Project

Residential Development, Sandford Road, Dublin 6

Report Title

Infrastructure Design Report

Client

Sandford Living Limited

INFRASTRUCTURE

DBFL CONSULTING ENGINEERS

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1.0 INTRODUCTION

1.1 Background

DBFL have been instructed to prepare an Infrastructure Design Report to accompany a planning application for a proposed development at Milltown Park, Sandford Road, Dublin 6.

The proposed development ("the site") comprises of 671 residential dwelling (604 No. Build to Rent and 67 No. Build to Sell) on a c. 4.26 ha site (developable area). The development also includes a creche with outdoor play area and communal internal amenities and facilities (co-working space, lounges, libraries and multi-purpose hall).

1.2 Objectives

This report provides information regarding the existing site and addresses the infrastructural demands of the proposed development including the following:

- Site Access and Road Layout
- Surface Water Drainage
- Flood Risk
- Foul Drainage
- Water Supply

1.3 Location

The subject site is located at the corner of Sandford Road and Milltown Road (refer to Figure 1.1 below). The site is currently occupied by institutional buildings comprising Milltown Park House with 5 No. extensions attached to the original structure, two of which are to be retained within the proposed development (The Chapel and Tabor House).

Sandford Road is located along the site's north-eastern boundary and Milltown Road is located along the site's south-eastern boundary.

Existing residential development is located to the north-west and west of the site while lands in the ownership of the Jesuit Order are located to the south-west and south of the site.

Figure 1.1: Site Location Plan (Site Boundary Indicative Only)

1.4 Topography and Site Characteristics

The site generally falls from south to north at a gradient of approx. 1:45. Surface gradients become flatter (approx. 1:100) on approach to the existing site access off Sandford Road.

Existing topographical survey of the site is shown in the background of the Proposed Road Layout Plan and the Proposed Site Services Layout Plan (refer to DBFL's Drawings 190226-DBFL-RD-SP-DR-C-1001 and 190226-DBFL-CS-SP-DR-C-1001).

Existing surface gradients across the site have been a key factor in the design of road levels, finished floor levels, the surface water drainage network and the foul drainage network.

Existing trees and vegetation are located along the site's western, eastern and northern boundaries. These trees and vegetation have also been considered in the design of the surface water drainage network and foul drainage network.

1.5 Ground Conditions

Ground Investigations Ireland carried out site investigations between January and June 2020.

The site is generally overlain by a 0.2m to 0.4 m thick topsoil layer. An asphalt layer was observed at some locations (existing access road / carpark) and is typically 100mm thick.

Made ground deposits were encountered under topsoil/surfacing at some locations at depths between 0.5 and 1.0m BGL. These deposits were described generally as brown slightly sandy, slightly gravelly CLAY with occasional cobbles or grey sandy angular Gravel. In some locations the made ground contained occasional fragments of brick.

The site is generally underlain by cohesive deposits comprising of slightly sandy / slightly gravelly CLAY with occasional cobbles overlying a stiff or very stiff dark grey/black slightly sandy slightly gravelly CLAY with occasional cobbles. The strength of the cohesive deposits typically increases with depth. Granular deposits were encountered in BH16 within the cohesive deposits and were typically grey brown slightly clayey sandy sub angular sub rounded fine to coarse GRAVEL with occasional cobbles.

The rotary core boreholes recovered weak to strong grey/dark grey fines to medium grained LIMESTONE with calcite veining. Residual weather mudstone also found in some locations. Depths to rock varies from 9.0m to 18.45m BGL.

At the time of the initial site investigations, groundwater was observed at 4 of 16 borehole locations at depths typically ranging from 2.5m to 3.0m BGL. Standpipes were installed at 7 no. boreholes locations to determine the equilibrium groundwater level over time. Ground water measurements taken in June 2020 and October 2020 indicated ground water depths of 1.0m to 7.5m BGL.

Soakaway testing was carried out at three locations (in the vicinity of the proposed attenuation facility). Infiltration was not observed at any of the test locations; therefore, infiltration has not been allowed for in surface water design and calculations for the proposed development. Infiltration test results are included in Appendix F of this report.

1.6 **Proposed Development**

As noted in Section 1.1, the proposed development comprises of 672 residential dwellings a creche and communal internal amenities. Refer to O'Mahony Pike Architects' Schedule of Accommodation and Site Layout Plan for further detail.

The proposed development will also include the following associated engineering infrastructure:

- Provision of surface water drainage, foul drainage and water supply infrastructure and connections.
- Construction of a surface water outfall which exits the site along its south-eastern boundary, continues along Milltown Road, through the junction of Milltown Road / Sandford Road prior to discharging to the existing public surface water drainage network in Eglinton Road. The surface water outfall extends approximately 300m from the developable site boundary to the outfall location.
- Provision of a new vehicle access off Milltown Road (primary vehicle access to the proposed development facilitating access to the basement carpark, the forecourt area adjacent to Tabor House and the duplex units along the western boundary). This new site access shall be a priority junction and also serves pedestrians and cyclists.
- Retain existing entrance on Sandford Road (facilitates pedestrian and cycle access as well as limited vehicle access to the area adjacent to Block A1). Improvements to pedestrian facilities adjacent to the entrance off Sandford Road are also proposed.
- Provision of additional a access point for pedestrians and cyclists adjacent to the junction of Sandford Road / Milltown Road.

2.0 ACCESS AND ROADS

2.1 Vehicular Site Access

Vehicular Access – Milltown Road

The primary access point for vehicles is off Milltown Road facilitating access to the basement carpark, the forecourt area adjacent to Tabor House and the duplex units along the western boundary. This access point also serves pedestrians and cyclists.

This proposed site access shall operate as a priority junction with associated signage and line marking in accordance with the Department of Transport's Traffic Signs Manual.

A Toucan Crossing is also proposed in vicinity of the Milltown Road access to improve facilities for vulnerable road users.

Milltown Road has a posted speed limit of 50km/hour. The site entrance complies with minimum visibility splays as required by DMURS (Y Distance = 49m, X Distance = 2.4m).

Refer to Drawing No. 190226-DBFL-RD-SP-DR-C-1001 for the proposed site access layout at Milltown Road.

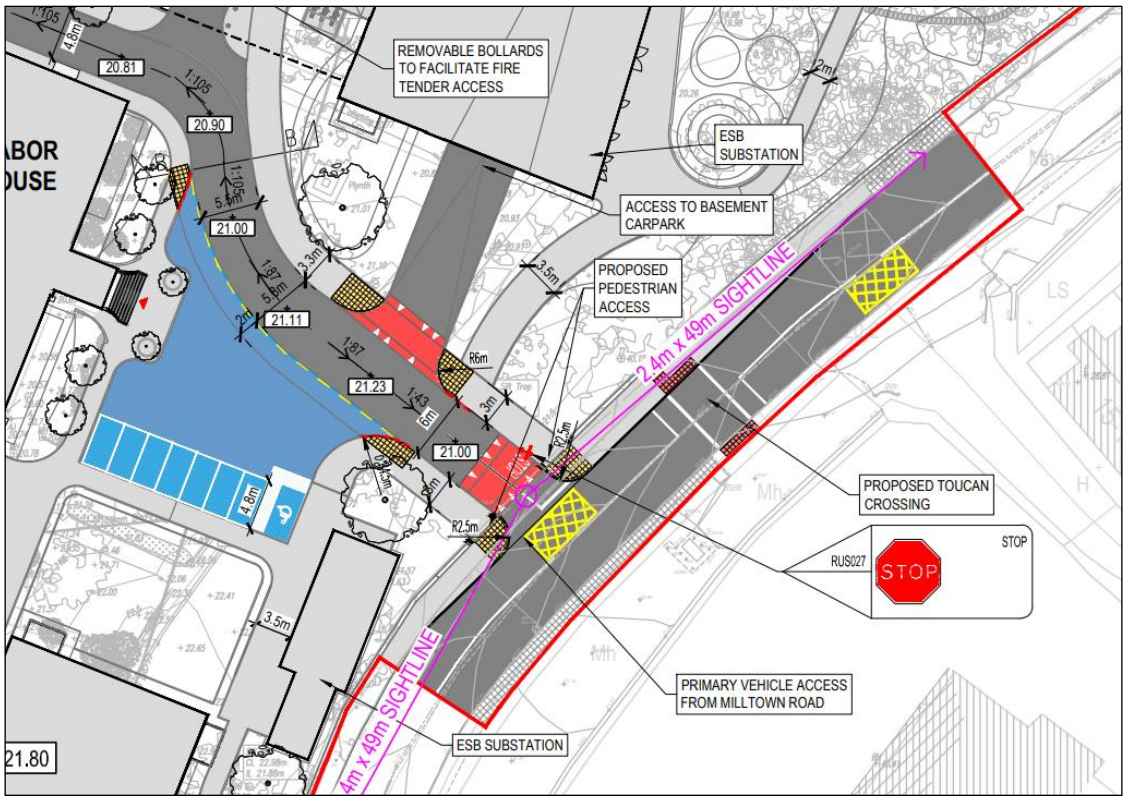


Figure 2.1: Site Access off Milltown Road

Vehicular Access – Sandford Road

A secondary access point for vehicles is located at the existing entrance from Sandford Road which facilitates access to the area adjacent to Block A (for deliveries, taxi pick up / drop off and disabled parking) as well as fire tender access to the northern end of the site.

This access point also serves pedestrians and cyclists. As such, improvements to pedestrian facilities at the Sandford Road / Belmont Avenue junction are proposed (upgrading of the existing pedestrian crossing on Sandford Road, amendments to line marking at the junction, improved tactile paving and reduction of corner radii).

There is no vehicular access from Sandford Road to the basement carpark, the forecourt area adjacent to Tabor House and the duplex units along the western boundary (which are all served exclusively from Milltown Road).

Refer to Drawing No. 190226-DBFL-RD-SP-DR-C-1001 for the proposed site access layout at Milltown Road.

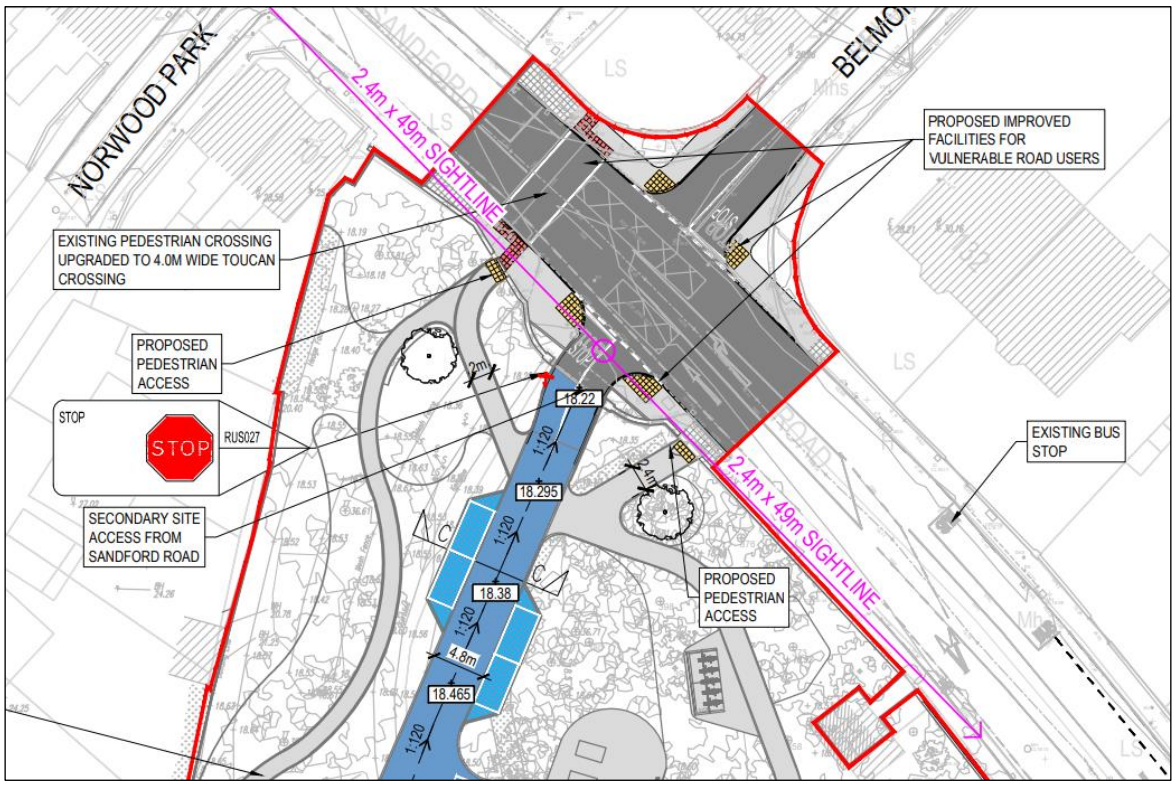


Figure 2.1: Site Access off Milltown Road

2.2 Pedestrian and Cycle Access

With reference to DBFL Drawing 190226-DBFL-RD-SP-DR-C-1001 (Roads Layout), the site layout facilitates high levels of cycle and pedestrian connectivity as noted below:

- As noted above in Section 2.1, pedestrian and cycle access is proposed at the Milltown Road and Sandford Road entrances.
- An additional access point for pedestrians and cyclists is proposed adjacent to the junction of Sandford Road / Milltown Road (adjacent to the north-east corner of the site).
- The site layout also facilitates potential future pedestrian connectivity to the Jesuit lands south-west of the site.
- A Toucan Crossing is proposed in vicinity of the Milltown Road access to improve facilities for vulnerable road users.
- Improved facilities for vulnerable road users are also proposed at the Sandford Road access (at present there is a single push button pedestrian crossing at Sandford Road which is to be upgraded to a Toucan Crossing).
- The scheme proposals for the subject site will ensure pedestrians are given priority within the internal site layout arranged to ensure pedestrian desire lines are accommodated within the development.

The proposed pedestrian and cycle access points as described above are shown on Drawing 190226-DBFL-RD-SP-DR-C-1001.

2.3 Street Layout Design

DMURS Street Design guidelines have been incorporated into the site's street layout and are detailed further in DBFL's DMURS Design Statement (Technical Note, 190226-TN-001).

2.4 Vehicle Tracking

The proposed site layout has been tracked (using AutoTrack software) to demonstrate that large vehicles such as fire tender, refuse vehicles and ESB trucks can access and circulate around the site (refer to Drawings 190226-DBFL-RD-SP-DR-C-1002 to 190226-DBFL-RD-SP-DR-C-1007).

2.5 Pavement Design Standards

Pavement design at site access points from Milltown Road and Sandford Road and local streets within the development are to be designed in accordance with the Design Manual for Urban Roads and Streets (DMURS) and Local Authority requirements.

Actual CBR (California Bearing Ratio) values and ground conditions are to be confirmed by site specific investigations prior to road construction.

2.6 Traffic & Transportation

A separate Traffic and Transportation Assessment has been prepared as part of this planning application (refer to DBFL Report No. 190226-rep-005).

3.0 SURFACE WATER DRAINAGE

3.1 Existing Surface Water Drainage Infrastructure

As noted in Section 1.4, Topography and Site Characteristics, the site generally falls from south to north at a gradient of approx. 1:45 with surface gradients becoming flatter on approach to the existing site access off Sandford Road.

An existing 225mm diameter surface water drain is located approximately 80m from the eastern corner of the site on Eglington Road. Refer to Figure 3.1 below and Irish Water's Network Plan as included in Appendix A of this report.

Existing surface water drains on site discharge to the existing combined sewer network along Sandford Road and Milltown Road rather than the existing surface water drain in Eglinton Road / Dodder River.

It is proposed to discharge attenuated flows from the site to the existing drainage network on Eglington Road (approximately 200m from the Sandford Road / Eglinton Road junction where the public line increases to a 300mm diameter pipe).

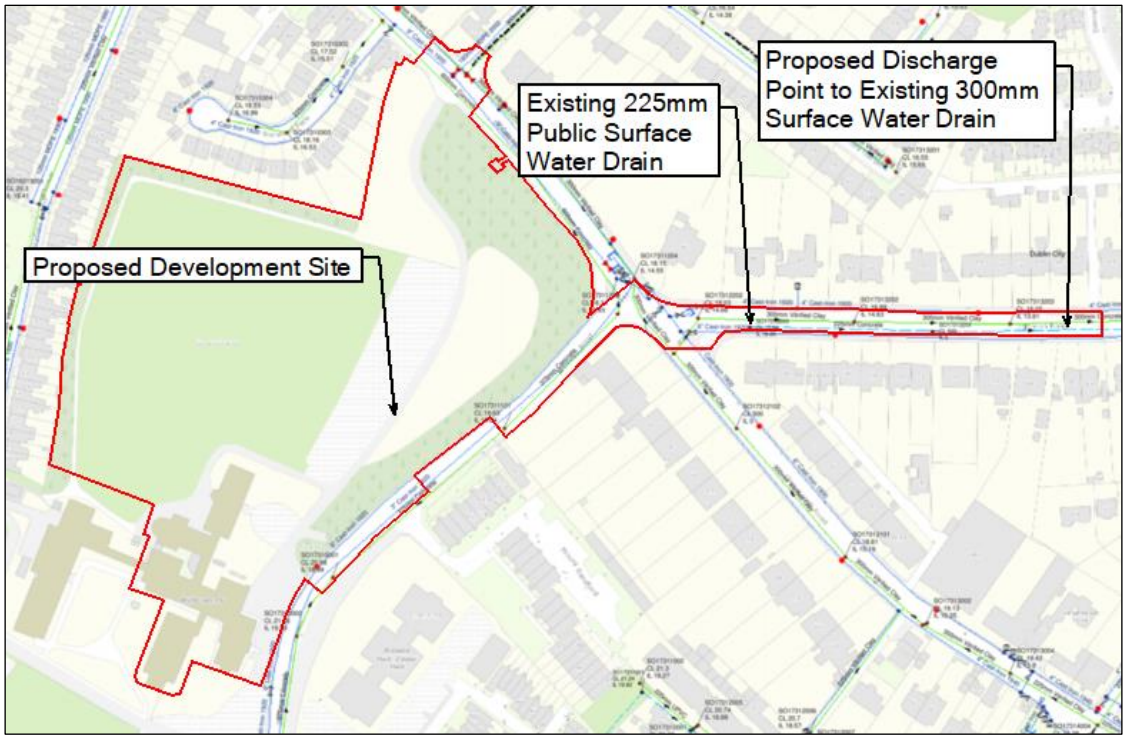


Figure 3.1: Extract from Irish Water's Network Plan (Site Boundary Indicative Only)

3.2 **Basis of Design**

3.2.1 General Description of Surface Water Design

The public surface water network on Eglington Road (as described above in Section 3.1) will provide a suitable surface water discharge point for the proposed development. However, in order to achieve the required drainage invert levels on site, approximately 160m of the existing drainage network along Eglington Road will need to be replaced with a 300mm pipe running at a flatter gradient. The total length of the surface water outfall from the point it crosses the developable site boundary at Milltown Road to the discharge point on Eglinton Road is approximately 300m.

Detailed topographic and GPR surveys were carried out along the proposed outfall route (Milltown Road, through the junction of Milltown Road / Sandford Road and Eglinton Road) to assess feasibility with regard to the location of existing services. The interaction between existing services and the alignment / level of the outfall route is shown on DBFL Drawing 190226-DBFL-CS-SP-DR-C-1003. The development's surface water outfall has been designed based on a self -cleansing velocity of 1.0 m/sec (300mm diameter @ min. gradient of 1/252).

The proposed surface water drainage network for the site is shown on Drawings 190226-DBFL-CS-SP-DR-C-1001.

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 attenuation tanks (Stormtech Chambers or equivalent). Surface water discharge will also pass via a full retention fuel / oil separator (sized in accordance with permitted discharge rate 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 **apartment roofs** will be captured by green roof (sedum blanket or equivalent) prior to being routed to the piped surface water drainage network.

Surface water runoff from the **roofs of duplex units located along the western boundary will be routed to the proposed surface water pipe network via porous aggregates beneath permeable paved driveways** (providing an additional element of attenuation).

A **drainage reservoir (drainage board) is to be provided on the podium slab over basement** (for green areas and paved areas).

Surface water runoff from the majority of **site's internal street network will be directed to the proposed pipe network via tree pits or other SUDS features** (with overflows to conventional road gullies). Part of the **site's internal street network (adjacent to Block E) drains via 3 no. bio-retention areas.**

Surface water runoff from **in curtilage parking spaces associated with duplex units located along the western boundary will be captured by permeable paving**.

In limited instances, surface water runoff from **paved areas will be directed to the proposed pipe network via conventional road gullies**.

Any incidental surface water runoff generated from the basement carpark would drain through a separate system beneath the basement slab (out falling to the proposed foul drainage network via a petrol interceptor).

3.2.2 Compliance with Surface Water Policy

The site's surface water management infrastructure has been designed in accordance with the Greater Dublin Strategic Drainage Study (GDSDS).

The GDSDS (Vol. 2, Chapter 6.3.4) requires that the following design criteria are applied to all sites:

- Criterion 1:

  River Water Quality Protection – Satisfied by providing interception storage and treatment of surface water run-off by SUDS features such as permeable paving of driveways, green roofs, tree pits, bioretention areas, underground attenuation tanks and full retention fuel / oil separators at surface water discharge points.

- Criterion 2:

  River Regime Protection – Satisfied by attenuating surface water run-off in association with flow control devices prior to discharge off site at greenfield runoff rate. Site critical duration storm used to assess attenuation volume.

- Criterion 3:

  Level of Service (Flooding) for the Site – Satisfied by reviewing available flood hazard information (e.g. Eastern CFRAM Study) relating to the site's proximity to fluvial flood plains (up to 1 in 100-year flood event).

  Also refer to DBFL Report No. 162085-rep-004 (Site Specific Flood Risk Assessment).

- Criterion 4:

  River Flood Protection – Satisfied by attenuating surface water discharge to greenfield runoff rates, addressing pluvial flood risk associated with the 1 in 100 year storm and avoiding development in flood plains.

3.2.3 Design Standards

Proposed surface water drains have been designed in accordance with the Greater Dublin Strategic Drainage Study (GDSDS), the Department of the Environment's Recommendations for Site Development Works for Housing Areas, the Department of the Environment's Building Regulations "Technical Guidance Document Part H Drainage and Waste Water Disposal" and BS EN 752: 2008 Drain and Sewer Systems Outside Buildings.

Design Criteria:

- Return period for pipe work design — 5 years
- Return period for attenuation design — 100 years
- Allowable Outflow — 2.0 l/sec/ha
- Time of entry — 4 minutes
- M5 - 60 (based on site specific rainfall data) — 17.3 mm
- Ratio "r" (based on site specific rainfall data) — 0.280
- Pipe Friction (Ks) — 0.6 mm
- Minimum Velocity (based on pipe flowing full) — 1.0 m/s
- Rainfall Depth Factored for Climate Change — 20%

Climate Change Category	Characteristics
River flows	20% increase in flows for all return periods up to 100 years
Sea level	400+mm rise (see Climate Change policy document for sea levels as a function of return period)
Rainfall	10% increase in depth (factor all intensities by 1.1)
	Modify time series rainfall in accordance with the GDSDS climate change policy document

Table 6.2 Climate Change Factors to be Applied to Drainage Design

Refer to Appendix B for Attenuation Design Calculations and Appendix C for Surface Water Network Design Calculations which have been carried out using Microdrainage WinDes analysis software.

3.2.4 SuDS

The following methodologies are being implemented as part of a SuDS treatment train approach:

- Green Roof – The proposed build-up will be an extensive type with 100mm minimum construction depth and sedum planting.
- Roof Areas Draining Via SuDS – Duplex units located along the site's western boundary drain via porous aggregates beneath permeable paved driveways (providing an additional element of attenuation).
- Green Areas Over Podium –Soft landscaped podium areas will have typical soil depths of up to 300mm to facilitate grassed areas, plants, shrubs and trees i.e. similar to a deep intensive green roof build up.
- Permeable Paving Over Podium – Free draining material within the build-up and will reduce the flow rate from these areas.
- Surface water runoff from the site's internal street network will be directed to the proposed pipe network via tree pits or other SUDS features like swales or bioretention areas with overflows to conventional road gullies.
- Surface water runoff from in curtilage parking spaces (duplex units located along the site's western boundary) captured by permeable paving.
- Soft Landscaped/Grassed Areas – Slows runoff at source.
- Attenuation of the 30 and 100 year return period storms within Stormtech Attenuation Chambers or equivalent
- Installation of a vortex flow control device (Hydrobrake or equivalent), limiting surface water discharge from the site to 2.0 l/sec/ha
- Surface water discharge will also pass via a Class 1 full retention fuel / oil separator (sized in accordance with permitted discharge from the site)

3.2.5 Proposed Runoff Coefficients and Factored Impermeable Areas

Proposed Runoff Coefficients

Noted below are the proposed reduction factors for the proposed development.

- Green Roof – 30% Reduction Factor

  The proposed build up will be an extensive type with 100mm minimum construction depth and sedum planting. The soil build-up will partially absorb some of the initial run-off and once saturated will reduce flow rates through green roof medium to the outlets and final attenuation storage location.

- Duplex Roof Draining via SuDs – 20% Reduction Factor

  Reduction of velocity as the aggregate/filter material used in the SuDS feature (permeable paving) slows run-off at source and ultimately reduces the peak inflow for attenuation calculations.

- Roads Draining via SuDs – 20% Reduction Factor

  Typically, road gullies discharge to tree pits (with high level overflow to the piped surface water network). Also takes account of run-off stored within the micro and macro texture of the surfacing (i.e. runoff not collected by piped network).

- In Curtilage Parking Spaces, Permeable Paving – 30% reduction Factor

  Reduction of velocity as the aggregate/filter material used in the SuDS feature (permeable paving) slows the run-off at source ultimately reduce the peak inflow for attenuation calculations.

- Green Areas Over Podium – 50% Reduction Factor

  Soft landscaped podium areas will have typical soil depths of up to 300mm to facilitate grassed areas, plants, shrubs and trees i.e. similar to a deep intensive green roof build up.

- Permeable Paving Over Podium – 20% Reduction Factor

  Permeable paving on the podium will have a free draining material within the build-up and will reduce the flow rate from these areas. A reduction in velocity will also occur as the aggregate used will slow the run-off at source.

- Soft Landscaped/Grassed Areas – 90% Reduction Factor

  Grassed/ landscaped areas slows the run-off at source ultimately reducing the peak inflow for attenuation calculation.

- Impermeable Areas (footpaths and hard stand areas) – 5% Reduction Factor

  A 5% reduction of the surface area is applied to take account of run-off not collected and stored within the micro and macro texture of the surfacing.

Factored Impermeable Areas

	Runoff Coefficients	Gross Areas m^2	Factored Areas m^2
Green Roof	0.70	8,018	5,613
Roof Draining via SuDS	0.80	1,389	1,111
Roads/Footpaths draining to tree pits with Overflow to Gullies	0.80	4,677	3,742
Green Areas on Podium	0.50	2,669	1,334
Permeable Areas on Podium	0.80	1,427	1,142
Permeable Paving	0.70	1,089	763
Landscaped Area	0.10	21,265	2,127
Impermeable areas	0.95	2,066	1,963
Total (m^2)		**42,600**	**17,795**
Total (ha)		**4.26**	**1.8**

Table 3.1 Proposed Runoff Coefficients and Factored Impermeable Areas.

3.2.6 Attenuation Calculation

Attenuation volumes have been calculated based on an allowable outflow / greenfield runoff rate of 2.00 l/sec/ha. This results in a permitted discharge from the site of 8.52 l/sec.

Run-off from the proposed development will be controlled / attenuated using vortex type flow control devices (Hydrobrake or equivalent).

Due to the topography and site layout, it is proposed that the site be divided in to 5 no. catchments each containing an attenuated storage system.

The resultant storage system types, discharge limits and storage volumes for each catchment are detailed in Table 3.2.

Catchment / Attenuation Area	Draining/ cascading to	Catchment Area (Total) ha	Impermeable Catchment Area (Total) ha	Allowable Outflow (Max.) l/sec	Storage Volume Required (100 Yr.) m^3	Storage Volume Provided (100 Yr.) m^3
1	Cascading to Catchment 2	0.80	0.36	2	238.5	261.6
2	Cascading to Catchment 3	0.79	0.51	4.7	285.6	327.4
3	Cascading to Catchment 5	0.48	0.146	4.7	201.6	209.2
4	Cascading to Catchment 5	1.18	0.548	2.6	364.6	377.9
5	Draining to Eglington Rd.	1.00	0.219	8.5	182.5	229.2
TOTAL		**4.26**	**1.8**		**1272.8**	**1405.3**

Table 3.2 – Surface Water Attenuation Storage and Discharge Limits

The locations of the proposed attenuation systems are shown on Drawing 190226-DBFL-CS-SP-DR-C-1001. Refer to Appendix B for Attenuation Calculations (attenuation volumes have been carried out using Microdrainage analysis software).

3.2.7 Interception Volume

The GDSDS (Vol. 2, Table 6.3) requires interception storage to be incorporated into surface water drainage design in order to limit discharge of sediment and pollutants into the downstream surface water drainage network and receiving water courses.

This interception storage is designed to capture surface water run-off from rainfall depths of 5mm (and up to 10mm if possible).

The SuDS features included in the development (refer to Section 3.2.4) will provide the necessary interception volume required by the GDSDS (i.e. green roofs, permeable paving, tree pits, bioretention areas, landscaped areas, stone backfill associated with attenuation tank).

3.3 Flood Risk

A separate Site-Specific Flood Risk Assessment has been prepared as part of this planning application (refer to DBFL Report No. 190226-rep-003).

This flood risk assessment has been undertaken by reviewing information from the Office of Public Works (OPW) National Flood Hazard Mapping (www.floodmaps.ie) and the Eastern CFRAM Study and has been carried out in accordance with the OPW's Guidelines for Planning Authorities – The Planning System and Flood Risk Management (November 2009).

3.4 Surface Water Quality Impact

Run-off rates from the site are controlled by flow control devices.

Surface water management proposals for the development also incorporate the following impact reduction measures;

- Surface water network designed in accordance with GDSDS requirements.
- Incorporates SUDS features e.g. green roofs, drainage reservoir (drainage board) on the podium slab over basement, permeable paving in parking areas at the front of duplex units (i.e. treatment / filtration provided within the stone reservoir beneath permeable paved driveways) and tree pits with overflow to conventional road gullies.
- Surface water attenuation (i.e. treatment / filtration provided within the granular surround of the Stormtech Chambers) in conjunction with a final Class 1 fuel / oil separator prior to discharge to the downstream surface water network.

4.0 FOUL DRAINAGE

4.1 Existing Drainage Infrastructure

An existing 600mm diameter combined sewer is located adjacent to the site's north-eastern boundary (Sandford Road). An existing 375mm diameter combined sewer is also located adjacent to the site's south-eastern boundary (Milltown Road) which outfalls to the 600mm diameter combined sewer on Sandford Road. Refer to Figure 4.1 and Irish Water's Network Plan as included in Appendix A of this report.

An existing private foul drainage network is located within the site (typically 150mm diameter) which outfalls to the combined sewer on the Sandford Road via a combined connection with the private surface water drainage network.

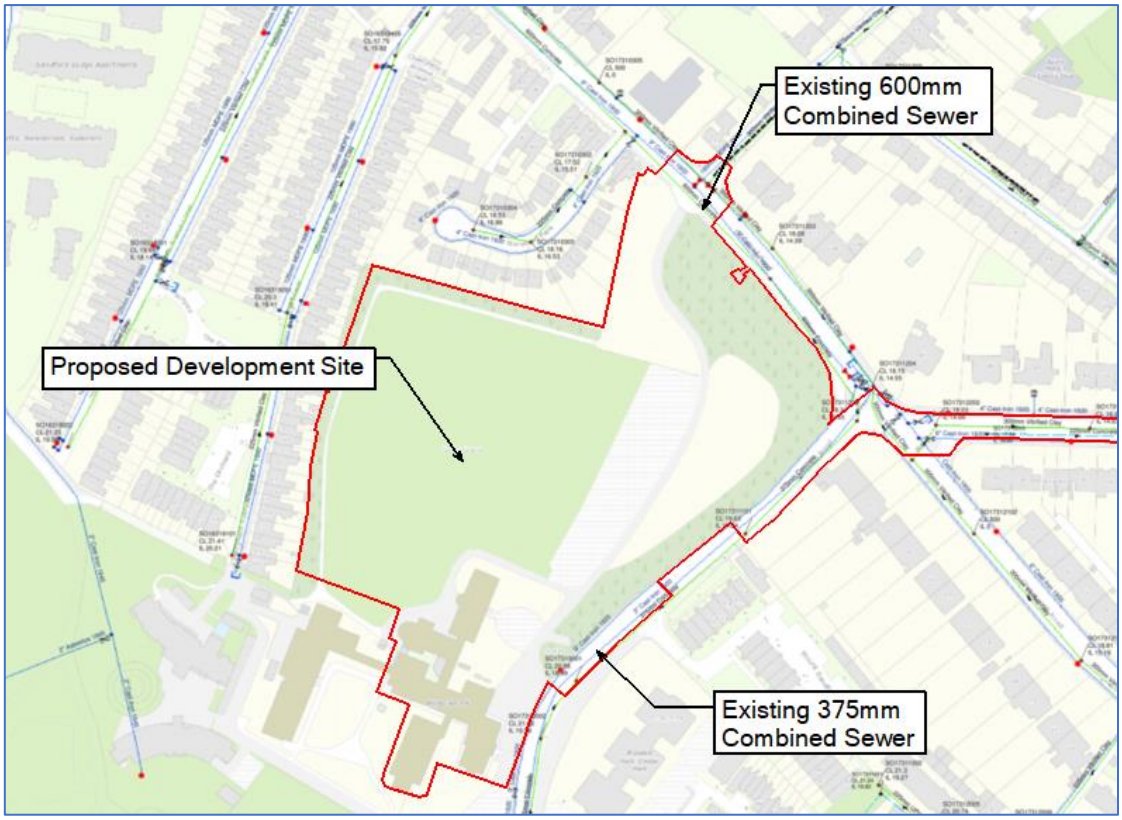


Figure 4.1: Extract from Irish Water's Network Plan (Site Boundary Indicative Only)

4.2 Design Strategy

As noted in Section 4.1 above, an existing combined sewer network is located in Sandford Road and Milltown Road.

Two foul drainage discharge points are proposed for the site (in the vicinity of the proposed access off Milltown Road and the existing access of Sandford Road). This facilitates a gravity drainage solution for the site. Refer to Drawing 190226-DBFL-CS-SP-DR-C-1001 for the proposed foul drainage layout.

The proposed foul drainage network within the site comprises of a series of 225mm diameter pipes. Duplex units (located along the western boundary) will be serviced by individual 100mm diameter connections.

We note that a Statement of Design Acceptance has been received from Irish Water for the proposed foul drainage layout (refer to Appendix D).

4.3 Pre-Connection Feedback from Irish Water

Pre-connection enquiry feedback has been received from Irish Water (included in Appendix D). Irish Water have advised as follows:

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

DBFL have engaged with Irish Water regarding feasibility of providing a foul drainage connection for the proposed development (refer to e-mail trail from March 2020 to June 2020 as included in Appendix D of this report).

With reference to Section 3.1 above, it is proposed to discharge surface water flows from the proposed development to existing surface water drainage infrastructure on Eglington Road. On this basis, Irish Water have advised that discharge of foul drainage flows to existing combined sewers adjacent to the site is feasible:

- "*if you were to connect to the storm sewer and divert any existing hardstanding to this storm sewer it would offset any impact from the foul connection. In this scenario, given the development will be delivering a net reduction in flows we could allow the connection without surveys and modelling*", Irish Water e-mail dated 30th March 2020

- "*The connection of the developments ww flows to the combined sewer is feasible once the surface water flows are discharged to the storm sewer*", Irish Water e-mail dated 6th May 2020.

Irish Water also issued a letter to ABP dated 4th September 2020 which confirmed their earlier issue of a Confirmation of Feasibility letter and a Statement of Design Acceptance dated 19th January 2021 (as included in Appendix D of this report).

4.4 **Design Calculations**

The foul drainage network for the proposed development has been designed in accordance with the following guidelines: (Add Dates of Publication)

- Irish Water Code of Practice for Wastewater Infrastructure (July 2020)
- Department of the Environment's Building Regulations "Technical Guidance Document Part H Drainage and Waste Water Disposal" (2016)
- BS EN 752: 2008 Drain and Sewer Systems Outside Buildings
- IS EN 12056: Part 2 (2000) Gravity Drainage Systems Inside Buildings

Foul drainage network calculations for the proposed development have been carried out using Microdrainage WinDes analysis software (refer to Appendix E).

Design Criteria:

Demand	446 l/dwelling/day
Discharge units	14 units per house (as BS8301)
Pipe Friction (Ks)	1.5 mm
Minimum Velocity	0.75 m/s (self-cleansing velocity)
Maximum Velocity	3.0 m/s (1:18 maximum pipe gradient)
Frequency Factor	0.5 for domestic use

4.5 Foul Drainage – Environmental Impact

Residential

Waste Water Discharge Calculation (as outlined in Irish Water's Pre-Connection Enquiry Application Form)

Dry Weather Flow	446 l/dwelling /day
No. of Dwellings	671
Post Development Average Discharge (DWF)	3.46 l/sec
Post Development Peak Discharge (6 x DWF)	20.8 l/sec
Daily Foul Discharge Volume (600l per dwelling)	299,266 l

Communal Internal Amenities (Within Residential Blocks, Tabor House and Chapel)

Waste Water Discharge Calculation (as outlined in Irish Water's Pre-Connection Enquiry Application Form)

Assumed occupancy (persons)	50
Flow Rate / Person / Day (litres)	50
(Based on IW Flow Rate for Design non-residential school with canteen)	
Post Development Average Discharge (based on 8 hour occupancy)	0.1 l/sec
Post Development Peak Discharge (6 X DWF)	0.6 l/sec
Daily Foul Discharge Volume (50l per person)	2,500 l/Day

Residential and Communal Internal Amenities

Post Development Peak Discharge	21.4 l/sec

5.0 WATER SUPPLY

5.1 Existing Public Water Mains

Existing public water supply infrastructure (9" Cast Iron Water Main) is located along the site's northern-eastern boundary (Sandford Road) and south-eastern boundary (Milltown Road) as identified in Figure 5.1 and Irish Water's Network Plan as included in Appendix A of this report.

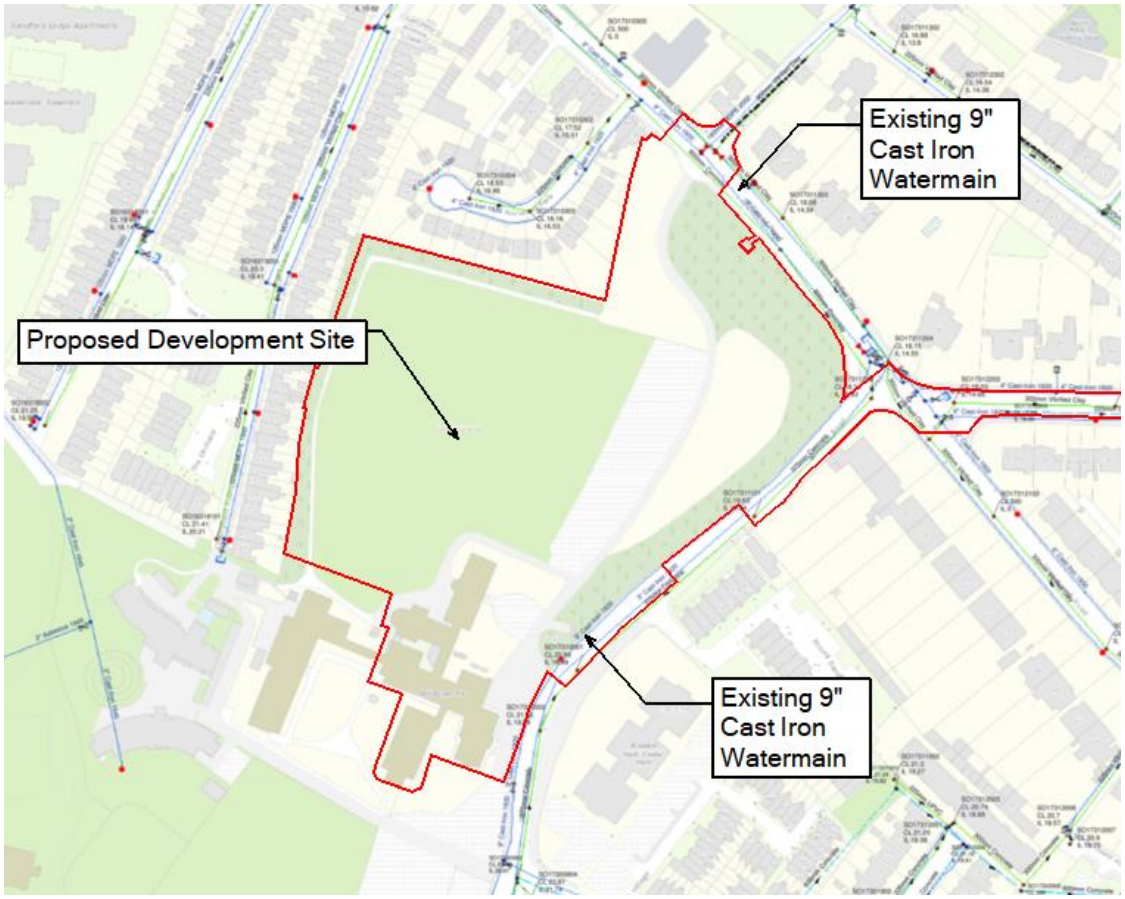


Figure 5.1: Extract from Irish Water's Network Plan (Site Boundary Indicative Only)

5.2 Pre-Connection Feedback from Irish Water

Pre-connection enquiry feedback has been received from Irish Water (included in Appendix D). Irish Water have advised as follows:

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

5.3 Proposed Water Main Layout

The site's proposed water main layout is shown on Drawing 190226-DBFL-WM-SP-DR-C-1001. It is proposed to take 2 No. 200mm diameter connections off the existing 9" water mains located along Sandford Road and Milltown Road. These connections will link within the site.

Bulk flow meters and sluice valves will be installed at connection points to the public water main in accordance with the Irish Water Code of Practice and Standard Details.

Duplex units (located along the western boundary) will have their own connections (25mm O.D. PE pipe) to distribution water mains via service connections and boundary boxes. Individual connections are to be installed in accordance with Irish Water Standard Detail STD-W-03.

5.4 Hydrants

The proposed water main layout is arranged such that all buildings are a maximum of 46.0m from a hydrant in accordance with the Department of the Environment's Building Regulations "Technical Guidance Document Part B Fire Safety".

Hydrants shall comply with the requirements of BS 750:2012 and shall be installed in accordance with Irish Water's Code of Practice and Standard Details.

5.5 Materials

Proposed water mains and connections to duplex units are to be PE100 SDR17.

5.6 Water Demand

Residential

Water Demand has been calculated in accordance with the guidelines outlined in Irish Water's Pre-Connection Enquiry Application Form:

- No. of Housing Units 671
- Average Occupancy Ration (Persons Per Dwelling) 2.7
- Per-Capita Consumption (l/person/day) 150
- Average Domestic Daily Demand (l/sec) 3.15
- Post Development Average Hour Water Demand (l/sec) 3.94
  (1.25 x Average Domestic Daily Demand)
- Post Development Peak Hour Water Demand (l/sec) 19.7
  (5.0 x Post Development Average Hour Water Demand)

Communal Internal Amenities (Within Residential Blocks, Tabor House and Chapel)

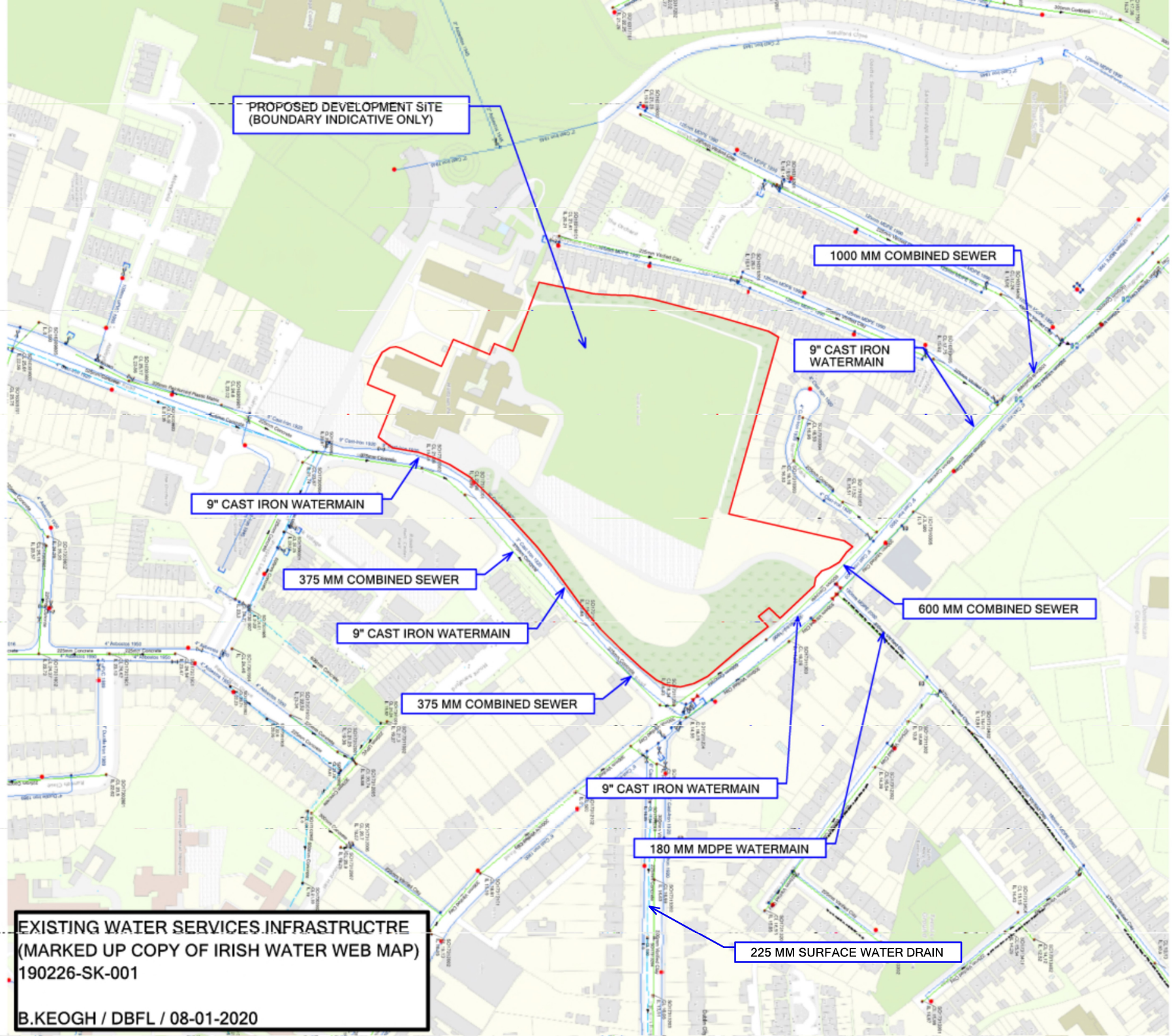
Water Demand has been calculated in accordance with the guidelines outlined in Irish Water's Pre-Connection Enquiry Application Form:

- Assumed occupancy (persons) 50
- Per-Capita Consumption (l/person/day) 50
  (Based on IW Flow Rate for Design
  non-residential school with canteen)
- Average Domestic Daily Demand (l/sec) 0.1
  (based on 8 hour occupancy)
- Post Development Average Hour Water Demand (l/sec) 0.13
  (1.25 x Average Domestic Daily Demand)
- Post Development Peak Hour Water Demand (l/sec) 0.7
  (5.0 x Post Development Average Hour Water Demand)

Residential and Communal Internal Amenities

Post Development Peak Hour Water Demand 20.4 l/sec

APPENDIX A – IRISH WATER NETWORK PLANS



EXISTING WATER SERVICES INFRASTRUCTRE
(MARKED UP COPY OF IRISH WATER WEB MAP)
190226-SK-001

B.KEOGH / DBFL / 08-01-2020

APPENDIX B –ATTENUATION CALCULATION

Cascade Summary of Results for 190226 Source Control Catchment 1 09.08.2021.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	190226 Source Control Catchment 2 09.08.2021.SRCX	(None)

Half Drain Time : 1783 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	17.109	0.267	0.0	1.1	1.1	60.9	O K
30 min Summer	17.208	0.366	0.0	1.1	1.1	83.5	O K
60 min Summer	17.310	0.468	0.0	1.1	1.1	106.8	O K
120 min Summer	17.422	0.580	0.0	1.1	1.1	132.2	O K
180 min Summer	17.489	0.647	0.0	1.1	1.1	147.5	O K
240 min Summer	17.537	0.695	0.0	1.1	1.1	158.5	O K
360 min Summer	17.603	0.761	0.0	1.1	1.1	173.6	O K
480 min Summer	17.647	0.805	0.0	1.1	1.1	183.5	O K
600 min Summer	17.678	0.836	0.0	1.2	1.2	190.5	O K
720 min Summer	17.699	0.857	0.0	1.2	1.2	195.5	O K
960 min Summer	17.726	0.884	0.0	1.2	1.2	201.6	O K
1440 min Summer	17.743	0.901	0.0	1.2	1.2	205.4	O K
2160 min Summer	17.744	0.902	0.0	1.2	1.2	205.8	O K
2880 min Summer	17.735	0.893	0.0	1.2	1.2	203.6	O K
4320 min Summer	17.705	0.863	0.0	1.2	1.2	196.7	O K
5760 min Summer	17.668	0.826	0.0	1.2	1.2	188.4	O K
7200 min Summer	17.630	0.788	0.0	1.1	1.1	179.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	91.546	0.0	58.8	27
30 min Summer	63.018	0.0	79.4	42
60 min Summer	40.649	0.0	108.2	72
120 min Summer	25.571	0.0	135.6	132
180 min Summer	19.343	0.0	152.9	190
240 min Summer	15.831	0.0	164.9	250
360 min Summer	11.908	0.0	175.4	370
480 min Summer	9.717	0.0	176.1	490
600 min Summer	8.295	0.0	175.7	610
720 min Summer	7.287	0.0	175.1	728
960 min Summer	5.938	0.0	174.3	968
1440 min Summer	4.449	0.0	175.2	1322
2160 min Summer	3.330	0.0	320.7	1696
2880 min Summer	2.709	0.0	340.8	2084
4320 min Summer	2.022	0.0	320.9	2940
5760 min Summer	1.642	0.0	425.3	3752
7200 min Summer	1.397	0.0	452.0	4616

Cascade Summary of Results for 190226 Source Control Catchment 1 09.08.2021.SRCX

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
8640 min Summer	17.591	0.749	0.0	1.1	1.1	170.7	O K
10080 min Summer	17.552	0.710	0.0	1.1	1.1	161.9	O K
15 min Winter	17.142	0.300	0.0	1.1	1.1	68.3	O K
30 min Winter	17.253	0.411	0.0	1.1	1.1	93.7	O K
60 min Winter	17.368	0.526	0.0	1.1	1.1	119.9	O K
120 min Winter	17.494	0.652	0.0	1.1	1.1	148.6	O K
180 min Winter	17.570	0.728	0.0	1.1	1.1	166.1	O K
240 min Winter	17.626	0.784	0.0	1.1	1.1	178.7	O K
360 min Winter	17.703	0.861	0.0	1.2	1.2	196.3	O K
480 min Winter	17.755	0.913	0.0	1.2	1.2	208.2	O K
600 min Winter	17.793	0.951	0.0	1.2	1.2	216.7	O K
720 min Winter	17.820	0.978	0.0	1.3	1.3	223.1	O K
960 min Winter	17.857	1.015	0.0	1.3	1.3	231.5	O K
1440 min Winter	17.888	1.046	0.0	1.3	1.3	238.5	O K
2160 min Winter	17.885	1.043	0.0	1.3	1.3	237.9	O K
2880 min Winter	17.874	1.032	0.0	1.3	1.3	235.2	O K
4320 min Winter	17.825	0.983	0.0	1.3	1.3	224.1	O K
5760 min Winter	17.765	0.923	0.0	1.2	1.2	210.4	O K
7200 min Winter	17.703	0.861	0.0	1.2	1.2	196.2	O K
8640 min Winter	17.640	0.798	0.0	1.1	1.1	181.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.224	0.0	475.0	5448
10080 min Summer	1.094	0.0	494.9	6256
15 min Winter	91.546	0.0	65.7	27
30 min Winter	63.018	0.0	86.5	41
60 min Winter	40.649	0.0	121.1	70
120 min Winter	25.571	0.0	151.2	130
180 min Winter	19.343	0.0	168.5	188
240 min Winter	15.831	0.0	176.4	248
360 min Winter	11.908	0.0	178.5	364
480 min Winter	9.717	0.0	178.7	480
600 min Winter	8.295	0.0	179.0	596
720 min Winter	7.287	0.0	179.5	710
960 min Winter	5.938	0.0	181.7	940
1440 min Winter	4.449	0.0	185.6	1378
2160 min Winter	3.330	0.0	355.2	1764
2880 min Winter	2.709	0.0	357.6	2224
4320 min Winter	2.022	0.0	339.1	3160
5760 min Winter	1.642	0.0	476.3	4048
7200 min Winter	1.397	0.0	506.2	4976
8640 min Winter	1.224	0.0	531.8	5872

Cascade Summary of Results for 190226 Source Control Catchment 1 09.08.2021.SRCX

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
10080 min Winter	17.578	0.736	0.0	1.1	1.1	167.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.094	0.0	553.3	6752

Cascade Rainfall Details for 190226 Source Control Catchment 1 09.08.2021.SRCX

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)	17.300	Shortest Storm (mins)	15
Ratio R	0.280	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.360

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000	4	8	0.074	8	12	0.286

Time Area Diagram

Total Area (ha) 0.000

Time From:	(mins) To:	Area (ha)
0	4	0.000

Cascade Model Details for 190226 Source Control Catchment 1 09.08.2021.SRCX

Storage is Online Cover Level (m) 19.100

Cellular Storage Structure

Invert Level (m) 16.842 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	240.0	240.0	1.675	0.0	240.0
1.670	240.0	240.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0053-2000-2733-2000
Design Head (m)	2.733
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	53
Invert Level (m)	16.842
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.733	2.0
Flush-Flo™	0.226	1.1
Kick-Flo®	0.470	0.9
Mean Flow over Head Range	-	1.4

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

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

Cascade Summary of Results for 190226 Source Control Catchment 2 09.08.2021.SRCX

Upstream Structures | **Outflow To** | **Overfl**

190226 Source Control Catchment 1 09.08.2021.SRCX | 190226 Source Control Catchment 3 09.08.2021.SRCX

Half Drain Time : 567 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	16.843	0.300	0.0	4.2	4.2	85.1	O K
30 min Summer	16.952	0.409	0.0	4.2	4.2	116.1	O K
60 min Summer	17.060	0.517	0.0	4.2	4.2	147.0	O K
120 min Summer	17.173	0.630	0.0	4.2	4.2	178.9	O K
180 min Summer	17.238	0.695	0.0	4.2	4.2	197.4	O K
240 min Summer	17.282	0.739	0.0	4.2	4.2	209.9	O K
360 min Summer	17.340	0.797	0.0	4.2	4.2	226.3	O K
480 min Summer	17.376	0.833	0.0	4.2	4.2	236.6	O K
600 min Summer	17.397	0.854	0.0	4.2	4.2	242.5	O K
720 min Summer	17.407	0.864	0.0	4.2	4.2	245.3	O K
960 min Summer	17.410	0.867	0.0	4.2	4.2	246.2	O K
1440 min Summer	17.398	0.855	0.0	4.2	4.2	242.8	O K
2160 min Summer	17.355	0.812	0.0	4.2	4.2	230.6	O K
2880 min Summer	17.299	0.756	0.0	4.2	4.2	214.6	O K
4320 min Summer	17.186	0.643	0.0	4.2	4.2	182.8	O K
5760 min Summer	17.084	0.541	0.0	4.2	4.2	153.7	O K
7200 min Summer	16.996	0.453	0.0	4.2	4.2	128.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	91.546	0.0	141.2	19
30 min Summer	63.018	0.0	191.5	33
60 min Summer	40.649	0.0	260.9	64
120 min Summer	25.571	0.0	327.0	122
180 min Summer	19.343	0.0	368.7	182
240 min Summer	15.831	0.0	398.3	242
360 min Summer	11.908	0.0	435.5	362
480 min Summer	9.717	0.0	459.6	482
600 min Summer	8.295	0.0	479.0	600
720 min Summer	7.287	0.0	495.7	720
960 min Summer	5.938	0.0	524.2	878
1440 min Summer	4.449	0.0	568.5	1138
2160 min Summer	3.330	0.0	774.0	1516
2880 min Summer	2.709	0.0	826.5	1900
4320 min Summer	2.022	0.0	864.0	2676
5760 min Summer	1.642	0.0	1027.2	3408
7200 min Summer	1.397	0.0	1091.8	4112

Cascade Summary of Results for 190226 Source Control Catchment 2 09.08.2021.SRCX

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
8640 min Summer	16.924	0.381	0.0	4.2	4.2	108.1	O K
10080 min Summer	16.866	0.323	0.0	4.2	4.2	91.8	O K
15 min Winter	16.879	0.336	0.0	4.2	4.2	95.5	O K
30 min Winter	17.002	0.459	0.0	4.2	4.2	130.5	O K
60 min Winter	17.126	0.583	0.0	4.2	4.2	165.5	O K
120 min Winter	17.256	0.713	0.0	4.2	4.2	202.4	O K
180 min Winter	17.333	0.790	0.0	4.2	4.2	224.5	O K
240 min Winter	17.389	0.846	0.0	4.2	4.2	240.2	O K
360 min Winter	17.459	0.916	0.0	4.2	4.2	260.2	O K
480 min Winter	17.500	0.957	0.0	4.2	4.2	271.9	O K
600 min Winter	17.525	0.982	0.0	4.2	4.2	278.9	O K
720 min Winter	17.539	0.996	0.0	4.2	4.2	283.0	O K
960 min Winter	17.548	1.005	0.0	4.2	4.2	285.6	O K
1440 min Winter	17.528	0.985	0.0	4.2	4.2	279.7	O K
2160 min Winter	17.478	0.935	0.0	4.2	4.2	265.7	O K
2880 min Winter	17.405	0.862	0.0	4.2	4.2	244.9	O K
4320 min Winter	17.199	0.656	0.0	4.2	4.2	186.4	O K
5760 min Winter	17.035	0.492	0.0	4.2	4.2	139.7	O K
7200 min Winter	16.909	0.366	0.0	4.2	4.2	104.1	O K
8640 min Winter	16.822	0.279	0.0	4.1	4.1	79.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.224	0.0	1147.2	4840
10080 min Summer	1.094	0.0	1195.1	5544
15 min Winter	91.546	0.0	157.9	19
30 min Winter	63.018	0.0	210.7	33
60 min Winter	40.649	0.0	291.9	62
120 min Winter	25.571	0.0	364.4	120
180 min Winter	19.343	0.0	407.5	180
240 min Winter	15.831	0.0	434.8	238
360 min Winter	11.908	0.0	470.6	354
480 min Winter	9.717	0.0	497.8	470
600 min Winter	8.295	0.0	520.6	584
720 min Winter	7.287	0.0	540.7	694
960 min Winter	5.938	0.0	575.3	914
1440 min Winter	4.449	0.0	607.1	1194
2160 min Winter	3.330	0.0	858.9	1644
2880 min Winter	2.709	0.0	900.6	2132
4320 min Winter	2.022	0.0	950.1	2896
5760 min Winter	1.642	0.0	1150.4	3632
7200 min Winter	1.397	0.0	1222.7	4320
8640 min Winter	1.224	0.0	1284.3	4928

Cascade Summary of Results for 190226 Source Control Catchment 2 09.08.2021.SRCX

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
10080 min Winter	16.764	0.221	0.0	4.0	4.0	62.7	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.094	0.0	1336.1	5544

Cascade Rainfall Details for 190226 Source Control Catchment 2 09.08.2021.SRCX

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)	17.300	Shortest Storm (mins)	15
Ratio R	0.280	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.510

Time (mins) From:	To:	Area (ha)
0	4	0.510

Cascade Model Details for 190226 Source Control Catchment 2 09.08.2021.SRCX

Storage is Online Cover Level (m) 18.600

Cellular Storage Structure

Invert Level (m) 16.543 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	299.0	299.0	1.675	0.0	299.0
1.670	299.0	299.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0093-4700-1675-4700
Design Head (m)	1.675
Design Flow (l/s)	4.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	16.543
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	4.7
Flush-Flo™	0.409	4.2
Kick-Flo®	0.829	3.4
Mean Flow over Head Range	-	3.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	4.0	3.000	6.2	7.000	9.2
0.200	3.9	1.400	4.3	3.500	6.6	7.500	9.5
0.300	4.2	1.600	4.6	4.000	7.1	8.000	9.8
0.400	4.2	1.800	4.9	4.500	7.5	8.500	10.1
0.500	4.2	2.000	5.1	5.000	7.8	9.000	10.4
0.600	4.1	2.200	5.3	5.500	8.2	9.500	10.6
0.800	3.6	2.400	5.6	6.000	8.6		
1.000	3.7	2.600	5.8	6.500	8.9		

Cascade Summary of Results for 190226 Source Control Catchment 3 09.08.2021.SRCX

Upstream Structures	Outflow To	Overfl
190226 Source Control Catchment 2 09.08.2021.SRCX 190226 Source Control Catchment 1 09.08.2021.SRCX	190226 Source Control Catchment 5 09.08.2021.SRCX	

Half Drain Time : 403 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	16.248	0.171	0.0	3.7	3.7	29.5	O K
30 min Summer	16.302	0.225	0.0	4.0	4.0	38.9	O K
60 min Summer	16.356	0.279	0.0	4.1	4.1	48.2	O K
120 min Summer	16.416	0.339	0.0	4.2	4.2	58.6	O K
180 min Summer	16.461	0.384	0.0	4.2	4.2	66.4	O K
240 min Summer	16.493	0.416	0.0	4.2	4.2	71.9	O K
360 min Summer	16.535	0.458	0.0	4.2	4.2	79.3	O K
480 min Summer	16.560	0.483	0.0	4.2	4.2	83.4	O K
600 min Summer	16.577	0.500	0.0	4.2	4.2	86.5	O K
720 min Summer	16.591	0.514	0.0	4.2	4.2	88.9	O K
960 min Summer	16.614	0.537	0.0	4.2	4.2	92.8	O K
1440 min Summer	16.642	0.565	0.0	4.2	4.2	97.7	O K
2160 min Summer	16.691	0.614	0.0	4.2	4.2	106.2	O K
2880 min Summer	16.949	0.872	0.0	4.2	4.2	150.8	O K
4320 min Summer	17.079	1.002	0.0	4.2	4.2	173.3	O K
5760 min Summer	17.052	0.975	0.0	4.2	4.2	168.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	91.546	0.0	162.6	231
30 min Summer	63.018	0.0	220.1	317
60 min Summer	40.649	0.0	303.4	416
120 min Summer	25.571	0.0	379.8	124
180 min Summer	19.343	0.0	427.7	184
240 min Summer	15.831	0.0	461.6	242
360 min Summer	11.908	0.0	505.5	362
480 min Summer	9.717	0.0	536.2	480
600 min Summer	8.295	0.0	561.4	600
720 min Summer	7.287	0.0	583.1	702
960 min Summer	5.938	0.0	619.9	828
1440 min Summer	4.449	0.0	642.2	1084
2160 min Summer	3.330	0.0	901.5	2816
2880 min Summer	2.709	0.0	961.3	3400
4320 min Summer	2.022	0.0	1015.1	4088
5760 min Summer	1.642	0.0	1199.0	4672

Cascade Summary of Results for 190226 Source Control Catchment 3 09.08.2021.SRCX

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
7200 min Summer	16.993	0.916	0.0	4.2	4.2	158.3	O K
8640 min Summer	16.873	0.796	0.0	4.2	4.2	137.6	O K
10080 min Summer	16.746	0.669	0.0	4.2	4.2	115.7	O K
15 min Winter	16.265	0.188	0.0	3.8	3.8	32.6	O K
30 min Winter	16.324	0.247	0.0	4.1	4.1	42.7	O K
60 min Winter	16.380	0.303	0.0	4.2	4.2	52.4	O K
120 min Winter	16.452	0.375	0.0	4.2	4.2	64.8	O K
180 min Winter	16.499	0.422	0.0	4.2	4.2	72.9	O K
240 min Winter	16.531	0.454	0.0	4.2	4.2	78.5	O K
360 min Winter	16.581	0.504	0.0	4.2	4.2	87.1	O K
480 min Winter	16.619	0.542	0.0	4.2	4.2	93.8	O K
600 min Winter	16.651	0.574	0.0	4.2	4.2	99.2	O K
720 min Winter	16.677	0.600	0.0	4.2	4.2	103.8	O K
960 min Winter	16.719	0.642	0.0	4.2	4.2	111.0	O K
1440 min Winter	16.774	0.697	0.0	4.2	4.2	120.6	O K
2160 min Winter	16.869	0.792	0.0	4.2	4.2	136.9	O K
2880 min Winter	17.025	0.948	0.0	4.2	4.2	163.9	O K
4320 min Winter	17.243	1.166	0.0	4.2	4.2	201.6	O K
5760 min Winter	17.198	1.121	0.0	4.2	4.2	193.8	O K
7200 min Winter	17.099	1.022	0.0	4.2	4.2	176.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Summer	1.397	0.0	1274.4	5304
8640 min Summer	1.224	0.0	1338.8	5936
10080 min Summer	1.094	0.0	1394.2	6432
15 min Winter	91.546	0.0	181.7	256
30 min Winter	63.018	0.0	242.1	355
60 min Winter	40.649	0.0	339.3	468
120 min Winter	25.571	0.0	422.9	122
180 min Winter	19.343	0.0	472.1	180
240 min Winter	15.831	0.0	504.3	238
360 min Winter	11.908	0.0	549.7	356
480 min Winter	9.717	0.0	584.7	472
600 min Winter	8.295	0.0	614.0	590
720 min Winter	7.287	0.0	639.4	708
960 min Winter	5.938	0.0	664.5	942
1440 min Winter	4.449	0.0	631.0	1412
2160 min Winter	3.330	0.0	999.1	3368
2880 min Winter	2.709	0.0	1051.5	3800
4320 min Winter	2.022	0.0	1119.7	4252
5760 min Winter	1.642	0.0	1342.9	4816
7200 min Winter	1.397	0.0	1427.2	5456

Cascade Summary of Results for 190226 Source Control Catchment 3 09.08.2021.SRCX

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
8640 min Winter	16.856	0.779	0.0	4.2	4.2	134.7	O K
10080 min Winter	16.620	0.543	0.0	4.2	4.2	93.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Winter	1.224	0.0	1498.7	6120
10080 min Winter	1.094	0.0	1558.1	6448

Cascade Rainfall Details for 190226 Source Control Catchment 3 09.08.2021.SRCX

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)	17.300	Shortest Storm (mins)	15
Ratio R	0.280	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.146

Time (mins) From:	To:	Area (ha)
0	4	0.146

Cascade Model Details for 190226 Source Control Catchment 3 09.08.2021.SRCX

Storage is Online Cover Level (m) 18.283

Cellular Storage Structure

Invert Level (m) 16.077 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	182.0	182.0	1.675	0.0	182.0
1.670	182.0	182.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0093-4700-1675-4700
Design Head (m)	1.675
Design Flow (l/s)	4.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	93
Invert Level (m)	16.077
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	4.7
Flush-Flo™	0.409	4.2
Kick-Flo®	0.829	3.4
Mean Flow over Head Range	-	3.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	4.0	3.000	6.2	7.000	9.2
0.200	3.9	1.400	4.3	3.500	6.6	7.500	9.5
0.300	4.2	1.600	4.6	4.000	7.1	8.000	9.8
0.400	4.2	1.800	4.9	4.500	7.5	8.500	10.1
0.500	4.2	2.000	5.1	5.000	7.8	9.000	10.4
0.600	4.1	2.200	5.3	5.500	8.2	9.500	10.6
0.800	3.6	2.400	5.6	6.000	8.6		
1.000	3.7	2.600	5.8	6.500	8.9		

Cascade Summary of Results for 190226 Source Control Catchment 4 09.08.2021.SRCX

Upstream Structures	Outflow To	Overflow To
(None)	190226 Source Control Catchment 5 09.08.2021.SRCX	(None)

Half Drain Time : 1761 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	18.636	0.271	0.0	1.8	1.8	92.8	O K
30 min Summer	18.737	0.372	0.0	1.8	1.8	127.1	O K
60 min Summer	18.840	0.475	0.0	1.8	1.8	162.3	O K
120 min Summer	18.953	0.588	0.0	1.8	1.8	201.0	O K
180 min Summer	19.022	0.657	0.0	1.8	1.8	224.6	O K
240 min Summer	19.071	0.706	0.0	1.8	1.8	241.5	O K
360 min Summer	19.139	0.774	0.0	1.8	1.8	264.7	O K
480 min Summer	19.184	0.819	0.0	1.8	1.8	280.1	O K
600 min Summer	19.216	0.851	0.0	1.8	1.8	290.9	O K
720 min Summer	19.238	0.873	0.0	1.8	1.8	298.7	O K
960 min Summer	19.267	0.902	0.0	1.8	1.8	308.3	O K
1440 min Summer	19.285	0.920	0.0	1.8	1.8	314.5	O K
2160 min Summer	19.286	0.921	0.0	1.8	1.8	314.9	O K
2880 min Summer	19.276	0.911	0.0	1.8	1.8	311.4	O K
4320 min Summer	19.244	0.879	0.0	1.8	1.8	300.5	O K
5760 min Summer	19.205	0.840	0.0	1.8	1.8	287.2	O K
7200 min Summer	19.164	0.799	0.0	1.8	1.8	273.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	91.546	0.0	88.5	19
30 min Summer	63.018	0.0	120.3	34
60 min Summer	40.649	0.0	164.2	64
120 min Summer	25.571	0.0	206.0	124
180 min Summer	19.343	0.0	232.5	184
240 min Summer	15.831	0.0	251.6	242
360 min Summer	11.908	0.0	273.2	362
480 min Summer	9.717	0.0	276.4	482
600 min Summer	8.295	0.0	275.0	602
720 min Summer	7.287	0.0	272.9	722
960 min Summer	5.938	0.0	268.7	960
1440 min Summer	4.449	0.0	262.6	1368
2160 min Summer	3.330	0.0	487.3	1708
2880 min Summer	2.709	0.0	519.7	2104
4320 min Summer	2.022	0.0	490.7	2940
5760 min Summer	1.642	0.0	646.8	3800
7200 min Summer	1.397	0.0	687.5	4608

Cascade Summary of Results for 190226 Source Control Catchment 4 09.08.2021.SRCX

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
8640 min Summer	19.122	0.757	0.0	1.8	1.8	259.1	O K
10080 min Summer	19.080	0.715	0.0	1.8	1.8	244.5	O K
15 min Winter	18.669	0.304	0.0	1.8	1.8	104.0	O K
30 min Winter	18.782	0.417	0.0	1.8	1.8	142.6	O K
60 min Winter	18.898	0.533	0.0	1.8	1.8	182.3	O K
120 min Winter	19.026	0.661	0.0	1.8	1.8	226.1	O K
180 min Winter	19.104	0.739	0.0	1.8	1.8	252.9	O K
240 min Winter	19.161	0.796	0.0	1.8	1.8	272.1	O K
360 min Winter	19.239	0.874	0.0	1.8	1.8	299.0	O K
480 min Winter	19.293	0.928	0.0	1.8	1.8	317.3	O K
600 min Winter	19.331	0.966	0.0	1.8	1.8	330.5	O K
720 min Winter	19.360	0.995	0.0	1.8	1.8	340.3	O K
960 min Winter	19.398	1.033	0.0	1.9	1.9	353.4	O K
1440 min Winter	19.431	1.066	0.0	1.9	1.9	364.6	O K
2160 min Winter	19.428	1.063	0.0	1.9	1.9	363.5	O K
2880 min Winter	19.415	1.050	0.0	1.9	1.9	359.2	O K
4320 min Winter	19.365	1.000	0.0	1.8	1.8	342.0	O K
5760 min Winter	19.302	0.937	0.0	1.8	1.8	320.5	O K
7200 min Winter	19.235	0.870	0.0	1.8	1.8	297.7	O K
8640 min Winter	19.168	0.803	0.0	1.8	1.8	274.6	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
8640 min Summer	1.224	0.0	722.4	5448
10080 min Summer	1.094	0.0	752.6	6256
15 min Winter	91.546	0.0	99.0	19
30 min Winter	63.018	0.0	132.5	33
60 min Winter	40.649	0.0	183.8	64
120 min Winter	25.571	0.0	229.8	122
180 min Winter	19.343	0.0	257.5	180
240 min Winter	15.831	0.0	273.6	240
360 min Winter	11.908	0.0	279.7	358
480 min Winter	9.717	0.0	278.6	474
600 min Winter	8.295	0.0	277.1	590
720 min Winter	7.287	0.0	275.8	706
960 min Winter	5.938	0.0	274.4	932
1440 min Winter	4.449	0.0	276.7	1370
2160 min Winter	3.330	0.0	540.4	1820
2880 min Winter	2.709	0.0	548.0	2220
4320 min Winter	2.022	0.0	513.4	3156
5760 min Winter	1.642	0.0	724.4	4096
7200 min Winter	1.397	0.0	769.9	4976
8640 min Winter	1.224	0.0	808.7	5880

Cascade Summary of Results for 190226 Source Control Catchment 4 09.08.2021.SRCX

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
10080 min Winter	19.099	0.734	0.0	1.8	1.8	251.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
10080 min Winter	1.094	0.0	841.8	6760

Cascade Rainfall Details for 190226 Source Control Catchment 4 09.08.2021.SRCX

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)	17.300	Shortest Storm (mins)	15
Ratio R	0.280	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.548

Time (mins) From:	To:	Area (ha)
0	4	0.548

Cascade Model Details for 190226 Source Control Catchment 4 09.08.2021.SRCX

Storage is Online Cover Level (m) 21.000

Cellular Storage Structure

Invert Level (m) 18.365 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	360.0	360.0	1.675	0.0	360.0
1.670	360.0	360.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0064-2600-2110-2600
Design Head (m)	2.110
Design Flow (l/s)	2.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	64
Invert Level (m)	18.365
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.110	2.6
Flush-Flo™	0.283	1.8
Kick-Flo®	0.577	1.4
Mean Flow over Head Range	-	1.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	1.200	2.0	3.000	3.1	7.000	4.5
0.200	1.7	1.400	2.1	3.500	3.3	7.500	4.7
0.300	1.8	1.600	2.3	4.000	3.5	8.000	4.8
0.400	1.7	1.800	2.4	4.500	3.7	8.500	5.0
0.500	1.6	2.000	2.5	5.000	3.9	9.000	5.1
0.600	1.5	2.200	2.6	5.500	4.0	9.500	5.2
0.800	1.7	2.400	2.8	6.000	4.2		
1.000	1.8	2.600	2.9	6.500	4.4		

Cascade Summary of Results for 190226 Source Control Catchment 5 09.08.2021.SRCX

Upstream Structures	Outflow To	Overflow To
190226 Source Control Catchment 3 09.08.2021.SRCX	(None)	(None)
190226 Source Control Catchment 2 09.08.2021.SRCX		
190226 Source Control Catchment 1 09.08.2021.SRCX		
190226 Source Control Catchment 4 09.08.2021.SRCX		

Half Drain Time : 229 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	15.813	0.197	0.0	5.8	5.8	37.4	O K
30 min Summer	15.886	0.270	0.0	6.3	6.3	51.3	O K
60 min Summer	15.962	0.346	0.0	6.5	6.5	65.8	O K
120 min Summer	16.045	0.429	0.0	6.7	6.7	81.5	O K
180 min Summer	16.096	0.480	0.0	6.7	6.7	91.3	O K
240 min Summer	16.135	0.519	0.0	6.7	6.7	98.6	O K
360 min Summer	16.192	0.576	0.0	6.7	6.7	109.4	O K
480 min Summer	16.233	0.617	0.0	6.7	6.7	117.2	O K
600 min Summer	16.264	0.648	0.0	6.7	6.7	123.2	O K
720 min Summer	16.289	0.673	0.0	6.7	6.7	127.9	O K
960 min Summer	16.326	0.710	0.0	6.7	6.7	134.9	O K
1440 min Summer	16.366	0.750	0.0	6.7	6.7	142.5	O K
2160 min Summer	16.366	0.750	0.0	6.7	6.7	142.5	O K
2880 min Summer	16.339	0.723	0.0	6.7	6.7	137.3	O K
4320 min Summer	16.292	0.676	0.0	6.7	6.7	128.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	91.546	0.0	283.3	19
30 min Summer	63.018	0.0	383.7	34
60 min Summer	40.649	0.0	531.4	64
120 min Summer	25.571	0.0	665.4	122
180 min Summer	19.343	0.0	749.3	182
240 min Summer	15.831	0.0	808.7	242
360 min Summer	11.908	0.0	883.0	362
480 min Summer	9.717	0.0	925.5	482
600 min Summer	8.295	0.0	957.5	602
720 min Summer	7.287	0.0	984.4	722
960 min Summer	5.938	0.0	1026.4	962
1440 min Summer	4.449	0.0	1005.1	1442
2160 min Summer	3.330	0.0	1580.2	2052
2880 min Summer	2.709	0.0	1683.2	2160
4320 min Summer	2.022	0.0	1729.9	2848

Cascade Summary of Results for 190226 Source Control Catchment 5 09.08.2021.SRCX

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
5760 min Summer	16.248	0.632	0.0	6.7	6.7	120.0	O K
7200 min Summer	16.206	0.590	0.0	6.7	6.7	112.2	O K
8640 min Summer	16.170	0.554	0.0	6.7	6.7	105.2	O K
10080 min Summer	16.138	0.522	0.0	6.7	6.7	99.2	O K
15 min Winter	15.837	0.221	0.0	6.0	6.0	41.9	O K
30 min Winter	15.919	0.303	0.0	6.4	6.4	57.5	O K
60 min Winter	16.003	0.387	0.0	6.6	6.6	73.6	O K
120 min Winter	16.096	0.480	0.0	6.7	6.7	91.2	O K
180 min Winter	16.156	0.540	0.0	6.7	6.7	102.6	O K
240 min Winter	16.201	0.585	0.0	6.7	6.7	111.1	O K
360 min Winter	16.267	0.651	0.0	6.7	6.7	123.8	O K
480 min Winter	16.317	0.701	0.0	6.7	6.7	133.2	O K
600 min Winter	16.356	0.740	0.0	6.7	6.7	140.6	O K
720 min Winter	16.389	0.773	0.0	6.7	6.7	146.8	O K
960 min Winter	16.440	0.824	0.0	6.7	6.7	156.6	O K
1440 min Winter	16.512	0.896	0.0	6.7	6.7	170.3	O K
2160 min Winter	16.576	0.960	0.0	6.7	6.7	182.5	O K
2880 min Winter	16.502	0.886	0.0	6.7	6.7	168.3	O K
4320 min Winter	16.352	0.736	0.0	6.7	6.7	139.8	O K
5760 min Winter	16.276	0.660	0.0	6.7	6.7	125.5	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
5760 min Summer	1.642	0.0	2103.7	3584
7200 min Summer	1.397	0.0	2235.8	4328
8640 min Summer	1.224	0.0	2348.7	5104
10080 min Summer	1.094	0.0	2445.7	5848
15 min Winter	91.546	0.0	316.7	19
30 min Winter	63.018	0.0	422.0	33
60 min Winter	40.649	0.0	594.4	62
120 min Winter	25.571	0.0	740.8	122
180 min Winter	19.343	0.0	827.2	180
240 min Winter	15.831	0.0	882.0	240
360 min Winter	11.908	0.0	946.0	358
480 min Winter	9.717	0.0	991.1	476
600 min Winter	8.295	0.0	1028.2	594
720 min Winter	7.287	0.0	1054.3	714
960 min Winter	5.938	0.0	1038.5	952
1440 min Winter	4.449	0.0	967.4	1430
2160 min Winter	3.330	0.0	1750.3	2796
2880 min Winter	2.709	0.0	1823.8	2768
4320 min Winter	2.022	0.0	1881.7	2924
5760 min Winter	1.642	0.0	2356.0	3688

Cascade Summary of Results for 190226 Source Control Catchment 5 09.08.2021.SRCX

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
7200 min Winter	16.219	0.603	0.0	6.7	6.7	114.7	O K
8640 min Winter	16.173	0.557	0.0	6.7	6.7	105.9	O K
10080 min Winter	16.131	0.515	0.0	6.7	6.7	97.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
7200 min Winter	1.397	0.0	2503.8	4528
8640 min Winter	1.224	0.0	2629.1	5368
10080 min Winter	1.094	0.0	2733.3	6248

Cascade Rainfall Details for 190226 Source Control Catchment 5 09.08.2021.SRCX

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)	17.300	Shortest Storm (mins)	15
Ratio R	0.280	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.219

Time (mins) From:	To:	Area (ha)
0	4	0.219

Cascade Model Details for 190226 Source Control Catchment 5 09.08.2021.SRCX

Storage is Online Cover Level (m) 18.100

Cellular Storage Structure

Invert Level (m) 15.616 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	200.0	200.0	1.671	0.0	200.0
1.670	200.0	200.0			

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0111-8500-2749-8500
Design Head (m)	2.749
Design Flow (l/s)	8.5
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	111
Invert Level (m)	15.616
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.749	8.5
Flush-Flo™	0.486	6.7
Kick-Flo®	0.999	5.3
Mean Flow over Head Range	-	6.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	1.200	5.8	3.000	8.8	7.000	13.2
0.200	5.9	1.400	6.2	3.500	9.5	7.500	13.7
0.300	6.4	1.600	6.6	4.000	10.1	8.000	14.1
0.400	6.6	1.800	7.0	4.500	10.7	8.500	14.5
0.500	6.7	2.000	7.3	5.000	11.3	9.000	14.9
0.600	6.6	2.200	7.6	5.500	11.8	9.500	15.3
0.800	6.3	2.400	8.0	6.000	12.3		
1.000	5.3	2.600	8.3	6.500	12.8		

APPENDIX C – SURFACE WATER DRAINAGE CALCULATIONS

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Water Network

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	5	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	17.300	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	1.200
Ratio R	0.280	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	20	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200		

Designed with Level Soffits

Network Design Table for Surface Water Network

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design

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)

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	45.534	0.569	80.0	0.159	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	37.539	1.104	34.0	0.109	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	56.453	0.896	63.0	0.066	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	26.659	0.089	299.5	0.024	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	13.463	0.299	45.0	0.010	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	3.468	0.035	99.1	0.219	4.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	16.441	0.149	110.0	0.068	4.00	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)
S1.000	50.00	4.52	19.575	0.159	0.0	0.0	4.3	1.46	58.2	25.8
S1.001	50.00	4.80	19.006	0.268	0.0	0.0	7.3	2.25	89.5	43.5
S1.002	50.00	5.37	17.902	0.334	0.0	0.0	9.0	1.65	65.6	54.3
S1.003	50.00	5.86	16.931	0.358	0.0	0.0	9.7	0.90	63.8	58.2
S1.004	50.00	5.95	16.842	0.368	0.0	0.0	10.0	2.35	166.1	59.8
S2.000	50.00	4.04	16.708	0.219	0.0	0.0	5.9	1.58	111.7	35.6
S3.000	50.00	4.22	16.908	0.068	0.0	0.0	1.8	1.25	49.5	11.0

Network Design Table for Surface Water Network

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
S2.001	16.571	0.055	301.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S4.000	10.520	0.062	169.7	0.210	4.00	0.0	0.600	o	300	Pipe/Conduit	
S1.005	22.944	0.126	182.0	0.014	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.006	31.083	0.089	350.0	0.080	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.000	28.375	0.465	61.0	0.032	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.007	9.494	0.047	202.0	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)
S2.001	50.00	4.53	16.673	0.287	0.0	0.0	7.8	0.90	63.7	46.6
S4.000	50.00	4.15	16.680	0.210	0.0	0.0	5.7	1.20	85.1	34.1
S1.005	50.00	6.24	16.543	0.879	0.0	0.0	23.8	1.34	148.0	142.8
S1.006	50.00	6.72	16.342	0.959	0.0	0.0	26.0	1.08	171.9	155.8
S5.000	50.00	4.28	16.944	0.032	0.0	0.0	0.9	1.68	66.7	5.2
S1.007	50.00	6.83	16.254	0.991	0.0	0.0	26.8	1.43	226.9	161.0

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.008	29.925	0.130	230.2	0.014	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.009	10.755	0.035	307.3	0.012	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.010	25.432	0.102	249.3	0.015	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.011	45.007	0.183	245.9	0.050	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.012	12.339	0.037	333.5	0.008	0.00	0.0	0.600	o	450	Pipe/Conduit	
S6.000	6.457	0.099	65.2	0.035	4.00	0.0	0.600	o	225	Pipe/Conduit	
S6.001	10.656	0.155	68.7	0.001	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.002	15.711	0.225	69.9	0.001	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)
S1.008	50.00	7.20	16.207	1.005	0.0	0.0	27.2	1.34	212.4	163.3
S1.009	50.00	7.36	16.077	1.017	0.0	0.0	27.5	1.15	183.6	165.3
S1.010	50.00	7.69	16.042	1.032	0.0	0.0	27.9	1.28	204.0	167.7
S1.011	50.00	8.27	15.940	1.082	0.0	0.0	29.3	1.29	205.5	175.8
S1.012	50.00	8.46	15.757	1.090	0.0	0.0	29.5	1.11	176.2«	177.1
S6.000	50.00	4.07	19.575	0.035	0.0	0.0	0.9	1.62	64.5	5.7
S6.001	50.00	4.18	19.476	0.036	0.0	0.0	1.0	1.58	62.8	5.8
S6.002	50.00	4.35	19.321	0.037	0.0	0.0	1.0	1.57	62.3	6.0

Upstream of hydrobrake and attenuation

Network Design Table for Surface Water Network

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
S7.000	41.999	0.677	62.0	0.034	4.00	0.0	0.600	o	225	Pipe/Conduit	
S6.003	33.244	0.277	120.0	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit	
S8.000	26.970	0.270	100.0	0.090	4.00	0.0	0.600	o	225	Pipe/Conduit	
S8.001	4.205	0.068	62.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.004	22.515	0.113	199.2	0.041	0.00	0.0	0.600	o	300	Pipe/Conduit	
S9.000	32.583	0.543	60.0	0.035	4.00	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)
S7.000	50.00	4.42	19.775	0.034	0.0	0.0	0.9	1.66	66.1	5.5
S6.003	50.00	4.89	19.096	0.076	0.0	0.0	2.1	1.19	47.4	12.3
S8.000	50.00	4.34	19.575	0.090	0.0	0.0	2.4	1.31	52.0	14.6
S8.001	50.00	4.39	19.305	0.090	0.0	0.0	2.4	1.66	66.2	14.6
S6.004	50.00	5.22	18.744	0.207	0.0	0.0	5.6	1.11	78.5	33.6
S9.000	50.00	4.32	19.475	0.035	0.0	0.0	0.9	1.69	67.3	5.7

Network Design Table for Surface Water Network

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
S6.005	22.917	0.082	279.5	0.047	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.006	16.601	0.055	301.9	0.036	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.007	16.165	0.054	300.0	0.034	0.00	0.0	0.600	o	375	Pipe/Conduit	
S10.000	21.651	0.492	44.0	0.021	4.00	0.0	0.600	o	225	Pipe/Conduit	
S10.001	20.030	0.250	80.0	0.023	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.002	23.954	0.260	92.0	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.003	50.972	0.631	80.8	0.031	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)
S6.005	50.00	5.58	18.556	0.289	0.0	0.0	7.8	1.08	119.2	47.0
S6.006	50.00	5.84	18.474	0.325	0.0	0.0	8.8	1.04	114.6	52.8
S6.007	50.00	6.10	18.419	0.359	0.0	0.0	9.7	1.04	115.0	58.3
S10.000	50.00	4.18	20.475	0.021	0.0	0.0	0.6	1.98	78.6	3.4
S10.001	50.00	4.41	19.983	0.044	0.0	0.0	1.2	1.46	58.2	7.1
S10.002	50.00	4.70	19.733	0.053	0.0	0.0	1.4	1.36	54.2	8.6
S10.003	50.00	5.29	19.472	0.084	0.0	0.0	2.3	1.46	57.9	13.6

Network Design Table for Surface Water Network

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
S11.000	27.528	0.376	73.2	0.086	4.00	0.0	0.600	o	225	Pipe/Conduit	
S10.004	31.220	0.156	200.1	0.008	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.008	11.371	0.037	311.0	0.017	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.009	21.052	0.070	300.7	0.020	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.010	52.584	0.939	56.0	0.055	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.011	17.288	0.288	60.0	0.023	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.012	18.044	0.323	55.9	0.010	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)
S11.000	50.00	4.30	19.475	0.086	0.0	0.0	2.3	1.53	60.8	14.0
S10.004	50.00	5.69	18.521	0.178	0.0	0.0	4.8	1.28	141.1	28.9
S6.008	50.00	6.29	18.365	0.554	0.0	0.0	15.0	1.02	112.9	90.0
S6.009	50.00	6.63	18.327	0.574	0.0	0.0	15.5	1.04	114.8	93.3
S6.010	50.00	6.99	18.257	0.629	0.0	0.0	17.0	2.43	267.9	102.2
S6.011	50.00	7.11	17.318	0.652	0.0	0.0	17.7	2.34	258.7	105.9
S6.012	50.00	7.23	17.030	0.662	0.0	0.0	17.9	2.43	268.1	107.6

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.013	12.708	0.104	122.2	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.014	6.243	0.027	231.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.015	25.474	0.136	188.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.016	29.555	0.130	227.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.017	29.961	0.119	251.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.018	19.883	0.079	251.7	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.019	24.828	0.099	250.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.020	35.005	0.140	250.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.021	36.565	0.146	250.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.022	38.440	0.156	246.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.013	50.00	8.57	15.720	1.752	0.0	0.0	47.4	1.84	292.3	284.7
S1.014	50.00	8.67	15.616	1.752	0.0	0.0	47.4	1.03	72.8«	284.7
S1.015	50.00	9.04	15.589	1.752	0.0	0.0	47.4	1.14	80.8«	284.7
S1.016	49.95	9.52	15.454	1.752	0.0	0.0	47.4	1.04	73.4«	284.7
S1.017	48.74	10.02	15.324	1.752	0.0	0.0	47.4	0.99	69.7«	284.7
S1.018	47.98	10.36	15.205	1.752	0.0	0.0	47.4	0.99	69.7«	284.7
S1.019	47.07	10.78	15.126	1.752	0.0	0.0	47.4	0.99	69.9«	284.7
S1.020	45.86	11.37	14.150	1.752	0.0	0.0	47.4	0.99	70.0«	284.7
S1.021	44.68	11.98	14.010	1.752	0.0	0.0	47.4	0.99	69.9«	284.7
S1.022	43.52	12.63	13.863	1.752	0.0	0.0	47.4	1.00	70.5«	284.7

Reduced fLow Following Hydrobrake

MaxQ 8.5 l/s

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.023	85.511	0.339	252.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.023	41.17	14.07	13.707	1.752	0.0	0.0	47.4	0.99	69.7«	284.7

Manhole Schedules for Surface Water Network

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S25	20.994	1.419	Open Manhole	1200	S1.000	19.575	225				
S24	20.740	1.734	Open Manhole	1200	S1.001	19.006	225	S1.000	19.006	225	
S23	19.378	1.476	Open Manhole	1200	S1.002	17.902	225	S1.001	17.902	225	
S22	19.100	2.169	Open Manhole	1200	S1.003	16.931	300	S1.002	17.006	225	
S21	19.100	2.258	Open Manhole	1200	S1.004	16.842	300	S1.003	16.842	300	
S20-1-1	18.796	2.088	Open Manhole	1200	S2.000	16.708	300				
S20-2	18.685	1.777	Open Manhole	1200	S3.000	16.908	225				
S20-1	18.717	2.044	Open Manhole	1200	S2.001	16.673	300	S2.000	16.673	300	
								S3.000	16.759	225	11
S9	18.880	2.200	Open Manhole	1200	S4.000	16.680	300				
S20	18.839	2.296	Open Manhole	1350	S1.005	16.543	375	S1.004	16.543	300	
								S2.001	16.618	300	
								S4.000	16.618	300	
S19	18.747	2.405	Open Manhole	1350	S1.006	16.342	450	S1.005	16.417	375	
S18-1	18.238	1.294	Open Manhole	1200	S5.000	16.944	225				
S18	18.498	2.245	Open Manhole	1350	S1.007	16.254	450	S1.006	16.253	450	
								S5.000	16.479	225	
S17	18.414	2.207	Open Manhole	1350	S1.008	16.207	450	S1.007	16.207	450	
S16	18.270	2.193	Open Manhole	1350	S1.009	16.077	450	S1.008	16.077	450	

Manhole Schedules for Surface Water Network

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S15	18.094	2.052	Open Manhole	1350	S1.010	16.042	450	S1.009	16.042	450	
S14	18.244	2.304	Open Manhole	1350	S1.011	15.940	450	S1.010	15.940	450	
S13	18.602	2.845	Open Manhole	1350	S1.012	15.757	450	S1.011	15.757	450	
S12-13	20.908	1.333	Open Manhole	1200	S6.000	19.575	225				
S12-12	20.947	1.471	Open Manhole	1200	S6.001	19.476	225	S6.000	19.476	225	
S12-11	21.560	2.239	Open Manhole	1200	S6.002	19.321	225	S6.001	19.321	225	
S12-10-1	21.338	1.563	Open Manhole	1200	S7.000	19.775	225				
S12-10	21.125	2.029	Open Manhole	1200	S6.003	19.096	225	S6.002	19.096	225	
								S7.000	19.098	225	2
S23	20.994	1.419	Open Manhole	1200	S8.000	19.575	225				
S12-9-1	20.712	1.407	Open Manhole	1200	S8.001	19.305	225	S8.000	19.305	225	
S12-9	20.679	1.935	Open Manhole	1200	S6.004	18.744	300	S6.003	18.819	225	
								S8.001	19.237	225	418
S12-8-1	20.900	1.425	Open Manhole	1200	S9.000	19.475	225				
S12-8	20.690	2.134	Open Manhole	1350	S6.005	18.556	375	S6.004	18.631	300	
								S9.000	18.932	225	226
S12-7	20.876	2.402	Open Manhole	1350	S6.006	18.474	375	S6.005	18.474	375	
S12-6	21.020	2.601	Open Manhole	1350	S6.007	18.419	375	S6.006	18.419	375	
S12-5-5	22.029	1.554	Open Manhole	1200	S10.000	20.475	225				

Manhole Schedules for Surface Water Network

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S12-5-4	21.800	1.817	Open Manhole	1200	S10.001	19.983	225	S10.000	19.983	225	
S12-5-3	22.077	2.344	Open Manhole	1200	S10.002	19.733	225	S10.001	19.733	225	
S12-5-2	22.250	2.778	Open Manhole	1200	S10.003	19.472	225	S10.002	19.472	225	
S12-5-1-1	21.237	1.762	Open Manhole	1200	S11.000	19.475	225				
S12-5-1	21.782	3.261	Open Manhole	1350	S10.004	18.521	375	S10.003	18.841	225	170
								S11.000	19.099	225	428
S12-5	21.200	2.835	Open Manhole	1350	S6.008	18.365	375	S6.007	18.365	375	
								S10.004	18.365	375	
S12-4	20.935	2.608	Open Manhole	1350	S6.009	18.327	375	S6.008	18.328	375	1
S12-3	20.589	2.332	Open Manhole	1350	S6.010	18.257	375	S6.009	18.257	375	
S12-2	19.050	1.732	Open Manhole	1350	S6.011	17.318	375	S6.010	17.318	375	
S12-1	18.987	1.957	Open Manhole	1350	S6.012	17.030	375	S6.011	17.030	375	
S12	18.649	2.929	Open Manhole	1350	S1.013	15.720	450	S1.012	15.720	450	
								S6.012	16.707	375	912
S11	18.610	2.994	Open Manhole	1350	S1.014	15.616	300	S1.013	15.616	450	
S10	18.709	3.120	Open Manhole	1200	S1.015	15.589	300	S1.014	15.589	300	
S9	19.024	3.571	Open Manhole	1200	S1.016	15.454	300	S1.015	15.454	300	
S8	18.716	3.392	Open Manhole	1200	S1.017	15.324	300	S1.016	15.324	300	
S7	18.520	3.315	Open Manhole	1200	S1.018	15.205	300	S1.017	15.205	300	

Manhole Schedules for Surface Water Network

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
S6	18.314	3.188	Open Manhole	1200	S1.019	15.126	300	S1.018	15.126	300	
S5	18.333	4.183	Open Manhole	1200	S1.020	14.150	300	S1.019	15.027	300	877
S4	17.620	3.610	Open Manhole	1200	S1.021	14.010	300	S1.020	14.010	300	
S3	17.151	3.288	Open Manhole	1200	S1.022	13.863	300	S1.021	13.864	300	1
S2	16.667	2.960	Open Manhole	1200	S1.023	13.707	300	S1.022	13.707	300	
S	15.660	2.292	Open Manhole	0		OUTFALL		S1.023	13.368	300	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S25	716876.126	731222.283	716876.126	731222.283	Required	
S24	716887.061	731266.484	716887.061	731266.484	Required	
S23	716900.259	731301.627	716900.259	731301.627	Required	

Manhole Schedules for Surface Water Network

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S22	716953.133	731281.848	716953.133	731281.848	Required	
S21	716977.747	731271.608	716977.747	731271.608	Required	
S20-1-1	717000.380	731257.076	717000.380	731257.076	Required	
S20-2	717015.030	731270.557	717015.030	731270.557	Required	
S20-1	717002.982	731259.369	717002.982	731259.369	Required	
S9	716984.191	731263.171	716984.191	731263.171	Required	
S20	716991.197	731271.018	716991.197	731271.018	Required	
S19	717005.797	731288.719	717005.797	731288.719	Required	

Manhole Schedules for Surface Water Network

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S18-1	717026.680	731344.231	717026.680	731344.231	Required	
S18	717014.752	731318.484	717014.752	731318.484	Required	
S17	717023.639	731315.144	717023.639	731315.144	Required	
S16	717043.112	731292.421	717043.112	731292.421	Required	
S15	717053.473	731295.304	717053.473	731295.304	Required	
S14	717069.800	731275.806	717069.800	731275.806	Required	
S13	717035.882	731246.222	717035.882	731246.222	Required	
S12-13	716893.572	731132.840	716893.572	731132.840	Required	

Manhole Schedules for Surface Water Network

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S12-12	716887.540	731135.143	716887.540	731135.143	Required	
S12-11	716882.573	731144.571	716882.573	731144.571	Required	
S12-10-1	716849.313	731175.124	716849.313	731175.124	Required	
S12-10	716888.193	731159.242	716888.193	731159.242	Required	
S23	716872.532	731203.849	716872.532	731203.849	Required	
S12-9-1	716897.335	731193.258	716897.335	731193.258	Required	
S12-9	716900.246	731190.224	716900.246	731190.224	Required	
S12-8-1	716908.845	731151.687	716908.845	731151.687	Required	

Manhole Schedules for Surface Water Network

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S12-8	716921.150	731181.858	716921.150	731181.858	Required	
S12-7	716942.608	731173.814	716942.608	731173.814	Required	
S12-6	716946.662	731157.716	716946.662	731157.716	Required	
S12-5-5	716894.758	731106.699	716894.758	731106.699	Required	
S12-5-4	716915.025	731099.083	716915.025	731099.083	Required	
S12-5-3	716907.813	731080.396	716907.813	731080.396	Required	
S12-5-2	716930.106	731071.630	716930.106	731071.630	Required	
S12-5-1-1	716922.727	731129.624	716922.727	731129.624	Required	

Manhole Schedules for Surface Water Network

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S12-5-1	716948.233	731119.269	716948.233	731119.269	Required	
S12-5	716959.784	731148.274	716959.784	731148.274	Required	
S12-4	716970.743	731151.303	716970.743	731151.303	Required	
S12-3	716986.207	731165.588	716986.207	731165.588	Required	
S12-2	717003.968	731215.082	717003.968	731215.082	Required	
S12-1	717019.726	731222.192	717019.726	731222.192	Required	
S12	717033.217	731234.174	717033.217	731234.174	Required	
S11	717041.734	731224.743	717041.734	731224.743	Required	

Manhole Schedules for Surface Water Network

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S10	717047.619	731222.660	717047.619	731222.660	Required	
S9	717065.548	731204.563	717065.548	731204.563	Required	
S8	717085.867	731226.026	717085.867	731226.026	Required	
S7	717105.562	731248.604	717105.562	731248.604	Required	
S6	717122.095	731259.649	717122.095	731259.649	Required	
S5	717140.120	731242.576	717140.120	731242.576	Required	
S4	717175.116	731243.364	717175.116	731243.364	Required	
S3	717211.680	731243.249	717211.680	731243.249	Required	

Manhole Schedules for Surface Water Network

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
S2	717250.120	731243.155	717250.120	731243.155	Required	
S	717335.630	731242.904			No Entry	

PIPELINE SCHEDULES for Surface Water Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	o	225	S25	20.994	19.575	1.194	Open Manhole	1200
S1.001	o	225	S24	20.740	19.006	1.509	Open Manhole	1200
S1.002	o	225	S23	19.378	17.902	1.251	Open Manhole	1200
S1.003	o	300	S22	19.100	16.931	1.869	Open Manhole	1200
S1.004	o	300	S21	19.100	16.842	1.958	Open Manhole	1200
S2.000	o	300	S20-1-1	18.796	16.708	1.788	Open Manhole	1200
S3.000	o	225	S20-2	18.685	16.908	1.552	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.000	45.534	80.0	S24	20.740	19.006	1.509	Open Manhole	1200
S1.001	37.539	34.0	S23	19.378	17.902	1.251	Open Manhole	1200
S1.002	56.453	63.0	S22	19.100	17.006	1.869	Open Manhole	1200
S1.003	26.659	299.5	S21	19.100	16.842	1.958	Open Manhole	1200
S1.004	13.463	45.0	S20	18.839	16.543	1.996	Open Manhole	1350
S2.000	3.468	99.1	S20-1	18.717	16.673	1.744	Open Manhole	1200
S3.000	16.441	110.0	S20-1	18.717	16.759	1.733	Open Manhole	1200

PIPELINE SCHEDULES for Surface Water Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S2.001	o	300	S20-1	18.717	16.673	1.744	Open Manhole	1200
S4.000	o	300	S9	18.880	16.680	1.900	Open Manhole	1200
S1.005	o	375	S20	18.839	16.543	1.921	Open Manhole	1350
S1.006	o	450	S19	18.747	16.342	1.955	Open Manhole	1350
S5.000	o	225	S18-1	18.238	16.944	1.069	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S2.001	16.571	301.3	S20	18.839	16.618	1.921	Open Manhole	1350
S4.000	10.520	169.7	S20	18.839	16.618	1.921	Open Manhole	1350
S1.005	22.944	182.0	S19	18.747	16.417	1.955	Open Manhole	1350
S1.006	31.083	350.0	S18	18.498	16.253	1.795	Open Manhole	1350
S5.000	28.375	61.0	S18	18.498	16.479	1.794	Open Manhole	1350

PIPELINE SCHEDULES for Surface Water Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.007	o	450	S18	18.498	16.254	1.794	Open Manhole	1350
S1.008	o	450	S17	18.414	16.207	1.757	Open Manhole	1350
S1.009	o	450	S16	18.270	16.077	1.743	Open Manhole	1350
S1.010	o	450	S15	18.094	16.042	1.602	Open Manhole	1350
S1.011	o	450	S14	18.244	15.940	1.854	Open Manhole	1350
S1.012	o	450	S13	18.602	15.757	2.395	Open Manhole	1350
S6.000	o	225	S12-13	20.908	19.575	1.108	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.007	9.494	202.0	S17	18.414	16.207	1.757	Open Manhole	1350
S1.008	29.925	230.2	S16	18.270	16.077	1.743	Open Manhole	1350
S1.009	10.755	307.3	S15	18.094	16.042	1.602	Open Manhole	1350
S1.010	25.432	249.3	S14	18.244	15.940	1.854	Open Manhole	1350
S1.011	45.007	245.9	S13	18.602	15.757	2.395	Open Manhole	1350
S1.012	12.339	333.5	S12	18.649	15.720	2.479	Open Manhole	1350
S6.000	6.457	65.2	S12-12	20.947	19.476	1.246	Open Manhole	1200

PIPELINE SCHEDULES for Surface Water Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.001	o	225	S12-12	20.947	19.476	1.246	Open Manhole	1200
S6.002	o	225	S12-11	21.560	19.321	2.014	Open Manhole	1200
S7.000	o	225	S12-10-1	21.338	19.775	1.338	Open Manhole	1200
S6.003	o	225	S12-10	21.125	19.096	1.804	Open Manhole	1200
S8.000	o	225	S23	20.994	19.575	1.194	Open Manhole	1200
S8.001	o	225	S12-9-1	20.712	19.305	1.182	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.001	10.656	68.7	S12-11	21.560	19.321	2.014	Open Manhole	1200
S6.002	15.711	69.9	S12-10	21.125	19.096	1.804	Open Manhole	1200
S7.000	41.999	62.0	S12-10	21.125	19.098	1.802	Open Manhole	1200
S6.003	33.244	120.0	S12-9	20.679	18.819	1.635	Open Manhole	1200
S8.000	26.970	100.0	S12-9-1	20.712	19.305	1.182	Open Manhole	1200
S8.001	4.205	62.0	S12-9	20.679	19.237	1.217	Open Manhole	1200

PIPELINE SCHEDULES for Surface Water Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.004	o	300	S12-9	20.679	18.744	1.635	Open Manhole	1200
S9.000	o	225	S12-8-1	20.900	19.475	1.200	Open Manhole	1200
S6.005	o	375	S12-8	20.690	18.556	1.759	Open Manhole	1350
S6.006	o	375	S12-7	20.876	18.474	2.027	Open Manhole	1350
S6.007	o	375	S12-6	21.020	18.419	2.226	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.004	22.515	199.2	S12-8	20.690	18.631	1.759	Open Manhole	1350
S9.000	32.583	60.0	S12-8	20.690	18.932	1.533	Open Manhole	1350
S6.005	22.917	279.5	S12-7	20.876	18.474	2.027	Open Manhole	1350
S6.006	16.601	301.9	S12-6	21.020	18.419	2.226	Open Manhole	1350
S6.007	16.165	300.0	S12-5	21.200	18.365	2.460	Open Manhole	1350

PIPELINE SCHEDULES for Surface Water Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S10.000	o	225	S12-5-5	22.029	20.475	1.329	Open Manhole	1200
S10.001	o	225	S12-5-4	21.800	19.983	1.592	Open Manhole	1200
S10.002	o	225	S12-5-3	22.077	19.733	2.119	Open Manhole	1200
S10.003	o	225	S12-5-2	22.250	19.472	2.553	Open Manhole	1200
S11.000	o	225	S12-5-1-1	21.237	19.475	1.537	Open Manhole	1200
S10.004	o	375	S12-5-1	21.782	18.521	2.886	Open Manhole	1350

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S10.000	21.651	44.0	S12-5-4	21.800	19.983	1.592	Open Manhole	1200
S10.001	20.030	80.0	S12-5-3	22.077	19.733	2.119	Open Manhole	1200
S10.002	23.954	92.0	S12-5-2	22.250	19.472	2.553	Open Manhole	1200
S10.003	50.972	80.8	S12-5-1	21.782	18.841	2.716	Open Manhole	1350
S11.000	27.528	73.2	S12-5-1	21.782	19.099	2.458	Open Manhole	1350
S10.004	31.220	200.1	S12-5	21.200	18.365	2.460	Open Manhole	1350

PIPELINE SCHEDULES for Surface Water Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.008	o	375	S12-5	21.200	18.365	2.460	Open Manhole	1350
S6.009	o	375	S12-4	20.935	18.327	2.233	Open Manhole	1350
S6.010	o	375	S12-3	20.589	18.257	1.957	Open Manhole	1350
S6.011	o	375	S12-2	19.050	17.318	1.357	Open Manhole	1350
S6.012	o	375	S12-1	18.987	17.030	1.582	Open Manhole	1350
S1.013	o	450	S12	18.649	15.720	2.479	Open Manhole	1350
S1.014	o	300	S11	18.610	15.616	2.694	Open Manhole	1350
S1.015	o	300	S10	18.709	15.589	2.820	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S6.008	11.371	311.0	S12-4	20.935	18.328	2.232	Open Manhole	1350
S6.009	21.052	300.7	S12-3	20.589	18.257	1.957	Open Manhole	1350
S6.010	52.584	56.0	S12-2	19.050	17.318	1.357	Open Manhole	1350
S6.011	17.288	60.0	S12-1	18.987	17.030	1.582	Open Manhole	1350
S6.012	18.044	55.9	S12	18.649	16.707	1.567	Open Manhole	1350
S1.013	12.708	122.2	S11	18.610	15.616	2.544	Open Manhole	1350
S1.014	6.243	231.2	S10	18.709	15.589	2.820	Open Manhole	1200
S1.015	25.474	188.0	S9	19.024	15.454	3.271	Open Manhole	1200

PIPELINE SCHEDULES for Surface Water Network

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.016	o	300	S9	19.024	15.454	3.270	Open Manhole	1200
S1.017	o	300	S8	18.716	15.324	3.092	Open Manhole	1200
S1.018	o	300	S7	18.520	15.205	3.015	Open Manhole	1200
S1.019	o	300	S6	18.314	15.126	2.888	Open Manhole	1200
S1.020	o	300	S5	18.333	14.150	3.883	Open Manhole	1200
S1.021	o	300	S4	17.620	14.010	3.310	Open Manhole	1200
S1.022	o	300	S3	17.151	13.863	2.988	Open Manhole	1200
S1.023	o	300	S2	16.667	13.707	2.660	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S1.016	29.555	227.3	S8	18.716	15.324	3.092	Open Manhole	1200
S1.017	29.961	251.8	S7	18.520	15.205	3.015	Open Manhole	1200
S1.018	19.883	251.7	S6	18.314	15.126	2.888	Open Manhole	1200
S1.019	24.828	250.8	S5	18.333	15.027	3.006	Open Manhole	1200
S1.020	35.005	250.0	S4	17.620	14.010	3.310	Open Manhole	1200
S1.021	36.565	250.4	S3	17.151	13.864	2.987	Open Manhole	1200
S1.022	38.440	246.4	S2	16.667	13.707	2.660	Open Manhole	1200
S1.023	85.511	252.2	S	15.660	13.368	1.992	Open Manhole	0

Free Flowing Outfall Details for Surface Water Network

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.023	S	15.660	13.368	0.000	0	0

Simulation Criteria for Surface Water Network

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	20.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 5 Number of Storage Structures 5 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	17.300	Cv (Summer)	0.750
Return Period (years)	5	Ratio R	0.280	Cv (Winter)	0.840
Region	Scotland and Ireland	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Surface Water Network

Hydro-Brake® Optimum Manhole: S21, DS/PN: S1.004, Volume (m³): 4.4

Unit Reference	MD-SHE-0053-2000-2733-2000	Sump Available	Yes
Design Head (m)	2.733	Diameter (mm)	53
Design Flow (l/s)	2.0	Invert Level (m)	16.842
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.733	2.0	Kick-Flo®	0.470	0.9
Flush-Flo™	0.226	1.1	Mean Flow over Head Range	-	1.4

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

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

Hydro-Brake® Optimum Manhole: S20, DS/PN: S1.005, Volume (m³): 5.9

Unit Reference	MD-SHE-0093-4700-1675-4700	Sump Available	Yes
Design Head (m)	1.675	Diameter (mm)	93
Design Flow (l/s)	4.7	Invert Level (m)	16.543
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	4.7	Kick-Flo®	0.829	3.4
Flush-Flo™	0.409	4.2	Mean Flow over Head Range	-	3.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	0.600	4.1	1.600	4.6	2.600	5.8	5.000	7.8	7.500	9.5
0.200	3.9	0.800	3.6	1.800	4.9	3.000	6.2	5.500	8.2	8.000	9.8
0.300	4.2	1.000	3.7	2.000	5.1	3.500	6.6	6.000	8.6	8.500	10.1
0.400	4.2	1.200	4.0	2.200	5.3	4.000	7.1	6.500	8.9	9.000	10.4
0.500	4.2	1.400	4.3	2.400	5.6	4.500	7.5	7.000	9.2	9.500	10.6

Hydro-Brake® Optimum Manhole: S16, DS/PN: S1.009, Volume (m³): 7.7

Unit Reference	MD-SHE-0093-4700-1670-4700	Flush-Flo™	Calculated
Design Head (m)	1.670	Objective	Minimise upstream storage
Design Flow (l/s)	4.7	Application	Surface

Hydro-Brake® Optimum Manhole: S16, DS/PN: S1.009, Volume (m³): 7.7

Sump Available Yes
Diameter (mm) 93
Invert Level (m) 16.077

Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	4.7	Kick-Flo®	0.825	3.4
Flush-Flo™	0.403	4.3	Mean Flow over Head Range	-	3.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	0.600	4.1	1.600	4.6	2.600	5.8	5.000	7.9	7.500	9.5
0.200	3.9	0.800	3.5	1.800	4.9	3.000	6.2	5.500	8.2	8.000	9.8
0.300	4.2	1.000	3.7	2.000	5.1	3.500	6.6	6.000	8.6	8.500	10.1
0.400	4.3	1.200	4.0	2.200	5.3	4.000	7.1	6.500	8.9	9.000	10.4
0.500	4.2	1.400	4.3	2.400	5.6	4.500	7.5	7.000	9.2	9.500	10.7

Hydro-Brake® Optimum Manhole: S12-5, DS/PN: S6.008, Volume (m³): 9.0

Unit Reference MD-SHE-0064-2600-2110-2600
Design Head (m) 2.110
Design Flow (l/s) 2.6
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface

Sump Available Yes
Diameter (mm) 64
Invert Level (m) 18.365
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Hydro-Brake® Optimum Manhole: S12-5, DS/PN: S6.008, Volume (m³): 9.0

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.110	2.6	Kick-Flo®	0.577	1.4
Flush-Flo™	0.283	1.8	Mean Flow over Head Range	-	1.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	0.600	1.5	1.600	2.3	2.600	2.9	5.000	3.9	7.500	4.7
0.200	1.7	0.800	1.7	1.800	2.4	3.000	3.1	5.500	4.0	8.000	4.8
0.300	1.8	1.000	1.8	2.000	2.5	3.500	3.3	6.000	4.2	8.500	5.0
0.400	1.7	1.200	2.0	2.200	2.6	4.000	3.5	6.500	4.4	9.000	5.1
0.500	1.6	1.400	2.1	2.400	2.8	4.500	3.7	7.000	4.5	9.500	5.2

Hydro-Brake® Optimum Manhole: S11, DS/PN: S1.014, Volume (m³): 6.1

Unit Reference	MD-SHE-0111-8500-2749-8500	Sump Available	Yes
Design Head (m)	2.749	Diameter (mm)	111
Design Flow (l/s)	8.5	Invert Level (m)	15.616
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.749	8.5	Kick-Flo®	0.999	5.3
Flush-Flo™	0.486	6.7	Mean Flow over Head Range	-	6.6

Hydro-Brake® Optimum Manhole: S11, DS/PN: S1.014, Volume (m³): 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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	0.600	6.6	1.600	6.6	2.600	8.3	5.000	11.3	7.500	13.7
0.200	5.9	0.800	6.3	1.800	7.0	3.000	8.8	5.500	11.8	8.000	14.1
0.300	6.4	1.000	5.3	2.000	7.3	3.500	9.5	6.000	12.3	8.500	14.5
0.400	6.6	1.200	5.8	2.200	7.6	4.000	10.1	6.500	12.8	9.000	14.9
0.500	6.7	1.400	6.2	2.400	8.0	4.500	10.7	7.000	13.2	9.500	15.3

Summary of Results for 30 minute 5 year Summer (Surface Water Network)

Margin for Flood Risk Warning (mm) 300.0 DTS Status ON Inertia Status OFF
Analysis Timestep Fine DVD Status OFF

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S25	19.700	-0.100	0.000	0.58			32.1	OK
S1.001	S24	19.131	-0.100	0.000	0.60			50.5	OK
S1.002	S23	18.082	-0.045	0.000	0.96			60.5	OK
S1.003	S22	17.239	0.008	0.000	1.09			62.8	SURCHARGED
S1.004	S21	17.029	-0.113	0.000	0.01			0.7	OK
S2.000	S20-1-1	16.982	-0.026	0.000	0.70			43.0	OK
S3.000	S20-2	17.000	-0.133	0.000	0.32			13.9	OK
S2.001	S20-1	16.968	-0.005	0.000	1.00			54.1	OK
S4.000	S9	16.956	-0.024	0.000	0.68			42.1	OK
S1.005	S20	16.955	0.037	0.000	0.03			4.2	SURCHARGED
S1.006	S19	16.449	-0.343	0.000	0.12			17.3	OK
S5.000	S18-1	16.993	-0.176	0.000	0.11			6.5	OK
S1.007	S18	16.370	-0.334	0.000	0.15			23.6	OK
S1.008	S17	16.319	-0.338	0.000	0.14			25.9	OK
S1.009	S16	16.216	-0.311	0.000	0.02			2.3	OK
S1.010	S15	16.148	-0.344	0.000	0.02			3.0	OK
S1.011	S14	16.148	-0.242	0.000	0.05			9.4	OK
S1.012	S13	16.147	-0.060	0.000	0.04			5.3	OK
S6.000	S12-13	19.636	-0.164	0.000	0.16			7.2	OK
S6.001	S12-12	19.532	-0.169	0.000	0.14			7.3	OK
S6.002	S12-11	19.376	-0.170	0.000	0.14			7.5	OK
S7.000	S12-10-1	19.825	-0.175	0.000	0.11			6.9	OK

Attenuation Tank

Attenuation Tank

Summary of Results for 30 minute 5 year Summer (Surface Water Network)

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S6.003	S12-10	19.187	-0.134	0.000	0.34			15.1	OK
S8.000	S23	19.672	-0.128	0.000	0.38			18.2	OK
S8.001	S12-9-1	19.419	-0.111	0.000	0.50			18.4	OK
S6.004	S12-9	18.908	-0.136	0.000	0.57			39.6	OK
S9.000	S12-8-1	19.526	-0.174	0.000	0.11			7.1	OK
S6.005	S12-8	18.768	-0.163	0.000	0.53			53.6	OK
S6.006	S12-7	18.729	-0.120	0.000	0.62			57.7	OK
S6.007	S12-6	18.727	-0.068	0.000	0.65			60.6	OK
S10.000	S12-5-5	20.511	-0.189	0.000	0.06			4.3	OK
S10.001	S12-5-4	20.042	-0.166	0.000	0.15			8.1	OK
S10.002	S12-5-3	19.800	-0.158	0.000	0.19			9.7	OK
S10.003	S12-5-2	19.551	-0.146	0.000	0.27			14.8	OK
S11.000	S12-5-1-1	19.562	-0.138	0.000	0.31			17.5	OK
S10.004	S12-5-1	18.725	-0.171	0.000	0.26			32.6	OK
S6.008	S12-5	18.725	-0.015	0.000	0.02			1.8	OK
S6.009	S12-4	18.383	-0.319	0.000	0.05			5.1	OK
S6.010	S12-3	18.315	-0.317	0.000	0.06			14.1	OK
S6.011	S12-2	17.392	-0.301	0.000	0.09			17.9	OK
S6.012	S12-1	17.105	-0.300	0.000	0.09			19.6	OK
S1.013	S12	16.146	-0.024	0.000	0.10			18.6	OK
S1.014	S11	16.144	0.228	0.000	0.13		22	6.7	SURCHARGED
S1.015	S10	15.650	-0.239	0.000	0.09			6.7	OK
S1.016	S9	15.517	-0.237	0.000	0.10			6.7	OK
S1.017	S8	15.389	-0.235	0.000	0.11			6.7	OK
S1.018	S7	15.271	-0.234	0.000	0.11			6.7	OK

Attenuation Tank

Summary of Results for 30 minute 5 year Summer (Surface Water Network)

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.019	S6	15.191	-0.235	0.000	0.11			6.7	OK
S1.020	S5	14.214	-0.236	0.000	0.10			6.7	OK
S1.021	S4	14.074	-0.236	0.000	0.10			6.7	OK
S1.022	S3	13.927	-0.236	0.000	0.10			6.7	OK
S1.023	S2	13.770	-0.237	0.000	0.10			6.7	OK

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Water Network

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	30	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	17.300	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	1.200
Ratio R	0.280	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	20	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200		

Designed with Level Soffits

Network Design Table for Surface Water Network

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design

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)

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	45.534	0.569	80.0	0.159	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	37.539	1.104	34.0	0.109	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	56.453	0.896	63.0	0.066	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	26.659	0.089	299.5	0.024	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	13.463	0.299	45.0	0.010	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	3.468	0.035	99.1	0.219	4.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	16.441	0.149	110.0	0.068	4.00	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)
S1.000	50.00	4.52	19.575	0.159	0.0	0.0	4.3	1.46	58.2	25.8
S1.001	50.00	4.80	19.006	0.268	0.0	0.0	7.3	2.25	89.5	43.5
S1.002	50.00	5.37	17.902	0.334	0.0	0.0	9.0	1.65	65.6	54.3
S1.003	50.00	5.86	16.931	0.358	0.0	0.0	9.7	0.90	63.8	58.2
S1.004	50.00	5.95	16.842	0.368	0.0	0.0	10.0	2.35	166.1	59.8
S2.000	50.00	4.04	16.708	0.219	0.0	0.0	5.9	1.58	111.7	35.6
S3.000	50.00	4.22	16.908	0.068	0.0	0.0	1.8	1.25	49.5	11.0

Network Design Table for Surface Water Network

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
S2.001	16.571	0.055	301.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S4.000	10.520	0.062	169.7	0.210	4.00	0.0	0.600	o	300	Pipe/Conduit	
S1.005	22.944	0.126	182.0	0.014	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.006	31.083	0.089	350.0	0.080	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.000	28.375	0.465	61.0	0.032	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.007	9.494	0.047	202.0	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)
S2.001	50.00	4.53	16.673	0.287	0.0	0.0	7.8	0.90	63.7	46.6
S4.000	50.00	4.15	16.680	0.210	0.0	0.0	5.7	1.20	85.1	34.1
S1.005	50.00	6.24	16.543	0.879	0.0	0.0	23.8	1.34	148.0	142.8
S1.006	50.00	6.72	16.342	0.959	0.0	0.0	26.0	1.08	171.9	155.8
S5.000	50.00	4.28	16.944	0.032	0.0	0.0	0.9	1.68	66.7	5.2
S1.007	50.00	6.83	16.254	0.991	0.0	0.0	26.8	1.43	226.9	161.0

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.008	29.925	0.130	230.2	0.014	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.009	10.755	0.035	307.3	0.012	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.010	25.432	0.102	249.3	0.015	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.011	45.007	0.183	245.9	0.050	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.012	12.339	0.037	333.5	0.008	0.00	0.0	0.600	o	450	Pipe/Conduit	
S6.000	6.457	0.099	65.2	0.035	4.00	0.0	0.600	o	225	Pipe/Conduit	
S6.001	10.656	0.155	68.7	0.001	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.002	15.711	0.225	69.9	0.001	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)
S1.008	50.00	7.20	16.207	1.005	0.0	0.0	27.2	1.34	212.4	163.3
S1.009	50.00	7.36	16.077	1.017	0.0	0.0	27.5	1.15	183.6	165.3
S1.010	50.00	7.69	16.042	1.032	0.0	0.0	27.9	1.28	204.0	167.7
S1.011	50.00	8.27	15.940	1.082	0.0	0.0	29.3	1.29	205.5	175.8
S1.012	50.00	8.46	15.757	1.090	0.0	0.0	29.5	1.11	176.2«	177.1
S6.000	50.00	4.07	19.575	0.035	0.0	0.0	0.9	1.62	64.5	5.7
S6.001	50.00	4.18	19.476	0.036	0.0	0.0	1.0	1.58	62.8	5.8
S6.002	50.00	4.35	19.321	0.037	0.0	0.0	1.0	1.57	62.3	6.0

Network Design Table for Surface Water Network

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
S7.000	41.999	0.677	62.0	0.034	4.00	0.0	0.600	o	225	Pipe/Conduit	
S6.003	33.244	0.277	120.0	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit	
S8.000	26.970	0.270	100.0	0.090	4.00	0.0	0.600	o	225	Pipe/Conduit	
S8.001	4.205	0.068	62.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.004	22.515	0.113	199.2	0.041	0.00	0.0	0.600	o	300	Pipe/Conduit	
S9.000	32.583	0.543	60.0	0.035	4.00	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)
S7.000	50.00	4.42	19.775	0.034	0.0	0.0	0.9	1.66	66.1	5.5
S6.003	50.00	4.89	19.096	0.076	0.0	0.0	2.1	1.19	47.4	12.3
S8.000	50.00	4.34	19.575	0.090	0.0	0.0	2.4	1.31	52.0	14.6
S8.001	50.00	4.39	19.305	0.090	0.0	0.0	2.4	1.66	66.2	14.6
S6.004	50.00	5.22	18.744	0.207	0.0	0.0	5.6	1.11	78.5	33.6
S9.000	50.00	4.32	19.475	0.035	0.0	0.0	0.9	1.69	67.3	5.7

Network Design Table for Surface Water Network

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
S6.005	22.917	0.082	279.5	0.047	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.006	16.601	0.055	301.9	0.036	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.007	16.165	0.054	300.0	0.034	0.00	0.0	0.600	o	375	Pipe/Conduit	
S10.000	21.651	0.492	44.0	0.021	4.00	0.0	0.600	o	225	Pipe/Conduit	
S10.001	20.030	0.250	80.0	0.023	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.002	23.954	0.260	92.0	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.003	50.972	0.631	80.8	0.031	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)
S6.005	50.00	5.58	18.556	0.289	0.0	0.0	7.8	1.08	119.2	47.0
S6.006	50.00	5.84	18.474	0.325	0.0	0.0	8.8	1.04	114.6	52.8
S6.007	50.00	6.10	18.419	0.359	0.0	0.0	9.7	1.04	115.0	58.3
S10.000	50.00	4.18	20.475	0.021	0.0	0.0	0.6	1.98	78.6	3.4
S10.001	50.00	4.41	19.983	0.044	0.0	0.0	1.2	1.46	58.2	7.1
S10.002	50.00	4.70	19.733	0.053	0.0	0.0	1.4	1.36	54.2	8.6
S10.003	50.00	5.29	19.472	0.084	0.0	0.0	2.3	1.46	57.9	13.6

Network Design Table for Surface Water Network

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
S11.000	27.528	0.376	73.2	0.086	4.00	0.0	0.600	o	225	Pipe/Conduit	
S10.004	31.220	0.156	200.1	0.008	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.008	11.371	0.037	311.0	0.017	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.009	21.052	0.070	300.7	0.020	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.010	52.584	0.939	56.0	0.055	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.011	17.288	0.288	60.0	0.023	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.012	18.044	0.323	55.9	0.010	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)
S11.000	50.00	4.30	19.475	0.086	0.0	0.0	2.3	1.53	60.8	14.0
S10.004	50.00	5.69	18.521	0.178	0.0	0.0	4.8	1.28	141.1	28.9
S6.008	50.00	6.29	18.365	0.554	0.0	0.0	15.0	1.02	112.9	90.0
S6.009	50.00	6.63	18.327	0.574	0.0	0.0	15.5	1.04	114.8	93.3
S6.010	50.00	6.99	18.257	0.629	0.0	0.0	17.0	2.43	267.9	102.2
S6.011	50.00	7.11	17.318	0.652	0.0	0.0	17.7	2.34	258.7	105.9
S6.012	50.00	7.23	17.030	0.662	0.0	0.0	17.9	2.43	268.1	107.6

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.013	12.708	0.104	122.2	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.014	6.243	0.027	231.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.015	25.474	0.136	188.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.016	29.555	0.130	227.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.017	29.961	0.119	251.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.018	19.883	0.079	251.7	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.019	24.828	0.099	250.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.020	35.005	0.140	250.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.021	36.565	0.146	250.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.022	38.440	0.156	246.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.013	50.00	8.57	15.720	1.752	0.0	0.0	47.4	1.84	292.3	284.7
S1.014	50.00	8.67	15.616	1.752	0.0	0.0	47.4	1.03	72.8«	284.7
S1.015	50.00	9.04	15.589	1.752	0.0	0.0	47.4	1.14	80.8«	284.7
S1.016	50.00	9.52	15.454	1.752	0.0	0.0	47.4	1.04	73.4«	284.7
S1.017	50.00	10.02	15.324	1.752	0.0	0.0	47.4	0.99	69.7«	284.7
S1.018	50.00	10.36	15.205	1.752	0.0	0.0	47.4	0.99	69.7«	284.7
S1.019	50.00	10.78	15.126	1.752	0.0	0.0	47.4	0.99	69.9«	284.7
S1.020	50.00	11.37	14.150	1.752	0.0	0.0	47.4	0.99	70.0«	284.7
S1.021	50.00	11.98	14.010	1.752	0.0	0.0	47.4	0.99	69.9«	284.7
S1.022	50.00	12.63	13.863	1.752	0.0	0.0	47.4	1.00	70.5«	284.7

Reduced flow Following Hydrobrake

MaxQ 8.5 l/s

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.023	85.511	0.339	252.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.023	50.00	14.07	13.707	1.752	0.0	0.0	47.4	0.99	69.7«	284.7

Free Flowing Outfall Details for Surface Water Network

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.023	S	15.660	13.368	0.000	0	0

Simulation Criteria for Surface Water Network

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	20.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 5 Number of Storage Structures 5 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	17.300	Cv (Summer)	0.750
Return Period (years)	30	Ratio R	0.280	Cv (Winter)	0.840
Region	Scotland and Ireland	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Surface Water Network

Hydro-Brake® Optimum Manhole: S21, DS/PN: S1.004, Volume (m³): 4.4

Unit Reference	MD-SHE-0053-2000-2733-2000	Sump Available	Yes
Design Head (m)	2.733	Diameter (mm)	53
Design Flow (l/s)	2.0	Invert Level (m)	16.842
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.733	2.0	Kick-Flo®	0.470	0.9
Flush-Flo™	0.226	1.1	Mean Flow over Head Range	-	1.4

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

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

Hydro-Brake® Optimum Manhole: S20, DS/PN: S1.005, Volume (m³): 5.9

Unit Reference	MD-SHE-0093-4700-1675-4700	Sump Available	Yes
Design Head (m)	1.675	Diameter (mm)	93
Design Flow (l/s)	4.7	Invert Level (m)	16.543
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	4.7	Kick-Flo®	0.829	3.4
Flush-Flo™	0.409	4.2	Mean Flow over Head Range	-	3.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	0.600	4.1	1.600	4.6	2.600	5.8	5.000	7.8	7.500	9.5
0.200	3.9	0.800	3.6	1.800	4.9	3.000	6.2	5.500	8.2	8.000	9.8
0.300	4.2	1.000	3.7	2.000	5.1	3.500	6.6	6.000	8.6	8.500	10.1
0.400	4.2	1.200	4.0	2.200	5.3	4.000	7.1	6.500	8.9	9.000	10.4
0.500	4.2	1.400	4.3	2.400	5.6	4.500	7.5	7.000	9.2	9.500	10.6

Hydro-Brake® Optimum Manhole: S16, DS/PN: S1.009, Volume (m³): 7.7

Unit Reference	MD-SHE-0093-4700-1670-4700	Flush-Flo™	Calculated
Design Head (m)	1.670	Objective	Minimise upstream storage
Design Flow (l/s)	4.7	Application	Surface

Hydro-Brake® Optimum Manhole: S16, DS/PN: S1.009, Volume (m³): 7.7

Sump Available Yes
Diameter (mm) 93
Invert Level (m) 16.077

Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	4.7	Kick-Flo®	0.825	3.4
Flush-Flo™	0.403	4.3	Mean Flow over Head Range	-	3.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	0.600	4.1	1.600	4.6	2.600	5.8	5.000	7.9	7.500	9.5
0.200	3.9	0.800	3.5	1.800	4.9	3.000	6.2	5.500	8.2	8.000	9.8
0.300	4.2	1.000	3.7	2.000	5.1	3.500	6.6	6.000	8.6	8.500	10.1
0.400	4.3	1.200	4.0	2.200	5.3	4.000	7.1	6.500	8.9	9.000	10.4
0.500	4.2	1.400	4.3	2.400	5.6	4.500	7.5	7.000	9.2	9.500	10.7

Hydro-Brake® Optimum Manhole: S12-5, DS/PN: S6.008, Volume (m³): 9.0

Unit Reference MD-SHE-0064-2600-2110-2600
Design Head (m) 2.110
Design Flow (l/s) 2.6
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface

Sump Available Yes
Diameter (mm) 64
Invert Level (m) 18.365
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Hydro-Brake® Optimum Manhole: S12-5, DS/PN: S6.008, Volume (m³): 9.0

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.110	2.6	Kick-Flo®	0.577	1.4
Flush-Flo™	0.283	1.8	Mean Flow over Head Range	-	1.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	0.600	1.5	1.600	2.3	2.600	2.9	5.000	3.9	7.500	4.7
0.200	1.7	0.800	1.7	1.800	2.4	3.000	3.1	5.500	4.0	8.000	4.8
0.300	1.8	1.000	1.8	2.000	2.5	3.500	3.3	6.000	4.2	8.500	5.0
0.400	1.7	1.200	2.0	2.200	2.6	4.000	3.5	6.500	4.4	9.000	5.1
0.500	1.6	1.400	2.1	2.400	2.8	4.500	3.7	7.000	4.5	9.500	5.2

Hydro-Brake® Optimum Manhole: S11, DS/PN: S1.014, Volume (m³): 6.1

Unit Reference	MD-SHE-0111-8500-2749-8500	Sump Available	Yes
Design Head (m)	2.749	Diameter (mm)	111
Design Flow (l/s)	8.5	Invert Level (m)	15.616
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.749	8.5	Kick-Flo®	0.999	5.3
Flush-Flo™	0.486	6.7	Mean Flow over Head Range	-	6.6

Hydro-Brake® Optimum Manhole: S11, DS/PN: S1.014, Volume (m³): 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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	0.600	6.6	1.600	6.6	2.600	8.3	5.000	11.3	7.500	13.7
0.200	5.9	0.800	6.3	1.800	7.0	3.000	8.8	5.500	11.8	8.000	14.1
0.300	6.4	1.000	5.3	2.000	7.3	3.500	9.5	6.000	12.3	8.500	14.5
0.400	6.6	1.200	5.8	2.200	7.6	4.000	10.1	6.500	12.8	9.000	14.9
0.500	6.7	1.400	6.2	2.400	8.0	4.500	10.7	7.000	13.2	9.500	15.3

Summary of Results for 30 minute 30 year Summer (Surface Water Network)

Margin for Flood Risk Warning (mm) 300.0 DTS Status ON Inertia Status OFF
Analysis Timestep Fine DVD Status OFF

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S25	19.776	-0.024	0.000	0.84			46.7	OK
S1.001	S24	19.467	0.236	0.000	0.80			68.1	SURCHARGED
S1.002	S23	18.794	0.667	0.000	1.27			80.5	SURCHARGED
S1.003	S22	17.326	0.095	0.000	1.48			85.0	SURCHARGED
S1.004	S21	17.121	-0.021	0.000	0.00			0.6	OK
S2.000	S20-1-1	17.129	0.121	0.000	1.04			64.0	SURCHARGED
S3.000	S20-2	17.102	-0.031	0.000	0.45			19.8	OK
S2.001	S20-1	17.066	0.093	0.000	1.54			83.2	SURCHARGED
S4.000	S9	17.057	0.077	0.000	0.99			61.6	SURCHARGED
S1.005	S20	17.055	0.137	0.000	0.03			4.2	SURCHARGED
S1.006	S19	16.482	-0.310	0.000	0.19			28.1	OK
S5.000	S18-1	17.004	-0.165	0.000	0.16			9.7	OK
S1.007	S18	16.403	-0.301	0.000	0.24			37.7	OK
S1.008	S17	16.352	-0.305	0.000	0.22			41.1	OK
S1.009	S16	16.260	-0.267	0.000	0.02			2.2	OK
S1.010	S15	16.192	-0.300	0.000	0.02			4.0	OK
S1.011	S14	16.191	-0.199	0.000	0.07			13.3	OK
S1.012	S13	16.190	-0.017	0.000	0.10			12.0	OK
S6.000	S12-13	19.650	-0.150	0.000	0.24			10.7	OK

Upstream of Catchment 1 Hydrobrake

Attenuation Tank

Attenuation Tank

Upstream of Catchment 2 Hydrobrake

Summary of Results for 30 minute 30 year Summer (Surface Water Network)

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S6.001	S12-12	19.546	-0.155	0.000	0.21			10.9	OK
S6.002	S12-11	19.391	-0.155	0.000	0.21			11.3	OK
S7.000	S12-10-1	19.836	-0.164	0.000	0.16			10.2	OK
S6.003	S12-10	19.211	-0.110	0.000	0.51			22.9	OK
S8.000	S23	19.698	-0.102	0.000	0.56			27.0	OK
S8.001	S12-9-1	19.452	-0.078	0.000	0.75			27.4	OK
S6.004	S12-9	18.965	-0.079	0.000	0.88			60.9	OK
S9.000	S12-8-1	19.537	-0.163	0.000	0.17			10.6	OK
S6.005	S12-8	18.857	-0.074	0.000	0.80			81.2	OK
S6.006	S12-7	18.819	-0.031	0.000	0.93			87.2	OK
S6.007	S12-6	18.814	0.020	0.000	1.00			93.1	SURCHARGED
S10.000	S12-5-5	20.520	-0.180	0.000	0.09			6.4	OK
S10.001	S12-5-4	20.060	-0.148	0.000	0.25			13.4	OK
S10.002	S12-5-3	19.821	-0.136	0.000	0.32			16.1	OK
S10.003	S12-5-2	19.580	-0.117	0.000	0.46			25.5	OK
S11.000	S12-5-1-1	19.584	-0.116	0.000	0.46			26.0	OK
S10.004	S12-5-1	18.813	-0.083	0.000	0.42			53.0	OK
S6.008	S12-5	18.813	0.073	0.000	0.02			1.8	SURCHARGED
S6.009	S12-4	18.400	-0.302	0.000	0.08			7.8	OK
S6.010	S12-3	18.336	-0.296	0.000	0.10			24.2	OK
S6.011	S12-2	17.415	-0.278	0.000	0.15			31.2	OK
S6.012	S12-1	17.129	-0.276	0.000	0.15			34.3	OK
S1.013	S12	16.189	0.019	0.000	0.24			43.3	SURCHARGED
S1.014	S11	16.187	0.271	0.000	0.13			6.7	SURCHARGED
S1.015	S10	15.650	-0.239	0.000	0.09			6.7	OK

Upstream of Catchment 4 Hydrobrake

Attenuation

Upstream of Catchment 5 Hydrobrake

Summary of Results for 30 minute 30 year Summer (Surface Water Network)

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.016	S9	15.517	-0.237	0.000	0.10			6.7	OK
S1.017	S8	15.389	-0.235	0.000	0.11			6.7	OK
S1.018	S7	15.271	-0.234	0.000	0.11			6.7	OK
S1.019	S6	15.191	-0.235	0.000	0.11			6.7	OK
S1.020	S5	14.214	-0.236	0.000	0.10			6.7	OK
S1.021	S4	14.074	-0.236	0.000	0.10			6.7	OK
S1.022	S3	13.927	-0.236	0.000	0.10			6.7	OK
S1.023	S2	13.770	-0.237	0.000	0.10			6.7	OK

Ormond House
Upper Ormond Quay
Dublin 7

SURFACE WATER DRAINAGE CALCULATION
1 in 100 YEAR STORM EVENT

Date 23/08/2021 17:58
File 190226 - Drainage Design 23.08.2021.MDX

Designed by dalye
Checked by

Innovyze | Network 2020.1

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Surface Water Network

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	Foul Sewage (l/s/ha)	0.000	Maximum Backdrop Height (m)	1.500
M5-60 (mm)	17.300	Volumetric Runoff Coeff.	0.750	Min Design Depth for Optimisation (m)	1.200
Ratio R	0.280	PIMP (%)	100	Min Vel for Auto Design only (m/s)	1.00
Maximum Rainfall (mm/hr)	50	Add Flow / Climate Change (%)	20	Min Slope for Optimisation (1:X)	500
Maximum Time of Concentration (mins)	30	Minimum Backdrop Height (m)	0.200		

Designed with Level Soffits

Network Design Table for Surface Water Network

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design

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)

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	45.534	0.569	80.0	0.159	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.001	37.539	1.104	34.0	0.109	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.002	56.453	0.896	63.0	0.066	0.00	0.0	0.600	o	225	Pipe/Conduit	
S1.003	26.659	0.089	299.5	0.024	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.004	13.463	0.299	45.0	0.010	0.00	0.0	0.600	o	300	Pipe/Conduit	
S2.000	3.468	0.035	99.1	0.219	4.00	0.0	0.600	o	300	Pipe/Conduit	
S3.000	16.441	0.149	110.0	0.068	4.00	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)
S1.000	50.00	4.52	19.575	0.159	0.0	0.0	4.3	1.46	58.2	25.8
S1.001	50.00	4.80	19.006	0.268	0.0	0.0	7.3	2.25	89.5	43.5
S1.002	50.00	5.37	17.902	0.334	0.0	0.0	9.0	1.65	65.6	54.3
S1.003	50.00	5.86	16.931	0.358	0.0	0.0	9.7	0.90	63.8	58.2
S1.004	50.00	5.95	16.842	0.368	0.0	0.0	10.0	2.35	166.1	59.8
S2.000	50.00	4.04	16.708	0.219	0.0	0.0	5.9	1.58	111.7	35.6
S3.000	50.00	4.22	16.908	0.068	0.0	0.0	1.8	1.25	49.5	11.0

Network Design Table for Surface Water Network

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
S2.001	16.571	0.055	301.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S4.000	10.520	0.062	169.7	0.210	4.00	0.0	0.600	o	300	Pipe/Conduit	
S1.005	22.944	0.126	182.0	0.014	0.00	0.0	0.600	o	375	Pipe/Conduit	
S1.006	31.083	0.089	350.0	0.080	0.00	0.0	0.600	o	450	Pipe/Conduit	
S5.000	28.375	0.465	61.0	0.032	4.00	0.0	0.600	o	225	Pipe/Conduit	
S1.007	9.494	0.047	202.0	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)
S2.001	50.00	4.53	16.673	0.287	0.0	0.0	7.8	0.90	63.7	46.6
S4.000	50.00	4.15	16.680	0.210	0.0	0.0	5.7	1.20	85.1	34.1
S1.005	50.00	6.24	16.543	0.879	0.0	0.0	23.8	1.34	148.0	142.8
S1.006	50.00	6.72	16.342	0.959	0.0	0.0	26.0	1.08	171.9	155.8
S5.000	50.00	4.28	16.944	0.032	0.0	0.0	0.9	1.68	66.7	5.2
S1.007	50.00	6.83	16.254	0.991	0.0	0.0	26.8	1.43	226.9	161.0

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.008	29.925	0.130	230.2	0.014	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.009	10.755	0.035	307.3	0.012	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.010	25.432	0.102	249.3	0.015	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.011	45.007	0.183	245.9	0.050	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.012	12.339	0.037	333.5	0.008	0.00	0.0	0.600	o	450	Pipe/Conduit	
S6.000	6.457	0.099	65.2	0.035	4.00	0.0	0.600	o	225	Pipe/Conduit	
S6.001	10.656	0.155	68.7	0.001	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.002	15.711	0.225	69.9	0.001	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)
S1.008	50.00	7.20	16.207	1.005	0.0	0.0	27.2	1.34	212.4	163.3
S1.009	50.00	7.36	16.077	1.017	0.0	0.0	27.5	1.15	183.6	165.3
S1.010	50.00	7.69	16.042	1.032	0.0	0.0	27.9	1.28	204.0	167.7
S1.011	50.00	8.27	15.940	1.082	0.0	0.0	29.3	1.29	205.5	175.8
S1.012	50.00	8.46	15.757	1.090	0.0	0.0	29.5	1.11	176.2«	177.1
S6.000	50.00	4.07	19.575	0.035	0.0	0.0	0.9	1.62	64.5	5.7
S6.001	50.00	4.18	19.476	0.036	0.0	0.0	1.0	1.58	62.8	5.8
S6.002	50.00	4.35	19.321	0.037	0.0	0.0	1.0	1.57	62.3	6.0

Upstream of hydrobrake and attenuation

Network Design Table for Surface Water Network

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
S7.000	41.999	0.677	62.0	0.034	4.00	0.0	0.600	o	225	Pipe/Conduit	
S6.003	33.244	0.277	120.0	0.005	0.00	0.0	0.600	o	225	Pipe/Conduit	
S8.000	26.970	0.270	100.0	0.090	4.00	0.0	0.600	o	225	Pipe/Conduit	
S8.001	4.205	0.068	62.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
S6.004	22.515	0.113	199.2	0.041	0.00	0.0	0.600	o	300	Pipe/Conduit	
S9.000	32.583	0.543	60.0	0.035	4.00	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)
S7.000	50.00	4.42	19.775	0.034	0.0	0.0	0.9	1.66	66.1	5.5
S6.003	50.00	4.89	19.096	0.076	0.0	0.0	2.1	1.19	47.4	12.3
S8.000	50.00	4.34	19.575	0.090	0.0	0.0	2.4	1.31	52.0	14.6
S8.001	50.00	4.39	19.305	0.090	0.0	0.0	2.4	1.66	66.2	14.6
S6.004	50.00	5.22	18.744	0.207	0.0	0.0	5.6	1.11	78.5	33.6
S9.000	50.00	4.32	19.475	0.035	0.0	0.0	0.9	1.69	67.3	5.7

Network Design Table for Surface Water Network

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
S6.005	22.917	0.082	279.5	0.047	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.006	16.601	0.055	301.9	0.036	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.007	16.165	0.054	300.0	0.034	0.00	0.0	0.600	o	375	Pipe/Conduit	
S10.000	21.651	0.492	44.0	0.021	4.00	0.0	0.600	o	225	Pipe/Conduit	
S10.001	20.030	0.250	80.0	0.023	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.002	23.954	0.260	92.0	0.009	0.00	0.0	0.600	o	225	Pipe/Conduit	
S10.003	50.972	0.631	80.8	0.031	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)
S6.005	50.00	5.58	18.556	0.289	0.0	0.0	7.8	1.08	119.2	47.0
S6.006	50.00	5.84	18.474	0.325	0.0	0.0	8.8	1.04	114.6	52.8
S6.007	50.00	6.10	18.419	0.359	0.0	0.0	9.7	1.04	115.0	58.3
S10.000	50.00	4.18	20.475	0.021	0.0	0.0	0.6	1.98	78.6	3.4
S10.001	50.00	4.41	19.983	0.044	0.0	0.0	1.2	1.46	58.2	7.1
S10.002	50.00	4.70	19.733	0.053	0.0	0.0	1.4	1.36	54.2	8.6
S10.003	50.00	5.29	19.472	0.084	0.0	0.0	2.3	1.46	57.9	13.6

Network Design Table for Surface Water Network

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
S11.000	27.528	0.376	73.2	0.086	4.00	0.0	0.600	o	225	Pipe/Conduit	
S10.004	31.220	0.156	200.1	0.008	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.008	11.371	0.037	311.0	0.017	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.009	21.052	0.070	300.7	0.020	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.010	52.584	0.939	56.0	0.055	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.011	17.288	0.288	60.0	0.023	0.00	0.0	0.600	o	375	Pipe/Conduit	
S6.012	18.044	0.323	55.9	0.010	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)
S11.000	50.00	4.30	19.475	0.086	0.0	0.0	2.3	1.53	60.8	14.0
S10.004	50.00	5.69	18.521	0.178	0.0	0.0	4.8	1.28	141.1	28.9
S6.008	50.00	6.29	18.365	0.554	0.0	0.0	15.0	1.02	112.9	90.0
S6.009	50.00	6.63	18.327	0.574	0.0	0.0	15.5	1.04	114.8	93.3
S6.010	50.00	6.99	18.257	0.629	0.0	0.0	17.0	2.43	267.9	102.2
S6.011	50.00	7.11	17.318	0.652	0.0	0.0	17.7	2.34	258.7	105.9
S6.012	50.00	7.23	17.030	0.662	0.0	0.0	17.9	2.43	268.1	107.6

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.013	12.708	0.104	122.2	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
S1.014	6.243	0.027	231.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.015	25.474	0.136	188.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.016	29.555	0.130	227.3	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.017	29.961	0.119	251.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.018	19.883	0.079	251.7	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.019	24.828	0.099	250.8	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.020	35.005	0.140	250.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.021	36.565	0.146	250.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
S1.022	38.440	0.156	246.4	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.013	50.00	8.57	15.720	1.752	0.0	0.0	47.4	1.84	292.3	284.7
S1.014	50.00	8.67	15.616	1.752	0.0	0.0	47.4	1.03	72.8«	284.7
S1.015	50.00	9.04	15.589	1.752	0.0	0.0	47.4	1.14	80.8«	284.7
S1.016	50.00	9.52	15.454	1.752	0.0	0.0	47.4	1.04	73.4«	284.7
S1.017	50.00	10.02	15.324	1.752	0.0	0.0	47.4	0.99	69.7«	284.7
S1.018	50.00	10.36	15.205	1.752	0.0	0.0	47.4	0.99	69.7«	284.7
S1.019	50.00	10.78	15.126	1.752	0.0	0.0	47.4	0.99	69.9«	284.7
S1.020	50.00	11.37	14.150	1.752	0.0	0.0	47.4	0.99	70.0«	284.7
S1.021	50.00	11.98	14.010	1.752	0.0	0.0	47.4	0.99	69.9«	284.7
S1.022	50.00	12.63	13.863	1.752	0.0	0.0	47.4	1.00	70.5«	284.7

Reduced fLow Following Hydrobrake

MaxQ 8.5 l/s

Network Design Table for Surface Water Network

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.023	85.511	0.339	252.2	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.023	50.00	14.07	13.707	1.752	0.0	0.0	47.4	0.99	69.7«	284.7

Following Hydrobrake - flow control MaxQ 8.5 l/s

Free Flowing Outfall Details for Surface Water Network

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.023	S	15.660	13.368	0.000	0	0

Simulation Criteria for Surface Water Network

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	20.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	Output Interval (mins)	1

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
Number of Online Controls 5 Number of Storage Structures 5 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	17.300	Cv (Summer)	0.750
Return Period (years)	100	Ratio R	0.280	Cv (Winter)	0.840
Region	Scotland and Ireland	Profile Type	Summer	Storm Duration (mins)	30

Online Controls for Surface Water Network

Hydro-Brake® Optimum Manhole: S21, DS/PN: S1.004, Volume (m³): 4.4

Unit Reference	MD-SHE-0053-2000-2733-2000	Sump Available	Yes
Design Head (m)	2.733	Diameter (mm)	53
Design Flow (l/s)	2.0	Invert Level (m)	16.842
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	75
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.733	2.0	Kick-Flo®	0.470	0.9
Flush-Flo™	0.226	1.1	Mean Flow over Head Range	-	1.4

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

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

Hydro-Brake® Optimum Manhole: S20, DS/PN: S1.005, Volume (m³): 5.9

Unit Reference	MD-SHE-0093-4700-1675-4700	Sump Available	Yes
Design Head (m)	1.675	Diameter (mm)	93
Design Flow (l/s)	4.7	Invert Level (m)	16.543
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.675	4.7	Kick-Flo®	0.829	3.4
Flush-Flo™	0.409	4.2	Mean Flow over Head Range	-	3.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	0.600	4.1	1.600	4.6	2.600	5.8	5.000	7.8	7.500	9.5
0.200	3.9	0.800	3.6	1.800	4.9	3.000	6.2	5.500	8.2	8.000	9.8
0.300	4.2	1.000	3.7	2.000	5.1	3.500	6.6	6.000	8.6	8.500	10.1
0.400	4.2	1.200	4.0	2.200	5.3	4.000	7.1	6.500	8.9	9.000	10.4
0.500	4.2	1.400	4.3	2.400	5.6	4.500	7.5	7.000	9.2	9.500	10.6

Hydro-Brake® Optimum Manhole: S16, DS/PN: S1.009, Volume (m³): 7.7

Unit Reference	MD-SHE-0093-4700-1670-4700	Flush-Flo™	Calculated
Design Head (m)	1.670	Objective	Minimise upstream storage
Design Flow (l/s)	4.7	Application	Surface

Hydro-Brake® Optimum Manhole: S16, DS/PN: S1.009, Volume (m³): 7.7

Sump Available Yes
Diameter (mm) 93
Invert Level (m) 16.077

Minimum Outlet Pipe Diameter (mm) 150
Suggested Manhole Diameter (mm) 1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.670	4.7	Kick-Flo®	0.825	3.4
Flush-Flo™	0.403	4.3	Mean Flow over Head Range	-	3.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	0.600	4.1	1.600	4.6	2.600	5.8	5.000	7.9	7.500	9.5
0.200	3.9	0.800	3.5	1.800	4.9	3.000	6.2	5.500	8.2	8.000	9.8
0.300	4.2	1.000	3.7	2.000	5.1	3.500	6.6	6.000	8.6	8.500	10.1
0.400	4.3	1.200	4.0	2.200	5.3	4.000	7.1	6.500	8.9	9.000	10.4
0.500	4.2	1.400	4.3	2.400	5.6	4.500	7.5	7.000	9.2	9.500	10.7

Hydro-Brake® Optimum Manhole: S12-5, DS/PN: S6.008, Volume (m³): 9.0

Unit Reference MD-SHE-0064-2600-2110-2600
Design Head (m) 2.110
Design Flow (l/s) 2.6
Flush-Flo™ Calculated
Objective Minimise upstream storage
Application Surface

Sump Available Yes
Diameter (mm) 64
Invert Level (m) 18.365
Minimum Outlet Pipe Diameter (mm) 100
Suggested Manhole Diameter (mm) 1200

Hydro-Brake® Optimum Manhole: S12-5, DS/PN: S6.008, Volume (m³): 9.0

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.110	2.6	Kick-Flo®	0.577	1.4
Flush-Flo™	0.283	1.8	Mean Flow over Head Range	-	1.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.5	0.600	1.5	1.600	2.3	2.600	2.9	5.000	3.9	7.500	4.7
0.200	1.7	0.800	1.7	1.800	2.4	3.000	3.1	5.500	4.0	8.000	4.8
0.300	1.8	1.000	1.8	2.000	2.5	3.500	3.3	6.000	4.2	8.500	5.0
0.400	1.7	1.200	2.0	2.200	2.6	4.000	3.5	6.500	4.4	9.000	5.1
0.500	1.6	1.400	2.1	2.400	2.8	4.500	3.7	7.000	4.5	9.500	5.2

Hydro-Brake® Optimum Manhole: S11, DS/PN: S1.014, Volume (m³): 6.1

Unit Reference	MD-SHE-0111-8500-2749-8500	Sump Available	Yes
Design Head (m)	2.749	Diameter (mm)	111
Design Flow (l/s)	8.5	Invert Level (m)	15.616
Flush-Flo™	Calculated	Minimum Outlet Pipe Diameter (mm)	150
Objective	Minimise upstream storage	Suggested Manhole Diameter (mm)	1200
Application	Surface		

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.749	8.5	Kick-Flo®	0.999	5.3
Flush-Flo™	0.486	6.7	Mean Flow over Head Range	-	6.6

Hydro-Brake® Optimum Manhole: S11, DS/PN: S1.014, Volume (m³): 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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.9	0.600	6.6	1.600	6.6	2.600	8.3	5.000	11.3	7.500	13.7
0.200	5.9	0.800	6.3	1.800	7.0	3.000	8.8	5.500	11.8	8.000	14.1
0.300	6.4	1.000	5.3	2.000	7.3	3.500	9.5	6.000	12.3	8.500	14.5
0.400	6.6	1.200	5.8	2.200	7.6	4.000	10.1	6.500	12.8	9.000	14.9
0.500	6.7	1.400	6.2	2.400	8.0	4.500	10.7	7.000	13.2	9.500	15.3

Summary of Results for 30 minute 100 year Summer (Surface Water Network)

Margin for Flood Risk Warning (mm) 300.0 DTS Status ON Inertia Status OFF
Analysis Timestep Fine DVD Status OFF

WARNING: Half Drain Time has not been calculated as the structure is too full.

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.000	S25	20.449	0.649	0.000	0.89			49.5	SURCHARGED
S1.001	S24	20.096	0.865	0.000	0.88			74.5	SURCHARGED
S1.002	S23	19.254	1.127	0.000	1.43			90.6	FLOOD RISK
S1.003	S22	17.378	0.147	0.000	1.67			95.6	SURCHARGED
S1.004	S21	17.209	0.067	0.000	0.00			0.6	SURCHARGED
S2.000	S20-1-1	17.316	0.308	0.000	1.35			82.9	SURCHARGED
S3.000	S20-2	17.258	0.125	0.000	0.57			25.2	SURCHARGED
S2.001	S20-1	17.210	0.237	0.000	1.99			107.8	SURCHARGED
S4.000	S9	17.152	0.172	0.000	1.31			81.6	SURCHARGED
S1.005	S20	17.150	0.232	0.000	0.03			4.2	SURCHARGED
S1.006	S19	16.501	-0.291	0.000	0.24			35.4	OK
S5.000	S18-1	17.013	-0.156	0.000	0.20			12.7	OK
S1.007	S18	16.424	-0.280	0.000	0.31			48.0	OK
S1.008	S17	16.372	-0.285	0.000	0.29			52.4	OK
S1.009	S16	16.300	-0.227	0.000	0.02			2.1	OK
S1.010	S15	16.234	-0.258	0.000	0.02			4.0	OK
S1.011	S14	16.233	-0.157	0.000	0.10			19.0	OK
S1.012	S13	16.232	0.025	0.000	0.14			17.2	SURCHARGED
S6.000	S12-13	19.662	-0.138	0.000	0.31			14.0	OK

Upstream of hydrobrake and within attenuation

Summary of Results for 30 minute 100 year Summer (Surface Water Network)

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S6.001	S12-12	19.556	-0.145	0.000	0.27			14.2	OK
S6.002	S12-11	19.401	-0.145	0.000	0.27			14.7	OK
S7.000	S12-10-1	19.846	-0.154	0.000	0.21			13.3	OK
S6.003	S12-10	19.232	-0.089	0.000	0.67			29.8	OK
S8.000	S23	19.722	-0.078	0.000	0.73			35.3	OK
S8.001	S12-9-1	19.483	-0.047	0.000	0.97			35.8	OK
S6.004	S12-9	19.120	0.076	0.000	1.08			75.0	SURCHARGED
S9.000	S12-8-1	19.547	-0.153	0.000	0.22			13.8	OK
S6.005	S12-8	18.998	0.067	0.000	0.99			101.3	SURCHARGED
S6.006	S12-7	18.922	0.072	0.000	1.19			111.3	SURCHARGED
S6.007	S12-6	18.899	0.104	0.000	1.28			118.9	SURCHARGED
S10.000	S12-5-5	20.526	-0.174	0.000	0.12			8.4	OK
S10.001	S12-5-4	20.073	-0.135	0.000	0.33			17.5	OK
S10.002	S12-5-3	19.836	-0.122	0.000	0.42			21.0	OK
S10.003	S12-5-2	19.598	-0.099	0.000	0.60			33.2	OK
S11.000	S12-5-1-1	19.603	-0.097	0.000	0.60			34.0	OK
S10.004	S12-5-1	18.896	0.000	0.000	0.55			69.0	SURCHARGED
S6.008	S12-5	18.897	0.157	0.000	0.02			1.8	SURCHARGED
S6.009	S12-4	18.409	-0.293	0.000	0.10			9.6	OK
S6.010	S12-3	18.346	-0.286	0.000	0.13			31.2	OK
S6.011	S12-2	17.430	-0.263	0.000	0.19			40.3	OK
S6.012	S12-1	17.144	-0.261	0.000	0.20			44.3	OK
S1.013	S12	16.231	0.061	0.000	0.33			59.5	SURCHARGED
S1.014	S11	16.229	0.313	0.000	0.13			6.7	SURCHARGED
S1.015	S10	15.650	-0.239	0.000	0.09			6.7	OK

upstream of hydrobrake

Attenuation

Summary of Results for 30 minute 100 year Summer (Surface Water Network)

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status
S1.016	S9	15.517	-0.237	0.000	0.10			6.7	OK
S1.017	S8	15.389	-0.235	0.000	0.11			6.7	OK
S1.018	S7	15.271	-0.234	0.000	0.11			6.7	OK
S1.019	S6	15.191	-0.235	0.000	0.11			6.7	OK
S1.020	S5	14.214	-0.236	0.000	0.10			6.7	OK
S1.021	S4	14.074	-0.236	0.000	0.10			6.7	OK
S1.022	S3	13.927	-0.236	0.000	0.10			6.7	OK
S1.023	S2	13.770	-0.237	0.000	0.10			6.7	OK

APPENDIX D – CORRESPONDANCE WITH IRISH WATER

Brendan Keogh - DBFL Consulting Engineers

From: Brendan Keogh - DBFL Consulting Engineers
Sent: Wednesday 17 June 2020 16:14
To: Brian O'Mahony
Subject: RE: 190226 - Sandford Road - PCE Request CDS19008588
Attachments: Irish Water Map - Sandford Ranelagh (BK 17 06 2020).pdf

Brian,

RE: PCE Request CDS19008588 (Ardstone Homes Lands at Sandford Road, Ranelagh).

Just following up on the e-mail trail below.

We have explored options to direct surface water flows from the proposed development to the existing surface water drainage infrastructure in Eglinton Road rather than the combined sewers adjacent to the site.

We now confirmed that surface water drainage flows will go to Eglinton Road and only foul drainage flows will be directed to the combined sewer in Milltown Road and Sandford Road (also refer to the attached marked up extract from the IW network plan).

As per the yellow highlight in the e-mail below, can you provide Irish Water's COF letter ?

Regards

From: Brian O'Mahony <bomahony@water.ie>
Sent: Wednesday 6 May 2020 16:50
To: Brendan Keogh - DBFL Consulting Engineers <Brendan.Keogh@dbfl.ie>
Subject: RE: 190226 - Sandford Road - PCE Request CDS19008588

Brendan,

As discussed, see comments below in relation to you sewer connection:

Based on the grades the customer has provided and contour map (below) it appears a connection to the storm water sewer to the north of the site is feasible. This will require some revision of internal storm sewers.
The connection of the developments ww flows to the combined sewer is feasible once the surface water flows are discharged to the storm sewer.
AP will only consider a connection of surface water flows to the storm sewer with supporting correspondence from the LA that a connection to the storm sewer will not be permitted.

Regards,

Brian O'Mahony (CEng MIEI)
Connections & Developer Services - Southern Region – Design Engineer

Uisce Éireann
Teach na hAbhann Móire, Páirc Ghnó Mhala, Mala, Contae Chorcaí, Éire
Irish Water
Blackwater House, Mallow Business Park, Mallow, County Cork, Ireland

P: +353 22 52205
E: bomahony@water.ie
www.water.ie

From: Brendan Keogh - DBFL Consulting Engineers [mailto:Brendan.Keogh@dbfl.ie]
Sent: 20 April 2020 11:02
To: Brian O'Mahony
Subject: FW: 190226 - Sandford Road - PCE Request CDS19008588

Brian,

Just following up on our discussion on Ardstone's site at Sandford Road, Ranelagh.

You mentioned that another department in IW was to look at DBFL's response to IW's queries.

Have you had any feedback that I could update the design team here with ?

Thanks

From: Brendan Keogh - DBFL Consulting Engineers <Brendan.Keogh@dbfl.ie>
Sent: Tuesday 14 April 2020 11:58
To: bomahony@water.ie
Subject: RE: 190226 - Sandford Road - PCE Request CDS19008588

Brian,

In response to your queries in the e-mail below, please see attached DBFL Technical Note, 190226-TN-002.

An assessment of existing/proposed surface water and foul drainage flows is included. In summary, the proposed development results in a significant reduction of flows when compared to the pre-development scenario (due to implementation of SUDS methodologies which are outlined in the technical note).

The feasibility of directing surface water flows to the existing surface water infrastructure at Milltown Road / Prospect Lane and Eglinton Road has also been assessed.

Can you please review and comment on the attached information ?

You can contact me if you need to discuss this further on 086 4056246.

Regards

From: Brian O'Mahony <bomahony@water.ie>
Sent: Monday 30 March 2020 15:44
To: Brendan Keogh - DBFL Consulting Engineers <Brendan.Keogh@dbfl.ie>
Subject: RE: 190226 - Sandford Road - PCE Request CDS19008588

Brendan,

Our asset planning team have just finished their review of this. They have requested further information in relation to the storm connection. As you can see from the screenshot below there are 2 storm sewers relatively close to the development. Have these options been explored with Dublin City Council?

In addition to this there is some concern over the capacity of the Combined sewers to take the foul flow load from the development, this would have to go through our modelling team and depend on onginng surveys in the area. All of this would take time. However if you were to connect to the storm sewer and divert any existing hardstanding to this storm sewer it would offset any impact from the foul connection. In this scenario, given the development will be delivering a net reduction in flows we could allow the connection without surveys and modelling.

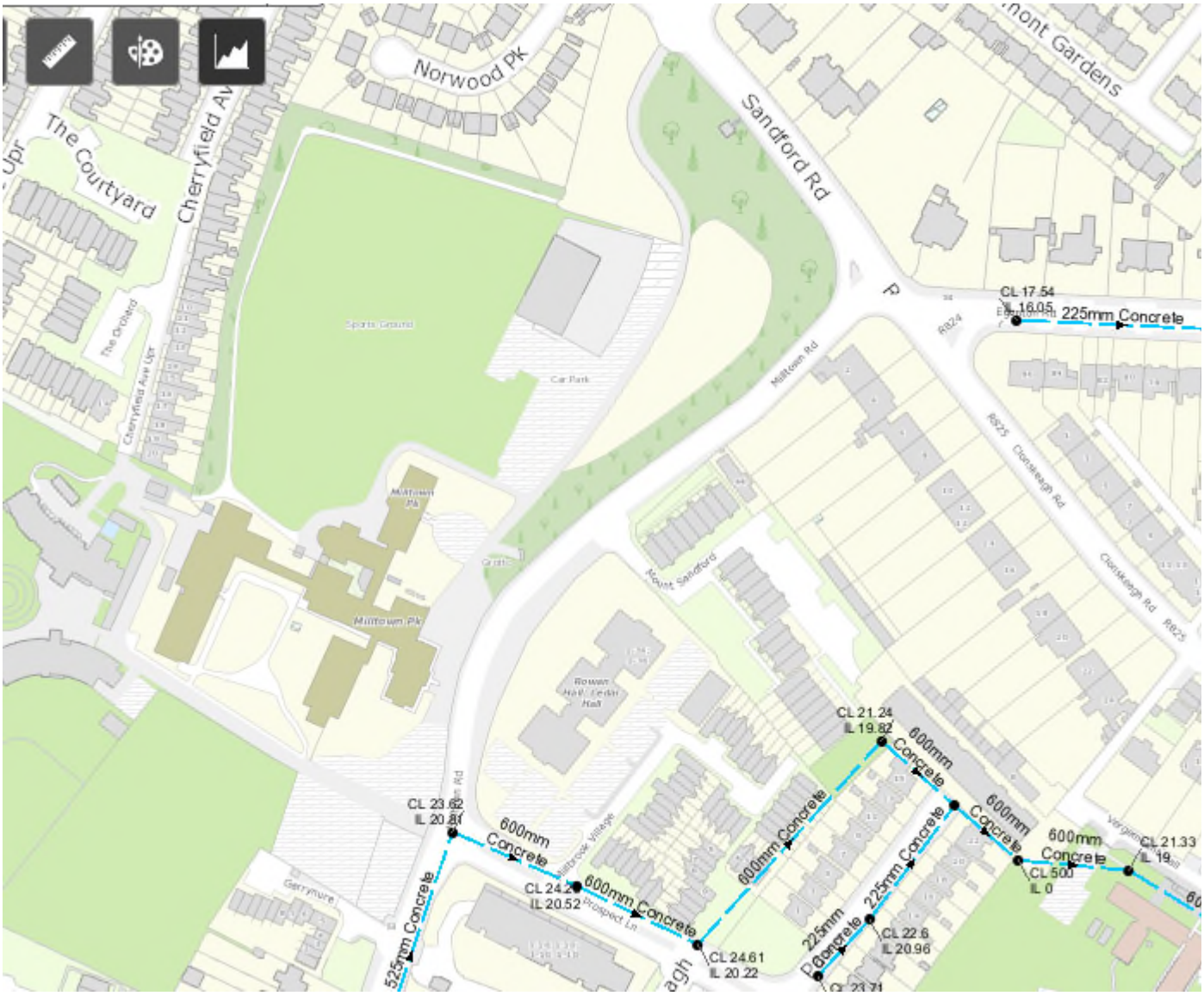
Please return with

- confirmation that you will not connect the storm drainage to the combined sewer
- a high level calculation as to the existing storm load flow from the site

Following this I can give you a confirmation of feasibility letter.

Regards,

Brian



Brian O'Mahony (CEng MIEI)
Connections & Developer Services - Southern Region – Design Engineer

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E: bomahony@water.ie
www.water.ie

From: Brendan Keogh - DBFL Consulting Engineers [mailto:Brendan.Keogh@dbfl.ie]
Sent: 30 March 2020 14:52
To: Brian O'Mahony
Subject: 190226 - Sandford Road - PCE Request CDS19008588

Brian,

I'm following up on Fionan's e-mail from last week.

Ardstone have a PCE request in for a site in Ranelagh (CDS19008588). It was submitted in December 2019.

The last update we received from IW was that this PCE is currently with the Asset Planning team.

Could you advise when this PCE letter might be issued ? We're about 2 weeks from requesting a pre-app meeting with ABP.

If needed you can contact me directly on 086 4056246.

Thanks

From: Fionan Ginty <fginty@water.ie>
Sent: Monday 23 March 2020 15:01
To: Brian O'Mahony <bomahony@water.ie>
Cc: Brendan Keogh - DBFL Consulting Engineers <Brendan.Keogh@dbfl.ie>
Subject: FW: 190226 - Sandford Road - PCE Request CDS19008588

Brian,

See below from DBFL in relation to CDS19008588.

Regards

Fionán

From: Brendan Keogh - DBFL Consulting Engineers [mailto:Brendan.Keogh@dbfl.ie]
Sent: 23 March 2020 14:44
To: Fionan Ginty
Subject: 190226 - Sandford Road - PCE Request CDS19008588

Fionan,

Thanks for your time on the phone this afternoon, as discussed, Ardstone have a PCE request in for a site in Ranelagh (CDS19008588). It was submitted in December 2019.

From our correspondence with newconnections@water.ie we understand this PCE is with asset planning.

As discussed, could you forward this e-mail to your colleague in asset planning that is handling this enquiry?

We're getting closer to requesting a pre-app meeting with ABP (2-3 weeks) and would like an update as to when the IW letter might get issued ? If needed asset planning can contact me directly on 086 4056246.

Thanks

Brendan Keogh
Associate Director Civils
+ 353 1 4004000

Steve Cassidy
Ardstone Residential Partners
48 Fitzwilliam Square
Dublin 2, Co. 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

18 June 2020

Dear Steve Cassidy,

Re: Connection Reference No CDS19008588 pre-connection enquiry - Subject to contract | Contract denied

Connection for Multi/Mixed Use Development of 750 unit(s) at Sandford Road, Ranelagh, Dublin.

Irish Water has reviewed your pre-connection enquiry in relation to a water connection at Sandford Road, Ranelagh, Dublin.

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

Strategic Housing Development:
Irish Water notes that the scale of this development dictates that it is subject to the Strategic Housing Development planning process. Therefore, in advance of submitting your full application to An Bord Pleanala for assessment, you must have reviewed this development with Irish Water and received a Statement of Design Acceptance in relation to the layout of water and wastewater services. Please submit your design to CDSDesignQA@water.ie.

All infrastructure should be designed and installed in accordance with the Irish Water Codes of Practice and Standard Details. A design proposal for the water and/or wastewater infrastructure should be submitted to Irish Water for assessment. Prior to submitting your planning application, you are required to submit these detailed design proposals to Irish Water for review.

You are advised that this correspondence does not constitute an offer in whole or in part to provide a connection to any Irish Water infrastructure and is provided subject to a connection agreement being signed at a later date.

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

If you have any further questions, please contact Brian O'Mahony from the design team on 022 52205 or email bomahony@water.ie. For further information, visit **www.water.ie/connections.**

Yours sincerely,

Maria O'Dwyer

Connections and Developer Services

Uisce Éireann
Bosca OP 6000
Baile Átha Cliath 1
Éire

Irish Water
PO Box 6000
Dublin 1
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F: +353 1 89 25001
www.water.ie

Your Ref: ABP-307977-20
Our Ref: CDS19008588

An Bord Pleanála,
64 Marlborough Street,
Dublin 1

4th September 2020

Dear Sir/ Madam,

Re: Strategic Housing Development – 714 no. residential units (583 no. Build to Rent apartment, 131 no. Build to Sell apartments) and associated site works.
Milltown Park, Sanford Road, Dublin 6.

Irish Water has received notification of Sandford Living Limited request to enter into consultations under Section 5 of the Planning and Development (Housing) and Residential Tenancies Act 2016 in respect of the above mentioned proposed development.

Irish Water has assessed and has issued a Confirmation of Feasibility for 750 residential units for connection(s) to the Irish Water network(s).

Please note in general, all development is to be carried out in compliance with Irish Waters Standards Codes and Practices. Where any proposals by the applicant to build over or divert existing water or wastewater services the applicant is required to submit details to Irish Water for assessment of feasibility ahead of any SHD application to the board.

Queries relating to the observations above should be sent to planning@water.ie

_____

Maria O'Dwyer
Connections and Developer Services Manager

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Cathrach Theas
Cathair Chorcaí

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

www.water.ie

Steve Cassidy
Ardstone Residential Partners
48 Fitzwilliam Square
Dublin 2, Co. Dublin

19 January 2021

Re: Design Submission for Sandford Road, Ranelagh, Dublin (the "Development") (the "Design Submission") / Connection Reference No: CDS19008588

Dear Steve Cassidy,

Many thanks for your recent Design Submission.

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

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

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

If you have any further questions, please contact your Irish Water representative:
Name: Alvaro Garcia
Email: agarcia@water.ie

Yours sincerely,

Yvonne Harris

Yvonne Harris
Head of Customer Operations

Appendix A

Document Title & Revision

190226-DBFL-CS-SP-DR-C-1001 Site Services Layout
190226-DBFL-CS-SP-DR-C-1001 Site Services
190226-DBFL-FW-SP-DR-C-3001 Foul Water Longsection Sheet 1
190226-DBFL-FW-SP-DR-C-3002 Foul Water Longsection Sheet 2
190226-DBFL-WM-SP-DR-C-1001 Site Watermain Layout

*For further information, visit **www.water.ie/connections***

Notwithstanding any matters listed above, the Customer (including any appointed designers/contractors, etc.) is entirely responsible for the design and construction of the Self-Lay Works. Acceptance of the Design Submission by Irish Water will not, in any way, render Irish Water liable for any elements of the design and/or construction of the Self-Lay Works.

APPENDIX E – FOUL DRAINAGE CALCULATIONS

FOUL SEWERAGE DESIGN

Design Criteria for Foul

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Domestic (l/s/ha)	0.00	Maximum Backdrop Height (m)	1.500
Industrial Peak Flow Factor	0.00	Domestic Peak Flow Factor	6.00	Min Design Depth for Optimisation (m)	1.200
Calculation Method	EN 752	Add Flow / Climate Change (%)	20	Min Vel for Auto Design only (m/s)	1.00
Frequency Factor	0.50	Minimum Backdrop Height (m)	0.200	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul

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
F1.000	14.021	0.174	80.6	0.000	54.0	0.0	1.500	o	225	Pipe/Conduit	
F1.001	45.021	0.752	59.9	0.000	117.0	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)
F1.000	19.575	0.000	0.0	54.0	0.7	45	0.78	1.28	50.9	4.4
F1.001	19.401	0.000	0.0	171.0	1.3	56	1.03	1.48	59.0	7.8

Network Design Table for Foul

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
F1.002	34.879	0.650	53.7	0.000	114.0	0.0	1.500	o	225	Pipe/Conduit	
F1.003	52.249	0.349	149.7	0.000	39.0	0.0	1.500	o	225	Pipe/Conduit	
F1.004	31.048	0.206	150.7	0.000	60.0	0.0	1.500	o	225	Pipe/Conduit	
F1.005	7.611	0.127	59.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F2.000	5.244	0.052	100.8	0.000	411.0	0.0	1.500	o	225	Pipe/Conduit	
F1.006	26.559	0.443	60.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F3.000	21.433	0.268	80.0	0.000	267.0	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)
F1.002	18.649	0.000	0.0	285.0	1.7	61	1.15	1.57	62.4	10.1
F1.003	18.000	0.000	0.0	324.0	1.8	83	0.81	0.94	37.3	10.8
F1.004	17.651	0.000	0.0	384.0	2.0	87	0.83	0.93	37.1	11.8
F1.005	17.445	0.000	0.0	384.0	2.0	68	1.16	1.48	59.0	11.8
F2.000	17.370	0.000	0.0	411.0	2.0	79	0.97	1.14	45.4	12.2
F1.006	17.318	0.000	0.0	795.0	2.8	82	1.28	1.48	59.0	16.9
F3.000	17.375	0.000	0.0	267.0	1.6	67	0.99	1.28	51.1	9.8

Network Design Table for Foul

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
F3.001	22.804	0.219	104.0	0.000	21.0	0.0	1.500	o	225	Pipe/Conduit	
F1.007	29.528	0.340	86.8	0.000	15.0	0.0	1.500	o	225	Pipe/Conduit	
F4.000	35.906	0.378	95.0	0.000	60.0	0.0	1.500	o	225	Pipe/Conduit	
F1.008	14.769	0.238	62.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F5.000	53.271	1.665	32.0	0.000	141.0	0.0	1.500	o	225	Pipe/Conduit	
F5.001	17.438	0.174	100.2	0.000	30.0	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)
F3.001	17.107	0.000	0.0	288.0	1.7	73	0.91	1.13	44.8	10.2
F1.007	16.875	0.000	0.0	1098.0	3.3	100	1.17	1.23	49.0	19.9
F4.000	17.207	0.000	0.0	60.0	0.8	48	0.75	1.18	46.8	4.6
F1.008	16.534	0.000	0.0	1158.0	3.4	92	1.33	1.46	58.0	20.4
F5.000	19.104	0.000	0.0	141.0	1.2	45	1.25	2.03	80.9	7.1
F5.001	17.439	0.000	0.0	171.0	1.3	63	0.86	1.15	45.6	7.8

Network Design Table for Foul

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
F5.002	17.803	0.178	100.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F5.003	10.346	0.071	146.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F5.004	49.372	0.291	169.8	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
F5.005	24.696	0.137	180.3	0.000	60.0	0.0	1.500	o	225	Pipe/Conduit	
F5.006	6.627	0.037	180.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F5.007	45.675	0.254	180.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F1.009	27.304	0.182	150.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F1.010	5.875	0.039	151.0	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)
F5.002	17.265	0.000	0.0	171.0	1.3	63	0.86	1.15	45.6	7.8
F5.003	17.087	0.000	0.0	171.0	1.3	70	0.75	0.95	37.7	7.8
F5.004	17.016	0.000	0.0	255.0	1.6	80	0.75	0.88	35.0	9.6
F5.005	16.725	0.000	0.0	315.0	1.8	87	0.76	0.85	33.9	10.6
F5.006	16.588	0.000	0.0	315.0	1.8	87	0.76	0.85	34.0	10.6
F5.007	16.551	0.000	0.0	315.0	1.8	87	0.76	0.85	34.0	10.6
F1.009	16.297	0.000	0.0	1473.0	3.8	128	0.99	0.94	37.2	23.0
F1.010	16.115	0.000	0.0	1473.0	3.8	128	0.98	0.93	37.1	23.0

Network Design Table for Foul

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
F6.000	25.575	0.400	63.9	0.000	24.0	0.0	1.500	o	225	Pipe/Conduit	
F6.001	7.584	0.092	82.4	0.000	20.0	0.0	1.500	o	225	Pipe/Conduit	
F6.002	8.025	0.096	83.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F6.003	18.170	0.216	84.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F7.000	40.493	0.425	95.2	0.000	69.0	0.0	1.500	o	225	Pipe/Conduit	
F6.004	26.821	0.215	125.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F8.000	25.953	0.270	96.1	0.000	69.0	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)
F6.000	20.454	0.000	0.0	24.0	0.5	35	0.75	1.44	57.1	2.9
F6.001	20.054	0.000	0.0	44.0	0.7	43	0.75	1.26	50.3	4.0
F6.002	19.962	0.000	0.0	44.0	0.7	43	0.75	1.26	49.9	4.0
F6.003	19.866	0.000	0.0	44.0	0.7	43	0.75	1.25	49.8	4.0
F7.000	20.075	0.000	0.0	69.0	0.8	50	0.77	1.18	46.8	5.0
F6.004	19.650	0.000	0.0	113.0	1.1	60	0.75	1.03	40.8	6.4
F8.000	19.775	0.000	0.0	69.0	0.8	50	0.76	1.17	46.6	5.0

Network Design Table for Foul

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
F8.001	8.467	0.070	121.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F6.005	11.751	0.079	149.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F6.006	11.472	0.072	159.0	0.000	36.0	0.0	1.500	o	225	Pipe/Conduit	
F9.000	36.078	0.488	74.0	0.000	24.0	0.0	1.500	o	225	Pipe/Conduit	
F6.007	22.858	0.134	170.9	0.000	12.0	0.0	1.500	o	225	Pipe/Conduit	
F6.008	16.081	0.088	182.7	0.000	48.0	0.0	1.500	o	225	Pipe/Conduit	
F6.009	22.129	0.120	185.0	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)
F8.001	19.505	0.000	0.0	69.0	0.8	53	0.70	1.04	41.5	5.0
F6.005	19.435	0.000	0.0	182.0	1.3	71	0.75	0.94	37.4	8.1
F6.006	19.356	0.000	0.0	218.0	1.5	76	0.75	0.91	36.2	8.9
F9.000	19.775	0.000	0.0	24.0	0.5	36	0.71	1.34	53.1	2.9
F6.007	19.284	0.000	0.0	254.0	1.6	80	0.75	0.88	34.9	9.6
F6.008	19.150	0.000	0.0	302.0	1.7	86	0.75	0.85	33.7	10.4
F6.009	19.062	0.000	0.0	302.0	1.7	86	0.74	0.84	33.5	10.4

Network Design Table for Foul

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
F10.000	19.952	0.306	65.2	0.000	24.0	0.0	1.500	o	225	Pipe/Conduit	
F10.001	18.563	0.232	80.0	0.000	39.0	0.0	1.500	o	225	Pipe/Conduit	
F10.002	29.015	0.290	100.1	0.000	42.0	0.0	1.500	o	225	Pipe/Conduit	
F10.003	50.942	0.553	92.1	0.000	69.0	0.0	1.500	o	225	Pipe/Conduit	
F11.000	33.762	0.482	70.0	0.000	90.0	0.0	1.500	o	225	Pipe/Conduit	
F10.004	24.542	0.223	110.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F10.005	9.577	0.128	74.8	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)
F10.000	20.675	0.000	0.0	24.0	0.5	35	0.75	1.42	56.6	2.9
F10.001	20.368	0.000	0.0	63.0	0.8	46	0.80	1.28	51.0	4.8
F10.002	20.136	0.000	0.0	105.0	1.0	56	0.80	1.15	45.6	6.1
F10.003	19.846	0.000	0.0	174.0	1.3	62	0.89	1.20	47.6	7.9
F11.000	19.775	0.000	0.0	90.0	0.9	49	0.89	1.37	54.6	5.7
F10.004	19.293	0.000	0.0	264.0	1.6	72	0.88	1.09	43.5	9.7
F10.005	19.070	0.000	0.0	264.0	1.6	66	1.01	1.33	52.8	9.7

Network Design Table for Foul

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
F6.010	17.210	0.075	229.5	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F6.011	8.324	0.036	231.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
F6.012	6.019	0.026	230.0	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)
F6.010	18.942	0.000	0.0	566.0	2.4	109	0.75	0.76	30.1	14.3
F6.011	18.867	0.000	0.0	566.0	2.4	109	0.74	0.75	29.9	14.3
F6.012	18.831	0.000	0.0	566.0	2.4	109	0.75	0.76	30.0	14.3

Manhole Schedules for Foul

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
FA-11	20.978	1.403	Open Manhole	1200	F1.000	19.575	225				
FA-10	20.935	1.534	Open Manhole	1200	F1.001	19.401	225	F1.000	19.401	225	
FA-9	20.754	2.105	Open Manhole	1200	F1.002	18.649	225	F1.001	18.649	225	
FA-8	19.408	1.408	Open Manhole	1200	F1.003	18.000	225	F1.002	18.000	225	
FA-7	19.086	1.435	Open Manhole	1200	F1.004	17.651	225	F1.003	17.651	225	
FA-6	19.018	1.573	Open Manhole	1200	F1.005	17.445	225	F1.004	17.445	225	
FA-5-1	18.900	1.530	Open Manhole	1200	F2.000	17.370	225				
FA-5	18.871	1.553	Open Manhole	1200	F1.006	17.318	225	F1.005	17.318	225	
								F2.000	17.318	225	
FA-4-2	18.740	1.365	Open Manhole	1200	F3.000	17.375	225				
FA-4-1	18.787	1.680	Open Manhole	1200	F3.001	17.107	225	F3.000	17.107	225	
FA-4	18.793	1.918	Open Manhole	1200	F1.007	16.875	225	F1.006	16.875	225	
								F3.001	16.888	225	13
FA-3-1	18.524	1.317	Open Manhole	1200	F4.000	17.207	225				
FA-3	18.502	1.968	Open Manhole	1200	F1.008	16.534	225	F1.007	16.534	225	
								F4.000	16.829	225	295
FA-2-8	20.618	1.514	Open Manhole	1200	F5.000	19.104	225				
FA-2-7	18.954	1.515	Open Manhole	1200	F5.001	17.439	225	F5.000	17.439	225	
FA-2-6	18.937	1.672	Open Manhole	1200	F5.002	17.265	225	F5.001	17.265	225	

Manhole Schedules for Foul

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
FA-2-5	18.665	1.578	Open Manhole	1200	F5.003	17.087	225	F5.002	17.087	225	
FA-2-4	18.601	1.585	Open Manhole	1200	F5.004	17.016	225	F5.003	17.016	225	
FA-2-3	18.036	1.311	Open Manhole	1200	F5.005	16.725	225	F5.004	16.725	225	
FA-2-2	17.942	1.354	Open Manhole	1200	F5.006	16.588	225	F5.005	16.588	225	
FA-2-1	18.145	1.594	Open Manhole	1200	F5.007	16.551	225	F5.006	16.552	225	1
FA-2	18.378	2.081	Open Manhole	1200	F1.009	16.297	225	F1.008	16.297	225	
								F5.007	16.297	225	1
FA-1	18.049	1.934	Open Manhole	1200	F1.010	16.115	225	F1.009	16.115	225	
F	0.000		Open Manhole	0		OUTFALL		F1.010	16.076	225	
FB-13	21.912	1.458	Open Manhole	1200	F6.000	20.454	225				
FB-12	20.902	0.848	Open Manhole	1200	F6.001	20.054	225	F6.000	20.054	225	
FB-11	20.923	0.961	Open Manhole	1200	F6.002	19.962	225	F6.001	19.962	225	
FB-10	21.278	1.412	Open Manhole	1200	F6.003	19.866	225	F6.002	19.866	225	
FB-9-1	21.272	1.197	Open Manhole	1200	F7.000	20.075	225				
FB-9	21.075	1.425	Open Manhole	1200	F6.004	19.650	225	F6.003	19.650	225	
								F7.000	19.650	225	
FB-8-2	20.953	1.178	Open Manhole	1200	F8.000	19.775	225				
FB-8-1	20.705	1.200	Open Manhole	1200	F8.001	19.505	225	F8.000	19.505	225	

Manhole Schedules for Foul

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
FB-8	20.665	1.230	Open Manhole	1200	F6.005	19.435	225	F6.004	19.435	225	
								F8.001	19.435	225	
FB-7	20.671	1.315	Open Manhole	1200	F6.006	19.356	225	F6.005	19.356	225	
FB-6-1	20.900	1.125	Open Manhole	1200	F9.000	19.775	225				
FB-6	20.665	1.381	Open Manhole	1200	F6.007	19.284	225	F6.006	19.284	225	
								F9.000	19.287	225	4
FB-5	20.859	1.709	Open Manhole	1200	F6.008	19.150	225	F6.007	19.150	225	
FB-4	21.059	1.997	Open Manhole	1200	F6.009	19.062	225	F6.008	19.062	225	
FB-3-6	22.181	1.506	Open Manhole	1200	F10.000	20.675	225				
FB-3-5	21.893	1.525	Open Manhole	1200	F10.001	20.368	225	F10.000	20.369	225	1
F40	22.398	2.262	Open Manhole	1200	F10.002	20.136	225	F10.001	20.136	225	
FB-3-3	22.663	2.817	Open Manhole	1200	F10.003	19.846	225	F10.002	19.846	225	
FB-3-2-1	21.015	1.240	Open Manhole	1200	F11.000	19.775	225				
FB-3-2	21.800	2.507	Open Manhole	1200	F10.004	19.293	225	F10.003	19.293	225	
								F11.000	19.293	225	
FB-3-1	21.274	2.204	Open Manhole	1200	F10.005	19.070	225	F10.004	19.070	225	
FB-3	20.991	2.049	Open Manhole	1200	F6.010	18.942	225	F6.009	18.942	225	
								F10.005	18.942	225	
FB-2	21.025	2.158	Open Manhole	1200	F6.011	18.867	225	F6.010	18.867	225	

Manhole Schedules for Foul

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	Pipe Out PN	Pipe Out Invert Level (m)	Pipe Out Diameter (mm)	Pipes In PN	Pipes In Invert Level (m)	Pipes In Diameter (mm)	Backdrop (mm)
FB-1	20.173	1.342	Open Manhole	1200	F6.012	18.831	225	F6.011	18.831	225	
F	0.000		Open Manhole	0		OUTFALL		F6.012	18.805	225	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FA-11	716873.438	731210.053	716873.438	731210.053	Required	
FA-10	716878.604	731223.087	716878.604	731223.087	Required	
FA-9	716889.041	731266.882	716889.041	731266.882	Required	
FA-8	716901.560	731299.436	716901.560	731299.436	Required	
FA-7	716950.127	731280.169	716950.127	731280.169	Required	

Manhole Schedules for Foul

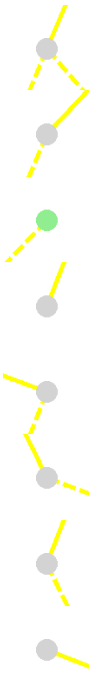
MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FA-6	716978.963	731268.659	716978.963	731268.659	Required	
FA-5-1	716983.043	731264.350	716983.043	731264.350	Required	
FA-5	716986.562	731268.238	716986.562	731268.238	Required	
FA-4-2	717002.631	731257.044	717002.631	731257.044	Required	
FA-4-1	717018.287	731271.681	717018.287	731271.681	Required	
FA-4	717003.294	731288.864	717003.294	731288.864	Required	
FA-3-1	717035.643	731290.252	717035.643	731290.252	Required	
FA-3	717011.834	731317.129	717011.834	731317.129	Required	

Manhole Schedules for Foul

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FA-2-8	716984.484	731166.621	716984.484	731166.621	Required	
FA-2-7	717002.892	731216.610	717002.892	731216.610	Required	
FA-2-6	717018.850	731223.640	717018.850	731223.640	Required	
FA-2-5	717031.265	731236.401	717031.265	731236.401	Required	
FA-2-4	717032.317	731246.693	717032.317	731246.693	Required	
FA-2-3	717069.884	731278.730	717069.884	731278.730	Required	
FA-2-2	717053.949	731297.597	717053.949	731297.597	Required	
FA-2-1	717047.456	731296.270	717047.456	731296.270	Required	

Manhole Schedules for Foul

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FA-2	717017.514	731330.763	717017.514	731330.763	Required	
FA-1	717028.234	731355.875	717028.234	731355.875	Required	
F	717032.266	731360.148			No Entry	
FB-13	716886.436	731111.011	716886.436	731111.011	Required	
FB-12	716895.817	731134.803	716895.817	731134.803	Required	
FB-11	716888.709	731137.448	716888.709	731137.448	Required	
FB-10	716885.193	731144.661	716885.193	731144.661	Required	
FB-9-1	716854.034	731176.312	716854.034	731176.312	Required	



Manhole Schedules for Foul

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FB-9	716891.761	731161.602	716891.761	731161.602	Required	
FB-8-2	716871.440	731202.531	716871.440	731202.531	Required	
FB-8-1	716895.305	731192.333	716895.305	731192.333	Required	
FB-8	716901.521	731186.584	716901.521	731186.584	Required	
FB-7	716912.524	731182.456	716912.524	731182.456	Required	
FB-6-1	716910.199	731150.288	716910.199	731150.288	Required	
FB-6	716923.934	731183.650	716923.934	731183.650	Required	
FB-5	716945.025	731174.838	716945.025	731174.838	Required	

Manhole Schedules for Foul

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FB-4	716948.683	731159.179	716948.683	731159.179	Required	
FB-3-6	716893.117	731104.165	716893.117	731104.165	Required	
FB-3-5	716911.640	731096.750	716911.640	731096.750	Required	
F40	716904.949	731079.435	716904.949	731079.435	Required	
FB-3-3	716932.017	731068.988	716932.017	731068.988	Required	
FB-3-2-1	716917.549	731129.900	716917.549	731129.900	Required	
FB-3-2	716948.786	731117.090	716948.786	731117.090	Required	
FB-3-1	716958.253	731139.733	716958.253	731139.733	Required	

Manhole Schedules for Foul

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
FB-3	716965.985	731145.384	716965.985	731145.384	Required	
FB-2	716979.313	731134.495	716979.313	731134.495	Required	
FB-1	716985.231	731140.348	716985.231	731140.348	Required	
F	716991.183	731139.444			No Entry	

PIPELINE SCHEDULES for Foul

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.000	o	225	FA-11	20.978	19.575	1.178	Open Manhole	1200
F1.001	o	225	FA-10	20.935	19.401	1.309	Open Manhole	1200
F1.002	o	225	FA-9	20.754	18.649	1.880	Open Manhole	1200
F1.003	o	225	FA-8	19.408	18.000	1.183	Open Manhole	1200
F1.004	o	225	FA-7	19.086	17.651	1.210	Open Manhole	1200
F1.005	o	225	FA-6	19.018	17.445	1.348	Open Manhole	1200
F2.000	o	225	FA-5-1	18.900	17.370	1.305	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.000	14.021	80.6	FA-10	20.935	19.401	1.309	Open Manhole	1200
F1.001	45.021	59.9	FA-9	20.754	18.649	1.880	Open Manhole	1200
F1.002	34.879	53.7	FA-8	19.408	18.000	1.183	Open Manhole	1200
F1.003	52.249	149.7	FA-7	19.086	17.651	1.210	Open Manhole	1200
F1.004	31.048	150.7	FA-6	19.018	17.445	1.348	Open Manhole	1200
F1.005	7.611	59.9	FA-5	18.871	17.318	1.328	Open Manhole	1200
F2.000	5.244	100.8	FA-5	18.871	17.318	1.328	Open Manhole	1200

PIPELINE SCHEDULES for Foul

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.006	o	225	FA-5	18.871	17.318	1.328	Open Manhole	1200
F3.000	o	225	FA-4-2	18.740	17.375	1.140	Open Manhole	1200
F3.001	o	225	FA-4-1	18.787	17.107	1.455	Open Manhole	1200
F1.007	o	225	FA-4	18.793	16.875	1.693	Open Manhole	1200
F4.000	o	225	FA-3-1	18.524	17.207	1.092	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.006	26.559	60.0	FA-4	18.793	16.875	1.693	Open Manhole	1200
F3.000	21.433	80.0	FA-4-1	18.787	17.107	1.455	Open Manhole	1200
F3.001	22.804	104.0	FA-4	18.793	16.888	1.680	Open Manhole	1200
F1.007	29.528	86.8	FA-3	18.502	16.534	1.743	Open Manhole	1200
F4.000	35.906	95.0	FA-3	18.502	16.829	1.448	Open Manhole	1200

PIPELINE SCHEDULES for Foul

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.008	o	225	FA-3	18.502	16.534	1.743	Open Manhole	1200
F5.000	o	225	FA-2-8	20.618	19.104	1.289	Open Manhole	1200
F5.001	o	225	FA-2-7	18.954	17.439	1.290	Open Manhole	1200
F5.002	o	225	FA-2-6	18.937	17.265	1.447	Open Manhole	1200
F5.003	o	225	FA-2-5	18.665	17.087	1.353	Open Manhole	1200
F5.004	o	225	FA-2-4	18.601	17.016	1.360	Open Manhole	1200
F5.005	o	225	FA-2-3	18.036	16.725	1.086	Open Manhole	1200
F5.006	o	225	FA-2-2	17.942	16.588	1.129	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F1.008	14.769	62.1	FA-2	18.378	16.297	1.856	Open Manhole	1200
F5.000	53.271	32.0	FA-2-7	18.954	17.439	1.290	Open Manhole	1200
F5.001	17.438	100.2	FA-2-6	18.937	17.265	1.447	Open Manhole	1200
F5.002	17.803	100.0	FA-2-5	18.665	17.087	1.353	Open Manhole	1200
F5.003	10.346	146.0	FA-2-4	18.601	17.016	1.360	Open Manhole	1200
F5.004	49.372	169.8	FA-2-3	18.036	16.725	1.086	Open Manhole	1200
F5.005	24.696	180.3	FA-2-2	17.942	16.588	1.129	Open Manhole	1200
F5.006	6.627	180.0	FA-2-1	18.145	16.552	1.368	Open Manhole	1200

PIPELINE SCHEDULES for Foul

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F5.007	o	225	FA-2-1	18.145	16.551	1.369	Open Manhole	1200
F1.009	o	225	FA-2	18.378	16.297	1.856	Open Manhole	1200
F1.010	o	225	FA-1	18.049	16.115	1.709	Open Manhole	1200
F6.000	o	225	FB-13	21.912	20.454	1.233	Open Manhole	1200
F6.001	o	225	FB-12	20.902	20.054	0.623	Open Manhole	1200
F6.002	o	225	FB-11	20.923	19.962	0.736	Open Manhole	1200
F6.003	o	225	FB-10	21.278	19.866	1.187	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F5.007	45.675	180.0	FA-2	18.378	16.297	1.856	Open Manhole	1200
F1.009	27.304	150.0	FA-1	18.049	16.115	1.709	Open Manhole	1200
F1.010	5.875	151.0	F	0.000	16.076		Open Manhole	0
F6.000	25.575	63.9	FB-12	20.902	20.054	0.623	Open Manhole	1200
F6.001	7.584	82.4	FB-11	20.923	19.962	0.736	Open Manhole	1200
F6.002	8.025	83.6	FB-10	21.278	19.866	1.187	Open Manhole	1200
F6.003	18.170	84.0	FB-9	21.075	19.650	1.200	Open Manhole	1200

PIPELINE SCHEDULES for Foul

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F7.000	o	225	FB-9-1	21.272	20.075	0.972	Open Manhole	1200
F6.004	o	225	FB-9	21.075	19.650	1.200	Open Manhole	1200
F8.000	o	225	FB-8-2	20.953	19.775	0.953	Open Manhole	1200
F8.001	o	225	FB-8-1	20.705	19.505	0.975	Open Manhole	1200
F6.005	o	225	FB-8	20.665	19.435	1.005	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F7.000	40.493	95.2	FB-9	21.075	19.650	1.200	Open Manhole	1200
F6.004	26.821	125.0	FB-8	20.665	19.435	1.005	Open Manhole	1200
F8.000	25.953	96.1	FB-8-1	20.705	19.505	0.975	Open Manhole	1200
F8.001	8.467	121.0	FB-8	20.665	19.435	1.005	Open Manhole	1200
F6.005	11.751	149.0	FB-7	20.671	19.356	1.090	Open Manhole	1200

PIPELINE SCHEDULES for Foul

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F6.006	o	225	FB-7	20.671	19.356	1.090	Open Manhole	1200
F9.000	o	225	FB-6-1	20.900	19.775	0.900	Open Manhole	1200
F6.007	o	225	FB-6	20.665	19.284	1.156	Open Manhole	1200
F6.008	o	225	FB-5	20.859	19.150	1.484	Open Manhole	1200
F6.009	o	225	FB-4	21.059	19.062	1.772	Open Manhole	1200
F10.000	o	225	FB-3-6	22.181	20.675	1.281	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F6.006	11.472	159.0	FB-6	20.665	19.284	1.156	Open Manhole	1200
F9.000	36.078	74.0	FB-6	20.665	19.287	1.153	Open Manhole	1200
F6.007	22.858	170.9	FB-5	20.859	19.150	1.484	Open Manhole	1200
F6.008	16.081	182.7	FB-4	21.059	19.062	1.772	Open Manhole	1200
F6.009	22.129	185.0	FB-3	20.991	18.942	1.824	Open Manhole	1200
F10.000	19.952	65.2	FB-3-5	21.893	20.369	1.299	Open Manhole	1200

PIPELINE SCHEDULES for Foul

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F10.001	o	225	FB-3-5	21.893	20.368	1.300	Open Manhole	1200
F10.002	o	225	F40	22.398	20.136	2.037	Open Manhole	1200
F10.003	o	225	FB-3-3	22.663	19.846	2.592	Open Manhole	1200
F11.000	o	225	FB-3-2-1	21.015	19.775	1.015	Open Manhole	1200
F10.004	o	225	FB-3-2	21.800	19.293	2.282	Open Manhole	1200
F10.005	o	225	FB-3-1	21.274	19.070	1.979	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F10.001	18.563	80.0	F40	22.398	20.136	2.037	Open Manhole	1200
F10.002	29.015	100.1	FB-3-3	22.663	19.846	2.592	Open Manhole	1200
F10.003	50.942	92.1	FB-3-2	21.800	19.293	2.282	Open Manhole	1200
F11.000	33.762	70.0	FB-3-2	21.800	19.293	2.282	Open Manhole	1200
F10.004	24.542	110.1	FB-3-1	21.274	19.070	1.979	Open Manhole	1200
F10.005	9.577	74.8	FB-3	20.991	18.942	1.824	Open Manhole	1200

PIPELINE SCHEDULES for Foul

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F6.010	o	225	FB-3	20.991	18.942	1.824	Open Manhole	1200
F6.011	o	225	FB-2	21.025	18.867	1.933	Open Manhole	1200
F6.012	o	225	FB-1	20.173	18.831	1.117	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
F6.010	17.210	229.5	FB-2	21.025	18.867	1.933	Open Manhole	1200
F6.011	8.324	231.2	FB-1	20.173	18.831	1.117	Open Manhole	1200
F6.012	6.019	230.0	F	0.000	18.805		Open Manhole	0

Free Flowing Outfall Details for Foul

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
F1.010	F	0.000	16.076	0.000	0	0

Free Flowing Outfall Details for Foul

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
F6.012	F	0.000	18.805	0.000	0	0

Simulation Criteria for Foul

Volumetric Runoff Coeff	0.750	Manhole Headloss Coeff (Global)	0.500	Inlet Coeffiecient	0.800
Areal Reduction Factor	1.000	Foul Sewage per hectare (l/s)	0.000	Flow per Person per Day (l/per/day)	0.000
Hot Start (mins)	0	Additional Flow - % of Total Flow	20.000	Run Time (mins)	60
Hot Start Level (mm)	0	MADD Factor * 10m³/ha Storage	2.000	Output Interval (mins)	1

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

Synthetic Rainfall Details

Rainfall Model	FSR	M5-60 (mm)	17.300	Cv (Summer)	0.750
Return Period (years)	5	Ratio R	0.280	Cv (Winter)	0.840
Region	Scotland and Ireland	Profile Type	Summer	Storm Duration (mins)	30

APPENDIX F – EXTRACTS FROM SITE INVESTIGATION REPORT

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Ground Investigations Ireland

Sandford Park Milltown

DBFL

Ground Investigation Report

October 2020

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Ground Investigations Ireland Ltd. present the results of the fieldworks and laboratory testing in accordance with the specification and related documents provided by or on behalf of the client The possibility of variation in the ground and/or groundwater conditions between or below exploratory locations or due to the investigation techniques employed must be taken into account when this report and the appendices inform designs or decisions where such variation may be considered relevant. Ground and/or groundwater conditions may vary due to seasonal, man-made or other activities not apparent during the fieldworks and no responsibility can be taken for such variation. The data presented and the recommendations included in this report and associated appendices are intended for the use of the client and the client's geotechnical representative only and any duty of care to others is excluded unless approved in writing.

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APPENDICES

1.0 Preamble

On the instructions of DBFL Consulting Engineers, a site investigation was carried out by Ground Investigations Ireland Ltd., between January and June 2020 at the site of the proposed residential development in Milltown Park in Milltown, Dublin 6, Co. Dublin. A second phase of investigation was undertaken in October 2020.

2.0 Overview

2.1. Background

It is proposed to construct a new residential development including apartments and town houses with associated services, access roads and car parking at the site. The site is currently the grounds of Millfield Park and is partly greenfield with a portion on the eastern side of the site occupied by a car park and existing access road. The proposed construction is envisaged to consist of conventional or piles foundations and pavement make up with some local excavations for services and plant. A basement is proposed as part of the proposed scheme beneath the apartments at the centre of the site which will require excavation of approximately 4m BGL.

2.2. Purpose and Scope

The purpose of the site investigation was to investigate subsurface conditions utilising a variety of investigative methods in accordance with the project specification. The scope of the work undertaken, including both phases of this investigation for this project included the following:

- Visit project site to observe existing conditions
- Carry out 11 No. Trial / Foundation Inspection Pits to determine existing foundation details
- Carry out 3 No. Soakaways to determine a soil infiltration value to BRE digest 365
- Carry out 14 No. Window Sample Boreholes to recover soil samples
- Carry out 13 No. Dynamic Probes to determine soil strength/density characteristics
- Carry out 16 No. Cable Percussion boreholes to a maximum depth of 8m BGL
- Carry out 5 No. Rotary Core follow on boreholes to a maximum depth of 20m BGL
- Carry out 9 No. Plate Load tests to determine CBR Value
- Carry out 1 No TRL probe to determine CBR Value
- Installation of 7 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing
- Report with recommendations

3.0 Subsurface Exploration

3.1. General

During the ground investigation a programme of intrusive investigation specified by the Consulting Engineer was undertaken to determine the sub surface conditions at the proposed site. Regular sampling and in-situ testing was undertaken in the exploratory holes to facilitate the geotechnical descriptions and to enable laboratory testing to be carried out on the soil samples recovered during excavation and drilling.
The procedures used in this site investigation are in accordance with Eurocode 7 Part 2: Ground Investigation and testing (ISEN 1997 – 2:2007) and B.S. 5930:2015.

3.2. Trial Pits / Foundation Pits

The trial pits were excavated using a JCB 3CX or 3T excavator at the locations shown in the exploratory hole location plan in Appendix 1. The locations were checked using a CAT scan to minimise the potential for encountering services during the excavation. The trial pits were sampled, logged and photographed by a Geotechnical Engineer/Engineering Geologist prior to backfilling with arisings. Notes were made of any services, inclusions, pit stability, groundwater encountered and the characteristics of the strata encountered and the exposed foundations were logged and sketched prior to backfilling and reinstatement. The logs and sketches are provided in Appendix 2 of this Report.

3.3. Soakaway Testing

The soakaway testing was carried out in selected trial pits at the locations shown in the exploratory hole location plan in Appendix 1. These pits were carefully excavated and filled with water to assess the infiltration characteristics of the proposed site. The pits were allowed to drain and the drop in water level was recorded over time as required by BRE Digest 365. The pits were logged prior to completing the soakaway test and were backfilled with arising's upon completion. The soakaway test results are provided in Appendix 3 of this Report.

3.4. Window Sampling

The window sampling was carried out at the locations shown in the location plan in Appendix 1 using a Tecopsa SPT Tec 10 percussion drilling rig. The window sampling consists of a 1m long steel tube with a cutting edge and an internal plastic liner which is mechanically driven into the ground utilising a 50kg weight falling a height of 500mm. Upon completion of the 1m sample, the tube is withdrawn and the plastic liner removed and sealed for logging and sub sampling by a Geotechnical Engineer/Engineering Geologist. The tube is replaced in the borehole and a subsequent 1m sample can be recovered. Occasionally outer casing or a reduced diameter tube is utilised to enable the window sample to progress in difficult drilling conditions. Geotechnical or environmental soil samples can be recovered from each of the liners following logging. The window sample records are provided in Appendix 6 of this Report.

3.5. Dynamic Probing

The dynamic probe tests (DPH) were carried out at the locations shown in the location plan in Appendix 1 in accordance with B.S. 1377: Part 9 1990. The test consists of mechanically driving a cone with a 50kg weight in 100mm intervals and monitoring the number of blows required. An equivalent Standard Penetration Test (SPT) 'N' value may be calculated by dividing the total number of blows over a 300mm drive length by 1.5. The dynamic probe logs are provided in Appendix 5 of this Report.

3.6. Cable Percussion Boreholes

The Cable Percussion Boreholes were drilled using a Dando 2000 drilling rig with regular in-situ testing and sampling undertaken to facilitate the production of geotechnical logs and laboratory testing.
The standard method of boring in soil for site investigation is known as the Cable Percussion method. It consists of using a Shell in non cohesive soils and a clay cutter in cohesive soils, both operated on a wire cable. Very hard soils, boulders and other hard obstructions are broken up by chiselling and the fragments removed with the Shell. Where ground conditions made it necessary, the borehole was lined with 200mm diameter steel casing. While the use of the Cable Percussion method of boring gives the maximum data on soil conditions, some mixing of laminated soil is inevitable. For this reason, thin lenses of granular material may not be noticed. Disturbed samples were taken from the boring tools at suitable depths, so that there is a representative sample at the top of each change in stratum and thereafter at regular intervals down the borehole until the next stratum was encountered. The disturbed samples were then sealed and sent to the laboratory where they were visually examined to confirm the description of the relevant strata.
Standard Penetration Tests were carried out in the boreholes. The results of these tests, together with the depths at which the tests were taken are shown on the accompanying borehole records. The test consists of a thick wall sampler tube, 50mm external diameter, being driven into the soil by a monkey weighing 63.5kg and with a free drop of 760mm. For gravels and glacial till the driving shoe was replaced by a solid 60º cone. The Standard Penetration Test number referred to as the 'N' value is the number of blows required to drive the tube 300mm, after an initial penetration of 150mm. The number gives a guide to the consistency of the soil and can also be used to estimate the relative strength/density at the depth of the test and also to estimate the bearing capacity and compressibility of the soil. The cable percussion borehole logs are provided in Appendix 7 of this Report.

3.7. Rotary Boreholes

The rotary coring was carried out by a track mounted T44 Beretta rig at the locations shown on the location plan in Appendix 1. The rotary boreholes were completed from the ground surface or alternatively, where noted on the individual borehole log, from the base of the cable percussion borehole where a temporary liner was installed to facilitate follow-on rotary coring.
The T44 Beretta is equipped with rubber tracks which allow for short travel on pavement surfaces avoiding any damage to the surface. The T44 Beretta utilises a triple tube core barrel system operated using a wireline drilling process. The outer barrel is rotated by the drill rods and at its lower end, carries the coring bit. The inner barrel is mounted on a swivel so that it does not rotate during the process. The third barrel or

liner is placed within the second one to retain the core intact and to preserve as much as possible the fabric of the drilling stratum. The core is cut by the coring bit and passes to the inner liner. The core is brought up to the surface within the inner barrel on a small diameter wire rope or line attached to the “overshoot” recovery tool which is then placed into a core box in order of recovery. A drilling fluid, typically air mist or water flush is passed from the surface through hollow drill rods to the drill bit and is used to cool the drill bit. Temporary casing is used in some situations to support unstable ground or to seal off fissures or voids. It should be noted that the rotary coring can only achieve limited recovery in overburden, particularly granular or weakly cemented strata due to the flushing medium washing away the cohesive fraction during coring. The recovery achieved, where required is noted on the borehole logs and core photographs are provided to allow assessment of the core recovered. The rotary borehole logs are provided in Appendix 7 of this Report.

3.8. Surveying

The exploratory hole locations have been recorded using a KQ GEO Technologies KQ-M8 System which records the coordinates and elevation of the locations to ITM or Irish National Grid as required by the project specification. The coordinates and elevations will be included on the exploratory hole logs in the appendices of the final Report. Where levels are not shown on the logs coordinates were taken from GIS.

3.9. Groundwater/Gas Monitoring Installations

Groundwater and or Gas Monitoring Installation were installed upon the completion of the boreholes to enable sampling and the determination of the equilibrium groundwater level. The typical groundwater monitoring installation consists of a 50mm HDPE slotted pipe with a pea gravel response zone and bentonite seal installed to the Engineers specification. Where required the standpipe is sealed with a gas tap and finished with a durable steel cover fixed in place with a concrete surround. The installation details are provided on the exploratory hole logs in the appendices of this Report.

3.10. Insitu Plate Bearing Test

The plate bearing tests were carried out using a 305mm or 450mm diameter plate at the locations shown on the site plan in Appendix 1. The plate was loaded in increments using a hydraulic jack and an excavator to provide a reaction and the displacement was monitored in accordance with BS1377 Part 9 using independently mounted digital strain gauges. The constrained modulus and equivalent CBR are calculated in accordance with HD29/75 and are provided on the test reports in Appendix 4 of this Report.

3.1. TRL Dynamic Cone Penetrometer

The TRL DCP tests were carried out at locations where plate load tests were not possible, to determine a CBR design value for the design of external pavements. The testing was carried out below the Topsoil or existing pavement at the depths detailed on the test report. The test consists of dropping a 10kg weight on

an anvil to drive a small diameter cone and recording the blows for a given penetration. The results of the DCP testing is included in Appendix 4 of this Report.

3.2. Laboratory Testing

Samples were selected from the exploratory holes for a range of geotechnical and environmental testing to assist in the classification of soils and to provide information for the proposed design.
Environmental & Chemical testing as required by the specification, including the Rilta Suite pH and sulphate testing was carried out by Element Materials Technology Laboratory in the UK. The Rilta suite testing includes both Solid Waste and Leachate Waste Acceptance Criteria.
Geotechnical testing consisting of moisture content, Atterberg limits, Particle Size Distribution (PSD), hydrometer tests were carried out in NMTL's Geotechnical Laboratory in Carlow.
The results of the laboratory testing are included in Appendix 8 of this Report.

4.0 Ground Conditions

4.1. General

The ground conditions encountered during the investigation are summarised below with reference to insitu and laboratory test results. The full details of the strata encountered during the ground investigation are provided in the exploratory hole logs included in the appendices of this report.

The sequence of strata encountered were consistent across the site and are generally comprised;

- Topsoil/Surfacing
- Made Ground
- Cohesive Deposits
- Granular Deposits (Rarely Encountered)
- Bedrock

TOPSOIL/SURFACING: Topsoil was encountered in the majority of the exploratory holes and was typically present to a depth of between 0.20 and 0.40m BGL with a maximum depth of 0.7m BGL encountered in TP05. Tarmac surfacing was present in WS04, WS12, BH05 and BH11 typically to a depth of between 0.08m and 0.10mBGL. Concrete was encountered in BH08 to a depth on 0.10m BGL.

MADE GROUND: Made Ground deposits were encountered beneath the Topsoil/Surfacing in some investigation locations and were present to a depth of between 0.5m and 1.0m BGL. These deposits were described generally as *brown slightly sandy slightly gravelly CLAY with occasional cobbles* or *grey sandy angular Gravel.* In some locations the made ground contained *occasional fragments of mortar, red brick, and charcoal.*

COHESIVE DEPOSITS: Cohesive deposits were encountered beneath the Topsoil or Made Ground and were described typically as *brown slightly sandy slightly gravelly CLAY with occasional cobbles* overlying a *stiff or very stiff dark grey /black slightly sandy slightly gravelly CLAY with occasional cobbles*. A brown *very stiff slightly sandy slightly gravelly CLAY* was also encountered in some boreholes below the dark grey/black clay. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the glacial till matrix. The strength of the cohesive deposits typically increased with depth and was very stiff below 2.2m BGL in the majority of the exploratory holes with some extending to 2.6m BGL before very stiff deposits were encountered.

GRANULAR DEPOSITS: Granular deposits were encountered in BH16 within the cohesive deposits and were typically described as G*rey brown slightly clayey sandy sub angular sub rounded fine to coarse GRAVEL with occasional cobbles.*
Based on the SPT N values the deposits are typically medium dense. A significant groundwater strike was noted in the borehole on encountering the granular deposits.

BEDROCK: The rotary core boreholes recovered weak to strong grey/dark grey fine to medium grained LIMESTONE w calcite veining. In some locations the beds of stiff brown clay were encountered which have been interpreted as residual weathered mudstone. This is typical of the Calp Formation, which is noted on the geological mapping to the east of the proposed site.
The depth to rock varies from 9.0m BGL in BH11 to a maximum of 18.45m BGL in BH03. In BH03 there was poor recovery and where cobbles of limestone where recovered that presumed to be rock. Generally rock was encountered at higher levels in the eastern area of the site. The total core recovery is good, typically 100% with some of the uppermost runs dropping to 80 or 90%. The SCR and RQD vary in the borehole across the site, with some core recovered as non-intact and some hole encountering clay bands within the limestone, however generally both indices show an increase with depth.

4.2. Insitu Strength Testing

The correlated DPH blow counts indicate that the overburden deposits are typically soft to depths of between 0.7 and 1.6m BGL and become firm to stiff and stiff to very stiff with depth. Generally stiff soils were encountered from between depths of 1.2 and 2.4m BGL at the dynamic probe locations.

4.3. Groundwater

Groundwater strikes are noted on the exploratory hole logs where they occurred and where possible drilling was suspended for twenty minutes to allow the subsequent rise in groundwater to be recorded. We would point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the tide, time of year, rainfall, nearby construction and other factors. For this reason, standpipes were installed in BH02, BH03, BH07, BH09, BH11 BH14 and BH16 to allow the equilibrium groundwater level to be determined. The groundwater monitoring will be included in Appendix 9 of the final Report.

4.4. Laboratory Testing

4.4.1. Geotechnical Laboratory Testing

The geotechnical testing carried out on soil samples recovered generally confirm the descriptions on the logs with the primary constituent of the cohesive deposits found to be a CLAY of low to intermediate plasticity. The Particle Size Distribution tests confirm that generally the cohesive deposits are well-graded with percentages of sands and gravels ranging between 20% and 30% generally with fines contents of 40% to 60%.

4.4.1. Chemical Laboratory Testing

The pH and sulphate testing carried out indicate that pH results are near neutral and that the water soluble sulphate results is low when compared to the guideline values from BRE Special Digest 1:2005. The samples tested classify the soil as a Design Sulphate Level DS-1.

4.4.1. Environmental Laboratory Testing

A number of samples were analysed for a suite of parameters which allows for the assessment of the sampled material in terms of total pollutant content for classification of materials as *hazardous* or *non-hazardous*. The suite also allows for the assessment of the sampled material in terms of suitability for placement at licenced landfills (inert, stable non-reactive, hazardous etc.). The parameter list for the suite includes analysis of the solid samples for arsenic, barium, cadmium, chromium, copper, cyanide, lead, nickel, mercury, zinc, speciated aliphatic and aromatic petroleum hydrocarbons, pH, sulphate, sulphide, moisture content, soil organic matter and an asbestos screen.

The suite also includes those parameters specified in the EU Council Decision establishing criteria for the acceptance of waste at Landfills (Council Decision 2003/33/EC), which for the solid samples are total organic carbon (TOC), speciated aliphatic and aromatic petroleum hydrocarbons, BTEX, phenol, polychlorinated biphenyls (PCB) and PAH.

As part of the suite a leachate is generated from the solid sample which is analysed for antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, chloride, fluoride, soluble sulphate, sulphide, phenols, dissolved organic carbon (DOC) and total dissolved solids (TDS).

While the laboratory report provides a comparison with the waste acceptance criteria limits it does not provide a waste classification of the material sampled nor does it comment on any potentially hazardous properties of the materials tested. The possibility for contamination, not revealed by the testing undertaken should be borne in mind particularly where Made Ground deposits are present or the previous site use or location indicate a risk of environmental variation. The waste classification report is included under the cover of a sperate report by Ground Investigations Ireland.

5.0 Recommendations & Conclusions

5.1. General

The recommendations given and opinions expressed in this report are based on the findings as detailed in the exploratory hole records. Where an opinion is expressed on the material between exploratory hole locations, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for conditions which have not been revealed by the exploratory holes. Limited information has been provided at the ground investigation stage and any designs based on the recommendations or conclusions should be completed in accordance with the current design codes, taking into account the variation and the specific details contained within the exploratory hole logs.

5.2. Foundations

An allowable bearing capacity of 200 kN/m^2 is recommended for conventional strip or pad foundations on the stiff or very stiff dark grey/back cohesive deposits encountered at a depth of between 2.0m and 2.6m BGL on the northern part of the site.

On the western part of the site where the 3 storey structures are proposed in the locations of DP03 to DP06 and DP10 to DP12 a bearing capacity 100 kN/m^2 is achievable at depths of between 1.2m and 1.5m BGL.

For the area of the proposed basement a bearing capacity of 350 kN/m^2 would be achievable at 4 m below ground level in the very stiff dark grey Clay, however a settlement assessment should be carried out to ensure the structure can deal with the potential settlement, total and differential due to this increased loading.

In the area to the west on the existing building in the location of BH13, BH16, DP01 and DP02 where a 5 story building is proposed an allowable bearing capacity of 200 kN/m^2 is achievable between depths of 2.0 and 2.6mBGL for conventional strip or pad foundations on the stiff or very stiff dark grey/back cohesive deposits or medium dense granular deposits. It should be noted that the strata varied between holes in this area so foundation inspections should be undertaken and it is recommended that the foundations from the structure be placed on the same strata to avoid differential settlement.

For the area to the south of the existing building near to the location of BH13, BH14 and BH15 where a 7 story building is proposed, a bearing capacity of 200 kN/m^2 would be achievable at depths of between 2.4m to 2.7m BGL and below ground level in the very stiff dark grey Clay. A bearing capacity of 125 kN/m^2 is achievable on the firm to stiff brown clay at a depth of 2.0m BGL.

The possibility for variation in the depth of the made ground of soft ground in the vicinity of these foundations should be considered and foundation inspections should be carried out. Any soft spots encountered at the proposed foundation depths should be excavated and replaced with lean mix concrete.

A ground bearing floor slab is recommended to be based on the firm to stiff cohesive deposits with an appropriate depth of compacted hardcore specified by the consulting engineer and in accordance with the limits and guidelines in SR21:2014 +A1:2016 and/or NRA SRW CL808 Type E granular stone fill. Where the depth of Made Ground/Soft deposits exceeds 0.9m then suspended floor slabs should be considered.

Due to the potential high loading anticipated from some of the proposed structures, piled foundations may be more economically advantageous. The type, size and depth of the pile foundations should be confirmed by a specialist piling contractor based on the loading from the proposed building.

The pH and sulphate testing completed on samples recovered from the exploratory holes indicates the pH results are near neutral and the sulphate results are low, when compared to the guideline values from BRE Special Digest 1:2005. No special precautions are required for concrete foundations to prevent sulphate attack. The samples tested were below the limits of DS1 in the BRE Special Digest 1:2005.

5.3. External Pavements

The proposed pavements are recommended to be designed in accordance with the CBR test results included in the Appendixes of this Report. The low CBR test results indicate that a capping layer or a sufficient depth of crushed stone fill may be required. Plate bearing tests are recommended at the time of construction to verify the design assumptions for the proposed pavement make up and to verify adequate compaction has been achieved.
The use of a geogrid and separation membrane may improve the performance of the proposed pavement and enable a more economical pavement design to be achieved, a specialist supplier is recommended to advise of the required strength, depth and type of geotextile for the proposed design.

5.4. Excavations

Short term temporary excavations in the cohesive deposits will remain stable for a limited time only and will require to be appropriately battered or the sides supported if the excavation is below 1.25m BGL or is required to permit man entry.
Excavations in the Made Ground, or soft Cohesive Deposits will require to be appropriately battered or the sides supported due to the low strength of these deposits.
Any excavations which penetrate the granular deposits will require to be appropriately battered or the sides supported and are likely to require dewatering due to the groundwater seepages noted in the exploratory hole logs in the Appendices of this Report.
The groundwater and stability noted on the trial pit logs should be consulted when determining the most appropriate construction methods for excavations. An assessment by a specialist dewatering contractor is recommended to determine the most cost effective approach to the proposed excavation.

Excavations in the upper cohesive deposits are expected to be excavatable with conventional excavation equipment.

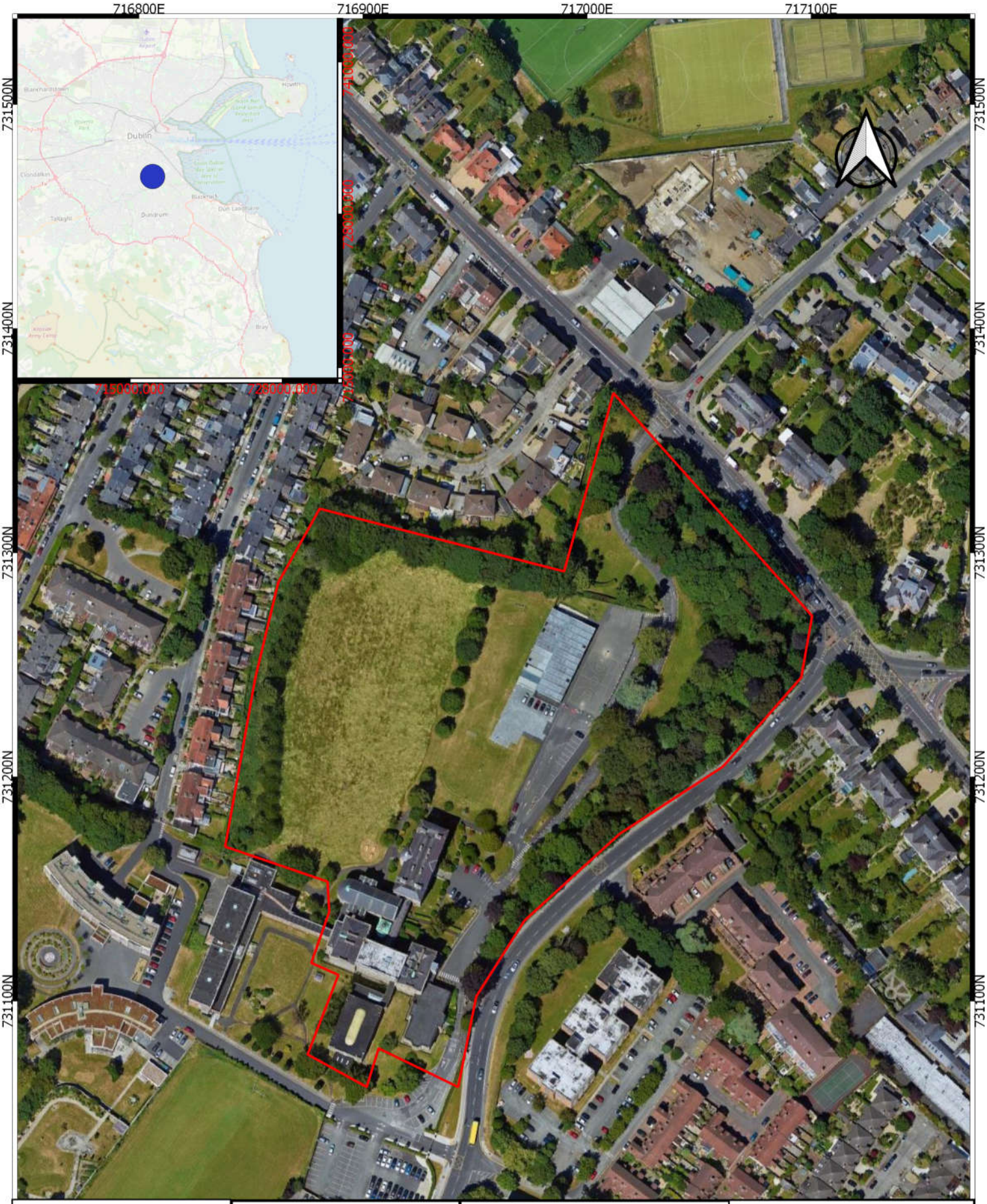
Any waste material to be removed off site should be disposed of to a suitably licenced landfill.
The environmental testing completed during the ground investigation is reported under the cover of a separate GII Waste Classification/Subsoil Assessment Report.

5.5. Soakaway Design

At the locations of SA01, SA02 and SA03 the water level dropped too slowly to allow calculation of ‘f’ the soil infiltration rate. These locations are therefore not recommended as suitable for soakaway design and construction.

The recommendations provided in this report should be verified in the design of the proposed buildings, using the full details of the loading conditions and taking into consideration the allowable tolerable settlements/movements that the building can accommodate. The founding strata should be inspected and verified by a suitably qualified engineer prior to construction of the building foundations.

APPENDIX 1 - Site Location Plan



GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Ground Investigations Ireland Ltd.
Catherinstown House,
Hazelhatch Road,
Newcastle, Co. Dublin
www.gii.ie 01-6015175/5176

Client:

Project Title:
Sandford Park

Drawing Title:
Figure 1 Site Location

GII Project Reference:
9338-12-19

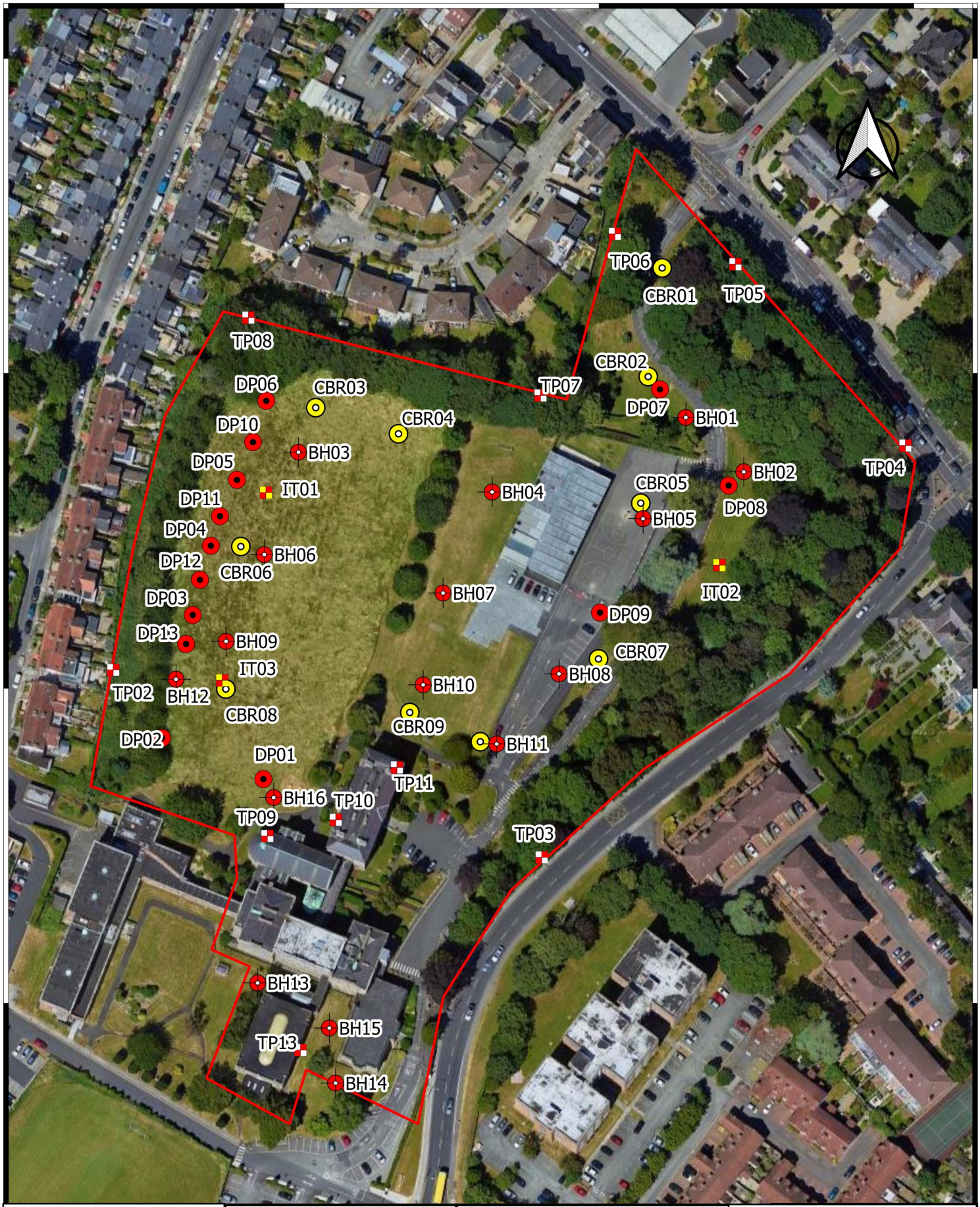
0 20 40 60 80 m

Drawn By:
NM

Date:
18/06/2020

Site Location

Indicative Site Boundary



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Geotechnical & Environmental

Ground Investigations Ireland Ltd.
Catherinstown House,
Hazelhatch Road,
Newcastle, Co. Dublin
www.gii.ie 01-6015175/5176

Client:

0 20 40 60 m

Project Title:
Sandford Park

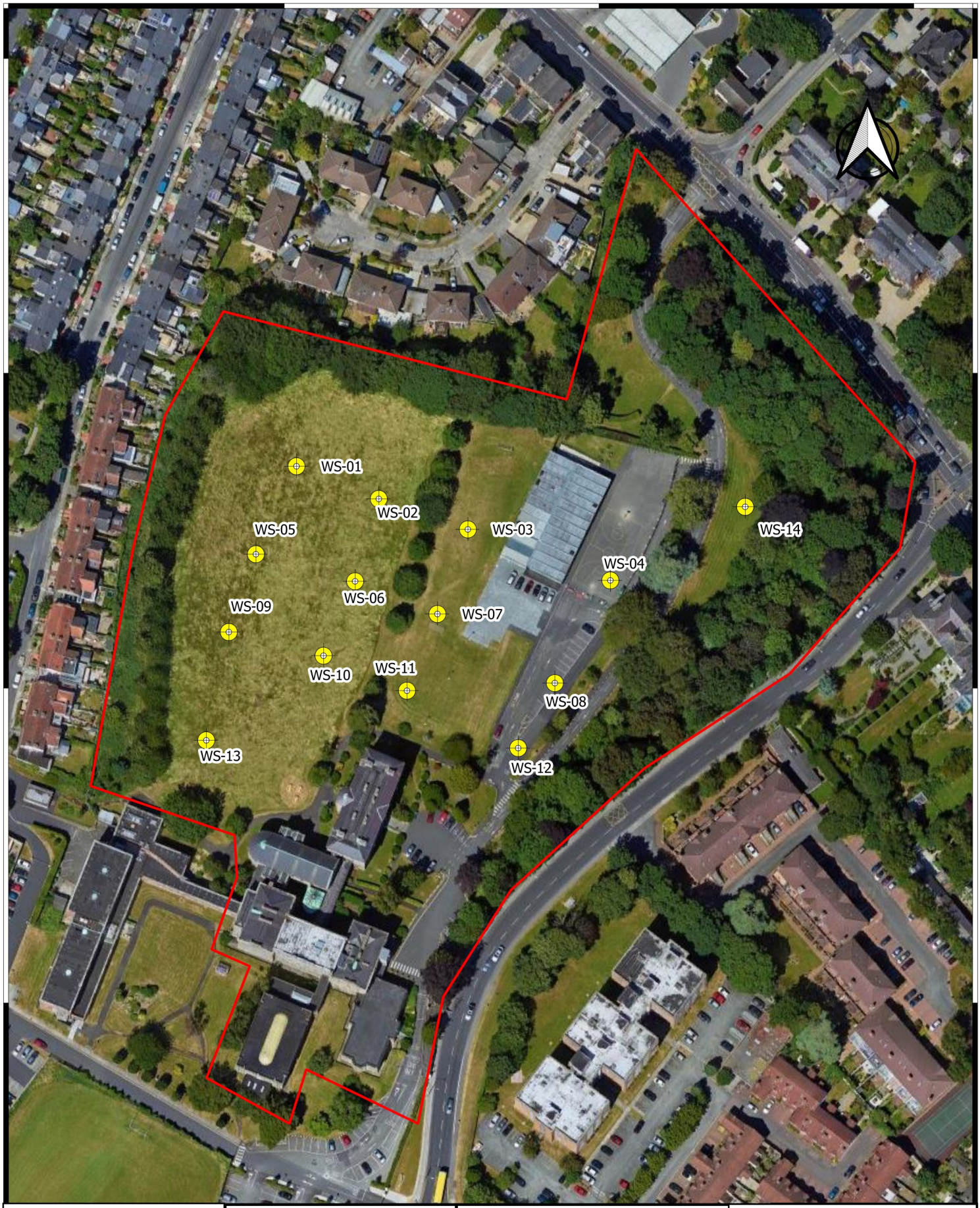
Drawing Title:
Figure 2: GI Locations

GII Project Reference:
9338-12-19

Drawn By:
NM

Date:
23/10/2020

- Indicative Site Boundary
- Borehole
- CBR
- Dynamic Probe
- Trial Pit
- Window Sample
- Soakaway



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Ground Investigations Ireland Ltd.
Catherinstown House,
Hazelhatch Road,
Newcastle, Co. Dublin
www.gii.ie 01-6015175/5176

Client:

0 20 40 60 m

Project Title:
Sandford Park

Drawing Title:
Figure 3: WS Locations

GII Project Reference:
9338-12-19

Drawn By:
NM

Date:
23/10/2020

- Indicative Site Boundary
- Borehole
- CBR
- Dynamic Probe
- Trial Pit
- Window Sample
- Soakaway

APPENDIX 2 – Trial Pit Records

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** TP02
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 1.2m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location 716845.6 E 731205.5 N	**Dates** 17/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	TOPSOIL.		
					(0.55)	Firm light brown slightly sandy slightly gravelly CLAY.		
					0.75 (0.30)	Firm to stiff brown slightly sandy slightly gravelly CLAY with occasional sub-angular cobbles.		
					1.05	Complete at 1.05m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.05m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.TP02

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** TP03
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 1.4m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location 716981.8 E 731146 N	**Dates** 17/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	MADE GROUND: Topsoil with roots plastic redbrick and concrete fragments.		
					0.30	MADE GROUND: Brown slightly sandy slightly gravelly CLAY with root concrete and fragments.		
					(0.90)			
					1.20	Complete at 1.20m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.20m BGL due to a concrete protection and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.TP03

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** TP04
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 1.5m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location 717097.4 E 731276.8 N	**Dates** 17/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	TOPSOIL with roots.		
					(0.50) 0.70	Firm dark brown slightly sandy slightly gravelly CLAY with root fragments.		
					(0.70) 1.40	Firm to stiff light brown slightly sandy slightly gravelly CLAY.		
						Complete at 1.40m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.40m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.TP04

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** TP05
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 1.5m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location 717043.4 E 731334.3 N	**Dates** 17/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.70)	TOPSOIL with roots.		
					0.70	Firm to stiff brown slightly sandy slightly gravelly CLAY.		
					(0.80)			
					1.50	Complete at 1.50m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.50m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.TP05

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** TP06
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 1.2m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location 717005.1 E 731344 N	**Dates** 17/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25) 0.25	TOPSOIL with small concrete and plastic fragments.		
					(0.75)	Firm dark brown slightly sandy slightly gravelly CLAY.		
					1.00	Complete at 1.00m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.0m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.TP06

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Trial Pit Number** TP07
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 1.3m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location 716981.4 E 731292.7 N	**Dates** 17/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25) 0.25	TOPSOIL.		
					(0.90) 1.15	Firm to stiff light brown slightly sandy slightly gravelly CLAY.		
						Complete at 1.15m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.15m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.TP07

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** TP08
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 1.5m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location 716888.6 E 731317.4 N	**Dates** 17/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40) 0.40	MADE GROUND: Topsoil with roots plastic redbrick and concrete fragments.		
					(0.30) 0.70	Firm light brown grey slightly sandy slightly gravelly CLAY.		
					(0.50) 1.20	Firm to stiff light brown slightly sandy slightly gravelly CLAY.		
						Complete at 1.20m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.20m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.TP08

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** TP09
Machine : 3T 360 **Method :** Trial Pit	**Dimensions** 0.6m W x 2.0m L	**Ground Level (mOD)** 20.90	**Client** DBFL	**Job Number** 9338-12-19
	Location (dGPS) 716894.6 E 731152.8 N	**Dates** 27/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
				20.75	(0.15) 0.15	Topsoil		
					(0.45)	Firm to stiff brown mottled grey slightly sandy slightly gravelly CLAY with occasional subangular cobbles. Gravel is angular to subrounded fine to coarse.		
0.50	B			20.30	0.60			
1.00	B				(0.80)	Stiff greyish brown slightly sandy slightly gravelly CLAY with occasional subanugular cobbles and boulders. Gravel is angular to subrounded fine to coarse.		
				19.50	1.40	Complete at 1.40m		

Plan

Remarks

Groundwater encountered at 1.40m
Trial pit stable.
Trial pit terminated at 1.40m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	PC	9338-12-19.TP09

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Trial Pit Number** TP10
Machine : 3T 360 **Method :** Trial Pit	**Dimensions** 0.6m W x 1.1m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location (Handheld GPS) 716916.4 E 731157.9 N	**Dates** 27/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.15) 0.15	Topsoil		
					(0.25) 0.40	MADE GROUND: Brown slightly gravelly sandy Clay with occassional fragments of metal and red brick.		
					(0.40) 0.80	Firm to stiff brown mottled grey slightly sandy slightly gravelly CLAY with occasional subangular cobbles. Gravel is angular to subrounded fine to coarse.		
					(0.40) 1.20	Stiff brown mottled grey slightly sandy slightly gravelly CLAY with occasional subanugular cobbles and boulders. Gravel is angular to subrounded fine to coarse.		
1.20	B					Complete at 1.20m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.20m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	PC	9338-12-19.TP10

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Trial Pit Number** TP11
Machine : 3T 360 **Method :** Trial Pit	**Dimensions** 0.6m W x 1.6m L	**Ground Level (mOD)** 20.81	**Client** DBFL	**Job Number** 9338-12-19
	Location (dGPS) 716935.8 E 731174.6 N	**Dates** 27/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.15)	Topsoil		
				20.66	0.15			
					(0.15)	MADE GROUND: Brown slightly gravelly sandy Clay with occassional fragments of red brick.		
				20.51	0.30			
						Stiff brown mottled grey slightly sandy slightly gravelly CLAY with occasional subanugular cobbles and boulders. Gravel is angular to subrounded fine to coarse.		
					(0.70)			
0.80	B							
				19.81	1.00			
						Complete at 1.00m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.00m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	PC	9338-12-19.TP11

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** TP13
Machine : 3T 360 **Method :** Trial Pit	**Dimensions** 0.6m W x 1.0m L	**Ground Level (mOD)** 21.95	**Client** DBFL	**Job Number** 9338-12-19
	Location (dGPS) 716905.1 E 731084.8 N	**Dates** 27/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.15)	Topsoil		
				21.80	0.15	MADE GROUND: Brown slightly gravelly sandy Clay with rootlets and occassional fragments of glass and red brick.		
					(0.45)			
0.50	B			21.35	0.60	Stiff brown mottled grey slightly sandy slightly gravelly CLAY with occasional subanugular cobbles. Gravel is angular to subrounded fine to coarse. Possible madeground.		
					(0.70)			
1.00	B			20.65	1.30	Complete at 1.30m		

Plan

Remarks

Groundwater not encountered during excavation.
Trial pit stable.
Trial pit terminated at 1.30m BGL on exposing the foundation and backfilled upon completion.

Scale (approx)	Logged By	Figure No.
1:25	PC	9338-12-19.TP13

APPENDIX 3 – Soakaway Records

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
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D22 YD52

Tel: 01 601 5175 / 5176
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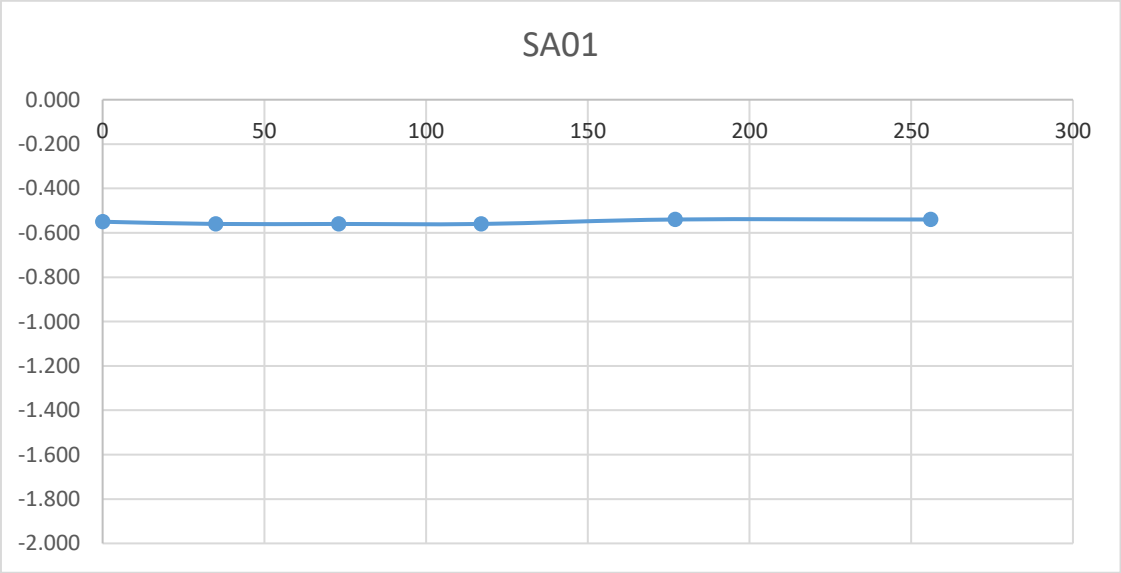
SA01

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.5m x 0.60m 2.5m (L x W x D)

Date	Time	Water level (m bgl)
16/01/2020	0	-0.550
16/01/2020	35	-0.560
16/01/2020	73	-0.560
16/01/2020	117	-0.560
16/01/2020	177	-0.540
16/01/2020	256	-0.540

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.55	2.500	1.950	1.0375	2.0125



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Co. Dublin.
D22 YD52

Tel: 01 601 5175 / 5176
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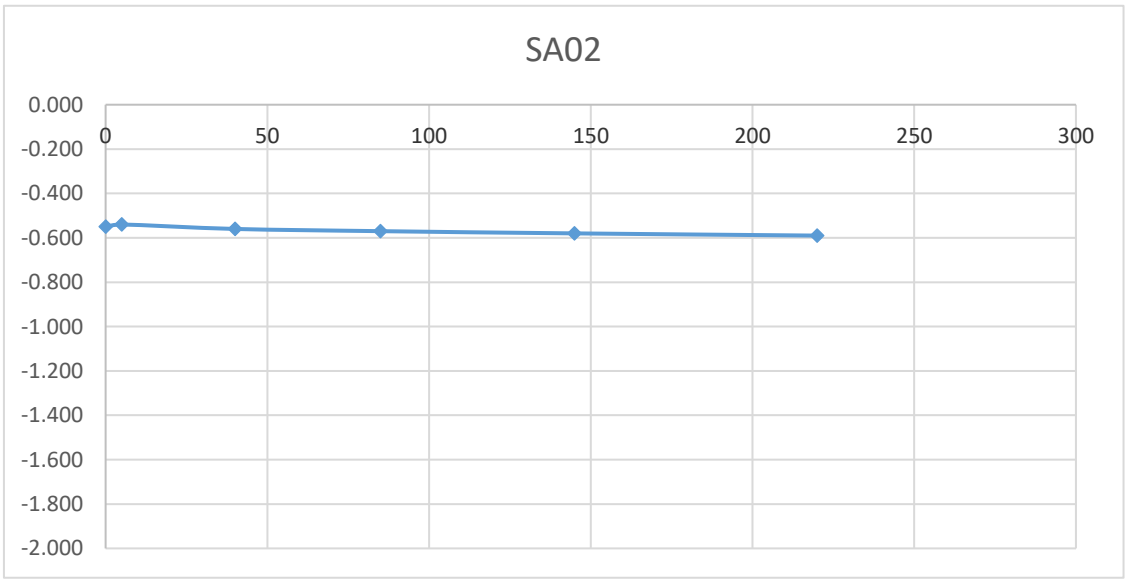
SA02

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.5m x 0.60m 2.5m (L x W x D)

Date	Time	Water level (m bgl)
16/01/2020	0	-0.550
16/01/2020	5	-0.540
16/01/2020	40	-0.560
16/01/2020	85	-0.570
16/01/2020	145	-0.580
16/01/2020	220	-0.590

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.55	2.500	1.950	1.0375	2.0125



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Tel: 01 601 5175 / 5176
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Web: www.gii.ie

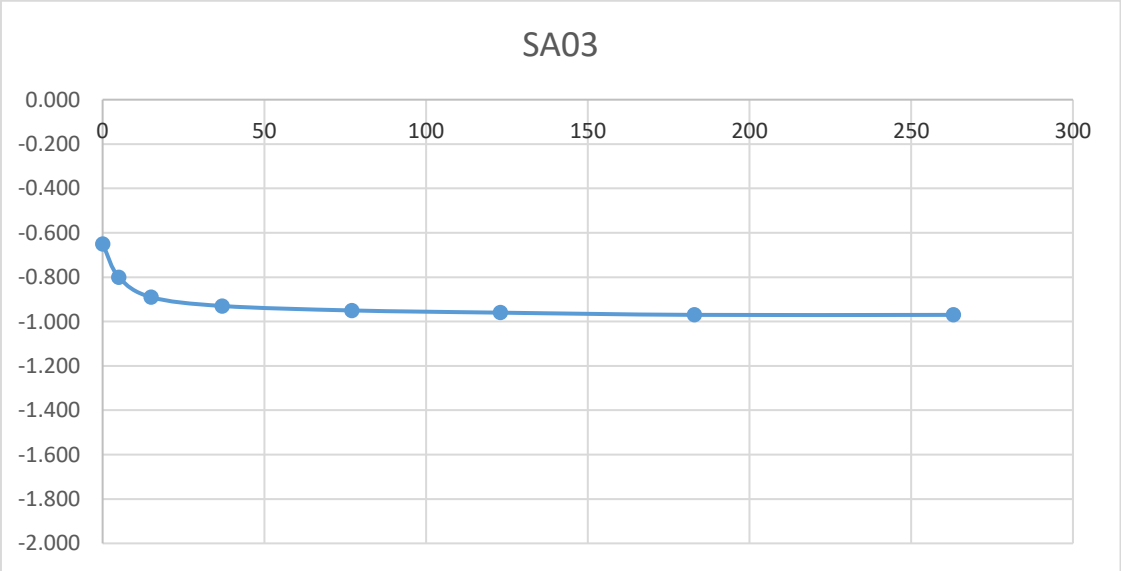
SA03

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.6m x 0.60m 2.60m (L x W x D)

Date	Time	Water level (m bgl)
16/01/2020	0	-0.650
16/01/2020	5	-0.800
16/01/2020	15	-0.890
16/01/2020	37	-0.930
16/01/2020	77	-0.950
16/01/2020	123	-0.960
16/01/2020	183	-0.970
16/01/2020	263	-0.970

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.65	2.600	1.950	1.1375	2.1125



Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** SA01
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 2.5m L	**Ground Level (mOD)** 20.09	**Client** DBFL	**Job Number** 9338-12-19
	Location 716894.1 E 731261.8 N	**Dates** 16/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20)	TOPSOIL.		
				19.89	0.20	POSSIBLE MADE GROUND: Brown slightly sandy slightly gravelly Clay.		
					(0.25)			
				19.64	0.45	Firm light brown slightly sandy slightly gravelly CLAY.		
					(1.85)			
				17.79	2.30	Firm to stiff brown grey slightly sandy gravelly CLAY with occasional sub-angular to sub-rounded cobbles and boulders		
					(0.20)			
				17.59	2.50	Complete at 2.50m		

Plan

Remarks

Groundwater not encountered during excvation.
Trial pit stable.
Trial pit terminated at 2.50m BGL and backfilled upon completion of soakaway.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.SA01

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** SA02
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 2.5m L	**Ground Level (mOD)**	**Client** DBFL	**Job Number** 9338-12-19
	Location 717038.2 E 731238.8 N	**Dates** 16/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20) 0.20	TOPSOIL.		
					(0.20) 0.40	Soft to firm brown grey mottled sandy very gravelly CLAY with occasional sub-angular cobbles.		
					(0.80) 1.20	Brown grey sandy very clayey fine to coarse sub-angular to sub-rounded GRAVEL.		
					(0.90) 2.10	Firm brown slightly sandy slightly gravelly CLAY with occasional sub-angular to sub-rounded cobbles.		
					(0.40) 2.50	Stiff dark grey black slightly sandy slightly gravelly CLAY.		
						Complete at 2.50m		

Plan

Remarks

No groundwater encountered.
Trial pit spalling at 0.50m BGL.
Trial pit terminated at 2.50m BGL and backfilled upon completion of soakaway.

Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.SA02

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Trial Pit Number** SA03
Machine : JCB 3CX **Method :** Trial Pit	**Dimensions** 0.6m W x 2.6m L	**Ground Level (mOD)** 21.18	**Client** DBFL	**Job Number** 9338-12-19
	Location 716880.2 E 731202.2 N	**Dates** 16/01/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.20)	TOPSOIL.		
				20.98	0.20	POSSIBLE MADE GROUND: Brown slightly sandy slightly gravelly Clay.		
					(0.20)			
				20.78	0.40	Firm light brown slightly sandy slightly gravelly CLAY.		
					(0.30)			
				20.48	0.70	Firm to stiff brown grey slightly sandy gravelly CLAY with occasional sub-angular cobbles.		
					(1.10)			
				19.38	1.80	Stiff to very stiff brown grey slightly sandy gravelly CLAY with occasional sub-angular to sub-rounded cobbles.		
					(0.80)			
			Water strike(1) at 2.50m.	18.58	2.60	Complete at 2.60m		▽1

Plan

Remarks

Slow ingress of groundwater encountered at 2.5m BGL.
Trial pit stable.
Trial pit terminated at 2.60m BGL and backfilled upon completion of soakaway.

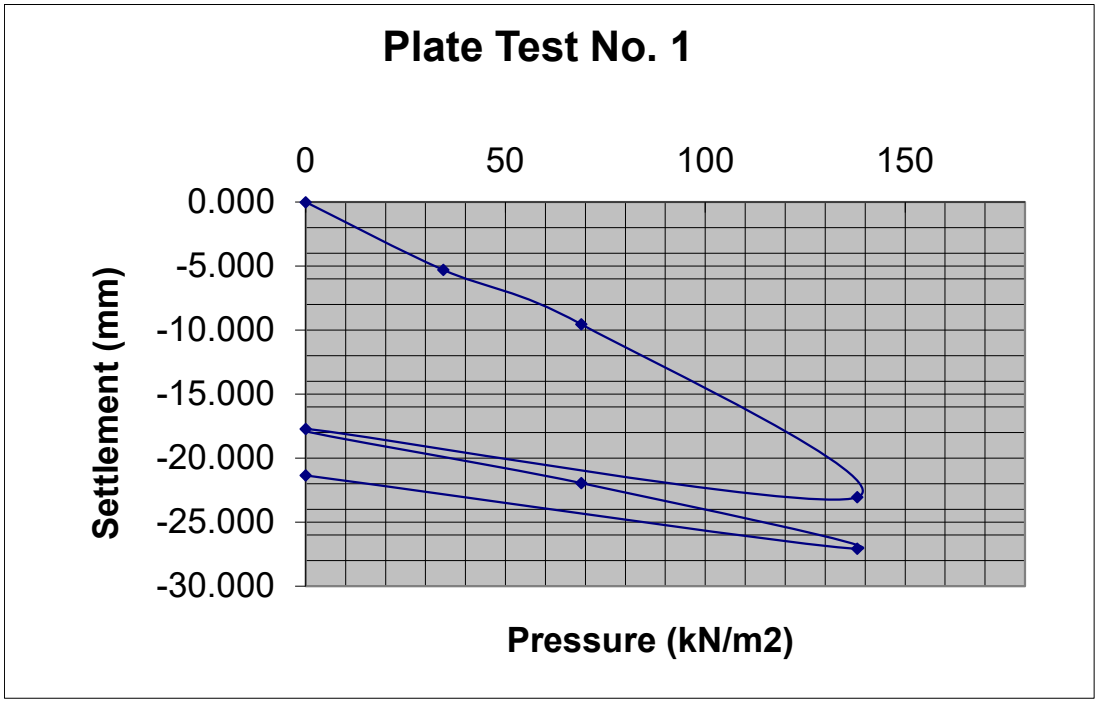
Scale (approx)	Logged By	Figure No.
1:25	NM	9338-12-19.SA03

APPENDIX 4 – Plate Load Test and TRL Probe Records

Applied Load	Gauge settlement
0	**0.000**
34.5	-5.3
69	-9.535
138	-23.05
0	-17.715
69	-21.95
138	-27.07
0	-21.335

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets and small redbrick and mortar fragments.
CONTRACT NO.	9338-12-19		
DATE	21/01/2020		
CLIENT	DBFL	**DEPTH**	0.40m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR01	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **4.89 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **11.01 MN/m2/m**

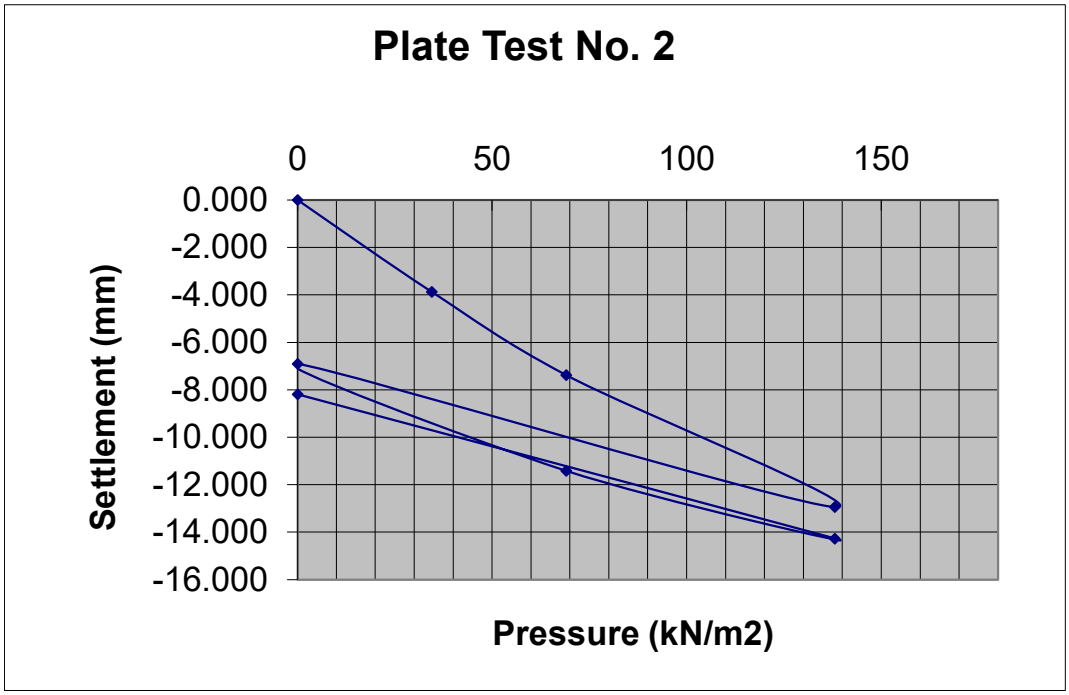
Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.15 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **0.62 %**

Applied Load	Gauge settlement
0	**0.000**
34.5	-3.87
69	-7.38
138	-12.93
0	-6.9
69	-11.415
138	-14.265
0	-8.19

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets and small redbrick fragments.
CONTRACT NO.	9338-12-19		
DATE	21/01/2020		
CLIENT	DBFL	**DEPTH**	0.40m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR02	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **6.32 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **10.33 MN/m2/m**

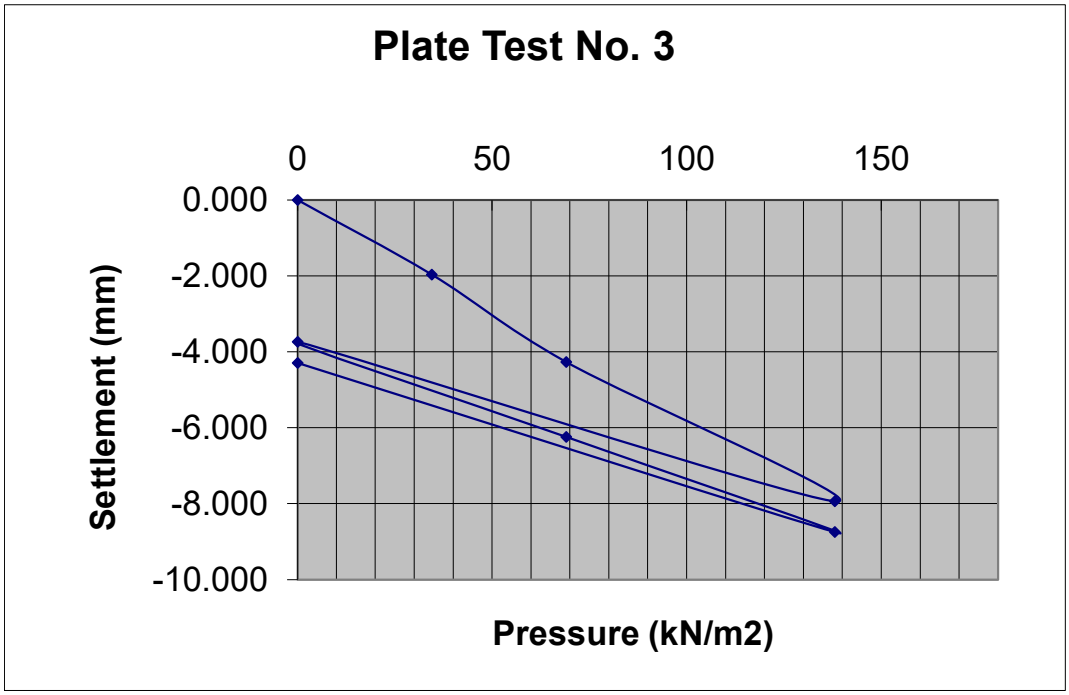
Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.24 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **0.55 %**

Applied Load	Gauge settlement
0	**0.000**
34.5	-1.96
69	-4.265
138	-7.93
0	-3.73
69	-6.24
138	-8.745
0	-4.29

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	POSSIBLE MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets.
CONTRACT NO.	9338-12-19		
DATE	21/01/2020		
CLIENT	DBFL	**DEPTH**	0.40m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR03	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **10.93 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **18.58 MN/m2/m**

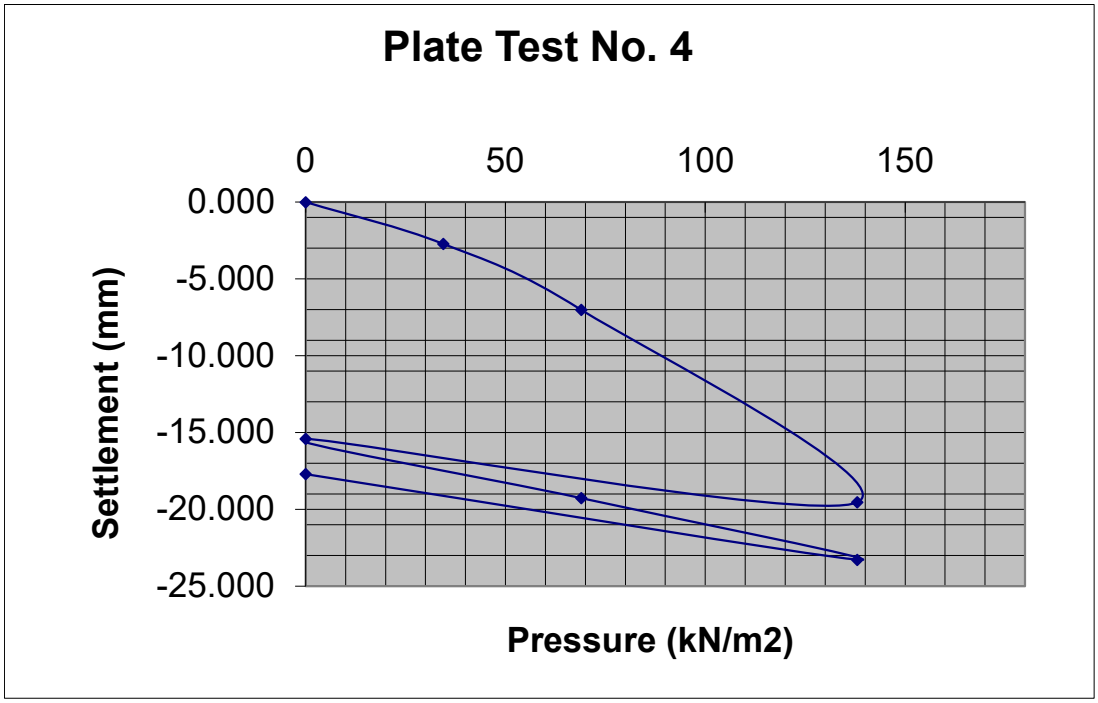
Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.61 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **1.53 %**

Applied Load	Gauge settlement
0	**0.000**
34.5	-2.71
69	-7.01
138	-19.54
0	-15.41
69	-19.275
138	-23.28
0	-17.7

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	POSSIBLE MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets
CONTRACT NO.	9338-12-19		
DATE	20/01/2020		
CLIENT	DBFL	**DEPTH**	0.30m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR04	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **6.65 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **12.06 MN/m2/m**

Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.26 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **0.72 %**

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House,
Hazelhatch Road,
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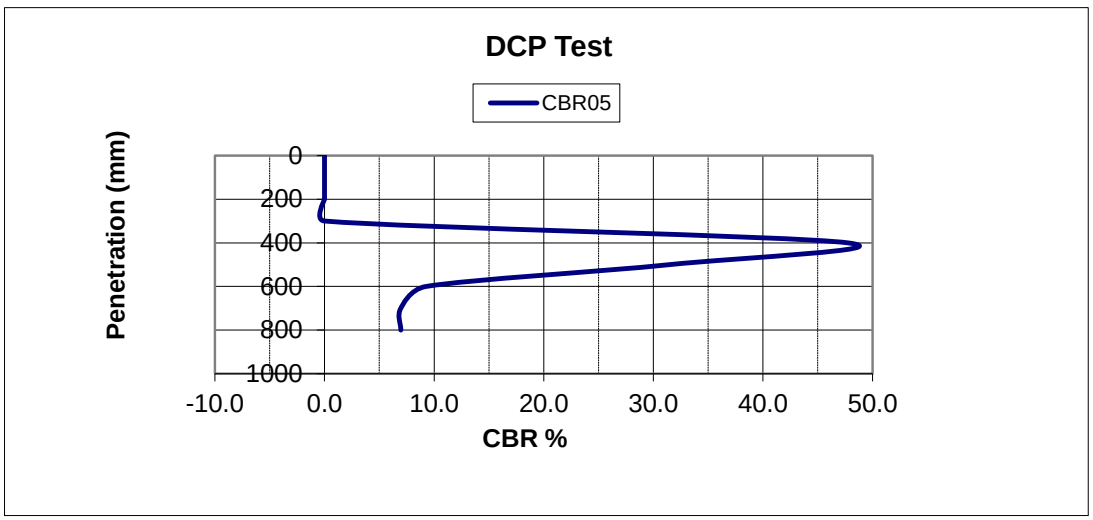
Web: www.gii.ie

Job Name	Sandford Park Milltown	**Test Type**	Dynamic Cone Penetration Test
Job No.	9338-12-19	**Test Reference**	CBR05
Client	DBFL	**By**	N Morgan
		Date	21/01/2020
Initial Depth	0.3		

Depth (mm bgl)	No. of Blows per 100mm	Penetration per Blow (mm)	CBR (%)
0	-	-	0.0
100	-	-	0.0
200	-	-	0.0
300	-	-	0.0
400	18	5.6	47.7
500	13	7.7	31.5
600	5	20.0	9.3
700	4	25.0	7.0
800	4	25.0	7.0
900	4	25.0	7.0
1000	-		
1100	-		
1200	-		
1300	-		
1400	-		
1500	-		

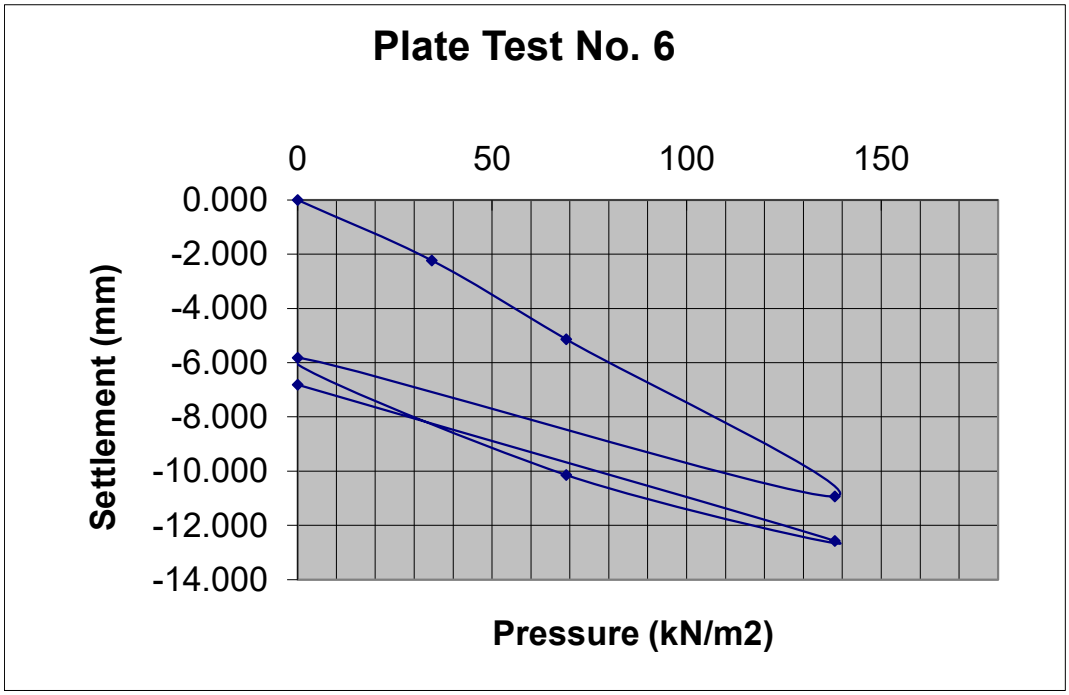
Reference **Kleyn and Van Heerden (60^{o} Cone)**
Formula Log10 (CBR) = 2.632 - 1.28 Log10 (mm/blow)



Applied Load	Gauge settlement
0	**0.000**
34.5	-2.225
69	-5.135
138	-10.93
0	-5.815
69	-10.14
138	-12.565
0	-6.81

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	Possible MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets.
CONTRACT NO.	9338-12-19		
DATE	21/01/2020		
CLIENT	DBFL	**DEPTH**	0.40m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR06	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **9.08 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **10.78 MN/m2/m**

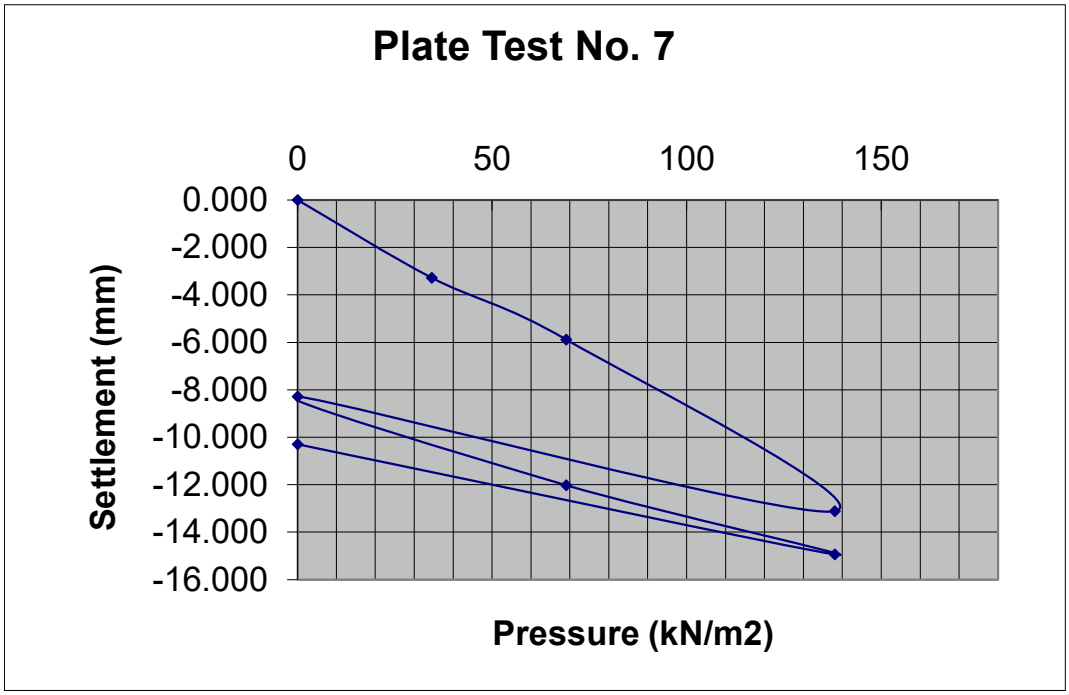
Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.44 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **0.59 %**

Applied Load	Gauge settlement
0	**0.000**
34.5	-3.275
69	-5.88
138	-13.11
0	-8.275
69	-12.015
138	-14.935
0	-10.29

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets redbrick mortar and bone fragments.
CONTRACT NO.	9338-12-19		
DATE	21/01/2020		
CLIENT	DBFL	**DEPTH**	0.45m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR07	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **7.93 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **12.47 MN/m2/m**

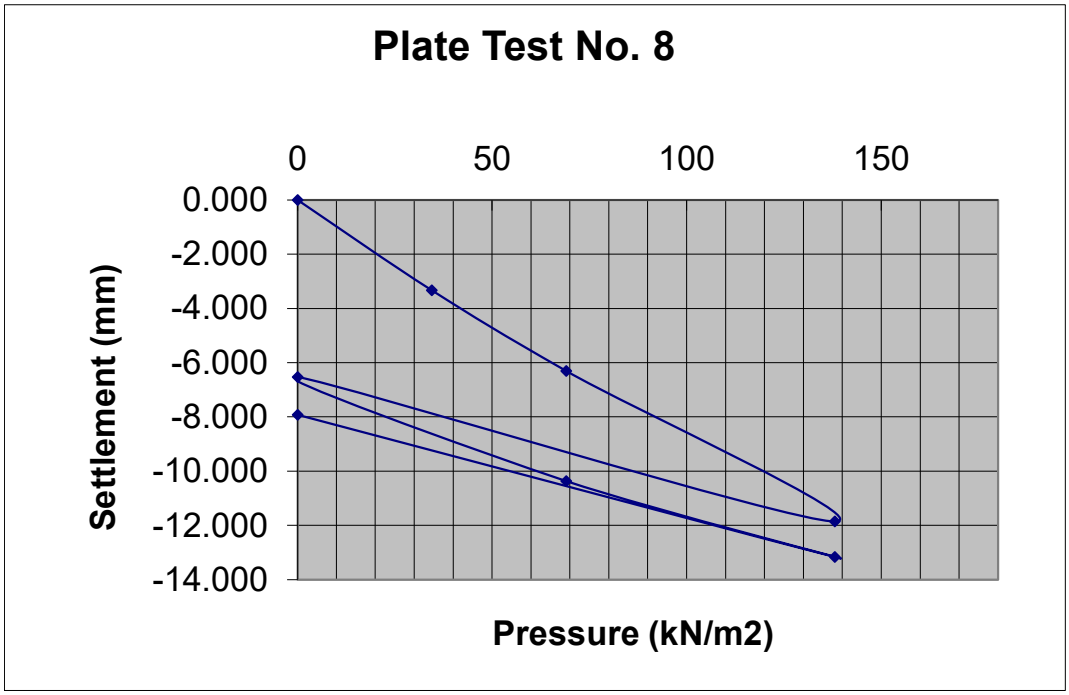
Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.35 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **0.76 %**

Applied Load	Gauge settlement
0	**0.000**
34.5	-3.33
69	-6.305
138	-11.85
0	-6.52
69	-10.36
138	-13.16
0	-7.92

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	POSSIBLE MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets.
CONTRACT NO.	9338-12-19		
DATE	21/01/2020		
CLIENT	DBFL	**DEPTH**	0.40m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR08	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **7.39 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **12.14 MN/m2/m**

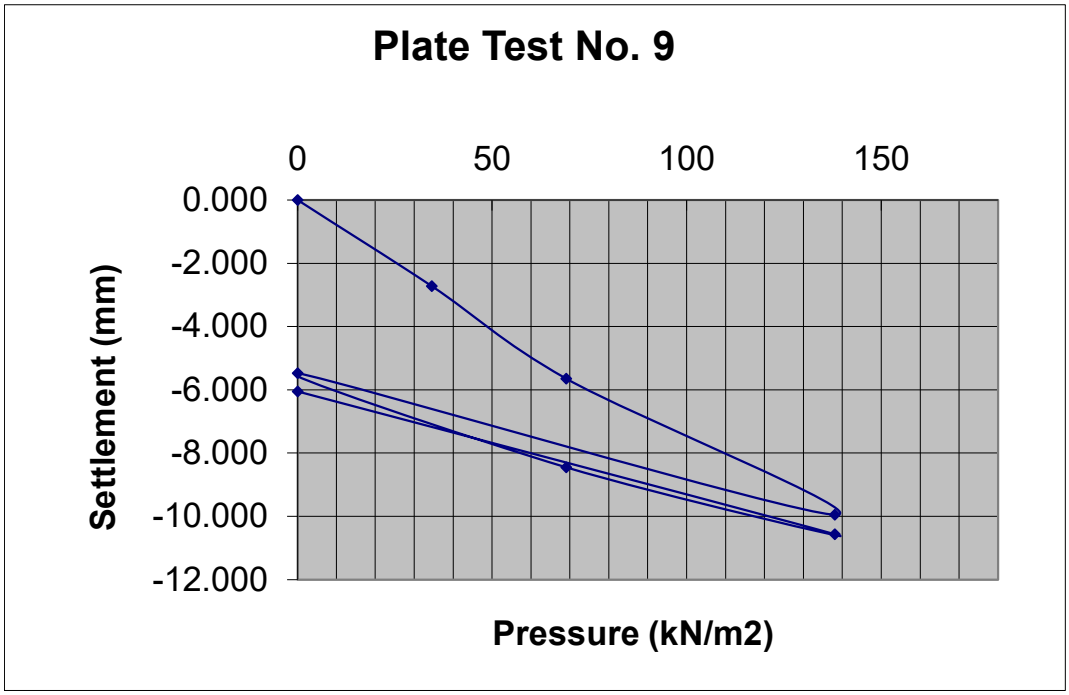
Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.31 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **0.73 %**

Applied Load	Gauge settlement
0	**0.000**
34.5	-2.715
69	-5.64
138	-9.94
0	-5.47
69	-8.445
138	-10.56
0	-6.045

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets and small redbrick and plastic fragments.
CONTRACT NO.	9338-12-19		
DATE	21/01/2020		
CLIENT	DBFL	**DEPTH**	0.30m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR09	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **8.27 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **15.67 MN/m2/m**

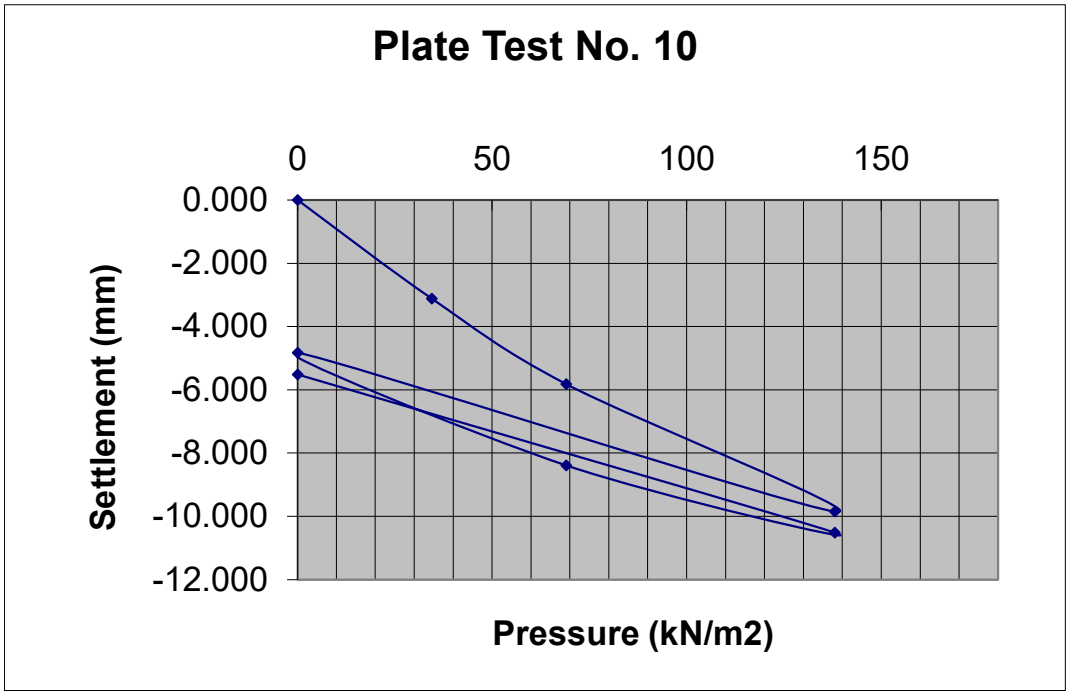
Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.38 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **1.14 %**

Applied Load	Gauge settlement
0	**0.000**
34.5	-3.11
69	-5.82
138	-9.84
0	-4.82
69	-8.385
138	-10.515
0	-5.51

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

LOCATION	Sandford Park Milltown	**MATERIAL**	MADE GROUND: Light brown slightly sandy slightly gravelly Clay with rootlets and small redbrick and plastic fragments.
CONTRACT NO.	9338-12-19		
DATE	21/01/2020		
CLIENT	DBFL	**DEPTH**	0.30m
PLATE DIAMETER	457mm	**NOTES**	
TEST NO.	CBR10	**SAMPLES**	



Modulus of subgrade reaction, K (Initial) = **8.01 MN/m2/m**

Modulus of subgrade reaction, K (Reload) = **13.08 MN/m2/m**

Equivalent CBR(initial)in accordance with HD25/94 volume7 section2 = **0.36 %**

Equivalent CBR(reload)in accordance with HD25/94 volume7 section2 = **0.83 %**

APPENDIX 7 – Borehole Records

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Borehole Number** BH01
Machine : Dando 2000 **Method :** Cable Percussion	**Casing Diameter** 200mm cased to 5.70m	**Ground Level (mOD)** 18.33	**Client** DBFL	**Job Number** 9338-12-19
	Location (dGPS) 717027.6 E 731285.9 N	**Dates** 04/03/2020-05/03/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					18.03	(0.30) 0.30	Dark brown sandy slightly gravelly TOPSOIL with occasional rootlets.		
0.50	B				17.53	(0.50) 0.80	Soft light brown slightly sandy slightly gravelly CLAY.		
1.00-1.45 1.00	SPT(C) N=11 B			1,2/2,3,3,3			Firm to stiff light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
2.00-2.45 2.00	SPT(C) N=19 B			2,3/4,5,5,5		(1.70)			
3.00-3.45 3.00	SPT(C) N=40 B			3,5/7,9,11,13	15.83	2.50	Very stiff dark grey slightly silty slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
4.00-4.45 4.00	SPT(C) N=39 B			5,6/7,9,9,14		(3.20)			
5.00-5.38 5.00	SPT(C) 50/225 B			6,9/13,17,19,1					
					12.63	5.70	Refusal at 5.70m		

Remarks
No groundwater encountered during drilling
Borehole backfilled on complertion.
Borehole terminated at 5.70m BGL due to obstruction, possible boulder or rock
Chiselling from 5.70m to 5.70m for 1 hour.

Scale (approx)	Logged By
1:50	PM

Figure No. 9338-12-19.BH01

Ground Investigations Ireland Ltd
www.gii.ie

Site	Borehole Number
Sandford Park Milltown	BH02

Machine : Dando 2000 Method : Cable Percussion	Casing Diameter 200mm cased to 7.00m	Ground Level (mOD) 18.40	Client DBFL	Job Number 9338-12-19
	Location (dGPS) 717045.9 E 731268.6 N	Dates 06/03/2020	Project Contractor GII	Sheet 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					18.10	(0.30) 0.30	Dark brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets.			
0.50	B					(0.80)	Soft light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
1.00-1.45 1.00	SPT(C) N=14 B			1,2/3,3,4,4	17.30	1.10	Firm to stiff light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
2.00-2.45 2.00	SPT(C) N=18 B			2,3/4,5,4,5	16.10	(1.20) 2.30	Very stiff dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
3.00-3.45 3.00	SPT(C) N=33 B			4,6/7,8,9,9						
4.00-4.40 4.00	SPT(C) 50/250 B			6,8/11,15,17,7		(4.70)				
5.00-5.40 5.00	SPT(C) 50/250 B			7,10/13,15,17,5						
6.00-6.30 6.00	SPT(C) 50/150 B			8,10/17,21,12						
7.00-7.00 7.00	SPT(C) 25*/0 50/0 B			25/50	11.40	7.00	Refusal at 7.00m			

Remarks
No groundwater encountered during drilling
Slotted pipe with pea gravel surround from 7.0m BGL to 1.0m BGL, plain pipe with bentonite seal from 1.0m BGL to GL, finished with an upright cover
Borehole terminated at 7.00m BGL due to obstruction, possible boulder or rock
Chiselling from 7.00m to 7.00m for 1 hour.

Scale (approx)	Logged By
1:50	PM

Figure No.
9338-12-19.BH02

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Borehole Number** BH03
Machine : Dando 2000, Beretta T44 **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 7.20m 63mm cased to 20.00m	**Ground Level (mOD)** 19.67	**Client** DBFL	**Job Number** 9338-12-19
	Location 716904.5 E 731274.9 N	**Dates** 06/03/2020	**Project Contractor** GII	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					19.37	(0.30) 0.30	Dark brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets.			
0.50	B						Soft light brown slightly sandy slightly gravelly CLAY.			
1.00	B				18.77	(0.60) 0.90				
1.00-1.45	SPT(C) N=13			1,2/3,2,4,4	18.47	(0.30) 1.20	Soft light brown mottled orange grey slightly sandy slightly gravelly CLAY.			
							Firm to stiff light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Some yellow and grey mottling.			
2.00	B					(1.10)				
2.00-2.45	SPT(C) N=22			7,4/5,6,6,5	17.37	2.30				
							Very stiff dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
3.00	B									
3.00-3.31	SPT(C) 50/160			7,12/18,25,7						
4.00	B									
4.00-4.45	SPT(C) N=39			7,10/8,9,11,11						
						(4.20)				
5.00	B									
5.00-5.45	SPT(C) N=47			6,8/10,12,12,13						
6.00	B									
6.00-6.45	SPT(C) N=50			6,9/10,11,14,15						
					13.17	6.50	Very stiff brown slightly sandy gravelly CLAY.			
7.00	TCR / SCR	RQD	FI	10,20/50		(0.50)				
7.00-7.22				B SPT(C) 50/70	12.67	7.00				
7.00	75						Very stiff brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
8.20-8.28				22,3/50 SPT(C) 25*/75						
8.20	93			50/0		(4.20)				
9.70-9.78				22,3/50 SPT(C) 25*/75						
9.70				50/0						

Remarks
No groundwater encountered during cable percusion drilling.
Cable percussion to 7.00m BGL with Rotary core follow on to 20.00m BGL.
Slotted pipe installed from 8.5m BGL to 3m BGL with pea grval filter zone from 8.5m BGL to 1.0m BGL and bentonite seal from 1.0m BGL to GL, finished with an upright cover
Chiselling from 7.20m to 7.20m for 1 hour.

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH03

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Borehole Number** BH03
Machine : Dando 2000, Beretta T44 **Flush :** Water **Core Dia :** 63 mm **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 7.20m 63mm cased to 20.00m	**Ground Level (mOD)** 19.67	**Client** DBFL	**Job Number** 9338-12-19
	Location 716904.5 E 731274.9 N	**Dates** 06/03/2020	**Project Contractor** GII	**Sheet** 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
	93				26/50 SPT(C) 26*/75 50/0						
11.20-11.28 11.20						8.47	11.20	Very stiff brown slightly sandy gravelly CLAY with some subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse.			
	67						(2.20)				
12.70-12.70 12.70					25/50 SPT(C) 25*/0 50/0						
	73					6.27	13.40	Very stiff grey slightly sandy gravelly CLAY with many subangular to subrounded cobbles and boulders. Gravel is subangular to subrounded fine to coarse.			
14.20-14.20 14.20					25/50 SPT(C) 25*/0 50/0						
	73						(3.80)				
15.70-15.78 15.70					22,3/50 SPT(C) 25*/75 50/0						
	100										
17.20-17.28 17.20					21,4/50 SPT(C) 25*/75 50/0	2.47	17.20	Poor recovery. Recovery consists of slightly clayey slightly gravelly clayey subangular to subrounded COBBLES of limestone.			
	33						(1.25)				
18.70						1.22	18.45	Poor recovery. Recovery consists of COBBLES of limestone. Presumed rock.			
	62						(1.55)				
20.00						-0.33	20.00				

Remarks

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH03

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Borehole Number** BH04
Machine : Dando 2000 **Method :** Cable Percussion	**Casing Diameter** 200mm cased to 7.30m	**Ground Level (mOD)** 19.44	**Client** DBFL	**Job Number** 9338-12-19
	Location 716966.1 E 731262.2 N	**Dates** 10/03/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					19.24	(0.20) 0.20	Dark brown sandy slightly gravelly TOPSOIL with occasional rootlets.		
0.50	B					(0.70)	Soft to firm light brown mottled grey slightly sandy slightly gravelly CLAY.		
1.00-1.45 1.00	SPT(C) N=8 B			1,1/2,1,2,3	18.54	0.90			
						(0.50)	Soft to firm light brown slightly sandy slightly gravelly CLAY.		
					18.04	1.40			
2.00-2.02 2.00	SPT(C) 25*/20 50/0 B			25/50		(1.10)	Firm to stiff light brown slightly sandy slightly gravelly CLAY.		
					16.94	2.50			
3.00-3.45 3.00	SPT(C) N=47 B			6,8/11,12,13,11			Very stiff, dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
4.00-4.45 4.00	SPT(C) N=50 B			6,8/11,13,14,12					
						(4.40)			
5.00-5.43 5.00	SPT(C) 50/275 B			7,8/10,15,16,9					
6.00-6.37 6.00	SPT(C) 50/215 B			9,10/14,16,20					
					12.54	6.90			
7.00-7.35 7.00	SPT(C) 50/195 B			10,10/15,20,15		(0.40)	Very stiff greyish brown slightly silty slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
					12.14	7.30	Refusal at 7.30m		

Remarks
No groundwater encountered during drilling
Borehole backfilled on complertion.
Borehole terminated at 7.30m BGL due to obstruction, possible boulder or rock
Chiselling from 2.50m to 2.62m for 0.75 hours. Chiselling from 7.30m to 7.30m for 1 hour.

Scale (approx)	Logged By
1:50	PM

Figure No. 9338-12-19.BH04

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Borehole Number** BH05
Machine : Dando 2000, Beretta T44 **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 5.30m 63mm cased to 16.50m	**Ground Level (mOD)** 18.75	**Client** DBFL	**Job Number** 9338-12-19
	Location 717014 E 731253.8 N	**Dates** 03/03/2020	**Project Contractor** GII	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					18.65	0.10	MADE GROUND: Tarmacadam		
						(0.40)	MADE GROUND: Light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles and occasional fragments of red brick cloth fibres and tarmacadam.		
0.50	B				18.25	0.50			
1.00 1.00-1.45	B SPT(C) N=12			1,2/3,3,3,3			Firm light brown slightly sandy slightly gravelly CLAY. Some orange mottling.		
						(1.70)			
2.00 2.00-2.45	B SPT(C) N=37			2,4/5,7,12,13	16.55	2.20			
							Very stiff dark grey slightly sandy slightly gravelly CLAY. Gravel is subangular to subrounded fine to coarse.		
3.00 3.00-3.45	B SPT(C) N=51			5,7/11,11,14,15 Water strike(1) at 3.10m, rose to 2.60m in 20 mins, sealed at NOm.					▼1 ▽1
4.00 4.00-4.45	B SPT(C) N=55			5,7/10,13,15,17					
						(4.50)			
5.00 5.00-5.30	B SPT(C) 50/150			7,15/20,30					
5.30	**TCR** 25	**SCR**	**RQD**	**FI**					
6.70-6.85 6.70	100			14,22/50 SPT(C) 50/0	12.05	6.70	Very stiff brown slightly sandy slightly gravelly CLAY with some subangular to subrounded cobbles and boulders. Gravel is subanugular to subrounded fine to coarse.		
8.20-8.28 8.20	100			22,3/50 SPT(C) 25*/75 50/0					
9.70-9.78 9.70				22,3/50 SPT(C) 25*/75 50/0					

Remarks
Groundwater encountered at 3.10m BGL.
Borehole backfilled on completion.
Cable percussion to 5.30m BGL with Rotary core follow on to 16.50m BGL.
Chiselling from 5.30m to 5.30m for 1 hour.

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH05

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Borehole Number** BH05
Machine : Dando 2000, Beretta T44 **Flush :** Water **Core Dia :** 63 mm **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 5.30m 63mm cased to 16.50m	**Ground Level (mOD)** 18.75	**Client** DBFL	**Job Number** 9338-12-19
	Location 717014 E 731253.8 N	**Dates** 03/03/2020	**Project Contractor** GII	**Sheet** 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
	93						(6.60)			
11.20-11.28					22,3/50 SPT(C) 25*/75					
11.20	73				50/0					
12.70-13.15					8,9/10,12,12,11 SPT(C) N=45					
12.70										
13.30	50	22	22	7		5.45	13.30	Weak- medium strong fine grained grey LIMESTONE distinctly weathered with calcite veining and occasional beds of stiff brown Clay. (possible residual mudstone) One set of fractures. F1: 0-10 degrees. Very closely-closely spaced undulating smooth occasionally open with brown staining and clay smearing.		
14.20	87	59	52				(3.20)			
15.40				N.I.				From 15.40 to 16.50 Non Intact.		
15.70	81	23	16							
16.50						2.25	16.50	Complete at 16.50m		

Remarks

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH05

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH06
Machine : Dando 2000 **Method :** Cable Percussion	**Casing Diameter** 200mm cased to 8.00m	**Ground Level (mOD)** 20.32	**Client** DBFL	**Job Number** 9338-12-19
	Location 716893.6 E 731242.4 N	**Dates** 11/03/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					20.12	(0.20) 0.20	Dark brown sandy slightly gravelly TOPSOIL with occasional rootlets.		
						(0.40)	Soft light brown slightly sandy slightly gravelly CLAY with some grey mottling.		
0.50	B				19.72	0.60	Firm light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
1.00-1.45 1.00	SPT(C) N=10 B			1,1/2,2,3,3		(1.60)			
2.00-2.45 2.00	SPT(C) N=19 B			2,2/3,4,5,7	18.12	2.20	Very stiff dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
3.00-3.42 3.00	SPT(C) 50/265 B			10,10/10,15,15,10					
4.00-4.39 4.00	SPT(C) 50/235 B			11,12/13,14,16,7		(4.80)			
5.00-5.38 5.00	SPT(C) 50/230 B			10,12/12,16,17,5					
6.00-6.35 6.00	SPT(C) 50/200 B			11,13/17,19,14					
7.00-7.33 7.00	SPT(C) 50/180 B			12,14/16,22,12	13.32	7.00	Very stiff light brown slightly sandy slightly gravelly CLAY.		
						(1.00)			
8.00-8.28 8.00	SPT(C) 50/125 B			16,19/25,25	12.32	8.00	Complete at 8.00m		

Remarks
No groundwater encountered during drilling
Borehole terminated at 8.00m BGL

Scale (approx)	Logged By
1:50	PM

Figure No. 9338-12-19.BH06

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH07
Machine : Dando 2000 **Method :** Cable Percussion	**Casing Diameter** 200mm cased to 8.00m	**Ground Level (mOD)** 20.00	**Client** DBFL	**Job Number** 9338-12-19
	Location 716950.4 E 731230.1 N	**Dates** 12/03/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
0.50	B					(1.00)	MADE GROUND: Light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles and occasional fragments of concrete and red brick.			
1.00-1.45 1.00	SPT(C) N=5 B			1,1/1,2,1,1	19.00	1.00 (0.40)	POSSIBLE MADE GROUND: Light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
2.00-2.45 2.00	SPT(C) N=27 B			1,2/4,6,8,9	18.60	1.40 (1.00)	Firm to Stiff light brown slightly sandy slightly gravelly CLAY.			
3.00-3.45 3.00	SPT(C) N=44 B			5,7/10,11,11,12	17.60	2.40	Very stiff dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
4.00-4.44 4.00	SPT(C) 50/285 B			8,8/11,14,15,10						
5.00-5.43 5.00	SPT(C) 50/275 B			9,11/11,13,17,9		(4.80)				
6.00-6.37 6.00	SPT(C) 50/220 B			11,14/15,16,19						
7.00-7.37 7.00	SPT(C) 50/220 B			12,12/14,16,20	12.80	7.20 (0.80)	Very stiff light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
8.00-8.31 8.00	SPT(C) 50/155 B			14,17/20,25,5	12.00	8.00	Complete at 8.00m			

Remarks
No groundwater encountered during drilling
Slotted pipe with pea gravel surround from 8.0m BGL to 1.0m BGL, plain pipe with bentonite seal from 1.0m BGL to GL, finished with an upright cover
Borehole terminated at 8.00m BGL

Scale (approx)	Logged By
1:50	PM

Figure No. 9338-12-19.BH07

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH08
Machine : Dando 2000, Beretta T44 **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 8.00m 96mm cased to 13.70m	**Ground Level (mOD)** 19.76	**Client** DBFL	**Job Number** 9338-12-19
	Location 716987.3 E 731204.4 N	**Dates** 13/03/2020	**Project Contractor** GII	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					19.66	0.10	CONCRETE.		
						(0.40)			
0.50	B				19.26	0.50	MADE GROUND: Light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles and occasional fragments of red brick and concrete.		
1.00	B					(0.80)	Soft light brown very sandy slightly gravelly CLAY.		
1.00-1.45	SPT(C) N=5			1,1/1,1,1,2	18.46	1.30			
2.00	B					(1.30)	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
2.00-2.45	SPT(C) N=9			1,1/1,2,3,3	17.16	2.60			
3.00	B						Very stiff dark grey slightly sandy slightly gravelly CLAY with rare subangular to subrounded cobbles.		
3.00-3.45	SPT(C) N=38			5,5/8,9,10,11					
4.00	B								
4.00-4.45	SPT(C) N=41			4,5/8,10,11,12					
5.00	B					(4.60)			
5.00-5.45	SPT(C) N=41			5,6/7,9,11,14					
6.00	B								
6.00-6.45	SPT(C) N=47			8,9/10,11,13,13					
7.00	B								
7.00-7.37	SPT(C) 55/220			11,14/16,17,22	12.56	7.20	Very stiff dark brown very sandy very gravelly CLAY. Gravel is subangular to subrounded fine to coarse.		
						(0.80)			
8.00	B			14,20/27,23					
8.00-8.25	SPT(C) 50/95				11.76	8.00			
8.00	TCR: 100	SCR:	RQD:	FI:			Very stiff brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles and boulders. Gravel is subangular to subrounded fine to coarse.		
8.20						(1.70)			
9.70-9.78	63			12,13/50 SPT(C) 25*/75	10.06	9.70			
9.70				50/0			Medium strong- strong fine grained grey LIMESTONE partially- distinctly weathered with calcite veining.		

Remarks
No groundwater encountered during drilling
Cable percussion to 8.00m BGL with Rotary core follow on to 13.70m BGL.
Borehole backfilled on completion.

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH08

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH08
Machine : Dando 2000, Beretta T44 **Flush :** Water **Core Dia :** 96 mm **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 8.00m 96mm cased to 13.70m	**Ground Level (mOD)** 19.76	**Client** DBFL	**Job Number** 9338-12-19
	Location 716987.3 E 731204.4 N	**Dates** 13/03/2020	**Project Contractor** GII	**Sheet** 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
	100	67	60					Two sets of fractures. F1: 0-10 degrees. Very closely-closely spaced undulating smooth occasionally open with clay smearing. F2: 30-45 degrees. Very closely-closely spaced undulating smooth closed.		
11.20	100	59	59	9			(4.00)			
12.50	100	75	68							
13.70						6.06	13.70	Complete at 13.70m		

Remarks

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH08

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH09
Machine : Dando 2000, Beretta T44 **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 8.00m 63mm cased to 18.70m	**Ground Level (mOD)** 20.84	**Client** DBFL	**Job Number** 9338-12-19
	Location 716881.5 E 731214.8 N	**Dates** 17/03/2020	**Project Contractor** GII	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						(0.30)	Dark brown sandy slightly gravelly TOPSOIL with occasional rootlets.			
					20.54	0.30				
0.50	B					(0.60)	Soft light brown slightly sandy slightly gravelly CLAY.			
1.00	B				19.94	0.90				
1.00-1.45	SPT(C) N=10			1,1/2,3,3,2			Firm light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
						(1.50)				
2.00	B									
2.00-2.45	SPT(C) N=11			1,2/3,3,3,2						
					18.44	2.40				
3.00	B						Very stiff dark grey slightly silty slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
3.00-3.45	SPT(C) N=28			2,3/5,7,7,9						
4.00	B									
4.00-4.45	SPT(C) N=38			5,7/7,9,11,11						
5.00	B									
5.00-5.45	SPT(C) N=43			7,7/8,10,12,13		(5.20)				
6.00	B									
6.00-6.44	SPT(C) 50/285			10,12/12,14,14,10						
7.00	B									
7.00-7.34	SPT(C) 50/190			12,14/16,23,11						
				12,17/24,26	13.24	7.60				
8.00	B					(0.40)	Very stiff light brown slightly sandy slightly gravelly CLAY with rare subangular to subrounded cobbles.			
8.00-8.28	SPT(C) 50/125				12.84	8.00				
8.00	TCR 100 SCR	RQD	FI				Very stiff slightly sandy slightly gravelly CLAY with occsional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse.			
8.20										
	100									
						(2.50)				
				12,22/50						
9.70-9.85	SPT(C) 50/0									
9.70										

Remarks
No groundwater encountered durig cable percussion drilling
Cable percussion drilling to 8.00m BGL with rotary follow on to 18.70m BGL.
Slotted pipe installed from 9.5 BGL to 3.0m BGL with pea gravel filter zone from 9.5m BGL to 1.0m BGL and bentonite seal from 1.0m BGL to GL, finished with an upright cover

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH09

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH09
Machine : Dando 2000, Beretta T44 **Flush :** Water **Core Dia :** 63 mm **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 8.00m 63mm cased to 18.70m	**Ground Level (mOD)** 20.84	**Client** DBFL	**Job Number** 9338-12-19
	Location 716881.5 E 731214.8 N	**Dates** 17/03/2020	**Project Contractor** GII	**Sheet** 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
	100					10.34	10.50	Very stiff brown slightly sandy slightly gravelly CLAY with somel subangular to subrounded cobbles and boulders.			
11.20-11.28 11.20	83				19,6/50 SPT(C) 25*/75 50/0		(2.50)				
12.70	27					7.84	13.00	No recovery. Driller notes possible rock at 13.00m.			
							(1.20)				
14.20	77					6.64	14.20	Possible weathered rock recovered as slightly sandy gravelly CLAY with subangular to subrounded cobbles of limestone.			
							(1.50)				
15.70	93	51	51			5.14	15.70	Medium strong- strong fine grained grey LIMESTONE partially to distinctly weathered, with closely to medium spaced thin beds of stiff brown Clay (possible residual mudstone). One set of fractures. F1: 0-10 degrees. Very closely-closely spaced undulating smooth occasionally open with brown staining and clay smearing.			
							(3.00)				
17.20	80	32	32								
18.70						2.14	18.70	Complete at 18.70m			

Remarks

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH09

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH10
Machine : Dando 2000 **Method :** Cable Percussion	**Casing Diameter** 200mm cased to 7.20m	**Ground Level (mOD)** 20.35	**Client** DBFL	**Job Number** 9338-12-19
	Location 716944.1 E 731201 N	**Dates** 17/03/2020-18/03/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					20.15	(0.20) 0.20	Dark brown sandy slightly gravelly TOPSOIL with occasional rootlets.		
0.50	B					(1.00)	Soft light brown slightly sandy slightly gravelly CLAY. Mottled grey.		
1.00-1.45 1.00	SPT(C) N=11 B			1,1/2,3,3,3	19.15	1.20	Firm to stiff light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
2.00-2.45 2.00	SPT(C) N=21 B			2,3/4,5,5,7		(1.30)			
3.00-3.45 3.00	SPT(C) N=44 B			5,7/9,10,12,13	17.85	2.50	Very stiff dark grey slightly silty slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
4.00-4.44 4.00	SPT(C) 50/285 B			7,9/11,14,16,9 Water strike(1) at 4.30m, rose to 4.20m in 20 mins.		(4.70)			▼1 ▽1
5.00-5.40 5.00	SPT(C) 44/245 B			7,10/10,10,17,7					
6.00-6.37 6.00	SPT(C) 50/215 B			9,11/14,17,19					
7.00-7.17 7.00	SPT(C) 50/20 B			12,14/50	13.15	7.20	Refusal at 7.20m		

Remarks
Groundwater encountered at 4.30m.
Borehole backfilled on completion
Borehole terminated at 7.20m BGL due to obstruction, possible boulder or rock

Scale (approx)	Logged By
1:50	PM

Figure No. 9338-12-19.BH10

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH11
Machine : Dando 2000, Beretta T44 **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 8.00m 96mm cased to 13.00m	**Ground Level (mOD)** 20.45	**Client** DBFL	**Job Number** 9338-12-19
	Location 716967.5 E 731182.2 N	**Dates** 18/03/2020	**Project Contractor** GII	**Sheet** 1/2

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
					20.35	0.10	MADE GROUND: Tarmacadam			
						(0.40)	MADE GROUND: Light brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles			
0.50	B				19.95	0.50				
					19.75	(0.20) 0.70	Soft light brown slightly sandy slightly gravelly CLAY with rare subangular to subrounded cobbles.			
1.00	B					(0.50)				
1.00-1.45	SPT(C) N=6			1,1/1,2,1,2	19.25	1.20	Soft light brown mottled grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
						(1.20)	Firm light brown slightly sandy slightly gravelly CLAY.			
2.00	B				18.05	2.40				
2.00-2.45	SPT(C) N=12			1,1/2,3,3,4			Very stiff dark grey slightly silty slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.			
3.00	B									
3.00-3.45	SPT(C) N=48			7,9/10,12,12,14						
4.00	B									
4.00-4.45	SPT(C) N=49			7,10/10,12,14,13						
						(4.70)				
5.00	B									
5.00-5.44	SPT(C) 50/285			8,9/11,12,13,14						
6.00	B									
6.00-6.40	SPT(C) 50/245			8,10/12,14,14,10						
7.00	TCR	SCR	RQD	FI						
7.00-7.37										
7.00										
	33	-								
8.00-8.34										
8.00										
8.20										
	87	18	9							
9.00										
9.70										

10,11/14,16,20
B
SPT(C) 50/220

12,14/17,20,15
SPT(C) 52/190
B

		13.35	7.10
			(0.90)
		12.45	8.00
			(1.00)
		11.45	9.00

Very stiff light brown slightly sandy gravelly CLAY with occasional subangular to subrounded cobbles.

Very stiff brown slightly sandy slightly gravelly CLAY with some subangular to subrounded cobbles and boulders.

Medium strong-strong grey fine grained LIMESTONE partially weathered with calcite veining.
Two sets of fractures. F1: 0-10 degrees. Very closely- closely spaced undulating smooth closed. F2 35-45 degrees. Closely- medium spaced undulating smooth closed.

Remarks
No groundwater encountered during cable percussive drilling
Cable percussion to 8.00m BGL with Rotary core follow on to 13.00m BGL.
Slotted pipe installed from 7.0m BGL to 3m BGL with pea gravel filter zone from 7.0m BGL to 1.0m BGL and bentonite seal from 1.0m BGL to GL, finished with a flush cover.

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH11

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Site Sandford Park Milltown			**Borehole Number** BH11
Machine : Dando 2000, Beretta T44 **Flush :** Water **Core Dia :** 96 mm **Method :** Cable Percussion with Rotary follow on	**Casing Diameter** 200mm cased to 8.00m 96mm cased to 13.00m	**Ground Level (mOD)** 20.45	**Client** DBFL	**Job Number** 9338-12-19
	Location 716967.5 E 731182.2 N	**Dates** 18/03/2020	**Project Contractor** GII	**Sheet** 2/2

Depth (m)	TCR (%)	SCR (%)	RQD (%)	FI	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
	93	89	87	8			(4.00)				
11.20	100	67	36								
12.70	100	67	67								
13.00						7.45	13.00	Complete at 13.00m			

Remarks

Scale (approx)	Logged By
1:50	PM, CB

Figure No. 9338-12-19.BH11

Ground Investigations Ireland Ltd
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Site Sandford Park Milltown			**Borehole Number** BH12
Machine : Dando 2000 **Method :** Cable Percussion	**Casing Diameter** 200mm cased to 8.00m	**Ground Level (mOD)** 21.41	**Client** DBFL	**Job Number** 9338-12-19
	Location 716865.6 E 731202.8 N	**Dates** 19/03/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.30)	Dark brown sandy slightly gravelly TOPSOIL with occasional rootlets.		
					21.11	0.30			
0.50	B					(0.70)	POSSIBLE MADE GROUND: light brown sandy gravelly CLAY.		
1.00-1.45 1.00	SPT(C) N=6 B			1,1/1,1,2,2	20.41	1.00			
						(0.90)	Soft light brown mottled grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
2.00-2.45 2.00	SPT(C) N=10 B			2,2/2,3,3,2	19.51	1.90			
						(0.70)	Firm light brown slightly sandy slightly gravelly CLAY.		
3.00-3.45 3.00	SPT(C) N=25 B			2,3/4,5,7,9	18.81	2.60			
4.00-4.45 4.00	SPT(C) N=30 B			3,4/5,7,9,9			Very stiff dark grey slightly silty slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles.		
5.00-5.45 5.00	SPT(C) N=35 B			6,6/7,8,9,11		(5.40)			
6.00-6.45 6.00	SPT(C) N=46 B			7,10/10,11,12,13					
7.00-7.40 7.00	SPT(C) 50/245 B			10,12/14,14,15,7					
8.00-8.37 8.00	SPT(C) 50/220 B			10,14/16,17,17	13.41	8.00	Complete at 8.00m		

Remarks
No groundwater encountered durig drillling
Borehole backfilled on completion.
Borehole complete at 8.00m BGL

Scale (approx)	Logged By
1:50	PM

Figure No. 9338-12-19.BH12

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Borehole Number** BH13
Machine : Dando 2000 **Method :** Cable Percussion	**Casing Diameter** 200mm cased to 3.70m	**Ground Level (mOD)** 22.64	**Client** DBFL	**Job Number** 9338-12-19
	Location 716891.5 E 731106.3 N	**Dates** 05/10/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
					22.34	0.30			
0.50	B						Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles and occasional rootlets. Gravel is subangular to subrounded fine to coarse		
1.00-1.45 1.00	SPT(C) N=7 B			1,2/2,1,2,2		(1.70)			
					20.64	2.00			
2.00-2.45 2.00	SPT(C) N=14 B			2,2/3,3,4,4		(0.60)	Firm to stiff brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse		
					20.04	2.60			
							Very stiff dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse		
3.00-3.45 3.00	SPT(C) N=39 B			4,6/7,9,10,13		(1.10)			
					18.94	3.70			
3.70	B						Obstruction: presumed boulder		
							Complete at 3.70m		

Remarks
Borehole terminated at 3.70m BGL due to an obstruction on a presumed boulder
No groundwater encountered during drilling
Borehole backfilled upon completion
Chiselling from 3.70m to 3.70m for 1 hour.

Scale (approx)	Logged By
1:50	PC

Figure No. 9338-12-19.BH13

Ground Investigations Ireland Ltd
www.gii.ie

Site	Borehole Number
Sandford Park Milltown	BH14

Machine : Dando 2000 Method : Cable Percussion	Casing Diameter 200mm cased to 3.50m	Ground Level (mOD) 22.96	Client DBFL	Job Number 9338-12-19
	Location 716916.3 E 731074.5 N	Dates 05/10/2020	Project Contractor GII	Sheet 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets			
					22.56	0.40				
0.50	B						Firm brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse			
1.00-1.45 1.00	SPT(C) N=11 B			2,2/2,3,3,3		(1.60)				
2.00-2.45 2.00	SPT(C) N=15 B			2,3/3,3,4,5	20.96	2.00				
						(0.70)	Firm to stiff brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse			
					20.26	2.70				
3.00-3.45 3.00	SPT(C) N=36 B			4,5/6,8,10,12		(0.80)	Very stiff dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse		▼1	
3.50	B			Water strike(1) at 3.50m, rose to 3.00m in 20 mins.	19.46	3.50	Obstruction: presumed boulder		▽1	
							Complete at 3.50m			

Remarks
Borehole terminated at 3.50m BGL due to an obstruction on a presumed boulder
Groundwater encountered at 3.50m BGL
Slotted pipe with pea gravel surround from 3.50m BGL to 1.00m BGL, plain pipe with bentonite seal from 1.00m BGL to GL, finished with a flush cover
Chiselling from 3.50m to 3.50m for 1 hour.

Scale (approx)	Logged By
1:50	PC

Figure No.
9338-12-19.BH14

Ground Investigations Ireland Ltd
www.gii.ie

Site Sandford Park Milltown			**Borehole Number** BH15
Machine : Dando 2000 **Method :** Cable Percussion	**Casing Diameter** 200mm cased to 9.50m	**Ground Level (mOD)** 22.71	**Client** DBFL	**Job Number** 9338-12-19
	Location 716914.3 E 731092 N	**Dates** 06/10/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets		
					22.41	0.30			
0.50	B					(0.60)	MADE GROUND: Brown slightly sandy slightly gravelly Clay with occasional rootlets and occasional fragments of concrete and red brick		
					21.81	0.90			
1.00-1.45 1.00	SPT(C) N=13 B			2,2/3,3,3,4			Firm to stiff brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse		
						(1.10)			
					20.71	2.00			
2.00-2.45 2.00 2.00	SPT(C) N=17 B EN			2,3/3,4,5,5		(0.40)	Stiff brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse		
					20.31	2.40			
							Very stiff dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse		
3.00-3.45 3.00 3.00	SPT(C) N=32 B EN			3,5/6,8,9,9					
4.00-4.45 4.00	SPT(C) N=39 B			3,6/7,10,11,11					
5.00-5.42 5.00	SPT(C) 50/270 B			5,8/11,15,17,7					
						(6.70)			
6.00-6.39 6.00	SPT(C) 50/240 B			4,7/12,15,19,4					
7.00-7.38 7.00	SPT(C) 50/225 B			5,9/13,15,22					
8.00-8.36 8.00	SPT(C) 50/210 B			6,10/14,17,19					
9.00-9.38 9.00	SPT(C) 50/225 B			5,9/12,18,20	13.61	9.10			
						(0.40)	Very stiff brown slightly sandy gravelly CLAY with some angular to subrounded cobbles. Gravel is angular to subrounded fine to coarse		
9.50	B				13.21	9.50	Obstruction: presumed boulder		
							Complete at 9.50m		

Remarks
Borehole terminated at 9.50m BGL due to an obstruction on a presumed boulder
No groundwater encountered during drilling
Borehole backfilled upon completion
Chiselling from 9.40m to 9.50m for 1 hour.

Scale (approx)	Logged By
1:50	PC

Figure No. 9338-12-19.BH15

Ground Investigations Ireland Ltd
www.gii.ie

Site	Borehole Number
Sandford Park Milltown	BH16

Machine	Casing Diameter	Ground Level (mOD)	Client	Job Number
DANDO 2000	200mm cased to 5.70m	21.38	DBFL	9338-12-19
Method : Cable Percussion	**Location** 716896.6 E 731165.2 N	**Dates** 07/10/2020	**Project Contractor** GII	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water	Instr
						(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with occasional rootlets			
					20.98	0.40				
0.50	B						Firm brown slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles and occasional rootlets			
1.00-1.45	SPT(C) N=12			2,2/3,3,3,3		(1.40)				
1.00	B								▼1	
				Water strike(1) at 1.80m, rose to 1.30m in 20 mins.	19.58	1.80			▽1	
2.00	B						Medium dense greyish brown slightly clayey sandy subangular to subrounded fine to coarse GRAVEL with occasional angular to subrounded cobbles			
2.00-2.45	SPT(C) N=15			2,3/4,3,4,4						
3.00-3.45	SPT(C) N=16			3,4/3,3,5,5		(2.70)				
3.00	B									
4.00-4.17	SPT(C) 25*/95 50/75			19,6/50						
4.00	B									
					16.88	4.50	Very stiff dark grey slightly sandy slightly gravelly CLAY with occasional subangular to subrounded cobbles. Gravel is subangular to subrounded fine to coarse			
5.00-5.45	SPT(C) N=41			4,3/7,9,12,13		(1.20)				
5.00	B									
					15.68	5.70	Obstruction: presumed boulder			
5.70	B						Complete at 5.70m			

Remarks
Borehole terminated at 5.70m BGL due to an obstruction on a presumed boulder
Groundwater encountered at 1.80m BGL
Slotted pipe with pea gravel surround from 5.70m BGL to 1.00m BGL, plain pipe with bentonite seal from 1.00m BGL to GL, finished with a raised cover
Chiselling from 4.30m to 4.40m for 0.10 hours. Chiselling from 5.70m to 5.70m for 1 hour.

Scale (approx)	Logged By
1:50	PC

Figure No. 9338-12-19.BH16

APPENDIX 9 – Groundwater Monitoring

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

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Web: www.gii.ie

GROUNDWATER MONITORING

Sandford Park Miltown

BOREHOLE	DATE	TIME	GROUNDWATER (m BGL)	Comments
BH02	04/06/2020	17:15	1.31	
BH02	09/06/2020	16:15	1.37	
BH03	05/06/2020	14:58	7.00	
BH03	09/06/2020	15:50	7.25	
BH07	05/06/2020	14:37	1.47	
BH07	09/06/2020	16:06	1.50	
BH09	05/06/2020	15:20	7.50	
BH09	09/06/2020	15:25	7.74	
BH11	05/06/2020	15:55	1.40	
BH11	09/06/2020	16:11	1.50	

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GROUNDWATER MONITORING

Sandford Park Miltown

BOREHOLE	DATE	TIME	GROUNDWATER (m BGL)	Comments
BH02	23/10/2020	09:05	0.77	
BH03	23/10/2020	08:50	6.30	
BH07	23/10/2020	08:52	1.37	
BH09	23/10/2020	08:47	6.69	
BH11	23/10/2020	09:00	1.10	
BH14	23/10/2020	08:35	1.43	
BH16	23/10/2020	08:45	1.22	