BARRETT **MAHONY**
CIVIL & STRUCTURAL
CONSULTING ENGINEERS

Infrastructure Report

Project:

Proposed Strategic Housing Development, Kenelm, Deer Park, Howth

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1.0 INTRODUCTION

1.1 General Description

Barrett Mahony Consulting Engineers (BMCE) have been commissioned to prepare a Civil Engineering Infrastructure Report (IR) by GLL PRS Holdco Limited for a proposed residential development at Howth Road, Howth, Dublin. The site is currently a greenfield site.

The proposed development will consist of 162no. residential apartment units in 3no. multi-storey blocks A,B & C. Basement level car parking will be provided beneath blocks A-B. The total number of car parking spaces provided is 132no.

- Apartments 162 no.
- Car Parking Spaces 132 no.
- Bicycle Parking Spaces 355 no.

Apartment breakdown as follows;

•	1 Bedroom	29 no.
•	2 Bedroom	104 no.
•	3 Bedroom	29 no.
	Total	162 no.

The site is bounded to the north by Howth Road (R105) and to the east, by the access road to Howth Castle. The west of the site is bounded by garden boundary walls to existing houses. The south is bounded by the Deer Park Golf Club. There will be one permanent road access point to the site on Howth Road to the north west of the site. There is also a proposed pedestrian/cyclist access point to the north boundary from Howth Road. The development will have no through route. The proposed entrance will serve the respective apartment blocks, (blocks A-C).

Figure 1.1 – Site Location (boundary shown indicatively)

1.2 Scope of this Report

This report describes the proposed civil engineering infrastructure for the development and how it connects to the public infrastructure serving the area.

Foul, surface water drainage and water supply aspects are addressed. This report should be read in conjunction with the following drawings submitted with the application.

PROJECT DELIVERABLE REGISTER (QPF06.01)

Sheet 1

Drg. Ref.	Drawing Title
HOW-BMD-00-ZZ-DR-C1000	Proposed Site Layout
HOW-BMD-00-ZZ-DR-C1001	Proposed Road Layout / Sightlines
HOW-BMD-00-ZZ-DR-C1002	Proposed Basement Layout
HOW-BMD-00-ZZ-DR-C1010	Watermain Layout
HOW-BMD-00-ZZ-DR-C1020	Extended Site Plan: Foul & Surface Water Drainage Layout
HOW-BMD-00-ZZ-DR-C1021	Site Plan: Foul & Surface Water Drainage Layout
HOW-BMD-00-ZZ-DR-C1022	Roof Drainage Layout
HOW-BMD-00-ZZ-DR-C1023	SUDS Strategy Layout
HOW-BMD-00-ZZ-DR-C1040	Autotrack - Car
HOW-BMD-00-ZZ-DR-C1041	Autotrack - ESB Van
HOW-BMD-00-ZZ-DR-C1043	Autotrack - Refuse Vehicle
HOW-BMD-00-ZZ-DR-C1045	Autotrack - Fire truck
HOW-BMD-00-ZZ-DR-C1050	Site Sections
HOW-BMD-00-ZZ-DR-C1051	Basement Excavation Analysis
HOW-BMD-00-ZZ-DR-C1052	Basement Excavation Analysis Site Sections
HOW-BMD-00-ZZ-DR-C1100	Drainage Schematic Sections
HOW-BMD-00-ZZ-DR-C1101	Drainage Sections Sheet 1
HOW-BMD-00-ZZ-DR-C1102	Drainage Sections Sheet 2
HOW-BMD-00-ZZ-DR-C1210	Standard Road Details
Doc. Ref.	**Document Title**
19.196-IR-01	Infrastructure Report
19.196-IR-02	Flood Risk Assessment Report
19.196-IR-03	Mobility Management Report
19.196-IR-04	Traffic Assessment Report
19.196-IR-05	DMURS Statement of Compliance
19.196-IR-06	Construction Environmental Management Plan

1.3 Pre-planning Discussion

A S247 meeting took place with Fingal County Council on the 27th of January 2020. During this meeting representatives from the water services section of the FCC review committee reviewed the proposed surface water drainage strategy and the proposed roads layout.

A representative from the drainage department of FCC agreed in principle with the general drainage strategy for the site. He requested the extent of green roofs on Blocks A-C to be clarified. Full details of the design are provided in this report and appendices.

1.4 Irish Water

A Pre-Connection Enquiry (PCE) was submitted to Irish Water on the 23rd October 2019 to determine the feasibility of connecting to the public water and drainage infrastructure. A response to the PCE was received on the 22nd of January 2020 and Irish Water confirmed a connection is feasible. Confirmation of Feasibility is included in Appendix II.

The project is subject to the Strategic Housing Development (SHD) planning process and therefore a Statement of Design Acceptance of the project's water & wastewater proposals is required from Irish Water. BMCE submitted our drawing package on the 29th of April 2020 and received comments from Irish Water on the 30th of April. These comments have been addressed and the drawing package was resubmitted on the 15th of May 2020.

BMCE received the Irish Water Statement of Design Acceptance on 19th of May, which is included in Appendix II.

2.0 SITE TOPOGRAPHY

A detailed topographical survey of the existing site has been prepared by Murphy Surveys. Adjacent to the Howth Road to the north, the site is at a level of approximately +6.500m and gradually rises to a level of +14.000m towards the Deer Park golf course. These levels are summarised in the plan below.

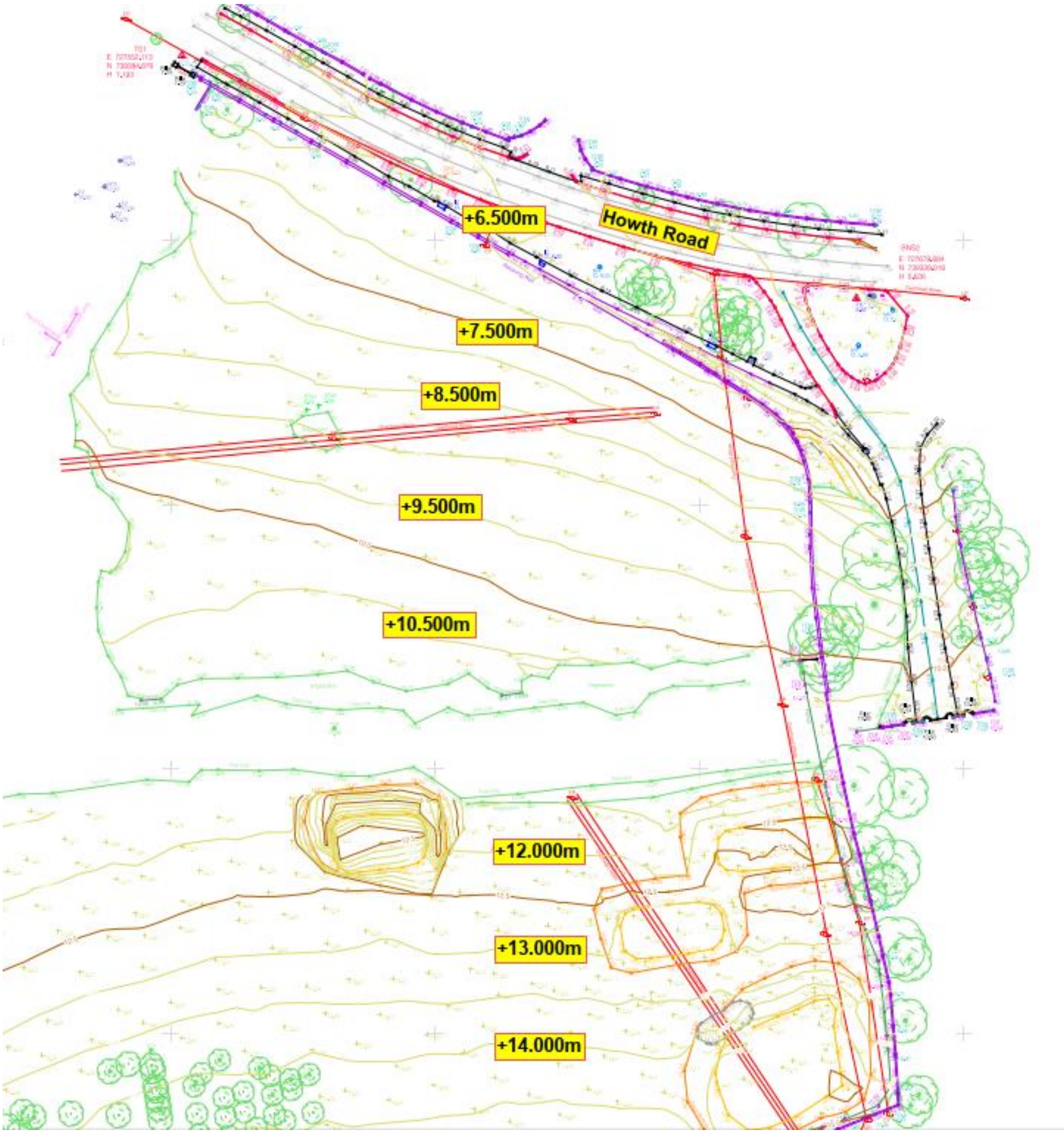

Figure 2.1 - Site Levels

3.0 SURFACE WATER DRAINAGE SYSTEM

3.1 Introduction

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

The SuDS strategy is developed with the following steps:

- The existing greenfield run-off for the site is calculated for determining the allowable discharge rate.
- A set of SuDS measures is chosen based on their applicability and usage for the site.
- A "microdrainage" model is created to analyse the rainfall on the site and the effectiveness of the proposed SuDS measures.
- If effective, these SuDS measures will be implemented on the site.

3.2 Existing Surface Water Infrastructure

There is no existing surface water infrastructure within the greenfield site. On Howth Road, to the north west of the site, there is an existing 450mm diameter surface water sewer that discharges north towards the coast (see drawing HOW-BMD-00-ZZ-DR-C1020).

3.3 Compliance with the Principles of SuDS

3.3.1 Compliance with the principles of the GDSDS

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

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

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

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

3.3.2 Compliance with the principles of the CIRIA C573 SuDS Manual

The C573 SuDS Manual explains that the primary function of SuDS measures is to protect watercourses from any impact due to the new development. However, SuDS can also improve the quality of life in a new development and urban spaces by making them more vibrant, visually attractive, sustainable and more resilient to change. This document explains the wider social context of SuDS and how SuDS can deliver high quality drainage while supporting urban areas to cope better with sever rainfall both now and in the future.

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

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

3.4 SuDS Measure Selection

The development will be an urban environment and therefore the available applicable SuDS measures are limited within the site. Below are the applicable SuDS measures which have been chosen for the site and are feasible. The proposed site comprises of podium areas between the blocks of apartments. A significant portion of the podium area comprises of pathways which allows for permeable paving to be incorporated. Other measures such as rain gardens and tree pits have also been identified as suitable measures.

3.4.1.1 Green Roofs – General

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

3.4.1.2 Green Roof – Extensive:

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

It is proposed to cover the apartment block roofs with extensive green roofs. The apartment block roofs take up a considerable portion of the site area and therefore by utilising these for green roofs, there will be interception and treatment storage provided at source. The proposed system will be a sedum roof over a drainage tray, which will intercept water.

3.4.1.3 Permeable Paving

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

The pathways throughout the site will be of a permeable paving build up which will include a network of perforated pipes that discharge to the proposed attenuation tank. The paving within the podium slab area will incorporate a drainage board which also contributes to the interception storage within the site.

3.4.1.4 Rain Gardens

A rain garden is a bioretention shallow depression designed to collect, store, filter and treat surface water runoff.

The rainwater downpipes for the three blocks will be directed to the adjacent rain gardens. The system will incorporate a drainage board to provide a degree of additional interception storage, and outlets below connected to the surface water drainage system.

3.4.1.5 Tree Pits

Tree pits are shallow landscaped depressions that can reduce the runoff rates and volumes of surface water. They treat pollution using engineered soils and vegetation. They are very effective in delivering interception and treatment storage. By including tree pits, the effectiveness of the overall system in meeting the requirements of water quality, water quantity, amenity and biodiversity is significantly improved. Trees provide benefits to the SuDS measures by:

- Transpiration – Water evaporates through the stomata on the leaf as a result of photosynthesis.
- Interception – Leaves, branches and trunk surfaces intercept and absorb rainfall reducing the amount of water that reaches the ground.
- Infiltration – Root growth increases the soil infiltration capacity and rate, ultimately reducing run-off volumes.
- Phytoremediation – When drawing up water, trees also take up trace amounts of harmful chemicals. These chemicals can be transformed into less harmful substances within the tree.

Tree-pits will be used throughout the landscape arrangement and within the landscape podium areas between the blocks incorporating a drainage tray below.

3.4.1.6 Attenuation Tanks

Attenuation tanks are used to create below-ground void space for the temporary storage of surface water before infiltration, controlled release, or use. Attenuation tanks can be constructed using geocellular crates, which offer flexibility in size, shape and constructability meaning that they can be tailored to suit specific site characteristics.

It is proposed to provide an attenuation tank to the north west of the site. This will be designed for the 1 in 100 year storm + 20% climate change, and will form the last part of the SuDS management train. A Hydrobrake will be fitted downstream of the tank in order to restrict the flow to Qbar for the catchment area.

Please refer to BMCE drawing HOW-BMD-00-XX-DR-C-1023 for plan & details of SuDS measures.

3.5 SuDS Management Train

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

A robust SMT will ensure that the most effective measures are utilised in the correct sequence throughout the site.

Figure 2.2 – C1023 SuDS Layout

3.6 SuDS Pollutant Analysis

To ensure that the SuDS measures proposed are sufficient in removing pollutants from the generated run-off, a SuDS pollutant analysis has been carried out. This is performed in conjunction with the guidelines and steps set out in Section 26.7 of CIRIA SuDS Manual (2015). The main source of pollutant is potentially from surface water run-off from the basement car park & access road. Table 26.2 highlights the pollution hazards for different land uses (extract below Figure 3.2). The pollution hazards on site are generally 'very low'. Residential car parking areas are classed as 'Low'.

TABLE 26.2 Pollution hazard indices for different land use classifications				
Land use	**Pollution hazard level**	**Total suspended solids (TSS)**	**Metals**	**Hydro-carbons**
Residential roofs	Very low	0.2	0.2	0.05
Other roofs (typically commercial/ industrial roofs)	Low	0.3	0.2 (up to 0.8 where there is potential for metals to leach from the roof)	0.05
Individual property driveways, residential car parks, low traffic roads (eg cul de sacs, homezones and general access roads) and non-residential car parking with infrequent change (eg schools, offices) ie < 300 traffic movements/day	Low	0.5	0.4	0.4

Figure 3.1 – C573 SuDS Manual Table 26.2 Extract

Given the very low to low pollution index, the 'Simple Index Approach,' is applied, and can be summarised below;

Total SuDS Mitigation Index ≥ Pollution Hazard Index

By inspection the extensive use of SuDS measures throughout the site ensures this criterion is met. Using Table 26.2 and Table 26.3, from the SuDS manual we can compare the mitigation index for bioretention rain gardens with the hazard index for the residential roofs:

Table 3-1 - Pollution Hazard Assessment

	Total SuDS Mitigation Index		Pollution Hazard Index	Status
Total Suspended Solids	0.8	>	0.2	O.K.
Metals	0.8	>	0.2	O.K.
Hydrocarbons	0.8	>	0.05	O.K.

From Table 3-1 above it is clear that the SuDS strategy for the site is effective in removing pollutants from the surface water and therefore protecting the watercourse.

3.7 Attenuation Storage

The GDSDS requires that flood waters be managed within the site for a 1 in 100 year flood + 20% climate change. Any surface water run-off that is not lost to interception will flow to the attenuation tank, which has been designed for that specific area.

The surface water system within the catchment has been hydraulically modelled in Microdrainage. The system has been designed to ensure that it's discharge rate does not exceed the existing greenfield run-off rate from the site.

The attenuation tank has been designed assuming an Aquacell type attenuation system which will be implemented.

For the purposes of the SuDS & attenuation calculations, relevant areas in m^2 are as follows:

Location	Area (m^2)	Run-off Coefficient	Effective Area (MD Calcs) (m^2)
Impermeable Roof	657	0.95	624
Green Roof	2026.5	0.60	1216
Roof Decking	787.5	0.60	472.5
Hardstanding Road	711	0.95	675.5
Permeable paving (podium)	2156	0.60	1293.5
Rain Gardens	388	0.60	233
Soft Landscaping/ paving	3357	0.50	1678.5
Reprofiled area	7400	0.50	3700
Total	**17,483**		**9,893**

The reprofiled area to the southern part of the site (area highlighted in yellow in Figure 3-1), has been included conservatively with a factor of 50% contributing to the drainage network (3,700m^2) with much of the rainfall falling on this reprofiled area will transpire through vegetation uptake, or will be lost to infiltration to the ground, similar to its existing greenfield condition.

Figure 3.2 – Reprofiled area in yellow totalling 7400m^2

In accordance with the IH124 method, the greenfield runoff for existing undeveloped sites measuring less than 50ha can be estimated using the following formula:

$Qbar_{rural}$ (in m^3/s) = $0.00108 \times (0.01 \times AREA)^{0.89} \times SAAR^{1.17} \times SPR^{2.17}$

The soil parameter for clay is 0.45, as can be seen in Figure 3.1 below.

where

SAAR = Standard Average Annual Rainfall in mm = 721mm
(Determined from 1981 – 2010 Annual Average Rainfall Grid)

SOIL = SI boreholes indicate silty clays with poor infiltration approx. 300mm below existing ground level (soakaway tests failed).
Soil type 4 - An index based on the Winter Rain Acceptance Potential of the soil for this area = 0.45

AREA = Area of the positively drained site = 1.74ha

$Qbar_{rural}$ (for a 50ha site) = $0.00108 \times (0.01 \times 50)^{0.89} \times 721^{1.17} \times 0.45^{2.17}$

$Qbar_{rural}$ (for a 50ha site) = 0.22739m^3 / s

$Qbar_{rural}$ (for a 50ha site) = 227.39 litres / s

Interpolating this figure for a site area of 1.74ha:

$Qbar_{rural}$ (for a 1.74ha site) = 7.91 litres / s

SOIL

The soil index SOIL is based on the Winter Rain Acceptance Parameter (WRAP) included in the Flood Studies Report. The index broadly describes infiltration potential and was derived by a consideration of soil permeability, topographic slope, and the likelihood of impermeable layers. Five classes of soils are recognised as shown in Table D1 below and Figure D2.

SOIL	WRAP	Runoff	SOIL Value	Soil Characteristics
1	Very high	Very low	0.15	Sandy, well drained
2	High	Low	0.30	Intermediate soils (sandy)
3	Moderate	Moderate	0.40	Intermediate soils (silty)
4	Low	High	0.45	Clayey, poorly drained
5	Very low	Very high	0.50	Steep, rocky areas

Table D1 Different Classes of Soil

Figure 3.3 – Soil Class Table

It is proposed to provide an attenuation tank to the north west of the site, adjacent to Block A, with a storage volume of 76m^3.

Please see Appendix III for Microdrainage calculation output.

3.8 Interception Storage

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

Interception storage can be attained using SuDS features which allow the rainwater to infiltrate into the ground, evaporate into the atmosphere or transpire through vegetation.

3.8.1 Interception Storage – Contributing Areas

Table 3-2 – Interception Storage Catchment Areas

Area Type	Area (m^2)
Total Green Roof/Roof Decking/Impermeable Roof	3,471
Total Podium Slab	2,156
Hardstanding Road	711
Total Drained Impermeable Area	**6,338**

The Total Drained Impermeable Area refers to the cumulative area of the building footprints, podium slab and the hardstanding access road.

In the context of the subject site the total impermeable area = 6,338m^2.

3.8.2 Green Roof/Roof Decking

The proposed apartment roofs will be covered in extensive green roof and roof decking with drainage board below in all roof areas. The build-up proposed is fully in accordance with the manufacturer's specification. The proposed green roof and roof decking, with a drainage board that has a capacity of 13.5 l/m^2 gives an interception storage of:

$$= 2{,}814 \times \frac{13.5}{1000} = \mathbf{38.0\ m^3}$$

It should be noted that the green roof on apartment buildings is specified on the highest roof levels (not accessible to private apartment residents) of each block and will be the responsibility of the management company to maintain.

3.8.3 Podium Slabs

The podium landscape build ups will comprise of both permeable paving and soft landscaping features. The podium slab will incorporate a drainage board with 12 l/m^2 beneath these build ups providing further interception storage to the green roofs. This drainage board has an interception storage capacity of 12 l/m^2.

$$= 2{,}156 \times \frac{12}{1000} = \mathbf{25.9\ m^3}$$

The proposed interception storage methods, green roof and podium slab, provide 38.0 m^3 and 25.9 m^3 of storage respectively. As outlined in the GDSDS Criterion 1, a new development should provide interception storage to retain the first 5mm to 10mm to fall over the new impermeable area of the site. In this case, the impermeable area of the site amounts to 6,338 m^2 requiring the storage of 31.7 m^3 to 63.4m^3.

The cumulative interception storage provided therefore is as follows:

Desirable Interception Storage (10mm criteria)	
Total Impermeable Area within Proposed Development Site (Refer to Table 3-3)	0.6338ha
Optimum level of interception storage as per GDSDS Table 6.3	10mm
□ Minimum Required Interception Storage = ($0.005 \times 0.6338 \times 10^4$) = 31.7m^3	
Optimum Interception Storage	**63.4m^3**

Interception Storage Provided	
Extensive Green Roof Area = 2,814m^2	
(@ 13.5 l/m²))	38.0m^3
Podium area= 2,156m^2	
(@ 12 l/m²)	25.9m^3
Interception Storage Provided	**63.9m^3**

Table 3-3 - Interception Storage

It is noted that the provided interception volume is in excess of the minimum requirement.

3.9 GSDS Criterion Compliance

3.9.1 Criterion 1 GDSDS – River Water Quality Protection

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

As discussed in Section 3.8, interception storage is provided for the site by a variety of measures.

3.9.2 Criterion 3 GDSDS – Site Flooding

The GDSDS requires that no flooding should occur on site for storms up to and including the 1 in 30-year event. The pipe network and the attenuation storage volumes should, therefore, be checked for such storms to ensure that no site flooding occurs although partial surcharging of the system is allowed if it does not threaten to flood.

For the 1 in 100-year event, manholes are permitted to flood but the flood waters should be contained within the site. In addition, the top water level in any attenuation device during the 100-year storm must be at least 500mm below any vulnerable internal floor levels.

Microdrainage analysis shows the following;

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

The basement car park is covered by a podium slab and does not receive direct rainfall. There will be very limited outflow from the basement, rainfall coming off cars & rainwater coming in through car park vents. The car park drainage is pumped to the nearest foul manhole and is not at risk of any backflow from the surface water system during storm conditions. GDSDS Criterion 3 is therefore complied with.

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

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

Qbar for the site has been calculated in accordance with the IH124 method as 7.91 l/s. A hydro brake downstream of the attenuation tank will be limited to 7.91 l/s, the max site discharge of Qbar for the site. As the surface runoff flow rate generated on site does not exceed Qbar, there is no requirement for long-term storage to limit the impact on the receiving watercourse.

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

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

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

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

3.10 SuDS CIRIA Pillars of Design

3.10.1 Water Quantity

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

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

Per Section 3.7, the attenuation tank & hydrobrake have been designed to ensure that the new peak flow does not exceed the existing peak runoff rate. The various other SuDS measures have been implemented to limit the amount of runoff volume in accordance with the guidelines within the site boundary, by the use of interception storage.

3.10.2 Water Quality

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

A pollutant analysis was performed in Section 3.6 of this report. In that section, the only applicable area within the site capable of providing surface water runoff are the residential roofs. From Section 6 of this report, it is clear that the SuDS strategy for the site is effective in removing pollutants from the surface water and therefore protecting the watercourse.

3.10.3 Amenity

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

BMCE have worked closely with the landscaping architect throughout the SuDS strategy design process to ensure that the measures which have been suggested and incorporated have a high sense of public use. Throughout the site, there is green roofs, permeable paving, tree pits and rain gardens.

3.10.4 Biodiversity

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

By incorporating rain gardens and tree pits within the podium area, bio-diversity is present on site.

3.11 SuDS Conclusion

This section of the report has comprehensively discussed the various SuDS measures which can be applied to the site and then selected them based on the site layout. The chosen SuDs measure were developed in conjunction with the landscaping consultant. A pollutant analysis and a series of SuDS management trains have then been developed based upon these SuDS measures.

In conclusion, the chosen SuDS measures have been analysed for various rainfall scenarios to ensure the most effective measures which can be applied to the site and these measures are effective in treating rainfall on the site to GDSDS and CIRIA criterion, before ultimately discharging into the sea.

4.0 FOUL DRAINAGE SYSTEM

4.1 Existing Foul Sewer Infrastructure

There is no existing foul sewer infrastructure within the site boundary. There is an existing 400mm diameter concrete foul sewer and manhole to the north of the site adjacent to Howth Road (see drawing HOW-BMD-00-ZZ-DR-C1020).

4.2 Proposed Foul Drainage System

The project is subject to the Strategic Housing Development (SHD) planning process and therefore a Statement of Design Acceptance of the project's water & wastewater proposals is required from Irish Water. BMCE submitted our drawing package on the 29th of April 2020 and received comments from Irish Water on the 30th of April. These comments have been addressed and the drawing package was resubmitted on the 15th of May 2020. A Confirmation of Feasibility & Statement of Design Acceptance has been received from IW and is appended to this report.

The new development will be served by a gravity foul network and it is proposed to provide 1no. connection from the site drainage system into the existing public 400mm diameter wastewater network.

Rain water run-off from vehicles entering the basement will be collected via ACOs/gullys and a below slab sewer which will be pumped to ground floor level and directed to a petrol interceptor before discharging into the foul network F1.2

A new 225mm diameter foul sewer will connect into the existing foul manhole to the north of the site. This connection will serve as the developments foul connection to the I.W wastewater network. The I.W foul network will then discharge to Ringsend wastewater treatment plant via a pump station located in Sutton. See drawing HOW-BMD-00-ZZ-DR-C1020 for proposed foul strategy.

The flow table below is calculated using Irish Water flow rates of 150 l/person per day for residential use and the I.W. recommended occupancy rate of 2.7 persons per unit.

Table 4-1 – Foul Network Summary

		Units / m²	Daily Flow (l/day)	Average Flow (l/s)	Peak Flow (l/s)
Blocks A-C	Residential	162 units	72,171	0.835	5.012

For a full breakdown of the calculations see Appendix VI.

5.0 WATER SUPPLY

5.1 Existing Water Supply Infrastructure

There is an existing 160mm diameter MOPVC watermain on Howth Road to the north of the site.

5.2 Proposed Water Supply

The project is subject to the Strategic Housing Development (SHD) planning process and therefore a Statement of Design Acceptance of the project's water & wastewater proposals is required from Irish Water. BMCE submitted our drawing package on the 29th of April 2020 and received comments from Irish Water on the 30th of April. These comments have been addressed and the drawing package was resubmitted on the 15th of May 2020. A Confirmation of Feasibility & Statement of Design Acceptance has been received from IW and is appended to this report.

A new 150mm diameter HDPE water main pipe will be installed on site. It is proposed to provide 1no. connection to the existing water main system on Howth Road. The watermain connection will incorporate a bulk water meter and sluice valves to the requirements of Irish Water. See drawing HOW-BMD-00-ZZ-DR-C1010 for proposed watermain strategy.

A summary of the water demand for the proposed development is summarized in Table 5-1 below.

Table 5-1 – Watermain Summary

		Units / m²	Daily Flow (l/day)	Average Flow (l/s)	Peak Flow (l/s)
Blocks A-C	Residential	162 units	65,610	0.949	4.746

For a full breakdown of the calculations see Appendix VII.

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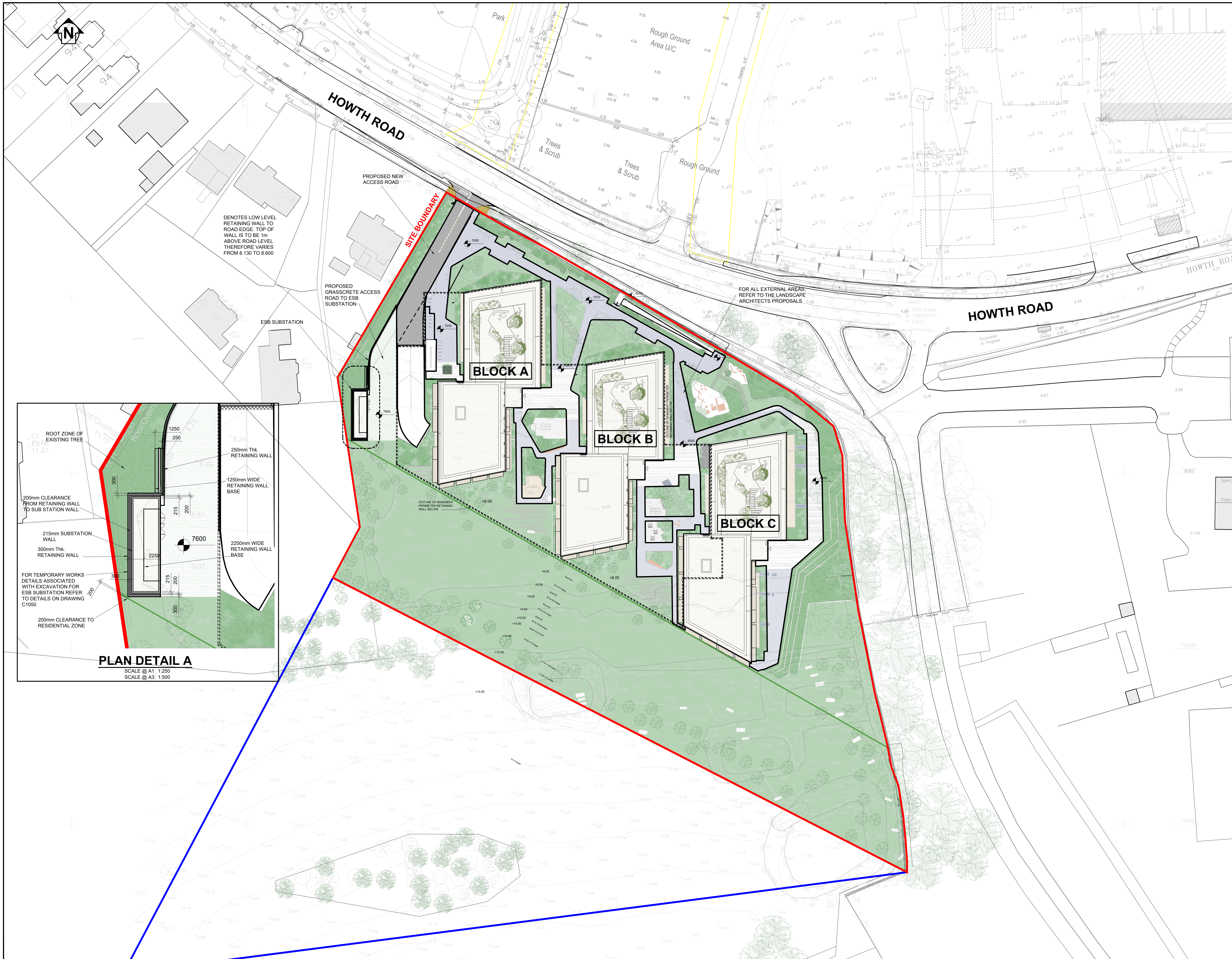
APPENDIX I SITE LOCATION



PROPOSED SITE LAYOUT

SCALE @ A1: 1:500
SCALE @ A3: 1:1000

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL ENGINEERS & ARCHITECT'S DRAWINGS.FIGURED DIMENSIONS ONLY (NOT SCALING) TO BE USED. WHERE A CONFLICT OF INFORMATION EXISTS OR IF IN ANY DOUBT - `ASK'.
2. CONSULTANTS TO BE INFORMED IMMEDIATELY OF ANY DISCREPANCIES BEFORE WORK PROCEEDS.

ISSUE	DATE	DESCRIPTION	DRN / ORIG	P.E. / P.D.
P7	20.05.21	ISSUED FOR SHD APPLICATION	jn / DOR	SOC / SOC
P6	01.04.21	REVISED AS NOTED	MR / DOR	SOC / SOC
P5	25.03.21	REVISED AS NOTED	EC / DOR	SOC / SOC
P4	21.06.20	ISSUED FOR PRE-APPLICATION	AT / DOR	SOC / SOC
P3	14.01.20	PRE-PLANNING ISSUE	AT / DOR	SOC / SOC
P2	18.12.19	ISSUED FOR COMMENT	AT / DOR	SOC / SOC
P1	10.12.19	ISSUED FOR COMMENT	AT / DOR	SOC / SOC

DRAWING STAGE
PLANNING

BM
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QAS INTERNATIONAL ISO 9001:2008 REGISTERED COMPANY Certificate No. IRE1213
The Institution of Structural Engineers
ACEI
FIDIC International Federation of Consulting Engineers

CLIENT
GLL PRS HOLDCO LIMITED

PROJECT TITLE	BM PROJECT No.	
DEVELOPMENT AT HOWTH ROAD	**19196**	
MODEL REFERENCE	MODEL REV.	SUITABILITY

DRAWING TITLE
PROPOSED SITE LAYOUT

DRAWING No.	ISSUE
HOW-BMD-00-ZZ-DR-C1000	**P7**

BARRETT MAHONY
CONSULTING ENGINEERS
CIVIL & STRUCTURAL

APPENDIX II

IRISH WATER DETAILS

UISCE ÉIREANN : IRISH WATER

Stephen O' Connor
52-54 Lower Sandwith Street
Co. Dublin

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

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

www.water.ie

22 January 2020

Dear Stephen,

Re: Connection Reference No CDS19007704 pre-connection enquiry - Subject to contract | Contract denied

Connection for Housing Development of 210 unit(s) at Howth Road, Howth, Co.Dublin.

Irish Water has reviewed your pre-connection enquiry in relation to a water connection at Howth Road, Howth, Co.Dublin. Based upon the details you have provided with your pre-connection enquiry and on the capacity currently available 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 can be facilitated.

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

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

If you have any further questions, please contact us on **1850 278 278** or **+353 1 707 2828, 9.00am-5.30pm, Mon-Fri** or email **newconnections@water.ie**. For further information, visit **www.water.ie/connections.**

Yours sincerely,

M O'Dwyer

Maria O'Dwyer

Connections and Developer Services

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

Stephen O' Connor
52-54 Lower Sandwith Street
Dublin
Co. Dublin

19 May 2020

Re: Design Submission for Howth Road, Howth, Co.Dublin (the "Development") (the "Design Submission") / Connection Reference No: CDS19007704

Dear Stephen O' Connor,

Many thanks for your recent Design Submission.

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

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

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

If you have any further questions, please contact your Irish Water representative:
Name: Dario Alvarez
Email: dalvarez@water.ie

Yours sincerely,

M O'Dwyer

Maria O'Dwyer
Connections and Developer Services

Appendix A

Document Title & Revision

- [19196-HOW-BMD-00-ZZ-DR-C1010_WATERMAIN LAYOUT_Rev. P6]
- [19196-HOW-BMD-00-ZZ-DR-C1021_FOUL & SURFACE WATER DRAINAGE LAYOUT_Rev. P1]
- [19196-HOW-BMD-00-ZZ-DR-C1020_EXTENDED SITE FOUL & SURFACE WATER LAYOUT_Rev. P7]
- [19196-HOW-BMD-00-ZZ-DR-C1100_DRAINAGE SCHEMATIC SECTIONS_Rev. P4]
- [19196-HOW-BMD-00-ZZ-DR-C1101_DRAINAGE SECTIONS SHEET 1_Rev. P4]
- [19196-HOW-BMD-00-ZZ-DR-C1101_DRAINAGE SECTIONS SHEET 2_Rev. P2]

*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.

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CIVIL & STRUCTURAL

APPENDIX III

MICRODRAINAGE CALCULATIONS

STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - Scotland and Ireland

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	15.500	Add Flow / Climate Change (%)	0
Ratio R	0.284	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	1.000	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Time Area Diagram for Storm

Time (mins)	Area (ha)	Time (mins)	Area (ha)	Time (mins)	Area (ha)
0-4	0.107	4-8	0.796	8-12	0.088

Total Area Contributing (ha) = 0.991

TOTAL AREA WITH RUNOFF APPLIED

Total Pipe Volume (m³) = 14.097

Network Design Table for Storm

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	33.000	0.165	200.0	0.187	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	37.900	0.190	199.5	0.060	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	43.100	0.431	100.0	0.045	0.00	0.0	0.600	o	225	Pipe/Conduit	
2.000	77.000	0.385	200.0	0.275	4.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	40.400	0.162	249.4	0.016	0.00	0.0	0.600	o	225	Pipe/Conduit	
3.000	76.800	1.024	75.0	0.334	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)
1.000	50.00	4.60	6.650	0.000	36.0	0.0	0.0	0.92	36.6	36.0
1.001	50.00	4.69	6.485	0.000	36.0	0.0	0.0	0.92	36.7	36.0
1.002	50.00	4.55	6.295	0.000	36.0	0.0	0.0	1.31	52.0	36.0
2.000	50.00	5.39	6.600	0.000	36.0	0.0	0.0	0.92	36.6	36.0
1.003	50.00	4.82	5.864	0.000	29.0	0.0	0.0	0.82	32.7	29.0
3.000	50.00	4.85	6.800	0.000	50.0	0.0	0.0	1.51	60.1	50.0

Network Design Table for Storm

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
1.004	10.000	0.040	250.0	0.074	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.005	1.000	0.004	250.0	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.006	1.000	0.004	250.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.007	13.350	0.053	250.0	0.000	0.00	0.0	0.600	o	150	Pipe/Conduit	
1.008	65.161	0.261	250.0	0.000	0.00	0.0	0.600	o	150	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)
1.004	50.00	4.20	5.700	0.000	30.0	0.0	0.0	0.82	32.7	30.0
1.005	50.00	4.02	5.660	0.000	30.0	0.0	0.0	0.82	32.7	30.0
1.006	50.00	4.03	5.656	0.000	11.0	0.0	0.0	0.63	11.2	11.0
1.007	50.00	4.38	5.650	0.000	11.0	0.0	0.0	0.63	11.2	11.0
1.008	50.00	6.10	5.597	0.000	11.0	0.0	0.0	0.63	11.2	11.0

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1.0	8.000	1.350	Open Manhole	1200	1.000	6.650	225				
S1.1	8.000	1.515	Open Manhole	1200	1.001	6.485	225	1.000	6.485	225	
S1.2	8.000	1.705	Open Manhole	1200	1.002	6.295	225	1.001	6.295	225	
re	8.000	1.400	Open Manhole	1200	2.000	6.600	225				
S1.3	8.000	2.136	Open Manhole	1200	1.003	5.864	225	1.002	5.864	225	
								2.000	6.215	225	351
re.2	8.000	1.200	Open Manhole	1200	3.000	6.800	225				
S1.4	8.000	2.300	Open Manhole	1200	1.004	5.700	225	1.003	5.702	225	2
								3.000	5.776	225	76
S1.5	8.000	2.340	Open Manhole	1200	1.005	5.660	225	1.004	5.660	225	
Tank	6.900	1.244	Open Manhole	1200	1.006	5.656	150	1.005	5.656	225	
S1.5 Hyd	6.900	1.250	Open Manhole	1200	1.007	5.650	150	1.006	5.652	150	2
S1.6	7.120	1.523	Open Manhole	1200	1.008	5.597	150	1.007	5.597	150	
	6.900	1.564	Open Manhole	0		OUTFALL		1.008	5.336	150	

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	S1.0	8.000	6.650	1.125	Open Manhole	1200
1.001	o	225	S1.1	8.000	6.485	1.290	Open Manhole	1200
1.002	o	225	S1.2	8.000	6.295	1.480	Open Manhole	1200
2.000	o	225	re	8.000	6.600	1.175	Open Manhole	1200
1.003	o	225	S1.3	8.000	5.864	1.911	Open Manhole	1200
3.000	o	225	re.2	8.000	6.800	0.975	Open Manhole	1200
1.004	o	225	S1.4	8.000	5.700	2.075	Open Manhole	1200
1.005	o	225	S1.5	8.000	5.660	2.115	Open Manhole	1200
1.006	o	150	Tank	6.900	5.656	1.094	Open Manhole	1200
1.007	o	150	S1.5 Hyd	6.900	5.650	1.100	Open Manhole	1200
1.008	o	150	S1.6	7.120	5.597	1.373	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	33.000	200.0	S1.1	8.000	6.485	1.290	Open Manhole	1200
1.001	37.900	199.5	S1.2	8.000	6.295	1.480	Open Manhole	1200
1.002	43.100	100.0	S1.3	8.000	5.864	1.911	Open Manhole	1200
2.000	77.000	200.0	S1.3	8.000	6.215	1.560	Open Manhole	1200
1.003	40.400	249.4	S1.4	8.000	5.702	2.073	Open Manhole	1200
3.000	76.800	75.0	S1.4	8.000	5.776	1.999	Open Manhole	1200
1.004	10.000	250.0	S1.5	8.000	5.660	2.115	Open Manhole	1200
1.005	1.000	250.0	Tank	6.900	5.656	1.019	Open Manhole	1200
1.006	1.000	250.0	S1.5 Hyd	6.900	5.652	1.098	Open Manhole	1200
1.007	13.350	250.0	S1.6	7.120	5.597	1.373	Open Manhole	1200
1.008	65.161	250.0		6.900	5.336	1.414	Open Manhole	0

Area Summary for Storm

Pipe Number	PIMP Type	PIMP Name	PIMP (%)	Gross Area (ha)	Imp. Area (ha)	Pipe Total (ha)
1.000	-	-	100	0.187	0.187	0.187
1.001	-	-	100	0.060	0.060	0.060
1.002	-	-	100	0.045	0.045	0.045
2.000	-	-	100	0.275	0.275	0.275
1.003	-	-	100	0.016	0.016	0.016
3.000	-	-	100	0.334	0.334	0.334
1.004	-	-	100	0.074	0.074	0.074
1.005	-	-	100	0.000	0.000	0.000
1.006	-	-	100	0.000	0.000	0.000
1.007	-	-	100	0.000	0.000	0.000
1.008	-	-	100	0.000	0.000	0.000
				Total	Total	Total
				0.991	0.991	0.991

Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	S1.0	225	1.125	1.290	Unclassified	1200	0	1.125	Unclassified
1.001	S1.1	225	1.290	1.480	Unclassified	1200	0	1.290	Unclassified
1.002	S1.2	225	1.480	1.911	Unclassified	1200	0	1.480	Unclassified
2.000	re	225	1.175	1.560	Unclassified	1200	0	1.175	Unclassified
1.003	S1.3	225	1.911	2.073	Unclassified	1200	0	1.911	Unclassified
3.000	re.2	225	0.975	1.999	Unclassified	1200	0	0.975	Unclassified
1.004	S1.4	225	2.075	2.115	Unclassified	1200	0	2.075	Unclassified
1.005	S1.5	225	1.019	2.115	Unclassified	1200	0	2.115	Unclassified
1.006	Tank	150	1.094	1.098	Unclassified	1200	0	1.094	Unclassified
1.007	S1.5 Hyd	150	1.100	1.373	Unclassified	1200	0	1.100	Unclassified
1.008	S1.6	150	1.373	1.414	Unclassified	1200	0	1.373	Unclassified

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
1.008		6.900	5.336	5.294	0	0

Simulation Criteria for Storm

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	17
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Winter
Return Period (years)	100	Cv (Summer)	1.000
Region	Scotland and Ireland	Cv (Winter)	1.000
M5-60 (mm)	15.500	Storm Duration (mins)	30
Ratio R	0.284		

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S1.5 Hyd, DS/PN: 1.007, Volume (m³): 1.4

Unit Reference	MD-SHE-0134-7900-0800-7900
Design Head (m)	0.800
Design Flow (l/s)	7.9
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	134
Invert Level (m)	5.650
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

QBAR

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.800	7.9	Kick-Flo®	0.556	6.7
Flush-Flo™	0.251	7.9	Mean Flow over Head Range	-	6.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	4.8	1.200	9.6	3.000	14.7	7.000	22.1
0.200	7.8	1.400	10.3	3.500	15.9	7.500	22.9
0.300	7.8	1.600	10.9	4.000	16.9	8.000	23.6
0.400	7.6	1.800	11.6	4.500	17.9	8.500	24.2
0.500	7.2	2.000	12.2	5.000	18.8	9.000	24.9
0.600	6.9	2.200	12.7	5.500	19.7	9.500	25.6
0.800	7.9	2.400	13.3	6.000	20.5		
1.000	8.8	2.600	13.8	6.500	21.4		

Storage Structures for Storm

Cellular Storage Manhole: Tank, DS/PN: 1.006

Invert Level (m) 5.650 Safety Factor 1.0
Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	**Area (m²)**	**Inf. Area (m²)**	**Depth (m)**	**Area (m²)**	**Inf. Area (m²)**
0.000	100.0	100.0	0.801	0.0	132.0
0.800	100.0	132.0			

Time Area Diagram for Green Roof at Pipe Number 1.000 (Storm)

Area (m³) 111 Evaporation (mm/day) 3
Depression Storage (mm) 14 Decay Coefficient 0.050

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.002017	32	36	0.000407	64	68	0.000082	96	100	0.000017
4	8	0.001651	36	40	0.000333	68	72	0.000067	100	104	0.000014
8	12	0.001352	40	44	0.000273	72	76	0.000055	104	108	0.000011
12	16	0.001107	44	48	0.000223	76	80	0.000045	108	112	0.000009
16	20	0.000906	48	52	0.000183	80	84	0.000037	112	116	0.000007
20	24	0.000742	52	56	0.000150	84	88	0.000030	116	120	0.000006
24	28	0.000608	56	60	0.000123	88	92	0.000025			
28	32	0.000497	60	64	0.000100	92	96	0.000020			

Time Area Diagram for Green Roof at Pipe Number 1.000 (Storm)

Area (m³) 39 Evaporation (mm/day) 3
Depression Storage (mm) 14 Decay Coefficient 0.050

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.000709	32	36	0.000143	64	68	0.000029	96	100	0.000006
4	8	0.000580	36	40	0.000117	68	72	0.000024	100	104	0.000005
8	12	0.000475	40	44	0.000096	72	76	0.000019	104	108	0.000004
12	16	0.000389	44	48	0.000079	76	80	0.000016	108	112	0.000003
16	20	0.000318	48	52	0.000064	80	84	0.000013	112	116	0.000003
20	24	0.000261	52	56	0.000053	84	88	0.000011	116	120	0.000002
24	28	0.000213	56	60	0.000043	88	92	0.000009			
28	32	0.000175	60	64	0.000035	92	96	0.000007			

Time Area Diagram for Green Roof at Pipe Number 1.000 (Storm)

Area (m³) 150 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.002726	4	8	0.002232	8	12	0.001827	12	16	0.001496

Time Area Diagram for Green Roof at Pipe Number 1.000 (Storm)

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
16	20	0.001225	44	48	0.000302	72	76	0.000074	100	104	0.000018
20	24	0.001003	48	52	0.000247	76	80	0.000061	104	108	0.000015
24	28	0.000821	52	56	0.000202	80	84	0.000050	108	112	0.000012
28	32	0.000672	56	60	0.000166	84	88	0.000041	112	116	0.000010
32	36	0.000550	60	64	0.000136	88	92	0.000033	116	120	0.000008
36	40	0.000451	64	68	0.000111	92	96	0.000027			
40	44	0.000369	68	72	0.000091	96	100	0.000022			

Time Area Diagram for Green Roof at Pipe Number 1.001 (Storm)

Area (m³) 111 Evaporation (mm/day) 3
Depression Storage (mm) 14 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.002017	32	36	0.000407	64	68	0.000082	96	100	0.000017
4	8	0.001651	36	40	0.000333	68	72	0.000067	100	104	0.000014
8	12	0.001352	40	44	0.000273	72	76	0.000055	104	108	0.000011
12	16	0.001107	44	48	0.000223	76	80	0.000045	108	112	0.000009
16	20	0.000906	48	52	0.000183	80	84	0.000037	112	116	0.000007
20	24	0.000742	52	56	0.000150	84	88	0.000030	116	120	0.000006
24	28	0.000608	56	60	0.000123	88	92	0.000025			
28	32	0.000497	60	64	0.000100	92	96	0.000020			

Time Area Diagram for Green Roof at Pipe Number 1.001 (Storm)

Area (m³) 39 Evaporation (mm/day) 3
Depression Storage (mm) 14 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000709	32	36	0.000143	64	68	0.000029	96	100	0.000006
4	8	0.000580	36	40	0.000117	68	72	0.000024	100	104	0.000005
8	12	0.000475	40	44	0.000096	72	76	0.000019	104	108	0.000004
12	16	0.000389	44	48	0.000079	76	80	0.000016	108	112	0.000003
16	20	0.000318	48	52	0.000064	80	84	0.000013	112	116	0.000003
20	24	0.000261	52	56	0.000053	84	88	0.000011	116	120	0.000002
24	28	0.000213	56	60	0.000043	88	92	0.000009			
28	32	0.000175	60	64	0.000035	92	96	0.000007			

Time Area Diagram for Green Roof at Pipe Number 1.001 (Storm)

Area (m³) 114 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.002072	12	16	0.001137	24	28	0.000624	36	40	0.000342
4	8	0.001696	16	20	0.000931	28	32	0.000511	40	44	0.000280
8	12	0.001389	20	24	0.000762	32	36	0.000418	44	48	0.000230

Time Area Diagram for Green Roof at Pipe Number 1.001 (Storm)

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
48	52	0.000188	68	72	0.000069	88	92	0.000025	108	112	0.000009
52	56	0.000154	72	76	0.000057	92	96	0.000021	112	116	0.000008
56	60	0.000126	76	80	0.000046	96	100	0.000017	116	120	0.000006
60	64	0.000103	80	84	0.000038	100	104	0.000014			
64	68	0.000084	84	88	0.000031	104	108	0.000011			

Time Area Diagram for Green Roof at Pipe Number 1.002 (Storm)

Area (m^3) 96 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.001745	32	36	0.000352	64	68	0.000071	96	100	0.000014
4	8	0.001428	36	40	0.000288	68	72	0.000058	100	104	0.000012
8	12	0.001169	40	44	0.000236	72	76	0.000048	104	108	0.000010
12	16	0.000957	44	48	0.000193	76	80	0.000039	108	112	0.000008
16	20	0.000784	48	52	0.000158	80	84	0.000032	112	116	0.000006
20	24	0.000642	52	56	0.000130	84	88	0.000026	116	120	0.000005
24	28	0.000525	56	60	0.000106	88	92	0.000021			
28	32	0.000430	60	64	0.000087	92	96	0.000018			

Time Area Diagram for Green Roof at Pipe Number 2.000 (Storm)

Area (m^3) 415 Evaporation (mm/day) 3
Depression Storage (mm) 14 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.007541	32	36	0.001523	64	68	0.000307	96	100	0.000062
4	8	0.006174	36	40	0.001247	68	72	0.000252	100	104	0.000051
8	12	0.005055	40	44	0.001021	72	76	0.000206	104	108	0.000042
12	16	0.004139	44	48	0.000836	76	80	0.000169	108	112	0.000034
16	20	0.003389	48	52	0.000684	80	84	0.000138	112	116	0.000028
20	24	0.002774	52	56	0.000560	84	88	0.000113	116	120	0.000023
24	28	0.002271	56	60	0.000459	88	92	0.000093			
28	32	0.001860	60	64	0.000375	92	96	0.000076			

Time Area Diagram for Green Roof at Pipe Number 2.000 (Storm)

Area (m^3) 158 Evaporation (mm/day) 3
Depression Storage (mm) 14 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.002871	20	24	0.001056	40	44	0.000389	60	64	0.000143
4	8	0.002351	24	28	0.000865	44	48	0.000318	64	68	0.000117
8	12	0.001925	28	32	0.000708	48	52	0.000260	68	72	0.000096
12	16	0.001576	32	36	0.000580	52	56	0.000213	72	76	0.000078
16	20	0.001290	36	40	0.000475	56	60	0.000175	76	80	0.000064

Time Area Diagram for Green Roof at Pipe Number 2.000 (Storm)

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
80	84	0.000053	92	96	0.000029	104	108	0.000016	116	120	0.000009
84	88	0.000043	96	100	0.000024	108	112	0.000013			
88	92	0.000035	100	104	0.000019	112	116	0.000011			

Time Area Diagram for Green Roof at Pipe Number 2.000 (Storm)

Area (m^3) 99 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.001799	32	36	0.000363	64	68	0.000073	96	100	0.000015
4	8	0.001473	36	40	0.000297	68	72	0.000060	100	104	0.000012
8	12	0.001206	40	44	0.000243	72	76	0.000049	104	108	0.000010
12	16	0.000987	44	48	0.000199	76	80	0.000040	108	112	0.000008
16	20	0.000808	48	52	0.000163	80	84	0.000033	112	116	0.000007
20	24	0.000662	52	56	0.000134	84	88	0.000027	116	120	0.000005
24	28	0.000542	56	60	0.000109	88	92	0.000022			
28	32	0.000444	60	64	0.000090	92	96	0.000018			

Time Area Diagram for Green Roof at Pipe Number 2.000 (Storm)

Area (m^3) 321 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.005833	32	36	0.001178	64	68	0.000238	96	100	0.000048
4	8	0.004776	36	40	0.000964	68	72	0.000195	100	104	0.000039
8	12	0.003910	40	44	0.000789	72	76	0.000159	104	108	0.000032
12	16	0.003201	44	48	0.000646	76	80	0.000130	108	112	0.000026
16	20	0.002621	48	52	0.000529	80	84	0.000107	112	116	0.000022
20	24	0.002146	52	56	0.000433	84	88	0.000087	116	120	0.000018
24	28	0.001757	56	60	0.000355	88	92	0.000072			
28	32	0.001438	60	64	0.000290	92	96	0.000059			

Time Area Diagram for Green Roof at Pipe Number 1.003 (Storm)

Area (m^3) 96 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.001745	28	32	0.000430	56	60	0.000106	84	88	0.000026
4	8	0.001428	32	36	0.000352	60	64	0.000087	88	92	0.000021
8	12	0.001169	36	40	0.000288	64	68	0.000071	92	96	0.000018
12	16	0.000957	40	44	0.000236	68	72	0.000058	96	100	0.000014
16	20	0.000784	44	48	0.000193	72	76	0.000048	100	104	0.000012
20	24	0.000642	48	52	0.000158	76	80	0.000039	104	108	0.000010
24	28	0.000525	52	56	0.000130	80	84	0.000032	108	112	0.000008

Time Area Diagram for Green Roof at Pipe Number 1.003 (Storm)

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
112	116	0.000006	116	120	0.000005						

Time Area Diagram for Green Roof at Pipe Number 3.000 (Storm)

Area (m^3) 580 Evaporation (mm/day) 3
Depression Storage (mm) 14 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.010540	32	36	0.002128	64	68	0.000430	96	100	0.000087
4	8	0.008629	36	40	0.001742	68	72	0.000352	100	104	0.000071
8	12	0.007065	40	44	0.001426	72	76	0.000288	104	108	0.000058
12	16	0.005784	44	48	0.001168	76	80	0.000236	108	112	0.000048
16	20	0.004736	48	52	0.000956	80	84	0.000193	112	116	0.000039
20	24	0.003877	52	56	0.000783	84	88	0.000158	116	120	0.000032
24	28	0.003175	56	60	0.000641	88	92	0.000129			
28	32	0.002599	60	64	0.000525	92	96	0.000106			

Time Area Diagram for Green Roof at Pipe Number 3.000 (Storm)

Area (m^3) 236 Evaporation (mm/day) 3
Depression Storage (mm) 14 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.004289	32	36	0.000866	64	68	0.000175	96	100	0.000035
4	8	0.003511	36	40	0.000709	68	72	0.000143	100	104	0.000029
8	12	0.002875	40	44	0.000580	72	76	0.000117	104	108	0.000024
12	16	0.002354	44	48	0.000475	76	80	0.000096	108	112	0.000019
16	20	0.001927	48	52	0.000389	80	84	0.000079	112	116	0.000016
20	24	0.001578	52	56	0.000319	84	88	0.000064	116	120	0.000013
24	28	0.001292	56	60	0.000261	88	92	0.000053			
28	32	0.001058	60	64	0.000214	92	96	0.000043			

Time Area Diagram for Green Roof at Pipe Number 3.000 (Storm)

Area (m^3) 46 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.000836	32	36	0.000169	64	68	0.000034	96	100	0.000007
4	8	0.000684	36	40	0.000138	68	72	0.000028	100	104	0.000006
8	12	0.000560	40	44	0.000113	72	76	0.000023	104	108	0.000005
12	16	0.000459	44	48	0.000093	76	80	0.000019	108	112	0.000004
16	20	0.000376	48	52	0.000076	80	84	0.000015	112	116	0.000003
20	24	0.000308	52	56	0.000062	84	88	0.000013	116	120	0.000003
24	28	0.000252	56	60	0.000051	88	92	0.000010			
28	32	0.000206	60	64	0.000042	92	96	0.000008			

Time Area Diagram for Green Roof at Pipe Number 3.000 (Storm)

Area (m³) 312 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.005670	32	36	0.001145	64	68	0.000231	96	100	0.000047
4	8	0.004642	36	40	0.000937	68	72	0.000189	100	104	0.000038
8	12	0.003800	40	44	0.000767	72	76	0.000155	104	108	0.000031
12	16	0.003112	44	48	0.000628	76	80	0.000127	108	112	0.000026
16	20	0.002548	48	52	0.000514	80	84	0.000104	112	116	0.000021
20	24	0.002086	52	56	0.000421	84	88	0.000085	116	120	0.000017
24	28	0.001708	56	60	0.000345	88	92	0.000070			
28	32	0.001398	60	64	0.000282	92	96	0.000057			

Time Area Diagram for Green Roof at Pipe Number 1.004 (Storm)

Area (m³) 60 Evaporation (mm/day) 3
Depression Storage (mm) 12 Decay Coefficient 0.050

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.001090	32	36	0.000220	64	68	0.000044	96	100	0.000009
4	8	0.000893	36	40	0.000180	68	72	0.000036	100	104	0.000007
8	12	0.000731	40	44	0.000148	72	76	0.000030	104	108	0.000006
12	16	0.000598	44	48	0.000121	76	80	0.000024	108	112	0.000005
16	20	0.000490	48	52	0.000099	80	84	0.000020	112	116	0.000004
20	24	0.000401	52	56	0.000081	84	88	0.000016	116	120	0.000003
24	28	0.000328	56	60	0.000066	88	92	0.000013			
28	32	0.000269	60	64	0.000054	92	96	0.000011			

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

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	17
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.284
Region	Scotland and Ireland	Cv (Summer)	1.000
M5-60 (mm)	15.500	Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	0.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1.0	360 Summer	1	+20%					6.674
1.001	S1.1	360 Summer	1	+20%					6.517
1.002	S1.2	360 Summer	1	+20%					6.324
2.000	re	360 Summer	1	+20%					6.644
1.003	S1.3	360 Summer	1	+20%	30/240 Summer				5.925
3.000	re.2	360 Summer	1	+20%					6.836
1.004	S1.4	360 Summer	1	+20%	30/120 Summer				5.787
1.005	S1.5	720 Summer	1	+20%	30/60 Summer				5.776
1.006	Tank	720 Summer	1	+20%	30/60 Summer				5.774
1.007	S1.5 Hyd	720 Summer	1	+20%	30/60 Summer				5.772
1.008	S1.6	720 Summer	1	+20%					5.665

CLIMATE CHANGE

WATER LEVEL BELOW MH COVER LEVEL ALL OK

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1.0	-0.201	0.000	0.03		0.9	OK	
1.001	S1.1	-0.193	0.000	0.05		1.7	OK	
1.002	S1.2	-0.196	0.000	0.04		1.9	OK	
2.000	re	-0.181	0.000	0.08		3.0	OK	
1.003	S1.3	-0.164	0.000	0.17		5.1	OK	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3.000	re.2	-0.189	0.000	0.06		3.6	OK	
1.004	S1.4	-0.138	0.000	0.32		8.7	OK	
1.005	S1.5	-0.109	0.000	0.26		7.6	OK	
1.006	Tank	-0.032	0.000	0.44		4.7	OK	
1.007	S1.5 Hyd	-0.028	0.000	0.47		4.7	OK	
1.008	S1.6	-0.081	0.000	0.43		4.7	OK	

TOTAL MAX FLOW

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

Simulation Criteria

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

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 17
Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR Ratio R 0.284
Region Scotland and Ireland Cv (Summer) 1.000
M5-60 (mm) 15.500 Cv (Winter) 1.000

Margin for Flood Risk Warning (mm) 0.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status OFF
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years) 1, 30, 100
Climate Change (%) 20, 20, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1.0	120 Summer	30	+20%					6.695
1.001	S1.1	120 Summer	30	+20%					6.546
1.002	S1.2	120 Summer	30	+20%					6.349
2.000	re	120 Summer	30	+20%					6.682
1.003	S1.3	480 Summer	30	+20%	30/240 Summer				6.136
3.000	re.2	120 Summer	30	+20%					6.869
1.004	S1.4	480 Summer	30	+20%	30/120 Summer				6.122
1.005	S1.5	480 Summer	30	+20%	30/60 Summer				6.111
1.006	Tank	480 Summer	30	+20%	30/60 Summer				6.109
1.007	S1.5 Hyd	480 Summer	30	+20%	30/60 Summer				6.102
1.008	S1.6	600 Summer	30	+20%					5.691

CLIMATE CHANGE

WATER LEVEL BELOW MH COVER LEVEL ALL OK

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1.0	-0.180	0.000	0.09		3.0	OK	
1.001	S1.1	-0.164	0.000	0.16		5.6	OK	
1.002	S1.2	-0.171	0.000	0.13		6.6	OK	
2.000	re	-0.143	0.000	0.29		10.2	OK	
1.003	S1.3	0.047	0.000	0.35		10.9	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3.000	re.2	-0.156	0.000	0.20		11.8	OK	
1.004	S1.4	0.197	0.000	0.68		18.5	SURCHARGED	
1.005	S1.5	0.226	0.000	0.62		18.5	SURCHARGED	
1.006	Tank	0.303	0.000	0.73		7.9	SURCHARGED	
1.007	S1.5 Hyd	0.302	0.000	0.77		7.8	SURCHARGED	
1.008	S1.6	-0.056	0.000	0.71		7.8	OK	

TOTAL MAX FLOW

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

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	17
Number of Online Controls	1	Number of Storage Structures	1	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Ratio R	0.284
Region	Scotland and Ireland	Cv (Summer)	1.000
M5-60 (mm)	15.500	Cv (Winter)	1.000

Margin for Flood Risk Warning (mm)	0.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	OFF
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440, 2160, 2880, 4320, 5760, 7200, 8640, 10080
Return Period(s) (years)	1, 30, 100
Climate Change (%)	20, 20, 20

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
1.000	S1.0	60 Summer	100	+20%					6.702
1.001	S1.1	60 Summer	100	+20%					6.556
1.002	S1.2	480 Summer	100	+20%					6.407
2.000	re	60 Summer	100	+20%					6.698
1.003	S1.3	480 Summer	100	+20%	30/240 Summer				6.401
3.000	re.2	60 Summer	100	+20%					6.881
1.004	S1.4	480 Summer	100	+20%	30/120 Summer				6.388
1.005	S1.5	480 Summer	100	+20%	30/60 Summer				6.377
1.006	Tank	480 Summer	100	+20%	30/60 Summer				6.375
1.007	S1.5 Hyd	480 Summer	100	+20%	30/60 Summer				6.369
1.008	S1.6	600 Winter	100	+20%					5.691

CLIMATE CHANGE

WATER LEVEL BELOW MH COVER LEVEL ALL OK

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	S1.0	-0.173	0.000	0.12		4.1	OK	
1.001	S1.1	-0.154	0.000	0.22		7.5	OK	
1.002	S1.2	-0.113	0.000	0.11		5.2	OK	
2.000	re	-0.127	0.000	0.39		13.8	OK	
1.003	S1.3	0.312	0.000	0.42		13.1	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
3.000	re.2	-0.144	0.000	0.27		15.5	OK	
1.004	S1.4	0.463	0.000	0.82		22.2	SURCHARGED	
1.005	S1.5	0.492	0.000	0.74		22.1	SURCHARGED	
1.006	Tank	0.569	0.000	0.74		8.0	SURCHARGED	
1.007	S1.5 Hyd	0.569	0.000	0.77		7.8	SURCHARGED	
1.008	S1.6	-0.056	0.000	0.71		7.8	OK	

TOTAL MAX FLOW

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APPENDIX

IV

FOUL WATER CALULATIONS

BM
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PROJECT TITLE:	RESIDENTIAL DEVELOPMENT, HOWTH ROAD		BY: DO'R
CALCULATION:	FOUL WATER DEMAND		PAGE: 1
CATCHMENT:	BLOCKS A - C		DATE: 11/06/2020

SUMMARY:

		Total Peak Flow	Total Average Flow
A:	Residential (162 units)	5.012 l/s	0.835 l/s
TOTAL		5.012 l/s	0.835 l/s

A: RESIDENTIAL

The foul effluent from the proposed dwellings is calculated as per the Irish Water Code of Practice for Wastewater Infrastructure (Dec. 2017) assuming dry weather flow of 150 l/head/day plus a 10% infiltration rate and using the Irish Water assumed average occupancy of 2.7 persons/unit.

No. of Units = 162

No. of Occupants = 162 x 2.7 = 437.4

Daily Flow = No. of Occupants x Dry Weather Flow

Daily Flow = 437.4 x 150 x 1.1 = 72,171 l/day

$$\text{Average Flow} = \frac{\text{Daily Flow}}{\text{Flow Duration}} = \frac{72{,}171 \text{ l/day}}{24 \times 60 \times 60} = 0.835 \text{ l/s}$$

Peak Flow = Average Flow x 6

Peak Flow = 0.835 l/s x 6 = 5.012 l/s

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APPENDIX

V

WATER SUPPLY CALCULATIONS

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PROJECT TITLE:	RESIDENTIAL DEVELOPMENT, HOWTH ROAD	BY: DO'R
CALCULATION:	WATER DEMAND	PAGE: 1
CATCHMENT:	BLOCKS A-C	DATE: 11/06/2020

	SUMMARY:	Total Peak Demand	Total Average Day / Peak Week Demand
A:	Residential (162 units)	4.746 l/s	0.949 l/s
	TOTAL	4.746 l/s	0.949 l/s

A: RESIDENTIAL

The water demand for the proposed development has been calculated using the guidelines given in the Irish Water Code of Pract for Water Infrastructure (Dec. 17) Section 3.7.2 assuming a per-capita consumption of 150 l/head/day and using the Irish Water assumed average occupancy of 2.7 persons/unit. The average day/peak week demand is taken as 1.25 times the average daily domestic demand. The peak demand factor is taken as 5 times the average day/peak week demand.

No. of Units = 162

No. of Occupants = 162 x 2.7 = 437.4

Avg. Daily Demand = No. of Occupants x Allowance per head

Avg. Daily Demand = 437.4 x 150 = 65,610 l/day

$$\text{Avg. Day / Peak Week Demand} = \frac{\text{Daily Flow}}{\text{Flow Duration}} \times 1.25 = \frac{65{,}610 \text{ l/day}}{24 \times 60 \times 60} \times 1.25 = 0.949 \text{ l/s}$$

Peak Demand = Average Flow x 5

Peak Demand = 0.949 l/s x 5 = 4.746 l/s