AtkinsRéalis

Stormwater Impact Assessment

Aeval Unlimited Company

May 2026

DG0005

WOODBROOK DART GATEWAY RESIDENTIAL DEVELOPMENT

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Client signoff

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1. Introduction

The purpose of this LRD Stage 1 Preplanning Stormwater Impact Assessment is to provide the necessary information for the agreement with DLRCC of the Storm water elements associated with proposed Dart Gateway Development at Woodbrook.

The proposed development will comprise of 359 no. units consisting of 2 blocks, Block P: 154no units (consisting of 83no. 1-Bed, 18no. 2-Bed(3P), 46no. 2-Bed(4P), 4no. 3-Bed(4P) and 3no Duplexes (5P). Block Q: 205no units (consisting of 77no. 1-Bed, 34no. 2-Bed(3P), 91no. 2-Bed(4P) and 3no. 3- Bed(5P) Duplexes). Communal space of 2320sqm, Ground level comprising (a) ESB substation (b) car, bicycle and motorcycle parking; (c) bin storage; (d) bulk storage area; (e) bus turning and taxi turning area; and (f) supporting mechanical, electrical and water infrastructure. Landscaping works including (a) Tree protection, tree removal and tree planting; (b) green roofs; (c)boundary treatment; (d) internal roads and footpaths; and (e) electrical services. All associated site development works including (a) provisions for water services; (b) foul and surface water drainage and connections; and (c) attenuation proposal.

1.1 Site Location

The proposed development site is located at Woodbrook, Co Dublin. The proposed development site is located on existing agricultural lands.

The residential site is bound by an active DART line on the east, Woodbrook Golf Club on the south, a cemetery and undeveloped open greenfields to the North, and the permitted Phase 2 of the Woodbrook development to the west. The M11 Motorway is located approximately 970m West of the residential site.

The site location is indicated on Atkins drawing 100119017-ATK-ZZ-XX-DR-CE-090001.

1.2 Existing Site Description

The existing topographical levels within the residential site range from 21.00 mOD to 25.00 mOD. The highest point is located at the north-eastern corner, while the lowest point is at the north-western corner, with the terrain generally sloping towards the south. Additionally, the levels gradually fall from all directions towards the centre of the southern portion of the site. The site is currently accessed via the recently constructed junction to the Woodbrook Avenue on the R119 Dublin Road.

1.3 Principal Design Considerations

During the design of the storm water drainage for the proposed site, including SuDS, the following key documents / standards were taken into consideration.

- Dún Laoghaire Rathdown County Development Plan, 2022 - 2028
- Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas Interim Guidelines
- Shanganagh Woodbrook Local Area Plan (LAP)
- Greater Dublin Strategic Drainage Study (GDSDS)
- CIRIA report C753 The SuDS Manual-v6

The proposed stormwater drainage will be developed in consultation with the relevant authorities including Dún Laoghaire Rathdown County Council (DLRCC) Municipal services department.

2. Surface Water Design

The storm drainage system will be designed in accordance with the key documents and standards listed in Section 1.3 above.

Surface water generated from the proposed residential development will be conveyed through the proposed and recently constructed as part of the phase 1 development surface water network including SuDS and attenuated / managed on site prior to final discharge at Qbar greenfield run-off rates. The restricted discharge from the proposed overall site will remain unchanged and be conveyed via the recently constructed surface water sewer on the Dublin Road before discharge to the receiving Crinken / Rathmichael Stream. The proposed storm drainage network for the Woodbrook Dart Gateway development is as indicated on the planning drawings 0119017-ATK-ZZ-02-DR-CE-090503.

The principles behind the proposed design were discussed and agreed with DLRCC Municipal services department as part of the overall Woodbrook phase 1 application. Aspects of the proposed development that were discussed and agreed have been incorporated within this design.

In accordance with the DLRCC Development Plan, a Stage 1 Stormwater Audit has been carried out prior to the final planning application.

The proposed measures included within the design proposal are as follows:

- Permeable paving in light traffic areas (parking bays)
- Green roofs to suitable apartment blocks
- Green courtyards to suitable apartment blocks
- Rain Gardens to residential areas
- Underground modular system within green corridors / park areas / open spaces
- Tree pits
- Vortex Flow control devices

2.1 Proposed Sustainable Urban Drainage (SuDS) Strategy

For the proposed development a “SuDS triangle” was utilised to ensure all three functions are provided for within the SuDS strategy.

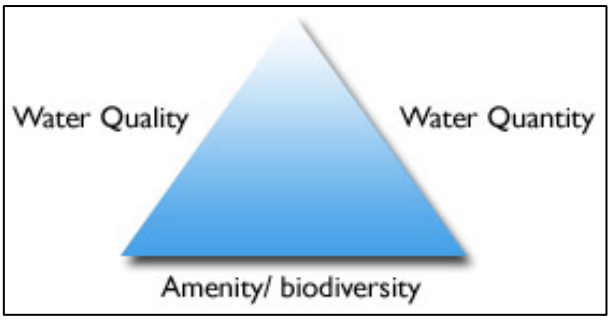


Figure 2-1 - SuDS Triangle

By considering the three functions of the triangle, a SuDS system will allow for water quality treatment through natural processes by;

- Encouraging infiltration (where appropriate) and attenuating peak flows
- Improving water quality by providing treatment to storm water prior to discharge.
- Providing habitat and function were possible for those using the area (including wildlife)

The principles of a SuDS treatment train were used during the design of the surface water drainage system. The treatment train as illustrated in the image below provides an understanding of prevention and source control to reduced water run-off from a site and improve water quality.

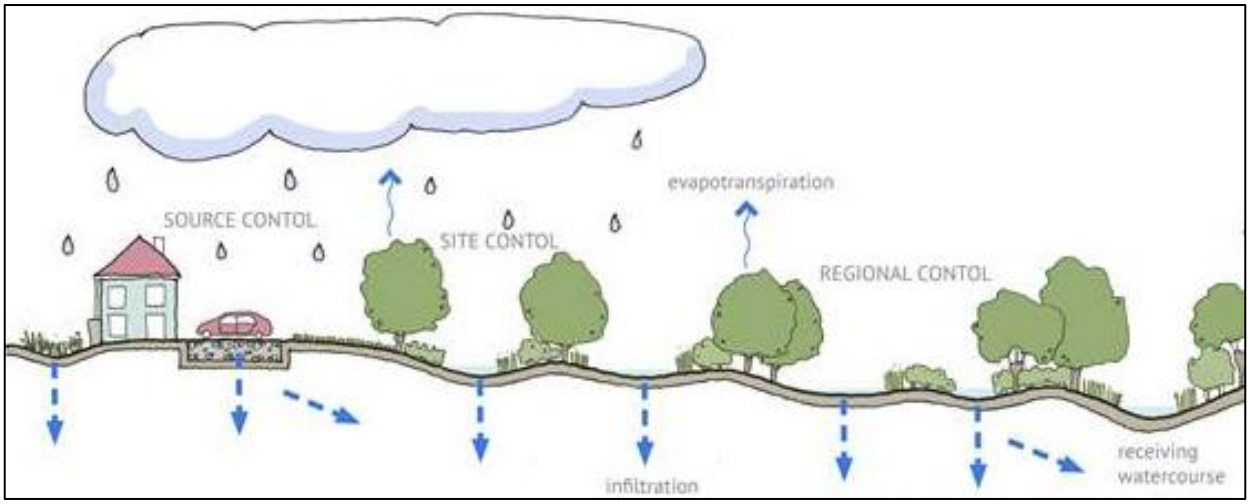


Figure 2-2 - SuDS Treatment Train

The treatment train principles include;

- Prevention of surface water run-off from the proposed site by use of filter drains, swales, permeable paving, tree pits, extensive green roofs, intensive green courtyards and modular attenuation systems with a permeable base (where appropriate)
- Minimising impermeable paved areas using permeable paving, extensive green roofs, intensive green courtyards and modular grass road proprietary product.
- Infiltration by use of filter drains, swales, permeable paving and tree pits.
- Site control using underground modular attenuation storage and vortex flow control devices to manage flows and agreed final Qbar runoff rate.

Each of the items outlined above will help to improve water quality, reduce storm water runoff quantity from the proposed site and ensure that there is no increased risk to downstream flooding where discharging to the Crinken / Rathmichael Stream.

Drawing 0119017-ATK-ZZ-XX-DR-CE-090503 outlines the proposed details of the storm water network.

For the purposes of designing the storm water network for the entire development (Phase 1, Phase 2, amended application to Phase 1 and this current Dart Gateway (Phase 4)) and including associated Qbar calculations a total overall catchment area of 21ha has been calculated as indicated below in Figure 2-3.

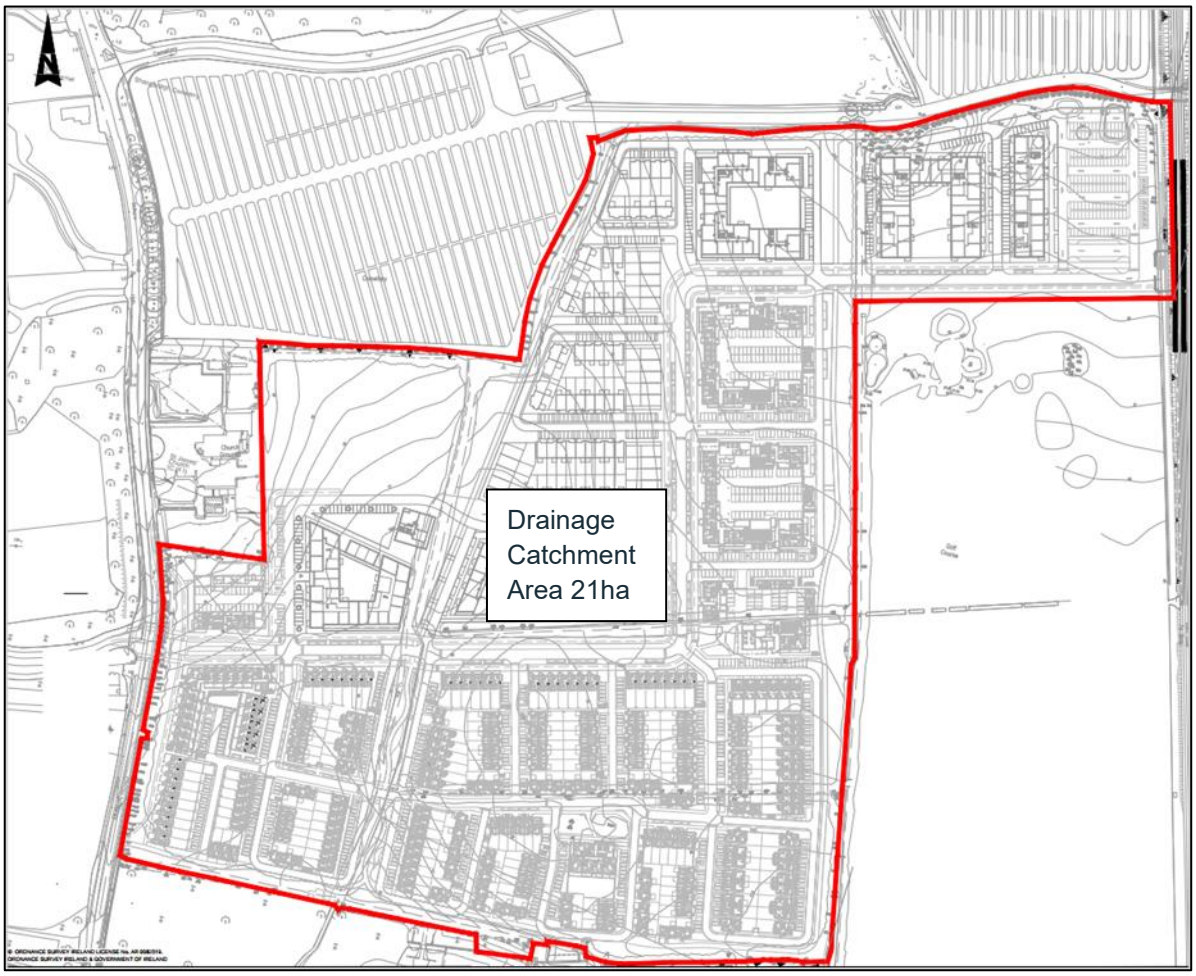


Figure 2-3 - Overall Catchment Area

There are 10 No. proposed drainage sub-catchment areas (Catchments A – J) within the proposed masterplan lands for the purpose of site control as outlined on drawing 0119017/EWE/DR/0517. The catchments are segregated by use of a vortex control device to limit / manage discharge from each catchment. Section 7 of this report provides further details on Catchment areas.

The SuDS techniques proposed within the development are as outlined below:

- Permeable paving will be used in light traffic areas to the front of residential units, courtyards and carparks. The permeable paving will allow for attenuation, infiltration to ground, reduction of peak flow rates and improved water quality. Roof run-off from the front roof area of residential housing units will discharge directly into the subbase below each permeable paving area allowing for reduced runoff from these roof areas.

- Extensive green roof and intensive green courtyards will be provided on suitable buildings as indicated on drawing 0119017-ATK-ZZ-XX-DR-CE-090521 in accordance with Dún Laoghaire Rathdown County Development Plan, 2022 – 2028. The green roofs / courtyards will provide reduced peak flow rates, attenuation, evaporation, and improved water quality.
- Underground modular systems will be used within public green corridors / park areas. The modular systems will allow for storm water attenuation underground for storm events up to 1 in 100-year events. The modular systems will also allow for infiltration to ground were suitable.
- Filter drains within rear gardens of the housing units will allow for infiltration to ground, reduced peak flow rates and improved water quality. Only roof run-off from the rear roof of the residential unit will discharge into the filter drain. The filter drain will allow for infiltration to ground and reduce the overall site runoff.
- Vortex flow control devices will be used throughout the site to allow for storm water control and reduce peak runoff.
- Catchment A has been separated into three sub-catchments. This is due to minor change to Phase layout and sufficient separation distance between the building and final attenuation tank A.
- The overall maximum discharge rate from Catchment A remains unchanged at 2.0 l/s for 1 in 100 year storm event including allowance for 30% climate change (20% climate change and 10% urban creep).

The storm water drainage network will be assessed for compliance with the key design parameters as set out in below.

Table 2-1 - key Design Parameters

Parameter	Value/Requirement
Minimum depth	1.2m cover under highways 0.9m elsewhere*
Maximum depth	5.0m
Minimum sewer size for main drainage	225mm
DLRCC Municipal services agreed for phase 1 co-efficient runoff factors for pipe sizing and storage requirements	100% - Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network) 75% - Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains. 60% - Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving. 85% - Extensive Green Roof (> 150mm thk.) 70% - Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)

Parameter	Value/Requirement
Max. velocity at pipe full	3.0 m/s
Min. velocity in	0.75 m/s (1.0 m/s used where achievable)
Roughness	0.6mm
DLRCC Municipal services agreed Maximum discharge rate	56.34 l/s at final discharge location (56.34 l/s/21ha** = 2.68 l/s/ha)
Level of Service Critical Storm 1 in 2 yr return period	No surcharge within the pipe network, no flooding
Level of Service Critical Storm 1 in 30 yr return period	Surcharge allowed, no flooding
Level of Service Critical Storm 1 in 100 yr return period	No flooding unless planned and contained on site.

**Without recourse to concrete. Absolute minimum cover in roads is 0.9m. Pipes with cover between 0.9m and 1.2m shall be bedded and surrounded in concrete, 150mm thick, Class E, in accordance with Clause 1502 of the Specification for Roadworks.*

***Overall catchment area for storm water design purposes is 21ha as discussed in Section 2.1 above.*

"Micro Drainage", which is an industry standard tool for the design and assessment of gravity sewer drainage networks, has been used to simulate the proposed storm drainage network including flow controls and attenuation requirements.

3. Site Investigation

Site Investigations were carried out by Ground Investigations Ireland Ltd, between June and August 2018.

The purpose of the site investigation was to investigate subsurface conditions utilising a variety of investigative methods. The scope of the site investigation works undertaken for this project included the following:

- 12 No. Trial Pits to a maximum depth of 3.0m Below Ground Level (BGL).
- 6 No. Soakaways to determine a soil infiltration value to BRE digest 365.
- 3 No. Cable Percussion boreholes to a maximum depth of 10.0m BGL.
- 3 No. Groundwater monitoring wells.
- Geotechnical & Environmental Laboratory testing.

The locations for the site investigation testing including soakaways and ground water monitoring wells were discussed and agreed with DLRCC Municipal services prior to works commencing on site. Refer to Figure 3-1 below for borehole and trial pit locations. Soakaway tests were also carried out in the following trial pits; TP1, TP2, TP6, TP8, TP9 & TP11. Note the below image is taken from the Phase 1 submission to indicate locations of SI testing, the red line indicated does not represent the red line for the phase 2 boundary.

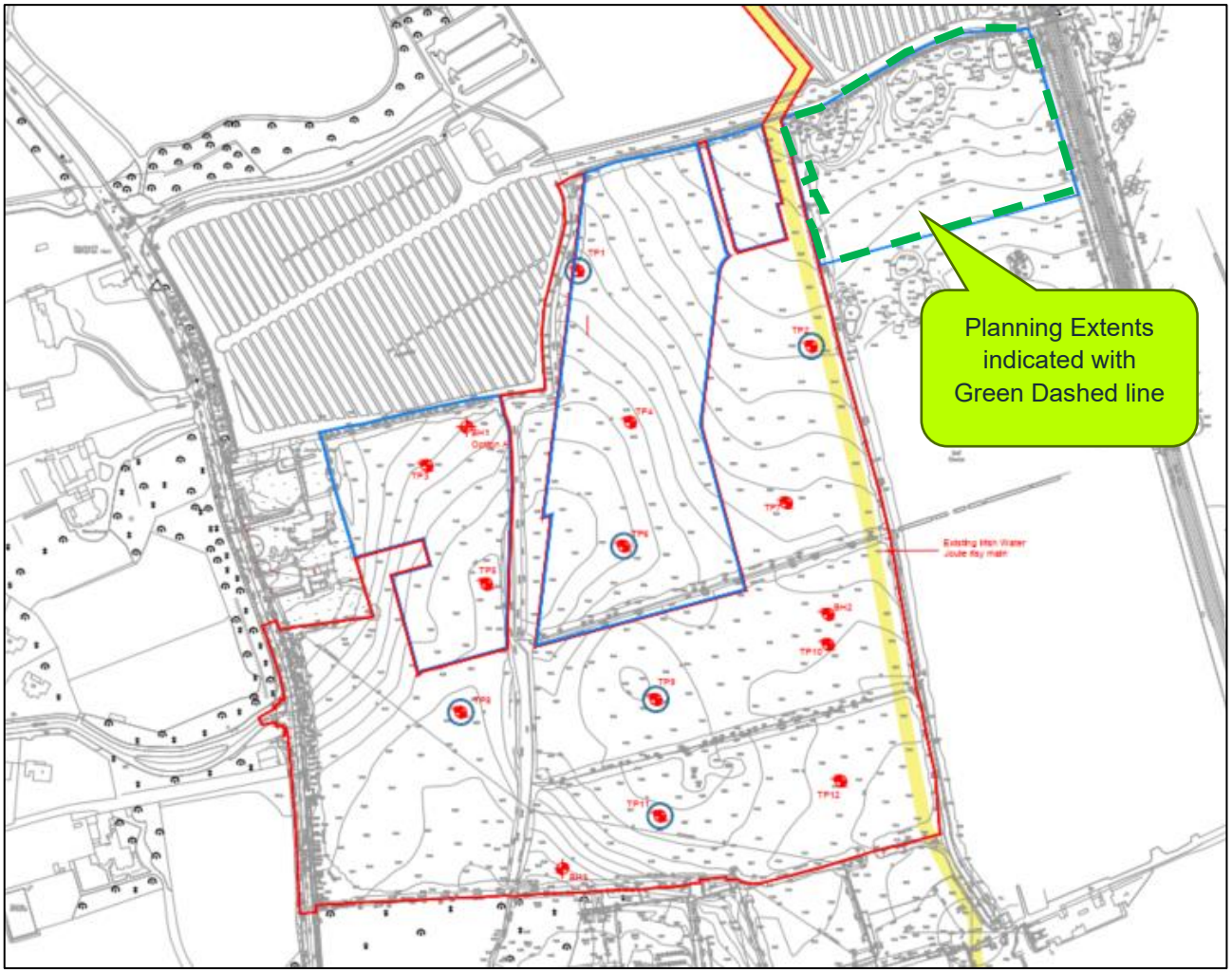


Figure 3-1 - SI Testing Locations

Review of the SI results including Trial Pit (TP) logs indicate that out of the 12No. TP, ground water was encountered within 4No. TP's. The ground water levels within the TP logs varied between 1.70m – 2.50m in depth.

The location of trial pits, ground levels and ground water levels are currently indicated in Figure 3-1 above.

For Woodbrook Phase 1, DLRCC indicated concerns in relation to high water table levels to the North – Northeast of the site along the boundary with the existing Shanganagh Cemetery in addition to queries relating to underground flow-paths. An assessment to determine ground water flows was undertaken and included the installation of groundwater monitoring wells on site.

The report concluded that based on site-specific geological and hydrogeological data, there will be no perceptible impacts on surface water levels, surface water flows, groundwater levels or groundwater flows, specifically in the vicinity of the areas in question. Furthermore, the report notes that potential impacts to the onsite field ditch or groundwater flow paths do not warrant further consideration.

4. Existing Site Hydrology

An existing ditch traverses the site from North to South along an existing hedge and treeline as indicated in Figure 4-1 below. This ditch has a long-established existence and functions in draining the fields within the site. A review of Historical Ordinance Survey Ireland information (www.osi.ie) was then carried out to determine if the OSI 6-inch Maps indicated historic water courses / surface water features within the site. The maps do not indicate any record of a water course onsite.

The ditch ultimately discharges to a local watercourse Crinken \ Rathmichael Stream (EPA 10R18) located to the South of the proposed Woodbrook Development via 3rd party lands.

The Crinken \ Rathmichael Stream flows from North-West to East approx. 150 metres from the southern boundary of the proposed development site. The stream then discharges to the Irish Sea approximately 1km southeast of the site boundary.

Lands within the proposed Woodbrook Development drain to the existing ditch as indicated by the flow arrows indicated in Figure 4-1 below.

During pre-planning discussions with DLRCC, concerns were raised in relation to the existing drainage ditch on site. DLRCC requested confirmation that the existing onsite drainage ditch is a field ditch and not a stream or river.

The Technical Note concluded that having reviewed all available desk-based information, including historical mapping and aerial photography, and based on the observations of an experienced Hydrogeologist during a walkover survey of the Site, the drainage feature is a field ditch. Furthermore, there is no evidence that this drainage feature was historically a stream or a river.

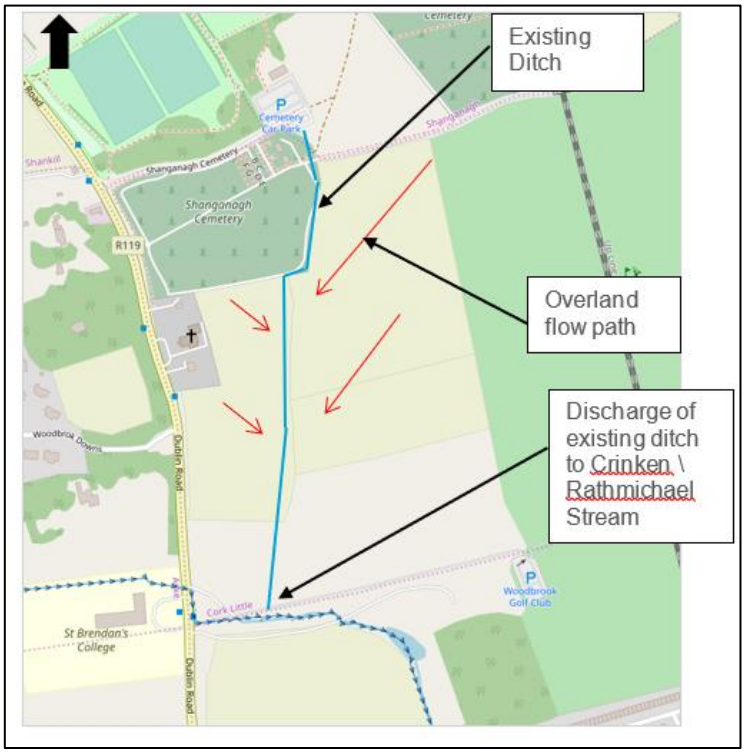
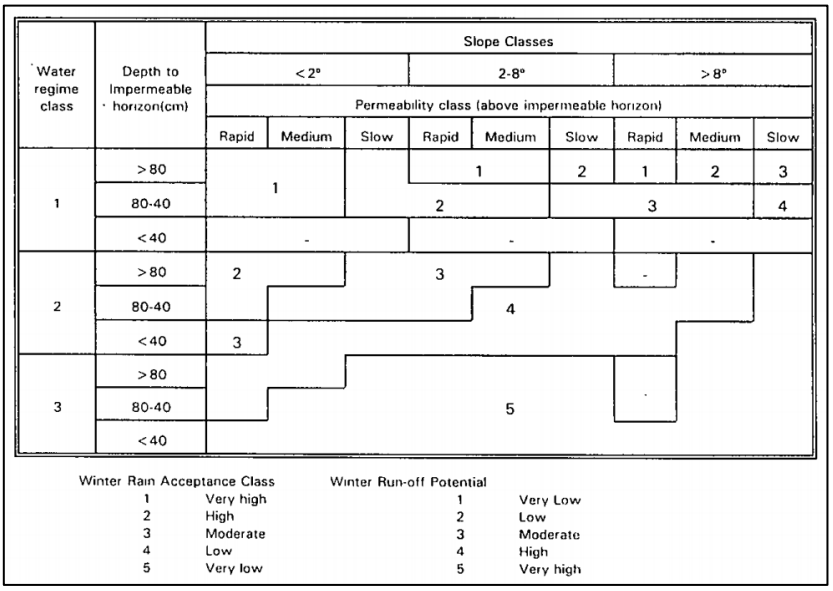


Figure 4-1 - Site Hydrology Overview

5. Soil Type Classification

To determine the allowable Qbar discharge rate from the proposed site, the SOIL value for the existing site was classified using the 'Winter Rain Acceptance Potential classification' Table 2.1 from the Institute of Hydrology Report No. 126, see Figure 5-1 below.



Water regime class	Depth to Impermeable horizon(cm)	Slope Classes								
		<2°			2-8°			>8°		
		Permeability class (above impermeable horizon)								
		Rapid	Medium	Slow	Rapid	Medium	Slow	Rapid	Medium	Slow
1	>80	1			1		2	1	2	3
	80-40			2			3			4
	<40	-			-			-		
2	>80	2			3			-		
	80-40					4				
	<40	3								
3	>80									
	80-40					5				
	<40									

Winter Rain Acceptance Class		Winter Run-off Potential	
1	Very high	1	Very Low
2	High	2	Low
3	Moderate	3	Moderate
4	Low	4	High
5	Very low	5	Very high

Figure 5-1 - WRAP Table

The table considers four main soil and site properties which include:

- Soil water regime
- Depth to an impermeable layer
- Slope class
- Permeability of the soil horizons above the impermeable layer

5.1 Soil Water Regime

The water regime class is taken from the Soil Survey Field Handbook (Hodgson 1974). The classes are identified as:

1) soils rarely waterlogged within 40 cm depth, and for less than 90 days within 70 cm in most years,

2) soils commonly waterlogged within 40 cm, but for less than 335 days within 70 cm in most years, and

3) soils waterlogged within 40 cm for more than 180 days, and for more than 335 days within 70 cm in most years.

Figure 5-2 - Water Regime Classes

The Site Investigations findings indicated a ranging depth of topsoil for each of the 12No. Trial Pits including the 6 Soakaway Trial Pits from 250mm to 400mm in depth.

Due to the maximum depth of the topsoil (400mm thk.) and the depth to impermeable layer discussed in Section 5.2 below, it was determined that water regime Class 2 “soils commonly waterlogged within 40cm, but for less than 335 days within the 70mm in most years” is the most suitable selection for this site.

5.2 Depth to an Impermeable Layer

Site Investigations were carried out on site as previously discussed in Section 3 of this report. During the Site Investigations 6No. soakaway tests were performed in accordance with BRE digest 365 at specified locations to determine the suitability of the soils for the infiltration of surface water.

The Site Investigations findings indicated a depth of topsoil for each of the 6No. soakaway Trial Pits ranging from 250mm to 400mm in depth.

Below the topsoil the test medium varied from slightly sandy slightly gravelly CLAY with occasional subrounded cobbles to firm to stiff brown slightly gravelly CLAY.

The Institute of Hydrology Report No. 126 outlines that “an impermeable layer is defined as a layer with a hydraulic conductivity of less than 0.1 m/day”.

Based on this information with predominant soil type for each of the soakaway tests being CLAY, the depth to an impermeable layer is determined to be located between 250mm and 400mm below surface level or at the underside of the topsoil or, accordance with the WRAP table a depth to impermeable horizon of <40cm.

5.3 Slope Class

Following a review of the topographical survey a 3D heatmap model of the existing site gradients was generated. The 3D model allowed for identification of the slopes on site between the ranges set out in the ‘Winter Rain Acceptance Potential classification’, see Figure 5-3 below for slope classifications

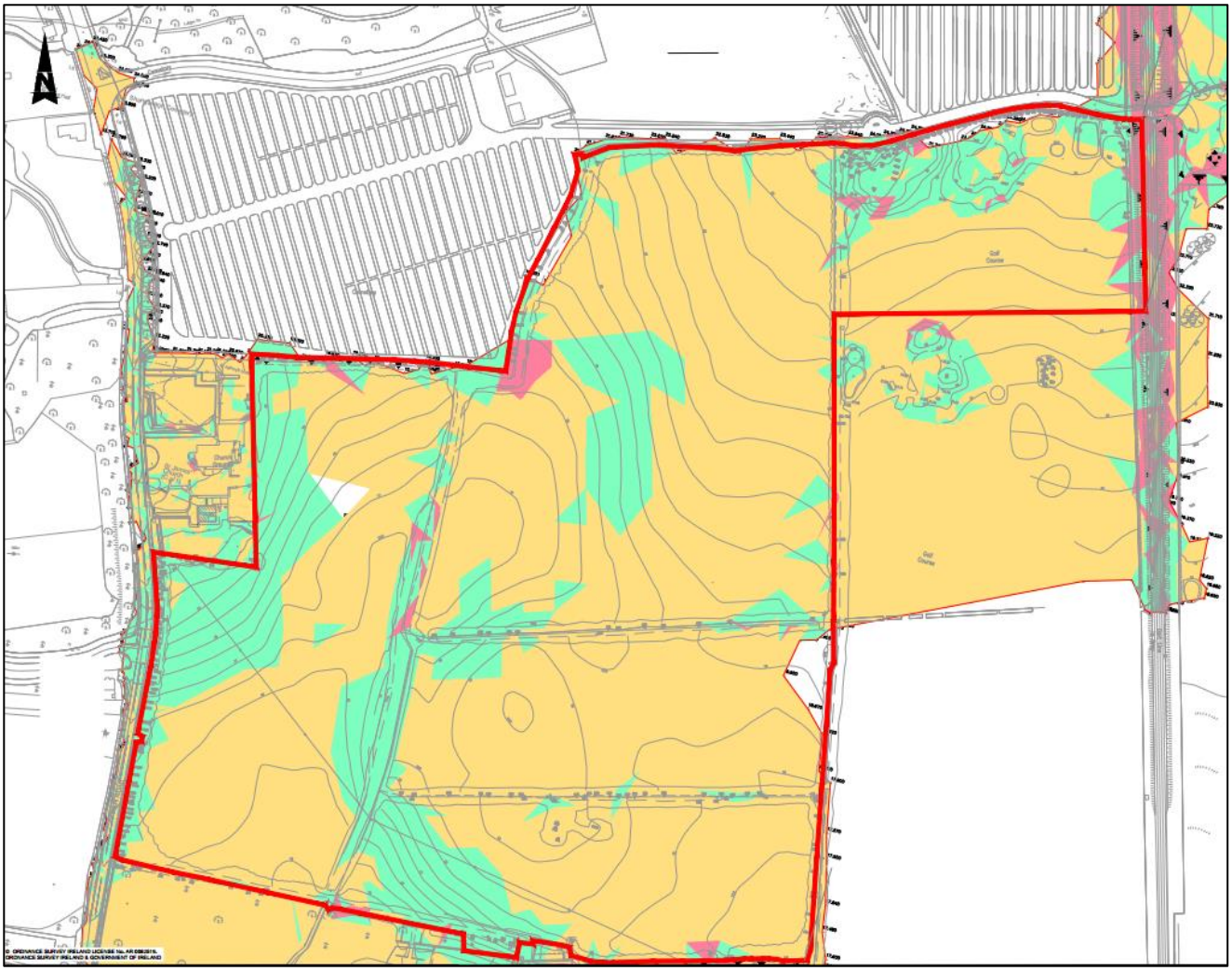


Figure 5-3 - Site Slope Classifications

The majority of the site has a slope of < 2 degrees indicated in yellow. It is noted however that parts of the site have a slope of between 2 – 8 degrees indicated in green with some minor areas having a slope of > 8 degrees indicated in red. For this assessment based on the predominate, a < 2 degrees slope will therefore be used.

5.4 Permeability Class

The Handbook of Soils for Landscape Architects by Robert F. Keeler Table 6.1 provides a soil characterisation for permeability from slow to rapid as outlined in Figure 5-4 below:

Table 6.1 Soil Permeability Class Related to Flow of Water through a Saturated Soil

Permeability Class	Rate of Flow (inches per hour)
Very slow	Less than 0.06
Slow	0.06–0.2
Moderately slow	0.2–0.6
Moderate	0.6–2.0
Moderately rapid	2.0–6.0
Rapid	6.0–20.0
Very rapid	More than 20

Figure 5-4 - Permeability Classifications

From review of the soakaway test results, the site has been subdivided into two areas based on permeability classes as per Figure 5-5 below. Area A to the east and west of the site encompasses an area of 11.02ha and Area B in the middle of the site encompasses an area of 10.08ha.

The soakaway tests in Area A indicate results between 0.325 inch / hour and 0.444 inch / hour. Based on this it is determined that permeability class is ‘Moderately Slow’.

The Site Investigations indicate that for Area B ‘water level dropped too slowly to allow for calculations of ‘f’ the soil infiltration rate’. For Area B it is determined that the permeability class is ‘Slow’.

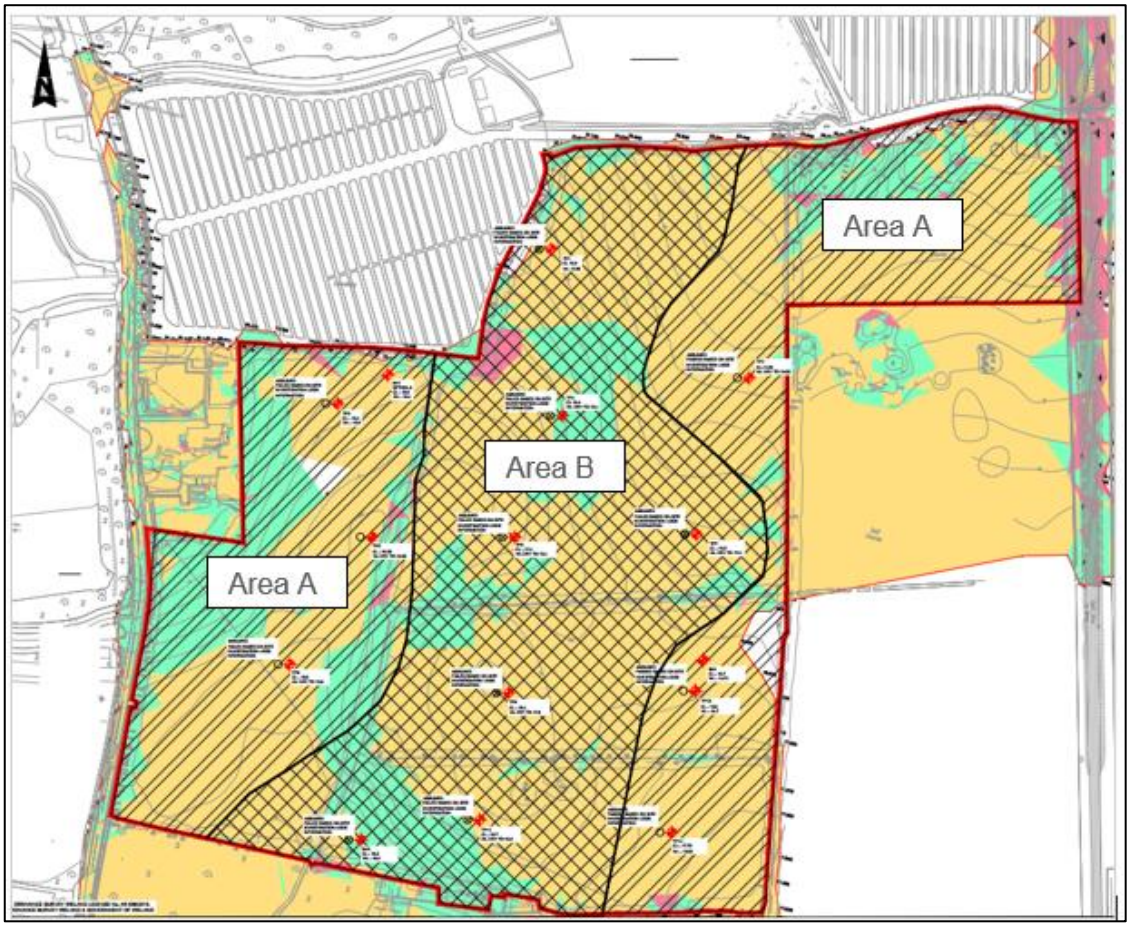


Figure 5-5 - Site Permeability Classification

5.5 Soil Type Classification

5.5.1 Area A

Based on the rational discussed in Sections 5.1-5.4 above, Area A would fall into the Soil Type 4 classification as per Figure 5-6 below.

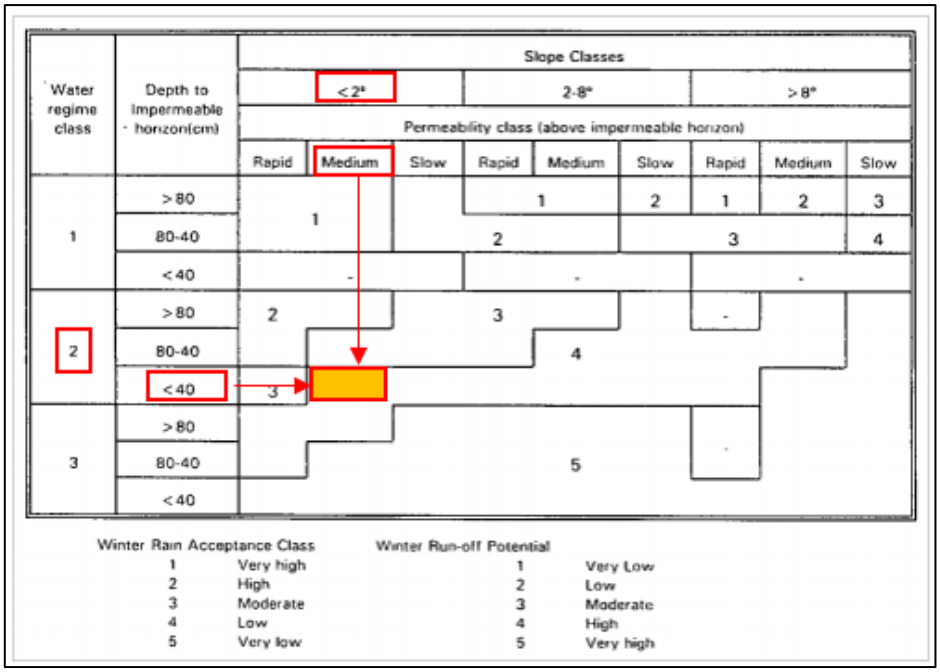


Figure 5-6 - Area A Soil Type Classification (Original)

However, DLRCC Municipal services opinion was that the depth to impermeable horizon across the site is in the range of 80cm – 40cm. Based on this Area A has been reclassified to Soil Type 3 for the purpose of Qbar discharge rate calculations, as per Figure 5-7 below.

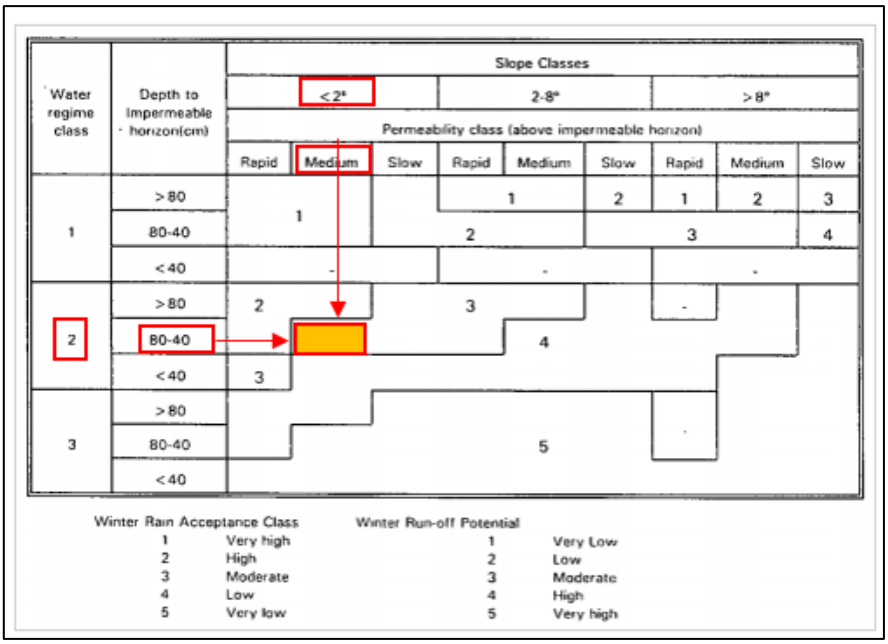


Figure 5-7 - Area A Soil Type Classification (Amended)

The reclassification of Soil Type 4 to Soil Type 3 provides a lower Qbar runoff rate and increases the attenuation volume requirements on site. The use of Soil Type 3 is therefore considered to be more onerous.

5.5.2 Area B

Based on the rational discussed in Sections 5.1-5.4 above, Area A would fall into the Soil Type 4 classification as per Figure 5-8 below.

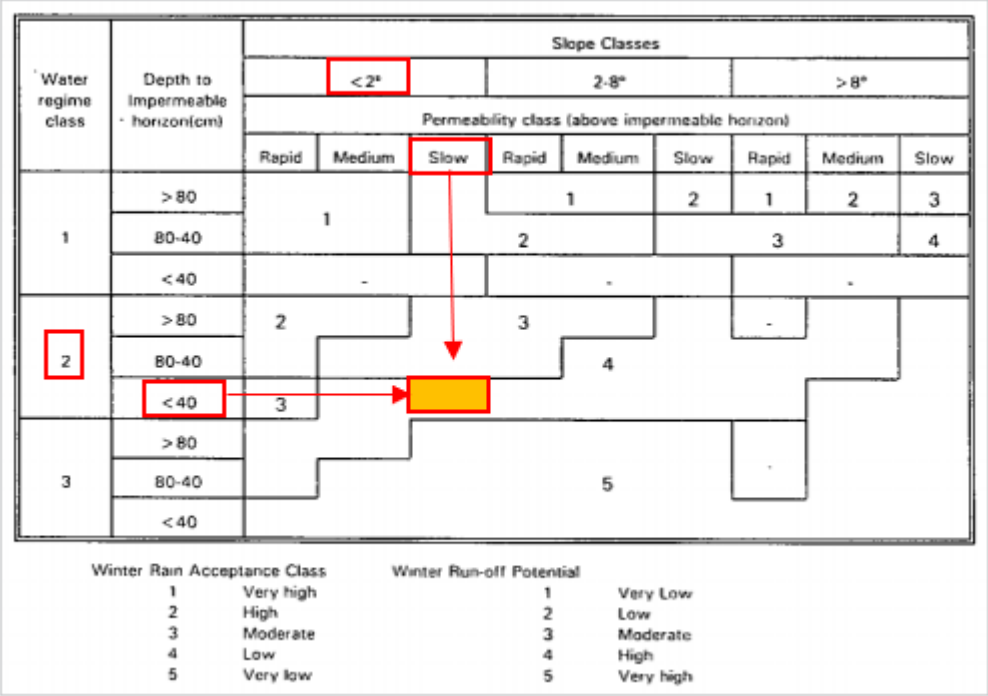


Figure 5-8 - Area B soil Classification (Original)

For phase 1, DLRCC Municipal services opinion was that the depth to impermeable horizon across the site is in the range of 80cm – 40cm and that possibly Soil Type 3 should be used. However, it was further considered that as each of the soakaway tests within Area B failed due to poor infiltration rates the area should classified as Soil Type 4. DLRCC Municipal services agreed that Soil Type 4 was acceptable within this area of the site, as per Figure 5-8 above. The design for the phase 2 submission will therefore remain unchanged based on previous agreements.

The Qbar value for the proposed site will therefore be determined using a combination of Soil Type Classification 3 and 4.

6. Surface Water Storage Requirements

For phase 1 and as agreed with DLRCC Municipal services, the www.uksuds.com surface water storage volume estimation tool was used to determine the maximum Qbar discharge rate from the site for a 1 in 100-year storm event. Site specific data was confirmed using Met Eireann rainfall data as indicated below;

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 325915, Northing: 220611,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.7,	3.8,	4.4,	5.2,	5.8,	6.2,	7.7,	9.3,	10.3,	11.8,	13.1,	14.1,	15.6,	16.8,	17.8,	N/A ,
10 mins	3.8,	5.3,	6.1,	7.3,	8.1,	8.7,	10.7,	12.9,	14.4,	16.4,	18.2,	19.6,	21.8,	23.4,	24.8,	N/A ,
15 mins	4.5,	6.3,	7.2,	8.6,	9.5,	10.2,	12.6,	15.2,	16.9,	19.3,	21.4,	23.1,	25.6,	27.6,	29.2,	N/A ,
30 mins	6.0,	8.2,	9.3,	11.0,	12.2,	13.1,	15.9,	19.1,	21.2,	24.0,	26.6,	28.5,	31.5,	33.8,	35.7,	N/A ,
1 hours	7.9,	10.6,	12.1,	14.2,	15.6,	16.7,	20.2,	24.0,	26.5,	29.9,	33.0,	35.3,	38.8,	41.5,	43.8,	N/A ,
2 hours	10.4,	13.9,	15.7,	18.3,	20.0,	21.3,	25.6,	30.2,	33.2,	37.3,	40.9,	43.6,	47.8,	51.0,	53.6,	N/A ,
3 hours	12.3,	16.2,	18.2,	21.2,	23.1,	24.6,	29.4,	34.5,	37.8,	42.4,	46.4,	49.4,	54.0,	57.5,	60.3,	N/A ,
4 hours	13.8,	18.1,	20.3,	23.5,	25.7,	27.3,	32.4,	38.0,	41.5,	46.4,	50.7,	53.9,	58.8,	62.6,	65.6,	N/A ,
6 hours	16.2,	21.1,	23.6,	27.3,	29.7,	31.5,	37.2,	43.4,	47.4,	52.8,	57.5,	61.1,	66.4,	70.5,	73.9,	N/A ,
9 hours	19.1,	24.7,	27.5,	31.6,	34.3,	36.3,	42.8,	49.7,	54.1,	60.0,	65.2,	69.1,	75.0,	79.5,	83.2,	N/A ,
12 hours	21.4,	27.6,	30.7,	35.1,	38.0,	40.2,	47.2,	54.6,	59.3,	65.8,	71.3,	75.5,	81.8,	86.6,	90.5,	N/A ,
18 hours	25.2,	32.2,	35.7,	40.7,	44.0,	46.5,	54.2,	62.5,	67.7,	74.8,	80.9,	85.5,	92.4,	97.6,	101.8,	N/A ,
24 hours	28.3,	35.9,	39.8,	45.2,	48.8,	51.4,	59.8,	68.7,	74.3,	81.9,	88.4,	93.3,	100.7,	106.2,	110.8,	126.0,
2 days	35.7,	44.5,	48.9,	55.0,	59.0,	62.0,	71.2,	81.0,	87.1,	95.3,	102.2,	107.5,	115.3,	121.1,	125.9,	141.8,
3 days	41.7,	51.4,	56.2,	62.9,	67.2,	70.5,	80.5,	90.9,	97.4,	106.1,	113.5,	119.0,	127.2,	133.4,	138.4,	155.0,
4 days	46.9,	57.5,	62.6,	69.8,	74.4,	77.9,	88.5,	99.5,	106.4,	115.6,	123.3,	129.1,	137.7,	144.1,	149.3,	166.6,
6 days	56.2,	68.1,	73.8,	81.9,	87.0,	90.8,	102.5,	114.6,	122.0,	132.0,	140.3,	146.6,	155.8,	162.7,	168.2,	186.6,
8 days	64.4,	77.4,	83.7,	92.5,	98.0,	102.1,	114.7,	127.7,	135.7,	146.3,	155.2,	161.8,	171.6,	178.8,	184.7,	204.0,
10 days	71.9,	86.0,	92.7,	102.1,	108.0,	112.4,	125.8,	139.6,	148.0,	159.2,	168.6,	175.6,	185.8,	193.4,	199.5,	219.8,
12 days	79.0,	94.0,	101.2,	111.1,	117.4,	122.0,	136.2,	150.6,	159.5,	171.2,	181.0,	188.3,	199.0,	206.9,	213.3,	234.3,
16 days	92.1,	108.8,	116.8,	127.7,	134.6,	139.7,	155.1,	170.9,	180.5,	193.1,	203.7,	211.5,	223.0,	231.5,	238.3,	260.7,
20 days	104.3,	122.5,	131.1,	143.0,	150.4,	155.9,	172.5,	189.4,	199.6,	213.1,	224.4,	232.7,	244.8,	253.8,	261.0,	284.7,
25 days	118.7,	138.6,	147.9,	160.8,	168.8,	174.8,	192.7,	210.8,	221.8,	236.2,	248.2,	257.0,	270.0,	279.6,	287.2,	312.2,

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

A SAAR Value of 825mm was utilised to calculate the green field runoff rate as confirmed by DLRCC Municipal services.

Refer to Appendix B for the output from the www.uksuds.com surface water storage volume estimation tool and maximum Qbar discharge rate.

A summary of the calculations is outlined below (see Table 7-3 for further breakdown of areas)

- Total site (overall catchment) area; 21ha
- Total area drained; 12.199ha
- Total impermeable area based on reduced coefficient runoff rate; 9.094ha
- Total % of drainage area that is impermeable; 75%

Significant public open space (public open spaces, rear gardens etc.) has been calculated by subtracting the total site area from the total positively drained area; 8.801ha.

As discussed in Section 5.5 above, the overall catchment area has been divided into two areas based on the corresponding soil types. These figures have been utilised to calculate the Qbar runoff rate (including 10% allowance for climate change) as summarised in Table 6-1 below and displayed in the UK SuDS output included within Appendix B.

Table 6-1 - Qbar Calculation Summary

Area Ref.	Soil Type	Area Size (ha)	% of Total Area (21ha)	Resulting Qbar (l/s)	Total Qbar (l/s)
A	3	11.02	52	22.08	**56.34**
B	4	10.08	48	34.26	

The calculated Qbar rate of 56.34l/s has been discussed and agreed with DLRCC Municipal services. The figure is the final permittable discharge from the Woodbrook site (Phase 1, Phase 2, amendment to Phase 1 & this currently application phase 4).

7. Proposed Site Characteristics

The proposed overall catchment area of 21ha has been split into 10No. catchment areas (catchment A – J) as indicated in Figure 7-1 below and on planning drawing 0119017-EWE-DR-0517. All catchments have incorporated multiple SuDS features as outlined in Section 2 above. Each catchment will have a flow control device to limit discharge rates to the maximum allowable Qbar runoff rate from the site (56.34l/s) and attenuation storage.

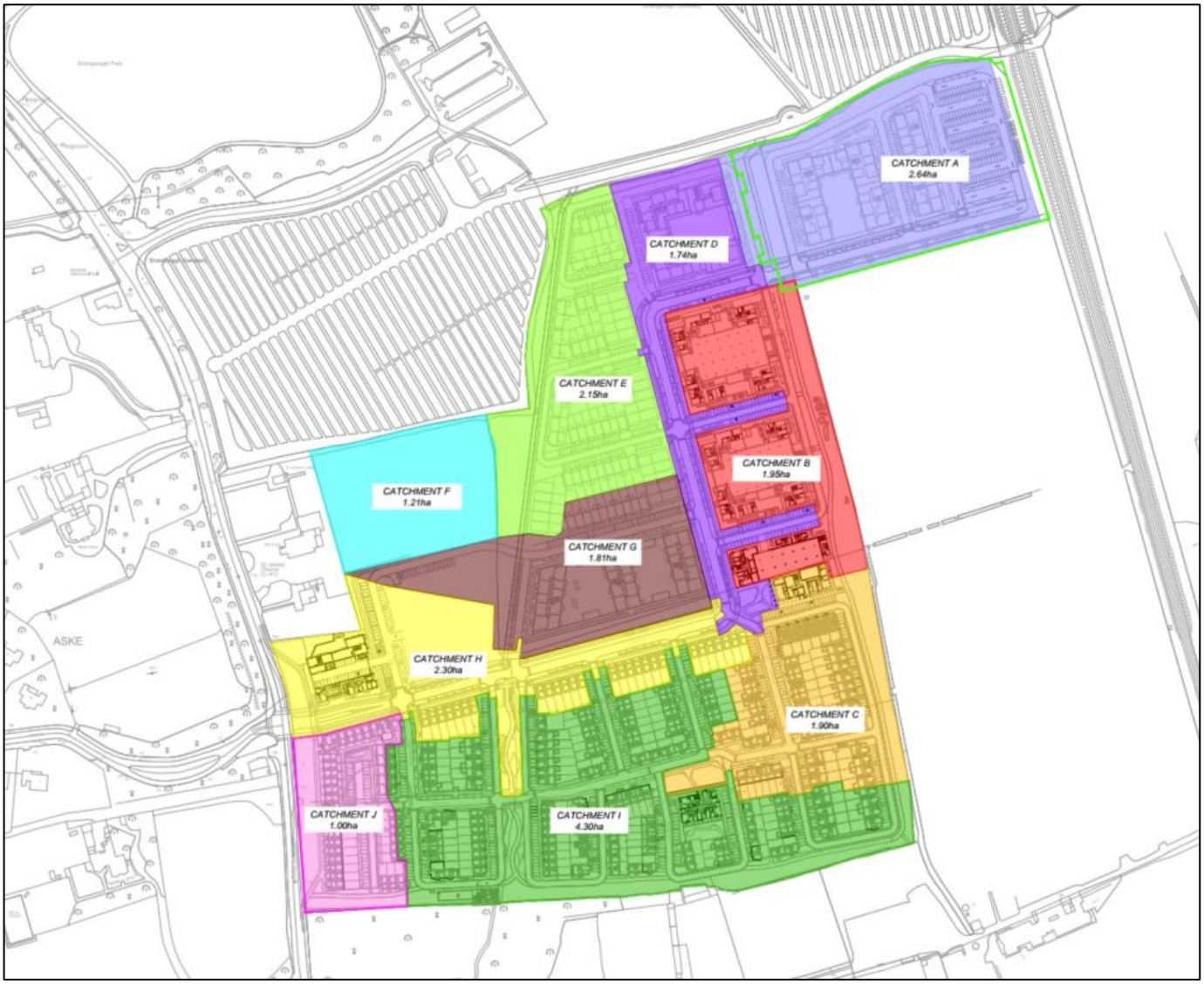


Figure 7-1 - Site Catchment Areas

Based on a maximum allowable Qbar final runoff rate from the site of 56.34l/s (including 10% allowance for climate change & 10% urban creep for 11.44ha and 20% climate change & 10% urban creep for 9.56ha) over a 21ha area, the runoff per hectare has been calculated as 2.68l/s/ha. In the first instance, the maximum discharge rates for each catchment were calculated based on the equivalent runoff per hectare, see Table 7-1 below for a summary of the results.

Two final flow control devices are proposed due to the topography and layout of the site. Attenuated flows from Catchment's A – I will pass through the final flow control device downstream of Catchment I. Catchment J will also have a flow control device to restrict flows before combining with the proposed storm water drainage network exiting the site at the southwestern corner as indicated on the planning drawings 0119017-ATK-ZZ-DR-CE-090503

It is proposed that the final discharge from the overall site will be directly to the Crinkeen / Woodbrook Stream culvert via a new storm water network along the Dublin Road. The outfall will be downstream of flow controls in catchment I and J.

In addition, due to the natural drainage routes, drainage design and catchment configuration within the proposed site, attenuated storm water will travel in a northeast to southwest direction through a series of catchments. Therefore, the initial discharge rates calculated are based on the cumulative value of the upstream discharge rate and the discharge rate for the current catchment, see Table 7-1 below for details.

Table 7-1 - Initial Catchment Area Discharge Rates

Catchment	Area	% of Total Site Area	Maximum Discharge rates per catchment based on Qbar 2.68 l/s/ha	Maximum Cumulative Discharge rates
A	2.64ha	12.6%	7.09l/s	**7.09l/s** (A only)
B	1.95ha	9.3%	5.24l/s	**12.33l/s** (A+B)
C	1.90ha	9.0%	5.09l/s	**17.42l/s** (A+B+C)
D	1.74ha	8.3%	4.67l/s	**4.67l/s** (D only)
E	2.15ha	10.2%	5.77l/s	**5.77l/s** (E only)
F (School Site)	1.21ha	5.7%	3.24l/s	**3.24l/s** (F only)
G	1.81ha	8.6%	4.86l/s	**13.87l/s** (E+F+G)
H	2.30ha	11.0%	6.17l/s	**24.71l/s** (D+E+F+G+H)
I	4.30ha	20.5%	11.53l/s	**53.66l/s** (A+B+C+D+E+F+G+H+I)
J	1.00ha	4.8%	2.68l/s	**2.68l/s** (I only)
Total	**21ha**	**100**	**56.34l/s**	**56.34l/s (Final discharge from site)**

Upon review of the green open space within each catchment it was not possible to attenuate storm water within each of the catchments to achieve the cumulative discharge rates listed in Table 7-1 above. Therefore, catchment discharge rates have been revised to either decrease upstream discharge rates thus reducing the volume of water into the

downstream catchment or by increasing the discharge rates from the current catchment thus increasing attenuation volume being provided downstream.

Changes to catchment flow rates within the site are managed locally and have no effect on the ultimate discharge rate from the entire site which is limited to 56.34l/s, as agreed with DLRCC Municipal services.

Based on attenuation space available throughout the site and ensuring the maximum ultimate discharge rate from the entire site of 56.34l/s is achieved, catchment discharge rates have been revised as per Table 7-2 below.

Table 7-2 - Amended Catchment Areas Discharge Rates

Catchment	Area	% of Total Site Area	Maximum Discharge rates per catchment based on Qbar 2.68 l/s/ha	Maximum Cumulative Discharge rates	Maximum Discharge rates per catchment-based attenuation volume available
A	2.64ha	12.6%	7.09l/s	7.09l/s (A only)	**2.0l/s**
B	1.95ha	9.3%	5.24l/s	12.33l/s (A+B)	**14.2l/s**
C	1.90ha	9.0%	5.09l/s	17.42l/s (A+B+C)	**19l/s**
D	1.74ha	8.3%	4.67l/s	4.67l/s (D only)	**29.0l/s**
E	2.15ha	10.2%	5.77l/s	5.77l/s (E only)	**2.0l/s**
F (School Site)	1.21ha	5.7%	3.24l/s	3.24l/s (F only)	**3.2l/s**
G	1.81ha	8.6%	4.86l/s	13.87l/s (E+F+G)	**13.0l/s**
H	2.30ha	11.0%	6.17l/s	24.71l/s (D+E+F+G+H)	**20.0l/s**
I	4.30ha	20.5%	11.53l/s	53.66l/s (A+B+C+D+E+F+G+H+I)	**53.8l/s**
J	1.00ha	4.8%	2.68l/s	2.68l/s (I only)	**2.5l/s**
Total	21ha	100	56.34l/s	**56.34l/s** (final discharge from site)	**56.3l/s** (final discharge from site)

The total Site Impermeable Areas and reduced Impermeable Areas based on coefficient runoff factors are indicated below in Table 7-3.

Table 7-3 - Site Impermeable Areas

	Total Impermeable Area	Impermeable Area based on co-efficient runoff factors (Table 2-1)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	1.77ha	1.77ha
Roads / Cycle tracks / Footpaths / Roofs when discharging directly, tree pits and filter drains	1.843ha	1.383ha
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	4.807ha	2.887ha
Extensive Green Roof (> 150mm thk.)	2.735ha	2.322ha
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1.044ha	0.732ha
Total	**12.199ha**	**9.094ha**

7.1 Catchment Design Details

It was agreed with DLRCC at pre-planning stage that the catchments submitted as part of the phase 1, 2 and 3 applications which are completed or currently at construction stage on site would not be required to be remodelled as part of this proposed development application. It is noted that the storm network for the entire site has been constructed with an allowance to cater for the Woodbrook Dart Gateway Development.

Based on this agreement, only Catchment A has been included in the hydraulic model as part of this submission including the revised site layout, 20% climate change requirements and 10% urban growth allowance.

Attenuation is proposed in catchment A using underground modular attenuation system. Details of attenuation system are indicated on drawing 0119017-ATK-ZZ-XX-DR-CE-903124 & 903125.

A controlled discharge from each catchment will be via a vortex flow control device downstream of the underground modular system. Each flow control devise has been designed based on the maximum head of water within the underground modular attenuation systems. The design head has been calculated for each catchment to ensure the flows rates indicated in Table 7-2 are not exceeded for the 1 in 100-year 6-hour storm event. It is noted that penstock will be installed within the hydro break chambers to allow maintenance when required. Flow control devices will not have bypass doors or high-level overflows as required by DLRCC.

A catch pit manhole will be provided at all inlets to the underground modular attenuation systems to reduce the levels of silts entering the system.

Porous paving provided will cater for runoff from the porous paving surface, adjacent roads / footpaths and roof runoff from the front of residential units. The subbase below the porous paving will allow for infiltration, reduced peak flows and 30% storage capacity within the subbase voids. An orifice plate / flow control will be used in the outfall chamber from each porous paving area to reduce the flow and increase the overall storage capacity of the subbase.

Tree pits and raingardens will be used at locations as indicated. Runoff from adjacent roads / footpaths and excess runoff from adjoining impermeable surface will discharge into the pit via a dropped kerb. The tree pit will allow for interception and percolation to ground. An overflow pipe with a raised level of 50mm above the finished surface level will allow for overflow into the storm drainage network during high intensity rainfall events. It is noted that tree pit interception volumes have not been included within the interception calculations below however, a minimum interception volume of 0.1m3 will be provided with each tree pit.

Extensive green roofs and Intensive green courtyards will be provided to suitable apartment blocks and retail units. A run-off factor of 85% has been used within the calculations.

7.2 Catchment A – Design Details

The drainage catchments that form part of the proposed Dart Gateway Development planning application will be assessed on the following criteria.

Attenuation is proposed in catchment A using an underground modular attenuation system which is divided into three separate tanks with individual vortex controls of which two tanks fall under this Phase of development. It was determined during modelling of the network that the tanks can be sized according to the volume of drainage received from the adjacent areas. The attenuation volume of the tanks P and Q are 200 m3 each.

The discharge rate from tanks P and Q via a vortex flow control device which continues to discharge at rate of 2.0 l/s and 1.0 l/s via a vortex flow control device for 1 in 100 year 6-hour event including 20% for climate change and 10% urban creep. Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 200m3 each provided was also sufficient.

The final discharge rate from catchment A will be 2.0 l/s as indicated on drawing 0119017-ATK-ZZ-XX-DR-CE-090503 which remains unchanged from original phase 1 planning application.

Table 7-4 - Design Summary - Catchment P

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment B1	2 l/s	1.9 l/s	1.9 l/s	200 m3

Table 7-5 - Site Impermeable Areas - Catchment P

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	1,827	1,827
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	370	278
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	4,177	2,506
Extensive Green Roof (> 150mm thk.)	2,350	1,998
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1,012	708
Total	9,736	7,317

Table 7-6 - Interception Volume Requirement - Catchment P

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	0.4177 ha
Volume of Interception Required	4,177 x 0.005 x 0.8 = 17 m3

Table 7-7 - Interception Volume Provided - Catchment P

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	2,350m2 x 0.005 = 12m3
Intensive Green Courtyead (landscape courtyard area with soil >500mm thk.)	1,012m2 x 0.005 = 5m3
Permeable paving	450m2 x 0.05 = 23m3 23 x 30% Voids = 7m3
Underground modular attenuation system	8.63(W) x 28(L) = 242m2 0.3(D) x 242m2 = 73m3 73 x 43% Voids = 31m3
Total	55m3 provide > 17m3 required (OK)

Interception Volume will be provided in catchment P using a series of SuDS. The overall volume interception volume provided is 55m3 which is greater than the required 17m3.

Table 7-8 - Design Summary - Catchment Q

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment B1	1.2 l/s	1.1 l/s	1.0 l/s	200 m3

Table 7-9 - Site Impermeable Areas - Catchment Q

	Total Impermeable Area (m2)	**Impermeable Area based on co-efficient runoff factors (**Table 2-1**)** **(m2)**
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	3,166	3,166
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	1,584	1,188
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	6,001	3,600
Extensive Green Roof (> 150mm thk.)	2,835	2,027
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1,427	602
Total	15,013	10,583

Table 7-10 - Interception Volume Requirement - Catchment Q

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	0.6001 ha
Volume of Interception Required	6,001 x 0.005 x 0.8 = 24 m3

Table 7-11 - Interception Volume Provided - Catchment Q

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	2,835m2 x 0.005 = 14m3
Intensive Green Courtyead (landscape courtyard area with soil >500mm thk.)	1,427m2 x 0.005 = 7m3
Permeable paving	1,460m2 x 0.05 = 73m3 7 x 30% Voids = 22m3
Underground modular attenuation system	16.80(W) x 15(L) = 252m2 0.3(D) x 252m2 = 76m3 76 x 43% Voids = 33m3
Total	76m3 provide > 24m3 required (OK)

Interception Volume will be provided in catchment Q using a series of SuDS. The overall volume interception volume provided is 76m3 which is greater than the required 24m3.

8. Compliance with GDSDS Design Criteria

Outfall Section 6.3.4 of the GDSDS Volume 2 New Development sets out four design criterion which are required to be met by the proposed drainage system. Compliance with these criteria is outlined below:

8.1 Interception Volume – Criterion 1.1

Interception storage volume is based on 80% runoff from paved areas and 0% runoff from pervious surfaces for the first 5mm of rainfall.

Table 8-1 - Interception Volume

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.03 ha
Volume of Interception Required	10,300x 0.005 x 0.8 = 41m3
Catchment P+Q	55 m3+76m3
Total Provided	131 m3

Interception Volume will be provided in each catchment using a series of SuDS. The overall volume will be greater than the required set out in the GDSDS based on a rainfall rate of 5mm.

- Permeable pavement to parking bays
- Conveyance Swales
- Green roofs (to apartment buildings only)
- Green courtyards (to apartment buildings only)
- Tree pits (along main avenue)
- Underground modular systems (within green open spaces)

The CIRIA report C753 The SuDS Manual-v6 provides guidance that were surface water drains through SuDS systems then interception is deemed to have been provided. In addition to that the stone base within the attenuation systems provided are used as part of the calculations indicated above. On that basis interception provided would be in excess of those volume indicated to be provided above.

8.2 Treatment Volume – Criterion 1.2

Interception storage volume is based on 80% runoff from paved areas and 0% runoff from pervious surfaces for the first 15mm of rainfall.

Table 8-2 - Treatment Volume

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.03 ha
Volume of Treatment Storage Required	10,300 x 0.015 x 0.8 = 124m3

Due to site constraints including open space set out in the Local Area Plan (LAP) and density requirements there is insufficient space on site to provide the Treatment Volume (retention pond or wetland) and therefore Criterion 1.2 cannot be successfully met for this site.

In accordance with Table 6.3 of the Regional Drainage Policies – Volume 2 New Development, as Criterion 1.1 is being achieved, Criterion 1.2 is not required.

8.3 River Regime Protection – Criterion 2

An allowable overall outflow rate for Qbar of 56.34l/s has been calculated for the site and agreed with DLRCC drainage department as part of the overall Woodbrook Site Development. This flow control has been constructed as part of the Woodbrook phase 1 catchment I and its associated attenuation system. The final discharge rate will remain unchanged as part of this phase 4 planning application.

The overall site attenuation volume is currently calculated to be > 4,377m3 as outlined in the table below which is provided for the appropriate throttle rate.

Table 8-3 - Attenuation Tanks

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Minimum Tank Volume	Excavation Dimensions W x L x D
Catchment A	2.0 l/s	432 m3	Refer to Details Drawing
* Catchment B	14.2 l/s	230 m3	N/A
* Catchment C	17.6 l/s	144 m3	N/A
Catchment D	29.0 l/s	246 m3	N/A
Catchment E	2.0 l/s	704 m3	N/A
* Catchment F (School Site)	3.2 l/s	500 m3	N/A
Catchment G	13.0 l/s	630 m3	N/A
* Catchment H	20.0 l/s	720 m3	N/A
* Catchment I	53.8 l/s	675 m3	N/A
* Catchment J	2.5 l/s	96 m3	N/A
Total	**56.3l/s (final discharge from site)**	****4,377 m3**	

**No proposed changes Catchment attenuation volumes from Woodbrook Phase 1 Planning submission.*

***The volume indicated does not include volume contained in Tanks X, Y and Z as part of the Northern Catchment attenuation.*

8.4 Level of Service – Criterion 3

The four criteria for levels of service are as follows:

- Criterion 3.1: No external flooding (30-year high intensity rainfall event)
- Criterion 3.2: No internal flooding (100-year high intensity rainfall event)
- Criterion 3.3: No internal flooding (100-year river event and critical duration for site storage)
- Criterion 3.4: No flood routing off site except where specifically planned (100-year high intensity rainfall event)

Criteria 3.1, 3.2, 3.3 & 3.4: All potential flooding will be reviewed and modelled using micro drainage for up to the required 1 in 100-year storm event including 20% for climate change and 10% for urban creep. Outputs from the model for the proposed storm network will be provided.

8.5 River Flood Protection – Criterion 4

Of the three methods referred to in the GDSDS for establishing River Flood Protection, by comparison of the pre and post development runoff volumes, (Criteria 4.1, 4.2 and 4.3 respectively), Criteria 4.3 has been selected most suitable for use on this proposed site. An extract from the GDSDS for Criterion 4 is indicated in Figure 8-1 below.

Criterion 4 River flood protection (Criterion 4.1, or 4.2 or 4.3 to be applied)	4.1	100	"Long-term" floodwater accommodated on site for development runoff volume which is in excess of the greenfield runoff volume. Temporary flood storage drained by infiltration on a designated flooding area brought into operation by extreme events only. 100 year, 6 hour duration storm to be used for assessment of the additional volume of runoff.
	4.2	100	Infiltration storage provided equal in volume to "long term" storage. Usually designed to operate for all events. 100year, 6-hour duration storm to be used for assessment of the additional volume of runoff.
	4.3	100	Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided.

Figure 8-1 - GDSDS River Flood Protection

Criterion 4.3 has been satisfied for the proposed site by providing an agreed Maximum discharge rate of Qbar (56.3l/s, from entire Woodbrook development site) and on-site attenuation for up to the 1 in 100-year storm event including 20% for climate change and 10% for urban creep.

9. Flooding & Exceedance Flows

9.1 Flood Risk Assessment

A Flood Risk Assessment (FRA) Atkins Document No. 0119017DG0007 has been undertaken for the site to satisfy the requirements of the Planning System and Flood Risk Management Guidelines. The report aimed at scoping sources of flooding, assessing whether any significant flood risk issues exist and proposing appropriate flood risk management measures as required. The flood risk assessment can be considered to satisfy the Stage 1 – Flood Risk identification as set out in The Guidelines. It is considered that this level of assessment is sufficient given the nature of the development and the level of flood risk identified for the site. Therefore, the FRA was not required to progress to Stage 2 & 3.

The FRA conclusion identifies that there is no potential flood risk identified in the vicinity of the proposed residential development site.

9.2 Exceedance Flows

The Surface Water exceedance flows from the site will be considered as part of the drainage design. A modelling exercise was carried out with a 50% blockage within vorterx flow control units at 2 locations. The locations selected are based on importance following a review if the surface water flow paths 0119017-ATK-ZZ-XX-DR-CE-090514.

The table below outlines the catchments and vortex flow controls that had a restriction applied.

Table 9-1 - Exceedance Flows

Catchment	Vortex Flow Control Restriction	Storm Event	Maximum Flood Volume
Catchment A	50% (Attenuation Tank P & Q)	1 in 100-year 6-hour event	No flooding

Catchment A

From a review of the model output no flooding was indicated for the 1 in 100-yr storm event at the vortex flow control manholes. From further investiagetion of the model output data it was determined why no flooding had occurred, it was determined that maximum flow rate design was set to 2 l/s and 1.2 l/s (for tank P & Q under normal conditions) the flow rate only reached 0.9 l/s and 0.6 l/s (for tank P & Q) for the 100 year rainfall event. The restricted flow rate from indicated above has no negative effect on drainage system and no flooding was indicated.

10. SuDS Maintenance

Regular checks and maintenance of the SuDS systems is required and have been considered as part of the overall drainage design for the proposed development. This will ensure both the design life of the SuDS systems, ongoing improved water quality, reduced water runoff and reduce the risk of onsite flooding and exceedance flows. The below guidance is provided by the CIRIA report C753 The SuDS Manual-v6, further guidance should be provided for areas of landscape including tree / shrubs and specialist suppliers for items such as green roofs. The following SuDS systems will be proposed as part of the Woodbrook Park Edge development planning application and therefore the design will consider the following maintenance requirements.

10.1 Permeable Paving

Paving should be inspected regularly, preferable during and after heavy rainfall to ensure effective operation.

Vacuum brushing or jetting of the permeable paving should be carried out once a year. Cleaning is generally carried out after Autumn leaf fall to remove silts and sediments.

10.2 Green Roofs / Green Courtyards

All components (soil substrate, vegetation, drains, membranes and rood structure) should be inspected annually and after severe storms.

Underside of roof should also be inspected annually and after severe storms for evidence of leakage.

Debris, fallen leaves and litter should be regularly removed to prevent clogging of inlet drains.

10.3 Underground Modular Attenuation Systems

Inspection of the system should be carried out monthly for the first 3 months and then annually to ensure the system is working correctly.

Debris should be removed monthly from the catchment surface where may cause risk to the performance of the underground attenuation system.

As required sediment from pre-treatment (catch pit) manholes prior to the attenuation system should be removed to ensure on going performance of the system.

The inside of the tank should be surveyed every 5 years or as required if performance is reduced. Sediment build up removed if necessary.

10.4 Tree Pits / Rain Gardens

Maintenance of trees will be greatest in the first few years, which will include regular inspection of tree condition including inlets and outlets, removal of invasive vegetation and possibly irrigation during long dry periods.

10.5 Filter Drains

Inspection of the system should be carried out monthly on the inlet / outlet pipework and any control systems for blockages.

Inspection of pre-treatment systems including should be carried out every 6 months for catch pits manholes prior to the filter drain with removal of silt or other build-ups. Removal of silt build-up may be required more frequent.

Annual cleaning of roof runoff gutters etc should be part of the generally maintenance of the drainage system to ensure debris is removed prior to entering the network.

Perforated pipework should be cleared of blockage if required.

10.6 Vortex Flow Control Maintenance

The Vortex flow control while not a SuDS system, forms an important part in controlling and restricting the surface water discharge from each catchment within the site and the final discharge from the site.

The Vortex flow control should be inspected monthly for the first three months and following every six months after. If necessary due to sediment build up the flow control should be hosed down and the silt removed from the sump.

The bypass door should also be checked in accordance with the manufacturer's maintenance guidelines and bypass door / rope replaced as required.

11. SuDS Audit Overview

The Stage 1 Surface Water Audit has been completed prior to the lodgement of this planning application.

APPENDICES

Appendix A. Surface Water Audit

PUNCH
consulting engineers

Woodbrook Dart Gateway, Woodbrook, Co. Dublin

Stage 1 Stormwater Audit

262105-PUNCH-XX-XX-RP-C-001

March 2026

Document Control

Document Number: **262105-PUNCH-XX-XX-RP-C-001**

Status	Rev	Description	Date	Prepared	Checked	Approved
S3	P01	Draft Issue	27/01/2026	A Ní Shúilleabháin	A Mc Carthy	T Horan
A0	C01	Final Issue	13/03/2026	A Ní Shúilleabháin	A Mc Carthy	T Horan

Report by: _____ Date: 13th March 2026

Aoife Ní Shúilleabháin

Graduate Engineer, BSc CSE, PgDip EIZC

PUNCH Consulting Engineers

Checked by: _____ Date: 13th March 2026

Andrew McCarthy

Project Engineer, BE, ME, MIEI

PUNCH Consulting Engineers

Checked by: _____ Date: 13th March 2026

Tomás Horan

Technical Director, BEng PGDipCE CEng MIEI

PUNCH Consulting Engineers

Table of Contents

1 Introduction

1.1 Purpose of Report

This report presents a Stage 1 Stormwater Audit carried out for a proposed residential development in Woodbrook, Co. Dublin.

PUNCH Consulting Engineers have been appointed by Atkins Réalis to carry out an independent Stage 1 Stormwater Audit in accordance with Dún Laoghaire-Rathdown County Council's Stormwater Procedure and Development Plan's requirements, which includes design of the surface water network and associated sustainable drainage systems (SuDS) proposed.

1.2 Site Details

The proposed development site measures c.2.63 hectares and is currently greenfield, located on existing agricultural lands. The proposed development comprises primarily of a residential development, with 360no. residential units, consisting of 354no. apartment units and 6no. duplex units proposed in a mix of 1, 2 and 3-bedroom units accommodated within 2no. apartment blocks, ranging in height of 2-7 storeys, including balconies and terraces. The development also includes public open space, communal open space serving the blocks; internal road networks; pedestrian and cycle facilities; car and bicycle parking spaces; ESB substations and all associated and ancillary site development and infrastructural works, hard and soft landscaping and boundary.

The site is bounded by an active DART line on the east, Woodbrook Golf Club on the south, a cemetery and undeveloped open greenfields to the North, and the permitted Phase 2 of the Woodbrook development to the west.

The existing topographical levels within the residential site range from 21.00 mOD to 25.00 mOD. The highest point is located at the north-eastern corner, while the lowest point is at the north-western corner, with the terrain generally sloping towards the south. Additionally, the levels gradually fall from all directions towards the centre of the southern portion of the site. The site is currently accessed via the recently constructed junction to the Woodbrook Avenue on the R119 Dublin Road.

1.3 Report Details

The audit was carried out by Aoife Ní Shúilleabháin, checked by Andrew McCarthy, and approved by Tomás Horan between the dates of January 20th and March 13th, 2026.

This Stage 1 Audit has been carried out in accordance with the Dún Laoghaire-Rathdown County Council (DLRCC) procedures outlined in the Dun Laoghaire Rathdown Development Plan 2022-2028, Appendix 7 "Stormwater Management Policy - Including Stormwater Audit Procedure". The auditor has examined only those issues within the design relating to surface water drainage and Sustainable Drainage Systems (SuDS) implications of the scheme and has therefore not examined or verified the compliance of the design to any other criteria. Design responsibility for the stormwater drainage and SuDS remains solely with the Design Engineer.

Appendix A contains the copies of drawings and documents examined by the auditor. Appendix B contains the Stage 1 Surface Water Audit Feedback form.

All findings outlined in Section 2 of this report are considered by the auditor to require action to improve the stormwater credentials of the scheme.

1.4 Drawings & Documents Reviewed

Initial documents received 14-01-2026:

Drawings:

1. ~~Proposed Storm Drainage Layout (0119017-ATK-ZZ-XX-DR-CE-090503) - Rev A~~
2. Proposed Storm Drainage Sub Catchment Areas (0119017 / EWE / DR / 0517)
3. ~~Proposed Storm Water Long Section (0119017-ATK-ZZ-XX-DR-CE-090507)~~
4. Proposed Surface Water Flow Path (0119017-ATK-ZZ-XX-DR-CE-090514)
5. Standard Construction Details Sheet 1 (0119017-ATK-ZZ-XX-DR-CE-903121)
6. Standard Construction Details Sheet 2 (0119017-ATK-ZZ-XX-DR-CE-903122)
7. Standard Construction Details Sheet 3 (0119017-ATK-ZZ-XX-DR-CE-903123)
8. Standard Construction Details Sheet 4 (0119017-ATK-ZZ-XX-DR-CE-903124)
9. Standard Construction Details Sheet 5 (0119017-ATK-ZZ-XX-DR-CE-903125)
10. Proposed Green Intensive Courtyard and Extensive Roof Layout (0119017-ATK-ZZ-XX-DR-CE-090521)

Reports:

1. ~~Stormwater Impact Assessment (0119017DG0005) - Rev 0~~

Response documents received 27-02-2026:

Drawings:

1. Proposed Storm Drainage Layout (0119017-ATK-ZZ-XX-DR-CE-090503) - Rev B
2. Proposed Storm Water Long Section (0119017-ATK-ZZ-XX-DR-CE-090507) - Rev A

Reports:

1. Stormwater Impact Assessment (0119017DG0005) - Rev A

Note: Strikethrough text indicates documents that were superseded during the audit. These superseded documents are not included in the final audit report.

2 Stage 1 Audit Findings

2.1 General Requirements as per DLRCC County Development Plan 2022-2028

Table 2-1 below outlines the result of a review of the scheme designer's proposals against the general requirements outlined in the DLRCC County Development Plan 2022-2028, Appendix 7, section 7.1.1.

Table 2-1 General Requirements for all developments greater than a single house

	Requirements as per DLRCC 2022-2028 Development Plan	Addressed by Scheme Designer?
2.1.1	**Climate Change** All developments must apply a minimum factor of 1.2 to their drainage design and attenuation volumes to accommodate climate change.	Highlighted as part of this Audit
2.1.2	**Urban Creep** All developments must apply a factor of 1.1 to their drainage design and attenuation volumes to accommodate urban creep.	Y
2.1.3	**Blockage Analysis** Scheme Designers must submit details of the proposed surface water drainage system in the event of blockage or partial blockage of the system, commenting on any surcharging or flood risk that may be identified, particularly in relation to freeboard used in the simulation analysis. The proposal must include a drawing confirming that safe overland flow routes do not negatively impact properties both within and without the site. The overland flow route plan should identify drop kerbs or ramps required for channelling the flow and address low point areas in the site and detail how properties, both within the development and on adjacent lands, will be protected in the event of excessive overland flows.	Highlighted as part of this Audit
2.1.4	**Utility Clash Check** The Scheme Designer must undertake a utilities clash check to ensure all utilities' vertical and horizontal separation distances can be provided throughout the scheme. The Scheme Designer should demonstrate this with cross-sections at critical locations such as junctions, site thresholds and connection points to public utilities. Minimum separation distances must be in accordance with applicable Codes of Practice.	Highlighted as part of this Audit
2.1.5	**Private Drains** Where an applicant's land is crossed by a private drain, the applicant is responsible for acquiring any rights or permissions necessary to connect to, or to increase the discharge into, or to build over, or divert, or to ensure the adequate capacity is not exceeded, or otherwise alter any private drains not in their exclusive ownership or control, and for ensuring their adequacy.	Highlighted as part of this Audit
2.1.6	**Pumping of Surface Water**	N/A
2.1.7	**Sustainable Drainage Systems (SuDS):** The proposal must demonstrate that they meet the requirements of the Greater Dublin Strategic Drainage Study (GDSDS) policies in relation to Sustainable Drainage Systems (SuDS). The design must incorporate SuDS measures appropriate to the scale of the proposed development such as green roofs, bioretention areas, permeable	Highlighted as part of this Audit

	paving, rainwater harvesting, swales, etc. that minimise flows to the public drainage system and maximises local infiltration potential. The Scheme Designer should provide cross-sections and long-sections, and commentary that demonstrates all proposed SuDS measures have been designed in accordance with the relevant industry standards and the recommendations of The SuDS Manual (CIRIA C753)	
2.1.8	**Infiltration:** The Scheme Designer should submit Site Investigation Report and results, including infiltration tests, and a plan showing the trial pits/soakaway test locations across the site. The report should address instances where groundwater, if any, was encountered during testing and its impact.	Highlighted as part of this Audit
2.1.9	**Hardstanding/Parking Areas:** All proposed parking and hardstanding areas should maximise local infiltration before discharge to the surface water drainage system, via a specifically designed permeable paving/porous asphalt system, in accordance with the requirements of Section 12.4.8 of the County Development Plan 2022-2028.	Highlighted as part of this Audit
2.1.10	**Basement:** If basement carparking is provided, then all incidental run-off from the basement should be shown to drain to the foul system and not the surface water system	N/A
2.1.11	**Run-off Factors:** Where Scheme Designers propose to use reduced run-off factors (or reduced impermeable contributing areas) for areas of their site that drain to SuDS measures these factors must be agreed with Municipal Services, preferable during the pre-planning process. It should be noted that standard surface water simulation software uses default Cv values of 0.84 for Winter and 0.75 for Summer. If the Scheme Designer proposes to use their own reduced run-off rates, then the default Cv values should be amended to a value of 1.0. Maintaining the default Cv values in conjunction with the Scheme Designers proposed rates reduces the run-off in simulations of rainfall events, giving inaccurate simulation results which may lead to under sizing of the drainage system and attenuation storage required.	Highlighted as part of this Audit
2.1.12	**Hydrological Parameters** Scheme Designers must use site specific or local data in their Qbar, attenuation volume and surface water system design such as: • SAAR • Soil Type • Rainfall Return Period Table (available from MET Eireann) • Rainfall intensity • Other hydrological parameters	Highlighted as part of this Audit
2.1.13	**Discharge Rate:** Surface Water discharge from a development must be restricted to 2 l/s/ha or the calculated Qbar, whichever is greater. The Qbar should be calculated using the net area drained and not the gross area of the site (i.e. red line boundary). This discharge rate should be marked on the drainage drawing on the manhole in which the flow restricting device if located. The manhole in which the flow restricting device is located should not have a bypass pipe and, a penstock and silt trap should be provided. Flow restricting devices with an orifice of less than 50mm in diameter should be avoided. Where this is not possible then the Scheme Designer must submit a robust maintenance regime to ensure blockages are avoided, to the satisfaction of dlr. Scheme Designers are recommended to use the HR Wallingford UK SuDS Greenfield runoff rate estimation tool to estimate Qbar for their site: https://www.uksuds.com/drainage-calculation-tools/greenfield-runoff-rate-estimation	Highlighted as part of this Audit

2.1.14	**Attenuation:** If an attenuation system is proposed it should, where possible, not be located under the internal roads but in/under open space or parking areas. Attenuation systems must be inline. The preference is for attenuation systems that allow for infiltration and/or treatment within the site. The Scheme Designer should note that certain landscaping items, such as trees, may not be compatible with attenuation systems. The Scheme Designer must provide fully dimensioned plans and sections of the attenuation storage system. All relevant inlet and outlet levels, dimensioned clearances between other utilities, and actual depths of cover to the system should be provided. Details of the proposed inlet and outlet manholes and arrangements to facilitate draw down and maintenance should also be provided. Scheme Designers are recommended to use the HR Wallingford UK SuDS Surface water storage volume estimation tool to estimate the attenuation storage required for their site: https://www.uksuds.com/drainage-calculation-tools/surface-water-storage.	Highlighted as part of this Audit
2.1.15	**Green Roof:** The proposal must meet the requirements of Appendix 7.2: Green Roof Policy of the County Development Plan 2022-2028.	Highlighted as part of this Audit
2.1.16	**Interception and Treatment:** The Scheme Designer must demonstrate that required interception and/or treatment of surface water run-off is achieved in accordance with GDSDS policy. To be in compliance with GDSDS Volume 2 Section 6.3.3 Table 6.3 Criterion 1, interception of the first 5-10mm is required. If interception of first 5-10mm can't be achieved, then treatment of first 15mm is required.	Highlighted as part of this Audit
2.1.17	**Maintenance:** Scheme Designers must submit a post-construction maintenance specification and schedule for the drainage system, including SuDS measures and attenuation system to DLRCC for approval. This maintenance specification and schedule must be included in the Safety File.	Highlighted as part of this Audit
2.1.18	**New Connections:** Prior to submission of the planning application, the Scheme Designer must obtain the sewer network records from DLRCC and assess if a new connection to the public sewer is technically feasible.	Highlighted as part of this Audit

2.2 DLRCC 2022 Development Plan – Stormwater Audit Procedure Table

Table 2-2 Stormwater Audit Procedure Table - Completed by Scheme Designer

Surface Cover Type	Area (m^2)
Wetland or open water (semi-natural; not chlorinated) maintained or established on site.	N/A
Semi-natural vegetation (e.g. hedgerows, trees, woodland, species-rich grassland) maintained or established on site.	N/A
Reuse of existing soils and seed source to develop vegetation cover	TBC at Detail Design
Standard trees planted in connected tree pits with a minimum soil volume equivalent to at least two thirds of the projected canopy area of the mature tree.	N/A
Standard trees planted in pits with soil volumes less than two thirds of the projected canopy area of the mature tree.	Refer to Landscape Architects Pack
Intensive green roof or vegetation over structure. Substrate minimum settled depth of 150mm.	2,439m^2
Non intensive Brown Roof (Biodiversity Roof). Substrate minimum settled depth of 150mm. Design will be site specific and developed by a suitably qualified ecologist.	N/A
Extensive green roof with substrate of minimum settled depth of 80mm (or 60mm beneath vegetation blanket)	N/A
Extensive green roof of sedum mat or other lightweight systems	5,185m^2
Green wall – modular system or climbers rooted in soil.	N/A
Rain gardens and other vegetated sustainable drainage elements.	198m^2
Flower-rich perennial planting.	Refer to Landscape Architects Pack
Hedges (line of mature shrubs one or two shrubs wide).	Refer to Landscape Architects Pack
Hedgerows or double hedgerow of native species (may have an associated ditch and bank)	N/A
Groundcover planting.	Refer to Landscape Architects Pack
Amenity grassland entire area or sections managed for lesser mowing frequencies for pollinators (e.g. six-week meadow)	Refer to Landscape Architects Pack
Amenity grassland (species-poor, regularly mown lawn).	Refer to Landscape Architects Pack
Water features (chlorinated) or unplanted detention basins.	N/A
Permeable paving.	1,910m^2
Sealed surfaces (e.g. concrete, asphalt, waterproofing, stone)	3,083m^2
Blue roof	N/A

2.3 Climate Change

Problem: It is unclear if the minimum factor of 1.2 has been applied to the drainage design and attenuation volumes to accommodate climate change as a factor of 1.1 for the climate change factor was also mentioned in the Stormwater Impact Assessment report.

Recommendation: The Designer is to confirm whether the minimum factor of 1.2 for climate change is allowed for in their design.

2.4 Blockage Analysis (Flow Exceedance)

Problem: There is potential for blockages within attenuation and drainage infrastructure, and the proposal does not confirm that overland flow routes currently shown on drawing no. 0119017-ATK-ZZ-XX-DR-CE-090514 will not negatively impact properties both within and outside the site.

Recommendation: The Designer should consider carrying out a blockage analysis of the system, assuming scenarios such as a blocked hydrobrake and orifice manhole. The results should identify any potential flooding and demonstrate how exceedance flows are managed. The Designer should also confirm that the overland flow routes do not negatively impact properties within and outside the proposed development.

2.5 Utility Survey

Problem: Existing utility services should be confirmed on-site before finalising SuDS measures as per SuDS Manual Section 29.3.6.

Recommendation: The Designer should confirm that they have verified the location of utilities and confirm the coordination of SuDS measures with existing services.

2.6 Utility Clash Checks

Problem: No utility clash check is evident from the documents provided.

Recommendation: The Designer is to confirm that a utility clash check has been carried out, and adequate separation distances are achieved between the surface water network and SuDS features, and other utilities, all in accordance with relevant Uisce Éireann Code of Practice and Council requirements.

2.7 Private Drains

Problem: Where an applicant's land is crossed by a private drain, the applicant is responsible for acquiring any rights or permissions necessary to connect to, or to increase the discharge into, or to build over, or divert, or to ensure the adequate capacity is not exceeded, or otherwise alter any private drains not in their exclusive ownership or control, and for ensuring their adequacy.

Recommendation: The Designer is to confirm whether a private drain crosses over the land and if so whether the drainage design takes account of any such drain.

2.8 Infiltration

Problem: A Site Investigation report has been included in Appendix G of the Stormwater Impact Assessment report. However, it appears that no site investigation testing was carried out on the subject site.

Recommendation: It would appear that elements of the design are reliant on infiltration to ground from the various SuDS features including filter drains, permeable paving etc. The Designer should consider carrying out BRE 365 tests within the subject site.

2.9 Water Table

Problem: It is unclear from the Site Investigation information provided if the formation level of the permeable paving is 1000mm above the highest ground water level.

Recommendation: The Designer should consider carrying out further site investigation testing to ensure the ground water level is not less than 1000mm below the formation level of the permeable paving build-up.

2.10 CBR Values – Permeable Paving

Problem: Californian bearing ration (CBR) varies inversely with moisture content (as the latter increases the CBR value decreases). The equilibrium CBR value is the long-term value that occurs once the pavement is constructed, and the moisture content of the subgrade soil comes into equilibrium with the suction forces within the subgrade air spaces. Carrying out CBR tests will allow for appropriate permeable paving design including capping material if and where required. This capping is typically quite impermeable when compacted.

Recommendation: The Designer should consider undertaking CBR tests on site to allow for appropriate permeable paving design. These CBR tests are to be carried out in accordance with BS 1377-4:1990.

2.11 Road Surfacing/Porous Asphalt

Problem: It is unclear if porous asphalt is proposed for use on the roads within the development.

Recommendation: The Designer should advise on whether porous asphalt or porous concrete surfacing is proposed throughout the development as road surfacing. This would allow surface water runoff from all areas subject to vehicular traffic to achieve an enhanced environmental quality level as well as a greater opportunity for infiltration.

2.12 Run-off Factors

Problem: Table 2-1 of the Stormwater Impact Assessment report notes that reduced run-off coefficients have been applied based on surface finish type, as agreed with DLRCC Municipal Services. However, a volumetric runoff coefficient of 0.75 has been used in the calculations.

Recommendation: It would appear that factors of 0.75 and 1.0 have been used in parts of the calculations. The Designer should consider adopting a volumetric run-off coefficient of 1.0 throughout where reduced run-off rates are used, to avoid inaccurate simulation results.

2.13 Hydrological Parameters Item No. 1

Problem: The submitted calculations adopt an M5-60 value of 16.7mm and an r value of 0.269. An independent check using the latest Met Éireann rainfall data for the site-specific coordinates returned M5-60 = 15.9mm and r = 0.279.

Recommendation: The Designer should consider using the latest Met Éireann data to determine the M5-60 and r values for the site and update the calculations accordingly.

2.14 Hydrological Parameters Item No. 2

Problem: Met Éireann 1991-2020 data shows a SAAR value of 861.2mm, while the Stormwater Impact Assessment report outlines that a SAAR value of 825mm was used.

Recommendation: The Designer should consider using the latest Met Éireann data to determine the SAAR value for the site and update the greenfield runoff rate calculations accordingly.

2.15 Discharge Rate

Problem: It is unclear as to whether the discharge rate calculated for the site is being achieved.

Recommendation: The Designer should apply a consistent naming convention for manholes, pipelines and SuDS features across both the drawings and calculations to verify that the allowable discharge rate is achieved at the outfall.

2.16 Hydrobrake

Problem: A summary of the Hydrobrake Optimum Manhole S3, included in the calculation's states that the diameter of the hydrobrake orifice is 47mm. It is also unclear where this manhole is located on the site.

Recommendation: The Designer should consider using a flow control device with an orifice size 50mm in diameter as a minimum. Where this is not possible then the designer must submit a robust maintenance regime to ensure blockages are avoided, to the satisfaction of DLRCC. Additionally, a consistent naming convention for manholes should be adopted across both the drawings and calculations.

2.17 Attenuation Item No. 1

Problem: The information provided for storage structures within the calculations does not correspond with the storage structures shown on the drawings.

Recommendation: The Designer should apply a consistent naming convention for manholes, pipelines and SuDS features across both the drawings and calculations.

2.18 Attenuation Item No. 2

Problem: It is unclear in the calculations if any attenuation measures allow for infiltration within the site.

Recommendation: The Designer should confirm which measures allow for infiltration and which are tanked systems.

2.19 Attenuation Item No. 3

Problem: Attenuation Tanks P & Q are located very close to Blocks P and Block Q respectively.

Recommendation: The Designer should review the separation distances between the attenuation tanks and adjacent building foundations. The Designer should also confirm that the finished floor levels of these buildings are at least 500mm above the maximum water level within the adjacent on-site storage.

2.20 Green Roofs

Problem: Green roofs require access for maintenance.

Recommendation: The Designer should allow for a portion of the roof area on both blocks to be allocated for access and maintenance purposes.

2.21 Interception and Treatment

Problem: The Stormwater Impact Assessment report addresses interception and treatment for the subject catchment. However, some of the attenuation volumes shown in the interception tables differ to those in the drawing and calculations.

Recommendation: The Designer should review the interception tables and ensure that the attenuation volumes shown are accurate and consistent with the accompanying drawing and calculations, and that

interception of the first 5-10mm is achieved. If interception of the first 5-10mm can't be achieved, then treatment of the first 15mm is required.

2.22 Maintenance

Problem: Detailed maintenance schedule for the stormwater and SuDS components has not been provided as part of the documentation.

Recommendation: The Designer should consider including a maintenance schedule for the drainage system, including SuDS measures, for review.

2.23 New Connections

Problem: It is unclear if the necessary consents have been obtained from DLRCC regarding the stormwater outfall to the existing stormwater network.

Recommendation: The designer should confirm appropriate consent has been granted to discharge into the existing stormwater network.

2.24 Minimum Velocity

Problem: Table 6.4 of the GDSDS requires a minimum velocity (pipe full) of 1.0m/s. It is unclear from the information provided if this minimum velocity is achieved.

Recommendation: The Designer should confirm if minimum velocity is achieved.

2.25 Gradients and Ground Modelling

Problem: As per Chapter 29.2, Section E of The SuDS Manual, successfully integrating SuDS measures including swales and tree pits require areas of ground modelling to ensure proposed SuDS measures are located in appropriate areas to ensure adequate drainage of the site.

Recommendation: It is recommended that the integration of each SuDS component be considered, and it's contouring adjusted to allow the levels to flow towards to SuDS measure, in a naturalistic manner that is visually attractive and accords with the local surrounding landscape.

2.26 Bypass Interceptors

Problem: A Bypass Interceptor has not been incorporated in the surface water network within the subject site.

Recommendation: The Designer should provide a justification for not including a Bypass Interceptor within the subject site.

2.27 Rainwater Harvesting Tanks

Problem: If utilising green roofs, there is potential to install a rainwater harvesting facility for the proposed units. The rainwater collected can be used for toilet flushing within the new units.

Recommendation: The Designer should consider incorporating rainwater harvesting tanks.

2.28 Taking in Charge

Problem: It is not clear which SuDS measures are proposed to be private and which SuDS devices are proposed to be taken in charge by DLRCC.

Recommendation: The Designer should confirm whether all proposed SuDS within the site boundary will remain private or specify which SuDS devices are proposed to be adopted by DLRCC.

2.29 Status of Documentation

Problem: Some drawings lack revision information.

Recommendation: Submit final drawings with revisions noted and a completed Stormwater Impact Assessment Report for inclusion in the audit.

2.30 Recommendation to be taken to the next Audit Stage

Recommendation: A Stage 2 Stormwater Audit should be undertaken in accordance with the Dun Laoghaire–Rathdown County Development Plan 2022–2028 following the granting of planning permission and prior to the commencement of construction on site.

Appendix A Drawings and Documents Examined by the Author

A1

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DO NOT SCALE

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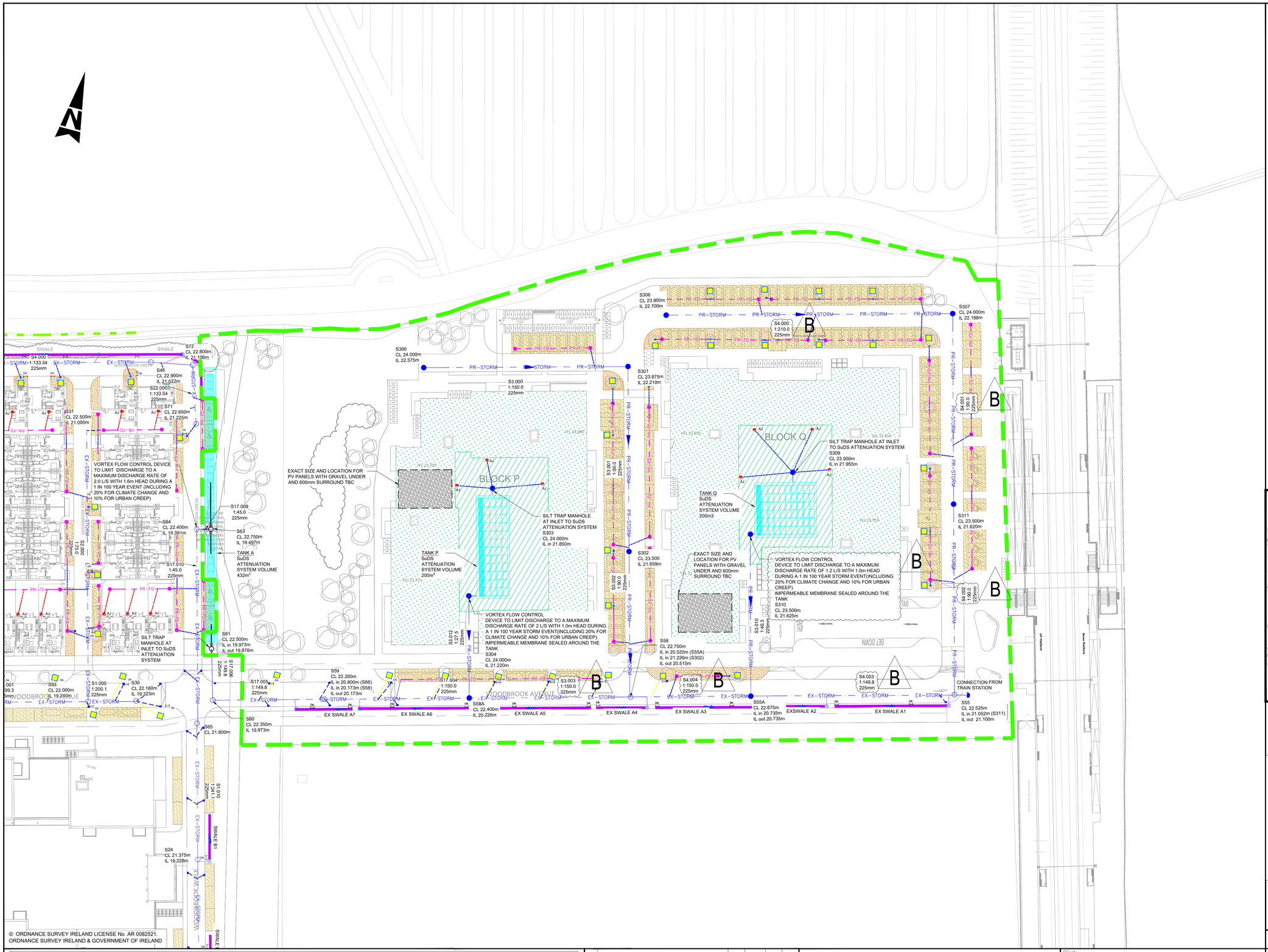
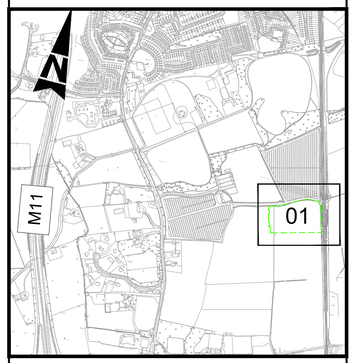
Date: Feb 20, 2026 - 4:37pm





KEY PLAN

Scale NTS

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

NOTE:

1. THE SURFACE WATER DRAINAGE NETWORK IS TO BE DESIGNED AND CONSTRUCTED IN COMPLIANCE WITH THE 'REGIONAL CODE OF PRACTICE FOR DRAINAGE WORKS VERSION 6.0'
2. NO SURFACE WATER/RAINWATER TO DISCHARGE INTO THE FOUL SEWER SYSTEM UNDER ANY CIRCUMSTANCES.
3. ALL RWP, GULLY AND CHANNEL DRAIN CONNECTIONS TO THE MAIN SURFACE WATER DRAINAGE SYSTEM ARE TO BE ACHIEVED VIA DIRECT CONNECTION TO THE MANHOLE AT LEVELS SOFFITS OR VIA SADDLE CONNECTION TO THE STORM SEWER PIPE.
4. ALL GULLIES TO HAVE SEPARATE CONNECTIONS TO THE STORM DRAINAGE NETWORK.

PLANNING NOTES:
PLANNING PACKAGE HAS BEEN SENT FOR STAGE 1 STORMWATER AUDIT. AWAITING RESPONSE FROM AUDITOR.

LEGEND

- PR-STORM — PROPOSED STORM DRAINAGE
- SXX — PROPOSED STORM WATER MANHOLE
- GY — PROPOSED ROAD GULLY
- IC — PROPOSED CONNECTION FROM TREE PIT
- PR-FD — PROPOSED INSPECTION CHAMBER & FILTER DRAIN (150mm)
- PR-FD — PROPOSED COLLECTOR DRAIN
- PROPOSED SWALE & PERFORATED MANHOLE COVER
- PROPOSED TREE PIT LOCATION
- PR-FD — BIO RETENTION RAIN GARDEN AND CONNECTION TO MAIN DRAINAGE
- PROPOSED UNDERGROUND SUDS ATTENUATION SYSTEM
- PROPOSED PERMEABLE PAVING
- PROPOSED INTENSIVE GREEN COURTYARD
- PROPOSED EXTENSIVE GREEN ROOF
- EX-STORM — EXISTING STORM DRAINAGE REVIOUSLY GRANTED PERMISSION. ABP SHD PLANNING REFERENCE ABP-305844-19
- EXISTING DITCH TO BE RETAINED
- PR-FD — PROPOSED OVERFLOW CATCH PIT & 150Ø CONNECTION TO SW MAIN
- AREA SUBJECTED TO PROPOSED DEVELOPMENT

Rev	Description	By	Date	Chk'd	Auth
B	FOR PLANNING	IH	20.02.26	SK	GH
A	FOR PLANNING	IH	09.12.25	SK	GH
-	FOR INFORMATION	IH	30.05.25	SK	GH

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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: PROPOSED STORM DRAINAGE LAYOUT

Original Scale	Design/Drawn	Checked	Authorised
1:500@A1 1:1000@A3	IH	SK	GH
	Date 30.05.25	Date 30.05.25	Date 30.05.25

Status: P

Drawing Number: 0119017-ATK-ZZ-XX-DR-CE-090503

Rev: B

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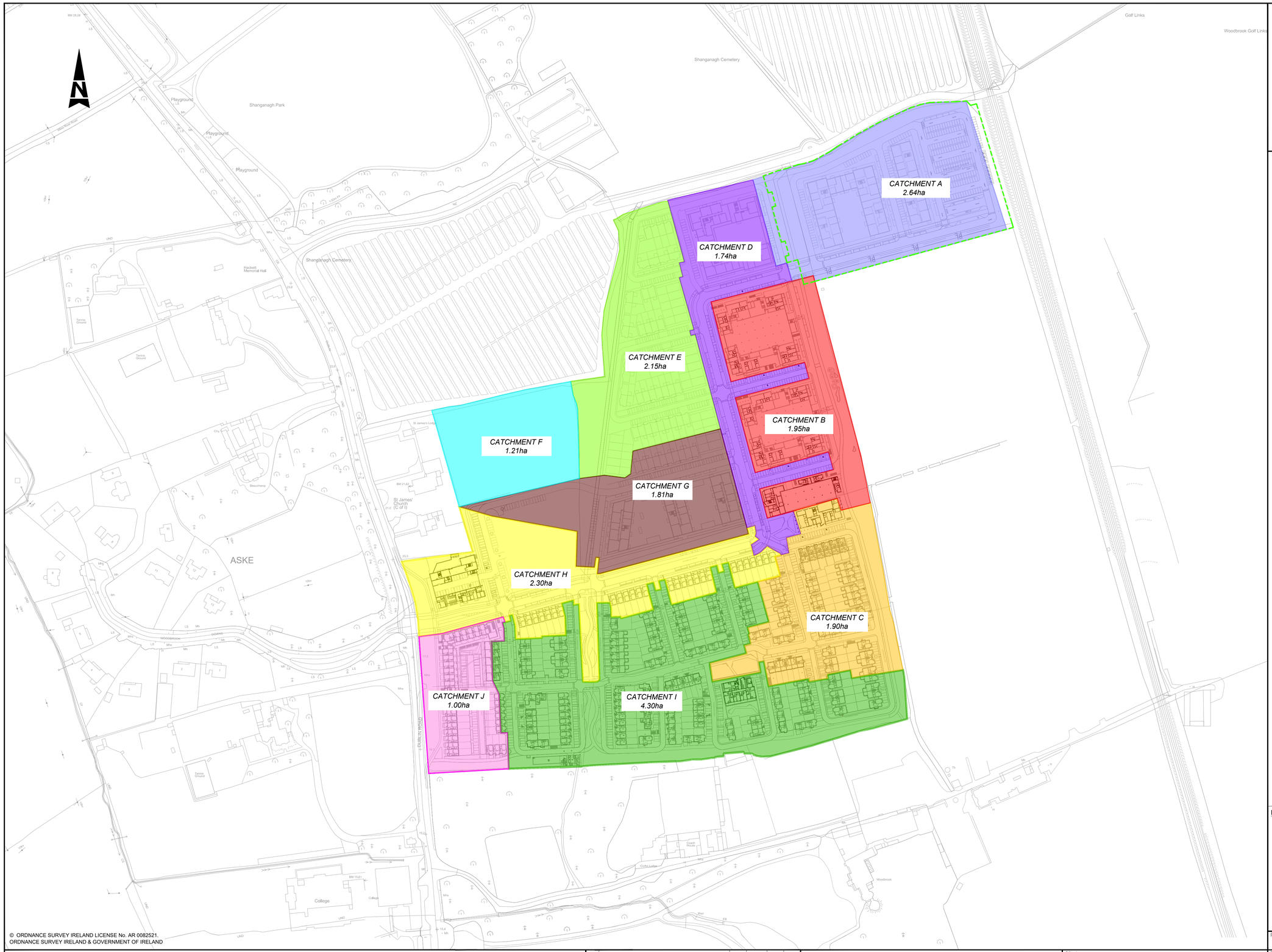

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

NOTE:

1. THE SURFACE WATER DRAINAGE NETWORK IS TO BE DESIGNED AND CONSTRUCTED IN COMPLIANCE WITH THE 'REGIONAL CODE OF PRACTICE FOR DRAINAGE WORKS VERSION 6.0'
2. NO SURFACE WATER/RAINWATER TO DISCHARGE INTO THE FOUL SEWER SYSTEM UNDER ANY CIRCUMSTANCES.
3. ALL RWP, GULLY AND CHANNEL DRAIN CONNECTIONS TO THE MAIN SURFACE WATER DRAINAGE SYSTEM ARE TO BE ACHIEVED VIA DIRECT CONNECTION TO THE MANHOLE AT LEVELS SOFFITS OR VIA SADDLE CONNECTION TO THE STORM SEWER PIPE.
4. ALL GULLIES TO HAVE SEPARATE CONNECTIONS TO THE STORM DRAINAGE NETWORK.

LEGEND

- CATCHMENT A
- CATCHMENT B
- CATCHMENT C
- CATCHMENT D
- CATCHMENT E
- CATCHMENT F
- CATCHMENT G
- CATCHMENT H
- CATCHMENT I
- CATCHMENT J
- AREA SUBJECTED TO PROPOSED DEVELOPMENT

Rev	Description	By	Date	Chk'd	Auth
-	FOR PLANNING	IH	02.01.26	SK	GH

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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: SUB CATCHMENT AREAS

Original Scale	Design/Drawn	Checked	Authorised
NTS	IH	SK	GH
	Date 02.01.26	Date 02.01.26	Date 02.01.26

Status	Drawing Number	Rev
P	0119017 / EWE / DR / 0517	-

A1

DO NOT SCALE

File: 0119017_EWE_DR_0517.dwg
Date: Jan 06, 2026 - 3:53pm
Plotted by: ULHA7849

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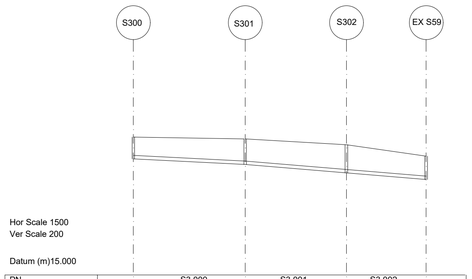
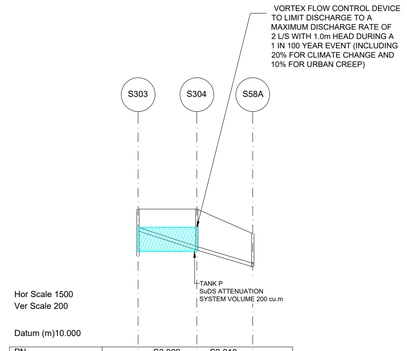


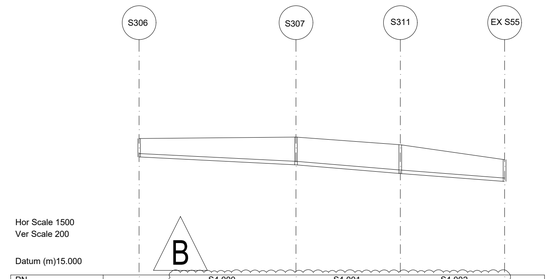
PN	S3.000	S3.001	S3.002	
Dia (mm)	225	225	225	
Slope (1:X)	150.0	90.0	90.0	
Cover Level (m)	24.000	23.875	23.500	22.750
Invert Level (m)	22.575	22.210	21.669	21.226
Length (m)	54.768	49.599	39.006	

Block P - Longitudinal Section S300 - EX S59
Scale 1:1500 (Horizontally), 1:200 (Vertically)



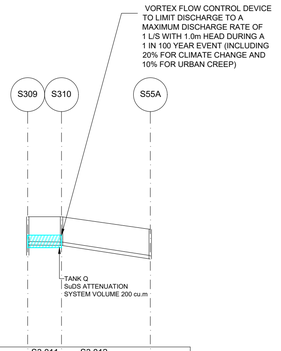
PN	S3.009	S3.010	
Dia (mm)	225	225	
Slope (1:X)	89.2	25.0	
Cover Level (m)	24.000	24.000	22.400
Invert Level (m)	21.850	21.320	20.226
Length (m)	28.773	27.368	

Block P - Longitudinal Section S303 - S58A
Scale 1:1500 (Horizontally), 1:200 (Vertically)



PN	S4.000	S4.001	S4.002	
Dia (mm)	225	225	225	
Slope (1:X)	210.0	210.2	176.0	
Cover Level (m)	23.900	24.000	23.500	22.525
Invert Level (m)	22.700	22.188	21.620	21.100
Length (m)	76.839	51.086	51.086	

Block Q - Longitudinal Section S306 - EX S55
Scale 1:1500 (Horizontally), 1:200 (Vertically)



PN	S3.011	S3.012	
Dia (mm)	225	225	
Slope (1:X)	552.2	46.3	
Cover Level (m)	23.500	23.500	22.675
Invert Level (m)	21.965	21.625	20.735
Length (m)	16.567	43.445	

Block Q - Longitudinal Section S309 - S55A
Scale 1:1500 (Horizontally), 1:200 (Vertically)

Rev	Description	By	Date	Chk'd	Auth
A	FOR PLANNING	IH	20.02.26	SK	GH
-	FOR PLANNING	IH	09.12.25	SK	GH

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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: PROPOSED STORM WATER LONG SECTION

Original Scale	Design/Drawn	Checked	Authorised
AS SHOWN	IH Date 08.12.25	SK Date 08.12.25	GH Date 08.12.25

Status: P

Drawing Number: 0119017-ATK-ZZ-XX-DR-CE-090507

Rev: A

A1

DO NOT SCALE

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File: 0119017-ATK-ZZ-02-DR-CE-090507.dwg
Date: Feb 20, 2026 - 4:50pm Plotted by: ULHA7849

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A1

DO NOT SCALE

GENERAL NOTES

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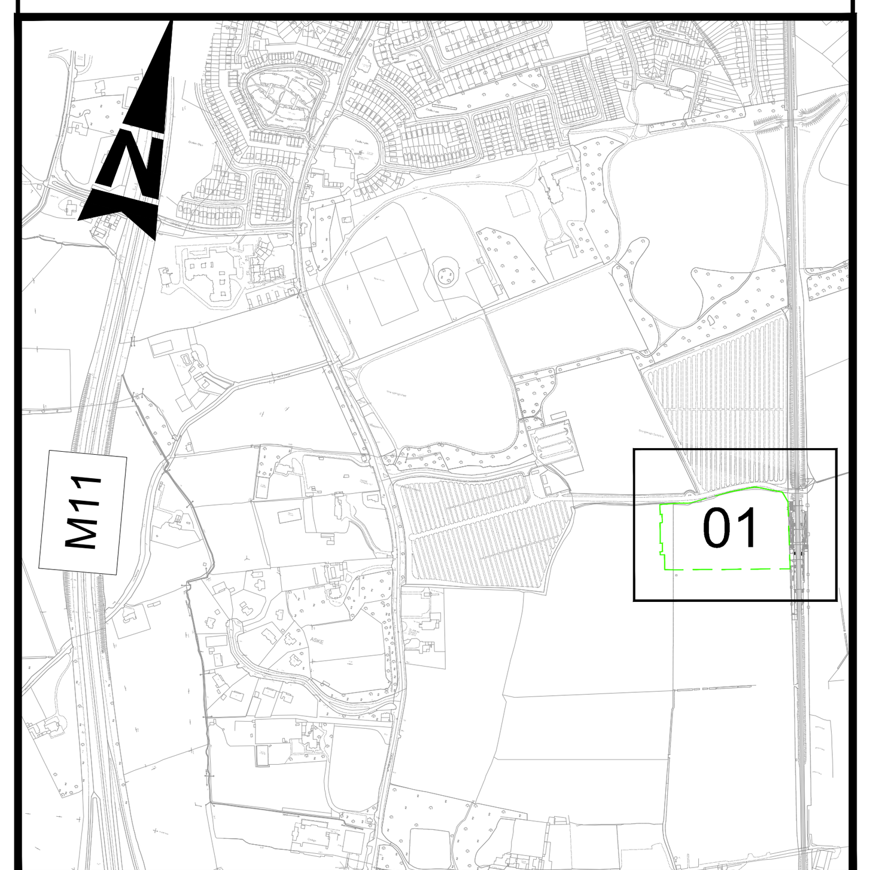

KEY PLAN
Scale NTS

LEGEND

AREA SUBJECTED TO PROPOSED DEVELOPMENT

Rev	Description	By	Date	Chk'd	Auth
-	FOR PLANNING	IH	22.12.25	SK	GH

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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: SURFACE WATER FLOW PATH

Original Scale	Design/Drawn	Checked	Authorised
1:500@A1 1:1000@A3	IH Date 22.12.25	SK Date 22.12.25	GH Date 22.12.25

Status	Drawing Number	Rev
P	0119017-ATK-ZZ-XX-DR-CE-090514	-

File: 0119017-ATK-ZZ-02-DR-CE-090514.dwg Plotted by: ULHA7849 Date: Jan 06, 2026 - 4:45pm

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MANHOLE GENERAL NOTES:

I.) ALL BRICK TO BE SOLID ENGINEERING BRICK CLASS A OR B

II.) FOR PIPE DIAMETER >750MM USE MANHOLE WITH INTERNAL DIAMETER SIZE = PIPE SIZE + 1 METRE + 300MM

III.) DISTANCE FROM TOP RUNG OF THE LADDER TO GROUND LEVEL MUST BE A MAXIMUM OF 500MM

MANHOLE DRAWING NOTES:

1.) 225mm THICK C120/20 MASS CONCRETE FOUNDATIONS.

2.) PREFORMED HALF CIRCLE CHANNEL PIPES. THE PIPELINE MAY WHERE PRACTICABLE, BE LAID THROUGH THE MANHOLE AND THE CROWN CUT OUT TO HALF DIAMETER, PROVIDED FLEXIBLE JOINTS ARE SITUATED ON EACH SIDE NO FURTHER THAN 600mm FROM THE INNER FACE OF THE MANHOLE WALL.

3.) MANHOLE CONSTRUCTION
FOR SURFACE WATER MANHOLES HIGH DENSITY BLOCKS TO CL.S10 OF I.S.20 PART 1: 1987 OR CL.3020 IN-SITU CONCRETE.
BLOCKWORK SHALL BE BEDDED AND JOINTED USING MORTAR DESIGNATION THREE TO I.S.406. BEDS AND VERTICAL JOINTS SHALL BE COMPLETELY FILLED WITH MORTAR AS THE BLOCKS ARE LAID.
JOINTS SHALL BE FLUSH POINTED AS THE WORK PROCEEDS
ALL FOUL MANHOLES MUST BE FACED IN SOLID ENGINEERING BRICK (MIN CLASS A OR B), OR IN-SITU CONCRETE FOR 1m ABOVE BENCHING LEVEL
BRICK TO BE BONDED TO BLOCKWORK USING ENGLISH GARDEN WALL BOND.

4.) RELIVING ARCH FORMED BY 215x103x65 BRICK CLASS A OR B AS PER DRAWING. RELIEVING ARCHES USED IN BRICK OR BLOCKWORK MANHOLES TO EXTEND OVER FULL THICKNESS OF WALL.
A DOUBLE ARCH IS TO BE FORMED FOR PIPE DIAMETERS GREATER THAN 600mm.

5.) BENCHING AND PIPE CHANNEL PIPE SURROUND -CL.20/20 CONCRETE.

6.) BENCHING FINISHED IN 2:1 SAND-CEMENT MORTAR WITH SMOOTH TROWEL FINISH, AT 1 IN 30 SLOPE TOWARDS CHANNEL.

7.) STANDARD RUNGS AT 300c/c VERTICALLY AND GALVANISED TO LATEST VERSION OF BS729 OR EQUIVALENT.

8.) 600mm SQUARE OPE. IN ROOF SLAB.

9.) PRECAST R.C. ROOF SLAB SHALL BE 200MM THICK IN CL.30N/20MM CONCRETE, WITH 40MM COVER TO STEEL.

10.) 1 TO 2 COURSES OF SOLID ENGINEERING BRICKS CLASS B TO I.S.91:1983 SET IN 1:3 (CEMENT AND MORTAR)

11.) CLASS D400 OR E600 MANHOLE COVER AND FRAME TO IS/EN 124. 150mm DEEP FRAME FOR ROADS, 100mm DEEP FOR FOOTPATHS AND GREEN AREAS.
NON-ROCK DESIGN, CLOSED KEYWAYS, MANUFACTURED FROM SPHEROIDAL GRAPHITE CAST IRON (DUCTILE CAST IRON), 600x600 (OR 600 DIAM) CLEAR OPENING, COVER & FRAME COATED IN BITUMEN OR OTHER APPROVED MATERIAL. COVER TO HAVE A MINIMUM MASS OF 140kg/m2, FRAME BEARING AREA SHALL BE 80,000mm2 MIN., FRAMES SHALL BE DESIGNED TO PREVENT COVERS FALLING INTO MANHOLE. FRAMES SHALL BE BEDDED ON APPROVED MORTAR TO MANUFACTURER'S CONSTRUCTIONS.

12.) SHORT LENGTH PIPE, PIPE JOINT EXTERNAL TO MANHOLE SHALL NOT EXCEED 600mm FROM THE INNER FACE OF MANHOLE WALL.

13.) TOE HOLES OF 230mm MIN. DEPTH AND GALVANISED STEEL SAFETY RAILINGS TO BE PROVIDED IN BENCHING OF SEWERS GREATER THAN 525 DIAMETER, AND DEPTH TO INVERT >3m FOR ACCESS TO INVERT.

14.) SAFETY CHAIN TO BE PROVIDED ON PIPES THAT EXCEED 450mm IN DIAMETER. MILD STEEL SAFETY CHAIN SHALL BE 10mm NOMINAL SIZE GRADE M(H) NON CALIBRATED CHAIN TYPE 1, COMPLYING WITH BS- 4942 Part 2 OR EQUIVALENT.

15.) WHEN DEPTH OF MANHOLES TO INVERT IS GREATER THAN 3.0m LADDERS SHALL BE USED. INSTEAD OF RUNGS, TO BS4211 EXCEPT THAT STRINGERS SHOULD BE NOT LESS THAN 65x12mm IN SECTION AND RUNGS 25mm IN DIAMETER.
FIXED LADDERS SHOULD MEET THE DIMENSIONAL REQUIREMENTS OF BS 4211.

16.) LADDER STRINGERS SHOULD BE ADEQUATELY SUPPORTED FROM THE MANHOLE WALL AT INTERVALS OF NOT MORE THAN 2.0m. STRINGERS SHOULD BE BOLTED TO CLEATS TO FACILITATE RENEWAL.

17.) ALL LADDERS, RUNGS, HANDRAILS, SAFETY CHAINS ETC. SHALL BE HOT DIP GALVANISED TO BS729.

18.) SOCKET OF PIPE SHOULD BE CUT FLUSH WITH THE INSIDE SURFACE OF THE MANHOLE WALL SO THAT THE CHANNEL EXTENDS FULL LENGTH OF THE MANHOLE (EXCEPT FOR PRECAST MANHOLES).

19.) POSITION OF 910 SQUARE OPENING IN INTERMEDIATE ROOF SLAB.

-ALL MANHOLES SHALL BE WATERTIGHT TO THE SATISFACTION OF THE ENGINEER.

-FORMWORK TO REINFORCEMENT CONCRETE AND MASS CONCRETE SHALL COMPLY TO CLASS 2, SECTION 6.2.7, BS8110: PART 1: 1997.

-FINISH TO THE TOP OF SLABS SHALL COMPLY TO TYPE A, SECTION 6.2.7, BS8110: PART 1: 1997.

-PLAN DIMENSIONS OF MANHOLES ARE BASED ON BLOCKWORK HAVING A CO-ORDINATING SIZE OF 450x225x100.

-MANHOLES ARE DESIGNED TO BS8005 AND WALL THICKNESSES TO IS325 BLOCKWORK DESIGN CODE TAKING GRANULAR FILL PRESSURE AND H.B. SURCHARGE.

-REINFORCEMENT TO SLABS TO ENGINEERS DETAILS.

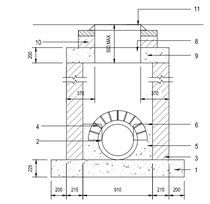
20.) FOR MANHOLES >3.0m DEPTH TO INVERT USE 30N/20 IN-SITU CONCRETE. REINFORCING MESH REF. A393 @6.16kg/m TO BE FIXED AT MID POINT OF WALL. ADDITIONAL REINFORCEMENT TO BE SUPPLIED OVER PIPE CROWN.

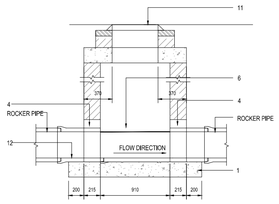
21.) FOR PRECAST MANHOLES, CHAMBER WALLS AND COVER SLAB TO BE CONSTRUCTED TO IS EN 1917 AND 1S 420 2004.

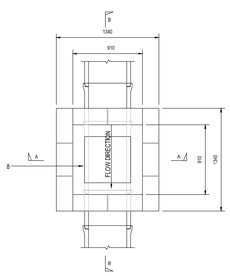
22.) MANHOLE OPENING TO BE SITUATED FURTHEST FROM THE NEAREST CARRIAGEWAY, MANHOLE STEPS/ACCESS TO BE POSITIONED TO ALLOW VIEWING OF ONCOMING TRAFFIC.

23.) FOR BEDDING AND SEALING OF CHAMBER RINGS, THE TOP RING (TO PRECAST COVER SLAB) AND BOTTOM TING TO BE BEDDED WITH CEMENT MORTAR. FOR INTERMEDIATE RINGS, JOINTS TO BE SEALED WITH APPROVED PRE-FORMED JOINTING STRIP.

24.) PRECAST MANHOLES TO BE SURROUNDED WITH A MINIMUM OF 150MM THICK GRADE C20/40 CONCRETE

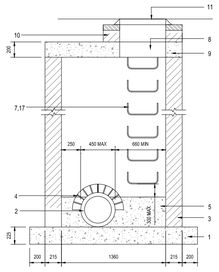


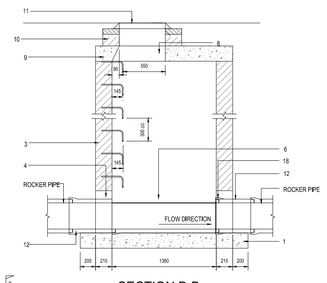


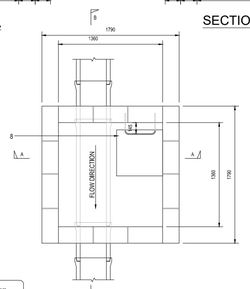


TYPE A MANHOLE

MANHOLE DETAILS FOR PIPE Ø's 150, 225, 300, 375 & 450mm, DEPTH TO INVERT LESS THAN 1.0m.

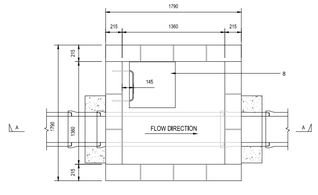


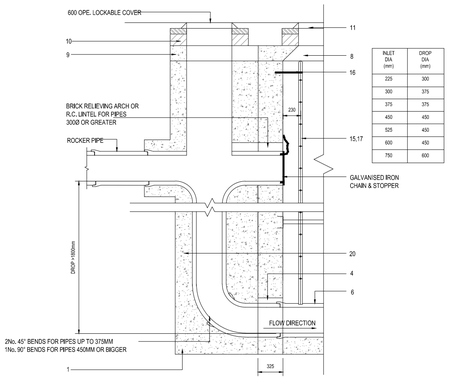




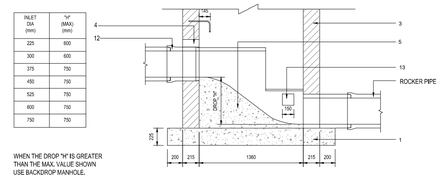
MANHOLE DTEAILS FOR PIPE Ø's 225, 300, 375 & 450mm, DEPTH TO INVERT 1.0m TO 3.0m.

TYPE B MANHOLE



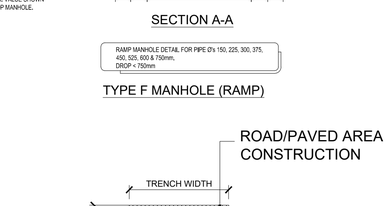


INLET DIA (mm)	DROP DIA (mm)
225	300
300	375
375	375
450	450
525	450
600	450
750	600



INLET DIA (mm)	"H" (MAX) (mm)
225	600
300	600
375	750
450	750
525	750
600	750
750	750

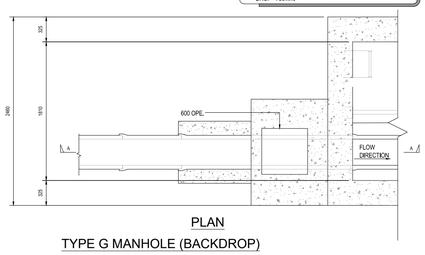
WHEN THE DROP "H" IS GREATER THAN THE MAX. VALUE SHOWN USE BACKDROP MANHOLE.



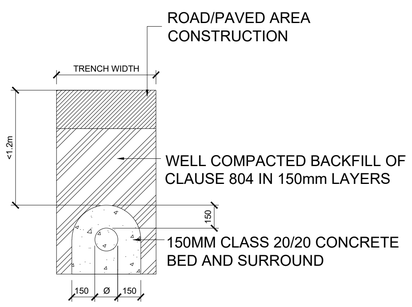
RAMP MANHOLE DETAIL FOR PIPE Ø's 150, 225, 300, 375, 450, 525, 600 & 750mm. DROP < 750mm

TYPE F MANHOLE (RAMP)

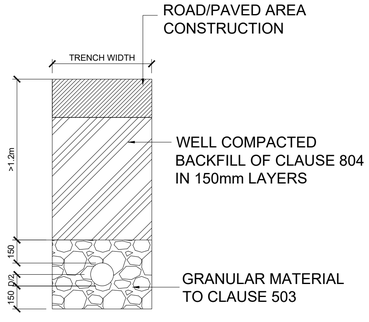
BACKDROP MANHOLE DETAILS FOR PIPE Ø's 225, 300, 375, 450, 525, 600 & 750mm. DROP >750mm.



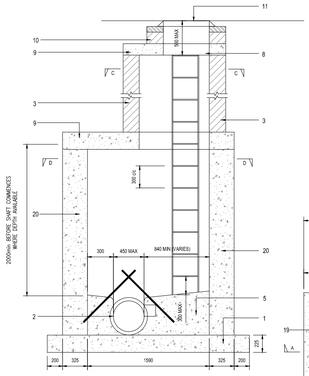
TYPE G MANHOLE (BACKDROP)

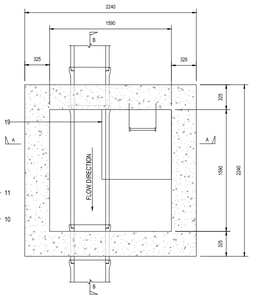


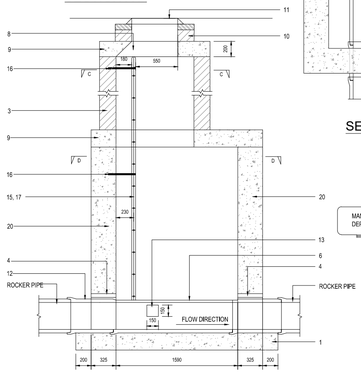
PIPE BEDDING TYPE 2



PIPE BEDDING TYPE 1
IF DEPTH OF COVER >1.2M

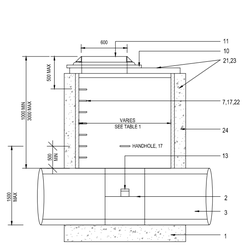




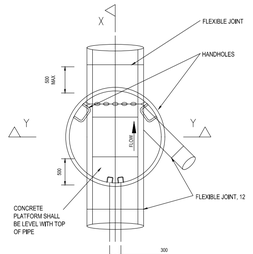


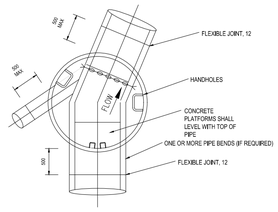
MANHOLE DETAILS FOR PIPE Ø's 225, 300, 375 & 450mm. DEPTH TO INVERT 3m TO 6m.

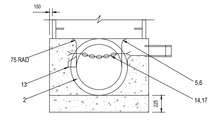
TYPE C MANHOLE

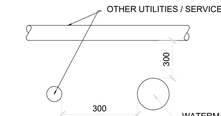


INTEGRAL IN-SITU 20N/20MM CONCRETE BASE WALLS, BENCHING AND BASE SLAB WITH PRECAST CHANNEL AS SHOWN OR IN-SITU FORMED INVERT AS ALTERNATIVE, WALLS TO EXTEND 150mm BEYOND OUTER FACES OF CHAMBER RING. ALTERNATIVELY PRECAST CONCRETE CHAMBER RINGS MAY BE BEDDED IN MORTOR OR ON IN-SITU 20N/20MM CONCRETE BASE SLAB 300MM GREATHER IN DIAMETER THAN CHAMBER RINGS









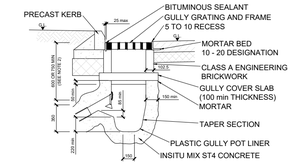
NOTES:

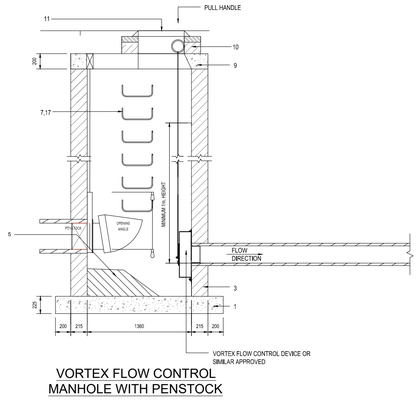
DETAILS INDICATED IN ACCORDANCE WITH GDSOS REQUIREMENTS FOR STORM DRAINAGE

FOUL DRAINAGE TO BE CONSTRUCTED IN ACCORDANCE WITH IRISH WATER STANDARD DETAILS AND CODE OF PRACTICE

NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. THE MINIMUM DEPTH FROM THE TOP OF THE GRATING TO THE TOP OF THE GULLY OUTLET IS TO BE 750mm WHEN THE CONNECTING PIPE IS UNDER A CARRIAGE WAY OR A HARD SHOULDER AND 600 ELSEWHERE.
3. PRE CAST CONCRETE GULLIES AND COVER SLABS SHALL BE TO BS 5911-6.
4. WHEN AN INSITU CAST GULLY HAS A TRAP, THE STOPPERS SHALL COMPLY WITH THE REQUIREMENTS OF BS 5911-4 AND BS EN 1917.
5. ALL ST CONCRETE SHALL BE TO SHW, CLAUSE 2602





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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: STANDARD CONSTRUCTION DETAILS SHEET 1

Original Scale	Design/Drawn	Checked	Authorised
AS SHOWN	IH Date 02.01.26	SK Date 02.01.26	GH Date 02.01.26

Status: P

Drawing Number: 0119017-ATK-ZZ-XX-DR-CE-903121

Rev: -

File: 0119017-ATK-ZZ-02-DR-CE-903121.dwg
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Plotted by: ULHA7849

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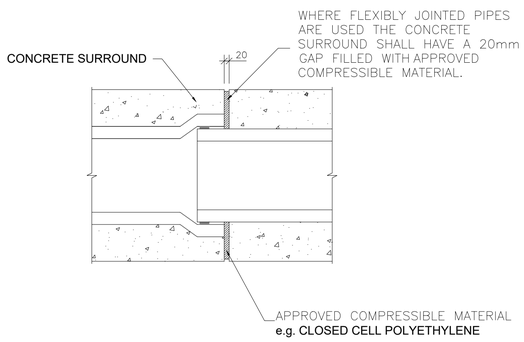
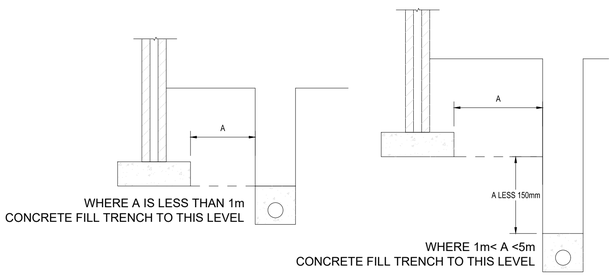
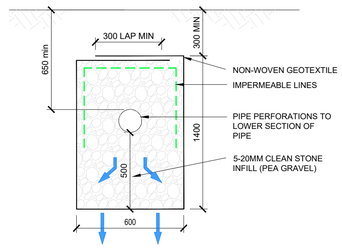
GULLY CONNECTIONS:
1: EACH GULLEY SHALL HAVE A SEPERATE 150 mm CONNECTION SURROUNDED WITH 150mm CLASS 20N/20mm CONCRETE. GULLIES SHALL NOT BE INTERCONNECTED.
2: WHEN CONNECTION TO PUBLIC SEWERS, BENDS FROM 7° UP TO 45° SHOULD BE USED AS REQUIRED AND A SADDLE JUNCTION FITTED TO MAKE THE CONNECTION TO THE SEWER. LONG RADIUS BENDS ARE PREFERED.
3: GULLEY CONNECTIONS SHOULD NOT, IF POSSIBLE EXCEED 20m IN LENGHT AND CONNECT TO THE SEWER IN THE DIRECTION OF THE FLOW.
5: IN UNSEALED GULLIES THE OUTLET PIPE SHALL BE 450mm ABOVE THE FLOOR OF THE GULLY PIT.
6: WHERE THE GULLIES ARE CONNECTED TO MANHOLES, THEY SHALL BE CONNECTED AT THE BENCHING LEVEL OR A MAXIMUN OF 500mm ABOVE INVERT OF MAIN PIPE.
7: CONNECTIONS SHALL BE TURNED WITH THE DIRECTION OF FLOW.



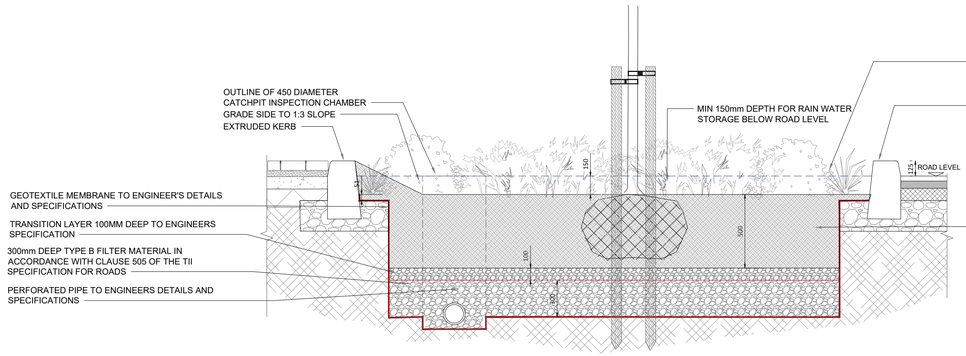
JOINT IN CONCRETE SURROUND



CONCRETE SURROUND TO PIPE RUN NEAR BUILDINGS / FOUNDATIONS



TYPICAL FILTER DRAIN DETAIL



TYPICAL RAIN GARDEN DETAILS
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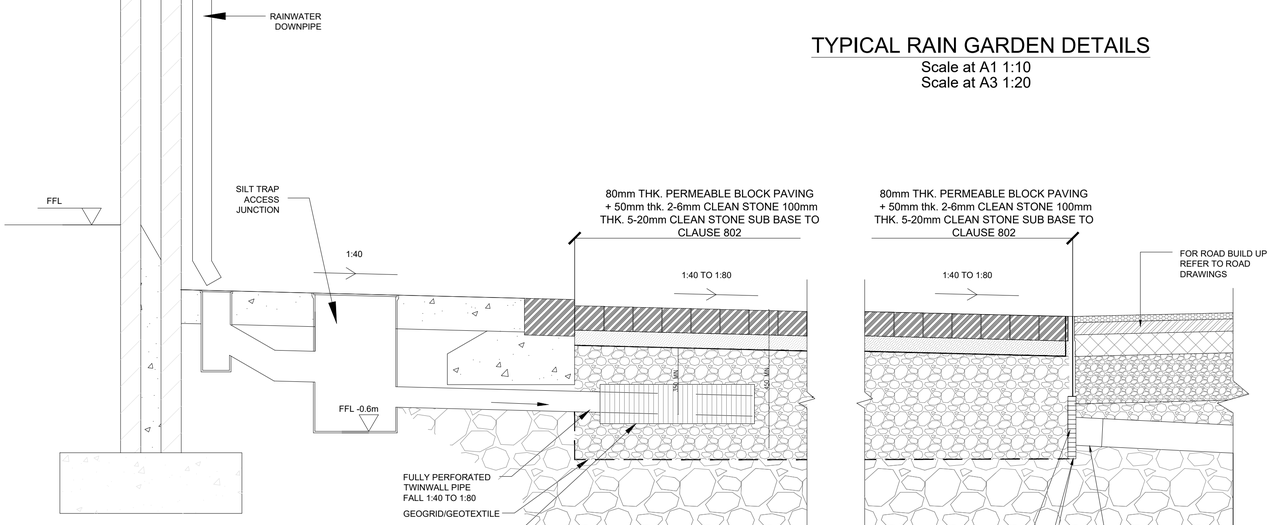
Scale at A3 1:20



PAVEMENT DRAINAGE DETAILS
Scale at A1 1:10
Scale at A3 1:20

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-	FOR PLANNING	IH	02.01.26	SK	GH

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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: STANDARD CONSTRUCTION DETAILS SHEET 2

Original Scale	Design/Drawn	Checked	Authorised
AS SHOWN	IH Date 02.01.26	SK Date 02.01.26	GH Date 02.01.26

Status	Drawing Number	Rev
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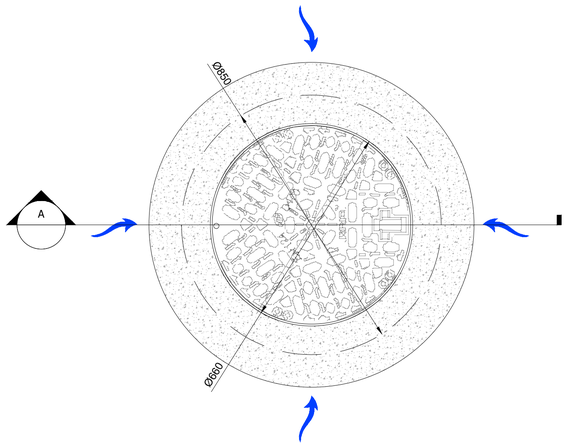
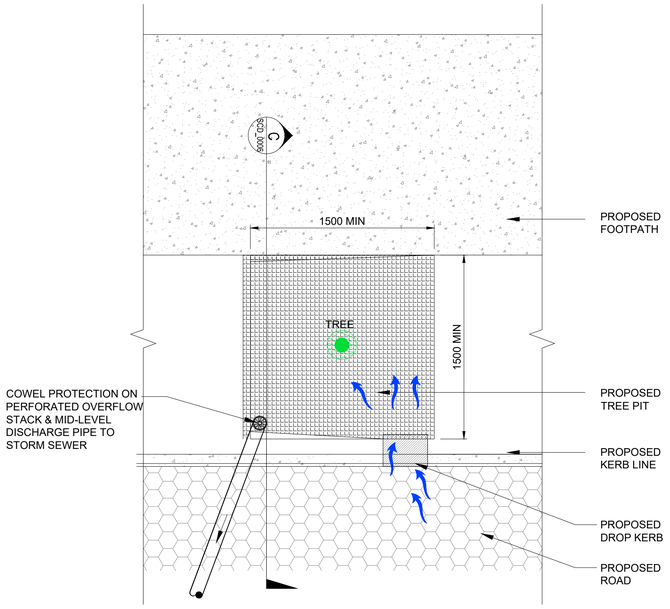


PERFORATED MANHOLE LID TYPICAL PLAN

Scale at A1 1:10
Scale at A3 1:20

PERFORATED MANHOLE LID TYPICAL SECTION A



TREE PIT - TYPICAL PLAN

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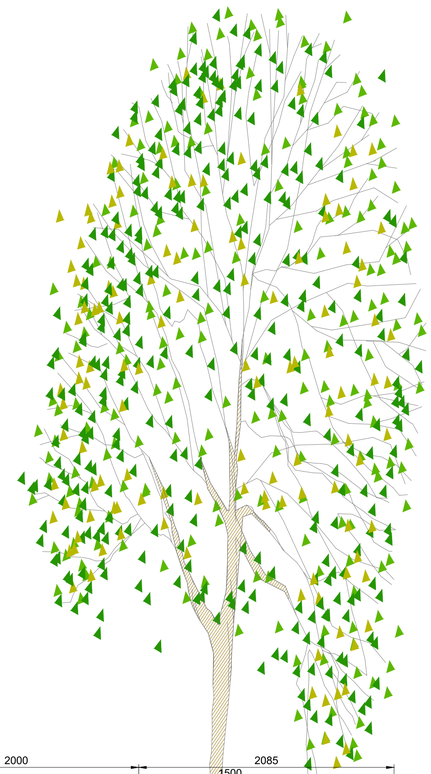
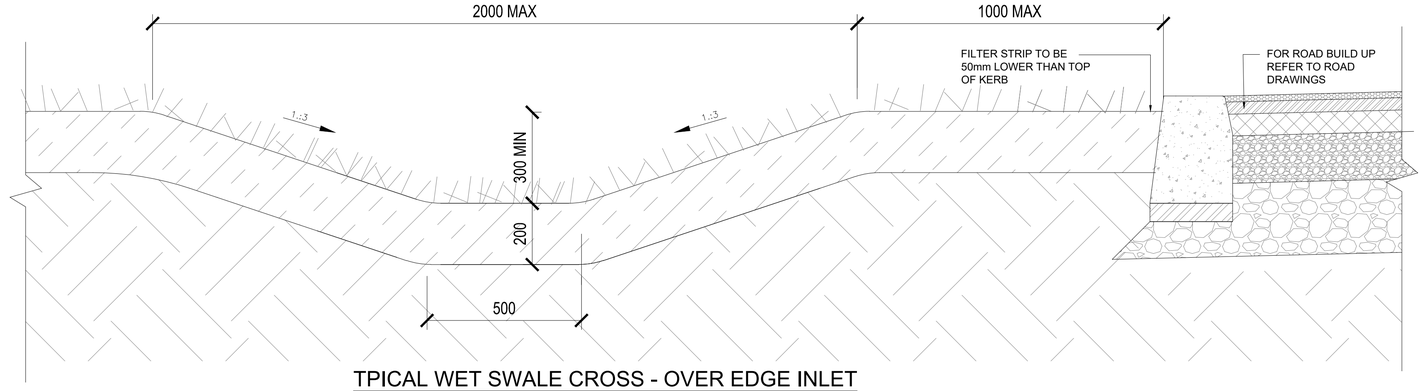
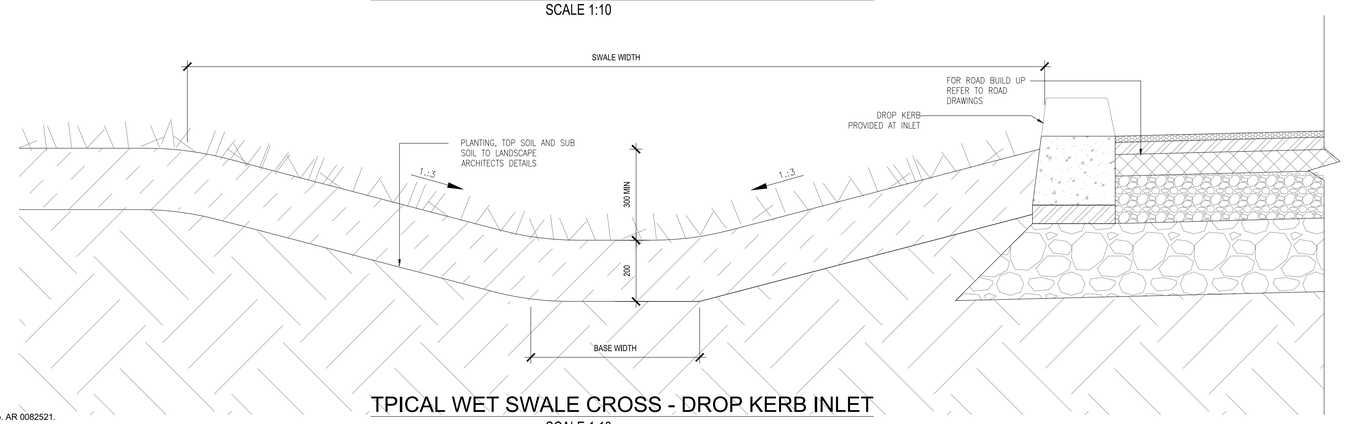
Scale at A3 1:50





TPICAL WET SWALE CROSS - OVER EDGE INLET

SCALE 1:10



TPICAL WET SWALE CROSS - DROP KERB INLET

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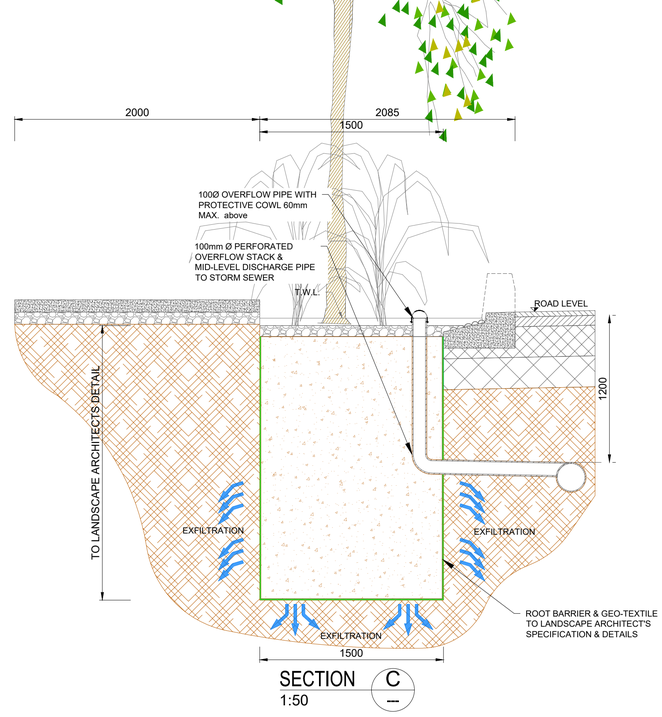

SECTION C
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Rev	Description	By	Date	Chk'd	Auth
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Purpose: FOR PLANNING

Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Title: STANDARD CONSTRUCTION DETAILS SHEET 3

Original Scale	Design/Drawn	Checked	Authorised
AS SHOWN	IH	SK	GH
	Date 02.01.26	Date 02.01.26	Date 02.01.26

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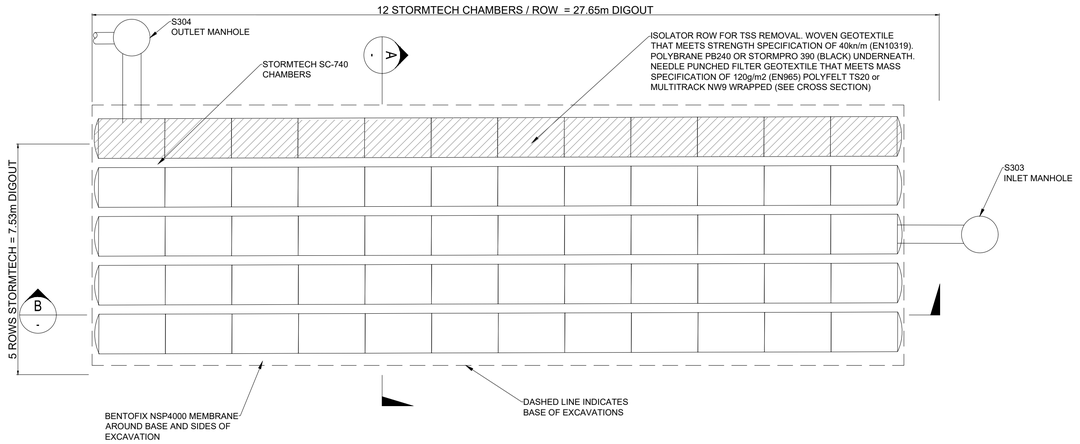
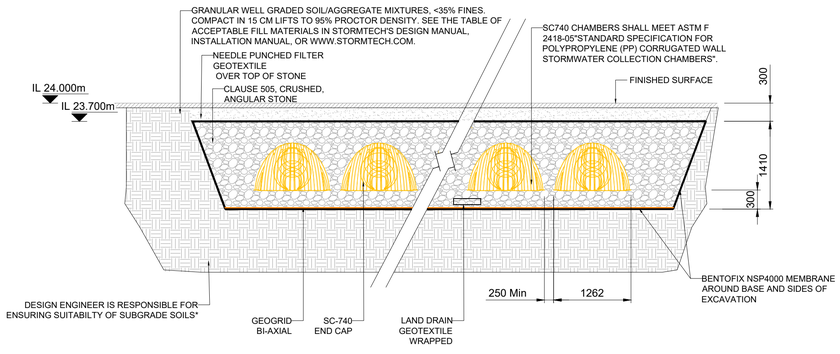


PROPOSED TANK P 200m^3 CUMULATIVE CHAMBER LAYOUT PLAN

Scale at A1 1:100
Scale at A3 1:200



SECTION A
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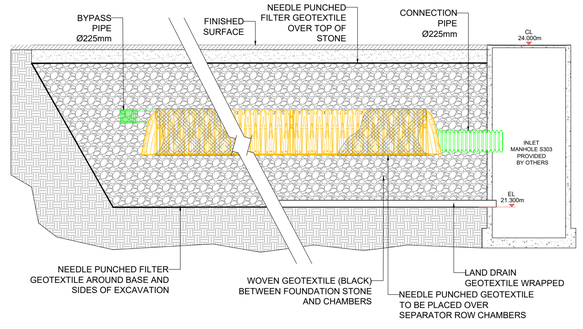

SECTION B
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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: STANDARD CONSTRUCTION DETAILS SHEET 4

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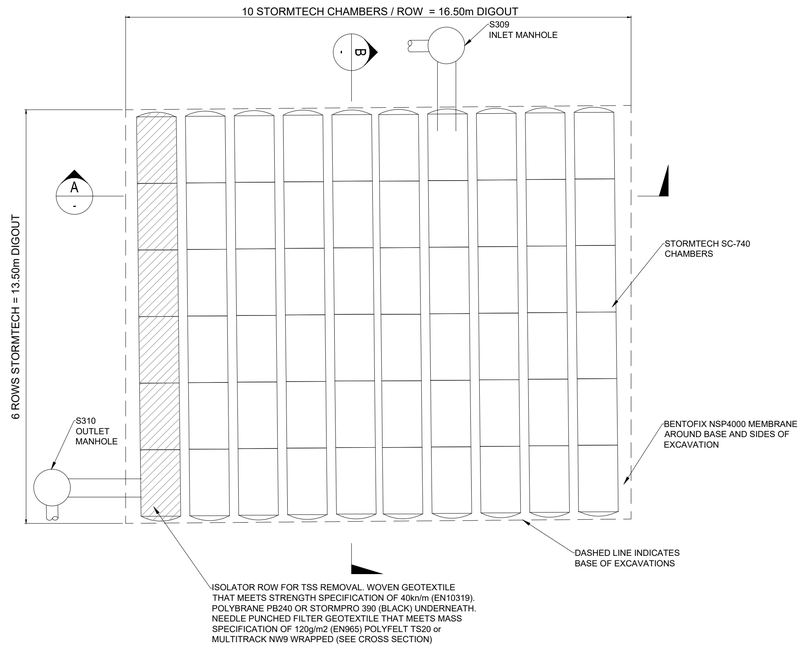
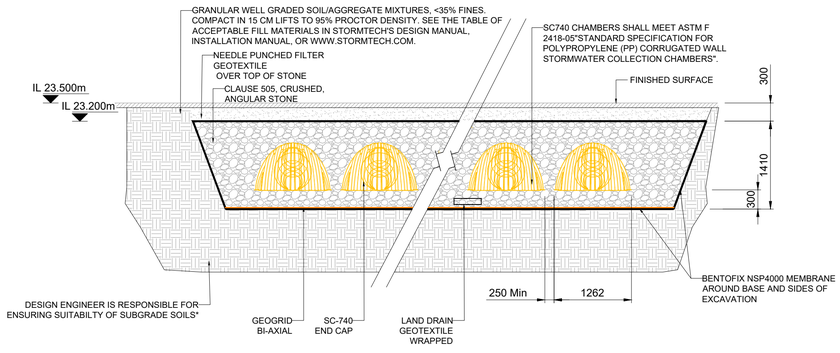


PROPOSED TANK Q 200m^3 CUMULATIVE CHAMBER LAYOUT PLAN

Scale at A1 1:100
Scale at A3 1:200



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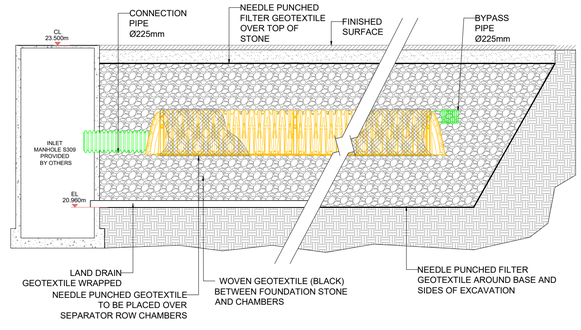

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Rev	Description	By	Date	Chk'd	Auth
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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: STANDARD CONSTRUCTION DETAILS SHEET 5

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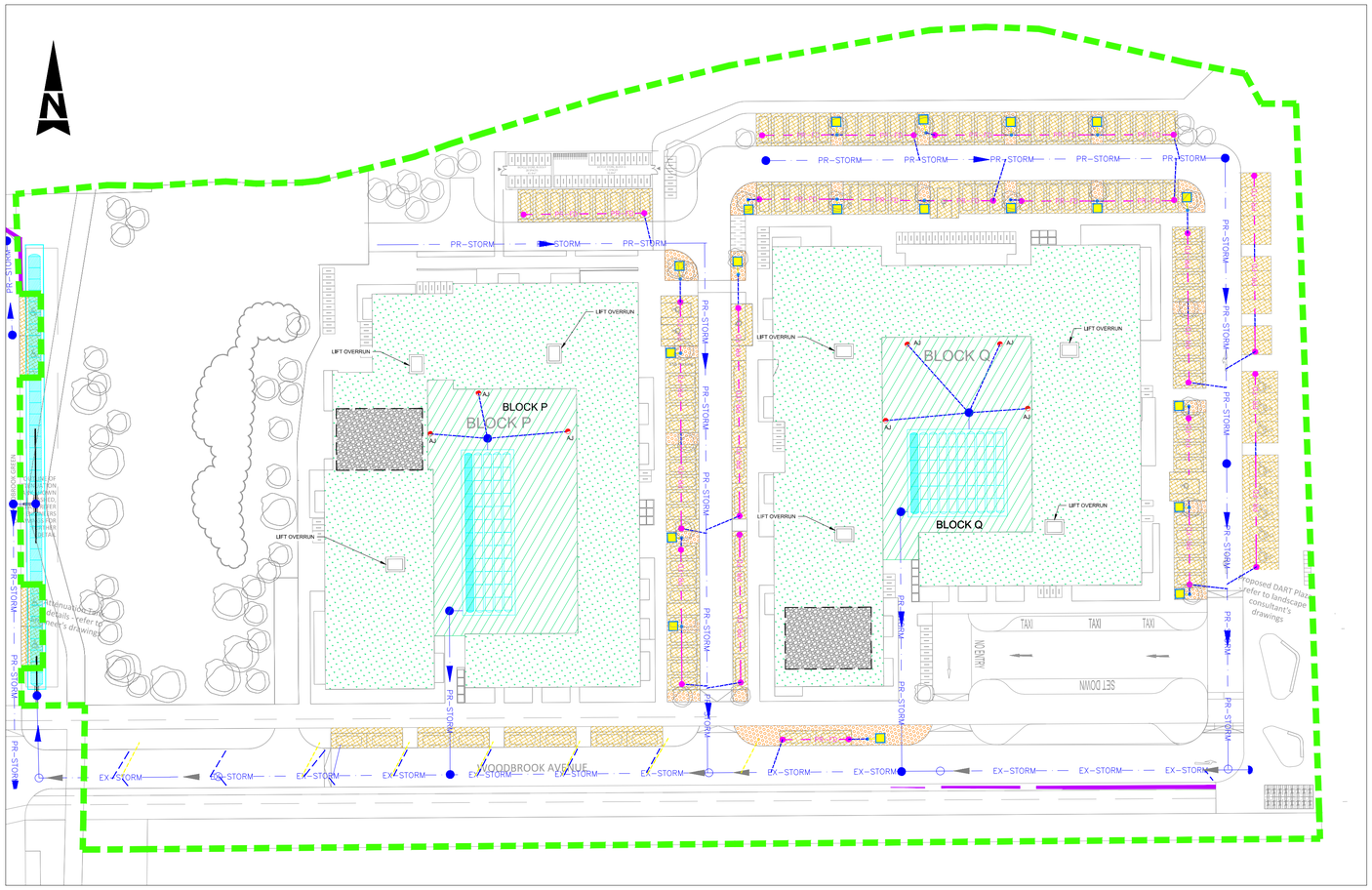
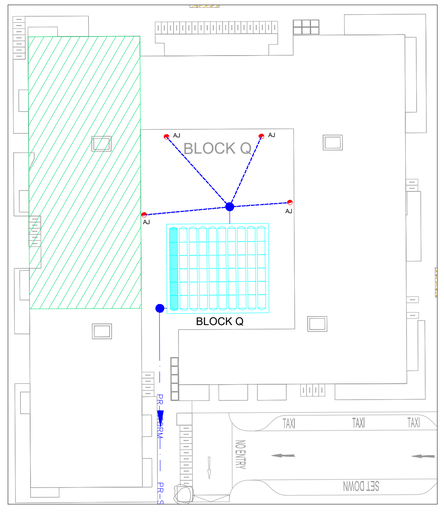


GREEN ROOF AREAS BLOCK P AND Q

Scale at A1 1:500 at A1
Scale at A3 1:1000 at A3



INTENSIVE GREEN ROOF FOR BLOCK Q - FLOOR SIX

Scale at A1 1:500 at A1
Scale at A3 1:1000 at A3

PV PANEL ON GREEN ROOF

Scale at A1 NTS
Scale at A3 NTS

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

LEGEND

- EXTENSIVE GREEN ROOF
- INTENSIVE GREEN COURTYARD

COURTYARD BUILD UP (INTENSIVE)

- INTENSIVE VEGATION
- DIADEM SIM INTENSIVE SUBSTRATE
- DIADEM VLF200 FILTER GEOTEXTILE
- DIADEM DIADRAIN-60H DRAINAGE BOARD FILLED
- DIADEM VLF-110 SEPERATION GEOTEXTILE CLOSED CELL THERMAL INSULATION
- DIADEM VLU-500 PROTECTION GEOTEXTILE ROOT RESISTANT WATERPROOFING MEMBRANE ADDITIONAL LAYERS

IMPORTANT NOTE:
THE COMBINED THICKNESS OF ALL THE ELEMENTS USED IN COURTYARD ROOF BUILD UP IS > 500mm,

PLANTING TO LANDSCAPE ARCHITECTS DETAILS

EXTENSIVE GREEN ROOF BUILD UP

- PRE CULTIVATED SEDUM BLANKET
- EXTENSIVE ROOF GARDEN SOIL MIX 150mm
- VLF150 FILTRATION FLEECE 1.5mm THICK
- DEC25 DRAINAGE & RESERVOIR LAYER 25mm THICK
- ULU300 PROTECTIVE/RESERVOIR FLEECE 2.5mm
- 4mm UNOSINT ROOT RESISTANT CAP SHEET
- 4mm TOP/S BASE SHEET
- 100mm PARATORCH INSULATION BOARD
- 2mm VAPOBAR VAPOUR CONTROL LAYER

IMPORTANT NOTE:
THE COMBINED THICKNESS OF ALL THE ELEMENTS USED IN GREEN ROOF BUILD UP FROM TOP DECKING IS MINIMUM 315mm,

SEDUM PLANTS WILL TYPICALLY REACH HEIGHTS OF 100-150mm

EXTENSIVE GREEN ROOF AREA CALCULATIONS

BLOCK P

TOTAL ROOF AREA = 2,350 m²
MINIMUM SEDUM ROOF AREA REQUIRED 85%) = 1,998 m²
TOTAL SEDUM ROOF AREA PROVIDED = 2,327 m² (99%)

BLOCK Q

TOTAL ROOF AREA = 2,835 m²
MINIMUM SEDUM ROOF AREA REQUIRED (85%) = 2,410 m²
TOTAL SEDUM ROOF AREA PROVIDED = 2,804 m² (99%)

INTENSIVE GREEN ROOF AREA CALCULATIONS

BLOCK P

TOTAL ROOF AREA = 1,012 m²
MINIMUM INTENSIVE GREEN AREA REQUIRED (70%) = 708 m²

BLOCK Q COURTYARD + FLOOR SIX

TOTAL ROOF AREA = 1,427 m²
MINIMUM INTENSIVE GREEN AREA REQUIRED (70%) = 602 m²

NOTE:

PROPOSED GREEN ROOF AND GREEN COURTYARD DESIGNED IN ACCORDANCE WITH SECTION 7.2 GREEN ROOF POLICY 2022 DLRCC COUNTY DEVELOPMENT PLAN 2022-2028

LEGEND

- PR-STORM — PROPOSED STORM DRAINAGE
- SXX — PROPOSED STORM WATER MANHOLE
- PROPOSED UNDERGROUND ATTENUATION SYSTEM
- PROPOSED PERMEABLE PAVING
- BIO RETENTION RAIN GARDEN
- AREA SUBJECTED TO PROPOSED DEVELOPMENT

Rev	Description	By	Date	Chk'd	Auth
-	FOR PLANNING	IH	17.12.25	SK	GH

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Client: AEVAL UNLIMITED COMPANY

Project: WOODBROOK DART GATEWAY

Purpose: FOR PLANNING

Title: PROPOSED GREEN INTENSIVE COURTYARD AND EXTENSIVE ROOF LAYOUT

Original Scale	Design/Drawn	Checked	Authorised
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Status: P
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Plotted by: ULHA7849

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AtkinsRéalis

Stormwater Impact Assessment

Aeval Unlimited Company

December 2025

0119017DG0005

WOODBROOK DART GATEWAY

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AtkinsRéalis Ireland Limited assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 51 pages including the cover.

Document history

Document title: Stormwater Impact Assessment

Document reference: 0119017DG0005

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0	Draft	S. Kamuni	G. Hanratty	A. Corrigan	K. Boyle	10.12.25
A	For Planning	S. Kamuni	G. Hanratty	A. Corrigan	K. Boyle	13.02.26

Client signoff

Client	Aeval Unlimited Company
Project	WOODBROOK DART GATEWAY
Job number	100119017
Client signature/date	

Contents

Tables

Figures

1. Introduction

The purpose of this LRD Stage 1 Preplanning Stormwater Impact Assessment is to provide the necessary information for the agreement with DLRCC of the Storm water elements associated with proposed Phase 4, Dart Gateway Development at Woodbrook.

The proposed residential development is on a site measuring c.2.63 hectares at lands south of the Shanganagh cemetery and east of the Woodbrook Dart Station, within the Woodbrook Local Area Plan boundary, Shanganagh, Shankill, Cork Little, Dublin. The proposed development comprises primarily of a residential development, with 360no. residential units, consisting of 354no. apartment units and 6no. duplex units proposed in a mix of 1, 2 and 3-bedroom units accommodated within 2no. apartment blocks, ranging in height of 2-7 storeys, including balconies and terraces. The development also includes public open space, communal open space serving the blocks; internal road networks; pedestrian and cycle facilities; car and bicycle parking spaces; ESB substations and all associated and ancillary site development and infrastructural works, hard and soft landscaping and boundary.

1.1 Site Location

The proposed development site is located at Woodbrook, Co Dublin. The proposed development site is located on existing agricultural lands.

The residential site is bound by an active DART line on the east, Woodbrook Golf Club on the south, a cemetery and undeveloped open greenfields to the North, and the permitted Phase 2 of the Woodbrook development to the west. The M11 Motorway is located approximately 970m West of the residential site.

The site location is indicated on Atkins drawing 100119017-ATK-ZZ-XX-DR-CE-090001.

1.2 Existing Site Description

The existing topographical levels within the residential site range from 21.00 mOD to 25.00 mOD. The highest point is located at the north-eastern corner, while the lowest point is at the north-western corner, with the terrain generally sloping towards the south. Additionally, the levels gradually fall from all directions towards the centre of the southern portion of the site. The site is currently accessed via the recently constructed junction to the Woodbrook Avenue on the R119 Dublin Road.

1.3 Principal Design Considerations

During the design of the storm water drainage for the proposed site, including SuDS, the following key documents / standards were taken into consideration.

- Dún Laoghaire Rathdown County Development Plan, 2022 - 2028
- Nature-based Solutions to the Management of Rainwater and Surface Water Runoff in Urban Areas Interim Guidelines
- Shanganagh Woodbrook Local Area Plan (LAP)
- Greater Dublin Strategic Drainage Study (GDSDS)
- CIRIA report C753 The SuDS Manual-v6

The proposed stormwater drainage will be developed in consultation with the relevant authorities including Dún Laoghaire Rathdown County Council (DLRCC) Municipal services department.

2. Surface Water Design

The storm drainage system will be designed in accordance with the key documents and standards listed in Section 1.3 above.

Surface water generated from the proposed residential development will be conveyed through the proposed and recently constructed as part of the phase 1 development surface water network including SuDS and attenuated / managed on site prior to final discharge at Qbar greenfield run-off rates. The restricted discharge from the proposed overall site will remain unchanged and be conveyed via the recently constructed surface water sewer on the Dublin Road before discharge to the receiving Crinken / Rathmichael Stream. The proposed storm drainage network for the Woodbrook Dart Gateway development is as indicated on the planning drawings 0119017-ATK-ZZ-02-DR-CE-090503.

The principles behind the proposed design were discussed and agreed with DLRCC Municipal services department as part of the overall Woodbrook phase 1 application. Aspects of the proposed development that were discussed and agreed have been incorporated within this design.

In accordance with the DLRCC Development Plan, a Stage 1 Stormwater Audit will be carried out prior to the final planning application.

The proposed measures included within the design proposal are as follows:

- Permeable paving in light traffic areas (parking bays)
- Green roofs to suitable apartment blocks
- Green courtyards to suitable apartment blocks
- Rain Gardens to residential areas
- Underground modular system within green corridors / park areas / open spaces
- Tree pits
- Vortex Flow control devices

2.1 Proposed Sustainable Urban Drainage (SuDS) Strategy

For the proposed development a “SuDS triangle” was utilised to ensure all three functions are provided for within the SuDS strategy.

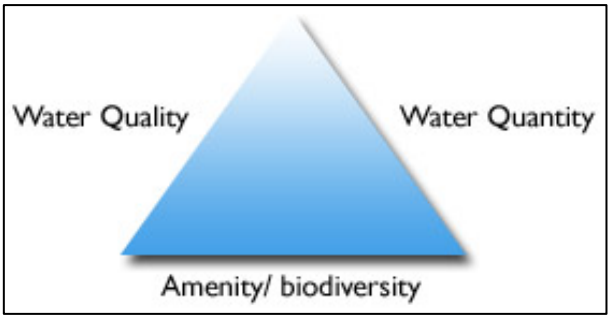


Figure 2-1 - SuDS Triangle

By considering the three functions of the triangle, a SuDS system will allow for water quality treatment through natural processes by;

- Encouraging infiltration (where appropriate) and attenuating peak flows
- Improving water quality by providing treatment to storm water prior to discharge.
- Providing habitat and function were possible for those using the area (including wildlife)

The principles of a SuDS treatment train were used during the design of the surface water drainage system. The treatment train as illustrated in the image below provides an understanding of prevention and source control to reduced water run-off from a site and improve water quality.

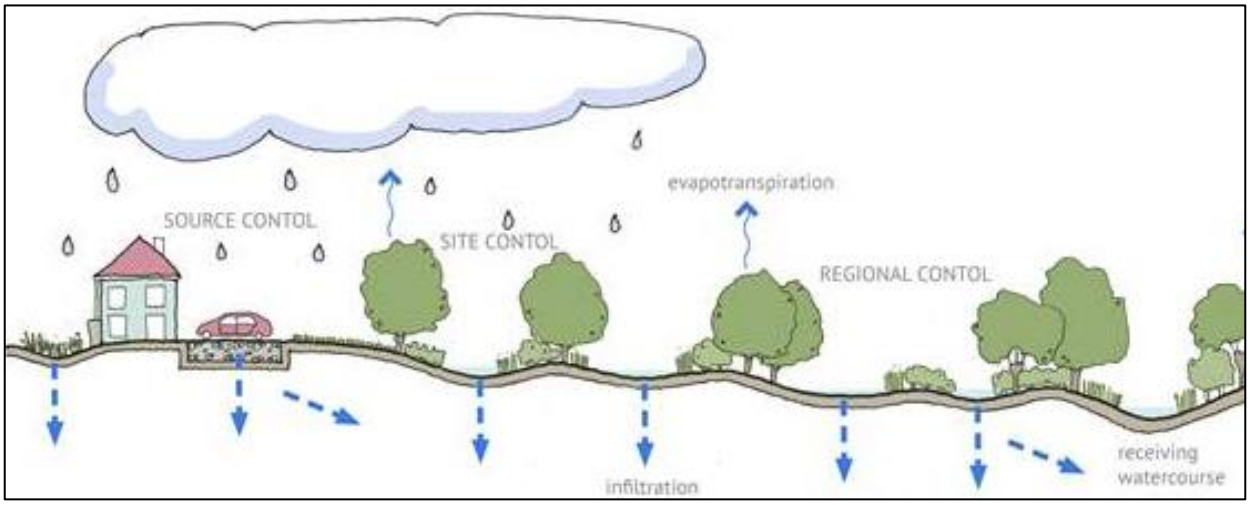


Figure 2-2 - SuDS Treatment Train

The treatment train principles include;

- Prevention of surface water run-off from the proposed site by use of filter drains, swales, permeable paving, tree pits, extensive green roofs, intensive green courtyards and modular attenuation systems with a permeable base (where appropriate)
- Minimising impermeable paved areas using permeable paving, extensive green roofs, intensive green courtyards and modular grass road proprietary product.
- Infiltration by use of filter drains, swales, permeable paving and tree pits.
- Site control using underground modular attenuation storage and vortex flow control devices to manage flows and agreed final Qbar runoff rate.

Each of the items outlined above will help to improve water quality, reduce storm water runoff quantity from the proposed site and ensure that there is no increased risk to downstream flooding where discharging to the Crinken / Rathmichael Stream.

Drawing 0119017-ATK-ZZ-XX-DR-CE-090503 inclusive outline the proposed details of the storm water network.

For the purposes of designing the storm water network for the entire development (Phase 1, Phase 2, amended application to Phase 1 and this current Phase 4) and including associated Qbar calculations a total overall catchment area of 21ha has been calculated as indicated below in Figure 2-3.

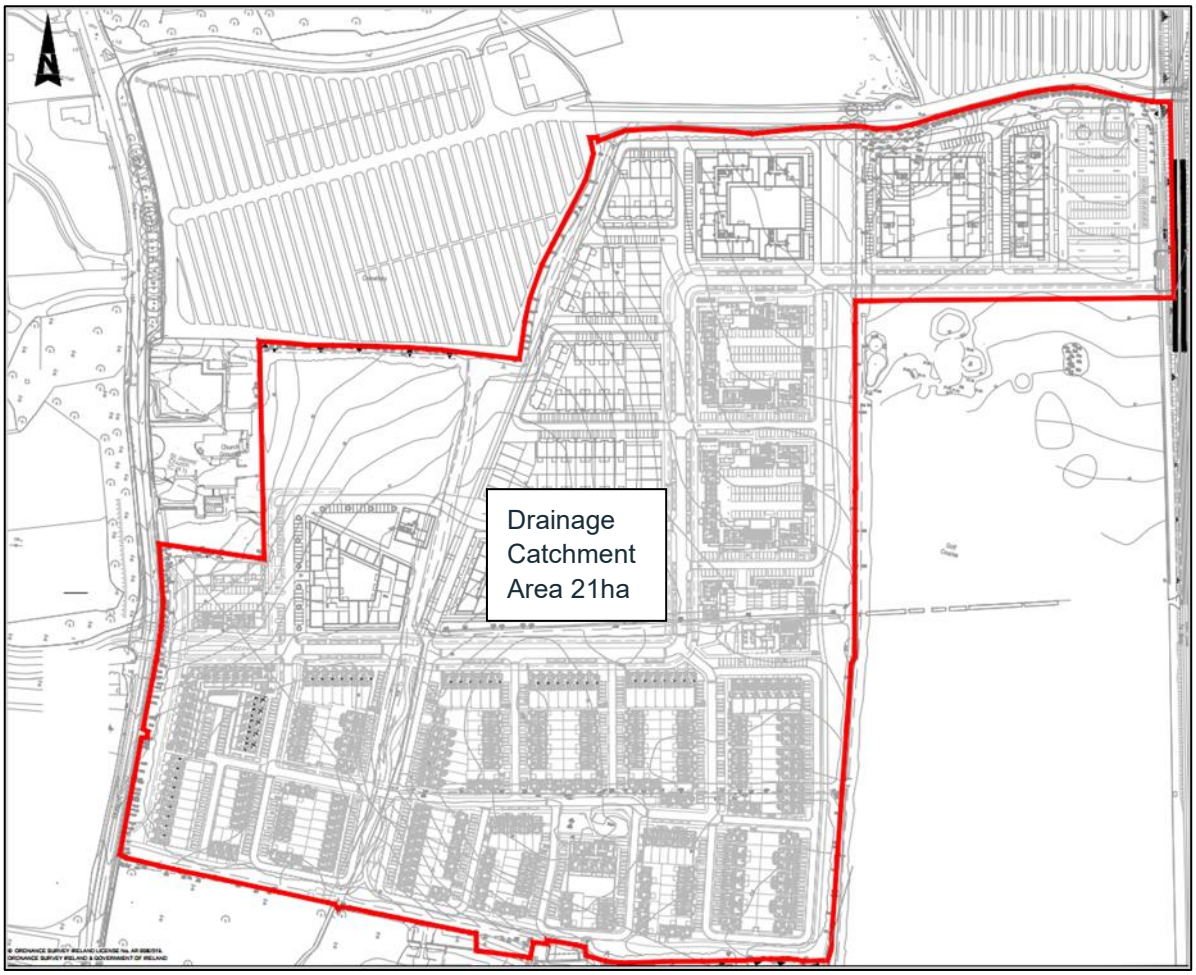


Figure 2-3 - Overall Catchment Area

There are 10 No. proposed drainage sub-catchment areas (Catchments A – J) within the proposed masterplan lands for the purpose of site control as outlined on drawing 0089771-ATK-ZZ-02-DR-CE-090511. The catchments are segregated by use of a vortex control device to limit / manage discharge from each catchment. Section 7 provides further details on Catchment areas.

The SuDS techniques proposed within the development are as outlined below:

- Permeable paving will be used in light traffic areas to the front of residential units, courtyards and carparks. The permeable paving will allow for attenuation, infiltration to ground, reduction of peak flow rates and improved water quality. Roof run-off from the front roof area of residential housing units will discharge directly into the subbase below each permeable paving area allowing for reduced runoff from these roof areas.

- Extensive green roof and intensive green courtyards will be provided on suitable buildings as indicated on drawing 0119017-ATK-ZZ-XX-DR-CE-090521 in accordance with Dún Laoghaire Rathdown County Development Plan, 2022 – 2028. The green roofs / courtyards will provide reduced peak flow rates, attenuation, evaporation, and improved water quality.
- Underground modular systems will be used within public green corridors / park areas. The modular systems will allow for storm water attenuation underground for storm events up to 1 in 100-year events. The modular systems will also allow for infiltration to ground were suitable.
- Filter drains within rear gardens of the housing units will allow for infiltration to ground, reduced peak flow rates and improved water quality. Only roof run-off from the rear roof of the residential unit will discharge into the filter drain. The filter drain will allow for infiltration to ground and reduce the overall site runoff.

- Vortex flow control devices will be used throughout the site to allow for storm water control and reduce peak runoff.
- Catchment A has been separated into three sub-catchments. This is due to minor change to Phase layout and sufficient separation distance between the building and final attenuation tank A.
- The overall maximum discharge rate from Catchment A remains unchanged at 2.0 l/s for 1 in 100 year storm event including allowance for 30% climate change (20% climate change and 10% urban creep).

The storm water drainage network will be assessed for compliance with the key design parameters as set out in below.

Table 2-1 - key Design Parameters

Parameter	Value/Requirement
Minimum depth	1.2m cover under highways 0.9m elsewhere*
Maximum depth	5.0m
Minimum sewer size for main drainage	225mm
DLRCC Municipal services agreed for phase 1 co-efficient runoff factors for pipe sizing and storage requirements	100% - Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network) 75% - Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains. 60% - Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving. 85% - Extensive Green Roof (> 150mm thk.) 70% - Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)
Max. velocity at pipe full	3.0 m/s
Min. velocity in	0.75 m/s (1.0 m/s used where achievable)
Roughness	0.6mm
DLRCC Municipal services agreed Maximum discharge rate	56.34 l/s at final discharge location (56.34 l/s/21ha** = 2.68 l/s/ha)
Level of Service Critical Storm 1 in 2 yr return period	No surcharge within the pipe network, no flooding
Level of Service Critical Storm 1 in 30 yr return period	Surcharge allowed, no flooding
Level of Service Critical Storm 1 in 100 yr return period	No flooding unless planned and contained on site.

**Without recourse to concrete. Absolute minimum cover in roads is 0.9m. Pipes with cover between 0.9m and 1.2m shall be bedded and surrounded in concrete, 150mm thick, Class E, in accordance with Clause 1502 of the Specification for Roadworks.*

***Overall catchment area for storm water design purposes is 21ha as discussed in Section 2.1 above.*

“Micro Drainage”, which is an industry standard tool for the design and assessment of gravity sewer drainage networks, has been used to simulate the proposed storm drainage network including flow controls and attenuation requirements.

3. Site Investigation

Site Investigations were carried out by Ground Investigations Ireland Ltd, between June and August 2018.

The purpose of the site investigation was to investigate subsurface conditions utilising a variety of investigative methods. The scope of the site investigation works undertaken for this project included the following:

- 12 No. Trial Pits to a maximum depth of 3.0m Below Ground Level (BGL).
- 6 No. Soakaways to determine a soil infiltration value to BRE digest 365.
- 3 No. Cable Percussion boreholes to a maximum depth of 10.0m BGL.
- 3 No. Groundwater monitoring wells.
- Geotechnical & Environmental Laboratory testing.

The locations for the site investigation testing including soakaways and ground water monitoring wells were discussed and agreed with DLRCC Municipal services prior to works commencing on site. Refer to Figure 3-1 below for borehole and trial pit locations. Soakaway tests were also carried out in the following trial pits; TP1, TP2, TP6, TP8, TP9 & TP11. Note the below image is taken from the Phase 1 submission to indicate locations of SI testing, the red line indicated does not represent the red line for the phase 2 boundary.

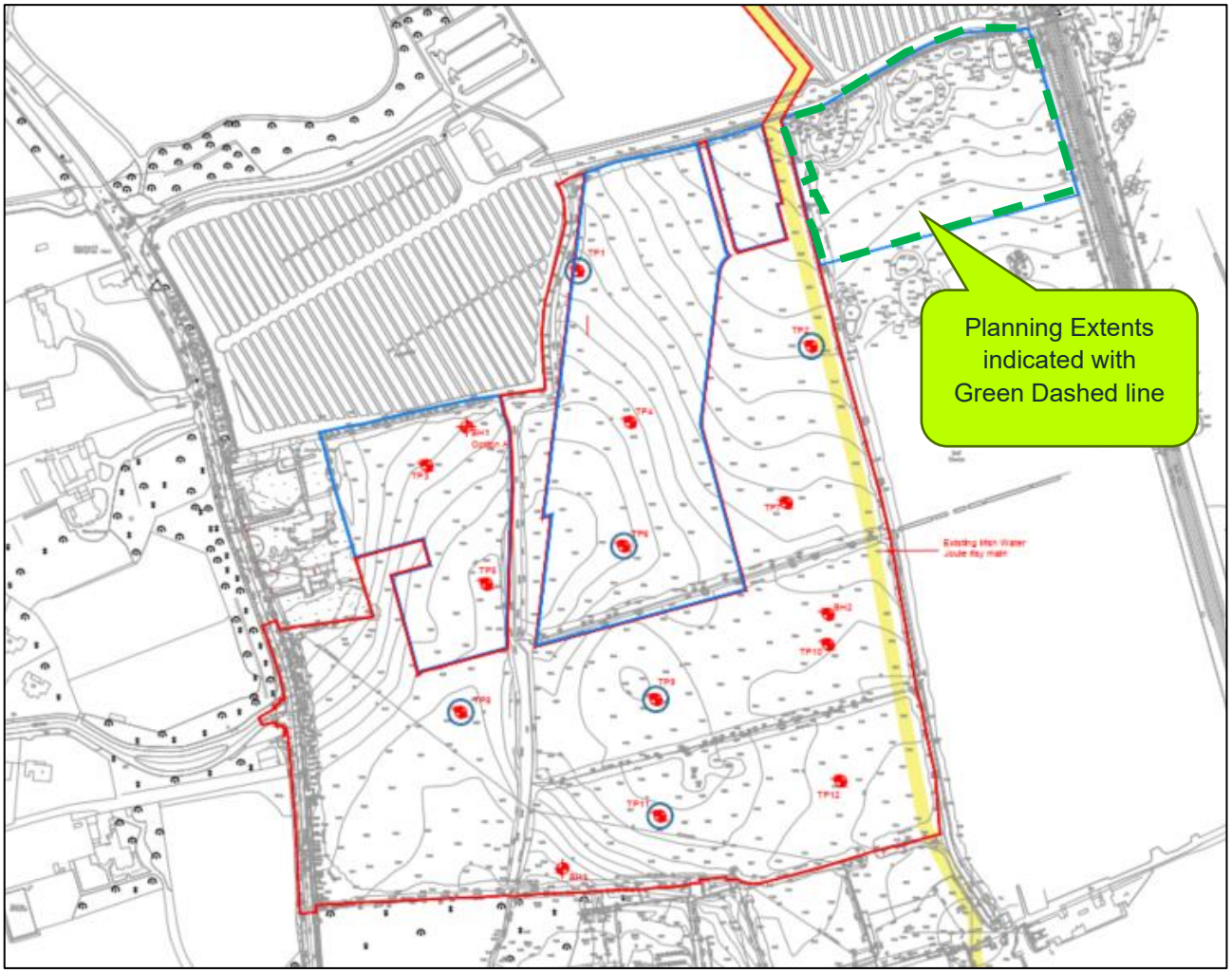


Figure 3-1 - SI Testing Locations

Review of the SI results including Trial Pit (TP) logs indicate that out of the 12No. TP, ground water was encountered within 4No. TP's. The ground water levels within the TP logs varied between 1.70m – 2.50m in depth.

The location of trial pits, ground levels and ground water levels are currently indicated in Figure 3-1 above.

For Woodbrook Phase 1, DLRCC indicated concerns in relation to high water table levels to the North – Northeast of the site along the boundary with the existing Shanganagh Cemetery in addition to queries relating to underground flow-paths. An assessment to determine ground water flows was undertaken and included the installation of groundwater monitoring wells on site.

The report concluded that based on site-specific geological and hydrogeological data, there will be no perceptible impacts on surface water levels, surface water flows, groundwater levels or groundwater flows, specifically in the vicinity of the areas in question. Furthermore, the report notes that potential impacts to the onsite field ditch or groundwater flow paths do not warrant further consideration.

4. Existing Site Hydrology

An existing ditch traverses the site from North to South along an existing hedge and treeline as indicated in Figure 4-1 below. This ditch has a long-established existence and functions in draining the fields within the site. A review of Historical Ordinance Survey Ireland information (www.osi.ie) was then carried out to determine if the OSI 6-inch Maps indicated historic water courses / surface water features within the site. The maps do not indicate any record of a water course onsite.

The ditch ultimately discharges to a local watercourse Crinken \ Rathmichael Stream (EPA 10R18) located to the South of the proposed Woodbrook Development via 3rd party lands.

The Crinken \ Rathmichael Stream flows from North-West to East approx. 150 metres from the southern boundary of the proposed development site. The stream then discharges to the Irish Sea approximately 1km southeast of the site boundary.

Lands within the proposed Woodbrook Development drain to the existing ditch as indicated by the flow arrows indicated in Figure 4-1 below.

During pre-planning discussions with DLRCC, concerns were raised in relation to the existing drainage ditch on site. DLRCC requested confirmation that the existing onsite drainage ditch is a field ditch and not a stream or river.

The Technical Note concluded that having reviewed all available desk-based information, including historical mapping and aerial photography, and based on the observations of an experienced Hydrogeologist during a walkover survey of the Site, the drainage feature is a field ditch. Furthermore, there is no evidence that this drainage feature was historically a stream or a river.

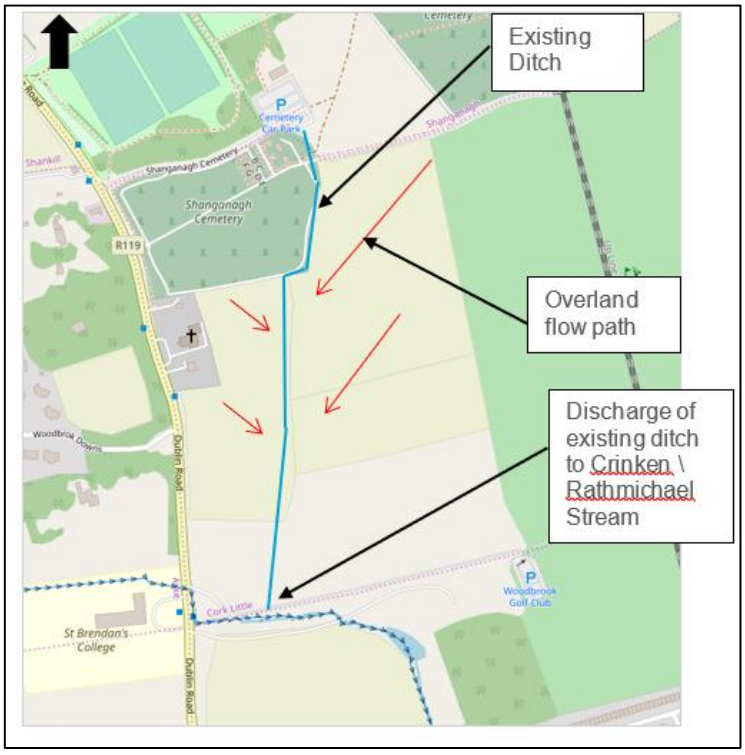
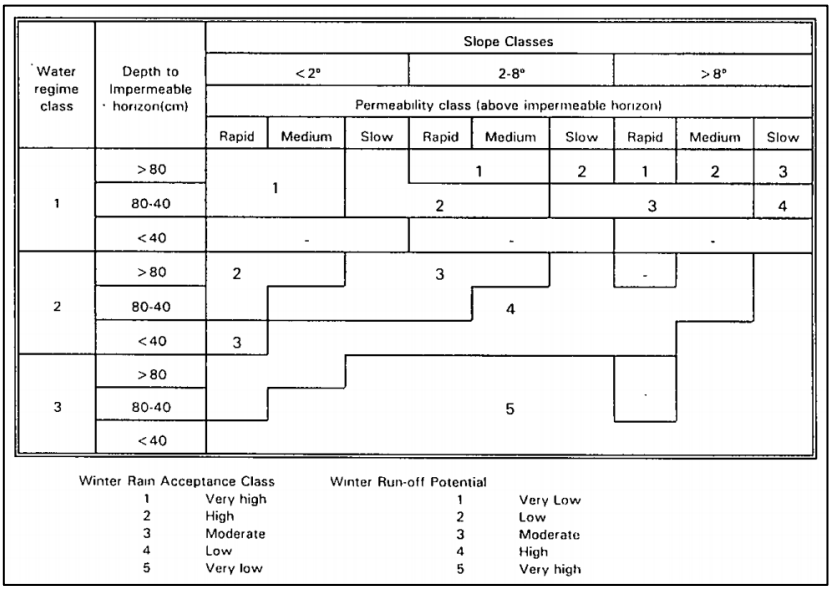


Figure 4-1 - Site Hydrology Overview

5. Soil Type Classification

To determine the allowable Qbar discharge rate from the proposed site, the SOIL value for the existing site was classified using the 'Winter Rain Acceptance Potential classification' Table 2.1 from the Institute of Hydrology Report No. 126, see Figure 5-1 below.



Water regime class	Depth to Impermeable horizon(cm)	Slope Classes								
		<2°			2-8°			>8°		
		Permeability class (above impermeable horizon)								
		Rapid	Medium	Slow	Rapid	Medium	Slow	Rapid	Medium	Slow
1	>80	1			1		2	1	2	3
	80-40			2			3			4
	<40	-			-			-		
2	>80	2			3			-		
	80-40					4				
	<40	3								
3	>80									
	80-40					5				
	<40									

Winter Rain Acceptance Class		Winter Run-off Potential	
1	Very high	1	Very Low
2	High	2	Low
3	Moderate	3	Moderate
4	Low	4	High
5	Very low	5	Very high

Figure 5-1 - WRAP Table

The table considers four main soil and site properties which include:

- Soil water regime
- Depth to an impermeable layer
- Slope class
- Permeability of the soil horizons above the impermeable layer

5.1 Soil Water Regime

The water regime class is taken from the Soil Survey Field Handbook (Hodgson 1974). The classes are identified as:

1) soils rarely waterlogged within 40 cm depth, and for less than 90 days within 70 cm in most years,

2) soils commonly waterlogged within 40 cm, but for less than 335 days within 70 cm in most years, and

3) soils waterlogged within 40 cm for more than 180 days, and for more than 335 days within 70 cm in most years.

Figure 5-2 - Water Regime Classes

The Site Investigations findings indicated a ranging depth of topsoil for each of the 12No. Trial Pits including the 6 Soakaway Trial Pits from 250mm to 400mm in depth.

Due to the maximum depth of the topsoil (400mm thk.) and the depth to impermeable layer discussed in Section 5.2 below, it was determined that water regime Class 2 “soils commonly waterlogged within 40cm, but for less than 335 days within the 70mm in most years” is the most suitable selection for this site.

5.2 Depth to an Impermeable Layer

Site Investigations were carried out on site as previously discussed in Section 3 of this report. During the Site Investigations 6No. soakaway tests were performed in accordance with BRE digest 365 at specified locations to determine the suitability of the soils for the infiltration of surface water.

The Site Investigations findings indicated a depth of topsoil for each of the 6No. soakaway Trial Pits ranging from 250mm to 400mm in depth.

Below the topsoil the test medium varied from slightly sandy slightly gravelly CLAY with occasional subrounded cobbles to firm to stiff brown slightly gravelly CLAY.

The Institute of Hydrology Report No. 126 outlines that “an impermeable layer is defined as a layer with a hydraulic conductivity of less than 0.1 m/day”.

Based on this information with predominant soil type for each of the soakaway tests being CLAY, the depth to an impermeable layer is determined to be located between 250mm and 400mm below surface level or at the underside of the topsoil or, accordance with the WRAP table a depth to impermeable horizon of <40cm.

5.3 Slope Class

Following a review of the topographical survey a 3D heatmap model of the existing site gradients was generated. The 3D model allowed for identification of the slopes on site between the ranges set out in the ‘Winter Rain Acceptance Potential classification’, see Figure 5-3 below for slope classifications

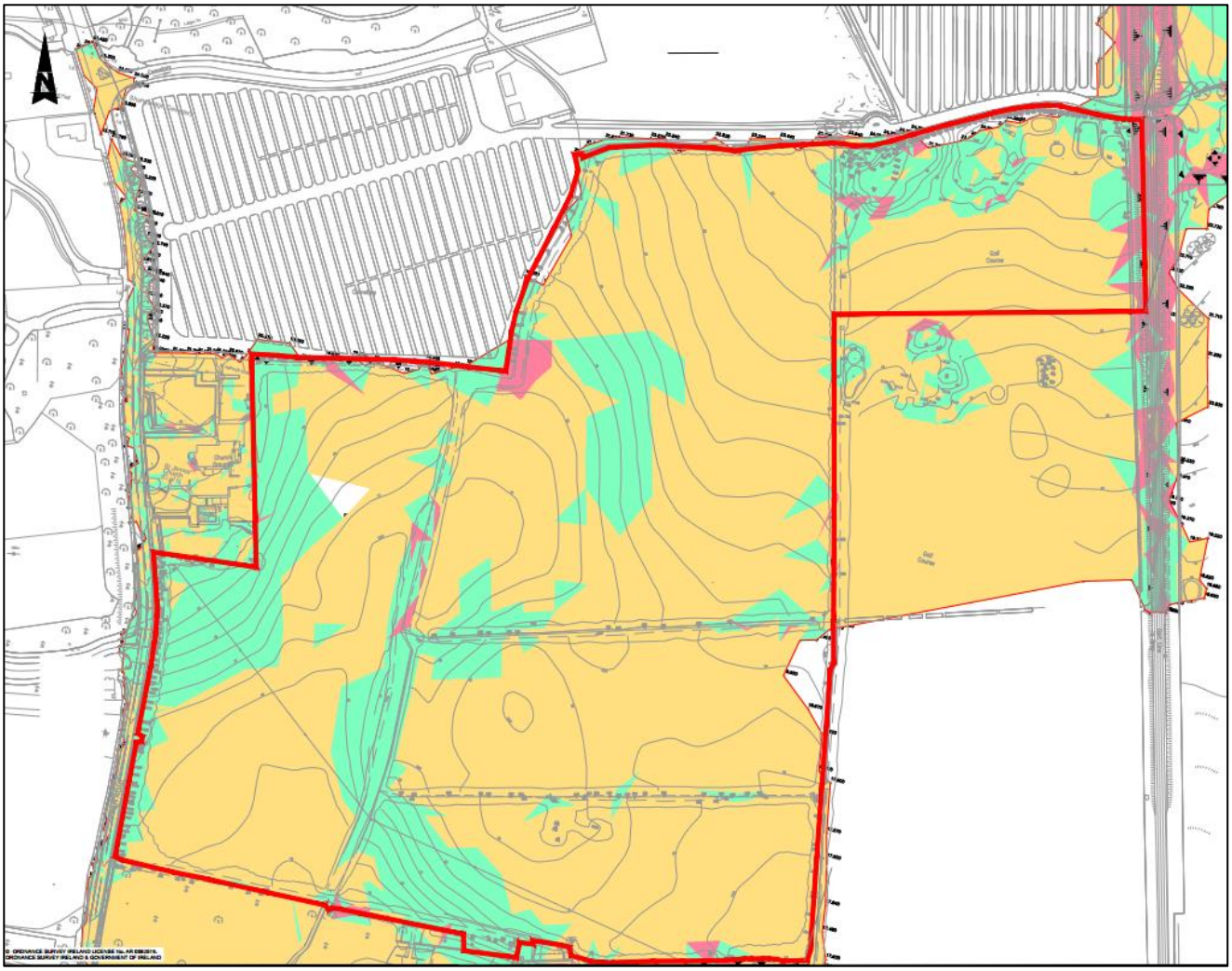


Figure 5-3 - Site Slope Classifications

The majority of the site has a slope of < 2 degrees indicated in yellow. It is noted however that parts of the site have a slope of between 2 – 8 degrees indicated in green with some minor areas having a slope of > 8 degrees indicated in red. For this assessment based on the predominate, a < 2 degrees slope will therefore be used.

5.4 Permeability Class

The Handbook of Soils for Landscape Architects by Robert F. Keeler Table 6.1 provides a soil characterisation for permeability from slow to rapid as outlined in Figure 5-4 below:

Table 6.1 Soil Permeability Class Related to Flow of Water through a Saturated Soil

Permeability Class	Rate of Flow (inches per hour)
Very slow	Less than 0.06
Slow	0.06–0.2
Moderately slow	0.2–0.6
Moderate	0.6–2.0
Moderately rapid	2.0–6.0
Rapid	6.0–20.0
Very rapid	More than 20

Figure 5-4 - Permeability Classifications

From review of the soakaway test results, the site has been subdivided into two areas based on permeability classes as per Figure 5-5 below. Area A to the east and west of the site encompasses an area of 11.02ha and Area B in the middle of the site encompasses an area of 10.08ha.

The soakaway tests in Area A indicate results between 0.325 inch / hour and 0.444 inch / hour. Based on this it is determined that permeability class is ‘Moderately Slow’.

The Site Investigations indicate that for Area B ‘water level dropped too slowly to allow for calculations of ‘f’ the soil infiltration rate’. For Area B it is determined that the permeability class is ‘Slow’.

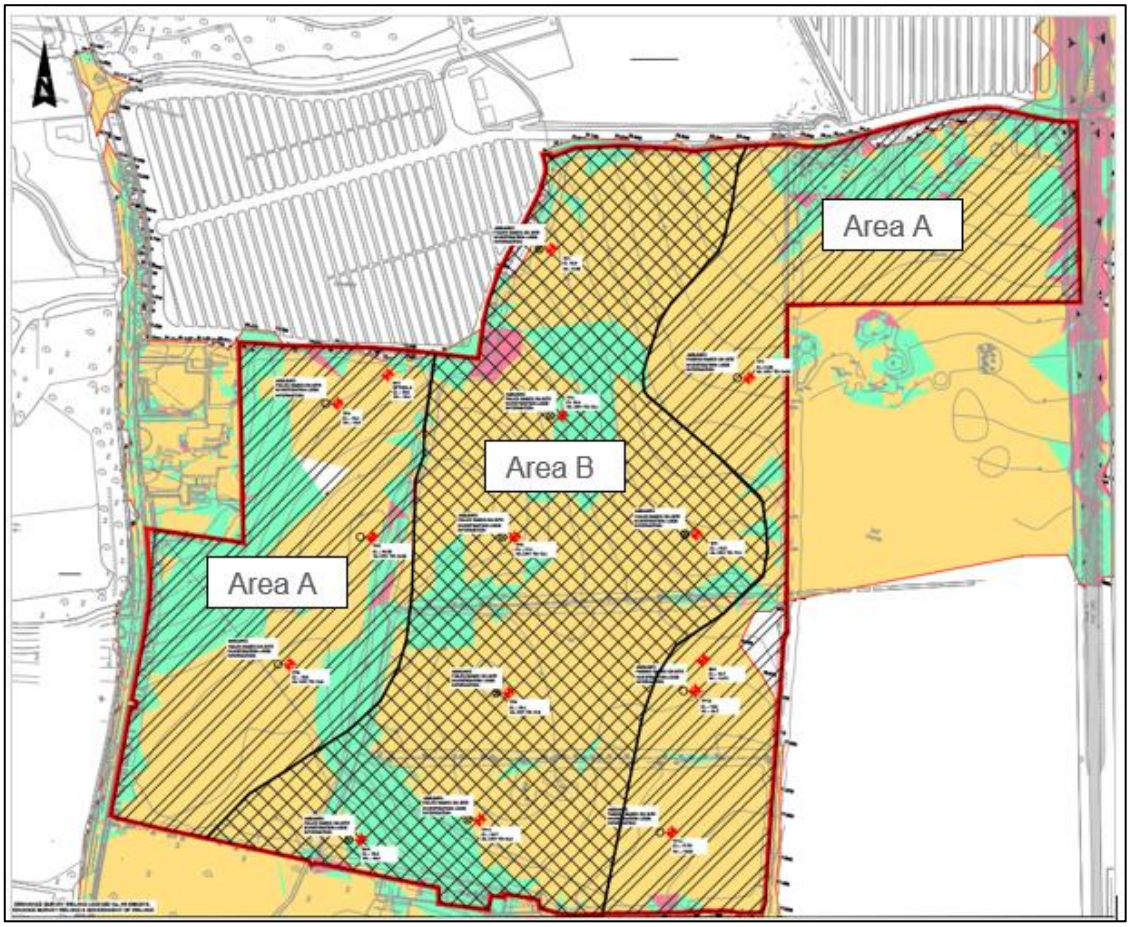


Figure 5-5 - Site Permeability Classification

5.5 Soil Type Classification

5.5.1 Area A

Based on the rational discussed in Sections 5.1-5.4 above, Area A would fall into the Soil Type 4 classification as per Figure 5-6 below.

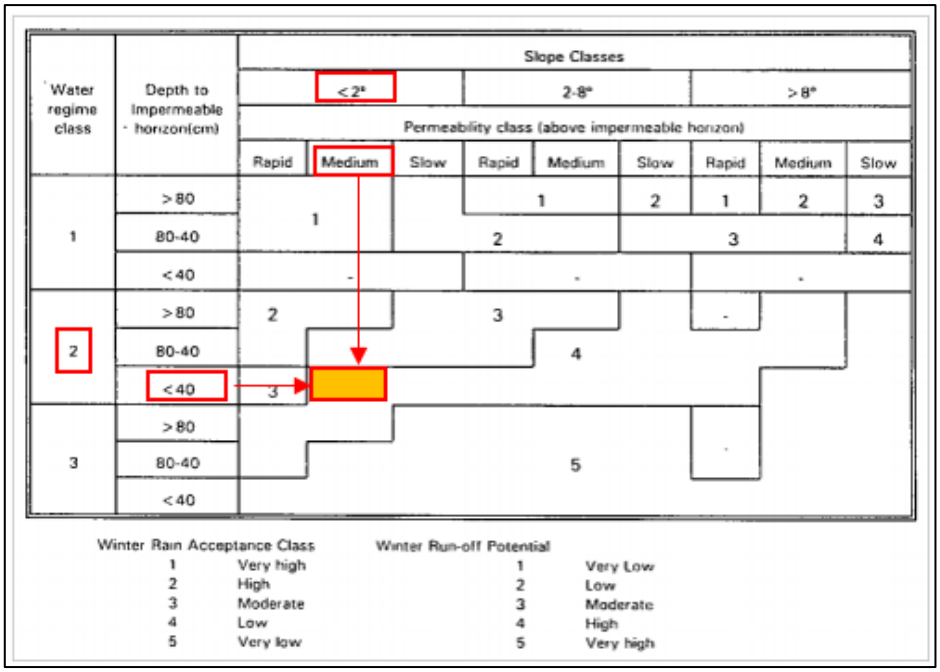


Figure 5-6 - Area A Soil Type Classification (Original)

However, DLRCC Municipal services opinion was that the depth to impermeable horizon across the site is in the range of 80cm – 40cm. Based on this Area A has been reclassified to Soil Type 3 for the purpose of Qbar discharge rate calculations, as per Figure 5-7 below.

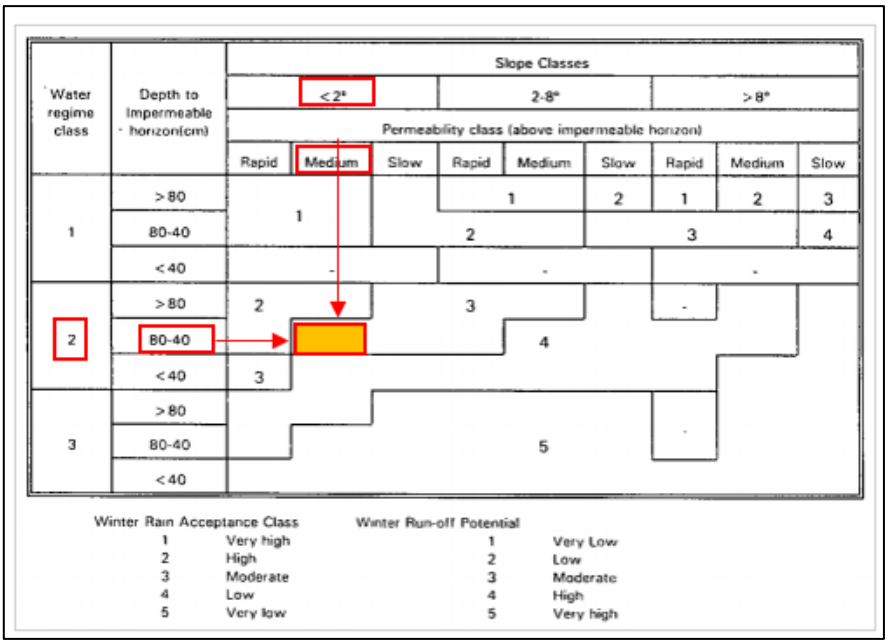


Figure 5-7 - Area A Soil Type Classification (Amended)

The reclassification of Soil Type 4 to Soil Type 3 provides a lower Qbar runoff rate and increases the attenuation volume requirements on site. The use of Soil Type 3 is therefore considered to be more onerous.

5.5.2 Area B

Based on the rational discussed in Sections 5.1-5.4 above, Area A would fall into the Soil Type 4 classification as per Figure 5-8 below.

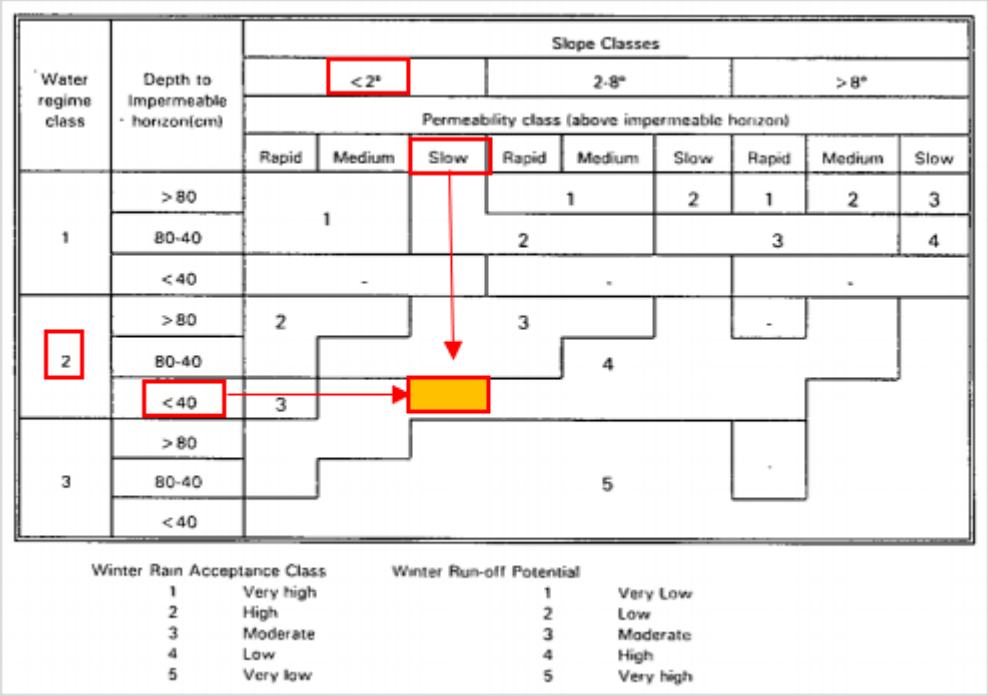


Figure 5-8 - Area B soil Classification (Original)

For phase 1, DLRCC Municipal services opinion was that the depth to impermeable horizon across the site is in the range of 80cm – 40cm and that possibly Soil Type 3 should be used. However, it was further considered that as each of the soakaway tests within Area B failed due to poor infiltration rates the area should classified as Soil Type 4. DLRCC Municipal services agreed that Soil Type 4 was acceptable within this area of the site, as per Figure 5-8 above. The design for the phase 2 submission will therefore remain unchanged based on previous agreements.

The Qbar value for the proposed site will therefore be determined using a combination of Soil Type Classification 3 and 4.

6. Surface Water Storage Requirements

For phase 1 and as agreed with DLRCC Municipal services, the www.uksuds.com surface water storage volume estimation tool was used to determine the maximum Qbar discharge rate from the site for a 1 in 100-year storm event. Site specific data was confirmed using Met Eireann rainfall data as indicated below;

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 325915, Northing: 220611,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.7,	3.8,	4.4,	5.2,	5.8,	6.2,	7.7,	9.3,	10.3,	11.8,	13.1,	14.1,	15.6,	16.8,	17.8,	N/A ,
10 mins	3.8,	5.3,	6.1,	7.3,	8.1,	8.7,	10.7,	12.9,	14.4,	16.4,	18.2,	19.6,	21.8,	23.4,	24.8,	N/A ,
15 mins	4.5,	6.3,	7.2,	8.6,	9.5,	10.2,	12.6,	15.2,	16.9,	19.3,	21.4,	23.1,	25.6,	27.6,	29.2,	N/A ,
30 mins	6.0,	8.2,	9.3,	11.0,	12.2,	13.1,	15.9,	19.1,	21.2,	24.0,	26.6,	28.5,	31.5,	33.8,	35.7,	N/A ,
1 hours	7.9,	10.6,	12.1,	14.2,	15.6,	16.7,	20.2,	24.0,	26.5,	29.9,	33.0,	35.3,	38.8,	41.5,	43.8,	N/A ,
2 hours	10.4,	13.9,	15.7,	18.3,	20.0,	21.3,	25.6,	30.2,	33.2,	37.3,	40.9,	43.6,	47.8,	51.0,	53.6,	N/A ,
3 hours	12.3,	16.2,	18.2,	21.2,	23.1,	24.6,	29.4,	34.5,	37.8,	42.4,	46.4,	49.4,	54.0,	57.5,	60.3,	N/A ,
4 hours	13.8,	18.1,	20.3,	23.5,	25.7,	27.3,	32.4,	38.0,	41.5,	46.4,	50.7,	53.9,	58.8,	62.6,	65.6,	N/A ,
6 hours	16.2,	21.1,	23.6,	27.3,	29.7,	31.5,	37.2,	43.4,	47.4,	52.8,	57.5,	61.1,	66.4,	70.5,	73.9,	N/A ,
9 hours	19.1,	24.7,	27.5,	31.6,	34.3,	36.3,	42.8,	49.7,	54.1,	60.0,	65.2,	69.1,	75.0,	79.5,	83.2,	N/A ,
12 hours	21.4,	27.6,	30.7,	35.1,	38.0,	40.2,	47.2,	54.6,	59.3,	65.8,	71.3,	75.5,	81.8,	86.6,	90.5,	N/A ,
18 hours	25.2,	32.2,	35.7,	40.7,	44.0,	46.5,	54.2,	62.5,	67.7,	74.8,	80.9,	85.5,	92.4,	97.6,	101.8,	N/A ,
24 hours	28.3,	35.9,	39.8,	45.2,	48.8,	51.4,	59.8,	68.7,	74.3,	81.9,	88.4,	93.3,	100.7,	106.2,	110.8,	126.0,
2 days	35.7,	44.5,	48.9,	55.0,	59.0,	62.0,	71.2,	81.0,	87.1,	95.3,	102.2,	107.5,	115.3,	121.1,	125.9,	141.8,
3 days	41.7,	51.4,	56.2,	62.9,	67.2,	70.5,	80.5,	90.9,	97.4,	106.1,	113.5,	119.0,	127.2,	133.4,	138.4,	155.0,
4 days	46.9,	57.5,	62.6,	69.8,	74.4,	77.9,	88.5,	99.5,	106.4,	115.6,	123.3,	129.1,	137.7,	144.1,	149.3,	166.6,
6 days	56.2,	68.1,	73.8,	81.9,	87.0,	90.8,	102.5,	114.6,	122.0,	132.0,	140.3,	146.6,	155.8,	162.7,	168.2,	186.6,
8 days	64.4,	77.4,	83.7,	92.5,	98.0,	102.1,	114.7,	127.7,	135.7,	146.3,	155.2,	161.8,	171.6,	178.8,	184.7,	204.0,
10 days	71.9,	86.0,	92.7,	102.1,	108.0,	112.4,	125.8,	139.6,	148.0,	159.2,	168.6,	175.6,	185.8,	193.4,	199.5,	219.8,
12 days	79.0,	94.0,	101.2,	111.1,	117.4,	122.0,	136.2,	150.6,	159.5,	171.2,	181.0,	188.3,	199.0,	206.9,	213.3,	234.3,
16 days	92.1,	108.8,	116.8,	127.7,	134.6,	139.7,	155.1,	170.9,	180.5,	193.1,	203.7,	211.5,	223.0,	231.5,	238.3,	260.7,
20 days	104.3,	122.5,	131.1,	143.0,	150.4,	155.9,	172.5,	189.4,	199.6,	213.1,	224.4,	232.7,	244.8,	253.8,	261.0,	284.7,
25 days	118.7,	138.6,	147.9,	160.8,	168.8,	174.8,	192.7,	210.8,	221.8,	236.2,	248.2,	257.0,	270.0,	279.6,	287.2,	312.2,

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

A SAAR Value of 825mm was utilised to calculate the green field runoff rate as confirmed by DLRCC Municipal services.

Refer to Appendix B for the output from the www.uksuds.com surface water storage volume estimation tool and maximum Qbar discharge rate.

A summary of the calculations is outlined below (see Table 7-3 for further breakdown of areas)

- Total site (overall catchment) area; 21ha
- Total area drained; 12.199ha
- Total impermeable area based on reduced coefficient runoff rate; 9.094ha
- Total % of drainage area that is impermeable; 75%

Significant public open space (public open spaces, rear gardens etc.) has been calculated by subtracting the total site area from the total positively drained area; 8.801ha.

As discussed in Section 5.5 above, the overall catchment area has been divided into two areas based on the corresponding soil types. These figures have been utilised to calculate the Qbar runoff rate (including 10% allowance for climate change) as summarised in Table 6-1 below and displayed in the UK SuDS output included within Appendix B.

Table 6-1 - Qbar Calculation Summary

Area Ref.	Soil Type	Area Size (ha)	% of Total Area (21ha)	Resulting Qbar (l/s)	Total Qbar (l/s)
A	3	11.02	52	22.08	**56.34**
B	4	10.08	48	34.26	

The calculated Qbar rate of 56.34l/s has been discussed and agreed with DLRCC Municipal services. The figure is the final permittable discharge from the Woodbrook site (Phase 1, Phase 2, amendment to Phase 1 & this currently application phase 4).

7. Proposed Site Characteristics

The proposed overall catchment area of 21ha has been split into 10No. catchment areas (catchment A – J) as indicated in Figure 7-1 below and on planning drawing 0119017-EWE-DR-0517. All catchments have incorporated multiple SuDS features as outlined in Section 2 above. Each catchment will have a flow control device to limit discharge rates to the maximum allowable Qbar runoff rate from the site (56.34l/s) and attenuation storage.

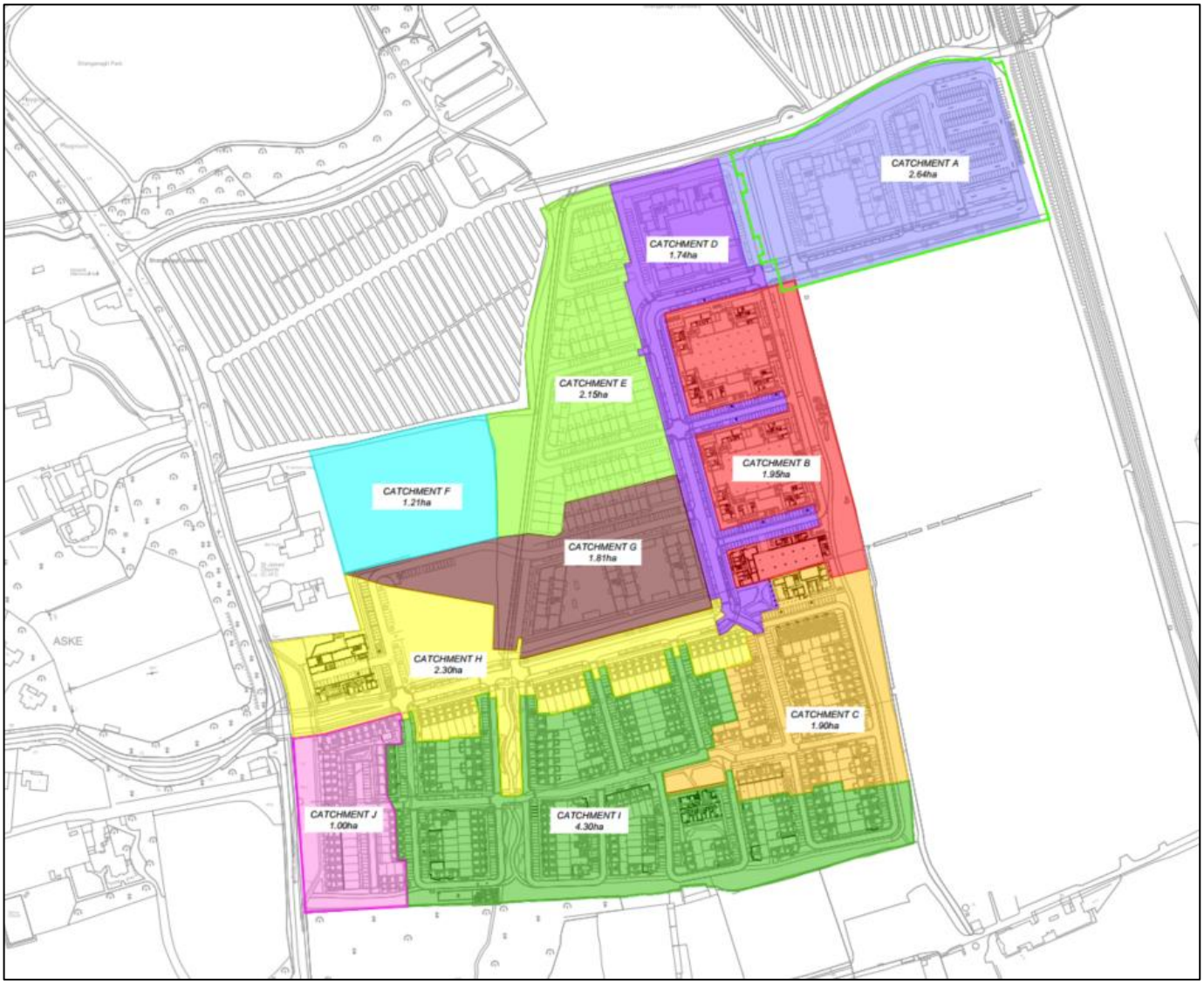


Figure 7-1 - Site Catchment Areas

Based on a maximum allowable Qbar final runoff rate from the site of 56.34l/s (including 10% allowance for climate change & 10% urban creep for 11.44ha and 20% climate change & 10% urban creep for 9.56ha) over a 21ha area, the runoff per hectare has been calculated as 2.68l/s/ha. In the first instance, the maximum discharge rates for each catchment were calculated based on the equivalent runoff per hectare, see Table 7-1 below for a summary of the results.

Two final flow control devices are proposed due to the topography and layout of the site. Attenuated flows from Catchment's A – I will pass through the final flow control device downstream of Catchment I. Catchment J will also have a flow control device to restrict flows before combining with the proposed storm water drainage network exiting the site at the southwestern corner as indicated on the planning drawings 0119017-ATK-ZZ-DR-CE-090503

It is proposed that the final discharge from the overall site will be directly to the Crinkeen / Woodbrook Stream culvert via a new storm water network along the Dublin Road. The outfall will be downstream of flow controls in catchment I and J.

In addition, due to the natural drainage routes, drainage design and catchment configuration within the proposed site, attenuated storm water will travel in a northeast to southwest direction through a series of catchments. Therefore, the initial discharge rates calculated are based on the cumulative value of the upstream discharge rate and the discharge rate for the current catchment, see Table 7-1 below for details.

Table 7-1 - Initial Catchment Area Discharge Rates

Catchment	Area	% of Total Site Area	Maximum Discharge rates per catchment based on Qbar 2.68 l/s/ha	Maximum Cumulative Discharge rates
A	2.64ha	12.6%	7.09l/s	**7.09l/s** (A only)
B	1.95ha	9.3%	5.24l/s	**12.33l/s** (A+B)
C	1.90ha	9.0%	5.09l/s	**17.42l/s** (A+B+C)
D	1.74ha	8.3%	4.67l/s	**4.67l/s** (D only)
E	2.15ha	10.2%	5.77l/s	**5.77l/s** (E only)
F (School Site)	1.21ha	5.7%	3.24l/s	**3.24l/s** (F only)
G	1.81ha	8.6%	4.86l/s	**13.87l/s** (E+F+G)
H	2.30ha	11.0%	6.17l/s	**24.71l/s** (D+E+F+G+H)
I	4.30ha	20.5%	11.53l/s	**53.66l/s** (A+B+C+D+E+F+G+H+I)
J	1.00ha	4.8%	2.68l/s	**2.68l/s** (I only)
Total	**21ha**	**100**	**56.34l/s**	**56.34l/s (Final discharge from site)**

Upon review of the green open space within each catchment it was not possible to attenuate storm water within each of the catchments to achieve the cumulative discharge rates listed in Table 7-1 above. Therefore, catchment discharge rates have been revised to either decrease upstream discharge rates thus reducing the volume of water into the

downstream catchment or by increasing the discharge rates from the current catchment thus increasing attenuation volume being provided downstream.

Changes to catchment flow rates within the site are managed locally and have no effect on the ultimate discharge rate from the entire site which is limited to 56.34l/s, as agreed with DLRCC Municipal services.

Based on attenuation space available throughout the site and ensuring the maximum ultimate discharge rate from the entire site of 56.34l/s is achieved, catchment discharge rates have been revised as per Table 7-2 below.

Table 7-2 - Amended Catchment Areas Discharge Rates

Catchment	Area	% of Total Site Area	Maximum Discharge rates per catchment based on Qbar 2.68 l/s/ha	Maximum Cumulative Discharge rates	Maximum Discharge rates per catchment-based attenuation volume available
A	2.64ha	12.6%	7.09l/s	7.09l/s (A only)	**2.0l/s**
B	1.95ha	9.3%	5.24l/s	12.33l/s (A+B)	**14.2l/s**
C	1.90ha	9.0%	5.09l/s	17.42l/s (A+B+C)	**19l/s**
D	1.74ha	8.3%	4.67l/s	4.67l/s (D only)	**29.0l/s**
E	2.15ha	10.2%	5.77l/s	5.77l/s (E only)	**2.0l/s**
F (School Site)	1.21ha	5.7%	3.24l/s	3.24l/s (F only)	**3.2l/s**
G	1.81ha	8.6%	4.86l/s	13.87l/s (E+F+G)	**13.0l/s**
H	2.30ha	11.0%	6.17l/s	24.71l/s (D+E+F+G+H)	**20.0l/s**
I	4.30ha	20.5%	11.53l/s	53.66l/s (A+B+C+D+E+F+G+H+I)	**53.8l/s**
J	1.00ha	4.8%	2.68l/s	2.68l/s (I only)	**2.5l/s**
Total	21ha	100	56.34l/s	**56.34l/s** (final discharge from site)	**56.3l/s** (final discharge from site)

The total Site Impermeable Areas and reduced Impermeable Areas based on coefficient runoff factors are indicated below in Table 7-3.

Table 7-3 - Site Impermeable Areas

	Total Impermeable Area	Impermeable Area based on co-efficient runoff factors (Table 2-1)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	1.77ha	1.77ha
Roads / Cycle tracks / Footpaths / Roofs when discharging directly, tree pits and filter drains	1.843ha	1.383ha
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	4.807ha	2.887ha
Extensive Green Roof (> 150mm thk.)	2.735ha	2.322ha
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1.044ha	0.732ha
Total	**12.199ha**	**9.094ha**

7.1 Catchment Design Details

It was agreed with DLRCC at pre-planning stage that the catchments submitted as part of the phase 1 application which are constructed on site would not be required to be remodelled as part of this Park Edge development application. It is noted that the entire site had already been made allowance for at the phase 1 application stage.

Based on this agreement, only Catchment B has been included in the hydraulic model as part of this submission including the revised site layout, 20% climate change requirements and 10% urban growth allowance. All other catchments areas including C H, I & J have been agreed in phase 1 and constructed. Catchment F (School Site) does not form part of this application and will therefore be included in a later application.

Attenuation is proposed in each catchment using underground modular attenuation system. Details of attenuation system are indicated on drawing 0119017-ATK-ZZ-XX-DR-CE-903124 & 903125.

A controlled discharge from each catchment will be via a vortex flow control device downstream of the underground modular system. Each flow control devise has been designed based on the maximum head of water within the underground modular attenuation systems. The design head has been calculated for each catchment to ensure the flows rates indicated in Table 7-2 are not exceeded for the 1 in 100-year 6-hour storm event. It is noted that penstock will be installed within the hydro break chambers to allow maintenance when required. Flow control devices will not have bypass doors or high-level overflows as required by DLRCC.

A catch pit manhole will be provided at all inlets to the underground modular attenuation systems to reduce the levels of silts entering the system.

Porous paving provided will cater for runoff from the porous paving surface, adjacent roads / footpaths and roof runoff from the front of residential units. The subbase below the porous paving will allow for infiltration, reduced peak flows

and 30% storage capacity within the subbase voids. An orifice plate / flow control will be used in the outfall chamber from each porous paving area to reduce the flow and increase the overall storage capacity of the subbase.

Tree pits and raingardens will be used at locations as indicated. Runoff from adjacent roads / footpaths and excess runoff from adjoining impermeable surface will discharge into the pit via a dropped kerb. The tree pit will allow for interception and percolation to ground. An overflow pipe with a raised level of 50mm above the finished surface level will allow for overflow into the storm drainage network during high intensity rainfall events. It is noted that tree pit interception volumes have not been included within the interception calculations below however, a minimum interception volume of 0.1m3 will be provided with each tree pit.

Extensive green roofs and Intensive green courtyards will be provided to suitable apartment blocks and retail units. A run-off factor of 85% has been used within the calculations.

7.2 Catchment A – Design Details

The drainage catchments that form part of the proposed Dart Gateway Development planning application will be assessed on the following criteria.

Attenuation is proposed in catchment A using an underground modular attenuation system which is divided into three separate tanks with individual vortex controls of which two tanks fall under this Phase of development. It was determined during modelling of the network that the tanks can be sized according to the volume of drainage received from the adjacent areas. The attenuation volume of the tanks P and Q are 200 m3 each.

The discharge rate from tanks P and Q via a vortex flow control device which continues to discharge at rate of 2.0 l/s and 1.0 l/s via a vortex flow control device for 1 in 100 year 6-hour event including 20% for climate change and 10% urban creep. Modelling of the 1 in 30-year storm for up to 24-hour event confirmed that the attenuation storage volume of 200m3 each provided was also sufficient.

The final discharge rate from catchment A will be 2.0 l/s as indicated in XX which remains unchanged from original phase 1 planning application.

Table 7-4 - Design Summary - Catchment P

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment B1	2 l/s	1.9 l/s	1.9 l/s	200 m3

Table 7-5 - Site Impermeable Areas - Catchment P

	Total Impermeable Area (m2)	**Impermeable Area based on co-efficient runoff factors (**Table 2-1**) (m2)**
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	1,827	1,827
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	370	278
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	4,177	2,506
Extensive Green Roof (> 150mm thk.)	2,350	1,998
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1,012	708
Total	9,736	7,317

Table 7-6 - Interception Volume Requirement - Catchment P

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	0.4177 ha
Volume of Interception Required	4,177 x 0.005 x 0.8 = 17 m3

Table 7-7 - Interception Volume Provided - Catchment P

SuDS	**Volume**
Extensive Green Roof (> 150mm thk.)	2,350m2 x 0.005 = 12m3
Intensive Green Courtyead (landscape courtyard area with soil >500mm thk.)	1,012m2 x 0.005 = 5m3
Permeable paving	450m2 x 0.05 = 23m3 23 x 30% Voids = 7m3
Underground modular attenuation system	8.63(W) x 28(L) = 242m2 0.3(D) x 242m2 = 73m3 73 x 43% Voids = 31m3
Total	55m3 provide > 17m3 required (OK)

Interception Volume will be provided in catchment P using a series of SuDS. The overall volume interception volume provided is 55m3 which is greater than the required 17m3.

Table 7-8 - Design Summary - Catchment Q

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Resulting Maximum Design Flow for 1 in 100 yr	Resulting Maximum Design Flow for 1 in 30 yr	Minimum Tank Volume
Catchment B1	1.2 l/s	1.1 l/s	1.0 l/s	200 m3

Table 7-9 - Site Impermeable Areas - Catchment Q

	Total Impermeable Area (m2)	Impermeable Area based on co-efficient runoff factors (Table 2-1) (m2)
Roads / Cycle tracks / Footpaths / Roofs (when discharging directly to storm drainage network)	3,166	3,166
Roads / Cycle tracks / Footpaths / Roofs when discharging directly swales, tree pits and filter drains	1,584	1,188
Roads / Cycle tracks / Footpaths / Roofs when discharging directly to permeable paving	6,001	3,600
Extensive Green Roof (> 150mm thk.)	2,835	2,027
Intensive Green Courtyard (landscape courtyard areas with soil > 500mm thk.)	1,427	602
Total	15,013	10,583

Table 7-10 - Interception Volume Requirement - Catchment Q

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	0.6001 ha
Volume of Interception Required	6,001 x 0.005 x 0.8 = 24 m3

Table 7-11 - Interception Volume Provided - Catchment Q

SuDS	Volume
Extensive Green Roof (> 150mm thk.)	2,835m2 x 0.005 = 14m3
Intensive Green Courtyead (landscape courtyard area with soil >500mm thk.)	1,427m2 x 0.005 = 7m3
Permeable paving	1,460m2 x 0.05 = 73m3 7 x 30% Voids = 22m3
Underground modular attenuation system	16.80(W) x 15(L) = 252m2 0.3(D) x 252m2 = 76m3 76 x 43% Voids = 33m3
Total	76m3 provide > 24m3 required (OK)

Interception Volume will be provided in catchment Q using a series of SuDS. The overall volume interception volume provided is 76m3 which is greater than the required 24m3.

8. Compliance with GDSDS Design Criteria

Outfall Section 6.3.4 of the GDSDS Volume 2 New Development sets out four design criterion which are required to be met by the proposed drainage system. Compliance with these criteria is outlined below:

8.1 Interception Volume – Criterion 1.1

Interception storage volume is based on 80% runoff from paved areas and 0% runoff from pervious surfaces for the first 5mm of rainfall.

Table 8-1 - Interception Volume

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.03 ha
Volume of Interception Required	10,300x 0.005 x 0.8 = 41m3
Catchment P+Q	55 m3+76m3
Total Provided	131 m3

Interception Volume will be provided in each catchment using a series of SuDS. The overall volume will be greater than the required set out in the GDSDS based on a rainfall rate of 5mm.

- Permeable pavement to parking bays
- Conveyance Swales
- Green roofs (to apartment buildings only)
- Green courtyards (to apartment buildings only)
- Tree pits (along main avenue)
- Underground modular systems (within green open spaces)

The CIRIA report C753 The SuDS Manual-v6 provides guidance that were surface water drains through SuDS systems then interception is deemed to have been provided. In addition to that the stone base within the attenuation systems provided are used as part of the calculations indicated above. On that basis interception provided would be in excess of those volume indicated to be provided above.

8.2 Treatment Volume – Criterion 1.2

Interception storage volume is based on 80% runoff from paved areas and 0% runoff from pervious surfaces for the first 15mm of rainfall.

Table 8-2 - Treatment Volume

	Total Paved Site
Paved surfaces (roads, footpaths, permeable paving & roof areas)	1.03 ha
Volume of Treatment Storage Required	10,300 x 0.015 x 0.8 = 124m3

Due to site constraints including open space set out in the Local Area Plan (LAP) and density requirements there is insufficient space on site to provide the Treatment Volume (retention pond or wetland) and therefore Criterion 1.2 cannot be successfully met for this site.

In accordance with Table 6.3 of the Regional Drainage Policies – Volume 2 New Development, as Criterion 1.1 is being achieved, Criterion 1.2 is not required.

8.3 River Regime Protection – Criterion 2

An allowable overall outflow rate for Qbar of 56.34l/s has been calculated for the site and agreed with DLRCC drainage department as part of the overall Woodbrook Site Development. This flow control has been constructed as part of the Woodbrook phase 1 catchment I and its associated attenuation system. The final discharge rate will remain unchanged as part of this phase 4 planning application.

The overall site attenuation volume is currently calculated to be > 4,377m3 as outlined in the table below which is provided for the appropriate throttle rate.

Table 8-3 - Attenuation Tanks

Catchment Reference	Maximum Design Flow from Vortex Flow Control	Minimum Tank Volume	Excavation Dimensions W x L x D
Catchment A	2.0 l/s	432 m3	Refer to Details Drawing
* Catchment B	14.2 l/s	230 m3	N/A
* Catchment C	17.6 l/s	144 m3	N/A
Catchment D	29.0 l/s	246 m3	N/A
Catchment E	2.0 l/s	704 m3	N/A
* Catchment F (School Site)	3.2 l/s	500 m3	N/A
Catchment G	13.0 l/s	630 m3	N/A
* Catchment H	20.0 l/s	720 m3	N/A
* Catchment I	53.8 l/s	675 m3	N/A
* Catchment J	2.5 l/s	96 m3	N/A
Total	**56.3l/s (final discharge from site)**	****4,377 m3**	

**No proposed changes Catchment attenuation volumes from Woodbrook Phase 1 Planning submission.*

***The volume indicated does not include volume contained in Tanks X, Y and Z as part of the Northern Catchment attenuation.*

8.4 Level of Service – Criterion 3

The four criteria for levels of service are as follows:

- Criterion 3.1: No external flooding (30-year high intensity rainfall event)
- Criterion 3.2: No internal flooding (100-year high intensity rainfall event)
- Criterion 3.3: No internal flooding (100-year river event and critical duration for site storage)
- Criterion 3.4: No flood routing off site except where specifically planned (100-year high intensity rainfall event)

Criteria 3.1, 3.2, 3.3 & 3.4: All potential flooding will be reviewed and modelled using micro drainage for up to the required 1 in 100-year storm event including 20% for climate change and 10% for urban creep. Outputs from the model for the proposed storm network will be provided.

8.5 River Flood Protection – Criterion 4

Of the three methods referred to in the GDSDS for establishing River Flood Protection, by comparison of the pre and post development runoff volumes, (Criteria 4.1, 4.2 and 4.3 respectively), Criteria 4.3 has been selected most suitable for use on this proposed site. An extract from the GDSDS for Criterion 4 is indicated in Figure 8-1 below.

Criterion 4 River flood protection (Criterion 4.1, or 4.2 or 4.3 to be applied)	4.1	100	"Long-term" floodwater accommodated on site for development runoff volume which is in excess of the greenfield runoff volume. Temporary flood storage drained by infiltration on a designated flooding area brought into operation by extreme events only. 100 year, 6 hour duration storm to be used for assessment of the additional volume of runoff.
	4.2	100	Infiltration storage provided equal in volume to "long term" storage. Usually designed to operate for all events. 100year, 6-hour duration storm to be used for assessment of the additional volume of runoff.
	4.3	100	Maximum discharge rate of QBAR or 2 l/s/ha, whichever is the greater, for all attenuation storage where separate "long term" storage cannot be provided.

Figure 8-1 - GDSDS River Flood Protection

Criterion 4.3 has been satisfied for the proposed site by providing an agreed Maximum discharge rate of Qbar (56.3l/s, from entire Woodbrook development site) and on-site attenuation for up to the 1 in 100-year storm event including 20% for climate change and 10% for urban creep.

9. Flooding & Exceedance Flows

9.1 Flood Risk Assessment

A Flood Risk Assessment (FRA) Atkins Document No. 0119017DG0007 has been undertaken for the site to satisfy the requirements of the Planning System and Flood Risk Management Guidelines. The report aimed at scoping sources of flooding, assessing whether any significant flood risk issues exist and proposing appropriate flood risk management measures as required. The flood risk assessment can be considered to satisfy the Stage 1 – Flood Risk identification as set out in The Guidelines. It is considered that this level of assessment is sufficient given the nature of the development and the level of flood risk identified for the site. Therefore, the FRA was not required to progress to Stage 2 & 3.

The FRA conclusion identifies that there is no potential flood risk identified in the vicinity of the proposed residential development site.

9.2 Exceedance Flows

The Surface Water exceedance flows from the site will be considered as part of the drainage design. A modelling exercise was carried out with a 50% blockage within vorterx flow control units at 2 locations. The locations selected are based on importance following a review if the surface water flow paths 0119017-ATK-ZZ-XX-DR-CE-090514.

The table below outlines the catchments and vortex flow controls that had a restriction applied.

Table 9-1 - Exceedance Flows

Catchment	Vortex Flow Control Restriction	Storm Event	Maximum Flood Volume
Catchment A	50% (Attenuation Tank P & Q)	1 in 100-year 6-hour event	No flooding

Catchment A

From a review of the model output no flooding was indicated for the 1 in 100-yr storm event at the vortex flow control manholes. From further investiagetion of the model output data it was determined why no flooding had occurred, it was determined that maximum flow rate design was set to 2 l/s and 1.2 l/s (for tank P & Q under normal conditions) the flow rate only reached 0.9 l/s and 0.6 l/s (for tank P & Q) for the 100 year rainfall event. The restricted flow rate from indicated above has no negative effect on drainage system and no flooding was indicated.

10. SuDS Maintenance

Regular checks and maintenance of the SuDS systems is required and have been considered as part of the overall drainage design for the proposed development. This will ensure both the design life of the SuDS systems, ongoing improved water quality, reduced water runoff and reduce the risk of onsite flooding and exceedance flows. The below guidance is provided by the CIRIA report C753 The SuDS Manual-v6, further guidance should be provided for areas of landscape including tree / shrubs and specialist suppliers for items such as green roofs. The following SuDS systems will be proposed as part of the Woodbrook Park Edge development planning application and therefore the design will consider the following maintenance requirements.

10.1 Permeable Paving

Paving should be inspected regularly, preferable during and after heavy rainfall to ensure effective operation.

Vacuum brushing or jetting of the permeable paving should be carried out once a year. Cleaning is generally carried out after Autumn leaf fall to remove silts and sediments.

10.2 Green Roofs / Green Courtyards

All components (soil substrate, vegetation, drains, membranes and rood structure) should be inspected annually and after severe storms.

Underside of roof should also be inspected annually and after severe storms for evidence of leakage.

Debris, fallen leaves and litter should be regularly removed to prevent clogging of inlet drains.

10.3 Underground Modular Attenuation Systems

Inspection of the system should be carried out monthly for the first 3 months and then annually to ensure the system is working correctly.

Debris should be removed monthly from the catchment surface where may cause risk to the performance of the underground attenuation system.

As required sediment from pre-treatment (catch pit) manholes prior to the attenuation system should be removed to ensure on going performance of the system.

The inside of the tank should be surveyed every 5 years or as required if performance is reduced. Sediment build up removed if necessary.

10.4 Tree Pits / Rain Gardens

Maintenance of trees will be greatest in the first few years, which will include regular inspection of tree condition including inlets and outlets, removal of invasive vegetation and possibly irrigation during long dry periods.

10.5 Filter Drains

Inspection of the system should be carried out monthly on the inlet / outlet pipework and any control systems for blockages.

Inspection of pre-treatment systems including should be carried out every 6 months for catch pits manholes prior to the filter drain with removal of silt or other build-ups. Removal of silt build-up may be required more frequent.

Annual cleaning of roof runoff gutters etc should be part of the generally maintenance of the drainage system to ensure debris is removed prior to entering the network.

Perforated pipework should be cleared of blockage if required.

10.6 Vortex Flow Control Maintenance

The Vortex flow control while not a SuDS system, forms an important part in controlling and restricting the surface water discharge from each catchment within the site and the final discharge from the site.

The Vortex flow control should be inspected monthly for the first three months and following every six months after. If necessary due to sediment build up the flow control should be hosed down and the silt removed from the sump.

The bypass door should also be checked in accordance with the manufacturer's maintenance guidelines and bypass door / rope replaced as required.

11. SuDS Audit Overview

The Stage 1 Surface Water Audit will be completed prior to the lodgement of the final planning application.

APPENDICES

Appendix A. Surface Water Audit

Appendix B. Simulation Criteria

Simulation Criteria for Storm

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

Number of Input Hydrographs	0	Number of Storage Structures	5
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	5	Cv (Summer)	1.000
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.700	Storm Duration (mins)	30
Ratio R	0.269		

Appendix C. Pipeline Schedules

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S3.000	o	225	S300	24.000	22.575	1.200	Open Manhole	1200
S3.001	o	225	S301	23.875	21.908	1.742	Open Manhole	1200
S3.002	o	225	S302	23.500	21.497	1.778	Open Manhole	1200
S4.000	o	150	S306	23.900	22.475	1.275	Open Manhole	1200
S4.001	o	225	S307	24.000	22.034	1.741	Open Manhole	1200
S4.002	o	225	S311	23.500	21.902	1.373	Open Manhole	1200
S4.003	o	225	S55	22.500	21.075	1.200	Open Manhole	1200
S4.004	o	225	S55A	22.650	20.800	1.625	Open Manhole	1200
S3.003	o	225	S58	22.750	20.500	2.025	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S3.000	54.249	150.0	S301	23.875	22.213	1.437	Open Manhole	1200
S3.001	36.994	90.0	S302	23.500	21.497	1.778	Open Manhole	1200
S3.002	57.150	85.0	S58	22.750	20.825	1.700	Open Manhole	1200
S4.000	76.840	38.4	S307	24.000	20.475	3.375	Open Manhole	1200
S4.001	27.749	210.2	S311	23.500	21.902	1.373	Open Manhole	1200
S4.002	84.786	102.5	S55	22.500	21.075	1.200	Open Manhole	1200
S4.003	56.671	160.1	S55A	22.650	20.721	1.704	Open Manhole	1200
S4.004	32.696	160.3	S58	22.750	20.596	1.929	Open Manhole	1200
S3.003	73.170	38.2	S59	22.350	18.584	3.541	Open Manhole	225

Appendix D. Storage Structures

Storage Structures for Storm

Porous Car Park Manhole: S301, DS/PN: S3.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	59.0
Max Percolation (l/s)	90.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	21.908	Membrane Depth (mm)	275

Tank or Pond Manhole: S302, DS/PN: S3.002

TANK P
TOTAL VOLUME 200m3
CATCHMENT A

Invert Level (m) 21.497

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	0.400	200.0	0.800	200.0	1.200	0.0
0.200	200.0	0.600	200.0	1.000	200.0		

Porous Car Park Manhole: S306, DS/PN: S4.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	64.0
Max Percolation (l/s)	97.8	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.475	Membrane Depth (mm)	275

Porous Car Park Manhole: S307, DS/PN: S4.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	60.0
Max Percolation (l/s)	91.7	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.034	Membrane Depth (mm)	275

Tank or Pond Manhole: S311, DS/PN: S4.002

TANK Q
TOTAL VOLUME 200m3
CATCHMENT A

Invert Level (m) 21.902

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	0.400	200.0	0.800	200.0	1.200	0.0
0.200	200.0	0.600	200.0	1.000	200.0		

Appendix E. Online Controls

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S302, DS/PN: S3.002, Volume (m³): 3.7

Tank P
CATCHMENT A

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	21.497
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0
Flush-Flo™	0.296	1.9
Kick-Flo®	0.599	1.6
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.9	1.400	2.3	3.500	3.5	7.500	5.1
0.300	1.9	1.600	2.5	4.000	3.8	8.000	5.2
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.7	5.000	4.2	9.000	5.5
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.7
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.7		

Hydro-Brake® Optimum Manhole: S311, DS/PN: S4.002, Volume (m³): 2.9

Tank Q
CATCHMENT A

Unit Reference	MD-SHE-0051-1200-1000-1200
Design Head (m)	1.000
Design Flow (l/s)	1.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	51
Invert Level (m)	21.902
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Manhole: S311, DS/PN: S4.002, Volume (m³): 2.9

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	1.2
Flush-Flo™	0.228	1.0
Kick-Flo®	0.458	0.8
Mean Flow over Head Range	-	1.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.9	1.200	1.3	3.000	2.0	7.000	2.9
0.200	1.0	1.400	1.4	3.500	2.1	7.500	3.0
0.300	1.0	1.600	1.5	4.000	2.2	8.000	3.1
0.400	0.9	1.800	1.6	4.500	2.4	8.500	3.2
0.500	0.9	2.000	1.6	5.000	2.5	9.000	3.3
0.600	1.0	2.200	1.7	5.500	2.6	9.500	3.4
0.800	1.1	2.400	1.8	6.000	2.7		
1.000	1.2	2.600	1.8	6.500	2.8		

Appendix F. Summary of Results

F.1 Results Status Description

OK when the maximum water level is lower than the pipe's soffit.

SURCHARGED when the maximum water level is above the pipe's soffit and to within 300mm of the manhole cover level. (Allowable for 1 in 30 year storm events and greater in accordance with the GDSDS, refer to table 2-1)

FLOOD RISK when the maximum water level is above the pipe's soffit but below the manhole cover by the depth specified in the Preferences.

FLOOD when the maximum water level is above the manhole cover (No Flooding has been indicated within Summary of Results for up to the 1 in 100 year storm event)

F.2 1 in 100-year Outputs

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

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	5
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.269
Region	Scotland and Ireland	Cv (Summer)	1.000
M5-60 (mm)	16.700	Cv (Winter)	1.000

Cv adjusted to 1.0 in accordance with DLRCC County Development Plan 2022-2028

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	100
Climate Change (%)	30

Allowance for 20% climate change and 10% urban creep in accordance with DLRCC County Development Plan 2022-2028

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S3.000	S300	15 Summer	100	+30%	100/15 Summer				23.126
S3.001	S301	30 Summer	100	+30%	100/15 Summer				22.397
S3.002	S302	960 Summer	100	+30%	100/15 Summer				22.151
S4.000	S306	30 Summer	100	+30%	100/15 Summer				23.074
S4.001	S307	1440 Winter	100	+30%	100/15 Summer				22.803
S4.002	S311	1440 Winter	100	+30%	100/15 Summer				22.800
S4.003	S55	1440 Winter	100	+30%					21.100
S4.004	S55A	1440 Winter	100	+30%					20.825
S3.003	S58	1440 Winter	100	+30%					20.528

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S3.000	S300	0.326	0.000	1.35			55.1	SURCHARGED	
S3.001	S301	0.264	0.000	1.29		5	66.8	SURCHARGED	
S3.002	S302	0.429	0.000	0.04			1.9	SURCHARGED	
S4.000	S306	0.449	0.000	0.61		16	17.4	SURCHARGED	
S4.001	S307	0.544	0.000	0.22		1248	7.4	SURCHARGED	
S4.002	S311	0.673	0.000	0.02			1.1	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S4.003	S55	-0.200	0.000	0.03			1.1	OK	
S4.004	S55A	-0.200	0.000	0.03			1.1	OK	
S3.003	S58	-0.197	0.000	0.04			3.0	OK	

F.3 1 in 30-year Output

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

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	5
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.269
Region	Scotland and Ireland	Cv (Summer)	1.000
M5-60 (mm)	16.700	Cv (Winter)	1.000

Cv adjusted to 1.0 in accordance with DLRCC County Development Plan 2022-2028

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	30
Climate Change (%)	30

Allowance for 20% climate change and 10% urban creep in accordance with DLRCC County Development Plan 2022-2028

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S3.000	S300	15 Summer	30	+30%	30/15 Summer				22.859
S3.001	S301	15 Summer	30	+30%	30/15 Summer				22.272
S3.002	S302	360 Winter	30	+30%	30/30 Summer				21.962
S4.000	S306	30 Summer	30	+30%	30/15 Summer				22.955
S4.001	S307	360 Summer	30	+30%	30/15 Summer				22.505
S4.002	S311	360 Winter	30	+30%	30/30 Summer				22.501
S4.003	S55	360 Winter	30	+30%					21.099
S4.004	S55A	360 Winter	30	+30%					20.824
S3.003	S58	60 Summer	30	+30%					20.528

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S3.000	S300	0.059	0.000	1.07			43.8	SURCHARGED	
S3.001	S301	0.139	0.000	1.16		4	60.3	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S3.002	S302	0.240	0.000	0.04			1.9	SURCHARGED	
S4.000	S306	0.330	0.000	0.59		13	16.6	SURCHARGED	
S4.001	S307	0.246	0.000	0.71			23.6	SURCHARGED	
S4.002	S311	0.374	0.000	0.02			1.0	SURCHARGED	
S4.003	S55	-0.201	0.000	0.03			1.0	OK	
S4.004	S55A	-0.201	0.000	0.03			1.0	OK	
S3.003	S58	-0.197	0.000	0.04			3.0	OK	

Appendix G. Site Investigation Report

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Ground Investigations Ireland

Woodbrook

Ground Investigation Report

DOCUMENT CONTROL SHEET

Project Title	Woodbrook
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GROUND INVESTIGATIONS IRELAND

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CONTENTS

APPENDICES

1.0 Preamble

On the instructions of Atkins Consulting engineers, a site investigation was carried out by Ground Investigations Ireland Ltd., between June and August 2018 at the site of the proposed development in Bray, Co. Dublin.

2.0 Overview

2.1. Background

It is proposed to construct a new residential development with associated services, access roads and car parking at the proposed site. The site is currently greenfield and is situated to the north or Bray town. The proposed construction is envisaged to consist of conventional foundations and pavement make up with some local excavations for services and plant.

2.2. Purpose and Scope

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

- Visit project site to observe existing conditions
- Carry out 12 No. Trial Pits to a maximum depth of 3.0m BGL
- Carry out 6 No. Soakaways to determine a soil infiltration value to BRE digest 365
- Carry out 3 No. Cable Percussion boreholes to a maximum depth of 10.0m BGL
- Installation of 3 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing
- Report with recommendations

3.0 Subsurface Exploration

3.1. General

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

3.2. Trial Pits

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

3.3. Soakaway Testing

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

3.4. Cable Percussion Boreholes

The Cable Percussion Boreholes were drilled using a Dando 2000 drilling rig with regular in-situ testing and sampling undertaken to facilitate the production of geotechnical logs and laboratory testing.
The standard method of boring in soil for site investigation is known as the Cable Percussion method. It consists of using a Shell in non cohesive soils and a clay cutter in cohesive soils, both operated on a wire cable. Very hard soils, boulders and other hard obstructions are broken up by chiselling and the fragments removed with the Shell. Where ground conditions made it necessary, the borehole was lined with 200mm diameter steel casing. While the use of the Cable Percussion method of boring gives the maximum data on soil conditions, some mixing of laminated soil is inevitable. For this reason, thin lenses of granular material may not be noticed. Disturbed samples were taken from the boring tools at suitable depths, so that there is a representative sample at the top of each change in stratum and thereafter at regular intervals down the borehole until the next stratum was encountered. The disturbed samples were then sealed and sent to the laboratory where they were visually examined to confirm the description of the relevant strata.

3.5. Surveying

The exploratory hole locations have been recorded using a Trimble R10 GNSS System which records the coordinates and elevation of the locations to ITM or Irish National Grid as required by the project specification. The coordinates and elevations are provided on the exploratory hole logs in the appendices of this Report.

3.6. Groundwater/Gas Monitoring Installations

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

4.0 Ground Conditions

4.1. General

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

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

- Topsoil
- Granular Deposits
- Cohesive Deposits

TOPSOIL: Topsoil was encountered in all the exploratory holes and was present to a maximum depth of 0.35m BGL.

COHESIVE DEPOSITS: Cohesive deposits were encountered beneath the TOPSOIL and were described typically as *brown sandy gravelly CLAY with occasional cobbles* overlying a *soft to firm greyish brown sandy gravelly CLAY with occasional cobbles*. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the cohesive matrix. These deposits had some, occasional or frequent cobble and boulder content where noted on the exploratory hole logs.

GRANULAR DEPOSITS: The granular deposits were encountered at the base of the cohesive deposits and were typically described as *Greyish brown very sandy slightly clayey sub angular to rounded fine to coarse GRAVEL with occasional cobbles and rare boulders.* The secondary sand/gravel and silt/clay constituents varied across the site and with depth while occasional or frequent cobble and boulder content also present where noted on the exploratory hole logs.

4.2. Groundwater

Groundwater strikes are noted on the exploratory hole logs where they occurred and where possible drilling was suspended for twenty minutes to allow the subsequent rise in groundwater to be recorded. We would

point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the tide, time of year, rainfall, nearby construction and other factors. For this reason, standpipes were installed in BH1A, BH2 and BH3 to allow the equilibrium groundwater level to be determined. The groundwater monitoring is included in Appendix 6 of this Report.

4.3. Soakaway Design

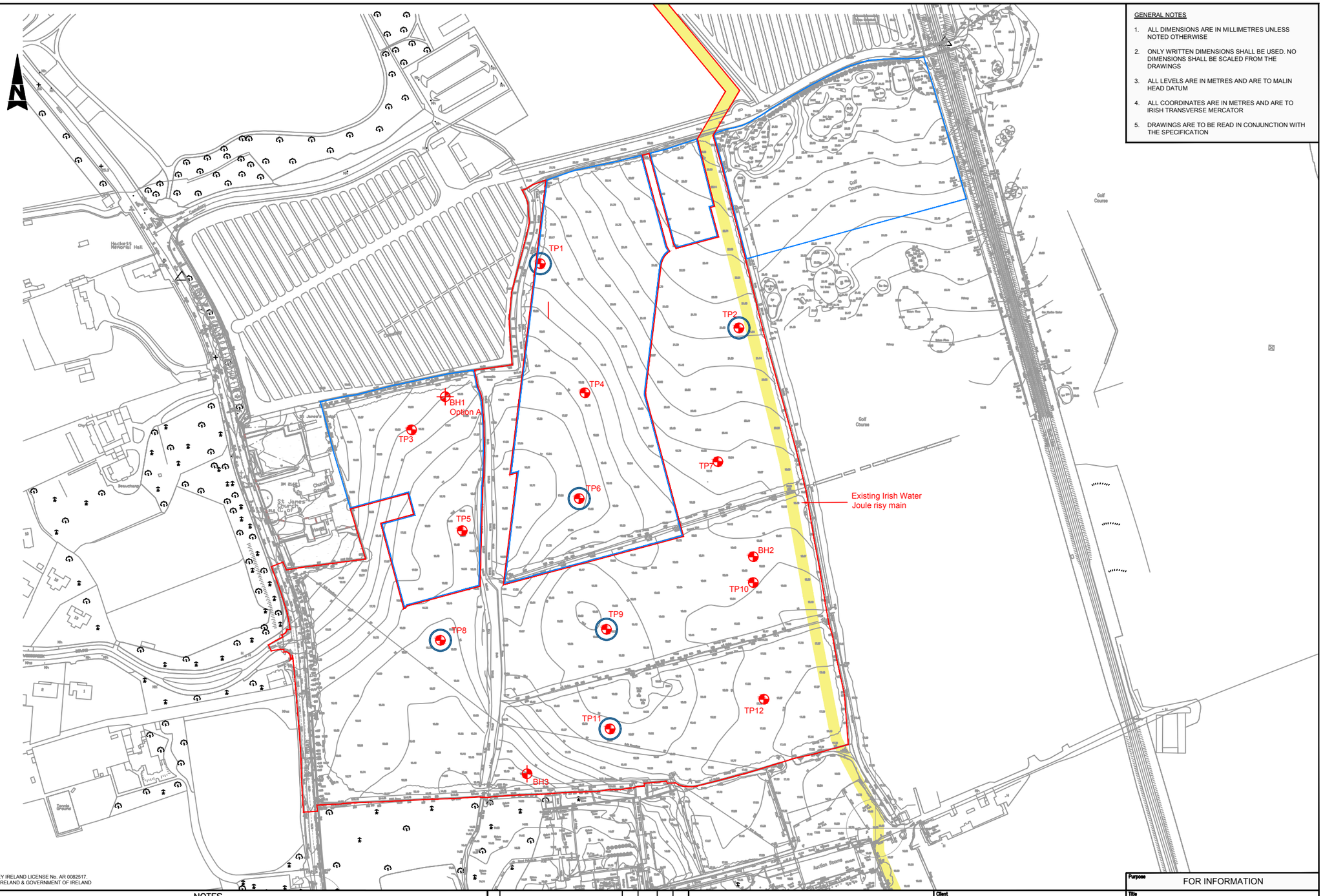
Infiltration rates of 3.137×10^{-6} and 2.298×10^{-6} m/s respectively were calculated for the soakaway locations TP02 and TP06 for the design and construction of soakaways.
At the locations of TP01, TP06, TP09 and TP11 the water level dropped too slowly to allow calculation of 'f' the soil infiltration rate.

APPENDIX 1 - Site Location Plan

A1

0 10 100

DO NOT SCALE



GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

LEGEND

- PERCOLATION TEST IN ACCORDANCE WITH BRE365.
- TRIAL PIT 2.5–3M DEPTH
- (BH1 – BH3) S+A (Cable Percussive)

NOTES

1. PERCOLATION TEST TO BE CARRIED OUT IN ACCORDANCE WITH BRE DIGEST 365 SOAKAWAY DESIGN.
2. TRIAL PIT TO A DEPTH OF 2.5–3M AND TO LOG STRATA CLASSIFICATION INCLUDING DEPTH AND CHANGE IN STRATA.
3. WATER STRIKE DEPTHS.

~ Depth 10m

– all to be committed to groundwater monitoring wells (raised covers)

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Client: AEVAL

Project: WOODBROOK DEVELOPMENT

Purpose: FOR INFORMATION

Title: PROPOSED GROUNDWATER MONITORING WELL

Original Scale	Design/Drawn	Checked	Authorised
NTS	GH	JN	JN
	Date 04/18	Date 04/18	Date 04/18

Status: DR

Drawing Number: 5154251_EWE_SK_0005

Rev:

APPENDIX 2 – Trial Pit Records

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP01
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 2.00	**Ground Level (mOD)** 19.91	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725776.1 E 720639.5 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.35)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				19.56	0.35			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
				19.36	0.55			
					(1.05)	Dark greyish brown sandy slightly clayey subangular to subrounded fine to coarse GRAVEL with occasional subrounded cobbles.		
				18.31	1.60			
					(0.40)	Soft to firm dark greyish brown very sandy slightly gravelly CLAY.		
			Medium Seepage(1) at 1.95m.	17.91	2.00	Trial pit terminated at scheduled depth.		▽1
						Complete at 2.00m		

Plan

Remarks

Groundwater encountered at 1.95m BGL.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP01

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP02
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.50m X 0.70m X 2.00m	**Ground Level (mOD)** 21.71	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725947.4 E 720584.4 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				21.31	0.40			
					(0.60)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				20.71	1.00			
					(1.00)	Brown slightly clayey gravelly fine to coarse SAND with some grey fine sand lenses.		
				19.71	2.00	Trial pit terminated at scheduled depth.		
						Complete at 2.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP02

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Site Woodbrook			**Trial Pit Number** TP03
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.90m X 0.70m X 3.00m	**Ground Level (mOD)** 18.43	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725665.2 E 720495.3 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				18.18	0.25	Firm brown slightly sandy slightly gravelly CLAY		
0.50	B				(0.35)			
				17.83	0.60	Soft to firm greyish brown sandy gravelly CLAY.		
					(0.60)			
				17.23	1.20	Dark greyish brown very gravelly slightly clayey fine to coarse SAND with occasional subrounded cobbles.		
					(0.55)			
				16.68	1.75	Greyish brown very sandy slightly clayey subangular to subrounded fine to coarse GRAVEL with occasional subrounded cobbles.		
2.20	B				(1.25)			
			Slight seepage(1) at 2.50m. Slight seepage(2) at 2.70m. Slow ingress(3) at 3.00m, rose to 2.90m in 20 mins.	15.43	3.00	Complete at 3.00m		▽1 ▽2 ▼3 ▽3

Plan

Remarks

Groundwater encountered at 2.50m, 2.70m and 3.00m BGL.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP03

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Site Woodbrook			**Trial Pit Number** TP04
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.90m X 0.70m X 3.00m	**Ground Level (mOD)** 18.35	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725813.1 E 720528.3 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				18.10	0.25			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				17.90	0.45			
					(0.20)	Brown slightly sandy clayey subangular to subrounded fine to coarse GRAVEL.		
0.65	B			17.70	0.65			
					(0.65)	Dark greyish brown slightly sandy slightly clayey subangular to subrounded fine to coarse GRAVEL.		
1.30	B			17.05	1.30			
					(0.40)	Soft to firm greyish brown sandy gravelly CLAY.		
				16.65	1.70			
					(1.05)	Grey sandy subrounded to rounded fine to coarse GRAVEL.		
				15.60	2.75			
					(0.25)	Grey slightly gravelly slightly silty fine SAND.		
				15.35	3.00	Complete at 3.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP04

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Trial Pit Number** TP05
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.70m X 0.70m X 2.50	**Ground Level (mOD)** 16.39	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725708.8 E 720410.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				15.99	0.40			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
0.50	B			15.79	0.60			
					(0.50)	Brown slightly sandy clayey subangular to rounded fine to coarse GRAVEL with some subrounded cobbles.		
				15.29	1.10			
					(0.40)	Brown gravelly slightly clayey fine to coarse SAND with occasional subangular cobbles.		
				14.89	1.50			
					(0.70)	Dark brown slightly gravelly slightly clayey fine to coarse SAND.		
2.00	B							
				14.19	2.20			
					(0.30)	Brown very sandy slightly clayey subrounded to rounded fine to coarse GRAVEL with occasional subrounded cobbles.		
				13.89	2.50			
						Complete at 2.50m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP05

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Trial Pit Number** TP06
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.30m X 0.70m X 2.00m	**Ground Level (mOD)** 17.43	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725805.4 E 720435.7 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				17.13	0.30	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
					(0.50)			
				16.63	0.80	Soft to firm dark dark brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
					(0.50)			
				16.13	1.30	Soft to firm dark brown slightly sandy gravelly CLAY with some subangular to subrounded cobbles and boulders.		
					(0.50)			
				15.63	1.80	Brown slightly gravelly slightly clayey fine to medium SAND.		
					(0.20)			
				15.43	2.00	Trial pit terminated at scheduled depth.		
						Complete at 2.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP06

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Trial Pit Number** TP07
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 3.40m X 0.70m X 2.50m	**Ground Level (mOD)** 19.90	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725927.9 E 720469.6 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
				19.60	0.30			
					(0.30)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
0.50	B			19.30	0.60			
					(0.60)	Soft to firm dark brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
				18.70	1.20			
					(0.80)	Soft to firm grey mottled brown sandy gravelly CLAY with occasional subangular to subrounded cobbles.		
1.90	B			17.90	2.00			
				17.80	(0.10) 2.10	Brown gravelly slightly clayey fine to coarse SAND with occasional cobbles.		
					(0.40)	Brown very gravelly slightly clayey fine to coarse SAND with occasional cobbles.		
				17.40	2.50	Complete at 2.50m		

Plan

Remarks

No Grounwater encountered.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP07

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP08
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 2.00	**Ground Level (mOD)** 15.81	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725689.9 E 720316.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.35)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				15.46	0.35			
					(0.45)	Firm to stiff brown slightly sandy slightly gravelly CLAY.		
				15.01	0.80			
					(1.00)	Brown very sandy slightly clayey subangular to rounded fine to coarse GRAVEL with some subrounded cobbles.		
				14.01	1.80			
					(0.20)	Soft to firm brown sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				13.81	2.00	Trial pit terminated at scheduled depth.		
						Complete at 2.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP08

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP09
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 1.90m	**Ground Level (mOD)** 19.41	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725832.8 E 720325.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.35)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				19.06	0.35	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
					(0.65)			
1.00	B			18.41	1.00	Soft to firm greyish brown sandy gravelly CLAY.		
					(0.70)			
				17.71	1.70	Soft to firm greyish brown slightly sandy gravelly CLAY.		
1.80	B				(0.20)			
				17.51	1.90	Trial pit terminated at scheduled depth.		
						Complete at 1.90m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP09

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP10
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 2.40m	**Ground Level (mOD)** 18.54	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725957.4 E 720361.8 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
				18.24	0.30			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
0.50	B			18.04	0.50	Soft to firm dark greyish brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
					(1.10)			
1.50	B			16.94	1.60	Greyish brown sandy slightly clayey subrounded to rounded fine to coarse GRAVEL with occasional subrounded cobbles and boulders.		
			Slight seepage(1) at 1.90m.		(0.80)			▽1
			Medium ingress(2) at 2.20m.					▽2
				16.14	2.40	Trial pit terminated due to excessive groundwater.		
						Complete at 2.40m		

Plan

Remarks

Groundwater encountered at 1.90m and 2.20m BGL.
Trial pit side walls spalling.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP10

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Trial Pit Number** TP11
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 1.90m	**Ground Level (mOD)** 18.87	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725836 E 720237.6 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
				18.57	0.30	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
					(0.90)			
1.00	B							
				17.67	1.20	Soft to firm dark brown slightly sandy gravelly CLAY.		
					(0.70)			
1.80	B			16.97	1.90	Trial pit terminated at scheduled depth.		
						Complete at 1.90m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP11

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Trial Pit Number** TP12
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.50m X 0.70m X 2.90m	**Ground Level (mOD)** 17.69	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725968.8 E 720265.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
				17.39	0.30			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles		
				17.19	0.50			
					(0.60)	Soft to firm dark greyish brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles		
1.00	B			16.59	1.10			
					(0.60)	Soft to firm grey mottled brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
			Slight seepage(1) at 1.70m.	15.99	1.70			▽1
2.00	B				(0.60)	Greyish brown gravelly slightly clayey SAND.		
			Slow ingress(2) at 2.40m.	15.39	2.30			▽2
					(0.60)	Grey very sandy slightly clayey subangular to rounded fine to coarse GRAVEL.		
				14.79	2.90			
						Complete at 2.90m		

Plan

Remarks

Grounwater encountered at 1.70m and 2.40m.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP12

Woodbrook, Bray - Trial Pit Photographs

TP01

TP02

TP02

TP03

TP03

TP04

TP04

TP05

TP05

TP06

TP06

TP07

TP07

TP08

TP08

TP09

TP09

TP10

TP10

TP11

TP11

TP12

TP12

APPENDIX 3 – Cable Percussion Borehole Records

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Borehole Number** BH01
Machine : Dando2000 **Method :** Cable Percussion	**Casing Diameter** 200mm to 5.00m	**Ground Level (mOD)** 18.95	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725691.3 E 720522.8 N	**Dates** 27/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
					18.65	0.30	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
1.00	B					(1.40)			
					17.25	1.70	Brown slightly sandy very gravelly CLAY with occasional subrounded cobbles.		
2.00	B					(1.30)			▼1
3.00	B			Water strike(1) at 3.10m, rose to 2.40m in 20 mins, sealed at 3.60m.	15.95	3.00	Brown slightly sandy slightly gravelly CLAY.		▽1
4.00	B					(2.00)			
5.00	B				13.95	5.00	End of Borehole.		
							Complete at 5.00m		

Remarks
Groundwater encountered at 3.10m BGL.
Standpipe installed, borehole backfilled to 3.40m with bentonite ,slotted standpipe installed from 3.40m to 1.90m with a gravel filter, sealed standpipe from 1.90m to ground level with a raised cover.

Scale (approx)	Logged By
1:50	Tmcl

Figure No. 7757-05-18.BH01

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Borehole Number** BH02
Machine : Dando2000 **Method :** Cable Percussion	**Casing Diameter**	**Ground Level (mOD)** 19.16	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725957.9 E 720383.4 N	**Dates** 28/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					18.76	0.40	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
1.00	B					(1.00)			
					17.76	1.40	Brown slightly sandy gravelly CLAY with occasional subrounded cobbles and boulders.		
2.00	B					(1.60)			
3.00	B				16.16	3.00	Brown slightly sandy very gravelly CLAY with occasional cobbles.		▼1
						(1.00)			
4.00	B			Water strike(1) at 3.98m, rose to 3.50m in 20 mins, sealed at 2.40m.	15.16	4.00	Brown slightly sandy slightly gravelly CLAY.		▽1
						(1.00)			
5.00	B				14.16	5.00	End of Borehole.		
							Complete at 5.00m		

Remarks
Grounwater encountered at 3.98m BGL.
Stanpipe installed, slotted stanpipe installed from 5.0m to 3.50m with a gravel filter, sealed from 3.50m to ground level with a raised cover.

Scale (approx)	Logged By
1:50	Tmcl

Figure No. 7757-05-18.BH02

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Borehole Number** BH03
Machine : Dando2000 **Method :** Cable Percussion	**Casing Diameter**	**Ground Level (mOD)** 15.90	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725764.2 E 720201.8 N	**Dates** 29/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
					15.50	0.40	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
1.00	B					(0.80)			
					14.70	1.20	Brown slightly sandy very gravelly CLAY with occasional subrounded cobbles.		
2.00	B					(0.80)			
					13.90	2.00	Brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
3.00	B					(1.00)			
					12.90	3.00	Greyish brown sandy slightly clayey subangular to rounded fine to coarse GRAVEL.		
4.00	B					(1.00)			
					11.90	4.00	Brown sandy slightly gravelly CLAY with occasional lenses of fine to coarse sand.		▼1
5.00	B			Water strike(1) at 5.00m, rose to 4.40m in 20 mins.		(1.00)			
					10.90	5.00	End of Borehole.		▽1
							Complete at 5.00m		

Remarks
Groundwater encountered at 5.0m BGL.
Standpipe installed, slotted from 5.0m to 3.5m with a gravel filter, sealed from 3.50m to ground level with a rasied cover

Scale (approx)	Logged By
1:50	Tmcl

Figure No. 7757-05-18.BH03

APPENDIX 4 – Groundwater Monitoring

Ground Investigations Ireland Ltd.,
Catherinestown House,
Hazelhatch Road,
Newcastle, Co Dublin.
Tel: 01 601 5175 / 5176 | Fax: 01 601 5173
Email: info@gii.ie | Web: gii.ie

GROUNDWATER MONITORING

Woodbrook

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
BH1	16/07/2018	17.00	2.18	Depths from Ground level
BH2	16/07/2018	17.05	2.37	
BH3	16/07/2018	17.15	4.55	

Ground Investigations Ireland Ltd.,
Catherinestown House,
Hazelhatch Road,
Newcastle, Co Dublin.
Tel: 01 601 5175 / 5176 | Fax: 01 601 5173
Email: info@gii.ie | Web: gii.ie

GROUNDWATER MONITORING

Woodbrook Bray

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
BH1	16/08/2918	12:02:00	2.28m	
BH2	16/08/2018	12:11:00	3.32m	
BH3	16/08/2918	12:25:00	5.00m	No Water

Ground Investigations Ireland Ltd.,
Catherinestown House,
Hazelhatch Road,
Newcastle, Co Dublin.
Tel: 01 601 5175 / 5176 | Fax: 01 601 5173
Email: info@gii.ie | Web: gii.ie

GROUNDWATER MONITORING

Woodbrook

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
				Depths from Ground level
BH1	13/09/2018	11.14	2.36	
BH2	13/09/2018	11.21	3.08	
BH3	13/09/2018	11.27	5.00	No Groundwater

APPENDIX 5 – Soakaway Results

TP02

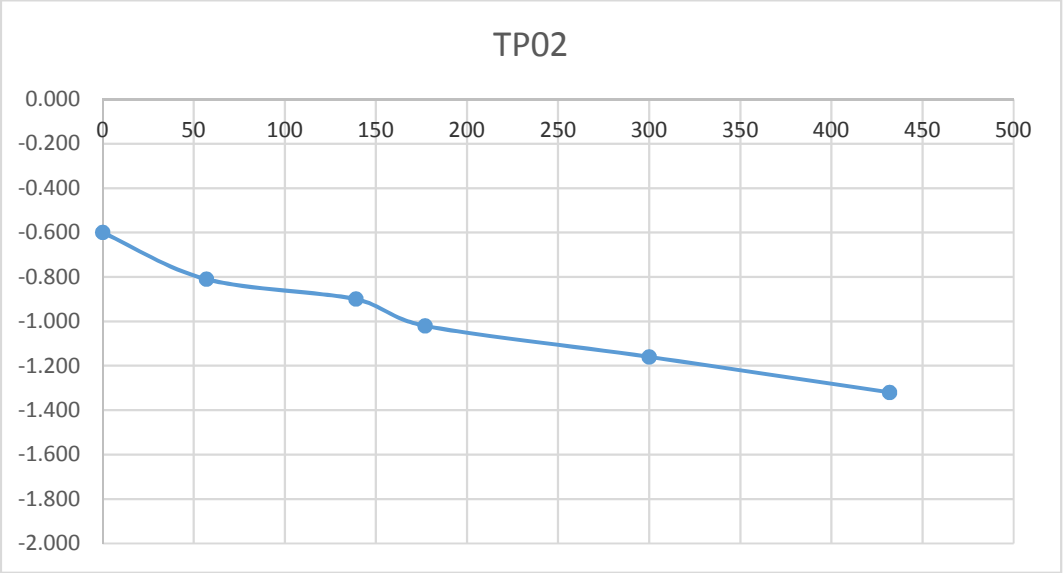
Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.50m x 0.70m 2.00m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.600
14/09/2016	57	-0.810
14/09/2016	139	-0.900
14/09/2016	177	-1.020
14/09/2016	300	-1.160
14/09/2016	432	-1.320

Start depth	Depth of Pit		Diff	75% full	25%full
0.60	**2.000**		**1.400**	**0.95**	**1.65**

Length of pit (m)	Width of pit (m)		75-25Ht (m)	Vp75-25 (m3)
2.500	0.700		0.700	1.23
Tp75-25 (from graph) (s)		**62686**	50% Eff Depth	ap50 (m2)
			0.700	6.23

f = 3.137E-06 m/s

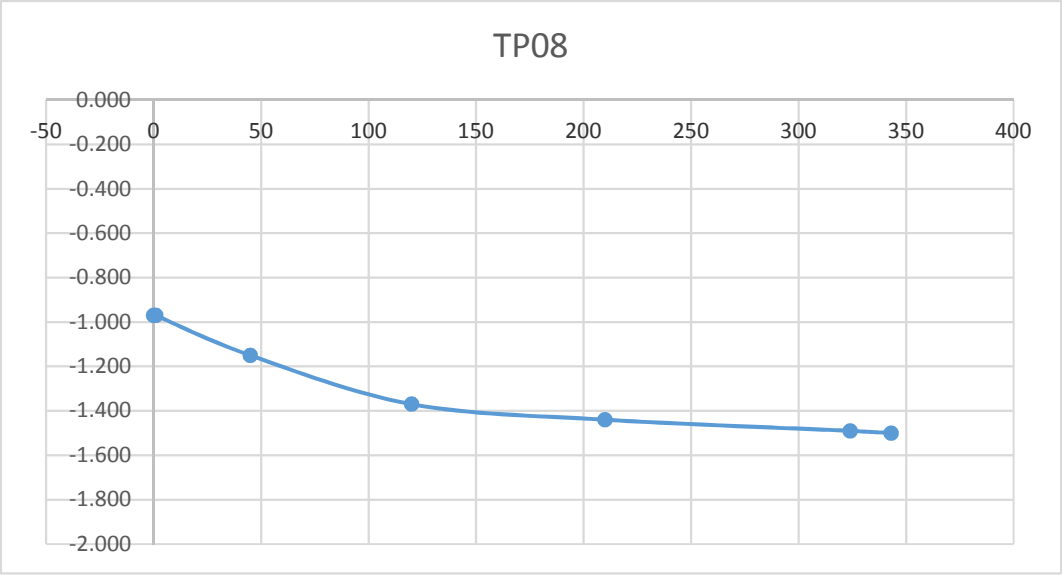


TP08

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.40m x 0.70m 2.00m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.970
14/09/2016	1	-0.970
14/09/2016	45	-1.150
14/09/2016	120	-1.370
14/09/2016	210	-1.440
14/09/2016	324	-1.490
14/09/2016	343	-1.500

Start depth	Depth of Pit		Diff	75% full	25%full
0.97	**2.000**		**1.030**	**1.2275**	**1.7425**
Length of pit (m)	Width of pit (m)			75-25Ht (m)	Vp75-25 (m3)
2.400	0.700			0.515	0.87
Tp75-25 (from graph) (s)		**77250**		50% Eff Depth	ap50 (m2)
				0.515	4.873
f =	**2.298E-06**	**m/s**			



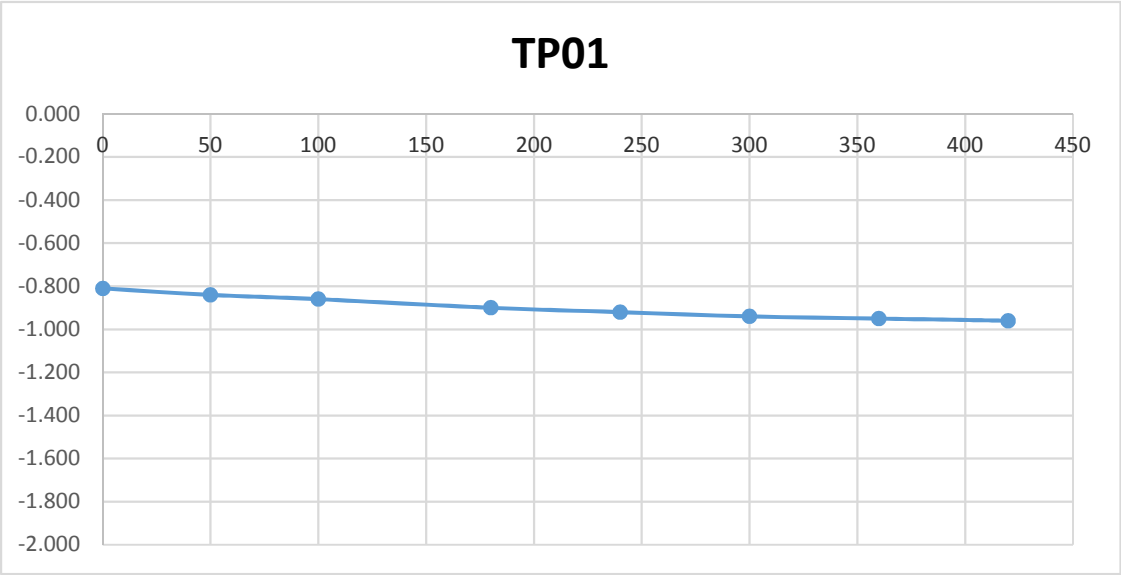
TP01

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.40m x 0.70m 2.0m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.810
14/09/2016	50	-0.840
14/09/2016	100	-0.860
14/09/2016	180	-0.900
14/09/2016	240	-0.920
14/09/2016	300	-0.940
14/09/2016	360	-0.950
14/09/2016	420	-0.960

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.81	2.000	1.190	1.1075	1.7025



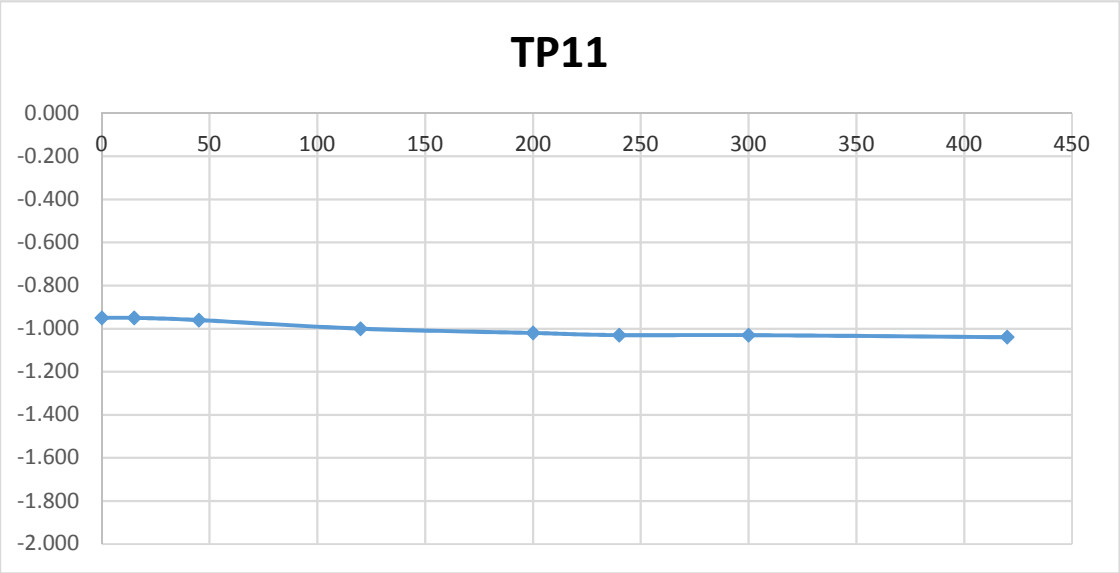
TP11

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.4m x 0.70m 1.9m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.950
14/09/2016	15	-0.950
14/09/2016	45	-0.960
14/09/2016	120	-1.000
14/09/2016	200	-1.020
14/09/2016	240	-1.030
14/09/2016	300	-1.030
14/09/2016	420	-1.040

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.95	1.900	0.950	1.1875	1.6625



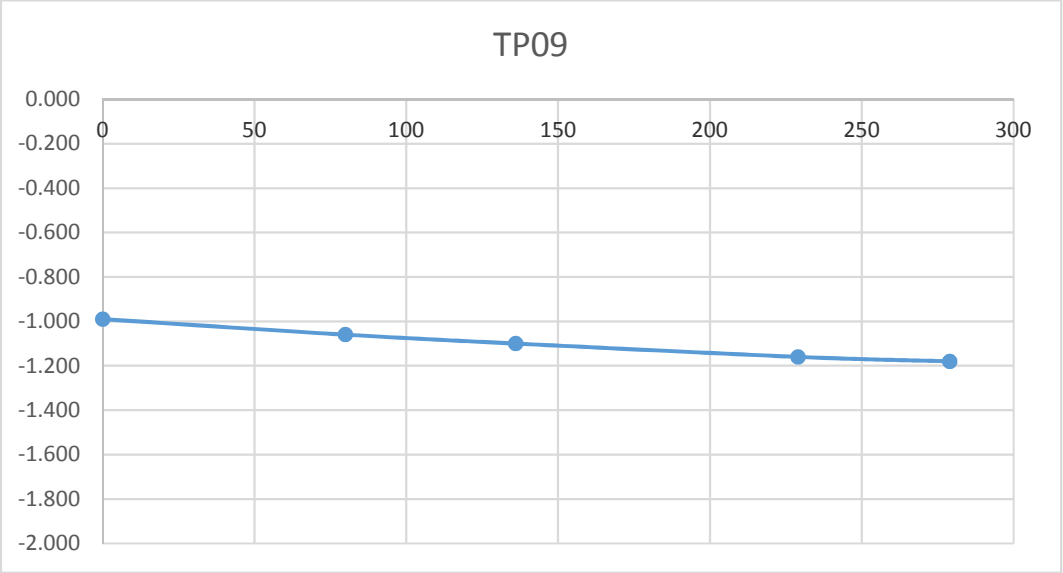
TP09

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 12.40m x 0.70m 1.90m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.990
14/09/2016	80	-1.060
14/09/2016	136	-1.100
14/09/2016	229	-1.160
14/09/2016	279	-1.180

*Soakaway failed - Pit backfilled

Start depth	Depth of Pit	Diff	75% full	25%full
0.99	1.900	0.910	1.2175	1.6725



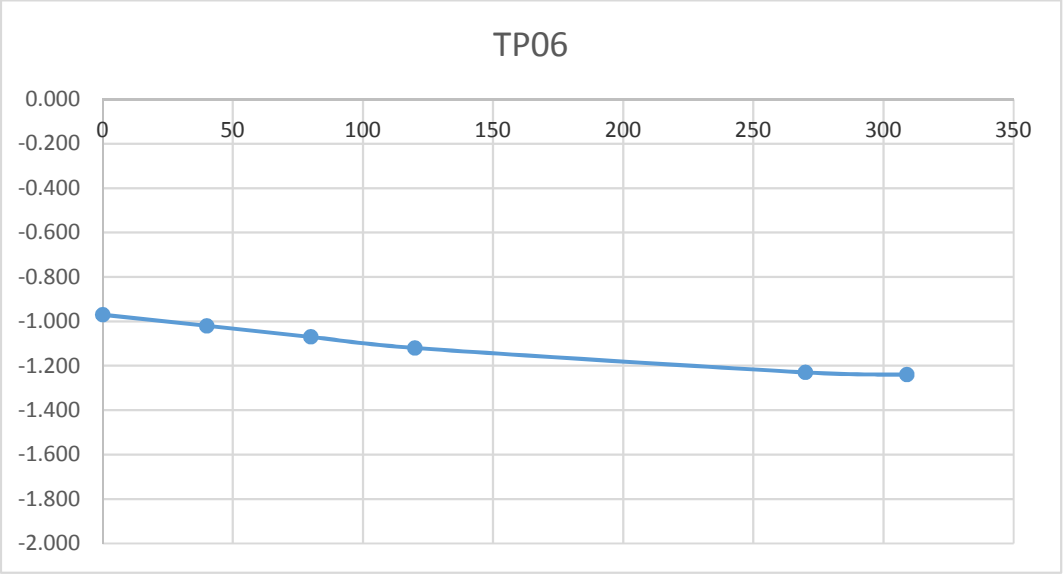
TP06

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.30m x 0.70m 2.00m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.970
14/09/2016	40	-1.020
14/09/2016	80	-1.070
14/09/2016	120	-1.120
14/09/2016	270	-1.230
14/09/2016	309	-1.240

*Soakaway failed - Pit backfilled

Start depth	Depth of Pit	Diff	75% full	25%full
0.97	2.000	1.030	1.2275	1.7425



Appendix H. Hydrogeologist Technical Note

Technical Note

Project:	Woodbrook Proposed Strategic Housing Development		
Subject:	Technical Response to DLRCC Drainage Queries		
Author:	Deirdre Larkin & Garry Hanratty	Atkins No.:	5154251DG0010 Rev2
Date:	13/04/2019	Icepac No.:	N/A
		Project No.:	5154251
Distribution:	Drainage Department	Representing:	DLRCC

Atkins have prepared this technical note on behalf of Aeval in relation to a proposed residential development on existing greenfield lands and a golf course, located at Woodbrook, Co. Dublin (hereafter referred to as the Site). The purpose of this technical assessment is to address queries raised by Dún Laoghaire–Rathdown County Council (DLRCC) in relation to the existing Site drainage system, and shallow groundwater flow paths in the vicinity of an existing onsite drainage ditch.

Specifically, DLRCC have requested a response to the following;

1. Confirmation that the existing onsite drainage ditch is a field ditch and not a stream or river (as discussed during a pre-application meeting with DLRCC); and,

2. A request that '*the applicant …be required to undertake further investigations to determine the (underground?) flowpaths of the outflow from the existing watercourse / ditch which terminates near the proposed school site. The proximity and possible flow interaction of the proposed attenuation tanks nos. 4 and 5 in Zone B with the above mentioned watercourse / ditch needs further examination'* (Item no. 25, pg 34 of DLRCC Report File Ref: SHD/PAC/86/18).

This detailed technical response has been prepared based on the following scope of works;

- Review of all available desk-based information, including historic mapping and aerial photography;
- Site walkover survey undertaken by an experienced Hydrogeologist on 12th June and 18th September 2018;
- Groundwater investigation works undertaken by Ground Investigations Ltd. between 13th to 15th June 2018;
- Baseline groundwater level monitoring carried out between 16th June to 13th September 2018; and,
- A Hydrological and Hydrogeological Impact Assessment completed by Atkins (2019).

This assessment should be read in conjunction with the following documents;

- Atkins Stage 1 Flood Risk Assessment
- Atkins Stormwater Impact Assessment Report
- Atkins Environmental Impact Assessment Report (EIAR) – Chapter 5: Water Impact Assessment

Response to Query Item No. 1:
Characterisation of the onsite Drainage Feature

Desk-based Review

The subject existing field drain indicated in Figure 1 traversing the Site from North to South has a long-established existence and function in draining the fields down to the local watercourse outside of the proposed Woodbrook Development. Topographic levels across the Site have been mapped, and likely overland storm water flow paths have been evaluated for the current baseline setting, as presented in Figure 1. It should be noted that green colours denote higher Site levels, red colours denote lower Site levels, and the black arrows denote likely natural water flow paths within the overall Site.

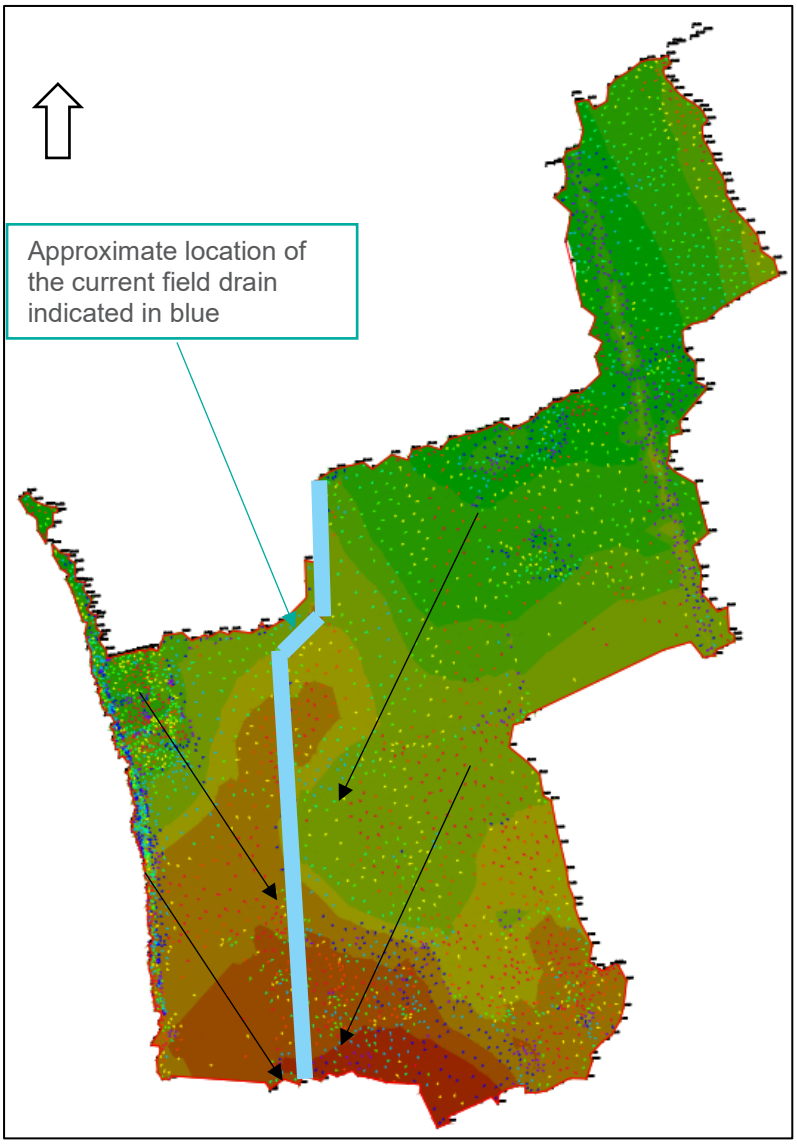


Figure 1 - Site Topography Heat Map

A review of Historical Ordinance Survey Ireland information (www.osi.ie) was then carried out to determine if the OSI 6 inch Maps indicated historic water courses / surface water features within the Site. The image below does not indicate any record of a water course onsite.

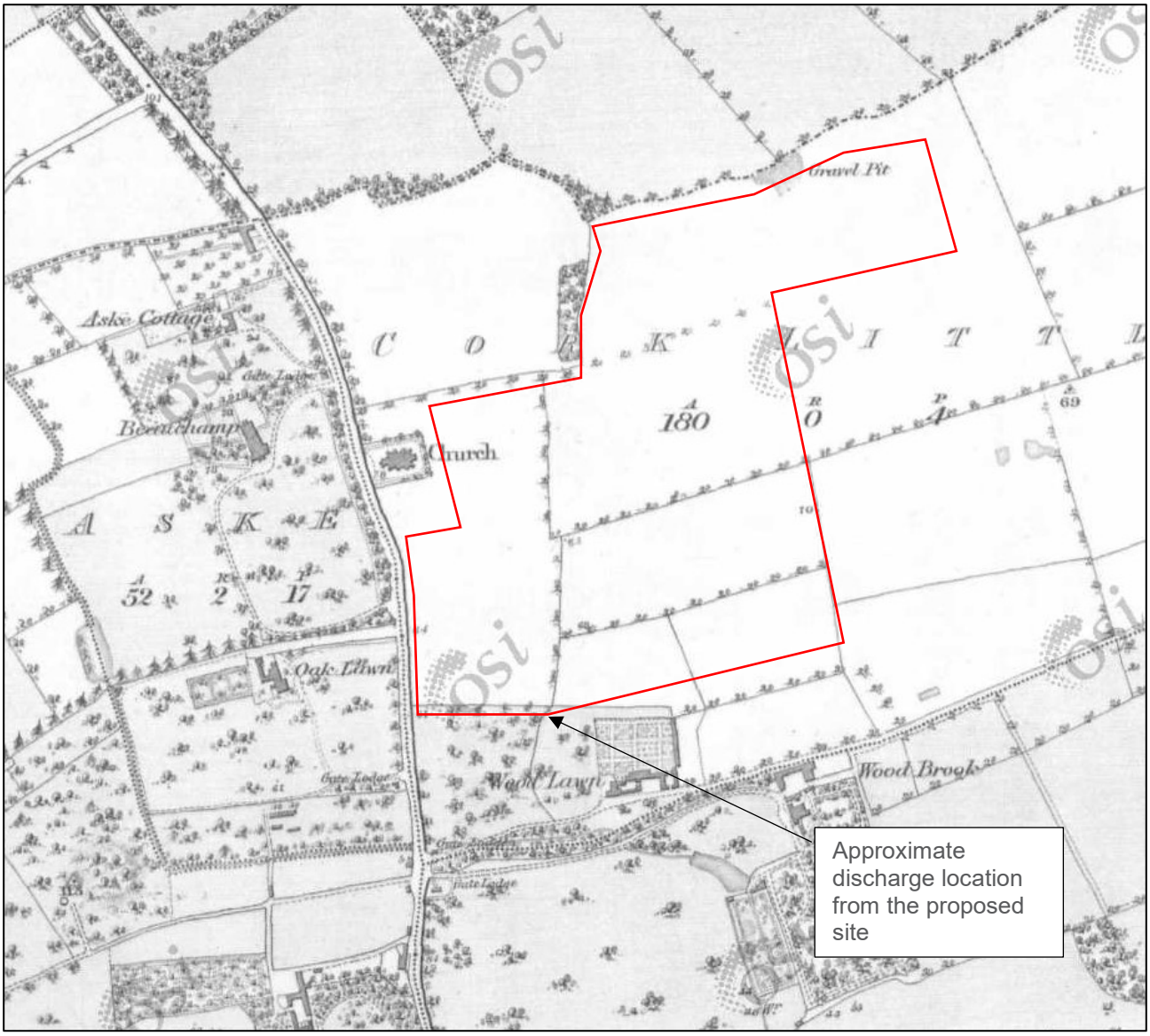


Figure 2 - OSI 6 Inch Colour Map

A review of the OPW CFRAM study Flood Maps (www.floodinfo.ie) was carried out to determine if the onsite field drain / water course formed part of the study. The CFRAM Flood Maps do not indicate flooding for 1 in 10, 1 in 100 or 1 in 1000-year flood events. It is noted that no part of the proposed Site formed part of the CFRAM study, as clearly presented in Figure 3.

Figure 3 - CFRAM Flood Study Map

A review of the EPA Maps (www.epa.ie) was also carried out to determine if the onsite field drain / water course is indicated as part of the river features water networks. The maps name the Rathmichael river to the south of the Site to which the existing Woodbrook lands drain into. However, the EPA mapping resource does not identify any water features within the existing Site. Refer to Figure 4.

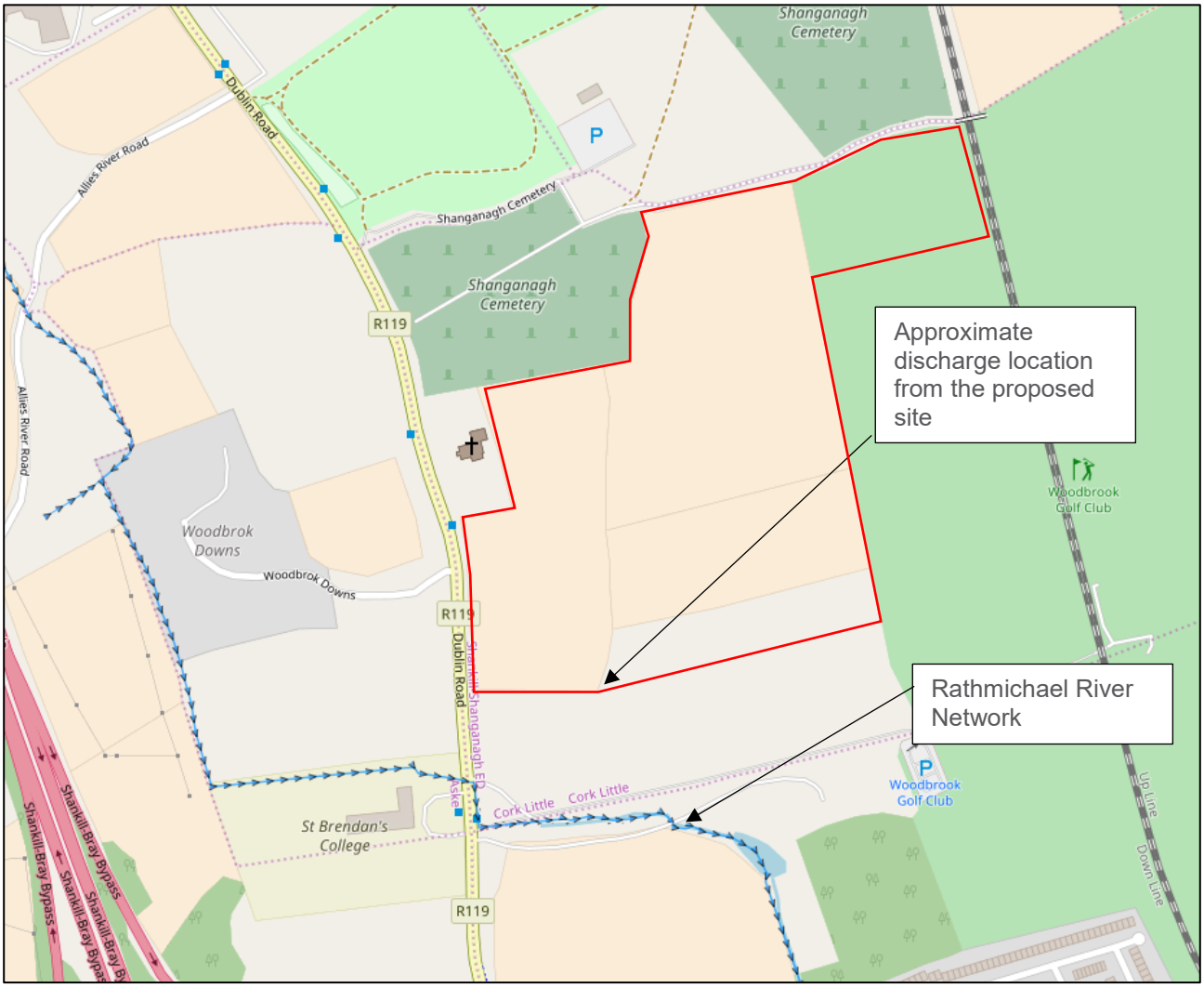


Figure 4 – EPA Mapping

A review of the Woodbrook-Shanganagh Local Area Plan (LAP) 2017-2023 Strategic Flood Risk Assessment (SFRA) was carried out to determine if the onsite field drain / water course is indicated as part the LAP SFRA that was prepared and informed having regard to '*The Planning System and Flood Risk Management Guidelines for Planning Authorities'*. However, the Woodbrook-Shanganagh LAP 2017-2023 SFRA does not indicate any existing water features within the zoned lands of the Site. Refer to Figure 5.

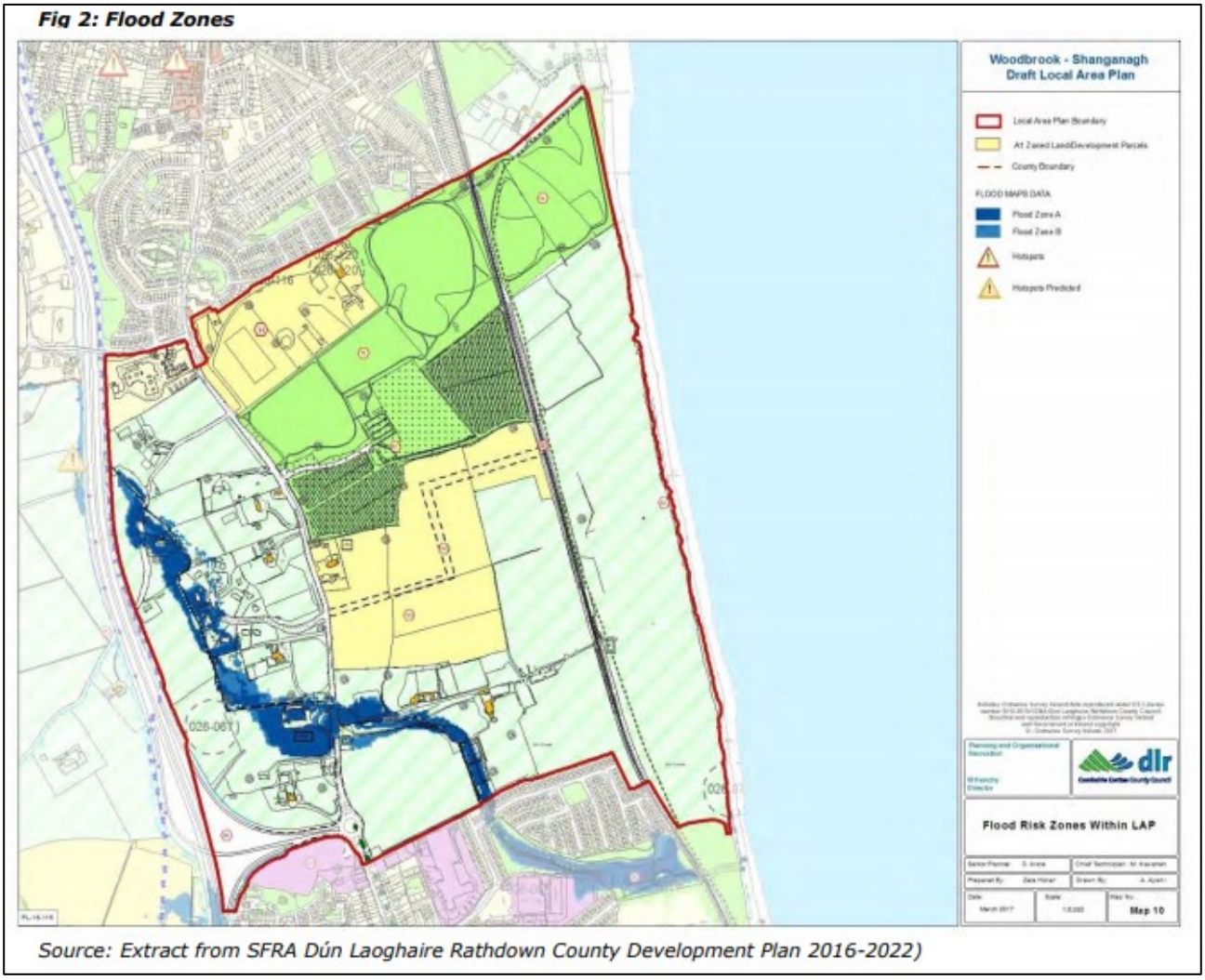


Figure 5 – Woodbrook-Shanganagh LAP 2017-2023: Flood Risk Zones Map

Site Walkover Survey

In order to verify the desk-based review, a Site walkover survey was conducted by an experienced Atkins Hydrogeologist on two separate occasions (26th June 2018 and 18th September). The onsite field drain / water course transecting the Site was visually checked at all accessible locations. No flowing or standing water was encountered during the survey. Based on the geology of the exposed open channel, the orientation of the channel, and existing land use, it is considered that this feature is a manmade field / drainage ditch.

Conclusion

Having reviewed all available desk-based information, including historic mapping and aerial photography, and based on the observations of an experienced Hydrogeologist during a walkover survey of the Site, it is concluded that this drainage feature is a field ditch. Furthermore there is no evidence that this drainage feature was historically a stream or a river.

Response to Query Item No. 2:
Investigation to Determine Groundwater Flow paths in the vicinity of Proposed Attenuation Tanks nos. 4 and 5 in Zone B, and Potential Impacts

(Note; Tanks 4 & 5 are now referred to as Tanks E and G within the final submitted design report)

Groundwater Investigation to Determine Groundwater Flow paths

Groundwater investigation works were undertaken by Ground Investigations Ireland Ltd. (GIIL) between 27th June and 29th June 2018, and are summarised as follows;

- 3no. boreholes were drilled to a target depth using a Dando 2000 drilling rig; each borehole was then converted to a groundwater monitoring well and screened across the shallow groundwater zone (within saturated subsoils generally gravel / sandy gravelly clay).
- All drilling and installation works were supervised full-time by a Hydrogeologist, who also designed each well installation based on encountered Site conditions at each location.
- Wells were positioned in order to obtain representative baseline data, taking account of the topography of the Site (and therefore likely groundwater flow direction), and adjacent land-uses (which may potentially impact groundwater quality beneath the site).
- One offsite borehole (BH1) was located upgradient of the site, while two boreholes (BH2, BH3) were located onsite, in the eastern and southern portions respectively.
- All wells were screened within the shallow groundwater zone (within saturated subsoils i.e. gravel / sandy gravelly clay).
- All onsite drainage ditches were observed to be dry during both Site walkover surveys carried out by Atkins on 26th June and 18th September.
- Baseline groundwater level monitoring was carried out by GIIL between 16th July and 13th September at groundwater monitoring wells BH1 to BH3.

The following key findings arising from the groundwater investigation were made;

- The results of the groundwater level monitoring programme, undertaken by GIIL over a three-month monitoring period, are presented in Table 1. Shallow groundwater levels ranged from 2.18 meters below ground level (mbgl) (BH1) to >5.00m (BH3) during this period.

Monitoring Location	16th July 2018		19th August 2018		13th September 2018	
	Water Level (mbgl)*	Water Level (mOD)**	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)
BH1	2.18	16.77	2.28	16.67	2.36	16.59
BH2	2.37	16.79	3.32	15.84	3.08	16.08
BH3	4.55	11.35	Assumed Dry	-	Assumed Dry	-

**mbgl denotes meters below ground level, ** mOD denotes meters above Ordnance Datum*

Table 1 - Measured Groundwater Levels (July 2018 to September 2018).

- Shallow groundwater flow is expected to be a subdued reflection of the topography of the Site (refer to Figure 1). Therefore based on topographic levels shallow groundwater from the western portion of the Site will flow in a south-easterly direction. Shallow groundwater from the eastern portion of the Site will flow in a south-westerly direction.
- This is confirmed by site-specific groundwater level monitoring data which verifies that groundwater flow beneath the Site is towards the field ditch. Refer to Figure 6.
- Locally shallow groundwater is likely to discharge to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the Site.

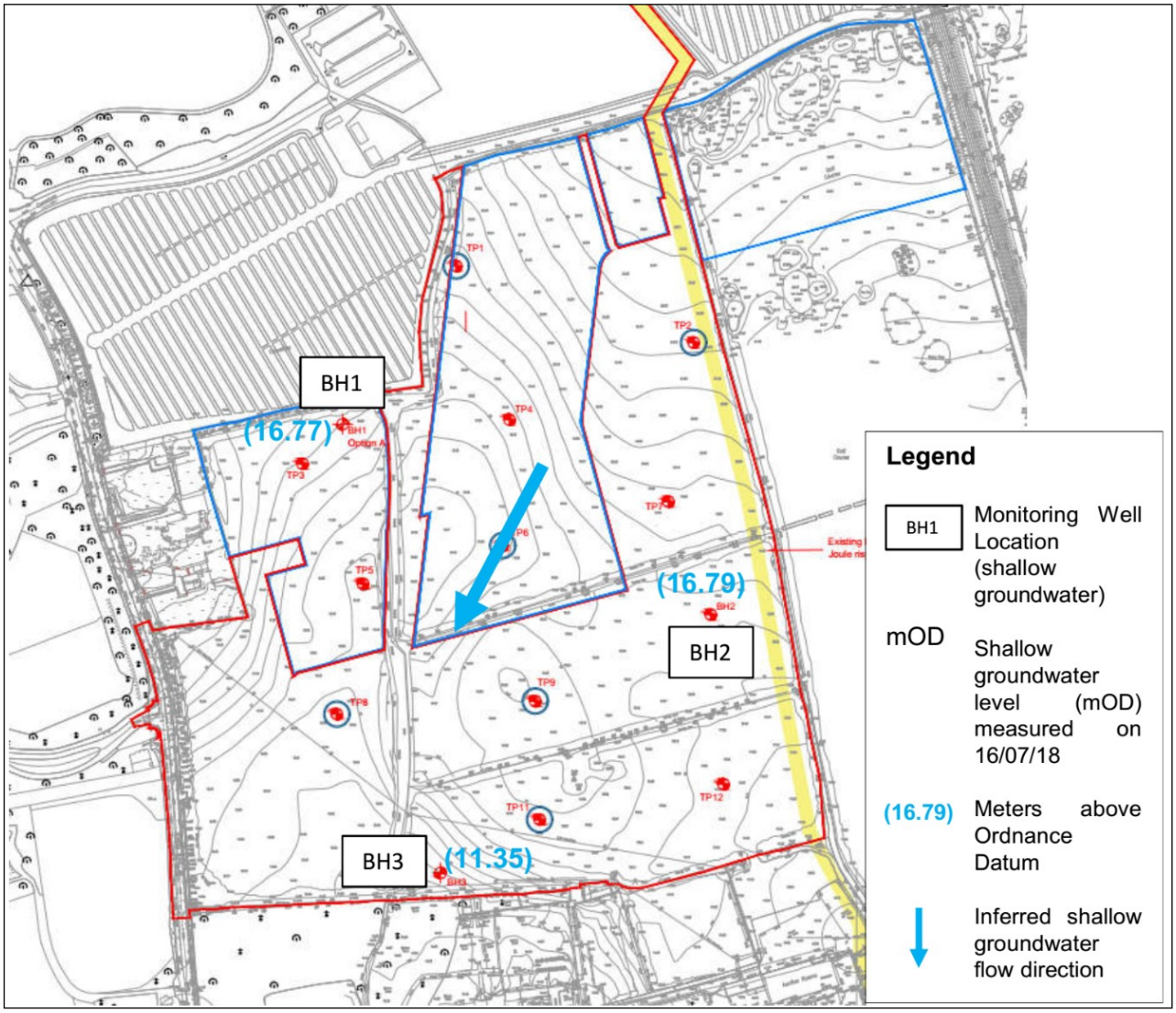


Figure 6 - Piezometric Map Showing Shallow Groundwater Monitoring Locations and Inferred Shallow Groundwater Flow Direction. *(Note shallow groundwater flow confirmed to follow topography as presented in Figure 1).*

Current Hydrogeological Conceptual Site Model – Zone B

Based on the findings of the Groundwater Investigation the following Hydrogeological Conceptual Site Model (CSM) has been derived for the Site;

- Existing rainfall recharge occurs across the greenfield site;
- Recharge is partitioned between overland flow (which discharges to the field ditch north of Zone B), and discharge to ground (via. layers and lenses of sand and gravel, encountered beneath the site). The field ditch north of Zone B also discharges to ground in the vicinity of Zone B, as observed during a number of Site walkover surveys carried out by Atkins Engineers
- Based on groundwater piezometry mapping, shallow water levels specifically in the vicinity of Zone B are estimated to range from approximately 2.0 to 3.5m below ground level (mbgl).
- Shallow groundwater flow will likely follow the topographic contours of the site, towards the field ditch in Zone B; albeit based on site specific data, as evidenced in Figure 7 (a) and (b), this ditch is not groundwater fed. Shallow groundwater flows beneath the ditch, and follows the topography of the site. Shallow groundwater from the western portion of the Site flows in

a south-easterly direction, and from the eastern portion of the Site flows in a south-westerly direction.

- Locally shallow groundwater discharges to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the Site.

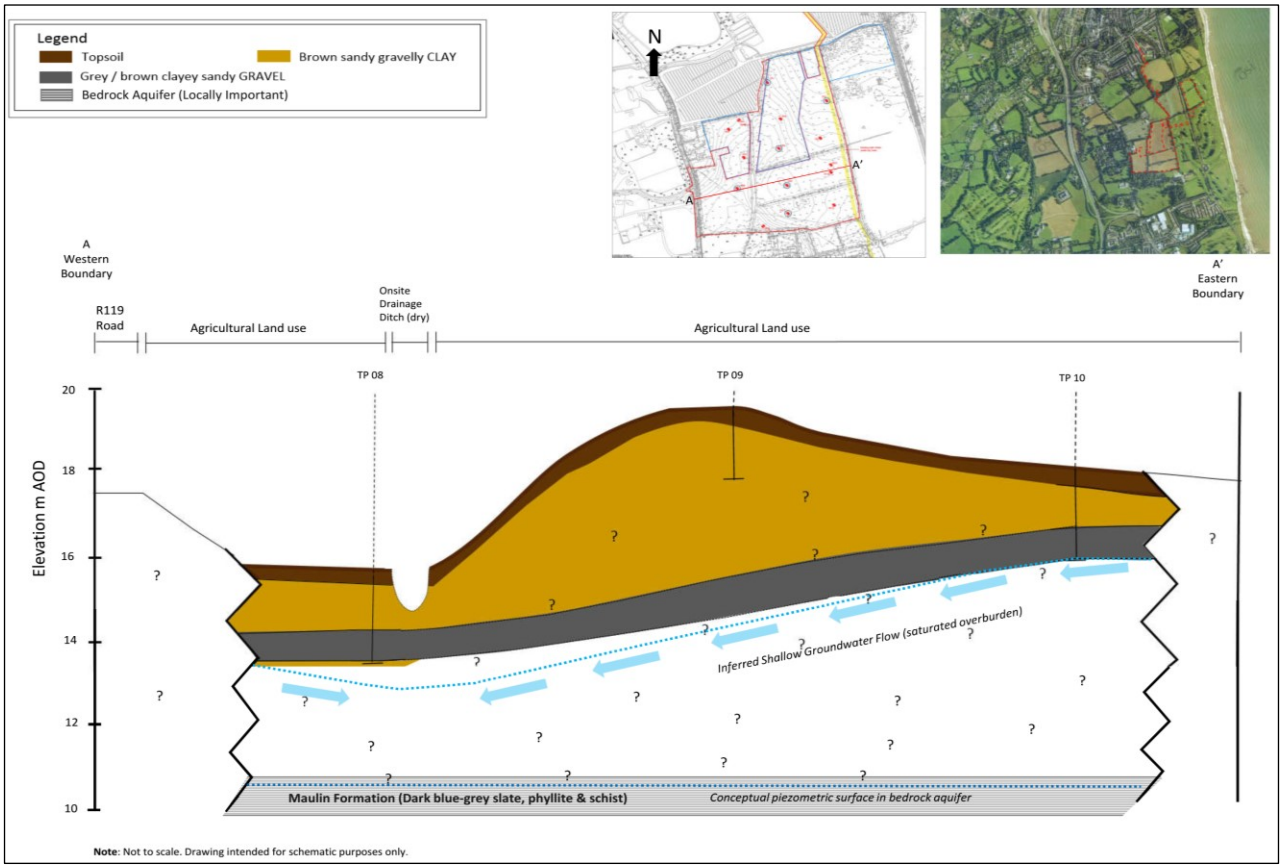
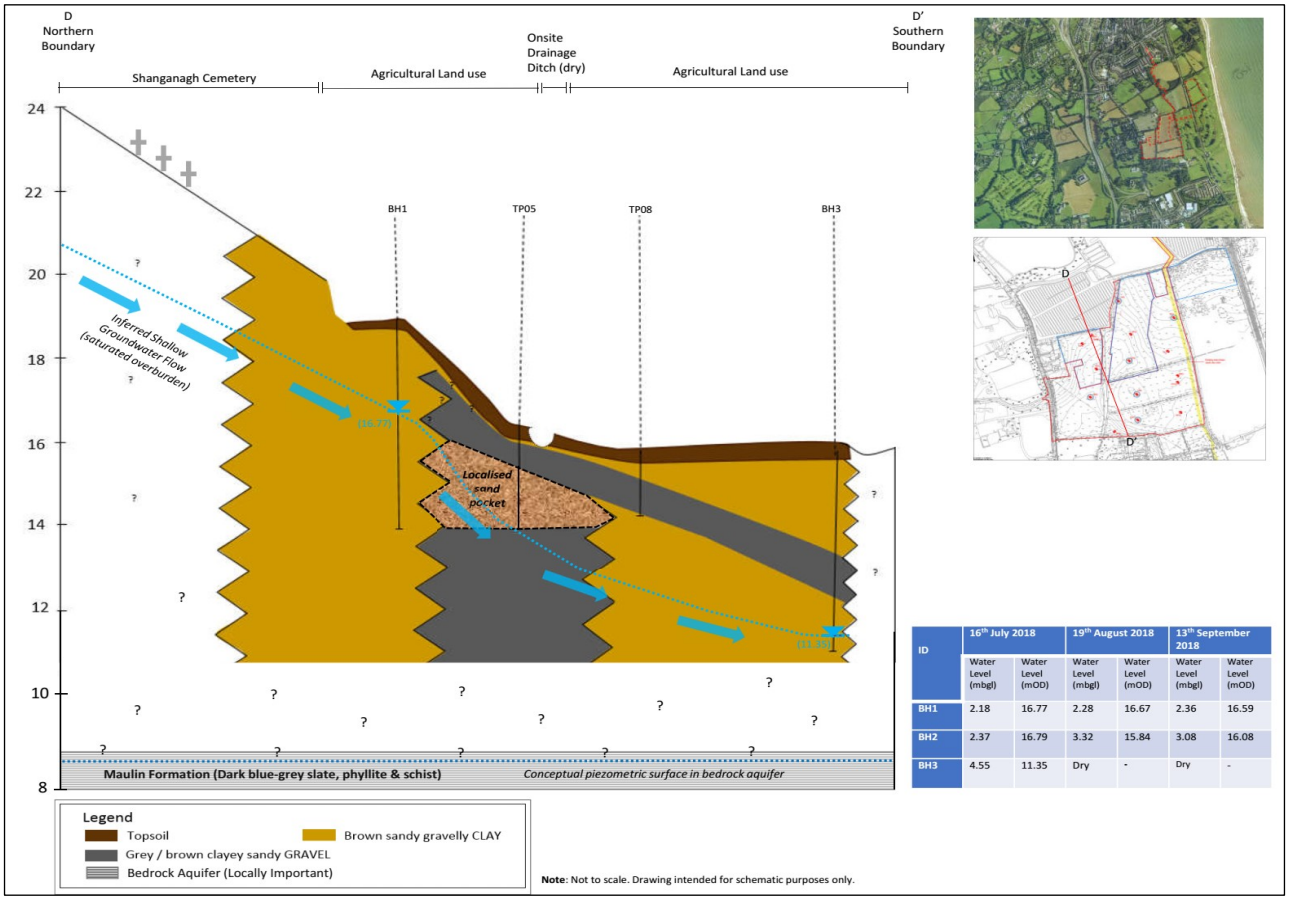


Figure 7 (a) - Site-Specific Geological Cross Sections (A-A') Showing Shallow Groundwater Flow Regime



ID	16th July 2018		19th August 2018		13th September 2018	
	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)
BH1	2.18	16.77	2.28	16.67	2.36	16.59
BH2	2.37	16.79	3.32	15.84	3.08	16.08
BH3	4.55	11.35	Dry	-	Dry	-

Figure 7 (b) - Site-Specific Geological Cross Sections (D-D') Showing Shallow Groundwater Flow Regime

In summary, any storm water drainage captured by the field ditch likely discharges to ground in the vicinity of Zone B, via. layers and lenses of sand and gravel in this area. From here, subsurface groundwater flow paths follow topography and are likely to ultimately discharge to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the site.

Potential Impacts of Proposed Attenuation Tanks nos. 4 and 5 in Zone B

The location of proposed attenuation tanks E and G (4 and 5) are presented in Figure 8. The installation of the proposed attenuation tanks in Zone B will not have any impact on the existing field ditch or groundwater flow paths based on the following facts: -

- The field ditch is not groundwater fed, as shown in site-specific geological cross sections through Zone B;
- There is no surface water flow in the field ditch downstream of this zone;
- Shallow water levels in this zone are estimated to range from approximately 2.0 to 3.5mbgl;
- The maximum depth of the tanks will not exceed 3m;
- Shallow groundwater flow follows topography across the site; flow paths occur within the saturated overburden comprising gravel and sandy gravelly clay. Groundwater flow across the Site is controlled by hydrostatic head, from areas of high to lower groundwater levels, as clearly shown in Figure 7 (a) and (b). The proposed development will not result in any significant change to the existing topography.
- The tanks have been designed to ensure that they are weighed down where required by increasing the volume of stone below the tank to counteract the hydrostatic head pressure as per design guidelines of the tank supplier. Shallow groundwater will continue to flow, following topography, around and beneath the proposed tanks in this localised area.

Therefore the installation of the proposed attenuation tanks will not have any perceptible impact on existing groundwater flow paths.

- During the construction phase, dewatering maybe required to facilitate the installation of the attenuation tanks (with a maximum excavation depth of approximately 3m). However, any dewatering will be localised and temporary and will not result in any permanent impacts to the existing groundwater flow regime or regional groundwater resource.

Similarly the installation of the proposed attenuation tanks downstream of Zone B, where the dry portions of the field ditch will be infilled as part of the proposed drainage design, will not have any perceptible impact on surface water flows, or groundwater flow paths, based on the above principles. Therefore, based on the hydrogeological conceptual understanding, and the drainage design for the proposed development, there will be no perceptible impacts on local or regional surface water levels, surface water flows, groundwater levels or groundwater flows.

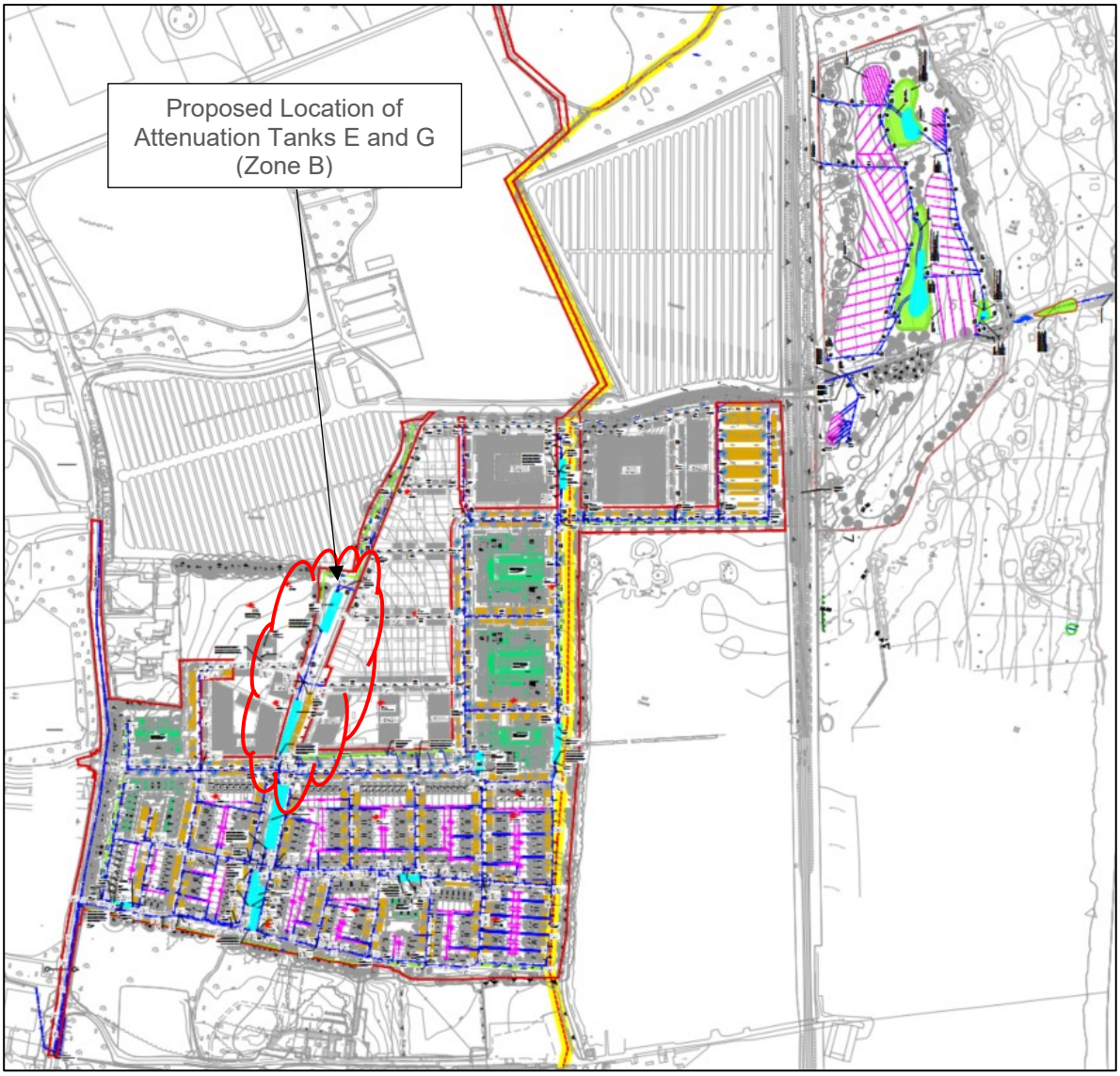


Figure 8 – Proposed Drainage Design and Development Layout

Conclusion

A detailed hydrogeological assessment has been undertaken as requested by DLRCC. This assessment has established shallow groundwater flow paths near the proposed school site, where standing storm water discharges to ground within the field ditch. The proximity and possible flow

interaction of proposed attenuation tanks E and G with the field ditch have been fully evaluated. Based on site-specific geological and hydrogeological data, there will be no perceptible impacts on surface water levels, surface water flows, groundwater levels or groundwater flows, specifically in the vicinity of proposed attenuation tanks E and G in Zone B. Furthermore, no such impacts will occur on a local or regional scale associated with the proposed drainage design. Accordingly, potential impacts to the onsite field ditch or groundwater flow paths do not warrant further consideration.

Appendix I. Surface Cover Type

Surface Cover type	Area m^2
Wetland or open water (semi-natural; not chlorinated) maintained or established on site.	n/a
Semi natural vegetation (e.g. hedgerows, trees, woodland, species-rich grassland) maintained or established on site.	n/a
Reuse of existing soils and seed source to develop vegetation cover	TBC at Detail Design
Standard tree planted in connected tree pits with a minimum soil volume equivalent to at least two thirds of the projected canopy area of the mature tree.	n/a
Standard trees planted in pits with soil volumes less than two thirds of the projected canopy area of the mature tree.	refer to landscape architect pack for further details
Intensive green roof or vegetation over structure. Substrate minimum settled depth of 150mm.	2,439m2
Non intensive Brown Roof (Biodiversity Roof). Substrate minimum settled depth of 150mm. Design will be site specific and developed by a suitably qualified ecologist.	n/a
Extensive green roof with substrate of minimum settled depth of 80mm (or 60mm beneath vegetation blanket)	n/a
Extensive green roof of sedum mat or other lightweight system.	5,185m2
Green wall – Modular system or climbers rooted in soil.	n/a
Rain gardens and other vegetated sustainable drainage elements.	198m2
Flower-rich perennial planting.	Refer to landscape
Hedges (line of mature shrubs one or two shrubs wide).	Refer to landscape
Hedgerows or double hedgerow of native species (may have an associated ditch and bank)	n/a
Groundcover planting.	Refer to landscape
Amenity grassland entire area or sections managed for lesser mowing frequencies for pollinators (e.g. six week meadow)	Refer to landscape
Amenity grassland (species-poor, regularly mown lawn).	Refer to landscape
Water features (chlorinated) or unplanted detention basins.	n/a
Permeable paving.	1,910m2
Sealed surface (e.g. concrete, asphalt, waterproofing, stone)	3,083m2

AtkinsRéalis

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Appendix B Surface Water Audit Feedback Form

Scheme Title: WOODBROOK DART GATEWAY (360 No. UNITS)

Audit Stage: 1 **Audit Completed:** 29-01-2026 **Project Ref:** 262105

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.3	Yes	Yes	AtikinsRéalis confirms that a factor of 1.3 was applied for climate change and urban creep. See section 2.1 & Appendix F.	Yes
2.4	Yes	Yes	Blockage analysis, assuming the hydrobrake blocked 50% had been carried out, see Section 9.2. AtkinsRéalis confirms that overland flow routes do not negatively impact properties within and outside the proposed development.	Yes
2.5	Yes	Yes	AtkinsRéalis carried out a check with utility providers as part of construction works for the Woodbrook Avenue and Dart Station. It is noted that the site was previously a golf course with no presence of utilities or services within the site.	Yes
2.6	Yes	Yes	AtkinsRéalis has done full design review with UÉ for the development and received no comments. A full utility check will be done at a detailed stage design.	Yes
2.7	Yes	Yes	An existing 630mmOD rising main is in place and the applicant has legal rights over the lands right now. This process was completed during the previous Woodbrook development phase.	Yes
2.8	Yes	Yes	When site investigation was carried out, the site was used as golf course and no access was permitted then. The proposed system is not designed to purely rely on infiltration to ground, with filter drains present in the car park and swale, excess surface water will be carried down the existing network.	Yes

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.9	Yes	Yes	The ground water level at TP1 was 1.95m below ground level (19.91mOD) & no ground water was encountered at TP2 for ground level at 21.71mOD, refer to Appendix G. With proposed ground level of 23.50mOD, the ground water will be below 1000mm o formation level of permeable paving build up.	Yes
2.10	Yes	Yes	CBR testing will be carried out prior to Stage 2 Stormwater Audit. Capping layer for permeable and impermeable area will be calculated at detailed design stage.	Yes
2.11	Yes	Yes	The proposed roads will be HRA with buff chip. The surface water will drain towards the permeable car park spaces and drain down to the existing network.	Yes
2.12	Yes	Yes	Revised runoff coefficient of 1.0 has been used in the model.	Yes
2.13	No	No	The M50-60 16.7 and an r value of 0.296 was used after confirming with DLRCC municipal services. These values were also used for other development phases of Woodbrook.	Yes
2.14	No	No	The SAAR value of 825mm was used after confirming with DLRCC municipal services. This value was also used for other development phases at Woodbrook.	Yes
2.15	Yes	Yes	Revised model with consistent names for manhole and pipes.	Yes
2.16	Yes	Yes	Model revised to show minimum 50mm diameter is used in a hydrobreak. A tank specialist will provide maintenance guidelines. Revised model with consistent names for manhole and pipes.	Yes

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.17	Yes	Yes	Revised model with consistent names for manhole and pipes.	Yes
2.18	Yes	Yes	The attenuation tanks will not infiltrate to the ground. A land drain is proposed at the bottom of the attenuation tanks which will drain down to the outlet manhole, see standard construction detail sheet 4 and 5.	Yes
2.19	Yes	Yes	The attenuation tanks P and Q are minimum 3m away from the structures, giving enough separation distance. The finished floor levels of the buildings are over 1.3m higher than maximum water level in the attenuation tanks.	Yes
2.20	Yes	Yes	Roof access hatches will be designed during detailed design stage.	Yes
2.21	Yes	No	The bottom of the attenuation tanks will have minimum 30mm of stone for overall area. There will be 31 cu.m and 33 cu.m of storage below tanks P and Q respectively. The above storage volumes will be able to intercept 5-10mm of rainfall. Refer to Table 7-6 and Table 7-11.	Yes
2.22	Yes	Yes	An individual SuDS specialist and tank specialist will provide maintenance guidelines.	Yes
2.23	Yes	Yes	Within the permitted SHD Woodbrook Masterplan (ABP30584419) 2019, the principal of storm drainage design was agreed for the entire site with DLRCC. This principal including catchment area, discharge remains unchanged. AtkinsRéalis confirms that the whole storm drainage network for entire Woodbrook is under the applicant.	Yes
2.24	Yes	Yes	AtkinsRéalis confirms the minimum velocity of 1m/s is achieved.	Yes

Paragraph No. in Audit Report	Issue Accepted (Yes/No)	Recommended Measure Accepted (Yes/No)	Alternative Measures (described) [or reason problem not accepted]	Alternative Measures Accepted by Auditors (Yes/No)
2.25	Yes	Yes	The grading of the roads are done in such a manner that the surface water drains to the rain gardens, permeable car parks, and existing swales. The levels and gradients on site have been reduce cut and fill and reduce environmental impact. Further details will be confirmed at detail design stage.	Yes
2.26	Yes	Yes	The bypass interceptor was considered, however, as all the car park areas are permeable parking which is capable of treating the oil/petrol leaks. As this is a residential development, there is very low possibility of oil/petrol leaks.	Yes
2.27	No	No	Rainwater harvesting was avoided by the Client due to problems regarding construction costs and periodic maintenance by building management. AtkinsRealis design provides sufficient SuDS measures have been taken into consideration such as green roofs, permeable areas, & raingardens. All the above reduce the volume of runoff and have lowered the attenuation storage required on site. As part of development, aerated taps, high-efficiency toilets, reduced water discharge taps will be proposed.	Yes
2.28	Yes	Yes	Area inside the building will be private and all SuDS devices out the building will be taken in charge by DLRCC.	Yes
2.29	Yes	Yes	Revised final drawings and stormwater impact assessment report included for audit.	Yes
2.30	Yes	Yes	Stage 2 Storm water Audit will be undertaken prior to commencement of construction on site as per all previous phases of Woodbrook.	Yes

Signed:  ..... *Design Team Project Manager* **Date:** .....20/02/2026.....

Please complete and return to the auditor

Auditor Signed Off:  ..... *Auditor* **Date:** .....13/03/2026.....

Appendix B. Simulation Criteria

Simulation Criteria for Storm

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

Number of Input Hydrographs	0	Number of Storage Structures	5
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	5	Cv (Summer)	1.000
Region	Scotland and Ireland	Cv (Winter)	0.840
M5-60 (mm)	16.700	Storm Duration (mins)	30
Ratio R	0.269		

Appendix C. Pipeline Schedules

PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S3.000	o	225	S300	24.000	22.575	1.200	Open Manhole	1200
S3.001	o	225	S301	23.875	21.908	1.742	Open Manhole	1200
S3.002	o	225	S302	23.500	21.497	1.778	Open Manhole	1200
S4.000	o	150	S306	23.900	22.475	1.275	Open Manhole	1200
S4.001	o	225	S307	24.000	22.034	1.741	Open Manhole	1200
S4.002	o	225	S311	23.500	21.902	1.373	Open Manhole	1200
S4.003	o	225	S55	22.500	21.075	1.200	Open Manhole	1200
S4.004	o	225	S55A	22.650	20.800	1.625	Open Manhole	1200
S3.003	o	225	S58	22.750	20.500	2.025	Open Manhole	1200

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
S3.000	54.249	150.0	S301	23.875	22.213	1.437	Open Manhole	1200
S3.001	36.994	90.0	S302	23.500	21.497	1.778	Open Manhole	1200
S3.002	57.150	85.0	S58	22.750	20.825	1.700	Open Manhole	1200
S4.000	76.840	38.4	S307	24.000	20.475	3.375	Open Manhole	1200
S4.001	27.749	210.2	S311	23.500	21.902	1.373	Open Manhole	1200
S4.002	84.786	102.5	S55	22.500	21.075	1.200	Open Manhole	1200
S4.003	56.671	160.1	S55A	22.650	20.721	1.704	Open Manhole	1200
S4.004	32.696	160.3	S58	22.750	20.596	1.929	Open Manhole	1200
S3.003	73.170	38.2	S59	22.350	18.584	3.541	Open Manhole	225

Appendix D. Storage Structures

Storage Structures for Storm

Porous Car Park Manhole: S301, DS/PN: S3.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	59.0
Max Percolation (l/s)	90.1	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	21.908	Membrane Depth (mm)	275

Tank or Pond Manhole: S302, DS/PN: S3.002

Invert Level (m) 21.497

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	0.400	200.0	0.800	200.0	1.200	0.0
0.200	200.0	0.600	200.0	1.000	200.0		

Porous Car Park Manhole: S306, DS/PN: S4.000

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	64.0
Max Percolation (l/s)	97.8	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.475	Membrane Depth (mm)	275

Porous Car Park Manhole: S307, DS/PN: S4.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	5.5
Membrane Percolation (mm/hr)	1000	Length (m)	60.0
Max Percolation (l/s)	91.7	Slope (1:X)	60.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	22.034	Membrane Depth (mm)	275

Tank or Pond Manhole: S311, DS/PN: S4.002

Invert Level (m) 21.902

Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	200.0	0.400	200.0	0.800	200.0	1.200	0.0
0.200	200.0	0.600	200.0	1.000	200.0		

Appendix E. Online Controls

Online Controls for Storm

Hydro-Brake® Optimum Manhole: S302, DS/PN: S3.002, Volume (m³): 3.7

Unit Reference	MD-SHE-0067-2000-1000-2000
Design Head (m)	1.000
Design Flow (l/s)	2.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	67
Invert Level (m)	21.497
Minimum Outlet Pipe Diameter (mm)	100
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	2.0
Flush-Flo™	0.296	1.9
Kick-Flo®	0.599	1.6
Mean Flow over Head Range	-	1.7

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	1.6	1.200	2.2	3.000	3.3	7.000	4.9
0.200	1.9	1.400	2.3	3.500	3.5	7.500	5.1
0.300	1.9	1.600	2.5	4.000	3.8	8.000	5.2
0.400	1.9	1.800	2.6	4.500	4.0	8.500	5.4
0.500	1.8	2.000	2.7	5.000	4.2	9.000	5.5
0.600	1.6	2.200	2.9	5.500	4.4	9.500	5.7
0.800	1.8	2.400	3.0	6.000	4.6		
1.000	2.0	2.600	3.1	6.500	4.7		

Hydro-Brake® Optimum Manhole: S311, DS/PN: S4.002, Volume (m³): 2.9

Unit Reference	MD-SHE-0051-1200-1000-1200
Design Head (m)	1.000
Design Flow (l/s)	1.2
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	51
Invert Level (m)	21.902
Minimum Outlet Pipe Diameter (mm)	75
Suggested Manhole Diameter (mm)	1200

Hydro-Brake® Optimum Manhole: S311, DS/PN: S4.002, Volume (m³): 2.9

Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	1.2
Flush-Flo™	0.228	1.0
Kick-Flo®	0.458	0.8
Mean Flow over Head Range	-	1.0

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

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	0.9	1.200	1.3	3.000	2.0	7.000	2.9
0.200	1.0	1.400	1.4	3.500	2.1	7.500	3.0
0.300	1.0	1.600	1.5	4.000	2.2	8.000	3.1
0.400	0.9	1.800	1.6	4.500	2.4	8.500	3.2
0.500	0.9	2.000	1.6	5.000	2.5	9.000	3.3
0.600	1.0	2.200	1.7	5.500	2.6	9.500	3.4
0.800	1.1	2.400	1.8	6.000	2.7		
1.000	1.2	2.600	1.8	6.500	2.8		

Appendix F. Summary of Results

F.1 Results Status Description

OK when the maximum water level is lower than the pipe's soffit.

SURCHARGED when the maximum water level is above the pipe's soffit and to within 300mm of the manhole cover level. (Allowable for 1 in 30 year storm events and greater in accordance with the GDSDS, refer to table 2-1)

FLOOD RISK when the maximum water level is above the pipe's soffit but below the manhole cover by the depth specified in the Preferences.

FLOOD when the maximum water level is above the manhole cover (No Flooding has been indicated within Summary of Results for up to the 1 in 100 year storm event)

F.2 1 in 100-year Outputs

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

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	5
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR	Ratio R 0.269
Region	Scotland and Ireland	Cv (Summer)	1.000
M5-60 (mm)	16.700	Cv (Winter)	1.000

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360, 480, 600, 720, 960, 1440
Return Period(s) (years)	100
Climate Change (%)	30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S3.000	S300	15 Summer	100	+30%	100/15 Summer				23.126
S3.001	S301	30 Summer	100	+30%	100/15 Summer				22.397
S3.002	S302	960 Summer	100	+30%	100/15 Summer				22.151
S4.000	S306	30 Summer	100	+30%	100/15 Summer				23.074
S4.001	S307	1440 Winter	100	+30%	100/15 Summer				22.803
S4.002	S311	1440 Winter	100	+30%	100/15 Summer				22.800
S4.003	S55	1440 Winter	100	+30%					21.100
S4.004	S55A	1440 Winter	100	+30%					20.825
S3.003	S58	1440 Winter	100	+30%					20.528

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S3.000	S300	0.326	0.000	1.35			55.1	SURCHARGED	
S3.001	S301	0.264	0.000	1.29		5	66.8	SURCHARGED	
S3.002	S302	0.429	0.000	0.04			1.9	SURCHARGED	
S4.000	S306	0.449	0.000	0.61		16	17.4	SURCHARGED	
S4.001	S307	0.544	0.000	0.22		1248	7.4	SURCHARGED	
S4.002	S311	0.673	0.000	0.02			1.1	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S4.003	S55	-0.200	0.000	0.03			1.1	OK	
S4.004	S55A	-0.200	0.000	0.03			1.1	OK	
S3.003	S58	-0.197	0.000	0.04			3.0	OK	

F.3 1 in 30-year Output

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

Simulation Criteria

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

Number of Input Hydrographs	0	Number of Storage Structures	5
Number of Online Controls	2	Number of Time/Area Diagrams	0
Number of Offline Controls	0	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model		FSR Ratio R	0.269
Region	Scotland and Ireland	Cv (Summer)	1.000
M5-60 (mm)	16.700	Cv (Winter)	1.000

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

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 180, 240, 360
Return Period(s) (years)	30
Climate Change (%)	30

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)
S3.000	S300	15 Summer	30	+30%	30/15 Summer				22.859
S3.001	S301	15 Summer	30	+30%	30/15 Summer				22.272
S3.002	S302	360 Winter	30	+30%	30/30 Summer				21.962
S4.000	S306	30 Summer	30	+30%	30/15 Summer				22.955
S4.001	S307	360 Summer	30	+30%	30/15 Summer				22.505
S4.002	S311	360 Winter	30	+30%	30/30 Summer				22.501
S4.003	S55	360 Winter	30	+30%					21.099
S4.004	S55A	360 Winter	30	+30%					20.824
S3.003	S58	60 Summer	30	+30%					20.528

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S3.000	S300	0.059	0.000	1.07			43.8	SURCHARGED	
S3.001	S301	0.139	0.000	1.16		4	60.3	SURCHARGED	

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

PN	US/MH Name	Surcharged Depth (m)	Flooded Volume (m^3)	Flow / Cap.	Overflow (l/s)	Half Drain Time (mins)	Pipe Flow (l/s)	Status	Level Exceeded
S3.002	S302	0.240	0.000	0.04			1.9	SURCHARGED	
S4.000	S306	0.330	0.000	0.59		13	16.6	SURCHARGED	
S4.001	S307	0.246	0.000	0.71			23.6	SURCHARGED	
S4.002	S311	0.374	0.000	0.02			1.0	SURCHARGED	
S4.003	S55	-0.201	0.000	0.03			1.0	OK	
S4.004	S55A	-0.201	0.000	0.03			1.0	OK	
S3.003	S58	-0.197	0.000	0.04			3.0	OK	

Appendix G. Site Investigation Report

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Ground Investigations Ireland

Woodbrook

Ground Investigation Report

DOCUMENT CONTROL SHEET

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GROUND INVESTIGATIONS IRELAND

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CONTENTS

APPENDICES

1.0 Preamble

On the instructions of Atkins Consulting engineers, a site investigation was carried out by Ground Investigations Ireland Ltd., between June and August 2018 at the site of the proposed development in Bray, Co. Dublin.

2.0 Overview

2.1. Background

It is proposed to construct a new residential development with associated services, access roads and car parking at the proposed site. The site is currently greenfield and is situated to the north or Bray town. The proposed construction is envisaged to consist of conventional foundations and pavement make up with some local excavations for services and plant.

2.2. Purpose and Scope

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

- Visit project site to observe existing conditions
- Carry out 12 No. Trial Pits to a maximum depth of 3.0m BGL
- Carry out 6 No. Soakaways to determine a soil infiltration value to BRE digest 365
- Carry out 3 No. Cable Percussion boreholes to a maximum depth of 10.0m BGL
- Installation of 3 No. Groundwater monitoring wells
- Geotechnical & Environmental Laboratory testing
- Report with recommendations

3.0 Subsurface Exploration

3.1. General

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

3.2. Trial Pits

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

3.3. Soakaway Testing

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

3.4. Cable Percussion Boreholes

The Cable Percussion Boreholes were drilled using a Dando 2000 drilling rig with regular in-situ testing and sampling undertaken to facilitate the production of geotechnical logs and laboratory testing.
The standard method of boring in soil for site investigation is known as the Cable Percussion method. It consists of using a Shell in non cohesive soils and a clay cutter in cohesive soils, both operated on a wire cable. Very hard soils, boulders and other hard obstructions are broken up by chiselling and the fragments removed with the Shell. Where ground conditions made it necessary, the borehole was lined with 200mm diameter steel casing. While the use of the Cable Percussion method of boring gives the maximum data on soil conditions, some mixing of laminated soil is inevitable. For this reason, thin lenses of granular material may not be noticed. Disturbed samples were taken from the boring tools at suitable depths, so that there is a representative sample at the top of each change in stratum and thereafter at regular intervals down the borehole until the next stratum was encountered. The disturbed samples were then sealed and sent to the laboratory where they were visually examined to confirm the description of the relevant strata.

3.5. Surveying

The exploratory hole locations have been recorded using a Trimble R10 GNSS System which records the coordinates and elevation of the locations to ITM or Irish National Grid as required by the project specification. The coordinates and elevations are provided on the exploratory hole logs in the appendices of this Report.

3.6. Groundwater/Gas Monitoring Installations

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

4.0 Ground Conditions

4.1. General

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

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

- Topsoil
- Granular Deposits
- Cohesive Deposits

TOPSOIL: Topsoil was encountered in all the exploratory holes and was present to a maximum depth of 0.35m BGL.

COHESIVE DEPOSITS: Cohesive deposits were encountered beneath the TOPSOIL and were described typically as *brown sandy gravelly CLAY with occasional cobbles* overlying a *soft to firm greyish brown sandy gravelly CLAY with occasional cobbles*. The secondary sand and gravel constituents varied across the site and with depth, with granular lenses occasionally present in the cohesive matrix. These deposits had some, occasional or frequent cobble and boulder content where noted on the exploratory hole logs.

GRANULAR DEPOSITS: The granular deposits were encountered at the base of the cohesive deposits and were typically described as *Greyish brown very sandy slightly clayey sub angular to rounded fine to coarse GRAVEL with occasional cobbles and rare boulders.* The secondary sand/gravel and silt/clay constituents varied across the site and with depth while occasional or frequent cobble and boulder content also present where noted on the exploratory hole logs.

4.2. Groundwater

Groundwater strikes are noted on the exploratory hole logs where they occurred and where possible drilling was suspended for twenty minutes to allow the subsequent rise in groundwater to be recorded. We would

point out that these exploratory holes did not remain open for sufficiently long periods of time to establish the hydrogeological regime and groundwater levels would be expected to vary with the tide, time of year, rainfall, nearby construction and other factors. For this reason, standpipes were installed in BH1A, BH2 and BH3 to allow the equilibrium groundwater level to be determined. The groundwater monitoring is included in Appendix 6 of this Report.

4.3. Soakaway Design

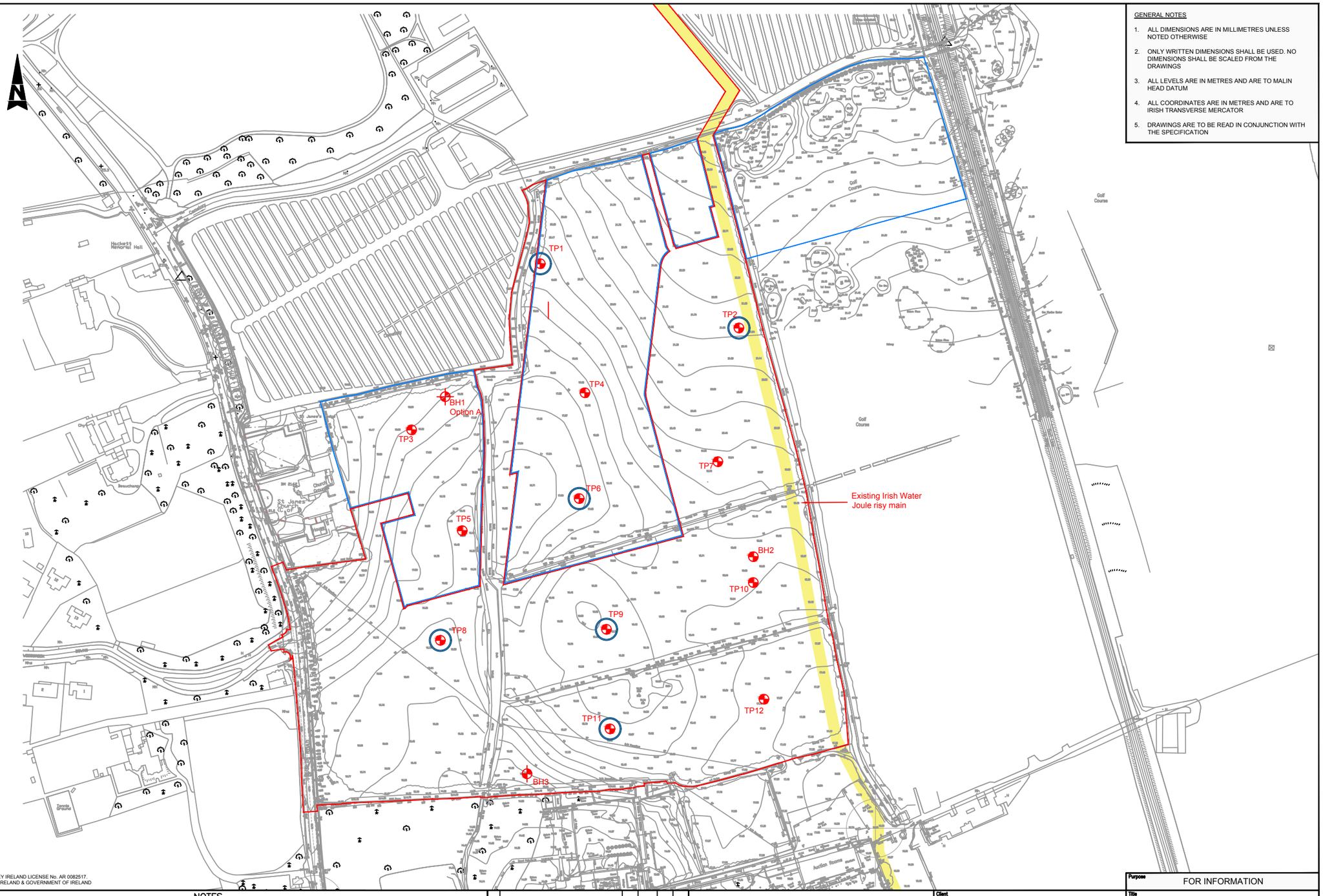
Infiltration rates of 3.137×10^{-6} and 2.298×10^{-6} m/s respectively were calculated for the soakaway locations TP02 and TP06 for the design and construction of soakaways.
At the locations of TP01, TP06, TP09 and TP11 the water level dropped too slowly to allow calculation of 'f' the soil infiltration rate.

APPENDIX 1 - Site Location Plan

A1

0 10 100

DO NOT SCALE



GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ONLY WRITTEN DIMENSIONS SHALL BE USED. NO DIMENSIONS SHALL BE SCALED FROM THE DRAWINGS
3. ALL LEVELS ARE IN METRES AND ARE TO MALIN HEAD DATUM
4. ALL COORDINATES ARE IN METRES AND ARE TO IRISH TRANSVERSE MERCATOR
5. DRAWINGS ARE TO BE READ IN CONJUNCTION WITH THE SPECIFICATION

LEGEND

- PERCOLATION TEST IN ACCORDANCE WITH BRE365.
- TRIAL PIT 2.5–3M DEPTH
- (BH1 – BH3) S+A (Cable Percussive)

NOTES

1. PERCOLATION TEST TO BE CARRIED OUT IN ACCORDANCE WITH BRE DIGEST 365 SOAKAWAY DESIGN.
2. TRIAL PIT TO A DEPTH OF 2.5–3M AND TO LOG STRATA CLASSIFICATION INCLUDING DEPTH AND CHANGE IN STRATA.
3. WATER STRIKE DEPTHS.

~ Depth 10m

– all to be committed to groundwater monitoring wells (raised covers)

Rev	Description	By	Date	Chk'd	Auth

Atkins House, 150-155 Airside Business Park, Swords, Co. Dublin
Tel (+353) 01 810 8000
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Unit 2B, 2200 Cork Airport Business Park, Cork
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2nd Floor Technology House Parkmore Technology Park, Galway
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Client: AEVAL

Project: WOODBROOK DEVELOPMENT

Purpose: FOR INFORMATION

Title: PROPOSED GROUNDWATER MONITORING WELL

Original Scale	Design/Drawn	Checked	Authorised
NTS	GH	JN	JN
	Date 04/18	Date 04/18	Date 04/18

Status: DR

Drawing Number: 5154251_EWE_SK_0005

Rev:

APPENDIX 2 – Trial Pit Records

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Trial Pit Number** TP01
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 2.00	**Ground Level (mOD)** 19.91	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725776.1 E 720639.5 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.35)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				19.56	0.35			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
				19.36	0.55			
					(1.05)	Dark greyish brown sandy slightly clayey subangular to subrounded fine to coarse GRAVEL with occasional subrounded cobbles.		
				18.31	1.60			
					(0.40)	Soft to firm dark greyish brown very sandy slightly gravelly CLAY.		
			Medium Seepage(1) at 1.95m.	17.91	2.00	Trial pit terminated at scheduled depth.		▽1
						Complete at 2.00m		

Plan

Remarks

Groundwater encountered at 1.95m BGL.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP01

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Trial Pit Number** TP02
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.50m X 0.70m X 2.00m	**Ground Level (mOD)** 21.71	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725947.4 E 720584.4 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				21.31	0.40			
					(0.60)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				20.71	1.00			
					(1.00)	Brown slightly clayey gravelly fine to coarse SAND with some grey fine sand lenses.		
				19.71	2.00	Trial pit terminated at scheduled depth.		
						Complete at 2.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP02

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP03
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.90m X 0.70m X 3.00m	**Ground Level (mOD)** 18.43	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725665.2 E 720495.3 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				18.18	0.25	Firm brown slightly sandy slightly gravelly CLAY		
0.50	B				(0.35)			
				17.83	0.60	Soft to firm greyish brown sandy gravelly CLAY.		
					(0.60)			
				17.23	1.20	Dark greyish brown very gravelly slightly clayey fine to coarse SAND with occasional subrounded cobbles.		
					(0.55)			
				16.68	1.75	Greyish brown very sandy slightly clayey subangular to subrounded fine to coarse GRAVEL with occasional subrounded cobbles.		
2.20	B				(1.25)			
			Slight seepage(1) at 2.50m. Slight seepage(2) at 2.70m. Slow ingress(3) at 3.00m, rose to 2.90m in 20 mins.	15.43	3.00	Complete at 3.00m		▽1 ▽2 ▼3 ▽3

Plan

Remarks

Groundwater encountered at 2.50m, 2.70m and 3.00m BGL.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP03

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Trial Pit Number** TP04
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.90m X 0.70m X 3.00m	**Ground Level (mOD)** 18.35	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725813.1 E 720528.3 N	**Dates** 26/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.25)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				18.10	0.25			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				17.90	0.45			
					(0.20)	Brown slightly sandy clayey subangular to subrounded fine to coarse GRAVEL.		
0.65	B			17.70	0.65			
					(0.65)	Dark greyish brown slightly sandy slightly clayey subangular to subrounded fine to coarse GRAVEL.		
1.30	B			17.05	1.30			
					(0.40)	Soft to firm greyish brown sandy gravelly CLAY.		
				16.65	1.70			
					(1.05)	Grey sandy subrounded to rounded fine to coarse GRAVEL.		
				15.60	2.75			
					(0.25)	Grey slightly gravelly slightly silty fine SAND.		
				15.35	3.00	Complete at 3.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP04

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP05
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.70m X 0.70m X 2.50	**Ground Level (mOD)** 16.39	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725708.8 E 720410.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				15.99	0.40			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
0.50	B			15.79	0.60			
					(0.50)	Brown slightly sandy clayey subangular to rounded fine to coarse GRAVEL with some subrounded cobbles.		
				15.29	1.10			
					(0.40)	Brown gravelly slightly clayey fine to coarse SAND with occasional subangular cobbles.		
				14.89	1.50			
					(0.70)	Dark brown slightly gravelly slightly clayey fine to coarse SAND.		
2.00	B							
				14.19	2.20			
					(0.30)	Brown very sandy slightly clayey subrounded to rounded fine to coarse GRAVEL with occasional subrounded cobbles.		
				13.89	2.50			
						Complete at 2.50m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP05

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP06
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.30m X 0.70m X 2.00m	**Ground Level (mOD)** 17.43	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725805.4 E 720435.7 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				17.13	0.30	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
					(0.50)			
				16.63	0.80	Soft to firm dark dark brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
					(0.50)			
				16.13	1.30	Soft to firm dark brown slightly sandy gravelly CLAY with some subangular to subrounded cobbles and boulders.		
					(0.50)			
				15.63	1.80	Brown slightly gravelly slightly clayey fine to medium SAND.		
					(0.20)			
				15.43	2.00	Trial pit terminated at scheduled depth.		
						Complete at 2.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP06

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Site Woodbrook			**Trial Pit Number** TP07
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 3.40m X 0.70m X 2.50m	**Ground Level (mOD)** 19.90	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725927.9 E 720469.6 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
				19.60	0.30			
					(0.30)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
0.50	B			19.30	0.60			
					(0.60)	Soft to firm dark brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
				18.70	1.20			
					(0.80)	Soft to firm grey mottled brown sandy gravelly CLAY with occasional subangular to subrounded cobbles.		
1.90	B			17.90	2.00			
				17.80	(0.10) 2.10	Brown gravelly slightly clayey fine to coarse SAND with occasional cobbles.		
					(0.40)	Brown very gravelly slightly clayey fine to coarse SAND with occasional cobbles.		
				17.40	2.50	Complete at 2.50m		

Plan

Remarks

No Grounwater encountered.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP07

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Site Woodbrook			**Trial Pit Number** TP08
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 2.00	**Ground Level (mOD)** 15.81	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725689.9 E 720316.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.35)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				15.46	0.35			
					(0.45)	Firm to stiff brown slightly sandy slightly gravelly CLAY.		
				15.01	0.80			
					(1.00)	Brown very sandy slightly clayey subangular to rounded fine to coarse GRAVEL with some subrounded cobbles.		
				14.01	1.80			
					(0.20)	Soft to firm brown sandy slightly gravelly CLAY with occasional subrounded cobbles.		
				13.81	2.00	Trial pit terminated at scheduled depth.		
						Complete at 2.00m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP08

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Site Woodbrook			**Trial Pit Number** TP09
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 1.90m	**Ground Level (mOD)** 19.41	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725832.8 E 720325.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.35)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
				19.06	0.35	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
					(0.65)			
1.00	B			18.41	1.00	Soft to firm greyish brown sandy gravelly CLAY.		
					(0.70)			
				17.71	1.70	Soft to firm greyish brown slightly sandy gravelly CLAY.		
1.80	B				(0.20)			
				17.51	1.90	Trial pit terminated at scheduled depth.		
						Complete at 1.90m		

Plan

Remarks

No Groundwater encountered.
Trial pit side walls spalling.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP09

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP10
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 2.40m	**Ground Level (mOD)** 18.54	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725957.4 E 720361.8 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
				18.24	0.30			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY.		
0.50	B			18.04	0.50	Soft to firm dark greyish brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
					(1.10)			
1.50	B			16.94	1.60	Greyish brown sandy slightly clayey subrounded to rounded fine to coarse GRAVEL with occasional subrounded cobbles and boulders.		
			Slight seepage(1) at 1.90m.		(0.80)			▽1
			Medium ingress(2) at 2.20m.					▽2
				16.14	2.40	Trial pit terminated due to excessive groundwater.		
						Complete at 2.40m		

Plan

Remarks

Groundwater encountered at 1.90m and 2.20m BGL.
Trial pit side walls spalling.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP10

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Site Woodbrook			**Trial Pit Number** TP11
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.40m X 0.70m X 1.90m	**Ground Level (mOD)** 18.87	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725836 E 720237.6 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
				18.57	0.30	Soft to firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
					(0.90)			
1.00	B							
				17.67	1.20	Soft to firm dark brown slightly sandy gravelly CLAY.		
					(0.70)			
1.80	B			16.97	1.90	Trial pit terminated at scheduled depth.		
						Complete at 1.90m		

Plan

Remarks

No Groundwater encountered.
Trial pit stable.
Soakaway completed in trial pit.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP11

Ground Investigations Ireland Ltd
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Site Woodbrook			**Trial Pit Number** TP12
Machine : JCB JCX **Method :** Trial Pit	**Dimensions** 2.50m X 0.70m X 2.90m	**Ground Level (mOD)** 17.69	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725968.8 E 720265.1 N	**Dates** 25/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
					(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
				17.39	0.30			
					(0.20)	Firm brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles		
				17.19	0.50			
					(0.60)	Soft to firm dark greyish brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles		
1.00	B			16.59	1.10			
					(0.60)	Soft to firm grey mottled brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
			Slight seepage(1) at 1.70m.	15.99	1.70			▽1
2.00	B				(0.60)	Greyish brown gravelly slightly clayey SAND.		
			Slow ingress(2) at 2.40m.	15.39	2.30			▽2
					(0.60)	Grey very sandy slightly clayey subangular to rounded fine to coarse GRAVEL.		
				14.79	2.90			
						Complete at 2.90m		

Plan

Remarks

Grounwater encountered at 1.70m and 2.40m.
Trial pit stable.
Trial pit backfilled on completion.

Scale (approx)	Logged By	Figure No.
1:25	Tmcl	7757-05-18.TP12

Woodbrook, Bray - Trial Pit Photographs

TP01

TP02

TP02

TP03

TP03

TP04

TP04

TP05

TP05

TP06

TP06

TP07

TP07

TP08

TP08

TP09

TP09

TP10

TP10

TP11

TP11

TP12

TP12

APPENDIX 3 – Cable Percussion Borehole Records

Ground Investigations Ireland Ltd
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Site Woodbrook			**Borehole Number** BH01
Machine : Dando2000 **Method :** Cable Percussion	**Casing Diameter** 200mm to 5.00m	**Ground Level (mOD)** 18.95	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725691.3 E 720522.8 N	**Dates** 27/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.30)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
					18.65	0.30	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
1.00	B					(1.40)			
					17.25	1.70	Brown slightly sandy very gravelly CLAY with occasional subrounded cobbles.		
2.00	B					(1.30)			▼1
3.00	B			Water strike(1) at 3.10m, rose to 2.40m in 20 mins, sealed at 3.60m.	15.95	3.00	Brown slightly sandy slightly gravelly CLAY.		▽1
4.00	B					(2.00)			
5.00	B				13.95	5.00	End of Borehole.		
							Complete at 5.00m		

Remarks
Groundwater encountered at 3.10m BGL.
Standpipe installed, borehole backfilled to 3.40m with bentonite ,slotted standpipe installed from 3.40m to 1.90m with a gravel filter, sealed standpipe from 1.90m to ground level with a raised cover.

Scale (approx)	Logged By
1:50	Tmcl

Figure No. 7757-05-18.BH01

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Borehole Number** BH02
Machine : Dando2000 **Method :** Cable Percussion	**Casing Diameter**	**Ground Level (mOD)** 19.16	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725957.9 E 720383.4 N	**Dates** 28/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with grass rootlets.		
					18.76	0.40	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles and boulders.		
1.00	B					(1.00)			
					17.76	1.40	Brown slightly sandy gravelly CLAY with occasional subrounded cobbles and boulders.		
2.00	B					(1.60)			
3.00	B				16.16	3.00	Brown slightly sandy very gravelly CLAY with occasional cobbles.		▼1
						(1.00)			
4.00	B			Water strike(1) at 3.98m, rose to 3.50m in 20 mins, sealed at 2.40m.	15.16	4.00	Brown slightly sandy slightly gravelly CLAY.		▽1
						(1.00)			
5.00	B				14.16	5.00	End of Borehole.		
							Complete at 5.00m		

Remarks
Grounwater encountered at 3.98m BGL.
Stanpipe installed, slotted stanpipe installed from 5.0m to 3.50m with a gravel filter, sealed from 3.50m to ground level with a raised cover.

Scale (approx)	Logged By
1:50	Tmcl

Figure No. 7757-05-18.BH02

Ground Investigations Ireland Ltd
www.gii.ie

Site Woodbrook			**Borehole Number** BH03
Machine : Dando2000 **Method :** Cable Percussion	**Casing Diameter**	**Ground Level (mOD)** 15.90	**Client** Castlethorn	**Job Number** 7757-05-18
	Location 725764.2 E 720201.8 N	**Dates** 29/06/2018	**Project Contractor** Ground Investigations Ireland	**Sheet** 1/1

Depth (m)	Sample / Tests	Casing Depth (m)	Water Depth (m)	Field Records	Level (mOD)	Depth (m) (Thickness)	Description	Legend	Water
						(0.40)	Brown slightly sandy slightly gravelly TOPSOIL with rootlets.		
					15.50	0.40	Brown slightly sandy slightly gravelly CLAY with occasional subrounded cobbles.		
1.00	B					(0.80)			
					14.70	1.20	Brown slightly sandy very gravelly CLAY with occasional subrounded cobbles.		
2.00	B					(0.80)			
					13.90	2.00	Brown slightly sandy gravelly CLAY with occasional subrounded cobbles.		
3.00	B					(1.00)			
					12.90	3.00	Greyish brown sandy slightly clayey subangular to rounded fine to coarse GRAVEL.		
4.00	B					(1.00)			
					11.90	4.00	Brown sandy slightly gravelly CLAY with occasional lenses of fine to coarse sand.		▼1
5.00	B			Water strike(1) at 5.00m, rose to 4.40m in 20 mins.		(1.00)			
					10.90	5.00	End of Borehole.		▽1
							Complete at 5.00m		

Remarks
Groundwater encountered at 5.0m BGL.
Standpipe installed, slotted from 5.0m to 3.5m with a gravel filter, sealed from 3.50m to ground level with a rasied cover

Scale (approx)	Logged By
1:50	Tmcl

Figure No. 7757-05-18.BH03

APPENDIX 4 – Groundwater Monitoring

Ground Investigations Ireland Ltd.,
Catherinestown House,
Hazelhatch Road,
Newcastle, Co Dublin.
Tel: 01 601 5175 / 5176 | Fax: 01 601 5173
Email: info@gii.ie | Web: gii.ie

GROUNDWATER MONITORING

Woodbrook

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
BH1	16/07/2018	17.00	2.18	Depths from Ground level
BH2	16/07/2018	17.05	2.37	
BH3	16/07/2018	17.15	4.55	

Ground Investigations Ireland Ltd.,
Catherinestown House,
Hazelhatch Road,
Newcastle, Co Dublin.
Tel: 01 601 5175 / 5176 | Fax: 01 601 5173
Email: info@gii.ie | Web: gii.ie

GROUNDWATER MONITORING

Woodbrook Bray

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
BH1	16/08/2918	12:02:00	2.28m	
BH2	16/08/2018	12:11:00	3.32m	
BH3	16/08/2918	12:25:00	5.00m	No Water

Ground Investigations Ireland Ltd.,
Catherinestown House,
Hazelhatch Road,
Newcastle, Co Dublin.
Tel: 01 601 5175 / 5176 | Fax: 01 601 5173
Email: info@gii.ie | Web: gii.ie

GROUNDWATER MONITORING

Woodbrook

BOREHOLE	DATE	TIME	GROUNDWATER (mBGL)	Comments
				Depths from Ground level
BH1	13/09/2018	11.14	2.36	
BH2	13/09/2018	11.21	3.08	
BH3	13/09/2018	11.27	5.00	No Groundwater

APPENDIX 5 – Soakaway Results

TP02

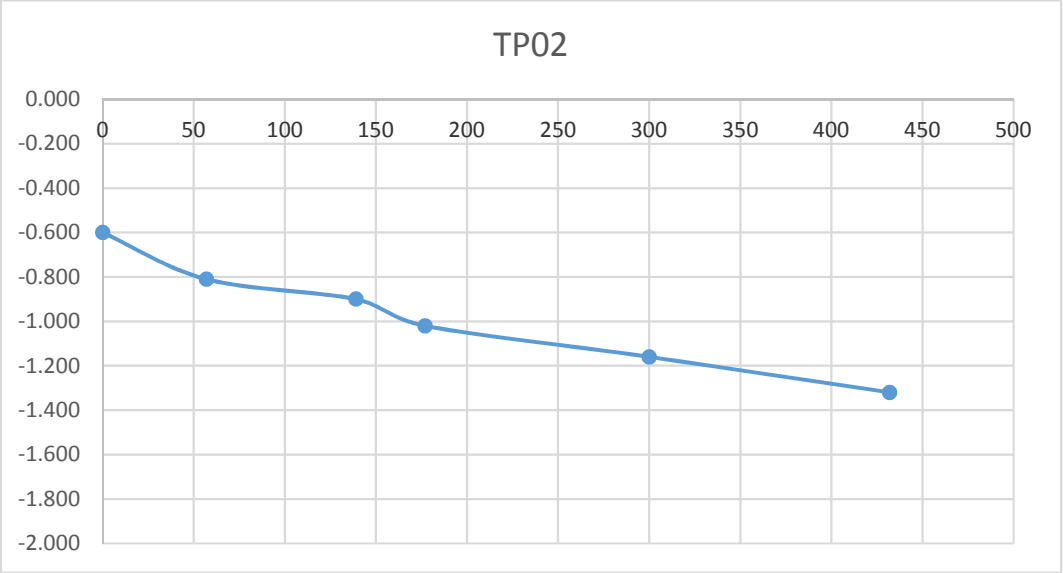
Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.50m x 0.70m 2.00m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.600
14/09/2016	57	-0.810
14/09/2016	139	-0.900
14/09/2016	177	-1.020
14/09/2016	300	-1.160
14/09/2016	432	-1.320

Start depth	Depth of Pit		Diff	75% full	25%full
0.60	**2.000**		**1.400**	**0.95**	**1.65**

Length of pit (m)	Width of pit (m)		75-25Ht (m)	Vp75-25 (m3)
2.500	0.700		0.700	1.23
Tp75-25 (from graph) (s)		**62686**	50% Eff Depth	ap50 (m2)
			0.700	6.23

f = 3.137E-06 m/s

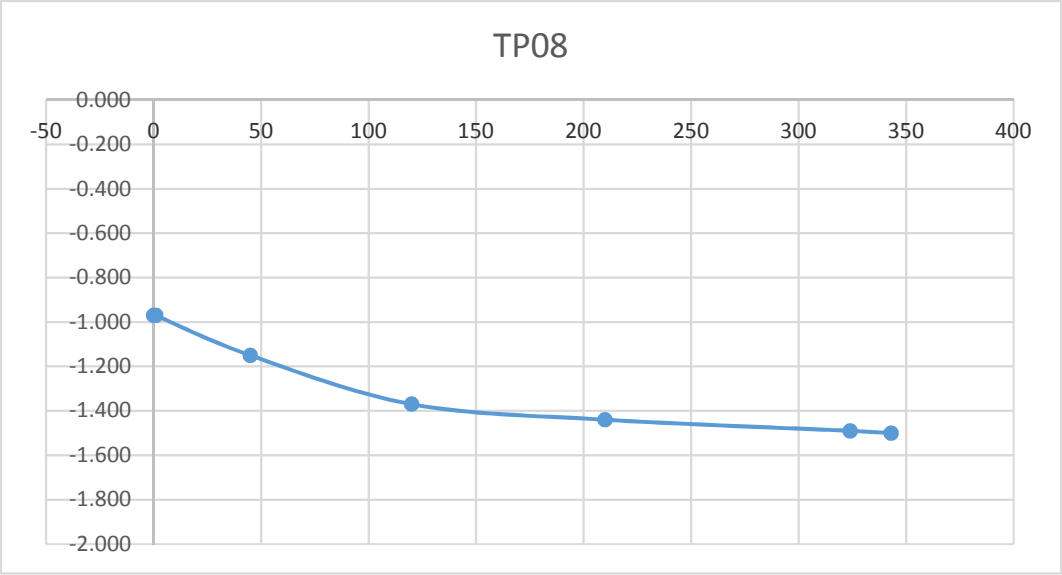


TP08

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.40m x 0.70m 2.00m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.970
14/09/2016	1	-0.970
14/09/2016	45	-1.150
14/09/2016	120	-1.370
14/09/2016	210	-1.440
14/09/2016	324	-1.490
14/09/2016	343	-1.500

Start depth	Depth of Pit		Diff	75% full	25%full
0.97	**2.000**		**1.030**	**1.2275**	**1.7425**
Length of pit (m)	Width of pit (m)			75-25Ht (m)	Vp75-25 (m3)
2.400	0.700			0.515	0.87
Tp75-25 (from graph) (s)		**77250**		50% Eff Depth	ap50 (m2)
				0.515	4.873
f =	**2.298E-06**	**m/s**			



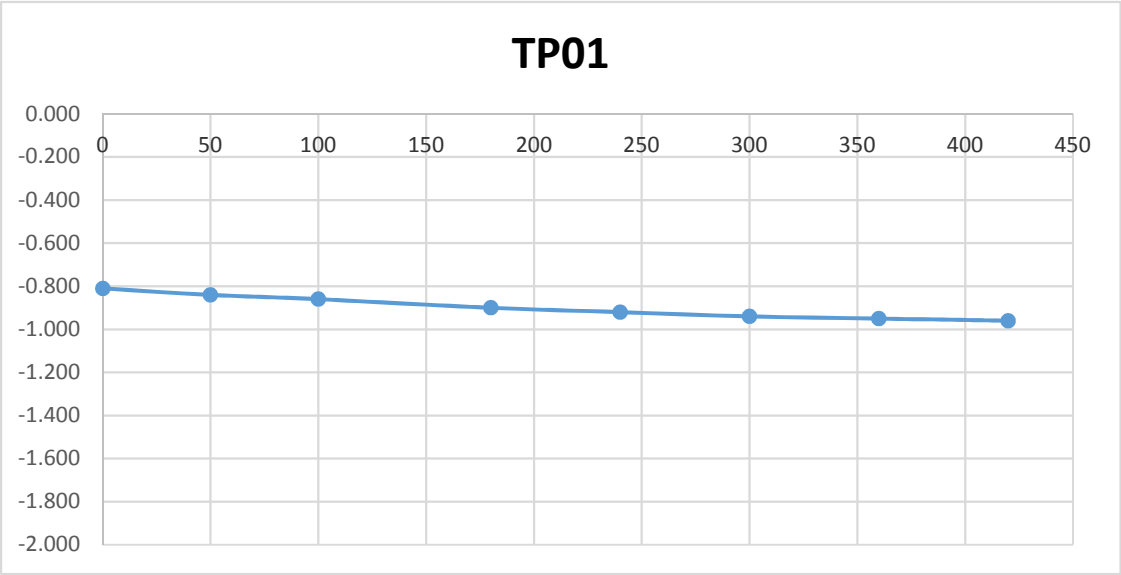
TP01

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.40m x 0.70m 2.0m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.810
14/09/2016	50	-0.840
14/09/2016	100	-0.860
14/09/2016	180	-0.900
14/09/2016	240	-0.920
14/09/2016	300	-0.940
14/09/2016	360	-0.950
14/09/2016	420	-0.960

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.81	2.000	1.190	1.1075	1.7025



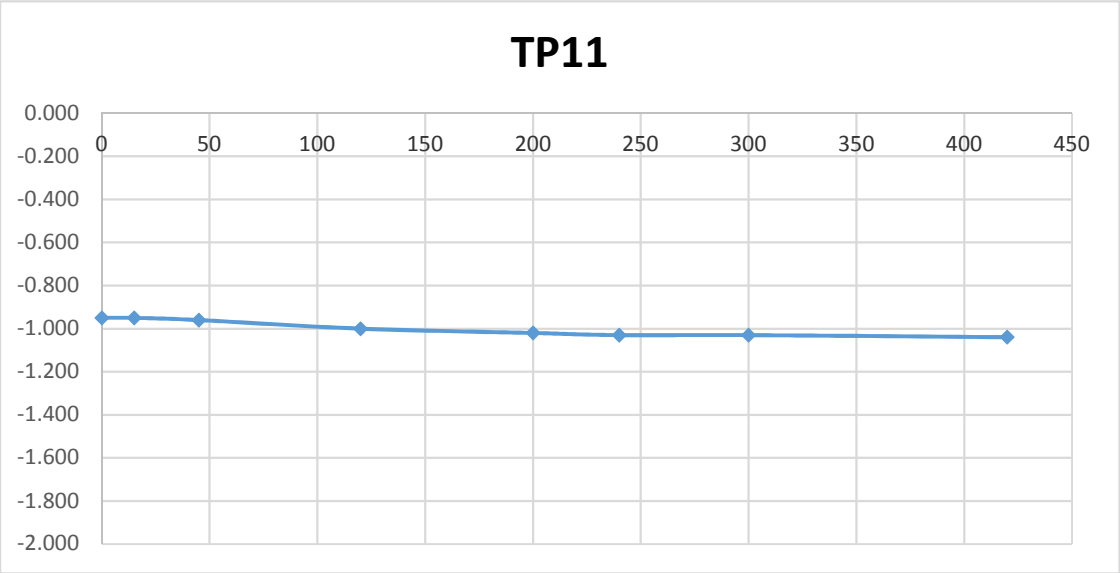
TP11

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.4m x 0.70m 1.9m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.950
14/09/2016	15	-0.950
14/09/2016	45	-0.960
14/09/2016	120	-1.000
14/09/2016	200	-1.020
14/09/2016	240	-1.030
14/09/2016	300	-1.030
14/09/2016	420	-1.040

***Soakaway failed - Pit backfilled**

Start depth	Depth of Pit	Diff	75% full	25%full
0.95	1.900	0.950	1.1875	1.6625



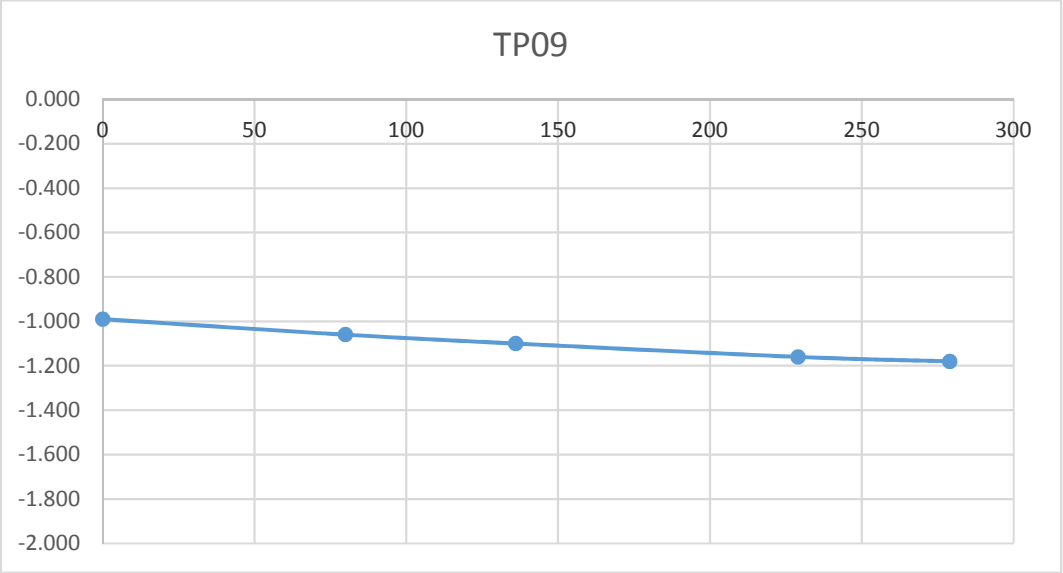
TP09

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 12.40m x 0.70m 1.90m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.990
14/09/2016	80	-1.060
14/09/2016	136	-1.100
14/09/2016	229	-1.160
14/09/2016	279	-1.180

*Soakaway failed - Pit backfilled

Start depth	Depth of Pit	Diff	75% full	25%full
0.99	1.900	0.910	1.2175	1.6725



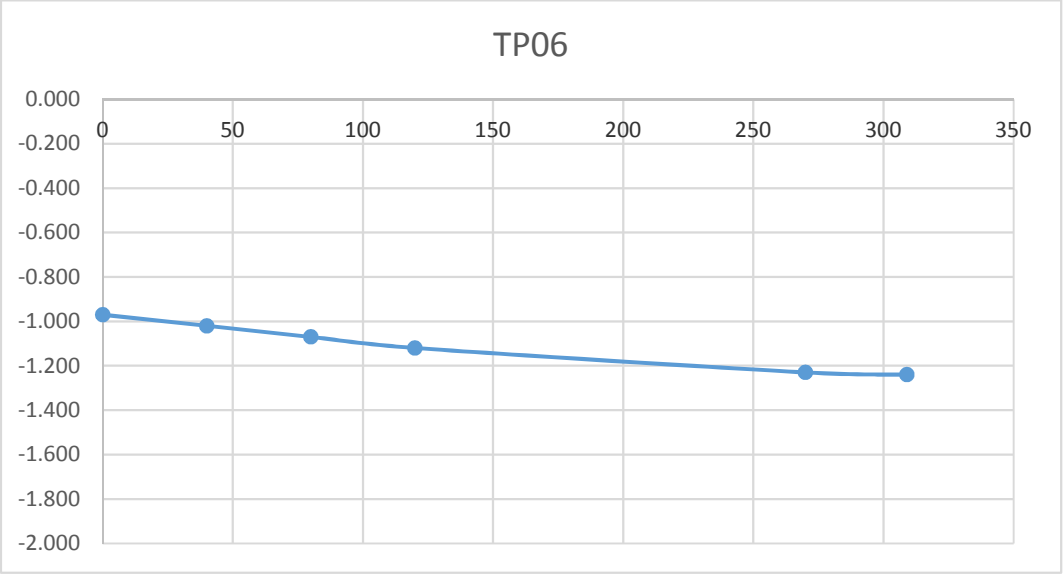
TP06

Soakaway Test to BRE Digest 365
Trial Pit Dimensions: 2.30m x 0.70m 2.00m (L x W x D)

Date	Time	Water level (m bgl)
14/09/2016	0	-0.970
14/09/2016	40	-1.020
14/09/2016	80	-1.070
14/09/2016	120	-1.120
14/09/2016	270	-1.230
14/09/2016	309	-1.240

*Soakaway failed - Pit backfilled

Start depth	Depth of Pit	Diff	75% full	25%full
0.97	2.000	1.030	1.2275	1.7425



Appendix H. Hydrogeologist Technical Note

Technical Note

Project:	Woodbrook Proposed Strategic Housing Development		
Subject:	Technical Response to DLRCC Drainage Queries		
Author:	Deirdre Larkin & Garry Hanratty	Atkins No.:	5154251DG0010 Rev2
Date:	13/04/2019	Icepac No.:	N/A
		Project No.:	5154251
Distribution:	Drainage Department	Representing:	DLRCC

Atkins have prepared this technical note on behalf of Aeval in relation to a proposed residential development on existing greenfield lands and a golf course, located at Woodbrook, Co. Dublin (hereafter referred to as the Site). The purpose of this technical assessment is to address queries raised by Dún Laoghaire–Rathdown County Council (DLRCC) in relation to the existing Site drainage system, and shallow groundwater flow paths in the vicinity of an existing onsite drainage ditch.

Specifically, DLRCC have requested a response to the following;

1. Confirmation that the existing onsite drainage ditch is a field ditch and not a stream or river (as discussed during a pre-application meeting with DLRCC); and,

2. A request that '*the applicant …be required to undertake further investigations to determine the (underground?) flowpaths of the outflow from the existing watercourse / ditch which terminates near the proposed school site. The proximity and possible flow interaction of the proposed attenuation tanks nos. 4 and 5 in Zone B with the above mentioned watercourse / ditch needs further examination'* (Item no. 25, pg 34 of DLRCC Report File Ref: SHD/PAC/86/18).

This detailed technical response has been prepared based on the following scope of works;

- Review of all available desk-based information, including historic mapping and aerial photography;
- Site walkover survey undertaken by an experienced Hydrogeologist on 12th June and 18th September 2018;
- Groundwater investigation works undertaken by Ground Investigations Ltd. between 13th to 15th June 2018;
- Baseline groundwater level monitoring carried out between 16th June to 13th September 2018; and,
- A Hydrological and Hydrogeological Impact Assessment completed by Atkins (2019).

This assessment should be read in conjunction with the following documents;

- Atkins Stage 1 Flood Risk Assessment
- Atkins Stormwater Impact Assessment Report
- Atkins Environmental Impact Assessment Report (EIAR) – Chapter 5: Water Impact Assessment

Response to Query Item No. 1:
Characterisation of the onsite Drainage Feature

Desk-based Review

The subject existing field drain indicated in Figure 1 traversing the Site from North to South has a long-established existence and function in draining the fields down to the local watercourse outside of the proposed Woodbrook Development. Topographic levels across the Site have been mapped, and likely overland storm water flow paths have been evaluated for the current baseline setting, as presented in Figure 1. It should be noted that green colours denote higher Site levels, red colours denote lower Site levels, and the black arrows denote likely natural water flow paths within the overall Site.

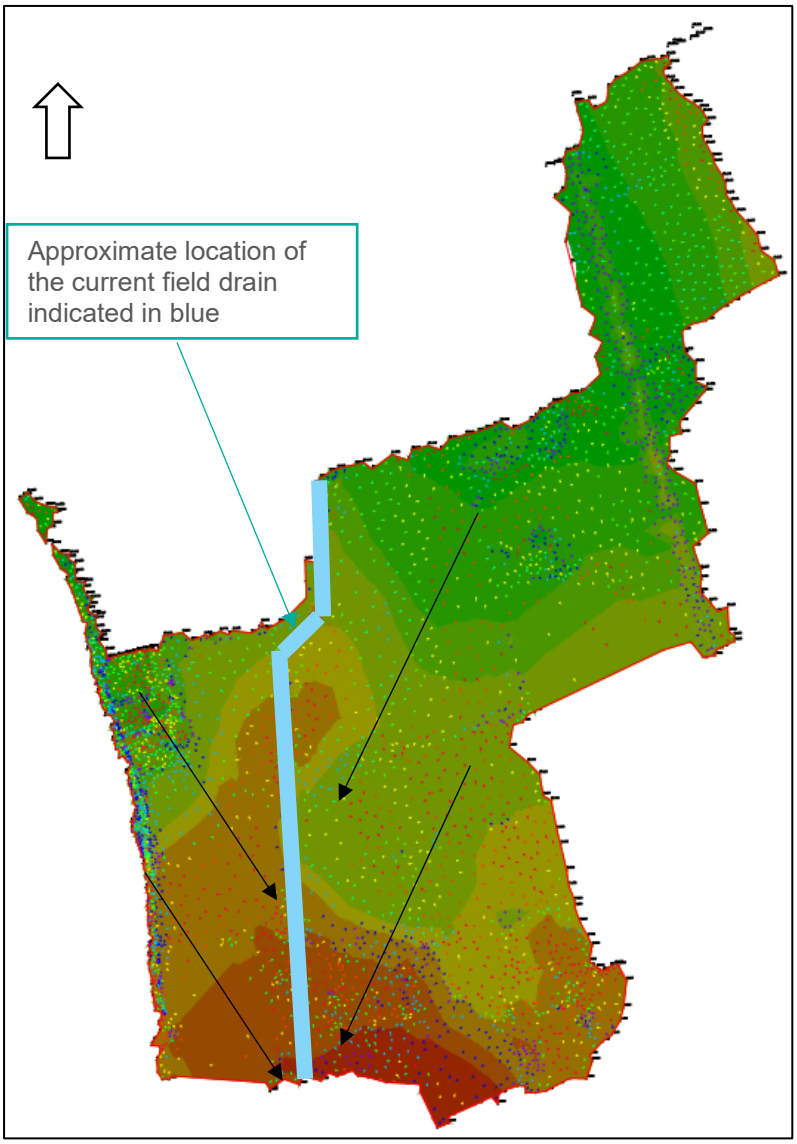


Figure 1 - Site Topography Heat Map

A review of Historical Ordinance Survey Ireland information (www.osi.ie) was then carried out to determine if the OSI 6 inch Maps indicated historic water courses / surface water features within the Site. The image below does not indicate any record of a water course onsite.

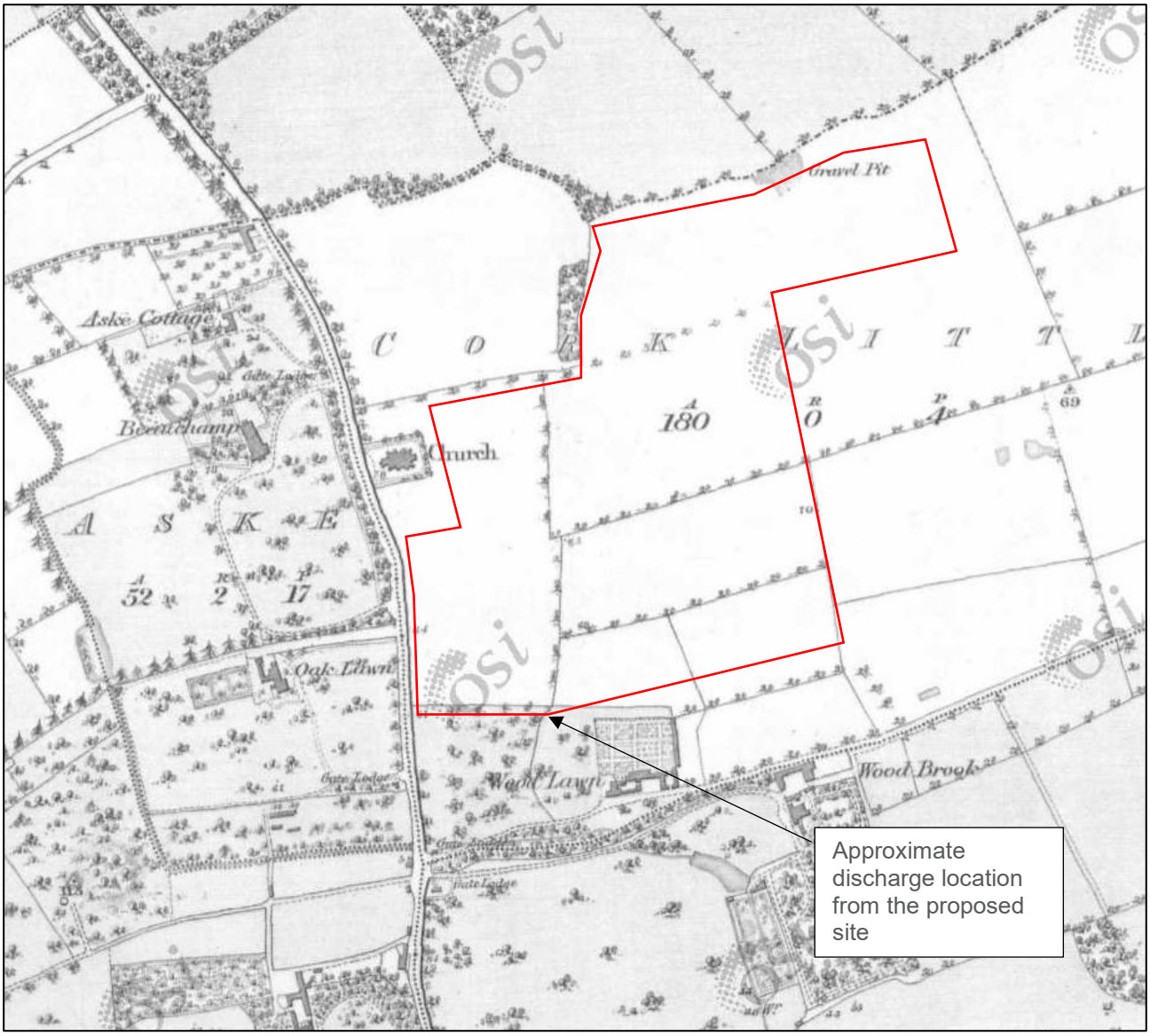


Figure 2 - OSI 6 Inch Colour Map

A review of the OPW CFRAM study Flood Maps (www.floodinfo.ie) was carried out to determine if the onsite field drain / water course formed part of the study. The CFRAM Flood Maps do not indicate flooding for 1 in 10, 1 in 100 or 1 in 1000-year flood events. It is noted that no part of the proposed Site formed part of the CFRAM study, as clearly presented in Figure 3.

Figure 3 - CFRAM Flood Study Map

A review of the EPA Maps (www.epa.ie) was also carried out to determine if the onsite field drain / water course is indicated as part of the river features water networks. The maps name the Rathmichael river to the south of the Site to which the existing Woodbrook lands drain into. However, the EPA mapping resource does not identify any water features within the existing Site. Refer to Figure 4.

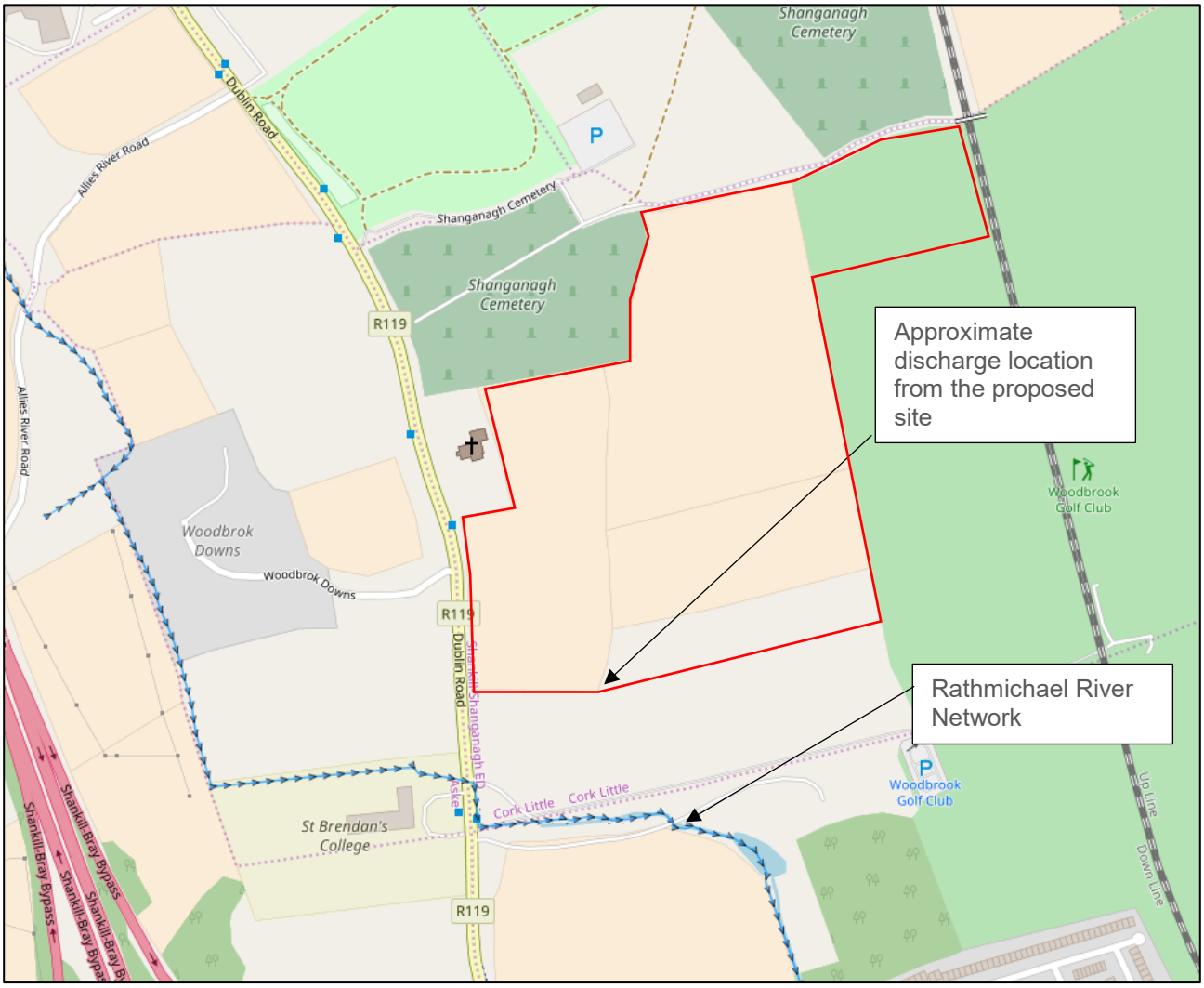


Figure 4 – EPA Mapping

A review of the Woodbrook-Shanganagh Local Area Plan (LAP) 2017-2023 Strategic Flood Risk Assessment (SFRA) was carried out to determine if the onsite field drain / water course is indicated as part the LAP SFRA that was prepared and informed having regard to '*The Planning System and Flood Risk Management Guidelines for Planning Authorities'*. However, the Woodbrook-Shanganagh LAP 2017-2023 SFRA does not indicate any existing water features within the zoned lands of the Site. Refer to Figure 5.

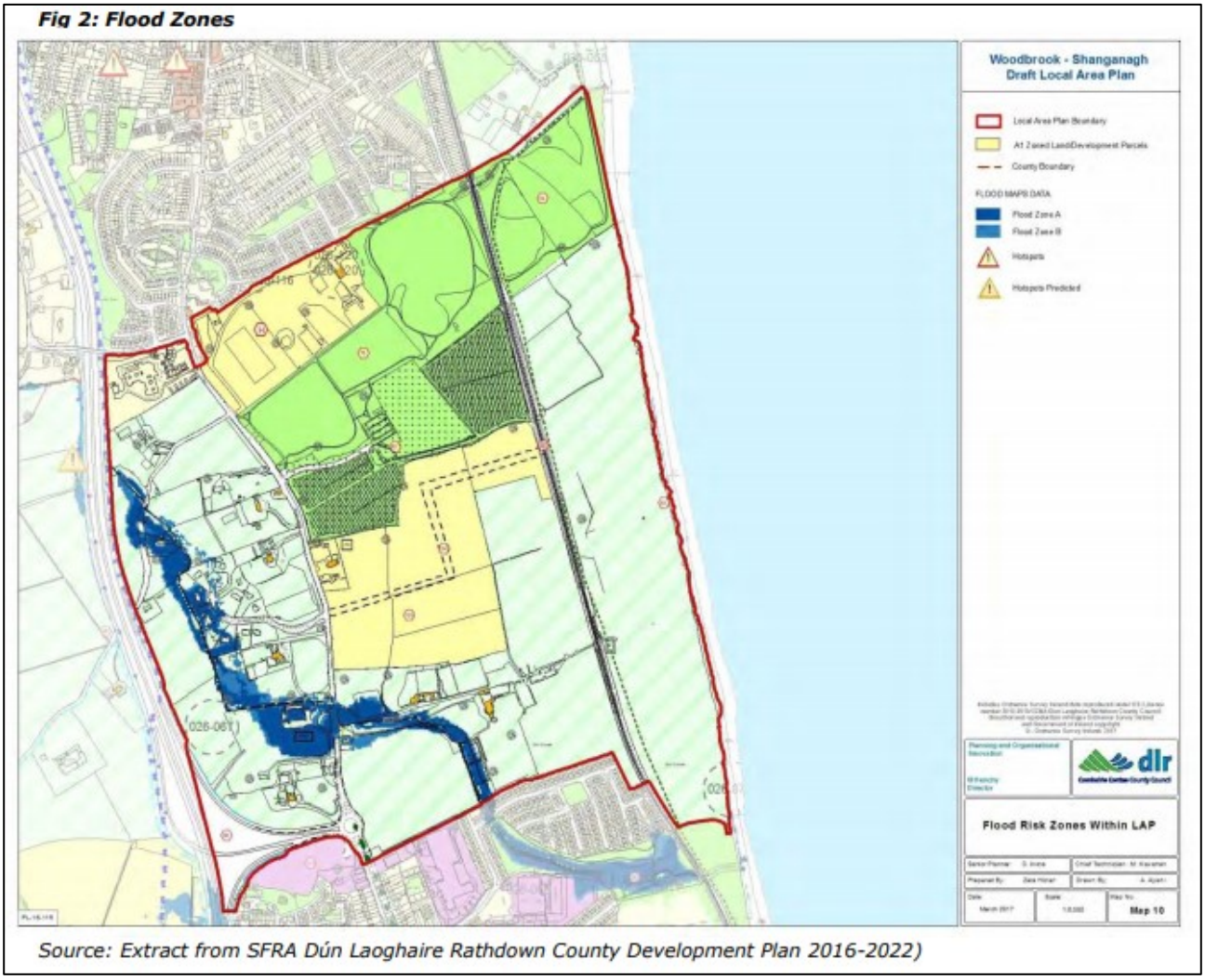


Figure 5 – Woodbrook-Shanganagh LAP 2017-2023: Flood Risk Zones Map

Site Walkover Survey

In order to verify the desk-based review, a Site walkover survey was conducted by an experienced Atkins Hydrogeologist on two separate occasions (26th June 2018 and 18th September). The onsite field drain / water course transecting the Site was visually checked at all accessible locations. No flowing or standing water was encountered during the survey. Based on the geology of the exposed open channel, the orientation of the channel, and existing land use, it is considered that this feature is a manmade field / drainage ditch.

Conclusion

Having reviewed all available desk-based information, including historic mapping and aerial photography, and based on the observations of an experienced Hydrogeologist during a walkover survey of the Site, it is concluded that this drainage feature is a field ditch. Furthermore there is no evidence that this drainage feature was historically a stream or a river.

Response to Query Item No. 2:
Investigation to Determine Groundwater Flow paths in the vicinity of Proposed Attenuation Tanks nos. 4 and 5 in Zone B, and Potential Impacts

(Note; Tanks 4 & 5 are now referred to as Tanks E and G within the final submitted design report)

Groundwater Investigation to Determine Groundwater Flow paths

Groundwater investigation works were undertaken by Ground Investigations Ireland Ltd. (GIIL) between 27th June and 29th June 2018, and are summarised as follows;

- 3no. boreholes were drilled to a target depth using a Dando 2000 drilling rig; each borehole was then converted to a groundwater monitoring well and screened across the shallow groundwater zone (within saturated subsoils generally gravel / sandy gravelly clay).
- All drilling and installation works were supervised full-time by a Hydrogeologist, who also designed each well installation based on encountered Site conditions at each location.
- Wells were positioned in order to obtain representative baseline data, taking account of the topography of the Site (and therefore likely groundwater flow direction), and adjacent land-uses (which may potentially impact groundwater quality beneath the site).
- One offsite borehole (BH1) was located upgradient of the site, while two boreholes (BH2, BH3) were located onsite, in the eastern and southern portions respectively.
- All wells were screened within the shallow groundwater zone (within saturated subsoils i.e. gravel / sandy gravelly clay).
- All onsite drainage ditches were observed to be dry during both Site walkover surveys carried out by Atkins on 26th June and 18th September.
- Baseline groundwater level monitoring was carried out by GIIL between 16th July and 13th September at groundwater monitoring wells BH1 to BH3.

The following key findings arising from the groundwater investigation were made;

- The results of the groundwater level monitoring programme, undertaken by GIIL over a three-month monitoring period, are presented in Table 1. Shallow groundwater levels ranged from 2.18 meters below ground level (mbgl) (BH1) to >5.00m (BH3) during this period.

Monitoring Location	16th July 2018		19th August 2018		13th September 2018	
	Water Level (mbgl)*	Water Level (mOD)**	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)
BH1	2.18	16.77	2.28	16.67	2.36	16.59
BH2	2.37	16.79	3.32	15.84	3.08	16.08
BH3	4.55	11.35	Assumed Dry	-	Assumed Dry	-

**mbgl denotes meters below ground level, ** mOD denotes meters above Ordnance Datum*

Table 1 - Measured Groundwater Levels (July 2018 to September 2018).

- Shallow groundwater flow is expected to be a subdued reflection of the topography of the Site (refer to Figure 1). Therefore based on topographic levels shallow groundwater from the western portion of the Site will flow in a south-easterly direction. Shallow groundwater from the eastern portion of the Site will flow in a south-westerly direction.
- This is confirmed by site-specific groundwater level monitoring data which verifies that groundwater flow beneath the Site is towards the field ditch. Refer to Figure 6.
- Locally shallow groundwater is likely to discharge to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the Site.

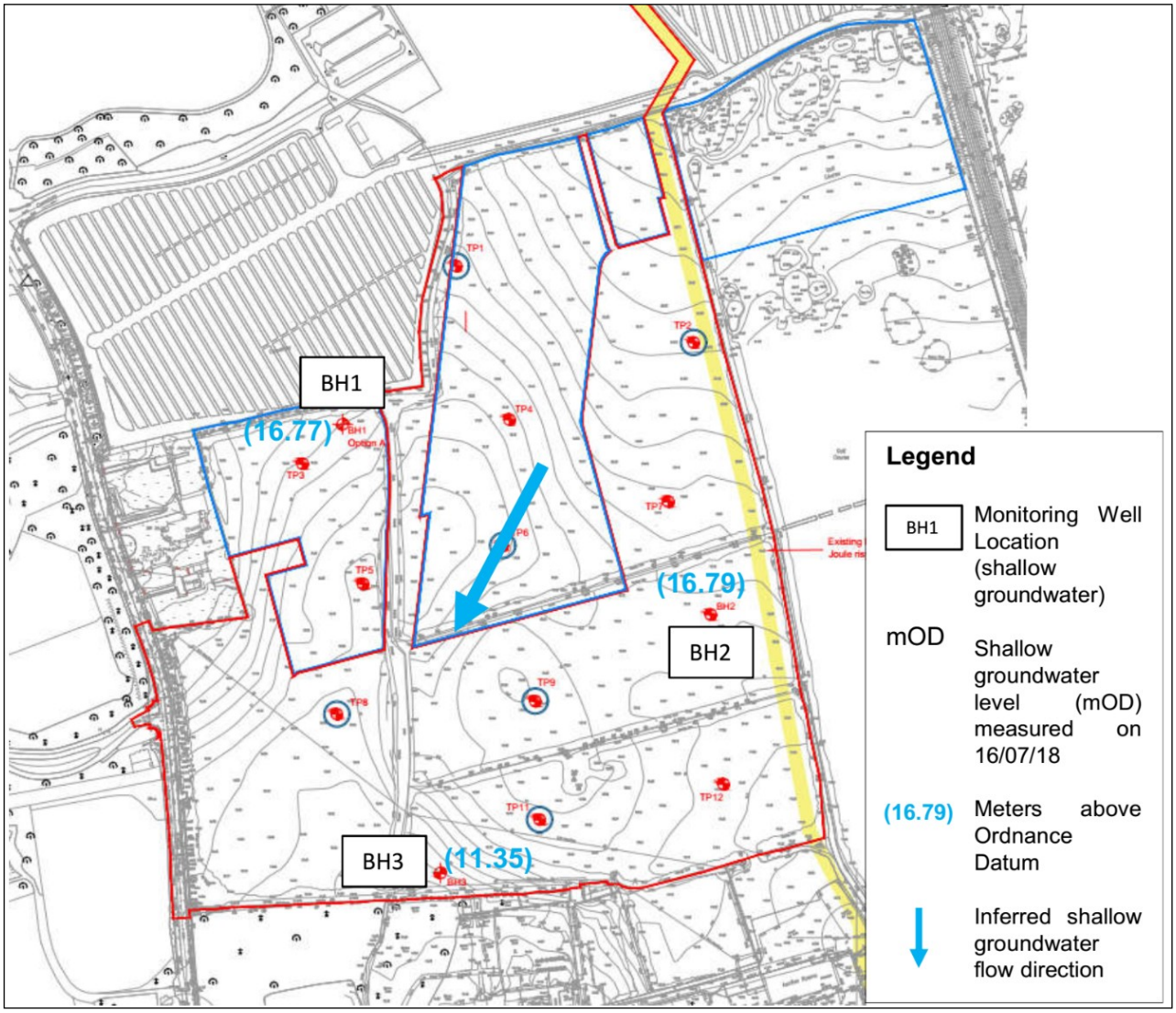


Figure 6 - Piezometric Map Showing Shallow Groundwater Monitoring Locations and Inferred Shallow Groundwater Flow Direction. *(Note shallow groundwater flow confirmed to follow topography as presented in Figure 1).*

Current Hydrogeological Conceptual Site Model – Zone B

Based on the findings of the Groundwater Investigation the following Hydrogeological Conceptual Site Model (CSM) has been derived for the Site;

- Existing rainfall recharge occurs across the greenfield site;
- Recharge is partitioned between overland flow (which discharges to the field ditch north of Zone B), and discharge to ground (via. layers and lenses of sand and gravel, encountered beneath the site). The field ditch north of Zone B also discharges to ground in the vicinity of Zone B, as observed during a number of Site walkover surveys carried out by Atkins Engineers
- Based on groundwater piezometry mapping, shallow water levels specifically in the vicinity of Zone B are estimated to range from approximately 2.0 to 3.5m below ground level (mbgl).
- Shallow groundwater flow will likely follow the topographic contours of the site, towards the field ditch in Zone B; albeit based on site specific data, as evidenced in Figure 7 (a) and (b), this ditch is not groundwater fed. Shallow groundwater flows beneath the ditch, and follows the topography of the site. Shallow groundwater from the western portion of the Site flows in

a south-easterly direction, and from the eastern portion of the Site flows in a south-westerly direction.

- Locally shallow groundwater discharges to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the Site.

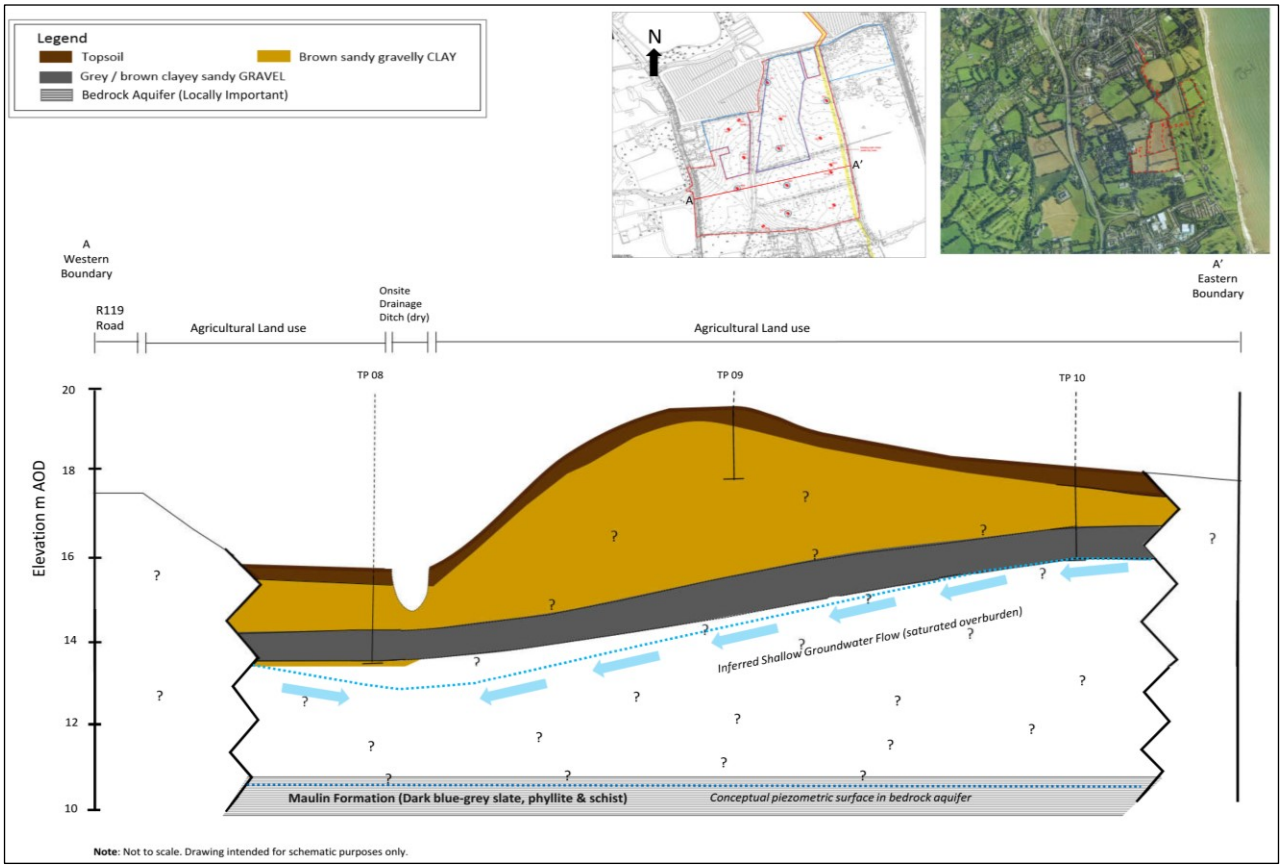
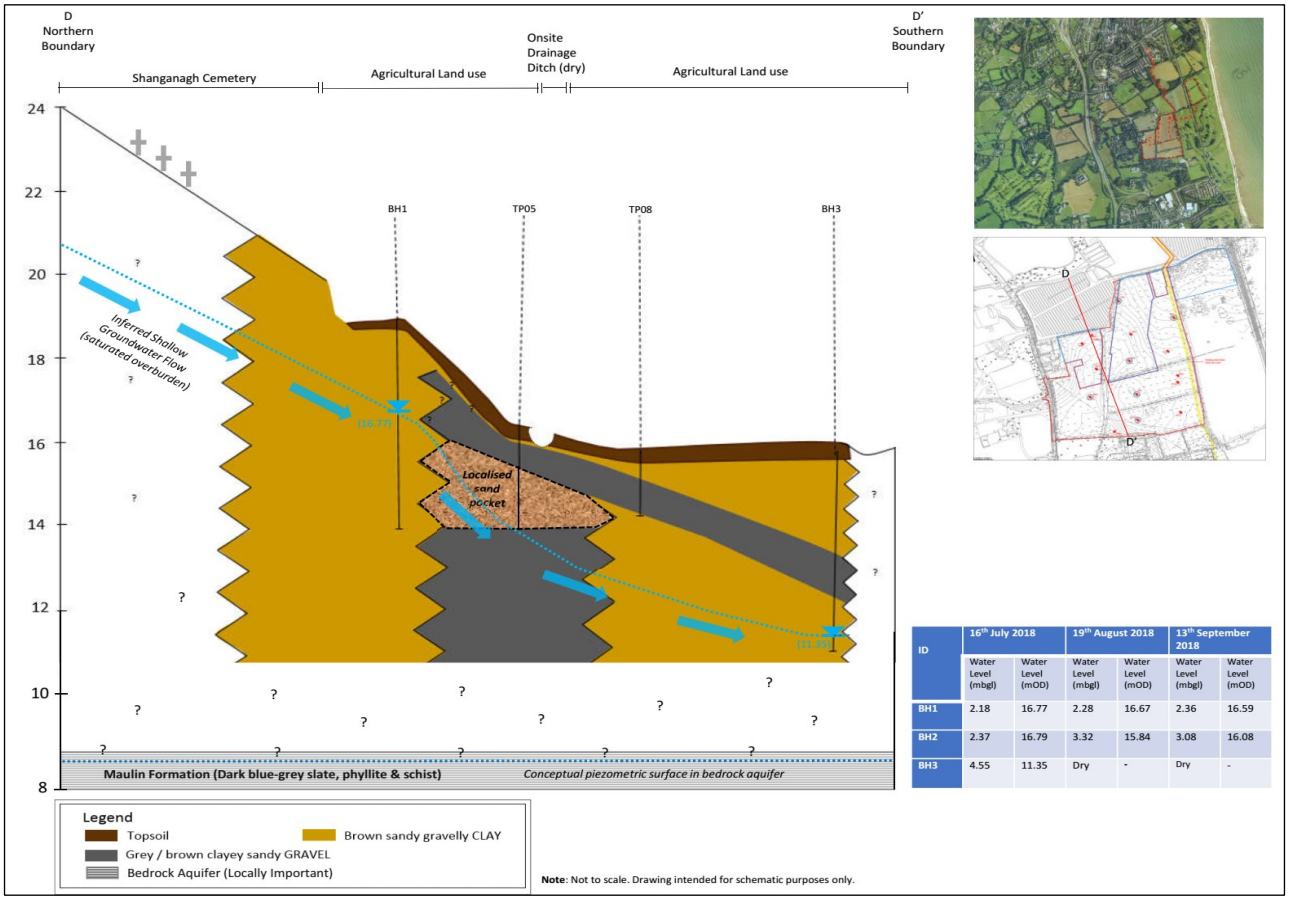


Figure 7 (a) - Site-Specific Geological Cross Sections (A-A') Showing Shallow Groundwater Flow Regime



ID	16th July 2018		19th August 2018		13th September 2018	
	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)	Water Level (mbgl)	Water Level (mOD)
BH1	2.18	16.77	2.28	16.67	2.36	16.59
BH2	2.37	16.79	3.32	15.84	3.08	16.08
BH3	4.55	11.35	Dry	-	Dry	-

Figure 7 (b) - Site-Specific Geological Cross Sections (D-D') Showing Shallow Groundwater Flow Regime

In summary, any storm water drainage captured by the field ditch likely discharges to ground in the vicinity of Zone B, via. layers and lenses of sand and gravel in this area. From here, subsurface groundwater flow paths follow topography and are likely to ultimately discharge to the Rathmichael River (also referred to as the Crinkeen / Woodbrook Stream) further south of the site.

Potential Impacts of Proposed Attenuation Tanks nos. 4 and 5 in Zone B

The location of proposed attenuation tanks E and G (4 and 5) are presented in Figure 8. The installation of the proposed attenuation tanks in Zone B will not have any impact on the existing field ditch or groundwater flow paths based on the following facts: -

- The field ditch is not groundwater fed, as shown in site-specific geological cross sections through Zone B;
- There is no surface water flow in the field ditch downstream of this zone;
- Shallow water levels in this zone are estimated to range from approximately 2.0 to 3.5mbgl;
- The maximum depth of the tanks will not exceed 3m;
- Shallow groundwater flow follows topography across the site; flow paths occur within the saturated overburden comprising gravel and sandy gravelly clay. Groundwater flow across the Site is controlled by hydrostatic head, from areas of high to lower groundwater levels, as clearly shown in Figure 7 (a) and (b). The proposed development will not result in any significant change to the existing topography.
- The tanks have been designed to ensure that they are weighed down where required by increasing the volume of stone below the tank to counteract the hydrostatic head pressure as per design guidelines of the tank supplier. Shallow groundwater will continue to flow, following topography, around and beneath the proposed tanks in this localised area.

Therefore the installation of the proposed attenuation tanks will not have any perceptible impact on existing groundwater flow paths.

- During the construction phase, dewatering maybe required to facilitate the installation of the attenuation tanks (with a maximum excavation depth of approximately 3m). However, any dewatering will be localised and temporary and will not result in any permanent impacts to the existing groundwater flow regime or regional groundwater resource.

Similarly the installation of the proposed attenuation tanks downstream of Zone B, where the dry portions of the field ditch will be infilled as part of the proposed drainage design, will not have any perceptible impact on surface water flows, or groundwater flow paths, based on the above principles. Therefore, based on the hydrogeological conceptual understanding, and the drainage design for the proposed development, there will be no perceptible impacts on local or regional surface water levels, surface water flows, groundwater levels or groundwater flows.

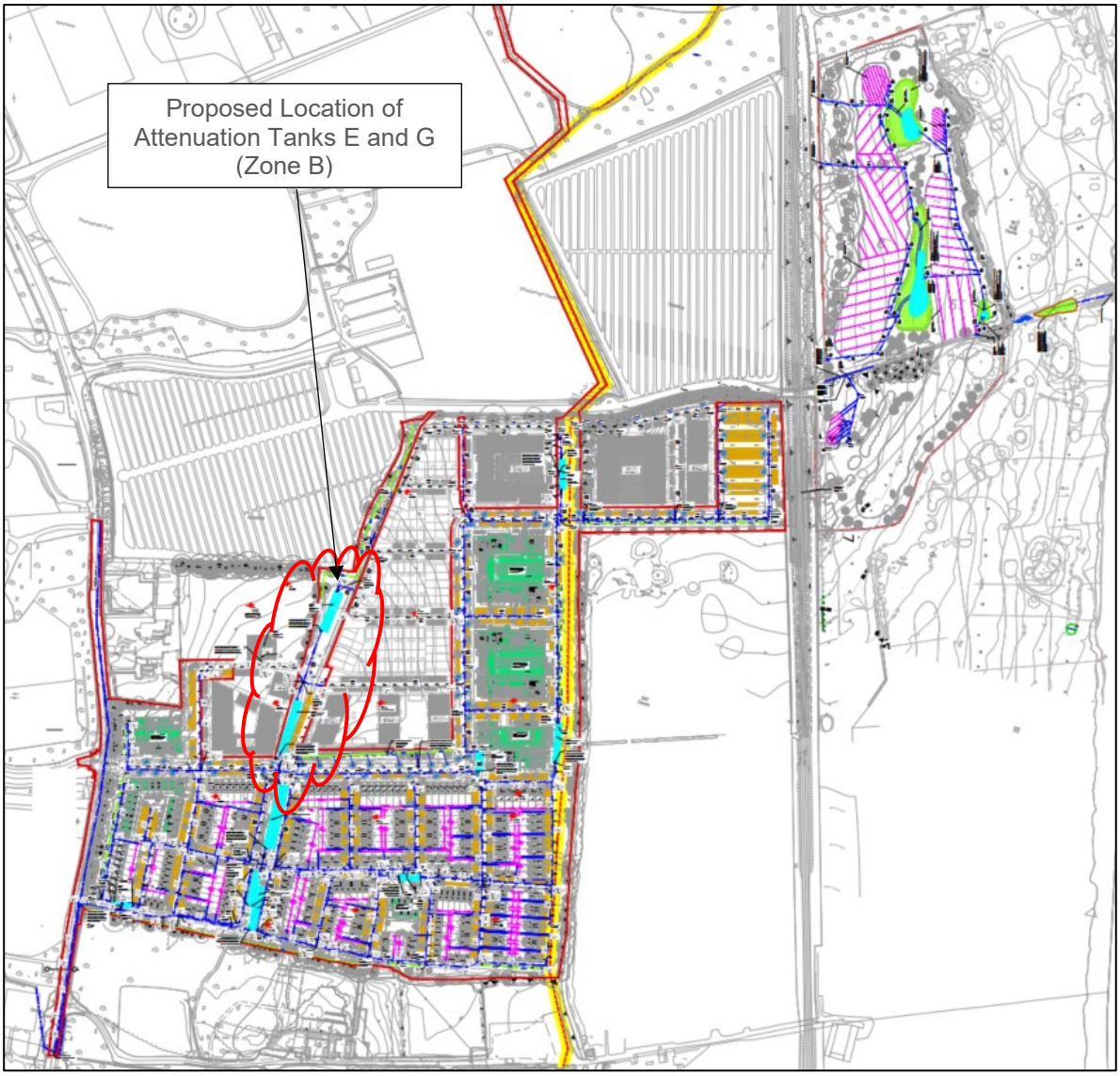


Figure 8 – Proposed Drainage Design and Development Layout

Conclusion

A detailed hydrogeological assessment has been undertaken as requested by DLRCC. This assessment has established shallow groundwater flow paths near the proposed school site, where standing storm water discharges to ground within the field ditch. The proximity and possible flow

interaction of proposed attenuation tanks E and G with the field ditch have been fully evaluated. Based on site-specific geological and hydrogeological data, there will be no perceptible impacts on surface water levels, surface water flows, groundwater levels or groundwater flows, specifically in the vicinity of proposed attenuation tanks E and G in Zone B. Furthermore, no such impacts will occur on a local or regional scale associated with the proposed drainage design. Accordingly, potential impacts to the onsite field ditch or groundwater flow paths do not warrant further consideration.

Appendix I. Surface Cover Type

Surface Cover type	Area m^2
Wetland or open water (semi-natural; not chlorinated) maintained or established on site.	n/a
Semi natural vegetation (e.g. hedgerows, trees, woodland, species-rich grassland) maintained or established on site.	n/a
Reuse of existing soils and seed source to develop vegetation cover	TBC at Detail Design
Standard tree planted in connected tree pits with a minimum soil volume equivalent to at least two thirds of the projected canopy area of the mature tree.	n/a
Standard trees planted in pits with soil volumes less than two thirds of the projected canopy area of the mature tree.	refer to landscape architect pack for further details
Intensive green roof or vegetation over structure. Substrate minimum settled depth of 150mm.	2,439m2
Non intensive Brown Roof (Biodiversity Roof). Substrate minimum settled depth of 150mm. Design will be site specific and developed by a suitably qualified ecologist.	n/a
Extensive green roof with substrate of minimum settled depth of 80mm (or 60mm beneath vegetation blanket)	n/a
Extensive green roof of sedum mat or other lightweight system.	5,185m2
Green wall – Modular system or climbers rooted in soil.	n/a
Rain gardens and other vegetated sustainable drainage elements.	198m2
Flower-rich perennial planting.	Refer to landscape
Hedges (line of mature shrubs one or two shrubs wide).	Refer to landscape
Hedgerows or double hedgerow of native species (may have an associated ditch and bank)	n/a
Groundcover planting.	Refer to landscape
Amenity grassland entire area or sections managed for lesser mowing frequencies for pollinators (e.g. six week meadow)	Refer to landscape
Amenity grassland (species-poor, regularly mown lawn).	Refer to landscape
Water features (chlorinated) or unplanted detention basins.	n/a
Permeable paving.	1,910m2
Sealed surface (e.g. concrete, asphalt, waterproofing, stone)	3,083m2

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