Project

Ashbourne SHD

Report Title

Infrastructure Design Report

Client

Arnub Ltd. & Aspect Homes (ADC) Ltd

INFRASTRUCTURE

DBFL CONSULTING ENGINEERS

Job Title: **Ashbourne SHD**

Job Number: **200059**

Report Title: **Infrastructure Design Report**

Report Reference: **200059-DBFL-CS-SP-RP-C-0001**

Author: **Jack Butler**

Approved by: **Brendan Manning**

Date: **September 2022**

Distribution: **Planning**
Client
Architect
Planning Consultant
File

DBFL Consulting Engineers

Dublin Office
Ormond House
Ormond Quay
Dublin 7

Tel 01 4004000
Email info@dbfl.ie
Web www.dbfl.ie

Waterford Office
Suite 8b, The Atrium,
Maritana Gate, Canada Street,
Waterford. X91W028

Tel 051 309500
Email info@dbfl.ie
Web www.dbfl.ie

Cork Office
14 South Mall
Cork
T12CT91

Tel 021 202 4538
Email info@dbfl.ie
Web www.dbfl.ie

Revision	Issue Date	Description	Prepared	Reviewed	Approved
*	10/12/2021	Draft	JLB	BCM	DJR
P01	15/12/2021	SHD Stage 2 Final	JLB	BCM	DJR
*	23/08/2022	Final Draft SHD Stage 3	JLB	BCM	DJR
P02	02/09/2022	SHD Stage 3 Final	JLB	BCM	DJR

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

1.1 Background

DBFL were commissioned to undertake an infrastructure design report for residential development at Cherry Lane, Ashbourne, Co. Meath. The overall site area of the development including all infrastructure, park etc is approximately 20.04 Ha.

The application also includes associated infrastructure comprising a road layout, streets, footpaths and site services including foul and surface water drainage and watermains in accordance with Meath County Council's Development Plan (2017-2021) and Irish Water's Code of Practice for Water & Wastewater infrastructure (July 2020).

Figure 1.1: Site Plan

1.2 Objectives

This report addresses the development's main infrastructure elements, including the following;

- Surface water strategy and servicing;
- Foul drainage strategy and servicing;
- Water supply and servicing;
- Preliminary flood risk assessment;
- Road layout and site access.

1.3 Location and Topography

1.3.1 Location

The site is located to the south-east of Ashbourne town centre in Co. Meath.

The site is bound primarily by existing agricultural land and residential developments to the north. Cherry Lane and Hickeys Lane provide access points to the proposed development off the Dublin road.

This Masterplan relates to c.20.04 hectares of land at Milltown to the south of Ashbourne, which are identified as Master Plan 1 in the County Development Plan. This document sets out the main organising principles for the site to guide the future development of the lands. Meath County Council propose that these lands shall provide a primary school site, lands for recreational uses, including playing fields, and lands for residential development. The development of the lands shall be on a phased basis to be agreed as part of the preparation of the Master Plan

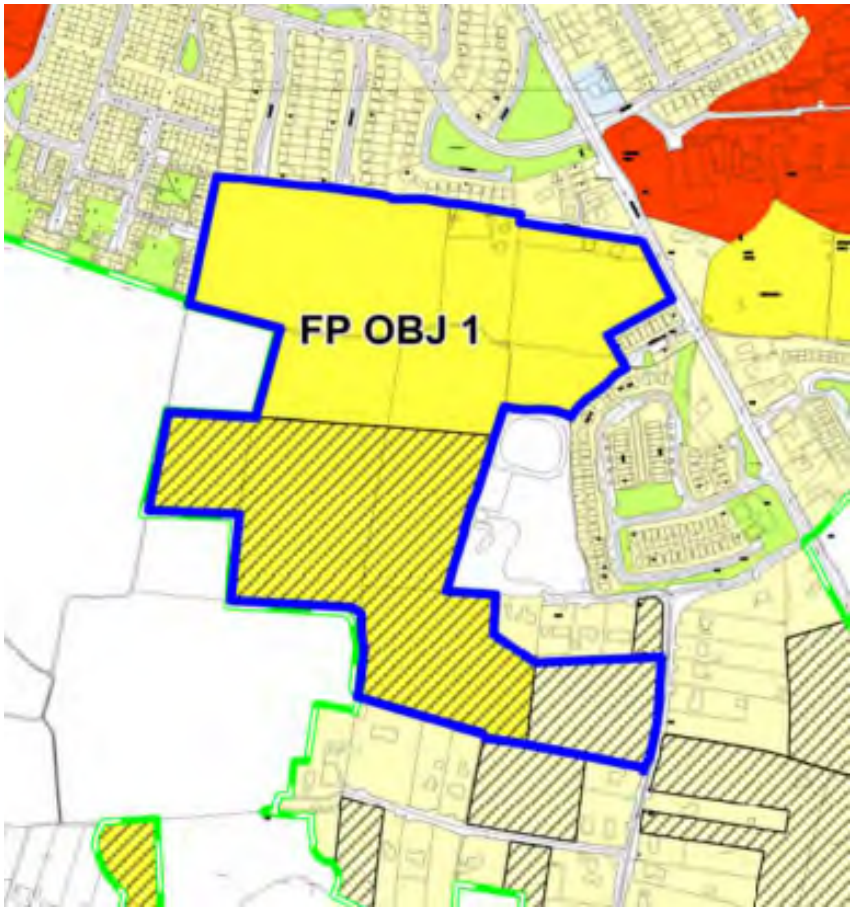


Figure 1.2: Extract from Meath County Development Plan (2013 – 2019) land use zoning map

1.3.2 Topography

A Topographical Survey was undertaken by Land Surveys in July 2012. The site generally slopes from east to west with the exception of an area near the school site which slopes from

west to east. A topographical survey of the site is provided as a background to the road layout drawing 200059-DBFL-RD-SP-DR-C-1200 to 1204.

The existing Fairyhouse stream is located to the south of the subject site which, in turn, discharges to the Broadmeadows River to the west of the proposed development. It is proposed to discharge some of the controlled surface water outflow to this location. See figure 1.3 below for further information.

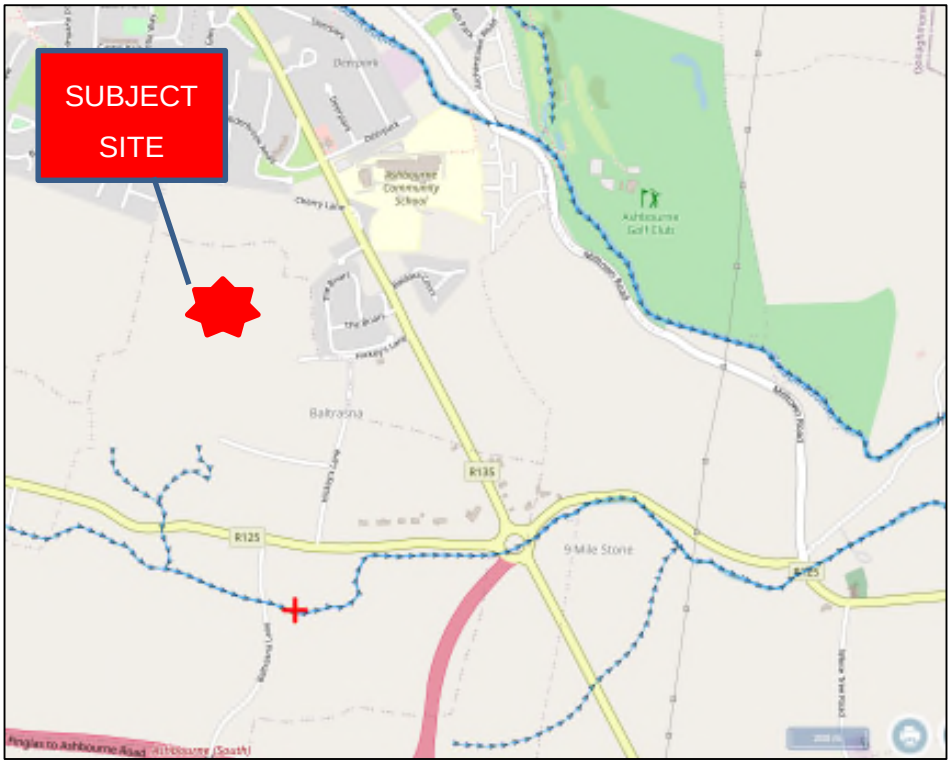


Figure 1.3: Existing Surface Water Systems (EPA)

1.4 Proposed development

Arnub Ltd. & Aspect Homes (ADC) Ltd. seek permission for a strategic housing development, located in the townlands of Baltrasna and Milltown, Ashbourne, Co. Meath. The proposed development site is located to the west of the R135 Dublin Road, south of existing housing at Alderbrook Rise, Alderbrook Downs & Alderbrook Heath, east of existing housing at Tara Close & Tara Court, south of Cherry Lane and west of Hickey's Lane.

The development will consist of 702 no. dwellings, comprised of 420 no. 2 & 3 storey, 2, 3, 4 & 5 bed houses, 39 no. 2 & 3 bed duplex units in 19 no. blocks, and 243 no. 1, 2 & 3 bed apartments in 20 no. buildings, which range in height from 3, 3-4, 4-5, & 4-6 storeys. The proposed development also provides for the following uses: (i) 2 no. creches (c.278m² & 331m²) accommodated in Blocks A and A1 respectively, (ii) 4 no. retail/commercial units (c.53m² & c.102m² in Block A, c.268m² in Block A1 & c.469m² in Block B1), (iii) 1 no. café (c. 174m²) in Block A & (iv) GP practice / medical use unit (c.186m²) in Block A1.

Access to the development will by via (i) Cherry Lane to the north-east, off the R135 Dublin Road, via a new proposed internal access road and (ii) via Hickey's Lane to the east, off the R135 Dublin Road, including pedestrian and cycle paths.

The proposed development provides for (i) all ancillary / associated site development works above and below ground, (ii) public open spaces, including hard & soft landscaping, play equipment & boundary treatments, (iii) communal open spaces, (iv) undercroft, basement & surface car parking (v) bicycle parking (vi) bin storage, (vii) public lighting, (viii) plant (M&E), utility services & ESB sub-stations, all on an overall application site area of 20.04Ha.

The proposed development also includes for an area of c. 1Ha reserved for a school site and playing pitch in the western part of the site. Permission is also sought to demolish all existing structures on site, i.e. 3 no. single storey dwellings & associated out-buildings (659m² in total). The proposed development includes all ancillary / associated site development works, hard & soft landscaping, boundary treatments, public lighting, car and bicycle parking, pedestrian and cyclist connections, bin storage areas, etc..

1.5 Flood Risk

A separate Site Specific Flood Risk Assessment has been prepared as part of the application. Refer to DBFL report 200059-DBFL-CS-SP-RP-C-0002 for further information.

1.6 Existing Ground Conditions

A site investigation was undertaken by IGSL on the 25th of July 2022 within the proposed development. At the time of writing preliminary results have been received from IGSL and have been factored into design calculations. Trial pits varied in depth from 2.2m to 3.1m with ground conditions varying from "*Soft to firm brown to black silty sandy gravelly CLAY*" to "*Brown clayey sandy cobbly bouldery GRAVEL*". Soakaway tests were conducted at each trial pit with infiltrations rates ranging from 0.0076m/min to 0.000089m/min and it is noted that no infiltration rate was recorded at SA06 as the water level rose during the test. Please refer to Appendix F for all preliminary results received from IGSL.

2.0 ACCESS AND ROADS

2.1 Overall Road and Access Layout

The subject site will be accessed from the existing Hickeys Lane and Cherry Lane in two locations. Refer to DBFL drawings 200059-DBFL-RD-SP-DR-C-1200 to 1204 for locations of same. Raised tables at these junctions provide a suitable transition from the existing constructed roads to the proposed DMURS local streets.

It is proposed to construct a new link road, extending west from the Dublin Road, and providing access to the school and future developments to the west of the subject site, and consisting of a 6m wide single carriageway plus on either side of the carriageway 2m wide footpath, 1.75m wide cycle track and 1.5m wide verge.

The proposed 4m wide green link weaves through the site from East to West, connecting the Dublin Road with the main green spine, local centre, school, playing pitches and into the adjoining lands to the west.

Pedestrian linkages will be provided to connect existing and new developments with the existing and future residential and open space areas.

Upgrade works will be carried out on the existing Dublin Road / Cherry Lane junction to provide a DMURS compliant junction to the northeast corner of the site.

The development's internal layout has been designed with speed reduction bends and landscape buildouts to provide traffic calming together with a combination of road vertical and horizontal geometry and forward sight visibility to reduce speeds. *Design speed at the link road*

2.2 Road Layout Design

The proposed development's road layout and hierarchy is shown on drawings 200059-DBFL-RD-SP-DR-C-1200 to 1204. The road layout is designed in accordance with the recommendations of the Design Manual for Urban Roads and Streets (DMURS), as outlined in the DMURS Compliance Statement submitted as part of the TTA.

The standard road cross-sections and construction details are shown on drawings 200059-DBFL-RD-SP-DR-C-5201 to 5202 and comprise the following;

- Link street – 6.0m wide carriageway, with 2.0m wide footpath and 2.0m wide cycletrack on both sides of the street.
- Internal Local Streets – 5.0 to 5.5m wide carriageway, with 2.0m wide footpath on one / both sides of the street and perpendicular / parallel parking spaces.
- Shared Area / Homezones – 4.8m wide carriageway, with1.2 (or 1.5m) wide flush footpath on one side of the street and perpendicular / parallel parking spaces.

2.3 Pavement Design Standards

Local streets within the site are designed in accordance with the Department of the Environment Recommendations for Site Development Works, the Design Manual for Urban Roads and Streets (DMURS) and Local Authority requirements.

2.4 Traffic & Transportation

A Traffic & Transport Assessment (TTA) report prepared by DBFL Consulting Engineers is included in the overall planning application pack.

2.5 Vehicle Tracking

The proposed street layout has been tracked to demonstrate that the site's proposed corner radii and turning heads will accommodate large vehicles such as refuse trucks, fire engines and delivery vans. Refer to DBFL drawings No. 200059-DBFL-RD-SP-DR-C-1200 to 1204 for locations of same.

3.0 SURFACE WATER DRAINAGE

3.1 Existing Surface Water Arrangement

The existing site is predominantly greenfield and the topography of the site generally falls from the north-east corner towards the west corner. A topographical Survey was undertaken by Land Surveys in July 2012 and has been incorporated into DBFL Drawings 200059-DBFL-CS-SP-DR-C-1300 to 1304. It is noted that there are a number of drainage ditches located on the site's boundary. These discharge to the existing Fairyhouse stream to the south. There is an existing 375mm surface water line located opposite Cherry Lane on the Dublin Road.

3.2 Surface Water Drainage Strategy

3.2.1 General

Surface water runoff from the development will be limited to greenfield runoff rates (Q_{bar}) in accordance with the Greater Dublin Strategic Drainage Study (GDSDS).

Storms up to the 30-year critical storm with an additional 20% allowance for climate change will be stored underground in attenuation systems such as Stormtech or similar approved. Storms up to the 100 year critical storm with an additional 20% allowance for climate change will be stored above ground in detention/infiltration basins. Typical construction details are shown on drawings 200059-DBFL-CS-SP-DR-C-5301 to 5303.

Refer to DBFL Drawing No. 200059-DBFL-CS-SP-DR-C-1300 to 1304 for proposed surface water outfall locations.

Surface water discharge rates from the proposed surface water drainage network will be controlled by a vortex flow control device (Hydrobrake or equivalent) and associated underground geo-cellular attenuation systems (Stormtech or approved equivalent). Surface water discharge will also pass via a Class 1 separator (sized in accordance with permitted discharge from the site).

The proposed surface water drainage network will collect surface water runoff from the site via a piped network prior to discharging off site via the attenuation tank, flow control device and separator arrangement as noted above.

Surface water runoff from the site's road network and roofs will be directed to the proposed pipe network via conventional road gullies while surface water runoff from driveways will be captured by permeable paving.

3.2.2 Compliance with Surface Water Policy

Surface water management for the proposed development is designed to comply with the Greater Dublin Strategic Drainage Study (GDSDS) policies and guidelines and the requirements of Wicklow County Council. The guidelines require the following four main criteria to be provided by the development's surface water design;

- Criterion 1: River Water Quality Protection – satisfied by providing interception storage using permeable paving in car parking spaces, treatment of run-off within the SUDS features e.g. permeable paving for parking bays and within the attenuation storage system, infiltration/detention basins, tree pits, rain gardens swales and oil separators on the main surface water outfalls from the development.
- Criterion 2: River Regime Protection – satisfied by attenuating run-off with flow control devices prior to discharge to the outfall.
- Criterion 3: Level of Service (flooding) for the site – satisfied by the Site being outside the 1000 year coastal and fluvial flood zones, (See Flood Risk Assessment). Pluvial flood risk addressed by development designed to accommodate a 100-year storm as per GDSDS. Planned flood routing for storms greater than 100-year level, considered in design, the development has been designed to provide an overland flood route from the development towards the surface water outfall.
- Criterion 4: River flood protection – attenuation and long-term storage provided within the SUDS features e.g. permeable paving construction, swales, tree pits, rain gardens and attenuation facilities.

3.2.3 Ground Investigation

A site investigation was undertaken by IGSL on the 25th of July 2022 within the proposed development. At the time of writing preliminary results have been received from IGSL and have been factored into design calculations. Trial pits varied in depth from 2.2m to 3.1m with ground conditions varying from "*Soft to firm brown to black silty sandy gravelly CLAY*" to "*Brown clayey sandy cobbly bouldery GRAVEL*". Soakaway tests were conducted at each trial pit with infiltrations rates ranging from 0.0076m/min to 0.000089m/min and it is noted that no infiltration rate was recorded at SA06 as the water level rose during the test. Please refer to Appendix G for all preliminary results received from IGSL.

3.3 Sustainable Drainage Systems (SuDS)

In accordance with the GDSDS it is proposed to use Sustainable Urban Drainage systems (SUDS) for managing storm-water for the proposed development. The aim of the SUDS strategy for the site will be to;

- Attenuate storm-water runoff.
- Reduce storm-water runoff.
- Reduce pollution impact.
- Replicate the natural characteristics of rainfall runoff for the site.
- Recharge the groundwater profile

The proposed layout of the drainage and SUDS is detailed on drawings 200059-DBFL-CS-SP-DR-C-1300 to 1304.

An assessment of the potential SuDS that could be incorporated within the site was conducted using the SuDS Manual, CIRIA 753. The SuDS elements which were found applicable to the proposed scheme design and layout include the following:

1- Permeable Paving for driveways and for on-street parking under the control of the management company of the apartment blocks;
2- Swales providing additional storage at source and also providing additional treatment of run off.
3- Pedestrian/green links to drain to surrounding landscape for reduction and treatment of run-off; permeable paving, swales, infiltration basins, tree pits, rain gardens and petrol interceptors.
4- Underground storage in the form of 'Stormtech' units or similar approved systems to store runoff from a 1 in 30-year event. The storage systems will be designed to maximise water quality.
5- Attenuation storage systems provided using on-line infiltration/detention basins to store run off from a 1 in 100 year event. This will promote infiltration to ground and to improve water quality.
6- A petrol interceptor to be provided before the outfall from each catchment of the Subject Site.
7- Hydrobrake flow control will be used.

The incorporation of the above SuDS elements will provide a sustainable manner in which to disperse surface water from the site, encourage groundwater recharge and provide treatment of run-off and subsequent improvement of discharge quality.

The proposed surface water drainage layout for the scheme is detailed in DBFL drawing no. 200059-DBFL-CS-SP-DR-C-1300.

3.4 Surface Attenuation Storage

Surface water runoff from the overall development lands will be attenuated to greenfield runoff (Qbar). This is calculated as 77.70 l/s using the *Institute of Hydrology* equation, as recommended in the Greater Dublin Strategic Drainage Study (GDSDS) based on an area of 20.04 Ha.

Refer to Appendix A for surface water allowable outflow details calculations.

Soil Type 3 has been used to calculate Qbar and the attenuation storage. The Soil value was selected using Table 4.5 of the Flood Studies report – The Classification of Soils from Winter Rainfall Acceptance with the following criteria:

Property	Classes
A- Drainage Group	3- Commonly waterlogged within 60 cm during winter
B- Depth to “impermeable” layers	2- >80 cm
C- Permeability group	2- Medium
D- Slope	2- 2-8

Table 3.1 Summary of Site Characteristics

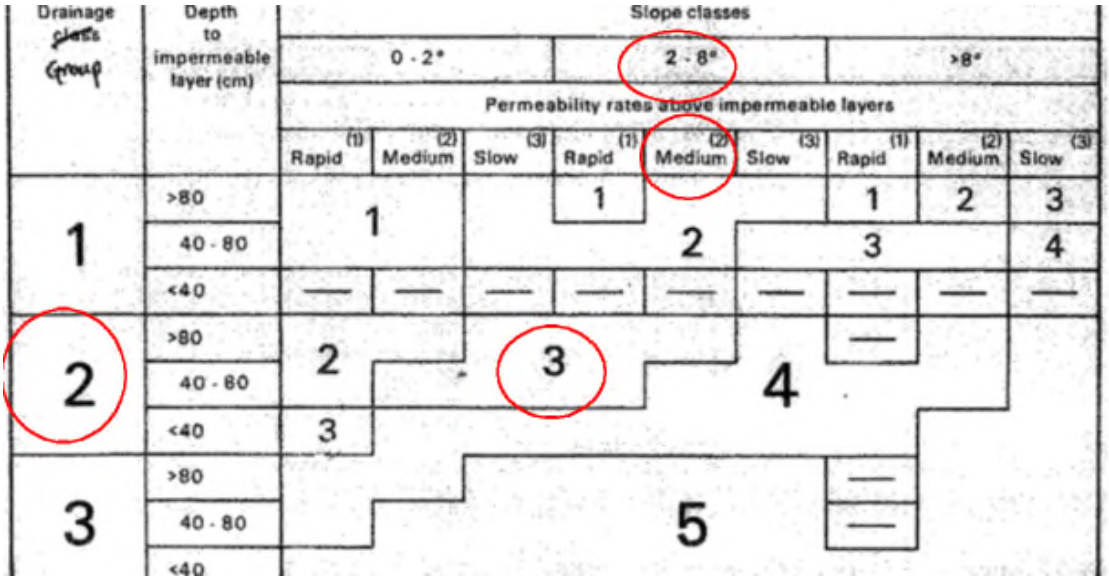


Table 3.2 The classification of soils by winter rain acceptance rate from soil survey data

Surface water run-off from each surface water catchment (*Figure 3.2*) will be attenuated using a vortex flow control device (Hydrobrake or equivalent) on the surface water outlet from each catchment.

The resultant design attenuation volumes, discharge limits, types of storage and storage volumes for each catchment are summarised in Table 3.1 (See Appendix B for attenuation calculations).

Catchment	Storage System Type	Calculated Allowable Outflow (l/s)	Storage Volume Required (m3) (30 years)	Storage Volume Required (m3) (100 years)
A	Stormtech MC3500	12.00	-	675
B	Stormtech SC740 & Detention Basin	16.55	435	138
C	Stormtech SC740	7.00	260	
D	Stormtech SC740 & Detention Basin	10.30	365	75
E	Stormtech MC3500 & Detention Basin	21.18	477	120
F	Stormtech SC740 & Detention Basin	10.67	310	75
Total	-	77.70	2930	

Table 3.3 – Surface Water Attenuation Storage and Discharge Limits

Attenuation volumes have been designed using MicroDrainage Windes analysis software taking account of design invert levels, ground levels and depth and type of system. In total approximately 2930 m^3 of storm-water storage is provided within the attenuation facilities for the subject site. Calculations for same are included in Appendix B.

Surface water storage volumes to accommodate a 100 year storm include for climate change, refer to Appendix B for attenuation calculations.

3.5 Interception Volume

To prevent pollutants or sediments discharging into water courses the GDSDS requires “interception storage” to be incorporated into the development. This interception storage is designed to receive the run-off for rainfall depths of 5mm up to 10mm if possible. The SUDS features including permeable parking bays, tree pits, rain gardens, infiltration basins and “open bottom” attenuation facilities will provide the necessary interception volume required by the GDSDS.

3.6 Surface Water Drainage Design Standards

Proposed surface water drainage is designed in accordance with the recommendations of Greater Dublin Strategic Drainage Strategy (GDSDS), EN752 and BS8301:1985.

Surface water pipe-work was sized using the Microdrainage Windes drainage modelling software. The following parameters apply to the design:

- Return period for pipe network 5 years,
    - check 30-year 15 minute, no flooding;
    - check 100-year flooding in designated areas;
- Time of entry 5 minutes
- Discharge Limit 41.73 l/s @ 100 years for subject site
- Pipe Friction (Ks) 0.6 mm
- Minimum Velocity 1.0 m/s
- Standard Average Annual Rainfall 791 (Met Eireann)
- M5-60 14.7mm (Met Eireann)
- Ratio r (M5-60/M5-2D) 0.269 (Met Eireann)
- Storage System Storm Return Event GDSDS Volume 2, p61, Criterion 3
    - 30-year no flooding on site;
    - 100-year check no internal property flooding. Flood routing plan. FFL freeboard above 100-year flood level. No flooding to adjacent areas.
- Climate Change 20% for rainfall intensities.
- Factor of Safety for infiltration 2.0
- Runoff from Roads and Footpaths 100%
- Runoff from roofs 95%
- Runoff from permeable parking bays and driveways 50%

Standard drainage details, as outlined on DBFL drawings 200059-DBFL-CS-SP-DR-C-5001 to 5003, are in accordance with the Greater Dublin Regional Code of Practice for Drainage Works.

The surface water drainage network including the surface water storage system has been designed and simulated for a range of storm events (including 1 in 2, 1 in 10, 1 in 30 and 1 in 100-year storm events) using the *Network* module of *Microdrainage*. This is based on the Modified Rational Method. The surface water drainage network is designed in accordance with IS EN 752, BS8301:1985 and the recommendations of the 'Greater Dublin Strategic Drainage Study', (GDSDS).

The minimum pipe diameter for public surface water sewers is 225mm. Private drains within the proposed development will be 100mm diameter and collector drains will be 150mm diameter.

Refer to DBFL drawing number 200059-DBFL-CS-SP-DR-C-1300 for the proposed surface water layout plan.

Surface water sewer modelling results for the main drainage networks are included in Appendix C.

3.7 Climate Change

Surface water calculations made for the development use rainfall values for Blessington Demesne, provided by Met Eireann. Rainfall intensities were increased by a factor of 20% to take account of climate change, as required by the GDSDS for surface water drainage design included surface water storage design.

3.8 Flood Risk

The surface water network, attenuation storage and site levels are designed to accommodate a 100-year return period storm event and includes climate change provision. Floor levels of houses are set above the 100-year flood levels by a minimum of 0.5m for protection. All footpaths are falling away from houses. For storms events, exceeding a 100-year return period, the development has been designed to provide overland flood routes along the various development roads towards green areas, where possible.

Refer to the 'Site Specific flood Risk Assessment' (SSFRA) by DBFL Consulting Engineers, which is included as a separate report.

3.9 Surface Water Quality Impact

Run-off rates from the site are controlled by vortex flow control devices. Surface water management proposals for the development also incorporate the following to reduce its impact;

- Designed in accordance with GDSDS requirements;
- Incorporates SUDS features e.g. permeable paving for driveways, tree pits, rain gardens, infiltration basins and for on-street parking under the control of the apartment blocks management company, swales.
- On-line attenuation/infiltration facilities with an oil separator prior to discharge to a public surface water sewer.

4.0 FOUL DRAINAGE

4.1 Existing Foul Drainage

The subject site has no existing foul loading as it a greenfield site. According to the records, there is an existing 225/300mm foul sewer which is located immediately to the west of the subject site in the Dublin Road. Proposed foul loading calculations for the development are detailed in Table 4.1 below:

Development	No. of Units	Total site Occupancy	Discharge per person per day	Peak Discharge (l/s)	Average Discharge (l/s)
	702	1895	150	21.719	3.620

Table 4.1 – Proposed Developments Foul Loading

4.2 Design Strategy

Due to the site topography and proposed site layout, the subject site has been divided in two areas for the purposes of foul drainage management. The northern half of the site will discharge via gravity to the existing Ashbourne WWPS located to the north of the proposed development. The units in the southern portion of the site will discharge to an existing foul sewer located in the Briars residential development which ultimately discharges to the Miltown WWPS located to the east of the proposed development. These pumps stations ultimately discharge to the existing waste water treatment plant located in Ringsend, Co. Dublin. According to correspondence received from Irish Water there are upgrade works planned for the Ashbourne WWTP in the future but there are capacity issues with the treatment plant at present. Refer to DBFL drawing 200059-DBFL-CS-SP-DR-C-1300 to 1304 for locations of proposed discharge points. All connections are to be agreed with Irish Water prior to commencement.

Individual houses will connect to the 150/225mm diameter foul drains via individual 100mm diameter house connections, as per Irish Water Code of Practice for Wastewater Infrastructure. 100mm individual connections from apartments will be provided with the 150mm diameter drainage being provided around extent of apartments.

4.3 Design Calculations

Foul sewers have been designed in accordance with the principles and methods set out in the Irish Water Code of Practice and Standard Details.

The following criteria have been applied:

Demand	150 l/head/day
Discharge units	14 units per house (as per BS8301)

Pipe Friction (Ks)	1.5 mm
Minimum Velocity	0.75 m/s (self-cleansing velocity)
Maximum Velocity	2.50 m/s
Frequency Factor	0.5 for domestic use
Manhole Depths	< 5.0m

Foul sewer design calculations from Windes are provided in Appendix D.

All foul sewers and manholes will be constructed in accordance with the Irish Water Standard Details and the Irish Water Code of Practice for Wastewater.

4.4 Compliance with Irish Water Standards

The proposed foul sewer design and layout is in accordance with the Irish Water Code of Practice for Wastewater Infrastructure and The Irish Water Wastewater Infrastructure Standard Details. A confirmation of feasibility was received from Irish Water and is attached in Appendix E. A statement of design acceptance was received from Irish Water and is attached in Appendix F.

5.0 WATER SUPPLY AND DISTRIBUTION

5.1 Existing Water supply

There is an existing 50mm diameter water main located within Hickeys Lane and an existing 75mm watermain located in Cherry Lane. A 315mm trunk watermain is noted within the Dublin Road.

5.2 Development Water Main Layout

It is proposed to connect the proposed new watermain system to the existing 315mm trunk watermain to the east of the subject site in Dublin Road.

A 160/180mm diameter looped PE watermain will be provided along the site's main roads, while 110/125mm diameters PE looped branch pipes will be provided along the "cul-de-sac" streets. The connection to the public water main will include meter and sluice valves in accordance with the Irish Water's requirements.

Individual houses will have their own connections (25mm O.D. PE pipe) to distribution water mains via service connections and meter / boundary boxes.

The development's proposed water-main distribution system is indicated on drawing 200059-DBFL-WM-SP-DR-C-1300 to 1304.

5.3 Compliance with Irish Water Standards

The proposed watermain design and layout is in accordance with the Irish Water Code of Practice for Water Infrastructure and The Irish Water, Water Infrastructure Standard Details. A confirmation of feasibility was received from Irish Water and is attached in Appendix E. A statement of design acceptance was received from Irish Water and is attached in Appendix F.

5.4 Water Demand & Conservation

The estimated water demand for the proposed development is detailed below in table 5.1. Each house will provide 24 hours of cold-water storage in the header tank and houses will utilise water saving features for the fittings to reduce water demand.

Development	No. of Units	Total site occupancy	Discharge per person per day	Peak Demand (l/s)	Average Demand (l/s)
	702	1895	150	20.566	3.291

Table 5.1 – Proposed Developments Water Demand

Appendix A

SURFACE WATER ALLOWABLE OUTFLOW

PROJECT			JOB REF.
Site at cherry lane, Ashbourne			p200059
SUBJECT			**Calc. Sheet No.**
Surface Water Calculations Allowable Outflow			1
Drawing ref.	**Calculations by**	**Checked by**	**Date**
200059-DBFL-CS-S	COL	NCG	/2021

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the overall site area? **19.79** Hectares (ha) Site is Less than 50 Hectares

Pre-Development Catchment Soil Characteristics

Are there different soil types present on the pre-developed site? No

Catchment (This refers to the entire site area)	1	
Area	19.79	Hectares (ha)
Drainage Group	3	Class
Depth to Impermeable Layers	3	Class
Permeability Group above Impermeable Layers	3	Class
Slope [(6)]	3	Class
SOIL Type	3	From FSR Table
[1]SOIL Index	0.40	

SOIL	SOIL Value	SPR
1	0.15	0.10
2	0.30	0.30
3	0.40	0.37
4	0.45	0.47
5	0.50	0.53

Site SOIL Index Value **0.40**

Site SPR Value **0.37**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? Yes

How many sub-catchments? 4

Catchment A

What is the overall site area for Catchment A 3.42 Hectares (ha)

Catchment A	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)		1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	7143.0	0.80	5714.4
Green Roofs		0.80	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	3907.0	1.00	3907.0
Roads and Footpaths - Type 2 (Draining to Suds features)	4363.0	0.80	3490.4
Paved Areas		1.00	0.0
Permeable Paving	1575.0	0.75	1181.3
Bioretention Areas	0.0	1.00	0.0
Grassed Areas (Open)	2100.0	0.15	315.0
Grassed Areas (Enclosed)	15112.0	0.00	0.0

Include Public Open Space in Effective Catchment Area A? No

Catchment A - Effective Catchment Area **14608.1** m^2

Catchment A - Effective Catchment Runoff Coefficient **0.43**

Catchment B

What is the overall site area for Catchment B 3.99 Hectares (ha)

Catchment B	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)		1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	8050.0	0.80	6440.0
Green Roofs		0.50	0.0
Roads and Footpaths - Type 1 (Draining to gullies)		1.00	0.0
Roads and Footpaths - Type 2 (Draining to Suds features)	7034.0	0.80	5627.2
Paved Areas		1.00	0.0
Permeable Paving	2510.0	0.75	1882.5
Bioretention Areas		1.00	0.0
Grassed Areas (Open)	500.0	0.15	75.0
Grassed Areas (Enclosed)	21806.0	0.00	0.0
Public Open Space		0.30	0.0

Include Public Open Space in Effective Catchment Area B? No

Catchment B - Effective Catchment Area **14024.7** m^2

Catchment B - Effective Catchment Runoff Coefficient **0.35**

Catchment C

What is the overall site area for Catchment C | 2.04 | Hectares (ha)

Catchment C	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)		1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	3784.0	0.80	3027.2
Green Roofs		0.50	0.0
Roads and Footpaths - Type 1 (Draining to gullies)		1.00	0.0
Roads and Footpaths - Type 2 (Draining to Suds features)	3110.0	0.80	2488.0
Paved Areas		1.00	0.0
Permeable Paving	1850.0	0.75	1387.5
Bioretention Areas		1.00	0.0
Grassed Areas (Open)	1395.0	0.15	209.3
Grassed Areas (Enclosed)	9901.0	0.00	0.0
Public Open Space		0.30	0.0

Include Public Open Space in Effective Catchment Area C? | No

Catchment C - Effective Catchment Area | **7112.0** | m^2

Catchment C - Effective Catchment Runoff Coefficient | **0.35**

Catchment D

What is the overall site area for Catchment D? | 2.49 | Hectares (ha)

Catchment D	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)		1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	5317.0	0.80	4253.6
Green Roofs		0.75	0.0
Roads and Footpaths - Type 1 (Draining to gullies)		1.00	0.0
Roads and Footpaths - Type 2 (Draining to Suds features)	6023.0	0.80	4818.4
Paved Areas		1.00	0.0
Permeable Paving	2324.0	0.75	1743.0
Bioretention Areas		1.00	0.0
Grassed Areas (Open)	1765.0	0.15	264.8
Grassed Areas (Enclosed)	9471.0	0.00	0.0
Public Open Space		0.30	0.0

Include Public Open Space in Effective Catchment Area 1B? | No

Catchment D - Effective Catchment Area | **11079.8** | m^2

Catchment D - Effective Catchment Runoff Coefficient | **0.44**

Catchment E

What is the overall site area for Catchment C | 4.63 | Hectares (ha)

Catchment C	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)		1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	7601.0	0.80	6080.8
Green Roofs		0.50	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	1179.0	1.00	1179.0
Roads and Footpaths - Type 2 (Draining to Suds features)	10919.0	0.80	8735.2
Paved Areas		1.00	0.0
Permeable Paving	3267.0	0.75	2450.3
Bioretention Areas		1.00	0.0
Grassed Areas (Open)	1160.0	0.15	174.0
Grassed Areas (Enclosed)	22174.0	0.00	0.0
Public Open Space		0.30	0.0

Include Public Open Space in Effective Catchment Area C?	No	
Catchment C - Effective Catchment Area	**18619.3**	m^2
Catchment C - Effective Catchment Runoff Coefficient	**0.40**	

Catchment F

What is the overall site area for Catchment C — 2.20 Hectares (ha)

Catchment C	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)		1.00	0.0
Roofs - Type 2 (Draining to SUDS features)	3255.0	0.80	2604.0
Green Roofs		0.50	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	1180.0	1.00	1180.0
Roads and Footpaths - Type 2 (Draining to Suds features)	6231.0	0.80	4984.8
Paved Areas		1.00	0.0
Permeable Paving	2203.0	0.75	1652.3
Bioretention Areas		1.00	0.0
Grassed Areas (Open)	1000.0	0.15	150.0
Grassed Areas (Enclosed)	8131.0	0.00	0.0
Public Open Space		0.30	0.0

Include Public Open Space in Effective Catchment Area C?	No	
Catchment C - Effective Catchment Area	**10571.1**	m^2
Catchment C - Effective Catchment Runoff Coefficient	**0.48**	

Catchment xx (Future school Site)

What is the overall site area for Catchment 2B? — 1.02 Hectares (ha)

Catchment 2B will be attenuated within its own Catchment

What is the Standard Average Annual Rainfall (SAAR)?	791.0	mm	From Met Eireann, Co-ordinates 306000, 251000
Is the overall site area less than 50 hectares?	Yes		
[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site	77.70	Litres/sec	
[7]Site Discharge - 1 year Return Period	**66.0**	Litres/sec	
[7]Site Discharge - 30 year Return Period	**163.2**	Litres/sec	
[7]Site Discharge - 100 year Return Period	**202.0**	Litres/sec	
[7]Site Discharge =	**77.70**	Litres/sec	

Outflow for Each Sub-Catchment

Sub - Catchment	Area (m^2)	Calculated Allowable Outflow (l/s)
A	34286	13.46
B	39881	15.66
C	20432	8.02
D	24933	9.79
E	46315	18.18
F	21972	8.63
xx	10204	4.01
	0	0.00
		77.75

Notes and Formulae

1. SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5).

2. SPR value calculated from GDSDS - Table 6.7.

3. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change.

4. Long-term storage Vol_{xs} (m^3) = Rainfall.Area.10.[(PIMP/100)(0.8.α)+(1-PIMP/100)(β.SPR)-SPR]. (GDSDS Section 6.7.3).

   Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$.

5. Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies

   (Volume 2 - Chapter 6), i.e. $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas samller than 50hectares.

6. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible.

7. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2.

Appendix B

ATTENUATION CALCULATIONS

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

Half Drain Time : 369 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	67.706	0.606	4.1	12.0	16.1	244.5	O K
30 min Summer	67.933	0.833	4.1	12.0	16.1	336.3	O K
60 min Summer	68.165	1.065	4.1	12.0	16.1	430.2	O K
120 min Summer	68.368	1.268	4.1	12.0	16.1	511.8	O K
180 min Summer	68.458	1.358	4.1	12.0	16.1	548.5	O K
240 min Summer	68.500	1.400	4.1	12.0	16.1	565.1	O K
360 min Summer	68.519	1.419	4.1	12.0	16.1	573.1	O K
480 min Summer	68.517	1.417	4.1	12.0	16.1	572.0	O K
600 min Summer	68.506	1.406	4.1	12.0	16.1	567.8	O K
720 min Summer	68.492	1.392	4.1	12.0	16.1	562.2	O K
960 min Summer	68.457	1.357	4.1	12.0	16.1	548.1	O K
1440 min Summer	68.368	1.268	4.1	12.0	16.1	512.0	O K
2160 min Summer	68.211	1.111	4.1	12.0	16.1	448.7	O K
2880 min Summer	68.019	0.919	4.1	12.0	16.1	371.2	O K
4320 min Summer	67.692	0.592	4.1	12.0	16.1	238.9	O K
5760 min Summer	67.471	0.371	4.1	12.0	16.1	149.8	O K
7200 min Summer	67.331	0.231	4.1	11.5	15.6	93.2	O K
8640 min Summer	67.244	0.144	4.1	10.8	15.0	58.0	O K
10080 min Summer	67.191	0.091	4.1	10.2	14.3	36.6	O K
15 min Winter	67.783	0.683	4.1	12.0	16.1	275.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	75.731	0.0	261.7	22
30 min Summer	52.870	0.0	365.5	37
60 min Summer	34.911	0.0	482.9	66
120 min Summer	22.206	0.0	613.9	126
180 min Summer	16.903	0.0	701.5	184
240 min Summer	13.882	0.0	768.1	242
360 min Summer	10.500	0.0	871.1	326
480 min Summer	8.597	0.0	951.3	388
600 min Summer	7.357	0.0	1017.3	454
720 min Summer	6.476	0.0	1074.7	522
960 min Summer	5.292	0.0	1171.1	660
1440 min Summer	3.979	0.0	1320.5	942
2160 min Summer	2.991	0.0	1488.8	1360
2880 min Summer	2.442	0.0	1620.8	1736
4320 min Summer	1.831	0.0	1823.4	2464
5760 min Summer	1.492	0.0	1980.6	3120
7200 min Summer	1.272	0.0	2110.8	3816
8640 min Summer	1.116	0.0	2223.2	4496
10080 min Summer	1.000	0.0	2322.6	5144
15 min Winter	75.731	0.0	293.1	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	68.043	0.943	4.1	12.0	16.1	380.8	O K
60 min Winter	68.310	1.210	4.1	12.0	16.1	488.5	O K
120 min Winter	68.551	1.451	4.1	12.0	16.1	585.8	O K
180 min Winter	68.667	1.567	4.1	12.0	16.1	632.9	O K
240 min Winter	68.728	1.628	4.1	12.0	16.1	657.1	O K
360 min Winter	68.770	1.670	4.1	12.0	16.1	674.3	O K
480 min Winter	68.760	1.660	4.1	12.0	16.1	670.2	O K
600 min Winter	68.743	1.643	4.1	12.0	16.1	663.2	O K
720 min Winter	68.720	1.620	4.1	12.0	16.1	654.1	O K
960 min Winter	68.660	1.560	4.1	12.0	16.1	629.7	O K
1440 min Winter	68.507	1.407	4.1	12.0	16.1	568.2	O K
2160 min Winter	68.246	1.146	4.1	12.0	16.1	462.6	O K
2880 min Winter	67.922	0.822	4.1	12.0	16.1	331.8	O K
4320 min Winter	67.473	0.373	4.1	12.0	16.1	150.5	O K
5760 min Winter	67.254	0.154	4.1	11.0	15.1	62.3	O K
7200 min Winter	67.166	0.066	4.1	9.6	13.7	26.5	O K
8640 min Winter	67.145	0.045	3.7	8.4	12.1	18.2	O K
10080 min Winter	67.137	0.037	3.0	7.9	10.9	14.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	52.870	0.0	409.1	37
60 min Winter	34.911	0.0	540.7	66
120 min Winter	22.206	0.0	688.1	124
180 min Winter	16.903	0.0	785.3	180
240 min Winter	13.882	0.0	860.0	236
360 min Winter	10.500	0.0	975.9	346
480 min Winter	8.597	0.0	1065.0	442
600 min Winter	7.357	0.0	1139.6	478
720 min Winter	6.476	0.0	1203.6	556
960 min Winter	5.292	0.0	1311.7	714
1440 min Winter	3.979	0.0	1479.3	1016
2160 min Winter	2.991	0.0	1667.6	1472
2880 min Winter	2.442	0.0	1815.4	1848
4320 min Winter	1.831	0.0	2042.4	2508
5760 min Winter	1.492	0.0	2218.3	3120
7200 min Winter	1.272	0.0	2364.3	3680
8640 min Winter	1.116	0.0	2490.1	4400
10080 min Winter	1.000	0.0	2601.3	5104

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.844

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.404	4	8	1.400	8	12	0.040

Model Details

Storage is Online Cover Level (m) 71.300

Cellular Storage Structure

Invert Level (m) 67.100 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.03420 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.03420

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	425.0	864.0	1.300	425.0	864.0
0.100	425.0	864.0	1.400	425.0	864.0
0.200	425.0	864.0	1.500	425.0	864.0
0.300	425.0	864.0	1.600	425.0	864.0
0.400	425.0	864.0	1.700	425.0	864.0
0.500	425.0	864.0	1.701	0.0	864.0
0.600	425.0	864.0	1.900	0.0	864.0
0.700	425.0	864.0	2.000	0.0	864.0
0.800	425.0	864.0	2.100	0.0	864.0
0.900	425.0	864.0	2.200	0.0	864.0
1.000	425.0	864.0	2.300	0.0	864.0
1.100	425.0	864.0	2.400	0.0	864.0
1.200	425.0	864.0	2.500	0.0	864.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0146-1200-1798-1200
Design Head (m)	1.798
Design Flow (l/s)	12.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	146
Invert Level (m)	67.002
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.798	12.0
Flush-Flo™	0.528	12.0
Kick-Flo®	1.105	9.5
Mean Flow over Head Range	-	10.5

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.3	1.200	9.9	3.000	15.3	7.000	22.9
0.200	10.3	1.400	10.6	3.500	16.4	7.500	23.7
0.300	11.4	1.600	11.3	4.000	17.5	8.000	24.4
0.400	11.8	1.800	12.0	4.500	18.5	8.500	25.2
0.500	12.0	2.000	12.6	5.000	19.5	9.000	25.9
0.600	12.0	2.200	13.2	5.500	20.4	9.500	26.5
0.800	11.6	2.400	13.7	6.000	21.3		
1.000	10.6	2.600	14.3	6.500	22.1		

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

Half Drain Time : 193 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	67.121	0.421	1.6	16.5	18.2	171.8	O K
30 min Summer	67.269	0.569	1.6	16.5	18.2	232.4	O K
60 min Summer	67.413	0.713	1.6	16.5	18.2	291.3	O K
120 min Summer	67.517	0.817	1.6	16.5	18.2	333.9	O K
180 min Summer	67.545	0.845	1.6	16.5	18.2	345.1	O K
240 min Summer	67.550	0.850	1.6	16.5	18.2	347.4	O K
360 min Summer	67.549	0.849	1.6	16.5	18.2	346.8	O K
480 min Summer	67.539	0.839	1.6	16.5	18.2	342.8	O K
600 min Summer	67.524	0.824	1.6	16.5	18.2	336.4	O K
720 min Summer	67.504	0.804	1.6	16.5	18.2	328.3	O K
960 min Summer	67.456	0.756	1.6	16.5	18.2	309.0	O K
1440 min Summer	67.335	0.635	1.6	16.5	18.2	259.5	O K
2160 min Summer	67.148	0.448	1.6	16.5	18.2	183.0	O K
2880 min Summer	67.001	0.301	1.6	16.5	18.2	122.9	O K
4320 min Summer	66.819	0.119	1.6	16.3	17.9	48.7	O K
5760 min Summer	66.744	0.044	1.5	15.5	17.0	18.1	O K
7200 min Summer	66.720	0.020	0.7	14.4	15.1	8.3	O K
8640 min Summer	66.706	0.006	0.2	13.2	13.4	2.4	O K
10080 min Summer	66.700	0.000	0.0	12.1	12.1	0.0	O K
15 min Winter	67.177	0.477	1.6	16.5	18.2	195.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	58.637	0.0	193.3	22
30 min Summer	40.578	0.0	267.8	36
60 min Summer	26.793	0.0	353.3	64
120 min Summer	17.163	0.0	452.3	122
180 min Summer	13.134	0.0	519.6	174
240 min Summer	10.836	0.0	572.2	204
360 min Summer	8.249	0.0	653.3	270
480 min Summer	6.788	0.0	717.7	340
600 min Summer	5.832	0.0	769.8	410
720 min Summer	5.151	0.0	816.2	480
960 min Summer	4.232	0.0	894.8	620
1440 min Summer	3.206	0.0	1016.2	894
2160 min Summer	2.429	0.0	1153.9	1256
2880 min Summer	1.994	0.0	1264.3	1612
4320 min Summer	1.508	0.0	1434.2	2292
5760 min Summer	1.236	0.0	1567.6	2944
7200 min Summer	1.060	0.0	1679.4	3672
8640 min Summer	0.934	0.0	1775.9	4400
10080 min Summer	0.839	0.0	1862.2	0
15 min Winter	58.637	0.0	216.5	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	67.350	0.650	1.6	16.5	18.2	265.6	O K
60 min Winter	67.519	0.819	1.6	16.5	18.2	334.5	O K
120 min Winter	67.651	0.951	1.6	16.5	18.2	388.7	O K
180 min Winter	67.696	0.996	1.6	16.5	18.2	407.0	O K
240 min Winter	67.705	1.005	1.6	16.5	18.2	410.4	O K
360 min Winter	67.695	0.995	1.6	16.5	18.2	406.4	O K
480 min Winter	67.672	0.972	1.6	16.5	18.2	397.3	O K
600 min Winter	67.643	0.943	1.6	16.5	18.2	385.1	O K
720 min Winter	67.607	0.907	1.6	16.5	18.2	370.4	O K
960 min Winter	67.524	0.824	1.6	16.5	18.2	336.5	O K
1440 min Winter	67.316	0.616	1.6	16.5	18.2	251.5	O K
2160 min Winter	67.023	0.323	1.6	16.5	18.2	132.1	O K
2880 min Winter	66.839	0.139	1.6	16.4	18.0	56.7	O K
4320 min Winter	66.724	0.024	0.8	14.7	15.5	10.0	O K
5760 min Winter	66.701	0.001	0.0	12.8	12.8	0.5	O K
7200 min Winter	66.700	0.000	0.0	11.0	11.0	0.0	O K
8640 min Winter	66.700	0.000	0.0	9.7	9.7	0.0	O K
10080 min Winter	66.700	0.000	0.0	8.7	8.7	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	40.578	0.0	300.1	36
60 min Winter	26.793	0.0	396.2	64
120 min Winter	17.163	0.0	507.0	120
180 min Winter	13.134	0.0	583.1	176
240 min Winter	10.836	0.0	641.2	228
360 min Winter	8.249	0.0	732.1	286
480 min Winter	6.788	0.0	803.0	364
600 min Winter	5.832	0.0	863.0	442
720 min Winter	5.151	0.0	913.5	520
960 min Winter	4.232	0.0	1000.8	672
1440 min Winter	3.206	0.0	1138.2	956
2160 min Winter	2.429	0.0	1293.7	1304
2880 min Winter	1.994	0.0	1415.6	1616
4320 min Winter	1.508	0.0	1606.2	2208
5760 min Winter	1.236	0.0	1755.8	2936
7200 min Winter	1.060	0.0	1880.9	0
8640 min Winter	0.934	0.0	1989.3	0
10080 min Winter	0.839	0.0	2085.7	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.761

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.700	4	8	1.000	8	12	0.061

Model Details

Storage is Online Cover Level (m) 70.000

Cellular Storage Structure

Invert Level (m) 66.700 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01740 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	430.0	680.0	1.300	0.0	680.0
0.100	430.0	680.0	1.400	0.0	680.0
0.200	430.0	680.0	1.500	0.0	680.0
0.300	430.0	680.0	1.600	0.0	680.0
0.400	430.0	680.0	1.700	0.0	680.0
0.500	430.0	680.0	1.800	0.0	680.0
0.600	430.0	680.0	1.900	0.0	680.0
0.700	430.0	680.0	2.000	0.0	680.0
0.800	430.0	680.0	2.100	0.0	680.0
0.900	430.0	680.0	2.200	0.0	680.0
1.000	430.0	680.0	2.300	0.0	680.0
1.060	430.0	680.0	2.400	0.0	680.0
1.070	0.0	680.0	2.500	0.0	680.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0180-1660-1219-1660
Design Head (m)	1.219
Design Flow (l/s)	16.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	180
Invert Level (m)	66.541
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.219	16.6
Flush-Flo™	0.373	16.5
Kick-Flo®	0.820	13.7
Mean Flow over Head Range	-	14.2

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.3	1.200	16.5	3.000	25.5	7.000	38.3
0.200	15.5	1.400	17.7	3.500	27.4	7.500	39.6
0.300	16.4	1.600	18.9	4.000	29.3	8.000	40.9
0.400	16.5	1.800	20.0	4.500	31.0	8.500	42.1
0.500	16.3	2.000	21.0	5.000	32.6	9.000	43.3
0.600	16.0	2.200	22.0	5.500	34.1	9.500	44.4
0.800	14.1	2.400	22.9	6.000	35.6		
1.000	15.1	2.600	23.8	6.500	37.0		

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

Half Drain Time : 333 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	67.189	0.559	0.3	16.6	16.8	228.5	O K
30 min Summer	67.402	0.772	0.3	16.6	16.8	315.4	O K
60 min Summer	67.611	0.981	0.3	16.6	16.8	400.9	O K
120 min Summer	68.133	1.503	0.3	16.6	16.8	470.7	O K
180 min Summer	68.165	1.535	0.3	16.6	16.8	495.3	O K
240 min Summer	68.173	1.543	0.3	16.6	16.8	501.3	O K
360 min Summer	68.172	1.542	0.3	16.6	16.8	500.6	O K
480 min Summer	68.168	1.538	0.3	16.6	16.8	497.9	O K
600 min Summer	68.163	1.533	0.3	16.6	16.8	493.8	O K
720 min Summer	68.156	1.526	0.3	16.6	16.8	488.3	O K
960 min Summer	68.137	1.507	0.3	16.6	16.8	474.2	O K
1440 min Summer	67.704	1.074	0.3	16.6	16.8	438.7	O K
2160 min Summer	67.541	0.911	0.3	16.6	16.8	372.1	O K
2880 min Summer	67.352	0.722	0.3	16.6	16.8	294.9	O K
4320 min Summer	66.992	0.362	0.3	16.6	16.8	147.9	O K
5760 min Summer	66.778	0.148	0.3	16.6	16.8	60.7	O K
7200 min Summer	66.665	0.035	0.2	16.6	16.8	14.5	O K
8640 min Summer	66.630	0.000	0.0	16.1	16.1	0.0	O K
10080 min Summer	66.630	0.000	0.0	14.4	14.4	0.0	O K
15 min Winter	67.264	0.634	0.3	16.6	16.8	258.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	75.731	0.0	249.3	22
30 min Summer	52.870	0.0	349.0	37
60 min Summer	34.911	0.0	461.4	66
120 min Summer	22.206	0.0	586.7	124
180 min Summer	16.903	0.0	669.6	182
240 min Summer	13.882	0.0	733.9	240
360 min Summer	10.500	0.0	832.0	304
480 min Summer	8.597	0.0	907.8	368
600 min Summer	7.357	0.0	970.8	434
720 min Summer	6.476	0.0	1025.5	504
960 min Summer	5.292	0.0	1118.0	644
1440 min Summer	3.979	0.0	1261.4	930
2160 min Summer	2.991	0.0	1423.1	1344
2880 min Summer	2.442	0.0	1546.2	1756
4320 min Summer	1.831	0.0	1740.3	2424
5760 min Summer	1.492	0.0	1892.4	3064
7200 min Summer	1.272	0.0	2015.5	3680
8640 min Summer	1.116	0.0	2123.3	0
10080 min Summer	1.000	0.0	2218.3	0
15 min Winter	75.731	0.0	280.0	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	67.506	0.876	0.3	16.6	16.8	358.0	O K
60 min Winter	67.767	1.137	0.3	16.6	16.8	457.2	O K
120 min Winter	68.226	1.596	0.3	16.6	16.8	541.7	O K
180 min Winter	68.276	1.646	0.3	16.6	16.8	579.3	O K
240 min Winter	68.297	1.667	0.3	16.6	16.8	595.3	O K
360 min Winter	68.300	1.670	0.3	16.6	16.8	597.9	O K
480 min Winter	68.286	1.656	0.3	16.6	16.8	587.0	O K
600 min Winter	68.277	1.647	0.3	16.6	16.8	580.1	O K
720 min Winter	68.263	1.633	0.3	16.6	16.8	569.7	O K
960 min Winter	68.227	1.597	0.3	16.6	16.8	542.1	O K
1440 min Winter	68.142	1.512	0.3	16.6	16.8	477.8	O K
2160 min Winter	67.538	0.908	0.3	16.6	16.8	370.8	O K
2880 min Winter	67.187	0.557	0.3	16.6	16.8	227.6	O K
4320 min Winter	66.732	0.102	0.3	16.6	16.8	41.7	O K
5760 min Winter	66.630	0.000	0.0	15.5	15.5	0.0	O K
7200 min Winter	66.630	0.000	0.0	13.2	13.2	0.0	O K
8640 min Winter	66.630	0.000	0.0	11.6	11.6	0.0	O K
10080 min Winter	66.630	0.000	0.0	10.4	10.4	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	52.870	0.0	390.3	36
60 min Winter	34.911	0.0	516.9	64
120 min Winter	22.206	0.0	656.7	122
180 min Winter	16.903	0.0	750.2	178
240 min Winter	13.882	0.0	821.6	234
360 min Winter	10.500	0.0	932.7	342
480 min Winter	8.597	0.0	1017.8	390
600 min Winter	7.357	0.0	1089.3	466
720 min Winter	6.476	0.0	1149.3	544
960 min Winter	5.292	0.0	1252.8	698
1440 min Winter	3.979	0.0	1413.4	998
2160 min Winter	2.991	0.0	1593.2	1452
2880 min Winter	2.442	0.0	1733.7	1820
4320 min Winter	1.831	0.0	1950.2	2420
5760 min Winter	1.492	0.0	2118.6	0
7200 min Winter	1.272	0.0	2258.0	0
8640 min Winter	1.116	0.0	2378.1	0
10080 min Winter	1.000	0.0	2484.4	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.761

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.700	4	8	1.000	8	12	0.061

Model Details

Storage is Online Cover Level (m) 70.000

Cellular Storage Structure

Invert Level (m) 66.630 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00290 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00290

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	430.0	680.0	1.300	0.0	680.0
0.100	430.0	680.0	1.499	0.0	680.0
0.200	430.0	680.0	1.500	800.0	730.0
0.300	430.0	680.0	1.600	800.0	780.0
0.400	430.0	680.0	1.700	800.0	830.0
0.500	430.0	680.0	1.701	0.0	830.0
0.600	430.0	680.0	1.900	0.0	830.0
0.700	430.0	680.0	2.000	0.0	830.0
0.800	430.0	680.0	2.100	0.0	830.0
0.900	430.0	680.0	2.200	0.0	830.0
1.000	430.0	680.0	2.300	0.0	830.0
1.060	430.0	680.0	2.400	0.0	830.0
1.070	430.0	680.0	2.500	0.0	830.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0162-1660-2409-1660
Design Head (m)	2.409
Design Flow (l/s)	16.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	162
Invert Level (m)	65.921
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.409	16.6
Flush-Flo™	0.701	16.6
Kick-Flo®	1.444	13.0
Mean Flow over Head Range	-	14.5

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.8	1.200	15.3	3.000	18.4	7.000	27.6
0.200	13.0	1.400	13.6	3.500	19.8	7.500	28.6
0.300	14.7	1.600	13.7	4.000	21.1	8.000	29.5
0.400	15.7	1.800	14.4	4.500	22.4	8.500	30.4
0.500	16.2	2.000	15.2	5.000	23.5	9.000	31.2
0.600	16.5	2.200	15.9	5.500	24.6	9.500	32.0
0.800	16.5	2.400	16.6	6.000	25.7		
1.000	16.1	2.600	17.2	6.500	26.7		

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

Half Drain Time : 321 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	66.687	0.387	0.0	7.0	7.0	95.7	O K
30 min Summer	66.833	0.533	0.0	7.0	7.0	131.6	O K
60 min Summer	66.979	0.679	0.0	7.0	7.0	167.8	O K
120 min Summer	67.099	0.799	0.0	7.0	7.0	197.3	O K
180 min Summer	67.146	0.846	0.0	7.0	7.0	208.8	O K
240 min Summer	67.160	0.860	0.0	7.0	7.0	212.3	O K
360 min Summer	67.157	0.857	0.0	7.0	7.0	211.8	O K
480 min Summer	67.152	0.852	0.0	7.0	7.0	210.4	O K
600 min Summer	67.144	0.844	0.0	7.0	7.0	208.4	O K
720 min Summer	67.134	0.834	0.0	7.0	7.0	205.9	O K
960 min Summer	67.107	0.807	0.0	7.0	7.0	199.4	O K
1440 min Summer	67.041	0.741	0.0	7.0	7.0	183.0	O K
2160 min Summer	66.923	0.623	0.0	7.0	7.0	153.8	O K
2880 min Summer	66.774	0.474	0.0	7.0	7.0	117.1	O K
4320 min Summer	66.556	0.256	0.0	7.0	7.0	63.2	O K
5760 min Summer	66.420	0.120	0.0	7.0	7.0	29.6	O K
7200 min Summer	66.343	0.043	0.0	6.8	6.8	10.7	O K
8640 min Summer	66.305	0.005	0.0	6.6	6.6	1.2	O K
10080 min Summer	66.300	0.000	0.0	6.0	6.0	0.0	O K
15 min Winter	66.739	0.439	0.0	7.0	7.0	108.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	75.731	0.0	104.2	22
30 min Summer	52.870	0.0	145.7	37
60 min Summer	34.911	0.0	192.6	66
120 min Summer	22.206	0.0	245.0	124
180 min Summer	16.903	0.0	279.9	182
240 min Summer	13.882	0.0	306.4	240
360 min Summer	10.500	0.0	347.4	312
480 min Summer	8.597	0.0	379.2	378
600 min Summer	7.357	0.0	406.1	444
720 min Summer	6.476	0.0	428.8	512
960 min Summer	5.292	0.0	466.7	652
1440 min Summer	3.979	0.0	526.9	930
2160 min Summer	2.991	0.0	593.8	1348
2880 min Summer	2.442	0.0	647.1	1708
4320 min Summer	1.831	0.0	727.6	2420
5760 min Summer	1.492	0.0	790.3	3064
7200 min Summer	1.272	0.0	841.9	3744
8640 min Summer	1.116	0.0	886.9	4408
10080 min Summer	1.000	0.0	926.7	0
15 min Winter	75.731	0.0	116.9	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	66.906	0.606	0.0	7.0	7.0	149.7	O K
60 min Winter	67.074	0.774	0.0	7.0	7.0	191.2	O K
120 min Winter	67.220	0.920	0.0	7.0	7.0	227.3	O K
180 min Winter	67.285	0.985	0.0	7.0	7.0	243.3	O K
240 min Winter	67.313	1.013	0.0	7.0	7.0	250.3	O K
360 min Winter	67.321	1.021	0.0	7.0	7.0	252.1	O K
480 min Winter	67.300	1.000	0.0	7.0	7.0	247.1	O K
600 min Winter	67.288	0.988	0.0	7.0	7.0	244.1	O K
720 min Winter	67.271	0.971	0.0	7.0	7.0	239.9	O K
960 min Winter	67.226	0.926	0.0	7.0	7.0	228.6	O K
1440 min Winter	67.112	0.812	0.0	7.0	7.0	200.6	O K
2160 min Winter	66.913	0.613	0.0	7.0	7.0	151.3	O K
2880 min Winter	66.674	0.374	0.0	7.0	7.0	92.4	O K
4320 min Winter	66.397	0.097	0.0	6.9	6.9	23.9	O K
5760 min Winter	66.300	0.000	0.0	6.5	6.5	0.0	O K
7200 min Winter	66.300	0.000	0.0	5.5	5.5	0.0	O K
8640 min Winter	66.300	0.000	0.0	4.8	4.8	0.0	O K
10080 min Winter	66.300	0.000	0.0	4.3	4.3	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	52.870	0.0	163.1	36
60 min Winter	34.911	0.0	215.8	64
120 min Winter	22.206	0.0	274.5	122
180 min Winter	16.903	0.0	313.5	180
240 min Winter	13.882	0.0	342.9	236
360 min Winter	10.500	0.0	389.3	342
480 min Winter	8.597	0.0	424.8	394
600 min Winter	7.357	0.0	454.4	468
720 min Winter	6.476	0.0	479.7	548
960 min Winter	5.292	0.0	522.8	704
1440 min Winter	3.979	0.0	589.8	1012
2160 min Winter	2.991	0.0	664.9	1468
2880 min Winter	2.442	0.0	723.7	1792
4320 min Winter	1.831	0.0	814.4	2424
5760 min Winter	1.492	0.0	885.0	0
7200 min Winter	1.272	0.0	943.3	0
8640 min Winter	1.116	0.0	993.5	0
10080 min Winter	1.000	0.0	1037.9	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.736

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.265	4	8	0.467	8	12	0.003

Model Details

Storage is Online Cover Level (m) 68.900

Cellular Storage Structure

Invert Level (m) 66.300 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	260.0	0.0	1.300	0.0	0.0
0.100	260.0	0.0	1.400	0.0	0.0
0.200	260.0	0.0	1.500	0.0	0.0
0.300	260.0	0.0	1.600	0.0	0.0
0.400	260.0	0.0	1.700	0.0	0.0
0.500	260.0	0.0	1.800	0.0	0.0
0.600	260.0	0.0	1.900	0.0	0.0
0.700	260.0	0.0	2.000	0.0	0.0
0.800	260.0	0.0	2.100	0.0	0.0
0.900	260.0	0.0	2.200	0.0	0.0
1.000	260.0	0.0	2.300	0.0	0.0
1.060	260.0	0.0	2.400	0.0	0.0
1.061	0.0	0.0	2.500	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0120-7000-1260-7000
Design Head (m)	1.260
Design Flow (l/s)	7.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	120
Invert Level (m)	66.100
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.260	7.0
Flush-Flo™	0.371	7.0
Kick-Flo®	0.789	5.6
Mean Flow over Head Range	-	6.1

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.2	1.200	6.8	3.000	10.5	7.000	15.8
0.200	6.6	1.400	7.3	3.500	11.3	7.500	16.3
0.300	6.9	1.600	7.8	4.000	12.1	8.000	16.8
0.400	7.0	1.800	8.3	4.500	12.8	8.500	17.3
0.500	6.9	2.000	8.7	5.000	13.4	9.000	17.8
0.600	6.7	2.200	9.1	5.500	14.0	9.500	18.2
0.800	5.7	2.400	9.5	6.000	14.6		
1.000	6.3	2.600	9.8	6.500	15.2		

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

Half Drain Time : 244 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	65.742	0.392	0.9	10.3	11.1	122.9	O K
30 min Summer	65.882	0.532	0.9	10.3	11.1	166.7	O K
60 min Summer	66.023	0.673	0.9	10.3	11.1	211.1	O K
120 min Summer	66.145	0.795	0.9	10.3	11.1	249.3	O K
180 min Summer	66.192	0.842	0.9	10.3	11.1	264.0	O K
240 min Summer	66.210	0.860	0.9	10.3	11.1	269.5	O K
360 min Summer	66.223	0.873	0.9	10.3	11.1	273.8	O K
480 min Summer	66.222	0.872	0.9	10.3	11.1	273.3	O K
600 min Summer	66.213	0.863	0.9	10.3	11.1	270.6	O K
720 min Summer	66.200	0.850	0.9	10.3	11.1	266.6	O K
960 min Summer	66.167	0.817	0.9	10.3	11.1	256.2	O K
1440 min Summer	66.085	0.735	0.9	10.3	11.1	230.5	O K
2160 min Summer	65.928	0.578	0.9	10.3	11.1	181.2	O K
2880 min Summer	65.795	0.445	0.9	10.3	11.1	139.4	O K
4320 min Summer	65.608	0.258	0.9	10.3	11.1	80.8	O K
5760 min Summer	65.509	0.159	0.9	9.9	10.7	49.9	O K
7200 min Summer	65.465	0.115	0.9	9.3	10.2	36.1	O K
8640 min Summer	65.447	0.097	0.9	8.3	9.1	30.3	O K
10080 min Summer	65.433	0.083	0.9	7.4	8.2	26.1	O K
15 min Winter	65.793	0.443	0.9	10.3	11.1	138.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	58.637	0.0	133.0	22
30 min Summer	40.578	0.0	184.1	36
60 min Summer	26.793	0.0	243.3	66
120 min Summer	17.163	0.0	311.5	124
180 min Summer	13.134	0.0	357.7	180
240 min Summer	10.836	0.0	393.6	218
360 min Summer	8.249	0.0	449.3	284
480 min Summer	6.788	0.0	493.1	350
600 min Summer	5.832	0.0	529.5	420
720 min Summer	5.151	0.0	561.3	490
960 min Summer	4.232	0.0	614.9	630
1440 min Summer	3.206	0.0	698.9	910
2160 min Summer	2.429	0.0	794.1	1296
2880 min Summer	1.994	0.0	869.0	1648
4320 min Summer	1.508	0.0	986.3	2336
5760 min Summer	1.236	0.0	1078.0	3000
7200 min Summer	1.060	0.0	1154.7	3672
8640 min Summer	0.934	0.0	1221.3	4408
10080 min Summer	0.839	0.0	1280.5	5136
15 min Winter	58.637	0.0	148.9	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	65.953	0.603	0.9	10.3	11.1	188.9	O K
60 min Winter	66.117	0.767	0.9	10.3	11.1	240.5	O K
120 min Winter	66.261	0.911	0.9	10.3	11.1	285.5	O K
180 min Winter	66.323	0.973	0.9	10.3	11.1	305.0	O K
240 min Winter	66.349	0.999	0.9	10.3	11.1	313.3	O K
360 min Winter	66.359	1.009	0.9	10.3	11.1	316.2	O K
480 min Winter	66.354	1.004	0.9	10.3	11.1	314.7	O K
600 min Winter	66.337	0.987	0.9	10.3	11.1	309.3	O K
720 min Winter	66.312	0.962	0.9	10.3	11.1	301.7	O K
960 min Winter	66.253	0.903	0.9	10.3	11.1	283.1	O K
1440 min Winter	66.113	0.763	0.9	10.3	11.1	239.1	O K
2160 min Winter	65.851	0.501	0.9	10.3	11.1	157.0	O K
2880 min Winter	65.659	0.309	0.9	10.3	11.1	96.8	O K
4320 min Winter	65.476	0.126	0.9	9.5	10.4	39.4	O K
5760 min Winter	65.441	0.091	0.9	7.9	8.8	28.6	O K
7200 min Winter	65.424	0.074	0.9	6.7	7.5	23.1	O K
8640 min Winter	65.413	0.063	0.9	5.8	6.7	19.6	O K
10080 min Winter	65.404	0.054	0.9	5.1	6.0	17.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	40.578	0.0	206.2	36
60 min Winter	26.793	0.0	272.4	64
120 min Winter	17.163	0.0	349.0	122
180 min Winter	13.134	0.0	400.7	178
240 min Winter	10.836	0.0	440.7	232
360 min Winter	8.249	0.0	503.5	296
480 min Winter	6.788	0.0	552.2	372
600 min Winter	5.832	0.0	593.1	450
720 min Winter	5.151	0.0	628.7	530
960 min Winter	4.232	0.0	688.6	684
1440 min Winter	3.206	0.0	782.6	984
2160 min Winter	2.429	0.0	889.7	1364
2880 min Winter	1.994	0.0	973.6	1696
4320 min Winter	1.508	0.0	1104.6	2292
5760 min Winter	1.236	0.0	1207.4	2944
7200 min Winter	1.060	0.0	1293.3	3672
8640 min Winter	0.934	0.0	1367.9	4400
10080 min Winter	0.839	0.0	1434.2	5144

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.211

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.398	4	8	0.799	8	12	0.014

Model Details

Storage is Online Cover Level (m) 68.000

Cellular Storage Structure

Invert Level (m) 65.350 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01020 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	330.0	600.0	1.300	0.0	600.0
0.100	330.0	600.0	1.400	0.0	600.0
0.200	330.0	600.0	1.500	0.0	600.0
0.300	330.0	600.0	1.600	0.0	600.0
0.400	330.0	600.0	1.700	0.0	600.0
0.500	330.0	600.0	1.800	0.0	600.0
0.600	330.0	600.0	1.900	0.0	600.0
0.700	330.0	600.0	2.000	0.0	600.0
0.800	330.0	600.0	2.100	0.0	600.0
0.900	330.0	600.0	2.200	0.0	600.0
1.000	330.0	600.0	2.300	0.0	600.0
1.060	330.0	600.0	2.400	0.0	600.0
1.061	0.0	600.0	2.500	0.0	600.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0146-1030-1104-1030
Design Head (m)	1.104
Design Flow (l/s)	10.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	146
Invert Level (m)	65.306
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.104	10.3
Flush-Flo™	0.333	10.3
Kick-Flo®	0.731	8.5
Mean Flow over Head Range	-	8.9

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.3	1.200	10.7	3.000	16.5	7.000	24.8
0.200	9.8	1.400	11.5	3.500	17.8	7.500	25.7
0.300	10.3	1.600	12.3	4.000	19.0	8.000	26.5
0.400	10.2	1.800	13.0	4.500	20.1	8.500	27.3
0.500	10.0	2.000	13.6	5.000	21.1	9.000	28.0
0.600	9.7	2.200	14.3	5.500	22.1	9.500	28.8
0.800	8.9	2.400	14.9	6.000	23.0		
1.000	9.8	2.600	15.4	6.500	23.9		

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

Half Drain Time : 345 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	65.865	0.515	0.9	10.3	11.1	161.5	O K
30 min Summer	66.058	0.708	0.9	10.3	11.1	221.9	O K
60 min Summer	66.254	0.904	0.9	10.3	11.1	283.5	O K
120 min Summer	66.726	1.376	0.9	10.3	11.1	339.4	O K
180 min Summer	66.781	1.431	0.9	10.3	11.1	363.2	O K
240 min Summer	66.805	1.455	1.0	10.3	11.1	374.2	O K
360 min Summer	66.819	1.469	1.0	10.3	11.1	381.1	O K
480 min Summer	66.820	1.470	1.0	10.3	11.1	381.7	O K
600 min Summer	66.816	1.466	1.0	10.3	11.1	379.5	O K
720 min Summer	66.808	1.458	1.0	10.3	11.1	375.6	O K
960 min Summer	66.786	1.436	0.9	10.3	11.1	365.4	O K
1440 min Summer	66.731	1.381	0.9	10.3	11.1	340.7	O K
2160 min Summer	66.281	0.931	0.9	10.3	11.1	291.7	O K
2880 min Summer	66.118	0.768	0.9	10.3	11.1	240.8	O K
4320 min Summer	65.862	0.512	0.9	10.3	11.1	160.5	O K
5760 min Summer	65.692	0.342	0.9	10.1	11.0	107.2	O K
7200 min Summer	65.586	0.236	0.9	9.7	10.5	73.8	O K
8640 min Summer	65.520	0.170	0.9	9.1	9.9	53.3	O K
10080 min Summer	65.480	0.130	0.9	8.6	9.4	40.6	O K
15 min Winter	65.931	0.581	0.9	10.3	11.1	182.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	75.731	0.0	171.8	22
30 min Summer	52.870	0.0	240.0	37
60 min Summer	34.911	0.0	316.9	66
120 min Summer	22.206	0.0	403.3	124
180 min Summer	16.903	0.0	460.3	184
240 min Summer	13.882	0.0	504.2	242
360 min Summer	10.500	0.0	572.1	312
480 min Summer	8.597	0.0	624.8	378
600 min Summer	7.357	0.0	668.3	444
720 min Summer	6.476	0.0	705.9	512
960 min Summer	5.292	0.0	769.0	652
1440 min Summer	3.979	0.0	867.4	928
2160 min Summer	2.991	0.0	978.0	1344
2880 min Summer	2.442	0.0	1064.3	1708
4320 min Summer	1.831	0.0	1197.5	2424
5760 min Summer	1.492	0.0	1300.7	3112
7200 min Summer	1.272	0.0	1386.3	3816
8640 min Summer	1.116	0.0	1460.1	4488
10080 min Summer	1.000	0.0	1525.3	5144
15 min Winter	75.731	0.0	192.4	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	66.150	0.800	0.9	10.3	11.1	250.8	O K
60 min Winter	66.378	1.028	0.9	10.3	11.1	322.3	O K
120 min Winter	66.830	1.480	1.0	10.3	11.1	386.2	O K
180 min Winter	66.895	1.545	1.0	10.3	11.1	417.1	O K
240 min Winter	66.929	1.579	1.0	10.3	11.1	433.2	O K
360 min Winter	66.953	1.603	1.1	10.3	11.1	444.6	O K
480 min Winter	66.949	1.599	1.1	10.3	11.1	442.7	O K
600 min Winter	66.942	1.592	1.1	10.3	11.1	439.3	O K
720 min Winter	66.929	1.579	1.0	10.3	11.1	433.1	O K
960 min Winter	66.891	1.541	1.0	10.3	11.1	415.4	O K
1440 min Winter	66.800	1.450	1.0	10.3	11.1	371.8	O K
2160 min Winter	66.286	0.936	0.9	10.3	11.1	293.5	O K
2880 min Winter	66.023	0.673	0.9	10.3	11.1	211.1	O K
4320 min Winter	65.685	0.335	0.9	10.1	11.0	104.9	O K
5760 min Winter	65.526	0.176	0.9	9.2	10.0	55.3	O K
7200 min Winter	65.461	0.111	0.9	8.2	9.0	34.7	O K
8640 min Winter	65.440	0.090	0.9	7.1	7.9	28.2	O K
10080 min Winter	65.426	0.076	0.9	6.3	7.1	23.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	52.870	0.0	268.7	36
60 min Winter	34.911	0.0	355.0	66
120 min Winter	22.206	0.0	451.8	122
180 min Winter	16.903	0.0	515.8	180
240 min Winter	13.882	0.0	564.8	236
360 min Winter	10.500	0.0	640.9	344
480 min Winter	8.597	0.0	699.7	398
600 min Winter	7.357	0.0	748.4	470
720 min Winter	6.476	0.0	790.6	548
960 min Winter	5.292	0.0	861.4	706
1440 min Winter	3.979	0.0	971.4	1012
2160 min Winter	2.991	0.0	1095.3	1452
2880 min Winter	2.442	0.0	1192.1	1796
4320 min Winter	1.831	0.0	1341.3	2468
5760 min Winter	1.492	0.0	1456.8	3112
7200 min Winter	1.272	0.0	1552.7	3680
8640 min Winter	1.116	0.0	1635.3	4408
10080 min Winter	1.000	0.0	1708.4	5144

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.211

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.398	4	8	0.799	8	12	0.014

Model Details

Storage is Online Cover Level (m) 68.000

Cellular Storage Structure

Invert Level (m) 65.350 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.01020 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.01020

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	330.0	600.0	1.300	0.0	600.0
0.100	330.0	600.0	1.400	500.0	650.0
0.200	330.0	600.0	1.500	500.0	700.0
0.300	330.0	600.0	1.600	500.0	750.0
0.400	330.0	600.0	1.700	0.0	750.0
0.500	330.0	600.0	1.800	0.0	750.0
0.600	330.0	600.0	1.900	0.0	750.0
0.700	330.0	600.0	2.000	0.0	750.0
0.800	330.0	600.0	2.100	0.0	750.0
0.900	330.0	600.0	2.200	0.0	750.0
1.000	330.0	600.0	2.300	0.0	750.0
1.060	330.0	600.0	2.400	0.0	750.0
1.061	0.0	600.0	2.500	0.0	750.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0137-1030-1744-1030
Design Head (m)	1.744
Design Flow (l/s)	10.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	137
Invert Level (m)	65.306
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.744	10.3
Flush-Flo™	0.515	10.3
Kick-Flo®	1.070	8.2
Mean Flow over Head Range	-	9.0

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.9	1.200	8.6	3.000	13.3	7.000	19.9
0.200	8.9	1.400	9.3	3.500	14.3	7.500	20.6
0.300	9.8	1.600	9.9	4.000	15.2	8.000	21.3
0.400	10.2	1.800	10.4	4.500	16.1	8.500	21.9
0.500	10.3	2.000	11.0	5.000	17.0	9.000	22.5
0.600	10.3	2.200	11.5	5.500	17.8	9.500	23.1
0.800	9.9	2.400	12.0	6.000	18.5		
1.000	8.9	2.600	12.4	6.500	19.2		

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

Half Drain Time : 121 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	66.687	0.487	0.7	24.9	25.5	185.2	O K
30 min Summer	66.849	0.649	0.7	26.1	26.8	246.7	O K
60 min Summer	66.987	0.787	0.7	27.1	27.8	298.9	O K
120 min Summer	67.057	0.857	0.7	27.6	28.3	325.6	O K
180 min Summer	67.067	0.867	0.7	27.7	28.3	329.5	O K
240 min Summer	67.067	0.867	0.7	27.7	28.3	329.5	O K
360 min Summer	67.051	0.851	0.7	27.6	28.2	323.5	O K
480 min Summer	67.024	0.824	0.7	27.4	28.0	313.0	O K
600 min Summer	66.990	0.790	0.7	27.1	27.8	300.1	O K
720 min Summer	66.953	0.753	0.7	26.9	27.5	286.0	O K
960 min Summer	66.876	0.676	0.7	26.3	27.0	256.7	O K
1440 min Summer	66.728	0.528	0.7	25.2	25.8	200.7	O K
2160 min Summer	66.545	0.345	0.7	23.7	24.4	131.1	O K
2880 min Summer	66.409	0.209	0.7	22.5	23.2	79.4	O K
4320 min Summer	66.246	0.046	0.6	21.1	21.7	17.6	O K
5760 min Summer	66.200	0.000	0.0	19.7	19.7	0.0	O K
7200 min Summer	66.200	0.000	0.0	16.8	16.8	0.0	O K
8640 min Summer	66.200	0.000	0.0	14.8	14.8	0.0	O K
10080 min Summer	66.200	0.000	0.0	13.3	13.3	0.0	O K
15 min Winter	66.755	0.555	0.7	25.4	26.0	210.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	58.637	0.0	213.2	21
30 min Summer	40.578	0.0	295.9	35
60 min Summer	26.793	0.0	391.2	62
120 min Summer	17.163	0.0	500.4	106
180 min Summer	13.134	0.0	575.5	140
240 min Summer	10.836	0.0	633.6	174
360 min Summer	8.249	0.0	722.1	244
480 min Summer	6.788	0.0	793.7	314
600 min Summer	5.832	0.0	850.3	382
720 min Summer	5.151	0.0	901.4	450
960 min Summer	4.232	0.0	989.0	582
1440 min Summer	3.206	0.0	1124.1	840
2160 min Summer	2.429	0.0	1275.6	1212
2880 min Summer	1.994	0.0	1396.1	1560
4320 min Summer	1.508	0.0	1585.2	2248
5760 min Summer	1.236	0.0	1733.1	0
7200 min Summer	1.060	0.0	1856.5	0
8640 min Summer	0.934	0.0	1963.5	0
10080 min Summer	0.839	0.0	2058.6	0
15 min Winter	58.637	0.0	239.7	21

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	66.943	0.743	0.7	26.8	27.4	282.3	O K
60 min Winter	67.111	0.911	0.7	28.0	28.6	346.3	O K
120 min Winter	67.212	1.012	0.7	28.7	29.3	384.7	O K
180 min Winter	67.224	1.024	0.7	28.8	29.4	389.2	O K
240 min Winter	67.215	1.015	0.7	28.7	29.4	385.6	O K
360 min Winter	67.177	0.977	0.7	28.4	29.1	371.4	O K
480 min Winter	67.124	0.924	0.7	28.1	28.7	351.0	O K
600 min Winter	67.062	0.862	0.7	27.6	28.3	327.7	O K
720 min Winter	66.998	0.798	0.7	27.2	27.9	303.4	O K
960 min Winter	66.872	0.672	0.7	26.3	26.9	255.4	O K
1440 min Winter	66.648	0.448	0.7	24.5	25.2	170.1	O K
2160 min Winter	66.395	0.195	0.7	22.4	23.1	74.1	O K
2880 min Winter	66.242	0.042	0.6	21.0	21.6	16.0	O K
4320 min Winter	66.200	0.000	0.0	17.3	17.3	0.0	O K
5760 min Winter	66.200	0.000	0.0	14.2	14.2	0.0	O K
7200 min Winter	66.200	0.000	0.0	12.2	12.2	0.0	O K
8640 min Winter	66.200	0.000	0.0	10.7	10.7	0.0	O K
10080 min Winter	66.200	0.000	0.0	9.6	9.6	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	40.578	0.0	331.9	35
60 min Winter	26.793	0.0	436.8	62
120 min Winter	17.163	0.0	561.1	116
180 min Winter	13.134	0.0	643.3	148
240 min Winter	10.836	0.0	708.0	186
360 min Winter	8.249	0.0	808.9	264
480 min Winter	6.788	0.0	888.8	340
600 min Winter	5.832	0.0	952.8	414
720 min Winter	5.151	0.0	1010.7	484
960 min Winter	4.232	0.0	1106.1	622
1440 min Winter	3.206	0.0	1257.5	884
2160 min Winter	2.429	0.0	1429.6	1236
2880 min Winter	1.994	0.0	1564.8	1556
4320 min Winter	1.508	0.0	1775.8	0
5760 min Winter	1.236	0.0	1941.1	0
7200 min Winter	1.060	0.0	2079.2	0
8640 min Winter	0.934	0.0	2199.1	0
10080 min Winter	0.839	0.0	2305.7	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.947

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.726	4	8	1.221

Model Details

Storage is Online Cover Level (m) 69.000

Cellular Storage Structure

Invert Level (m) 66.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00531 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	400.0	900.0	1.300	0.0	900.0
0.100	400.0	900.0	1.400	0.0	900.0
0.200	400.0	900.0	1.500	0.0	900.0
0.300	400.0	900.0	1.600	0.0	900.0
0.400	400.0	900.0	1.700	0.0	900.0
0.500	400.0	900.0	1.800	0.0	900.0
0.600	400.0	900.0	1.900	0.0	900.0
0.700	400.0	900.0	2.000	0.0	900.0
0.800	400.0	900.0	2.100	0.0	900.0
0.900	400.0	900.0	2.200	0.0	900.0
1.000	400.0	900.0	2.300	0.0	900.0
1.060	400.0	900.0	2.400	0.0	900.0
1.061	0.0	900.0	2.500	0.0	900.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0203-2120-1080-2120
Design Head (m)	1.080
Design Flow (l/s)	21.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	203
Invert Level (m)	65.180
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.080	21.2
Flush-Flo™	0.357	21.2
Kick-Flo®	0.767	18.0
Mean Flow over Head Range	-	17.9

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.0	1.200	22.3	3.000	34.6	7.000	52.1
0.200	19.3	1.400	24.0	3.500	37.2	7.500	53.9
0.300	21.1	1.600	25.6	4.000	39.7	8.000	55.6
0.400	21.1	1.800	27.1	4.500	42.1	8.500	57.2
0.500	20.8	2.000	28.5	5.000	44.2	9.000	58.8
0.600	20.3	2.200	29.8	5.500	46.3	9.500	60.4
0.800	18.4	2.400	31.1	6.000	48.3		
1.000	20.4	2.600	32.3	6.500	50.2		

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

Half Drain Time : 213 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	66.861	0.661	0.7	21.0	21.6	251.0	O K
30 min Summer	67.101	0.901	0.7	22.3	23.0	342.2	O K
60 min Summer	67.599	1.399	0.7	24.9	25.6	427.2	O K
120 min Summer	67.678	1.478	0.7	25.3	26.1	487.2	O K
180 min Summer	67.698	1.498	0.7	25.4	26.2	502.9	O K
240 min Summer	67.701	1.501	0.7	25.4	26.2	504.9	O K
360 min Summer	67.696	1.496	0.7	25.4	26.1	501.2	O K
480 min Summer	67.686	1.486	0.7	25.4	26.1	493.8	O K
600 min Summer	67.674	1.474	0.7	25.3	26.0	484.2	O K
720 min Summer	67.659	1.459	0.7	25.2	26.0	472.8	O K
960 min Summer	67.625	1.425	0.7	25.1	25.8	447.5	O K
1440 min Summer	67.249	1.049	0.7	23.1	23.8	398.8	O K
2160 min Summer	67.044	0.844	0.7	22.0	22.7	320.7	O K
2880 min Summer	66.864	0.664	0.7	21.0	21.6	252.3	O K
4320 min Summer	66.581	0.381	0.7	19.2	19.9	144.9	O K
5760 min Summer	66.384	0.184	0.7	18.6	18.6	70.0	O K
7200 min Summer	66.239	0.039	0.5	18.5	18.6	14.8	O K
8640 min Summer	66.200	0.000	0.0	17.7	17.7	0.0	O K
10080 min Summer	66.200	0.000	0.0	15.9	15.9	0.0	O K
15 min Winter	66.948	0.748	0.7	21.5	22.1	284.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	75.731	0.0	276.4	22
30 min Summer	52.870	0.0	386.2	36
60 min Summer	34.911	0.0	509.2	64
120 min Summer	22.206	0.0	648.3	122
180 min Summer	16.903	0.0	740.7	162
240 min Summer	13.882	0.0	811.1	196
360 min Summer	10.500	0.0	919.4	262
480 min Summer	8.597	0.0	1003.2	332
600 min Summer	7.357	0.0	1073.4	402
720 min Summer	6.476	0.0	1135.1	470
960 min Summer	5.292	0.0	1236.1	608
1440 min Summer	3.979	0.0	1394.4	882
2160 min Summer	2.991	0.0	1572.2	1272
2880 min Summer	2.442	0.0	1710.1	1644
4320 min Summer	1.831	0.0	1926.0	2380
5760 min Summer	1.492	0.0	2091.9	3064
7200 min Summer	1.272	0.0	2228.0	3744
8640 min Summer	1.116	0.0	2347.3	0
10080 min Summer	1.000	0.0	2452.2	0
15 min Winter	75.731	0.0	309.4	22

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	67.223	1.023	0.7	23.0	23.7	388.8	O K
60 min Winter	67.680	1.480	0.7	25.3	26.1	488.8	O K
120 min Winter	67.783	1.583	0.8	25.8	26.6	567.2	O K
180 min Winter	67.822	1.622	0.8	26.0	26.8	593.5	O K
240 min Winter	67.832	1.632	0.8	26.1	26.8	597.5	O K
360 min Winter	67.816	1.616	0.8	26.0	26.8	590.6	O K
480 min Winter	67.791	1.591	0.8	25.9	26.6	573.5	O K
600 min Winter	67.768	1.568	0.8	25.8	26.5	556.1	O K
720 min Winter	67.741	1.541	0.8	25.6	26.4	535.5	O K
960 min Winter	67.682	1.482	0.7	25.3	26.1	490.6	O K
1440 min Winter	67.552	1.352	0.7	24.7	25.4	406.4	O K
2160 min Winter	66.968	0.768	0.7	21.6	22.2	291.7	O K
2880 min Winter	66.713	0.513	0.7	20.1	20.7	194.8	O K
4320 min Winter	66.340	0.140	0.7	18.6	18.6	53.1	O K
5760 min Winter	66.200	0.000	0.0	17.1	17.1	0.0	O K
7200 min Winter	66.200	0.000	0.0	14.6	14.6	0.0	O K
8640 min Winter	66.200	0.000	0.0	12.8	12.8	0.0	O K
10080 min Winter	66.200	0.000	0.0	11.5	11.5	0.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	52.870	0.0	431.6	36
60 min Winter	34.911	0.0	571.6	64
120 min Winter	22.206	0.0	725.3	120
180 min Winter	16.903	0.0	828.5	174
240 min Winter	13.882	0.0	908.1	224
360 min Winter	10.500	0.0	1030.0	280
480 min Winter	8.597	0.0	1124.4	358
600 min Winter	7.357	0.0	1204.1	436
720 min Winter	6.476	0.0	1270.5	510
960 min Winter	5.292	0.0	1385.1	656
1440 min Winter	3.979	0.0	1560.7	928
2160 min Winter	2.991	0.0	1760.6	1344
2880 min Winter	2.442	0.0	1916.4	1728
4320 min Winter	1.831	0.0	2156.7	2424
5760 min Winter	1.492	0.0	2342.1	0
7200 min Winter	1.272	0.0	2496.1	0
8640 min Winter	1.116	0.0	2629.0	0
10080 min Winter	1.000	0.0	2746.5	0

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.947

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.726	4	8	1.221

Model Details

Storage is Online Cover Level (m) 69.000

Cellular Storage Structure

Invert Level (m) 66.200 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00531 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00531

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	400.0	900.0	1.300	0.0	900.0
0.100	400.0	900.0	1.400	800.0	950.0
0.200	400.0	900.0	1.500	800.0	1000.0
0.300	400.0	900.0	1.600	800.0	1050.0
0.400	400.0	900.0	1.700	0.0	1050.0
0.500	400.0	900.0	1.800	0.0	1050.0
0.600	400.0	900.0	1.900	0.0	1050.0
0.700	400.0	900.0	2.000	0.0	1050.0
0.800	400.0	900.0	2.100	0.0	1050.0
0.900	400.0	900.0	2.200	0.0	1050.0
1.000	400.0	900.0	2.300	0.0	1050.0
1.060	400.0	900.0	2.400	0.0	1050.0
1.061	0.0	900.0	2.500	0.0	1050.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0193-2120-1720-2120
Design Head (m)	1.720
Design Flow (l/s)	21.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	193
Invert Level (m)	65.180
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.720	21.2
Flush-Flo™	0.510	21.2
Kick-Flo®	1.099	17.1
Mean Flow over Head Range	-	18.4

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.7	1.200	17.9	3.000	27.6	7.000	41.6
0.200	17.9	1.400	19.2	3.500	29.8	7.500	43.0
0.300	20.2	1.600	20.5	4.000	31.7	8.000	44.4
0.400	21.0	1.800	21.7	4.500	33.6	8.500	45.7
0.500	21.2	2.000	22.8	5.000	35.3	9.000	47.0
0.600	21.1	2.200	23.8	5.500	37.0	9.500	48.2
0.800	20.4	2.400	24.8	6.000	38.6		
1.000	18.8	2.600	25.8	6.500	40.1		

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

Half Drain Time : 212 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control Σ (l/s)	Max Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	65.928	0.428	0.4	10.7	11.1	109.7	O K
30 min Summer	66.080	0.580	0.4	10.7	11.1	148.7	O K
60 min Summer	66.231	0.731	0.4	10.7	11.1	187.6	O K
120 min Summer	66.347	0.847	0.4	10.7	11.1	217.2	O K
180 min Summer	66.384	0.884	0.4	10.7	11.1	226.8	O K
240 min Summer	66.397	0.897	0.4	10.7	11.1	230.1	O K
360 min Summer	66.403	0.903	0.4	10.7	11.1	231.7	O K
480 min Summer	66.396	0.896	0.4	10.7	11.1	229.8	O K
600 min Summer	66.382	0.882	0.4	10.7	11.1	226.2	O K
720 min Summer	66.364	0.864	0.4	10.7	11.1	221.5	O K
960 min Summer	66.320	0.820	0.4	10.7	11.1	210.5	O K
1440 min Summer	66.217	0.717	0.4	10.7	11.1	183.9	O K
2160 min Summer	66.025	0.525	0.4	10.7	11.1	134.8	O K
2880 min Summer	65.877	0.377	0.4	10.7	11.1	96.7	O K
4320 min Summer	65.691	0.191	0.4	10.6	11.0	49.0	O K
5760 min Summer	65.607	0.107	0.4	10.0	10.4	27.3	O K
7200 min Summer	65.578	0.078	0.4	9.0	9.4	20.1	O K
8640 min Summer	65.562	0.062	0.4	7.9	8.3	15.9	O K
10080 min Summer	65.551	0.051	0.4	7.1	7.5	13.0	O K
15 min Winter	65.983	0.483	0.4	10.7	11.1	124.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	58.637	0.0	120.8	23
30 min Summer	40.578	0.0	167.2	37
60 min Summer	26.793	0.0	221.0	66
120 min Summer	17.163	0.0	282.9	124
180 min Summer	13.134	0.0	324.9	178
240 min Summer	10.836	0.0	357.3	208
360 min Summer	8.249	0.0	408.2	274
480 min Summer	6.788	0.0	447.9	342
600 min Summer	5.832	0.0	480.9	412
720 min Summer	5.151	0.0	509.6	482
960 min Summer	4.232	0.0	558.5	622
1440 min Summer	3.206	0.0	634.8	900
2160 min Summer	2.429	0.0	721.2	1264
2880 min Summer	1.994	0.0	789.3	1620
4320 min Summer	1.508	0.0	895.7	2296
5760 min Summer	1.236	0.0	979.0	2944
7200 min Summer	1.060	0.0	1048.8	3672
8640 min Summer	0.934	0.0	1109.2	4400
10080 min Summer	0.839	0.0	1162.9	5136
15 min Winter	58.637	0.0	135.2	23

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	66.159	0.659	0.4	10.7	11.1	169.0	O K
60 min Winter	66.333	0.833	0.4	10.7	11.1	213.7	O K
120 min Winter	66.476	0.976	0.4	10.7	11.1	250.3	O K
180 min Winter	66.529	1.029	0.4	10.7	11.1	264.1	O K
240 min Winter	66.546	1.046	0.4	10.7	11.1	268.3	O K
360 min Winter	66.547	1.047	0.4	10.7	11.1	268.5	O K
480 min Winter	66.531	1.031	0.4	10.7	11.1	264.5	O K
600 min Winter	66.504	1.004	0.4	10.7	11.1	257.5	O K
720 min Winter	66.470	0.970	0.4	10.7	11.1	248.9	O K
960 min Winter	66.394	0.894	0.4	10.7	11.1	229.2	O K
1440 min Winter	66.217	0.717	0.4	10.7	11.1	183.8	O K
2160 min Winter	65.908	0.408	0.4	10.7	11.1	104.7	O K
2880 min Winter	65.717	0.217	0.4	10.6	11.0	55.7	O K
4320 min Winter	65.584	0.084	0.4	9.3	9.7	21.4	O K
5760 min Winter	65.557	0.057	0.4	7.6	8.0	14.7	O K
7200 min Winter	65.543	0.043	0.3	6.5	6.9	11.1	O K
8640 min Winter	65.534	0.034	0.3	5.8	6.0	8.8	O K
10080 min Winter	65.528	0.028	0.2	5.2	5.5	7.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	40.578	0.0	187.3	37
60 min Winter	26.793	0.0	247.5	66
120 min Winter	17.163	0.0	317.0	122
180 min Winter	13.134	0.0	363.8	178
240 min Winter	10.836	0.0	400.2	230
360 min Winter	8.249	0.0	457.3	288
480 min Winter	6.788	0.0	501.6	366
600 min Winter	5.832	0.0	538.7	444
720 min Winter	5.151	0.0	570.8	522
960 min Winter	4.232	0.0	625.5	676
1440 min Winter	3.206	0.0	710.9	972
2160 min Winter	2.429	0.0	807.9	1324
2880 min Winter	1.994	0.0	884.1	1644
4320 min Winter	1.508	0.0	1003.1	2212
5760 min Winter	1.236	0.0	1096.5	2944
7200 min Winter	1.060	0.0	1174.5	3672
8640 min Winter	0.934	0.0	1242.3	4408
10080 min Winter	0.839	0.0	1302.5	5096

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.100

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.073	4	8	0.857	8	12	0.170

Model Details

Storage is Online Cover Level (m) 68.250

Cellular Storage Structure

Invert Level (m) 65.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00531 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	270.0	530.0	1.300	0.0	530.0
0.100	270.0	530.0	1.400	0.0	530.0
0.200	270.0	530.0	1.500	0.0	530.0
0.300	270.0	530.0	1.600	0.0	530.0
0.400	270.0	530.0	1.700	0.0	530.0
0.500	270.0	530.0	1.800	0.0	530.0
0.600	270.0	530.0	1.900	0.0	530.0
0.700	270.0	530.0	2.000	0.0	530.0
0.800	270.0	530.0	2.100	0.0	530.0
0.900	270.0	530.0	2.200	0.0	530.0
1.000	270.0	530.0	2.300	0.0	530.0
1.060	270.0	530.0	2.400	0.0	530.0
1.061	0.0	530.0	2.500	0.0	530.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0148-1070-1131-1070
Design Head (m)	1.131
Design Flow (l/s)	10.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	148
Invert Level (m)	65.429
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.131	10.7
Flush-Flo™	0.338	10.7
Kick-Flo®	0.745	8.8
Mean Flow over Head Range	-	9.2

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.3	1.200	11.0	3.000	17.0	7.000	25.5
0.200	10.2	1.400	11.8	3.500	18.3	7.500	26.4
0.300	10.7	1.600	12.6	4.000	19.5	8.000	27.2
0.400	10.6	1.800	13.3	4.500	20.6	8.500	28.0
0.500	10.4	2.000	14.0	5.000	21.7	9.000	28.8
0.600	10.1	2.200	14.7	5.500	22.7	9.500	29.5
0.800	9.1	2.400	15.3	6.000	23.7		
1.000	10.1	2.600	15.9	6.500	24.6		

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

Half Drain Time : 302 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	66.063	0.563	0.4	10.7	11.1	144.5	O K
30 min Summer	66.275	0.775	0.4	10.7	11.1	198.8	O K
60 min Summer	66.489	0.989	0.4	10.7	11.1	253.6	O K
120 min Summer	66.930	1.430	0.5	10.7	11.1	299.0	O K
180 min Summer	66.973	1.473	0.5	10.7	11.1	317.3	O K
240 min Summer	66.988	1.488	0.5	10.7	11.1	323.9	O K
360 min Summer	66.996	1.496	0.5	10.7	11.1	327.3	O K
480 min Summer	66.993	1.493	0.5	10.7	11.1	325.9	O K
600 min Summer	66.985	1.485	0.5	10.7	11.1	322.5	O K
720 min Summer	66.974	1.474	0.5	10.7	11.1	318.0	O K
960 min Summer	66.948	1.448	0.5	10.7	11.1	306.8	O K
1440 min Summer	66.887	1.387	0.4	10.7	11.1	281.2	O K
2160 min Summer	66.404	0.904	0.4	10.7	11.1	231.9	O K
2880 min Summer	66.212	0.712	0.4	10.7	11.1	182.5	O K
4320 min Summer	65.933	0.433	0.4	10.7	11.1	111.0	O K
5760 min Summer	65.767	0.267	0.4	10.3	10.7	68.4	O K
7200 min Summer	65.672	0.172	0.4	9.7	10.1	44.0	O K
8640 min Summer	65.616	0.116	0.4	9.1	9.5	29.7	O K
10080 min Summer	65.586	0.086	0.4	8.5	8.9	22.1	O K
15 min Winter	66.136	0.636	0.4	10.7	11.1	163.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	75.731	0.0	156.0	23
30 min Summer	52.870	0.0	217.9	38
60 min Summer	34.911	0.0	287.9	68
120 min Summer	22.206	0.0	366.4	126
180 min Summer	16.903	0.0	418.3	184
240 min Summer	13.882	0.0	458.0	240
360 min Summer	10.500	0.0	519.8	300
480 min Summer	8.597	0.0	567.2	366
600 min Summer	7.357	0.0	606.8	432
720 min Summer	6.476	0.0	640.9	502
960 min Summer	5.292	0.0	698.4	642
1440 min Summer	3.979	0.0	787.7	916
2160 min Summer	2.991	0.0	888.2	1324
2880 min Summer	2.442	0.0	966.7	1680
4320 min Summer	1.831	0.0	1087.6	2380
5760 min Summer	1.492	0.0	1181.3	3056
7200 min Summer	1.272	0.0	1259.1	3744
8640 min Summer	1.116	0.0	1326.0	4416
10080 min Summer	1.000	0.0	1385.3	5136
15 min Winter	75.731	0.0	174.7	23

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

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	66.378	0.878	0.4	10.7	11.1	225.1	O K
60 min Winter	66.905	1.405	0.4	10.7	11.1	288.3	O K
120 min Winter	67.031	1.531	0.5	10.7	11.1	342.4	O K
180 min Winter	67.089	1.589	0.5	10.7	11.1	366.9	O K
240 min Winter	67.118	1.618	0.5	10.7	11.1	378.1	O K
360 min Winter	67.139	1.639	0.5	10.7	11.1	382.7	O K
480 min Winter	67.123	1.623	0.5	10.7	11.1	379.4	O K
600 min Winter	67.105	1.605	0.5	10.7	11.1	373.9	O K
720 min Winter	67.087	1.587	0.5	10.7	11.1	366.0	O K
960 min Winter	67.041	1.541	0.5	10.7	11.1	346.5	O K
1440 min Winter	66.936	1.436	0.5	10.7	11.1	301.7	O K
2160 min Winter	66.358	0.858	0.4	10.7	11.1	220.1	O K
2880 min Winter	66.068	0.568	0.4	10.7	11.1	145.6	O K
4320 min Winter	65.740	0.240	0.4	10.2	10.6	61.6	O K
5760 min Winter	65.611	0.111	0.4	9.0	9.4	28.3	O K
7200 min Winter	65.573	0.073	0.4	7.8	8.2	18.8	O K
8640 min Winter	65.556	0.056	0.4	6.8	7.2	14.3	O K
10080 min Winter	65.545	0.045	0.3	6.1	6.5	11.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	52.870	0.0	244.1	37
60 min Winter	34.911	0.0	322.5	66
120 min Winter	22.206	0.0	410.2	124
180 min Winter	16.903	0.0	468.4	180
240 min Winter	13.882	0.0	513.1	236
360 min Winter	10.500	0.0	581.9	340
480 min Winter	8.597	0.0	635.4	386
600 min Winter	7.357	0.0	679.8	464
720 min Winter	6.476	0.0	717.8	542
960 min Winter	5.292	0.0	782.1	696
1440 min Winter	3.979	0.0	882.3	998
2160 min Winter	2.991	0.0	994.6	1412
2880 min Winter	2.442	0.0	1082.8	1760
4320 min Winter	1.831	0.0	1218.1	2384
5760 min Winter	1.492	0.0	1323.1	3008
7200 min Winter	1.272	0.0	1410.2	3672
8640 min Winter	1.116	0.0	1485.2	4408
10080 min Winter	1.000	0.0	1551.6	5096

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	14.700	Shortest Storm (mins)	15
Ratio R	0.269	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 1.100

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.073	4	8	0.857	8	12	0.170

Model Details

Storage is Online Cover Level (m) 68.250

Cellular Storage Structure

Invert Level (m) 65.500 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00531 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00531

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	270.0	530.0	1.300	0.0	530.0
0.100	270.0	530.0	1.400	450.0	600.0
0.200	270.0	530.0	1.500	450.0	650.0
0.300	270.0	530.0	1.600	450.0	700.0
0.400	270.0	530.0	1.700	0.0	700.0
0.500	270.0	530.0	1.800	0.0	700.0
0.600	270.0	530.0	1.900	0.0	700.0
0.700	270.0	530.0	2.000	0.0	700.0
0.800	270.0	530.0	2.100	0.0	700.0
0.900	270.0	530.0	2.200	0.0	700.0
1.000	270.0	530.0	2.300	0.0	700.0
1.060	270.0	530.0	2.400	0.0	700.0
1.061	0.0	530.0	2.500	0.0	700.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0139-1070-1771-1070
Design Head (m)	1.771
Design Flow (l/s)	10.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	139
Invert Level (m)	65.429
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.771	10.7
Flush-Flo™	0.518	10.7
Kick-Flo®	1.079	8.5
Mean Flow over Head Range	-	9.3

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.0	1.200	8.9	3.000	13.7	7.000	20.6
0.200	9.2	1.400	9.6	3.500	14.8	7.500	21.3
0.300	10.2	1.600	10.2	4.000	15.7	8.000	21.9
0.400	10.6	1.800	10.8	4.500	16.7	8.500	22.6
0.500	10.7	2.000	11.3	5.000	17.5	9.000	23.2
0.600	10.6	2.200	11.9	5.500	18.3	9.500	23.8
0.800	10.3	2.400	12.4	6.000	19.1		
1.000	9.2	2.600	12.8	6.500	19.9		

Appendix C

SURFACE WATER NETWORK CALCULATIONS

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SW_1

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	14.700	Add Flow / Climate Change (%)	20
Ratio R	0.269	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	2.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for SW_1

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.707	4-8	1.495	8-12	1.379	12-16	0.071

Total Area Contributing (ha) = 3.652

Total Pipe Volume (m³) = 198.047

Network Design Table for SW_1

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	5.980	0.035	170.9	0.044	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	20.580	0.121	170.1	0.016	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	36.606	0.215	170.3	0.028	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	66.793	0.393	170.0	0.319	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	13.948	0.057	244.7	0.031	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.005	38.408	0.157	244.6	0.019	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.006	4.889	0.122	40.0	0.013	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)
1.000	58.32	4.10	69.800	0.044	0.0	0.0	1.4	1.00	39.7	8.4
1.001	56.76	4.44	69.765	0.060	0.0	0.0	1.8	1.00	39.7	11.0
1.002	54.23	5.05	69.644	0.088	0.0	0.0	2.6	1.00	39.7	15.5
1.003	50.89	5.98	69.354	0.407	0.0	0.0	11.2	1.20	85.0	67.4
1.004	50.23	6.18	68.886	0.438	0.0	0.0	11.9	1.15	127.4	71.5
1.005	48.51	6.74	68.829	0.457	0.0	0.0	12.0	1.15	127.4	72.1
1.006	48.43	6.76	68.672	0.470	0.0	0.0	12.3	2.87	317.2	74.0

Network Design Table for SW_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
2.000	8.388	0.215	39.0	0.012	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	12.826	0.338	37.9	0.020	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.002	61.817	1.071	57.7	0.136	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	10.405	0.061	170.6	0.010	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.003	55.856	0.228	245.0	0.055	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.004	7.207	0.036	200.2	0.021	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.000	9.569	0.100	95.7	0.014	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.005	7.829	0.045	174.0	0.021	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.006	85.010	0.264	322.0	0.232	0.00	0.0	0.600	o	375	Pipe/Conduit	
2.007	11.374	0.035	325.0	0.033	0.00	0.0	0.600	o	375	Pipe/Conduit	
2.008	15.947	0.049	325.0	0.013	0.00	0.0	0.600	o	375	Pipe/Conduit	
2.009	75.647	0.233	325.0	0.189	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.007	13.061	0.064	203.4	0.009	0.00	0.0	0.600	o	450	Pipe/Conduit	
5.000	37.872	0.762	49.7	0.095	4.00	0.0	0.600	o	225	Pipe/Conduit	
5.001	7.122	0.135	52.8	0.013	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
2.000	58.47	4.07	70.074	0.012	0.0	0.0	0.4	2.10	83.5	2.2
2.001	58.00	4.17	69.859	0.031	0.0	0.0	1.0	2.13	84.7	5.9
2.002	55.39	4.76	69.521	0.168	0.0	0.0	5.0	1.72	68.6	30.2
3.000	57.97	4.17	68.511	0.010	0.0	0.0	0.3	1.00	39.7	1.9
2.003	51.85	5.70	68.375	0.233	0.0	0.0	6.6	1.00	70.7	39.3
2.004	51.48	5.80	68.147	0.255	0.0	0.0	7.1	1.11	78.3	42.6
4.000	58.23	4.12	67.899	0.014	0.0	0.0	0.4	1.34	53.2	2.6
2.005	51.11	5.91	67.724	0.289	0.0	0.0	8.0	1.19	84.0	48.0
2.006	46.85	7.32	67.604	0.521	0.0	0.0	13.2	1.00	110.9	79.3
2.007	46.34	7.51	67.340	0.554	0.0	0.0	13.9	1.00	110.4	83.4
2.008	45.66	7.78	67.305	0.566	0.0	0.0	14.0	1.00	110.4	84.0
2.009	42.72	9.04	67.256	0.756	0.0	0.0	17.5	1.00	110.4	104.9
1.007	42.39	9.19	66.948	1.235	0.0	0.0	28.4	1.42	226.1	170.2
5.000	57.22	4.34	70.494	0.095	0.0	0.0	2.9	1.86	73.9	17.6
5.001	56.92	4.41	69.732	0.108	0.0	0.0	3.3	1.80	71.8	20.0

Network Design Table for SW_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
6.000	20.265	0.119	170.0	0.047	4.00	0.0	0.600	o	225	Pipe/Conduit	
6.001	6.824	0.040	170.0	0.015	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.002	11.132	0.065	170.0	0.015	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.003	73.899	1.173	63.0	0.191	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.004	59.434	0.243	244.6	0.033	0.00	0.0	0.600	o	300	Pipe/Conduit	
7.000	39.656	0.350	113.3	0.140	4.00	0.0	0.600	o	225	Pipe/Conduit	
8.000	37.803	0.222	170.3	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
7.001	26.525	0.156	170.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
7.002	65.851	0.269	245.0	0.150	0.00	0.0	0.600	o	300	Pipe/Conduit	
9.000	42.022	0.680	61.8	0.190	4.00	0.0	0.600	o	225	Pipe/Conduit	
9.001	13.599	0.629	21.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
10.000	44.535	0.354	125.8	0.080	4.00	0.0	0.600	o	225	Pipe/Conduit	
10.001	9.777	0.339	28.8	0.006	0.00	0.0	0.600	o	225	Pipe/Conduit	
9.002	8.630	0.035	246.6	0.015	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)
6.000	57.22	4.34	69.291	0.047	0.0	0.0	1.5	1.00	39.8	8.8
6.001	56.72	4.45	69.172	0.062	0.0	0.0	1.9	1.00	39.8	11.4
5.002	55.92	4.64	69.132	0.185	0.0	0.0	5.6	1.00	39.8	33.5
5.003	52.97	5.38	69.066	0.376	0.0	0.0	10.8	1.65	65.6	64.7
5.004	49.61	6.37	67.818	0.409	0.0	0.0	11.0	1.00	70.7	66.0
7.000	56.34	4.54	69.495	0.140	0.0	0.0	4.3	1.23	48.8	25.7
8.000	55.95	4.63	69.300	0.000	0.0	0.0	0.0	1.00	39.7	0.0
7.001	54.15	5.07	69.078	0.140	0.0	0.0	4.3	1.00	39.8	25.7
7.002	50.26	6.17	68.847	0.290	0.0	0.0	7.9	1.00	70.7	47.4
9.000	56.86	4.42	69.551	0.190	0.0	0.0	5.9	1.67	66.3	35.2
9.001	56.51	4.50	68.871	0.190	0.0	0.0	5.9	2.83	112.4	35.2
10.000	55.92	4.64	68.971	0.080	0.0	0.0	2.4	1.16	46.3	14.5
10.001	55.64	4.70	68.617	0.086	0.0	0.0	2.6	2.45	97.2	15.5
9.002	55.04	4.85	68.167	0.291	0.0	0.0	8.7	1.00	70.5	52.0

Network Design Table for SW_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
9.003	29.919	0.122	245.0	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
9.004	11.811	0.123	96.0	0.023	0.00	0.0	0.600	o	300	Pipe/Conduit	
9.005	30.298	0.093	325.0	0.058	0.00	0.0	0.600	o	375	Pipe/Conduit	
9.006	24.781	0.076	325.0	0.065	0.00	0.0	0.600	o	375	Pipe/Conduit	
9.007	31.752	0.098	325.0	0.052	0.00	0.0	0.600	o	375	Pipe/Conduit	
7.003	13.256	0.033	405.0	0.009	0.00	0.0	0.600	o	450	Pipe/Conduit	
11.000	46.002	0.271	170.0	0.074	4.00	0.0	0.600	o	225	Pipe/Conduit	
11.001	8.178	0.076	107.6	0.016	0.00	0.0	0.600	o	225	Pipe/Conduit	
11.002	46.780	0.460	101.7	0.094	0.00	0.0	0.600	o	225	Pipe/Conduit	
11.003	39.233	0.160	245.0	0.131	0.00	0.0	0.600	o	300	Pipe/Conduit	
11.004	48.053	0.196	245.2	0.111	0.00	0.0	0.600	o	300	Pipe/Conduit	
12.000	42.142	0.248	170.0	0.101	4.00	0.0	0.600	o	225	Pipe/Conduit	
11.005	53.162	0.313	169.8	0.080	0.00	0.0	0.600	o	375	Pipe/Conduit	
7.004	92.796	0.157	590.0	0.346	0.00	0.0	0.600	o	600	Pipe/Conduit	
7.005	6.648	0.011	590.0	0.014	0.00	0.0	0.600	o	600	Pipe/Conduit	
7.006	68.975	0.117	590.0	0.029	0.00	0.0	0.600	o	600	Pipe/Conduit	
7.007	7.446	0.013	590.0	0.047	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)
9.003	53.11	5.35	68.132	0.351	0.0	0.0	10.1	1.00	70.7	60.6
9.004	52.66	5.47	68.010	0.374	0.0	0.0	10.7	1.60	113.4	64.0
9.005	50.90	5.97	67.812	0.432	0.0	0.0	11.9	1.00	110.4	71.4
9.006	49.57	6.39	67.719	0.497	0.0	0.0	13.3	1.00	110.4	80.1
9.007	47.98	6.92	67.642	0.549	0.0	0.0	14.3	1.00	110.4	85.6
7.003	47.36	7.14	67.470	0.848	0.0	0.0	21.7	1.00	159.7	130.5
11.000	55.38	4.77	69.765	0.074	0.0	0.0	2.2	1.00	39.8	13.3
11.001	54.94	4.87	69.494	0.090	0.0	0.0	2.7	1.26	50.1	16.0
11.002	52.63	5.48	69.418	0.184	0.0	0.0	5.2	1.30	51.5	31.5
11.003	50.39	6.13	68.883	0.315	0.0	0.0	8.6	1.00	70.7	51.6
11.004	47.94	6.93	68.723	0.427	0.0	0.0	11.1	1.00	70.7	66.5
12.000	55.65	4.70	69.375	0.101	0.0	0.0	3.0	1.00	39.8	18.3
11.005	46.19	7.57	68.452	0.607	0.0	0.0	15.2	1.39	153.2	91.2
7.004	42.54	9.12	67.287	1.801	0.0	0.0	41.5	1.00	281.4	249.0
7.005	42.31	9.24	67.130	1.815	0.0	0.0	41.6	1.00	281.4	249.5
7.006	40.05	10.39	67.118	1.844	0.0	0.0	41.6	1.00	281.4	249.5
7.007	39.83	10.52	67.002	1.891	0.0	0.0	41.6	1.00	281.4	249.5

Network Design Table for SW_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
7.008	39.125	0.066	590.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	
7.009	111.287	0.189	590.0	0.084	0.00	0.0	0.600	o	600	Pipe/Conduit	
1.008	10.329	0.023	449.1	0.033	0.00	0.0	0.600	o	675	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)
7.008	38.69	11.17	66.989	1.891	0.0	0.0	41.6	1.00	281.4	249.5
7.009	35.87	13.03	66.923	1.975	0.0	0.0	41.6	1.00	281.4	249.5
1.008	35.68	13.17	66.659	3.652	0.0	0.0	70.6	1.23	440.2	423.5

Free Flowing Outfall Details for SW_1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.008	SA11	70.392	66.636	0.000	1350	0

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SW_2

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	14.700	Add Flow / Climate Change (%)	20
Ratio R	0.269	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 SW_2

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.239	4-8	0.490	8-12	0.007

Total Area Contributing (ha) = 0.736

Total Pipe Volume (m³) = 28.973

Network Design Table for SW_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
1.000	29.638	0.174	170.3	0.086	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	6.732	0.040	168.3	0.006	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	7.180	0.100	71.8	0.009	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	7.012	0.041	171.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	47.263	0.691	68.4	0.112	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	4.49	69.042	0.086	0.0	0.0	2.3	1.00	39.7	14.0
1.001	50.00	4.61	68.868	0.092	0.0	0.0	2.5	1.00	40.0	14.9
2.000	50.00	4.08	68.928	0.009	0.0	0.0	0.3	1.55	61.4	1.5
1.002	50.00	4.72	68.828	0.101	0.0	0.0	2.7	1.00	39.6	16.5
1.003	50.00	5.22	68.787	0.214	0.0	0.0	5.8	1.58	63.0	34.7

Network Design Table for SW_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
3.000	36.184	0.363	99.7	0.101	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	9.757	0.109	89.5	0.022	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	47.397	0.307	154.4	0.060	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.000	10.951	0.100	109.5	0.018	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.006	8.827	0.027	326.9	0.016	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.007	40.485	0.125	323.9	0.114	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.008	9.802	0.036	272.3	0.042	0.00	0.0	0.600	o	375	Pipe/Conduit	
5.000	6.976	0.047	148.4	0.009	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.009	47.390	0.135	351.0	0.097	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.010	25.357	0.261	97.2	0.023	0.00	0.0	0.600	o	375	Pipe/Conduit	
6.000	37.997	0.224	169.6	0.020	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.011	19.613	0.048	408.6	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
3.000	50.00	4.46	68.459	0.101	0.0	0.0	2.7	1.31	52.1	16.4
1.004	50.00	5.34	68.096	0.337	0.0	0.0	9.1	1.38	55.0	54.7
1.005	50.00	5.96	67.912	0.397	0.0	0.0	10.8	1.26	89.3	64.5
4.000	50.00	4.15	67.780	0.018	0.0	0.0	0.5	1.25	49.7	3.0
1.006	50.00	6.11	67.530	0.431	0.0	0.0	11.7	1.00	110.1	70.1
1.007	48.37	6.79	67.503	0.545	0.0	0.0	14.3	1.00	110.6	85.6
1.008	47.93	6.93	67.378	0.586	0.0	0.0	15.2	1.09	120.7	91.3
5.000	50.00	4.11	67.586	0.009	0.0	0.0	0.2	1.07	42.6	1.5
1.009	45.71	7.76	67.342	0.692	0.0	0.0	17.1	0.96	106.2	102.9
1.010	45.14	7.99	67.207	0.716	0.0	0.0	17.5	1.84	203.1	105.0
6.000	50.00	4.63	67.320	0.020	0.0	0.0	0.5	1.00	39.8	3.2
1.011	44.35	8.31	66.400	0.736	0.0	0.0	17.7	1.00	159.0	106.0

Free Flowing Outfall Details for SW_2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.011	SA3-5	68.279	66.352	0.000	1200	0

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SW_3

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	14.700	Add Flow / Climate Change (%)	20
Ratio R	0.269	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 SW_3

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.410	4-8	0.759	8-12	0.019

Total Area Contributing (ha) = 1.188

Total Pipe Volume (m³) = 49.021

Network Design Table for SW_3

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	16.080	0.095	169.3	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	24.235	0.143	170.0	0.028	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	9.708	0.057	170.3	0.006	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	72.569	0.427	170.0	0.143	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	13.929	0.082	170.0	0.011	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	59.642	0.243	245.0	0.114	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	11.699	0.048	243.7	0.171	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)
1.000	50.00	4.27	66.636	0.000	0.0	0.0	0.0	1.00	39.8	0.0
1.001	50.00	4.67	66.541	0.028	0.0	0.0	0.8	1.00	39.8	4.6
1.002	50.00	4.83	66.398	0.034	0.0	0.0	0.9	1.00	39.7	5.5
1.003	50.00	6.04	66.341	0.177	0.0	0.0	4.8	1.00	39.8	28.8
1.004	49.92	6.28	65.914	0.189	0.0	0.0	5.1	1.00	39.8	30.6
1.005	47.00	7.27	65.758	0.303	0.0	0.0	7.7	1.00	70.7	46.3
1.006	46.54	7.44	65.439	0.474	0.0	0.0	12.0	1.16	127.7	71.8

Network Design Table for SW_3

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
2.000	12.450	0.073	170.5	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	17.845	0.105	170.0	0.029	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	38.324	0.225	170.0	0.058	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.002	56.407	0.332	170.0	0.110	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.003	12.521	0.128	97.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.007	48.244	0.148	325.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.008	11.825	0.045	263.3	0.013	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.000	45.886	0.315	145.7	0.142	4.00	0.0	0.600	o	225	Pipe/Conduit	
5.000	37.121	0.218	170.3	0.081	4.00	0.0	0.600	o	225	Pipe/Conduit	
4.001	4.622	0.019	245.0	0.012	0.00	0.0	0.600	o	300	Pipe/Conduit	
4.002	52.774	0.162	325.8	0.154	0.00	0.0	0.600	o	375	Pipe/Conduit	
6.000	41.345	0.243	170.1	0.026	4.00	0.0	0.600	o	225	Pipe/Conduit	
4.003	15.940	0.049	325.3	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)
2.000	50.00	4.21	66.500	0.000	0.0	0.0	0.0	1.00	39.7	0.0
3.000	50.00	4.30	66.332	0.029	0.0	0.0	0.8	1.00	39.8	4.7
2.001	50.00	4.94	66.227	0.087	0.0	0.0	2.3	1.00	39.8	14.1
2.002	50.00	5.88	66.002	0.197	0.0	0.0	5.3	1.00	39.8	32.0
2.003	50.00	6.03	65.670	0.197	0.0	0.0	5.3	1.32	52.6	32.0
1.007	44.52	8.24	65.391	0.671	0.0	0.0	16.2	1.00	110.4	97.1
1.008	44.10	8.42	65.243	0.685	0.0	0.0	16.4	1.11	122.8	98.1
4.000	50.00	4.71	65.921	0.142	0.0	0.0	3.9	1.08	43.0	23.1
5.000	50.00	4.62	65.899	0.081	0.0	0.0	2.2	1.00	39.7	13.2
4.001	50.00	4.78	65.531	0.236	0.0	0.0	6.4	1.00	70.7	38.3
4.002	50.00	5.67	65.437	0.389	0.0	0.0	10.5	1.00	110.3	63.2
6.000	50.00	4.69	66.500	0.026	0.0	0.0	0.7	1.00	39.7	4.3
4.003	50.00	5.93	65.275	0.415	0.0	0.0	11.3	1.00	110.3	67.5

Network Design Table for SW_3

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
4.004	9.132	0.028	326.1	0.035	0.00	0.0	0.600	o	375	Pipe/Conduit	
7.000	51.876	1.305	39.8	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
7.001	6.253	0.037	170.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.009	16.799	0.034	495.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.010	19.591	0.040	495.0	0.053	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.011	8.886	0.018	495.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
4.004	50.00	6.08	65.226	0.451	0.0	0.0	12.2	1.00	110.2	73.2
7.000	50.00	4.42	66.964	0.000	0.0	0.0	0.0	2.08	82.7	0.0
7.001	50.00	4.52	65.659	0.000	0.0	0.0	0.0	1.00	39.8	0.0
1.009	43.47	8.70	65.048	1.135	0.0	0.0	26.7	1.00	216.5	160.4
1.010	42.75	9.03	65.014	1.188	0.0	0.0	27.5	1.00	216.5	165.1
1.011	42.43	9.17	64.974	1.188	0.0	0.0	27.5	1.00	216.5	165.1

Free Flowing Outfall Details for SW_3

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.011	SA0	0.000	64.956	0.000	1200	0

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SW_4

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	14.700	Add Flow / Climate Change (%)	20
Ratio R	0.269	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 SW_4

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.682	4-8	1.265

Total Area Contributing (ha) = 1.947

Total Pipe Volume (m³) = 74.345

Network Design Table for SW_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
1.000	38.348	0.328	116.9	0.179	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	52.623	0.310	169.8	0.116	0.00	0.0	0.600	o	300	Pipe/Conduit	
2.000	11.181	0.231	48.4	0.037	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	21.383	0.305	70.1	0.013	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	20.013	0.082	244.1	0.039	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	4.53	67.802	0.179	0.0	0.0	4.8	1.21	48.0	29.1
1.001	50.00	5.26	67.399	0.295	0.0	0.0	8.0	1.20	85.1	47.9
2.000	50.00	4.10	67.700	0.037	0.0	0.0	1.0	1.88	74.9	5.9
2.001	50.00	4.33	67.469	0.050	0.0	0.0	1.3	1.56	62.2	8.0
1.002	50.00	5.59	67.089	0.383	0.0	0.0	10.4	1.00	70.8	62.2

Network Design Table for SW_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
3.000	47.059	0.659	71.4	0.129	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.001	27.032	0.353	76.6	0.052	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.002	27.797	0.164	169.5	0.040	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	31.052	0.096	323.5	0.062	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.004	58.904	0.317	185.8	0.105	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.000	35.050	1.012	34.6	0.076	4.00	0.0	0.600	o	225	Pipe/Conduit	
4.001	10.041	0.076	132.1	0.018	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.002	57.801	0.340	170.0	0.108	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.000	38.293	0.589	65.0	0.076	4.00	0.0	0.600	o	225	Pipe/Conduit	
4.003	29.099	0.171	170.2	0.061	0.00	0.0	0.600	o	300	Pipe/Conduit	
6.000	14.749	0.516	28.6	0.012	4.00	0.0	0.600	o	225	Pipe/Conduit	
6.001	48.647	0.353	137.8	0.052	0.00	0.0	0.600	o	225	Pipe/Conduit	
7.000	46.865	0.276	169.8	0.109	4.00	0.0	0.600	o	225	Pipe/Conduit	
6.002	19.309	0.114	169.4	0.008	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)
3.000	50.00	4.51	68.510	0.129	0.0	0.0	3.5	1.55	61.6	20.9
3.001	50.00	4.81	67.851	0.180	0.0	0.0	4.9	1.50	59.5	29.3
3.002	50.00	5.27	67.498	0.220	0.0	0.0	6.0	1.00	39.8	35.8
1.003	50.00	6.11	66.932	0.665	0.0	0.0	18.0	1.00	110.7	108.1
1.004	48.18	6.85	66.836	0.771	0.0	0.0	20.1	1.33	146.4	120.7
4.000	50.00	4.26	69.758	0.076	0.0	0.0	2.1	2.23	88.7	12.4
4.001	50.00	4.41	68.746	0.094	0.0	0.0	2.6	1.14	45.2	15.3
4.002	50.00	5.37	68.670	0.202	0.0	0.0	5.5	1.00	39.8	32.8
5.000	50.00	4.39	69.375	0.076	0.0	0.0	2.0	1.62	64.6	12.3
4.003	50.00	5.78	68.255	0.338	0.0	0.0	9.2	1.20	85.0	55.0
6.000	50.00	4.10	68.168	0.012	0.0	0.0	0.3	2.46	97.7	1.9
6.001	50.00	4.83	67.652	0.064	0.0	0.0	1.7	1.11	44.2	10.3
7.000	50.00	4.78	67.575	0.109	0.0	0.0	2.9	1.00	39.8	17.7
6.002	50.00	5.15	67.299	0.181	0.0	0.0	4.9	1.00	39.8	29.3

Network Design Table for SW_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
4.004	5.649	0.017	332.3	0.014	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.005	6.316	0.019	332.4	0.005	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.006	21.300	0.066	322.7	0.011	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.007	10.077	0.031	325.1	0.020	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.008	9.531	0.029	328.7	0.033	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.009	10.930	0.119	91.8	0.014	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.005	53.691	0.166	324.3	0.060	0.00	0.0	0.600	o	525	Pipe/Conduit	
8.000	17.503	0.103	169.9	0.244	4.00	0.0	0.600	o	225	Pipe/Conduit	
8.001	59.538	0.243	245.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
8.002	27.439	0.112	245.0	0.098	0.00	0.0	0.600	o	300	Pipe/Conduit	
9.000	28.609	0.168	170.3	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
8.003	20.335	0.148	137.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
8.004	10.433	0.043	242.6	0.022	0.00	0.0	0.600	o	300	Pipe/Conduit	
8.005	22.237	0.091	244.4	0.012	0.00	0.0	0.600	o	300	Pipe/Conduit	
8.006	16.470	0.424	38.9	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	6.094	0.012	505.0	0.000	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)
4.004	50.00	5.87	67.035	0.533	0.0	0.0	14.4	0.99	109.2	86.6
4.005	50.00	5.98	67.018	0.538	0.0	0.0	14.6	0.99	109.1	87.4
4.006	49.74	6.33	66.999	0.549	0.0	0.0	14.8	1.00	110.8	88.8
4.007	49.22	6.50	66.933	0.569	0.0	0.0	15.2	1.00	110.4	91.0
4.008	48.74	6.66	66.902	0.602	0.0	0.0	15.9	0.99	109.8	95.3
4.009	48.45	6.76	66.873	0.615	0.0	0.0	16.2	1.89	208.9	96.9
1.005	46.19	7.57	66.369	1.446	0.0	0.0	36.2	1.24	268.0	217.1
8.000	50.00	4.29	67.667	0.244	0.0	0.0	6.6	1.00	39.8	39.7
8.001	50.00	5.28	67.489	0.244	0.0	0.0	6.6	1.00	70.7	39.7
8.002	50.00	5.74	67.246	0.342	0.0	0.0	9.3	1.00	70.7	55.6
9.000	50.00	4.48	67.425	0.000	0.0	0.0	0.0	1.00	39.7	0.0
8.003	50.00	5.99	67.134	0.342	0.0	0.0	9.3	1.34	94.7	55.6
8.004	50.00	6.17	66.986	0.365	0.0	0.0	9.9	1.00	71.0	59.2
8.005	49.11	6.54	66.943	0.376	0.0	0.0	10.0	1.00	70.8	60.1
8.006	48.78	6.65	66.852	0.376	0.0	0.0	10.0	2.53	178.8	60.1
1.006	45.95	7.66	66.128	1.822	0.0	0.0	45.4	1.08	304.5	272.1

Network Design Table for SW_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
10.000	75.290	0.443	170.0	0.125	4.00	0.0	0.600	o	225	Pipe/Conduit	
11.000	45.170	0.266	170.0	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.007	5.333	0.011	505.0	0.000	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)
10.000	50.00	5.25	68.052	0.125	0.0	0.0	3.4	1.00	39.8	20.3
11.000	50.00	4.75	66.780	0.000	0.0	0.0	0.0	1.00	39.8	0.0
1.007	45.74	7.75	66.116	1.947	0.0	0.0	48.2	1.08	304.5	289.4

Free Flowing Outfall Details for SW_4

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.007	SB10-2	68.646	66.106	0.000	0	0

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for SW_5

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	PIMP (%)	100
M5-60 (mm)	14.700	Add Flow / Climate Change (%)	20
Ratio R	0.269	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 SW_5

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.082	4-8	0.858	8-12	0.160

Total Area Contributing (ha) = 1.100

Total Pipe Volume (m³) = 65.038

Network Design Table for SW_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
1.000	74.709	0.439	170.2	0.190	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	7.144	0.042	170.1	0.015	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	15.817	0.093	170.1	0.058	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.001	6.309	0.037	170.5	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	28.420	0.116	245.0	0.032	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.25	66.578	0.190	0.0	0.0	5.1	1.00	39.7	30.9
1.001	50.00	5.37	66.139	0.205	0.0	0.0	5.6	1.00	39.7	33.4
2.000	50.00	4.26	67.163	0.058	0.0	0.0	1.6	1.00	39.7	9.4
2.001	50.00	4.37	67.070	0.058	0.0	0.0	1.6	1.00	39.7	9.4
1.002	50.00	5.84	66.022	0.295	0.0	0.0	8.0	1.00	70.7	47.9

Network Design Table for SW_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
1.003	10.427	0.043	242.5	0.006	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.000	15.827	0.093	170.2	0.071	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.001	43.042	0.253	170.1	0.030	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.002	42.620	0.251	169.8	0.065	0.00	0.0	0.600	o	225	Pipe/Conduit	
4.000	46.159	0.272	169.7	0.137	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.003	32.671	0.133	245.6	0.069	0.00	0.0	0.600	o	300	Pipe/Conduit	
5.000	26.998	0.159	169.8	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.004	7.472	0.030	245.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
6.000	12.053	0.471	25.6	0.000	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	18.418	0.045	409.3	0.025	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.005	8.359	0.068	123.8	0.019	0.00	0.0	0.600	o	450	Pipe/Conduit	
7.000	38.694	0.258	150.0	0.102	4.00	0.0	0.600	o	225	Pipe/Conduit	
7.001	10.875	0.084	129.5	0.048	0.00	0.0	0.600	o	225	Pipe/Conduit	
7.002	46.398	0.273	170.0	0.081	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.003	50.00	6.01	65.906	0.301	0.0	0.0	8.1	1.01	71.1	48.9
3.000	50.00	4.26	67.395	0.071	0.0	0.0	1.9	1.00	39.7	11.6
3.001	50.00	4.98	67.302	0.101	0.0	0.0	2.7	1.00	39.7	16.5
3.002	50.00	5.69	67.049	0.166	0.0	0.0	4.5	1.00	39.8	27.0
4.000	50.00	4.77	67.362	0.137	0.0	0.0	3.7	1.00	39.8	22.3
3.003	50.00	6.24	66.723	0.371	0.0	0.0	10.1	1.00	70.6	60.4
5.000	50.00	4.45	68.000	0.000	0.0	0.0	0.0	1.00	39.8	0.0
3.004	49.65	6.36	66.590	0.371	0.0	0.0	10.1	1.00	70.7	60.4
6.000	50.00	4.08	68.175	0.000	0.0	0.0	0.0	2.60	103.3	0.0
1.004	48.71	6.67	65.713	0.698	0.0	0.0	18.4	1.00	158.8	110.4
1.005	48.48	6.75	65.668	0.717	0.0	0.0	18.8	1.83	290.4	112.9
7.000	50.00	4.61	66.515	0.102	0.0	0.0	2.8	1.07	42.4	16.5
7.001	50.00	4.76	66.257	0.149	0.0	0.0	4.0	1.15	45.6	24.3
7.002	50.00	5.54	66.173	0.230	0.0	0.0	6.2	1.00	39.8	37.4

Network Design Table for SW_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
7.003	18.199	0.075	244.2	0.020	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.006	12.910	0.026	495.0	0.020	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.007	35.324	0.071	495.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.008	10.190	0.021	495.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.009	22.276	0.045	495.0	0.095	0.00	0.0	0.600	o	525	Pipe/Conduit	
8.000	25.386	0.393	64.6	0.018	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.010	7.816	0.016	495.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.011	26.338	0.053	495.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.012	36.584	0.074	495.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.013	21.915	0.044	495.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
7.003	50.00	5.84	65.825	0.250	0.0	0.0	6.8	1.00	70.8	40.7
1.006	47.86	6.96	65.525	0.987	0.0	0.0	25.6	1.00	216.5	153.5
1.007	46.25	7.55	65.499	0.987	0.0	0.0	25.6	1.00	216.5	153.5
1.008	45.81	7.72	65.428	0.987	0.0	0.0	25.6	1.00	216.5	153.5
1.009	44.89	8.09	65.407	1.081	0.0	0.0	26.3	1.00	216.5	157.8
8.000	50.00	4.26	66.060	0.018	0.0	0.0	0.5	1.63	64.8	3.0
1.010	44.57	8.22	65.362	1.100	0.0	0.0	26.6	1.00	216.5	159.3
1.011	43.56	8.66	65.347	1.100	0.0	0.0	26.6	1.00	216.5	159.3
1.012	42.24	9.27	65.293	1.100	0.0	0.0	26.6	1.00	216.5	159.3
1.013	41.49	9.63	65.220	1.100	0.0	0.0	26.6	1.00	216.5	159.3

Free Flowing Outfall Details for SW_5

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.013	SB0	0.000	65.175	0.000	1200	0

Appendix D

FOUL SEWER CALCULATIONS

FOUL SEWERAGE DESIGN

Design Criteria for FS_1

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00
Industrial Peak Flow Factor	0.00
Calculation Method	BS 8301
Frequency Factor	0.00
Domestic (l/s/ha)	0.00
Domestic Peak Flow Factor	6.00
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.100
Maximum Backdrop Height (m)	2.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	46.579	0.453	102.8	0.000	168.0	0.0	1.500	o	150	Pipe/Conduit	
1.001	39.337	0.342	115.0	0.000	112.0	0.0	1.500	o	150	Pipe/Conduit	
1.002	40.906	0.356	114.9	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
1.003	10.158	0.088	115.4	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.004	59.762	0.520	114.9	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
2.000	73.994	1.233	60.0	0.000	280.0	0.0	1.500	o	150	Pipe/Conduit	
1.005	16.865	0.125	134.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
3.000	38.729	0.495	78.2	0.000	140.0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	69.786	0.000	0.0	168.0	0.0	56	0.75	0.86	15.3	4.4
1.001	69.333	0.000	0.0	280.0	0.0	62	0.75	0.82	14.4	5.1
1.002	68.916	0.000	0.0	420.0	0.0	56	0.75	1.07	42.6	5.8
1.003	68.560	0.000	0.0	420.0	0.0	56	0.75	1.07	42.5	5.8
1.004	68.472	0.000	0.0	448.0	0.0	57	0.75	1.07	42.6	5.9
2.000	69.870	0.000	0.0	280.0	0.0	52	0.94	1.13	20.0	5.1
1.005	67.952	0.000	0.0	728.0	0.0	65	0.75	0.99	39.3	7.1
3.000	69.644	0.000	0.0	140.0	0.0	50	0.81	0.99	17.5	4.3

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
4.000	37.476	0.435	86.2	0.000	42.0	0.0	1.500	o	150	Pipe/Conduit	
3.001	80.044	0.696	115.0	0.000	224.0	0.0	1.500	o	225	Pipe/Conduit	
3.002	17.268	0.150	115.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.006	26.664	0.172	155.0	0.000	14.0	0.0	1.500	o	225	Pipe/Conduit	
1.007	22.915	0.148	154.8	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.008	15.913	0.099	160.7	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
5.000	45.192	0.459	98.5	0.000	280.0	0.0	1.500	o	150	Pipe/Conduit	
5.001	11.430	0.122	93.7	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
5.002	8.021	0.082	97.8	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
5.003	30.537	0.500	61.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
5.004	13.321	0.201	66.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.000	36.850	0.246	149.8	0.000	168.0	0.0	1.500	o	150	Pipe/Conduit	
5.005	18.862	0.126	150.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.009	20.449	0.108	190.0	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
1.010	50.771	0.267	190.0	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
4.000	69.300	0.000	0.0	42.0	0.0	45	0.73	0.94	16.7	3.3
3.001	68.790	0.000	0.0	406.0	0.0	56	0.75	1.07	42.5	5.7
3.002	68.094	0.000	0.0	406.0	0.0	56	0.75	1.07	42.5	5.7
1.006	67.827	0.000	0.0	1148.0	0.0	74	0.75	0.92	36.6	8.6
1.007	67.655	0.000	0.0	1148.0	0.0	74	0.75	0.92	36.6	8.6
1.008	67.507	0.000	0.0	1288.0	0.0	77	0.75	0.90	36.0	9.0
5.000	69.398	0.000	0.0	280.0	0.0	59	0.79	0.88	15.6	5.1
5.001	68.939	0.000	0.0	280.0	0.0	58	0.80	0.91	16.0	5.1
5.002	68.742	0.000	0.0	364.0	0.0	53	0.78	1.16	46.1	5.5
5.003	68.660	0.000	0.0	364.0	0.0	47	0.92	1.47	58.5	5.5
5.004	68.160	0.000	0.0	364.0	0.0	48	0.90	1.41	56.1	5.5
6.000	68.039	0.000	0.0	168.0	0.0	62	0.65	0.71	12.6	4.4
5.005	67.718	0.000	0.0	532.0	0.0	63	0.70	0.94	37.2	6.3
1.009	67.408	0.000	0.0	1904.0	0.0	89	0.75	0.83	33.1	11.0
1.010	67.300	0.000	0.0	1988.0	0.0	91	0.75	0.83	33.1	11.3

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
7.000	41.194	0.458	90.0	0.000	84.0	0.0	1.500	o	150	Pipe/Conduit	
1.011	14.724	0.076	195.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
8.000	30.954	0.925	33.5	0.000	70.0	0.0	1.500	o	150	Pipe/Conduit	
8.001	4.851	0.055	88.2	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
8.002	56.796	0.568	100.0	0.000	112.0	0.0	1.500	o	150	Pipe/Conduit	
9.000	32.974	0.575	57.3	0.000	70.0	0.0	1.500	o	150	Pipe/Conduit	
8.003	28.319	0.246	115.0	0.000	42.0	0.0	1.500	o	150	Pipe/Conduit	
8.004	6.591	0.057	115.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
1.012	40.170	0.201	199.9	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
10.000	15.385	0.103	150.0	0.000	56.0	0.0	1.500	o	150	Pipe/Conduit	
10.001	24.755	0.184	134.5	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
11.000	41.922	0.279	150.3	0.000	84.0	0.0	1.500	o	150	Pipe/Conduit	
10.002	18.628	0.124	150.2	0.000	42.0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
7.000	67.704	0.000	0.0	84.0	0.0	49	0.75	0.92	16.3	3.8
1.011	67.033	0.000	0.0	2072.0	0.0	92	0.75	0.82	32.6	11.5
8.000	69.657	0.000	0.0	70.0	0.0	37	1.05	1.52	26.8	3.6
8.001	68.732	0.000	0.0	70.0	0.0	48	0.75	0.93	16.5	3.6
8.002	68.677	0.000	0.0	182.0	0.0	56	0.76	0.88	15.5	4.5
9.000	69.439	0.000	0.0	70.0	0.0	43	0.87	1.16	20.5	3.6
8.003	68.109	0.000	0.0	294.0	0.0	62	0.75	0.82	14.4	5.2
8.004	67.863	0.000	0.0	294.0	0.0	62	0.75	0.82	14.4	5.2
1.012	66.758	0.000	0.0	2450.0	0.0	98	0.76	0.81	32.2	12.7
10.000	68.500	0.000	0.0	56.0	0.0	54	0.61	0.71	12.6	3.5
10.001	68.397	0.000	0.0	56.0	0.0	52	0.63	0.75	13.3	3.5
11.000	68.494	0.000	0.0	84.0	0.0	56	0.62	0.71	12.6	3.8
10.002	68.213	0.000	0.0	182.0	0.0	62	0.65	0.71	12.6	4.5

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
12.000	15.055	0.100	150.6	0.000	42.0	0.0	1.500	o	150	Pipe/Conduit	
10.003	27.911	0.186	150.1	0.000	168.0	0.0	1.500	o	225	Pipe/Conduit	
10.004	34.748	0.232	149.8	0.000	98.0	0.0	1.500	o	225	Pipe/Conduit	
10.005	56.876	0.379	150.1	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
1.013	23.767	0.119	199.7	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
13.000	22.446	0.214	104.9	0.000	294.0	0.0	1.500	o	225	Pipe/Conduit	
13.001	101.311	0.965	105.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.014	13.842	0.069	200.6	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
1.015	10.120	0.051	200.0	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
1.016	24.590	0.123	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
14.000	63.326	0.688	92.0	0.000	98.0	0.0	1.500	o	150	Pipe/Conduit	
14.001	34.558	0.376	92.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
1.017	26.672	0.152	175.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
15.000	70.537	0.470	150.1	0.000	224.0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
12.000	68.212	0.000	0.0	42.0	0.0	52	0.60	0.71	12.6	3.3
10.003	68.014	0.000	0.0	392.0	0.0	59	0.68	0.94	37.2	5.7
10.004	67.828	0.000	0.0	490.0	0.0	62	0.69	0.94	37.3	6.1
10.005	67.596	0.000	0.0	630.0	0.0	65	0.71	0.94	37.2	6.7
1.013	66.557	0.000	0.0	3080.0	0.0	106	0.79	0.81	32.2	14.6
13.000	67.817	0.000	0.0	294.0	0.0	52	0.75	1.12	44.6	5.2
13.001	67.603	0.000	0.0	294.0	0.0	52	0.75	1.12	44.5	5.2
1.014	66.438	0.000	0.0	3430.0	0.0	111	0.80	0.81	32.2	15.7
1.015	66.369	0.000	0.0	3486.0	0.0	112	0.81	0.81	32.2	15.9
1.016	66.318	0.000	0.0	3486.0	0.0	112	0.81	0.81	32.2	15.9
14.000	68.122	0.000	0.0	98.0	0.0	50	0.75	0.91	16.1	3.9
14.001	67.434	0.000	0.0	98.0	0.0	50	0.75	0.91	16.1	3.9
1.017	66.195	0.000	0.0	3584.0	0.0	108	0.85	0.87	34.5	16.2
15.000	66.643	0.000	0.0	224.0	0.0	64	0.66	0.71	12.6	4.8

Network Design Table for FS_1

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
15.001	8.305	0.055	151.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
1.018	31.275	0.156	200.5	0.000	70.0	0.0	1.500	o	225	Pipe/Conduit	
1.019	5.258	0.026	202.2	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
16.000	26.343	0.222	118.7	0.000	84.0	0.0	1.500	o	150	Pipe/Conduit	
16.001	48.127	0.222	216.8	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
16.002	41.026	0.410	100.1	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
1.020	19.586	0.098	199.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.021	8.072	0.040	200.0	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
17.000	35.224	0.235	149.9	0.000	98.0	0.0	1.500	o	150	Pipe/Conduit	
17.001	4.796	0.032	149.9	0.000	98.0	0.0	1.500	o	150	Pipe/Conduit	
17.002	4.796	0.047	102.0	0.000	14.0	0.0	1.500	o	225	Pipe/Conduit	
17.003	44.722	0.298	150.1	0.000	126.0	0.0	1.500	o	225	Pipe/Conduit	
17.004	14.685	0.116	126.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.022	64.610	0.323	200.0	0.000	112.0	0.0	1.500	o	225	Pipe/Conduit	
1.023	7.917	0.040	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.024	33.533	0.168	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.025	39.013	0.195	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
15.001	66.173	0.000	0.0	224.0	0.0	64	0.66	0.71	12.6	4.8
1.018	66.043	0.000	0.0	3878.0	0.0	117	0.82	0.81	32.2	17.1
1.019	65.887	0.000	0.0	3906.0	0.0	117	0.82	0.81	32.0	17.2
16.000	68.386	0.000	0.0	84.0	0.0	53	0.68	0.80	14.2	3.8
16.001	68.164	0.000	0.0	84.0	0.0	62	0.54	0.59	10.5	3.8
16.002	67.867	0.000	0.0	140.0	0.0	46	0.72	1.15	45.6	4.3
1.020	65.550	0.000	0.0	4046.0	0.0	119	0.83	0.81	32.2	17.6
1.021	65.452	0.000	0.0	4074.0	0.0	119	0.83	0.81	32.2	17.7
17.000	66.894	0.000	0.0	98.0	0.0	57	0.63	0.71	12.6	3.9
17.001	66.659	0.000	0.0	196.0	0.0	63	0.66	0.71	12.6	4.6
17.002	66.552	0.000	0.0	210.0	0.0	49	0.73	1.14	45.2	4.7
17.003	66.505	0.000	0.0	336.0	0.0	58	0.67	0.94	37.2	5.4
17.004	66.207	0.000	0.0	336.0	0.0	56	0.71	1.02	40.5	5.4
1.022	65.412	0.000	0.0	4522.0	0.0	125	0.84	0.81	32.2	19.1
1.023	65.089	0.000	0.0	4522.0	0.0	125	0.84	0.81	32.2	19.1
1.024	65.049	0.000	0.0	4522.0	0.0	125	0.84	0.81	32.2	19.1
1.025	64.881	0.000	0.0	4522.0	0.0	125	0.84	0.81	32.2	19.1

Free Flowing Outfall Details for FS_1

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.025	FA0	0.000	64.686	68.000	1200	0

FOUL SEWERAGE DESIGN

Design Criteria for FS_2

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00
Industrial Peak Flow Factor	0.00
Calculation Method	BS 8301
Frequency Factor	0.00
Domestic (l/s/ha)	0.00
Domestic Peak Flow Factor	6.00
Add Flow / Climate Change (%)	0
Minimum Backdrop Height (m)	0.100
Maximum Backdrop Height (m)	2.000
Min Design Depth for Optimisation (m)	1.200
Min Vel for Auto Design only (m/s)	0.75
Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	26.006	0.289	90.0	0.000	84.0	0.0	1.500	o	150	Pipe/Conduit	
1.001	9.720	0.108	90.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
1.002	44.112	0.432	102.0	0.000	112.0	0.0	1.500	o	150	Pipe/Conduit	
1.003	9.228	0.090	102.5	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
2.000	39.431	0.415	95.0	0.000	126.0	0.0	1.500	o	150	Pipe/Conduit	
1.004	11.049	0.105	105.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.005	42.276	0.384	110.0	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
1.006	9.950	0.090	110.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.007	9.950	0.087	115.0	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	69.350	0.000	0.0	84.0	0.0	49	0.75	0.92	16.3	3.8
1.001	69.061	0.000	0.0	84.0	0.0	49	0.75	0.92	16.3	3.8
1.002	68.953	0.000	0.0	196.0	0.0	57	0.76	0.87	15.3	4.6
1.003	68.521	0.000	0.0	196.0	0.0	57	0.76	0.86	15.3	4.6
2.000	68.450	0.000	0.0	126.0	0.0	52	0.75	0.90	15.9	4.1
1.004	67.960	0.000	0.0	322.0	0.0	53	0.75	1.12	44.5	5.3
1.005	67.855	0.000	0.0	378.0	0.0	55	0.75	1.09	43.5	5.6
1.006	67.470	0.000	0.0	378.0	0.0	55	0.75	1.09	43.5	5.6
1.007	67.380	0.000	0.0	462.0	0.0	57	0.75	1.07	42.5	6.0

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.008	37.709	0.290	130.0	0.000	196.0	0.0	1.500	o	225	Pipe/Conduit	
1.009	7.999	0.070	114.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
3.000	12.274	0.164	75.0	0.000	28.0	0.0	1.500	o	150	Pipe/Conduit	
1.010	52.103	0.378	137.7	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
1.011	8.047	0.060	134.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
4.000	80.443	0.789	102.0	0.000	168.0	0.0	1.500	o	150	Pipe/Conduit	
4.001	5.652	0.049	115.0	0.000	140.0	0.0	1.500	o	150	Pipe/Conduit	
4.002	32.970	0.287	115.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
5.000	66.381	0.664	100.0	0.000	140.0	0.0	1.500	o	150	Pipe/Conduit	
4.003	26.384	0.240	110.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
6.000	13.004	0.182	71.5	0.000	294.0	0.0	1.500	o	150	Pipe/Conduit	
6.001	9.382	0.182	51.5	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
6.002	83.734	0.728	115.0	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
4.004	14.797	0.110	135.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
4.005	19.284	0.143	135.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.008	67.293	0.000	0.0	658.0	0.0	63	0.75	1.01	40.0	6.8
1.009	67.003	0.000	0.0	658.0	0.0	61	0.78	1.07	42.7	6.8
3.000	68.300	0.000	0.0	28.0	0.0	41	0.75	1.01	17.9	3.0
1.010	66.933	0.000	0.0	770.0	0.0	66	0.75	0.98	38.9	7.2
1.011	66.555	0.000	0.0	770.0	0.0	65	0.75	0.99	39.4	7.2
4.000	69.800	0.000	0.0	168.0	0.0	55	0.75	0.87	15.3	4.4
4.001	69.011	0.000	0.0	308.0	0.0	63	0.75	0.82	14.4	5.3
4.002	68.962	0.000	0.0	308.0	0.0	63	0.75	0.82	14.4	5.3
5.000	70.292	0.000	0.0	140.0	0.0	54	0.75	0.88	15.5	4.3
4.003	68.600	0.000	0.0	448.0	0.0	56	0.76	1.09	43.5	5.9
6.000	69.200	0.000	0.0	294.0	0.0	55	0.89	1.04	18.3	5.2
6.001	69.018	0.000	0.0	294.0	0.0	50	1.00	1.22	21.6	5.2
6.002	68.836	0.000	0.0	294.0	0.0	62	0.75	0.82	14.4	5.2
4.004	68.033	0.000	0.0	742.0	0.0	65	0.75	0.99	39.3	7.1
4.005	67.923	0.000	0.0	742.0	0.0	65	0.75	0.99	39.3	7.1

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
7.000	81.066	0.771	105.1	0.000	210.0	0.0	1.500	o	150	Pipe/Conduit	
4.006	43.468	0.290	150.0	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
4.007	8.063	0.054	150.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
8.000	22.731	0.267	85.1	0.000	84.0	0.0	1.500	o	150	Pipe/Conduit	
8.001	10.680	0.416	25.7	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
4.008	7.702	0.050	155.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
4.009	52.070	0.316	165.0	0.000	196.0	0.0	1.500	o	225	Pipe/Conduit	
4.010	51.018	0.309	165.0	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
4.011	11.111	0.267	41.5	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.012	6.921	0.035	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.013	11.933	0.060	200.0	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
1.014	10.068	0.150	67.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
9.000	43.136	0.454	95.0	0.000	126.0	0.0	1.500	o	150	Pipe/Conduit	
9.001	7.843	0.220	35.6	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
1.015	51.824	0.259	200.1	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
7.000	69.370	0.000	0.0	210.0	0.0	58	0.75	0.85	15.1	4.7
4.006	67.780	0.000	0.0	1036.0	0.0	72	0.75	0.94	37.2	8.2
4.007	67.491	0.000	0.0	1036.0	0.0	72	0.75	0.94	37.2	8.2
8.000	69.050	0.000	0.0	84.0	0.0	49	0.76	0.95	16.8	3.8
8.001	68.783	0.000	0.0	84.0	0.0	36	1.17	1.73	30.6	3.8
4.008	67.437	0.000	0.0	1120.0	0.0	74	0.75	0.92	36.6	8.5
4.009	67.387	0.000	0.0	1316.0	0.0	78	0.75	0.89	35.5	9.1
4.010	67.072	0.000	0.0	1372.0	0.0	79	0.75	0.89	35.5	9.3
4.011	66.762	0.000	0.0	1372.0	0.0	55	1.23	1.78	70.9	9.3
1.012	66.495	0.000	0.0	2142.0	0.0	94	0.75	0.81	32.2	11.8
1.013	66.460	0.000	0.0	2170.0	0.0	94	0.75	0.81	32.2	11.8
1.014	66.401	0.000	0.0	2170.0	0.0	70	1.11	1.40	55.8	11.8
9.000	67.000	0.000	0.0	126.0	0.0	52	0.75	0.90	15.9	4.1
9.001	66.546	0.000	0.0	126.0	0.0	41	1.07	1.47	26.0	4.1
1.015	66.251	0.000	0.0	2352.0	0.0	97	0.76	0.81	32.2	12.4

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
10.000	20.781	0.291	71.4	0.000	28.0	0.0	1.500	o	150	Pipe/Conduit	
10.001	41.418	0.543	76.3	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
1.016	8.640	0.043	200.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
11.000	54.020	0.750	72.0	0.000	168.0	0.0	1.500	o	150	Pipe/Conduit	
1.017	59.151	0.296	199.8	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
12.000	57.930	0.579	100.1	0.000	168.0	0.0	1.500	o	150	Pipe/Conduit	
12.001	60.881	0.576	105.7	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
12.002	9.695	0.092	105.4	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
13.000	16.063	0.107	150.1	0.000	84.0	0.0	1.500	o	150	Pipe/Conduit	
13.001	4.684	0.031	151.1	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
13.002	11.911	0.079	150.8	0.000	0.0	0.0	1.500	o	150	Pipe/Conduit	
12.003	8.820	0.079	111.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
12.004	14.193	0.267	53.2	0.000	224.0	0.0	1.500	o	225	Pipe/Conduit	
14.000	46.006	0.100	460.1	0.000	42.0	0.0	1.500	o	150	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
10.000	67.350	0.000	0.0	28.0	0.0	41	0.76	1.04	18.3	3.0
10.001	67.059	0.000	0.0	28.0	0.0	42	0.74	1.00	17.7	3.0
1.016	65.992	0.000	0.0	2380.0	0.0	97	0.76	0.81	32.1	12.5
11.000	67.240	0.000	0.0	168.0	0.0	51	0.85	1.03	18.3	4.4
1.017	65.949	0.000	0.0	2688.0	0.0	101	0.77	0.81	32.2	13.4
12.000	67.950	0.000	0.0	168.0	0.0	55	0.76	0.88	15.5	4.4
12.001	67.296	0.000	0.0	308.0	0.0	52	0.75	1.12	44.4	5.3
12.002	66.720	0.000	0.0	308.0	0.0	52	0.75	1.12	44.5	5.3
13.000	67.091	0.000	0.0	84.0	0.0	56	0.62	0.71	12.6	3.8
13.001	66.984	0.000	0.0	84.0	0.0	56	0.62	0.71	12.6	3.8
13.002	66.953	0.000	0.0	84.0	0.0	56	0.62	0.71	12.6	3.8
12.003	66.628	0.000	0.0	392.0	0.0	55	0.75	1.09	43.2	5.7
12.004	66.549	0.000	0.0	616.0	0.0	49	1.02	1.58	62.7	6.6
14.000	66.500	0.000	0.0	42.0	0.0	71	0.40	0.41	7.2	3.3

Network Design Table for FS_2

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
12.005	54.244	0.267	203.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
12.006	9.751	0.122	80.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.018	47.550	0.238	200.0	0.000	70.0	0.0	1.500	o	225	Pipe/Conduit	
1.019	27.758	0.139	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.020	15.293	0.076	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.021	32.323	0.162	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.022	27.518	0.138	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.023	20.082	0.100	200.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
12.005	66.282	0.000	0.0	658.0	0.0	70	0.64	0.80	32.0	6.8
12.006	66.015	0.000	0.0	658.0	0.0	56	0.89	1.28	51.0	6.8
1.018	65.653	0.000	0.0	3416.0	0.0	111	0.80	0.81	32.2	15.7
1.019	65.415	0.000	0.0	3416.0	0.0	111	0.80	0.81	32.2	15.7
1.020	65.276	0.000	0.0	3416.0	0.0	111	0.80	0.81	32.2	15.7
1.021	65.200	0.000	0.0	3416.0	0.0	111	0.80	0.81	32.2	15.7
1.022	65.038	0.000	0.0	3416.0	0.0	111	0.80	0.81	32.2	15.7
1.023	64.900	0.000	0.0	3416.0	0.0	111	0.80	0.81	32.2	15.7

Free Flowing Outfall Details for FS_2

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.023	FB0	0.000	64.800	67.000	1200	0

Appendix E

CONFIRMATION OF FEASIBILITY

Martin Lyndon

702 NW Business Park
Ballycoolin, Blanchardstown
Dublin

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

29 November 2021

Re: CDS21000957 pre-connection enquiry - Subject to contract | Contract denied

Connection for Multi/Mixed Use Development of 800 unit(s) at Cherry Lane, Ashbourne, Meath

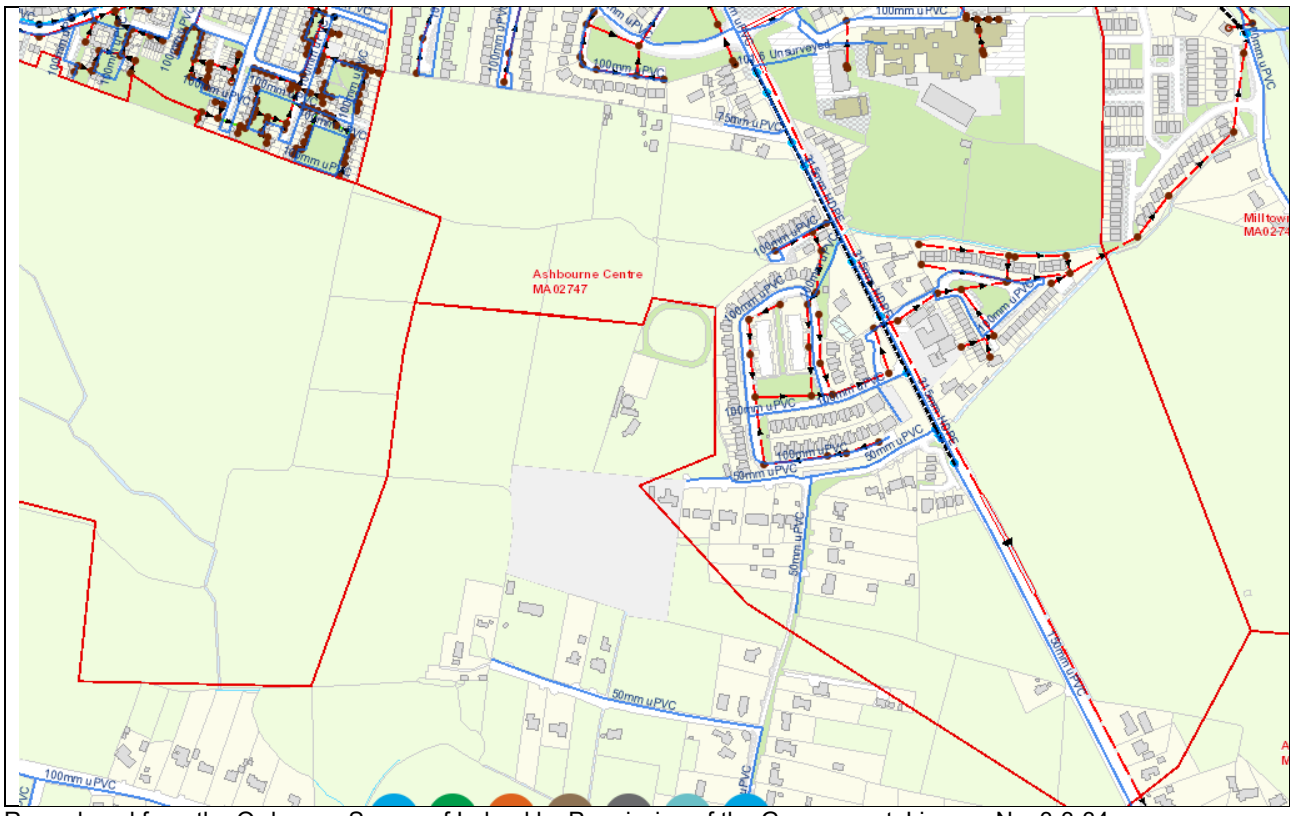
Dear Sir/Madam,

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

SERVICE	**OUTCOME OF PRE-CONNECTION ENQUIRY** **THIS IS NOT A CONNECTION OFFER. YOU MUST APPLY FOR A CONNECTION(S) TO THE IRISH WATER NETWORK(S) IF YOU WISH TO PROCEED.**
Water Connection	Feasible Subject to upgrades
Wastewater Connection	Feasible Subject to upgrades
SITE SPECIFIC COMMENTS	
Water Connection	In order to connected the proposed development, a connection should be made to the new main in the Dublin Rd at the entrance to the development. Minimum connection size 180mmID and this size pipe should continue into the development to act as a spine main.
Wastewater Connection	The existing Pump Stations at Ashbourne and Kilbride would require some upgrade works regarding installation of new flow meters, storm overflow storage facilities and telemetry. Irish Water do not have plans to upgrade these pump stations. A study and investigation of the pump station to determine the upgrades would be required. In addition, a 570m wastewater network extension is required.

The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this development shall comply with the Irish Water Connections and Developer Services Standard Details and Codes of Practice that are available on the Irish Water website. Irish Water reserves the right to supplement these requirements with Codes of Practice and these will be issued with the connection agreement.

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



Reproduced from the Ordnance Survey of Ireland by Permission of the Government. License No. 3-3-34

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

General Notes:

1) The initial assessment referred to above is carried out taking into account water demand and wastewater discharge volumes and infrastructure details on the date of the assessment. **The availability of capacity may change at any date after this assessment.**

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

If you have any further questions, please contact Paul Fuller from the design team on (087) 718-6226 or email PFuller@water.ie For further information, visit **www.water.ie/connections.**

Yours sincerely,

Yvonne Harris

Head of Customer Operations

Appendix F

STATEMENT OF DESIGN ACCEPTANCE

Brendan Manning
Ormond House
Upper Ormond Quay
Dublin 7

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

2 September 2022

Re: Design Submission for Cherry Lane, Ashbourne, Meath (the "Development") (the "Design Submission") / Connection Reference No: CDS21000957

Dear Brendan Manning,

Many thanks for your recent Design Submission.

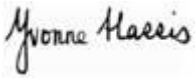
We have reviewed your proposal for the connection(s) at the Development. Based on the information provided, which included the documents outlined in Appendix A to this letter, Irish Water has no objection to your proposals.

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

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

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

Yours sincerely,



Yvonne Harris
Head of Customer Operations

Appendix A

Document Title & Revision

- 200059-DBFL-CS-SP-DR-C-1301 Site Services Layout Sheet 1
- 200059-DBFL-CS-SP-DR-C-1302 Site Services Layout Sheet 2
- 200059-DBFL-CS-SP-DR-C-1303 Site Services Layout Sheet 3
- 200059-DBFL-CS-SP-DR-C-1304 Site Services Layout Sheet 4
- 200059-DBFL-FW-SP-DR-C-3301 Longitudinal Sections Through Foul Sewer Sheet 1
- 200059-DBFL-FW-SP-DR-C-3302 Longitudinal Sections Through Foul Sewer Sheet 2
- 200059-DBFL-FW-SP-DR-C-3303 Longitudinal Sections Through Foul Sewer Sheet 3
- 200059-DBFL-FW-SP-DR-C-3304 Longitudinal Sections Through Foul Sewer Sheet 4
- 200059-DBFL-FW-SP-DR-C-3305 Longitudinal Sections Through Foul Sewer Sheet 5
- 200059-DBFL-FW-SP-DR-C-3306 Longitudinal Sections Through Foul Sewer Sheet 6
- 200059-DBFL-FW-SP-DR-C-3307 Longitudinal Sections Through Foul Sewer Sheet 7
- 200059-DBFL-WM-SP-DR-C-1301 Proposed Watermain Layout Sheet 1
- 200059-DBFL-WM-SP-DR-C-1302 Proposed Watermain Layout Sheet 2
- 200059-DBFL-WM-SP-DR-C-1303 Proposed Watermain Layout Sheet 3
- 200059-DBFL-WM-SP-DR-C-1304 Proposed Watermain Layout Sheet 4

Additional Comments

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

Irish Water cannot guarantee that its Network in any location will have the capacity to deliver a particular flow rate and associated residual pressure to meet the requirements of the relevant Fire Authority, see Section 1.17 of Water Code of Practice.

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 G

GROUND INVESTIGATION

PROPOSED HOUSING
DEVELOPMENT
ASHBOURNE
COUNTY MEATH

DBFL
CONSULTING ENGINEERS

CONTENTS

APPENDICES

REPORT ON A SITE INVESTIGATION
FOR A PROPOSED HOUSING DEVELOPMENT
AT
CHERRY LANE ASHBOURNE

FOR

ARNUB LTD / ASPECT HOMES LTD

DBFL
CONSULTING ENGINEERS

Report No. 24190 **August 2022**

I Introduction

A new housing development is proposed for a greenfield site located at Cherry Lane in Ashbourne, County Meath.

An investigation of sub soil conditions in the area of the new development has been carried out by IGSL for DBFL Consulting Engineers on behalf of the developers.

The site investigation included the following elements.

*	Cable Percussion Boreholes	2 nr.
•	Rotary Core Holes	2 nr
•	Trial Pits	7 nr.
•	Heavy Duty Dynamic Probes	7 nr.
•	BRE Digest Percolation Tests	7 nr.
•	Geotechnical Laboratory Testing	
•	Environmental and Chemical Laboratory Testing	

This report includes all factual data available from field and laboratory operations and discusses these findings relative to foundation and infrastructural design for the proposed new development.

II Fieldwork

This major housing development is to take place on a site located in Ashbourne, County Meath. The site is extensive with ground level variations from 67.5 to 78.0 OD recorded.

The site and exploratory locations are noted on the drawings enclosed in Appendix VII and were marked out by IGSL on site. All locations were referenced to National Grid and OD levels were established. Commencing surface was generally topsoil.

Two boreholes were completed at one major structure as noted on the site plan. Over the remainder of the site seven locations were selected for Trial Pit / Percolation and Dynamic Probe assessment, widely spaced over the site area.

The various elements of the investigation are detailed in the following paragraphs. All field works were supervised by an experienced geotechnical engineer who carefully recorded stratification, took photographs as necessary, recovered samples and prepared detailed records.

Close liaison was maintained throughout with Consulting Engineer and Civic Authorities. All appropriate documentation was submitted and approved prior to site commencement. Each location was scanned electronically (CAT) to ensure that existing services were not damaged. A shallow trial pit was also opened by hand at the exploratory borehole / corehole locations to confirm this.

Statutory HSE safety precautions relating to COVID 19 were observed, with working areas restricted to IGSL personnel only, to ensure safety of the general public.

Boreholes

Boreholes were 200mm diameter and were constructed using conventional 200mm diameter cable percussion equipment. Holes were referenced BH01 and BH02. A trial pit was opened at each borehole location to 1.00 metre deep to ensure that underground services were not damaged.

Detailed geotechnical records are contained in Appendix I to this report - the records give details of stratification, sampling, in-situ testing and groundwater. Note is also taken of any obstructions to normal boring requiring the use of the heavy chisel for advancement. In general it was not possible to recover undisturbed samples because of the granular nature of the strata encountered and the presence of cobbles and boulders and shallow bedrock.

At BH01 topsoil overlies firm grey and black gravelly silty CLAY which continues to 2.50 metres. Very stiff black gravelly CLAY with cobbles and occasional boulders continues from 2.50 to 5.20 metres. A boulder obstruction at 5.20 prevented advancement. Water ingress was noted at 1.80 metres and a standpipe was installed to monitor ground water variations.

BH02 encountered firm to stiff gravelly CLAY below topsoil, with very stiff black gravelly CLAY encountered at 2.40 metres and continuing to refusal at 5.30 metres. This borehole was DRY and a standpipe was also installed.

The soils encountered represent glacial till or boulder clay deposition, the very stiff to hard gravelly CLAY below 2.50 metres is a black lodgement till, locally referred to as BLACK BOULDER CLAY. The shallower gravelly brown boulder clay varies in strength from soft to firm to occasionally stiff.

Rotary Core Drilling

Rotary core drilling was employed at both borehole locations to advance investigation depth, establish bedrock horizon and recover representative rock core.

A Geo-405 drilling rig was used to core drill using triple tube core drilling technique and an air-mist coolant. Symmetrix open hole drilling (100mm diameter) was used through the overburden deposits.

Detailed drilling records are presented in Appendix II with accompanying core photographs. The records note Total and Solid Core Recovery (TCR / SCR) record Rock Quality Designation (RQD), present a fracture spacing log and provide a detailed geological description of the rock.

The equipment penetrated surface topsoil, firm to stiff brown and black gravelly clay (BOULDER CLAY). Very strong to medium strong medium bedded fine grained grey/black LIMESTONE was encountered in both locations with a thin weathered zone noted overlying the solid bedrock. 100% core recovery was recorded in the bedrock in both locations.

The rotary core findings are summarised in the following table.

Hole No.	Overburden	Weathered Rock	Solid LIMESTONE	Standpipe
RC01	0 – 5.50	5.50 – 6.00	6.00 – 9.00	0 – 9.00
RC02	0 – 6.85	6.85 – 7.50	7.50 – 9.00	

Standard Penetration tests were performed in both locations to confirm overburden strength.

Trial Pits

Trial Pits were scheduled at seven locations and referenced TP01 to TP07.

A JCB excavator was used under engineering supervision. Detailed records for each location are presented in Appendix III. These records note the soil stratification and record sampling, stability and ground water details. Each location was CAT scanned to ensure that underground services were not damaged.

Topsoil was noted in each location generally overlying brown or brown grey gravelly CLAY, varying from soft to firm in consistency. Stiff to hard dark grey or black gravelly CLAY was noted in several locations at depths between 1.50 and 2.50 metres. Excavations were terminated between 2.50 and 3.00 metres. No ground water was observed during the investigation period.

One major variation to the general trend was noted at TP04 where a stratum of slightly clayey GRAVEL was penetrated from 0.20 to 2.20 metres. Cobbles and boulders were observed in this excavation.

TRIAL PIT SUMMARY

Ref No.	Soft to Firm gravelly CLAY	Stiff gravelly CLAY	GRAVEL
TP01	0.30 – 1.60	1.60 – 2.50	
TP02	0.30 – 1.00	1.00 – 3.00	
TP03	0.20 – 2.60		
TP04			0.20 – 2.20
TP05	0.80 – 2.60	2.60 – 3.00	
TP06	0.40 – 2.60	2.60 – 3.10	
TP07	0.30 – 3.00		

HD Dynamic Probes

Heavy Duty Dynamic Probes were carried out at each of the trial pit locations and referenced DP01 to DP07.

Probing was in accordance with the heavy-duty probe specification of BS 1377: Part 9: 1990. In these tests, the soil resistance is measured in terms of the number of drop-hammer blows required to drive the test probe through each 100 mm increment of penetration. Probing is terminated when the blow count exceeds 25/100mm to avoid damage to the apparatus. Where loose material is present a single blow count may drive the apparatus in excess of 100mm. In this instance blow counts of zero may be recorded. Individual probe records are contained in Appendix IV.

A Probe resistance of $N_{100} < 2$ is indicative of soft or weak material, unsuitable as founding medium. A probe resistance of $N_{100}=4$ is indicative of firm to stiff soils, with an allowable bearing pressure of 100 kPa.

A stiff or dense zone has been noted at surface in a number of locations with relatively shallow probe refusal recorded (1.20 to 1.60 metres). This may partly reflect very dry weather conditions at the time of the investigation.

The probe results are summarised in the following table.

Ref No.	**Soft $N_{100} < 2$**	**Depth to Firm Soils $N_{100} > 4$**	**Final Refusal Depth**
DP01	0 – 1.60	1.70	2.00
DP02		0.30	1.60
DP03		0.30	1.20
DP04		0.30	1.20
DP05	0 – 1.80	2.60	3.40
DP06	0 – 2.40	2.50	3.60
DP07		0.30	1.20

BRE Digest 365 Soakaway

Infiltration testing was scheduled at each trial pit location and was carried out in accordance with BRE Digest 365 'Soakaway Design'. The stratification in each location is noted on the respective Trial Pit record. Tests are referenced SA01 to SA07.

To obtain a measure of the infiltration rate of the sub-soils, water was poured into a test pit, and a record taken of the fall in water level against time. The test was carried over two cycles following initial soakage. Designs are based on the slowest infiltration rate, which is calculated from the final cycle.

The results are summarised as follows;

Ref No.	Infiltration Rate (f) Metres/ Minute	
SA01	0.00031	
SA02	8.9E-05	
SA03	0.00076	
SA04	0.00057	
SA05	0.00029	
SA06	0.00000	* Water Level Rose
SA07	0.00017	

III. Testing

In Situ

Standard penetration tests were carried out at approximate 1.00 metre intervals in the geotechnical Boreholes and in each rotary hole to measure relative in-situ soil strength. N values are noted in the right hand column of the boring / drilling records, representing the blow count required to drive the standard sampler 300mm into the soil, following initial seating blows. Where full test penetration was not achieved the blow count for a specific penetration is recorded, or refusal is indicated where appropriate. The results of the tests are summarised as follows:

STRATUM	N VALUES		COMMENT
	BH01	BH02	
Brown Gravelly CLAY			
1.00 m BGL	10	24	Firm / Stiff
2.00 m BGL	11	14	Firm
Black gravelly CLAY			
3.00 m BGL	51	35	Very Stiff
4.00 m BGL	49	53	Hard
> 5.00 m BGL	>50	>50	Hard

Limited penetration of SPT apparatus was noted in the lower hard black boulder clay.

Laboratory

A programme of laboratory testing was scheduled following completion of site operations. Geotechnical soil and rock testing was carried out by IGSL in its INAB-Accredited laboratory. Chemical and environmental testing was carried out in the UK by EUROFINS Ltd. The test programme included the following elements:

Liquid and Plastic Limits / Moisture Content	IGSL
PSD Grading by Wet Sieve and Hydrometer	IGSL
Point Load Tests	IGSL
Sulphate / Chloride / pH	EUROFINS
RILTA Suite Environmental / Ground Water Suite	EUROFINS

All laboratory data is presented in Appendices VIa and VIb and individual tests are discussed briefly as follows:

Index Properties / Moisture Content

Samples from the overburden deposits had Index Properties and Natural Moisture Contents established. The results consistently plot in the CL zone of the standard classification indicative of sensitive clay matrix soil (typical of glacially deposited boulder clay).

Natural Moisture Contents range from 7.2 to 23%, the higher values are generally associated with the upper brown gravelly CLAY. Lower moisture contents were recorded in the black boulder clay stratum.

Grading

Wet Sieve analysis has been carried out on two samples of the gravelly CLAY stratum. The grading curves consistently confirm material smoothly graded from the fine clay to coarse gravel fraction. The grading pattern is again typical of glacial till or boulder clay.

Point Load Tests

Sub samples of the recovered LIMESTONE core have been selected for Diametrial Testing in The Point Load Apparatus. A total of 8 tests were performed and equivalent UCS values have been calculated. Rock strength (UCS) varies from 56 to 92 MPa with an average value of 72 MPa. The results confirm the high strength of the limestone bedrock.

Chemical

Two samples were sent for analysis to BRE Chemical Suite parameters. Sulphate concentrations (SO4 2:1 extract) of < 0.010 g/l were established with pH values of 9.2 and 9. Low Chloride concentrations (< 0.010 g/l) were also determined.

No special precautions are necessary to protect foundation concrete from sulphate or chloride aggression. A sulphate design class of DS-1 (ACEC Classification for Concrete) is indicated for concentrations less than 0.5 g/l.

RILTA Environmental Suite

Two samples of the soils from the site were sent to EUROFINS environmental laboratory and testing was carried out in accordance with RILTA requirements to establish Landfill Waste Acceptance Criteria (WAC).

All samples fall into the INERT Category with no elevated levels of contamination recorded. No traces of ASBESTOS were noted during routine screening.

Material excavated during this development can be safely disposed of either on the site or to a suitably licensed INERT Landfill facility. No issues arise as to safety of site personnel

IV. Discussion:

A major new housing development is to be carried out on this site at Ashbourne. An investigation of ground conditions has been carried out by IGSL for D.B.F.L. Consulting Engineers on behalf of the two developers.

The investigation consisted of conventional Boreholes, Rotary Core Holes and Trial Pits, with supplementary Dynamic Probes and Percolation Tests.

Geotechnical and Environmental laboratory testing has also been carried out to confirm soil parameters.

STRATIFICATION

The stratification pattern is typical of the Ashbourne and Meath / Dublin area where GLACIAL TILL or BOULDER CLAY forms the overburden with underlying strong LIMESTONE noted at approximately 7.00 metres BGL.

The overburden comprises upper brown or grey brown BOULDER CLAY or ABLATION TILL extending from about 0.50 metres to 2.50 metres BGL. This layer can vary significantly in both strength and composition. Strength can range from soft to stiff, while composition can typically vary from gravelly CLAY or gravelly SILT to clay or silt bound sandy GRAVEL. Isolated bands of granular soil can randomly occur as typified in TP04. Trial excavations in this stratum were generally DRY. Water ingress was however noted in BH01at 1.80 metres BG.

Below the upper brown boulder clay a stratum of very stiff to hard grey-black or black gravelly CLAY is noted. This is BLACK BOULDER CLAY or LODGEMENT TILL and was encountered in both boreholes and in several trial pits generally between about 1.70 and 2.50 metres.

LIMESTONE bedrock has been noted at 7.00 metres BGL in the area of BH01 and BH02 with 3.00 metres of solid core recovered.

The strength and behavioural characteristics of the glacial till in the general area are very well documented and the limited laboratory information from this investigation is consistent with the published data.

This investigation comprised two boreholes / coreholes located at a major structure and seven widely separated locations examined by trial pit and dynamic probe with infiltration characteristics determined by soakaway test.

This report will comment on the findings at the individual locations and indicate allowable bearing pressures available at specific depths.

STRUCTURE AT BH01/BH02

In both borehole locations very stiff black boulder clay has been noted at about 2.50 metres BGL below generally FIRM upper brown boulder clay.

The allowable bearing pressures available in this area on both the upper and lower boulder clay are summarised as follows:

	BH01	**BH02**	
Ground Level (OD)	75.81	72.28	
ABP 100 kN/sq/m.	74.50	71.20	Brown B. Clay
ABP 250 kN/sq.m.	73.30	69.50	Black B. Clay

The allowable bearing pressure in the black boulder clay will increase with penetration depth, 300 kPa is indicated by SPT values in excess of N=40.

TRIAL PIT LOCATIONS SUMMARY DATA

An allowable bearing pressure of 100 kP has been assumed for traditional two storey house construction. The depth to achieve this and permit construction of traditional reinforced strip or pad foundations has been assessed from both Trial Pit data and Heavy-Duty Dynamic Probes and is summarised as follows.

Location	**O.D. Level**	**Founding Depth for 100 kPa.**	**/ OD**	**Comment**
TP01	72.37	1.60	70.7	Grey black boulder clay
TP02	72.82	0.50	72.3	Brown Boulder clay
TP03	73.96	0.50	73.5	Poss. weakening @ 73 OD
TP04	78.08	0.50	77.5	Dense Gravel
TP05	71.95	2.50	69.3	Black Boulder clay
TP06	67.42	2.50	64.9	Black Boulder clay
TP07	68.23	0.50	67.7	Poss. weakening @ 67 OD

Given the wide spacing of the trial pits, the variation in ground level and the variation in soil strength and founding depth it is difficult to provide a simplified consistent allowable bearing pressure for the site as a whole.

It is likely that extensive site works will be required involving cut and fill operations, construction of roadways etc.

Further investigation is strongly recommended, ideally using Dynamic Probing at specific houses or groups of houses.

SETTLEMENT

Settlement of foundations placed on the upper brown boulder clay using an allowable bearing pressure of 100 kPa will be of the order of 10 to15 mm. Settlement should be uniform.

Settlement of foundations placed on the hard black boulder clay under 250 kPa loading will be very low (< 5mm)

GROUND WATER

Trial Pit excavations were dry throughout. Water ingress was noted in the boreholes at about 5.00 metres BGL. Standpipes were installed in the boreholes with standing water levels rising to within 2.50 metres of surface.

Water ingress to shallow foundation excavations is not expected, however isolated water bearing gravel pockets or zones can randomly occur.

PERCOLATION

Tests were carried out at the seven trial pit locations with results generally reflection low soil permeability. The results are typical of the local glacial till with one failure recorded.

FOUNDATION CONCRETE

Low Sulphate and Chloride concentrations and near neutral pH values indicate that no special precautions are required to protect foundation below ground concrete from deterioration.

ENVIRONMENTAL

IGSL/JC
August 2022

Summary

The greenfield site is an extensive one with ground levels varying from 67 to 78 metres OD.

The stratification over the development area , comprises GLACIAL TILL or BOULDER CLAY presenting as brown gravelly CLAY overlying black gravelly CLAY. The pattern is typical of Ashbourne, County Meath and North County Dublin, and the characteristics of the glacial soils are well documented.

Brown Boulder CLAY

Below topsoil and superficial material, brown gravelly CLAY has been noted extending from about 0.50 to 2.00 metres. The deposit varies in strength and in composition and foundation recommendations at the specific exploratory locations has been presented in the main report. This suggests that founding depths for conventional housing may range from 0.50 to 2.50 metres, assuming an allowable bearing pressure of 100 Kpa.

Black Boulder Clay

The base black lodgement till is very stiff to hard and suitable for foundation support with an allowable bearing pressure increasing from 200 to 300 kPa with penetration. The hard black clay has been noted at depths between about 1.50 and 2.50 metres. It is readily identified on site and can be difficult to excavate. It is recommended as founding medium for multi storey development or for structures incorporating basements.

Additional Works

We would recommend considering additional site investigation when preliminary site works (cut and fill operations) have been completed.

House specific investigation using heavy duty dynamic probing will accurately establish allowable bearing pressures and recommend foundation depths at individual houses or close groups of houses.

This technique is widely adopted for a high percentage of large-scale housing developments.

Appendix I Boring Records

GEOTECHNICAL BORING RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**BOREHOLE NO.**	**BH01**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,400.77 E 751,393.21 N	**RIG TYPE**	Dando 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (m AOD)	75.81	**BOREHOLE DEPTH (m)**	5.20
		DATE COMMENCED	19/07/2022
		DATE COMPLETED	21/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC)	**SPT HAMMER REF. NO.**	
ENGINEER	DBFL Consluting Engineers	**ENERGY RATIO (%)**	
		BORED BY	P.Thomas
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		75.71	0.10						
	Soft to firm grey/brown sandy SILT/CLAY with occasional gravel				AA175377	B	1.00		N = 10 (1, 2, 2, 2, 3, 3)	
1			74.41	1.40						
	Firm black sandy SILT/CLAY with some gravel				AA175378	B	2.00		N = 11 (2, 2, 2, 3, 3, 3)	
2			73.31	2.50						
	Very stiff to hard black sandy gravelly silty CLAY with occasional cobbles				AA175379	B	3.00		N = 51 (10, 7, 11, 15, 14, 11)	
3										
4					AA175380	B	4.00		N = 49 (9, 10, 10, 11, 14, 14)	
5			70.61	5.20	AA175381	B	5.00		N = 50/75 mm (25, 33, 50)	
	Obstruction End of Borehole at 5.20 m									
6										
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
2.9	3.2	1.5	
4.8	5.2	2	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
1.80	1.80	No	2.50	20	Slow

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type
21-07-22	5.20	1.00	5.20	50mm SP

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments
21-07-22	5.20	Nil	1.20	End of BH

REMARKS CAT scanned location and hand dug inspection pit carried out .

Sample Legend
D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 24190.GPJ IGSL.GDT 3/8/22

GEOTECHNICAL BORING RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**BOREHOLE NO.**	**BH02**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,449.56 E 751,466.48 N	**RIG TYPE**	Dando 2000
		BOREHOLE DIAMETER (mm)	200
GROUND LEVEL (m AOD)	72.28	**BOREHOLE DEPTH (m)**	5.30
		DATE COMMENCED	21/07/2022
		DATE COMPLETED	21/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC)	**SPT HAMMER REF. NO.**	
ENGINEER	DBFL Consluting Engineers	**ENERGY RATIO (%)**	
		BORED BY	P.Thomas
		PROCESSED BY	F.C

Depth (m)	Description	Legend	Elevation	Depth (m)	Samples: Ref. Number	Samples: Sample Type	Samples: Depth (m)	Samples: Recovery	Field Test Results	Standpipe Details
0	TOPSOIL		72.18	0.10						
1	Stiff grey/brown sandy SILT/CLAY with occasional gravel		71.08	1.20	AA175382	B	1.00		N = 24 (3, 5, 5, 6, 6, 7)	
2	Firm grey/brown sandy SILT/CLAY with frequent gravel		69.88	2.40	AA175383	B	2.00		N = 14 (2, 2, 3, 3, 3, 5)	
3	Very stiff to hard black/dark brown sandy silty gravelly CLAY with occasional cobbles				AA175384	B	3.00		N = 35 (3, 5, 6, 9, 9, 11)	
4					AA175385	B	4.00		N = 53 (5, 9, 12, 14, 12, 15)	
5			66.98	5.30	AA175386	B	5.00		N = 50/75 mm (25, 36, 50)	
6	Obstruction End of Borehole at 5.30 m									
7										
8										
9										

HARD STRATA BORING/CHISELLING

From (m)	To (m)	Time (h)	Comments
4.8	5	1	
5.1	5.3	2	

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike

GROUNDWATER PROGRESS

Date	Hole Depth	Casing Depth	Depth to Water	Comments

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type
21-07-22	5.30	1.00	5.30	50mm SP

REMARKS Standing 2hrs on access to site .CAT scanned location and hand dug inspection pit carried out .

Sample Legend

D - Small Disturbed (tub)
B - Bulk Disturbed
LB - Large Bulk Disturbed
Env - Environmental Sample (Jar + Vial + Tub)
UT - Undisturbed 100mm Diameter Sample
P - Undisturbed Piston Sample
W - Water Sample

IGSL BH LOG 24190.GPJ IGSL.GDT 3/8/22

Appendix II Rotary Core Logs Photographs

GEOTECHNICAL CORE LOG RECORD

REPORT NUMBER 24190

CONTRACT Cherry Lane, Ashbourne, Co.Meath

DRILLHOLE NO RC01
SHEET Sheet 1 of 1

CO-ORDINATES

GROUND LEVEL (mOD)

CLIENT

ENGINEER Glanbrind

RIG TYPE Geo405
FLUSH Air/Mist
INCLINATION (deg) -90
CORE DIAMETER (mm) 78

DATE COMMENCED 22/07/2022
DATE COMPLETED 25/07/2022
DRILLED BY IGSL - AK
LOGGED BY D.O'Shea

Downhole Depth (m)	Core Run Depth (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing Log (mm) 0 250 500	Non-intact Zone	Legend	Description	Depth (m)	Elevation	Standpipe Details	SPT (N Value)
0								SYMMETRIX DRILLING: No recovery, observed by driller as returns of CLAY				
1									1.50			
2								SYMMETRIX DRILLING: No recovery, observed by driller as returns of gravelly CLAY				
3												
4									4.50			
5								SYMMETRIX DRILLING: No recovery, observed by driller as returns of clayey GRAVEL				
6	6.00								6.00			N = 50/27 mm (25, 50)
7		100	98	87				Very strong to medium strong, medium to thinly bedded, grey/dark grey/black, fine-grained, LIMESTONE (predominantely calci-siltite limestone with subordinate muddy limestone, local stylolites, localised chert formation), slightly weathered. Discontinuities are medium to closely spaced, smooth to locally rough, planar. Apertures are tight to locally moderately open, locally clay-smeared, locally calcite-veined (1-10mm thick). Dips are 20-30° & locally 70-80°.				
8	7.50	100	94	88								
9	9.00							End of Borehole at 9.00 m	9.00			

REMARKS

Hole cased 0.00-6.00m.

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike recorded

INSTALLATION DETAILS

Date	Tip Depth	RZ Top	RZ Base	Type
25-07-22	9.00	6.00	9.00	50mm SP

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments
25-07-22	9.00	6.00	4.00	Water level recorded 5 mins after end of drilling.

IGSL RC FI 10M 24190.GPJ IGSL.GDT 29/7/22

GEOTECHNICAL CORE LOG RECORD

REPORT NUMBER 24190

CONTRACT Cherry Lane, Ashbourne, Co.Meath

DRILLHOLE NO RC02
SHEET Sheet 1 of 1

CO-ORDINATES

GROUND LEVEL (mOD)

CLIENT

ENGINEER Glanbrind

RIG TYPE Geo405
FLUSH Air/Mist
INCLINATION (deg) -90
CORE DIAMETER (mm) 78

DATE COMMENCED 25/07/2022
DATE COMPLETED 26/07/2022
DRILLED BY IGSL - AK
LOGGED BY D.O'Shea

Downhole Depth (m)	Core Run Depth (m)	T.C.R.%	S.C.R.%	R.Q.D.%	Fracture Spacing Log (mm) 0 250 500	Non-intact Zone	Legend	Description	Depth (m)	Elevation	Standpipe Details	SPT (N Value)
0								SYMMETRIX DRILLING: No recovery, observed by driller as returns of CLAY	1.50			
1								SYMMETRIX DRILLING: No recovery, observed by driller as returns of gravelly CLAY	5.00			
2												
3												
4												
5								SYMMETRIX DRILLING: No recovery, observed by driller as returns of clayey GRAVEL	6.85			N = 49 (9, 9, 13, 10, 13, 13)
6												
7	7.50							SYMMETRIX DRILLING: No recovery, observed by driller as returns of ROCK	7.50			N = 50/38 mm (25, 50)
8		100	99	81				Very strong to medium strong, medium to thinly bedded, grey/dark grey/black, fine-grained, LIMESTONE (predominantely calci-siltite limestone with subordinate muddy limestone, local stylolites, localised chert formation), slightly weathered. Discontinuities are medium to closely spaced, smooth to locally rough, planar. Apertures are tight to locally moderately open, locally clay-smeared, locally calcite-veined (1-20mm thick). Dips are 20-30° & locally 70-80°.	9.00			
9	9.00							End of Borehole at 9.00 m				

REMARKS

Hole cased 0.00-6.00m.

WATER STRIKE DETAILS

Water Strike	Casing Depth	Sealed At	Rise To	Time (min)	Comments
					No water strike recorded

INSTALLATION DETAILS

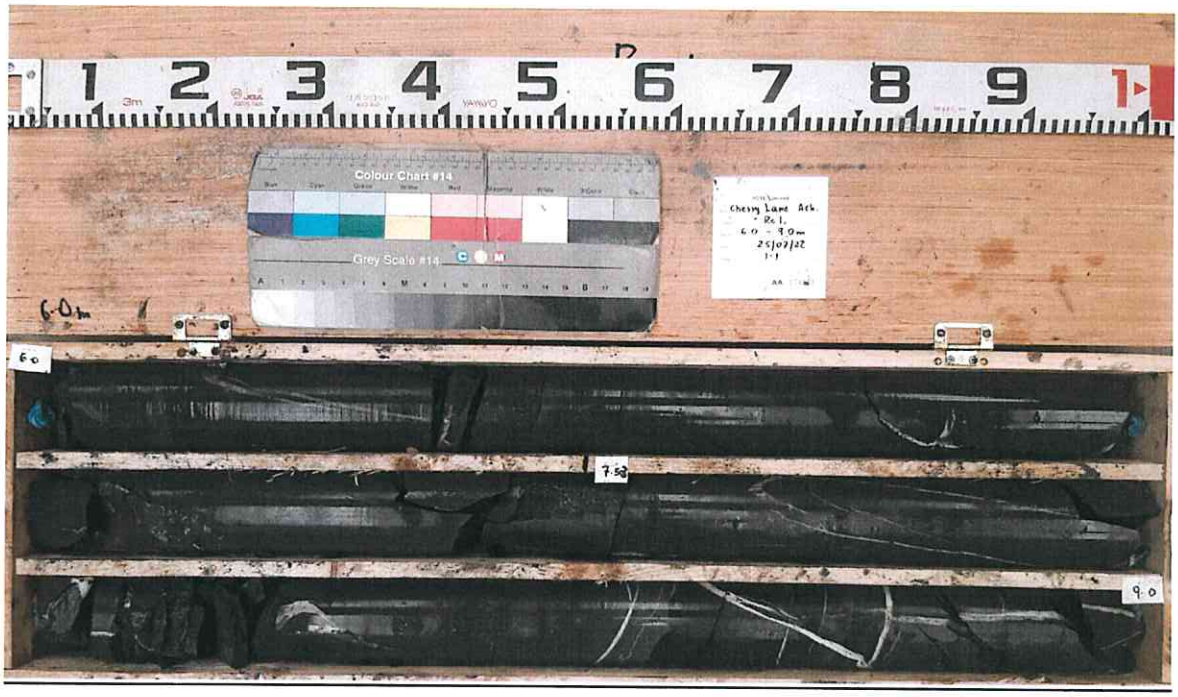
Date	Tip Depth	RZ Top	RZ Base	Type

GROUNDWATER DETAILS

Date	Hole Depth	Casing Depth	Depth to Water	Comments
26-07-22	9.00	7.50	8.20	Water level recorded 5 mins after end of drilling.

IGSL RC FI 10M 24190.GPJ IGSL.GDT 29/7/22

RC01 Box 1 of 1 – 6.00-9.00m



RC02 Box 1 of 1 – 7.50-9.00m

Appendix III Trial Pit Records

TRIAL PIT RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**TRIAL PIT NO.**	**TP01**
		SHEET	Sheet 1 of 1
LOGGED BY	T.M	**CO-ORDINATES**	706,377.65 E 751,588.82 N
		DATE STARTED	25/07/2022
		DATE COMPLETED	25/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**GROUND LEVEL (m)**	72.37
ENGINEER	DBFL Consluting Engineers	**EXCAVATION METHOD**	JCB

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 Topsoil									
Firm to stiff greyish brown silty gravelly CLAY,gravel is medium to coarse grained and subrounded		0.30	72.07		AA137825	B	0.50		
1.0 Soft to firm dark grey gravelly CLAY with high cobble content and boulders		1.00	71.37		AA137826	B	1.20		
Stiff dark grey gravelly CLAY with high cobble content and boulders		1.60	70.77		AA137827	B	1.70		
2.0 3.0 4.0 Obstruction on boulders End of Trial Pit at 2.50m		2.50	69.87						

Groundwater Conditions
Dry

Stability
Stable

General Remarks
Stopped due to obstruction from boulders

IGSL TP LOG 24190.GPJ IGSL.GDT 3/8/22

TRIAL PIT RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**TRIAL PIT NO.**	**TP02**
		SHEET	Sheet 1 of 1
LOGGED BY	T.M	**CO-ORDINATES**	706,659.95 E 751,478.08 N
		DATE STARTED	25/07/2022
		DATE COMPLETED	25/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**GROUND LEVEL (m)**	72.82
ENGINEER	DBFL Consluting Engineers	**EXCAVATION METHOD**	JCB

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 Topsoil		0.30	72.52						
Firm to stiff brown sandy gravelly CLAY with cobbles					AA137834	B	0.50		
1.0 Stiff dark brown sandy gravelly CLAY with high cobble content .Cobbles are angular -subangular		1.00	71.82		AA137835	B	1.30		
2.0					AA137836	B	2.30		
3.0 End of Trial Pit at 3.00m		3.00	69.82						
4.0									

Groundwater Conditions
Dry

Stability
Stable

General Remarks
Maximum required depth reached

IGSL TP LOG 24190.GPJ IGSL.GDT 3/8/22

TRIAL PIT RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**TRIAL PIT NO.**	**TP03**
		SHEET	Sheet 1 of 1
LOGGED BY	T.M	**CO-ORDINATES**	706,467.65 E 751,427.90 N
		DATE STARTED	25/07/2022
		DATE COMPLETED	25/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**GROUND LEVEL (m)**	73.96
		EXCAVATION METHOD	JCB
ENGINEER	DBFL Consluting Engineers		

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 Topsoil		0.20	73.76						
Firm to stiff brown silty sandy gravelly CLAY.gravel is medium to coarse grained and subangular					AA137831	B	0.50		
1.0 Soft to firm dark brown silty sandy gravelly CLAY with high cobble content		1.00	72.96		AA137832	B	1.20		
2.0					AA137833	B	2.00		
End of Trial Pit at 2.60m		2.60	71.36						
3.0									
4.0									

Groundwater Conditions
Dry

Stability
Stable

General Remarks
Stopped due to obstruction from boulders

IGSL TP LOG 24190.GPJ IGSL.GDT 3/8/22

TRIAL PIT RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**TRIAL PIT NO.**	**TP04**
		SHEET	Sheet 1 of 1
LOGGED BY	T.M	**CO-ORDINATES**	706,399.95 E 751,378.28 N
		DATE STARTED	26/07/2022
		DATE COMPLETED	26/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**GROUND LEVEL (m)**	78.08
ENGINEER	DBFL Consluting Engineers	**EXCAVATION METHOD**	JCB

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 Topsoil		0.20	77.88						
Brown clayey sandy cobbly bouldery GRAVEL. Gravel is subrounded and medium to coarse grained					AA137828	B	0.50		
1.0					AA137829	B	1.30		
2.0 End of Trial Pit at 2.20m		2.20	75.88		AA137830	B	2.20		
3.0									
4.0									

Groundwater Conditions
Dry

Stability
Stable

General Remarks
Stopped due to obstruction from boulders

IGSL TP LOG 24190.GPJ IGSL.GDT 3/8/22

TRIAL PIT RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**TRIAL PIT NO.**	**TP05**
		SHEET	Sheet 1 of 1
LOGGED BY	T.M	**CO-ORDINATES**	706,465.30 E 751,254.17 N
		DATE STARTED	26/07/2022
		DATE COMPLETED	26/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**GROUND LEVEL (m)**	71.95
ENGINEER	DBFL Consluting Engineers	**EXCAVATION METHOD**	JCB

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 Topsoil									
Stiff dark brown to black silty sandy gravelly CLAY		0.40	71.55						
					AA137844	B	0.60		
Very soft dark brown to black silty sandy gravelly CLAY		0.80	71.15						
1.0									
					AA137845	B	1.60		
Firm brownish black silty sandy gravelly CLAY with cobbles and boulders		1.90	70.05						
2.0									
Very stiff brownish black silty sandy gravelly CLAY with cobbles and boulders		2.60	69.35		AA137846	B	2.60		
3.0 End of Trial Pit at 3.00m		3.00	68.95						
4.0									

Groundwater Conditions
Dry

Stability
Stable

General Remarks
Maximum required depth reached

IGSL TP LOG 24190.GPJ IGSL.GDT 3/8/22

TRIAL PIT RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	TRIAL PIT NO.	TP06
		SHEET	Sheet 1 of 1
LOGGED BY	T.M	CO-ORDINATES	706,523.70 E 751,164.09 N
		DATE STARTED	26/07/2022
		DATE COMPLETED	26/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	GROUND LEVEL (m)	67.42
		EXCAVATION METHOD	JCB
ENGINEER	DBFL Consluting Engineers		

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 Topsoil									
Very soft grey brown silty slighlty gravelly CLAY		0.40	67.02		AA137840	B	0.60		
					AA137841	B	1.50		
				(Slow)					
Very stiff dark brown silty sandy gravelly CLAY with high cobble content		2.60	64.82		AA137842	B	2.50		
End of Trial Pit at 3.10m		3.10	64.32		AA137843	B	3.00		

1.0
2.0
3.0
4.0

Groundwater Conditions
Wet

Stability
Moderate

General Remarks
Maximum required depth reached,hole collapsing

IGSL TP LOG 24190.GPJ IGSL.GDT 3/8/22

TRIAL PIT RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**TRIAL PIT NO.**	**TP07**
		SHEET	Sheet 1 of 1
LOGGED BY	T.M	**CO-ORDINATES**	706,590.04 E 751,075.86 N
		DATE STARTED	26/07/2022
		DATE COMPLETED	26/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**GROUND LEVEL (m)**	68.23
ENGINEER	DBFL Consluting Engineers	**EXCAVATION METHOD**	JCB

Geotechnical Description	Legend	Depth (m)	Elevation	Water Strike	Samples: Sample Ref	Samples: Type	Samples: Depth	Vane Test (KPa)	Hand Penetrometer (KPa)
0.0 Topsoil									
Firm to stiff brown silty sandy gravelly CLAY with cobbles and angular boulders.gravel is medium to coarse grained		0.30	67.93		AA137837	B	0.50		
1.0 Soft to firm brown to black silty sandy gravelly CLAY with high cobble content		1.10	67.13		AA137838	B	1.50		
					AA137839	B	2.50		
3.0 End of Trial Pit at 3.00m		3.00	65.23						
4.0									

Groundwater Conditions
Dry

Stability
Stable

General Remarks
Maximum required depth reached

IGSL TP LOG 24190.GPJ IGSL.GDT 3/8/22

Appendix IV Dynamic Probes

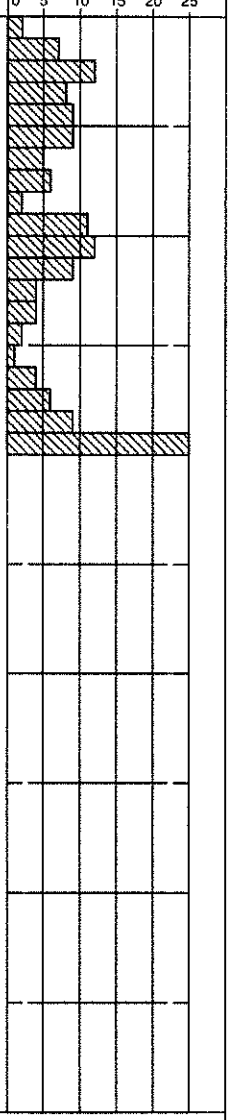
DYNAMIC PROBE RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**PROBE NO.**	**DP01**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,377.65 E 751,588.82 N	**DATE DRILLED**	25/07/2022
GROUND LEVEL (mOD)	72.37	**DATE LOGGED**	25/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**HAMMER MASS (kg)**	50
ENGINEER	DBFL Consluting Engineers	**INCREMENT SIZE (mm)**	100
		FALL HEIGHT (mm)	500
		PROBE TYPE	DPH

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water
0.0	.		0.00		
2.0	End of Probe at 2.00 m			70.37	

Depth (m)	Probe Readings (Blows/Increment)
0.00	2
0.10	7
0.20	12
0.30	8
0.40	9
0.50	9
0.60	5
0.70	6
0.80	2
0.90	11
1.00	12
1.10	9
1.20	4
1.30	4
1.40	2
1.50	1
1.60	4
1.70	6
1.80	9
1.90	25



GROUNDWATER OBSERVATIONS

REMARKS

IGSL DP LOG 100MM INCREMENTS 24190.GPJ IGSL.GDT 3/8/22

DYNAMIC PROBE RECORD

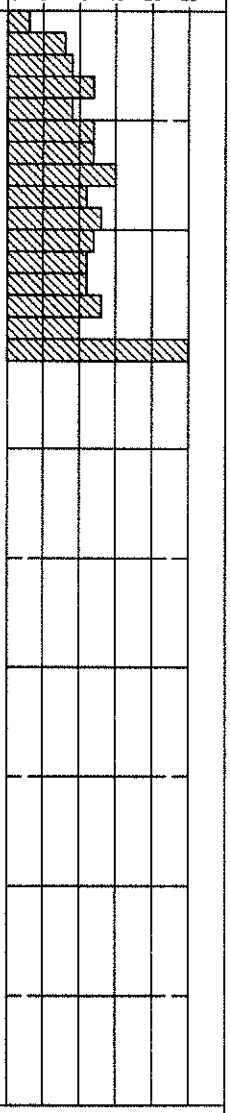
REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**PROBE NO.**	**DP02**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,659.95 E 751,478.08 N	**DATE DRILLED**	25/07/2022
GROUND LEVEL (mOD)	72.82	**DATE LOGGED**	25/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**HAMMER MASS (kg)**	50
ENGINEER	DBFL Consluting Engineers	**INCREMENT SIZE (mm)**	100
		FALL HEIGHT (mm)	500
		PROBE TYPE	DPH

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water
0.0	.		0.00		
1.0					
	End of Probe at 1.60 m			71.22	
2.0					
3.0					
4.0					

Depth (m)	Probe Readings (Blows/Increment)
0.00	3
0.10	8
0.20	9
0.30	12
0.40	9
0.50	12
0.60	12
0.70	15
0.80	11
0.90	13
1.00	12
1.10	11
1.20	11
1.30	13
1.40	10
1.50	25

Graphic Probe Record



GROUNDWATER OBSERVATIONS

REMARKS

IGSL DP LOG 100MM INCREMENTS 24190.GPJ IGSL.GDT 3/8/22

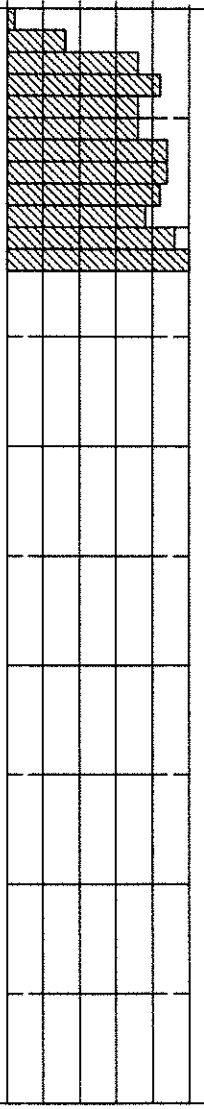
DYNAMIC PROBE RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**PROBE NO.**	**DP03**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,467.65 E 751,427.90 N	**DATE DRILLED**	25/07/2022
GROUND LEVEL (mOD)	73.96	**DATE LOGGED**	25/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**HAMMER MASS (kg)**	50
ENGINEER	DBFL Consluting Engineers	**INCREMENT SIZE (mm)**	100
		FALL HEIGHT (mm)	500
		PROBE TYPE	DPH

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water	Depth (m)	Probe Readings (Blows/Increment)
0.0	.		0.00			0.00	1
						0.10	8
						0.20	18
						0.30	21
						0.40	18
						0.50	18
						0.60	22
						0.70	22
						0.80	21
						0.90	19
1.0						1.00	23
						1.10	25
	End of Probe at 1.20 m			72.76			
2.0							
3.0							
4.0							

Graphic Probe Record



GROUNDWATER OBSERVATIONS

REMARKS

IGSL DP LOG 100MM INCREMENTS 24190.GPJ IGSL.GDT 3/8/22

DYNAMIC PROBE RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**PROBE NO.**	**DP04**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,399.95 E 751,378.28 N	**DATE DRILLED**	25/07/2022
GROUND LEVEL (mOD)	78.08	**DATE LOGGED**	25/07/2022
HAMMER MASS (kg)	50		
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**INCREMENT SIZE (mm)**	100
ENGINEER	DBFL Consluting Engineers	**FALL HEIGHT (mm)**	500
		PROBE TYPE	DPH

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water	Depth (m)	Probe Readings (Blows/increment)
0.0	.		0.00			0.00	1
						0.10	6
						0.20	11
						0.30	18
						0.40	16
						0.50	14
						0.60	20
						0.70	22
						0.80	21
						0.90	20
1.0						1.00	22
	End of Probe at 1.20 m			76.88		1.10	25
2.0							
3.0							
4.0							

Graphic Probe Record: 0 5 10 15 20 25

GROUNDWATER OBSERVATIONS

REMARKS

IGSL DP LOG 100MM INCREMENTS 24190.GPJ IGSL.GDT 3/8/22

DYNAMIC PROBE RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**PROBE NO.**	**DP05**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,465.30 E 751,254.17 N	**DATE DRILLED**	25/07/2022
GROUND LEVEL (mOD)	71.95	**DATE LOGGED**	25/07/2022
HAMMER MASS (kg)	50		
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**INCREMENT SIZE (mm)**	100
ENGINEER	DBFL Consluting Engineers	**FALL HEIGHT (mm)**	500
		PROBE TYPE	DPH

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water	Depth (m)	Probe Readings (Blows/Increment)
0.0	.		0.00			0.00	3
						0.10	4
						0.20	12
						0.30	9
						0.40	9
						0.50	7
						0.60	6
						0.70	4
						0.80	2
						0.90	0
1.0						1.00	0
						1.10	0
						1.20	0
						1.30	0
						1.40	0
						1.50	0
						1.60	1
						1.70	1
						1.80	1
						1.90	5
2.0						2.00	6
						2.10	5
						2.20	2
						2.30	3
						2.40	3
						2.50	4
						2.60	7
						2.70	7
						2.80	8
						2.90	13
3.0						3.00	15
						3.10	19
						3.20	20
						3.30	25
	End of Probe at 3.40 m			68.55			
4.0							

Graphic Probe Record: 0 5 10 15 20 25

GROUNDWATER OBSERVATIONS

REMARKS

IGSL DP LOG 100MM INCREMENTS 24190.GPJ IGSL.GDT 3/8/22

DYNAMIC PROBE RECORD

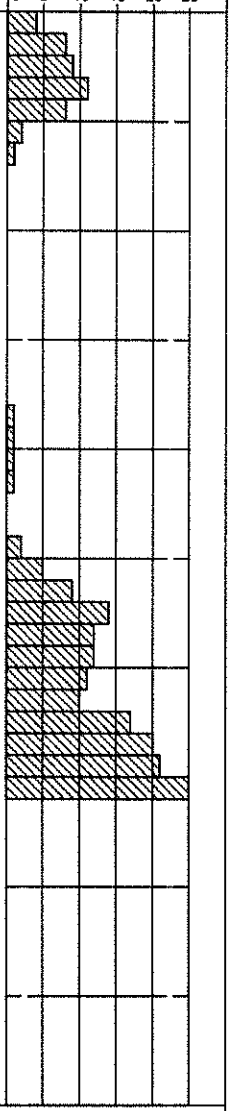
REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**PROBE NO.**	**DP06**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,523.70 E 751,164.09 N	**DATE DRILLED**	25/07/2022
GROUND LEVEL (mOD)	67.42	**DATE LOGGED**	25/07/2022
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**HAMMER MASS (kg)**	50
ENGINEER	DBFL Consluting Engineers	**INCREMENT SIZE (mm)**	100
		FALL HEIGHT (mm)	500
		PROBE TYPE	DPH

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water
0.0	.		0.00		
	End of Probe at 3.60 m			63.82	

Depth (m)	Probe Readings (Blows/Increment)
0.00	4
0.10	8
0.20	9
0.30	11
0.40	8
0.50	2
0.60	1
0.70	0
0.80	0
0.90	0
1.00	0
1.10	0
1.20	0
1.30	0
1.40	0
1.50	0
1.60	0
1.70	0
1.80	1
1.90	1
2.00	1
2.10	1
2.20	0
2.30	0
2.40	2
2.50	5
2.60	9
2.70	14
2.80	12
2.90	12
3.00	11
3.10	10
3.20	17
3.30	20
3.40	21
3.50	25

Graphic Probe Record



GROUNDWATER OBSERVATIONS

REMARKS

IGSL DP LOG 100MM INCREMENTS 24190.GPJ IGSL.GDT 3/8/22

DYNAMIC PROBE RECORD

REPORT NUMBER 24190

CONTRACT	Cherry Lane Ashbourne	**PROBE NO.**	**DP07**
		SHEET	Sheet 1 of 1
CO-ORDINATES	706,590.04 E 751,075.86 N	**DATE DRILLED**	25/07/2022
GROUND LEVEL (mOD)	68.23	**DATE LOGGED**	25/07/2022
HAMMER MASS (kg)	50		
CLIENT	Arnub Ltd and Aspect Homes(ADC) LTD	**INCREMENT SIZE (mm)**	100
ENGINEER	DBFL Consluting Engineers	**FALL HEIGHT (mm)**	500
		PROBE TYPE	DPH

Depth (m)	Geotechnical Description	Legend	Depth (m)	Elevation (mOD)	Water	Depth (m)	Probe Readings (Blows/Increment)
0.0	.		0.00			0.00	2
						0.10	10
						0.20	13
						0.30	18
						0.40	14
						0.50	14
						0.60	16
						0.70	16
						0.80	17
						0.90	19
1.0						1.00	19
						1.10	25
	End of Probe at 1.20 m			67.03			
2.0							
3.0							
4.0							

Graphic Probe Record: 0 5 10 15 20 25

GROUNDWATER OBSERVATIONS

REMARKS

IGSL DP LOG 100MM INCREMENTS 24190.GPJ IGSL.GDT 3/8/22

Appendix V Percolation Tests

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

Contract: Ashbourne,Cherry Lane Contract No. 24190
Test No. SA01
Client Arnub Ltd and Aspect Homes(ACD) Ltd
Date: 25/07/2022

Summary of ground conditions

from	to	Description	Ground water
0.00	0.30	Topsoil	Dry
0.30	1.00	Greyish brown silty gravelly CLAY	
1.00	1.80	Dark grey gravelly CLAY with high cobble content and boulders	

Notes:

Field Data

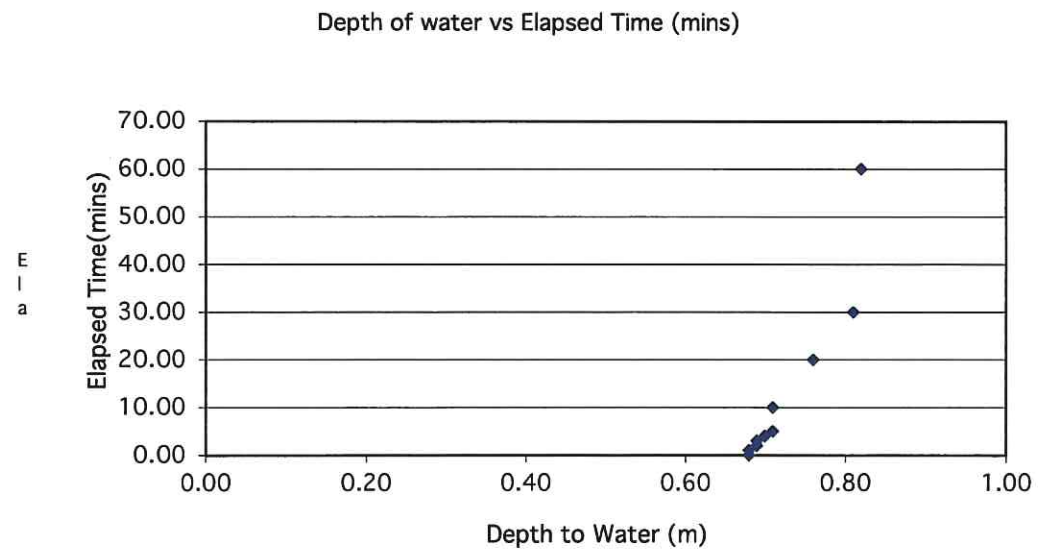
Depth to Water (m)	Elapsed Time (min)
0.68	0.00
0.68	1.00
0.69	2.00
0.69	3.00
0.70	4.00
0.71	5.00
0.71	10.00
0.76	20.00
0.81	30.00
0.82	60.00

Field Test

Depth of Pit (D)	1.80	m
Width of Pit (B)	0.40	m
Length of Pit (L)	1.65	m
Initial depth to Water =	0.68	m
Final depth to water =	0.82	m
Elapsed time (mins)=	60.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	0.66	m2
*Av. side area of permeable stratum over test perio	4.305	m2
Total Exposed area =	4.965	m2

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

f= 0.00031 m/min or 5.17E-06 m/sec



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

Contract: Ashbourne,Cherry Lane Contract No. 24190
Test No. SA02
Client Arnub Ltd and Aspect Homes(ACD) Ltd
Date: 25/07/2022

Summary of ground conditions

from	to	Description	Ground water
0.00	0.30	Topsoil	Dry
0.30	1.00	Firm brown sandy gravelly CLAY with cobbles	
1.00	1.50	Firm to stiff dark brown sandy gravelly CLAY with cobbles	

Notes:

Field Data

Depth to Water (m)	Elapsed Time (min)
0.48	0.00
0.48	1.00
0.49	2.00
0.49	3.00
0.49	4.00
0.49	5.00
0.50	10.00
0.50	20.00
0.51	30.00
0.53	60.00
0.54	90.00
0.56	120.00

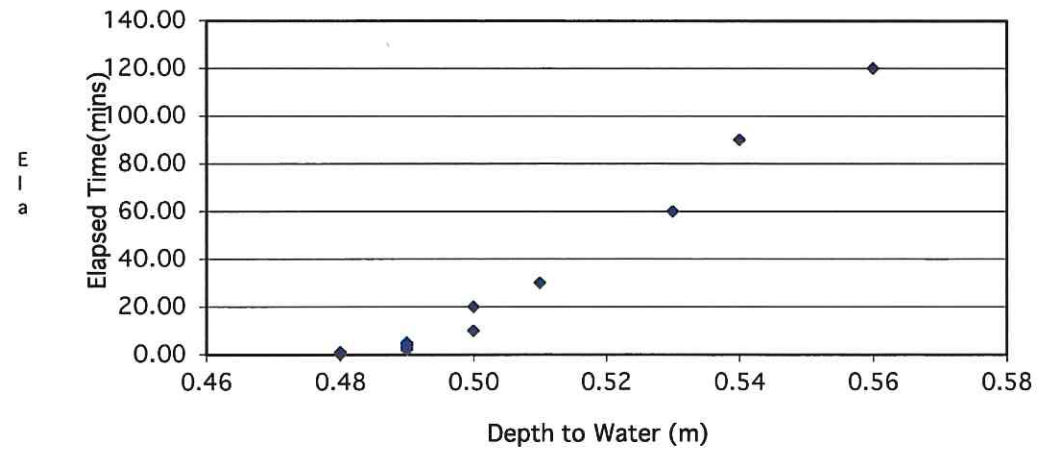
Field Test

Depth of Pit (D)	1.50	m
Width of Pit (B)	0.37	m
Length of Pit (L)	1.60	m
Initial depth to Water =	0.48	m
Final depth to water =	0.56	m
Elapsed time (mins)=	120.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	0.592	m2
*Av. side area of permeable stratum over test perio	3.8612	m2
Total Exposed area =	4.4532	m2

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

f= 8.9E-05 m/min or 1.477E-06 m/sec

Depth of water vs Elapsed Time (mins)



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

Contract: Ashbourne,Cherry Lane Contract No. 24190
Test No. SA03
Client Arnub Ltd and Aspect Homes(ACD) Ltd
Date: 25/07/2022

Summary of ground conditions

from	to	Description	Ground water
0.00	0.20	Topsoil	Dry
0.20	1.00	Brown silty sandy gravelly CLAY	
1.00	1.50	Dark brown silty sandy gravelly CLAY with high cobble content	

Notes:

Field Data

Depth to Water (m)	Elapsed Time (min)
0.70	0.00
0.71	1.00
0.73	2.00
0.75	3.00
0.77	4.00
0.79	5.00
0.84	10.00
0.86	20.00
0.88	30.00
0.94	60.00

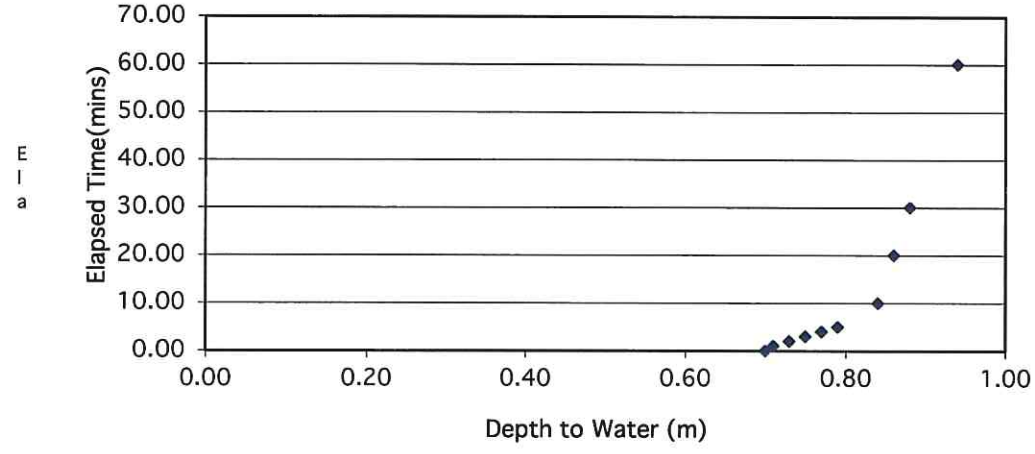
Field Test

Depth of Pit (D)	1.50	m
Width of Pit (B)	0.40	m
Length of Pit (L)	1.55	m
Initial depth to Water =	0.70	m
Final depth to water =	0.94	m
Elapsed time (mins)=	60.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	0.62	m2
*Av. side area of permeable stratum over test perio	2.652	m2
Total Exposed area =	3.272	m2

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

f= 0.00076 m/min or 1.263E-05 m/sec

Depth of water vs Elapsed Time (mins)



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

Contract: Ashbourne,Cherry Lane Contract No. 24190
Test No. SA04
Client Arnub Ltd and Aspect Homes(ACD) Ltd
Date: 26/07/2022

Summary of ground conditions

from	to	Description	Ground water
0.00	0.20	Topsoil	
0.20	1.50	Brown clayey sandy cobbly bouldery GRAVEL	Dry

Notes:

Field Data

Depth to Water (m)	Elapsed Time (min)
0.83	0.00
0.84	1.00
0.85	2.00
0.87	3.00
0.88	4.00
0.88	5.00
0.90	10.00
0.95	20.00
0.96	30.00
1.00	60.00
1.06	90.00

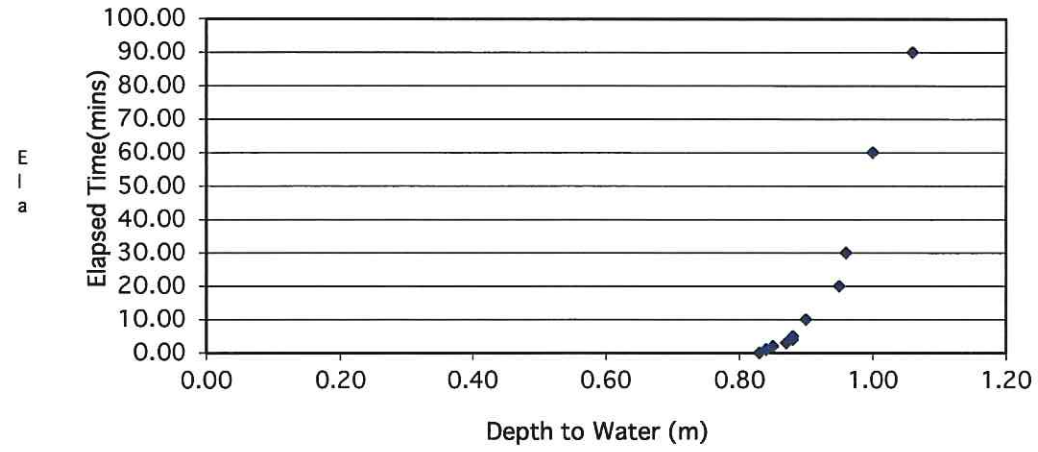
Field Test

Depth of Pit (D)	1.50	m
Width of Pit (B)	0.40	m
Length of Pit (L)	1.60	m
Initial depth to Water =	0.83	m
Final depth to water =	1.06	m
Elapsed time (mins)=	90.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	0.64	m2
*Av. side area of permeable stratum over test perio	2.22	m2
Total Exposed area =	2.86	m2

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

f= 0.00057 m/min or 9.531E-06 m/sec

Depth of water vs Elapsed Time (mins)



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

Contract: Ashbourne,Cherry Lane Contract No. 24190
Test No. SA05
Client Arnub Ltd and Aspect Homes(ACD) Ltd
Date: 26/07/2022

Summary of ground conditions

from	to	Description	Ground water
0.00	0.40	Topsoil	Dry
0.40	1.50	Stiff dark brown to black silty sandy gravelly CLAY	

Notes:

Field Data

Depth to Water (m)	Elapsed Time (min)
0.60	0.00
0.60	1.00
0.60	2.00
0.61	3.00
0.61	4.00
0.62	5.00
0.63	10.00
0.64	20.00
0.68	30.00
0.75	60.00
0.76	90.00

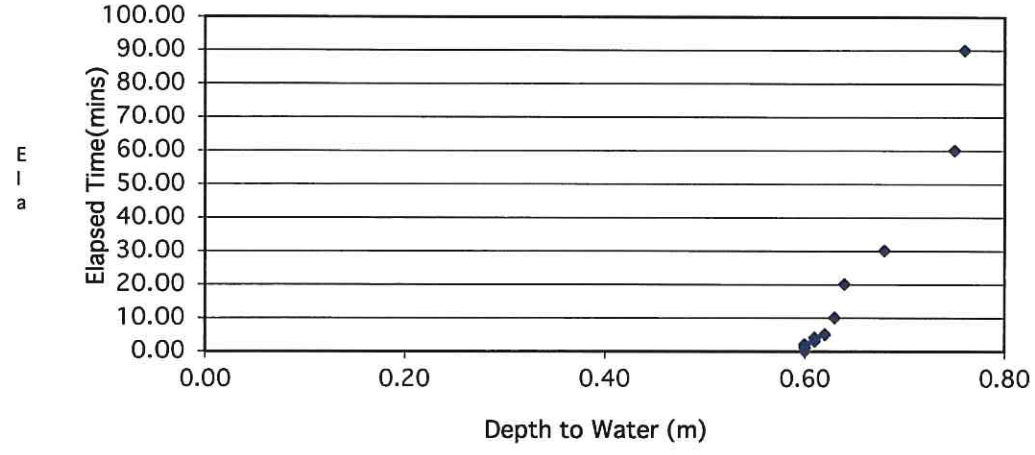
Field Test

Depth of Pit (D)	1.50	m
Width of Pit (B)	0.40	m
Length of Pit (L)	1.50	m
Initial depth to Water =	0.60	m
Final depth to water =	0.76	m
Elapsed time (mins)=	90.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	0.6	m2
*Av. side area of permeable stratum over test perio	3.116	m2
Total Exposed area =	3.716	m2

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

f= 0.00029 m/min or 4.784E-06 m/sec

Depth of water vs Elapsed Time (mins)



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

Contract: Ashbourne,Cherry Lane Contract No. 24190
Test No. SA06
Client Arnub Ltd and Aspect Homes(ACD) Ltd
Date: 26/07/2022

Summary of ground conditions

from	to	Description	Ground water
0.00	0.40	Topsoil	
0.40	1.10	Grey brown silty slighlty gravelly CLAY	Seepage at 1.8m
1.10	1.80	Dark brown silty CLAY	

Notes: Seepage at 1.8m

Field Data

Depth to Water (m)	Elapsed Time (min)
1.00	0.00
1.00	1.00
1.00	2.00
0.99	3.00
0.99	4.00
0.99	5.00
0.98	10.00
0.96	20.00
0.94	30.00
0.92	60.00
0.92	90.00

Field Test

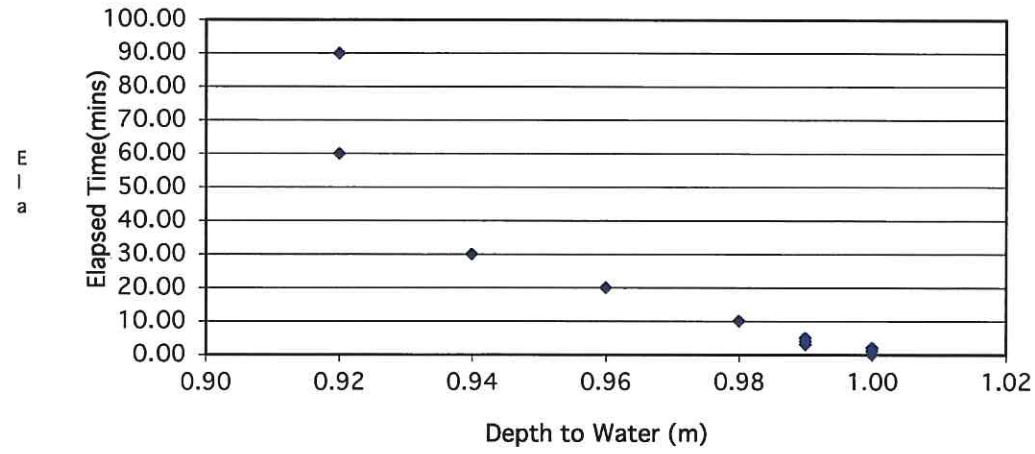
Depth of Pit (D)	1.80	m
Width of Pit (B)	0.37	m
Length of Pit (L)	1.60	m
Initial depth to Water =	1.00	m
Final depth to water =	0.92	m
Elapsed time (mins)=	60.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	0.592	m2
*Av. side area of permeable stratum over test perio	3.3096	m2
Total Exposed area =	3.9016	m2

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

f= 0 m/min or 0 m/sec

Water level rose during test

Depth of water vs Elapsed Time (mins)



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

Contract: Ashbourne,Cherry Lane Contract No. 24190
Test No. SA07
Client Arnub Ltd and Aspect Homes(ACD) Ltd
Date: 26/07/2022

Summary of ground conditions

from	to	Description	Ground water
0.00	0.30	Topsoil	Dry
0.30	1.10	Brown silty sandy gravelly CLAY with cobbles and angular boulders	
1.10	1.50	Brown to black silty sandy gravelly CLAY with high cobble content	

Notes:

Field Data

Depth to Water (m)	Elapsed Time (min)
0.80	0.00
0.80	1.00
0.81	2.00
0.82	3.00
0.83	4.00
0.83	5.00
0.84	10.00
0.85	20.00
0.86	30.00
0.87	60.00
0.88	90.00

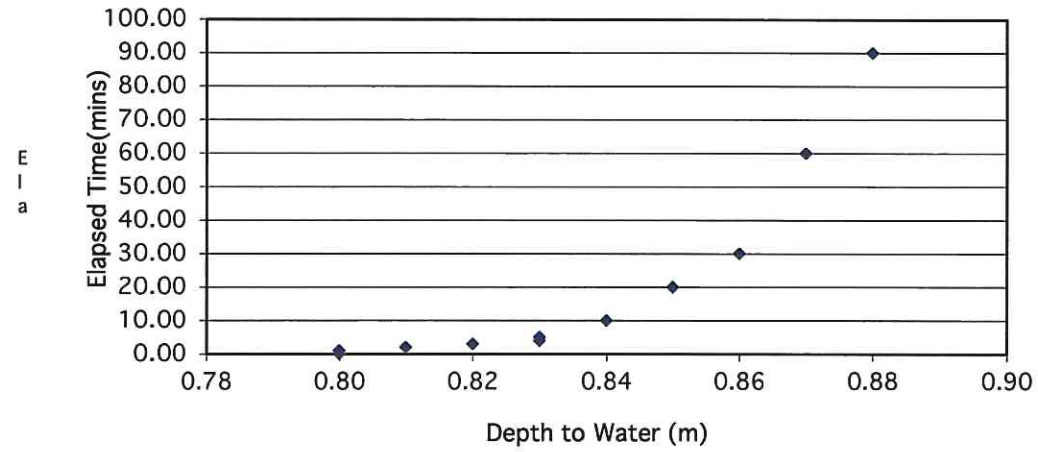
Field Test

Depth of Pit (D)	1.50	m
Width of Pit (B)	0.40	m
Length of Pit (L)	1.60	m
Initial depth to Water =	0.80	m
Final depth to water =	0.88	m
Elapsed time (mins)=	90.00	
Top of permeable soil		m
Base of permeable soil		m
Base area=	0.64	m2
*Av. side area of permeable stratum over test perio	2.64	m2
Total Exposed area =	3.28	m2

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

f= 0.00017 m/min or 2.891E-06 m/sec

Depth of water vs Elapsed Time (mins)



Appendix VI Laboratory Data

a. Geotechnical / Rock Tests

IGSL Ltd
Materials Laboratory
Unit J5, M7 Business Park
Newhall, Naas
Co. Kildare
045 846176

Test Report

Determination of Moisture Content, Liquid & Plastic Limits

Tested in accordance with BS1377:Part 2:1990, clauses 3.2, 4.3, 4.4 & 5.3**

Report No. **R137361** Contract No. 24190 Contract Name: Cherry Lane Ashbourne Meath

Customer DBFL

Samples Received: 11/08/22 Date Tested: 11/08/22

BH/TP*	Sample No.	Depth* (m)	Lab. Ref	Sample Type*	Moisture Content %	Liquid Limit %	Plastic Limit %	Plasticity Index	% <425µm	Preparation	Liquid Limit Clause	Classification (BS5930)	Description
BH01	AA175378	2.0	A22/4516	B	13	33	17	16	53	WS	4.4	C L	Grey brown sandy gravelly CLAY
BH01	AA175380	4.0	A22/4517	B	7.2	25	14	11	31	WS	4.4	C L	Grey brown slightly sandy, gravelly, CLAY
BH02	AA175382	1.0	A22/4518	B	7.9	29	15	14	57	WS	4.4	C L	Brown sandy gravelly CLAY
BH02	AA175284	3.0	A22/4519	B	8.0	28	15	13	56	WS	4.4	C L	Grey brown slightly sandy, gravelly, CLAY
TP01	AA137826	1.2	A22/4520	B	16	31	17	14	60	WS	4.4	C L	Brown sandy gravelly CLAY
TP05	AA137845	1.6	A22/4521	B	21	38	21	17	77	WS	4.4	C I	Brown sandy gravelly CLAY
TP06	AA137841	1.5	A22/4522	B	23	28	15	13	95	WS	4.4	C L	Brown sandy gravelly CLAY

Preparation: WS - Wet sieved
AR - As received
NP - Non plastic

Liquid Limit Clause: 4.3 Cone Penetrometer definitive method
4.4 Cone Penetrometer one point method

Sample Type: B - Bulk Disturbed
U - Undisturbed

Remarks:
Results relate only to the specimen tested,in as received condition unless otherwise noted.
NOTE: **These clauses have been superceded by EN 17892-1 and EN17892-12.
Opinions and interpretations are outside the scope of accreditation. * denotes Customer supplied information.
This report shall not be reproduced except in fullwithout written approval from the Laboratory.

IGSL Ltd Materials Laboratory

Persons authorized to approve reports
H Byrne (Laboratory Manager)

Approved by | Date: 18/08/22 | Page: 1 of 1

TEST REPORT

Determination of Particle Size Distribution

Tested in accordance with: BS1377:Part2:1990 , clause 9.2 & 9.5**

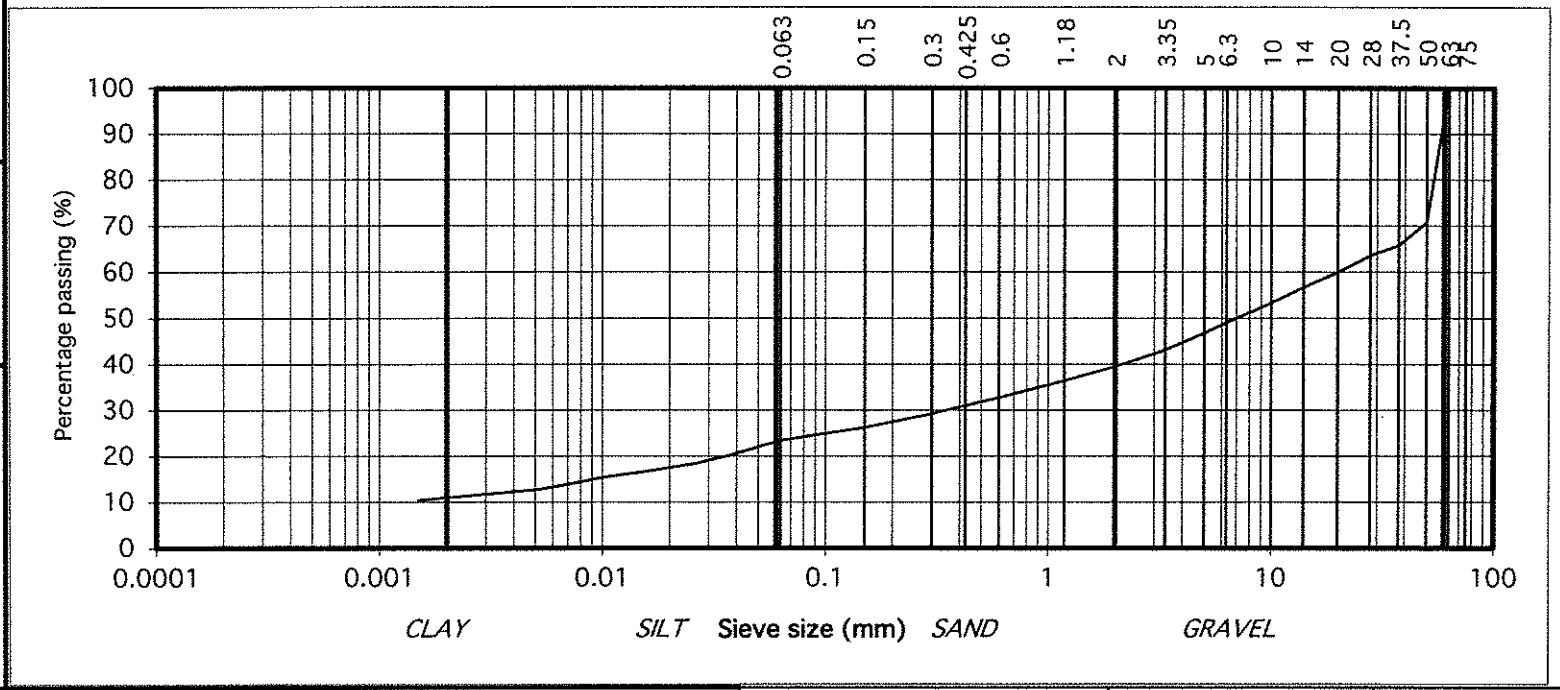
(note: Sedimentation stage not accredited)

ISO 17025 INAB ACCREDITED TESTING DETAILED IN SCOPE REG NO. 133T

particle size	% passing	
75	100	COBBLES
63	100	
50	71	GRAVEL
37.5	66	
28	64	
20	60	
14	57	
10	53	
6.3	49	
5	47	
3.35	43	
2	40	
1.18	36	SAND
0.6	33	
0.425	31	
0.3	29	
0.15	26	
0.063	23	SILT/CLAY
0.037	20	
0.027	18	
0.017	17	
0.010	15	
0.007	14	
0.005	13	
0.001	10	

Contract No.	24190	Report No.	R137362	
Contract Name :	Cherry Lane Ashbourne Meath			
BH/TP* :	Bh01			
Sample No.*	AA175380	Lab. Sample No.		A22/4517
Sample Type:	B			
Depth* (m)	4m	Customer:	DBFL	
Date Received	11/08/2022	Date Testing started		11/08/2022
Description:	Grey brown slightly sandy, gravelly, CLAY			
Remarks	Note: **Clause 9.2 and Clause 9.5 of BS1377:Part 2:1990 have been superseded by ISO17892-4:2 Sample size did not meet the requirements of BS1377			

Results relate only to the specimen tested in as received condition unless otherwise noted. * denotes Customer supplied information. Opinions and interpretations are outside the scope of accreditation.



IGSL Ltd Materials Laboratory

Approved by:	Date:	Page no:
	18/08/22	1 of 1

Persons authorised to approve report: J Barrett (Quality Manager) H Byrne (Laboratory Manager)

TEST REPORT
Determination of Particle Size Distribution
Tested in accordance with: BS1377:Part2:1990 , clause 9.2 & 9.5**
(note: Sedimentation stage not accredited)

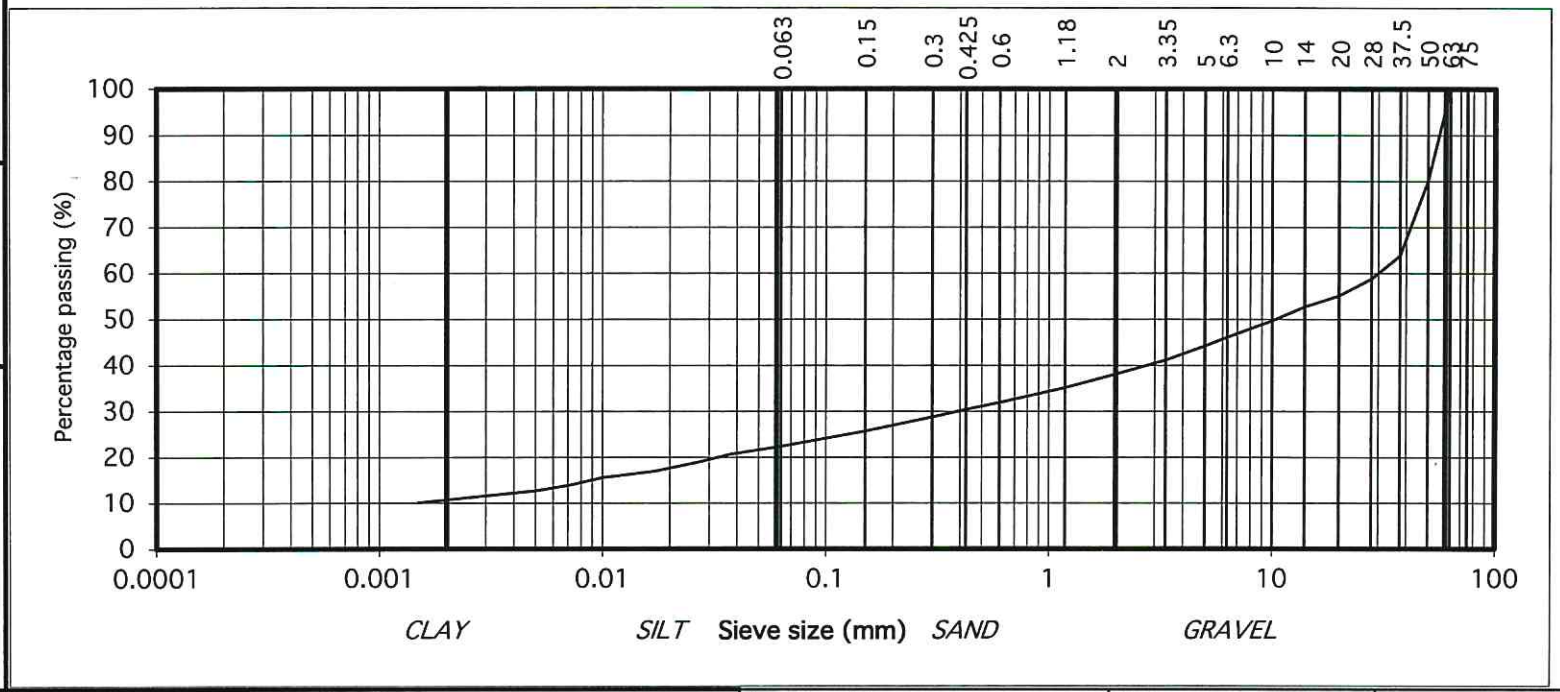
ISO 17025 IVNAB ACCREDITED TESTING DETAILED IN SCOPE REG NO. 133T

particle size	% passing	
75	100	COBBLES
63	100	
50	80	GRAVEL
37.5	64	
28	59	
20	55	
14	53	
10	50	
6.3	46	
5	44	
3.35	41	
2	38	
1.18	35	SAND
0.6	32	
0.425	30	
0.3	29	
0.15	26	
0.063	22	SILT/CLAY
0.037	21	
0.027	19	
0.017	17	
0.010	16	
0.007	14	
0.005	13	
0.001	10	

Contract No.	24190	Report No.	R137363
Contract Name :	Cherry Lane Ashbourne Meath		
BH/TP* :	Bh02		
Sample No.*	AA175384	Lab. Sample No.	A22/4520
Sample Type:	B		
Depth* (m)	3m	Customer:	DBFL
Date Received	11/08/2022	Date Testing started	11/08/2022
Description:	Grey brown slightly sandy, gravelly, CLAY		

Results relate only to the specimen tested in as received condition unless otherwise noted. * denotes Customer supplied information. Opinions and interpretations are outside the scope of accreditation.
This report shall not be reproduced except in full without the written approval of the Laboratory.

Remarks: Note: **Clause 9.2 and Clause 9.5 of BS1377:Part 2:1990 have been superseded by ISO17892-4:2 Sample size did not meet the requirements of BS1377



IGSL Ltd Materials Laboratory

Approved by:	Date:	Page no:
	18/08/22	1 of 1

Persons authorised to approve report: J Barrett (Quality Manager) H Byrne (Laboratory Manager)

(Diametrial) POINT LOAD STRENGTH INDEX TEST DATA

Contract: Cherry Lane, Ashbourne, Co.Meath
Contract no. 24190
Date of test: 29/7/22

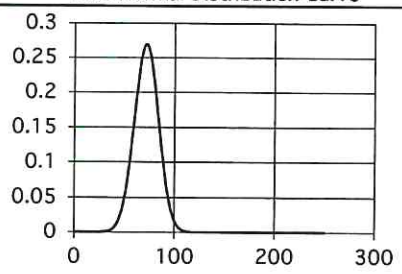
Sample Type: Core

RC No.	Depth m	D (Diameter) mm	P (failure load) kN	F	Is (index strength) Mpa	Is(50) (index strength) Mpa	*UCS MPa	Type	Orienation
RC01	6.2	78	16.0	1.222	2.63	3.21	64	d	//
	6.7	78	19.0	1.222	3.12	3.81	76	d	//
	7.6	78	20.0	1.222	3.29	4.02	80	d	//
	7.7	78	15.0	1.222	2.47	3.01	60	d	//
	8.5	78	14.0	1.222	2.30	2.81	56	d	//
RC02	7.9	78	23.0	1.222	3.78	4.62	92	d	//
	8.1	78	19.0	1.222	3.12	3.81	76	d	//
	8.7	78	17.0	1.222	2.79	3.41	68	d	//

Statistical Summary Data	Is(50)	UCS*
Number of Samples Tested	8	8
Minimum	2.81	56
Average	3.59	72
Maximum	4.62	92
Standard Dev.	0.59	12
Upper 95% Confidence Limit	4.75	94.99
Lower 95% Confidence Limit	2.43	48.57

Comments:
*UCS taken as k x Point Load Is(50): k= 20

*UCS Normal Distribution Curve



Abbreviations	
i	irregular
a	axial
b	block
d	diametral

approx. orientation to planes of weakness/bedding

U	unknown
P	perpendicular
//	parallel

Appendix VI Laboratory Data

b. Environmental and Chemical

eurofins | Chemtest
Eurofins Chemtest Ltd
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	22-31079-1		
Initial Date of Issue:	23-Aug-2022		
Client	IGSL		
Client Address:	M7 Business Park Naas County Kildare Ireland		
Contact(s):	Darren Keogh		
Project	24190 Cherry Lane Ashbourne Meath (DBFL - Glanbrind)		
Quotation No.:	Q20-19951	**Date Received:**	15-Aug-2022
Order No.:		**Date Instructed:**	15-Aug-2022
No. of Samples:	4		
Turnaround (Wkdays):	7	**Results Due:**	23-Aug-2022
Date Approved:	23-Aug-2022		
Approved By:			
Details:	Stuart Henderson, Technical Manager		

Results - Leachate

Project: 24190 Cherry Lane Ashbourne Meath (DBFL - Glanbrind)

Client: IGSL				Chemtest Job No.:		22-31079	22-31079
Quotation No.: Q20-19951				Chemtest Sample ID.:		1487865	1487868
				Client Sample ID.:		175377	137831
				Sample Location:		BH1	TP3
				Sample Type:		SOIL	SOIL
				Top Depth (m):		1.00	0.50
Determinand	**Accred.**	**SOP**	**Type**	**Units**	**LOD**		
pH	U	1010	10:1		N/A	8.1	8.2
Ammonium	U	1220	10:1	mg/l	0.050	< 0.050	0.087
Ammonium	N	1220	10:1	mg/kg	0.10	0.50	0.94
Boron (Dissolved)	U	1455	10:1	mg/kg	0.01	< 0.01	< 0.01
Benzo[j]fluoranthene	N	1800	10:1	µg/l	0.010	< 0.010	< 0.010

Results - Soil

Project: 24190 Cherry Lane Ashbourne Meath (DBFL - Glanbrind)

Client: IGSL				Chemtest Job No.:	22-31079	22-31079	22-31079	22-31079
Quotation No.: Q20-19951				Chemtest Sample ID.:	1487865	1487866	1487867	1487868
				Client Sample ID.:	175377	175378	137826	137831
				Sample Location:	BH1	BH1	TP1	TP3
				Sample Type:	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	1.00	2.00	1.20	0.50
				Asbestos Lab:	DURHAM			DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
ACM Type	U	2192		N/A	-			-
Asbestos Identification	U	2192		N/A	No Asbestos Detected			No Asbestos Detected
Moisture	N	2030	%	0.020	14	10	9.8	3.0
pH (2.5:1)	N	2010		4.0		[A] 9.2	[A] 9.0	
Boron (Hot Water Soluble)	U	2120	mg/kg	0.40	[A] < 0.40			[A] < 0.40
Magnesium (Water Soluble)	N	2120	g/l	0.010		[A] < 0.010	[A] < 0.010	
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010		[A] < 0.010	[A] < 0.010	
Total Sulphur	U	2175	%	0.010		[A] 0.16	[A] 0.11	
Sulphur (Elemental)	U	2180	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Chloride (Water Soluble)	U	2220	g/l	0.010		[A] < 0.010	[A] < 0.010	
Nitrate (Water Soluble)	N	2220	g/l	0.010		< 0.010	< 0.010	
Cyanide (Total)	U	2300	mg/kg	0.50	[A] < 0.50			[A] < 0.50
Sulphide (Easily Liberatable)	N	2325	mg/kg	0.50	[A] 4.4			[A] 1.5
Ammonium (Water Soluble)	U	2220	g/l	0.01		< 0.01	< 0.01	
Sulphate (Acid Soluble)	U	2430	%	0.010	[A] 0.024	[A] 0.026	[A] 0.027	[A] 0.024
Arsenic	U	2455	mg/kg	0.5	8.3			12
Barium	U	2455	mg/kg	0	74			44
Cadmium	U	2455	mg/kg	0.10	1.2			2.0
Chromium	U	2455	mg/kg	0.5	13			14
Molybdenum	U	2455	mg/kg	0.5	3.6			4.5
Antimony	N	2455	mg/kg	2.0	< 2.0			2.4
Copper	U	2455	mg/kg	0.50	16			28
Mercury	U	2455	mg/kg	0.05	< 0.05			0.10
Nickel	U	2455	mg/kg	0.50	33			41
Lead	U	2455	mg/kg	0.50	12			17
Selenium	U	2455	mg/kg	0.25	0.77			1.7
Zinc	U	2455	mg/kg	0.50	53			57
Chromium (Trivalent)	N	2490	mg/kg	1.0	13			14
Chromium (Hexavalent)	N	2490	mg/kg	0.50	< 0.50			< 0.50
Mineral Oil (TPH Calculation)	N	2670	mg/kg	10	< 10			< 10
Aliphatic TPH >C5-C6	N	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aliphatic TPH >C6-C8	N	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aliphatic TPH >C8-C10	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aliphatic TPH >C10-C12	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aliphatic TPH >C12-C16	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aliphatic TPH >C16-C21	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aliphatic TPH >C21-C35	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0

Results - Soil

Project: 24190 Cherry Lane Ashbourne Meath (DBFL - Glanbrind)

Client: IGSL				Chemtest Job No.:	22-31079	22-31079	22-31079	22-31079
Quotation No.: Q20-19951				Chemtest Sample ID.:	1487865	1487866	1487867	1487868
				Client Sample ID.:	175377	175378	137826	137831
				Sample Location:	BH1	BH1	TP1	TP3
				Sample Type:	SOIL	SOIL	SOIL	SOIL
				Top Depth (m):	1.00	2.00	1.20	0.50
				Asbestos Lab:	DURHAM			DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**				
Aliphatic TPH >C35-C44	N	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Total Aliphatic Hydrocarbons	N	2680	mg/kg	5.0	[A] < 5.0			[A] < 5.0
Aromatic TPH >C5-C7	N	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aromatic TPH >C7-C8	N	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aromatic TPH >C8-C10	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aromatic TPH >C10-C12	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aromatic TPH >C12-C16	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aromatic TPH >C16-C21	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aromatic TPH >C21-C35	U	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Aromatic TPH >C35-C44	N	2680	mg/kg	1.0	[A] < 1.0			[A] < 1.0
Total Aromatic Hydrocarbons	N	2680	mg/kg	5.0	[A] < 5.0			[A] < 5.0
Total Petroleum Hydrocarbons	N	2680	mg/kg	10.0	[A] < 10			[A] < 10
Benzene	U	2760	µg/kg	1.0	[A] < 1.0			[A] < 1.0
Toluene	U	2760	µg/kg	1.0	[A] < 1.0			[A] < 1.0
Ethylbenzene	U	2760	µg/kg	1.0	[A] < 1.0			[A] < 1.0
m & p-Xylene	U	2760	µg/kg	1.0	[A] < 1.0			[A] < 1.0
o-Xylene	U	2760	µg/kg	1.0	[A] < 1.0			[A] < 1.0
Methyl Tert-Butyl Ether	U	2760	µg/kg	1.0	[A] < 1.0			[A] < 1.0
Naphthalene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Acenaphthylene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Acenaphthene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Fluorene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Phenanthrene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Anthracene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Fluoranthene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Pyrene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Benzo[a]anthracene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Chrysene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Benzo[b]fluoranthene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Benzo[k]fluoranthene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Benzo[a]pyrene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Indeno(1,2,3-c,d)Pyrene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Dibenz(a,h)Anthracene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Benzo[g,h,i]perylene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Coronene	N	2800	mg/kg	0.010	[A] < 0.010			[A] < 0.010
Total Of 17 PAH's	N	2800	mg/kg	0.20	[A] < 0.20			[A] < 0.20
PCB 28	N	2815	mg/kg	0.0010	[A] < 0.0010			[A] < 0.0010
PCB 52	N	2815	mg/kg	0.0010	[A] < 0.0010			[A] < 0.0010

Results - Soil

Project: 24190 Cherry Lane Ashbourne Meath (DBFL - Glanbrind)

Client: IGSL					Chemtest Job No.:	22-31079	22-31079	22-31079	22-31079
Quotation No.: Q20-19951					Chemtest Sample ID.:	1487865	1487866	1487867	1487868
					Client Sample ID.:	175377	175378	137826	137831
					Sample Location:	BH1	BH1	TP1	TP3
					Sample Type:	SOIL	SOIL	SOIL	SOIL
					Top Depth (m):	1.00	2.00	1.20	0.50
					Asbestos Lab:	DURHAM			DURHAM
Determinand	**Accred.**	**SOP**	**Units**	**LOD**					
PCB 90+101	N	2815	mg/kg	0.0010	[A] < 0.0010				[A] < 0.0010
PCB 118	N	2815	mg/kg	0.0010	[A] < 0.0010				[A] < 0.0010
PCB 153	N	2815	mg/kg	0.0010	[A] < 0.0010				[A] < 0.0010
PCB 138	N	2815	mg/kg	0.0010	[A] < 0.0010				[A] < 0.0010
PCB 180	N	2815	mg/kg	0.0010	[A] < 0.0010				[A] < 0.0010
Total PCBs (7 congeners)	N	2815	mg/kg	0.0010	[A] < 0.0010				[A] < 0.0010
Total Phenols	U	2920	mg/kg	0.10	< 0.10				< 0.10

Results - Single Stage WAC

Project: 24190 Cherry Lane Ashbourne Meath (DBFL - Glanbrind)

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	22-31079						
Chemtest Sample ID:	1487865						
Sample Ref:							
Sample ID:	175377						
Sample Location:	BH1						
Top Depth(m):	1.00						
Bottom Depth(m):							
Sampling Date:							
Determinand	**SOP**	**Accred.**	**Units**		**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Total Organic Carbon	2625	U	%	[A] < 0.20	3	5	6
Loss On Ignition	2610	U	%	3.7	--	--	10
Total BTEX	2760	U	mg/kg	[A] < 0.010	6	--	--
Total PCBs (7 congeners)	2815	N	mg/kg	[A] < 0.0010	1	--	--
TPH Total WAC	2670	U	mg/kg	[A] < 10	500	--	--
Total Of 17 PAH's	2800	N	mg/kg	[A] < 0.20	100	--	--
pH	2010	U		9.0	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.0050	--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1455	U	0.0005	0.0045	0.5	2	25
Barium	1455	U	0.005	0.051	20	100	300
Cadmium	1455	U	< 0.00011	< 0.0011	0.04	1	5
Chromium	1455	U	< 0.0005	< 0.0050	0.5	10	70
Copper	1455	U	0.0011	0.011	2	50	100
Mercury	1455	U	< 0.00005	< 0.00050	0.01	0.2	2
Molybdenum	1455	U	0.0074	0.074	0.5	10	30
Nickel	1455	U	0.0008	0.0080	0.4	10	40
Lead	1455	U	< 0.0005	< 0.0050	0.5	10	50
Antimony	1455	U	< 0.0005	< 0.0050	0.06	0.7	5
Selenium	1455	U	0.0008	0.0077	0.1	0.5	7
Zinc	1455	U	< 0.003	< 0.025	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.48	4.8	10	150	500
Sulphate	1220	U	< 1.0	< 10	1000	20000	50000
Total Dissolved Solids	1020	N	65	650	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	17	170	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	14

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Results - Single Stage WAC

Project: 24190 Cherry Lane Ashbourne Meath (DBFL - Glanbrind)

					Landfill Waste Acceptance Criteria Limits		
Chemtest Job No:	22-31079						
Chemtest Sample ID:	1487868						
Sample Ref:							
Sample ID:	137831				**Inert Waste Landfill**	**Stable, Non-reactive hazardous waste in non-hazardous Landfill**	**Hazardous Waste Landfill**
Sample Location:	TP3						
Top Depth(m):	0.50						
Bottom Depth(m):							
Sampling Date:							
Determinand	**SOP**	**Accred.**	**Units**				
Total Organic Carbon	2625	U	%	[A] 0.53	3	5	6
Loss On Ignition	2610	U	%	2.7	--	--	10
Total BTEX	2760	U	mg/kg	[A] < 0.010	6	--	--
Total PCBs (7 congeners)	2815	N	mg/kg	[A] < 0.0010	1	--	--
TPH Total WAC	2670	U	mg/kg	[A] < 10	500	--	--
Total Of 17 PAH's	2800	N	mg/kg	[A] < 0.20	100	--	--
pH	2010	U		9.3	--	>6	--
Acid Neutralisation Capacity	2015	N	mol/kg	0.010	--	To evaluate	To evaluate
Eluate Analysis			**10:1 Eluate mg/l**	**10:1 Eluate mg/kg**	**Limit values for compliance leaching test using BS EN 12457 at L/S 10 l/kg**		
Arsenic	1455	U	0.0004	0.0039	0.5	2	25
Barium	1455	U	< 0.005	< 0.050	20	100	300
Cadmium	1455	U	< 0.00011	< 0.0011	0.04	1	5
Chromium	1455	U	< 0.0005	< 0.0050	0.5	10	70
Copper	1455	U	0.0020	0.020	2	50	100
Mercury	1455	U	< 0.00005	< 0.00050	0.01	0.2	2
Molybdenum	1455	U	0.0026	0.026	0.5	10	30
Nickel	1455	U	0.0009	0.0086	0.4	10	40
Lead	1455	U	< 0.0005	< 0.0050	0.5	10	50
Antimony	1455	U	< 0.0005	< 0.0050	0.06	0.7	5
Selenium	1455	U	0.0006	0.0064	0.1	0.5	7
Zinc	1455	U	< 0.003	< 0.025	4	50	200
Chloride	1220	U	< 1.0	< 10	800	15000	25000
Fluoride	1220	U	0.33	3.3	10	150	500
Sulphate	1220	U	< 1.0	< 10	1000	20000	50000
Total Dissolved Solids	1020	N	60	600	4000	60000	100000
Phenol Index	1920	U	< 0.030	< 0.30	1	-	-
Dissolved Organic Carbon	1610	U	16	160	500	800	1000

Solid Information	
Dry mass of test portion/kg	0.090
Moisture (%)	3.0

Waste Acceptance Criteria

Landfill WAC analysis (specifically leaching test results) must not be used for hazardous waste classification purposes. This analysis is only applicable for hazardous waste landfill acceptance and does not give any indication as to whether a waste may be hazardous or non-hazardous.

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
1487865		175377	BH1		A	Amber Glass 250ml
1487865		175377	BH1		A	Plastic Tub 500g
1487866		175378	BH1		A	Amber Glass 250ml
1487866		175378	BH1		A	Plastic Tub 500g
1487867		137826	TP1		A	Amber Glass 250ml
1487867		137826	TP1		A	Plastic Tub 500g
1487868		137831	TP3		A	Amber Glass 250ml
1487868		137831	TP3		A	Plastic Tub 500g

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1020	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Electrical Conductivity and Total Dissolved Solids (TDS) in Waters	Conductivity Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1455	Metals in Waters by ICP-MS	Metals, including: Antimony; Arsenic; Barium; Beryllium; Boron; Cadmium; Chromium; Cobalt; Copper; Lead; Manganese; Mercury; Molybdenum; Nickel; Selenium; Tin; Vanadium; Zinc	Filtration of samples followed by direct determination by inductively coupled plasma mass spectrometry (ICP-MS).
1610	Total/Dissolved Organic Carbon in Waters	Organic Carbon	TOC Analyser using Catalytic Oxidation
1800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Waters by GC-MS	Acenaphthene; Acenaphthylene; Anthracene; Benzo[a]Anthracene; Benzo[a]Pyrene; Benzo[b]Fluoranthene; Benzo[ghi]Perylene; Benzo[k]Fluoranthene; Chrysene; Dibenz[ah]Anthracene; Fluoranthene; Fluorene; Indeno[123cd]Pyrene; Naphthalene; Phenanthrene; Pyrene	Pentane extraction / GCMS detection
1920	Phenols in Waters by HPLC	Phenolic compounds including: Phenol, Cresols, Xylenols, Trimethylphenols Note: Chlorophenols are excluded.	Determination by High Performance Liquid Chromatography (HPLC) using electrochemical detection.
2010	pH Value of Soils	pH	pH Meter
2015	Acid Neutralisation Capacity	Acid Reserve	Titration
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2040	Soil Description(Requirement of MCERTS)	Soil description	As received soil is described based upon BS5930
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2180	Sulphur (Elemental) in Soils by HPLC	Sulphur	Dichloromethane extraction / HPLC with UV detection
2192	Asbestos	Asbestos	Polarised light microscopy / Gravimetry
2220	Water soluble Chloride in Soils	Chloride	Aqueous extraction and measurement by 'Aquakem 600' Discrete Analyser using ferric nitrate / mercuric thiocyanate.
2300	Cyanides & Thiocyanate in Soils	Free (or easy liberatable) Cyanide; total Cyanide; complex Cyanide; Thiocyanate	Allkaline extraction followed by colorimetric determination using Automated Flow Injection Analyser.
2325	Sulphide in Soils	Sulphide	Steam distillation with sulphuric acid / analysis by 'Aquakem 600' Discrete Analyser, using N,N–dimethyl-p-phenylenediamine.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.
2490	Hexavalent Chromium in Soils	Chromium [VI]	Soil extracts are prepared by extracting dried and ground soil samples into boiling water. Chromium [VI] is determined by 'Aquakem 600' Discrete Analyser using 1,5-diphenylcarbazide.
2610	Loss on Ignition	loss on ignition (LOI)	Determination of the proportion by mass that is lost from a soil by ignition at 550°C.
2625	Total Organic Carbon in Soils	Total organic Carbon (TOC)	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.

Test Methods

SOP	Title	Parameters included	Method summary
2670	Total Petroleum Hydrocarbons (TPH) in Soils by GC-FID	TPH (C6–C40); optional carbon banding, e.g. 3-band – GRO, DRO & LRO*TPH C8–C40	Dichloromethane extraction / GC-FID
2680	TPH A/A Split	Aliphatics: >C5–C6, >C6–C8,>C8–C10, >C10–C12, >C12–C16, >C16–C21, >C21–C35, >C35– C44Aromatics: >C5–C7, >C7–C8, >C8– C10, >C10–C12, >C12–C16, >C16– C21, >C21– C35, >C35– C44	Dichloromethane extraction / GCxGC FID detection
2760	Volatile Organic Compounds (VOCs) in Soils by Headspace GC-MS	Volatile organic compounds, including BTEX and halogenated Aliphatic/Aromatics.(cf. USEPA Method 8260)*please refer to UKAS schedule	Automated headspace gas chromatographic (GC) analysis of a soil sample, as received, with mass spectrometric (MS) detection of volatile organic compounds.
2800	Speciated Polynuclear Aromatic Hydrocarbons (PAH) in Soil by GC-MS	Acenaphthene*; Acenaphthylene; Anthracene*; Benzo[a]Anthracene*; Benzo[a]Pyrene*; Benzo[b]Fluoranthene*; Benzo[ghi]Perylene*; Benzo[k]Fluoranthene; Chrysene*; Dibenz[ah]Anthracene; Fluoranthene*; Fluorene*; Indeno[123cd]Pyrene*; Naphthalene*; Phenanthrene*; Pyrene*	Dichloromethane extraction / GC-MS
2815	Polychlorinated Biphenyls (PCB) ICES7Congeners in Soils by GC-MS	ICES7 PCB congeners	Acetone/Hexane extraction / GC-MS
2920	Phenols in Soils by HPLC	Phenolic compounds including Resorcinol, Phenol, Methylphenols, Dimethylphenols, 1-Naphthol and TrimethylphenolsNote: chlorophenols are excluded.	60:40 methanol/water mixture extraction, followed by HPLC determination using electrochemical detection.
640	Characterisation of Waste (Leaching C10)	Waste material including soil, sludges and granular waste	ComplianceTest for Leaching of Granular Waste Material and Sludge

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"
SOP	Standard operating procedure
LOD	Limit of detection

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis

The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols

For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

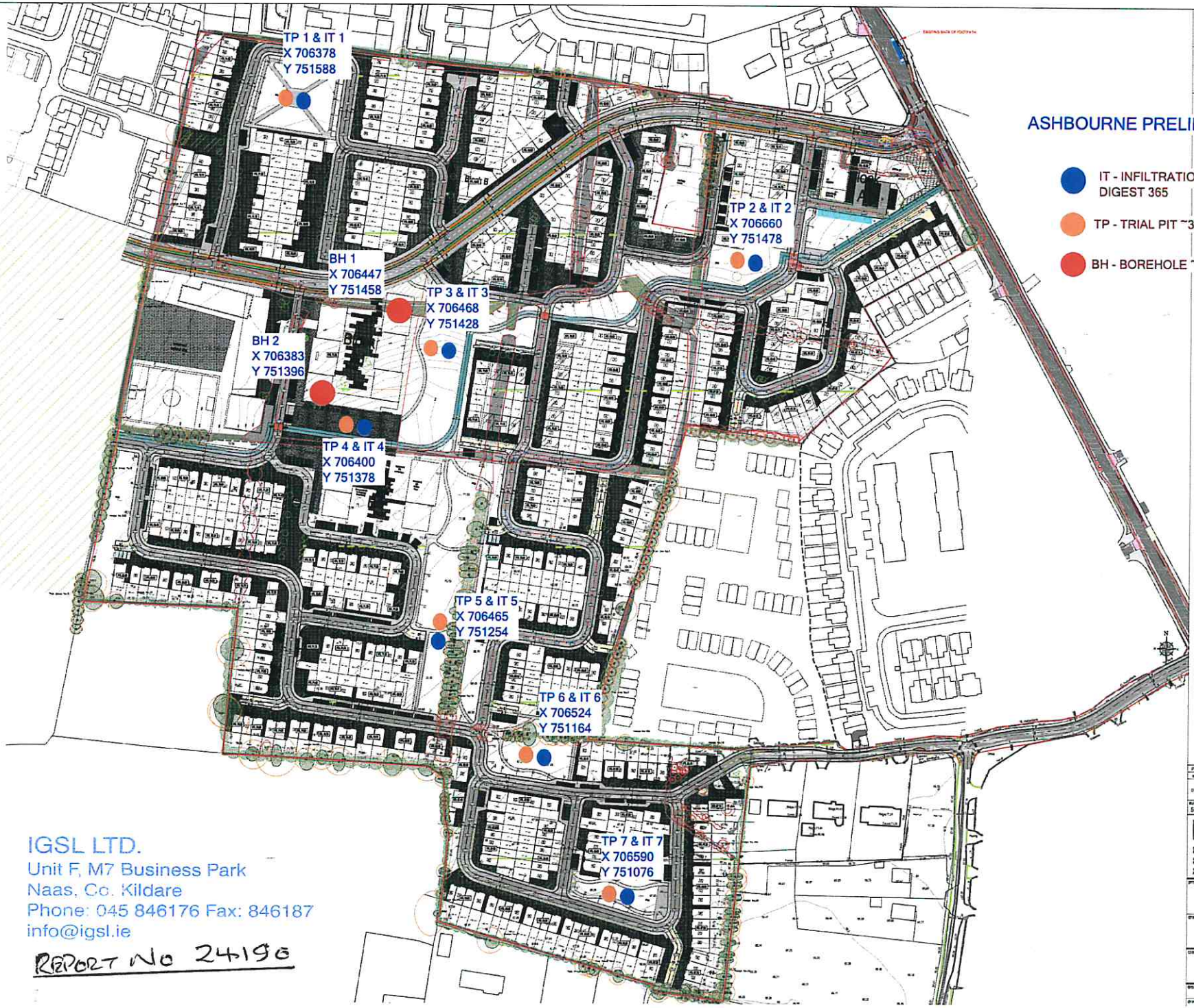
A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 30 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

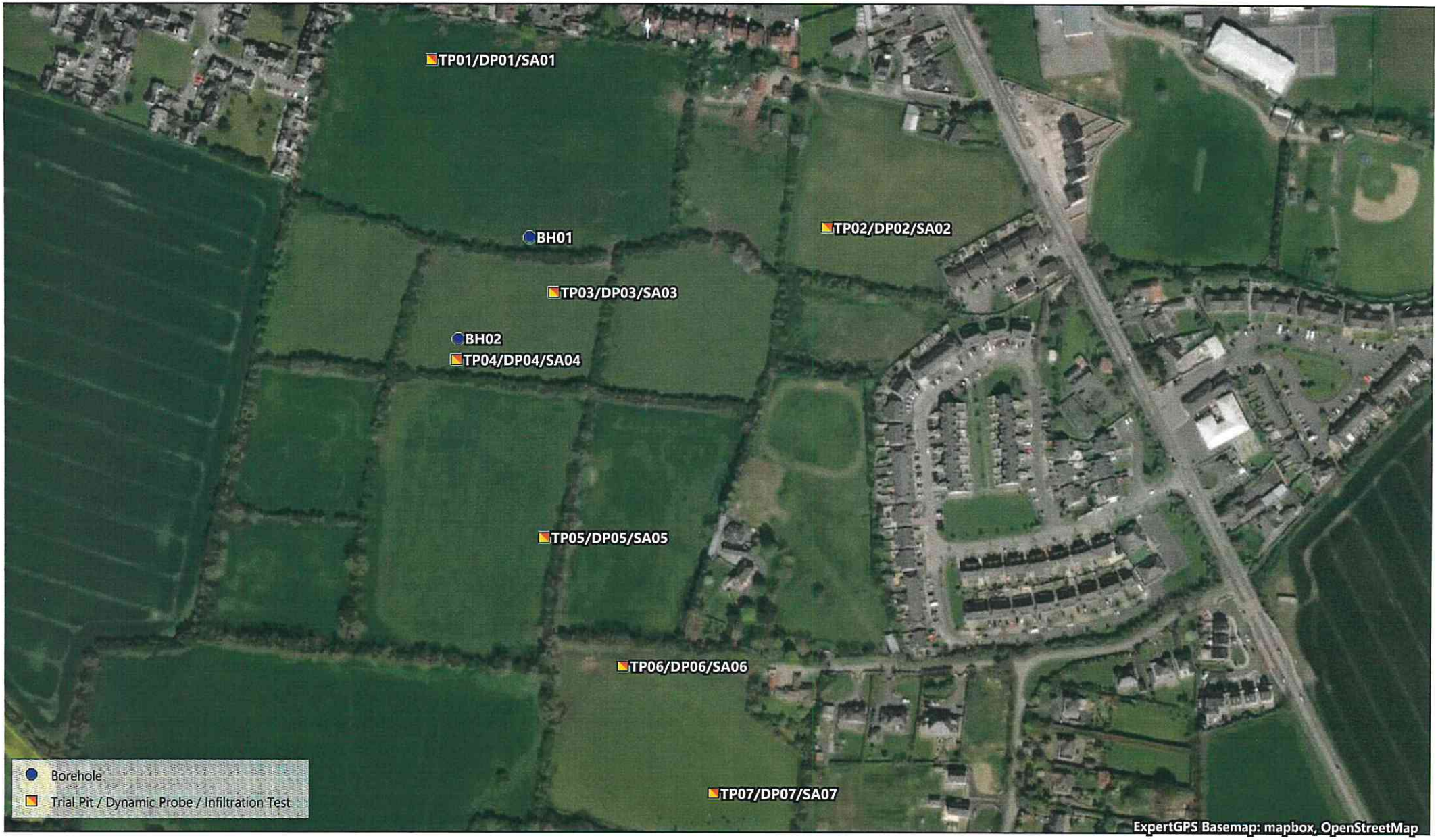
If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Appendix VII Site Plans



IGSL LTD.
Unit F, M7 Business Park
Naas, Co. Kildare
Phone: 045 846176 Fax: 846187
info@igsl.ie

REPORT NO 24196



ExpertGPS

24190 Cherry Lane Ashbourne

50 0 50 100 150 200 250 300 350 400 450 500 550 600 m

Scale: 1 : 3500.

MN

2°00'