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CONSULTING STRUCTURAL and CIVIL ENGINEERS

DRAINAGE and WATER INFRASTRUCTURE ENGINEERING REPORT for a Residential Development at Boherboy, Saggart, Co. Dublin

PROJECT:	**BOHERBOY – 1324D**
CLIENT:	**EVARA/KELLAND**
DATE:	**APRIL'25**
ISSUE NO:	**LRD- STAGE 3**
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0.0 EXECUTIVE SUMMARY

This is A briefing Executive Summary only and the reader is directed to the main body and appendix of this report for more detailed information and calculations.

Project Brief

The planning application includes for 611No.residential units and a c.630m^2 Crèche and the associated ancillary roads, drainage, pumping and services infrastructure on an overall site application area of c.18.7Ha site.

Constraints –

There is c.38m drop in level along the length of the site; and there are 5No.existing trunk watermains traversing the site; there is a 10m wide riparian strip along the eastern site boundary.

Drinking Water –

The drinking water is to be supplied by a new connection to the existing 400mm watermain on Boherboy Road and distributed throughout the site in 225/180/110mm OD watermains.

Foul Drainage

A new gravity foul sewer is to be constructed to an existing manhole located in Verschoyle Green via the SDCC lands to the NE of the site. c.25% of the site foul drainage will be pumped from a new pumping station in the NE corner into the proposed new gravity sewer while the remaining 75% flows by gravity in the same main. The 10No.units on the "east" Corbally site will drain foul by gravity into the existing sewer in Corbally Rise. Uisce Eireann have issued a Confirmation of Feasibility for this site noting the proposal was "*feasible subject to upgrades*".

Levels

The existing ground level gradients range from 1/7 to 1/30 generally along the 38m drop in elevation along the site. The proposed road gradients vary between 1/120 (0.83%) and 1/15 (6.7%) which are in accordance with the DOELG Recommendations for Site Development Works for Housing Areas and the Department of Transport's Design Manual for Urban Roads and Streets (DMURS) documentation. Accessible public footpath routes limited to 1/20 (5%) gradients are provided on the site to ensure all housing is accessible in accordance with Part M of the Building regulations. Refer to Gannon Associates Landscape architects drawings/reports for further detail in this regards.

Surface Water Drainage

The site is to be drained following a SuDS treatment train philosophy and replicating a nature based solution in providing swales, tree-pits, bio-retention, use of open watercourse, over grassland flow, open detention basins, rain garden planters and permeable paving. All runoff is to be slowed down and treated naturally throughout the SuDS process before been attenuated to the site Qbar greenfield rate and out falling the Corbally stream to the east & north and to the Coldwater watercourse to the west.

The S/W drainage is divided into 9No. separate catchment areas, each with its own SuDS interception, treatment, attenuation and storage. There is a potential c.1Ha future school site reserved on the lands that does not form part of this application but has been allowed for in the drainage calculations.

The greenfield runoff Qbar was calculated using the recommended IH124 method using the HRWallingford uksuds.com designer tool based on the following data shown in Fig.Ex.1 below;

Soil	SPR	SAAR	M5/60	r	Drained Area Main Site	"East" Corbally site
3	0.37	878mm	17.9	0.229	14.65Ha	0.36Ha

Fig.ExS.1

Qbar for the main site was determined to be **55.0 l/s** and for the "east" Corbally site of **1.3 l/s**. The main site Qbar has been divided to suit the design into individual catchment outfall rates for 8No.designed catchments (plus the potential school site) and the "east" Corbally site retains its own 1.3 l/s Qbar. A table showing each catchments gross area and applied outfall rate is shown in Fig.Ex.2 below;

The MicroDrainage/WinDes software was used to create a drainage model for the full site, analyzing storm events for 2-year, 30 year and 100-year return events over multiple time periods ranging between 15 minutes to 7-day durations. An allowance of and additional 20% for climate change has been applied as has an allowance for 10% urban creep to the rear gardens of the houses. The resulting required storage volumes extracted from the drainage model are summarised in Fig.Ex.2 below. It is noted that on the request of the SDCC Water Services Department, provision for additional attenuation storage volume has been made in each of the nine designed catchments and is summarised in Fig.Ex.2 below.

BOHERBOY LRD - STAGE 3 S/W Design Summary Table

Catchment S/W Outfall (l/s)			Storage Volumes (m^3)				
Catchment No.	Gross Area (Ha)	Outfall rates applied (l/s)	Catchment	Attenuated Storage Volumes Required (m^3)			ATTENUATION STORAGE AVAILABLE IN EACH CATCHMENT (in upstream SuDS elements and basin)
				Q2+20%CC	Q30+20%CC	Q100+20%CC	Q100+20%CC
1	1.17	3	1	167	327	435	737
2	1.93	8	2	187	405	547	1,027
3	0.74	3	3	74	154	211	411
4	3.04	11.6	4	467	993	1294	1,204
5	4.8	18.6	5	622	1251	1675	2,618
6	0.55	2	6	53	123	171	374
7	0.53	2	7	62	133	179	277
8	0.91	5.3	8	47	118	165	290
9	0.36	1.3	9	40	83	111	198
*Potential future school site	1.03	1.5	*Potential future school site	*Potential school site not part of this application			
Main Site	14.7	55	Main Site	1679	3504	4677	6,937
Corbally East Site	0.36	1.3	Corbally East Site	40	83	111	198
TOTAL SITE	15.06	56.3		1719	3587	4788	7136

Fig.ExS.2

The gross & net drained areas used to calculate the attenuation volumes are identified on a catchment-by-catchment basis in Fig.Ex.3 below. All surface areas are drained via SuDS elements and therefore Paved Area factors have been applied to the gross areas as identified in Fig.Ex.3 below;

BOHERBOY LRD - STAGE 3 Surface Areas Summary Table

Catchment Areas (m^2)

Catchment	Gross Drained Areas (m^2)					
	Roofs via SuDS	Roads/Paths via SuDS	Permeable Paving	Grassland	Rear Garden	TOTAL AREA PER CATCHMENT
1	2670	3860	1210	2370	1580	11690
2	3440	6580	1080	6390	1790	19280
3	1880	1760	500	1480	1800	7420
4	7890	9390	3150	5700	0	26130
5	12300	15120	4350	10780	5430	47980
6	1750	1630	310	1830	0	5520
7	2140	1240	420	1520	0	5320
8	1150	2480	920	4560	0	9110
9	520	1330	410	830	480	3570
*Potential future school site	School site is not designed as part of this planning application					
TOTAL AREA PER SURFACE	33740	43390	12350	35460	11080	136020

Catchment	Net Drained Areas (m^2)					
	Roofs via SuDS (PAF=0.80)	Roads/Paths Via Suds (PAF=0.81)	Permeable Paving (PAF=0.50)	Grassland (PAF=0.25)	Rear Garden (PAV=0.1)	TOTAL AREA PER CATCHMENT
1	2136	3127	605	474	158	6500
2	2752	5330	540	1278	179	10079
3	1504	1426	250	296	180	3656
4	6312	7606	1575	1140	0	16633
5	9840	12247	2175	2156	543	26961
6	1400	1320	155	366	0	3241
7	1712	1004	210	304	0	3230
8	920	2009	460	912	0	4301
9	416	1077	205	166	48	1912
*Potential future school site	School site is not designed as part of this planning application					
TOTAL AREA PER SURFACE	26992	35146	6175	7092	1108	76513

Fig.ExS.3

Using the results from the drainage model the total attenuated Q100 + 20% CC plus 10% Urban Creep volume for the site (east and west) is **4,788m³** but it is noted that on the request of the SDCC Water Services Department, provision for additional attenuation storage volume has been made in each of the nine designed catchments which totals to **7,315m³**. To clarify, the available attenuation storage volume for the 9No.catchments is **7,315m³** and exceeds the calculated required volume and is therefore determined to be a safe and conservative approach. Furthermore, on specific request of the SDCC Water Services Department, the calculation of the additional storage made available excludes any storage held within the permeable paving. A table outlining the available attenuated storage capacity in each catchment is summarised in Fig.ExS.4 below.

BOHERBOY LRD - STAGE 3 - Attenuation Volumes Available				
Catchment	AVAILABLE VOLUME IN BASIN(m^3)	AVAILABLE VOLUME IN UPSTREAM SuDS - Excluding Permeable Paving(m^3)	AVAILABLE VOLUME IN UPSTREAM SURCHARGED PIPES & MANHOLES(m^3)	TOTAL AvailableStorage Volume per Catchment (m^3)
1	636.5	91.9	8.2	736.6
2	942	79.2	5.6	1026.8
3	361.5	43.2	5.8	410.5
4	895	307.6	1.1	1203.7
5	2287	314.7	16.7	2618.4
6	334	32.8	7.1	373.8
7	234	33.4	10.0	277.4
8	240	37.6	12.5	290.1
9	182	14.0	2.3	198.4
			TOTAL	7135.7

Fig.ExS.4

In accordance with the GDSDS, a "first flush" of 5mm rainfall is to be intercepted before outfalling from the site and this has been achieved using all of the available SuDS elements provided on the site. The resulting volumes are summarised in Fig.Ex.4 below and are dealt with in detail in the main body of report section 5;

BOHERBOY LRD - STAGE 3 Interception Summary		
	Interception Volumes (m3)	
Catchment	Interception Volume Required (m^3)	Interception Volume Provided (m^3)
1	31	183
2	44	160
3	17	81
4	82	544
5	127	638
6	15	56
7	15	65
8	18	107
9	9	45
*Potential future school site	School site is not designed as part of this planning application	
Totals	358	1877

Fig.ExS.5

A Hydrological and Hydrogeological Risk Assessment Report examining the ground water flows and interface with the proposed development has been carried out in detail by DNV Consulting. Interception of groundwater flows as determined by the Hydrological study has been detailed on a catchment by catchment basis and, where required, has been intercepted by suitable landrains and captured by the surface water drainage system as detailed on the application drawings 1324B/401-406. The groundwater discharge has been determined to be c.26m^3 per day for the entire site which is captured by the above noted land drains and the resulting flowrates allowed for in the drainage modelling. Please refer to the report by DNV for further detail.

A full SSFRA has been carried out by Kilgallen & Partners Consulting Engineers and please refer to that report on aspects of flood mitigation measures.

0.1 RESPONSE TO WATER SERVICES STAGE 2 OPINION

The Stage 2 SDCC Opinion report contained a number of observations in *Appendix 05 – Water Services Report* that are summarised and responded to in the following table;

SDCC Water Services report Comments	Response
1.1 Water services estimate that the proposed surface water attenuation is undersized by between 21% and 82%. The overall attenuation of 4,905m^3 for the site is undersized by 41%. The following catchments are estimated to have surface water attenuation undersized as follows: This is based on 1:100 year flood risk event only. (Table not reproduced here)	Subsequent to the issuing of the SDCC Stage 2 opinion, discussions were held with the Water Services Department to explain and agree the design approach undertaken in the submission. The conclusion of those discussions was to provide in tablature form the attenuated volume available in each of the S/W catchments. Notwithstanding the provided drainage modelling results, additional storage capacity has been provided on the site to significantly align with the volumes specifically requested by the Water Services Department. Table 3 in this report summarizes the available attenuated storage volumes in each catchment and Appendix 11.13 provides detail in the determination of same.
1.2 Submit a drawing in plan and cross sectional view to show the slope and setback distance between Pumping station and Corbally stream east of same. Is there a 10m setback distance and riparian strip and is there a suitable slope angle not more than 45 degree to base of proposed pumping station.	Plan and cross section indicating the requested setback distances and details are included on Dwg.No.'s 1324B/402 & 410 & 417 & 421
1.3 Provide tree pits and ensure that tree pits do not have road gullies in front of same because this would prevent surface water reaching same. Also, the surface of tree pits should be lower that the level of the road so that surface water run off can flow to same.	No gullies are proposed in front of tree pits. Tree pit surfaces have been lowered to promote inflow as agreed by SDCC Water Services Department and are shown in detail on Dwg.1324B/416.
1.4 Provide SuDS (Sustainable Drainage Systems) such that surface water is conveyed across site on SUDS systems as much as possible.	A comprehensive SuDS treatment train has been applied across the entire development incorporating permeable paving, tree pits, swales, bio-retention areas, rain garden planters, usage of the central open watercourse, green roofs and landscaped detention basins as agreed with the SDCC water services Department

1.5 The setback distance to watercourses are unclear. Submit a drawing to show the setback distance to all water courses. This include watercourses where the setback distance is less than 10m to the to of bank of watercourse/stream.	The setback distances have been dimensioned on the S/W general arrangement drainage drawings 1324B/404-407.
1.6 Submit separate drawing showing all setback distance from buildings to all watercourses. If there are areas where stream is less than 10m setback distance this is also to be shown on a drawing with a justification for same for review. Water services look for a 10m setback distance to all water courses.	Set back to buildings from all watercourses has been shown on the Gannon Landscape Architecture drawing No.24212_Boherbpy_PA_C_RBZ entitled "*Riparian Buffer Zone*" included in the Stage 3 submission
1.7 It is unclear where sections on storage areas are. For example, sections are shown for each storage attenuation area but its is unclear where the storage area is. Submit a drawing showing where all the storage area are and where the sections are that correspond to each storage area.	Dwg.1324B/425 shows the detention basin sections and section marks.
FRA- Submit a drawing showing the ground levels of proposed pumping station location predevelopment and post development. Show in plan and cross sectional view the levels and setback distance of location of pumping station pre-development and post development and include site location and levels of riparian strip adjacent to Corbally stream pre and post development.	Similar to comment No.1.2 above, a cross-section showing the pumping station relative to the Corbally Stream is shown on Dwg.No.'s 1324B/402 & 410 & 417 & 421
Appendix 06 – Uisce Éireann	A "*Confirmation of Feasibility*" letter has been obtained from Uisce Éireann and is included in Appendix 11.11 of this report. As part of this and previous applications on this site, extensive discussions were held with Uisce Éireann regarding build-over and crossings of the existing water infrastructure. Approval from UÉ was confirmed by UÉ in the Statement of Design acceptance letter (Ref.CDS20004359) issued on 19/08/21. A copy of that UÉ design acceptance letter can be viewed in Appendix 11.11 of this report. More recently, a submission to and discussions with UÉ requesting them update their review based on the current design, which is substantially similar to previous iterations, and subject to a successful planning permission,

	at connection application stage any further requirements of UÉ will be ascertained and agreed.

1.0 Introduction

1.1 This document relates to the Drainage and Water Infrastructure design for a proposed residential development located on greenfield lands at Boherboy, Saggart, Co. Dublin.

1.2 We, Roger Mullarkey & Associates, were appointed by Evara Developments Ltd & Kelland Homes Ltd, to carry out the drainage and water supply infrastructure report to accompany the suite of other drawings and documentation relating to a proposed residential development at the above noted address.

1.3 The planning application will consist of 611No.residential units and a c.630m^2 Crèche and the associated ancillary roads, drainage, pumping and services infrastructure on a c.18.5Ha site. The residential units will consist of semi-detached and terraced houses, duplex apartments and 5No. apartment blocks. A full description of the application details are contained in the main application documentation noted by Armstrong Fenton Associates Planning consultants and MCORM/Davey Smith Architects.

2.0 Key Objectives

2.1 This document relates to the Drainage and Water Infrastructure engineering that incorporates the design, background and detail of the following aspects.

- Road and Block Levels
- Storm Water Site Drainage
- Foul Water Site Drainage
- Sustainable Drainage Systems (SuDS)
- Attenuation
- Water Supply Infrastructure

2.2 In accordance with the OPW's *The Planning System and Flood Risk Management- Guidelines for Local Authorities 2009* (the Guidelines), Kilgallen & Partners Consulting Engineers have assessed and prepared a Site Specific Flood Risk Assessment (SSFRA) which forms part of the planning application. Mitigation measures proposed in detail in the SSFRA include the development of a flood compensatory area along the northern site boundary and the raising of the stream bank along the eastern boundary. The SSFRA concluded that implementation of the mitigation measures will increase the available flood storage capacity, that the application was subject to and passed the Development Management Justification Test as required under the Guidelines, that the proposed development will not be at risk of flooding and will not increase flood risk elsewhere and that the development is therefore appropriate from a flood risk perspective. Reference can be made to the separate SSFRA document that forms part of the overall planning submission documentation for greater detail in this regards.

2.3 Traffic/transportation assessments and the Boherboy Road upgrade are contained in the separate submission documentation by Pinnacle Consulting Engineers included in the overall planning submission.

2.4 Reference should be made to all drainage drawings and designs included in the Appendix of this report and all other consultant's reports and drawings as part of the overall application documentation.

2.5 This report will outline in detail that;

All surface water will drain to SuDS elements in accordance with the SDCC Sustainable Drainage Explanatory design & Evaluation Guide 2022. The S/W runoff will be intercepted by, Tree Pits, Bio-Retention areas, Rain Gardens (as raised planter rain gardens to rear of houses), Permeable Paving, Swales, Filter Drains, central open conveyance watercourse and 9No. detention basins and 1 No. below ground attenuation storage system. It is noted that there is a significant vertical drop in level of c.38m from the highest to lowest along the length of the site and there are 5No.existing trunk watermains that traverse the site.

The centrally located hedgerow is maintained as much as practically feasible and the watercourse within is re-used as a conveyance swale as part of the overall SuDS strategy. The existing western boundary watercourse is also to be re-used as a conveyance swale and the hedgerow will remain largely unaffected by the proposed development.

All S/W is intercepted, SuDS treated and attenuated within the site and outfalls to the Corbally, Coldwater & Cooldown streams bounding the site at the calculated greenfield QBar.

Approximately 75% of the foul water drainage system outfalls by gravity flow into the existing Uisce Éireann infrastructure located to the east of the subject site at Verschoyle Green.

The lower level c.25% north end of the site incorporates a pumping station to drain the foul via a rising main into the outfalling gravity pipe.

Foul drainage for the 10No. “east” Corbally site is to connect to the existing foul drainage in Corbally Rise.

Potable water supply for the main site is to be supplied from the existing 400mm DI Uisce Éireann owned infrastructure on Boherboy Road to the south of the site. Water for the 10No. “east” Corbally site is to be supplied from the existing main in Corbally Rise.

3.0 Site Location and Topography

3.1 The proposed development is located along the Boherboy Road, Saggart, Co. Dublin and the lands are zoned objective A1: *“To provide for new Residential Communities in accordance with approved Area Plans”* in the current South Dublin County Development Plan (CDP).

3.2 The site is currently a Greenfield with some remaining farm sheds/outbuildings. The site is located just south of the Carrigmore and just west of Corbally residential developments. To the north-west of the site lies the Saggart golf course and the Boherboy Road bounds the southern elevation of the subject lands.

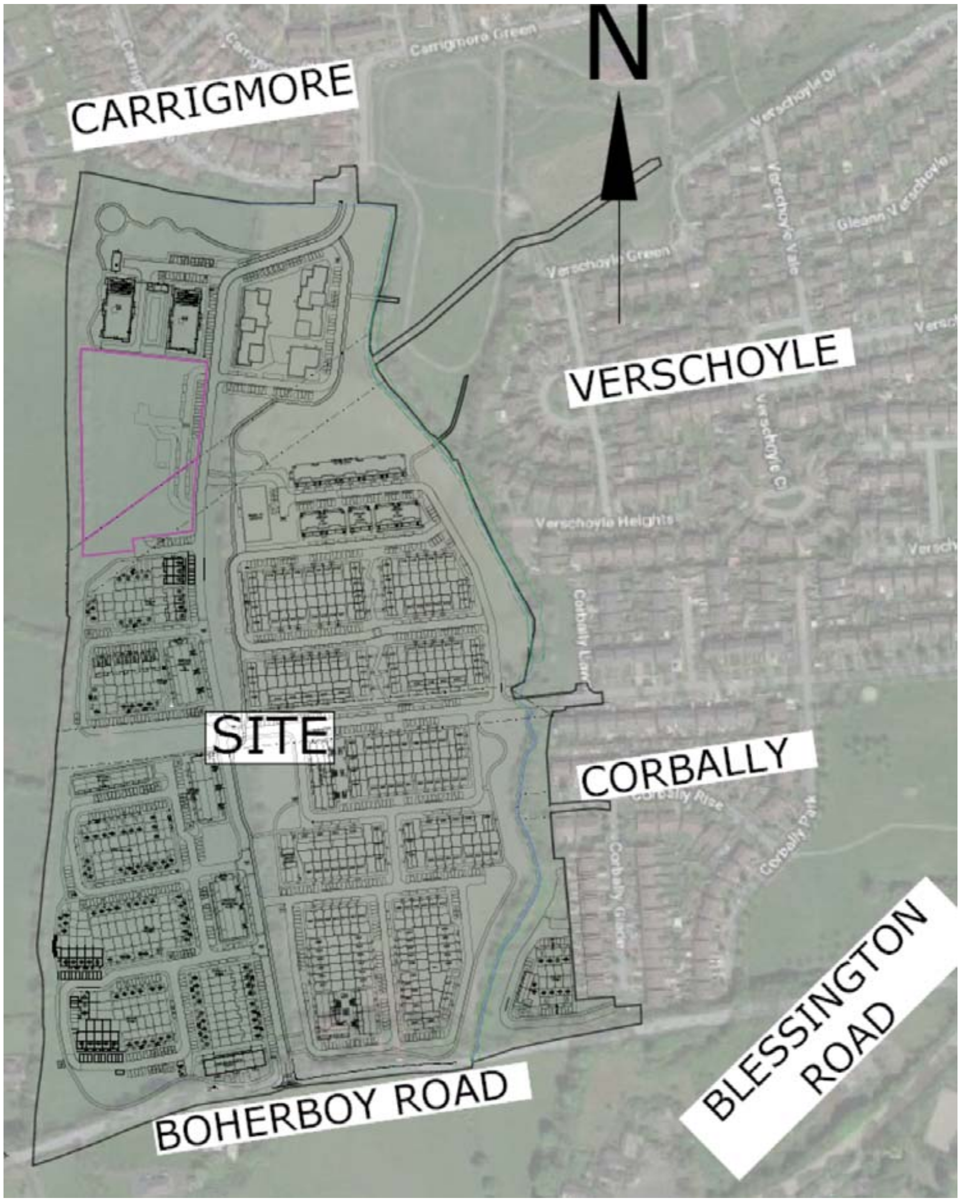


Fig. 1 – Site Location

3.3 A topographical survey was carried out on the site and indicates that the lands slopes sharply downwards from the south end of the site towards the north. The existing ground level gradients range from 1/7 to 1/30 generally. There is an approximate drop in level of 38m from the highest portion (SW) of the site to the lowest point (NW).

3.4 The existing ground topography forms a natural catchment with approximately 75% of the site draining towards the north-west and the remainder draining towards the north-east of the lands. All catchments drain to existing natural watercourses either side of the site.

3.5 A site survey drawing is included in the application and can be viewed as background on the Road & Block Levels drawing Dwg.No.'s 1324D/400-403.

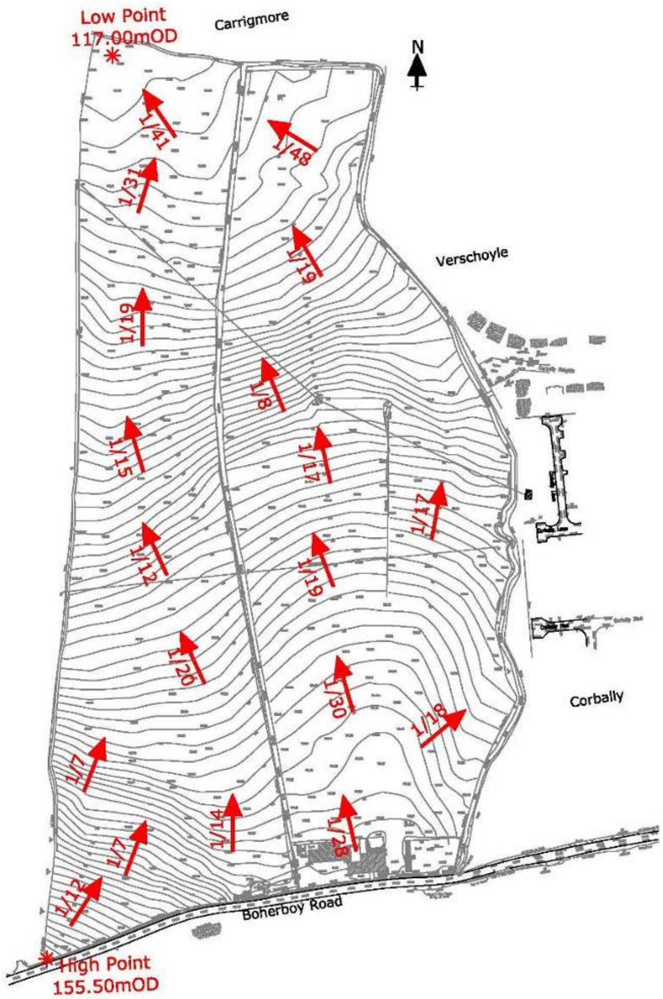


Fig.2 – Existing Topography

3.6 The site is bounded by a hedgerow and fencing to the southern edge along the Boherboy Road, by a treeline/hedgerow and open field drain along the western boundary (Ref; Coldwater 09C62), by the Corbally open course stream (Ref; 09C10) and hedgerow facing onto the Corbally and Verschoyle residential schemes to the east and by the same open course stream along the northern boundary to hedgerows/trees to the northwest and north. There is also a local field watercourse located centrally on the site and is referred to as the Cooldown (EPA code 09C60).

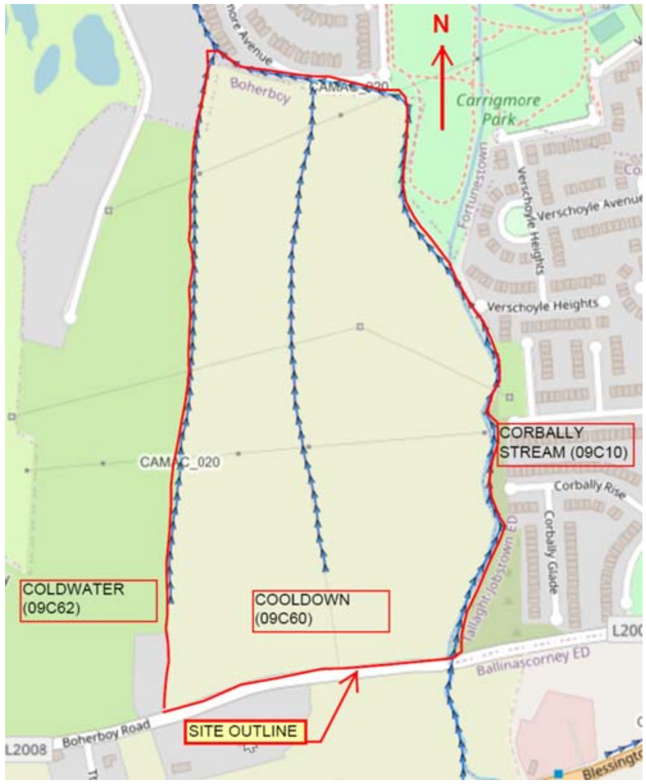


Fig.3 – EPA noted Existing Watercourses

3.7 A Road and Block levels design has been prepared as part of this application and reference should be made to Dwg.No.1324D/400-304 in this regards. Generally, the proposed road levels and house levels follow the existing contours of the site topography where possible.

3.8 Proposed road gradients vary between 1/120 (0.83%) and 1/15 (6.7%) which are in accordance with the DOELG Recommendations for Site Development Works for Housing Areas and the Dept. Of Transport's Design Manual for Urban Roads and Streets (DMURS) documentation.

3.9 In relation to road gradients, the Design Manual for Urban Roads and Streets (DMURS) section 4.4.6 on page 112 states"*...vertical alignment should be considered at the network level as a response to the topography of a site"*. As the existing topography of the subject site is steep up to a maximum gradient of 1/7 (14.3%), the proposed development will provide road gradients, in limited locations, of 1/14 (7.1%) is a *response to the topography of the site* and in accordance with the DMURS standards.

3.10 The DMURS document further allows that the normal recommended maximum gradient of 1/20 (5%) can be exceeded on "*hilly terrain*" up to a maximum of 1/12 (8.3%), section 4.4.6 on page 113. The subject application includes gradients in limited areas up to a maximum of 1/15 (6.7%) and is therefore in accordance with the DMURS standards document.

3.11 The DOELG Recommendations for Site Development Works for Housing Areas document allows road gradients to 1/10 (1%) vertical alignment and as noted above, the limited use of 1/15 (6.7%) gradients on the site is therefore in accordance with DOELG document.

3.12 Given that the existing topography in parts of the site are approximately 1/7 and 1/8, the proposed developments road gradients are an improvement on the existing topography and are in accordance with both the DOELG and DMURS documents.

3.13 Accessible public footpath routes limited to 1/20 (5%) gradients are provided on the site to ensure all housing is accessible in accordance with Part M of the Building regulations. Refer to Gannon Associates Landscape architects drawings/reports for further detail in this regards.

3.14 A roads and DMURS compliance audit and road safety assessment (RSA) has been carried out by Roadplan Consulting, which includes vehicle tracking and speed attenuation measures. The results of those studies are contained under separate heading and are included in the overall development application.

3.15 The site road and block levels have been designed to follow as closely as reasonably possible the existing site levels and the housing layouts are placed parallel across the contours with stepped blocks following the downward slope of the site. The architectural drawings submitted include site sections illustrating how the housing cells are designed to accommodate the stepped levels where necessary. A sample image from the architectural submission drawings is shown in Fig.4 below;

Fig.4 – Housing along slopes

3.16 A number of the housing cells on the steeper parts of the site have been designed as split-level units incorporating 3 storey on one elevation and 2 storey on the opposite to as a solution to reduce the visual impact and improve access in locations where the drop in level across housing cells in unavoidable. A sample image from the architectural submission drawings is shown in Fig.5 below;

Fig.5 – Split-Level Housing

3.17 Careful consideration has been given to the balancing of the cut & fill elements to reduce as much as is reasonably possible excavations necessary to create a useable and practical development on a steeply sloped site. A sample image from the architectural submission drawings is shown in Fig.6 below;

Fig.6 – Balanced development along slope

3.18 Tiered back gardens further reduce the requirement for retaining elements but given the c.38m vertical drop along the site, garden boundary retaining walls are inevitable but are reduced to a minimum where feasible. Reference can be made to the Gannon Associates Landscape Architects drawings for further illustration of the proposed solutions considered, a sample of which is shown in Fig.7 below;

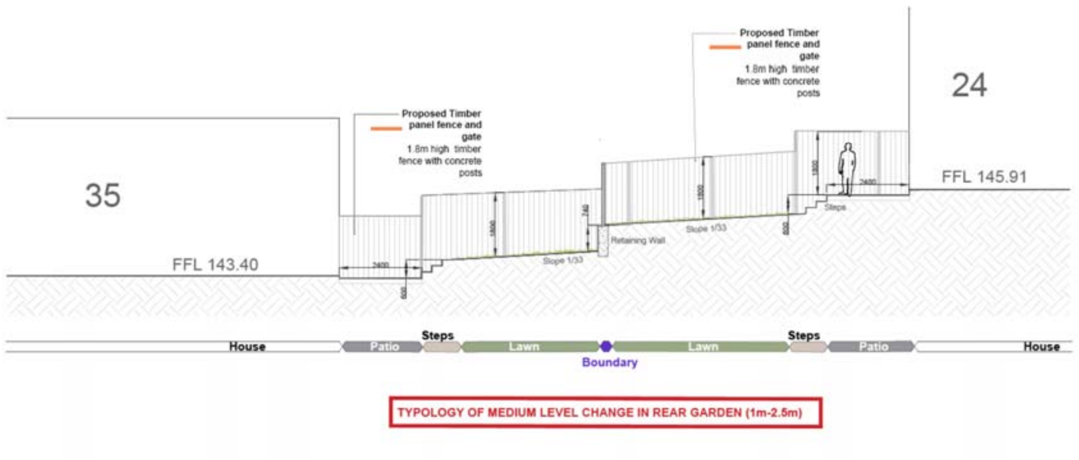


Fig.7 – ex.Gannon & Associates Dwg. RG1

3.19 The constraints associated with the 5No.existing trunk watermains crossing the site also impact on how the development has been designed. As services and roads must cross the watermains, greater than minimum vertical minimum separation must be achieved and this also been considered in the design of the road levels and drainage/services crossings.

3.20 A Traffic and Transport Assessment study and report has been carried out by Pinnacle Consulting Engineers and is included in the overall application under separate heading and the reader is referred to that document for further information in that regards.

3.21 The proposed development includes 5No.crossings of the Corbally Stream connecting the proposed development with the adjoining Corbally and Carrigmore housing estates and the public Carrigmore Park. These are discussed in further detail in Section 5.7-5.9 below and in greater detail in the SSFRA prepared by Kilgallen & Partners Consulting Engineers .

4.0 Existing Drainage and Water Services

4.1 Records drawings were obtained from SDCC/UÉ in preparation for this planning application and are included in Appendix 11.8 of this document.

4.2 There are no known public drainage services on the subject lands (refer to 4.9-4.13 below for watermains).

4.3 The proposed attenuated S/W outfalls will be into the existing Corbally stream and the Coldwater watercourse bounding the east/west/north of the site. The centrally located Cooldown watercourse has its source on the site and acts as a filed ditch draining the existing site. This application seeks to maintain as much as feasible of this open watercourse to act as a conveyance swale on the site.

4.4 There is no foul water sewer located on the subject lands. Therefore, it is proposed to service the subject lands by providing a new gravity foul sewer across the SDCC park to the northeast of the site connecting into the existing Uisce Éireann (UÉ) foul infrastructure in Verschoyle Green. This has been agreed with Uisce Éireann and approved by them under Ref.CDS24005491, see Appendix 11.11 of this document for Confirmation of Feasibility letter.

4.5 Due to the sloping topography of the subject lands it is not feasible to drain the apartments on the northern c.20% of the site or potential future school site by gravity. Therefore, a foul water pumping station is proposed as part of this application to drain the above blocks from lower NE corner of the site into the gravity sewer to be constructed connecting into Verschoyle Green. The foul pumping station is to be in accordance with the Uisce Éireann Code of Practice for Wastewater Infrastructure 2025 and is detailed on Dwg.1324B/221 included in the application with calculations relating to same included in appendix 11.4 of this report.

4.6 Uisce Éireann have issued a Confirmation of Feasibility letter Ref.CDS24005491 (refer to Appendix 11.12 of this document) for this planning application noting that the water connection is "*feasible without infrastructure upgrade*" and the wastewater connection is "*feasible subject to upgrades*".

4.7 These trunk watermains are in the control of Uisce Éireann. The set-back requirements from these mains is in accordance with the Uisce Éireann Code of Practice for Water Infrastructure document and extensive discussions were held with Uisce Éireann regarding build-over and crossings of the existing water infrastructure as part of previous planning applications on this site and subsequently agreement was reached and was confirmed by UÉ in the Statement of Design acceptance letter

(Ref.CDS20004359) issued on 19/08/21. A copy of that UÉ design acceptance letter can be viewed in Appendix 11.11 of this report. More recently, a submission has been made to UÉ to update their review based on the current design, which is substantially similar to previous iterations, and subject to a successful planning permission, at connection application stage any further requirements of UÉ will be ascertained and agreed.

4.8 Refer to Dwg.No.'s 1324D/408-411 and 421 for details of the proposed foul sewer infrastructure.

4.9 There are 3No.existing watermains (4inch uPVC/400mmDI/600mmDI) in Boherboy Road along the site frontage. This application proposes to make a new water connection to the Boherboy watermain in the Boherboy Road.

4.10 There are 5No.existing trunk watermains crossing the subject land. A 1.2m Ø (1982 Concrete), a 27inch Ø (1938 Steel) and a 24inch (AC 1975) lie parallel to each other in the northern third of the site and also a 1.2m Ø (1983 Concrete) and 24inch Ø (1952 Cast Iron) lie parallel approximately in the middle of the site. Please refer to drawing No.1324D/412-415 for location of these existing trunk watermains.

4.11 These trunk watermains are in the control of Uisce Éireann. The set-back requirements from these mains are in accordance with the Uisce Éireann Code of Practice for Water Infrastructure document and extensive discussions were previously held with Uisce Éireann relating to development in proximity to same. Based on those discussions and design/drawing submissions, UÉ have previously confirmed their approval in issuing a Statement of Design acceptance letter (Ref.CDS20004359). A copy of the UÉ design acceptance letter can be viewed in the Appendix 11.11 of this report. As noted above, upon a successfully grant of planning on the subject site and prior to commencement of development, the Applicants will agree with Uisce Éireann all the necessary protection details as part of the Connection Application process.

4.12 In order to precisely locate these existing trunk watermains, excavation of silt trenches was carried out with the permission of the then overseeing authority of Dublin City Council and South Dublin County Councils *EWCC Dept*. All mains were located, surveyed, mapped and the results issued to both SDCC, DCC and Uisce Éireann for their records. Furthermore, GPR (ground penetrating radar) surveys were carried confirming the watermain locations offsite through the SDCC park to the NE of the subject lands. The surveyed location of the existing watermains are as shown on the submission drawings 1324D/412-415.

4.13 It was discovered during the excavations to precisely locate the existing trunk mains that one of the existing watermains (1.2m Ø 1982 main) was in a different location to that as was shown on the Local Authority records drawings. This records anomaly was brought to the attention of each of SDCC, DCC and Uisce Éireann and the actual correct position of the 1.2m Ø 1982 main was surveyed-in and issued to all the relevant authorities. The correct and surveyed location of each the existing watermains are as shown on the submission drawings 1324D/412-415.

5.0 Surface Water Drainage

5.1 Chapter 5 of this report is intended as an addition of detail to the Executive Summary already provided at the head of this report relating to the surface water drainage design. Further detailed information on aspects relating to GDSDS compliance, SuDS measures and the determination of Qbar and design calculations are discussed in Chapters 7 & 8. Refer to Appendices 11.1-11.3 for detailed calculations of the S/W system and to Appendix 11.6 for the determination of Qbar.

5.2 As part of the design of the storm water network and SuDS components, the following documentation were the principal references;

- South Dublin Council Development Plan 2022 – 2028
- SDCC Sustainable Drainage Explanatory design & Evaluation Guide
- CIRIA Report c753 "The SuDS Manual" 2015
- Greater Dublin Strategic Drainage Study (GDSDS) 2005
- The Greater Dublin Regional Code of Practice for Drainage Works
- DOELG Recommendations for Site Development Works for Housing Areas.
- SDCC Drainage and Water Records maps
- Available OPW flood maps and reports (from *floodmaps.ie*)
- OPW Eastern CFRAM study
- OPW PFRM mapping
- Geological Survey of Ireland (GSI) website
- Teagasc soils data sets
- Ordnance Survey mapping
- Topographical survey
- Site Investigation reports
- Site walkover visits
- Discussions with SDCC *EWCC Dept. ("water & drainage")*
- Discussions with DCC Water Department
- Discussions/correspondence with Uisce Éireann

5.3 The design of the storm water network has been carried out in accordance with and in conjunction with the requirements of South Dublin County *EWCC Dept*. as were ascertained in meetings and discussions as part of the pre-planning process.

5.4 In accordance with the OPW's *The Planning System and Flood Risk Management- Guidelines for Local Authorities 2009* (the Guidelines), Kilgallen & Partners Consulting Engineers have assessed and prepared a Site Specific Flood Risk Assessment (SSFRA) which forms part of the planning application. The summary conclusion from that report notes that *"The SSFRA concluded that the proposed development is not at the risk* *of flooding and will not increase flood risk elsewhere. In accordance with the Flood Risk Management Guidelines, the proposed development is therefore appropriate from a flood risk perspective."*

However, it was determined that there was a risk of Fluvial flooding from the Corbally Stream along the northern boundary of the site and thus that part of the site is categorised under the Guidelines as being in a flood risk zone A & B. It was also identified in the SSFRA that there is a flood risk of the Corbally Stream overtopping the bank in the northeast portion of the site.

Mitigation measures proposed in detail in the SSFRA include the development of a flood compensatory area along the northern site boundary and the raising of a slight embankment along the eastern boundary with the Corbally Stream. It is noted that the embankment is located outside the riparian corridor as was requested by SDCC in pre-planning consultations.

It is relevant to note that the flood compensation area provided at the north of the site does not from part of the sites pluvial drainage system and is separate from attenuated storage provided on the site.

Refer to the SSFRA for specific details of the mitigation measures.

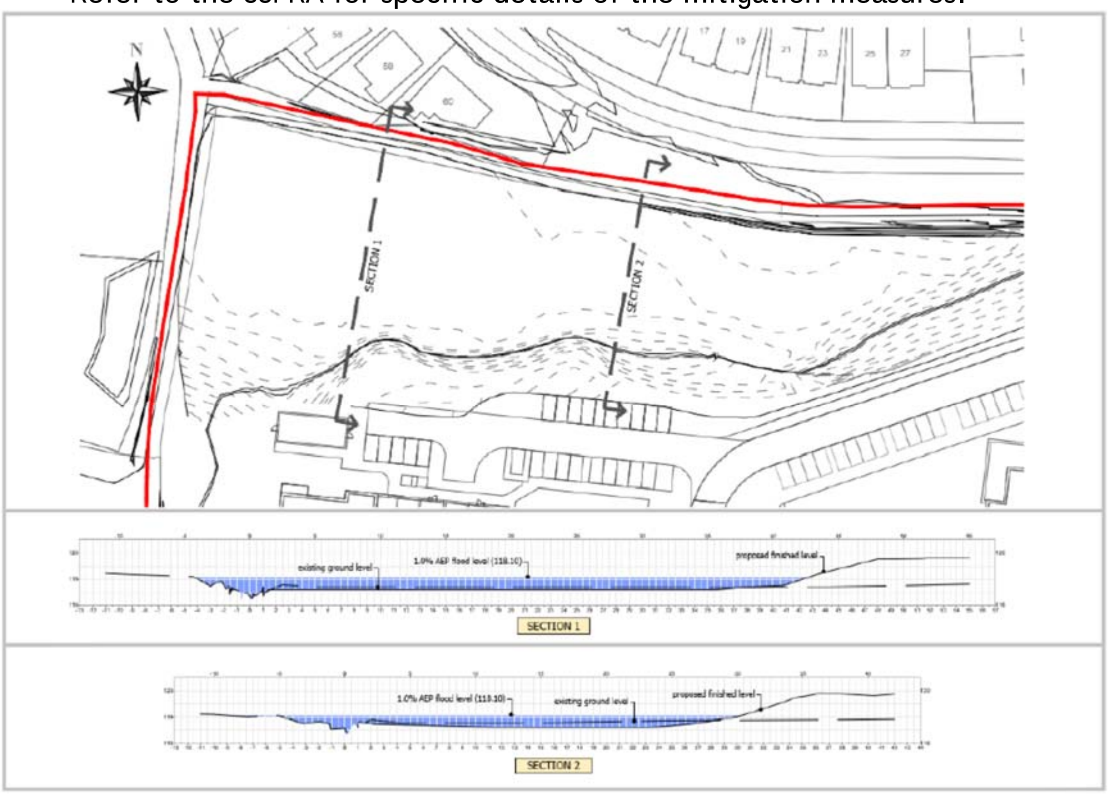


Fig.8 – Extract from SSFRA fig.5.3 Plan and Typical Section for Compensatory Basin

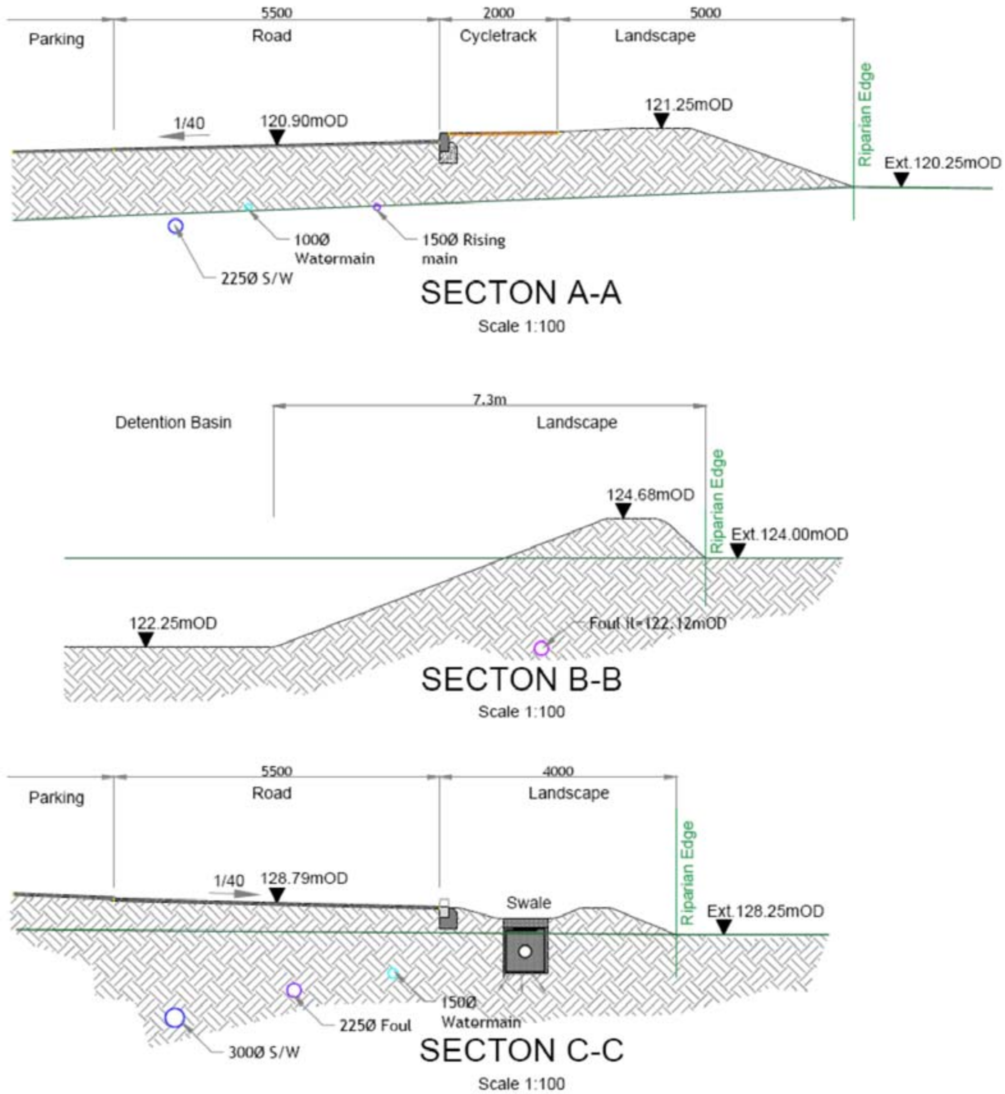


Fig.9 – Extract from RMA Dwg.1324/402 – Sections showing raised embankment to east

The SSFRA concluded that implementation of the mitigation measures will increase the available flood storage capacity, that the application was subject to and passed the Development Management Justification Test as required under the Guidelines, that the proposed development will not be at risk of flooding and will not increase flood risk elsewhere and that the development is therefore appropriate from a flood risk perspective.

Reference can be made to the separate SSFRA document that forms part of the overall planning submission documentation for greater detail in this regards.

5.5 The SSFRA analysis determined that the top water level from the 100-year event otherwise know as the 1% Annual Exceedance Probability (1% AEP) at the lower northern end of the site was 118.10mOD. The *Flood Risk Management Guidelines* recommend that a freeboard of 500mm and 250mm be applied for 1% AEP event for floors and roads respectively.

5.6 In this application the lowest proposed floor level is 120.75mOD resulting in a freeboard of 2.65m above the Q100 + 20% Climate Change event, well above the minimum 500mm recommended. The lowest proposed road level on the site is 120.03mOD which results in a 1.931m freeboard, again well above the minimum recommended 250mm.

5.7 There are 5No. pedestrian and vehicular access connections between the proposed development and Carrigmore, Carrigmore Park to the north and northeast and Corbally to the east.

Fig.10 – Extract from SSFRA fig.5.7

5.8 The SSFRA has determined the top water level in the Corbally Stream for the 1.0% AEP rainfall event at each of the 5No.crossing locations and the minimum recommend soffit levels of the conveying culverts as summarised in Table 1 below;

Crossing	1.0% AEP water level (m OD)	min. soffit Level m OD
1	118.84m	119.34m
2	120.29m	120.79m
3	124.64m	125.14m
4	132.88m	133.38m
5	139.45m	139.95m

Table 1 – Extract from SSFRA Table 5.2 – Crossing Details

5.9 The OPW requires that there be a minimum of 300mm freeboard between the estimated top water level during the 1%AEP event and the soffit of the inlet to the culvert conveying the flow. The SSFRA has calculated the top water level at all crossings for the 1%AEP event and determined that the soffit levels of the proposed crossings are more that 500mm above the 1%AEP top water level and therefore comfortably comply with the recommendations given in the Guidelines. Fig.11 below illustrates a typical crossing detail to the north of the site.

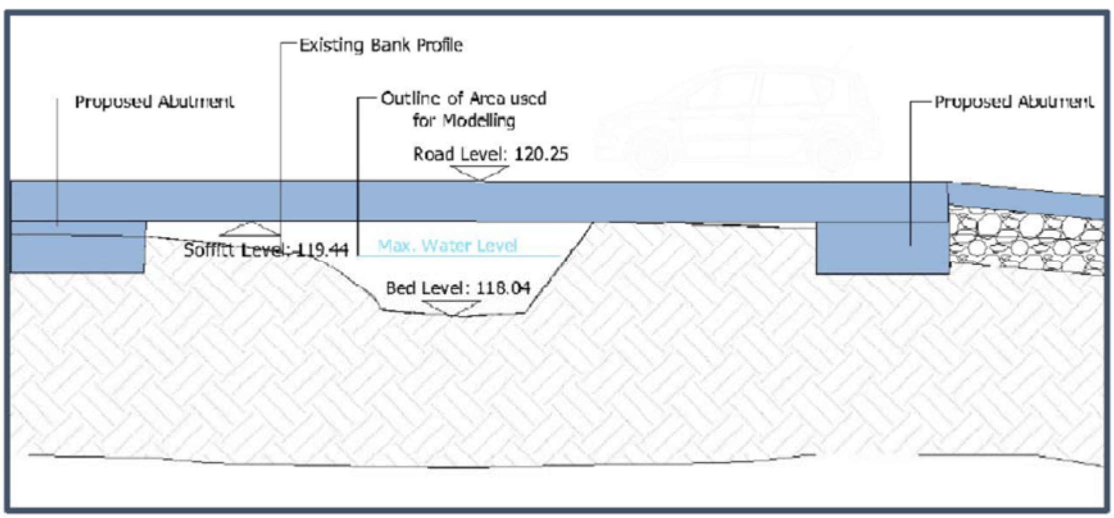


Fig.11- Extract from SSFRA fig.5.8 – Typical section at Stream Crossing

5.10 The SSFRA concluded that implementation of the mitigation measures will increase the available flood storage capacity, that the application was subject to and passed the Development Management Justification Test as required under the Guidelines, that the proposed development will not be at risk of flooding and will not increase flood risk elsewhere and that the development is therefore appropriate from a flood risk perspective. The SSFRA has also concluded that by constructing the flood compensatory area there will be 688m^3 of additional flood storage provided than the do nothing scenario (refer to Table 5.1 of SSFRA).

5.11 The reader is referred to Site Specific Flood Risk Assessment (SSFRA) prepared by Kilgallen & Partners Consulting Engineers for further information.

5.12 The existing topography ground falls steeply downhill (c.38m drop in level) from the Boherboy Road towards the Corbally stream along the northern boundary.

5.13 As part of the design process, Soakaway Testing was commissioned by the applicants and were carried out by Ground Investigations Ltd. 4No.soakaway tests were carried out and 3No.of the tests failed to allow any infiltration. Refer to the GII Ltd report in Appendix 12.7 of this document.

5.14 The surface water drainage design has been carried out in accordance with the Greater Dublin Regional Code of Practice, the GDSDS and the CIRIA Report c753 "The SuDS Manual" 2015. Attenuation and SuDS are included in the design.

5.15 The MicroDrainage analysis and design software was used to generate the surface water drainage computer models and flow simulations, the results of which can be viewed in Appendix 11.1 of this report.

5.16 Refer to Dwg.No.1324D/404-407 for the surface water general arrangement layouts and to Dwg.No.1324D/416-417 for attenuation and SuDS details. S/W Longitudinal Sections are included in Appendix 12.1 of this report

5.17 A full SuDS treatment train approach has been implemented in accordance with the CIRIA SuDS Manual as described in detail in Chapter 7 of this report.

Replicating the natural characteristics and providing amenity/biodiversity has been achieved in the SuDS elements included in this application.

The SuDS elements included in this application are summarised as follows and please refer to Chapter 7 of this report for detailed information;

- Rain Garden planters to the rear down pipes of the houses
- Permeable paving to all private parking areas draining roads and front roofs of the houses
- Filter Swales adjacent to roadways where feasible
- Tree pits where practically feasible
- Use of the existing centrally located watercourse and hedgerow as a conveyance swale
- Use of 9No.open detention basins and 1No. below ground system
- Bio-Retention areas draining roads/paths and roofs
- Silt-trap/catchpit manholes
- Hydrobrakes limiting flow to the total Qbar greenfield rate
- Petrol interceptors upstream of all outfall points

With the inclusion of these measures, it is proposed that the SuDS treatment of the run-off has been adequately addressed.

5.18 The above proposals are agreed in principle with the *EWCC Dept*. of South Dublin County Council.

5.19 Private house surface water drainage is limited to 8No.units per pipe run and is to be in accordance with the DOELG Recommendations for Site Development Works for Housing Areas and in accordance with best practice, the internal drainage system has been designed as a completely separate foul and surface water system.

5.20 The surface water drainage infrastructure for the development will collect and treat the rainfall on the site and convey the runoff via roadside swales, tree pits, bio-retention areas, rain garden planters, open course conveyance swales, pipes, manholes, catchpit manholes and direct the flows via 9No open detention basins and 1No. below ground attenuation system towards vortex flow restricting devices (Hydrobrake or similar) and petrol interceptors before outfalling to the existing on site open watercourses.

5.21 The vast majority of the application (c.99.5%) is located to the west of the Corbally Stream and the remaining c.0.5% (10No.units) is located to the east of the stream. Throughout this report the terms "*main site*" and "*Corbally site*" will be used to differentiate the separate sites where appropriate.

5.22 The surface water outfall rate **QBar** is determined from the existing greenfield run-off rate based on the drained surface area (c.14.7Ha for main site and 0.36Ha for Corbally site) and on the known soil conditions and is calculated in accordance with IH124 as per the GDSDS Section 6.6.1.2 using the recommended HR Wallingford Greenfield Runoff Estimation tool on the *uksuds.com* website. The QBar for the main site was determined to be 55.0ls and 1.3l/s for the Corbally site. The determination of the SPR value and Qbar is comprehensively detailed in Appendix 11.6 of this report and is summarised in Table 2 below;

Soil	SPR	SAAR	M5/60	r	Drained Area Main Site	"East" Corbally site
3	0.37	878mm	17.9	0.229	14.65Ha	0.36Ha

Table 2 – S/W Design Summary Table

5.23 The **main site** Qbar of **55.0 l/s** has been sub-divided into 8No. sub-catchments, but the overall main site QBar remains the same. The Corbally site (catchment 9) is independent of the main catchment and drains to the Corbally Stream at a Qbar of **1.3l/s**. As the main site contains an area (c.1Ha) set aside for a possible future school, it does not form part this planning application. However, a S/W outflow rate of 1.5l/s has been allocated to this part of the site and a similar reduction to the main site Qbar (55.0 l/s) has been applied. Dwg.No.1324D/419 submitted with this application identifies each separate catchment and the associated area/flowrate/attenuation volume/etc. For detailed analysis of the derivation of QBar please refer to Appendix 11.6 of this report.

5.24 The MicroDrainage/WinDes software was used to create a drainage model for the full site, analyzing storm events for 2-year, 30 year and 100-year return events over multiple time periods ranging between 15 minutes to 7-day durations. An allowance of and additional 20% for climate change has been applied as has an allowance for 10% urban creep to the rear gardens of the houses.

5.25 A summary table with all the relevant separate catchment Qbars and resulting calculated attenuated storage volumes are illustrated in Table 3 below and the surface type/areas used to determine the attenuated volumes are summarised in Table 4. It is noted that on the request of the SDCC Water Services Department, provision for additional attenuation storage volume has been made in each of the nine designed catchments and is summarised in the Table 3.

BOHERBOY LRD - STAGE 3 S/W Design Summary Table

Catchment S/W Outfall (l/s)			Storage Volumes (m^3)				
Catchment No.	Gross Area (Ha)	Outfall rates applied (l/s)	Catchment	Attenuated Storage Volumes Required (m^3)			ATTENUATION STORAGE AVAILABLE IN EACH CATCHMENT (in upstream SuDS elements and basin)
				Q2+20%CC	Q30+20%CC	Q100+20%CC	Q100+20%CC
1	1.17	3	1	167	327	435	737
2	1.93	8	2	187	405	547	1,027
3	0.74	3	3	74	154	211	411
4	3.04	11.6	4	467	993	1294	1,204
5	4.8	18.6	5	622	1251	1675	2,618
6	0.55	2	6	53	123	171	374
7	0.53	2	7	62	133	179	277
8	0.91	5.3	8	47	118	165	290
9	0.36	1.3	9	40	83	111	198
*Potential future school site	1.03	1.5	*Potential future school site	*Potential school site not part of this application			
Main Site	14.7	55	Main Site	1679	3504	4677	6,937
Corbally East Site	0.36	1.3	Corbally East Site	40	83	111	198
TOTAL SITE	15.06	56.3		1719	3587	4788	7136

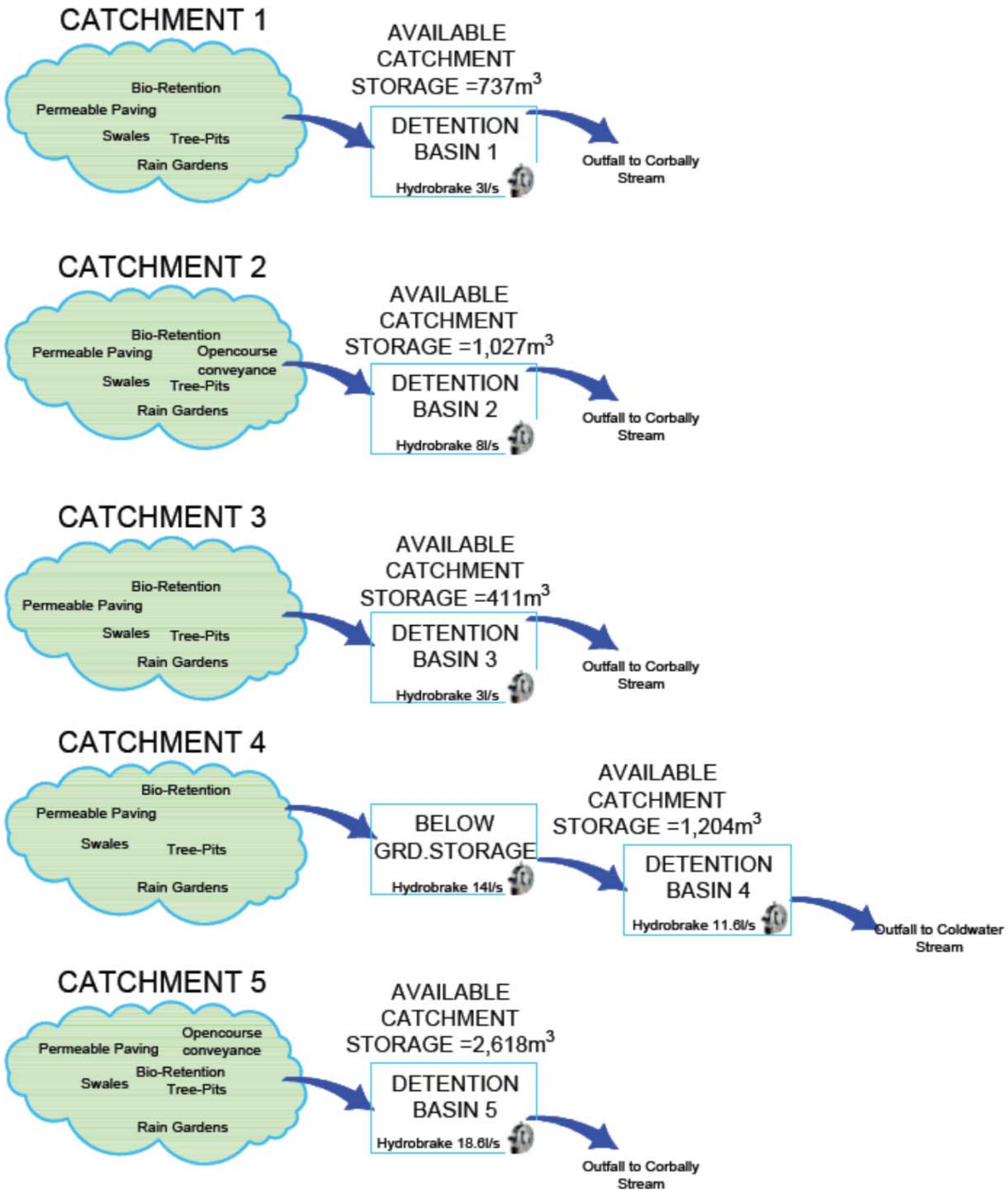
Table 3 – Qbar and Attenuated Volumes Summary

BOHERBOY LRD - STAGE 3 Surface Areas Summary Table

Catchment Areas (m^2)

Catchment	Gross Drained Areas (m^2)						Net Drained Areas (m^2)					
	Roofs via SuDS	Roads/Paths via SuDS	Permeable Paving	Grassland	Rear Garden	TOTAL AREA PER CATCHMENT	Roofs via SuDS (PAF=0.80)	Roads/Paths Via Suds (PAF=0.81)	Permeable Paving (PAF=0.50)	Grassland (PAF=0.25)	Rear Garden (PAV=0.1)	TOTAL AREA PER CATCHMENT
1	2670	3860	1210	2370	1580	11690	2136	3127	605	474	158	6500
2	3440	6580	1080	6390	1790	19280	2752	5330	540	1278	179	10079
3	1880	1760	500	1480	1800	7420	1504	1426	250	296	180	3656
4	7890	9390	3150	5700	0	26130	6312	7606	1575	1140	0	16633
5	12300	15120	4350	10780	5430	47980	9840	12247	2175	2156	543	26961
6	1750	1630	310	1830	0	5520	1400	1320	155	366	0	3241
7	2140	1240	420	1520	0	5320	1712	1004	210	304	0	3230
8	1150	2480	920	4560	0	9110	920	2009	460	912	0	4301
9	520	1330	410	830	480	3570	416	1077	205	166	48	1912
*Potential future school site	School site is not designed as part of this planning application						School site is not designed as part of this planning application					
TOTAL AREA PER SURFACE	33740	43390	12350	35460	11080	136020	26992	35146	6175	7092	1108	76513

Table 4 – Paved Areas Summary


CATCHMENT 1
Bio-Retention
Permeable Paving
Swales
Tree-Pits
Rain Gardens
AVAILABLE CATCHMENT STORAGE =737m³
DETENTION BASIN 1
Hydrobrake 3l/s
Outfall to Corbally Stream
CATCHMENT 2
Bio-Retention
Permeable Paving
Opencourse conveyance
Swales
Tree-Pits
Rain Gardens
AVAILABLE CATCHMENT STORAGE =1,027m³
DETENTION BASIN 2
Hydrobrake 8l/s
Outfall to Corbally Stream
CATCHMENT 3
Bio-Retention
Permeable Paving
Swales
Tree-Pits
Rain Gardens
AVAILABLE CATCHMENT STORAGE =411m³
DETENTION BASIN 3
Hydrobrake 3l/s
Outfall to Corbally Stream
CATCHMENT 4
Bio-Retention
Permeable Paving
Swales
Tree-Pits
Rain Gardens
BELOW GRD.STORAGE
Hydrobrake 14l/s
AVAILABLE CATCHMENT STORAGE =1,204m³
DETENTION BASIN 4
Hydrobrake 11.6l/s
Outfall to Coldwater Stream
CATCHMENT 5
Opencourse conveyance
Permeable Paving
Bio-Retention
Swales
Tree-Pits
Rain Gardens
AVAILABLE CATCHMENT STORAGE =2,618m³
DETENTION BASIN 5
Hydrobrake 18.6l/s
Outfall to Corbally Stream

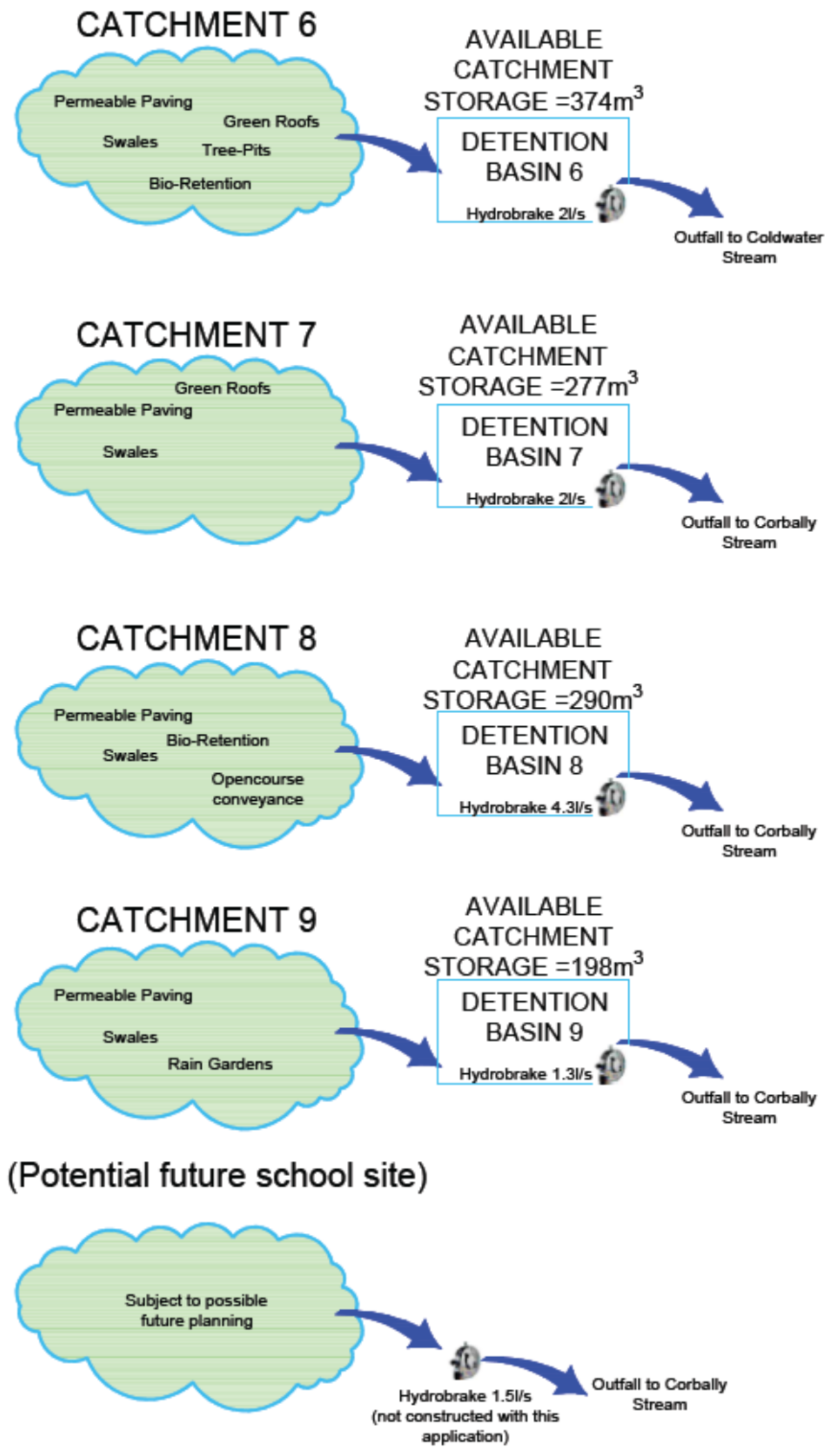


Fig.12 – Cascading Catchments Summary

5.26 Dwg.No.1324D/419 representing the above narrative is shown in Fig.13 below at reduced scale;

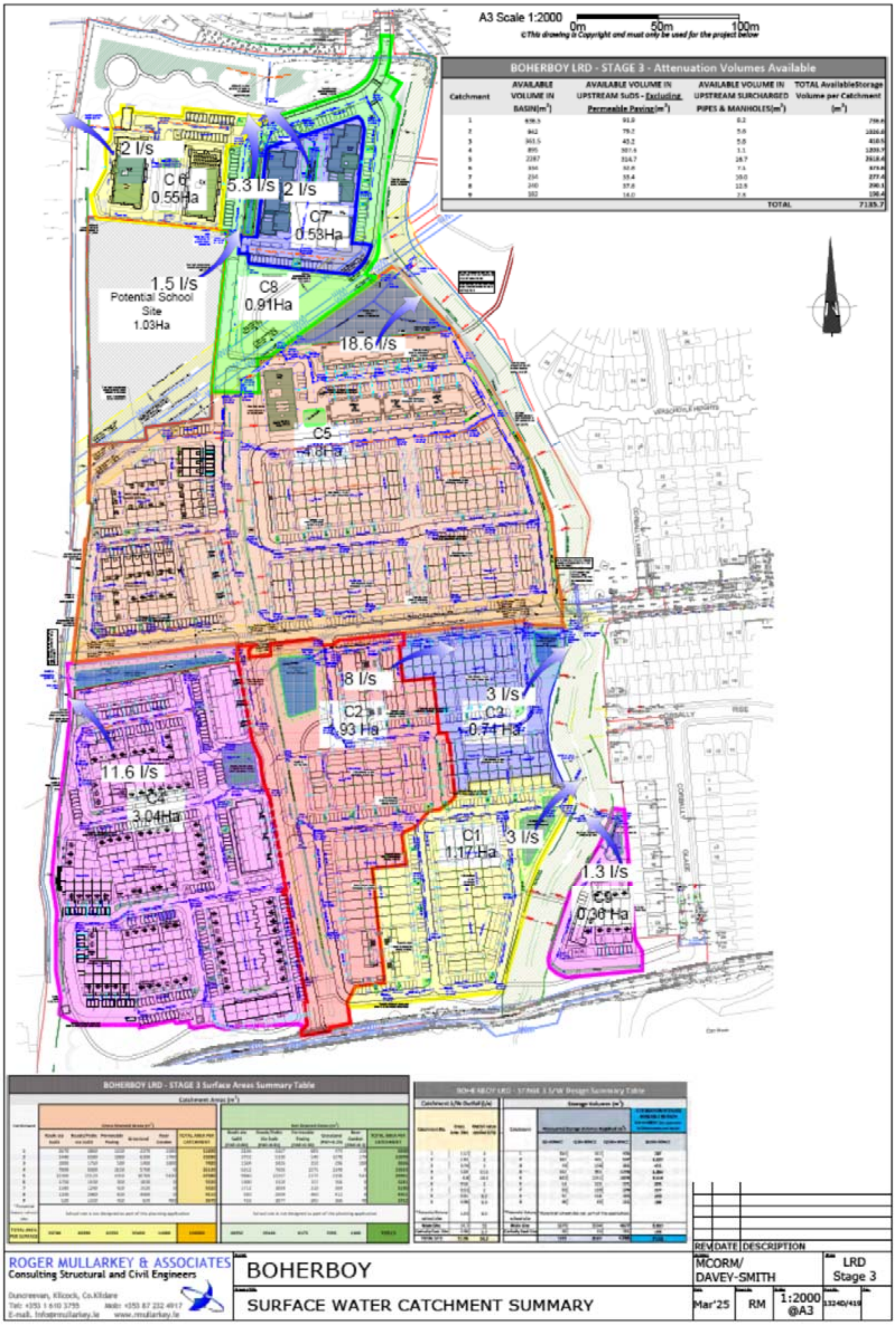


Fig.13 – S/W Catchment Areas (reduced scale)

5.27 Each of the surface water outfall locations are to include a wing-wall outfall detail, each of which is detailed on Dwg.No.1324D/417. A non-return valve is to be included at each outfall location to prevent backflow in the event of a swamped outfall condition.

5.28 To reflect the SuDS elements noted in paragraph 5.17 above, and in agreed in principle with the *EWCC Dept*. Paved Area Factors (PAF) have been applied to the drained surface areas directed via-SuDS aspects (rain gardens/bio-retention areas/tree pits/over grass grassland flow/permeable paving/swales/green roofs). The PAF's applied are identified in Table 4 above and are summarised as follows;

- Roofs draining SuDS features = 0.80
- Roads/paths draining via SuDS features =0.81
- Permeable paving = 0.50
- Grassland = 0.25
- Undrained Rear Gardens = 0.10

5.29 A summary of the catchment surface areas and SuDS interception volumes is summarised in Table 10 in Section 8.4 and each separate individual catchment interception is detailed in Appendix 11.13.

5.30 Using the results from the drainage model the total attenuated Q100 + 20% CC plus 10% Urban Creep volume for the site (east and west) is **4,788m^3** but it is noted that on the request of the SDCC Water Services Department, provision for additional attenuation storage volume has been made in each of the nine designed catchments which totals to **7,315m^3**. To clarify, the available attenuation storage volume for the 9No.catchments is **7,315m^3** and exceeds the calculated required volume and is therefore determined to be a safe and conservative approach.

5.31 It is noted that on specific request of the water services Department, the calculation of the additional storage made available excludes any storage held within the permeable paving. A table outlining the available attenuated storage capacity in each catchment is summarised in Table 5 below. Further detail of the SuDS interception volumes can be viewed in Appendix 11.13.

BOHERBOY LRD - STAGE 3 - Attenuation Volumes Available				
Catchment	AVAILABLE VOLUME IN BASIN(m^3)	AVAILABLE VOLUME IN UPSTREAM SuDS - Excluding Permeable Paving(m^3)	AVAILABLE VOLUME IN UPSTREAM SURCHARGED PIPES & MANHOLES(m^3)	TOTAL AvailableStorage Volume per Catchment (m^3)
1	636.5	91.9	8.2	736.6
2	942	79.2	5.6	1026.8
3	361.5	43.2	5.8	410.5
4	895	307.6	1.1	1203.7
5	2287	314.7	16.7	2618.4
6	334	32.8	7.1	373.8
7	234	33.4	10.0	277.4
8	240	37.6	12.5	290.1
9	182	14.0	2.3	198.4
			TOTAL	7135.7

Table 5 – Attenuation Storage Per Catchment

5.32 In accordance with the *GDSDS Volume 2, Section 6.3.4*, the four principal design criteria set out are summarised as follows;

- **Criterion 1** - River water quality protection
- **Criterion 2** – River regime protection
- **Criterion 3** – Level of service (flooding) for the site
- **Criterion 4** – River flood protection

5.33 Compliance with these criterion is summarised in Table 6 below and is discussed in detail in Section 8 of this report.

Criterion	*Method*	*Required*	*Provided*	*Compliance*
1	Interception	358m^3	1,877m^3	**Yes**
2	Qbar and storage	55.0 l/s and 1.3 l/s and 4,788m^3	54.9 l/s & 1.3l/s/s and >7,315m^3	**Yes**
3	Flooding	No flooding and 500mm freeboard	No flooding and >500mm freeboard	**Yes**
4	River Flood Protection	Qbar rate applied	Qbar rate applied	**Yes**

Table 6 – GDSDS Criterion

5.34 A Hydrological and Hydrogeological Risk Assessment Report examining the ground water flows and interface with the proposed development has been carried out in detail by DNV Consultants. A summary of the groundwater flows is shown in Fig.14 & Table 7 below and reference can be made to the DNV study for more detail;

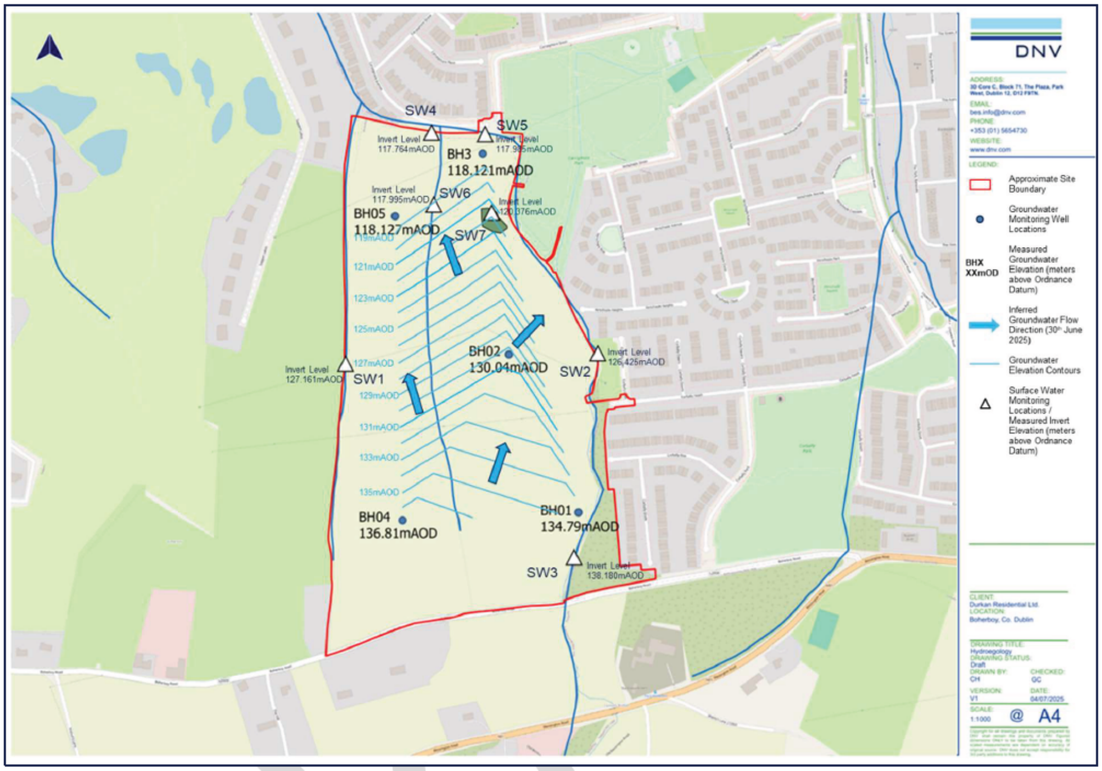


Fig.14 – Ground Water Flows (ex. DNV Hydrological report)

Location / Zone	Hydraulic Conductivity (k)	Approximate Groundwater Depth (D)*	Drainage - Length (L)	Cross Sectional Area (DxL)	Hydraulic Gradient	Groundwater
Catchment 4	0.147m/d (BH4)	2.0mbGL	34.03m	$68.06m^2$	0.0488m/m	$0.49m^3/day$
		2.0mbGL	30.83m	$61.66m^2$		$0.44m^3/day$
Catchment 5	0.147m/d (BH4)	1.4mbGL	30.02m	$42.03m^2$	0.0488m/m	$0.30m^3/day$
		1.4mbGL	30.01m	$42.01m^2$		$0.30m^3/day$
		2.8mbGL	38.24m	$107.07m^2$		$0.77m^3/day$
		2.8mbGL	39.42m	$110.38m^2$		$0.79m^3/day$
		2.8mbGL	32.36m	$90.61m^2$		$0.65m^3/day$
		1.6mbGL	24.55m	$39.28m^2$		$0.28m^3/day$
		1.6mbGL	24.89m	$39.82m^2$		$0.29m^3/day$
		2.1mbGL	18.10m	$38.01m^2$		$0.27m^3/day$
		2.1mbGL	28.97m	$60.84m^2$		$0.44m^3/day$
		2.3mbGL	37.30m	$85.79m^2$		$0.62m^3/day$
		1.1mbGL	39.03m	$42.93m^2$		$0.31m^3/day$
		1.5mbGL	32.55m	$48.83m^2$		$0.35m^3/day$
		1.7mbGL	16.89m	$28.71m^2$		$0.21m^3/day$
Catchment 6	1.168m/d (BH3)	1.7mbGL	36.12m	$61.40m^2$	0.0488m/m	$3.50m^3/day$
		1.7mbGL	34.09m	$57.95m^2$		$3.30m^3/day$
		2.3mbGL	40.26m	$92.60m^2$		$5.28m^3/day$
		1.5mbGL	41.88m	$62.82m^2$		$3.58m^3/day$
Catchment 7	1.168m/d (BH3)	1.2mbGL	30.81m	$36.97m^2$	0.0488m/m	$2.11m^3/day$
		1.2mbGL	26.35m	$31.62m^2$		$1.80m^3/day$
					Total	**$26.07m^3/day$**

Notes:
'*' = Groundwater is conservatively assumed to be intercepted ground level to the invert of the proposed drainage channel.

Table 7 – Ground Water Flows Intercepted (ex. DNV Hydrological report)

5.35 Interception of groundwater flows has been detailed on a catchment by catchment basis and, where required, has been intercepted by suitable landrains and captured by the surface water drainage system as detailed on the application drawings 1324B/401-406.

5.36 The groundwater discharge has been estimated to be c.26m^3 per day for the entire site which is captured by the above noted land drains. On a total site assessment 26m^3 per day is converted to a l/s flowrate of c.0.3l/s for the total site. As the surface water drainage design system is divided into 9 separate catchments, not each of the catchments will interface with the groundwater. Just 4No. of the catchments (No.'s 4, 5, 6 & 7) will capture the ground water flows as follows in Table 8;

Catchment 4	0.93m^3/d	0.01 l/s
Catchment 5	5.58m^3/d	0.06 l/s
Catchment 6	15.66m^3/d	0.18 l/s
Catchment 7	3.91m^3/d	0.05 l/s
Total Site	26.07 m^3/d	0.3 l/s

Table 8 – Ground Water Flows Intercepted by Catchment

5.37 Each of the above noted catchment intercepted groundwater flowrates have been added to the Micro Drainage modelling software to assess for any impact on the attenuated volumes stored in the various detention basins. There the assessment has determined that there is no significant impact on the proposed volumes.

6.0 Summary of Surface Water Drainage Design Conclusions

6.1 Full SuDS treatment train approach has been implemented in accordance with the CIRIA SuDS Manual as described in Chapter 7 below. This has been achieved utilising the elements described in 5.17 above. The centrally located Cooldown watercourse has been incorporated into the S/W drainage system and retained as an open-course conveyance swale where feasible and with elements of road/paths and roof runoff directed to this feature.

6.2 Both the Q30 + 20% and Q100 + 20% climate change attenuated storage volumes are summarised in Tables 3 & Ex.4. Refer to the MicroDrainage simulation modelling software calculations in Appendix 11.1 of this report for the detailed calculations.

6.3 Using the results from the drainage model the total attenuated Q100 + 20% CC plus 10% Urban Creep volume for the site (east and west) is **4,788m^3** but it is noted that on the request of the SDCC Water Services Department, provision for additional attenuation storage volume has been made in each of the nine designed catchments which totals to **7,315m^3**. To clarify, the available attenuation storage volume for the 9No.catchments is **7,315m^3** and exceeds the calculated required volume and is therefore determined to be a safe and conservative approach. Refer to Appendix 11.1 of this report for calculations of the required volumes and to Dwg.No.'s 1324D/404-407 for typical details of same.

6.4 The maximum top water levels in each of the 9 separate catchments is more than 500mm below the lowest floor level of any dwelling drained by that network.

6.5 The 4No.GDSDS criterion have been complied with.

6.6 A thorough examination of the site characteristics were undertaken in determination of the soil type and greenfield run off rate as described in Appendix 11.6.

6.7 In accordance with the OPW's *The Planning System and Flood Risk Management- Guidelines for Local Authorities 2009* (the Guidelines), Kilgallen & Partners Consulting Engineers have assessed and prepared a Site Specific Flood Risk Assessment (SSFRA) which forms part of the planning application. The SSFRA concluded that implementation of the mitigation measures will increase the available flood storage capacity by c.688m^3, that the application was subject to and passed the Development Management Justification Test as required under the Guidelines, that the proposed development will not be at risk of flooding and will not increase flood risk elsewhere and that the development is therefore appropriate from a flood risk perspective. Reference can be made to the separate SSFRA document that forms part of the overall planning submission documentation for greater detail in this regards. It is relevant to re-iterate that the flood compensation area provided at the north of the site does not from part of the sites pluvial drainage system and is separate from attenuated storage provided on the site.

6.8 Post issuing of the SDCC Stage 2 opinion, consultations were held with the SDCC *EWCC Dept*. and their requirements were ascertained and complied with in this document and the accompanying drawings.

7.0 Sustainable Drainage Systems - SuDS

7.0.1 SuDS addresses the water quality, water quantity, amenity and biodiversity by the management of surface water run off in a sequence of treatment processes along the drainage infrastructure network.

7.0.2 The SuDS philosophy is illustrated in the GDSDS Volume 3 Section 6.3 as the "SuDS triangle", shown below. The principle is to reduce the storm water run-off through managed processes, improve the quality of the run-off and to replicate the natural characteristics of the rainfall run off.

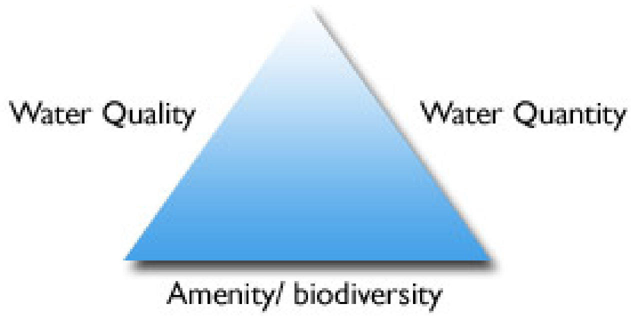


Fig.15 – The SuDS Triangle

7.0.3 Using the www.uksuds.com website, an assessment of the appropriate applicable SuDS features were evaluated and the resulting report is included in Appendix 11.5 of this document.

7.0.4 The appropriate SuDS features included in this proposal include the following;

- Rain Garden planters to the rear down pipes of the houses
- Permeable paving to all private parking areas for drainage of roads and front roofs of the houses
- Filter Swales adjacent to roadways where feasible
- Tree pits where practically feasible
- Use of the existing centrally located Cooldown watercourse and hedgerow as a conveyance swale
- Bio-Retention areas draining roads/paths and roofs
- Silt-trap/catchpit manholes
- Hydrobrakes limiting flow to the total Qbar greenfield rate

- 9No.open detention basins and 1No. below ground retention storage system

7.0.5 The SuDS management train approach to designing the storm water network has been applied in this proposed developments design, similar in principle to Fig.16 below

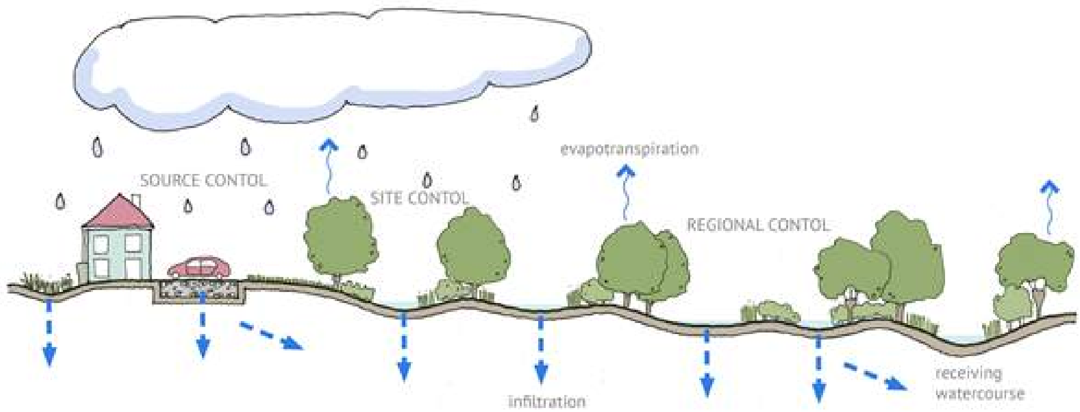


Fig.16 – Treatment Train

7.1 Source control

7.1.1 Source Control aims to detain or infiltrate runoff as close as possible to the point of origin.

7.1.2 The site investigation results (see Appendix 12.7 of this report) suggest that in one location there is some but limited ($1.38x10^{-5}$ mm/s) scope for infiltration of surface water flows. Of the 4No.tests carried out, only 1No.yielded a positive infiltration value. Even if the infiltration is limited there is still scope to provide some level of interception storage, time delay and treatment as the surface water flows through the stone medium of the following SuDS features in accordance with the UKSuDS.com report (included in Appendix 11.5 of this report).

7.1.3 t is proposed to use drained **tree pits** and **bio-retention** areas where possible to collect run-off from the single camber road surface. The use of these tree pits will encourage run off to infiltrate directly to ground and will also provide interception storage below the high-level connection to the main S/W drainage. House roof drainage will also drain via the Bio-Retention areas where feasible. Any run-off that cannot infiltrate to ground will overflow to the high-level drain and connect to the main drainage system. The surface water runoff rate is also attenuated by the use of these tree pits and bio-retention areas.

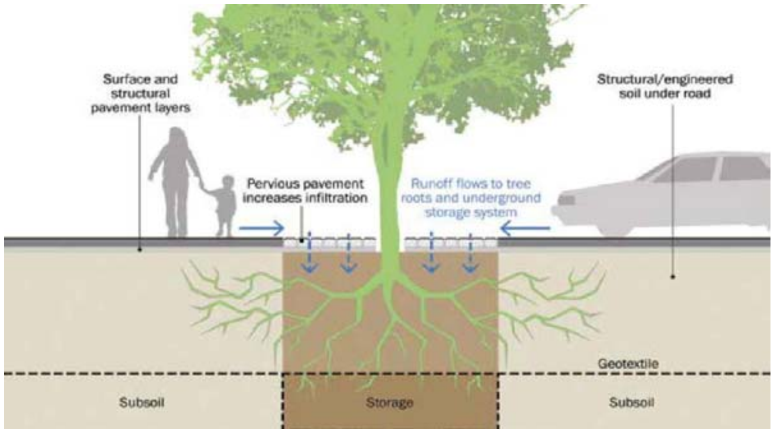


Fig.17 – Tree Pit (ex. SuDS Manual fig.19.3)

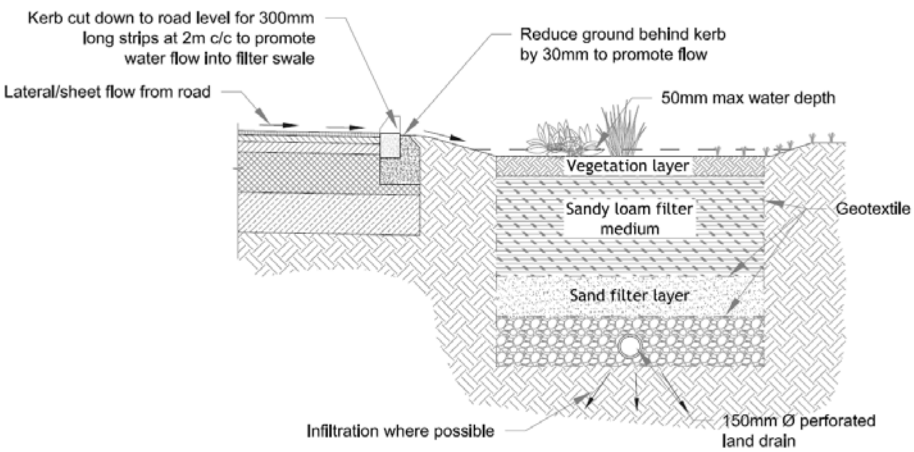


Fig.16 – Bio-Retention (ex.Dwg.1324D/416)

7.1.4 It is proposed to use **permeable paving** surfacing to all of the parking spaces on the site to drain the road/path and roof-runoff. This allows for the rainfall to percolate through open joints in the pavement and be strained through the unwoven geo-textile membrane beneath the paved surface. House roofs, particularly to the front of the units, will drain into these permeable parking areas. This method of surface water collection will improve water quality and prevent excessive sedimentation. There is a natural interception, attenuation and storage of surface waters flowing through the permeable paving system and an outfall pipe is provided 150mm above the bottom of the system to drain the overflow filtered/attenuated run off into the main drainage system.

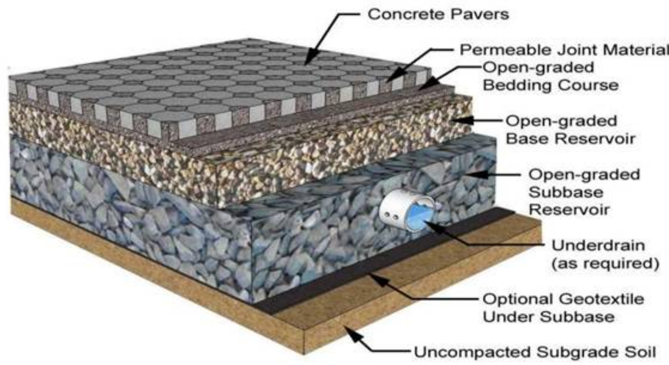


Fig.18 – Permeable Paving

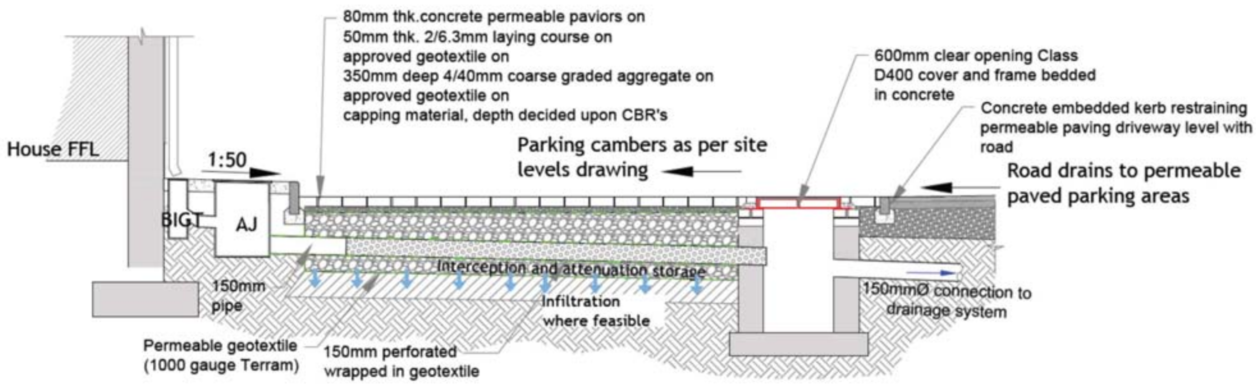


Fig.19 – Roads and Roofs draining to permeable paving

7.1.5 In providing permeable paving, a run-off rate of 50% (0.50 paved area factor applied) has been applied for the carparking areas in the drainage model calculations as was agreed in principle with the SDCC *EWCC Dept*. as part of the pre-planning discussions. Refer to Appendix 12.11 of this report and Dwg.No.1324D/416-417 for details.

7.1.6 In accordance with the CIRIA SuDS Manual 2015, **green roofs** can be used to treat and attenuate runoff in their substrate and support root uptake of water with appropriate planting and are an integral part of source control on a site. Green roofs can increase the indigenous biodiversity and is an encouraging environmentally design strategy, which is in accordance with the objectives as specified in the Greater Dublin Strategic Drainage Strategy (GDSDS).

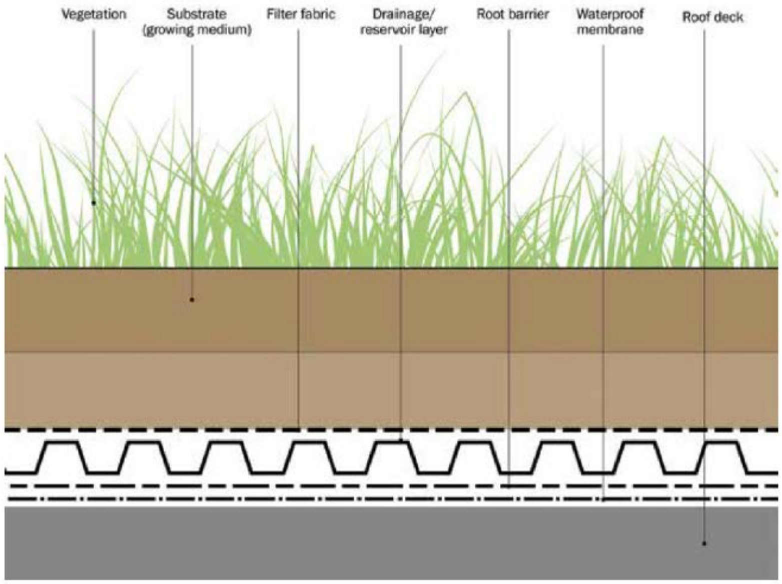


Fig.20- Green Roof

7.1.7 Green roofs with extensive planting are proposed for the flat roof areas of the apartment blocks the roof of the creche.

7.1.8 In providing a suitable substrate depth to the green roof system, a run-off rate of 80% (0.80 paved area factor applied) has been applied in the surface water calculations as was agreed in principle with the SDCC *EWCC Dept*. as part of the pre-planning discussions. Refer to Appendix 11.10 of this report and Dwg.No.1324D/416-417 for details.

7.1.9 Access for maintenance to the green roof is to be facilitated via opening hatches in the stair cores of the apartment blocks. A fall arrest system is to be included in the design of the roof.

7.1.10 The use of planter **raingardens** is another source control method in the SuDS treatment train process. It is proposed to provide rain garden planters to the rear down pipes of the houses to collect rainwater from the house roofs thus intercepting, treating and decreasing runoff from the site.

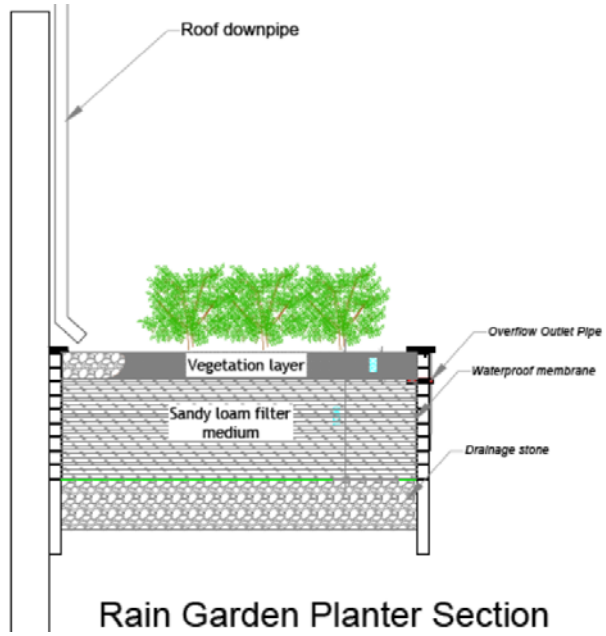


Fig.21 – Rain Garden Planters

7.1.11 In providing rain garden planters draining the roof down pipes, a run-off rate of 80% (0.80 paved area factor applied) has been applied in the surface water calculations as was agreed in principle with the SDCC *EWCC Dept*. as part of the pre-planning discussions. Refer to Appendix 11.11 of this report and Dwg.No.1324D/416-417 for details.

7.1.12 An important aspect of Source Control is reducing pollution by prevention of chemicals and other pollutants from coming into contact with rainfall runoff. In this respect, it is proposed that the homeowner will be provided with information regarding the appropriate usage of the proposed drainage system.

7.2 Site Control

7.2.1 Site control in the treatment train process involves the reduction in volume and rate of surface water run-off and also provides some treatment of the run-off.

7.2.2 Roadside **filter swales** are a method of site control that reduces harmful chemical pollutants and sediment reaching the piped network. These pollutants are trapped in the grassed areas leading to the filter strip. Filter swales reduce the surface water runoff rate and attenuate flows locally, therefore reducing stress on downstream facilities. Filter swales also facilitate interception of the "first flush" of rainfall. Fig.22 below from the CIRIA SuDS Manual illustrates the principle.

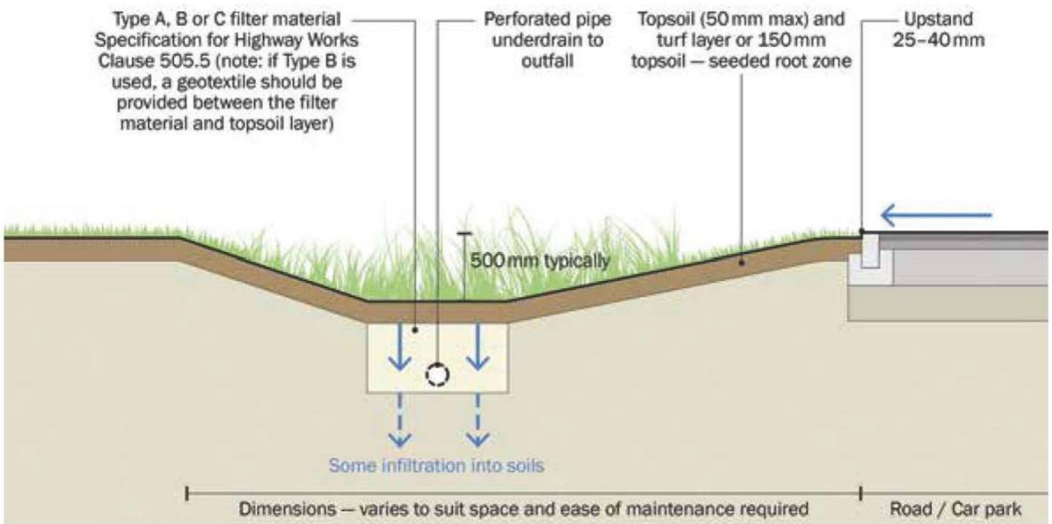


Fig.22 – Filter Swale

7.2.3 As part of the site control it is proposed to construct **filter swales** along the site roads at specified locations which will allow surface water runoff from roads to be intercepted and infiltrate to ground. In the event the ground is saturated, there are also positive drainage connections from the filter swales into the piped network. Refer to Dwg.No.'s 1324D/404-407 for proposed locations of the filter swales and to Dwg.1324D/416 for details of this proposal. Typical calculations for these features are included in Appendix 11.3 of this report.

7.2.4 A PAF of 0.81 (81%) will apply to areas draining to these swales as was agreed in principle with the SDCC *EWCC Dept*. as part of the pre-planning discussions. Refer to Dwg.No.1324D/417 for details.

7.2.5 Single camber roads are to be constructed to drain into these filter swales where appropriate to maximize the drained area. Road cambers are shown on Dwg.No.'s 1324D/400-403 and details on Dwg.No.'s 1324D/423 and 424.

7.2.6 Included in the layout design of the proposed development is the existing hedgerow forming a central north/south spine to the site and thus creating a Bio-Retention feature replicating the natural drainage characteristics of the existing site. Re-using the Coolwater open course within this hedgerow as a conveyance swale provides an important role of intercepting rainfall run-off and managing same through evapotranspiration as well as infiltration to vegetation roots. Road runoff is directed to over grassland flow into the open course swale thus intercepting, treating and attenuating the runoff before outfalling to the swale. The addition of landscaping and planting throughout the development is also an important aspect of site control in providing biodiversity, run off reduction, interception, infiltration and amenity. Refer to the landscape architects' drawings for more information.

7.2.7 The quality of the run-off is to be maintained by minimizing the impermeable surfaces especially in the car parking areas, and also where possible by diverting road generated surface water runoff into the permeable paving, filter swales tree pits and bio-retention areas.

7.2.8 Silt-trap/catchpit manholes are provided upstream of each of the below ground attenuation storage systems which will remove sediments and silts and forms part of the site control methodology used in the proposed development.

7.3 Regional Control

7.3.1 Regional control comprises of treatment facilities to reduce pollutants from runoff and control the surface water runoff rate to pre-development rates.

7.3.2 As part of the overall regional control for the site it is proposed to use 9No.open detention basins and 1 No. below ground storage cell system, such as the voided arch system (Fig.23). These attenuation storage areas are located at the bottom of each catchment and attenuated flows outfall to the existing watercourses downstream at each location.

Fig.23 – Voided Arch Attenuation System

7.3.3 The reduced flow rate of the run-off from the attenuation systems is to be controlled using a vortex control devices such as a Hydrobrake. The total site outfall rate is restricted to the equivalent of the existing greenfield runoff rate , Qbar, of 55.0l/s & 1.3l/s - refer to paragraph 5.22-5.23 for more detail.

7.3.4 Interception of the "first flush" of rainfall is captured in the grass and voids of the stone beneath the roadside filter swales, rain garden planters bio-retention areas, tree-pits, permeable paving and the open detention basins and attenuation cell system and can infiltrate to ground where possible.

7.3.5 Prevention of pollutants and sediments entering the receiving watercourse has been achieved in providing Interception Storage throughout the proposed development. The interception will take place from the head of the catchment right down to the Hydrobrake manhole on the application lands.

7.3.6 Non return valves and concrete wing wall details are to be used at each of the attenuated outfall points.

7.4 SuDS Summary

7.4.1 The interception storage will be within the stone base of the permeable paving/swales/bio-retention areas/rain gardens, in the sub-strata of the green roof systems/the detention basins. In accordance with the GDSDS, the volume of interception storage provided is greater that generated by 5mm of rainfall on the site and up to 10mm if possible. A summary of the calculations of the interception volumes are shown in paragraph 8.4 and are shown in detail in Appendix 11.13.

7.4.2 Replicating the natural characteristics and providing amenity/biodiversity will be encouraged by creating the roadside grassed swales, green roofs, filter drains, rain gardens, tree-pits, bio-retention areas, grassed detention basins and the centrally located open course conveyance swale.

7.4.3 The surface water runoff rate has been restricted to the greenfield runoff rate, Qbar and calculations for same can be viewed in Appendix 11.6 of this report.

7.4.4 Refer to the appendices of this report and to Dwg. No's 1324D/404-407 and Dwg.No.'s 1324D/416-417 for the drainage layout and SuDS features details.

7.4.5 In providing the above noted elements it is proposed that the SuDS treatment of the run-off has been adequately addressed. The above noted proposals have been discussed and agreed in principle with SDCC *EWCC Dept*. during the pre-planning process.

8.0 GDSDS Criterion and Design Standards

8.1 In accordance with best practice, the internal drainage system has been designed as a completely separate foul and surface water system.

8.2 In accordance with the Greater Dublin Regional Code of Practice for Drainage Works (GDSDS) the surface water drainage infrastructure was designed to the parameters as outlined in Table 9 below;

Time of entry	**6mins (all via SuDS devices)**
Return periods for pipework	2 years
	Q30 15min no flooding
	Q100 15min – storage in designated areas only
Climate Change	20%
Min.velocity	0.75m/s
Max.velocity	3m/s
Min.sewer size for TIC	225mm diameter
Pipe friction (Ks)	0.6mm
Minimum pipe depth	1.2m below roads 0.9m in open/grassed spaces Concrete bed and surround otherwise
Standard Annual Average Rainfall (SAAR)	878mm (Met Eireann data)
M5-60	17.9mm
Ratio r (M5-60/M5-2Day)	0.229
Outfall Rate	Drained Site Qbar = 55.0 l/s and 1.3l/s
Attenuation storage	Q30 – no flooding on site Q100 – overflow into detention basin only, 500mm freeboard to FFLs of houses, flood routing plan.
Paved Area Runoff percentage	80% from roofs drained to SuDS features 81% from roads/paths drained to SuDS features 50% from permeable paved surfacing 20% drained grassland 10% undrained rear gardens

Table 9 – S/W Design Parameters

8.3 In accordance with the GDSDS, the four principal design criteria as set out in section 6.3.4 of volume 2 of GDSDS are summarized as follows;

- **Criterion 1** - River water quality protection

- **Criterion 2** – River regime protection
- **Criterion 3** – Level of service (flooding) for the site
- **Criterion 4** – River Flood protection

8.4 **Criterion 1** has been complied with by inclusion of **Interception** of at least 5mm of rainfall to prevent runoff to the receiving water. The interception storage will be within the stone base of the permeable paving, in the stone below the filter drains in swales, in the sub-strata of the green roof systems, in the filtering medium of the raingarden planters, tree pits and bio-retention areas and captured in the open detention basins where the outlet is 50mm above the bed level. As per the parameters laid out in the GDSDS the interception volume was calculated for the total site as per Table 10 below;

BOHERBOY LRD - STAGE 3 Interception Summary		
	Interception Volumes (m3)	
Catchment	Interception Volume Required (m^3)	Interception Volume Provided (m^3)
1	31	183
2	44	160
3	17	81
4	82	544
5	127	638
6	15	56
7	15	65
8	18	107
9	9	45
*Potential future school site	School site is not designed as part of this planning application	
Totals	358	1877

Table 10 – Summary of Total Site Interception

8.5 Interception calculations for each individual catchment are included in Appendix 11.13 of this report.

8.6 **Criterion 2** is complied with in applying the Qbar outfall rates and providing the more than required volume of attenuation storage.

8.7 **Criterion 3** is satisfied with as each of the 4No.sub-criterion design objectives have been met as per Table 11 the below;

Sub-criterion	*Design objective*	*Satisfied*
3.1	No flooding on site for the Q30 except where specifically planned	**OK**
3.2	No internal property flooding for site critical duration storm event.	**OK**
3.3	No internal property flooding satisfied as 500mm freeboard to house FFL's is achieved.	**OK**
3.4	No flooding of adjacent areas unless specific routing planned for the Q100 + 20% climate change	**OK**
Refer to the MicroDrainage surface water model results (Q1-Q100+20%) included in Appendix 11.1 of this report for further detail		

Table 11 – GDSDS Sub-criterion

8.8 **Criterion 4** River flood protection is satisfied under GDSDS sub-criterion 4.3 in accordance with the application of the Qbar outfall rates and therefore long-term storage is not required.

9.0 Wastewater Site Drainage

9.1 Foul drainage records drawings were obtained from UÉ/SDCC in preparation for this planning application and are included in Appendix 11.8 of this document.

9.2 A Pre-Connection Enquiry Form application (PCEA) was submitted to Uisce Éireann and a Confirmation of Feasibility(CoF) was received (Ref.CDS24005491) from UÉ noting that the wastewater connection was "*feasible subject to upgrades*". A copy of the UÉ confirmation letter can be viewed in Appendix 11.11 of this report.

9.3 Extensive discussions were held with Uisce Éireann regarding build-over and crossings of the existing water infrastructure as part of previous planning applications on this site and subsequently agreement was reached and was confirmed by UÉ in the Statement of Design acceptance letter (Ref.CDS20004359) issued on 19/08/21. A copy of that UÉ design acceptance letter can be viewed in Appendix 11.11 of this report. More recently, a submission has been made to UÉ to update their review based on the current design, which is substantially similar to previous iterations, and all queries arising have been addressed in this application. Subject to a successful planning permission, at connection application stage any further requirements of UÉ will be ascertained and agreed.

9.4 The minimum public sewer diameter is to be 225mm and the foul drains/sewer are to be in accordance with the Uisce Éireann Code of Practice for Wastewater Infrastructure 2025 and the criteria applied in the design is as per Table 12 below.

Foul Sewer Design Criteria	
Min.velocity	0.75m/s
Max.velocity	3m/s
Min.sewer size for TIC	225mm diameter
Pipe friction (Ks)	1.5mm
Minimum pipe depth	1.2m below roads 0.9m in open/grassed spaces
Ave.Occupancy	2.7 persons/unit
Residential loading/person/day	150 l/day
Commercial loading/person/day	50 l/d

Table 12- Foul Sewer Design Criteria

9.5 The foul water drainage system is to outfall by gravity into the existing Uisce Éireann infrastructure located to the east of the subject site at Verschoyle Green as was agreed with Uisce Éireann. The "east" site with

10No.houses is proposed to be connected into the existing foul sewer in Corbally Rise.

9.6 The lower level north end of the site (25% of the site) incorporates a pumping station to drain the apartments, houses and the possible future school site via a rising main into the outfalling into the gravity pipe. This has been agreed with Uisce Éireann.

9.7 The proposed foul pumping station is to be in accordance with the Uisce Éireann Code of Practice for Wastewater Infrastructure – Part 5 – Pumping Stations. The details of which can be viewed on the provided drawing No.1324D/421. Please note that the foul pumping station is below ground and is proposed to have only 2No.above ground kiosks visible as per the UÉ standard shown in Fig.24 and 25 below;

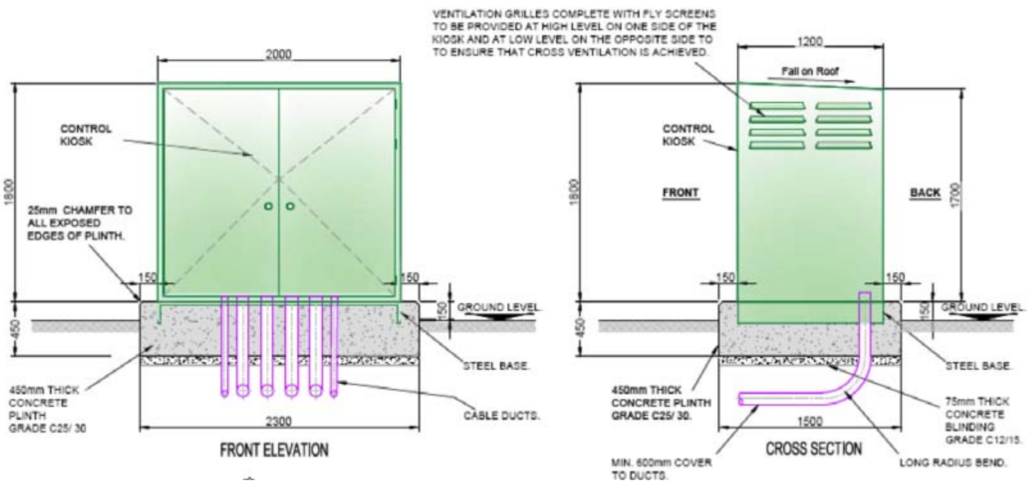


Fig.24 – ex.UÉ STD-WW-30A

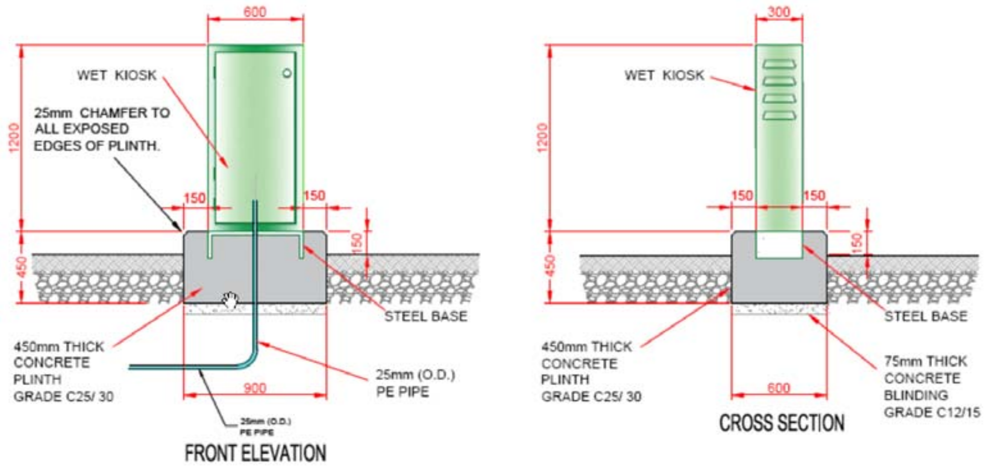


Fig.25 – ex.UÉ STD-WW-31A

9.8 The calculations for the site foul estimates and pumping station are included in Appendix 11.4 of the document. Please refer to Dwg.No.1324D/321 for details of the foul pumping station and to Dwg.No.'s 1324D/408-411 for the site foul drainage layouts.

9.9 Each individual house connection is to be in accordance with the Uisce Éireann Code of Practice for Wastewater Infrastructure 2020 which requires individual house connections to each dwelling. Each individual house is to be connected to the main public foul sewer using a 100mm diameter drain with a minimum gradient of 1/80 in any one drain. Refer also to UÉ-STD-WW-02.

9.10 Details of manholes are to be as per Dwg.No.1324D/442 and in accordance with the Uisce Éireann Code of Practice for Wastewater Infrastructure 2025 and Standard Details documents.

10.0 Site Potable Watermain

10.1 Water infrastructure records drawings were obtained from SDCC/UÉ in preparation for this planning application and are included in Appendix 11.8 of this document.

10.2 A Pre-Connection Enquiry Form application (PCEA) was submitted to Uisce Éireann and a Confirmation of Feasibility(CoF) was received (Ref.CDS24005491) from UÉ noting that the water connection was "*feasible without infrastructure upgrade*". A copy of the UÉ confirmation letter can be viewed in Appendix 11.11 of this report.

10.3 The proposed water supply for the development is to be made by connecting to an existing 400mm diameter main located in the Boherboy Road (L2008) to the south of the site.

10.4 A single 225mm outside diameter connection has been approved by Uisce Éireann and will supply the proposed development via a 225mm outside diameter watermain with interconnecting 180mm and 110mm diameter looped branch watermains connected to it. Individual houses are to be supplied with a 25mm connection.

10.5 There are 3No.existing watermains (4inch uPVC/400mmDI/600mmDI) in Boherboy Road along the southern site frontage. This application proposes to make a new water connection to the 400mm DI watermain in the Boherboy Road. This has been agreed with Uisce Éireann.

10.6 There are 5No.existing trunk watermains crossing the applicant's lands. A 1.2m Ø (1982 Concrete), a 27inch Ø (1938 Steel) and a 24inch (AC 1975) lie approximately parallel to each other in the northern third of the site and also a 1.2m Ø (1983 Concrete) and 24inch Ø (1952 Cast Iron) lie parallel approximately in the middle of the site. Please refer to drawing No.'s 1324D/310-312 for location of these existing trunk watermains.

10.7 These trunk watermains are in the control of Uisce Éireann. The set-back requirements from these mains is in accordance with the Uisce Éireann Code of Practice for Water Infrastructure document and extensive discussions were held with Uisce Éireann regarding build-over and crossings of the existing water infrastructure as part of previous planning applications on this site and subsequently agreement was reached and was confirmed by UÉ in the Statement of Design acceptance letter (Ref.CDS20004359) issued on 19/08/21. A copy of that UÉ design acceptance letter can be viewed in Appendix 11.11 of this report. More recently, a submission has been made to UÉ to update their review based on the current design, which is substantially similar to previous iterations, and subject to a successful planning permission, at connection application stage any further requirements of UÉ will be ascertained and agreed.

10.8 In order to precisely locate these existing trunk watermains, excavation of silt trenches was carried out in Dec 2013 with the permission of the then overseeing authorities of Dublin City Council and South Dublin County Council *EWCC Dept*. All mains were located, surveyed, mapped and the results issued to both SDCC, DCC and Uisce Éireann for their records.

10.9 It was discovered during the excavations to precisely locate the existing trunk mains that one of the existing watermains (1.2m Ø 1982 main) was in a different location to that as was shown on the Local Authority records drawings. This record anomaly was brought to the attention of each of SDCC, DCC and Uisce Éireann and the actual correct position of the 1.2m Ø 1982 main was surveyed-in and issued to all the relevant authorities. The correct and surveyed location of each the existing watermains are as shown on the submission drawings 1324D/412-415.

10.10 Refer to Dwg.No.'s 1324D/412-415 for the watermain layout and to Dwg.1324D/420 for sections across the existing trunk watermains which have previously been approved by Uisce Éireann.

10.11 In reference to the Uisce Éireann Code of Practice for Water Infrastructure document, each individual residential dwelling within the development is to be provided with a boundary box. The type and configuration of the boundary box is to be in accordance with the UÉ STW-W-03.

10.12 Each dwelling will be fitted with a cold-water storage tank to provide 24 hours of supply.

10.13 In accordance with best practice, the use of water conservation appliances in the buildings are to be employed as part of this scheme to reduce the water demand. Although the consumption of treated water depends a lot on the behaviour of consumers, demand on the network is limited in the scheme by incorporating water saving tap valves, eco-flush toilet system and water saving appliances.

10.14 All watermain layout and details are to be in accordance with the Uisce Éireann Code of Practice for Water Infrastructure 2025 and the Water Infrastructure Standard details 2025.

11.0 APPENDIX

Contents:

Appendix 11.1

MicroDrainage S/W Calculations

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	0.900
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 1

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.390	4-8	0.264	8-12	0.002

Total Area Contributing (ha) = 0.656

Total Pipe Volume (m³) = 18.558

Network Design Table for Catchment 1

« - Indicates pipe capacity < flow

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**
SW100.000	37.087	0.806	46.0	0.137	6.00	0.0	0.600	o	225	Pipe/Conduit	
SW100.001	37.069	0.805	46.0	0.081	0.00	0.0	0.600	o	225	Pipe/Conduit	
SW100.002	55.436	2.217	25.0	0.079	0.00	0.0	0.600	o	225	Pipe/Conduit	
SW101.000	39.113	0.501	78.1	0.067	6.00	0.0	0.600	o	225	Pipe/Conduit	
SW101.001	31.182	0.866	36.0	0.048	0.00	0.0	0.600	o	225	Pipe/Conduit	
SW101.002	54.728	2.280	24.0	0.053	0.00	0.0	0.600	o	225	Pipe/Conduit	
SW101.003	52.490	1.117	47.0	0.090	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)**
SW100.000	50.00	6.32	141.240	0.137	0.0	0.0	0.0	1.93	76.9	18.5
SW100.001	50.00	6.64	140.440	0.218	0.0	0.0	0.0	1.93	76.8	29.5
SW100.002	50.00	6.99	139.630	0.297	0.0	0.0	0.0	2.63	104.5	40.2
SW101.000	50.00	6.44	142.160	0.067	0.0	0.0	0.0	1.48	58.9	9.1
SW101.001	50.00	6.68	141.660	0.115	0.0	0.0	0.0	2.19	87.0	15.6
SW101.002	50.00	7.02	140.800	0.169	0.0	0.0	0.0	2.68	106.6	22.9
SW101.003	50.00	7.48	138.530	0.259	0.0	0.0	0.0	1.91	76.1	35.1

Network Design Table for Catchment 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
SW100.003	26.916	0.179	150.0	0.070	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW100.004	6.779	0.045	150.0	0.029	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW100.005	24.867	0.166	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW100.003	50.00	7.75	136.710	0.627	0.0	0.0	0.0	1.66	263.6	84.9
SW100.004	50.00	7.81	136.480	0.656	0.0	0.0	0.0	1.66	263.6	88.8
SW100.005	50.00	8.20	136.430	0.656	0.0	0.0	0.0	1.07	42.4«	88.8

Area Summary for Catchment 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
100.000	User	-	50	0.010	0.005	0.005
	User	-	50	0.015	0.007	0.012
	User	-	50	0.007	0.003	0.016
	User	-	50	0.007	0.003	0.019
	User	-	25	0.001	0.000	0.019
	User	-	25	0.001	0.000	0.019
	User	-	25	0.000	0.000	0.019
	User	-	25	0.001	0.000	0.020
	User	-	25	0.001	0.000	0.020
	User	-	25	0.001	0.000	0.020
	User	-	25	0.002	0.000	0.021
	User	-	80	0.043	0.034	0.055
	User	-	80	0.030	0.024	0.079
	User	-	81	0.025	0.020	0.100
	User	-	81	0.016	0.013	0.113
	User	-	81	0.001	0.001	0.114
	User	-	10	0.023	0.002	0.116
	User	-	25	0.001	0.000	0.116
	User	-	25	0.001	0.000	0.117
	User	-	25	0.002	0.001	0.117
	User	-	25	0.001	0.000	0.118
	User	-	81	0.017	0.014	0.131
	User	-	81	0.007	0.005	0.137
100.001	User	-	50	0.006	0.003	0.003
	User	-	25	0.002	0.000	0.004
	User	-	25	0.001	0.000	0.004
	User	-	25	0.002	0.000	0.004
	User	-	80	0.030	0.024	0.029
	User	-	81	0.023	0.019	0.047
	User	-	81	0.011	0.009	0.056
	User	-	81	0.024	0.020	0.076
	User	-	10	0.023	0.002	0.078
	User	-	10	0.032	0.003	0.081
100.002	User	-	50	0.006	0.003	0.003
	User	-	50	0.006	0.003	0.006
	User	-	50	0.002	0.001	0.007
	User	-	50	0.017	0.008	0.016
	User	-	25	0.003	0.001	0.016
	User	-	25	0.001	0.000	0.016
	User	-	25	0.002	0.000	0.017
	User	-	25	0.001	0.000	0.017
	User	-	25	0.001	0.000	0.017
	User	-	80	0.018	0.015	0.032
	User	-	81	0.033	0.027	0.059
	User	-	81	0.009	0.007	0.066
	User	-	81	0.016	0.013	0.079
101.000	User	-	50	0.016	0.008	0.008
	User	-	25	0.001	0.000	0.008
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.009
	User	-	25	0.003	0.001	0.010
	User	-	25	0.017	0.004	0.014
	User	-	80	0.037	0.030	0.044
	User	-	81	0.029	0.023	0.067
	User	-	50	0.001	0.000	0.067
101.001	User	-	50	0.011	0.006	0.006
	User	-	25	0.001	0.000	0.006

Area Summary for Catchment 1

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	25	0.001	0.000	0.006
	User	-	25	0.008	0.002	0.008
	User	-	80	0.014	0.011	0.019
	User	-	81	0.026	0.021	0.040
	User	-	81	0.011	0.009	0.048
101.002	User	-	25	0.003	0.001	0.001
	User	-	25	0.007	0.002	0.002
	User	-	20	0.006	0.001	0.004
	User	-	80	0.014	0.011	0.015
	User	-	81	0.047	0.038	0.052
	User	-	10	0.008	0.001	0.053
101.003	User	-	50	0.006	0.003	0.003
	User	-	25	0.012	0.003	0.006
	User	-	25	0.001	0.000	0.006
	User	-	25	0.005	0.001	0.007
	User	-	25	0.001	0.000	0.008
	User	-	25	0.002	0.000	0.008
	User	-	25	0.003	0.001	0.009
	User	-	80	0.034	0.027	0.036
	User	-	80	0.020	0.016	0.052
	User	-	81	0.030	0.024	0.075
	User	-	81	0.009	0.008	0.083
	User	-	10	0.018	0.002	0.085
	User	-	10	0.054	0.005	0.090
100.003	User	-	50	0.006	0.003	0.003
	User	-	50	0.005	0.002	0.005
	User	-	25	0.003	0.001	0.006
	User	-	25	0.003	0.001	0.007
	User	-	25	0.001	0.000	0.007
	User	-	25	0.001	0.000	0.007
	User	-	80	0.014	0.011	0.018
	User	-	80	0.013	0.010	0.029
	User	-	81	0.013	0.010	0.039
	User	-	81	0.028	0.022	0.062
	User	-	81	0.011	0.009	0.070
100.004	User	-	25	0.117	0.029	0.029
100.005	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				1.152	0.656	0.656

Free Flowing Outfall Details for Catchment 1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW100.005	SMh	138.000	136.264	136.250	0	0

Simulation Criteria for Catchment 1

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 1

Hydro-Brake® Optimum Manhole: SMh109, DS/PN: SW100.005, Volume (m^3): 3.1

Unit Reference	MD-SHE-0082-3000-1000-3000
Design Head (m)	1.000
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	82
Invert Level (m)	136.430
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.0	Kick-Flo®	0.623	2.4
Flush-Flo™	0.297	3.0	Mean Flow over Head Range	-	2.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.4	0.800	2.7	2.000	4.1	4.000	5.7	7.000	7.4
0.200	2.9	1.000	3.0	2.200	4.3	4.500	6.0	7.500	7.7
0.300	3.0	1.200	3.3	2.400	4.5	5.000	6.3	8.000	7.9
0.400	2.9	1.400	3.5	2.600	4.7	5.500	6.6	8.500	8.2
0.500	2.8	1.600	3.7	3.000	5.0	6.000	6.9	9.000	8.4
0.600	2.5	1.800	3.9	3.500	5.4	6.500	7.2	9.500	8.6

Storage Structures for Catchment 1

Tank or Pond Manhole: SMh109, DS/PN: SW100.005

Invert Level (m) 136.950

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	450.0	1.000	800.0

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW100.000	SMh100	15 minute 2 year Winter I+20%	142.750	141.328	-0.137	0.000	0.32		0.119
SW100.001	SMh101	15 minute 2 year Winter I+20%	141.940	140.553	-0.112	0.000	0.50		0.212
SW100.002	SMh102	15 minute 2 year Winter I+20%	141.100	139.740	-0.115	0.000	0.48		0.184
SW101.000	SMh103	15 minute 2 year Winter I+20%	143.660	142.229	-0.156	0.000	0.21		0.092
SW101.001	SMh104	15 minute 2 year Winter I+20%	143.160	141.734	-0.151	0.000	0.23		0.138
SW101.002	SMh105	15 minute 2 year Winter I+20%	142.300	140.879	-0.146	0.000	0.27		0.134
SW101.003	SMh106	15 minute 2 year Winter I+20%	140.030	138.651	-0.104	0.000	0.56		0.214
SW100.003	SMh107	1440 minute 2 year Winter I+20%	138.900	137.281	0.121	0.000	0.04		0.810
SW100.004	SMh108	1440 minute 2 year Winter I+20%	138.000	137.280	0.350	0.000	0.06		5.204
SW100.005	SMh109	1440 minute 2 year Winter I+20%	138.000	137.279	0.624	0.000	0.08		167.214

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW100.000	SMh100	1.6	23.5	OK
SW100.001	SMh101	1.8	36.1	OK
SW100.002	SMh102	2.5	48.1	OK
SW101.000	SMh103	1.1	11.5	OK
SW101.001	SMh104	1.7	19.0	OK
SW101.002	SMh105	2.2	27.2	OK
SW101.003	SMh106	1.9	41.0	OK
SW100.003	SMh107	0.7	10.0	SURCHARGED
SW100.004	SMh108	0.4	10.4	SURCHARGED
SW100.005	SMh109	0.6	3.0	SURCHARGED

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model   FSR M5-60 (mm) 19.300   Cv (Summer) 0.750
Region Scotland and Ireland   Ratio R 0.256   Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0   DVD Status OFF
Analysis Timestep Fine   Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW100.000	SMh100	15 minute 30 year Winter I+20%	142.750	141.366	-0.099	0.000	0.60		0.173
SW100.001	SMh101	15 minute 30 year Winter I+20%	141.940	140.623	-0.042	0.000	0.97		0.398
SW100.002	SMh102	15 minute 30 year Winter I+20%	141.100	139.811	-0.044	0.000	0.98		0.371
SW101.000	SMh103	15 minute 30 year Winter I+20%	143.660	142.256	-0.129	0.000	0.38		0.131
SW101.001	SMh104	15 minute 30 year Winter I+20%	143.160	141.770	-0.115	0.000	0.46		0.217
SW101.002	SMh105	15 minute 30 year Winter I+20%	142.300	140.921	-0.104	0.000	0.55		0.222
SW101.003	SMh106	15 minute 30 year Winter I+20%	140.030	139.044	0.289	0.000	1.12		1.121
SW100.003	SMh107	960 minute 30 year Winter I+20%	138.900	137.547	0.387	0.000	0.09		1.301
SW100.004	SMh108	960 minute 30 year Winter I+20%	138.000	137.546	0.616	0.000	0.13		5.585
SW100.005	SMh109	960 minute 30 year Winter I+20%	138.000	137.546	0.891	0.000	0.08		327.148

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW100.000	SMh100	1.9	43.4	OK
SW100.001	SMh101	2.1	70.6	OK
SW100.002	SMh102	2.9	98.1	OK
SW101.000	SMh103	1.3	21.3	OK
SW101.001	SMh104	2.0	37.6	OK
SW101.002	SMh105	2.6	55.9	OK
SW101.003	SMh106	2.1	81.7	SURCHARGED
SW100.003	SMh107	0.7	20.5	SURCHARGED
SW100.004	SMh108	0.3	21.4	SURCHARGED
SW100.005	SMh109	0.6	3.2	SURCHARGED

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	19.300	Cv (Summer)	0.750
Region	Scotland and Ireland	Ratio R	0.256	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	150.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW100.000	SMh100	15 minute 100 year Winter I+20%	142.750	141.502	0.037	0.000	0.74		0.368
SW100.001	SMh101	15 minute 100 year Winter I+20%	141.940	141.096	0.431	0.000	1.09		1.901
SW100.002	SMh102	15 minute 100 year Winter I+20%	141.100	140.135	0.280	0.000	1.06		1.391
SW101.000	SMh103	15 minute 100 year Winter I+20%	143.660	142.272	-0.113	0.000	0.50		0.154
SW101.001	SMh104	15 minute 100 year Winter I+20%	143.160	141.789	-0.096	0.000	0.60		0.285
SW101.002	SMh105	15 minute 100 year Winter I+20%	142.300	140.944	-0.081	0.000	0.71		0.277
SW101.003	SMh106	15 minute 100 year Winter I+20%	140.030	139.781	1.026	0.000	1.38		2.863
SW100.003	SMh107	1440 minute 100 year Winter I+20%	138.900	137.706	0.546	0.000	0.09		1.910
SW100.004	SMh108	1440 minute 100 year Winter I+20%	138.000	137.705	0.775	0.000	0.12		5.812
SW100.005	SMh109	1440 minute 100 year Winter I+20%	138.000	137.704	1.049	0.000	0.09		434.599

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW100.000	SMh100	2.0	53.8	SURCHARGED
SW100.001	SMh101	2.1	79.5	SURCHARGED
SW100.002	SMh102	2.9	106.6	SURCHARGED
SW101.000	SMh103	1.4	27.7	OK
SW101.001	SMh104	2.1	48.9	OK
SW101.002	SMh105	2.8	72.8	OK
SW101.003	SMh106	2.5	100.6	SURCHARGED
SW100.003	SMh107	0.7	19.1	SURCHARGED
SW100.004	SMh108	0.3	19.9	SURCHARGED
SW100.005	SMh109	0.6	3.4	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Catchment 2

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.175	4-8	0.723	8-12	0.136

Total Area Contributing (ha) = 1.034

Total Pipe Volume (m³) = 232.471

Network Design Table for Catchment 2

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW200.000	27.500	0.676	40.7	0.161	6.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW200.001	46.396	1.178	39.4	0.000	0.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW200.002	14.563	0.607	24.0	0.021	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW201.000	49.937	0.875	57.1	0.095	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW202.000	21.146	0.798	26.5	0.060	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW202.001	43.586	1.503	29.0	0.066	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)
SW200.000	50.00	6.07	140.800	0.161	0.0	0.0	0.0	6.76	7093.4	21.8
SW200.001	50.00	6.18	140.120	0.161	0.0	0.0	0.0	6.87	7209.3	21.8
SW200.002	50.00	6.24	138.900	0.182	0.0	0.0	0.0	4.16	662.2	24.6
SW201.000	50.00	6.48	139.340	0.095	0.0	0.0	0.0	1.73	69.0	12.8
SW202.000	50.00	6.14	140.870	0.060	0.0	0.0	0.0	2.55	101.5	8.1
SW202.001	50.00	6.44	140.080	0.126	0.0	0.0	0.0	2.44	97.0	17.0

Network Design Table for Catchment 2

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW201.001	12.601	0.155	81.3	0.047	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW200.003	39.641	1.634	24.3	0.053	0.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW200.004	56.221	1.429	39.3	0.098	0.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW200.005	19.412	0.091	212.2	0.019	0.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW203.000	26.415	0.330	80.0	0.111	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW204.000	52.045	0.652	79.9	0.145	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW204.001	9.874	0.234	42.2	0.062	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW204.002	45.692	1.696	26.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW203.001	16.356	0.137	119.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW200.006	13.393	0.054	247.5	0.097	0.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW200.007	63.846	0.426	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW200.008	62.427	0.416	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW200.009	29.838	0.199	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW200.010	5.453	0.036	150.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW201.001	50.00	6.62	138.400	0.267	0.0	0.0	0.0	1.45	57.7	36.2
SW200.003	50.00	6.70	138.250	0.502	0.0	0.0	0.0	8.75	9189.6	68.0
SW200.004	50.00	6.84	136.600	0.601	0.0	0.0	0.0	6.87	7212.7	81.4
SW200.005	50.00	6.95	135.200	0.619	0.0	0.0	0.0	2.95	3098.4	83.9
SW203.000	50.00	6.30	135.570	0.111	0.0	0.0	0.0	1.46	58.2	15.0
SW204.000	50.00	6.59	137.800	0.145	0.0	0.0	0.0	1.46	58.2	19.6
SW204.001	50.00	6.67	137.140	0.207	0.0	0.0	0.0	2.02	80.3	28.1
SW204.002	50.00	6.97	136.920	0.207	0.0	0.0	0.0	2.53	100.6	28.1
SW203.001	50.00	7.20	135.300	0.318	0.0	0.0	0.0	1.20	47.5	43.1
SW200.006	50.00	7.28	135.000	1.034	0.0	0.0	0.0	2.73	2867.8	140.1
SW200.007	50.00	8.28	134.100	1.034	0.0	0.0	0.0	1.07	42.4«	140.1
SW200.008	50.00	9.26	133.680	1.034	0.0	0.0	0.0	1.07	42.4«	140.1
SW200.009	50.00	9.73	133.260	1.034	0.0	0.0	0.0	1.07	42.4«	140.1
SW200.010	50.00	9.81	133.050	1.034	0.0	0.0	0.0	1.07	42.4«	140.1

Area Summary for Catchment 2

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
200.000	User	-	25	0.162	0.040	0.040
	User	-	81	0.033	0.027	0.068
	User	-	81	0.024	0.020	0.087
	User	-	81	0.019	0.015	0.102
	User	-	81	0.072	0.058	0.161
200.001	-	-	100	0.000	0.000	0.000
200.002	User	-	81	0.026	0.021	0.021
201.000	User	-	50	0.009	0.005	0.005
	User	-	50	0.021	0.010	0.015
	User	-	25	0.000	0.000	0.015
	User	-	25	0.000	0.000	0.015
	User	-	25	0.002	0.001	0.016
	User	-	25	0.001	0.000	0.016
	User	-	25	0.001	0.000	0.016
	User	-	25	0.001	0.000	0.016
	User	-	25	0.002	0.001	0.017
	User	-	25	0.002	0.000	0.017
	User	-	80	0.022	0.018	0.035
	User	-	80	0.023	0.018	0.053
	User	-	81	0.028	0.022	0.076
	User	-	81	0.024	0.019	0.095
202.000	User	-	50	0.003	0.001	0.001
	User	-	25	0.001	0.000	0.002
	User	-	25	0.003	0.001	0.003
	User	-	25	0.001	0.000	0.003
	User	-	80	0.041	0.033	0.036
	User	-	70	0.007	0.005	0.041
	User	-	25	0.001	0.000	0.041
	User	-	25	0.001	0.000	0.041
	User	-	81	0.006	0.005	0.046
	User	-	81	0.017	0.014	0.060
202.001	User	-	50	0.018	0.009	0.009
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.009
	User	-	80	0.020	0.016	0.025
	User	-	80	0.019	0.016	0.041
	User	-	80	0.023	0.019	0.059
	User	-	10	0.062	0.006	0.066
	User	-	25	0.001	0.000	0.066
201.001	User	-	50	0.010	0.005	0.005
	User	-	25	0.002	0.001	0.005
	User	-	25	0.001	0.000	0.006
	User	-	25	0.001	0.000	0.006
	User	-	81	0.032	0.026	0.032
	User	-	81	0.018	0.015	0.047
200.003	User	-	25	0.070	0.017	0.017
	User	-	25	0.011	0.003	0.020
	User	-	81	0.011	0.009	0.029
	User	-	81	0.030	0.024	0.053
200.004	User	-	80	0.012	0.010	0.010
	User	-	80	0.012	0.009	0.019
	User	-	81	0.021	0.017	0.036
	User	-	81	0.013	0.010	0.047
	User	-	81	0.008	0.006	0.053
	User	-	81	0.056	0.045	0.098
200.005	User	-	25	0.056	0.014	0.014

Area Summary for Catchment 2

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	25	0.018	0.005	0.019
203.000	User	-	50	0.014	0.007	0.007
	User	-	25	0.005	0.001	0.008
	User	-	25	0.002	0.000	0.009
	User	-	25	0.001	0.000	0.009
	User	-	80	0.025	0.020	0.029
	User	-	80	0.050	0.040	0.069
	User	-	81	0.018	0.015	0.084
	User	-	81	0.009	0.007	0.091
	User	-	81	0.014	0.011	0.102
	User	-	20	0.026	0.005	0.107
	User	-	10	0.036	0.004	0.111
204.000	User	-	50	0.023	0.012	0.012
	User	-	25	0.003	0.001	0.013
	User	-	25	0.007	0.002	0.014
	User	-	25	0.000	0.000	0.014
	User	-	25	0.003	0.001	0.015
	User	-	25	0.007	0.002	0.017
	User	-	20	0.001	0.000	0.017
	User	-	25	0.000	0.000	0.017
	User	-	25	0.001	0.000	0.017
	User	-	25	0.001	0.000	0.017
	User	-	80	0.019	0.015	0.032
	User	-	80	0.013	0.010	0.043
	User	-	80	0.019	0.015	0.058
	User	-	81	0.006	0.005	0.063
	User	-	81	0.047	0.038	0.101
	User	-	81	0.018	0.015	0.115
	User	-	80	0.009	0.007	0.122
	User	-	81	0.025	0.021	0.143
	User	-	10	0.019	0.002	0.145
204.001	User	-	50	0.010	0.005	0.005
	User	-	25	0.002	0.001	0.006
	User	-	80	0.014	0.011	0.017
	User	-	81	0.026	0.021	0.038
	User	-	10	0.062	0.006	0.044
	User	-	80	0.023	0.018	0.062
204.002	-	-	100	0.000	0.000	0.000
203.001	-	-	100	0.000	0.000	0.000
200.006	User	-	81	0.052	0.043	0.043
	User	-	81	0.005	0.004	0.047
	User	-	25	0.202	0.050	0.097
200.007	-	-	100	0.000	0.000	0.000
200.008	-	-	100	0.000	0.000	0.000
200.009	-	-	100	0.000	0.000	0.000
200.010	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				1.896	1.034	1.034

Free Flowing Outfall Details for Catchment 2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW200.010	SMh	134.750	133.014	133.000	225	0

Simulation Criteria for Catchment 2

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 2

Hydro-Brake® Optimum Manhole: SMh216, DS/PN: SW200.007, Volume (m³): 14.1

Unit Reference	MD-SHE-0132-8000-1000-8000
Design Head (m)	1.000
Design Flow (l/s)	8.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	132
Invert Level (m)	134.750
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	8.0	Kick-Flo®	0.664	6.6
Flush-Flo™	0.302	8.0	Mean Flow over Head Range	-	6.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.7	0.800	7.2	2.000	11.1	4.000	15.4	7.000	20.1
0.200	7.8	1.000	8.0	2.200	11.6	4.500	16.3	7.500	20.8
0.300	8.0	1.200	8.7	2.400	12.1	5.000	17.1	8.000	21.5
0.400	7.9	1.400	9.4	2.600	12.6	5.500	17.9	8.500	22.1
0.500	7.7	1.600	10.0	3.000	13.4	6.000	18.7	9.000	22.7
0.600	7.2	1.800	10.5	3.500	14.5	6.500	19.4	9.500	23.3

Storage Structures for Catchment 2

Tank or Pond Manhole: SMh216, DS/PN: SW200.007

Invert Level (m) 135.000

Depth (m)	Area (m^2)	Depth (m)	Area (m^2)	Depth (m)	Area (m^2)
0.000	700.0	1.000	1250.0	1.200	1500.0

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW200.000	SMh200	15 minute 2 year Winter I+20%	142.650	140.815	-0.585	0.000	0.01		0.010
SW200.001	SMh201	15 minute 2 year Winter I+20%	142.200	140.135	-0.585	0.000	0.01		0.024
SW200.002	SMh202	15 minute 2 year Winter I+20%	140.650	138.978	-0.372	0.000	0.07		0.111
SW201.000	SMh203	15 minute 2 year Winter I+20%	140.840	139.416	-0.149	0.000	0.25		0.080
SW202.000	SMh204	15 minute 2 year Winter I+20%	142.370	140.920	-0.175	0.000	0.11		0.051
SW202.001	SMh205	15 minute 2 year Winter I+20%	141.590	140.152	-0.153	0.000	0.22		0.099
SW201.001	SMh206	15 minute 2 year Winter I+20%	139.800	138.567	-0.058	0.000	0.89		0.234
SW200.003	SMh207	15 minute 2 year Winter I+20%	139.250	138.285	-0.565	0.000	0.02		0.056
SW200.004	SMh208	15 minute 2 year Winter I+20%	138.000	136.652	-0.548	0.000	0.02		0.079
SW200.005	SMh209	15 minute 2 year Winter I+20%	137.000	135.288	-0.512	0.000	0.05		0.342
SW203.000	SMh210	15 minute 2 year Winter I+20%	136.750	135.662	-0.133	0.000	0.35		0.099
SW204.000	SMh211	15 minute 2 year Winter I+20%	139.300	137.905	-0.120	0.000	0.44		0.113
SW204.001	SMh212	15 minute 2 year Winter I+20%	138.920	137.255	-0.110	0.000	0.51		0.190
SW204.002	SMh213	15 minute 2 year Winter I+20%	138.410	137.013	-0.132	0.000	0.35		0.144
SW203.001	SMh214	15 minute 2 year Winter I+20%	136.630	135.588	0.063	0.000	1.24		1.354
SW200.006	SMh215	480 minute 2 year Winter I+20%	136.500	135.240	-0.360	0.000	0.02		1.505
SW200.007	SMh216	480 minute 2 year Winter I+20%	136.500	135.240	0.915	0.000	0.19		186.720
SW200.008	SMh217	4320 minute 2 year Summer I+20%	136.730	133.747	-0.158	0.000	0.20		0.149
SW200.009	SMh218	360 minute 2 year Winter I+20%	136.150	133.328	-0.157	0.000	0.20		0.133
SW200.010	SMh219	30 minute 2 year Winter I+20%	134.250	133.130	-0.145	0.000	0.27		0.143

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW200.000	SMh200	2.4	27.7	OK
SW200.001	SMh201	2.5	27.7	OK
SW200.002	SMh202	1.7	31.0	OK*

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW201.000	SMh203	1.4	16.2	OK
SW202.000	SMh204	1.6	10.3	OK
SW202.001	SMh205	1.9	20.7	OK
SW201.001	SMh206	1.4	44.3	OK
SW200.003	SMh207	3.1	83.6	OK
SW200.004	SMh208	2.5	98.7	OK
SW200.005	SMh209	1.3	101.2	OK
SW203.000	SMh210	1.2	19.1	OK
SW204.000	SMh211	1.4	24.7	OK
SW204.001	SMh212	1.7	34.2	OK
SW204.002	SMh213	2.2	33.9	OK
SW203.001	SMh214	1.3	52.4	SURCHARGED
SW200.006	SMh215	1.0	32.7	OK
SW200.007	SMh216	0.8	8.0	SURCHARGED*
SW200.008	SMh217	0.8	8.0	OK
SW200.009	SMh218	0.8	8.0	OK
SW200.010	SMh219	0.6	8.0	OK

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW200.000	SMh200	15 minute 30 year Winter I+20%	142.650	140.827	-0.573	0.000	0.02		0.022
SW200.001	SMh201	15 minute 30 year Winter I+20%	142.200	140.147	-0.573	0.000	0.01		0.055
SW200.002	SMh202	15 minute 30 year Winter I+20%	140.650	139.009	-0.341	0.000	0.13		0.173
SW201.000	SMh203	15 minute 30 year Winter I+20%	140.840	139.446	-0.119	0.000	0.45		0.115
SW202.000	SMh204	15 minute 30 year Winter I+20%	142.370	140.939	-0.156	0.000	0.21		0.072
SW202.001	SMh205	15 minute 30 year Winter I+20%	141.590	140.188	-0.117	0.000	0.46		0.153
SW201.001	SMh206	15 minute 30 year Winter I+20%	139.800	138.920	0.295	0.000	1.73		1.584
SW200.003	SMh207	15 minute 30 year Winter I+20%	139.250	138.313	-0.537	0.000	0.03		0.102
SW200.004	SMh208	15 minute 30 year Winter I+20%	138.000	136.680	-0.520	0.000	0.04		0.126
SW200.005	SMh209	480 minute 30 year Winter I+20%	137.000	135.480	-0.320	0.000	0.02		2.245
SW203.000	SMh210	15 minute 30 year Winter I+20%	136.750	136.175	0.380	0.000	0.60		0.679
SW204.000	SMh211	15 minute 30 year Winter I+20%	139.300	137.956	-0.069	0.000	0.81		0.171
SW204.001	SMh212	15 minute 30 year Winter I+20%	138.920	137.324	-0.041	0.000	0.99		0.409
SW204.002	SMh213	15 minute 30 year Winter I+20%	138.410	137.058	-0.087	0.000	0.68		0.241
SW203.001	SMh214	15 minute 30 year Winter I+20%	136.630	136.052	0.527	0.000	2.23		2.675
SW200.006	SMh215	480 minute 30 year Winter I+20%	136.500	135.481	-0.119	0.000	0.03		8.542
SW200.007	SMh216	480 minute 30 year Winter I+20%	136.500	135.481	1.156	0.000	0.19		404.967
SW200.008	SMh217	2880 minute 30 year Summer I+20%	136.730	133.747	-0.158	0.000	0.20		0.149
SW200.009	SMh218	2880 minute 30 year Winter I+20%	136.150	133.328	-0.157	0.000	0.20		0.133
SW200.010	SMh219	15 minute 30 year Summer I+20%	134.250	133.130	-0.145	0.000	0.27		0.143

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW200.000	SMh200	2.4	51.2	OK
SW200.001	SMh201	2.5	51.2	OK
SW200.002	SMh202	2.0	58.2	OK*

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW201.000	SMh203	1.6	30.0	OK
SW202.000	SMh204	1.8	19.1	OK
SW202.001	SMh205	2.3	42.5	OK
SW201.001	SMh206	2.2	85.7	SURCHARGED
SW200.003	SMh207	3.2	160.8	OK
SW200.004	SMh208	2.9	192.5	OK
SW200.005	SMh209	1.1	32.3	OK
SW203.000	SMh210	1.2	32.3	SURCHARGED
SW204.000	SMh211	1.6	45.5	OK
SW204.001	SMh212	1.9	65.8	OK
SW204.002	SMh213	2.6	65.8	OK
SW203.001	SMh214	2.4	94.0	SURCHARGED
SW200.006	SMh215	1.0	52.8	OK
SW200.007	SMh216	0.8	8.0	SURCHARGED*
SW200.008	SMh217	0.8	8.0	OK
SW200.009	SMh218	0.8	8.0	OK
SW200.010	SMh219	0.6	8.0	OK

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

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW200.000	SMh200	15 minute 100 year Winter I+20%	142.650	140.835	-0.565	0.000	0.02		0.031
SW200.001	SMh201	15 minute 100 year Winter I+20%	142.200	140.155	-0.565	0.000	0.02		0.076
SW200.002	SMh202	15 minute 100 year Winter I+20%	140.650	139.026	-0.324	0.000	0.17		0.256
SW201.000	SMh203	15 minute 100 year Winter I+20%	140.840	139.511	-0.054	0.000	0.58		0.188
SW202.000	SMh204	15 minute 100 year Winter I+20%	142.370	140.949	-0.146	0.000	0.27		0.084
SW202.001	SMh205	15 minute 100 year Winter I+20%	141.590	140.207	-0.098	0.000	0.60		0.187
SW201.001	SMh206	15 minute 100 year Winter I+20%	139.800	139.213	0.588	0.000	2.19		2.895
SW200.003	SMh207	15 minute 100 year Winter I+20%	139.250	138.322	-0.528	0.000	0.04		0.116
SW200.004	SMh208	15 minute 100 year Winter I+20%	138.000	136.692	-0.508	0.000	0.06		0.146
SW200.005	SMh209	600 minute 100 year Winter I+20%	137.000	135.621	-0.179	0.000	0.02		5.318
SW203.000	SMh210	15 minute 100 year Winter I+20%	136.750	136.516	0.721	0.000	0.74		1.065
SW204.000	SMh211	15 minute 100 year Winter I+20%	139.300	138.179	0.154	0.000	0.99		0.423
SW204.001	SMh212	15 minute 100 year Winter I+20%	138.920	137.552	0.187	0.000	1.15		1.350
SW204.002	SMh213	15 minute 100 year Winter I+20%	138.410	137.278	0.133	0.000	0.75		0.728
SW203.001	SMh214	15 minute 100 year Winter I+20%	136.630	136.331	0.806	0.000	2.64		3.280
SW200.006	SMh215	600 minute 100 year Winter I+20%	136.500	135.622	0.022	0.000	0.03		14.258
SW200.007	SMh216	600 minute 100 year Winter I+20%	136.500	135.622	1.297	0.000	0.19		546.715
SW200.008	SMh217	7200 minute 100 year Winter I+20%	136.730	133.747	-0.158	0.000	0.20		0.149
SW200.009	SMh218	10080 minute 100 year Summer I+20%	136.150	133.328	-0.157	0.000	0.20		0.133
SW200.010	SMh219	15 minute 100 year Winter I+20%	134.250	133.130	-0.145	0.000	0.27		0.143

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW200.000	SMh200	2.4	66.7	OK
SW200.001	SMh201	2.5	66.7	OK
SW200.002	SMh202	2.1	75.7	OK*

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

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW201.000	SMh203	1.7	38.4	OK
SW202.000	SMh204	2.0	24.8	OK
SW202.001	SMh205	2.4	55.3	OK
SW201.001	SMh206	2.8	108.9	SURCHARGED
SW200.003	SMh207	3.5	206.5	OK
SW200.004	SMh208	3.1	247.6	OK
SW200.005	SMh209	1.1	34.3	OK
SW203.000	SMh210	1.3	39.6	SURCHARGED
SW204.000	SMh211	1.6	55.2	SURCHARGED
SW204.001	SMh212	2.0	76.9	SURCHARGED
SW204.002	SMh213	2.6	72.4	SURCHARGED
SW203.001	SMh214	2.8	111.2	SURCHARGED
SW200.006	SMh215	0.9	55.8	SURCHARGED*
SW200.007	SMh216	0.8	8.0	SURCHARGED*
SW200.008	SMh217	0.8	8.0	OK
SW200.009	SMh218	0.8	8.0	OK
SW200.010	SMh219	0.6	8.0	OK

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 3

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	150

Designed with Level Soffits

Time Area Diagram for Catchment 3

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.241	4-8	0.129

Total Area Contributing (ha) = 0.371

Total Pipe Volume (m³) = 10.618

Network Design Table for Catchment 3

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW300.000	37.243	0.908	41.0	0.125	6.00	0.0	0.600	o	225	Pipe/Conduit	
SW300.001	9.765	0.287	34.0	0.039	0.00	0.0	0.600	o	225	Pipe/Conduit	
SW300.002	49.852	1.916	26.0	0.026	0.00	0.0	0.600	o	225	Pipe/Conduit	
SW301.000	59.360	1.324	44.8	0.082	6.00	0.0	0.600	o	225	Pipe/Conduit	
SW300.003	24.732	0.163	151.7	0.098	0.00	0.0	0.600	o	450	Pipe/Conduit	
SW300.004	11.897	0.079	150.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW300.000	50.00	6.30	137.300	0.125	0.0	0.0	0.0	2.05	81.5	17.0
SW300.001	50.00	6.38	136.380	0.165	0.0	0.0	0.0	2.25	89.5	22.3
SW300.002	50.00	6.70	136.090	0.191	0.0	0.0	0.0	2.58	102.4	25.9
SW301.000	50.00	6.51	135.070	0.082	0.0	0.0	0.0	1.96	77.9	11.0
SW300.003	50.00	6.95	133.700	0.371	0.0	0.0	0.0	1.65	262.1	50.2
SW300.004	50.00	7.13	133.300	0.371	0.0	0.0	0.0	1.06	42.3«	50.2

Area Summary for Catchment 3

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
300.000	User	-	50	0.011	0.005	0.005
	User	-	50	0.017	0.009	0.014
	User	-	25	0.000	0.000	0.014
	User	-	25	0.000	0.000	0.014
	User	-	25	0.001	0.000	0.014
	User	-	25	0.003	0.001	0.015
	User	-	25	0.001	0.000	0.015
	User	-	25	0.001	0.000	0.015
	User	-	80	0.010	0.008	0.024
	User	-	80	0.007	0.006	0.029
	User	-	80	0.006	0.005	0.034
	User	-	80	0.019	0.016	0.049
	User	-	81	0.026	0.021	0.071
	User	-	81	0.020	0.016	0.087
	User	-	81	0.027	0.022	0.109
	User	-	81	0.002	0.001	0.110
	User	-	10	0.043	0.004	0.115
	User	-	80	0.014	0.011	0.125
300.001	User	-	80	0.016	0.013	0.013
	User	-	80	0.007	0.005	0.018
	User	-	80	0.013	0.010	0.028
	User	-	81	0.009	0.007	0.036
	User	-	10	0.039	0.004	0.039
300.002	User	-	25	0.008	0.002	0.002
	User	-	25	0.014	0.004	0.006
	User	-	25	0.004	0.001	0.007
	User	-	80	0.019	0.015	0.022
	User	-	81	0.005	0.004	0.026
301.000	User	-	50	0.006	0.003	0.003
	User	-	50	0.016	0.008	0.011
	User	-	25	0.001	0.000	0.011
	User	-	25	0.004	0.001	0.012
	User	-	25	0.001	0.000	0.013
	User	-	25	0.004	0.001	0.014
	User	-	80	0.032	0.026	0.039
	User	-	80	0.007	0.005	0.045
	User	-	81	0.032	0.026	0.070
	User	-	81	0.002	0.001	0.072
	User	-	10	0.037	0.004	0.075
	User	-	10	0.061	0.006	0.082
300.003	User	-	25	0.096	0.024	0.024
	User	-	81	0.048	0.039	0.063
	User	-	80	0.026	0.021	0.084
	User	-	80	0.012	0.010	0.094
	User	-	81	0.005	0.004	0.098
300.004	-	-	100	0.000	0.000	0.000
				Total 0.733	Total 0.371	Total 0.371

Free Flowing Outfall Details for Catchment 3

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW300.004	SMh	134.150	133.221	133.000	225	0

Simulation Criteria for Catchment 3

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 3

Hydro-Brake® Optimum Manhole: SMh305, DS/PN: SW300.004, Volume (m^3): 5.8

Unit Reference	MD-SHE-0082-3000-1000-3000
Design Head (m)	1.000
Design Flow (l/s)	3.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	82
Invert Level (m)	133.450
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	3.0	Kick-Flo®	0.623	2.4
Flush-Flo™	0.297	3.0	Mean Flow over Head Range	-	2.6

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

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	2.4	0.800	2.7	2.000	4.1	4.000	5.7	7.000	7.4
0.200	2.9	1.000	3.0	2.200	4.3	4.500	6.0	7.500	7.7
0.300	3.0	1.200	3.3	2.400	4.5	5.000	6.3	8.000	7.9
0.400	2.9	1.400	3.5	2.600	4.7	5.500	6.6	8.500	8.2
0.500	2.8	1.600	3.7	3.000	5.0	6.000	6.9	9.000	8.4
0.600	2.5	1.800	3.9	3.500	5.4	6.500	7.2	9.500	8.6

Storage Structures for Catchment 3

Tank or Pond Manhole: SMh305, DS/PN: SW300.004

Invert Level (m) 133.500

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	225.0	1.000	500.0	1.200	750.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 3

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW300.000	SMh300	15 minute 2 year Winter I+20%	138.800	137.381	-0.144	0.000	0.28		0.086
SW300.001	SMh301	15 minute 2 year Winter I+20%	137.890	136.475	-0.130	0.000	0.37		0.121
SW300.002	SMh302	15 minute 2 year Winter I+20%	137.600	136.178	-0.137	0.000	0.32		0.111
SW301.000	SMh303	15 minute 2 year Winter I+20%	136.750	135.135	-0.160	0.000	0.19		0.068
SW300.003	SMh304	15 minute 2 year Winter I+20%	135.670	133.861	-0.289	0.000	0.28		0.275
SW300.004	SMh305	480 minute 2 year Winter I+20%	134.750	133.780	0.255	0.000	0.08		73.921

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW300.000	SMh300	1.7	21.6	OK
SW300.001	SMh301	1.7	27.7	OK
SW300.002	SMh302	2.2	31.8	OK
SW301.000	SMh303	1.5	14.0	OK
SW300.003	SMh304	1.2	60.6	OK
SW300.004	SMh305	0.6	3.0	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 3

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	19.300	Cv (Summer)	0.750
Region	Scotland and Ireland	Ratio R	0.256	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	150.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW300.000	SMh300	15 minute 30 year Winter I+20%	138.800	137.415	-0.110	0.000	0.52		0.124
SW300.001	SMh301	15 minute 30 year Winter I+20%	137.890	136.524	-0.081	0.000	0.71		0.217
SW300.002	SMh302	15 minute 30 year Winter I+20%	137.600	136.222	-0.093	0.000	0.63		0.186
SW301.000	SMh303	15 minute 30 year Winter I+20%	136.750	135.161	-0.134	0.000	0.34		0.097
SW300.003	SMh304	600 minute 30 year Winter I+20%	135.670	134.021	-0.129	0.000	0.08		0.728
SW300.004	SMh305	600 minute 30 year Winter I+20%	134.750	134.020	0.495	0.000	0.08		153.806

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW300.000	SMh300	2.0	39.9	OK
SW300.001	SMh301	2.0	52.8	OK
SW300.002	SMh302	2.6	62.1	OK
SW301.000	SMh303	1.7	25.8	OK
SW300.003	SMh304	0.8	16.6	OK
SW300.004	SMh305	0.6	3.0	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 3

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	19.300	Cv (Summer)	0.750
Region	Scotland and Ireland	Ratio R	0.256	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	150.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW300.000	SMh300	15 minute 100 year Winter I+20%	138.800	137.436	-0.089	0.000	0.67		0.148
SW300.001	SMh301	15 minute 100 year Winter I+20%	137.890	136.554	-0.051	0.000	0.92		0.282
SW300.002	SMh302	15 minute 100 year Winter I+20%	137.600	136.249	-0.066	0.000	0.82		0.238
SW301.000	SMh303	15 minute 100 year Winter I+20%	136.750	135.176	-0.119	0.000	0.45		0.114
SW300.003	SMh304	720 minute 100 year Winter I+20%	135.670	134.171	0.021	0.000	0.08		1.205
SW300.004	SMh305	720 minute 100 year Winter I+20%	134.750	134.170	0.645	0.000	0.08		210.692

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW300.000	SMh300	2.1	51.9	OK
SW300.001	SMh301	2.1	68.6	OK
SW300.002	SMh302	2.7	80.8	OK
SW301.000	SMh303	1.8	33.6	OK
SW300.003	SMh304	0.8	18.1	SURCHARGED
SW300.004	SMh305	0.6	3.0	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 4

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 4

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.684	4-8	0.985	8-12	0.058

Total Area Contributing (ha) = 1.726

Total Pipe Volume (m³) = 60.671

Network Design Table for Catchment 4

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW400.000	40.703	2.037	20.0	0.128	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW400.001	9.319	0.458	20.3	0.055	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW400.002	53.241	2.655	20.1	0.125	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW401.000	20.484	0.944	21.7	0.083	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW401.001	12.508	0.383	32.7	0.045	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW401.002	38.742	1.760	22.0	0.092	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW400.003	25.099	0.402	62.4	0.067	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW400.000	50.00	6.23	144.510	0.128	0.0	0.0	0.0	2.94	116.9	17.4
SW400.001	50.00	6.28	142.470	0.183	0.0	0.0	0.0	2.91	115.9	24.8
SW400.002	50.00	6.59	142.010	0.309	0.0	0.0	0.0	2.94	116.7	41.8
SW401.000	50.00	6.12	142.470	0.083	0.0	0.0	0.0	2.82	112.2	11.2
SW401.001	50.00	6.21	141.530	0.128	0.0	0.0	0.0	2.30	91.3	17.4
SW401.002	50.00	6.44	141.150	0.221	0.0	0.0	0.0	2.80	111.4	29.9
SW400.003	50.00	6.80	139.300	0.596	0.0	0.0	0.0	1.99	140.9	80.7

Network Design Table for Catchment 4

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW402.000	30.223	1.406	21.5	0.064	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW402.001	29.615	1.476	20.1	0.034	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW402.002	36.997	1.247	29.7	0.037	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW400.004	57.845	2.652	21.8	0.134	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW403.000	36.667	0.432	84.8	0.115	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW403.001	41.259	0.449	91.9	0.126	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW400.005	14.879	0.174	85.5	0.049	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW404.000	21.043	0.535	39.3	0.046	6.00	0.0	0.600	o	225	Pipe/Conduit	🔓
SW400.006	24.461	0.162	151.0	0.021	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW400.007	12.783	0.158	81.0	0.016	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW400.008	27.936	0.766	36.5	0.095	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW405.000	13.683	0.682	20.1	0.000	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW405.001	13.220	0.665	19.9	0.071	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW405.002	9.309	0.391	23.8	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW405.003	34.729	0.277	125.3	0.068	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW405.004	34.115	0.277	123.2	0.100	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW400.009	20.915	0.239	87.5	0.058	0.00	0.1	0.600	o	375	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW402.000	50.00	6.18	143.120	0.064	0.0	0.0	0.0	2.83	112.7	8.6
SW402.001	50.00	6.35	141.740	0.098	0.0	0.0	0.0	2.93	116.7	13.2
SW402.002	50.00	6.60	140.260	0.134	0.0	0.0	0.0	2.41	95.9	18.2
SW400.004	50.00	7.04	138.900	0.864	0.0	0.0	0.0	3.89	430.1	117.1
SW403.000	50.00	6.43	137.100	0.115	0.0	0.0	0.0	1.42	56.5	15.6
SW403.001	50.00	6.79	136.650	0.241	0.0	0.0	0.0	1.89	208.8	32.6
SW400.005	50.00	7.16	136.100	1.154	0.0	0.0	0.0	2.20	349.8	156.3
SW404.000	50.00	6.17	137.250	0.046	0.0	0.0	0.0	2.09	83.2	6.3
SW400.006	50.00	7.40	135.930	1.221	0.0	0.0	0.0	1.65	262.8	165.4
SW400.007	50.00	7.55	135.000	1.237	0.0	0.0	0.0	1.45	57.8«	167.5
SW400.008	50.00	7.76	134.870	1.332	0.0	0.0	0.0	2.17	86.4«	180.4
SW405.000	50.00	6.08	135.680	0.000	0.0	0.0	0.0	2.93	116.7	0.0
SW405.001	50.00	6.15	134.990	0.071	0.0	0.0	0.0	2.95	117.2	9.6
SW405.002	50.00	6.21	134.320	0.076	0.0	0.0	0.0	2.69	107.1	10.3
SW405.003	50.00	6.71	133.940	0.144	0.0	0.0	0.0	1.17	46.4	19.5
SW405.004	50.00	7.11	133.570	0.244	0.0	0.0	0.0	1.42	100.1	33.1
SW400.009	50.00	7.94	133.280	1.634	0.1	0.0	0.0	1.94	214.0«	221.4

Network Design Table for Catchment 4

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW400.010	8.961	0.110	81.5	0.019	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW406.000	42.397	2.052	20.7	0.009	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW406.001	38.450	0.148	259.6	0.021	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW400.011	64.031	0.263	243.7	0.041	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW400.012	11.462	0.077	148.1	0.002	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)
SW400.010	50.00	8.02	132.350	1.653	0.1	0.0	0.0	2.01	221.9«	224.0
SW406.000	50.00	6.24	135.140	0.009	0.0	0.0	0.0	2.89	115.0	1.2
SW406.001	50.00	6.75	132.500	0.030	0.0	0.0	0.0	1.26	199.9	4.1
SW400.011	50.00	8.84	132.250	1.724	0.1	0.0	0.0	1.30	206.4«	233.6
SW400.012	50.00	9.02	131.800	1.726	0.1	0.0	0.0	1.07	42.6«	233.9

Area Summary for Catchment 4

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
400.000	User	-	50	0.013	0.006	0.006
	User	-	50	0.015	0.007	0.014
	User	-	50	0.016	0.008	0.022
	User	-	25	0.001	0.000	0.022
	User	-	25	0.001	0.000	0.022
	User	-	25	0.001	0.000	0.022
	User	-	25	0.001	0.000	0.023
	User	-	25	0.001	0.000	0.023
	User	-	25	0.001	0.000	0.023
	User	-	25	0.001	0.000	0.023
	User	-	80	0.016	0.013	0.036
	User	-	80	0.019	0.015	0.052
	User	-	81	0.052	0.042	0.094
	User	-	81	0.029	0.024	0.118
	User	-	100	0.001	0.001	0.119
	User	-	25	0.009	0.002	0.122
	User	-	25	0.020	0.005	0.127
	User	-	25	0.007	0.002	0.128
400.001	User	-	20	0.009	0.002	0.002
	User	-	80	0.048	0.038	0.040
	User	-	25	0.008	0.002	0.042
	User	-	25	0.002	0.000	0.042
	User	-	25	0.004	0.001	0.044
	User	-	25	0.006	0.002	0.045
	User	-	81	0.010	0.008	0.053
	User	-	81	0.002	0.002	0.055
400.002	User	-	50	0.022	0.011	0.011
	User	-	25	0.002	0.000	0.012
	User	-	25	0.001	0.000	0.012
	User	-	25	0.001	0.000	0.012
	User	-	25	0.001	0.000	0.012
	User	-	25	0.001	0.000	0.013
	User	-	50	0.004	0.002	0.015
	User	-	80	0.032	0.025	0.040
	User	-	80	0.018	0.015	0.055
	User	-	80	0.018	0.015	0.069
	User	-	81	0.039	0.032	0.101
	User	-	81	0.015	0.012	0.113
	User	-	81	0.004	0.003	0.116
	User	-	10	0.058	0.006	0.122
	User	-	10	0.022	0.002	0.124
	User	-	25	0.004	0.001	0.125
401.000	User	-	50	0.007	0.004	0.004
	User	-	25	0.001	0.000	0.004
	User	-	25	0.002	0.000	0.004
	User	-	25	0.005	0.001	0.006
	User	-	25	0.010	0.003	0.008
	User	-	80	0.010	0.008	0.016
	User	-	81	0.080	0.065	0.081
	User	-	80	0.002	0.002	0.083
401.001	User	-	50	0.013	0.006	0.006
	User	-	25	0.001	0.000	0.007
	User	-	25	0.002	0.001	0.007
	User	-	80	0.015	0.012	0.019
	User	-	80	0.009	0.007	0.027
	User	-	80	0.017	0.014	0.041
	User	-	10	0.045	0.005	0.045

Area Summary for Catchment 4

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
401.002	User	-	50	0.012	0.006	0.006
	User	-	25	0.008	0.002	0.008
	User	-	25	0.001	0.000	0.008
	User	-	25	0.002	0.000	0.009
	User	-	80	0.019	0.015	0.024
	User	-	80	0.016	0.013	0.036
	User	-	81	0.042	0.034	0.070
	User	-	81	0.016	0.013	0.083
	User	-	81	0.011	0.009	0.092
400.003	User	-	50	0.009	0.005	0.005
	User	-	25	0.004	0.001	0.005
	User	-	80	0.013	0.011	0.016
	User	-	81	0.018	0.014	0.030
	User	-	81	0.017	0.014	0.044
	User	-	81	0.016	0.013	0.057
	User	-	81	0.011	0.009	0.067
402.000	User	-	50	0.016	0.008	0.008
	User	-	25	0.001	0.000	0.008
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.009
	User	-	80	0.009	0.007	0.016
	User	-	80	0.015	0.012	0.028
	User	-	81	0.029	0.024	0.052
	User	-	81	0.009	0.007	0.059
	User	-	81	0.002	0.001	0.060
	User	-	81	0.002	0.002	0.062
	User	-	25	0.003	0.001	0.063
	User	-	81	0.001	0.001	0.064
402.001	User	-	50	0.010	0.005	0.005
	User	-	25	0.001	0.000	0.005
	User	-	80	0.019	0.015	0.020
	User	-	80	0.011	0.009	0.029
	User	-	10	0.026	0.003	0.032
	User	-	10	0.021	0.002	0.034
402.002	User	-	50	0.006	0.003	0.003
	User	-	55	0.004	0.002	0.005
	User	-	25	0.003	0.001	0.006
	User	-	25	0.001	0.000	0.006
	User	-	25	0.002	0.001	0.007
	User	-	25	0.003	0.001	0.008
	User	-	25	0.003	0.001	0.009
	User	-	80	0.015	0.012	0.021
	User	-	81	0.016	0.013	0.034
	User	-	81	0.004	0.003	0.037
400.004	User	-	50	0.009	0.005	0.005
	User	-	50	0.013	0.006	0.011
	User	-	25	0.003	0.001	0.012
	User	-	25	0.002	0.001	0.012
	User	-	25	0.001	0.000	0.012
	User	-	80	0.012	0.010	0.022
	User	-	80	0.016	0.013	0.035
	User	-	80	0.048	0.038	0.074
	User	-	81	0.028	0.023	0.096
	User	-	81	0.033	0.027	0.123
	User	-	81	0.011	0.009	0.132
	User	-	10	0.017	0.002	0.134

Area Summary for Catchment 4

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
403.000	User	-	50	0.015	0.007	0.007
	User	-	50	0.014	0.007	0.015
	User	-	25	0.001	0.000	0.015
	User	-	25	0.001	0.000	0.015
	User	-	25	0.006	0.001	0.017
	User	-	25	0.007	0.002	0.018
	User	-	25	0.014	0.004	0.022
	User	-	20	0.005	0.001	0.023
	User	-	80	0.019	0.015	0.038
	User	-	80	0.015	0.012	0.050
	User	-	80	0.008	0.006	0.056
	User	-	80	0.025	0.020	0.076
	User	-	81	0.024	0.019	0.095
	User	-	81	0.021	0.017	0.112
	User	-	10	0.038	0.004	0.115
403.001	User	-	50	0.013	0.006	0.006
	User	-	50	0.006	0.003	0.009
	User	-	25	0.001	0.000	0.010
	User	-	25	0.001	0.000	0.010
	User	-	25	0.001	0.000	0.010
	User	-	80	0.009	0.007	0.017
	User	-	80	0.025	0.020	0.037
	User	-	80	0.018	0.015	0.051
	User	-	80	0.022	0.018	0.069
	User	-	81	0.013	0.011	0.080
	User	-	81	0.017	0.014	0.094
	User	-	81	0.026	0.021	0.115
	User	-	10	0.080	0.008	0.123
	User	-	10	0.029	0.003	0.126
400.005	User	-	25	0.003	0.001	0.001
	User	-	25	0.001	0.000	0.001
	User	-	25	0.001	0.000	0.001
	User	-	81	0.047	0.038	0.040
	User	-	81	0.011	0.009	0.049
404.000	User	-	50	0.009	0.005	0.005
	User	-	25	0.003	0.001	0.005
	User	-	25	0.002	0.001	0.006
	User	-	25	0.002	0.001	0.006
	User	-	25	0.001	0.000	0.007
	User	-	25	0.001	0.000	0.007
	User	-	25	0.001	0.000	0.007
	User	-	25	0.001	0.000	0.007
	User	-	80	0.035	0.028	0.036
	User	-	81	0.013	0.011	0.046
400.006	User	-	50	0.006	0.003	0.003
	User	-	50	0.009	0.005	0.008
	User	-	25	0.002	0.000	0.008
	User	-	81	0.016	0.013	0.021
400.007	User	-	25	0.062	0.016	0.016
400.008	User	-	50	0.022	0.011	0.011
	User	-	25	0.001	0.000	0.011
	User	-	25	0.002	0.001	0.012
	User	-	25	0.003	0.001	0.012
	User	-	80	0.018	0.014	0.026
	User	-	81	0.031	0.025	0.051
	User	-	81	0.015	0.012	0.064
	User	-	81	0.026	0.021	0.085

Area Summary for Catchment 4

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	81	0.009	0.007	0.092
	User	-	10	0.030	0.003	0.095
405.000	-	-	100	0.000	0.000	0.000
405.001	User	-	50	0.009	0.005	0.005
	User	-	25	0.011	0.003	0.007
	User	-	25	0.001	0.000	0.008
	User	-	80	0.019	0.015	0.023
	User	-	81	0.037	0.030	0.053
	User	-	81	0.010	0.008	0.061
	User	-	10	0.028	0.003	0.064
	User	-	81	0.007	0.005	0.069
	User	-	25	0.005	0.001	0.071
405.002	User	-	50	0.007	0.004	0.004
	User	-	25	0.001	0.000	0.004
	User	-	25	0.005	0.001	0.005
405.003	User	-	50	0.014	0.007	0.007
	User	-	50	0.009	0.005	0.012
	User	-	25	0.001	0.000	0.012
	User	-	25	0.001	0.000	0.012
	User	-	25	0.004	0.001	0.013
	User	-	25	0.001	0.000	0.014
	User	-	25	0.007	0.002	0.015
	User	-	80	0.020	0.016	0.031
	User	-	81	0.027	0.022	0.053
	User	-	81	0.019	0.016	0.068
405.004	User	-	50	0.013	0.007	0.007
	User	-	25	0.001	0.000	0.007
	User	-	25	0.001	0.000	0.007
	User	-	25	0.001	0.000	0.007
	User	-	25	0.001	0.000	0.008
	User	-	80	0.019	0.015	0.023
	User	-	80	0.023	0.018	0.041
	User	-	80	0.035	0.028	0.069
	User	-	81	0.025	0.020	0.090
	User	-	81	0.008	0.007	0.097
	User	-	10	0.035	0.004	0.100
400.009	User	-	25	0.002	0.001	0.001
	User	-	25	0.005	0.001	0.002
	User	-	25	0.001	0.000	0.002
	User	-	25	0.001	0.000	0.002
	User	-	80	0.037	0.029	0.032
	User	-	81	0.020	0.016	0.048
	User	-	81	0.013	0.010	0.058
400.010	User	-	25	0.005	0.001	0.001
	User	-	80	0.022	0.018	0.019
406.000	User	-	25	0.004	0.001	0.001
	User	-	25	0.005	0.001	0.002
	User	-	25	0.006	0.001	0.004
	User	-	81	0.002	0.002	0.006
	User	-	81	0.002	0.002	0.007
	User	-	81	0.002	0.002	0.009
406.001	User	-	25	0.005	0.001	0.001
	User	-	25	0.006	0.002	0.003
	User	-	80	0.023	0.018	0.021
400.011	User	-	25	0.164	0.041	0.041
400.012	User	-	25	0.008	0.002	0.002
				Total	Total	Total

Area Summary for Catchment 4

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
				3.000	1.726	1.726

Free Flowing Outfall Details for Catchment 4

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW400.012	SMh	133.000	131.723	131.600	0	0

Simulation Criteria for Catchment 4

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 4

Hydro-Brake® Optimum Manhole: SMh416, DS/PN: SW400.007, Volume (m³): 6.9

Unit Reference	MD-SHE-0170-1400-1000-1400
Design Head (m)	1.000
Design Flow (l/s)	14.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	170
Invert Level (m)	135.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	14.0	Kick-Flo®	0.694	11.8
Flush-Flo™	0.317	13.9	Mean Flow over Head Range	-	11.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.0	0.800	12.6	2.000	19.5	4.000	27.1	7.000	35.5
0.200	13.4	1.000	14.0	2.200	20.4	4.500	28.7	7.500	36.7
0.300	13.9	1.200	15.3	2.400	21.2	5.000	30.2	8.000	37.9
0.400	13.8	1.400	16.4	2.600	22.1	5.500	31.6	8.500	39.0
0.500	13.5	1.600	17.5	3.000	23.6	6.000	33.0	9.000	40.1
0.600	13.0	1.800	18.5	3.500	25.4	6.500	34.3	9.500	41.2

Hydro-Brake® Optimum Manhole: SMh427, DS/PN: SW400.012, Volume (m³): 12.0

Unit Reference	MD-SHE-0156-1160-1000-1160
Design Head (m)	1.000
Design Flow (l/s)	11.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	156
Invert Level (m)	131.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	11.6	Kick-Flo®	0.683	9.7
Flush-Flo™	0.308	11.6	Mean Flow over Head Range	-	9.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.6	0.200	11.2	0.300	11.6	0.400	11.5	0.500	11.2

Hydro-Brake® Optimum Manhole: SMh427, DS/PN: SW400.012, Volume (m³): 12.0

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.600	10.7	1.600	14.5	2.600	18.3	5.000	25.0	7.500	30.4
0.800	10.4	1.800	15.3	3.000	19.5	5.500	26.1	8.000	31.3
1.000	11.6	2.000	16.1	3.500	21.0	6.000	27.3	8.500	32.3
1.200	12.6	2.200	16.9	4.000	22.4	6.500	28.3	9.000	33.2
1.400	13.6	2.400	17.6	4.500	23.7	7.000	29.4	9.500	34.0

Storage Structures for Catchment 4

Tank or Pond Manhole: SMh416, DS/PN: SW400.007

Invert Level (m) 135.050

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	450.0	1.450	450.0	1.451	0.0

Tank or Pond Manhole: SMh427, DS/PN: SW400.012

Invert Level (m) 132.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	900.0	1.000	1200.0	1.250	1500.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW400.000	SMh400	15 minute 2 year Winter I+20%	146.110	144.578	-0.157	0.000	0.20		0.071
SW400.001	SMh401	15 minute 2 year Winter I+20%	144.090	142.558	-0.137	0.000	0.32		0.105
SW400.002	SMh402	15 minute 2 year Winter I+20%	143.620	142.116	-0.119	0.000	0.45		0.128
SW401.000	SMh403	15 minute 2 year Winter I+20%	143.970	142.526	-0.169	0.000	0.14		0.058
SW401.001	SMh404	15 minute 2 year Winter I+20%	143.130	141.610	-0.145	0.000	0.27		0.101
SW401.002	SMh405	15 minute 2 year Winter I+20%	142.750	141.241	-0.134	0.000	0.34		0.120
SW400.003	SMh406	15 minute 2 year Winter I+20%	140.930	139.500	-0.100	0.000	0.77		0.271
SW402.000	SMh407	15 minute 2 year Winter I+20%	144.720	143.168	-0.177	0.000	0.10		0.049
SW402.001	SMh408	15 minute 2 year Winter I+20%	143.240	141.798	-0.167	0.000	0.15		0.101
SW402.002	SMh409	15 minute 2 year Winter I+20%	141.720	140.336	-0.149	0.000	0.24		0.089
SW400.004	SMh410	15 minute 2 year Winter I+20%	140.510	139.053	-0.222	0.000	0.35		0.377
SW403.000	SMh411	15 minute 2 year Winter I+20%	138.650	137.195	-0.130	0.000	0.37		0.102
SW403.001	SMh412	15 minute 2 year Winter I+20%	138.250	136.766	-0.259	0.000	0.21		0.216
SW400.005	SMh413	15 minute 2 year Winter I+20%	137.900	136.403	-0.147	0.000	0.79		0.926
SW404.000	SMh414	15 minute 2 year Winter I+20%	138.770	137.299	-0.176	0.000	0.11		0.049
SW400.006	SMh415	15 minute 2 year Winter I+20%	138.250	136.264	-0.116	0.000	0.90		1.670
SW400.007	SMh416	360 minute 2 year Winter I+20%	137.250	135.518	0.293	0.000	0.28		211.331
SW400.008	SMh417	30 minute 2 year Winter I+20%	136.870	134.959	-0.136	0.000	0.33		0.203
SW405.000	SMh19	15 minute 2 year Summer I+20%	137.200	135.680	-0.225	0.000	0.00		0.000
SW405.001	SMh418	15 minute 2 year Winter I+20%	136.510	135.040	-0.175	0.000	0.11		0.055
SW405.002	SMh419	15 minute 2 year Winter I+20%	135.950	134.375	-0.170	0.000	0.14		0.063
SW405.003	SMh420	15 minute 2 year Winter I+20%	135.440	134.056	-0.109	0.000	0.52		0.167
SW405.004	SMh421	15 minute 2 year Winter I+20%	135.720	133.705	-0.165	0.000	0.41		0.178
SW400.009	SMh422	15 minute 2 year Winter I+20%	135.950	133.443	-0.212	0.000	0.39		0.517
SW400.010	SMh423	15 minute 2 year Winter I+20%	134.920	132.553	-0.172	0.000	0.56		0.283
SW406.000	SMh424	15 minute 2 year Winter I+20%	136.740	135.155	-0.210	0.000	0.01		0.011
SW406.001	SMh425	15 minute 2 year Winter I+20%	134.630	132.550	-0.400	0.000	0.03		0.064
SW400.011	SMh426	15 minute 2 year Winter I+20%	133.500	132.458	-0.242	0.000	0.44		0.966
SW400.012	SMh427	960 minute 2 year Winter I+20%	133.250	132.269	0.244	0.000	0.32		256.277

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW400.000	SMh400	2.2	22.1	OK
SW400.001	SMh401	2.1	30.7	OK
SW400.002	SMh402	2.8	50.4	OK
SW401.000	SMh403	1.9	14.3	OK
SW401.001	SMh404	1.7	21.4	OK
SW401.002	SMh405	2.4	35.9	OK
SW400.003	SMh406	2.0	96.9	OK
SW402.000	SMh407	1.8	11.0	OK
SW402.001	SMh408	2.0	16.3	OK
SW402.002	SMh409	1.9	22.1	OK
SW400.004	SMh410	3.3	139.9	OK
SW403.000	SMh411	1.3	19.8	OK
SW403.001	SMh412	1.4	39.2	OK
SW400.005	SMh413	1.6	186.1	OK
SW404.000	SMh414	1.3	8.0	OK
SW400.006	SMh415	1.6	196.6	OK
SW400.007	SMh416	1.2	13.9	SURCHARGED
SW400.008	SMh417	1.8	26.5	OK
SW405.000	SMh19	0.0	0.0	OK
SW405.001	SMh418	1.7	11.2	OK
SW405.002	SMh419	1.6	11.9	OK
SW405.003	SMh420	1.1	22.7	OK
SW405.004	SMh421	1.2	38.0	OK
SW400.009	SMh422	1.5	70.4	OK
SW400.010	SMh423	1.2	73.3	OK
SW406.000	SMh424	1.4	1.5	OK
SW406.001	SMh425	0.5	4.8	OK
SW400.011	SMh426	1.2	83.8	OK
SW400.012	SMh427	0.9	11.6	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW400.000	SMh400	15 minute 30 year Winter I+20%	146.110	144.604	-0.131	0.000	0.37		0.101
SW400.001	SMh401	15 minute 30 year Winter I+20%	144.090	142.601	-0.094	0.000	0.63		0.170
SW400.002	SMh402	15 minute 30 year Winter I+20%	143.620	142.301	0.066	0.000	0.89		0.444
SW401.000	SMh403	15 minute 30 year Winter I+20%	143.970	142.548	-0.147	0.000	0.26		0.082
SW401.001	SMh404	15 minute 30 year Winter I+20%	143.130	141.649	-0.106	0.000	0.54		0.158
SW401.002	SMh405	15 minute 30 year Winter I+20%	142.750	141.294	-0.081	0.000	0.72		0.216
SW400.003	SMh406	15 minute 30 year Winter I+20%	140.930	140.189	0.589	0.000	1.57		2.136
SW402.000	SMh407	15 minute 30 year Winter I+20%	144.720	143.187	-0.158	0.000	0.19		0.070
SW402.001	SMh408	15 minute 30 year Winter I+20%	143.240	141.824	-0.141	0.000	0.30		0.137
SW402.002	SMh409	15 minute 30 year Winter I+20%	141.720	140.374	-0.111	0.000	0.50		0.141
SW400.004	SMh410	15 minute 30 year Winter I+20%	140.510	139.139	-0.136	0.000	0.71		0.770
SW403.000	SMh411	15 minute 30 year Winter I+20%	138.650	137.354	0.029	0.000	0.65		0.282
SW403.001	SMh412	15 minute 30 year Winter I+20%	138.250	137.174	0.149	0.000	0.40		1.971
SW400.005	SMh413	15 minute 30 year Winter I+20%	137.900	137.111	0.561	0.000	1.53		7.425
SW404.000	SMh414	15 minute 30 year Winter I+20%	138.770	137.317	-0.158	0.000	0.19		0.070
SW400.006	SMh415	15 minute 30 year Winter I+20%	138.250	136.694	0.314	0.000	1.74		3.243
SW400.007	SMh416	480 minute 30 year Winter I+20%	137.250	136.021	0.796	0.000	0.28		439.661
SW400.008	SMh417	15 minute 30 year Winter I+20%	136.870	134.996	-0.099	0.000	0.58		0.316
SW405.000	SMh19	15 minute 30 year Summer I+20%	137.200	135.680	-0.225	0.000	0.00		0.000
SW405.001	SMh418	15 minute 30 year Winter I+20%	136.510	135.067	-0.148	0.000	0.26		0.089
SW405.002	SMh419	15 minute 30 year Winter I+20%	135.950	134.407	-0.138	0.000	0.32		0.102
SW405.003	SMh420	15 minute 30 year Winter I+20%	135.440	134.273	0.108	0.000	1.17		0.571
SW405.004	SMh421	15 minute 30 year Winter I+20%	135.720	133.801	-0.069	0.000	0.92		0.452
SW400.009	SMh422	15 minute 30 year Winter I+20%	135.950	133.547	-0.108	0.000	0.83		1.253
SW400.010	SMh423	15 minute 30 year Winter I+20%	134.920	132.767	0.042	0.000	1.21		0.589
SW406.000	SMh424	15 minute 30 year Winter I+20%	136.740	135.164	-0.201	0.000	0.03		0.022
SW406.001	SMh425	15 minute 30 year Winter I+20%	134.630	132.609	-0.341	0.000	0.06		0.148
SW400.011	SMh426	15 minute 30 year Winter I+20%	133.500	132.593	-0.107	0.000	0.92		3.134
SW400.012	SMh427	2160 minute 30 year Winter I+20%	133.250	132.554	0.529	0.000	0.32		552.698

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW400.000	SMh400	2.6	40.8	OK
SW400.001	SMh401	2.5	59.7	OK
SW400.002	SMh402	3.1	100.2	SURCHARGED
SW401.000	SMh403	2.2	26.4	OK
SW401.001	SMh404	2.0	42.1	OK
SW401.002	SMh405	2.9	75.8	OK
SW400.003	SMh406	2.8	197.3	SURCHARGED
SW402.000	SMh407	2.1	20.3	OK
SW402.001	SMh408	2.4	32.1	OK
SW402.002	SMh409	2.3	45.3	OK
SW400.004	SMh410	3.9	286.1	OK
SW403.000	SMh411	1.4	34.9	SURCHARGED
SW403.001	SMh412	1.5	75.5	SURCHARGED
SW400.005	SMh413	2.3	360.9	SURCHARGED
SW404.000	SMh414	1.5	14.7	OK
SW400.006	SMh415	2.4	381.0	SURCHARGED
SW400.007	SMh416	1.2	14.1	SURCHARGED
SW400.008	SMh417	2.1	46.5	OK
SW405.000	SMh19	0.0	0.0	OK
SW405.001	SMh418	2.2	26.1	OK
SW405.002	SMh419	2.0	28.0	OK
SW405.003	SMh420	1.3	51.0	SURCHARGED
SW405.004	SMh421	1.5	84.7	OK
SW400.009	SMh422	1.8	150.4	OK
SW400.010	SMh423	1.4	157.2	SURCHARGED
SW406.000	SMh424	1.3	2.8	OK
SW406.001	SMh425	0.6	9.9	OK
SW400.011	SMh426	1.4	176.6	OK
SW400.012	SMh427	0.9	11.6	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW400.000	SMh400	15 minute 100 year Winter I+20%	146.110	144.620	-0.115	0.000	0.48		0.118
SW400.001	SMh401	15 minute 100 year Winter I+20%	144.090	143.347	0.652	0.000	0.73		1.569
SW400.002	SMh402	15 minute 100 year Winter I+20%	143.620	143.112	0.877	0.000	0.99		1.564
SW401.000	SMh403	15 minute 100 year Winter I+20%	143.970	142.560	-0.135	0.000	0.34		0.096
SW401.001	SMh404	15 minute 100 year Winter I+20%	143.130	141.837	0.082	0.000	0.65		0.503
SW401.002	SMh405	15 minute 100 year Winter I+20%	142.750	141.677	0.302	0.000	0.82		1.024
SW400.003	SMh406	15 minute 100 year Winter I+20%	140.930	140.491	0.891	0.000	1.76		2.970
SW402.000	SMh407	15 minute 100 year Winter I+20%	144.720	143.196	-0.149	0.000	0.25		0.081
SW402.001	SMh408	15 minute 100 year Winter I+20%	143.240	141.838	-0.127	0.000	0.38		0.160
SW402.002	SMh409	15 minute 100 year Winter I+20%	141.720	140.395	-0.090	0.000	0.65		0.175
SW400.004	SMh410	15 minute 100 year Winter I+20%	140.510	139.245	-0.030	0.000	0.83		1.424
SW403.000	SMh411	15 minute 100 year Winter I+20%	138.650	137.877	0.552	0.000	0.86		0.873
SW403.001	SMh412	15 minute 100 year Winter I+20%	138.250	137.589	0.564	0.000	0.45		2.743
SW400.005	SMh413	15 minute 100 year Winter I+20%	137.900	137.488	0.938	0.000	1.83		8.859
SW404.000	SMh414	15 minute 100 year Winter I+20%	138.770	137.327	-0.148	0.000	0.25		0.081
SW400.006	SMh415	15 minute 100 year Winter I+20%	138.250	136.900	0.520	0.000	2.08		3.649
SW400.007	SMh416	480 minute 100 year Winter I+20%	137.250	136.330	1.105	0.000	0.32		581.215
SW400.008	SMh417	15 minute 100 year Winter I+20%	136.870	135.014	-0.081	0.000	0.72		0.373
SW405.000	SMh19	15 minute 100 year Summer I+20%	137.200	135.680	-0.225	0.000	0.00		0.000
SW405.001	SMh418	15 minute 100 year Winter I+20%	136.510	135.079	-0.136	0.000	0.33		0.105
SW405.002	SMh419	15 minute 100 year Winter I+20%	135.950	134.589	0.044	0.000	0.38		0.404
SW405.003	SMh420	15 minute 100 year Winter I+20%	135.440	134.531	0.366	0.000	1.43		0.998
SW405.004	SMh421	15 minute 100 year Winter I+20%	135.720	133.957	0.087	0.000	1.12		1.277
SW400.009	SMh422	15 minute 100 year Winter I+20%	135.950	133.603	-0.052	0.000	1.00		1.734
SW400.010	SMh423	15 minute 100 year Winter I+20%	134.920	132.960	0.235	0.000	1.44		0.866
SW406.000	SMh424	15 minute 100 year Winter I+20%	136.740	135.167	-0.198	0.000	0.03		0.024
SW406.001	SMh425	15 minute 100 year Winter I+20%	134.630	132.735	-0.215	0.000	0.07		0.329
SW400.011	SMh426	15 minute 100 year Winter I+20%	133.500	132.729	0.029	0.000	1.07		5.645
SW400.012	SMh427	2160 minute 100 year Winter I+20%	133.250	132.701	0.676	0.000	0.32		713.157

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 4

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW400.000	SMh400	2.8	53.2	OK
SW400.001	SMh401	2.5	69.5	SURCHARGED
SW400.002	SMh402	3.0	111.2	SURCHARGED
SW401.000	SMh403	2.3	34.4	OK
SW401.001	SMh404	2.1	51.3	SURCHARGED
SW401.002	SMh405	2.9	86.7	SURCHARGED
SW400.003	SMh406	3.1	221.7	SURCHARGED
SW402.000	SMh407	2.2	26.4	OK
SW402.001	SMh408	2.6	41.9	OK
SW402.002	SMh409	2.4	59.0	OK
SW400.004	SMh410	4.0	332.0	OK
SW403.000	SMh411	1.4	45.9	SURCHARGED
SW403.001	SMh412	1.5	85.5	SURCHARGED
SW400.005	SMh413	2.7	429.6	SURCHARGED
SW404.000	SMh414	1.6	19.2	OK
SW400.006	SMh415	2.9	456.0	SURCHARGED
SW400.007	SMh416	1.2	16.0	SURCHARGED
SW400.008	SMh417	2.2	57.8	OK
SW405.000	SMh19	0.0	0.0	OK
SW405.001	SMh418	2.3	33.9	OK
SW405.002	SMh419	2.0	33.4	SURCHARGED
SW405.003	SMh420	1.6	62.4	SURCHARGED
SW405.004	SMh421	1.5	102.6	SURCHARGED
SW400.009	SMh422	1.9	180.6	OK
SW400.010	SMh423	1.7	187.2	SURCHARGED
SW406.000	SMh424	1.4	3.7	OK
SW406.001	SMh425	0.6	12.2	OK
SW400.011	SMh426	1.4	204.2	SURCHARGED
SW400.012	SMh427	0.9	11.6	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 5

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 5

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	1.255	4-8	1.419	8-12	0.058

Total Area Contributing (ha) = 2.732

Total Pipe Volume (m³) = 258.219

Network Design Table for Catchment 5

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW500.000	31.762	0.390	81.3	0.021	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW500.001	29.185	0.954	30.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW500.002	9.882	0.089	111.0	0.007	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW500.003	46.648	3.709	12.6	0.214	0.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW501.000	39.793	0.485	82.1	0.166	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW501.001	41.650	0.780	53.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW501.002	17.364	0.982	17.7	0.125	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)
SW500.000	50.00	6.36	134.550	0.021	0.0	0.0	0.0	1.45	57.7	2.9
SW500.001	50.00	6.57	134.160	0.021	0.0	0.0	0.0	2.37	94.4	2.9
SW500.002	50.00	6.70	133.200	0.029	0.0	0.0	0.0	1.24	49.3	3.9
SW500.003	50.00	6.77	133.000	0.243	0.0	0.0	0.0	12.16	12768.5	32.9
SW501.000	50.00	6.46	131.850	0.166	0.0	0.0	0.0	1.44	57.4	22.4
SW501.001	50.00	6.85	131.350	0.166	0.0	0.0	0.0	1.79	71.3	22.4
SW501.002	50.00	6.94	130.580	0.291	0.0	0.0	0.0	3.13	124.3	39.4

Network Design Table for Catchment 5

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW500.004	59.383	4.295	13.8	0.054	0.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW502.000	39.774	0.488	81.5	0.201	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW502.001	39.705	0.517	76.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW502.002	17.887	0.220	81.2	0.093	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW500.005	29.294	2.018	14.5	0.075	0.00	0.0	0.600	/	-2	Pipe/Conduit	🔒
SW503.000	33.682	0.421	80.0	0.161	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW504.000	31.405	0.699	44.9	0.043	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW504.001	31.550	0.745	42.3	0.043	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW504.002	6.661	0.333	20.0	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW504.003	22.274	1.115	20.0	0.008	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW504.004	30.201	1.513	20.0	0.049	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW504.005	40.439	0.406	99.6	0.082	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW504.006	40.622	0.404	100.5	0.142	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW505.000	24.774	1.236	20.0	0.046	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW504.007	29.455	0.245	120.2	0.001	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW504.008	30.905	0.232	133.2	0.042	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW503.001	22.142	1.107	20.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW503.002	10.996	0.550	20.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW500.004	50.00	7.02	129.300	0.588	0.0	0.0	0.0	11.60	12178.0	79.6
SW502.000	50.00	6.46	127.620	0.201	0.0	0.0	0.0	1.45	57.6	27.2
SW502.001	50.00	6.90	127.250	0.201	0.0	0.0	0.0	1.49	59.4	27.2
SW502.002	50.00	7.11	126.190	0.294	0.0	0.0	0.0	1.45	57.7	39.8
SW500.005	50.00	7.15	125.050	0.957	0.0	0.0	0.0	11.32	11885.1	129.6
SW503.000	50.00	6.38	125.240	0.161	0.0	0.0	0.0	1.46	58.2	21.8
SW504.000	50.00	6.27	131.500	0.043	0.0	0.0	0.0	1.96	77.8	5.8
SW504.001	50.00	6.53	130.800	0.086	0.0	0.0	0.0	2.02	80.2	11.6
SW504.002	50.00	6.57	130.050	0.116	0.0	0.0	0.0	2.94	116.9	15.7
SW504.003	50.00	6.69	129.710	0.124	0.0	0.0	0.0	2.94	116.9	16.8
SW504.004	50.00	6.83	128.600	0.173	0.0	0.0	0.0	3.54	249.9	23.4
SW504.005	50.00	7.21	127.090	0.255	0.0	0.0	0.0	1.82	200.5	34.5
SW504.006	50.00	7.58	126.680	0.397	0.0	0.0	0.0	1.81	199.6	53.7
SW505.000	50.00	6.14	130.250	0.046	0.0	0.0	0.0	2.94	116.8	6.2
SW504.007	50.00	7.88	126.200	0.443	0.0	0.0	0.0	1.65	182.4	60.0
SW504.008	50.00	8.21	125.960	0.486	0.0	0.0	0.0	1.57	173.2	65.8
SW503.001	50.00	8.30	124.680	0.646	0.0	0.0	0.0	4.07	449.2	87.5
SW503.002	50.00	8.34	123.580	0.646	0.0	0.0	0.0	4.07	449.2	87.5

Network Design Table for Catchment 5

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW500.006	8.888	0.121	73.5	0.017	0.00	0.0	0.600	o	675	Pipe/Conduit	🔒
SW500.007	39.886	0.160	250.0	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit	🔒
SW506.000	35.664	0.446	80.0	0.061	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW506.001	36.925	0.443	83.4	0.100	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW506.002	12.508	0.107	116.9	0.085	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW506.003	15.605	0.149	104.7	0.088	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW500.008	68.386	0.273	250.5	0.040	0.00	0.1	0.600	o	675	Pipe/Conduit	🔒
SW507.000	35.213	1.075	32.7	0.128	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW507.001	34.202	1.044	32.7	0.007	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW508.000	56.339	1.911	29.5	0.025	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW508.001	45.718	2.286	20.0	0.008	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW507.002	33.966	1.735	19.6	0.229	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW507.003	36.918	1.846	20.0	0.050	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW509.000	32.885	1.174	28.0	0.130	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW509.001	18.633	0.656	28.4	0.018	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW507.004	35.894	1.631	22.0	0.068	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
SW507.005	23.694	0.799	29.6	0.014	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW500.006	50.00	8.39	122.850	1.620	0.0	0.0	0.0	3.06	1095.2	219.4
SW500.007	50.00	8.79	122.750	1.620	0.0	0.0	0.0	1.65	591.5	219.4
SW506.000	50.00	6.41	123.820	0.061	0.0	0.0	0.0	1.46	58.2	8.3
SW506.001	50.00	6.76	123.380	0.161	0.0	0.0	0.0	1.72	121.8	21.8
SW506.002	50.00	6.91	122.940	0.246	0.0	0.0	0.0	1.45	102.7	33.4
SW506.003	50.00	7.08	122.750	0.334	0.0	0.0	0.0	1.54	108.6	45.3
SW500.008	50.00	9.48	122.610	1.995	0.1	0.0	0.0	1.65	590.9	270.2
SW507.000	50.00	6.26	131.900	0.128	0.0	0.0	0.0	2.29	91.2	17.4
SW507.001	50.00	6.50	130.820	0.135	0.0	0.0	0.0	2.29	91.2	18.3
SW508.000	50.00	6.39	134.500	0.025	0.0	0.0	0.0	2.42	96.2	3.3
SW508.001	50.00	6.65	132.200	0.033	0.0	0.0	0.0	2.94	116.9	4.4
SW507.002	50.00	6.81	129.400	0.397	0.0	0.0	0.0	3.57	252.3	53.7
SW507.003	50.00	6.98	127.300	0.446	0.0	0.0	0.0	3.53	249.6	60.5
SW509.000	50.00	6.22	127.550	0.130	0.0	0.0	0.0	2.48	98.7	17.6
SW509.001	50.00	6.35	126.360	0.149	0.0	0.0	0.0	2.46	98.0	20.1
SW507.004	50.00	7.13	125.460	0.663	0.0	0.0	0.0	3.88	428.2	89.7
SW507.005	50.00	7.25	123.850	0.677	0.0	0.0	0.0	3.34	368.8	91.6

Network Design Table for Catchment 5

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW507.006	32.575	0.560	58.2	0.010	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW507.007	22.713	0.151	150.0	0.050	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW500.009	23.355	0.157	148.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW507.006	50.00	7.46	123.090	0.686	0.0	0.0	0.0	2.67	424.6	92.9
SW507.007	50.00	7.68	122.500	0.737	0.0	0.0	0.0	1.66	263.6	99.7
SW500.009	50.00	9.85	122.120	2.732	0.1	0.0	0.0	1.07	42.5«	370.0

Area Summary for Catchment 5

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
500.000	User	-	81	0.025	0.021	0.021
	User	-	25	0.003	0.001	0.021
500.001	-	-	100	0.000	0.000	0.000
500.002	User	-	81	0.009	0.007	0.007
500.003	User	-	50	0.010	0.005	0.005
	User	-	50	0.021	0.011	0.016
	User	-	81	0.066	0.054	0.069
	User	-	81	0.013	0.010	0.080
	User	-	80	0.048	0.039	0.118
	User	-	80	0.053	0.043	0.161
	User	-	25	0.072	0.018	0.179
	User	-	25	0.017	0.004	0.183
	User	-	81	0.036	0.029	0.212
	User	-	70	0.002	0.001	0.214
	User	-	25	0.002	0.000	0.214
501.000	User	-	50	0.008	0.004	0.004
	User	-	50	0.015	0.007	0.012
	User	-	81	0.041	0.033	0.045
	User	-	81	0.006	0.005	0.050
	User	-	81	0.022	0.018	0.067
	User	-	80	0.029	0.023	0.090
	User	-	80	0.077	0.062	0.152
	User	-	25	0.030	0.007	0.159
	User	-	81	0.005	0.004	0.164
	User	-	10	0.017	0.002	0.166
501.001	-	-	100	0.000	0.000	0.000
501.002	User	-	50	0.009	0.004	0.004
	User	-	50	0.023	0.011	0.016
	User	-	81	0.056	0.045	0.061
	User	-	80	0.071	0.057	0.118
	User	-	10	0.074	0.007	0.125
500.004	User	-	81	0.041	0.034	0.034
	User	-	25	0.082	0.021	0.054
502.000	User	-	50	0.018	0.009	0.009
	User	-	50	0.009	0.005	0.014
	User	-	81	0.042	0.034	0.048
	User	-	81	0.019	0.016	0.064
	User	-	70	0.003	0.002	0.066
	User	-	80	0.069	0.055	0.121
	User	-	80	0.037	0.030	0.150
	User	-	25	0.025	0.006	0.156
	User	-	25	0.007	0.002	0.158
	User	-	25	0.002	0.000	0.159
	User	-	81	0.011	0.009	0.167
	User	-	81	0.009	0.007	0.174
	User	-	80	0.020	0.016	0.191
	User	-	80	0.010	0.008	0.199
	User	-	10	0.017	0.002	0.201
502.001	-	-	100	0.000	0.000	0.000
502.002	User	-	50	0.012	0.006	0.006
	User	-	50	0.016	0.008	0.014
	User	-	81	0.046	0.037	0.051
	User	-	80	0.028	0.023	0.074
	User	-	81	0.010	0.008	0.082
	User	-	10	0.110	0.011	0.093
500.005	User	-	25	0.145	0.036	0.036
	User	-	25	0.002	0.001	0.037

Area Summary for Catchment 5

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	81	0.047	0.038	0.075
503.000	User	-	25	0.006	0.002	0.002
	User	-	25	0.023	0.006	0.007
	User	-	80	0.016	0.013	0.021
	User	-	80	0.025	0.020	0.041
	User	-	80	0.011	0.009	0.049
	User	-	80	0.015	0.012	0.061
	User	-	80	0.011	0.009	0.070
	User	-	81	0.002	0.002	0.072
	User	-	81	0.049	0.039	0.111
	User	-	81	0.017	0.014	0.125
	User	-	25	0.005	0.001	0.126
	User	-	25	0.038	0.009	0.136
	User	-	50	0.017	0.008	0.144
	User	-	10	0.088	0.009	0.153
	User	-	50	0.007	0.003	0.157
	User	-	50	0.005	0.002	0.159
	User	-	25	0.007	0.002	0.161
504.000	User	-	50	0.018	0.009	0.009
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.009
	User	-	81	0.036	0.029	0.039
	User	-	81	0.005	0.004	0.043
504.001	User	-	50	0.018	0.009	0.009
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.010
	User	-	80	0.014	0.012	0.021
	User	-	81	0.015	0.012	0.033
	User	-	25	0.040	0.010	0.043
504.002	User	-	25	0.001	0.000	0.000
	User	-	81	0.024	0.019	0.020
	User	-	81	0.004	0.003	0.023
	User	-	25	0.026	0.006	0.030
504.003	User	-	81	0.004	0.003	0.003
	User	-	25	0.019	0.005	0.008
504.004	User	-	80	0.016	0.013	0.013
	User	-	81	0.042	0.034	0.047
	User	-	10	0.025	0.003	0.049
504.005	User	-	50	0.008	0.004	0.004
	User	-	50	0.005	0.002	0.006
	User	-	50	0.005	0.002	0.009
	User	-	50	0.008	0.004	0.013
	User	-	50	0.005	0.002	0.015
	User	-	25	0.002	0.000	0.016
	User	-	25	0.002	0.000	0.016
	User	-	25	0.001	0.000	0.017
	User	-	25	0.004	0.001	0.018
	User	-	80	0.006	0.005	0.022
	User	-	80	0.009	0.007	0.029
	User	-	80	0.011	0.008	0.038
	User	-	80	0.007	0.006	0.043
	User	-	81	0.024	0.020	0.063
	User	-	81	0.006	0.005	0.068
	User	-	70	0.001	0.001	0.068
	User	-	81	0.003	0.003	0.071
	User	-	81	0.011	0.009	0.080

Area Summary for Catchment 5

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	25	0.009	0.002	0.082
504.006	User	-	50	0.005	0.002	0.002
	User	-	25	0.001	0.000	0.003
	User	-	25	0.000	0.000	0.003
	User	-	25	0.001	0.000	0.003
	User	-	25	0.001	0.000	0.003
	User	-	25	0.004	0.001	0.004
	User	-	25	0.001	0.000	0.005
	User	-	25	0.017	0.004	0.009
	User	-	80	0.013	0.010	0.019
	User	-	80	0.014	0.011	0.030
	User	-	80	0.038	0.030	0.060
	User	-	80	0.010	0.008	0.068
	User	-	81	0.035	0.028	0.096
	User	-	81	0.017	0.014	0.110
	User	-	81	0.008	0.007	0.117
	User	-	81	0.003	0.003	0.120
	User	-	81	0.021	0.017	0.137
	User	-	10	0.049	0.005	0.142
505.000	User	-	50	0.009	0.005	0.005
	User	-	25	0.000	0.000	0.005
	User	-	25	0.001	0.000	0.005
	User	-	25	0.001	0.000	0.005
	User	-	80	0.025	0.020	0.025
	User	-	81	0.016	0.013	0.038
	User	-	81	0.009	0.008	0.046
504.007	User	-	25	0.002	0.001	0.001
	User	-	25	0.002	0.000	0.001
504.008	User	-	50	0.005	0.002	0.002
	User	-	50	0.005	0.002	0.005
	User	-	50	0.009	0.004	0.009
	User	-	25	0.001	0.000	0.009
	User	-	25	0.001	0.000	0.010
	User	-	80	0.009	0.007	0.017
	User	-	80	0.012	0.009	0.026
	User	-	81	0.003	0.002	0.029
	User	-	81	0.017	0.014	0.042
503.001	-	-	100	0.000	0.000	0.000
503.002	-	-	100	0.000	0.000	0.000
500.006	User	-	81	0.021	0.017	0.017
500.007	-	-	100	0.000	0.000	0.000
506.000	User	-	80	0.021	0.017	0.017
	User	-	81	0.009	0.008	0.024
	User	-	25	0.001	0.000	0.024
	User	-	25	0.001	0.000	0.025
	User	-	25	0.001	0.000	0.025
	User	-	25	0.001	0.000	0.025
	User	-	25	0.005	0.001	0.026
	User	-	25	0.002	0.000	0.027
	User	-	25	0.001	0.000	0.027
	User	-	25	0.001	0.000	0.027
	User	-	25	0.001	0.000	0.027
	User	-	25	0.001	0.000	0.028
	User	-	50	0.023	0.011	0.039
	User	-	50	0.004	0.002	0.041
	User	-	81	0.025	0.020	0.061
506.001	User	-	80	0.010	0.008	0.008

Area Summary for Catchment 5

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	81	0.010	0.008	0.016
	User	-	25	0.001	0.000	0.017
	User	-	25	0.001	0.000	0.017
	User	-	25	0.001	0.000	0.017
	User	-	25	0.003	0.001	0.018
	User	-	25	0.001	0.000	0.018
	User	-	25	0.001	0.000	0.018
	User	-	25	0.001	0.000	0.019
	User	-	25	0.001	0.000	0.019
	User	-	25	0.001	0.000	0.019
	User	-	80	0.047	0.037	0.056
	User	-	50	0.013	0.007	0.063
	User	-	50	0.006	0.003	0.066
	User	-	81	0.026	0.021	0.086
	User	-	81	0.016	0.013	0.100
506.002	User	-	80	0.020	0.016	0.016
	User	-	25	0.027	0.007	0.023
	User	-	81	0.007	0.006	0.029
	User	-	81	0.007	0.006	0.035
	User	-	25	0.001	0.000	0.035
	User	-	80	0.028	0.023	0.057
	User	-	50	0.006	0.003	0.060
	User	-	81	0.011	0.009	0.069
	User	-	81	0.019	0.016	0.085
	User	-	25	0.001	0.000	0.085
506.003	User	-	50	0.004	0.002	0.002
	User	-	50	0.004	0.002	0.004
	User	-	80	0.069	0.055	0.059
	User	-	25	0.001	0.000	0.059
	User	-	81	0.034	0.027	0.086
	User	-	81	0.001	0.001	0.087
	User	-	25	0.001	0.000	0.088
	User	-	25	0.002	0.000	0.088
500.008	User	-	81	0.025	0.020	0.020
	User	-	81	0.019	0.015	0.035
	User	-	25	0.018	0.005	0.040
507.000	User	-	50	0.032	0.016	0.016
	User	-	50	0.014	0.007	0.023
	User	-	81	0.074	0.060	0.083
	User	-	80	0.028	0.023	0.106
	User	-	81	0.011	0.009	0.114
	User	-	25	0.001	0.000	0.114
	User	-	81	0.007	0.006	0.121
	User	-	10	0.076	0.008	0.128
507.001	User	-	70	0.009	0.006	0.006
	User	-	25	0.002	0.001	0.007
508.000	User	-	81	0.029	0.024	0.024
	User	-	25	0.003	0.001	0.025
508.001	User	-	25	0.007	0.002	0.002
	User	-	81	0.008	0.006	0.008
507.002	User	-	50	0.016	0.008	0.008
	User	-	50	0.004	0.002	0.010
	User	-	81	0.077	0.062	0.072
	User	-	81	0.031	0.025	0.097
	User	-	81	0.019	0.016	0.113
	User	-	80	0.031	0.025	0.138
	User	-	80	0.044	0.035	0.173

Area Summary for Catchment 5

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
	User	-	71	0.030	0.021	0.194
	User	-	25	0.017	0.004	0.198
	User	-	25	0.001	0.000	0.199
	User	-	81	0.007	0.006	0.205
	User	-	70	0.035	0.024	0.229
507.003	User	-	80	0.015	0.012	0.012
	User	-	80	0.033	0.026	0.038
	User	-	25	0.020	0.005	0.043
	User	-	25	0.001	0.000	0.043
	User	-	50	0.003	0.002	0.045
	User	-	25	0.004	0.001	0.046
	User	-	10	0.038	0.004	0.050
509.000	User	-	50	0.014	0.007	0.007
	User	-	50	0.010	0.005	0.012
	User	-	81	0.036	0.029	0.041
	User	-	80	0.040	0.032	0.073
	User	-	80	0.023	0.018	0.091
	User	-	25	0.002	0.000	0.091
	User	-	25	0.006	0.001	0.093
	User	-	81	0.013	0.010	0.103
	User	-	81	0.008	0.006	0.109
	User	-	80	0.020	0.016	0.125
	User	-	10	0.049	0.005	0.130
509.001	User	-	80	0.019	0.015	0.015
	User	-	25	0.002	0.000	0.016
	User	-	50	0.005	0.002	0.018
507.004	User	-	81	0.008	0.006	0.006
	User	-	25	0.003	0.001	0.007
	User	-	50	0.002	0.001	0.008
	User	-	50	0.005	0.003	0.011
	User	-	81	0.025	0.020	0.031
	User	-	81	0.012	0.010	0.041
	User	-	81	0.030	0.024	0.065
	User	-	25	0.001	0.000	0.065
	User	-	25	0.010	0.002	0.068
507.005	User	-	25	0.003	0.001	0.001
	User	-	81	0.010	0.008	0.009
	User	-	25	0.020	0.005	0.014
507.006	User	-	25	0.038	0.010	0.010
	User	-	25	0.001	0.000	0.010
507.007	User	-	25	0.201	0.050	0.050
500.009	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				4.750	2.732	2.732

Free Flowing Outfall Details for Catchment 5

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW500.009	SMh	123.500	121.963	122.000	0	0

Simulation Criteria for Catchment 5

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 5

Hydro-Brake® Optimum Manhole: SMh543, DS/PN: SW500.009, Volume (m³): 30.0

Unit Reference	MD-SHE-0192-1860-1000-1860
Design Head (m)	1.000
Design Flow (l/s)	18.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	192
Invert Level (m)	122.150
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	18.6	Kick-Flo®	0.713	15.8
Flush-Flo™	0.333	18.6	Mean Flow over Head Range	-	15.7

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

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	6.7	0.800	16.7	2.000	25.9	4.000	36.1	7.000	47.4
0.200	17.8	1.000	18.6	2.200	27.1	4.500	38.2	7.500	49.0
0.300	18.6	1.200	20.3	2.400	28.3	5.000	40.2	8.000	50.5
0.400	18.5	1.400	21.8	2.600	29.4	5.500	42.1	8.500	52.0
0.500	18.1	1.600	23.3	3.000	31.5	6.000	44.0	9.000	53.5
0.600	17.5	1.800	24.6	3.500	33.9	6.500	45.7	9.500	54.9

Storage Structures for Catchment 5

Tank or Pond Manhole: SMh543, DS/PN: SW500.009

Invert Level (m) 122.250

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	2015.0	1.000	2550.0	1.250	2800.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Maximum Velocity (m/s)
SW500.000	SMh500	15 minute 2 year Winter I+20%	135.900	134.588	-0.187	0.000	0.07		0.038	0.8
SW500.001	SMh501	15 minute 2 year Winter I+20%	135.550	134.189	-0.196	0.000	0.04		0.042	1.2
SW500.002	SMh502	15 minute 2 year Winter I+20%	134.500	133.251	-0.174	0.000	0.12		0.060	0.7
SW500.003	SMh503	15 minute 2 year Winter I+20%	134.750	133.012	-0.588	0.000	0.01		0.007	4.4
SW501.000	SMh504	15 minute 2 year Winter I+20%	133.350	131.966	-0.109	0.000	0.52		0.125	1.4
SW501.001	SMh6	15 minute 2 year Winter I+20%	133.000	131.451	-0.124	0.000	0.41		0.146	1.6
SW501.002	SMh505	15 minute 2 year Winter I+20%	132.090	130.683	-0.122	0.000	0.42		0.170	2.7
SW500.004	SMh506	15 minute 2 year Winter I+20%	131.000	129.329	-0.571	0.000	0.01		0.051	4.2
SW502.000	SMh507	15 minute 2 year Winter I+20%	129.120	127.750	-0.095	0.000	0.63		0.142	1.5
SW502.001	SMh10	15 minute 2 year Winter I+20%	128.950	127.377	-0.098	0.000	0.61		0.674	1.5
SW502.002	SMh508	15 minute 2 year Winter I+20%	128.580	126.363	-0.052	0.000	0.92		0.190	1.5
SW500.005	SMh509	15 minute 2 year Winter I+20%	126.750	125.099	-0.551	0.000	0.03		0.140	4.1
SW503.000	SMh510	15 minute 2 year Winter I+20%	126.560	125.353	-0.112	0.000	0.51		0.123	1.4
SW504.000	SMh511	15 minute 2 year Winter I+20%	133.000	131.548	-0.177	0.000	0.10		0.048	1.2
SW504.001	SMh512	15 minute 2 year Winter I+20%	132.300	130.866	-0.159	0.000	0.19		0.088	1.5
SW504.002	SMh513	15 minute 2 year Winter I+20%	131.600	130.123	-0.152	0.000	0.23		0.095	1.7
SW504.003	SMh514	15 minute 2 year Winter I+20%	131.320	129.776	-0.159	0.000	0.19		0.075	2.1
SW504.004	SMh515	15 minute 2 year Winter I+20%	130.200	128.669	-0.231	0.000	0.12		0.088	2.2
SW504.005	SMh516	15 minute 2 year Winter I+20%	128.570	127.209	-0.256	0.000	0.22		0.196	1.3
SW504.006	SMh517	15 minute 2 year Winter I+20%	129.290	126.831	-0.224	0.000	0.34		0.472	1.5
SW505.000	SMh518	15 minute 2 year Winter I+20%	131.930	130.290	-0.185	0.000	0.07		0.040	1.7
SW504.007	SMh519	15 minute 2 year Winter I+20%	130.620	126.373	-0.202	0.000	0.43		0.349	1.4
SW504.008	SMh520	15 minute 2 year Winter I+20%	129.000	126.146	-0.189	0.000	0.49		0.787	1.4
SW503.001	SMh521	15 minute 2 year Winter I+20%	127.200	124.812	-0.243	0.000	0.27		0.186	3.0
SW503.002	SMh522	15 minute 2 year Winter I+20%	125.610	123.733	-0.222	0.000	0.35		0.284	2.4
SW500.006	SMh523	15 minute 2 year Winter I+20%	124.000	123.208	-0.317	0.000	0.55		0.789	1.3
SW500.007	SMh524	15 minute 2 year Winter I+20%	124.000	123.102	-0.323	0.000	0.51		1.803	1.4
SW506.000	SMh525	15 minute 2 year Winter I+20%	125.250	123.887	-0.158	0.000	0.19		0.070	1.1
SW506.001	SMh526	15 minute 2 year Winter I+20%	124.950	123.478	-0.202	0.000	0.23		0.167	1.3

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

PN	US/MH Name	Pipe Flow (l/s)	Status
SW500.000	SMh500	3.7	OK
SW500.001	SMh501	3.7	OK
SW500.002	SMh502	4.8	OK
SW500.003	SMh503	38.5	OK
SW501.000	SMh504	28.4	OK
SW501.001	SMh6	28.0	OK
SW501.002	SMh505	47.1	OK
SW500.004	SMh506	93.6	OK
SW502.000	SMh507	34.4	OK
SW502.001	SMh10	34.3	OK
SW502.002	SMh508	47.8	OK
SW500.005	SMh509	152.2	OK
SW503.000	SMh510	27.7	OK
SW504.000	SMh511	7.4	OK
SW504.001	SMh512	14.1	OK
SW504.002	SMh513	18.8	OK
SW504.003	SMh514	20.0	OK
SW504.004	SMh515	27.7	OK
SW504.005	SMh516	40.2	OK
SW504.006	SMh517	61.4	OK
SW505.000	SMh518	7.9	OK
SW504.007	SMh519	69.2	OK
SW504.008	SMh520	75.6	OK
SW503.001	SMh521	102.5	OK
SW503.002	SMh522	102.4	OK
SW500.006	SMh523	255.5	OK
SW500.007	SMh524	252.0	OK
SW506.000	SMh525	10.5	OK
SW506.001	SMh526	26.0	OK

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW506.002	SMh527	15 minute 2 year Winter I+20%	124.660	123.087	-0.153	0.000	0.48		0.361
SW506.003	SMh528	15 minute 2 year Winter I+20%	124.400	123.027	-0.023	0.000	0.55		0.663
SW500.008	SMh529	15 minute 2 year Winter I+20%	124.000	122.981	-0.304	0.000	0.58		7.690
SW507.000	SMh530	15 minute 2 year Winter I+20%	133.400	131.977	-0.148	0.000	0.26		0.082
SW507.001	SMh531	15 minute 2 year Winter I+20%	132.300	130.899	-0.146	0.000	0.27		0.099
SW508.000	SMh532	15 minute 2 year Winter I+20%	135.850	134.531	-0.194	0.000	0.05		0.029
SW508.001	SMh533	15 minute 2 year Winter I+20%	133.940	132.232	-0.193	0.000	0.05		0.031
SW507.002	SMh535	15 minute 2 year Winter I+20%	131.200	129.508	-0.192	0.000	0.28		0.117
SW507.003	SMh536	15 minute 2 year Winter I+20%	1293.000	127.416	-0.184	0.000	0.31		0.125
SW509.000	SMh537	15 minute 2 year Winter I+20%	129.050	127.625	-0.150	0.000	0.24		0.079
SW509.001	SMh538	15 minute 2 year Winter I+20%	127.860	126.442	-0.143	0.000	0.29		0.097
SW507.004	SMh539	15 minute 2 year Winter I+20%	127.340	125.596	-0.239	0.000	0.28		0.237
SW507.005	SMh540	15 minute 2 year Winter I+20%	125.450	124.003	-0.222	0.000	0.35		0.323
SW507.006	SMh541	15 minute 2 year Winter I+20%	124.900	123.259	-0.281	0.000	0.30		0.440
SW507.007	SMh542	15 minute 2 year Winter I+20%	124.000	122.739	-0.211	0.000	0.54		0.696
SW500.009	SMh543	720 minute 2 year Winter I+20%	123.650	122.546	0.201	0.000	0.47		621.458

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW506.002	SMh527	1.1	39.3	OK
SW506.003	SMh528	1.2	50.1	OK
SW500.008	SMh529	1.5	305.2	OK
SW507.000	SMh530	1.8	22.1	OK
SW507.001	SMh531	1.9	23.2	OK
SW508.000	SMh532	1.3	4.2	OK
SW508.001	SMh533	1.6	5.5	OK
SW507.002	SMh535	2.8	64.4	OK
SW507.003	SMh536	2.9	72.2	OK
SW509.000	SMh537	1.9	22.5	OK
SW509.001	SMh538	1.9	25.3	OK
SW507.004	SMh539	3.0	108.2	OK
SW507.005	SMh540	2.6	110.4	OK
SW507.006	SMh541	2.1	111.6	OK
SW507.007	SMh542	1.4	118.4	OK
SW500.009	SMh543	1.0	18.5	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW500.000	SMh500	15 minute 30 year Winter I+20%	135.900	134.603	-0.172	0.000	0.13		0.054
SW500.001	SMh501	15 minute 30 year Winter I+20%	135.550	134.201	-0.184	0.000	0.08		0.062
SW500.002	SMh502	15 minute 30 year Winter I+20%	134.500	133.273	-0.152	0.000	0.22		0.089
SW500.003	SMh503	15 minute 30 year Winter I+20%	134.750	133.026	-0.574	0.000	0.01		0.021
SW501.000	SMh504	15 minute 30 year Winter I+20%	133.350	132.026	-0.049	0.000	0.96		0.193
SW501.001	SMh6	15 minute 30 year Winter I+20%	133.000	131.499	-0.076	0.000	0.76		0.289
SW501.002	SMh505	15 minute 30 year Winter I+20%	132.090	130.742	-0.063	0.000	0.83		0.322
SW500.004	SMh506	15 minute 30 year Winter I+20%	131.000	129.361	-0.539	0.000	0.03		0.099
SW502.000	SMh507	15 minute 30 year Winter I+20%	129.120	128.042	0.197	0.000	1.08		0.472
SW502.001	SMh10	15 minute 30 year Winter I+20%	128.950	127.487	0.012	0.000	1.02		1.142
SW502.002	SMh508	15 minute 30 year Winter I+20%	128.580	126.789	0.374	0.000	1.64		0.685
SW500.005	SMh509	15 minute 30 year Winter I+20%	126.750	125.128	-0.522	0.000	0.06		0.212
SW503.000	SMh510	15 minute 30 year Winter I+20%	126.560	125.411	-0.054	0.000	0.93		0.188
SW504.000	SMh511	15 minute 30 year Winter I+20%	133.000	131.565	-0.160	0.000	0.19		0.068
SW504.001	SMh512	15 minute 30 year Winter I+20%	132.300	130.898	-0.127	0.000	0.38		0.133
SW504.002	SMh513	15 minute 30 year Winter I+20%	131.600	130.162	-0.113	0.000	0.48		0.155
SW504.003	SMh514	15 minute 30 year Winter I+20%	131.320	129.809	-0.126	0.000	0.39		0.116
SW504.004	SMh515	15 minute 30 year Winter I+20%	130.200	128.705	-0.195	0.000	0.26		0.135
SW504.005	SMh516	15 minute 30 year Winter I+20%	128.570	127.277	-0.188	0.000	0.48		0.339
SW504.006	SMh517	15 minute 30 year Winter I+20%	129.290	126.930	-0.125	0.000	0.75		1.152
SW505.000	SMh518	15 minute 30 year Winter I+20%	131.930	130.305	-0.170	0.000	0.14		0.056
SW504.007	SMh519	15 minute 30 year Winter I+20%	130.620	126.521	-0.054	0.000	0.92		1.234
SW504.008	SMh520	15 minute 30 year Winter I+20%	129.000	126.323	-0.012	0.000	1.00		2.557
SW503.001	SMh521	15 minute 30 year Winter I+20%	127.200	124.876	-0.179	0.000	0.53		0.289
SW503.002	SMh522	15 minute 30 year Winter I+20%	125.610	123.850	-0.105	0.000	0.70		0.592
SW500.006	SMh523	15 minute 30 year Winter I+20%	124.000	123.582	0.057	0.000	1.05		4.581
SW500.007	SMh524	15 minute 30 year Winter I+20%	124.000	123.447	0.022	0.000	0.97		3.850
SW506.000	SMh525	15 minute 30 year Winter I+20%	125.250	123.912	-0.133	0.000	0.35		0.099
SW506.001	SMh526	15 minute 30 year Winter I+20%	124.950	123.575	-0.105	0.000	0.48		0.482

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW500.000	SMh500	1.0	6.8	OK
SW500.001	SMh501	1.4	6.8	OK
SW500.002	SMh502	0.8	9.1	OK
SW500.003	SMh503	4.4	87.8	OK
SW501.000	SMh504	1.6	52.3	OK
SW501.001	SMh6	1.9	51.8	OK
SW501.002	SMh505	3.1	91.8	OK
SW500.004	SMh506	4.2	197.7	OK
SW502.000	SMh507	1.5	59.3	SURCHARGED
SW502.001	SMh10	1.6	57.6	SURCHARGED
SW502.002	SMh508	2.1	85.0	SURCHARGED
SW500.005	SMh509	4.7	304.1	OK
SW503.000	SMh510	1.6	51.0	OK
SW504.000	SMh511	1.4	13.6	OK
SW504.001	SMh512	1.8	28.7	OK
SW504.002	SMh513	2.0	39.3	OK
SW504.003	SMh514	2.5	42.0	OK
SW504.004	SMh515	2.8	59.7	OK
SW504.005	SMh516	1.6	87.9	OK
SW504.006	SMh517	1.8	136.9	OK
SW505.000	SMh518	2.0	14.6	OK
SW504.007	SMh519	1.7	148.6	OK
SW504.008	SMh520	1.6	153.5	OK
SW503.001	SMh521	3.5	204.0	OK
SW503.002	SMh522	2.8	202.5	OK
SW500.006	SMh523	1.5	489.3	SURCHARGED
SW500.007	SMh524	1.5	478.1	SURCHARGED
SW506.000	SMh525	1.3	19.5	OK
SW506.001	SMh526	1.6	54.0	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW506.002	SMh527	15 minute 30 year Winter I+20%	124.660	123.505	0.265	0.000	0.87		2.857
SW506.003	SMh528	15 minute 30 year Winter I+20%	124.400	123.439	0.389	0.000	1.06		1.573
SW500.008	SMh529	15 minute 30 year Winter I+20%	124.000	123.302	0.017	0.000	1.09		15.362
SW507.000	SMh530	15 minute 30 year Winter I+20%	133.400	132.009	-0.116	0.000	0.47		0.118
SW507.001	SMh531	15 minute 30 year Winter I+20%	132.300	130.933	-0.112	0.000	0.50		0.150
SW508.000	SMh532	15 minute 30 year Winter I+20%	135.850	134.544	-0.181	0.000	0.08		0.044
SW508.001	SMh533	15 minute 30 year Winter I+20%	133.940	132.247	-0.178	0.000	0.09		0.047
SW507.002	SMh535	15 minute 30 year Winter I+20%	131.200	129.568	-0.132	0.000	0.58		0.184
SW507.003	SMh536	15 minute 30 year Winter I+20%	1293.000	127.482	-0.118	0.000	0.66		0.200
SW509.000	SMh537	15 minute 30 year Winter I+20%	129.050	127.655	-0.120	0.000	0.45		0.113
SW509.001	SMh538	15 minute 30 year Winter I+20%	127.860	126.479	-0.106	0.000	0.54		0.151
SW507.004	SMh539	15 minute 30 year Winter I+20%	127.340	125.668	-0.167	0.000	0.58		0.396
SW507.005	SMh540	15 minute 30 year Winter I+20%	125.450	124.090	-0.135	0.000	0.71		0.568
SW507.006	SMh541	15 minute 30 year Winter I+20%	124.900	123.351	-0.189	0.000	0.63		0.775
SW507.007	SMh542	15 minute 30 year Winter I+20%	124.000	122.977	0.027	0.000	1.14		2.612
SW500.009	SMh543	720 minute 30 year Winter I+20%	123.650	122.821	0.476	0.000	0.47		1250.455

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW506.002	SMh527	1.2	71.5	SURCHARGED
SW506.003	SMh528	1.4	97.0	SURCHARGED
SW500.008	SMh529	1.7	573.6	SURCHARGED
SW507.000	SMh530	2.1	40.8	OK
SW507.001	SMh531	2.2	43.0	OK
SW508.000	SMh532	1.4	7.8	OK
SW508.001	SMh533	1.8	10.5	OK
SW507.002	SMh535	3.4	135.3	OK
SW507.003	SMh536	3.5	152.8	OK
SW509.000	SMh537	2.3	41.5	OK
SW509.001	SMh538	2.3	47.5	OK
SW507.004	SMh539	3.6	222.8	OK
SW507.005	SMh540	3.1	226.0	OK
SW507.006	SMh541	2.4	231.7	OK
SW507.007	SMh542	1.6	249.2	SURCHARGED
SW500.009	SMh543	1.0	18.5	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW500.000	SMh500	15 minute 100 year Winter I+20%	135.900	134.611	-0.164	0.000	0.16		0.063
SW500.001	SMh501	15 minute 100 year Winter I+20%	135.550	134.208	-0.177	0.000	0.10		0.073
SW500.002	SMh502	15 minute 100 year Winter I+20%	134.500	133.284	-0.141	0.000	0.29		0.104
SW500.003	SMh503	15 minute 100 year Winter I+20%	134.750	133.034	-0.566	0.000	0.02		0.029
SW501.000	SMh504	15 minute 100 year Winter I+20%	133.350	132.296	0.221	0.000	1.20		0.498
SW501.001	SMh6	15 minute 100 year Winter I+20%	133.000	131.525	-0.050	0.000	0.95		0.368
SW501.002	SMh505	15 minute 100 year Winter I+20%	132.090	130.826	0.021	0.000	1.01		0.571
SW500.004	SMh506	15 minute 100 year Winter I+20%	131.000	129.368	-0.532	0.000	0.03		0.110
SW502.000	SMh507	15 minute 100 year Winter I+20%	129.120	128.556	0.711	0.000	1.30		1.053
SW502.001	SMh10	15 minute 100 year Winter I+20%	128.950	127.736	0.261	0.000	1.23		2.133
SW502.002	SMh508	15 minute 100 year Winter I+20%	128.580	126.979	0.564	0.000	1.89		1.270
SW500.005	SMh509	15 minute 100 year Winter I+20%	126.750	125.137	-0.513	0.000	0.07		0.240
SW503.000	SMh510	15 minute 100 year Winter I+20%	126.560	125.623	0.158	0.000	1.17		0.427
SW504.000	SMh511	15 minute 100 year Winter I+20%	133.000	131.575	-0.150	0.000	0.24		0.079
SW504.001	SMh512	15 minute 100 year Winter I+20%	132.300	130.914	-0.111	0.000	0.50		0.165
SW504.002	SMh513	15 minute 100 year Winter I+20%	131.600	130.182	-0.093	0.000	0.63		0.199
SW504.003	SMh514	15 minute 100 year Winter I+20%	131.320	129.826	-0.109	0.000	0.51		0.140
SW504.004	SMh515	15 minute 100 year Winter I+20%	130.200	128.722	-0.178	0.000	0.34		0.163
SW504.005	SMh516	15 minute 100 year Winter I+20%	128.570	127.310	-0.155	0.000	0.63		0.417
SW504.006	SMh517	15 minute 100 year Winter I+20%	129.290	127.060	0.005	0.000	0.94		2.504
SW505.000	SMh518	15 minute 100 year Winter I+20%	131.930	130.313	-0.162	0.000	0.18		0.066
SW504.007	SMh519	15 minute 100 year Winter I+20%	130.620	126.739	0.164	0.000	1.11		3.616
SW504.008	SMh520	15 minute 100 year Winter I+20%	129.000	126.442	0.107	0.000	1.24		3.518
SW503.001	SMh521	15 minute 100 year Winter I+20%	127.200	124.904	-0.151	0.000	0.66		0.357
SW503.002	SMh522	15 minute 100 year Winter I+20%	125.610	124.331	0.376	0.000	0.88		2.252
SW500.006	SMh523	15 minute 100 year Winter I+20%	124.000	123.905	0.380	0.000	1.26		10.120
SW500.007	SMh524	15 minute 100 year Winter I+20%	124.000	123.694	0.269	0.000	1.18		4.368
SW506.000	SMh525	15 minute 100 year Winter I+20%	125.250	124.029	-0.016	0.000	0.44		0.231
SW506.001	SMh526	15 minute 100 year Winter I+20%	124.950	123.956	0.276	0.000	0.53		1.959

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW500.000	SMh500	1.0	8.8	OK
SW500.001	SMh501	1.4	8.8	OK
SW500.002	SMh502	0.9	11.9	OK
SW500.003	SMh503	4.4	114.3	OK
SW501.000	SMh504	1.6	65.4	SURCHARGED
SW501.001	SMh6	2.0	64.8	OK
SW501.002	SMh505	3.2	112.3	SURCHARGED
SW500.004	SMh506	4.5	250.9	OK
SW502.000	SMh507	1.8	71.3	SURCHARGED
SW502.001	SMh10	1.7	69.3	SURCHARGED
SW502.002	SMh508	2.5	97.7	SURCHARGED
SW500.005	SMh509	5.0	380.2	OK
SW503.000	SMh510	1.6	63.9	SURCHARGED
SW504.000	SMh511	1.5	17.7	OK
SW504.001	SMh512	1.9	37.3	OK
SW504.002	SMh513	2.2	51.1	OK
SW504.003	SMh514	2.7	54.6	OK
SW504.004	SMh515	2.9	77.7	OK
SW504.005	SMh516	1.7	114.2	OK
SW504.006	SMh517	1.9	170.0	SURCHARGED
SW505.000	SMh518	2.1	19.0	OK
SW504.007	SMh519	1.6	177.7	SURCHARGED
SW504.008	SMh520	1.7	189.9	SURCHARGED
SW503.001	SMh521	3.7	253.2	OK
SW503.002	SMh522	2.7	256.5	SURCHARGED
SW500.006	SMh523	1.6	586.7	FLOOD RISK
SW500.007	SMh524	1.6	581.8	SURCHARGED
SW506.000	SMh525	1.3	24.3	OK
SW506.001	SMh526	1.6	59.5	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 5

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW506.002	SMh527	15 minute 100 year Winter I+20%	124.660	123.843	0.603	0.000	1.05		3.544
SW506.003	SMh528	15 minute 100 year Winter I+20%	124.400	123.718	0.668	0.000	1.30		1.889
SW500.008	SMh529	15 minute 100 year Winter I+20%	124.000	123.470	0.185	0.000	1.34		16.283
SW507.000	SMh530	15 minute 100 year Winter I+20%	133.400	132.028	-0.097	0.000	0.62		0.139
SW507.001	SMh531	15 minute 100 year Winter I+20%	132.300	130.953	-0.092	0.000	0.65		0.190
SW508.000	SMh532	15 minute 100 year Winter I+20%	135.850	134.549	-0.176	0.000	0.11		0.050
SW508.001	SMh533	15 minute 100 year Winter I+20%	133.940	132.253	-0.172	0.000	0.12		0.054
SW507.002	SMh535	15 minute 100 year Winter I+20%	131.200	129.600	-0.100	0.000	0.76		0.221
SW507.003	SMh536	15 minute 100 year Winter I+20%	1293.000	127.519	-0.081	0.000	0.86		0.242
SW509.000	SMh537	15 minute 100 year Winter I+20%	129.050	127.673	-0.102	0.000	0.58		0.134
SW509.001	SMh538	15 minute 100 year Winter I+20%	127.860	126.501	-0.084	0.000	0.70		0.190
SW507.004	SMh539	15 minute 100 year Winter I+20%	127.340	125.709	-0.126	0.000	0.75		0.504
SW507.005	SMh540	15 minute 100 year Winter I+20%	125.450	124.170	-0.055	0.000	0.93		0.835
SW507.006	SMh541	15 minute 100 year Winter I+20%	124.900	123.465	-0.075	0.000	0.81		1.272
SW507.007	SMh542	15 minute 100 year Winter I+20%	124.000	123.105	0.155	0.000	1.46		3.918
SW500.009	SMh543	960 minute 100 year Winter I+20%	123.650	122.997	0.652	0.000	0.47		1674.471

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW506.002	SMh527	1.2	85.9	SURCHARGED
SW506.003	SMh528	1.7	119.2	SURCHARGED
SW500.008	SMh529	2.0	704.6	SURCHARGED
SW507.000	SMh530	2.3	53.1	OK
SW507.001	SMh531	2.3	56.0	OK
SW508.000	SMh532	1.6	10.2	OK
SW508.001	SMh533	2.0	13.6	OK
SW507.002	SMh535	3.6	176.1	OK
SW507.003	SMh536	3.7	198.9	OK
SW509.000	SMh537	2.4	54.0	OK
SW509.001	SMh538	2.4	61.8	OK
SW507.004	SMh539	3.8	290.0	OK
SW507.005	SMh540	3.2	295.2	OK
SW507.006	SMh541	2.5	299.4	OK
SW507.007	SMh542	2.0	318.1	SURCHARGED
SW500.009	SMh543	1.0	18.5	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 6

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 6

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.206	4-8	0.123

Total Area Contributing (ha) = 0.329

Total Pipe Volume (m³) = 13.262

Network Design Table for Catchment 6

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW600.000	11.432	0.705	16.2	0.038	6.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW600.001	23.092	0.120	193.0	0.017	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW601.000	42.731	0.427	100.0	0.035	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW601.001	16.947	0.169	100.0	0.067	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW601.002	10.633	0.053	200.0	0.144	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW601.003	2.810	0.014	200.0	0.024	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
SW600.002	10.770	0.054	200.0	0.004	0.00	0.0	0.600	o	600	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)
SW600.000	50.00	6.05	119.100	0.038	0.0	0.0	0.0	3.92	277.4	5.1
SW600.001	50.00	6.31	118.310	0.055	0.0	0.0	0.0	1.46	232.2	7.4
SW601.000	50.00	6.54	118.940	0.035	0.0	0.0	0.0	1.31	52.0	4.7
SW601.001	50.00	6.76	118.670	0.102	0.0	0.0	0.0	1.31	52.0	13.8
SW601.002	50.00	6.92	118.340	0.246	0.0	0.0	0.0	1.11	78.3	33.3
SW601.003	50.00	6.96	118.190	0.271	0.0	0.0	0.0	1.11	78.3	36.6
SW600.002	50.00	7.07	118.150	0.329	0.0	0.0	0.0	1.72	485.8	44.6

Network Design Table for Catchment 6

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
SW600.003	18.134	0.102	177.8	0.000	0.00	0.2	0.600	o	225	Pipe/Conduit	🔒
SW600.004	42.549	0.377	112.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW600.003	50.00	7.38	118.120	0.329	0.2	0.0	0.0	0.98	38.9«	44.8
SW600.004	50.00	7.95	118.030	0.329	0.2	0.0	0.0	1.23	48.9	44.8

Area Summary for Catchment 6

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
600.000	User	-	25	0.004	0.001	0.001
	User	-	25	0.013	0.003	0.004
	User	-	81	0.016	0.013	0.017
	User	-	81	0.018	0.015	0.032
	User	-	25	0.018	0.004	0.036
	User	-	25	0.006	0.001	0.038
600.001	User	-	81	0.018	0.015	0.015
	User	-	25	0.009	0.002	0.017
601.000	User	-	50	0.008	0.004	0.004
	User	-	25	0.001	0.000	0.004
	User	-	25	0.001	0.000	0.004
	User	-	25	0.003	0.001	0.005
	User	-	81	0.019	0.015	0.021
	User	-	81	0.004	0.003	0.024
	User	-	81	0.007	0.005	0.029
	User	-	81	0.001	0.001	0.030
	User	-	25	0.004	0.001	0.031
	User	-	25	0.005	0.001	0.032
	User	-	80	0.004	0.003	0.035
601.001	User	-	50	0.014	0.007	0.007
	User	-	50	0.009	0.005	0.012
	User	-	81	0.001	0.001	0.012
	User	-	80	0.008	0.007	0.019
	User	-	81	0.009	0.007	0.027
	User	-	81	0.001	0.001	0.028
	User	-	81	0.006	0.005	0.033
	User	-	81	0.004	0.003	0.036
	User	-	81	0.008	0.006	0.042
	User	-	81	0.023	0.019	0.061
	User	-	25	0.015	0.004	0.064
	User	-	25	0.004	0.001	0.065
	User	-	25	0.003	0.001	0.066
	User	-	80	0.001	0.001	0.067
601.002	User	-	25	0.021	0.005	0.005
	User	-	81	0.012	0.010	0.015
	User	-	81	0.006	0.005	0.020
	User	-	80	0.075	0.060	0.080
	User	-	80	0.080	0.064	0.144
601.003	User	-	81	0.004	0.004	0.004
	User	-	81	0.004	0.003	0.007
	User	-	80	0.007	0.006	0.012
	User	-	25	0.048	0.012	0.024
600.002	User	-	81	0.002	0.002	0.002
	User	-	25	0.008	0.002	0.004
600.003	-	-	100	0.000	0.000	0.000
600.004	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.533	0.329	0.329

Free Flowing Outfall Details for Catchment 6

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW600.004	SMh	119.000	117.653	0.000	0	0

Simulation Criteria for Catchment 6

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 6

Hydro-Brake® Optimum Manhole: SMh606, DS/PN: SW600.003, Volume (m³): 7.1

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	118.120
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

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

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

Storage Structures for Catchment 6

Tank or Pond Manhole: SMh606, DS/PN: SW600.003

Invert Level (m) 119.250

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	250.0	1.000	430.0	1.200	600.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 6

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW600.000	SMh600	720 minute 2 year Winter I+20%	120.650	119.433	0.033	0.000	0.00		0.371
SW600.001	SMh601	720 minute 2 year Winter I+20%	120.650	119.433	0.673	0.000	0.01		2.315
SW601.000	SMh602	720 minute 2 year Winter I+20%	120.290	119.436	0.271	0.000	0.02		0.555
SW601.001	SMh603	720 minute 2 year Winter I+20%	120.050	119.436	0.541	0.000	0.05		2.690
SW601.002	SMh604	720 minute 2 year Winter I+20%	120.650	119.435	0.795	0.000	0.10		1.859
SW601.003	SMh6	720 minute 2 year Winter I+20%	120.650	119.434	0.944	0.000	0.13		2.068
SW600.002	SMh605	720 minute 2 year Winter I+20%	120.650	119.433	0.683	0.000	0.03		5.808
SW600.003	SMh606	720 minute 2 year Winter I+20%	120.650	119.433	1.088	0.000	0.06		53.409
SW600.004	SMh607	720 minute 2 year Winter I+20%	120.650	118.062	-0.193	0.000	0.05		0.089

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW600.000	SMh600	0.4	0.9	SURCHARGED
SW600.001	SMh601	0.1	1.3	SURCHARGED
SW601.000	SMh602	0.6	0.8	SURCHARGED
SW601.001	SMh603	0.6	2.4	SURCHARGED
SW601.002	SMh604	0.4	5.9	SURCHARGED
SW601.003	SMh6	0.3	6.5	SURCHARGED
SW600.002	SMh605	0.1	7.9	SURCHARGED
SW600.003	SMh606	0.5	2.3	SURCHARGED
SW600.004	SMh607	0.7	2.3	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 6

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW600.000	SMh600	720 minute 30 year Winter I+20%	120.650	119.665	0.265	0.000	0.01		0.634
SW600.001	SMh601	720 minute 30 year Winter I+20%	120.650	119.665	0.905	0.000	0.01		2.651
SW601.000	SMh602	720 minute 30 year Winter I+20%	120.290	119.669	0.504	0.000	0.03		0.819
SW601.001	SMh603	720 minute 30 year Winter I+20%	120.050	119.669	0.774	0.000	0.08		2.953
SW601.002	SMh604	720 minute 30 year Winter I+20%	120.650	119.667	1.027	0.000	0.16		2.122
SW601.003	SMh6	720 minute 30 year Winter I+20%	120.650	119.666	1.176	0.000	0.20		2.331
SW600.002	SMh605	720 minute 30 year Winter I+20%	120.650	119.666	0.916	0.000	0.04		6.219
SW600.003	SMh606	720 minute 30 year Winter I+20%	120.650	119.665	1.320	0.000	0.07		123.230
SW600.004	SMh607	720 minute 30 year Winter I+20%	120.650	118.063	-0.192	0.000	0.05		0.092

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW600.000	SMh600	0.4	1.4	SURCHARGED
SW600.001	SMh601	0.1	2.1	SURCHARGED
SW601.000	SMh602	0.5	1.3	SURCHARGED
SW601.001	SMh603	0.6	3.9	SURCHARGED
SW601.002	SMh604	0.4	9.6	SURCHARGED
SW601.003	SMh6	0.3	10.5	SURCHARGED
SW600.002	SMh605	0.1	12.6	SURCHARGED
SW600.003	SMh606	0.5	2.4	SURCHARGED
SW600.004	SMh607	0.7	2.4	OK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 6

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW600.000	SMh600	720 minute 100 year Winter I+20%	120.650	119.809	0.409	0.000	0.01		0.796
SW600.001	SMh601	720 minute 100 year Winter I+20%	120.650	119.809	1.049	0.000	0.01		2.856
SW601.000	SMh602	15 minute 100 year Winter I+20%	120.290	119.838	0.673	0.000	0.31		1.010
SW601.001	SMh603	720 minute 100 year Winter I+20%	120.050	119.812	0.917	0.000	0.10		3.115
SW601.002	SMh604	720 minute 100 year Winter I+20%	120.650	119.811	1.171	0.000	0.19		2.284
SW601.003	SMh6	720 minute 100 year Winter I+20%	120.650	119.809	1.319	0.000	0.25		2.493
SW600.002	SMh605	720 minute 100 year Winter I+20%	120.650	119.809	1.059	0.000	0.05		6.472
SW600.003	SMh606	720 minute 100 year Winter I+20%	120.650	119.809	1.464	0.000	0.07		170.997
SW600.004	SMh607	720 minute 100 year Winter I+20%	120.650	118.064	-0.191	0.000	0.05		0.094

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW600.000	SMh600	0.3	1.8	SURCHARGED
SW600.001	SMh601	0.1	2.6	SURCHARGED
SW601.000	SMh602	0.9	15.5	SURCHARGED
SW601.001	SMh603	0.5	4.8	SURCHARGED
SW601.002	SMh604	0.4	11.8	SURCHARGED
SW601.003	SMh6	0.3	13.0	SURCHARGED
SW600.002	SMh605	0.1	15.7	SURCHARGED
SW600.003	SMh606	0.6	2.5	SURCHARGED
SW600.004	SMh607	0.7	2.5	OK

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 7

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 7

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.227	4-8	0.102

Total Area Contributing (ha) = 0.329

Total Pipe Volume (m³) = 8.358

Network Design Table for Catchment 7

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
SW700.000	33.182	0.379	87.6	0.110	6.00	0.1	0.600	o	225	Pipe/Conduit	🔒
SW700.001	31.269	0.208	150.3	0.165	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW700.002	4.490	0.029	154.8	0.053	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW700.003	33.994	0.268	126.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW700.000	50.00	6.40	119.420	0.110	0.1	0.0	0.0	1.40	55.6	15.0
SW700.001	50.00	6.71	118.890	0.276	0.1	0.0	0.0	1.66	263.4	37.4
SW700.002	50.00	6.76	118.650	0.329	0.1	0.0	0.0	1.63	259.5	44.6
SW700.003	50.00	7.24	118.290	0.329	0.1	0.0	0.0	1.16	46.1	44.6

Area Summary for Catchment 7

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
700.000	User	-	80	0.040	0.032	0.032
	User	-	50	0.031	0.016	0.048
	User	-	50	0.011	0.005	0.053
	User	-	81	0.061	0.050	0.103
	User	-	25	0.010	0.002	0.105
	User	-	25	0.002	0.001	0.106
	User	-	25	0.006	0.002	0.107
	User	-	81	0.004	0.003	0.110
700.001	User	-	80	0.090	0.072	0.072
	User	-	80	0.084	0.067	0.139
	User	-	25	0.011	0.003	0.142
	User	-	25	0.005	0.001	0.143
	User	-	81	0.003	0.002	0.146
	User	-	81	0.005	0.004	0.150
	User	-	81	0.010	0.008	0.158
	User	-	25	0.006	0.002	0.160
	User	-	25	0.007	0.002	0.161
	User	-	25	0.016	0.004	0.165
700.002	User	-	81	0.010	0.008	0.008
	User	-	81	0.015	0.012	0.021
	User	-	81	0.016	0.013	0.033
	User	-	25	0.079	0.020	0.053
700.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.523	0.329	0.329

Free Flowing Outfall Details for Catchment 7

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW700.003	SMh13	120.720	118.022	118.000	225	0

Simulation Criteria for Catchment 7

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 7

Hydro-Brake® Optimum Manhole: SMh703, DS/PN: SW700.003, Volume (m³): 4.2

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	118.290
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0	Kick-Flo®	0.599	1.6
Flush-Flo™	0.296	1.9	Mean Flow over Head Range	-	1.7

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

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

Storage Structures for Catchment 7

Tank or Pond Manhole: SMh703, DS/PN: SW700.003

Invert Level (m) 119.250

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	175.0	0.500	297.0	1.000	432.0	1.150	476.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 7

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW700.000	SMh700	360 minute 2 year Winter I+20%	120.630	119.540	-0.105	0.000	0.08		0.130
SW700.001	SMh701	360 minute 2 year Winter I+20%	120.900	119.537	0.197	0.000	0.05		2.085
SW700.002	SMh702	10080 minute 2 year Summer I+20%	120.900	119.541	0.441	9.449	0.15		6.026
SW700.003	SMh703	360 minute 2 year Winter I+20%	120.900	119.536	1.021	0.000	0.05		61.552

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW700.000	SMh700	0.8	4.3	OK
SW700.001	SMh701	0.5	10.3	SURCHARGED
SW700.002	SMh702	0.5	20.9	FLOOD
SW700.003	SMh703	0.6	2.2	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 7

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW700.000	SMh700	720 minute 30 year Winter I+20%	120.630	119.798	0.153	0.000	0.08		0.422
SW700.001	SMh701	720 minute 30 year Winter I+20%	120.900	119.796	0.456	0.000	0.05		2.558
SW700.002	SMh702	720 minute 30 year Winter I+20%	120.900	119.795	0.695	0.000	0.09		6.390
SW700.003	SMh703	720 minute 30 year Winter I+20%	120.900	119.794	1.279	0.000	0.06		132.699

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW700.000	SMh700	0.8	4.4	SURCHARGED
SW700.001	SMh701	0.5	10.7	SURCHARGED
SW700.002	SMh702	0.4	12.8	SURCHARGED
SW700.003	SMh703	0.6	2.4	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 7

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW700.000	SMh700	960 minute 100 year Winter I+20%	120.630	119.940	0.295	0.000	0.08		0.582
SW700.001	SMh701	960 minute 100 year Winter I+20%	120.900	119.937	0.597	0.000	0.05		2.761
SW700.002	SMh702	960 minute 100 year Winter I+20%	120.900	119.936	0.836	0.000	0.09		6.592
SW700.003	SMh703	960 minute 100 year Winter I+20%	120.900	119.936	1.421	0.000	0.06		179.050

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW700.000	SMh700	0.8	4.4	SURCHARGED
SW700.001	SMh701	0.5	11.0	SURCHARGED
SW700.002	SMh702	0.4	13.0	SURCHARGED
SW700.003	SMh703	0.6	2.5	SURCHARGED

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 8

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 8

Time (mins)	**Area (ha)**	**Time (mins)**	**Area (ha)**	**Time (mins)**	**Area (ha)**
0-4	0.286	4-8	0.158	8-12	0.000

Total Area Contributing (ha) = 0.444

Total Pipe Volume (m³) = 46.044

Network Design Table for Catchment 8

« - Indicates pipe capacity < flow

PN	**Length (m)**	**Fall (m)**	**Slope (1:X)**	**I.Area (ha)**	**T.E. (mins)**	**Base Flow (l/s)**	**k (mm)**	**HYD SECT**	**DIA (mm)**	**Section Type**	**Auto Design**
S800.000	36.644	1.047	35.0	0.051	6.00	0.0	0.600	o	600	Pipe/Conduit	
S800.001	9.332	0.336	27.8	0.095	0.00	0.0	0.600	o	600	Pipe/Conduit	
S800.002	22.494	0.165	136.1	0.014	0.00	0.0	0.600	o	600	Pipe/Conduit	
S800.003	50.369	0.202	249.4	0.029	0.00	0.0	0.600	o	600	Pipe/Conduit	
S801.000	48.654	0.486	100.1	0.072	6.00	0.0	0.600	o	300	Pipe/Conduit	
S801.001	16.074	0.161	99.8	0.028	0.00	0.0	0.600	o	300	Pipe/Conduit	
S801.002	41.339	0.345	119.8	0.048	0.00	0.0	0.600	o	300	Pipe/Conduit	
S801.003	24.708	0.206	119.9	0.017	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	**Rain (mm/hr)**	**T.C. (mins)**	**US/IL (m)**	**Σ I.Area (ha)**	**Σ Base Flow (l/s)**	**Foul (l/s)**	**Add Flow (l/s)**	**Vel (m/s)**	**Cap (l/s)**	**Flow (l/s)**
S800.000	50.00	6.15	120.000	0.051	0.0	0.0	0.0	4.13	1166.5	6.9
S800.001	50.00	6.18	118.950	0.146	0.0	0.0	0.0	4.63	1309.6	19.8
S800.002	50.00	6.36	118.450	0.160	0.0	0.0	0.0	2.09	589.8	21.7
S800.003	50.00	6.91	118.285	0.189	0.0	0.0	0.0	1.54	434.7	25.6
S801.000	50.00	6.52	119.700	0.072	0.0	0.0	0.0	1.57	111.1	9.7
S801.001	50.00	6.69	119.220	0.100	0.0	0.0	0.0	1.57	111.2	13.5
S801.002	50.00	7.17	119.050	0.148	0.0	0.0	0.0	1.44	101.5	20.0
S801.003	50.00	7.45	118.710	0.165	0.0	0.0	0.0	1.43	101.4	22.3

Network Design Table for Catchment 8

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
S801.004	7.344	0.061	120.4	0.053	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S801.005	3.912	0.031	126.2	0.009	0.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S800.004	4.521	0.042	107.6	0.028	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S800.005	18.394	0.138	133.4	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S800.006	9.905	0.083	120.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S801.004	50.00	7.54	118.510	0.218	0.0	0.0	0.0	1.43	101.2	29.6
S801.005	50.00	7.59	118.450	0.228	0.0	0.0	0.0	1.40	98.8	30.8
S800.004	50.00	7.62	118.080	0.444	0.0	0.0	0.0	2.35	663.5	60.2
S800.005	50.00	7.89	118.020	0.444	0.0	0.0	0.0	1.13	44.9«	60.2
S800.006	50.00	8.03	117.600	0.444	0.0	0.0	0.0	1.19	47.4«	60.2

Area Summary for Catchment 8

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
800.000	User	-	81	0.037	0.030	0.030
	User	-	81	0.020	0.017	0.047
	User	-	25	0.017	0.004	0.051
800.001	User	-	81	0.028	0.023	0.023
	User	-	25	0.029	0.007	0.030
	User	-	25	0.258	0.065	0.095
800.002	User	-	81	0.015	0.012	0.012
	User	-	25	0.011	0.003	0.014
800.003	User	-	50	0.006	0.003	0.003
	User	-	50	0.005	0.002	0.005
	User	-	25	0.022	0.005	0.011
	User	-	25	0.001	0.000	0.011
	User	-	81	0.006	0.005	0.016
	User	-	81	0.015	0.012	0.029
801.000	User	-	50	0.012	0.006	0.006
	User	-	50	0.006	0.003	0.009
	User	-	25	0.002	0.001	0.009
	User	-	25	0.002	0.000	0.010
	User	-	81	0.024	0.019	0.029
	User	-	81	0.012	0.010	0.039
	User	-	81	0.032	0.026	0.066
	User	-	25	0.016	0.004	0.070
	User	-	25	0.006	0.001	0.071
	User	-	25	0.002	0.001	0.072
801.001	User	-	50	0.007	0.003	0.003
	User	-	50	0.006	0.003	0.006
	User	-	25	0.002	0.000	0.007
	User	-	25	0.001	0.000	0.007
	User	-	25	0.018	0.004	0.012
	User	-	80	0.017	0.013	0.025
	User	-	81	0.004	0.003	0.028
801.002	User	-	81	0.007	0.006	0.006
	User	-	25	0.001	0.000	0.006
	User	-	25	0.005	0.001	0.007
	User	-	25	0.001	0.000	0.007
	User	-	80	0.013	0.010	0.018
	User	-	80	0.028	0.022	0.040
	User	-	81	0.010	0.008	0.048
801.003	User	-	50	0.022	0.011	0.011
	User	-	50	0.012	0.006	0.017
	User	-	25	0.001	0.000	0.017
	User	-	25	0.001	0.000	0.017
	User	-	25	0.001	0.000	0.017
	User	-	25	0.001	0.000	0.017
801.004	User	-	50	0.006	0.003	0.003
	User	-	25	0.002	0.001	0.004
	User	-	81	0.019	0.015	0.019
	User	-	80	0.043	0.034	0.053
801.005	User	-	81	0.011	0.009	0.009
800.004	User	-	50	0.005	0.002	0.002
	User	-	50	0.005	0.003	0.005
	User	-	25	0.024	0.006	0.011
	User	-	25	0.001	0.000	0.011
	User	-	25	0.001	0.000	0.012
	User	-	81	0.008	0.006	0.018
	User	-	70	0.014	0.010	0.028
800.005	-	-	100	0.000	0.000	0.000

Area Summary for Catchment 8

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
800.006	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.880	0.444	0.444

Free Flowing Outfall Details for Catchment 8

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S800.006	S	120.000	117.517	117.500	0	0

Simulation Criteria for Catchment 8

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 8

Hydro-Brake® Optimum Manhole: S810, DS/PN: S800.005, Volume (m³): 5.5

Unit Reference	MD-SHE-0108-5300-1000-5300
Design Head (m)	1.000
Design Flow (l/s)	5.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	108
Invert Level (m)	118.020
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	5.3	Kick-Flo®	0.641	4.3
Flush-Flo™	0.295	5.3	Mean Flow over Head Range	-	4.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.7	0.800	4.8	2.000	7.3	4.000	10.2	7.000	13.3
0.200	5.2	1.000	5.3	2.200	7.7	4.500	10.7	7.500	13.7
0.300	5.3	1.200	5.8	2.400	8.0	5.000	11.3	8.000	14.1
0.400	5.2	1.400	6.2	2.600	8.3	5.500	11.8	8.500	14.6
0.500	5.0	1.600	6.6	3.000	8.9	6.000	12.3	9.000	15.0
0.600	4.6	1.800	7.0	3.500	9.5	6.500	12.8	9.500	15.4

Storage Structures for Catchment 8

Tank or Pond Manhole: S810, DS/PN: S800.005

Invert Level (m) 118.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	250.0	1.000	250.0	1.200	250.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 8

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Maximum Velocity (m/s)
S800.000	S800	15 minute 2 year Winter I+20%	122.000	120.025	-0.575	0.000	0.01		0.036	1.2
S800.001	S801	15 minute 2 year Winter I+20%	121.500	119.028	-0.522	0.000	0.04		0.158	1.1
S800.002	S802	180 minute 2 year Winter I+20%	121.650	118.680	-0.370	0.000	0.02		0.414	0.7
S800.003	S803	180 minute 2 year Winter I+20%	120.650	118.680	-0.205	0.000	0.03		3.752	0.5
S801.000	S805	15 minute 2 year Winter I+20%	121.050	119.768	-0.232	0.000	0.12		0.072	1.0
S801.001	S806	15 minute 2 year Winter I+20%	120.770	119.304	-0.216	0.000	0.18		0.168	1.0
S801.002	S807	15 minute 2 year Winter I+20%	121.120	119.152	-0.198	0.000	0.25		0.171	1.1
S801.003	S808	15 minute 2 year Winter I+20%	120.720	118.821	-0.189	0.000	0.29		0.268	1.1
S801.004	S809	180 minute 2 year Winter I+20%	120.850	118.682	-0.128	0.000	0.20		0.588	0.7
S801.005	S11	180 minute 2 year Winter I+20%	120.850	118.681	-0.069	0.000	0.21		0.551	0.7
S800.004	S804	180 minute 2 year Winter I+20%	120.850	118.680	0.000	0.000	0.07		13.135	0.4
S800.005	S810	180 minute 2 year Winter I+20%	120.650	118.679	0.434	0.000	0.13		46.789	0.8
S800.006	S811	2160 minute 2 year Summer I+20%	120.000	117.655	-0.170	0.000	0.13		0.056	0.7

PN	US/MH Name	Pipe Flow (l/s)	Status
S800.000	S800	8.8	OK
S800.001	S801	23.6	OK
S800.002	S802	9.2	OK
S800.003	S803	9.9	OK
S801.000	S805	12.2	OK
S801.001	S806	16.5	OK
S801.002	S807	23.6	OK
S801.003	S808	26.3	OK
S801.004	S809	12.6	OK
S801.005	S11	13.0	OK

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 8

PN	US/MH Name	Pipe Flow (l/s)	Status
S800.004	S804	22.4	OK
S800.005	S810	5.3	SURCHARGED
S800.006	S811	5.1	OK

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 8

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR   M5-60 (mm) 19.300   Cv (Summer) 0.750
Region Scotland and Ireland   Ratio R 0.256   Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0   DVD Status OFF
Analysis Timestep Fine   Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)	Maximum Velocity (m/s)
S800.000	S800	15 minute 30 year Winter I+20%	122.000	120.047	-0.553	0.000	0.02		0.074	1.7
S800.001	S801	15 minute 30 year Winter I+20%	121.500	119.070	-0.480	0.000	0.09		0.270	1.3
S800.002	S802	360 minute 30 year Winter I+20%	121.650	118.960	-0.090	0.000	0.02		1.463	0.5
S800.003	S803	360 minute 30 year Winter I+20%	120.650	118.961	0.076	0.000	0.03		6.923	0.4
S801.000	S805	15 minute 30 year Winter I+20%	121.050	119.795	-0.205	0.000	0.22		0.101	1.2
S801.001	S806	15 minute 30 year Winter I+20%	120.770	119.342	-0.178	0.000	0.34		0.301	1.2
S801.002	S807	15 minute 30 year Winter I+20%	121.120	119.205	-0.145	0.000	0.51		0.379	1.3
S801.003	S808	360 minute 30 year Winter I+20%	120.720	118.965	-0.045	0.000	0.12		1.197	0.9
S801.004	S809	360 minute 30 year Winter I+20%	120.850	118.963	0.153	0.000	0.22		2.124	0.6
S801.005	S11	360 minute 30 year Winter I+20%	120.850	118.962	0.212	0.000	0.23		1.008	0.6
S800.004	S804	360 minute 30 year Winter I+20%	120.850	118.961	0.281	0.000	0.08		15.546	0.4
S800.005	S810	360 minute 30 year Winter I+20%	120.650	118.960	0.715	0.000	0.13		117.602	0.8
S800.006	S811	15 minute 30 year Summer I+20%	120.000	117.654	-0.171	0.000	0.13		0.056	0.7

PN	US/MH Name	Pipe Flow (l/s)	Status
S800.000	S800	16.2	OK
S800.001	S801	50.6	OK
S800.002	S802	10.0	OK
S800.003	S803	10.8	SURCHARGED
S801.000	S805	22.6	OK
S801.001	S806	31.8	OK
S801.002	S807	47.9	OK
S801.003	S808	10.4	OK
S801.004	S809	13.3	SURCHARGED
S801.005	S11	13.7	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 8

PN	US/MH Name	Pipe Flow (l/s)	Status
S800.004	S804	24.8	SURCHARGED
S800.005	S810	5.2	SURCHARGED
S800.006	S811	5.3	OK

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 8

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
S800.000	S800	15 minute 100 year Winter I+20%	122.000	120.060	-0.540	0.000	0.02		0.098
S800.001	S801	240 minute 100 year Winter I+20%	121.500	119.150	-0.400	0.000	0.03		0.557
S800.002	S802	240 minute 100 year Winter I+20%	121.650	119.150	0.100	0.000	0.04		2.613
S800.003	S803	240 minute 100 year Winter I+20%	120.650	119.150	0.265	0.000	0.05		7.457
S801.000	S805	15 minute 100 year Winter I+20%	121.050	119.808	-0.192	0.000	0.28		0.117
S801.001	S806	15 minute 100 year Winter I+20%	120.770	119.361	-0.159	0.000	0.44		0.390
S801.002	S807	15 minute 100 year Winter I+20%	121.120	119.233	-0.117	0.000	0.66		0.495
S801.003	S808	240 minute 100 year Winter I+20%	120.720	119.155	0.145	0.000	0.18		2.787
S801.004	S809	240 minute 100 year Winter I+20%	120.850	119.152	0.342	0.000	0.34		2.389
S801.005	S11	240 minute 100 year Winter I+20%	120.850	119.150	0.400	0.000	0.36		1.222
S800.004	S804	240 minute 100 year Winter I+20%	120.850	119.149	0.469	0.000	0.13		15.879
S800.005	S810	240 minute 100 year Winter I+20%	120.650	119.149	0.904	0.000	0.14		165.052
S800.006	S811	5760 minute 100 year Summer I+20%	120.000	117.658	-0.167	0.000	0.13		0.060

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S800.000	S800	1.6	21.1	OK
S800.001	S801	1.0	15.3	OK
S800.002	S802	0.4	16.3	SURCHARGED
S800.003	S803	0.5	17.5	SURCHARGED
S801.000	S805	1.3	29.4	OK
S801.001	S806	1.3	41.3	OK
S801.002	S807	1.4	62.4	OK
S801.003	S808	1.0	16.7	SURCHARGED
S801.004	S809	0.7	21.3	SURCHARGED
S801.005	S11	0.5	22.0	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 8

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
S800.004	S804	0.4	41.6	SURCHARGED
S800.005	S810	0.8	5.6	SURCHARGED
S800.006	S811	0.7	5.0	OK

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 9

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	19.300	Add Flow / Climate Change (%)	0
Ratio R	0.256	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)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	180

Designed with Level Soffits

Time Area Diagram for Catchment 9

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.132	4-8	0.063

Total Area Contributing (ha) = 0.195

Total Pipe Volume (m³) = 6.692

Network Design Table for Catchment 9

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
SW900.000	42.170	1.754	24.0	0.100	6.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW900.001	33.246	0.971	34.3	0.085	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
SW900.002	19.372	0.097	200.0	0.010	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
SW900.003	15.405	0.224	68.8	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
SW900.000	50.00	6.26	140.100	0.100	0.0	0.0	0.0	2.68	106.5	13.5
SW900.001	50.00	6.51	138.150	0.185	0.0	0.0	0.0	2.24	89.2	25.0
SW900.002	50.00	6.73	137.550	0.195	0.0	0.0	0.0	1.43	228.1	26.4
SW900.003	50.00	6.90	137.400	0.195	0.0	0.0	0.0	1.58	62.8	26.4

Area Summary for Catchment 9

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
900.000	User	-	50	0.010	0.005	0.005
	User	-	50	0.005	0.002	0.008
	User	-	80	0.015	0.012	0.020
	User	-	80	0.012	0.010	0.029
	User	-	25	0.003	0.001	0.030
	User	-	25	0.002	0.001	0.031
	User	-	25	0.003	0.001	0.031
	User	-	25	0.023	0.006	0.037
	User	-	81	0.044	0.036	0.073
	User	-	81	0.021	0.017	0.090
	User	-	81	0.011	0.009	0.100
900.001	User	-	55	0.004	0.002	0.002
	User	-	50	0.010	0.005	0.007
	User	-	55	0.012	0.007	0.014
	User	-	80	0.025	0.020	0.033
	User	-	25	0.003	0.001	0.034
	User	-	81	0.034	0.028	0.062
	User	-	81	0.006	0.005	0.067
	User	-	81	0.008	0.007	0.073
	User	-	81	0.009	0.007	0.080
	User	-	10	0.048	0.005	0.085
900.002	User	-	25	0.038	0.010	0.010
	User	-	25	0.001	0.000	0.010
900.003	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.349	0.195	0.195

Free Flowing Outfall Details for Catchment 9

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
SW900.003	SMh	138.500	137.176	137.300	0	0

Simulation Criteria for Catchment 9

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

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

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	19.300	Storm Duration (mins)	30
Ratio R	0.256		

Online Controls for Catchment 9

Hydro-Brake® Optimum Manhole: SMh903, DS/PN: SW900.003, Volume (m³): 4.4

Unit Reference	MD-SHE-0057-1300-0750-1300
Design Head (m)	0.750
Design Flow (l/s)	1.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	57
Invert Level (m)	137.400
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.750	1.3	Kick-Flo®	0.475	1.1
Flush-Flo™	0.232	1.3	Mean Flow over Head Range	-	1.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.2	0.800	1.3	2.000	2.0	4.000	2.8	7.000	3.6
0.200	1.3	1.000	1.5	2.200	2.1	4.500	2.9	7.500	3.7
0.300	1.3	1.200	1.6	2.400	2.2	5.000	3.1	8.000	3.9
0.400	1.2	1.400	1.7	2.600	2.3	5.500	3.2	8.500	4.0
0.500	1.1	1.600	1.8	3.000	2.4	6.000	3.4	9.000	4.1
0.600	1.2	1.800	1.9	3.500	2.6	6.500	3.5	9.500	4.2

Storage Structures for Catchment 9

Tank or Pond Manhole: SMh903, DS/PN: SW900.003

Invert Level (m) 137.500

Depth (m)	Area (m^2)	Depth (m)	Area (m^2)
0.000	125.0	1.000	200.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 9

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW900.000	SMh900	15 minute 2 year Winter I+20%	141.610	140.162	-0.163	0.000	0.17		0.064
SW900.001	SMh901	15 minute 2 year Winter I+20%	139.650	138.244	-0.131	0.000	0.36		0.101
SW900.002	SMh902	600 minute 2 year Winter I+20%	138.900	137.777	-0.223	0.000	0.03		1.477
SW900.003	SMh903	600 minute 2 year Winter I+20%	138.500	137.777	0.152	0.000	0.02		39.501

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW900.000	SMh900	1.9	17.2	OK
SW900.001	SMh901	1.9	30.5	OK
SW900.002	SMh902	0.5	5.3	OK
SW900.003	SMh903	0.6	1.3	SURCHARGED

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 9

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model		FSR M5-60 (mm)	19.300	Cv (Summer)	0.750
Region	Scotland and Ireland	Ratio R	0.256	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	150.0	DVD Status	OFF
Analysis Timestep	Fine	Inertia Status	OFF
DTS Status	ON		

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	2, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW900.000	SMh900	15 minute 30 year Winter I+20%	141.610	140.186	-0.139	0.000	0.31		0.092
SW900.001	SMh901	15 minute 30 year Winter I+20%	139.650	138.298	-0.077	0.000	0.73		0.162
SW900.002	SMh902	600 minute 30 year Winter I+20%	138.900	138.052	0.052	0.000	0.05		2.230
SW900.003	SMh903	600 minute 30 year Winter I+20%	138.500	138.051	0.426	0.000	0.02		83.286

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW900.000	SMh900	2.3	31.7	OK
SW900.001	SMh901	2.3	61.6	OK
SW900.002	SMh902	0.5	8.6	SURCHARGED
SW900.003	SMh903	0.6	1.3	SURCHARGED

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Catchment 9

Simulation Criteria

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

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

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.300 Cv (Summer) 0.750
Region Scotland and Ireland Ratio R 0.256 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 150.0 DVD Status OFF
Analysis Timestep Fine Inertia Status OFF
DTS Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Event	US/CL (m)	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Maximum Vol (m³)
SW900.000	SMh900	15 minute 100 year Winter I+20%	141.610	140.200	-0.125	0.000	0.41		0.107
SW900.001	SMh901	15 minute 100 year Winter I+20%	139.650	138.600	0.225	0.000	0.92		0.631
SW900.002	SMh902	720 minute 100 year Winter I+20%	138.900	138.215	0.215	0.000	0.05		2.654
SW900.003	SMh903	720 minute 100 year Winter I+20%	138.500	138.215	0.590	0.000	0.02		111.387

PN	US/MH Name	Maximum Velocity (m/s)	Pipe Flow (l/s)	Status
SW900.000	SMh900	2.4	41.2	OK
SW900.001	SMh901	2.2	77.3	SURCHARGED
SW900.002	SMh902	0.5	9.5	SURCHARGED
SW900.003	SMh903	0.6	1.3	SURCHARGED

Appendix 11.2

StormTech Calculations & Details

CubicM3 Stormwater Management System Design Tool

Ver: June 2025

PROJECT REF:	
PROJECT:	
DATE:	13-Nov-25
CREATED BY:	

SYSTEM PARAMETERS

Required Total Storage	580	m^3
Attenuation Chamber Model	RT-1140	
Filtration Permeable Geo or Impermeable Geo	Filter geo - TS1000	
Number of Separator Rows (IR)	1	

SITE PARAMETERS

			Minimum Requirement
Stone Porosity	45%		
Excavation Batter Angle (degrees)	60	°	
Stone Above Chambers	0.45	m	0.15
Stone Below Chambers	0.375	m	0.2 if cover <= 2.5m or 0.25 for bigger cover
In-between Row Spacing	1.00	m	0.15
Additional Storage outside Excavation. E.g manholes, Header Pipe	5	m^3	

HEADER PIPE

Is Header pipe required within excavation	No	
Orientation of Header Pipe	Perp to IR	
Diameter of Header Pipe	0.6	m
Length of Header Pipe	0	m

CHAMBER SYSTEM DIMENSIONS

	Calculated	Adopted	
Number of Rows		6	ea
Number of units per Row		12	ea
System Installed Storage Depth (effective storage depth)	1.965		m
Tank overall installed Width at base	17.70	19.5	m
Tank overall installed Length at Base	24.602	25	m
Total Effective System Storage	**542.5**	**590.8**	m^3

SYSTEM DETAIL

Chamber Model	RT-1140	
Unit Width	1.95	m
Unit Length	1.88	m
Unit Height	1.14	m
Min Cover Over System	0.3	m
Max Cover Over Chamber	4	m
Chamber Internal Storage Vol.	2.67	m^3
Header Pipe Internal Storage Vol in Excavation	0.0	m^3

STONE AND EXCAVATION DETAIL

Volume of Dig for System	1062	m^3
Width at base	19.50	m
Width at top	21.77	m
Length at base	25.00	m
Length at top	27.27	m
Depth Of System	1.97	m
Area of Dig at Base of System	488	m^2
Area of Dig at Top of System	594	m^2
Void Ratio	56%	
Stone Requirement - m3	864	m^3
Stone Requirement - tonne	1309	tonne

SYSTEM ITEM LIST

Item	Product	Calculated	Adopted	unit	€/unit	Total	Comments
Storage							
Chamber Type	RT-1140	72	72	ea	€ -	€ -	
Endcap Type	RT-1140 ec	12	12	ea	€ -	€ -	

StormTech® Subsurface Stormwater Management

The advanced design of StormTech's chambers allows stormwater professionals to create more profitable, environmentally sound installations. Compared with other subsurface systems, StormTech's innovative chambers offer lower overall installed costs, superior design flexibility and enhanced long-term performance.

Superior Design Flexibility for Optimal Land Use

StormTech chambers are ideal for commercial, municipal and residential applications. One of the key advantages of the StormTech chamber system is design flexibility. StormTech chambers can be configured into beds or trenches, in centralized or decentralized layouts to fit on nearly any site.

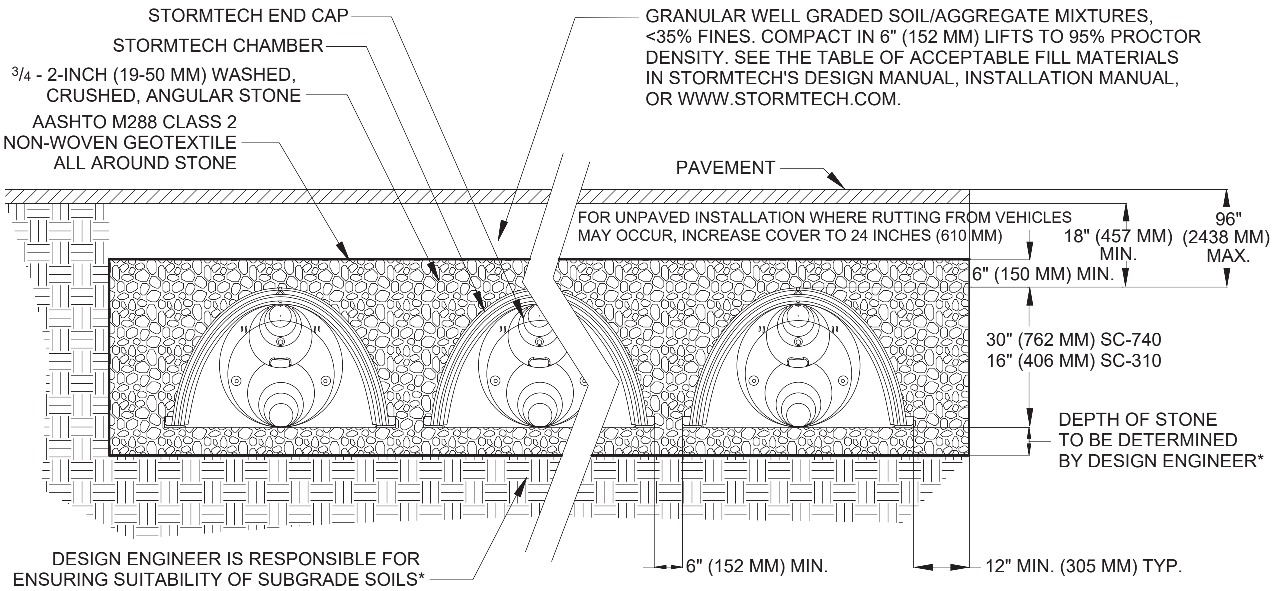
L to R: SC-310 chamber and SC-740 chamber

Product Features and Benefits

The advanced features and innovative technology of StormTech chambers streamline installations while lowering overall installed costs. StormTech chambers offer these unique advantages:

- Lightweight, two people can install chambers quickly and easily, saving time and money
- Extensive product research & development and rigorous testing ensure long term reliability and performance
- Versatile product design accommodates a wide range of site constraints with cost-effective system designs
- The chamber length can be cut in 6.5" (165 mm) increments – reducing waste and optimizing the use of available space
- Injection molded polypropylene ensures precise control of wall thickness and product consistency
- Isolator Row – a patent pending technique to inexpensively enhance total suspended solids (TSS) removal and provide easy access for inspection and maintenance
- Corrugated Arch Design – a proven geometry for structural integrity under H-20 live loads and deep burial loads, also provides high storage capacity

Typical Cross Section Detail (not to scale)



Detention-Retention-Recharge

The StormTech SC-740 chamber optimizes storage volumes in relatively small footprints by providing 2.2 ft^3/ft^2 (0.67 m^3/m^2) (minimum) of storage. This can decrease excavation, backfill and associated costs. The StormTech SC-310 chamber is ideal for systems requiring low-rise and wide-span solutions. The chamber allows the storage of large volumes, 1.3 ft^3/ft^2 (0.4 m^3/m^2) (minimum), at minimum depths.

StormTech SC-740 Chamber
(not to scale)

Nominal Chamber Specifications

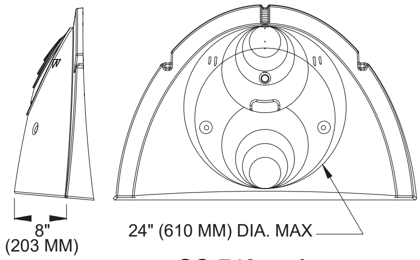
Size (L x W x H)
85.4" x 51.0" x 30.0"
(2169 x 1295 x 762 mm)

Chamber Storage
45.9 ft^3 (1.30 m^3)

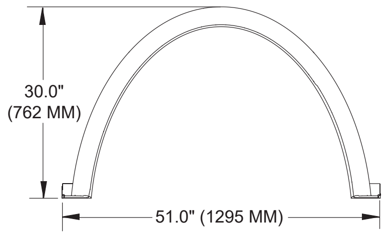
Minimum Installed Storage*
74.9 ft^3 (2.12 m^3)

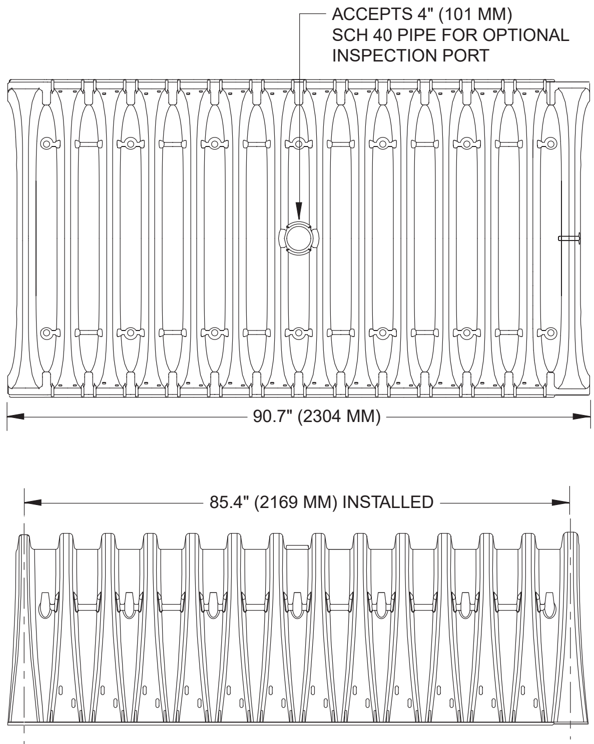
Weight
74.0 lbs (33.6 kg)

Shipping
30 chambers/pallet
60 end caps/pallet
12 pallets/truck



SC-740 end cap





SC-740 chamber

StormTech SC-310 Chamber
(not to scale)

Nominal Chamber Specifications

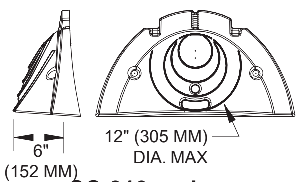
Size (L x W x H)
85.4" x 34.0" x 16.0"
(2169 x 864 x 406 mm)

Chamber Storage
14.7 ft^3 (0.42 m^3)

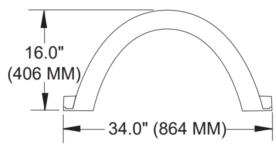
Minimum Installed Storage*
31.0 ft^3 (0.88 m^3)

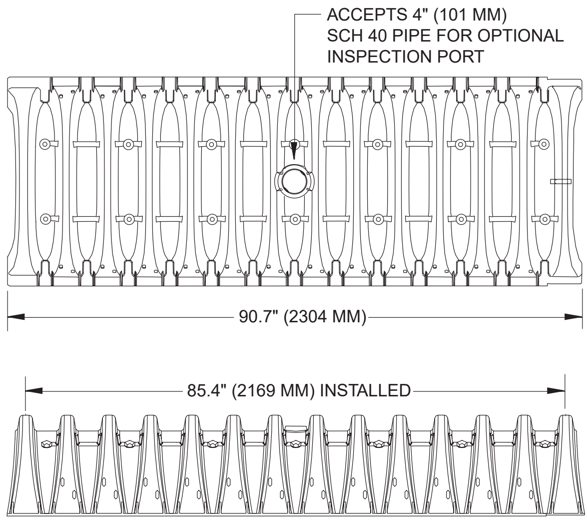
Weight
37.0 lbs (16.8 kg)

Shipping
41 chambers/pallet
108 end caps/pallet
18 pallets/truck



SC-310 end cap





SC-310 chamber

*This assumes a minimum of 6 inches (152 mm) of stone below, above and between chamber rows.

Advanced Structural Performance for Greater Long-Term Reliability

StormTech developed a state of the art chamber design through:

- Collaboration with world-renowned experts of buried drainage structures to develop and evaluate the structural testing program and product design
- Designing chambers to exceed AASHTO LRFD design specifications for HS-20 live loads and deep burial earth loads
- Subjecting the chambers to rigorous full scale testing, under severe loading conditions to verify the AASHTO safety factors for live load and deep burial applications

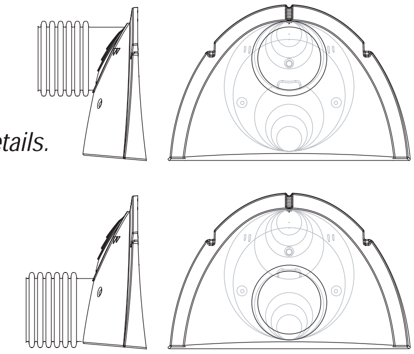
StormTech continues to conduct research and consult with outside experts to meet customer needs for alternative backfill materials, designs for special loadings and other technical solutions.

Technical Assistance

StormTech's technical support staff is available to provide assistance to engineers, contractors and developers. Please contact one of our engineers or product managers to discuss your particular application. A wide variety of technical support material is available in print, electronic media or from our website at www.stormtech.com. For any questions, please call StormTech at 888-892-2694.

Fabricated End Caps

Contact StormTech for details.



StormTech®
Detention • Retention • Recharge
Subsurface Stormwater Management℠

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Appendix 11.3

Typical Swale/Tree Pits & Permeable Paving Calculations

SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

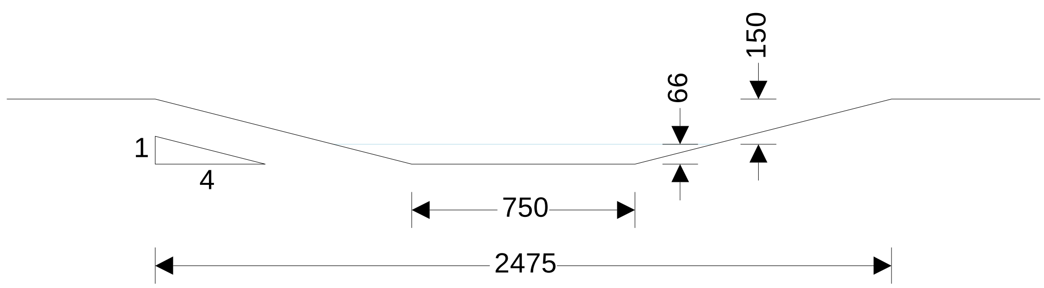
Width of swale base $w = \mathbf{0.750}$ m

Longitudinal gradient of swale $S = \mathbf{0.020}$

Side slope gradient of swale $s = \mathbf{0.250}$

Manning number $n = \mathbf{0.25}$

Length of swale $L = \mathbf{28}$ m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert $d_{outlet} = \mathbf{0}$ mm

Design rainfall intensity

Location of catchment area Other

Storm duration $D = \mathbf{10}$ min

Return period Period = **2** yr

Ratio 60 min to 2 day rainfall of 5 yr return period $r = \mathbf{0.229}$

5-year return period rainfall of 60 minutes duration M5_60min = **17.9** mm

Increase of rainfall intensity due to global warming $p_{climate} = \mathbf{0}$ %

Factor Z1 (Wallingford procedure) Z1 = **0.45**

Rainfall for 10min storm with 5 year return period $M5\_10min_i = Z1 \times M5\_60min = \mathbf{8.0}$ mm

Factor Z2 (Wallingford procedure) Z2 = **0.82**

Rainfall for 10min storm with 2 year return period $M2\_10min = Z2 \times M5\_10min_i = \mathbf{6.6}$ mm

Design rainfall intensity $I_{max} = M2\_10min / D = \mathbf{39.5}$ mm/hr

Maximum surface water runoff

Catchment area $A_{catch} = \mathbf{520}$ m^2

Percentage of area that is impermeable $p = \mathbf{90}$ %

Maximum surface water runoff $Q_{max} = A_{catch} \times p \times I_{max} = \mathbf{5.1}$ l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow $x = \mathbf{66}$ mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow $A = (w + x / s) \times x = \mathbf{0.067}$ m^2

Perimeter of flow $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)} = \mathbf{1.292}$ m

Hydraulic radius $R = A / P = \mathbf{0.051}$ m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n = \mathbf{5.2}\ l/s$

Maximum velocity of flow $V_{max} = Q_{max} / A = \mathbf{0.077}\ m/s$

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} = \mathbf{150}\ mm$

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w = \mathbf{2.475}\ m$

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D = \mathbf{3.1}\ m^3$

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w = \mathbf{21.0}\ m^2$

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} = \mathbf{0.2}\ m^3$

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} = \mathbf{2.9}\ m^3$

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 = \mathbf{0.0}\ m^3$

Interception volume required exceeds volume provided. Additional interception storage will be required.

Roger Mullarkey & Associates Duncreevan Kilcock Co.Kildare	Project Boherboy LRD Stage 3				Job Ref. 1324B	
	Section Swale 2				Sheet no./rev. 1	
	Calc. by RM	Date 10/11/2025	Chk'd by	Date	App'd by	Date

SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

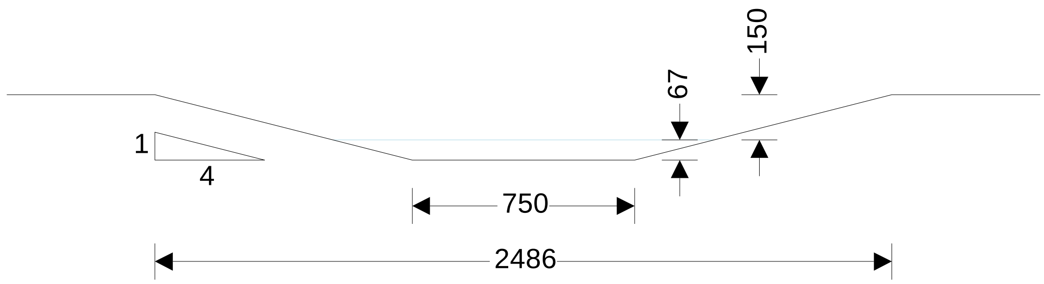
Width of swale base — w = **0.750** m

Longitudinal gradient of swale — S = **0.020**

Side slope gradient of swale — s = **0.250**

Manning number — n = **0.25**

Length of swale — L = **43** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert — d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area — Other

Storm duration — D = **10** min

Return period — Period = **2** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.229**

5-year return period rainfall of 60 minutes duration — M5_60min = **17.9** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **0** %

Factor Z1 (Wallingford procedure) — Z1 = **0.45**

Rainfall for 10min storm with 5 year return period — $M5\_10min_i = Z1 \times M5\_60min$ = **8.0** mm

Factor Z2 (Wallingford procedure) — Z2 = **0.82**

Rainfall for 10min storm with 2 year return period — $M2\_10min = Z2 \times M5\_10min_i$ = **6.6** mm

Design rainfall intensity — $I_{max} = M2\_10min / D$ = **39.5** mm/hr

Maximum surface water runoff

Catchment area — A_{catch} = **540** m^2

Percentage of area that is impermeable — p = **90** %

Maximum surface water runoff — $Q_{max} = A_{catch} \times p \times I_{max}$ = **5.3** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow — x = **67** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow — $A = (w + x / s) \times x$ = **0.068** m^2

Perimeter of flow — $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.303** m

Hydraulic radius — $R = A / P$ = **0.052** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n =$ **5.4** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.078** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **2.486** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **3.2** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **32.3** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.3** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **2.9** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

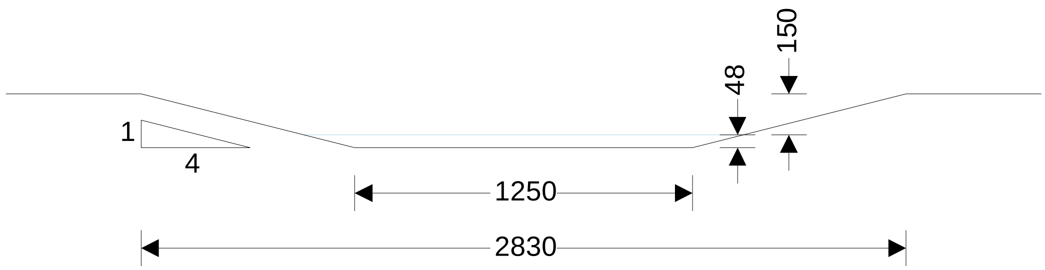
SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

Width of swale base w = **1.250** m
Longitudinal gradient of swale S = **0.020**
Side slope gradient of swale s = **0.250**
Manning number n = **0.25**
Length of swale L = **26** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area Other
Storm duration D = **10** min
Return period Period = **2** yr
Ratio 60 min to 2 day rainfall of 5 yr return period r = **0.229**
5-year return period rainfall of 60 minutes duration M5_60min = **17.9** mm
Increase of rainfall intensity due to global warming $p_{climate}$ = **0** %
Factor Z1 (Wallingford procedure) Z1 = **0.45**
Rainfall for 10min storm with 5 year return period $M5\_10min_i = Z1 \times M5\_60min$ = **8.0** mm
Factor Z2 (Wallingford procedure) Z2 = **0.82**
Rainfall for 10min storm with 2 year return period $M2\_10min = Z2 \times M5\_10min_i$ = **6.6** mm
Design rainfall intensity $I_{max} = M2\_10min / D$ = **39.5** mm/hr

Maximum surface water runoff

Catchment area A_{catch} = **467** m^2
Percentage of area that is impermeable p = **90** %
Maximum surface water runoff $Q_{max} = A_{catch} \times p \times I_{max}$ = **4.6** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow x = **48** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow $A = (w + x / s) \times x$ = **0.068** m^2
Perimeter of flow $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.642** m
Hydraulic radius $R = A / P$ = **0.042** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n = \mathbf{4.7}$ l/s

Maximum velocity of flow $V_{max} = Q_{max} / A = \mathbf{0.067}$ m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} = \mathbf{150}$ mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w = \mathbf{2.830}$ m

Storage

Infiltration capacity of the base $f = \mathbf{0.000014}$ m/s

Flow into swale $V_{in} = Q_{max} \times D = \mathbf{2.8}\ m^3$

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w = \mathbf{32.5}\ m^2$

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} = \mathbf{0.3}\ m^3$

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} = \mathbf{2.5}\ m^3$

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 = \mathbf{0.0}\ m^3$

Interception volume required exceeds volume provided. Additional interception storage will be required.

SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

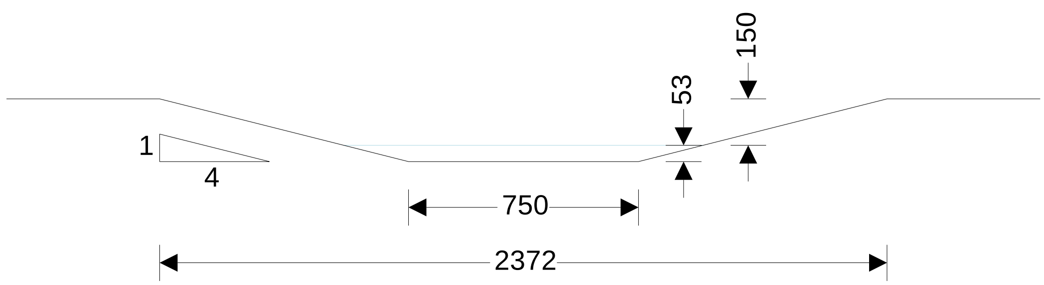
Width of swale base — w = **0.750** m

Longitudinal gradient of swale — S = **0.020**

Side slope gradient of swale — s = **0.250**

Manning number — n = **0.25**

Length of swale — L = **40** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert — d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area — Other

Storm duration — D = **10** min

Return period — Period = **2** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.229**

5-year return period rainfall of 60 minutes duration — M5_60min = **17.9** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **0** %

Factor Z1 (Wallingford procedure) — Z1 = **0.45**

Rainfall for 10min storm with 5 year return period — $M5\_10min_i = Z1 \times M5\_60min$ = **8.0** mm

Factor Z2 (Wallingford procedure) — Z2 = **0.82**

Rainfall for 10min storm with 2 year return period — $M2\_10min = Z2 \times M5\_10min_i$ = **6.6** mm

Design rainfall intensity — $I_{max} = M2\_10min / D$ = **39.5** mm/hr

Maximum surface water runoff

Catchment area — A_{catch} = **351** m^2

Percentage of area that is impermeable — p = **90** %

Maximum surface water runoff — $Q_{max} = A_{catch} \times p \times I_{max}$ = **3.5** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow — x = **53** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow — $A = (w + x / s) \times x$ = **0.051** m^2

Perimeter of flow — $P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.185** m

Hydraulic radius — $R = A / P$ = **0.043** m

Check flow using Manning equation — $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n$ = **3.5** l/s

Maximum velocity of flow — $V_{max} = Q_{max} / A$ = **0.068** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard — d_{free} = **150** mm

Minimum required swale width — $w_{total,min} = 2 \times (x + d_{free}) / s + w$ = **2.372** m

Storage

Infiltration capacity of the base — f = **0.000014** m/s

Flow into swale — $V_{in} = Q_{max} \times D$ = **2.1** m^3

Infiltration area of swale (assume flat base only) — $A_{infil} = L \times w$ = **30.0** m^2

Infiltration volume of swale — $V_{infil} = f \times D \times A_{infil}$ = **0.2** m^3

Interception storage volume required — $V_{infil\_req} = V_{in} - V_{infil}$ = **1.8** m^3

Interception storage volume provided — $V_{infil\_prov} = L \times w \times d_{outlet} / 2$ = **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

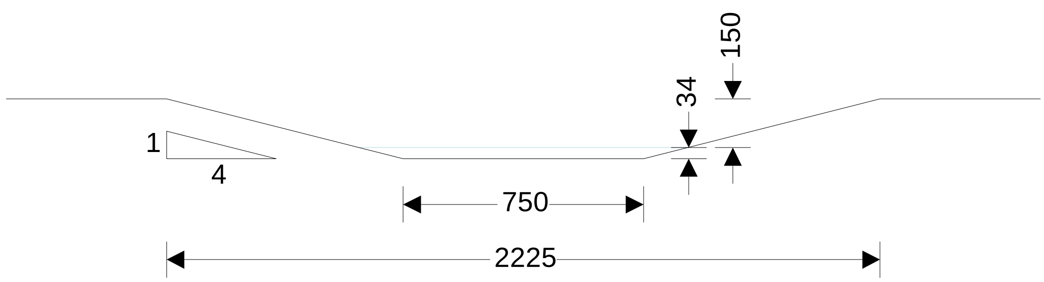
SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

Width of swale base	w = **0.750** m
Longitudinal gradient of swale	S = **0.020**
Side slope gradient of swale	s = **0.250**
Manning number	n = **0.25**
Length of swale	L = **19** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert	d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area	Other
Storm duration	D = **10** min
Return period	Period = **2** yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = **0.229**
5-year return period rainfall of 60 minutes duration	M5_60min = **17.9** mm
Increase of rainfall intensity due to global warming	$p_{climate}$ = **0** %
Factor Z1 (Wallingford procedure)	Z1 = **0.45**
Rainfall for 10min storm with 5 year return period	$M5\_10min_i = Z1 \times M5\_60min$ = **8.0** mm
Factor Z2 (Wallingford procedure)	Z2 = **0.82**
Rainfall for 10min storm with 2 year return period	$M2\_10min = Z2 \times M5\_10min_i$ = **6.6** mm
Design rainfall intensity	I_{max} = M2_10min / D = **39.5** mm/hr

Maximum surface water runoff

Catchment area	A_{catch} = **165** m^2
Percentage of area that is impermeable	p = **90** %
Maximum surface water runoff	$Q_{max} = A_{catch} \times p \times I_{max}$ = **1.6** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow	x = **34** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow	$A = (w + x / s) \times x$ = **0.030** m^2
Perimeter of flow	$P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.033** m
Hydraulic radius	R = A / P = **0.029** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n =$ **1.6** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.054** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **2.225** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **1.0** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **14.3** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.1** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **0.9** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

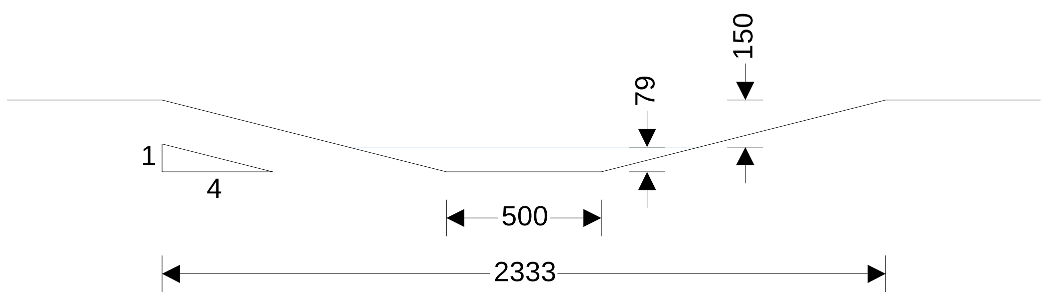
SWALE AND FILTER STRIP DESIGN

In accordance with CIRIA publication C753 - The SUDS Manual

Tedds calculation version 2.0.03

Swale details

Width of swale base	w = **0.500** m
Longitudinal gradient of swale	S = **0.020**
Side slope gradient of swale	s = **0.250**
Manning number	n = **0.25**
Length of swale	L = **120** m



Cross section of swale

Outlet pipe details

Height of outlet pipe above invert	d_{outlet} = **0** mm

Design rainfall intensity

Location of catchment area	Other
Storm duration	D = **10** min
Return period	Period = **1** yr
Ratio 60 min to 2 day rainfall of 5 yr return period	r = **0.256**
5-year return period rainfall of 60 minutes duration	M5_60min = **19.3** mm
Increase of rainfall intensity due to global warming	$p_{climate}$ = **0** %
Factor Z1 (Wallingford procedure)	Z1 = **0.47**
Rainfall for 10min storm with 5 year return period	$M5\_10min_i = Z1 \times M5\_60min$ = **9.1** mm
Factor Z2 (Wallingford procedure)	Z2 = **0.68**
Rainfall for 10min storm with 1 year return period	$M1\_10min = Z2 \times M5\_10min_i$ = **6.2** mm
Design rainfall intensity	I_{max} = M1_10min / D = **37.0** mm/hr

Maximum surface water runoff

Catchment area	A_{catch} = **576** m^2
Percentage of area that is impermeable	p = **90** %
Maximum surface water runoff	$Q_{max} = A_{catch} \times p \times I_{max}$ = **5.3** l/s

Calculate depth of flow using iteration of Manning's formula

Minimum depth of flow	x = **79** mm

Depth of flow is less than or equal to 100 mm so filtration is effective (cl.17.4)

Area of flow	$A = (w + x / s) \times x$ = **0.065** m^2
Perimeter of flow	$P = w + 2 \times \sqrt{(x^2 + (x / s)^2)}$ = **1.153** m
Hydraulic radius	R = A / P = **0.056** m

Check flow using Manning equation $Q_{check} = A \times (R / 1\ m)^{2/3} \times S^{1/2} \times 1\ m/s / n =$ **5.4** l/s

Maximum velocity of flow $V_{max} = Q_{max} / A =$ **0.082** m/s

PASS - velocity is small enough to encourage settlement and prevent erosion (cl.17.4.1)

Minimum width

Freeboard $d_{free} =$ **150** mm

Minimum required swale width $w_{total,min} = 2 \times (x + d_{free}) / s + w =$ **2.333** m

Storage

Infiltration capacity of the base f = **0.000014** m/s

Flow into swale $V_{in} = Q_{max} \times D =$ **3.2** m^3

Infiltration area of swale (assume flat base only) $A_{infil} = L \times w =$ **60.0** m^2

Infiltration volume of swale $V_{infil} = f \times D \times A_{infil} =$ **0.5** m^3

Interception storage volume required $V_{infil\_req} = V_{in} - V_{infil} =$ **2.7** m^3

Interception storage volume provided $V_{infil\_prov} = L \times w \times d_{outlet} / 2 =$ **0.0** m^3

Interception volume required exceeds volume provided. Additional interception storage will be required.

PLANE INFILTRATION SYSTEM DESIGN

In accordance with CIRIA C753 SUDS

Tedds calculation version 2.0.05

Design rainfall intensity

Location of catchment area — Other

Impermeable area drained to the system — A = **150.0** m^2

Return period — Period = **2** yr

Ratio 60 min to 2 day rainfall of 5 yr return period — r = **0.229**

5-year return period rainfall of 60 minutes duration — M5_60min = **19.9** mm

Increase of rainfall intensity due to global warming — $p_{climate}$ = **20** %

Infiltration blanket details

Depth of infiltration blanket — d = **300** mm

Porosity — n = **0.3**

Soil infiltration rate — f = **2.50×10^{-6}** m/s

Table equations

Rainfall intensity — i = M2 / D

Minimum base area required — $A_b = A \times i \times D / (n \times d + f \times D)$

Duration, D (min)	Growth factor Z1	M5 rainfalls (mm)	Growth factor Z2	2 year rainfall, M2 (mm)	Intensity, i (mm/hr)	Blanket area (m^2)
5	0.30;	7.2;	0.82;	5.9;	71.12;	10;
10	0.45;	10.7;	0.82;	8.8;	52.85;	14;
15	0.55;	13.2;	0.83;	10.9;	43.63;	18;
30	0.74;	17.7;	0.84;	14.8;	29.63;	24;
60	1.00;	23.9;	0.84;	20.1;	20.06;	30;
120	1.31;	31.3;	0.85;	26.7;	13.33;	37;
240	1.73;	41.4;	0.86;	35.6;	8.91;	42;
360	2.08;	49.6;	0.87;	43.1;	7.19;	45;
600	2.48;	59.2;	0.87;	51.8;	5.18;	43;
1440	3.44;	82.2;	0.88;	72.3;	3.01;	35;

Min area of blanket req'd — A_{b_max} = **45** m^2

Time to empty blanket to half volume - Eq.25.6(1) — $t_{s50} = n \times d / (2 \times f)$ = 5hr

PASS - Infiltration system discharge time less than or equal to 24 hours

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Project	Boherboy
Ref	1324D
Sheet	1
Date	Nov'25
By	RM
Revised	

Tree Pit Interception Volume — No.1

Length	5	m
Width	1.2	m
Storage depth	0.1	m
Interception Volume Available	**0.6**	m^3
Interception Volume Required *	A x 0.8 x I	
Drained Impermeable Area (A)	120	m^2
Rainfall depth (i)	5	mm
Interception Volume Required	**0.48**	m^3
Volume Required =	0.480	**PASS**
Volume Provided =	0.600	

* GDSDS E2.1.1

Tree Pit Interception Volume — No.2

Length	5.5	m
Width	6.5	m
Storage depth	0.1	m
Interception Volume Available	**3.575**	m^3
Interception Volume Required *	A x 0.8 x I	
Drained Impermeable Area (A)	155	m^2
Rainfall depth (i)	5	mm
Interception Volume Required	**0.62**	m^3
Volume Required =	0.62	**PASS**
Volume Provided =	3.575	

* GDSDS E2.1.1

Tree Pit Interception Volume — No.3

Length	5.000	m
Width	2.000	m
Storage depth	0.100	m
Interception Volume Available	**1.000**	m^3
Interception Volume Required *	A x 0.8 x I	
Drained Impermeable Area (A)	160.000	m^2
Rainfall depth (i)	5.000	mm
Interception Volume Required	**0.640**	m^3
Volume Required =	0.640	**PASS**
Volume Provided =	1.000	

* GDSDS E2.1.1

Tree Pit Interception Volume — No.4

Length	5.000	m
Width	2.000	m
Storage depth	0.100	m
Interception Volume Available	**1.000**	m^3
Interception Volume Required *	A x 0.8 x I	
Drained Impermeable Area (A)	110.000	m^2
Rainfall depth (i)	5.000	mm
Interception Volume Required	**0.440**	m^3
Volume Required =	0.440	**PASS**
Volume Provided =	1.000	

* GDSDS E2.1.1

Tree Pit Interception Volume — No.5

Length	5.000	m
Width	1.200	m
Storage depth	0.100	m
Interception Volume Available	**0.600**	m^3
Interception Volume Required *	A x 0.8 x I	
Drained Impermeable Area (A)	90.000	m^2
Rainfall depth (i)	5.000	mm
Interception Volume Required	**0.360**	m^3
Volume Required =	0.360	**PASS**
Volume Provided =	0.600	

* GDSDS E2.1.1

Tree Pit Interception Volume — No.6

Length	5.000	m
Width	2.000	m
Storage depth	0.100	m
Interception Volume Available	**1.000**	m^3
Interception Volume Required *	A x 0.8 x I	
Drained Impermeable Area (A)	95.000	m^2
Rainfall depth (i)	5.000	mm
Interception Volume Required	**0.380**	m^3
Volume Required =	0.380	**PASS**
Volume Provided =	1.000	

* GDSDS E2.1.1

Appendix 11.4

Foul Drainage & Pumping Station Calculations

Foul flow estimates – Domestic

<table>
<tr><th colspan="7">BOHERBOY</th></tr>
<tr><th colspan="7">New Network - DOMESTIC Wastewater Flows</th></tr>
<tr><th>Usage</th><th>Quantity</th><th>Occupancy (h)</th><th>Population (P)</th><th>Consumption (G)
(l/h/day)</th><th colspan="2">Loading (PxG)(l/day)</th></tr>
<tr><td>Residential</td><td>611 Units</td><td>2.7No./Unit</td><td>1650</td><td>150</td><td colspan="2">247,500</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td colspan="5">Total =</td><td colspan="2">247,500 l/day</td></tr>
<tr><td colspan="7"></td></tr>
<tr><td colspan="5">Flowrate per day (l/s)</td><td></td><td>2.87 l/s</td></tr>
<tr><td colspan="5">Growth Rate</td><td>1</td><td>1</td></tr>
<tr><td colspan="5">Infiltration (I)</td><td>10%</td><td>0.29</td></tr>
<tr><td colspan="5">Dry Weather Flow</td><td>PG + I</td><td>3.16 l/s</td></tr>
<tr><td colspan="5">Peaking Factor (Pf_{Dom})</td><td>3</td><td></td></tr>
<tr><td colspan="5">Design Foul Flow (l/s)</td><td>Pf_{Dom} x PG</td><td>9.47 l/s</td></tr>
<tr><td colspan="5">Misconnection Allowance (SW)</td><td>1.5%</td><td>0.03 l/s</td></tr>
<tr><td colspan="5">Design Flow (l/s)</td><td></td><td>9.5 l/s</td></tr>
</table>

Based on Irish Water Code of Practice Wastewater Infrastructure (Aug'25)

Residential Wastewater Calculations

Foul flow estimates – Commercial

BOHERBOY					
New Network – COMMERCIAL Wastewater Flows					
Usage	***Quantity***	***Occupancy (h)***	***Population (P)***	***Consumption (G) (l/h/day)***	***Loading (PxG)(l/day)***
Possible School Site	1 Ha	16 Classes	450	50	22,500
Crèche	630m^2	1child/8m^2 + Staff (20%) + support accommodation	95	50	4,750
Total =					**27,250 l/day**

Flowrate per 12 hr day (l/s)		**0.63 l/s**
Growth Rate	1	1
Infiltration (I)	10%	0.06
Dry Weather Flow	**PG + I**	**0.69 l/s**
Peaking Factor ($Pf_{Dom.Ind}$)	4.5	
Design Foul Flow (l/s)	**$Pf_{Dom\ Ind}$ x PG**	**3.1 l/s**
Misconnection Allowance (SW)	1.5%	0.05l/s
Design Flow (l/s)		**3.11 l/s**

Based on Irish Water Code of Practice Wastewater Infrastructure (Aug'25)

Table 10 – Commercial Wastewater Calculations

Foul flow estimates into Pumping Station

BOHERBOY					
New Network – DOMESTIC/COMMERCIAL/SCHOOL Wastewater Flows					
Usage	***Quantity***	***Occupancy (h)***	***Population (P)***	***Consumption (G) (l/h/day)***	***Loading (PxG)(l/day)***
Possible School Site	1 Ha	16 Classes	450	50	22,500
Residential Units	146	2.7No./Unit	394	150	59,130
Crèche	630m²	1child/8m² + Staff (20%) + support accommodation	95	50	4,750
Total =					**86,380 l/day**

Flowrate per 24 hr day (l/s)		**1.00l/s**
Growth Rate	1	1
Infiltration (I)	10%	0.1
Dry Weather Flow	**PG + I**	**1.1 l/s**
Peaking Factor ($Pf_{Dom.Ind}$)	4.5	
Design Foul Flow (l/s)	**$Pf_{Dom\ Ind}$ x PG**	**4.95 l/s**
Misconnection Allowance (SW)	1.5%	0.02l/s
Design Flow (l/s)		**4.8 l/s**

Based on Irish Water Code of Practice Wastewater Infrastructure (Aug'25)

Pumping Station Details

Inflow DWF (146 Resi + School site only + creche) = 1.1 l/s

Sump Area = 2 x 2.5m = 5m^2 – Refer to Dwg.1324D/421

Invert of sump = 114.52mOD; Inlet Invert = 117.00mOD

Volume of Storage in Sump Chamber = (117.00-114.52) x 5m^2 = 12.4m^3

Overflow Storage

Overflow Storage Capacity Required			
DWF (l/s)	**Storage Time (hrs)**	**Calculation**	**Volume (m^3)**
1.1	24	1.1 x 24 x 60 x 60	95
		Total Overflow Storage Required =	**95m^3**

Inlet to overflow storage chamber = 117.00mOD

Outlet return from overflow storage into sump chamber = 115.46mOD

Overflow storage chamber depth = 117.00 – 115.46 = 1.54m

Volume to be stored in overflow chamber = 95m^3 – 12.4m^3 (in sump) = 82.6m^3

Area of storage chamber = 82.6m^3 / 1.54 = 53.6m^2 = **c.10m x 5.4m on plan**

Pump Starts per Hour

Pumps cut-in level = 115.60mOD; Pumps cut-out level = 115.10mOD

Volume in sump at 0.5m depth = 5m^2 x 0.5 = **2.5 m^3**

Pumps to be rated to maintain Velocity in rising main @ **1.2m/s**

Diameter of rising main to be 100mm Ø

Volume in 100mm Ø rising main per m run = πr^2 x 1m = **0.0078m^3**

Volume pumped in 1s (flowrate) = 1.2 m/s x 0.0078m^3 = 9.36 l

Time taken to pump (outflow) 2.5 m^3 = 2500 / 9.36 = **4.45 min**

Time taken to fill (inflow) 2.5 m^3 @ DWF = 2.5 x 10^3 / 1.1 = 2273 s = **37.9 min**

Therefore pump cycle time = inflow time + outflow time = 4.45+37.9 = 42.35**min**

Cycles per hour = 60 / 42.35 = 1.4 starts per hour < 10 therefore OK

Time Taken to Clear Rising Main

Length of rising main = 100m

Volume of rising main = 100 x 0.0078 = 0.78 m^3

Volume pumped in 1 cycle = 2.5m^3 > 0.78m^3 ; therefore rising main is cleared during each pump cycle which is **< 6hrs therefore OK**

Appendix 11.5

Small Scale SuDS

SMALL SCALE SuDS FOR INDIVIDUAL BUILDINGS

SOURCE CONTROL

DESCRIPTION

Sustainable Drainage Systems for individual buildings focus on reducing the amount of stormwater leaving a property and/or conserving water. This can be achieved by a variety of methods which are generally low cost and low maintenance, i.e.:

- Avoiding misconnections
- Minimisation of impermeable areas and diversion of run-off to infiltration/soakaway devices
- Rainwater harvesting: Water butts, Rainwater Tanks
- Greywater re-use
- Rooftop greening

AVOIDING MISCONNECTIONS

Misconnections of stormwater to foul sewers and wastewater to storm sewers result in considerable polluting impact in receiving waters. It is the responsibility of the developer and property owner to ensure that there are no such misconnections from their development/property. Rigorous policing of connections by the local authority is required to eliminate inappropriate discharges.

MINIMISATION OF IMPERMEABLE AREAS

DIVERTING TO INFILTRATION/SOAKAWAY DEVICES

The minimisation of impermeable areas can be achieved through the use of permeable paving or gravelled surfaces instead of conventional paving/concrete. The diversion of stormwater, such as the first flush of roof run-off or from disconnected downpipes, to infiltration devices such as soakaways, reduces the volume of water discharge to receiving waters. Roofwater can be discharged directly to the sub-base of infiltration devices. Maintenance requirements and costs are low. See separate SuDS information sheets (Infiltration trenches & Soakaways/Permeable paving) for further details.

WATER BUTT

A water butt is a receptacle or tank, usually covered and placed at ground level, connected to a downpipe, to provide offline attenuation of runoff from roofs. Pollutant removal improves if used in conjunction with first flush devices to divert the first 2mm of roof rainfall run-off and screens to filter out leaves and insects. Desludging is recommended on a regular (annual/bi-ennial) basis.

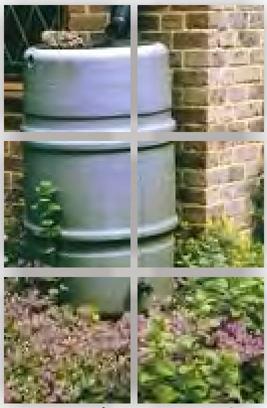
RAINWATER TANKS

Rainwater tanks collect rainwater for re-use for car washing, gardens and firewater. Tanks can be placed on flat roofs of suitable bearing capacity or connected to downpipes and placed above or under ground. In the latter cases a pump will be required such that the water can be reused, for example, in toilet flushing.

If connecting to the toilet or washing machine a minimum level of water must be maintained by a top-up system from the mains supply. A non-return valve is required to prevent backflow from the tank to the drinking water supply.

Effluent Discharge - Dry Weather Flow

Water Butt - (source: www.blackwell-ltd.com)



Water Butt - (source:www.southern water.co.uk)

Gutter Filter
(LB Plastics Ltd.)

Leafeater
(City Rainwater Tanks Aust Pty Ltd.)

Rainwater Tank

MORE OVERLEAF - 1 of 2

SMALL SCALE SuDS FOR INDIVIDUAL BUILDINGS

SOURCE CONTROL

GREYWATER TANKS

Greywater is a term applied to all bath, dish and laundry water except toilet waste and food waste derived from garbage grinders. Greywater tanks are generally placed underground. A pump is required such that the water can be re-used, for example, in toilet flushing or for watering plants.

When properly managed, greywater is a valuable resource which horticultural and agricultural growers as well as home gardeners can benefit from. It can also be valuable to landscape planners, builders, developers and contractors. While phosphorous, potassium and nitrogen makes greywater a source of pollution for lakes, rivers and groundwater they are excellent nutrient sources for vegetation when this particular form of wastewater is made available for irrigation. Greywater irrigation has long been practiced in areas where water is in short supply.

A key to successful greywater treatment lies in its immediate processing before it turns anaerobic. The simplest, most appropriate treatment technique consists of directly introducing freshly generated greywater into an active, live topsoil environment. Pollutant removal is achieved by treating the greywater with aerobic pre-treatment or anaerobic to aerobic pre-treatment.
Refer www.clivusmultrum.com and www.greywater.com.

International Experience

Australia

The Healthy Homes project on Australia's Gold Coast is an environmentally sustainable demonstration project incorporating small scale SuDS. Refer to Case Study within this document and www.oca.nsw.gov.au/resource/wramsartwork.pdf.

ROOFTOP GREENING

Fleishman from www.ecocentre.com

DESCRIPTION

Rooftop greening involves vegetating urban walls and rooftops as a way of gaining access to valuable open space while making urban environments healthier more attractive places in which to live and work. Rooftop greening strategies aim to:

- reduce the quantity and increase the quality of surface water run-off
- improve indoor and outdoor comfort levels for residents
- conserve indigenous biodiversity (genetic, species and ecosystem)
- reduce energy demand for heating and cooling
- encourage environmentally responsive design strategies in the City.

Rooftop Greening is moving from the fringe to the mainstream for two reasons:

1)Increasing urban densities are leading to a desire for greater access to green open space; and
2)The role of urban vegetation in producing oxygen, fixing carbon dioxide and filtering urban air and water is becoming more widely recognised.

Rooftop Gardens can function as:
"Extensive" systems require little or no maintenance; are developed primarily for their environmental benefits; and normally consist of thin soils and hardy vegetation applied to large roof areas. The use of Sedum varieties is common.
"Intensive" systems require high levels of maintenance; are developed primarily for aesthetic enjoyment. Extensive greening is generally a much cheaper option than intensive greening. For design considerations refer www.roofmeadows.com. Also, Grodan (www.grodan.com) produce rockwool, a lightweight substrate.

International Experience

Germany

One in 10 flat roofs in German cities are of Esslingen in Germany has a by-law which requires that flat and sloping roofs (up to 15 degrees) must be vegetated. Similarly, in Mannheim, declining air quality prompted the City Council to impose a by-law in 1988 which requires all central business district buildings to be vegetated.

Japan

In Tokyo, guidelines encourage 20% of rooftop areas to be planted. From April 2001, companies that fail to meet these guidelines will face fines. Reductions have been implemented to fixed assets taxes for buildings with rooftop greening. These types of policies are expected to increase throughout Japan, as a consequence of revisions of city regulations.
The Takenaka Corporation have developed a "Thin Layer Rooftop Greening System," by using sedum varieties and a thin mat as a planting base, which reduces the live load on buildings and has limited maintenance requirements. Significant energy conservation has been achieved.
Refer www.takenaka.co.jp/takenaka_e/.

America

The award-winning Chicago City Hall green roof was installed for the Urban Heat Island Initiative project. The design includes a 3.5" deep **'extensive'** system to 24" deep **'intensive'** landscape islands. The project shows the benefit of green roofs in lowering summer temperatures within ultra-urban environments.
Refer www.cityofchicago.org .

Chicago City Hall 2002
Source www.roofmeadows.com

Appendix 11.6

Soil/SPR/Qbar/HR Wallingford Qbar Calculations

Greenfield runoff rate estimation tool

www.uksuds.com | Greenfield runoff rate estimation tool (https://www.uksuds.com/)

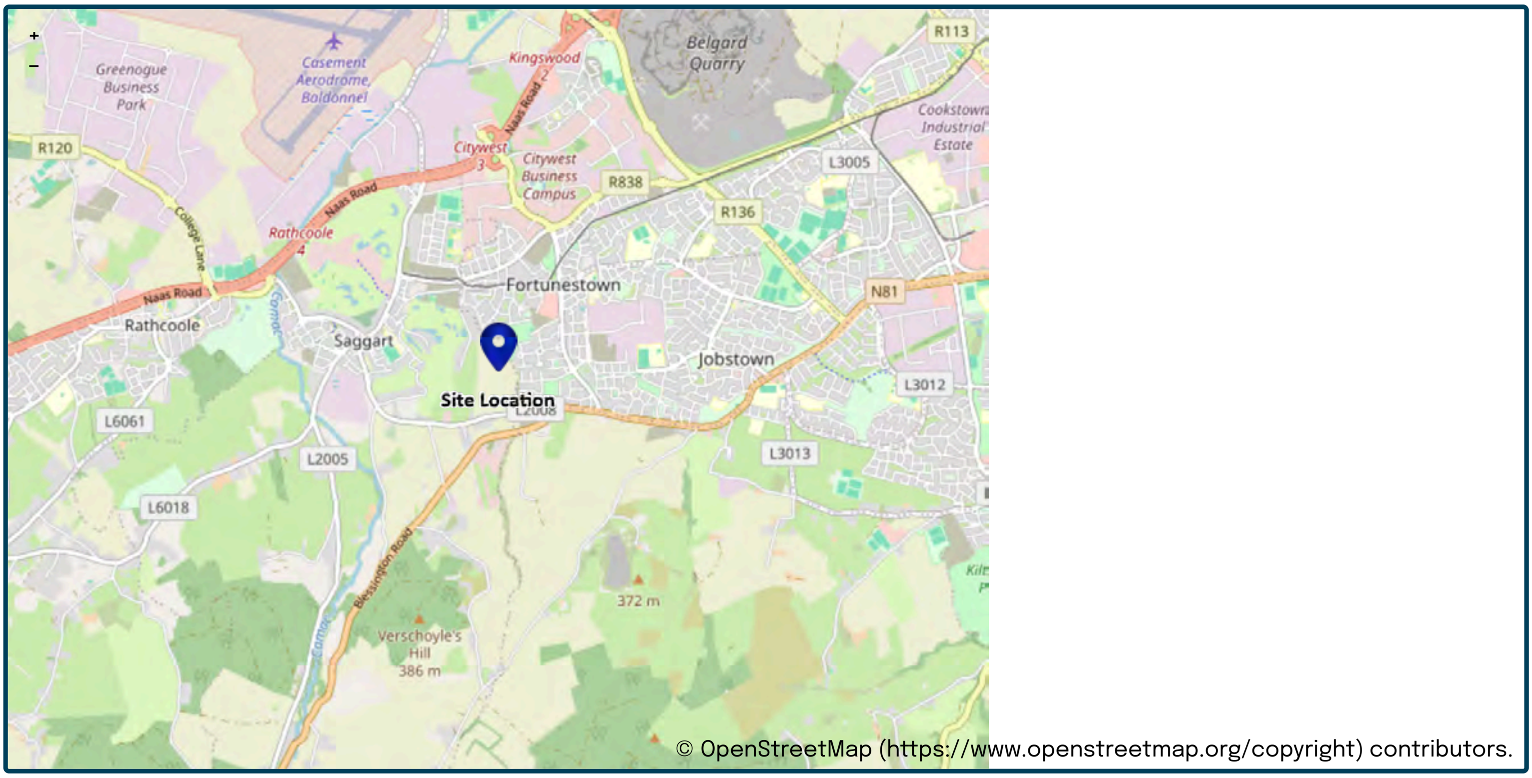
This is an estimation of the greenfield runoff rates that are used to meet normal best practice criteria in line with Environment Agency guidance "Rainfall runoff management for developments", SC030219 (2013), the SuDS Manual C753 (CIRIA, 2015) and the non-statutory standards for SuDS (Defra, 2015).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

Project details

Date	14/11/2025
Calculated by	Roger Mullarkey
Reference	BoherBoy
Model version	2.2.2

Location

Site name	Boherboy
Site location	Main Site Catchments 1-8 + School Site



Site easting (Irish Grid)	304862
Site northing (Irish Grid)	226257
Site easting (Irish Transverse Mercator)	704790
Site northing (Irish Transverse Mercator)	726285

Site details

Total site area (ha)	14.7	ha

Greenfield runoff

Method

Method	IH124

IH124

	My value		Map value
SAAR (mm)	878	mm	1043
How should SPR be derived?	WRAP soil type		
WRAP soil type	3		5
SPR	0.37		
QBar (IH124) (l/s)	55	l/s	

Growth curve factors

	My value	Map value
Hydrological region	12	12
1 year growth factor	0.85	
2 year growth factor	0.95	
10 year growth factor	1.72	
30 year growth factor	2.13	
100 year growth factor	2.61	
200 year growth factor	2.86	

Results

Method	IH124	
Flow rate 1 year (l/s)	46.8	l/s
Flow rate 2 year (l/s)	52.3	l/s
Flow rate 10 years (l/s)	94.7	l/s
Flow rate 30 years (l/s)	117.3	l/s
Flow rate 100 years (l/s)	143.7	l/s
Flow rate 200 years (l/s)	157.4	l/s

Please note runoff estimation is subject to significant uncertainty. Results are therefore normally reported to only 1 decimal place. Where 2 decimal places are provided, this does not indicate accuracy to this level, it has been adopted to prevent 'zero' figures from being reported. Outputs less than 0.01 l/s are reported as 0.01 l/s.

Disclaimer

Greenfield runoff rate estimation tool

www.uksuds.com | Greenfield runoff rate estimation tool (https://www.uksuds.com/)

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

Project details

Date	09/04/2025
Calculated by	Roger Mullarkey
Reference	Boherboy QBar
Model version	0.6.5

Location

Site name	Boherboy
Site location	Corbally East Site

Site easting	105004
Site northing	384544

Site details

Total site area (ha)	0.36 ha

Greenfield runoff

Method

Method	IH124

IH124

	My value		Map value
SAAR (mm)	878 mm		1043
How should SPR be derived?	WRAP soil type		
WRAP soil type	3		5
SPR	0.37		0.37
QBar (IH124) (l/s)	1.3 l/s		

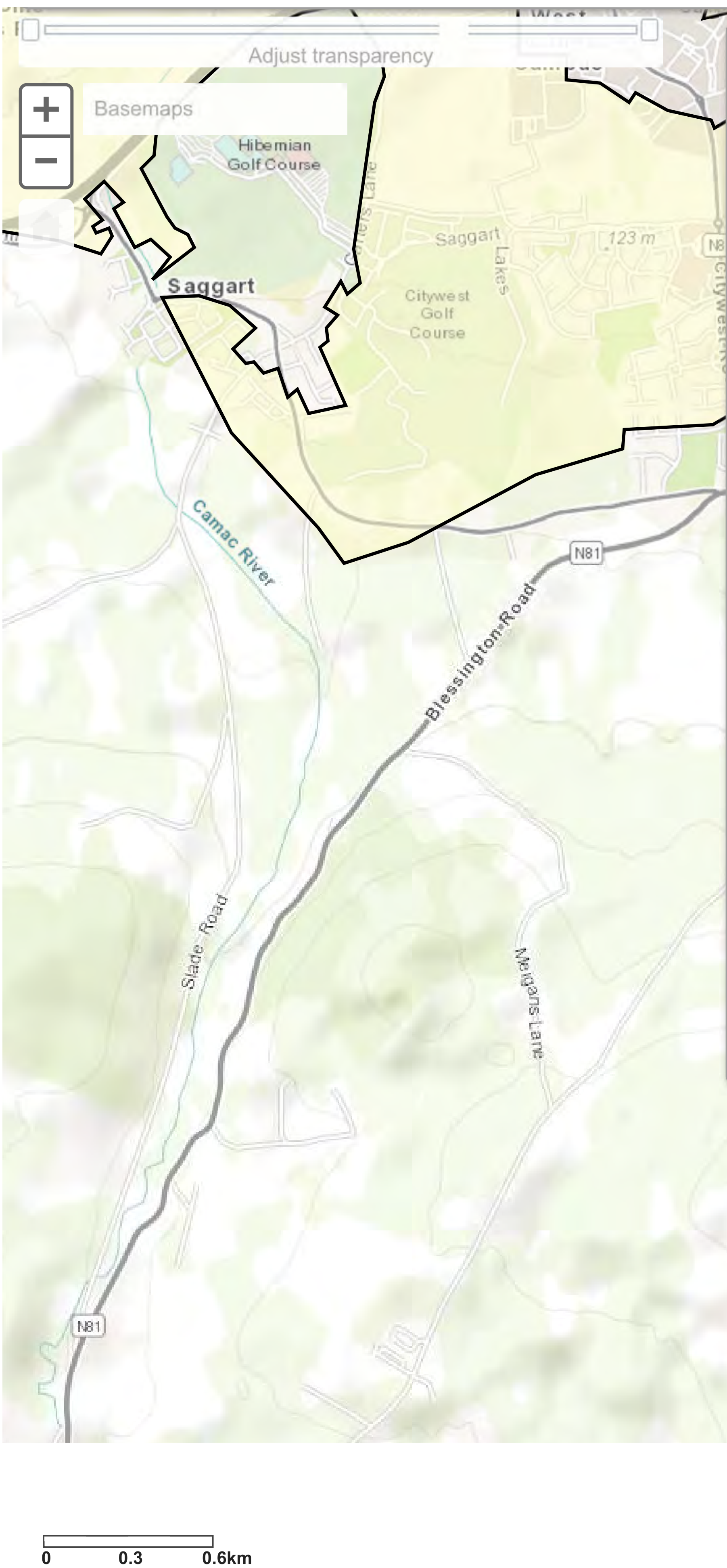
Growth curve factors

	My value		Map value
Hydrological region	12		12
1 year growth factor	0.85		
2 year growth factor	0.95		
10 year growth factor	1.72		
30 year growth factor	2.13		
100 year growth factor	2.61		
200 year growth factor	2.86		

Results

Method	IH124
Flow rate 1 year (l/s)	1.1 l/s
Flow rate 2 year (l/s)	1.3 l/s
Flow rate 10 years (l/s)	2.3 l/s
Flow rate 30 years (l/s)	2.9 l/s
Flow rate 100 years (l/s)	3.5 l/s
Flow rate 200 years (l/s)	3.9 l/s

Disclaimer



Soil association:
Elton *(1000x)*
Fine loamy drift with limestones
Area covered: 92.52km^2

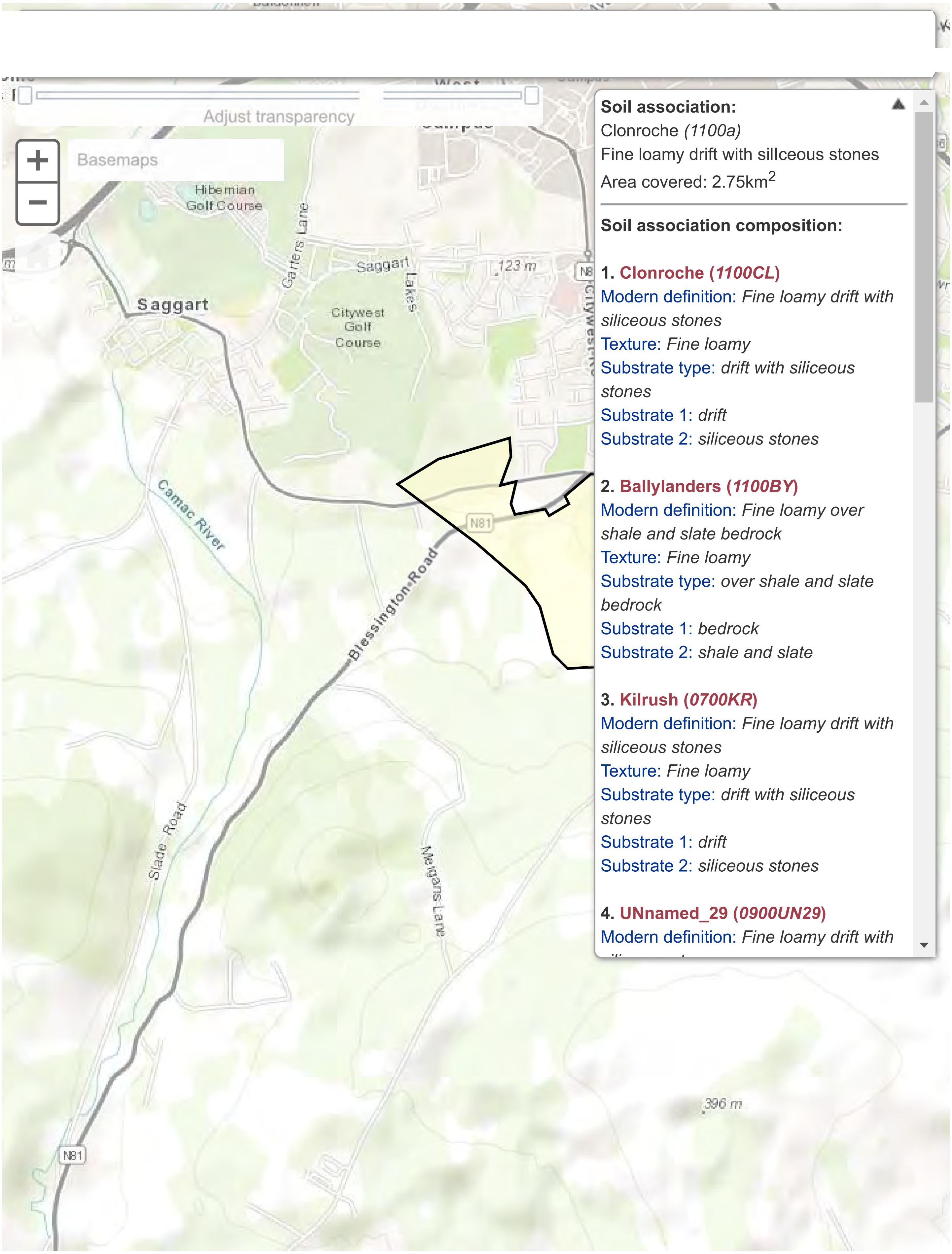
Soil association composition:

1. Elton (*1000ET*)
Modern definition: *Fine loamy drift with limestones*
Texture: *Fine loamy*
Substrate type: *drift with limestones*
Substrate 1: *drift*
Substrate 2: *limestones*

2. Dunboyne (*1000DB*)
Modern definition: *Fine loamy drift with siliceous stones*
Texture: *Fine loamy*
Substrate type: *drift with siliceous stones*
Substrate 1: *drift*
Substrate 2: *siliceous stones*

3. Howardstown (*0760HN*)
Modern definition: *Clayey drift with limestones*
Texture: *Clayey*
Substrate type: *drift with limestone*
Substrate 1: *drift*
Substrate 2: *limestones*

4. Straffan (*0700ST*)
Modern definition: *Fine loamy drift with limestones*
Texture: *Fine loamy*


Adjust transparency
Basemaps
Hibernian Golf Course
Carters Lane
Saggart
Saggart
Citywest Golf Course
Saggart Lakes
123 m
Citywest
Camac River
N81
Blessington Road
Slade Road
Mellgans Lane
396 m
N81
Soil association:
Clonroche (1100a)
Fine loamy drift with sillceous stones
Area covered: 2.75km²
Soil association composition:
1. Clonroche (1100CL)
Modern definition: Fine loamy drift with siliceous stones
Texture: Fine loamy
Substrate type: drift with siliceous stones
Substrate 1: drift
Substrate 2: siliceous stones
2. Ballylanders (1100BY)
Modern definition: Fine loamy over shale and slate bedrock
Texture: Fine loamy
Substrate type: over shale and slate bedrock
Substrate 1: bedrock
Substrate 2: shale and slate
3. Kilrush (0700KR)
Modern definition: Fine loamy drift with siliceous stones
Texture: Fine loamy
Substrate type: drift with siliceous stones
Substrate 1: drift
Substrate 2: siliceous stones
4. UNnamed_29 (0900UN29)
Modern definition: Fine loamy drift with

0 0.3 0.6km

SERIES: ELTON (1000ET) - REPRESENTATIVE PROFILE DESCRIPTION - **PDF version available**

Reference profile: RPS36RC18
Weather: Overcast

TOPOGRAPHY
Position: Middle slope
Form: Straight
Aspect: SW

PARENT MATERIAL
Substrate type: Drift
Substrate subgroup: Limestones

TEXTURAL CRITERIA
Texture 1: Fine loamy
Texture 2: -

LAND USE
Land use: Grassland improved
Human technologies: Slurry applications

ROCK OUTCROPS None (0 %)

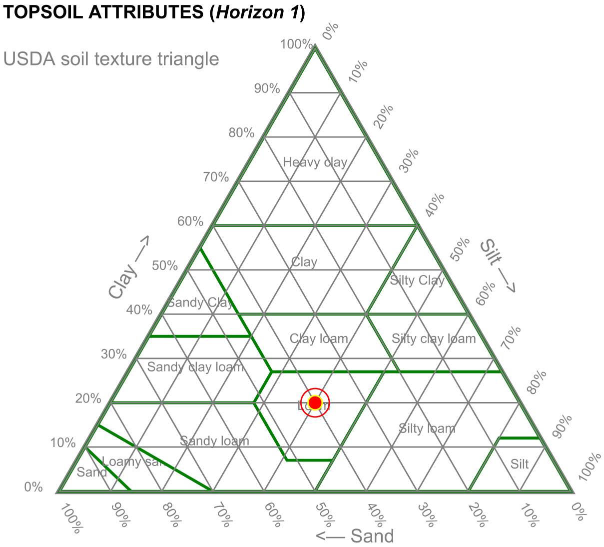
SURFACE STONE None (0 %)

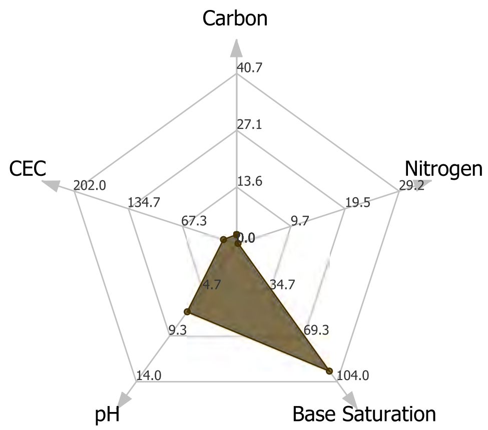
IRISH CLASSIFICATION (2013)
Soil subgroup: 1000 Typical Luvisols
National Soil Series: Elton
Definition: Fine loamy drift with limestones

Download a PDF version of this profile description here

TOPSOIL ATTRIBUTES (*Horizon 1*)

USDA soil texture triangle





Horizon 1: 0 - 25 cm

Humose: No
Matrix colour (moist): 10YR43
Texture: Fine loamy

Stones (% total): Few (2-5 %)
Stones details: Fine gravels (2-6 mm)
Stickiness: Sticky

HCL reaction: No reaction
Packing density: Medium
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.24
Carbon: 2.21
Organic carbon: 1.94
Loss on ignition: -

PARTICLE SIZE %
Sand: 40%
Silt: 40%
Clay: 20%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.90

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.10
K: 0.17
Mg: 0.80
Ca: 14.69

CEC (cmol kg^{-1}): 16.46
Base saturation: 96%

Horizon 2: 25 - 60 cm

Humose: No
Matrix colour (moist): 75YR44
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Very sticky

HCL reaction: No reaction
Packing density: Medium
Plasticity: Very plastic

TOTAL %
Nitrogen: 0.08
Carbon: 0.78
Organic carbon: 0.57
Loss on ignition: -

PARTICLE SIZE %
Sand: 37%
Silt: 37%
Clay: 26%

Textural Class (USDA): Loam
Bulk density: -
pH: 7.37

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})

CEC (cmol kg^{-1}): 9.42

Na: 0.08
K: 0.10
Mg: 0.79
Ca: 8.86

Base saturation: 100%

Horizon 3: 60 - 120 cm

Humose: No
Matrix colour (moist): 10YR54
Texture: Coarse loamy

Stones (% total): Abundant (40-80 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Slightly sticky

HCL reaction: Extremely strong (thick foam)
Packing density: High
Plasticity: Non-plastic

TOTAL %
Nitrogen: 0.01
Carbon: 7.75
Organic carbon: 0.25
Loss on ignition: -

PARTICLE SIZE %
Sand: 57%
Silt: 29%
Clay: 14%

Textural Class (USDA): Sandy Loam
Bulk density: -
pH: 8.56

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.05
Mg: 0.51
Ca: 32.03

CEC (cmol kg^{-1}): 8.63
Base saturation: 100%

SERIES: CLONROCHE (1100CL) - REPRESENTATIVE PROFILE DESCRIPTION - **PDF version available**

Reference profile: RPS62RC04
Weather: Overcast

TOPOGRAPHY
Position: Lower slope
Form: Straight
Aspect:

PARENT MATERIAL
Substrate type: Drift
Substrate subgroup: Siliceous stones

TEXTURAL CRITERIA
Texture 1: Fine loamy
Texture 2: -

LAND USE
Land use: Grassland improved
Human technologies: Fertilizer applications

ROCK OUTCROPS None (0 %)

SURFACE STONE None (0 %)

IRISH CLASSIFICATION (2013)
Soil subgroup: 1100 Typical Brown Earths
National Soil Series: Clonroche
Definition: Fine loamy drift with siliceous stones

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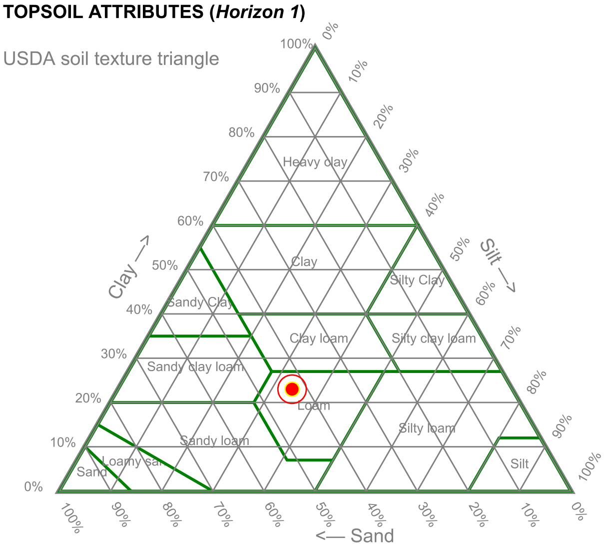
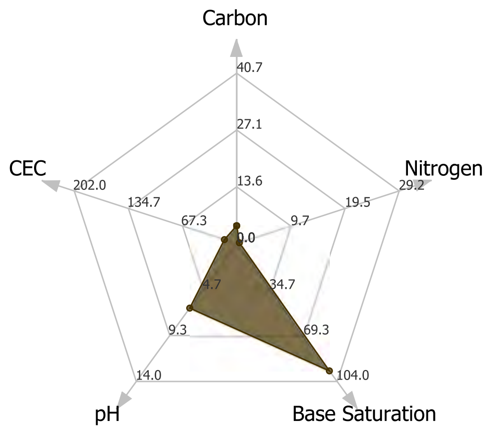
TOPSOIL ATTRIBUTES (*Horizon 1*)

USDA soil texture triangle





Horizon 1: 0 - 21 cm

Humose: No
Matrix colour (moist): 10YR43
Texture: Fine loamy

Stones (% total): - (-)
Stones details: - (-)
Stickiness: Slightly sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Plastic

TOTAL %
Nitrogen: 0.48
Carbon: 4.27
Organic carbon: 3.57
Loss on ignition: -

PARTICLE SIZE %
Sand: 43%
Silt: 34%
Clay: 23%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.55

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.13
K: 0.59
Mg: 1.67
Ca: 12.35

CEC (cmol kg^{-1}): 15.30
Base saturation: 96%

Horizon 2: 21 - 48 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: - (-)
Stickiness: Sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Plastic

TOTAL %
Nitrogen: 0.29
Carbon: 2.42
Organic carbon: 1.40
Loss on ignition: -

PARTICLE SIZE %
Sand: 40%
Silt: 35%
Clay: 25%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.54

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})

CEC (cmol kg^{-1}): 9.63

Na: 0.14
K: 0.63
Mg: 1.26
Ca: 6.29

Base saturation: 86%

Horizon 3: 48 - 75 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Fine loamy

Stones (% total): Many (15-40 %)
Stones details: Coarse gravels (2-6 cm)
Stickiness: Sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Plastic

TOTAL %
Nitrogen: 0.18
Carbon: 1.23
Organic carbon: 0.80
Loss on ignition: -

PARTICLE SIZE %
Sand: 35%
Silt: 41%
Clay: 24%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.50

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.10
K: 0.42
Mg: 1.14
Ca: 4.19

CEC (cmol kg^{-1}): 8.05
Base saturation: 73%

Horizon 4: 75 - 100 cm

Humose: No
Matrix colour (moist): 25Y54
Texture: Fine loamy

Stones (% total): Many (15-40 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Sticky

HCL reaction: No reaction
Packing density: Medium
Plasticity: Plastic

TOTAL %
Nitrogen: 0.06
Carbon: 0.32
Organic carbon: 0.18
Loss on ignition: -

PARTICLE SIZE %
Sand: 53%
Silt: 33%
Clay: 14%

Textural Class (USDA): Sandy Loam
Bulk density: -
pH: 6.53

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.23
Mg: 0.65
Ca: 1.82

CEC (cmol kg^{-1}): 4.35
Base saturation: 64%

SERIES: BALLYLANDERS (1100BY) - REPRESENTATIVE PROFILE DESCRIPTION - **PDF version available**

Reference profile: RPS62RC05
Weather: Overcast

TOPOGRAPHY
Position: Middle slope
Form: Straight
Aspect: NNE

PARENT MATERIAL
Substrate type: Bedrock
Substrate subgroup: Shale/slate

TEXTURAL CRITERIA
Texture 1: Fine loamy
Texture 2: -

LAND USE
Land use: Grassland improved
Human technologies: Fertilizer applications

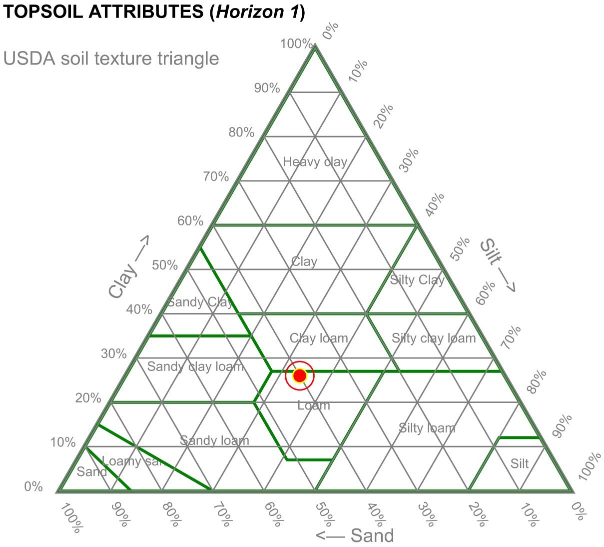
ROCK OUTCROPS None (0 %)

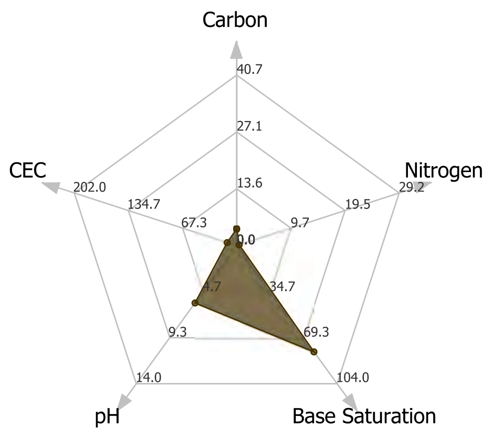
SURFACE STONE Common (5-15 %)

IRISH CLASSIFICATION (2013)
Soil subgroup: 1100 Typical Brown Earths
National Soil Series: Ballylanders
Definition: Fine loamy over shale and slate bedrock

Download a PDF version of this profile description here

TOPSOIL ATTRIBUTES (*Horizon 1*)





Horizon 1: 0 - 25 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: Coarse gravels (2-6 cm)
Stickiness: Slightly sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.45
Carbon: 3.99
Organic carbon: 2.81
Loss on ignition: -

PARTICLE SIZE %
Sand: 40%
Silt: 34%
Clay: 26%

Textural Class (USDA): Loam
Bulk density: -
pH: 5.81

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.14
Mg: 0.68
Ca: 8.62

CEC (cmol kg^{-1}): 11.86
Base saturation: 80%

Horizon 2: 25 - 45 cm

Humose: No
Matrix colour (moist): 75YR44
Texture: Fine loamy

Stones (% total): Many (15-40 %)
Stones details: Stones (6-20 cm)
Stickiness: Slightly sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.23
Carbon: 2.02
Organic carbon: 1.14
Loss on ignition: -

PARTICLE SIZE %
Sand: 43%
Silt: 36%
Clay: 21%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.11

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.05
Mg: 0.63
Ca: 4.55

CEC (cmol kg^{-1}): 6.31
Base saturation: 84%

Horizon 3: 45 - 75 cm

Humose: No
Matrix colour (moist): 5YR44
Texture: Fine loamy

Stones (% total): Many (15-40 %)
Stones details: Stones (6-20 cm)
Stickiness: -

HCL reaction: -
Packing density: Medium
Plasticity: -

TOTAL %
Nitrogen: 0.17
Carbon: 1.80
Organic carbon: 0.89
Loss on ignition: -

PARTICLE SIZE %
Sand: 49%
Silt: 34%
Clay: 17%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.13

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.03
Mg: 0.45
Ca: 2.92

CEC (cmol kg^{-1}): 7.19
Base saturation: 49%

Horizon 4: 75 - 85 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Fine loamy

Stones (% total): Abundant (40-80 %)
Stones details: Boulders (20-60 cm)
Stickiness: Sticky

HCL reaction: -
Packing density: Medium
Plasticity: Plastic

TOTAL %
Nitrogen: 0.14
Carbon: 1.41
Organic carbon: 0.48
Loss on ignition: -

PARTICLE SIZE %
Sand: 59%
Silt: 32%
Clay: 9%

Textural Class (USDA): Sandy Loam
Bulk density: -
pH: 6.15

EXCHANGEABLE COMPLEX

Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.02
Mg: 0.24
Ca: 1.89

CEC (cmol kg^{-1}): 4.34
Base saturation: 51%

SERIES: DUNBOYNE (1000DB) - REPRESENTATIVE PROFILE DESCRIPTION - **PDF version available**

Reference profile: RPR30BR02
Weather: Overcast

TOPOGRAPHY
Position: Upper slope
Form: Convex
Aspect: SSW

PARENT MATERIAL
Substrate type: Drift
Substrate subgroup: Siliceous stones

TEXTURAL CRITERIA
Texture 1: Fine loamy
Texture 2: -

LAND USE
Land use: Grassland improved
Human technologies: Fertilizer applications

ROCK OUTCROPS None (0 %)

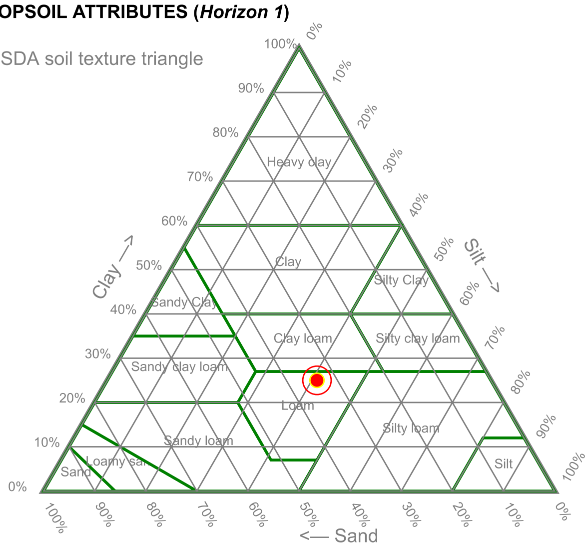
SURFACE STONE None (0 %)

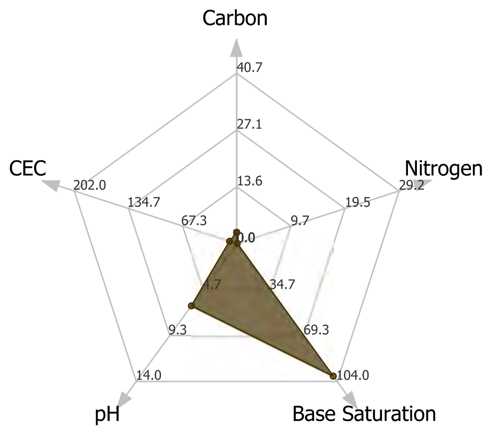
IRISH CLASSIFICATION (2013)
Soil subgroup: 1000 Typical Luvisols
National Soil Series: Dunboyne
Definition: Fine loamy drift with siliceous stones

Download a PDF version of this profile description here

TOPSOIL ATTRIBUTES (*Horizon 1*)

USDA soil texture triangle





Horizon 1: 0 - 22 cm

Humose: No
Matrix colour (moist): 10YR44
Texture: Coarse loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: High
Plasticity: Non-plastic

TOTAL %
Nitrogen: 0.09
Carbon: 2.68
Organic carbon: 2.02
Loss on ignition: -

PARTICLE SIZE %
Sand: 34%
Silt: 41%
Clay: 25%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.32

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.16
Mg: 0.65
Ca: 8.39

CEC (cmol kg^{-1}): 8.90
Base saturation: 100%

Horizon 2: 22 - 35 cm

Humose: No
Matrix colour (moist): 5YR56
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: Medium
Plasticity: Non-plastic

TOTAL %
Nitrogen: 0.08
Carbon: 0.83
Organic carbon: 0.38
Loss on ignition: -

PARTICLE SIZE %
Sand: 32%
Silt: 46%
Clay: 22%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.23

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})

CEC (cmol kg^{-1}): 4.56

Na: 0.08
K: 0.03
Mg: 0.26
Ca: 3.45

Base saturation: 84%

Horizon 3: 35 - 60 cm

Humose: No
Matrix colour (moist): 75YR56
Texture: Fine loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: High
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.08
Carbon: 0.47
Organic carbon: 0.24
Loss on ignition: -

PARTICLE SIZE %
Sand: 27%
Silt: 46%
Clay: 27%

Textural Class (USDA): Clay Loam
Bulk density: -
pH: 6.33

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.05
Mg: 0.26
Ca: 3.13

CEC (cmol kg^{-1}): 3.74
Base saturation: 94%

Horizon 4: 60 - 85 cm

Humose: No
Matrix colour (moist): 10YR58
Texture: Coarse loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: Low
Plasticity: Slightly plastic

TOTAL %
Nitrogen: 0.08
Carbon: 0.37
Organic carbon: 0.19
Loss on ignition: -

PARTICLE SIZE %
Sand: 66%
Silt: 21%
Clay: 13%

Textural Class (USDA): Sandy Loam
Bulk density: -
pH: 6.35

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.07
Mg: 0.29
Ca: 3.18

CEC (cmol kg^{-1}): 3.65
Base saturation: 99%

Horizon 5: 85 - 100 cm

Humose: No
Matrix colour (moist): 75YR53
Texture: Coarse loamy

Stones (% total): Common (5-15 %)
Stones details: Medium gravels (6mm -2 cm)
Stickiness: Non-sticky

HCL reaction: No reaction
Packing density: Very High
Plasticity: Plastic

TOTAL %
Nitrogen: 0.37
Carbon: 0.18
Organic carbon: 0.10
Loss on ignition: -

PARTICLE SIZE %
Sand: 35%
Silt: 42%
Clay: 23%

Textural Class (USDA): Loam
Bulk density: -
pH: 6.30

EXCHANGEABLE COMPLEX
Exchangeable Bases (cmol kg^{-1})
Na: 0.08
K: 0.14
Mg: 0.30
Ca: 3.53

CEC (cmol kg^{-1}): 3.25
Base saturation: 100%

Appendix 11.7

Site Investigation/Soakaway Report

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GROUND INVESTIGATIONS IRELAND LTD

BOHERBOY SAGGART

GROUND INVESTIGATION REPORT

DOCUMENT CONTROL SHEET

Engineer	Roger Mularkey
Project Title	Boherboy Saggart
Project No	4019-11-13
Document Title	Ground Investigation Report

Rev.	Status	Author(s)	Reviewed By	Approved By	Office of Origin	Issue Date
A	Final	C Finnerty	F McNamara	F McNamara	Dublin	3rd February 2014

Saggart, Boherboy - Ground Investigation Report

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Appendix 8 Desk Study – Hydrogeological and Karst Mapping

1.0 Preamble

On the instructions of Roger Mularkey Consulting Engineers, a site investigation was carried out by Ground Investigations Ireland Ltd., between the 9th and the 12th of December 2013 on a site in Boherboy, Saggart, Co. Dublin.

2.0 Overview

2.1 Background

The site consists of two greenfield sites which have been combined for the purpose of the proposed development. The site is located on the outskirts of Saggart as shown in the location plan in Appendix 1. It is proposed to develop a portion of the site closest to the road and to construct two and three story residential dwellings. The site slopes from the southern boundary along the road towards the north with the highest point at the south west corner. Earthworks and a retaining wall are proposed along the highest portion of the site to make it more accessible and suitable for construction. There are a series of two large diameter water mains passing through the centre of the site from east to west and a second series of three large diameter water mains along the same axis in the northern portion of the site.

2.2 Purpose and Scope

The purpose of the site investigation was to investigate subsurface soil conditions by means of trial pitting, dynamic probing and slit trenching. The scope of the work undertaken for this project included the following:

- Visit project site to observe existing conditions
- Carry out 8 No. Trial Pit to a maximum depth of 3.5m BGL
- Carry out 6 No. Slit Trenches to a maximum depth of 2.5m BGL
- Carry out 9 No. Dynamic Probes to a maximum depth of 3.3m BGL
- Carry out 4 No. Soakaway tests to BRE Digest 365
- Geotechnical and Environmental Laboratory testing

3.0 <u>Desk Study</u>

3.1 Sources of Information

A desk study has been carried out for the site and the surrounding area to determine the nature of the underlying bedrock geology and overburden materials, relevant geomorphological features, previous land use for the site and to identify any other geotechnical considerations for the area. This study comprised a search of relevant geotechnical, geological and hydrogeological information. The Geological Survey of Ireland (GSI) was consulted for this purpose and the following sources of information were reviewed:

<u>GSI Publications:</u>

- Geology of Kildare Wicklow, GSI, 1994, B. McConnell, M.E. Philcox,

- Bedrock Geology 1:100,000 Scale Map Series, Sheet 16: Kildare - Wicklow.

GSI Online Mapping:

- GSI Drift Geology Maps
- GSI Hydrogeological Mapping
- GSI Groundwater Well Database
- GSI Karst Database
- GSI Quarries Database

In addition, the Ordnance Survey of Ireland (OSI) was also consulted and the following sources of information reviewed.

OSI Online Mapping:

- Historical Mapping – 6 Inch Sheets
- Historical Mapping – 25 Inch Sheets
- Ortho Mapping
- Historical Land Use Mapping Database

3.2 Land Use

The OSI mapping indicates that the site has historically been used as agricultural land. A number of agricultural and/or accommodation buildings are shown on the 6" and 25" Historic Mapping close to the road, with little change from the current site layout. A drain or watercourse is shown on the 25" Mapping feeding into the current watercourse from the west between the two field boundaries. Based on the current

Orthophotographs this section of the drain or watercourse has been in-filled. Caution should be exercised with foundations in area of this in-filled stream. The 1995, 200 and 2005 Orthophotographs show little or no discernable change to the land use in the recent past.

3.3 Superficial Geology

The GSI publications and mapping indicate that the estate and surrounding area is underlain primarily by glacial till derived from Sandstone and Shale. The soils mapping indicates that glacial till derived from Limestone are present to the north of the site and rock outcrops or is very near to the surface to the north and north west of the site, coinciding with areas of extreme groundwater vulnerability and the locations of historic quarries on the historic mapping.

3.4 Regional Bedrock Geology

The site is mapped as being underlain by coarse greywacke & shale of the Pollaphuca Formation. The Calp or Lucan formation is present to the north of the site.

3.5 Hydrogeology

GSI mapping indicates that the bedrock underlying the site (Pollaphuca Formation) is classified as a Poor Aquifer (P) - bedrock which is generally unproductive except only in local zones.

The aquifer vulnerability for the area ranges from Low to Extreme. At the site location, the area is classified as having a Low Vulnerability. An area of Moderate and High Vulnerability is present surrounding the area of the site area. Generally, the High/Extreme Vulnerability areas are close to areas where bedrock is shallow or where sand and gravel deposits are expected and/or there is a thin cover of cohesive material above the bedrock. The Moderate/Low Vulnerability areas are likely to coincide with areas where sufficient thicknesses of cohesive glacial deposits are present above the bedrock or where deeper bedrock is expected.

The GSI Karst database mapping confirms that no karst features are present on or around the site location.

There are no recorded mineral or aggregate extractive licences sites in the immediate vicinity of the site as shown in the GSI Quarries Database, however there are a number of metallic and non-metallic mineral locations in Belgard to the east and in Lugmore to the south east of the site.

4.0 Subsurface Exploration

4.1 General

During the ground investigation in December 2013 a programme of trial pitting, dynamic probing and slit trenching was undertaken to determine the sub surface conditions at the proposed site. Soakway testing was carried out in accordance with BRE Digest 365 to determine the infiltration characteristics of the site. Regular sampling and in-situ testing was undertaken in the trial pits to facilitate the geotechnical descriptions and to enable laboratory testing to be carried out on the soil samples recovered during excavation.

4.2 Trial Pits

Eight trial pits were excavated using a JCB 3 CX at the locations shown in the exploratory hole location plan in Appendix 1. The locations were checked using a CAT scan to minimise the potential for encountering services during the excavation. The trial pits were logged and photographed by a Geotechnical Engineer prior to backfilling with arisings.

The trial pit logs are provided in Appendix 2 of this Report.

4.3 Dynamic Probes

The dynamic probe tests (DPH) were carried out beside the trial pits using Terrier 2000 rig in accordance with B.S. 1377: Part 9 1990. The test consists of mechanically driving a cone with a 50kg weight in 100mm intervals and monitoring the number of blows required. An equivalent Standard Penetration Test (SPT) ‘N’ value may be calculated by dividing the total number of blows over a 300mm drive length by 2. The probes DP1 to DP8 were undertaken adjacent to the trial pits locations while DP9 was carried out beside SP4.

The dynamic probe logs are provided in Appendix 3 of this Report.

4.4 Soakaway Testing

The soakaway pits were excavated to a maximum depth of 2.2m BGL and filled with water to assess the infiltration characteristics of the proposed site. The pits were allowed to drain and the drop in water level recorded over time as required by BRE Digest 365. The pits were logged and photographed prior to completing the soakaway test and were backfilled with arisings and reinstated upon completion.

The soakaway test results are provided in Appendix 4 of this Report.

4.5 Slit Trenching

A number of slit trenches were excavated to determine the line and location of the large diameter water services which cross the site. Some of the trenches were completed as separate excavations to locate the services with minimum disturbance to the ground surface. Each of the services shown on the local authority plans were identified and logged. The services were marked using 6 foot posts and were surveyed by the project topographical surveyors. The line, depth and location of the services located are shown on the plan in Appendix 1.

The slit trench logs are provided in Appendix 5 of this Report.

The above notes outline the procedures used in this site investigation and are in accordance with Eurocode 7 Part 2: Ground Investigation and testing (ISEN 1997 – 2:2007) and B.S. 5930:1999 + A2:2010.

4.6 Laboratory Testing

Samples were selected from the trial pits for a range of geotechnical and chemical testing to assist in the classification of soils and to provide information for the proposed design. Testing consisting of Particle Size Distribution (PSD), moisture content, atterberg limits, CBR and compaction testing were sent to NTML's Geotechnical Laboratory for analysis. Environmental laboratory testing was carried out on samples of soil by Jones Environmental Laboratory in the UK. The results of the laboratory testing is included in Appendix 6 of this Report.

5.0 Ground Conditions

5.1 General

The recommendations given and opinions expressed in this report are based on the findings as detailed in the borehole and trial pit records. Where an opinion is expressed on the material between exploratory hole locations, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for conditions which have not been revealed by the exploratory holes.

5.2 Ground Conditions

The ground conditions encountered during the investigation are summarised below with reference to insitu and laboratory test results. The full details of the strata encountered during the ground investigation are provided in the trial pit and dynamic probe records included in the appendices of this report. The sequence of strata encountered are generally consistent across the site and are generally consisted of;

- Topsoil
- Cohesive Deposits
- Granular Deposits

Topsoil: Topsoil was encountered in the majority of exploratory holes and was present to a maximum depth of 0.3m BGL.

Cohesive Deposits: Cohesive deposits were encountered beneath the Topsoil and were quite variable, described typically as brown, grey brown or occasionally as black *slightly sandy slightly gravelly CLAY, slightly gravelly sandy CLAY/SILT, Laminated sandy SILT* and *sandy gravelly slightly organic CLAY*. The strength of the cohesive deposits generally increased with depth and was typically soft or soft to firm at shallow depths increasing to stiff or stiff to very stiff at the base of the majority of the trial pits. These deposits had occasional cobble and rare boulder content where noted on the trial pit logs.

Granular Deposits: Granular deposits were encountered in the trial pits in the south of the site either as lenses within the cohesive deposits or as strata underlying upper cohesive deposits to the base of the trial pits. These deposits were typically described as brown or dark grey *gravelly fine to coarse SAND and clayey sandy sub angular to sub rounded fine to coarse GRAVEL*. These deposits had occasional cobble and rare boulder content where noted on the trial pit logs.

5.3 **Groundwater**

The groundwater strikes were noted during the investigation and were generally encountered as slow seepage at depths between 2.0m and 3.0m BGL. We would point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the time of year, rainfall nearby construction and other factors.

5.4 Soakaway Testing

At the test locations a trial pit was excavated and filled with water to a nominal invert level. The pits were allowed to drain and the rate of fall in water level was monitored to determine the time for the water level to drop from 75% to 25% the pit volume.

Based on the soakaway test results we would recommend that the soakaway design be based on a soil infiltration rate of $f = 1.38 \times 10^{-5}$ m/s in the vicinity of SP1.

The remaining test locations SP2 to SP4, indicate that the ground conditions are not favourable for soakaway design.

5.5 Laboratory Testing

A series of tests were completed on samples collected from the trial pits and were sent to GSTL's geotechnical laboratory in the UK.

The classification test results generally confirm the descriptions on the logs with the primary constituent for the cohesive deposits plotting as a CLAY of low to intermediate plasticity. The Particle Size Distribution tests confirm that generally the cohesive overburden strata have variable clay, silt, sand and gravel content. The granular deposits were generally well graded and had high fines content, typical of the granular glacial till deposits in the region.

Four samples were selected from the boreholes and trial pits and sent to Jones Environmental Laboratories in the UK for a range of contamination testing.

The results were assessed in accordance with European Council Directive 1999 131/EC Article 16 Annex II ‘Criteria and procedures for the acceptance of waste at landfills which lays down guidelines for the classification of waste as “Inert’ ‘Non Hazardous’ and ‘Hazardous’. The results classify the material tested as below the limits for inert waste at Murphy Environmental Landfill in Co. Dublin. Any material removed off site should be disposed of at a suitable licenced facility. The results of this testing can be found at the rear of this report.

6.0 Recommendations and Conclusions

6.1 General

The recommendations given and opinions expressed in this report are based on the findings as detailed in the trial pit records. Where an opinion is expressed on the material between exploratory hole locations, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for conditions which have not been revealed by the exploratory holes.

Earthworks are proposed in the south west corner of the site and a retaining wall is proposed to be constructed. The material excavated in this area, based on TP1 and TP2, will be suitable for re-use as landscaping fill within the proposed development. The material has a high fines content and the optimum moisture content is close to or above the natural moisture content. The CBR test results indicate that material reused from excavations will have a CBR value of 2% or below.

The retaining wall should be designed using the approach advocated in BS8002: Code of Practice for Earth Retaining Structures or Eurocode 7: Geotechnical Design. The appropriate design parameters should be determined from the trial pit logs for the depths retained.

Due to the presence of loose granular deposits and/or soft cohesive deposits foundations in the vicinity of TP1, TP2 & TP5 foundations are recommended to be taken to the firm to stiff cohesive deposits, or the medium dense granular deposits at a depth of 2.0m BGL. An allowable bearing capacity of $70kN/m^2$ is recommended at this depth based on the dynamic probe records in Appendix 5. Vibro compaction or other forms of ground improvement may be more economical than deep excavations for foundations, however depending on the proposed development levels and the earthworks proposed in the south west corner of the site, the proposed foundation levels may be more achievable.

An allowable bearing capacity of 70kN/m^2 is recommended for the foundations at 1.0m BGL on the firm to stiff cohesive deposits in the vicinity of TP3, TP4 & TP6. An increased value of 100kN/m^2 is recommended at 1.0m BGL for TP7 & TP8. Any soft spots encountered at this depth should be excavated and replaced with lean mix concrete.

Excavations for services which are required to be installed in the water bearing granular deposits may require temporary support and dewatering. Note should be taken of the stability of the trial pits recorded on the logs in Appendix 2.

The recommendations provided in this report should be verified in the design of the proposed buildings, using the full details of the loading conditions and taking into consideration the allowable tolerable settlements/movements that the building can accommodate. The founding strata should be inspected and verified by a suitably qualified engineer prior to construction of the building foundations.

****

TRENCH 1
TRENCH 2
NCH 3
WAYLEAVE FOR SERVICES 1.00 ACRES APPROX
WAYLEAVE FOR SERVICES 1.36 ACRES APPROX
FOR SERVICES 1.23 ACRES APPROX
TP 1
TP 2
TP 4
TP 5
TP 6
TP 7
TP 8
SP 1
SP 2
SP 3
SP 4
LAYOUT T
Corbally R
Background unavailable
304830, 226365

TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: TP1**

Client: Pinnacle
Consultant: Roger Mullarkey & Associates
Location: Saggart
Date: 09/12/2013
Excavator used: JCB 3CX

Co-ordinates: 304720.00 226091.00
Elevation: 149.930
Project no. 4040-11-13
Logged by: C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Samples / tests Depth	Result	Water Depth	Date
TOPSOIL		0.30	149.63					
Soft dark brown slightly sandy slightly gravelly CLAY		0.60	149.33					
Firm laminated brown and light brown slightly sandy slightly gravelly CLAY/SILT		0.90	149.03	T	0.90			
Loose brown slightly gravelly fine to medium SAND with lenses of slightly clayey slightly gravelly SAND				B	1.00			
				T	1.00			
				B	2.00			
		2.70	147.23	B	2.70			
Stiff dark brown sandy gravelly CLAY with occasional cobbles and rare boulders				B	3.00			
		3.20	146.73					
End of Trial pit at 3.20 m								

Remarks:
Stability: Stable
Water: Slow seepage at 3.1m bgl
Remarks:

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

Dimensions: 3.00 × 0.70
Depth: 3.20

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: TP2**

Client: Pinnacle
Consultant: Roger Mullarkey & Associates
Location: Saggart
Date: 09/12/2013
Excavator used: JCB 3CX

Co-ordinates: 304727.00 226146.00
Elevation: 144.800
Project no. 4040-11-13
Logged by: C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Samples / tests Depth	Result	Water Depth	Date
TOPSOIL								
Soft to firm grey brown slightly sandy slightly gravelly CLAY		0.30	144.50					
Firm grey sandy gravelly slightly organic CLAY		0.50	144.30	T	0.50			
Firm brown sandy gravelly CLAY with occasional cobbles and rare boulders		0.90	143.90	B	1.00			
				B	2.00			
Dark grey slightly gravelly fine to coarse SAND (wet)		2.20	142.60					
Stiff black slightly sandy gravelly CLAY with occasional cobbles and rare boulders		2.50	142.30	B	2.50			
End of Trial pit at 2.70 m		2.70	142.10					

Remarks:
Stability: Collapsing below 1.5m bgl
Water: Slow seepage at 2.0m bgl
Remarks:

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

Dimensions: 3.00 × 0.70
Depth: 2.70

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: TP3**

Client:	Pinnacle	Co-ordinates:	304802.00 226242.00
Consultant:	Roger Mullarkey & Associates	Elevation:	137.700
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Depth	Result	Water Depth	Date
TOPSOIL		0.30	137.40					
Soft to firm brown slightly sandy slightly gravelly CLAY with occasional cobbles and rare boulders				T B LB	1.00 1.00 1.00			
		1.50	136.20					
Firm to stiff brown sligthly sandy gravelly CLAY with occasional cobbles and rare boulders				B	2.00			
		2.20	135.50					
Stiff to very stiff dark brown slightly sandy gravelly CLAY		3.00	134.70	B	3.00			
End of Trial pit at 3.00 m								

Depth scale: 1, 2, 4

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

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

Dimensions: 3.00
Depth: 0.70
3.00

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: TP4**

Client:	Pinnacle	Co-ordinates:	304714.00 226270.00
Consultant:	Roger Mullarkey & Associates	Elevation:	134.700
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Depth	Result	Water Depth	Date
TOPSOIL		0.20	134.50					
Soft orange brown sandy slightly gravelly CLAY		0.30	134.40					
Soft to firm brown slightly sandy slightly gravelly CLAY with occasional cobbles and rare boulders		0.90	133.80					
Firm brown slightly sandy slightly gravelly CLAY with occasional cobbles and rare boulders				T B	1.00 1.00			
		1.50	133.20	LB	1.50			
Medium dense brown clayey sandy sub rounded to sub angular fine to coarse GRAVEL with occasional cobbles and rare boulders		2.70	132.00					
Medium dense to dense brown sligthly sandy clayey sub angular to sub rounded fine to coarse GRAVEL with frequent cobbles (wet)		3.00	131.70	LB	3.00			
End of Trial pit at 3.00 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

KEY

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

Dimensions: 3.00 × 0.70
Depth: 3.00

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: TP5**

Client: Pinnacle
Consultant: Roger Mullarkey & Associates
Location: Saggart
Date: 09/12/2013
Excavator used: JCB 3CX

Co-ordinates: 304883.00 226244.00
Elevation: 141.630
Project no. 4040-11-13
Logged by: C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Depth	Result	Water Depth	Date
TOPSOIL		0.30	141.33					
Soft orange brown sandy slightly gravelly CLAY		0.80	140.83	B	0.70			
Soft grey brown slightly sandy slightly gravelly CLAY		1.20	140.43					
Soft laminated grey brown sandy CLAY/SILT		1.70	139.93	B	1.50			
Soft to firm grey brown slightly gravelly sub fine to medium SAND with occasional lenses of sandy SILT		2.30	139.33	LB	2.00			
Medium dense grey brown sandy sub angular to sub rounded fine to coarse GRAVEL with occasional cobbles		3.50	138.13	LB	3.00			
End of Trial pit at 3.50 m								

Remarks:
Stability: Stable
Water: No groundwater encountered
Remarks:

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

Dimensions: 3.00 × 0.70
Depth: 3.50

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: TP6**

Client:	Pinnacle	Co-ordinates:	304963.00 226248.00
Consultant:	Roger Mullarkey & Associates	Elevation:	139.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Depth	Result	Water Depth	Date
TOPSOIL		0.30	138.70					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		1.10	137.90	B	0.70			
Firm to stiff brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		2.00	137.00	B LB	1.50 2.00			
End of Trial pit at 2.00 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

KEY

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

Dimensions: 3.00
Depth: 0.70
2.00

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TRIAL PIT RECORD

Project Name: Saggart, Boherboy — Hole ID: TP7

Client: Pinnacle
Consultant: Roger Mullarkey & Associates
Location: Saggart
Date: 09/12/2013
Excavator used: JCB 3CX

Co-ordinates: 304883.00 226244.00
Elevation: 139.390
Project no. 4040-11-13
Logged by: C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL		0.30	139.09					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		0.70	138.69					
Stiff brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders				B	1.00			
				T LB	1.50 1.50			
				B	2.00			
		2.60	136.79	B	2.60			
End of Trial pit at 2.60 m								

Remarks:
Stability: Stable
Water: No groundwater encountered
Remarks:

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

Dimensions: 3.00 × 0.70
Depth: 2.60

www.gii.ie

TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: TP8**

Client:	Pinnacle	Co-ordinates:	304957.00 226309.00
Consultant:	Roger Mullarkey & Associates	Elevation:	137.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Depth	Result	Water Depth	Date
TOPSOIL		0.30	136.70					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		0.70	136.30	LB	0.70			
Stiff brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders				T	1.00			
		1.50	135.50					
End of Trial pit at 2.00 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks:

KEY

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

Dimensions: 3.00
Depth: 0.70
2.00

www.gii.ie

TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: SP1**

Client:	Pinnacle	Co-ordinates:	304814.00 226147.00
Consultant:	Roger Mullarkey & Associates	Elevation:	141.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Samples / tests: Depth	Samples / tests: Result	Water Depth	Date
TOPSOIL		0.30	140.70					
Soft to firm orange brown slightly sandy gravelly CLAY		0.70	140.30					
Soft brown slightly sandy slightly gravelly CLAY		1.50	139.50					
Brown gravelly fine to coarse SAND		2.00	139.00					
Brown sandy sub angular to sub rounded fine to coarse GRAVEL with occasional cobbles		2.20	138.80					
End of Trial pit at 2.20 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks: Soakaway test completed in accordance with BRE365.

KEY

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

Dimensions: 2.50 × 0.70
Depth: 2.20

www.gii.ie

TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: SP2**

Client:	Pinnacle	Co-ordinates:	304714.00 262220.00
Consultant:	Roger Mullarkey & Associates	Elevation:	137.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Depth	Result	Water Depth	Date
TOPSOIL		0.30	136.70					
Soft to firm orange brown slightly sandy gravelly CLAY		0.50	136.50					
Soft brown sandy gravelly CLAY with occasinal cobbles and boulders (damp)		1.50	135.50					
Brown clayey sandy sub angular to sub rounded fine to coarse GRAVEL with occasional cobbles and rare boulders (wet)		1.90	135.10					
End of Trial pit at 1.90 m								

Remarks:

Stability: Collapsing beow 0.5m BGL
Water: Slow groundwater seepage encountered below 2.0m BGL
Remarks: Soakaway test completed in accordance with BRE365.

KEY

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

Dimensions: 2.30 × 0.70
Depth: 1.90

www.gii.ie

TRIAL PIT RECORD

Project Name: Saggart, Boherboy | **Hole ID: SP3**

Client:	Pinnacle	Co-ordinates:	304939.00 226195.00
Consultant:	Roger Mullarkey & Associates	Elevation:	141.500
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests: Type	Depth	Result	Water Depth	Date
TOPSOIL		0.30	141.20					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		1.00	140.50					
Firm to stiff grey brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		2.00	139.50					
End of Trial pit at 2.00 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks: Soakaway test completed in accordance with BRE365.

KEY

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

Dimensions: 2.20
Depth: 0.70
2.00

www.gii.ie

TRIAL PIT RECORD

Project Name: Saggart, Boherboy — **Hole ID: SP4**

Client:	Pinnacle	Co-ordinates:	304886.00 226304.00
Consultant:	Roger Mullarkey & Associates	Elevation:	138.000
Location:	Saggart	Project no.	4040-11-13
Date:	09/12/2013		
Excavator used:	JCB 3CX	Logged by:	C Finnerty

Strata Description	Legend	Depth	Level (mOD)	Samples / tests Type	Samples / tests Depth	Samples / tests Result	Water Depth	Date
TOPSOIL		0.30	137.70					
Soft to firm brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		1.20	136.80					
Firm to stiff grey brown sandy slightly gravelly CLAY with occasional cobbles and rare boulders		2.10	135.90					
End of Trial pit at 2.10 m								

Remarks:

Stability: Stable
Water: No groundwater encountered
Remarks: Soakaway test completed in accordance with BRE365.

KEY

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

Dimensions: 2.30 × 0.70
Depth: 2.10

www.gii.ie

Soakaway Test

Saggart Soakaway Testing

SP01

Soakaway Test to BRE Digest 365

The Trial Pit was filled with water to 0.7m BGL and the drop in water level with time was recorded below.
*Note: Effective length of pit includes conservative correction for sloping end wall

Date	Elapsed Time	Mins	Fall of Water (m)
09/12/2013	12.17	0	-0.7
09/12/2013	12.23	6	-0.78
09/12/2013	12.31	14	-0.83
09/12/2013	12.54	37	-0.95
09/12/2013	13.12	55	-1.02
09/12/2013	13.20	63	-1.05
09/12/2013	14.32	135	-1.23
09/12/2013	16.45	268	-1.55

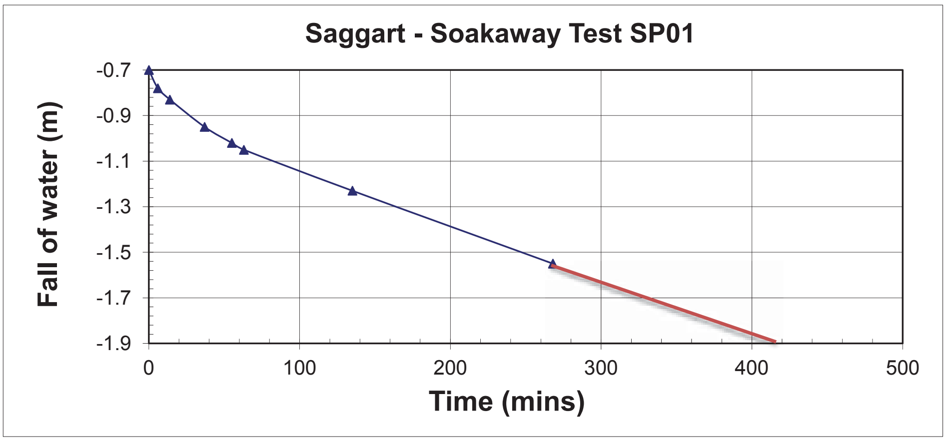
Start depth to water	Depth of Hole	Δ [m]	75% full	25% full	
0.70	2.200	1.500	**1.075**	**1.825**	**m bgl**

Effective length of pit (m)*	Width of pit (m)	75-25H_t (m)	Vp_{75-25} (m^3)
2.000	0.700	0.750	**1.05**

Effective length of pit (m)*	Width of pit (m)	50% Eff Depth	Ap_{50} (m^2)
2.000	0.700	0.375	**3.95**

tp_{75-25} seconds (from graph) **19200**

f = 1.38E-05 m/s



SP2

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.94m BGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.94	Hole filled with water
6	0.92	
20	0.89	
50	0.88	
90	0.87	
150	0.86	
210	0.85	Test Failed

Water level is rising due to location of soakaway at the base of a hill. This Soakaway failed.

SP3

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.61m BGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.55	Hole filled with water
48	0.61	
98	0.65	
173	0.69	
220	0.77	Test Failed

Test failed due to insufficient drop in water level to calculate infiltration value.

SP4

Soakaway Test to BRE Digest 365

The Trial pit was filled with water to 0.5m BGL and the drop in water level with time was recorded below.

Elapsed Time Minutes	**Water Level mBGL**	**Remarks**
0	0.5	Hole filled with water
20	0.55	
98	0.6	
173	0.68	
220	0.75	Test Failed

Test failed due to insufficient drop in water level to calculate infiltration value.

Soil Map

Map center: 305041, 226438

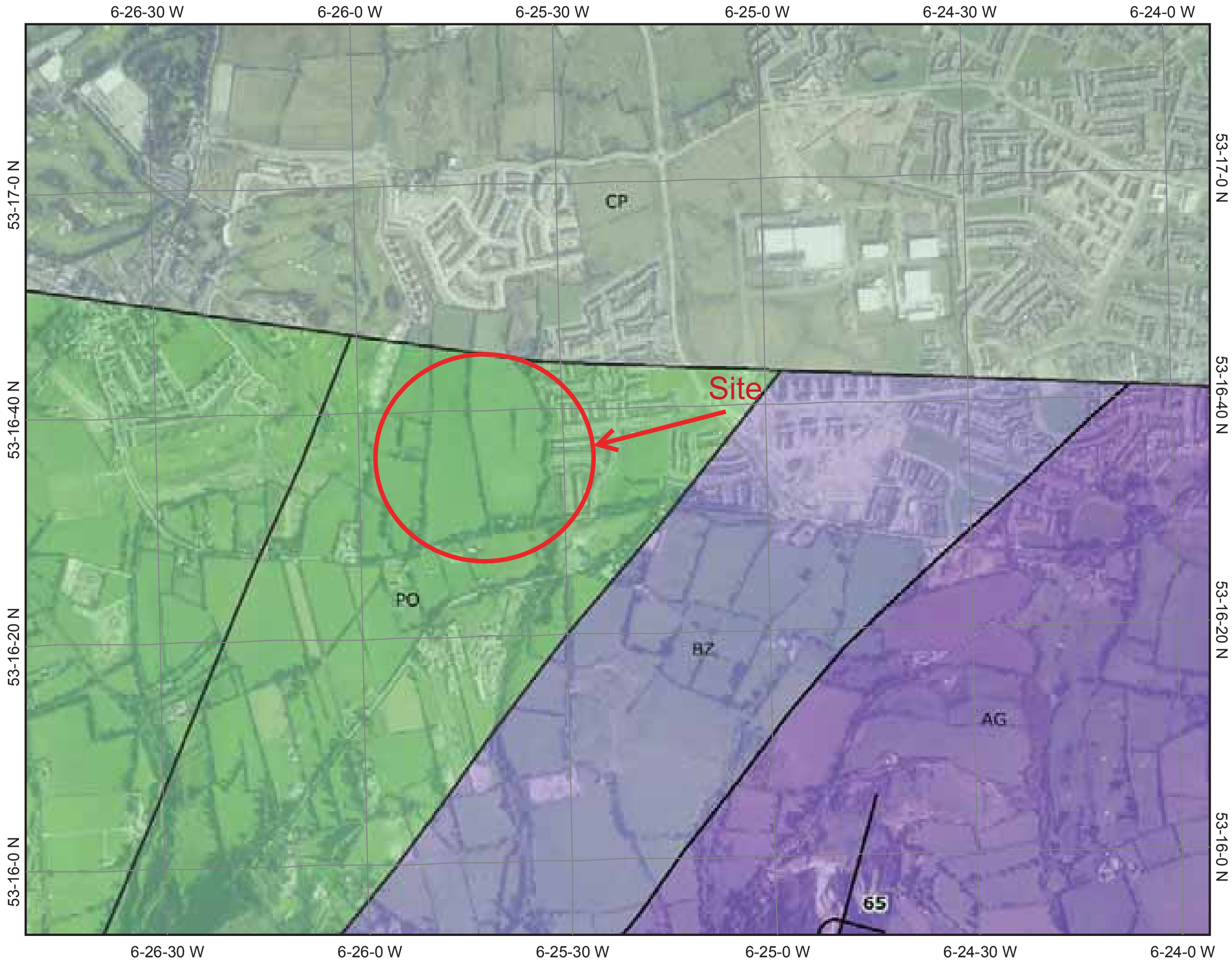
Legend

Quaternary

Till derived from Limestone

Till derived from Sandstone

Bedrock



Map center: 305200, 226234

Legend

Symbol Labels 100k

Cross Section Labels

Minerals 100k

- Disused metal mines and pits
- Disused quarries, pits and mines non metallic
- Prospects, metallic and non metallic
- Working metal mines and pits
- Working quarries, pits and mines non metallic

Symbols 100k

Cross Sections 100k

100k Structural Linework

- Anticlinal axis
- Antiformal axis
- Fault
- line od cross section
- Slide
- Synclinal axis
- Synformal axis
- Thrust

100k Stratigraphical Linework

- Area of abundant P-dykes
- Area of fine-grained metabasite pods
- Basalt with mantle xenoliths (Bx)
- Boundary of Felsic igneous intrusion
- Boundary of dolomitization
- Boundary of igneous intrusion
- Boundary of raft cluster within MdGr
- Boundary of volcanic b
- Coal seam
- Dyke/Sill
- Ghost Line
- Limit of MdGr D6 granitic sheets
- Limit of granite sheeting (Ox Mountains)

Minerals and Quarries

Map center: 305200, 226234

Legend

Mineral Localities

- Both
- Metallic
- Non-metallic

Quarries (Active 2001)

- Mine
- Pit
- Quarry
- Quarry&Pit

Irish National Seabed Survey Zones (50m-5000m)

Irish Designated Seabed Zone

Bathymetry

Bedrock Aquifer

Map center: 305200, 226234

Legend

Mineral Localities

- Both
- Metallic
- Non-metallic

Quarries (Active 2001)

- Mine
- Pit
- Quarry
- Quarry&Pit

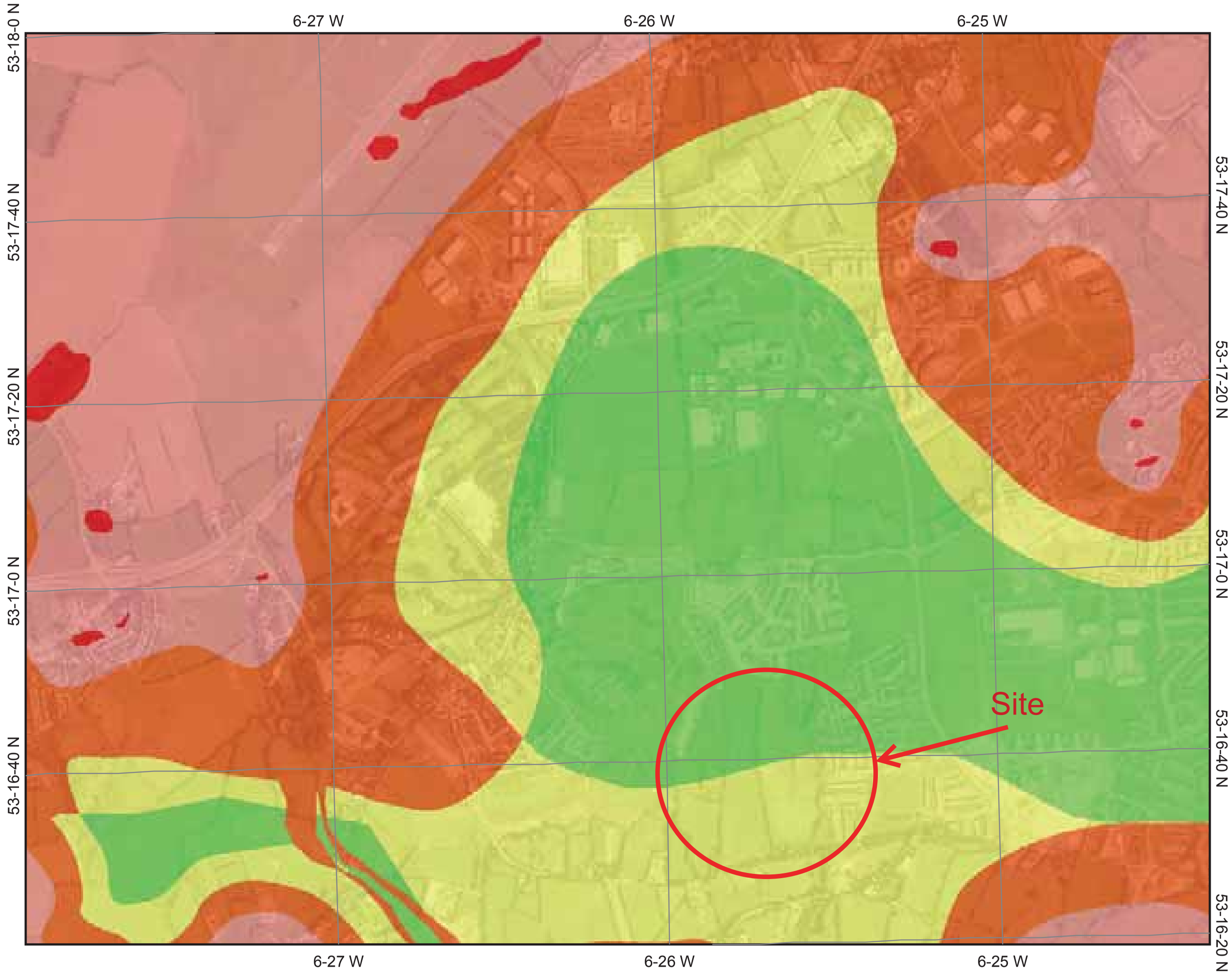
National Draft Bedrock Aquifer Map

- Rf - Regionally Important Aquifer - Fissured bedrock
- Rk - Regionally Important Aquifer - Karstified
- Rkd - Regionally Important Aquifer - Karstified (diffuse)
- Rkc - Regionally Important Aquifer - Karstified (conduit)
- Lm - Locally Important Aquifer - Bedrock which is Generally Moderately Productive
- Lk - Locally Important Aquifer - Karstified
- Ll - Locally Important Aquifer - Bedrock which is Moderately Productive only in Local Zones
- Pl - Poor Aquifer - Bedrock which is Generally Unproductive except for Local Zones
- Pu - Poor Aquifer - Bedrock which is Generally Unproductive
- Unclassified

Irish National Seabed Survey Zones (50m-5000m)

Irish Designated Seabed Zone

Aquifer Vunribility



Legend

Vulnerability

- X (Rock near Surface or Karst)
- E - Extreme
- H - High
- M - Moderate
- L - Low
- Water
- Irish National Seabed Survey Zones (50m-5000m)
- Irish Designated Seabed Zone Bathymetry

Map center: 304329, 227328

Karst

Map center: 305200, 226234

Legend

Karst Features

- Borehole
- Cave
- Dry Valley
- Enclosed Depression
- Estevelle
- Spring
- Superficial Solution Features
- Swallow Hole
- Turlough

Irish National Seabed Survey Zones (50m-5000m)

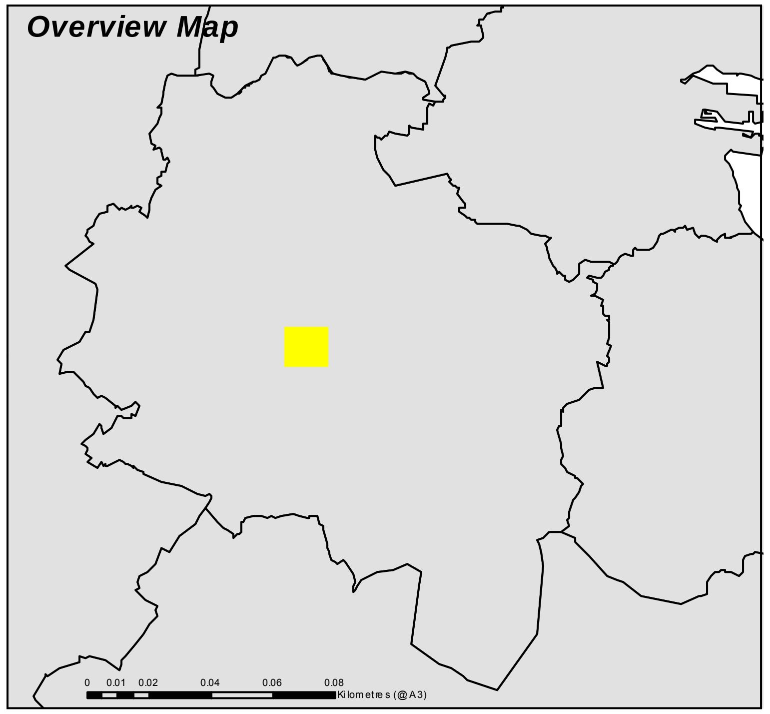
Irish Designated Seabed Zone

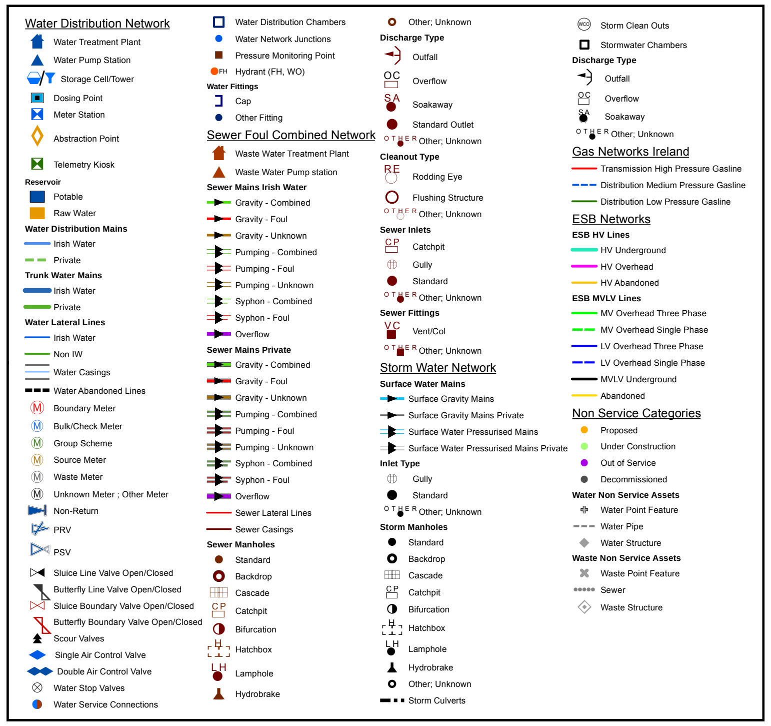
Bathymetry

Appendix 11.8

SDCC/UÉ Records Drawings

IWGIS Water Utilities Network

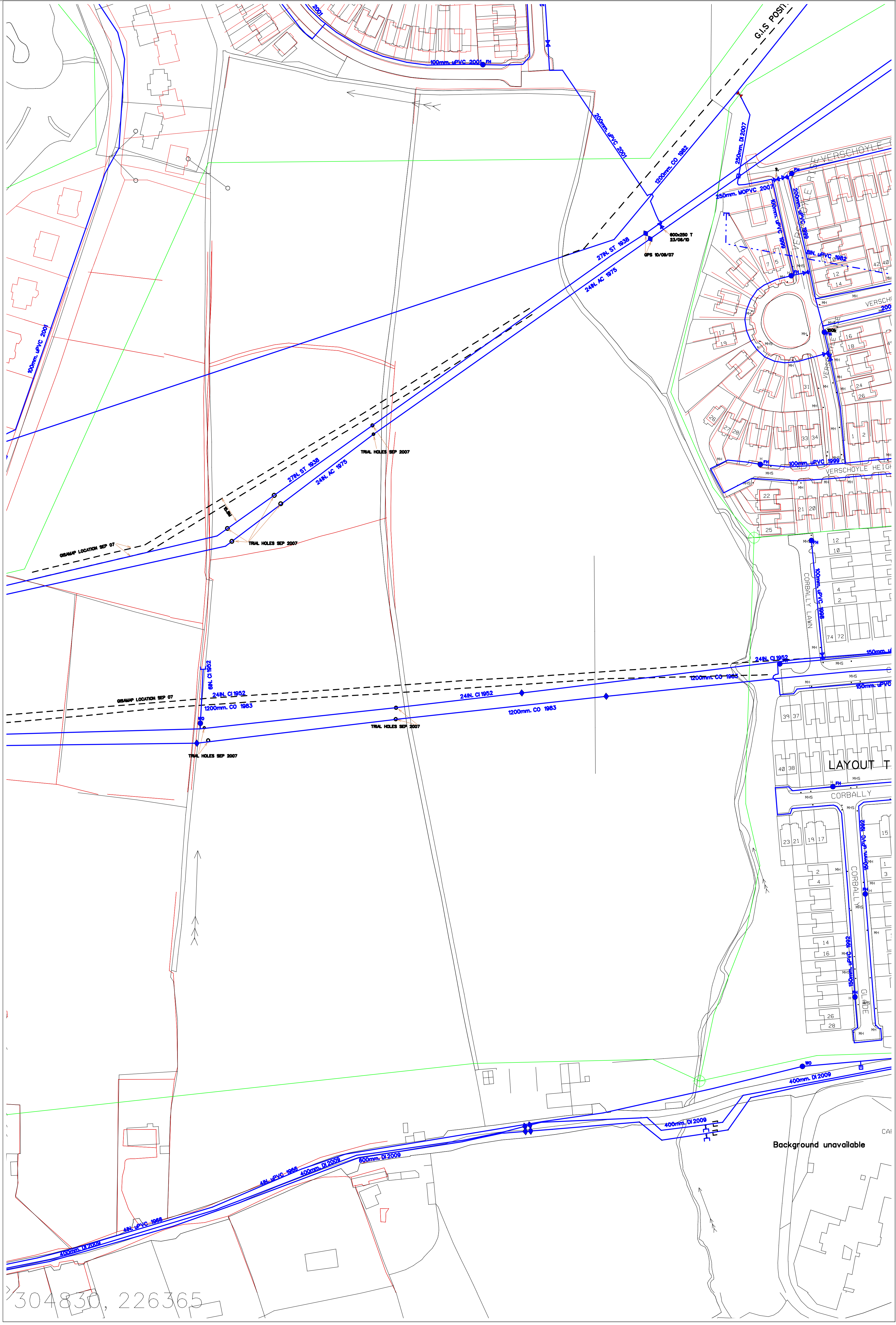




UISCE ÉIREANN : IRISH WATER

Print Date: 17/02/2020

Printed by: cbolger



N

Legend:	
	Sluice Valve
	Pressure Reducing Valve
	Meter
	Bulk Meter
	Hydrant
	Cap End
	Air Valve
	Stop Tap
	Existing Main
	Proposed Abandoned Main

Aug 08 2013

Scale: 1:2000

South Dublin County Council gives this information as to the position of its underground apparatus by way of general guidance only on the strict understanding that it is based on the best information available and no warranty as to its correctness is relied upon in the event of excavations or other works made in vicinity of the Companys apparatus and any onus of locating the apparatus before carrying out any excavations rests entirely on you.

Service Pipes are not generally shown but their presence should be anticipated.

EXACT LOCATIONS OF ALL APPARATUS TO BE DETERMINED ON SITE.

Appendix 11.9

Met Eireann Data

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 304865, Northing: 226349,

	Interval		Years										
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	120,
5 mins	2.8,	3.8,	4.4,	5.2,	5.7,	6.2,	7.5,	9.0,	10.0,	11.3,	12.5,	13.4,	14.0,
10 mins	3.9,	5.4,	6.1,	7.2,	8.0,	8.6,	10.4,	12.5,	13.9,	15.8,	17.4,	18.7,	19.6,
15 mins	4.6,	6.3,	7.2,	8.5,	9.4,	10.1,	12.3,	14.7,	16.3,	18.5,	20.5,	22.0,	23.0,
30 mins	6.2,	8.4,	9.6,	11.4,	12.5,	13.4,	16.3,	19.5,	21.6,	24.5,	27.1,	29.1,	30.4,
1 hours	8.3,	11.3,	12.8,	15.1,	16.7,	17.9,	21.7,	25.9,	28.7,	32.5,	35.8,	38.4,	40.1,
2 hours	11.1,	15.1,	17.1,	20.2,	22.2,	23.8,	28.8,	34.4,	38.0,	43.0,	47.4,	50.8,	53.0,
3 hours	13.2,	17.9,	20.3,	23.9,	26.3,	28.1,	34.0,	40.6,	44.8,	50.7,	55.8,	59.8,	62.4,
4 hours	14.9,	20.2,	22.9,	26.9,	29.6,	31.7,	38.3,	45.6,	50.4,	56.9,	62.7,	67.1,	70.1,
6 hours	17.7,	23.9,	27.1,	31.9,	35.1,	37.5,	45.3,	53.8,	59.4,	67.1,	73.9,	79.0,	82.5,
9 hours	21.1,	28.4,	32.2,	37.8,	41.5,	44.3,	53.5,	63.6,	70.1,	79.1,	87.0,	93.1,	97.1,
12 hours	23.8,	32.0,	36.3,	42.6,	46.7,	49.9,	60.2,	71.5,	78.8,	88.9,	97.8,	104.5,	109.1,
18 hours	28.3,	38.0,	43.0,	50.4,	55.3,	59.1,	71.1,	84.4,	93.0,	104.8,	115.2,	123.1,	128.4,
24 hours	32.0,	42.9,	48.5,	56.8,	62.3,	66.6,	80.1,	94.9,	104.5,	117.8,	129.4,	138.3,	144.2,
2 days	40.1,	52.3,	58.6,	67.7,	73.6,	78.1,	92.5,	108.0,	117.9,	131.4,	143.2,	152.1,	158.0,
3 days	46.9,	60.3,	67.1,	76.8,	83.1,	87.9,	103.1,	119.3,	129.5,	143.5,	155.6,	164.7,	170.7,
4 days	52.9,	67.3,	74.6,	84.9,	91.6,	96.7,	112.5,	129.4,	140.0,	154.5,	166.8,	176.2,	182.4,
6 days	63.8,	80.0,	88.0,	99.3,	106.6,	112.1,	129.2,	147.3,	158.6,	173.9,	186.9,	196.7,	203.1,
8 days	73.6,	91.3,	100.0,	112.2,	120.0,	125.9,	144.2,	163.3,	175.2,	191.2,	204.8,	215.0,	221.7,
10 days	82.8,	101.8,	111.1,	124.1,	132.4,	138.7,	157.9,	177.9,	190.4,	207.1,	221.2,	231.8,	238.7,
12 days	91.5,	111.7,	121.5,	135.3,	144.0,	150.6,	170.7,	191.7,	204.6,	221.9,	236.6,	247.4,	254.6,
16 days	107.9,	130.3,	141.1,	156.2,	165.7,	172.8,	194.6,	217.1,	230.9,	249.3,	264.8,	276.4,	283.9,
20 days	123.4,	147.8,	159.4,	175.7,	185.9,	193.5,	216.7,	240.6,	255.2,	274.6,	290.9,	303.0,	310.9,
25 days	141.9,	168.5,	181.1,	198.6,	209.6,	217.8,	242.7,	268.0,	283.6,	304.1,	321.2,	333.9,	342.2,

NOTES:
These values are derived from a Depth Duration Frequency (DDF) Model update 2023
For details refer to:
'Mateus C., and Coonan, B. 2023. Estimation of point rainfall frequencies in Ireland. Technical Note No. 68. Met Eireann',
Available for download at:
http://hdl.handle.net/2262/102417

Boherboy, Saggart
304865E 226349N
SAAR = 878mm
M5/60 = 17.9
r= 0.229

Appendix 11.10

Green Roofs

MOY TOTAL EXTENSIVE GREEN ROOF SYSTEM.

Intended Use.

The Moy Total Extensive Green Roof System is a robust waterproofing assembly finished with a native Irish Sedum mix species extensive green roof assembly, designed to provide a self-sustaining low maintenance green roof which provides substantial rainwater attenuation benefits and provides habitat for bees and invertebrates. The Moy Extensive Green roof may be installed in “Blue Roof” configuration, whereby drainage of the roof is delayed, or may be installed on roofs where free drainage takes place.

Green Roof Assembly and Key Data.

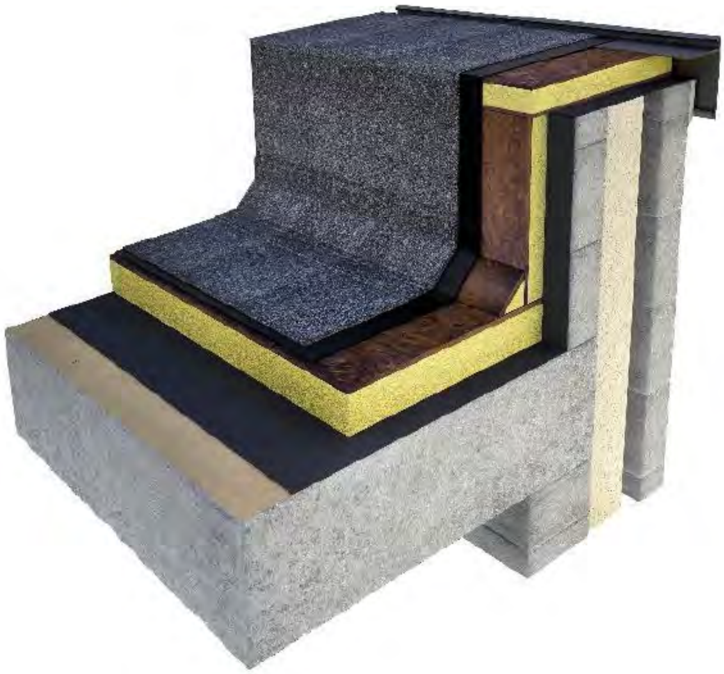
Element	Key Characteristics	Notes
Moy Sedum Mix Blanket	30mm Thickness	Native Irish Species Mix.
Moy Growing Media	50mmThickness	Recycled Brick & Organic Materials
Filtration Fleece VLF150	1mm Thickness	Recycled fibres.
DE25H Reservoir Layer	25mm Thickness	Recycled Plastics.
Protection Fleece VLU300	2mm Thickness	Recycled fibres.
System PH Value	PH 7.1	-

Weight & Water Attenuation Data.

Total Mass per M2 – Dry Condition.	C. 70 Kg / M2.
Total Mass per M2 – Saturated Condition	C. 125 Kg / M2.
Rainwater Attenuation Capacity	C. 44 litres / M2. (Dynamic Value).

Moy Extensive Green Roofs provide a substantial rainwater attenuation capacity and may be incorporated in site specific SUDs Design.

Moy Warm Roof Waterproofing & Insulation Assembly.



Paralon System Assembly.

1. Vapour Controlling Layer, Parabase modified bitumen.

2. Thermal Insulation, Paratherm T, PIR foam core by Kingspan Insulation, available as a flat or tapered layer. High Efficiency of 0.024 W/mK.

3. Paralon TOP/S polyester reinforced base layer, modified bitumen, torch applied membrane.

4. Paralon NT4 polyester reinforced cap layer, root resistant, modified bitumen, torch applied membrane.

Approvals, Compliance & Certification.

- ❖ BBA Certified Certificate No. 09/4688 (Life Expectancy in Excess of 40 Years).
- ❖ FM Global Insurance Corporation Approved.
- ❖ Compliant with FLL (Germany) and GRO (UK) Green Roof Design Guidelines.

LEED & BREEAM CREDITS.

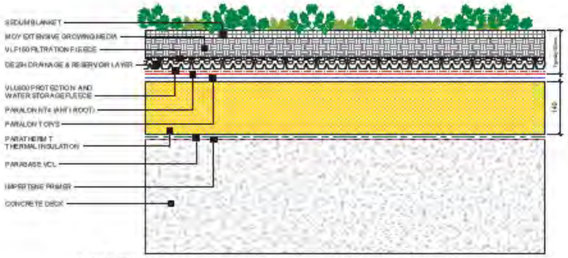
Moy Extensive Green Roofs are locally sourced where possible, with over 80% of the bulk mass material being produced or grown in Ireland, reducing the carbon footprint and promoting sustainability.

IRELAND
Unit K, South City Business Park
Whitestown Way, Tallaght, Dublin 24
T 01 463 3900 E info@moymaterials.com

ENGLAND
Victoria House (4th Floor)
Victoria Road, Chelmsford, CM1 1JR
T 01245 707 449 E info@moymaterials.co.uk

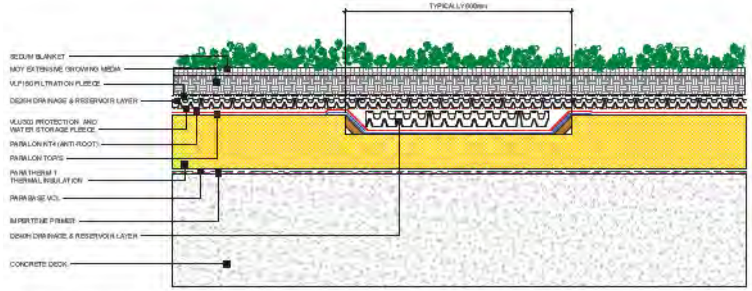
SCOTLAND
6 Mackean Street
Paisley, Glasgow, PA3 1QP
T 0141 840 4660 E enquiries@moymaterials.co.uk

Ver. April 2020.



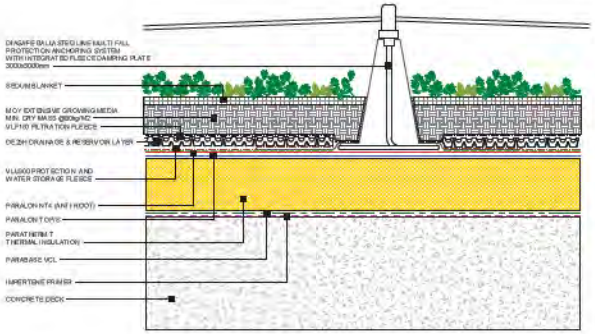
MOY EXTENSIVE GREEN ROOF SYSTEM (CONCRETE DECK)

① 1 : 5



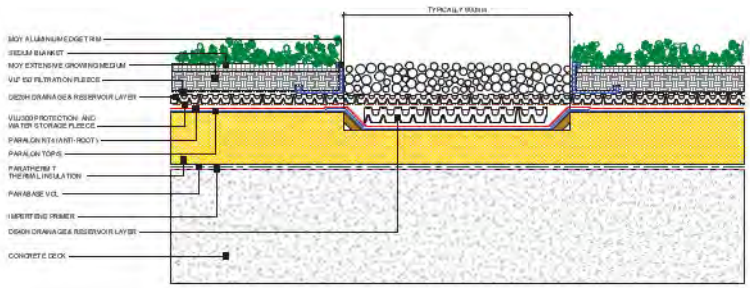
MOY EXTENSIVE GREEN ROOF SYSTEM - GUTTER CHANNEL WITH SEDUM COVERING DETAIL

④ 1 : 5



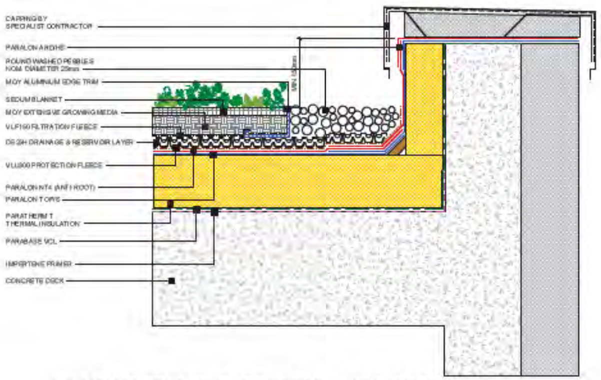
MOY EXTENSIVE GREEN ROOF SYSTEM - PROTECTION ANCHORING SYSTEM DETAIL

② 1 : 5



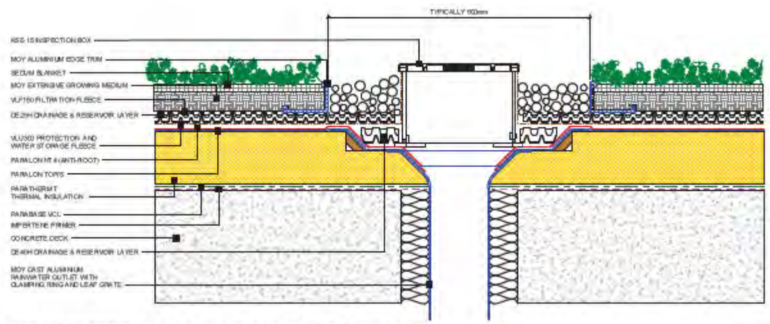
MOY EXTENSIVE GREEN ROOF SYSTEM - GUTTER CHANNEL WITH PEBBLES DETAIL

⑤ 1 : 5



MOY EXTENSIVE GREEN ROOF - PARAPET DETAIL

③ 1 : 5



MOY EXTENSIVE GREEN ROOF SYSTEM - RAINWATER OUTLET INSPECTION BOX DETAIL

⑥ 1 : 5

Detail: EXTENSIVE GREEN ROOF TYPICAL DETAILS	
System Ref:	DWG. NO: GR-E-01
Scale: 1 : 5	Date: MAY 2021

MOY

DUBLIN - LONDON - GLASGOW - FRANKFURT

WWW.MOYMATERIALS.COM

INFO@MOYMATERIALS.COM

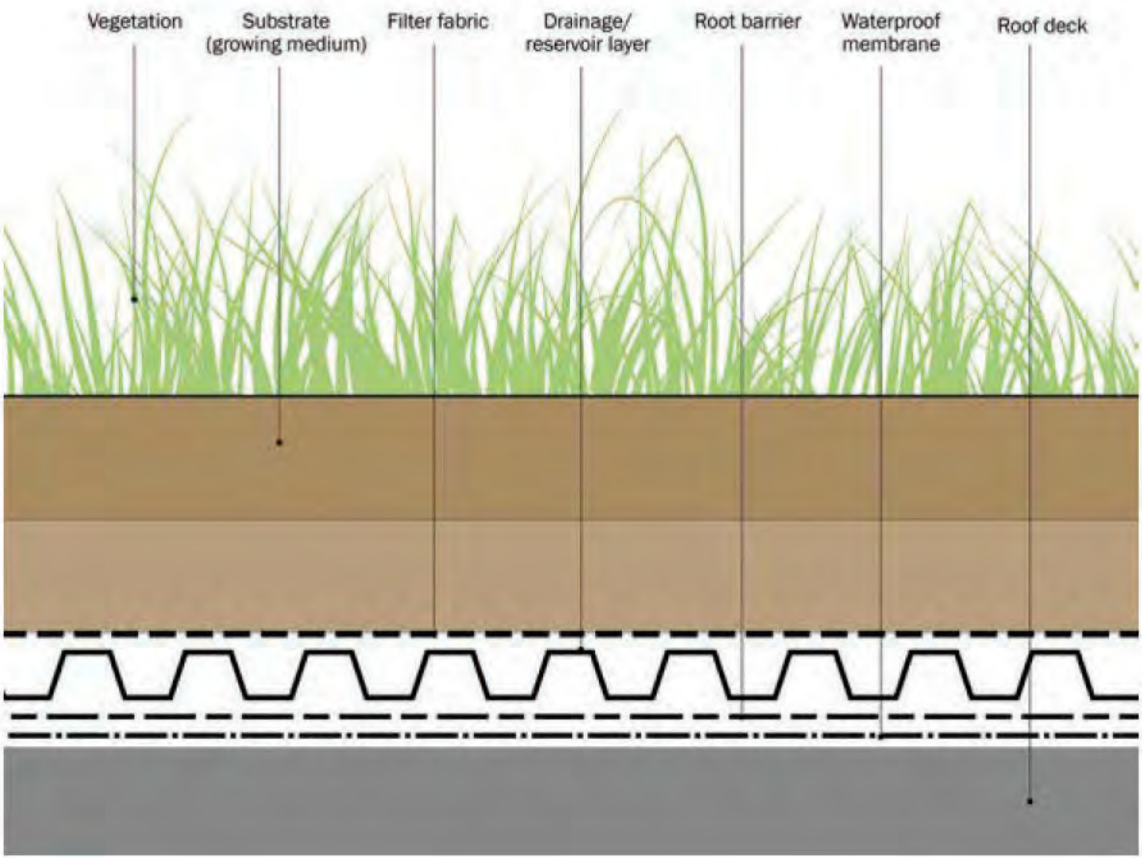


Figure 12.1 Section showing typical extensive green roof components

As mentioned earlier, there are two main types of green roof:

Extensive green roofs – These systems cover the entire roof area with hardy, slow growing, drought tolerant, low maintenance plants (eg mosses, succulents, herbs, grasses) often enhanced with wildflowers. Planting often establishes more slowly, but the long-term biodiversity can be of high value. They are only accessed for maintenance and can be flat or sloping. Extensive green roofs typically comprise a 20–150 mm thick growing medium and can be further divided into "single-layer" systems (which consist of a single medium designed to be free-draining and support plant growth), and "multi-layer" systems that include both a growing medium layer and a separate underlying drainage layer. They are lightweight and low cost to maintain, and can be used in a wide variety of locations with minimal intervention. They are often suitable for retrofit on existing structures due to their light weight. Biodiverse extensive green roofs are often planted with a mix of species supported by a range of soil depths.

Intensive green roofs (or roof gardens) – These are designed to sustain more complex landscaped environments that can provide high amenity or biodiversity benefits. They are planted with a range of plants including grasses, shrubs and/or trees, either as ground cover or within planters, and may also include water features and storage of rainwater for irrigation (ie blue roof elements). They are usually easily accessible, as they normally require a fairly high level of regular maintenance, and in some cases they are made accessible to the public. Intensive roofs have a deeper substrate, with >150 mm growing medium, and therefore impose greater loads on the roof structure.

Green roofs with substrate depths of 100–200 mm tend to be semi-intensive roofs, and can include characteristics of both extensive and intensive roofs, with plants that include shrubs and woody plants. Irrigation and maintenance requirements of this type of roof will be dependent upon the plant species chosen for the roof. There are also various combinations of green roof that combine both types in a single roof system.

A comparison of the main differences between extensive and intensive green roof systems is given in **Table 12.1**.

Extensive Green Roof

Blackdown extensive green roofs provide a lightweight, drought tolerant and low maintenance planting solution. They are suitable for lightweight roof decks, inaccessible roofs, flat or sloping roofs. Ongoing maintenance will keep extensive green roofs looking healthy and attractive

Vegetation

Extensive green roofs rely on hardy, drought tolerant sedum plants to form the majority of the planting. The sedums that Blackdown select and grow at the nursery in Somerset represent years of experience and horticultural knowledge.

There are three planting options to choose from – sedum NatureMat®, plugs or hydroplant (sedum cuttings).

Key Features

Substrate

Blackdown extensive substrates are made from carefully selected organic and inorganic materials. These materials are then blended to very specific proportions which enables plant material to establish as quickly as possible.

Waterproofing

Typical waterproofing options include suitable root-resistant bituminous membranes from the Derbigum and Euroroof ranges along with standing seam metal roofing.

Warranty

Warranties are available for the Alumasc waterproofing system used in the green roof build-up.

Build-up height	100mm
Drainage layer	25mm
Saturated weight	95-100 kg per m²
Plant coverage at installation	<5 to 90%
Maximum pitch	45 degrees
Irrigation requirements	Not required once plant material is established
Maintenance requirements	Twice a year

Appendix 11.11

Uisce Éireann CoF Letter

CONFIRMATION OF FEASIBILITY

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

Uisce Éireann
PO Box 448
South City
Delivery Office
Cork City

www.water.ie

Phillip Assaf

Kelland Homes Ltd & Durkan Estates Ireland Ltd
1st Floor Maple House
Lower Kilmacud Road
Stillorgan
Dublin
A94E3F2

31 January 2025

Our Ref: CDS24005491 Pre-Connection Enquiry
Site at, Boherboy Road, Saggart, Dublin

Dear Applicant/Agent,

We have completed the review of the Pre-Connection Enquiry.

Uisce Éireann has reviewed the pre-connection enquiry in relation to a Water & Wastewater connection for a Multi/Mixed Use Development of 627 unit(s) at Site at, Boherboy Road, Saggart, Dublin, (the **Development)**.

Based upon the details provided we can advise the following regarding connecting to the networks;

- **Water Connection** - Feasible without infrastructure upgrade by Uisce Éireann

- Uisce Éireann GIS records indicate that Uisce Éireann strategic water trunk mains are present on the site. the Developer must demonstrate that proposed structures and works will not inhibit access for maintenance or endanger structural or functional integrity of the assets during and after the works. For design submissions and queries related to diversion/build near or over, please contact UÉ Diversion Team via email address diversions@water.ie
-

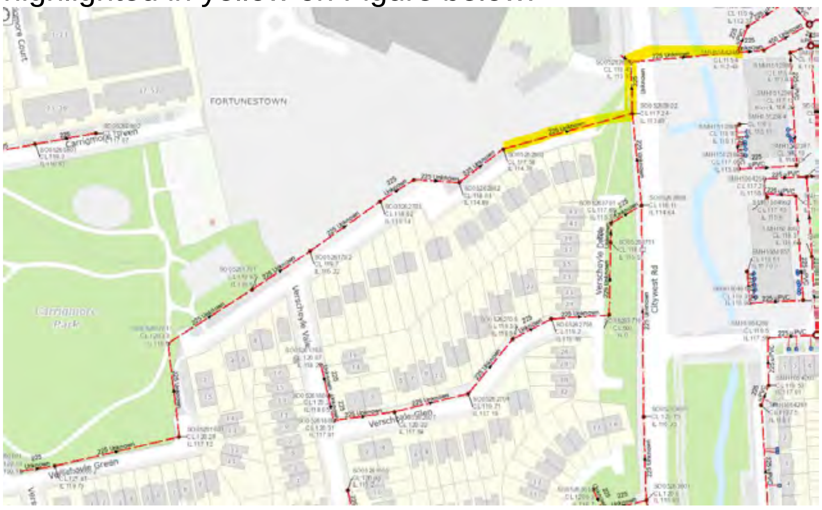
- **Wastewater Connection** - Feasible Subject to upgrades

- Approximately 135m network extension, via private lands, is required from the existing 225m gravity sewer on Verschoyle Green Road to the

UE / LH / OP448 / 0323

Development site. Please be advised that at a connection application stage you have to provide evidence of consent of the Third Party Landowners.

- Proposed wastewater rising main crossing the existing water pipes must be in accordance with Uisce Éireann Code of Practice and Standard Details (separation distances, crossing under the mains). The details must be approved by Uisce Éireann Diversion Team.
- Approximately 154m of 225mm sewer upgrade to a 450mm pipe is required. The sewer section is downstream of the Development site and highlighted in yellow on Figure below:



- The Developer will be required to fund the above network extension and upgrade works. The fee will be calculated at a connection application stage.

This letter does not constitute an offer, in whole or in part, to provide a connection to any Uisce Éireann infrastructure. Before the Development can be connected to our network(s) you must submit a connection application and be granted and sign a connection agreement with Uisce Éireann.

As the network capacity changes constantly, this review is only valid at the time of its completion. As soon as planning permission has been granted for the Development, a completed connection application should be submitted. The connection application is available at www.water.ie/connections/get-connected/

Where can you find more information?

- **Section A -** What is important to know?
- **Section B -** Details of Uisce Éireann's Network(s)

This letter is issued to provide information about the current feasibility of the proposed connection(s) to Uisce Éireann’s network(s). This is not a connection offer and capacity in Uisce Éireann’s network(s) may only be secured by entering into a connection agreement with Uisce Éireann.

For any further information, visit **www.water.ie/connections, email newconnections@water.ie** or contact 1800 278 278**.**

Yours sincerely,

Dermot Phelan
Connections Delivery Manager

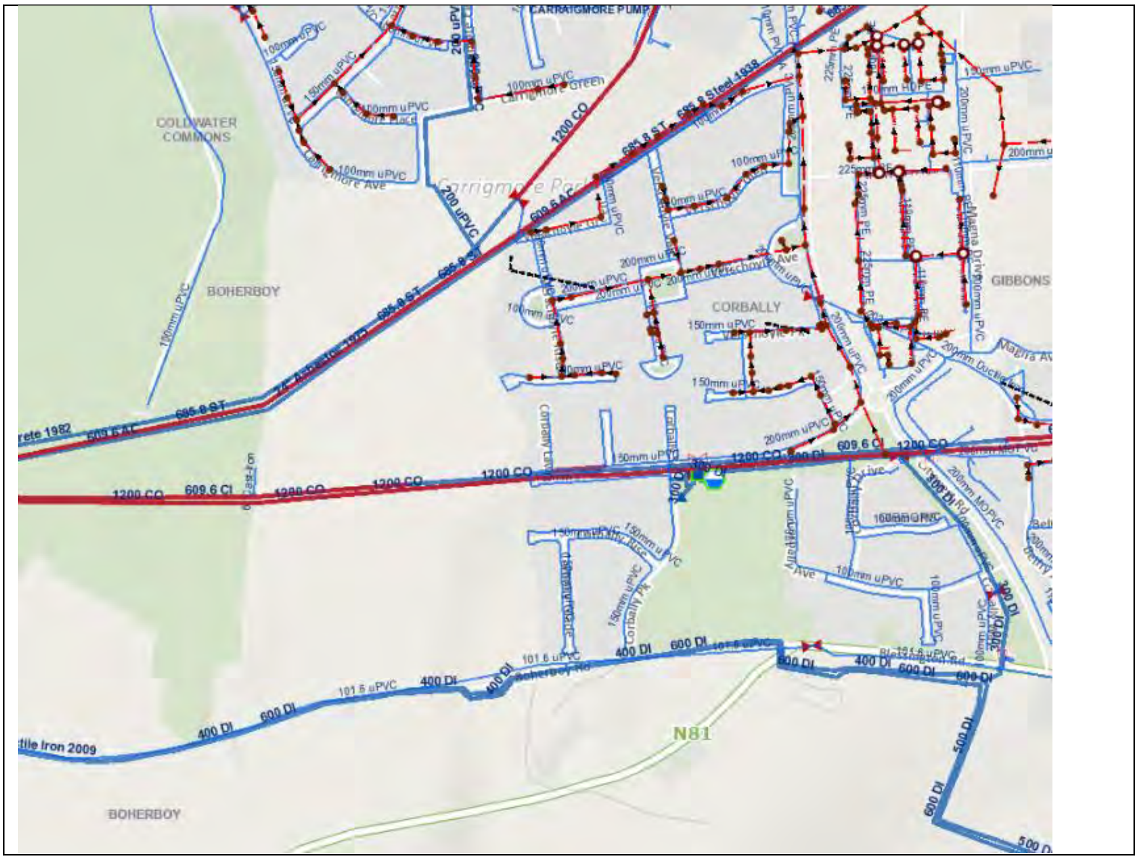
Section A - What is important to know?

What is important to know?	Why is this important?
Do you need a contract to connect?	• Yes, a contract is required to connect. This letter does not constitute a contract or an offer in whole or in part to provide a connection to Uisce Éireann's network(s). • Before the Development can connect to Uisce Éireann's network(s), you must submit a connection application and be granted and sign a connection agreement with Uisce Éireann.
When should I submit a Connection Application?	• A connection application should only be submitted after planning permission has been granted.
Where can I find information on connection charges?	• Uisce Éireann connection charges can be found at: https://www.water.ie/connections/information/charges/
Who will carry out the connection work?	• All works to Uisce Éireann's network(s), including works in the public space, must be carried out by Uisce Éireann*. *Where a Developer has been granted specific permission and has been issued a connection offer for Self-Lay in the Public Road/Area, they may complete the relevant connection works
Fire flow Requirements	• The Confirmation of Feasibility does not extend to fire flow requirements for the Development. Fire flow requirements are a matter for the Developer to determine. • **What to do?** - Contact the relevant Local Fire Authority
Plan for disposal of storm water	• The Confirmation of Feasibility does not extend to the management or disposal of storm water or ground waters. • **What to do?** - Contact the relevant Local Authority to discuss the management or disposal of proposed storm water or ground water discharges.
Where do I find details of Uisce Éireann's network(s)?	• Requests for maps showing Uisce Éireann's network(s) can be submitted to: datarequests@water.ie

What are the design requirements for the connection(s)?	• The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this Development shall comply with ***the Uisce Éireann Connections and Developer Services Standard Details and Codes of Practice,*** available at www.water.ie/connections
Trade Effluent Licensing	• Any person discharging trade effluent** to a sewer, must have a Trade Effluent Licence issued pursuant to section 16 of the Local Government (Water Pollution) Act, 1977 (as amended). • More information and an application form for a Trade Effluent License can be found at the following link: https://www.water.ie/business/trade-effluent/about/ **trade effluent is defined in the Local Government (Water Pollution) Act, 1977 (as amended)

Section B – Details of Uisce Éireann's Network(s)

The map included below outlines the current Uisce Éireann infrastructure adjacent the Development: To access Uisce Éireann Maps email datarequests@water.ie



Note: The information provided on the included maps as to the position of Uisce Éireann's underground network(s) is provided as a general guide only. The information is based on the best available information provided by each Local Authority in Ireland to Uisce Éireann.

Whilst every care has been taken in respect of the information on Uisce Éireann's network(s), Uisce Éireann assumes no responsibility for and gives no guarantees, undertakings or warranties concerning the accuracy, completeness or up to date nature of the information provided, nor does it accept any liability whatsoever arising from or out of any errors or omissions. This information should not be solely relied upon in the event of excavations or any other works being carried out in the vicinity of Uisce Éireann's underground network(s). The onus is on the parties carrying out excavations or any other works to ensure the exact location of Uisce Éireann's underground network(s) is identified prior to excavations or any other works being carried out. Service connection pipes are not generally shown but their presence should be anticipated.

UISCE ÉIREANN / IRISH WATER

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

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

www.water.ie

Phillip Assaf
1st Floor Maple House
Lower Kilmacud Road
Stillorgan,
Co. Dublin
A94E3F2

19 August 2021

Re: Design Submission for Boherboy Road,, Saggart, Co. Dublin (the "Development") (the "Design Submission") / Connection Reference No: CDS20004359

Dear Phillip Assaf,

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

- [1324B-307 – V2 - Foul drainage layout]
- [1324B-308 – V2 - Foul drainage layout]
- [1324B-309 – V2 - Foul drainage layout]
- [1324B-310 – V2 - Watermain layout]
- [1324B-311 – V2 - Watermain layout]
- [1324B-312 – V2 - Watermain layout]
- [1324B-316 –Sections At Existing Watermains]
- [1324B-321 to 328–Foul Water sections]

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.

Appendix 11.12

Water Demand Calculations

New Network – DOMESTIC Water Demand								
Usage	Quantity	Occupancy	Population	Consumption (l//h/day)	Ave. Daily Domestic Demand (l/day)	Ave. Daily Domestic Demand (l/s)	Ave. Day/Peak Week (l/s)	Peak Hour Water Demand (l/s)
Resi'	611 Units	2.7 No./Unit	1,650	150	247,500	2.87	3.59	**17.94l/s**
Peak Hour Water Demand (Domestic)								**17.94 /s**

Based on Irish Water Code of Practice for Water Infrastructure (Aug'25)
Residential Water Demand Calculations

New Network – COMMERCIAL Water Demand								
Usage	Quantity	Occupancy	Population	Consumption (l//h/day)	Ave. Daily Domestic Demand (l/day)	Ave. Daily(12hr) Domestic Demand (l/s)	Ave. Day/Peak Week (l/s)	Peak Hour Water Demand (l/s)
Possible School Site	1Ha	16 Classes	450	50	22,500	0.52	0.65	3.25
Crèche	630m^2	1child/8m^2 + Staff (20%) + support accommodation	95	50	4750	0.11	0.14	0.69
Peak Hour Water Demand (Commercial)								3.94 l/s

Based on Irish Water Code of Practice for Water Infrastructure (Aug'25)
Commercial Water Demand Calculations

Appendix 11.13

Interception Calculations

PAVED AREAS PER CATCHMENT

BOHERBOY LRD - STAGE 3 Surface Areas Summary Table

Catchment Areas (m^2)												
Catchment	Gross Drained Areas (m^2)						Net Drained Areas (m^2)					
	Roofs via SuDS	Roads/Paths via SuDS	Permeable Paving	Grassland	Rear Garden	TOTAL AREA PER CATCHMENT	Roofs via SuDS (PAF=0.80)	Roads/Paths Via Suds (PAF=0.81)	Permeable Paving (PAF=0.50)	Grassland (PAF=0.25)	Rear Garden (PAV=0.1)	TOTAL AREA PER CATCHMENT
1	2670	3860	1210	2370	1580	11690	2136	3127	605	474	158	6500
2	3440	6580	1080	6390	1790	19280	2752	5330	540	1278	179	10079
3	1880	1760	500	1480	1800	7420	1504	1426	250	296	180	3656
4	7890	9390	3150	5700	0	26130	6312	7606	1575	1140	0	16633
5	12300	15120	4350	10780	5430	47980	9840	12247	2175	2156	543	26961
6	1750	1630	310	1830	0	5520	1400	1320	155	366	0	3241
7	2140	1240	420	1520	0	5320	1712	1004	210	304	0	3230
8	1150	2480	920	4560	0	9110	920	2009	460	912	0	4301
9	520	1330	410	830	480	3570	416	1077	205	166	48	1912
*Potential future school site	School site is not designed as part of this planning application						School site is not designed as part of this planning application					
TOTAL AREA PER SURFACE	33740	43390	12350	35460	11080	136020	26992	35146	6175	7092	1108	76513

BOHERBOY LRD - STAGE 3 - Attenuation Volumes Available

Catchment	AVAILABLE VOLUME IN BASIN(m^3)	AVAILABLE VOLUME IN UPSTREAM SuDS - Excluding Permeable Paving(m^3)	AVAILABLE VOLUME IN UPSTREAM SURCHARGED PIPES & MANHOLES(m^3)	TOTAL AvailableStorage Volume per Catchment (m^3)
1	636.5	91.9	8.2	736.6
2	942	79.2	5.6	1026.8
3	361.5	43.2	5.8	410.5
4	1078	307.6	1.1	1386.7
5	2287	311.3	16.7	2614.9
6	334	32.8	7.1	373.8
7	234	33.4	10.0	277.4
8	240	37.6	12.5	290.1
9	182	14.0	2.3	198.4
			TOTAL	7315.3

BOHERBOY LRD - STAGE 3 Interception Summary

Interception Volumes (m3)		
Catchment	Interception Volume Required (m^3)	Interception Volume Provided (m^3)
1	31	183
2	44	160
3	17	81
4	82	544
5	127	638
6	15	56
7	15	65
8	18	107
9	9	45
*Potential future school site	School site is not designed as part of this planning application	
Totals	358	1877

INTERCEPTION - Catchment 1

Paved Surfaces connected to the drainage system (Ha) = 0.77	Volume of Interception Required (m^3)		31.0	Gross Paved Area x 5% x 0.8	(GDSDS E2.1.1 - Criterion 1)		
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rain Gardens	1	1	1	52	0.6	0.45	14.0
Green Roof	0	0	0	0	0.08	0.4	0.0
Voids of stone below Peremable Paving overflow	0	0	1,210	1	0.25	0.3	90.8
Retention in Detention Basin			485		0.05	1	24.3
Voids of stone below Swale overflow	10	0.75			0.25	0.45	0.8
Bio-Retention			0	0	1	0.4	0.0
Tree Pit			12	11	1	0.4	52.8
			Volume of Interception Provided (m^3) =				182.7
			Volume of Interception Required (m^3) =				31.0
			Interception provided > Required			OK	

INTERCEPTION - Catchment 2

Paved Surfaces connected to the drainage system (Ha) = 1.11	Volume of Interception Required (m^3)		44.4	Gross Paved Area x 5% x 0.8	(GDSDS E2.1.1 - Criterion 1)		
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rain Gardens	1	1	1	51	0.6	0.45	13.8
Green Roof	0	0	0	0	0.08	0.4	0.0
Voids of stone below Peremable Paving overflow	0	0	1080	1	0.25	0.3	81.0
Retention in Detention Basin			728		0.05	1	36.4
Voids of stone below Swale overflow	34	0.75			0.25	0.45	2.9
Bio-Retention			0	1	1	0.4	0.0
Tree Pit			7	7	1	0.4	19.6
Retention in Central Swale	175	0.75	131	1	0.05	1	6.6
			Volume of Interception Provided (m^3) =				160.2
			Volume of Interception Required (m^3) =				44.4
			Interception provided > Required			OK	

INTERCEPTION - Catchment 3

Paved Surfaces connected to the drainage system (Ha) = 0.41	Volume of Interception Required (m^3)		16.6	Gross Paved Area x 5% x 0.8	(GDSDS E2.1.1 - Criterion 1)		
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rain Gardens	1	1	1	36	0.6	0.45	9.7
Green Roof	0	0	0	0	0.08	0.4	0.0
Voids of stone below Peremable Paving overflow	0	0	500	1	0.25	0.3	37.5
Retention in Detention Basin			278		0.05	1	13.9
Voids of stone below Swale overflow	19	0.75			0.25	0.45	1.6
Bio-Retention			0	0	1	0.4	0.0
Tree Pit			45	1	1	0.4	18.0
			Volume of Interception Provided (m^3) =				80.7
			Volume of Interception Required (m^3) =				16.6
			Interception provided > Required			OK	

INTERCEPTION - Catchment 4

Paved Surfaces connected to the drainage system (Ha) =	2.04	Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8	81.7	(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rain Gardens	1	1	1	116	0.6	0.45	31.3
Green Roof	0	0	0	0	0.08	0.4	0.0
Voids of stone below Peremable Paving overflow	0	0	3150	1	0.25	0.3	236.3
Retention in Detention Basin			900		0.05	1	45.0
Retention in Stone below tank			480	1	0.35	0.45	75.6
Voids of stone below Swale overflow	145	0.75			0.25	0.45	12.2
Bio-Retention			285	1	0.6	0.4	68.4
Tree Pit			12.5	15	1	0.4	75.0
			Volume of Interception Provided (m^3) =				**543.8**
			Volume of Interception Required (m^3) =				**81.7**
			Interception provided > Required			**OK**	

INTERCEPTION - Catchment 5

Paved Surfaces connected to the drainage system (Ha) =	3.18	Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8	127.1	(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rain Gardens	1	1	1	151	0.6	0.45	40.8
Green Roof	0	0	500	1	0.2	0.4	40.0
Voids of stone below Peremable Paving overflow	0	0	4350	1	0.25	0.3	326.3
Retention in Detention Basin			2,014		0.05	1	100.7
Voids of stone below Swale overflow	204	1			0.25	0.45	23.0
Bio-Retention			140	1	1	0.4	56.0
Tree Pit			6	19	1	0.4	45.6
Retention in Central Swale	140	0.75	105	1	0.05	1	5.3
			Volume of Interception Provided (m^3) =				**637.5**
			Volume of Interception Required (m^3) =				**127.1**
			Interception provided > Required			**OK**	

INTERCEPTION - Catchment 6

Paved Surfaces connected to the drainage system (Ha) =	0.37	Volume of Interception Required (m^3)		Gross Paved Area x 5% x 0.8	14.8	(GDSDS E2.1.1 - Criterion 1)	
Volume of Interception Provided (m^3)	**Length**	**Width (m)**	**Area (m^2)**	**Quantity**	**Stone Depth (m)**	**Void Ratio**	**Volume (m^3)**
Rain Gardens	1	1	1	0	0.6	0.4	0.0
Green Roof	0	0	950	1	0.08	0.4	9.9
Voids of stone below Peremable Paving overflow	0	0	310	1	0.25	0.3	23.3
Retention in Detention Basin			257		0.05	1	12.9
Voids of stone below Swale overflow	0	0.75		0	0.15	0.4	0.0
Bio-Retention			0	0	1	0.4	0.0
Tree Pit			25	1	1	0.4	10.0
			Volume of Interception Provided (m^3) =				**56.0**
			Volume of Interception Required (m^3) =				**14.8**
			Interception provided > Required			**OK**	

INTERCEPTION - Catchment 7							
Paved Surfaces connected to the drainage system (Ha) = 0.38	Volume of Interception Required (m³)		Gross Paved Area x 5% x 0.8		(GDSDS E2.1.1 - Criterion 1)		
	15.2						
Volume of Interception Provided (m³)	Length	Width (m)	Area (m²)	Quantity	Stone Depth (m)	Void Ratio	Volume (m³)
Rain Gardens	1	1	1	0	0.6	0.4	0.0
Green Roof	0	0	1500	1	0.08	0.4	13.4
Voids of stone below Peremable Paving overflow	0	0	420	1	0.25	0.3	31.5
Retention in Detention Basin			180		0.05	1	9.0
Voids of stone below Swale overflow	0	0.75			0.25	0.45	0.0
Bio-Retention			0	0	1	0.4	0.0
Tree Pit			27.5	1	1	0.4	11.0
			Volume of Interception Provided (m³) =				64.9
			Volume of Interception Required (m³) =				15.2
			Interception provided > Required			OK	

INTERCEPTION - Catchment 8							
Paved Surfaces connected to the drainage system (Ha) = 0.46	Volume of Interception Required (m³)		Gross Paved Area x 5% x 0.8		(GDSDS E2.1.1 - Criterion 1)		
	18.2						
Volume of Interception Provided (m³)	Length	Width (m)	Area (m²)	Quantity	Stone Depth (m)	Void Ratio	Volume (m³)
Rain Gardens	1	1	1	0	0.6	0.4	0.0
Green Roof	0	0	0	0	0.08	0.4	0.0
Voids of stone below Peremable Paving overflow	0	0	920	1	0.25	0.3	69.0
Retention in Detention Basin			240		0.05	1	12.0
Voids of stone below Swale overflow	0	0.75			0.25	0.45	0.0
Bio-Retention			0	0	1	0.4	0.0
Tree Pit			16	4	1	0.4	25.6
			Volume of Interception Provided (m³) =				106.6
			Volume of Interception Required (m³) =				18.2
			Interception provided > Required			OK	

INTERCEPTION - Catchment 9							
Paved Surfaces connected to the drainage system (Ha) = 0.23	Volume of Interception Required (m³)		Gross Paved Area x 5% x 0.8		(GDSDS E2.1.1 - Criterion 1)		
	9.0						
Volume of Interception Provided (m³)	Length	Width (m)	Area (m²)	Quantity	Stone Depth (m)	Void Ratio	Volume (m³)
Rain Gardens	1	1	1	10	0.6	0.4	2.4
Green Roof	0	0	0	0	0.08	0.4	0.0
Voids of stone below Peremable Paving overflow	0	0	410	1	0.25	0.3	30.8
Retention in Detention Basin			140		0.05	1	7.0
Voids of stone below Swale overflow	55	0.75			0.25	0.45	4.6
Bio-Retention			0	0	1	0.4	0.0
Tree Pit			0	0	1	0.4	0.0
			Volume of Interception Provided (m³) =				44.8
			Volume of Interception Required (m³) =				9.0
			Interception provided > Required			OK	