BM BARRETT **MAHONY**
CIVIL & STRUCTURAL
CONSULTING ENGINEERS

Infrastructure Report

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Dundrum Central Development

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1. INTRODUCTION

1.1 GENERAL DESCRIPTION

The Land Development Agency intend to apply to An Bord Pleanála (the Board) for a 10 year permission for a Strategic Housing Development with a total application site area of c.9.6 ha, on lands at the Central Mental Hospital, Dundrum Road, Dundrum, Dublin 14.

This report will form part of the strategic housing development (SHD) submitted to An Bord Pleanála.

Figure 1.1 – Site Location

The development will consist of the demolition of existing structures associated with the existing use (3,736 sq m), including:

- Single storey former swimming pool / sports hall and admissions unit (2,750 sq m);
- Two storey redbrick building (305 sq m);
- Single storey ancillary and temporary structures including portacabins (677 sq m);
- Removal of existing internal sub-divisions/ fencing, including removal of security fence at Dundrum Road entrance;
- Demolition of section of porch and glazed screens at Gate Lodge building (4 sq m);
- Removal of walls adjacent to Main Hospital Building;
- Alterations and removal of section of wall to Walled Garden.

The development will also consist of alterations and partial demolition of the perimeter wall, including:

- Alterations and removal of section of perimeter wall adjacent to Rosemount Green (south);
- Formation of a new opening in perimeter wall at Annaville Grove to provide a pedestrian and cyclist access;

- Alterations and removal of sections of wall adjacent to Dundrum Road (including removal of existing gates and entrance canopy), including reduction in height of section, widening of existing vehicular access, provision of a new vehicular, cyclist and pedestrian access;
- Alterations and removal of section of perimeter wall adjacent to Mulvey Park to provide a pedestrian and cyclist access.

The development with a total gross floor area of c. 106,770 sq m (c. 106,692 sq m excluding retained existing buildings), will consist of 977 no. residential units comprising:

- 940 no. apartments (consisting of 53 no. studio units; 423 no. one bedroom units; 37 no. two bedroom (3 person) units; 317 no. two bedroom (4 person) units; and 110 no. 3 bedroom units) arranged in 9 blocks (Blocks 02-10) ranging between 2 and 6 storeys in height (with a lower ground floor to Block 03 and Block 10, resulting in part 7 storey), together with private (balconies and private terraces) and communal amenity open space provision (including courtyards and roof gardens) and ancillary residential facilities;
- 17 no. duplex apartments (consisting of 3 no. 2 bedroom units and 14 no. 3 bedrooms units located at Blocks 02, 08 and 09), together with private balconies and terraces.
- 20 no. two and three storey houses (consisting of 7 no. three bedroom units and 13 no. 4 bedrooms units) and private rear gardens located at Blocks 02, 08 and 09).

The development will also consist of 3,889 sq m of non-residential uses, comprising:

- Change of use and renovation of existing single storey Gate Lodge building (reception/staff area) to provide a café unit (78 sq m);
- 1 no restaurant unit (307 sq m) located at ground floor level at Block 03;
- 6 no. retail units (1,112 sq m) located at ground floor level at Blocks 03, 06 and 07;
- 1 no. medical unit (245 sq m) located at ground floor level at Block 02;
- A new childcare facility (463 sq m) and associated outdoor play area located at ground floor level at Block 10; and
- A new community centre facility, including a multi-purpose hall, changing rooms, meeting rooms, storage and associated facilities (1,684 sq m) located at ground and first floor level at Block 06.

Vehicular access to the site will be from the existing access off Dundrum Road, as revised, and from a new access also off Dundrum Road to the south of the existing access.

The development will also consist of the provision of public open space and related play areas; hard and soft landscaping including internal roads, cycle and pedestrian routes, pathways and boundary treatments, street furniture, wetland feature, part-basement, car parking (547 no. spaces in total, including car sharing and accessible spaces); motorcycle parking; electric vehicle charging points; bicycle parking (long and short stay spaces including stands); ESB substations, piped infrastructural services and connections (including connection into existing surface water sewer in St. Columbanus Road); ducting; plant (including external plant for district heating and pumping station); waste management provision; SuDS measures (including green roofs); attenuation tanks; sustainability measures (including solar panels); signage; public lighting; any making good works to perimeter wall and all site development and excavation works above and below ground.

1.2 PURPOSE OF THIS REPORT

This report considers the proposed development's main infrastructural elements and how they connect to the public infrastructure in the area.

In particular, foul and surface water drainage, water supply and road engineering aspects are addressed. This report should be read in conjunction with the following drawings submitted with the planning application:

DCD-BMD-00-00-DR-C-1000	Roads Layout & Levels
DCD-BMD-00-00-DR-C-1001	Road Finishes, Road Markings & Road Signage Layout
DCD-BMD-00-00-DR-C-1002	Dundrum Road Access Junction (South)
DCD-BMD-00-00-DR-C-1003	Dundrum Road Access Junction (North)
DCD-BMD-00-00-DR-C-1004	Vehicle Tracking . Refuse Vehicle (Twin Rear Axle)
DCD-BMD-00-00-DR-C-1005	Vehicle Tracking . Dublin Fire Brigade Tender Vehicle
DCD-BMD-00-00-DR-C-1011	Typical Road Cross-Sections Sheet 1 of 3
DCD-BMD-00-00-DR-C-1012	Typical Road Cross-Sections Sheet 2 of 3
DCD-BMD-00-00-DR-C-1013	Typical Road Cross-Sections Sheet 3 of 3
DCD-BMD-00-00-DR-C-1020	Buried Surface Water Drainage Layout
DCD-BMD-00-00-DR-C-1021	Buried Foul Water Drainage Layout
DCD-BMD-00-00-DR-C-1022	Buried Foul Water & Surface Water Drainage Layouts Combined
DCD-BMD-00-00-DR-C-1023	Undercroft & Basement Car Parking Buried Drainage Layout
DCD-BMD-00-00-DR-C-1025	Surface Water Overland Flow Routes
DCD-BMD-00-00-DR-C-1030	SuDS Layout
DCD-BMD-00-00-DR-C-1039	Existing Buried Drainage Layout
DCD-BMD-00-00-DR-C-1040	Buried Watermain Layout
DCD-BMD-00-ZZ-DR-C-1050	Site Perimeter Foundation Sections Sheet 1 of 2
DCD-BMD-00-ZZ-DR-C-1051	Site Perimeter Foundation Sections Sheet 2 of 2
DCD-BMD-ZZ-ZZ-DR-C-1100	Road Long-sections (Sheet 1 of 2)
DCD-BMD-ZZ-ZZ-DR-C-1101	Road Long-sections (Sheet 2 of 2)
DCD-BMD-00-00-DR-C-1110	Foul Water Drainage Longitudinal Sections Sheet 1 of 3
DCD-BMD-00-00-DR-C-1111	Foul Water Drainage Longitudinal Sections Sheet 2 of 3
DCD-BMD-00-00-DR-C-1112	Foul Water Drainage Longitudinal Sections Sheet 3 of 3
DCD-BMD-00-00-DR-C-1115	Surface Water Drainage Longitudinal Sections Sheet 1 of 3
DCD-BMD-00-00-DR-C-1116	Surface Water Drainage Longitudinal Sections Sheet 2 of 3
DCD-BMD-00-00-DR-C-1117	Surface Water Drainage Longitudinal Sections Sheet 3 of 3
DCD-BMD-00-00-DR-C-1200	Road & Hardstanding Details Sheet 1 of 2
DCD-BMD-00-00-DR-C-1201	Road & Hardstanding Details Sheet 2 of 2
DCD-BMD-00-00-DR-C-1205	SuDS Details. Typical Green & Blue Roof Details
DCD-BMD-00-00-DR-C-1206	SuDS Details. Permeable Paving Details
DCD-BMD-00-00-DR-C-1207	SuDS Details. Filter Drain Typical Details
DCD-BMD-00-00-DR-C-1208	SuDS Details. Typical Stormtech Attenuation Tank Details
DCD-BMD-00-00-DR-C-1209	SuDS Details. Typical Bio-Retention Area & Tree Pit Details
DCD-BMD-00-00-DR-C-1210	SuDS Details. Swales, Detention Basin & Over-the-edge Drainage
DCD-BMD-00-00-DR-C-1220	Foul Water Lifting Station Details Sheet 1 of 2
DCD-BMD-00-00-DR-C-1221	Foul Water Lifting Station Details Sheet 2 of 2
DCD-BMD-00-00-DR-C-1225	Standard Surface Water Drainage Details

1.3 SITE TOPOGRAPHY

A detailed topographical survey of the existing site has been prepared. There is considerable variation in ground levels across the site. In broad terms the main part of the site slopes down gradually from the southwest corner towards the northeast corner, from +45.21m OD down to +38.76m OD. The western portion of the site slopes down towards the Dundrum Road entrance at +38.44m OD. These low points are the furthest locations from the high topography in the south corner at a distance of over 400m away. Figure 1 shows typical spot levels across the site.

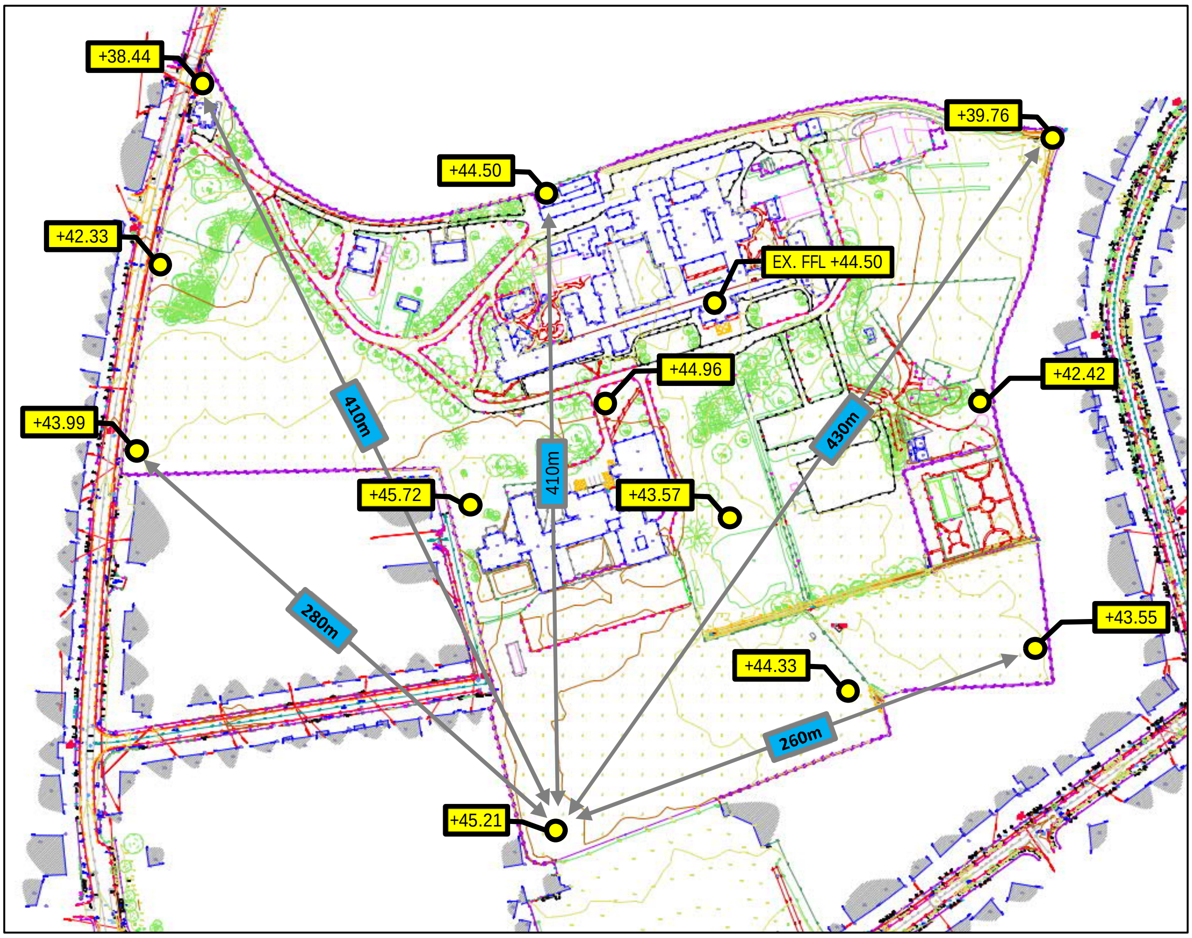


Fig 1.2 – Summary of the Existing Site Topography Superimposed on Topographical Survey Drawing. (Ordnance Datum Levels).

1.4 Engagement with the Local Authorities

1.4.1 Meetings

Meetings were held with DLRCC, via Microsoft Teams, on the 17th of November 2020 and the 26th of March 2021 to discuss the surface water and foul water drainage proposals. Mr Bernard Egan and Ms Elaine Carroll from DLRCC were in attendance.

Another meeting was held via Microsoft Teams with Ms Elaine Carroll from DLRCC on the 3rd of June 2021 to discuss the proposed drainage network and strategy.

Email correspondence with Irish Water and with DLRCC continues.

1.4.2 DLRCC Report of the Chief Executive, 9th of July 2021, on the PAC Submission to the Bord

Set out below are Barrett Mahony responses to the items raised in the DLRCC Drainage Planning Report in relation to surface water drainage. This section is abstracted from Appendix B of the Chief Executives report. DLRCC text is shown below in italics.

1. “The applicant proposes to limit the outflow from the site to 38 l/s based on the entire site area of 8.41ha being drained, using SAAR value 772 and Soll Type 4. Although the discharge rate and volume of attenuation appear sufficient for this site, the accompanying modelled data does not seem to match the layout submitted. There are flow control devices missing from the modelling and additional storage areas have been Included that are not the surface water drainage layout drawing. Also, the site Is divided into five catchments, with separate outfalls for each, and not two as presented in the Infrastructure report. In order to assess the application, each catchment will need to be modelled and presented separately to ensure they are designed appropriately for the area of the site they serve. It Is also unclear what contributing areas have been used in the modelling and where or how reduced run-off coefficients have been applied. The applicant Is requested to resubmit the Infrastructure report, surface water drainage layout and modelling results to demonstrate that all five catchments have been assessed Independently as well as collectively. The networks modelled should match those shown on the drawing. Additional labels should be added to the modelling outputs to clearly Identify each catchment, attenuation storage area and flow control device. The applicant shall tabulate the contributing areas for each catchment In accordance with type and run-off coefficient applied. The applicant shall clearly state the total attenuation volume for the site, and each catchment, and ensure the discharge rate from each flow control device Is clearly shown on the surface water drainage layout drawing.”

BM Response: The requested information has been provided by BM in this updated report and in the updated drawings.

2. “It Is unclear if this site is to be constructed in phases. If phased construction is proposed then the applicant must demonstrate how discharge rates will be limited and sufficient attenuation volumes and Interception/treatment of run-off provided for each phase of the work. Sufficient detail must be provided in the Construction Management Plan regarding the measures proposed to construct the surface water drainage system during each phase of works while protecting the existing surface water drainage elements. “

BM Response: Phasing is addressed in the CEMP report submitted with the application, there are five phases proposed. The impact of the phasing on the surface water system is dealt with in this updated report. Refer to Section 5 of this report. Each phase of the development incorporates a full suite of SuDS measures, in accordance with GDSDS. The attenuated outflow from each phase does not exceed the Qbar value for the area covered by that phase.

3. “There appears to be a section of the site along the east boundary that is pumped in "Catchment B1". The applicant should note that pumping of surface water run-off is not acceptable. The applicant shall amend their surface water drainage design to remove the need for surface water pumping. “

BM Response: Catchment B1 is not pumped. It drains by gravity through the existing wall opening into the adjacent open drain as shown on BM drg no. C1020.

4. “There appears to be a section of the drainage system to the north-west of the site that drains unattenuated, according to the surface water layout. The applicant is requested to amend their design to ensure that all areas of the site are attenuated and Intercepted/treated prior to restricted discharge from the site. “

BM Response: This area, at the gate lodge, now drains into a bio-retention area. Please refer to BM drawing no. C1020.

5. “The applicant Is requested to submit supporting details, Including cross-sections, of each of the proposed outfalls from the site. “

BM Response: Sections through each outfall are shown on the longitudinal surface water drainage sections drawing, drg. No. C1115-C1117. Details of a typical outfall to the existing on-site open ditch are shown on BM drawing no. C1225. Also refer to the SW layout drawing C1020.

6. “As standard, the applicant Is requested to submit long-sections of the surface water drainage system, clearly labelling cover levels, Invert levels, pipe gradients and pipe diameters. “

BM Response: Refer to BM drawing no’s C1115 – C1117.

7. As standard, the applicant shall provide details of maintenance access to the green roofs and should note that, in the absence of a stairwell type access to the roof, provision should be made for alternative maintenance and access arrangements such as external mobile access that will be centrally managed. The applicant should comment on the compatibility of the green roofs with PV panels if they are to be Incorporated Into the design.

BM Response: Roof access arrangements are shown on the Architect’s drawings accompanying the application. Areas of PV panels are indicated. Green roofs will not be provided beneath PV panels.

8. “As standard, the applicant is requested to provide a penstock in the flow control device chamber and ensure that the flow control device provided does not have a bypass door. The applicant shall also clarify whether a silt trap Is being provided in the flow control device chamber and if not to make provision for same.”

BM Response: A penstock gate valve is shown on the typical flow control device chamber on BM drawing no. C1208.

9. As standard, the applicant is requested to confirm that required clearances are provided between other utilities and confirm the actual depths of cover to each burled attenuation system. The applicant shall Include confirmation from the chosen manufacturer of the storage systems that the specific model chosen, with the depth of cover being provided, has the requested load bearing capacity to support the loading that may Imposed upon it.

BM Response: The required clearances are provided between other utilities and the surface water drains. A plan layout drawing showing the foul drainage and surface water drainage has been prepared to ensure all conflicts are addressed. The site watermain layout plan has been coordinated with this plan. Refer to BM drawing C1022. Longitudinal sections throughout the foul and surface water drains have also been prepared.

The depth of cover to each attenuation tank is shown on BM drawing no. C1020. The tanks will be designed to support vehicular loading (fire tender).

10. "As standard, the applicant Is requested to confirm that a utilities clash check has been carried out ensuring all utilities' vertical and horizontal separation distances can be provided throughout the scheme. The applicant should demonstrate this with cross-sections at critical locations such as junctions, site thresholds and connection points to public utilities. Minimum separation distances shall be in accordance with applicable Codes of Practice. "

BM Response: A utilities clash check has been carried out. A plan layout drawing showing the foul drainage and surface water drainage has been prepared to ensure all conflicts are addressed. The site watermain layout plan has been coordinated with this plan. Refer to BM drawing C1022. Longitudinal sections throughout the foul and surface water drains have also been prepared.

11. "Although the applicant has tabulated that the required volume can be intercepted/treated, they have not demonstrated that the entire area of the site is accommodated. As standard, the applicant Is requested to show the options being proposed for Interception and treatment with contributing areas on a drawing together with-an accompanying text and tabular submission showing the calculations, to demonstrate that the entire site is in compliance with GDSDS requirements. The applicant should note that over-provision in one location does not compensate for under provision elsewhere. "

BM Response: The requested information has been provided in this report and on the BM SuDS layout drawing, drawing no. C1030.

12. "If the applicant proposes SuDS measures that Incorporate the use of infiltration, the applicant Is requested to provide details of each SuDS measure and confirm whether it will be lined/tanked or not. If lined/tanked systems are to be used, then the applicant will be requested to explain the rationale behind this. If unlined systems are to be used then the applicant Is requested to demonstrate on a drawing that all Infiltration SuDS proposals, Including the attenuation systems, have a 5m separation distance from building foundations and 3m separation from site boundaries."

BM Response: All SuDS devices are typically lined with a permeable geotextile, as shown in the typical SuDS details drawings, drg no's C1205 to C1210. Impermeable membranes are to be provided, as noted in these drawings and on the surface water layout plan C1020, where a device is within 5 metres of building foundations or within 3metres of a site boundary. For permeable paving areas not taking additional flow, an impermeable lining within 1.5m will only be provided of boundaries or foundations. Refer to BM drawing C1206.

13. "A Stormwater Audit will be requested for this application. In accordance with the Stormwater Audit policy, the audit shall be forwarded to DLRCC prior to lodging the planning application. All recommendations shall be complied with, unless agreed in writing otherwise with DLRCC. "

BM Response: A Stormwater Audit has been prepared by JBA Consulting Engineers. Please refer to Appendix 8. The recommendations in the audit have been complied with.

14. "The applicant Is requested to confirm if access through the north-east corner of the site can be provided for maintenance access of the ditch. There is a door in the wall in the northeast corner that allows access to the ditch."

BM Response: The door provides access to lands owned by DLRCC. This allows access up to the edge of the ditch. The open ditch, along its length at the back of boundary wall is in third party ownership before entering an adjacent surface water sewer in DLR ownership.

1.4.2.1 Email Dated 10/03/2022 form Ms Elain Carroll, DLRCC

Email response on the submitted surface water report (attached in Appendix 8):

"We would consider using the local Soil Type SPR for landscaped areas to be drained, rather than the proposed run-off factor of 0.3, would be more appropriate. Other than this the other items accepted by the Auditors appear to be acceptable in principle."

BM Response: The runoff factors for landscaped areas will be revisited prior to construction.

2. SURFACE WATER DRAINAGE SYSTEM

2.1 INTRODUCTION

This chapter follows the guidelines set out in Greater Dublin Strategic Drainage Study (GDSDS) and the CIRIA 2015 SuDS Manual.

The aim of any SuDS strategy is to ensure that a new development does not negatively affect surrounding watercourse systems, existing surface water networks and groundwater systems. This SuDS strategy will achieve these aims by using a variety of SuDS measures within the site. These measures include water interception, treatment, infiltration and attenuation.

The SuDS strategy will be developed with the following steps:

1. The existing greenfield run-off of the development site will be calculated and used as the minimum benchmark for the SuDS design. This run-off calculation is based on the drained area of the new development. The post development run-off will not exceed the greenfield run-off.
2. A set of SuDS measures will be chosen based on their applicability and usage for the site.
3. A “FLOW” model will be created to analyse the rainfall on the site and the effectiveness of the proposed SuDS measures.
4. If effective, these SuDS measures will be incorporated into the proposed design.

2.2 EXISTING SURFACE WATER INFRASTRUCTURE

The lands/roads surrounding the site contain a number of surface water sewers and a combined sewer. The River Slang runs south to north, approximately 70m to the west of the site and a drainage ditch runs through the site and northwards along the eastern boundary as shown in Figure 2.1.

2.2.1 Existing Site Drainage

Existing site drainage confirmed by CCTV and dye testing have shown the existing buildings on site discharging to a combined drainage system on site. This system discharges to the Ø300mm combined sewer in the Dundrum Road, connecting at the current site entrance.

2.2.2 Existing Surface Water Drainage in The Vicinity of The Site:

a) The River Slang: The River Slang runs from south of Dundrum Village northwards down to the River Dodder and passes approximately 70 metres west of the western site boundary on the Dundrum Road. The estimated 100-year storm level in the river is approximately 1.5metres lower than the lowest point of the site, at the existing Dundrum Road entrance. Predicted floods, for storms with 1 in 10, 1 in 100 & 1 in 1000-year return periods are shown on the OPW CFRAMS Flood Maps. This flooding does not encroach on the subject site. Refer to the Site-Specific Flood Risk Assessment for further information.

b) Public Sewer and drainage ditch on the south and east boundary: A 525mm diameter surface water sewer enters the south side of the site from Rosemount Green. Refer to Figure 2.1 below. This connects into an open drainage ditch which runs west to east across the site along the southern edge of the walled garden and discharges through a grated opening in the boundary wall (Location B1 in Figure 2.1 below) where it continues as a drainage ditch running northwards just along and outside of the east boundary wall. Property Registration Authority maps indicate that the drainage ditch is in third party ownership along the outside of the wall. There are no records of flooding in this watercourse. Flow monitoring by LowFlow Ltd was carried out at Location B1, refer to the report attached in Appendix 3. The report indicates that there is a correlation between the flow in the channel and rainfall events.

2.2.3 Drainage Ditch flood level

The Lowflo flow logger results showed that the depth of water in the drainage ditch varied between 25mm and 180mm during the two and a half months of recordings. The drainage ditch is approximately 1m deep. There is insufficient data to calculate a flood level for the 1 in 100 year storm event. In the case that the level in the ditch rises, the head of water in the pipe network discharging to it, will be sufficient to push the water through and out into the ditch.

Figure 2.1 - Aerial view of the site with two surface water drainage connection locations indicated.

2.3 PROPOSED SURFACE WATER DRAINAGE SYSTEM

The proposed surface water drainage system is designed to comply with the 'Greater Dublin Strategic Drainage Study (GDSDS) Regional Drainage Policies Technical Document – Volume 2, New Developments, 2005' and the 'Greater Dublin Regional Code of Practice for Drainage Works, V6.0 2005'. CIRIA Design Manuals C753, C697 and C609 have also been used to design the surface water drainage system within the site.

2.3.1 Catchment strategy

The development will be split into three catchments. The catchments will be attenuated separately by means of blue roofs and attenuation tanks, which follow approximately the existing site topography and natural drainage routes on site. Catchment A drains to the Slang, via an existing surface water sewer. Catchments B drains to the open drainage ditch on site (B1) or just outside the site (B2). Connection points 'A' , 'B1' and 'B2' shown in Figure 2.1 and 2.2.

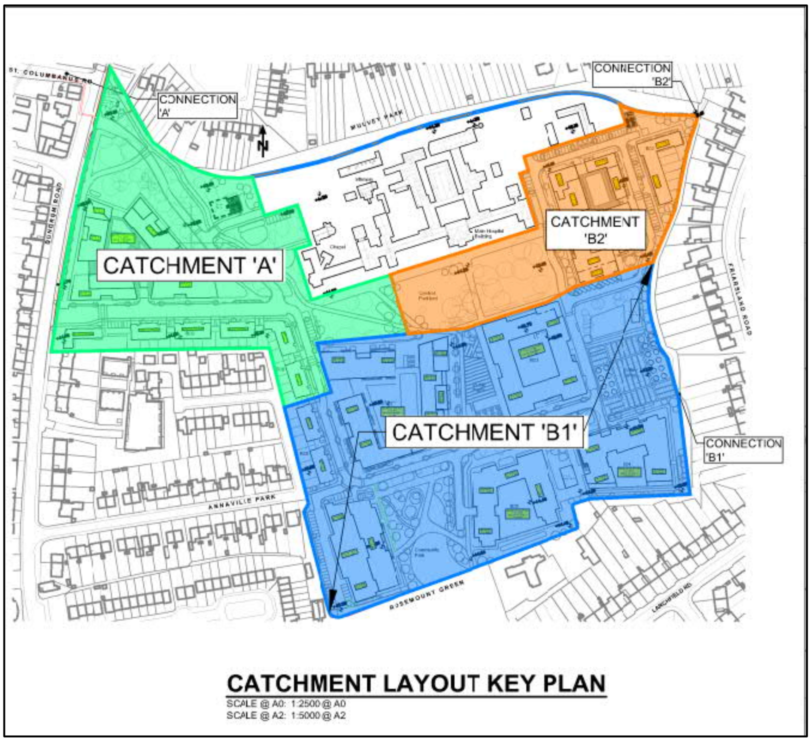


Figure 2.2 – Catchment Strategy

2.3.1.1 Catchment Area

The total site area is c9.6ha. The positively drained area on site is c6.46ha in size, comprising of Catchment A (1.406ha) , Catchment B1 (4.05ha) and Catchment B2 (1.01ha). The total area will collect all the surface water drainage into an underground pipe network. The drainage system will use different SuDS measures in the treatment train, which will have an influence on the runoff coefficients. The more porous the material, the lower the runoff coefficient. Surface materials will consist of, but not limited to permeable paving, intensive and extensive green/blue roofs and podiums, impermeable roofs, bio-retention areas, filter strips, a detention basin, impermeable hardstanding, tree pits and landscaped areas. Please refer to the BMCE SuDS layout drawing C1030 for the illustration and location of the SuDS measures and attenuation storage areas.

The runoff coefficients used in the calculations are as requested by DLR:

Table 2.1: Runoff Coefficients

Type of areas	CV
Landscaping (Grass / Soft)	0.3
Intensive Green Roof / Podium	0.8
Extensive Green Roof	0.8
Permeable Paving	0.8
Impermeable Surface (incl tree pits)	0.9
Standard Roof (impermeable)	0.95

Please refer to Appendix 7 for a tabulated schedule of all the contributing areas

2.3.2 Estimation of greenfield runoff rate

In accordance with the IH124 method, the greenfield runoff for existing undeveloped sites measuring less than 50ha can be estimated using the following formula:
$Qbar_{rural}$ (in m³ /s) = $0.00108 \times (0.01 \times AREA)^{0.89} \times SAAR^{1.17} \times SPR^{2.17}$
where:

- $Qbar_{rural}$ is the mean annual flood flow from a catchment
- AREA is the area of the catchment in ha.
- SAAR is the standard average annual rainfall for the period 1981-2010 Annual Average Rainfall Grid produced by Met Éireann.
- SPR is Standard Percentage Runoff coefficient for the SOIL category – geotechnical report.

Rainfall data for the site was sourced from an Annual Average Rainfall (AAR) Grid (1981-2010) produced by Met Éireann (Available from: http://www.met.ie/climate/products03.asp). The rainfall data for the Irish Grid Coordinates closest to the site indicates a SAAR value of 772mm is appropriate.

Table 2.2: Met Éireann Annual Average Rainfall (AAR) Grid (1981-2010) Extract

east	north	Annual Average Rainfall (mm)
317000	226000	928
317000	227000	876
317000	228000	822
317000	229000	772
317000	230000	744
317000	231000	744
317000	232000	740

Therefore, $Qbar_{rural}$ for a 50ha site has been calculated as follows:

$Qbar_{rural}$ (for a 50ha site) $= 0.00108 \times (0.01 \times 50)^{0.89} \times 772^{1.17} \times 0.45^{2.17}$
$Qbar_{rural}$ (for a 50ha site) = 0.246314 m³ /s
= 246.315 l/s

Interpolating linearly, this corresponds with a Qbar figure for the drained area (6.467ha) of 31.86l/s. The discharge limit to the site has been taken as a conservative 29.0 l/s. The runoff rate for each catchment is set out in the table below:

Table 2.3: Runoff rate per catchment

Catchment	Area (m^2)	Drained Area (m^2)	Calculated Qbar (l/s)	Proposed Qbar (l/s)
Catchment A	29 747	14 059	6.925	7.0
Catchment B1	47 961	40 499	19.951	18.0
Catchment B2	17 788	10 116	4.998	4.0
Total	95 496*	64 673	31.86	29.0

*Please note, the red line has a 374m^2 area outside of the drained catchment area for the surface water drainage connection in the public road to the surface water sewer in St Columbus Road.

2.3.3 Compliance with the Principles of SuDS

2.3.3.1 Compliance with the principles of the GDSDS

The proposed development will be designed in accordance with the principles of Sustainable Drainage Systems (SuDS) as embodied in the recommendations of the Greater Dublin Strategic Drainage Study (GDSDS) and will significantly reduce run-off rates and improve storm water quality discharging to the public storm water system. The GDSDS addresses the issue of sustainability by requiring designs to comply with a set of drainage criteria which aim to minimize the impact of urbanization by replicating the run-off characteristics of the greenfield site. The criteria provide a consistent approach to addressing the increase in both rate and volume of run-off, as well as ensuring the environment is protected from any pollution from roads and buildings. These drainage design criteria are as follows:

- Criterion 1 – River Water Quality Protection
- Criterion 2 – River Regime Protection
- Criterion 3 – Flood Risk Assessment
- Criterion 4 – River Flood Protection

The requirements of SuDS are typically addressed by provision of the following:

- Interception storage
- Treatment storage (commonly addressed in interception storage)
- Attenuation storage
- Long term storage (not applicable if growth factors are not applied to Qbar when designing attenuation storage)

2.3.3.2 Compliance with the principles of the CIRIA C573 SuDS Manual

The C753 SuDS Manual explains that the primary function of SuDS measures is to protect watercourses from any impact due to the new development. However, SuDS can also improve the quality of life in a new development and urban spaces by making them more vibrant, visually attractive, sustainable and more resilient to change. This document explains the wider social context of SuDS and how SuDS can deliver high quality drainage while supporting urban areas to cope better with sever rainfall both in present and future.

There are four main categories of benefits that can be achieved by SuDS:

1. Water Quantity (mitigate flood risk & protect natural water cycle)
2. Water Quality (manage the quality of the runoff to prevent pollution)
3. Amenity (create and sustain better places for people)
4. Biodiversity (create and sustain better places for nature)

2.3.4 SuDS Measure Selection

Below are the applicable SuDS measures which have been chosen for the site. The proposed site has been divided into 3no sub-catchment areas. Sub catchment A is the north-western part of the site, connecting into the public surface water sewer network at Dundrum Road, adjacent to the discharge point into the River Slang. Sub catchment B1 and B2 will drain the remainder of the site, connecting to the existing drainage ditch on the eastern side of the site.

The runoff generated from the catchments will be attenuated in storage structures below ground and in the blue roof attenuation systems. The proposed attenuation systems are explained in section 2.3.5.

A wide range of SuDS measures are proposed across the site to maximise interception and treatment.

2.3.4.1 Green Roofs – General

Green roofs are areas of living vegetation, installed on the top of buildings. They provide water quality, water quantity, amenity and provide biodiversity benefits. Green roofs also intercept rainfall at source reducing the reliance on attenuation storage structures.

Refer to the Barrett Mahony SuDS detail drawing no. 1205 for typical roof details.

2.3.4.2 Green Roof – Extensive:

Extensive roofs have low substrate depths and therefore low loadings on the building structure, they are lightweight and have a low cost to maintain. These systems cover the entire roof area with hardy, slow growing, drought resistance, low maintenance plants and vegetation, such as sedums. The planting usually matures slowly, with the long-term biodiverse benefits being the sought-after results. These roofs are typically only accessed for maintenance and are usually comprised of between 20mm – 150mm overall total depth.

Extensive green roofs have the effect of providing some initial storage of rainwater, while also reducing the rate at which rainwater from heavier rainfall events will discharge to the main attenuation tank. It can also help to filter the run-off, removing any pollutants and resulting in a higher quality of water discharging to the drainage system. A typical extensive green roof system can intercept and retain over 30 litres/m² (i.e. 30 mm) depending on the build-up. Since these roofs are exposed to the Irish climate, there is a high probability that the roof will not be completely dry, and the storage capacity will be compromised on any given rainfall event. Thus, the more conservative estimate of 12 liters/m² (12mm) interception storage will be assumed. Refer to BMCE drawing C1205 for details.

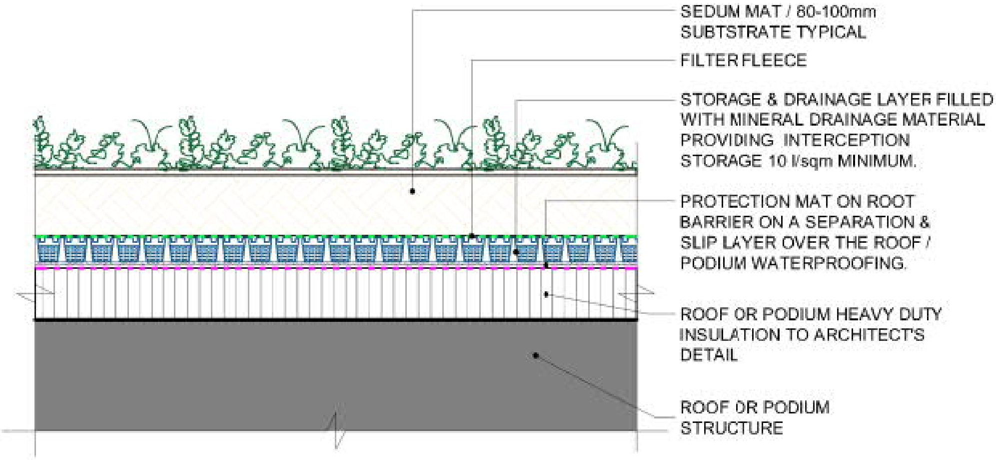


Figure 2.3 – Green Roof Extension

2.3.4.3 Green Roof – Intensive

Intensive green roofs are designed to sustain more complex landscaped environments that can provide high amenity and biodiverse benefits. They are planted with a range of plants, including grasses, shrubs, trees and may also include water features, as well as hard landscape paved areas. They are designed to be accessible and normally require regular maintenance.

Intensive paved soft landscaped roofs will be proposed on some of the apartment blocks roofs in the public amenity areas and in some courtyard podium areas over the basement car parking. The use of intensive green roofs will also allow the planting of large shrubs, small trees, and small water features within the podium area. These features improve the amenity value for the residents. The build-up selected for the Intensive Green Roof on the top of the roofs will include an interception tray to capture the first 12mm of rainfall falling on each roof, providing an intercept and retain capacity of 12 litres/m² (minimum). Refer to BMCE drawing C1205 for details.

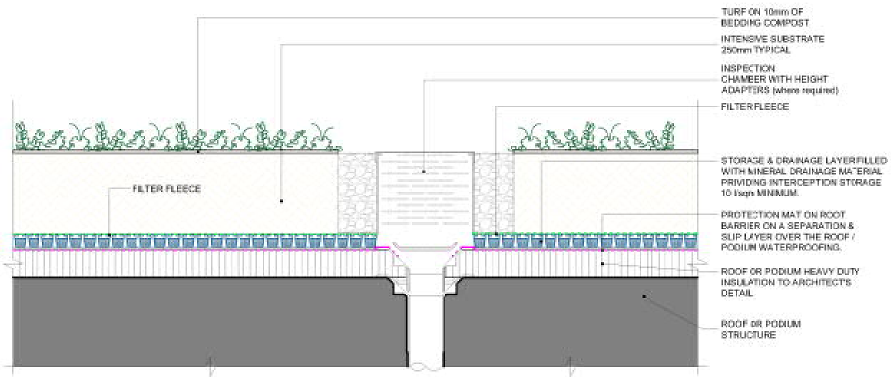


Figure 2.4 – Green Roof Intensive

2.3.4.4 Permeable Paving

Permeable paving provides a surface suitable for pedestrian and/or vehicular traffic, while also allowing rainwater to infiltrate through the surface and into the underlying structural layers. The water is temporarily stored beneath the overlying surface before slowly infiltrating. Permeable paving systems are an effective way of managing surface water runoff close to its source.

The car parking spaces, podium courtyards and footpaths throughout the site will be made up of permeable paving. The larger open spaces and car parking in Catchment A and B will be linked with the overall management train used in each respective catchment.

By providing a raised drainage outlet above the base of the coarse graded gravel bed it is possible to achieve interception storage. Raising the invert of the drainage pipe to 100mm above the gravel bed gives 30mm interception storage @ 30% voids in the gravel. Refer to BMCE drawing C1206 for details.

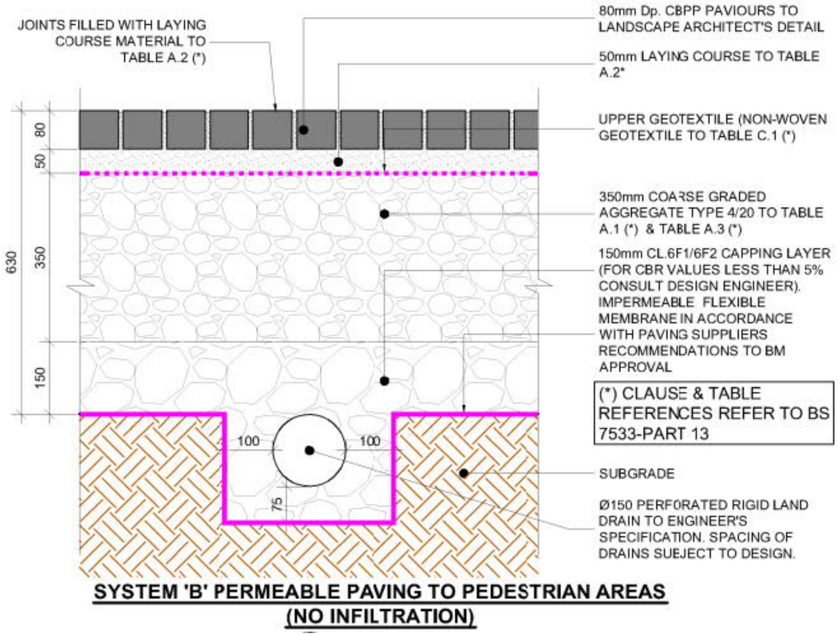


Figure 2.5 – Permeable Paving Build-up

2.3.5 Attenuation Devices

a) Buried Tanks

Attenuation tanks are used to create below-ground void space for the temporary storage of surface water before infiltration, controlled release or use. Attenuation tank shape can be constructed up using Stormtech type systems, which offer flexibility in size, shape and constructability of the tank. The tanks can be tailored to suit specific site characteristics. Refer to BMCE drawing C1208 for details. Tanks formed with proprietary cellular units or concrete tanks have also bene used on site where the available space is constrained

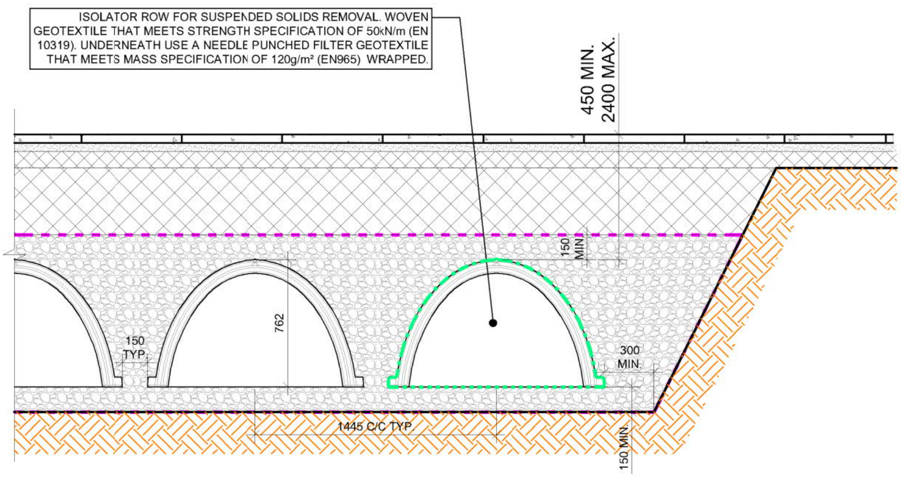


Figure 2.6 – Buried Tank section

b) Blue Roofs

A blue roof is a solution for urban areas where options for ground-based attenuation systems are limited. The blue roof will discharge water through an orifice control device to the surface water network. The blue roofs will be combined with the intensive and extensive green roof systems.

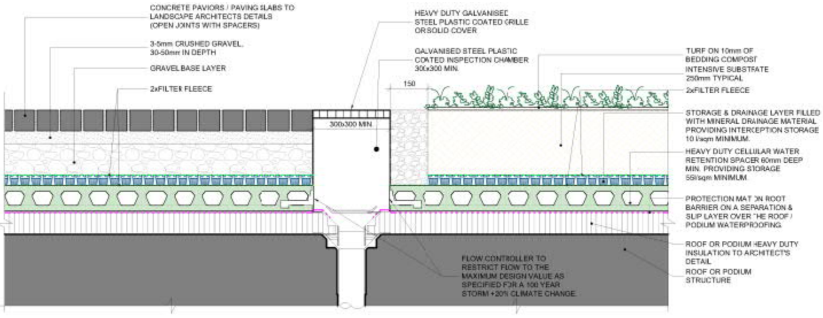


Figure 2.7 – Blue Roof Detail

2.3.6 Bio-Retention and Tree Pits

Both catchments contain bio-retention areas and tree pits to treat and intercept runoff from neighbouring road surfaces and to take the rainwater from adjacent rainwater downpipes. These systems also allow some direct infiltration to the ground since they will be lined with permeable geotextile material. In each case there is a slotted drainage pipe above the base which collects and re-directs excess runoff to the stormwater network. For the location of these SuDS measures on BMCE drawing C1020 and C1030.

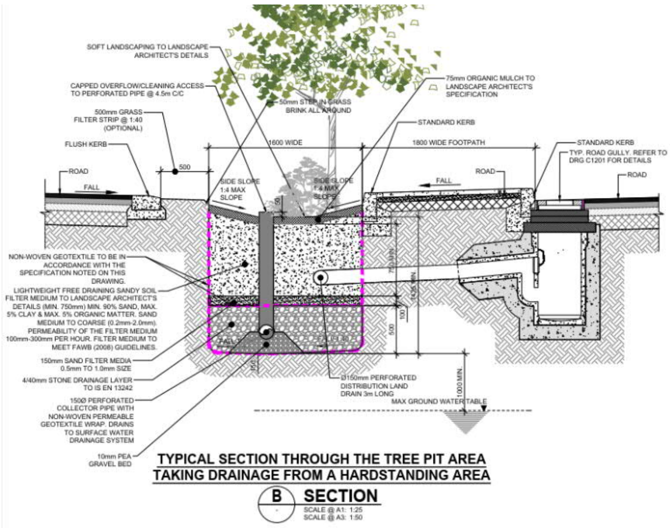


Figure 2.8 – Tree Pit Detail

2.3.7 Detention Basin

Detention systems are primarily designed to reduce runoff rate from a contributing drainage area. A detention basin treats and intercepts runoff. Infiltration can also occur. The detention basin proposed in the eastern part of the site will cater for the adjacent roads. This will allow road runoff to be treated and intercepted in the basin and be discharged in a controlled state.

2.3.8 Filter Trenches

Filter Trenches systems are shallow landscaped depressions adjacent to the roadway. The trenches collect, intercepts and treat the road runoff. Filter trenches can reduce the runoff rates and volumes of surface water. They treat pollution using engineered soils and vegetation. They are very effective in delivering interception and treatment storage. By including filter strips within the depression, the effectiveness of the overall system in meeting the requirements of water quality, water quantity, amenity and biodiversity is significantly improved.

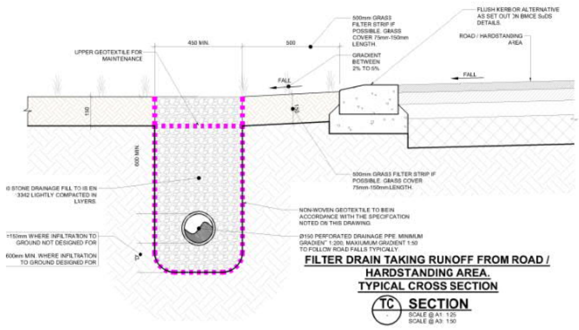


Figure 2.8 –Filter Drain Detail

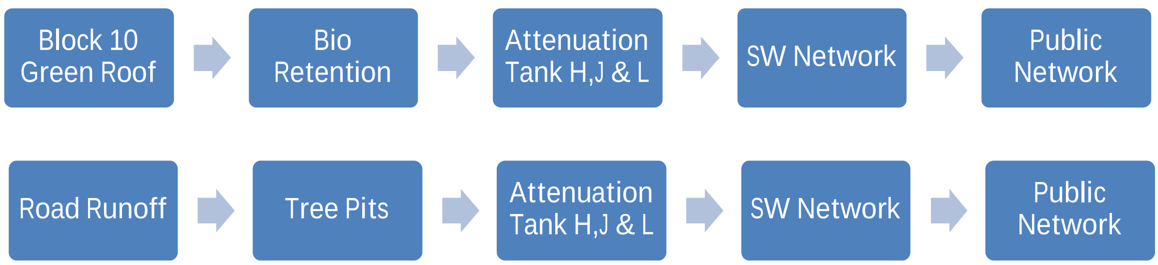
2.4 SuDS Management Train

The SuDS measures proposed are linked in series, and this is commonly known as a SuDS Management Train, (SMT). The SMT ensures that rainwater falling on a site is captured, conveyed, stored, intercepted and removed of any pollutants, correctly and efficiently before it is discharged back into the surrounding water course of network.

A robust SMT will ensure that the most effective measures are utilised in the correct sequence throughout the site. Table 26.7 (Figure 2.2 below) in (CIRIA, SuDS Manual 2015) illustrates the effectiveness of each SuDS measure along the SMT.

2.4.1 Catchment A

The following flowchart was created to illustrate the drainage train that each block will use. This flowchart should be read in conjunction with the proposed drainage drawing C1020 and SuDS layout C1030.



2.4.2 Catchment B1 and B2

The following flowchart was created to illustrate the drainage process that each block will use. This flowchart should be read in conjunction with the proposed drainage drawing.

Proposed SuDS management trains on this site are as follows:

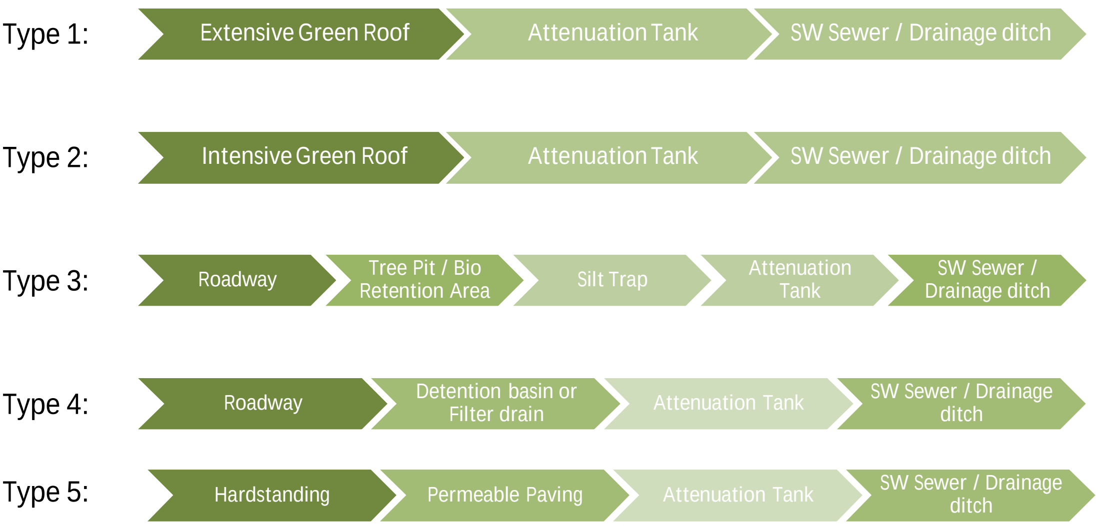


TABLE 26.7 Indicative suitability of SuDS components within the Management Train				
SuDS component	**Interception[1]**	**Close to source/ primary treatment**	**Secondary treatment**	**Tertiary treatment**
Rainwater harvesting	Y			
Filter strip	Y	Y		
Swale	Y	Y	Y	
Filter drain	Y		Y	
Permeable pavement	Y	Y		
Bioretention	Y	Y	Y	
Green roof	Y	Y		
Detention basin	Y	Y	Y	
Pond	[3]	Y[2]	Y	Y
Wetland	[3]	Y[2]	Y	Y
Infiltration system (soakaways/ trenches/ blankets/basins)	Y	Y	Y	Y
Attenuation storage tanks	Y[4]			
Catchpits and gullies		Y		
Proprietary treatment systems		Y[5]	Y[5]	Y[5]

Figure 2.9 - C753 SuDS Manual Table 26.7

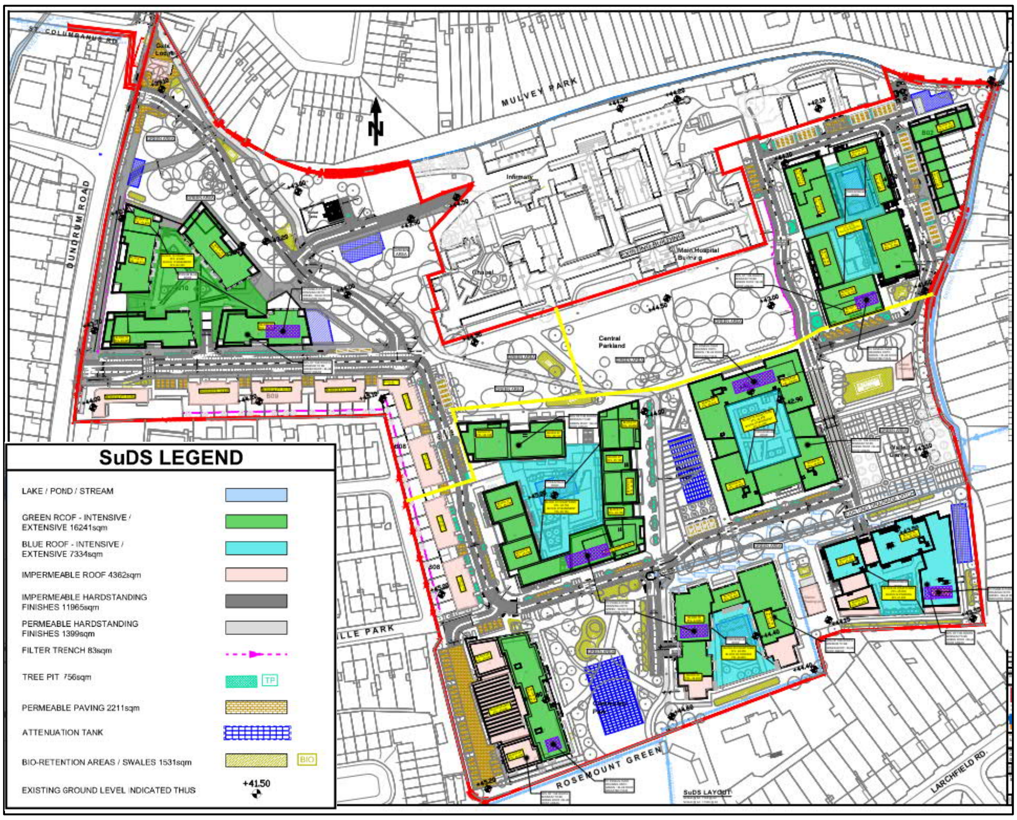


Figure 2.10 – BM SuDS Layout drg C-1030

2.4.3 SuDS Pollutant Analysis

To ensure that the SuDS measures proposed are sufficient in removing pollutants from the generated run-off, a SuDS pollutant analysis has been carried out. This is performed in conjunction with the guidelines and steps set out in Section 26.7 of CIRIA SuDS Manual (2015).

The main form of pollutant is from surface water run-off from roofs, roads and driveways. Table 26.2 of CIRIA SuDS Manual 2015 highlights the pollution hazards for different land uses (extract below Figure 2.4). The pollution hazards on site are generally 'very low" from roofs. Roads are classed as 'Low'.

TABLE 26.2 Pollution hazard indices for different land use classifications

Land use	Pollution hazard level	Total suspended solids (TSS)	Metals	Hydro-carbons
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4

Figure 2.11 – C753 SuDS Manual Table 26.2 Extract

Given that a very low to low pollution index applies, then the 'Simple Index Approach,' is applied and can be summarised below.

Total SuDS Mitigation Index ≥ Pollution Hazard Index

By inspection the extensive use of SuDS measures throughout the site ensures that criterion is met, considering typical road area. Using Table 26.2 and Table 26.3, from the SuDS manual we can compare the mitigation index for permeable paving (taking road drainage) with the hazard index for Roads:

Table 2.4 - Pollution Hazard Assessment for road drained through permeable paving

	Total SuDS Mitigation Index (Table 26.3)		Pollution Hazard Index (Table 26.2)	Status
Total Suspended Solids	0.7	>	0.5	O.K.
Metals	0.6	>	0.4	O.K.
Hydrocarbons	0.7	>	0.4	O.K.

From Table 2-2 above it is clear that the SuDS strategy for the site is effective in removing pollutants from the surface water and therefore protecting downstream watercourses.

2.4.4 Surface Water Attenuation Storage

The GDSDS requires that flood waters be managed within the site for a 1 in 100-year flood. The surface water from each sub-catchment will flow into an attenuation tank or detention basin, which has been designed for that drained area.

The surface water system within each catchment has been hydraulically modelled in CAUSEWAY FLOW software. Please see Appendix 6 for full breakdown of calculations.

Table 2.5: Summary of Attenuation Structures

Attenuation Structure	Catchment	Size (m^3)	Discharge (l/s)
Tank H (Block 10)	A	364	2.0
Tank J	A	690	4.0
Tank L (Block 10)	A	154	2.0
Tank A	B1	423	4.0
Tank E (Block 7)	B1	289	2.0
Tank D (Block 7 + 3)	B1	254	2.0
Tank B	B1	280	2.0
Tank C	B1	132	2.0
Tank K (Block 2)	B2	364	1.0
Tank G	B2	274	4.0

2.4.4.1 Maintenance of Attenuation Systems

The SuDS detail drawings submitted with this report set out the maintenance requirements for the various SuDS measures proposed.

2.4.5 Interception Storage

The GDSDS requires that Interception storage, where provided, should ensure that at a minimum the first 5mm and preferably the first 10mm of rainfall is intercepted on site and does not directly pass to the receiving watercourse.

Interception storage can be attained using SuDS features which allow the rainwater to infiltrate into the ground, evaporate into the atmosphere or transpire through vegetation. Soft landscaping and planted areas are conservatively taken as providing natural interception storage of 15mm. Interception storage volumes for each Sub-catchment areas shown below:

2.4.5.1 Interception Storage - Catchment A

Interception storage required m³ = Total catchment area (m²) x minimum rainfall (mm)
Interception storage required for Catchment A = 29 747m² x 10mm = 297.47m³

Table 2.6: Interception Storage Catchment A

Type of areas	Areas (m²)	Storage (l/m²)	Capacity (m³)
Landscaping (Grass / Soft)	15 682	15	235.23
Green Roof: Intensive / Extensive	5 312	12	63.744
Permeable Paving	850	30	25.50
Impermeable Paving	5 929	0	0.00
Tree Pits	117	75	8.775
Bio Retention Areas	407	75	30.525
Filter Trenches	63	75	4.725
Standard Roof (impermeable)	1 372	0	6.75
Total	29 747	-	375.249

The proposed Interception storage meets the preferred 10mm storage criteria

2.4.5.2 Interception Storage - Catchment B1

Interception storage required m³ = Total catchment area (m²) x minimum rainfall (mm).
Interception storage required for Catchment B1 = 47 961m² x 10mm = 479.61m³

Table 2.7 – Interception Storage Catchment B1

Type of areas	Areas (m²)	Storage (l/m²)	Capacity (m³)
Landscaping (Grass / Soft)	17 812	15	267.18
Green Roof: Intensive / Extensive	12 905	12	154.86
Permeable Paving	1 360	30	40.80
Impermeable Paving	7 804	0	0.00
Tree Pits	305	75	22.875
Bio Retention Areas	1 182	75	88.65
Filter Trenches	24	75	1.80
Standard Roof (impermeable)	6 569	0	0.00
Total	47 961	-	576.165

The proposed Interception storage meets the preferred 10mm storage criteria.

2.4.5.3 Interception Storage - Catchment B2

Interception storage required m^3 = Total catchment area (m^2) x minimum rainfall (mm)
Interception storage required for Catchment B2 = 17 788^2 x 10mm = $177.88m^3$

Table 2.8 – Interception Storage Catchment B2

Type of areas	Areas (m^2)	Storage (l/m^2)	Capacity (m^3)
Landscaping (Grass / Soft)	8 906	15	133.59
Green Roof: Intensive / Extensive	3 322	12	39.864
Permeable Paving	962	30	28.86
Impermeable Paving	2 986	0	0
Tree Pits	222	75	16.65
Bio Retention Areas	66	75	4.95
Filter Trenches	35	75	2.625
Standard Roof (impermeable)	1 289	0	0
Total	17 788	-	226.539

The proposed Interception storage meets the preferred 10mm storage criteria.

2.4.5.4 Green Roof Provision

Green or blue roofs are provided on all apartment block roofs. The green roof provision is 21 $539m^2$ and exceeds the 60% of the total roof areas required by DLR.

2.4.6 GSDS Criterion Compliance

2.4.6.1 Criterion 1 GDSDS – River Water Quality Protection

Run-off from natural greenfield areas contributes very little pollution and sediment to rivers and for most rainfall events direct run-off from greenfield sites to rivers does not take place as rainfall percolates into the ground. By contrast, urban run-off, when drained by pipe systems, results in run-off from virtually every rainfall event with high levels of pollution, particularly in the first phase of run-off, with little rainfall percolating to the ground. To prevent this happening, Criterion 1 requires that interception storage and/or treatment storage is provided, thereby replicating the run-off characteristics of the pre-development greenfield site.

2.4.6.2 Criterion 3 GDSDS – Site Flooding

The GDSDS requires that no flooding should occur on site for storms up to and including the 1 in 30-year event. The pipe network and the attenuation storage volumes should, therefore, be checked for such storms to ensure that no site flooding occurs although partial surcharging of the system is allowed if it does not threaten to flood.
For the 1 in 100-year event, the pipe network can fully surcharge and cause site flooding, but the top water level due to any such flooding must be at least 500mm below any vulnerable internal floor levels, and the flood waters should be contained within the site. In addition, the top water level in any attenuation device during the 100-year storm must be at least 500mm below any vulnerable internal floor levels.

Surface water drains have been oversized to ensure the following:

The system does not surcharge for the 1-year event
The system surcharges but does not flood for the 30-year event.
The system surcharges but does not flood for the 100-year event.

Detailed modelling of the surface water sewer network has been carried out using Causeway Flow software to confirm the above criteria is adequately met. The outputs are appended to this report.

Basements or under croft car parks are covered by podium slabs and do not receive direct rainfall. There will be limited outflow from these areas (rainfall coming off cars & rainwater coming in through car park vents). They are drained by a separate system that outfalls to a petrol interceptor buried below the ground floor slab. From there, the car park drainage is pumped to the nearest foul water manhole, in accordance with DLR requirements, and is not at risk of any backflow from the surface water system during storm conditions. GDSDS Criterion 3 is therefore complied with.

2.4.6.3 Criterion 2 & Criterion 4 GDSDS – River Regime and Flood Protection

Regardless of the rainfall event, unchecked run-off from the developed site through traditional pipe networks will discharge into receiving waters at rates that are an order of magnitude greater than that prior to development. This can cause flash flow in the outfall river / stream that can cause scour, erosion & downstream flooding. Attenuation storage is provided to prevent this occurring by limiting the rate of run-off to that which took place from the pre-development greenfield site. In practice, the rate of run-off needs to be appropriately low for most rainfall events, and attenuation storage volumes should be provided for the 1 and 100-year storm event + 20% for climate change. The rate of outflow from such storage should be controlled so that it does not exceed the greenfield run-off rate of QBAR, which can be factored upwards by factors appropriate to the various return periods (given in the Flood Studies Report) if long term storage is provided. Notwithstanding that significant long-term storage will be provided in the form of interception storage, this does not equate to full long-term storage volume provision and so growth factors will not be applied to QBAR when calculating the attenuation storage volume required.

Qbar for the site has been calculated in accordance with the IH124 method as 31.86 l/s, based on the drained areas of the site. As the surface runoff flow rate discharged from the site does not exceed Qbar, there is no requirement for long-term storage to limit the impact on the receiving watercourse. The calculated QBar for Catchment A = 6.9 l/s, for Catchment B1 = 19.95 l/s and for Catchment B2 = 4.9l/s. Please refer to section 2.3.2 of this report for the Qbar calculation.

Criterion 4 is intended to prevent flooding of the receiving system / watercourse by either.

- limiting the volume of run-off to the pre-development greenfield volume using 'long-term storage' (Option 1) or by

- limiting the rate of run-off for the 1 in 100-year storm to QBAR without applying growth factors using 'extended attenuation storage' (Option 2).

Significant long-term storage will be provided in the form of interception storage. This does not, however, equate to full long term storage volumes and it is not feasible to provide additional storage areas elsewhere on site to achieve the required volume.

Option (2) has therefore been used to comply with Criterion 4 and an attenuation volume will be provided in the proposed attenuation tank to limit the rate of discharge in the 1 in 100-year storm +20% event to QBAR without growth factors applied.

Refer to Appendix 6 for surface water network design calculations.

2.4.7 SuDS CIRIA Pillars of Design

2.4.7.1 Water Quantity

The "Water Quantity" design objective is to ensure that the surface water runoff from a developed site does not have a detrimental impact on people, property or the environment, it is important to control:

- How fast the runoff is discharged from the site (ie the peak runoff rate) and
- How much runoff is discharged from the site (ie the runoff volume)

2.4.7.2 Water Quality

The "Water Quality" design objective seeks to ensure the surface water runoff from the site does not compromise the groundwater or surrounding water courses relating to the site.

A pollutant analysis was performed in 2.3.8 of this report. Pollution hazard levels on site are 'low' or 'very low' and the SuDS treatment trains on site will reduce pollution levels in discharging surface water to acceptable levels.

2.4.7.3 Amenity

The "Amenity" design objective aims to deliver attractive, pleasant, useful and above all liveable urban environments. SuDS measures should be designed to replicate the existing natural environment and blend in with the urban development.

BMCE have worked closely with the landscaping architect throughout the SuDS strategy design process to ensure that the measures which have been suggested and incorporated have a high sense of public use. Throughout the site, there are podium green roofs, bio-retention areas, tree pits and a detention basin.

2.4.7.4 Biodiversity

The encouragement of biodiverse environments within urban environments is incredibly important. The SuDS measures must not only replicate the pre-development surface water runoff systems and treatment for rainfall, but they must only replicate the existing habitats pre-development.

By incorporating large landscaped areas in all areas, green roofs throughout the site and the bio-retention areas, biodiversity on site is promoted. In addition, a large number of mature trees have been retained on site.

2.4.8 SuDS Conclusion

This section of the report has comprehensively discussed the various SuDS measures which can be applied to the site and then selected the applicable devices, based on the site layout. A wide range of measures have been employed. A pollutant analysis and a series of SuDS management trains have then been developed based upon these SuDS measures.

Finally, the chosen SuDS measures have been analysed for various rainfall scenarios to ensure that all the SuDS design criteria are met an extensive range of SuDS measures are proposed with extensive coverage of the developed area of the site. These measures will be effective in treating rainfall on the site to meet GDSDS and CIRIA.

2.5 Assessment for Flood Risk due to Potential Blockage of the surface water drainage system on site.

A secondary check has been carried out to assess for flood risk arising from potential blockages in the proposed surface water network. This analysis was carried out using Causeway Flow by modelling the Hydrobrake at half of the Qbar for 50% blockage of the system. The results are appended in Appendix 6 of the report and indicate the flood volumes. Refer to the Site Specific flood risk assessment report for further information.

3. FOUL DRAINAGE SYSTEM

3.1 Existing Foul Drainage System

The foul drainage from the existing buildings on site drains to a combined drainage system on site which discharges to the Ø300mm combined sewer on the Dundrum Road. The combined sewer drains in a northerly direction towards the River Dodder.

3.2 Proposed Foul Drainage System

Refer to Appendix 2 for existing drainage records & drawing C1021 for additional information.

3.3 Proposed Foul Drainage System

The proposed foul drainage system will be designed to take discharges from the new residential units. There is a small amount of commercial/retail space on site. Drainage from any kitchen/canteen facilities will discharge through a grease separator designed in accordance with IS EN 1825 Part 1 and Part 2 and to Irish Water requirements. The foul system will connect to the Irish Water network at the existing 300mm combined sewer in the Dundrum Road surface.

It is calculated that the proposed development will have a total hydraulic loading of 451m^3 per day of foul effluent generated during the operational phase of the development. This equates to an average flow of 5.17 litres/second (over a 24-hour period) and a peak flow of 16.06 litres/second. A breakdown of the foul loading calculations is included in Appendix 4.

A Pre-connection Enquiry application was submitted to Irish Water to confirm capacity in the receiving network and a Confirmation of Feasibility letter was obtained on the 23rd of September 2021. The letter included site specific comments. A controlled and limited foul drainage outflow from the site has been requested to limit the impact on the Irish Water receiving system. This has been addressed by the provision of a controlled flow wastewater pumping station on site. Refer to BM drawing nr C1220 and C1221 for details. See Appendix 5 for a copy of the Irish Water Confirmation of Feasibility Letter. An Irish Water Statement of Design Acceptance has been received on the 3rd of March and can be found in Appendix 5.

3.3.1 Residential Flow – 977 no. units

Dry Weather Flow (Daily)	= (Population)(Consumption/Capita) + (Infiltration)
Number of Residential Units	= 977
Population Estimate	= 977 x 2.7 = 2 638 persons
Consumption/Capita	= 150 litres / person / day
Infiltration	= 10% (as per App C Section 1.2.4 of CoP for WW Infrastructure)
Average Flow (DWF)	= (977 x 2.7 x 150 x 1.1) = 435 253 litres / day
	= 5.04 litres/second
Peak Flow	= (Average Flow) × (4.5) = 5.04 x 3
	= 15.11 litres/second

3.3.2 Commercial Flow – 3889 m^2

Combined Peak flow	= 0.952 l/s
Total Average Flow	= 0.135 l/s

Please refer to Appendix 4 for the breakdown of calculations.

3.3.3 Foul Network Design

The proposed pipe network has been designed in accordance with the relevant requirements of the Irish Water Code of Practice for Wastewater Infrastructure.

The proposed foul drainage network comprises of a series of 150mm, 225mm and 300mm diameter pipes, designed for a minimum velocity of 0.75m/s (self-cleansing) and maximum velocity of 3.0m/s. A pipe friction coefficient of 1.5mm has been assumed.
Each residential block is serviced by 225mm diameter (SN8 uPVC) branch connections in accordance with the Irish Water Code of Practice for Wastewater Infrastructure. It is noted the proposed foul outfall pipe is 300mm diameter pipe at 1:100 minimum fall which has a capacity of approximately 100 l/s and is deemed adequate for the peak foul flows anticipated.

Refer to BMCE drawings C1021 for layout of the proposed foul drainage.

4. WATER SUPPLY

4.1 EXISTING WATERMAIN INFRASTRUCTURE

There is an existing 9-inch public watermain in Dundrum Road. The existing buildings on site are serviced from this main. This watermain is to be upgraded to a ø250mm HDPE pipe, to Irish Water requirements, to cater for the development. This has been set out in the specific comments in the Irish Water confirmation of feasibility letter of the 23rd of September 2021.

Refer to Appendix 2 for details of the IW / DCC drainage and watermain records for the area.

All of the existing watermains on site will be decommissioned and grubbed up as part of the new proposed development.

4.2 PROPOSED WATERMAINS

The proposed development will be connected to the new Ø250mm public watermain in the Dundrum Road.

The proposed watermain system through the site will vary between 250mm diameter, 200 diameter, 150mm diameter and 100mm diameter – as shown on Barrett Mahony drawing C1040.

The peak flow demand during the operational phase of the development will be 26.6 litres/second, equivalent to an average daily demand of 410m^3. The installation of low flow fittings for the development will reduce the demand on the existing water supply network.

A Pre-connection Enquiry application was submitted to Irish Water to confirm capacity in the network and a Confirmation of Feasibility Letter was obtained. See Appendix 5 for a copy of the Irish Water Confirmation of the Feasibility letter. An Irish Water Statement of Design Acceptance has been received on the 3rd of March and can be found in Appendix 5.

4.2.1 Residential Demand – 977 no. units

Average Daily Demand	= (Population)(Consumption/Capita)
Number of Residential Units	= 977
Population Estimate	= 977 x 2.7 = 2638 persons
Consumption/Capita	= 150 litres / person / day
Average Daily Demand	= 2 638 x 150
	= 395 700 litres/day
Average Day/Peak Week Demand	= (Average Daily Demand) x 1.25
	= 494 625 litres/day
	= 5.72 litres/second
Peak Demand	= (Average Day/Peak Week Demand) x 5
	= 28.62 litres/second

4.2.2 Commercial Flow – 4350 m^2

Combined Peak flow	= 0.980 l/s
Total Average Flow	= 0.196 l/s

Please refer to Appendix 4 for the breakdown of calculations.

4.2.3 Watermain Design

All proposed water ring mains will be PE-80 SDR17 and (100, 150, 200, 250 internal diameter) SDR17, in accordance with Irish Water Standards. Individual houses will have their own connections (25mm O.D. PE pipe MDPE 80 SDR11) to distribution water mains via service connections and meter / boundary boxes. Individual connections are to be installed in accordance with Irish Water Standard Details. All apartment blocks will have their own metered connection with a bulkmeter in accordance with Irish Water requirements.

The proposed water main layout is arranged such that all buildings are a maximum of 46m from a hydrant in accordance with the Department of the Environment's Building Regulations "Technical Guidance Document Part B Fire Safety". Hydrants are to be installed in accordance with Irish Water's Code of Practice and Standard Details. Final positions of hydrants will be agreed as part of the Fire Safety Certificate requirements.

Sluice valves are provided at all junctions and appropriate locations to facilitate isolation of the system. Air valve at high points and scour valves at low points are also provided. Individual houses will accommodate minimum 24-hour water storage (in accordance with the requirements of Irish Water's Code of Practice) and include provision of water conservation measures such as dual flush water cisterns and low flow taps. Apartments will also incorporate 24-hour storage, either in a communal basement storage tank or individual in each apartment.

5. DRAINAGE & WATERMAIN DESIGN TO CATER FOR THE PROPOSED PHASING OF THE DEVELOPMENT

5.1 INTRODUCTION

The number of phases and the make-up of each will be subject to market conditions and commercial considerations at the time. It is currently envisaged that there will be five phased clusters as outlined in Table 5.1 & Figure 5.1 below and that the construction of the phases will partially overlap and run concurrently. Subject to Planning Permission & commercial considerations the construction is expected to run from late-2022 to the near the end of 2028, six and a half years approximately. Completion of the first residential units is anticipated in 2024. The start date may run out in 2023 depending on commercial considerations and potential legal challenges.

Table 5.1: Estimated Construction Sequence & Programme

Phase	Description	*Approx % of the total Development	Estimated Construction Period (Months
1	Block 10	16%	18
2	Blocks 02	13%	17
3	Blocks 03, 04, & 05 and the walled garden.	38%	20
4	Blocks 06 & 07 and the community park.	28%	23
5	Blocks 08 & 09	5%	10
Total 977 residential units + Other uses. *Measured by unit numbers. **The construction of the clusters overlap.		100%	76**

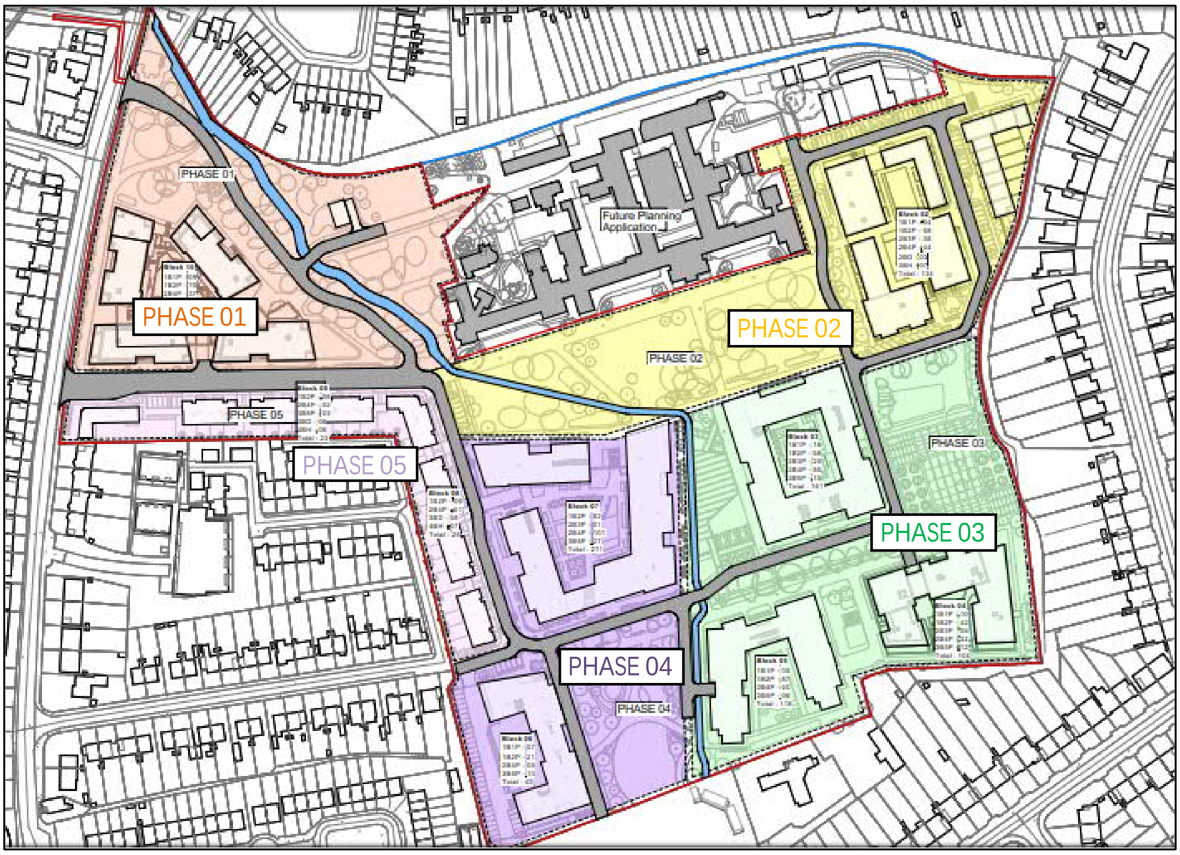


Fig 5.1 Plan View of the Development Showing the Block Layout and Outline Phasing.

Phase 01:

- Block 10: 158 no. apartments including basement car parking and a creche.
- Entrance road from Dundrum Road and pedestrian and cycle paths.
- Second access road off the Dundrum Road.

Phase 02:

- Block 02: 134 no. houses and apartments, including surface car parking, and a medical unit.
- Entrance road and pedestrian and cycle paths.
- Parkland areas and landscaping.

Phase 03:

- Block 03: 161 no. apartments, including surface car parking, retail and amenity units.
- Block 04: 104 no. apartments, including basement car parking.
- Block 05: 118 no. apartments, including surface car parking.
- Installation of the eco corridor and landscaping
- Refurbishment of the walled garden.

Phase 04

- Block 06: 43 no. apartments and a community, art and cultural centre.
- Block 07: 211 no. apartments, including surface car parking, retail and amenity units.
- Installation of the community park.

Phase 05

- Block 08: 25 no. duplex units, including surface car parking.
- Block 09: 23 no. houses, including surface car parking.

A more detailed programme will be developed by the Main Contractor, once appointed, in agreement with the professional design team to reach early agreement on an acceptable construction sequence.

5.2 Surface Water Drainage Design & SuDS for the Phasing

The surface water system has been designed to cater for the proposed phasing as follows:

- Each phase will incorporate SuDS measures and surface water attenuation devices to ensure that each phase is compliant with the GDSDS and that QBar flow rates are not exceeded for the areas drained.
- The three surface water connections from the site will be made as follows:
  - Phase 1: Surface water connection to the sw sewer feeding into the River Slang.
  - Phase 2: Surface water connection to the open channel flow ditch in the north east corner of the site.
  - Phase 3: Surface water connection to the open channel flow ditch in the east of the site.
  - Phases 4 & 5 will tie into the surface water infrastructure laid in the previous phases.
- The Catchment strategy set out in Section 2.3.1 of this report will be adhered to and there will not be any temporary additional flows into another sub-catchment.

5.3 Foul Water Drainage Design for the phasing

The foul water drainage system has been designed to cater for the proposed phasing as follows:

- The controlled outflow wastewater pumping station requested by Irish Water will be installed & commissioned in Phase 1 as will the connection from it to the combined sewer on the Dundrum Road. Phase 1 and subsequent phases will drain into this by gravity.
- Phase 3 incorporates the main ring road which passes through Phase 4. The foul drain serving Phase 3 and discharging to the pumping station will be laid under this road. All phases of the development will therefore be served by their permanent foul drainage lines and temporary connections will not be required.
- Phases 4 & 5 will tie into the foul water infrastructure laid in the previous phases.

5.4 Water Supply

The water main layout on site has been designed to cater for the proposed phasing on site as follows:

- Phase 1: The connection to the public watermain on the Dundrum Road will be made. Subject to Irish Water requirements the upgrades to the watermain on the Dundrum Road, requested by them, will be made at this stage.
- Phase 2: The looped main in Phase 2 will tie into the Phase 1 main.
- Phase 3: The principal site water main layout will be completed in this phase.
- Phases 4 & 5 will tie into the water main infrastructure laid in the previous phases.

6. TRANSPORT INFRASTRUCTURE

6.1 Traffic Impact and Mobility Management

Please refer to the separate reports on these items prepared by ILTP Traffic & Transport Consultants.

6.2 Existing Road Access

The existing site is served by an access off the Dundrum Road at the north west corner. Refer to Photo 5.1 below.

Photo 5.1 Existing access off the Dundrum Road R117 – Looking South

6.3 Proposed Road Accesses to the New Development

The site will be served by two accesses off the Dundrum Road. One access at the existing entrance, adjusted to ensure adequate sightlines. A second access 150m south along the Dundrum Road, close to the Annaville housing estate. These junctions are shown on the Barrett Mahony drawings accompanying the application. Refer to drawing numbers C1000, C1001, C1002 & C1003. The sightlines at both junctions will be in excess of 45metres on a 2.4m set back dimension, in accordance with DMURS.

6.4 Internal Road Network

Various types of roads are incorporated into the development as set out on Barrett Mahony road plans & typical road cross-section drawings. Typically, the road section is a 5.5m wide kerbed road to accommodate two-way traffic. In some locations 2.0m wide footpaths are provided on either side or one side. In other locations to protect trees, the footpath is set back from the road. Traffic calming is achieved by non-linear horizontal alignments & raised table pedestrian crossings.

A 7.2m wide shared surface is used on the east side of the development, in the less trafficked area, locations to achieve traffic calming in accordance with DMURS requirements. A 30kph speed limit will apply inside the development.

Vehicle tracking drawings for a fire tender and refuse truck across the site road layout has been prepared by Barrett Mahony as part of the planning package.

6.5 Pedestrian Access

Pedestrian access to the site will be via the two road accesses referred to above. In addition, there will be pedestrian access to the existing public footpath at the northwest corner of the site, adjacent to traffic light controlled pedestrian crossing here.

Pedestrian permeability through the site will be enhanced by new pedestrian accesses to Annaville Park in the southwest of the site and to Rosemount Green in the south of the site. Refer to the ILTP reports and Architect's drawings for further information.

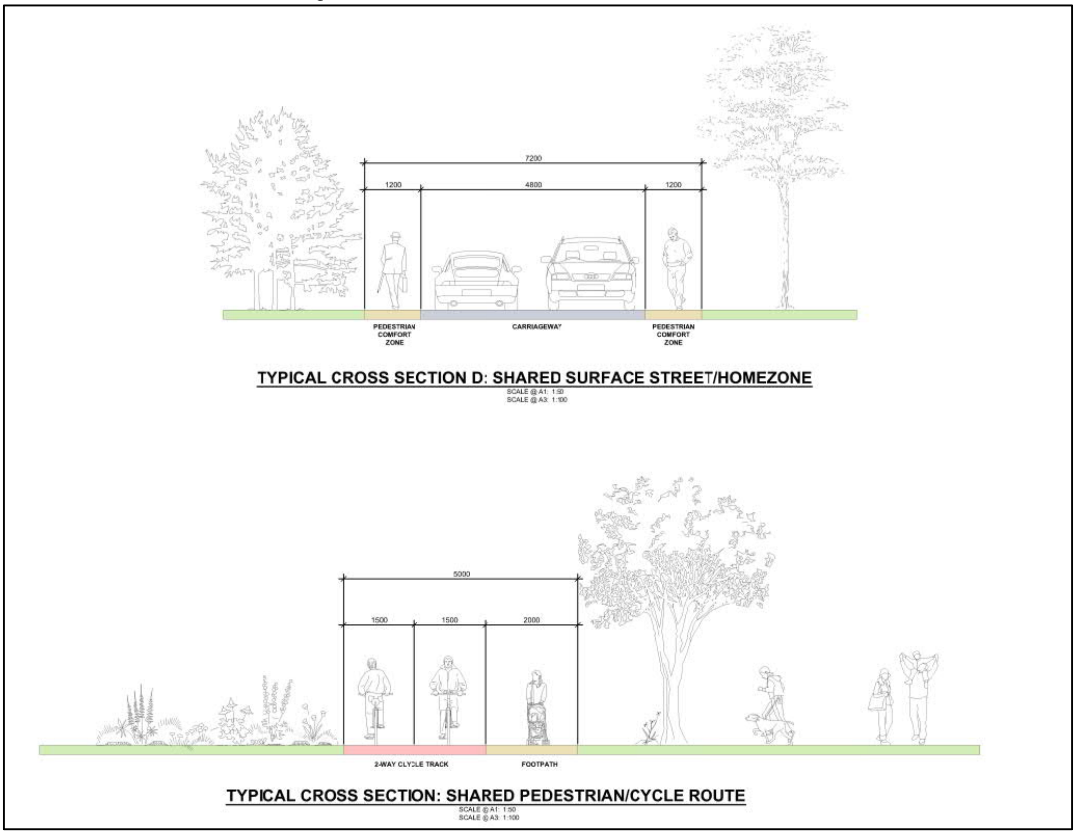


Fig 5.1 Typical Road Sections in the development taken from BM drg. No C1012

6.6 Cyclists

Cycle parking will be provided throughout the site as set out on the Architect's/Landscape Architect's plan & in the ILTP traffic reports. Cycle path locations in the site are shown on the Barrett Mahony Roads Layout drawings C1000 and C1001 and on the Architect's/Landscape Architect's site layout plans. The cycle paths, 1.80m wide typical each way, are kept separate from roads where possible to enhance the safety of cyclists. Cyclists will share the same accesses to the site as pedestrians, as set out in the preceding section above.

6.7 DMURS Compliance

A DMURS Compatibility Statement has been completed by ILTP Traffic & Transport Consultants and is submitted under separate cover with this planning application.

6.8 Stage 1 Road Safety Audit

A Stage 1 Road Safety Audit has been carried out by ILTP Traffic & Transport Consultants and is submitted under separate cover with this planning application and examines the road safety implication of the proposed development.

It is noted that all recommendations of the Stage 1 Road Safety Audit have been accepted by the Design Team and incorporated into the design proposals.

6.9 Stage 1 Quality Audit

A Stage 1 Quality Audit has been carried out by ILTP Traffic & Transport Consultants and is submitted under separate cover with this planning application, and is a third party audit of access, walking and cycling infrastructure proposals.

It is noted that all recommendations of the Quality Audit have been accepted by the Design Team and incorporated into the design proposals.

The Quality Audit process has been integral to the project, ensuring a considerate and coordinated multidisciplinary approach to the overall development design proposals, and resulting in an attractive, safe and DMURS compliant urban residential environment.

Appendix 1

Site Investigation Report

S.I. Ltd Contract No: 5811

Client:	Land Development Agency
Engineer:	Barrett Mahony
Contractor:	Site Investigations Ltd

Dundrum Central Development

Dundrum, Dublin 14

Site Investigation Report

Prepared by:

Letch

....

Stephen Letch

Issue Date:	09/11/2021
Status	Final
Revision	1

Contents: Page No.

Appendices:

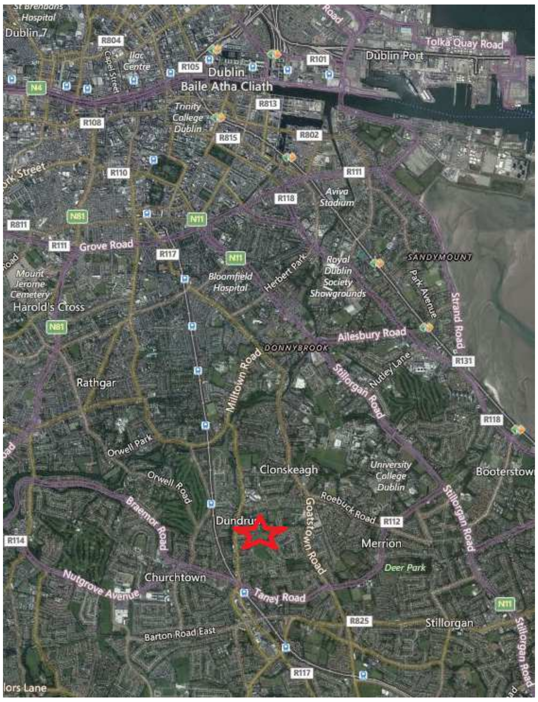
1. Introduction

On the instructions of Barrett Mahony, Site Investigations Ltd (SIL) was appointed to complete a ground investigation at the former Central Mental Hospital site in Dundrum, Dublin 14. The investigation was for a residential development on the site and was completed on behalf of the Client, Land Development Agency. Due to supervision issues, the fieldworks were initially started in March 2021 and then postponed until August and completed in September 2021.

This report presents the factual geotechnical data obtained from the field and laboratory testing with interpretation of the ground conditions discussed.

2. Site Location

The site is located in to the north of Dundrum town centre, which is to the south of Dublin city centre. The first map below shows the location of the site to the south of the city centre and the second map shows the location of the site to the north of Dundrum town centre.



3. Fieldwork

The fieldworks comprised a programme of cable percussive boreholes, trial pits, soakaway tests, foundation pits, slit trenches and California Bearing Ratio tests. All fieldwork was carried out in accordance with BS 5930:2015, Engineers Ireland GI Specification and Related Document 2nd Edition 2016 and Eurocode 7: Geotechnical Design.

The fieldworks comprised of the following:

- 16 No. cable percussive boreholes
- 35 No. trial pits
- 4 No. soakaway tests
- 7 No. foundation inspection pits
- 3 No. slit trenches
- 6 No. California Bearing Ratio tests

3.1. Cable Percussive Boreholes

Cable percussion boring was undertaken at 16 No. locations using a Dando 150 rig and constructed 200mm diameter boreholes. Hand dug inspection pits were excavated to check for underground services at each borehole location. The boreholes terminated at depths ranging from 4.50mbgl (BH12) to 8.60mbgl (BH11). It was not possible to collect undisturbed samples due to the granular soils encountered so bulk disturbed samples were recovered at regular intervals.

To test the strength of the stratum, Standard Penetration Tests (SPT's) were performed at 1.00m intervals in accordance with BS 1377 (1990). In soils with high gravel and cobble content it is appropriate to use a solid cone (60°) (CPT) instead of the split spoon and this was used throughout the testing. The test is completed over 450mm and the cone is driven 150mm into the stratum to ensure that the test is conducted over an undisturbed zone. The cone is then driven the remaining 300mm and the blows recorded to report the N-Value. The report shows the N-Value with the 75mm incremental blows listed in brackets (e.g., BH01 at 1.00mbgl where N=12-(2,2/2,4,3,3)). Where refusal of 50 blows across the test zone was encountered was achieved during testing, the penetration depth is also reported (e.g., BH01 at 7.60mbgl where N=50-(25 for 5mm/50 for 5mm)).

At 5 No. locations, standpipes to allow for long term groundwater monitoring were installed. These were slotted pipes with a gravel response zone to allow for the groundwater to equalise within the standpipe.

The logs are presented in Appendix 1.

3.2. Trial Pits

35 No. trial pits were excavated using a wheeled excavator with TP21 cancelled due to access issues. The pits were logged and photographed by SIL geotechnical engineer and representative disturbed bulk samples were recovered as the pits were excavated, which were returned to the laboratory for geotechnical testing.

The trial pit logs and photographs are presented in Appendix 2.

3.3. Soakaway Tests

At 4 No. locations, soakaway tests were completed and logged by SIL geotechnical engineer. BRE Special Digest 365 stipulates that the pit should be filled three times and that the final cycle is used to provide the infiltration rate. The time taken for the water level to fall from 75% volume to 25% volume is required to calculate the rate of infiltration. However, if the water level does not fall at a steady rate, then the test is deemed to have failed and the area is unsuitable for storm water drainage.

The soakaway test results and photographs are presented in Appendix 3.

3.4. Foundation Pits

At seven locations, foundation pits were excavated to investigate the depths of the foundations of the existing structure. FI02 was cancelled due to issues accessing the proposed location. The pits included hand excavating around the foundation to measure the depth to the top, extension out from the wall and the thickness of the foundation. The pits were then photographed, backfilled with arisings and reinstated.

The foundation pit logs are presented in Appendix 4.

3.5. Slit Trenches

Slit trenching was completed at 3 No. locations by hand digging with machine assistance where possible. The trenches were completed to check for any underground services at the selected locations. The trenches were logged and photographed before they were backfilled with the arisings.

The slit trench logs with photographs are presented in Appendix 5.

3.6. California Bearing Ratio Tests

At 6 No. locations, undisturbed cylindrical mould samples were recovered to complete California Bearing Ratio tests in the laboratory. The results facilitate the designing of the access roads and associated areas and are completed to BS1377: 1990: Part 4, Clause 7 'Determination of California Bearing Ratio'. The results are presented as part of Appendix 6 with the geotechnical laboratory test data.

3.7. Surveying

Following completion of all the fieldworks, a survey of the exploratory hole locations was completed using a GeoMax GPS Rover. The data is supplied on each individual log and along with a site plan in Appendix 9.

4. Laboratory Testing

Geotechnical laboratory testing was completed on representative soil samples in accordance with BS 1377 (1990). Testing included:

- 65 No. Moisture contents
- 12 No. Atterberg limits
- 25 No. Particle size gradings with 12 No. hydrometers
- 3 No. shear boxes
- 10 No. pH and sulphate content

Environmental testing was completed by Eurofins Chemtest Ltd and this allows for a Waste Classification report to be produced. The environmental testing consists of the following:

- 70 No. Suite I analysis

The geotechnical laboratory test results are presented in Appendix 6 with the environmental test results and Waste Classification report in Appendix 7 and 8 respectively.

5. Ground Conditions

5.1. MADE GROUND

MADE GROUND was encountered at most locations across the site generally to 1.10mbgl or shallower although it did extend deeper at 6 No. locations with TP02 recording fill material to 2.20mbgl. The fill material is dominated by consists of granular sand and gravel fill although some cohesive clay soils were also recorded. The foreign material recorded in these soils include concrete, timber, tarmacadam, pottery, bone, ash, slag, plastic bags and red brick fragments.

5.2. Overburden

The natural ground conditions are consistent with cohesive soils encountered across the site. This includes brown and brown grey overlying black slightly sandy gravelly silty CLAY with high cobble and low boulder content soils. The black CLAY was recorded at depths ranging from 1.80mbgl to 3.20mbgl. At the trial pit locations, some layers of granular GRAVEL were also recorded towards the north of the site. The boreholes terminated at depths ranging from 4.50mbgl to 8.60mbgl on boulder obstructions.

The SPT N-values in the natural ground at 1.00mbgl range from 4 to 19 indicating soft to stiff soils. The N-values then increase to 11 to 33 at 2.00mbgl and steadily increase with depth as the boreholes progress.

Laboratory tests of the shallow cohesive soils confirm that CLAY soils dominate the site with low to intermediate plasticity indexes of 14% to 16% recorded. The particle size distribution curves were poorly sorted straight-line curves with 22% to 53% fines content.

5.3. Groundwater

Groundwater details in the boreholes and trial pits during the fieldworks are noted on the logs in Appendix 1 and 2. Groundwater ingresses were recorded in 13 No. boreholes with initial water strikes between 0.80mbgl and 3.20mbgl. At four of the boreholes, BH11, BH13, BH15 and BH16, the initial strike was sealed off by the borehole casings and then groundwater re-entered the borehole between 3.50mbgl and 4.50mbgl.

Groundwater was recorded in 12 of the trial pits at depths ranging from 1.30mbgl to 2.10mbgl with ingress rates recorded as seepages to slow.

6. Recommendations and Conclusions

Please note the following caveats:

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 the exploratory hole locations or below the final level of excavation, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for adjacent unexpected conditions that have not been revealed by the exploratory holes. It is further recommended that all bearing surfaces when excavated should be inspected by a suitably qualified Engineer to verify the information given in this report.

Excavated surfaces in clay strata should be kept dry to avoid softening prior to foundation placement. Foundations should always be taken to a minimum depth of 0.50mBGL to avoid the effects of frost action and possible seasonal shrinkage/swelling.

If it is intended that on-site materials are to be used as fill, then the necessary laboratory testing should be specified by the Client to confirm the suitability. Also, relevant lab testing should be specified where stability of side slopes to excavations is a concern, or where contamination may be an issue.

6.1. Shallow Foundations

Due to the unknown depth of foundation and no longer-term groundwater information, this analysis assumes the groundwater will not influence the construction or performance of these foundations.

As stated previously, man-made soils were recorded across the site to a maximum depth of 2.20mbgl. SIL do not recommend that narrow shallow foundations are placed on fill material due to the unknown compaction methods used during laying of man-made material. This unknown could result in softer spots and differential settlement once construction is completed. If shallow foundations are to be used and man-made soils are encountered below foundation level, then the soil should be removed and replaced with engineered fill which is compacted to the required standard.

Beneath the fill material the boreholes recorded cohesive CLAY soils. Using a correlation proposed by Stroud and Butler, the SPT N-values and plasticity indices can be used to calculate the undrained shear strength. With the low to intermediate plasticity indexes recorded in the laboratory for the soils encountered on site, this correlation is C_u=6N. This value can then be used to calculate the ultimate bearing capacity (UBC), and finally, a factor of safety is applied to get the allowable bearing capacity, with a factor of 3 chosen for this project.

BH:	1.20m				2.00m				3.00m			
	SPT	C_u	UBC	ABC	SPT	C_u	UBC	ABC	SPT	C_u	UBC	ABC
01	-	-	-	**-**	33	198	1045	**350**	32	192	1033	**345**
02	7	42	235	**80**	13	78	434	**145**	21	126	695	**230**
03	-	-	-	**-**	18	108	587	**195**	29	174	942	**315**
04	-	-	-	**-**	20	120	648	**215**	30	180	972	**325**
05	15	90	480	**160**	14	84	465	**155**	20	120	666	**220**
06	7	42	235	**80**	17	102	556	**185**	21	126	695	**230**
07	-	-	-	**-**	22	132	710	**235**	24	144	788	**265**
08	11	66	358	**120**	14	84	465	**155**	31	156	1000	**335**
09	19	114	603	**200**	19	114	617	**205**	31	156	1000	**335**
10	14	84	450	**150**	31	156	985	**330**	31	156	1000	**335**
11	10	60	328	**110**	19	114	617	**205**	35	210	1125	**375**
12	4	24	144	**50**	17	102	556	**185**	22	132	727	**245**
13	11	66	358	**120**	11	66	372	**125**	26	156	850	**285**
14	11	66	358	**120**	25	150	800	**265**	30	180	972	**325**
15	9	54	297	**100**	15	90	495	**165**	32	192	1033	**345**
16	14	84	450	**150**	33	198	1045	**350**	39	234	1247	**415**

All values are in kN/m^2.

The following assumptions were made as part of these analyses. If any of these assumptions are not in accordance with detailed design or observations made during construction these recommendations should be re-evaluated.

- Foundations are to be constructed on a level formation of uniform material type (described above).
- The bulk unit weight of the material in this stratum has a minimum density of $19kN/m^3$.
- All bearing capacity calculations allow for a settlement of 25mm.

The trial pit walls remained stable during excavation. However, it would still be recommended that all excavations should be checked immediately and regular inspection of temporary excavations should be completed during construction to ensure that all slopes are stable. Temporary support should be used on any excavation that will be left open for an extended period.

6.2. Groundwater

The caveats below relating to interpretation of groundwater levels should be noted:
There is always considerable uncertainty as to the likely rates of water ingress into excavations in clayey soil sites due to the possibility of localised unforeseen sand and gravel lenses acting as permeable conduits for unknown volumes of water.

Furthermore, water levels noted on the borehole and trial pit logs do not generally give an accurate indication of the actual groundwater conditions as the borehole or trial pit is rarely left open for sufficient time for the water level to reach equilibrium.

Also, during boring procedures, a permeable stratum may have been sealed off by the borehole casing, or water may have been added to aid drilling. Therefore, an extended period of groundwater monitoring using any constructed standpipes is required to provide more accurate information regarding groundwater conditions. Finally, groundwater levels vary with time of year, rainfall, nearby construction and tides.

Pumping tests would be required to determine likely seepage rates and persistence into excavations taken below the groundwater level. Deep trial pits also aid estimation of seepage rates.

As discussed previously, groundwater was recorded in 13 No. boreholes and 12 No. trial pits during the fieldworks. There is always considerable uncertainty as to the likely rates of water ingress into excavations in cohesive soil sites due to the possibility of localised unforeseen sand and gravel lenses acting as permeable conduits for unknown volumes of water. Based on this information at the exploratory hole locations to date, it is considered likely that any shallow ingress (less than 2.00mbgl) into excavations of the CLAY will be slow to medium. If granular soils are encountered in shallow excavations, then the possibility of water ingressing into an excavation increases.

If groundwater is encountered during excavations then mechanical pumps will be required to remove the groundwater from sumps. Sumps should be carefully located and constructed to ensure that groundwater is efficiently removed from excavations and trenches.

6.3. Soakaway Test

SA02 and SA03 passed the BRE specification with the water draining from the trial pit. SA02 was completed in fill material, which may not have been compacted as much as the natural soils and SA03 was completed in granular SAND and GRAVEL soils. The f-values were calculated as **7.36×10^{-5}m/s** and **2.20×10^{-4}m/s.** It would be recommended that any soakaway is placed in the natural granular soils.

The soakaway tests, SA01 and SA04, failed the specification as the water level did not fall sufficiently enough to complete the test. The BRE Digest stipulates that the pit should half empty within 24hrs, and extrapolation indicates this condition would not be satisfied. The tests were terminated at the end of the first (of a possible three) fill/empty cycle since further testing would give even slower fall rates due to increased soil saturation.

6.4. Pavement Design

The CBR test results in Appendix 6 indicate CBR values ranging from 6.4% to 8.9%.

The CBR samples were recovered at 0.40mbgl and inspection of the formation strata should be completed prior to construction of the pavement. Once the exact formation levels are finalised then additional in-situ testing could be completed to assist with the detailed pavement design.

6.5. Contamination

Environmental testing was carried out on seventy samples from the investigation and the results are shown in Appendix 7. For material to be removed from site, Suite I testing was carried out to determine if the material is hazardous or non-hazardous and then the leachate results were compared with the published waste acceptance limits of BS EN 12457-2 to determine whether the material on the site could be accepted as 'inert material' by an Irish landfill.

The Waste Classification report in Appendix 8, created using HazWasteOnline™ software, shows that the material tested can be classified as non-hazardous material.

Following this analysis of the solid test results, the leachate disposal suite results showed 36 No. samples remained within the Inert waste thresholds. 23 No. samples recorded determinands that exceed the Inert threshold but remain below the non-hazardous waste landfill levels whereas 11 samples exceeded these upper levels. It would be recommended that an Environmental Engineer is consulted prior to any earthworks commencing on site.

Seventy samples were tested for analysis but it cannot be discounted that any localised contamination may have been missed. Any MADE GROUND excavated on site should be stockpiled separately to natural soils to avoid any potential cross contamination of the soils. Additional testing of these soils may be requested by the individual landfill before acceptance and a testing regime designed by an environmental engineer would be recommended to satisfy the landfill.

6.6. Aggressive Ground Conditions

The chemical test results in Appendix 6 indicate a general pH value between 7.32 and 8.11, which is close to neutral and below the level of 9, therefore no special precautions are required.

The maximum value obtained for water soluble sulphate was 127mg/l as SO_3. The BRE Special Digest 1:2005 – '*Concrete in Aggressive Ground'* guidelines require SO_4 values and after conversion ($SO_4 = SO_3 \times 1.2$), the maximum value of 152mg/l shows Class 1 conditions and no special precautions are required.

Legend Key

- Locations By Type - CP
- Locations By Type - DP
- Locations By Type - ICBR
- Locations By Type - IP
- Locations By Type - OP
- Locations By Type - TP

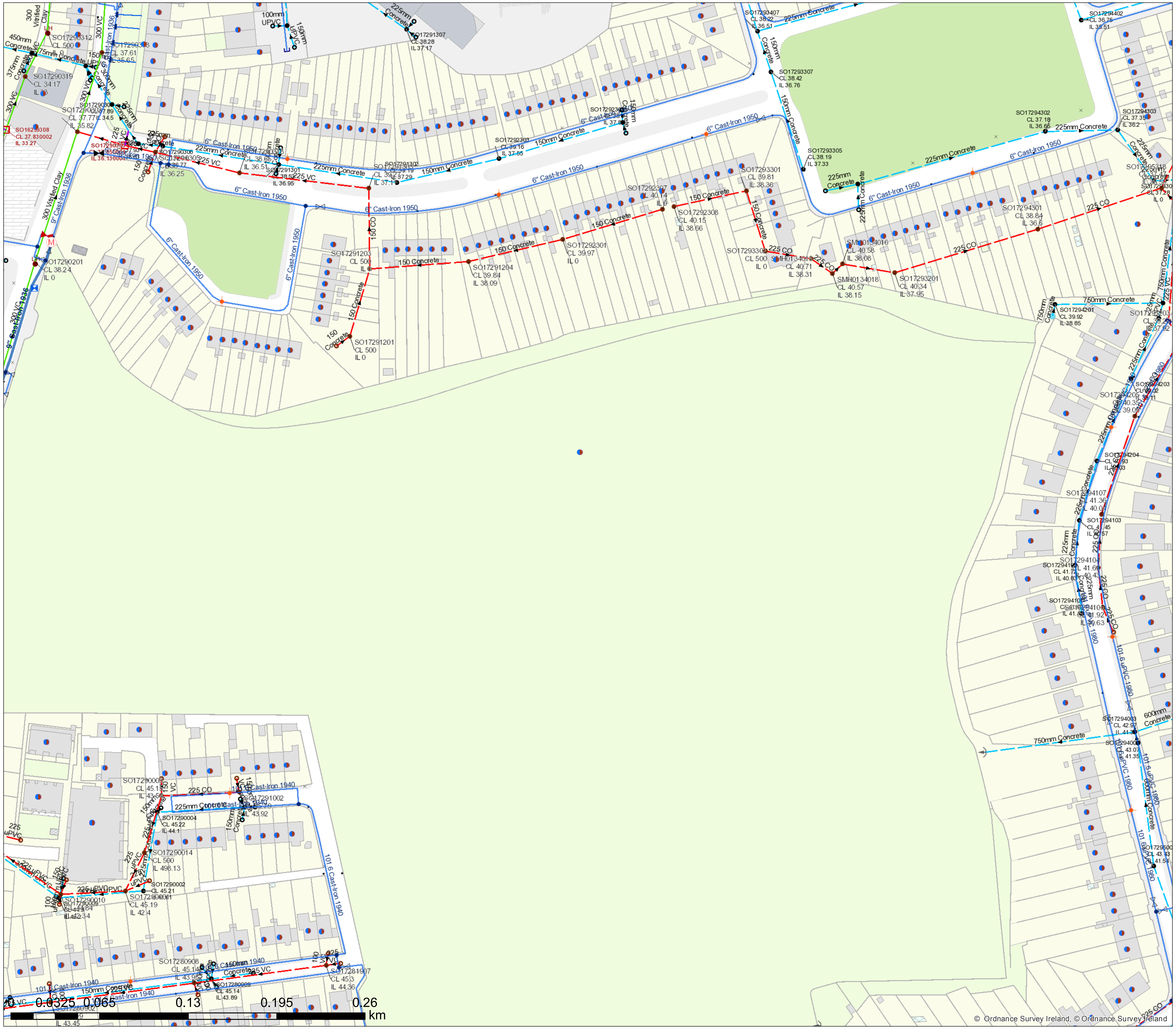
Contract No:	5811
Contract Name:	Dundrum Central Development
Location:	Dundrum, Dublin 14
Client:	Land Development Agency
Engineer:	Barrett Mahony
Title:	Site Plan
Scale:	1:2250
Drawn By:	SL

Site Investigations Ltd
The Grange
12th Lock Road
Lucan
Co. Dublin
T: 01 6108768
e: info@siteinvestigations.ie

Appendix 2

Existing Services

Windy Arbour



UISCE ÉIREANN : IRISH WATER

Print Date: 23/04/2020

Printed by:Irish Water

Windy Arbour - South1

Print Date: 01/05/2020

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Water Distribution Network
Water Treatment Plant
Water Pump Station
Storage Cell/Tower
Dosing Point
Meter Station
Abstraction Point
Telemetry Kiosk
Reservoir
Potable
Raw Water
Water Distribution Mains
Irish Water
Private
Trunk Water Mains
Irish Water
Private
Water Lateral Lines
Irish Water
Non IW
Water Casings
Water Abandoned Lines
Boundary Meter
Bulk/Check Meter
Group Scheme
Source Meter
Waste Meter
Unknown Meter ; Other Meter
Non-Return
PRV
PSV
Sluice Line Valve Open/Closed
Butterfly Line Valve Open/Closed
Sluice Boundary Valve Open/Closed
Butterfly Boundary Valve Open/Closed
Scour Valves
Single Air Control Valve
Double Air Control Valve
Water Stop Valves
Water Service Connections
Water Distribution Chambers
Water Network Junctions
Pressure Monitoring Point
Fire Hydrant
Fire Hydrant/Washout
Water Fittings
Cap
Reducer
Tap
Other Fittings

Sewer Foul Combined Network
Waste Water Treatment Plant
Waste Water Pump station
Sewer Mains Irish Water
Gravity - Combined
Gravity - Foul
Gravity - Unknown
Pumping - Combined
Pumping - Foul
Pumping - Unknown
Syphon - Combined
Syphon - Foul
Overflow
Sewer Mains Private
Gravity - Combined
Gravity - Foul
Gravity - Unknown
Pumping - Combined
Pumping - Foul
Pumping - Unknown
Syphon - Combined
Syphon - Foul
Overflow
Sewer Lateral Lines
Sewer Casings
Sewer Manholes
Standard
Backdrop
Cascade
Catchpit
Bifurcation
Hatchbox
Lamphole
Hydrobrake
Other; Unknown
Discharge Type
Outfall
Overflow
Soakaway
Standard Outlet
Other; Unknown
Cleanout Type
Rodding Eye
Flushing Structure
Other; Unknown
Sewer Inlets
Catchpit
Gully
Standard
Other; Unknown
Sewer Fittings
Vent/Col
Other; Unknown

Storm Water Network
Surface Water Mains
Surface Gravity Mains
Surface Gravity Mains Private
Surface Water Pressurised Mains
Surface Water Pressurised Mains Private
Inlet Type
Gully
Standard
Other; Unknown
Storm Manholes
Standard
Backdrop
Cascade
Catchpit
Bifurcation
Hatchbox
Lamphole
Hydrobrake
Other; Unknown
Storm Culverts
Storm Clean Outs
Stormwater Chambers
Discharge Type
Outfall
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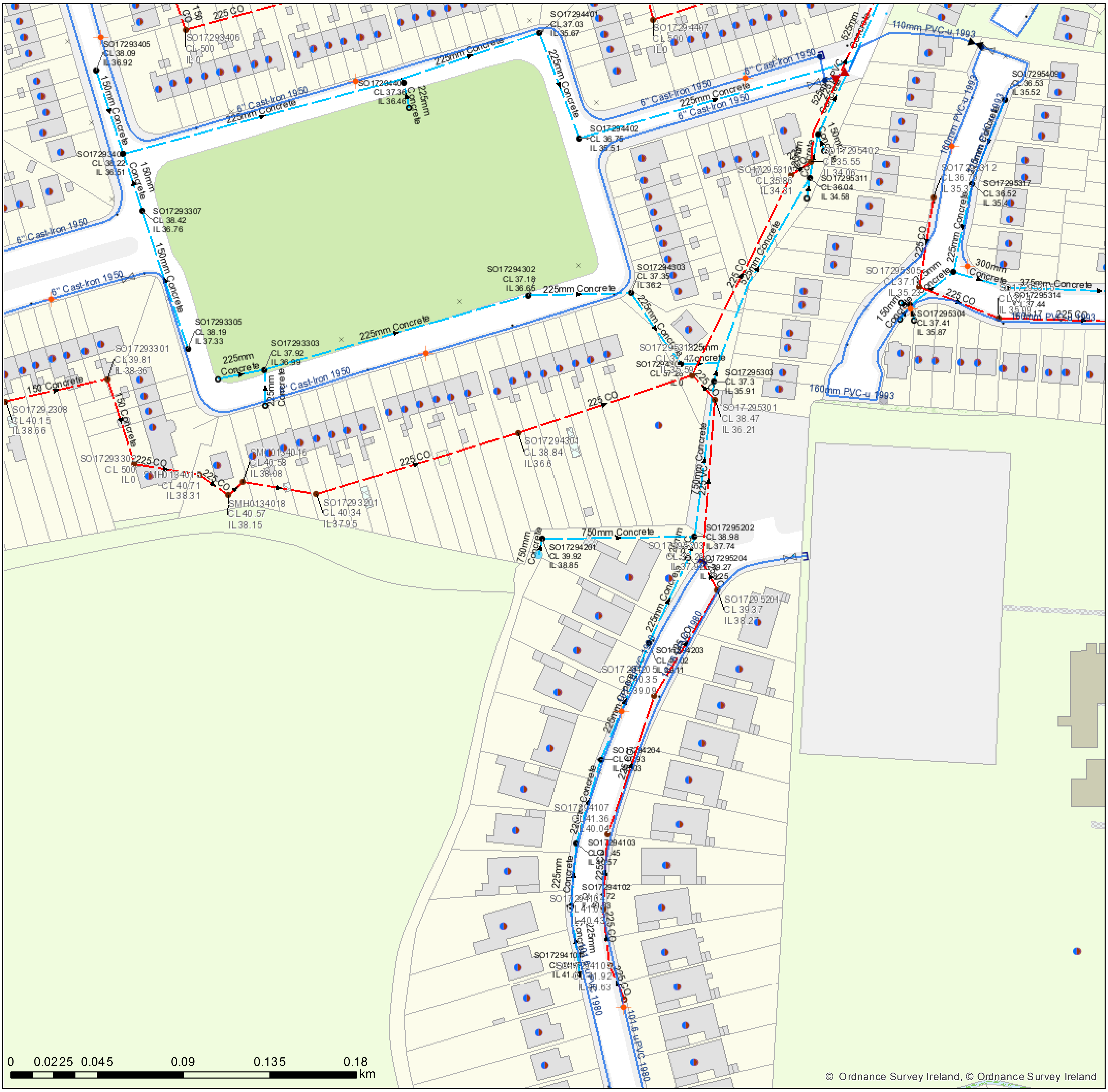
Soakaway
Other; Unknown
Gas Networks Ireland
Transmission High Pressure Gasline
Distribution Medium Pressure Gasline
Distribution Low Pressure Gasline
ESB Networks
ESB HV Lines
HV Underground
HV Overhead
HV Abandoned
ESB MVLV Lines
MV Overhead Three Phase
MV Overhead Single Phase
LV Overhead Three Phase
LV Overhead Single Phase
MVLV Underground
Abandoned
Non Service Categories
Proposed
Under Construction
Out of Service
Decommissioned
Water Non Service Assets
Water Point Feature
Water Pipe
Water Structure
Waste Non Service Assets
Waste Point Feature
Sewer
Waste Structure

Windy Arbour - East1



Water Distribution Network
- Water Treatment Plant
- Water Pump Station
- Storage Cell/Tower
- Dosing Point
- Meter Station
- Abstraction Point
- Telemetry Kiosk

Reservoir
- Potable
- Raw Water

Water Distribution Mains
- Irish Water
- Private

Trunk Water Mains
- Irish Water
- Private

Water Lateral Lines
- Irish Water
- Non IW
- Water Casings
- Water Abandoned Lines
- Boundary Meter
- Bulk/Check Meter
- Group Scheme
- Source Meter
- Waste Meter
- Unknown Meter ; Other Meter
- Non-Return
- PRV
- PSV
- Sluice Line Valve Open/Closed
- Butterfly Line Valve Open/Closed
- Sluice Boundary Valve Open/Closed
- Butterfly Boundary Valve Open/Closed
- Scour Valves
- Single Air Control Valve
- Double Air Control Valve
- Water Stop Valves
- Water Service Connections
- Water Distribution Chambers
- Water Network Junctions
- Pressure Monitoring Point
- Fire Hydrant
- Fire Hydrant/Washout

Water Fittings
- Cap
- Reducer
- Tap
- Other Fittings

Sewer Foul Combined Network
- Waste Water Treatment Plant
- Waste Water Pump station

Sewer Mains Irish Water
- Gravity - Combined
- Gravity - Foul
- Gravity - Unknown
- Pumping - Combined
- Pumping - Foul
- Pumping - Unknown
- Syphon - Combined
- Syphon - Foul
- Overflow

Sewer Mains Private
- Gravity - Combined
- Gravity - Foul
- Gravity - Unknown
- Pumping - Combined
- Pumping - Foul
- Pumping - Unknown
- Syphon - Combined
- Syphon - Foul
- Overflow
- Sewer Lateral Lines
- Sewer Casings

Sewer Manholes
- Standard
- Backdrop
- Cascade
- Catchpit
- Bifurcation
- Hatchbox
- Lamphole
- Hydrobrake
- Other; Unknown

Discharge Type
- Outfall
- Overflow
- Soakaway
- Standard Outlet
- Other; Unknown

Cleanout Type
- Rodding Eye
- Flushing Structure
- Other; Unknown

Sewer Inlets
- Catchpit
- Gully
- Standard
- Other; Unknown

Sewer Fittings
- Vent/Col
- Other; Unknown

Storm Water Network

Surface Water Mains
- Surface Gravity Mains
- Surface Gravity Mains Private
- Surface Water Pressurised Mains
- Surface Water Pressurised Mains Private

Inlet Type
- Gully
- Standard
- Other; Unknown

Storm Manholes
- Standard
- Backdrop
- Cascade
- Catchpit
- Bifurcation
- Hatchbox
- Lamphole
- Hydrobrake
- Other; Unknown
- Storm Culverts
- Storm Clean Outs
- Stormwater Chambers

Discharge Type
- Outfall
- Overflow
- Soakaway
- Other; Unknown

Gas Networks Ireland
- Transmission High Pressure Gasline
- Distribution Medium Pressure Gasline
- Distribution Low Pressure Gasline

ESB Networks

ESB HV Lines
- HV Underground
- HV Overhead
- HV Abandoned

ESB MVLV Lines
- MV Overhead Three Phase
- MV Overhead Single Phase
- LV Overhead Three Phase
- LV Overhead Single Phase
- MVLV Underground
- Abandoned

Non Service Categories
- Proposed
- Under Construction
- Out of Service
- Decommissioned

Water Non Service Assets
- Water Point Feature
- Water Pipe
- Water Structure

Waste Non Service Assets
- Waste Point Feature
- Sewer
- Waste Structure

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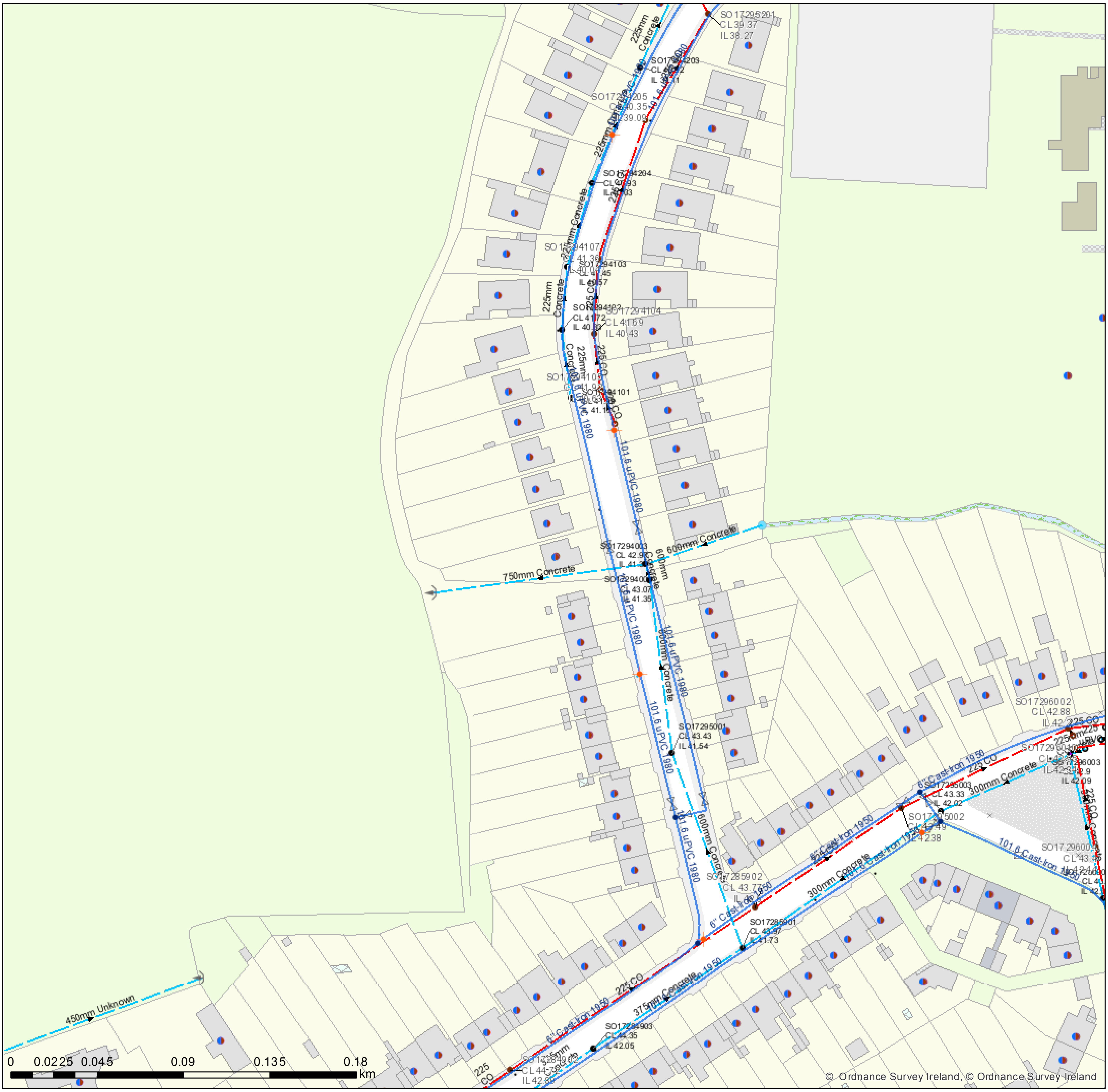
Windy Arbour - East2



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- Sewer Casings

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- Standard
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- Other; Unknown

Discharge Type
- Outfall
- Overflow
- Soakaway
- Standard Outlet
- Other; Unknown

Cleanout Type
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- Flushing Structure
- Other; Unknown

Sewer Inlets
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- Gully
- Standard
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Sewer Fittings
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- Other; Unknown

Storm Water Network

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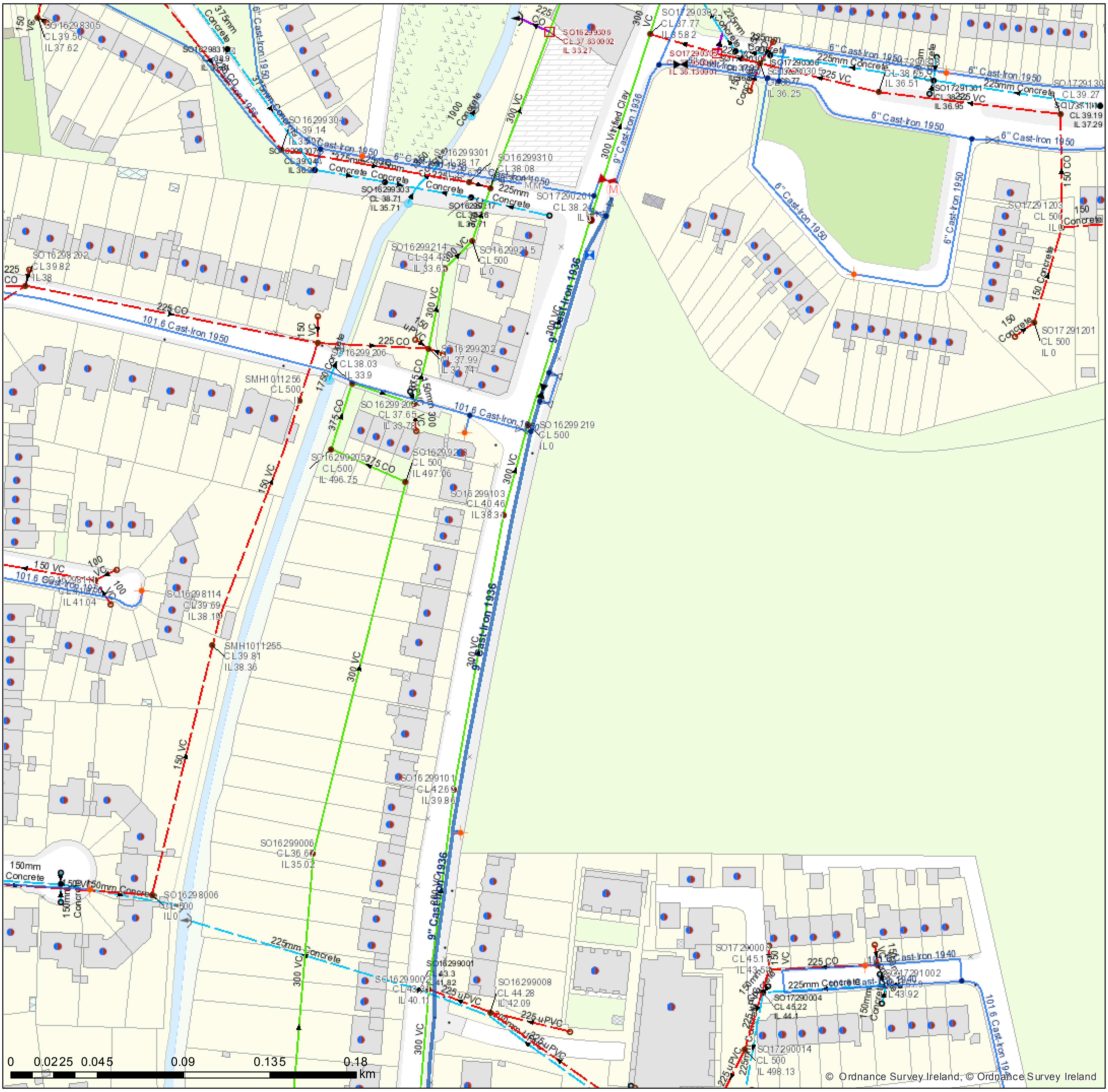
Windy Arbour - West1



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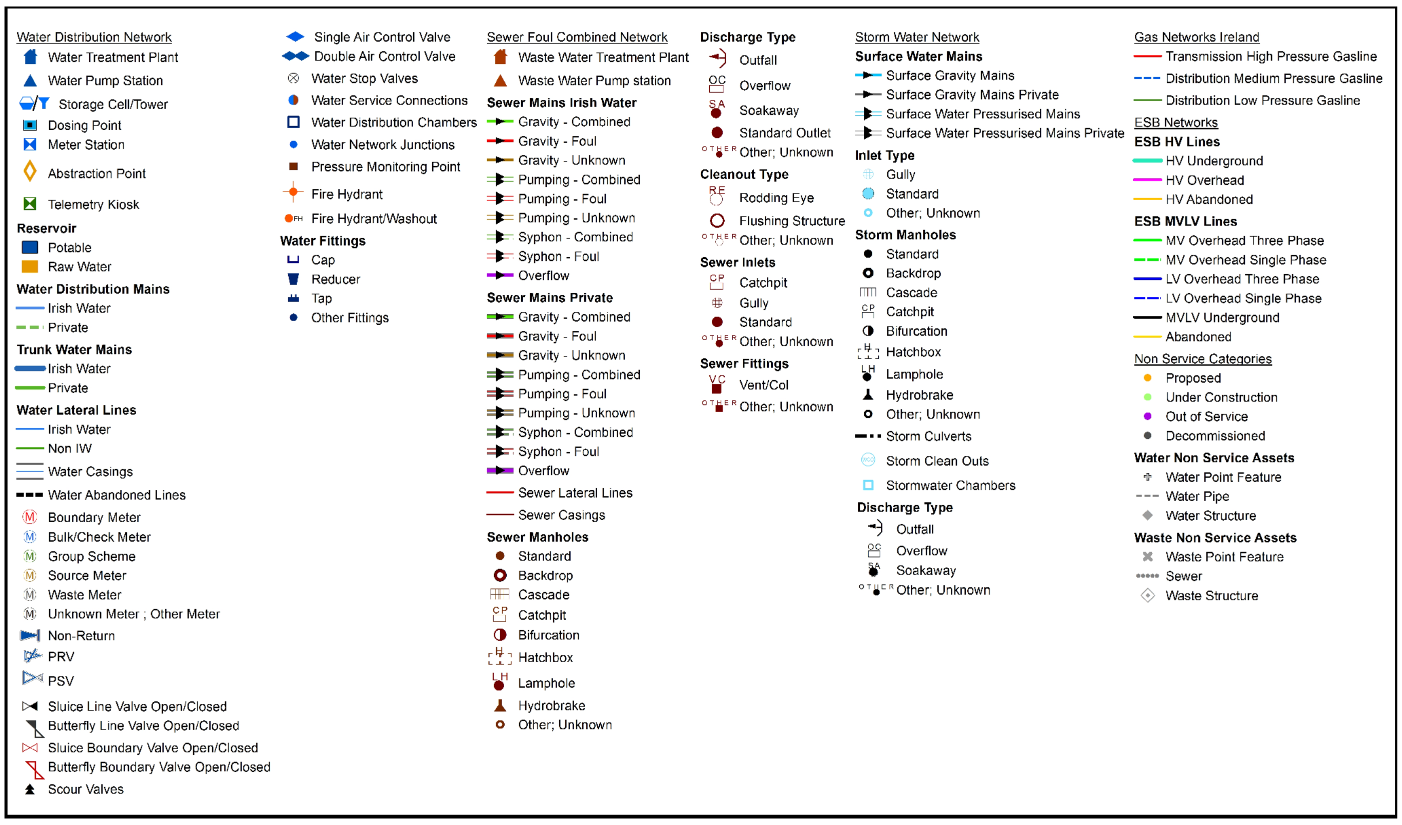
Windy Arbour - West2



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Appendix 3

LowFlow Flow Logger

Lowflo
Water Control &
Leak Detection

Flow Survey Report

Reddy Architecture

reddy a+u

HSE, Central Mental Hospital,

Dundrum Rd, Friarland, Dublin 14, D14 W0V6

Document Title:	Pressure Testing Report – IW Network Framework		
Document Reference:	LF-REA-WIN-024-0002		
Version:	V. 1.0	Date:	19th May 2021
Written By:	Thomas Algier	Title:	Projects Engineer
Approved By:	Charles Dwyer	Title:	Managing Director

Contents

1. Project

Title: Flow Survey Report
Client: Reddy Architecture
Contact/s: Email Address: rtobin@reddyarchitecture.com
Site: HSE, Central Mental Hospital, Dundrum Rd, Friarland, Dublin 14, D14 W0V6
Engineer: Bob Fagan, Dean McVeight, Angelos Prassas, Mick VanDerMeer
Date: 19th May 2021

2. Brief

Lowflo were commissioned by Reddy Architecture to carry out a Flow and Load Survey at HSE, Central Mental Hospital in Dundrum from the 25th of February 2021 until the 12th of May 2021. The basis of this report is to produce flow data to determine the volumes of overflow into the receiving environment. 2 flow monitors were installed.

3. Training and H&S

Lowflo strive to provide a safe and healthy work environment; this is facilitated via a consultative approach through the use of toolbox meetings involving employees and the client, with the ultimate aim of working safely to achieve zero harm to both personnel and the environment on all projects.

We achieve this by having a suitably trained, competent and committed workforce who undergo extensive training in all aspects of leak detection, water management, as well as workplace health and safety. Below is a list of qualifications of personnel within the organisation:

- Mechanical and Environmental Engineering
- Leakage Detection
- Workplace Health and Safety
- Safe Pass
- Manual Handling
- Confined space entry (using BA)
- Valve Operations
- Hydrant Standpipe Operations
- Leak Correlator Training
- Plumbing (City and Guilds)
- Location of Underground services
- Sign, Lighting & Guarding
- Water Hygiene Card

4. Methodology

ISCO 2150 flow modules was used in combination with Area Velocity (AV) probes. The AV probe was fitted to a 2mm stainless steel insert that was subsequently centred and fixed at the inlet or outlet of the flow stream depending on which was more appropriate for the most accurate measurement.

The flowmeter probes are calibrated on an annual basis by the suppliers of the equipment, Water Technology. Onsite checks are performed to ensure the data produced is accurate and reliable. This involves connecting a flowmeter to a laptop with Flowlink software, getting an instantaneous level measurement, then comparing this reading to the measured level in the liquid stream. If there are any differences, there is an option to recalibrate the flowmeter with the true level thereby applying the appropriate adjustment to flow rates.

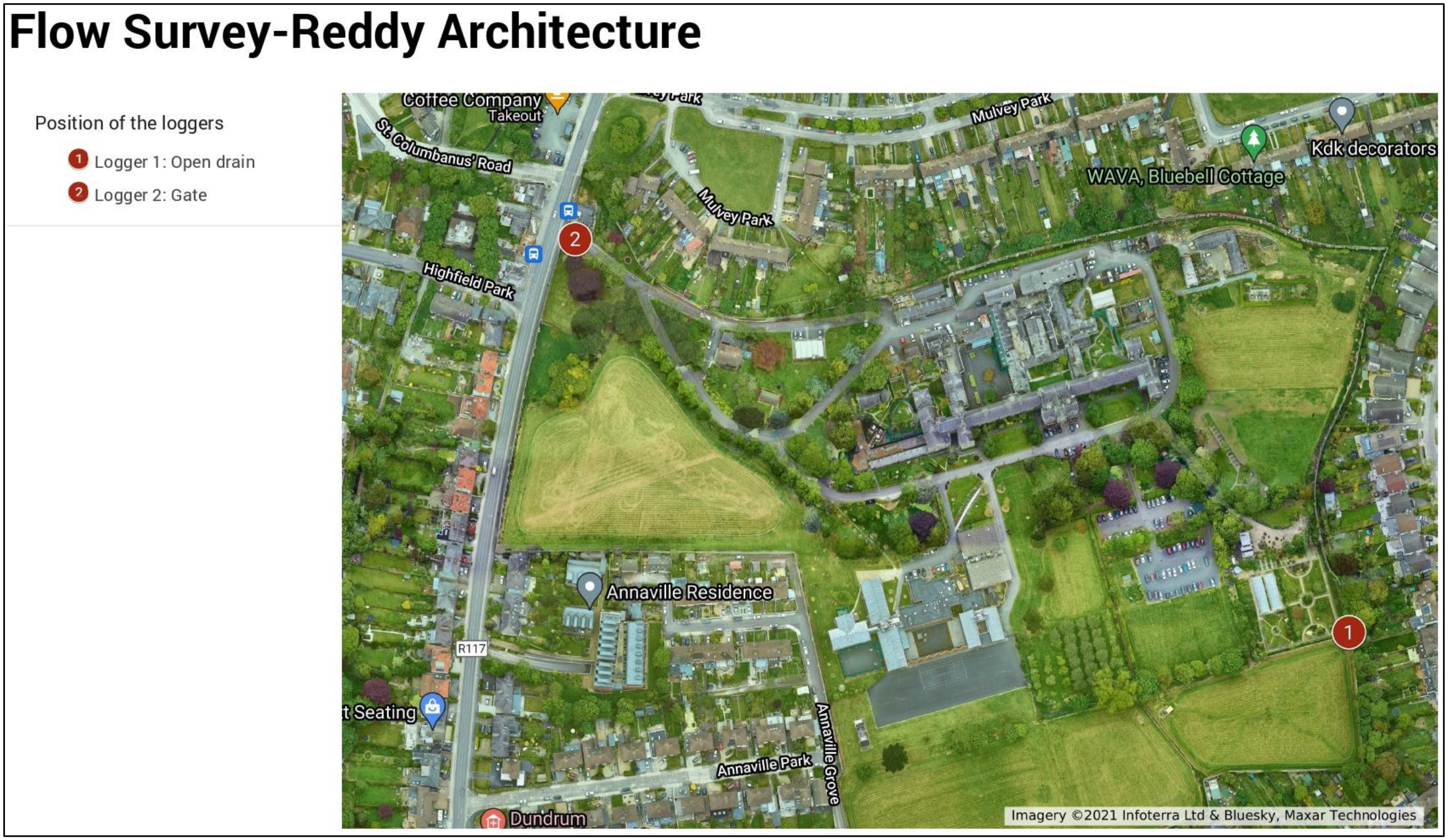
Alternatively, these adjustments can be made retroactively after the data has been considered. Ragging, stones, grit and any number of unspecified solids can potentially interfere with velocity readings, whereas silting can give rise to false levels.

These checks are performed during the installation of the equipment, and during retrieval of equipment if required.

5. Map and pictures of installation

5.1. Interactive Map

To see the Map online, click HERE:



5.2. Pictures of installation

5.2.1. Pictures of the installation on the 25/02/2021

Table 1: Logger at the Open Drain

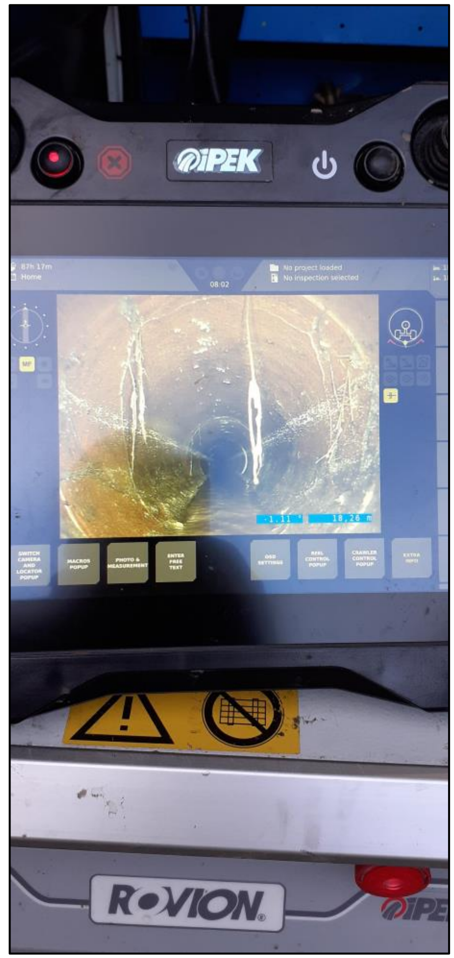
	
	

Table 2: Logger in the Manhole at the gate

5.2.2. Pictures of the CCTV Survey on the 29/03/2021

Table 3: CCTV Survey

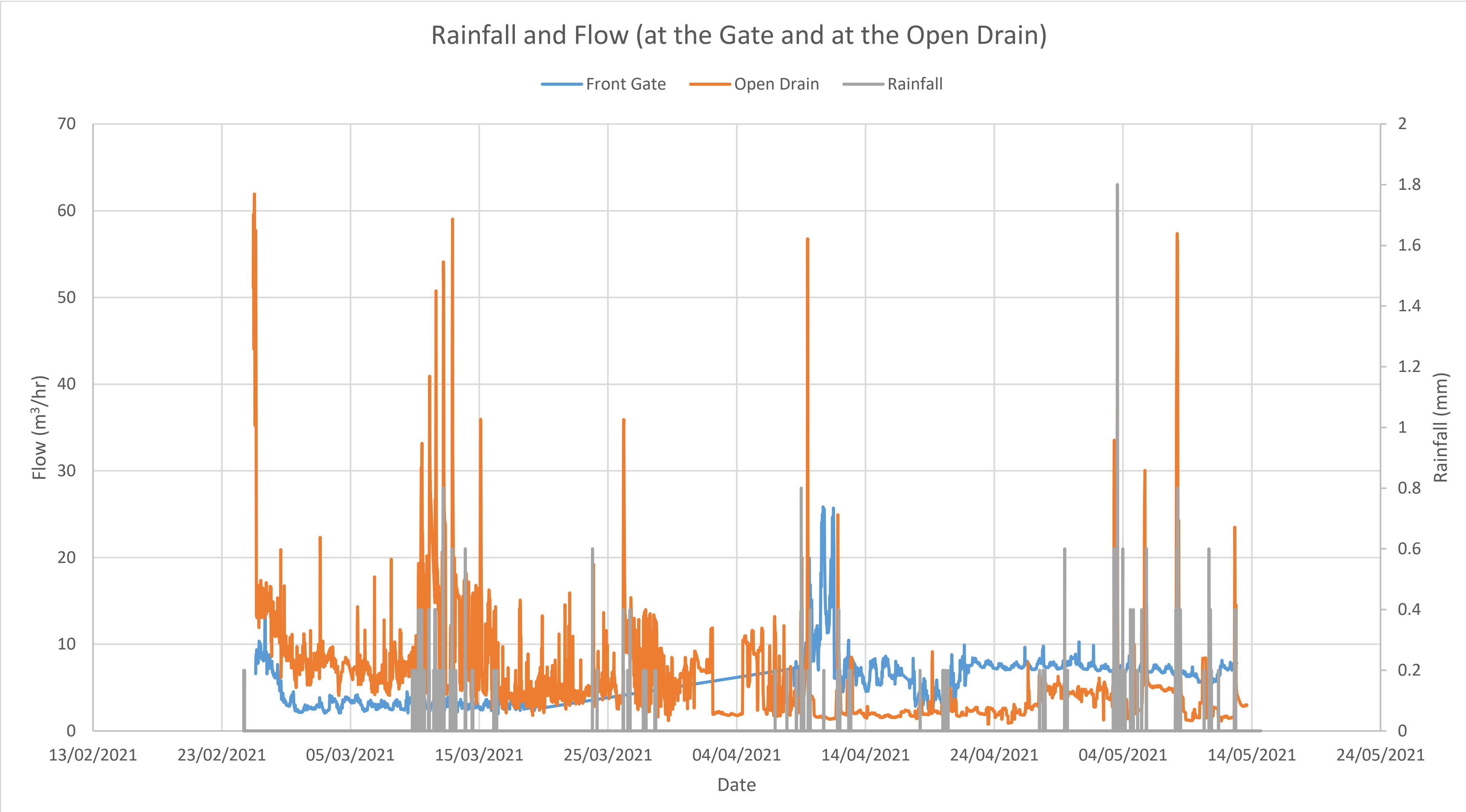


5.2.3. Pictures of the flow equipment in chamber

Table 4: Equipment in chamber

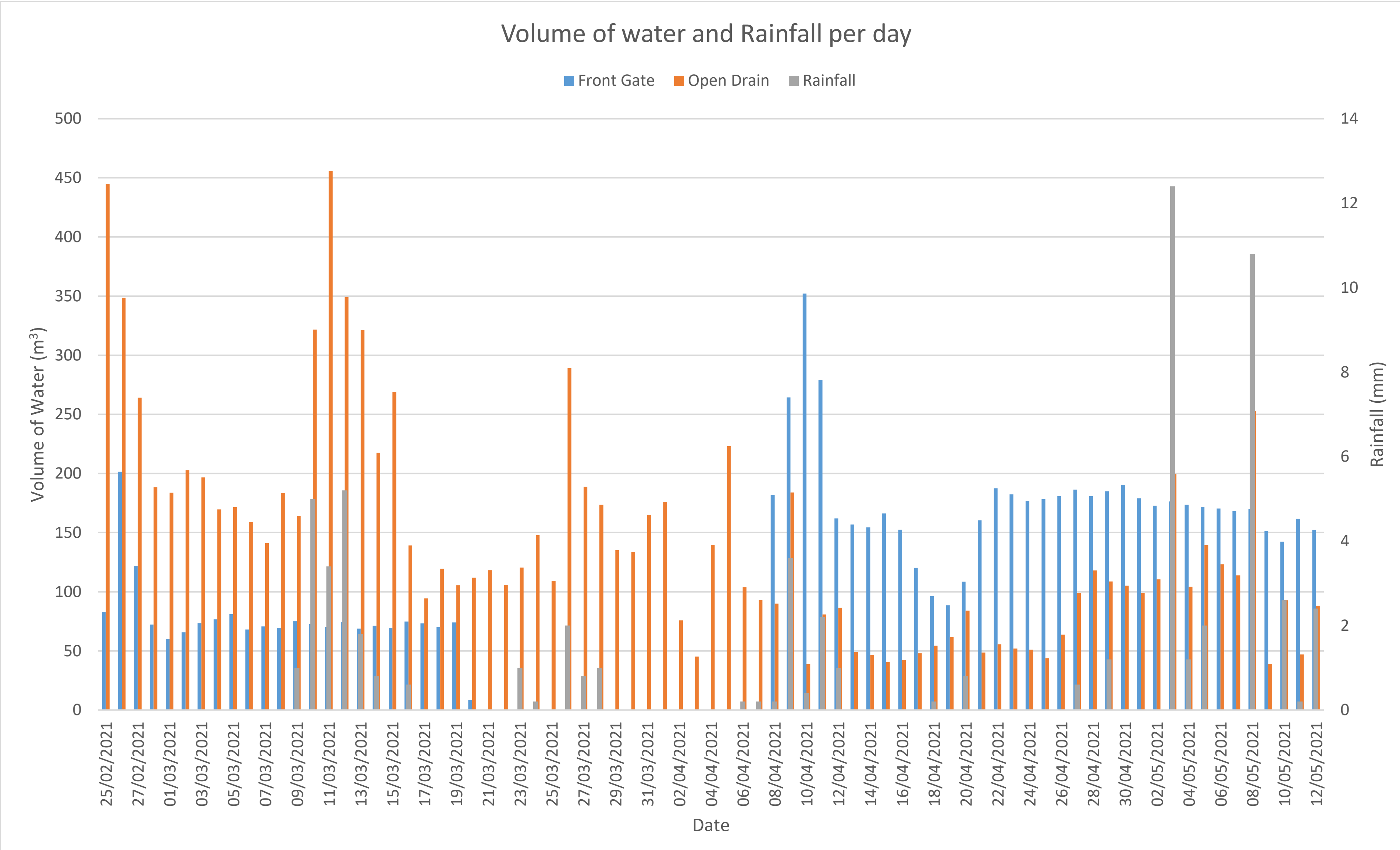
		

6. Flow and Rainfall Graph



See Appendix 1 to see the Volume of water per day at the Gate and at the Open Drain, Appendix 2 for the rainfall Table per day.

7. Volume of Water and Rainfall per day



Should you have any queries do not hesitate to contact me.

Kind Regards,

Charles Dwyer, Managing Director
Lowflo – Water Control & Leak Detection

Appendix 1 – Daily Totals

Date	Water at Front Gate (m^3)	Water at Open Drain (m^3)
25/02/2021	82.831	444.83
26/02/2021	201.373	348.588
27/02/2021	121.943	264.047
28/02/2021	72.299	188.342
01/03/2021	60.041	183.823
02/03/2021	65.721	202.802
03/03/2021	73.391	196.748
04/03/2021	76.586	169.619
05/03/2021	80.922	171.575
06/03/2021	68.057	158.815
07/03/2021	70.71	141.219
08/03/2021	69.441	183.439
09/03/2021	75.079	164.061
10/03/2021	72.673	321.621
11/03/2021	70.306	455.826
12/03/2021	74.171	349.12
13/03/2021	68.841	321.3
14/03/2021	71.238	217.66
15/03/2021	69.483	269.157
16/03/2021	74.877	139.046
17/03/2021	73.163	94.402
18/03/2021	70.266	119.363
19/03/2021	74.04	105.485
20/03/2021	8.405	111.847

Date	Water at Front Gate (m^3)	Water at Open Drain (m^3)
21/03/2021	X	118.2
22/03/2021	X	105.806
23/03/2021	X	120.407
24/03/2021	X	147.959
25/03/2021	X	109.215
26/03/2021	X	289.262
27/03/2021	X	188.767
28/03/2021	X	173.564
29/03/2021	X	135.245
30/03/2021	X	133.754
31/03/2021	X	164.977
01/04/2021	X	176.101
02/04/2021	X	75.784
03/04/2021	X	45.178
04/04/2021	X	139.759
05/04/2021	X	223.073
06/04/2021	X	103.966
07/04/2021	X	92.971
08/04/2021	181.859	90.024
09/04/2021	264.403	183.996
10/04/2021	352.201	38.759
11/04/2021	279.074	80.809
12/04/2021	161.987	86.361
13/04/2021	156.885	49.093

Date	Water at Front Gate (m^3)	Water at Open Drain (m^3)
14/04/2021	154.403	46.611
15/04/2021	166.232	40.671
16/04/2021	152.431	42.497
17/04/2021	120.288	48.024
18/04/2021	96.306	54.285
19/04/2021	88.561	61.696
20/04/2021	108.469	84.06
21/04/2021	160.397	48.477
22/04/2021	187.5	55.532
23/04/2021	182.309	51.936
24/04/2021	176.467	50.931
25/04/2021	178.258	43.699
26/04/2021	181.039	63.68
27/04/2021	186.271	98.886
28/04/2021	180.968	118.021
29/04/2021	184.884	108.659
30/04/2021	190.47	105.128
01/05/2021	178.992	98.955
02/05/2021	172.791	110.528
03/05/2021	176.348	199.418
04/05/2021	173.621	104.309
05/05/2021	171.817	139.635
06/05/2021	170.443	123.198
07/05/2021	168.138	113.814

Date	Water at Front Gate (m^3)	Water at Open Drain (m^3)
08/05/2021	169.942	253.074
09/05/2021	151.19	39.088
10/05/2021	142.282	92.833
11/05/2021	161.687	47.065
12/05/2021	152.285	88.086

Appendix 2 – Rainfall Table per day

Date	Rainfall (mm)
25/02/2021	0
26/02/2021	0
27/02/2021	0
28/02/2021	0
01/03/2021	0
02/03/2021	0
03/03/2021	0
04/03/2021	0
05/03/2021	0
06/03/2021	0
07/03/2021	0
08/03/2021	0
09/03/2021	1
10/03/2021	5
11/03/2021	3.4
12/03/2021	5.2
13/03/2021	1.8
14/03/2021	0.8
15/03/2021	0
16/03/2021	0.6
17/03/2021	0
18/03/2021	0
19/03/2021	0

Date	Rainfall (mm)
20/03/2021	0
21/03/2021	0
22/03/2021	0
23/03/2021	1
24/03/2021	0.2
25/03/2021	0
26/03/2021	2
27/03/2021	0.8
28/03/2021	1
29/03/2021	0
30/03/2021	0
31/03/2021	0
01/04/2021	0
02/04/2021	0
03/04/2021	0
04/04/2021	0
05/04/2021	0
06/04/2021	0.2
07/04/2021	0.2
08/04/2021	0.2
09/04/2021	3.6
10/04/2021	0.4
11/04/2021	2.2

Date	Rainfall (mm)
12/04/2021	1
13/04/2021	0
14/04/2021	0
15/04/2021	0
16/04/2021	0
17/04/2021	0
18/04/2021	0.2
19/04/2021	0
20/04/2021	0.8
21/04/2021	0
22/04/2021	0
23/04/2021	0
24/04/2021	0
25/04/2021	0
26/04/2021	0
27/04/2021	0.6
28/04/2021	0
29/04/2021	1.2
30/04/2021	0
01/05/2021	0
02/05/2021	0
03/05/2021	12.4
04/05/2021	1.2

Date	Rainfall (mm)
05/05/2021	2
06/05/2021	0
07/05/2021	0
08/05/2021	10.8
09/05/2021	0
10/05/2021	2.6
11/05/2021	0.2
12/05/2021	2.4

Appendix 4

Water and Foul Demand Calculations

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PROJECT TITLE: DUNDRUM CENTRAL — BY: D.K

CALCULATION: FOUL WATER FLOW — PAGE: 1

APPENDIX: A — DATE: 07/01/2022

	SUMMARY:	Total Peak Flow	Total Average Flow
A:	Residential	15.113 l/s	5.038 l/s
B:	Creche	0.344 l/s	0.000 l/s
C:	Commercial - Retail	0.286 l/s	0.064 l/s
D:	Commercial - Office	0.322 l/s	0.072 l/s
		16.065 l/s	5.173 l/s

A: RESIDENTIAL - 985 UNITS

The foul effluent from the proposed dwellings is calculated as per the Irish Water Code of Practice for Wastewater Infrastructure (July 2020 (rev. 2)) assuming dry weather flow of 150 l/head/day plus a 10% infiltration rate and using the Irish Water assumed average occupancy of 2.7 persons/unit.

No. of Units = 977

No. of Occupants = 977 x 2.7 = 2637.9

Daily Flow = No. of Occupants x Dry Weather Flow

Daily Flow = 2637.9 x 150 x 1.1 = 435,254 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} = \frac{435{,}254 \text{ l/day}}{24 \times 60 \times 60} = 5.038 \text{ l/s}$$

Peak Flow = Average Flow x 3

Peak Flow = 5.038 l/s x 3 = 15.113 l/s

B: CRÈCHE

Assume conservatively 75no. children catered for. Assume staff:child ratio of 1:5 on average (based on Schedule 6 Part 1 of Child Care Act 1991 (Early Years Services) Regulations 2016.). Thus assume total of 15no. staff + 75no. children = 85no. persons. As per Irish Water CoP for WW Infrastructure Appendix D, assume flow rate for "Schools - non-residential without a canteen" = 50litres/person/day.

No. of Children = 75

Staff:Child Ratio = 1:5

Total Population = 75 + 15 = 90

Daily Flow = Population x Dry Weather Flow

Daily Flow = 90 x 50 x 1.1 = 4,950 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} = \frac{4{,}950 \text{ l/day}}{24 \times 60 \times 60} = 0.057 \text{ l/s}$$

Peak Flow = Average Flow x 6

Peak Flow = 0.057 l/s x 6 = 0.344 l/s

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C: COMMERCIAL: RETAIL UNITS

The foul effluent from the proposed commerical unit is calculated as per the Irish Water Code of Practice for Wastewater Infrastructure (Dec. 2017) assuming dry weather flow of 45 l/occupant/day plus a 10% infiltration rate. Workers calculated: area in m² / area per FTE; as per Employment Densities Guide from OFFPAT. Type Retail A1 – High street with 18 FTE per m².

Area = 2000 m²
FTE per m² = 18

No. of FTE = Area / FTE m²
No. of Occupants = 2000 m² / 18 = 111.1

No. of FTE = No. of Occupants x Dry Weather Flow
Daily Flow = 111.1 x 45 x 1.1 = 5,500 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} = \frac{5{,}500\ \text{l/day}}{24 \times 60 \times 60} = 0.064\ \text{l/s}$$

Peak Flow = Average Flow x 4.5
Peak Flow = 0.064 l/s x 4.5 = 0.286 l/s

D: COMMERCIAL: OFFICE UNITS

The foul effluent from the proposed commerical unit is calculated as per the Irish Water Code of Practice for Wastewater Infrastructure (Dec. 2017) assuming dry weather flow of 45 l/occupant/day plus a 10% infiltration rate. Workers calculated: area in m² / area per FTE; as per Employment Densities Guide from OFFPAT. Type OFFICE - B1A – General Offices with 12 FTE per m².

Area = 1500 m²
FTE per m² = 12

No. of FTE = Area / FTE m²
No. of Occupants = 1500 m² / 12 = 125.0

No. of FTE = No. of Occupants x Dry Weather Flow
Daily Flow = 125.0 x 45 x 1.1 = 6,188 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} = \frac{6{,}188\ \text{l/day}}{24 \times 60 \times 60} = 0.072\ \text{l/s}$$

Peak Flow = Average Flow x 4.5
Peak Flow = 0.072 l/s x 4.5 = 0.322 l/s

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PROJECT TITLE:	DUNDRUM CENTRAL		BY: D.K.
CALCULATION:	WATER DEMAND		PAGE: 2
APPENDIX:	B		DATE: 07/01/2022

SUMMARY:		Total Peak Demand	Total Average Demand
A:	Residential	28.623 l/s	5.725 l/s
B:	Creche	0.293 l/s	0.059 l/s
C:	Commercial - Retail	0.362 l/s	0.072 l/s
D:	Commercial - Office	0.326 l/s	0.065 l/s
		29.603 l/s	5.921 l/s

A: RESIDENTIAL - 547 UNITS

The water demand for the proposed development has been calculated using the guidelines given in the Irish Water Code of Practice for Water Infrastructure July 2020 Rev 2) Section 3.7.2 assuming a per-capita consumption of 150 l/head/day and using the Irish Water assumed average occupancy of 2.7 persons/unit. The average day/peak week demand is taken as 1.25 times the average daily domestic demand. The peak demand factor is taken as 5 times the average day/peak week demand.

No. of Units = 977
No. of Occupants = 977 x 2.7 = 2637.9

Avg. Daily Demand = No. of Occupants x Allowance per head
Avg. Daily Demand = 2637.9 x 150 = 395,685 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} \times 1.25 = \frac{395{,}685 \text{ l/day}}{24 \times 60 \times 60} \times 1.25 = 5.725 \text{ l/s}$$

Peak Demand = Average Flow x 5
Peak Demand = 5.725 l/s x 5 = 28.623 l/s

B: CRÈCHE

Assume conservatively 75no. children catered for. Assume staff:child ratio of 1:5 on average (based on Schedule 6 Part 1 of Child Care Act 1991 (Early Years Services) Regulations 2016.). Thus assume total of 15no. staff + 75no. children = 75no. persons. As per Irish Water CoP for WW Infrastructure Appendix D, assume flow rate for "Schools - non-residential without a canteen" = 50litres/person/day. The average day/peak week demand is taken as 1.25 times the average daily domestic demand. The peak demand factor is taken as 5 times the average day/peak week demand.

No. of Children = 75
Staff:Child Ratio = 1:5
Total Population = 75 + 15 = 90

Daily Flow = No. of Workers x Dry Weather Flow
Daily Flow = 90 x 45 = 4,050 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} \times 1.25 = \frac{4{,}050 \text{ l/day}}{24 \times 60 \times 60} \times 1.25 = 0.059 \text{ l/s}$$

Peak Flow = Average Flow x 5
Peak Flow = 0.059 l/s x 5 = 0.293 l/s

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C: COMMERCIAL: RETAIL UNITS

The water demand from the proposed commerical unit is calculated as per the Irish Water Code of Practice for Water Infrastructure (Dec. 2017) assuming a water demand of 45 l/occupant/day . W Workers calculated: area in m² / area per FTE; as per Employment Densities Guide from OFFPAT. Type Retail A1 – High street with 18 FTE per m².

Area = 2000 m²
FTE per m² = 18

No. of FTE = Area / FTE m²
No. of Occupants = 2000 m² / 18 = 111.1

Daily Flow = Occupants x Dry Weather Flow
Daily Flow = 111.1 x 45 = 5,000 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} \times 1.25 = \frac{5{,}000\ \text{l/day}}{24 \times 60 \times 60} \times 1.25 = 0.072\ \text{l/s}$$

Peak Flow = Average Flow x 5
Peak Flow = 0.072 l/s x 5 = 0.362 l/s

D: COMMERCIAL: OFFICE UNITS

The water demand from the proposed commerical unit is calculated as per the Irish Water Code of Practice for Water Infrastructure (Dec. 2017) assuming a water demand of 45 l/occupant/day . Workers calculated: area in m² / area per FTE; as per Employment Densities Guide from OFFPAT. Type OFFICE - B1A – General Offices with 12 FTE per m².

Area = 1500 m²
FTE per m² = 12

No. of FTE = Area / FTE m²
No. of Occupants = 1500 m² / 12 = 125.0

No. of FTE = No. of Occupants x Dry Weather Flow
Daily Flow = 125.0 x 45 = 5,625 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} = \frac{5{,}625\ \text{l/day}}{24 \times 60 \times 60} = 0.065\ \text{l/s}$$

Peak Flow = Average Flow x 5.0
Peak Flow = 0.065 l/s x 5 = 0.326 l/s

Appendix 5

Irish Water Letters

PUNCH Cosulting /Jamie Fennell

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Uisce Éireann
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Oifig Sheachadta na
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Irish Water
PO Box 448,
South City
Delivery Office,
Cork City.

www.water.ie

23 September 2021

Re: CDS19005661 pre-connection enquiry - Subject to contract | Contract denied

Connection for Housing Development of 1,251 units at Central Mental Hospital, 14 Dundrum Road, Dundrum, Dublin

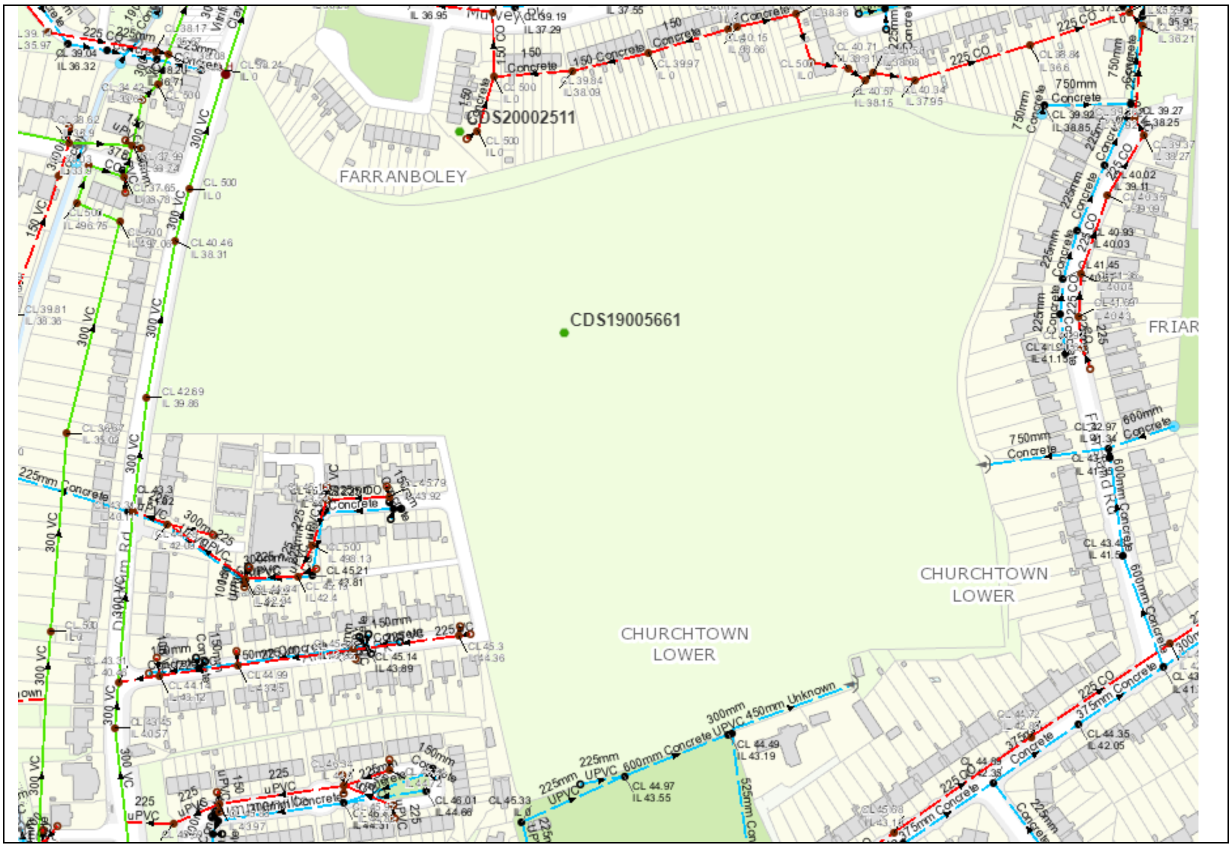
Dear Sir/Madam,

Irish Water has reviewed your pre-connection enquiry in relation to a Water & Wastewater connection at Central Mental Hospital, 14 Dundrum Road, Dundrum, Dublin (the **Premises**). Based upon the details you have provided with your pre-connection enquiry and on our desk top analysis of the capacity currently available in the Irish Water network(s) as assessed by Irish Water, we wish to advise you that your proposed connection to the Irish Water network(s) can be facilitated at this moment in time.

SERVICE	**OUTCOME OF PRE-CONNECTION ENQUIRY** **THIS IS NOT A CONNECTION OFFER. YOU MUST APPLY FOR A CONNECTION(S) TO THE IRISH WATER NETWORK(S) IF YOU WISH TO PROCEED.**
Water Connection	Feasible Subject to upgrades
Wastewater Connection	Feasible Subject to upgrades
SITE SPECIFIC COMMENTS	
Water Connection	Upgrade for approximately 720 metres of existing 9'' CI (1936) main in Dundrum Road to 250mm ID will be required to accommodate the proposed connection. Irish Water currently does not have any plans to commence upgrade works to its network in this area. At connection application stage the network upgrade will be reviewed and the upgrade works fee will be calculated in the connection offer fee or in a separate upgrade project agreement.
Wastewater Connection	• Separate storm and foul water connection services should be provided for the Development. Current storm water discharge from the Site must be removed from the combined network. The storm water must be discharged only into the existing storm water network that is not connected to the Irish Water combined network. The storm water connection arrangement should be agreed with the Local Authority Drainage Division.

	• The Customer will be required to implement wastewater discharge management to limit the foul flows from the Development to 3DWF (13l/s based on unit info in the PCE Application). The limitation of flows should be stepped in phases. At a connection application stage, the Customer must confirm how they plan to limit the flows (throttle or pump station) and provide details of the stepped discharges.
The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this development shall comply with the Irish Water Connections and Developer Services Standard Details and Codes of Practice that are available on the Irish Water website. Irish Water reserves the right to supplement these requirements with Codes of Practice and these will be issued with the connection agreement.	

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



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

General Notes:

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

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

Yours sincerely,

Yvonne Harris

Yvonne Harris

Head of Customer Operations

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

Irish Water
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South City
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Cork City.

www.water.ie

John Considine
BMCE
Sandwith House
52-54 Lower Sandwith Street
Dublin 2, Co. Dublin

3 March 2022

Re: Design Submission for Central Mental Hospital, 14 Dundrum Road, Dundrum, Dublin (the "Development")
(the "Design Submission") / Connection Reference No: CDS19005661

Dear John Considine,

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: Fionán Ginty
Phone: 01 89 25734 / 087 149 6032
Email: fginty@water.ie

Yours sincerely,

Yvonne Harris

Yvonne Harris
Head of Customer Operations

Appendix A

Document Title & Revision

- DCD-BMD-00-00-DR-C-1021 PL4

- DCD-BMD-00-00-DR-C-1040 PL4

Notes:

- A full detailed design submission for the proposed wastewater pump station(s) shall be submitted at connection application stage and will be subject to detailed design review. The impact of any Irish Water Capital projects will require review and further site design assessment at connection application stage.
- Wastewater long sections to be and submitted at connection application stage.

*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 6

Causeway Flow Network Model

Design Settings

Rainfall Methodology	FSR
Return Period (years)	5
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	18.000
Ratio-R	0.277
CV	1.000
Time of Entry (mins)	4.00

Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Soffits
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	✓
Enforce best practice design rules	x

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S2.0	0.078	4.00	45.060	1200	-37.004	-39.118	1.610
S2.1	0.038	4.00	44.940	1200	-47.311	-6.499	1.718
S1.7	0.000	4.00	44.820	1200	-45.001	25.858	1.620
S1.8	0.031	4.00	44.520	1200	-54.842	17.260	1.539
S1.8A	0.045	4.00	43.990	1350	-63.566	27.207	2.868
S1.9	0.051	4.00	43.850	1350	-83.594	50.171	2.908
S1.10	0.025	4.00	43.750	1350	-111.959	65.318	3.022
S12.3	0.409	4.00	43.340	1200	-117.599	51.937	2.540
S12.4	0.000		43.520	1200	-122.275	60.403	2.784
S1.11	0.015	4.00	43.560	1350	-117.985	74.660	2.998
S1.12	0.015	4.00	43.390	1350	-100.494	85.972	3.036
S1.13	0.035	4.00	43.520	1350	-81.423	92.065	4.670
S1.14	0.000		43.750	1350	-88.593	114.679	5.058
S1.15	0.000		42.630	1350	-121.629	104.139	4.169
S1.16	0.009	4.00	43.100	1350	-137.098	92.300	4.769
S1.17	0.013	4.00	42.030	1350	-152.100	111.900	3.849
S1.18	0.017	4.00	40.020	1350	-167.504	139.464	2.039
S3.0	0.063	4.00	43.530	1200	-169.331	21.994	1.430
S3.1	0.053	4.00	42.710	1200	-226.629	20.964	1.374
S3.2	0.006	4.00	43.060	1200	-226.745	27.434	1.853
S3.3	0.000		43.100	1200	-226.985	40.771	2.071
S3.4	0.000	4.00	41.240	1200	-221.854	71.886	0.526
S3.5	0.000	4.00	40.420	1200	-214.194	113.174	0.406
S3.6	0.030	4.00	40.620	1200	-209.623	114.558	0.686
S3.7	0.000		40.010	1200	-205.576	130.131	1.935
S3.8	0.000		39.760	1200	-208.554	135.453	1.787
S1.19	0.032	4.00	38.770	1350	-201.014	163.218	1.770
S1.20	0.000		38.700	1350	-216.765	168.251	1.878
S12.2	0.082	4.00	44.070	1200	-66.074	23.848	2.831
S12.0	0.050	4.00	43.600	1200	-154.630	22.256	1.400
S12.1	0.050	4.00	43.810	1200	-113.229	23.003	2.024

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
2.000	S2.0	S2.1	34.209	0.600	43.450	43.222	0.228	150.0	225	4.54	50.0
2.001	S2.1	S1.8	24.924	0.600	43.222	43.056	0.166	150.0	225	4.93	50.0
3.000	S1.7	S1.8	13.068	0.600	43.200	43.113	0.087	150.0	225	4.20	50.0
2.002	S1.8	S1.8A	13.231	0.600	42.981	42.903	0.078	169.6	300	5.11	50.0

Links (Input)

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	S12.0	S12.1	41.408	0.600	42.200	41.786	0.414	100.0	225	4.53	50.0
1.001	S12.1	S12.2	47.163	0.600	41.786	41.314	0.472	100.0	225	5.13	50.0
1.002	S12.2	S1.8A	4.192	0.600	41.239	41.197	0.042	100.0	300	5.17	50.0
1.003	S1.8A	S1.9	30.471	0.600	41.122	40.942	0.180	169.3	375	5.54	50.0
1.004	S1.9	S1.10	32.156	0.600	40.942	40.728	0.214	150.0	375	5.90	50.0
1.005	S1.10	S1.11	11.117	0.600	40.728	40.654	0.074	150.0	375	6.03	50.0
4.000	S12.3	S12.4	9.672	0.600	40.800	40.736	0.064	150.0	300	4.13	50.0
4.001	S12.4	S1.11	14.888	0.600	40.736	40.637	0.099	150.0	300	4.32	50.0
1.006	S1.11	S1.12	20.830	0.600	40.562	40.354	0.208	100.0	375	6.22	50.0
1.007	S1.12	S1.13	20.021	0.600	40.354	40.154	0.200	100.0	375	6.40	50.0
1.008	S1.13	S1.14	23.723	0.600	38.850	38.692	0.158	150.0	450	6.64	50.0
1.009	S1.14	S1.15	34.677	0.600	38.692	38.461	0.231	150.0	450	6.99	50.0
1.010	S1.15	S1.16	19.480	0.600	38.461	38.331	0.130	150.0	450	7.19	50.0
1.011	S1.16	S1.17	24.682	0.600	38.331	38.181	0.150	164.5	450	7.45	50.0
1.012	S1.17	S1.18	31.576	0.600	38.181	37.981	0.200	157.9	450	7.77	50.0
1.013	S1.18	S1.19	41.075	0.600	37.981	37.000	0.981	41.9	450	7.99	50.0
5.000	S3.0	S3.1	57.307	0.600	42.100	41.336	0.764	75.0	225	4.63	50.0
5.001	S3.1	S3.2	6.471	0.600	41.336	41.207	0.129	50.0	225	4.69	50.0
5.002	S3.2	S3.3	13.339	0.600	41.207	41.029	0.178	75.0	225	4.84	50.0
5.003	S3.3	S3.4	31.535	0.600	41.029	40.714	0.315	100.0	225	5.24	50.0
5.004	S3.4	S3.5	41.993	0.600	40.714	40.014	0.700	60.0	225	5.65	50.0
5.005	S3.5	S3.6	4.776	0.600	40.014	39.934	0.080	60.0	225	5.70	50.0
5.006	S3.6	S3.7	16.090	0.600	39.934	39.666	0.268	60.0	225	5.86	50.0
5.007	S3.7	S3.8	6.099	0.600	38.075	37.973	0.102	60.0	225	5.92	50.0
5.008	S3.8	S1.19	28.771	0.600	37.973	37.493	0.480	60.0	225	6.20	50.0
1.014	S1.19	S1.20	16.536	0.600	37.000	36.822	0.178	92.9	450	8.12	50.0

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	Scotland and Ireland	Drain Down Time (mins)	240
M5-60 (mm)	18.000	Additional Storage (m^3/ha)	20.0
Ratio-R	0.277	Check Discharge Rate(s)	x
Summer CV	1.000	Check Discharge Volume	x
Analysis Speed	Normal		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
5	20	0	0
30	20	0	0
100	20	0	0

Node S1.13 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	38.850	Product Number	CTL-SHE-0074-4000-3000-4000
Design Depth (m)	3.000	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	4.0	Min Node Diameter (mm)	1200

Node S12.3 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	40.800	Product Number	CTL-SHE-0057-2000-2000-2000
Design Depth (m)	2.000	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S3.7 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	38.075	Product Number	CTL-SHE-0057-2000-2000-2000
Design Depth (m)	2.000	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S1.19 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	37.000	Product Number	CTL-SHE-0116-7000-1500-7000
Design Depth (m)	1.500	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	7.0	Min Node Diameter (mm)	1200

Node S1.13 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	5.0	Invert Level (m)	38.850
Side Inf Coefficient (m/hr)	0.26400	Porosity	0.95	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	226.0	226.0	3.000	226.0	422.8	3.010	0.0	422.8

Node S12.3 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	40.800
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	182.2	0.0	2.000	182.2	0.0	2.010	0.0	0.0

Node S3.7 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	2.0	Invert Level (m)	38.075
Side Inf Coefficient (m/hr)	0.26400	Porosity	1.00	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	77.0	77.0	2.000	77.0	156.4	2.010	0.0	156.4

Results for 5 year +20% CC Critical Storm Duration. Lowest mass balance: 99.84%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S2.0	10	43.573	0.123	24.9	0.2582	0.0000	OK
15 minute summer	S2.1	10	43.393	0.171	37.1	0.2696	0.0000	OK
15 minute summer	S1.7	1	43.200	0.000	0.0	0.0000	0.0000	OK
15 minute summer	S1.8	10	43.151	0.170	46.1	0.2612	0.0000	OK
15 minute summer	S1.8A	10	41.389	0.267	115.4	0.4654	0.0000	OK
15 minute summer	S1.9	11	41.221	0.279	129.8	0.4975	0.0000	OK
15 minute summer	S1.10	11	41.028	0.300	136.2	0.4793	0.0000	OK
2160 minute summer	S12.3	1560	41.762	0.962	8.7	179.4976	0.0000	SURCHARGED
15 minute summer	S12.4	11	40.831	0.095	1.4	0.1071	0.0000	OK
15 minute summer	S1.11	11	40.828	0.266	141.8	0.4079	0.0000	OK
15 minute summer	S1.12	11	40.619	0.265	145.5	0.4060	0.0000	OK
600 minute summer	S1.13	435	39.484	0.634	27.2	137.1219	0.0000	SURCHARGED
60 minute summer	S1.14	38	38.723	0.031	2.5	0.0444	0.0000	OK
240 minute summer	S1.15	440	38.492	0.031	2.5	0.0445	0.0000	OK
30 minute summer	S1.16	18	38.372	0.041	4.5	0.0597	0.0000	OK
30 minute summer	S1.17	18	38.236	0.055	7.9	0.0823	0.0000	OK
30 minute summer	S1.18	18	38.029	0.048	12.4	0.0768	0.0000	OK
15 minute summer	S3.0	10	42.189	0.089	20.1	0.1788	0.0000	OK
15 minute summer	S3.1	10	41.471	0.135	36.9	0.2569	0.0000	OK
15 minute summer	S3.2	10	41.352	0.145	38.4	0.1739	0.0000	OK
15 minute summer	S3.3	10	41.180	0.151	38.2	0.1712	0.0000	OK
15 minute summer	S3.4	11	40.835	0.121	37.6	0.1363	0.0000	OK
15 minute summer	S3.5	11	40.168	0.154	38.2	0.1742	0.0000	OK
15 minute summer	S3.6	11	40.085	0.151	46.1	0.3019	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S2.0	2.000	S2.1	25.0	0.930	0.589	0.9347	
15 minute summer	S2.1	2.001	S1.8	36.2	1.169	0.855	0.7755	
15 minute summer	S1.7	3.000	S1.8	0.0	0.000	0.000	0.0291	
15 minute summer	S1.8	2.002	S1.8A	45.4	1.174	0.534	0.5135	
15 minute summer	S1.8A	1.003	S1.9	113.5	1.329	0.740	2.6043	
15 minute summer	S1.9	1.004	S1.10	129.6	1.420	0.795	2.9353	
15 minute summer	S1.10	1.005	S1.11	137.0	1.560	0.840	0.9738	
2160 minute summer	S12.3	Hydro-Brake®	S12.4	1.4				
15 minute summer	S12.4	4.001	S1.11	3.1	0.464	0.034	0.4949	
15 minute summer	S1.11	1.006	S1.12	141.5	1.694	0.707	1.7405	
15 minute summer	S1.12	1.007	S1.13	145.1	1.873	0.725	1.5523	
600 minute summer	S1.13	Hydro-Brake®	S1.14	2.5				
600 minute summer	S1.13	Infiltration		3.9				
60 minute summer	S1.14	1.009	S1.15	2.5	0.530	0.009	0.1631	
240 minute summer	S1.15	1.010	S1.16	2.5	0.519	0.009	0.1030	
30 minute summer	S1.16	1.011	S1.17	4.3	0.497	0.017	0.2225	
30 minute summer	S1.17	1.012	S1.18	7.8	0.779	0.030	0.3160	
30 minute summer	S1.18	1.013	S1.19	12.2	0.281	0.024	3.4350	
15 minute summer	S3.0	5.000	S3.1	20.0	1.026	0.334	1.1304	
15 minute summer	S3.1	5.001	S3.2	36.5	1.404	0.495	0.1683	
15 minute summer	S3.2	5.002	S3.3	38.2	1.376	0.636	0.3704	
15 minute summer	S3.3	5.003	S3.4	37.6	1.515	0.723	0.7824	
15 minute summer	S3.4	5.004	S3.5	38.2	1.515	0.569	1.0627	
15 minute summer	S3.5	5.005	S3.6	38.2	1.349	0.569	0.1366	
15 minute summer	S3.6	5.006	S3.7	46.1	1.732	0.686	0.4283	

Results for 5 year +20% CC Critical Storm Duration. Lowest mass balance: 99.84%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	S3.7	86	38.371	0.296	22.1	23.1219	0.0000	SURCHARGED
180 minute summer	S3.8	152	37.995	0.022	1.3	0.0249	0.0000	OK
120 minute summer	S1.19	86	37.927	0.927	14.0	1.6622	0.0000	SURCHARGED
15 minute summer	S1.20	1	36.822	0.000	7.0	0.0000	0.0000	OK
15 minute summer	S12.2	10	41.440	0.201	57.3	0.3438	0.0000	OK
15 minute summer	S12.0	10	42.285	0.085	16.0	0.1568	0.0000	OK
15 minute summer	S12.1	10	41.915	0.129	32.0	0.2103	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute summer	S3.7	Hydro-Brake®	S3.8	1.3				
120 minute summer	S3.7	Infiltration		3.2				
180 minute summer	S3.8	5.008	S1.19	1.3	0.669	0.020	0.6005	
120 minute summer	S1.19	Hydro-Brake®	S1.20	7.0				77.1
15 minute summer	S12.2	1.002	S1.8A	55.6	1.266	0.501	0.2048	
15 minute summer	S12.0	1.000	S12.1	16.0	0.891	0.307	0.7730	
15 minute summer	S12.1	1.001	S12.2	31.1	1.349	0.598	1.0967	

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.84%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S2.0	10	43.634	0.184	36.6	0.3870	0.0000	OK
15 minute summer	S2.1	10	43.509	0.287	53.0	0.4512	0.0000	SURCHARGED
15 minute summer	S1.7	1	43.200	0.000	0.0	0.0000	0.0000	OK
15 minute summer	S1.8	10	43.197	0.216	64.9	0.3314	0.0000	OK
15 minute summer	S1.8A	11	41.699	0.577	155.1	1.0062	0.0000	SURCHARGED
15 minute summer	S1.9	11	41.468	0.526	173.8	0.9374	0.0000	SURCHARGED
15 minute summer	S1.10	11	41.154	0.426	185.5	0.6799	0.0000	SURCHARGED
2160 minute summer	S12.3	1680	42.195	1.395	11.7	260.2497	0.0000	SURCHARGED
15 minute summer	S12.4	11	40.952	0.216	4.7	0.2444	0.0000	OK
15 minute summer	S1.11	11	40.952	0.390	192.2	0.5969	0.0000	SURCHARGED
15 minute summer	S1.12	11	40.701	0.347	196.6	0.5316	0.0000	OK
720 minute summer	S1.13	540	39.849	0.999	33.8	216.0671	0.0000	SURCHARGED
15 minute summer	S1.14	13	38.723	0.031	2.5	0.0445	0.0000	OK
5760 minute summer	S1.15	3720	38.492	0.031	2.5	0.0445	0.0000	OK
30 minute summer	S1.16	18	38.378	0.047	6.0	0.0692	0.0000	OK
30 minute summer	S1.17	18	38.247	0.066	11.3	0.0982	0.0000	OK
120 minute summer	S1.18	84	38.228	0.247	10.8	0.3945	0.0000	OK
15 minute summer	S3.0	10	42.211	0.111	29.6	0.2224	0.0000	OK
15 minute summer	S3.1	10	41.527	0.191	54.4	0.3626	0.0000	OK
15 minute summer	S3.2	11	41.432	0.225	56.0	0.2693	0.0000	SURCHARGED
15 minute summer	S3.3	11	41.261	0.232	55.1	0.2619	0.0000	SURCHARGED
15 minute summer	S3.4	10	40.865	0.151	53.4	0.1704	0.0000	OK
15 minute summer	S3.5	11	40.233	0.219	52.8	0.2482	0.0000	OK
15 minute summer	S3.6	11	40.141	0.207	64.5	0.4153	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S2.0	2.000	S2.1	35.2	0.982	0.831	1.2758	
15 minute summer	S2.1	2.001	S1.8	50.3	1.280	1.188	0.9343	
15 minute summer	S1.7	3.000	S1.8	0.0	0.000	0.000	0.0883	
15 minute summer	S1.8	2.002	S1.8A	64.1	1.261	0.753	0.6732	
15 minute summer	S1.8A	1.003	S1.9	154.0	1.396	1.004	3.3609	
15 minute summer	S1.9	1.004	S1.10	175.8	1.594	1.078	3.5467	
15 minute summer	S1.10	1.005	S1.11	186.4	1.704	1.143	1.1631	
2160 minute summer	S12.3	Hydro-Brake®	S12.4	1.7				
15 minute summer	S12.4	4.001	S1.11	7.1	0.463	0.079	0.9287	
15 minute summer	S1.11	1.006	S1.12	190.8	1.738	0.954	2.2592	
15 minute summer	S1.12	1.007	S1.13	193.9	1.956	0.969	1.9810	
720 minute summer	S1.13	Hydro-Brake®	S1.14	2.5				
720 minute summer	S1.13	Infiltration		4.2				
15 minute summer	S1.14	1.009	S1.15	2.5	0.577	0.009	0.1631	
5760 minute summer	S1.15	1.010	S1.16	2.5	0.520	0.009	0.0938	
30 minute summer	S1.16	1.011	S1.17	5.9	0.519	0.024	0.2837	
30 minute summer	S1.17	1.012	S1.18	11.3	0.865	0.044	0.9110	
120 minute summer	S1.18	1.013	S1.19	10.7	0.281	0.021	5.0826	
15 minute summer	S3.0	5.000	S3.1	29.5	1.086	0.492	1.5840	
15 minute summer	S3.1	5.001	S3.2	53.2	1.444	0.722	0.2410	
15 minute summer	S3.2	5.002	S3.3	55.1	1.438	0.918	0.5303	
15 minute summer	S3.3	5.003	S3.4	53.4	1.612	1.026	1.0667	
15 minute summer	S3.4	5.004	S3.5	52.8	1.579	0.786	1.4144	
15 minute summer	S3.5	5.005	S3.6	53.1	1.423	0.789	0.1856	
15 minute summer	S3.6	5.006	S3.7	64.6	1.811	0.961	0.5738	

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.84%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	S3.7	128	38.562	0.487	24.3	38.0751	0.0000	SURCHARGED
120 minute summer	S3.8	80	38.234	0.261	2.6	0.2956	0.0000	SURCHARGED
120 minute summer	S1.19	86	38.230	1.230	19.0	2.2049	0.0000	SURCHARGED
15 minute summer	S1.20	1	36.822	0.000	7.0	0.0000	0.0000	OK
15 minute summer	S12.2	11	41.742	0.503	80.5	0.8604	0.0000	SURCHARGED
15 minute summer	S12.0	10	42.305	0.105	23.5	0.1940	0.0000	OK
15 minute summer	S12.1	11	41.999	0.213	47.0	0.3457	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
180 minute summer	S3.7	Hydro-Brake®	S3.8	1.3				
180 minute summer	S3.7	Infiltration		3.5				
120 minute summer	S3.8	5.008	S1.19	3.9	0.669	0.058	1.1443	
120 minute summer	S1.19	Hydro-Brake®	S1.20	7.0				88.0
15 minute summer	S12.2	1.002	S1.8A	73.8	1.232	0.664	0.2952	
15 minute summer	S12.0	1.000	S12.1	23.5	0.938	0.452	1.1458	
15 minute summer	S12.1	1.001	S12.2	44.5	1.274	0.857	1.8553	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.84%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S2.0	10	43.973	0.523	47.6	1.0987	0.0000	SURCHARGED
15 minute summer	S2.1	11	43.696	0.474	66.2	0.7454	0.0000	SURCHARGED
15 minute summer	S1.7	11	43.246	0.046	1.8	0.0523	0.0000	OK
15 minute summer	S1.8	11	43.246	0.265	82.4	0.4065	0.0000	OK
15 minute summer	S1.8A	11	42.234	1.112	185.0	1.9404	0.0000	SURCHARGED
15 minute summer	S1.9	11	41.907	0.965	207.1	1.7195	0.0000	SURCHARGED
15 minute summer	S1.10	11	41.470	0.742	217.8	1.1844	0.0000	SURCHARGED
2160 minute summer	S12.3	1680	42.593	1.793	14.3	334.4710	0.0000	SURCHARGED
15 minute summer	S12.4	11	41.238	0.502	7.8	0.5673	0.0000	SURCHARGED
15 minute summer	S1.11	11	41.237	0.675	224.5	1.0331	0.0000	SURCHARGED
15 minute summer	S1.12	11	40.870	0.516	229.5	0.7895	0.0000	SURCHARGED
600 minute summer	S1.13	495	40.182	1.331	46.5	287.9774	0.0000	SURCHARGED
600 minute summer	S1.14	495	38.724	0.032	2.7	0.0465	0.0000	OK
600 minute summer	S1.15	495	38.494	0.033	2.7	0.0466	0.0000	OK
120 minute summer	S1.16	94	38.405	0.074	4.9	0.1091	0.0000	OK
120 minute summer	S1.17	88	38.409	0.228	8.5	0.3420	0.0000	OK
120 minute summer	S1.18	90	38.406	0.425	13.2	0.6796	0.0000	OK
15 minute summer	S3.0	10	42.230	0.130	38.5	0.2610	0.0000	OK
15 minute summer	S3.1	11	41.839	0.503	70.8	0.9570	0.0000	SURCHARGED
15 minute summer	S3.2	11	41.691	0.484	63.6	0.5783	0.0000	SURCHARGED
15 minute summer	S3.3	11	41.422	0.393	62.9	0.4444	0.0000	SURCHARGED
15 minute summer	S3.4	12	40.947	0.233	62.5	0.2637	0.0000	FLOOD RISK
15 minute summer	S3.5	11	40.370	0.356	61.7	0.4026	0.0000	FLOOD RISK
15 minute summer	S3.6	11	40.257	0.323	71.8	0.6485	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S2.0	2.000	S2.1	43.1	1.085	1.019	1.3605	
15 minute summer	S2.1	2.001	S1.8	64.3	1.618	1.519	0.9681	
15 minute summer	S1.7	3.000	S1.8	-1.8	0.252	-0.042	0.1978	
15 minute summer	S1.8	2.002	S1.8A	81.8	1.331	0.961	0.8079	
15 minute summer	S1.8A	1.003	S1.9	181.3	1.644	1.181	3.3609	
15 minute summer	S1.9	1.004	S1.10	205.2	1.861	1.258	3.5467	
15 minute summer	S1.10	1.005	S1.11	216.9	1.967	1.330	1.2262	
2160 minute summer	S12.3	Hydro-Brake®	S12.4	1.9				
15 minute summer	S12.4	4.001	S1.11	-7.8	0.454	-0.086	1.0484	
15 minute summer	S1.11	1.006	S1.12	221.9	2.012	1.109	2.2975	
15 minute summer	S1.12	1.007	S1.13	229.2	2.080	1.146	2.1556	
600 minute summer	S1.13	Hydro-Brake®	S1.14	2.7				
600 minute summer	S1.13	Infiltration		4.6				
600 minute summer	S1.14	1.009	S1.15	2.7	0.544	0.010	0.1754	
600 minute summer	S1.15	1.010	S1.16	2.7	0.533	0.010	0.1018	
120 minute summer	S1.16	1.011	S1.17	4.9	0.524	0.019	1.1831	
120 minute summer	S1.17	1.012	S1.18	9.5	0.789	0.037	3.7078	
120 minute summer	S1.18	1.013	S1.19	12.0	0.276	0.024	6.4400	
15 minute summer	S3.0	5.000	S3.1	38.5	1.120	0.640	1.8184	
15 minute summer	S3.1	5.001	S3.2	60.2	1.513	0.816	0.2574	
15 minute summer	S3.2	5.002	S3.3	62.9	1.582	1.047	0.5305	
15 minute summer	S3.3	5.003	S3.4	62.5	1.602	1.202	1.2542	
15 minute summer	S3.4	5.004	S3.5	61.7	1.597	0.917	1.6701	
15 minute summer	S3.5	5.005	S3.6	61.2	1.538	0.910	0.1899	
15 minute summer	S3.6	5.006	S3.7	70.3	1.771	1.046	0.6299	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.84%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
180 minute summer	S3.7	136	38.752	0.677	31.2	52.8639	0.0000	SURCHARGED
120 minute summer	S3.8	86	38.420	0.447	1.8	0.5055	0.0000	SURCHARGED
120 minute summer	S1.19	86	38.410	1.410	21.6	2.5283	0.0000	SURCHARGED
15 minute summer	S1.20	1	36.822	0.000	7.0	0.0000	0.0000	OK
15 minute summer	S12.2	11	42.289	1.050	89.0	1.7954	0.0000	SURCHARGED
15 minute summer	S12.0	11	42.691	0.491	30.5	0.9064	0.0000	SURCHARGED
15 minute summer	S12.1	11	42.629	0.843	59.6	1.3697	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
180 minute summer	S3.7	Hydro-Brake®	S3.8	1.3				
180 minute summer	S3.7	Infiltration		3.8				
120 minute summer	S3.8	5.008	S1.19	3.5	0.669	0.051	1.1443	
120 minute summer	S1.19	Hydro-Brake®	S1.20	7.0				105.0
15 minute summer	S12.2	1.002	S1.8A	79.8	1.244	0.718	0.2952	
15 minute summer	S12.0	1.000	S12.1	29.1	0.972	0.560	1.6468	
15 minute summer	S12.1	1.001	S12.2	48.5	1.528	0.932	1.8757	

Design Settings

Rainfall Methodology	FSR
Return Period (years)	5
Additional Flow (%)	0
FSR Region	Scotland and Ireland
M5-60 (mm)	18.000
Ratio-R	0.277
CV	1.000
Time of Entry (mins)	4.00

Maximum Time of Concentration (mins)	30.00
Maximum Rainfall (mm/hr)	50.0
Minimum Velocity (m/s)	1.00
Connection Type	Level Inverts
Minimum Backdrop Height (m)	0.200
Preferred Cover Depth (m)	1.200
Include Intermediate Ground	✓
Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S15.0	0.000	4.00	45.120	1200	-24.316	-196.731	0.970
S15.1	0.288	4.00	44.610	1200	-43.371	-122.402	0.710
S15.2			44.680	1200	-45.580	-113.725	1.030
S14.0	0.002	4.00	45.060	1200	-41.780	-45.270	1.260
S14.1	0.018	4.00	44.900	1200	-35.355	-53.625	1.175
S14.2	0.195	4.00	44.980	1350	-18.758	-103.519	1.518
S14.3	0.069	4.00	45.330	1350	12.523	-107.910	1.973
S14.4	0.069	4.00	44.980	1200	32.746	-107.762	1.630
S14.5	0.069	4.00	45.350	1350	23.224	-129.481	2.158
S14.6	0.000		45.290	1350	29.894	-150.521	2.172
S14.7	0.110	4.00	44.730	1350	51.629	-143.631	1.688
S14.8	0.028	4.00	45.070	1350	34.561	-89.787	2.216
S11.3	0.250	4.00	45.150	1200	14.194	-33.373	1.950
S11.4	0.250	4.00	45.150	1200	18.279	-46.345	2.050
S11.5	0.001	4.00	44.970	1500	52.736	-84.020	2.180
S11.6	0.001	4.00	44.820	1500	70.955	-78.236	2.094
S10.0	0.000	4.00	45.130	1200	31.862	-1.093	1.130
S10.1	0.000	4.00	45.620	1200	53.582	5.742	1.970
S10.2	0.000	4.00	45.620	1200	63.713	4.833	2.420
S10.3	0.000	4.00	45.630	1200	64.231	-12.328	2.530
S10.4	0.329	4.00	45.590	1200	80.801	-12.301	2.590
S10.5	0.160	4.00	45.410	1200	91.528	-46.216	2.760
S10.6	0.098	4.00	44.500	1500	97.022	-63.935	1.943
S10.7	0.062	4.00	43.890	1500	165.026	-42.384	1.571
S6.4	0.092	4.00	42.550	1200	181.313	7.004	0.350
S10.8			44.220	1500	212.002	-27.557	2.205
OUTB1			43.250	1500	215.937	-39.970	1.278
S8.0	0.033	4.00	43.580	1200	221.375	-109.988	0.780
S23.0	0.051	4.00	44.900	1200	218.641	-81.141	2.100
S8.1	0.086	4.00	43.970	1200	224.677	-80.460	1.370
S7.0	0.033	4.00	44.950	1200	215.716	-53.889	2.350
S7.1	0.086	4.00	44.310	1200	221.124	-48.579	2.310
OUT4			43.250	1200	220.140	-40.010	1.270
S9.0	0.218	4.00	44.800	1200	113.003	-119.211	0.800
S9.1	0.136	4.00	44.800	1200	108.849	-106.174	1.550
S9.2	0.000	4.00	44.780	1200	102.077	-84.600	1.655
OUT5			44.700	1200	98.931	-74.566	1.687

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.000	S15.0	S15.1	76.733	0.600	44.150	43.900	0.250	306.9	225	5.73	50.0
1.001	S15.1	S15.2	8.954	0.600	43.900	43.840	0.060	150.0	300	5.84	50.0
1.002	S15.2	S14.2	28.698	0.600	43.650	43.507	0.143	200.0	300	6.27	50.0
2.000	S14.0	S14.1	10.540	0.600	43.800	43.725	0.075	140.5	300	4.13	50.0
2.001	S14.1	S14.2	52.600	0.600	43.725	43.462	0.263	200.0	300	4.92	50.0
1.003	S14.2	S14.3	31.596	0.600	43.462	43.357	0.105	300.0	375	6.78	50.0
1.004	S14.3	S14.5	24.079	0.600	43.357	43.277	0.080	300.0	375	7.17	50.0
3.000	S14.4	S14.5	23.715	0.600	43.350	43.192	0.158	150.0	225	4.37	50.0
1.005	S14.5	S14.6	22.072	0.600	43.192	43.118	0.074	300.0	375	7.52	50.0
1.006	S14.6	S14.7	22.801	0.600	43.118	43.042	0.076	300.0	375	7.88	50.0
1.007	S14.7	S14.8	56.484	0.600	43.042	42.854	0.188	300.0	300	8.93	50.0
1.008	S14.8	S11.5	19.068	0.600	42.854	42.790	0.064	300.0	300	9.28	50.0
4.000	S11.3	S11.4	13.600	0.600	43.200	43.109	0.091	150.0	225	4.21	50.0
4.001	S11.4	S11.5	51.056	0.600	43.100	42.845	0.255	200.0	300	4.98	50.0
1.009	S11.5	S11.6	19.115	0.600	42.790	42.726	0.064	300.0	375	9.59	50.0
1.010	S11.6	S10.6	29.732	0.600	42.726	42.627	0.099	300.0	375	10.06	50.0
5.000	S10.0	S10.1	22.770	0.600	44.000	43.886	0.114	200.0	300	4.34	50.0
5.001	S10.1	S10.2	10.172	0.600	43.650	43.599	0.051	200.0	300	4.50	50.0
5.002	S10.2	S10.3	17.186	0.600	43.200	43.114	0.086	200.0	300	4.75	50.0
5.003	S10.3	S10.4	16.587	0.600	43.100	43.017	0.083	200.0	300	5.00	50.0
5.004	S10.4	S10.5	35.571	0.600	43.000	42.822	0.178	200.0	300	5.54	50.0
5.005	S10.5	S10.6	18.551	0.600	42.650	42.557	0.093	200.0	300	5.82	50.0

Name	Vel (m/s)	Cap (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.000	0.741	29.5	0.745	0.485	0.000	0.0
1.001	1.281	90.6	0.410	0.540	0.288	0.0
1.002	1.108	78.3	0.730	1.173	0.288	0.0
2.000	1.324	93.6	0.960	0.875	0.002	0.0
2.001	1.108	78.3	0.875	1.218	0.020	0.0
1.003	1.041	114.9	1.143	1.598	0.503	0.0
1.004	1.041	114.9	1.598	1.698	0.572	0.0
3.000	1.065	42.3	1.405	1.933	0.069	0.0
1.005	1.041	114.9	1.783	1.797	0.710	0.0
1.006	1.041	114.9	1.797	1.313	0.710	0.0
1.007	0.902	63.8	1.388	1.916	0.820	0.0
1.008	0.902	63.8	1.916	1.880	0.848	0.0
4.000	1.065	42.3	1.725	1.816	0.250	0.0
4.001	1.108	78.3	1.750	1.825	0.500	0.0
1.009	1.041	114.9	1.805	1.719	1.349	0.0
1.010	1.041	114.9	1.719	1.498	1.350	0.0
5.000	1.108	78.3	0.830	1.434	0.000	0.0
5.001	1.108	78.3	1.670	1.721	0.000	0.0
5.002	1.108	78.3	2.120	2.216	0.000	0.0
5.003	1.108	78.3	2.230	2.273	0.000	0.0
5.004	1.108	78.3	2.290	2.288	0.329	0.0
5.005	1.108	78.3	2.460	1.643	0.489	0.0

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
1.011	S10.6	S10.7	71.337	0.600	42.557	42.319	0.238	300.0	450	11.08	48.3
1.012	S10.7	S10.8	49.260	0.600	42.319	42.155	0.164	300.0	450	11.78	46.9
6.000	S6.4	S10.8	46.220	0.600	42.200	42.015	0.185	250.0	225	4.94	50.0
1.013	S10.8	OUTB1	13.022	0.600	42.015	41.972	0.043	300.0	225	12.07	46.3
7.000	S8.0	S8.1	29.712	0.600	42.800	42.600	0.200	148.6	300	4.38	50.0
8.000	S23.0	S8.1	6.074	0.600	42.800	42.739	0.061	100.0	300	4.06	50.0
7.001	S8.1	S7.1	32.078	0.600	42.600	42.279	0.321	100.0	300	4.72	50.0
9.000	S7.0	S7.1	7.579	0.600	42.600	42.524	0.076	100.0	225	4.10	50.0
7.002	S7.1	OUT4	8.625	0.600	42.000	41.980	0.020	431.3	300	4.92	50.0
10.000	S9.0	S9.1	13.683	0.600	44.000	43.863	0.137	100.0	375	4.13	50.0
10.001	S9.1	S9.2	22.612	0.600	43.250	43.125	0.125	180.9	375	4.41	50.0
10.002	S9.2	OUT5	10.516	0.600	43.125	43.013	0.112	93.9	225	4.54	50.0

Name	Vel (m/s)	Cap (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
1.011	1.168	185.8	1.493	1.121	1.937	0.0
1.012	1.168	185.8	1.121	1.615	1.999	0.0
6.000	0.822	32.7	0.125	1.980	0.092	0.0
1.013	0.750	29.8	1.980	1.053	2.091	0.0
7.000	1.287	91.0	0.480	1.070	0.033	0.0
8.000	1.572	111.1	1.800	0.931	0.051	0.0
7.001	1.572	111.1	1.070	1.731	0.170	0.0
9.000	1.307	52.0	2.125	1.561	0.033	0.0
7.002	0.751	53.1	2.010	0.970	0.289	0.0
10.000	1.812	200.1	0.425	0.562	0.318	0.0
10.001	1.344	148.4	1.175	1.280	0.454	0.0
10.002	1.349	53.7	1.430	1.462	0.454	0.0

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	Scotland and Ireland	Drain Down Time (mins)	240
M5-60 (mm)	18.000	Additional Storage (m³/ha)	20.0
Ratio-R	0.277	Check Discharge Rate(s)	x
Summer CV	1.000	Check Discharge Volume	x
Analysis Speed	Normal		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
5	20	0	0
30	20	0	0
100	20	0	0

Node S7.1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	42.000	Product Number	CTL-SHE-0073-2000-0600-2000
Design Depth (m)	0.600	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S9.2 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	43.125	Product Number	CTL-SHE-0065-2000-1125-2000
Design Depth (m)	1.125	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S15.1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	43.900	Product Number	CTL-SHE-0067-2000-1000-2000
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S14.7 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	43.042	Product Number	CTL-SHE-0093-4000-1100-4000
Design Depth (m)	1.100	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	4.0	Min Node Diameter (mm)	1200

Node S11.4 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	43.100	Product Number	CTL-SHE-0063-2000-1325-2000
Design Depth (m)	1.325	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S10.5 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	42.650	Product Number	CTL-SHE-0060-2000-1600-2000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S10.8 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	42.015	Product Number	CTL-SHE-0158-1400-1800-1400
Design Depth (m)	1.800	Min Outlet Diameter (m)	0.225
Design Flow (l/s)	14.0	Min Node Diameter (mm)	1500

Node S6.4 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	42.200	Product Number	CTL-SHE-0075-2000-0500-2000
Design Depth (m)	0.500	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S7.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	42.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	220.5	0.0	0.600	220.5	0.0	0.601	0.0	0.0

Node S7.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	42.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1830.0	0.0	0.065	1830.0	0.0	0.066	0.0	0.0

Node S9.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.250
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	267.0	0.0	1.050	267.0	0.0	1.051	0.0	0.0

Node S9.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.250
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	2021.0	0.0	0.065	2021.0	0.0	0.066	0.0	0.0

Node S15.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.900
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	948.0	0.0	0.700	948.0	0.0	0.701	0.0	0.0

Node S14.7 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	5.0	Invert Level (m)	43.042
Side Inf Coefficient (m/hr)	0.26400	Porosity	0.60	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	640.0	640.0	1.100	640.0	765.0	1.101	0.0	765.0

Node S11.4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.100
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	2760

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	218.0	0.0	1.325	218.0	0.0	1.326	0.0	0.0

Node S11.4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.100
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	3985.0	0.0	0.065	3985.0	0.0	0.066	0.0	0.0

Node S10.5 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	42.650
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1025.0	0.0	0.065	1025.0	0.0	0.066	0.0	0.0

Node S10.5 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	10.0	Invert Level (m)	42.650
Side Inf Coefficient (m/hr)	0.26400	Porosity	0.60	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	385.0	385.0	1.100	385.0	489.0	1.101	0.0	489.0

Node S6.4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	2.0	Invert Level (m)	42.250
Side Inf Coefficient (m/hr)	0.26400	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	300.0	300.0	0.400	340.0	330.0	0.401	0.0	330.0

Results for 5 year +20% CC Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute summer	S15.0	675	44.233	0.083	0.2	0.0938	0.0000	OK
960 minute summer	S15.1	675	44.233	0.333	11.0	97.7573	0.0000	SURCHARGED
15 minute summer	S15.2	11	43.693	0.043	2.1	0.0484	0.0000	OK
15 minute summer	S14.0	10	43.817	0.017	0.6	0.0200	0.0000	OK
15 minute summer	S14.1	10	43.781	0.056	6.4	0.0806	0.0000	OK
15 minute summer	S14.2	10	43.683	0.221	68.5	0.8834	0.0000	OK
15 minute summer	S14.3	11	43.625	0.268	86.2	0.5713	0.0000	OK
15 minute summer	S14.4	10	43.596	0.246	22.1	0.4862	0.0000	SURCHARGED
15 minute summer	S14.5	11	43.546	0.354	124.7	0.7335	0.0000	OK
15 minute summer	S14.6	10	43.429	0.311	124.3	0.4450	0.0000	OK
180 minute summer	S14.7	128	43.286	0.244	61.4	94.5101	0.0000	OK
30 minute summer	S14.8	18	42.939	0.085	10.5	0.1427	0.0000	OK
15 minute summer	S11.3	10	43.735	0.535	79.9	1.9775	0.0000	SURCHARGED
7200 minute summer	S11.4	4560	43.479	0.379	5.2	331.9063	0.0000	SURCHARGED
30 minute summer	S11.5	18	42.869	0.079	10.8	0.1409	0.0000	OK
30 minute summer	S11.6	19	42.805	0.079	10.9	0.1401	0.0000	OK
15 minute summer	S10.0	1	44.000	0.000	0.0	0.0000	0.0000	OK
15 minute summer	S10.1	1	43.650	0.000	0.0	0.0000	0.0000	OK
15 minute summer	S10.2	11	43.357	0.157	6.1	0.1781	0.0000	OK
15 minute summer	S10.3	11	43.355	0.255	11.6	0.2881	0.0000	OK
15 minute summer	S10.4	11	43.348	0.348	105.1	1.2790	0.0000	SURCHARGED
960 minute summer	S10.5	630	43.038	0.388	18.7	154.3290	0.0000	SURCHARGED
60 minute summer	S10.6	42	42.707	0.150	29.8	0.4151	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute summer	S15.0	1.000	S15.1	-0.2	-0.007	-0.006	2.0349	
960 minute summer	S15.1	Hydro-Brake®	S15.2	2.0				
15 minute summer	S15.2	1.002	S14.2	3.0	0.456	0.038	0.6986	
15 minute summer	S14.0	2.000	S14.1	0.6	0.123	0.006	0.0563	
15 minute summer	S14.1	2.001	S14.2	6.1	0.192	0.078	1.7008	
15 minute summer	S14.2	1.003	S14.3	64.2	0.853	0.558	2.3908	
15 minute summer	S14.3	1.004	S14.5	83.4	1.081	0.726	2.0344	
15 minute summer	S14.4	3.000	S14.5	20.8	0.523	0.491	0.9432	
15 minute summer	S14.5	1.005	S14.6	124.3	1.214	1.082	2.2665	
15 minute summer	S14.6	1.006	S14.7	127.6	2.253	1.110	1.2845	
180 minute summer	S14.7	Hydro-Brake®	S14.8	3.9				
180 minute summer	S14.7	Infiltration		9.7				
30 minute summer	S14.8	1.008	S11.5	10.4	0.670	0.164	0.2973	
15 minute summer	S11.3	4.000	S11.4	78.3	1.968	1.848	0.5354	
7200 minute summer	S11.4	Hydro-Brake®	S11.5	1.7				
30 minute summer	S11.5	1.009	S11.6	10.6	0.644	0.092	0.3201	
30 minute summer	S11.6	1.010	S10.6	10.7	0.673	0.093	0.4732	
15 minute summer	S10.0	5.000	S10.1	0.0	0.000	0.000	0.0000	
15 minute summer	S10.1	5.001	S10.2	0.0	0.000	0.000	0.0000	
15 minute summer	S10.2	5.002	S10.3	-6.1	-0.262	-0.077	0.8424	
15 minute summer	S10.3	5.003	S10.4	13.9	0.277	0.178	1.1129	
15 minute summer	S10.4	5.004	S10.5	93.3	1.352	1.191	2.3172	
960 minute summer	S10.5	Hydro-Brake®	S10.6	1.5				
960 minute summer	S10.5	Infiltration		3.1				
60 minute summer	S10.6	1.011	S10.7	29.5	0.755	0.159	6.6912	

Results for 5 year +20% CC Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute summer	S10.7	41	42.704	0.385	42.5	0.9832	0.0000	OK
60 minute summer	S6.4	41	42.286	0.086	22.0	11.4169	0.0000	OK
30 minute summer	S10.8	25	42.720	0.705	40.9	1.2449	0.0000	SURCHARGED
15 minute summer	OUTB1	1	41.972	0.000	14.0	0.0000	0.0000	OK
15 minute summer	S8.0	10	42.868	0.068	10.6	0.1352	0.0000	OK
15 minute summer	S23.0	10	42.886	0.086	16.3	0.1384	0.0000	OK
15 minute summer	S8.1	10	42.755	0.155	54.4	0.3699	0.0000	OK
15 minute summer	S7.0	10	42.674	0.074	10.6	0.1049	0.0000	OK
2880 minute summer	S7.1	1800	42.141	0.141	5.3	143.5980	0.0000	OK
15 minute summer	OUT4	1	41.980	0.000	0.2	0.0000	0.0000	OK
15 minute summer	S9.0	10	44.187	0.187	69.7	1.2313	0.0000	OK
15 minute summer	10.000:50%	10	44.139	0.207	101.7	0.0000	0.0000	OK
2880 minute summer	S9.1	1980	43.565	0.315	10.2	210.8604	0.0000	OK
2880 minute summer	S9.2	1920	43.561	0.436	5.0	0.4936	0.0000	SURCHARGED
15 minute summer	OUT5	1	43.013	0.000	1.3	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
60 minute summer	S10.7	1.012	S10.8	34.7	0.697	0.187	7.4565	
60 minute summer	S6.4	Hydro-Brake®	S10.8	1.4				
60 minute summer	S6.4	Infiltration		7.8				
30 minute summer	S10.8	Hydro-Brake®	OUTB1	14.0				64.3
15 minute summer	S8.0	7.000	S8.1	10.6	0.443	0.116	0.7246	
15 minute summer	S23.0	8.000	S8.1	16.3	1.060	0.147	0.0935	
15 minute summer	S8.1	7.001	S7.1	54.0	1.528	0.486	1.1333	
15 minute summer	S7.0	9.000	S7.1	10.6	0.981	0.204	0.0819	
2880 minute summer	S7.1	Hydro-Brake®	OUT4	2.0				155.3
15 minute summer	S9.0	10.000	10.000:50%	69.7	1.189	0.348	0.4012	
15 minute summer	S9.0	10.000	S9.1	101.7	1.742	0.508	0.3995	
2880 minute summer	S9.1	10.001	S9.2	5.0	0.160	0.034	2.3657	
2880 minute summer	S9.2	Hydro-Brake®	OUT5	1.8				236.0

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
1440 minute summer	S15.0	1050	44.404	0.254	0.3	0.2878	0.0000	SURCHARGED
1440 minute summer	S15.1	1050	44.404	0.504	11.3	148.0664	0.0000	FLOOD RISK
15 minute summer	S15.2	11	43.855	0.205	12.4	0.2318	0.0000	OK
15 minute summer	S14.0	12	43.870	0.070	4.5	0.0816	0.0000	OK
15 minute summer	S14.1	12	43.870	0.145	16.5	0.2084	0.0000	OK
15 minute summer	S14.2	11	43.864	0.402	99.5	1.6104	0.0000	SURCHARGED
15 minute summer	S14.3	11	43.795	0.438	110.3	0.9336	0.0000	SURCHARGED
15 minute summer	S14.4	10	43.811	0.461	32.4	0.9114	0.0000	SURCHARGED
15 minute summer	S14.5	11	43.697	0.505	161.7	1.0468	0.0000	SURCHARGED
15 minute summer	S14.6	10	43.509	0.391	162.3	0.5601	0.0000	SURCHARGED
240 minute summer	S14.7	172	43.434	0.392	73.9	151.7302	0.0000	SURCHARGED
120 minute summer	S14.8	80	43.049	0.195	9.9	0.3283	0.0000	OK
15 minute summer	S11.3	10	44.173	0.973	117.3	3.5951	0.0000	SURCHARGED
8640 minute summer	S11.4	5520	43.988	0.888	5.7	444.8205	0.0000	SURCHARGED
120 minute summer	S11.5	80	43.048	0.258	11.3	0.4585	0.0000	OK
120 minute summer	S11.6	82	43.048	0.322	15.4	0.5725	0.0000	OK
15 minute summer	S10.0	1	44.000	0.000	0.0	0.0000	0.0000	OK
15 minute summer	S10.1	11	43.754	0.104	5.3	0.1173	0.0000	OK
15 minute summer	S10.2	11	43.744	0.544	7.9	0.6149	0.0000	SURCHARGED
15 minute summer	S10.3	11	43.740	0.640	18.8	0.7243	0.0000	SURCHARGED
15 minute summer	S10.4	10	43.727	0.727	154.4	2.6708	0.0000	SURCHARGED
960 minute summer	S10.5	675	43.349	0.699	25.8	226.8687	0.0000	SURCHARGED
120 minute summer	S10.6	80	43.054	0.497	32.6	1.3802	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
1440 minute summer	S15.0	1.000	S15.1	-0.3	-0.012	-0.010	3.0518	
1440 minute summer	S15.1	Hydro-Brake®	S15.2	2.0				
15 minute summer	S15.2	1.002	S14.2	11.3	0.468	0.145	1.7463	
15 minute summer	S14.0	2.000	S14.1	4.7	-0.219	0.050	0.2437	
15 minute summer	S14.1	2.001	S14.2	24.1	0.404	0.308	2.7391	
15 minute summer	S14.2	1.003	S14.3	88.0	0.873	0.766	3.4849	
15 minute summer	S14.3	1.004	S14.5	110.1	1.126	0.958	2.6558	
15 minute summer	S14.4	3.000	S14.5	31.7	0.798	0.749	0.9432	
15 minute summer	S14.5	1.005	S14.6	162.3	1.472	1.412	2.4345	
15 minute summer	S14.6	1.006	S14.7	163.4	2.148	1.422	1.6323	
240 minute summer	S14.7	Hydro-Brake®	S14.8	4.0				
240 minute summer	S14.7	Infiltration		10.0				
120 minute summer	S14.8	1.008	S11.5	9.8	0.656	0.154	1.0768	
15 minute summer	S11.3	4.000	S11.4	112.3	2.825	2.653	0.5354	
8640 minute summer	S11.4	Hydro-Brake®	S11.5	1.7				
120 minute summer	S11.5	1.009	S11.6	13.4	0.633	0.116	1.7335	
120 minute summer	S11.6	1.010	S10.6	10.6	0.662	0.092	3.1376	
15 minute summer	S10.0	5.000	S10.1	0.0	0.000	0.000	0.0000	
15 minute summer	S10.1	5.001	S10.2	5.6	0.406	0.072	0.2808	
15 minute summer	S10.2	5.002	S10.3	10.0	-0.325	0.127	1.2102	
15 minute summer	S10.3	5.003	S10.4	22.5	0.362	0.287	1.1680	
15 minute summer	S10.4	5.004	S10.5	136.3	1.937	1.741	2.4559	
960 minute summer	S10.5	Hydro-Brake®	S10.6	1.5				
960 minute summer	S10.5	Infiltration		3.3				
120 minute summer	S10.6	1.011	S10.7	31.7	0.690	0.171	11.3029	

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	S10.7	80	43.047	0.728	45.2	1.8598	0.0000	SURCHARGED
60 minute summer	S6.4	41	42.303	0.103	31.1	16.8533	0.0000	OK
120 minute summer	S10.8	82	43.044	1.029	24.4	1.8177	0.0000	SURCHARGED
15 minute summer	OUTB1	1	41.972	0.000	14.0	0.0000	0.0000	OK
15 minute summer	S8.0	10	42.883	0.083	15.5	0.1638	0.0000	OK
15 minute summer	S23.0	10	42.906	0.106	24.0	0.1716	0.0000	OK
15 minute summer	S8.1	10	42.800	0.200	79.8	0.4778	0.0000	OK
15 minute summer	S7.0	10	42.692	0.092	15.5	0.1301	0.0000	OK
2880 minute summer	S7.1	1920	42.388	0.388	7.0	195.8463	0.0000	SURCHARGED
15 minute summer	OUT4	1	41.980	0.000	0.3	0.0000	0.0000	OK
15 minute summer	S9.0	10	44.244	0.244	102.3	1.6048	0.0000	OK
15 minute summer	10.000:50%	10	44.198	0.266	149.4	0.0000	0.0000	OK
2880 minute summer	S9.1	2100	43.930	0.680	12.1	309.1609	0.0000	SURCHARGED
2880 minute summer	S9.2	2160	43.938	0.813	5.3	0.9194	0.0000	SURCHARGED
15 minute summer	OUT5	1	43.013	0.000	1.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute summer	S10.7	1.012	S10.8	24.4	0.685	0.131	7.8049	
60 minute summer	S6.4	Hydro-Brake®	S10.8	1.3				
60 minute summer	S6.4	Infiltration		11.0				
120 minute summer	S10.8	Hydro-Brake®	OUTB1	14.0				168.7
15 minute summer	S8.0	7.000	S8.1	15.5	0.478	0.170	0.9772	
15 minute summer	S23.0	8.000	S8.1	24.0	1.170	0.216	0.1247	
15 minute summer	S8.1	7.001	S7.1	79.4	1.662	0.715	1.5325	
15 minute summer	S7.0	9.000	S7.1	15.5	1.081	0.298	0.1087	
2880 minute summer	S7.1	Hydro-Brake®	OUT4	2.0				205.3
15 minute summer	S9.0	10.000	10.000:50%	102.4	1.283	0.512	0.5459	
15 minute summer	S9.0	10.000	S9.1	149.4	1.904	0.747	0.5365	
2880 minute summer	S9.1	10.001	S9.2	5.3	0.162	0.036	2.4940	
2880 minute summer	S9.2	Hydro-Brake®	OUT5	1.8				236.4

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute summer	S15.0	930	44.580	0.430	0.5	0.4866	0.0000	SURCHARGED
960 minute summer	S15.1	930	44.580	0.680	18.8	199.6666	0.0000	FLOOD RISK
15 minute summer	S15.2	11	44.268	0.618	23.2	0.6986	0.0000	SURCHARGED
15 minute summer	S14.0	11	44.201	0.401	23.4	0.4659	0.0000	SURCHARGED
15 minute summer	S14.1	11	44.198	0.473	53.9	0.6800	0.0000	SURCHARGED
15 minute summer	S14.2	11	44.269	0.807	124.7	3.2270	0.0000	SURCHARGED
15 minute summer	S14.3	11	44.136	0.779	145.5	1.6594	0.0000	SURCHARGED
15 minute summer	S14.4	11	44.067	0.717	42.1	1.4191	0.0000	SURCHARGED
15 minute summer	S14.5	11	43.960	0.768	207.0	1.5915	0.0000	SURCHARGED
15 minute summer	S14.6	11	43.636	0.518	201.8	0.7416	0.0000	SURCHARGED
180 minute summer	S14.7	152	43.578	0.536	110.7	207.2697	0.0000	SURCHARGED
60 minute summer	S14.8	41	43.702	0.848	15.5	1.4274	0.0000	SURCHARGED
15 minute summer	S11.3	10	44.684	1.484	152.6	5.4835	0.0000	SURCHARGED
7200 minute summer	S11.4	4680	44.362	1.262	7.9	527.5642	0.0000	SURCHARGED
60 minute summer	S11.5	41	43.720	0.930	50.5	1.6515	0.0000	SURCHARGED
60 minute summer	S11.6	41	43.691	0.965	16.2	1.7155	0.0000	SURCHARGED
15 minute summer	S10.0	11	44.144	0.144	3.7	0.1630	0.0000	OK
15 minute summer	S10.1	11	44.102	0.452	15.3	0.5113	0.0000	SURCHARGED
15 minute summer	S10.2	11	44.094	0.894	31.0	1.0110	0.0000	SURCHARGED
15 minute summer	S10.3	10	44.089	0.989	40.2	1.1187	0.0000	SURCHARGED
15 minute summer	S10.4	10	44.075	1.075	200.9	3.9471	0.0000	SURCHARGED
960 minute summer	S10.5	690	43.634	0.984	31.8	293.3784	0.0000	SURCHARGED
60 minute summer	S10.6	40	43.689	1.132	72.1	3.1424	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute summer	S15.0	1.000	S15.1	-0.5	-0.015	-0.016	3.0518	
960 minute summer	S15.1	Hydro-Brake®	S15.2	2.0				
15 minute summer	S15.2	1.002	S14.2	-21.6	0.473	-0.276	2.0209	
15 minute summer	S14.0	2.000	S14.1	-22.2	-0.402	-0.237	0.7422	
15 minute summer	S14.1	2.001	S14.2	-43.0	-0.613	-0.549	3.7041	
15 minute summer	S14.2	1.003	S14.3	110.7	1.004	0.963	3.4849	
15 minute summer	S14.3	1.004	S14.5	138.6	1.257	1.206	2.6558	
15 minute summer	S14.4	3.000	S14.5	37.2	0.936	0.879	0.9432	
15 minute summer	S14.5	1.005	S14.6	201.8	1.830	1.756	2.4345	
15 minute summer	S14.6	1.006	S14.7	198.7	2.258	1.729	2.0017	
180 minute summer	S14.7	Hydro-Brake®	S14.8	4.0				
180 minute summer	S14.7	Infiltration		10.2				
60 minute summer	S14.8	1.008	S11.5	15.9	0.738	0.250	1.3428	
15 minute summer	S11.3	4.000	S11.4	142.1	3.574	3.356	0.5354	
7200 minute summer	S11.4	Hydro-Brake®	S11.5	2.0				
60 minute summer	S11.5	1.009	S11.6	-41.2	0.710	-0.359	2.1083	
60 minute summer	S11.6	1.010	S10.6	14.3	0.693	0.124	3.2794	
15 minute summer	S10.0	5.000	S10.1	3.8	0.389	0.048	0.9992	
15 minute summer	S10.1	5.001	S10.2	26.4	0.749	0.337	0.7163	
15 minute summer	S10.2	5.002	S10.3	31.9	0.453	0.407	1.2102	
15 minute summer	S10.3	5.003	S10.4	-40.2	-0.571	-0.514	1.1680	
15 minute summer	S10.4	5.004	S10.5	168.9	2.399	2.157	2.4795	
960 minute summer	S10.5	Hydro-Brake®	S10.6	1.6				
960 minute summer	S10.5	Infiltration		3.5				
60 minute summer	S10.6	1.011	S10.7	44.2	0.744	0.238	11.3029	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.85%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
60 minute summer	S10.7	40	43.703	1.384	66.6	3.5380	0.0000	FLOOD RISK
60 minute summer	S6.4	43	42.324	0.124	40.2	23.4837	0.0000	OK
60 minute summer	S10.8	40	43.689	1.674	32.4	2.9580	0.0000	SURCHARGED
15 minute summer	OUTB1	1	41.972	0.000	14.0	0.0000	0.0000	OK
15 minute summer	S8.0	10	42.895	0.095	20.1	0.1874	0.0000	OK
15 minute summer	S23.0	10	42.923	0.123	31.1	0.1995	0.0000	OK
15 minute summer	S8.1	10	42.848	0.248	103.6	0.5924	0.0000	OK
15 minute summer	S7.0	10	42.707	0.107	20.1	0.1516	0.0000	OK
2160 minute summer	S7.1	1500	42.591	0.591	10.2	238.8462	0.0000	SURCHARGED
15 minute summer	OUT4	1	41.980	0.000	0.5	0.0000	0.0000	OK
15 minute summer	S9.0	10	44.305	0.305	133.1	2.0086	0.0000	OK
15 minute summer	10.000:50%	10	44.260	0.329	194.1	0.0000	0.0000	OK
2880 minute summer	S9.1	2160	44.205	0.955	13.6	383.6065	0.0000	SURCHARGED
2880 minute summer	S9.2	2160	44.205	1.080	3.8	1.2219	0.0000	SURCHARGED
15 minute summer	OUT5	1	43.013	0.000	1.8	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
60 minute summer	S10.7	1.012	S10.8	32.4	0.682	0.174	7.8049	
60 minute summer	S6.4	Hydro-Brake®	S10.8	1.3				
60 minute summer	S6.4	Infiltration		11.1				
60 minute summer	S10.8	Hydro-Brake®	OUTB1	14.0				153.9
15 minute summer	S8.0	7.000	S8.1	20.1	0.496	0.221	1.2095	
15 minute summer	S23.0	8.000	S8.1	31.0	1.236	0.279	0.1533	
15 minute summer	S8.1	7.001	S7.1	102.6	1.734	0.923	1.9021	
15 minute summer	S7.0	9.000	S7.1	20.1	1.153	0.387	0.1322	
2160 minute summer	S7.1	Hydro-Brake®	OUT4	2.0				167.9
15 minute summer	S9.0	10.000	10.000:50%	133.0	1.339	0.665	0.6791	
15 minute summer	S9.0	10.000	S9.1	194.1	2.000	0.970	0.6617	
2880 minute summer	S9.1	10.001	S9.2	3.8	0.160	0.026	2.4940	
2880 minute summer	S9.2	Hydro-Brake®	OUT5	2.0				268.8

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	18.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.277	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Nodes

Name	Area (ha)	T of E (mins)	Cover Level (m)	Diameter (mm)	Easting (m)	Northing (m)	Depth (m)
S4.0	0.030	4.00	41.530	1200	183.503	49.540	0.780
S4.1	0.016	4.00	41.280	1200	193.179	58.131	0.616
S4.2	0.013	4.00	41.210	1200	199.740	55.840	0.592
S4.3	0.000		41.270	1200	206.427	74.988	0.787
S4.4	0.064	4.00	41.210	1200	193.976	114.268	1.002
S22.0	0.142	4.00	41.840	1200	155.887	141.385	1.840
Tank_K	0.333	4.00	41.450	1200	168.678	122.733	1.850
S4.5	0.100	4.00	41.480	1350	182.687	149.880	2.159
S4.6	0.059	4.00	41.450	1350	195.970	154.087	2.268
OUTB2			40.150	1350	238.487	164.519	1.406
S4.7			40.740	1350	219.945	160.673	1.807

Links

Name	US Node	DS Node	Length (m)	ks (mm) / n	US IL (m)	DS IL (m)	Fall (m)	Slope (1:X)	Dia (mm)	T of C (mins)	Rain (mm/hr)
8	S4.0	S4.1	12.971	0.600	40.750	40.664	0.086	150.0	225	4.20	50.0
7	S4.1	S4.2	6.949	0.600	40.664	40.618	0.046	150.0	225	4.31	50.0
6	S4.2	S4.3	20.282	0.600	40.618	40.483	0.135	150.0	225	4.63	50.0
5	S4.3	S4.4	41.206	0.600	40.483	40.208	0.275	150.0	225	5.27	50.0
4	S4.4	S4.5	37.358	0.600	40.208	39.834	0.374	100.0	225	5.75	50.0
9	S22.0	S4.5	28.114	0.600	40.000	39.719	0.281	100.0	225	4.36	50.0
10	Tank_K	S4.5	30.549	0.600	39.600	39.396	0.204	150.0	150	4.62	50.0
3	S4.5	S4.6	13.935	0.600	39.321	39.182	0.139	100.0	375	5.88	50.0
2	S4.6	S4.7	24.863	0.600	39.182	38.933	0.249	100.0	375	6.11	50.0
1.007	S4.7	OUTB2	18.937	0.600	38.933	38.744	0.189	100.0	225	6.35	50.0

Name	Vel (m/s)	Cap (l/s)	US Depth (m)	DS Depth (m)	Σ Area (ha)	Σ Add Inflow (l/s)
8	1.065	42.3	0.555	0.391	0.030	0.0
7	1.065	42.3	0.391	0.367	0.046	0.0
6	1.065	42.3	0.367	0.562	0.059	0.0
5	1.065	42.3	0.562	0.777	0.059	0.0
4	1.307	52.0	0.777	1.421	0.123	0.0
9	1.307	52.0	1.615	1.536	0.142	0.0
10	0.818	14.5	1.700	1.934	0.333	0.0
3	1.812	200.1	1.784	1.893	0.698	0.0
2	1.812	200.1	1.893	1.432	0.757	0.0
1.007	1.307	52.0	1.582	1.181	0.757	0.0

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	Scotland and Ireland	Drain Down Time (mins)	240
M5-60 (mm)	18.000	Additional Storage (m^3/ha)	20.0
Ratio-R	0.277	Check Discharge Rate(s)	x
Summer CV	1.000	Check Discharge Volume	x
Analysis Speed	Normal		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
5	20	0	0
30	20	0	0
100	20	0	0

Node Tank_K Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	39.600	Product Number	CTL-SHE-0042-1000-1600-1000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	1.0	Min Node Diameter (mm)	1200

Node S4.7 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	38.933	Product Number	CTL-SHE-0086-4000-1600-4000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	4.0	Min Node Diameter (mm)	1200

Node Tank_K Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	39.600
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	303.8	0.0	1.200	303.8	0.0	1.201	0.0	0.0

Node S4.7 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	5.0	Invert Level (m)	38.933
Side Inf Coefficient (m/hr)	0.26400	Porosity	0.95	Time to half empty (mins)	320

Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)	Depth (m)	Area (m^2)	Inf Area (m^2)
0.000	169.7	169.7	1.600	169.7	267.0	1.601	0.0	267.0

Results for 5 year +20% CC Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S4.0	10	40.824	0.074	9.6	0.1405	0.0000	OK
15 minute summer	S4.1	10	40.769	0.105	14.7	0.1737	0.0000	OK
15 minute summer	S4.2	10	40.728	0.110	18.9	0.1730	0.0000	OK
15 minute summer	S4.3	11	40.585	0.102	18.9	0.1155	0.0000	OK
15 minute summer	S4.4	11	40.353	0.145	38.6	0.3493	0.0000	OK
15 minute summer	S22.0	10	40.174	0.174	45.4	0.4640	0.0000	OK
5760 minute summer	Tank_K	4080	40.240	0.640	4.0	197.4906	0.0000	SURCHARGED
15 minute summer	S4.5	10	39.563	0.242	113.4	0.5696	0.0000	OK
360 minute summer	S4.6	256	39.492	0.310	31.9	0.6050	0.0000	OK
15 minute summer	OUTB2	1	38.744	0.000	3.5	0.0000	0.0000	OK
360 minute summer	S4.7	256	39.492	0.559	31.8	90.9036	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S4.0	8	S4.1	9.6	0.653	0.227	0.1917	
15 minute summer	S4.1	7	S4.2	14.7	0.784	0.347	0.1304	
15 minute summer	S4.2	6	S4.3	18.9	1.025	0.445	0.3730	
15 minute summer	S4.3	5	S4.4	18.3	0.818	0.431	0.9181	
15 minute summer	S4.4	4	S4.5	37.0	1.402	0.711	0.9851	
15 minute summer	S22.0	9	S4.5	45.3	1.433	0.872	0.8881	
5760 minute summer	Tank_K	Hydro-Brake®	S4.5	0.7				
15 minute summer	S4.5	3	S4.6	113.0	1.514	0.565	1.0589	
360 minute summer	S4.6	2	S4.7	31.8	1.059	0.159	2.5823	
360 minute summer	S4.7	Hydro-Brake®	OUTB2	3.6				96.2
360 minute summer	S4.7	Infiltration		3.0				

Results for 30 year +20% CC Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S4.0	10	40.843	0.093	14.1	0.1776	0.0000	OK
15 minute summer	S4.1	10	40.800	0.136	21.6	0.2242	0.0000	OK
15 minute summer	S4.2	10	40.758	0.140	27.7	0.2198	0.0000	OK
15 minute summer	S4.3	10	40.611	0.128	27.6	0.1453	0.0000	OK
15 minute summer	S4.4	11	40.416	0.208	56.8	0.5018	0.0000	OK
15 minute summer	S22.0	10	40.403	0.403	66.7	1.0788	0.0000	SURCHARGED
5760 minute summer	Tank_K	4200	40.487	0.887	5.2	273.5883	0.0000	SURCHARGED
360 minute summer	S4.5	280	39.839	0.518	38.8	1.2204	0.0000	SURCHARGED
360 minute summer	S4.6	280	39.838	0.656	44.8	1.2813	0.0000	SURCHARGED
15 minute summer	OUTB2	1	38.744	0.000	3.6	0.0000	0.0000	OK
360 minute summer	S4.7	280	39.838	0.905	42.9	147.2025	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S4.0	8	S4.1	14.1	0.697	0.333	0.2635	
15 minute summer	S4.1	7	S4.2	21.6	0.846	0.509	0.1773	
15 minute summer	S4.2	6	S4.3	27.6	1.117	0.651	0.5007	
15 minute summer	S4.3	5	S4.4	26.7	0.863	0.631	1.2714	
15 minute summer	S4.4	4	S4.5	53.3	1.479	1.025	1.3893	
15 minute summer	S22.0	9	S4.5	63.8	1.605	1.227	1.0910	
5760 minute summer	Tank_K	Hydro-Brake®	S4.5	0.8				
360 minute summer	S4.5	3	S4.6	38.6	1.172	0.193	1.5370	
360 minute summer	S4.6	2	S4.7	42.9	1.172	0.214	2.7423	
360 minute summer	S4.7	Hydro-Brake®	OUTB2	3.6				98.9
360 minute summer	S4.7	Infiltration		3.3				

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.86%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S4.0	10	40.863	0.113	18.3	0.2144	0.0000	OK
15 minute summer	S4.1	10	40.830	0.166	28.0	0.2739	0.0000	OK
15 minute summer	S4.2	11	40.813	0.195	35.7	0.3054	0.0000	OK
15 minute summer	S4.3	11	40.742	0.259	35.3	0.2933	0.0000	SURCHARGED
15 minute summer	S4.4	11	40.600	0.392	68.1	0.9450	0.0000	SURCHARGED
15 minute summer	S22.0	10	40.761	0.761	86.7	2.0349	0.0000	SURCHARGED
4320 minute summer	Tank_K	3540	40.711	1.111	7.5	342.6375	0.0000	SURCHARGED
480 minute summer	S4.5	360	40.142	0.821	39.3	1.9352	0.0000	SURCHARGED
480 minute summer	S4.6	360	40.141	0.959	44.9	1.8729	0.0000	SURCHARGED
15 minute summer	OUTB2	1	38.744	0.000	3.6	0.0000	0.0000	OK
480 minute summer	S4.7	360	40.141	1.208	44.4	196.4874	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S4.0	8	S4.1	18.3	0.718	0.431	0.3328	
15 minute summer	S4.1	7	S4.2	27.9	0.877	0.658	0.2317	
15 minute summer	S4.2	6	S4.3	35.3	1.176	0.833	0.7734	
15 minute summer	S4.3	5	S4.4	32.8	0.868	0.774	1.6388	
15 minute summer	S4.4	4	S4.5	61.9	1.558	1.191	1.4449	
15 minute summer	S22.0	9	S4.5	82.8	2.082	1.593	1.1068	
4320 minute summer	Tank_K	Hydro-Brake®	S4.5	0.9				
480 minute summer	S4.5	3	S4.6	38.6	1.130	0.193	1.5370	
480 minute summer	S4.6	2	S4.7	44.4	1.172	0.222	2.7423	
480 minute summer	S4.7	Hydro-Brake®	OUTB2	3.6				123.1
480 minute summer	S4.7	Infiltration		3.6				

50% Blockage

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	18.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.277	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	x

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	Scotland and Ireland	Drain Down Time (mins)	240
M5-60 (mm)	18.000	Additional Storage (m^3/ha)	20.0
Ratio-R	0.277	Check Discharge Rate(s)	x
Summer CV	1.000	Check Discharge Volume	x
Analysis Speed	Normal		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	20	0	0

Node S1.13 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	38.850	Product Number	CTL-SHE-0074-4000-3000-4000
Design Depth (m)	3.000	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	4.0	Min Node Diameter (mm)	1200

Node S12.3 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	40.800	Product Number	CTL-SHE-0057-2000-2000-2000
Design Depth (m)	2.000	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S3.7 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	38.075	Product Number	CTL-SHE-0057-2000-2000-2000
Design Depth (m)	2.000	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S1.19 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	37.000	Product Number	CTL-SHE-0082-3500-1500-3500
Design Depth (m)	1.500	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	3.5	Min Node Diameter (mm)	1200

Node S1.13 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	5.0	Invert Level (m)	38.850
Side Inf Coefficient (m/hr)	0.26400	Porosity	0.95	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	226.0	226.0	3.000	226.0	422.8	3.010	0.0	422.8

Node S12.3 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	40.800
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	182.2	0.0	2.000	182.2	0.0	2.010	0.0	0.0

Node S3.7 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	2.0	Invert Level (m)	38.075
Side Inf Coefficient (m/hr)	0.26400	Porosity	1.00	Time to half empty (mins)	0

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	77.0	77.0	2.000	77.0	156.4	2.010	0.0	156.4

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 98.66%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S2.0	10	43.973	0.523	47.6	1.0987	0.0000	SURCHARGED
15 minute summer	S2.1	11	43.696	0.474	66.2	0.7454	0.0000	SURCHARGED
15 minute summer	S1.7	11	43.246	0.046	1.8	0.0523	0.0000	OK
15 minute summer	S1.8	11	43.246	0.265	82.4	0.4065	0.0000	OK
15 minute summer	S1.8A	11	42.234	1.112	185.0	1.9404	0.0000	SURCHARGED
15 minute summer	S1.9	11	41.907	0.965	207.1	1.7195	0.0000	SURCHARGED
15 minute summer	S1.10	11	41.470	0.742	217.8	1.1844	0.0000	SURCHARGED
2160 minute summer	S12.3	1680	42.593	1.793	14.3	334.4710	0.0000	SURCHARGED
15 minute summer	S12.4	11	41.238	0.502	7.8	0.5673	0.0000	SURCHARGED
15 minute summer	S1.11	11	41.237	0.675	224.5	1.0331	0.0000	SURCHARGED
15 minute summer	S1.12	11	40.870	0.516	229.5	0.7895	0.0000	SURCHARGED
600 minute summer	S1.13	495	40.182	1.331	46.5	287.9774	0.0000	SURCHARGED
240 minute summer	S1.14	164	38.773	0.081	2.7	0.1162	0.0000	OK
240 minute summer	S1.15	160	38.772	0.311	4.8	0.4456	0.0000	OK
240 minute summer	S1.16	160	38.772	0.441	5.1	0.6485	0.0000	OK
240 minute summer	S1.17	160	38.772	0.591	6.9	0.8857	0.0000	SURCHARGED
240 minute summer	S1.18	160	38.771	0.790	9.9	1.2624	0.0000	SURCHARGED
15 minute summer	S3.0	10	42.230	0.130	38.5	0.2610	0.0000	OK
15 minute summer	S3.1	11	41.839	0.503	70.8	0.9570	0.0000	SURCHARGED
15 minute summer	S3.2	11	41.691	0.484	63.6	0.5783	0.0000	SURCHARGED
15 minute summer	S3.3	11	41.422	0.393	62.9	0.4444	0.0000	SURCHARGED
15 minute summer	S3.4	12	40.947	0.233	62.5	0.2637	0.0000	FLOOD RISK
15 minute summer	S3.5	11	40.370	0.356	61.7	0.4026	0.0000	FLOOD RISK
15 minute summer	S3.6	11	40.257	0.323	71.8	0.6485	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S2.0	2.000	S2.1	43.1	1.085	1.019	1.3605	
15 minute summer	S2.1	2.001	S1.8	64.3	1.618	1.519	0.9681	
15 minute summer	S1.7	3.000	S1.8	-1.8	0.252	-0.042	0.1978	
15 minute summer	S1.8	2.002	S1.8A	81.8	1.331	0.961	0.8079	
15 minute summer	S1.8A	1.003	S1.9	181.3	1.644	1.181	3.3609	
15 minute summer	S1.9	1.004	S1.10	205.2	1.861	1.258	3.5467	
15 minute summer	S1.10	1.005	S1.11	216.9	1.967	1.330	1.2262	
2160 minute summer	S12.3	Hydro-Brake®	S12.4	1.9				
15 minute summer	S12.4	4.001	S1.11	-7.8	0.454	-0.086	1.0484	
15 minute summer	S1.11	1.006	S1.12	221.9	2.012	1.109	2.2975	
15 minute summer	S1.12	1.007	S1.13	229.2	2.080	1.146	2.1556	
600 minute summer	S1.13	Hydro-Brake®	S1.14	2.7				
600 minute summer	S1.13	Infiltration		4.6				
240 minute summer	S1.14	1.009	S1.15	3.6	0.532	0.014	2.3564	
240 minute summer	S1.15	1.010	S1.16	3.9	0.517	0.015	2.6762	
240 minute summer	S1.16	1.011	S1.17	4.3	0.515	0.017	3.9019	
240 minute summer	S1.17	1.012	S1.18	5.3	0.679	0.020	5.0030	
240 minute summer	S1.18	1.013	S1.19	5.7	0.171	0.011	6.5081	
15 minute summer	S3.0	5.000	S3.1	38.5	1.120	0.640	1.8184	
15 minute summer	S3.1	5.001	S3.2	60.2	1.513	0.816	0.2574	
15 minute summer	S3.2	5.002	S3.3	62.9	1.582	1.047	0.5305	
15 minute summer	S3.3	5.003	S3.4	62.5	1.602	1.202	1.2542	
15 minute summer	S3.4	5.004	S3.5	61.7	1.597	0.917	1.6701	
15 minute summer	S3.5	5.005	S3.6	61.2	1.538	0.910	0.1899	
15 minute summer	S3.6	5.006	S3.7	70.3	1.771	1.046	0.6299	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 98.66%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
240 minute summer	S3.7	180	38.796	0.721	26.3	56.3025	0.0000	SURCHARGED
240 minute summer	S3.8	164	38.770	0.797	3.4	0.9018	0.0000	SURCHARGED
360 minute summer	S1.19	224	38.770	1.770	6.8	3.1736	3.4367	FLOOD
15 minute summer	S1.20	1	36.822	0.000	3.3	0.0000	0.0000	OK
15 minute summer	S12.2	11	42.289	1.050	89.0	1.7954	0.0000	SURCHARGED
15 minute summer	S12.0	11	42.691	0.491	30.5	0.9064	0.0000	SURCHARGED
15 minute summer	S12.1	11	42.629	0.843	59.6	1.3697	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
240 minute summer	S3.7	Hydro-Brake®	S3.8	1.2				
240 minute summer	S3.7	Infiltration		3.8				
240 minute summer	S3.8	5.008	S1.19	-2.2	0.577	-0.033	1.1443	
360 minute summer	S1.19	Hydro-Brake®	S1.20	3.8				114.3
15 minute summer	S12.2	1.002	S1.8A	79.8	1.244	0.718	0.2952	
15 minute summer	S12.0	1.000	S12.1	29.1	0.972	0.560	1.6468	
15 minute summer	S12.1	1.001	S12.2	48.5	1.528	0.932	1.8757	

50% Blockage

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Inverts
M5-60 (mm)	18.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.277	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	Scotland and Ireland	Drain Down Time (mins)	240
M5-60 (mm)	18.000	Additional Storage (m^3/ha)	20.0
Ratio-R	0.277	Check Discharge Rate(s)	x
Summer CV	1.000	Check Discharge Volume	x
Analysis Speed	Normal		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	20	0	0

Node S7.1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	42.000	Product Number	CTL-SHE-0073-2000-0600-2000
Design Depth (m)	0.600	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S9.2 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	43.125	Product Number	CTL-SHE-0067-2000-1000-2000
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S15.1 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	43.900	Product Number	CTL-SHE-0067-2000-1000-2000
Design Depth (m)	1.000	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S14.7 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	43.042	Product Number	CTL-SHE-0093-4000-1100-4000
Design Depth (m)	1.100	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	4.0	Min Node Diameter (mm)	1200

Node S11.4 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	43.100	Product Number	CTL-SHE-0063-2000-1325-2000
Design Depth (m)	1.325	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S10.5 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	42.650	Product Number	CTL-SHE-0060-2000-1600-2000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S10.8 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	42.015	Product Number	CTL-SHE-0121-7000-1200-7000
Design Depth (m)	1.200	Min Outlet Diameter (m)	0.150
Design Flow (l/s)	7.0	Min Node Diameter (mm)	1200

Node S6.4 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	42.300	Product Number	CTL-SHE-0075-2000-0500-2000
Design Depth (m)	0.500	Min Outlet Diameter (m)	0.100
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node S7.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	42.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	220.5	0.0	0.600	220.5	0.0	0.601	0.0	0.0

Node S7.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	42.000
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1830.0	0.0	0.065	1830.0	0.0	0.066	0.0	0.0

Node S9.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.250
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	267.0	0.0	1.050	267.0	0.0	1.051	0.0	0.0

Node S9.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.250
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1021.0	0.0	0.065	1021.0	0.0	0.066	0.0	0.0

Node S15.1 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.900
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.30	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	948.0	0.0	0.700	948.0	0.0	0.701	0.0	0.0

Node S14.7 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	5.0	Invert Level (m)	43.042
Side Inf Coefficient (m/hr)	0.26400	Porosity	0.60	Time to half empty (mins)	56

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	640.0	640.0	1.100	640.0	765.0	1.101	0.0	765.0

Node S11.4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.100
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	218.0	0.0	1.325	218.0	0.0	1.326	0.0	0.0

Node S11.4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	43.100
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1985.0	0.0	0.065	1985.0	0.0	0.066	0.0	0.0

Node S10.5 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	42.650
Side Inf Coefficient (m/hr)	0.00000	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	1024.0	0.0	0.065	1024.0	0.0	0.066	0.0	0.0

Node S10.5 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	10.0	Invert Level (m)	42.650
Side Inf Coefficient (m/hr)	0.26400	Porosity	0.60	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	385.0	385.0	1.100	385.0	489.0	1.101	0.0	489.0

Node S6.4 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	2.0	Invert Level (m)	42.300
Side Inf Coefficient (m/hr)	0.26400	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	300.0	300.0	0.400	340.0	330.0	0.401	0.0	330.0

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.81%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
960 minute summer	S15.0	945	44.580	0.430	0.5	0.4866	0.0000	SURCHARGED
960 minute summer	S15.1	930	44.580	0.680	18.8	199.6667	0.0000	FLOOD RISK
15 minute summer	S15.2	11	44.272	0.622	23.2	0.7035	0.0000	SURCHARGED
15 minute summer	S14.0	11	44.195	0.395	23.7	0.4593	0.0000	SURCHARGED
15 minute summer	S14.1	11	44.202	0.477	54.0	0.6861	0.0000	SURCHARGED
15 minute summer	S14.2	11	44.272	0.810	124.6	3.2420	0.0000	SURCHARGED
15 minute summer	S14.3	11	44.141	0.784	145.8	1.6704	0.0000	SURCHARGED
15 minute summer	S14.4	11	44.070	0.720	42.1	1.4233	0.0000	SURCHARGED
15 minute summer	S14.5	11	43.964	0.772	207.5	1.5993	0.0000	SURCHARGED
15 minute summer	S14.6	11	43.638	0.520	202.3	0.7442	0.0000	SURCHARGED
240 minute summer	S14.7	188	43.615	0.573	94.9	221.4548	0.0000	SURCHARGED
60 minute summer	S14.8	37	43.937	1.083	16.3	1.8235	0.0000	SURCHARGED
4320 minute summer	S11.3	2520	45.150	1.950	5.6	7.2053	37.0994	FLOOD
2880 minute summer	S11.4	1740	45.150	2.050	14.4	419.7941	5.7404	FLOOD
60 minute summer	S11.5	39	43.944	1.154	27.5	2.0486	0.0000	SURCHARGED
60 minute summer	S11.6	39	43.928	1.202	48.8	2.1368	0.0000	SURCHARGED
15 minute summer	S10.0	11	45.130	1.130	33.5	1.2780	3.7016	FLOOD
15 minute summer	S10.1	11	45.254	1.604	34.1	1.8146	0.0000	SURCHARGED
15 minute summer	S10.2	11	45.321	2.121	41.7	2.3984	0.0000	FLOOD RISK
15 minute summer	S10.3	11	45.419	2.319	53.5	2.6230	0.0000	FLOOD RISK
15 minute summer	S10.4	11	45.517	2.517	200.8	9.2413	0.0000	FLOOD RISK
960 minute summer	S10.5	705	43.687	1.037	31.8	305.6826	0.0000	SURCHARGED
60 minute summer	S10.6	39	43.928	1.371	65.9	3.8066	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
960 minute summer	S15.0	1.000	S15.1	-0.5	-0.015	-0.016	3.0518	
960 minute summer	S15.1	Hydro-Brake®	S15.2	2.0				
15 minute summer	S15.2	1.002	S14.2	-21.6	0.473	-0.276	2.0209	
15 minute summer	S14.0	2.000	S14.1	-22.5	-0.407	-0.241	0.7422	
15 minute summer	S14.1	2.001	S14.2	-43.0	-0.614	-0.549	3.7041	
15 minute summer	S14.2	1.003	S14.3	111.1	1.007	0.966	3.4849	
15 minute summer	S14.3	1.004	S14.5	139.3	1.263	1.212	2.6558	
15 minute summer	S14.4	3.000	S14.5	37.2	0.935	0.878	0.9432	
15 minute summer	S14.5	1.005	S14.6	202.3	1.834	1.760	2.4345	
15 minute summer	S14.6	1.006	S14.7	199.0	2.261	1.732	2.0119	
240 minute summer	S14.7	Hydro-Brake®	S14.8	4.0				
240 minute summer	S14.7	Infiltration		10.3				
60 minute summer	S14.8	1.008	S11.5	14.7	0.737	0.230	1.3428	
4320 minute summer	S11.3	4.000	S11.4	5.4	0.416	0.129	0.5409	
2880 minute summer	S11.4	Hydro-Brake®	S11.5	2.4				
60 minute summer	S11.5	1.009	S11.6	17.5	0.689	0.153	2.1083	
60 minute summer	S11.6	1.010	S10.6	-46.1	0.670	-0.401	3.2794	
15 minute summer	S10.0	5.000	S10.1	-33.5	-0.842	-0.915	0.9056	
15 minute summer	S10.1	5.001	S10.2	-34.1	-0.857	-0.931	0.4046	
15 minute summer	S10.2	5.002	S10.3	-41.7	-1.050	-1.140	0.6835	
15 minute summer	S10.3	5.003	S10.4	-53.5	-1.345	-1.461	0.6597	
15 minute summer	S10.4	5.004	S10.5	129.8	3.264	3.545	1.4004	
960 minute summer	S10.5	Hydro-Brake®	S10.6	1.5				
960 minute summer	S10.5	Infiltration		3.5				
60 minute summer	S10.6	1.011	S10.7	40.6	0.594	0.218	11.3029	

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.81%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
120 minute summer	S10.7	68	43.890	1.571	37.2	4.0155	4.7890	FLOOD
60 minute summer	S6.4	43	42.377	0.077	40.3	24.0734	0.0000	OK
60 minute summer	S10.8	38	43.907	1.892	23.3	3.3429	0.0000	SURCHARGED
15 minute summer	OUTB1	1	41.972	0.000	7.5	0.0000	0.0000	OK
15 minute summer	S8.0	10	42.895	0.095	20.1	0.1874	0.0000	OK
15 minute summer	S23.0	10	42.923	0.123	31.1	0.1996	0.0000	OK
15 minute summer	S8.1	10	42.848	0.248	103.6	0.5926	0.0000	OK
15 minute summer	S7.0	10	42.707	0.107	20.1	0.1516	0.0000	OK
2160 minute summer	S7.1	1500	42.591	0.591	10.2	238.8443	0.0000	SURCHARGED
15 minute summer	OUT4	1	41.980	0.000	0.5	0.0000	0.0000	OK
2160 minute summer	S9.0	1560	44.780	0.780	7.6	5.1351	0.0000	FLOOD RISK
1440 minute summer	10.000:50%	1170	44.780	0.848	15.3	0.0000	0.0000	SURCHARGED
1440 minute summer	S9.1	1200	44.780	1.530	22.4	348.4314	0.0000	FLOOD RISK
1440 minute summer	S9.2	1170	44.780	1.655	3.1	1.8718	0.6528	FLOOD
15 minute summer	OUT5	1	43.013	0.000	2.0	0.0000	0.0000	OK

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
120 minute summer	S10.7	1.012	S10.8	21.1	0.583	0.113	7.8049	
60 minute summer	S6.4	Hydro-Brake®	S10.8	0.0				
60 minute summer	S6.4	Infiltration		11.1				
60 minute summer	S10.8	Hydro-Brake®	OUTB1	8.7				111.8
15 minute summer	S8.0	7.000	S8.1	20.1	0.496	0.221	1.2098	
15 minute summer	S23.0	8.000	S8.1	31.0	1.236	0.279	0.1534	
15 minute summer	S8.1	7.001	S7.1	102.6	1.735	0.923	1.9026	
15 minute summer	S7.0	9.000	S7.1	20.1	1.153	0.387	0.1322	
2160 minute summer	S7.1	Hydro-Brake®	OUT4	2.0				167.9
2160 minute summer	S9.0	10.000	10.000:50%	7.6	0.743	0.068	0.4817	
2160 minute summer	S9.0	10.000	S9.1	12.3	0.994	0.111	0.4817	
1440 minute summer	S9.1	10.001	S9.2	3.1	0.182	0.037	1.5923	
1440 minute summer	S9.2	Hydro-Brake®	OUT5	2.5				177.4

50% Blockage

Design Settings

Rainfall Methodology	FSR	Maximum Time of Concentration (mins)	30.00
Return Period (years)	5	Maximum Rainfall (mm/hr)	50.0
Additional Flow (%)	0	Minimum Velocity (m/s)	1.00
FSR Region	Scotland and Ireland	Connection Type	Level Soffits
M5-60 (mm)	18.000	Minimum Backdrop Height (m)	0.200
Ratio-R	0.277	Preferred Cover Depth (m)	1.200
CV	1.000	Include Intermediate Ground	✓
Time of Entry (mins)	4.00	Enforce best practice design rules	✓

Simulation Settings

Rainfall Methodology	FSR	Skip Steady State	x
FSR Region	Scotland and Ireland	Drain Down Time (mins)	240
M5-60 (mm)	18.000	Additional Storage (m³/ha)	20.0
Ratio-R	0.277	Check Discharge Rate(s)	x
Summer CV	1.000	Check Discharge Volume	x
Analysis Speed	Normal		

Storm Durations

15	60	180	360	600	960	2160	4320	7200	10080
30	120	240	480	720	1440	2880	5760	8640	

Return Period (years)	Climate Change (CC %)	Additional Area (A %)	Additional Flow (Q %)
100	20	0	0

Node Tank_K Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	39.600	Product Number	CTL-SHE-0042-1000-1600-1000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	1.0	Min Node Diameter (mm)	1200

Node S4.7 Online Hydro-Brake® Control

Flap Valve	x	Objective	(HE) Minimise upstream storage
Replaces Downstream Link	✓	Sump Available	✓
Invert Level (m)	38.933	Product Number	CTL-SHE-0060-2000-1600-2000
Design Depth (m)	1.600	Min Outlet Diameter (m)	0.075
Design Flow (l/s)	2.0	Min Node Diameter (mm)	1200

Node Tank_K Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.00000	Safety Factor	2.0	Invert Level (m)	39.600
Side Inf Coefficient (m/hr)	0.00000	Porosity	1.00	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	303.8	0.0	1.200	303.8	0.0	1.201	0.0	0.0

Node S4.7 Depth/Area Storage Structure

Base Inf Coefficient (m/hr)	0.26400	Safety Factor	5.0	Invert Level (m)	38.933
Side Inf Coefficient (m/hr)	0.26400	Porosity	0.95	Time to half empty (mins)	

Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)	Depth (m)	Area (m²)	Inf Area (m²)
0.000	169.7	169.7	1.600	169.7	267.0	1.601	0.0	267.0

Results for 100 year +20% CC Critical Storm Duration. Lowest mass balance: 99.88%

Node Event	US Node	Peak (mins)	Level (m)	Depth (m)	Inflow (l/s)	Node Vol (m³)	Flood (m³)	Status
15 minute summer	S4.0	10	40.863	0.113	18.3	0.2144	0.0000	OK
15 minute summer	S4.1	10	40.830	0.166	28.0	0.2739	0.0000	OK
15 minute summer	S4.2	11	40.813	0.195	35.7	0.3054	0.0000	OK
15 minute summer	S4.3	11	40.742	0.259	35.3	0.2933	0.0000	SURCHARGED
15 minute summer	S4.4	11	40.600	0.392	68.1	0.9450	0.0000	SURCHARGED
15 minute summer	S22.0	10	40.761	0.761	86.7	2.0349	0.0000	SURCHARGED
4320 minute summer	Tank_K	3540	40.723	1.123	7.5	346.4813	0.0000	SURCHARGED
720 minute summer	S4.5	540	40.295	0.974	29.4	2.2963	0.0000	SURCHARGED
720 minute summer	S4.6	540	40.295	1.113	33.6	2.1720	0.0000	SURCHARGED
15 minute summer	OUTB2	1	38.744	0.000	1.5	0.0000	0.0000	OK
720 minute summer	S4.7	540	40.294	1.361	33.2	221.4356	0.0000	SURCHARGED

Link Event (Upstream Depth)	US Node	Link	DS Node	Outflow (l/s)	Velocity (m/s)	Flow/Cap	Link Vol (m³)	Discharge Vol (m³)
15 minute summer	S4.0	8	S4.1	18.3	0.718	0.431	0.3328	
15 minute summer	S4.1	7	S4.2	27.9	0.877	0.658	0.2317	
15 minute summer	S4.2	6	S4.3	35.3	1.176	0.833	0.7734	
15 minute summer	S4.3	5	S4.4	32.8	0.868	0.774	1.6388	
15 minute summer	S4.4	4	S4.5	61.9	1.558	1.191	1.4449	
15 minute summer	S22.0	9	S4.5	82.8	2.082	1.593	1.1068	
4320 minute summer	Tank_K	Hydro-Brake®	S4.5	0.9				
720 minute summer	S4.5	3	S4.6	29.0	0.975	0.145	1.5370	
720 minute summer	S4.6	2	S4.7	33.2	1.030	0.166	2.7423	
720 minute summer	S4.7	Hydro-Brake®	OUTB2	1.9				83.8
720 minute summer	S4.7	Infiltration		3.7				

Appendix 7

Contributing Areas

20.170 - Dundrum SW Drainage

Drained Area Summary

Catchment		Manhole Ref	Total unfactored areas m²	Surface Roof	CV Value 0.95	Surface Green Roof (Extensive or Intensive)	CV Value 0.8	Surface Road + Footpath	CV Value 0.9	Surface Permeable Paving	CV Value 0.8	Surface Landscape	CV Value 0.3	Total Reduced Areas m²
CATCHMENT B1	Tank C	S7.0	1100									1100.0	330.0	330.0
		S7.1	994	397.8	377.9	596.5	477.2							855.1
		S8.0	1100									1100.0	330.0	330.0
		S8.1	994	397.8	377.9	596.5	477.2							855.1
		S23.0	637			637.0	509.6							509.6
	Tank B	S9.0	3587	422.0	400.9	1655.0	1324.0					1510.0	453.0	2177.9
		S9.1	2566	422.0	400.9	633.0	506.4					1511.0	453.3	1360.6
		S9.2	0											0.0
		S9.3	0											0.0
	Attenuation F	S15.0	0											0.0
		S15.1	3437	874.0	830.3	1615.0	1292.0			948.0	758.4			2880.7
	Tank A	S14.0	30							30.0	24.0			24.0
		S14.1	204					204.0	183.6					183.6
		S14.2	2146	596.0	566.2			1268.0	1141.2	282.0	225.6			1933.0
		S14.3	763					763.0	686.7					686.7
		S14.4	2286									2286.0	685.8	685.8
		S14.5	2286									2286.0	685.8	685.8
		S14.6	0											0.0
		S14.7	1858					908.0	817.2			950.0	285.0	1102.2
	Tank E	S11.3	4450	655.0		3795.3	3036.2							3036.2
		S11.4	2208	1215.2	1154.4	992.5	794.0							1948.4
	Tank D	S10.0	0		0.0		0.0							0.0
		S10.1	0		0.0		0.0							0.0
		S10.2	0		0.0		0.0							0.0
		S10.3	0		0.0		0.0							0.0
		S10.4	3973	770.6	732.1	3202.4	2561.9							3294.0
		S10.5	2292					1531.0	1377.9			761.0	228.3	1606.2
		S14.8	310					310.0	279.0					279.0
		S11.5	111					111.0	99.9					99.9
		S11.6	111					111.0	99.9					99.9
		S10.6	1101					1001.0	900.9	100.0	80.0			980.9
		S10.7	693					693.0	623.7					623.7
		S6.4	1262					905.0	814.5			357.0	107.1	921.6
	totals		40500											27490.0
CATCHMENT B2	Tank G	S4.0	564							269.0	215.2	295.0	88.5	303.7
		S4.1	432							62.5	50.0	369.0	110.7	160.7
		S4.2	144					144.0	129.6					129.6
		S4.3	0											0.0
		S4.4	727					589.0	530.1	138.0	110.4			640.5
		S4.5	1148					843.0	758.7	305.0	244.0			1002.7
		S4.6	952	275.6	261.8	413.4	330.7	263.0						592.5
		S22.0	561					451.0	405.9	110.0	88.0			493.9
	Tank K	S4.6_Tank	2421	406.8	386.5	1968.2	1574.6					46.0	13.8	1974.8
		S1.0_Tank	1564	198.2	188.3	1319.8	1055.8					46.0	13.8	1257.9
		S1.2 to S22	1603					674.0	606.6	78.0	62.4	851.0	255.3	924.3
	totals		10116											7480.7
CATCHMENT A	Tank J	S2.0	848	298.0	283.1			550.0	495.0					778.1
		S2.1	439					323.0	290.7	116.0	92.8			383.5
		S1.7	0											0.0
		S1.8	325	325.0	308.8									308.8
		S1.9	351					351.0	315.9					315.9
		S1.10	355					281.0	252.9	73.7	58.9			311.8
		S1.11	246					172.0	154.8	73.7	58.9			213.7
		S1.12	246					172.0	154.8	73.7	58.9			213.7
		S1.13	731					386.0	347.4	345.0	276.0			623.4
		S1.14	0											0.0
		S1.15	0											0.0
		S1.16	96					95.8	86.2					86.2
		S1.17	145					144.5	130.1					130.1
		S1.18	194					193.7	174.3					174.3
		S1.19	355					355.0	319.5					319.5
		S1.20	0											0.0
		S12.0	556					524.5	472.1	31.0	24.8			496.9
		S12.1	556					524.5	472.1	31.0	24.8			496.9
		S12.2	899	371.3	352.7			497.0	447.3	31.0	24.8			824.8
		S1.9A	482	371.3	352.7			111.0	99.9					452.6
	Tank H	S12.3	5362	703.8	668.6	3878.2	3102.6					780.0	234.0	4005.2
		S3.0	857	148.5	141.1			633.0	569.7	75.0	60.0			770.8
		S3.1	573	244.0	231.8			329.0	296.1					527.9
		S3.2	71					70.7	63.6					63.6
		S3.3	0											0.0
		S3.4	0											0.0
		S3.5	0											0.0
		S3.6	375	138.0	131.1	237.0	189.6							320.7
		S3.7	0											0.0
		S3.8	0											0.0
	totals		14059											11818.3
		TOTAL	64673.80											46789.0

Average CV value	0.72

Appendix 8

SW Audit Feedback Form

STORMWATER AUDIT (STAGE 1)

JBA Project Code	2021s1635
Contract	SHD, Dundrum CMH, Dundrum, Co Dublin
Client	Land Development Agency
Prepared by	Chris Wason
Subject	Stormwater Audit Stage 1 Report

Revision History

Issue	Date	Status	Issued to
S3.P01	21/01/2022	First issue	BMCE
S3.P02	28/02/2022	Final issue	BMCE

1 Introduction

JBA Consulting have been contracted by Land Development Agency to undertake a Stage 1 SW Audit of the surface water drainage design prepared by Barrett Mahony Consulting Engineers (BMCE) for the proposed SHD at Dundrum Central Mental Hospital site, Dundrum, Co. Dublin. The surface water audit was undertaken in advance of a Strategic Housing Development (SHD) planning submission to An Bord Pleanála.

The subject of this Stage 1 stormwater audit is to review the proposed surface water drainage design and sustainable urban drainage system (SuDS) proposals for the proposed development. The audit has been completed in accordance with Dún Laoghaire Rathdown County Council's (DLRCC) Stormwater Audit Procedure (Rev 0, Jan 2012) as set out below.

Stage 1 – Pre Planning Stage: *A Stage 1 audit shall be carried out of the Stormwater Impact Assessment (SIA) prepared by the applicant. The audit will focus on the SUDS management train and whether the applicant has carefully considered all known SUDS techniques and applied the most appropriate type(s) for the site that will ensure improved water quality, biodiversity and volume control*.

1.1 Report Structure

The Feedback Form in Appendix A identifies queries raised in this report which are to be answered by the Design Engineers. Once an 'Acceptable' status is achieved for each query the audit is deemed to be closed out.

The results of the audit are set out hereunder, where items raised in the feedback form are shown in bold within this report.

1.2 Relevant Studies and Documents

The following documents were considered as part of this surface water audit:

- Greater Dublin Strategic Drainage Strategy (GDSDS);
- Greater Dublin Regional Code of Practice for Drainage Works;
- The SUDs Manual (CIRIA C753).
- Current Development Plan

1.3 Key Considerations and Benefits of SuDS

The key benefits and objectives of SuDS considered as part of this audit and listed below include:

- Water Quantity
- Water Quality
- Amenity
- Biodiversity

Which can be achieved by;

- Storing runoff and releasing it slowly (attenuation)
- Harvesting and using the rain close to where it falls
- Allowing water to soak into the ground (infiltration)
- Slowly transporting (conveying) water on the surface
- Filtering out pollutants
- Allowing sediments to settle out by controlling the flow of the water

1.3.1 SuDs Management Train

A SuDs Management Train is a robust pollutant removal strategy. The treatment train can comprise four stages:

1. *Prevention*
2. *Source Control*
3. *Site Control*
4. *Regional control*

In s2.4 of the report BMCE have demonstrated that a SuDs management train has been sufficiently demonstrated for the majority of runoff with at least two SuDS components, except for some locations identified above. A 'Simple Index Approach' has been applied to pollutant hazard analysis which is considered appropriate.

2 Proposed Development (SHD) at Dundrum CMH, Dundrum, Co. Dublin

The subject site is located the Central Mental Hospital, Dundrum Road, Dundrum, Dublin 14 as shown in Figure 1

Figure 1- Site Location

The total area is c9.42ha.and the positively drained area is c6.46ha. comprising of three catchment areas of Catchment A (1.403ha.), Catchment B1 (4.05ha.) and Catchment B2 (1.014ha.).

Existing buildings and infrastructure on the site will be demolished. The existing buildings discharge to a combined drainage system which connects to the DN300 combined sewer in the Dundrum Road.

2.1 Review of SW Drainage Proposals

The review is based on the following documents provided by BMCE on 12th January;

- DCD-BMD-00-00-DR-C-1000 Roads Layout & Levels.pdf
- DCD-BMD-00-00-DR-C-1020 Buried Surface Water Drainage Layout.pdf
- DCD-BMD-00-00-DR-C-1021 Buried Foul Water Drainage Layout.pdf
- DCD-BMD-00-00-DR-C-1022 Buried Foul Water & Surface Water Drainage Layouts Combined.pdf
- DCD-BMD-00-00-DR-C-1025 Surface Water Overland Flow Routes.pdf
- DCD-BMD-00-00-DR-C-1030 SuDS Layout.pdf
- DCD-BMD-00-00-DR-C-1039 Existing Buried Drainage Layout.pdf
- DCD-BMD-00-00-DR-C-1115 Surface Water Drainage Longitudinal Sections Sheet 1 of 3.pdf
- DCD-BMD-00-00-DR-C-1116 Surface Water Drainage Longitudinal Sections Sheet 2 of 3.pdf
- DCD-BMD-00-00-DR-C-1117 Surface Water Drainage Longitudinal Sections Sheet 3 of 3.pdf
- DCD-BMD-00-00-DR-C-1205 SuDS Details. Typical Green & Blue Roof Details.pdf
- DCD-BMD-00-00-DR-C-1206 SuDS Details. Permeable Paving Details.pdf
- DCD-BMD-00-00-DR-C-1207 SuDS Details. Filter Drain Typical Details.pdf
- DCD-BMD-00-00-DR-C-1208 SuDS Details. Typical Stormtech Attenuation Tank Details.pdf
- DCD-BMD-00-00-DR-C-1209 SuDS Details. Typical Bio-retention Area & Tree Pit Details.pdf
- DCD-BMD-00-00-DR-C-1210 SuDS Details. Swales, Detention Basin & Over-the-edge Road Drainage .pdf
- DCD-BMD-00-00-DR-C-1225 Standard Surface Water Drainage Details.pdf
- IR.01 Infrastructure Report PL2_full.pdf

2.1.1 Pre-Planning Meeting

Various meetings and correspondence have been held with DLRCC which has been set out in s1.4 of the BMCE report.

2.1.2 Site Characteristics

A site investigation was carried out by S.I Ltd. In 11/21 and a summary of the report provided in Appendix 1 of the BMCE report. Four number soakage tests were completed. Two failed the test and two provided infiltration 'f' values of 7.36x10-5 m/s (SA02) and 2.2x10-4 m/s (SA703) which are located in the upper north/northwest of the development (Catchment B2). The ground is typically made ground overlying a black slightly sandy gravelly silty CLAY and natural ground conditions consistent with cohesive soils encountered across the site.

Groundwater was encountered in the majority of boreholes and a third of the trial pits, ranging in depth from 0.8mbgl to 3.3mbgl typically. Standpipes were provided in 5 locations. Details of where GW was encountered are not provided and consideration of SuDS proposals will have to take cognisance of the depth of GW rising within 1m of the base. It may be required to line SuDs features

Details of trial holes and boreholes are not included in the report submitted.

The SOIL type adopted by BMCE is SOIL 4 and SPR 0.47 which would seem appropriate with poor infiltration although the northwest area of the site Catchment B2 could be classed as good infiltration

BMCE to clarify whether infiltration has been considered within Catchment B2.

BMCE to provide more details and assessment of where GWL is across the site and identify which SuDS features mare to be lined and unlined.

The general fall across the lands is from south to north.

2.2 Design Parameters

Rainfall parameters can be estimated using Met Eireann data, using the Flood Studies Report (FSR) values or the values in the GDSDS. The Met Eireann method can be more representative of a site if selected correctly. The design values used by BMCE and considered by JBA are shown below:

Rainfall parameters	Designer values	JBA Comment
M5_60	18	Ok - Met Eireann
Ratio R	0.278	Ok – Met Eireann
SAAR (mm)	772	From Met Eireann. Default in UKSuDS is 840 but use 772
Qbar l/s	31.86	34.97 - UKSuDs
Climate Change	20%	Ok – 10% required in GDSDS

The BMCE report states that the discharge limit from the site (Qbar) has been taken as a conservative 29 l/s which is less than those noted above. The runoff rate for each catchment is set out in table 2.3 (BMCE report) and repeated below;

Table 2.3: Runoff rate per catchment

Catchment	Area (m^2)	Drained Area (m^2)	Calculated Qbar (l/s)	Proposed Qbar (l/s)
Catchment A	28 593	14 029	6.911	7.0
Catchment B1	47 962	40 499	19.951	18.0
Catchment B2	17 319	10 146	4.998	4.0
Total	93 874*	64 674	31.86	29.0

Drg. 1020/PL4 identifies the hydrobrakes that control the flow from the site as;

Catchment A: Node S1.19 = 7 l/s

Catchment B1: Node S10.8 = 14l/s and Node S7.1 = 2l/s and node S9.1 = 2.0l/s – Total 18 l/s

Catchment B2: Node S4.7 = 4l/s

The total pass forward flow (29 l/s) is deemed to satisfy the site greenfield runoff.

The runoff coefficient has been set to 1.0 from the default Flow hydraulic model values of 0.75 (summer) and 0.84 (winter) and designer Cv applied to different surfaces as shown below in Table 2.1 repeated below;

The runoff coefficients used are as prescribed in the DLR Draft Development plan for 2022:

Table 2.1: Runoff Coefficients

Type of areas	CV
Landscaping (Grass / Soft)	0.3
Intensive Green Roof / Podium	0.8
Extensive Green Roof	0.8
Permeable Paving	0.8
Impermeable Surface (incl tree pits)	0.9
Standard Roof (impermeable)	0.95

BMCE state that these values are taken from the Draft Development Plan 2022-2028 and would generally seem reasonable (JBA do not have access to this draft document). However, the landscaping (grass) value of 0.3 might seem low for a SPR value of 0.47 and it could be expected that the SPR value would be applied to contributing grassed areas.

BMCE to confirm if Cv value of 0.3 for grassed areas is adequate for this site with SPR of 0.47.

2.3 Surface Water Drainage Strategy

The development is split into three catchments which are attenuated separately to the combined value of 29 l/s, which is less than Qbar for the site.

A fairly comprehensive SuDS management system has been proposed by BMCE which is generally clearly laid out and should achieve the general principles and aims of SUDS. A pollutant analysis has also been undertaken. A review of the proposals is considered in more detail below.

A FLOW model has been used for the drainage analysis. Pipe design calculations are not provided but simulation runs for the three catchments are provided for the 5-, 30- and 100-year storm return periods.

No infiltration has been allowed for in the design except for the detention basin.

2.3.1 SuDS Measures Considered

SuDS Technology	Comments
Green/Blue Roofs	Blue/Green roofs are proposed, both intensive and extensive. The coverage exceeds the DLRCC requirement of 60%
Swale, Filter Drain, Infiltration Trench	Some filter drains are proposed to drain some roads.
Tree Pits, Bioretention Areas, Rain Gardens	Extensive tree pits and bio areas are proposed to take roof and road
Permeable Paving	Permeable paving is proposed around the site but not designed for any infiltration. Typical detail drawings are provided but it is not clear if the pavements to be provided are lined or unlined.
Soakaways	None proposed. SOIL type 4 would indicate very poor infiltration but some areas of Catchment B2 would be considered suitable for soakaways/infilttration
Detention Basins, Retention Ponds, Stormwater	A detention basin is proposed in catchment B2

Wetlands	
Rainwater Harvesting	None proposed
Petrol Interceptor	The report refers to basement car park drainage and use of a PI to pump to the sw network. No details are provided. It is also queried if the basement drainage should connect to the foul system.
Attenuation	RC tanks, stormtech units and geocellular tanks are proposed. The use of RC tanks outside of buildings is queried and alternatives may be possible.
Other	N/A

2.3.2 Review of drainage drawing 1020/PL4 and SuDS drawing 1030/PL3;

A number of storage tanks are concrete tanks which are not normally considered acceptable. For those under or within building structures then no other alternative may be available. However, tanks H, J are not located under buildings and there could be more suitable alternatives. Use of concrete tanks is also subject to Planning Authority approval.

BMCE to clarify the use of concrete tanks and consider alternatives outside building footprints.

The majority of RG's are connected to tree pits, bio areas, filter drains or permeable paved areas. A small number of RG's appear to be connected directly to the sw network e.g.;

- Adjacent to s12.2.
- Two road gullies at the BM-Road 2 entrance are connected directly to the to the sw network. Although only a small area could these be connected to a filter drain or tree pit?

Road 2: from S1.8A to S1.11 - how is this road drained? No RG's or filter drain is shown. Also, there is a junction table which might interfere with the flow path. Raised speed tables are located in other areas.

It is not clear how all road sections are to be drained and how speed tables/junction tables might interfere with flow paths. All gullies, if possible, should be connected to a SuDs feature. BMCE to clarify.

2.3.3 Review of BMCE report

S2.4.6.2 refers to drainage of the basement car park pumped to the storm network via a PI. It is more usual to pump highly contaminated underground car park drainage (created from washdown rather than rainfall) to the foul system as per the GDSDS CoP s3.18. It is not clear what the DLRCC policy is on this.

BMCE to justify disposal of u/g car park drawing to the storm network rather than pumped to foul, subject to Planning Authority requirements.

S2.4.-Catchment A refers to pumping Block 1 and eastern side of Block 2 to catchment B but this does not make sense with the layout shown on the drawing. Is pumping of storm water still proposed? Pumping is also referred to in the legend of drg. 1020/PL4

BMCE to clarify if pumping of storm water is still proposed and update the report and drawings if not. It should be noted that pumping of storm water is not preferred by the Planning Authority.

S2.3.4.4 refers to provision of a raised drainage pipe in the paving substrata by 100mm to give interception storage. It is queried if there is no infiltration if this could be provided. Also, the typical detail provided shows a land drain below the pavement substrata.

BMCE to justify their assumption that interception storage is provided in the undrained pavement substrata and amend the typical detail to suit if appropriate.

2.3.4 Review of Hydraulic Model

FLOW hydraulic model has been used for the design. A Detailed Area Summary is provided in Appendix 7 of the BMCE report which includes for surface type breakdown with Cv factor applied. A spot check would indicate that the aeras in the model are complimentary to those in the summary sheet for each node.

- 20% climate change allowed for in the simulation for 5-, 30- and 100-year storms which are analysed for the range of durations and is satisfactory.
- Hydrobrakes have min.50mm orifice except for tank K (42mm dia) but all contributing areas would appear to connect to a SuDS element first which would help to mitigate blockage
- No TWL within 500mm of adjacent FFL of buildings
- Drained area breakdown provided in Appendix 7

Some queries for BMCE to address are listed below

- Pipe design calculations are not provided. The summary calculations for simulation runs indicate no flooding for the 100-year event.
- In Catchment B1 hydrobrake flow controls are provided at s7.1, s9.1, s11.4 and s10.5 with two tank structures allocated to them. One of these is related to the tank as shown on the drawing, the other is a depth of 0.06 and varying area to give volumes of 119m3, 66m3 129m3 and 66m3 respectively with porosity set at 0.95. It is not clear what these storage structures relate to.
- No infiltration has been allowed for except for the detention basin (node s6.4) with a rate of 7.3x10-5 m/s, based on the lower of the two soakage tests undertaken. However, no soakage test was undertaken in the vicinity of the proposed detention basin and BMCE and details of nearby TH's and BH's nor provided. BMCE should justify the rationale.
- JBA would recommend that BMCE put head + pass forward flow on drawings for hydrobrake controls
- Stormtech storage units are proposed for tanks A & D. The type of stormtech unit proposed is not clear but the typical detail provided (drg. 1208/PL3) is a SC740 with a typical available head of 0.9m. Manufacturer's design details of the actual units to be provided to match the volume of storage required should be provided at detailed design stage if acceptable to the Planning Authority.
- Tank A (S14.7) has a design head in the Model of 0.6m which would be more suitable for a SC310 stormtech unit. The head on drg is shown as 1.06m.
- Tank D (S10.5) has a design head in the Model of 1.6m which would be more appropriate for a MC3500 type unit. The head on the drg. Is shown as 1.06m
- Detention basin tank (S6.4) is in the Model but no hydrobrake control is indicated as shown on the drawing.

Catchment B2

- Tank G (S4.7) has a volume of 260m3 in the Model but only 171m3 is indicated on the drawing.
- Drg 1205/PL4 provides typical details of permeable paving, both unlined and lined, but it is not clear whether the units proposed will be lined or unlined. The type to be adopted would make a difference in the assessment of interception as per Table 24.6 of the CIRIA manual.

2.3.5 Interception/Treatment

Interception of runoff is intended to prevent any runoff for small rainfall events which are less than 5mm (and up to 10mm if possible). Treatment of 15mm is required if interception is not provided.

Table 24.6 of the CIRIA manual provides indication of deemed to satisfy criteria and it is considered that this should be complied with. All sources of runoff should also be intercepted where possible. A high level of Interception provided for some parts of the site is not to be considered as adequate compensation for a low degree of interception provision for other locations. Compliance is required for the whole site, or at least for road/paved areas, for it to be considered effective. Interception mechanisms are based on runoff retention. This can be achieved using rainwater harvesting or using soil storage and evaporation. Either *infiltration or transpiration rates can dispose of the runoff from minor events to enable the next event to be captured.*

Interception of flow is dealt with in s2.4.5 of the BMCE report and assumes varying storage rates for different surfaces. Interception is dealt with by volumetrics which is not necessarily applicable. No infiltration is assumed in the design and the SOIL type=4 would typically indicate a clay/ impervious soil. Whilst storage and retention within different surfaces can provide for some interception it can be very subjective as to how much, especially if there is no infiltration.

Impermeable roof areas for Blocks 09 are connected to small permeable paved areas. There is no infiltration in this area and the impermeable area drained should not exceed that of the permeable paved area (if unlined) to comply with table 24.6 of the CIRIA manual.

No RWP are shown draining the impermeable roofs on Blocks 08. BMCE should provide details and if they are draining to permeable paving areas or tree pits they should be in compliance with table 24.6 of the CIRIA manual and indicate if pavements are lined or unlined. It is also noted that tree pits are proposed immediately adjacent to some buildings in Blocks 08 and BMCE should confirm that this is acceptable

The Gate Lodge roof and paved area are drained to a bioretention area which also takes one road gully. Table 24.6 states that unlined components can take up to five times the vegetated surface area. BMCE to provide details of the impermeable area and bioretention area to show compliance

BMCE to clarify that adequate provision for interception for all impermeable surfaces has been made where possible and in compliance with Table 24.6 of the CIRIA manual.

2.3.6 Exceedance Flows

BMCE have provided a drawing 1025/PL3 showing overland flow routes in case of blockage etc. FLOW analysis has been provided assuming 50% blockage of the outlets.

2.4 Health & Safety and Maintenance Issues

The proposed drainage system comprises SuDS devices, traditional road gullies, manholes, attenuation systems, a petrol interceptor and underground pipes. These elements are considered acceptable from a Health & Safety perspective once supplier/manufacturers guides are followed and complied with during the detailed design, construction and operation.

Optimum performance of the SUDs treatment train is subject to the frequency of maintenance provided. At detailed design stage, it is recommended that a maintenance regime be adopted.

Particular consideration is required at detailed design stage to the design, maintenance requirements and whole life plan (and replacement) of the SuDS system as a whole.

Regular maintenance of the hydrobrake will be required to remove any blockages, particularly in the wake of heavy rainfall events or local floods.

It is recommended that the petrol interceptors be fitted with an audible high-level silt and oil alarm for maintenance and safety purposes. Regular inspection and maintenance is recommended for the petrol interceptor.

Please note that silt and debris removed from the petrol interceptor during maintenance will be classified as contaminated material and should only be handled and transported by a suitably licensed contractor and haulier and disposed of at a suitably licensed landfill only.

2.5 Items to be considered at Detailed Design Stage

There are a number of items that require attention at detailed design stage. A summary of same are as follows:

- Proper detail design and construction of SuDS devices is paramount to ensure long term optimum hydraulic performance as well as maximisation of biodiversity opportunity. It is recommended that a collaborated approach to detail design is adopted between engineers, architects, ecologists and Landscape Architects.
- Location, layout and levels of basement vents should be cognisant of exceedance flow routes.
- Operation & Maintenance regime for each of the components on site;
- Hydrobrake selection to be give due consideration to hydraulic performance, actual head behind the unit, maximum potential clear passage size and maintenance requirements.

2.6 Audit Report sign Off

Audit Report Prepared by:

Chris Wason BEng CEng MICE
Principal Engineer

Approved by:

Leanne Leonard BEng (Hons) MIEI
Design Engineer

Note:

JBA Consulting Engineers & Scientists Ltd. role on this project is as an independent reviewer/auditor. JBA Consulting Engineers & Scientists hold no design responsibility on this project. All issues raised and comments made by JBA are for the consideration of the Design Engineer. Final design, construction supervision, with sign-off and/or commissioning of the surface water system so that the final product is fit for purpose with a suitable design, capacity and life-span, remains the responsibility of the Design Engineers.

Appendix A – Audit Feedback Form

JBA Consulting Stormwater Audit - Stage 1 Feedback Form	
Project:	SHD at CMH Dundrun Road, Dundrum, Dunlin 14
Date:	20/01/2022
JBA Reviewers	Chris Wason
Status	S3/P02
Project Number:	2021s1635

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable / Not Acceptable
	21/01/2022	21/01/2022	28/02/2022	28/02/2022
	Reference Documents see SW Audit Report			
1	Site investigation and ground conditions 1 -the site investigation indicates a cohesive natural soil across the site and BMCE have adopted a SOIL type 4 which seems appropriate. However, soakage teets in Catchment B2 indicate that some areas may have good infiltration. 2 - GWL across the site may pose a problem and SuDs elements may need to be lined if the level is within 1m of the base of proposed SuDS features. General details of GWL have been given but no specifics	1 - Would BMCE consider infiltration in the Catchment B2 or at least confirm that SuDs units will be unlined if GWL is suitable. 2 - It is not clear from the information provided if , or where, GW may be an issue and which SuDS elements may be affected and may be need to be lined. BMCE should confirm the GWL across the site and indicate if SuDs elements are to be lined or unlined	1 - Yes, infiltration in Catchment B2 will be considered. SuDS units on this project are generally 'unlined' (they have a high permeablity geotextile lining only). 2 - Based on the SI report and experience in the south Dublin area, the groundwater table is likely to be 3.0-4.0m bgl but with higher level water perched on top of and travelling over the relatively impermeable boulder clays. SuDS devices located below the perched water level will be lined. Further site investigations (trial pits) will be carried out prior to construction to confirm the water table levels in more detail at the locations of the larger buried devices e.g. the attenuation tanks (these are generally unlined & indicated 'Permeable' in the tank details note on BM drg C1020).	Accepted
2	Flow Model (1) 1 - it is noted that the default runoff coefficient in the model has been edited to 1 and that coefficients for different surface types has been applied which generally seem reasonable (and in agreement with draft DLRCC Development Plan). The Cv for grassed lands is 0.3 but he soil investigation indicates cohesive soils. 2 - In Catchment B1 hydrobrake flow controls are provided at s7.1, s9.1, s11.4 and s10.5 with two tank structures allocated to them. One of these is related to the tank as shown on the drawing, the other is a depth of 0.065 and varying area to give volumes of 119m3, 66m3 129m3 and 66m3 respectively with porosity set at 0.95. It is not clear what these storage structures relate to. 3 - No infiltration has been allowed for except for the detention basin (node s6.4) with a rate of 7.3x10-5 m/s, based on the lower of the two soakage tests undertaken. However, no soakage test was undertaken in the vicinity of the proposed detention basin and BMCE and details of nearby TH's and BH's are not provided. BMCE should justify the rationale. 4 - JBA would recommend that BMCE put head + pass forward flow on drawings for hydrobrake controls 5 - Stormtech storage units are proposed for tanks A & D. The type of stormtech unit proposed is not clear but the typical detail provided (drg. 1208/PL3) is a SC740 with a typical available head of 0.9m. Manufacturer's design details of the actual units to be provided to match the volume of storage required should be provided at detailed design stage if acceptable to the Planning Authority.	1 - BMCE to confirm that the Cv for grassed areas of 0.3 is suitable bearing in mind the SPR value is 0.47. 2 - BMCE to clarify the second storage tank inputs wit depth of 0.065mm 3 - BMCE to justify the use of the infiltration rate at the detention basin location 4 - Would BMCE consider putting the head and discharge rate on the drawing for all flow controls 5 - BMCE should indicate the type of Stormtech unit proposed and also provide calculation from Stormtech to confirm the actual size required to suit the volume needed. Flow analysis should be representative of the storage type proposed.	1 - The SOIL Class for the existing undeveloped greenfield site is esimated as Class 4 which has an SPR value of 0.45 (low permeability boulder clay typical of the Dublin area). The development, by its nature will change the topography of the site, and higher quality topsoil for landscaping purposes will be applied to all soft landscape areas to ensure proposed planting can thrive, and to allow for a greater level of natural infiltration through the soil. It is therefore reasonable to use a Cv value of 0.3 bearing in mind the current industry guidance which suggest run-off coefficients from soft landscaping in the region of 0.10-0.25. A run-off coefficient of 0.3 has been used in the design of the proposed development to account for any run-off arising from the areas of soft landscaping. 2 - The storage tanks with a depth of 0.065m represent the various blue roofs on the different blocks (where applicable) 3 - The detention basin will be a dry, landscaped area with the ability to attenuate surface water in high storm events. Due to the fact that the facility will be able to dry out, infiltration will be possible when it fills with water. The infiltration rate used in the calculations is the average result from the two nearby soakaway tests. (0.264m/hr - As per section 6.3 of Site Investigation) 4 - Yes, the head and discharge rate will be put on drawing C-1020 for all controls. 5 - Stormtech type proprietary arch unit 740 deep assumed throughout. Tanks A & D was updated in the Flow model to reflect 60% typical porosity with a depth of 1.1m.	Accepted
3	Flow Model (2) 1 - Tank A (S14.7) has a design head in the Model of 0.6m which would be more suitable for a SC310 Stormtech unit. The head on drg is shown as 1.06m. 2 - Tank D (S10.5) has a design head in the Model of 1.6m which would be more appropriate for an MC3500 type unit. The head on the drg. Is shown as 1.06m 3 - Detention basin tank (S6.4) is in the Model but no hydrobrake control is indicated as shown on the drawing Catchment B2 4 - Tank G (S4.7) has a volume of 260m3 in the Model but only 171m3 is indicated on the drawing.	1 & 2 - BMCE should indicate the type of Stormtech unit proposed and also provide calculation from Stormtech to confirm the actual size required to suit the volume needed. Flow analysis should be representative of the storage type proposed. 3 - Is a hydrobrake proposed at node S6.4 and if so should this be represented in the Flow model. 4 - Please confirm the correct volume for this tank and ensure Mode land drawing are complimentary	1 & 2 - Noted. Calculations will be obtained off Stormtech or an alternative unit provided (if used) at tender preparation stage. BM will re-visit the calculations and update the sw drainage drawing C-1020 to indicate the correct unit type for each Stormtech type tank. 3 - Flow control to the detention basin is provided at manhole S6.4 as noted on BM drg C-1020. 4 - The correct volume is 258 cum. The drawing will be updated to reflect this. The area was shown in the drawing text box - 171m2.	Accepted

JBA Consulting Stormwater Audit - Stage 1 Feedback Form	
Project:	SHD at CMH Dundrun Road, Dundrum, Dunlin 14
Date:	20/01/2022
JBA Reviewers	Chris Wason
Status	S3/P02
Project Number:	2021s1635

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable / Not Acceptable
	21/01/2022	21/01/2022	28/02/2022	28/02/2022
4	Interception/Treatment 1 - Drg 1205/PL4 provides typical details of permeable paving, both unlined and lined, but it is not clear whether the units proposed will be lined or unlined. The type to be adopted would make a difference in the assessment of interception as per Table 24.6 of the CIRIA manual 2 - Impermeable roof areas for Blocks 09 are connected to small permeable paved areas. Are these to be lined or unlined? Are they in compliance with table 24.6 of the CIRIA manual 3 - No RWP are shown draining the impermeable roofs on Blocks 08. 4 - It is also noted that tree pits are proposed immediately adjacent to some buildings in Blocks 08 and BMCE should confirm that this is acceptable. 5 - The Gate Lodge roof and paved area are drained to a bioretention area which also takes one road gully. Table 24.6 states that unlined components can take up to five times the vegetated surface area.	1 -What are the type (s) of permeable paving to be used from the typical details provided 2 - BMCE to clarify that adequate provision has been made for all impermeable surfaces 3 - BMCE should provide details and if they are draining to permeable paving areas or tree pits they should be in compliance with table 24.6 of the CIRIA manual and indicate if pavements are lined or unlined. 4 - are tree pits immediately adjacent to building ok? BMCE to confirm. 5 - BMCE to provide details of the impermeable area and bioretention area to show compliance with Table 24.6 of the CIRIA manual.	1 - As noted on BM drg C-1207 a Type B system (partial infiltration) will apply throughout except within 1.5m of building foundations or 1.5m of the site boundary where Type C will apply (=impermeable membrane - no infiltration). We will update the note so that this is clearer. Note 1: During a recent IEI Seminar on Perm Pavements it was stated that the normal rule of 5m separation distance between soakaways and building foundations was unduly onerous for a thin flat soakaway like a permeable pavement. 1.5m or less was suggested unless there are significant additional inflows. Note 2 - On the sw drainage layout drawing, BM drg no C-1020, Attn tank 'F' which is a permeable pavement with a deepened granular base, will have an impermeable membrane up to 5m from the building. 2 - The roof areas of Blocks 08 & 09 will connect to a soakaway in each rear garden. The soakaways will each have a high level overflow to the site sw drainage system. Infiltration tests along these gardens will be carried prior to construction to verify infiltration rates and the required soakaway sizes. 3 - Noted. Drainage will be locally revised if necessary to ensure compliance with Table 24.6. 4 - Yes, tree pits/bio-rention areas beside buildings can take water directly from rainwater downpipes. These pits will be lined with an impermeable lining. This will be noted on the sw drainage layout drg no. C-1020. 5 - Following discussions with the Landscape Architect the large area of paving around the gate lodge with be revised to perm. paving and the bio retention area will be enlarged. These will be sufficient to take the road and road drainage while complying with Table 24.6.	Accepted
5	Review of Drawing 1020/PL4 and 1030/PL3 1 - a number of RC tanks are proposed which would not normally be considered acceptable but no other option may be available. However, H & J do not seem to be located under or within buildings 2 - A small number of RG's appear to be connected directly to the sw network e.g.; •adjacent to s12.2. •Two road gullies at the BM-Road 2 entrance are connected directly to the to the sw network. Although only a small area could these be connected to a filter drain or tree pit? 3 - Road 2: from S1.8A to S1.11 - how is this road drained? No RG's or filter drain is shown. Also, there is a junction table which might interfere with the flow path. Raised speed tables are located in other areas	1 - Use of concrete tanks is subject to Planning Authority approval. BMCE to confirm that no other suitable alternatives are available, particulalry with regard to tanks H & J which appear to outside the building lines. 2 - BMCE to review RG connections and connect to a SuDS feature where possible 3 - BMCE to review all sections of road and confirm that adequate provison has been made for their drainage and that any new RG are connected to a SuDS feature.	1 -Conrete tank H is an extension of the Block 10 basement and will need to remain a concrete tank. Tank J will be revised to a tank constructed with proprietary cellular units with a permeable lining. A low infiltration value has been used in the calculations (0.264m/hr - As per section 6.3 of Site Investigation). 2 - All RG locations will be reviewed and addressed. 3 - All RG locations will be reviewed.	Accepted
6	Review of BMCE report 1 - S2.4.6.2 refers to drainage of the basement car park pumped to the storm network via a PI. It is more usual to pump highly contaminated underground car park drainage (created from washdown rather than rainfall) to the foul system as per the GDSDS CoP s3.18. It is not clear what the DLRCC policy is on this. 2 - S2.4.-Catchment A refers to pumping Block 1 and eastern side of Block 2 to catchment B but this does not make sense with the layout shown on the drawing. Is pumping of storm water still proposed? Pumping is also referred to in the legend of drg. 1020/PL4 3 - S2.3.4.4 refers to provision of a raised drainage pipe in the paving substrata by 100mm to give interception storage. It is queried if there is no infiltration if this could be provided. Also, the typical detail provided shows a land drain below the pavement substrata.	1 - BMCE to justify disposal of u/g car park drawing to the storm network rather than pumped to foul, subject to Planning Authority requirements 2 - BMCE to clarify if pumping of storm water is still proposed and update the report and drawings if not. It should be noted that pumping of storm water is not preferred by the Planning Authority. 3 - BMCE to justify their assumption that interception storage is provided in the undrained pavement substrata and amend the typical detail to suit if appropriate.	1 - Basement drainage will be pumped to foul network. 2 - Pumping is not proposed. The note in the Infrastructure Report is an error and will be removed. 3 - The permeable pavements are typically 'unlined' i.e. have a high permeability geotextile lining except in proximity to buildings or the site boundary where an impermeable membrane should be used as noted on BM drg C-1207. Infiltration in the top layers of soil on site/granular fill will be sufficient to ensure that interception storage is achieved. In the case of the permeable paved area taking part of the run-off from Block 06, a shallow soakaway test will be carried out prior to construction to confirm the infiltration rate.	Accepted

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