the audit trail to be followed.

The results of the audit are set out hereunder, where items raised in the feedback form are shown in **bold** within this report. Note these comments in bold are raised on the first sight of the drainage proposal. The feedback form is to be referenced in relation to how these comments were subsequently resolved.

### 1.2 Relevant Studies and Documents

The following documents were considered as part of this surface water audit:

- Greater Dublin Strategic Drainage Strategy (GDSDS);
- Greater Dublin Regional Code of Practice for Drainage Works;
- The SUDs Manual (CIRIA C753).
- BRE Digest 365
- Current Development Plan

### 1.3 Key Considerations and Benefits of SuDS

The key benefits and objectives of SuDS considered as part of this audit and listed below include:

- Water Quantity
- Water Quality
- Amenity
- Biodiversity

Which can be achieved by;

- Storing runoff and releasing it slowly (attenuation)
- Harvesting and using the rain close to where it falls
- Allowing water to soak into the ground (infiltration)
- Slowly transporting (conveying) water on the surface
- Filtering out pollutants
- Allowing sediments to settle out by controlling the flow of the water

### 1.3.1 SuDs Management Train

*A SuDs Management Train is a robust pollutant removal strategy. The treatment train can comprise four stages:*

1. *Prevention*
2. *Source Control*
3. *Site Control*
4. *Regional control*

## 2 Proposed Development at Monkstown Road, Co. Dublin

The existing site is located 11km southeast of Dublin City Centre and approx. 2km from Dun Laoghaire and has an overall area of 3.58ha. It is bounded to the north by the Monkstown Road, Monkstown Valley to the West, Richmond Park to the East, and Brock Court to the South. The location of the site is shown in Figure 1 below.


*Figure 1- Site Location*

The proposed development involves the construction of 11no. apartment buildings, construction of 3 no. houses and reuse of existing buildings providing a total of 491 units. The development will also consist of a new bridge over the Stradbrook Stream, basement and on- street car parking as well as all ancillary site works above and below ground. The planning application for the development defines the site area as 3.58Ha. The site is currently occupied by Dalguise House, 2 gate lodges and a dwelling house. Access to the proposed development will be via the existing Dalguise House entrance and a new entrance via Purbeck on Monkstown Road.

A small area of land north of the Stradbroke Stream at Purbeck is included in the Planning Application boundary (with the consent of a third party) to allow for the relocation of 4 no. existing car parking spaces and in order to facilitate the construction of the new bridge.

**Byrne Looby Partners to clarify if the lands north of Block B & Block C are deemed not to contribute and confirm that proposed site levels in this area support this.**

## 2.1 Review of SW Drainage Proposals

The review is based on the following documents provided by Byrne Looby Partners on 6th,12th and 14th April 2022;

- 433-SHD-00-01_Existing Site Plan.pdf
- Dalguise – Greenfield Run-off.pdf
- Dalguise MicroDrainage Model
- MKS-RAU-ZZ-XX-M3-AR-100 - GA-Site-Garden Level.pdf
- SHDSiteInvestigation1-40_compressed1.pdf
- SHDSiteInvestigation41-63_compressed.pdf
- SHE-0073-2000-0600-2000-2022-Mar-31-013132.zip
- SHE-0080-3400-1500-3400-2022-Mar-31-013722.zip
- SHE-0138-8900-1000-8900-2022-Mar-31-014410.zip
- W3683-DR-1014-00.pdf
- W3683-DR-1018-00.pdf
- W3683-BLPXX-XX-RP-Z-02-Engineering Services Report Draft

Subsequent to the Feedback Form issue the design was updated and the following final documents provided on 4th and 10th October;

- W3683-DR-1005-01.pdf
- W3683-DR-1014-07.pdf
- W3683-DR-1018-06.pdf
- W3683-DR-1023-00.pdf
- W3683-DR-1025-01.pdf
- W3683-DR-1026-00.pdf
- W3683-DR-1032-00.pdf
- W3683-DR-1034-00.pdf
- W3683-DR-1035-00.pdf
- W3683-DR-1036-00.pdf
- W3683-DR-1037-00.pdf
- W3683–DR–1019–01.pdf
- W3683–DR–1030–00.pdf
- 23927 Dalguise GI Report.pdf
- 23927 Dalguise GW 22_08_08.pdf
- Flood Risk Assessment - Dalguise Monkstown.pdf
- IGSL Project 23927 - Dalguise House,Monkstown ( WCR Reports ).pdf
- W3683-BLP-XX-XX-RP-Z-02 Engineering Services Report_Rev05.pdf
- Greenfield runoff rate estimation Lower Catchment.pdf
- Greenfield runoff rate estimation Upper Catchment.pdf
- Lower Catchment 100-year analysis Rev A.pdf
- Lower Catchment 2-year analysis RevC.pdf
- Lower Catchment 30-year analysis Rev C.pdf
- Lower Catchment Tank Sizing RevA.pdf
- Upper Catchment 100-year analysis Rev C.pdf
- Upper Catchment 2-year analysis Rev B.pdf
- Upper Catchment 30-year analysis RevB.pdf
- Upper Catchment Tank No. 1 Sizing RevA.pdf
- Upper Catchment Tank No. 2 Sizing RevB.pdf
- Green/Blue Roof Calculations

### 2.1.1 Site Characteristics

The site rises from the south to a peak of approx. 28mOD before a fall of 13m to the north down to a level of approx. 15mOD.

A site Investigation was carried out by Ground Investigations Ireland Ltd. between August and September 2018. The purpose was to investigate subsurface conditions using a variety of different methods in accordance with the project specification. 7 no. Soakaway tests were carried out. 4 no. Cable Percussion boreholes bored to a maximum depth of 6m BGL (BH03).

Infiltration tests were carried out and noted that SA02 and SA03 yielded infiltration rates of $2.235\times10^{-6}$ m/s and $1.977\times10^{-6}$ m/s. At the locations SA01, SA04, SA05, SA06, SA07 the water level dropped too slowly to allow calculation of the infiltration rate.

Further infiltration rates were undertaken in 2019 by Hydrocare Environmental Ltd. These yielded 10 no. infiltration rates across the site, varying from $9.523\times10^{-6}$ to $2.38\times10^{-6}$ .

Boreholes BH01 and BH02 yielded groundwater results at 2.1m and 2.7m respectively. Three of the boreholes were ceased at approx. 3m deep due to encountering presumed rock. This possible rock stratum is overlain with sandy, gravelly clays.

**Two SOIL types are identified within the report, SOIL Type 2 and SOIL Type 4. The trial holes and infiltration test would not indicate that Type 4 is appropriate.**

**BLP to provide rationale for choosing SOIL Type 4, considering the trial holes.**

## 2.2 Design Parameters

Rainfall parameters can be estimated using Met Eireann data, using the Flood Studies Report (FSR) values or the values in the GDSDS. The Met Eireann method can be more representative of a site if selected correctly. The design values used by Byrne Looby Partners and considered by JBA are shown below:

| Rainfall parameters | Designer values | JBA Comment |
|---|---|---|
| M5_60 | 16.2 | -------- |
| Ratio R | 0.277 | -------- |
| SAAR (mm) | 881 | Ok – Met Éireann |
| Qbar l/s | 22.14l/s | |
| Climate Change | 20%* | Ok – 10% required in GDSDS |

***10% is included within the design criteria, but the storm event applies 20% in each case.**

**BL to confirm whether climate change is doubled up due to inclusion in two separate locations.**

## 2.3 Surface Water Drainage Strategy

### 2.3.1 Site Drainage Strategy

The drainage for the proposed development and attenuation systems has been divided into two separate sub-catchments. The upper catchment includes runoff from Block I (No. 1 & 2), Block H, Block J, existing buildings to the north and south of Block J and all hardstanding areas/roads upstream of the first attenuation tank. The lower catchment is split into two separate networks, with two separate outfalls from the site on the northern boundary.

### 2.3.2 SuDS Measures Considered

| SuDS Technology | Comments |
|---|---|
| Green/Blue Roofs | Extensive blue roofs have been proposed on all **of** the blocks on the site. |
| Swale, Filter Drain, Infiltration Trench | Swales have been proposed on the eastern side of the site, east of Block C & Block F. A swale has also been proposed on the southern side of the site, south of Block J.<br><br>The purpose of these swales is unclear, with no direct discharge identified. |

| | |
|---|---|
| | **BL to confirm purpose of dry swales and whether there is opportunity to incorporate these into the network design, to provide attenuation or treatment benefit.** |
| Tree Pits, Bioretention Areas, Rain Gardens | None proposed. |
| Permeable Paving | Permeable paving has been proposed throughout the site. It has not been specified whether an impermeable or permeable liner will be provided with the permeable paving. If impermeable lining is proposed a review of the site for interception should be completed to ensure that it complies with Table 24.6 in the SuDS Manual.<br><br>If a permeable liner is proposed, it should be ensured that infiltration does not occur within 1m of the groundwater table.<br><br>**Byrne Looby Partners to clarify whether a permeable/impermeable liner is proposed to permeable paving. If an impermeable liner is proposed a review of the contributing areas for interception should be undertaken to ensure that they comply with Table 24.6 in the SuDS Manual. If a permeable liner is proposed, a review will be required at detailed design stage to ensure that infiltration does not occur within 1m of the groundwater table.** |
| Soakaways | None proposed. |
| Detention Basins, Retention Ponds, Stormwater Wetlands | None proposed.<br><br>**BL to confirm whether the proposed dry swales can be incorporated to provide treatment or attenuation benefit.** |
| Rainwater Harvesting | None proposed. |
| Petrol Interceptor | Two oil interceptors have been proposed: north of Block C, and east of Block A.<br>**The interceptors have been sited between the attenuation and the hydrobrakes. This risks surcharging the petrol interceptor. BL to review whether this is the most efficient arrangement.** |
| Attenuation | Attenuation for the proposed development will be via 3 different structures. Specific details of the attenuation structures have not been provided.<br><br>Attenuation of overland flows will be provided in swales.<br><br>**Byrne Looby Partners to provide detailed drawings of attenuation structures on the site.** |
| Other | N/A |

### 2.3.3 Review of drainage drawings and SuDS drawings;

The SuDS drawings show a range of SuDS measures proposed throughout the site including permeable paving, green/blue roofs and swales. According to W3683-DR-1014-00, it is proposed that runoff will be conveyed to these SuDS measures through road gullies and existing/new surface water pipes, however many areas appear to not pass through any SuDS measures, mainly Block B & Block C, and will therefore not be intercepted. Detail drawings for SuDS and drainage measures have not been provided.

Swales have also been proposed to collect, convey and attenuate overland flows from adjacent undeveloped lands.

**It is not clear how runoff from all areas will be intercepted. Byrne Looby Partners to clarify how all areas will be intercepted.**

**Details drawings for SuDS and drainage measures should be provided.**

### 2.3.4 Review of Hydraulic Model

A MicroDrainage hydraulic model has been used for the design.

- The QBar calc provided is based on a contributing area of 3.58Ha. This differs significantly from that included in the MicroDrainage model.
- The attenuation structures have been designed separately from the network. This can result in an under sizing of the proposed volume.
- The system has been designed as having a free outfall.
- The drawings don't include any labels, making a full assessment of the network impossible.
- No connectivity is evident between the podium area and the network.
- It isn't clear how the discharge rates have been distributed between the various outfalls.

**Some queries for BL to address are listed below:**

- **Clarify how flow rates are allocated to each outfall**
- **Provide fully annotated drawings to allow for network analysis to be undertaken**
- **The network should be assessed with online structures included to ensure an accurate assessment is derived.**
- **Determine how the podium and the blue roofs are incorporated into the network.**

### 2.3.5 Interception/Treatment

*Interception of runoff is intended to prevent any runoff for small rainfall events which are less than 5mm (and up to 10mm if possible). Treatment of 15mm is required if interception is not provided.*

*Table 24.6 of the CIRIA manual provides indication of deemed to satisfy criteria and it is considered that this should be complied with. All sources of runoff should also be intercepted where possible. A high level of Interception provided for some parts of the site is not to be considered as adequate compensation for a low degree of interception provision for other locations. Compliance is required for the whole site, or at least for road/paved areas, for it to be considered effective. Interception mechanisms are based on runoff retention. This can be achieved using rainwater harvesting or using soil storage and evaporation. Either infiltration or transpiration rates can dispose of the runoff from minor events to enable the next event to be captured.*

SuDS measures have been proposed throughout the site. However, no interception calculations have been provided to determine whether 100% interception has been achieved. Tree pits are identified as being used as interception measures, but the number and connectivity isn't presented in a way to allow assessment. The areal extent of the interception measures isn't defined on any of the drawings.

**The interception assessment should be presented on a SUDS measure vs. individual catchment basis. BL should ensure that all runoff from the roads passes through at least one of these SuDS measures prior to entering the piped network.**

**The number and treatment capacity of the proposed tree pits should be provided.**

## 2.4 Health & Safety and Maintenance Issues

The proposed drainage system comprises SuDS devices, traditional road gullies, manholes, attenuation systems, oil interceptors and underground pipes. These elements are considered acceptable from a Health & Safety perspective once supplier/manufacturers guides are followed and complied with during the detailed design, construction, and operation.

Optimum performance of the SUDs treatment train is subject to the frequency of maintenance provided. At detailed design stage, it is recommended that a maintenance regime be adopted.

Particular consideration is required at detailed design stage to the design, maintenance requirements and whole life plan (and replacement) of the SuDS system as a whole.

Regular maintenance of the hydrobrake will be required to remove any blockages, particularly in the wake of heavy rainfall events or local floods.

It is recommended that the oil interceptors be fitted with an audible high-level silt and oil alarm for maintenance and safety purposes. Regular inspection and maintenance are recommended for the oil interceptors.

Please note that silt and debris removed from the oil interceptor during maintenance will be classified as contaminated material and should only be handled and transported by a suitably licensed contractor and haulier and disposed of at a suitably licensed landfill only.

## 2.5 Items to be considered at Detailed Design Stage

There are a number of items that require attention at detailed design stage. A summary of same are as follows:

- Proper detail design and construction of SuDS devices is paramount to ensure long term optimum hydraulic performance as well as maximisation of biodiversity opportunity. Initial collaboration has been undertaken with the various design team members (engineers, architects, ecologists and landscape architects) and it is important this continues through the detailed design stage. This is particularly important for the design of the sub-surface attenuation structures.

## 2.6 Audit Report sign Off

Audit Report Prepared by:

David Micks
Technical Assistant

Approved by: ______________________

Michael O'Donoghue
Associate Director

***Note:***

*JBA Consulting Engineers & Scientists Ltd. role on this project is as an independent reviewer/auditor. JBA Consulting Engineers & Scientists hold no design responsibility on this project. All issues raised and comments made by JBA are for the consideration of the Design Engineer. Final design, construction supervision, with sign-off and/or commissioning of the surface water system so that the final product is fit for purpose with a suitable design, capacity and life-span, remains the responsibility of the Design Engineers.*

## Appendix A – Audit Feedback Form

| Item No. | JBA Review Comment | Comment/Clarification Request/Suggested Mitigation | Response from Client/Client Representative | Acceptable / Not Acceptable |
|---|---|---|---|---|
| P01 | 20/04/2022 | 20/04/2022 | | |
| Ref Docs | •433-SHD-00-01_Existing Site Plan.pdf<br>•Dalguise – Greenfield Run-off.pdf<br>•Dalguise MicroDrainage Model<br>•MKS-RAU-ZZ-XX-M3-AR-100 - GA-Site-Garden Level.pdf<br>•SHDSiteInvestigation1-40_compressed1.pdf<br>•SHDSiteInvestigation41-63_compressed.pdf<br>•SHE-0073-2000-0600-2000-2022-Mar-31-013132.zip<br>•SHE-0080-3400-1500-3400-2022-Mar-31-013722.zip<br>•SHE-0138-8900-1000-8900-2022-Mar-31-014410.zip<br>•W3683-DR-1014-00.pdf<br>•W3683-DR-1018-00.pdf<br>•W3683-BLPXX-XX-RP-Z-02-Engineering Services Report_Draft | | | |
| 1 | W3683-BLPXX-XX-RP-Z-02-Engineering Services Report_Draft | | | |
| a | The Qbar calc provided allows for a contributing area of 3.504Ha. However, the MicroDrainage calculations have significantly less contributing areas. | Only areas that are being positively drained by the proposed stormwater network should be included in the Qbar calc. Please provide a sketch of the positively drained areas and amend the Qbar value accordingly. | Sketch W3683-CS-SK003-00 attached and Qbar for the site adjusted in the report and calcs. | See Note 6a |
| b | The flow rates allocated to each of the outfalls don't seem to correlate to the Qbar value. In one location the overall Qbar value is defined as l/s/ha, and elsewhere it is defined as l/s. | Provide rationale for allocated discharge rates at each of the outfalls. | Qbar discharge should be in sections is l/s. updated page 14. | See Note 6b |
| c | Two soil types are identified within the report, SOIL Type 2 and SOIL Type 4. The trial holes and infiltration tests would not indicate that type 4 is appropriate. | Provide rationale for choosing SOIL type 4, taking into account trial holes. | Based on UKSUDS.com Soil classification ahead of SI completion. The most Northern Third of the site is identified as Soile Type 4. When the SI report is provided to us we can verify this classification. | Acceptable |
| d | No interception or treatment calcs have been provided within the submission. It is integral as part of the SuDS management train that interception as per GDSDS is achieved. | Please provide interception calcs for the site, identifying interception measures, their capacities and their allocated sub-catchments. | No on site treatment required.<br>Interception calcs included. | See Note 6c |
| e | Some text appears to be missing from pages 15 & 16. | Amend as required | We are still waiting on the SI and test reports following completion of the site investigation. This report names will be input when received.<br>All sections completed | Acceptable |
| 2 | W3683-DR-1014-00.pdf | | | |
| a | The large public space adjacent to the attenuation tank in the centre of the development does not appear to have any surface drainage. | Please clarify how this area will be drained. | There will be an arangement simialr to the blue roofs, below the podium that will collect run-off and drain towards the southern. Attenuation tank. | See Note 6d |
| b | The oil interceptors are located between the attenuation and the hydrobrakes. The hydrobrake is best located immediately downstream of the tank so as to maximise the volume within the tank and not surcharge the interceptor. | Consider relocating hydrobrake manholes to immediately downstream of attenuation tanks. | Correct - Hydrobrakes are to be located downstream of the attenuation tanks - they were not currently indicated on the drawings. | Acceptable |
| c | Large areas of the permeable paving do not appear to have any overflow capacity. | Clarify how overflow from the permeable paving will be drained into the network. | The overflow ill be connected to the network by isolated gullies across all hardstanding. | Acceptable |
| d | No connectivity is shown between the network and any potential tree pits. | Please clarify whether tree pits are proposed and how they will interact with the network. | Tree pits to be identified at detailed deisgn stage with the landscape architect. | See Note 6e |

| | | | | |
|---|---|---|---|---|
| e | There is no connectivity between the swale to the south east and the network, rendering it underutilised as a SuDS measure. In both cases for the swales to the north of the site, the swales are immediately adjacent to sub-surface attenuation which is doubling up on stormwater storage. | Has it been considered to use the swales as attenuation storage volumes on the network, therefore removing the need for some if not all of the sub-surface attenuation? This would provide cost savings, provide a positive benefit to the SuDS contribution on the site and increase habitat and biodiversity on the site. | The swales available across the site had been reviewed in tandum with the landsacpe architect and envionmentalist and found that the size and depths that could be provided would not provide a volume that could be suitably utilised consistently for SUDs. Connection to the swales will be made for when unexpected rainfall events arise for overflows from the permeable paving. | See Note 6f |
| f | The extent of permeable paving on dwg 1018 does not correlate with the area on 1014. | Clarify extent of permeable paving, including provision of total area. | Permeable paving is only shown on drawing 1018 - which was to idenify SUDs provisions, 1014 is only for identifying the storm pipe network. Permeable paving is currently proposed for the new hard standing roads and parking bays. Existing hardstanding is to be reinstated to asphalt/bitmac. Permeable paving area clarified on dwg 1018. | Acceptable |
| g | The manholes are not fully labelled, and the pipe numbers are not provided. This does not allow an assessment of the network design, as the calculations can't be correlated to the design. | Please label drawing so that it correlates with the calculations. | Labels included in revised draft. | Acceptable |
| h | The attenuation structures aren't labelled. These should include provided volume, invert and high water level. | Please label attenuation structures with design information. | Labels included in revised draft. | Acceptable |
| i | There appears to be no surface drainage around Blocks B & C | Clarify | road drainage and blue roof connection now included | Acceptable |
| j | Given the topography, is there a risk of surface run-off from the lands to the south of the site? If so, is this incorporated into the networks? | Clarify | Road gullies are to capture this run off. | See Note 6g |
| k | Are any land drains proposed at the uphill side of the apartment blocks? | Clarify | These weren't considered necessary due to infiltration into the soil. | See Note 6h |
| l | There appear to be parking spaces at Block A, but they are not shown on drawing 1018. | Clarify whether these areas are to remain within the current layout. | The layout has been updated and there is a total of 2 spaces. These will be included in drawing 1018. | Acceptable |
| m | There are three hydrobrakes proposed but only two shown on the drawing. | Clarify, labelling each hydrobrake manhole clearly with design head and flow rate. | There maybe some confusion - The oil interceptors are shown as manholes. The hydrobrakes haven't been included in the drawings - will update with updated Qbar. | See Note 6j |
| n | The swale to the south east of the site is in close proximity to the buildings to the north. | Clarify whether this swale is within 5m of the buidling foundation. | 1m currently. All buildings will be constructed using piled excavations. So it will be within 1m effectivley of the building. As mentioned above the swale availability across the site doesn't provide much attenuation and so the swales are primarily a secondary proposal. | See Note 6k |
| o | The attenuation adjacent to Block A is tight to the building footprint. | Is this attenuation to be lined? | Lined in Concrete or other? Please clarify. | See Note 6l |
| p | The individual areas of the Blue roofs should be labelled, including any space on the roof for maintenance or M & E equipment. | Please show correct extent of blue roofs, providing % of overall roof area. | We don't have any M&E information at this time - This is to be provided at detailed deisgn stage. | See Note 6m |
| **3** | **W3683-DR-1018-00.pdf** | | | |
| a | Area of permeable paving, blue roof, green areas, footpaths, and impermeable surfaces is not defined. | Provide m2 values for each of the differing surfaces. | These areas are labelled on Sketch SK003 | See Note 6n |
| b | Please identify locations of tree pits. | Update drawing. | Tree pits to be identified at detailed deisgn stage with the landscape architect. | See Note 6o |
| c | How is the green podium area above the basement drained and incorporated into the network? | Please clarify | The green podium is to be drained simmilar to the blue roofs, where it will be connected to the attenuation tank. | See Note 6p |

| | | | | |
|---|---|---|---|---|
| **d** | The swale adjacent to Block J should be lined if it is within 5m of the foundation of the structure. | Please clarify distance from Block J foundation and swale. | 1m currently. All buildings will be constructed using piled excavations. So it will be within 1m effectivley of the building. As mentioned above the swale availability across the site doesn't provide much attenuation and so the swales are primarily a secondary meausre for permeable paving overflow events. | **See Note 6q** |
| **4** | **Calculations** | | | |
| **a** | A full assessment of the calculations could not be undertaken as there is no way of correlating the design to the calculations | Please provide drawings that are coordinated to the Microdrainage calculations. | drawing 1018 updated | **Acceptable** |
| **b** | There appears separate calculations for the attenuation and network calculations. | The attenuation structures should be incorporated into the network design and not designed in isolation. Please update calcs incorporating storage structures. | They are spearate calculations because the pipe network is deisgned for a 30-year return period and the tanks are for a 100-year return period. They are connected via exporting the network time-area diagram for the attenuation modelling. | **See Note 7a** |
| **c** | It is not clear how the blue roofs are included within the calculations. | Please clarify. | the blue roofs are incorporated assuming a 50% blockage and therefor only 50% is discharged to the network and included in the netwrok calculations. The blue roof technical claculations from the supplier are less conservative. | **See Note 7b** |
| **d** | As per 1a, clarify contributing areas. | As per 1a. | Updated | **See Note 6a** |
| **e** | Has a surcharged outfall been assessed? | Please clarify. | Has been Asssessed. | **See Note 6u** |
| **5** | **Omissions** | | | |
| **a** | Was a flood risk assessment undertaken for the site? | If so, please provide. | This will be completed on 29/04/2022 | **See Note 6r** |
| **b** | No long sections have been provided. | Please provide long sections of proposed storm water network. | Long Sections to be provded when a finalized surface from the Lanscape architect. | **Acceptable** |
| **c** | No details of the blue roof are provided. | Please provide | Attatched drawing from blue roof sub-Contractor | **Acceptable** |
| **d** | No details of the proposed attenuation are provided. | Please provide | What detail is required here - we only have volumes and type of attenation tank/storage at this time. | **See Note 6s** |
| **e** | No details of swales, permeable paving build-up, or tree pits have been included. | Please provide | tree pit design will be provided at detailed deisgn stage along with landscape architect and biodiversity consultant. | **See Note 6t** |
| **f** | How are exceedance flows managed on the site? | Clarify | For extreme rainfall exceedance events follow the natural grading of the site and flows towards Stradbrook River at the northern boundary. | **Acceptable** |
| **P02** | **29/04/2022** | **29/04/2022** | | |
| **6** | | | | |

| | | | | |
|---|---|---|---|---|
| **a** | The Qbar areas don't correlate with the areas identified on the provided sketch. The area of the lower catchment is .99Ha (assuming all of 5568m2 is drained by lower catchment). Only .18Ha is included in Qbar calc. | Clarify correct contributing areas for both catchments | the blue roofs are incorporated assuming a 50% blockage and therefor only 50% is discharged to the network is included in the netwrok calculations. The blue roof technical claculations from the supplier are less conservative.<br>Upper Catchment<br>•Blue Roof – 6485.5m2<br>•Road – 5568.23m2<br>•Ex. Dalguise House – 410m2<br>•Ex. Building/Hardstanding (SW corner) – 560m2<br>•Podium Grassed Area – 801m2<br>•Total = 13,824.74m2<br><br>Lower Catchment<br>•Blue Roof – 870.31m2<br>•Ex. Properties – 170m2<br>•Road = 370m2<br>•Permeable Paving – 440m2 | **See Note 8a** |
| **b** | Revised report not provided | Please provide revised report | Issued | **Acceptable** |
| **c** | Calcs not included in response | Please provide interception calcs for the site | These are located in the ESR Report. | **See Note 8b** |
| **d** | It is not clear how whether this connects to the upper or lower catchment. | Please clarify method of connecting podium to network | This is connected to the upper catchment tank 1 - Similarly to the blue roofs an outlet pipe from the system on the podium will connect into the tank | **See Note 8c** |
| **e** | The size and number of tree pits, if to be used for interception, need to be defined at this stage to allow analysis of robustness of interception regime | Please clarify interception capacity requirement of tree pit proposals, including minimum number required. | We won't be including tree pits for the SUDs approach. | **Acceptable** |
| **f** | These swales offer huge opportunity to provide interception for the site, and as such their use should be maximised. | Clarify which events will result in use of swales. There is the potential for signficant financial savings by utilising these swales as attenuation elements. | The swales are to be utilised for the permeable paving overflow events or tank overflow. | **See Note 8d** |
| **g** | No gullies are currently shown. | Identify where gullies are to be located. | They are to be located intermitantly along the road edge.<br>Gullies shown in legend of drawing W3683-DR-1014-01 for clarity. | **Acceptable** |
| **h** | Have infiltration tests been undertaken? | Please clarify | These have been completed, we haven't received these results yet | **See Note 8e** |
| **i** | | | | |
| **j** | The hydrobrakes will require their own manholes. | Identify whether an existing manhole on the current system will be used or whether a new manhole will be included. In either case, identify this location on the drawing. | New hydrobrake manholes will be installed. - Highlighted on the drawing and legend - type alos noted | **See Note 8g** |
| **k** | The query was in relation to the existing buildings to the east of the swale. | Clarify distance and determine whether there is a need to line the swales | Swales are 12m and 13m to the existing buildings. | **Acceptable** |
| **l** | An impermeable liner. | | Noted | **Acceptable** |
| **m** | Whilst this may not be known, taking 100% of the roof space for blue roof is over-estimating. | An allowance for non-blue roof area should be made | refer to 4c | **See Note 8f** |
| **n** | Area of permeable paving not provided. | Please provide | c.2665.49m2 | **Acceptable** |
| **o** | See 6e | | | |
| **p** | See 6d | | | |
| **q** | See 6k. If any building is within 5m of the swales, the swales should be lined. | Please clarify whether swales will be lined. If so provide outlet drainage locations | South Swale within 1m of a building will be lined. Outlet shown on dwg | **Acceptable** |
| **r** | Noted, please provide on completion. | | | |
| **s** | The type of attenuation needs to be determined to ensure that the proposed design head is feasible from a construction point of view. | Please provide long section through proposed attenuation system. | Section thorugh for tanks prior to outlet sown on w3683-DR-1014 | **See Note 8h** |

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| t | See 6E | | We won't be including tree pits for the SUDs approach. | Acceptable |
| u | Please provide calculations for the same. | | The models have been re-run with an surcharge level of 15.40m for the Upper Catchment outfall and 15.72m for the Lower Catchment outfall which corresponds to the 1% AEP + CC flood level | Acceptable |
| P03 | 04/05/2022 | 04/05/2022 | | |
| 7 | | | | |
| a | The network should be assessed with the attenuation for the 1% AEP event. As stated in GDSDS, this method can result in undersizing by up to 25% as it doesn't account for backwater effects or the head-discharge relationship of the hydraulic control. | Please provide calculations that assess the system as a whole for the 30 year and 100 year events. | The system has been designed as a whole with the site specific flow control device, therefore the head discharge relationship has been accounted for. | See Note 8j |
| b | The M5-60 value differs between the tank analysis and the network analysis. | Clarify the correct value and ensure consistency across all documents | M5-60 of 16.2mm has been adopted and is consistant between tank and network analysis. | Acceptable |
| c | No calculations have been provided for the attenuation tank beside Block A | Please provide | See document named 'Lower Catchment Tank Sizing' | Acceptable |
| d | The tank included in the "Lower Catchment Sizing" equates to 86m3. The drawing allows for 68m3 only. The design flow for the hydrobrake is different from the Qbar rate for the lower catchment. | Clarify correct volume and discharge requirements, amending drawings and calculations as necessary. | Volumes updated on dwgs and report<br>Upper Catchment tank 1 is 390m3.<br>Upper Catchment tank 2 is 94m3<br>Lower catchment tank is 78m3 | See Note 8k |
| e | The design head for the attenuation tank at the hydrobrake for the upper catchment is 1m. The attenuation depth is 1.5m. For this to be utilised in full, the hydrobrake outflow rate would be exceeded. | As stated in 7a, an analysis of the network combined with the attenuation is needed to fully assess the suitability of the proposed network. | The design head for Upper Catchment Tank 1 is 1.5m and the hydrobrake has been designed for 1.5m head. Upper catchment Tank No. 2 has been designed for 1m head. Please see updated calculations | Acceptable |
| f | The attenuation tank upstream of this attenuation tank is 240m3 in one the calculations, 375m3 in the "Part1 calc". Neither tank on the drawing matches this volume. The tank included in "Part 2" calc is 140m3, but is only 45m3 in the drawing. | The upper catchment doesn't need to be broken up into two separate networks. In order to properly analyse how the network operates, it should be treated as one network, with the attenuation tanks incorporated into the network. | The network has now been combined in a single file. The attenuation volume of the Upper Catchment Tank No. 2 has been obtained by using the "Cascade" funtion in the "Source Control" module of MicroDrainage which calculates the required volume accounting for the upstream tank. | See Note 8j |
| g | The contributing area in the upper catchment calcs 0.697Ha. The Qbar area is 1.384Ha. The relationship between these values is not clear. | Clarify run-off factors, ensuring they correlate to latest development plan. | The difference in area between the Qbar area and contributing area is as we have taken 50% of all the roof areas and 30% of the podium area to contribute to the catchment calcs. | See Note 8K |
| P04 | 17/05/2022 | 17/05/2022 | | |
| 8 | | | | |
| a | In the event that there isn't 50% blockage, will this result in a volume entering the network which is greater than has been designed for? | Please clarify. See also 8f | As a conservative approach, the design of the network/attenuation considers that 50% of the blue roof area acts as an impermeable surface. i.e assuming that there is no blue roof attenuation/or it is exceeded. This approach has been adopted in line with the ESR report that was submitted as part of the SHD application. During normal operation of the blue roof system flows will be consideraby lower than what has been allowed for. | Acceptable |
| b | The calculations provided do not identify the level of interception provided. Storage within swales or permeable paving does not equate to a volume of interception. The permeable paving provided can only intercept approx. 27m3 (Twice it's area x 5mm) These allowances are detailed in Chapter 24 of the CIRIA Suds manual. | Compare interception measures provided against the minimum allowances identified in Ch 24 of the CIRIA SUDS Manual. If proposed interception measures can provide interception greater than the minimum allowances, then this needs to be detailed. | Combined with the green/blue rrofs the interception volume across the site is met.<br>Total Interception Required - 179m3<br>Total Inderception Provided - 670.055m3<br>using swales, permeable paving and green/blue roofs. | Revised design submitted, see Feedback Form 07 |
| c | Identify which manhole this enters the system at and whether it is a throttled flow. | Please clarify | It is to have the same limited flow as the blue roofs, it is connected directly into Upper catchment Tank 1 as shown on dwg W3683 - DR-1014 | Revised design submitted, see Feedback Form 07 |

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| **d** | There doesn't appear to be any connectivity between the permeable paving and the swales. In relation to Upper Catchment Tank 2, is this connection for exceedence flows or as part of the proposed volume? | Please clarify. These should be considered based on the result of the calculations from 8b, as there may be a need to utilise these swales for interception. | Swales layout changed.<br>Outlet into Upper Catchement Tank 2. | **Revised design submitted, see Feedback Form 07** |
| **e** | Please share when provided. The SI results will fundamentally influence the drainage design, therefore the results are needed to determine suitability of proposed interception measures. | Provide SI results | This is not available for this LRD review stage with DLR but is noted and when received will be provided for the planning submission. | **Revised design submitted, see Feedback Form 07** |
| **f** | 100% of the roof area can't be included as blue roof, as this won't be the case when you discount m&e facilities, maintenance access etc. This is slightly different from allowance for blockage. The query relates to volumetric capacity on the roof. Is the reference to blockage stating that only 50% of the roof space will be available as a volume, or that the outlet has a blockage. | Please clarify. It would be useful to identify the nodes the blue roofs enter the network at within the calculations. | It is noted that not all the roof can be included as blue roof, a more detailed assessment will be carried out at detailed design stage when roof layout has been confirmed. As a conservative approach, where there are a number of possible MHs to connect to, the furthest u/s manhole has been selected. The design has been carried out assuming 50% of the blue roof area acts as an impermeable surface | **Revised design submitted, see Feedback Form 07** |
| **g** | The hydrobrake downstream of the lower catchment tank is not included on the drawing | Update drawing. | Hydrobrake manholes for all Manholes has been shown and labelled | **Acceptable** |
| **h** | Only section through one of the attenuation tanks is provided. Each have a different design head and volume. Section 1 appears to show the outlet exiting the tank at mid-level. Will this result in a permanent volume being retained? | Revise attenuation sections to show correct inlets/outlets and any overflow details. No section provided on tank within centre of site | Upper Catchment Tanks 2 and Lower Catchment Tank has been shown. Base of Upper Catchment Tank 2 has been raised to match invert level of the outlet pipe.<br>Upper Catchment Tank 1 now shown. | **Acceptable** |
| **j** | The tank included at MH6 in the upper catchment has a capacity of 520m3, with a depth of 2m. The hydrobrake is set for 1.5m.<br>107m3 is provided for the tanks at MH 21, but 94m3 is provided. 135m3 is included in the calculations for the lower catchment.<br>No calculations have been provided for in the 1% AEP for the lower catchment. The pipe results have not been included within the calculations for all events. The flow rates at the outlets exceed the permitted flow rates. | Provide full network results for all flood events, including within manhole water levels and resulting pipe flows. Ensure that the labelling on the drawing is consistent with the labelling on the calculations. | The tank capacity is 390m3 from invert to top water level (260m2 x 1.5m). 2m depth included in model to provide freeboard above TWL. Similarly for other tanks, the plan area is as per the layout drawings with an allowance for freeboard above the TWL. The summary of results for the Upper Catchment network 30-year return period now includes the worst case water level for each node for storms ranging from 15 minutes to 2 days. The flow rate at the outlet is marginally exceeded due to the effect of surcharging caused by the 1 in 100 year design flood level within the Stradbrook stream. The effect of surcharging was assessed asusuming a constant surcharge level of 15.4m at the outfall. In reality, the flood level varies over time hence we have overestimated the impact of the design flood level. | **Revised design submitted, see Feedback Form 07** |
| **k** | 100% of the roof area (both blue roof and other) will at some point contribute to the network, it just depends on the flow control method for discharge to network. | Please provide rationale for discounting 50% of roof area. | Yes 100% of the blue roof will contribute to the network, however this flow will be controlled through the use of a ACO Blue Roof Flow Restrictor. The design assumes that 50% of the roof area is impermeable and contributes directly to the storm network (i.e no attenuation provided). This rationale was adopted in the SHD ESR report has been carried forward to detailed design. | **Revised design submitted, see Feedback Form 07** |

| Item No. | JBA Review Comment | Comment/Clarification Request/Suggested Mitigation | Response from Client/Client Representative | Acceptable / Not Acceptable |
|---|---|---|---|---|
| P01 | 15/09/2022 | 15/09/2022 | | |
| Ref Docs | LRD Opinion_Drainage_BLP Response<br>W3683-DR-1014-05<br>W3683-DR-1018-05<br>W3683-DR-1019-01<br>W3683-DR-1025-01<br>W3683-DR-1026-00<br>W3683-DR-1030-00<br>W3683-DR-1032-00<br>W3683-DR-1034-00<br>Green Blue Blue Roof Calcs<br>Greenfield runoff rate estimation Lower Catchment<br>Greenfield runoff rate estimation Upper Catchment<br>Lower Catchment 2-year analysis RevA<br>Lower Catchment 30-year analysis Rev A<br>Lower Catchment Tank sizing<br>Upper Catchment 2-year analysis Rev A<br>Upper Catchment 30-year analysis Rev A<br>Upper Catchment Tank No.1 Sizing<br>Upper Catchment Tank No. 2 Sizing<br>23927 Dalguise GW 22_08_08<br>M02136-04_DG02 Dalguise House, Monkstown, Dublin 18 (site) FRA Rev 3<br>W3683-BLP-XX-XX-RP-Z-02 Engineering Services Report_Rev04 | | | |
| 1 | DLR Comments | | | |
| a | A full site investigation document is referenced within the responses, but isn't included in the submitted set to JBA. | Can you provide full SI documentation. | Included in next submission | Acceptable |
| b | Within the DLR comments, a drawing of the penstock is referenced W3683-DR-1023. This wasn't included in the submission. | Please provide dwg W3683-DR-1023. | Included in next submission | Acceptable |
| 2 | Drawings | | | |
| a | Upper Catchment Tank 2 is intended to be built within the footprints of Block B & C. A detailed plan and section drawing (as requested as well in the DLR Response) is not provided . | Provide plan and section drawings for all attenuation tank systems. | Sections Included in next submission. Not the building foundations are to be defined at the detailed design stage. | See Note 5a |
| b | It is unclear as to what the purpose of the connection between SWMH 12 and the adjacent swale/pond is. | Clarify if this is an overflow system or a drawing error. If it is the former, how is this incorporated into the calculations? | it is an error. Drawing will be updated for next submission | Acceptable |
| c | There are a number of connections between gullies and tree pits to the east of Block F, which have no subsequent overflow connection to the storm network. This contradicts the typical tree pit detail. | Clarify extent of connectivity between tree pits and storm network. | The tree pits do not have individual connections to the network. The pits are connected and 1 pipe to the storm network is given to SWMH S14 | Acceptable |
| d | The rwp connection to SWMH S4 from Block I (south) enters the network angled against the flow. This might risk surcharging this outlet. | Review connection of RWP to SWMH S4 | Block F RWP is connected to upper catchment tank 1. the pipe you are referring to is to overflow connection from the tree pits. | Acceptable |
| e | A drainage connection exists between SWMH S6 and the adjacent swale. However there is a second direct connection between S6 & S7. The swale may be underutilised given the alternative direct connection. This swale will be effective in providing increased interception, and should be used as a replacement link between S6 & S7 if possible. | Review connectivity between S6 & S7 including better connectivity with the swale. | Swale proposal is to be used as an overflow event to the permeable paving. Due to the existing ground conditions the interception is minimal/negligible as there is no infiltration in the soil. Additionally this swale will be lined due to it's proximity to the building. | Acceptable |
| f | No carrier drain is included within the permeable paving adjacent to Block B | Update drawing to include carrier drain. | see updated dwg connection into SWMH S24. | Acceptable |

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| g | The hydrobrake flow rate for the lower catchment has a different flow rate to that within the calculations. | Ensure consistency across all drawings. | Lower Tank Sizing MD Calcs has been updated for Hydro-brake to have a discharge of 1.2L/s | **Acceptable** |
| h | Pipe 2.008 is shown to be installed at 1:5, with approx. 230mm cover. It is also shown as 300mm dia., but is at 375mm dia. In the calculations. The resultant velocities far exceed the recommended maximum limits. | Was a back drop considered to reduce the gradient of this pipe? Review diameters to ensure that they are consistent across all docs. | 2.018 update MD. Changed SWMH S17 into a back drop manhole to reduce velocities into the tank | **See Note 5b** |
| **3** | **MicroDrainage Calcs** | | | |
| **a** | No 100 yr event results are included. | Please provide results for the 100 year event. | Included in next submission | **See Note 5c** |
| **b** | The lower catchment in the calculations is 0.155Ha, whereas the Qbar flow rate is based on 0.185Ha. These should match. | Review contributing area to ensure consistency. Should the existing catchment to the south of the lower catchment be included? | updated in MD | **Acceptable** |
| **c** | Flooding is identified at MH20B & MH20 for the 30 yr event. | Review calculations to prevent flooding at these locations. | Updated - Surcharge only at hydrobrake which is acceptable | **See Note 5c** |
| **d** | | | | |
| **4** | **Reports** | | | |
| **a** | Rotary cores are referenced in the groundwater document, but no location is provided. | Provide drawing indicating locations of rotary cores | Included in next submission | **Acceptable** |
| **b** | | | | |
| **P02** | **23/09/2022** | **23/09/2022** | **07/10/2022** | **07/10/2022** |
| **5** | | | | see report for latest design data received |
| **a** | It would appear there are pile foundations going through the tank. In addition, any ring beam would drive down the cover level of the tank and have a knock-on effect on the invert and downstream network. | Whilst we don't need a detailed design for the foundations in Stage 1, we do require a design that will not see significant changes at detailed design. The inclusion of the foundations will drastically alter the design, therefore some allowance needs to be at least considered when sizing and locating the tank. | The location and level of the tanks cannot be changed as we are restricted with the river bed level, locations of building (day light and sunlight restrictions). Piles are an essential part of the construction as we are unable to install e.g. raft foundations given the topography of the site and the no. of trees to be retained as per the councils request. | Acceptable |
| **b** | This is not reflected in the long section drawing. | Amend long section to show new back-drop | File omitted from previous pack. See attached to email. | Acceptable |
| **c** | There are a number of issues with the 100year calculations:<br>- The discharge rate in the calcs for the lower catchment is showing 2.4 l/s, double that of the permissible rate<br>- There is extensive flooding from MHs 20B and 20 on the upper catchment calcs. It is unclear where these are, as the naming convention doesn't correlate with the drawing. 20B appears to be the manhole upstream of the attenuation, directly beneath the building. | Address flooding issues in Upper catchment, and discharge rates in lower catchment. | - The model has now been updated to ensure a discharge rate of no more than 1.2l/s<br>- MH 20 and 20B are in the lower catchment. No flooding issue with these. Previous flooding issues with MH 23 has been rectified and the swale connection has been re-directed to SWMH15. | Acceptable |
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