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CONSULTING ENGINEERS
STRUCTURAL & CIVIL

Engineering Planning Report

Charlestown Place SHD, Charlestown Place and St Margaret's Road, Charlestown, Dublin 11.

Ref: 1726-EPR-R1
Date of Issue: March 2021
Revision: R1

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1.0 INTRODUCTION

The subject site is located off the Finglas Road close to the M50 and measures approximately 3.31 Ha in size. Currently the site is used as an overflow carpark from the adjacent Charlestown Shopping Centre. Charlestown Place Road bounds the site to the North, St Margaret's Road to the East, a greenfield site lies to the West, and McKelvey Avenue residential housing estate and McKelvey AFC football pitch bound the site to the South. Access to the site is provided off the Charlestown Place via M50-N2 interchange and the Finglas Road.

The proposed development forms part of the wider Charlestown development, please refer to Appendix G for the overall SW scheme layout drawing. This scheme consists of a total of 590 residential apartment units, 224m² of Office space, a 542m² Crèche, 350m² of Retail space & a 525m² Medical Facility . The residential accommodation is provided in a mixture of four apartment blocks. Blocks 1 & 2 have basement parking consisting of 351 spaces and the Block 4 basement carpark consists of 82 spaces, 14 spaces are reserved for the Creche and Community Facilities, 69 parking spaces have been provided at surface level.

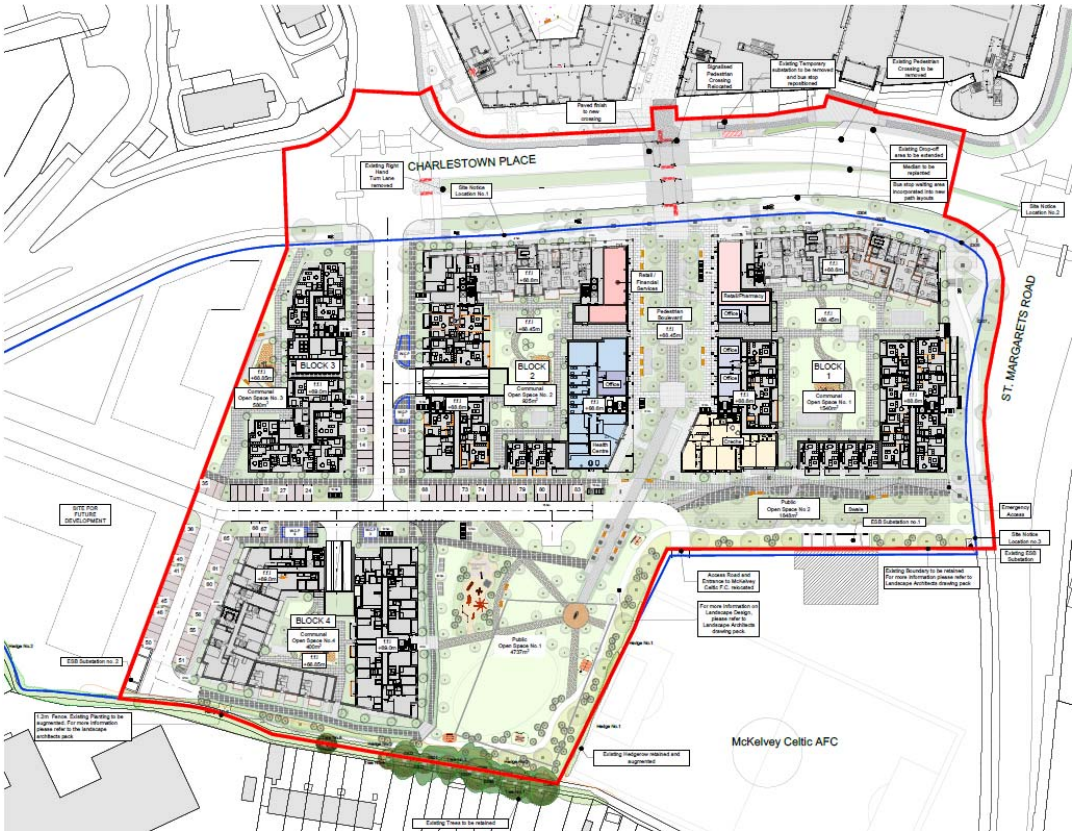

Figure 1.1 Proposed Site Plan

This report should be read in conjunction with POGA Consulting Engineers drawings and all other Consultants' reports and drawings.

The engineering drainage design philosophy is outlined below and detailed calculations are contained in the Appendices of this report.

2.0 EXISTING SERVICES

Wastewater Sewer

The Ø750mm Meakstown wastewater sewer (also known as the North Fringe Foul Sewer) lies adjacent to the Northern boundary of the subject site under Charlestown Place Road. It is proposed to connect to the sewer at North Eastern site boundary.

Surface Water

There is an existing Ø750mm surface water sewer running through the subject site along the Northern, Eastern, and Southern boundaries. This sewer was constructed as part of the existing Charlestown development. The surface water network outfalls into the existing Ø1200mm culvert on the applicant's lands to the South.

The underground attenuation tank at the South East of the subject site under the green open space is under construction under a separate planning permission. The tank is designed to have capacity to store the attenuated run-off from all of the land North of Charlestown Place Road and South of the M50 boundary including the Charlestown (Phase 1 & 2A and 2B) development. The tank was permitted under planning reference F19A/0146 and F18A/0718 and is under construction as part of the Phase 2b works, please refer to Appendix G for overall surface water layout.

Water

There is an existing Ø850mm trunk watermain which is within the applicant's land running under the Charlestown Place Road, please refer to Drawing 1726-105 for details. As part of the Phase 1 construction a new Ø250mm watermain was constructed either side of this distributor Road and connected into the trunk main with the agreement of the Water Department of Dublin City Council (the authority responsible for the Ø850mm watermain).

It is proposed to connect the subject site off the nearest (Southern) Ø250mm watermain via a Ø150mm HDPE watermain looping around the development.

3.0 FLOOD RISK ASSESMENT

A full site-specific flood risk assessment (SSFRA) will be completed as part of this application, and is enclosed separately with this application. The FRA follows the guidelines given in The Planning System and Flood Risk Management document published by the Office of Public Works (OPW) and the Department of the Environment Heritage and Local Government (DEHLG) in 2009.

4.0 PROPOSED SURFACE WATER MANAGEMENT

The management of surface water for the proposed development has been designed to comply with the policies and guidelines of the Greater Dublin Strategic Drainage Study (GDSDS). The overall objective is to minimise stormwater runoff and to collect and treat this minimised amount of runoff as close to the source as possible.

In accordance with the SuDS philosophy, a Surface Water Treatment Train approach has been applied to the design of the surface water drainage on this site. The techniques that apply here suit the site topography, ground conditions and receiving environment. There are also four main criteria to be satisfied in new developments regarding stormwater management, these are described below.

- **Criteria 1:** River Water Quality Protection – interception and treatment volume.
- **Criteria 2:** River Regime Protection – limit of discharge to receiving water.
- **Criteria 3:** Level of Service (flooding) for the site – internal protection against flooding of propriety.
- **Criteria 4:** River Flood Protection – long-term flood storage.

4.1 SuDS Techniques

SuDS techniques comprise a flexible series of options, which allow the drainage designer to select those systems that best suit the circumstances of the site. The treatment train approach assures that both runoff quantity and quality are addressed, through the overall techniques of: pollution prevention, source control, site control and regional control measures.

Pollution Prevention

Pollution prevention is essentially good housekeeping, since minimising or preventing pollution in the first place is more practical and cost effective than having to treat it afterwards. Thus, the best approach to urban runoff pollution is to prevent chemical and other pollutants from coming into contact with rainfall runoff through appropriate storage and management, and through education. In this respect, it is proposed that the developer will provide information to the operator on appropriate usage of the proposed drainage systems.

Source Control

The second element of the treatment train is to detain or infiltrate runoff as close as possible to the point of origin. The use of such source control devices reduces the peak run-off rate and attenuates flows, thus reducing stress on downstream facilities, allowing them to be smaller in capacity.

It is proposed to have four source control measures comprising; a green roof system, a podium retention system, an open swale, and permeable paving. These will minimise

impermeable areas and encourage stormwater to soak into the ground/soil while filtering pollutants.

The Green Roof Systems are located at roof level over each apartment block, the green roofs occupy approximately 25% of the total roof area (allowing for the inclusion of PV panels), please refer to Appendix B Paved Area factors. The system is designed to store part of the 1 in 100-year storm event plus 20% for climate change and will discharge the surface water at a Greenfield run-off rate. Refer to Figure 4.1 for indicative Green Roof Build up detail. The Green Roof System will include a 100mm deep void acting as a form of attenuation during storm events.

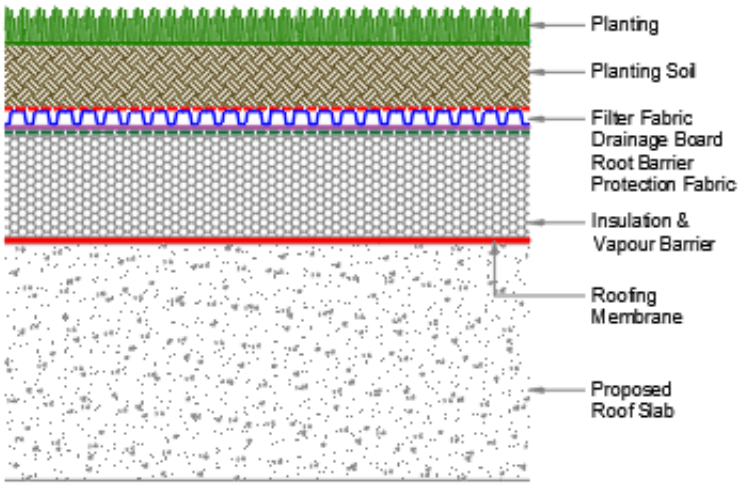

Figure 4.1 Typical Green Roof Detail

It is proposed to use a 100mm deep void in the landscaped podium area as a control measure. Refer to Figure 4.2 for specification with Sedum Carpet finish and Figure 4.3 for paving finish on adjustable paving supports. Green areas and paving areas to Architects drawings and details. The podium retention systems act as a form of attenuation during storm events.

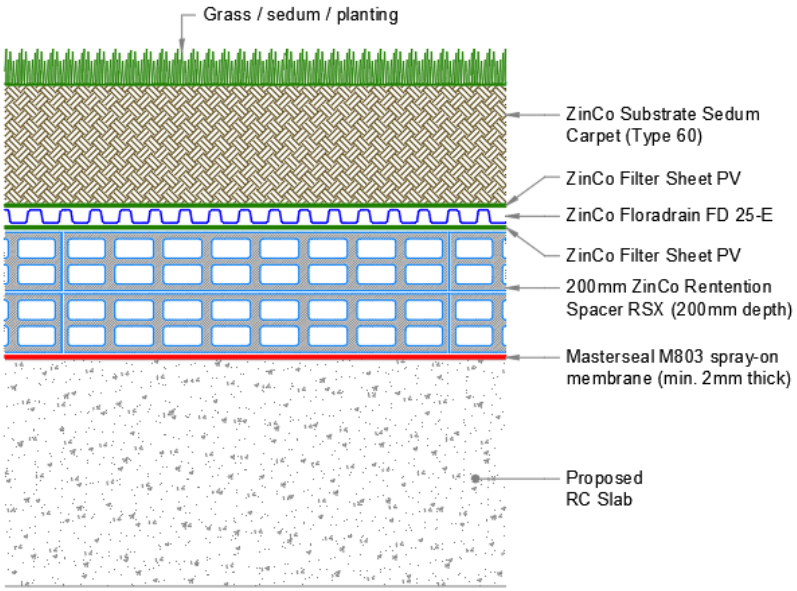

Figure 4.2 ZinCo Retention System or similar with Sedum Carpet

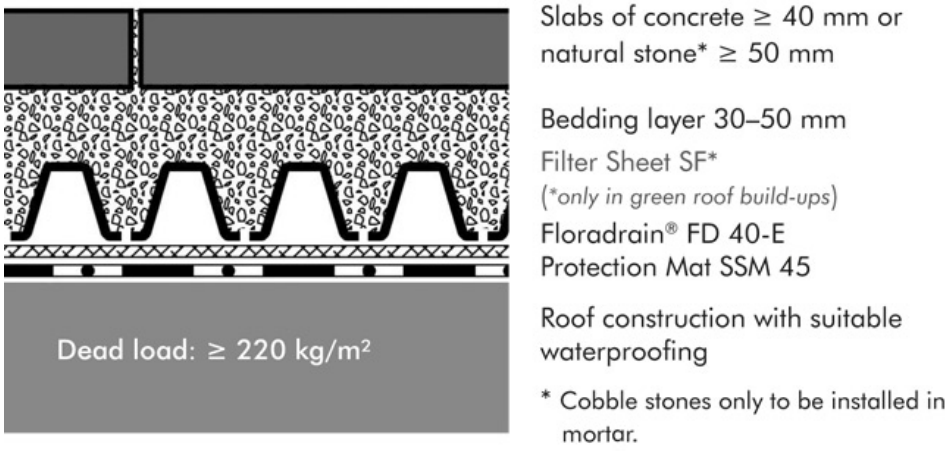

Figure 4.3 Typical ZinCo Retention System or similar for paving slabs

It is proposed to provide a swale along the Sothern edge of the site along the linear walkway to cater for the run off from Block 1. Swales are linear grass covered depressions which lead surface water overland and pipes systems from the drained surface to storage or discharge system. Unlike a conventional ditch, a swale is shallow and relatively wide. It provides temporary storage for storm water and reduces peak flows. They are located close to the source of runoff. Refer to Figure 4.4 below for typical details.

Figure 4.4 - A typical swale (Sudswales.com)

The proposed Swale will be dry for most of the year, but will fill during a rainfall event above the 1 in 2-year return storm; a manhole will be provided downstream of the outlet and fitted with a Hydrobrake type device in series to allow the swale to activate during storm events. The Hydrobrake will be set to allow for flows of 6.9l/s pass at peak storm. The swale has a storage capacity of approximately 180m³, please refer to Appendix D for swale calculations.

It is proposed to use permeable paving on the surface parking to collect the surface water from the parking bays, we have conservatively allowed for 5% of the run off from these areas into the pipe network, i.e. 95% infiltration. Permeable paving is a range of sustainable materials with a base and sub-base that allow the movement of stormwater through the surface. In addition to reducing runoff, this effectively traps suspended solids and filters pollutants from the water, and recharges the ground water. Refer to Figure 4.5 for a typical permeable paving and drawing 1726-101 for locations where this is proposed.

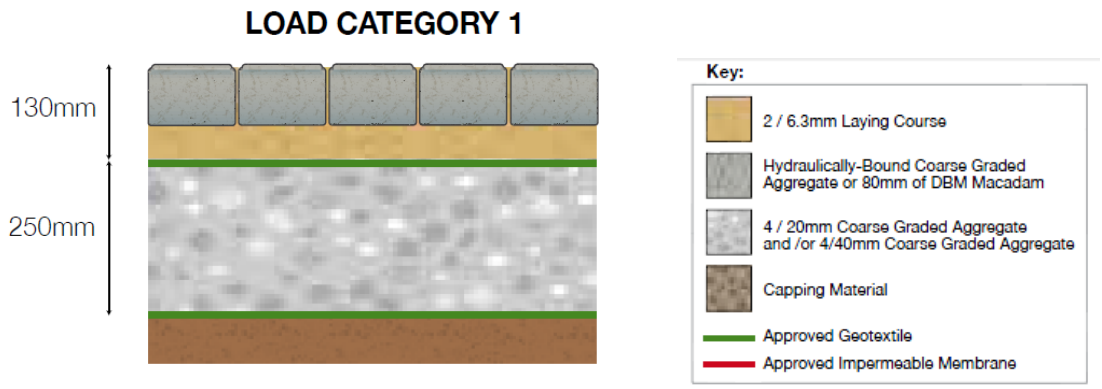

Figure 4.5 Typical Permeable Paving Build-up

Ground Investigations Ireland (GII) completed soil infiltration testing at the site (11/11/08), the report concluded that the soil is unsuitable for the design of soakaways. Therefore, the infiltration of surface water was not considered for this site, please see Appendix H for the full report.

Site Control

Site control comprises runoff and treatment installations to serve individual developments (or combinations of developments on adjacent sites), using elements such as detention basins or cellular systems. On this development it is proposed to use a large underground for the 1:100- year storm event plus 20% for climate change. The rainfall profile for the Dublin Airport Met-Éireann rainfall station as attached in Appendix A has been utilized.

The GDSDS allows for development sites to discharge surface water at either the Greenfield or brownfield run-off rate. We are proposing to use the GDSDS recommended Qbar formula as described by the Institute of Hydrology Report No.124 and then apply an interpolated rate for sites less than 50Ha. Using a 50ha site area, this allows an outfall of 98.8l/s or approximately 2l/s/Ha. The attenuation tank is designed to serve a drained area of 11.4ha; comprising the original Charlestown Shopping Centre (Phase 1 & 2A), and the apartment scheme under construction (Phase 2B), and this proposed scheme, as well as a significant area of surrounding roads. By linear interpolation this gives a Qbar for the drained area of 22.8 l/sec. [(98.8/50) x 11.4 = 22.8/s]. The calculation of Qbar is attached in Appendix B.

Storage volumes in the Attenuation area have been calculated using the 1, 30 and 100 year storm events, with no surface flooding taking place in the 100 year storm event. The attenuation tank is designed to have adequate capacity for future provision. The calculations are attached in Appendix C.

Please refer to drawings 1726-103 & 104 for the drainage plans and 1726-112 for attenuation details.

Regional Control

Regional control comprises of treatment facilities to reduce pollutants from contaminated runoff, with the potential to provide biological treatment on a catchment scale. They are often end-of-pipe facilities. This is not appropriate for a site of this size.

4.2 Surface Water Drainage Design

It is proposed to intercept, treat and attenuate the rainfall water falling on the site using the methods mentioned in section 4.1. The site slopes from North West to South East with a fall of 3m over 180m, resulting in an approximate slope of 1:60. It is proposed to construct a new Ø225mm surface water network flowing towards the underground attenuation tank located at the South Eastern site boundary. The attenuated surface water run-off outfalls into the existing Ø525mm surface water network flowing Eastwards towards the Ø1200mm surface water culvert located under St Margaret's Road. The culvert outfalls into the Finglas River please see drawings 1726-103 & 104 for details.

The following run-off rates factors have been applied to the scheme to calculate the Percentage Run-off or PIMP:

1. 40% from Green Roofs/Podium Areas
2. 95% from Roofs
3. 85% from Roads/Hardstanding
4. 5% from Permeable Paving/ Landscaped Areas
5. 5% Grassed areas

Interception, Treatment and Attenuation volumes

The design criteria mentioned previously has been achieved as per described below.

- **Criteria 1:** River Water Quality Protection – satisfied by providing interception and treatment volume within the green roofs, swales, and permeable paved areas.
- **Criteria 2:** River Regime Protection – satisfied by attenuating the run-off within the underground attenuation tank system.
- **Criteria 3:** Level of Service (flooding) for the site – Refer to item 3.0 mentioned previously on this report.
- **Criteria 4:** River Flood Protection – long term storage not provided; outflow limited to Qbar (22.8 l/s).

The storage requirements were designed according to Drainage Design Process Flow Charts provided in the GDSDS document. Refer to Figure 4.4 for summary of the calculations.

- Required interception volume provided by the permeable paving was calculated for a rainfall depth of 5mm and assuming 80% runoff from paved surfaces and 0% from pervious surfaces.
- Required treatment volume for the green roofs was estimated for a rainfall depth of 15mm and assuming 80% runoff from paved surfaces and 0% from pervious surfaces.

- Storage volume in the attenuation tank has been calculated using the 1, 30, and 100-year storm events +20% climate change, with no surface flooding taking place in the 100-year storm event.

STORAGE REQUIREMENTS	
Subject site information	
Site Area	3.3 Ha
PIMP Factor	0.39
Total Impermeable area	1.30 Ha
Criteria 1 - River Water Quality Protection	
Interception volume (5mm of rainfall)	52m³
Treatment volume (15mm of rainfall with interception volume deducted)	104m³
Total (Sum of interception and treatment Volume)	**156m³**
Criteria 2 - River Regime Protection	
Attenuation Volumes	
1-Year Storm	1162m³
30-Year Storm	2887m³
100-Year Storm	3790m³
Total volume Required (Attenuation minus Interception + Treatment Vol)	**2663m³**
Criteria 3 - Level of Service for the Site	
All house levels are set 500mm above top water level of attenuation tank	
Criteria 4 - River Flood Protection	
Long term storage is not provided. Outflow limited to Qbar.	

STORAGE PROVISION		
SUDS techniques	Interception + Treatment	Attenuation
Swale	180m³	-
Podium Retention System	577m³	-
Green Roof System	243m³	-
Permeable paving	127m³	-
Underground Attenuation Tank	-	3850m³
TOTAL	**1127m³ >156m³ Ok**	**3850m³>2663m³ Ok**

Figure 4.4 Treatment Train Calculations

Pipe Design

All surface water pipes sizes and gradients are designed in accordance with the Department of Environment Recommendation for Site Development Works, Building Regulations and Irish Water Standards. The pipes have been designed for a 2-year return period, please refer to Appendix E for pipe design calculations.

5.0 WASTEWATER

The nearest viable wastewater sewer network is the existing Ø750mm Meakstown Foul Sewer (North Fringe Sewer) located under Charlestown Place Road to the North of the site. It is proposed to connect to the existing wastewater network at the North Eastern site boundary. It is proposed to drain the surface water run-off at basement level in the underground carparks (under Blocks 1, 2, & 4) into a vertical pumping station which then outfalls into the proposed wastewater network via a discharge manhole.

All foul water pipes sizes and gradients are designed in accordance with the Department of Environment Recommendation for Site Development Works, Part H of the Building Regulations and Irish Water Standards. A Pre-Connection Enquiry has been submitted to Irish Water for this project and we have received a Confirmation of Feasibility which states "*A connection to the existing network is feasible without upgrade",* refer to Appendix J. A Statement of Design Acceptance from Irish Water is also attached in Appendix J.

Refer to drawings 1726-103 & 104 for drainage details and to Appendix F for wastewater loading and pipe design.

6.0 WATER SUPPLY

It is proposed to connect to the existing Ø250mm watermain located at the Northern section of the site. A Ø150mm HDPE pipe network will service the subject site. A bulk flow meter will be fitted at the main entrance of the site. Individual connections will be provided to both retail units, the Creche, and the 4No apartment blocks. A manifold box will be provided for each apartment block to provide separate metered connections to each dwelling and commercial unit.

All connection to the public water infrastructure will be made following a connection agreement with Irish Water and under their direction. Please refer to Appendix J for Irish Water Confirmation of Feasibility which states "*a new connection to the existing network is feasible without upgrade.*" A Statement of Design Acceptance from Irish Water is also attached in Appendix J. Refer to Appendix F for water demand calculation.

Refer to Drawing 1726-105 for the watermain layout.

6.1 Water Conservation and Management

To conserve water the following is proposed;

1. All bathroom and staff facilities to be fitted with low flow fittings such as taps, shower head, etc.
2. All electrical appliances will be A energy rated.
3. All bathrooms will be fitted with dual flush toilet cisterns

7.0 ROADS & TRAFFIC

7.1 Site Access

The existing development is accessed off Charlestown Place Road, which is an urban Road at the North Western boundary of the site. This will be used for vehicular and pedestrian access to the site; there will also be a separate pedestrian access from a relocated signalised pedestrian crossing at the shopping centre entrance and from St Margaret's Road. This will allow for connectivity from adjoining developments to access to the central green space and McKelvey Celtic AFC. The site access will consist of the following:

1. A pedestrian crossing with reduced crossing distance in one phased movement;
2. A pedestrian link via a signalised pedestrian crossing from Charlestown Place to the shopping centre, which links to the central open space and McKelvey Celtic AFC development via a pedestrian boulevard;
3. A pedestrian link from St Margret's Road, which links to the central open space and McKelvey Celtic AFC.

The proposed vehicular entrance is located at the existing entrance to the temporary car park off Charlestown Place. It is proposed that the existing traffic and pedestrian signals will be upgraded to allow for the altered traffic flows and improve the pedestrian and cyclist crossing.

The area within the development is considered a "Home Zone" and will have a speed limit of 30kph. Vehicular access to the underground car park is through an internal road which is part of the home zone. The basement access ramp is located in the centre of Block 2 and to the centre for Block 4, this allows for sufficient sightlines in both directions to allow for safe access and egress.

Please refer to drawings 1726-100 & 101 for Road & Block levels, traffic signs and site visibility splays, and 1726-111 for road standard details. A swept path analysis has been completed as part of this planning application, please refer to drawings 1726-106 & 107. Please refer to the Atkins Traffic & Transportation Assessment Report completed as part of this Planning Application.

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APPENDICES

8.1 APPENDIX A

Rainfall Data

Dublin Airport
MET EIREANN EXTREME RAINFALL DURATION SHEET

Duration (min)	Return Period								
	0.5	1	2	5	10	20	30	50	100
2min	1.7	2	2.3	3	3.5	4	4.6	5.7	6.5
5min	3	3.7	4.2	5.5	6.4	7.9	8.6	9.9	11.5
10min	4.4	5.4	6	8	9.5	12.5	13.3	15	18.5
15min	4.7	6	6.7	9.5	11.8	14.4	15.8	18.7	22
30min	6.2	7.8	8.8	12.4	15.4	18.9	20.7	24.4	28.5
60min	7.9	10	11.1	15.4	18.9	22.9	25.1	29.4	34.5
2Hr	10.9	13.5	15.1	20.1	24.2	28.8	31.2	36.1	42
4Hr	14.8	18.2	20	26	30.6	35.8	38.4	43.6	50.5
6Hr	17.5	21.5	23.7	30.7	36.6	42.4	45.5	51.6	56.5
12Hr	22.8	27.5	30.2	38.7	45.3	52.2	55.8	63.1	72
24Hr	27.5	33.1	36.4	46.6	54.6	63	67.3	76	87
48Hr	34.3	41	44.4	56.2	65.2	74.2	79.1	88.8	101
72Hr	41	50	54	65	74.5	83	88.3	99	111

M5 60min = 15.4mm **M5 2d = 53.0mm** **Annual Rainfall = 750**

M5 60/M5 2d = 0.29

8.2 APPENDIX B

Qbar Calculation
Paved Area Factors

poga Consulting Engineers

Project :	CHARLESTOWN PLACE SHD
POGA Ref:	1726
Title:	Paved Area Factors
Date:	May-20

Site Areas

Element	
Roofs (m²)	7287.00
Roads/Hardstanding (m²)	2626.00
Green Roof (m²)	2429.00
Podium Drainage (m²)	5770.00
Green Area/ Gravel Roads (m²)	14462.00
Permeable Paving (m²)	908.00
Sub Total (m²)	33482.00

Paved Area Factors (PIMP Factors)

Roofs	=	0.95
Roads/Hardstanding	=	0.85
Green Roof	=	0.40
Podium Drainage	=	0.40
Green Area	=	0.05
Permeable Paving	=	0.05

PIMP

Element	
Roofs	20.7%
Roads/Hardstanding	6.7%
Green Roof	2.9%
Podium Drainage	6.9%
Green Area	2.2%
Permeable Paving	0.1%
Average PIMP Factor Per site	39.4%

Allowable Outflow

Total Allowed based on IH 124 formula for a 50 Ha site, Qbar = 98.8 l/s (see seperate calcualtion enclosed)

Element	
Site Area (Ha)	3.3
QBar for 50Ha Site (l/s)	98.8
Qbar allowed ouflow (l/s)	**6.6**

IH 124 Mean Annual Flood

Input

Return Period (years)	100
Area (Ha)	50.000
SAAR (mm)	750.000
Soil	0.300
Urban	0.000
Region Number	11 (Ireland National)

Results	**l/s**
QBAR Rural	98.8
QBAR Urban	98.8
Q 100 years	181.8
Q 1 year	84.0
Q 2 years	94.8
Q 5 years	118.5
Q 10 years	133.4
Q 20 years	148.3
Q 25 years	153.1
Q 30 years	157.0
Q 50 years	167.9
Q 100 years	181.8
Q 200 years	196.6
Q 250 years	n/a
Q 1000 years	n/a

WARNING: Irish growth curves are not defined above 200 years.

Total Drained Area = 11.4 ha
Qbar 50ha = 98.8 l/second
Qbar = ((98.8/50) x 11.4) = 22.8 l/second

8.3 APPENDIX C

Attenuation Design
1, 30, 100 Year Storm Events
+20% Climate Change

Summary of Results for 1 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	65.754	0.179	15.8	335.2	O K
30 min Summer	65.815	0.240	20.2	450.7	O K
60 min Summer	65.884	0.309	21.4	580.5	O K
120 min Summer	65.959	0.384	22.2	719.5	O K
180 min Summer	66.001	0.426	22.5	799.3	O K
240 min Summer	66.029	0.454	22.6	851.3	O K
360 min Summer	66.064	0.489	22.7	916.5	O K
480 min Summer	66.087	0.512	22.8	960.4	O K
600 min Summer	66.103	0.528	22.8	991.5	O K
720 min Summer	66.115	0.540	22.8	1013.7	O K
960 min Summer	66.129	0.554	22.8	1039.8	O K
1440 min Summer	66.130	0.555	22.8	1041.2	O K
2160 min Summer	66.107	0.532	22.8	998.3	O K
2880 min Summer	66.075	0.500	22.7	937.1	O K
4320 min Summer	66.007	0.432	22.5	811.2	O K
5760 min Summer	65.949	0.374	22.1	701.4	O K
7200 min Summer	65.901	0.326	21.6	611.3	O K
8640 min Summer	65.862	0.287	21.1	537.8	O K
10080 min Summer	65.831	0.256	20.5	481.1	O K
15 min Winter	65.775	0.200	17.6	375.5	O K
30 min Winter	65.845	0.270	20.8	506.3	O K
60 min Winter	65.924	0.349	21.9	654.2	O K
120 min Winter	66.009	0.434	22.5	814.2	O K
180 min Winter	66.059	0.484	22.7	908.1	O K
240 min Winter	66.093	0.518	22.8	971.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	28.462	0.0	305.8	33
30 min Summer	19.376	0.0	429.2	46
60 min Summer	12.766	0.0	606.6	74
120 min Summer	8.264	0.0	791.2	130
180 min Summer	6.381	0.0	919.5	188
240 min Summer	5.307	0.0	1021.5	244
360 min Summer	4.090	0.0	1183.4	318
480 min Summer	3.400	0.0	1313.0	386
600 min Summer	2.947	0.0	1422.9	452
720 min Summer	2.622	0.0	1519.3	522
960 min Summer	2.181	0.0	1684.6	664
1440 min Summer	1.674	0.0	1933.0	942
2160 min Summer	1.283	0.0	2270.1	1352
2880 min Summer	1.063	0.0	2504.6	1744
4320 min Summer	0.815	0.0	2869.3	2516
5760 min Summer	0.675	0.0	3200.8	3240
7200 min Summer	0.584	0.0	3456.3	3968
8640 min Summer	0.517	0.0	3670.7	4664
10080 min Summer	0.467	0.0	3854.7	5352
15 min Winter	28.462	0.0	346.8	33
30 min Winter	19.376	0.0	485.1	46
60 min Winter	12.766	0.0	681.9	74
120 min Winter	8.264	0.0	888.7	130
180 min Winter	6.381	0.0	1032.3	186
240 min Winter	5.307	0.0	1146.5	242

Summary of Results for 1 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
360 min Winter	66.134	0.559	22.8	1048.5	O K
480 min Winter	66.156	0.581	22.8	1090.4	O K
600 min Winter	66.173	0.598	22.8	1121.2	O K
720 min Winter	66.184	0.609	22.8	1142.4	O K
960 min Winter	66.194	0.619	22.8	1161.6	O K
1440 min Winter	66.181	0.606	22.8	1136.9	O K
2160 min Winter	66.132	0.557	22.8	1044.9	O K
2880 min Winter	66.073	0.498	22.7	934.6	O K
4320 min Winter	65.965	0.390	22.3	731.6	O K
5760 min Winter	65.882	0.307	21.4	576.7	O K
7200 min Winter	65.825	0.250	20.4	469.6	O K
8640 min Winter	65.794	0.219	19.0	410.9	O K
10080 min Winter	65.774	0.199	17.5	372.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	4.090	0.0	1327.8	350
480 min Winter	3.400	0.0	1472.8	448
600 min Winter	2.947	0.0	1595.8	486
720 min Winter	2.622	0.0	1703.7	564
960 min Winter	2.181	0.0	1888.4	722
1440 min Winter	1.674	0.0	2165.5	1028
2160 min Winter	1.283	0.0	2544.1	1460
2880 min Winter	1.063	0.0	2807.3	1864
4320 min Winter	0.815	0.0	3218.4	2640
5760 min Winter	0.675	0.0	3586.3	3344
7200 min Winter	0.584	0.0	3873.0	3976
8640 min Winter	0.517	0.0	4114.1	4664
10080 min Winter	0.467	0.0	4323.0	5352

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.400	Shortest Storm (mins)	15
Ratio R	0.290	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Pipe Network

Volume in Pipe Network (m³)	102	Dia of Outfall Pipe (m)	0.8
Slope of Outfall Pipe (1:X)	250	Roughness of Outfall Pipe (mm)	0.600

Time Area Diagram

Total Area (ha) 1.308

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.730	4	8	0.573	8	12	0.005

Green Roof

Area (m³)	2430	Evaporation (mm/day)	3
Depression Storage (mm)	100	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	0.044158	32	36	0.008915	64	68	0.001800	96	100	0.000363
4	8	0.036153	36	40	0.007299	68	72	0.001474	100	104	0.000298
8	12	0.029600	40	44	0.005976	72	76	0.001207	104	108	0.000244
12	16	0.024234	44	48	0.004893	76	80	0.000988	108	112	0.000199
16	20	0.019841	48	52	0.004006	80	84	0.000809	112	116	0.000163
20	24	0.016245	52	56	0.003280	84	88	0.000662	116	120	0.000134
24	28	0.013300	56	60	0.002685	88	92	0.000542			
28	32	0.010889	60	64	0.002198	92	96	0.000444			

Time Area Diagram

Total Area (ha) 5.298

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	0.000	4	8	1.766	8	12	1.766	12	16	1.766

Green Roof

Area (m³)	5770	Evaporation (mm/day)	3
Depression Storage (mm)	100	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	0.104852	16	20	0.047113	32	36	0.021169	48	52	0.009512
4	8	0.085846	20	24	0.038573	36	40	0.017332	52	56	0.007788
8	12	0.070285	24	28	0.031581	40	44	0.014190	56	60	0.006376
12	16	0.057544	28	32	0.025856	44	48	0.011618	60	64	0.005220

Green Roof

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
64	68	0.004274	80	84	0.001920	96	100	0.000863	112	116	0.000388
68	72	0.003499	84	88	0.001572	100	104	0.000706	116	120	0.000317
72	76	0.002865	88	92	0.001287	104	108	0.000578			
76	80	0.002346	92	96	0.001054	108	112	0.000474			

Model Details

Storage is Online Cover Level (m) 68.075

Tank or Pond Structure

Invert Level (m) 65.575

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1876.0	1.400	1876.0	2.800	1876.0	4.200	1876.0
0.200	1876.0	1.600	1876.0	3.000	1876.0	4.400	1876.0
0.400	1876.0	1.800	1876.0	3.200	1876.0	4.600	1876.0
0.600	1876.0	2.000	1876.0	3.400	1876.0	4.800	1876.0
0.800	1876.0	2.200	1876.0	3.600	1876.0	5.000	1876.0
1.000	1876.0	2.400	1876.0	3.800	1876.0		
1.200	1876.0	2.600	1876.0	4.000	1876.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SCL-0179-2280-2500-2280
Design Head (m)	2.500
Design Flow (l/s)	22.8
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	179
Invert Level (m)	65.575
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.500	22.8	Kick-Flo®	1.301	16.7
Flush-Flo™	0.554	22.8	Mean Flow over Head Range	-	19.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.0	1.200	18.7	3.000	24.9	7.000	37.3
0.200	17.6	1.400	17.3	3.500	26.8	7.500	38.6
0.300	21.3	1.600	18.5	4.000	28.5	8.000	39.8
0.400	22.3	1.800	19.5	4.500	30.2	8.500	41.0
0.500	22.7	2.000	20.5	5.000	31.7	9.000	42.1
0.600	22.8	2.200	21.5	5.500	33.2	9.500	43.2
0.800	22.2	2.400	22.4	6.000	34.7		
1.000	21.0	2.600	23.2	6.500	36.0		

Summary of Results for 30 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	65.976	0.401	22.3	752.7	O K
30 min Summer	66.122	0.547	22.8	1026.3	O K
60 min Summer	66.279	0.704	22.8	1320.4	O K
120 min Summer	66.445	0.870	22.8	1633.0	O K
180 min Summer	66.546	0.971	22.8	1821.4	O K
240 min Summer	66.616	1.041	22.8	1953.5	O K
360 min Summer	66.713	1.138	22.8	2134.9	O K
480 min Summer	66.776	1.201	22.8	2253.4	O K
600 min Summer	66.820	1.245	22.8	2336.0	O K
720 min Summer	66.852	1.277	22.8	2395.0	O K
960 min Summer	66.889	1.314	22.8	2464.4	O K
1440 min Summer	66.901	1.326	22.8	2488.5	O K
2160 min Summer	66.883	1.308	22.8	2453.1	O K
2880 min Summer	66.841	1.266	22.8	2374.3	O K
4320 min Summer	66.733	1.158	22.8	2173.0	O K
5760 min Summer	66.619	1.044	22.8	1958.8	O K
7200 min Summer	66.508	0.933	22.8	1749.7	O K
8640 min Summer	66.403	0.828	22.8	1553.7	O K
10080 min Summer	66.308	0.733	22.8	1374.4	O K
15 min Winter	66.026	0.451	22.6	845.4	O K
30 min Winter	66.190	0.615	22.8	1153.4	O K
60 min Winter	66.367	0.792	22.8	1485.8	O K
120 min Winter	66.557	0.982	22.8	1842.5	O K
180 min Winter	66.674	1.099	22.8	2061.2	O K
240 min Winter	66.757	1.182	22.8	2217.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	63.147	0.0	721.7	33
30 min Summer	43.119	0.0	994.3	47
60 min Summer	28.020	0.0	1355.6	76
120 min Summer	17.716	0.0	1717.5	134
180 min Summer	13.453	0.0	1956.9	194
240 min Summer	11.039	0.0	2140.1	252
360 min Summer	8.342	0.0	2421.8	372
480 min Summer	6.829	0.0	2635.8	490
600 min Summer	5.844	0.0	2807.8	608
720 min Summer	5.144	0.0	2948.0	728
960 min Summer	4.205	0.0	3139.5	966
1440 min Summer	3.163	0.0	3094.4	1260
2160 min Summer	2.379	0.0	4209.7	1656
2880 min Summer	1.943	0.0	4578.4	2028
4320 min Summer	1.459	0.0	5128.5	2816
5760 min Summer	1.190	0.0	5650.1	3592
7200 min Summer	1.016	0.0	6027.0	4344
8640 min Summer	0.893	0.0	6349.0	5104
10080 min Summer	0.800	0.0	6624.5	5848
15 min Winter	63.147	0.0	811.8	33
30 min Winter	43.119	0.0	1114.8	47
60 min Winter	28.020	0.0	1520.2	76
120 min Winter	17.716	0.0	1924.5	134
180 min Winter	13.453	0.0	2191.2	190
240 min Winter	11.039	0.0	2394.4	250

Summary of Results for 30 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
360 min Winter	66.876	1.301	22.8	2441.4	O K
480 min Winter	66.956	1.381	22.8	2590.4	O K
600 min Winter	67.010	1.435	22.8	2691.8	O K
720 min Winter	67.048	1.473	22.8	2762.9	O K
960 min Winter	67.093	1.518	22.8	2847.2	O K
1440 min Winter	67.114	1.539	22.8	2886.9	O K
2160 min Winter	67.081	1.506	22.8	2825.1	O K
2880 min Winter	67.030	1.455	22.8	2728.9	O K
4320 min Winter	66.866	1.291	22.8	2421.7	O K
5760 min Winter	66.652	1.077	22.8	2020.6	O K
7200 min Winter	66.463	0.888	22.8	1666.8	O K
8640 min Winter	66.300	0.725	22.8	1359.9	O K
10080 min Winter	66.163	0.588	22.8	1103.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	8.342	0.0	2702.6	366
480 min Winter	6.829	0.0	2929.2	482
600 min Winter	5.844	0.0	3099.2	598
720 min Winter	5.144	0.0	3213.8	712
960 min Winter	4.205	0.0	3241.4	936
1440 min Winter	3.163	0.0	3055.7	1368
2160 min Winter	2.379	0.0	4711.5	1728
2880 min Winter	1.943	0.0	5117.5	2200
4320 min Winter	1.459	0.0	5680.8	3132
5760 min Winter	1.190	0.0	6328.9	3920
7200 min Winter	1.016	0.0	6752.1	4632
8640 min Winter	0.893	0.0	7114.0	5368
10080 min Winter	0.800	0.0	7426.1	6056

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.400	Shortest Storm (mins)	15
Ratio R	0.290	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Pipe Network

Volume in Pipe Network (m³)	102	Dia of Outfall Pipe (m)	0.8
Slope of Outfall Pipe (1:X)	250	Roughness of Outfall Pipe (mm)	0.600

Time Area Diagram

Total Area (ha) 1.308

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.730	4	8	0.573	8	12	0.005

Green Roof

Area (m³) 2430 Evaporation (mm/day) 3
Depression Storage (mm) 100 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	0.044158	32	36	0.008915	64	68	0.001800	96	100	0.000363
4	8	0.036153	36	40	0.007299	68	72	0.001474	100	104	0.000298
8	12	0.029600	40	44	0.005976	72	76	0.001207	104	108	0.000244
12	16	0.024234	44	48	0.004893	76	80	0.000988	108	112	0.000199
16	20	0.019841	48	52	0.004006	80	84	0.000809	112	116	0.000163
20	24	0.016245	52	56	0.003280	84	88	0.000662	116	120	0.000134
24	28	0.013300	56	60	0.002685	88	92	0.000542			
28	32	0.010889	60	64	0.002198	92	96	0.000444			

Time Area Diagram

Total Area (ha) 5.298

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	0.000	4	8	1.766	8	12	1.766	12	16	1.766

Green Roof

Area (m³) 5770 Evaporation (mm/day) 3
Depression Storage (mm) 100 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	0.104852	16	20	0.047113	32	36	0.021169	48	52	0.009512
4	8	0.085846	20	24	0.038573	36	40	0.017332	52	56	0.007788
8	12	0.070285	24	28	0.031581	40	44	0.014190	56	60	0.006376
12	16	0.057544	28	32	0.025856	44	48	0.011618	60	64	0.005220

Green Roof

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
64	68	0.004274	80	84	0.001920	96	100	0.000863	112	116	0.000388
68	72	0.003499	84	88	0.001572	100	104	0.000706	116	120	0.000317
72	76	0.002865	88	92	0.001287	104	108	0.000578			
76	80	0.002346	92	96	0.001054	108	112	0.000474			

Model Details

Storage is Online Cover Level (m) 68.075

Tank or Pond Structure

Invert Level (m) 65.575

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1876.0	1.400	1876.0	2.800	1876.0	4.200	1876.0
0.200	1876.0	1.600	1876.0	3.000	1876.0	4.400	1876.0
0.400	1876.0	1.800	1876.0	3.200	1876.0	4.600	1876.0
0.600	1876.0	2.000	1876.0	3.400	1876.0	4.800	1876.0
0.800	1876.0	2.200	1876.0	3.600	1876.0	5.000	1876.0
1.000	1876.0	2.400	1876.0	3.800	1876.0		
1.200	1876.0	2.600	1876.0	4.000	1876.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SCL-0179-2280-2500-2280
Design Head (m)	2.500
Design Flow (l/s)	22.8
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	179
Invert Level (m)	65.575
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.500	22.8	Kick-Flo®	1.301	16.7
Flush-Flo™	0.554	22.8	Mean Flow over Head Range	-	19.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.0	1.200	18.7	3.000	24.9	7.000	37.3
0.200	17.6	1.400	17.3	3.500	26.8	7.500	38.6
0.300	21.3	1.600	18.5	4.000	28.5	8.000	39.8
0.400	22.3	1.800	19.5	4.500	30.2	8.500	41.0
0.500	22.7	2.000	20.5	5.000	31.7	9.000	42.1
0.600	22.8	2.200	21.5	5.500	33.2	9.500	43.2
0.800	22.2	2.400	22.4	6.000	34.7		
1.000	21.0	2.600	23.2	6.500	36.0		

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	66.098	0.523	22.8	980.3	O K
30 min Summer	66.291	0.716	22.8	1344.1	O K
60 min Summer	66.501	0.926	22.8	1736.3	O K
120 min Summer	66.718	1.143	22.8	2144.7	O K
180 min Summer	66.852	1.277	22.8	2395.3	O K
240 min Summer	66.947	1.372	22.8	2573.6	O K
360 min Summer	67.077	1.502	22.8	2817.1	O K
480 min Summer	67.160	1.585	22.8	2973.1	O K
600 min Summer	67.217	1.642	22.8	3079.8	O K
720 min Summer	67.256	1.681	22.8	3154.1	O K
960 min Summer	67.302	1.727	22.8	3239.5	O K
1440 min Summer	67.320	1.745	22.8	3273.4	O K
2160 min Summer	67.305	1.730	22.8	3245.3	O K
2880 min Summer	67.273	1.698	22.8	3185.3	O K
4320 min Summer	67.187	1.612	22.8	3024.8	O K
5760 min Summer	67.087	1.512	22.8	2836.2	O K
7200 min Summer	66.977	1.402	22.8	2629.2	O K
8640 min Summer	66.838	1.263	22.8	2370.1	O K
10080 min Summer	66.694	1.119	22.8	2098.4	O K
15 min Winter	66.159	0.584	22.8	1095.1	O K
30 min Winter	66.382	0.807	22.8	1514.3	O K
60 min Winter	66.616	1.041	22.8	1953.0	O K
120 min Winter	66.865	1.290	22.8	2419.9	O K
180 min Winter	67.017	1.442	22.8	2705.8	O K
240 min Winter	67.124	1.549	22.8	2906.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	81.741	0.0	942.0	34
30 min Summer	56.242	0.0	1292.0	48
60 min Summer	36.471	0.0	1768.6	76
120 min Summer	22.895	0.0	2219.8	136
180 min Summer	17.295	0.0	2509.7	196
240 min Summer	14.129	0.0	2723.8	254
360 min Summer	10.612	0.0	3035.6	374
480 min Summer	8.646	0.0	3231.0	492
600 min Summer	7.371	0.0	3306.7	610
720 min Summer	6.468	0.0	3283.2	730
960 min Summer	5.260	0.0	3188.3	966
1440 min Summer	3.928	0.0	3012.2	1352
2160 min Summer	2.933	0.0	5179.1	1716
2880 min Summer	2.383	0.0	5581.8	2108
4320 min Summer	1.776	0.0	5691.4	2948
5760 min Summer	1.440	0.0	6835.6	3808
7200 min Summer	1.224	0.0	7258.1	4624
8640 min Summer	1.071	0.0	7619.1	5448
10080 min Summer	0.957	0.0	7925.6	6152
15 min Winter	81.741	0.0	1051.4	34
30 min Winter	56.242	0.0	1443.8	48
60 min Winter	36.471	0.0	1981.4	76
120 min Winter	22.895	0.0	2481.8	134
180 min Winter	17.295	0.0	2797.4	192
240 min Winter	14.129	0.0	3023.9	250

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
360 min Winter	67.273	1.698	22.8	3185.9	O K
480 min Winter	67.372	1.797	22.8	3370.5	O K
600 min Winter	67.441	1.866	22.8	3500.6	O K
720 min Winter	67.491	1.916	22.8	3594.6	O K
960 min Winter	67.554	1.979	22.8	3712.3	O K
1440 min Winter	67.595	2.020	22.8	3790.3	O K
2160 min Winter	67.566	1.991	22.8	3735.4	O K
2880 min Winter	67.523	1.948	22.8	3655.0	O K
4320 min Winter	67.391	1.816	22.8	3406.4	O K
5760 min Winter	67.232	1.657	22.8	3107.6	O K
7200 min Winter	67.055	1.480	22.8	2776.3	O K
8640 min Winter	66.826	1.251	22.8	2346.0	O K
10080 min Winter	66.590	1.015	22.8	1903.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
360 min Winter	10.612	0.0	3303.7	366
480 min Winter	8.646	0.0	3348.4	484
600 min Winter	7.371	0.0	3304.1	598
720 min Winter	6.468	0.0	3254.2	714
960 min Winter	5.260	0.0	3169.7	940
1440 min Winter	3.928	0.0	3067.5	1380
2160 min Winter	2.933	0.0	5783.6	1788
2880 min Winter	2.383	0.0	6183.1	2228
4320 min Winter	1.776	0.0	5884.2	3168
5760 min Winter	1.440	0.0	7691.1	4104
7200 min Winter	1.224	0.0	8198.7	5040
8640 min Winter	1.071	0.0	8631.1	5888
10080 min Winter	0.957	0.0	9001.4	6464

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.400	Shortest Storm (mins)	15
Ratio R	0.290	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Pipe Network

Volume in Pipe Network (m³)	102	Dia of Outfall Pipe (m)	0.8
Slope of Outfall Pipe (1:X)	250	Roughness of Outfall Pipe (mm)	0.600

Time Area Diagram

Total Area (ha) 1.308

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.730	4	8	0.573	8	12	0.005

Green Roof

Area (m³)	2430	Evaporation (mm/day)	3
Depression Storage (mm)	100	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	0.044158	32	36	0.008915	64	68	0.001800	96	100	0.000363
4	8	0.036153	36	40	0.007299	68	72	0.001474	100	104	0.000298
8	12	0.029600	40	44	0.005976	72	76	0.001207	104	108	0.000244
12	16	0.024234	44	48	0.004893	76	80	0.000988	108	112	0.000199
16	20	0.019841	48	52	0.004006	80	84	0.000809	112	116	0.000163
20	24	0.016245	52	56	0.003280	84	88	0.000662	116	120	0.000134
24	28	0.013300	56	60	0.002685	88	92	0.000542			
28	32	0.010889	60	64	0.002198	92	96	0.000444			

Time Area Diagram

Total Area (ha) 5.298

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	0.000	4	8	1.766	8	12	1.766	12	16	1.766

Green Roof

Area (m³)	5770	Evaporation (mm/day)	3
Depression Storage (mm)	100	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	0.104852	16	20	0.047113	32	36	0.021169	48	52	0.009512
4	8	0.085846	20	24	0.038573	36	40	0.017332	52	56	0.007788
8	12	0.070285	24	28	0.031581	40	44	0.014190	56	60	0.006376
12	16	0.057544	28	32	0.025856	44	48	0.011618	60	64	0.005220

Green Roof

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
64	68	0.004274	80	84	0.001920	96	100	0.000863	112	116	0.000388
68	72	0.003499	84	88	0.001572	100	104	0.000706	116	120	0.000317
72	76	0.002865	88	92	0.001287	104	108	0.000578			
76	80	0.002346	92	96	0.001054	108	112	0.000474			

Model Details

Storage is Online Cover Level (m) 68.075

Tank or Pond Structure

Invert Level (m) 65.575

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1876.0	1.400	1876.0	2.800	1876.0	4.200	1876.0
0.200	1876.0	1.600	1876.0	3.000	1876.0	4.400	1876.0
0.400	1876.0	1.800	1876.0	3.200	1876.0	4.600	1876.0
0.600	1876.0	2.000	1876.0	3.400	1876.0	4.800	1876.0
0.800	1876.0	2.200	1876.0	3.600	1876.0	5.000	1876.0
1.000	1876.0	2.400	1876.0	3.800	1876.0		
1.200	1876.0	2.600	1876.0	4.000	1876.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SCL-0179-2280-2500-2280
Design Head (m)	2.500
Design Flow (l/s)	22.8
Flush-Flo™	Calculated
Objective	Minimise blockage risk
Application	Surface
Sump Available	Yes
Diameter (mm)	179
Invert Level (m)	65.575
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.500	22.8	Kick-Flo®	1.301	16.7
Flush-Flo™	0.554	22.8	Mean Flow over Head Range	-	19.5

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.0	1.200	18.7	3.000	24.9	7.000	37.3
0.200	17.6	1.400	17.3	3.500	26.8	7.500	38.6
0.300	21.3	1.600	18.5	4.000	28.5	8.000	39.8
0.400	22.3	1.800	19.5	4.500	30.2	8.500	41.0
0.500	22.7	2.000	20.5	5.000	31.7	9.000	42.1
0.600	22.8	2.200	21.5	5.500	33.2	9.500	43.2
0.800	22.2	2.400	22.4	6.000	34.7		
1.000	21.0	2.600	23.2	6.500	36.0		

8.4 APPENDIX D

Swale Design

Summary of Results for 1 year Return Period (+20%)

Half Drain Time : 56 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	67.808	0.208	0.0	6.3	6.3	22.3	O K
30 min Summer	67.832	0.232	0.0	6.3	6.3	28.2	O K
60 min Summer	67.844	0.244	0.0	6.4	6.4	31.3	O K
120 min Summer	67.849	0.249	0.0	6.4	6.4	32.6	O K
180 min Summer	67.847	0.247	0.0	6.4	6.4	32.3	O K
240 min Summer	67.844	0.244	0.0	6.4	6.4	31.2	O K
360 min Summer	67.832	0.232	0.0	6.3	6.3	28.2	O K
480 min Summer	67.818	0.218	0.0	6.3	6.3	24.8	O K
600 min Summer	67.803	0.203	0.0	6.3	6.3	21.4	O K
720 min Summer	67.788	0.188	0.0	6.3	6.3	18.2	O K
960 min Summer	67.757	0.157	0.0	6.2	6.2	12.5	O K
1440 min Summer	67.694	0.094	0.0	6.1	6.1	4.4	O K
2160 min Summer	67.600	0.000	0.0	5.8	5.8	0.0	O K
2880 min Summer	67.600	0.000	0.0	4.8	4.8	0.0	O K
4320 min Summer	67.600	0.000	0.0	3.7	3.7	0.0	O K
5760 min Summer	67.600	0.000	0.0	3.0	3.0	0.0	O K
7200 min Summer	67.600	0.000	0.0	2.6	2.6	0.0	O K
8640 min Summer	67.600	0.000	0.0	2.3	2.3	0.0	O K
10080 min Summer	67.600	0.000	0.0	2.1	2.1	0.0	O K
15 min Winter	67.822	0.222	0.0	6.3	6.3	25.8	O K
30 min Winter	67.850	0.250	0.0	6.4	6.4	32.9	O K
60 min Winter	67.866	0.266	0.0	6.4	6.4	37.5	O K
120 min Winter	67.868	0.268	0.0	6.4	6.4	38.2	O K
180 min Winter	67.864	0.264	0.0	6.4	6.4	37.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	28.462	0.0	29.4	19
30 min Summer	19.376	0.0	39.9	32
60 min Summer	12.766	0.0	52.8	54
120 min Summer	8.264	0.0	68.3	88
180 min Summer	6.381	0.0	79.1	124
240 min Summer	5.307	0.0	87.7	158
360 min Summer	4.090	0.0	101.1	226
480 min Summer	3.400	0.0	111.9	292
600 min Summer	2.947	0.0	121.3	356
720 min Summer	2.622	0.0	129.7	418
960 min Summer	2.181	0.0	144.1	538
1440 min Summer	1.674	0.0	165.8	766
2160 min Summer	1.283	0.0	190.6	0
2880 min Summer	1.063	0.0	210.4	0
4320 min Summer	0.815	0.0	242.0	0
5760 min Summer	0.675	0.0	267.4	0
7200 min Summer	0.584	0.0	288.9	0
8640 min Summer	0.517	0.0	307.3	0
10080 min Summer	0.467	0.0	323.7	0
15 min Winter	28.462	0.0	32.8	20
30 min Winter	19.376	0.0	44.9	33
60 min Winter	12.766	0.0	59.0	58
120 min Winter	8.264	0.0	76.5	96
180 min Winter	6.381	0.0	88.5	134

Summary of Results for 1 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	67.856	0.256	0.0	6.4	6.4	34.7	O K
360 min Winter	67.835	0.235	0.0	6.4	6.4	29.0	O K
480 min Winter	67.811	0.211	0.0	6.3	6.3	23.1	O K
600 min Winter	67.785	0.185	0.0	6.3	6.3	17.6	O K
720 min Winter	67.757	0.157	0.0	6.2	6.2	12.6	O K
960 min Winter	67.698	0.098	0.0	6.1	6.1	4.7	O K
1440 min Winter	67.600	0.000	0.0	5.4	5.4	0.0	O K
2160 min Winter	67.600	0.000	0.0	4.2	4.2	0.0	O K
2880 min Winter	67.600	0.000	0.0	3.4	3.4	0.0	O K
4320 min Winter	67.600	0.000	0.0	2.6	2.6	0.0	O K
5760 min Winter	67.600	0.000	0.0	2.2	2.2	0.0	O K
7200 min Winter	67.600	0.000	0.0	1.9	1.9	0.0	O K
8640 min Winter	67.600	0.000	0.0	1.7	1.7	0.0	O K
10080 min Winter	67.600	0.000	0.0	1.5	1.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	5.307	0.0	98.1	172
360 min Winter	4.090	0.0	113.5	244
480 min Winter	3.400	0.0	125.6	310
600 min Winter	2.947	0.0	136.3	374
720 min Winter	2.622	0.0	145.3	434
960 min Winter	2.181	0.0	161.2	544
1440 min Winter	1.674	0.0	185.6	0
2160 min Winter	1.283	0.0	213.5	0
2880 min Winter	1.063	0.0	235.6	0
4320 min Winter	0.815	0.0	271.0	0
5760 min Winter	0.675	0.0	299.5	0
7200 min Winter	0.584	0.0	323.6	0
8640 min Winter	0.517	0.0	344.1	0
10080 min Winter	0.467	0.0	362.5	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	1	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.400	Shortest Storm (mins)	15
Ratio R	0.290	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.550

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.250	4	8	0.300

Model Details

Storage is Online Cover Level (m) 68.202

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	85.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	2.5
Safety Factor	1.0	Slope (1:X)	250.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	67.600	Cap Infiltration Depth (m)	0.000
Base Width (m)	3.8		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0108-6900-2000-6900
Design Head (m)	2.000
Design Flow (l/s)	6.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	66.156
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)	2.000	6.9	Kick-Flo®	0.966	4.9
Flush-Flo™	0.471	6.2	Mean Flow over Head Range	-	5.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	5.4	3.000	8.3	7.000	12.5
0.200	5.5	1.400	5.8	3.500	9.0	7.500	12.9
0.300	6.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	6.2	1.800	6.6	4.500	10.1	8.500	13.7
0.500	6.2	2.000	6.9	5.000	10.6	9.000	14.1
0.600	6.1	2.200	7.2	5.500	11.1	9.500	14.4
0.800	5.8	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.0		

Summary of Results for 30 year Return Period (+20%)

Half Drain Time : 160 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	67.925	0.325	0.0	6.5	6.5	57.2	Flood Risk
30 min Summer	67.971	0.371	0.0	6.6	6.6	75.6	Flood Risk
60 min Summer	68.009	0.409	0.0	6.7	6.7	91.4	Flood Risk
120 min Summer	68.029	0.429	0.0	6.7	6.7	100.0	Flood Risk
180 min Summer	68.030	0.430	0.0	6.7	6.7	100.4	Flood Risk
240 min Summer	68.029	0.429	0.0	6.7	6.7	99.9	Flood Risk
360 min Summer	68.024	0.424	0.0	6.7	6.7	97.9	Flood Risk
480 min Summer	68.017	0.417	0.0	6.7	6.7	94.7	Flood Risk
600 min Summer	68.008	0.408	0.0	6.6	6.6	90.9	Flood Risk
720 min Summer	67.998	0.398	0.0	6.6	6.6	86.7	Flood Risk
960 min Summer	67.976	0.376	0.0	6.6	6.6	77.7	Flood Risk
1440 min Summer	67.932	0.332	0.0	6.5	6.5	60.0	Flood Risk
2160 min Summer	67.866	0.266	0.0	6.4	6.4	37.5	O K
2880 min Summer	67.801	0.201	0.0	6.3	6.3	20.9	O K
4320 min Summer	67.676	0.076	0.0	6.1	6.1	2.8	O K
5760 min Summer	67.600	0.000	0.0	5.3	5.3	0.0	O K
7200 min Summer	67.600	0.000	0.0	4.6	4.6	0.0	O K
8640 min Summer	67.600	0.000	0.0	4.0	4.0	0.0	O K
10080 min Summer	67.600	0.000	0.0	3.6	3.6	0.0	O K
15 min Winter	67.945	0.345	0.0	6.5	6.5	65.0	Flood Risk
30 min Winter	67.997	0.397	0.0	6.6	6.6	86.5	Flood Risk
60 min Winter	68.042	0.442	0.0	6.7	6.7	105.6	Flood Risk
120 min Winter	68.071	0.471	0.0	6.8	6.8	118.6	Flood Risk
180 min Winter	68.075	0.475	0.0	6.8	6.8	120.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	63.147	0.0	65.0	21
30 min Summer	43.119	0.0	89.0	35
60 min Summer	28.020	0.0	115.5	64
120 min Summer	17.716	0.0	146.1	120
180 min Summer	13.453	0.0	166.4	152
240 min Summer	11.039	0.0	182.4	184
360 min Summer	8.342	0.0	206.6	252
480 min Summer	6.829	0.0	225.3	322
600 min Summer	5.844	0.0	241.1	392
720 min Summer	5.144	0.0	255.0	460
960 min Summer	4.205	0.0	277.5	594
1440 min Summer	3.163	0.0	313.2	854
2160 min Summer	2.379	0.0	353.0	1216
2880 min Summer	1.943	0.0	384.8	1560
4320 min Summer	1.459	0.0	433.3	2212
5760 min Summer	1.190	0.0	471.4	0
7200 min Summer	1.016	0.0	503.0	0
8640 min Summer	0.893	0.0	530.3	0
10080 min Summer	0.800	0.0	554.6	0
15 min Winter	63.147	0.0	72.8	21
30 min Winter	43.119	0.0	99.7	35
60 min Winter	28.020	0.0	129.0	62
120 min Winter	17.716	0.0	163.6	118
180 min Winter	13.453	0.0	186.6	172

Summary of Results for 30 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	68.070	0.470	0.0	6.8	6.8	118.2	Flood Risk
360 min Winter	68.062	0.462	0.0	6.7	6.7	114.5	Flood Risk
480 min Winter	68.049	0.449	0.0	6.7	6.7	108.8	Flood Risk
600 min Winter	68.034	0.434	0.0	6.7	6.7	102.1	Flood Risk
720 min Winter	68.017	0.417	0.0	6.7	6.7	94.8	Flood Risk
960 min Winter	67.981	0.381	0.0	6.6	6.6	79.8	Flood Risk
1440 min Winter	67.910	0.310	0.0	6.5	6.5	51.8	Flood Risk
2160 min Winter	67.796	0.196	0.0	6.3	6.3	19.7	O K
2880 min Winter	67.666	0.066	0.0	6.0	6.0	2.1	O K
4320 min Winter	67.600	0.000	0.0	4.7	4.7	0.0	O K
5760 min Winter	67.600	0.000	0.0	3.9	3.9	0.0	O K
7200 min Winter	67.600	0.000	0.0	3.3	3.3	0.0	O K
8640 min Winter	67.600	0.000	0.0	2.9	2.9	0.0	O K
10080 min Winter	67.600	0.000	0.0	2.6	2.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	11.039	0.0	204.3	196
360 min Winter	8.342	0.0	231.0	274
480 min Winter	6.829	0.0	252.7	352
600 min Winter	5.844	0.0	270.0	426
720 min Winter	5.144	0.0	285.4	500
960 min Winter	4.205	0.0	310.6	640
1440 min Winter	3.163	0.0	350.7	900
2160 min Winter	2.379	0.0	395.6	1252
2880 min Winter	1.943	0.0	430.8	1528
4320 min Winter	1.459	0.0	485.4	0
5760 min Winter	1.190	0.0	527.9	0
7200 min Winter	1.016	0.0	563.4	0
8640 min Winter	0.893	0.0	594.0	0
10080 min Winter	0.800	0.0	621.1	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.400	Shortest Storm (mins)	15
Ratio R	0.290	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.550

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.250	4	8	0.300

Model Details

Storage is Online Cover Level (m) 68.202

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	85.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	2.5
Safety Factor	1.0	Slope (1:X)	250.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	67.600	Cap Infiltration Depth (m)	0.000
Base Width (m)	3.8		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0108-6900-2000-6900
Design Head (m)	2.000
Design Flow (l/s)	6.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	66.156
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)	2.000	6.9	Kick-Flo®	0.966	4.9
Flush-Flo™	0.471	6.2	Mean Flow over Head Range	-	5.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	5.4	3.000	8.3	7.000	12.5
0.200	5.5	1.400	5.8	3.500	9.0	7.500	12.9
0.300	6.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	6.2	1.800	6.6	4.500	10.1	8.500	13.7
0.500	6.2	2.000	6.9	5.000	10.6	9.000	14.1
0.600	6.1	2.200	7.2	5.500	11.1	9.500	14.4
0.800	5.8	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.0		

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

Half Drain Time : 223 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	67.972	0.372	0.0	6.6	6.6	76.1	Flood Risk
30 min Summer	68.034	0.434	0.0	6.7	6.7	102.3	Flood Risk
60 min Summer	68.086	0.486	0.0	6.8	6.8	125.5	Flood Risk
120 min Summer	68.121	0.521	0.0	6.8	6.8	141.4	Flood Risk
180 min Summer	68.126	0.526	0.0	6.8	6.8	144.1	Flood Risk
240 min Summer	68.124	0.524	0.0	6.8	6.8	142.9	Flood Risk
360 min Summer	68.118	0.518	0.0	6.8	6.8	140.3	Flood Risk
480 min Summer	68.111	0.511	0.0	6.8	6.8	137.0	Flood Risk
600 min Summer	68.103	0.503	0.0	6.8	6.8	133.1	Flood Risk
720 min Summer	68.093	0.493	0.0	6.8	6.8	128.7	Flood Risk
960 min Summer	68.073	0.473	0.0	6.8	6.8	119.2	Flood Risk
1440 min Summer	68.028	0.428	0.0	6.7	6.7	99.5	Flood Risk
2160 min Summer	67.963	0.363	0.0	6.6	6.6	72.2	Flood Risk
2880 min Summer	67.903	0.303	0.0	6.5	6.5	49.4	Flood Risk
4320 min Summer	67.788	0.188	0.0	6.3	6.3	18.2	O K
5760 min Summer	67.678	0.078	0.0	6.1	6.1	3.0	O K
7200 min Summer	67.600	0.000	0.0	5.5	5.5	0.0	O K
8640 min Summer	67.600	0.000	0.0	4.8	4.8	0.0	O K
10080 min Summer	67.600	0.000	0.0	4.3	4.3	0.0	O K
15 min Winter	67.997	0.397	0.0	6.6	6.6	86.3	Flood Risk
30 min Winter	68.066	0.466	0.0	6.7	6.7	116.4	Flood Risk
60 min Winter	68.126	0.526	0.0	6.8	6.8	144.1	Flood Risk
120 min Winter	68.170	0.570	0.0	6.9	6.9	165.1	Flood Risk
180 min Winter	68.182	0.582	0.0	6.9	6.9	171.3	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	81.741	0.0	84.3	22
30 min Summer	56.242	0.0	116.0	36
60 min Summer	36.471	0.0	150.6	64
120 min Summer	22.895	0.0	189.2	122
180 min Summer	17.295	0.0	213.9	176
240 min Summer	14.129	0.0	233.0	204
360 min Summer	10.612	0.0	262.8	268
480 min Summer	8.646	0.0	285.4	336
600 min Summer	7.371	0.0	303.7	406
720 min Summer	6.468	0.0	320.0	476
960 min Summer	5.260	0.0	347.5	612
1440 min Summer	3.928	0.0	389.0	880
2160 min Summer	2.933	0.0	436.0	1256
2880 min Summer	2.383	0.0	472.1	1616
4320 min Summer	1.776	0.0	527.5	2296
5760 min Summer	1.440	0.0	570.5	2944
7200 min Summer	1.224	0.0	605.7	0
8640 min Summer	1.071	0.0	636.1	0
10080 min Summer	0.957	0.0	663.0	0
15 min Winter	81.741	0.0	94.3	21
30 min Winter	56.242	0.0	130.0	36
60 min Winter	36.471	0.0	168.5	64
120 min Winter	22.895	0.0	211.3	120
180 min Winter	17.295	0.0	240.0	176

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
240 min Winter	68.182	0.582	0.0	6.9	6.9	171.1	Flood Risk
360 min Winter	68.171	0.571	0.0	6.9	6.9	165.6	Flood Risk
480 min Winter	68.160	0.560	0.0	6.9	6.9	160.3	Flood Risk
600 min Winter	68.147	0.547	0.0	6.9	6.9	153.8	Flood Risk
720 min Winter	68.131	0.531	0.0	6.9	6.9	146.5	Flood Risk
960 min Winter	68.097	0.497	0.0	6.8	6.8	130.6	Flood Risk
1440 min Winter	68.026	0.426	0.0	6.7	6.7	98.7	Flood Risk
2160 min Winter	67.924	0.324	0.0	6.5	6.5	57.0	Flood Risk
2880 min Winter	67.822	0.222	0.0	6.3	6.3	25.8	O K
4320 min Winter	67.600	0.000	0.0	5.8	5.8	0.0	O K
5760 min Winter	67.600	0.000	0.0	4.7	4.7	0.0	O K
7200 min Winter	67.600	0.000	0.0	4.0	4.0	0.0	O K
8640 min Winter	67.600	0.000	0.0	3.5	3.5	0.0	O K
10080 min Winter	67.600	0.000	0.0	3.1	3.1	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
240 min Winter	14.129	0.0	261.0	230
360 min Winter	10.612	0.0	294.3	288
480 min Winter	8.646	0.0	319.9	364
600 min Winter	7.371	0.0	340.5	442
720 min Winter	6.468	0.0	358.3	518
960 min Winter	5.260	0.0	388.8	666
1440 min Winter	3.928	0.0	435.6	942
2160 min Winter	2.933	0.0	487.5	1320
2880 min Winter	2.383	0.0	528.5	1652
4320 min Winter	1.776	0.0	590.7	0
5760 min Winter	1.440	0.0	638.8	0
7200 min Winter	1.224	0.0	678.4	0
8640 min Winter	1.071	0.0	712.5	0
10080 min Winter	0.957	0.0	742.5	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	15.400	Shortest Storm (mins)	15
Ratio R	0.290	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.550

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.250	4	8	0.300

Model Details

Storage is Online Cover Level (m) 68.202

Swale Structure

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	85.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	2.5
Safety Factor	1.0	Slope (1:X)	250.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	67.600	Cap Infiltration Depth (m)	0.000
Base Width (m)	3.8		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0108-6900-2000-6900
Design Head (m)	2.000
Design Flow (l/s)	6.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	66.156
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)	2.000	6.9	Kick-Flo®	0.966	4.9
Flush-Flo™	0.471	6.2	Mean Flow over Head Range	-	5.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	1.200	5.4	3.000	8.3	7.000	12.5
0.200	5.5	1.400	5.8	3.500	9.0	7.500	12.9
0.300	6.0	1.600	6.2	4.000	9.6	8.000	13.3
0.400	6.2	1.800	6.6	4.500	10.1	8.500	13.7
0.500	6.2	2.000	6.9	5.000	10.6	9.000	14.1
0.600	6.1	2.200	7.2	5.500	11.1	9.500	14.4
0.800	5.8	2.400	7.5	6.000	11.6		
1.000	5.0	2.600	7.8	6.500	12.0		

8.5 APPENDIX E

Surface Water Pipe Design

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	15.900	Add Flow / Climate Change (%)	0
Ratio R	0.290	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	0.75
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	250

Designed with Level Soffits

Time Area Diagram for Surface Network 1

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.718	4-8	0.586	8-12	0.004

Total Area Contributing (ha) = 1.308

Total Pipe Volume (m³) = 101.862

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	80.412	0.292	275.4	0.190	5.00	0.0	0.600	o	300	Pipe/Conduit	
1.001	85.334	0.427	199.8	0.210	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.002	8.479	0.042	200.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
2.000	8.016	0.100	80.2	0.101	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	21.000	0.105	200.0	0.088	0.00	0.0	0.600	o	375	Pipe/Conduit	
3.000	55.102	0.200	275.5	0.100	5.00	0.0	0.600	o	225	Pipe/Conduit	
3.001	12.285	0.045	275.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.002	64.877	0.304	213.4	0.044	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	44.49	6.42	66.950	0.190	0.0	0.0	0.0	0.94	66.6	22.9
1.001	41.54	7.53	66.583	0.400	0.0	0.0	0.0	1.28	141.2	45.0
1.002	41.27	7.65	66.156	0.400	0.0	0.0	0.0	1.28	141.1	45.0
2.000	48.79	5.09	67.200	0.101	0.0	0.0	0.0	1.46	58.1	13.3
1.003	40.63	7.92	66.114	0.589	0.0	0.0	0.0	1.28	141.1	64.8
3.000	45.22	6.17	67.325	0.100	0.0	0.0	0.0	0.78	31.1	12.2
3.001	44.45	6.43	67.125	0.100	0.0	0.0	0.0	0.78	31.2	12.2
3.002	41.26	7.65	67.080	0.144	0.0	0.0	0.0	0.89	35.4	16.1

Network Design Table for Surface Network 1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
4.000	49.474	0.180	274.9	0.110	5.00	0.0	0.600	o	225	Pipe/Conduit	
4.001	52.200	0.190	274.7	0.120	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.000	6.929	0.028	247.5	0.000	0.10	389.0	0.600	o	750	Pipe/Conduit	
5.001	86.774	0.765	113.4	0.240	0.00	0.0	0.600	o	750	Pipe/Conduit	
4.002	12.506	0.056	223.3	0.010	0.00	0.0	0.600	o	750	Pipe/Conduit	
3.003	39.778	0.097	410.1	0.095	0.00	0.0	0.600	o	750	Pipe/Conduit	
3.004	9.994	0.434	23.1	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
1.004	7.588	0.045	168.2	0.000	0.00	0.0	0.600	o	750	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)
4.000	45.59	6.05	67.202	0.110	0.0	0.0	0.0	0.78	31.2	13.6
4.001	42.96	6.97	66.947	0.230	0.0	0.0	0.0	0.94	66.7	26.8
5.000	50.00	0.17	67.100	0.000	389.0	0.0	0.0	1.77	783.9	389.0
5.001	50.00	0.72	67.072	0.240	389.0	0.0	0.0	2.63	1160.6	421.5
4.002	42.67	7.09	66.307	0.480	389.0	0.0	0.0	1.87	825.5	444.5
3.003	40.15	8.13	66.251	0.719	389.0	0.0	0.0	1.38	607.7	467.2
3.004	40.08	8.16	66.154	0.719	389.0	0.0	0.0	5.84	2581.4	467.2
1.004	39.95	8.22	65.720	1.308	389.0	0.0	0.0	2.16	952.1	530.5

PIPELINE SCHEDULES for Surface Network 1

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	300	10	68.200	66.950	0.950	Open Manhole	1200
1.001	o	375	11	68.000	66.583	1.042	Open Manhole	1350
1.002	o	375	S2	68.208	66.156	1.677	Open Manhole	1350
2.000	o	225	12	68.300	67.200	0.875	Open Manhole	1200
1.003	o	375	13	68.120	66.114	1.631	Open Manhole	1350
3.000	o	225	6	68.750	67.325	1.200	Open Manhole	1200
3.001	o	225	7	68.750	67.125	1.400	Open Manhole	1200
3.002	o	225	8	68.750	67.080	1.445	Open Manhole	1200
4.000	o	225	1	68.627	67.202	1.200	Open Manhole	1200
4.001	o	300	2	69.498	66.947	2.251	Open Manhole	1200
5.000	o	750	3	68.900	67.100	1.050	Open Manhole	1800
5.001	o	750	4	69.912	67.072	2.090	Open Manhole	1800
4.002	o	750	5	68.296	66.307	1.239	Open Manhole	1800
3.003	o	750	9	68.201	66.251	1.200	Open Manhole	1800
3.004	o	750	S1	68.405	66.154	1.502	Open Manhole	1800
1.004	o	750	14	68.370	65.720	1.900	Open Manhole	1800

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	80.412	275.4	11	68.000	66.658	1.042	Open Manhole	1350
1.001	85.334	199.8	S2	68.208	66.156	1.677	Open Manhole	1350
1.002	8.479	200.0	13	68.120	66.114	1.631	Open Manhole	1350
2.000	8.016	80.2	13	68.120	67.100	0.795	Open Manhole	1350
1.003	21.000	200.0	14	68.370	66.009	1.986	Open Manhole	1800
3.000	55.102	275.5	7	68.750	67.125	1.400	Open Manhole	1200
3.001	12.285	275.0	8	68.750	67.080	1.445	Open Manhole	1200
3.002	64.877	213.4	9	68.201	66.776	1.200	Open Manhole	1800
4.000	49.474	274.9	2	69.498	67.022	2.251	Open Manhole	1200
4.001	52.200	274.7	5	68.296	66.757	1.239	Open Manhole	1800
5.000	6.929	247.5	4	69.912	67.072	2.090	Open Manhole	1800
5.001	86.774	113.4	5	68.296	66.307	1.239	Open Manhole	1800
4.002	12.506	223.3	9	68.201	66.251	1.200	Open Manhole	1800
3.003	39.778	410.1	S1	68.405	66.154	1.501	Open Manhole	1800
3.004	9.994	23.1	14	68.370	65.720	1.900	Open Manhole	1800
1.004	7.588	168.2		68.400	65.675	1.975	Open Manhole	0

8.6 APPENDIX F

Water Demand & Wastewater Design Flows, & Wastewater Pipe Design

poga Consulting Engineers

CALCULATIONS - PROPOSED DEVELOPMENT

Charlestown SHD					
Accomodation Schedule		**Average Occupancy Rate**	**Population (P)**	**Daily Water Consumption per Capita (G)**	**Daily Water Consumption (L/s)**
Existing Residential Units (unit)	0	2.7 people / unit	0	150 L/capita/day	0.000
Existing Commercial area (m2)	0	1 person / 25 m2	0	50 L/day/capita	0.000
Existing Light Industrial area (m2)	0	1 person / 33 m2	0	50 L/day/capita	0.000
Existing Retail area (m2)	0	1 person / 100 m2	0	30 L/day/capita	0.000
Proposed Residential Units (unit)	590	2.7 people / unit	1593	150 L/capita/day	0.922
Proposed Commercial area (m2)	749	1 person / 25 m2	30	50 L/day/capita	0.017
Proposed Light Industrial area (m2)	0	1 person / 33 m2	0	50 L/day/capita	0.000
Proposed Creche (m2)	542	1 person / 20 m2	27	40 L/day/capita	0.013
Proposed Retail area (m2)	350	1 person / 100 m2	4	30 L/day/capita	0.001

Coefficients for Subject Site

Infiltration rate for Existing properties (I)	=	20	
Infiltration rate for New properties (I)	=	10	
Commercial Peaking Factor (Pfdom,ind)	=	4.50	(up to 5.5Ha area)
Domestic Peaking Factor (Pfdom)	=	3.00	(up to 5000 people)
Trade Wastewater Flow Peaking Factor (Pftrade)	=	3.00	
Site Area	=	3.41	ha
Paved Area Factor	=	0.40	
C factor (Cv x Cr)	=	0.80	
Rainfall intensity (i) for sub-catchment greater than 400m2 for 2 years Return Period	=	7.00	mm/hr
Storm Design event peak rate runoff (Q = 2.78 x C x I x A)	=	21.23	l/s
SW Allowance (1.5% of Gross Area)	=	0.32	

Foul Wastewater Discharge

Domestic Dry Weather Flow (P x G + I)	=	1.01	l/s
Design Foul Flow (Eqn1 + SW Allowance)	=	3.36	l/s
Commercial/Retail Dry Weather Flow (P x G + I)	=	0.03	l/s
Design Foul Flow (Eqn1)	=	0.15	l/s
Industrial Dry Weather Flow (P x G + I)	=	0.00	l/s
Design Foul Flow (Eqn1)	=	0.00	l/s
Total		**3.51**	**l/s**

Waster Demand

Domestic	=	0.92	l/s
Commercial	=	0.03	l/s
Average Demand	=	0.95	l/s
Peak Demand (2.1 times average)	=	2.00	l/s
Normal Demand (Average demad over 8 hours)	=	**2.86**	**l/s**

FOUL SEWERAGE DESIGN

Design Criteria for Foul Network 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	10
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Flow Per Person (l/per/day)	150.00	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)	200

Designed with Level Soffits

Network Design Table for Foul Network 1

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
1.000	44.934	0.225	199.7	0.000	46	0.0	0.600	o	225	Pipe/Conduit	
1.001	52.555	0.263	199.8	0.000	102	0.0	0.600	o	225	Pipe/Conduit	
2.000	77.528	0.388	199.8	0.000	140	0.0	0.600	o	225	Pipe/Conduit	
1.002	78.394	0.392	200.0	0.000	45	0.0	0.600	o	225	Pipe/Conduit	
3.000	7.269	0.037	196.5	0.000	47	0.1	0.600	o	225	Pipe/Conduit	
1.003	98.728	0.494	199.9	0.000	60	0.0	0.600	o	225	Pipe/Conduit	
1.004	79.393	0.397	200.0	0.000	60	0.0	0.600	o	225	Pipe/Conduit	
1.005	7.449	0.037	201.3	0.000	50	0.0	0.600	o	225	Pipe/Conduit	
4.000	31.027	0.388	80.0	0.000	40	0.1	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)
1.000	67.617	0.000	0.0	46	0.1	32	0.46	0.92	36.6	1.6
1.001	67.393	0.000	0.0	148	0.5	56	0.65	0.92	36.6	5.1
2.000	67.517	0.000	0.0	140	0.4	55	0.64	0.92	36.6	4.8
1.002	67.130	0.000	0.0	333	1.0	86	0.82	0.92	36.6	11.4
3.000	66.775	0.000	0.1	47	0.2	33	0.48	0.93	36.9	1.7
1.003	66.738	0.000	0.1	440	1.4	101	0.88	0.92	36.6	15.2
1.004	66.244	0.000	0.1	500	1.6	109	0.91	0.92	36.6	17.3
1.005	65.847	0.000	0.1	550	1.7	115	0.93	0.92	36.5	19.0
4.000	66.619	0.000	0.1	40	0.1	27	0.56	1.28	51.1	1.5

PIPELINE SCHEDULES for Foul Network 1

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	1	68.687	67.617	0.845	Open Manhole	1200
1.001	o	225	2	69.499	67.393	1.881	Open Manhole	1200
2.000	o	225	3	68.851	67.517	1.109	Open Manhole	1200
1.002	o	225	4	68.231	67.130	0.876	Open Manhole	1200
3.000	o	225	5	68.263	66.775	1.263	Open Manhole	1200
1.003	o	225	6	68.215	66.738	1.252	Open Manhole	1200
1.004	o	225	7	67.516	66.244	1.047	Open Manhole	1200
1.005	o	225	8	67.687	65.847	1.615	Open Manhole	1200
4.000	o	225	F1	68.044	66.619	1.200	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)
1.000	44.934	199.7	2	69.499	67.392	1.882	Open Manhole	1200
1.001	52.555	199.8	4	68.231	67.130	0.876	Open Manhole	1200
2.000	77.528	199.8	4	68.231	67.129	0.877	Open Manhole	1200
1.002	78.394	200.0	6	68.215	66.738	1.252	Open Manhole	1200
3.000	7.269	196.5	6	68.215	66.738	1.252	Open Manhole	1200
1.003	98.728	199.9	7	67.516	66.244	1.047	Open Manhole	1200
1.004	79.393	200.0	8	67.687	65.847	1.615	Open Manhole	1200
1.005	7.449	201.3		67.832	65.810	1.797	Open Manhole	1200
4.000	31.027	80.0		67.832	66.231	1.376	Open Manhole	1200

Free Flowing Outfall Details for Foul Network 1

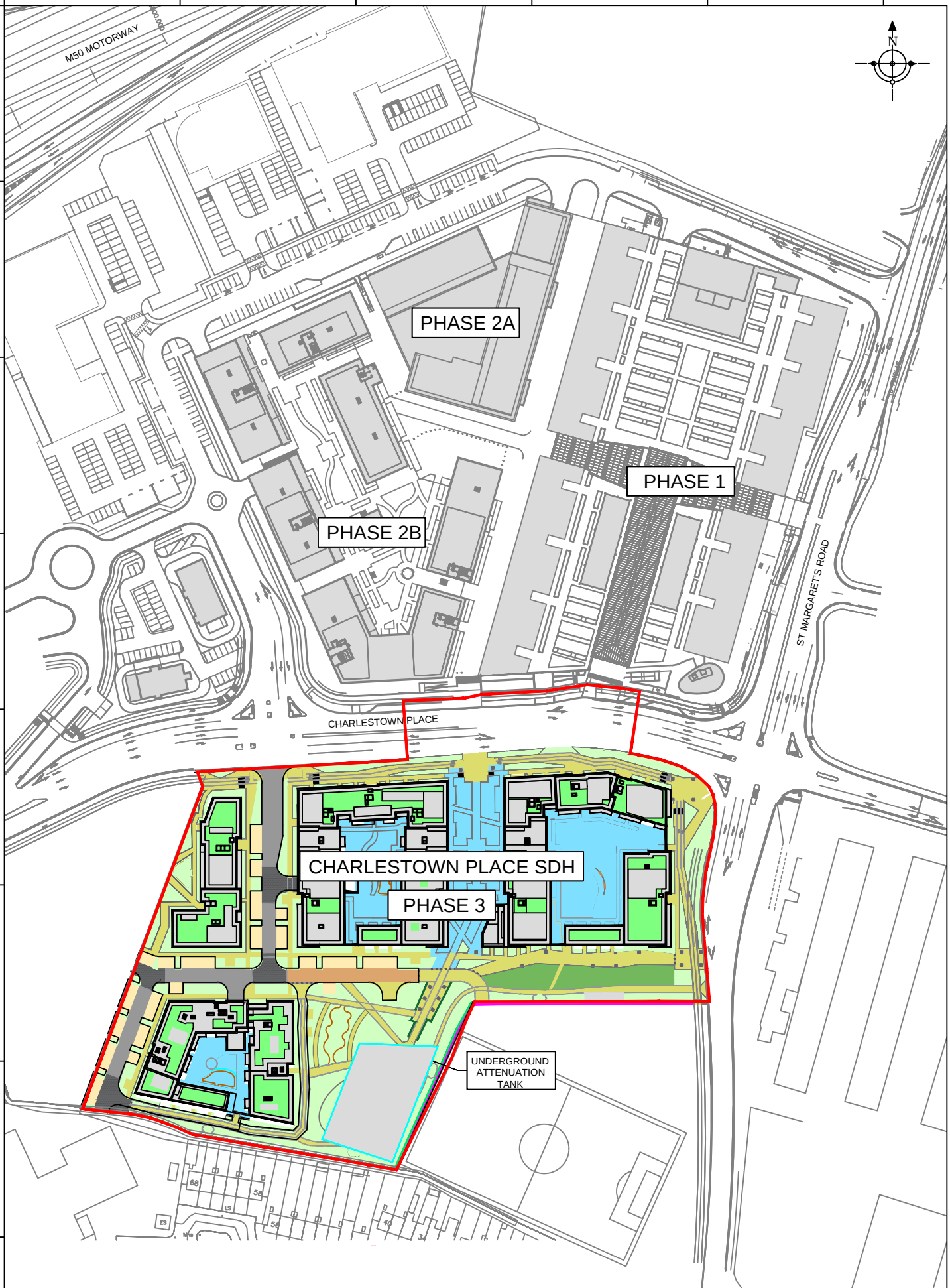
Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.005		67.832	65.810	0.000	1200	0

Free Flowing Outfall Details for Foul Network 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
4.000		67.832	66.231	0.000	1200	0

8.7 APPENDIX G

SURFACE WATER OVERALL SCHEME LAYOUT



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Date	Description	By

Project Title
SHD AT CHARLESTOWN PLACE AND ST MARGARET'S ROAD

Architect
MCORM ARCHITECTS

Date	By	Checked	Scale @ A3
MAR 2020	AL	PM	1:1500

Drawing Title
OVERALL DRAINAGE LAYOUT CONTRIBUTING PHASES

Drawing Status
PLANNING

Job No.	Drawing No.	Issue
1726	114	P0

poga CONSULTING ENGINEERS
STRUCTURAL & CIVIL
Pat O'Gorman & Associates
Unit C2, Nutgrove Office Park
Rathfarnham
Dublin 14
D14 CR20
Tel +353 (0)1 205 1101
www.poga.ie

8.8 APPENDIX H

SOIL INFILTRATION TEST REPORT
GROUND INVESTIGATIONS IRELAND

REPORT ON SOIL INFILTRATION TESTS

FOR

SOAKAWAY DESIGN

AT

CHARLESTOWN

FINGLAS

DUBLIN 11

Prepared by: Jonathan Naughton. B.Sc (Hons)

Signed..... **Date:** 24th November 2008

Checked by: EurGeol Fergal Mc Namara PGeo

Signed.....

File no: 2079-11-08

Contents

1.0 Preamble

On the instructions of Mr R Mullarkey of Pat O'Gorman and Associates, four soil infiltration tests were carried out by Ground Investigations Ireland Ltd., at the above site on the 10th and 11th of Nov 2008 to determine the suitability of the subsoil for the construction of a soakaway for surface water run-off.

2.0 Overview

2.1 Background

The site in question is located adjacent to the Charlestown Shopping Centre.

3.0 Soil Infiltration tests.

3.1 General

Four no. Trial Pits were excavated to depths between 1.00 and 2.40 metres below ground level (mBGL) at locations indicated by the Consulting Engineers. A Trial Pit Record representing the subsurface conditions encountered in the pits is included in Appendix 1. A site map showing the locations of the trial pits is displayed in Appendix 3. Soakaway tests were carried out in accordance with the *BRE Digest 365, Soakaway Design.*

3.2 Soakaway test 1

Trial Pit No. 1 (S1) was excavated with dimensions 2.40m x 0.90m x 2.40mBGL and filled with water to a nominal invert level of 0.85mBGL on 10/11/08. The drop in water level was monitored over time. In order to calculate the soil infiltration rate it is necessary to monitor the drop in water level from 75% pit volume to 25% pit volume. The results of the soakaway test can be found in Appendix 2 of this report. After 19hrs and 40mins the water dropped to 0.91mBGL.

3.3 Soakaway test 2

Trial Pit No. 2 was excavated with dimensions 2.10m x 0.90m x 1.70mBGL (metres below ground level) and filled with water to a nominal invert level of 0.71mBGL on the 10/11/2008 and allowed to drain. The fall in water level was monitored over time. Details of the trial pit excavated and the fall of water over time can be found in appendix 1 and 2 of this report. The water level dropped to 0.78mBGL in 20hours and 40 minutes.

3.4 Soakaway test 3

Trial Pit No. 3 was excavated with dimensions 2.10m x 0.95 x 1.30mBGL(metres below ground level) and filled with water to a nominal invert level of 0.78mBGL on the 11/11/2008 and allowed to drain. The fall in water level was monitored over time. Details of the trial pit excavated and the fall of water over time can be found in appendix 1 and 2 of this report. The water level dropped to 0.94mBGL in 3hours and 39 minutes.

3.5 Soakaway test 4

Trial Pit No. 4 was excavated with dimensions 2.70m x 0.80 x 1.00mBGL(metres below ground level) and filled with water to a nominal invert level of 0.50mBGL on the 11/11/2008 and allowed to drain. The fall in water level was monitored over time. Details of the trial pit excavated and the fall of water over time can be found in appendix 1 and 2 of this report. The water level dropped to 0.54mBGL in 2hours and 25 minutes.

4.0 Recommendations and Conclusions

4.1 General

The recommendations given and opinions expressed in this Report are based on the findings as detailed in the exploratory hole records. Where an opinion is expressed on the material between exploratory hole locations or below the final level of excavation, this is for guidance only and no liability can be accepted from its accuracy. No responsibility can be accepted for conditions which have not been revealed by the exploratory holes. It is further recommended that all excavations when excavated should be inspected to verify the information given in this Report.

4.2 Soakaway design

There was insufficient soakage in Trial Pit No.s 1 - 4 to enable calculation of the soil infiltration rate **f**

The site is therefore unsuitable for the design of a soakaway in this area.

TRIAL PIT RECORD

Project Name: Charlestown Centre Site

Hole ID: TPS1

Client:
Consultant: Pat O'Gorman
Location: Finglas
Date: 10/11/2008
Excavator used: JCB

Co-ordinates: -
-
Elevation: -
Project no. 2079-11-08
Logged by: J Naughton

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL								
FILL of clay cobbles and gravel.		0.50						
Stiff brown sandy gravelly CLAY		0.90						
Firm mottled grey/brown slightly sandy gravelly CLAY		1.10						
End of Trial pit at 2.40 m		2.40						

Remarks:

Stability: No sidewall collapse
Water: No groundwater encountered
Remarks: Trial pit backfilled on completion

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 2.40
Depth: 0.90
2.40

GROUND INVESTIGATIONS IRELAND
www.gii.ie

TRIAL PIT RECORD

Project Name: Charlestown Centre Site

Hole ID: TPS2

Client:
Consultant: Pat O'Gorman
Location: Finglas
Date: 10/11/2008
Excavator used: JCB

Co-ordinates: -
-
Elevation: -
Project no. 2079-11-08
Logged by: J Naughton

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
FILL of black clay cobbles and gravel								
Stiff brown sandy gravelly CLAY		0.20						
Grey firm to stiff sandy gravelly CLAY with some cobbles.		0.60						
		1						
End of Trial pit at 1.70 m		1.70						
		2						
		3						
		4						

Remarks:

Stability: No sidewall collapse
Water: No groundwater encountered.
Remarks: Trial pit backfilled on completion

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 2.10
Depth: 0.90
1.70

GROUND INVESTIGATIONS IRELAND
www.gii.ie

TRIAL PIT RECORD

Project Name: Charlestown Centre Site

Hole ID: TPS3

Client:
Consultant: Pat O'Gorman
Location: Finglas
Date: 11/11/2008
Excavator used: JCB

Co-ordinates: -
-
Elevation: -
Project no. 2079-11-08
Logged by: J Naughton

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
FILL of clay gravel and cobbles.								
Firm to stiff grey/brown slightly sandy gravelly CLAY		0.80						
End of Trial pit at 1.30 m		1.30						

Remarks:

Stability: No sidewall collapse
Water: No groundwater encountered.
Remarks: Trial pit backfilled on completion

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 2.10
Depth: 0.95
1.30

GROUND INVESTIGATIONS IRELAND
www.gii.ie

TRIAL PIT RECORD

Project Name: Charlestown Centre Site

Hole ID: TPS4

Client:
Consultant: Pat O'Gorman
Location: Finglas
Date: 11/11/2008
Excavator used: JCB

Co-ordinates: -
-
Elevation: -
Project no. 2079-11-08
Logged by: J Naughton

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL								
Firm brown slightly sandy slightly gravelly CLAY		0.50						
Firm grey slightly sandy gravelly CLAY		0.80						
End of Trial pit at 1.00 m		1.00						
		2						
		3						
		4						

Remarks:

Stability: No sidewall collapse
Water: No groundwater encountered
Remarks: Trial pit backfilled on completion

KEY

B Bulk disturbed sample.
D Small disturbed sample
U Undisturbed sample

Dimensions: 2.70
Depth: 0.80
1.00

GROUND INVESTIGATIONS IRELAND
www.gii.ie

TP S1

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.85mBGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.85	Hole filled with water
937	0.90	
1164	0.91	Test Complete

TP S2

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.71mBGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.71	Hole filled with water
976	0.76	
1224	0.78	Test Complete

TP S3

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.78mBGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.78	Hole filled with water
32	0.85	
100	0.90	
219	0.94	Test Complete

TP S4

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.50mBGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.50	Hole filled with water
5	0.51	
25	0.53	
145	0.54	Test Complete

PAT O'GORMAN & ASSOCIATES
Consulting Structural and Civil Engineers
Unit C2, Hudgrove Office Park, Rathfarnham, Dublin 14.
Tel: +353 1 205 1101 Fax: +353 1 205 1102
E-mail: info@pogorman.ie www.pogorman.ie

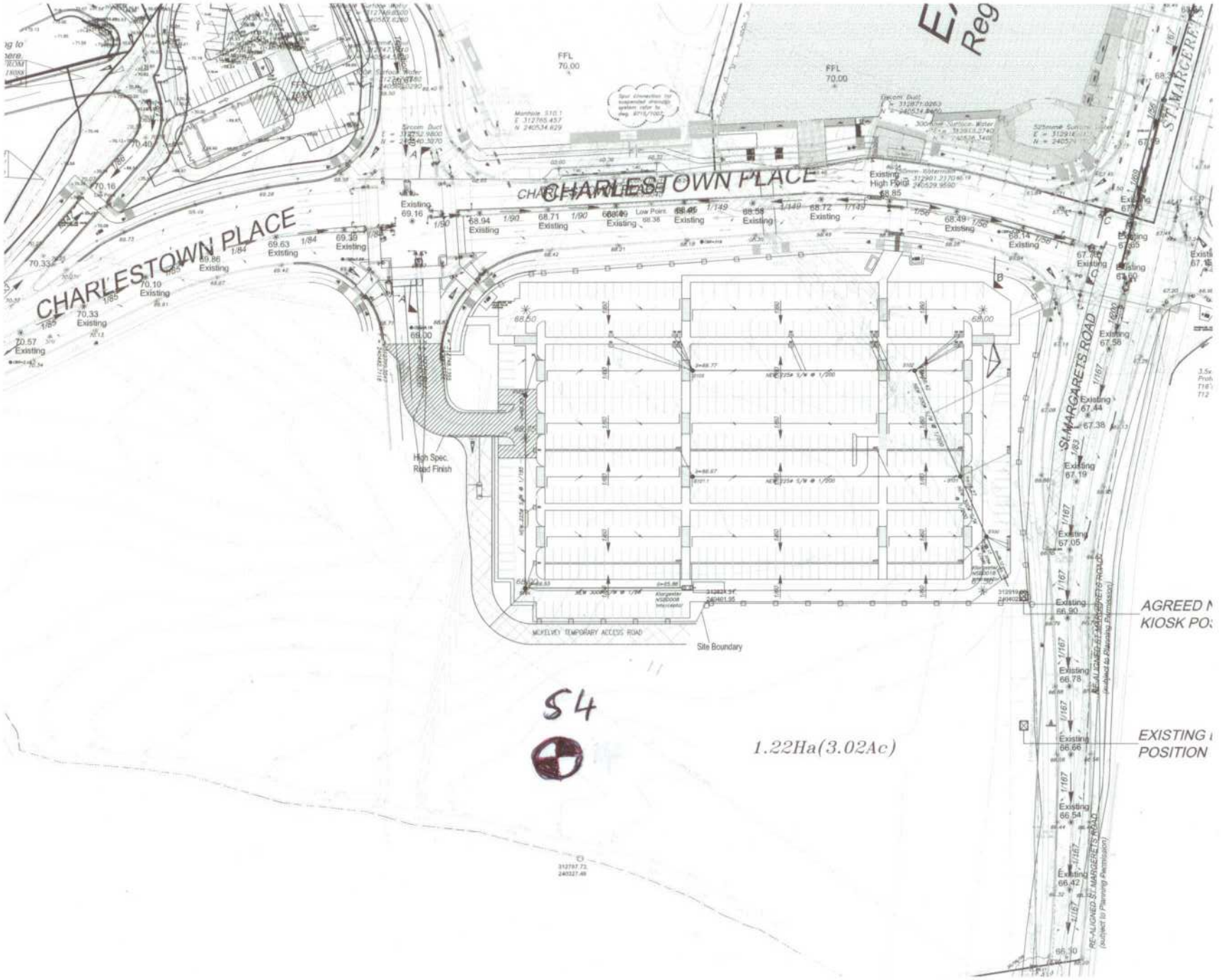
PROJECT
CHARLESTOWN CENTRE PHASE 03

DRAWING TITLE
PERCULATION TEST LOCATIONS

ARCHITECT

DATE	DRAWN	SCALES	STAGE
OCTOBER	PMC	1:1000	PRELIMINARY

DWG NO.	REV.
9715/3004	-


CHARLESTOWN PLACE
CHARLESTOWN PLACE
ST.MARGERETS ROAD
ST.MARGERETS ROAD
FFL
70.00
FFL
70.00
High Spec.
Road Finish
Site Boundary
McKELVEY TEMPORARY ACCESS ROAD
54
1.22Ha(3.02Ac)
AGREED
KIOSK PO
EXISTING
POSITION
RE-ALIGNED ST.MARGERETS ROAD
(subject to Planning Permission)

8.9 APPENDIX J

IRISH WATER CONFIRMATION OF FEASIBILITY & DESIGN ACCAPTANCE

Paul Moran
Poga Consulting Eng.
Unit C2, Nutgrove Office Park
Rathfarnham
Dublin 14,
D14CR20

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

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

www.water.ie

18 May 2020

Dear Paul Moran,

Re: Connection Reference No CDS20002444 pre-connection enquiry -
Subject to contract | Contract denied

Connection for Multi/Mixed Use Development of 603 units at Charlestown SHD Development, St. Margaret's Road, Dublin 11, Co. Dublin.

Irish Water has reviewed your pre-connection enquiry in relation to water and wastewater connections at Charlestown SHD Development, St. Margaret's Road, Dublin 11, Co. Dublin.

Based upon the details that you have provided with your pre-connection enquiry and on the capacity currently available in the network(s), as assessed by Irish Water, we wish to advise you that, subject to a valid connection agreement being put in place, your proposed connection to the Irish Water network(s) can be facilitated. Please be advised:

Water

- The Development should be connected via new 200 mm ID connection pipe to the existing 250 mm DI main in Saint Margaret's Road. A bulk meter with associated telemetry system will be required for the connection.
- Secondary connection should be made via new 200 mm ID connection pipe with controlled valve, to the existing 250mm DI main in Charlestown Place Road. The valve should be closed during normal operation.
- An on site storage, with re-fill time of 12 hours, for the average day peak week demand (0.07l/s) of the commercial section will be required to supply the demand for 24 hours.
- A section of the existing 250mm DI main is within the site boundary on the North of the Development. The Developer has to demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the infrastructure during and after the works. Drawings (showing clearance distances, changing to ground levels) and Method Statements should be included in the Detailed Design of the Development. A wayleave in favour of Irish Water will be required over the infrastructure that is not located within the Public Space.

Wastewater

- New connection to the existing network is feasible without upgrade.

Strategic Housing Development

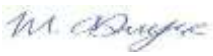
Irish Water notes that the scale of this development dictates that it is subject to the Strategic Housing Development planning process. Therefore:

- In advance of submitting your full application to An Bord Pleanala for assessment, you must have reviewed this development with Irish Water and received a Statement of Design Acceptance in relation to the layout of water and wastewater services. All infrastructure should be designed and installed in accordance with the Irish Water Codes of Practice and Standard Details.
- You are advised that this correspondence does not constitute an offer in whole or in part to provide a connection to any Irish Water infrastructure and is provided subject to a connection agreement being signed and appropriate connection fee paid at a later date.

A connection agreement can be applied for by completing the connection application form available at **www.water.ie/connections**. Irish Water's current charges for water and wastewater connections are set out in the Water Charges Plan as approved by the Commission for Regulation of Utilities.

If you have any further questions, please contact Marina Zivanovic Byrne from the design team on 01 89 25991 or email mzbyrne@water.ie. For further information, visit **www.water.ie/connections.**

Yours sincerely,



Maria O'Dwyer

Connections and Developer Services

Paul Moran
POGA Consulting Engineers
Unit C2, Nutgrove Office Park
Rathfarnham
Co. Dublin D14CR20

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

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

www.water.ie

8 February 2021

Re: Design Submission for Charlestown SHD Development, St. Margaret's Road, Dublin 11, Co. Dublin (the "Development")
(the "Design Submission") / Connection Reference No: CDS20002444

Dear Paul Moran,

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: Dario Alvarez
Email: dalvarez@water.ie

Yours sincerely,

Yvonne Harris

Yvonne Harris
Head of Customer Operations

Appendix A

Document Title & Revision

- [1726-103 Rev.P2 – Drainage layout]
- [1726-104 Rev.P2 – Drainage layout]
- [1726-105 Rev.P1 – Watermain layout]
- [1726-109 Rev.P1 – Foul Drainage longitudinal Sections]

Standard Details/Code of Practice Exemption:

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.

WATERMAIN NOTES

1. These are summary notes, refer to Irish Water Code of Practice and Standard Details for full notes and details. Where discrepancy between these and Irish Water publication are identified, Irish Water publications take precedence. All discrepancies should be reported to POGA.
2. The contractor shall agree the exact make, model and closing direction of sluice valves and hydrants with the Irish Water & the Water Inspector.
3. All boxes shall be as per Irish Water Code of Practice, Connection and Service Developer Services, Water Infrastructure latest standard details.
4. Watermains shall be tested in conjunction with the Irish Water , section 4.10 (Testing and Commissioning) to a minimum pressure of 10 Bars(150psi). The time taken (t) to pressure the watermain loop should be measured on site and the subsequent test held for a minimum duration of 2Þ. The water pressure should not be topped up during the test. The pressure readings should be recorded at 1 minute intervals and submitted to project engineer for evaluation prior to backfilling.
5. Anchor blocks of grade C20/25 Type F concrete shall be provided on watermains at dead ends, tees, bends of greater curvature than 11.25° and at both sides of sluice valve chambers.
6. All pipework shall be thoroughly flushed out, sterilised with chlorine and then scoured and flushed out again in conjunction with Irish Water Code of Practice, section 4.10.5 and 4.13.
7. Hydrant covers shall be painted canary yellow (BS 381C) and be in paved non-vehicular areas. Hydrant never to be placed in parking bays.
8. Where Watermains terminating in a loop, provide connection to a minimum of four properties and a hydrant. See section 3.5.14 of Irish Water Code of Practice.
9. Provide an offline hydrant downstream of the proposed bulk meter locations. See section 3.15.4 of Irish Water Code of Practice and STD-W-27 of Water Infrastructure Standard Details.
10. Distribution Watermains shall be laid in public areas and be kept a minimum distance from existing structures and trees and shrubs. Distance to be specified in Irish Water Code of Practice, Connection and Service Developer Services, Water Infrastructure standard detail, STD-W11 & STD-W-12 respectively.
11. Where water main is required to be laid in roadway, please ensure that this is located a away from the kerb line, refer to 3.5.8-3.5.13 of the Irish Water Code of Practice. Watermain 150mm diameter and smaller shall be located a minimum of 3m for a structure and 1m from a boundary Wall.
12. Air valves shall be provided at all summits on pipelines of 110mm(ID) Ø or greater.
13. Pipes should be jointed strictly in accordance with manufacturer's requirements.
14. All pipes blue in colour, be HDPE or MDPE for 25mm to 80mm diameters & HDPE or Ductile Iron for minimum 100mm to 300mm inside diameters, or HPPE or Ductile Iron for a minimum 350 to 600mm internal diameters. An example is, 150 internal diameter watermain pipe should be; 180mm outside diameter, SDR-17 and PE-100, this give an internal dia (from Wavinsuspaure range) of 158mm. The 100mm internal diameter should be 125mmOD, SDR-17 and PE-100, this gives and internal dia of 109.5mm.
15. HPPE and HDPE pipes to be be:
    15.1. Type PE-100
    15.2. SDR-17 rating
    15.3. Compliance with to IS EN 12201: Part 1 and Part 2 (Plastic Systems for Water Supply, Drainage and Sewerage Under Pressure - Part 1, General, and Part 2, Pipes)
    15.4. Compliance with I.S. EN 12201-3 (Plastic Systems for Water Supply, Drainage and Sewerage Under Pressure - Part 3: Fittings).
16. ALL PE pipes shall also conform to the following UK Water Industry Specifications:
    16.1. 4-32-08 - Specification for the fusion jointing of polyethylene pressure pipeline systems using PE80 and PE100 materials
    16.2. 4-32-16 - Specification for Butt Fusion Jointing Machines
    16.3. 4-32-19 - Specification for polyethylene pressure pipeline systems with an aluminium barrier layer for potable water supply in contaminated land
    16.4. IGN 4-01-03 - Pressure Testing of Pressure Pipes and Fittings for use by Public Water Supplies
    16.5. For pipes greater than 600mm refer to Engineer for approval.
17. All Watermain pipes to have minimum 10 bar working pressure rating.
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19. All changes in both vertical and horizontal alignment greater than 4° to be supported by a concrete anchor block.
20. Air valves locations to be accurately set out at summit points on site.
21. All watermains to be backfilled as per as per Irish Water Code of Practice latest, Connection and Service Developer Services, Water Infrastructure standard details, STD-W-13.
22. Service pipes to be a minimum of 20mm(ID) and shall not exceed 15m in length.
23. Depth of finished ground to the outlet of the Hydrant not to be greater than 350mm.
24. Boundary Box to be provided on all connection and should be located in pedestrian areas on the public side of the boundary, locations and type to be in constructed in accordance with standard detail STD-W-03.
25. All materials and details to comply with Irish Water Code of Practice latest, Connection and Service Developer Services, Water Infrastructure standard details.

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3. Hydrant Indicator plates shall be canary yellow (BS 381 C) with black lettering to BS 3251.
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STD-W-06	General pipe connections (sheet 3 of 7)	2
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STD-W-11	Typical service layout indicating separation distances	1
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STD-W-12A	Restrictions on new trees / shrubs planting adjacent to Watermains	0
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STD-W-36	Telemetry and wet kiosk	2
STD-W-37	Lamp bollard & lamp standard	1

DRAINAGE LEGEND

- SITE BOUNDARY
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- Existing SW Sewer — EXISTING SURFACE WATER SEWER
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Rev.	Date	Description	By
P2	05/02/21	REVISED AS PER IW COMMENTS	AL
P1	01/02/21	REVISED AS PER IW COMMENTS	AL

Project Title
SHD AT CHARLESTOWN PLACE AND ST MARGARET'S ROAD

Architect
MCORM ARCHITECTS

Date	By	Checked	Scale @ A1
MAY 2020	AL	PM	1:500

Drawing Title
SLUNG DRAINAGE LAYOUT UNDER PODIUM LEVEL

Drawing Status
PLANNING

Job No.	Drawing No.	Issue
1726	103	P2

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Dublin 14
D14 C620
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WATERMAIN NOTES

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6. All pipework shall be thoroughly flushed out, sterilised with chlorine and then scoured and flushed out again in conjunction with Irish Water Code of Practice, section 4.10.5 and 4.13.
7. Hydrant covers shall be painted canary yellow (BS 381C) and be in paved non-vehicular areas. Hydrant never to be placed in parking bays.
8. Where Watermains terminating in a loop, provide connection to a minimum of four properties and a hydrant. See section 3.5.14 of Irish Water Code of Practice.
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11. Where water main is required to be laid in roadway, please ensure that this is located a away from the kerb line, refer to 3.5.8-3.5.13 of the Irish Water Code of Practice. Watermain 150mm diameter and smaller shall be located a minimum of 3m for a structure and 1m from a boundary Wall.
12. Air valves shall be provided at all summits on pipelines of 110mm(ID) Ø or greater.
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14. All pipes blue in colour, be HDPE or MDPE for 25mm to 80mm diameters & HDPE or Ductile Iron for minimum 100mm to 300mm inside diameters, or HPPE or Ductile Iron for a minimum 350 to 600mm internal diameters. An example is, 150 internal diameter watermain pipe should be; 180mm outside diameter, SDR-17 and PE-100, this give an internal dia (from Wavinsupasure range) of 158mm. The 100mm internal diameter should be 125mmOD, SDR-17 and PE-100, this gives and internal dia of 109.5mm.
15. HPPE and HDPE pipes to be be:
    - 15.1. Type PE-100
    - 15.2. SDR-17 rating
    - 15.3. Compliance with to IS EN 12201: Part 1 and Part 2 (Plastic Systems for Water Supply, Drainage and Sewerage Under Pressure - Part 1, General, and Part 2, Pipes)
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Project Title
SHD AT CHARLESTOWN PLACE AND ST MARGARET'S ROAD

Architect
MCORM ARCHITECTS

Date	By	Checked	Scale @ A1
MAY 2020	AL	PM	1:500

Drawing Title
DRAINAGE LAYOUT

Drawing Status
PLANNING

Job No.	Drawing No.	Issue
1726	104	P2

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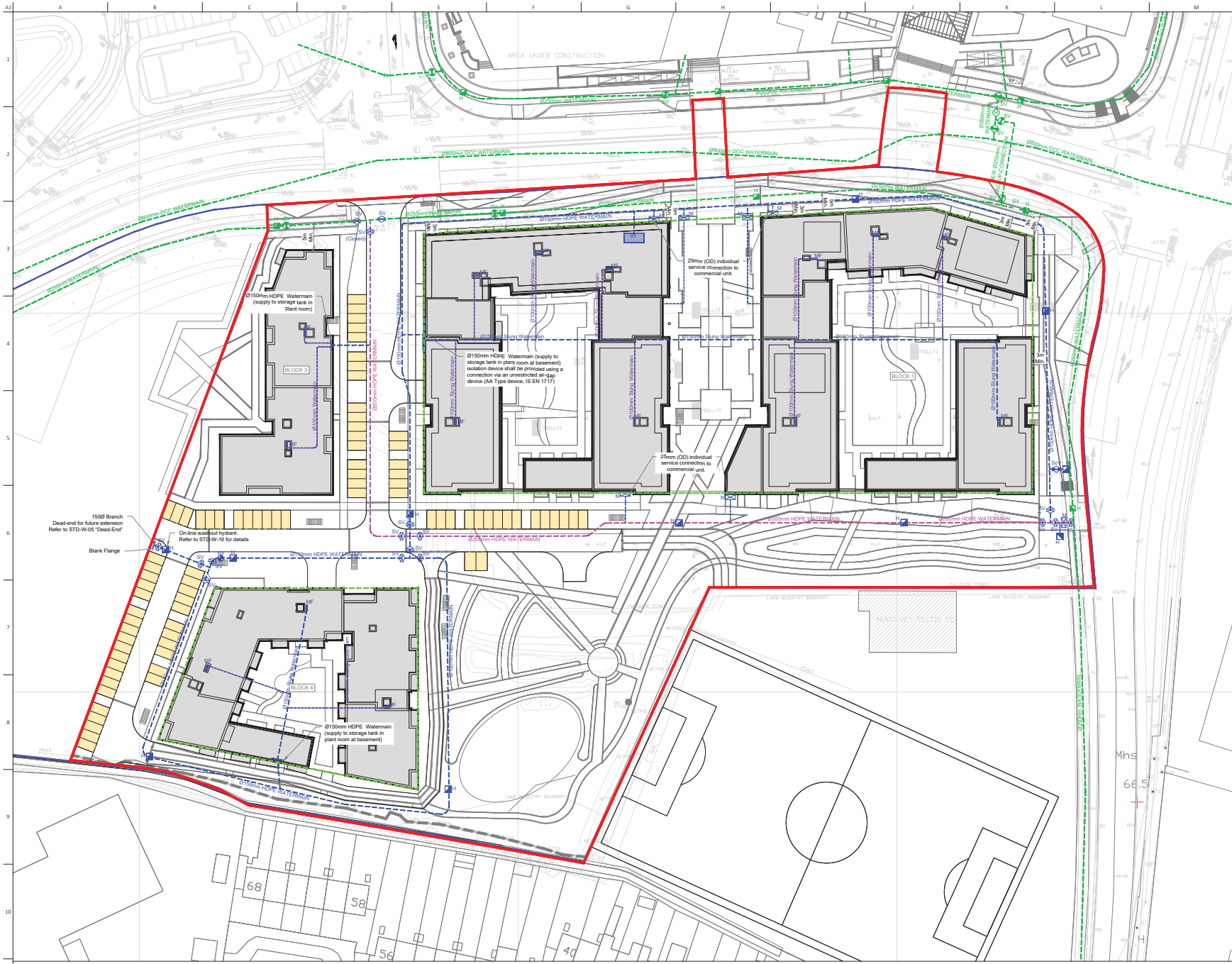

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WATERMAIN LEGEND

- SITE BOUNDARY
- PROPOSED Ø200mm HDPE WATERMAIN
- PROPOSED Ø100mm HDPE WATERMAIN
- PROPOSED Ø100mm HDPE WATERMAIN
- EXISTING WATERMAIN
- SV — SLUICE VALVE
- SCV — SCOUR VALVE
- H — HYDRANT
- M — BULK FLOW WATER METER
- AV — AIR VALVE
- MF — MANIFOLD BOX WITH 25MM (OD) INDIVIDUAL SERVICE CONNECTIONS AND INDIVIDUAL METERS TO EACH APARTMENT IN ACCORDANCE WITH SECTION 2.4.3/2.4.5/2.4.6/2.6.5 OF THE IRISH WATER CODE OF PRACTICE.
- ON SITE STORAGE TANK TO SUPPLY WATER DEMAND FOR 24 HOURS

Rev.	Date	Description	By
P1	01/02/21	REVISED AS PER IW COMMENTS	AL

Project Title
SHD AT CHARLESTOWN PLACE AND ST MARGARET'S ROAD

Architect
MCORM ARCHITECTS

Date	By	Checked	Scale @ A1
MAY 2020	AL	PM	1:500

Drawing Title
WATERMAIN LAYOUT

Drawing Status
PLANNING

Job No.	Drawing No.	Issue
1726	105	P1

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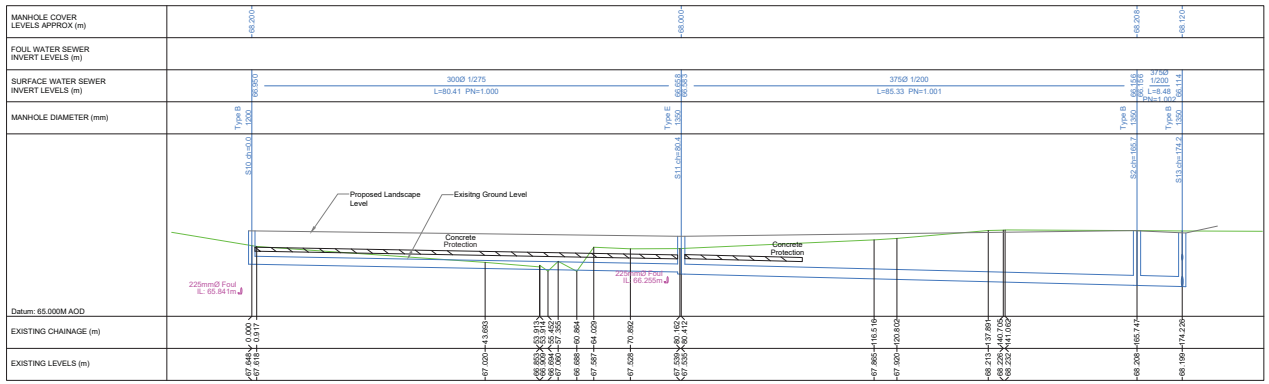
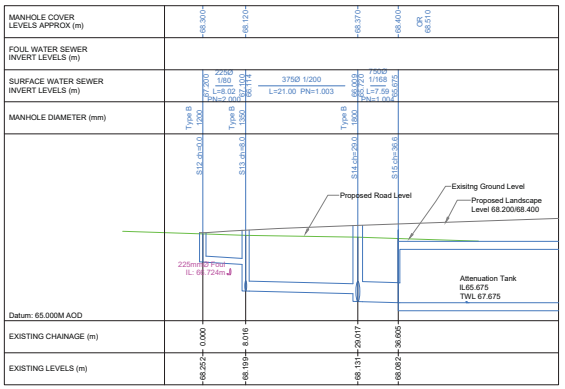


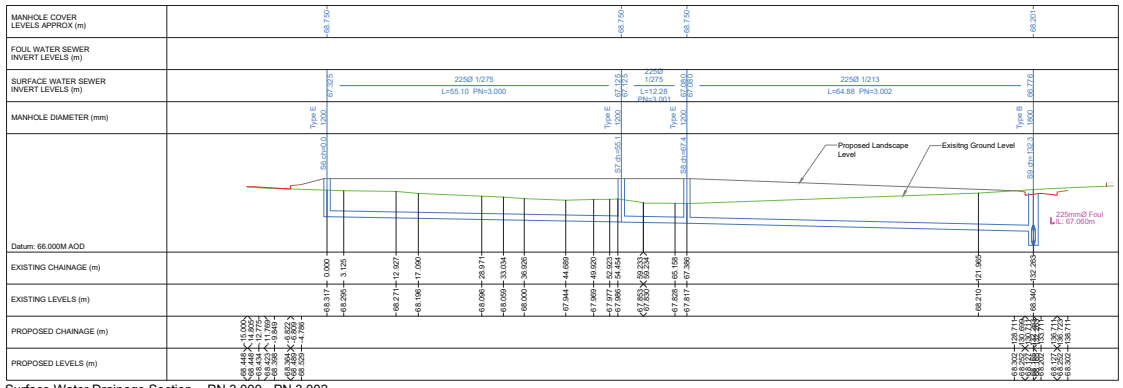
Surface Water Drainage Section - PN 1.000 - PN 1.002

Scale: 1:500H, 1:100V



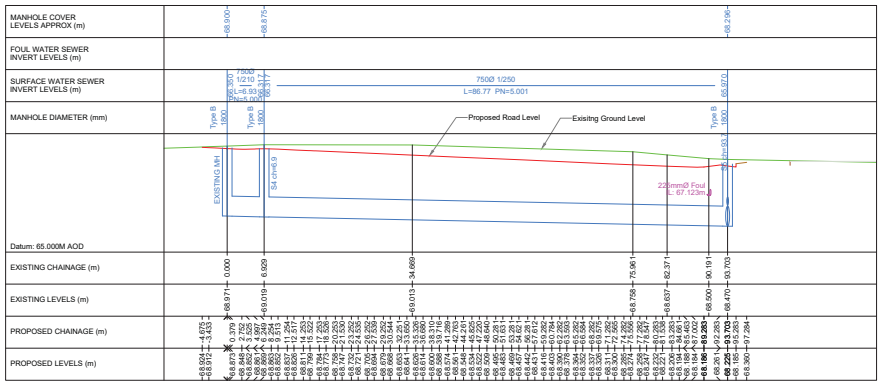
Surface Water Drainage Section - PN 2.000 - PN 1.004

Scale: 1:500H, 1:100V



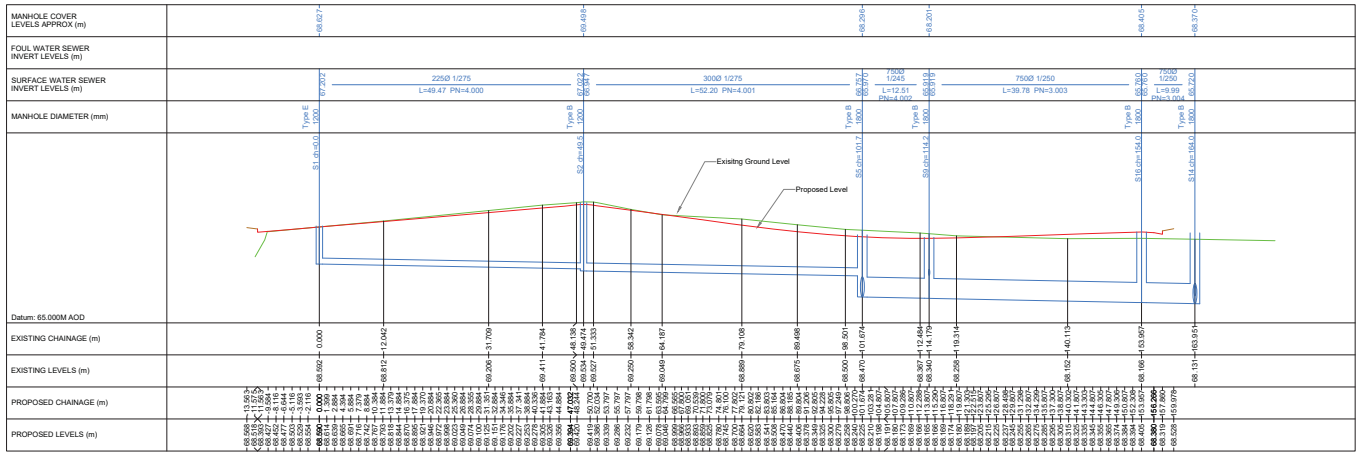
Surface Water Drainage Section - PN 3.000 - PN 3.002

Scale: 1:500H, 1:100V



Surface Water Drainage Section - PN 5.000 -PN 5.001

Scale: 1:500H, 1:100V



Surface Water Drainage Section - PN 4.000 - PN 3.004

Scale: 1:500H, 1:100V

Rev.	Date	Description	By
P1	01/02/21	REVISED AS PER IW COMMENTS	AL

Project Title
SHD AT CHARLESTOWN PLACE AND ST MARGARET'S ROAD

Architect
MCORM ARCHITECTS

Date	By	Checked	Scale @ A1
MAY 2020	AL	PM	AS SHOWN

Drawing Title
SURFACE WATER DRAINAGE LONG SECTIONS

Drawing Status
PLANNING

Job No.	Drawing No.	Issue
1726	109	P1

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