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CONSULTING STRUCTURAL and CIVIL ENGINEERS

Engineering Planning Drainage/Water Services Report and Flood Risk Assessment for a Residential site at Haydens Lane, Lucan, Co. Dublin

PROJECT:	HAYDENS LANE
CLIENT:	JACKIE GREENE CONSTRUCTION
DATE:	APR 2022
ISSUE NO:	ADDITIONAL INFORMATION
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Additional Information submission summary of changes made to this report;

- *The quantity of apartments proposed has been reduced to 66No., down from 74No.*
- *There are adjustments made to the carparking arrangement and an additional 2No.spaces are provided (44No. in total).*
- *Additional tree pits and bio-retention areas have been provided.*

Due to the amended surfacing as outlined above, there has been a slight change to the areas of the surfaces and the calculations relating to the surface water drainage have been updated to reflect the slight changes in area. Where amendments have been made to the calculation inputs & results, the changes are highlighted thus in the main body of this report. Updated calculations are included in the appendix and drawings are updated accordingly.

A very basic summary of the updates to the surface water design results are as follows;

Summary of Attenuation Storage Volumes and Levels			
	@Planning Attenuated Volume Reqd	**@Additional Information** Attenuated Volume Reqd	AttenuationVolume Provided
Q30	181m^3	192m^3	@1m =426m^3
Q100 + 20% CC	242m^3	255m^3	@1m =426m^3

1.0 Introduction

1.1 This document relates to the Roads, Drainage & Water Infrastructure design for a proposed residential development located on a brownfield site at Haydens Lane, Lucan, Co. Dublin.

1.2 The site application boundary area is c.1.09Ha and was formerly a used as a factory unit. In 2017 SDCC approved a grant of planning on the site for a nursing home under Reg.Ref. SD15A/0301.

1.3 The planning application will consist of 66No.residential units (reduced from 74 as per Additional Information response) and the associated ancillary roads and services infrastructure. The residential units will consist of 3No.apartment blocks. A full description of the application details is contained in the main application documentation noted by McGill Planning consultants and Oppermann Associates Architects.

Fig.1 - Site Location

1.4 As part of the pre-planning process, Roger Mullarkey and Associates (RMA) have met and discussed the drainage and water services with Mr. Brian Harkin and Mr. Ronan Toft of South Dublin County Council's (SDCC) Drainage Department and Mr. Laurence Colleran of the Parks Department on 01/02/21 and 24/03/21. Furthermore, a Pre-Connection Enquiry Form (PCEF) was submitted and approved by Irish Water (IW) and is included in the appendix of this report.

1.5 Site soakaway testing of was carried out and a summary of the report prepared by Ground Investigations Limited is included in the appendix of this document.

2.0 Key Objectives

2.1 This document incorporates the design, background and detail of the following aspects.

- Road & Block Levels
- Roads Access
- Storm Water Site Drainage
- Foul Water Site Drainage
- Sustainable Drainage Systems (SuDS)
- Attenuation
- Water Supply Infrastructure
- Flood Risk Assessment

2.2 Reference should be made to all drainage drawings and designs included in the appendix of this report and all other consultant's reports and drawings as part of the overall application documentation.

3.0 Site Location, Topography & Access

3.1 The proposed development is located at the end of Haydens Lane, a cul-de-sac residential road. Haydens Lane carriageway is approximately. 5.7m wide and has 2No.existing concrete footpaths fronting the site. There are currently 2No.gated vehicular access points from the site onto Haydens Lane.

3.2 The area of the site is c.1.09Ha and is currently a derelict brownfield site that was formerly used as a factory. The site is predominately hardstanding with original tarmac roads/car parking and a large concrete floor slab.

3.3 A Topographical survey was carried out on the site and surrounding area and indicates that the site is essentially flat with just c.400mm of a gradient from high to low point in a north/south direction. A site survey drawing is shown as a background on the Road & Block Levels drawing 2031B/01 included in this application.

3.4 The site is bounded by a fence facing Haydens Lane to the west, by an overgrown hedgerow and dry ditch to the north, east and south of the site.

3.5 Road & Block levels design has been prepared as part of this application (ref.Dwg.No.2031B/01). Generally, the proposed road and apartment block levels follow the existing contours of the site topography where possible.

3.6 Proposed road gradients vary between 1/120 (0.83%) and 1/94(1.06%) which are in accordance with the DOELG Recommendations for Site Development Works for Housing Areas and the Dept. Of Transport's Design Manual for Urban Roads and Streets (DMURS) documentation.

3.7 The existing site currently has 2No.vehicular accesses onto Haydens Lane separated by c.95m as outlined in Fig.1 above.

3.8 This application proposes to utilise only the northern access while closing off and landscaping the existing southern point. The existing Haydens Lane carriageway is approximately 5.7m wide and has an existing concrete footpath either side of the road fronting the site. This application proposes to widen the existing footpath along the site frontage onto Haydens Lane.

3.9 The access sightlines are achieved at a 2.4m offset and 49m site distance as outlined on Dwg.No.2031B/01.

3.10 Within the site there is a single 5.5m wide access road provided.

3.11 44No.car parking spaces are provided within the proposed development. A separate Transportation Assessment Report has been prepared by TPC Consulting Engineers and is included in the overall submission and the reader if referred to that document for details of the traffic and parking arrangements.

4.0 Existing Drainage Services

4.1 Records drawings were obtained from SDCC/IW in preparation for this planning application and are included in the appendix of this document. There are existing piped water, surface water and foul water services available adjacent to the site boundaries.

4.2 There are existing drainage and water connections to the public services already on the site. This application seeks to establish new foul and surface water connections and remove all existing defunct drainage services. The existing watermain connection point is to be re-used as per agreement with Irish Water.

4.3 A Confirmation of Feasibility (CoF) letter was obtained from Irish Water relating to the foul sewer and watermain supply available to the site and both connections were noted as *"Feasible without infrastructure upgrade by Irish Water"*, a copy of which is included in the appendix of this report.

5.0 Proposed Surface Water Drainage Summary

5.1 As part of the design of the storm water network and SuDS components, the following documentation were the principal references;

- South Dublin County Council County Development Plan 2016 - 2022
- CIRIA Report c753 "The SuDS Manual" 2015
- Greater Dublin Strategic Drainage Study (GDSDS) 2005
- The Greater Dublin Regional Code of Practice for Drainage Works
- DOELG Recommendations for Site Development Works for Housing Areas.
- SDCC/Irish Water Drainage Records maps
- Available OPW flood maps and reports (from *floodinfo.ie*)
- OPW Eastern CFRAM study
- OPW PFRM mapping
- Geological Survey of Ireland (GSI) and EPA websites
- Teagasc soils data sets
- Ordnance Survey mapping
- Topographical survey
- Site Investigation reports
- Site walkover visits
- Discussions with SDCC Drainage/Road/Water/Parks Departments
- Irish Water PCEA submission and approval

5.2 The design of the storm water network has been carried out in accordance with and in conjunction with the requirements of the SDCC Water Services and Parks Departments as were ascertained in pre-planning meetings/discussions. The proposed surface water network will utilise the existing dry-ditches surrounding the site as part of the overall SuDS strategy and which was specifically requested by the Parks Department.

5.3 A Site-Specific Flood Risk Assessment (SSFRA) study report was prepared and can be reviewed in chapter 8 of this report.

5.4 Refer to Dwg.No.2031B/01 for the surface water general arrangement layout and to Dwg.No.2031B/02 for attenuation and SuDS details.

5.5 The surface water drainage design has been carried out in accordance with the Greater Dublin Regional Code of Practice, the GDSDS and the CIRIA Report c753 "The SuDS Manual" 2015. Attenuation and SuDS are included in the design.

5.6 The surface water drainage infrastructure for the development will collect the rainfall on the site and convey the storm water run-off via roadside tree pits, existing surrounding dry-ditches, garden filter drains, permeable paving, gullies, underground pipes, manholes, catchpit manhole and direct the flows to the grassed detention swale area before outfalling via a vortex flow restricting device (Hydrobrake or similar) and a petrol interceptor before to the dry grassed depression in the Park to the SE of the site. The above was agreed in principle with both the Parks and Water Services Department during the pre-planning consultation process.

5.7 The total allowable surface water outfall rate is to be in proportion to the drained site area of 1.03Ha as per the GDSDS 2 l/s/ha resulting in an outfall Qbar rate of **2.1l/s.** It is noted that the existing brownfield site is >75% (c.0.65Ha) covered in drained hardstanding which results in a current run-off rate of c.40l/s. Therefore, this applications imposed attenuated Qbar rate of 2.1l/s is a **c.95% reduction of the current outfall rate** and a considerable improvement on the current situation.

5.8 The surface water drainage design is based on the Modified Rational Method based on a 2-year return period which is suitable to a flat site as this. Rainfall data was obtained from Met Eireann (ref. appendix) and noted that the SAAR = 773mm, the M5/60 = 16.6mm and R is 0.274.

5.9 Despite the soil conditions of the site being unsuitable for successful infiltration (f unobtainable in one test and 4.39 x10 $^{-6}$ m/s in the other), it is proposed to utilise several SuDS elements and attenuation storage upstream of the outfall. An estimate of the attenuated storage volume required for the site is based on the following runoff areas outlined in Table 1 below;

Surface Type	Gross Area (m^2)	PIMP (%)	Net Area (m^2)
Roads/Paths to drains	657	95	624
Roads/Paths via Tree Pits/SuDS	1277	70	894
Permeable paving	616	60	370
Green Roofs	1526	80	1221
Roofs/paths via Filter Drains	774	71	550
Grassed/Landscape	5479	15	822
TOTAL	**10,329 m^2**		**4,481 m^2**

Table 1 - Drained Areas

5.10 Detailed surface water design calculations were carried out using the MicroDrainage software including simulation of multiple rainfall events for 2, 30 & 100 year return periods. An allowance for a 20% climate change increase in rainfall was applied to the Q100 events as required under the GDSDS.

5.11 Based on the above noted **net 4,481m^2 runoff area** and using the MicroDrainage design software, the **Q30** total required attenuated storage volume was determined to be **192m^3** (refer to appendix for detailed calculations).

5.12 Based on the above noted **net 4,481m^2 runoff area** and using the MicroDrainage design software, the **Q100 +20% climate change** total required attenuated storage volume was determined to be **255m^3** (refer to appendix for detailed calculations).

5.13 In accordance with the GDSDS **Criterion 1, the required** interception volume is **19.3m^3** (refer to paragraph 5.18) and is provided in the SuDS features. This interception volume can be subtracted from the total required storage volume.

5.14 Therefore the required Q100 + 20% Climate change attenuation on site storage system volume is;

255m^3 (reqd) - 19.3m^3 (Interception) = **236m^3.**

5.15 As was requested by SDCC Public Realm Department (Parks) during the pre-planning process, this application seeks to utilise the existing dry ditch to the north and east of the site as a SuDS swale and also use the existing dry grassed depression to the south of the site as the bio-retention SuDS attenuation storage feature. The available water storage volume in the attenuation area is far greater than the maximum calculated required attenuation volume for the Q100+20% event. The Q100+20% event will generate 255m^3 at a storage depth of 735mm but the available storage depth is c.1.68m.

Calculating the available storage volume at say just 1m depth results in an available storage volume of **426m^3** at **1m** depth of water (remembering that the maximum depth generated by the Q100+20% = 255m^3 @ 735mm). Therefore, there is significantly more storage capacity will ever be generated by the Q100+20% event. This is concluded to be a safe and conservative approach to attenuation provision. Ref.Dwg.2031B/01 & 02 and to the appendix of this report for further detail.

5.16 The estimated top water level of the stored water for the **Q30** event was determined to be 53.09mOD which is 1.86m below the lowest finished floor level on the site. The estimated top water level of the stored water for the Q100+20% event was determined to be 53.24mOD which is 1.71m below the lowest finished floor level on the site.

5.17 A summary of the attenuation volumes and levels are provided in Table 2 below;

Summary of Attenuation Storage Volumes and Levels			
	Attenuated Volume Reqd	Attenuation Volume Provided	Top Water Level
Q30	192m^3	@1m =426m^3	53.09mOD(593mm deep)
Q100 + 20% CC	255m^3	@1m =426m^3	53.24mOD(735mm deep)

Table 2 - Attenuation Summary

5.18 In accordance with the GDSDS **Criterion 1**, interception of at least 5mm of rainfall is required to prevent runoff to the receiving water. The interception storage will be within the voids of the voids of the stone base of the permeable paving, below the filter drain pipework and that below the base of the attenuation storage, as well as the tree pit and bio-retention undrained volumes. As per the parameters laid out in the GDSDS the interception volume was calculated as per Table 3 below;

Paved surfaces connected to the drainage system = 1.03Ha	Drained Area = 1.03Ha-0.548ha grassed = 0.482Ha
Volume of Interception storage required	=0.482x10^{4}x0.005x0.8=19.3m^3
Volume of Interception Provided	
Voided stone below overflow pipe of of permeable paving =	616(area)x0.15(depth)x0.3(voids) = 27.7m^3
Voided stone below overflow pipe of of filter drains =	105m(length)x0.15m(width)x0.4(voids) = 6.3m^3
Tree Pit/Bio-Retention storage	2m(width)x5m(length)x0.05m(depth)x12No =6m^3
50mm of storage below outfall pipe	c.100m^2(area) x 0.05m (depth) = 5m^3
Total Interception Volume Provided =	38.7m^3
Volume Provided > Volume Required	**38.7 m^3>19.3m^3**
Criterion 1 is deemed satisfied as Volume Interception provided > Vol required	

Table 3 - Interception Storage Calculation

5.19 In accordance with the GDSDS, the four principal design criteria are set out in Section 6.3.4 of Vol 2 of the GDSDS and are summarised as follows;

- Criterion 1 - River water quality protection
- Criterion 2 - River Regime protection
- Criterion 3 - Level of service (flooding) for the site
- Criterion 4 - River Flood Protection

5.20 Compliance with those 4No.criterion is summarised in Table 4 below;

Criterion	Method	Required	Provided	Compliance
1	Interception	19.3m^3	38.7m^3	**Yes**
2	Qbar and storage	2.1 l/s and 255m^3	2.1 l/s and >426m^3	**Yes**
3	Flooding	No flooding and 500mm freeboard	No flooding and 500mm freeboard	**Yes**
4	River Flood Protection	Qbar rate applied	Qbar rate applied	**Yes**

Table 4 - GDSDS Criterion

5.21 Extensive SuDS measures have been provided in this application replicating the natural characteristics and providing amenity/biodiversity.

The appropriate SuDS features included in this proposal include the following;

- Use of the natural existing dry-ditches as bio-diverse conveyance. swale
- Attenuated storage provided in detention swale
- Filter drains to the rear of the apartment blocks
- 2No.roadside swales
- 12No. Tree pits & Bio-Retention areas to drain the roads
- Permeable paving to all private parking areas
- Green roofs to apartment blocks (c.1,526m^2 of 1,690m^2 = 90%)
- Silt-trap/catchpit manhole
- Hydrobrake limiting flow to Qbar greenfield rates
- Petrol interceptor upstream of all outfall points

5.22 With the inclusion of these measures it is proposed that the SuDS treatment of the runoff has been adequately addressed. Refer to Dwg.No.2031B/03 for details of each SuDS element and the appendix for calculations of the S/W drainage system.

6.0 Wastewater Site Drainage

6.1 Foul drainage records drawings were obtained from SDCC/IW in preparation for this planning application and are included in the appendix of this document.

6.2 A Pre-Connection Enquiry Form application (PCEA) was submitted to Irish Water and a confirmation of available service was received from IW noting that the connection is "*Feasible without infrastructure upgrade by Irish Water*". A copy of the IW confirmation letter can be viewed in the appendix of this report.

6.3 The minimum public sewer diameter is to be 150mm and the foul drains/sewer are to be in accordance with the Irish Water Code of Practice for Wastewater Infrastructure 2017.

Foul Sewer Design Criteria	
Min.velocity	0.75m/s
Max.velocity	3m/s
Min.sewer size for TIC	150mm diameter
Pipe friction (Ks)	1.5mm
Minimum pipe depth	1.2m below roads 0.9m in open/grassed spaces
Ave.Occupancy	2.7 persons/unit
Residential loading/person/day	150 l/day

Table 5 - Foul Sewer Design Criteria

6.4 Each of the 3No.apartment blocks are to be connected to the main public foul sewer using a 100mm diameter drain with a minimum gradient of 1/60 in any one drain.

6.5 The sites foul drainage system is to outfall into the IW 450mm foul sewer just south of the site in the Griffeen park. This proposal makes use of the original site topography and minimises deep pipeline excavation to allow the foul to flow by gravity in the most efficient design and utilize the nearest available public services. Refer to Dwg.2031B/02.

6.6 Design estimates for the foul water loading were carried out in accordance with eth Irish Water Code of Practice June '20 (Rev 4) and are included in the appendix of this report.

6.7 Details of manholes are to be as in accordance with the Irish Water Wastewater Standard Details June '20 (Rev 4).

7.0 Site Watermain

7.1 Water infrastructure records drawings were obtained from Irish Water/SDCC in preparation for this planning application and are included in the appendix of this document.

7.2 A Pre-Connection Enquiry Form application (PCEA) was submitted to Irish Water and a confirmation of available service was received from IW noting that the *"Feasible without infrastructure upgrade by Irish Water"*. A copy of the IW confirmation letter can be viewed in the appendix of this report.

7.3 This application seeks to make use of the existing watermain connection to the 150mm diameter watermain on the west of the site facing Haydens Lane.

7.4 Refer to **Dwg.No. 2031B/01** for the watermain layout.

7.5 Each of the 6No.apartments in Block 1 are to be provided with a boundary box for a separate domestic water meter. Blocks 2 & 3 are to be provided with an 80mm diameter connection as per the Irish Water Code of Practice (Rev 4 2020). The type and configuration of the water meter is to be agreed with Irish Water in advance of construction commencing at the development.

7.6 In accordance with best practice, the use of water conservation appliances in the buildings are to be employed as part of this scheme to reduce the water demand. Although the consumption of treated water depends a lot on the behaviour of consumers, demand on the network is limited in the scheme by incorporating water saving tap valves, eco-flush toilet system and water saving appliances.

7.7 All watermain layout and details are to be in accordance with the Irish Water Code of Practice for Water Infrastructure 2020 (Rev 4) and the Water Infrastructure Standard details 2020 (Rev 4).

7.8 Estimates of the water demand for the site were carried out using the guidelines in accordance with the IW COP for Water Infrastructure 2017 publication and are shown in the appendix of this report.

7.9 It is proposed to provide looped ends of the watermain/s in cul-de-sacs to prevent stagnation of water supply.

8.0 Flood Risk Assessment

8.0.1 In accordance with the requirements set out in the DoEHLG and OPW published guidelines *The Planning System and Flood Risk Management 2009* (the *Guidelines*), a Site-Specific Flood Risk Assessment (SSFRA) is carried out for this application.

8.0.2 The purpose of the SSFRA is to scope for possible sources of flooding, assess the types of flood risk for the proposed development and to consider if there are any possible impacts on flood risk elsewhere due to the development. Where appropriate, the SSFRA recommends flood mitigation and management measures and identifies residual risks, if any should remain after the implementation of the identified measures.

8.0.3 The report is intended for the sole use of the applicant, their elected agents and advisors and, further, solely for the purpose for which it was originally commissioned. It may not be assigned or copied to third parties or relied upon by third parties.

8.0.4 The criteria under which this Site-Specific Flood Risk Assessment is carried out in accordance with the DoEHLG and OPW requirements and the parameters ascertained by consultation with Drainage Department of South Dublin County Council.

8.1 Flood Risk Guidelines and the Planning System

8.1.1 The Planning System and Flood Risk Management, Guidelines for Planning Authorities (the Guidelines) was published in November 2009. The main purpose of the Guidelines is to ensure that sustainable development can be delivered by integrating flood risk management into the planning process.

8.1.2 The core objectives of the guidelines are to;

- Avoid inappropriate development in areas at risk of flooding;
- Avoid new developments increasing flooding elsewhere, including that which may arise from surface water runoff;
- Ensure effective management of residual risks for development permitted in floodplains;
- Avoid unnecessary restriction of national, regional, or local economic and social growth;
- Improve the understanding of flood risk among relevant stakeholders;

- Ensure that the requirements of EU and national law in relation to the environment and nature conservation are complied with at all stages of flood risk management.

8.1.3 A staged approach is adopted to the Flood Risk Assessment (FRA) as follows;

8.1.4 ***Stage 1 - Flood risk identification*** - identify whether there may be any flooding or surface water management issues related to either the area or regional planning guidelines, development plans and LAP's or a proposed development site that may warrant further investigation at the appropriate lower-level plan or planning application levels.

8.1.5 ***Stage 2 - Initial flood risk assessment*** - to confirm sources of flooding that may affect a plan area or proposed development site, to appraise the adequacy of existing information and to scope the extent of the risk of flooding which may involve preparing indicative flood zone maps. Where hydraulic models exist the potential impact of a development on flooding elsewhere and of the scope of possible mitigation measures can be assessed.

8.1.6 ***Stage 3 Detailed flood risk assessment*** - to assess flood risk issues in sufficient detail and to provide a quantitative appraisal of potential flood risk to a proposed or existing development or land to be zoned, of its potential impact on flood risk elsewhere and of the effectiveness of any proposed mitigation measures.

8.1.7 From the Guidelines Section 3.1, the broad philosophy underpinning the sequential approach in flood risk management is laid out as follows;

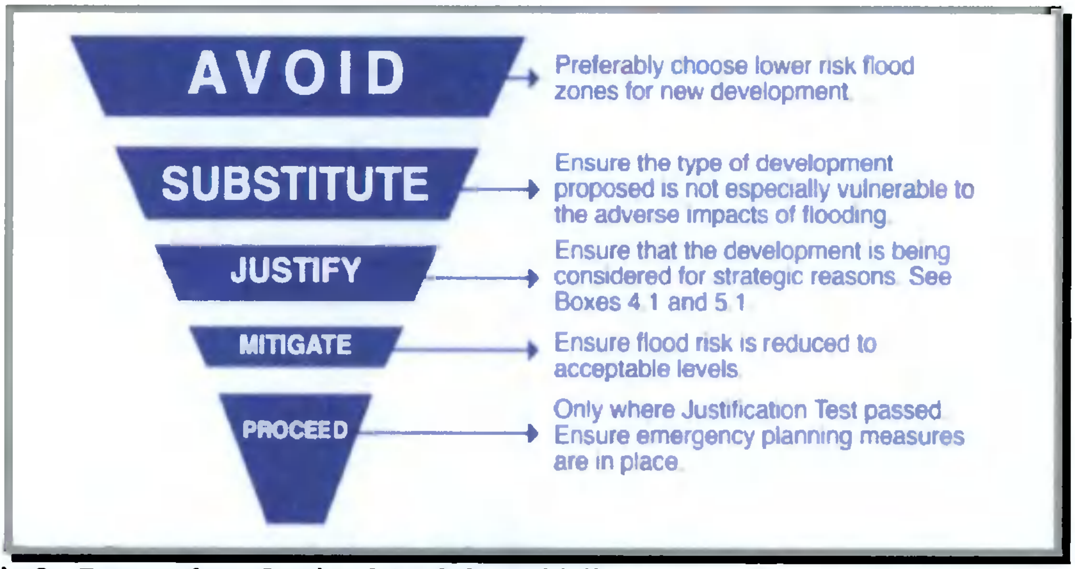

Fig.2 - Extract from Section 3.1 of the Guidelines

8.1.8 The sequential approach to planning is a key tool in ensuring that development, particularly new development, is first and foremost directed towards land that is at low risk of flooding.

8.1.9 The sequential approach described in Fig.2 above should be applied to all stages of the planning and development management process and is applicable in the layout and design of development within a specific site at the development management stage.

8.1.10 The following flow chart from Section 3.2 of the Guidelines describes its mechanism for use in the planning process.

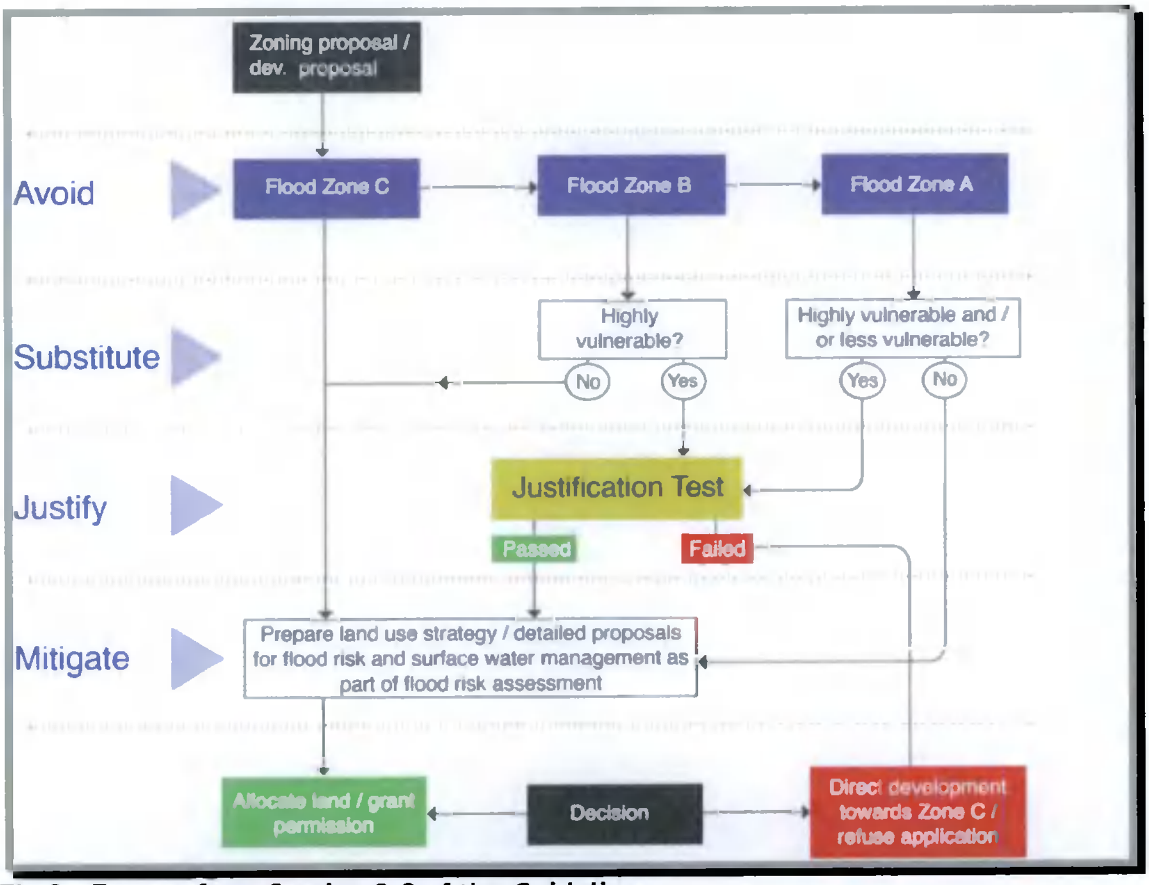

Fig.3 - Extract from *Section 3.2* of the *Guidelines*

8.1.11 There are 3 types or levels of flood zones defined in the Guidelines and are as described in Table 6 below;

Flood Zone	Description
A	Where the probability of flooding from rivers and the sea is highest (greater than 1% or 1 in 100 for river flooding or 0.5% or 1 in 200 for coastal flooding)
B	Where the probability of flooding from rivers and the sea is moderate (between 0.1% or 1 in 1000 years and 1% or 1 in 100 years for river flooding and between 0.1% or 1 in 1000 year and 0.5% or 1 in 200 for coastal flooding)
C	Where the probability of flooding from rivers and sea is low (less than 0.1% or 1 in 1000 years for both river and coastal flooding). Flood Zone C covers all areas of the plan which are non in Zones A or B.

Table 6 - Flood Zones

8.1.12 The following table extracted from the Guidelines section 3.5 defines the Vulnerability Classes of various types of development.

Vulnerability class	Land uses and types of development which include*:
Highly vulnerable development (including essential infrastructure)	Garda, ambulance and fire stations and command centres required to be operational during flooding; Hospitals; Emergency access and egress points; Schools; Dwelling houses, student halls of residence and hostels; Residential institutions such as residential care homes, children's homes and social services homes; Caravans and mobile home parks; Dwelling houses designed, constructed or adapted for the elderly or, other people with impaired mobility, and Essential infrastructure, such as primary transport and utilities distribution, including electricity generating power stations and sub-stations, water and sewage treatment, and potential significant sources of pollution (SEVESO sites, IPPC sites, etc.) in the event of flooding
Less vulnerable development	Buildings used for: retail, leisure, warehousing, commercial, industrial and non-residential institutions; Land and buildings used for holiday or short-let caravans and camping, subject to specific warning and evacuation plans; Land and buildings used for agriculture and forestry; Waste treatment (except landfill and hazardous waste); Mineral working and processing, and Local transport infrastructure
Water-compatible development	Flood control infrastructure; Docks, marinas and wharves; Navigation facilities; Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location; Water-based recreation and tourism (excluding sleeping accommodation), Lifeguard and coastguard stations; Amenity open space, outdoor sports and recreation and essential facilities such as changing rooms; and Essential ancillary sleeping or residential accommodation for staff required by uses in this category (subject to a specific warning and evacuation plan)

*Uses not listed here should be considered on their own merits

Fig.4 - Extract from Section 3.5 of the Guidelines

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8.1.13 The vulnerability of class of a development and the identified flood zone are used to determine the appropriateness of the development proposed and which types of development would need to undergo a Justification Test as per the extracted table from section 3.6 of the Guidelines below;

	Flood Zone A	Flood Zone B	Flood Zone C
Highly vulnerable development (including essential infrastructure)	Justification Test	Justification Test	Appropriate
Less vulnerable development	Justification Test	Appropriate	Appropriate
Water-compatible development	Appropriate	Appropriate	Appropriate

Fig.5 - Extract from Section 3.6 of the Guidelines

8.1.14 Should the review of the sequential approach determine that a Justification test is necessary, i.e., a development lies in a high/moderate risk of flooding and be inappropriate as per the Justification test able as above, the following table extracted from the Guidelines section 5.15 needs to be satisfied;

Box 5.1 Justification Test for development management (to be submitted by the applicant)

When considering proposals for development, which may be vulnerable to flooding, and that would generally be inappropriate as set out in Table 3.2, the following criteria must be satisfied:

1. The subject lands have been zoned or otherwise designated for the particular use or form of development in an operative development plan, which has been adopted or varied taking account of these Guidelines.
2. The proposal has been subject to an appropriate flood risk assessment that demonstrates:
   - (i) The development proposed will not increase flood risk elsewhere and, if practicable, will reduce overall flood risk;
   - (ii) The development proposal includes measures to minimise flood risk to people, property, the economy and the environment as far as reasonably possible;
   - (iii) The development proposed includes measures to ensure that residual risks to the area and/or development can be managed to an acceptable level as regards the adequacy of existing flood protection measures or the design, implementation and funding of any future flood risk management measures and provisions for emergency services access; and
   - (iv) The development proposed addresses the above in a manner that is also compatible with the achievement of wider planning objectives in relation to development of good urban design and vibrant and active streetscapes.

The acceptability or otherwise of levels of residual risk should be made with consideration of the type and foreseen use of the development and the local development context.

Fig.6- Extract from Section 5.15 of the Guidelines

8.2 Site Specific Flood Risk Assessment

8.2.1 The site is a greenfield development situated on c.0.88 Ha located along Haydens Lane, Lucan, Co. Dublin.

8.2.2 The existing site has a generally level topography at an elevation of 54.90mOD to 54.50mOD Malin.

8.2.3 The site is located in a residential area and is adjacent to the Griffeen Park to the east of the site.

8.2.4 The coastline is located more that 15km from the site.

8.2.5 This site-specific flood risk assessment has been compiled based on information received from the following sources:

- SDCC Drainage maps
- Available OPW flood maps and reports (from floodmaps.ie)
- Internet based search into local flooding
- Site visits

8.2.6 This report is complied from the information gathered from the above sources and is prepared for the purposes of a planning application for housing development consisting of 74No.units.

8.2.7 The risks categorised above are based on the judgement and experience for the Engineer carrying out the assessment and based on the documentation sourced from the above locations.

8.2.8 We concerned ourselves mainly with the flooding risks and do not refer to other engineering, architectural, or other defects or deficiency on this site.

8.2.9 The report is intended for the sole use of the applicant, their elected agents and advisors and, further, solely for the purpose for which it was originally commissioned. It may not be assigned or copied to third parties or relied upon by third parties.

8.2.10 The sources of potential risk of flooding include coastal, fluvial, pluvial, public sewers and groundwater. This document will identify these potential sources and categorise the risk as either very low, low, medium, high, and very high.

8.2.11 A Road & Block levels drawing has been prepared as part of this application and reference should be made to Dwg.No.2031B/01 in this regard. Generally, the proposed road levels and house levels follow the existing contours of the original site topography. No house level is lower than the adjacent centre of road level.

8.2.12 The following assessment will identify the potential sources of flooding and categorise the risk as either very low, low, medium, high, and very high.

8.2.13 The risks categorised above are based on the judgement and experience for the Engineer carrying out the assessment and based on the documentation sourced from the Flood Risk Indicator sources as noted in Section 8.4 of this report.

8.2.14 The initial assessment process will involve examining the flood risk indicators. Where it is demonstrated that there is a risk of flooding the study will progress to a more detailed flood risk assessment, if required. Each of the below 5 potential sources of flood risk will be assessed in this regard.

8.3 Potential Sources of Flood Risk

8.3.1 **Tidal**
Coastal flooding is caused by higher sea levels than normal, largely as a result of storm surges, resulting in the sea overflowing onto the land.

8.3.2 **Fluvial**
Caused by the overtopping of rivers/streams when the capacity of a watercourse is exceeded or the channel is blocked or restricted, and excess water spills out from the channel onto adjacent low-lying area.

8.3.3 **Pluvial**
Caused when the intensity of rainfall events cannot be absorbed into the ground or urban drainage systems cannot effectively convey the flowrates.

8.3.4 **Groundwater**
Groundwater flooding occurs when the level of water stored in the ground, the water table, rises as a result of prolonged rainfall. Groundwater flooding tends to be very local and result from interactions of site-specific factors such as tidal variations.

8.3.5 **Human/Mechanical Error**
Caused by blockages in piped systems or intervention of/failure of mechanical devices.

8.4 Flood Risk Indicators

8.4.1 The initial flood risk identification involves a scoping review of existing available information and datasets. The following source indicators were researched as part of the Stage 1 process;

- SDCC Drainage Records maps
- Available OPW flood maps and reports (from *floodmaps.ie*)
- Strategic Flood Risk Assessment for South Dublin County Council Development Plan 216-2022
- OPW Eastern CFRAM study
- OPW PFRM mapping
- Geological Survey of Ireland (GSI) website
- Teagasc soils data sets
- Ordnance Survey mapping
- Topographical survey
- Site Investigation reports
- Site walkover visits
- Discussions with SDCC Drainage Department

8.5 Tidal Flood Risk

8.5.1 Tidal flooding is caused by higher sea levels than normal, largely as a result of storm surges, resulting in the sea overflowing onto the land. There are also tidal effects on groundwater levels.

8.6 Tidal Flood Risk Indicators

8.6.1 Reference to land mapping websites such as google maps/OSI mapviewer indicate that this site is more than 15km from the coast. The site topographical survey demonstrates that the land is elevated at c.54.60mOD Malin Head.

8.7 Initial Tidal Flood Risk Assessment

8.7.1 Based on the remote distance from the coastline and the elevated nature of the site, in our opinion there is no risk of Tidal flooding on this site.

8.8 Fluvial Flood Risk

8.8.1 Fluvial river/stream flooding occurs when the capacity of a watercourse is exceeded or the channel is blocked or restricted, and excess water spills out from the channel onto adjacent low-lying area.

8.9 Fluvial Flood Risk Indicators

8.9.1 The Griffeen River which lies c.30m to the east of the subject site, flooded in November 2000 and the flooding extended over the application lands and the general area. The http://www.floodinfo.ie website contains the historical records of that flood event.

8.9.2 As the subject site was impacted by flooding in the past and due to the proximity of the Griffeen River, a Stage 3 Detailed flood risk assessment was carried out as summarised below.

8.10 Detailed Fluvial Flood Risk Assessment

8.10.1 The site has existing dry-ditches along the north, east and southern boundaries. The Griffeen River is located in the Griffeen Park c.30m from the eastern site boundary.

8.10.2 In researching the history of existing dry ditches to the north, east and south of the subject site, reference was made to the EPA web portal https://gis.epa.ie/EPAMaps/Water. Furthermore, discussions and a site visit were held with the SDCC Water Services Department engineers. The Irish Water Webmap showing the drainage records for the area was obtained and studies as part of the SSFRA research.

8.10.2 The existing dry-ditch to the north and east of the subject site was noted on the EPA mapping to be part of the original waterbody Ref. IE_EA_09L012100 Liffey_170.

8.10.3 Historically the pre-development field drains/ditches formed a network of waterbodies upstream of the subject site but these have since been removed as part of housing estate development west of the site over the past 20-25 years.

8.10.4 In examining the drainage records drawings provided by SDCC Water Services Department, there are no records of any surface water pipes draining into the existing dry-ditches to the north, east or south of the subject site.

8.10.5 Discussions were held with engineers from the SDCC Water Services Department and confirmed that there were no known surface water piped networks outfalling into the existing dry-ditches.

8.10.6 Site visits were carried, one of which was in the company of the SDCC Water Services Department Engineers and the SDCC Public realm (Parks) Department official, to determine if there was any evidence of water flowing into the existing ditches surrounding the site. As a result of those visits, it was concluded that there was no evidence of water flow entering the existing dry-ditches from lands upstream of the subject site.

8.10.7 The Griffeen River which lies c.30m to the east of the subject site, flooded in November 2000 and the flooding extended over the application lands and the general area. The http://www.floodinfo.ie website contains the historical records of that flood event.

8.10.8 A repository of past flood events is available on the website http://www.floodinfo.ie and in reference to same the OPW have provided a Past Flood Event Local Area Summary Report for the general area including the subject site. Refer to the appendix of this report for a copy of that summary.

8.10.9 Subsequent to the Nov 2000 flooding, South Dublin County Council commissioned JB Barry Consulting Engineers to produce a report entitled "Report on Flood Event 5/6th November 2000 In The River Griffeen Catchment". That report was published dated March 2001. That report also noted flooding on the subject site and the surrounding Old Forge and Grange Manor housing estates.

8.10.10 In the Mar'01 JB Barry report, in Section 7, listed recommendations and measures for the short and medium/long term flood alleviation improvements to be carried out on the Griffeen River. These recommendations ranged from cleaning out of existing ditches to carrying out more significant works such as regrading/widening of drainage channels, raising embankment levels, underpinning of bridge and installation of new culverts.

8.10.11 These works were subsequently completed under the Griffeen River Flood Alleviation Scheme in between the years c.2003-2005.

8.10.12 A summary of the above noted completed flood relief works is shown in Fig 7 extract below taken from the OPW 2018 publication "Flood Risk Management Plan" relating to River Basin district 09 concerning the River Liffey & Dublin Bay;

2.6.23 River Griffeen Flood Alleviation Scheme

The River Griffeen Flood Alleviation Scheme was initiated in 2003 following major flooding in 2000, and was constructed from 2003 to 2004. The Scheme, that provides protection to the 1 in 100 year Standard of Protection against flooding from the Griffeen River, comprised of:

- the lowering of the river bedrock in Lucan Village,
- the lowering of the horseshoe weir at Vesey Bridge,
- repointing and raising height of masonry pillars,
- repointing and raising height of wall in Main Street Lucan.

2.6.24 Griffeen River Flood Relief Works

In addition to the works on the River Griffeen described in Section 2.6.21 above, further developer led flood relief measures were completed along the watercourse. The Griffeen River Flood Relief Works was initiated in 2003 following severe flooding on 5th/6th November 2000 during which 48 newly occupied houses at Old Forge and Grange Manor were flooded. It was agreed that the developer would carry out the flood relief works. The Scheme, that provides protection against flooding from the Griffeen River, comprised of:

- Widening and deepening the Griffeen River between the Canal to the outlet structure downstream of Griffeen Avenue so as to convey a flood flow of $25m^3/S$.
- Installation of gabion protection along river bank at Lucan Pitch and Putt Club.
- New culverts under Hayden's Lane, the railway and Griffeen Avenue.
- The construction of 1 vehicular bridge and 5 pedestrian bridges.

Fig.7- Extract from OPW "Flood Risk Management Plan" - 2018

8.10.13 The OPW carried out a significant study known as the Eastern Catchment Flood Risk Assessment and Management (CFRAM) which commenced in June 2011 and was completed in 2016. The CFRAM study can be viewed on the http://www.floodinfo.ie/publications/ website.

8.10.14 As part of the CFRAMS program, flood extent maps were published in their final version in 2016. The relevant flood extents map local to the subject site on Haydens Lane is the "Baldonnel Fluvial Flood Extents" Dwg.No. E09BAL_EXFCD_F0_11 dated 21/07/16, an extract of which is shown in Fig 8 below and the full map is included in the appendix of this report;

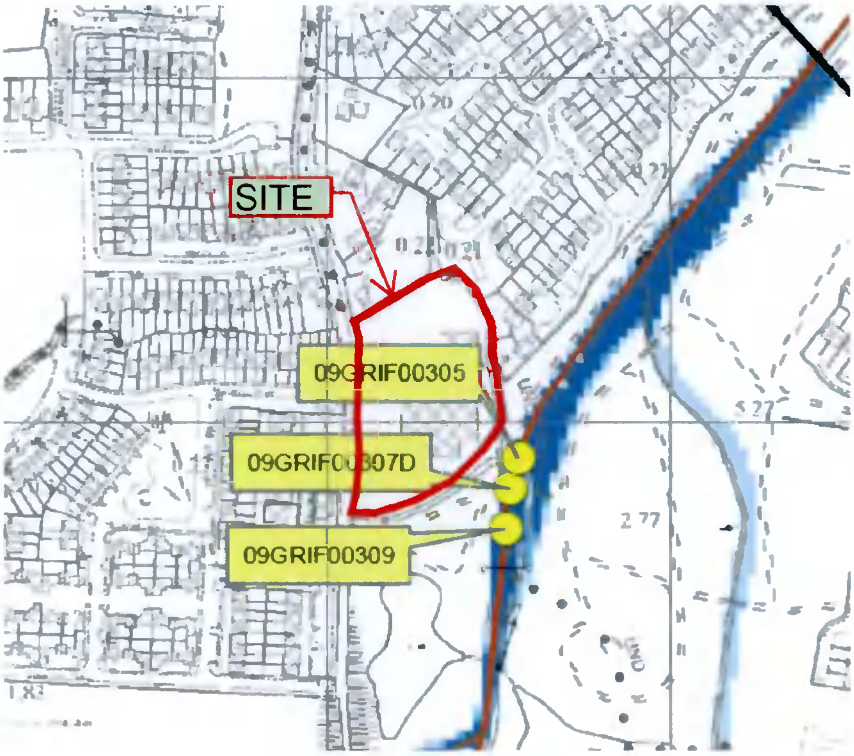


Fig.8 - Extract from *E09BAL_EXFCD_F0_11*

8.10.15 The CFRAM mapping indicates the flood extent boundaries for various return period events as shaded blue in the Fig X above. These Annual Exceedance Probability (AEP) events of 10%, 1% and 0.1% (or 1 in 10 year, 1 in 100 year and 1 in 1000 year) were examined as part of the CFRAM mapping and where shaded are referred to as Flood Zone A or B.

8.10.16 As was previously outlined in Table 6 in this report, where the probability of flooding from rivers and sea is low (less than 0.1% or 1 in 1000 years for both river and coastal flooding) remains unshaded, then a Flood Zone C covers all areas of the plan which are non in Zones A or B. In reference to the CFRAM map above, the subject site location is within a Zone C.

8.10.17 As outlined previously, Section 3.6 of the *Guidelines*, refer to Fig 8 above, a Flood Zone C is deemed "Appropriate" for development as there is a low risk of flooding.

8.10.18 The floor slab levels for the proposed residential development are to be 54.95mOD & 55.10mOD as identified in the application drawing No.2031B/01. The CFRAM study predicted top water level for the 0.1% (1 in 1000 year) event is noted as 53.13mOD. Therefore, there is a freeboard of 1.82m above the highest predicted 1000 year event and the finished floor levels of the proposed development.

8.11 *Fluvial Flood Risk Assessment*

8.11.1 As the subject site was impacted by flooding in the past and due to the proximity of the Griffeen River, a Stage 3 Detailed flood risk assessment was carried out.

8.11.1 Significant flood alleviation works were completed on the Griffeen River in c.2005 as confirmed in the OPW 2018 publication “Flood Risk Management Plan”.

8.11.1 Extensive hydraulic modelling of the Griffeen River was carried as part of the CFRAMS program.

8.11.1 The site is now outside the flood risk zone and is categorised as Zone C under the *Guidelines* and is deemed appropriate for development.

8.12 Pluvial Flood Risk

8.12.1 Pluvial flooding is caused when the intensity of rainfall events cannot be absorbed into the ground or urban drainage systems cannot effectively convey the flowrates.

8.13 Pluvial Flood Risk Indicators

8.13.1 Reference was made to the available drainage records drawings of SDCC.

8.13.2 There is an existing 525mm diameter S/W pipeline flowing in a southerly direction in Haydens Lane that than turns eastwards into a 600mm diameter pipe flowing through the Griffeen Park before outfalling to the Griffeen River. This invert of this S/W pipeline is c.52.52mOD and the existing ground level is c.54.74mOD.

8.13.3 There is also an existing 450mm diameter foul sewer pipe running parallel with eth above noted S/W pipe both along Haydens Lane and then through the Griffeen Park.

8.13.4 Reference can be made to the Irish Water Webmap indicating theses drainage pipes in the appendix of this report.

8.13.5 Discussions with both the SDCC Building Control Department and Water Services Department concluded that there is no known flooding from either of these sewers.

8.13.6 The surface water outfall rate from the proposed development has been restricted to 2.1 l/s as outlined in paragraph 5.7 of this report.

8.14 Initial Pluvial Flood Risk Assessment

8.14.1 Under Section 3.5 of *the Guidelines* the vulnerability of residential development is deemed as high risk of pluvial flooding from the new infrastructure, it is seen as appropriate that a detailed pluvial flood risk assessment be reviewed.

8.15 Detailed Pluvial Flood Risk assessment

8.15.1 The proposed new drainage surface water infrastructure for the development has been designed to cater for flows generated by all storms up to the Q100+20% (climate change) without flooding occurring.

8.15.2 The pipe sizes and gradients are designed to convey the storm water flows to a singular attenuation location where the storage capacity has been designed to exceed the Q100+20% event. Calculations for the critical rainfall events have been included in the appendix of this document.

8.15.3 The **required Q30** storm water storage volume for this site is **c.192m³** as determined from the MicroDrainage simulation modelling software. This volume will be stored within the interception areas and the grassed retention swale to the south of the site.

8.15.4 The **required volume for the Q100 +20% event** is **c.255m³** as determined from the MicroDrainage simulation modelling software results. This volume will be stored within the interception areas and the grassed retention swale to the south of the site.

8.15.5 The maximum top water level of stored attenuated flow in the detention swale was determined to be c.53.24mOD. As the lowest floor slab level on the site is 54.95mOD, there will be a freeboard of 1.71m which is greater than the minimum 0.5m as recommended in the GDSDS.

8.15.6 It is noted that the provided **interception storage** volume of **c.38.7m³** (refer to Table 3) has not been subtracted from the required attenuation volume nor has it been added to the available storage volume and is therefore considered to be a safer conservative approach to attenuation storage estimation.

8.15.7 SuDS elements included in the pluvial design include filter drains, bio-retention area, tree pits, permeable paving, rainwater butts, use of the existing ditches as a conveyance swale and a grassed detention swale.

8.16 Conclusion of the Detailed Pluvial Flood Risk Assessment

8.16.1 In accordance with the sequential assessment approach as per the Guidelines flowchart (section 8.1.10 above) it is concluded that the requirements have been met and no further assessment is required in regard to pluvial flood risk.

8.17 Groundwater Flood Risk

8.17.1 Groundwater flooding occurs when the level of water stored in the ground, the water table, rises as a result of prolonged rainfall. Groundwater flooding tends to be very local and result from interactions of site-specific factors such as tidal variations.

8.18 Groundwater Flood Risk Indicators

8.18.1 Soakaway testing carried out on the site indicated poor to no infiltration results. No ground water was noted as encountered during the trial holes investigations, but it is noted that ground water levels can vary depending on the time of year. Refer to Ground Investigations summary report in the appendix of this document.

8.18.2 A topographical survey was carried out on the site and indicates that the site is generally flat with an average ground level of c.54.75mOD.

8.18.3 Reference was also made to the online web portal provided by the Geological Survey of Ireland (GSI) https://gis.epa.ie/EPAMaps/Water as well as the alluvial maps provided by the Teagasc link on the GSI website.

8.18.4 The underlying soil conditions recorded on the GSI dataset are noted as predominantly “Bmin PD - Basic Deep Poorly Drained Material - derived from mainly calcareous parent materials” and the Soil Group noted as “Surface water Gleys, Ground water Gleys”. Refer to the appendix of this report for GSI mapping relating to the site.

8.18.5 There were no recorded groundwater issues for the subject site/area on the Geological Survey of Ireland online datasets and reference can be made to the summary groundwater map report included in the appendix of this report.

8.18.6 Site walkovers were carried out in varying weather conditions and the water table was not evident during of the visits.

8.18.7 In reference to the Road and Block Levels drawing No.2031B/01 it is noted that all finished floor levels of buildings on the site are to be constructed above the ground level and above the adjacent roads.

8.19 Initial Groundwater Flood Risk Assessment

8.19.1 The indicators described above suggest that the site is not at risk of flooding from groundwater and accordingly a detailed assessment of the flooding mechanism is not required, and, in our opinion, there is a low risk of groundwater flooding onto the site.

8.20 Human/Mechanical Error Flood Risk

8.21.1 There are flood risks associated with misuse, neglect, damage, intervention of or lack of intervention attributable to mechanical failure or human error. Such a risk can be caused by blockages in piped systems or lack of maintenance of mechanical devices.

8.22 Human/Mechanical Error Flood Risk Indicators

8.22.1 Based on the experienced professional judgement of the engineering designer and in consultation with the Drainage Department of SDCC, it has been considered that blockages can occur with systems for many reasons.

8.23 Initial Human/Mechanical Error Flood Risk Assessment

8.23.1 As there is some risk of pluvial flooding from human/mechanical error, the new infrastructure is not deemed as a low-risk occurrence and the vulnerability of residential development is classified as high (refer to Section 8.1.13 of this report), it is seen as appropriate that a more detailed human/mechanical error flood risk assessment be reviewed.

8.24 Detailed Human/Mechanical Error Flood Risk Assessment

8.24.1 As part of the assessment for blockages in the system, the MicroDrainage design model was run on the basis that there was a near 100% blockage of the outfall vortex control device for a 30minute period. Therefore, the model was run with a reduction in the outfall rate from 2.1 ls down to 0.1 l/s for a 30min duration in the Q100 + 20% event. The resulting top of water level was noted to be c.52.89mOD with a volume of backed up storage requirement c.112m^3. This volume and water level are easily contained in the attenuation area provided and no flooding was noted. Refer to appendix for MicroDrainage calculations of the blocked outfall.

8.25 Conclusion of the Detailed Human/Mechanical Error Risk Assessment

8.25.1 In accordance with the sequential assessment approach as per the Guidelines flowchart (section 8.1.10 above) it is concluded that the requirements have been met and no further assessment is required in regard to human/mechanical error flood risk.

8.26 Source Pathway Receptor Model

8.26.1 A source-pathway-receptor model as per the Appendix A 1.3 of the Technical Appendices accompanying the *Guidelines* was created and is shown in the Table 7 below. This model indicates the possible sources of flood water and the pathway to the receptors (the buildings/people) and the risks associated based on the findings of the FRA research.

Source	Pathway	Receptor	Likelihood	Consequence	Risk
Tidal	>15km from coast and elevated >45m above sea level	People/ property	Remote	N/A	Very Low
Fluvial	Overtopping of ditch	People/ property	Remote	N/A	Low
Pluvial (Surface water)	Flooding from drainage systems	People/ property	Possible	Low	Low
Groundwater	Rising water table	People/ property	Possible	Low	Low
Human/ Mechanical Error	Blockage of drainage	People/ property	Possible	Moderate	Low

Table 7

8.27 SSFRA Conclusion

8.27.1 As is required under the DoEHLG and OPW published guidelines *The Planning System and Flood Risk Management 2009* (the Guidelines), a Site-Specific Flood Risk Assessment (SSFRA) is carried out for this application.

8.27.2 In accordance with the above noted Guidelines, as sequential staged approach was adopted in assessing the flood risk for the subject development.

8.27.3 It was determined in accordance with the Guidelines that the lands on which the subject development is located is within a flood Zone C as defined in the Guidelines.

8.27.4 It is concluded that a residential development is appropriate on the subject lands flood Zone type C.

8.27.5 It is concluded that the above level of assessment is sufficient given the nature of the development and the level of flood risk identified for the site.

8.27.6 Based on the information available it is concluded that this site is suitable for development and has an overall low risk of been affected by flooding.

Report prepared by;

____________________________ Apr 2022

Roger Mullarkey BSc.Eng, Dip.Eng, C.Eng, MIEI, Eur.Ing, FconsEI

9.0 APPENDIX

Contents:

Appendix 9.1

MicroDrainage S/W Calculations

Q2 Event

Summary of Results for 2 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	52.611	0.111	1.8	28.0	O K
30 min Summer	52.646	0.146	2.0	37.6	O K
60 min Summer	52.670	0.170	2.0	44.2	O K
120 min Summer	52.726	0.226	2.1	60.7	O K
180 min Summer	52.745	0.245	2.1	66.4	O K
240 min Summer	52.758	0.258	2.1	70.3	O K
360 min Summer	52.772	0.272	2.1	74.8	O K
480 min Summer	52.780	0.280	2.1	77.3	O K
600 min Summer	52.785	0.285	2.1	78.7	O K
720 min Summer	52.787	0.287	2.1	79.5	O K
960 min Summer	52.788	0.288	2.1	79.7	O K
1440 min Summer	52.782	0.282	2.1	78.0	O K
2160 min Summer	52.767	0.267	2.1	73.3	O K
2880 min Summer	52.750	0.250	2.1	67.9	O K
4320 min Summer	52.715	0.215	2.1	57.2	O K
5760 min Summer	52.682	0.182	2.0	47.6	O K
7200 min Summer	52.655	0.155	2.0	39.9	O K
8640 min Summer	52.633	0.133	1.9	33.9	O K
10080 min Summer	52.617	0.117	1.9	29.4	O K
15 min Winter	52.624	0.124	1.9	31.4	O K
30 min Winter	52.664	0.164	2.0	42.5	O K
60 min Winter	52.708	0.208	2.1	55.3	O K
120 min Winter	52.755	0.255	2.1	69.3	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	36.467	0.0	29.0	30
30 min Summer	24.976	0.0	39.8	43
60 min Summer	16.597	0.0	49.2	68
120 min Summer	10.805	0.0	71.8	128
180 min Summer	8.323	0.0	83.0	186
240 min Summer	6.945	0.0	92.4	242
360 min Summer	5.374	0.0	107.4	312
480 min Summer	4.468	0.0	119.1	380
600 min Summer	3.872	0.0	129.0	446
720 min Summer	3.444	0.0	137.7	516
960 min Summer	2.864	0.0	152.7	656
1440 min Summer	2.208	0.0	176.4	936
2160 min Summer	1.695	0.0	204.5	1348
2880 min Summer	1.406	0.0	226.1	1740
4320 min Summer	1.080	0.0	260.1	2512
5760 min Summer	0.894	0.0	288.0	3232
7200 min Summer	0.771	0.0	310.5	3920
8640 min Summer	0.684	0.0	330.2	4600
10080 min Summer	0.617	0.0	347.4	5344
15 min Winter	36.467	0.0	32.6	30
30 min Winter	24.976	0.0	44.7	43
60 min Winter	16.597	0.0	61.1	70
120 min Winter	10.805	0.0	80.5	128

Q2 Event

Summary of Results for 2 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180 min Winter	52.778	0.278	2.1	76.4	O K
240 min Winter	52.793	0.293	2.1	81.4	O K
360 min Winter	52.811	0.311	2.1	87.0	O K
480 min Winter	52.818	0.318	2.1	89.4	O K
600 min Winter	52.823	0.323	2.1	91.1	O K
720 min Winter	52.825	0.325	2.1	91.9	O K
960 min Winter	52.825	0.325	2.1	91.7	O K
1440 min Winter	52.812	0.312	2.1	87.4	O K
2160 min Winter	52.781	0.281	2.1	77.5	O K
2880 min Winter	52.750	0.250	2.1	67.7	O K
4320 min Winter	52.691	0.191	2.1	50.2	O K
5760 min Winter	52.644	0.144	2.0	37.0	O K
7200 min Winter	52.612	0.112	1.8	28.2	O K
8640 min Winter	52.592	0.092	1.7	23.1	O K
10080 min Winter	52.583	0.083	1.6	20.6	O K

Q2 volume to be stored

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	8.323	0.0	93.1	184
240 min Winter	6.945	0.0	103.6	240
360 min Winter	5.374	0.0	120.3	348
480 min Winter	4.468	0.0	133.4	410
600 min Winter	3.872	0.0	144.5	480
720 min Winter	3.444	0.0	154.3	558
960 min Winter	2.864	0.0	171.0	716
1440 min Winter	2.208	0.0	197.5	1020
2160 min Winter	1.695	0.0	229.1	1452
2880 min Winter	1.406	0.0	253.3	1852
4320 min Winter	1.080	0.0	291.5	2604
5760 min Winter	0.894	0.0	322.6	3288
7200 min Winter	0.771	0.0	347.8	3968
8640 min Winter	0.684	0.0	369.9	4560
10080 min Winter	0.617	0.0	389.3	5264

Q2 Event

Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	2	Cv (Summer)	0.750
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.600	Shortest Storm (mins)	15
Ratio R	0.274	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Pipe Network

Volume in Pipe Network (m^3)	5	Dia of Outfall Pipe (m)	0.2
Slope of Outfall Pipe (1:X)	150	Roughness of Outfall Pipe (mm)	0.600

Time Area Diagram

Total Area (ha) 0.448

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.090	4	8	0.153	8	12	0.205

Model Details

Storage is Offline Cover Level (m) 54.000 Dividing Weir Level (m) 52.550

Tank or Pond Structure

Invert Level (m) 52.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	237.0	0.900	533.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0070-2100-0900-2100
Design Head (m)	0.900
Design Flow (l/s)	2.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	70
Invert Level (m)	52.500
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	2.1	Kick-Flo®	0.564	1.7
Flush-Flo™	0.273	2.1	Mean Flow over Head Range	-	1.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.4	3.000	3.7	7.000	5.4
0.200	2.1	1.400	2.6	3.500	3.9	7.500	5.6
0.300	2.1	1.600	2.7	4.000	4.2	8.000	5.8
0.400	2.0	1.800	2.9	4.500	4.4	8.500	6.0
0.500	1.9	2.000	3.0	5.000	4.6	9.000	6.1
0.600	1.7	2.200	3.2	5.500	4.8	9.500	6.3
0.800	2.0	2.400	3.3	6.000	5.1		
1.000	2.2	2.600	3.4	6.500	5.2		

Q30 Event

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	52.701	0.201	2.1	53.1	O K
30 min Summer	52.766	0.266	2.1	72.8	O K
60 min Summer	52.830	0.330	2.1	93.4	O K
120 min Summer	52.892	0.392	2.1	114.7	O K
180 min Summer	52.918	0.418	2.1	123.7	O K
240 min Summer	52.954	0.454	2.1	136.9	O K
360 min Summer	52.984	0.484	2.1	148.3	O K
480 min Summer	53.000	0.500	2.1	154.6	O K
600 min Summer	53.009	0.509	2.1	158.1	O K
720 min Summer	53.014	0.514	2.1	159.9	O K
960 min Summer	53.019	0.519	2.1	161.7	O K
1440 min Summer	53.017	0.517	2.1	161.2	O K
2160 min Summer	53.003	0.503	2.1	155.7	O K
2880 min Summer	52.983	0.483	2.1	148.0	O K
4320 min Summer	52.939	0.439	2.1	131.3	O K
5760 min Summer	52.892	0.392	2.1	114.7	O K
7200 min Summer	52.847	0.347	2.1	99.0	O K
8640 min Summer	52.804	0.304	2.1	85.0	O K
10080 min Summer	52.766	0.266	2.1	72.8	O K
15 min Winter	52.721	0.221	2.1	59.1	O K
30 min Winter	52.795	0.295	2.1	82.0	O K
60 min Winter	52.866	0.366	2.1	105.4	O K
120 min Winter	52.927	0.427	2.1	126.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	67.032	0.0	54.4	30
30 min Summer	46.105	0.0	75.2	44
60 min Summer	30.113	0.0	99.8	74
120 min Summer	19.191	0.0	126.6	132
180 min Summer	14.636	0.0	140.8	188
240 min Summer	12.059	0.0	160.4	250
360 min Summer	9.155	0.0	183.2	368
480 min Summer	7.521	0.0	200.6	486
600 min Summer	6.454	0.0	215.1	602
720 min Summer	5.695	0.0	227.6	690
960 min Summer	4.672	0.0	248.5	806
1440 min Summer	3.534	0.0	279.7	1066
2160 min Summer	2.672	0.0	322.4	1476
2880 min Summer	2.189	0.0	352.2	1884
4320 min Summer	1.652	0.0	398.3	2688
5760 min Summer	1.352	0.0	435.8	3464
7200 min Summer	1.157	0.0	466.2	4192
8640 min Summer	1.019	0.0	492.5	4936
10080 min Summer	0.915	0.0	515.5	5648
15 min Winter	67.032	0.0	60.4	31
30 min Winter	46.105	0.0	84.2	44
60 min Winter	30.113	0.0	111.8	72
120 min Winter	19.191	0.0	138.1	126

Q30 Event

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180 min Winter	52.979	0.479	2.1	146.4	O K
240 min Winter	53.007	0.507	2.1	157.2	O K
360 min Winter	53.043	0.543	2.1	171.2	O K
480 min Winter	53.065	0.565	2.1	180.1	O K
600 min Winter	53.078	0.578	2.1	185.8	O K
720 min Winter	53.087	0.587	2.1	189.2	O K
960 min Winter	53.093	0.593	2.1	191.8	O K
1440 min Winter	53.087	0.587	2.1	18[illegible]	O K
2160 min Winter	53.067	0.567	2.1	181.2	O K
2880 min Winter	53.032	0.532	2.1	167.1	O K
4320 min Winter	52.953	0.453	2.1	136.7	O K
5760 min Winter	52.875	0.375	2.1	108.6	O K
7200 min Winter	52.802	0.302	2.1	84.2	O K
8640 min Winter	52.739	0.239	2.1	64.5	O K
10080 min Winter	52.689	0.189	2.0	49.7	O K

Q30 volume to be stored

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	14.636	0.0	163.9	188
240 min Winter	12.059	0.0	180.2	246
360 min Winter	9.155	0.0	205.1	362
480 min Winter	7.521	0.0	224.5	476
600 min Winter	6.454	0.0	240.6	590
720 min Winter	5.695	0.0	254.4	702
960 min Winter	4.672	0.0	277.1	918
1440 min Winter	3.534	0.0	302.9	1172
2160 min Winter	2.672	0.0	361.1	1636
2880 min Winter	2.189	0.0	394.4	2080
4320 min Winter	1.652	0.0	446.0	2904
5760 min Winter	1.352	0.0	488.1	3696
7200 min Winter	1.157	0.0	522.2	4408
8640 min Winter	1.019	0.0	551.7	5096
10080 min Winter	0.915	0.0	577.6	5752

Q30 Event

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)	16.600	Shortest Storm (mins)	15
Ratio R	0.274	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Pipe Network

Volume in Pipe Network (m³)	5	Dia of Outfall Pipe (m)	0.2
Slope of Outfall Pipe (1:X)	150	Roughness of Outfall Pipe (mm)	0.600

Time Area Diagram

Total Area (ha) 0.448

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.090	4	8	0.153	8	12	0.205

Q30 Event

Model Details

Storage is Offline Cover Level (m) 54.000 Dividing Weir Level (m) 52.550

Tank or Pond Structure

Invert Level (m) 52.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	237.0	0.900	533.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0070-2100-0900-2100
Design Head (m)	0.900
Design Flow (l/s)	2.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	70
Invert Level (m)	52.500
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	2.1	Kick-Flo®	0.564	1.7
Flush-Flo™	0.273	2.1	Mean Flow over Head Range	-	1.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.4	3.000	3.7	7.000	5.4
0.200	2.1	1.400	2.6	3.500	3.9	7.500	5.6
0.300	2.1	1.600	2.7	4.000	4.2	8.000	5.8
0.400	2.0	1.800	2.9	4.500	4.4	8.500	6.0
0.500	1.9	2.000	3.0	5.000	4.6	9.000	6.1
0.600	1.7	2.200	3.2	5.500	4.8	9.500	6.3
0.800	2.0	2.400	3.3	6.000	5.1		
1.000	2.2	2.600	3.4	6.500	5.2		

Q100 + 20% Climate Change

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	52.755	0.255	2.1	69.5	O K
30 min Summer	52.837	0.337	2.1	95.8	O K
60 min Summer	52.918	0.418	2.1	123.7	O K
120 min Summer	52.995	0.495	2.1	152.4	O K
180 min Summer	53.040	0.540	2.1	170.0	O K
240 min Summer	53.068	0.568	2.1	181.6	O K
360 min Summer	53.096	0.596	2.1	193.2	O K
480 min Summer	53.130	0.630	2.1	207.4	O K
600 min Summer	53.143	0.643	2.1	213.2	O K
720 min Summer	53.151	0.651	2.1	216.6	O K
960 min Summer	53.156	0.656	2.1	219.1	O K
1440 min Summer	53.156	0.656	2.1	219.0	O K
2160 min Summer	53.146	0.646	2.1	214.5	O K
2880 min Summer	53.130	0.630	2.1	207.6	O K
4320 min Summer	53.089	0.589	2.1	190.2	O K
5760 min Summer	53.038	0.538	2.1	169.4	O K
7200 min Summer	52.984	0.484	2.1	148.4	O K
8640 min Summer	52.933	0.433	2.1	129.4	O K
10080 min Summer	52.886	0.386	2.1	112.4	O K
15 min Winter	52.769	0.269	2.1	73.7	O K
30 min Winter	52.872	0.372	2.1	107.7	O K
60 min Winter	52.959	0.459	2.1	138.7	O K
120 min Winter	53.045	0.545	2.1	172.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	86.922	0.0	70.8	31
30 min Summer	60.188	0.0	97.9	45
60 min Summer	39.120	0.0	130.1	74
120 min Summer	24.725	0.0	164.4	132
180 min Summer	18.739	0.0	187.4	192
240 min Summer	15.370	0.0	204.3	252
360 min Summer	11.588	0.0	226.2	368
480 min Summer	9.471	0.0	252.0	488
600 min Summer	8.094	0.0	268.6	608
720 min Summer	7.117	0.0	282.6	726
960 min Summer	5.808	0.0	303.4	940
1440 min Summer	4.360	0.0	303.8	1168
2160 min Summer	3.270	0.0	394.6	1568
2880 min Summer	2.664	0.0	428.4	1976
4320 min Summer	1.993	0.0	479.4	2820
5760 min Summer	1.621	0.0	522.4	3640
7200 min Summer	1.380	0.0	556.0	4392
8640 min Summer	1.210	0.0	584.9	5112
10080 min Summer	1.083	0.0	610.2	5856
15 min Winter	86.922	0.0	73.9	26
30 min Winter	60.188	0.0	109.4	45
60 min Winter	39.120	0.0	145.1	74
120 min Winter	24.725	0.0	183.9	132

Q100 + 20% Climate Change

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
180 min Winter	53.096	0.596	2.1	193.0	O K
240 min Winter	53.129	0.629	2.1	207.0	O K
360 min Winter	53.171	0.671	2.1	225.8	O K
480 min Winter	53.197	0.697	2.1	237.3	O K
600 min Winter	53.213	0.713	2.1	244.9	O K
720 min Winter	53.224	0.724	2.1	249.9	O K
960 min Winter	53.235	0.735	2.1	254.9	O K
1440 min Winter	53.234	0.734	2.1	[illegible].5	O K
2160 min Winter	53.220	0.720	2.1	2[illegible]7.[illegible]	O K
2880 min Winter	53.197	0.697	2.1	237.4	O K
4320 min Winter	53.135	0.635	2.1	209.8	O K
5760 min Winter	53.057	0.557	2.1	177.0	O K
7200 min Winter	52.965	0.465	2.1	141.1	O K
8640 min Winter	52.883	0.383	2.1	111.5	O K
10080 min Winter	52.810	0.310	2.1	87.0	O K

Q100+ 20% Climate Change volume to be stored

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
180 min Winter	18.739	0.0	209.7	190
240 min Winter	15.370	0.0	229.2	248
360 min Winter	11.588	0.0	258.9	364
480 min Winter	9.471	0.0	281.2	478
600 min Winter	8.094	0.0	298.8	594
720 min Winter	7.117	0.0	311.7	706
960 min Winter	5.808	0.0	317.7	928
1440 min Winter	4.360	0.0	306.0	1338
2160 min Winter	3.270	0.0	441.9	1672
2880 min Winter	2.664	0.0	479.6	2140
4320 min Winter	1.993	0.0	534.9	3072
5760 min Winter	1.621	0.0	585.1	3976
7200 min Winter	1.380	0.0	622.8	4688
8640 min Winter	1.210	0.0	655.2	5368
10080 min Winter	1.083	0.0	683.6	6056

Q100 + 20% Climate Change

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)	16.600	Shortest Storm (mins)	15
Ratio R	0.274	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+20

Pipe Network

Volume in Pipe Network (m^3)	5	Dia of Outfall Pipe (m)	0.2
Slope of Outfall Pipe (1:X)	150	Roughness of Outfall Pipe (mm)	0.600

Time Area Diagram

Total Area (ha) 0.448

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.090	4	8	0.153	8	12	0.205

Q100 + 20% Climate Change

Model Details

Storage is Offline Cover Level (m) 54.000 Dividing Weir Level (m) 52.550

Tank or Pond Structure

Invert Level (m) 52.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	237.0	0.900	533.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0070-2100-0900-2100
Design Head (m)	0.900
Design Flow (l/s)	2.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	70
Invert Level (m)	52.500
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	2.1	Kick-Flo®	0.564	1.7
Flush-Flo™	0.273	2.1	Mean Flow over Head Range	-	1.8

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.8	1.200	2.4	3.000	3.7	7.000	5.4
0.200	2.1	1.400	2.6	3.500	3.9	7.500	5.6
0.300	2.1	1.600	2.7	4.000	4.2	8.000	5.8
0.400	2.0	1.800	2.9	4.500	4.4	8.500	6.0
0.500	1.9	2.000	3.0	5.000	4.6	9.000	6.1
0.600	1.7	2.200	3.2	5.500	4.8	9.500	6.3
0.800	2.0	2.400	3.3	6.000	5.1		
1.000	2.2	2.600	3.4	6.500	5.2		

BLOCKED OUTFALL SIMULATION

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

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
30 min Summer	52.850	0.350	0.1	100.3	O K
30 min Winter	52.885	0.385	0.1	112.1	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
30 min Summer	60.188	0.0	5.8	64
30 min Winter	60.188	0.0	6.0	64

30min simulation for Q100+20%

Outfall blocked

Top water level > 2m below lowest floor level

BLOCKED OUTFALL SIMULATION

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)	16.600	Shortest Storm (mins)	30
Ratio R	0.274	Longest Storm (mins)	30
Summer Storms	Yes	Climate Change %	+20

Pipe Network

Volume in Pipe Network (m³)	5	Dia of Outfall Pipe (m)	0.2
Slope of Outfall Pipe (1:X)	150	Roughness of Outfall Pipe (mm)	0.600

Time Area Diagram

Total Area (ha) 0.448

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	0.090	4	8	0.153	8	12	0.205

BLOCKED OUTFALL SIMULATION

Model Details

Storage is Offline Cover Level (m) 54.000 Dividing Weir Level (m) 52.550

Tank or Pond Structure

Invert Level (m) 52.500

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	237.0	0.900	533.0

Hydro-Brake® Optimum Outflow Control

Unit Reference	MD-SHE-0014-1000-0900-1000
Design Head (m)	0.900
Design Flow (l/s)	0.1
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	14
Invert Level (m)	52.500
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	0.900	0.1	Kick-Flo®	0.122	0.0
Flush-Flo™	0.056	0.0	Mean Flow over Head Range	-	0.1

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.0	1.200	0.1	3.000	0.2	7.000	0.2
0.200	0.1	1.400	0.1	3.500	0.2	7.500	0.2
0.300	0.1	1.600	0.1	4.000	0.2	8.000	0.3
0.400	0.1	1.800	0.1	4.500	0.2	8.500	0.3
0.500	0.1	2.000	0.1	5.000	0.2	9.000	0.3
0.600	0.1	2.200	0.1	5.500	0.2	9.500	0.3
0.800	0.1	2.400	0.1	6.000	0.2		
1.000	0.1	2.600	0.2	6.500	0.2		

Appendix 9.2

Water and Wastewater Estimation Calculations

IW Foul Wastewater Calculations

New Network - DOMESTIC Wastewater Flows						
Usage	Quantity	Occupancy (h)	Population (P)	Consumption (G) (l/h/day)	Loading (PxG)(l/day)	
Residential	66 Units	2.7No./Unit	178	150	26,700	
				Total =	26,700 l/day	
				Flowrate per day (l/s)		**0.31l/s**
				Growth Rate	1	1
				Infiltration (I)	10%	0.03
				Dry Weather Flow	**PG + I**	**0.34 l/s**
				Peaking Factor (Pf_{Dom})	6	
				Design Foul Flow (l/s)	**Pf_{Dom} x PG**	**2.1 l/s**
				Misconnection Allowance (SW)	1.5%	0.03l/s
				Design Flow (l/s)		**2.13 l/s**

Based on Irish Water Code of Practice Wastewater Infrastructure (Rev 2 July'20)

IW Water Demand & Storage Calculations

New Network – DOMESTIC Water Demand								
Usage	**Quantity**	**Occupancy**	**Population**	**Consumption (l//h/day)**	**Ave. Daily Domestic Demand (l/day)**	**Ave. Daily Domestic Demand (l/s)**	**Ave. Day/Peak Week (l/s)**	**Peak Hour Water Demand (l/s)**
Resi'	66 Units	2.7 No./Unit	178	150	26,700	0.31	0.39	**1.93**

Based on Irish Water Code of Practice for Water Infrastructure (Rev 2 July'20)

Appendix 9.3

IW Confirmation of Feasibility

Brian Greene

Verdant House
Fortfield Square
Collage Drive
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

17 February 2021

Re: CDS21000687 pre-connection enquiry - Subject to contract | Contract denied

Connection for Housing Development of 70 unit(s) at Hayden's Lane, Lucan, Dublin

Dear Sir/Madam,

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

SERVICE	OUTCOME OF PRE-CONNECTION ENQUIRY THIS IS NOT A CONNECTION OFFER. YOU MUST APPLY FOR A CONNECTION(S) TO THE IRISH WATER NETWORK(S) IF YOU WISH TO PROCEED.
Water Connection	Feasible without infrastructure upgrade by Irish Water
Wastewater Connection	Feasible without infrastructure upgrade by Irish Water
SITE SPECIFIC COMMENTS	
Water Connection	This Confirmation of Feasibility to connect to the Irish Water infrastructure also does not extend to your fire flow requirements. Please note that Irish Water can not guarantee a flow rate to meet fire flow requirements and in order to guarantee a flow to meet the Fire Authority requirements, you should provide adequate fire storage capacity within your development.
Wastewater Connection	N/A
The design and construction of the Water & Wastewater pipes and related infrastructure to be installed in this development shall comply with the Irish Water Connections and Developer Services Standard Details and Codes of Practice that are available on the Irish Water website. Irish Water reserves the right to supplement these requirements with Codes of Practice and these will be issued with the connection agreement.	

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

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

General Notes:

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

If you have any further questions, please contact Marko Komso from the design team on 022 54611 or email mkomso@water.ie For further information, visit **www.water.ie/connections.**

Yours sincerely,

Yvonne Harris

Yvonne Harris

Head of Customer Operations

Appendix 9.4

Met Eireann Data

Met Eireann

Return Period Rainfall Depths for sliding Durations

Irish Grid: Easting: 303442, Northing: 233017,

	Interval		Years													
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.3,	3.4,	4.0,	5.0,	5.7,	6.2,	7.9,	9.9,	11.3,	13.2,	15.0,	16.4,	18.5,	20.2,	21.7,	N/A ,
10 mins	3.2,	4.8,	5.6,	7.0,	7.9,	8.6,	11.0,	13.8,	15.7,	18.4,	20.9,	22.8,	25.8,	28.2,	30.2,	N/A ,
15 mins	3.8,	5.6,	6.6,	8.2,	9.3,	10.1,	12.9,	16.2,	18.5,	21.7,	24.6,	26.8,	30.4,	33.2,	35.5,	N/A ,
30 mins	5.0,	7.3,	8.6,	10.6,	11.9,	13.0,	16.5,	20.5,	23.3,	27.2,	30.7,	33.4,	37.7,	41.1,	43.9,	N/A ,
1 hours	6.6,	9.5,	11.2,	13.6,	15.3,	16.6,	21.0,	26.0,	29.3,	34.1,	38.3,	41.7,	46.8,	50.9,	54.3,	N/A ,
2 hours	8.7,	12.4,	14.5,	17.5,	19.6,	21.3,	26.7,	32.8,	36.9,	42.7,	47.9,	51.9,	58.2,	63.0,	67.1,	N/A ,
3 hours	10.2,	14.5,	16.8,	20.4,	22.7,	24.6,	30.7,	37.6,	42.2,	48.7,	54.5,	59.0,	66.0,	71.4,	75.9,	N/A ,
4 hours	11.5,	16.2,	18.8,	22.6,	25.2,	27.3,	33.9,	41.5,	46.5,	53.5,	59.8,	64.7,	72.2,	78.1,	82.9,	N/A ,
6 hours	13.5,	18.9,	21.9,	26.2,	29.2,	31.5,	39.0,	47.6,	53.2,	61.1,	68.1,	73.6,	81.9,	88.5,	93.8,	N/A ,
9 hours	15.8,	22.1,	25.4,	30.4,	33.8,	36.4,	44.9,	54.5,	60.9,	69.7,	77.6,	83.7,	93.0,	100.2,	106.2,	N/A ,
12 hours	17.7,	24.7,	28.3,	33.8,	37.5,	40.4,	49.7,	60.1,	67.0,	76.6,	85.1,	91.7,	101.7,	109.5,	116.0,	N/A ,
18 hours	20.9,	28.8,	33.0,	39.2,	43.4,	46.7,	57.2,	69.0,	76.6,	87.4,	96.9,	104.2,	115.5,	124.1,	131.3,	N/A ,
24 hours	23.4,	32.1,	36.7,	43.6,	48.2,	51.7,	63.2,	76.0,	84.3,	96.0,	106.3,	114.2,	126.3,	135.7,	143.4,	170.2,
2 days	29.3,	39.2,	44.3,	51.8,	56.8,	60.6,	72.7,	86.1,	94.7,	106.6,	116.9,	124.9,	136.9,	146.1,	153.7,	179.8,
3 days	34.1,	44.9,	50.4,	58.5,	63.7,	67.8,	80.5,	94.4,	103.3,	115.5,	126.1,	134.2,	146.4,	155.7,	163.3,	189.3,
4 days	38.4,	49.9,	55.8,	64.2,	69.8,	74.0,	87.3,	101.7,	110.9,	123.4,	134.2,	142.4,	154.8,	164.2,	171.9,	198.1,
6 days	45.8,	58.6,	65.0,	74.3,	80.3,	84.8,	99.1,	114.3,	124.0,	137.1,	148.4,	156.9,	169.7,	179.3,	187.2,	213.9,
8 days	52.4,	66.3,	73.2,	83.1,	89.5,	94.3,	109.4,	125.4,	135.4,	149.0,	160.7,	169.5,	182.6,	192.5,	200.6,	227.8,
10 days	58.4,	73.2,	80.6,	91.1,	97.8,	102.9,	118.6,	135.3,	145.7,	159.8,	171.8,	180.9,	194.3,	204.5,	212.7,	240.4,
12 days	64.1,	79.8,	87.5,	98.5,	105.5,	110.8,	127.2,	144.5,	155.3,	169.8,	182.1,	191.3,	205.1,	215.5,	223.9,	252.0,
16 days	74.6,	91.8,	100.2,	112.1,	119.7,	125.3,	142.9,	161.2,	172.6,	187.8,	200.7,	210.4,	224.7,	235.5,	244.1,	273.1,
20 days	84.3,	102.9,	111.9,	124.5,	132.6,	138.6,	157.1,	176.3,	188.3,	204.1,	217.6,	227.6,	242.4,	253.5,	262.4,	292.2,
25 days	95.7,	115.8,	125.5,	139.0,	147.6,	154.0,	173.5,	193.8,	206.3,	222.9,	236.9,	247.3,	262.7,	274.1,	283.3,	314.0,

NOTES:

N/A Data not available

These values are derived from a Depth Duration Frequency (DDF) Model

For details refer to:

'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf

Haydens Lane, Lucan

SAAR=773mm

M5-60 = 16.6mm

R= M5-60 / M5-2Day = 16.6/60.6=0.274

Appendix 9.5

SuDS Evaluation and Small Scale Practices

Site Drainage Evaluation

Site name: Haydens lane
Site location: Lucan

Report Reference: 1614684027280
Date: 2/3/2021

1. INTRODUCTION

This is a bespoke report providing initial guidance on potential implementation of SuDS for the development site in line with current best practice.

The use of this tool should be supplemented by more detailed guidance on SuDS best practice provided in a number of sources, principally the CIRIA SUDS Manual (2007), other CIRIA documents; the Use of SUDS in High Density Developments, HR Wallingford, (2005) and other HR Wallingford documents.

The objective is to provide some early guidance on the numbers and types of components that might be suitable for consideration within the site design. This may facilitate pre-application discussions with planners and other relevant authorities.

This guidance has been provided prior to the completion of the SUDS standards and the supporting guidance. However the principles of this tool are unlikely to be very different to the aims of the SUDS standards. HR Wallingford is not liable for the use of any output from the use of this tool and the performance of the drainage system. It is recommended that detailed design using appropriately experienced engineers professionals and tools is undertaken before finalising any drainage scheme arrangement for a site.

THE CONTENT OF THE REPORT

This report is split into 8 sections as follows:

2. Generic SuDS Best Practice Principles
3. Runoff Destination
4. Hydraulic Design Criteria
5. Water Quality Design Criteria
6. Site-Specific Drainage Design Considerations
7. SuDS Construction
8. SuDS Components Performance
9. Guidance on The Use of Individual Components

2. GENERIC SuDS BEST PRACTICE PRINCIPLES

To comply with current best practice, the drainage system should:

(i) manage runoff at or close to its source;
(ii) manage runoff at the surface;
(iii) be integrated with public open space areas and contribute towards meeting the objectives of the urban plan;
(iv) be cost-effective to operate and maintain.

The drainage system should endeavour to ensure that, for any particular site:

(i) natural hydrological processes are protected through maintaining Interception of an initial depth of rainfall and prioritising infiltration, where appropriate;
(ii) flood risk is managed through the control of runoff peak flow rates and volumes discharged from the site;
(iii) stormwater runoff is treated to prevent detrimental impacts to the receiving water body as a result of urban contaminants.

In addition, it is desirable to maximise the amenity and ecological benefits associated with the drainage system where there are appropriate opportunities. SuDS are green infrastructure components and can provide health benefits, and reduce the vulnerability of developments to the impacts of climate change.

3. RUNOFF DESTINATION

Introduction
Infiltration should be prioritised as the method of controlling surface water runoff from the development site, unless it can be demonstrated that the use of infiltration would have a detrimental environmental impact.

Groundwater (via Infiltration)
Infiltration may not be appropriate for managing runoff from this site. Robust studies are reqired to confirm the significance of the following constraints to infiltration:

(1) The subsurface geology is primarily impermeable and the use of infiltration is unlikely to be suitable. Where infiltration rates are confirmed via testing to be < 1 x 10-7 m/s, infiltration will be very limited. Where infiltration rates are between 1 x 10-7 and 1 x 10-5 m/s, then soils can still provide Interception and partial infiltration. If rates are confirmed to be > 1 x 10-5 m/s, full infiltration can be considered in the design.

The groundwater beneath the site is designated as , and this designation will define the treatment requirement for any infiltrated water (See Water Quality Design Criteria).

Surface water body
All runoff that cannot be discharged to groundwater will be managed on site and discharged to a surface water body.

The receiving surface water body for runoff from the site is: the . The riparian owner is: .

Surface water sewer /local highway drain

All surface water runoff that cannot be discharged to groundwater via infiltration will be managed on site and discharged to a surface water sewer or local highway drain.

The surface sewer reference is: *SDCC 600mm S/W Sewer* and the asset owner is: *SDCC.*

4. HYDRAULIC DESIGN CRITERIA

Introduction
Best practice criteria for hydraulic control require Interception, runoff and volume control.

Interception
To fulfill the requirements for Interception, there should normally be no runoff from the site for an initial depth of rainfall - usually 5mm. This is achieved through the use of infiltration, evapotranspiration, or rainwater harvesting.

Flow and Volume Control
There are local planning policies which place controls on the discharges from this site which are more stringent than those imposed by current best practice. The extent to which flows and volumes must be controlled below greenfield must be determined from their policies.

5. WATER QUALITY DESIGN CRITERIA

Introduction
Current best practice takes a risk-based approach to managing discharges of surface runoff to the receiving environment. The following text provides guidance on the extent of water quality management likely to be appropriate for the site.

Hazard Classification
Runoff from clean roof surfaces (ie not metal roofs, roofs close to polluted atmospheric discharges, or roofs close to populations of flocking birds) is classified as Low in terms of hazard status.

Runoff from roads, parking and other areas of residential, commercial and industrial sites (that are not contaminated with waste, high levels of hydrocarbons, or other chemicals) is classified as Medium in terms of hazard status.

Treatment requirements for disposal to surface water systems
Roof runoff will not require treatment prior to discharge.

Runoff from other parts of this site such as roads, parking and other areas will require at least 2 treatment stages prior to discharge.

6. SITE-SPECIFIC DRAINAGE DESIGN CONSIDERATIONS

The site is a high density residential site. The HR Wallingford documenet 'SuDS for high density developments' is a useful guidance document for efficient drainage design where space is heavily constrained.

Components likely to be particularly suitable for high density sites include:

- permeable pavement parking areas which can often manage roof runoff as well as rainfall falling on the parking surface;
- green roofs which limit runoff from roof surfaces;
- bioretention areas integrated within impermeable zones;
- individual property soakaways;
- subsurface infiltration and/or detention systems (eg beneath functional, permeable surfaces);
- infiltration/detention/retention ponds/basins/channels integrated within public open space areas.

The design of SuDS with access to temporary or permanent water should consider public health and safety as well as issues associated with construction and operational management of the structures. Health and safety issues and risk mitigation features are presented in the CIRIA SuDS Manual.

Individual SuDS components should not be treated in isolation, but should be seen together as providing a suite of drainage features which are appropriate in different combinations for varying scales. It is always desirable to have a mix of SuDS components across the site as different components have different capacities for treatment of individual pollutants.

7. SuDS CONSTRUCTION

SuDS are a combination of civil engineering structures and landscaping practice. Due to the limited experience of building SuDS in the water industry, there are a number of key issues which need to be particularly considered as their construction requires a change in approach to some standard construction practices.

- SuDS components should be constructed in line with either the manufacturer's guidelines or best practice methods.
- The construction of SuDS usually only requires the use of fairly standard civil engineering construction and landscaping operations, such as excavation, filling, grading, top-soiling, seeding, planting etc. These operations are specified in various standard construction documents, such as the Civil Engineering Specification for the Water Industry (CESWI).
- Construction of soakaways is regulated by the Buildings Regulations part H (Drainage and waste disposal) which sets out the requirements for drainage of rainwater from the roofs of buildings.
- During construction, any surfaces which are intended to enable infiltration must be protected from compaction. This includes protecting from heavy traffic or storage of materials.
- Water contaminated with silt must not be allowed to enter a watercourse or drain as it can cause pollution. All parts of the drainage system must be protected from construction runoff to prevent silt clogging the system and causing pollution downstream. Measures to prevent this include soil stabilisation, early construction of sediment management basins, channelling run-off away from watercourses and surface water drains, and erosion prevention measures.
- After the end of the construction period and prior to handover to the site owner/operator:
  - Subsoil that has been compacted during construction activities should be broken up prior to the re-application of

topsoil to garden areas and other areas of public open space to reinstate the natural infiltration performance of the ground;
- Any areas of the SuDs that have been compacted during construction but are intended to permit infiltration must be completely refurbished;
- Checks must be made for blockages or partial blockages of orifices or pipe systems;
- Any silt deposited during the construction must be completely removed;
- Soils must be stabilised and protected from erosion whilst planting becomes established.

Detailed guidance on the construction related issues for SuDS is available in the SuDS Manual and the associated Construction Site handbook (CIRIA, 2007).

8. SuDS COMPONENTS PERFORMANCE

	Interception	Peak flow control: Low	Peak flow control: High	Volume reduction	Volume control	Gross sediments	Fine sediments	Hydrocarbons/ PAHs	Metals	Nutrients
Rainwater Harvesting	Y	Y	S	Y	N	N	N	N	N	N
Pervious Pavement	Y	Y	Y	Y	Y	Y	Y	Y	Y	Var
Filter Strips	Y	N	N	N	N	Y	N	Y	Y	Var
Swales	Y	Y	S	Y(*)	N	Y	Y(+)	Y	Y	Y(-)
Trenches	Y	Y	S	Y(*)	N	N	N	Y	Y	Y(-)
Detention Basins	Y	Y	Y	N	Y	Y	Y(+)	Y	Y	Var
Ponds	N	Y	Y	N	Y	N(~)	Y	Limited	Y	Var
Wetlands	N	Y	S	N	Y	N(~)	Y	Limited	Y	Y
Green Roofs	Y	Y	N	N	N	N	N	Y	N	N
Bioretention Systems	Y	Y	S	Y(*)	N	N(~)	Y	Y	Y	Y
Proprietary Treatment Systems	N	N	N	N	N	Y	Y	Y(!)	Y(!)	Y(!)
Subsurface Storage	N	Y	Y	N	Y	N(~)	N	N	N	N
Subsurface Conveyance Pipes	N	N	N	N	Y	N(~)	N	N	N	N

Notes:
S: Not normally with standard designs, but possible where space is available and designs mitigate impact of high flow rates.
Y(*): Where infiltration is facilitated by the design.
N(~): Gross sediment retention is possible, but not recommended due to negative maintenance and performance implications.
Y(+): Where designs minimise the risk of fine sediment mobilisation during larger events.
Y(!): Where designs specifically promote the trapping and breakdown of oils and PAH based constitutents.
Y("): Where subsurface soil structure facilitates the trapping and breakdown of oils and PAH based constituents.
Var: The nutrient removal performance is variable, and can be negative in some situations.
Y(-): Good nutrient removal performance where subsurface biofiltration systems with a permanently saturated zone included within the design.

9. GUIDANCE ON THE USE OF INDIVIDUAL COMPONENTS

Rainwater Harvesting

• *High density*
For large occupancy buildings (offices, supermarkets, etc.), communal rainwater harvesting systems may provide significant stormwater management benefits.

• *Roofs*
Rainwater harvesting systems can be used to effectively drain roofs and provide both water supply and stormwater management benefits.

Pervious Pavement

• *High density*
Pervious pavement systems provide an effective way to drain, store and treat the surface runoff, all within the footprint of the car park area. Larger areas of communal parking will provide the most cost effective systems.

• *Roofs*
Roof water can be drained into pervious pavement areas using diffusers to dissipate the point inflows. Detailed design of the pavement will need to take account of the additional impermeable roof area.

• *Roads*
Some types of pervious pavement can be used for relatively highly trafficked roads and pavement manufacturers should be consulted on the appropriate specification.

• *Car parks/other impermable surfaces*
Pervious pavements provide effective drainage, storage and treatment of car park surfacing,

Filter Strips

• *High density*
Filter strips can be used as treatment for road or car park runoff where space allows.

• *Roads*
Filter strips can provide treatment for road runoff, upstream of swales or trench components. They can reduce the need for kerbing and runoff collection systems.

• *Car parks/other impermable surfaces*
Filter strips can provide treatment for runoff from impermeable surfaces, upstream of swales or trench components. They can reduce the need for kerbing and runoff collection systems.

Swales

• *High density*
Swales can be used for road or car park drainage where space allows. Underdrained swales (ie with a subsurface gravel filled conveyance and treatment trench) can provide a more efficient solution for hydraulic control and water quality treatment.

• *Roofs*
Swales can be used to convey roof water to other parts of the site.

• *Roads*
Swales provide treatment and conveyance of road runoff. There are a range of swale types - standard grass channels, underdrained swales, and wetland swales - depending on drainage requirements.

• *Car parks/other impermable surfaces*
Swales provide treatment and conveyance of runoff from impermeable areas. There are a range of swale types - standard grass channels, underdrained swales, and wetland swales - depending on drainage requirements.

Trenches

• *High density*
Trenches can provide treatment and runoff control for road or car park drainage.

• *Roofs*
Trenches can be used to convey roof water to other parts of the site.

• *Roads*
Trenches can provide treatment and conveyance of road runoff. They require effective pretreatment to minimise the risk of blockage.

• *Car parks/other impermable surfaces*
Trenches can provide treatment and conveyance of runoff for impermeable areas.

Detention Basins

• *High density*
Detention basins can be used in high density developments when effectively integrated within public open space areas.

• *Roofs*
Detention basins can be used to attenuate and treat runoff.

• *Roads*
Detention basins can be used to attenuate and treat runoff.

• *Car parks/other impermable surfaces*
Detention basins can be used to attenuate and treat runoff.

Ponds

• *High density*
It is unlikely that a pond would be suitable for high density development, unless it is an integral amenity feature within the public open space area.

• *Roofs*
Ponds can be used to attenuate and treat roof runoff.

• *Roads*
Ponds can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in ponds for extended periods, nutrient concentrations can rise - particularly in the summer months, and the pond can become unattractive with poor amenity and biodiversity potential.

• *Car parks/other impermable surfaces*
Ponds can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in ponds for extended periods, nutrient concentrations can rise - particularly in the summer months, and the pond can become unattractive with poor amenity and biodiversity potential.

• *Other*
Ponds built in permeable soils will require lining to maintain the water level of the permanent pool. The lining may be finished 100 or 200 mm lower than the outlet invert to encourage some infiltration to take place to contribute to interception.

Wetlands

• *High density*
It is unlikely that a wetland would be suitable for high density development, unless it is an integral amenity feature within the public open space area.

• *Roofs*
Wetlands can be used to attenuate and treat roof runoff.

• *Roads*
Wetlands can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in wetlands for extended periods, nutrient concentrations can rise - particularly in the summer months, and the wetland can become unattractive with poor amenity and biodiversity potential.

• *Car parks/other impermable surfaces*
Wetlands can be used to attenuate and treat runoff. However, they are best implemented at the lower end of the treatment train as a 'polishing' component. They should not be used as sediment management devices, as sediment and wet vegetation is relatively costly to extract and dispose of. If poor quality water remains in wetlands for extended periods, nutrient concentrations can rise - particularly in the summer months, and the wetland can become unattractive with poor amenity and biodiversity potential.

Green Roofs

• *HighDensity*
Green roofs can be implemented most cost-effectively on larger roofs. They provide a range of benefits in addition to stormwater management, including combatting the heat island effect, biodiversity and amenity functions.

• *Roofs*
Green roofs can be designed to provide interception, management and treatment of rainfall up to specified rainfall depths.

Bioretention Systems

• *High density*
Biorention systems (either cells or linear systems) can be used for road or car park drainage where space allows.

• *Roofs*
Bioretention systems can be used to attenuate and treat roof runoff.

• *Roads*
Linear bioretention systems (ie biofiltration swales) can be used to attenuate and treat road runoff.

• *Car parks/other impermable surfaces*
Bioretention systems canbe used for car park drainage.

Proprietary Treatment Systems

• *High density*
Proprietary treatment systems may be appropriate to use particularly where there is no space for surface, vegetated treatment systems. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

• *Roads*
Proprietary treatment systems can be used where surface vegetated systems are impracticable. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

• *Car parks/other impermable surfaces*
Proprietary treatment systems could be used where surface vegetated systems are impracticable. However, regular monitoring needs to be ensured so that they are maintained so that they continue to function effectively.

Subsurface Storage

• *High density*
Subsurface storage of runoff is likely to be needed for high density developments. This can be implemented via a range of proprietary high void systems, or within gravels beneath permeable pavements which provide treatment as well. Sub-surface storage allows the land above the storage system to be used for car parking or public open space areas.

• *Roofs*
Subsurface storage can be used to attenuate roof runoff.

• *Roads*
Subsurface storage can be used to attenuate road runoff.

• *Car parks/other impermable surfaces*
Subsurface storage can be used to attenuate car park runoff.

Subsurface Conveyance Pipes

• *High density*
Subsurface conveyance systems may be an important means of connecting drainage components together and routing flows downstream. Space constraints in high density developments are likely to constrain the use of surface conveyance options.

HR Wallingford Ltd, the Environment Agency and any local authority are not liable for the performance of a drainage scheme which is based upon the output of this report.

SMALL SCALE SuDS FOR INDIVIDUAL BUILDINGS

SOURCE CONTROL

DESCRIPTION

Sustainable Drainage Systems for individual buildings focus on reducing the amount of stormwater leaving a property and/or conserving water. This can be achieved by a variety of methods which are generally low cost and low maintenance, i.e.:

- Avoiding misconnections
- Minimisation of impermeable areas and diversion of run-off to infiltration/soakaway devices
- Rainwater harvesting: Water butts, Rainwater Tanks
- Greywater re-use
- Rooftop greening

AVOIDING MISCONNECTIONS

Misconnections of stormwater to foul sewers and wastewater to storm sewers result in considerable polluting impact in receiving waters. It is the responsibility of the developer and property owner to ensure that there are no such misconnections from their development/property. Rigorous policing of connections by the local authority is required to eliminate inappropriate discharges.

MINIMISATION OF IMPERMEABLE AREAS

DIVERTING TO INFILTRATION/SOAKAWAY DEVICES

The minimisation of impermeable areas can be achieved through the use of permeable paving or gravelled surfaces instead of conventional paving/concrete. The diversion of stormwater, such as the first flush of roof run-off or from disconnected downpipes, to infiltration devices such as soakaways, reduces the volume of water discharge to receiving waters. Roofwater can be discharged directly to the sub-base of infiltration devices. Maintenance requirements and costs are low. See separate SuDS information sheets (Infiltration trenches & Soakaways/Permeable paving) for further details.

WATER BUTT

A water butt is a receptacle or tank, usually covered and placed at ground level, connected to a downpipe, to provide offline attenuation of runoff from roofs. Pollutant removal improves if used in conjunction with first flush devices to divert the first 2mm of roof rainfall run-off and screens to filter out leaves and insects. Desludging is recommended on a regular (annual/bi-ennial) basis.

RAINWATER TANKS

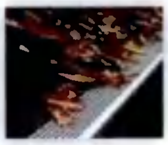
Rainwater tanks collect rainwater for re-use for car washing, gardens and firewater. Tanks can be placed on flat roofs of suitable bearing capacity or connected to downpipes and placed above or under ground. In the latter cases a pump will be required such that the water can be reused, for example, in toilet flushing.

If connecting to the toilet or washing machine a minimum level of water must be maintained by a top-up system from the mains supply. A non-return valve is required to prevent backflow from the tank to the drinking water supply.

Effluent Discharge - Dry Weather Flow

Water Butt - (source: www.blackwell-ltd.com)

Water Butt - (source:www.southern water.co.uk)



Gutter Filter
(LB Plastics Ltd.)

Leafeater
(City Rainwater Tanks Aust Pty Ltd.)

Rainwater Tank

MORE OVERLEAF - 1 of 2

SMALL SCALE SuDS FOR INDIVIDUAL BUILDINGS

GREYWATER TANKS

Greywater is a term applied to all bath, dish and laundry water except toilet waste and food waste derived from garbage grinders. Greywater tanks are generally placed underground. A pump is required such that the water can be re-used, for example, in toilet flushing or for watering plants.

When properly managed, greywater is a valuable resource which horticultural and agricultural growers as well as home gardeners can benefit from. It can also be valuable to landscape planners, builders, developers and contractors. While phosphorous, potassium and nitrogen makes greywater a source of pollution for lakes, rivers and groundwater they are excellent nutrient sources for vegetation when this particular form of wastewater is made available for irrigation. Greywater irrigation has long been practiced in areas where water is in short supply.

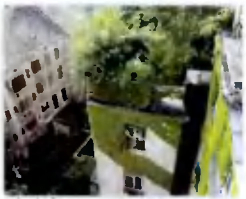
A key to successful greywater treatment lies in its immediate processing before it turns anaerobic. The simplest, most appropriate treatment technique consists of directly introducing freshly generated greywater into an active, live topsoil environment. Pollutant removal is achieved by treating the greywater with aerobic pre-treatment or anaerobic to aerobic pre-treatment.
Refer www.clivusmultrum.com and www.greywater.com.

International Experience

Australia

The Healthy Homes project on Australia's Gold Coast is an environmentally sustainable demonstration project incorporating small scale SuDS. Refer to Case Study within this document and www.oca.nsw.gov.au/resource/wramsartwork.pdf.

ROOFTOP GREENING



Fleishman from www.ecocentre.com

DESCRIPTION

Rooftop greening involves vegetating urban walls and rooftops as a way of gaining access to valuable open space while making urban environments healthier more attractive places in which to live and work. Rooftop greening strategies aim to:

- reduce the quantity and increase the quality of surface water run-off
- improve indoor and outdoor comfort levels for residents
- conserve indigenous biodiversity (genetic, species and ecosystem)
- reduce energy demand for heating and cooling
- encourage environmentally responsive design strategies in the City.

Rooftop Greening is moving from the fringe to the mainstream for two reasons:

1)Increasing urban densities are leading to a desire for greater access to green open space; and
2)The role of urban vegetation in producing oxygen, fixing carbon dioxide and filtering urban air and water is becoming more widely recognised.

Rooftop Gardens can function as:
"Extensive" systems require little or no maintenance; are developed primarily for their environmental benefits; and normally consist of thin soils and hardy vegetation applied to large roof areas. The use of Sedum varieties is common.
"Intensive" systems require high levels of maintenance; are developed primarily for aesthetic enjoyment. Extensive greening is generally a much cheaper option than intensive greening. For design considerations refer www.roofmeadows.com. Also, Grodan (www.grodan.com) produce rockwool, a lightweight substrate.

International Experience

Germany

One in 10 flat roofs in German cities are of Esslingen in Germany has a by-law which requires that flat and sloping roofs (up to 15 degrees) must be vegetated. Similarly, in Mannheim, declining air quality prompted the City Council to impose a by-law in 1988 which requires all central business district buildings to be vegetated.

Japan

In Tokyo, guidelines encourage 20% of rooftop areas to be planted. From April 2001, companies that fail to meet these guidelines will face fines. Reductions have been implemented to fixed assets taxes for buildings with rooftop greening. These types of policies are expected to increase throughout Japan, as a consequence of revisions of city regulations.
The Takenaka Corporation have developed a "Thin Layer Rooftop Greening System," by using sedum varieties and a thin mat as a planting base, which reduces the live load on buildings and has limited maintenance requirements. Significant energy conservation has been achieved.
Refer www.takenaka.co.jp/takenaka_e/.

America

The award-winning Chicago City Hall green roof was installed for the Urban Heat Island Initiative project. The design includes a 3.5" deep **'extensive'** system to 24" deep **'intensive'** landscape islands. The project shows the benefit of green roofs in lowering summer temperatures within ultra-urban environments.
Refer www.cityofchicago.org .

Chicago City Hall 2002
Source www.roofmeadows.com

FROM PREVIOUS - 2 of 2

Appendix 9.6

IW Webmap Drainage Records Drawing

Irish Water Web Map

UISCE ÉIREANN · IRISH WATER

Print Date: 04/12/2020

Printed by: Irish Water

Appendix 9.7

Soakaway Test Results

GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House
Hazelhatch Road,
Newcastle,
Co. Dublin
D22 YD52

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

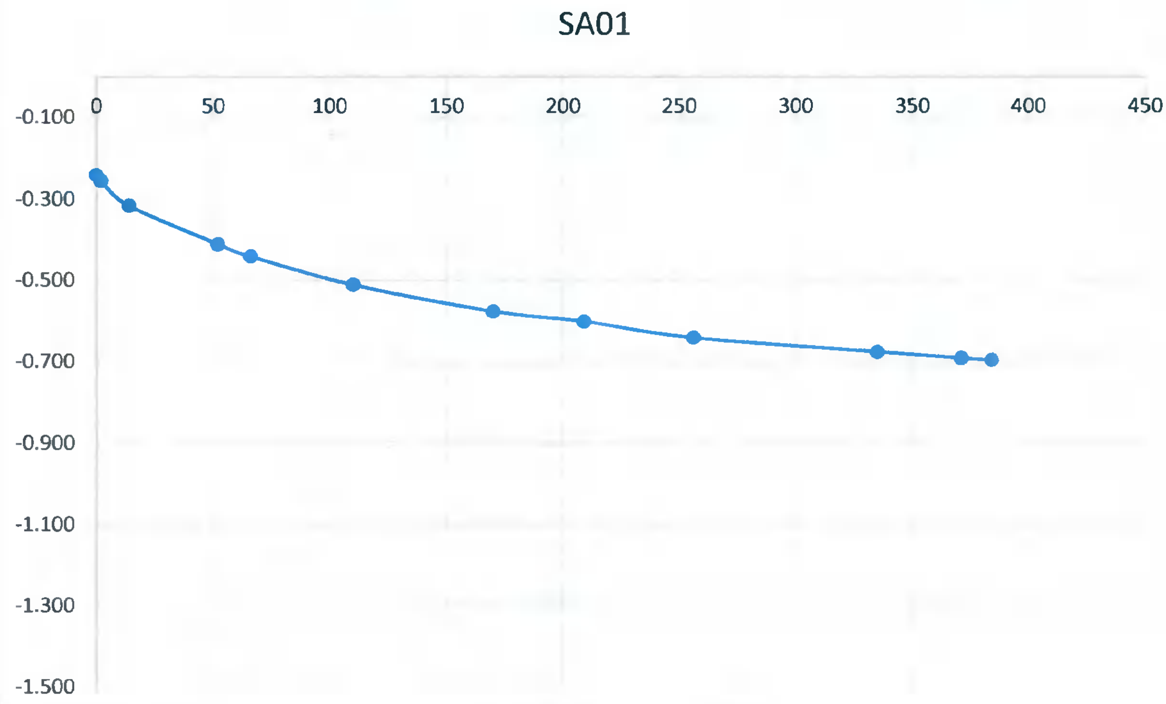
SA01

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.50m x 0.40m x 1.50m (L x W x D)

Date	Time	Water level (m bgl)
22/04/2021	0	-0.240
22/04/2021	2	-0.255
22/04/2021	14	-0.315
22/04/2021	52	-0.410
22/04/2021	66	-0.440
22/04/2021	110	-0.510
22/04/2021	170	-0.575
22/04/2021	209	-0.600
22/04/2021	256	-0.640
22/04/2021	335	-0.675
22/04/2021	371	-0.690
22/04/2021	384	-0.695

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.24	1.500	1.260	0.555	1.185



GROUND INVESTIGATIONS IRELAND
Geotechnical & Environmental

Catherinestown House
Hazelhatch Road
Newcastle,
Co Dublin
D22 YD52

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

SA02

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.30m x 0.30m x 1.50m (L x W x D)

Date	Time	Water level (m bgl)
22/04/2021	0	-0.340
22/04/2021	4	-0.375
22/04/2021	34	-0.520
22/04/2021	56	-0.600
22/04/2021	97	-0.710
22/04/2021	157	-0.845
22/04/2021	198	-0.900
22/04/2021	245	-0.960
22/04/2021	317	-1.040
22/04/2021	355	-1.080
22/04/2021	370	-1.100

Start depth	Depth of Pit	Diff	75% full	25%full
0.34	**1.500**	**1.160**	**0.63**	**1.21**

Length of pit (m)	Width of pit (m)	75-25Ht (m)	Vp75-25 (m3)
2.300	0.300	0.580	0.40

Tp75-25 (from graph) (s)		50% Eff Depth	ap50 (m2)
	24600	0.580	3.706

f = 4.390E-06 m/s

Appendix 9.8

OPW Flood Event History

Past Flood Event Local Area Summary Report

Oifig na nOibreacha Poiblí
Office of Public Works

Report Produced: 3/3/2021 10:33

This Past Flood Event Summary Report summarises all past flood events within 2.5 kilometres of the map centre.

This report has been downloaded from www.floodinfo.ie (the "**Website**"). The users should take account of the restrictions and limitations relating to the content and use of the Website that are explained in the Terms and Conditions. It is a condition of use of the Website that you agree to be bound by the disclaimer and other terms and conditions set out on the Website and to the privacy policy on the Website.

Map Legend

- Single Flood Event
- Recurring Flood Event
- Past Flood Event Extents
- Drainage Districts Benefited Lands*
- Land Commission Benefited Lands*
- Arterial Drainage Schemes Benefited Lands*

* Important: These maps do not indicate flood hazard or flood extent. Their purpose and scope is explained on Floodinfo.ie

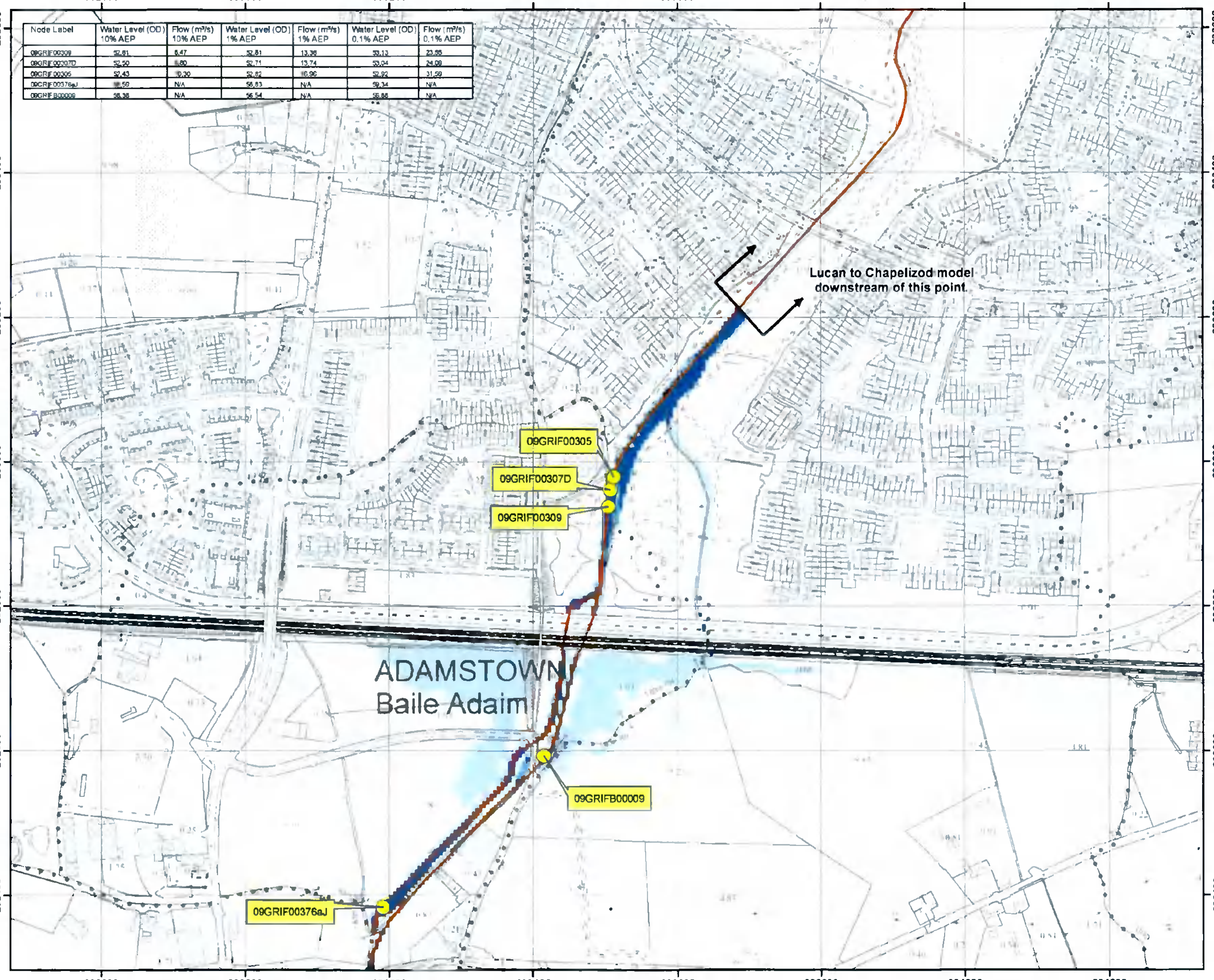
8 Results

	Name (Flood_ID)	Start Date	Event Location
1.	Griffeen November 2000 (ID-1237)	05/11/2000	Area
	Additional Information: Reports (16) Press Archive (6)		
2.	Griffeen Aug 1986 (ID-1239)	25/08/1986	Approximate Point
	Additional Information: Reports (3) Press Archive (0)		
3.	Griffeen June 1993 (ID-1240)	11/06/1993	Approximate Point
	Additional Information: Reports (7) Press Archive (0)		
4.	Griffeen Nov 2002 (ID-350)	15/11/2002	Approximate Point
	Additional Information: Reports (1) Press Archive (0)		
5.	Peamount R134 R120 junction Nov 2000 (ID-3320)	05/11/2000	Approximate Point
	Additional Information: Reports (1) Press Archive (1)		
6.	Liffey Lower - Dec 1954 (ID-241)	08/12/1954	Area
	Additional Information: Reports (5) Press Archive (2)		

	Name (Flood_ID)	Start Date	Event Location
7.	Liffey Lucan June 1993 (ID-2918)	10/06/1993	Approximate Point
	Additional Information: Reports (3) Press Archive (2)		
8.	Griffeen River 24th Oct 2011 Lucan (ID-11487)	24/10/2011	Approximate Point
	Additional Information: Reports (1) Press Archive (0)		

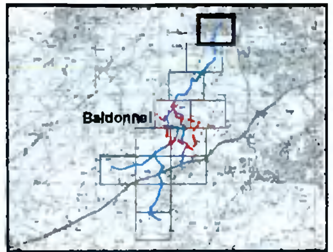
Appendix 9.9

CFRAM Dwg.No. E09BAL_EXFCD_F0_11



Node Label	Water Level (OD) 10% AEP	Flow (m³/s) 10% AEP	Water Level (OD) 1% AEP	Flow (m³/s) 1% AEP	Water Level (OD) 0.1% AEP	Flow (m³/s) 0.1% AEP
09GRIF00309	52.61	6.47	52.81	13.36	53.13	23.55
09GRIF00307D	52.50	8.80	52.71	13.74	53.04	24.09
09GRIF00305	52.43	10.30	52.62	16.96	52.92	31.59
09GRIF00376aJ	58.59	N/A	58.83	N/A	59.34	N/A
09GRIFB00009	56.38	N/A	56.54	N/A	56.88	N/A

0 50 100 200 300 400 500 Metres



IMPORTANT USER NOTE
THE VIEWER OF THIS MAP SHOULD REFER TO THE DISCLAIMER, GUIDANCE NOTES AND CONDITIONS OF USE THAT ACCOMPANY THIS MAP.

Legend

- 10% Fluvial AEP Event
- 1% Fluvial AEP Event
- 0.1% Fluvial AEP Event
- Modelled River Centreline
- AFA Extents
- Node Point
- Node ID Node Label

FINAL

REV	NOTE	DATE

CFRAM

OPW

RPS

The Office of Public Works
Jonathan Swift Street
Trim
Co Meath

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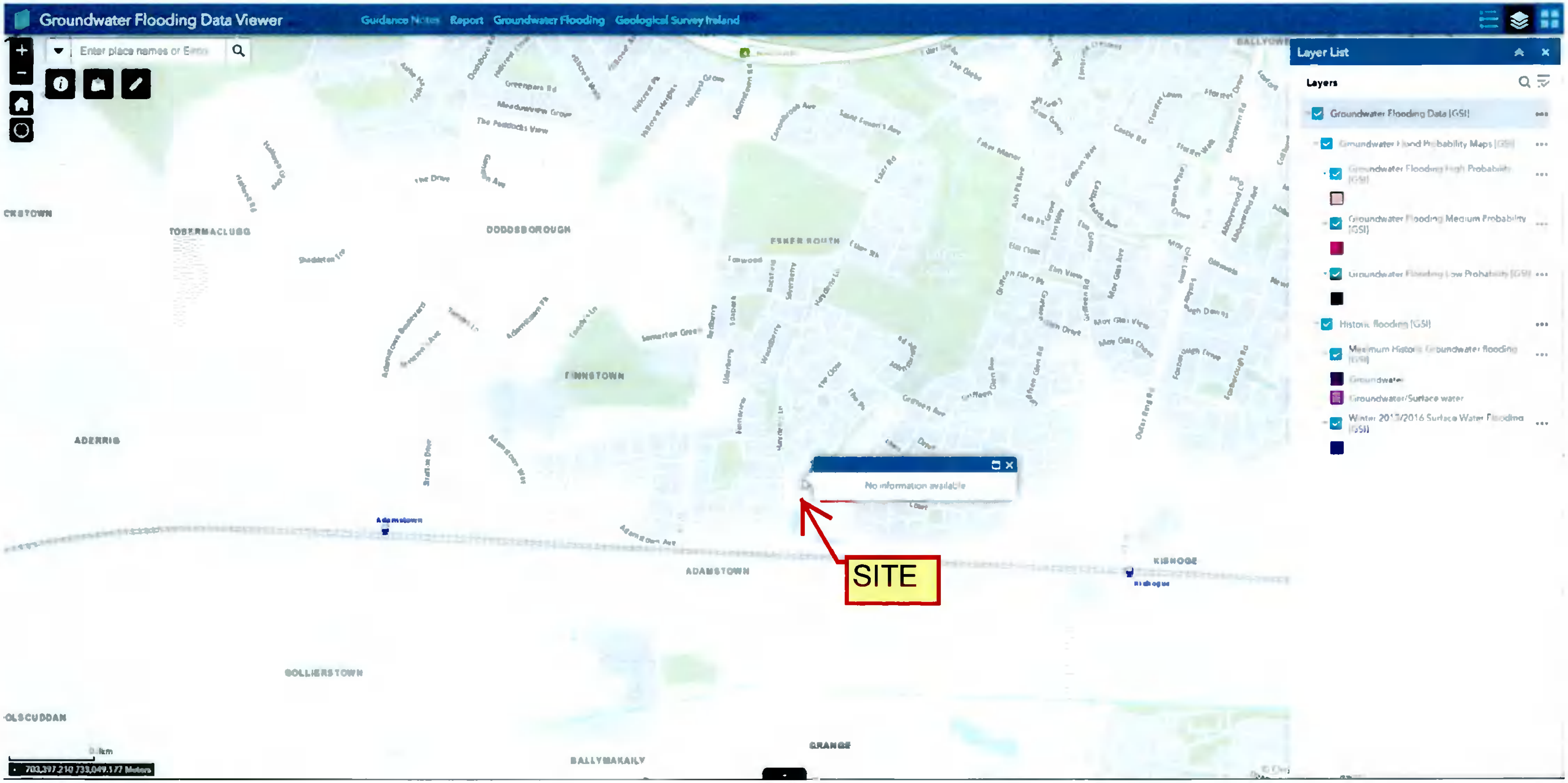
Belfast
BT12 6RZ

T +44(0) 28 90 667914
F +44(0) 28 90 668286
W www.rpsgroup.com
E ireland@rpsgroup.com

Map:
Baldonnel Fluvial Flood Extents
Map Type: EXTENT
Source: FLUVIAL
Map Area: HPW
Scenario: CURRENT
Drawn By: C.C. Date: 21 July 2016
Checked By: DJ. Date: 21 July 2016
Approved By: G.G. Date: 21 July 2016
Drawing No.:
E09BAL_EXFCD_F0_11
Map Series: Page 11 of 12
Drawing Scale: 1:5,000 @ A3

Appendix 9.10

GSI/EPA Maps


Groundwater Flooding Data Viewer
Guidance Notes
Report
Groundwater Flooding
Geological Survey Ireland
Enter place names or Eirco
Layer List
Layers
Groundwater Flooding Data (GSI)
Groundwater Flood Probability Maps (GSI)
Groundwater Flooding High Probability (GSI)
Groundwater Flooding Medium Probability (GSI)
Groundwater Flooding Low Probability (GSI)
Historic flooding (GSI)
Maximum Historic Groundwater flooding (GSI)
Groundwater
Groundwater/Surface water
Winter 2015/2016 Surface Water Flooding (GSI)
No information available
SITE
TOBERMACLUGG
DODDSBOROUGH
FINNSTOWN
ESKER SOUTH
ADERRIG
ADAMSTOWN
KISHOGE
COLLIERSTOWN
BALLYMAKAILY
GRANGE
703,397.210 733,049.177 Meters

Water

WATER, LAND & SOIL ▾ PROTECTED AREAS ▾ MONITORING & FLOW ▾ STATUS & RISK ▾ PRESSURES & ACTIVITIES ▾ TAKING ACTIO

Results

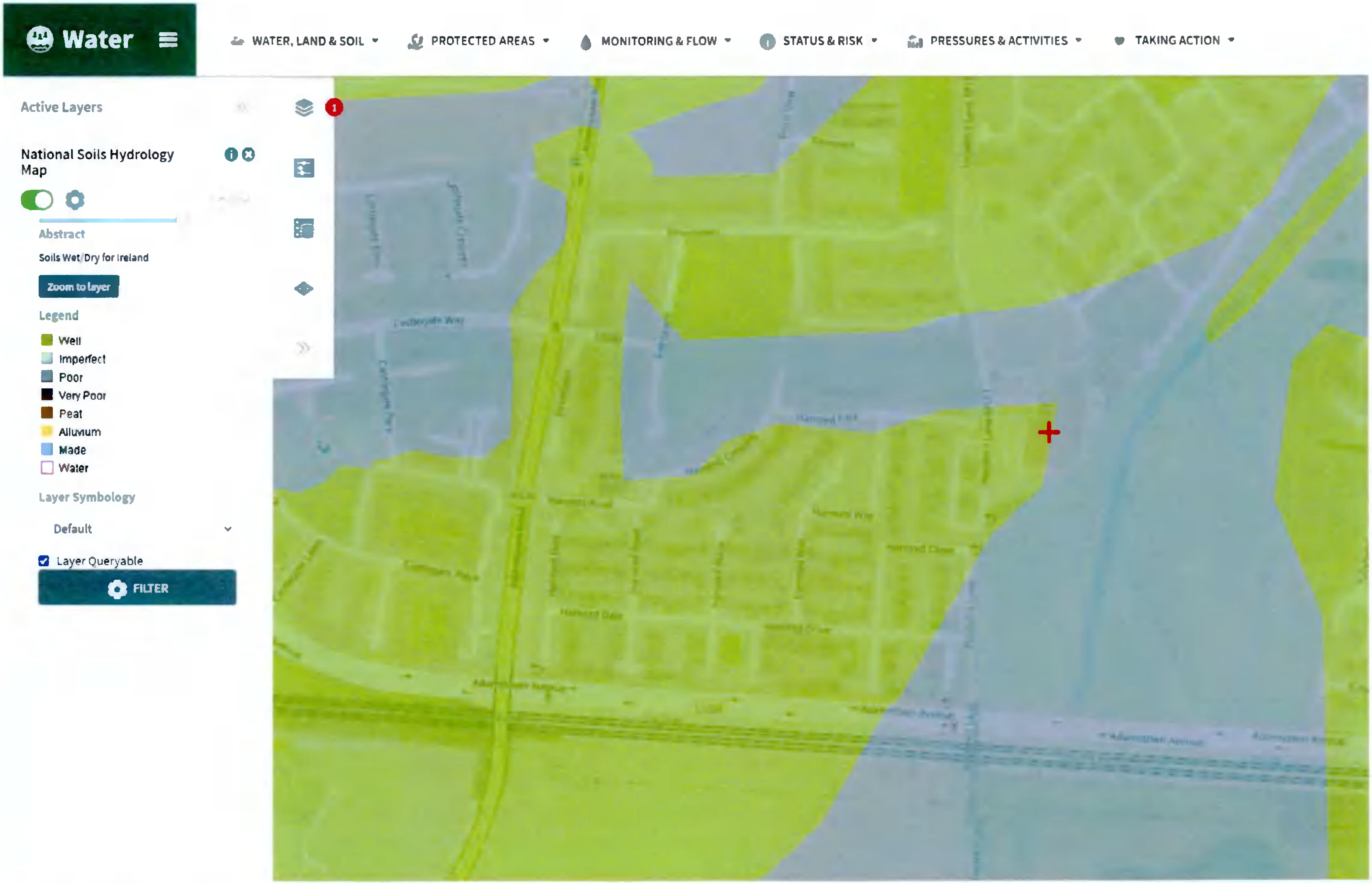
Keep Previous Results

National Soils
BminPD

IFS_Soil	BminPD
Parent_Material	TLs
IFS_Description	Basic Deep Poorly Drained Mineral
IFS_Type	Deep poorly drained mineral . Derived from mainly calcareous parent materials
Soil_Group	Surface water Gleys, Ground water Gleys,
County	DUBLIN
IFS_Code	32

National Soils
BminDW

EXPORT


Water
WATER, LAND & SOIL
PROTECTED AREAS
MONITORING & FLOW
STATUS & RISK
PRESSURES & ACTIVITIES
TAKING ACTION
Active Layers
National Soils Hydrology Map
Abstract
Soils Wet/Dry for Ireland
Zoom to layer
Legend
Well
Imperfect
Poor
Very Poor
Peat
Alluvium
Made
Water
Layer Symbology
Default
Layer Queryable
FILTER

Water

WATER, LAND & SOIL · PROTECTED AREAS · MONITORING & FLOW · STATUS & RISK · PRESSURES & ACTIVITIES · TAKING ACTION

Results

Keep Previous Results

Subsoils
167070.64093

PERIMETER	167070.64093
PAR_MAT	TLs
COUNTY	DUBLIN
CATEGORY	Till type
DESCRIPT	Limestone till (Carboniferous)
TEXTURE	Variable
Class	Tills (diamictons)

EXPORT