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Engineering Services Report

Strategic Housing Development

Clonkeen College, Clonkeen Road, Blackrock, Co. Dublin

Client: Clonkeen Investments DAC

Job No. W012

September 2021

PAC/SHD/162/20

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ENGINEERING SERVICES REPORT

STRATEGIC HOUSING DEVELOPMENT
CLONKEEN COLLEGE, CLONKEEN ROAD, BLACKROCK, CO. DUBLIN

CONTENTS

Appendix A: Service Records

Appendix B: Attenuation and Storm Water Design and Simulation Calculations

Appendix C: Green Roof Specification

Appendix D: Foul Water Design

Appendix E: Irish Water Pre-Connection Response

Appendix F: Irish Water Statement of Design Acceptance

Appendix G: JBA Storm Water Audit

File Location: Job-W012\B_Documents\C_Civil\A_CS Reports\ESR\

BS 1192 FIELD	**W012-CSC-ZZ-XX-RP-C-0001-P3**

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W012	OS	RFM	OS	16.12.2020	S2
W012	RFM	NB	OS	19.10.2020	S1
W012	RFM	NB	NB	02.07.2020	S0

1.0 INTRODUCTION

Cronin & Sutton Consulting Engineers (CS Consulting) have been commissioned D|RES Developments Ltd. to prepare an Engineering Services Report for a proposed residential development at Clonkeen College, Clonkeen Rd, Blackrock, Co. Dublin.

This report assesses the proposed development under the following headings:

- Foul Drainage Infrastructure;
- Stormwater Drainage Infrastructure;
- Potable Water Infrastructure; and

In preparing this report, CS Consulting has referred to the following:

- Dún Laoghaire-Rathdown Development Plan 2016–2022;
- Dún Laoghaire-Rathdown Strategic Flood Risk Assessment, 2016–2022;
- Regional Code of Practice For development works, Version 6;
- Irish Waters Code of Practice for Water Infrastructure;
- Irish Waters Code of Practice for Wastewater Infrastructure;
- Greater Dublin Strategic Development Study;

The Engineering Services Report is to be read in conjunction with the engineering drawings and documents submitted by CS Consulting and with the various additional information submitted by the other members of the design team.

2.0 SITE LOCATION AND PROPOSED DEVELOPMENT

2.1 Site Location

The proposed development site is located at Clonkeen College, Clonkeen Road, Blackrock, Co. Dublin. The site is located in the administrative jurisdiction of Dún Laoghaire-Rathdown County Council and has a total area of approximately 3.3ha.

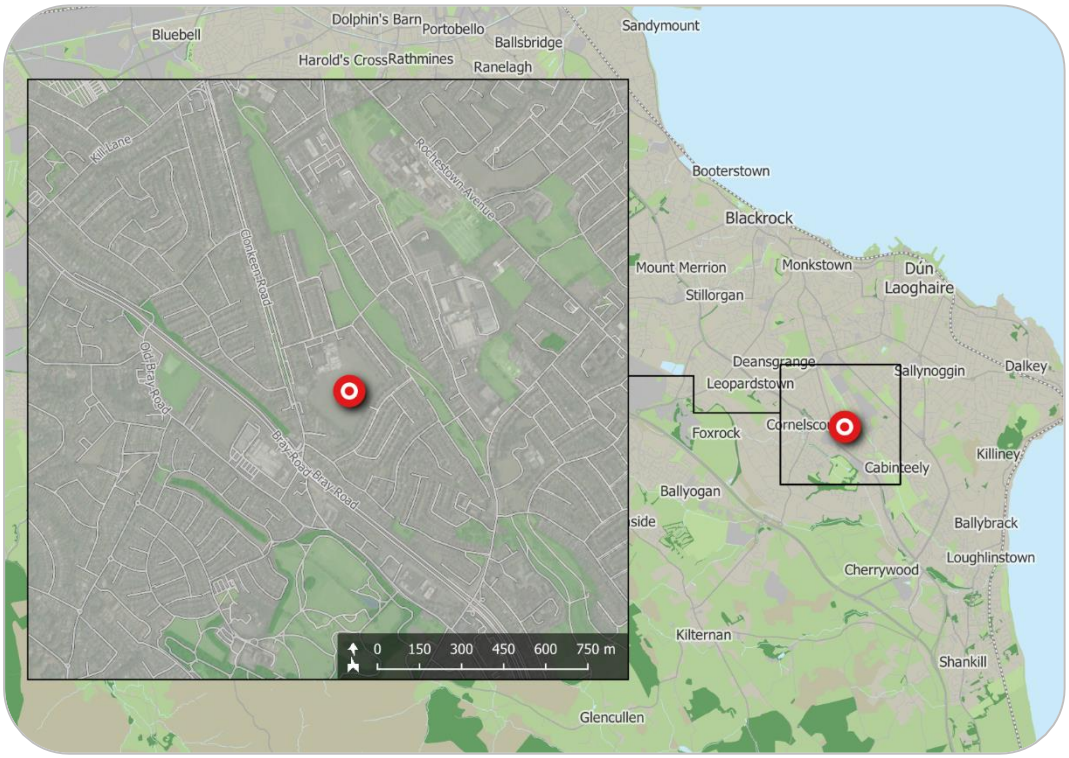


Figure 1 – Location of proposed development site
(*map data & imagery: EPA, OSM Contributors, Google*)

The location of the proposed development site is shown in Figure 1 above; the indicative extents of the development site, as well as relevant elements of the surrounding road network, are shown in more detail in Figure 2.

The site is bounded to the north-west by Clonkeen College, an existing filling station, and residential properties, to the north-east, south-east and south-

west by existing residential properties. The site has street frontage of approx. 23m on Meadow Vale, at its northernmost corner.

Figure 2 – Site extents and environs
(*map data & imagery: NTA, OSM Contributors, Google*)

2.2 Existing Land Use

The subject site is generally greenfield, having formed part of the grounds of Clonkeen College. To the south of the subject lands along the site boundary is an existing ditch. In addition, a public 375mm combined sewer crosses the site from west to east.

2.3 Description of Proposed Development

The proposed Strategic Housing Development, with a total gross floor area of c 33,851 sq m, will provide 299 no. residential units and a 1 no. storey 353 sq m childcare facility with dedicated play area 231 sq m. The development will consist of 18 no. ground floor 3 bedroom duplex

apartments and 18 no. 2 bedroom apartments above and 12 no. ground floor 2 bedroom apartments with 12 no. 3 bedroom duplex apartments above. The 60 no. duplex units are arranged in 6 no. three storey blocks. The development will also consist of 239 no. apartment units (111 no. 1 bedroom apartments, 120 no. 2 bedroom apartments and 8 no. 3 bed apartments) arranged in 4 no. 6 storey blocks over 1 no. storey basement; public open space, communal open space and private open space (including all balconies, terraces and individual unit gardens at all levels); 614 sq m communal resident facilities including concierge and welcome area (195 sq m), residents' flexible work facility (219 sq m), residents' lounge (100 sq m) and residents' gym area (100 sq m).

The development will also provide for the demolition of the 2 no. storey office building ('St. Helen's', Meadow Vale - 470 sq m) to facilitate new vehicular, pedestrian and cyclist access to the site, to the north of the proposed development via Meadow Vale.

The development will also include the provision of 2 no. designated play areas; internal roads and pathways; bin stores; 248 no. car parking spaces, including 167 no. at basement level and 2 no. shared vehicle (GoCar) spaces, 388 no. bicycle parking spaces, and 10 no. motorcycle parking spaces at basement and surface level; hard and soft landscaping; plant; boundary treatments including the repair and replacement of some existing boundary treatments; the provision of new surface water and foul drainage pipes and any required pipe diversion works or build over works; internal foul pumping station; a new internal access road and paths; changes in level; services provision and related pipework, ducting and cabling; electric vehicle charging points; 4 no. stormwater attenuation tanks; 1 no. ESB substation; photovoltaic panels; SUDS including green roof provision; signage; provision for future pedestrian access to Monaloe Park to the east of the development, including the provision of a pedestrian bridge, extending over the drainage ditch; public lighting and all site

development and excavation works above and below ground. The application contains a statement setting out how the proposal will be consistent with the objectives of the Dún Laoghaire-Rathdown County Development Plan 2016-2022. The application contains a statement indicating why permission should be granted for the proposed development, having regard to a consideration specified in section 37(2)(b) of the Planning and Development Act 2000, notwithstanding that the proposed development materially contravenes a relevant development plan or local area plan other than in relation to the zoning of the land.

3.0 SURFACE WATER INFRASTRUCTURE

3.1 Existing Storm Water Arrangements

The subject lands are greenfield in nature. The land falls from north to south. The lands fall from a high point of +37.21m OD to the north to a level of 35.00mOD to the south.

Following review of Dún Laoghaire-Rathdown County Council's drainage records and a review of the sites topographical survey indicates that there is an existing ditch to the site southern boundary. The lands drain to the south into the ditch along the southern boundary. The drain from west to east and ultimately discharges to the south east corner of the subject lands.

Please refer to **Appendix A** for the Dún Laoghaire-Rathdown County Council's drainage records & CS consulting drawing existing survey drawing.

3.2 Proposed Storm Water Network Arrangements

It is proposed to discharge surface water from the development by gravity to the existing watercourse to the southern boundary of the site. This watercourse is the natural greenfield drainage route.

The use of Suds features, including swales / filter drain, bio retention pits, permeable paving, green roofs, and detention basins will provide infiltration and evaporation as much as physical possible and optimise retention time, refer to section 3.7 of this report. Underground stormtech arch'd systems are being proposed throughout the site to provide an attenuation for the 1-100 year storm.

The proposed surface water network shall discharge via hydrobrake manholes at outfalls to limit the flow to the equivalent green field rate runoff with any excess flows surcharging back into the attenuation structures. The onsite attenuation has been designed to cater for the 1-100 year event allowing for 20% increase due to climate change. A petrol interceptor will be installed before any outfall location to the open watercourse.

It is proposed to incorporate a Storm Management Plan through the use of Suds devices and techniques to treat and minimise surface water from the site.

The Suds devices and techniques are based on the three key design principles – Water Quantity, Water Quality and Water Amenity. The proposed SuDs devices have considered the following;

- Source Control
- Site Control
- Regional control

The above is based on the GDSDS and in the Suds Manual.

3.3 Establishment of Soil Type

In order to calculate the allowable discharge rate off the site a number of parameters are required to be established.

- Standard Average Annual Rainfall, *SAAR* (take from Met Eireann data),
- *Sliding duration* rainfall data, (take from Met Eireann data),
- *Soil Type*, (taken from the Flood Studies Report & the HR Wallingford SuDs site).

Soil Type.

The Soil type designated for the site, based on the Flood Studies Report & Suds Website indicate that the site is designated as Soil Type 1. Soil type 1 would generally be a sandy type soil will high infiltration and with a low discharge rate. Discussions with the Local Authority gave rise to the soil type to be further investigated on site as the local environs indicated the subsoil to be dense clay rather than sand/gravel. The mapping from the Flood Studies Report can be viewed as a high-level interpretation of the soil characteristics as known at the time, but local areas may differ significantly from the map's values.

A site investigation was carried out Causeway Limited on the 25th May 2019. The results indicated that the site is firm gravelly clay soils with low permeability rather than sand. In order to confirm the soil type to be used in the Q-Bar

formula based on the site information obtained a different approach was followed.

The Institute of Hydrology Report No. 126 sets out a mechanism which can be followed when actual site parameters have been established. Four parameters are required:

i) The current sites gradient, (slope), in degrees.

The slope for the site has been determined as **less than 2-degrees**.

ii) Water regime class.

Based on the IH126 & Soil survey Field Handbook (Hodgson 1974), gives three regimes. The subject site is water regime **class 2**.

iii) Permeability Class.

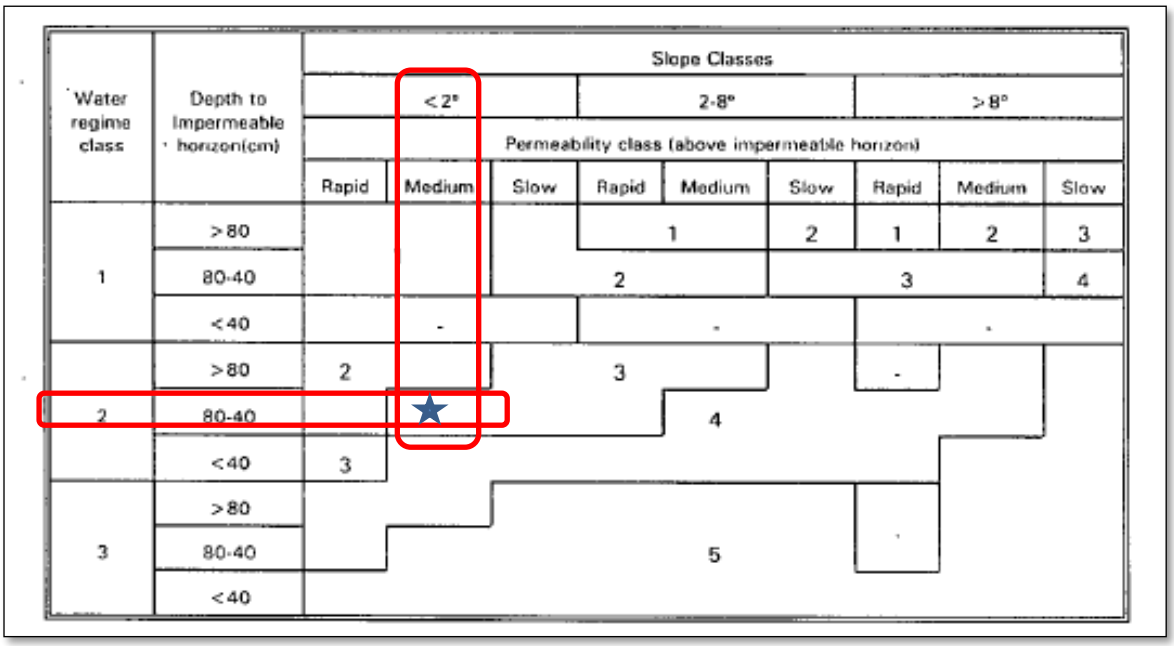
Permeability class has been deemed to be **medium**.

iv) Depth to Impermeable Horizon.

The depth to the impermeable horizon was established to be between **40 – 80 cm**.

These four parameters allow for the *Winter Rainfall Acceptance Potential Classification*, graph to be used to determine the soil type. See **Figure 3.0** below

for the illustrated graph indicating that soil type 3 is applicable for the site and this value was used in generating the Q-bar discharge rate for the scheme.



Water regime class	Depth to impermeable horizon(cm)	Slope Classes								
		<2°			2-8°			>8°		
		Permeability class (above impermeable horizon)								
		Rapid	Medium	Slow	Rapid	Medium	Slow	Rapid	Medium	Slow
1	>80				1		2	1	2	3
	80-40			2			3			4
	<40		-		-			-		
2	>80	2			3			-		
	80-40		★			4				
	<40	3								
3	>80									
	80-40					5				
	<40									

Figure 3 – IH126 Report – WRAP Classification Graph

3.4 Stormwater Drainage Design

In accordance with the requirements of Dún Laoghaire-Rathdown County Council all new developments are to incorporate the principles of Sustainable Urban Drainage Systems, (SuDS). The SuDS principles require a two-fold approach to address storm water management on new developments.

The **first** aspect is to reduce any post development run-off to pre-development discharge rates. The development is to retain storm water volumes predicted to be experienced during extreme rainfall events. This is defined as the volume of storm water generated during a 1 in 100 year storm event increased by 20% for predicted climate change factors.

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: 830mm/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 site investigation, as noted above, has been established as ***Soil Type 3***.

In accordance with the requirements of the Local Authority storm water from a proposed development is to be restricted to 2l/Ha or the greenfield runoff rate, whichever is the greater. As such a discharge rate of 3.51l/sec/Ha has been used for the discharge rate, giving a total discharge rate of 7.5l/sec for all storm water events for positively drain areas.

The proposed development is to retain storm water volumes predicted to be experienced during extreme rainfall events. This is defined as the volume of storm water generated during a 1 in 100 year storm event increased by 20% for predicted climate change factors, addresses Section 16.12 of the *Development Management – Thresholds Information Document*. The total site area of the development site is approximately 3.316Ha, with 2.1338Ha hardstanding area and 1.1827Ha soft land scaping. The proposed development has split the site into two catchments Area 1 & 2. Area 1 (the northern area of the site) requires an attenuation storage volume of **695m³**, while Area 2 (the southern section), requires **1047m³** for the 1 in 100 year storm event including allowance for 20% climate change. The storage volumes from both catchments will be provided by underground tanks. Both catchments will discharge separately into the existing water course along the boundary of the subject lands.

See **Appendix B** for the Met Eireann Data and Attenuation Calculation and See **Appendix C** for storm water calculations.

Please refer to CS Consulting Drawing **W012-CSC-ZZ-XX-DR-C-0005 P4 Proposed Storm Water Layout** for details of the surface water layout details.

3.5 Interception or Treatment Storage and Proposed Attenuation Storage

The GDSDS & the local authorities Regional Code of Practice for Drainage Works require that four main criteria to be provided by the developer.

- Criterion 1: River Water Quality Protection – satisfied by providing interception storage and treatment of run-off within SUDS features e.g. bio-retention 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.

3.6 Criterion 1: River Water Quality Protection

Interception

According to the GDSDS circa 40% of rainfall events are sufficiently small that there could be deemed no runoff of a measurable nature from greenfield areas in the receiving waters. These events are generally considered as the first 5 to 10mm of rainfall.

Therefore assuming 80% of runoff from paved area surfaces and 0% from pervious surfaces for the first 5mm of rainfall yields the following;

- Paved surfaces connected to drainage systems = 21338 m2 (Refer to drawing W012-CSC-ZZ-XX-DR-C-0023 for drainage contributing area valuations and drawing W012-CS-ZZ-XX-DR-C-0021SUDs layout plan for further breakdown of contributing area calculations.
- Volume of Interception Storage = 21338m2 x 5mm x 0.8 = 85.4.0 m3

The required interception storage volume is therefore 85.4m3.

The proposed interception volume is 256.0m3.

Treatment Volume

For events larger than 5mm. Therefore assuming 80% of runoff from paved area surfaces and 0% from pervious surfaces for the first 15mm of rainfall yields the following;

- Paved surfaces connected to drainage systems = 21338 m2
  ((Refer to drawing W012-CSC-ZZ-XX-DR-C-0023 for drainage contributing area valuations and drawing W012-CS-ZZ-XX-DR-C-0021 P4 -SUDs layout plan for further breakdown of contributing area calculations.
  Volume of Interception Storage = 21338m2 x 15mm x 0.8 = 256.0 m3

The required treatment storage volume is therefore 256.0m3. The proposed storage volume provided is 584.0m3. This is achieved through the use of swales / filter drain, bio-retention tree pits, permeable paving and green roofs. It should be noted that the proposed Stormtech attenuation system will provide an additional 435m3 volume for interception and treatment of surface water runoff. Therefore the total interception / treatment volume provided for the proposed development will be **1019.0m3.**

Surface water runoff from the roads and pavements will drain into a combination of swales / infiltration trenches with perforated pipes, tree pits and bio retention areas. Permeable paving will be located in all parking spaces.

The minimum interception areas required are calculated from 'deemed to satisfy' criteria outlined in Ciria SUDs Manual Table 24.6. The following table gives the detailed breakdown of interception / treatment calculations and is to be reqd in conjunction with drawing No. **W012-CSC-ZZ-XX-DR-C-0021 P4. – Suds Layout Plan.**

SUDs Feature Type	Contributing Areas (m^2)	Interception Area Required(m^2) (Minimum)	Interception Area Provided(m^2)	Interception Volume Required(m^3)	Teatment Volume Required(m^3)	Interception Treatment Volume Provided(m^3)
Green Roof	2428.0 m^2	2428.0 m^2	2428 m^2	9.70 m^3	29.1 m^3	122.0 m^3
Permeable paving	8283.0 m^2	1657.0 m^2	1876.0 m^2	33.1 m^3	99.4 m^3	254.0 m^3
Roadside Filter/swales	2498.0 m^2	99.50 m^2	421.0 m^2	10.0 m^3	30.0 m^3	101.0 m^3
Bio Retention Tree areas	1656.0 m^2	331.0 m^2	352.0 m^2	6.70 m^3	20.0 m^3	31.8 m^3
Filter Drains	6473.0 m^2	259.0 m^2	313.0 m^2	25.9 m^3	77.7 m^3	75.2 m^3
Total	**21338 m^2**	**4774.5 m^2**	**5390.0 m^2**	**85.4 m^3**	**256.0 m^3**	**584.0 m^3**

Table 1 – Volume and Interception Table.

3.7 Criterion 2: River Regime Protection

Attenuation storage is provided in the form of underground attenuation arched type systems surrounded in stone in two locations and are placed in line as per the council's request.

As per the GDSDS, the required attention volume is calculated assuming 100% run off from paved areas.

The storage volume for each catchment is calculated for 1 year, 30 year and 100-year return periods. Refer to table below for the 1-100-year storm and **Appendix B** for calculations.

Catchment	Storage Volume 1-100 year
A	695
B	1047

The preliminary calculated storage for the site as outlined above and in section 3.4 above is 1742m3. However, a Windes simulation of the network and proposed attenuation tanks shows that the required attenuation is 2299.6m3. We enclose Stormtech calculations for all 5 attenuation tanks with a total volume of 2296.6m3. We provide Windes calculations to support the final storage design of 2299.6m3. (See Drawings **W012-CSC-ZZ-XX-DR-C-0005 P4, 0021 P4**, **0023 P1** and **Appendix B**.

3.8 Criterion 3: Levels of Service

The GDSDS requires that no flooding should occur on site for storms up to and including the 1 in 30-year event. The pipe network and the attenuation storage volumes should, therefore, be checked for such storms to ensure that no site flooding occurs although partial surcharging of the system is allowed as long as it does not threaten to flood.

For the 1 in 100 year event, the pipe network can fully surcharge and cause site flooding, but the top water level due to any such flooding must be at least 500mm below any vulnerable internal floor levels, and the flood waters should be contained within the site. In addition, the top water level in any attenuation device during the 100 year storm must be at least 500mm below any vulnerable internal floor levels.

Refer to **Appendix C** for a copy of the Micro Drainage simulation as per GDSDS policy for storm water design. For simulation, we used storm durations of 15, 30,60, 180,360,720,1440,and 2880 minutes. The critical storm duration for storage attenuation occurs at the 24 hour (1440mins) storm event. The results demonstrates no surface water flooding to any part of the site for storms up to and including the 1 in 100 year plus 20% extra for climate change. Therefore, GDSDS Criterion 3 is complied with.

We refer to the Flood Risk Assessment as part of the planning submission for the analysis of flood risk at the subject site.

3.9 Criterion 4: River Flood Protection

Criterion 4 is intended to prevent flooding of the receiving system / watercourse by either limiting the volume of runoff to the pre-development greenfield volume using 'long-term storage' (Option 1) or by limiting the rate of runoff for the 1 in 100 year storm to QBAR or 2.0l/s/ha without applying growth factors using 'extended attenuation storage' (Option 2).

The proposed surface water system complies with Option 2. the proposed development will limit discharge line with GDSDS requirements.

The proposed development is to retain storm water volumes predicted to be experienced during extreme rainfall events. This is defined as the volume of storm water generated during a 1 in 100 year storm event increased by 20% for predicted climate change factors. The two catchments will therefore be required to provide 2299.6m3 of storage (See *Section 3.4* above). It should be noted that 5 attenuation tanks will provide proposed attenuation volumes as shown on drawing.

In compliance with GDSDS requirements, we carried out 50% blockage simulation for both catchments. The flood exceedance flow paths are shown in drawing No. **W012-CSC-ZZ-XX-DR-C-0034 – Potential Flood Route.**

3.10 Sustainable Urban Drainage System (SuDS) Measures

As mentioned in section 3.2 of the report a series of SuDs measures have been incorporated. The location, design and type of measures chosen have been derived taking into consideration that the measures used are design to taking in charge standards and the main roads and footpaths along with associated interception storage areas can be taken in charge if so required. We note that the development will not be required to be taking in charge. These are the following;

Green roof

The proposed green roofs will consist of sedum roofing. The proposed green roofs will cover 60% of new roof areas. The limitations in providing full green roof coverage is due to plant enclosures and sloped roof profiles. The green roof will provide interception of rainfall, filtration through the medium, and storage within the voids whilst facilitating evapotranspiration.

The green roofs will intercept and absorb the first 5 – 10mm of rainfall, thereby reducing the volume of runoff into the receiving systems. Rainfall runoff that is not absorbed by the green roof will filtrate through the substrate and geotextile filter fabric. A limited attenuation volume will be provided by the green roof crate layer system below the geotextile filter fabric, which will provide a time delay between the rainfall event and discharge into the system thereby reducing peak discharge rates. According to the leading green roof supplier/manufacturer Bauder, up to

40% of average annual rainfall can be absorbed and released back into the atmosphere by transpiration and evaporation.

Therefore, rainfall runoff from roof areas covered by the proposed green roofs will go through a two-stage treatment train including interception and primary treatment in line with SuDS Manual C753 Table 26.7. See **Appendix C** for details of proposed green roof system.

Permeable Pavement

The proposed permeable pavement will be located at parking bays throughout the development. The proposed permeable paving structures will be filled with suitable granular material with a minimum void porosity of 30% and wrapped in a geotextile filter membrane. The granular material will provide interception within the voids and by raising the invert of the outlet pipe to 100mm above the base. The geotextile filter material can offer secondary treatment of rainfall runoff by preventing ingress of fine material from paved areas through filtration prior to discharge into surface water drainage system.

Therefore, rainfall runoff from localised access road will go through a two-stage treatment train including interception and primary treatment in line with SuDS Manual C753 Table 26.7.

Bioretention Systems

The proposed bioretention systems include shallow landscaped swaled depressions around the site and series of tree pits. The proposed tree pits will be engineered soil filled tree boxes. The proposed bioretention systems will provide interception and treat pollution through the use of engineered soils and vegetation. Runoff collected from adjacent impermeable surfaces will pond temporarily on the surface before filtering through the vegetation and underlying soils. Interception will be provided by installing a weir / outfall pipe at an invert level above the required volume of interception. Part of the runoff volume will be removed through evaporation and plant transpiration.

Therefore, rainfall runoff that will discharge into the proposed bioretention system will go through a three-stage treatment train including interception, primary and secondary treatment in line with SuDS Manual C753 Table 26.7.

Shallow Infiltration Systems

The proposed shallow infiltration system will be linear excavations filled with suitable granular material with a minimum void porosity of 30% and wrapped in a geotextile filter membrane to a depth of 300mm. A perforated pipe will be installed at the bottom of the granular fill to collect any runoff that did not infiltrate to ground. The filter drains will intercept roads and footpath pavement runoff. Catchpits will be provided downstream of the filter drains to offer additional surface water treatment including retention.

The proposed filter drains will provide interception and reduce peak runoff rates prior to discharge into the surface water drainage system. The granular material and geotextile filter material will provide interception and act as a secondary treatment in preventing ingress of fine material from paved areas prior to discharge into surface water drainage system.

Therefore, rainfall runoff that will discharge into the filter drains / catchpits will go through a three-stage treatment train including interception, primary and secondary treatment in line with SuDS Manual C753 Table 26.7.

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.

3.11 Stormwater Network Design and Audit

As part of the Stage 3 submission a Storm Water Audit was carried out on the scheme.

The Auditor will be from the accredited list approved by the local authority.

Any items raised with the audit at this stage will be address as required.

4.0 EXISTING FOUL INFRASTRUCTURE

4.1 Existing Foul Arrangements

Following review of Dún Laoghaire-Rathdown County Council's drainage records indicates that there is a 375mm diameter sewer on passing through the site, which runs from west to east. Please refer to **Appendix A** for the Dún Laoghaire-Rathdown County Council's drainage records.

A slit trench was carried out on site to confirm the location. The pipe was located in the site and mapped on the application drawings. The crown of the pipe was carefully exposed and levelled. The depth to the crown of the pipe was 2.2m below existing ground.

4.2 Proposed Foul Drainage Arrangements

The proposed development will require a new separate drainage network to collect and convey the effluent generated by the proposed development. The drainage network for the proposed development has been designed in accordance with:

- The Regional Code of Practice Drainage Works,
- The Greater Dublin Strategic Drainage Study,
- Irish Water Code of Practice for Wastewater Infrastructure.

The drainage network for the development will be in accordance with Part H of the Building Regulations and to the requirements and specifications set out in the Irish Water Code of Practice for Wastewater.

4.3 Proposed Effluent Generation

The proposed development is to comprise 299no. residential units. Based on Irish Water guidelines, the foul effluent generated by these shall be:

FOUL WASTEWATER DISCHARGE CALCULATIONS
IW-CDS-5030-03 (Revision 2 – 2020)

Dry weather flows (DWF)	446	l/dwelling
Peaking factor (Pf)	6	Population 0 to 750

Wastewater Discharge = Dwelling x Dry weather flows

Dwelling	299	unit
Dry weather flows	446	l/dwelling
Wastewater Discharge	**133.35**	**m3/day**
Wastewater Discharge	**133354.00**	**l/day**

1 day	86400	s
Wastewater Discharge	1.543449074	l/s

Peak Discharge = Wastewater Discharge x Peaking Factor

Peak Discharge	**9.261**	**l/s**
Average Discharge	**1.543**	**l/s**

The proposed development shall also include a crèche with a Gross Floor Area of 353sqm. Based on Irish Water guidelines, the foul effluent generated by this shall be:

FOUL WASTEWATER DISCHARGE CALCULATIONS

Flow Rate	90	l/person/day
sq.m/person	3.5	
Peaking Factor (Average)	1.5	times
Peaking Factor (pipe network)	6	times
Creche Space	**353**	sq.m

No. Children/Staff	90	unit
Dry weather flows	90	l/person/day
Wastewater Discharge	**8.10**	**m3/day**
Wastewater Discharge	**8100**	**l/day**

1 day	86400	s
Water Demand	0.094	l/s

Peak Discharge = Wastewater Discharge x Peaking Factor

Peak Discharge	**0.563**	**l/s**
Average Discharge	**0.094**	**l/s**

4.4 Proposed Foul Drainage Arrangements

All foul effluent generated from the proposed development shall be collected in pipes and flow under gravity into the existing 375mm diameter sewer which crosses the site.

The development proposed pays respect to the required 6m wide wayleave associated with the existing drain.

The drainage network for the development will be in accordance with Part H of the Building Regulations and to the requirements and specifications of Irish Water. The proposed foul effluent generated by the subject lands shall be separate from all surface water flows.

For foul flows from the apartment development the effluent will be collected into a foul holding tank and pump station. The foul will be lifted to the gravity drain and standoff manhole outfall then to the existing 375mm diameter sewer.

For the basement level run off from cars and similar, all effluent shall be collected in pipe of 150mm in diameter flowing under gravity to petrol interceptor and then to a pump station located in the basement to a stand-off manhole at ground level.

Please refer to **Appendix D** for WinDes calculations for the proposed foul drainage network

4.5 Irish Water Pre-Connection Enquiry

A Pre-connection enquire submission was lodged with Irish Water; we have a COF for 404 units in excess of the 299 units proposed. The response is in **Appendix E.**

4.6 Statement of Design Acceptance

Refer to enclosed appendices.

5.0 POTABLE WATER SUPPLY

5.1 Existing Potable Water System

Following review of Dún Laoghaire-Rathdown County Council's records indicates that there is an existing public 6"(150mm) uPVC watermain, located in Meadow Vale road to the north of the subject lands.

Please refer to **Appendix A** for the Dún Laoghaire-Rathdown County Council's records.

5.2 Proposed Potable Water System

The proposed development is to comprise 299no. residential units. Based on Irish Water guidelines, the potable water demand of these shall be:

WATER DEMAND CALCULATIONS
IW-CDS-5020-03 (Revision 2 – 2020)

Consumption rate	150	l/person/day
Persons/house/per capita	2.7	
Peaking Factor (Average)	1.5	times
Peaking Factor (pipe network)	5	times

Water Demand = Dwelling x Persons per Dwelling x Consumption Rate

Dwelling	299	unit
Persons per Dwelling	2.7	persons
Consumption Rate	150	l/person/day
Water Demand	**121.10**	**m3/day**
Water Demand	**121095**	**l/day**

1 day	86400	s
Water Demand	1.402	l/s

Peak Water Demand = Water Demand Average x Peaking Factor

Peak Water Demand	2.102	l/s
Peak Water Demand - Pipe Network	**7.008**	**l/s**
Average Water Demand	**1.402**	**l/s**

The proposed development shall also include a crèche with a Gross Floor Area of 353sqm. Based on Irish Water guidelines, the potable water demand of this shall be:

WATER DEMAND CALCULATIONS

Consumption rate	90	l/person/day
sq.m/person	3.5	
Peaking Factor (Average)	1.5	times
Peaking Factor (pipe network)	5	times
Creche Space	**353**	sq.m

No. Children/Staff	101	unit
Consumption Rate	90	l/person/day
Water Demand	**9.08**	**m3/day**
Water Demand	**9077**	**l/day**

1 day	86400	s
Water Demand	0.105	l/s

It is proposed development shall be supplied via a new water connection off the 6" uPVC watermain.

5.3 Irish Water Confirmation of Feasibility

A Pre-Connection Enquiry was submitted to Irish Water, see **Appendix E** for their response.

Irish Water notes that up-grade works outside of the subject site is required.

CS have discussed the COF response with Irish Water. The outcome of those discussions is that these up-grade works can be carried out by Agents for Irish Water and funded by the applicant, subject to and under an agreement at the connection stage. This has been agreed with Irish Water and is normal practice.

5.4 Statement of Design Acceptance

Refer to enclosed appendices.

6.0 LOCAL AUTHORITY DISCUSSIONS

As part of the development process discussions were held with Local Authority personnel as part of the S247 planning process and off-line to ensure that the concerns of the Council were addressed. Submissions to the Council led to feed back overing seven general areas for which the Council required clarity. Below is noted the seven areas and CS Consulting's responses to same. The responses have been incorporated into the report, calculations & drawings prepared for this application.

S247 comments;

1) *The series of off-line attenuation tanks proposed is not acceptable. In-line systems will be required. System seems to be over-complicated.*

   This is noted and the revised drawing has endeavoured to place proposed tanks 'in-line' as opposed to off-line. The revised locations for the tanks are off the proposed carriageways serving the development.

2) *The existing watercourse /ditch on the South-western and South-eastern boundaries shall be retained with riparian corridor setbacks required.*

   Noted, the revised scheme does not locate any building structures within 10m of the top of bank level.

3) *SOIL Type 1 unlikely – Chosen SOIL type to be supported by the results of site investigations. Revise QBar and attenuation storage volumes to match chosen SOIL type.*

   The Soil Type maps located in Flood Studies Report & referenced in the Greater Dublin Strategic Drainage Study gives the site a soil type of '1'. As a cross check the sites location was analysed against the HR Wallingfords UKSuds database, which also gave the soil type as 1. Discussions with the Local Authority indicated that this was unlikely and a site investigation may give a more realistic soil type as the mapping from the Flood studies Report & HR Wallingford UKSuds database are more regional in nature than site specific. The data provided by the site investigation altered the soil type classification and determined that soil type 3 was applicable, see

Section 3.3 above for a detailed breakdown of the rationale behind same.

4) *Proposed 1.27ha of soft landscaping not immediately apparent.*

Noted, a new drawing has been prepared indicating the hard vs soft landscaping areas for the scheme. Refer to CS Consulting's drawing **W012-CSC-ZZ-XX-DR-C-0021 P1** for details of same.

5) *Interception treatment volumes will have to be provided across the site and across the various surface types. Over-provision in one area does not compensate for under-provision elsewhere. Preliminary calculations provided thus far do not adequately address this issue.*

As noted interception and treatment volumes have been calculated for the scheme, refer to Section 3.6 above.

6) *Levels and dimensioned details of proposed SuDS and SW drainage elements/measures to be provided.*

Refer to CS Consulting's drawing **W012-CSC-ZZ-XX-DR-C-0005 P1, 0021P1, & 0023** for details of the proposed stormwater system.

7) Green Roof provision coverage to be demonstrated in more detail.

Noted.

The green roof provision is indicated on **W012-CSC-ZZ-XX-DR-C-0021 P1 & Appendix C** gives details for the proposed green roofs to be provided. As the development will not be taken in charge post construction all operational and maintenance requirements will be carried out the scheme's management company.

Stage 2 Comments;

1. *The applicant refers to a site investigation undertaken in 2019 but has not included this information in the submitted package. The applicant is required to submit the complete Site Investigation Report and results, including Infiltration tests, and a plan showing the trial pits/soakaway test locations across the site. The report should address instances where groundwater, if any, was encountered during testing and its impact.*

   Response; We enclose Ground Investigation report Ref 19-0607 carried out by Causeway Geotec August 2019. The report states where groundwater was encountered on the site. We have shown trial pit locations with results on drawing W012-CSC-ZZ-XX-DR-C-0005 P2 Proposed Storm Water Layout. The water level in the trial pits where are a minimum 800mm below the invert levels of the proposed surface water infrastructure where shown.

2. *If the applicant proposes SuDS measures that incorporate the use of infiltration, the applicant is required to provide details of each SuDS measure and confirm whether it will be lined/tanked or not. If lined/tanked systems are to be used, then the applicant will be requested to explain the rationale behind this. If unlined systems are to be used then the applicant is requested to demonstrate on a drawing that all infiltration SuDS proposals, including the attenuation system, have a 5m separation distance from building foundations and 3m separation from site boundaries.*

   Response: All SuDs systems will have a minimum 5m separation distance from building foundations. We enclose drawing W012-CSC-ZZ-XX-DR-C-0021 P2 Suds Layout Plan showing the separation distances between Suds devices and buildings.

3. *The applicant shall make specific reference to infiltration devices and attenuation systems that are located in the riparian corridor and how these devices will be protected from ingress from the watercourse and groundwater. The applicant should address any possible flotation issues if groundwater is high.*

   Response: Infiltration devices and attenuation systems located in the riparian corridor are located at levels above the watercourse and groundwater. Possible flotation issues should not therefore arise.

4. *The applicant has described in the Engineering Services report the interception and treatment provided. However, upon interrogation of the Proposed Storm Water Layout, it is unclear how some of the bioretention areas and bioswales are utilised for this purpose. There appear to be significant areas of hardstanding that do not pass through an interception or treatment measure prior to discharge to the attenuation systems. The applicant is required to clearly show what contributing areas are drained to each interception/treatment measure on a drawing together with an accompanying text and tabular submission, to demonstrate that the entire site is in compliance with GDSDS requirements. The applicant should note that over-provision in one location does not compensate for under provision elsewhere.*

   Response: We enclose drawing W012-CSC-ZZ-XX-DR-C-0023 Catchment Layout Plan showing the areas contributing to each interception treatment measure.

5. *The applicant has only provided 55% green roof coverage, which is not in line with DLR policy, and do not seem to have provided specific and substantial soft SuDS to directly intercept/treat standard roof run-off. It is acknowledged that the applicant has provided a general technical brochure for the green roof, however, specific*

detail regarding the proposed green roof build-up for this site is required. The applicant is required to demonstrate by calculation and by representation on a drawing that the proposed green roof extents are in accordance with the Council's Green Roof Policy such that the minimum coverage requirement of 60% is achieved. The applicant shall also provide details of maintenance access to the green roofs and should note that, in the absence of a stairwell type access to the roof, provision should be made for alternative maintenance and access arrangements such as external mobile access that will be centrally managed. A detailed cross section of the proposed build-up of the green roof should be provided, including dimensions. The applicant should comment on the compatibility of the green roof with PV panels if they are to be incorporated into the design.

Response: Please refer to Landscape drawing Ref 19038-LP-01-PP by Doyle O Troithigh showing the proportion of greenroof areas as a percentage of the total roof areas. The Total roof area is 3907m2 of which 2428m2 consists of greenroof or the equivalent of 62.1%.

6. *As standard, the applicant is required to provide a penstock in the flow control device chambers and ensure that the flow control devices provided do not have a bypass door. The applicant shall also clarify whether a silt trap is being provided in each flow control device chamber and if not to make provision for same.*

Response: We enclose drawing W012-CSC-ZZ-XX-DR-C-0017 Drainage Details sheet 3 of 3 showing details of silt trap for the flow control device.

7. *It is acknowledged that the applicant has submitted standard details for the bioretention areas and bioswales. However, they do not appear to have provided standard details for the permeable*

paving. The applicant is required to submit supporting standard details, including cross-sections and long-sections, and commentary that demonstrates that all proposed SuDS measures, including permeable paving, have been designed in accordance with the recommendations of CIRIA C753 (The SuDS manual). The applicant shall also ensure that sufficient width is available for the bioswale so that the required side gradient and base width can be provided, in accordance with CIRIA C753 (The ŞuDS manual).

Response: We enclose drawing W012-CSC-ZZ-XX-DR-C-0022 P1 SuDs Details showing standard SuDs details including details of proposed permeable paving.

8. *As standard, the applicant is required to provide fully dimensioned plans and sections of all attenuation storage systems. All relevant inlet and outlet levels, dimensioned clearances between other utilities, and actual depths of cover to the tank shall be provided. The applicant shall include confirmation from the chosen manufacturer of the storage systems that the specific models chosen, with the depth of cover being provided, has the required load bearing capacity to support the loading that may imposed upon it.*

   Response: We enclose drawing W012-CSC-ZZ-XX-DR-C-0030 P1 Attenuation Systems showing details of proposed attenuation tanks.

9. *As standard, the applicant is required to confirm that a utilities clash check has been carried out ensuring all utilities' vertical and horizontal separation distances can be provided throughout the scheme. The applicant should demonstrate this with cross sections at critical locations such as junctions, site thresholds and connection points to public utilities. Minimum separation distances shall be in accordance with applicable Codes of Practice.*

Response: We enclose Response: We enclose drawing W012-CSC-ZZ-XX-DR-C-0031 Surface Water Longsections and W012-CSC-ZZ-XX-DR-C-0025 Foul Longsections showing vertical and horizontal separation distances.

10. *The long sections of the surface water drainage system show sections where cover is less than industry standard, the applicant shall confirm if this is the case and detail how these runs will be protected if shallower depths cannot be avoided.*

Response: Where cover to surface water drainage system is less than industry standard, protection will be afforded to the pipes by means of encasing in concrete as shown in drawing W012-CSC-ZZ-XX-DR-C-0016 Drainage Details Sheet 2 of 3.

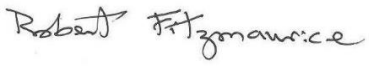
11. *There are significant inconsistencies between the SuDS Layout Plan and Proposed Storm Water Layout that the applicant is requested to rectify. The applicant should also ensure that there are no inconsistencies between engineering drawings and other disciplines drawings, including landscape and architectural drawings*

Response: Drawings have been co – ordinated.

12. *A Stormwater Audit will be required for this application. In accordance with the Stormwater Audit policy, 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.*

Response: refer to enclosed storm water audit. See **Appendix G**.

On behalf of Cronin & Sutton Consulting



Robert Fitzmaurice

Chartered Engineer

BEng(Hons), PG Dip EE, MIE, MIE.

Appendix A

Service Records

CS CONSULTING
GROUP

Irish Water Web Map

April 12, 2016

1:4,000

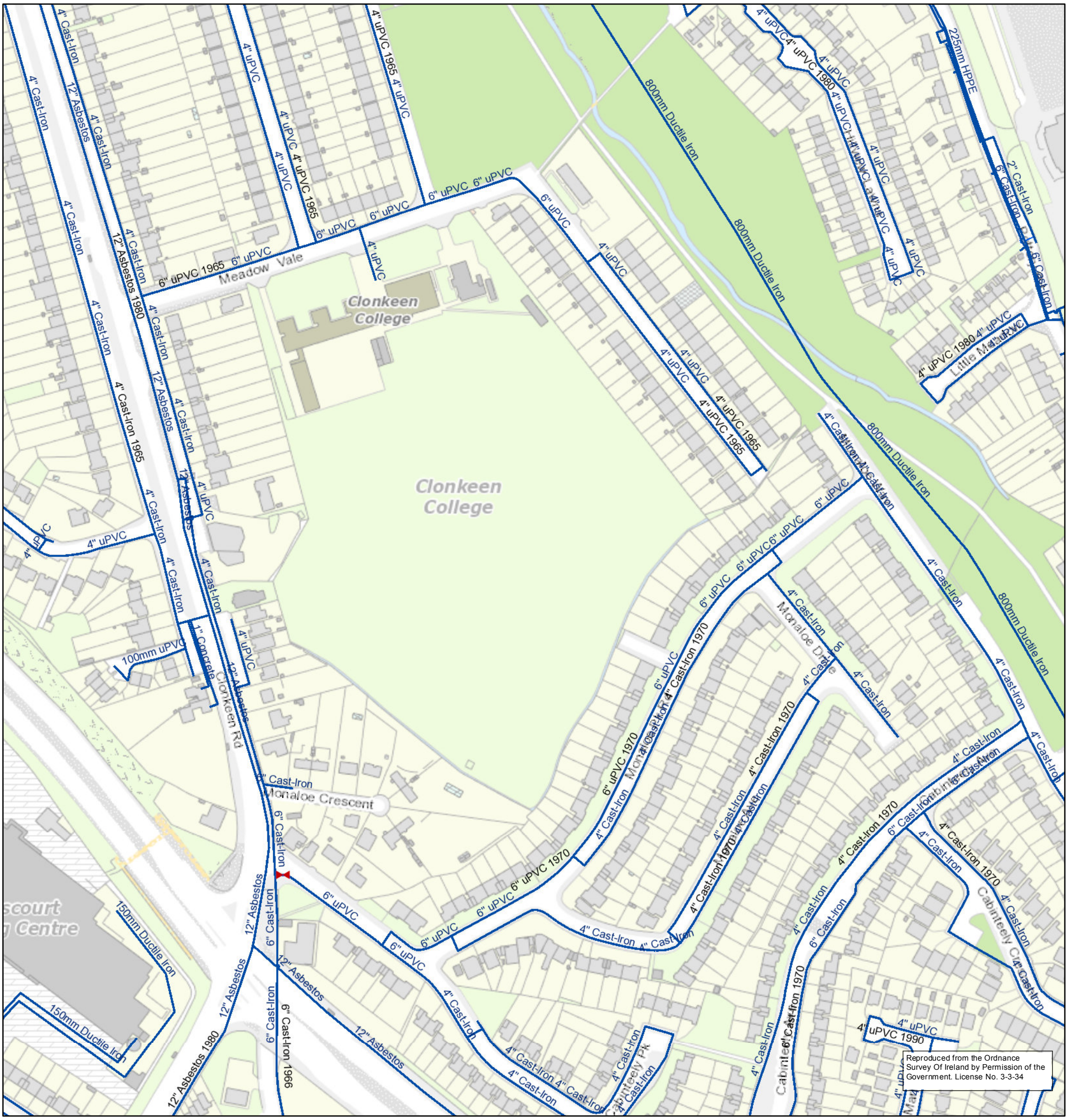
0 0.045 0.09 0.18 mi

0 0.05 0.1 0.2 km

Legend

Outfall	Gully	Foul
Overflow	Standard	Overflow
Soakaway	Other; Unknown	Unknown
Standard Outlet	Cascade	Combined
Other; Unknown	Catchpit	Foul
Rodding Eye	Hatchbox	Overflow
Flushing Structure	Lamphole	Unknown
Other; Unknown	Standard	Combined
Sewer Flow Control Valves	Other; Unknown	Foul
Treatment plant	Vent/Col	Overflow
Pump station	Other; Unknown	Unknown
Catchpit	Combined	

Irish Water Web Map



April 12, 2016

1:4,000

0 0.045 0.09 0.18 mi

0 0.05 0.1 0.2 km

Legend

- Non-return
- Hydro
- Orifice Plate
- PRV
- PSV
- Other
- Open
- Closed
- Part Closed
- District (Boundary Meter)
- Treatment Plant
- Potable
- Raw Water
- Pump Stations
- Untreated
- Potable Water
- Untreated
- Potable Water
- Irish Water
- Non IW
- Water Abandoned Lines
- Water Casings

UISCE ÉIREANN : IRISH WATER

Appendix B

Attenuation and Storm Water Design and Simulation Calculations

CS CONSULTING
GROUP

Project: Clonkeen Road-North Site
Project No.: W012
Calculation: Attenuation 100-year
Calcs By: RFM
Checked By:
Date: 20/10/20

CS CONSULTING GROUP
DUBLIN - LONDON - LIMERICK

Site Location:	Dublin		
Design Storm Return Period:	100 years		
Climate Change Factor:	20 %		
Soil Type:	3		
Total Site Area:	1.39 ha		
Positively Drained Area:	0.94 ha	.....@	100% Impervious
Softstand Area:	0.44 ha	.....@	0% Impervious
Effective Impermeable Area:	0.94 ha		

Allowable Outflow	**Calculate**	
IH124: QBAR = 0.00108 x $AREA^{0.89}$ x $SAAR^{1.17}$ x $SOIL^{2.17}$		
AREA:	0.01 km^2	
SAAR:	830 mm	
SOIL:	0.37	
QBAR/ha	3.51 l/s/ha	
Allowable Outflow	**3.3 l/s**	Smallest Allowable Discharge Rate (2l/s)

Storage required =	**770 m^3**	

Duration (min)	Rainfall 100-Year (mm)	Rainfall 100-Year with CCF (mm)	Intensity (mm/hr)	Discharge (Q = 2.71iA) (l/s)	Proposed Runoff (m^3)	Contiguous Land Runoff (m^3)	Total Runoff (m^3)	Allowable Outflow (m^3)	Storage Required (m^3)
5	14.4	17.3	207.4	530	159	0	159	1	158
10	20.1	24.1	144.7	370	222	0	222	2	220
15	23.6	28.3	113.3	289	261	0	261	3	258
30	29.2	35.0	70.1	179	322	0	322	6	316
60	36.1	43.3	43.3	111	399	0	399	12	387
120	44.7	53.6	26.8	69	493	0	493	24	470
180	50.6	60.7	20.2	52	559	0	559	36	523
240	55.3	66.4	16.6	42	611	0	611	48	563
360	51.0	61.2	10.2	26	563	0	563	71	492
540	70.8	85.0	9.4	24	782	0	782	107	674
720	77.3	92.8	7.7	20	853	0	853	143	711
1080	62.0	74.4	4.1	11	684	0	684	214	470
1440	95.6	114.7	4.8	12	1055	0	1055	286	770
2880	108.0	129.6	2.7	7	1192	0	1192	571	621
4320	118.3	142.0	2.0	5	1306	0	1306	857	449
5760	127.3	152.8	1.6	4	1405	0	1405	1143	263
8640	143.0	171.6	1.2	3	1579	0	1579	1714	-135
11520	156.7	188.0	1.0	3	1730	0	1730	2285	-555
14400	169.1	202.9	0.8	2	1867	0	1867	2857	-990
17280	180.6	216.7	0.8	2	1994	0	1994	3428	-1434
23040	201.5	241.8	0.6	2	2225	0	2225	4571	-2346
28800	220.5	264.6	0.6	1	2434	0	2434	5714	-3279
36000	242.3	290.8	0.5	1	2675	0	2675	7142	-4467

Project:	Clonkeen Road-South Site
Project No.:	W012
Calculation:	Attenuation 100-year
Calcs By:	RFM
Checked By:	
Date:	20/10/20

CS CONSULTING GROUP
DUBLIN - LONDON - LIMERICK

Site Location:	Dublin		
Design Storm Return Period:	100 years		
Climate Change Factor:	20 %		
Soil Type:	3		
Total Site Area:	1.92 ha		
Positively Drained Area:	1.205 ha	.....@	100% Impervious
Softstand Area:	0.72 ha	.....@	0% Impervious
Effective Impermeable Area:	1.21 ha		

Allowable Outflow	**Calculate**	
IH124: QBAR = 0.00108 x $AREA^{0.89}$ x $SAAR^{1.17}$ x $SOIL^{2.17}$		
AREA:	0.02 km^2	
SAAR:	830 mm	
SOIL:	0.37	
QBAR/ha	3.51 l/s/ha	
Allowable Outflow	**4.2 l/s**	Smallest Allowable Discharge Rate (2l/s)

Storage required =	**984 m^3**	

Duration (min)	Rainfall 100-Year (mm)	Rainfall 100-Year with CCF (mm)	Intensity (mm/hr)	Discharge (Q = 2.71iA) (l/s)	Proposed Runoff (m^3)	Contiguous Land Runoff (m^3)	Total Runoff (m^3)	Allowable Outflow (m^3)	Storage Required (m^3)
5	14.4	17.3	207.4	677	203	0	203	1	202
10	20.1	24.1	144.7	473	284	0	284	3	281
15	23.6	28.3	113.3	370	333	0	333	4	329
30	29.2	35.0	70.1	229	412	0	412	8	404
60	36.1	43.3	43.3	141	509	0	509	15	494
120	44.7	53.6	26.8	88	631	0	631	30	600
180	50.6	60.7	20.2	66	714	0	714	46	668
240	55.3	66.4	16.6	54	780	0	780	61	719
360	51.0	61.2	10.2	33	719	0	719	91	628
540	70.8	85.0	9.4	31	999	0	999	137	862
720	77.3	92.8	7.7	25	1090	0	1090	183	908
1080	62.0	74.4	4.1	13	875	0	875	274	601
1440	95.6	114.7	4.8	16	1349	0	1349	365	984
2880	108.0	129.6	2.7	9	1524	0	1524	730	793
4320	118.3	142.0	2.0	6	1669	0	1669	1095	574
5760	127.3	152.8	1.6	5	1796	0	1796	1460	336
8640	143.0	171.6	1.2	4	2017	0	2017	2190	-173
11520	156.7	188.0	1.0	3	2211	0	2211	2920	-710
14400	169.1	202.9	0.8	3	2386	0	2386	3651	-1265
17280	180.6	216.7	0.8	2	2548	0	2548	4381	-1833
23040	201.5	241.8	0.6	2	2843	0	2843	5841	-2998
28800	220.5	264.6	0.6	2	3111	0	3111	7301	-4190
36000	242.3	290.8	0.5	2	3418	0	3418	9126	-5708

Project: Clonkeen Road-(total site)
Project No.: W012
Calculation: Attenuation 100-year
Calcs By: RFM
Checked By:
Date: 20/10/20

CS CONSULTING GROUP
DUBLIN - LONDON - LIMERICK

Site Location:	Dublin		
Design Storm Return Period:	100 years		
Climate Change Factor:	20 %		
Soil Type:	3		
Total Site Area:	3.31 ha		
Positively Drained Area:	2.149 ha	.....@	100% Impervious
Softstand Area:	1.16 ha	.....@	0% Impervious
Effective Impermeable Area:	2.15 ha		

Allowable Outflow	**Calculate**	
IH124: QBAR = 0.00108 x $AREA^{0.89}$ x $SAAR^{1.17}$ x $SOIL^{2.17}$		
AREA:	0.03 km^2	
SAAR:	830 mm	
SOIL:	0.37	
QBAR/ha	3.51 l/s/ha	
Allowable Outflow	**7.5 l/s**	Smallest Allowable Discharge Rate (2l/s)

Storage required =	**1754 m^3**	

Duration (min)	Rainfall 100-Year (mm)	Rainfall 100-Year with CCF (mm)	Intensity (mm/hr)	Discharge (Q = 2.71iA) (l/s)	Proposed Runoff (m^3)	Contiguous Land Runoff (m^3)	Total Runoff (m^3)	Allowable Outflow (m^3)	Storage Required (m^3)
5	14.4	17.3	207.4	1208	362	0	362	2	360
10	20.1	24.1	144.7	843	506	0	506	5	501
15	23.6	28.3	113.3	660	594	0	594	7	587
30	29.2	35.0	70.1	408	735	0	735	14	721
60	36.1	43.3	43.3	252	908	0	908	27	881
120	44.7	53.6	26.8	156	1125	0	1125	54	1070
180	50.6	60.7	20.2	118	1273	0	1273	81	1192
240	55.3	66.4	16.6	97	1391	0	1391	109	1283
360	51.0	61.2	10.2	59	1283	0	1283	163	1120
540	70.8	85.0	9.4	55	1781	0	1781	244	1537
720	77.3	92.8	7.7	45	1945	0	1945	326	1619
1080	62.0	74.4	4.1	24	1560	0	1560	488	1072
1440	95.6	114.7	4.8	28	2405	0	2405	651	1754
2880	108.0	129.6	2.7	16	2717	0	2717	1302	1415
4320	118.3	142.0	2.0	11	2976	0	2976	1953	1023
5760	127.3	152.8	1.6	9	3203	0	3203	2604	599
8640	143.0	171.6	1.2	7	3598	0	3598	3906	-309
11520	156.7	188.0	1.0	6	3942	0	3942	5208	-1266
14400	169.1	202.9	0.8	5	4254	0	4254	6510	-2256
17280	180.6	216.7	0.8	4	4544	0	4544	7812	-3269
23040	201.5	241.8	0.6	4	5069	0	5069	10417	-5347
28800	220.5	264.6	0.6	3	5548	0	5548	13021	-7473
36000	242.3	290.8	0.5	3	6096	0	6096	16276	-10180

User Inputs

Chamber Model:	MC-3500
Outlet Control Structure:	No
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	49.00 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(6.80 m. x 9.50 m.)

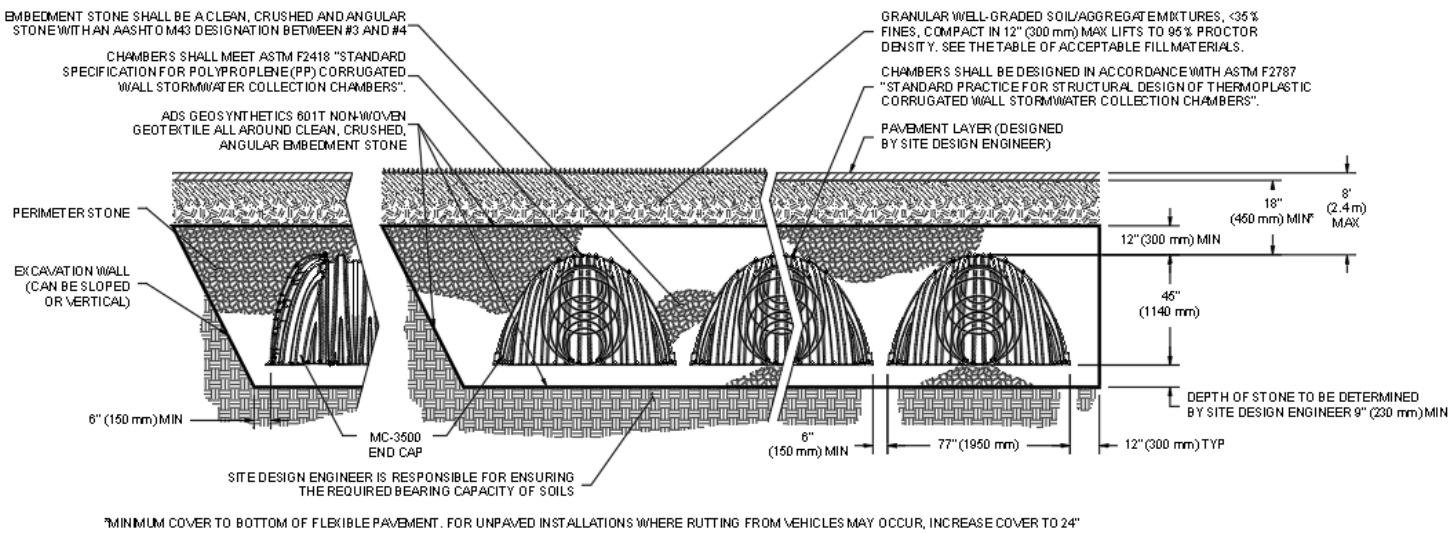
Results

System Volume and Bed Size

Installed Storage Volume:	56.59 cubic meters.
Storage Volume Per Chamber:	3.11 cubic meters.
Number of Chambers Required:	8
Number of End Caps Required:	6
Chamber Rows:	3
Maximum Length:	9.50 m.
Maximum Width:	6.78 m.
Approx. Bed Size Required:	59.85 square meters.

System Components

Amount Of Stone Required:	72.90 cubic meters
Volume of Excavation (Not Including Fill):	100.33 cubic meters
Total Non-woven Geotextile Required:	209.16 square meters
Woven Geotextile Required (excluding Isolator Row):	27.98 square meters
Woven Geotextile Required (Isolator Row):	24.63 square meters
Total Woven Geotextile Required:	52.61 square meters



User Inputs

Chamber Model:	MC-3500
Outlet Control Structure:	No
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	182.00 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(11.00 m. x 19.00 m.)

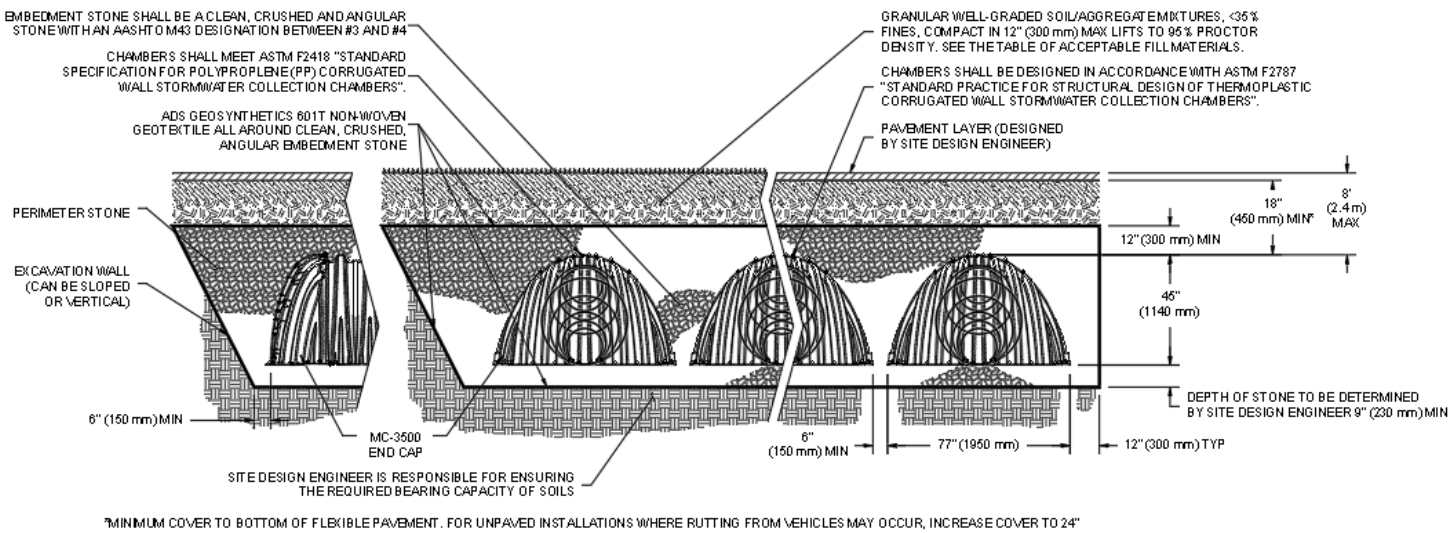
Results

System Volume and Bed Size

Installed Storage Volume:	190.09 cubic meters.
Storage Volume Per Chamber:	3.11 cubic meters.
Number of Chambers Required:	33
Number of End Caps Required:	10
Chamber Rows:	5
Maximum Length:	18.24 m.
Maximum Width:	11.00 m.
Approx. Bed Size Required:	187.81 square meters.

System Components

Amount Of Stone Required:	207.93 cubic meters
Volume of Excavation (Not Including Fill):	314.84 cubic meters
Total Non-woven Geotextile Required:	568.39 square meters
Woven Geotextile Required (excluding Isolator Row):	41.96 square meters
Woven Geotextile Required (Isolator Row):	52.59 square meters
Total Woven Geotextile Required:	94.56 square meters



User Inputs

Chamber Model:	MC-3500
Outlet Control Structure:	Yes
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	266.00 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	457 mm.
Design Constraint Dimensions:	(15.00 m. x 25.00 m.)

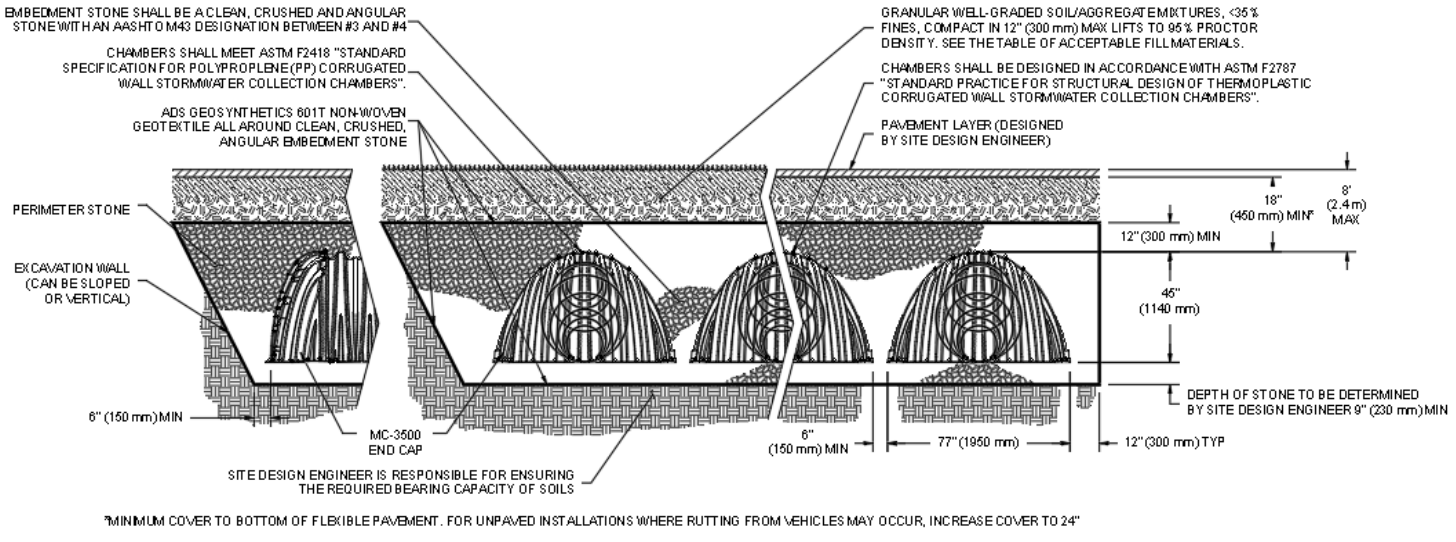
Results

System Volume and Bed Size

Installed Storage Volume:	277.03 cubic meters.
Storage Volume Per Chamber:	3.11 cubic meters.
Number of Chambers Required:	49
Number of End Caps Required:	10
Chamber Rows:	5
Maximum Length:	24.86 m.
Maximum Width:	11.18 m.
Approx. Bed Size Required:	272.91 square meters.

System Components

Amount Of Stone Required:	300.79 cubic meters
Volume of Excavation (Not Including Fill):	457.50 cubic meters
Total Non-woven Geotextile Required:	799.98 square meters
Woven Geotextile Required (excluding Isolator Row):	55.95 square meters
Woven Geotextile Required (Isolator Row):	73.57 square meters
Total Woven Geotextile Required:	129.52 square meters



User Inputs

Chamber Model:	MC-4500
Outlet Control Structure:	Yes
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	462.00 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	610 mm.
Design Constraint Dimensions:	(15.00 m. x 27.00 m.)

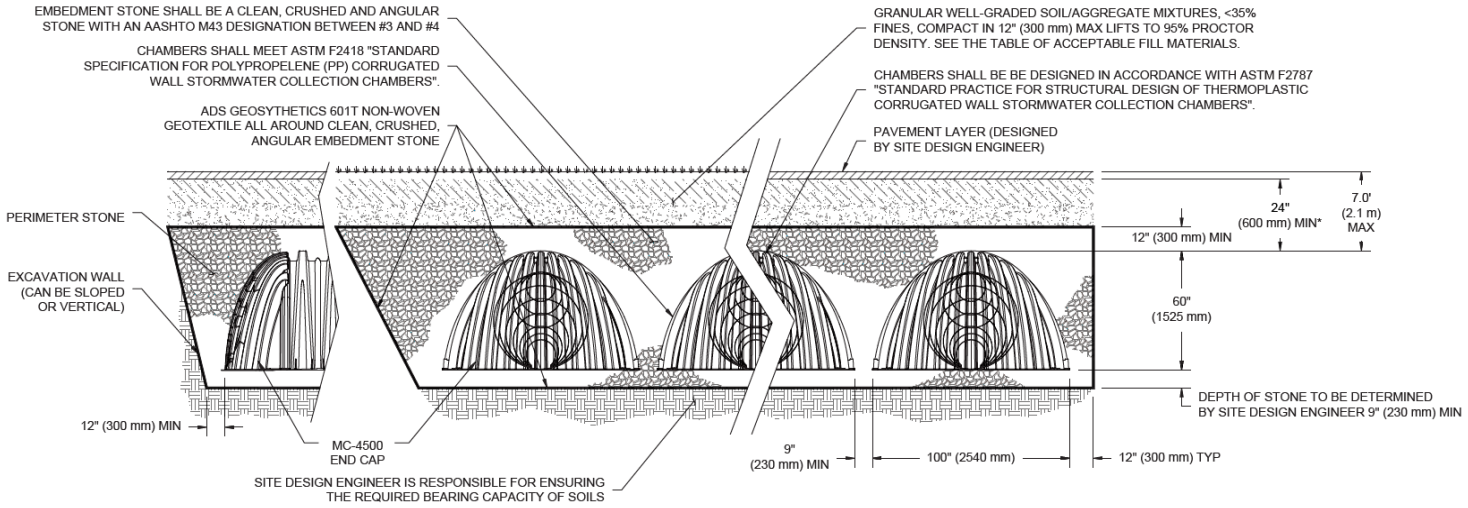
Results

System Volume and Bed Size

Installed Storage Volume:	483.49 cubic meters.
Storage Volume Per Chamber:	3.02 cubic meters.
Number of Chambers Required:	91
Number of End Caps Required:	10
Chamber Rows:	5
Maximum Length:	26.88 m.
Maximum Width:	14.41 m.
Approx. Bed Size Required:	379.27 square meters.

System Components

Amount Of Stone Required:	494.67 cubic meters
Volume of Excavation (Not Including Fill):	780.28 cubic meters
Total Non-woven Geotextile Required:	1120.15 square meters
Woven Geotextile Required (excluding Isolator Row):	71.01 square meters
Woven Geotextile Required (Isolator Row):	159.86 square meters
Total Woven Geotextile Required:	230.88 square meters



*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

User Inputs

Chamber Model:	MC-4500
Outlet Control Structure:	Yes
Project Name:	
Engineer:	N/A
Project Location:	
Measurement Type:	Metric
Required Storage Volume:	1270.00 cubic meters.
Stone Porosity:	40%
Stone Foundation Depth:	229 mm.
Stone Above Chambers:	305 mm.
Average Cover Over Chambers:	610 mm.
Design Constraint Dimensions:	(25.00 m. x 50.50 m.)

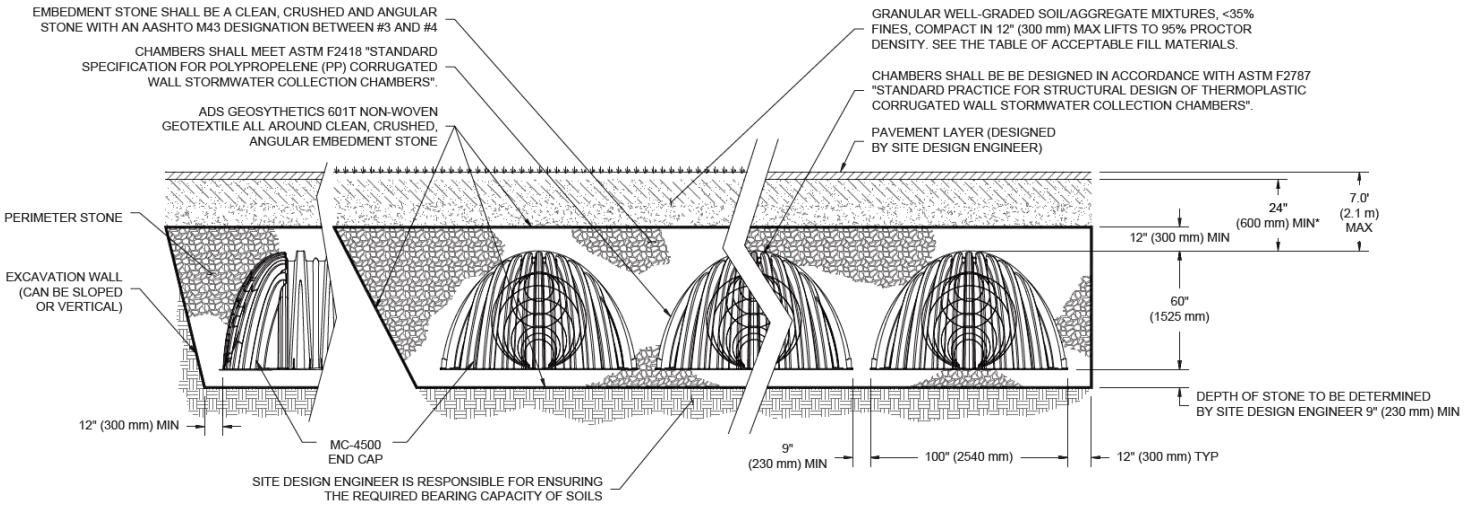
Results

System Volume and Bed Size

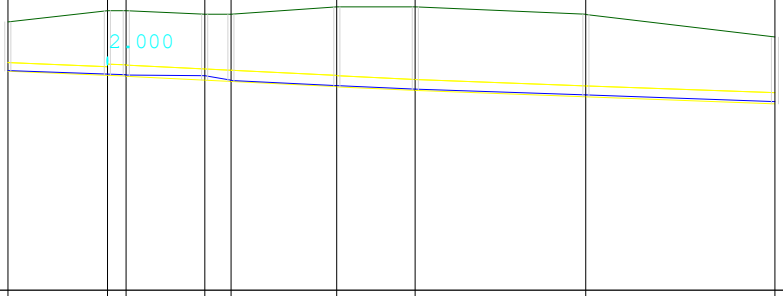
Installed Storage Volume:	1293.25 cubic meters.
Storage Volume Per Chamber:	3.02 cubic meters.
Number of Chambers Required:	261
Number of End Caps Required:	14
Chamber Rows:	7
Maximum Length:	50.30 m.
Maximum Width:	19.94 m.
Approx. Bed Size Required:	986.19 square meters.

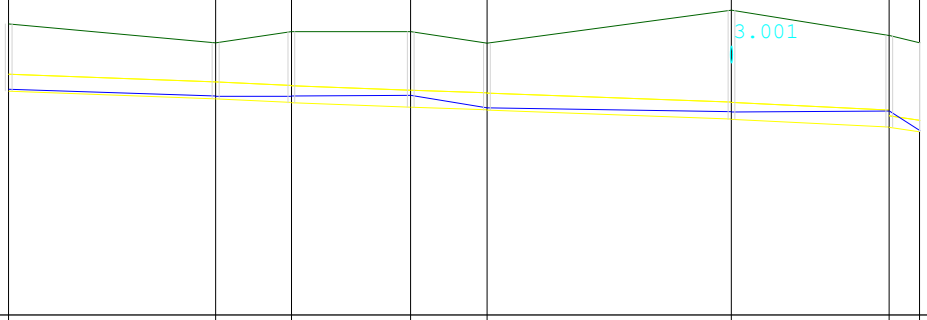
System Components

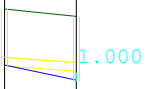
Amount Of Stone Required:	1226.19 cubic meters
Volume of Excavation (Not Including Fill):	2028.93 cubic meters
Total Non-woven Geotextile Required:	2719.74 square meters
Woven Geotextile Required (excluding Isolator Row):	88.77 square meters
Woven Geotextile Required (Isolator Row):	309.06 square meters
Total Woven Geotextile Required:	397.83 square meters

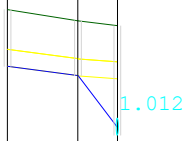


*MINIMUM COVER TO BOTTOM OF FLEXIBLE PAVEMENT. FOR UNPAVED INSTALLATIONS WHERE RUTTING FROM VEHICLES MAY OCCUR, INCREASE COVER TO 30" (750 mm).

MH Name		SS18				SS23		SS25	SS26	SS27
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000										
PN		S1.000				S1.004		S1.006	S1.007	
Dia (mm)		225				300		300	300	
Slope (1:X)		180.0				150.0		199.5	200.0	
Cover Level (m)		37.100		37.400		37.300	37.500	37.500	37.300	36.700
Invert Level (m)		35.800	35.690	35.665	35.561	35.526	35.386	35.386	35.282	35.282	35.112	35.112	34.925	
Length (m)		19.815				21.042		33.912	37.504	

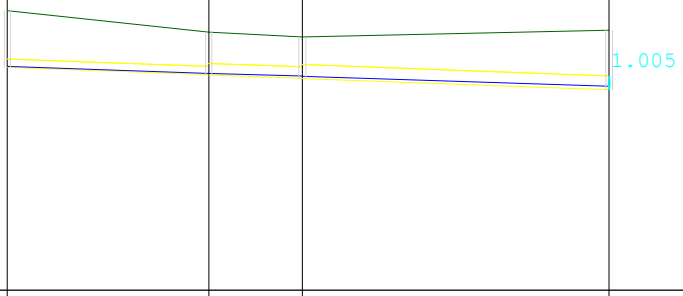
MH Name		SS27			SS29		SS31	SS34		SS36
Hor Scale 1500 Ver Scale 200 Datum (m) 29.000										
PN		S1.008			S1.010		S1.012	S1.013		
Dia (mm)		450			450		450	450		
Slope (1:X)		199.6			200.0		199.8	150.0		
Cover Level (m)		36.700		36.200	36.500	36.500	36.190	37.070	36.400	36.200
Invert Level (m)		34.925	34.719	34.719	34.618	34.500	34.424	34.424	34.181	34.181	33.972	33.972		
Length (m)		41.127			23.722		48.556	31.349		

MH Name			SS20
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000			
PN			
Dia (mm)			
Slope (1:X)			
Cover Level (m)		37.600	37.400
Invert Level (m)		36.100	35.958
Length (m)			

MH Name				SS34
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000				
PN				
Dia (mm)				
Slope (1:X)				
Cover Level (m)		37.500	37.200	37.070
Invert Level (m)		36.000	35.750	35.750
Length (m)				

MH Name				SS3		SS5	SS6		SS11			SS14
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000												
PN				S1.002		S1.004	S1.005		S1.007			
Dia (mm)				300		375	375		450			
Slope (1:X)				200.3		300.0	290.0		260.0			
Cover Level (m)		37.200	37.130	37.200	37.430	37.300	37.100	36.880	36.600		36.600	36.600
Invert Level (m)		35.870	35.809	35.747 / 35.562	35.562 / 35.492	35.492 / 35.426	35.426 / 35.299	35.299	35.269 / 35.172		35.160 / 35.106	
Length (m)				37.051		19.769	36.791		25.081			

MH Name				SS16		SS18
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000						
PN				S1.012		
Dia (mm)				525		
Slope (1:X)				300.0		
Cover Level (m)		36.600	36.600	36.600	36.600	36.600
Invert Level (m)		35.106	35.091 / 35.051	35.051 / 34.951	34.951	
Length (m)				30.018		

MH Name		SS7	SS8	SS9	SS10
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000					
PN		S2.000	S2.001	S2.002	
Dia (mm)		225	300	375	
Slope (1:X)		200.0	200.1	197.8	
Cover Level (m)		37.400	36.830	36.700	36.880
Invert Level (m)		35.900 35.700	35.700 35.607	35.607 35.299	
Length (m)		39.970	18.609	60.918	

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)	16.000	Add Flow / Climate Change (%)	20
Ratio R	0.272	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	500	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	300	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 Inverts

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.241	4-8	0.541	8-12	0.068

Total Area Contributing (ha) = 0.850

Total Pipe Volume (m³) = 36.596

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	19.716	0.110	179.4	0.061	2.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	14.247	0.143	99.9	0.009	2.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	3.681	0.030	123.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	15.671	0.090	175.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	5.112	0.051	100.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	21.109	0.120	176.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.005	15.553	0.100	155.5	0.007	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.006	33.882	0.100	340.0	0.111	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	60.27	2.34	35.800	0.061	0.0	0.0	2.7	0.97	38.7	15.9
S2.000	61.27	2.18	36.100	0.009	0.0	0.0	0.4	1.31	52.0	2.4
S1.001	59.95	2.39	35.690	0.070	0.0	0.0	3.0	1.18	46.8	18.2
S1.002	58.36	2.65	35.660	0.070	0.0	0.0	3.0	0.99	39.2	18.2
S1.003	57.99	2.72	35.571	0.070	0.0	0.0	3.0	1.31	51.9	18.2
S1.004	56.04	3.08	35.520	0.070	0.0	0.0	3.0	0.98	39.1	18.2
S1.005	54.78	3.33	35.400	0.077	0.0	0.0	3.0	1.05	41.6	18.3
S1.006	51.72	3.99	35.300	0.188	0.0	0.0	7.0	0.85	59.9	42.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.007	37.529	0.110	341.5	0.171	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.008	35.916	0.106	340.0	0.151	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.009	20.989	0.052	400.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.010	19.887	0.020	1000.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
S1.011	16.350	0.055	297.3	0.010	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.012	18.342	0.092	199.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.013	23.737	0.091	262.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.014	4.240	0.050	84.8	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.015	46.972	0.391	120.0	0.308	0.00	0.0	0.600	o	375	Pipe/Conduit	
S3.000	11.329	0.114	99.8	0.022	2.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	10.341	0.103	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.016	25.884	0.026	995.5	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.017	11.662	0.343	34.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.007	49.15	4.63	35.200	0.359	0.0	0.0	12.7	0.97	107.7	76.5
S1.008	46.98	5.25	35.090	0.510	0.0	0.0	17.3	0.98	107.9	103.8
S1.009	45.86	5.59	34.985	0.510	0.0	0.0	17.3	1.01	160.7	103.8
S1.010	44.42	6.07	34.932	0.510	0.0	0.0	17.3	0.70	151.5	103.8
S1.011	43.40	6.43	34.912	0.520	0.0	0.0	17.3	0.75	29.9«	103.8
S1.012	42.51	6.76	34.857	0.520	0.0	0.0	17.3	0.92	36.7«	103.8
S1.013	41.61	7.12	34.765	0.520	0.0	0.0	17.3	1.11	123.1	103.8
S1.014	41.53	7.15	34.674	0.520	0.0	0.0	17.3	1.97	217.4	103.8
S1.015	40.40	7.62	34.567	0.828	0.0	0.0	24.2	1.65	182.6	145.0
S3.000	61.52	2.14	35.000	0.022	0.0	0.0	1.0	1.31	52.0	5.9
S3.001	60.66	2.28	34.886	0.022	0.0	0.0	1.0	1.31	52.0	5.9
S1.016	38.75	8.39	34.176	0.850	0.0	0.0	24.2	0.57	62.5«	145.0
S1.017	38.62	8.45	34.150	0.850	0.0	0.0	24.2	3.12	344.2	145.0

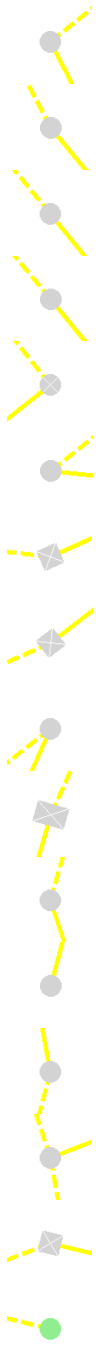
Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S17	37.100	1.300	Open Manhole	1200	S1.000	35.800	225				
S18	37.600	1.500	Open Manhole	1200	S2.000	36.100	225				
S19	37.400	1.710	Open Manhole	1200	S1.001	35.690	225	S1.000	35.690	225	
								S2.000	35.957	225	267
S20	37.400	1.740	Open Manhole	1200	S1.002	35.660	225	S1.001	35.660	225	
S21	37.300	1.729	Sealed Manhole	1800 x 1800	S1.003	35.571	225	S1.002	35.571	225	
S22	37.300	1.780	Open Manhole	1200	S1.004	35.520	225	S1.003	35.520	225	
S23	37.500	2.100	Open Manhole	1200	S1.005	35.400	225	S1.004	35.400	225	
S24	37.650	2.350	Open Manhole	1200	S1.006	35.300	300	S1.005	35.300	225	
S25	37.210	2.010	Open Manhole	1350	S1.007	35.200	375	S1.006	35.200	300	
S26	36.760	1.670	Open Manhole	1350	S1.008	35.090	375	S1.007	35.090	375	
S27	36.260	1.275	Sealed Manhole	1500	S1.009	34.985	450	S1.008	34.985	375	
S28	36.400	1.468	Open Manhole	1500	S1.010	34.932	525	S1.009	34.932	450	
S29	36.100	1.188	Sealed Manhole	2400 x 2400	S1.011	34.912	225	S1.010	34.912	525	
S30	36.100	1.243	Sealed Manhole	2400 x 2400	S1.012	34.857	225	S1.011	34.857	225	
S31	36.500	1.735	Open Manhole	1350	S1.013	34.765	375	S1.012	34.765	225	
S32	36.500	1.826	Sealed Manhole	2400 x 3000	S1.014	34.674	375	S1.013	34.674	375	
S33	36.190	1.623	Open Manhole	1350	S1.015	34.567	375	S1.014	34.624	375	57
S34	36.470	1.470	Open Manhole	1200	S3.000	35.000	225				
S35	36.580	1.694	Open Manhole	1200	S3.001	34.886	225	S3.000	34.886	225	
S36	36.650	2.474	Open Manhole	1350	S1.016	34.176	375	S1.015	34.176	375	
								S3.001	34.783	225	457
S37	36.700	2.550	Sealed Manhole	2400 x 2400	S1.017	34.150	375	S1.016	34.150	375	
SS38	35.500	1.693	Open Manhole	1500		OUTFALL		S1.017	33.807	375	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S17	722958.026	726028.646	722958.026	726028.646	Required	
S18	722965.936	725995.623	722965.936	725995.623	Required	
S19	722962.333	726009.407	722962.333	726009.407	Required	
S20	722965.862	726010.453	722965.862	726010.453	Required	
S21	722978.649	726019.513			No Entry	
S22	722981.739	726015.440	722981.739	726015.440	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S23	722965.190	726002.337	722965.190	726002.337	Required	
S24	722972.416	725988.564	722972.416	725988.564	Required	
S25	722994.039	725962.478	722994.039	725962.478	Required	
S26	723017.897	725933.510	723017.897	725933.510	Required	
S27	723040.398	725905.515			No Entry	
S28	723023.897	725892.543	723023.897	725892.543	Required	
S29	723043.658	725890.300			No Entry	
S30	723058.611	725896.911			No Entry	
S31	723073.107	725908.149	723073.107	725908.149	Required	
S32	723063.414	725886.482			No Entry	
S33	723062.241	725882.407	723062.241	725882.407	Required	
S34	723076.042	725816.717	723076.042	725816.717	Required	
S35	723078.948	725827.667	723078.948	725827.667	Required	
S36	723077.057	725837.833	723077.057	725837.833	Required	
S37	723101.234	725847.078			No Entry	
SS38	723112.578	725844.369			No Entry	



PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S17	37.100	35.800	1.075	Open Manhole	1200
S2.000	o	225	S18	37.600	36.100	1.275	Open Manhole	1200
S1.001	o	225	S19	37.400	35.690	1.485	Open Manhole	1200
S1.002	o	225	S20	37.400	35.660	1.515	Open Manhole	1200
S1.003	o	225	S21	37.300	35.571	1.504	Sealed Manhole	1800 x 1800
S1.004	o	225	S22	37.300	35.520	1.555	Open Manhole	1200
S1.005	o	225	S23	37.500	35.400	1.875	Open Manhole	1200
S1.006	o	300	S24	37.650	35.300	2.050	Open Manhole	1200
S1.007	o	375	S25	37.210	35.200	1.635	Open Manhole	1350
S1.008	o	375	S26	36.760	35.090	1.295	Open Manhole	1350
S1.009	o	450	S27	36.260	34.985	0.825	Sealed Manhole	1500
S1.010	o	525	S28	36.400	34.932	0.943	Open Manhole	1500
S1.011	o	225	S29	36.100	34.912	0.963	Sealed Manhole	2400 x 2400
S1.012	o	225	S30	36.100	34.857	1.018	Sealed Manhole	2400 x 2400
S1.013	o	375	S31	36.500	34.765	1.360	Open Manhole	1350
S1.014	o	375	S32	36.500	34.674	1.451	Sealed Manhole	2400 x 3000
S1.015	o	375	S33	36.190	34.567	1.248	Open Manhole	1350
S3.000	o	225	S34	36.470	35.000	1.245	Open Manhole	1200
S3.001	o	225	S35	36.580	34.886	1.469	Open Manhole	1200
S1.016	o	375	S36	36.650	34.176	2.099	Open Manhole	1350
S1.017	o	375	S37	36.700	34.150	2.175	Sealed Manhole	2400 x 2400

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	19.716	179.4	S19	37.400	35.690	1.485	Open Manhole	1200
S2.000	14.247	99.9	S19	37.400	35.957	1.218	Open Manhole	1200
S1.001	3.681	123.0	S20	37.400	35.660	1.515	Open Manhole	1200
S1.002	15.671	175.0	S21	37.300	35.571	1.504	Sealed Manhole	1800 x 1800
S1.003	5.112	100.2	S22	37.300	35.520	1.555	Open Manhole	1200
S1.004	21.109	176.0	S23	37.500	35.400	1.875	Open Manhole	1200
S1.005	15.553	155.5	S24	37.650	35.300	2.125	Open Manhole	1200
S1.006	33.882	340.0	S25	37.210	35.200	1.710	Open Manhole	1350
S1.007	37.529	341.5	S26	36.760	35.090	1.295	Open Manhole	1350
S1.008	35.916	340.0	S27	36.260	34.985	0.900	Sealed Manhole	1500
S1.009	20.989	400.0	S28	36.400	34.932	1.018	Open Manhole	1500
S1.010	19.887	1000.0	S29	36.100	34.912	0.663	Sealed Manhole	2400 x 2400
S1.011	16.350	297.3	S30	36.100	34.857	1.018	Sealed Manhole	2400 x 2400
S1.012	18.342	199.4	S31	36.500	34.765	1.510	Open Manhole	1350
S1.013	23.737	262.0	S32	36.500	34.674	1.451	Sealed Manhole	2400 x 3000
S1.014	4.240	84.8	S33	36.190	34.624	1.191	Open Manhole	1350
S1.015	46.972	120.0	S36	36.650	34.176	2.099	Open Manhole	1350
S3.000	11.329	99.8	S35	36.580	34.886	1.469	Open Manhole	1200
S3.001	10.341	100.0	S36	36.650	34.783	1.642	Open Manhole	1350
S1.016	25.884	995.5	S37	36.700	34.150	2.175	Sealed Manhole	2400 x 2400
S1.017	11.662	34.0	SS38	35.500	33.807	1.318	Open Manhole	1500

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.061	0.061	0.061
2.000	-	-	100	0.009	0.009	0.009
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.007	0.007	0.007
1.006	-	-	100	0.111	0.111	0.111
1.007	-	-	100	0.171	0.171	0.171
1.008	-	-	100	0.151	0.151	0.151
1.009	-	-	100	0.000	0.000	0.000
1.010	-	-	100	0.000	0.000	0.000
1.011	-	-	100	0.010	0.010	0.010
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.000	0.000	0.000
1.014	-	-	100	0.000	0.000	0.000
1.015	-	-	100	0.308	0.308	0.308
3.000	-	-	100	0.022	0.022	0.022
3.001	-	-	100	0.000	0.000	0.000
1.016	-	-	100	0.000	0.000	0.000
1.017	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.850	0.850	0.850

Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
S1.000	S17	225	1.075	1.485	Unclassified	1200	0	1.075	Unclassified
S2.000	S18	225	1.218	1.275	Unclassified	1200	0	1.275	Unclassified
S1.001	S19	225	1.485	1.515	Unclassified	1200	0	1.485	Unclassified
S1.002	S20	225	1.504	1.515	Unclassified	1200	0	1.515	Unclassified
S1.003	S21	225	1.504	1.555	Unclassified	1800	1800	1.504	Unclassified
S1.004	S22	225	1.555	1.875	Unclassified	1200	0	1.555	Unclassified
S1.005	S23	225	1.875	2.125	Unclassified	1200	0	1.875	Unclassified
S1.006	S24	300	1.710	2.050	Unclassified	1200	0	2.050	Unclassified
S1.007	S25	375	1.295	1.635	Unclassified	1350	0	1.635	Unclassified
S1.008	S26	375	0.900	1.295	Unclassified	1350	0	1.295	Unclassified
S1.009	S27	450	0.825	1.018	Unclassified	1500	0	0.825	Unclassified
S1.010	S28	525	0.663	0.943	Unclassified	1500	0	0.943	Unclassified
S1.011	S29	225	0.963	1.018	Unclassified	2400	2400	0.963	Unclassified
S1.012	S30	225	1.018	1.510	Unclassified	2400	2400	1.018	Unclassified
S1.013	S31	375	1.360	1.451	Unclassified	1350	0	1.360	Unclassified
S1.014	S32	375	1.191	1.451	Unclassified	2400	3000	1.451	Unclassified
S1.015	S33	375	1.248	2.099	Unclassified	1350	0	1.248	Unclassified
S3.000	S34	225	1.245	1.469	Unclassified	1200	0	1.245	Unclassified
S3.001	S35	225	1.469	1.642	Unclassified	1200	0	1.469	Unclassified
S1.016	S36	375	2.099	2.175	Unclassified	1350	0	2.099	Unclassified
S1.017	S37	375	1.318	2.175	Unclassified	2400	2400	2.175	Unclassified

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)
S1.017	SS38	35.500	33.807	33.100	1500	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	1.000	Additional Flow - % of Total Flow	20.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 3 Number of Storage Structures 4 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) 0.840
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.272		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S21, DS/PN: S1.003, Volume (m³): 6.2

Unit Reference	MD-SHE-0076-2000-0400-2000
Design Head (m)	0.400
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	76
Invert Level (m)	35.571
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	2.0	Kick-Flo®	0.286	1.7
Flush-Flo™	0.124	2.0	Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.0	0.800	2.7	2.000	4.2	4.000	5.8	7.000	7.6
0.200	1.9	1.000	3.0	2.200	4.4	4.500	6.1	7.500	7.9
0.300	1.8	1.200	3.3	2.400	4.6	5.000	6.5	8.000	8.2
0.400	2.0	1.400	3.5	2.600	4.7	5.500	6.8	8.500	8.4
0.500	2.2	1.600	3.8	3.000	5.1	6.000	7.1	9.000	8.7
0.600	2.4	1.800	4.0	3.500	5.4	6.500	7.4	9.500	8.9

Hydro-Brake® Optimum Manhole: S32, DS/PN: S1.014, Volume (m³): 15.6

Unit Reference	MD-SHE-0112-6000-1200-6000
Design Head (m)	1.200
Design Flow (l/s)	6.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	112
Invert Level (m)	34.674
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	6.0	Kick-Flo®	0.754	4.8
Flush-Flo™	0.357	6.0	Mean Flow over Head Range	-	5.2

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	0.400	6.0	0.800	5.0	1.400	6.4	2.000	7.6
0.200	5.7	0.500	5.9	1.000	5.5	1.600	6.8	2.200	7.9
0.300	5.9	0.600	5.7	1.200	6.0	1.800	7.2	2.400	8.3

Hydro-Brake® Optimum Manhole: S32, DS/PN: S1.014, Volume (m³): 15.6

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
2.600	8.6	4.000	10.5	5.500	12.3	7.000	13.8	8.500	15.1
3.000	9.2	4.500	11.1	6.000	12.8	7.500	14.2	9.000	15.5
3.500	9.9	5.000	11.7	6.500	13.3	8.000	14.7	9.500	15.9

Hydro-Brake® Optimum Manhole: S37, DS/PN: S1.017, Volume (m³): 17.3

Unit Reference	MD-SHE-0076-3000-1450-3000
Design Head (m)	1.450
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	76
Invert Level (m)	34.150
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.450	3.0	Kick-Flo®	0.679	2.1
Flush-Flo™	0.333	2.6	Mean Flow over Head Range	-	2.4

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

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

Storage Structures for Storm

Tank or Pond Manhole: S20, DS/PN: S1.002

Invert Level (m) 35.660

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	56.3	0.780	56.3

Tank or Pond Manhole: S28, DS/PN: S1.010

Invert Level (m) 34.932

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	190.0	1.000	190.0

Tank or Pond Manhole: S31, DS/PN: S1.013

Invert Level (m) 34.765

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	277.0	1.000	277.0

Tank or Pond Manhole: S36, DS/PN: S1.016

Invert Level (m) 34.176

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	284.0	1.700	284.0

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	20.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 3 Number of Storage Structures 4 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm) 16.000	Cv (Summer) 0.750
Region	Scotland and Ireland	Ratio R 0.272	Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 50.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 180, 360, 720, 1440, 2880
Return Period(s) (years)	1, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S1.000	S17	15 Summer	100	+20%	100/15 Summer				36.077	0.052
S2.000	S18	15 Summer	100	+20%					36.152	-0.173
S1.001	S19	180 Winter	100	+20%	100/15 Summer				35.995	0.080
S1.002	S20	180 Winter	100	+20%	30/60 Winter				35.994	0.108
S1.003	S21	180 Winter	100	+20%	30/15 Winter				35.990	0.194
S1.004	S22	15 Winter	100	+20%	100/15 Summer				35.990	0.245
S1.005	S23	15 Winter	100	+20%	30/15 Summer				35.999	0.374
S1.006	S24	15 Winter	100	+20%	30/15 Summer				35.999	0.399
S1.007	S25	15 Winter	100	+20%	30/15 Summer				35.941	0.366
S1.008	S26	15 Winter	100	+20%	30/15 Summer				35.790	0.325
S1.009	S27	2880 Winter	100	+20%	100/15 Summer				35.508	0.073
S1.010	S28	2880 Winter	100	+20%	100/2880 Winter				35.507	0.049
S1.011	S29	2880 Winter	100	+20%	30/15 Winter				35.652	0.515
S1.012	S30	2880 Winter	100	+20%	30/30 Summer				35.535	0.453
S1.013	S31	2880 Winter	100	+20%	30/180 Winter				35.494	0.354
S1.014	S32	2880 Winter	100	+20%	1/1440 Winter				35.938	0.888
S1.015	S33	2880 Winter	100	+20%	1/1440 Summer				35.629	0.687
S3.000	S34	2880 Winter	100	+20%	30/1440 Summer				35.636	0.411
S3.001	S35	2880 Winter	100	+20%	30/720 Winter				35.635	0.524
S1.016	S36	2880 Winter	100	+20%	1/360 Summer				35.637	1.086
S1.017	S37	1440 Winter	100	+20%	1/180 Winter				35.499	0.974

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S17	0.000	0.98			34.1	SURCHARGED	
S2.000	S18	0.000	0.12			5.4	OK	
S1.001	S19	0.000	0.28			8.4	SURCHARGED	
S1.002	S20	0.000	0.07			2.4	SURCHARGED	
S1.003	S21	0.000	0.06			2.0	SURCHARGED*	
S1.004	S22	0.000	0.13			4.6	SURCHARGED	

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

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.005	S23	0.000	0.35			12.8	SURCHARGED	
S1.006	S24	0.000	0.78			43.1	SURCHARGED	
S1.007	S25	0.000	1.14			110.9	SURCHARGED	
S1.008	S26	0.000	1.74			168.9	SURCHARGED	
S1.009	S27	0.000	0.07			9.2	SURCHARGED*	
S1.010	S28	0.000	0.11			8.3	SURCHARGED	
S1.011	S29	0.000	0.32			8.4	SURCHARGED*	
S1.012	S30	0.000	0.25			8.3	SURCHARGED*	
S1.013	S31	0.000	0.06			6.2	SURCHARGED	
S1.014	S32	0.000	0.05			5.4	SURCHARGED*	
S1.015	S33	0.000	0.06			9.7	SURCHARGED	
S3.000	S34	0.000	0.01			0.4	SURCHARGED	
S3.001	S35	0.000	0.01			0.4	SURCHARGED	
S1.016	S36	0.000	0.19			7.3	SURCHARGED	
S1.017	S37	0.000	0.01			2.7	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)	16.000	Add Flow / Climate Change (%)	20
Ratio R	0.272	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	500	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	300	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 Inverts

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.886	4-8	0.397

Total Area Contributing (ha) = 1.283

Total Pipe Volume (m³) = 42.460

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	9.017	0.060	150.3	0.093	2.00	0.0	0.600	o	300	Pipe/Conduit	
S1.001	9.432	0.063	149.7	0.013	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	37.062	0.185	200.3	0.075	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.003	13.964	0.070	199.5	0.028	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.004	18.073	0.090	200.8	0.024	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.005	38.763	0.194	199.8	0.270	0.00	0.0	0.600	o	375	Pipe/Conduit	
S2.000	48.607	0.324	150.0	0.168	2.00	0.0	0.600	o	300	Pipe/Conduit	
S2.001	5.653	0.038	148.8	0.018	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.006	13.639	0.068	200.6	0.139	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)
S1.000	61.70	2.12	35.550	0.093	0.0	0.0	4.1	1.28	90.5	24.9
S1.001	60.89	2.24	35.490	0.106	0.0	0.0	4.7	1.28	90.7	28.0
S1.002	57.55	2.80	35.427	0.181	0.0	0.0	7.5	1.11	78.3	45.1
S1.003	56.56	2.98	35.242	0.209	0.0	0.0	8.5	1.28	141.3	51.2
S1.004	55.33	3.22	35.172	0.233	0.0	0.0	9.3	1.27	140.8	55.9
S1.005	52.91	3.72	35.081	0.503	0.0	0.0	19.2	1.28	141.2	115.3
S2.000	58.49	2.63	35.400	0.168	0.0	0.0	7.1	1.28	90.6	42.6
S2.001	58.07	2.71	35.076	0.186	0.0	0.0	7.8	1.29	91.0	46.8
S1.006	52.21	3.88	34.887	0.828	0.0	0.0	31.2	1.43	227.7	187.3

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
S3.000	38.115	0.127	300.1	0.147	2.00	0.0	0.600	o	300	Pipe/Conduit	
S3.001	17.117	0.057	300.3	0.136	0.00	0.0	0.600	o	375	Pipe/Conduit	
S3.002	49.935	0.166	300.8	0.172	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.007	8.743	0.058	150.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
S1.008	42.462	0.160	265.4	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
S1.009	16.293	0.133	122.5	0.000	0.00	0.0	0.600	o	525	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)
S3.000	58.08	2.70	35.254	0.147	0.0	0.0	6.2	0.90	63.8	37.0
S3.001	56.57	2.98	35.127	0.283	0.0	0.0	11.6	1.04	114.9	69.4
S3.002	52.66	3.78	35.070	0.455	0.0	0.0	17.3	1.04	114.8	103.8
S1.007	51.86	3.96	34.819	1.283	0.0	0.0	48.1	1.83	395.4	288.3
S1.008	49.76	4.48	34.761	1.283	0.0	0.0	48.1	1.37	296.6	288.3
S1.009	49.24	4.61	34.753	1.283	0.0	0.0	48.1	2.02	437.9	288.3

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	37.100	1.550	Open Manhole	1200	S1.000	35.550	300				
S2	37.120	1.630	Open Manhole	1200	S1.001	35.490	300	S1.000	35.490	300	
S3	37.200	1.773	Open Manhole	1200	S1.002	35.427	300	S1.001	35.427	300	
S4	37.480	2.238	Open Manhole	1350	S1.003	35.242	375	S1.002	35.242	300	
S5	37.320	2.148	Open Manhole	1350	S1.004	35.172	375	S1.003	35.172	375	
S6	37.140	2.059	Open Manhole	1350	S1.005	35.081	375	S1.004	35.082	375	1
S7	36.600	1.200	Open Manhole	1200	S2.000	35.400	300				
S8	36.650	1.574	Open Manhole	1200	S2.001	35.076	300	S2.000	35.076	300	
S9	36.860	1.973	Open Manhole	1350	S1.006	34.887	450	S1.005	34.887	375	
								S2.001	35.038	300	1
S10	36.600	1.346	Sealed Manhole	1350	S3.000	35.254	300				
S11	36.830	1.703	Open Manhole	1350	S3.001	35.127	375	S3.000	35.127	300	
S12	37.030	1.960	Open Manhole	1350	S3.002	35.070	375	S3.001	35.070	375	
S13	37.000	2.181	Open Manhole	1500	S1.007	34.819	525	S1.006	34.819	450	
								S3.002	34.904	375	
S14	36.500	1.739	Sealed Manhole	1800 x 1800	S1.008	34.761	525	S1.007	34.761	525	
S15	36.800	2.199	Sealed Manhole	3600 x 3000	S1.009	34.753	525	S1.008	34.601	525	
S16	35.500	0.880	Open Manhole	1350		OUTFALL		S1.009	34.620	525	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	722879.419	725769.364	722879.419	725769.364	Required	
S2	722887.940	725772.312	722887.940	725772.312	Required	
S3	722891.821	725763.715	722891.821	725763.715	Required	
S4	722921.432	725741.426	722921.432	725741.426	Required	
S5	722932.598	725733.040	722932.598	725733.040	Required	
S6	722948.867	725725.168	722948.867	725725.168	Required	
S7	723029.304	725707.381	723029.304	725707.381	Required	
S8	722987.418	725732.044	722987.418	725732.044	Required	
S9	722985.646	725737.412	722985.646	725737.412	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S10	723071.522	725805.638			No Entry	
S11	723056.656	725770.541	723056.656	725770.541	Required	
S12	723046.107	725757.062	723046.107	725757.062	Required	
S13	722998.639	725741.560	722998.639	725741.560	Required	
S14	723001.492	725733.296			No Entry	
S15	723042.524	725744.220			No Entry	
S16	723058.442	725747.695			No Entry	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	300	S1	37.100	35.550	1.250	Open Manhole	1200
S1.001	o	300	S2	37.120	35.490	1.330	Open Manhole	1200
S1.002	o	300	S3	37.200	35.427	1.473	Open Manhole	1200
S1.003	o	375	S4	37.480	35.242	1.863	Open Manhole	1350
S1.004	o	375	S5	37.320	35.172	1.773	Open Manhole	1350
S1.005	o	375	S6	37.140	35.081	1.684	Open Manhole	1350
S2.000	o	300	S7	36.600	35.400	0.900	Open Manhole	1200
S2.001	o	300	S8	36.650	35.076	1.274	Open Manhole	1200
S1.006	o	450	S9	36.860	34.887	1.523	Open Manhole	1350
S3.000	o	300	S10	36.600	35.254	1.046	Sealed Manhole	1350
S3.001	o	375	S11	36.830	35.127	1.328	Open Manhole	1350
S3.002	o	375	S12	37.030	35.070	1.585	Open Manhole	1350
S1.007	o	525	S13	37.000	34.819	1.656	Open Manhole	1500
S1.008	o	525	S14	36.500	34.761	1.214	Sealed Manhole	1800 x 1800
S1.009	o	525	S15	36.800	34.753	1.522	Sealed Manhole	3600 x 3000

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	9.017	150.3	S2	37.120	35.490	1.330	Open Manhole	1200
S1.001	9.432	149.7	S3	37.200	35.427	1.473	Open Manhole	1200
S1.002	37.062	200.3	S4	37.480	35.242	1.938	Open Manhole	1350
S1.003	13.964	199.5	S5	37.320	35.172	1.773	Open Manhole	1350
S1.004	18.073	200.8	S6	37.140	35.082	1.683	Open Manhole	1350
S1.005	38.763	199.8	S9	36.860	34.887	1.598	Open Manhole	1350
S2.000	48.607	150.0	S8	36.650	35.076	1.274	Open Manhole	1200
S2.001	5.653	148.8	S9	36.860	35.038	1.522	Open Manhole	1350
S1.006	13.639	200.6	S13	37.000	34.819	1.731	Open Manhole	1500
S3.000	38.115	300.1	S11	36.830	35.127	1.403	Open Manhole	1350
S3.001	17.117	300.3	S12	37.030	35.070	1.585	Open Manhole	1350
S3.002	49.935	300.8	S13	37.000	34.904	1.721	Open Manhole	1500
S1.007	8.743	150.0	S14	36.500	34.761	1.214	Sealed Manhole	1800 x 1800
S1.008	42.462	265.4	S15	36.800	34.601	1.674	Sealed Manhole	3600 x 3000
S1.009	16.293	122.5	S16	35.500	34.620	0.355	Open Manhole	1350

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.093	0.093	0.093
1.001	-	-	100	0.013	0.013	0.013
1.002	-	-	100	0.075	0.075	0.075
1.003	-	-	100	0.028	0.028	0.028
1.004	-	-	100	0.024	0.024	0.024
1.005	-	-	100	0.270	0.270	0.270
2.000	-	-	100	0.168	0.168	0.168
2.001	-	-	100	0.018	0.018	0.018
1.006	-	-	100	0.139	0.139	0.139
3.000	-	-	100	0.147	0.147	0.147
3.001	-	-	100	0.136	0.136	0.136
3.002	-	-	100	0.172	0.172	0.172
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				1.283	1.283	1.283

Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
S1.000	S1	300	1.250	1.330	Unclassified	1200	0	1.250	Unclassified
S1.001	S2	300	1.330	1.473	Unclassified	1200	0	1.330	Unclassified
S1.002	S3	300	1.473	1.938	Unclassified	1200	0	1.473	Unclassified
S1.003	S4	375	1.773	1.863	Unclassified	1350	0	1.863	Unclassified
S1.004	S5	375	1.683	1.773	Unclassified	1350	0	1.773	Unclassified
S1.005	S6	375	1.598	1.684	Unclassified	1350	0	1.684	Unclassified
S2.000	S7	300	0.900	1.274	Unclassified	1200	0	0.900	Unclassified
S2.001	S8	300	1.274	1.522	Unclassified	1200	0	1.274	Unclassified
S1.006	S9	450	1.523	1.731	Unclassified	1350	0	1.523	Unclassified
S3.000	S10	300	1.046	1.403	Unclassified	1350	0	1.046	Unclassified
S3.001	S11	375	1.328	1.585	Unclassified	1350	0	1.328	Unclassified
S3.002	S12	375	1.585	1.721	Unclassified	1350	0	1.585	Unclassified
S1.007	S13	525	1.214	1.656	Unclassified	1500	0	1.656	Unclassified
S1.008	S14	525	1.214	1.674	Unclassified	1800	1800	1.214	Unclassified
S1.009	S15	525	0.355	1.522	Unclassified	3600	3000	1.522	Unclassified

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)
S1.009	S16	35.500	34.620	34.070	1350	0

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.272		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S15, DS/PN: S1.009, Volume (m³): 30.7

Unit Reference	MD-SHE-0065-2300-1600-2300
Design Head (m)	1.600
Design Flow (l/s)	2.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	65
Invert Level (m)	34.753
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	2.3	Kick-Flo®	0.577	1.4
Flush-Flo™	0.284	1.8	Mean Flow over Head Range	-	1.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	0.800	1.7	2.000	2.5	4.000	3.5	7.000	4.6
0.200	1.7	1.000	1.9	2.200	2.7	4.500	3.7	7.500	4.7
0.300	1.8	1.200	2.0	2.400	2.8	5.000	3.9	8.000	4.9
0.400	1.7	1.400	2.2	2.600	2.9	5.500	4.1	8.500	5.0
0.500	1.6	1.600	2.3	3.000	3.1	6.000	4.2	9.000	5.1
0.600	1.5	1.800	2.4	3.500	3.3	6.500	4.4	9.500	5.3

Storage Structures for Storm

Tank or Pond Manhole: S14, DS/PN: S1.008

Invert Level (m) 34.761

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	808.0	1.600	808.0

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

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm) 16.000	Cv (Summer) 0.750
Region	Scotland and Ireland	Ratio R 0.272	Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 50.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 180, 360, 720, 1440, 2880
Return Period(s) (years)	1, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S1.000	S1	15 Winter	100	+20%	100/15 Summer				36.212	0.362
S1.001	S2	15 Winter	100	+20%	30/15 Winter				36.199	0.409
S1.002	S3	15 Winter	100	+20%	30/15 Summer				36.184	0.457
S1.003	S4	15 Winter	100	+20%	30/15 Summer				36.095	0.478
S1.004	S5	15 Winter	100	+20%	30/15 Summer				36.065	0.518
S1.005	S6	15 Winter	100	+20%	30/15 Summer				36.027	0.571
S2.000	S7	2880 Winter	100	+20%	30/1440 Winter				35.944	0.244
S2.001	S8	2880 Winter	100	+20%	30/15 Summer				35.939	0.563
S1.006	S9	2880 Winter	100	+20%	30/15 Summer				35.940	0.603
S3.000	S10	15 Winter	100	+20%	30/15 Summer				36.024	0.470
S3.001	S11	15 Winter	100	+20%	30/15 Summer				35.952	0.450
S3.002	S12	2880 Winter	100	+20%	30/15 Summer				35.941	0.496
S1.007	S13	2880 Winter	100	+20%	30/15 Summer				35.940	0.596
S1.008	S14	2880 Winter	100	+20%	30/360 Summer				35.939	0.653
S1.009	S15	2880 Winter	100	+20%	30/360 Summer				36.800	1.522

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.000	0.64			39.3	SURCHARGED	
S1.001	S2	0.000	0.64			40.3	SURCHARGED	
S1.002	S3	0.000	0.79			57.0	SURCHARGED	
S1.003	S4	0.000	0.57			60.9	SURCHARGED	
S1.004	S5	0.000	0.60			69.5	SURCHARGED	
S1.005	S6	0.000	1.18			150.6	SURCHARGED	
S2.000	S7	0.000	0.03			2.6	SURCHARGED	
S2.001	S8	0.000	0.04			2.7	SURCHARGED	
S1.006	S9	0.000	0.07			11.9	SURCHARGED	
S3.000	S10	0.000	0.86			51.0	SURCHARGED*	
S3.001	S11	0.000	0.98			92.3	SURCHARGED	
S3.002	S12	0.000	0.06			6.6	SURCHARGED	

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

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.007	S13	0.000	0.07			18.4	SURCHARGED	
S1.008	S14	0.000	0.08			19.8	SURCHARGED*	
S1.009	S15	0.000	0.01			2.0	FLOOD RISK*	2

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)	16.000	Add Flow / Climate Change (%)	20
Ratio R	0.272	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	500	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	300	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 Inverts

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.886	4-8	0.397

Total Area Contributing (ha) = 1.283

Total Pipe Volume (m³) = 42.460

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	9.017	0.060	150.3	0.093	2.00	0.0	0.600	o	300	Pipe/Conduit	
S1.001	9.432	0.063	149.7	0.013	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.002	37.062	0.185	200.3	0.075	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.003	13.964	0.070	199.5	0.028	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.004	18.073	0.090	200.8	0.024	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.005	38.763	0.194	199.8	0.270	0.00	0.0	0.600	o	375	Pipe/Conduit	
S2.000	48.607	0.324	150.0	0.168	2.00	0.0	0.600	o	300	Pipe/Conduit	
S2.001	5.653	0.038	148.8	0.018	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.006	13.639	0.068	200.6	0.139	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)
S1.000	61.70	2.12	35.550	0.093	0.0	0.0	4.1	1.28	90.5	24.9
S1.001	60.89	2.24	35.490	0.106	0.0	0.0	4.7	1.28	90.7	28.0
S1.002	57.55	2.80	35.427	0.181	0.0	0.0	7.5	1.11	78.3	45.1
S1.003	56.56	2.98	35.242	0.209	0.0	0.0	8.5	1.28	141.3	51.2
S1.004	55.33	3.22	35.172	0.233	0.0	0.0	9.3	1.27	140.8	55.9
S1.005	52.91	3.72	35.081	0.503	0.0	0.0	19.2	1.28	141.2	115.3
S2.000	58.49	2.63	35.400	0.168	0.0	0.0	7.1	1.28	90.6	42.6
S2.001	58.07	2.71	35.076	0.186	0.0	0.0	7.8	1.29	91.0	46.8
S1.006	52.21	3.88	34.887	0.828	0.0	0.0	31.2	1.43	227.7	187.3

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
S3.000	38.115	0.127	300.1	0.147	2.00	0.0	0.600	o	300	Pipe/Conduit	
S3.001	17.117	0.057	300.3	0.136	0.00	0.0	0.600	o	375	Pipe/Conduit	
S3.002	49.935	0.166	300.8	0.172	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.007	8.743	0.058	150.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
S1.008	42.462	0.160	265.4	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
S1.009	16.293	0.133	122.5	0.000	0.00	0.0	0.600	o	525	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)
S3.000	58.08	2.70	35.254	0.147	0.0	0.0	6.2	0.90	63.8	37.0
S3.001	56.57	2.98	35.127	0.283	0.0	0.0	11.6	1.04	114.9	69.4
S3.002	52.66	3.78	35.070	0.455	0.0	0.0	17.3	1.04	114.8	103.8
S1.007	51.86	3.96	34.819	1.283	0.0	0.0	48.1	1.83	395.4	288.3
S1.008	49.76	4.48	34.761	1.283	0.0	0.0	48.1	1.37	296.6	288.3
S1.009	49.24	4.61	34.753	1.283	0.0	0.0	48.1	2.02	437.9	288.3

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S1	37.100	1.550	Open Manhole	1200	S1.000	35.550	300				
S2	37.120	1.630	Open Manhole	1200	S1.001	35.490	300	S1.000	35.490	300	
S3	37.200	1.773	Open Manhole	1200	S1.002	35.427	300	S1.001	35.427	300	
S4	37.480	2.238	Open Manhole	1350	S1.003	35.242	375	S1.002	35.242	300	
S5	37.320	2.148	Open Manhole	1350	S1.004	35.172	375	S1.003	35.172	375	
S6	37.140	2.059	Open Manhole	1350	S1.005	35.081	375	S1.004	35.082	375	1
S7	36.600	1.200	Open Manhole	1200	S2.000	35.400	300				
S8	36.650	1.574	Open Manhole	1200	S2.001	35.076	300	S2.000	35.076	300	
S9	36.860	1.973	Open Manhole	1350	S1.006	34.887	450	S1.005	34.887	375	
								S2.001	35.038	300	1
S10	36.600	1.346	Sealed Manhole	1350	S3.000	35.254	300				
S11	36.830	1.703	Open Manhole	1350	S3.001	35.127	375	S3.000	35.127	300	
S12	37.030	1.960	Open Manhole	1350	S3.002	35.070	375	S3.001	35.070	375	
S13	37.000	2.181	Open Manhole	1500	S1.007	34.819	525	S1.006	34.819	450	
								S3.002	34.904	375	
S14	36.500	1.739	Sealed Manhole	1800 x 1800	S1.008	34.761	525	S1.007	34.761	525	
S15	36.800	2.199	Sealed Manhole	3600 x 3000	S1.009	34.753	525	S1.008	34.601	525	
S16	35.500	0.880	Open Manhole	1350		OUTFALL		S1.009	34.620	525	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S1	722879.419	725769.364	722879.419	725769.364	Required	
S2	722887.940	725772.312	722887.940	725772.312	Required	
S3	722891.821	725763.715	722891.821	725763.715	Required	
S4	722921.432	725741.426	722921.432	725741.426	Required	
S5	722932.598	725733.040	722932.598	725733.040	Required	
S6	722948.867	725725.168	722948.867	725725.168	Required	
S7	723029.304	725707.381	723029.304	725707.381	Required	
S8	722987.418	725732.044	722987.418	725732.044	Required	
S9	722985.646	725737.412	722985.646	725737.412	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S10	723071.522	725805.638			No Entry	
S11	723056.656	725770.541	723056.656	725770.541	Required	
S12	723046.107	725757.062	723046.107	725757.062	Required	
S13	722998.639	725741.560	722998.639	725741.560	Required	
S14	723001.492	725733.296			No Entry	
S15	723042.524	725744.220			No Entry	
S16	723058.442	725747.695			No Entry	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	300	S1	37.100	35.550	1.250	Open Manhole	1200
S1.001	o	300	S2	37.120	35.490	1.330	Open Manhole	1200
S1.002	o	300	S3	37.200	35.427	1.473	Open Manhole	1200
S1.003	o	375	S4	37.480	35.242	1.863	Open Manhole	1350
S1.004	o	375	S5	37.320	35.172	1.773	Open Manhole	1350
S1.005	o	375	S6	37.140	35.081	1.684	Open Manhole	1350
S2.000	o	300	S7	36.600	35.400	0.900	Open Manhole	1200
S2.001	o	300	S8	36.650	35.076	1.274	Open Manhole	1200
S1.006	o	450	S9	36.860	34.887	1.523	Open Manhole	1350
S3.000	o	300	S10	36.600	35.254	1.046	Sealed Manhole	1350
S3.001	o	375	S11	36.830	35.127	1.328	Open Manhole	1350
S3.002	o	375	S12	37.030	35.070	1.585	Open Manhole	1350
S1.007	o	525	S13	37.000	34.819	1.656	Open Manhole	1500
S1.008	o	525	S14	36.500	34.761	1.214	Sealed Manhole	1800 x 1800
S1.009	o	525	S15	36.800	34.753	1.522	Sealed Manhole	3600 x 3000

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	9.017	150.3	S2	37.120	35.490	1.330	Open Manhole	1200
S1.001	9.432	149.7	S3	37.200	35.427	1.473	Open Manhole	1200
S1.002	37.062	200.3	S4	37.480	35.242	1.938	Open Manhole	1350
S1.003	13.964	199.5	S5	37.320	35.172	1.773	Open Manhole	1350
S1.004	18.073	200.8	S6	37.140	35.082	1.683	Open Manhole	1350
S1.005	38.763	199.8	S9	36.860	34.887	1.598	Open Manhole	1350
S2.000	48.607	150.0	S8	36.650	35.076	1.274	Open Manhole	1200
S2.001	5.653	148.8	S9	36.860	35.038	1.522	Open Manhole	1350
S1.006	13.639	200.6	S13	37.000	34.819	1.731	Open Manhole	1500
S3.000	38.115	300.1	S11	36.830	35.127	1.403	Open Manhole	1350
S3.001	17.117	300.3	S12	37.030	35.070	1.585	Open Manhole	1350
S3.002	49.935	300.8	S13	37.000	34.904	1.721	Open Manhole	1500
S1.007	8.743	150.0	S14	36.500	34.761	1.214	Sealed Manhole	1800 x 1800
S1.008	42.462	265.4	S15	36.800	34.601	1.674	Sealed Manhole	3600 x 3000
S1.009	16.293	122.5	S16	35.500	34.620	0.355	Open Manhole	1350

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.093	0.093	0.093
1.001	-	-	100	0.013	0.013	0.013
1.002	-	-	100	0.075	0.075	0.075
1.003	-	-	100	0.028	0.028	0.028
1.004	-	-	100	0.024	0.024	0.024
1.005	-	-	100	0.270	0.270	0.270
2.000	-	-	100	0.168	0.168	0.168
2.001	-	-	100	0.018	0.018	0.018
1.006	-	-	100	0.139	0.139	0.139
3.000	-	-	100	0.147	0.147	0.147
3.001	-	-	100	0.136	0.136	0.136
3.002	-	-	100	0.172	0.172	0.172
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
1.009	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				1.283	1.283	1.283

Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
S1.000	S1	300	1.250	1.330	Unclassified	1200	0	1.250	Unclassified
S1.001	S2	300	1.330	1.473	Unclassified	1200	0	1.330	Unclassified
S1.002	S3	300	1.473	1.938	Unclassified	1200	0	1.473	Unclassified
S1.003	S4	375	1.773	1.863	Unclassified	1350	0	1.863	Unclassified
S1.004	S5	375	1.683	1.773	Unclassified	1350	0	1.773	Unclassified
S1.005	S6	375	1.598	1.684	Unclassified	1350	0	1.684	Unclassified
S2.000	S7	300	0.900	1.274	Unclassified	1200	0	0.900	Unclassified
S2.001	S8	300	1.274	1.522	Unclassified	1200	0	1.274	Unclassified
S1.006	S9	450	1.523	1.731	Unclassified	1350	0	1.523	Unclassified
S3.000	S10	300	1.046	1.403	Unclassified	1350	0	1.046	Unclassified
S3.001	S11	375	1.328	1.585	Unclassified	1350	0	1.328	Unclassified
S3.002	S12	375	1.585	1.721	Unclassified	1350	0	1.585	Unclassified
S1.007	S13	525	1.214	1.656	Unclassified	1500	0	1.656	Unclassified
S1.008	S14	525	1.214	1.674	Unclassified	1800	1800	1.214	Unclassified
S1.009	S15	525	0.355	1.522	Unclassified	3600	3000	1.522	Unclassified

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)
S1.009	S16	35.500	34.620	34.070	1350	0

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.272		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S15, DS/PN: S1.009, Volume (m³): 30.7

Unit Reference	MD-SHE-0091-4500-1600-4500
Design Head (m)	1.600
Design Flow (l/s)	4.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	91
Invert Level (m)	34.753
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.600	4.5	Kick-Flo®	0.817	3.3
Flush-Flo™	0.399	4.1	Mean Flow over Head Range	-	3.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	0.800	3.4	2.000	5.0	4.000	6.9	7.000	9.0
0.200	3.8	1.000	3.6	2.200	5.2	4.500	7.3	7.500	9.3
0.300	4.1	1.200	3.9	2.400	5.4	5.000	7.7	8.000	9.6
0.400	4.1	1.400	4.2	2.600	5.6	5.500	8.0	8.500	9.9
0.500	4.1	1.600	4.5	3.000	6.0	6.000	8.4	9.000	10.1
0.600	4.0	1.800	4.7	3.500	6.5	6.500	8.7	9.500	10.4

Storage Structures for Storm

Tank or Pond Manhole: S14, DS/PN: S1.008

Invert Level (m) 34.761

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	808.0	1.600	808.0

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

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	16.000
Region	Scotland and Ireland	Ratio R	0.272
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm) 50.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 180, 360, 720, 1440, 2880
Return Period(s) (years)	1, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
S1.000	S1	15 Winter	100	+20%	100/15 Summer				36.212	0.362
S1.001	S2	15 Winter	100	+20%	30/15 Winter				36.199	0.409
S1.002	S3	15 Winter	100	+20%	30/15 Summer				36.184	0.457
S1.003	S4	15 Winter	100	+20%	30/15 Summer				36.095	0.478
S1.004	S5	15 Winter	100	+20%	30/15 Summer				36.065	0.518
S1.005	S6	15 Winter	100	+20%	30/15 Summer				36.027	0.571
S2.000	S7	15 Winter	100	+20%	100/15 Summer				35.893	0.193
S2.001	S8	2880 Winter	100	+20%	30/15 Summer				35.777	0.401
S1.006	S9	2880 Winter	100	+20%	30/15 Summer				35.777	0.440
S3.000	S10	15 Winter	100	+20%	30/15 Summer				36.024	0.470
S3.001	S11	15 Winter	100	+20%	30/15 Summer				35.952	0.450
S3.002	S12	15 Winter	100	+20%	30/15 Summer				35.895	0.450
S1.007	S13	2880 Winter	100	+20%	30/15 Summer				35.777	0.433
S1.008	S14	2880 Winter	100	+20%	30/360 Winter				35.777	0.491
S1.009	S15	1440 Summer	100	+20%	30/360 Winter				36.378	1.100

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.000	0.64			39.3	SURCHARGED	
S1.001	S2	0.000	0.64			40.3	SURCHARGED	
S1.002	S3	0.000	0.79			57.0	SURCHARGED	
S1.003	S4	0.000	0.57			60.9	SURCHARGED	
S1.004	S5	0.000	0.60			69.5	SURCHARGED	
S1.005	S6	0.000	1.18			150.6	SURCHARGED	
S2.000	S7	0.000	0.80			68.5	SURCHARGED	
S2.001	S8	0.000	0.04			2.7	SURCHARGED	
S1.006	S9	0.000	0.07			12.0	SURCHARGED	
S3.000	S10	0.000	0.86			51.0	SURCHARGED*	
S3.001	S11	0.000	0.98			92.3	SURCHARGED	
S3.002	S12	0.000	1.40			149.1	SURCHARGED	

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

PN	US/MH Name	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.007	S13	0.000	0.07			18.2	SURCHARGED	
S1.008	S14	0.000	0.07			18.1	SURCHARGED*	
S1.009	S15	0.000	0.01			4.2	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)	16.000	Add Flow / Climate Change (%)	20
Ratio R	0.272	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	500	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	300	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 Inverts

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.241	4-8	0.541	8-12	0.068

Total Area Contributing (ha) = 0.850

Total Pipe Volume (m³) = 36.596

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	19.716	0.110	179.4	0.061	2.00	0.0	0.600	o	225	Pipe/Conduit	
S2.000	14.247	0.143	99.9	0.009	2.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	3.681	0.030	123.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	15.671	0.090	175.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	5.112	0.051	100.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.004	21.109	0.120	176.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.005	15.553	0.100	155.5	0.007	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.006	33.882	0.100	340.0	0.111	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	60.27	2.34	35.800	0.061	0.0	0.0	2.7	0.97	38.7	15.9
S2.000	61.27	2.18	36.100	0.009	0.0	0.0	0.4	1.31	52.0	2.4
S1.001	59.95	2.39	35.690	0.070	0.0	0.0	3.0	1.18	46.8	18.2
S1.002	58.36	2.65	35.660	0.070	0.0	0.0	3.0	0.99	39.2	18.2
S1.003	57.99	2.72	35.571	0.070	0.0	0.0	3.0	1.31	51.9	18.2
S1.004	56.04	3.08	35.520	0.070	0.0	0.0	3.0	0.98	39.1	18.2
S1.005	54.78	3.33	35.400	0.077	0.0	0.0	3.0	1.05	41.6	18.3
S1.006	51.72	3.99	35.300	0.188	0.0	0.0	7.0	0.85	59.9	42.1

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.007	37.529	0.110	341.5	0.171	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.008	35.916	0.106	340.0	0.151	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.009	20.989	0.052	400.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.010	19.887	0.020	1000.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
S1.011	16.350	0.055	297.3	0.010	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.012	18.342	0.092	199.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.013	23.737	0.091	262.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.014	4.240	0.050	84.8	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.015	46.972	0.391	120.0	0.308	0.00	0.0	0.600	o	375	Pipe/Conduit	
S3.000	11.329	0.114	99.8	0.022	2.00	0.0	0.600	o	225	Pipe/Conduit	
S3.001	10.341	0.103	100.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.016	25.884	0.026	995.5	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.017	11.662	0.343	34.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.007	49.15	4.63	35.200	0.359	0.0	0.0	12.7	0.97	107.7	76.5
S1.008	46.98	5.25	35.090	0.510	0.0	0.0	17.3	0.98	107.9	103.8
S1.009	45.86	5.59	34.985	0.510	0.0	0.0	17.3	1.01	160.7	103.8
S1.010	44.42	6.07	34.932	0.510	0.0	0.0	17.3	0.70	151.5	103.8
S1.011	43.40	6.43	34.912	0.520	0.0	0.0	17.3	0.75	29.9«	103.8
S1.012	42.51	6.76	34.857	0.520	0.0	0.0	17.3	0.92	36.7«	103.8
S1.013	41.61	7.12	34.765	0.520	0.0	0.0	17.3	1.11	123.1	103.8
S1.014	41.53	7.15	34.674	0.520	0.0	0.0	17.3	1.97	217.4	103.8
S1.015	40.40	7.62	34.567	0.828	0.0	0.0	24.2	1.65	182.6	145.0
S3.000	61.52	2.14	35.000	0.022	0.0	0.0	1.0	1.31	52.0	5.9
S3.001	60.66	2.28	34.886	0.022	0.0	0.0	1.0	1.31	52.0	5.9
S1.016	38.75	8.39	34.176	0.850	0.0	0.0	24.2	0.57	62.5«	145.0
S1.017	38.62	8.45	34.150	0.850	0.0	0.0	24.2	3.12	344.2	145.0

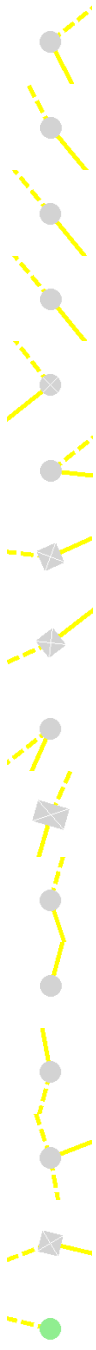
Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S17	37.100	1.300	Open Manhole	1200	S1.000	35.800	225				
S18	37.600	1.500	Open Manhole	1200	S2.000	36.100	225				
S19	37.400	1.710	Open Manhole	1200	S1.001	35.690	225	S1.000	35.690	225	
								S2.000	35.957	225	267
S20	37.400	1.740	Open Manhole	1200	S1.002	35.660	225	S1.001	35.660	225	
S21	37.300	1.729	Sealed Manhole	1800 x 1800	S1.003	35.571	225	S1.002	35.571	225	
S22	37.300	1.780	Open Manhole	1200	S1.004	35.520	225	S1.003	35.520	225	
S23	37.500	2.100	Open Manhole	1200	S1.005	35.400	225	S1.004	35.400	225	
S24	37.650	2.350	Open Manhole	1200	S1.006	35.300	300	S1.005	35.300	225	
S25	37.210	2.010	Open Manhole	1350	S1.007	35.200	375	S1.006	35.200	300	
S26	36.760	1.670	Open Manhole	1350	S1.008	35.090	375	S1.007	35.090	375	
S27	36.260	1.275	Sealed Manhole	1500	S1.009	34.985	450	S1.008	34.985	375	
S28	36.400	1.468	Open Manhole	1500	S1.010	34.932	525	S1.009	34.932	450	
S29	36.100	1.188	Sealed Manhole	2400 x 2400	S1.011	34.912	225	S1.010	34.912	525	
S30	36.100	1.243	Sealed Manhole	2400 x 2400	S1.012	34.857	225	S1.011	34.857	225	
S31	36.500	1.735	Open Manhole	1350	S1.013	34.765	375	S1.012	34.765	225	
S32	36.500	1.826	Sealed Manhole	2400 x 3000	S1.014	34.674	375	S1.013	34.674	375	
S33	36.190	1.623	Open Manhole	1350	S1.015	34.567	375	S1.014	34.624	375	57
S34	36.470	1.470	Open Manhole	1200	S3.000	35.000	225				
S35	36.580	1.694	Open Manhole	1200	S3.001	34.886	225	S3.000	34.886	225	
S36	36.650	2.474	Open Manhole	1350	S1.016	34.176	375	S1.015	34.176	375	
								S3.001	34.783	225	457
S37	36.700	2.550	Sealed Manhole	2400 x 2400	S1.017	34.150	375	S1.016	34.150	375	
SS38	35.500	1.693	Open Manhole	1500		OUTFALL		S1.017	33.807	375	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S17	722958.026	726028.646	722958.026	726028.646	Required	
S18	722965.936	725995.623	722965.936	725995.623	Required	
S19	722962.333	726009.407	722962.333	726009.407	Required	
S20	722965.862	726010.453	722965.862	726010.453	Required	
S21	722978.649	726019.513			No Entry	
S22	722981.739	726015.440	722981.739	726015.440	Required	

Manhole Schedules for Storm

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S23	722965.190	726002.337	722965.190	726002.337	Required	
S24	722972.416	725988.564	722972.416	725988.564	Required	
S25	722994.039	725962.478	722994.039	725962.478	Required	
S26	723017.897	725933.510	723017.897	725933.510	Required	
S27	723040.398	725905.515			No Entry	
S28	723023.897	725892.543	723023.897	725892.543	Required	
S29	723043.658	725890.300			No Entry	
S30	723058.611	725896.911			No Entry	
S31	723073.107	725908.149	723073.107	725908.149	Required	
S32	723063.414	725886.482			No Entry	
S33	723062.241	725882.407	723062.241	725882.407	Required	
S34	723076.042	725816.717	723076.042	725816.717	Required	
S35	723078.948	725827.667	723078.948	725827.667	Required	
S36	723077.057	725837.833	723077.057	725837.833	Required	
S37	723101.234	725847.078			No Entry	
SS38	723112.578	725844.369			No Entry	



PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S17	37.100	35.800	1.075	Open Manhole	1200
S2.000	o	225	S18	37.600	36.100	1.275	Open Manhole	1200
S1.001	o	225	S19	37.400	35.690	1.485	Open Manhole	1200
S1.002	o	225	S20	37.400	35.660	1.515	Open Manhole	1200
S1.003	o	225	S21	37.300	35.571	1.504	Sealed Manhole	1800 x 1800
S1.004	o	225	S22	37.300	35.520	1.555	Open Manhole	1200
S1.005	o	225	S23	37.500	35.400	1.875	Open Manhole	1200
S1.006	o	300	S24	37.650	35.300	2.050	Open Manhole	1200
S1.007	o	375	S25	37.210	35.200	1.635	Open Manhole	1350
S1.008	o	375	S26	36.760	35.090	1.295	Open Manhole	1350
S1.009	o	450	S27	36.260	34.985	0.825	Sealed Manhole	1500
S1.010	o	525	S28	36.400	34.932	0.943	Open Manhole	1500
S1.011	o	225	S29	36.100	34.912	0.963	Sealed Manhole	2400 x 2400
S1.012	o	225	S30	36.100	34.857	1.018	Sealed Manhole	2400 x 2400
S1.013	o	375	S31	36.500	34.765	1.360	Open Manhole	1350
S1.014	o	375	S32	36.500	34.674	1.451	Sealed Manhole	2400 x 3000
S1.015	o	375	S33	36.190	34.567	1.248	Open Manhole	1350
S3.000	o	225	S34	36.470	35.000	1.245	Open Manhole	1200
S3.001	o	225	S35	36.580	34.886	1.469	Open Manhole	1200
S1.016	o	375	S36	36.650	34.176	2.099	Open Manhole	1350
S1.017	o	375	S37	36.700	34.150	2.175	Sealed Manhole	2400 x 2400

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	19.716	179.4	S19	37.400	35.690	1.485	Open Manhole	1200
S2.000	14.247	99.9	S19	37.400	35.957	1.218	Open Manhole	1200
S1.001	3.681	123.0	S20	37.400	35.660	1.515	Open Manhole	1200
S1.002	15.671	175.0	S21	37.300	35.571	1.504	Sealed Manhole	1800 x 1800
S1.003	5.112	100.2	S22	37.300	35.520	1.555	Open Manhole	1200
S1.004	21.109	176.0	S23	37.500	35.400	1.875	Open Manhole	1200
S1.005	15.553	155.5	S24	37.650	35.300	2.125	Open Manhole	1200
S1.006	33.882	340.0	S25	37.210	35.200	1.710	Open Manhole	1350
S1.007	37.529	341.5	S26	36.760	35.090	1.295	Open Manhole	1350
S1.008	35.916	340.0	S27	36.260	34.985	0.900	Sealed Manhole	1500
S1.009	20.989	400.0	S28	36.400	34.932	1.018	Open Manhole	1500
S1.010	19.887	1000.0	S29	36.100	34.912	0.663	Sealed Manhole	2400 x 2400
S1.011	16.350	297.3	S30	36.100	34.857	1.018	Sealed Manhole	2400 x 2400
S1.012	18.342	199.4	S31	36.500	34.765	1.510	Open Manhole	1350
S1.013	23.737	262.0	S32	36.500	34.674	1.451	Sealed Manhole	2400 x 3000
S1.014	4.240	84.8	S33	36.190	34.624	1.191	Open Manhole	1350
S1.015	46.972	120.0	S36	36.650	34.176	2.099	Open Manhole	1350
S3.000	11.329	99.8	S35	36.580	34.886	1.469	Open Manhole	1200
S3.001	10.341	100.0	S36	36.650	34.783	1.642	Open Manhole	1350
S1.016	25.884	995.5	S37	36.700	34.150	2.175	Sealed Manhole	2400 x 2400
S1.017	11.662	34.0	SS38	35.500	33.807	1.318	Open Manhole	1500

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.061	0.061	0.061
2.000	-	-	100	0.009	0.009	0.009
1.001	-	-	100	0.000	0.000	0.000
1.002	-	-	100	0.000	0.000	0.000
1.003	-	-	100	0.000	0.000	0.000
1.004	-	-	100	0.000	0.000	0.000
1.005	-	-	100	0.007	0.007	0.007
1.006	-	-	100	0.111	0.111	0.111
1.007	-	-	100	0.171	0.171	0.171
1.008	-	-	100	0.151	0.151	0.151
1.009	-	-	100	0.000	0.000	0.000
1.010	-	-	100	0.000	0.000	0.000
1.011	-	-	100	0.010	0.010	0.010
1.012	-	-	100	0.000	0.000	0.000
1.013	-	-	100	0.000	0.000	0.000
1.014	-	-	100	0.000	0.000	0.000
1.015	-	-	100	0.308	0.308	0.308
3.000	-	-	100	0.022	0.022	0.022
3.001	-	-	100	0.000	0.000	0.000
1.016	-	-	100	0.000	0.000	0.000
1.017	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.850	0.850	0.850

Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
S1.000	S17	225	1.075	1.485	Unclassified	1200	0	1.075	Unclassified
S2.000	S18	225	1.218	1.275	Unclassified	1200	0	1.275	Unclassified
S1.001	S19	225	1.485	1.515	Unclassified	1200	0	1.485	Unclassified
S1.002	S20	225	1.504	1.515	Unclassified	1200	0	1.515	Unclassified
S1.003	S21	225	1.504	1.555	Unclassified	1800	1800	1.504	Unclassified
S1.004	S22	225	1.555	1.875	Unclassified	1200	0	1.555	Unclassified
S1.005	S23	225	1.875	2.125	Unclassified	1200	0	1.875	Unclassified
S1.006	S24	300	1.710	2.050	Unclassified	1200	0	2.050	Unclassified
S1.007	S25	375	1.295	1.635	Unclassified	1350	0	1.635	Unclassified
S1.008	S26	375	0.900	1.295	Unclassified	1350	0	1.295	Unclassified
S1.009	S27	450	0.825	1.018	Unclassified	1500	0	0.825	Unclassified
S1.010	S28	525	0.663	0.943	Unclassified	1500	0	0.943	Unclassified
S1.011	S29	225	0.963	1.018	Unclassified	2400	2400	0.963	Unclassified
S1.012	S30	225	1.018	1.510	Unclassified	2400	2400	1.018	Unclassified
S1.013	S31	375	1.360	1.451	Unclassified	1350	0	1.360	Unclassified
S1.014	S32	375	1.191	1.451	Unclassified	2400	3000	1.451	Unclassified
S1.015	S33	375	1.248	2.099	Unclassified	1350	0	1.248	Unclassified
S3.000	S34	225	1.245	1.469	Unclassified	1200	0	1.245	Unclassified
S3.001	S35	225	1.469	1.642	Unclassified	1200	0	1.469	Unclassified
S1.016	S36	375	2.099	2.175	Unclassified	1350	0	2.099	Unclassified
S1.017	S37	375	1.318	2.175	Unclassified	2400	2400	2.175	Unclassified

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)
S1.017	SS38	35.500	33.807	33.100	1500	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	1.000	Additional Flow - % of Total Flow	20.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 3 Number of Storage Structures 4 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)	0.840
M5-60 (mm)	16.000	Storm Duration (mins)	30
Ratio R	0.272		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S21, DS/PN: S1.003, Volume (m³): 6.2

Unit Reference	MD-SHE-0055-1000-0400-1000
Design Head (m)	0.400
Design Flow (l/s)	1.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	55
Invert Level (m)	35.571
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.400	1.0	Kick-Flo®	0.273	0.8
Flush-Flo™	0.117	1.0	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)	Depth (m)	Flow (l/s)
0.100	1.0	0.800	1.4	2.000	2.1	4.000	2.8	7.000	3.8
0.200	1.0	1.000	1.5	2.200	2.2	4.500	3.0	7.500	3.9
0.300	0.9	1.200	1.6	2.400	2.2	5.000	3.2	8.000	4.0
0.400	1.0	1.400	1.8	2.600	2.3	5.500	3.3	8.500	4.1
0.500	1.1	1.600	1.9	3.000	2.5	6.000	3.5	9.000	4.3
0.600	1.2	1.800	2.0	3.500	2.7	6.500	3.6	9.500	4.4

Hydro-Brake® Optimum Manhole: S32, DS/PN: S1.014, Volume (m³): 15.6

Unit Reference	MD-SHE-0079-3000-1200-3000
Design Head (m)	1.200
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	79
Invert Level (m)	34.674
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.200	3.0	Kick-Flo®	0.707	2.4
Flush-Flo™	0.348	2.9	Mean Flow over Head Range	-	2.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.3	0.400	2.9	0.800	2.5	1.400	3.2	2.000	3.8
0.200	2.8	0.500	2.8	1.000	2.8	1.600	3.4	2.200	4.0
0.300	2.9	0.600	2.7	1.200	3.0	1.800	3.6	2.400	4.1

Hydro-Brake® Optimum Manhole: S32, DS/PN: S1.014, Volume (m³): 15.6

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
2.600	4.3	4.000	5.2	5.500	6.1	7.000	6.8	8.500	7.5
3.000	4.6	4.500	5.5	6.000	6.3	7.500	7.0	9.000	7.7
3.500	4.9	5.000	5.8	6.500	6.6	8.000	7.3	9.500	7.9

Hydro-Brake® Optimum Manhole: S37, DS/PN: S1.017, Volume (m³): 17.3

Unit Reference	MD-SHE-0053-1500-1450-1500
Design Head (m)	1.450
Design Flow (l/s)	1.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	53
Invert Level (m)	34.150
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.450	1.5	Kick-Flo®	0.472	0.9
Flush-Flo™	0.233	1.1	Mean Flow over Head Range	-	1.1

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

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

Storage Structures for Storm

Tank or Pond Manhole: S20, DS/PN: S1.002

Invert Level (m) 35.660

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	56.3	0.780	56.3

Tank or Pond Manhole: S28, DS/PN: S1.010

Invert Level (m) 34.932

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	190.0	1.000	190.0

Tank or Pond Manhole: S31, DS/PN: S1.013

Invert Level (m) 34.765

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	277.0	1.000	277.0

Tank or Pond Manhole: S36, DS/PN: S1.016

Invert Level (m) 34.176

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	284.0	1.700	284.0

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

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	20.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 3 Number of Storage Structures 4 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	16.000
Region	Scotland and Ireland	Ratio R	0.272
Cv (Summer)	0.750		
Cv (Winter)	0.840		

Margin for Flood Risk Warning (mm) 50.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 180, 360, 720, 1440, 2880
Return Period(s) (years)	1, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S1.000	S17	2880 Summer	100	+20%	100/15 Summer				36.833
S2.000	S18	2880 Summer	100	+20%	100/2880 Summer				36.836
S1.001	S19	2880 Summer	100	+20%	30/60 Winter				36.837
S1.002	S20	2880 Summer	100	+20%	30/60 Summer				36.842
S1.003	S21	2880 Summer	100	+20%	30/15 Summer				36.991
S1.004	S22	2880 Summer	100	+20%	100/15 Summer				36.878
S1.005	S23	2880 Summer	100	+20%	30/15 Summer				36.881
S1.006	S24	2880 Summer	100	+20%	30/15 Summer				36.881
S1.007	S25	2880 Summer	100	+20%	30/15 Summer				36.881
S1.008	S26	2880 Summer	100	+20%	1/2880 Winter	100/2880 Summer			36.881
S1.009	S27	2880 Summer	100	+20%	1/2880 Winter				36.260
S1.010	S28	2880 Summer	100	+20%	1/2880 Winter	100/1440 Summer			36.934
S1.011	S29	2880 Summer	100	+20%	1/1440 Summer				36.100
S1.012	S30	2880 Summer	100	+20%	1/1440 Summer				36.100
S1.013	S31	2880 Summer	100	+20%	1/1440 Summer	100/2880 Summer			36.980
S1.014	S32	2880 Summer	100	+20%	1/1440 Summer				36.500
S1.015	S33	2880 Summer	100	+20%	1/1440 Summer	100/1440 Winter			36.501
S3.000	S34	2880 Summer	100	+20%	1/2880 Winter	100/2880 Summer			36.494
S3.001	S35	2880 Summer	100	+20%	1/1440 Summer				36.507
S1.016	S36	2880 Summer	100	+20%	1/360 Summer				36.523
S1.017	S37	2880 Summer	100	+20%	1/360 Summer				35.959

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S17	0.808	0.000	0.04			1.6	SURCHARGED	
S2.000	S18	0.511	0.000	0.01			0.2	SURCHARGED	
S1.001	S19	0.922	0.000	0.06			1.8	SURCHARGED	
S1.002	S20	0.956	0.000	0.03			1.0	SURCHARGED	
S1.003	S21	1.196	0.000	0.03			1.0	SURCHARGED*	
S1.004	S22	1.133	0.000	0.03			1.0	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S1.005	S23	1.257	0.000	0.03			1.1	SURCHARGED	
S1.006	S24	1.282	0.000	0.07			4.0	SURCHARGED	
S1.007	S25	1.306	0.000	0.09			8.3	SURCHARGED	
S1.008	S26	1.416	122.794	0.12			12.0	FLOOD	1
S1.009	S27	0.825	0.000	0.09			11.8	FLOOD RISK*	
S1.010	S28	1.477	119.865	0.27			20.4	FLOOD	2
S1.011	S29	0.963	0.000	0.31			8.2	FLOOD RISK*	
S1.012	S30	1.018	0.000	0.24			8.0	FLOOD RISK*	
S1.013	S31	1.840	138.516	0.03			3.5	FLOOD	1
S1.014	S32	1.451	0.000	0.03			2.8	FLOOD	2
S1.015	S33	1.559	311.372	0.05			8.3	FLOOD	3
S3.000	S34	1.269	24.221	0.01			0.5	FLOOD	1
S3.001	S35	1.396	0.000	0.01			0.4	SURCHARGED	
S1.016	S36	1.972	0.000	0.05			1.8	SURCHARGED	
S1.017	S37	1.434	0.000	0.01			1.9	SURCHARGED*	

Appendix C

Green Roof Specification

CS CONSULTING
GROUP

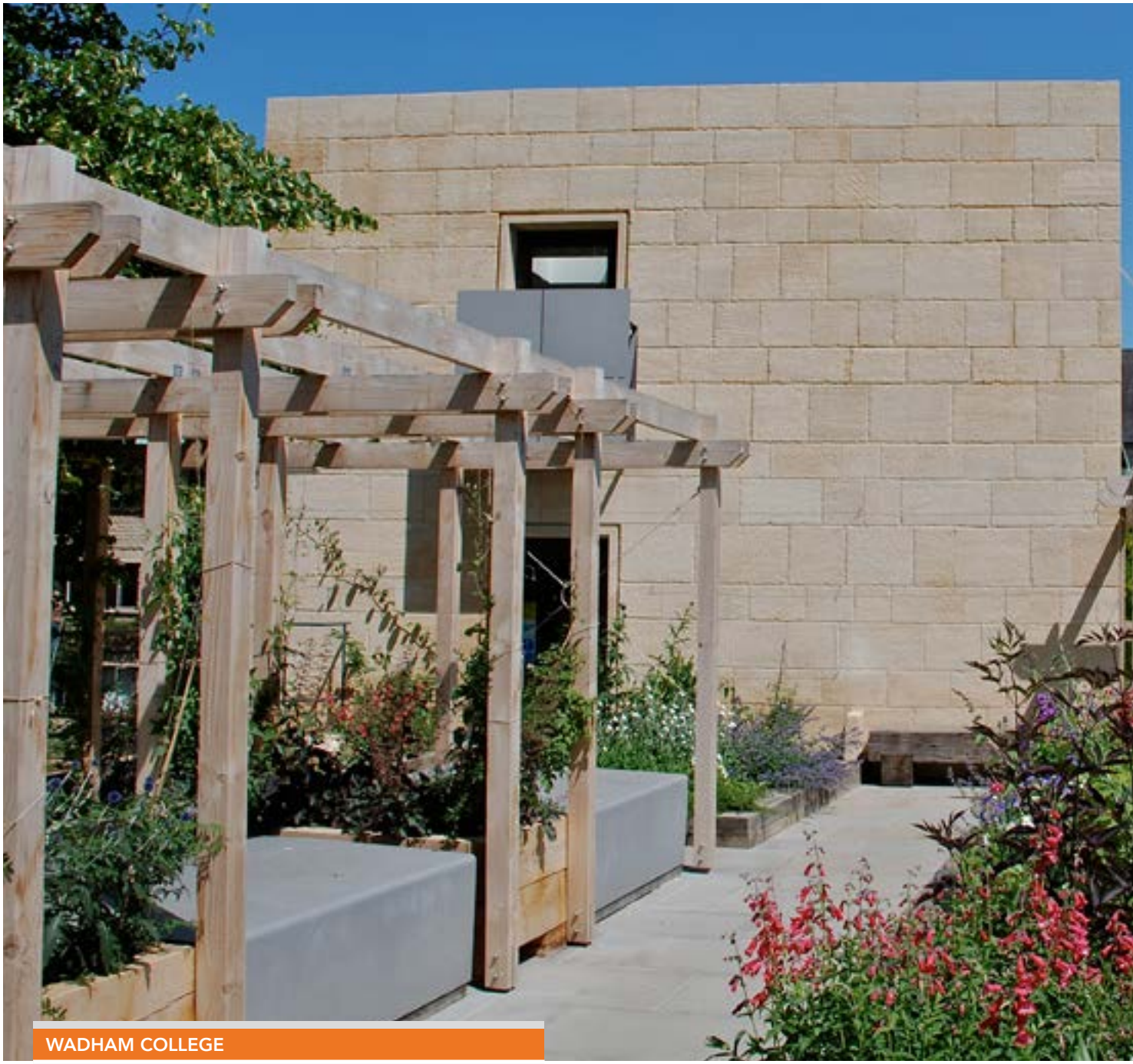
BAUDER

Green Roofs

We lead the way in the development of all types of green roofs having supplied and installed solutions for over 40 years.

We provide the complete package of waterproofing systems and associated landscaping components to ensure that every green or blue roof is fully compatible.

OVERVIEW OF GREEN ROOFS



WADHAM COLLEGE

Location: **Oxford**

"The Bauder Hot Melt System with intensive green roof landscaping offers incredible durability, versatility and cost effectiveness. The roof garden has transformed the graduate centre at Wadham and undeniably assisted in maximising the building's potential. Bauder provided the highest standards of technical support throughout the works and delivered a single-point of contact roofing solution that met our exact specifications under one all-encompassing guarantee."

Tim Lee, Lee Fitzgerald Architects

We were the first company to introduce lightweight landscaping technology into the UK and Ireland, partnering on many prestigious projects since 1982. Our unrivalled expertise ensures we deliver any green or blue roof scenario, from recreational gardens and parks to simple low maintenance environmental greening and biodiverse ecological solutions.

Sedum System
Non-Accessed Extensive Green Roof

All in one system comprising mature sedum species pre-grown on an integrated blanket with 20mm of extensive substrate. The system has been developed for use directly over our waterproofing.

Substrate Roofs
Extensive Non-Accessed Green Roofs

Substrate green roofs are designed to be comparatively lightweight, work towards providing some storm water attenuation and support a wide variety of low maintenance plant species which are generally self-sustaining, and wind, frost and drought tolerant.

Biodiverse Habitats

Created to encourage a wider spread of birds, insects and plant species into the area and generally replicate the ecological environment of the site. This is particularly important if there are planning conditions or a local Biodiversity Action Plan (BAP) must be followed.

Pre-grown Vegetation Blankets

Designed to give instant greening to a roof. Two options are available; Bauder WB native wildflower blanket or a sedum mix in the Bauder SB substrate blanket.

Plug Planted Systems

The selection and location of each plant species can be controlled according to requirements which is ideal when the roof has a number of different aspects. We can supply over 100 different plugs: British Native Wildflowers, herbs, grasses to sedums and other succulents.

Seeded Roofs

Our unique range of British native seed mixes provides the specifier with a selection of seed blends to suit particular locations and are designed to meet BREEAM and BAP requirements.

BioSOLAR Roofs

Combining a green roof with a solar PV array where the substrate and vegetation provide ballast for the PV mounting. The system raises the modules above the substrate to allow liberal growing room for the plants.

Recreational Gardens, Terraces and Spaces
Accessed Intensive Green Roofs

Rooftops and podiums where the design may include flowerbeds, lawns, shrubs and trees intermixed with paths, driveways and patios. The combinations of finishes will impact on the design, construction, drainage and components used to deliver to each element's requirements.

ENVIRONMENTAL CREDENTIALS

Aiding Biodiversity and Meeting a Biodiversity Action Plan (BAP)

A green roof can provide a range of natural habitats specifically designed to support particular species of plant, insect or wildlife. Designed for the local ecology, in which vegetation will establish and provide an environment for wildlife as well as insects and invertebrates. The provision of a healthy habitat in a place that could otherwise be empty encourages wildlife to remain in the area, providing wildlife corridors to support the natural colonisation of locally arising plants, birds and insects, boosting the resilience of species in the area.

Our wildflower blanket and Flora Seed Mixes are all specifically devised to meet BAP criteria through their inclusion of species within the RHS 'Perfect for Pollinators' and Flora Locale 'native origins criteria'.

Bauder works with Buglife, the invertebrate charity, to produce a range of habitat features that favour some of the UK's most vulnerable species.

Storm Water Management and SuDS

The specifically engineered outlet within a blue roof restricts the discharge of storm water to a calculated and predesigned flow rate to significantly slow down the volume of water leaving the site. As the storm passes, water continues to discharge from the roof at a controlled rate which helps to avoid downstream or localised flooding. (see chapter 10)

Green roofs can retain rainwater in the substrate, drainage/reservoir board and plants. This water is then used by the vegetation or evaporates back into the atmosphere. The FLL reports that, over the course of a calendar year, a green roof can frequently retain 40% of average rainfall on an extensive green roof with 20-40mm of substrate and sedum vegetation and 90% of average rainfall on an intensive green roof with over 500mm of substrate.

Improving Air Quality of Local Surroundings

Localised air quality is improved as the vegetation assists in filtering out both gaseous pollutants and dust particles, effectively purifying the air. Additionally, the natural evaporation of water from the plants and soil helps to cool and humidify the air, so lowering the ambient temperature and reducing the heat island effect.

Prof. Dr. H. J. Liesecke, the former chairman of the German FLL regulatory body, carried out tests at the University of Hanover to provide evidence of the natural air purifying effects of Xero Flor XF301 sedum system with its patented substrate.

The test container housing the sedums and mosses was filled with the waste gas from petrol and diesel engines and after 48 hours the pollution levels were measured showing a reduction by 95% within the period. A second chamber was also set up without vegetation as a comparative control.

In conclusion, extensive green roof systems effectively mitigate car emmissions.

Urban Heat Island Effect

The urban heat island effect is the difference in temperature between urban areas and the surrounding countryside and is a result of large building surfaces reflecting and radiating solar, which will not dissipate fully overnight. The substrate of a green roof will absorb some of this heat and the natural evaporation of water from both the plants and soil helps to cool and humidify the air, thus lowering the ambient air temperature.

Recycled Content of Green Roof Components

Many recycled or waste materials are used within our green roof build ups to enable us to provide environmental solutions to the industry.

Water Retention and Drainage Layers

Our DSE 20, 40 and 60 boards all utilise recycled high density polyethylene which is easily moulded to create the cupped profile boards that provides water retention and multi-directional drainage.

Protection Layers

Our protection layers FSM600 and FSM1100 are made from a mixture of two recycled materials, reground polyester and polypropylene fibre, that are combined before being mechanically and thermally solidified to deliver a layer which prevents mechanical damage to the waterproofing beneath the green roof build up.

Our ProMat is made of granulate from recycled shredded tyres reformed and bound by Polyurethane to give a high protection layer against mechanical damage.

Our Ecomat product is a protective layer created from mechanically bonded recycled Polyester clothing and fabric.

Substrates and Growing Mediums

Our FLL compliant substrates are based around recycled crushed brick and composted recycled organic material to give growing mediums which correctly balance water storage, structural stability, water permeability and grain size distribution according to the requirements of the planting scheme.

Separation and Slip Layer

Our PE Foil allows the green roof to operate independently of the waterproofing system and is manufactured from recycled polyethylene granulate.

Recycling End of Life

The level of recycled content within our components clearly demonstrates that these products are then easily returned to the convention.

BREEAM

Building Research Establishment Environmental Assessment Method

breeam

Our green roofs have the potential to count towards BREEAM. If you are working to this assessment standard, please contact a member of our technical team, who can advise on best practice for your individual project.

Health and Wellbeing

This category encourages the health, wellbeing and safety of the building users through the design and specification to create a comfortable internal and external environment.

Hea 05 Acoustic performance

The building looks to meet acoustic performance standards under 1.a Sound Insulation with the criteria to 'Achieve the performance standards set out in Section 1 of Building Bulletin 93: Acoustic design of schools: performance standards, February 2015 (BB93)1 relating to airborne sound insulation between spaces and impact sound insulation of floors'

The Bauder XF301 sedum blanket system on a metal deck has been tested in accordance with BS EN ISO 140-18: 2006 to determine the sound intensity level within the building during heavy rainfall. The sedum plants intercept the impact of rainfall and mitigate the noise so that a figure of 33.5dB is achieved. (See Chapter 9)

Hea 07 Safe and healthy surroundings

A credit is available for an outside space that provides building users with an external amenity area.

An intensive green roof provides recreational gardens and amenity spaces on podiums and at roof top level to maximise the full potential of the building by utilising all available space within the structure's footprint.

Energy

This category encourages the specification and design of energy efficient building solutions towards sustainable use and management throughout the operation of the building's life.

Ene 01 - Reduction of energy use and carbon emissions

Any low or zero carbon technologies installed can be used to offset emissions arising from regulated and unregulated (for exemplary credits) energy consumption. The requirement details for a private wire arrangement to be in place, i.e. no grid sustainable energy purchase.

Bauder BioSOLAR photovoltaic solution creates local energy generation from renewable sources on green roofs where the installation method ensures the waterproofing beneath remains completely intact and without compromise. (See chapter 11)

Materials

This category focuses designers on reducing the environmental and social impact of construction products used on a project through the specification of efficient construction products with reduced environmental impact that are responsible sourced and durable.

Mat 02 – Environmental impacts from construction products – Environmental Product Declarations (EPD)

The specification of products with a recognised environmental product declaration that has been independently verified and registered for its transparent communication of comparable information about the life-cycle impact of products.

Mat 03 – Responsible sourcing of construction products.

The section facilitates the selection of products that involve lower levels of negative environmental impact across the supply chain.

Bauder manufacturing processes hold ISO 14001:2015 Environmental Management Certification to measure and improve our impacts.

Green Roof Build Up Components

Many recycled or waste materials are used within our green roof components to enable us to provide environmental solutions to the industry.

Water Retention and Drainage Layers - Our DSE 20, 40 and 60 boards all utilise 100% recycled high density polyethylene moulded to create the cupped profile boards that provide water retention and multi-directional drainage.

Our Attenuation Cell 100 board is manufactured from recycled PolyPropylene.

Protection Layers - Our FSM 600 and 1100 are made from a mixture of recycled reground polyester and polypropylene fibre, which are combined before being mechanically and thermally solidified to create a layer to prevent mechanical damage to the waterproofing.

ProMat for intensive green roofs is made of granulate from recycled shredded tyres reformed and bound by Polyurethane to give a protective layer against mechanical damage.

Ecomat is a protective layer created from recycled Polyester clothing and fabric.

Substrates and Growing Mediums - Our substrates are based around recycled crushed brick and composted organic material to give growing mediums which balance water storage, structural stability, water permeability and grain size distribution according to the requirements of the planting scheme.

BREEAM *cont.*
Building Research Establishment Environmental Assessment Method

Separation and Slip Layer - PE Foil is manufactured from recycled polyethylene granulate. from construction and throughout the lifetime of the building.

Waste
This category focuses on the reduction of waste from construction and throughout the lifetime of the building.

Wst 01 Construction waste management
The reduction of excess and discarded construction materials through optimised design methods to minimise waste.

Bauder solution designs are created specifically to be efficient and minimise waste created onsite through excess product specification thus avoiding unnecessary material use in order to minimise waste going to landfill.

Wst 02 Use of recycled and sustainably sourced aggregates
Whilst BREEAM encourages the use of site sourced material. **GRO and Bauder recommendations** are that aggregate obtained from site is not used as a substitution for GRO and FLL compliant substrate, as the unknown content risks contaminated content to the living roof.
"To encourage the specification and use of more sustainably sourced aggregates." Bauder carefully select recycled material for use in their substrate to make the products 95%+ recycled whilst still compliant to GRO and FLL guidelines."

Land Use and Ecology
This category encourages sustainable land use, habitat protection and creation, and improvement of long-term biodiversity for the building's site and surrounding land.

Le 03 – Managing impacts on ecology
This section concentrates on avoiding or limiting negative ecological impacts associated with the site and surrounding areas as a result of the construction project and consequent building.

Bauder biodiverse green roofs help to conserve natural ecosystems and maintain the environmental asset, a matrix of habitats and specific plant species can be incorporated to meet the needs of the local biodiversity action plan (BAP) and the site ecology.

Le 04 – Ecological change and enhancement
The aim of this is to enhance ecological value of the area associated with the site in support of local, regional and national priorities. Exemplary level criteria is gained where significant Biodiversity Net Gain is achieved.

Bauder biodiverse green roofs can introduce and reinforce local native species flora and our wildflower blanket and seed mixes are all specifically devised to meet BAP criteria through their inclusion of species within the RHS 'Perfect for Pollinators' and Flora Locale 'native origin species'. Bauder also works with Buglife, the invertebrate charity, to produce a range of habitat features that favour some of the UK's most vulnerable species.

Le 05 – Long-term ecological management and maintenance
This section looks at ongoing monitoring, management and maintenance of the site and its habitats and ecological features, to ensure intended outcomes are realised for the long term.

Bauder green roof maintenance service delivers ongoing care of a green roof on a regular basis so that healthy plant growth of suitable species continues to provide a habitat for wildlife. We also provide maintenance information to allow building owneårs and asset managers to continue to maximise the building's asset value.

TECHNICAL CREDENTIALS

Adopting Standards
Throughout Europe, the standards most widely recognised as comprehensively covering green roofs are those of the Forschungsgesllschaft Landschaftsentwicklung Landschafttsbau (FLL). This independent foundation was set up by the German Government inn 2002 and develops specific guidelines for green roof systems.

We have adopted these well respected standards, which cover all aspects of waterproofing, root protection, landscaping, installation and maintenance and we will continue to do so whilst also working in conjunction with the GRO Code of Best Practice for the UK.

Protection of the Waterproofing
A green roof protects the waterproofing from UV damage and thermal movement. Research has shown that the life expectancy of the waterproofing is significantly extended and in many cases may last the estimated design life of the building, which can eliminate future replacement costs.

Fire Testing
Bauder XF301 was the first sedum blanket in the UK to be awarded a fire rating by the Building Research Establishment. The full system, including the waterproofing and insulation was tested, and so the EXT. F.AA rating applies to the complete system and not just the sedum blanket covering.

With the recent standardisation of fire tests across Europe. Bauder's Sedum Blankets are proven to be "unrestricted and can be used anywhere on the roof" when tested to TS1187 with BS EN 13501-5 European Class rating BROOF(t4). (for more information on see pages 38-40)

Increased Efficiency and Output of a BioSOLAR PV Array
A green roof helps to maximise solar energy generation as the vegetation preserves ambient rooftop temperatures, keeping the modules at optimal output. The cooling effect increases panel output by up to 5-7%.

Aid to Planning Consent
Many local authorities favour planning proposals that incorporate green roofs within the application as this helps meet their targets on sustainable environment and support of priority species

Sustainable Urban Drainage is now part of legislation and is a critical part of planning. Blue roofs form part of the options available for SuDS.

The Flood and Water Management Act 2010 was introduced in England and Wales and implemented to better manage flood risk. The Act creates safeguards against rises in surface water drainage charges and protects water supplies for consumers. The Act gives levels of responsibility to local authorities to co-ordinate flood risk management in their area.

Many local planning authorities (LPAs) are adopting early perspectives that encompass Schedule 3 of the Act to bring in measures that prevent flooding. Within construction and development, planners are restricting the amount of rainwater leaving a site via the drainage system, limiting water egress to 5-10 litres per second per hectare, the same flow rates for regional greenfield sites.

Reduction of External Noise Within the Building
Green roofs have excellent acoustic qualities for both external sound (up to 3dB) and internal noise (up to 8dB). This can prove to be both economically and environmentally effective when used on structures close to airports or industrial developments.

Reduced Building Running Costs
The enhanced thermal performance provided by a green roof provides a more balanced temperature within the building. This reduces heating costs in the winter and air conditioning expenses during the summer.

Reduced Lifecycle Costs
The main reduction in lifecycle costs comes from the green roof providing protection from the damaging effects of the weather, which effectively 'ages' the waterproofing, thus the time span between replacement is extended significantly, and in many cases replacement will become unnecessary.

Offset Construction Costs
In large construction projects a green or blue roof can mean that storm water holding tanks are reduced in size or no longer required, as the roof itself will attenuate required rainfall.

Creates an Amenity Space
The roof is often an under utilised asset of a building, as it offers the unique potential to replace the land lost to the construction as reusable space. Large roof areas covering underground car parks can provide parkland or sports facilities.

Increases Property Value
A green roof is an additional asset, once created will maximise the property's potential value.

Productivity in the Workplace
Research has shown that people working in offices that overlook green spaces have a higher productivity than those with a poorer outlook on to hard, impervious buildings. The evidence shows that there is a reduction in stress levels if people have visual and personal contact with natural greenery and that physically they benefit from the cleaner air.

Health
Hospitals are greening overlooked roofs or incorporating rooftop garden areas for the benefit of patients as they find that this speeds recovery. Some patients are also encouraged to access the gardens and to actively maintain them as part of therapeutic exercise.

RECREATIONAL SPACES, GARDENS

Accessed Intensive Green Roof Systems

HOLYROOD STUDENT ACCOMMODATION

Location: **Edinburgh**

The main flat roof podium area located was waterproofed with 1,400m2 of Bauder Plant E before then having soft and hard landscaping elements installed to provide a visually appealing, multi-purpose recreational area for students to socialise on. Other areas of the 4,000m2 roof area were waterproofed with Bauder Thermofol PVC single ply system with PIR insulation for superior thermal performance.

AND TERRACES

The £110 million student accommodation on the Holyrood campus at the University of Edinburgh features a picturesque podium roof garden that is designed to foster a sense of community among students and increase the overall value of their experience.

Intensive green roofs provide recreational gardens and amenity spaces on podiums and at roof level, with all the benefits usually associated with ground level landscaping. Increasingly, buildings in city areas are constructed with a green roof on the underground car park to provide additional facilities, thereby maximising the full potential of the building by utilising all available space within the structure's footprint. Typically they will feature landscapes combining shrubs, perennial and herbaceous plants as well as grassed areas and even trees.

Semi-Intensive Green Roofs

This term is generally used to describe a planting scheme where the vegetation has been selected to benefit the building occupants. This may be for its aesthetic qualities or as a public space. The planting is normally in planters with adjacent hard landscaping.

Key Features

- Assists in maximising the building's potential.
- Provides valuable recreational space.
- Offers storm water management benefits due to the depths of substrate used, particularly when specified in conjunction with permeable paving.
- Increases the overall value of the property.

The plants used make a heavy demand on the green roof and will require maintenance, irrigation and management throughout the year to ensure the upkeep of the landscape and allow the vegetation to flourish.

It is important to first establish the landscape finish you are looking to achieve. There is little to restrict the scope for design, other than the overall weight of the system dictating the construction of the supporting structure and the height and level of exposure of the roof.

All our green roof systems meet with GRO and FLL Guidelines.

GREEN ROOFS

Specification Support

Specification downloads:
www.bauder.co.uk/technical-centre

NBSPlus BIM DWG

Telephone helpline:
0845 271 8800

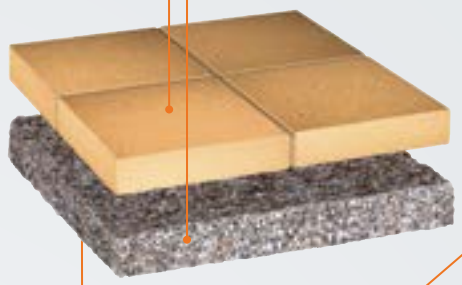
ECO PLATFORM EPD EN 15804 VERIFIED gro bre

RECREATIONAL SPACES, GARDENS AND TERRACES

Example System Configurations

Our lightweight substrates combined with specially developed water storage and drainage components all ensure that the modern green roof can replicate a traditional landscape at roof level at only a fraction of the weight and with a substantially shallower build up.

It is crucial that an integrated approach is taken to the design and specification of both the waterproofing and landscaping components, so that the desired outcomes are achieved. We can work with you from the earliest design stage to ensure that your green roof project is successful.



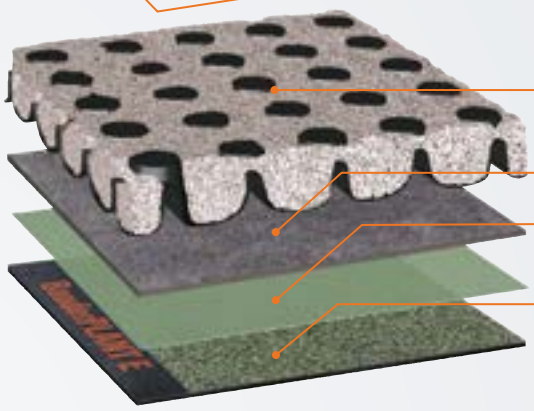
Paving/Pebble Ballast

Granite Chipping Base

Vegetation
specifically selected for each individual roof, from turf to trees.

Bauder Intensive Substrate
lightweight growing medium manufactured to meet FLL guidelines.

Bauder Filter Fleece
filtration layer that prevents substrate fines from washing into the drainage layer.



Bauder DSE60 or DSE40
water storage and drainage layer, infilled with Bauder Mineral Drain for structural stability.

Bauder FSM 1100 Protection Mat
recycled polyester and polythene fibre mix.

Bauder PE Foil
polythene foil separation and slip layer manufactured from recycled granules.

Bauder Waterproofing
root resistant, SBS modified bitumen membrane reinforced with 250g/m^2 recycled spunbond polyester.

www.bauder.co.uk/technical-centre

PROJECTS

Glasgow Harbour
Glasgow

02 Office
Leeds

James Terry Court
South Croydon

SUBSTRATE GREEN ROOF SYSTEMS

Non-accessed extensive green roof systems

A substrate-based green roof will often incorporate a mixed vegetation scheme of low maintenance plants chosen to suit the project and location.

These extensive green roof systems are primarily used for their ecological benefits or aesthetic appearance rather than for general access or for leisure purposes.

A traditional extensive substrate green roof system provides a depth of growing medium usually around 80-200mm to allow for the specification of a broader range of species and planting schemes. The plants are generally low maintenance, wind, frost and drought resistant and can be installed by different methods, including plug planting, vegetation mat and seeding.

Key Features

- Comparatively lightweight.
- Plants chosen to suit the project and location.
- Deep drainage and substrate layers enable excellent water retention to aid SuDS requirements.
- Creating natural habitats to encourage native plants, insect life and small wildlife to remain, so aiding biodiversity.
- Can be designed specifically to support particular flora and fauna.
- Aid to planning consent as biodiversity roofs help to meet local authority policies towards a sustainable environment.
- Aid to meeting BREEAM requirements of a development through points secured by the use of accredited native species plants.
- Cost effective on large roof areas.

An extensive substrate system allows a wider choice of suitable plants for the client. There are two types of substrate used within these systems designed to support the different forms of vegetation. Our extensive substrate is specifically for sedum planting schemes and our biodiverse substrate supports British native species.

Manually planting individual plants in plug format gives the client a much greater choice of species and the opportunity to plan the layout. This can be of particular benefit when the roof is to be overlooked and where the roof areas to be greened are either partially or wholly in shade.

All our green roof systems comply with GRO and FLL Guidelines.

Specification Support

Specification downloads:
www.bauder.co.uk/technical-centre

NBSPlus BIM DWG

Telephone helpline:
0845 271 8800

SUBSTRATE GREEN ROOF SYSTEMS

Example System Configurations

Substrate-based extensive green roofs can incorporate a variety of vegetation and hard landscaping finishes.

Vegetation Mats

The installation of a pre-grown vegetation mat allows instant coverage of the roof. Native wildflower blanket, Bauder WB, meets the growing demand to satisfy the requirements of BREEAM and should meet the biodiversity action plan for the site.

Bauder SB vegetation is a mature sedum blanket with a broad mix of sedums, 12-14 species, and is typically grown for a year prior to installation for excellent coverage.

Plug Planting

This method gives the client both a much greater choice of plant species and the opportunity to plan the layout. The individual immature plants or 'plugs' are planted into the substrate, which can then grow on to give good cover over the next few years.

Seeding

An economical and practical method for vegetating larger roof areas. Our seed mixes are designed for the harsh conditions on a roof. Plant establishment and coverage will take 18-24 months, depending upon the time of year sowing takes place and the weather conditions during the period of establishment.

Biodiverse Options

Bauder's range of seed, plug and blanket can be used in combination to create the matrix of habitat and surface finishes required. Bauder has allied with Buglife (the invertebrate charity, buglife.org.uk) to produce roofs designed with dead wood, sand/stone piles as well as dew ponds etc to give a truly sustainable insect friend environment.

Bauder Filter Fleece
filtration layer that prevents substrate fines from washing into the drainage layer.

Bauder DSE40
40mm water storage layer that provides multi directional drainage.

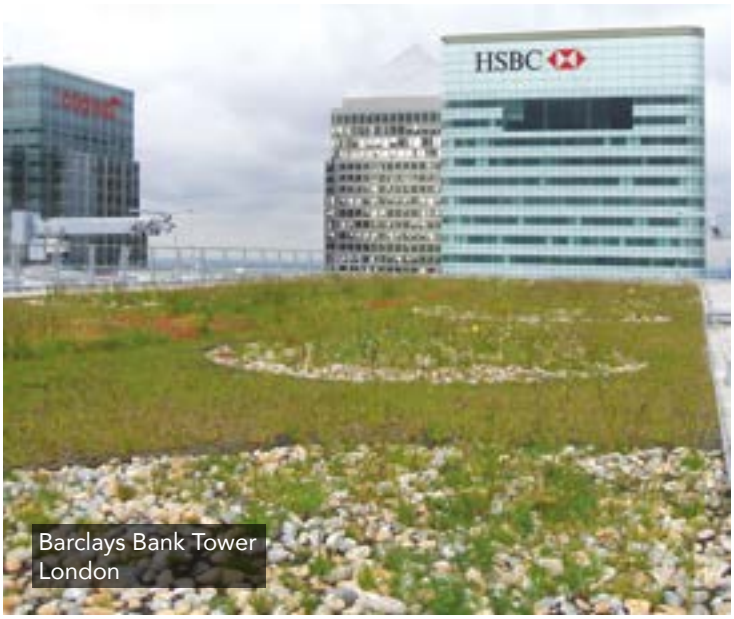
Bauder FSM600 Protection Mat
recycled polyester and polypropylene fibre mix.

Bauder PE Foil (specified in some projects)
polyethylene foil separation and slip layer manufactured from recycled granules.

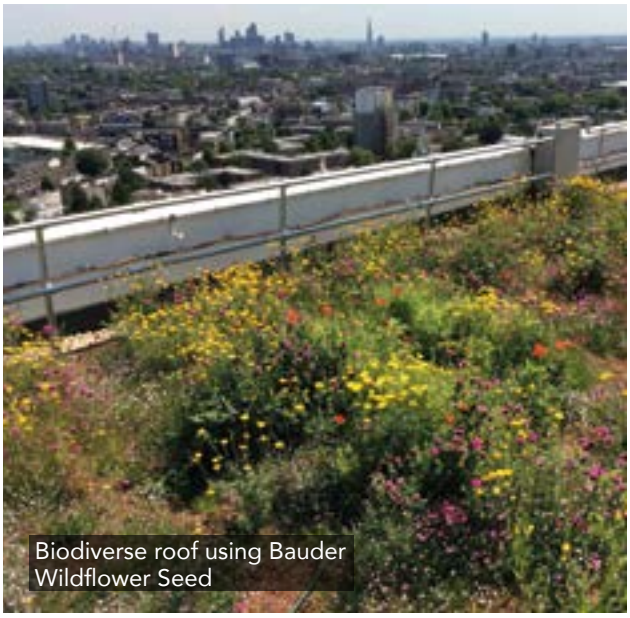
Bauder Waterproofing (all four types are suitable)
show here with root resistant, SBS modified bitumen membrane reinforced with 250g/m² recycled spunbond polyester.

www.bauder.co.uk/technical-centre

PROJECTS



Barclays Bank Tower
London


Biodiverse roof using Bauder
Wildflower Seed


Bord Gáis Networks
Dublin


Wildflower blanket
Private residence, Ullapool

SUBSTRATE PITCH ROOF SYSTEMS

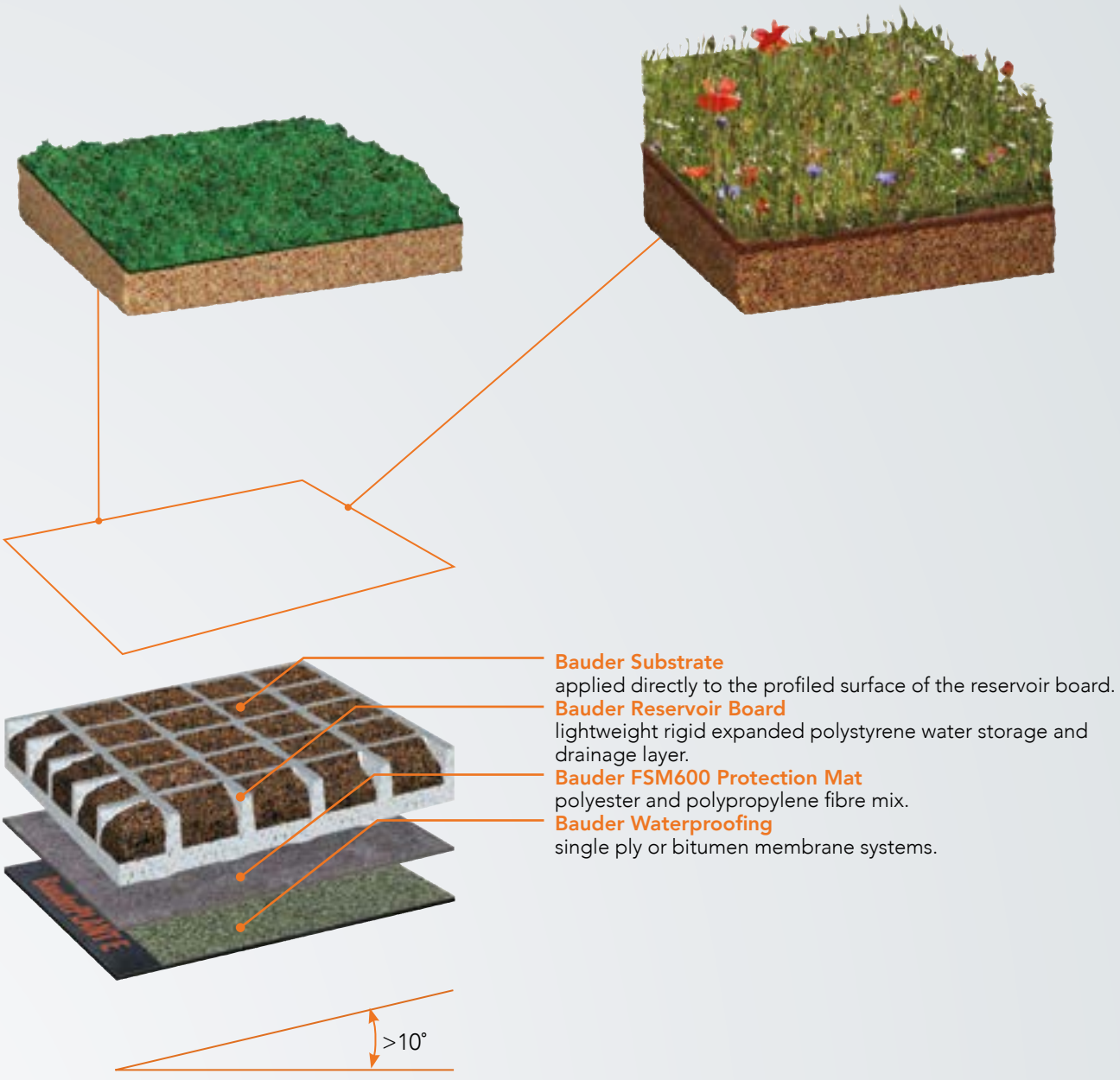
Example System Configurations Over 10°

An extensive substrate system on a pitch greater than 10° requires a water retention and storage board that will hold the substrate firmly in place and be sufficiently rigid to prevent board flexure and manage the imposed sheer load.

The extensive or biodiverse substrate is applied directly to the profiled surface of the board so that the green roof is stabilised whilst retaining sufficient levels of water to support the vegetation.

Sedum Vegetation on Bauder Extensive Substrate
upto 15 sedum species, drought and wind hardy.

Vegetation on Bauder Biodiverse Substrate
generally provided through plug planting, vegetation mat or seeding. If selected species are required, these can be specified to suit the project and location.



Bauder Substrate
applied directly to the profiled surface of the reservoir board.

Bauder Reservoir Board
lightweight rigid expanded polystyrene water storage and drainage layer.

Bauder FSM600 Protection Mat
polyester and polypropylene fibre mix.

Bauder Waterproofing
single ply or bitumen membrane systems.

www.bauder.co.uk/technical-centre

PROJECTS

Plug planted vegetation on
East Anglian Children's Hospice

Fulham Jetty

Pines Calyx
Dover, Kent

BIOSOLAR GREEN ROOF FINISH

Example System Configurations

Bauder BioSOLAR is a revolutionary solar PV mounting system for biodiverse or extensive green roofs. Well suited to new build applications where environmentally friendly solutions are required to meet planning and BREEAM requirements. Our BioSOLAR system can also be retrofitted on many existing roofs without the need for any structural modification to the building.

A key element is that the front edge of the PV panel is set 300mm above the level of the substrate, which allows liberal growing room for the vegetation without blocking light to the array that would otherwise reduce the efficiency of the panels. This height setting also enables light and moisture to reach beneath the panel to support the plants below.

See Chapter 11 for more indepth information

Vegetation Mats

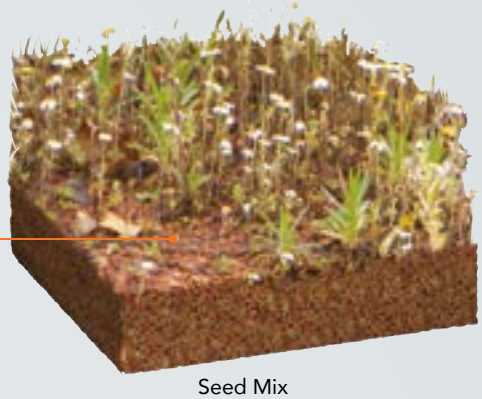
Bauder's SB substrate sedum blanket or WB native wildflower blanket can be used to stablise the substrate quickly in exposed locations and gives instant greening between panels. These are typically placed between rows only (not under the panels) with Bauder Flora 3 seed mix being used in these shadier areas.

Plug Planting

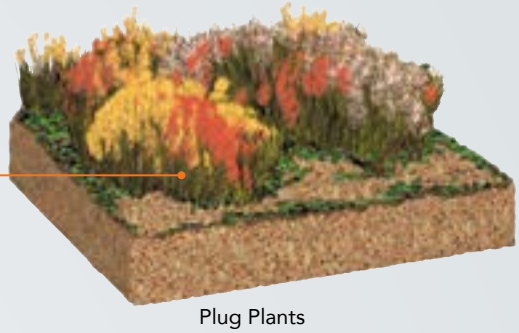
Plug plants are used in areas where particular species are required. Care is required to only specify species that do not grow higher than the panels.

Bauder Flora 3 Seed Mix

The Flora 3 seed mix has been specially designed to work with the Bauder BioSOLAR system and is a mix of low growing and shade tolerant species. The whole roof area can be of benefit to wildlife, taking advantage of the mixture of shade sun and shelter the BioSOLAR roof offers.

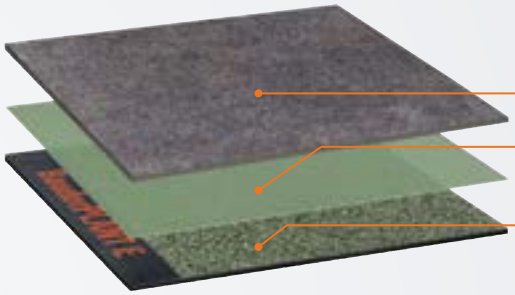


Seed Mix



Plug Plants

Vegetation Mat



Bauder FSM600 Protection Mat
recycled polyester and polypropylene fibre mix.

Bauder PE Foil
polyethylene foil separation and slip layer manufactured from recycled granules.

Bauder Waterproofing
shown here with Plant E root resistant, SBS modified bitumen membrane reinforced with 250g/m² recycled spunbond polyester.

www.bauder.co.uk/technical-centre

PROJECT

LIGHTWEIGHT SEDUM SYSTEM

Extensive green roof XF301

ST LUKE'S CHURCH

Location: **Reigate, Surrey**

The new annex, featuring two barrel vault green roofs, was added to the west end of the original church building to provide a new entrance, two large meeting rooms, toilets and a kitchen. The revitalised church was opened to the community by the Bishop of Croydon.

This is the lightest weight all in one system available. It comprises mature sedum on 20mm of extensive substrate and incorporating a multifunctional water retention and filter layer. The system is suitable for both new build construction and retrofit refurbishment projects.

Our extensive XF301 Sedum System is constructed using low maintenance drought resistance planting (sedum species) that provide excellent cover and increased protection to the waterproofing system.

The plants are grown on a 'blanket' that is harvested like turf and installed by rolling out on top of the waterproofing. The blankets are very lightweight, easy to maintain and provide instant greening to the roof.

The XF301 sedum system is a very versatile green roof system and is suitable for both new build and refurbishment projects.

Key Features

- The most lightweight green roof system available, making it ideal for retrofitting or refurbishment projects.
- Delivers instant greening of a roof with mature sedum species.
- Ideal solution where a green roof needs to be specified to meet planning requirements.
- Ideal for projects where there are weight, height or cost constraints.
- Sedum blankets are grown on our farm in the UK and delivered to site within 24 hours of harvesting.
- Fire classification BROOF (t4) and verified by the BBA as 'unrestricted' and suitable for use on any part of a roof in conjunction with Bauder Total Green Roof System.

The system features up to 14 species of sedum together with some mosses and grasses which ensures plant diversity regardless of location; species are selected to suit our climate and keep weight and maintenance to a minimum.

All our green roof systems comply with GRO and FLL guidelines.

Specification Support

Specification downloads:
www.bauder.co.uk/technical-centre

Telephone helpline:
0845 271 8800

LIGHTWEIGHT SEDUM SYSTEM

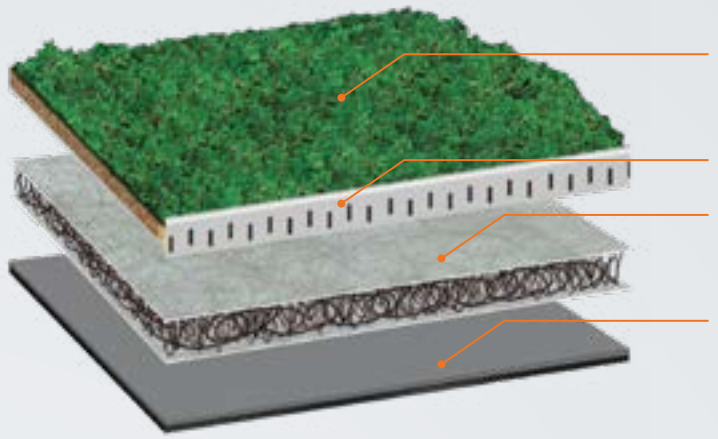
System Configuration

The multi-functional XF301 combines the vegetation support layer with a moisture retention fleece to provide the perfect base for all roofing scenarios with a labour efficient installation.

Our patented geo-textile carrier fleece with its ultraviolet resistant nylon loops provides a support base for the specially developed substrate growing medium and gives stability to the established vegetation whether on a flat roof or up to 25° degrees.

The integral fleece is a unique feature of our XF301 sedum system, retaining moisture after rainfall and thus allowing the plants to take up the water for future use. The sedums are grown to maturity before being harvested, thus ensuring that they acclimatise quickly to their new rooftop location.

We currently cultivate 60,000m^2 of XF301 and are able to harvest the sedum and deliver to site within 24 hours.



Bauder XF301 Sedum System
pre-cultivated vegetation blanket on a patented nylon loop and geo-textile base carrier with special substrate and a pre-attached integral 8mm moisture retention fleece.
AL40 Sedum Blanket Edge Trim
perforated edge/drainage trim.
Bauder SDF Mat
multifunctional drainage, filtration and protection layer manufactured from ultraviolet resistant nylon woven loops which are thermally bonded to geo-textile filter fleece facings.
Bauder Waterproofing (all four types are suitable)

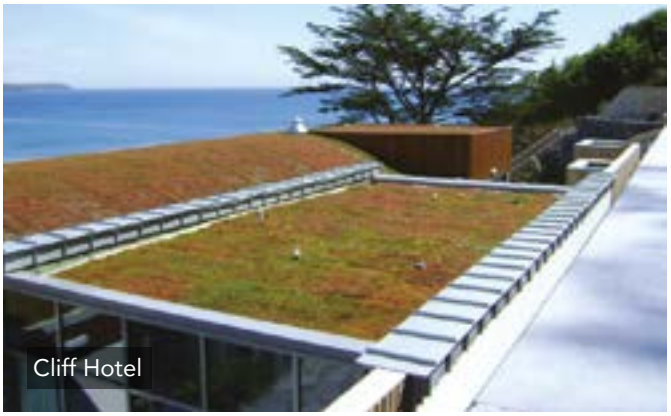
System Installation

Long length rolls are used to speed up installation process.

Short 2m rolls of XF301 Sedum System installed by hand.

PROJECTS

Waitrose
Bagshot, Surrey



Cliff Hotel

Rings Farm
Holiday Cottages, Cupar, Fife

PROJECT STUDIES

Bauder's XF301 Sedum Blanket system

Lagg Distillary

Bauder's XF301 Sedum Blanket

BUILDING BOARD	
Cliet:	**Quantum Solutions**
Location:	**Isle or Arran**
Roof Area:	**2,700m²**
Architect:	**Denham Benn Architects**
Contractor:	**Greenroof UK Ltd**

APPLIED PRODUCTS

- Bauder's XF301 Sedum Blanket
- Plant E cap sheet
- KSA DUO Underlayer
- PIR FA-TE Insulation
- DS1 DUO Air and Vapour Control Layer

Greenroof UK Ltd and Bauder were approached by Quantum Solutions and Denham Benn Architects to create a green roof system for the new distillery and visitors centre at Lagg, which is located at the southern tip of the Island of Arran just meters from the coast. The architect and client were keen that the roof scape would blend into the environment, but that the shape of the roof would reflect the distinctive hill scape of Arran as seen from the mainland.

The complex shape of the roof rose from 2.00 meters above ground level to 12.00 meters, the width varying from 16 meters to 40 meters with gradients ranging from 8 degrees to 31 degrees, all to create the look of a rolling hillside. In order to allow pattern for the introduction of restraint battens within the build-up which would carry the weight of the system over the slopes, a unique sedum restraint system had to be introduced to cope with the extreme prevailing winds from the coast.

The finished roof emulates the look of a rolling hillside and cuts an impressive view against the backdrop of the Firth of Clyde. Approved contractors Greenroof UK were recognised with the NFRC Scotland 2019 green roof award project trophy for their inspiring workmanship.

Biodiverse green roof

Sharrow Primary School

The Bauder green roof on Sharrow Primary School in Sheffield was the first in the country to be declared a nature reserve. A fitting accolade for a school that defies traditional ideas of what a school should be.

Restricted ground space opened up the opportunity to create green roofs at three levels for play space, and outdoor classrooms and a 2000m² biodiversity roof designed to replicate a meadow, complete with cornflowers and other urban plants. It is also a haven for birds and other kinds of wildlife, with rotting tree stumps provided for many kinds of insects. All of roofs are used as a learning resource with curriculum-friendly uses for all the children.

Sharrow Primary is also Sheffield's greenest school, with a heating system powered by warmth coming up from deep in the earth and toilets flushed by rainwater, further proving that Sharrow School is a real testament to what can be achieved and is a landmark construction that raises the benchmark. This sustainable building was delivered on time and within budget with ongoing whole life cost savings.

BUILDING BOARD	
Project:	**Sharrow Primary School**
Investor:	**Sheffield City Council**
Place:	**Sheffield**
Area Size:	**2000m²**
Architect:	**Sheffield City Council**
Contractor:	**Malden Roofing Contractors**

Intensive green roof

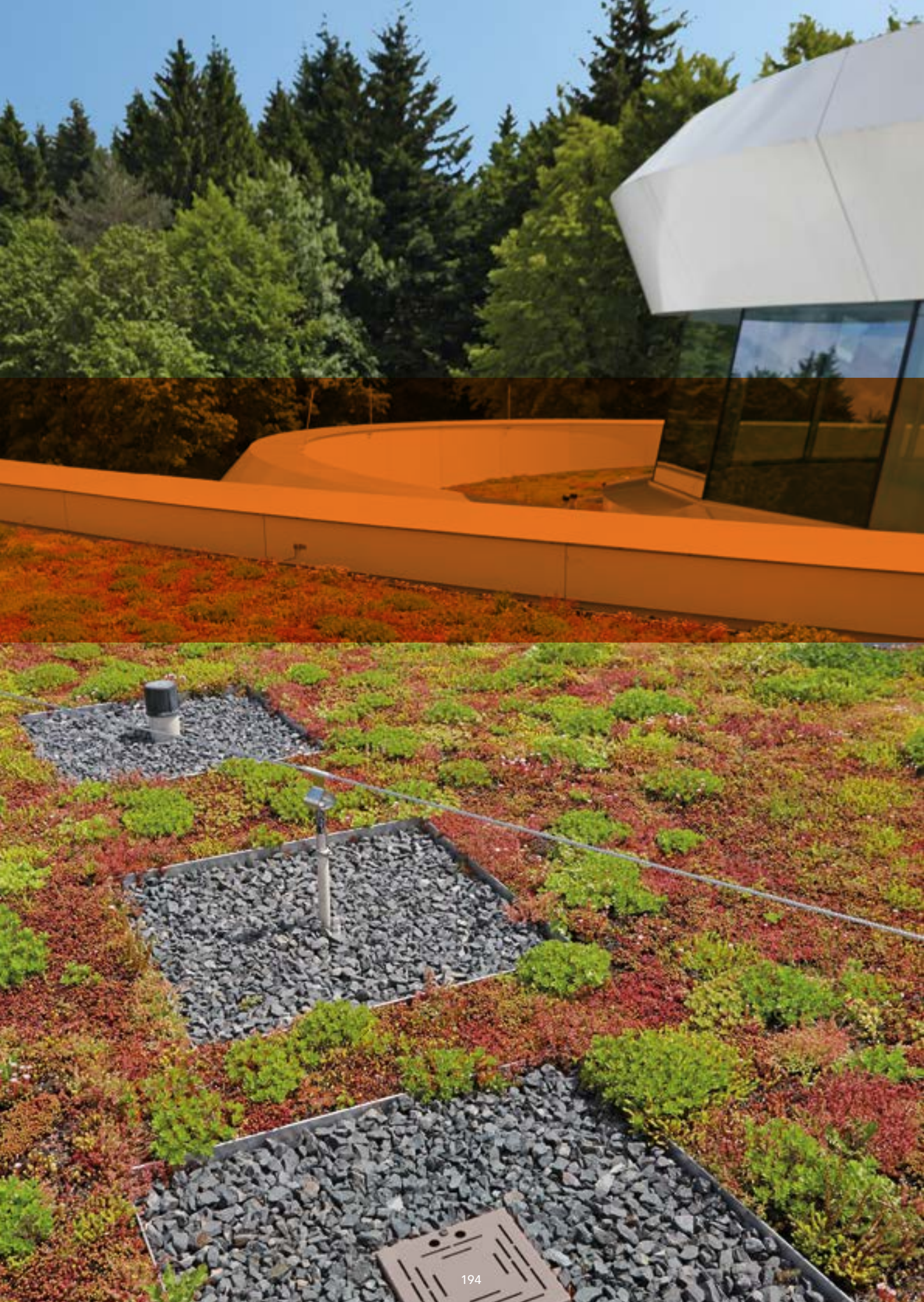
Small Animal Hospital

Set within the Garscbue Estate, Archial Group, the Architect, wanted a new build project with as minimal visual impact as possible, so the building was constructed within the side of a hill with a green roof. Towards the end of the roof's construction a seeded grass finish was opted for.

Past experience proves that the open texture of traditional substrates can allow the seed to be blown off the roof and to migrate down into the growing medium to a point where it cannot germinate properly, creating a patchy finish. To prevent this, Bauder developed a specialist seed bed substrate mix to be used as a topdressing over their traditional intensive substrate, allowing the use of a grass seed mix that could easily blend with the surrounding grassland. The seeds were dressed onto this top-dressing using traditional sowing techniques and equipment, which delivered both optimum germination and the swift establishment of a healthy, even greensward.

The building seamlessly blends into its surroundings, inviting visitors to explore the roof top vantage.

BUILDING BOARD	
Client:	**University of Glasgow**
Location:	**Glasgow**
Roof Area:	**2,800m²**
Architect:	**Davis Duncan Architects**
Contractor:	**Advanced Roofing Systems**



TECHNICAL DESIGN

Green Roofs

www.bauder.co.uk/technical-centre

GREEN ROOF DESIGN CONSIDERATIONS

Green roofs have now become big business and it is important that any supplier is able to prove their credibility and to offer valuable guarantees.

This section briefly explains items that need to be considered when designing a green roof.

We have a comprehensive Green Roof Design Considerations guide available to download from www.bauder.co.uk/technical-centre/design-guides

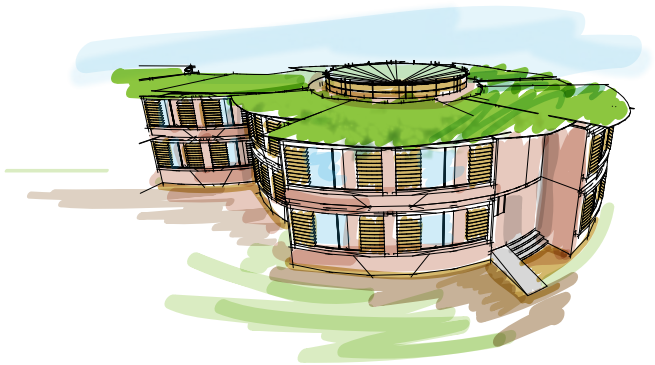
Why is a green roof required and what performance is expected?

There could be many reasons why a green roof is required. It may be to satisfy a planning constraint, in which case economic options will be considered; mitigate against storm water where the design will maximise rainwater attenuation; support specific wildlife for a biodiversity solution; provide recreational space with public access; offer additional energy savings or generation as photovoltaic units are up to 5% more efficient when used on a green roof; or for aesthetic reasons where the building needs to be masked into its surrounding environment.

Essential Factors to be Considered

The most important factor when considering a green roof is the strength and durability of the underlying waterproofing which must:

- Meet all waterproofing standards.
- Have an FLL Compliant Root Barrier.
- Be leak tested prior to installation of the green roof elements.
- Have drainage calculated to cope with severe storm events.
- Incorporate safe access to the roof for maintenance.
- The green roof should be designed to:
- Balance with the environment and growing conditions on the roof.
- Meet any planning requirements.
- Work within the constraints of the building design (height, weight etc).
- Be maintained safely.
- Provide a mixture of different habitats for plants and insects.



The Landscape Finish

The primary decision is the type of landscape required that best suits the rationale behind the development, whether it is an intensive, extensive or biodiversity roof. Whatever the landscape chosen, the plants will have some basic requirements to sustain them; nutrients, a balance between moisture and drainage to suit the vegetation, and aeration to the root system.

Structural Loading

Most roof deck constructions are suitable provided that they can support the imposed load. The saturated weight of the system should be determined at an early stage. Our technical team can provide information so relevant data can be passed to the client's structural engineer.

Indicative weight loadings:

- Intensive systems - 300-400Kg/m^2.
- Extensive substrate systems - 120-200Kg/m^2.
- Lightweight sedum system 44Kg/m^2.

Root Resistant Waterproofing System

All our waterproofing systems are suitable for green roofs, depending on the type speified.

Bituminous and single ply membranes have passed the stringent four year FLL root resistance test widely regarded as the toughest green roof performance trial currently available.

Falls

Intensive green roofs can be safely installed on horizontal decks whereas with extensive green roofs minimum falls of 1:60 and above are preferred. The criteria is to have a depth of drainage layer deep enough to hold the landscape above any residual standing water that occurs on the surface of the deck.

Drainage
The soft landscaping on a green roof will retain a large percentage of the average annual rainfall, as for example an intensive green roof can retain up to 90%, which will result in a significant reduction in the number of outlets required and will thus reduce costs.

All outlets should be protected by an inspection chamber with removable covers to allow access for maintenance, and be surrounded by a pebble vegetation barrier to prevent encroachment.

Growing Mediums
Usually referred to as substrates, they provide the necessary nutrients, aeration and anchorage for the plants. We blend a number of different substrates tailored to the vegetation being grown, they are FLL compliant, peat free, and weigh significantly less than top soil.

Vegetation Barriers
These provide important functions on a green roof:

- As required by FLL and GRO as a fire break.
- Provide rapid surface drainage during heavy rainfall.
- Reduce and ease routine maintenance.
- Protection of the waterproofing from mechanical damage during maintenance.
- Wind uplift resistance by increasing the imposed load at roof perimeters.

Pebble barriers should be provided at perimeters, abutments, rooflights, inspection chambers and all other protrusions. They are not suitable on roofs with a pitch greater than 9° where alternative materials are used.

Wind Uplift
The stability of the system is increased because the negative pressure forces that can develop during high wind conditions are counteracted by the weight of the green roof system.

Wind can also lead to erosion problems on exposed sites, especially if plant establishment is in the early stages.

Irrigation
Requirement for irrigation will depend upon the location of the building, the local climate and the type of plants used to vegetate the roof.

On our XF301 Sedum System, we recommend installing a leaky pipe irrigation system where the following conditions apply:

- South facing roof slopes exceeding 5° pitch.
- All roof slopes exceeding 10° pitch.
- Windy or exposed site locations.
- Inland sites where rainfall is less frequent.

On intensive green roofs an automated system is generally the best option and the frequency at which it is applied will depend on the plant species.

Safe Roof Access
Provision should always be made for safe access to the roof for routine maintenance, which may include man-safe systems with harness and attachment points, internal access hatches or an externally mounted bracket to secure a ladder.

Maintenance
All roofs require a minimum of two inspections a year to ensure that the outlets etc. are maintained. An extensive green roof will need only minimal maintenance to feed the vegetation and ensure that any unwanted species do not become established.

Intensive schemes will require more regular maintenance. download more information from the Technical Centre on our website, bauder.co.uk/technical-centre

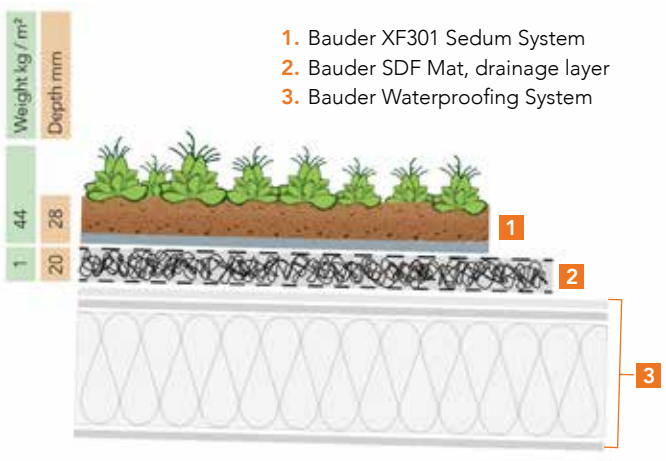
Bauder Green Roof Maintenance Service
Our green roof maintenance service focuses primarily on extensive systems and is set up to be tailor made to suit the client's budget and type of extensive roof installed.

The Bauder Green Roof Promise
Our Green Roof Promise links with our Maintenance Agreement to ensure the continuous health of the Bauder supplied vegetation and that all aspects of the green roof remains healthy and established with the appropriate vegetation.

These documents are bound together and work in unison to give clients peace of mind, knowing that the entire green roof is insafe hands.

DESIGN & WEIGHT LOADINGS

XF301 Lightweight sedum system

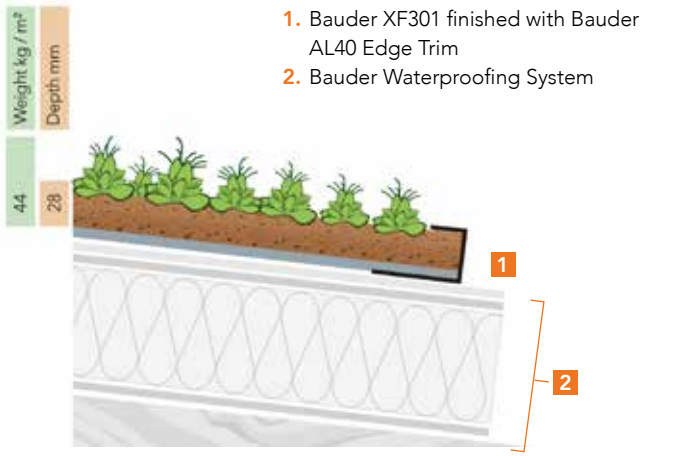


1. Bauder XF301 Sedum System
2. Bauder SDF Mat, drainage layer
3. Bauder Waterproofing System

Flat Roofs

Extensive green roofs should be designed with a minimum fall of 1:60, and even then, small areas of standing water may still occur. This water will rot and kill the vegetation.

Bauder SDF Mat drainage layer is specified within the system to lift the blanket clear of any standing water, allowing it to disperse during periods of prolonged heavy rain. It is lightweight, weighing only 0.6Kg/m^2.



1. Bauder XF301 finished with Bauder AL40 Edge Trim
2. Bauder Waterproofing System

Roof slopes 2° and up to 9°

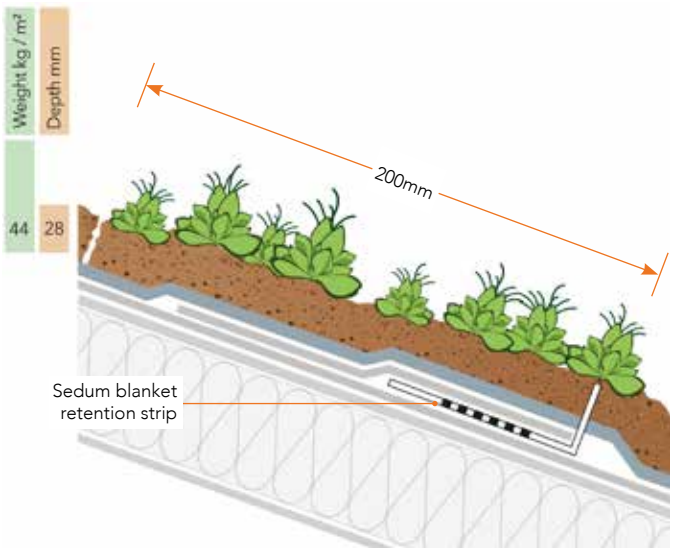
For roof slopes exceeding 2° standing water should not be an issue, allowing the SDF Mat drainage layer to be eliminated and the Bauder XF301 Sedum System installed directly over the waterproofing.

Standard 2 x 1m rolls can be used up to 5° but on larger roofs above this pitch, long rolls in lengths up to 10m reduce the number of joints and are more wind resistant. A crane that is capable of reaching all areas of the roof is imperative when using long rolls.

When installed over either a 'barrel vault or 'dual-pitched' roof, the long length blanket may be applied over the ridge as the forces imposed are counterbalanced. For all other situations, Bauder sedum blanket retention strip should be used.

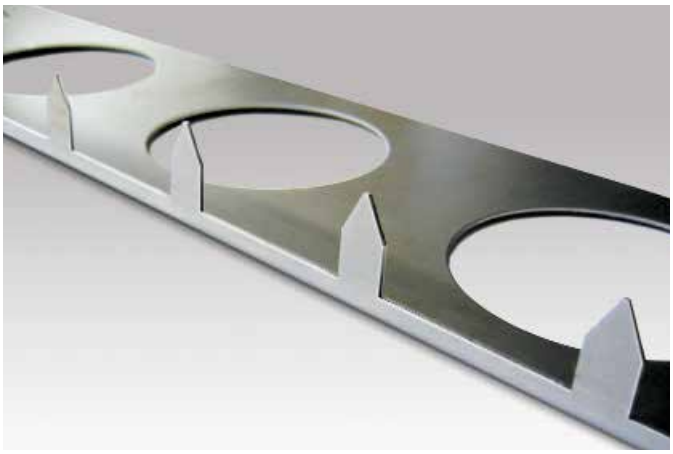
In some instances it is not possible to use the long length roll, i.e. if there are numerous rooflights or interruptions or if crane access is impossible. In these situations the standard 2x1m lengths may be used in conjunction with the Sedum Blanket Retention Strips to mechanically prevent slippage of the blanket, (see facing page).

AL40 Sedum Blanket Edge Trim



Roof slopes 10° and up to 25°

Where the XF301 blanket is to be installed on a pitch between 10° and 25°, it is essential to mechanically restrain the blanket against the sheer forces created by the slope. This is achieved by using the Bauder Retention Strip.



Sedum Blanket Retention Strip

Each retention strip is set in a staggered pattern 200mm below the leading edge of the blanket, the strip being secured by a 200mm wide strip of cap sheet which is bonded through the holes of the base plate of the strip to the waterproofing underneath. The teeth of the retention strip penetrate the underside of the blanket and ensure that no post-installation slippage occurs.

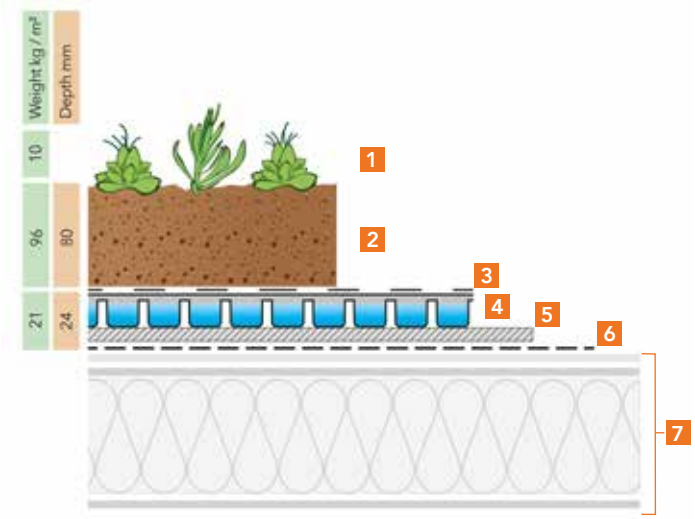
Roof Slopes > 25°

Sedum plants can thrive on slopes exceeding 25°, however, increasing the steepness of the roof slope above this will introduce issues in relation to building maintenance that must be taken into account within the design. It is very difficult to stand on a roof above this pitch without damaging the plants and fertiliser can be washed out of the blankets during heavy rainfall, necessitating additional applications.

Not all roof designs are suitable, should you be considering a green roof installation on an extreme slope we would suggest that you contact our green roof technical department in the first instance for guidance.

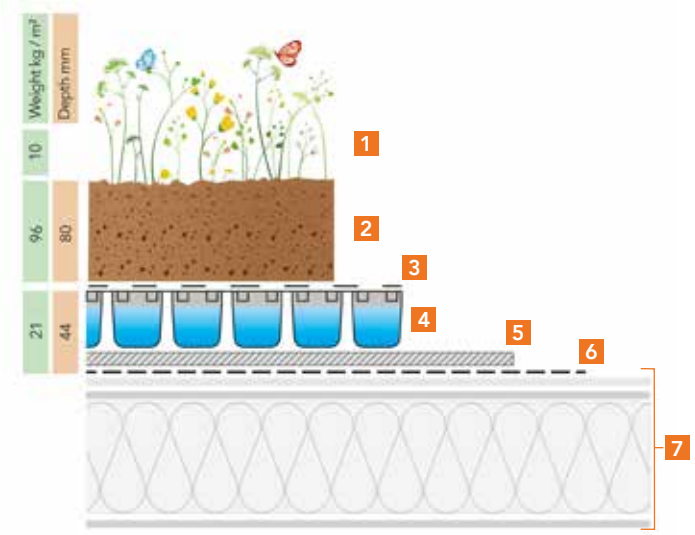
DESIGN & WEIGHT LOADINGS

Substrate green roof systems



Sedum plug plants on extensive substrate with DSE20

A broad range of individual sedum plug plants can be used to produce a particular design or planting layout suited to the roof conditions. Plugs are typically planted 15-25 per m² and normally in groups of 5-7s of similar species. Sedum plants are very drought tolerant and DSE20 with 80mm of FLL compliant Bauder Extensive Substrate gives adequate water storage to support the vegetation.



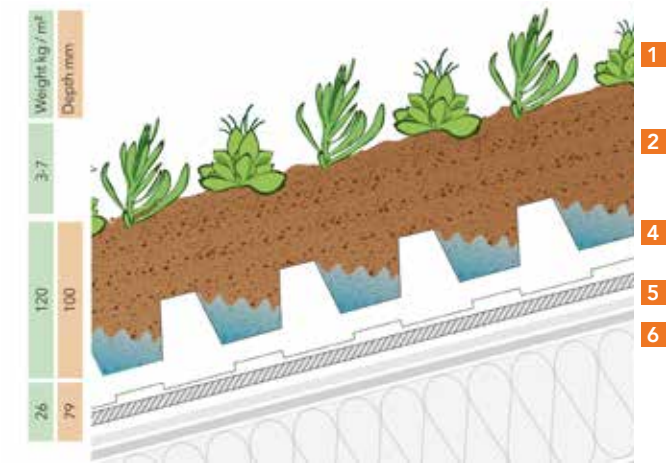
British native species vegetation on biodiverse substrate with DSE40

Often to ensure particular key species establish on a roof individual native species plug plants are used. The vegetation can be established either with a mix of plugs or seed or a combination of the two. When wildflower plugs are used substrate depth needs to be adequate to support the plants and water storage sufficient to maintain plant life. This is achieved with DSE40 water storage board and at least 100mm of substrate which conforms to FLL / GRO guidelines.

LEGEND

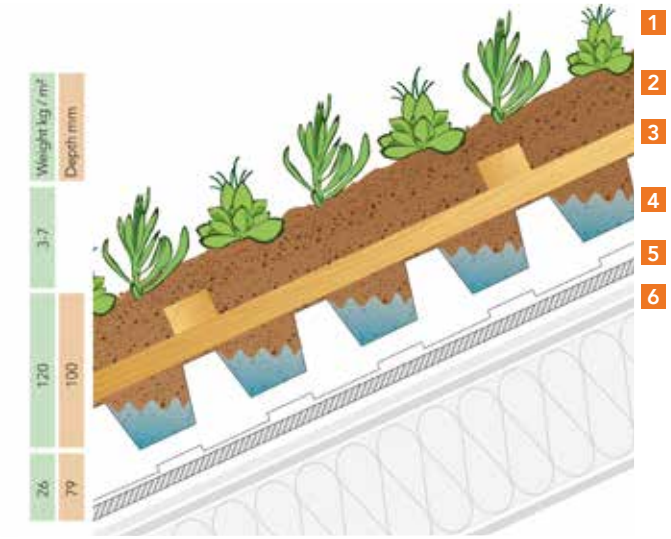
1. **Vegetation** to suit the project and site locality.
2. **Bauder Extensive or Biodiverse Substrate** Light weight growing medium. Manufactured and used in accordance with FLL / GRO guidelines.
3. **Bauder Filter Fleece** filtration layer prevents substrate fines from washing into the drainage layer.
4. **Bauder water storage and drainage DSE20 or DSE40,** capacity to suit the vegetation and project.
5. **Bauder FSM600** 4mm thick protection layer.
6. **Bauder PE Foil** A polyethylene foil separation and slip layer manufactured from recycled granules required on some project specifications.
7. **Bauder Waterproofing System** High performance waterproofing membranes suitable for green roof systems.

Substrate pitched roof systems



Slopes of 5 - 15°

On slopes above 5 degrees, a mechanical stop at the base of the green roof is required to prevent the system moving. Bauder 75mm Reservoir Board interlocks for greater stability and gives improved water storage on pitched roofs.



Slopes of 15° - 25°

On roof slopes above 15°, in addition to the mechanical stop, a trellis is added to the substrate to prevent it slipping whilst the plants become established. It is important that the root systems bed-in quickly to prevent erosion.

Early consideration of the design, construction method and ongoing maintenance of the green roof is vital if the roof is to be successful.

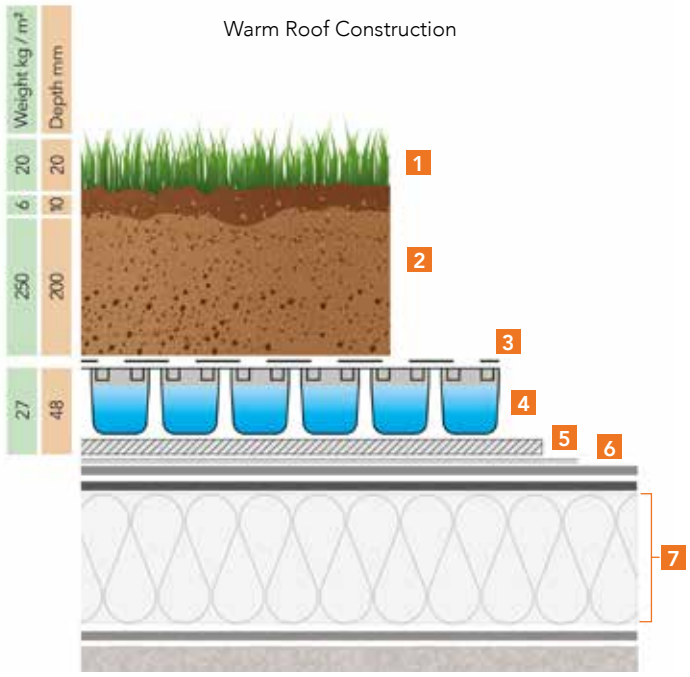
All pitched roof systems will require drip line irrigation to maintain the vegetation during dry weather.

LEGEND

1. **Vegetation** selected species to suit the project, site locality or BAP.
2. **Bauder Extensive or Biodiverse Substrate** lightweight growing medium, manufactured and used in accordance with FLL guidelines.
3. **Timber Trellis** fabricated from untreated timber for substrate retention.
4. **Bauder Reservoir Board** water storage and drainage, 75mm thick.
5. **Bauder FSM 600 Protection Mat** a 4mm thick protection layer.
6. **Bauder Waterproofing System** high performance waterproofing membranes suitable for green roof systems.

DESIGN & WEIGHT LOADINGS

Recreational spaces, gardens and terraces using DSE40 and DSE60



Turf finish

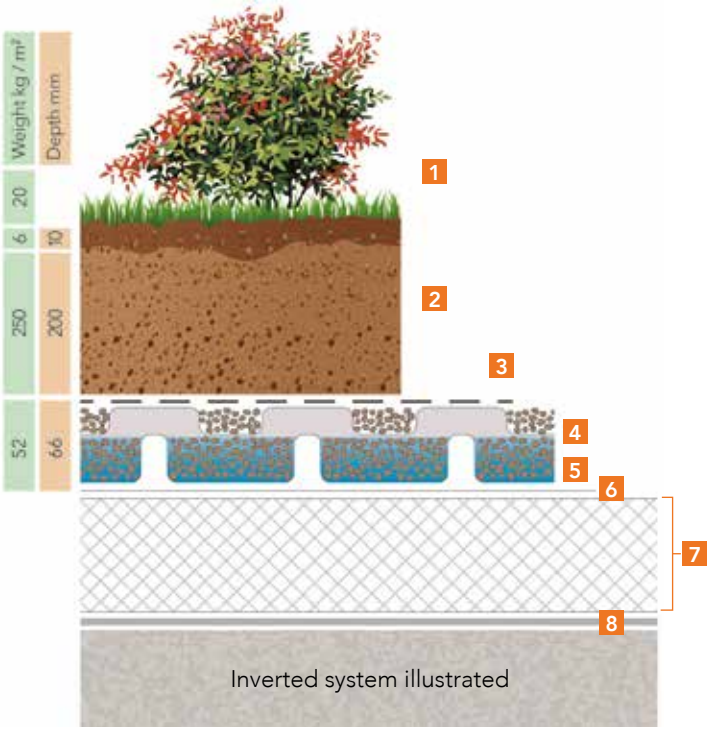
For a lawn finish, either real or artificial, it is important to correctly construct the base. The Bauder DSE40 board delivers stability whilst also ensuring adequate drainage and if required this product can be filled with Bauder Mineral drain, Type 1 or concrete to allow the constructions of paths or planter walls.

1. **Turf**
2. **Bauder Intensive Substrate**
   Lightweight growing medium, 200mm.
3. **Bauder Filter Fleece**
   Filtration layer prevents substrate fines from washing into the drainage layer.
4. **Bauder DSE40**
   Water storage and drainage 40mm thick.
5. **Bauder FSM1100 Protection Mat**
   Polyester and polypropylene fibre.
6. **Bauder PE Foil**
   Polyethylene foil separation layer (required on some project specifications).
7. **Bauder Waterproofing System**
   (Warm roof, Bauder Total Green Roof System shown)

Roadways and footpaths

In applications where roadways and footpaths are required, the board area immediately underneath can be infilled, to provide a stable base for construction capable of supporting heavy vehicular loads, to allow for uninterrupted drainage underneath the hard landscaping.

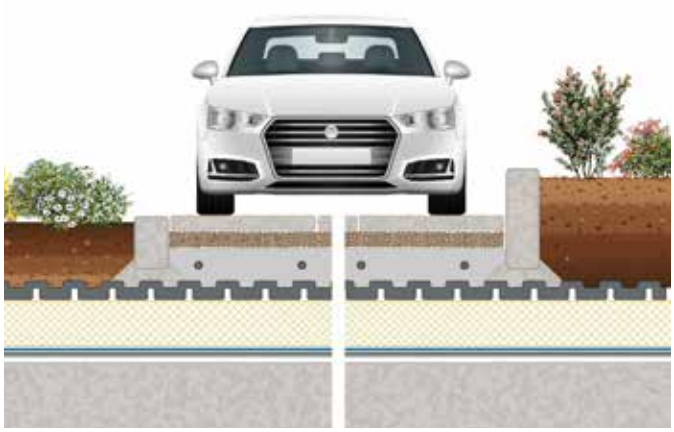
Recreational spaces, gardens and terraces with DSE 40 and DSE60



Soft and/or hard landscaping for heavy trafficking

Protection of the waterproof layers is vital where there is heavy traffic. The Bauder FSM1100 protection mat and DSE60 ensure there is no danger of mechanical damage to the waterproofing. DSE60 can then be filled with Bauder Mineral Drain or concrete to strengthen and spread the implied load.

1. **Turf or vegetation**
2. **Bauder Intensive Substrate**
   Lightweight growing medium to support the planting scheme.
3. **Bauder Filter Fleece**
   Filtration layer prevents substrate fines from washing into the drainage layer.
4. **Bauder DSE60**
   Water storage and drainage 60mm thick.
5. **Bauder FSM 1100 Protection Mat**
6. **Vapour Permeable Membrane**
7. **Bauder Inverted Insulation**
8. **Bauder Waterproofing System**
   (inverted hot melt shown)



Access roads and support slabs

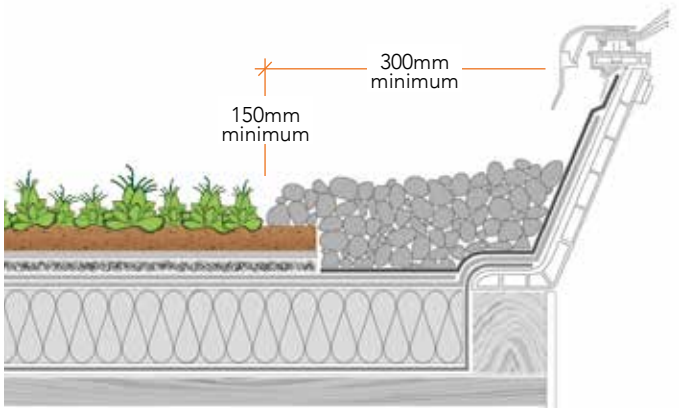
Many large modern developments incorporate planted central courtyards to utilise these valuable areas.

It is essential that a structural engineer assists you with specific information on loadings for your project. Bauder DSE40 and DSE60 is suitable for all walkways, driveways and road surfacing. Concrete covers over the upper board profile should be a minimum of 100mm. If you require an insulated system we will advise you on the depth of insulation necessary for your particular project. Bauder DSE40 and DSE60 will also provide a suitable base for constructing kerbs or foundations to support lightly loaded walls etc.

Bauder drainage boards are designed to support both hard and soft landscaping, laid in a continuous layer over the area to ensure there is free drainage.

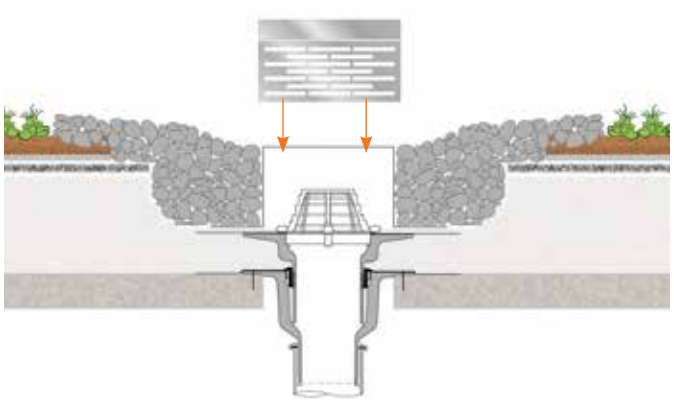
GENERAL DETAILING

XF301 Lightweight sedum system



Construction to Rooflight Upstands

Detailing around upstands and rooflights is important and, to follow best practice, all Bauder green roof specifications follow FLL and GRO guidelines shown which include a pebble 300mm margin to act as a fire break. Where there are opening doors, windows or rooflights the pebble margin should be increased to 500mm.

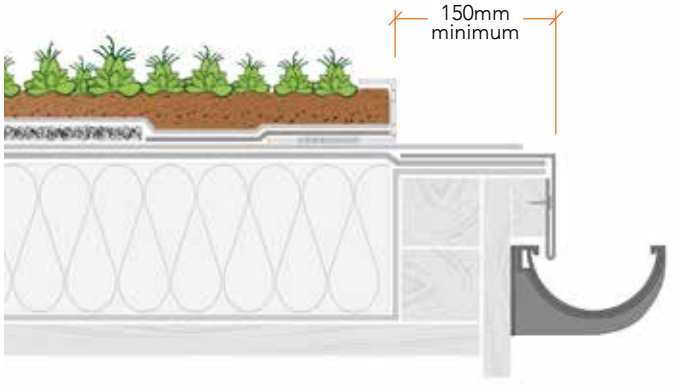


Bauder Inspection Chambers

These should be installed above all internal rainwater outlets to provide access for inspection and cleaning. The chamber lid is secured with a single quarter turn slot screw fixing and has finger holes for easy removal.

The base of the unit is slotted on all four sides to ensure effective drainage, has feet on three sides to provide a stable base onto the waterproofing and has a cut-away feature on the fourth side to allow for its installation at abutments to kerbs and upstands where either chutes or two way outlets are installed.

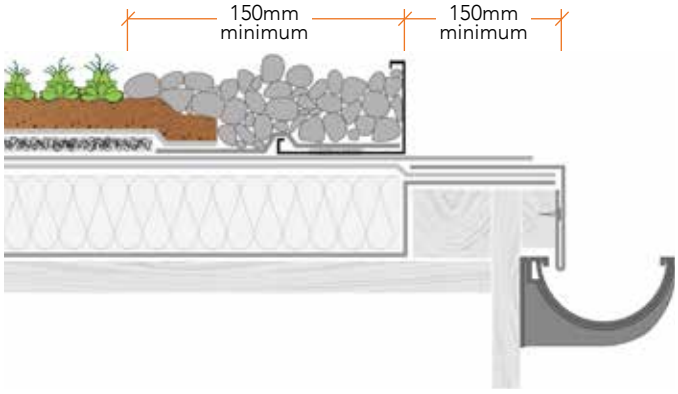
If required, the height of the chambers can be raised in 50mm increments by the use of extenders.



Bauder AL40 Sedum Blanket Edge Trim

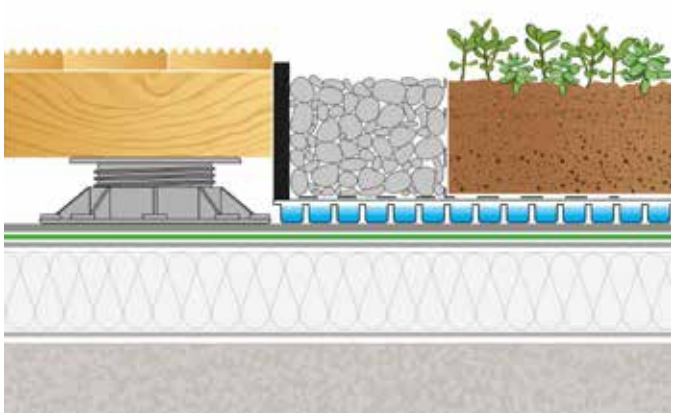
This is a perforated marine grade aluminium alloy trim used to retain the sedum blanket at open perimeters with external gutters and is suitable for bitumen, single ply and cold liquid system installations. It is automatically used on specifications where the roof slope exceeds 5°.

This trim prevents substrate erosion at the exposed edges of the blanket and, due to the excellent wind uplift and fire characteristics of the Bauder XF301 Sedum System, may be used where a pebble vegetation barrier is impractical. The trim should be set back from the drip edge by approx 150mm to prevent vegetation overhanging the gutter and impeding drainage.



Bauder AL80/100 Drainage Trim

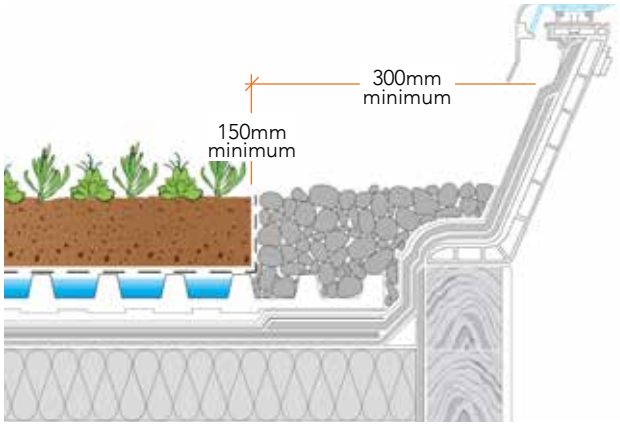
Perforated aluminium trim retains pebble vegetation barriers at open perimeters. The product is suitable for use with both bitumen and single ply waterproofing systems.



Timber Decking

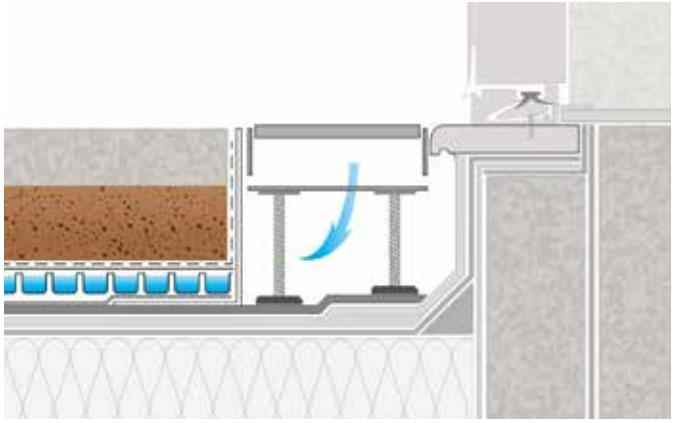
Timber decking should be constructed with a slight fall to disperse rainwater. The timber framework should be raised off the roof surface so that water can flow freely to rainwater outlets and prevent the bearers from eventually rotting.

The suggested method is to place the decking framework on Bauder pedestal support units.



Rooflight Upstand

Due to the combined depth of the waterproofing system and soft landscaping, the proprietary kerbs supplied with most standard rooflights may be insufficient in height.

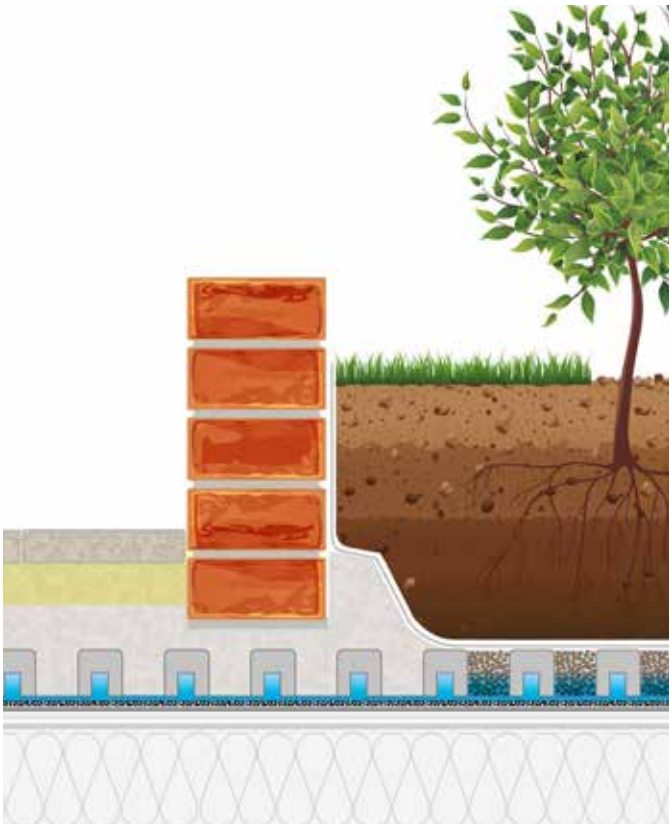


Bauder Linear Drainage System

For drainage close to walls or beneath door thresholds, linear drains can be used to collect surface water and discharge it directly into the drainage layer. The channel sections are perforated to allow water to seep through, and in the event of heavy rain, can direct water to outlets or drainage channels. The channel can be supplied separately for bedding on Bauder Mineral Drain (landscape depths exceeding 90 mm) or with adjustable support legs for depths of between 60 - 140mm. Stainless steel channel connectors and stop ends are also available for this unit.

GENERAL DETAILING

Recreational spaces, gardens and terraces



Raised Planter Beds

There are many different methods for constructing raised planter beds that are independent of the waterproofing system. However, they are all similar in that excess water must be free to drain away from the base to the nearest rainwater outlet.

To prevent staining, the inside of the planter should be waterproofed.

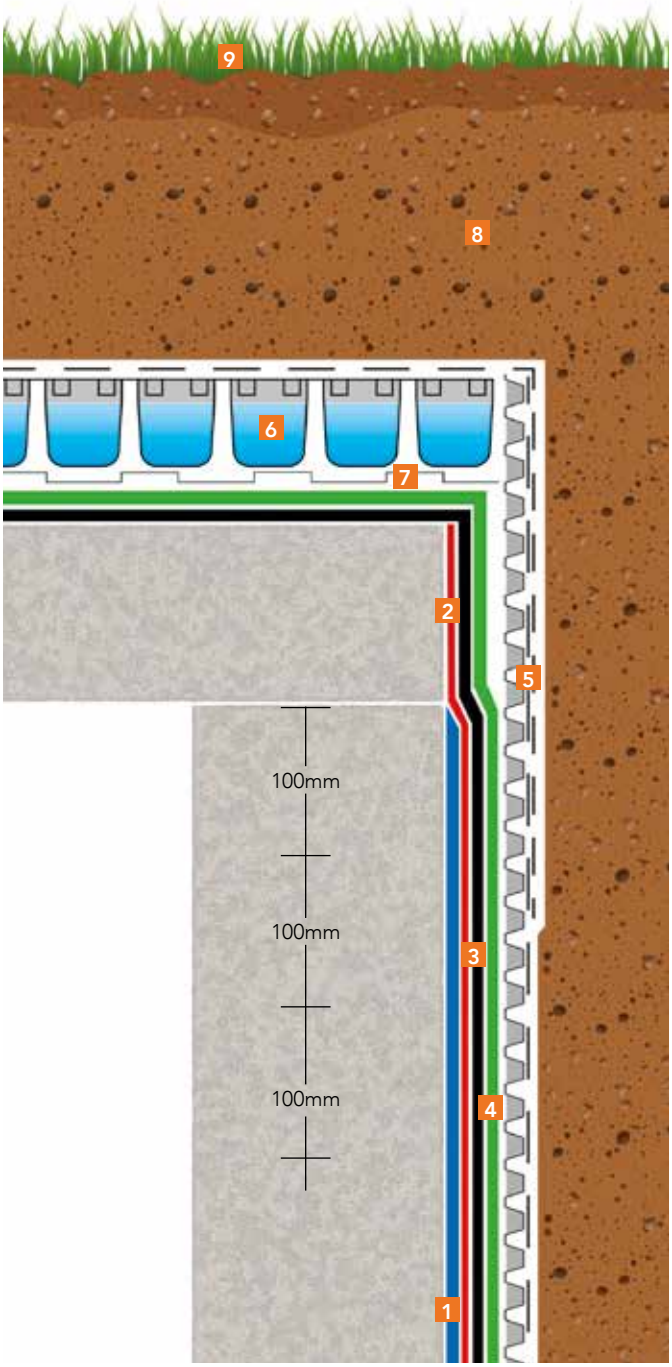
Wherever possible, we recommend that the waterproofing is applied to the whole roof surface to eliminate the need for complex detailing around structures built off the deck.

Perimeter Handrail

Intensive green roofs are predominantly used as recreational areas and therefore it is necessary to incorporate suitable perimeter protection within the design to meet current Health and Safety requirements.

Handrail systems should wherever possible be designed so that they do not penetrate the waterproofing system.

Where there is no practical alternative to a deck fixed handrail, it is important to ensure that the balustrade is circular to allow the waterproofing to be dressed and has an 'umbrella' cover welded to the stanchion positioned a minimum of 150mm above the finished height of the landscaping.



Join-On to Tanking

In situations where the Bauder waterproofing has to join to a structural tanking system, it is important to first establish that the proposed systems are fully compatible.

There are various proprietary tanking systems available on the market and our system is generally compatible with those that are bituminous based.

The illustration shows a typical example of the join-on detail to a Bauder Hot Melt System, in this instance the building is insulated internally. Bauder PLT10 to provide vertical drainage to a land drain at the base of the slab (not shown).

1. **Bituminous Tanking** (by others).
2. **Min 500mm wide strip of Bauder KSA DUO Self Adhesive Membrane.**
3. **Bauder Bakor 790-11.**
4. **Protection layer, shown here as AP2**
5. **Bauder PLT10 (providing vertical drainage).**
6. **DSE40.**
7. **Bauder Filter Fleece.**
8. **Top Soil.**
9. **Turf.**

Specification Support

Specification downloads:
www.bauder.co.uk/technical-centre

Telephone helpline:
0845 271 8800

BAUDER PLANTING & VEGETATION

Bauder WB Native Wildflower Blanket

The vegetation blanket meets GRO recommendations and is specifically designed to flourish in the difficult conditions found on roofs.

The blend of 38 British native wildflowers, herbs and grasses, that are included on most BAP lists, are sown on a 100% natural biodegradable coir blanket.

Bauder SB Sedum Blanket and XF301 Sedum System

Both of these vegetation blankets provide dense sedum foliage cover featuring up to 14 species of sedum.

The plants provide colour and are selected to suit our climate. The blankets are grown for 12 months. The Bauder SB Sedum Blanket is grown on a 100% biodegradable coir carrier and provides 90% ground coverage at installation.

Plug Planting

The use of small seedling plants have a number of advantages, each individual species can be chosen and the location and density of the planting can be controlled.

We can supply a wide range of British provenance plug plant species for a project.

Seeding

Seeding is a proven way to establish vegetation, however at roof level, the environment makes this a challenge without the correct provisions. We supply a range of British and Scottish provenance seed mixes which have a unique blend of seed species, adhesive to bind the seed to the substrate, organic fertiliser for nutrients and mycorrhizal fungi to increase the root surface area and establish the plants as they grow.

BIODIVERSE LANDSCAPES

These have been referred to, in the past as 'brown' or 'naturalised' roofs, and now come under the Biodiverse heading. Over the last few years there has been a dramatic growth in the requirement for biodiversity at roof level.

The issues are complex with each Local Authority producing their own Biodiversity Action Plan (BAP) and target species ensuring it complies with the ecological requirements to achieve maximum BREEAM credits and fulfils all the planning requirements.

Our technical team can produce comprehensive specifications for the roof and, if required, detailed roof plans and management plans.

Biodiverse Roof Plans

In discussions with architects, we can interpret the ecological requirements to show detail 'layout' drawings for the mounding of substrate and location of planting and surface finishes, ensuring the loading of the roof is compatible with the roof structure.

Biodiverse Green Roof Management Plans

Increasingly, local authorities require 3-5 year site specific management plans to ensure the roof establishes correctly and produces the habitat it was designed to deliver.

A further service offered by us is the Project Specific Management Plan. This enables the planning requirements to be discharged with our maintenance and monitoring team carrying out the work.

Vegetation

All BAP's are focused on the enhancement of the local ecosystems, to this end the provenance and suitability of the plant stock is key.

Our vegetation blankets are grown in the UK and all wildflower plugs are of British provenance.

Our Flora Seed Mix range uses seed from sources that are signatures to the Flora Locale code of practice. The seed mixes have been developed to offer suitable solutions for the variety of roof environments. They balance the requirement to have grasses and low ground cover to bind the substrate to prevent erosion with wildflowers to offer a nectar source to the many insects that inhabit biodiverse roofs.

Bauder Flora Seed Mix Range

Bauder Flora 3: General Purpose Mix

Broad range of species, generally low growing, including shade tolerant plants. Particularly suited for the BioSOLAR green roof system.

Bauder Flora 5: Urban Seed Mix

Specifically designed for city rooftops, there is a high percentage of annuals to give good colour in the first year.

Bauder Flora 7: Chalk Grassland

This mix has species particularly found on chalk soils, annuals are not included as they are not generally found on chalk grassland.

Bauder Flora 9: Coastal Mix

Designed for the harsh and saline conditions typically found around the coast of Britain.

Bauder Flora 11: Scottish Mix

The mix contains wildflower and grass species particularly suited to the Scottish environment. All the seed is of Scottish provenance.

WB NATIVE WILDFLOWER BLANKET				
Supply Form	Thickness (Nominal)	Coverage	Saturated Weight	Size
Roll	30-35mm	$2m^2$	≥30 kg/m^2	1x2m

SUBSTRATES
For intensive green roofs

Mineral Drain
This single size limestone aggregate provides drainage for an intensive green roof system. It is typically specified alongside our DSE40 and DSE60 board as an infill to provide additional support, particularly when hard landscaping and further construction such as roadways and raised planter beds is to take place above the drainage layer. The mineral drain increases the compressive strength of DSE60 to withstand ≥1000kN/m².

Intensive Substrate
Lightweight growing medium for intensive green roof planting schemes manufactured to FLL and GRO guidelines and comprises recycled crushed brick and expanded clay shale as well as organic content from composted pine bark. This formulation prevents compaction of soil which is common in topsoil applications. Intensive substrate weighs 1.25 tonnes per cubic metre compared to the average of 1.7 tonnes/m³ for top soil. A considerable weight load saving over an entire roof area.

For extensive green roofs

Extensive Substrate

Lightweight growing medium for extensive green roofs with sedum based planting schemes. Manufactured to FLL and GRO guidelines and comprises recycled crushed brick, expanded clay shale and composted organic material. Extensive substrate weighs 1.2 tonnes per cubic metre.

Biodiverse Substrate

Lightweight growing medium for biodiverse, wildflower and native species green roofs manufactured to FLL and GRO guidelines and comprises recycled crushed brick, expanded clay shale and composted organic material made from over 90% recycled content. Extensive substrate provides aeration qualities with some inherent water retention and weighs 1.2 tonnes per cubic metre.

Seed Bed Substrate

This substrate is a top dressing growing medium which is installed at a minimum depth of 25mm over either Bauder Intensive or Extensive Substrates, when the roof is to be either seeded or to receive vegetation cuttings. This substrate is made from recycled crushed brick and composted pine bark.

WATER STORAGE AND DRAINAGE

DSE60 for intensive green roof finishes

DSE60 is a multi functional product. Manufactured from recycled high density polyethylene (HDPE).

A deeply recessed surface profile provides water storage above and multi-directional drainage beneath. The large contact areas to the underside provide resistance to high loads and protect the waterproofing from point loading damage. The channels created beneath the board profile deliver high capacity drainage, whilst the upper profile, even when filled with our Mineral Drain, can store between 10 – 12 litres/m^2 of water.

Application

Our deepest and most robust drainage layer used under intensive landscaping and beneath paths or roadways.

Material	Recycled HDPE	
Board size	1m x 2m	
Thickness	60mm	
Weight	ca. 40 kg/m^2	When filled with Bauder Mineral Drain
Volume of board profile	ca. 33 litres/m^2	
Water storage	ca. 10 - 12 litres/m^2	
Compressive strength (unfilled)	ca. 100 kN/m^2	

DSE40 for intensive and extensive green roof finishes

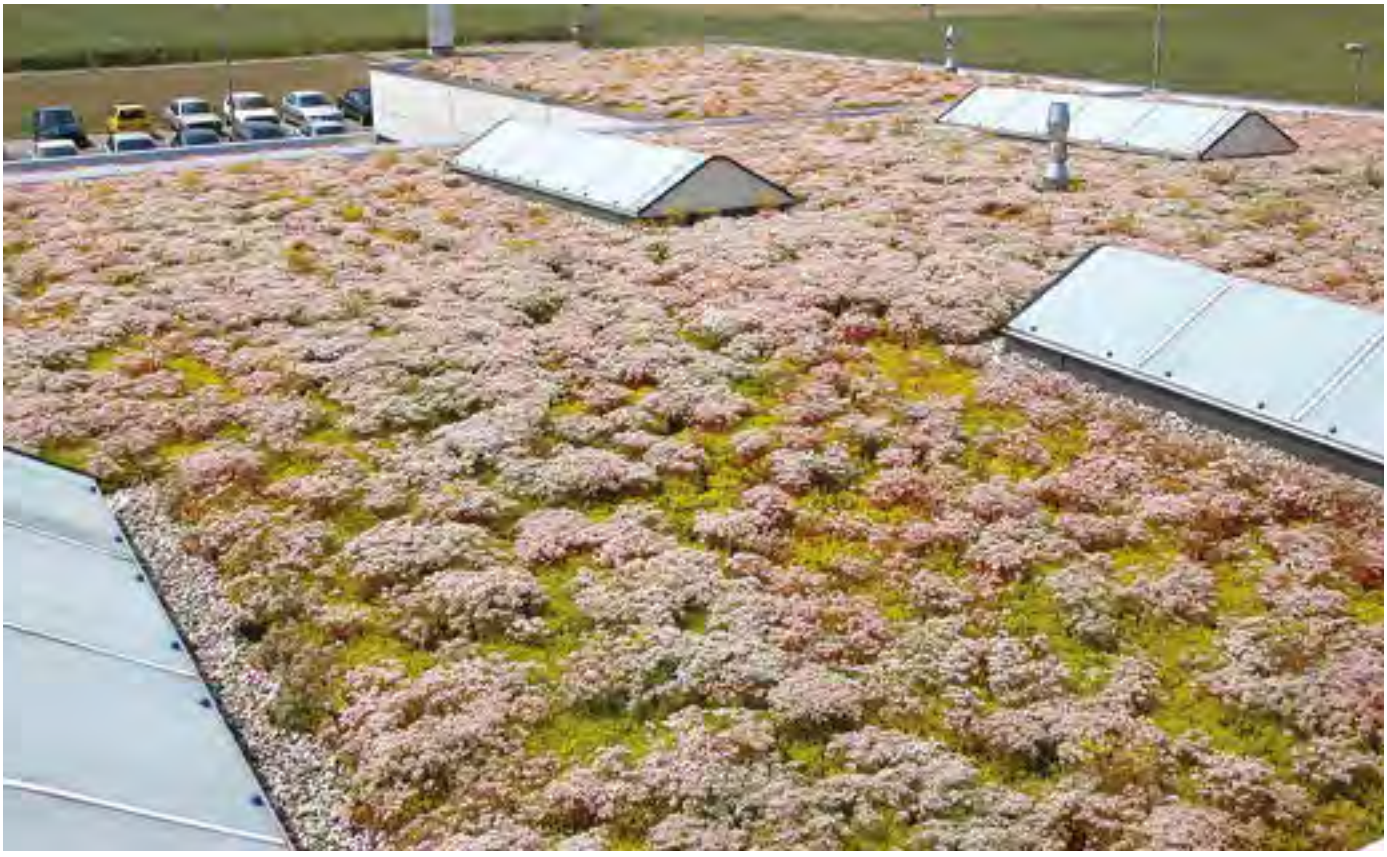
DSE40 is a medium depth board which can provide multidirectional drainage beneath hard or soft landscaping. Manufactured from recycled high density polyethylene (HDPE), the board has been specifically developed to provide a high water retention capacity. It can be used continuously under a multitude of different landscape finishes.

Application

Designed for wildflower and biodiverse applications, as well as deeper, intensive landscapes. Its impressive water storage capacity of 13.5ltr/m² makes it possible to use shallower substrate depths.

DSE40 has the option to fill the cells with type1 or concrete to increase its strength for pathways, dwarf walls etc.

Material	Recycled HDPE
Board size	1.04m x 2.03m
Thickness	40mm
Weight	ca. 1.8 kg/m²
Water storage capacity	ca. 13.5 litres/m²
Compressive strength	100 kN/m²



WATER STORAGE AND DRAINAGE

DSE20 for intensive and extensive green roof finishes

DSE20 is manufactured from recycled high density polyethylene (HDPE) where the cupped profile provides water storage whilst allowing the water to drain through the channels to the underside. It is primarily used to provide continuous drainage within landscaping situations where the loading is moderate.

Application

DSE20 is a lightweight, low profile drainage layer giving excellent drainage and some water storage capacity for sedum green roof systems. Its lightweight, thin profile makes it highly effective on roofs with minimal ponding.

Material	Recycled HDPE
Board size	1.06m x 2.3m
Thickness	20mm
Weight	ca. 1.2kg/m²
Water storage capacity	ca. 7.4 litres/m²
Compressive strength	ca. 110kN/m²

Reservoir Board for sloped extensive green roofs

Material	Expanded polystyrene
Board size	0.780m x 1.283m (rebated)
Thickness	75mm
Weight	ca. 0.95 kg/m²
Water storage capacity	21.5 litres/m² (when laid flat)
Compressive strength	35 kN/m²

Our Reservoir Board offers the maximum water retention under flat, soft landscaping and is now most commonly utilised where roof slopes are in excess of 10°. The unique surface profile retains the Bauder substrate when the board is used on roof slopes.

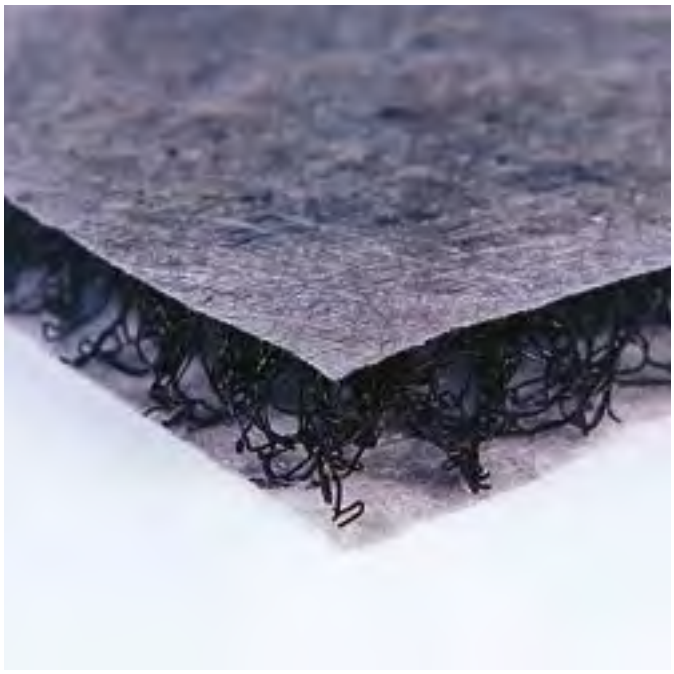
Constructed from rigid expanded polystyrene foam with a profile that is lightweight, the board provides good water retention and allows multi directional drainage. It allows the substrate to be packed into the profile, thus reducing the sheer load on the slopes.

Application

Used for all green roof build ups on slopes over 10°. The interlocking polystyrene board give a ridged surface to hold substrate in place on pitches up to 25°. Reservoir boards can be used with sedum, biodiverse, wildflower and intensive green roof build ups.

WATER DRAINAGE

SDF Mat for extensive green roof finishes



SDF Mat is a multifunctional drainage/filtration layer which also provides protection to the waterproofing system. The product is manufactured from ultraviolet resistant nylon woven loops which are thermally bonded to geo-textile filter fleece facings.

On larger projects with modest falls and where maintenance only foot traffic is anticipated, the SDF Mat offers a very cost-effective solution for lightweight extensive green roof construction.

Application

Our lightest drainage layer, SDF mat has no water storage capacity and therefore has a saturated weight of only 0.6Kg/m^2. It is primarily designed to lift Bauder's XF301 sedum system out of any standing water.

Material	Geo-textile facings with UV resistant woven nylon loops
Roll size	1m x 50m
Coverage	50m^2
Thickness	20mm
Weight	ca. 600g/m^2
Pressure resistance	ca. 20kN/m^2

AL40 Sedum Blanket Edge Trim

PROTECTION LAYERS

For intensive and extensive green roofs

Pro-Mat

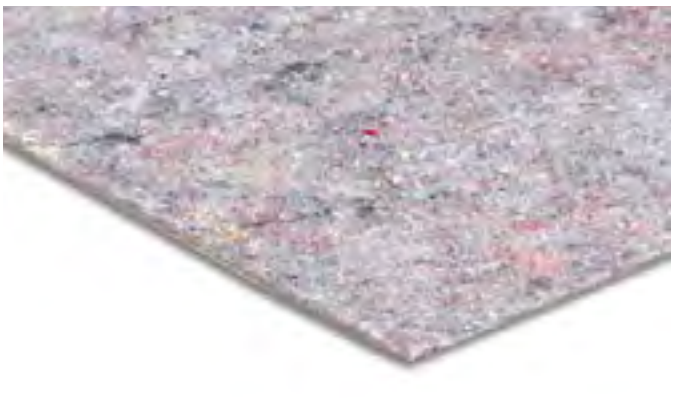
6mm heavy duty protection mat used within an intensive green roof to prevent mechanical damage to the waterproofing system. The product is manufactured from recycled shredded tyres.

FSM 1100

8mm substantial protection mat used within an intensive green roof to prevent mechanical damage to the waterproofing system. The product is manufactured from recycled polyester and polypropylene fibre mix.

FSM 600

4mm protection mat used within an extensive green roof to prevent mechanical damage to the waterproofing system. The product is manufactured from recycled polyester and polypropylene fibre mix.



Eco Mat

6mm lightweight protection fleece used within an extensive green roof to prevent mechanical damage to the waterproofing system. The product is manufactured from recycled polyester and polypropylene fibre mix.

PEDESTAL SUPPORT SYSTEM

Adjustable Pedestals for all Types of Terraces and Decking Areas

Our pedestal support system is a range of lightweight, durable paving and decking support units, designed to meet the most exacting standards of both finish and level demanded by architects and clients when specifying open-jointed paving and decking finishes. The range of units, which are adjustable in height from 17-850mm and incorporate slope corrector heads that are variable to a maximum of 5%, are manufactured from black, UV-resistant high density polypropylene. A range of head attachments allow the gaps between pavers to vary between 2-10mm and there is also a joist batten holder available to secure the bearers for timber decking systems.

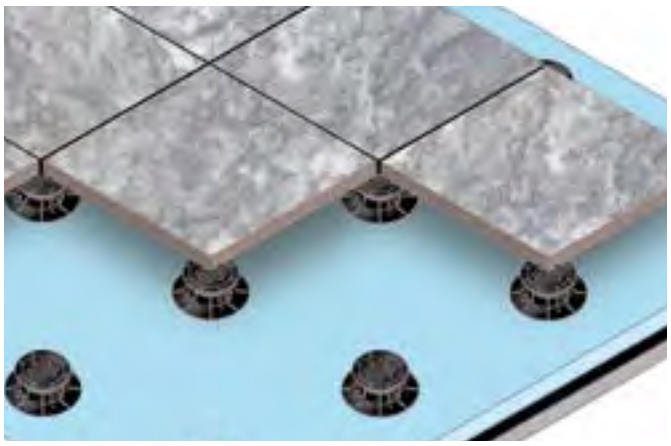
Advantages

- Eliminates algae and efflorescence.
- No bedding sand required.
- Quick to install.
- Cost-effective.
- Lightweight.
- Reduces sound transmission .
- Improves heat insulation.

Key Features

- A lightweight, heavy duty telescopic pedestal.
- Integrated slope corrector head.
- Suitable for a wide range of landscaping applications.
- Works with paving, decking and grillage.
- Allows easy access to concealed services and waterproofing.
- Supports loads of up to 1,000Kg per pedestal.

Slabs



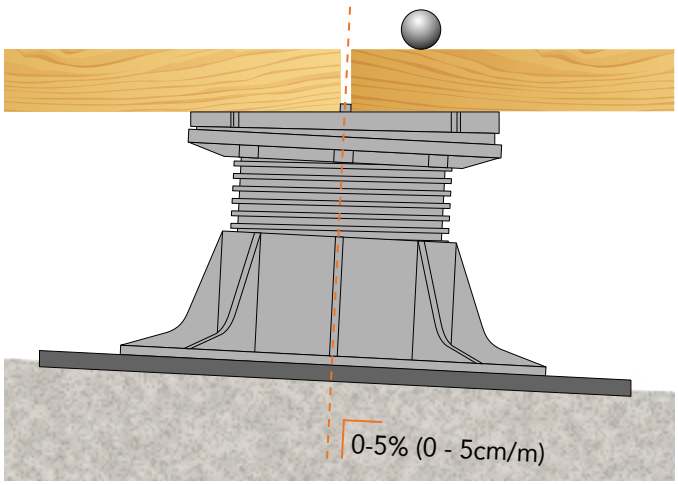
The most common use for the units is to support concrete and stone paving slabs. Where the longest edge of a slab is greater the 450mm, an additional pedestal is usually required under the centre of each slab.

Timber Deck Boards

The number of pedestals required is determined by the span of the joists used, and can only be calculated once the live load requirements are established. Please call us if you wish to discuss this further.

PH5 Slope Corrector

Compensates for a slope from 0 to 5% (slope from 0 to 5cm per linear metre). For good water run-off on roofs the slope should be around 2%.



Specification Support

Specification downloads:
www.bauder.co.uk/technical-centre

Telephone helpline:
0845 271 8800

Standard Pedestal from 17mm x 170mm

DPH-0
17mm

DPH-1
28mm

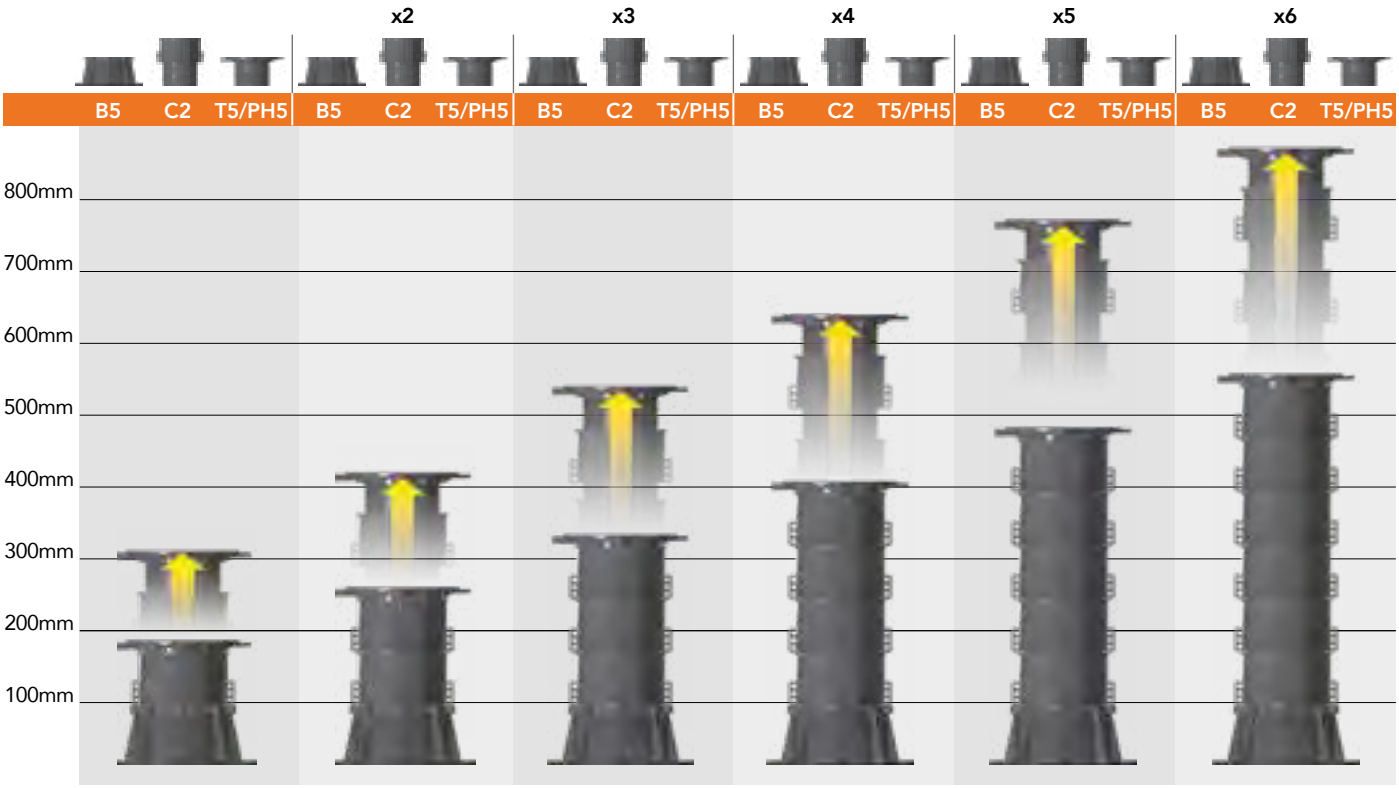
DPH-2
35 to 53mm

DPH-3
50 to 78mm

DPH-4
74 to 110mm

DPH-5
100 to 170mm

Standard Pedestal from 170mm x 850mm (with coupler C3)



DPH-6
170 to 290mm

DPH-7
240 to 400mm

DPH-8
320 to 520mm

DPH-9
390 to 620mm

DPH-10
460 to 750mm

DPH-11
530 to 850mm

IRRIGATION

Green roofs are an expensive finish for a roof so it makes sense to always design in a way to prevent the landscape from dying out in periods of drought. Irrigation should never be disregarded or excluded, because without it, the plants will find it very difficult to survive for the long-term in a healthy condition.

Although water is retained in the growing medium and water storage products this only serves to reduce the frequency of irrigation, particularly if the growing medium is shallow.

Automated irrigation is generally the best option in the long-term. There are many different types of irrigation available, ranging from fully automated with pop-up sprinklers to simple leaky pipe systems.

On the whole, the type of irrigation and frequency of application will depend on the plant species requirements and the prevailing weather conditions. Therefore, the system selected should follow the recommendations of the appointed landscape architect or nominated horticultural specialist and be installed strictly in accordance with the manufacturers recommendations.

▲ An example of a wall mounted control box used in conjunction with an automated irrigation system

OUR SERVICE AND PROMISE

Specifying a Bauder Green Roof System

Specifying Bauder materials for your project could not be easier. Simply contact your local technical manager or our technical department with details of your project and leave the rest to us.

- Design advice on waterproofing, planting and landscaping.
- Information on saturated loadings.
- Advice on drainage related issues.
- Thermal calculations.
- Condensation risk analysis.
- Detailed CAD drawings.
- Comprehensive project specifications.

Important

If you do specify our materials without seeking our advice, it is important that we are advised in order for your project to be eligible for guarantee.

Bauder is committed to ensuring our green roofs deliver as expected and by using our knowledge and experience of how green roofs perform best, we offer distinct levels of guarantee, assurance and support.

Our commitment to clients comprises:

Bauder Green Roof Maintenance Agreement - Keeping plants healthy and established on extensive green roofs.
Bauder Green Roof Promise - Safeguarding Bauder's planted vegetation.

Bauder Landscape Component Guarantee - Guarantees the non-living products specified to construct the green roof.

Bauder Waterproofing Guarantee - Covering the design, products and workmanship depending on the specified Bauder waterproofing system installed.

The Bauder Green Roof Promise

Our Green Roof Promise links with our Maintenance Agreement to ensure the continuous health of the Bauder supplied vegetation and that all aspects of the green roof remains healthy and established with the appropriate vegetation.

These documents are bound together and work in unison to give clients peace of mind, knowing that the entire green roof is in safe hands.

For a green roof to be eligible for the Promise, a Bauder Green Roof Maintenance Agreement must be in place as the green roof is a living ecosystem and as such is dependent on the aftercare the roof receives. The maintenance agreement requires levels of commitment by both the client and Bauder and these are detailed in the specific Bauder Green Roof Maintenance Plan provided within the agreement.

Working together in partnership to give confidence and certainty

The most effective maintenance regime is a partnership between the client 'on site' and Bauder's expertise to establish and nurture the roof. This partnership gives the client and other stakeholders (Local Authorities, Environmental Bodies, etc) the confidence that there is a comprehensive management plan in place for the roof ensuring it remains at its best for the duration of the maintenance cover.

Duration of the Promise

The Bauder Green Roof Promise will (subject to a continuous Bauder Green Roof Maintenance Agreement) match the duration of the guarantee for the underlying waterproofing system.

Technical Services

At Bauder, we pride ourselves on our service package. Through our national team of technical managers and highly trained technicians, we can provide for all your likely requirements, from initial design advice on waterproofing or landscaping related issues through to a detailed and comprehensive specification package supplied in National Building Specification (NBS) or BIM format.

We are increasingly being asked by our clients to assist their consultants with the development of ecological roof systems to meet a Biodiversity Action Plan required for planning consent or where BREEAM points are required.

Whatever your requirement may be for a green or biodiverse roof landscape we will be able to assist you from the conceptual stage in developing a practical solution which will be cost-effective whilst also delivering long-term performance.

Approved Contractors

The quality and experience of the installation operative is essential to ensuring a successful project. We have has always operated a policy where we train and approve the individual installer and not just the company they work for. By taking installers with proven experience and demonstrating the techniques particular to our system we can ensure a quality of workmanship that meets our client's expectations.

With our green roof systems, each installer is required to have a good level of knowledge and understanding of the products and systems that we supply and will regularly deal with our drainage and moisture retention layers, growing mediums and hard and soft landscaping.

On-site Support

Inspections are carried out at key stages of the contract by our own site technicians to satisfy the requirements of our insurance backed company guarantee on our waterproofing systems and ensure adherence to the specification for the landscaping.

ANNUAL MAINTENANCE

A green roof is a real asset to a building and for it to continue to deliver the environmental and aesthetic benefits for which it was originally designed, it is important to carry out maintenance on a regular basis.

A well maintained green roof will:

- Look at its best and ensure the optimum range of species for maximum coverage and longer flowering periods.
- Sustain healthy plant growth to provide a habitat for wildlife.
- Improve air quality by reducing airborne dust and help local air cooling.
- Offer protection to the waterproofing beneath.
- Help conserve and control rainwater runoff.
- Maximise the building's asset value.

Common Problems

Lack of Nutrients can lead to unhealthy plants and loss of vegetation coverage, resulting in bare patches and a reduction in the variety of species present.

Invasive Plants or Weeds, Fallen Leaves and Debris can spoil the aesthetic appearance and function of your green roof, and in some circumstances can even damage the waterproofing. The removal of leaf litter from overhanging trees and other accumulated debris is essential to prevent plants from being suffocated.

Impeded Drainage can be detrimental to plant health and roof performance. For example, when the growing medium is not free-draining it can become wet and lead to root rot or invasive grasses and weeds. Regular maintenance and inspection checks ensure that the outlets and areas surrounding outlet inspection chambers remain clear and perform as intended.

Health & Safety Considerations

Following health and safety best practice is essential to all successful green roof maintenance and should be carried out by fully trained personnel who should be:

- Familiar with working at rooftop levels.
- Able to carry out risk assessments.
- Inspecting mansafe equipment prior to use.
- Competent users of all apparatus.
- Wear all necessary personal protective equipment.

OUR MAINTENANCE SERVICE

With over 35 years' experience in the design and supply of green roofs throughout the UK and Ireland, we offer unparalleled knowledge and horticultural expertise for rooftop vegetation and green roof maintenance.

Our national coverage assures you of a prompt reliable service to fully meet your requirements and comprises a full inspection and evaluation of your green roof.

Our experienced maintenance team will fully comply with relevant health and safety legislation throughout the duration of the work to access the roof with suitable edge protection or fall protection systems; carry out pre-use inspections of all maintenance equipment, wear personal protective equipment where necessary; and risk assess all works prior to commencement.

Following each visit you will be provided with a bespoke report that highlights the work carried out, the condition of the roof and any necessary future works to be considered.

Call our team for a no obligation quote.

Sedum Roof Maintenance

It is a common misconception that extensive green roofs are maintenance free, but this is not the case and annual maintenance is required. Our sedum maintenance service typically concentrates on:

- Ensuring adequate fertilisation of the sedum blanket.
- Evaluating colour and growth rate of vegetation.
- Removal of leaves, debris and any unwanted invasive weeds or plants.
- Repairing of any bare patches.
- Clearance of outlets and testing of irrigation.

Biodiverse & Wildflower Maintenance

The level of maintenance of the horticultural element of this type of green roof varies significantly depending on the species of vegetation incorporated, and our biodiverse and wildflower maintenance service typically focuses on:

- Ensuring a suitable balance of species on the roof.
- Removal of leaves, debris and any unwanted invasive weeds.
- Strimming back of vegetation and sward growth where applicable.
- Ensuring adequate fertilisation of the vegetation.
- Examining and testing of irrigation.

Appendix D

Foul Water Design

CS CONSULTING
GROUP

FOUL SEWERAGE DESIGN

Design Criteria for Foul - Main

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	148.66	Maximum Backdrop Height (m)	1.500
Persons per House	3.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Inverts

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F1.000	9.212	0.061	150.0	0.000	8	0.0	1.500	o	225	Pipe/Conduit	
F1.001	54.805	0.274	200.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F1.002	14.960	0.075	200.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F1.003	30.695	0.153	200.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F2.000	25.184	0.252	100.0	0.000	8	0.0	1.500	o	150	Pipe/Conduit	
F2.001	9.871	0.082	120.0	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F1.004	42.626	0.213	200.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F3.000	25.651	0.257	100.0	0.000	8	0.0	1.500	o	150	Pipe/Conduit	
F3.001	10.186	0.102	100.0	0.000	0	0.0	1.500	o	150	Pipe/Conduit	
F4.000	13.366	0.134	99.7	0.000	249	0.0	1.500	o	225	Pipe/Conduit	
F1.005	27.792	0.138	202.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F1.006	15.717	0.079	200.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F1.007	58.825	0.281	209.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.000	36.160	0.000	0.0	8	0.0	13	0.26	0.94	37.2	0.2
F1.001	36.099	0.000	0.0	8	0.0	14	0.23	0.81	32.2	0.2
F1.002	35.825	0.000	0.0	8	0.0	14	0.23	0.81	32.2	0.2
F1.003	35.750	0.000	0.0	8	0.0	14	0.23	0.81	32.2	0.2
F2.000	36.000	0.000	0.0	8	0.0	14	0.31	0.88	15.5	0.2
F2.001	35.748	0.000	0.0	8	0.0	14	0.29	0.80	14.1	0.2
F1.004	35.591	0.000	0.0	16	0.0	20	0.29	0.81	32.2	0.5
F3.000	35.740	0.000	0.0	8	0.0	14	0.31	0.88	15.5	0.2
F3.001	35.483	0.000	0.0	8	0.0	14	0.31	0.88	15.5	0.2
F4.000	35.600	0.000	0.0	249	0.0	63	0.86	1.15	45.7	7.7
F1.005	35.378	0.000	0.0	273	0.0	79	0.68	0.81	32.1	8.5
F1.006	35.240	0.000	0.0	273	0.0	79	0.68	0.81	32.2	8.5
F1.007	35.162	0.000	0.0	273	0.0	79	0.67	0.79	31.5	8.5

Network Design Table for Foul - Main

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Houses	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
F1.008	35.141	0.176	200.0	0.000	12	0.0	1.500	o	225	Pipe/Conduit	
F1.009	32.514	0.163	200.0	0.000	72	0.0	1.500	o	225	Pipe/Conduit	
F1.010	20.107	0.101	200.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F1.011	36.394	0.182	200.0	0.000	12	0.0	1.500	o	225	Pipe/Conduit	
F1.012	9.473	0.047	200.0	0.000	0	0.0	1.500	o	225	Pipe/Conduit	
F5.000	59.085	0.671	88.0	0.000	12	0.0	1.500	o	225	Pipe/Conduit	
F5.001	10.448	0.116	90.0	0.000	8	0.0	1.500	o	225	Pipe/Conduit	
F1.013	47.547	0.340	139.8	0.000	0	0.0	1.500	o	375	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Hse	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
F1.008	34.880	0.000	0.0	285	0.0	80	0.69	0.81	32.2	8.8
F1.009	34.705	0.000	0.0	357	0.0	91	0.73	0.81	32.2	11.1
F1.010	34.542	0.000	0.0	357	0.0	91	0.73	0.81	32.2	11.1
F1.011	34.441	0.000	0.0	369	0.0	93	0.74	0.81	32.2	11.4
F1.012	34.259	0.000	0.0	369	0.0	93	0.74	0.81	32.2	11.4
F5.000	36.110	0.000	0.0	12	0.0	14	0.35	1.22	48.7	0.4
F5.001	35.439	0.000	0.0	20	0.0	18	0.41	1.21	48.1	0.6
F1.013	33.860	0.000	0.0	389	0.0	72	0.82	1.36	149.7	12.0

Manhole Schedules for Foul - Main

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
F1	37.150	0.990	Open Manhole	1200	F1.000	36.160	225				
F2	37.200	1.101	Open Manhole	1200	F1.001	36.099	225	F1.000	36.099	225	
F3	37.300	1.475	Open Manhole	1200	F1.002	35.825	225	F1.001	35.825	225	
F4	37.100	1.350	Open Manhole	1200	F1.003	35.750	225	F1.002	35.750	225	
F5	36.600	0.600	Open Manhole	1200	F2.000	36.000	150				
F6	36.600	0.852	Open Manhole	1200	F2.001	35.748	150	F2.000	35.748	150	
F7	36.830	1.239	Open Manhole	1200	F1.004	35.591	225	F1.003	35.597	225	6
								F2.001	35.666	150	
F8	36.600	0.860	Open Manhole	1200	F3.000	35.740	150				
F9	36.600	1.117	Open Manhole	1200	F3.001	35.483	150	F3.000	35.483	150	
FPump	36.600	1.000	Open Manhole	1200	F4.000	35.600	225				
F10	37.190	1.812	Open Manhole	1200	F1.005	35.378	225	F1.004	35.378	225	
								F3.001	35.381	150	
								F4.000	35.466	225	88
F11	36.980	1.740	Open Manhole	1200	F1.006	35.240	225	F1.005	35.240	225	
F12	36.840	1.678	Open Manhole	1200	F1.007	35.162	225	F1.006	35.162	225	
F13	36.550	1.670	Open Manhole	1200	F1.008	34.880	225	F1.007	34.880	225	
F14	36.500	1.795	Open Manhole	1200	F1.009	34.705	225	F1.008	34.705	225	
F15	36.100	1.558	Open Manhole	1200	F1.010	34.542	225	F1.009	34.542	225	
F16	36.250	1.809	Open Manhole	1200	F1.011	34.441	225	F1.010	34.441	225	
F17	36.730	2.471	Open Manhole	1200	F1.012	34.259	225	F1.011	34.259	225	
F18	37.560	1.450	Open Manhole	1200	F5.000	36.110	225				
F19	36.990	1.551	Open Manhole	1200	F5.001	35.439	225	F5.000	35.439	225	
F20	36.860	3.000	Open Manhole	1350	F1.013	33.860	375	F1.012	34.212	225	202
								F5.001	35.323	225	1313
F1903	36.000	2.480	Open Manhole	0		OUTFALL		F1.013	33.520	375	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
F1	722889.707	725775.269	722889.707	725775.269	Required	
F2	722892.604	725766.525	722892.604	725766.525	Required	
F3	722936.097	725733.180	722936.097	725733.180	Required	
F4	722949.759	725727.082	722949.759	725727.082	Required	
F5	723004.234	725716.086	723004.234	725716.086	Required	

Manhole Schedules for Foul - Main

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
F6	722981.682	725727.296	722981.682	725727.296	Required	
F7	722978.887	725736.764	722978.887	725736.764	Required	
F8	723008.249	725717.265	723008.249	725717.265	Required	
F9	723019.824	725740.156	723019.824	725740.156	Required	
FPump	723013.610	725762.423	723013.610	725762.423	Required	
F10	723019.297	725750.328	723019.297	725750.328	Required	
F11	723045.577	725759.372	723045.577	725759.372	Required	
F12	723055.242	725771.766	723055.242	725771.766	Required	
F13	723076.865	725826.472	723076.865	725826.472	Required	
F14	723066.106	725859.926	723066.106	725859.926	Required	
F15	723055.792	725890.760	723055.792	725890.760	Required	
F16	723039.555	725902.620	723039.555	725902.620	Required	
F17	723016.441	725930.730	723016.441	725930.730	Required	
F18	722966.946	725992.005	722966.946	725992.005	Required	
F19	723004.046	725946.019	723004.046	725946.019	Required	
F20	723011.746	725938.958	723011.746	725938.958	Required	
F1903	723052.763	725963.006			No Entry	

PIPELINE SCHEDULES for Foul - Main

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.000	o	225	F1	37.150	36.160	0.765	Open Manhole	1200
F1.001	o	225	F2	37.200	36.099	0.876	Open Manhole	1200
F1.002	o	225	F3	37.300	35.825	1.250	Open Manhole	1200
F1.003	o	225	F4	37.100	35.750	1.125	Open Manhole	1200
F2.000	o	150	F5	36.600	36.000	0.450	Open Manhole	1200
F2.001	o	150	F6	36.600	35.748	0.702	Open Manhole	1200
F1.004	o	225	F7	36.830	35.591	1.014	Open Manhole	1200
F3.000	o	150	F8	36.600	35.740	0.710	Open Manhole	1200
F3.001	o	150	F9	36.600	35.483	0.967	Open Manhole	1200
F4.000	o	225	FPump	36.600	35.600	0.775	Open Manhole	1200
F1.005	o	225	F10	37.190	35.378	1.587	Open Manhole	1200
F1.006	o	225	F11	36.980	35.240	1.515	Open Manhole	1200
F1.007	o	225	F12	36.840	35.162	1.453	Open Manhole	1200
F1.008	o	225	F13	36.550	34.880	1.445	Open Manhole	1200
F1.009	o	225	F14	36.500	34.705	1.570	Open Manhole	1200
F1.010	o	225	F15	36.100	34.542	1.333	Open Manhole	1200
F1.011	o	225	F16	36.250	34.441	1.584	Open Manhole	1200
F1.012	o	225	F17	36.730	34.259	2.246	Open Manhole	1200
F5.000	o	225	F18	37.560	36.110	1.225	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.000	9.212	150.0	F2	37.200	36.099	0.876	Open Manhole	1200
F1.001	54.805	200.0	F3	37.300	35.825	1.250	Open Manhole	1200
F1.002	14.960	200.0	F4	37.100	35.750	1.125	Open Manhole	1200
F1.003	30.695	200.0	F7	36.830	35.597	1.008	Open Manhole	1200
F2.000	25.184	100.0	F6	36.600	35.748	0.702	Open Manhole	1200
F2.001	9.871	120.0	F7	36.830	35.666	1.014	Open Manhole	1200
F1.004	42.626	200.0	F10	37.190	35.378	1.587	Open Manhole	1200
F3.000	25.651	100.0	F9	36.600	35.483	0.967	Open Manhole	1200
F3.001	10.186	100.0	F10	37.190	35.381	1.659	Open Manhole	1200
F4.000	13.366	99.7	F10	37.190	35.466	1.499	Open Manhole	1200
F1.005	27.792	202.0	F11	36.980	35.240	1.515	Open Manhole	1200
F1.006	15.717	200.0	F12	36.840	35.162	1.453	Open Manhole	1200
F1.007	58.825	209.0	F13	36.550	34.880	1.445	Open Manhole	1200
F1.008	35.141	200.0	F14	36.500	34.705	1.570	Open Manhole	1200
F1.009	32.514	200.0	F15	36.100	34.542	1.333	Open Manhole	1200
F1.010	20.107	200.0	F16	36.250	34.441	1.584	Open Manhole	1200
F1.011	36.394	200.0	F17	36.730	34.259	2.246	Open Manhole	1200
F1.012	9.473	200.0	F20	36.860	34.212	2.423	Open Manhole	1350
F5.000	59.085	88.0	F19	36.990	35.439	1.326	Open Manhole	1200

PIPELINE SCHEDULES for Foul - Main

Upstream Manhole

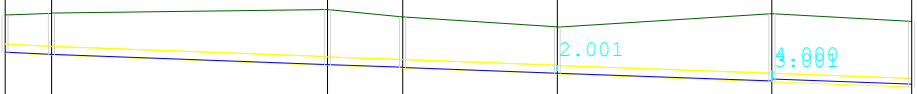
PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F5.001	o	225	F19	36.990	35.439	1.326	Open Manhole	1200
F1.013	o	375	F20	36.860	33.860	2.625	Open Manhole	1350

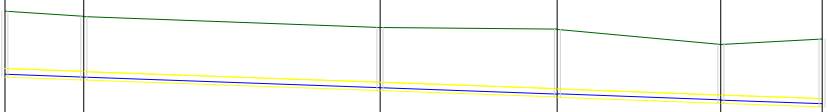
Downstream Manhole

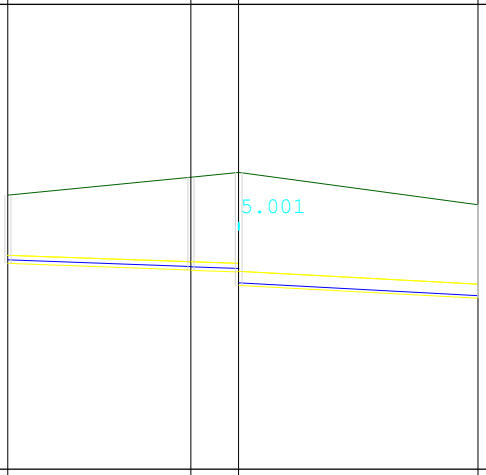
PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F5.001	10.448	90.0	F20	36.860	35.323	1.312	Open Manhole	1350
F1.013	47.547	139.8	F1903	36.000	33.520	2.105	Open Manhole	0

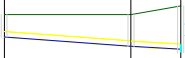
Free Flowing Outfall Details for Foul - Main

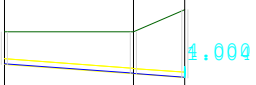
Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
F1.013	F1903	36.000	33.520	33.520	0	0

MH Name			F2		F4	F7	F10	F11
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000								
PN			F1.001		F1.003	F1.004	F1.005	
Dia (mm)			225		225	225	225	
Slope (1:X)			200.0		200.0	200.0	202.0	
Cover Level (m)		37.150	37.200	37.300	37.100	36.830	37.190	36.980
Invert Level (m)		36.160	36.099 35.825	35.825 35.750	35.750 35.597	35.591 35.378	35.378 35.240	
Length (m)			54.805		30.695	42.626	27.792	

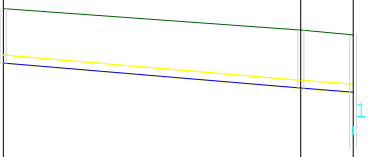
MH Name			F12	F13	F14	F15	F16
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000							
PN			F1.007	F1.008	F1.009	F1.010	
Dia (mm)			225	225	225	225	
Slope (1:X)			209.0	200.0	200.0	200.0	
Cover Level (m)		36.980	36.840	36.550	36.500	36.100	36.250
Invert Level (m)		35.240 35.162	35.162 34.880	34.880 34.705	34.705 34.542	34.542 34.441	
Length (m)			58.825	35.141	32.514	20.107	

MH Name		F16		F20	F1903
Hor Scale 1500 Ver Scale 200 Datum (m) 29.000					
PN		F1.011		F1.013	
Dia (mm)		225		375	
Slope (1:X)		200.0		139.8	
Cover Level (m)		36.250	36.730	36.860	36.000
Invert Level (m)		34.441	34.259	34.259 33.860	33.520
Length (m)		36.394		47.547	

MH Name		F5		F7
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000				
PN		F2.000		
Dia (mm)		150		
Slope (1:X)		100.0		
Cover Level (m)		36.600	36.600	36.830
Invert Level (m)		36.000	35.748 35.748	
Length (m)		25.184		

MH Name		F8		F10
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000				
PN		F3.000		
Dia (mm)		150		
Slope (1:X)		100.0		
Cover Level (m)		36.600	36.600	37.190
Invert Level (m)		35.740 35.483	35.483	
Length (m)		25.651		

MH Name			F10
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000			
PN			
Dia (mm)			
Slope (1:X)			
Cover Level (m)		36.600	37.190
Invert Level (m)		35.600 35.466	
Length (m)			

MH Name		F18		F20
Hor Scale 1500 Ver Scale 200 Datum (m) 30.000				1.012
PN		F5.000		
Dia (mm)		225		
Slope (1:X)		88.0		
Cover Level (m)		37.560	36.990	36.860
Invert Level (m)		36.110 35.439	35.439	
Length (m)		59.085		

Appendix E

Irish Water Pre-Connection Response

CS CONSULTING
GROUP

Gessica Silva

CS Consulting
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D02E267

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Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

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

www.water.ie

7 September 2020

Re: CDS20004047 pre-connection enquiry - Subject to contract | Contract denied

Connection for Housing Development of 404 units at Clonskeen Road, Johnstown, Deansgrange, Co. Dublin

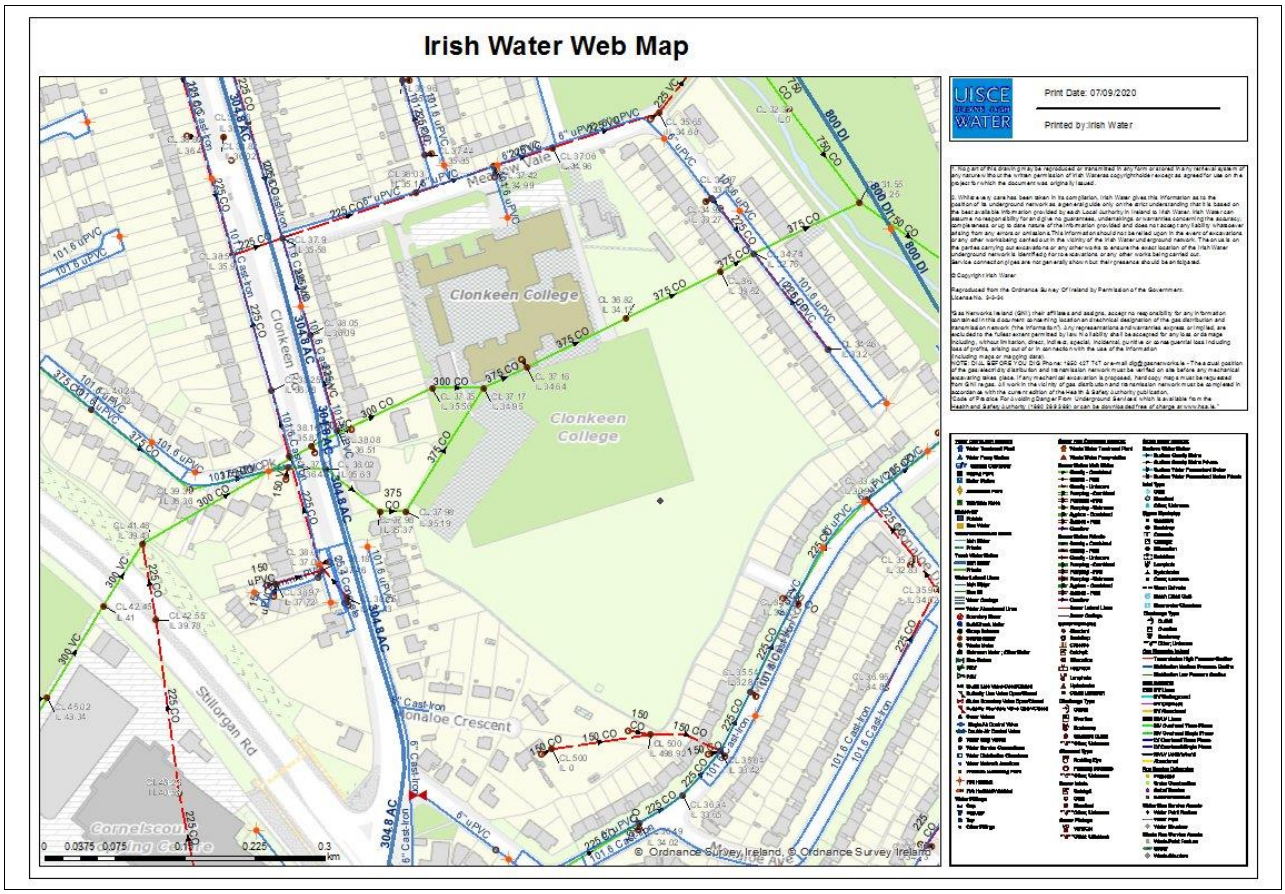
Dear Sir/Madam,

Irish Water has reviewed your pre-connection enquiry in relation to a Water & Wastewater connection at Clonskeen Road, Johnstown, Deansgrange, Co. 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 networks as assessed by Irish Water, we wish to advise you that your proposed connection to the Irish Water networks can be facilitated at this moment in time.

SERVICE	**OUTCOME OF PRE-CONNECTION ENQUIRY** **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 Subject to upgrades
Wastewater Connection	Feasible without infrastructure upgrade by Irish Water
SITE SPECIFIC COMMENTS	
Water Connection	Approximately 60m of new 200mm ID pipe main to be laid to connect the site development to the existing 12" AC main, see red dashed line in Figure 1. A bulk meter to be installed on this connection main, meter will be linked up with telemetry online system. This Confirmation of Feasibility to connect to the Irish Water infrastructure also does not extend to your fire flow requirements. Please note that Irish Water cannot guarantee a flow rate to meet fire flow requirements and in order to guarantee a flow to meet the Fire Authority requirements, you may need to provide adequate fire storage capacity within your development. In order to determine the potential flow that could be delivered during normal operational conditions, an onsite assessment of the existing network is required.

Wastewater Connection	No surface water from the development shall enter the Irish Water network. There is important Irish Water infrastructure within the site boundary (please find attached Irish Water GIS record of the area as a general guide only). The Developer will be required to survey the site to determine the exact location of the pipes. Any trial investigations should be carried out with the agreement and in the presence of the Local Authority Inspector. You are advised that structures or works over or in close proximity to Irish Water infrastructure that will inhibit access for maintenance or endanger structural or functional integrity of the infrastructure are not allowed. Separation distances between the Irish Water infrastructure and proposed structures, other services, trees, etc. have to be in accordance with the Irish Water Codes of Practice and Standard Details. If you wish to divert the asset to facilitate the development, you must have entered into a diversion agreement prior to commencing. In advance of obtaining final planning permission the developer is requested to contact Irish Water to agree the required separation distances or proposed diversion associated with the infrastructure to Irish Water Diversion Team via email address diversions@water.ie for review and approval.
Strategic Housing Development: Irish Water notes that the scale of this development dictates that it is subject to the Strategic Housing Development planning process. In advance of submitting your full application to An Bord Pleanála for assessment, you must have reviewed this development with Irish Water and received a Statement of Design Acceptance in relation to the layout of water and wastewater services.	
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:



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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.

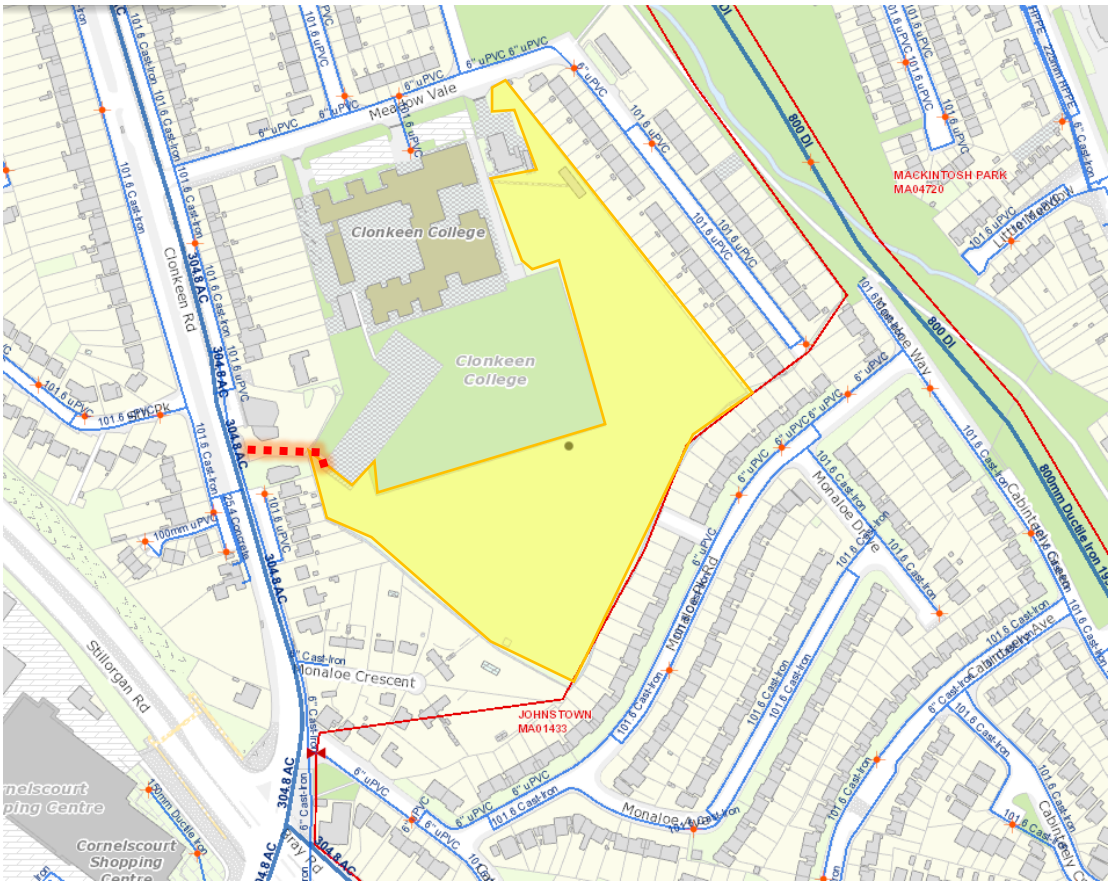
If you have any further questions, please contact Deirdre Ryan from the design team on 022 54620 or email deiryan@water.ie For further information, visit **www.water.ie/connections.**

Yours sincerely,

Maria O'Dwyer

Connections and Developer Services

Figure 1: Proposed Water connection



Irish Water Web Map

Print Date: 07/09/2020

Printed by:Irish Water

Appendix F

Irish Water Statement of Design Acceptance

CS CONSULTING
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Robert Fitzmaurice
Cronin & Sutton Consulting
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D02 E267

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Oifig Sheachadta na
Cathrach Theas
Cathair Chorcaí

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

www.water.ie

22 July 2021

Re: Design Submission for Clonskeen Road, Johnstown, Deansgrange, Co. Dublin (the "Development")
(the "Design Submission") / Connection Reference No: CDS20004047

Dear Robert Fitzmaurice,

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: Alvaro Garcia
Email: agarcia@water.ie

Yours sincerely,

Yvonne Harris

Yvonne Harris
Head of Customer Operations

Appendix A

Document Title & Revision

W012-CSC-ZZ-XX-DR-C-0004 P2_Proposed Basement Drainage Layout
W012-CSC-ZZ-XX-DR-C-0006 P2_Proposed Foul Sewer Layout
W012-CSC-ZZ-XX-DR-C-0024_Pump Station Details
W012-CSC-ZZ-XX-DR-C-0025_Foul Longsections
W012-CSC-ZZ-XX-DR-C-0032_Build Over and Wayleave Plan
W012-CSC-ZZ-XX-DR-C-0007 P2_Proposed Watermain Layout

*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.

LEGEND:

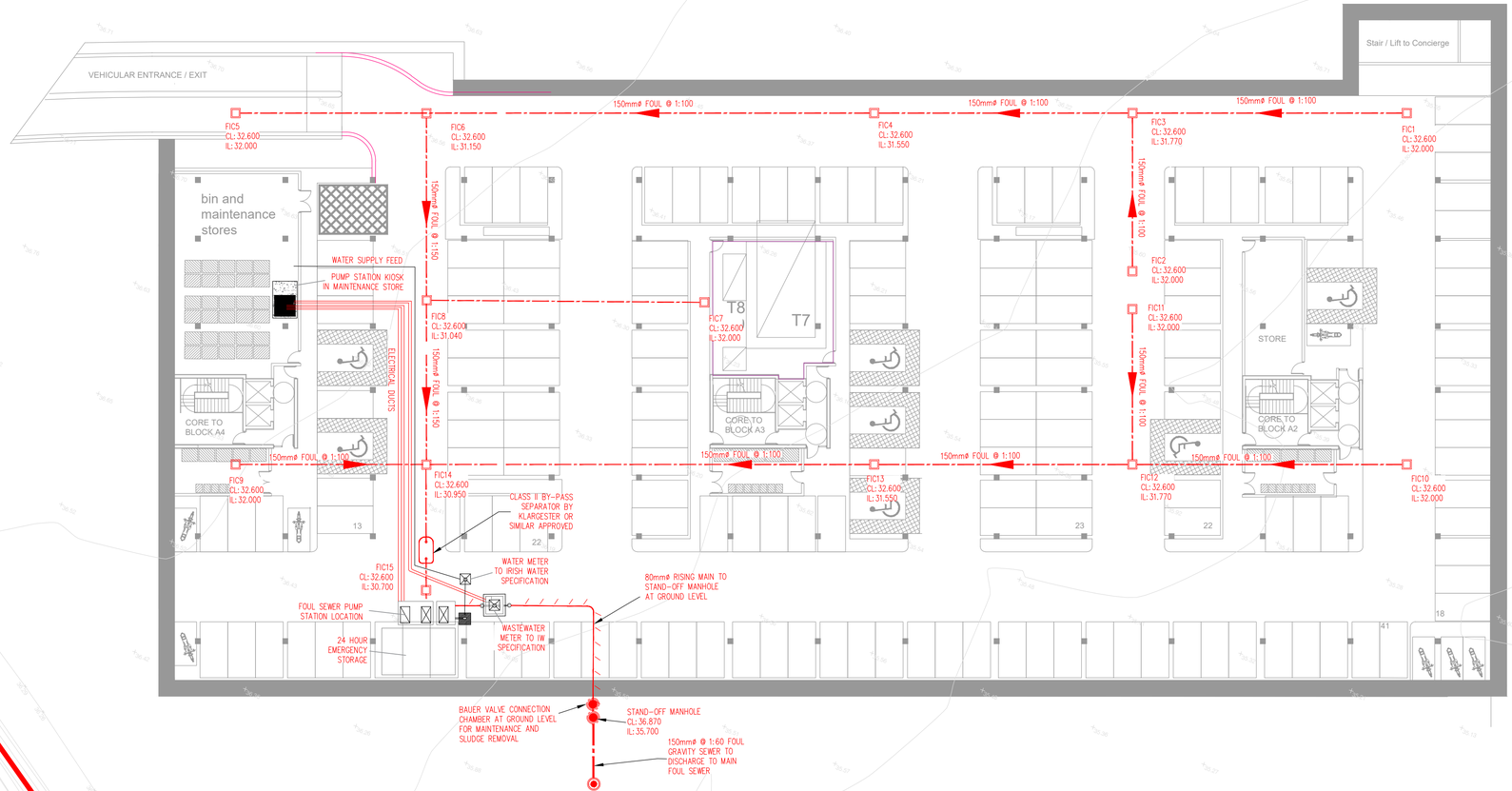
SITE BOUNDARY

LEGEND:

PROPOSED FOUL SEWER — TMH1

PROPOSED FOUL RISING MAIN

PROPOSED FOUL INSPECTION CHAMBER — FIC



PROPOSED BASEMENT DRAINAGE LAYOUT.

SCALE= 1:250

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PAC/SHD/162/20

W012

NOTES
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Rev. No.	Date	REVISION NOTE	Drn. By	Chkd. By
P1	13.10.2020	ARCHITECTS LAYOUT REVISED	JS	OS
P2	15.06.2021	ARCHITECTS LAYOUT REVISED	DF	OS

Architect	Scott Tallon Walker
Project	Proposed Development at Clonkeen Road
Title	Proposed Basement Drainage Layout
Dwg. No.	W012-CSC-ZZ-XX-DR-C-0004

Date	Drn by	Chkd by	Aprvd by	Scale	Revision
02.06.2020	JS	RFM	OS	1:250 @A1	P2

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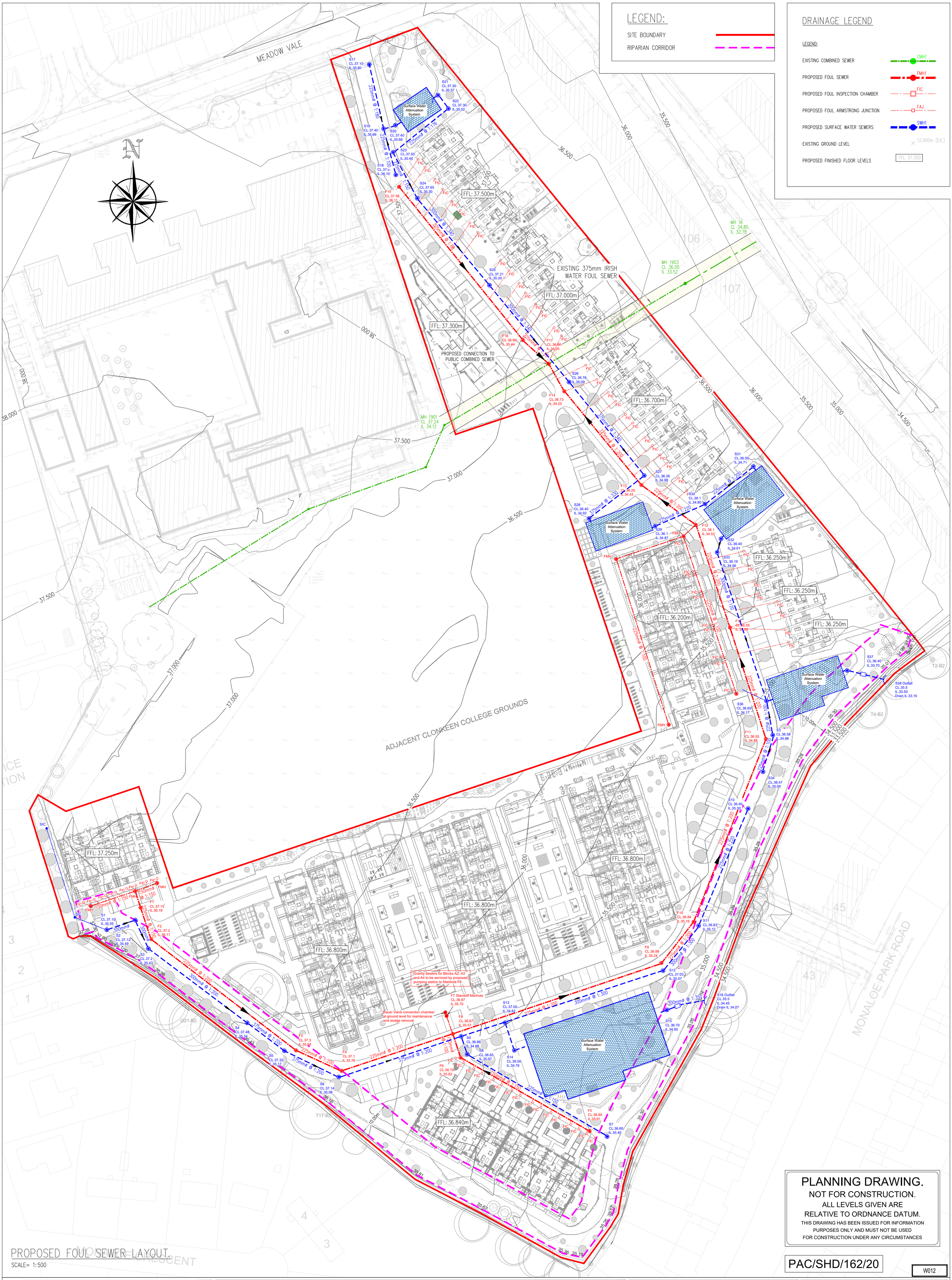
Energy	I.S. EN ISO 50001:2011
Health & Safety	OHSAS 18001:2007



PROPOSED FOUL SEWER LAYOUT.

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Rev. No.	Date	REVISION NOTE	Drn. By	Chkd. By
P1	14.10.2020	ARCHITECTS LAYOUT REVISED	JS	OS
P2	14.06.2021	ARCHITECTS LAYOUT REVISED	DF	OS

Architect	Scott Tallon Walker
Project	Proposed Development at Clonkeen Road
Title	Proposed Foul Sewer Layout
Dwg. No.	W012-CSC-ZZ-XX-DR-C-0006

Date	Drn by	Chkd by	Aprvd by	Scale	Revision
02.06.2020	JS	RFM	OS	1:500 @A1	P2

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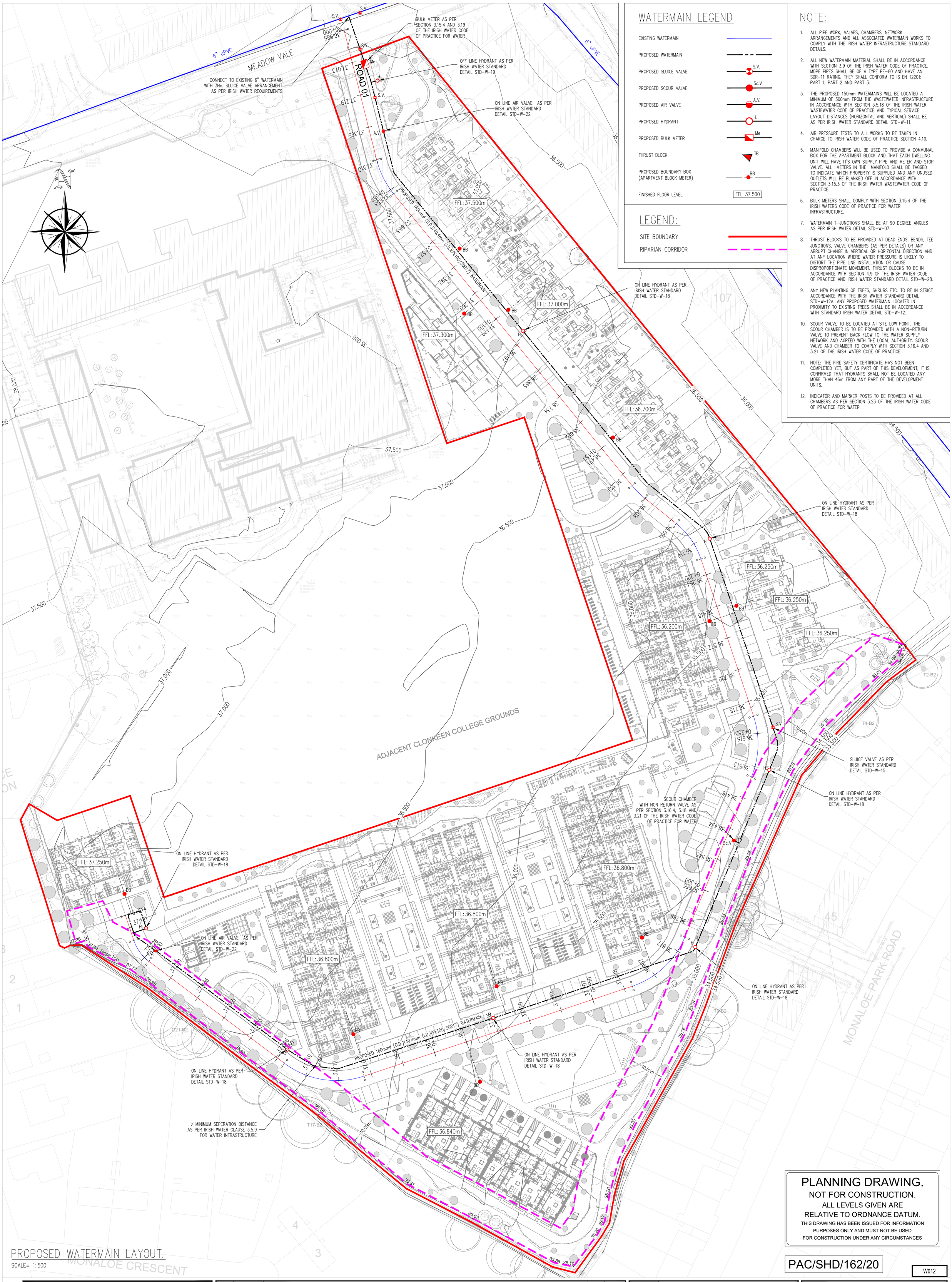
Environment I.S. EN ISO 14001:2004
Energy I.S. EN ISO 50001:2011
Health & Safety OHSAS 18001:2007



WATERMAIN LEGEND

- EXISTING WATERMAIN
- PROPOSED WATERMAIN
- PROPOSED SLUICE VALVE (S.V.)
- PROPOSED SCOUR VALVE (Sc.V)
- PROPOSED AIR VALVE (A.V.)
- PROPOSED HYDRANT (H.)
- PROPOSED BULK METER (Me)
- THRUST BLOCK (TB)
- PROPOSED BOUNDARY BOX (APARTMENT BLOCK METER) (BB)
- FINISHED FLOOR LEVEL (FFL 37.500)

LEGEND:

- SITE BOUNDARY
- RIPARIAN CORRIDOR

NOTE:

1. ALL PIPE WORK, VALVES, CHAMBERS, NETWORK ARRANGEMENTS AND ALL ASSOCIATED WATERMAIN WORKS TO COMPLY WITH THE IRISH WATER INFRASTRUCTURE STANDARD DETAILS.
2. ALL NEW WATERMAIN MATERIAL SHALL BE IN ACCORDANCE WITH SECTION 3.9 OF THE IRISH WATER CODE OF PRACTICE. MDPE PIPES SHALL BE OF A TYPE PE-80 AND HAVE AN SDR-11 RATING. THEY SHALL CONFORM TO IS EN 12201: PART 1, PART 2 AND PART 3.
3. THE PROPOSED 150mm WATERMAINS WILL BE LOCATED A MINIMUM OF 300mm FROM THE WASTEWATER INFRASTRUCTURE IN ACCORDANCE WITH SECTION 3.5.18 OF THE IRISH WATER WASTEWATER CODE OF PRACTICE AND TYPICAL SERVICE LAYOUT DISTANCES (HORIZONTAL AND VERTICAL) SHALL BE AS PER IRISH WATER STANDARD DETAIL STD-W-11.
4. AIR PRESSURE TESTS TO ALL WORKS TO BE TAKEN IN CHARGE TO IRISH WATER CODE OF PRACTICE SECTION 4.10.
5. MANIFOLD CHAMBERS WILL BE USED TO PROVIDE A COMMUNAL BOX FOR THE APARTMENT BLOCK AND THAT EACH DWELLING UNIT WILL HAVE IT'S OWN SUPPLY PIPE AND METER AND STOP VALVE. ALL METERS IN THE MANIFOLD SHALL BE TAGGED TO INDICATE WHICH PROPERTY IS SUPPLIED AND ANY UNUSED OUTLETS WILL BE BLANKED OFF IN ACCORDANCE WITH SECTION 3.15.3 OF THE IRISH WATER WASTEWATER CODE OF PRACTICE.
6. BULK METERS SHALL COMPLY WITH SECTION 3.15.4 OF THE IRISH WATERS CODE OF PRACTICE FOR WATER INFRASTRUCTURE.
7. WATERMAIN T-JUNCTIONS SHALL BE AT 90 DEGREE ANGLES AS PER IRISH WATER DETAIL STD-W-07.
8. THRUST BLOCKS TO BE PROVIDED AT DEAD ENDS, BENDS, TEE JUNCTIONS, VALVE CHAMBERS (AS PER DETAILS) OR ANY ABRUPT CHANGE IN VERTICAL OR HORIZONTAL DIRECTION AND AT ANY LOCATION WHERE WATER PRESSURE IS LIKELY TO DISTORT THE PIPE LINE INSTALLATION OR CAUSE DISPROPORTIONATE MOVEMENT. THRUST BLOCKS TO BE IN ACCORDANCE WITH SECTION 4.9 OF THE IRISH WATER CODE OF PRACTICE AND IRISH WATER STANDARD DETAIL STD-W-28.
9. ANY NEW PLANTING OF TREES, SHRUBS ETC. TO BE IN STRICT ACCORDANCE WITH THE IRISH WATER STANDARD DETAIL STD-W-12A. ANY PROPOSED WATERMAIN LOCATED IN PROXIMITY TO EXISTING TREES SHALL BE IN ACCORDANCE WITH STANDARD IRISH WATER DETAIL STD-W-12.
10. SCOUR VALVE TO BE LOCATED AT SITE LOW POINT. THE SCOUR CHAMBER IS TO BE PROVIDED WITH A NON-RETURN VALVE TO PREVENT BACK FLOW TO THE WATER SUPPLY NETWORK AND AGREED WITH THE LOCAL AUTHORITY. SCOUR VALVE AND CHAMBER TO COMPLY WITH SECTION 3.16.4 AND 3.21 OF THE IRISH WATER CODE OF PRACTICE.
11. NOTE: THE FIRE SAFETY CERTIFICATE HAS NOT BEEN COMPLETED YET, BUT AS PART OF THIS DEVELOPMENT, IT IS CONFIRMED THAT HYDRANTS SHALL NOT BE LOCATED ANY MORE THAN 46m FROM ANY PART OF THE DEVELOPMENT UNITS.
12. INDICATOR AND MARKER POSTS TO BE PROVIDED AT ALL CHAMBERS AS PER SECTION 3.23 OF THE IRISH WATER CODE OF PRACTICE FOR WATER

PROPOSED WATERMAIN LAYOUT.

SCALE= 1:500

NOTES

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Rev. No.	Date	REVISION NOTE	Drn. By	Chkd. By
P1	13.10.2020	ARCHITECTS LAYOUT REVISED	JS	OS
P2	14.06.2021	ARCHITECTS LAYOUT REVISED	DF	OS

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PAC/SHD/162/20

W012

Architect	Scott Tallon Walker
Project	Proposed Development at Clonkeen Road
Title	Proposed Watermain Layout
Dwg. No.	W012-CSC-ZZ-XX-DR-C-0007

Date	Drn by	Chkd by	Aprvd by	Scale	Revision
02.06.2020	JS	RFM	OS	1:500 @A1	P2

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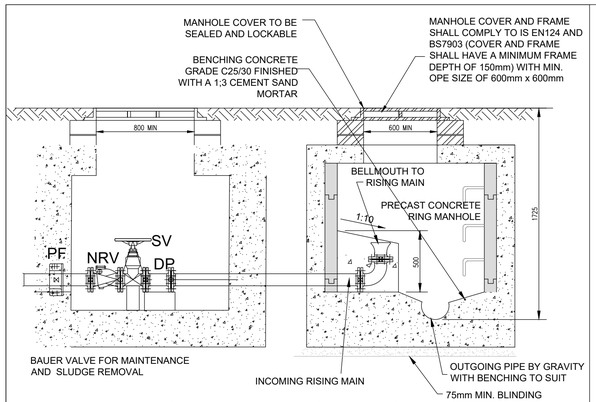
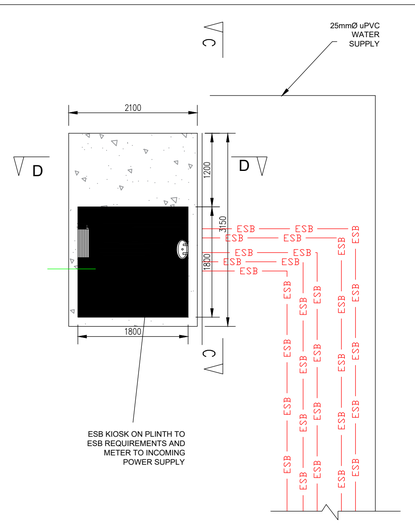
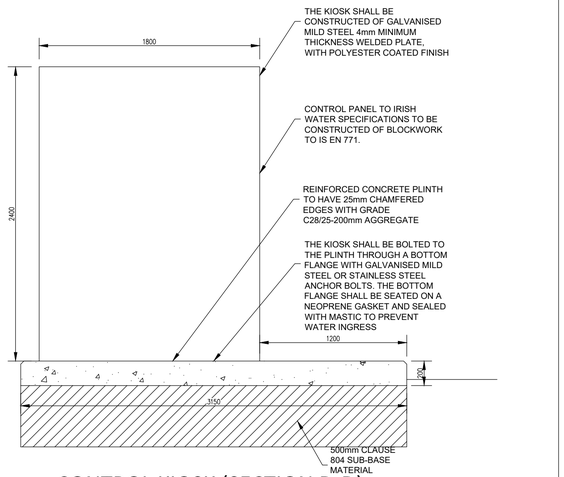
Environment	I.S. EN ISO 14001:2004
Energy	I.S. EN ISO 50001:2011
Health & Safety	OHSAS 18001:2007



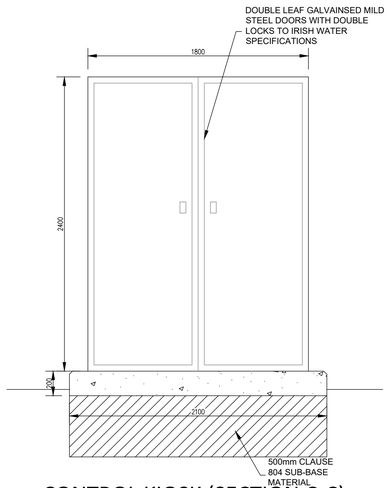
BAUER VALVE CHAMBER
SCALE 1:25



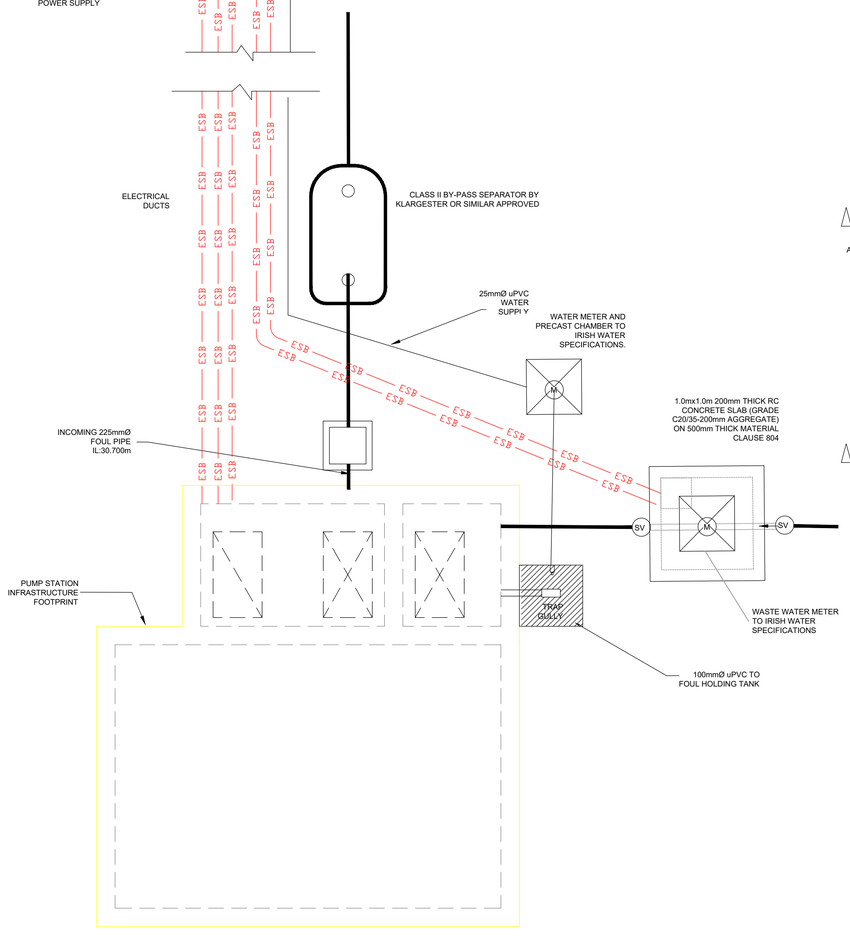
STAND-OFF HOLE DETAIL.
SCALE 1:25



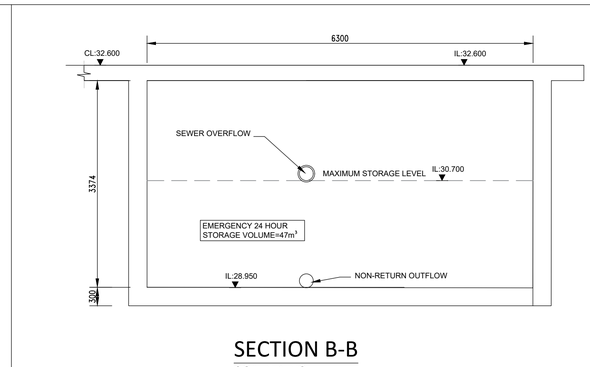
CONTROL KIOSK (SECTION D-D).
SCALE 1:25



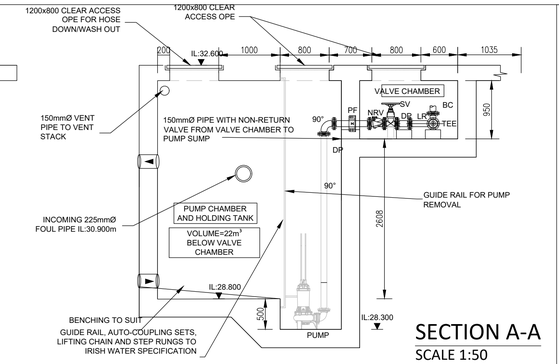
CONTROL KIOSK (SECTION C-C).
SCALE 1:25



PUMP STATION GROUND FLOOR PLAN.
SCALE 1:50

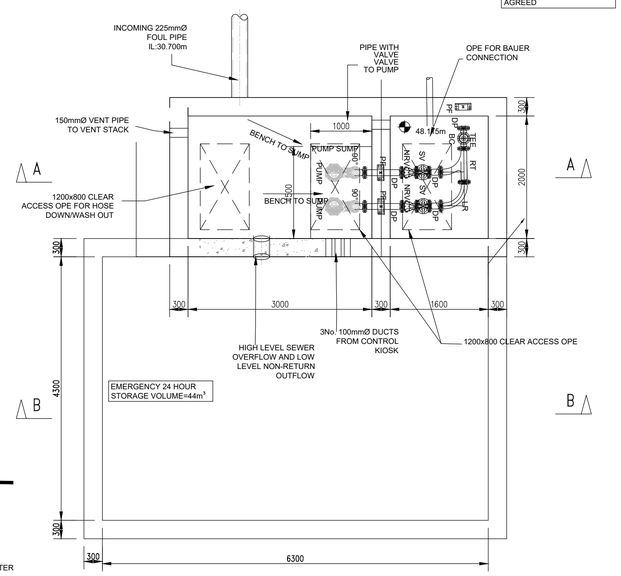


SECTION B-B
SCALE 1:50



SECTION A-A
SCALE 1:50

NOTE:
LOCATION OF PUMP STATION EQUIPMENT TO BE AGREED



PUMP STATION PLAN.
SCALE 1:50

ABBREVIATIONS

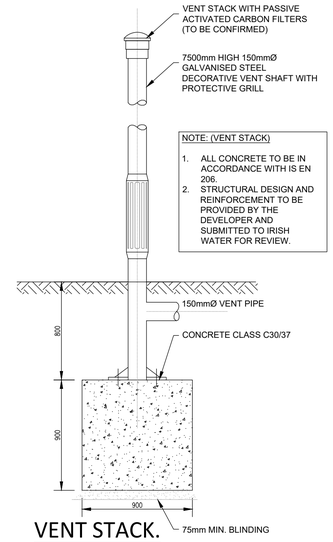
SV	SLUICE VALVE
NRV	NON RETURN VALVE
BC	BAUER CONNECTION
DP	DISTANCE PIECE
RT	RADIAL TEE
LR	LONG RADIUS BEND
TEE	TEE
90°	90° BEND
PF	PUDDLE FLANGE PUMPSPEC REQ'D

NOTE:

1. ALL PUMPING STATION PIPE WORK, FITTINGS AND VALVES ETC. TO BE ALL FLANGED DUCTILE IRON IS EN 598 WITH PN-16 FLANGES TO BE EN 1092-1.
2. ALL PUMP, VALVE AND TANK COVERS TO BE D400 LOCKABLE SEALED COVERS FLUSH WITH ROOF SLAB.
3. REFER TO STRUCTURAL DRAWINGS FOR EXACT POSITION OF WALLS, RC, THICKNESSES ETC.
4. PUMPS SET TO 2.5L/SEC. 5m HEAD

PUMPING PLANT:-
SPECIFIC MINIMUM REQUIREMENTS FOR PUMPING PLANT ARE AS FOLLOWS:

1. PUMPING PLANT SHOULD BE OF FAILSAFE DESIGN.
2. ALL PLANT AND EQUIPMENT TO BE SUITABLY EX-RATED IN ACCORDANCE WITH THE HAZARDOUS AREA CLASSIFICATION FOR THE PUMPING STATION SITE.
3. PUMPING PLANT TO BE DUTY AND STANDBY ARRANGEMENT OR DUTY/ASSIST AND STANDBY ARRANGEMENT;
4. PUMPS TO BE SUBMERSIBLE PUMPS WITH AUTOMATIC DECOUPLING ARRANGEMENTS COMPLETE WITH TWIN GUIDE RAILS, EASY LIFT, ETC.;
5. PUMPING PLANT TO BE OF PROVEN TRACK RECORD; INCLUDING COOLING JACKETS.
6. AUTOMATIC SELECTION ROTATION OF THE DUTY/STANDBY OR DUTY/ASSIST/STAND-BY PUMPS TO BE PROVIDED ON AN HOURS RUN BASIS WITH MANUAL OVER-RIDE;
7. PUMPS TO BE SIZED FOR A MINIMUM OF 3 TIMES DWF, IF STORAGE PROVIDED, AND 6 TIMES DWF OTHERWISE;
8. PUMPS TO BE SUITABLE FOR PUMPING UNSCREENED WASTEWATER CONTAINING FIBROUS MATERIAL WITH A MINIMUM SOLIDS PASSAGE SIZE OF 100MM. PUMPS CONNECTED TO SMALL DIAMETER RISING MAINS TO BE FITTED WITH AN ANTI-BLOCKAGE/ANTI-RAGGING SYSTEM LINKED TO THE POWER AMP RECORDING SYSTEM;
9. PUMPS TO HAVE A MINIMUM DISCHARGE SIZE OF 80MM;
10. PUMP CONTROL TO BE VIA ULTRASONIC LEVEL TRANSDUCERS, LOCATED ABOVE LIQUID LEVEL, IN AN EASILY ACCESSIBLE LOCATION;
11. THE PUMP GUIDE SYSTEM TO ALLOW THE PUMP UNITS TO BE AUTOMATICALLY COUPLED TO THE OUTLET PIPEWORK AND HELD IN PLACE BY ITS OWN WEIGHT;
12. THE GUIDE SYSTEM TO ALLOW THE PUMP UNITS TO BE LIFTED TO THE TOP OF THE WET WELL WITHOUT THE NEED TO UNDO ANY FIXING ARRANGEMENTS OR TO ENTER THE WET WELL;
13. ANCHOR BOLTS SHALL BE STAINLESS STEEL, STAINLESS STEEL AND GALVANISED STEEL SURFACES SHALL NOT COME INTO CONTACT WITH EACH OTHER;
14. PUMPS TO BE MOUNTED ON A CAST IRON COUPLING/DUCK-FOOT PEDESTAL, WITH AUTOMATIC DECOUPLING ARRANGEMENTS;
15. PUMP ARRANGEMENT TO ALLOW EASY INSTALLATION AND SPEEDY REMOVAL FROM THE SUMP WITHOUT NEED FOR OPERATOR ENTRY TO THE SUMP;
16. PUMPS GUIDE RAILS TO BE OF GALVANISED MILD STEEL OR STAINLESS STEEL (GRADE 316);
17. PUMPS TO BE PROVIDED WITH CERTIFIED, STAINLESS STEEL LIFTING CHAIN (DESIGNED TO BS4942), SUITABLY SIZED AND FIT FOR PURPOSE, WITH 8MM THICK LINKS, AT LEAST, AND LARGE LINKS A NOT MORE THAN 1M INTERVALS;
18. SPARE CERTIFIED STAINLESS STEEL CHAINS, OF SIMILAR CAPACITY TO THE INSTALLED CHAIN UNIT, SHALL BE PROVIDED TO FACILITATE REGULAR INSPECTION/REPLACEMENT OF THE LIFTING CHAIN;
19. ANCHOR BOLTS TO BE OF STAINLESS STEEL OR GALVANISED STEEL SUITABLE FOR THE MATERIAL BEING RETAINED (NO CONTACT BETWEEN STAINLESS STEEL AND GALVANISED STEEL);
20. DISCHARGE PIPEWORK WITHIN THE WET WELL TO BE COMPLETE WITH BENDS, TEE-PIECES, FITTINGS, ETC. TO LINK THE WET WELL PIPEWORK TO THE VALVE CHAMBER PIPEWORK;
21. PIPEWORK WITHIN THE VALVE CHAMBER TO INCORPORATE ISOLATION VALVES (ONE PER PUMP INSTALLED), NON-RETURN VALVES (ONE PER PUMP INSTALLED), BENDS, TEE-PIECES, ETC.;
22. NON-RETURN VALVES TO HAVE REMOVABLE COVERS, DUCTILE IRON BODY WITH RESILIENT SEATED DISC AND STAINLESS STEEL HINGE PIN, COMPLETE WITH EITHER A BALL WEIGHT OR LEVER ARM AND WEIGHT;
23. BENDS TO BE SWEPT/SLOW BENDS TO MINIMISE BLOCKAGES AND PIPE FRICTION LOSSES; SLUICE VALVES TO BE PROVIDED WITH REMOVABLE HAND-WHEELS;
24. FLANGE ADAPTORS TO BE PROVIDED TO PERMIT EASE OF REMOVAL OF VALVES FROM THE PIPEWORK;
25. ALL PIPEWORK AND VALVES TO BE OF DUCTILE IRON, PN-16, TO 85 4772 AND EN 598, SUITABLE FOR USE WITH SEWAGE;
26. PUMP MOTORS TO BE HIGH EFFICIENCY WITH CLASS F INSULATION AND LP68 RATING; PUMP EFFICIENCY SHALL BE MAINTAINED WITHIN 15% OF ITS MAXIMUM EFFICIENCY OVER THE WHOLE OF THE SPECIFIED DUTY RANGE.
27. MOTOR AND MOTOR HOUSING TO BE BOLTED TO THE PUMP HOUSING, SHRINK OR PRESS FIT ASSEMBLIES WILL NOT BE ACCEPTED;
28. MOTORS MUST INCLUDE STATOR OVER-TEMPERATURE PROTECTION IN THE FORM OF THERMISTORS EMBEDDED IN EACH PHASE OF THE WINDINGS, OVER-TEMPERATURE PROTECTION SHOULD AUTOMATICALLY RE-SET WHEN THE TEMPERATURE RETURNS TO NORMAL;
29. PUMPS SHALL HAVE A MAXIMUM SPEED OF 1500RPM. PUMP CHARACTERISTICS SHALL BE STABLE, NON-OVERLOADING AND SHALL BE SUCH THAT THE PUMPS SHALL OPERATE AS CLOSE TO MAXIMUM EFFICIENCY AT THE DESIGN POINT.
30. PUMPS TO BE PROVIDED WITH INDICATOR PLATES PROVIDING INFORMATION FOR THE PUMP, MOTOR, ETC. A DUPLICATE STAINLESS STEEL PLATE TO BE PROVIDED AND MOUNTED IN THE CONTROL PANEL.
31. WHERE VALVES ARE LOCATED IN DRYWELL SUMP, VALVE EXTENSIONS HANDLES TO BE SUPPLIED (INCLUDING THE CORING OF THE CONCRETE COVER ABOVE) WITH 80MM HOLE.
32. PUMP CHAIN TO BE STAINLESS GRADE STAMPED AND CERTIFIED WITH OVAL SHAPED MASTER RINGS EVERY ONE METER IN LENGTH.
33. ALL EMERGENCY STOPS TO BE LOCATED OVER GROUND ON STAINLESS STEEL PILLARS IN THE LOCATION /AREA OF PUMP SUMPS.
34. ALL PANELS TO BE LABELLED ACCORDINGLY.
35. ALL PIPE WORK TO BE LABELLED WITH DIRECTIONAL ARROWS AND LABELS STATING WHAT IS IN PIPE WORK .E.G. FERRIC/FOUL ETC.
36. ALL CHAMBERS TO HAVE SIGNAGE STAMPED ON THEM STATING WHAT THEY ARE E.G. FOUL SUMP/STORM SUMP.
37. NON RETURN VALVES TO BE GOOD QUALITY FLAP TYPE FOR SEWAGE NOT WATER.



NOTE: (VENT STACK)

1. ALL CONCRETE TO BE IN ACCORDANCE WITH IS EN 206.
2. STRUCTURAL DESIGN AND REINFORCEMENT TO BE PROVIDED BY THE DEVELOPER AND SUBMITTED TO IRISH WATER FOR REVIEW.

VENT STACK.
SCALE 1:50

PAC/SHD/162/20 | W012

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Rev. No.	Date	REVISION NOTE	Drn. By	Chkd. By

Architect	Scott Tallon Walker					
Project	Proposed Development at Clonkeen Road					
Title	Proposed Pump Station Details					
Dwg. No.	W012-CSC-ZZ-XX-DR-C-0024					
Date	Drn by	Chkd by	Aprvd by	Scale	Revision	
02.06.2020	DF	RFM	OS	AS SHOWN @A1		

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Environment I.S. EN ISO 14001:2004
Energy I.S. EN ISO 50001:2011
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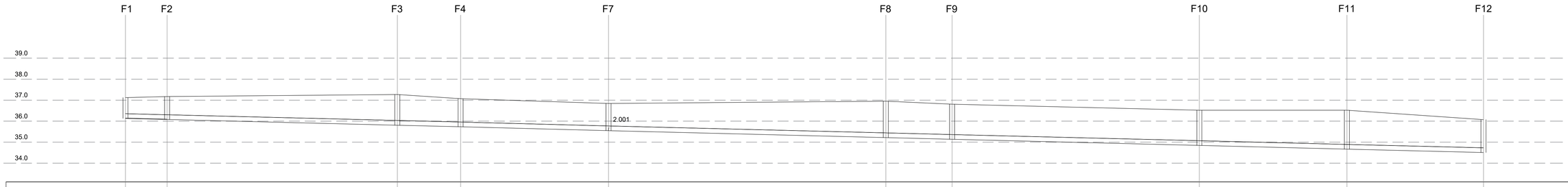
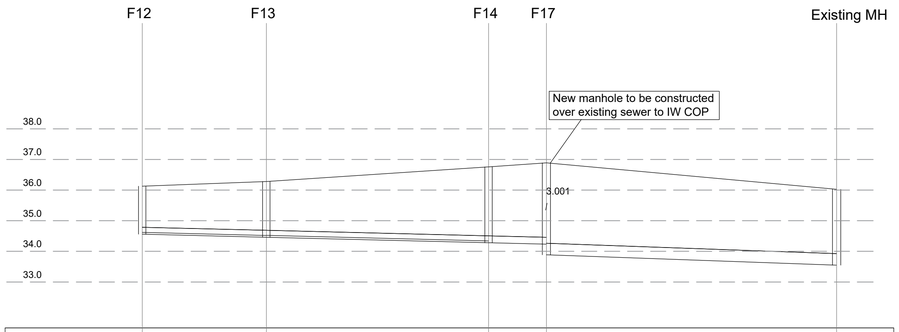


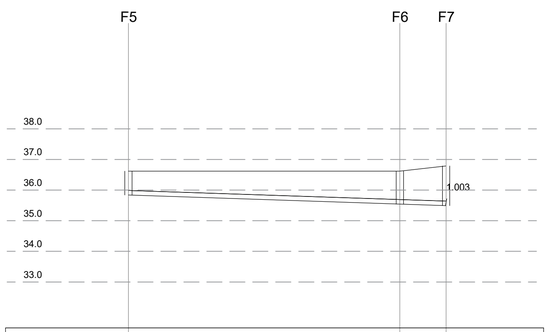
PN	F1.000	F1.001	F1.002	F1.003	F1.004	F1.005	F1.006	F1.007	F1.008	
DIA (mm)	225	225	225	225	225	225	225	225	225	
SLOPE (1:X)	200.0	200.0	200.0	190.0	200.0	200.0	200.1	200.0	200.6	
COVER LEVEL (m)	37.150	37.200	37.300	37.100	36.870	36.980	36.840	36.550	36.550	36.100
INVERT LEVEL (m)	36.160	36.110 / 36.110	35.837 / 35.837	35.761 / 35.761	35.576 / 35.575	35.245 / 35.245	35.166 / 35.166	34.872 / 34.872	34.696 / 34.696	34.534
LENGTH (m)	9.905	54.770	15.054	35.174	65.976	15.757	58.830	35.102	32.492	

FOUL WATER LONGSECTIONS FROM F1 TO F12
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



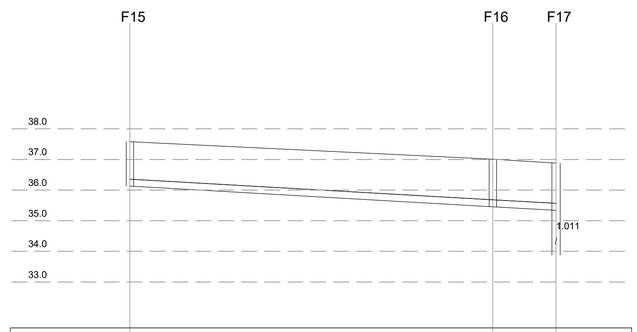
PN	F1.009	F1.010	F1.011	EXISTING IRISH WATER SEWER	
DIA (mm)	225	225	225	375	
SLOPE (1:X)	200.6	200.4	200.4	140.0	
COVER LEVEL (m)	36.100	36.250	36.730	36.860	36.000
INVERT LEVEL (m)	34.534	34.433 / 34.433	34.282 / 34.282	34.205 / 33.860	33.522
LENGTH (m)	20.256	36.280	9.439	47.375	

FOUL WATER LONGSECTIONS FROM F12 TO EXISTING MANHOLE
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



PN	F2.000	F2.001	
DIA (mm)	150	150	
SLOPE (1:X)	150.2	150.2	
COVER LEVEL (m)	36.700	36.700	36.870
INVERT LEVEL (m)	35.920	35.625 / 35.625	35.575
LENGTH (m)	44.311	7.551	

FOUL WATER LONGSECTIONS FROM F5 TO F7
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100



PN	F3.000	F3.001	
DIA (mm)	225	225	
SLOPE (1:X)	88.0	88.0	
COVER LEVEL (m)	37.560	36.990	36.860
INVERT LEVEL (m)	36.110	35.437 / 35.437	35.322 / 33.860
LENGTH (m)	59.248	10.316	

FOUL WATER LONGSECTIONS FROM F15 TO F17
HORIZONTAL SCALE 1:500
VERTICAL SCALE 1:100

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Rev. No.	Date	REVISION NOTE	Drn. By	Chkd. By

Architect	Scott Tallon Walker					
Project	Proposed Development at Clonkeen Road					
Title	Foul Sewer Longsections					
Dwg. No.	W012-CSC-ZZ-XX-DR-C-0025					
Date	Drn by	Chkd by	Aprvd by	Scale	Revision	
15.06.2021	DF	RFM	OS	AS SHOWN @A1		

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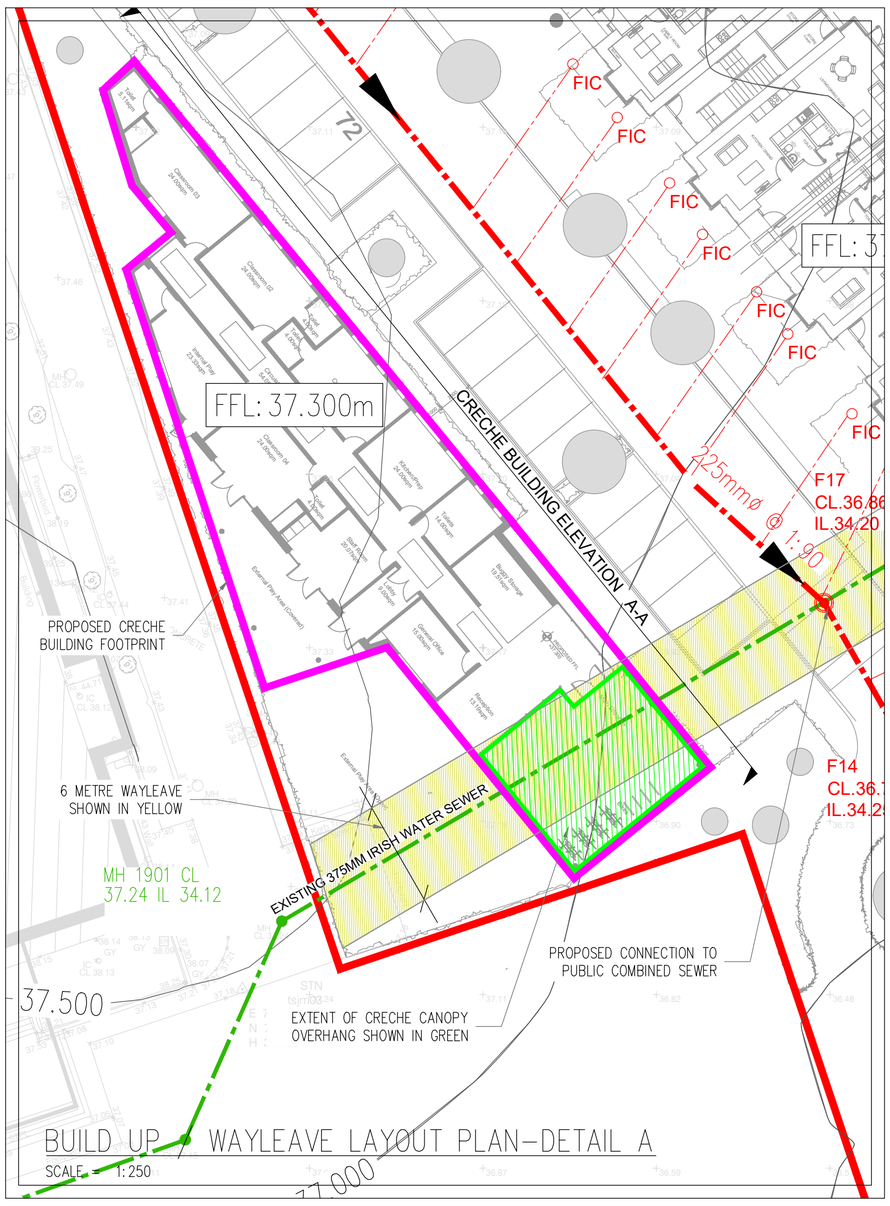
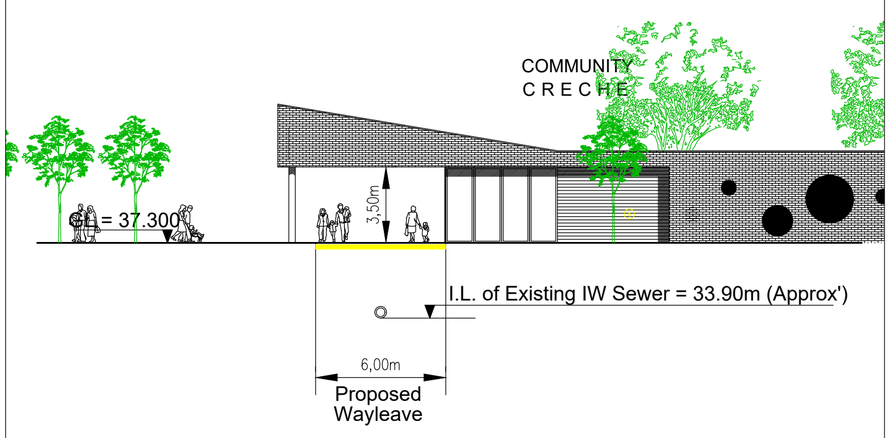


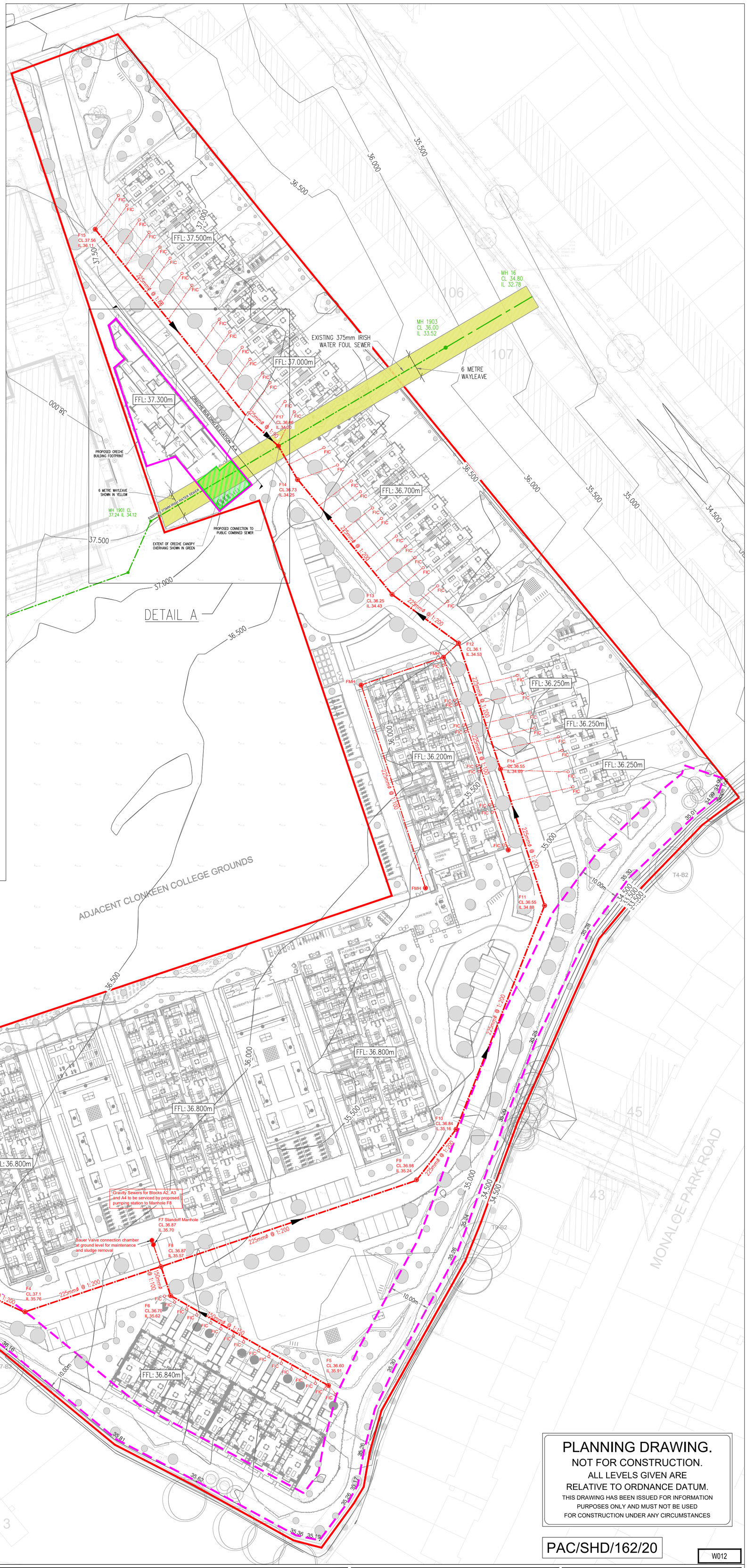
BUILD UP / WAYLEAVE LAYOUT PLAN–DETAIL A

SCALE = 1:250



CRECHE BUILDING ELEVATION A–A
BUILD OVER WAYLEAVE DETAILS

SCALE= 1:200



PROPOSED FOUL SEWER LAYOUT.

SCALE= 1:500

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Rev. No.	Date	REVISION NOTE	Drn. By	Chkd. By
P1	14.10.2020	ARCHITECTS LAYOUT REVISED	JS	OS
P2	14.06.2021	ARCHITECTS LAYOUT REVISED	DF	OS

Architect	Scott Tallon Walker
Project	Proposed Development at Clonkeen Road
Title	Build Over / Wayleave Layout Plan
Dwg. No.	W012-CSC-ZZ-XX-DR-C-0032

Date	Drn by	Chkd by	Aprvd by	Scale	Revision
02.06.2020	JS	RFM	OS	1:500 @A1	P2

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Appendix G

JBA Storm Water Audit

CS CONSULTING
GROUP

STORMWATER AUDIT (STAGE 1)

JBA Project Code	2021s1014
Contract	Development at Clonkeen Road, Blackrock, Co. Dublin
Client	D | RES Developments Ltd.
Date	30th July 2021
Author	Paul Browne
Subject	**Stormwater Audit - Stage 1 Report**

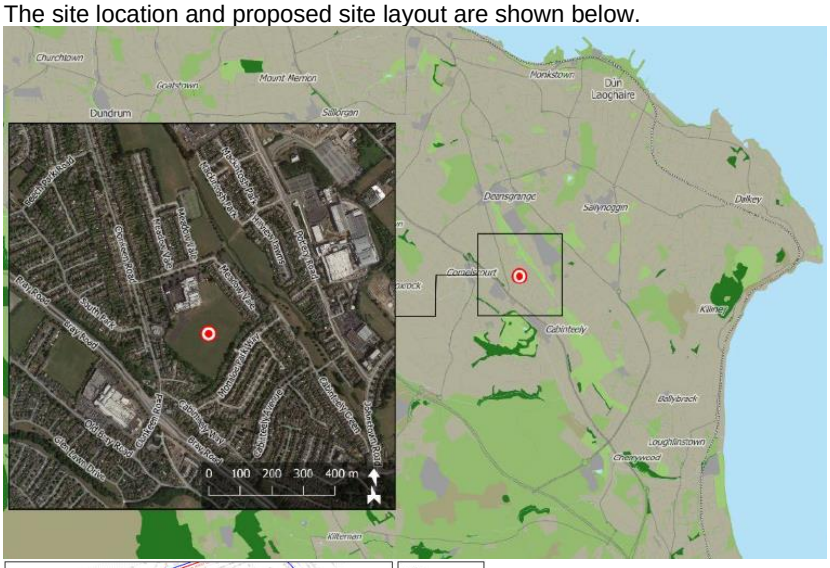
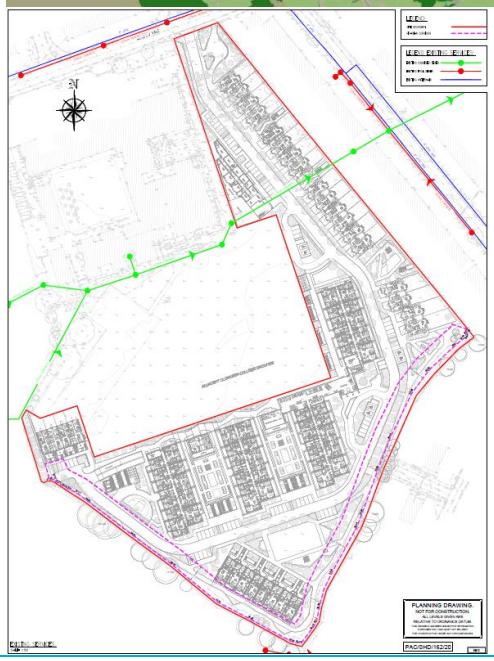
1 Residential Development at Clonkeen Road, Blackrock, Co. Dublin.

1.1 Introduction

JBA Consulting have been contracted by D | RES Developments Ltd. to undertake a Stage 1 audit of the surface water drainage design by CS Consulting Group for the proposed residential development at Clonkeen Road, Blackrock, Co. Dublin.

The results of the audit are set out in the table below.

1.2 Stage 1 Audit

Design Parameter	Audit Result
Proposed Development	The subject site is located on the Clonkeen Road in Blackrock, Co. Dublin. The proposed development will comprise a Strategic Housing Development to include 299no. residential units and a 1no. storey childcare facility with a dedicated play area, and all associated infrastructure and services. The site location and proposed site layout are shown below.  

	The total site area is stated to be 3.316 hectares (ha), of which 2.133 ha is the effective drainage area and 2.133 ha is the effective impermeable area. The catchment is divided into 2 smaller catchments, Catchment A (North) and Catchment B (South), with site areas of 1.367 ha and 1.949 ha, respectively, and effective drainage areas of 0.850 ha and 1.283 ha, respectively. The subject of this Stage 1 stormwater audit is to review the proposed surface water drainage design and sustainable urban drainage system proposals for the proposed development.
Relevant Studies/Documents	The following documents were considered as part of this surface water audit: • The SuDS Manual (CIRIA C753); • Recommendations for Site Development Works for Housing Areas (DoEHLG); • Greater Dublin Strategic Drainage Strategy (GDSDS); • Greater Dublin Regional Code of Practice for Drainage Works; • DLRCC Green Roof Guidance Document (Appendix 16 of the County Development Plan 2016-2022); • BRE Digest 365 • Stormwater Audit Procedure Jan 2012 - DLRCC
Key Considerations & Benefits of SUDs	The key benefits and objectives of SuDS considered as part of this audit and listed below include: • Reduction of run-off rates; • Provision of volume storage; • Volume treatment provided; • Reduction in volume run-off; • Water quality improvement; • Biodiversity.
Site Characteristics	**Soil:** The soil at the site has been indicated as being Soil Type 3 (SPR 0.37) following site investigation by Causeway Limited in August 2019. The site investigation showed gravelly clay soils with low permeability, which is consistent with Soil Type 3. A number of boreholes and trail pits were undertaken across the site with standpipes inserted into some boreholes. Dwg 0005 indicates locations of TP 7 & 13 to the southern part of the site, but no other TP or boreholes are indicated. Standpipes were installed in 8 bh's. Trial pit TP07 showed a ground water level of 34.30m with high inflow recorded, and TP13 showed a ground water level of 33.80m. The Engineers Report states that the water level in the pits referred to are a minimum of 800mm below the proposed SW infrastructure. This refers particularly to the stormtech tank serving Catchment B the base of which will be 230mm (min) lower than the base level of 34.76m and therefore within 0.73m of the recorded (summer) water table. The winter water table may be higher and this should be considered in the design as identified in the Causeway report. Two infiltration tests were attempted but both failed, indicating very poor infiltration rates. Other BH's and TP's recorded water levels and standpipes installed in a number of boreholes but these are not referred to on the drawing or report. The normal acceptable practise is that infrastructure should be 1m above the winter water table to protect groundwater and mitigate against the risk of ground water ingress, otherwise tanks etc. may need to be lined. Are winter water levels from the standpipes available? Soil Type 1 is the soil classification based on the Flood Studies Report and UK SuDS website but overridden by the local SI undertaken of SOIL=3.

	Rainfall (basis for surface water pipeline network design): Rainfall parameters can be estimated using Met Éireann data, using the Flood Studies Report (FSR) values or the values in the GDSDS. The Met Éireann method can be more representative of a site if selected correctly. A comparison of values estimated by CS Consulting and JBA is shown below: **CS Consulting value** / **JBA Value** Rainfall model: Met Éireann / Met Éireann M5-60 (mm): 16.0 / 15.9mm Ratio R: 0.272 / 0.271 It is proposed to discharge SW to the existing ditch on the south-eastern boundary via 2no. outfalls for the 2 catchments (A and B). Using an SPR value of 0.37 for the site, the greenfield runoff rate (QBAR) for the overall development has been calculated by CS Consulting as 7.5 l/sec for the effective drainage area. In terms of catchment effective drainage areas, the greenfield runoff rates for Catchments A and B are 3.0 l/sec and 4.5 l/sec, respectively, which are acceptable. As the QBAR figures are greater than the 2l/sec/ha allowance in the GDSDS, QBAR will be the limiting discharge for all storm events from the subject development. Dwg 0021 shows a filter drain running at the back of the apartment blocks in Catchment A in landscaped areas and it is not clear if these areas are excluded from the positively drained areas of 0.85ha. It is presumed that the filter drain will connect into the SW network but this is not shown. If this area is connected it should be considered as positively drained for Qbar purposes which my increase the value?
SuDS Measures Considered	CS Consulting have included the following SUDs measures within the proposed development. No reference has been made to any other measures considered.

SUDS Technology	Comments
Green Roofs	Roofs with provision for green roofs account for a gross area of 3907m^2, of which 2428m^2 are green roofs. This is equivalent to 62.1%, exceeding the DLR's Green Roof Policy minimum cover requirement of 60%. It is assumed that other apartment blocks have roof areas less than 300m2 or are otherwise not required to have green roofs under the DLRCC policy.
Swale/ Filter Drain / Infiltration trench	Filter drains have been proposed at numerous locations, including to the east and south of the proposed development. Several bio swales have been proposed on the site adjacent to the roadway. Surface water runoff from roads and pavements will be directed into swales and filter drains / infiltration trenches.
Permeable Paving	Permeable paving has been proposed at parking bays throughout the development. Also, it is proposed at 2no. courtyards on the south of the proposed site.
Petrol Interceptor	2no. petrol interceptors have been proposed downstream of the 2no. southern-most attenuation

	structures.
Surface Water Attenuation	Attenuation will be provided by way of StormTech storage structures at 5no. locations on the proposed site.
Site Run-off Rates	CS Consulting propose to limit discharge to the equivalent of QBAR for all storm events to the local drain.
Detention Basins, Retention Ponds, Stormwater Wetlands	A dry detention basin is referenced in the CS Consulting Engineering Services Report, however, no such item is indicated on the SuDS Layout Plan or included in calculations.
Tree Root Structural Cell Systems, Bio-retention, rain garden	Surface water runoff from roads and pavements will be directed into bioretention areas and tree pits.

Surface Water Drainage Design

All surface water flows generated by the development will be attenuated and discharged to the existing drainage ditch at a rate of QBAR.

SuDS Management Train

Source Control and **Site Control** are addressed by the use of SuDS devices (interception storage) and attenuation with outflow controlled by Hydro-Brakes.

2no. petrol interceptors have been proposed prior to discharge from site.

As recommended within the SUDs Manual (Table 26.7) assuming effective pre-treatment is in place the following number of treatment train components are recommended:

	No. of treatment train components recommended	Comment/Proposals
Roof areas	2	Green roofs have been proposed to cover a minimum of 60% of new roofs and go through a 2-stage treatment train (interception, primary).
Residential roads, parking areas, commercial zones	2	Permeable paving has been proposed to parking bays throughout the proposed development and at 2 no. courtyards to the south of the site and go through a 2-stage treatment train (interception, primary)
	3	Bioretention systems including swales and tree pits have been proposed around the site and go through a 3-stage treatment train (interception, primary, secondary)
	3	Shallow infiltration systems / Filter drains / Catchpits have been proposed around the site and go through a 3-stae treatment train

	<table><tr><td></td><td></td><td>(interception, primary, secondary)</td></tr><tr><td>**Refuse collection, industrial areas, loading bays, lorry parks and highways.**</td><td>3</td><td>Not applicable.</td></tr></table> The above figure summarises the SuDS Management Train for the site. 2no. Hydro-Brakes designed for a linear discharge profile will be provided prior to the outfalls to limit flows to a maximum of QBAR. +
Climate Change	An allowance of 20% increase in flows has been included for climate change for the rainfall intensities for the purposes of sizing the attenuation storage. This is in compliance with the requirements of the GDSDS.
Volume Storage	CS Consulting have provided attenuation calculations in spreadsheet form and also using MicroDrainage for the attenuation volumes proposed. The Report identifies storage volumes of 695m3 and 1047m3 as derived from the in-out calculations from the spreadsheets (Note: no allowance has been made for the non-variable head discharge relationship of 20-30% as advised in the GDSDS). However, this is for initial sizing and the Microdrainage calculations should supersede these initial estimates and the actual Microdrainage sizes should be quoted in the report and on drawings. It is noted that there are some anomalies between the MD calculations and volumes on dwg 0005 (and report). For catchment A the total tank size in the MD calculations is 984m3 whilst the drawing states a total of 937m3. For catchment B it is 1260m3 and 1120m3 respectively. These anomalies are not considered to be major but should be resolved at detailed design stage. Stormtech tank calculations should also be provided to ensure that they are properly sized. The proposed attenuation structures are sized such that surcharging to a level greater than 50mm below manhole cover level will not occur. Volumes account for the 100-year return storm event + 20% climate change.
Microdrainage Calculations	The Microdrainage network design and drawings are generally compatible and any slight adjustments required could be completed at detailed design stage to ensure calculations and drawings are fully compatible. However, the simulation results are limited to a critical duration of 1440 min. It is not clear how this has been arrived at and normal practise would be to run for the entire duration of storms and report on the critical duration for each pipe link. These should be completed for the planning stage issue. The hydrobrake/tank configurations may not reflect what is proposed. The tank adopts the IL of the US manhole but the tank performance and sizing is based on the hydrobrake manhole data. This may lead to inefficient use of the tanks and undersizing resulting the design head being exceeded e.g hydrobrake S37 IL =33.70m with design head of 2m (35.70m), the tank IL 34.176m and 1.25 deep (35.37m). It may be that tanks are kept as high as possible due to GWL? These anomalies are not considered to be major issues and can be resolved at detailed design stage.
Volume Run-off	No comparison of pre and post development storm volumes have been provided, however, as it is proposed to limit discharge to QBAR for all storm events, such a

	calculation is not deemed necessary.
Treatment Volume / Water Quality Improvement	Interception storage is proposed by way of green roofs, permeable/porous paving, bio swales, bioretention trees, filter drains and 2no. petrol interceptors. Interception and treatment is intended to retain the first 5mm and 15mm of flow on site. Generally, DLRCC consider that if a minimum of 5mm of flow is intercepted then treatment of flow is not absolutely necessary as this can be very difficult to achieve for a confined development site. CS Consulting have attempted to contain both although it is not clear how this is fully achieved. Table 24.6 in CIRIA c753 outlines techniques which are deemed to satisfy for interception of 5mm and rules of thumb that can be applied. CS Consulting have provided calculations which seem to indicate sufficiency (85.4m3 required for interception and 256m3 provided) although it is not entirely clear how these have been arrived at. The report states that permeable paving and tree structures have an overflow arrangement set 100mm above the base (for pavement) which is ok but it is not clear how the volume for interception has been arrived at. It is also noted that his arrangement is not shown on the standard detail drawings provided. Green roofs and filter drains will provide for interception but will also drain out to the network so runoff will not be fully retained on site. Infiltration to ground has not been allowed for based on the site investigation results. The base of the stormtech tank systems will also provide for interception of flow but interception is best achieved at source if possible. CS Consulting should ensure that all impermeable areas are intercepted for a minimum of 5mm runoff and this is not clear.
Return Period	A 100-year return period plus 20% for climate change has been used in the design for the attenuation systems. It is stated that the network has been designed for the 2-year return period, however, the rainfall intensities have been capped at 500mm/hr (from the default of 50mm/hr) which will exceed that generated for the 2-year storm and is considered to be good practise.
Exceedance flows	The MicroDrainage calculations show that no site flooding occurs for storms up to and including the 1-in-100 year storm event plus 20% allowance for climate change. Exceedance flow should also be a consideration.
Health & Safety and Maintenance Issues	The proposed drainage system comprises SuDS devices, attenuation systems 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 flow control devices will be required to remove any blockages, particularly in the wake of heavy rainfall events or local floods. It is recommended that the 2no. bypass petrol 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 2no. bypass

	petrol interceptors. Please note that silt and debris removed from the petrol interceptors 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.
Design Review Process	A summary of comments and record of the audit trail are appended to this report.

Audit Report Prepared by: Paul Browne BEng MIEI
Assistant Engineer

Approved by: Chris Wason BEng CEng MICE
Principal Engineer

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 Trail Record

JBA Consulting Stormwater Audit - Stage 1 Feedback Form

Project:	Development at Clonkeen Road, Blackrock, Co. Dublin - Stage 1 SWA
Date:	24/08/2021
JBA Reviewers	Paul Browne, Chris Wason
Project Number:	2021s1014

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable/Not Acceptable
	30/07/2021	30/07/2021	11/08/2021	26/08/2021
	Reference Documents W012-CSC-ZZ-XX-DR-C-0001_Topographical Survey-Sheet 1 W012-CSC-ZZ-XX-DR-C-0002_Topographical Survey-Sheet 2 W012-CSC-ZZ-XX-DR-C-0003_Existing Services W012-CSC-ZZ-XX-DR-C-0005_Proposed Storm Water Layout P2 W012-CSC-ZZ-XX-DR-C-0021_Proposed SUDs Layout W012-CSC-ZZ-XX-DR-C-0023 Drainage Contributing Areas W012-CSC-ZZ-XX-DR-C-0030_Storm Attenuation W012-CSC-ZZ-XX-DR-C-0031_Storm Long sections W012-CSC-ZZ-XX-DR-C-0015_Drainage Details Sheet 1 of 3 W012-CSC-ZZ-XX-DR-C-0016_Drainage Details Sheet 2 of 3 W012-CSC-ZZ-XX-DR-C-0017_Drainage Details Sheet 3 of 3 W012-CSC-ZZ-XX-DR-C-0022_Suds Details Engineering Services Report W012-CSC-ZZ-XX-LT-C-0001-P2E-ESR 22.07.2021 19-0607 Clonkeen College Report A01 18/08/21 ADS PDF Report - Clonkeen Tank 1 ADS PDF Report - Clonkeen Tank 2 ADS PDF Report - Clonkeen Tank 3 ADS PDF Report - Clonkeen Tank 4 ADS PDF Report - Clonkeen Tank 5 GJU-JBAI-XX-XX-AU-C-0001-S3-P01-Stage_1_Feedback_Form (CS Consulting Response 1 to JBA Feedback) W012-Clonkeen-North Catchment - 50% Blockage Check W012-Clonkeen-North Catchment Storm Design - Rev B W012-Clonkeen-South Catchment - 50% Blockage Check W012-Clonkeen-South Catchment Storm Design - Rev B W012-CSC-ZZ-XX-DR-C-0005 P3_Proposed Storm Water Layout W012-CSC-ZZ-XX-DR-C-0031 P2_Storm Sewer Longsections 25/08/21 W012-Clonkeen-North Catchment - Attenuation Required W012-Clonkeen-South Catchment - Attenuation Required W012-CSC-ZZ-XX-DR-C-0021 P3_SuDS Layout Plan W012-CSC-ZZ-XX-LT-C-0001-P2E-ESR 20210819 02/09/21 ADS PDF Report - Clonkeen Tank No.1 ADS PDF Report - Clonkeen Tank No.2 ADS PDF Report - Clonkeen Tank No.3 ADS PDF Report - Clonkeen Tank No.4 ADS PDF Report - Clonkeen Tank No.5 GJU-JBAI-XX-XX-AU-C-0001-S3-P02-Stage_1_Feedback_Form (CS Consulting Response to JBA Feedback) W012-Clonkeen-North Catchment Storm Design Rev C- 50% Blockage W012-Clonkeen-North Catchment Storm Design Rev C W012-Clonkeen-South Catchment Storm Design Rev C 50% Blockage W012-Clonkeen-South Catchment Storm Design Rev C W012-CSC-ZZ-XX-DR-C-0005 P4_Proposed Storm Water Layout W012-CSC-ZZ-XX-DR-C-0021 P4_SuDS Layout Plan W012-CSC-ZZ-XX-DR-C-0031 P3_Storm Sewer Longsections W012-CSC-ZZ-XX-LT-C-0001-P2E-ESR 20210901 W012-CSC-ZZ-XX-DR-C-0034_Potential Flood Route			
1	Outfalls Have stream water level been considered in choosing the outfall invert levels? Is there a risk of surcharging at the outfalls.	CS Consulting to confirm that surcharge is not an issue at the outfalls.	No known water levels recorded in stream. It is proposed to provide 700mm freeboard between outfall pipes and invert of stream channel at Outfall S16 and 700mm freeboard at S37 instead of 400mm as further explained in Section 2 below.	**Acceptable**
2	Hydro-Brakes and tank configuration in Microdrainage Hydro-Brake S15 has a design head of 1.400m and IL 34.6 with pass forward discharge of 4.5l/s. The tank has an IL of 34.761m and depth of 1.4m (IL taken from MMH S14). Will this give a correct design configuration and utilise the full tank volume available. The critical water level in this manhole is given as 36.260m, which exceeds the design head, potentially resulting in flow rates exceeding the stated flow rate for this Hydro-Brake. Similarly Hydro-Brake S37 has a design head of 2.000m and IL 33.7m with pass forward flow of 3l/s. The tank has an IL of 34.176m (taken from MHS36). The critical water level in this manhole is given as 36.039m, which exceeds the design head, potentially resulting in flow rates exceeding the stated flow rate for this Hydro-Brake. other hydrobrake/tank configurations are similar. A Hydro-Brake is proposed on the Storm Sewer Long sections drawing at S29, immediately downstream of the attenuation structure at S28. There are no calculations available for this Hydro-Brake in Microdrainage. It is also not shown on the Drainage Layout Plan or designed for in Microdrainage. the simulation runs have been undertaken for a duration of 1440 min only. How has the critical duration been arrived at? It would be normal practise to run for the entire suite of durations available in Microdrainage and report on the critical results summary for each link.	CS Consulting to confirm if the hydrobrake/tank configurations are correct and that the tank level is located at the upstream manhole level. Alternatively, locating the tank at the hydrobrake manhole offer a better solution although the base level will be lower which could could conflict with GWL. To be considered at detailed design stage and actual tank/flow control configurations can be fully reviewed if acceptable to DLRCC. CS Consulting to advise of the proposed configuration. CS consulting to advise on the simulation runs and critical duration adopted.	The proposed attenuation tanks are set at levels to provide maximum seperation distance from ground water levels in line with good practice, therefore it is proposed to maintain tank levels as submitted. To mitigate against potential higher winter ground water levels, it is proposed to provide liners around tanks. To utilise full tank volume and provide improved design configuration, it is proposed to reset hydrobrakes at a higher level of 34.753m at S15 and 34.170m at S37 with design head of 1.4m respectively. This will also provide higher outfall levels providing 550mm freeboard at Outfall S16 and 700mm freeboard at Outfall S38 instead of 400mm as previously submitted. This updated proposal will also further mitigate against any possible surcharging at the outfalls. We have also updated hydrobrake /tank configurations for all other hydrobrakes. With respect to hydrobrake shown at manhole S29 on storm sewer longsections, we wish to clarify that no hydrobrake is required at S29. Due to site constraints, the attenuation system is split in two parts between manholes S28 and S32 as shown. Storm attenuation tank nos. 2 and 3 are therefore designed as one system with one hydrobrake at S32. We submit updated storm sewer longsection drawing W012-CSC-ZZ-XX-DR-C-0031 P2 omitting incorrect hydrobrake detail at S29. The critical duration of 1440mins has been derived from first principles as shown in excel sheet. We submit updated Microdrainage calculations showing an entire suite of storm durations. The results show surcharging with no flooding.	**Not Acceptable (see note 16)**

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable/Not Acceptable
3	Attenuation Structures There are differing storage volume requirements on the Drainage Layout Plan than those in the calculations. Attenuation Structure Node — Drawing Vol. (m3) — Calc Vol. (m3) S20 — 49 — 69 (1m * 69m2) S28 — 160 — 180 (1m * 180m2) S31 — 266 — 233 (1m * 233m2) S36 — 462 — 503 (1.25m * 402m2) S14 — 1120 — 1260 (1.4m *900m2) Stormtech tank calculations should be provided to ensure that the required volumes and actual tank configurations are compatible. these sizes should then be shown on the drawings and in the report.	CS Consulting to advise and amend calculations, drawings and report. The differences are not considered to be significant and could be resolved at detailed design stage where necessary, if acceptable to DLRCC. Provide detailed Stormtech tank calculations, which can be provided at detailed design stage if acceptable to DLRCC.	The proposed storage and actual volume requirements have been clarified and shown on drawing W012-CSC-ZZ-XX-DR-C-0005 P3 -Storm Layout Plan, W012-CSC-ZZ-XX-DR-C-0031 P2-Storm Longsections and reflect the design storage volumes shown in the calculations. Our ESR report has been updated to include Storm Tech storage calculations for the actual tank sizes to be installed.	Not Acceptable (see note 17)
4	Rainfall Model The rainfall model region for Catchment A (North) is set to "England and Wales", while Catchment B (South) is set to "Scotland and Ireland". The same rainfall parameters have been entered for both. These should both be aligned.	While the same rainfall parameters have been used for both models, it is recommended that both should use Scotland and Ireland region. CS Consulting to advise and amend calculations at detailed design stage if necessary if acceptable to DLRCC.	The rainfall model for Catchment A (North) was inadvertently set to " England and Wales " has been correctly reset to"Scotland and Ireland". We submit updated Microdrainage calculations showing same.	**Acceptable** **(Note 20% additional flow for North Catchment Rev B and 0% for South Catchment Rev B calcs)**
5	Attenuation Structures Have the minimum cover levels for the StormTech MC-3500 and MC-4500 series chambers been considered? 600mm min. is indicated on the Storm Attenuation System (Typical) drawing. This appears to be the MC-3500 series model based on a check of the Product Information Sheet, although it is not specifically stated. No Stormtech calculations have been provided to ensure that the volumes calculated and the actual size of tanks match the volume requirements, which should also be reflected in the Microdrainage calculations to ensure that the flow control/tank configurations are compatible.	CS Consulting to advise. CS Consulting to advise.	The minimum cover level for the StormTech MC-3500 and MC-4500 series chambers will be to manufacturers instructions showing minimum cover of 600mm as shown on drawing W012-CSC-ZZ-XX-DR-C-0030 P2-Storm Attenuation Details. StormTech calculations have been provided and included in our Engineering Services Report. The actual StormTech tank sizes and calculated volumes and are shown on drawing W012-ZZ-XX-DR-C-0005 P3. The actual tank sizes slightly exceed to required calculated volumes.	**Acceptable**
6	Existing Services CS Consulting's response to DLRCC Stage 2 Point 9 states that vertical and horizontal separation distances of existing services are indicated on drawing W012-CSC-ZZ-XX-DR-C-0031 Storm Sewer Long sections. There are no vertical or horizontal separation distances shown on this drawing It is also noted that there are differences between the locations of existing services from the Irish Water web maps and the Existing Services drawings. It is assumed that the Existing Services drawing is the more accurate and based on a previous utilities survey.	CS Consulting to advise and amend drawings where necessary to show pipe crossings and required horizontal and vertical separation distances in accordance with Irish Water Wastewater Code of Practice. This can be done at detailed design stage if acceptable to DLRCC CS Consulting to advise and amend drawings at detailed design stage where necessary.	Drawing W012-CSC-ZZ-XX-DR-C-0031 P2-Storm Longsections has been updated to show vertical and horizontal seperation distances. In respect of differences between locations of existing services from the Irish Water web and the existing services drawing, these differences will be clarified at detailed design stage.	**Not Acceptable (see note 18)**
7	Groundwater Levels The groundwater level on the Proposed Storm Water Layout drawing, where the proposed attenuation structure is located at S14, was recorded at 33.80m in August 2019. The proposed invert level of the attenuation structure here is 34.761m. This is within the recommended 1m min. vertical separation distance above the groundwater table as per CIRIA C753 Part C Chapter 8 Figure 8.3.	CS Consulting to advise, and if necessary consider lining this tank (and others). Have water levels been taken in the 8 standpipes installed to give winter water levels? TP 7 and 13 are shown on the drawing 005. Should the location of other relevant TP's or BH's be shown or was no water encountered in the other test holes?	As mentioned in section 2 above, it is proposed to provide liners around tanks in order to mitigate against potential higher winter ground water levels. To date, no water levels have been taken in the 8 standpipes to give winter water levels. No water was encountered in the other test holes other than those shown on drawing W012-ZZ-XX-DR-C-0005 P3.	**Acceptable**
8	Detention Basin A dry detention basin is proposed in Section 3.10 of the Engineering Services Report, however, no such basin is shown on the Drainage Layout Plan, SuDS Layout Plan or SuDS Details drawing.	CS Consulting to advise.	We wish to clarify that as part of the SUDs proposals, there will be no detention basin. The Engineering Services Report has been corrected and updated.	**Acceptable** **(Remove Reference from S3.2 in Report)**
9	Flow Paths Have exceedance flows been considered	CS Consulting to advise.	In accordance with DLRCC Policy, we have analysed the proposed surface water drainage network for 50% blockage. The results show surcharging with no surface water flooding. We attach MD calculations for same.	Not Acceptable (see note 19)
10	Bypass Petrol Interceptors 2no. bypass petrol interceptors have been proposed downstream of the southern-most attenuation structures. Is it preferrable to locate the bypass interceptors at the upstream ends of the attenuation structures to prevent oil and grit from entering the attenuation structures? Also the hydrobrake, in times of high flow, will agitate runoff which will make separation more difficult to achieve? 2no. surface water inspection chambers and associated pipework are noted on the western corner of the proposed site connecting into S1. It is assumed that this network drains runoff from the proposed filter drain to the west of the site. The bypass petrol interceptor details have been provided, however, associated dimensions and storage capacities have not.	CS Consulting to advise and amend design at detailed design stage if necessary. CS Consulting to advise. CS Consulting to indicate bypass petrol interceptor dimensions and storage capacities on drawings at detailed design stage.	The 2no. Bypass petrol interceptors have been relocated at the upstream ends of the attenuation structures. This is shown on updated drawings W012-ZZ-XX-DR-C-0005 P3 and W012-ZZ-XX-DR-C-0031 P2. All proposed filter drains and SUDs features including the proposed filter drain to the west of the site will be connected to the proposed surface water network. Bypass Petrol interceptor dimensions and storage capacities to be provided at detailed design stage.	Not Acceptable (see note 20)

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable/Not Acceptable
11	SuDS Volume and Interception Tables Figure 4 of the Engineering Services Report has inconsistent naming convention with the SuDS Feature Type table on the SuDS Layout Plan drawing. The "Interception vol required(m^3)" column has incorrect units for "Roadside Filter /swales" and "Bio Retention areas". A quick check of the Interception vol required, Treatment vol required and Volume Provided calculations for the Permeable Paving in Figure 4 of the Engineering Services Report, and the SuDS Feature Type table on the SuDS Layout Plan, showed less volumes are required than stated. In addition, some of the significant figures (after decimal point) differ between the two tables. it is also not clear how the volumes have been arrived at and that all impermeable areas are intercepted. Permeable paving and tree structures have a high level overflow so that the lower levels act as permanent interception of flow but these are not shown on the typical detail drawings. It is also not clear how the stated volumes have been arrived at. Filter drains are stated to have a low level pipe to allow flow out therefore will not provide permanent storage volume (interception and treatment of flow). Table 24.6 of the CIRIA Suds manual identifies the 'deemed to satisfy' criteria for various SuDs techniques which may provide some guidance.	CS Consulting to advise. CS Consulting to align units of figures and tables at detailed design stage. CS Consulting to advise and amend calculations at detailed design stage where necessary if acceptable to DLRCC. CS Consulting to confirm that all areas are intercepted for at least 5mm of runoff and to clearly show how this is achieved.	The opaque blue is of no consequence and has been removed from SUDs drawing	Acceptable
12	SuDS Layout Plan An additional surface type (in blue) is shown on the SuDS Layout Plan but not specified in the drawing legend. It is not clear what this is, nor whether it is accounted for in the calculations.	CS Consulting to advise.	The surface type in blue refers to the riparian strip area	Not Acceptable (see note 21)
13	Storm Sewer Long sections Drawing It is noted that some of the pipe diameters and slopes of the Long sections drawing do not match with those stated on the Proposed Storm Water Layout drawing.	CS Consulting to align outputs from calculations and design drawings. It is considered that this could be done at detailed design stage if acceptable to DLRCC.	The pipe diameters and slopes on longsections and drawing plan have been reconciled and shown in updated drawings W012-ZZ-XX-DR-C-0005 P3 and W012-ZZ-XX-DR-C-0031 P2.	Acceptable
14	Pipe Cover It is noted from the Long sections drawing that there is less than the recommended 1.2m cover for pipe S3.000. For Pipe S1.009, although it states there is adequate cover at S16 Outfall, this is not reflected on the pipe section.	CS Consulting to advise.	Where a section of pipe has less than 1.2m cover, the pipe will be protected in concrete in agreement with DLRCC. Pipe section 1.009 will be located in landscaped area and will have the necessary pipe cover of 600mm as recommended for landscaped areas.	Acceptable
15	Road gully locations not shown. Details of how the filter drains and other SuDs proposals are connected to the network should be provided.	CS Consulting to show locations of proposed road gullies and connectivity details. This could be done at detailed design stage if acceptable to DLRCC.	All proposed road gullies are shown on updated drawing W012-ZZ-XX-DR-C-0005 P3 Storm Layout Plan. It is proposed to show connection details for all other SUDs features at design stage.	Acceptable
16	Green roofs Roofs with provision for green roofs account for a gross area of 3907m2, of which 2428m2 are green roofs. This is equivalent to 62.1%, exceeding the DLR's Green Roof Policy minimum cover requirement of 60%. It is assumed that other apartment blocks have roof areas less than 300m2 or are otherwise not required to have green roofs under the DLRCC policy	CS Consulting to advise	All calculated green roof areas for the development have been calculated to comply with DLRCC policy for green roofs.	Acceptable

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable/Not Acceptable
	26/08/2021	26/08/2021		02/09/2021
16	Hydro-Brake Microdrainage Calculations Hydro-Brake S21 has a design head of 1.300m, design flow of 2.0 l/s and IL of 35.571m. The simulation results show a water level of 36.019m at this HB, therefore achieving an actual head of 0.448m. Hydro-Brake S32 has a design head of 1.300m, design flow of 5.0 l/s and IL of 34.674m. The simulation results show a water level of 35.757m at this HB, therefore achieving an actual head of 1.083m. Hydro-Brake S37 has a design head of 1.400m, design flow of 3.0 l/s and IL of 34.170m. The simulation results show a water level of 35.319m at this HB, therefore achieving an actual head of 1.149m. Has consideration been given to reducing the design head for Hydro-Brakes S21, S32 and S37? Hydro-Brake S15 has a design head of 1.400m, design flow of 4.5 l/s and IL of 34.753m. The simulation results show a water level of 36.488m at this HB, therefore achieving an actual head of 1.735m, exceeding the design head and potentially resulting in a discharge rate beyond that allowed for. Has consideration been given to this?	CS Consulting to advise and amend Hydro-Brake calculations at detailed design where necessary.	All hydrobrakes have revised design heads that match as close as possible the actual output heads. See updated Microdrainage calculations.	Acceptable subject to DLRCC approval. Note: Amend Hydro-Brake S32 pass forward flow to match Microdrainage calculations on W012-CSC-ZZ-XX-DR-C-0005 P4_Proposed Storm Water Layout and W012-CSC-ZZ-XX-DR-C-0034_Potential Flood Route.
17	Attenuation Tank 5 StormTech Calculations The required and installed volumes on the Tank No. 5 Stormtech calculations do not correspond with those shown in the MicroDrainage Calculations / revised drawings / ESR.	CS Consulting to advise and amend StormTech calculations for Tank No. 5 where necessary.	The Microdrainage calc volume now matches stormtech calc for Tank No. 5 as shown in updated drawing W012-CSC-ZZ-XX-DR-C-0005 P4. For clarity, we have updated table showing required and actual tank attenuation volumes	Acceptable subject to DLRCC approval. Note: Remove rogue items from drawing W012-CSC-ZZ-XX-DR-C-0005 P4_Proposed Storm Water Layout. Ensure alignment between calculation outputs and drawings / ESR at detailed design.

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18	Horizontal / Vertical Separation Requirements Drawing W012-CSC-ZZ-XX-DR-C-0031 P2_Storm Sewer Longsections has not been updated to include the separation distances from the existing combined sewer crossing between manholes S25 and S26. Also, the drawing shows foul crossings between S6 / S9 and S29 / S30. It is unclear if these are existing / proposed services as these are not included in drawing W012-CSC-ZZ-XX-DR-C-0005 P3_Proposed Storm Water Layout.	CS Consulting to advise and amend drawings where necessary to show pipe crossings and required horizontal and vertical separation distances in accordance with Irish Water Wastewater Code of Practice. This can be done at detailed design stage if acceptable to DLRCC.	Drawing W012-CSC-ZZ-XX-DR-C-0031 P3-Storm Longsections has been updated to show vertical and horizontal seperation distancesfor existing combined sewer. We wish to clarify that the foul crossings between S6/S9 and S29/S30 are proposed foul sewers that will be servicing the proposed apartment blocks.	**Acceptable subject to DLRCC approval.** **Note: Existing combined sewer crossing incorrectly shown between manholes S24 and S25. Amend to show crossing between S25 and S26 at detailed design.**
19	Exceedance Flows Has consideration been given to analysing Hydro-Brakes S21 and S32 for 50% blockages?	CS Consulting to advise.	Microdrainage calcs updated to include 50% blockage simulation for hydrobrakes S21 and S32	**Acceptable subject to DLRCC approval.** **Note: DLRCC policy appears to refer to extreme storms for strategic flood risk assessment.**
20	Filter Drains It is still unclear if areas where filter drains are proposed as considered as being positively drained, and therefore result in a potentially higher value of QBAR.	CS Consulting to advise.	Proposed filter drains will be lined to take positive flows, therefore Qbar unaffected	**Acceptable**
21	Additional Surface Type There are 3no. areas (of a more opaque blue colour) within the propoed site north of the riparian corridor. It is unclear what these are.	CS Consulting to advise.	The opaque blue is of no consequence to drainage layout and has been removed from SUDs drawing	**Acceptable**