Project

Residential Development at Newcastle South, Phase 1, Co. Dublin

Report Title

Infrastructure Design Report

Client

Cairn Homes Properties Ltd

INFRASTRUCTURE

DBFL CONSULTING ENGINEERS

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1.0 INTRODUCTION

1.1 Background

DBFL were commissioned to undertake an infrastructure design report to accompany a planning submission for a residential development at Newcastle, South County Dublin.

The majority of the subject site and further lands to the east which are currently developed obtained planning permission from South Dublin City Council for 743 dwellings including a neighbourhood centre and a Creche in March 2006 under application Ref. SD05A/0344. This planning permission also granted permission to construct the western section of the main spine road through the site. A planning permission extension was requested under application Ref. SD05A/0344/EP in July 2014, which was granted by SDCC in September 2014 and expired in November 2017.

This application comprises 406 residential units, 67.7m^2 of retail area and a crèche facility. The application also includes infrastructure comprising a road layout, cyclist infrastructure, initial phase of public park, foul, surface water and water supply services in accordance with the Newcastle Local Area Plan 2012 and South Dublin County Development Plan (2016-2022).

1.2 Objectives

This report aims to consider the proposed development main infrastructure elements, including the following;

- Road Layout/Site access including cyclist infrastructure.
- Surface water strategy and servicing.
- Foul sewer strategy and servicing.
- Water supply and servicing.
- Preliminary flood risk assessment.

1.3 Location

The subject site, of approximately 16 hectares (39.5 acres), is located to the south of the R120/Main Street at Newcastle Village. The site is bounded by residential developments of different densities to the east and north and bounded by greenfield and single dwellings to the south and west. The St Finian's National School and Church is located to the north of the site.

The development lands form part of the South Dublin County Development Plan (2016-2022). The Main Development is zoned 'to provide for new residential communities in accordance with approved planning schemes' (RES-N) and 'to preserve and provide for open space and recreational amenities' (OS). The Ballynakelly Site is zoned RES-N.

The two smaller developments to the south-east of the Main Development are zoned 'to protect and/or improve residential amenity' (RES).

The Main Development Site and the Ballynakelly Site are predominantly green-field while some earthworks and site development works have been undertaken on the eastern area associated with the previously approved development. Existing boundaries within the site are predominantly hedgerows and fencing with some drainage ditches. The Ballynakelly Rise infill site is predominantly greenfield, while the Ballynakelly Edge infill site encloses an existing building intended for a change of use.

Figure 1.1 Site Location.

1.3.1 Topography

The overall topography of the Site falls from south to north toward Newcastle Village as shown in Figure 1.2. A topographical survey of the Site is provided as a background to the road layout drawings 170024-2001 and 2002.

Figure 1.2 Site Topography.

1.4 Proposed Development

The application site comprises of a main development site of approximately 15 hectares, to the south of Main Street, together with three infill sites which comprise of a 0.80ha site at Ballynakelly; a 0.18ha site at Ballynakelly Rise and a 0.05ha site at Ballynakelly Edge.

The proposed development comprises of 406 no. dwellings comprising 8 no. one-bed apartments; 20 no. two-bed apartments; 1 no. three-bed apartments; 48 no. two-bed apartments with 48 no. three bed duplex units above; 21 no. two-bed houses; 208 no. three-bed houses; and 52 no. four-bed houses.

In addition, the proposed development provides a childcare facility (518sqm) with capacity for in the order of 110 no. children to serve the needs of the proposed development and the wider community. The proposals also include 1 no. retail unit (total gross floor area 67.7sqm) at ground floor level within the Ballynakelly apartment block.

The proposed development also provides for the first phase of a new east-west link street, a continuation of Newcastle Boulevard, and a new north-south greenway linking

the Main Street to the new public park. The proposed development facilitates a number of future potential pedestrian, cycle and vehicular links to existing and proposed adjoining developments. Access to the proposed development is via a new north-south link street, with a new entrance onto Main Street, and via the existing road network from Newcastle Boulevard to the east.

A primary school site (approximately 1.5ha) has been reserved at the south-east of the application site in accordance with the Newcastle LAP 2012. A new public park is proposed (approximately 2ha) together with a range of pocket parks and greenways to serve the proposed development and the wider Newcastle community.

The proposed development provides all associated and ancillary infrastructure, landscaping, boundary treatments and development works on a total site area of approximately 16 hectares. The proposed development also provides for a temporary, single storey marketing suite and associated signage (including hoarding) during the construction phase of development only.

1.5 Flood Risk

A separate Site Specific Flood Risk Assessment has been prepared as part of the application.

1.6 Existing Ground Conditions

A detailed site investigation was undertaken by Ground Investigations Ireland in April 2018 to ascertain the existing ground conditions on the development site. The ground conditions generally consist of topsoil to a maximum depth of 400mm over sandy gravelly clays with occasional cobbles and boulders over gravel deposits. Bedrock was discovered between 3m and 11m below ground level. Made ground was discovered in two exploratory holes to maximum depth of 2.3m below ground level. A copy of the Ground Investigation Report is provided with the planning application.

2.0 ACCESS AND ROADS

2.1 Overall Road and Access Layout

The proposed development will be accessed from existing development to the east and a new priority junction on the R120, Main Street.

The main link street through the site, Newcastle Boulevard, follows a similar alignment to the Newcastle LAP, 2012 and respects the open space zoned lands to the west of the subject site. Newcastle Boulevard has been designed with a number of junctions and a meandering alignment through the development to promote traffic calming and discourage “rat running” through the development. The alignment has been tracked using vehicle tracking software for a future bus route.

The proposed carriageway is 6.5m wide with a raised adjacent cycle track on each side and intermittent parallel parking as per the Newcastle LAP, 2012. A raised table at the junction with Burgage Crescent provides a suitable transition from the existing constructed Newcastle Boulevard to the proposed DMURS link street. DBFL have agreed the link street design with South Dublin County Council’s Roads Department prior to submitting the planning application.

The development’s internal layout has been designed with speed reduction bends to provide traffic calming together with a combination of road vertical and horizontal deflections and forward sight visibility to reduce speeds. Flat top table ramps have been provided at strategic locations to calm traffic at junctions in particular at green-link/vehicular interfaces. Design speed limits of 30km/hr are applied throughout the development as per Design Manual for Urban Roads and Streets (DMURS).

2.2 Green-link Cycle Infrastructure

Green-link cycle infrastructure has been provided throughout the development to link existing and future schools, parks and local amenities in accordance with the Newcastle LAP 2012. Cycle infrastructure on the east/west link street has been provided as raised adjacent cycle tracks to align with the Newcastle LAP, 2012 and tie into existing cycle infrastructure to the east. The proposed north/south green-link is provided as a 4m wide shared surface for pedestrians and cyclists migrating between the various schools and amenities. This green-link is designed as an amenity route for less confident cyclists and children. The green-link has been designed to minimise the number of vehicular crossings. Where junctions and crossings are proposed, they have been designed in accordance with TII TD300 (Rural Cycleway Design Guide) and the National Cycle Manual. A signalised Toucan Crossing is proposed where the green-link crosses Newcastle Boulevard and priority junctions are proposed elsewhere.

Given the low vehicular traffic volumes within the internal local streets (<2,000 AADT), cyclists will share the road surface with vehicular traffic as per Section 1.7 of the National Cycle Manual.

2.3 Road Layout Design

The proposed development's road layout is shown on drawings 170024-2001 and 2002. Drawing number 170024-2000 outlines the road hierarchy and possible future connections. The standard road cross-sections and construction details are shown on drawings 170024-2020, 2021 & 2022 and comprise the following;

- Newcastle Boulevard – providing 6.5m carriageway, 2m raised adjacent cycle tracks and 2.0m wide footways on each side with intermittent parallel parking bays as per Newcastle LAP, 2012. A 750mm buffer zone is provided between parking bays and cycle tracks as per the requirements of the National Cycle Manual.
- Residential Local Streets – typically 5m to 5.5m wide carriageway with 2m footways and intermittent 2.4m wide public parking bays.
- Shared Home-Zone Streets – 4.8m to 6.0m shared surface with different colour contrast and texture to Local Street (no footpaths).

Maximum road corner radii of 4.5m are provided within the local streets and 6m on the main access road as per DMURS and the requirements of South Dublin County Council.

2.4 Pavement Design Standards

The main internal access roads are designed in accordance with the Design Manual for Urban Roads and Streets (DMURS) and Local Authority requirements. Refer to drawing 170024-2020 for the proposed road construction thicknesses based on an assumed existing ground minimum design CBR of 3%. Actual CBRs and ground conditions will be confirmed by detailed site investigations prior to construction.

2.5 Traffic & Transportation

A separate Traffic and Transportation Assessment has been prepared as part of this application and is included in the overall planning pack.

2.6 Vehicle Tracking

The proposed development has been tracked to show that the development's proposed turning heads will accommodate a large refuse vehicle as shown on drawings 170024-2001 and 2002.

2.7 Driveway Access

Access driveways are set to accommodate a targeted maximum 1:20 driveway gradient. All driveways are permeable paving within private curtilage. Entrances to driveways in public footpaths comprise drop kerbs with 150mm deep concrete pavement.

3.0 SURFACE WATER DRAINAGE

3.1 Existing Surface Water

The existing site is predominantly greenfield and the topography of the site generally falls to the north towards the R120 road through Newcastle Village. A network of existing drainage ditches currently drain the site. The following drainage infrastructure has been constructed on the eastern area of the site as part of the previously approved development:

Phase 1 (Main Development Site):

DBFL commissioned a manhole survey to confirm the 375mm diameter surface water outfall for Phase 1 has been constructed into the site from the R120 Main Street. This 375mm diameter surface water sewer outfalls to a 525mm surface water on the R120 which ultimately discharges to the Shinkeen River.

Ballynakelly Site (Infill Area C1):

The Ballynakelly Site to the east of Main Development Site benefits from core infrastructure constructed under the previously permitted development (Reg. Ref. SD05A/0344). Surface water sewers have been constructed in the roads surrounding the site and have been surveyed to confirm levels and diameters. Under Reg. Ref. SD05A/0344 a 609m^3 attenuation tank (attenuation 3) was proposed to serve the Ballynakelly catchment.

DBFL have undertaken a check on the adequacy of the existing attenuation volume provided as follows:

a) DBFL commissioned a CCTV survey of the constructed tank to confirm its size and condition. The CCTV report confirms the concrete tank is in very good condition and its approximate dimensions are 25m x 20m x 1.5m which equates to greater than 609m^3. A copy of the CCTV survey report is provided in Appendix A.

b) The catchment area for the attenuation facility under Reg. Ref. SD05A/0344 was approximately 2.2ha as shown in Figure 3.1 below.

c) Approximately 0.5ha of the western area of the catchment has now been included in the catchment area for proposed attenuation facility 1A as shown in Figure 3.1 below.

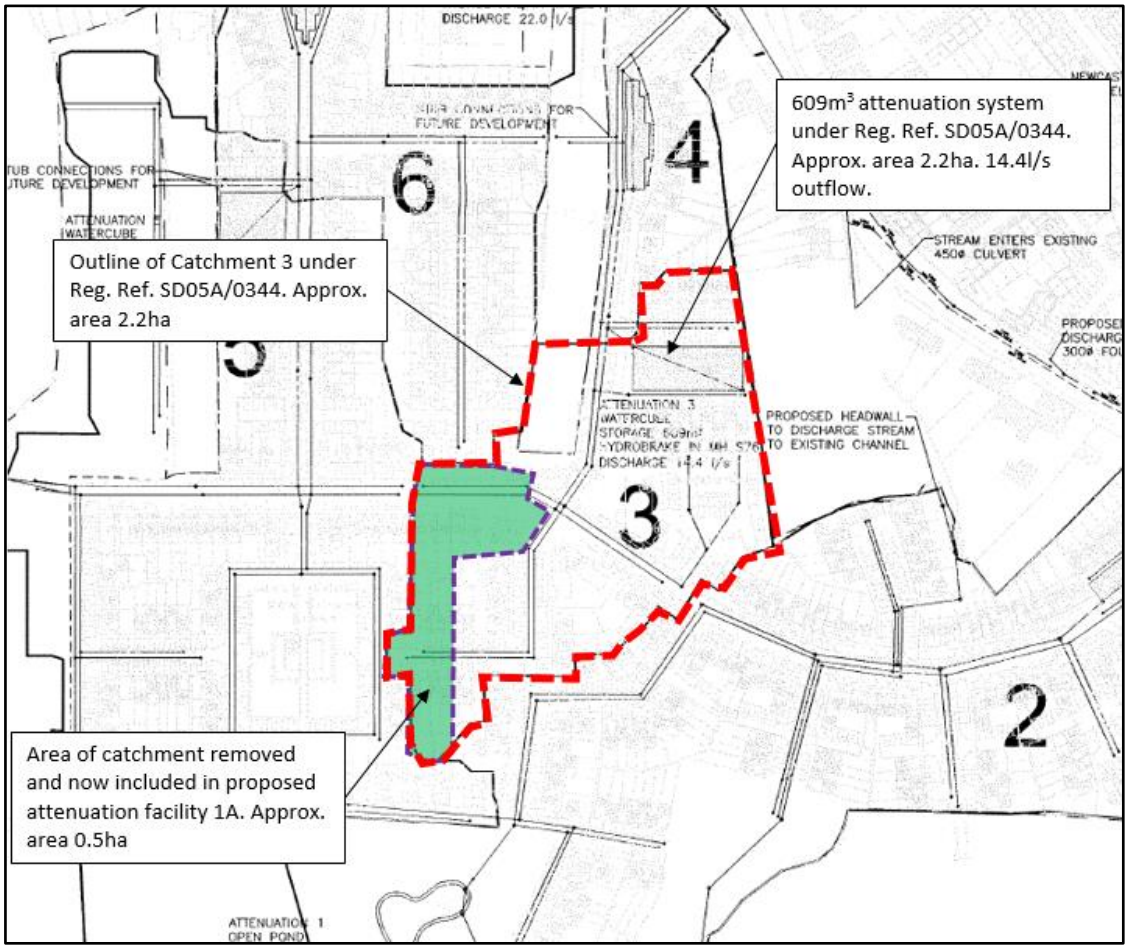


Figure 3.1 – Ballynakelly Site - Existing Attenuation Catchment

d) DBFL have prepared a Microdrainage Source Control model of the existing attenuation tank. The impermeable area was calculated using an overall run-off coefficient of 60% (conservative) for the revised catchment area (1.7ha) shown above.

e) The drainage design under Reg. Ref. SD05A/0344 was based on an allowable outflow of 6l/s/ha and it was noted on the planning documentation that this was a requirement of South Dublin County Council. Therefore an allowable outflow of 10.2l/s (1.7ha x 6l/s) was utilised in the model for this catchment.

f) The required storage volume is 429m^3 while the attenuation volume provided is 609m^3.

The above calculation and investigation clearly demonstrates the existing attenuation facility at the Ballynakelly Site is adequately sized to accommodate the proposed infill site. Refer to Appendix B for calculations.

Ballynakelly Rise (Infill Area C2):

The proposed infill site at Ballynakelly Rise to the east of Phase 1 benefits from core infrastructure constructed under the previously permitted development (Reg. Ref. SD05A/0344). Surface water sewers have been constructed in the roads surrounding the site and have been surveyed to confirm levels and diameters. Under Reg. Ref. SD05A/0344 two attenuation facilities were proposed to provide 1538m^3 of storage including oversized pipes to serve catchment 2 as shown below in Figure 3.3.

DBFL have undertaken a high level check on the adequacy of the existing attenuation volume to accommodate the proposed 7 no. housing units. It should be noted that the original drainage design under Reg. Ref. SD05A/0344 included the infill site in the calculations.

a) An estimate of the developed catchment area is 8ha, see Figure 3.2 below.

b) DBFL have prepared a Microdrainage source control model of the existing attenuation volume. The impermeable area was calculated using an overall run-off coefficient of 50% (conservative as development less dense than Catchment 3) for the catchment area.

c) Similar to catchment 3 above, the allowable outflow of the original drainage design was based on 6l/s/ha. Therefore an allowable outflow of 48 l/s (8ha x 6l/s) was utilised in the model for this catchment.

d) The required storage volume is 1529m^3 while the attenuation volume provided is 1538m^3.

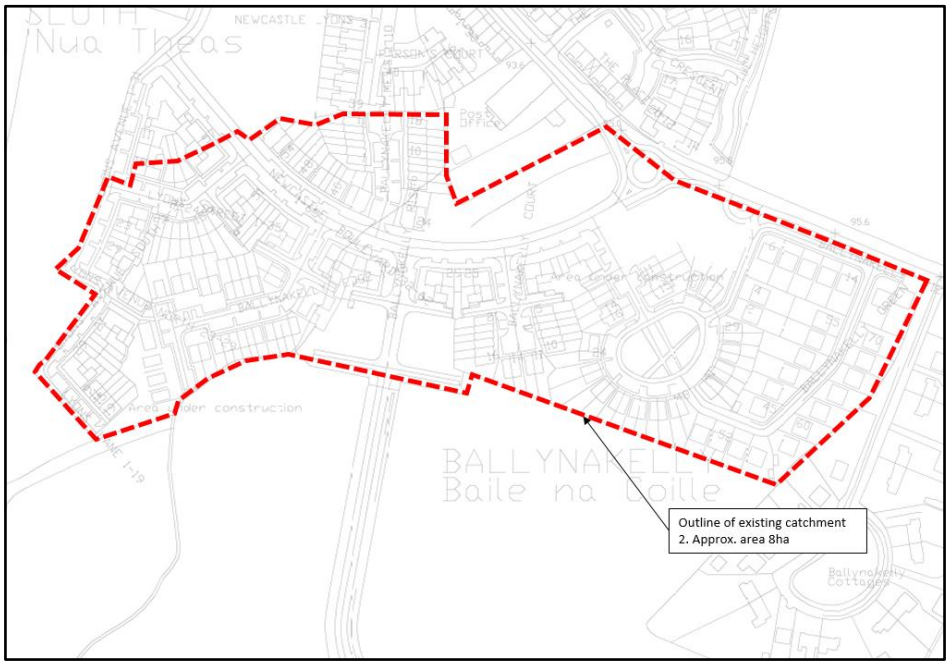


Figure 3.2 – Ballynakelly Rise - Existing Catchment

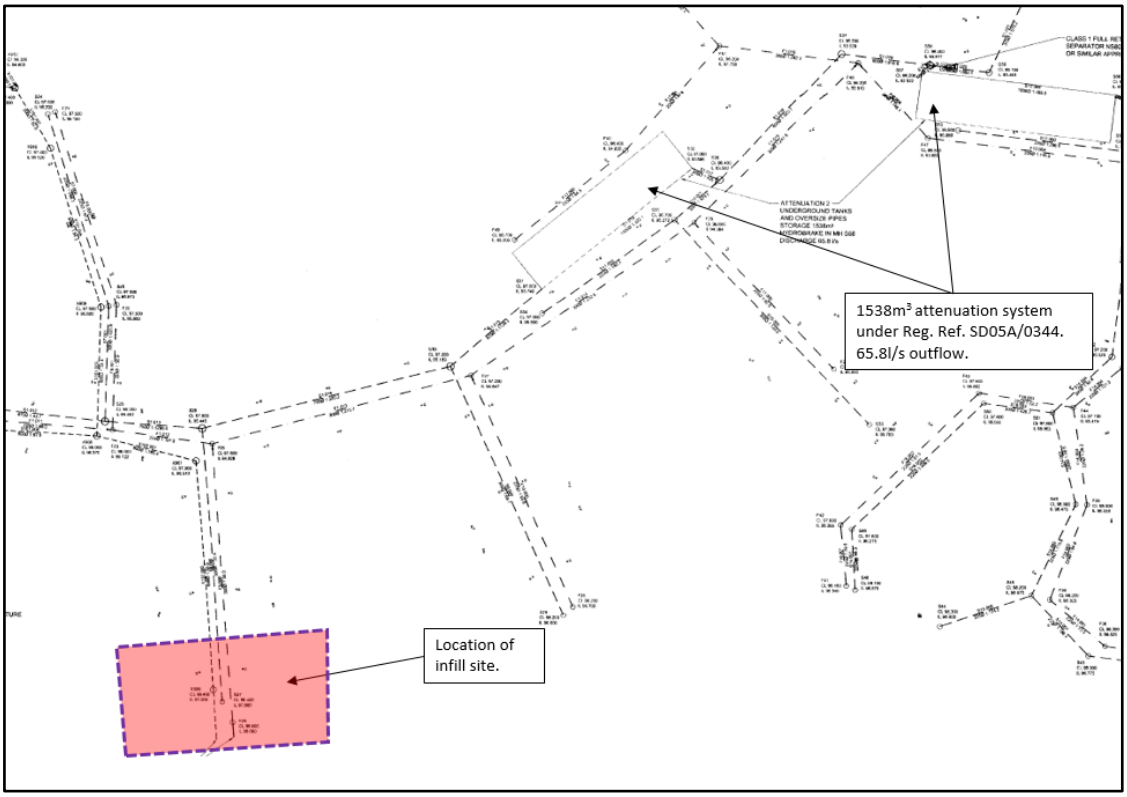


Figure 3.3 – Ballynakelly Rise - Existing Attenuation

The above calculation and investigation clearly demonstrates the existing attenuation facility at Ballynakelly adjacent to the Rathcoole Road is adequately sized for the proposed infill site (7 units). Refer to Appendix B for calculations.

Ballynakelly Edge (Infill Area C3):

The proposed works at Ballynakelly Edge are for a change of use to an existing building therefore, there will be no increased surface water run-off from the existing building and no alterations are proposed to the existing surface water network.

3.2 Surface Water Drainage Strategy

3.2.1 General

An overall surface water drainage strategy has been developed by DBFL Consulting Engineers for the overall development site including future residential development. This strategy is shown on drawing number 170024-3020 which outlines each catchment and its corresponding attenuation facility. Surface water runoff from the development will be attenuated to greenfield runoff rates (Qbar) in accordance with the Greater Dublin Strategic Drainage Study (GDSDS).

Storms up to the 30 year critical storm will be stored in underground geocellular attenuation systems. Shallow detention basins will be used to store surface water for

storms between the 30 year and the 100 year critical storms. This strategy has been agreed with SDCC at part of the Stage 1 and 2 SHD planning process. The detention basins will be incorporated into the landscape plan with gently sloping side slopes and the max open water depth in the detention basins will be 600mm in the 100 year critical storm. This arrangement ensures that the detention basins remain dry and usable during most rainfall events, with the detention basins only utilised during extreme events. Typical construction details are shown on drawings 170024-3021, 3022 and 3023.

The surface water drainage system will collect storm-water run-off generated from the proposed residential development using traditional pipe-work and manholes laid along the main access roads collecting run-off from impermeable road surfaces via gullies and adjoining areas. Swales will be utilised as a SuDs measure where possible to drain adjacent roads and greenlinks. Swales and other SuDs measures have been incorporated into the drainage design to reduce the run-off volume and improve run-off water quality as described in Section 3.3 below.

3.2.2 Compliance with Surface Water Policy

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

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

3.2.3 Ground Investigation

Preliminary site investigation was undertaken on the Subject Site which included trial pits, boreholes and Infiltration tests. Topsoil over clays over gravel was encountered with bedrock discovered between 3 and 11m below ground level. Infiltration tests in accordance with BRE Digest 365 were carried out at 6 locations on site. The results indicated negligible soakage rates therefore no benefit was taken from infiltration in the design of the attenuation facilities although some infiltration will naturally occur.

3.3 SUDS

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

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

The proposed layout of the drainage and SUDS is detailed on drawings 170024-3001, 3002 and 3003.

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

1. Permeable paving driveways for all on-curtilage driveways
2. Greenlinks to drain to swales for reduction and treatment of run-off
3. The attenuation storage systems will be an on-line system for treatment of run-off. The storage systems will be designed to maximise water quality.
4. Down pipes from roof surfaces diverted into driveway permeable paving to allow infiltration of run-off from roofs.
5. Green roof at Creche building
6. A petrol interceptor to be provided before the outfall from the Subject Site.

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

3.4 Surface Attenuation Storage

Surface water run-off from the overall Newcastle South development lands (subject site, future phases and zoned lands as outlined on drawing number 170024-3020) will be attenuated to greenfield runoff rates (Qbar). This is calculated as 52.00/s using the Institute of Hydrology equation as recommended in the Greater Dublin Strategic drainage Study (GDSDS) based on an area of 24.58Ha. This area is within the catchment of the new drainage networks and excludes open space areas not within new drainage networks. The overall catchment and a catchment plan strategy is shown on drawing number 170024-3020.

Catchments 1A, 1B and 1C within the subject site accounts for 46% of the overall site and will therefore be attenuated to 24.06l/s. Refer to figure 3.4 below for indicative overall catchments areas.

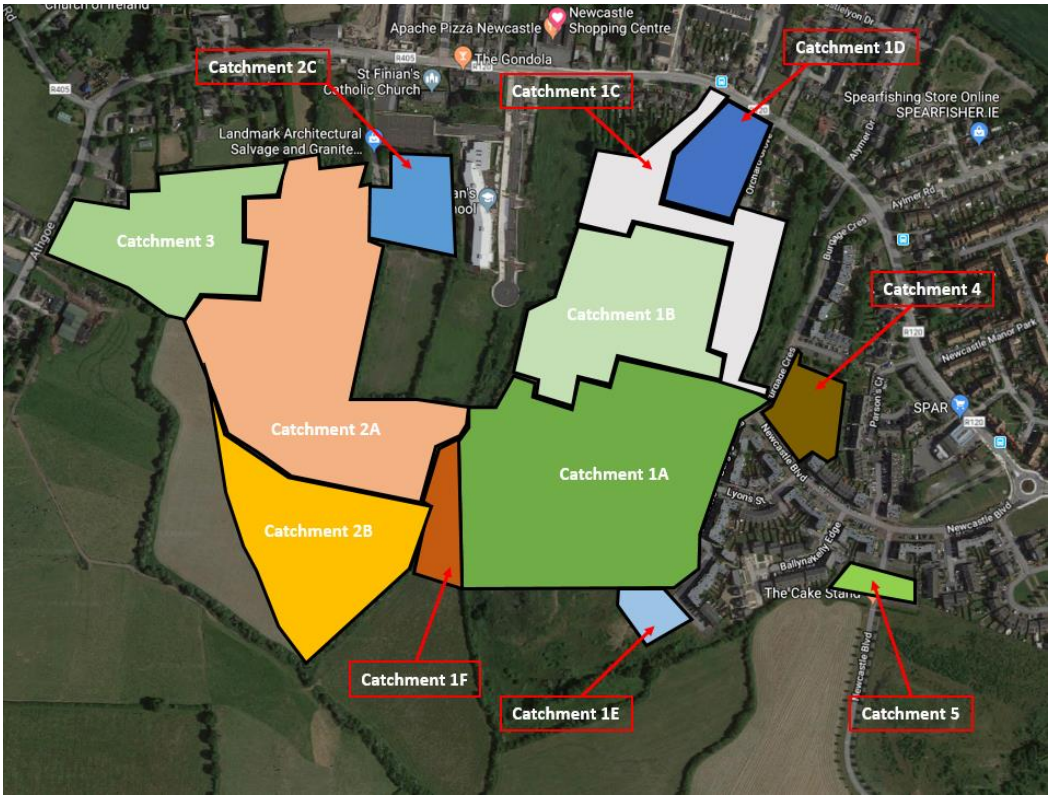


Figure 3.4 – Indicate overall catchment areas

A land drain has been included to the south of the development to intercept any overland flow from the south and will drain to existing field ditches to match the greenfield scenario therefore it is not included in the above calculation. As outlined on drawing number 170024-3020, a section of the future school site (Catchment 1E) to the south of the interceptor drain is included in Catchment 1A for the calculation of the greenfield run-off rate. The reason for including this is because greenfield run-off from this area may enter

the Catchment 1A drainage network in extreme events. This area is to be attenuated within its own catchment if developed in the future.

Catchment 1D (Future Commercial Site) and Catchment 1E (Future School Site) will be attenuated within their own catchments and their attenuated outflows, 1.78l/s and 1.59l/s respectively have been accommodated in the drainage design.

Refer to Appendix C for detailed calculations.

Soil Type 2 has been used to calculate Qbar and the attenuation storage. The SOIL value was selected using Table 4.5 of the Flood Studies report – The Classification of Soils from Winter Rainfall Acceptance with the following criteria:

Drainage Group	2 - Commonly waterlogged within 60cm
Depth to impermeable layer	2 - 80-40cm
Permeability group (above 'impermeable' layers or to 80cm)	2 - Medium
Slope	1 – 0 -2°

Table 3.1 Summary of Site Characteristics

Drainage Group	Depth to impermeable layer (cm)	Slope classes: 0 - 2°			2 - 8°			>8°		
		Permeability rates above impermeable layers: (1) Rapid	(2) Medium	(3) Slow	(1) Rapid	(2) Medium	(3) Slow	(1) Rapid	(2) Medium	(3) Slow
1	>80	1			1			1	2	3
	40 - 80					2		3		4
	<40	—	—	—	—	—	—	—	—	—
2	>80	2			3		4	—		
	40 - 80									
	<40	3								
3	>80					5		—		
	40 - 80							—		
	<40									

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

This is based on the detailed site investigation undertaken by Ground Investigations Ireland. It was noted in the Stormwater Audit undertaken by JBA Consulting that the use of SOIL type 2 is a conservative approach as the ground conditions suggests the use of SOIL type 3 would be acceptable. Use of SOIL type 3 would result in smaller

attenuation systems and a greater outflow rate from the site therefore reducing the protection to downstream drainage infrastructure.

Run-off from the proposed development will be limited/attenuated using vortex flow control devices (Hydrobrake or equivalent) at each outfall limiting discharge to greenfield runoff rates (Q_{bar}) in accordance with the GDSDS for the total area of the site within the catchment of the new drainage networks.

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

Catchment	**Catchment Area (m^2)**	**Storage System Type**	**Calculated Allowable Outflow (l/s)**	**Storage Volume Required (m^3) (100 years) calculated using Microdrainage**	**Storage Volume Required (m^3) (100 years) calculated using HR Wallingford**	**Storage Volume Provided (m^3) (100 years)**
1A	59,315	Detention Basin & Geocellular	12.55	1,260	1,218	1,295
1B	26,265	Detention Basin & Geocellular	5.56	1,014	926	1,155
1C	28,142	Detention Basin & Geocellular & Stormtech	5.95	600	664	614
Ballynakelly In-fill Sites	Attenuation constructed under Reg. Ref SD05A/0344					
Total	**113,722**		**24.06**	**2,874**	**2,808**	**3,064**

Table 3.3 – Surface Water Attenuation Storage and Discharge Limits

DBFL met with South Dublin County Council Drainage Department on the 09/01/2019, 21/01/2019 and 11/07/2019 to discuss differences in calculated attenuation volumes as highlighted at An Bord Pleanála tripartite meeting on the 07/01/2019. There is general agreement between DBFL and South Dublin County Council on the calculation of Qbar (the allowable outflow rate) and the calculation of the drained areas and run-off coefficients.

As highlighted at the above meetings, DBFL have calculated the attenuation volumes using Microdrainage as shown in Table 3.3 above, the following should be noted in relation to Microdrainage:

- Micro Drainage is the industry standard drainage design suite in the UK and Ireland for the last 30 years. Microdrainage is used by the majority of engineering consultancies and is the most recognised drainage calculation method by local authorities.
- Microdrainage models the variable head/ discharge relationship of the hydrobrake and models the actual tank shape
- Microdrainage models the time of concentration - the time needed for water to flow from the most remote point in the drainage network to the tank. This becomes significant in large sites such as the subject site.
- The M5-60 and r value (M5-60:M5-2Day) are sourced from Met Eireann and inputted to Microdrainage. The inflow hydrograph for each storm is then calculated by Microdrainage using the **Flood Studies Report method** as recommended by **Section 6.4 of the GDSDS**.
- Microdrainage uses the unit hydrograph method at 2min intervals to model the storm, i.e. it models the flow into the system and flow out of the system every 2 minutes for all storm events (38 storm events). Therefore it can accurately calculate the maximum storage volume required in the system for the critical storm.

To complete a sensitivity check on the attenuation volumes DBFL have also consulted with the HR Wallingford online surface water storage volume estimation tool (http://www.uksuds.com/). HR Wallingford was originally the Hydraulic Research Station of the UK Government and became a private entity in 1982 and have since operated as an independent, non-profit distributing organisation in hydraulics and water management. HR Wallingford storage volumes are shown in Table 3.3 above and the results sourced from the sizing tool are provided in Appendix E. The values show excellent correlation between the Micodrainage (UK & Ireland industry standard

software) and the HR Wallingford online estimation tool (Internationally recognised Hydraulics research institution).

It appears from the above meetings with South Dublin County Council that the main difference in attenuation storage calculation / sizing is the following:

- SDCC do not use the Flood Studies Report method (as required by **GDSDS Section 6.4**) to calculate the rainfall input hydrograph for each storm.
- SDCC are using a spreadsheet method to calculate storage volumes as opposed to Microsimulation Methods. A basic spreadsheet will not take account of varying times of concentration for large catchments, the variable head/ discharge relationship of the hydrobrake or the actual tank shape. Under Section 6.4 of the GDSDS it notes that "The design of a storm sewer network and determining its performance requires the use of network modelling tools, rainfall information based on the Flood Studies Report (FSR) and detailed network and ground information."
- SDCC are sourcing rainfall data for long duration 100 year storm events from Met Eireann data as opposed to the Flood Studies Report Method. The Met Eireann data is not referred to in the GDSDS and is based on a depth duration frequency model.

In total approximately 3064m^3 of storm-water storage is provided within the attenuation facilities for the subject site. This is 190m^3 higher than the volumes calculated using Microdrainage and HR Wallingford.

Notwithstanding the above sensitivity check, the applicant commissioned JBA Consulting to undertake a third party surface water audit on the proposed surface water drainage and attenuation strategy for the development. JBA Consulting specialise in hydraulics and hydrology and have undertaken a number of the regional flood risk management studies for the OPW. The appointment of JBA Consulting was agreed with South Dublin County Council in advance of the audit taking place.

The final audit report concludes that the surface water drainage design for the proposed development is acceptable and meets the requirements of the GDSDS, a copy of the report is included in Appendix H.

Typical details and cross-sections of the proposed surface water attenuation facilities are provided on drawings 170024-3021,3022 & 3022. Details of the "in curtilage" SUDS proposed includes the permeable driveways with stone reservoirs below as shown on drawing 170024-3018.

3.5 Interception Volume

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

3.6 Design Standards

Drainage is designed in accordance with the Greater Dublin Regional Code of Practice for Drainage Works. Surface water pipe-work was sized using the Microdrainage Windes drainage modelling software. The following parameters apply to the design:

- Return period for pipe work — 2 years,
  check 30 year 15 minute, no flooding.
  check 100 year 15 minute, flooding in designated areas.
- Time of entry — 4 minutes
- Discharge Limit — 25.65 l/s @ 100 years for subject site
- Pipe Friction (Ks) — 0.6 mm
- Minimum Velocity — 1.0 m/s
- Standard Average Annual Rainfall — 795mm (Met Eireann 1km^2 grid)
- M5-60 — 17.7mm (Met Eireann)
- Ratio r (M5-60/M5-2D) — 0.271 (Met Eireann)
- Attenuation Tank Storm Return Event — GDSDS Volume 2, p61, Criterion 3
  30 year no flooding on site.
  100 year check no internal property flooding. Flood routing plan. FFL freeboard above 100 year flood level. No flooding to adjacent areas.
- Climate Change Allowance — 10%
- Factor of Safety for infiltration — 2.0
- Runoff from Roads and Footpaths — 100%
- Runoff from houses draining direct to SW network: 100%

- Runoff from houses draining to permeable paving: 80%
- Runoff from green roofs: 80%
- Runoff from Roads, footpaths & Green-links draining to swales 80%
- Runoff from Permeable Paving Driveways 75%
- Runoff from Open Grassed Areas 15%

Surface water sewers have been designed in accordance with IS EN 752 and the recommendations of the 'Greater Dublin Strategic Drainage Study', (GDSDS).

Standard drainage details, as outlined on DBFL drawings 170024-3015 to 3017, are in accordance with the Greater Dublin Regional Code of Practice for Drainage Works.

The minimum pipe diameter for public surface water sewers is 225mm. Private drains within the proposed development will be 100mm as outlined on DBFL drawing 170024-3018.

Refer to drawings 170024-3001, 3002 and 3003 for the proposed surface water layout.

Surface water sewer modelling results for the main drainage networks is included in Appendix F. The surface water drainage network simulation results are included in Appendix G which demonstrate that stormwater is contained below ground and within the open detention basins for the 100 year critical storm.

3.7 Drainage Ditches

A network of drainage ditches exist within the existing hedgerows on the subject site. In general it is proposed to maintain these drainage ditches and incorporate them into the proposed development. Drainage ditch culverts are required where roads cross the existing ditches.

DBFL undertook a catchment analysis upstream of the proposed culverts using the Institute of Hydrology (IOH) formula for small catchments less than 25km^2. The flow for the 1% AEP event was calculated as 0.1m^3/s. This flow was also multiplied by the Standard Factorial Error (1.65) for the IOH formula factored up by 20% for climate change. The resulting design flow for the culverts sizing was calculated as 0.2m^3/s. It should be noted that these drainage ditches were observed to be dry during site visits in Spring 2018 and Autumn 2018.

The culverts are designed as two 450mm pipes to reduce the depth of the ditch and has a capacity of 0.6m^3/s.

It is also proposed to drain any greenfield runoff from the park (initial and future phases) to the south of the development into the existing drainage ditches. The additional

catchment area is approximately 4ha. Using the Institute of Hydrology (IOH) formula for small catchments less than 25km^2. The flow for the 1% AEP event was calculated as 0.04m^3/s. This flow was also multiplied by the Standard Factorial Error (1.65) for the IOH formula factored up by 20% for climate change. The existing drainage ditch and proposed culvert have adequate capacity to convey the additional 0.04m^3/s in the 100 year storm event.

Refer to Appendix I for design calculations.

3.8 Climate Change

Rainfall values for the proposed development are sourced from Met Eireann to calculate the FSR input hydrograph for the drainage design as required by the GDSDS. The design rainfall intensities were increased by a factor of 10% to take account of climate change, as required by the GDSDS for attenuation storage design.

3.9 Pluvial Flooding Provision

The surface water network, attenuation storage and site levels are designed to accommodate a 100 year storm event and includes climate change provision. Floor levels of houses are set above the 100 year flood levels by a minimum of 0.5m for protection. For storms in excess of 100 years, the development has been designed to provide overland flood routes along the various development roads towards the surface water drainage outfall. Refer to DBFL's Site Specific Flood Risk Assessment for further details.

3.10 Surface Water Quality Impact

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

- Designed in accordance with GDSDS requirements;
- Incorporates SUDS features e.g. permeable paving in high risk parking areas at the front of houses;
- On-line attenuation/infiltration facilities with an oil separator prior to discharge to a public surface water sewer.

4.0 FOUL DRAINAGE

4.1 Existing Foul Drainage

The existing site is predominantly greenfield and therefore has no foul loading at present. There is an existing 225mm diameter foul sewer on Main Street (R120) to the north of the site. According to records, this foul sewer connects to a 525mm foul sewer on Aylmer Road which ultimately outfalls to Newcastle Pump Station.

The Ballynakelly Site benefits from core infrastructure constructed under the previously permitted development (Reg. Ref. SD05A/0344). A 225mm diameter foul sewer spur has been constructed into the Ballynakelly Site. The existing foul sewers are shown on drawings 170024-3001 to 3002.

4.2 Consultation with Irish Water

An Irish Water Pre-Connection Enquiry form has been submitted to Irish Water and an Irish Water Feedback form has been received outlining that a Wastewater connection can be facilitated for the proposed development. Refer to Appendix K for a copy of the feedback form. The feedback letter also states a number of upgrades are required to the existing network including Newcastle Pump Station.

DBFL met with Irish Water on the 13th July 2018 to discuss the upgrades. Irish Water propose to upgrade the existing foul sewer on the R120 and Aylmer Road to a 375mm diameter foul sewer to alleviate the network constraints on Main Street.

The constraints at Newcastle Pump Station were also discussed at the meeting, it was noted by Irish Water that this constraint is not currently on the Irish Water Capital Investment plan but the constraints are assumed to be minor in nature. DBFL on behalf of Cairn Homes Properties Ltd have requested Irish Water to undertake an investigation into this constraint as part of a Project Works Service Agreement (PWSA). Any upgrade works required to Newcastle Pump Station can be agreed as part of a connection agreement with Irish Water.

Infiltration issues in the existing foul network in Newcastle were highlighted by South Dublin County Council Drainage Department at the An Bord Pleanála tripartite meeting on the 07/01/2019. DBFL subsequently followed up with Irish Water and it was noted by Irish Water that the infiltration issue does not affect the subject site.

4.3 Design Strategy

The proposed foul drainage system for the subject site will connect to the existing 525mm diameter foul sewer on Aylmer road via a new 375mm diameter foul sewer. This 375mm diameter foul sewer is proposed by Irish Water as part of the Local Network

Reinforcement Project for Newcastle. This foul sewer will be delivered in conjunction with Irish Water as part of the connection agreement for the subject site.

It is proposed to connect the proposed foul sewer for the Ballynakelly infill site (Area C1) to the existing 225mm diameter foul sewer along Burgage Crescent constructed under the previously permitted development (Reg. Ref. SD05A/0344).

It is proposed to connect the seven housing units at Ballynakelly Rise infill site (Area C2) to the existing 300mm diameter foul sewer along Ballynakelly Rise constructed under the previously permitted development (Reg. Ref. SD05A/0344).

It is proposed to use the existing foul sewer connection to the existing building at Ballynakelly Edge (Area C3).

Individual houses will connect to the 225mm diameter foul drains via individual 100mm diameter house connections, as per Irish Water Code of Practice for Wastewater Infrastructure.

4.4 Design Calculations

Foul sewers have been designed in accordance with the Building Regulations and specifically in accordance with the principles and methods set out in the Irish Water Code of Practice, IS EN752 (2008), IS EN12056: Part 2 (2000) and the recommendations of the 'Greater Dublin Strategic Drainage Study', (GDSDS).

The following criteria have been applied:

Demand	446l/dwelling/day (based on 2.7 persons per house, a per capita wastewater flow of 150 litres per head per day and a 10% allowance for infiltration)
	60l per person per day for Créche
	50l per person per day for Retail
Discharge units	14 units per house (as BS8301)
Pipe Friction (Ks)	1.5 mm
Minimum Velocity	0.75 m/s (self-cleansing velocity)
Maximum Velocity	2.5 m/s
Frequency Factor	0.5 for domestic use
Manhole Depths	< 5.0m

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

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

Longitudinal sections for the proposed foul sewers are detailed on drawings 170024-3025 to 3028.

4.5 Compliance with Irish Water Standards

The proposed foul sewer design and layout is in accordance with the Irish Water Code of Practice for Wastewater Infrastructure and The Irish Water Wastewater Infrastructure Standard Details. DBFL have engaged with Irish Water subsequent to the tripartite meeting and have received a Statement of Design Acceptance from Irish Water which is included in Appendix K.

4.6 Foul Environmental Impacts

This application comprises 406 residential units, 67.7m^2 of retail area and one crèche. The development will discharge to the existing Newcastle Pumping Station which pumps foul water to a gravity sewer at the Rathcoole Interchange which ultimately discharges to Ringsend waste water treatment works. The estimated average daily load from the development is 190m^3 with a total average BOD loading of 32 Kg per day. See below for calculations.

PREDICTED DEVELOPMENT FOUL FLOWS						
Use Type	**No. of Units / Area**	**Occupancy Rate**	**Population (P)**	**Loading (G) (l/day/person) ***	**Daily Loading (PG) (l/day)**	**Daily Loading (l/s)**
Residential	406	2.7 people/ dwelling	1096	150	164,400	1.90
Créche	1	132	132	60	7,920	0.09
Retail	67.7m^2	1 person/18m^2	4	50	200	0.002
					Total Loading (l/s)	**1.99**
					Growth Factor	1
					Infiltration @ 10% (as Cop App C 1.2.4)	0.2
					Dry Weather Flow l/s	**2.19**
					Residential Peaking factor (as CoP App C 1.2.5)	6
					Residential Design Foul Flow (l/s)	**13.14**
***Flow rates calculated using IW CoP for Wastewater Infrastructure Appendix C**						

Table 4.1 – Development Foul Flow Calculations

5.0 WATER SUPPLY AND DISTRIBUTION

5.1 Existing Water supply

A 450mm watermain was laid along Newcastle Boulevard as part of the previously permitted development (Reg. Ref. SD05A/0344). There is a 160mm diameter watermain along Burgage Cresent to the east of the site and a 100mm and 150mm watermain along the L6001 to the west of the subject site.

5.2 Development Water Main Layout

The development's proposed water-main distribution system is shown on drawings 170024-3011 and 3012. DBFL Consulting Engineers met with Irish Water on the 13th July 2018 to discuss the watermain layout. It was noted by Irish Water that there is no requirement to extend the existing 450mm diameter watermain along Newcastle Boulevard. Therefore it is proposed to construct a new 250mm diameter watermain along Newcastle Boulevard and connect it to the existing 450mm diameter watermain at a new pressure reducing valve. This 250mm diameter watermain will be constructed to the Phase 1 western boundary where it can be extended as part of future development phases to the west. Two connections including pressure reducing valves will be made to the new 250mm watermain which will serve a number of 150mm diameter watermain loops throughout the development. A number of 100mm watermain loops will be fed from the 150mm watermains along the Local Streets.

The connection to the public water main will include a metered connection with sluice valve arrangement in accordance with the requirements of Irish Water.

The selected pipe material options for the development will be PE-100.

Individual houses will have their own connections to the distribution main via service connections and boundary boxes. Individual service boundary boxes will be of the type to suit Irish Water and to facilitate domestic meter installation.

Hydrants are provided for fire-fighting at locations to ensure that each dwelling is within the required Building Regulations distance of a hydrant.

5.3 Compliance with Irish Water Standards

The proposed watermain design and layout is in accordance with the Irish Water Code of Practice for Water Infrastructure and The Irish Water, Water Infrastructure Standard Details. DBFL have engaged with Irish Water between the subsequent to the tripartite meeting and have received a Statement of Design Acceptance from Irish Water which is included in Appendix K.

5.4 Water Demand & Conservation

The average daily domestic demand (ADDD) for the proposed development is approximately 173m³ and an average day / peak week demand of 216m³ has been calculated as outlined in the Irish Water Code of Practice for Water Infrastructure.

The average water demand is estimated to be 2l/s. The peak demand for sizing of the pipe network (5 times the average day, peak week demand) is calculated as 12.48 l/s. See calculations below in Table 5.1.

An Irish Water Pre-Connection Enquiry form has been submitted to Irish Water and an Irish Water Feedback form has been received outlining that a Watermain connection is possible for the proposed development without Infrastructure upgrades. Refer to Appendix K for a copy of the feedback form.

WATER DEMAND							
Use Type	**No. of units / Area**	**Occupancy Rate**	**Population (P)**	**Average daily domestic demand (l/day)**	**Average daily domestic demand (l/s)**	**Average day/peak week demand (l/s)**	**Peak hour water demand (l/s)**
Residential	406	2.7 per dwelling	1,094	164,400	1.90	2.38	11.9
Créche	1	132	132	7,920	0.09	0.113	0.57
Retail	67.7m^2	1 person/18m^2	4	200	0.002	0.003	0.015
						Peak hour water demand (l/s)	**12.48**
***Flow rates calculated using IW CoP for Watermains**							

Table 5.1 – Development Water Demand

Appendix A

DRAINAGE CCTV SURVEY REPORT

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

Project Name:
APEX SURVEYS

Report Date:
31 May 2018

NEWCASTLE WEST,
CO DUBLIN.

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

Project Information

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**

Client Details:

APEX SURVEYS

Site Details:

NEWCASTLE WEST,
CO DUBLIN.

Contractor Details:

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

Office Contact Name: BARRY BENSON
Office Contact Number: 00353 01663 0844

Purpose of Survey:

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**

Report Contents

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

Defect Grade Descriptions

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**

1: Occurences without damage. For example, laterals, joints,etc.

NO DEFECTS WERE DETECTED.

2: Constructional deficiencies or occurences with insignificant influence to tightness, hydraulic or static pressure or pipe: Eg. wide joints, badly torched intakes, minor deformation of plastic pipes, minor erosions etc.

REHABILITATION CAN BE SCHEDULED LONG-TERM.

3: Constructional deficiencies diminishing static, hydraulic and tightness: Eg. untorched intakes, cracks, minor drainage obstructions such as calcite build ups, protruding laterals, minor damages to pipe wall, individual root penetrations, corroded pipe walls etc.

REHABILITATION IS NECESSARY MEDIUM-TERM WITHIN 3 TO 5 YEARS.

4: Constructional damages with insufficent static safety, hydraulic or tightness: Eg. axial/radial pipe bursts, pipe deformations, visually noticeable infiltration/exfiltration, cavities, in pipe-wall, severe protruding, laterals severe root penetrations, severe corrosion of pipe wall etc.

REHABILITATION PROCEDURE IS URGENT AND HAS TO BE COMPLETED WITHIN 1 TO 2 YEARS. NECESSITY FOR EMERGENCY OPERATIONS HAS TO BE EXAMINED.

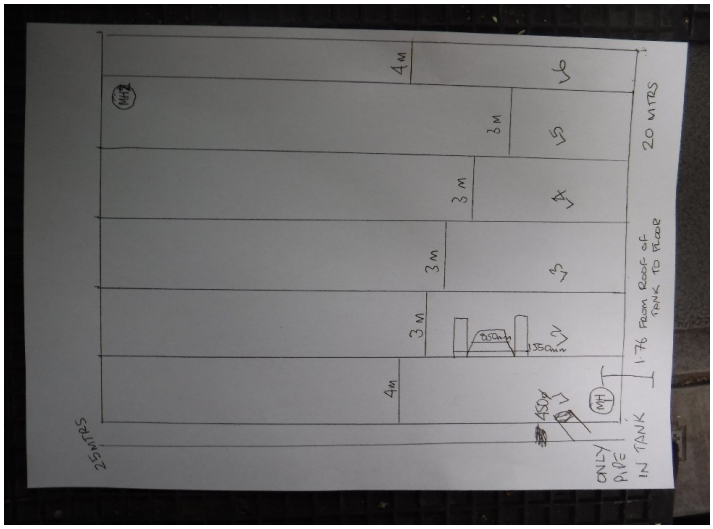
5: Pipe is already or will shortly be impermeable: Eg. collapsed pipe, deeply rooted pipe or other drainage obstructions. Pipe loses water or danger of backwater in basements etc.

REHABILITATION IS URGENT AND SHORT-TERM. IN ORDER TO PREVENT FURTHER DAMAGE, NECESSARY TEMPORARY SPOT REPAIR HAS TO BE CONDUCTED ON EMERGENCY LEVEL.

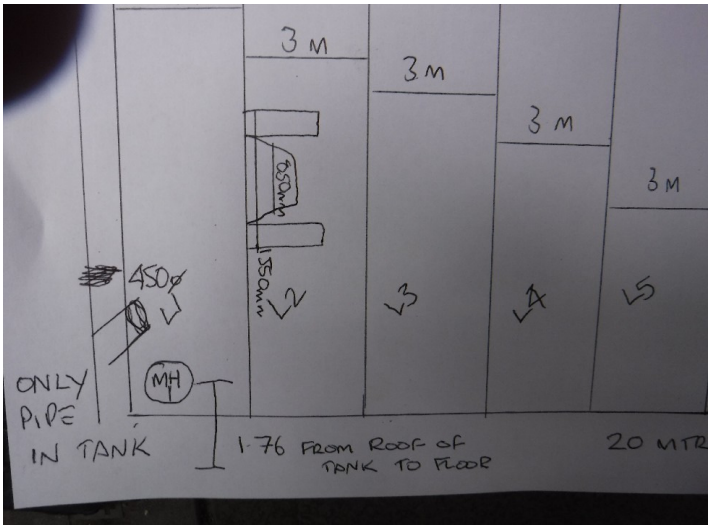
Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

Site Photos

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**



Manhole / **Access Point:** MH1 Location



Manhole / **Access Point:** MH1 Internal

Property: Front Elevation

Property: Rear Elevation

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

DYNO-ROD
Drain Cleaning, Inspection & Repair

CCTV Inspection Report

Surveyed by (Operator)	Job Number	Pipe Length Reference(PLR)	Date	Pre Cleaned
ANDY	**310518**	**MH1 X**	**31/05/2018**	**Flushed through to enable survey**
Weather	Customer Present	Service Grade/Structural Grade	Base Unit	Section Number
1 - Dry		**0/0**	**IAWHSOYGQ9**	**1**

Road **NEWCASTLE WEST, CO DUBLIN.**
Place
Location

Division
District
Location Details

Purpose
Duty **Surface water**
Catchment

Shape/Size **25000mm**
Material **Concrete**
Category

Start MH **MH1**
End MH **L1 TANK**
Total length **25.02 metres**

Scale **1:1.31**
Direction **Downstream**

M/H Ref:MH1 | I/L :mm

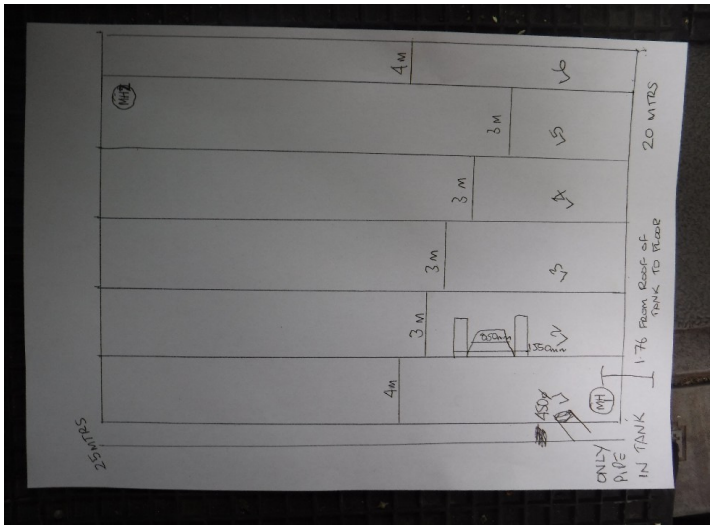
Position	Code	Description	Photo	Type/Grade
0.00	ST	Start of Survey Length	2565771	Comment / 0
0.00	MH	Start node type, manhole, reference MH1	2565772	Comment / 0
0.00	WL	Water level 6% height/diameter	2565773	Comment / 0
25.02	MHF	Manhole Finish (L1 TANK)	2565775	Comment / 0

M/H Ref:L1 TANK | I/L :mm

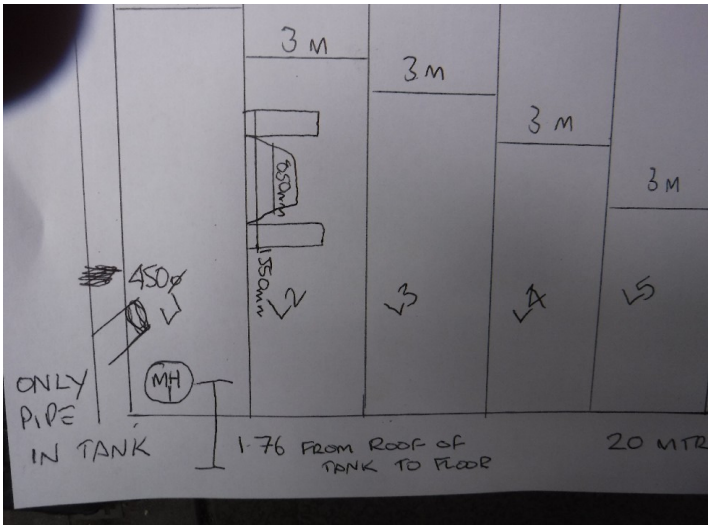
Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

CCTV Inspection Photos

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**



MH1 Location



MH1 Internal

Start of Survey Length

Start node type, manhole, reference MH1

Water level 6% height/diameter

Manhole Finish (L1 TANK)

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

DYNO-ROD
Drain Cleaning, Inspection & Repair

CCTV Inspection Report

Surveyed by (Operator)	Job Number	Pipe Length Reference(PLR)	Date	Pre Cleaned
ANDY	**310518**	**MH1 X**	**31/05/2018**	**Flushed through to enable survey**
Weather	Customer Present	Service Grade/Structural Grade	Base Unit	Section Number
1 - Dry		**0/0**	**IAWHSOYGQ9**	**2**

Road **NEWCASTLE WEST, CO DUBLIN.**
Place
Location

Division
District
Location Details

Purpose
Duty **Surface water**
Catchment

Shape/Size **25000mm**
Material **Concrete**
Category

Start MH **MH1**
End MH **L2 TANK**
Total length **24.1 metres**

Scale **1:1.26**
Direction **Downstream**

M/H Ref:MH1 | I/L :mm

Position	Code	Description	Photo	Type/Grade
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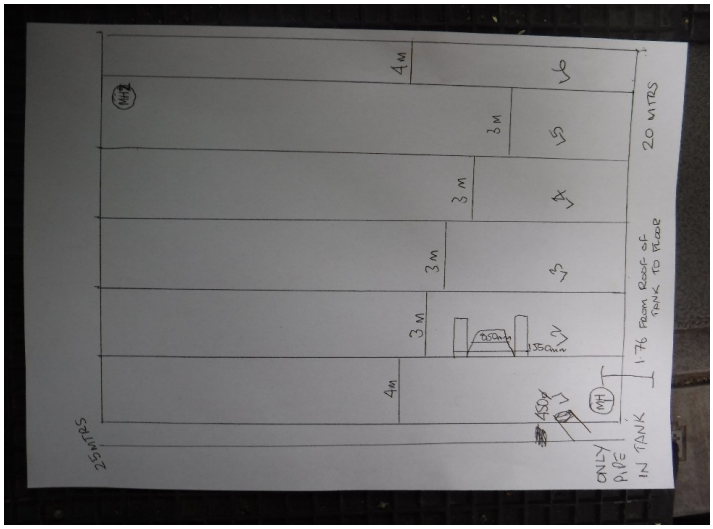
0.00	MH	Start node type, manhole, reference MH1	2565787	Comment / 0
0.00	WL	Water level 5% height/diameter	2565788	Comment / 0
24.10	MHF	Manhole Finish (L2 TANK)	2565789	Comment / 0

M/H Ref:L2 TANK | I/L :mm

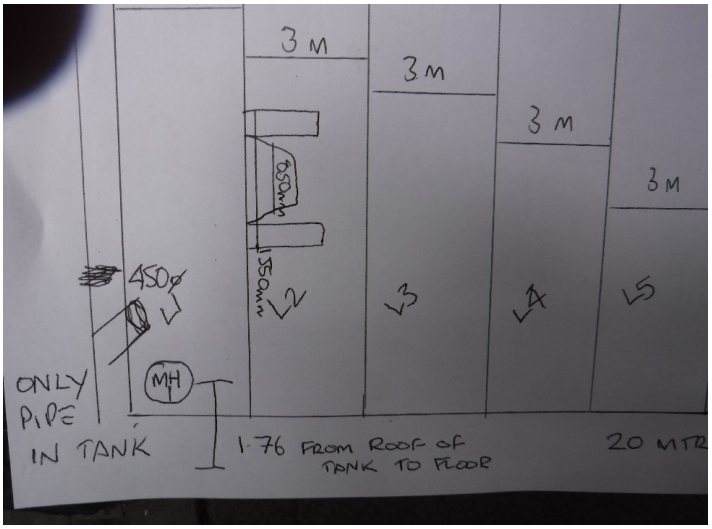
Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

CCTV Inspection Photos

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**



MH1 Location



MH1 Internal

Start of Survey Length

Start node type, manhole, reference MH1

Water level 5% height/diameter

Manhole Finish (L2 TANK)

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

DYNO-ROD
Drain Cleaning, Inspection & Repair

CCTV Inspection Report

Surveyed by (Operator)	Job Number	Pipe Length Reference(PLR)	Date	Pre Cleaned
ANDY	**310518**	**MH1 X**	**31/05/2018**	**Flushed through to enable survey**
Weather	Customer Present	Service Grade/Structural Grade	Base Unit	Section Number
1 - Dry		**0/0**	**IAWHSOYGQ9**	**3**

Road **NEWCASTLE WEST, CO DUBLIN.**
Place
Location

Division
District
Location Details

Purpose
Duty **Surface water**
Catchment

Shape/Size **25000mm**
Material **Concrete**
Category

Start MH **MH1**
End MH **L3 TANK**
Total length **22.72 metres**

Scale **1:1.15**
Direction **Downstream**

M/H Ref:MH1 | I/L :mm

Position	Code	Description	Photo	Type/Grade
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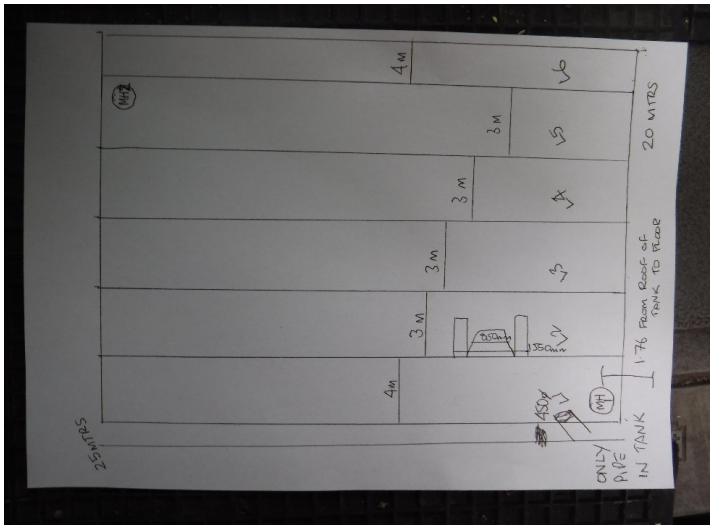
0.00	MH	Start node type, manhole, reference MH1	2565791	Comment / 0
0.00	WL	Water level 5% height/diameter	2565792	Comment / 0
22.72	MHF	Manhole Finish (L3 TANK)	2565793	Comment / 0

M/H Ref:L3 TANK | I/L :mm

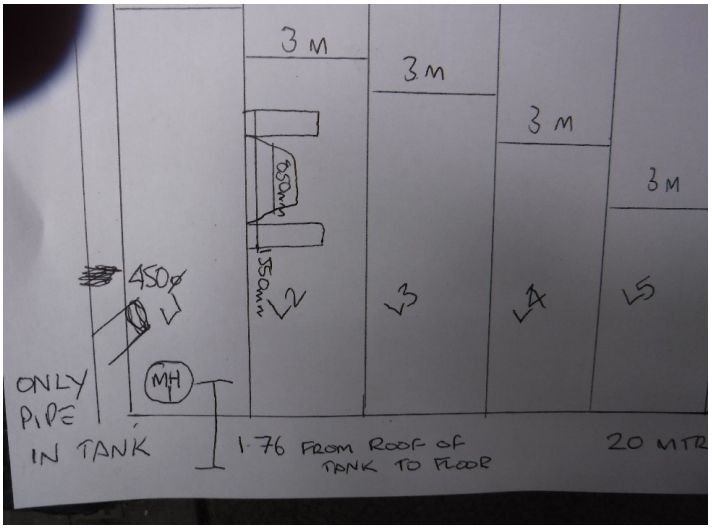
Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

CCTV Inspection Photos

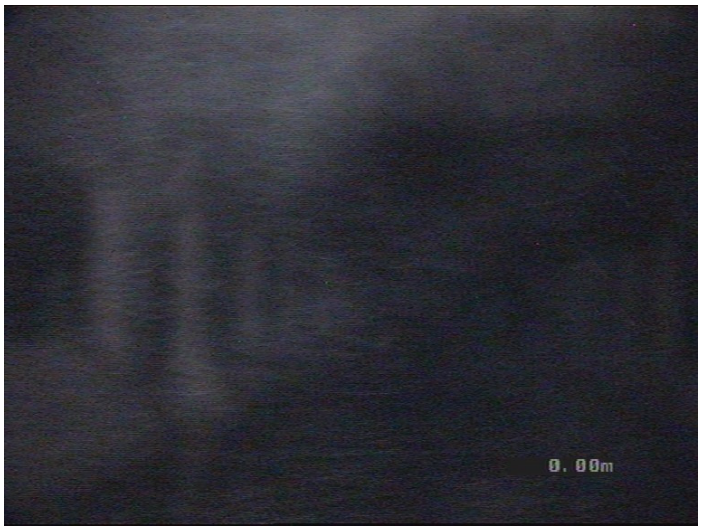
Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**



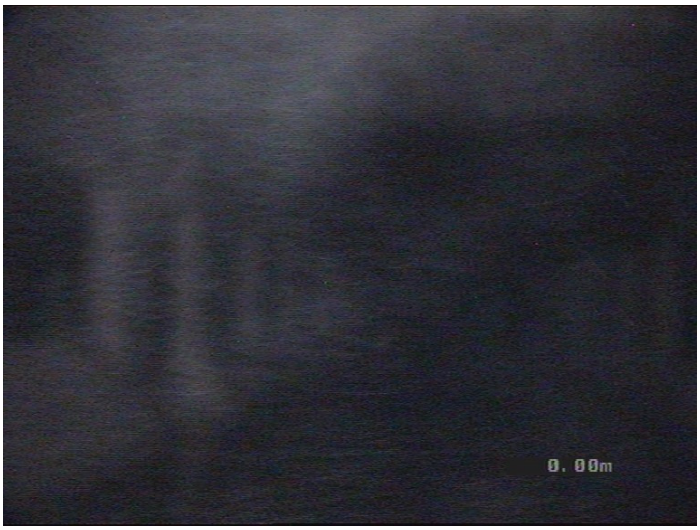
MH1 Location



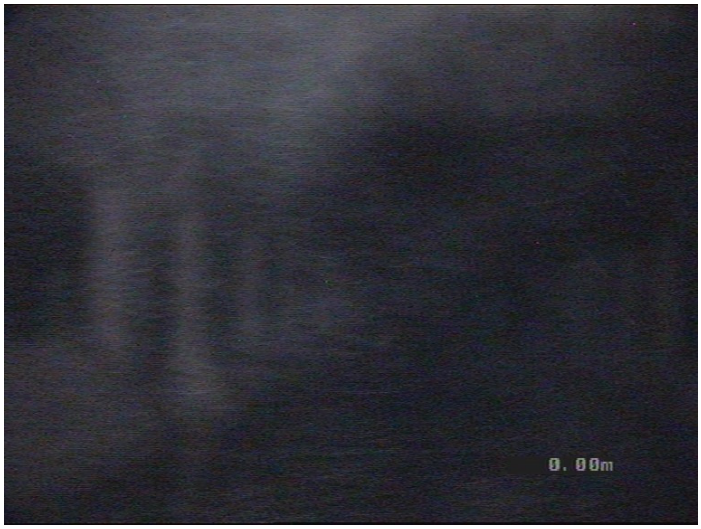
MH1 Internal



Start of Survey Length



Start node type, manhole, reference MH1



Water level 5% height/diameter

Manhole Finish (L3 TANK)

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

DYNO-ROD
Drain Cleaning, Inspection & Repair

CCTV Inspection Report

Surveyed by (Operator)	Job Number	Pipe Length Reference(PLR)	Date	Pre Cleaned
ANDY	**310518**	**MH1 X**	**31/05/2018**	**Flushed through to enable survey**
Weather	Customer Present	Service Grade/Structural Grade	Base Unit	Section Number
1 - Dry		**0/0**	**IAWHSOYGQ9**	**4**

Road **NEWCASTLE WEST, CO DUBLIN.**
Place
Location

Division
District
Location Details

Purpose
Duty **Surface water**
Catchment

Shape/Size **25000mm**
Material **Concrete**
Category

Start MH **MH1**
End MH **L4 TANK**
Total length **23.26 metres**

Scale **1:1.21**
Direction **Downstream**

M/H Ref:MH1 | I/L :mm

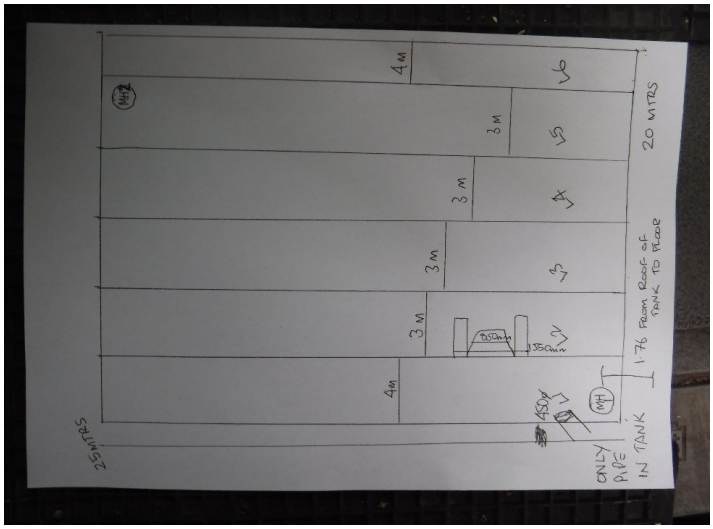
Position	Code	Description	Photo	Type/Grade
0.00	ST	Start of Survey Length	2565794	Comment / 0
0.00	MH	Start node type, manhole, reference MH1	2565795	Comment / 0
0.00	WL	Water level 5% height/diameter	2565797	Comment / 0
23.26	MHF	Manhole Finish (L4 TANK)	2565799	Comment / 0

M/H Ref:L4 TANK | I/L :mm

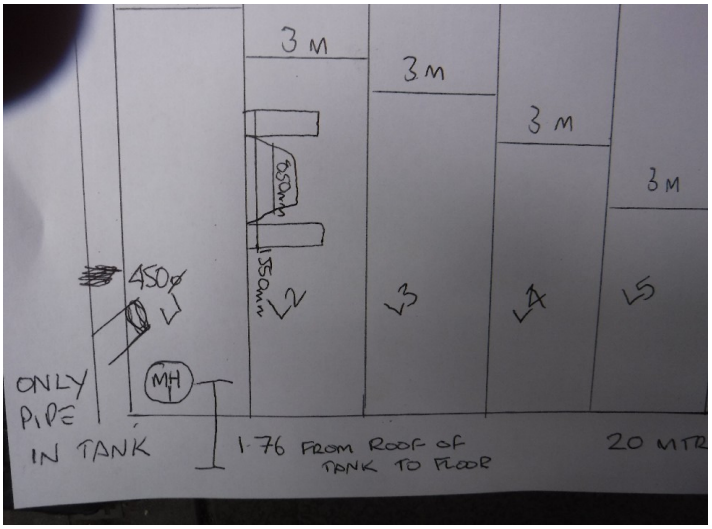
Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

CCTV Inspection Photos

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**



MH1 Location



MH1 Internal

Start of Survey Length

Start node type, manhole, reference MH1

Water level 5% height/diameter

Manhole Finish (L4 TANK)

Dyno Rod Dublin
11 York Road
Ringsend
Dublin, 4
Ireland

DYNO-ROD
Drain Cleaning, Inspection & Repair

CCTV Inspection Report

Surveyed by (Operator)	Job Number	Pipe Length Reference(PLR)	Date	Pre Cleaned
ANDY	**310518**	**MH1 X**	**31/05/2018**	**Flushed through to enable survey**
Weather	Customer Present	Service Grade/Structural Grade	Base Unit	Section Number
1 - Dry		**0/0**	**IAWHSOYGQ9**	**5**

Road **NEWCASTLE WEST, CO DUBLIN.**
Place
Location

Division
District
Location Details

Purpose
Duty **Surface water**
Catchment

Shape/Size **25000mm**
Material **Concrete**
Category

Start MH **MH1**
End MH **L5 TANK**
Total length **23.28 metres**

Scale **1:1.21**
Direction **Downstream**

M/H Ref:MH1 | I/L :mm

Position	Code	Description	Photo	Type/Grade
0.00	ST	Start of Survey Length	2565801	Comment / 0
0.00	MH	Start node type, manhole, reference MH1	2565802	Comment / 0
0.00	WL	Water level 5% height/diameter	2565803	Comment / 0
23.28	MHF	Manhole Finish (L5 TANK)	2565804	Comment / 0

M/H Ref:L5 TANK | I/L :mm

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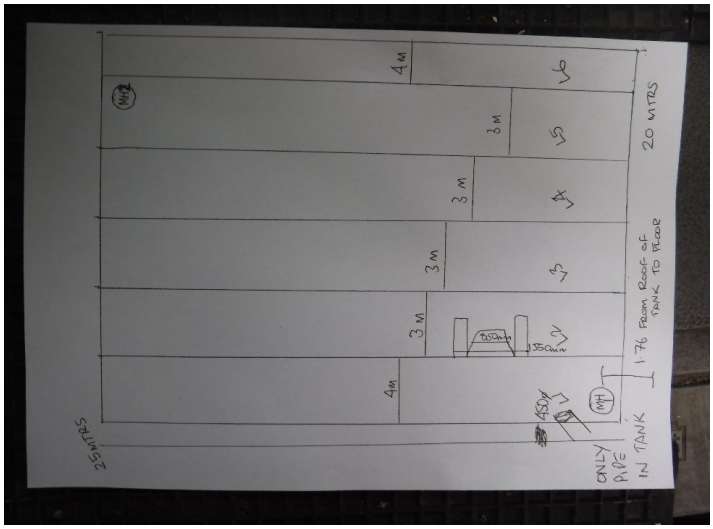
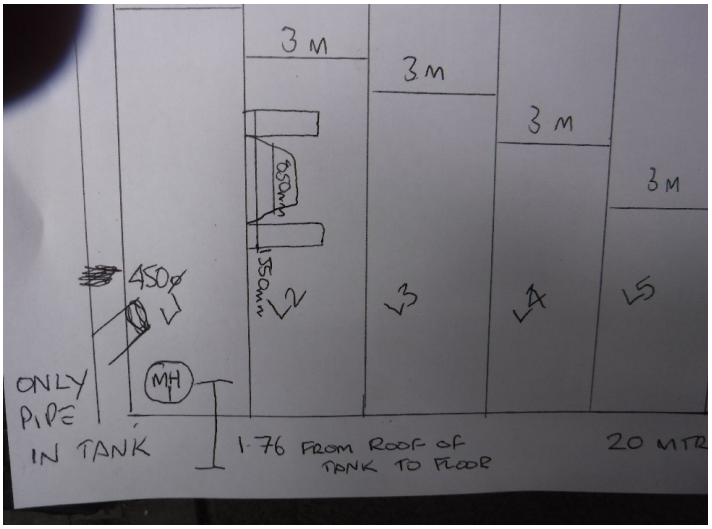
CCTV Inspection Photos

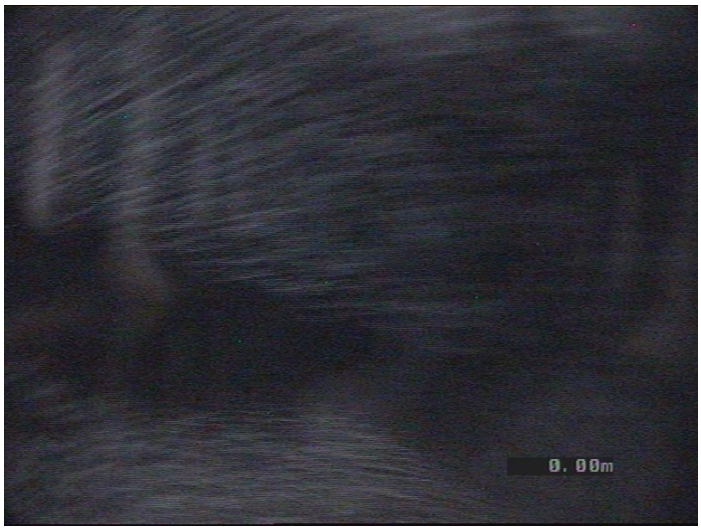
Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**



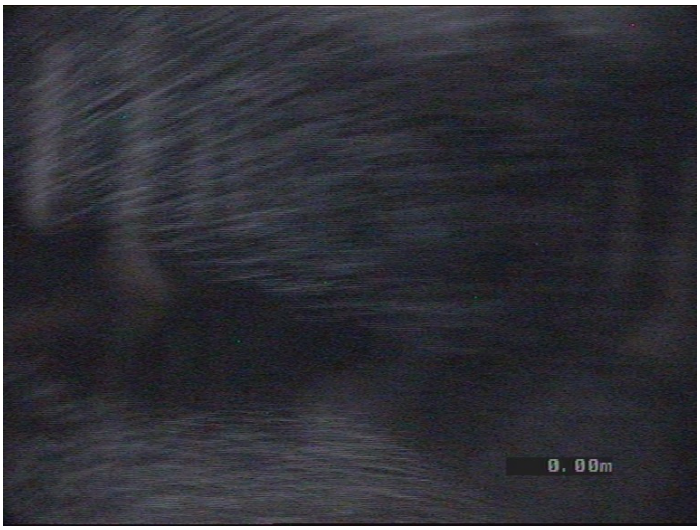
MH1 Location



MH1 Internal



Start of Survey Length



Start node type, manhole, reference MH1

Water level 5% height/diameter

Manhole Finish (L5 TANK)

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CCTV Inspection Report

Surveyed by (Operator)	Job Number	Pipe Length Reference(PLR)	Date	Pre Cleaned
ANDY	**310518**	**MH1 X**	**31/05/2018**	**Flushed through to enable survey**
Weather	Customer Present	Service Grade/Structural Grade	Base Unit	Section Number
1 - Dry		**0/0**	**IAWHSOYGQ9**	**6**

Road **NEWCASTLE WEST, CO DUBLIN.**
Place
Location

Division
District
Location Details

Purpose
Duty **Surface water**
Catchment

Shape/Size **25000mm**
Material **Concrete**
Category

Start MH **MH1**
End MH **L6 TANK**
Total length **23.23 metres**

Scale **1:1.21**
Direction **Downstream**

M/H Ref:MH1 | I/L :mm

Position	Code	Description	Photo	Type/Grade
0.00	ST	Start of Survey Length	2565805	Comment / 0
0.00	MH	Start node type, manhole, reference MH1	2565806	Comment / 0
0.00	WL	Water level 5% height/diameter	2565809	Comment / 0
23.23	MHF	Manhole Finish (L6 TANK MH2)	2565810	Comment / 0

M/H Ref:L6 TANK | I/L :mm

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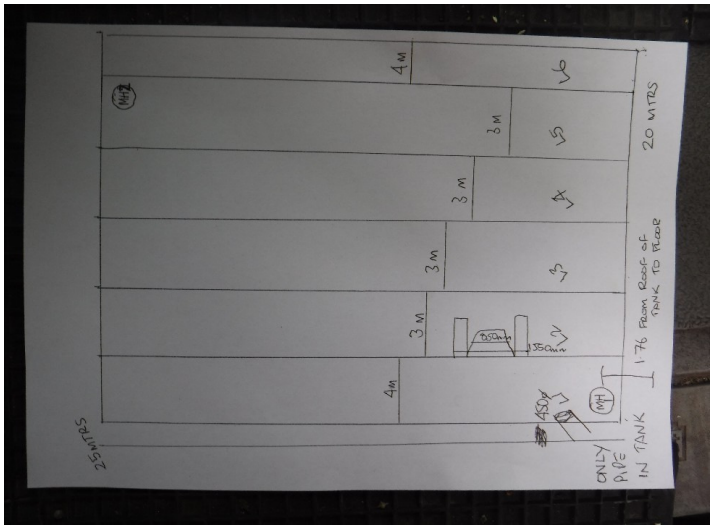
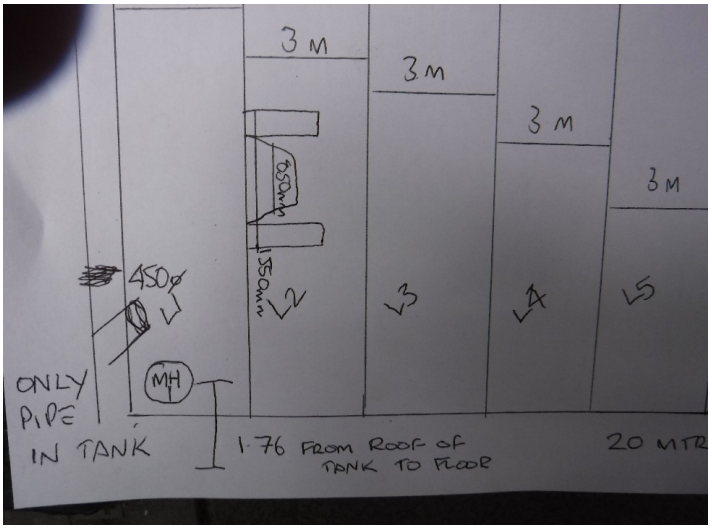
CCTV Inspection Photos

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**



MH1 Location



MH1 Internal

Start of Survey Length

Start node type, manhole, reference MH1

Water level 5% height/diameter

Manhole Finish (L6 TANK MH2)

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Drain Cleaning, Inspection & Repair

Structural Defects (SRM 4)

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**

No.	PLR	Dir.	Use	Shape/Size	Date	Mat.	Total Length	Inspection Length	Cat.	Peak Score	Grade	Mean Score	Total Score
1	MH1 X	D	S	25000	31/05/2018	Concrete	25.02 metres	25.02		0	1	0	0
2	MH1 X	D	S	25000	31/05/2018	Concrete	24.1 metres	24.1		0	1	0	0
3	MH1 X	D	S	25000	31/05/2018	Concrete	22.72 metres	22.72		0	1	0	0
4	MH1 X	D	S	25000	31/05/2018	Concrete	23.26 metres	23.26		0	1	0	0
5	MH1 X	D	S	25000	31/05/2018	Concrete	23.28 metres	23.28		0	1	0	0
6	MH1 X	D	S	25000	31/05/2018	Concrete	23.23 metres	23.23		0	1	0	0

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Service Defects (SRM 4)

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**

No.	PLR	Dir.	Use	Shape/Size	Date	Mat.	Total Length	Inspection Length	Cat.	Peak Score	Grade	Mean Score	Total Score
1	MH1 X	D	S	25000	31/05/2018	Concrete	25.02 metres	25.02		0	1	0	0
2	MH1 X	D	S	25000	31/05/2018	Concrete	24.1 metres	24.1		0	1	0	0
3	MH1 X	D	S	25000	31/05/2018	Concrete	22.72 metres	22.72		0	1	0	0
4	MH1 X	D	S	25000	31/05/2018	Concrete	23.26 metres	23.26		0	1	0	0
5	MH1 X	D	S	25000	31/05/2018	Concrete	23.28 metres	23.28		0	1	0	0
6	MH1 X	D	S	25000	31/05/2018	Concrete	23.23 metres	23.23		0	1	0	0

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Report Summary

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**

Job Information

Total Distance Surveyed: **141.61 metres**
Engineer: **ANDY**
Number of Surveys: **6**
Number of Surveys grade 4 or above: **0**

Job Comments

THERE IS ONLY ONE PIPE IN THE TANK A 450mm CONCRETE AS PER SURVEY SHOWS. THERE IN ANOTHER MH2 ACCESS POINT. THERE ARE 6 RUNS BETWEEN THE ARCH SUPPORTS AS PER SURVEYS. THE TANK IS IN VERY GOOD CONDITION.

Section 1 Overview (31/05/2018)

Manholes: **MH1 to L1 TANK**
Pipe Length: **25.02 metres**
Structural Grade: **0**
Service Grade: **0**
Material: **Concrete**
Pipe Size: **25000mm**
Use: **Surface water**

Section 2 Overview (31/05/2018)

Manholes: **MH1 to L2 TANK**
Pipe Length: **24.1 metres**
Structural Grade: **0**
Service Grade: **0**
Material: **Concrete**
Pipe Size: **25000mm**
Use: **Surface water**

Section 3 Overview (31/05/2018)

Manholes: **MH1 to L3 TANK**
Pipe Length: **22.72 metres**
Structural Grade: **0**
Service Grade: **0**
Material: **Concrete**
Pipe Size: **25000mm**
Use: **Surface water**

Section 4 Overview (31/05/2018)

Manholes: **MH1 to L4 TANK**
Pipe Length: **23.26 metres**
Structural Grade: **0**
Service Grade: **0**
Material: **Concrete**
Pipe Size: **25000mm**
Use: **Surface water**

Section 5 Overview (31/05/2018)

Manholes: **MH1 to L5 TANK**
Pipe Length: **23.28 metres**
Structural Grade: **0**
Service Grade: **0**
Material: **Concrete**
Pipe Size: **25000mm**
Use: **Surface water**

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Report Summary

Job Number	Surveyed by (Operator)	Base Unit	Date
310518	**ANDY**	**IAWHSOYGQ9**	**31/05/2018**

Section 6 Overview (31/05/2018)

Manholes: **MH1 to L6 TANK**
Pipe Length: **23.23 metres**
Structural Grade: **0**
Service Grade: **0**
Material: **Concrete**
Pipe Size: **25000mm**
Use: **Surface water**

Appendix B

EXISTING ATTENUATION SYSTEM MICRODRAINAGE CALCULATIONS

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	92.081	0.381	10.2	154.6	O K
30 min Summer	92.218	0.518	10.2	210.5	O K
60 min Summer	92.351	0.651	10.2	264.2	O K
120 min Summer	92.477	0.777	10.2	315.4	O K
180 min Summer	92.539	0.839	10.2	340.6	O K
240 min Summer	92.573	0.873	10.2	354.6	O K
360 min Summer	92.601	0.901	10.2	365.8	O K
480 min Summer	92.608	0.908	10.2	368.6	O K
600 min Summer	92.605	0.905	10.2	367.3	O K
720 min Summer	92.596	0.896	10.2	363.8	O K
960 min Summer	92.570	0.870	10.2	353.1	O K
1440 min Summer	92.501	0.801	10.2	325.2	O K
2160 min Summer	92.389	0.689	10.2	279.7	O K
2880 min Summer	92.282	0.582	10.2	236.5	O K
4320 min Summer	92.111	0.411	10.2	166.7	O K
5760 min Summer	91.997	0.297	9.9	120.6	O K
7200 min Summer	91.925	0.225	9.5	91.5	O K
8640 min Summer	91.880	0.180	9.0	73.3	O K
10080 min Summer	91.857	0.157	8.6	63.8	O K
15 min Winter	92.128	0.428	10.2	173.9	O K
30 min Winter	92.284	0.584	10.2	237.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	85.043	0.0	159.5	22
30 min Summer	58.731	0.0	221.2	36
60 min Summer	38.058	0.0	289.5	66
120 min Summer	24.044	0.0	366.2	124
180 min Summer	18.236	0.0	416.7	182
240 min Summer	14.954	0.0	455.7	242
360 min Summer	11.279	0.0	515.7	338
480 min Summer	9.222	0.0	562.2	398
600 min Summer	7.884	0.0	600.9	464
720 min Summer	6.935	0.0	634.3	526
960 min Summer	5.663	0.0	690.6	658
1440 min Summer	4.255	0.0	778.1	926
2160 min Summer	3.193	0.0	878.2	1320
2880 min Summer	2.601	0.0	953.8	1700
4320 min Summer	1.946	0.0	1069.6	2420
5760 min Summer	1.583	0.0	1162.2	3112
7200 min Summer	1.349	0.0	1237.5	3752
8640 min Summer	1.183	0.0	1302.4	4488
10080 min Summer	1.059	0.0	1359.3	5144
15 min Winter	85.043	0.0	178.9	22
30 min Winter	58.731	0.0	248.0	36

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	92.436	0.736	10.2	299.0	O K
120 min Winter	92.587	0.887	10.2	360.0	O K
180 min Winter	92.667	0.967	10.2	392.5	O K
240 min Winter	92.712	1.012	10.2	410.9	O K
360 min Winter	92.752	1.052	10.2	427.0	O K
480 min Winter	92.757	1.057	10.2	429.0	O K
600 min Winter	92.747	1.047	10.2	425.0	O K
720 min Winter	92.736	1.036	10.2	420.5	O K
960 min Winter	92.699	0.999	10.2	405.4	O K
1440 min Winter	92.580	0.880	10.2	357.1	O K
2160 min Winter	92.384	0.684	10.2	277.5	O K
2880 min Winter	92.216	0.516	10.2	209.6	O K
4320 min Winter	91.991	0.291	9.9	118.3	O K
5760 min Winter	91.883	0.183	9.0	74.4	O K
7200 min Winter	91.847	0.147	8.0	59.5	O K
8640 min Winter	91.830	0.130	7.1	52.7	O K
10080 min Winter	91.818	0.118	6.4	48.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	38.058	0.0	324.4	64
120 min Winter	24.044	0.0	410.2	122
180 min Winter	18.236	0.0	466.9	180
240 min Winter	14.954	0.0	510.5	236
360 min Winter	11.279	0.0	577.7	348
480 min Winter	9.222	0.0	629.8	452
600 min Winter	7.884	0.0	673.1	494
720 min Winter	6.935	0.0	710.5	566
960 min Winter	5.663	0.0	773.5	724
1440 min Winter	4.255	0.0	871.5	1024
2160 min Winter	3.193	0.0	983.7	1412
2880 min Winter	2.601	0.0	1068.4	1788
4320 min Winter	1.946	0.0	1198.3	2464
5760 min Winter	1.583	0.0	1301.7	3064
7200 min Winter	1.349	0.0	1386.1	3728
8640 min Winter	1.183	0.0	1458.9	4408
10080 min Winter	1.059	0.0	1522.9	5144

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.271	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.020

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.510	4	8	0.510

Model Details

Storage is Online Cover Level (m) 95.500

Tank or Pond Structure

Invert Level (m) 91.700

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	406.0	0.700	406.0	1.400	406.0	2.100	0.0
0.100	406.0	0.800	406.0	1.500	406.0	2.200	0.0
0.200	406.0	0.900	406.0	1.600	0.0	2.300	0.0
0.300	406.0	1.000	406.0	1.700	0.0	2.400	0.0
0.400	406.0	1.100	406.0	1.800	0.0	2.500	0.0
0.500	406.0	1.200	406.0	1.900	0.0		
0.600	406.0	1.300	406.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0140-1020-1500-1020
Design Head (m)	1.500
Design Flow (l/s)	10.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	140
Invert Level (m)	91.700
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	10.2	Kick-Flo®	0.934	8.2
Flush-Flo™	0.439	10.2	Mean Flow over Head Range	-	8.9

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.0	1.200	9.2	3.000	14.2	7.000	21.2
0.200	9.2	1.400	9.9	3.500	15.2	7.500	21.9
0.300	9.9	1.600	10.5	4.000	16.2	8.000	22.6
0.400	10.2	1.800	11.1	4.500	17.2	8.500	23.3
0.500	10.2	2.000	11.7	5.000	18.1	9.000	23.9
0.600	10.0	2.200	12.2	5.500	18.9	9.500	24.6
0.800	9.3	2.400	12.7	6.000	19.7		
1.000	8.4	2.600	13.2	6.500	20.5		

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	94.573	0.573	48.0	587.2	O K
30 min Summer	94.784	0.784	48.0	804.1	O K
60 min Summer	94.989	0.989	48.0	1013.5	O K
120 min Summer	95.177	1.177	48.0	1206.4	O K
180 min Summer	95.254	1.254	48.0	1285.8	O K
240 min Summer	95.286	1.286	48.0	1318.2	O K
360 min Summer	95.310	1.310	48.0	1342.8	O K
480 min Summer	95.311	1.311	48.0	1343.5	O K
600 min Summer	95.299	1.299	48.0	1331.6	O K
720 min Summer	95.280	1.280	48.0	1312.0	O K
960 min Summer	95.230	1.230	48.0	1261.0	O K
1440 min Summer	95.109	1.109	48.0	1137.1	O K
2160 min Summer	94.887	0.887	48.0	908.9	O K
2880 min Summer	94.701	0.701	48.0	718.3	O K
4320 min Summer	94.445	0.445	47.8	456.0	O K
5760 min Summer	94.315	0.315	46.3	323.0	O K
7200 min Summer	94.267	0.267	42.6	273.7	O K
8640 min Summer	94.241	0.241	38.0	247.3	O K
10080 min Summer	94.223	0.223	34.2	228.5	O K
15 min Winter	94.646	0.646	48.0	662.1	O K
30 min Winter	94.887	0.887	48.0	908.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	85.043	0.0	624.3	28
30 min Summer	58.731	0.0	866.5	42
60 min Summer	38.058	0.0	1134.8	70
120 min Summer	24.044	0.0	1435.3	126
180 min Summer	18.236	0.0	1633.7	182
240 min Summer	14.954	0.0	1786.6	230
360 min Summer	11.279	0.0	2021.9	290
480 min Summer	9.222	0.0	2204.5	356
600 min Summer	7.884	0.0	2356.2	424
720 min Summer	6.935	0.0	2487.1	496
960 min Summer	5.663	0.0	2708.0	636
1440 min Summer	4.255	0.0	3051.7	914
2160 min Summer	3.193	0.0	3443.3	1292
2880 min Summer	2.601	0.0	3739.8	1652
4320 min Summer	1.946	0.0	4193.2	2336
5760 min Summer	1.583	0.0	4557.3	3000
7200 min Summer	1.349	0.0	4852.4	3680
8640 min Summer	1.183	0.0	5106.8	4408
10080 min Summer	1.059	0.0	5329.6	5144
15 min Winter	85.043	0.0	700.6	28
30 min Winter	58.731	0.0	971.7	42

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	95.122	1.122	48.0	1150.2	O K
120 min Winter	95.335	1.335	48.0	1368.7	O K
180 min Winter	95.431	1.431	48.0	1466.3	O K
240 min Winter	95.474	1.474	48.0	1511.1	O K
360 min Winter	95.492	1.492	48.0	1529.7	O K
480 min Winter	95.489	1.489	48.0	1526.3	O K
600 min Winter	95.467	1.467	48.0	1503.7	O K
720 min Winter	95.434	1.434	48.0	1469.8	O K
960 min Winter	95.350	1.350	48.0	1384.1	O K
1440 min Winter	95.152	1.152	48.0	1181.1	O K
2160 min Winter	94.790	0.790	48.0	809.3	O K
2880 min Winter	94.523	0.523	48.0	536.0	O K
4320 min Winter	94.281	0.281	44.9	288.0	O K
5760 min Winter	94.236	0.236	37.0	242.2	O K
7200 min Winter	94.211	0.211	31.7	216.5	O K
8640 min Winter	94.194	0.194	27.8	198.8	O K
10080 min Winter	94.181	0.181	24.9	185.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	38.058	0.0	1271.7	70
120 min Winter	24.044	0.0	1608.3	124
180 min Winter	18.236	0.0	1830.4	180
240 min Winter	14.954	0.0	2001.7	234
360 min Winter	11.279	0.0	2265.3	304
480 min Winter	9.222	0.0	2469.8	378
600 min Winter	7.884	0.0	2639.7	456
720 min Winter	6.935	0.0	2786.4	534
960 min Winter	5.663	0.0	3033.8	688
1440 min Winter	4.255	0.0	3418.6	988
2160 min Winter	3.193	0.0	3857.1	1364
2880 min Winter	2.601	0.0	4189.3	1688
4320 min Winter	1.946	0.0	4698.1	2252
5760 min Winter	1.583	0.0	5104.5	2952
7200 min Winter	1.349	0.0	5435.3	3680
8640 min Winter	1.183	0.0	5720.5	4408
10080 min Winter	1.059	0.0	5971.2	5144

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.271	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 4.000

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	1.000	4	8	1.000	8	12	1.000	12	16	1.000

Model Details

Storage is Online Cover Level (m) 97.000

Tank or Pond Structure

Invert Level (m) 94.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	1025.0	0.700	1025.0	1.400	1025.0	2.100	0.0
0.100	1025.0	0.800	1025.0	1.500	1025.0	2.200	0.0
0.200	1025.0	0.900	1025.0	1.600	0.0	2.300	0.0
0.300	1025.0	1.000	1025.0	1.700	0.0	2.400	0.0
0.400	1025.0	1.100	1025.0	1.800	0.0	2.500	0.0
0.500	1025.0	1.200	1025.0	1.900	0.0		
0.600	1025.0	1.300	1025.0	2.000	0.0		

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0283-4800-1500-4800
Design Head (m)	1.500
Design Flow (l/s)	48.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	283
Invert Level (m)	94.000
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.500	48.0	Kick-Flo®	1.065	40.7
Flush-Flo™	0.502	48.0	Mean Flow over Head Range	-	40.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	8.8	1.200	43.1	3.000	67.1	7.000	101.3
0.200	29.2	1.400	46.4	3.500	72.3	7.500	104.7
0.300	45.9	1.600	49.5	4.000	77.1	8.000	108.1
0.400	47.5	1.800	52.4	4.500	81.7	8.500	111.3
0.500	48.0	2.000	55.1	5.000	86.0	9.000	114.5
0.600	47.7	2.200	57.7	5.500	90.0	9.500	117.6
0.800	46.3	2.400	60.2	6.000	93.9		
1.000	43.0	2.600	62.6	6.500	97.7		

Appendix C

SURFACE WATER ALLOWABLE OUTFLOW

PROJECT Newcastle South			**JOB REF.** p170024
SUBJECT Surface Water Calculations Allowable Outflow			**Calc. Sheet No.** 1
Drawing ref. 170024-3000	**Calculations by** FNS	**Checked by** NCG	**Date** 11-Jun-19

PERMISSIBLE SURFACE WATER DISCHARGE CALCULATIONS

Site Area

What is the overall site area? **24.58** Hectares (ha) Site is Less than 50 Hectares

(Area of site within catchment of new drainage networks excludes open space areas not within new drainage networks)
Shown on drawing 170024-3020

Pre-Development Catchment Soil Characteristics

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

Catchment This refers to the entire site area	1	
Area	24.80	Hectares (ha)
Drainage Group	1	Class
Depth to Impermeable Layers	1	Class
Permeability Group above Impermeable Layers	2	Class
Slope [(o)]	1	Class
SOIL Type	**2**	From FSR Table
[1]**SOIL Index**	0.30	

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

Site SOIL Index Value **0.30**

Site SPR Value **0.30**

Post-Development Catchment Characteristics

Is the development divided into sub-catchments? Yes

How many sub-catchments? 7

Catchment 1

What is the overall site area for Catchment 1A? 5.93 Hectares (ha)

Catchment 1	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	3395.0	1.00	3395.0
Roofs - Type 2 (Draining to SUDS features)	6575.0	0.80	5260.0
Green Roofs	300.0	0.80	240.0
Roads and Footpaths - Type 1 (Draining to gullies)	8618.0	1.00	8618.0
Roads and Footpaths - Type 2 (Draining to Suds features)	1403.0	0.80	1122.4
Paved Areas		1.00	0.0
Permeable Paving	3657.0	0.75	2742.8
Bioretention Areas		1.00	0.0
Grassed Areas (Open)	7500.0	0.15	1125.0
Area of School Site contributing to Catchment 1A	7200.0	0.15	1080.0
Grassed Areas (Enclosed)	20667.0	0.00	0.0

Include Public Open Space in Effective Catchment Area 1A? No

Catchment 1A - Effective Catchment Area **23583.2** m^2

Catchment 1A - Effective Catchment Runoff Coefficient **0.40**

Catchment 1B

What is the overall site area for Catchment 1B? 2.62 Hectares (ha)

Catchment 1B	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	2400.0	1.00	2400.0
Roofs - Type 2 (Draining to SUDS features)	4283.0	0.80	3426.4
Green Roofs	0.0	0.50	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	7388.0	1.00	7388.0
Roads and Footpaths - Type 2 (Draining to Suds features)	430.0	0.80	344.0
Paved Areas		1.00	0.0
Permeable Paving	1846.0	0.75	1384.5
Bioretention Areas		1.00	0.0
Grassed Areas (Open)	1950.0	0.15	292.5
Grassed Areas (Enclosed)	7968.0	0.00	0.0
Public Open Space		0.30	0.0

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

Catchment 1B - Effective Catchment Area **15235.4** m^2

Catchment 1B - Effective Catchment Runoff Coefficient **0.58**

Catchment 1C

What is the overall site area for Catchment 1C? 2.81 Hectares (ha)

Catchment 1C	Area (m^2)	Runoff Coeff.	Effective Area (m^2)
Roofs - Type 1 (Draining to gullies)	2144.0	1.00	2144.0
Roofs - Type 2 (Draining to SUDS features)	4197.0	0.80	3357.6
Green Roofs		0.50	0.0
Roads and Footpaths - Type 1 (Draining to gullies)	4630.0	1.00	4630.0
Roads and Footpaths - Type 2 (Draining to Suds features)	215.0	0.80	172.0
Paved Areas		1.00	0.0
Permeable Paving	2133.0	0.75	1599.8
Bioretention Areas		1.00	0.0
Grassed Areas (Open)	2950.0	0.15	442.5
Grassed Areas (Enclosed)	11873.0	0.00	0.0
Public Open Space		0.30	0.0

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

Catchment 1B - Effective Catchment Area **12345.9** m^2

Catchment 1B - Effective Catchment Runoff Coefficient **0.44**

Catchment 1D (Future Commercial Site)

What is the overall site area for Catchment 1D? 0.84 Hectares (ha)

Catchment 1D will be attenuated within its own Catchment

Catchment 1E (Future School Site, excluding area contributing to 1A)

What is the overall site area for Catchment 1E? 0.75 Hectares (ha)

Catchment 1E will be attenuated within its own Catchment

Catchment 1F (Attenuated within own catchment)

What is the overall site area for Catchment 1F? 0.27 Hectares (ha)

Catchment 1F will be attenuated within its own Catchment

Catchment 2 (Future Residential Development)

What is the overall site area for Catchment 2? 8.87 Hectares (ha)

Catchment 2 will be attenuated within its own Catchment

Catchment 3 (Future Residential Development)

What is the overall site area for Catchment 3? 2.47 Hectares (ha)

Catchment 3 will be attenuated within its own Catchment

Permissible Site Discharge

What is the Standard Average Annual Rainfall (SAAR)? 795.0 mm From Met Eireann, Co-ordinates 299000, 235000

Is the overall site area less than 50 hectares? Yes

[5]$QBAR_{Rural}$ calculated for 50 ha and linearly interpolated for area of site 52.00 Litres/sec

[7]Site Discharge = **52.00** Litres/sec

Outflow for Each Sub-Catchment

Sub - Catchment	Area (m^2)	Calculated Allowable Outflow (l/s)	
1A	59315	12.55	
1B	26265	5.56	
1C	28142	5.95	
1D	8400	1.78	
1E	7500	1.59	
1F	2740	0.58	
2	88700	18.77	
3	24700	5.23	
		52.00	

Notes and Formulae

1. SOIL index value calculated from Flood Studies Report - The Classification of Soils from Winter Rainfall Acceptance Rate (Table 4.5).
2. SPR value calculated from GDSDS - Table 6.7.
3. Rainfall depth for 100 year return period, 6 hour duration with additional 10% for climate change.
4. Long-term storage Vol_{xs} (m^3) = Rainfall.Area.10.[(PIMP/100)(0.8.α)+(1-PIMP/100)(β.SPR)-SPR]. (GDSDS Section 6.7.3).

   Where long-term storage cannot be provided on-site due to ground conditions, Total Permissible Outflow is to be kept to $QBAR_{(Rural)}$.
5. Total Permissible Outflow - $QBAR_{(Rural)}$ calculated in accordance with GDSDS - Regional Drainage Policies

   (Volume 2 - Chapter 6), i.e. $QBAR(m3/s)=0.00108x(Area)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$ - For catchments greater than 50 hectares in area. Flow rates are linearly interpolated for areas samller than 50hectares.
6. Where Total Permissible Outflow is less than 2.0l/s and not achievable, use 2.0 l/s or closest value possible.
7. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year and 2.6 for 100 year return period events, from GDSDS Figure C2.

Appendix D

SURFACE WATER ATTENUATION CALCULATIONS

Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 696 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	96.180	0.380	0.0	11.3	11.3	280.5	O K
30 min Summer	96.318	0.518	0.0	11.7	11.7	382.1	O K
60 min Summer	96.462	0.662	0.0	11.8	11.8	488.9	O K
120 min Summer	96.615	0.815	0.0	11.8	11.8	601.5	O K
180 min Summer	96.703	0.903	0.0	11.8	11.8	666.6	O K
240 min Summer	96.762	0.962	0.0	11.8	11.8	710.3	O K
360 min Summer	96.836	1.036	0.0	11.8	11.8	764.8	O K
480 min Summer	96.877	1.077	0.0	11.8	11.8	794.7	O K
600 min Summer	96.898	1.098	0.0	11.8	11.8	810.7	O K
720 min Summer	96.912	1.112	0.0	11.8	11.8	820.6	O K
960 min Summer	96.925	1.125	0.0	11.8	11.8	830.4	O K
1440 min Summer	96.920	1.120	0.0	11.8	11.8	826.9	O K
2160 min Summer	96.878	1.078	0.0	11.8	11.8	795.6	O K
2880 min Summer	96.820	1.020	0.0	11.8	11.8	752.8	O K
4320 min Summer	96.692	0.892	0.0	11.8	11.8	658.1	O K
5760 min Summer	96.567	0.767	0.0	11.8	11.8	565.7	O K
7200 min Summer	96.454	0.654	0.0	11.8	11.8	482.8	O K
8640 min Summer	96.359	0.559	0.0	11.8	11.8	412.5	O K
10080 min Summer	96.280	0.480	0.0	11.7	11.7	354.1	O K
15 min Winter	96.227	0.427	0.0	11.5	11.5	314.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	65.469	0.0	278.6	23
30 min Summer	44.986	0.0	385.3	37
60 min Summer	29.349	0.0	514.1	66
120 min Summer	18.713	0.0	656.5	126
180 min Summer	14.285	0.0	752.2	186
240 min Summer	11.771	0.0	826.6	244
360 min Summer	8.943	0.0	942.0	364
480 min Summer	7.351	0.0	1032.3	482
600 min Summer	6.311	0.0	1107.5	576
720 min Summer	5.571	0.0	1172.5	632
960 min Summer	4.574	0.0	1281.8	766
1440 min Summer	3.463	0.0	1448.1	1030
2160 min Summer	2.620	0.0	1666.2	1448
2880 min Summer	2.147	0.0	1820.7	1848
4320 min Summer	1.621	0.0	2059.8	2640
5760 min Summer	1.328	0.0	2256.1	3400
7200 min Summer	1.137	0.0	2414.6	4112
8640 min Summer	1.002	0.0	2551.6	4840
10080 min Summer	0.900	0.0	2671.4	5544
15 min Winter	65.469	0.0	312.8	23

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	96.382	0.582	0.0	11.8	11.8	429.5	O K
60 min Winter	96.546	0.746	0.0	11.8	11.8	550.7	O K
120 min Winter	96.722	0.922	0.0	11.8	11.8	680.4	O K
180 min Winter	96.826	1.026	0.0	11.8	11.8	757.4	O K
240 min Winter	96.899	1.099	0.0	11.8	11.8	810.8	O K
360 min Winter	96.995	1.195	0.0	11.8	11.8	881.8	O K
480 min Winter	97.055	1.255	0.0	11.8	11.8	926.5	O K
600 min Winter	97.094	1.294	0.0	11.8	11.8	954.8	O K
720 min Winter	97.119	1.319	0.0	11.8	11.8	970.8	O K
960 min Winter	97.149	1.349	0.0	11.8	11.8	980.7	O K
1440 min Winter	97.109	1.309	0.0	11.8	11.8	965.7	O K
2160 min Winter	97.032	1.232	0.0	11.8	11.8	909.2	O K
2880 min Winter	96.921	1.121	0.0	11.8	11.8	827.1	O K
4320 min Winter	96.693	0.893	0.0	11.8	11.8	659.3	O K
5760 min Winter	96.493	0.693	0.0	11.8	11.8	511.3	O K
7200 min Winter	96.332	0.532	0.0	11.8	11.8	392.5	O K
8640 min Winter	96.212	0.412	0.0	11.5	11.5	304.0	O K
10080 min Winter	96.125	0.325	0.0	11.0	11.0	240.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	44.986	0.0	432.2	37
60 min Winter	29.349	0.0	576.2	66
120 min Winter	18.713	0.0	735.7	124
180 min Winter	14.285	0.0	842.7	182
240 min Winter	11.771	0.0	926.0	240
360 min Winter	8.943	0.0	1055.0	356
480 min Winter	7.351	0.0	1155.6	472
600 min Winter	6.311	0.0	1239.2	584
720 min Winter	5.571	0.0	1311.3	694
960 min Winter	4.574	0.0	1431.4	908
1440 min Winter	3.463	0.0	1599.6	1144
2160 min Winter	2.620	0.0	1866.1	1604
2880 min Winter	2.147	0.0	2039.2	2024
4320 min Winter	1.621	0.0	2307.4	2852
5760 min Winter	1.328	0.0	2527.1	3576
7200 min Winter	1.137	0.0	2704.7	4320
8640 min Winter	1.002	0.0	2858.4	4936
10080 min Winter	0.900	0.0	2993.5	5648

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.271	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 2.362

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.671	4	8	1.521	8	12	0.170

Model Details

Storage is Online Cover Level (m) 98.500

Cellular Storage Structure

Invert Level (m) 95.800 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	738.0	0.0	1.300	738.0	0.0
0.100	738.0	0.0	1.400	0.0	0.0
0.200	738.0	0.0	1.500	0.0	0.0
0.300	738.0	0.0	1.600	0.0	0.0
0.400	738.0	0.0	1.700	0.0	0.0
0.500	738.0	0.0	1.800	500.0	0.0
0.600	738.0	0.0	1.900	500.0	0.0
0.700	738.0	0.0	2.000	500.0	0.0
0.800	738.0	0.0	2.100	500.0	0.0
0.900	738.0	0.0	2.200	500.0	0.0
1.000	738.0	0.0	2.300	500.0	0.0
1.100	738.0	0.0	2.400	0.0	0.0
1.200	738.0	0.0	2.500	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0141-1260-2400-1260
Design Head (m)	2.400
Design Flow (l/s)	12.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	141
Invert Level (m)	95.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.400	12.6	Kick-Flo®	1.263	9.3
Flush-Flo™	0.615	11.8	Mean Flow over Head Range	-	10.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.1	0.200	9.7	0.300	10.8	0.400	11.4

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.500	11.7	1.800	11.0	4.000	16.1	7.500	21.7
0.600	11.8	2.000	11.5	4.500	17.0	8.000	22.4
0.800	11.6	2.200	12.1	5.000	17.9	8.500	23.0
1.000	11.1	2.400	12.6	5.500	18.7	9.000	23.7
1.200	9.9	2.600	13.1	6.000	19.5	9.500	24.3
1.400	9.8	3.000	14.0	6.500	20.2		
1.600	10.4	3.500	15.1	7.000	21.0		

Summary of Results for 100 year Return Period (+10%)

Half Drain Time : 878 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	96.296	0.496	0.0	11.7	11.7	366.1	O K
30 min Summer	96.481	0.681	0.0	11.8	11.8	502.6	O K
60 min Summer	96.669	0.869	0.0	11.8	11.8	641.5	O K
120 min Summer	96.868	1.068	0.0	11.8	11.8	788.5	O K
180 min Summer	96.987	1.187	0.0	11.8	11.8	876.0	O K
240 min Summer	97.071	1.271	0.0	11.8	11.8	937.9	O K
360 min Summer	97.625	1.825	0.0	11.8	11.8	1013.0	O K
480 min Summer	97.703	1.903	0.0	11.8	11.8	1052.0	O K
600 min Summer	97.745	1.945	0.0	11.8	11.8	1073.3	O K
720 min Summer	97.765	1.965	0.0	11.8	11.8	1083.4	O K
960 min Summer	97.784	1.984	0.0	11.8	11.8	1092.7	O K
1440 min Summer	97.782	1.982	0.0	11.8	11.8	1091.5	O K
2160 min Summer	97.730	1.930	0.0	11.8	11.8	1065.5	O K
2880 min Summer	97.656	1.856	0.0	11.8	11.8	1028.6	O K
4320 min Summer	97.081	1.281	0.0	11.8	11.8	945.3	O K
5760 min Summer	96.909	1.109	0.0	11.8	11.8	818.3	O K
7200 min Summer	96.757	0.957	0.0	11.8	11.8	706.2	O K
8640 min Summer	96.625	0.825	0.0	11.8	11.8	608.7	O K
10080 min Summer	96.510	0.710	0.0	11.8	11.8	523.7	O K
15 min Winter	96.357	0.557	0.0	11.8	11.8	410.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	85.043	0.0	363.9	23
30 min Summer	58.731	0.0	504.4	38
60 min Summer	38.058	0.0	667.7	68
120 min Summer	24.044	0.0	844.4	126
180 min Summer	18.236	0.0	960.7	186
240 min Summer	14.954	0.0	1050.1	246
360 min Summer	11.279	0.0	1187.3	364
480 min Summer	9.222	0.0	1293.4	484
600 min Summer	7.884	0.0	1380.7	602
720 min Summer	6.935	0.0	1455.4	704
960 min Summer	5.663	0.0	1577.5	814
1440 min Summer	4.255	0.0	1714.8	1072
2160 min Summer	3.193	0.0	2030.5	1480
2880 min Summer	2.601	0.0	2204.8	1908
4320 min Summer	1.946	0.0	2469.7	2812
5760 min Summer	1.583	0.0	2690.7	3568
7200 min Summer	1.349	0.0	2864.8	4320
8640 min Summer	1.183	0.0	3014.7	5016
10080 min Summer	1.059	0.0	3145.6	5744
15 min Winter	85.043	0.0	408.3	24

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	96.565	0.765	0.0	11.8	11.8	564.6	O K
60 min Winter	96.778	0.978	0.0	11.8	11.8	722.1	O K
120 min Winter	97.008	1.208	0.0	11.8	11.8	891.5	O K
180 min Winter	97.583	1.783	0.0	11.8	11.8	993.4	O K
240 min Winter	97.719	1.919	0.0	11.8	11.8	1060.2	O K
360 min Winter	97.893	2.093	0.0	11.8	11.8	1147.0	O K
480 min Winter	97.996	2.196	0.0	12.1	12.1	1198.5	O K
600 min Winter	98.058	2.258	0.0	12.2	12.2	1229.6	O K
720 min Winter	98.094	2.294	0.0	12.3	12.3	1247.6	O K
960 min Winter	98.122	2.322	0.0	12.4	12.4	1259.4	O K
1440 min Winter	98.102	2.302	0.0	12.3	12.3	1251.9	O K
2160 min Winter	98.017	2.217	0.0	12.1	12.1	1209.0	O K
2880 min Winter	97.890	2.090	0.0	11.8	11.8	1145.7	O K
4320 min Winter	97.610	1.810	0.0	11.8	11.8	1005.6	O K
5760 min Winter	96.901	1.101	0.0	11.8	11.8	812.9	O K
7200 min Winter	96.660	0.860	0.0	11.8	11.8	634.3	O K
8640 min Winter	96.469	0.669	0.0	11.8	11.8	493.4	O K
10080 min Winter	96.322	0.522	0.0	11.7	11.7	385.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	58.731	0.0	565.0	38
60 min Winter	38.058	0.0	748.2	66
120 min Winter	24.044	0.0	945.8	126
180 min Winter	18.236	0.0	1075.8	184
240 min Winter	14.954	0.0	1175.8	242
360 min Winter	11.279	0.0	1329.0	356
480 min Winter	9.222	0.0	1446.8	470
600 min Winter	7.884	0.0	1543.2	582
720 min Winter	6.935	0.0	1624.5	692
960 min Winter	5.663	0.0	1749.7	900
1440 min Winter	4.255	0.0	1794.9	1128
2160 min Winter	3.193	0.0	2274.3	1600
2880 min Winter	2.601	0.0	2469.3	2052
4320 min Winter	1.946	0.0	2763.0	2980
5760 min Winter	1.583	0.0	3013.8	3808
7200 min Winter	1.349	0.0	3209.0	4536
8640 min Winter	1.183	0.0	3377.1	5192
10080 min Winter	1.059	0.0	3524.5	5856

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.271	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 2.362

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.671	4	8	1.521	8	12	0.170

Model Details

Storage is Online Cover Level (m) 98.500

Cellular Storage Structure

Invert Level (m) 95.800 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	738.0	0.0	1.300	738.0	0.0
0.100	738.0	0.0	1.400	0.0	0.0
0.200	738.0	0.0	1.500	0.0	0.0
0.300	738.0	0.0	1.600	0.0	0.0
0.400	738.0	0.0	1.700	0.0	0.0
0.500	738.0	0.0	1.800	500.0	0.0
0.600	738.0	0.0	1.900	500.0	0.0
0.700	738.0	0.0	2.000	500.0	0.0
0.800	738.0	0.0	2.100	500.0	0.0
0.900	738.0	0.0	2.200	500.0	0.0
1.000	738.0	0.0	2.300	500.0	0.0
1.100	738.0	0.0	2.400	0.0	0.0
1.200	738.0	0.0	2.500	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0141-1260-2400-1260
Design Head (m)	2.400
Design Flow (l/s)	12.6
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	141
Invert Level (m)	95.800
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.400	12.6	Kick-Flo®	1.263	9.3
Flush-Flo™	0.615	11.8	Mean Flow over Head Range	-	10.6

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.1	0.200	9.7	0.300	10.8	0.400	11.4

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.500	11.7	1.800	11.0	4.000	16.1	7.500	21.7
0.600	11.8	2.000	11.5	4.500	17.0	8.000	22.4
0.800	11.6	2.200	12.1	5.000	17.9	8.500	23.0
1.000	11.1	2.400	12.6	5.500	18.7	9.000	23.7
1.200	9.9	2.600	13.1	6.000	19.5	9.500	24.3
1.400	9.8	3.000	14.0	6.500	20.2		
1.600	10.4	3.500	15.1	7.000	21.0		

Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 399 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	91.914	0.314	0.0	15.5	15.5	176.0	O K
30 min Summer	92.022	0.422	0.0	16.5	16.5	236.5	O K
60 min Summer	92.128	0.528	0.0	17.0	17.0	295.7	O K
120 min Summer	92.233	0.633	0.0	17.3	17.3	354.2	O K
180 min Summer	92.302	0.702	0.0	17.3	17.3	393.2	O K
240 min Summer	92.361	0.761	0.0	17.3	17.3	426.4	O K
360 min Summer	92.466	0.866	0.0	17.3	17.3	484.7	O K
480 min Summer	92.554	0.954	0.0	17.3	17.3	534.2	O K
600 min Summer	92.607	1.007	0.0	17.3	17.3	564.0	O K
720 min Summer	92.662	1.062	0.0	17.3	17.3	594.8	O K
960 min Summer	92.752	1.152	0.0	17.3	17.3	645.2	O K
1440 min Summer	92.839	1.239	0.0	17.3	17.3	694.1	O K
2160 min Summer	92.817	1.217	0.0	17.3	17.3	681.4	O K
2880 min Summer	92.761	1.161	0.0	17.3	17.3	650.3	O K
4320 min Summer	92.678	1.078	0.0	17.3	17.3	603.9	O K
5760 min Summer	92.113	0.513	0.0	17.0	17.0	287.5	O K
7200 min Summer	91.819	0.219	0.0	13.9	13.9	122.5	O K
8640 min Summer	91.792	0.192	0.0	13.3	13.3	107.5	O K
10080 min Summer	91.788	0.188	0.0	13.3	13.3	105.4	O K
15 min Winter	91.953	0.353	0.0	15.9	15.9	198.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	65.469	0.0	979.2	21
30 min Summer	44.986	0.0	1049.1	36
60 min Summer	29.349	0.0	2036.1	64
120 min Summer	18.713	0.0	2128.4	122
180 min Summer	14.285	0.0	2190.4	182
240 min Summer	11.771	0.0	2238.7	242
360 min Summer	8.943	0.0	2313.8	364
480 min Summer	7.351	0.0	2372.6	482
600 min Summer	6.311	0.0	2421.7	602
720 min Summer	5.571	0.0	2464.2	722
960 min Summer	4.574	0.0	2534.2	962
1440 min Summer	3.463	0.0	2596.4	1216
2160 min Summer	2.620	0.0	2824.6	1472
2880 min Summer	2.147	0.0	2924.6	2016
4320 min Summer	1.621	0.0	3079.2	2640
5760 min Summer	1.328	0.0	3205.3	2888
7200 min Summer	1.137	0.0	3307.5	2544
8640 min Summer	1.002	0.0	3396.0	2360
10080 min Summer	0.900	0.0	3473.6	992
15 min Winter	65.469	0.0	1001.6	21

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	92.076	0.476	0.0	16.8	16.8	266.7	O K
60 min Winter	92.197	0.597	0.0	17.2	17.2	334.6	O K
120 min Winter	92.320	0.720	0.0	17.3	17.3	403.0	O K
180 min Winter	92.400	0.800	0.0	17.3	17.3	448.1	O K
240 min Winter	92.468	0.868	0.0	17.3	17.3	485.8	O K
360 min Winter	92.584	0.984	0.0	17.3	17.3	551.2	O K
480 min Winter	92.685	1.085	0.0	17.3	17.3	607.7	O K
600 min Winter	92.751	1.151	0.0	17.3	17.3	644.8	O K
720 min Winter	92.818	1.218	0.0	17.3	17.3	682.2	O K
960 min Winter	92.938	1.338	0.0	17.3	17.3	749.2	O K
1440 min Winter	93.076	1.476	0.0	17.3	17.3	826.7	O K
2160 min Winter	93.072	1.472	0.0	17.3	17.3	824.3	O K
2880 min Winter	92.973	1.373	0.0	17.3	17.3	769.1	O K
4320 min Winter	92.694	1.094	0.0	17.3	17.3	612.4	O K
5760 min Winter	92.152	0.552	0.0	17.1	17.1	309.3	O K
7200 min Winter	91.887	0.287	0.0	15.1	15.1	160.7	O K
8640 min Winter	91.811	0.211	0.0	13.8	13.8	118.4	O K
10080 min Winter	91.795	0.195	0.0	13.4	13.4	109.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	44.986	0.0	1080.0	35
60 min Winter	29.349	0.0	2076.3	64
120 min Winter	18.713	0.0	2179.7	120
180 min Winter	14.285	0.0	2249.1	180
240 min Winter	11.771	0.0	2303.2	238
360 min Winter	8.943	0.0	2387.3	356
480 min Winter	7.351	0.0	2453.2	472
600 min Winter	6.311	0.0	2508.0	588
720 min Winter	5.571	0.0	2554.4	708
960 min Winter	4.574	0.0	2615.4	944
1440 min Winter	3.463	0.0	2514.0	1372
2160 min Winter	2.620	0.0	2953.5	2116
2880 min Winter	2.147	0.0	3065.6	2392
4320 min Winter	1.621	0.0	3239.4	2692
5760 min Winter	1.328	0.0	3380.1	2744
7200 min Winter	1.137	0.0	3494.6	2648
8640 min Winter	1.002	0.0	3593.8	2480
10080 min Winter	0.900	0.0	3681.2	1040

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.271	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.523

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.686	4	8	0.837

Model Details

Storage is Online Cover Level (m) 94.600

Cellular Storage Structure

Invert Level (m) 91.600 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	560.0	0.0	1.400	560.0	0.0
0.100	560.0	0.0	1.500	560.0	0.0
0.200	560.0	0.0	1.600	560.0	0.0
0.300	560.0	0.0	1.700	0.0	0.0
0.400	560.0	0.0	1.800	0.0	0.0
0.500	560.0	0.0	1.900	0.0	0.0
0.600	560.0	0.0	2.000	0.0	0.0
0.700	560.0	0.0	2.100	419.0	0.0
0.800	560.0	0.0	2.200	419.0	0.0
0.900	560.0	0.0	2.300	419.0	0.0
1.000	560.0	0.0	2.400	419.0	0.0
1.100	560.0	0.0	2.500	419.0	0.0
1.200	560.0	0.0	2.600	419.0	0.0
1.300	560.0	0.0	2.700	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0165-1810-2700-1810
Design Head (m)	2.700
Design Flow (l/s)	18.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	165
Invert Level (m)	91.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.700	18.1	Kick-Flo®	1.475	13.6
Flush-Flo™	0.715	17.3	Mean Flow over Head Range	-	15.4

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	16.1	3.000	19.0	7.000	28.6
0.200	13.5	1.400	14.5	3.500	20.5	7.500	29.5
0.300	15.3	1.600	14.1	4.000	21.8	8.000	30.5
0.400	16.3	1.800	14.9	4.500	23.1	8.500	31.4
0.500	16.9	2.000	15.7	5.000	24.3	9.000	32.2
0.600	17.2	2.200	16.4	5.500	25.4	9.500	33.1
0.800	17.3	2.400	17.1	6.000	26.5		
1.000	16.9	2.600	17.8	6.500	27.6		

Summary of Results for 100 year Return Period (+10%)

Half Drain Time : 492 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	92.012	0.412	0.0	16.4	16.4	230.5	O K
30 min Summer	92.159	0.559	0.0	17.1	17.1	312.9	O K
60 min Summer	92.299	0.699	0.0	17.3	17.3	391.5	O K
120 min Summer	92.440	0.840	0.0	17.3	17.3	470.5	O K
180 min Summer	92.531	0.931	0.0	17.3	17.3	521.6	O K
240 min Summer	92.607	1.007	0.0	17.3	17.3	563.9	O K
360 min Summer	92.737	1.137	0.0	17.3	17.3	636.9	O K
480 min Summer	92.851	1.251	0.0	17.3	17.3	700.3	O K
600 min Summer	92.931	1.331	0.0	17.3	17.3	745.1	O K
720 min Summer	93.017	1.417	0.0	17.3	17.3	793.3	O K
960 min Summer	93.170	1.570	0.0	17.3	17.3	879.5	O K
1440 min Summer	93.681	2.081	0.0	17.3	17.3	922.1	O K
2160 min Summer	93.639	2.039	0.0	17.3	17.3	915.5	O K
2880 min Summer	93.650	2.050	0.0	17.3	17.3	916.4	O K
4320 min Summer	93.049	1.449	0.0	17.3	17.3	811.5	O K
5760 min Summer	92.279	0.679	0.0	17.3	17.3	380.2	O K
7200 min Summer	91.847	0.247	0.0	14.5	14.5	138.3	O K
8640 min Summer	91.803	0.203	0.0	13.6	13.6	113.9	O K
10080 min Summer	91.792	0.192	0.0	13.3	13.3	107.4	O K
15 min Winter	92.063	0.463	0.0	16.7	16.7	259.2	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	85.043	0.0	1035.1	22
30 min Summer	58.731	0.0	1127.6	36
60 min Summer	38.058	0.0	2135.6	66
120 min Summer	24.044	0.0	2250.2	124
180 min Summer	18.236	0.0	2325.8	184
240 min Summer	14.954	0.0	2384.1	244
360 min Summer	11.279	0.0	2473.8	364
480 min Summer	9.222	0.0	2543.1	484
600 min Summer	7.884	0.0	2597.0	604
720 min Summer	6.935	0.0	2622.5	726
960 min Summer	5.663	0.0	2520.1	966
1440 min Summer	4.255	0.0	2404.0	1310
2160 min Summer	3.193	0.0	3059.7	1708
2880 min Summer	2.601	0.0	3172.8	2224
4320 min Summer	1.946	0.0	3346.3	2724
5760 min Summer	1.583	0.0	3485.5	3000
7200 min Summer	1.349	0.0	3597.8	3752
8640 min Summer	1.183	0.0	3694.6	4416
10080 min Summer	1.059	0.0	3779.4	1016
15 min Winter	85.043	0.0	1064.2	22

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	92.230	0.630	0.0	17.3	17.3	352.5	O K
60 min Winter	92.391	0.791	0.0	17.3	17.3	442.8	O K
120 min Winter	92.555	0.955	0.0	17.3	17.3	534.7	O K
180 min Winter	92.661	1.061	0.0	17.3	17.3	594.0	O K
240 min Winter	92.748	1.148	0.0	17.3	17.3	642.7	O K
360 min Winter	92.898	1.298	0.0	17.3	17.3	726.8	O K
480 min Winter	93.034	1.434	0.0	17.3	17.3	802.8	O K
600 min Winter	93.135	1.535	0.0	17.3	17.3	859.9	O K
720 min Winter	93.239	1.639	0.0	17.3	17.3	910.5	O K
960 min Winter	93.793	2.193	0.0	17.3	17.3	967.8	O K
1440 min Winter	93.904	2.304	0.0	17.3	17.3	1014.0	O K
2160 min Winter	93.874	2.274	0.0	17.3	17.3	1001.7	O K
2880 min Winter	93.877	2.277	0.0	17.3	17.3	1002.7	O K
4320 min Winter	93.131	1.531	0.0	17.3	17.3	857.3	O K
5760 min Winter	92.308	0.708	0.0	17.3	17.3	396.7	O K
7200 min Winter	91.930	0.330	0.0	15.7	15.7	185.0	O K
8640 min Winter	91.828	0.228	0.0	14.1	14.1	127.7	O K
10080 min Winter	91.801	0.201	0.0	13.6	13.6	112.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	58.731	0.0	1167.8	36
60 min Winter	38.058	0.0	2187.8	64
120 min Winter	24.044	0.0	2316.1	122
180 min Winter	18.236	0.0	2400.8	180
240 min Winter	14.954	0.0	2466.1	240
360 min Winter	11.279	0.0	2566.2	360
480 min Winter	9.222	0.0	2634.6	480
600 min Winter	7.884	0.0	2592.9	598
720 min Winter	6.935	0.0	2541.2	716
960 min Winter	5.663	0.0	2525.6	942
1440 min Winter	4.255	0.0	2454.3	1334
2160 min Winter	3.193	0.0	3217.2	1712
2880 min Winter	2.601	0.0	3343.8	2244
4320 min Winter	1.946	0.0	3538.5	2792
5760 min Winter	1.583	0.0	3693.9	2840
7200 min Winter	1.349	0.0	3819.7	2680
8640 min Winter	1.183	0.0	3928.3	2536
10080 min Winter	1.059	0.0	4023.7	1072

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.271	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.523

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.686	4	8	0.837

Model Details

Storage is Online Cover Level (m) 94.600

Cellular Storage Structure

Invert Level (m) 91.600 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	560.0	0.0	1.400	560.0	0.0
0.100	560.0	0.0	1.500	560.0	0.0
0.200	560.0	0.0	1.600	560.0	0.0
0.300	560.0	0.0	1.700	0.0	0.0
0.400	560.0	0.0	1.800	0.0	0.0
0.500	560.0	0.0	1.900	0.0	0.0
0.600	560.0	0.0	2.000	0.0	0.0
0.700	560.0	0.0	2.100	419.0	0.0
0.800	560.0	0.0	2.200	419.0	0.0
0.900	560.0	0.0	2.300	419.0	0.0
1.000	560.0	0.0	2.400	419.0	0.0
1.100	560.0	0.0	2.500	419.0	0.0
1.200	560.0	0.0	2.600	419.0	0.0
1.300	560.0	0.0	2.700	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0165-1810-2700-1810
Design Head (m)	2.700
Design Flow (l/s)	18.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	165
Invert Level (m)	91.600
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.700	18.1	Kick-Flo®	1.475	13.6
Flush-Flo™	0.715	17.3	Mean Flow over Head Range	-	15.4

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

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	5.9	1.200	16.1	3.000	19.0	7.000	28.6
0.200	13.5	1.400	14.5	3.500	20.5	7.500	29.5
0.300	15.3	1.600	14.1	4.000	21.8	8.000	30.5
0.400	16.3	1.800	14.9	4.500	23.1	8.500	31.4
0.500	16.9	2.000	15.7	5.000	24.3	9.000	32.2
0.600	17.2	2.200	16.4	5.500	25.4	9.500	33.1
0.800	17.3	2.400	17.1	6.000	26.5		
1.000	16.9	2.600	17.8	6.500	27.6		

Summary of Results for 30 year Return Period (+10%)

Half Drain Time : 154 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	88.757	0.357	0.0	23.2	23.2	130.4	O K
30 min Summer	88.870	0.470	0.0	23.8	23.8	171.5	O K
60 min Summer	88.956	0.556	0.0	24.0	24.0	202.8	O K
120 min Summer	89.004	0.604	0.0	24.0	24.0	220.4	O K
180 min Summer	89.022	0.622	0.0	24.0	24.0	227.1	O K
240 min Summer	89.041	0.641	0.0	24.0	24.0	234.0	O K
360 min Summer	89.106	0.706	0.0	24.0	24.0	257.6	O K
480 min Summer	89.187	0.787	0.0	24.0	24.0	287.2	O K
600 min Summer	89.261	0.861	0.0	24.0	24.0	314.1	O K
720 min Summer	89.331	0.931	0.0	24.0	24.0	339.8	O K
960 min Summer	89.449	1.049	0.0	24.0	24.0	382.8	O K
1440 min Summer	89.481	1.081	0.0	24.0	24.0	394.5	O K
2160 min Summer	89.402	1.002	0.0	24.0	24.0	365.6	O K
2880 min Summer	89.273	0.873	0.0	24.0	24.0	318.5	O K
4320 min Summer	88.933	0.533	0.0	24.0	24.0	194.4	O K
5760 min Summer	88.818	0.418	0.0	23.6	23.6	152.4	O K
7200 min Summer	88.538	0.138	0.0	19.8	19.8	50.4	O K
8640 min Summer	88.505	0.105	0.0	18.4	18.4	38.4	O K
10080 min Summer	88.500	0.100	0.0	17.9	17.9	36.4	O K
15 min Winter	88.806	0.406	0.0	23.5	23.5	148.0	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	65.469	0.0	1291.6	20
30 min Summer	44.986	0.0	1348.4	33
60 min Summer	29.349	0.0	2670.9	60
120 min Summer	18.713	0.0	2745.6	98
180 min Summer	14.285	0.0	2796.0	136
240 min Summer	11.771	0.0	2835.1	176
360 min Summer	8.943	0.0	2896.0	270
480 min Summer	7.351	0.0	2943.8	364
600 min Summer	6.311	0.0	2983.6	462
720 min Summer	5.571	0.0	3018.3	580
960 min Summer	4.574	0.0	3076.9	742
1440 min Summer	3.463	0.0	3169.0	928
2160 min Summer	2.620	0.0	3303.3	1404
2880 min Summer	2.147	0.0	3384.8	1704
4320 min Summer	1.621	0.0	3511.6	2464
5760 min Summer	1.328	0.0	3613.3	2880
7200 min Summer	1.137	0.0	3695.9	2880
8640 min Summer	1.002	0.0	3767.7	2880
10080 min Summer	0.900	0.0	3832.1	728
15 min Winter	65.469	0.0	1309.8	20

Summary of Results for 30 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	88.936	0.536	0.0	24.0	24.0	195.8	O K
60 min Winter	89.043	0.643	0.0	24.0	24.0	234.6	O K
120 min Winter	89.103	0.703	0.0	24.0	24.0	256.6	O K
180 min Winter	89.122	0.722	0.0	24.0	24.0	263.7	O K
240 min Winter	89.144	0.744	0.0	24.0	24.0	271.5	O K
360 min Winter	89.218	0.818	0.0	24.0	24.0	298.7	O K
480 min Winter	89.307	0.907	0.0	24.0	24.0	331.1	O K
600 min Winter	89.400	1.000	0.0	24.0	24.0	364.9	O K
720 min Winter	89.492	1.092	0.0	24.0	24.0	398.5	O K
960 min Winter	89.612	1.212	0.0	24.0	24.0	442.4	O K
1440 min Winter	89.611	1.211	0.0	24.0	24.0	442.2	O K
2160 min Winter	89.504	1.104	0.0	24.0	24.0	403.1	O K
2880 min Winter	89.244	0.844	0.0	24.0	24.0	307.9	O K
4320 min Winter	88.843	0.443	0.0	23.7	23.7	161.8	O K
5760 min Winter	88.754	0.354	0.0	23.1	23.1	129.3	O K
7200 min Winter	88.579	0.179	0.0	20.8	20.8	65.3	O K
8640 min Winter	88.520	0.120	0.0	19.3	19.3	43.8	O K
10080 min Winter	88.505	0.105	0.0	18.4	18.4	38.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	44.986	0.0	1373.3	33
60 min Winter	29.349	0.0	2703.5	60
120 min Winter	18.713	0.0	2787.2	114
180 min Winter	14.285	0.0	2843.6	148
240 min Winter	11.771	0.0	2887.5	194
360 min Winter	8.943	0.0	2955.7	338
480 min Winter	7.351	0.0	3009.1	452
600 min Winter	6.311	0.0	3053.8	572
720 min Winter	5.571	0.0	3092.6	690
960 min Winter	4.574	0.0	3158.3	830
1440 min Winter	3.463	0.0	3261.4	1118
2160 min Winter	2.620	0.0	3408.1	1532
2880 min Winter	2.147	0.0	3499.3	1796
4320 min Winter	1.621	0.0	3641.5	2596
5760 min Winter	1.328	0.0	3755.1	2880
7200 min Winter	1.137	0.0	3848.1	2880
8640 min Winter	1.002	0.0	3929.0	2880
10080 min Winter	0.900	0.0	4000.3	2880

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	30	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.271	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.235

Time (mins) From:	To:	Area (ha)	Time (mins) From:	To:	Area (ha)
0	4	0.696	4	8	0.539

Model Details

Storage is Online Cover Level (m) 91.100

Cellular Storage Structure

Invert Level (m) 88.400 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	365.0	0.0	1.300	365.0	0.0
0.100	365.0	0.0	1.400	0.0	0.0
0.200	365.0	0.0	1.500	0.0	0.0
0.300	365.0	0.0	1.600	0.0	0.0
0.400	365.0	0.0	1.700	0.0	0.0
0.500	365.0	0.0	1.800	263.0	0.0
0.600	365.0	0.0	1.900	263.0	0.0
0.700	365.0	0.0	2.000	263.0	0.0
0.800	365.0	0.0	2.100	263.0	0.0
0.900	365.0	0.0	2.200	263.0	0.0
1.000	365.0	0.0	2.300	263.0	0.0
1.100	365.0	0.0	2.400	0.0	0.0
1.200	365.0	0.0	2.500	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0193-2406-2500-2406
Design Head (m)	2.500
Design Flow (l/s)	24.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	193
Invert Level (m)	88.300
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.500	24.0	Kick-Flo®	1.506	18.9
Flush-Flo™	0.720	24.0	Mean Flow over Head Range	-	21.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.7	0.200	17.9	0.300	21.2	0.400	22.6

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.500	23.5	1.800	20.5	4.000	30.1	7.500	40.7
0.600	23.9	2.000	21.6	4.500	31.8	8.000	42.0
0.800	24.0	2.200	22.6	5.000	33.5	8.500	43.3
1.000	23.5	2.400	23.6	5.500	35.1	9.000	44.5
1.200	22.6	2.600	24.5	6.000	36.6	9.500	45.7
1.400	20.7	3.000	26.2	6.500	38.0		
1.600	19.4	3.500	28.2	7.000	39.4		

Summary of Results for 100 year Return Period (+10%)

Half Drain Time : 211 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
15 min Summer	88.877	0.477	0.0	23.8	23.8	174.1	O K
30 min Summer	89.038	0.638	0.0	24.0	24.0	232.7	O K
60 min Summer	89.166	0.766	0.0	24.0	24.0	279.6	O K
120 min Summer	89.245	0.845	0.0	24.0	24.0	308.3	O K
180 min Summer	89.275	0.875	0.0	24.0	24.0	319.3	O K
240 min Summer	89.306	0.906	0.0	24.0	24.0	330.9	O K
360 min Summer	89.404	1.004	0.0	24.0	24.0	366.4	O K
480 min Summer	89.519	1.119	0.0	24.0	24.0	408.4	O K
600 min Summer	89.651	1.251	0.0	24.0	24.0	456.7	O K
720 min Summer	90.230	1.830	0.0	24.0	24.0	503.3	O K
960 min Summer	90.345	1.945	0.0	24.0	24.0	533.7	O K
1440 min Summer	90.357	1.957	0.0	24.0	24.0	536.7	O K
2160 min Summer	90.327	1.927	0.0	24.0	24.0	528.8	O K
2880 min Summer	89.670	1.270	0.0	24.0	24.0	463.5	O K
4320 min Summer	89.195	0.795	0.0	24.0	24.0	290.2	O K
5760 min Summer	88.934	0.534	0.0	24.0	24.0	194.8	O K
7200 min Summer	88.556	0.156	0.0	20.3	20.3	57.0	O K
8640 min Summer	88.509	0.109	0.0	18.7	18.7	39.9	O K
10080 min Summer	88.501	0.101	0.0	18.0	18.0	37.0	O K
15 min Winter	88.940	0.540	0.0	24.0	24.0	197.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	85.043	0.0	1336.8	20
30 min Summer	58.731	0.0	1412.0	34
60 min Summer	38.058	0.0	2751.5	62
120 min Summer	24.044	0.0	2844.5	116
180 min Summer	18.236	0.0	2905.7	156
240 min Summer	14.954	0.0	2953.1	210
360 min Summer	11.279	0.0	3025.9	360
480 min Summer	9.222	0.0	3082.4	480
600 min Summer	7.884	0.0	3129.3	602
720 min Summer	6.935	0.0	3169.9	722
960 min Summer	5.663	0.0	3238.4	822
1440 min Summer	4.255	0.0	3345.1	1102
2160 min Summer	3.193	0.0	3495.6	1500
2880 min Summer	2.601	0.0	3587.2	1844
4320 min Summer	1.946	0.0	3728.4	2552
5760 min Summer	1.583	0.0	3840.6	2888
7200 min Summer	1.349	0.0	3931.9	2880
8640 min Summer	1.183	0.0	4010.5	2880
10080 min Summer	1.059	0.0	4081.6	728
15 min Winter	85.043	0.0	1360.5	21

Summary of Results for 100 year Return Period (+10%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Control (l/s)	Max Σ Outflow (l/s)	Max Volume (m³)	Status
30 min Winter	89.126	0.726	0.0	24.0	24.0	265.1	O K
60 min Winter	89.282	0.882	0.0	24.0	24.0	321.9	O K
120 min Winter	89.392	0.992	0.0	24.0	24.0	362.0	O K
180 min Winter	89.436	1.036	0.0	24.0	24.0	378.3	O K
240 min Winter	89.481	1.081	0.0	24.0	24.0	394.6	O K
360 min Winter	89.599	1.199	0.0	24.0	24.0	437.5	O K
480 min Winter	90.166	1.766	0.0	24.0	24.0	489.2	O K
600 min Winter	90.336	1.936	0.0	24.0	24.0	531.3	O K
720 min Winter	90.462	2.062	0.0	24.0	24.0	564.3	O K
960 min Winter	90.573	2.173	0.0	24.0	24.0	593.6	O K
1440 min Winter	90.595	2.195	0.0	24.0	24.0	599.4	O K
2160 min Winter	90.540	2.140	0.0	24.0	24.0	584.9	O K
2880 min Winter	90.210	1.810	0.0	24.0	24.0	498.0	O K
4320 min Winter	89.125	0.725	0.0	24.0	24.0	264.5	O K
5760 min Winter	88.864	0.464	0.0	23.8	23.8	169.5	O K
7200 min Winter	88.613	0.213	0.0	21.4	21.4	77.7	O K
8640 min Winter	88.531	0.131	0.0	19.6	19.6	47.7	O K
10080 min Winter	88.509	0.109	0.0	18.7	18.7	39.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Winter	58.731	0.0	1444.7	34
60 min Winter	38.058	0.0	2793.9	62
120 min Winter	24.044	0.0	2897.9	118
180 min Winter	18.236	0.0	2966.6	176
240 min Winter	14.954	0.0	3019.6	234
360 min Winter	11.279	0.0	3101.1	352
480 min Winter	9.222	0.0	3164.4	472
600 min Winter	7.884	0.0	3217.0	588
720 min Winter	6.935	0.0	3262.4	700
960 min Winter	5.663	0.0	3339.1	836
1440 min Winter	4.255	0.0	3458.5	1112
2160 min Winter	3.193	0.0	3623.3	1540
2880 min Winter	2.601	0.0	3725.2	1992
4320 min Winter	1.946	0.0	3884.7	2812
5760 min Winter	1.583	0.0	4009.5	2880
7200 min Winter	1.349	0.0	4111.8	2880
8640 min Winter	1.183	0.0	4200.4	2880
10080 min Winter	1.059	0.0	4278.7	2880

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	17.700	Shortest Storm (mins)	15
Ratio R	0.271	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+10

Time Area Diagram

Total Area (ha) 1.235

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.696	4	8	0.539

Model Details

Storage is Online Cover Level (m) 91.100

Cellular Storage Structure

Invert Level (m) 88.400 Safety Factor 2.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 1.00
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	365.0	0.0	1.300	365.0	0.0
0.100	365.0	0.0	1.400	0.0	0.0
0.200	365.0	0.0	1.500	0.0	0.0
0.300	365.0	0.0	1.600	0.0	0.0
0.400	365.0	0.0	1.700	0.0	0.0
0.500	365.0	0.0	1.800	263.0	0.0
0.600	365.0	0.0	1.900	263.0	0.0
0.700	365.0	0.0	2.000	263.0	0.0
0.800	365.0	0.0	2.100	263.0	0.0
0.900	365.0	0.0	2.200	263.0	0.0
1.000	365.0	0.0	2.300	263.0	0.0
1.100	365.0	0.0	2.400	0.0	0.0
1.200	365.0	0.0	2.500	0.0	0.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0193-2406-2500-2406
Design Head (m)	2.500
Design Flow (l/s)	24.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	193
Invert Level (m)	88.300
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1800

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	2.500	24.0	Kick-Flo®	1.506	18.9
Flush-Flo™	0.720	24.0	Mean Flow over Head Range	-	21.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	6.7	0.200	17.9	0.300	21.2	0.400	22.6

Hydro-Brake® Optimum Outflow Control

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.500	23.5	1.800	20.5	4.000	30.1	7.500	40.7
0.600	23.9	2.000	21.6	4.500	31.8	8.000	42.0
0.800	24.0	2.200	22.6	5.000	33.5	8.500	43.3
1.000	23.5	2.400	23.6	5.500	35.1	9.000	44.5
1.200	22.6	2.600	24.5	6.000	36.6	9.500	45.7
1.400	20.7	3.000	26.2	6.500	38.0		
1.600	19.4	3.500	28.2	7.000	39.4		

Appendix E

HR WALLINGFORD ATTENUATION CALCULATIONS

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	
Site name:	Newcastle 1A
Site location:	South Dublin

Site coordinates

Latitude:	53.29576° N
Longitude:	6.4989° W
Reference:	
Date:	2019-07-04 10:54

Total site area edited to give impermeable area greater than 50% which is required for online tool

e needed to meet normal Preliminary rainfall runoff nd the SuDS Manual, C753 ystems. It is recommended uirements and design details before finalising the drainage scheme.

Impermeable area matches design on which storage is calculated

Methodology	IH124

Site characteristics

Total site area (ha)	4.72
Significant public open space (ha)	0
Area positively drained (ha)	4.72
Pervious area contribution (%)	0
Impermeable area (ha)	02.36
Percentage of drained area that is impermeable (%)	50
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	100
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	100
Compliance factor for rainwater harvesting system design (%)	100
Net site area for storage volume design (ha)	4.72
Net impermeable area for storage volume design (ha)	2.36

Edited to match site characteristics

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach	Flow control to max of 2 l/s/ha or

	Default	Edited
Climate change allowance factor	1.1	1.1
Urban creep allowance factor	1	1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method	Specify Qbar manually
SPR estimation method	Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	11.71	12.55
SOIL type	2	2
HOST class	N/A	N/A
SPR	0.3	0.3

Hydrology

	Default	Edited
SAAR (mm)	911	911
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
Rainfall 100 yrs 12 hrs	73	
FEH/FSR conversion factor	1	1
Hydrological region	12	
Growth curve factor: 1 year	0.85	0.85
Growth curve factor: 10 year	1.72	1.72
Growth curve factor: 30 year	2.13	2.13
Growth curve factor: 100 year	2.61	2.61

Storage required

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	11.71	12.55
Qbar net site area (l/s)	11.71	12.55
1 in 1 year (l/s)	10	10.7
1 in 30 years (l/s)	11.7	12.6
1 in 100 years (l/s)	11.7	12.6

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	94	94
Attenuation storage (m^3)	1248	1218
Long term storage (m^3)	0	0
Treatment storage (m^3)	283	283
Total storage *(excluding treatment)* (m^3)	1343	1312

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	
Site name:	Newcastle 1B
Site location:	South Dublin

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff management for developments", W5-074/A/TR1/1 rev. E (2012) and the SuDS Manual, C753 (Ciria, 2015). It is not to be used for detailed design of drainage systems. It is recommended that hydraulic modelling software is used to calculate volume requirements and design details before finalising the drainage scheme.

Site coordinates

Latitude:	53.29713° N
Longitude:	6.49761° W
Reference:	
Date:	2019-07-04 10:44

Impermeable area matches our design on which storage is calculated

Methodology	IH124

Site characteristics

Total site area (ha)	2.62
Significant public open space (ha)	0
Area positively drained (ha)	2.62
Pervious area contribution (%)	0
Impermeable area (ha)	1.53
Percentage of drained area that is impermeable (%)	58
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	100
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	100
Compliance factor for rainwater harvesting system design (%)	100
Net site area for storage volume design (ha)	2.62
Net impermeable area for storage volume design (ha)	1.53

Edited to match site characteristics

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach	Flow control to max of 2 l/s/ha or

	Default	Edited
Climate change allowance factor	1.1	1.1
Urban creep allowance factor	1	1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method	Specify Qbar manually
SPR estimation method	Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	6.5	5.56
SOIL type	2	2
HOST class	N/A	N/A
SPR	0.3	0.3

Hydrology

	Default	Edited
SAAR (mm)	911	911
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
Rainfall 100 yrs 12 hrs	73	
FEH/FSR conversion factor	1	1
Hydrological region	12	
Growth curve factor: 1 year	0.85	0.85
Growth curve fac	72	1.72
Growth curve factor: 30 year	2.13	2.13
Growth curve factor: 100 year	2.61	2.61

Storage required

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	6.5	5.56
Qbar net site area (l/s)	6.5	5.56
1 in 1 year (l/s)	5.5	5.2
1 in 30 years (l/s)	6.5	5.6
1 in 100 years (l/s)	6.5	5.6

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	61	61
Attenuation storage (m^3)	880	926
Long term storage (m^3)	0	0
Treatment storage (m^3)	184	184
Total storage *(excluding treatment)* (m^3)	941	987

HR Wallingford
Working with water

Surface water storage requirements for sites

www.uksuds.com | Storage estimation tool

Calculated by:	
Site name:	Newcastle 1C
Site location:	South Dublin

This is an estimation of the storage volume requirements that are needed to meet normal best practice criteria in line with Environment Agency guidance "Preliminary rainfall runoff ... S Manual, C753 ... recommended ... nd design

Site coordinates

Latitude:	53.29825° N
Longitude:	6.49698° W

Reference:	
Date:	2019-07-04 11:23

Total site area edited to give impermeable area greater than 50% which is required for online tool

Impermeable area matches our design on which storage is calculated

Methodology	IH124

Site characteristics

Total site area (ha)	2.48
Significant public open space (ha)	0
Area positively drained (ha)	2.48
Pervious area contribution (%)	0
Impermeable area (ha)	1.24
Percentage of drained area that is impermeable (%)	50
Impervious area drained via infiltration (ha)	0
Return period for infiltration system design (year)	100
Impervious area drained to rainwater harvesting systems (ha)	0
Return period for rainwater harvesting system design (year)	100
Compliance factor for rainwater harvesting system design (%)	100
Net site area for storage volume design (ha)	2.48
Net impermeable area for storage volume design (ha)	1.24

Edited to match site characteristics

* Where rainwater harvesting or infiltration has been used for managing surface water runoff such that the effective impermeable area is less than 50 % of the 'area positively drained', the 'net site area' and the estimates of Qbar and other flow rates will have been reduced accordingly.

Design criteria

Volume control approach	Flow control to max of 2 l/s/ha or

	Default	Edited
Climate change allowance factor	1.1	1.1
Urban creep allowance factor	1	1
Interception rainfall depth (mm)	5	5
Minimum flow rate (l/s)	5	5

Qbar estimation method	Specify Qbar manually
SPR estimation method	Calculate from SOIL type

	Default	Edited
Qbar total site area (l/s)	6.15	5.95
SOIL type	2	2
HOST class	N/A	N/A
SPR	0.3	0.3

Hydrology

	Default	Edited
SAAR (mm)	911	911
M5-60 Rainfall Depth (mm)	17	17
'r' Ratio M5-60/M5-2 day	0.3	0.3
Rainfall 100 yrs 6 hrs	61	
Rainfall 100 yrs 12 hrs	73	
FEH/FSR conversion factor	1	1
Hydrological region	12	
Growth curve factor: 1 year	0.85	0.85
Gro...	1.72	1.72
Growth curve factor: 30 year	2.13	2.13
Growth curve factor: 100 year	2.61	2.61

Storage required

Site discharge rates

	Default	Edited
Qbar total site area (l/s)	6.15	5.95
Qbar net site area (l/s)	6.15	5.95
1 in 1 year (l/s)	5.2	5.1
1 in 30 years (l/s)	6.2	6
1 in 100 years (l/s)	6.2	6

Estimated storage volumes

	Default	Edited
Interception storage (m^3)	50	50
Attenuation storage (m^3)	656	664
Long term storage (m^3)	0	0
Treatment storage (m^3)	149	149
Total storage *(excluding treatment)* (m^3)	705	713

Appendix F

SURFACE WATER NETWORK CALCULATIONS

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 1A

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	17.700	Add Flow / Climate Change (%)	10
Ratio R	0.271	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	2.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Catchment 1A

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.618	4-8	1.559	8-12	0.168

Total Area Contributing (ha) = 2.344

Total Pipe Volume (m³) = 102.738

Network Design Table for Catchment 1A

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
7.000	68.140	0.775	87.9	0.173	4.00	0.0	0.600	o	225	Pipe/Conduit	
7.001	73.305	1.935	37.9	0.085	0.00	0.0	0.600	o	225	Pipe/Conduit	
7.002	18.678	0.740	25.2	0.022	0.00	0.0	0.600	o	225	Pipe/Conduit	
8.000	76.663	1.845	41.6	0.286	4.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
7.000	53.54	4.81	102.575	0.173	0.0	0.0	2.5	1.40	55.5	27.6
7.001	51.37	5.39	101.800	0.258	0.0	0.0	3.6	2.13	84.8	39.5
7.002	50.94	5.51	99.865	0.280	0.0	0.0	3.9	2.62	104.0	42.5
8.000	54.30	4.63	102.420	0.286	0.0	0.0	4.2	2.04	80.9	46.3

Network Design Table for Catchment 1A

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
9.000	30.877	0.395	78.2	0.073	4.00	0.0	0.600	o	225	Pipe/Conduit	
8.001	36.958	0.739	50.0	0.071	0.00	0.0	0.600	o	300	Pipe/Conduit	
8.002	54.220	1.101	49.2	0.099	0.00	0.0	0.600	o	300	Pipe/Conduit	
7.003	36.016	0.385	93.5	0.043	0.00	0.0	0.600	o	375	Pipe/Conduit	
7.004	45.679	0.540	84.6	0.059	0.00	0.0	0.600	o	375	Pipe/Conduit	
7.005	9.643	0.120	80.4	0.011	0.00	0.0	0.600	o	375	Pipe/Conduit	
10.000	29.977	1.119	26.8	0.048	4.00	0.0	0.600	o	225	Pipe/Conduit	
10.001	11.599	0.396	29.3	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
7.006	10.007	0.120	83.4	0.010	0.00	0.0	0.600	o	375	Pipe/Conduit	
7.007	16.986	0.202	84.1	0.026	0.00	0.0	0.600	o	375	Pipe/Conduit	
7.008	72.627	0.333	218.1	0.125	0.00	0.0	0.600	o	450	Pipe/Conduit	
7.009	8.323	0.040	208.1	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
11.000	77.839	1.550	50.2	0.178	4.00	0.0	0.600	o	225	Pipe/Conduit	
11.001	89.386	2.425	36.9	0.133	0.00	0.0	0.600	o	225	Pipe/Conduit	
12.000	57.042	0.975	58.5	0.190	4.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
9.000	55.49	4.35	100.970	0.073	0.0	0.0	1.1	1.48	58.9	12.1
8.001	53.18	4.90	100.500	0.430	0.0	0.0	6.2	2.23	157.5	68.1
8.002	51.66	5.31	99.761	0.529	0.0	0.0	7.4	2.25	158.8	81.4
7.003	49.84	5.83	98.585	0.852	0.0	0.0	11.5	1.87	207.0	126.5
7.004	48.59	6.21	98.200	0.911	0.0	0.0	12.0	1.97	217.7	131.9
7.005	48.35	6.29	97.660	0.922	0.0	0.0	12.1	2.02	223.4	132.8
10.000	56.16	4.20	99.990	0.048	0.0	0.0	0.7	2.54	100.9	8.0
10.001	55.81	4.28	98.871	0.048	0.0	0.0	0.7	2.43	96.5	8.0
7.006	48.09	6.38	97.540	0.980	0.0	0.0	12.8	1.99	219.3	140.4
7.007	47.66	6.52	97.420	1.006	0.0	0.0	13.0	1.98	218.4	142.8
7.008	45.20	7.40	97.143	1.131	0.0	0.0	13.8	1.37	218.3	152.3
7.009	44.94	7.50	96.810	1.131	0.0	0.0	13.8	1.41	223.5	152.3
11.000	54.00	4.70	102.650	0.178	0.0	0.0	2.6	1.85	73.6	28.6
11.001	51.35	5.39	101.100	0.311	0.0	0.0	4.3	2.16	86.0	47.6
12.000	54.60	4.55	99.650	0.190	0.0	0.0	2.8	1.71	68.1	30.9

Network Design Table for Catchment 1A

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
11.002	9.107	0.100	91.1	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
7.010	34.705	0.087	398.9	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
7.011	49.124	0.107	459.1	0.039	0.00	0.0	0.600	o	525	Pipe/Conduit	
13.000	57.361	1.650	34.8	0.199	4.00	0.0	0.600	o	225	Pipe/Conduit	
14.000	35.214	0.600	58.7	0.167	4.00	0.0	0.600	o	225	Pipe/Conduit	
13.001	74.215	0.875	84.8	0.141	0.00	0.0	0.600	o	300	Pipe/Conduit	
13.002	34.056	0.540	63.1	0.040	0.00	0.0	0.600	o	300	Pipe/Conduit	
15.000	62.502	0.563	111.0	0.111	4.00	0.0	0.600	o	225	Pipe/Conduit	
13.003	3.450	0.035	100.0	0.000	0.00	0.0	0.600	o	300	Pipe/Conduit	
13.004	25.475	0.397	64.2	0.015	0.00	0.0	0.600	o	300	Pipe/Conduit	
7.012	8.465	0.101	83.8	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
7.013	40.849	0.600	68.1	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
7.014	17.585	0.125	140.7	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
11.002	51.03	5.48	98.600	0.501	0.0	0.0	6.9	1.65	116.5	76.2
7.010	43.65	8.02	96.695	1.632	0.0	0.0	19.3	1.12	241.4	212.2
7.011	41.87	8.81	96.608	1.671	0.0	0.0	19.3	1.04	224.9	212.2
13.000	55.14	4.43	101.250	0.199	0.0	0.0	3.0	2.23	88.5	32.7
14.000	55.51	4.34	100.200	0.167	0.0	0.0	2.5	1.71	68.0	27.6
13.001	52.23	5.15	99.525	0.507	0.0	0.0	7.2	1.71	120.8	78.9
13.002	51.18	5.44	98.650	0.547	0.0	0.0	7.6	1.98	140.2	83.4
15.000	53.44	4.84	98.470	0.111	0.0	0.0	1.6	1.24	49.3	17.7
13.003	51.05	5.48	97.832	0.658	0.0	0.0	9.1	1.57	111.1	100.1
13.004	50.30	5.69	97.798	0.673	0.0	0.0	9.2	1.97	139.0	100.8
7.012	41.74	8.86	96.501	2.344	0.0	0.0	26.5	2.45	529.9	291.5
7.013	41.21	9.11	95.800	2.344	0.0	0.0	26.5	2.72	588.2	291.5
7.014	40.90	9.27	95.200	2.344	0.0	0.0	26.5	1.89	408.4	291.5

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 1B

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	17.700	Add Flow / Climate Change (%)	10
Ratio R	0.271	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Catchment 1B

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.751	4-8	0.738

Total Area Contributing (ha) = 1.489

Total Pipe Volume (m³) = 62.197

Network Design Table for Catchment 1B

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	39.859	0.570	69.9	0.107	4.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	25.421	0.870	29.2	0.081	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	60.431	0.680	88.9	0.143	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.002	48.714	1.055	46.2	0.129	0.00	0.0	0.600	o	300	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	55.16	4.42	97.900	0.107	0.0	0.0	1.6	1.57	62.3	17.6
2.000	56.26	4.17	98.200	0.081	0.0	0.0	1.2	2.43	96.6	13.6
1.001	52.70	5.03	97.255	0.331	0.0	0.0	4.7	1.67	117.9	52.0
1.002	51.40	5.38	96.575	0.460	0.0	0.0	6.4	2.32	164.0	70.4

Network Design Table for Catchment 1B

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.003	4.677	0.150	31.2	0.004	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.004	76.921	2.370	32.5	0.240	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.005	32.535	0.050	650.7	0.000	0.00	0.0	0.600	o	750	Pipe/Conduit	
3.000	45.699	0.725	63.0	0.107	4.00	0.0	0.600	o	225	Pipe/Conduit	
4.000	29.671	0.370	80.2	0.059	4.00	0.0	0.600	o	225	Pipe/Conduit	
3.001	27.401	1.250	21.9	0.041	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.000	73.520	0.500	147.0	0.229	4.00	12.6	0.600	o	300	Pipe/Conduit	
3.002	42.795	0.350	122.3	0.085	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.003	5.764	0.050	115.3	0.006	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.004	35.911	0.980	36.6	0.092	0.00	0.0	0.600	o	300	Pipe/Conduit	
3.005	55.566	0.645	86.1	0.102	0.00	0.0	0.600	o	375	Pipe/Conduit	
3.006	9.687	0.145	66.8	0.008	0.00	0.0	0.600	o	375	Pipe/Conduit	
3.007	24.792	0.413	60.0	0.056	0.00	0.0	0.600	o	375	Pipe/Conduit	
3.008	13.231	0.150	88.2	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
3.009	18.370	0.050	367.4	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	
1.006	13.603	0.068	200.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.003	51.30	5.41	95.520	0.464	0.0	0.0	6.4	2.83	199.7	70.9
1.004	49.70	5.87	95.370	0.704	0.0	0.0	9.5	2.77	195.8	104.2
1.005	48.12	6.37	91.650	0.704	0.0	0.0	9.5	1.09	481.3	104.2
3.000	55.00	4.46	97.300	0.107	0.0	0.0	1.6	1.65	65.6	17.5
4.000	55.53	4.34	96.720	0.059	0.0	0.0	0.9	1.46	58.1	9.8
3.001	54.31	4.62	96.350	0.207	0.0	0.0	3.0	2.81	111.6	33.5
5.000	53.02	4.95	95.600	0.229	12.6	0.0	4.5	1.29	91.5	50.0
3.002	51.15	5.45	95.100	0.521	12.6	0.0	8.5	1.42	100.4	93.2
3.003	50.91	5.51	94.750	0.527	12.6	0.0	8.5	1.46	103.4	93.8
3.004	50.12	5.74	94.700	0.619	12.6	0.0	9.7	2.61	184.2	106.3
3.005	48.58	6.22	93.645	0.721	12.6	0.0	10.7	1.95	215.7	118.2
3.006	48.35	6.29	93.000	0.729	12.6	0.0	10.8	2.22	245.2	118.9
3.007	47.81	6.47	92.855	0.785	12.6	0.0	11.4	2.34	258.7	125.7
3.008	47.47	6.58	91.800	0.785	12.6	0.0	11.4	1.93	213.2	125.7
3.009	46.63	6.87	91.650	0.785	12.6	0.0	11.4	1.05	167.7	125.7
1.006	46.19	7.03	91.600	1.489	12.6	0.0	19.9	1.43	228.0	218.8

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Catchment 1C

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	17.700	Add Flow / Climate Change (%)	10
Ratio R	0.271	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	100	Maximum Backdrop Height (m)	2.000
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Catchment 1C

Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.555	4-8	0.680

Total Area Contributing (ha) = 1.235

Total Pipe Volume (m³) = 44.820

Network Design Table for Catchment 1C

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	35.610	1.017	35.0	0.108	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	4.477	0.128	35.0	0.004	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	48.634	1.304	37.3	0.188	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	33.411	0.903	37.0	0.101	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	4.608	0.115	40.1	0.004	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	34.765	0.998	34.8	0.037	0.00	0.0	0.600	o	225	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	55.85	4.27	96.940	0.108	0.0	0.0	1.6	2.22	88.2	18.0
1.001	55.70	4.30	95.923	0.112	0.0	0.0	1.7	2.22	88.2	18.6
1.002	54.09	4.68	95.795	0.300	0.0	0.0	4.4	2.15	85.4	48.3
1.003	53.06	4.94	94.491	0.401	0.0	0.0	5.8	2.16	85.8	63.4
1.004	52.91	4.97	93.588	0.405	0.0	0.0	5.8	2.07	82.4	63.8
1.005	51.93	5.23	93.473	0.442	0.0	0.0	6.2	2.22	88.4	68.4

Network Design Table for Catchment 1C

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
2.000	39.984	0.595	67.2	0.101	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.006	77.792	0.390	199.5	0.169	0.00	0.0	0.600	o	375	Pipe/Conduit	
3.000	32.216	0.650	49.6	0.094	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.007	44.049	0.260	169.4	0.040	0.00	0.0	0.600	o	375	Pipe/Conduit	
4.000	14.272	0.300	47.6	0.078	4.00	0.0	0.600	o	225	Pipe/Conduit	
4.001	20.715	0.195	106.2	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
5.000	65.119	1.025	63.5	0.134	4.00	0.0	0.600	o	225	Pipe/Conduit	
4.002	15.140	0.145	104.4	0.008	0.00	0.0	0.600	o	300	Pipe/Conduit	
1.008	5.132	0.114	45.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.009	35.632	0.966	36.9	0.039	0.00	0.0	0.600	o	375	Pipe/Conduit	
6.000	66.224	0.420	157.7	0.130	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.010	5.632	0.075	75.1	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
2.000	55.19	4.42	92.175	0.101	0.0	0.0	1.5	1.60	63.5	16.6
1.006	48.48	6.25	91.430	0.712	0.0	0.0	9.3	1.28	141.3	102.8
3.000	55.75	4.29	92.820	0.094	0.0	0.0	1.4	1.86	74.1	15.6
1.007	46.91	6.78	91.040	0.846	0.0	0.0	10.7	1.39	153.4	118.2
4.000	56.49	4.13	92.500	0.078	0.0	0.0	1.2	1.90	75.6	13.1
4.001	55.28	4.40	91.270	0.078	0.0	0.0	1.2	1.27	50.4	13.1
5.000	54.17	4.66	92.100	0.134	0.0	0.0	2.0	1.64	65.3	21.6
4.002	53.50	4.82	91.000	0.220	0.0	0.0	3.2	1.54	108.7	35.1
1.008	46.81	6.81	90.780	1.066	0.0	0.0	13.5	2.71	299.0	148.7
1.009	46.26	7.01	90.666	1.105	0.0	0.0	13.8	2.99	330.4	152.3
6.000	52.57	5.06	90.470	0.130	0.0	0.0	1.9	1.04	41.3	20.4
1.010	46.13	7.05	89.700	1.235	0.0	0.0	15.4	2.09	231.2	169.7

Network Design Table for Catchment 1C

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.011	8.700	0.100	87.0	0.000	0.00	0.0	0.600	o	375	Pipe/Conduit	
1.012	16.726	0.100	167.3	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.013	9.186	0.100	91.9	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	
1.014	12.440	0.100	124.4	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.011	45.93	7.13	88.500	1.235	0.0	0.0	15.4	1.94	214.7	169.7
1.012	45.50	7.29	88.400	1.235	0.0	0.0	15.4	1.73	374.3	169.7
1.013	45.32	7.35	88.300	1.235	0.0	0.0	15.4	2.34	506.1	169.7
1.014	45.05	7.46	88.200	1.235	0.0	0.0	15.4	2.01	434.5	169.7

Appendix G

SURFACE WATER SIMULATION CALCULATIONS

Summary of Results for 960 minute 100 year Winter (Catchment 1A)

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
7.000	S36	102.624	-0.176	0.000	0.11		5.8	OK
7.001	S35	101.848	-0.177	0.000	0.10		8.6	OK
7.002	S34	99.912	-0.178	0.000	0.10		9.3	OK
8.000	S33-3	102.472	-0.173	0.000	0.12		9.5	OK
9.000	S33-2A	101.000	-0.195	0.000	0.04		2.4	OK
8.001	S33-2	100.563	-0.237	0.000	0.10		14.3	OK
8.002	S33-1	99.829	-0.232	0.000	0.12		17.6	OK
7.003	S33	98.682	-0.278	0.000	0.15		28.3	OK
7.004	S32	98.297	-0.278	0.000	0.15		30.3	OK
7.005	S31	98.009	-0.026	0.000	0.23		30.6	OK
10.000	S30-2	100.008	-0.207	0.000	0.02		1.6	OK
10.001	S30-1	98.892	-0.204	0.000	0.02		1.6	OK
7.006	S30	98.001	0.086	0.000	0.24		32.6	SURCHARGED
7.007	S29	97.999	0.204	0.000	0.19		33.4	SURCHARGED
7.008	S28	97.996	0.403	0.000	0.18		37.6	SURCHARGED
7.009	S27	97.992	0.732	0.000	0.25		37.6	SURCHARGED
11.000	S26-3	102.693	-0.182	0.000	0.08		5.9	OK
11.001	S26-2	101.152	-0.173	0.000	0.12		10.3	OK
12.000	S26-1A	99.697	-0.178	0.000	0.10		6.3	OK
11.002	S26-1	98.693	-0.207	0.000	0.21		16.7	OK
7.010	S26	97.991	0.771	0.000	0.26		54.2	SURCHARGED
7.011	S25	97.988	0.855	0.000	0.27		55.0	SURCHARGED
13.000	S24-5	101.291	-0.184	0.000	0.08		6.6	OK
14.000	S24-4A	100.244	-0.181	0.000	0.09		5.6	OK
13.001	S24-4	99.601	-0.224	0.000	0.15		16.9	OK
13.002	S24-3	98.725	-0.225	0.000	0.14		18.2	OK
15.000	S24-2A	98.511	-0.184	0.000	0.08		3.7	OK
13.003	S24-2	97.990	-0.142	0.000	0.36		21.9	OK
13.004	S24-1	97.989	-0.109	0.000	0.18		22.4	OK
7.012	S24	97.985	0.959	0.000	0.31		77.2	SURCHARGED
7.013	S23	97.983	1.658	0.000	0.02		12.0	SURCHARGED
7.014	S22	97.971	1.646	0.000	0.04		12.0	SURCHARGED

Summary of Results for 1440 minute 100 year Winter (Catchment 1B)

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	S12-6	97.931	-0.194	0.000	0.05		2.7	OK
2.000	S12-5A	98.223	-0.202	0.000	0.02		2.0	OK
1.001	S12-5	97.308	-0.247	0.000	0.07		8.3	OK
1.002	S12-4	96.629	-0.246	0.000	0.07		11.5	OK
1.003	S12-3	95.589	-0.231	0.000	0.12		11.6	OK
1.004	S12-2	95.431	-0.239	0.000	0.09		17.6	OK
1.005	S12-1	93.889	1.489	0.000	0.03		12.6	SURCHARGED
3.000	S20-2	97.330	-0.195	0.000	0.04		2.7	OK
4.000	S20-1A	96.745	-0.200	0.000	0.03		1.5	OK
3.001	S20-1	96.382	-0.193	0.000	0.05		5.2	OK
5.000	S21	95.695	-0.205	0.000	0.22		19.2	OK
3.002	S20	95.208	-0.192	0.000	0.28		26.5	OK
3.003	S19	94.888	-0.162	0.000	0.43		26.7	OK
3.004	S18	94.783	-0.217	0.000	0.17		29.0	OK
3.005	S17	93.944	-0.076	0.000	0.16		31.5	OK
3.006	S16	93.945	0.570	0.000	0.21		31.7	SURCHARGED
3.007	S15	93.938	0.708	0.000	0.15		33.1	SURCHARGED
3.008	S14	93.936	1.761	0.000	0.22		32.9	FLOOD RISK
3.009	S13	93.934	1.834	0.000	0.25		32.8	SURCHARGED
1.006	S12	93.928	1.878	0.000	0.10		17.3	SURCHARGED

Summary of Results for 1440 minute 100 year Winter (Catchment 1C)

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

PN	US/MH Name	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status
1.000	S9-8	96.966	-0.199	0.000	0.03		2.7	OK
1.001	S9-7	95.957	-0.191	0.000	0.06		2.8	OK
1.002	S9-6	95.841	-0.179	0.000	0.09		7.5	OK
1.003	S9-5	94.543	-0.173	0.000	0.12		10.0	OK
1.004	S9-4	93.658	-0.155	0.000	0.21		10.1	OK
1.005	S9-3	93.527	-0.171	0.000	0.13		11.0	OK
2.000	S9-2A	92.204	-0.196	0.000	0.04		2.5	OK
1.006	S9-2	91.520	-0.285	0.000	0.13		17.8	OK
3.000	S9-1A	92.847	-0.198	0.000	0.03		2.3	OK
1.007	S9-1	91.136	-0.279	0.000	0.15		21.1	OK
4.000	S11A	92.525	-0.200	0.000	0.03		1.9	OK
4.001	S11	91.374	-0.121	0.000	0.44		20.2	OK
5.000	S10-1	92.133	-0.192	0.000	0.05		3.3	OK
4.002	S10	91.102	-0.198	0.000	0.25		23.2	OK
1.008	S9	90.976	-0.179	0.000	0.33		44.2	OK
1.009	S8	90.969	-0.072	0.000	0.15		45.2	OK
6.000	S7-1	90.944	0.249	0.000	0.08		3.2	SURCHARGED
1.010	S7	90.941	0.666	0.000	0.37		48.4	SURCHARGED
1.011	S6	90.866	1.991	0.000	0.39		48.3	SURCHARGED
1.012	N/A	90.792	1.867	0.000	0.10		24.2	SURCHARGED
1.013	S5	90.771	1.946	0.000	0.10		24.2	FLOOD RISK
1.014	S4	88.309	-0.416	0.000	0.10		24.2	OK

Appendix H

JBA STORMWATER DRAINAGE AUDIT REPORT

STORMWATER REVIEW / AUDIT

JBA Project Code	2019s0636
Contract	Residential Development at Newcastle South, Co Dublin
Client	Cairn Homes PLC
Day, Date and Time	26th June 2019
Author	Leanne Leonard
Subject	**Stormwater Review / Audit Report**

1 Proposed Residential Development, Newcastle South, Co. Dublin

1.1 Introduction

JBA Consulting have been contracted by Cairn Homes PLC c/o DBFL Consulting Engineers (DBFL) to undertake a review of the surface water drainage design for the proposed residential development at Newcastle, Co. Dublin. The surface water audit was undertaken in advance of a planning submission.

The objective of this stormwater review is to provide an independent 3rd party assessment of the proposed stormwater drainage for the subject development. The results of the audit are set out in the table below.

1.2 Stage 1 Audit

Design Parameter	Audit Result
Proposed Development	The subject application comprises c.404 residential units and a crèche facility. The application also includes infrastructure comprising a road layout, cyclist infrastructure, foul, surface water and water supply services in accordance with the Newcastle Local Area Plan 2012 and South Dublin County Development Plan (2016-2022). The subject site, of 15.82 hectares (39 acres), is located to the south of the R120/Main Street at Newcastle Village. The site is bounded by residential developments of different densities to the east and north and bounded by greenfield and single dwellings to the south and west. The St Finian's National School and Church is located to the north of the site. The development lands form part of the South Dublin County Development Plan (2016-2022) and is zoned R1 "New/Proposed Residential". The western area of the site is predominantly green-field while some earthworks and site development works have been undertaken on the eastern area associated with the previously approved development. Existing boundaries within the site are predominantly hedgerows and fencing with some drainage ditches
Relevant Studies/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 • BRE Digest 365
Site Characteristics	**Soil:** The SOIL type adopted by DBFL for the subject site is S2, although based on infiltration tests carried out in accordance with BRE365 by Ground Investigations Ireland, a SOIL type S3 is considered more appropriate which would allow a greater discharge rate from the overall site. Such an approach is therefore considered conservative resulting in additional storage that would otherwise be the case. **Rainfall (basis for surface water pipeline network design):** 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. A comparison of values estimated by DBFL and JBA is shown below: **DBFL value** / **JBA Value** Rainfall model: FSR / Met Eireann M5-60 (mm): 17.7 / 17.6 Ratio R: 0.271 / 0.271 The above variations are deemed within acceptable limits.

	Greenfield Runoff Rate (basis of surface water attenuation design): The Greenfield Runoff Rate has been estimated by DBFL for the subject site using guidance from the GDSDS, which states that surface water runoff from the overall development site would be limited to the equivalent of QBar or 2l/s/ha (whichever is greater). Greenfield Runoff Rate has been estimated using the Institute of Hydrology Report 124 (IH124) method for flood estimation on small catchments. **DBFL value** **JBA value** Qbar: 26.14 l/sec 26.10 l/sec JBA calculate the Qbar value to be similar to that calculated by DBFL on the basis of the Soil Type 2. If a soil type 3 was adopted given the results of the site investigation, the allowable discharge could be increased to 48.7 l/s. On the basis that the allowable discharge rate is lower and deemed more conservative, JBA have no issue with the proposed discharge rate. **Windes Calculations** The Windes models as submitted for catchments 1A, 1B and 1C account for an impermeable area of 5.085ha, which when compared to the gross area of the subject sites (10.87ha) equates to an impermeability factor of 47% which is appropriate for a medium density residential development. The design of the storm network is indicated as 2 years return period with the cap on maximum rainfall intensity set at 100mm/hr (typically set at 50mm/hr) which is deemed acceptable. It is noted that the capacity of all pipes are substantially in excess of the calculated flows. **SuDS Management Train** The SuDS as proposed, including the proposed discharge rate, are understood to have been discussed and agreed with SDCC.
Surface Water Drainage Design	All surface water flows generated by the proposed development will be attenuated and discharged at the controlled rate of 26.14 l/sec as per the GDSDS requirements and as highlighted within this storm water audit. No storm pipes less than 225mm diameter are proposed for sections of the site that may be taken in charge as per SDCC requirements.
Climate Change	An allowance of 10% increase in flows has been included for climate change, both for the storm sewer calculations provided and for the rainfall intensities for the purposes of sizing the attenuation tank. This is in compliance with Section 6.3.2.4 of the GDSDS.
Discharge Rate / Flow Control	From the IH124 method, the QBar discharge rate, using the FSR growth curves, from the development site is 26.14 l/s. This is in accordance with the requirements of the GDSDS. It is proposed by DBFL and as discussed with SDCC that surface water run-off from the site will be attenuated to QBar (26.14/sec) using a Hydrobrake flow control device, while providing surface water attenuation for the full 1 in 100 year event (plus climate change) within the proposed stormwater design / attenuation system(s). Following geotechnical site investigations it is likely that some run-off is likely from landscaped areas and the design has allowed for a 15% runoff factor for such areas which is deemed acceptable. It should be noted that not all rear gardens of houses can drain positively to the stormwater system given their orientation and cut-off (mid-terrace etc) and therefore do not contribute to

	attenuation volumes. Where such cut-off is provided, the subject gardens will rely on local infiltration. Clear passages less than 75mm can be particularly susceptible to blockage, however, given the proposed discharge rates, ope sizes are likely to be greater than 75mm where the risk is much reduced. This coupled with a detailed maintenance plan will reduce such risk further.
Volume Storage	DBFL have provided calculations for the proposed attenuation volumes. DBFL are proposing an overall attenuation volume of c.3,064m^3 (which has been sized for the 100 year return period + climate change). JBA have checked for attenuation volumes using Windes and attain similar volumes. The design of the storm sewer network and subsequent storage has been undertaken by the use of rainfall information based on the flood studies report (FSR) and detailed network and ground level information as per the requirements of the GDSDS.
Volume Run-off	Greenfield run-off is currently conveyed to the northern boundary of the site following the natural topography of the site. Whereas, the volume may ultimately be increased due to the increased paved area, the proposed attenuation measures and associated discharge rate from the site is limited to QBar for all storm events as per the requirements of the GDSDS. We note that the discharge rate is based on a soil type 2 which results in a lower Qbar value for the site as already noted.
Return Period	A 100 year return period plus 10% for climate change has been used in the design for the attenuation systems.
Health & Safety and Maintenance Issues	The proposed drainage system comprises traditional road gullies, manholes, a petrol interceptor, swales together with multiple attenuation features. 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 drainage system is subject to the frequency of maintenance provided and should be submitted for SDCC prior to commencement on site. 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 interceptor 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.
Detailed Design Stage	Particular consideration is required at detailed design to the design, maintenance requirements and whole life plan (and replacement) of the swales / interceptor storage. At detailed design stage, the number, type and location of road gullies should be reviewed such that exceedance flows are conveyed to the storm sewers and associated attenuation facilities, thereby, preventing off-site conveyance (cross-boundary flows) during exceedance rainfall conditions.

Design Review Process	Upon review of DBFL's initial drainage design, the following changes have been incorporated to the final design, namely: • Runoff co-efficient's from permeable paving, houses, roads and footpaths have been increased; • A runoff co-efficient of 15% has been applied to relevant grassed surfaces; • Overall attenuation volume requirements have increased. A summary of comments and record of the audit trail are appended to this report. Based on this being at preliminary design stage and a Stage 1 stormwater review, JBA Consulting's comments have all been satisfactorily addressed or sufficient commitment provided that details will be confirmed at detailed design stage.
Audit Result	JBA Consulting considers that the surface water drainage design for the proposed development is acceptable and meets the requirements of the stormwater requirements in the GDSDS.

Audit Report Prepared by: Leanne Leonard BEng
Engineer

Approved by: Declan White BEng CEng MIEI IMaPS
Principal 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 (*DBFL). *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 Trail Record

JBA Consulting Stormwater Review

Project: Cairn Residential Development at Newcastle, Co Dublin
Date: 23/05/2019
JBA Reviewers Leanne Leonard - Engineer

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable / Not Acceptable
	23/05/2019		12/06/2019	
1	**Classification of Soils** We note Table 3.2 of your engineering report where the drainage group is indicated to be 2, depth to impermeable layer is 40 - 80cm, the slope class 0 - 2^0 and the permeability rate taken as medium which suggests the soil type should be 3. However, soil type 2 has been taken for Qbar calculations.	DBFL to review	Based on the site investigation data and Table 4.5 of the Flood Studies Report, it is acknowledged that the most appropriate soil type for the subject site is soil type 3 which would result in an allowable run-off of approximately 4l/s/ha. Notwithstanding this, soil type 2 has been utilised in the drainage design to provide a more robust design and a greater level of protection to downstream drainage infrastructure and watercourses. The use of soil type 2 results in an allowable outflow of 2.1l/s/ha.	Acceptable
2	**Classification of Soils** Notwithstanding item 1 above, we note section 5.5 of the site investigation report which indicates that the infiltration testing was not favourable and the test locations were not considered suitable for soakaways. As local information on ground conditions is available, the findings of same should be considered in lieu of any generic mapping, SuDS or otherwise.	DBFL to review findings of SI as regards the most appropriate soil type for the subject site which may accommodate a revised Qbar figure	Based on the site investigation data and Table 4.5 of the Flood Studies Report, it is acknowledged that the most appropriate soil type for the subject site is soil Type 3 which would result in an allowable run-off of approximately 4l/s/ha. Notwithstanding this, soil type 2 has been utilised in the drainage design to provide a more robust design and a greater level of protection to downstream drainage infrastructure and watercourses.	Acceptable
3	**Runoff Co-Efficients** We note Section 3.2.3 and 3.6 of DBFL Infrastructure Design Report. Given items 1 and 2 above, there is little by way of any meaningful infiltration throughout the site. In view of same, the loss of stormwater volume will be limited and it is considered that the runoff co-efficients of 0.5 and to a lesser extent 0.75 for runoff from permeable paving, houses and roads/footpaths are low.	DBFL to review	It is acknowledged that the results of the infiltration tests in accordance with Bre Digest 365 indicated negligible soakage rates based on the test procedure. Notwithstanding the test results, some infiltration will naturally occur at the base of the permeable paving driveways. Also the permeable paving will have a free draining material within the build-up and will reduce the flow rate from these areas. Rainfall will 'wet' the initial surface of the paving allowing water to be stored in the micro and macrotexture of the surfacing and will be lost to evapotranspiration, as the run-off drains through the free draining aggregate, this build up will also 'wet' giving another volume reduction due to evapotranspiration and natural storage within the SuDS feature. A reduction in velocity will also occur as the aggregate used will slow the run-off at source, changing the input hydrograph which will ultimately reduce the peak inflow for attenuation calculations. It is impractical to create a combined model of each permeable paving area in a drainage model therefore a run-off coefficient of 0.5 was utilised in the original design for the above reasons. Based on JBA's comments we have now increased the run-off coefficients for permeable paving and houses draining to permeable paving to 0.75 and 0.80 respectively, to provide a more robust conservative design.	Acceptable
4	**Runoff from Grassed Areas** It is noted that no runoff from grassed areas is accommodated, however, it is acknowledged that runoff from some back gardens is prevented by concrete block boundary walls to rear gardens	DBFL to provide reasoning as to why all grassed surfaces can be omitted from calculations	The majority of green areas are not positively drained. Rear gardens are generally set 100mm to 200mm below the finished floor levels of houses which will provide adequate storage of surface water in an extreme rainfall event. Notwithstanding this, DBFL have reviewed the site layout and the likelihood of run-off from green areas entering the drainage network. The following allowances have been made for each catchment based on that review: Catchment 1A: a run-off coefficient of 0.15 has been applied to 25% of the total grassed areas. Catchment 1B: a run-off coefficient of 0.15 has been applied to 20% of the total grassed areas. Catchment 1C: a run-off coefficient of 0.15 has been applied to 20% of the total grassed areas.	Acceptable
5	**Road Drainage from Main Street to Storm MH S6** It is noted that the entrance road from the Main Street in as far as Storm MH S6 adjacent attenuation facility 1C is not connected to any formal storage facility.	DBFL to confirm if storage of same is accommodated & attenuated within the adjacent open filter drain with surface water swale	Due to the 2m level difference between Main Street and attenuation facility 1C, it is not possible to attenuate this section of road in attenuation facility 1C as it would result in excessively deep attenuation. The adjacent swale and filter drain will be utilised to attenuate this section of road although it is impractical to provide a hydrobrake on this small section of road.	Acceptable
6	**Exceedance Rainfall** Whereas the attenuation facilities are designed for the 1 in 100 year rainfall event + climate change, conveyance of exceedance flows is likely on the surface in lieu of within the stormwater network. Therefore, internal roads should be designed to convey flow towards same and not towards existing site boundaries. For example, the access road towards the north-west corner of catchment 1A and the south-west corner of catchment 1B will convey overland flows to the existing open drain on the western boundary which will result in increased runoff > Qbar for the site	DBFL to review and consider: 1. revised road levels to prevent cross boundary flows, thereby increasing runoff >Qbar and/or 2. provision of a filter drain along full length of western boundary which can connect to the stormwater system within catchment 1C	Please refer to microdrainage simulation results for each drainage network which shows that the 100 year storm event can be accommodated below the cover level of the manholes therefore there should be no overland flow for the 1 in 100 year rainfall event + climate change. It should be noted that the storm that will flood pipe networks is generally an intense storm that cannot get into the network quickly enough. In volumetric terms these storms or portion of storms are usually small therefore the impact on downstream drainage infrastructure and watercourses would be negligible.	Acceptable
7	**Drainage of Catchments 4 and 5** It is not clear from the drainage strategy drawings how catchments 4 and 5 are to be drained together with associated attenuation proposals	DBFL to review and advise	Please refer to attached report text which will be included in the updated Infrastructure Design Report submitted with the planning application. The infill sites benefits from core infrastructure constructed under the previously permitted development (Reg. Ref. SD05A/0344). Surface water sewers have been constructed in the roads surrounding the infill sites and have been surveyed to confirm levels and diameters. DBFL have undertaken a check on the adequacy of the existing attenuation volumes to accommodate the proposed infill sites which is outlined in the attached report and appended calculations	Acceptable

Item No.	JBA Review Comment	Comment/Clarification Request/Suggested Mitigation	Response from Client/Client Representative	Acceptable / Not Acceptable
8	**Drainage of Green Fields to south of subject development** A cut-off drain to the southern boundary of the subject residential development is noted which will convey any overland flows to an existing open drain bounding the western boundary. On the basis that Qbar for the discharge of surface water from the residential development has been calculated on the area of the subject residential development, we consider this appropriate and no attenuation of the subject green areas south of the residential development is required	DBFL to confirm: 1. the calculation of Qbar for the residential development is based on the net area of the overall site related to the residential houses/development and 2. if the said green areas south of the subject residential development are to be developed in due course, attenuation of same to GDSDS requirements will be provided at that stage	**Qbar for attenuation area 1A was calculated on the net area of the site (excluding proposed green open space to the south and the future school site). The future school site will be attenuated within it's own catchment in accordance with GDSDS when development progresses in that area. The drainage design allows for an attenuated outflow of 3.11l/s from the school site.** **The proposed open space to the south is zoned as Open Space therefore it is not anticipated that future development will take place in that area.** **If any development does occur, it would be required to provide attenuation within it's own catchment in accordance with GDSDS.** **The calculation of Qbar will be adjusted to include for overland flow to the north of the cut-off drain (area within school site to north of cut-off drain) and a run-off coefficient of 0.15 will be included on this area in the drainage design.**	**Acceptable**

Appendix I

DRAINAGE DITCHES CALCULATIONS

TITLE		Job Reference
Site at Newcastle Ditch Culverts		170024
SUBJECT		**Calc. Sheet No.**
QBAR Calculation using IOH Report 124 for Sites < 25 km²		1

DRAWING NUMBER	Calculations by	Checked by	Date
-	FNS	NCG	Mar 2019

Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation

²Site Area = 18.35 Ha

Site area is less t

AREA = 0.184 km²

SAAR = 789 mm

³SOIL = 0.30

¹$Q_{bar\ (rural)} = 0.00108 * (AREA)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$

$Q_{bar\ [rural]}$ = 0.038 m³/s

Note to Institute of Hydrology Report No. 124 Eqn	
Q_{bar}	The Mean Annual Flood (cumecs)
AREA	Area of the Catchment (km²)
SAAR	Standard Annual Average Rainfall (mm) *NERC Flood Studies Report, 1975*
SOIL	Soil Index Values of Catchment *Winter Rain Acceptance Potential, (Supplementary Report No. 7)*

Soil Classification for Runoff Potential FSR Maps

Soil 1	0	%
Soil 2	100	%
Soil 3	0	%
Soil 4	0	%
Soil 5	0	%

Permissible Outflow from Site using Growth Factor

Flood Return Event	⁵Growth Factor	Permitted Flow (m^3/s)	+ Climate Change 20%
1	0.85	0.03	0.04
QBAR	1	0.04	0.05
10	1.67	0.06	0.08
30	2.1	0.08	0.10
50	2.33	0.09	0.11
100	2.6	0.10	0.12
200	2.85	0.11	0.13
1000	3.5	0.13	0.16

⁴Factorial Error Allowance

r^2 =	0.847
n =	71
fse =	1.651

Q'_{bar} =	0.08	m^3/s
Q'_{100} =	**0.20**	m^3/s

(With Allowance for the standard factorial error)

Design Flow with allowance for Climate Change and Factorial Error

1 hectare = 10,000m² **1km² - 100 hectares**

Notes

1. Based on the Institute of Hydrology Report 124 for small catchments less than 25km².
2. For catchments smaller than 50 hectares in area, flow rates are linearly interpolated for smaller areas.
3. Soil index value (SPR) calculated from Flood Studies Report Vol V Fig I 4.18(1) - The Classification of Soils from Winter Rainfall Acceptance Rate .
4. Fse is the standard factoial error
5. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year, 2.3 for 50 and 2.6 for 100 year return period events, from GDSDS Figure C2.

TITLE		Job Reference
Site at Newcastle		170024
Parkland run-off		
SUBJECT		**Calc. Sheet No.**
QBAR Calculation using IOH Report 124 for Sites < 25 km²		1

DRAWING NUMBER	Calculations by	Checked by	Date
-	FNS	NCG	Mar 2019

Estimation of QBAR from IOH Report 124 for catchments less than 25 km² using the 3 variable equation

²Site Area = 4.00 Ha

Site area is less t

AREA = 0.040 km²

SAAR = 789 mm

³SOIL = 0.30

¹$Q_{bar\ (rural)} = 0.00108 * (AREA)^{0.89}(SAAR)^{1.17}(SOIL)^{2.17}$

$Q_{bar\ [rural]}$ = 0.008 m³/s

Note to Institute of Hydrology Report No. 124 Eqn	
Q_{bar}	The Mean Annual Flood (cumecs)
AREA	Area of the Catchment (km²)
SAAR	Standard Annual Average Rainfall (mm)
	NERC Flood Studies Report, 1975
SOIL	Soil Index Values of Catchment
	Winter Rain Acceptance Potential, (Supplementary Report No. 7)

Soil Classification for Runoff Potential FSR Maps

Soil 1	0	%
Soil 2	100	%
Soil 3	0	%
Soil 4	0	%
Soil 5	0	%

Permissible Outflow from Site using Growth Factor

Flood Return Event	⁵Growth Factor	Permitted Flow (m^3/s)	+ Climate Change 20%
1	0.85	0.01	0.01
QBAR	1	0.01	0.01
10	1.67	0.01	0.02
30	2.1	0.02	0.02
50	2.33	0.02	0.02
100	2.6	0.02	0.03
200	2.85	0.02	0.03
1000	3.5	0.03	0.04

⁴Factorial Error Allowance

r^2 =	0.847
n =	71
fse =	1.651

Q'_{bar} =	0.02	m^3/s
Q'_{100} =	**0.04**	m^3/s

(With Allowance for the standard factorial error)

Design Flow with allowance for Climate Change and Factorial Error

1 hectare = 10,000m² **1km² - 100 hectares**

Notes

1. Based on the Institute of Hydrology Report 124 for small catchments less than 25km².
2. For catchments smaller than 50 hectares in area, flow rates are linearly interpolated for smaller areas.
3. Soil index value (SPR) calculated from Flood Studies Report Vol V Fig I 4.18(1) - The Classification of Soils from Winter Rainfall Acceptance Rate .
4. Fse is the standard factoial error
5. QBAR multiplied by growth factors of 0.85 for 1 year, 2.1 for 30 year, 2.3 for 50 and 2.6 for 100 year return period events, from GDSDS Figure C2.

Appendix J

FOUL SEWER CALCULATIONS

FOUL SEWERAGE DESIGN

Design Criteria for Foul - Unit

Pipe Sizes STANDARD Manhole Sizes STANDARD

Industrial Flow (l/s/ha)	0.00	Add Flow / Climate Change (%)	0
Industrial Peak Flow Factor	0.00	Minimum Backdrop Height (m)	0.200
Calculation Method	BS 8301	Maximum Backdrop Height (m)	2.000
Frequency Factor	0.00	Min Design Depth for Optimisation (m)	1.200
Domestic (l/s/ha)	0.00	Min Vel for Auto Design only (m/s)	0.75
Domestic Peak Flow Factor	6.00	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	58.410	0.840	69.5	0.000	112.0	0.0	1.500	o	225	Pipe/Conduit	
1.001	70.939	1.850	38.3	0.000	42.0	0.0	1.500	o	225	Pipe/Conduit	
1.002	20.509	0.310	66.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
2.000	79.118	2.250	35.2	0.000	392.0	0.0	1.500	o	225	Pipe/Conduit	
3.000	28.711	0.750	38.3	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
2.001	36.952	1.149	32.2	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
4.000	31.931	0.456	70.0	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
2.002	54.727	0.771	71.0	0.000	112.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	102.440	0.000	0.0	112.0	0.0	41	0.80	1.38	54.8	4.0
1.001	101.600	0.000	0.0	154.0	0.0	37	1.01	1.86	73.8	4.4
1.002	99.750	0.000	0.0	154.0	0.0	42	0.83	1.41	56.2	4.4
2.000	102.300	0.000	0.0	392.0	0.0	41	1.13	1.94	77.1	5.7
3.000	100.800	0.000	0.0	56.0	0.0	33	0.94	1.86	73.9	3.5
2.001	100.050	0.000	0.0	532.0	0.0	43	1.20	2.03	80.6	6.3
4.000	99.300	0.000	0.0	56.0	0.0	39	0.77	1.37	54.6	3.5
2.002	98.901	0.000	0.0	700.0	0.0	54	0.94	1.36	54.2	7.0

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.003	32.490	0.430	75.6	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
1.004	44.495	0.560	79.5	0.000	42.0	0.0	1.500	o	225	Pipe/Conduit	
1.005	11.208	0.150	74.7	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.006	10.664	0.140	76.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.007	19.279	0.250	77.1	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
5.000	82.791	1.750	47.3	0.000	112.0	0.0	1.500	o	225	Pipe/Conduit	
5.001	71.726	1.630	44.0	0.000	126.0	0.0	1.500	o	225	Pipe/Conduit	
6.000	49.813	1.100	45.3	0.000	196.0	0.0	1.500	o	225	Pipe/Conduit	
7.000	34.656	0.300	115.5	0.000	420.0	0.0	1.500	o	225	Pipe/Conduit	
6.001	75.672	0.946	80.0	0.000	168.0	0.0	1.500	o	225	Pipe/Conduit	
6.002	59.722	1.150	51.9	0.000	280.0	0.0	1.500	o	225	Pipe/Conduit	
6.003	3.229	0.069	46.8	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
5.002	82.336	1.435	57.4	0.000	168.0	0.0	1.500	o	225	Pipe/Conduit	
1.008	44.775	0.620	72.2	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.003	98.130	0.000	0.0	882.0	0.0	58	0.94	1.32	52.5	7.6
1.004	97.700	0.000	0.0	924.0	0.0	59	0.93	1.29	51.2	7.8
1.005	97.140	0.000	0.0	924.0	0.0	58	0.95	1.33	52.8	7.8
1.006	96.990	0.000	0.0	924.0	0.0	59	0.94	1.32	52.3	7.8
1.007	96.850	0.000	0.0	952.0	0.0	59	0.94	1.31	52.0	7.9
5.000	102.750	0.000	0.0	112.0	0.0	38	0.92	1.67	66.5	4.0
5.001	101.000	0.000	0.0	238.0	0.0	41	1.00	1.73	68.9	4.9
6.000	101.300	0.000	0.0	196.0	0.0	40	0.97	1.71	67.9	4.6
7.000	100.500	0.000	0.0	420.0	0.0	56	0.75	1.07	42.5	5.8
6.001	100.200	0.000	0.0	784.0	0.0	57	0.91	1.28	51.1	7.3
6.002	99.254	0.000	0.0	1064.0	0.0	55	1.10	1.59	63.4	8.3
6.003	98.104	0.000	0.0	1064.0	0.0	53	1.14	1.68	66.8	8.3
5.002	98.035	0.000	0.0	1470.0	0.0	61	1.11	1.52	60.3	9.6
1.008	96.600	0.000	0.0	2506.0	0.0	75	1.11	1.35	53.7	12.9

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
8.000	32.325	0.520	62.2	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
1.009	27.278	0.180	151.5	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
9.000	67.789	0.900	75.3	0.000	154.0	0.0	1.500	o	225	Pipe/Conduit	
1.010	45.810	1.250	36.6	0.000	84.0	0.0	1.500	o	225	Pipe/Conduit	
1.011	5.877	0.150	39.2	0.000	14.0	0.0	1.500	o	225	Pipe/Conduit	
1.012	33.891	1.000	33.9	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
1.013	52.472	1.100	47.7	0.000	126.0	0.0	1.500	o	225	Pipe/Conduit	
1.014	6.348	0.100	63.5	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.015	66.721	1.700	39.2	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
10.000	61.934	1.600	38.7	0.000	112.0	0.0	1.500	o	225	Pipe/Conduit	
1.016	18.625	0.500	37.3	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
11.000	34.283	0.516	66.4	0.000	210.0	0.0	1.500	o	225	Pipe/Conduit	
12.000	37.633	0.470	80.1	0.000	98.0	0.0	1.500	o	225	Pipe/Conduit	
13.000	21.105	0.970	21.8	0.000	42.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
8.000	96.500	0.000	0.0	56.0	0.0	37	0.80	1.46	57.9	3.5
1.009	95.980	0.000	0.0	2590.0	0.0	93	0.85	0.93	37.0	13.1
9.000	96.700	0.000	0.0	154.0	0.0	44	0.80	1.32	52.6	4.4
1.010	95.800	0.000	0.0	2828.0	0.0	65	1.45	1.90	75.5	13.9
1.011	94.550	0.000	0.0	2842.0	0.0	67	1.42	1.84	73.0	13.9
1.012	94.400	0.000	0.0	2898.0	0.0	64	1.49	1.98	78.5	14.1
1.013	93.400	0.000	0.0	3024.0	0.0	71	1.33	1.66	66.2	14.5
1.014	92.300	0.000	0.0	3024.0	0.0	77	1.20	1.44	57.3	14.5
1.015	92.200	0.000	0.0	3164.0	0.0	69	1.44	1.84	73.0	14.9
10.000	92.100	0.000	0.0	112.0	0.0	36	0.98	1.85	73.5	4.0
1.016	90.500	0.000	0.0	3276.0	0.0	69	1.48	1.88	74.9	15.2
11.000	97.100	0.000	0.0	210.0	0.0	44	0.85	1.41	56.0	4.7
12.000	98.300	0.000	0.0	98.0	0.0	42	0.76	1.28	51.0	3.9
13.000	98.800	0.000	0.0	42.0	0.0	28	1.13	2.47	98.1	3.3

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
12.001	33.736	1.246	27.1	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
11.001	60.787	0.614	99.0	0.000	56.0	0.0	1.500	o	225	Pipe/Conduit	
11.002	44.647	0.650	68.7	0.000	280.0	0.0	1.500	o	225	Pipe/Conduit	
11.003	6.435	0.160	40.2	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
11.004	83.069	2.160	38.5	0.000	350.0	0.0	1.500	o	225	Pipe/Conduit	
11.005	4.483	0.150	29.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
11.006	30.785	0.850	36.2	0.000	112.0	0.0	1.500	o	225	Pipe/Conduit	
14.000	32.051	0.916	35.0	0.000	70.0	0.0	1.500	o	225	Pipe/Conduit	
14.001	5.178	0.130	39.8	0.000	28.0	0.0	1.500	o	225	Pipe/Conduit	
14.002	49.112	1.403	35.0	0.000	266.0	0.0	1.500	o	225	Pipe/Conduit	
14.003	33.904	1.077	31.5	0.000	112.0	0.0	1.500	o	225	Pipe/Conduit	
14.004	5.283	0.160	33.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
14.005	31.189	1.489	20.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
15.000	40.357	0.475	85.0	0.000	126.0	0.0	1.500	o	225	Pipe/Conduit	
14.006	72.402	1.125	64.4	0.000	182.0	0.0	1.500	o	225	Pipe/Conduit	
11.007	3.895	0.050	77.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
12.001	97.830	0.000	0.0	140.0	0.0	34	1.13	2.21	87.9	4.3
11.001	96.584	0.000	0.0	406.0	0.0	54	0.79	1.15	45.9	5.7
11.002	95.970	0.000	0.0	686.0	0.0	54	0.95	1.39	55.1	6.9
11.003	95.320	0.000	0.0	686.0	0.0	47	1.14	1.81	72.1	6.9
11.004	95.160	0.000	0.0	1036.0	0.0	51	1.22	1.85	73.7	8.2
11.005	93.000	0.000	0.0	1036.0	0.0	48	1.34	2.10	83.7	8.2
11.006	92.850	0.000	0.0	1148.0	0.0	51	1.27	1.91	76.0	8.6
14.000	96.800	0.000	0.0	70.0	0.0	33	0.99	1.94	77.3	3.6
14.001	95.884	0.000	0.0	98.0	0.0	36	0.97	1.82	72.4	3.9
14.002	95.754	0.000	0.0	364.0	0.0	41	1.12	1.94	77.3	5.5
14.003	94.351	0.000	0.0	476.0	0.0	42	1.20	2.05	81.5	6.0
14.004	93.274	0.000	0.0	476.0	0.0	42	1.18	2.00	79.6	6.0
14.005	93.114	0.000	0.0	476.0	0.0	38	1.38	2.51	100.0	6.0
15.000	92.100	0.000	0.0	126.0	0.0	44	0.75	1.25	49.5	4.1
14.006	91.625	0.000	0.0	784.0	0.0	54	0.98	1.43	56.9	7.3
11.007	90.500	0.000	0.0	1932.0	0.0	71	1.04	1.30	51.7	11.1

Network Design Table for Foul - Unit

PN	Length (m)	Fall (m)	Slope (1:X)	Area (ha)	Units	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
11.008	50.404	0.450	112.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.017	4.018	0.115	34.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.018	33.433	0.510	65.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
16.000	63.219	1.095	57.7	0.000	140.0	0.0	1.500	o	225	Pipe/Conduit	
1.019	16.403	0.475	34.5	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.020	20.355	0.370	55.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.021	10.803	0.139	77.7	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.022	29.144	0.374	77.9	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.023	17.475	0.224	78.0	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.024	18.651	0.239	78.0	0.000	420.0	0.0	1.500	o	225	Pipe/Conduit	
1.025	8.053	0.114	70.6	0.000	0.0	0.0	1.500	o	225	Pipe/Conduit	
1.026	88.505	1.440	61.5	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
1.027	68.330	0.228	299.7	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
1.028	61.041	0.207	294.9	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
1.029	87.926	0.464	189.5	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
1.030	50.839	0.269	189.0	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	
1.031	98.278	0.392	250.7	0.000	0.0	0.0	1.500	o	375	Pipe/Conduit	

Network Results Table

PN	US/IL (m)	Σ Area (ha)	Σ Base Flow (l/s)	Σ Units	Add Flow (l/s)	P.Dep (mm)	P.Vel (m/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
11.008	90.450	0.000	0.0	1932.0	0.0	78	0.91	1.08	43.1	11.1
1.017	90.000	0.000	0.0	5208.0	0.0	80	1.66	1.95	77.4	21.2
1.018	89.885	0.000	0.0	5208.0	0.0	96	1.32	1.42	56.4	21.2
16.000	90.470	0.000	0.0	140.0	0.0	41	0.87	1.51	60.1	4.3
1.019	89.375	0.000	0.0	5348.0	0.0	81	1.67	1.96	77.8	21.6
1.020	88.900	0.000	0.0	5348.0	0.0	92	1.41	1.55	61.6	21.6
1.021	88.539	0.000	0.0	5348.0	0.0	101	1.24	1.30	51.8	21.6
1.022	88.401	0.000	0.0	5348.0	0.0	101	1.24	1.30	51.7	21.6
1.023	88.027	0.000	0.0	5348.0	0.0	101	1.24	1.30	51.7	21.6
1.024	87.803	0.000	0.0	5768.0	0.0	104	1.26	1.30	51.7	22.6
1.025	87.564	0.000	0.0	5768.0	0.0	101	1.31	1.37	54.3	22.6
1.026	87.300	0.000	0.0	5768.0	0.0	80	1.32	2.05	226.1	22.6
1.027	85.860	0.000	0.0	5768.0	0.0	120	0.75	0.92	102.1	22.6
1.028	85.632	0.000	0.0	5768.0	0.0	119	0.75	0.93	102.9	22.6
1.029	85.425	0.000	0.0	5768.0	0.0	106	0.88	1.16	128.5	22.6
1.030	84.961	0.000	0.0	5768.0	0.0	106	0.88	1.17	128.7	22.6
1.031	84.692	0.000	0.0	5768.0	0.0	114	0.80	1.01	111.7	22.6

Appendix K
IRISH WATER DESIGN ACCEPTANCE & COF (CONFIRMATION OF FEASIBILITY)

CAIRN HOMES CONSTRUCTION LTD c/o NOEL GORMAN
ORMOND HOUSE ORMOND QUAY UPPER DUBLIN 7

Uisce Éireann
Bosca OP 6000
Baile Átha Cliath 1
Éire

Irish Water
PO Box 6000
Dublin 1
Ireland

T: +353 1 89 25000
F: +353 1 89 25001
www.water.ie

11 October 2018

Dear Sir/Madam,

Re: Customer Reference No 849834035 pre-connection enquiry - Subject to contract | Contract denied
[Connection for 430 domestic units]

Irish Water has reviewed your pre-connection enquiry in relation to water and wastewater connections at NEWCASTLE SOUTH, PHASE 1 CO. DUBLIN. Based upon the details that you have provided with your pre-connection enquiry and on the capacity currently available in the network(s), as assessed by Irish Water, we wish to advise you that, subject to a valid connection agreement being put in place, your proposed connection to the Irish Water network(s) can be facilitated.

In the case of wastewater connections this assessment does not confirm that a gravity connection is achievable. Therefore a suitably sized pumping station may be required to be installed on your site. All infrastructure should be designed and installed in accordance with the Irish Water Code of Practice.

Water:
New connection to the existing network is feasible with following conditions:
• The connection must be made from the 450mm DI trunk main on the east of the Development and should include installation of a 150mm diameter offtake with a PRV controller.
• A bulk meter and associated telemetry system are also required for the Development.

Wastewater:
Existing 225mm foul sewer on the Main Street/R120 Road adjacent to the site and Newcastle Pumping Station downstream of the site have capacity deficiency. It will be necessary to carry out further detailed study and investigations to confirm the available capacity and to determine the full extent of any upgrades which may be required to be completed to Irish Water Infrastructure, prior to agreeing to the proposed connection. Irish Water currently does not have any plans to extend or commence upgrade works to its network in this area.

Strategic Housing Development
Irish Water notes that the scale of this development dictates that it is subject to the Strategic Housing Development planning process. Therefore:
A. In advance of submitting your full application to An Bord Pleanala for assessment, you must have reviewed this development with Irish Water and received a Statement of Design Acceptance in relation to the layout of water and wastewater services. All infrastructure should be designed and installed in accordance with the Irish Water Codes of Practice and Standard Details.
B. You are advised that this correspondence does not constitute an offer in whole or in part to provide a connection to any Irish Water infrastructure and is provided subject to a connection agreement being signed and appropriate connection fee paid at a later date.
C. In advance of submitting this development to An Bord Pleanala for full assessment, the Developer is required to have entered into a Project Works Services Agreement to deliver studies to confirm the available capacity and to determine the full extent of any upgrades which may be required to be completed to Irish Water infrastructure.
D. In advance of submitting this development to An Bord Pleanala for full assessment, the Developer is required to have entered into a Project Works Services Agreement to deliver infrastructure upgrades to facilitate the connection of the development to Irish Water infrastructure.

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

If you have any further questions, please contact Marina Byrne from the design team on 018925991 or email mzbyrne@water.ie. For further information, visit **www.water.ie/connections**

Yours sincerely,

Maria O'Dwyer
Connections and Developer Services

Cairn Homes Construction Limited c/o Noel Gorman,
DBFL Consulting Engineers,
Ormond House,
Ormond Quay Upper,
Dublin 7

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

Irish Water
PO Box 448
South City
Delivery Office
Cork City

www.water.ie

12 July 2019

Re: Design Submission for Development at Newcastle South, Phase 1, Co. Dublin (the "Development") (the "Design Submission") / 849834035.

Dear Noel Gorman,

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: Marina Byrne
Phone: 01 8925991
Email: mzbyrne@water.ie

Yours sincerely,

Maria O'Dwyer

Connections and Developer Services

Appendix A

Document Title & Revision

- 170024-3001-B Site Services Layout Sheet 1
- 170024-3002-B Site Services Layout Sheet 2
- 170024-3011-B Water Mains Layout Sheet 1
- 170024-3012-B Water Mains Layout Sheet 2
- 170024-3025 Longitudinal Sections Through Foul Sewer Sheet 1
- 170024-3026 Longitudinal Sections Through Foul Sewer Sheet 2
- 170024-3027 Longitudinal Sections Through Foul Sewer Sheet 3
- 170024-3028 Longitudinal Sections Through Foul Sewer Sheet 4

Standard Details/Code of Practice Exemption: N/A

*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.