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CIVIL & STRUCTURAL
CONSULTING ENGINEERS

DRAINAGE STRATEGY REPORT FOR PLANNING

Project:

KILNAMANAGH AFC

OCT 2021

DOCUMENT CONTROL

Project: KILNAMANAGH AFC PROPOSED NEW CLUBHOUSE

Project No: 21.309

Document Title: DRAINAGE STRATEGY REPORT FOR PLANNING

Document No: 21.309 - RP – 01

DOCUMENT STATUS

Issue	Date	Description	Orig.	PE	Issue Check
PL1	21.10.21	ISSUED FOR PLANNING	POD	POD	SOC

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APPENDICES

1. INTRODUCTION

1.1 SCOPE OF THIS REPORT

Barrett Mahony Consulting Engineers Ltd. (BMCE) have been commissioned by Mr. John Murphy c/o Kilnamanagh AFC to prepare surface water drainage design proposals for a new clubhouse development at Kilnamanagh AFC, Tree Park Road, Kilnamanagh, Dublin 24.

This report describes the proposed surface water drainage infrastructure and sustainable drainage measures for the development and how it connects to the public infrastructure serving the area. This report has been prepared on foot of a Further Information Request from South Dublin County Council (Planning Reg Ref SD21A/0044) dated 21st April 2021, specifically items 1(b) & 1(c) as noted below:

1 (b) There is no SuDS (Sustainable Drainage Systems) shown in proposed development. The applicant is requested to submit a drawing showing what SuDS are proposed for the development. Example of SuDS include filter drains, channel rills, green roofs, tree pits, permeable paving, green area detention areas and other such SuDS. Show on drawing how surface water is being attenuated for proposed development before discharge to public surface water sewer. Where SuDS is insufficient to attenuate surface water an additional arched type system can be used to attenuate surface water. The drawing should also show the attenuation capacity of each attenuation type system proposed.

1 (c) The applicant is requested to submit a report to show surface water attenuation calculations for proposed development. The report should show the site area in Hectares or m2 and each of the different surface types in Hectares or m2 such as building, roads pathways, permeable paving and grass areas and their respective run-off coefficients.

1.2 GENERAL DESCRIPTION

Kilnamanagh AFC are seeking to construct a two storey clubhouse and external activity area to further develop their existing playing facilities at Tree Park Road, Kilnamanagh. It is envisaged that the clubhouse construction will be the final piece in the clubs main infrastructure. Once completed, KAFC will continue to offer its facilities, new and existing, to national sporting bodies, local schools, community groups and surrounding football/GAA clubs.

The building is to be located between the existing all-weather pitch to the north and Kilnamanagh Community Centre to the southeast. The external activity area is to be on the western side of the clubhouse, adjacent to the first team grass pitch at Ned Kelly Park.

The building will comprise of:

- Two FAI standard sized changing rooms
- Dedicated referee's changing and shower room
- Toilet facilities on both levels
- Club shop for hot drinks, snacks and club merchandise
- Two indoor activity areas, one on each level
- Dedicated treatment/First Aid room
- Visitors room/Canteen
- Club Administration/Office and Services/Plant areas

The building construction will be concrete frame with an insulated render façade, double glazed units throughout, green/sedum roof to clubhouse and astro turf finish to external activity area. The first floor of the clubhouse will be served by both a stair core and passenger lift. Permeable paving to surrounding footpaths and covered bike stores to both the eastern side of the clubhouse (main entrance) and also in the carpark to the southeast of the clubhouse location

This report should be read in conjunction with the following civil engineering drawings submitted with the response to this Further Information Request:

- 19305 - C-1000 – Proposed Drainage & SuDS Plan Layout
- 19305 - C-1200 – Typical SuDS Details

2. SURFACE WATER DRAINAGE SYSTEM

2.1 EXISTING SURFACE WATER INFRASTRUCTURE

There is an existing 600mm diameter stormwater pipe to the southwest of the proposed development site and this flows in a north westerly direction along Tree Park Road. The subject site in question is currently greenfield and no known drainage infrastructure passes directly through the site.

2.2 PROPOSED SURFACE WATER DRAINAGE SYSTEM SUMMARY

The proposed development will deal with surface water run-off using best practice sustainable drainage measures in accordance with the CIRIA SuDS Manual, Greater Dublin Strategic Drainage Study guidance, and SDCC's own new development standards for stormwater drainage.

The SuDS strategy will involve a number of measures including:

- Full extensive green roof (sedum blanket) coverage to the proposed clubhouse building
- Permeable paving to all proposed external footpath areas
- Permeable external artificial grass area with stone fill subbase to accommodate attenuation storage
- Silt trap manhole with 0.5m sump for collection of silt.
- Hydrobrake vortex flow control device prior to discharge to the existing surface water network

2.3 MET EIREANN RAINFALL DATA

Appendix I of this report contains data extracted from Met Eireann sources for rainfall at the subject site location. In summary the following values are noted:

- SAAR (Standard Average Annual Rainfall) = 721mm
- M5-60 = 17.7mm
- M5-2D = 64.4mm
- Ratio "r" = 0.275
- Rainfall 100 yrs 6hrs = 77.7mm
- Rainfall 100yrs 12hrs = 96.3mm

2.4 GREENFIELD RUNOFF AND SURFACE WATER DISCHARGE RATE

The IH124 method of calculating greenfield runoff, recommended for use by the Greater Dublin Strategic Drainage Study 2005 calculates a value, QBAR, to estimate the undeveloped "greenfield"

run-off from a catchment. The GDSDS recommends limiting discharge to QBAR or 2l/s/ha, whichever is greater.
The IH124 equation estimates Qbar with the following equation:

$$Qbar_{rural} = 0.00108[Area^{0.89}] \times [SAAR^{1.17}] \times [Soil^{2.17}]$$

where:

- $Qbar_{rural}$ is the mean annual flood flow from a rural catchment (approximately 2.3 year return period).
- AREA is the area of the catchment in ha.
- SAAR is the standard average annual rainfall derived from Met Eireann data in mm.
- SPR is Standard Percentage Runoff coefficient for the SOIL category.

The greenfield run-off rate for the catchment (0.104ha or 1,040sq.m) has been calculated based on an estimated SOIL category of 3 (SPR value = 0.37) and Met Eireann SAAR value of 721mm:

Qbar for the Catchment: = 0.31/s

Refer to Appendix II for Qbar Calculation using UK SuDS Greenfield Runoff Rate Estimation tool.

The specification however of discharge rates less than 2l/s is not recommended through vortex flow controls due to the high risk of blockages. Therefore, a baseline discharge limit of 2l/s for the 1 in 100yr storm plus 20% climate change is proposed - i.e. the surface water attenuation system will be designed to ensure discharge rates do not exceed 2l/s for the 1 in 100yr storm plus 20% climate change. A hydrobrake vortex flow control will be installed to facilitate this, in the final manhole upstream of the proposed discharge location to the existing surface water network. Refer to Appendix V for details of proposed hydrobrake vortex flow control device.

2.5 Proposed Extensive Green Roof

The clubhouse building will be covered with a proprietary extensive (sedum blanket) green roof system. The system will provide a minimum storage capacity of 5litres/m^2.

Rainwater outlet positions will be subject to detailed design by specialist subcontractor, however the SuDS strategy for the development will involve discharging all rainwater downpipes to the permeable paving subbase around the perimeter of the building footprint using proprietary rainwater diffuser units.

Refer to Appendix VI for typical rainwater diffuser data sheet. Refer to Appendix VII for typical sedum blanket extensive green roof to achieve 5litres/m^2.

2.6 Proposed Permeable Paving Footpaths

The proposed external footpaths will be constructed using permeable paving. The permeable paving design has been designed in accordance with BS7533 Part 13 for pedestrian traffic, and allows for partial infiltration ("System B") through the base. In the event of poor infiltration rates on site, it should be noted that infiltration has been conservatively ignored in all attenuation storage requirement calculations.

Accumulations of surface water in the subbase will be collected using 100mm diameter perforated land drain pipes, with all pipes connected by standard domestic access junctions to facilitate rodding at changes in direction.

These collector pipes will flow towards the proposed outdoor artificial grass area, and the final access junctions before entering this area, will incorporate raised outlet pipes to provide guaranteed interception storage over the footprint of the permeable paved area.

2.7 SURFACE WATER ATTENUATION

Surface water attenuation is provided by means of a "surface water reservoir" in the stone void space below the external artificial grass area.

A surface water storage estimation was calculated using the UKSuDS online tool (refer to Appendix III) and indicated that approximately 43m^3 of storage would be required for the development area of 1040m^2.

The contributing areas are noted as follows:

- Extensive Sedum Green Roof = 317m^2
- Permeable Paving to Footpaths = 384m^2
- Permeable Artificial Grass Area = 338m^2

It should be noted that run-off coefficients have been conservatively ignored in the design calculations, and the full areas noted above have been used to calculate the required attenuation storage volumes.

Microdrainage Source Control software has been used to to model calculate the requried minimum attenuation storage requirements for the above contributing areas.

Output from the software for each network is provided in Appendix IV.

The Microdrainage Source Control output demonstrates that for a 1m tank footprint of 48.6m2 (i.e. 48.6m3 tank), the water level in the tank rises to a top water level of approximately 901mm, and discharge does not exceed 2l/s through the hydrobrake for the range of storm events for the 100yr return period plus 20% climate change.

Therefore the provision of a minimum attenuation storage volume can be calculated as follows:

$$48.6 \times 0.901 = \mathbf{43.78m^3\ required}$$

In order to provide the above minimum storage, it is proposed to utilize the stone fill beneath the external artificial grass area as a storage reservoir for the purposes of surface water attenuation. Assuming 40% voids space, the above volume requirement over the footprint of the artificial grass area gives a water depth as follows:

$43.78m^3 / 338m^2$ = 130mm depth of water @ 100% voids
= 324mm depth of water @ 40% voids

Thus a minimum depth of stone of **324mm** is required to provide the required 43.78m^3 water storage capacity.

It is proposed to conservatively provide a minimum 400mm depth of stone below the artificial grass system along with a series of 100mm diameter perforated land drains, 10m long spaced at 2m centres, and each connected to a central collector pipe (150mm diameter rigid perforated surface

water drain). This collector pipe, then leads to a silt trap manhole (0.5m sump), prior to connecting via a solid 150mm diameter pipe to the hydrobrake manhole.

3. CONCLUSION

In summary, it is considered the surface water drainage proposals are adequately sized to serve the proposed development. The design represent a robust and cost effective sustainable solution to managing surface water, and is in accordance with best practice design guidance on sustainable drainage systems.

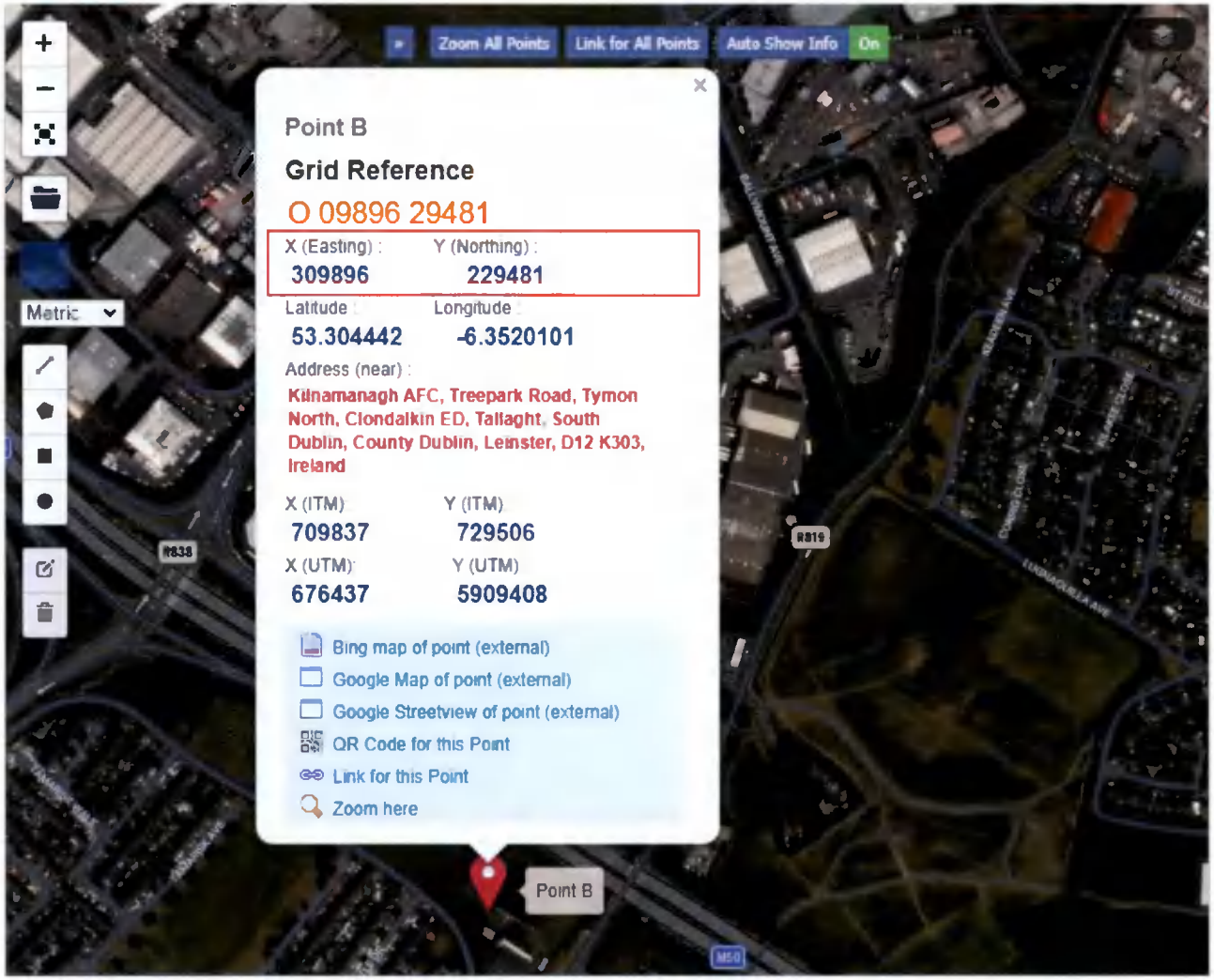
Appendix I

Rainfall Data

Irish Grid Coordinates
at the Subject Site:

X (Easting): 309896
Y (Northing): 229481

Source:
https://irish.gridreferencefinder.com/



Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 309896, Northing: 229481,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.4,	3.6,	4.3,	5.3,	6.0,	6.6,	8.4,	10.6,	12.1,	14.2,	16.1,	17.7,	20.0,	21.9,	23.4,	N/A ,
10 mins	3.4,	5.1,	6.0,	7.4,	8.4,	9.2,	11.8,	14.8,	16.9,	19.8,	22.5,	24.6,	27.9,	30.5,	32.7,	N/A ,
15 mins	4.0,	6.0,	7.0,	8.7,	9.9,	10.8,	13.8,	17.4,	19.8,	23.3,	26.5,	28.9,	32.8,	35.9,	38.4,	N/A ,
30 mins	5.3,	7.8,	9.1,	11.2,	12.7,	13.8,	17.6,	22.0,	24.9,	29.1,	32.9,	35.9,	40.5,	44.2,	47.2,	N/A ,
1 hours	7.0,	10.1,	11.9,	14.5,	16.3,	17.7,	22.3,	27.7,	31.3,	36.4,	40.9,	44.5,	50.1,	54.4,	58.1,	N/A ,
2 hours	9.2,	13.2,	15.4,	18.6,	20.9,	22.6,	28.3,	34.9,	39.2,	45.4,	50.9,	55.2,	61.9,	67.0,	71.4,	N/A ,
3 hours	10.9,	15.4,	17.9,	21.6,	24.1,	26.1,	32.6,	39.9,	44.8,	51.7,	57.8,	62.6,	70.0,	75.7,	80.5,	N/A ,
4 hours	12.2,	17.2,	19.9,	24.0,	26.8,	28.9,	36.0,	44.0,	49.2,	56.7,	63.3,	68.5,	76.4,	82.6,	87.7,	N/A ,
6 hours	14.3,	20.1,	23.2,	27.9,	31.0,	33.4,	41.4,	50.3,	56.2,	64.6,	71.9,	77.7,	86.5,	93.3,	99.0,	N/A ,
9 hours	16.9,	23.5,	27.0,	32.3,	35.8,	38.6,	47.5,	57.6,	64.2,	73.5,	81.7,	88.1,	97.9,	105.4,	111.7,	N/A ,
12 hours	18.9,	26.2,	30.1,	35.9,	39.8,	42.8,	52.5,	63.4,	70.6,	80.6,	89.5,	96.3,	106.8,	114.9,	121.7,	N/A ,
18 hours	22.3,	30.6,	35.0,	41.6,	46.0,	49.4,	60.4,	72.6,	80.6,	91.8,	101.7,	109.3,	120.9,	129.9,	137.3,	N/A ,
24 hours	25.0,	34.2,	39.0,	46.2,	51.0,	54.7,	66.6,	79.9,	88.6,	100.7,	111.3,	119.5,	132.0,	141.6,	149.5,	177.1,
2 days	31.3,	41.7,	47.2,	55.1,	60.4,	64.4,	77.2,	91.3,	100.4,	113.0,	123.9,	132.3,	145.0,	154.7,	162.7,	190.1,
3 days	36.3,	47.8,	53.7,	62.3,	67.9,	72.2,	85.8,	100.6,	110.1,	123.2,	134.5,	143.1,	156.1,	166.1,	174.2,	202.0,
4 days	40.8,	53.1,	59.4,	68.5,	74.4,	79.0,	93.3,	108.7,	118.6,	132.1,	143.8,	152.6,	166.0,	176.1,	184.4,	212.7,
6 days	48.6,	62.3,	69.3,	79.3,	85.8,	90.7,	106.2,	122.8,	133.3,	147.5,	159.8,	169.1,	183.1,	193.7,	202.3,	231.5,
8 days	55.4,	70.4,	78.0,	88.7,	95.7,	100.9,	117.4,	134.9,	146.0,	161.0,	173.8,	183.5,	198.0,	209.0,	217.9,	248.0,
10 days	61.7,	77.8,	85.9,	97.3,	104.6,	110.2,	127.5,	145.9,	157.5,	173.1,	186.4,	196.4,	211.5,	222.8,	232.0,	262.9,
12 days	67.6,	84.7,	93.2,	105.2,	112.9,	118.8,	136.9,	156.1,	168.0,	184.2,	198.0,	208.4,	223.8,	235.5,	244.9,	276.6,
16 days	78.5,	97.4,	106.7,	119.8,	128.2,	134.5,	154.0,	174.5,	187.3,	204.5,	219.0,	230.0,	246.2,	258.5,	268.3,	301.4,
20 days	88.6,	109.0,	119.0,	133.1,	142.0,	148.8,	169.5,	191.2,	204.7,	222.8,	238.1,	249.5,	266.5,	279.2,	289.5,	323.8,
25 days	100.4,	122.6,	133.4,	148.5,	158.1,	165.3,	187.5,	210.5,	224.7,	243.8,	259.8,	271.8,	289.6,	302.9,	313.6,	349.3,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

Based on the above Met Eireann Rainfall Return Period for Irish Grid Coordinates at the subject site:

- **M5-60** = 17.7mm
- **M5-2D** = 64.4mm
- **ratio "r"** = 0.275

For the purposes of stormwater storage estimation in Appendix III it is noted that:
Rainfall 100yrs 6hrs = 77.7mm
Rainfall 100yrs 12hrs = 96.3mm

SAAR Value based on Met Eireann **"1981-2010 Annual Average Rainfall Grid"**

Nearest Coordinates:
E: 310000 and **N: 229000**

SAAR = 721mm

Source: Met Eireann

Easting and Northing Irish Grid Co-ordinates

east	north	Annual Average Rainfall(mm)
310000	225000	991
310000	226000	906
310000	227000	824
310000	228000	763
310000	229000	721
310000	230000	700
310000	231000	702
310000	232000	718
310000	233000	733
310000	234000	746
310000	235000	759
310000	236000	773
310000	237000	786
310000	238000	798
310000	239000	812
310000	240000	821
310000	241000	826
310000	242000	828
310000	243000	826
310000	244000	823
310000	245000	814

Appendix II

Greenfield Run-off Rate Estimation

HR Wallingford
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Greenfield runoff rate estimation for sites

www.uksuds.com | Greenfield runoff tool

Calculated by: Peter O'Dwyer

Site name: Kilnamanagh AFC

Site location: Tree Park Road, Dublin 24

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

Site Details

Latitude:	53.30443° N
Longitude:	6.35199° W
Reference:	1051279887
Date:	Oct 19 2021 08:26

Runoff estimation approach IH124

Site characteristics

Total site area (ha): 0.104

Methodology

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

SPR estimation method: Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	3
HOST class:	N/A	N/A
SPR/SPRHOST:	0.3	0.37

Hydrological characteristics	Default	Edited
SAAR (mm):	948	721
Hydrological region:	12	12
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 30 years:	2.13	2.13
Growth curve factor 100 years:	2.61	2.61
Growth curve factor 200 years:	2.86	2.86

Notes

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

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

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

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

(3) Is SPR/SPRHOST ≤ 0.3?

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

Greenfield runoff rates	Default	Edited
Q_{BAR} (l/s):	0.27	0.31
1 in 1 year (l/s):	0.23	0.26
1 in 30 years (l/s):	0.58	0.66
1 in 100 year (l/s):	0.71	0.81
1 in 200 years (l/s):	0.77	0.88

Appendix III

Surface Water Storage Estimation

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	Peter O'Dwyer
Site name:	Kilnamanagh AFC
Site location:	Tree Park Road, Dublin 24

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (Ciria, 2015) and the non-statutory standards for SuDS (Defra, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the design of the drainage scheme.

Site Details

Latitude:	53.30444° N
Longitude:	6.35202° W
Reference:	1239444614
Date:	Oct 19 2021 18:32

Site characteristics

Total site area (ha):	0.104
Significant public open space (ha):	0
Area positively drained (ha):	0.104
Impermeable area (ha):	0.104
Percentage of drained area that is impermeable (%):	100
Impervious area drained via infiltration (ha):	0
Return period for infiltration system design (year):	100
Impervious area drained to rainwater harvesting (ha):	0
Return period for rainwater harvesting system (year):	100
Compliance factor for rainwater harvesting system (%):	66
Net site area for storage volume design (ha):	0.1
Net impermable area for storage volume design (ha):	0.1
Pervious area contribution to runoff (%):	0

* where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50% of the 'area positively drained', the 'net site area' and the estimates of Q_{BAR} and other flow rates will have been reduced accordingly.

Design criteria

Climate change allowance factor:	1.2
Urban creep allowance factor:	1.0
Volume control approach	Flow control to max of 2 l/s/ha or Qbar
Interception rainfall depth (mm):	5
Minimum flow rate (l/s):	2

Methodology

esti	IH124
Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics	Default	Edited
SOIL type:	2	3
SPR:	0.3	0.37

Hydrological characteristics	Default	Edited
Rainfall 100 yrs 6 hrs:	--	77.7
Rainfall 100 yrs 12 hrs:	--	96.3
FEH / FSR conversion factor:	1	1.32
SAAR (mm):	948	721
M5-60 Rainfall Depth (mm):	14	17
'r' Ratio M5-60/M5-2 day:	0.3	0.3
Hydological region:	12	12
Growth curve factor 1 year:	0.85	0.85
Growth curve factor 10 year:	1.72	1.72
Growth curve factor 30 year:	2.13	2.13
Growth curve factor 100 years:	2.61	2.61
Q_{BAR} for total site area (l/s):	0.27	0.31
Q_{BAR} for net site area (l/s):	0.27	0.31

Site discharge rates	Default	Edited	Estimated storage volumes	Default	Edited
1 in 1 year (l/s):	2	2	Attenuation storage 1/100 years (m^3):	20	43
1 in 30 years (l/s):	2	2	Long term storage 1/100 years (m^3):	0	0
1 in 100 year (l/s):	2	2	Total storage 1/100 years (m^3):	20	43

This report was produced using the storage estimation tool developed by HRWallingford and available at www.uksuds.com. The use of this tool is subject to the UK SuDS terms and conditions and licence agreement, which can both be found at http://uksuds.com/terms-and-conditions.htm. The outputs from this tool have been used to estimate storage volume requirements. The use of these results is the responsibility of the users of this tool. No liability will be accepted by HR Wallingford, the Environment Agency, CEH, Hydrosolutions or any other organisation for the use of these data in the design or operational characteristics of any drainage scheme.

Appendix IV

Microdrainage Output for Attenuation Sizing

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	-0.748	0.252	1.9	0.0	1.9	12.3	O K
30 min Summer	-0.584	0.416	1.9	0.0	1.9	20.2	O K
60 min Summer	-0.399	0.601	1.9	0.0	1.9	29.2	O K
120 min Summer	-0.222	0.778	1.9	0.0	1.9	37.8	O K
180 min Summer	-0.144	0.856	1.9	0.0	1.9	41.6	O K
240 min Summer	-0.115	0.885	1.9	0.0	1.9	43.0	O K
360 min Summer	-0.099	0.901	1.9	0.0	1.9	43.8	O K
480 min Summer	-0.103	0.897	1.9	0.0	1.9	43.6	O K
600 min Summer	-0.118	0.882	1.9	0.0	1.9	42.9	O K
720 min Summer	-0.137	0.863	1.9	0.0	1.9	41.9	O K
960 min Summer	-0.183	0.817	1.9	0.0	1.9	39.7	O K
1440 min Summer	-0.283	0.717	1.9	0.0	1.9	34.8	O K
2160 min Summer	-0.472	0.528	1.9	0.0	1.9	25.6	O K
2880 min Summer	-0.626	0.374	1.9	0.0	1.9	18.2	O K
4320 min Summer	-0.799	0.201	1.9	0.0	1.9	9.8	O K
5760 min Summer	-0.875	0.125	1.7	0.0	1.7	6.1	O K
7200 min Summer	-0.909	0.091	1.6	0.0	1.6	4.4	O K
8640 min Summer	-0.922	0.078	1.4	0.0	1.4	3.8	O K
10080 min Summer	-0.930	0.070	1.3	0.0	1.3	3.4	O K
15 min Winter	-0.748	0.252	1.9	0.0	1.9	12.3	O K
30 min Winter	-0.584	0.416	1.9	0.0	1.9	20.2	O K
60 min Winter	-0.401	0.599	1.9	0.0	1.9	29.1	O K
120 min Winter	-0.227	0.773	1.9	0.0	1.9	37.6	O K
180 min Winter	-0.150	0.850	1.9	0.0	1.9	41.3	O K
240 min Winter	-0.118	0.882	1.9	0.0	1.9	42.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
15 min Summer	93.240	0.0	18.7	0.0	54
30 min Summer	64.218	0.0	27.8	0.0	69
60 min Summer	41.518	0.0	37.6	0.0	96
120 min Summer	26.170	0.0	48.7	0.0	138
180 min Summer	19.823	0.0	56.0	0.0	186
240 min Summer	16.240	0.0	61.6	0.0	234
360 min Summer	12.233	0.0	70.1	0.0	298
480 min Summer	9.993	0.0	76.7	0.0	362
600 min Summer	8.537	0.0	82.1	0.0	430
720 min Summer	7.505	0.0	86.7	0.0	500
960 min Summer	6.123	0.0	94.4	0.0	636
1440 min Summer	4.595	0.0	106.2	0.0	912
2160 min Summer	3.443	0.0	118.9	0.0	1292
2880 min Summer	2.803	0.0	128.3	0.0	1628
4320 min Summer	2.095	0.0	142.2	0.0	2300
5760 min Summer	1.703	0.0	152.2	0.0	2992
7200 min Summer	1.450	0.0	160.0	0.0	3680
8640 min Summer	1.271	0.0	166.3	0.0	4408
10080 min Summer	1.137	0.0	171.6	0.0	5128
15 min Winter	93.240	0.0	18.7	0.0	54
30 min Winter	64.218	0.0	27.8	0.0	69
60 min Winter	41.518	0.0	37.6	0.0	96
120 min Winter	26.170	0.0	48.7	0.0	138
180 min Winter	19.823	0.0	56.0	0.0	186
240 min Winter	16.240	0.0	61.6	0.0	236

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Overflow (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
360 min Winter	-0.113	0.887	1.9	0.0	1.9	43.1	O K
480 min Winter	-0.127	0.873	1.9	0.0	1.9	42.4	O K
600 min Winter	-0.154	0.846	1.9	0.0	1.9	41.1	O K
720 min Winter	-0.190	0.810	1.9	0.0	1.9	39.4	O K
960 min Winter	-0.271	0.729	1.9	0.0	1.9	35.4	O K
1440 min Winter	-0.483	0.517	1.9	0.0	1.9	25.1	O K
2160 min Winter	-0.721	0.279	1.9	0.0	1.9	13.5	O K
2880 min Winter	-0.840	0.160	1.8	0.0	1.8	7.8	O K
4320 min Winter	-0.916	0.084	1.5	0.0	1.5	4.1	O K
5760 min Winter	-0.933	0.067	1.2	0.0	1.2	3.3	O K
7200 min Winter	-0.942	0.058	1.0	0.0	1.0	2.8	O K
8640 min Winter	-0.948	0.052	0.9	0.0	0.9	2.5	O K
10080 min Winter	-0.952	0.048	0.8	0.0	0.8	2.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Overflow Volume (m³)	Time-Peak (mins)
360 min Winter	12.233	0.0	70.2	0.0	308
480 min Winter	9.993	0.0	76.7	0.0	380
600 min Winter	8.537	0.0	82.1	0.0	456
720 min Winter	7.505	0.0	86.7	0.0	532
960 min Winter	6.123	0.0	94.5	0.0	682
1440 min Winter	4.595	0.0	106.2	0.0	950
2160 min Winter	3.443	0.0	119.0	0.0	1280
2880 min Winter	2.803	0.0	128.5	0.0	1592
4320 min Winter	2.095	0.0	142.3	0.0	2232
5760 min Winter	1.703	0.0	152.4	0.0	2936
7200 min Winter	1.450	0.0	160.3	0.0	3672
8640 min Winter	1.271	0.0	166.7	0.0	4392
10080 min Winter	1.137	0.0	171.9	0.0	5128

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	1.000
Region	Scotland and Ireland	Cv (Winter)	1.000
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.275	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Green Roof

Area (m³)	1040	Evaporation (mm/day)	3
Depression Storage (mm)	5	Decay Coefficient	0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.018899	32	36	0.003816	64	68	0.000770	96	100	0.000156
4	8	0.015473	36	40	0.003124	68	72	0.000631	100	104	0.000127
8	12	0.012668	40	44	0.002558	72	76	0.000516	104	108	0.000104
12	16	0.010372	44	48	0.002094	76	80	0.000423	108	112	0.000085
16	20	0.008492	48	52	0.001714	80	84	0.000346	112	116	0.000070
20	24	0.006952	52	56	0.001404	84	88	0.000283	116	120	0.000057
24	28	0.005692	56	60	0.001149	88	92	0.000232			
28	32	0.004660	60	64	0.000941	92	96	0.000190			

Model Details

Storage is Online Cover Level (m) 0.500

Tank or Pond Structure

Invert Level (m) -1.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	48.6	1.000	48.6	1.001	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	-1.000
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)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	0.800	1.8	2.000	2.7	4.000	3.8	7.000	4.9
0.200	1.9	1.000	2.0	2.200	2.9	4.500	4.0	7.500	5.1
0.300	1.9	1.200	2.2	2.400	3.0	5.000	4.2	8.000	5.2
0.400	1.9	1.400	2.3	2.600	3.1	5.500	4.4	8.500	5.4
0.500	1.8	1.600	2.5	3.000	3.3	6.000	4.6	9.000	5.5
0.600	1.6	1.800	2.6	3.500	3.5	6.500	4.7	9.500	5.7

Pipe Overflow Control

Diameter (m) 0.100 Roughness k (mm) 0.600 Upstream Invert Level (m) -0.100
Slope (1:X) 100.0 Entry Loss Coefficient 0.500
Length (m) 1.000 Coefficient of Contraction 0.600

Appendix V

Hydrobrake Data Sheet

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.000	2.000
Flush-Flo™	0.296	1.950
Kick-Flo®	0.599	1.584
Mean Flow		1.730

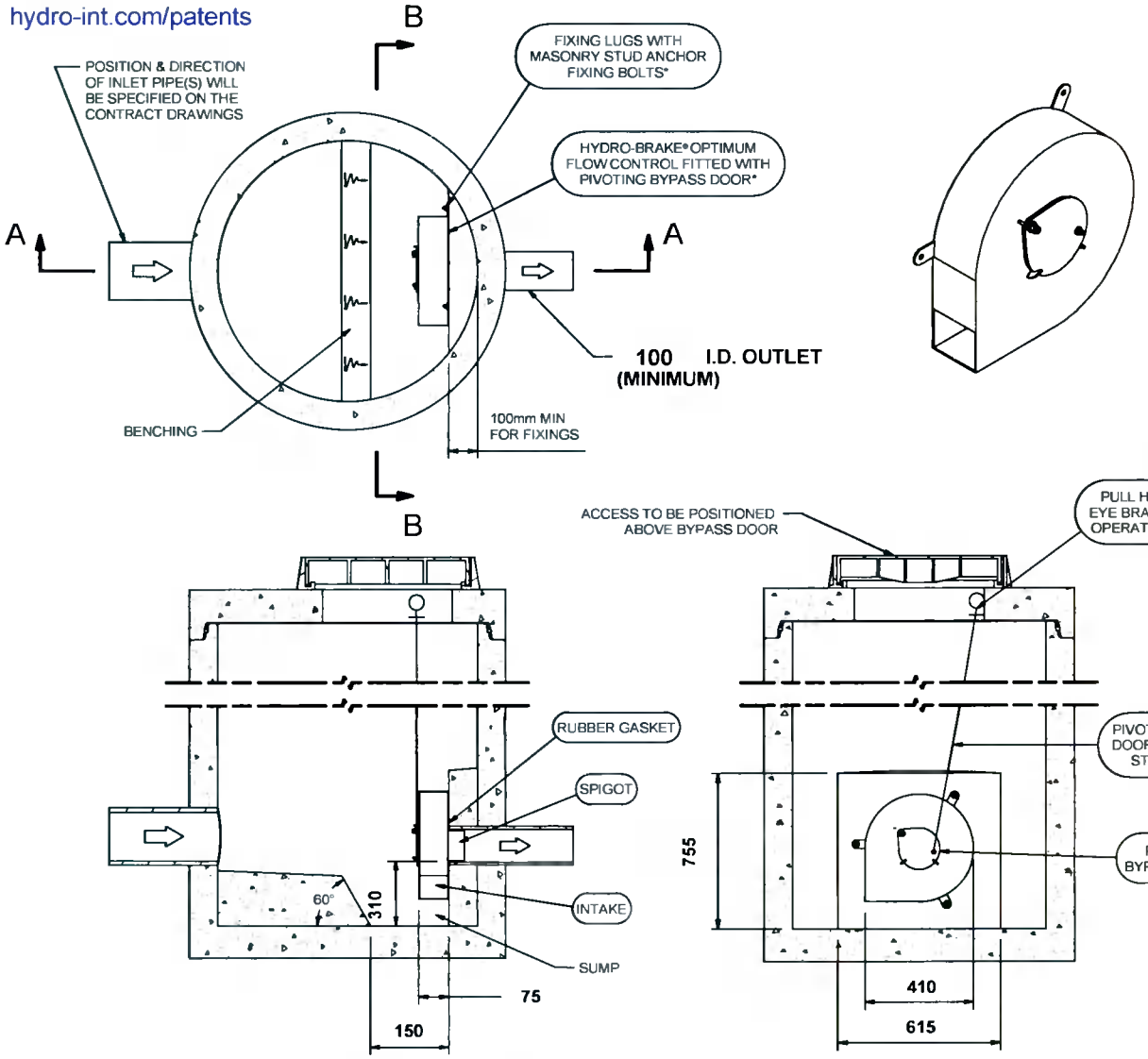
Hydro-Brake® Optimum Flow Control including:

- 3 mm grade 304L stainless steel
- Integral stainless steel pivoting by-pass door allowing clear line of sight through to outlet, c/w stainless steel operating rope
- Beed blasted finish to maximise corrosion resistance
- Stainless steel fixings
- Rubber gasket to seal outlet

BBA APPROVAL INSPECTION TESTING CERTIFICATION CERTIFICATE 08/4596

WRc Approved PT/329/0412

hydro-int.com/patents



SECTION A-A

SECTION B-B

IMPORTANT: ⬭ LIMIT OF HYDRO INTERNATIONAL SUPPLY
THE DEVICE WILL BE HANDED TO SUIT SITE CONDITIONS
FOR SITE SPECIFIC DETAILS AND MINIMUM CHAMBER SIZE REFER TO HYDRO INTERNATIONAL
ALL CIVIL AND INSTALLATION WORK BY OTHERS
* WHERE SUPPLIED
HYDRO-BRAKE® FLOW CONTROL & HYDRO-BRAKE® OPTIMUM FLOW CONTROL ARE REGISTERED TRADEMARKS FOR FLOW CONTROLS DESIGNED AND MANUFACTURED EXCLUSIVELY BY HYDRO INTERNATIONAL

THIS DESIGN LAYOUT IS FOR ILLUSTRATIVE PURPOSES ONLY. NOT TO SCALE.

DESIGN ADVICE !

The head/flow characteristics of this SHE-0067-2000-1000-2000 Hydro-Brake® Optimum Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.
The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.

Hydro International®

DATE	10/19/2021 6:58 PM
SITE	Dublin 24
DESIGNER	Peter O'Dwyer
REF	Kilnamanagh AFC

SHE-0067-2000-1000-2000
Hydro-Brake® Optimum

podwyer@bmce.ie

Technical Specification

Control Point	Head (m)	Flow (l/s)
Primary Design	1.000	2.000
Flush-Flo	0.296	1.950
Kick-Flo®	0.599	1.584
Mean Flow		1.730

BBA APPROVAL INSPECTION TESTING CERTIFICATION
CERTIFICATE No 08/4596

WRc APPROVED
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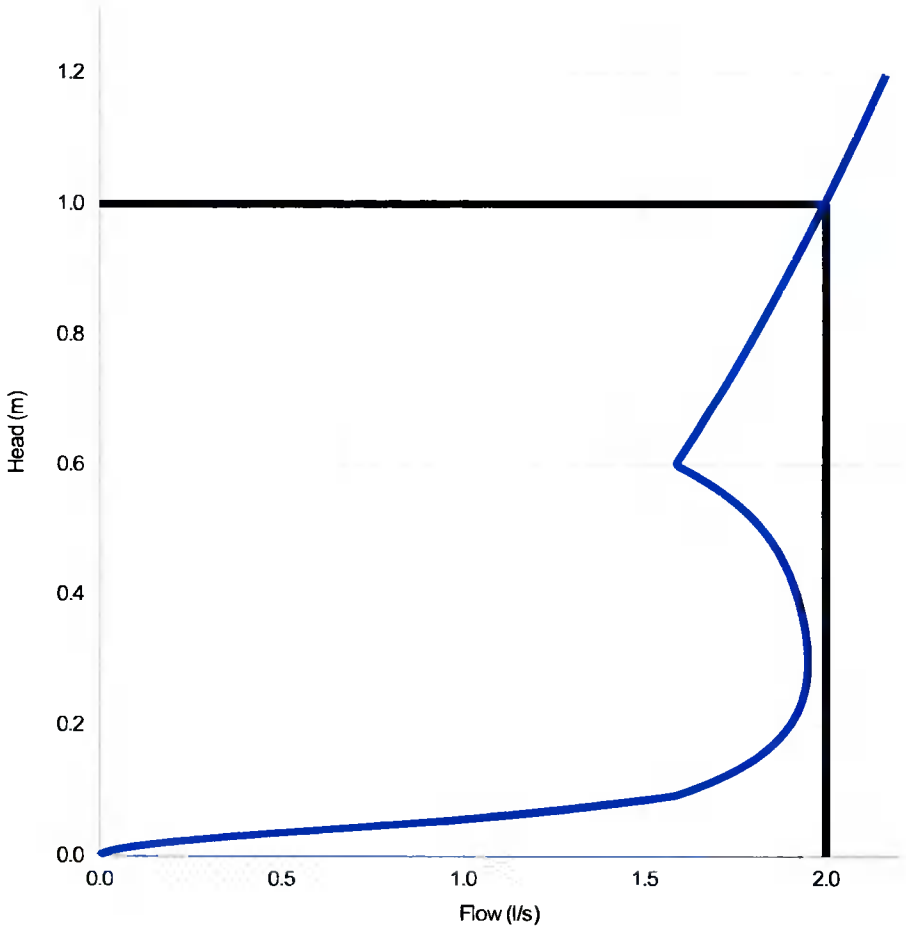
hydro-int.com/patents



Head (m)	Flow (l/s)
0.000	0.000
0.034	0.462
0.069	1.240
0.103	1.646
0.138	1.775
0.172	1.858
0.207	1.909
0.241	1.936
0.276	1.948
0.310	1.949
0.345	1.942
0.379	1.929
0.414	1.911
0.448	1.884
0.483	1.848
0.517	1.797
0.552	1.726
0.586	1.631
0.621	1.609
0.655	1.649
0.690	1.687
0.724	1.725
0.759	1.761
0.793	1.797
0.828	1.832
0.862	1.866
0.897	1.899
0.931	1.932
0.966	1.964
1.000	1.995

DESIGN ADVICE

The head/flow characteristics of this SHE-0067-2000-1000-2000 Hydro-Brake Optimum® Flow Control are unique. Dynamic hydraulic modelling evaluates the full head/flow characteristic curve.

! **The use of any other flow control will invalidate any design based on this data and could constitute a flood risk.**

Hydro International®

DATE	19/10/2021 18:58
Site	Dublin 24
DESIGNER	Peter O'Dwyer
Ref	Kilnamanagh AFC

SHE-0067-2000-1000-2000

Hydro-Brake Optimum®

Appendix VI

Rainwater Diffuser Data Sheet

Permavoid Rainwater Diffuser Unit

Data Sheet

Run-off from building roofs is collected into downpipes and flows into a back inlet gully incorporating an internal filter or catchpit inspection chambers. The back inlet gully or chamber discharges the filtered stormwater into the permeable sub-base via Permavoid Rainwater Diffuser Unit encapsulated in a 2mm mesh fabric. The run-off will then diffuse out of the Permavoid Rainwater Diffuser Unit and into the modified granular sub-base layer. The Permavoid unit is a 150mm deep modular interlocking plastic unit storage system designed for use as a combined drainage component and sub-base replacement system, ideal for shallow infiltration/attenuation.

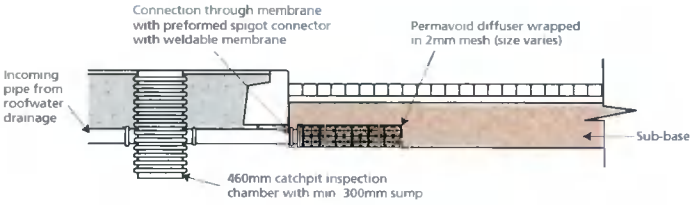
Permavoid Rainwater Diffuser Unit - Configuration Options

Length \ Width	354mm	708mm	1062mm	1416mm	2124mm
708mm	✓	✓	✓	✓	✓
1062mm	✗	✓	✓*	✓	✓
1416mm	✓	✓	✓	✓	✓
2124mm	✓	✓	✓	✓	✓

*1062 x 1062mm diffuser unit has a 354 x 354mm central opening.
Depths available are either 150mm or 300mm.
Connections available are either Ø110mm or Ø160mm.

Catchpit: 460mm diameter catchpit with 160mm inlet - PSMST 160
460mm diameter catchpit with 110mm inlet - PSMST 110

Typical Layout - Rainwater downpipe drainage into sub-base reservoir



Technical Support

Detailed guidance and assistance is available.
For further information, please contact our Technical Team on **+44 (0) 1509 615 100** or email **civils@polypipe.com** or visit **www.polypipe.com/civils-technical-hub**

ELEMENT	VALUE
PHYSICAL PROPERTIES	
Weight per unit	3kg
Length	708mm
Width	354mm
Depth	150mm
SHORT TERM COMPRESSIVE STRENGTH	
Vertical	715kN/m²
Lateral	156kN/m²
SHORT TERM DEFLECTION	
Vertical	1mm per 126kN/m²
Lateral	1mm per 15kN/m²
TENSILE STRENGTH	
Of a single joint	42.4kN/m²
Of a single joint at (1% secant modulus)	18.8kN/m²
Bending resistance of unit	0.71kN/m
Bending resistance of single joint	0.16kN/m
OTHER PROPERTIES	
Volumetric void ratio	95%
Average effective perforated surface area	52%
Intrinsic permeability (k)	Minimum 1.0 x 10^{-5}
Ancillary	Permavoid Permatie Permavoid Shear Connector
Material	Polypropylene (PP)

HYDRAULIC PERFORMANCE						
3 units wide, 1 unit deep (1.06m x 0.15m)						
FREE DISCHARGE						
Gradient (%)	0	1	2	3	4	5
Flow rate (l/m/s)	8	13	15	17	19	21

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Polypipe

Permavoid Rainwater Diffuser Unit

Data Sheet

Permavoid Rainwater Diffuser Unit can be utilised in these SuDS techniques

TECHNIQUES													
Blue-Green roofs	Podium Decks	Trees	Sports Pitches	Cycle Paths	Permeable Paving (sub base & podium)	Bioretention & Rain Gardens	Attenuation Storage Tanks	Infiltration	Swales	Filter Drains	Detention Basins	Ponds & Wetlands	Filter Strips
			✓		✓		✓						

Visit www.polypipe.com/greeninfrastructure

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Polypipe

Appendix VII

Extensive Green Roof Data Sheet

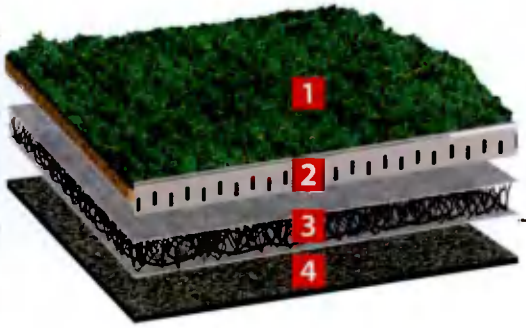
Revision: November 2020 V2

SYSTEM SUMMARY

Bauder XF301 Sedum System

Lightweight sedum blanket system

Bauder XF301 Single Layer Sedum System is an ultra-light weight sedum system. Where the roof is laid to a fall of <2° the product can be laid directly onto the waterproofing. When laid on flat roofs, an additional drainage mat (SDF mat layer 3 below) is fitted. XF301 also contains a moisture mat which retains up to 5 Ltr of water/m². The vegetation within the system is a mix of sedum varieties. Bauder's "Green Roof Promise" is available for this system.



Product	Description	thickness	weight
1 Bauder XF301 Sedum Blanket*	A single layer sedum system, GRO compliant substrate is held within a nylon mesh with attached moisture mat. The sedum blanket is grown for circa 12 months and contains up to 17 species of sedum	28mm	44Kg/m²
2 Bauder AL40	A bespoke edge trim which retains the XF301 system and secures the system to the underlying waterproofing	N/A	N/A
3 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. (Only required on flat roofs)	20mm	1Kg/m²
4 Underlying Waterproofing system	Bauder's underlying waterproofing system, options for Bituminous Membrane, Hot Melt, Single-ply or Cold applied liquid systems.	N/A	N/A
Green Roof Build up (fully saturated, excludes the waterproofing)		**48mm**	**45Kg/m²**

*Bauder also produce deeper sedum & wildflower blankets solutions

Where to specify:

Ideally suited to lightweight wooden roof decks or any building where weight and depth of system is critical.

Please note: All green roofs require water during times of drought. Bauder recommend that the watering and maintenance of this roof is considered and addressed during its design.

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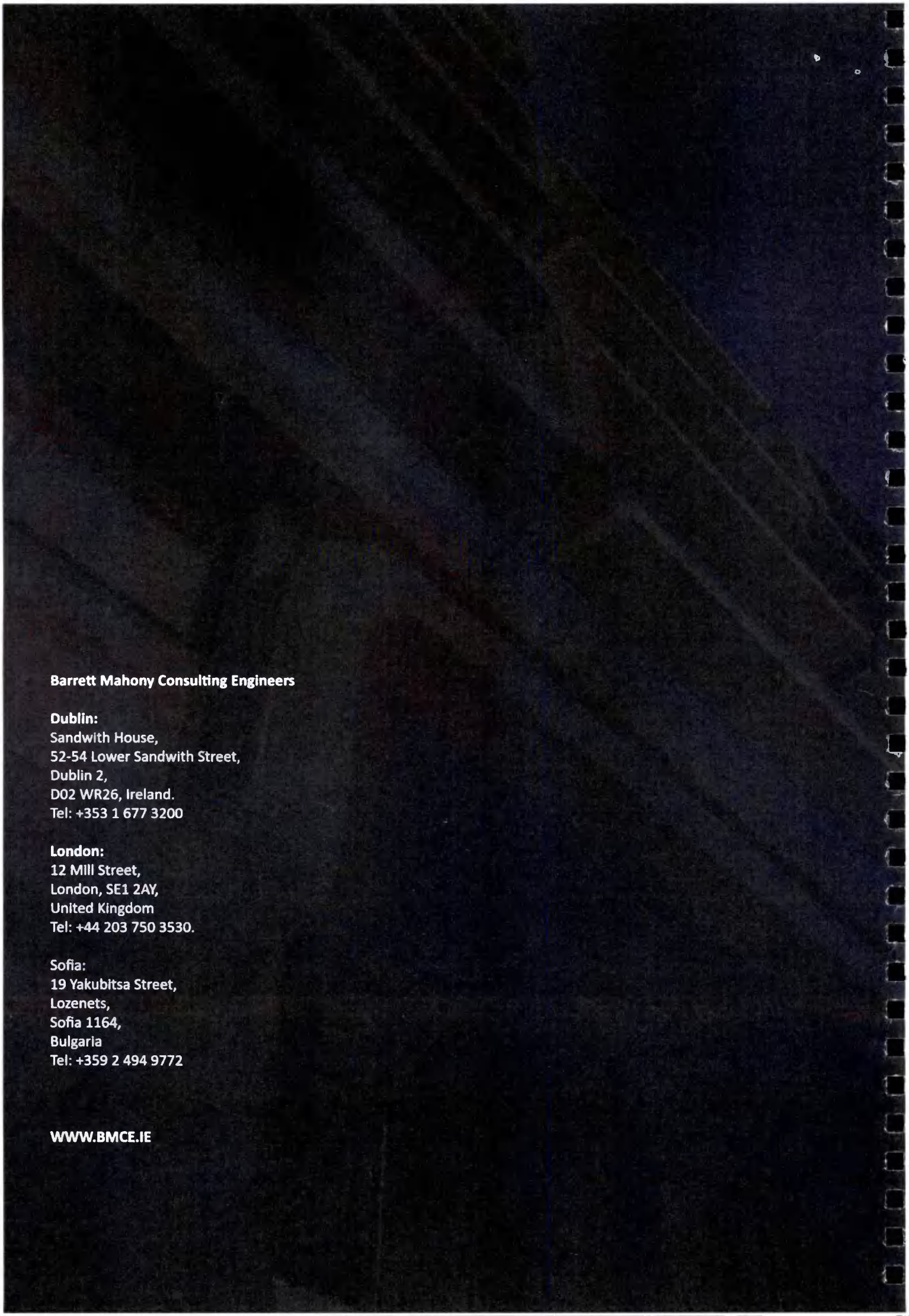

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